FCC / IC Test Report

FOR:

Moog Inc.

Model #:

ILC3000

Product Description:

Asset tracker

FCC ID: 2AGRZ-ILC3000
IC ID: 20942-ILC3000

Per:

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

REPORT #: EMC_MOOGI-005-15001_15.247_BTLE

DATE: February 3, 2016

***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 ◆ http://www.cetecom.com
CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

© Copyright by *CETECOM*

TABLE OF CONTENTS

1 ASSESSMENT 4

2 ADMINISTRATIVE DATA 5

2.1 IDENTIFICATION OF THE TESTING LABORATORY ISSUING THE EMC TEST REPORT 5
2.2 IDENTIFICATION OF THE CLIENT 5
2.3 IDENTIFICATION OF THE MANUFACTURER 5

3 EQUIPMENT UNDER TEST (EUT) 6

3.1 EUT SPECIFICATIONS 6
3.2 EUT SAMPLE DETAILS 8
3.3 ACCESSORY EQUIPMENT (AE) DETAILS 8
3.1 TEST SAMPLE CONFIGURATION 8
3.2 DUTY CYCLE 10

4 SUBJECT OF INVESTIGATION 11

5 MEASUREMENT RESULTS SUMMARY 12

6 MEASUREMENT UNCERTAINTY 13

7 ENVIRONMENTAL CONDITIONS DURING TESTING: 13

8 DATES OF TESTING: 13

9 MEASUREMENT PROCEDURES 14

9.1 RADIATED MEASUREMENT 14
9.2 SAMPLE CALCULATIONS FOR FIELD STRENGTH MEASUREMENTS 16
9.3 POWER LINE CONDUCTED MEASUREMENT PROCEDURE 16
9.4 RF CONDUCTED MEASUREMENT PROCEDURE 17

10 MAXIMUM PEAK CONDUCTED OUTPUT POWER 18

10.1 MEASUREMENT ACCORDING TO FCC KDB 558074 D01 V03R04 18
10.2 LIMITS: 18
10.3 TEST CONDITIONS AND SETUP: 18
10.4 MEASUREMENT RESULT: 18
10.5 MEASUREMENT PLOTS: 19

11 POWER SPECTRAL DENSITY 22

11.1 MEASUREMENT ACCORDING TO FCC KDB 558074 D01 V03R03 22
11.2 LIMITS: §15.247 & RSS-247 22
11.3 TEST CONDITIONS AND SETUP: 22
11.4 MEASUREMENT RESULT: 22
11.5 MEASUREMENT PLOTS: 23

12 BAND EDGE COMPLIANCE 26

12.1 MEASUREMENT ACCORDING TO FCC KDB 558074 D01 V03R04 26
12.2 LIMITS RESTRICTED BAND §15.205 AND RSS-GEN 8.10 26
12.3 LIMITS NON RESTRICTED BAND §15.247 AND RSS-247 5.5 27
12.4 TEST CONDITIONS AND SETUP: 27
12.5 MEASUREMENT RESULT: 28
12.6 MEASUREMENT PLOTS: 29

13 EMISSION BANDWIDTH 6DB AND 99% OCCUPIED BANDWIDTH 32

13.1 MEASUREMENT ACCORDING TO FCC KDB 558074 D01 V03R04 32
13.2 LIMITS: §15.247 32

13.3 TEST CONDITIONS AND SETUP: 32
13.4 MEASUREMENT RESULT: 32
13.5 MEASUREMENT PLOTS: 33

14 RADIATED TRANSMITTER SPURIOUS EMISSIONS AND RESTRICTED BANDS 36

14.1 MEASUREMENT ACCORDING TO ANSI C63.10 (2013) 36
14.2 LIMITS: §15.247/15.205/15.209 & RSS-GEN 8.9/ 8.10 (RESTRICTED BANDS) 36
14.3 TEST CONDITIONS AND SETUP: 37
14.4 MEASUREMENT RESULT: 37
14.5 MEASUREMENT PLOTS: 38

15 AC POWER LINE CONDUCTED EMISSIONS 49

15.1 LIMITS: 49
15.2 TEST CONDITIONS AND SETUP: 49
15.3 TEST PROCEDURE: 49
15.4 RESULTS: 50
15.5 TEST DATA: 50
15.6 MEASUREMENT PLOTS: 51

16 SETUP PICTURES 52

17 EUT PICTURES 53

18 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTING 54

19 REVISION HISTORY 55

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.

No deviations were ascertained during the course of testing performed.

Company	Description	Model #
Moog Inc.	asset tracker	ILC3000

Responsible for Testing Laboratory:

Date	Section	Name	Signature
February 3, 2016	Compliance	Franz Engert (Compliance 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
February 3, 2016	Compliance	Yu-Chien Ho (EMC Engineer)	Yu-Chien Ho

The test results of this test report relate exclusively to the test item specified in Section3.
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
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
Project Engineer:	Yu-Chien Ho

2.2 Identification of the Client

Name:	Moog Inc.
Street Address:	1421 McCarthy Blvd.
City/Zip Code:	Milpitas, CA 95035
Country:	USA

2.3 Identification of the Manufacturer

Name:	Same as Client
Street Address:	
City/Zip Code:	
Country:	

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model #:	ILC3000
HW Version :	001
SW Version :	3.0.0.1
FCC-ID :	2AGRZ-ILC3000
IC-ID:	20942-ILC3000
HVIN:	ILC3000
PMN:	ILC3000
FVIN:	N/A
Product Description:	Asset Tracker
Regulatory Band:	Nominal band: 2400 – 2483.5 MHz
Operating Frequency Ranges (MHz)/ Channels:	BTLE: Nominal band: 2400 – 2483.5 MHz; 2402 MHz (Ch. 0) – 2480 (Ch.39), 40 channels;
Type(s) of Modulation:	Bluetooth LE version 4.1, using Direct Sequence Spread Spectrum with GFSK modulation.
Modes of Operation:	client
Antenna Type:	1 x internal integrated loop antenna. For RF conducted measurements, a temporary connection was made from measurement equipment to the 50Ohm UFL port of the EUT.
Max. Declared Antenna Gain:	Documented max antenna gain: 2.4GHz = 2.5 dBi
Max. Measured Conducted Output	0.9dBm
Power Supply:	Li-ion Rechargeable Battery and AC/DC Battery Charger
Rated Operating Voltage Range:	• Li-ion Rechargeable Battery: Vmin: 3.3V dDC/ Vnom: 3.7V DC / Vmax: 4.2V DC • AC/DC Battery Charger: 110V – 230V AC, 120mA.
Operating Temperature Range:	Tlow: -20° C/ Tnom: 22° C/ Tmax: 60° C
Other Radios included in the Device:	Cellular WLAN 2.4GHz GPS
Sample Revision:	■Prototype; ☐Production; ☐Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	320009	001	3.0.0.1	Radiated Sample
2	320004	001	3.0.0.1	Conducted Sample

3.3 Accessory Equipment (AE) details

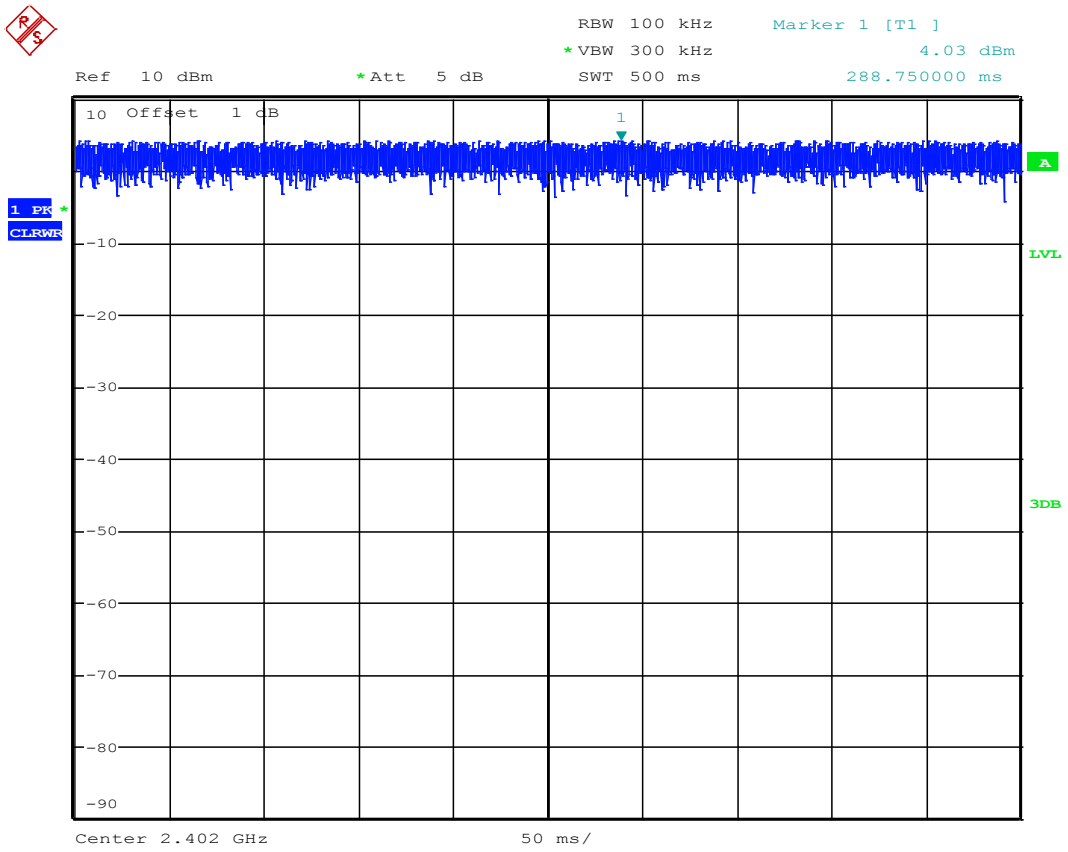
AE #	Type	Model	Manufacturer	Serial Number
1	AC/DC Power Supply	DCH3-05OUS-0002	Emerson	002187

3.1 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 internal antenna was connected.
2	EUT#2	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.
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.

3.2 Duty Cycle

Mode	Duty Cycle	Correction Factor
GFSK	100%	0 dB



Date: 19.JAN.2016 15:18:22

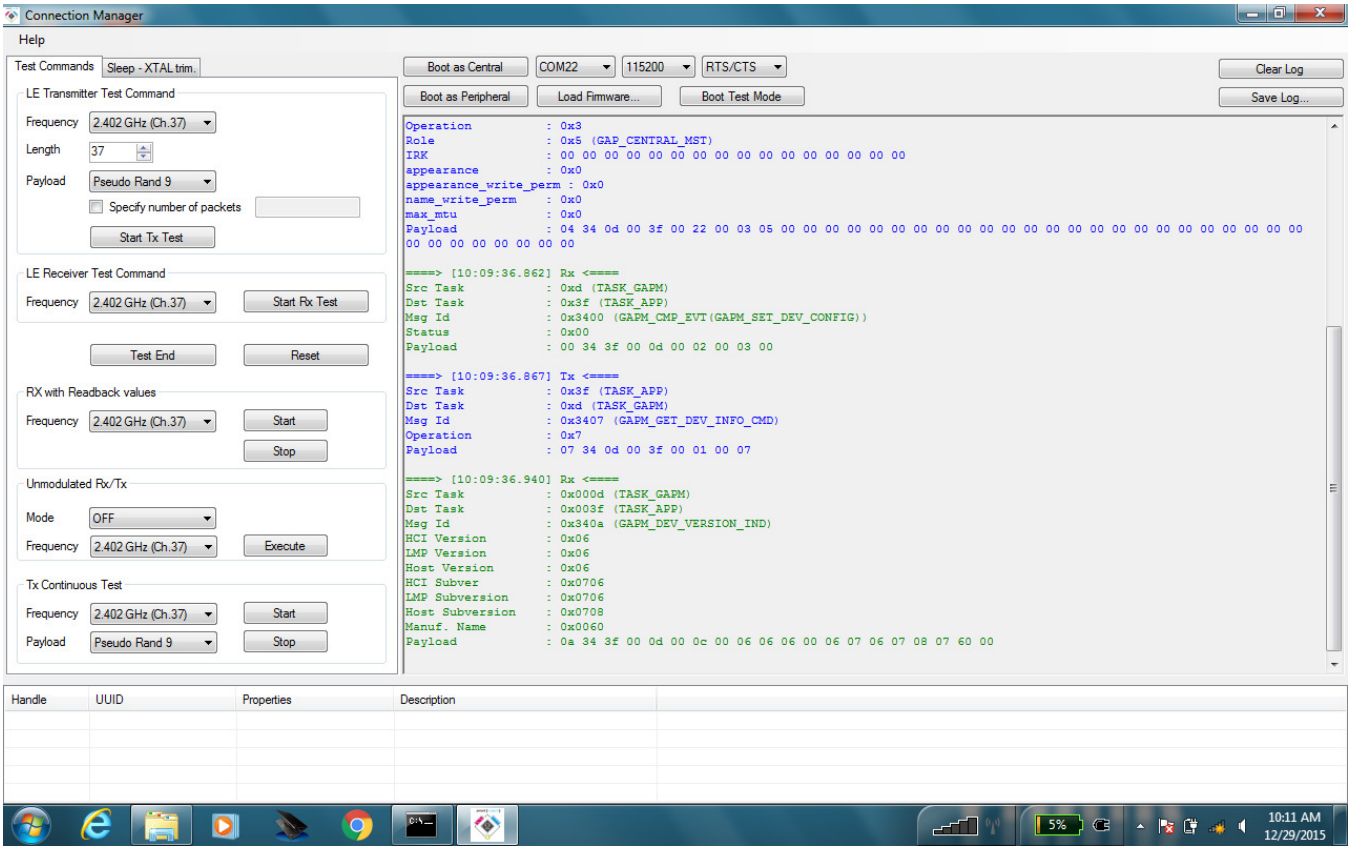
4 Subject of Investigation

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 of Industry Canada.

This test report is to support a request for new equipment authorization under the FCC ID: 2AGRZ-ILC3000. IC ID: 20942-ILC3000.

Testing procedures are based on
558074 D01 DTS Meas Guidance v03r03
ANSI C63.10 2013

Software tool used to control EUT:



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	Low, Mid, High channel	■	☐	☐	☐	Complies
§15.247(a)(1) RSS247 5.2(1)	Emission Bandwidth	Nominal	Mid channel only	■	☐	☐	☐	Complies
§15.247(b)(1) RSS247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal	Low, Mid, High channel	■	☐	☐	☐	Complies
§15.247/15.209/15.205 RSS-Gen 8.9/ 8.10	Band edge compliance- Restricted Band Edges	Nominal	Low, High channel	■	☐	☐	☐	Complies
§15.247(d) RSS247 5.5	Band edge compliance- Unrestricted Band Edges	Nominal	Low, High channel	■	☐	☐	☐	Complies
§15.247(d) §15.209 RSS-Gen 6.13	TX Spurious emissions- Radiated	Nominal	Low, Mid, High channel	■	☐	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	Mid channel	■	☐	☐	☐	Complies

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

6 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.

	Uncertainty in dB radiated <30MHz	Uncertainty in dB radiated 30MHz - 1GHz	Uncertainty in dB radiated > 1GHz	Uncertainty in dB Conducted measurement
Standard Deviation k=1	2.48	1.94	2.16	0.64
95% confidence interval in dB.	4.86	3.79	4.24	1.25
95% confidence interval in dB in delta to Result (rounded up to next decimal point).	+/- 2.5 dB	+/- 2.0 dB	+/- 2.3dB	+/- 0.7dB

7 Environmental Conditions During Testing:

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

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

8 Dates of Testing:

November 17, 2015 – December 21, 2015

9 Measurement Procedures

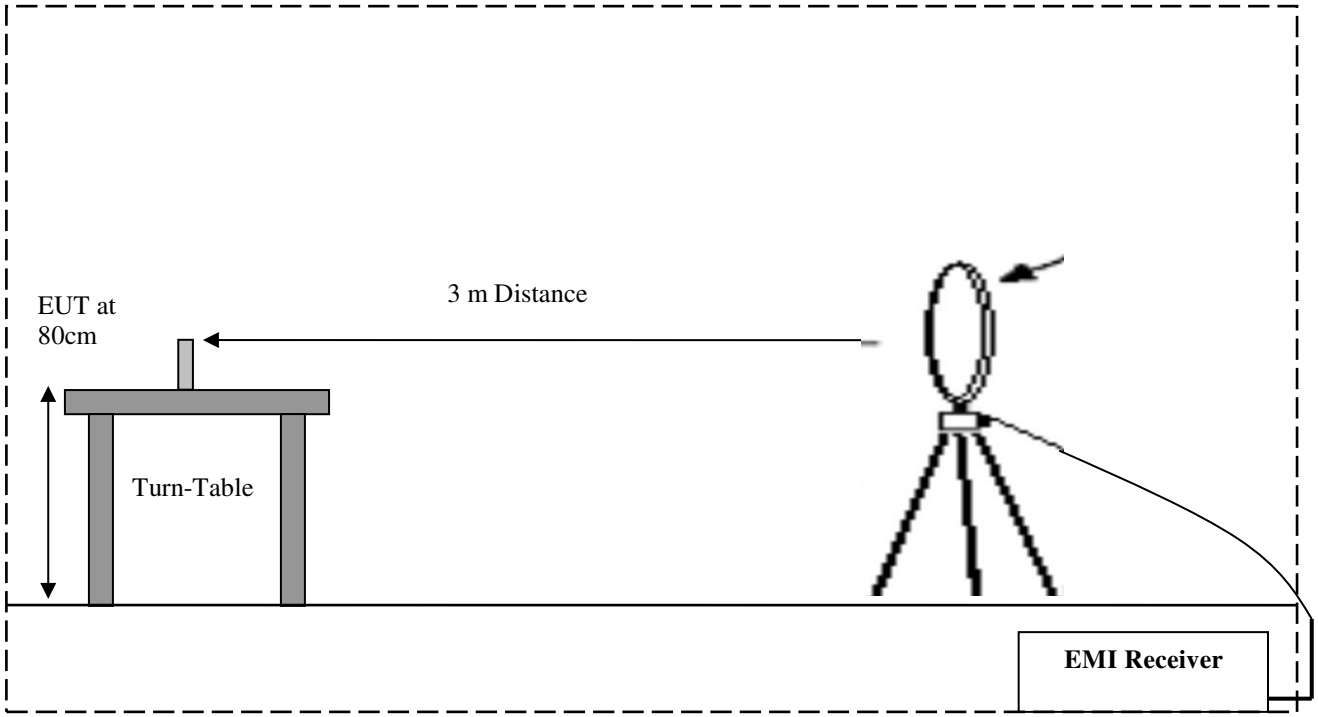
9.1 Radiated Measurement

The radiated measurement is performed according to:

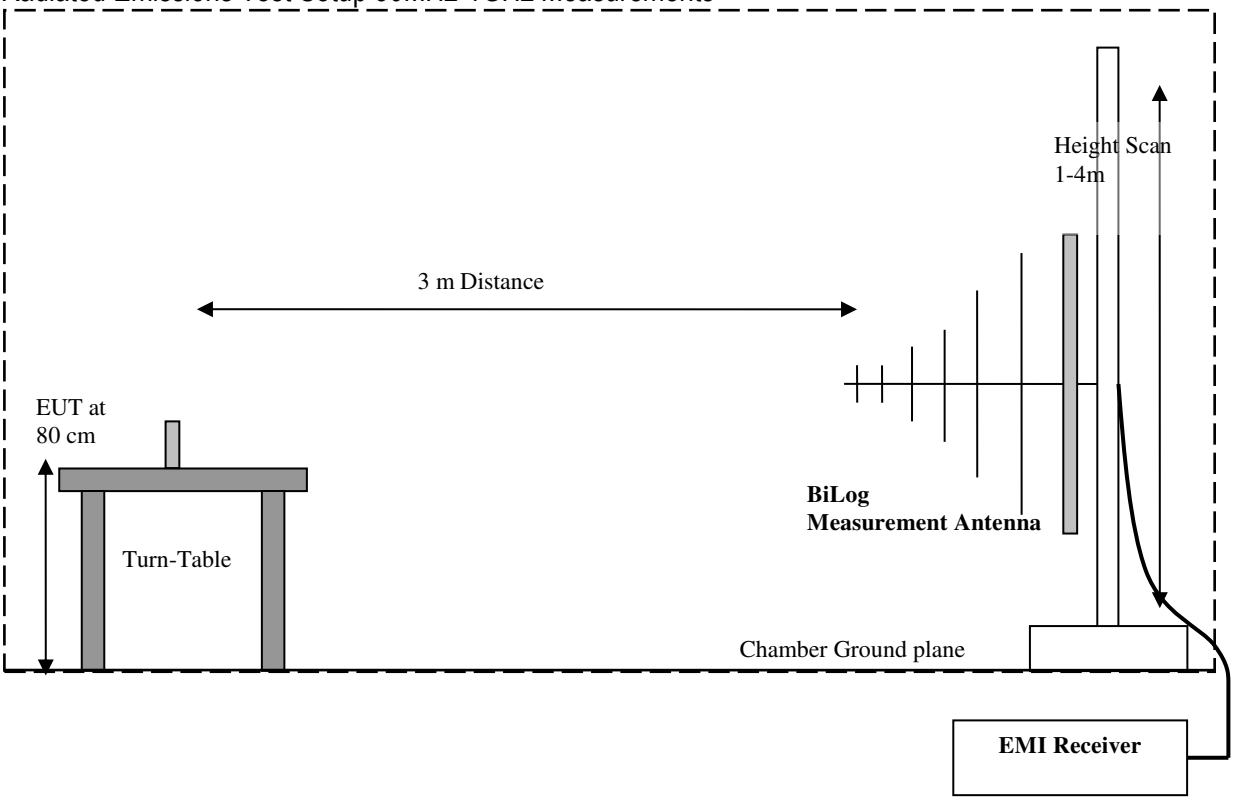
ANSI C63.10 (2013)

- The exploratory measurement is accomplished by running sweeps at 1 and 4m antenna heights over the required frequency range with R&S Test-SW EMC32 for both antenna polarizations. During each frequency scan the turntable rotates by no more than10deg.
- 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 again maximized through a fine search in frequency domain, maximized in the 360deg range of the turntable, and maximized over antenna height between 1m and 4m and for positioning of the EUT.
- The above procedure is repeated for transmission low mid and high channel.
- 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.

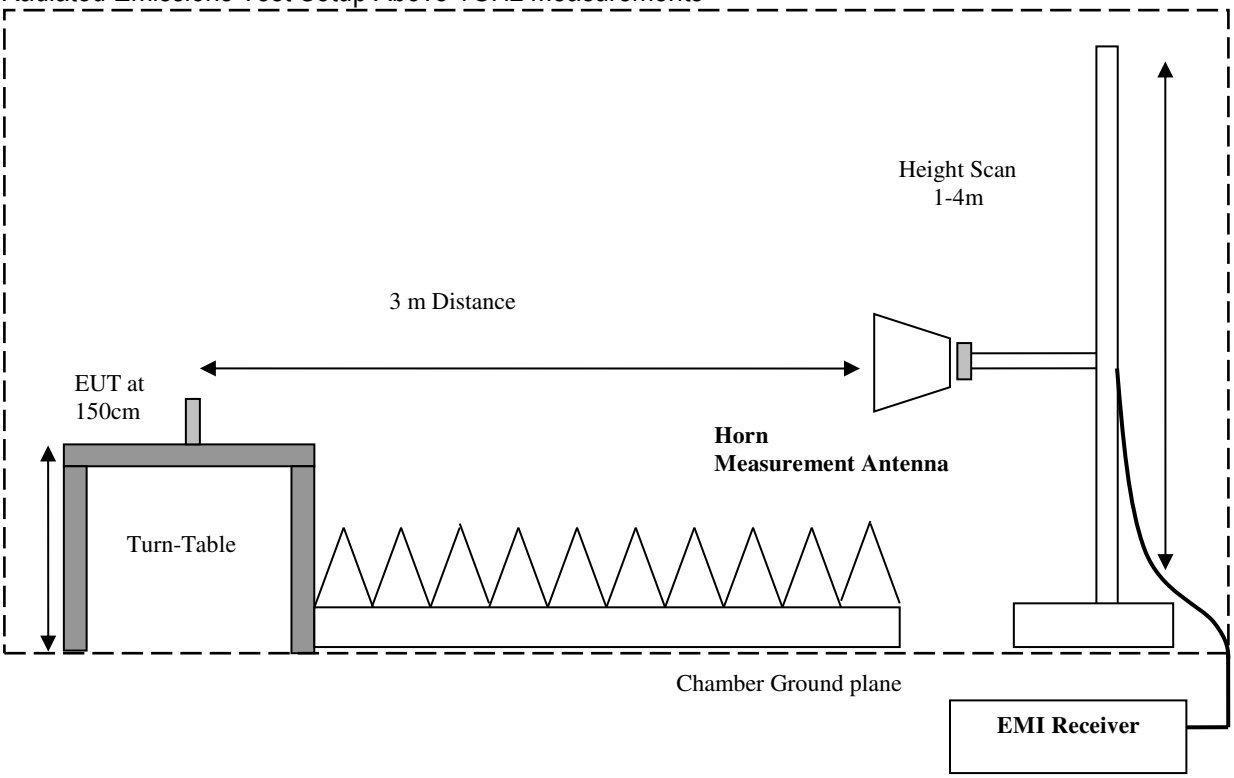
Radiated Emissions Test Setup Below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup Above 1GHz Measurements



9.2 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

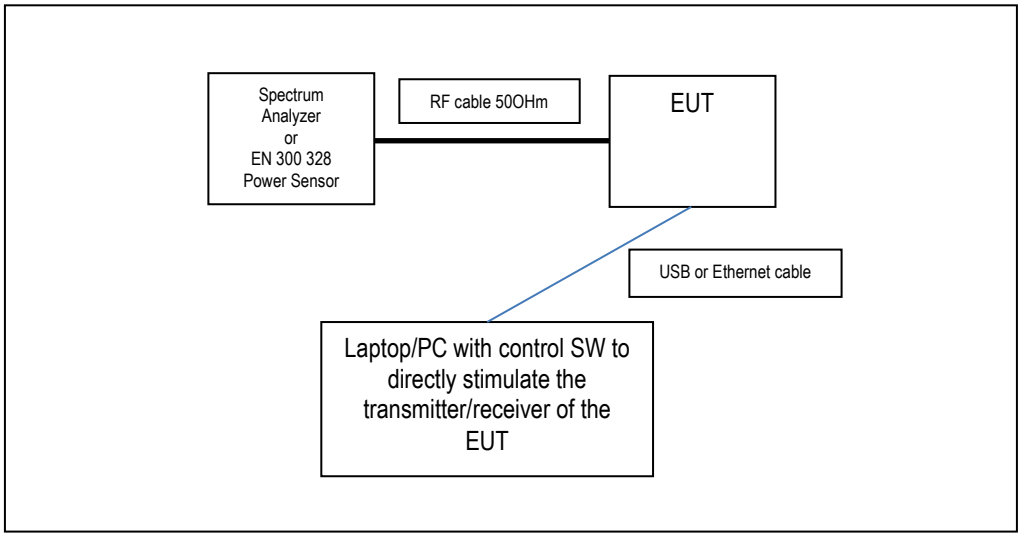
9.3 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to:

ANSI C63.4 (2014)

9.4 RF Conducted Measurement Procedure

9.4.1 Conducted Measurement Setup without companion device



10 Maximum Peak Conducted Output Power

10.1 Measurement according to FCC KDB 558074 D01 V03R04

Spectrum Analyzer settings:
According to KDB section 9.1.1 RBW ≥ DTS bandwidth

10.2 Limits:

Maximum Peak Output Power:
FCC §15.247 (b)(1): 1W
IC RSS-247: 1W

EIRP:
IC RSS-247: 4W

10.3 Test conditions and setup:

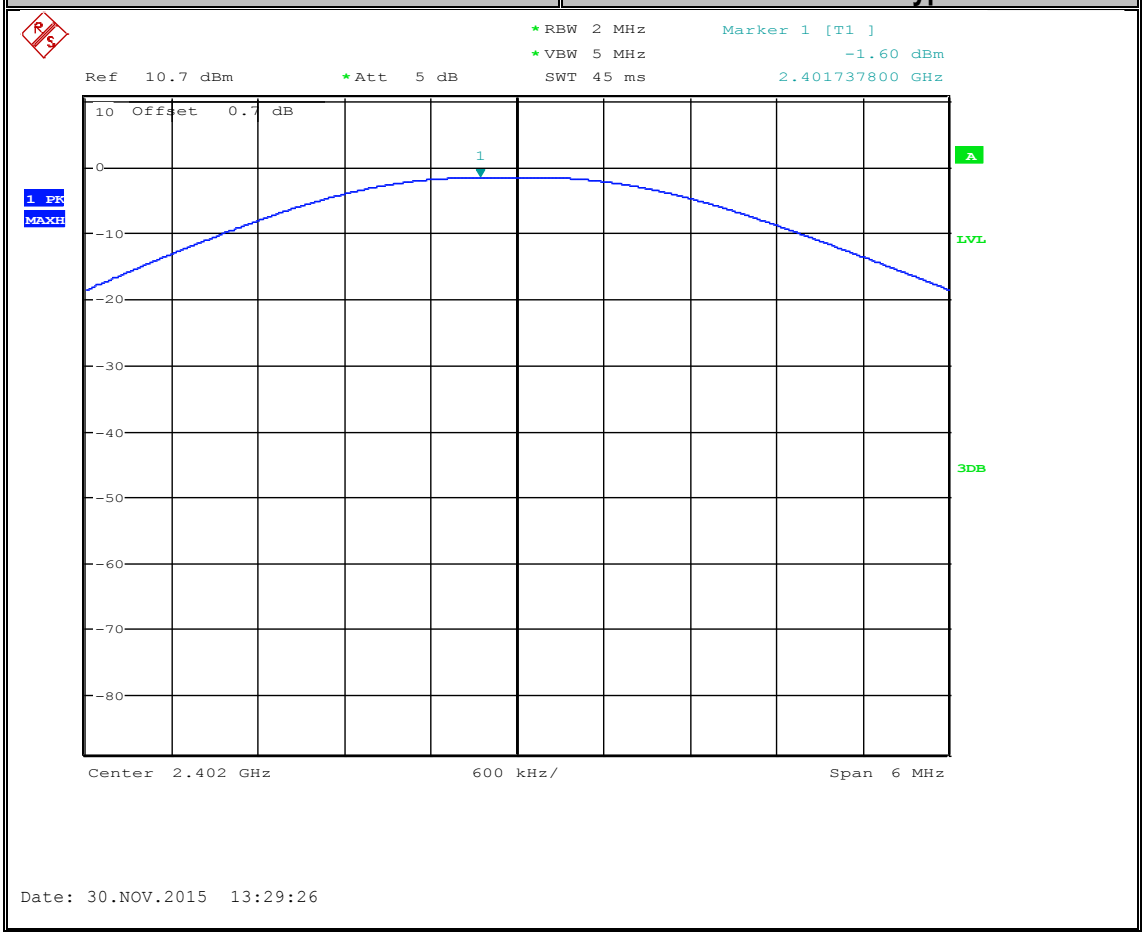
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23º C	2	Tx	Battery, 3.8V DC

10.4 Measurement result:

Plot #	Frequency (MHz)	Maximum Peak Conducted Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Result
1	2402	-1.6	+2.5	0.9	30(Pk) / 36(EIRP)	Pass
2	2440	-1.93	+2.5	0.57	30(Pk) / 36(EIRP)	Pass
3	2480	-2.7	+2.5	-0.2	30(Pk) / 36(EIRP)	Pass

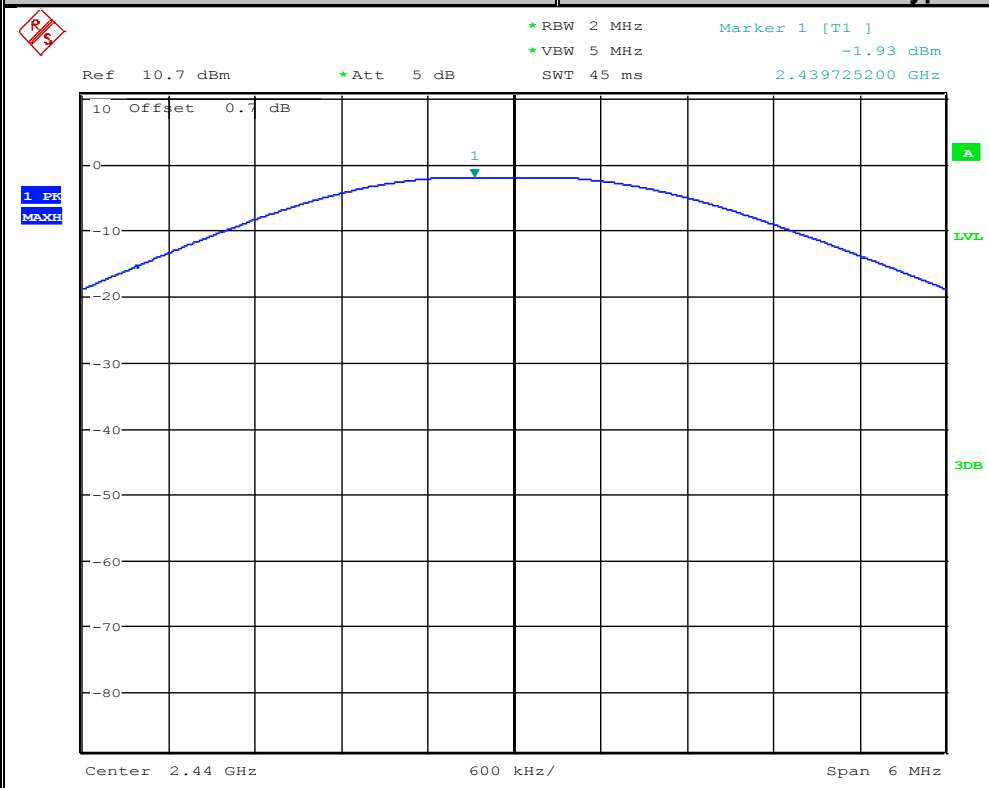
10.5 Measurement Plots:

Plot #1	
Ch. 0 / 2402MHz	Modulation/Packet Type: BTLE



Plot #2

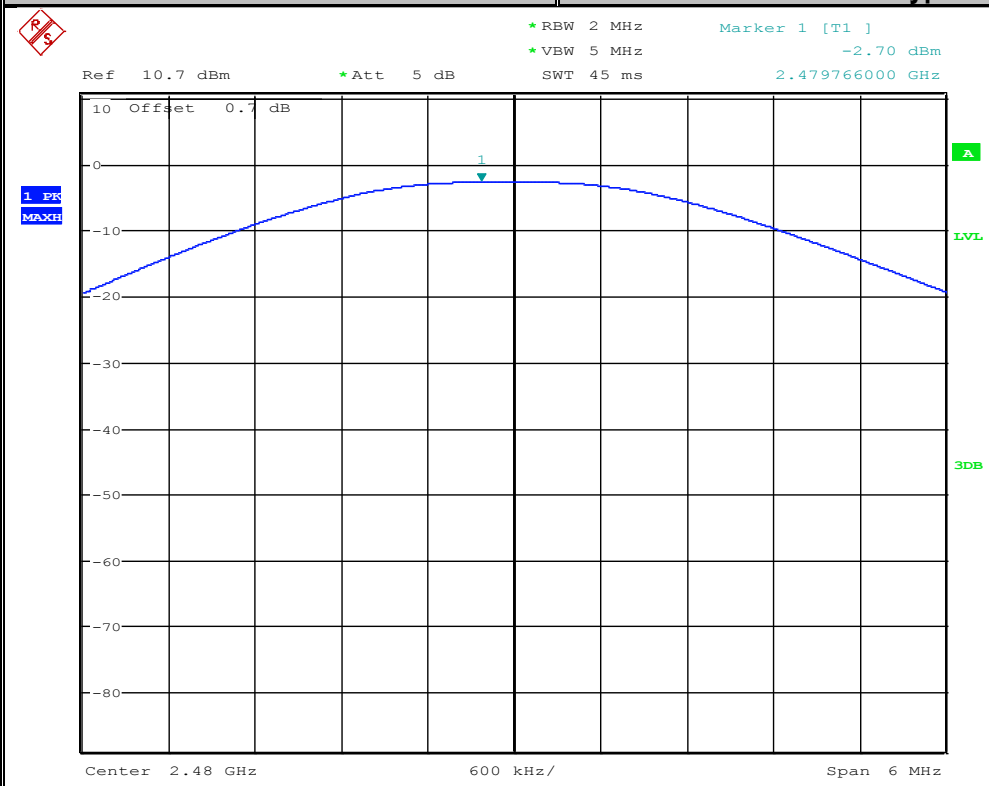
Ch. 19 / 2440MHz	Modulation/Packet Type: BTLE



Date: 30.NOV.2015 13:28:50

Plot #3

Ch. 39 / 2480MHz	Modulation/Packet Type: BTLE



Date: 30.NOV.2015 13:28:22

11 Power Spectral Density

11.1 Measurement according to FCC KDB 558074 D01 V03R03

Spectrum Analyzer settings:
According to KDB section 10.2 Method PKPSD (peak PSD)

11.2 Limits: §15.247 & RSS-247

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.

11.3 Test conditions and setup:

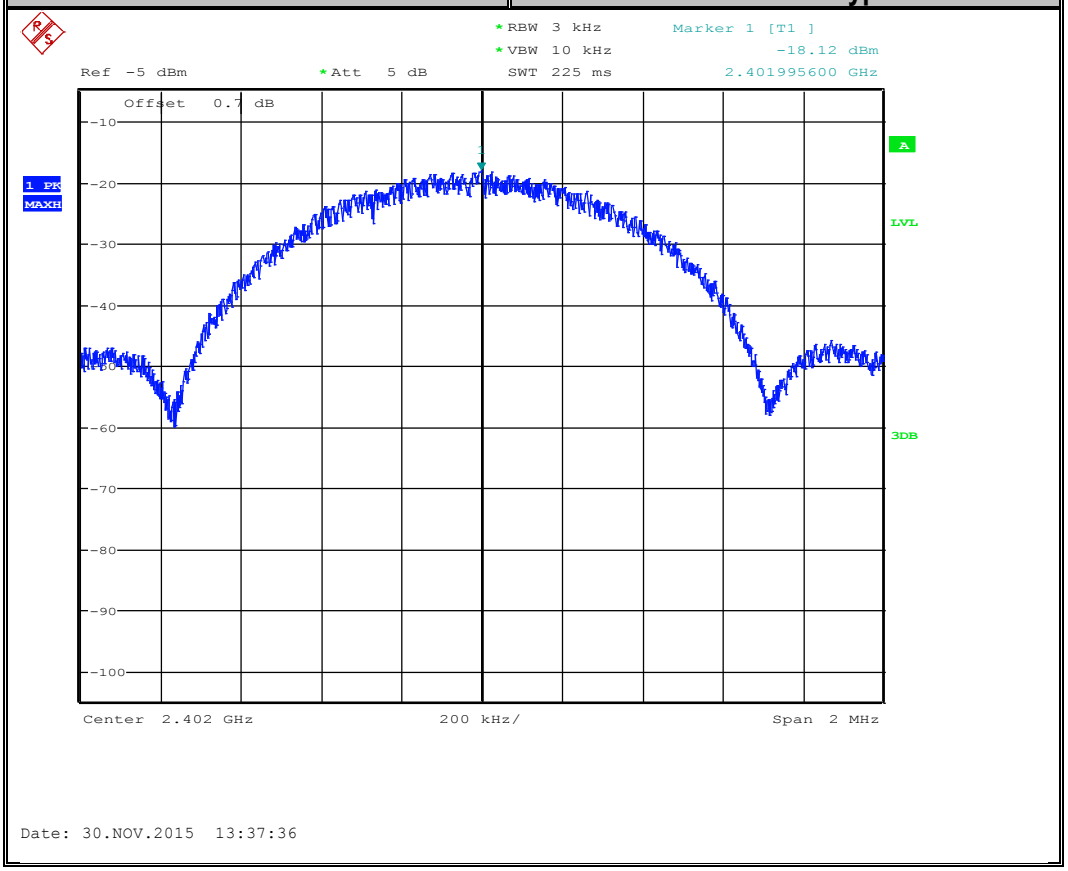
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23º C	2	Tx	Battery, 3.8V DC

11.4 Measurement result:

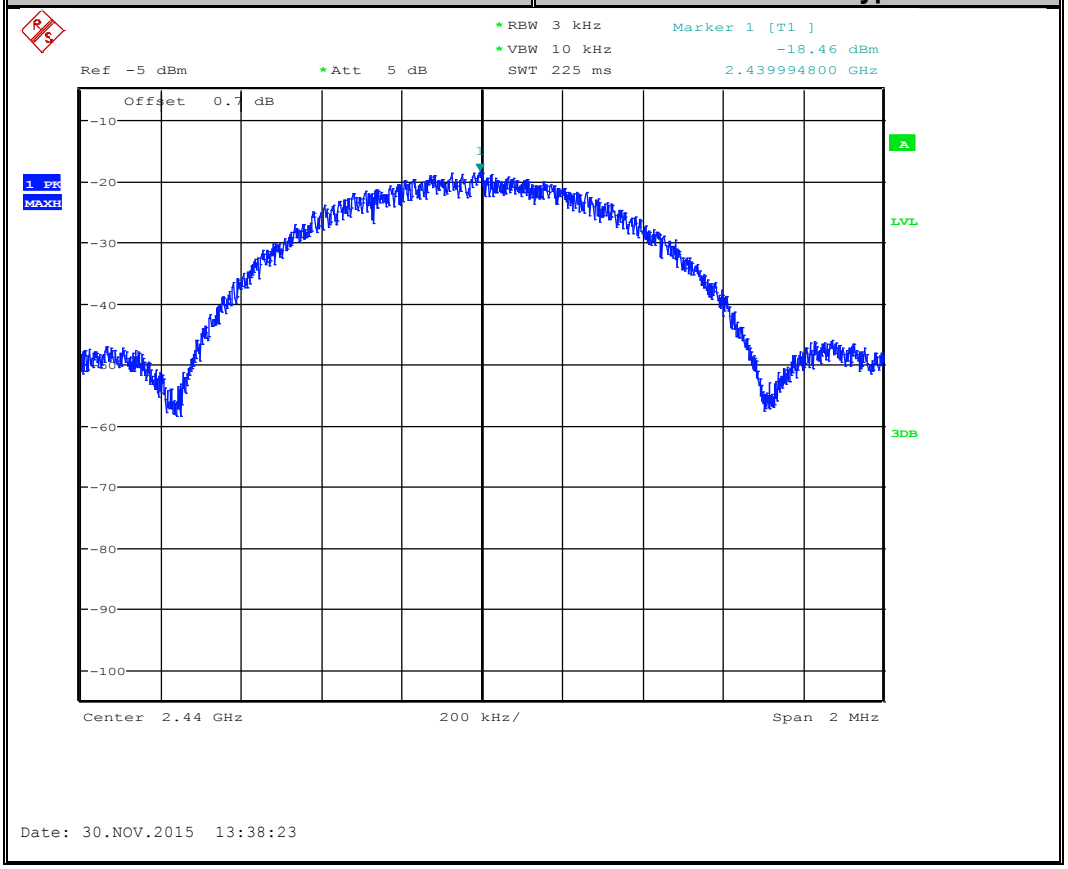
Plot #	Frequency (MHz)	Maximum Power Spectral Density (dBm/3kHz)	Limit (dBm / 3 KHz)	Result
1	2402	-18.12	8	Pass
2	2440	-18.46	8	Pass
3	2480	-18.92	8	Pass

11.5 Measurement Plots:

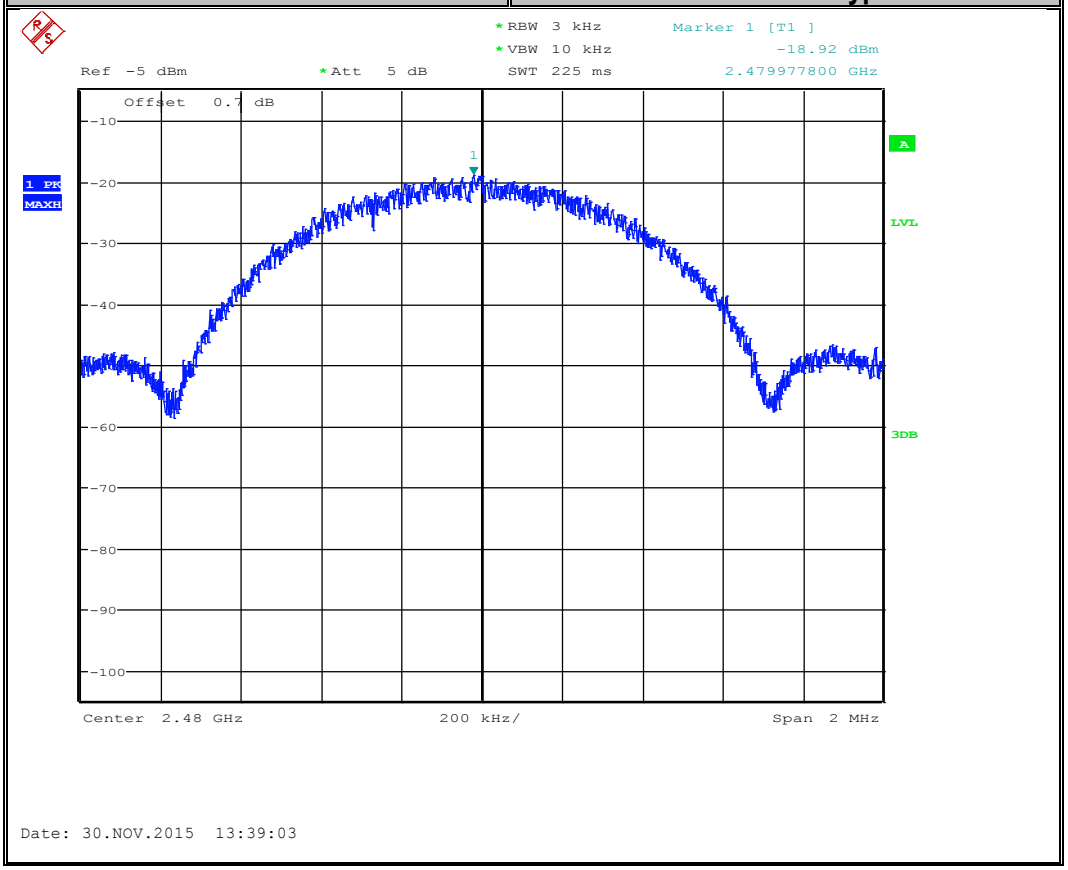
Plot #1	
Ch. 0 / 2402MHz	Modulation/Packet Type: BTLE



Plot #2	
Ch. 19 / 2440MHz	Modulation/Packet Type: BTLE



Plot #3	
Ch. 39 / 2480MHz	Modulation/Packet Type: BTLE



12 Band Edge Compliance

12.1 Measurement according to FCC KDB 558074 D01 v03r04

Spectrum Analyzer settings for band edge:
Set the center frequency and span to encompass frequency range to be measured
RBW ≥ 1oo kHz
VBW ≥ RBW
Sweep Time: Auto
Detector = peak
Trace = max hold
Allow trace to fully stabilize
Use the peak marker function to determine the maximum amplitude level
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.

12.2 Limits restricted band §15.205 and RSS-Gen 8.10

*PEAK LIMIT= 74dBµV/m @3m =-21.23dBm
*AVG. LIMIT= 54dBµV/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
[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			

12.3 Limits non restricted band §15.247 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.

12.4 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23º C	2	Tx	Battery, 3.8V DC

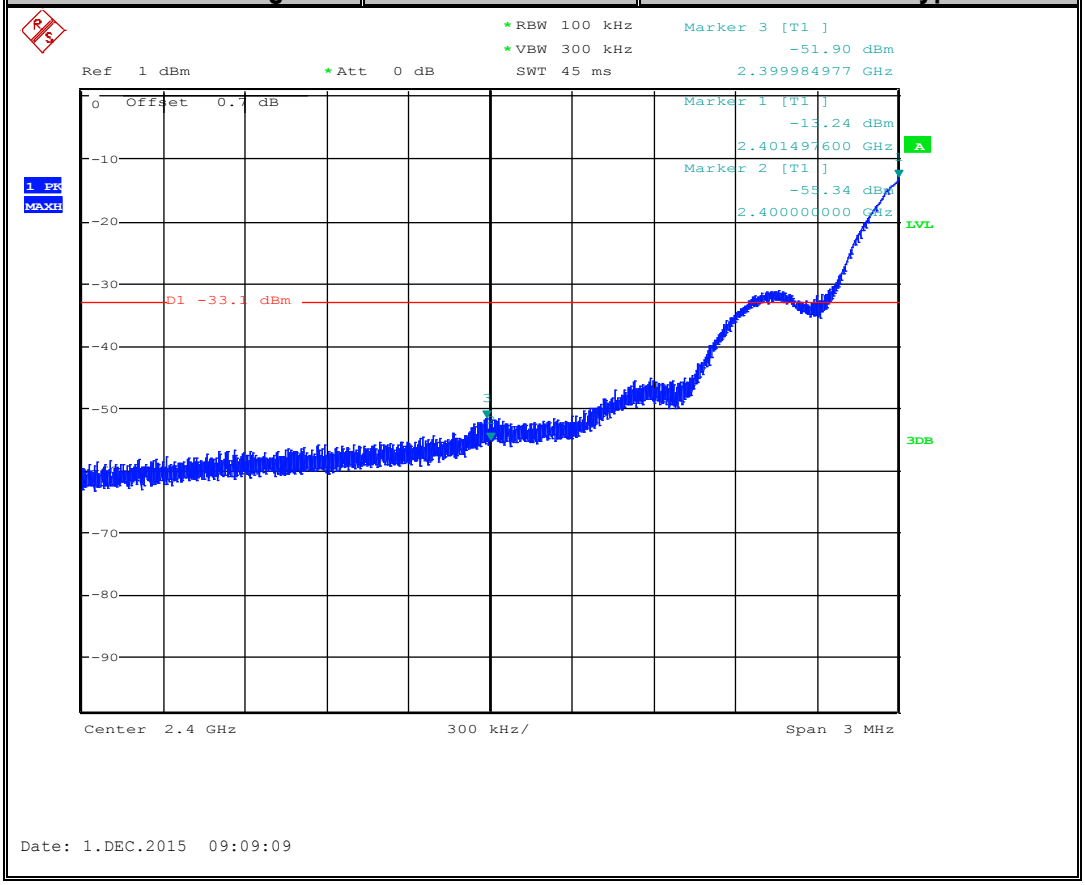
12.5 Measurement result:

Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
1	BTLE	Lower, non-restricted	-55.34	-20dBc if fundamental measured with peak detector	Pass

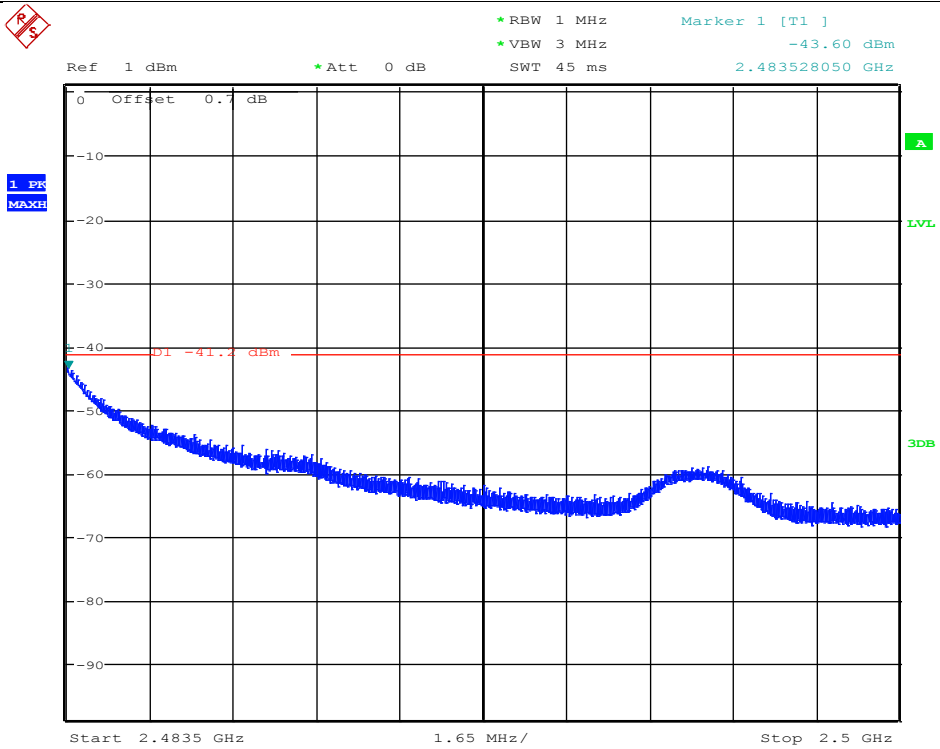
Plot #	EUT operating mode	Band Edge	Measured value	Corrected by duty cycle according to 3.2	Corrected by gain (min 2dBi)	Limit (dBm)	Result
2	BTLE	Upper restricted peak	-43.6 peak	100% Duty Cycle	2.5	-41.23 average	Pass
3	BTLE	Upper restricted average	-48.82 peak	100% Duty Cycle	2.5	-41.23 average	Pass

12.6 Measurement Plots:

Plot #1		
Lower Band Edge	Ch. 0 / 2402MHz	Modulation/Packet Type: GFSK

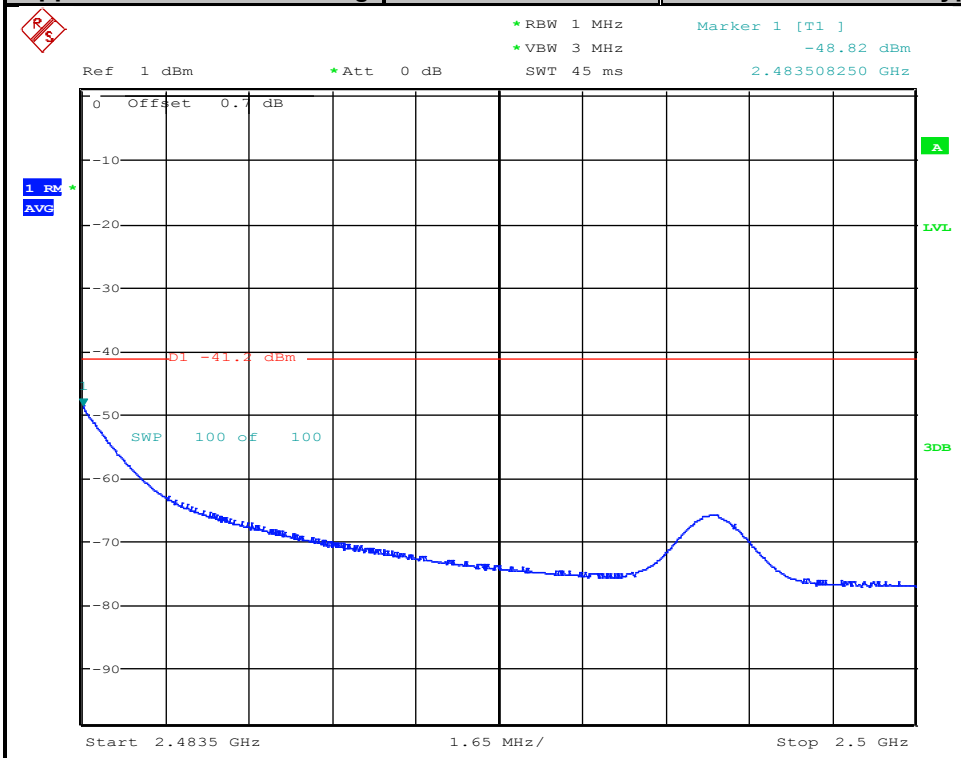


Plot #2		
Upper Restricted Band: Peak	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK



Date: 1.DEC.2015 09:17:32

Plot #3		
Upper Restricted Band: Avg	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK



Date: 1.DEC.2015 09:18:36

13 Emission Bandwidth 6dB and 99% Occupied Bandwidth

13.1 Measurement according to FCC KDB 558074 D01 v03r04

Spectrum Analyzer settings:
Set RBW = 100 kHz
Set the video bandwidth (VBW) ≥ 3 x 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.

13.2 Limits: §15.247

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.

13.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
°21 C	2	Tx	Battery, 3.8V DC

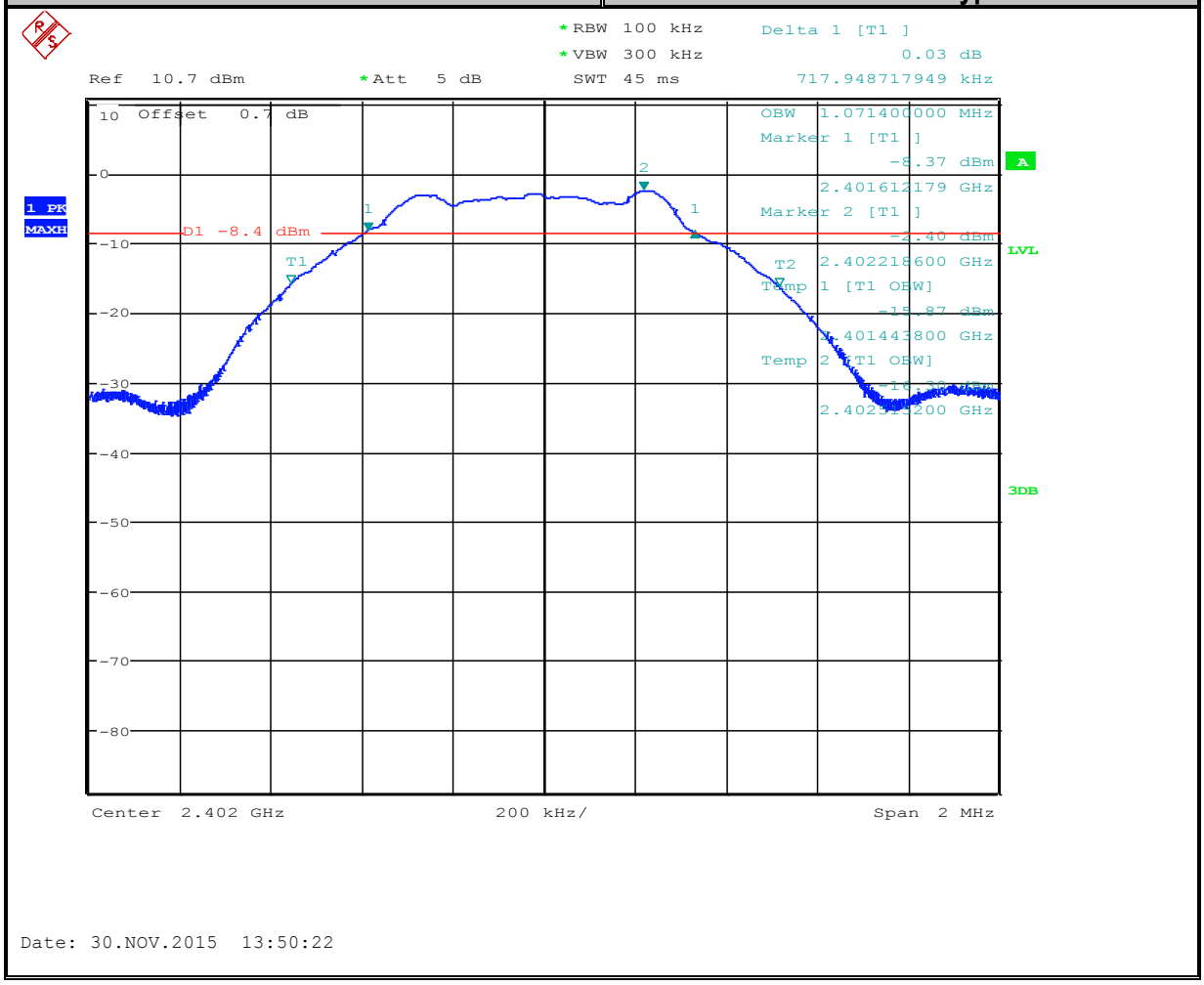
13.4 Measurement result:

Plot #	Frequency (MHz)	Modulation / Bandwidth	6dB Emissions Bandwidth (MHz)	Limit (MHz)	Result
1	2402	GFSK	0.717	> 0.5	Pass
2	2440	GFSK	0.778	> 0.5	Pass
3	2480	GFSK	0.611	> 0.5	Pass

Plot #	Frequency (MHz)	99% Occupied Bandwidth (MHz)
1	2402	1.0714
2	2440	1.0814
3	2480	1.0812

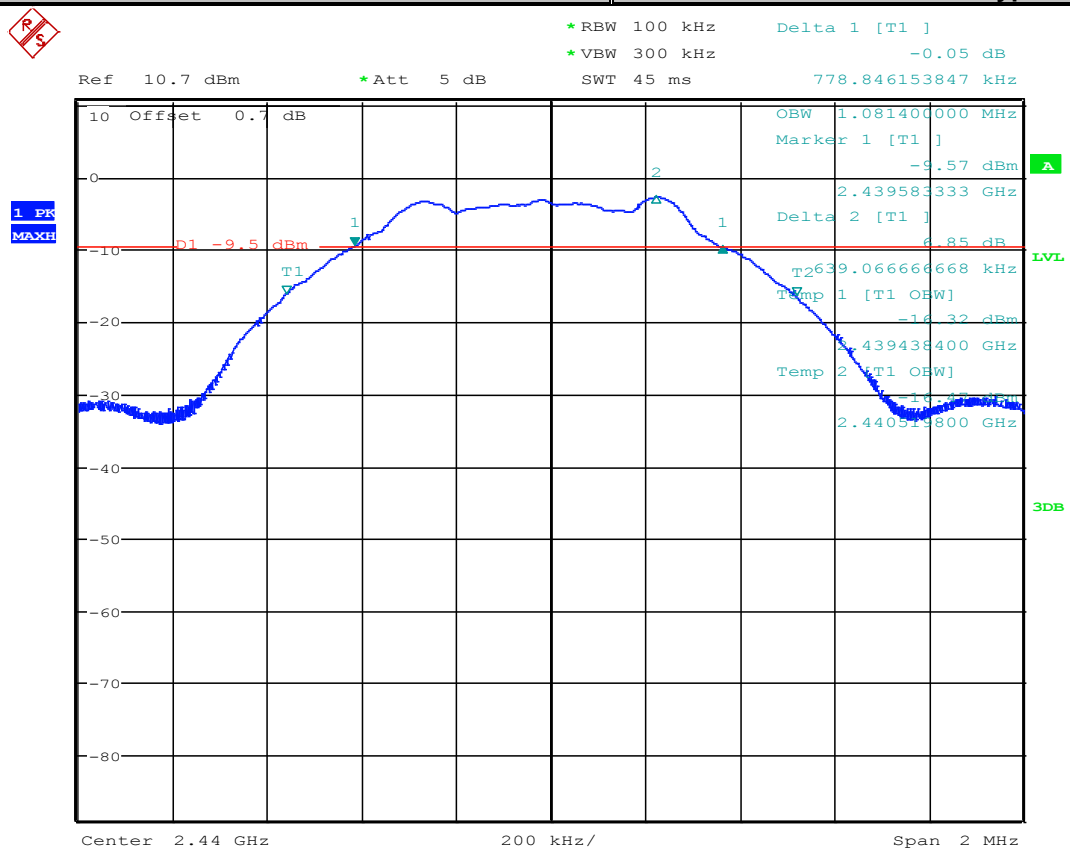
13.5 Measurement Plots:

Plot #1	
Ch. 0 / 2402MHz	Modulation/Packet Type: GFSK



Plot #2

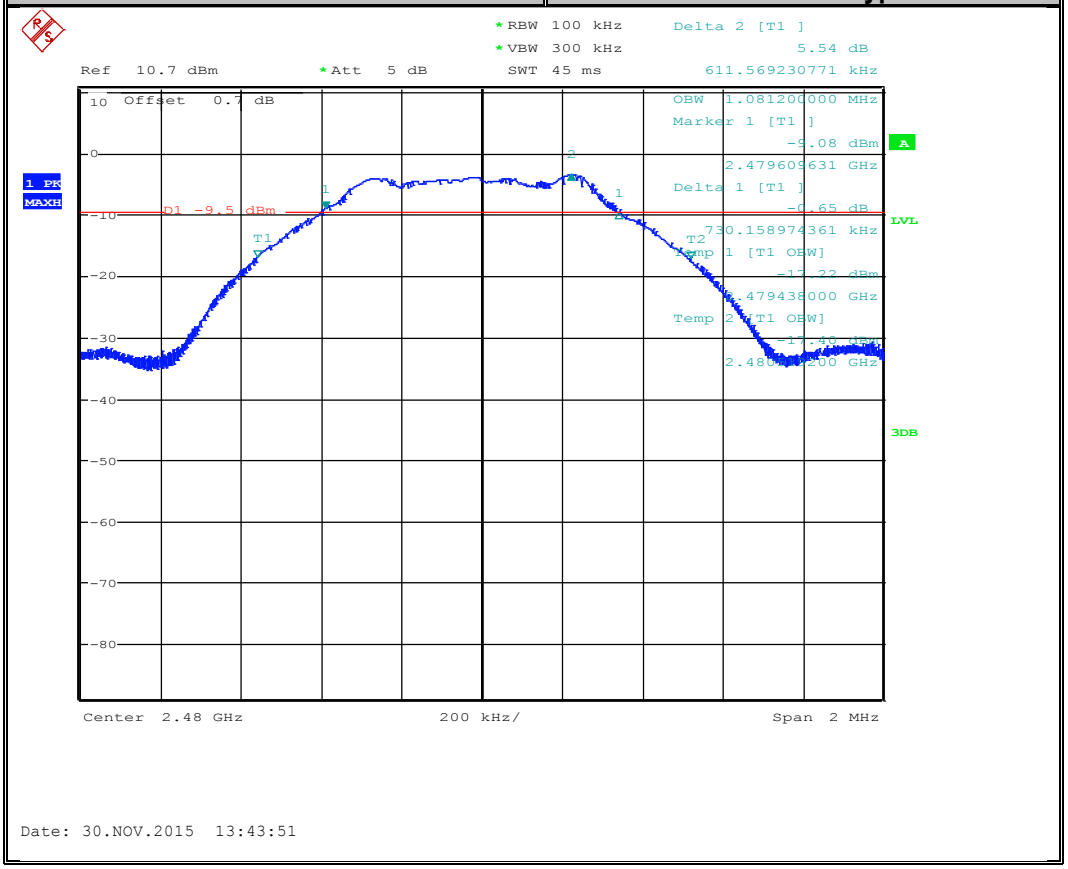
Ch. 19 / 2440MHz	Modulation/Packet Type: GFSK



Date: 30.NOV.2015 13:47:59

Plot #3

Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK



Date: 30.NOV.2015 13:43:51

14 Radiated Transmitter Spurious Emissions and Restricted Bands

14.1 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.

14.2 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	43.5dBµV/m
216–960	200	46dBµV/m
Above 960	500	54dBµV/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

14.3 Test conditions and setup:

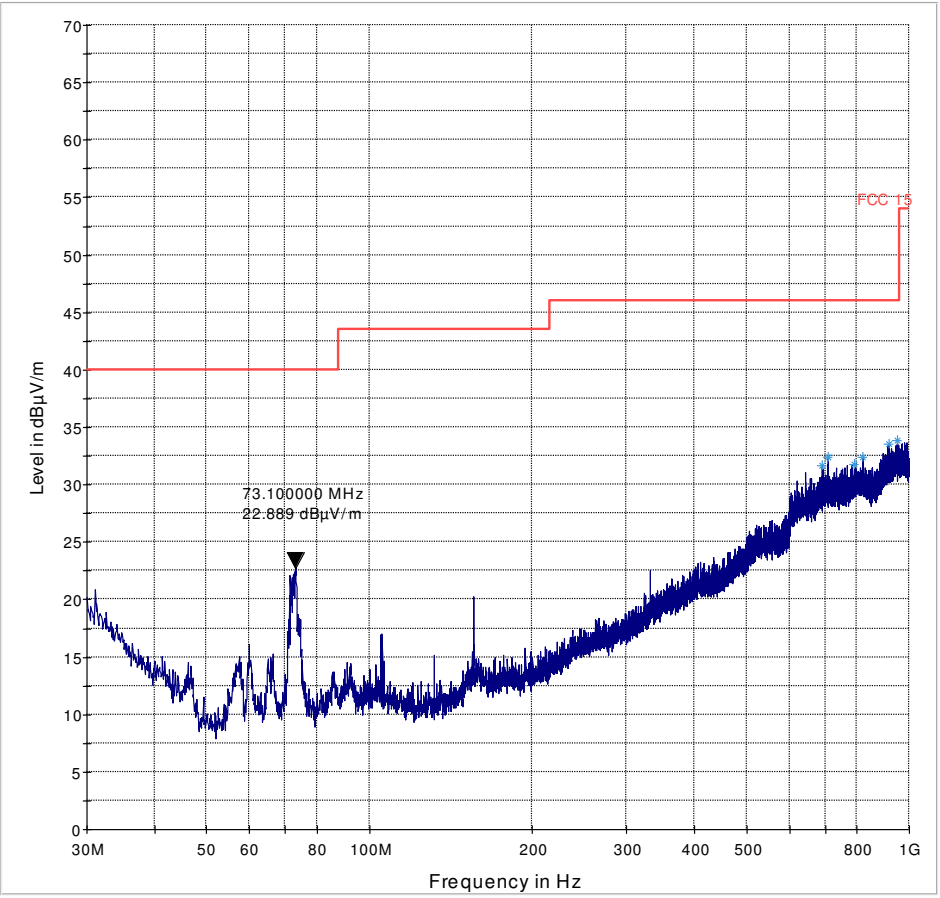
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23º C	1	Tx	Battery

14.4 Measurement result:

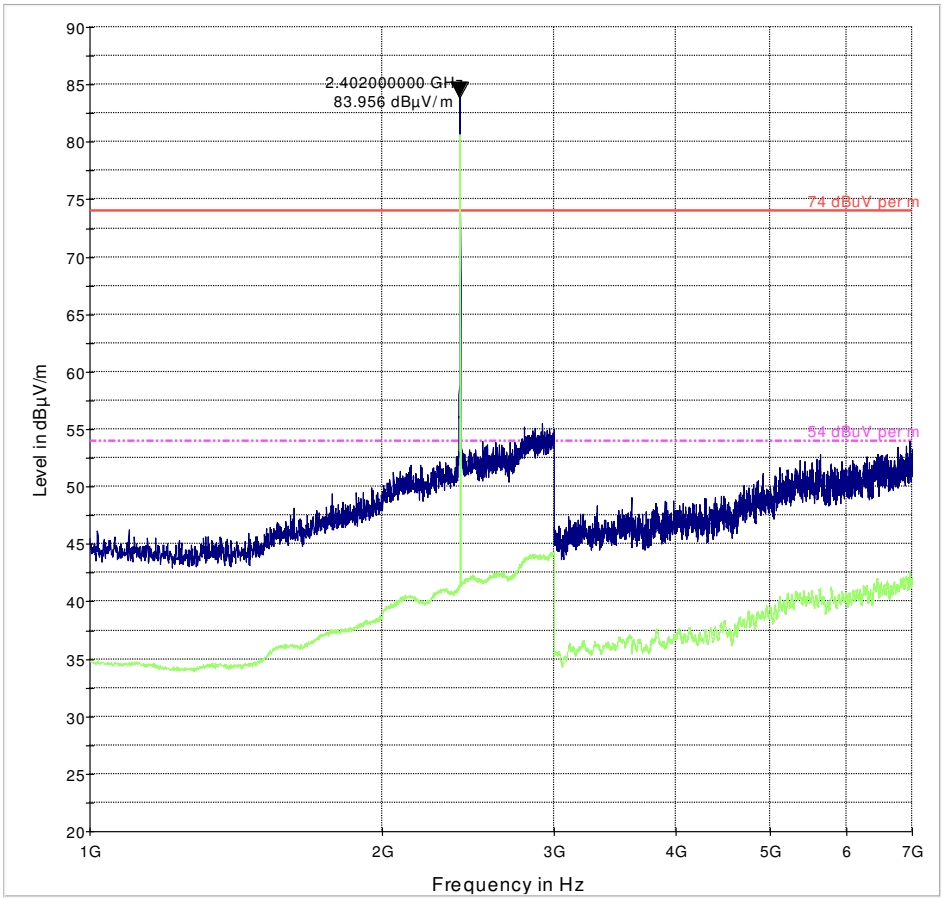
Plot #	Channel #	Scan Frequency	Limit	Result
1-3	0	30MHz – 18GHz	See section 8.7.2	Pass
4-8	19	9kHz – 26GHz	See section 8.7.2	Pass
9-12	39	30MHz – 18GHz	See section 8.7.2	Pass

14.5 Measurement Plots:

Plot #1		
RE: 30MHz – 1GHz	**Ch. 0 / 2402MHz**	**Modulation/Packet Type: GFSK**

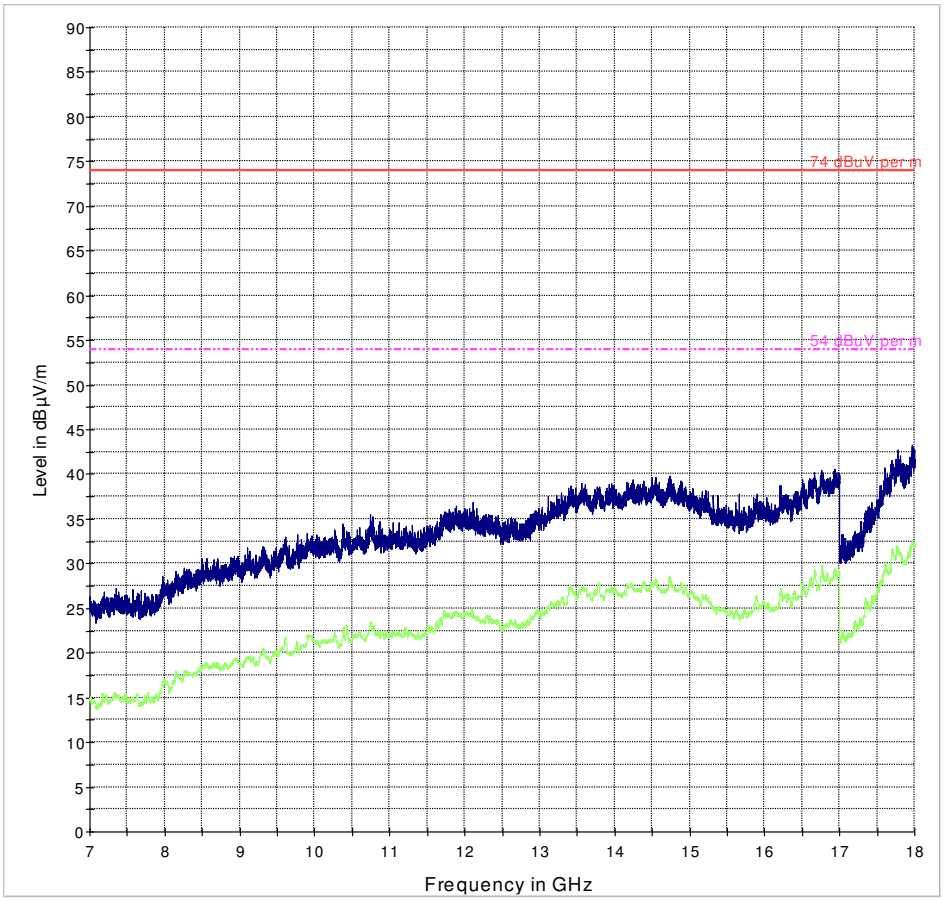


Plot #2		
RE: 1GHz – 7GHz	Ch. 0 / 2402MHz	Modulation/Packet Type: GFSK

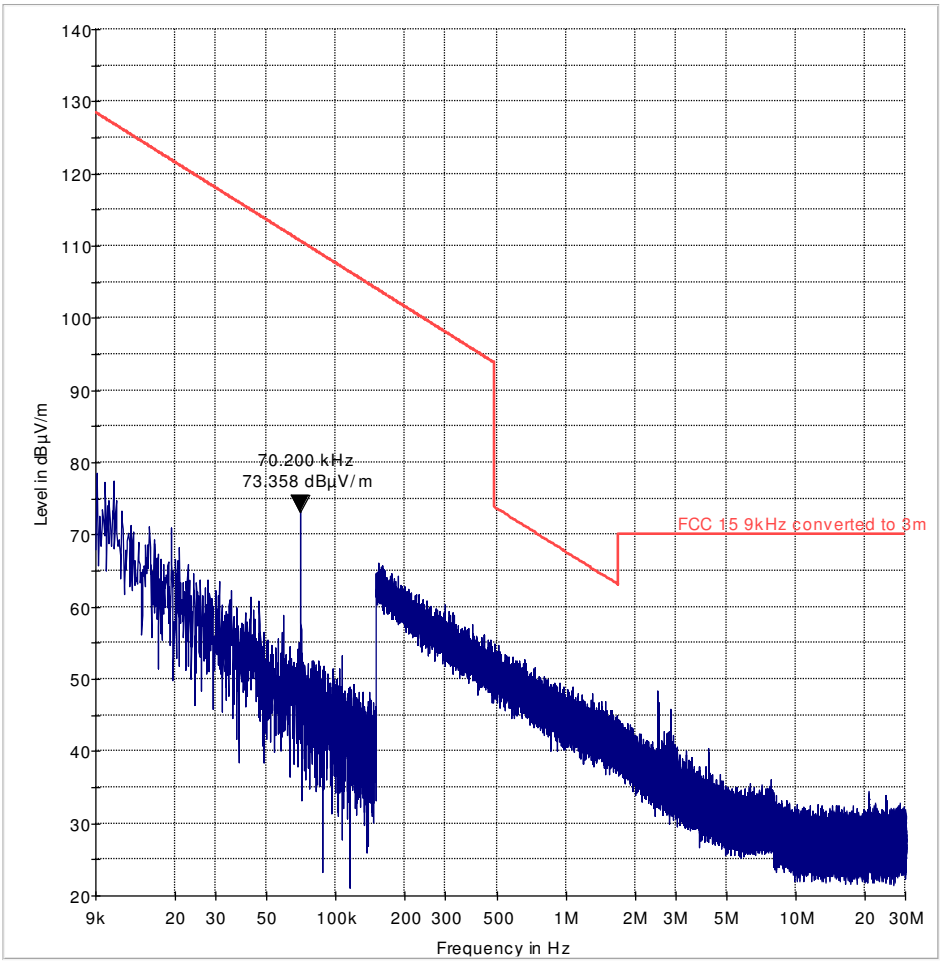


*Note: The peak signal is the Tx Ch. Low.

Plot #3		
RE: 7GHz – 18GHz	Ch. 0 / 2402MHz	Modulation/Packet Type: GFSK

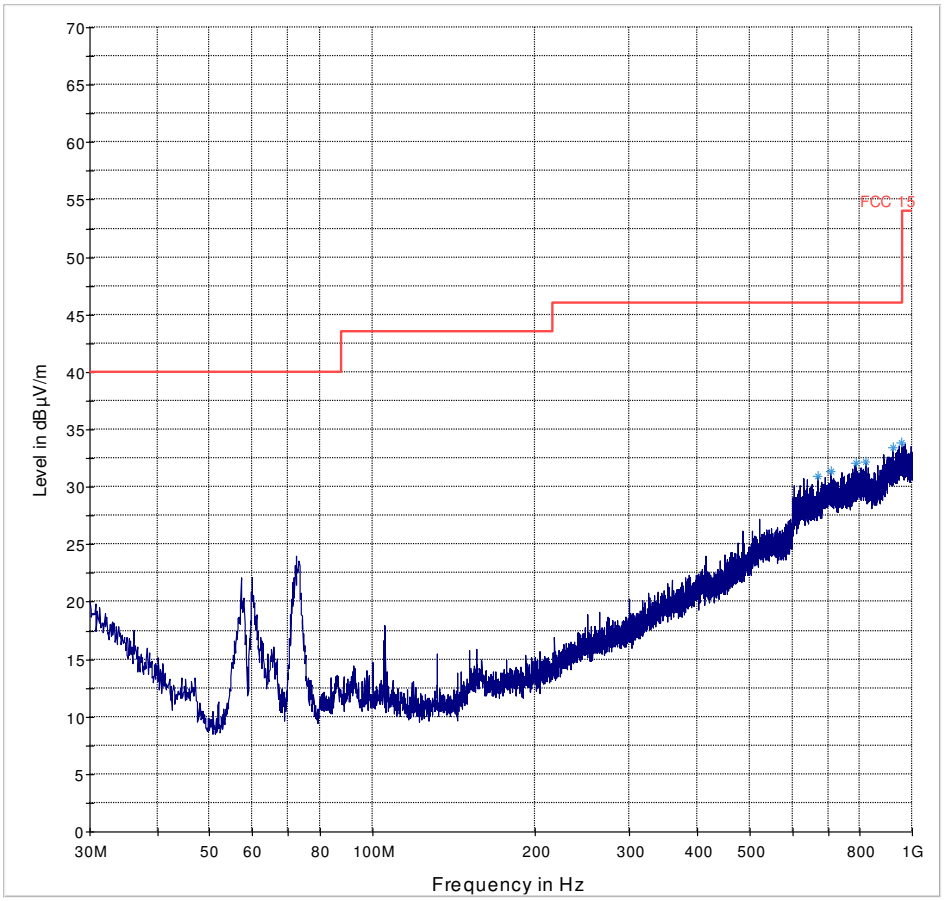


Plot #4		
RE: 9KHz – 30MHz	Ch. 19 / 2440MHz	Modulation/Packet Type: GFSK

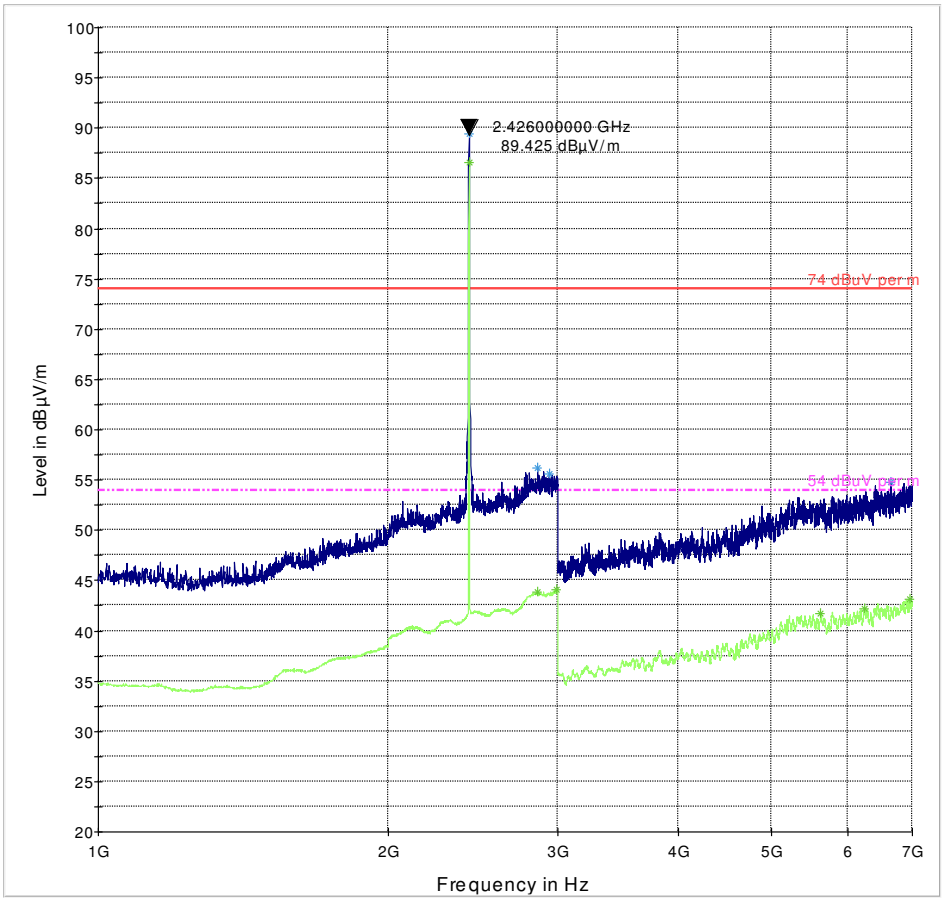


FCC 15 9kHz converted to 3m — Preview Result 1-PK+

Plot #5		
RE: 30MHz – 1GHz	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK

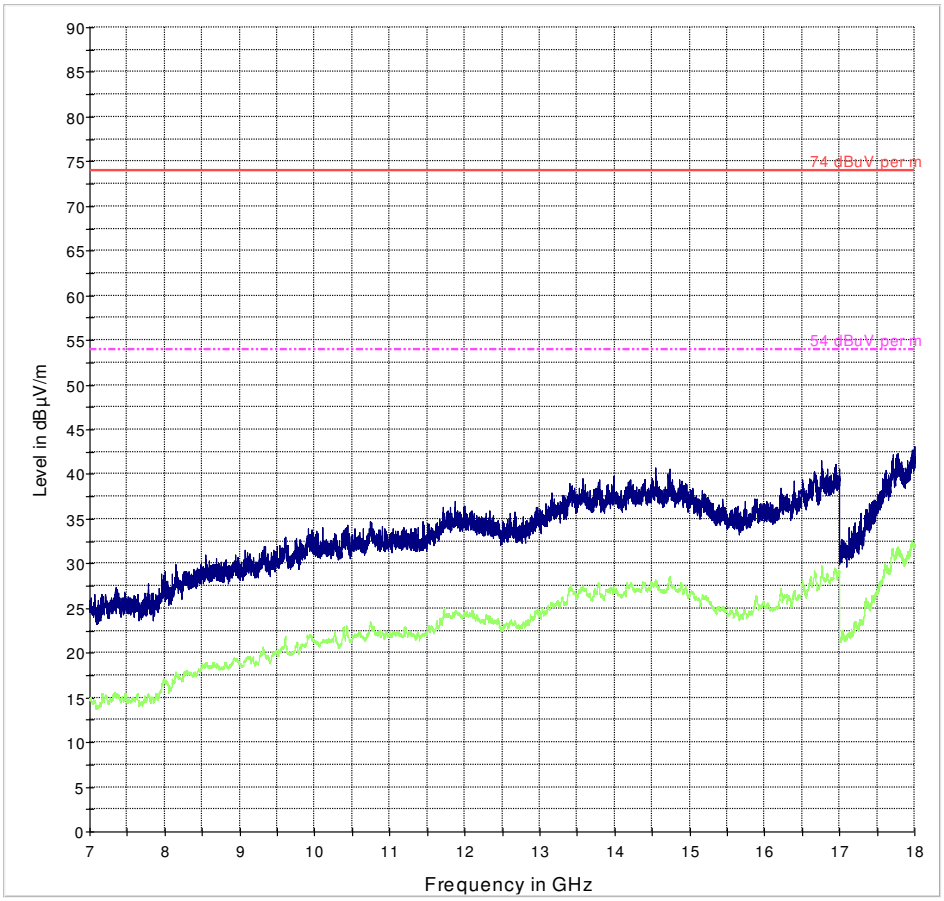


Plot #6		
RE: 1GHz – 7GHz	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK

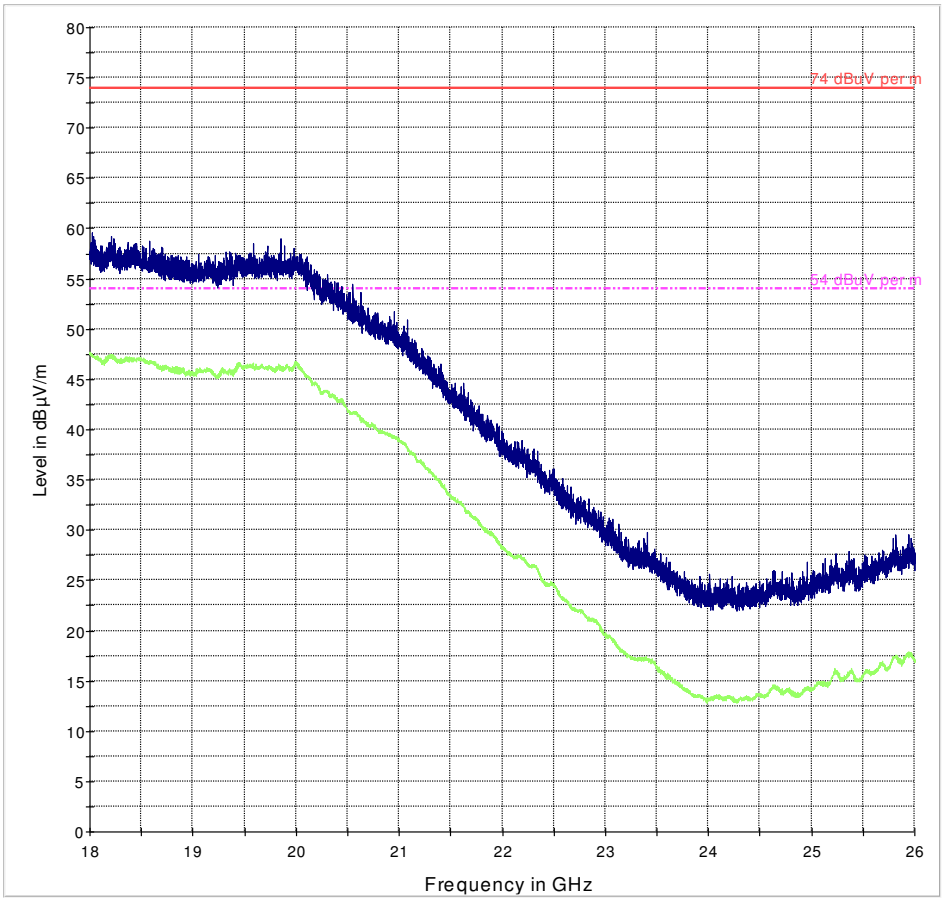


*Note: The peak signal is the Tx Ch. Mid.

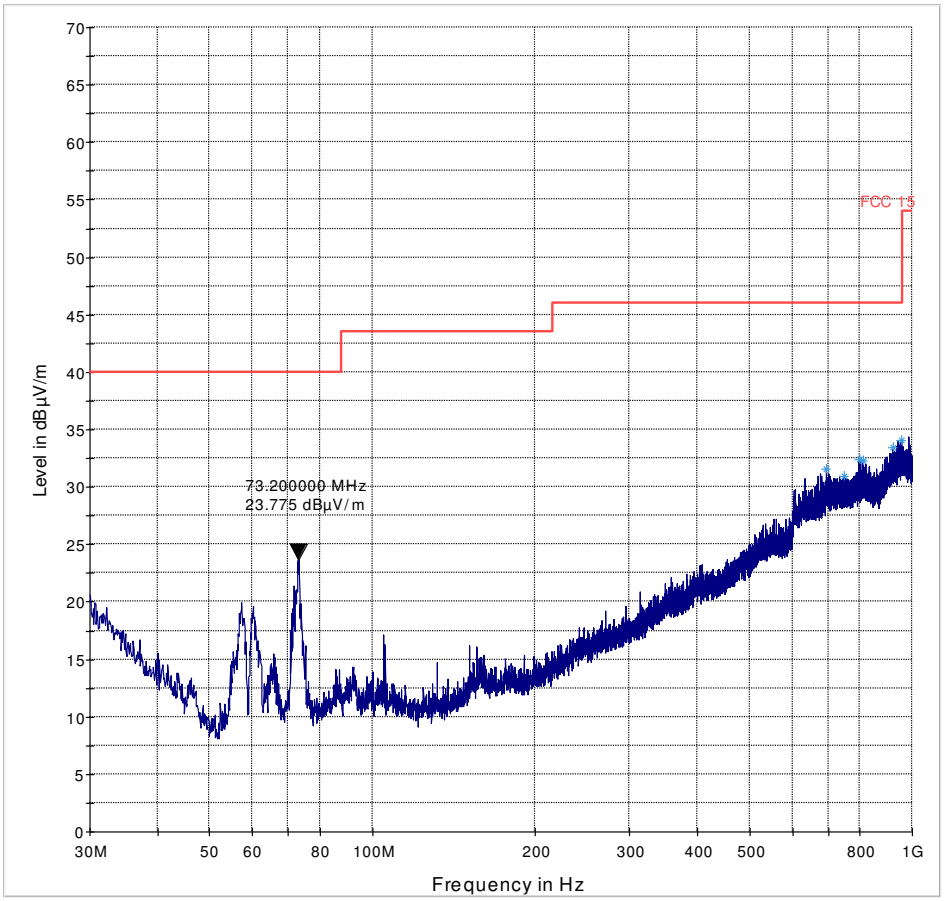
Plot #7		
RE: 7GHz – 18GHz	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK



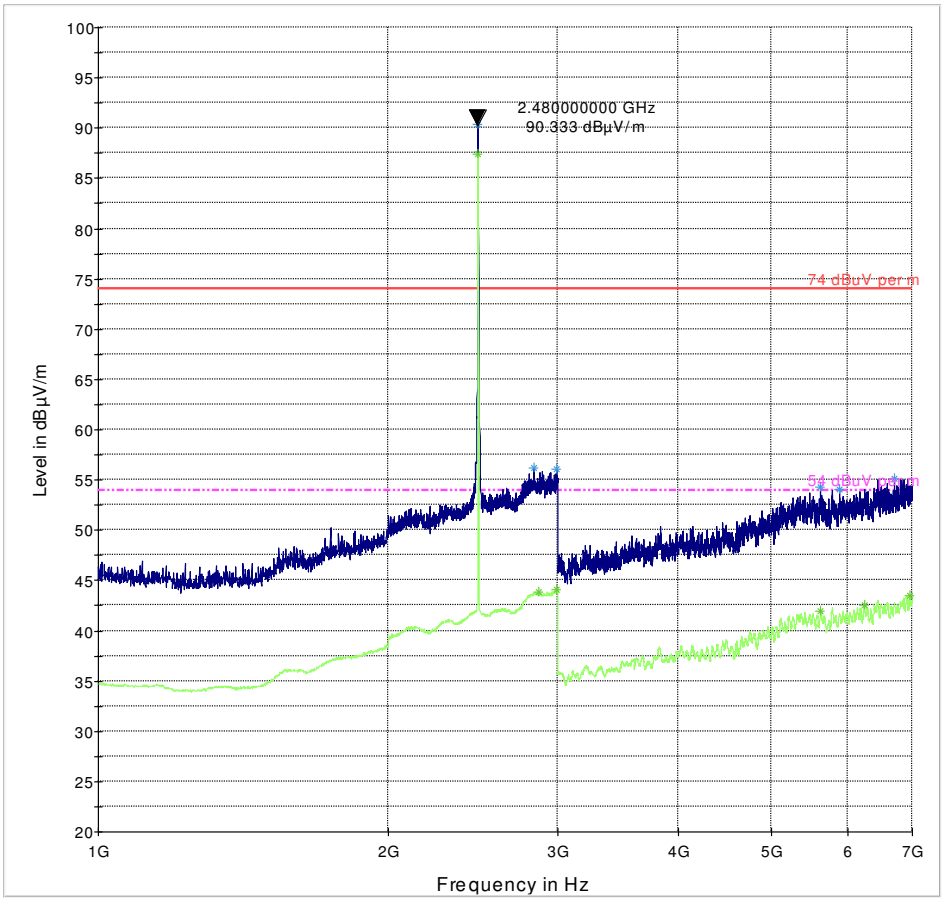
Plot #8		
RE: 18GHz – 26GHz	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK



Plot #9		
RE: 30MHz – 1GHz	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK

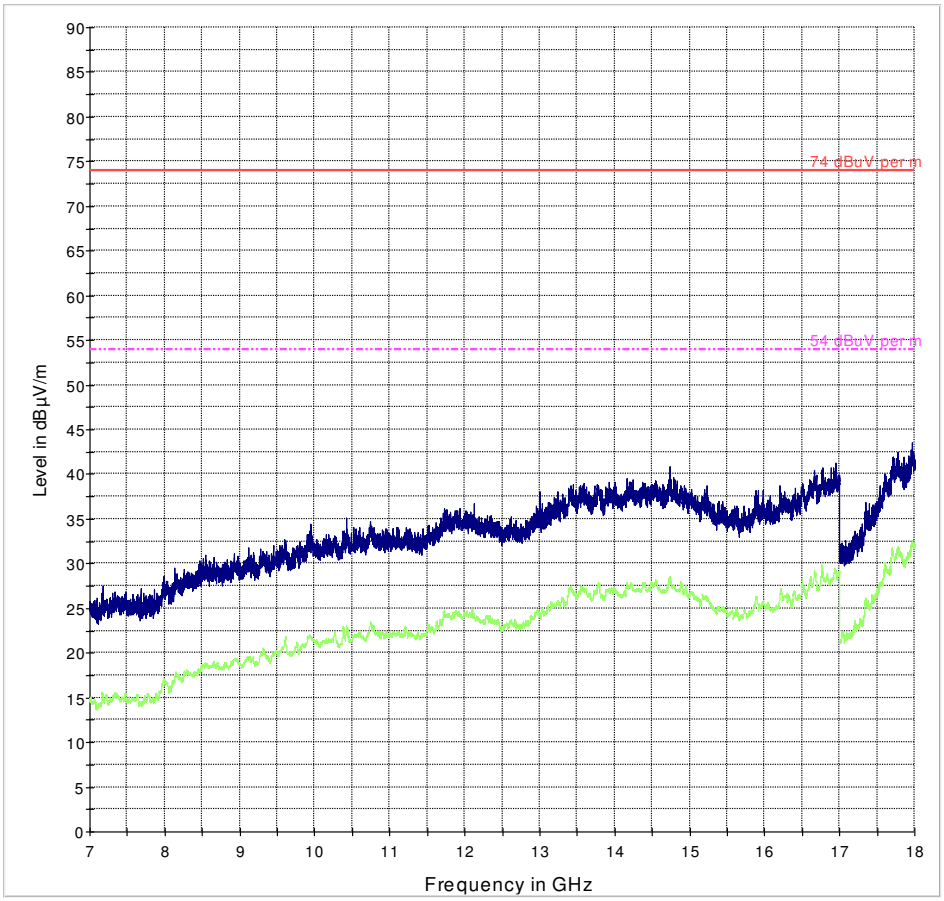


Plot # 10		
RE: 1GHz – 6GHz	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK



*Note: The peak signal is the Tx Ch. High.

Plot #11		
RE: 18GHz – 26GHz	Ch. 39 / 2480MHz	Modulation/Packet Type: GFSK



15 AC Power Line Conducted Emissions

The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

15.1 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 the 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.

15.2 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	3	Tx	AC/DC Power Supply, 120V AC

15.3 Test Procedure:

Measurement according to ANSI C63.10:2013 section 6.2 and 4.1 (also refer to section 6, 6.3 in this test report)

Analyzer Settings:
RBW = 9 KHz (CISPR Bandwidth)
Detector: Qusi-Peak / Average

15.4 Results:

Pass

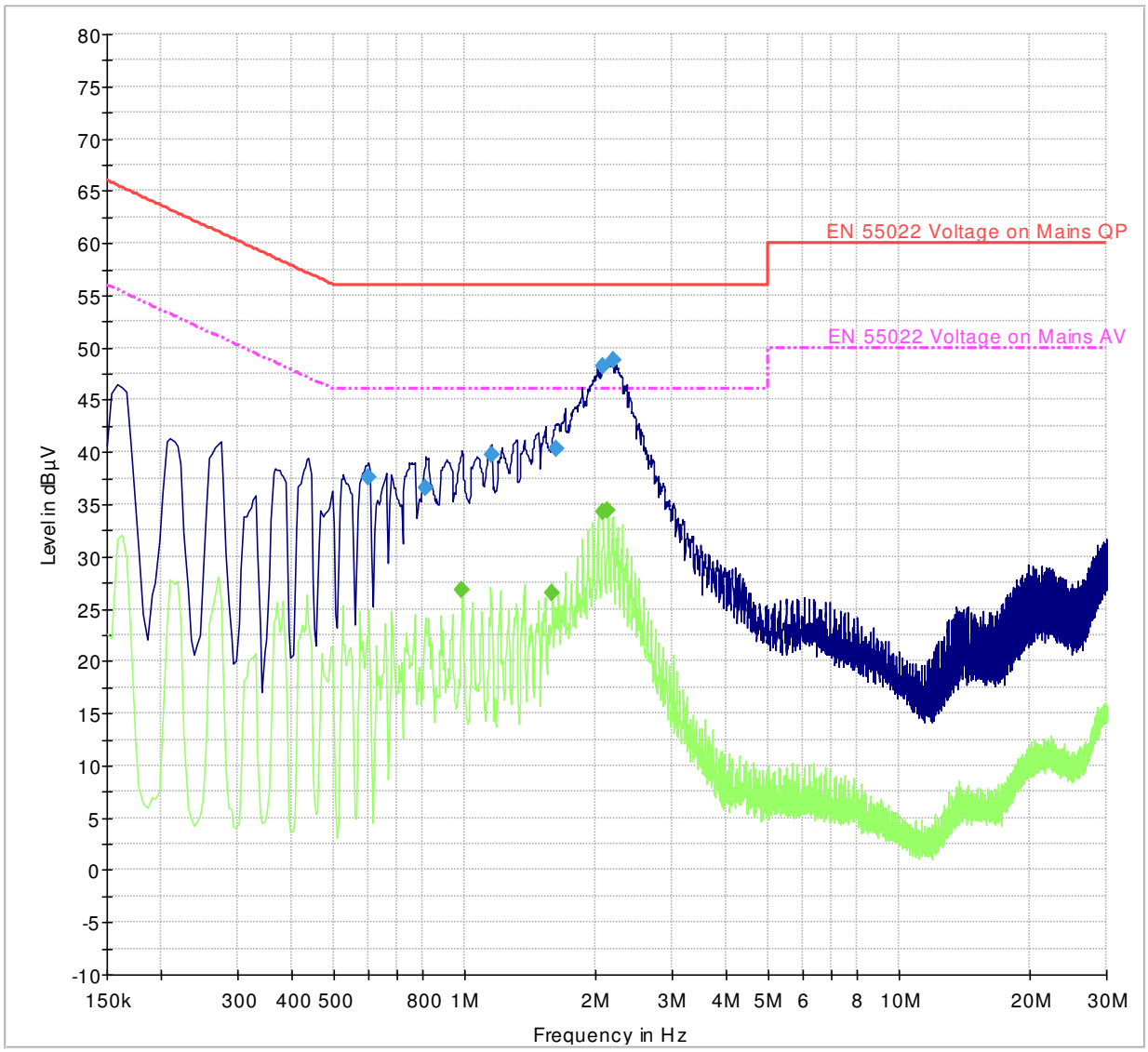
15.5 Test Data:

Conducted Emissions: 150 KHz – 30 MHz

Frequency (MHz)	Quasi-Peak (dBuV)	Meassurement Time (ms)	BW (KHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)	Comments
0.602000	37.6	500.0	9.000	GND	N	0.4	18.4	56.0	
0.814000	36.6	500.0	9.000	GND	L1	0.4	19.4	56.0	
1.154000	39.8	500.0	9.000	GND	N	0.4	16.2	56.0	
1.622000	40.3	500.0	9.000	GND	L1	0.5	15.7	56.0	
2.086000	48.2	500.0	9.000	GND	L1	0.5	7.8	56.0	
2.194000	48.8	500.0	9.000	GND	L1	0.5	7.2	56.0	

15.6 Measurement Plots:

Conducted Emissions: 150 KHz – 30 MHz



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

Note: Plots shown here represent the combined worse case emissions for power lines (phases and neutral line).

16 Setup Pictures

See EMC_MOOGI-005-15001_TestSetupPhotos.pdf

17 EUT pictures

See EMC_MOOGI-005-15001_TestSetupPhotos.pdf

18 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 Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	7/22/2015
Antenna Loop 6512	Loop Antenna	ETS Lindgren	6512	49838	3 years	3/13/2014
Digital Barometer	Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	4/7/2015
Receiver ESU40	EMI Receiver	R&S	ESU40	100251	3 years	6/29/2015
Spectrum Analyzer FSU26 #2	Spectrum Analyzer	R&S	FSU26	200065	3 years	7/4/2015

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.

19 Revision History

Date	Report Name	Changes to report	Report prepared by
February 3, 2016	EMC_MOOGI-005-15001_15.247_BTLE	Initial Version	Yu-Chien Ho