FCC Test Report

FOR:

iRhythm Technologies

Model Name / Model #: ZIO SR / K101A5001

Product Description: ZIO SR ECG Patch

FCC ID: 2AFBP-SR15P

47 CFR Part 15.247 (DTS)

TEST REPORT #: EMC_IRHYT-002-15001_15.247_BTLE-Rev1
DATE: 2015-Oct-09

FCC listed
A2LA Accredited

IC recognized #
3462B

***CETECOM* Inc.**
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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 of the Code of Federal Regulations and no deviations were ascertained during the course of the tests performed.

Company	Description	Model #
iRhythm Technologies	ZIO SR ECG Patch	K101A5001

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2015-10-09	Compliance	Franz Engert Manager Compliance Services	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
2015-10-09	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: 2015.10.09 19:13:43 -07'00'

The test results of this test report relate exclusively to the test item specified in Section3.
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2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Address:	411 Dixon Landing Road Milpitas, CA 95035 U.S.A.
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Compliance Manager:	Franz Engert
Responsible Project Leader:	James Donnellan

2.2 Identification of the Client

Applicant's Name:	iRhythm Technologies
Street Address:	650 Townsend St., Ste 380
City/Zip Code	San Francisco, CA 94103
Country	USA
Contact Person:	Matt Ho
Phone No.	415-632-5714
Fax:	415-632-5701
e-mail:	mho@irhythmtech.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 Specification of the Equipment under Test

Model Name / Model No:	ZIO SR / K101A5001
HW / SW Revision :	1 / CC2541_SmartRF_Host
FCC-ID:	2AFBP-SR15P
Product Description:	ZIO SR ECG Patch
Technology / Type(s) of Modulation:	Bluetooth v4.0, LE with GFSK Modulation
Operating Frequency Ranges (MHz) / Channels:	Nominal band: 2400 – 2483.5; Center to center: 2402(ch 0) – 2480(ch 39), 40 channels
Antenna gain measured:	Radiated EIRP 0.01dBm according to CTIA Report (RP_2440.000_tot)_unit_vertical and conducted power -2.02dBm results in measured gain of ~2.0 dBi .
Declared Max. Output Power:	Conducted: -1.72dBm
Rated Operating Voltage Range / Power Supply:	Li-ion Battery Vmin: 2.75V dc/ Vnom: 3.0V dc / Vmax: 3.2V dc
Rated Operating Temperature Range:	0 ºC to 45 ºC
Other Radios included in the device:	N/A
EUT status	Prototype

3.2 Identification of the Equipment under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	#4	1.0	CC2541_SmartRF_Host	Radiated RF Sample
2	#36	1.0	CC2541_SmartRF_Host	Conducted RF Sample

3.3 Identification of Accessory equipment

STE #	Type	Manufacturer	Model	Serial Number
1	XT Patch Assembly	iRhythm	-	-
2	3V Battery	Panasonic	CR 2032	-

3.4 Identification of Ancillary equipment:

STE #	Type	Manufacturer	Model	Serial Number
1	Patch Programming Assembly	iRhythm	-	-
2	Laptop	Dell	Latitude E6430s	966X7W1

3.5 Environmental conditions during Test:

The following environmental conditions were maintained during the course of testing:
Ambient Temperature: 20-25^{o}C Relative humidity: 40-60%

3.6 Dates of Testing:

05-26-2015 – 06-03-2015

3.7 Test mode of operation:

Mode	Data rate (Mbps)	Modulation scheme
BTLE	1.0	GFSK

The device was configured with a laptop and manufacturer provided software (TiWi Bluetooth Eval Tool V5.0.0.0) capable of setting the unit in Bluetooth LE mode / GFSK modulation while mounted on the Patch Programming Assembly

For radiated spurious emissions, the EUT was tested on low, mid and high channels (2.4GHz) in Bluetooth LE mode / GFSK.

4 Subject Of Investigation

The objective of the evaluation documented in this report was to assess if the performance of the EUT meets 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: 2AFBP-SR15P.

During the testing process the EUT was tested with transmitter sets on low, mid and high channels. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations.

4.1 Summary of Measurement Results

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§15.247(e)	Power Spectral Density	Nominal	Bluetooth LE	■	☐	☐	☐	Complies
§15.247(a)(1)	Emission Bandwidth	Nominal	Bluetooth LE	■	☐	☐	☐	Complies
§15.247(b)(1)	Maximum Conducted Output Power and EIRP	Nominal	Bluetooth LE	■	☐	☐	☐	Complies
§15.247/15.209/15.205	Band edge & Restricted Band Edge compliance	Nominal	Bluetooth LE	■	☐	☐	☐	Complies
§15.247(d)	Band edge compliance-Unrestricted Band Edges	Nominal	Bluetooth LE	■	☐	☐	☐	Complies
§15.247(d) §15.209	TX Spurious emissions-Radiated	Nominal	Bluetooth LE	■	☐	☐	☐	Complies
§15.207(a)	AC Conducted Emissions	Nominal	Bluetooth LE	☐	☐	■	☐	Note 1

Note: NA= Not Applicable; NP= Not Performed.
Note 1: There is no external AC charging mechanism for this device.

5 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

5.1 Environmental conditions during Test:

The following environmental conditions were maintained during the course of testing:
Ambient Temperature: 20-25°C Relative humidity: 40-60%

5.2 Dates of Testing:

05-26-2015 – 06-03-2015

6 Measurements

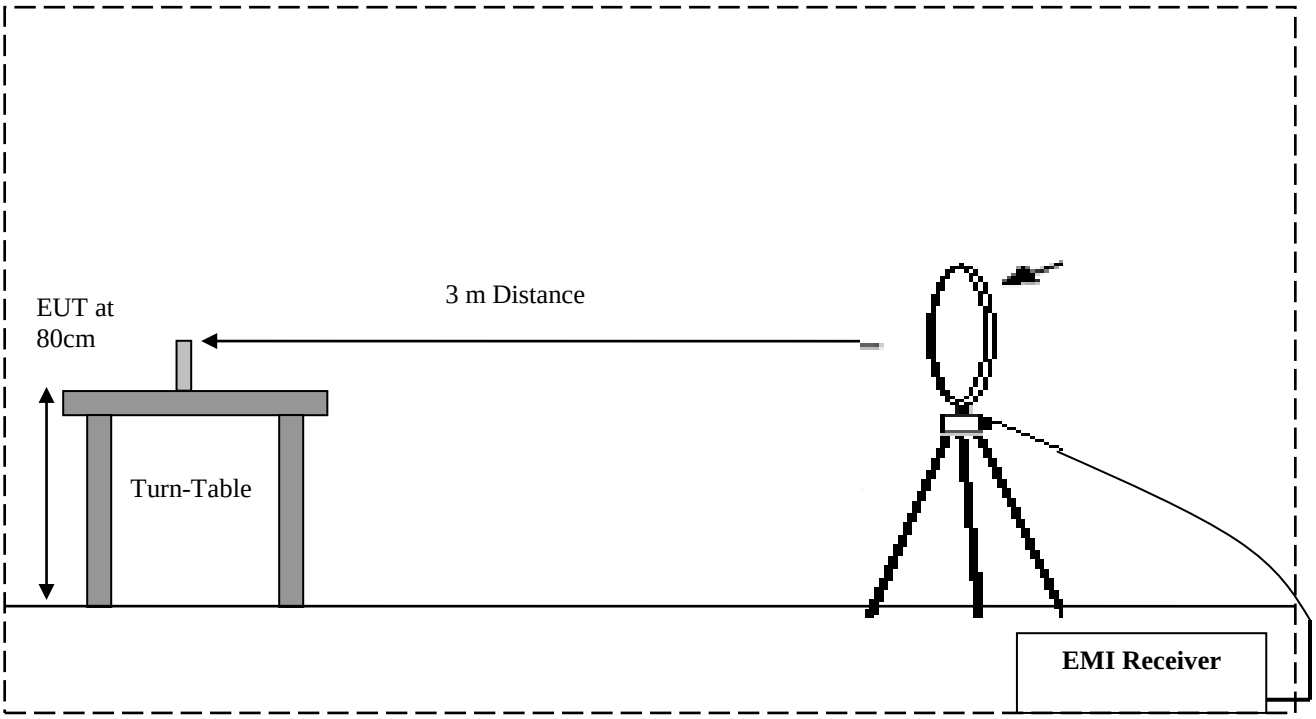
6.1 Radiated Measurement

The radiated measurement is performed according to:

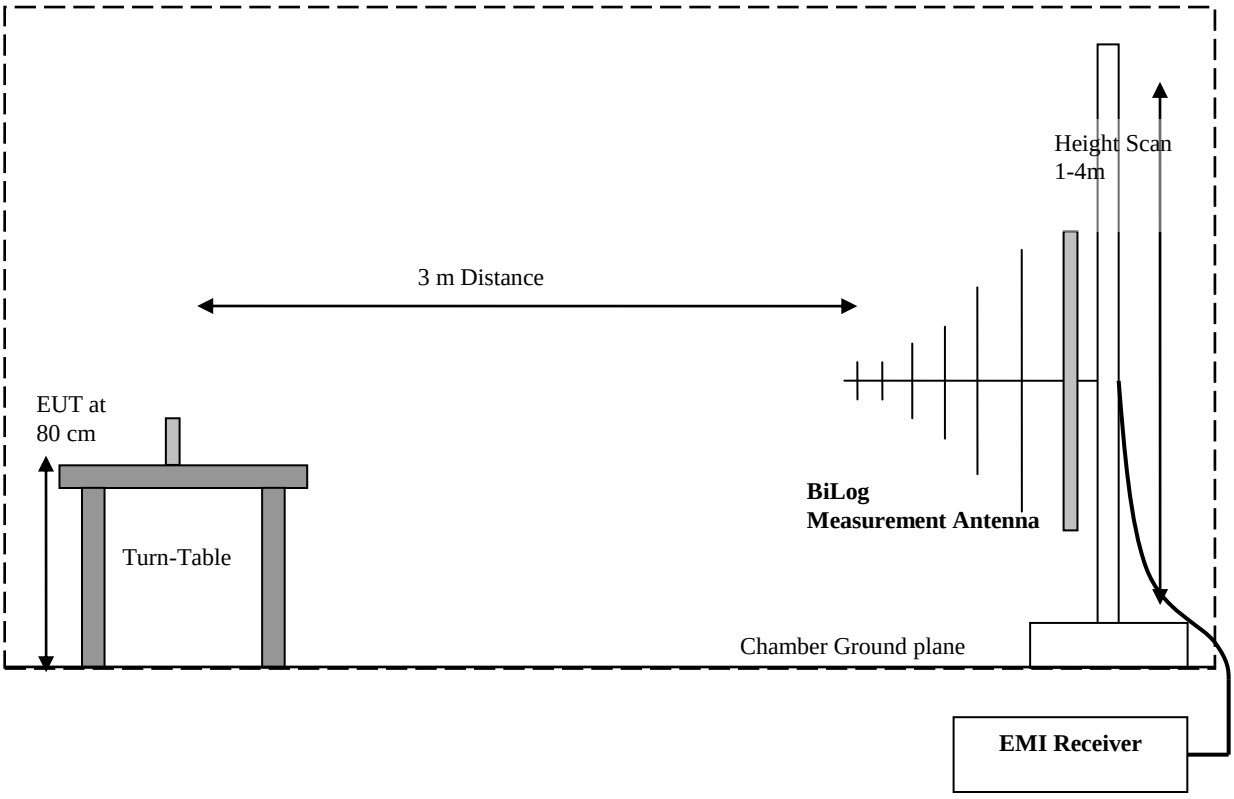
ANSI C63.10 (2013)

- 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.

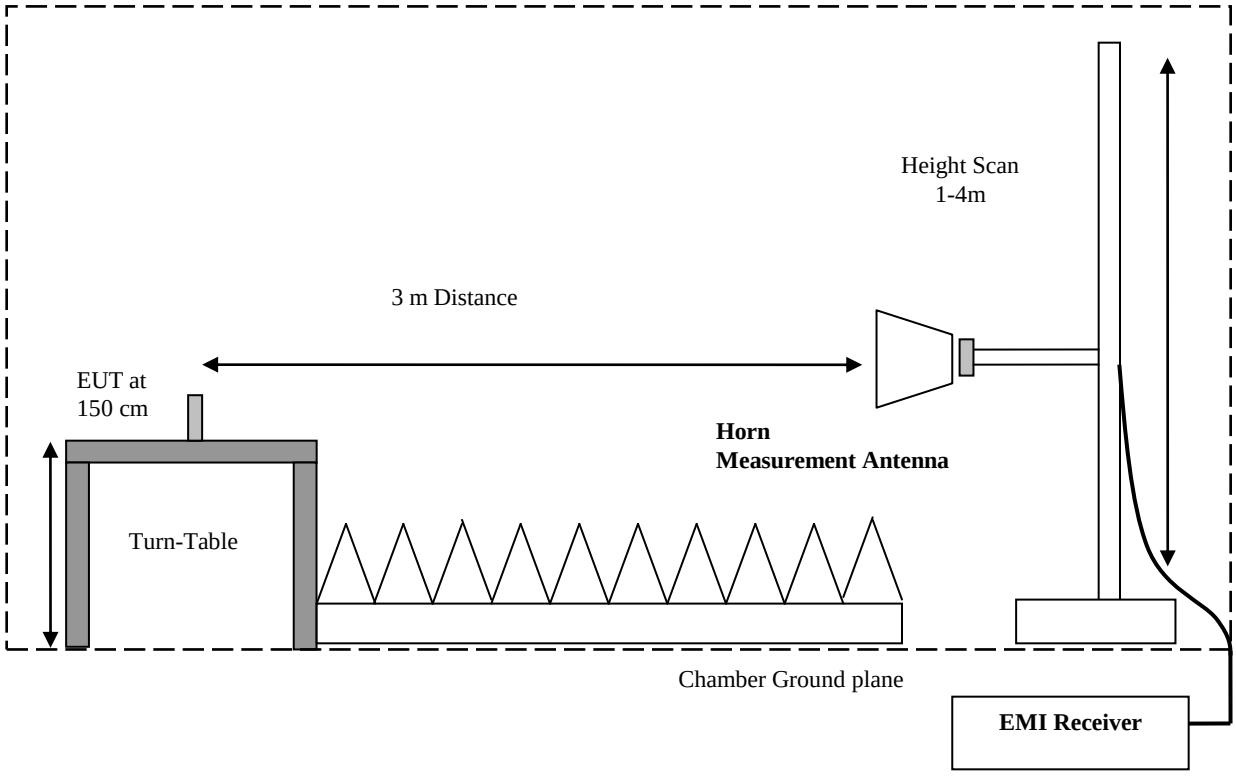
Radiated Emissions Test Setup Below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup Above 1GHz Measurements



6.1.1 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)

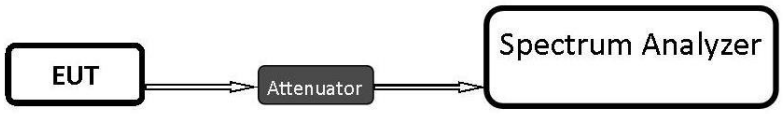
Example:

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

6.2 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: SI C63.10 (2013)

Reference: FCC Public Notice DA 00-705:2000 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).



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

7 Maximum Conducted Output Power and EIRP

7.1 Limits:

Maximum Conducted Output Power:
FCC §15.247 (b)(1): 1W

7.2 Test Conditions:

Tnom: 21.5°C; Vnom: 3.0V

7.3 Test Procedure

Measurement according to FCC KDB 558074 D01 DTS Meas Guidance v03r02 section 9.2.2.4

Maximum conducted (average) output power
Method AVGSA-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction)

Span ≥ 1.5 times the OBW.
RBW = 1-5% of the OBW, not to exceed 1 MHz.
VBW ≥ 3 x RBW
Sweep points ≥ 2 × span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
Sweep time = auto.
Detector = RMS (*i.e.*, power averaging), if available. Otherwise, use sample detector mode.
Trace = average at least 100 traces in power averaging (*i.e.*, RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the on and off periods of the transmitter.
- Do not use sweep triggering. Allow the sweep to "free run".
- Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges..
- Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add 10 log (1/0.62) = 2 dB if the dc is 62 %.

7.4 Test Data

BTLE Mode 802.15 GFSK Average Measurement							
Maximum Conducted Output Power (dBm)							
Limit = 30 dBm		**Frequency (MHz)**					
		2402 Channel 0		**2440 Channel 19**		**2480 Channel 39**	
Cable Attenuation dB	Duty Cycle CF (dB)	Measured	Corrected	Measured	Corrected	Measured	Corrected
1	2	-4.72	-1.72	-5.02	-2.02	-5.85	-2.85

Calculated Radiated Output Power EIRP (dBm)				
Limit = 36 dBm		**Frequency (MHz)**		
Mod	**Antenna Gain (dBi)**	**2402 Channel 0**	**2440 Channel 19**	**2480 Channel 39**
GFSK	2.0	0.28	-0.02	-0.85

Antenna Gain in the 2.4GHz band: 2.0 dBi
DC = Txon / Txon + Txoff = 0.4004 ms / 0.635 ms = 0.629 or 62.9%

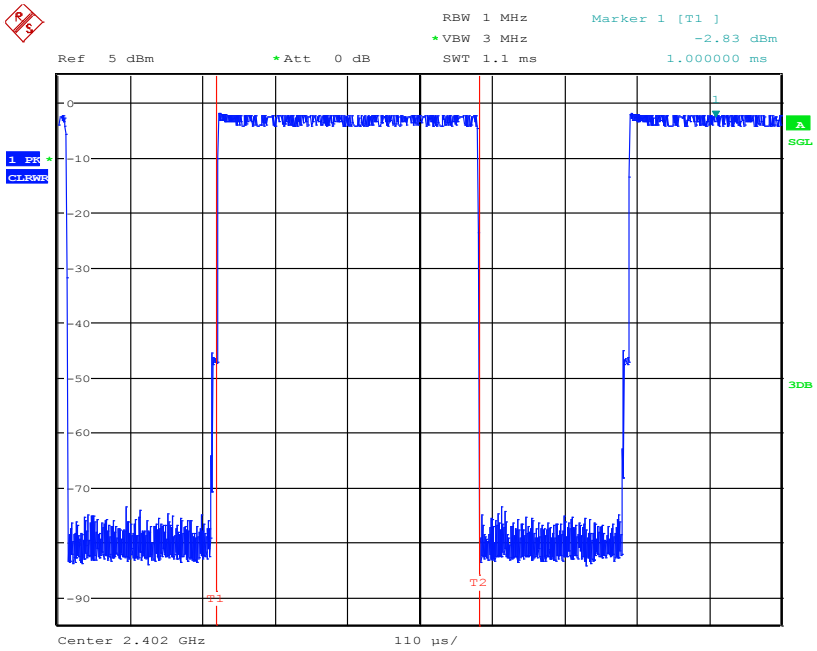
DCCF = 10 log (1/x); x = duty cycle
DCCF = 10 log (1/0.641) = 2.0 dB

7.5 Measurement Result

Pass.

7.6 Measurement Plots:

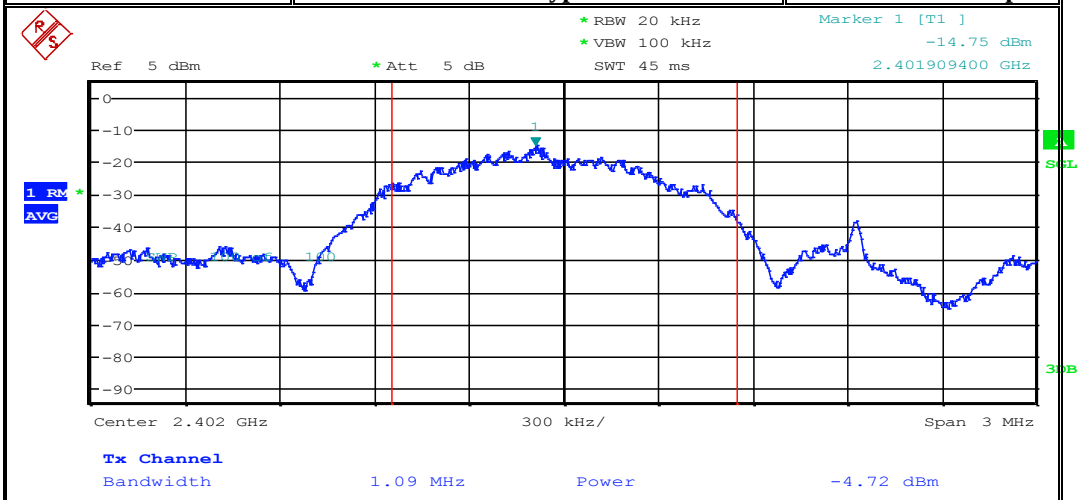
Duty Cycle



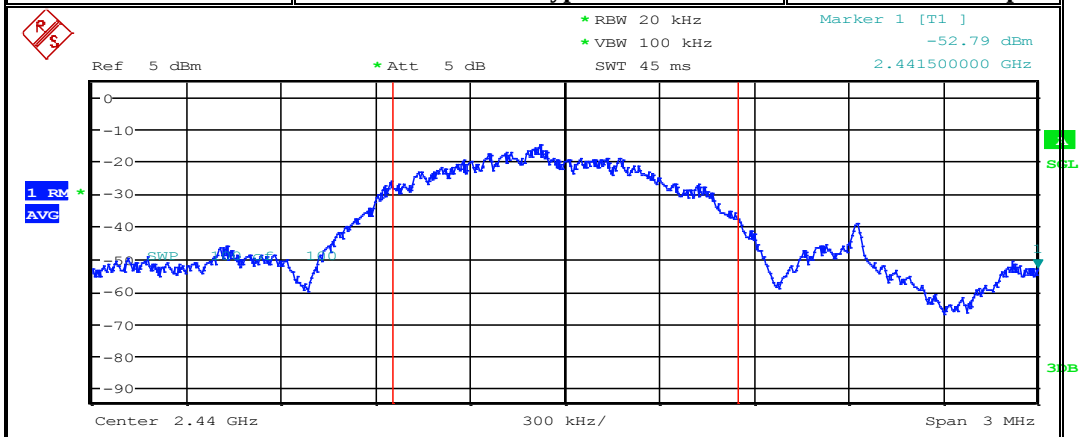
Date: 26.MAY.2015 15:36:32

Maximum Conducted Output Power

Ch.0 / 2402 MHz	Modulation/Packet Type: GFSK	Data Rate: 1 Mbps



Ch.19 / 2440 MHz	Modulation/Packet Type: GFSK	Data Rate: 1 Mbps

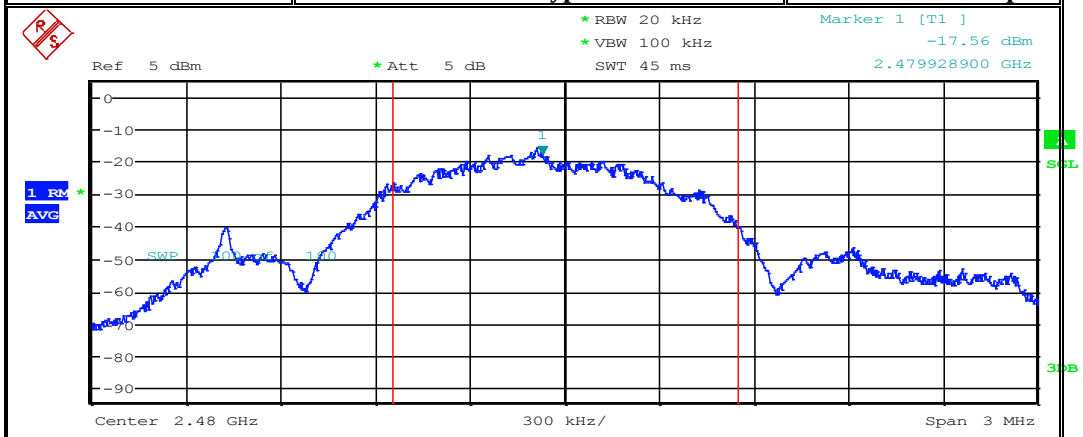


Tx Channel

Bandwidth	1.09 MHz	Power	-5.02 dBm

Date: 27.MAY.2015 15:18:35

Ch.39 / 2480 MHz	Modulation/Packet Type: GFSK	Data Rate: 1 Mbps



8 Power Spectral Density

8.1 Limits:

§ 15.247 (e)

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 Test Conditions:

Tnom: 21°C; Vnom: 3.0V

8.3 Measurement procedure

Measurement according to FCC KDB 558074 D01 V03R02

Maximum power spectral density
Method AVGPSD-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction)
Center Frequency = DTS channel center frequency.
Span ≥ 1.5 times the OBW.
RBW = 3 kHz ≤ RBW ≤ 100 kHz.
VBW ≥ 3 x RBW
Detector = power averaging (RMS) or sample detector (when RMS not available)
Sweep time = auto couple
Trace = averaging (RMS) mode over a minimum of 100 traces
- Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW.
- Do not use sweep triggering. Allow sweep to "free run".
- Use the peak marker function to determine the maximum amplitude level.
- Add 10 log (1/x), where x is the duty cycle measured in step (a, to the measured PSD to compute the average PSD during the actual transmission time.
- If resultant value exceeds the limit, then reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

8.4 Test Data:

Maximum Power Spectral Density (dBm)							
Limit = 8 dBm / 3KHz		Frequency (MHz)					
		2402 Channel 0		2440 Channel 19		2480 Channel 39	
Cable Att in dB	Duty Cycle CF	Measured	Corrected	Measured	Corrected	Measured	Corrected
1	2	-19.94	-16.94	-20.66	-17.66	-20.62	-17.62

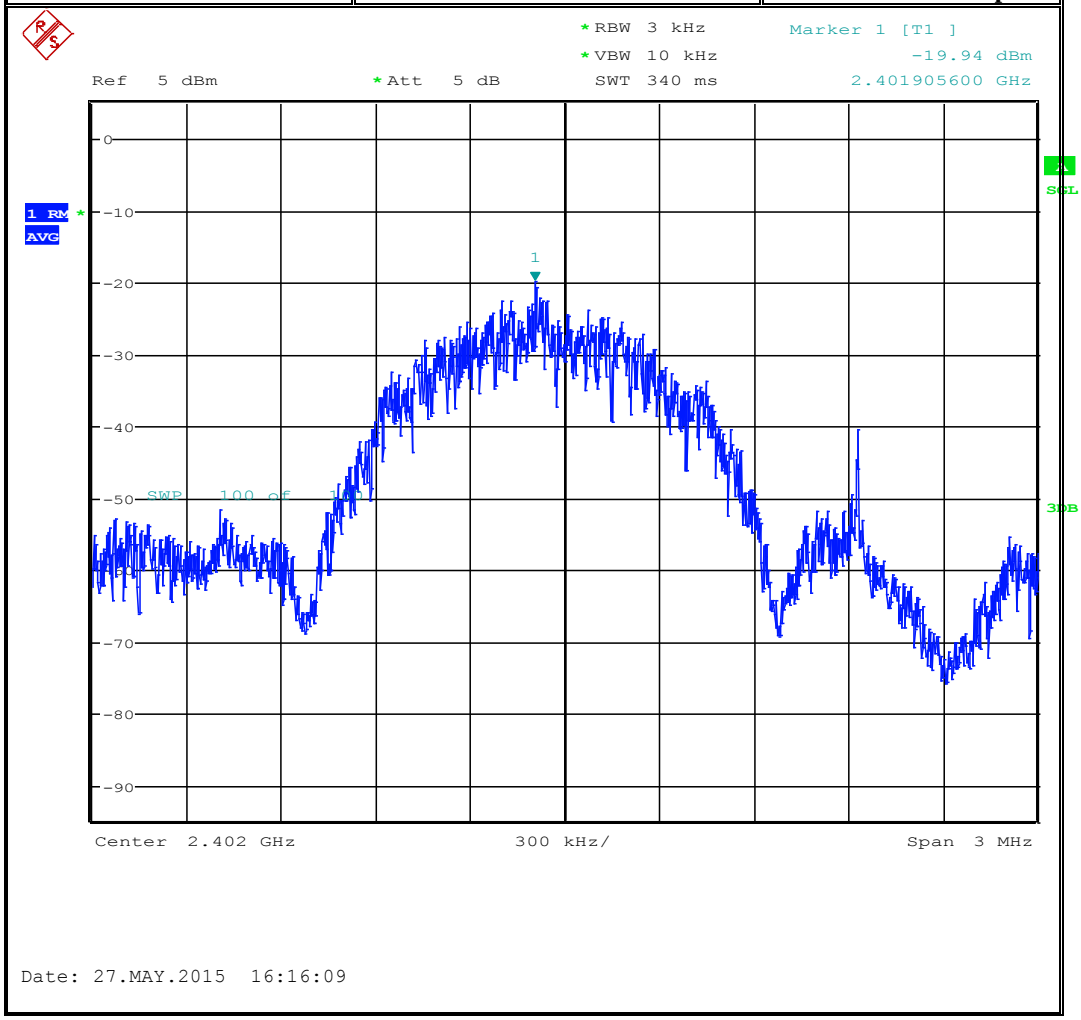
8.5 Measurement Result:

Pass.

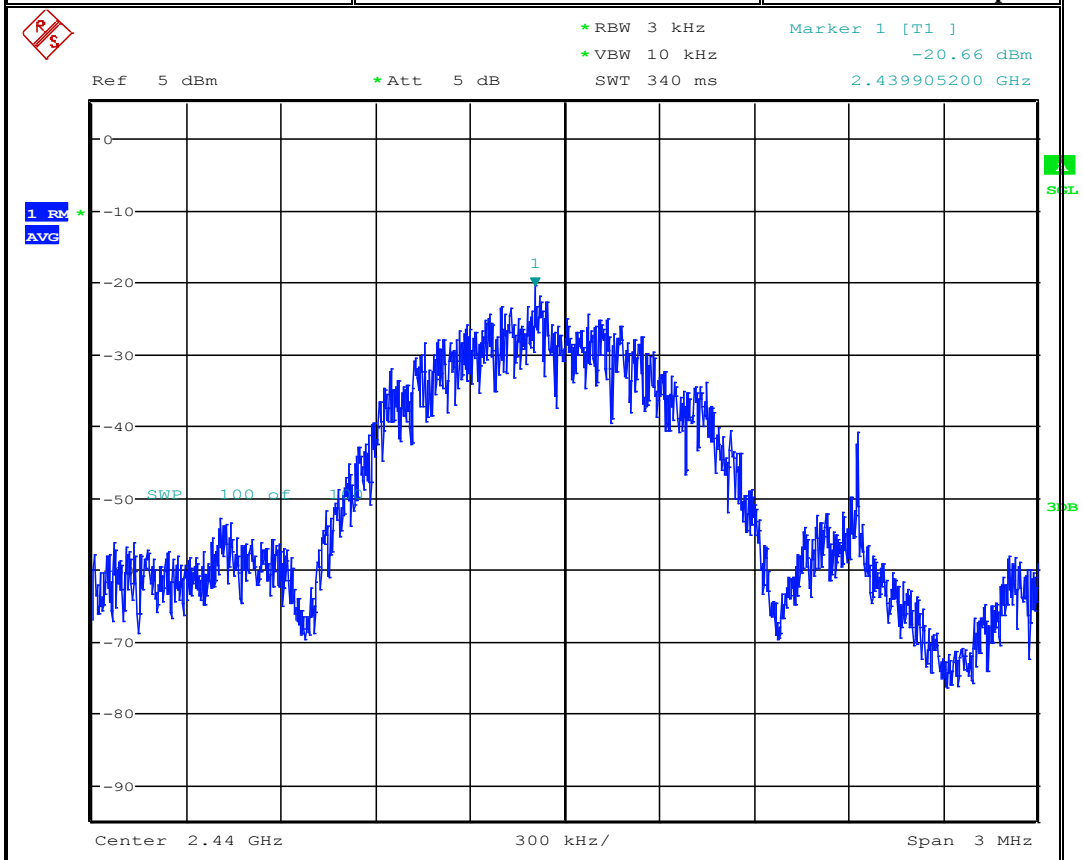
8.6 Measurement Plots:

Maximum Power Spectral Density

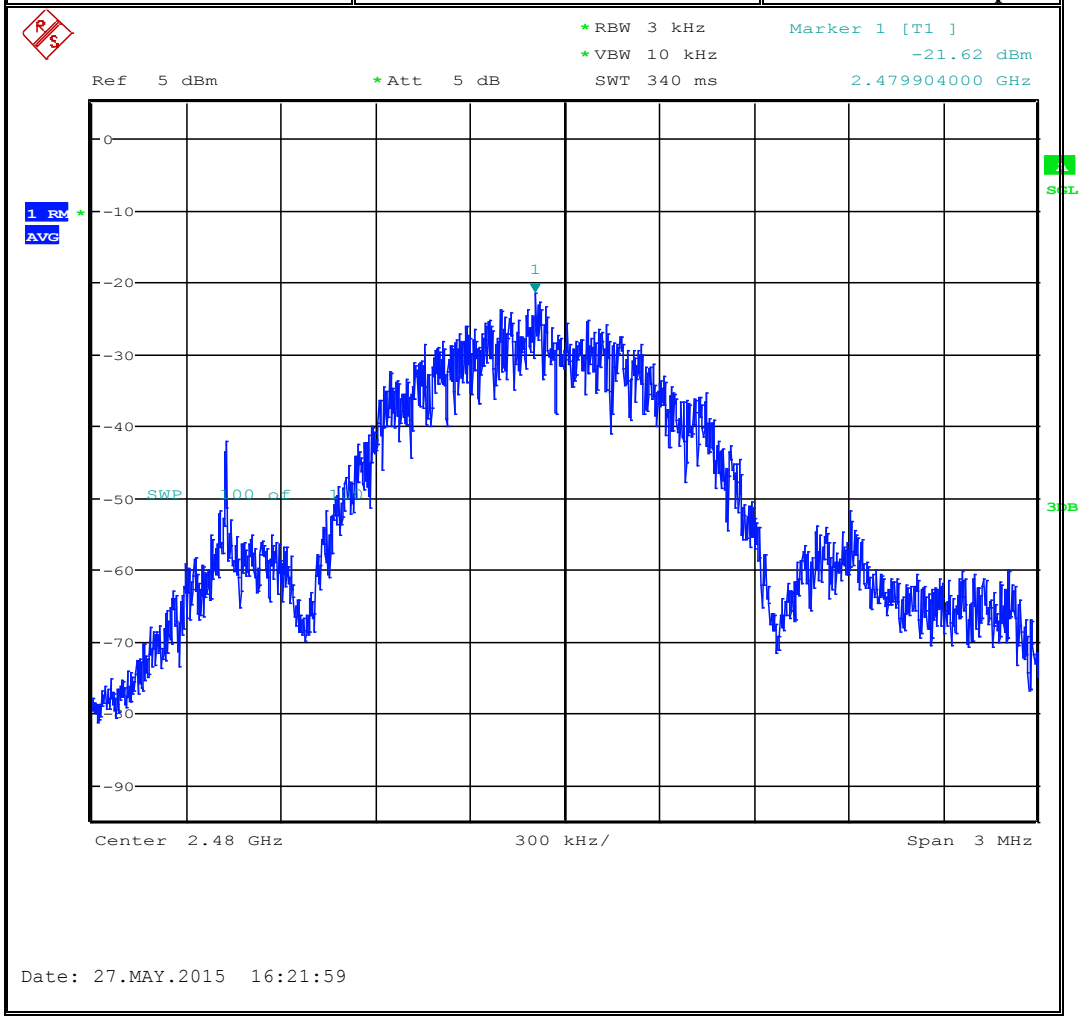
Ch.0 / 2402 MHz	Modulation: GFSK	Data Rate: 1 Mbps



Ch.19 / 2440 MHz	Modulation: GFSK	Data Rate: 1 Mbps



Ch.39 / 2480 MHz	Modulation: GFSK	Data Rate: 1 Mbps



9 Band Edge Compliance – at restricted and non-restricted band edges

9.1 Limits:

§15.209/15.205

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.

9.2 Test Conditions:

Tnom: 22°C; Vnom: 3.0V

9.3 Measurement Procedure:

Measurement according to FCC KDB 558074 D01 v03r02 section 11/12

For non-Restricted Band Edge measurement

11.2 Reference level measurement

Establish a reference level by using the following procedure:
Center frequency = band edge
Span ≥ 1.5 times the *DTS bandwidth* or encompass frequency range to be measured.
RBW = 100 kHz
VBW ≥ 3 x 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 PSD level.
- Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

11.3 Emission level measurement

Establish a reference level by using the following procedure:
Center frequency = band edge
Span ≥ 1.5 times the *DTS bandwidth* or encompass frequency range to be measured.
RBW = 100 kHz
VBW ≥ 3 x 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 PSD level.
- Ensure that the band edge and the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power and at least 30 dB if measurement based on the use of RMS averaging.

For Restricted Bands measurement

*PEAK LIMIT= 74dBµV/m @ 3m (-21.2 dBm)
*AVG. LIMIT = 54dBµV/m @ 3m (-41.2 dBm)

12.2.4 Peak power measurement procedure

Peak emission levels are measured by setting the instrument as follows:
Start frequency = the beginning of the restricted band
Stop frequency = the end of the restricted band
RBW = 1 MHz
VBW ≥ 3 x RBW
Detector = Peak.
Sweep time = auto.
Trace mode = max hold.
- Allow sweeps to continue until the trace stabilizes.
- Use the peak marker function to determine the maximum amplitude level.
- Add the specified antenna gain to the peak readings.
- Compare to the peak limit (-21.2 dBm) specified above.

12.2.5.2 Average power measurement procedure

Repeat the measurement in average by setting the instrument as follows:
Start frequency = the beginning of the restricted band
Stop frequency = the end of the restricted band
RBW =1 MHz
VBW ≥ 3 x RBW
Detector = power averaging (RMS) or sample detector (when RMS not available)
Sweep time = auto couple
Trace = averaging (RMS) mode over a minimum of 100 traces
- Use the peak marker function to determine the maximum amplitude level.
- Add the duty cycle correction factor and the specified antenna gain to the maximum readings.
- Compare to the average limit (-41.2 dBm) specified above.

9.4 Measurement Result

Pass.

9.5 Test Data summary:

Mode: Bluetooth LE
Modulation: GFSK
Data Rate: 1 Mbps
Test Channel: 0

Recorded Frequency (MHz)	Emission Lvl Peak/Average (dBm)	Cable Loss/ ext. attenuator (dB)	Duty Cycle C F (dB)	Antenna Gain (dBi)	Calculated Emission Level (dBm)	Limit Peak/Average (dBm)	Margin (dB)
Lower Restricted Band / Frequency Range: 2310 MHz – 2390 MHz							
2369.7	-55.95 Pk	Compensated in offset function	n.a.	2	-52.95	-21.2	31.75
2370.0	-67.51 Av	Compensated in offset function	2	2	-62.51	-41.2	21.31
Upper Restricted Band / Frequency Range: 2483.5 MHz – 2500 MHz							
2483.5	-42.58 Pk	Compensated in offset function	n.a.	2	-39.58	-21.2	18.38
2483.6	-57.97Av	Compensated in offset function	2	2	-52.97	-41.2	11.77

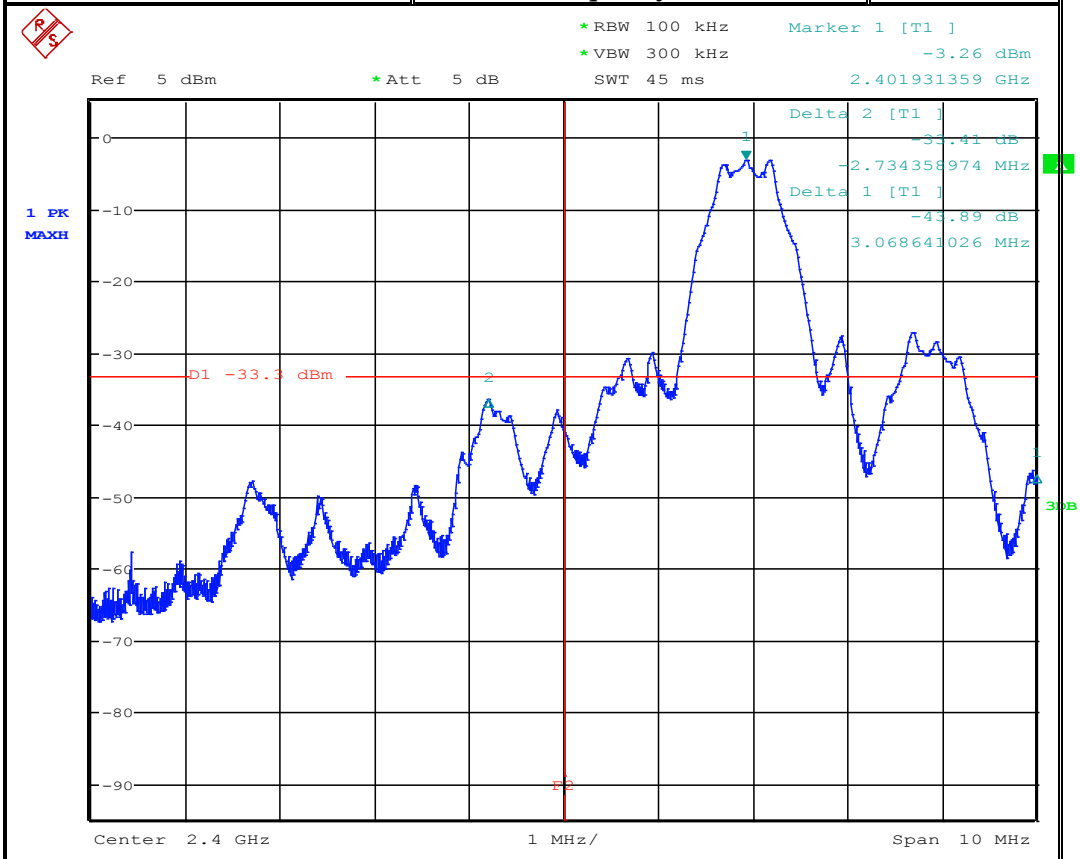
Un-Restricted Band Edge

Band Edge	Recorded Frequency (MHz)	Delta between highest peak of signal to highest peak below band-edge	Limit (dBc)	Margin (dB)
Lower	2399.2	33.41	30	3.41
Upper	2485.1	46.57	30	16.57

9.6 Measurement Plots:

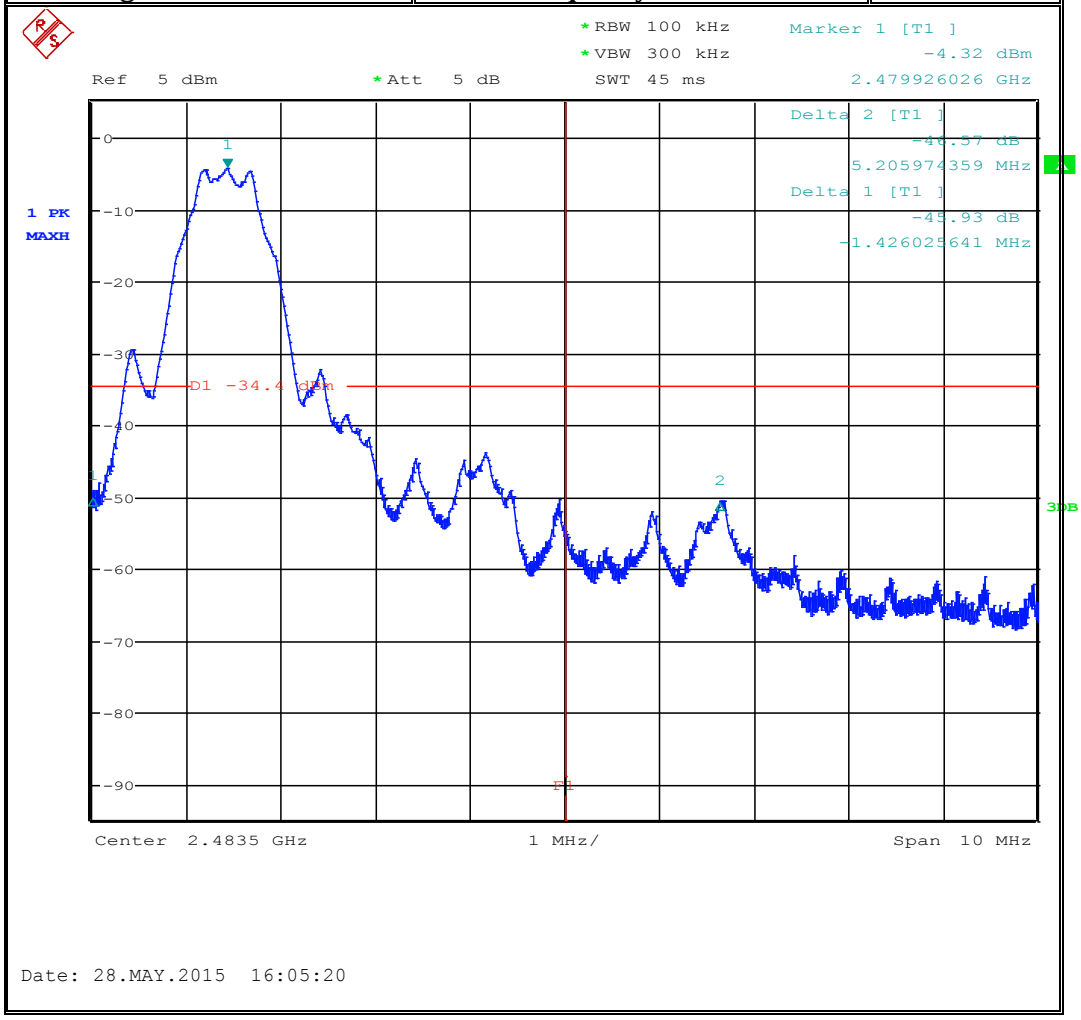
Lower non-restricted Band Edge

Ch. Low / 2402MHz / Peak	BE Frequency: 2.4 GHz	GFSK



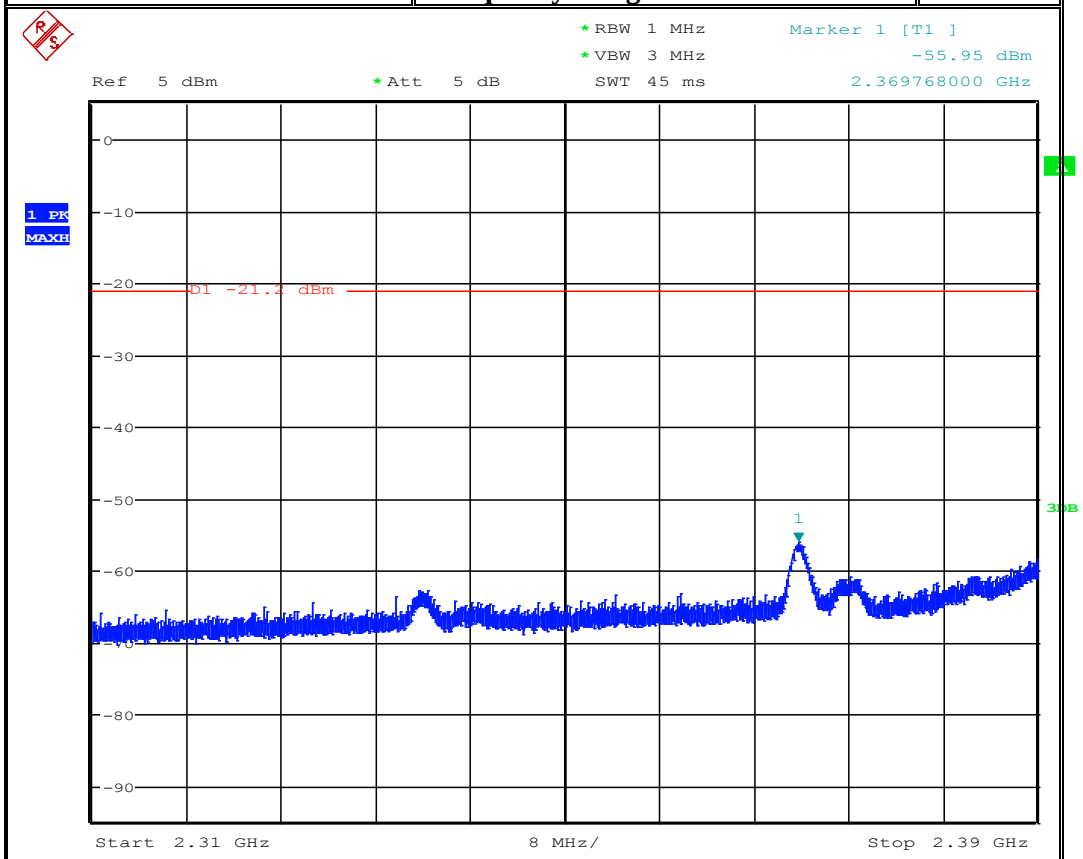
Upper non-restricted Band Edge

Ch. High / 2480 MHz / Peak	BE Frequency: 2.4835 GHz	GFSK



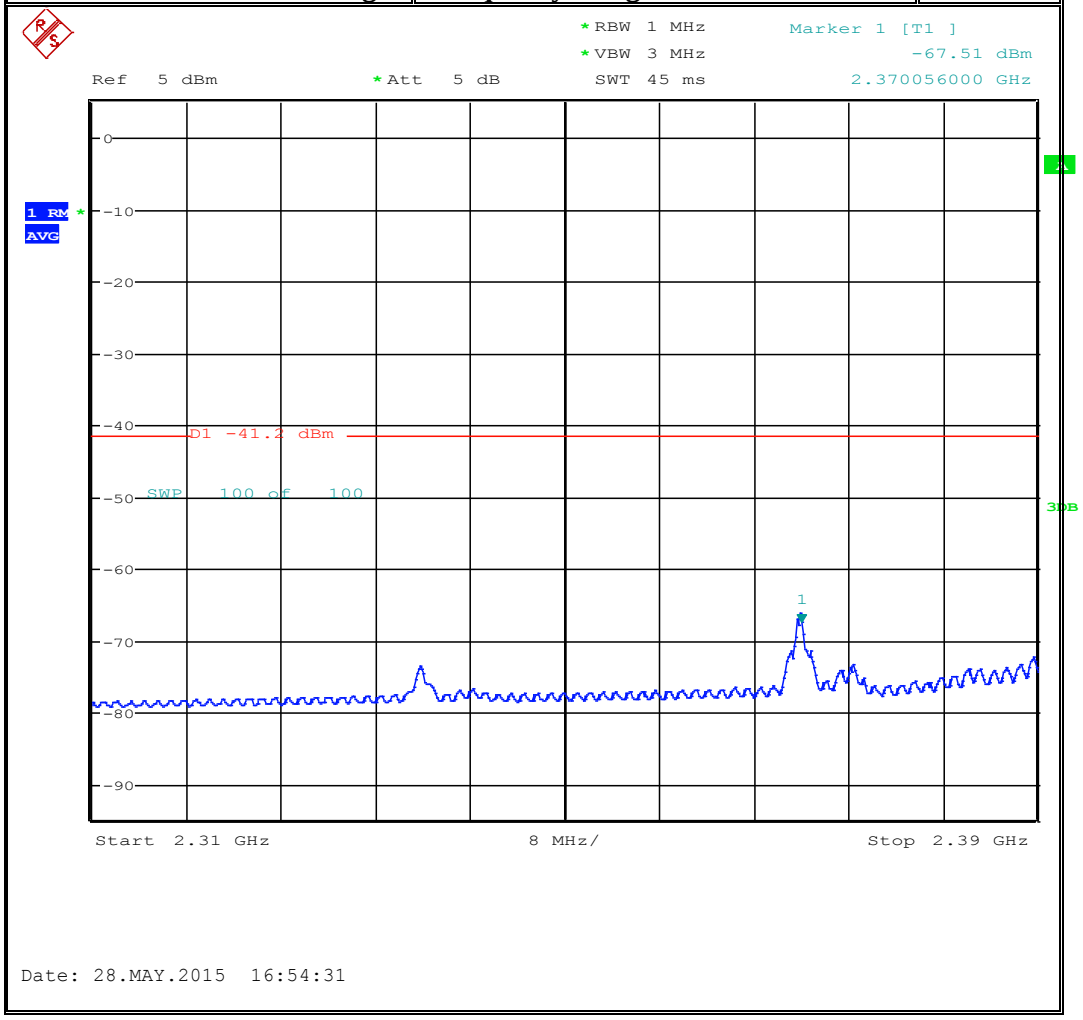
Lower Restricted Band Edge - peak

Ch. Low / 2402MHz / Peak	Frequency Range: 2.310 – 2.390 GHz	GFSK



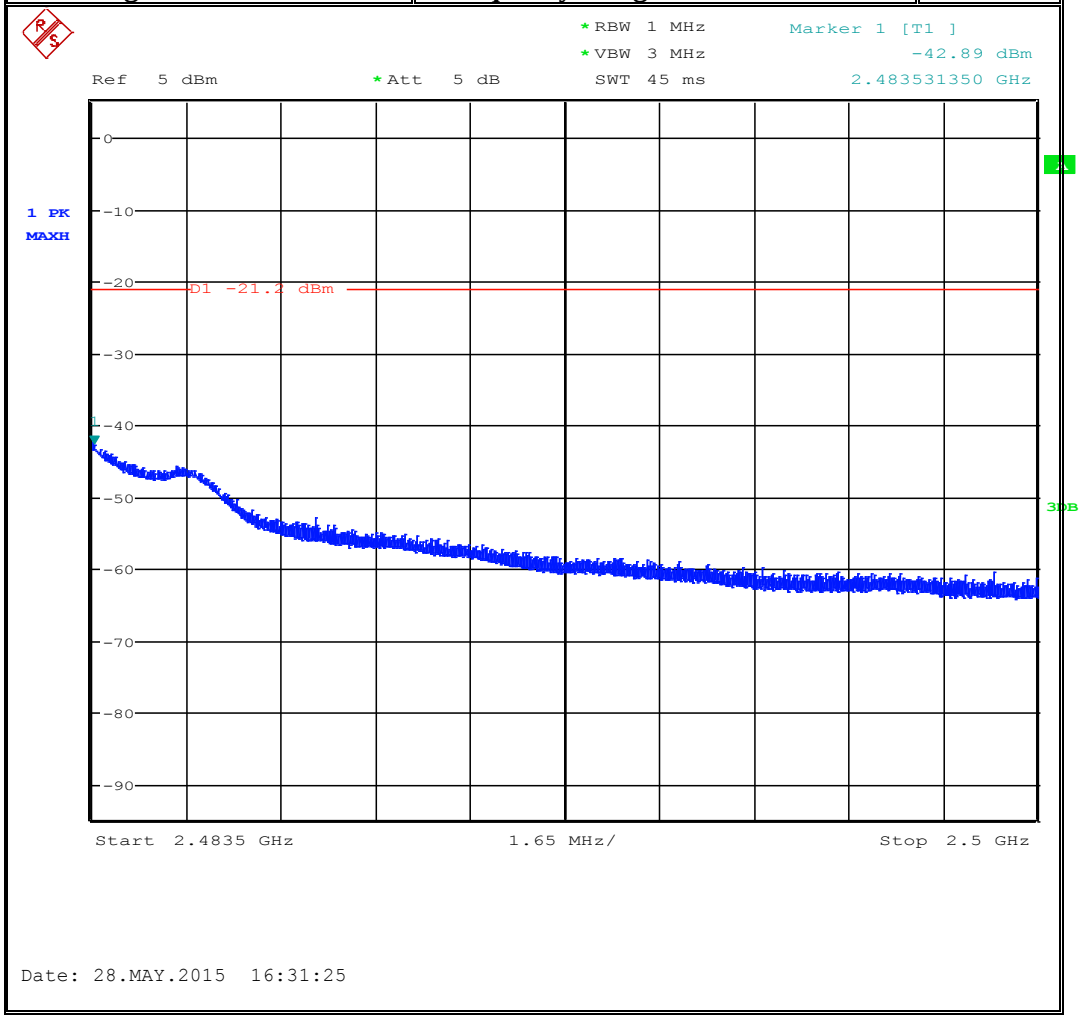
Lower Restricted Band Edge - average

Ch. Low / 2402MHz / Avg	Frequency Range: 2.310 – 2.390 GHz	GFSK



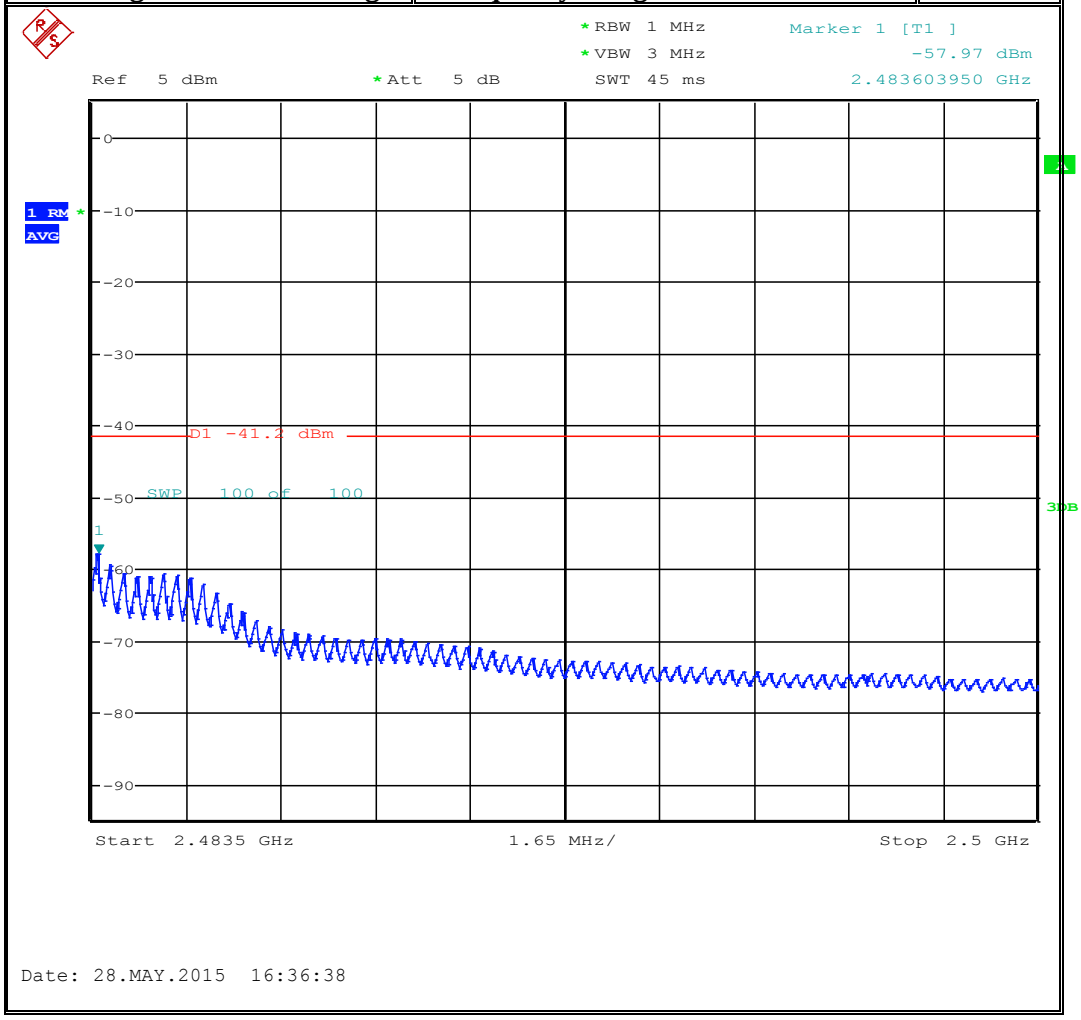
Upper Restricted Band Edge - peak

Ch. High / 2480MHz / Peak	Frequency Range: 2.4835 – 2.5 GHz	GFSK



Upper Restricted Band Edge - average

Ch. High / 2480MHz / Avg	Frequency Range: 2.4935 – 2.5 GHz	GFSK



10 Emission Bandwidth (6dB) and Occupied Bandwidth (99%)

10.1 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.

10.2 Test Conditions:

Tnom: 22 °C; Vnom: 3.0 V

10.3 Test Procedure

Measurement according to FCC KDB 558074 D01 v03r02 section 8.1

For 6 dB bandwidth:
Spectrum Analyzer settings:
Span= Wide enough to capture the entire emission bandwidth
RBW= 100 KHz
VBW≥ 3xRBW
Detector: Peak-
Sweep Time: Auto
Trace = Max Hold
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 peak level measured in the fundamental emission.

For 99% bandwidth:
Use the occupied bandwidth in the measurement function of the spectrum analyzer with power bandwidth setting at 99%

10.4 Test Data Results:

Emission / Occupied Bandwidth (MHz)						
Mode	Frequency (MHz)					
	2404 Channel 0		2440 Channel 19		2480 Channel 39	
	6dB (KHz)	99% (MHz)	6dB (KHz)	99% (MHz)	6dB (KHz)	99% (MHz)
LE	677	1.09	691	1.08	684	1.07

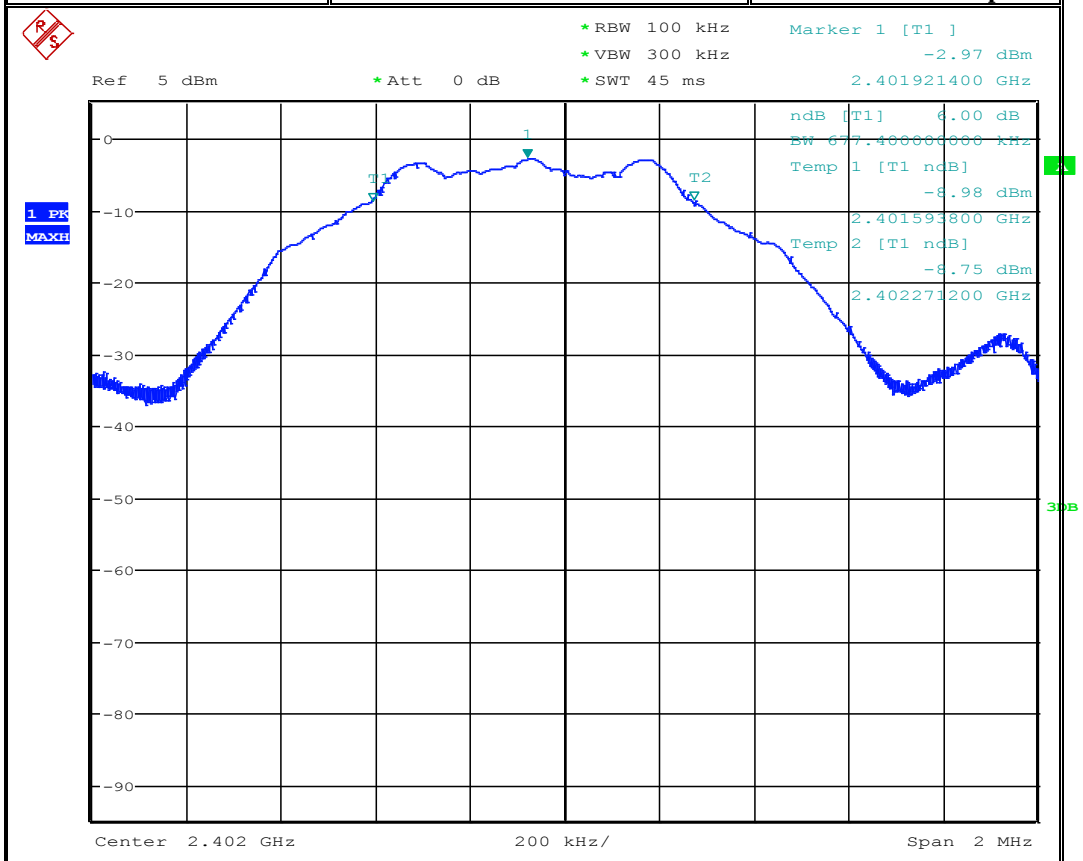
10.5 Measurement Result

Pass.

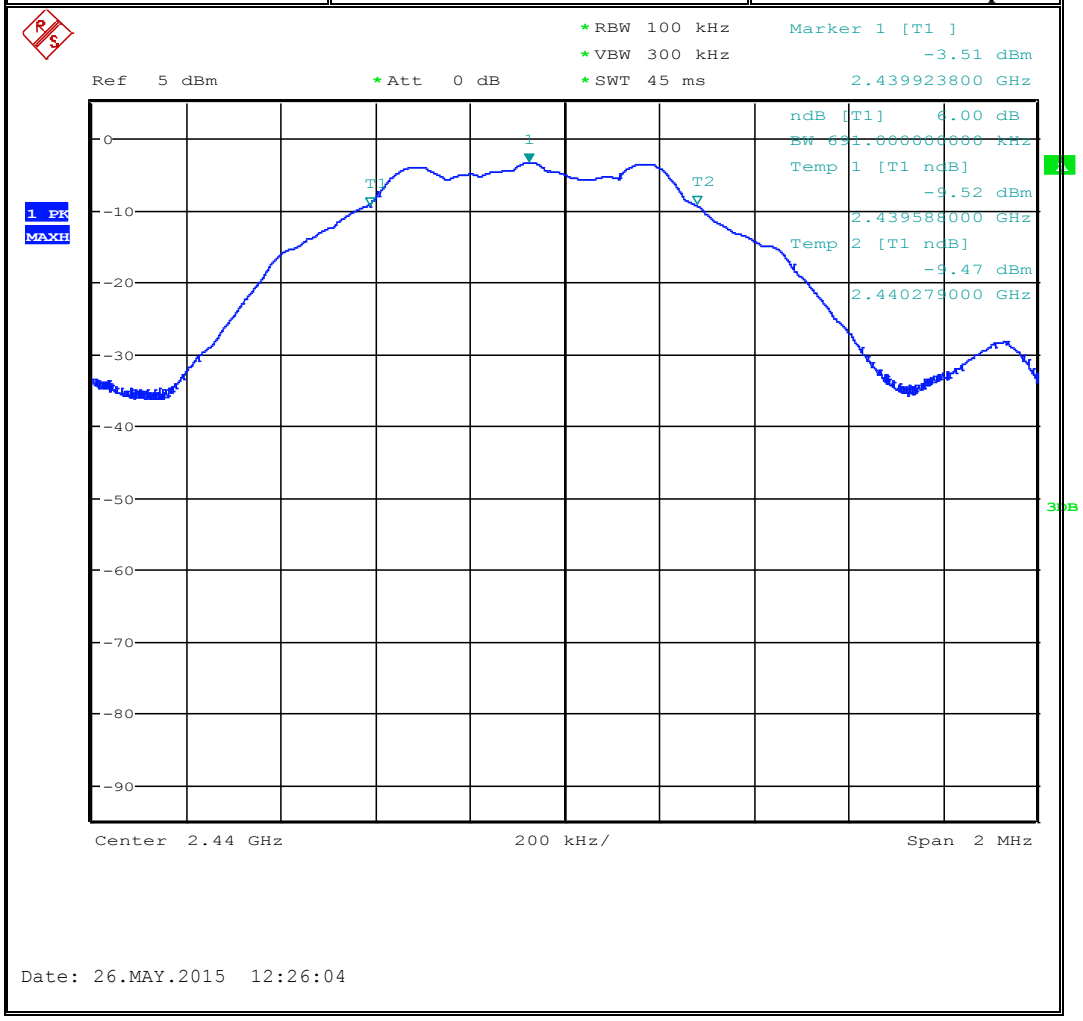
10.6 Measurement Plots:

6dB Bandwidth

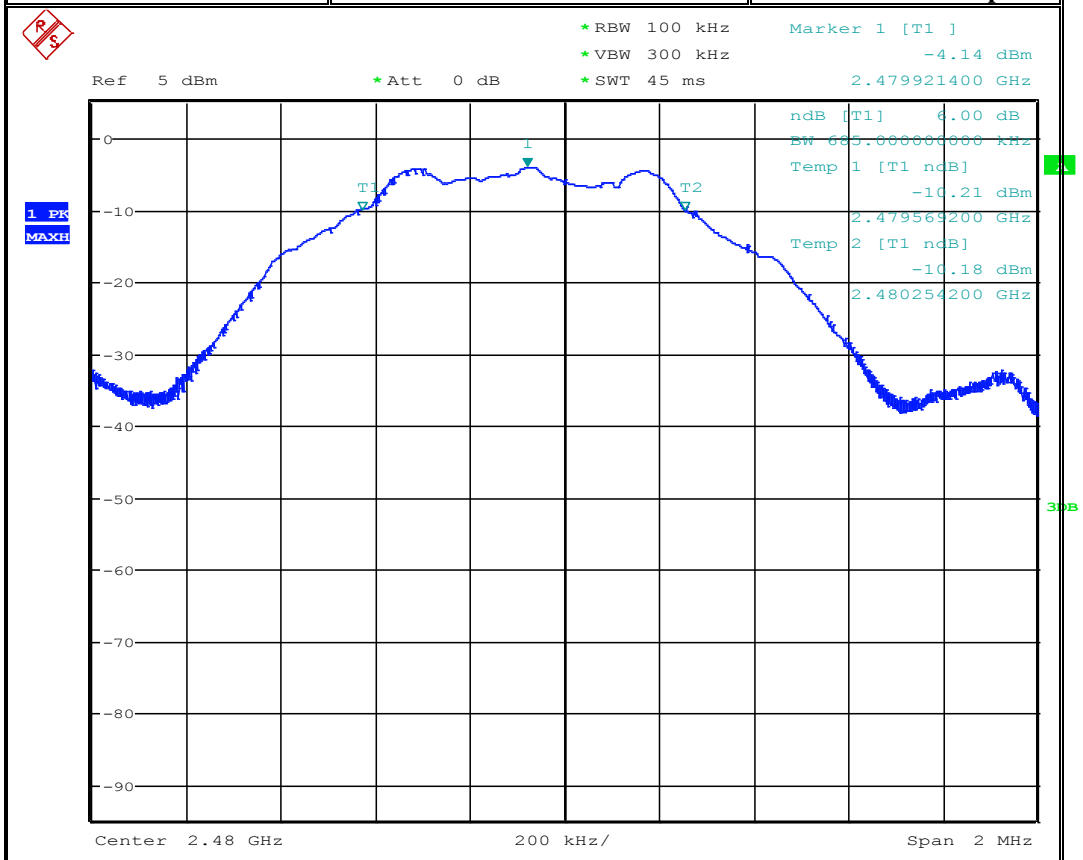
Ch.0 / 2402 MHz	Modulation: GFSK	Data Rate: 1 Mbps



Ch.19 / 2440 MHz	Modulation: GFSK	Data Rate: 1 Mbps

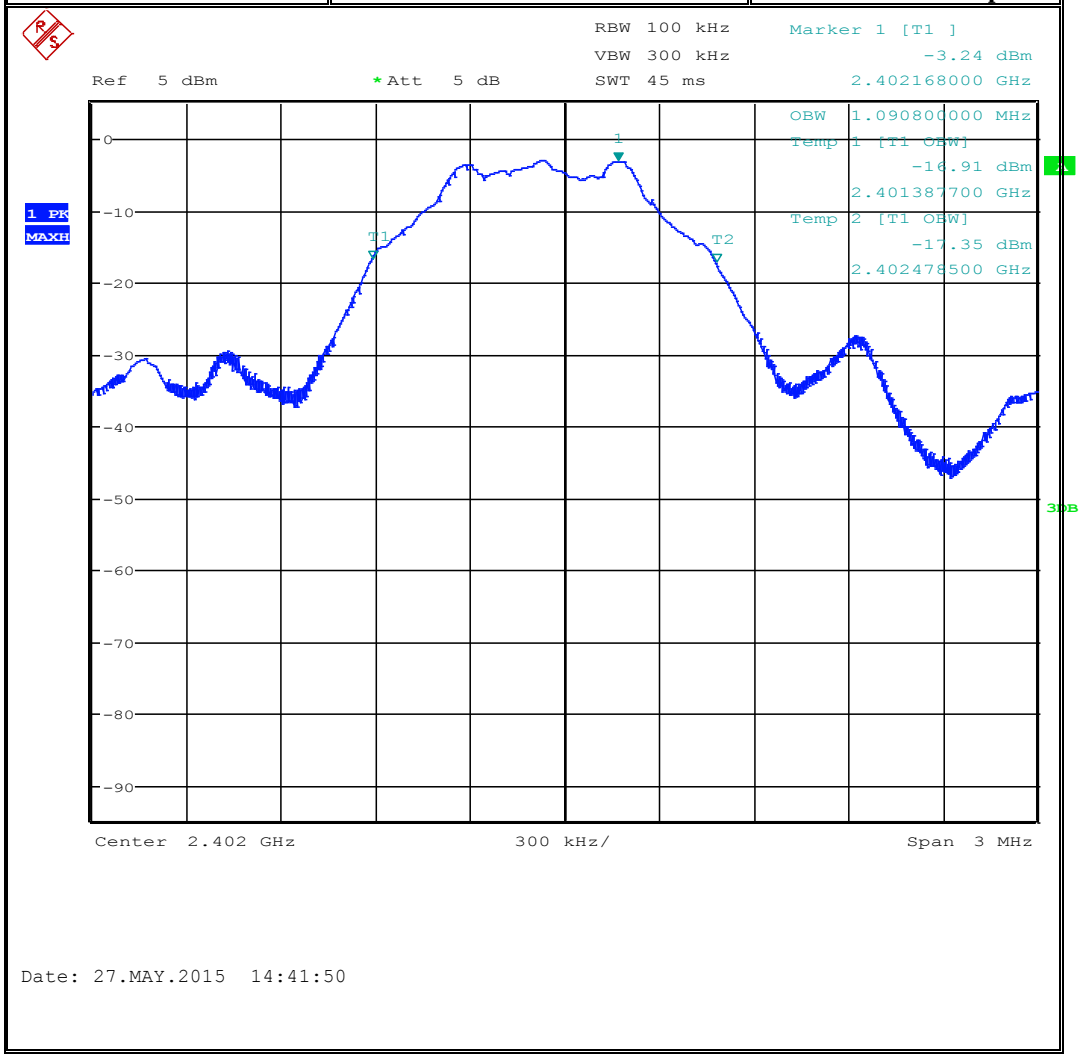


Ch.39 / 2480 MHz	Modulation: GFSK	Data Rate: 1 Mbps

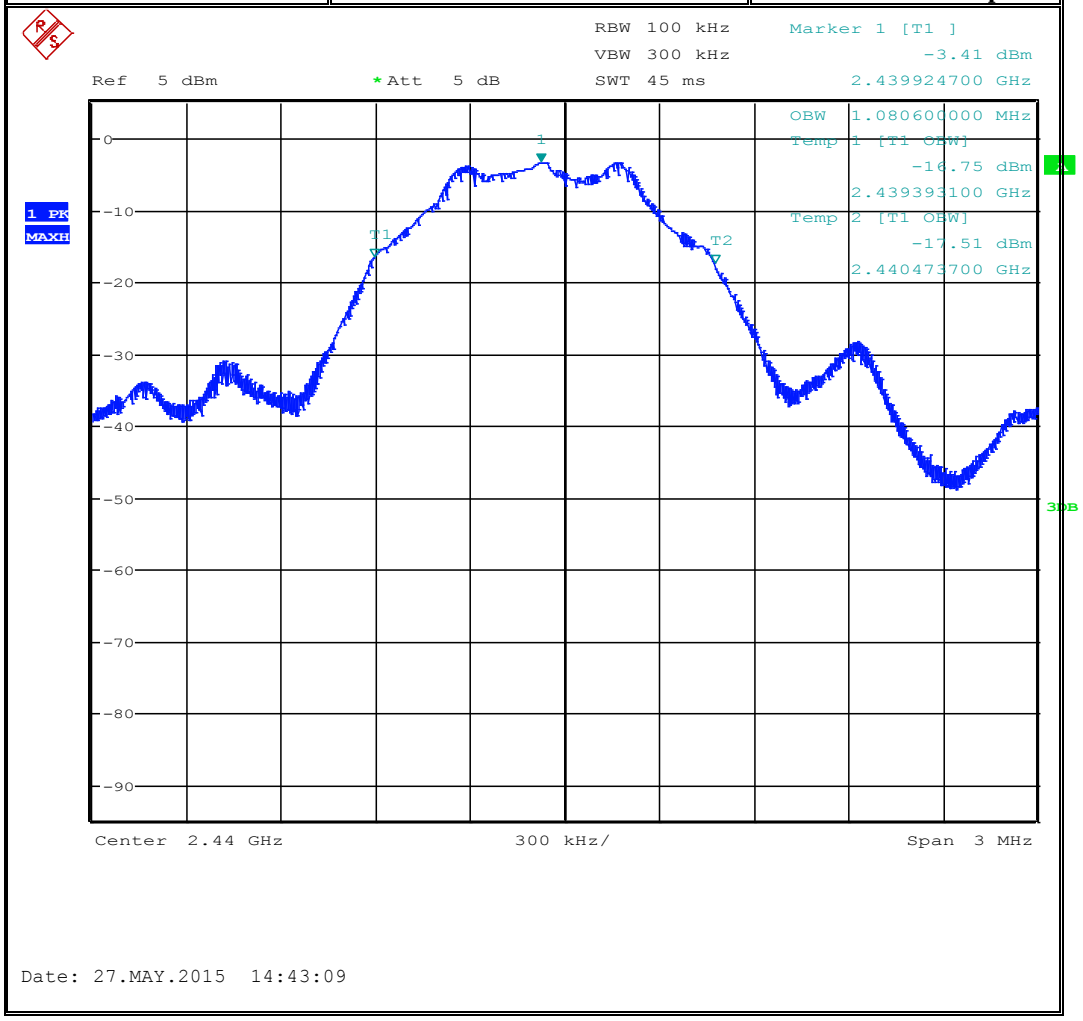


OBW 99% Channel Power

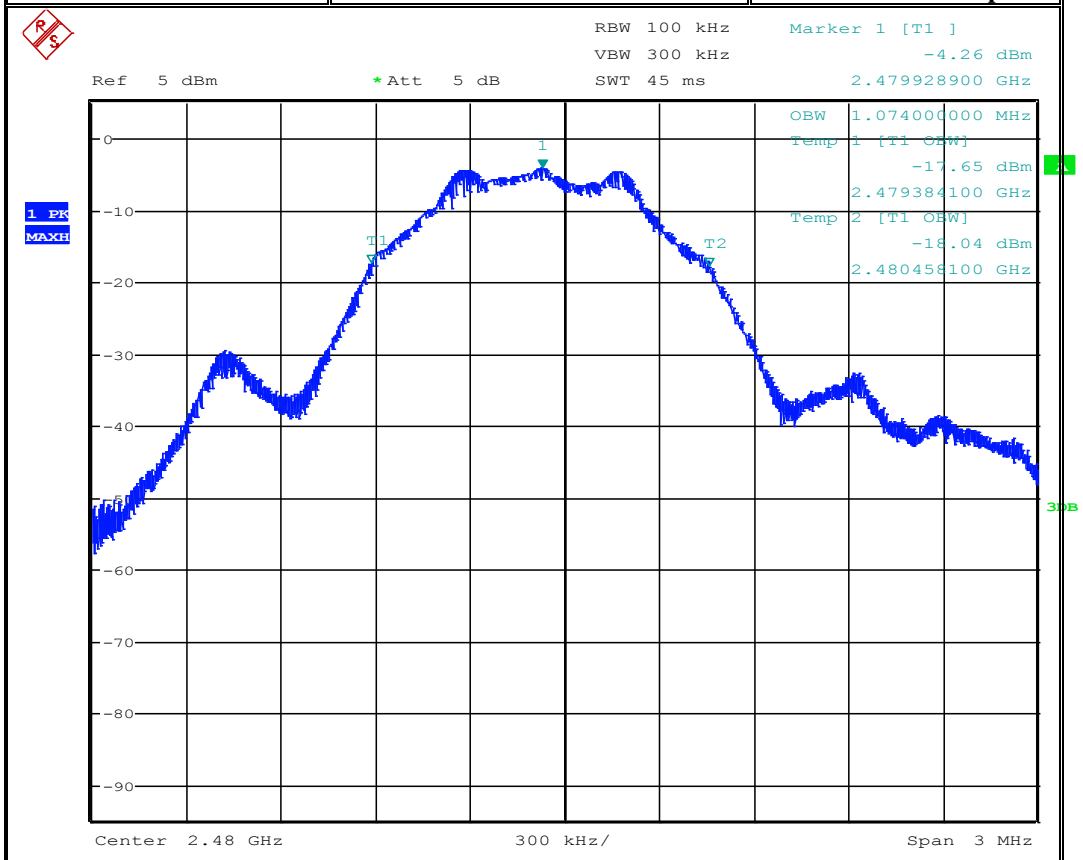
Ch.0 / 2402 MHz	Modulation: GFSK	Data Rate: 1 Mbps



Ch.19 / 2440 MHz	Modulation: GFSK	Data Rate: 1 Mbps



Ch.39 / 2480 MHz	Modulation: GFSK	Data Rate: 1 Mbps



11 Radiated Transmitter Spurious Emissions - Restricted Bands

11.1 Limits:

§15.247/15.205/15.209

(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: Field strength limits table above 30 MHz

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

Table 2: Field strength limits table below 30 MHz

Frequency of emission (MHz)	Field strength (µV/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	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.

11.2 Test Conditions:

Tnom: 23 °C; Vnom: 3.0V
Test mode: *Modulation:* GFSK

11.3 Measurement procedure:

Measurement according to ANSI C63.10:2013 (also refer to section 6.1 in this test report)

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

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

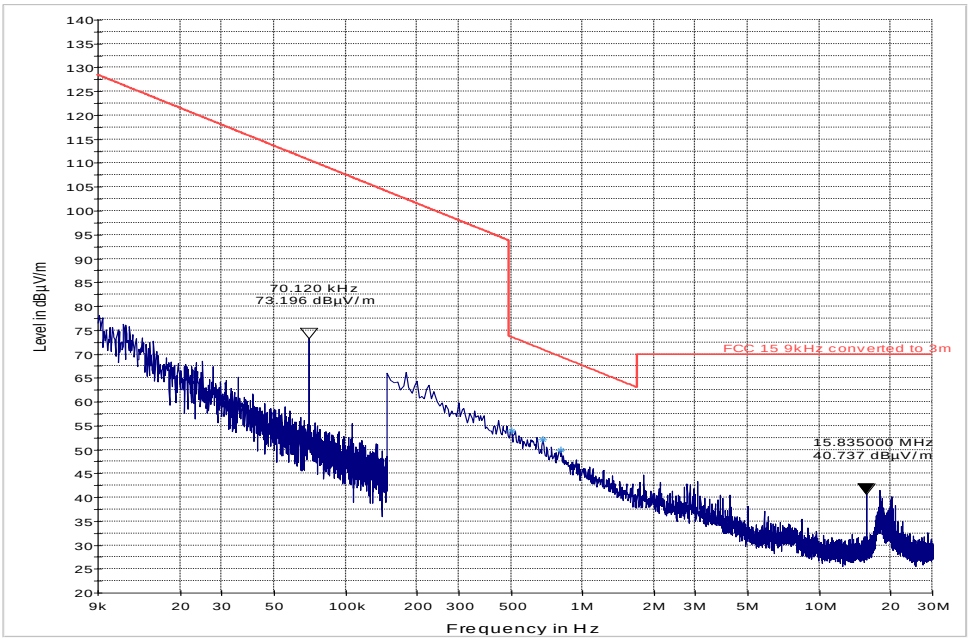
Test mode: *Modulation:* GFSK- the highest conducted output power.
Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT.

11.4 Verdict:

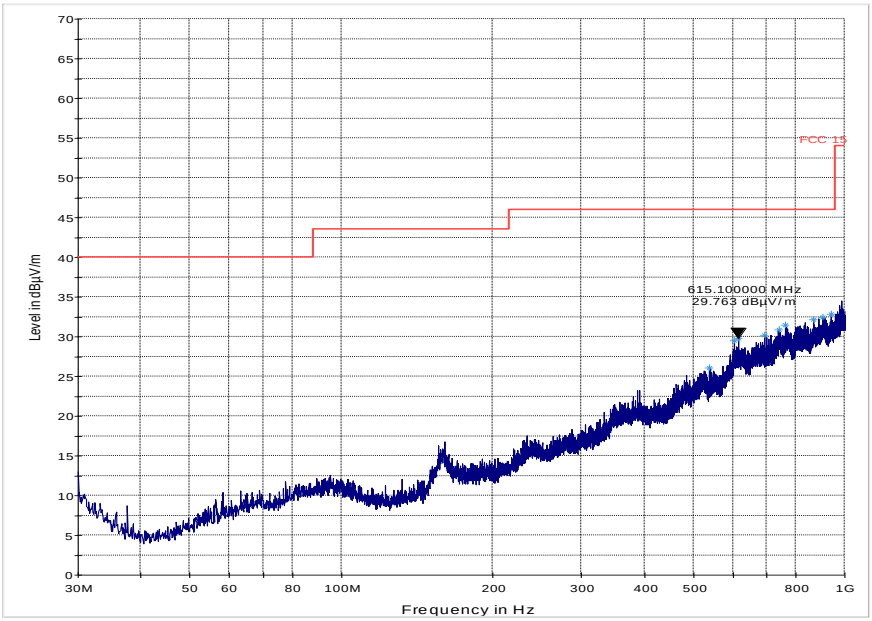
Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT. PASS

11.5 Measurement Plots:

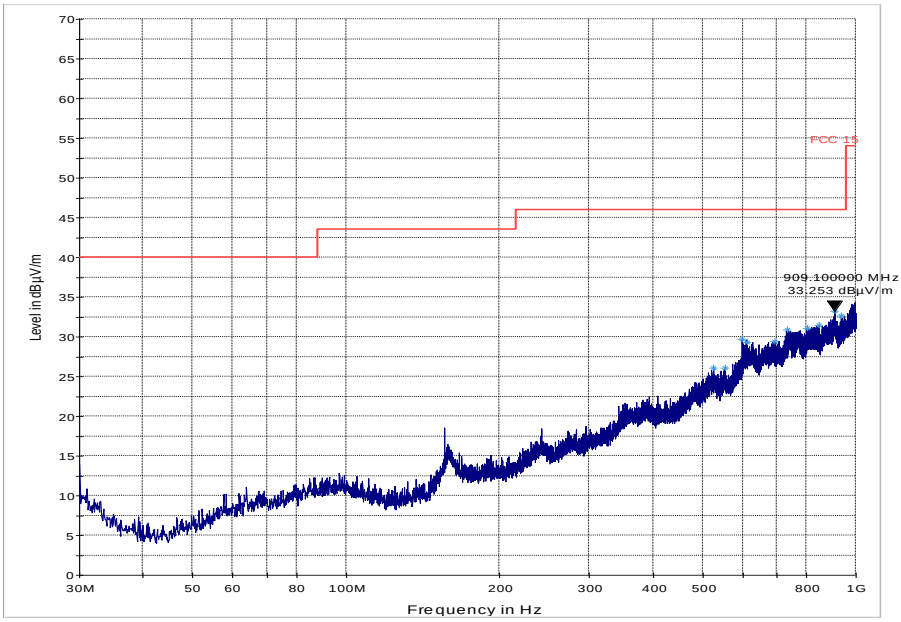
TX Radiated Spurious Emissions: 9kHz – 30MHz			
Ch. Mid	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**



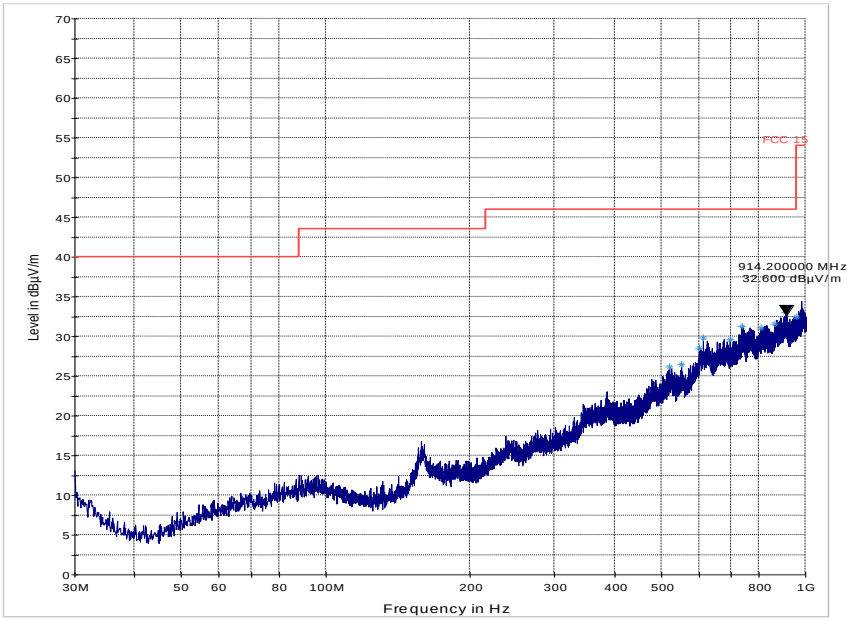
TX Radiated Spurious Emission: 30 MHz – 1GHz			
Ch. Low	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**



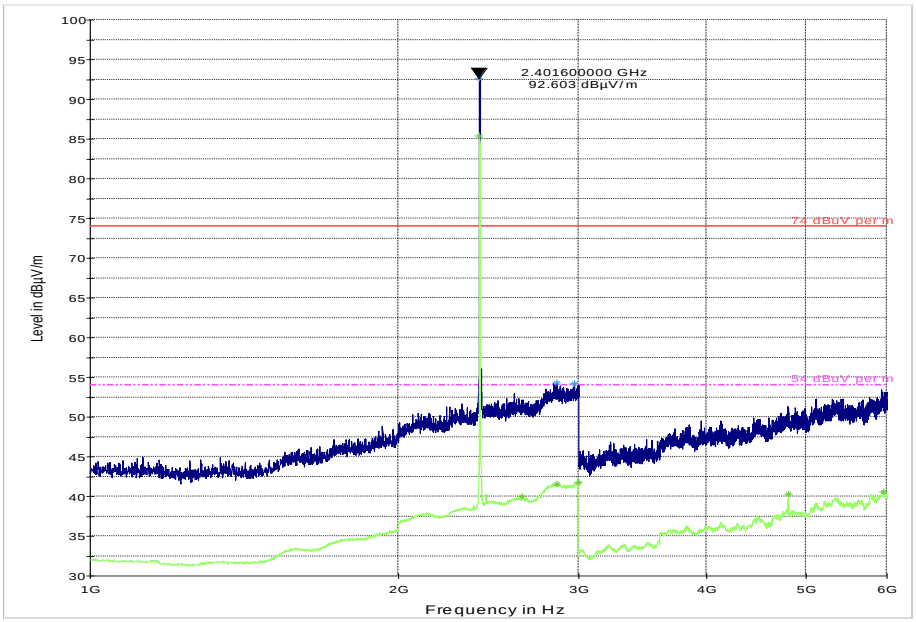
TX Radiated Spurious Emission: 30 MHz – 1GHz			
Ch. Mid	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**



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

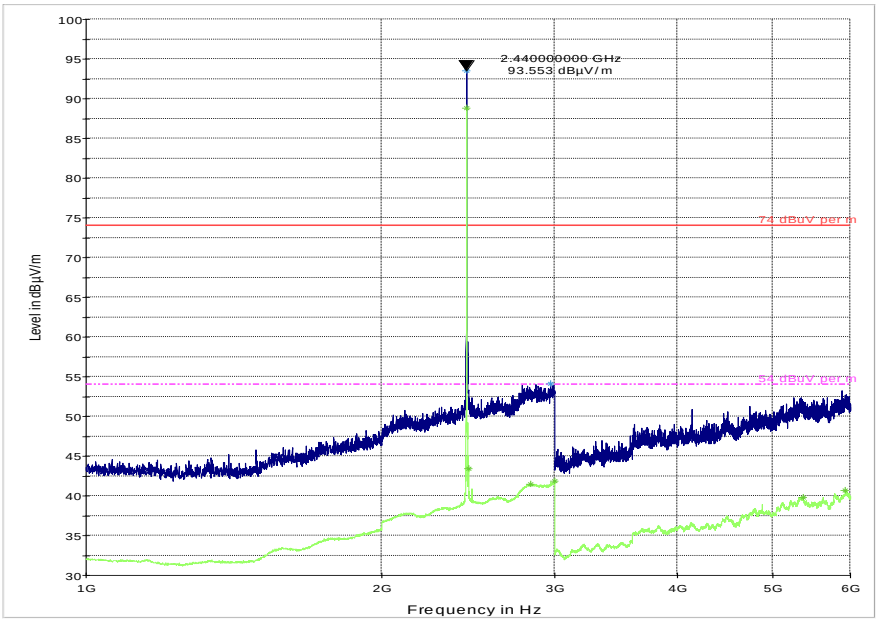


TX Radiated Spurious Emission: 1 GHz –6GHz			
Ch. Low	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**



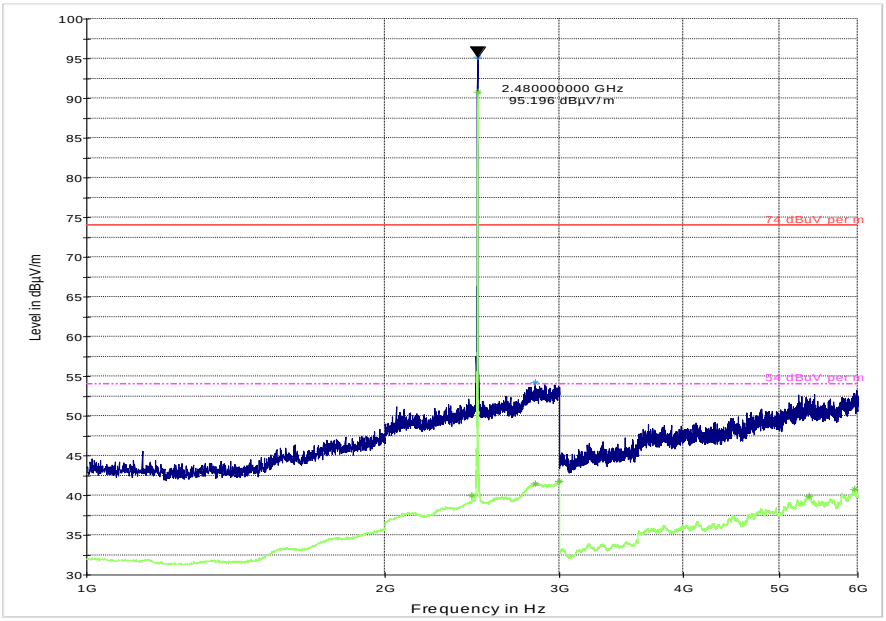
Note: the peaks above the limit is the uplink signal

TX Radiated Spurious Emission: 1 GHz – 6GHz			
Ch. Mid	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**



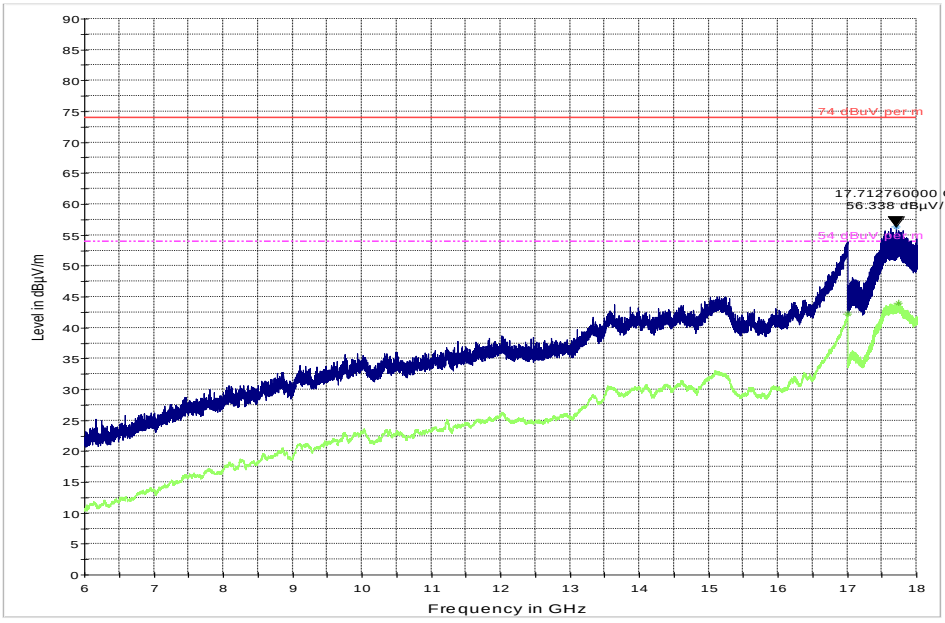
Note: the peaks above the limit is the uplink signal

TX Radiated Spurious Emission: 1 GHz – 6 GHz			
Ch. High	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**

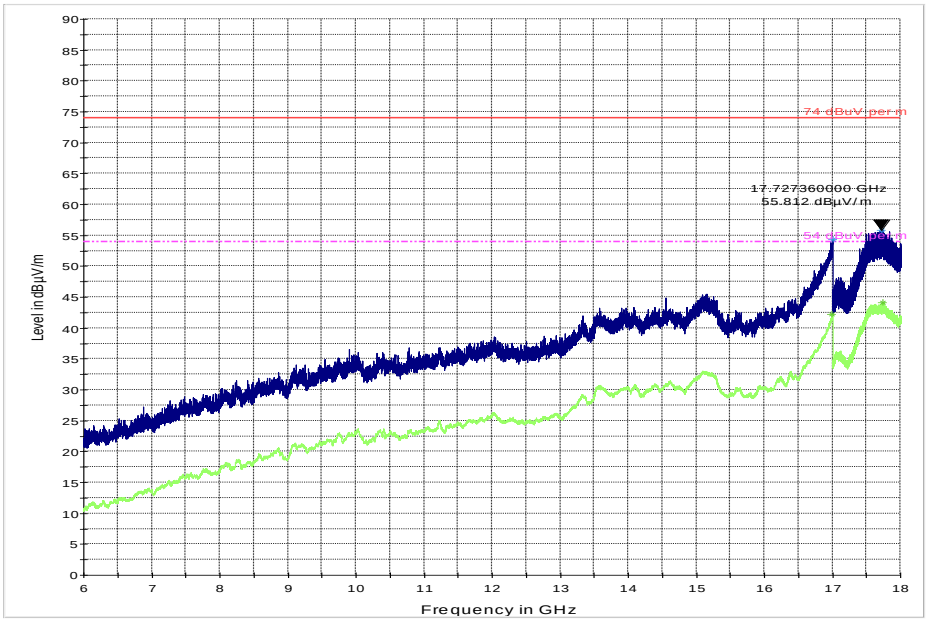


Note: the peaks above the limit is the uplink signal

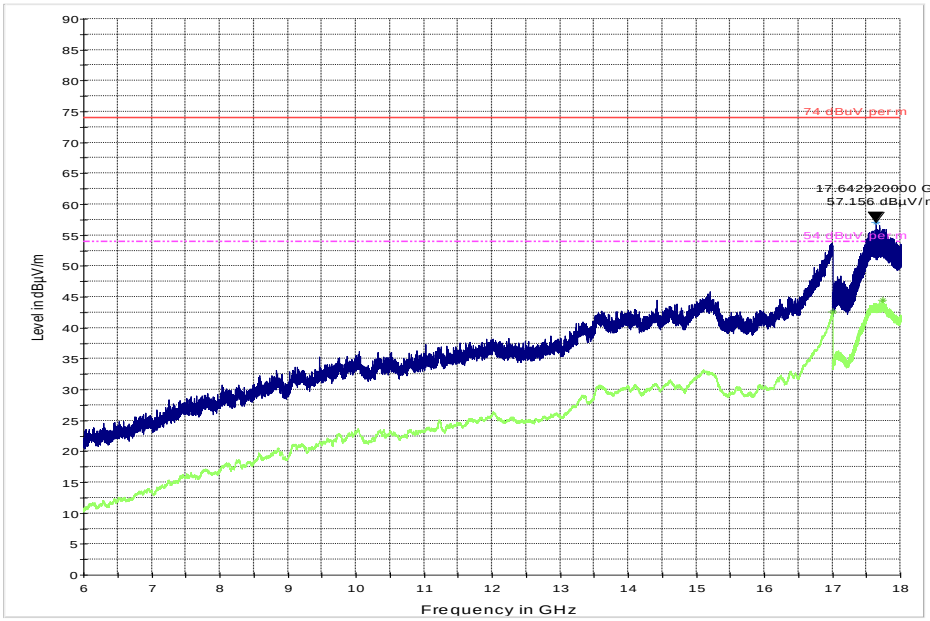
TX Radiated Spurious Emission: 6 GHz - 18 GHz			
Ch. Low	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**



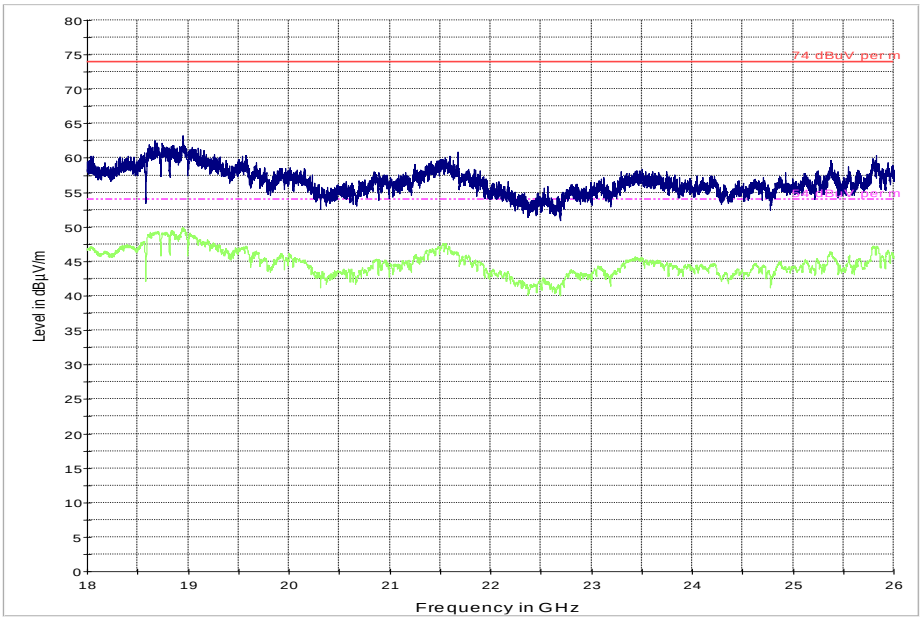
TX Radiated Spurious Emission: 6 GHz - 18 GHz			
Ch. Mid	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**



TX Radiated Spurious Emission: 6 GHz - 18 GHz			
Ch. High	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**



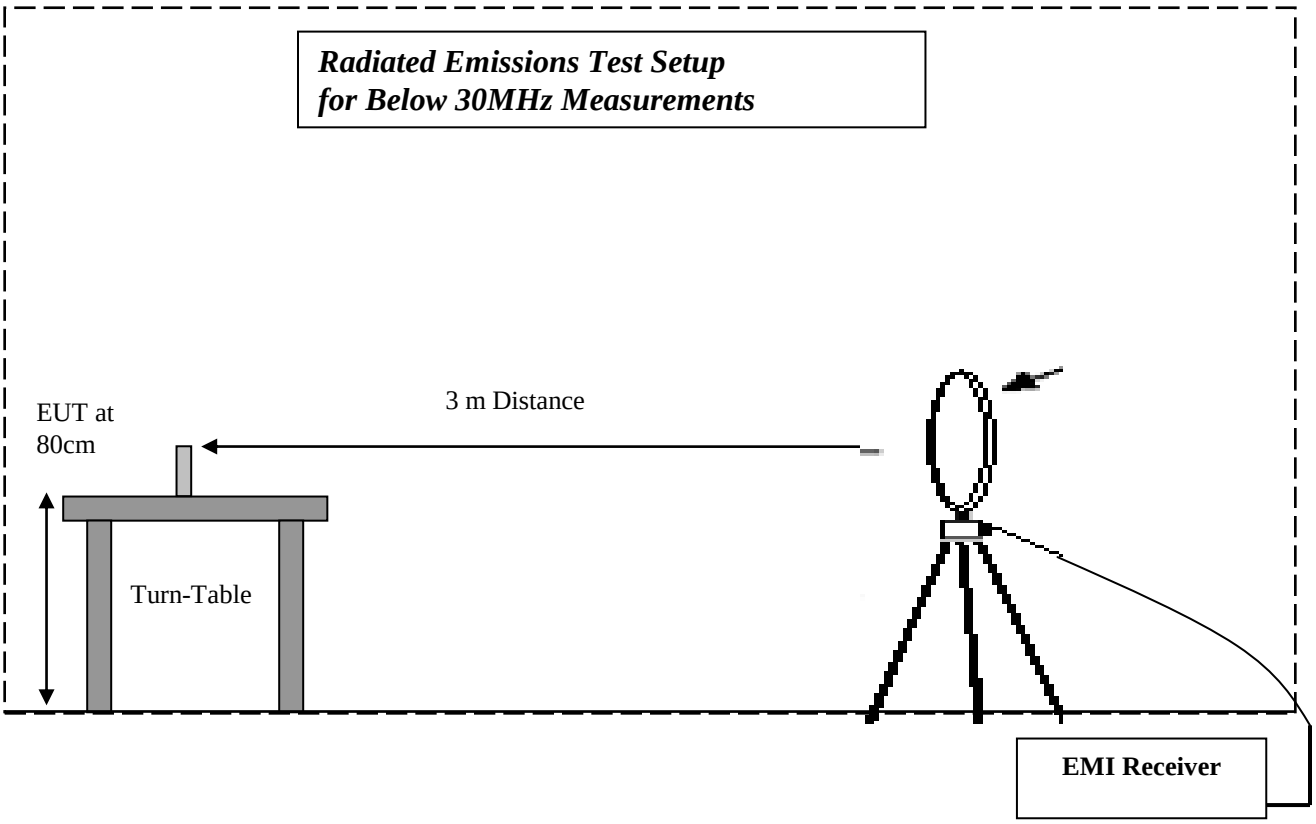
TX Radiated Spurious Emission: 18 GHz – 26 GHz			
Ch. Mid	**Mode: Bluetooth LE**	**Modulation: GFSK**	**Data Rate: 1 Mbps**

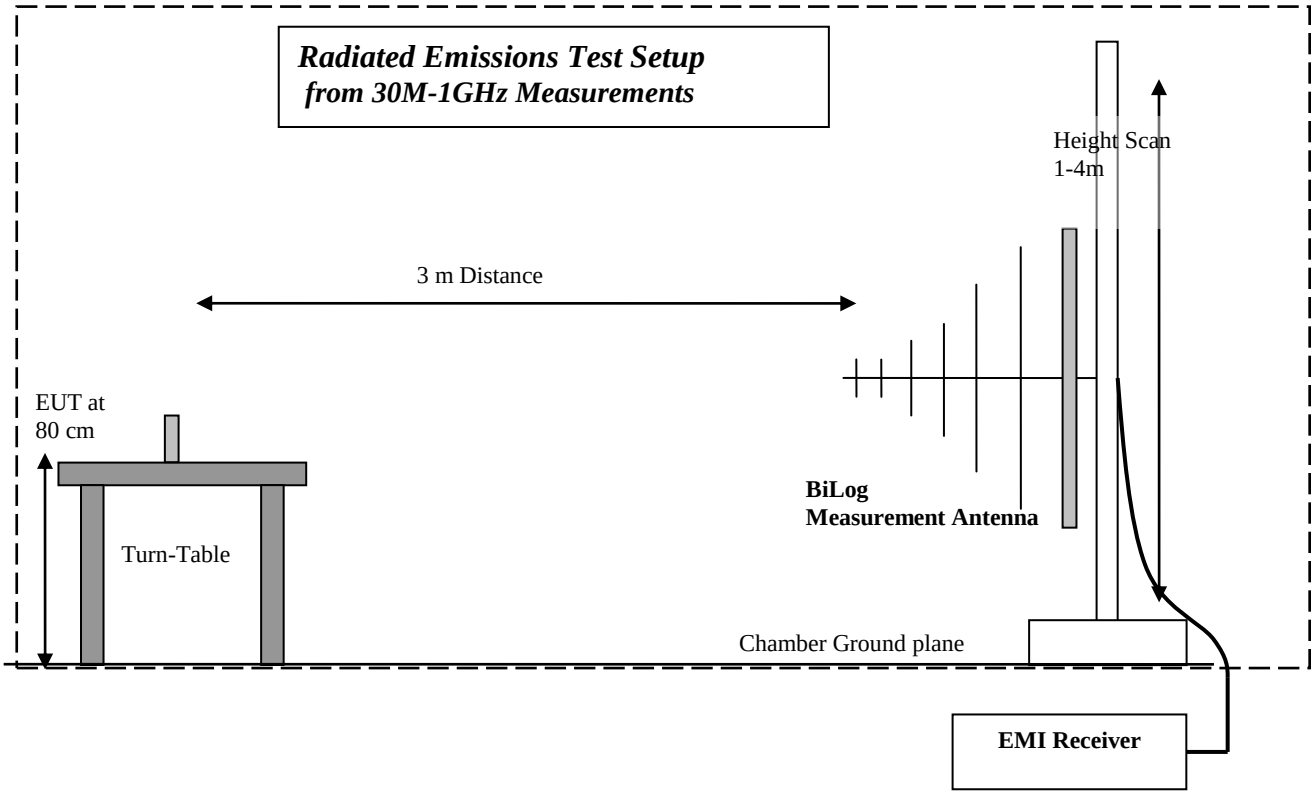


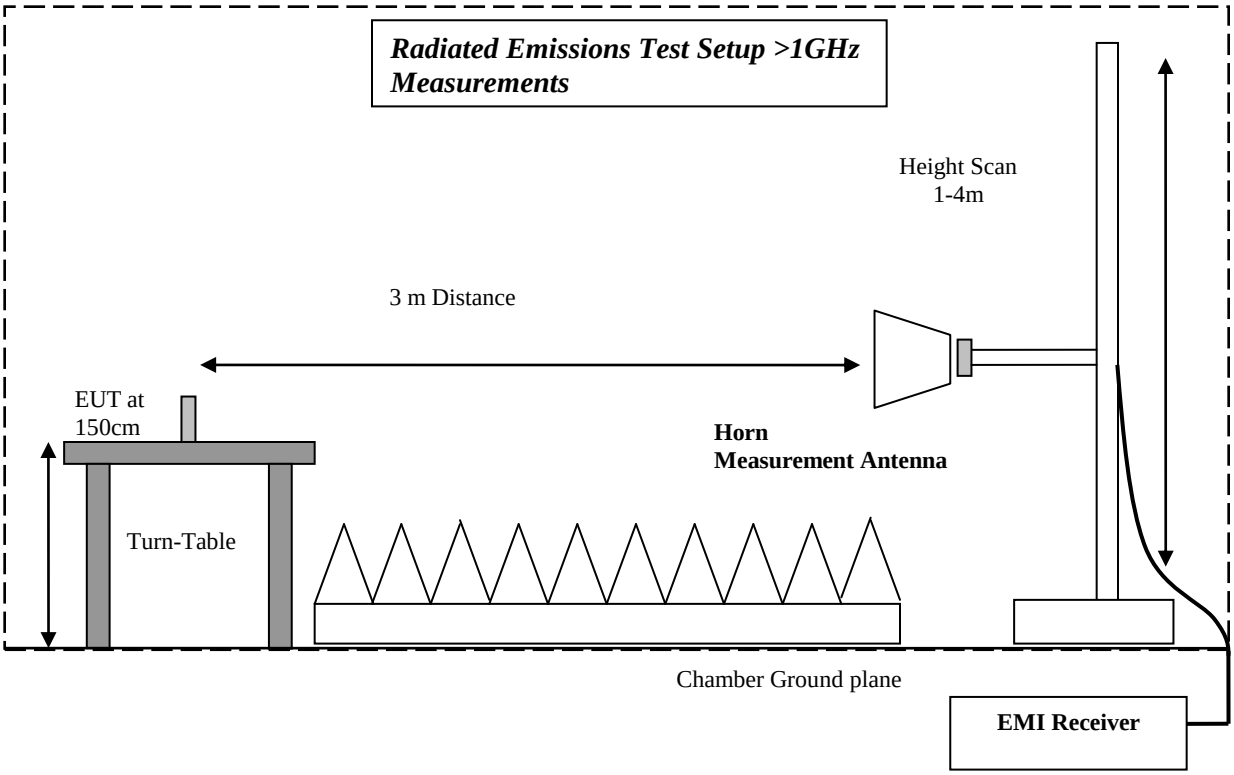
12 Test Equipment and Ancillaries used for tests

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	Jul 2015	2 Years
	Spectrum Analyzer	Rohde&Schwarz	FSU	200302	Jul 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	3149	J000123908	Feb 2014	3 Years
	Horn Antenna	EMCO	3115	35114	Jul 2015	3 Years
	Spectrum Analyzer	Rohde&Schwarz	FSU	100189	Jul 2015	2 Years
	Loop Antenna 6512	ETS Lindgren	6507	161344	Feb 2015	3 Years
	Ancillary equipment					
	Humidity Temperature Logger	Dickson	TM325	14150156	Jul 2015	1 Year
	DC Power Supply	HP	E3610A	KR83023316	N/A	N/A

13 Block Diagrams






Radiated Emissions Test Setup >1GHz Measurements
Height Scan
1-4m
3 m Distance
EUT at
150cm
Horn
Measurement Antenna
Turn-Table
Chamber Ground plane
EMI Receiver

14 Revision History

Date	Report Name	Report Changes	Report prepared by
2015-07-16	EMC_IRHYT-002-15001_15.247_BTLE	First Revision	James Donnellan
2015-10-09	EMC_IRHYT-002-15001_15.247_BTLE-Rev1	Updated Per Review	James Donnellan