FCC Test Report

FOR:

Hykso

Model Name:

Hykso Wearable Sensors

Product Description:

Wearable device for combat sports. Installed on the wrists, the boxers and MMA athletes can know how many punches, at what speed, and what is the type of the punches they thrown during their trainings.

FCC ID: 2AK2R-HWS01
IC ID: 22370-HWS01

Per:

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

REPORT #: EMC_ARROW-001-16501_15.247_BT_LE_Rev1

DATE: 2017-03-28

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 ◆ http://www.cetecom.com
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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 IC standard RSS-247 Issue 1, Section 5. and RSS-Gen Issue 4.

Company	Description	Model #
Hykso	Wearable device for combat sports. Installed on the wrists, the boxers and MMA athletes can know how many punches, at what speed, and what is the type of the punches they thrown during their trainings.	HWS-01

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2017-03-28	Compliance	James Donnellan (Sr. EMC Test 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: 2017.03.28 14:20:16 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
2017-03-28	Compliance	Douglas Antioco (Sr. EMC Test Engineer)	Douglas Antioco 2017.03.28 14:05:12 -07'00'

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
Test Engineer	Douglas Antioco
Project Manager	Laith Saman

2.2 Identification of the Client

Applicant's Name:	Hykso
Street Address:	234 E 17th St, Suite 207
City/Zip Code	Costa Mesa, CA 92627
Country	USA

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same As Client.
Manufacturers Address:	
City/Zip Code	
Country	

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	hws-01
HW Version :	hws-trk-01c
SW Version :	firmware version: 1.03r
FCC-ID :	2AK2R-HWS01
IC-ID:	22370-HWS01
HVIN:	hws01
PMN:	Hykso Wearable Sensors
Product Description:	Wearable device for combat sports. Installed on the wrists, the boxers and MMA athletes can know how many punches, at what speed, and what is the type of the punches they thrown during their trainings.
Frequency Range / number of channels:	Nominal band: 2400 – 2483.5; Center to center: 2402(ch 0) – 2480(ch 39), 40 channels
Type(s) of Modulation:	Bluetooth version 4.0, Low Energy, using Dynamic Sequence Spread Spectrum with GFSK modulation.
Modes of Operation:	Advertising, Hopping
Integrated Module Info:	Nordic Semiconductor NRF52832-CIAA • Bluetooth 4.0 Low Energy (BT LE)
Antenna Information as declared:	Internal antenna: Antenna Gain: 1.8 dBi @ 2.4 GHz.
Max. Output Power:	Conducted Power 0 dBm (Peak)
Power Supply/ Rated Operating Voltage Range:	Dedicated Battery Pack (Li-ion) Vmin: 3.4VDC/ Vnom: 3.7VDC / Vmax: 4.2VDC
Operating Temperature Range	15.6° C (60° F) to 32.2° C (90° F)
Other Radios included in the device:	None
Sample Revision	☐Prototype Unit; ■Production Unit; ☐Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	HWS-01	hws-trk-01c	firmware version: 1.03r	Radiated Emissions Measurements
2	HWS-02	hws-trk-01c	firmware version: 1.03r	Conducted Measurements

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Docking Station	hws-chg-01b	Hykso	-

3.4 Ancillary Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
2	Laptop	E5440	Dell	N/A
3	AC Adapter	PSAI05R-050Q	Phihong	N/A

3.5 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE#1 + AE#3	The radio of the EUT was stimulated directly in a test mode not accessible by the end user via USB connection with a laptop utilizing a command line interface. The EUT transmitted a modulated BT LE signal on a specified channel. (Used for all Radiated Measurements)
2	EUT#2 + AE #2	The radio of the EUT was stimulated directly in a test mode not accessible by the end user via USB connection with a laptop utilizing a command line interface. The EUT transmitted a modulated BT LE signal on a specified channel. (Used for all Conducted Measurements)

4 Subject of Investigation

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

This test report is to support a request for new equipment authorization under the
FCC ID: 2AK2R-HWS01 and **IC ID: 22370-HWS01.**

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

5 Measurement Results Summary

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

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

6 Measurements

6.1 Measurement Uncertainty

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

Radiated measurement:

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

Conducted measurement:

150 kHz to 30 MHz ±0.7 dB (LISN)

RF conducted measurement ±0.5 dB

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

6.2 Environmental Conditions During Testing:

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

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

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

6.3 Dates of Testing:

2017-01-03 to 2017-02-01

6.4 Additional Test Information

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

7 Measurement Procedures

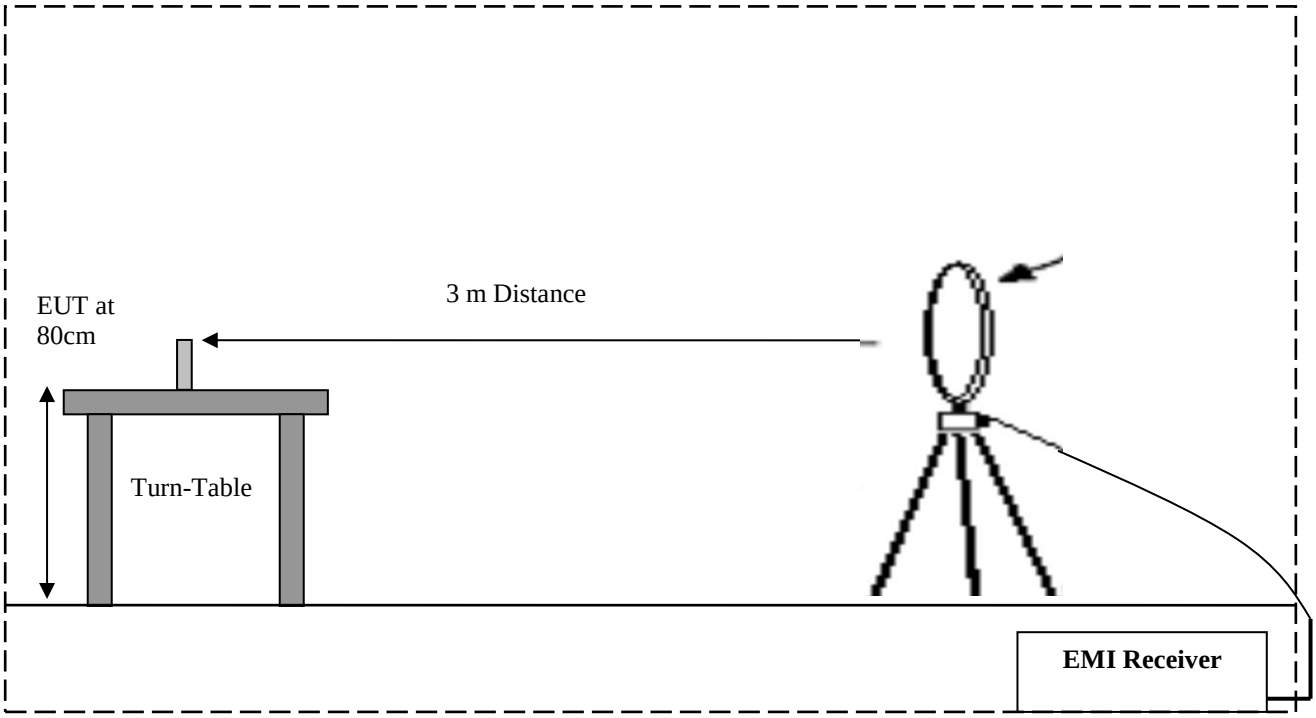
7.1 Radiated Measurement

The radiated measurement is performed according to:

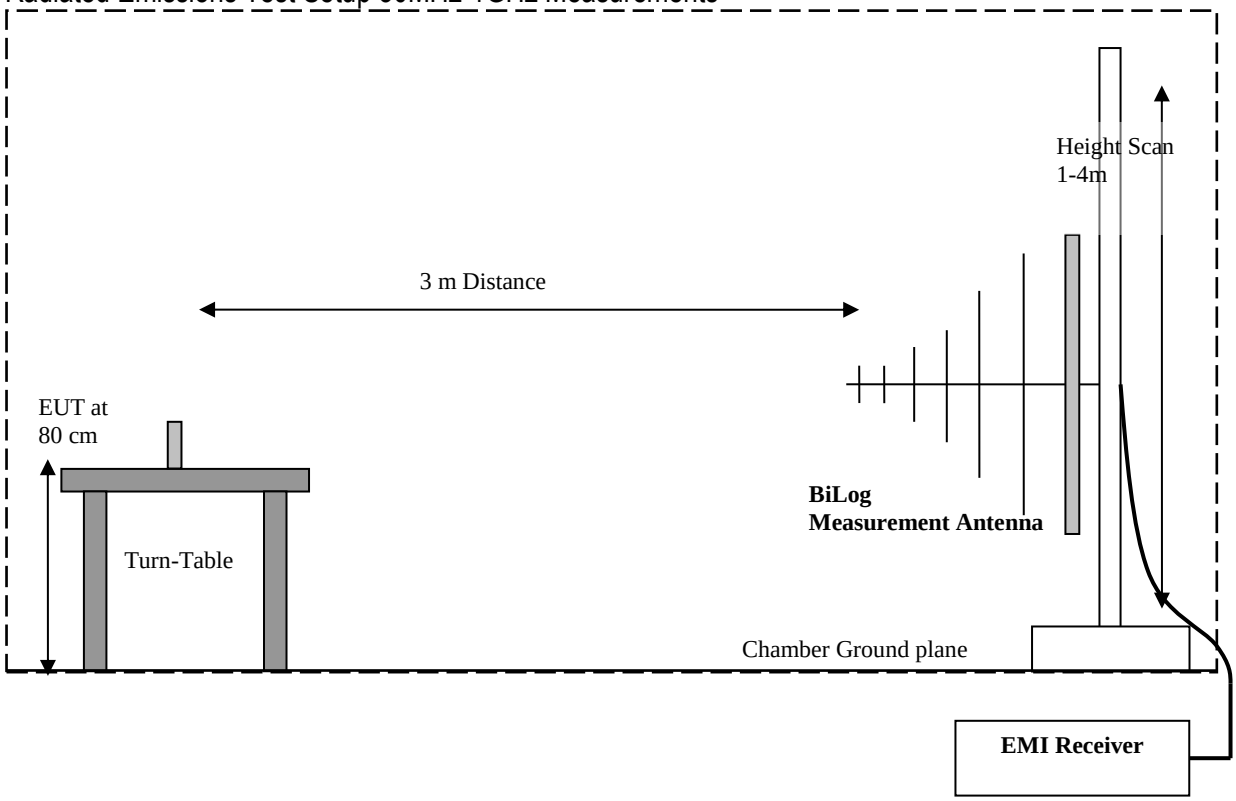
ANSI C63.10 (2013)

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

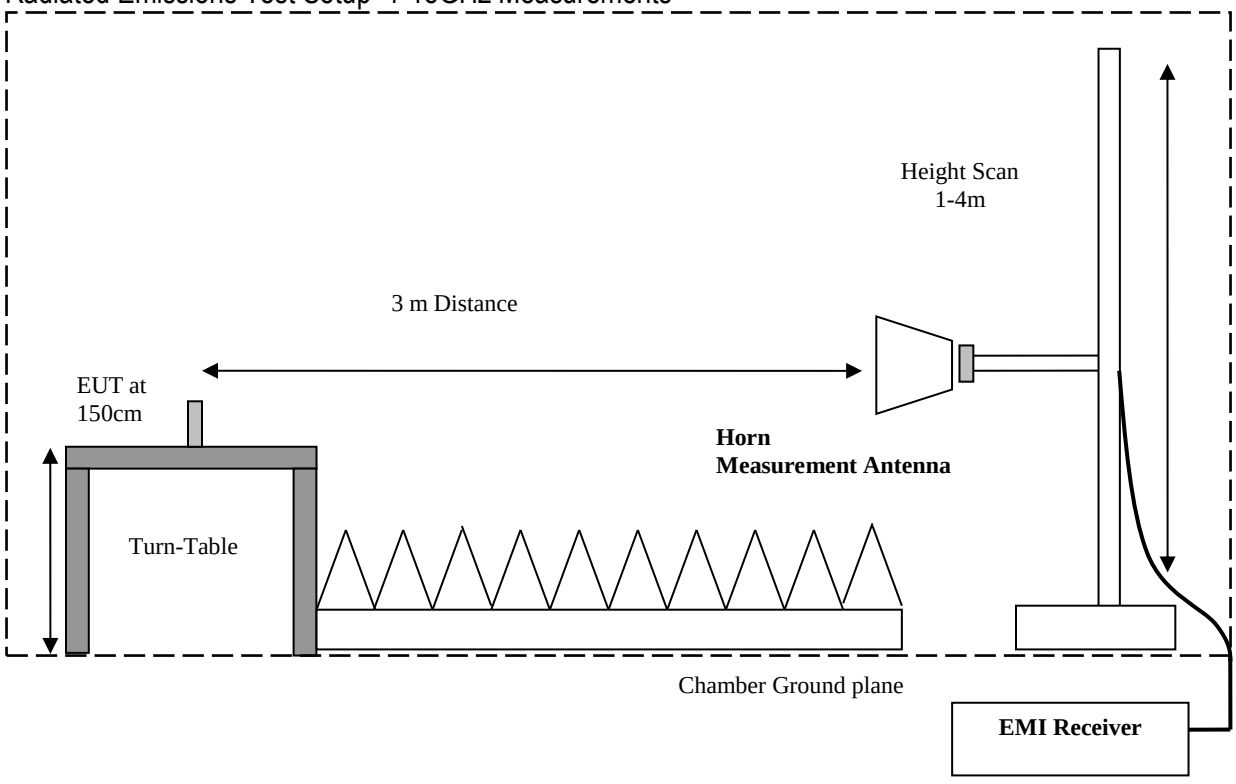
Radiated Emissions Test Setup below 30MHz Measurements



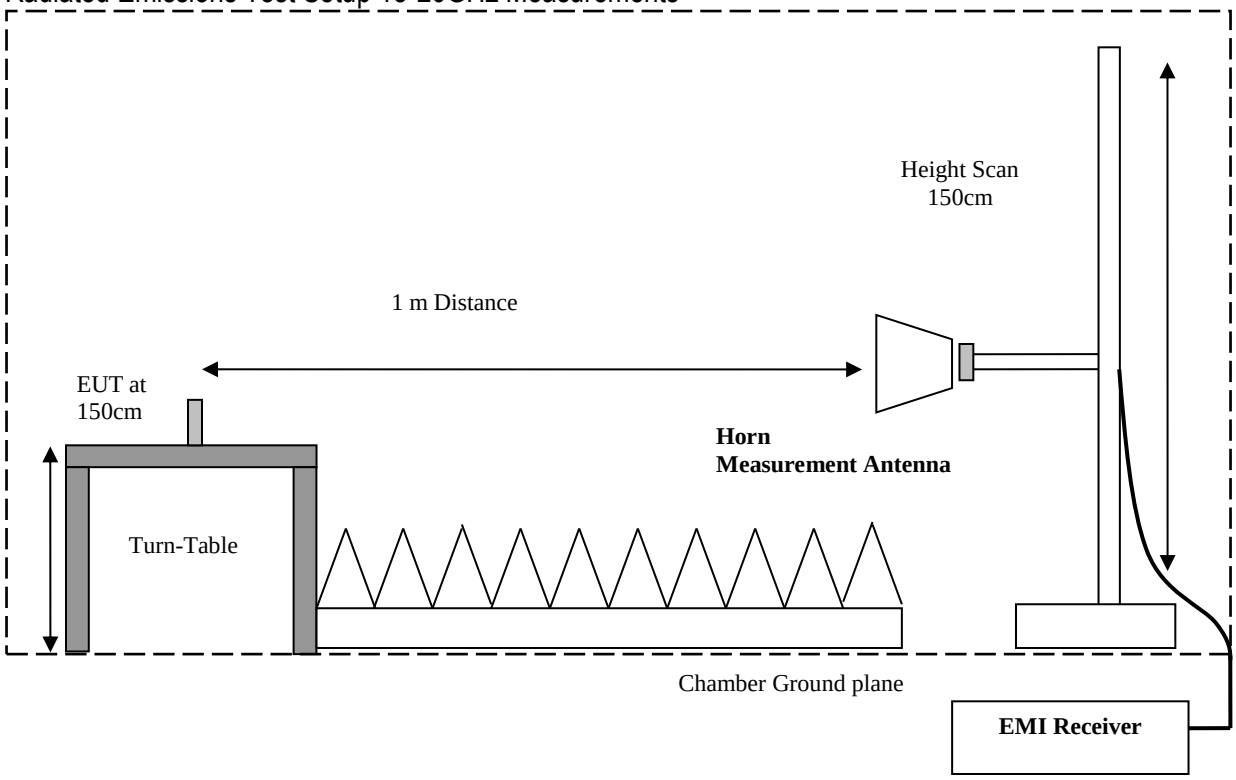
Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup 1-18GHz Measurements



Radiated Emissions Test Setup 18-26GHz Measurements



7.1.1 Sample Calculations for Field Strength Measurements

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

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

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

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

Example:

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

7.2 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to:

ANSI C63.10 (2013)

8 Test Result Data

8.1 Maximum Conducted Peak Output Power

8.1.1 Measurement settings

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

8.1.2 Limits:

Maximum Conducted Output Power:
FCC §15.247 (b)(3): 1W
IC RSS-247 issue 1, Section 5.4(4): 1W (30dBm)
EIRP:
IC RSS-247 issue 1, annex 8.4(2): 4W (36 dBm)

8.1.3 Test conditions and setup:

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

Ambient Temperature	EUT Set-Up #	EUT operating mode	Antenna Gain (dB)
22° C	1	GFSK continuous fixed channel	1.8

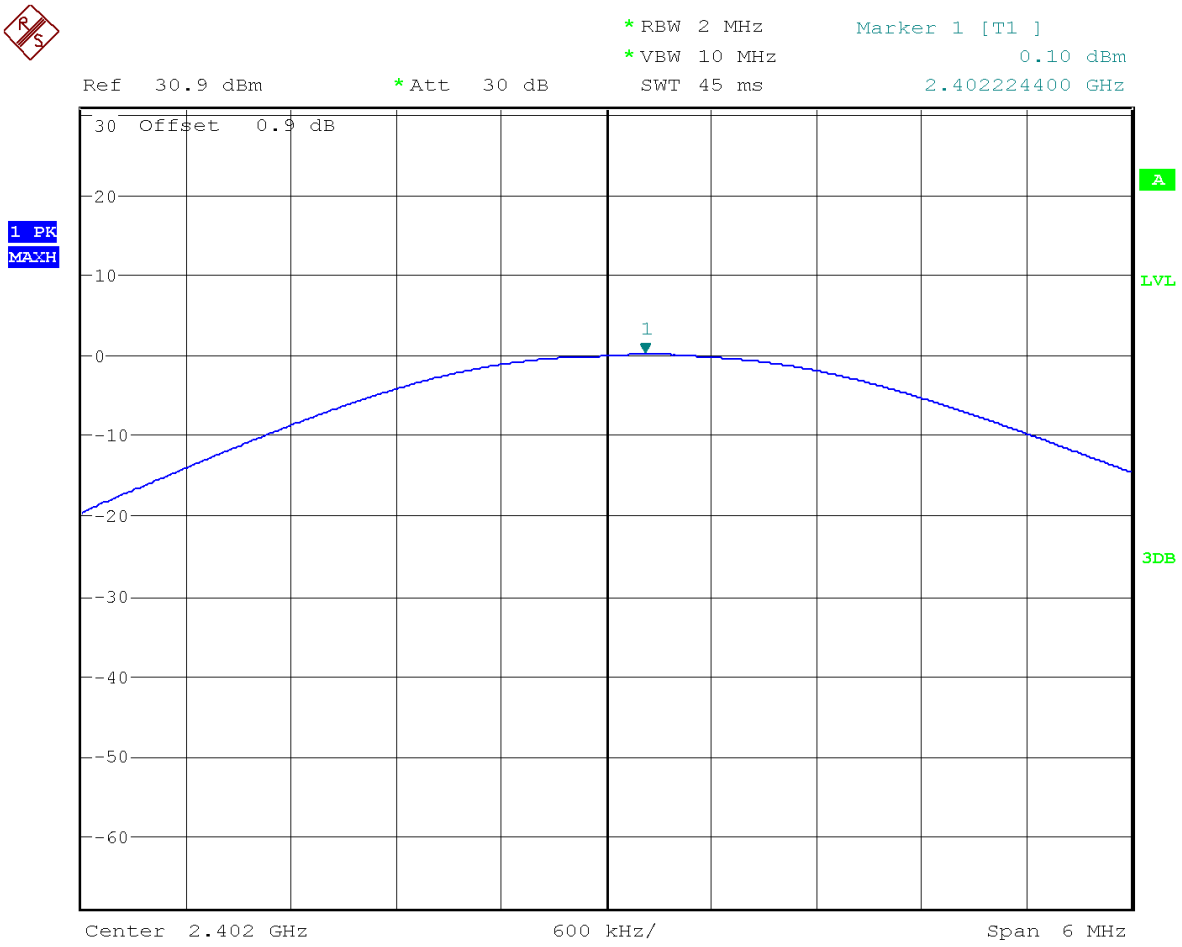
Cable Loss = 0.9 dB

8.1.4 Measurement result:

Frequency (MHz)	Conducted Peak Output Power (dBm)	Limit (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Result
2402	0.1	30	1.8	1.9	36	Pass
2440	0.0	30	1.8	1.8	36	Pass
2480	-0.1	30	1.8	1.7	36	Pass

8.1.5 Measurement Plots:

8.1.5.1 Channel 0 (2402 MHz)



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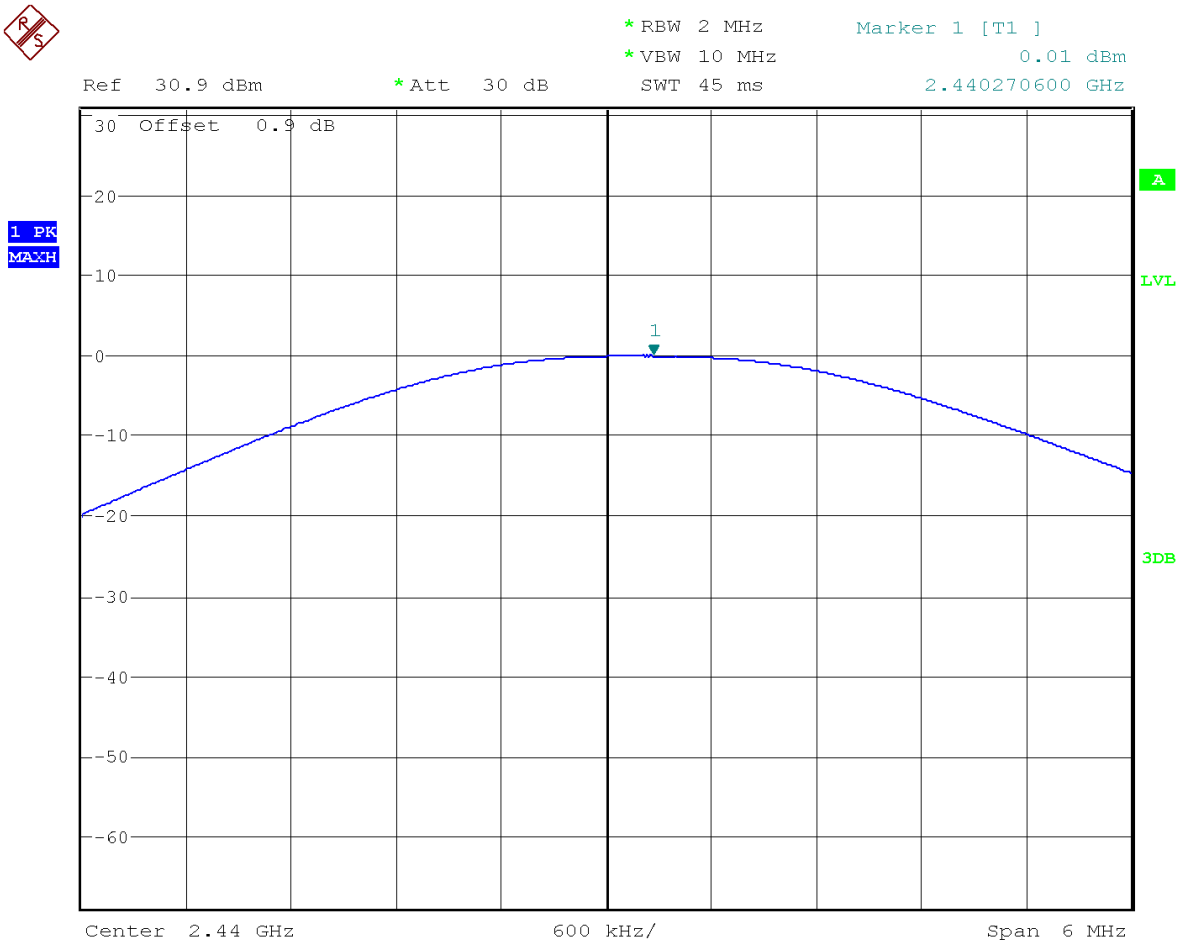
8.1.5.2 Channel 19 (2440 MHz)



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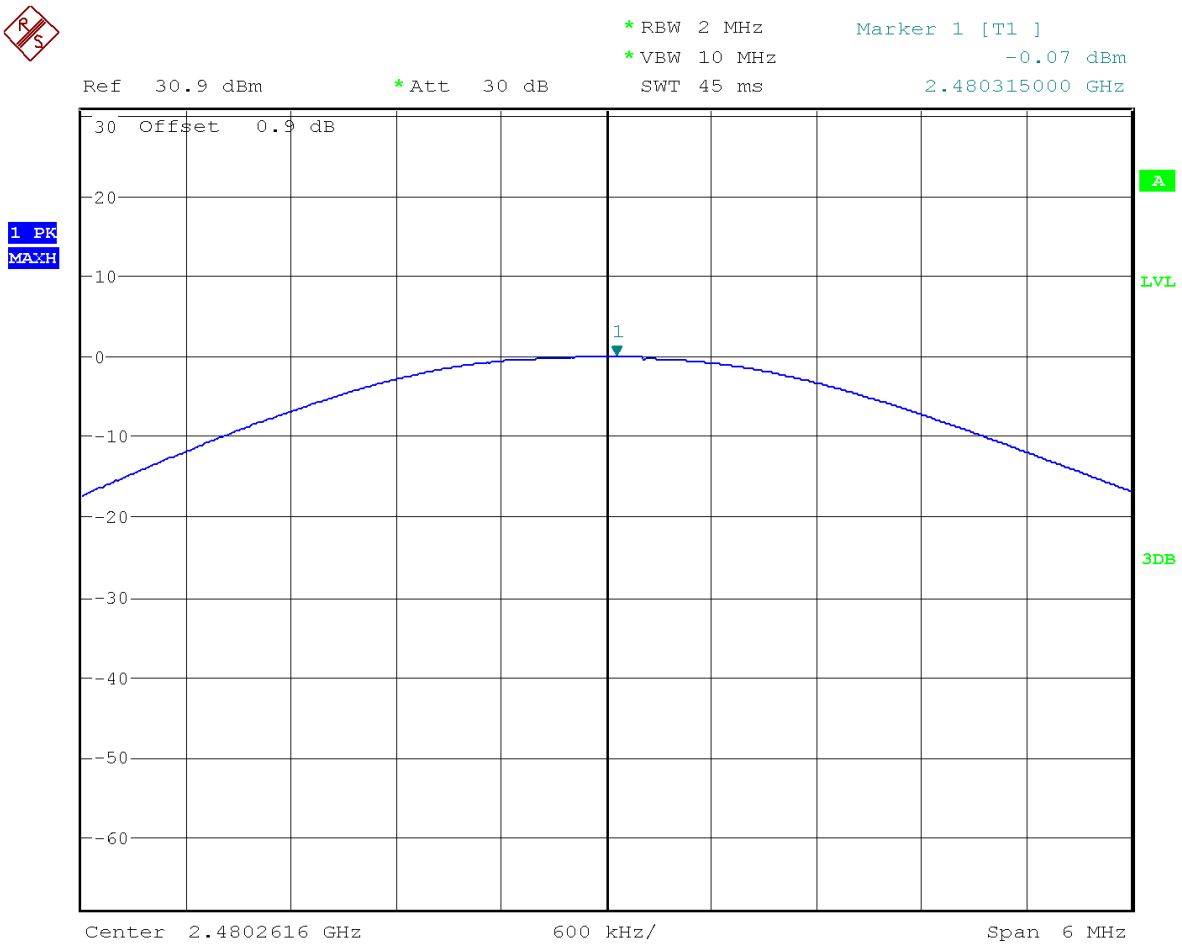
8.1.5.3 Channel 39 (2480 MHz)



Date: 5.JAN.2017 19:00:18

8.2 Power Spectral Density

8.2.1 Limits:

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

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

8.2.2 Test Conditions:

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

Cable Loss= 0.8 dB

8.2.3 Measurement procedure:

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

8.2.4 Test Data:

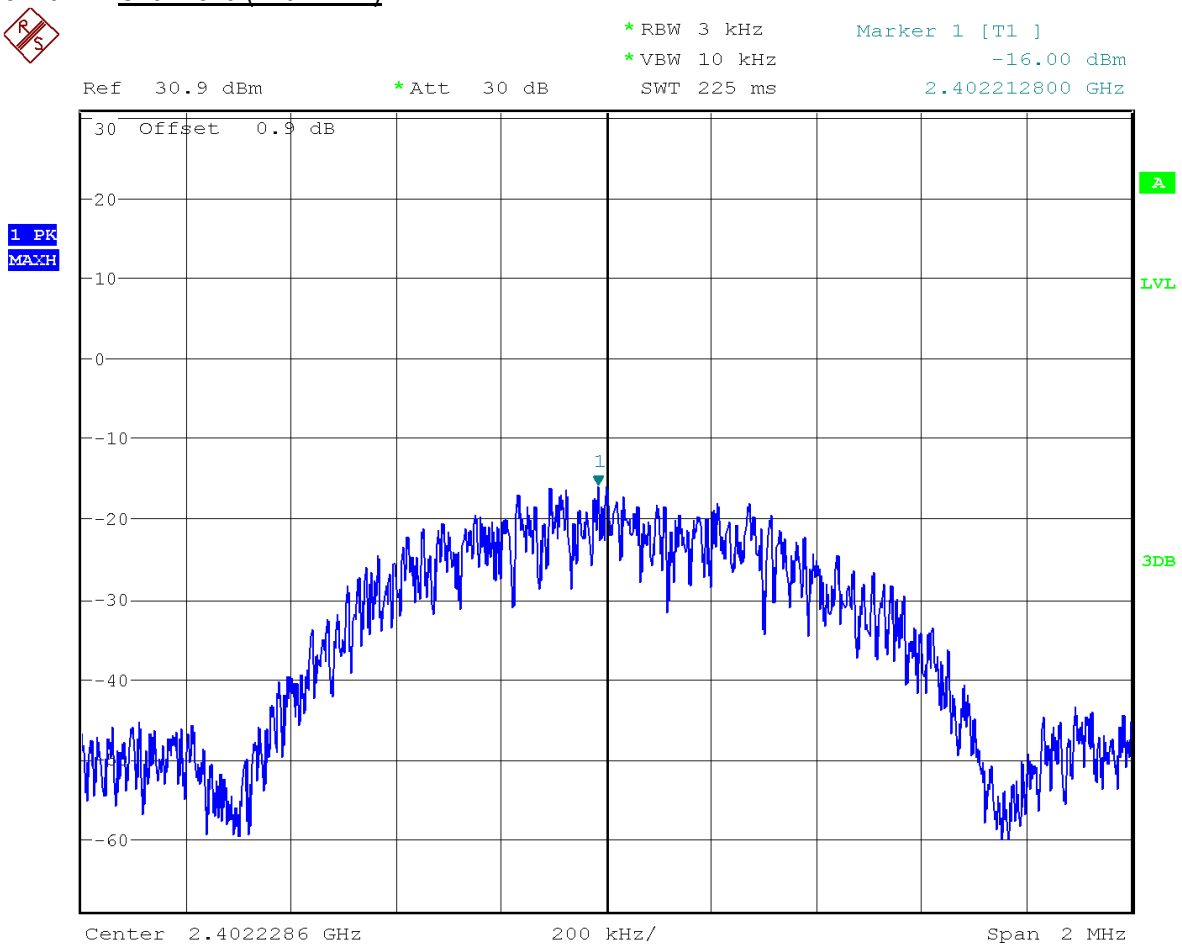
Power Spectral Density (dBm)			
Limit = 8 dBm @ 3KHz	Frequency (MHz)		
Mode	2402 Channel 0	2440 Channel 19	2480 Channel 39
BT LE	-16.0	-16.3	-16.1

8.2.5 Measurement Result

Pass.

8.2.6 Measurement Plots:

8.2.6.1 Channel 0 (2402 MHz)



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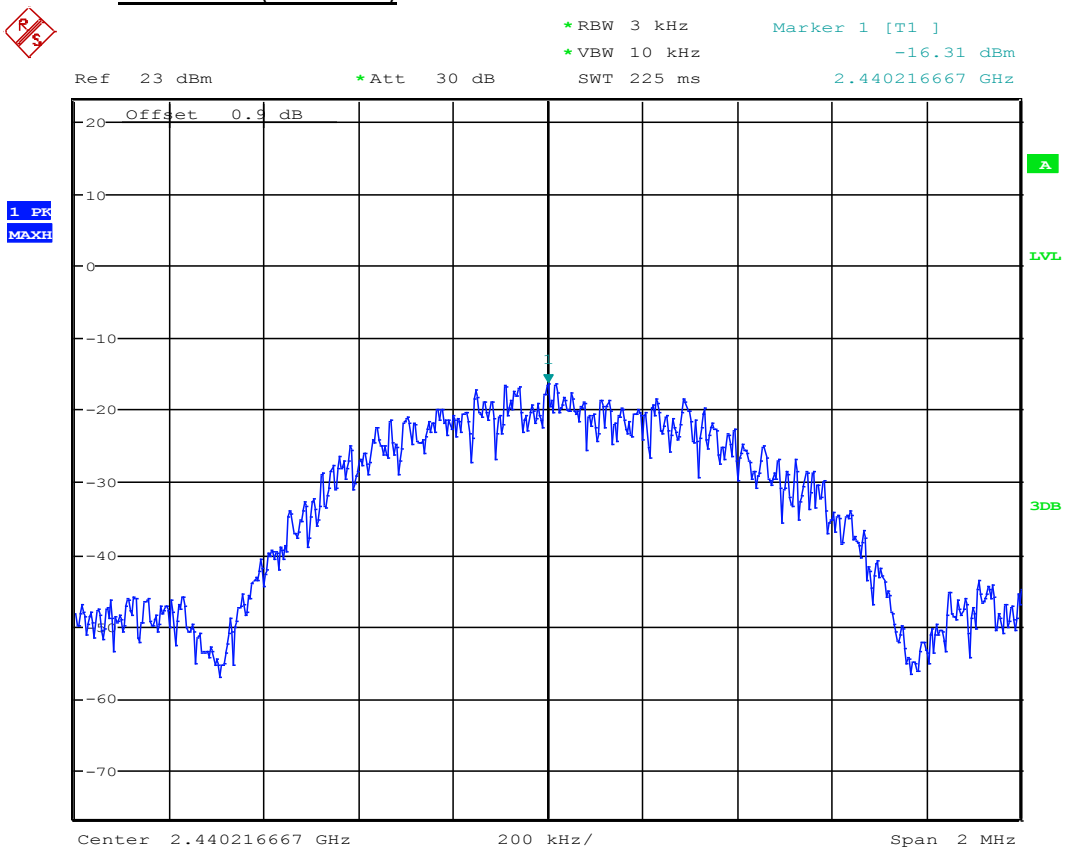
8.2.6.2 Channel 19 (2440 MHz)



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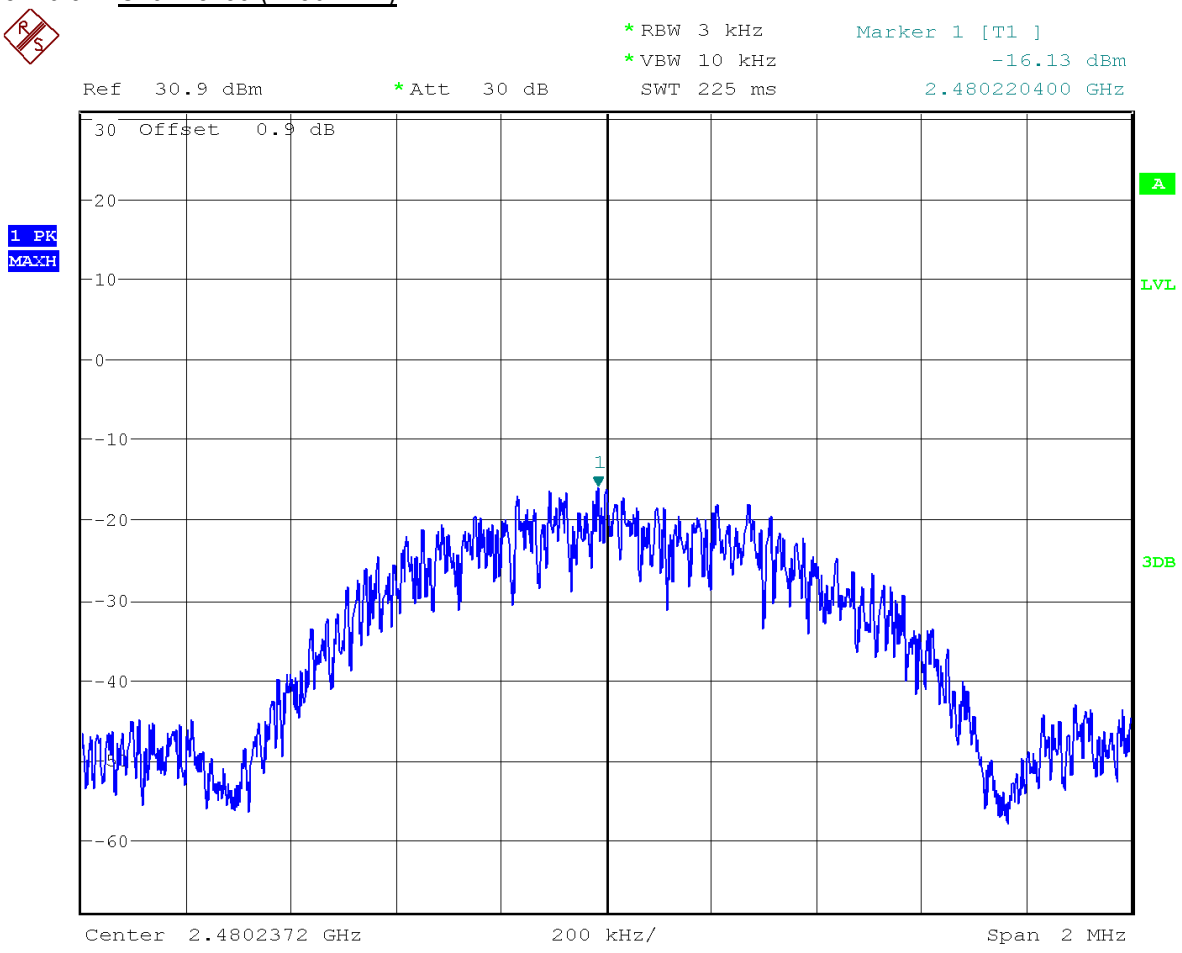
8.2.6.3 Channel 39 (2480 MHz)



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8.3 Compliance at Restricted and Non-Restricted Bandedges

8.3.1 Limits:

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

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

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

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

*PEAK LIMIT= 74dBµV/m

*AVG. LIMIT= 54dBµV/m

§15.247 (d) / RSS-247 Section 5.5

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

8.3.2 Measurement Procedure:

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

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

Correction Factors (applied to measurement as offset unless noted otherwise):
Antenna Gain- 2 dBi per section 11.12.2.6 of C63.10.2013
Cable Loss- 0.9 dB
Duty Cycle Correction Factor (Section 8.3.5.1) – 2 dB

8.3.3 Measurement Result

Pass.

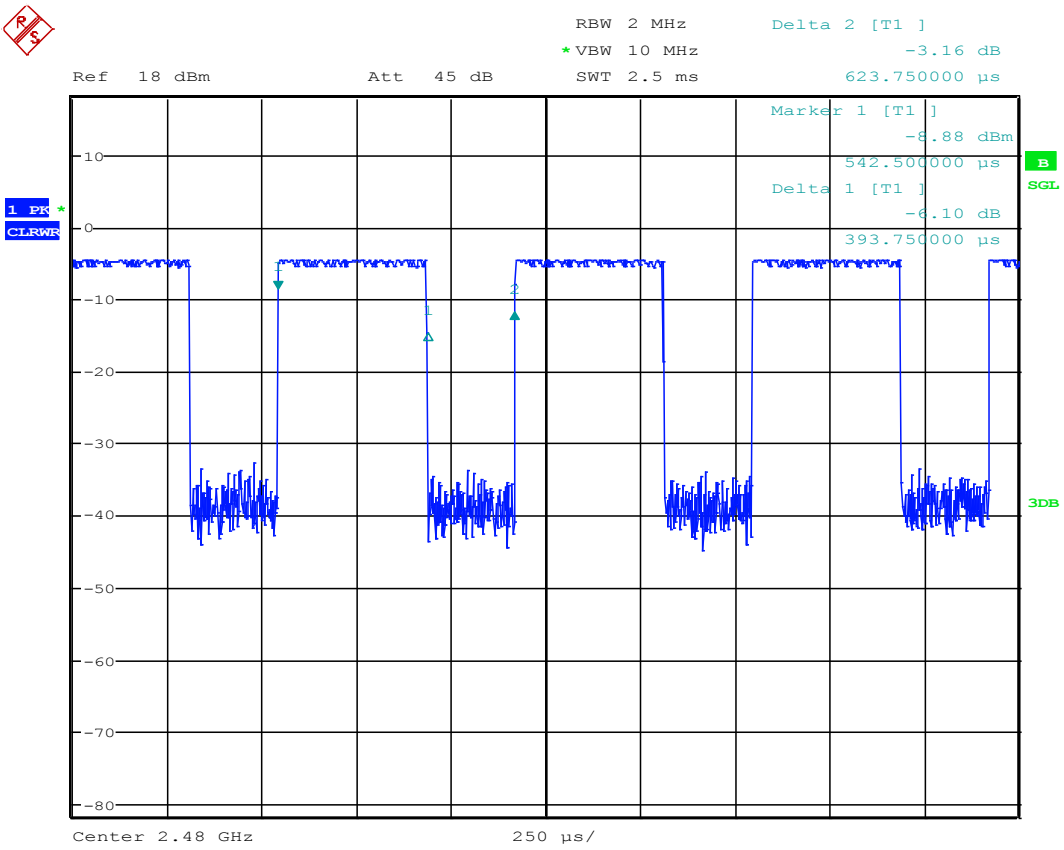
8.3.4 Test Data:

Mode: BT LE		Modulation: GFSK		Test Channel: 0		
Lower non Restricted Band / Frequency Range: 2390MHz – 2400 MHz						
Measured Frequency Range (MHz)	Fundamental Emission	Maximum Emission Level in Frequency Range (dBm)	Difference from Fundamental (dBc)	Limit (dBc)	Margin (dB)	Result
2390-2400	-0.5	-49.2	-48.7	-20	28.7	Pass

Mode: BT LE	Modulation: GFSK	Test Channel: 39		
Upper Restricted Band / Frequency Range: 2483.5 MHz – 2500 MHz				
Frequency (MHz)	Measured Emission Level (dBm)	Limit Peak/Average (dBm)	Margin (dB)	Result
2483.5	-31.2 (Peak)	-21.2 (Peak)	9.7	Pass
2483.5	-42.4 (RMS)	-41.2 (RMS)	1.2	Pass

8.3.5 Band Edge Measurement Plots:

8.3.5.1 BT LE Continuous Transmit Mode Measured Duty cycle

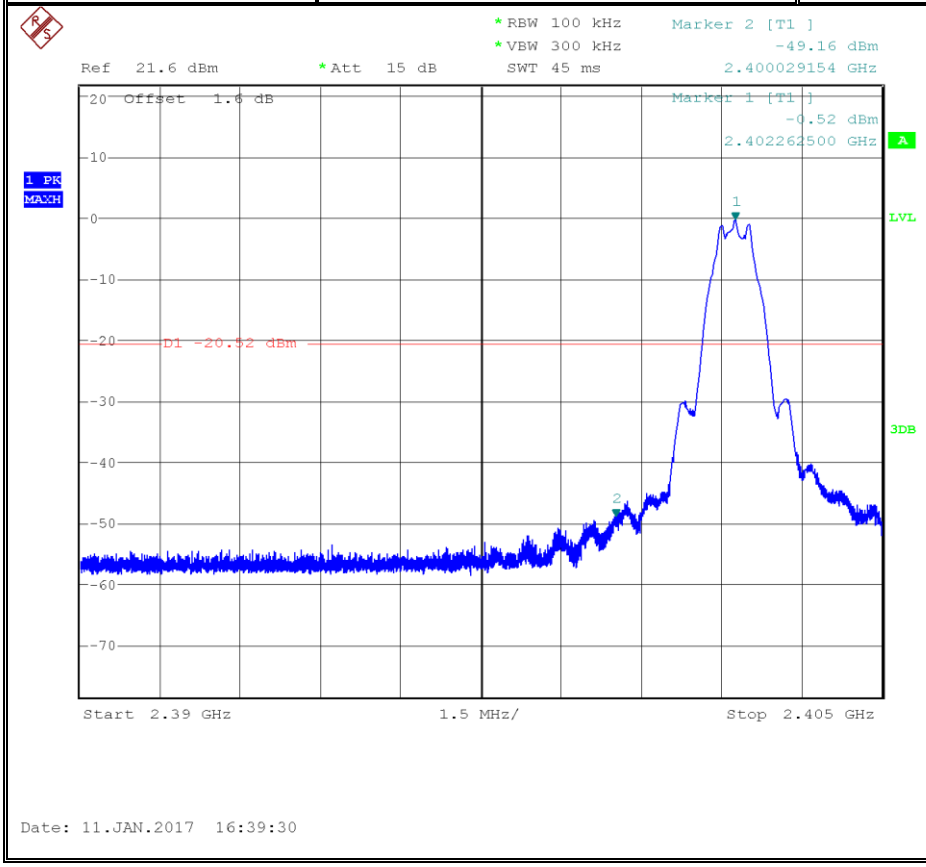


Date: 3.JAN.2017 17:16:17

Duty Cycle= 394/624=0.631= 63.1%
Duty Cycle Correction Factor = 10*log(1/0.631) = 2 dB

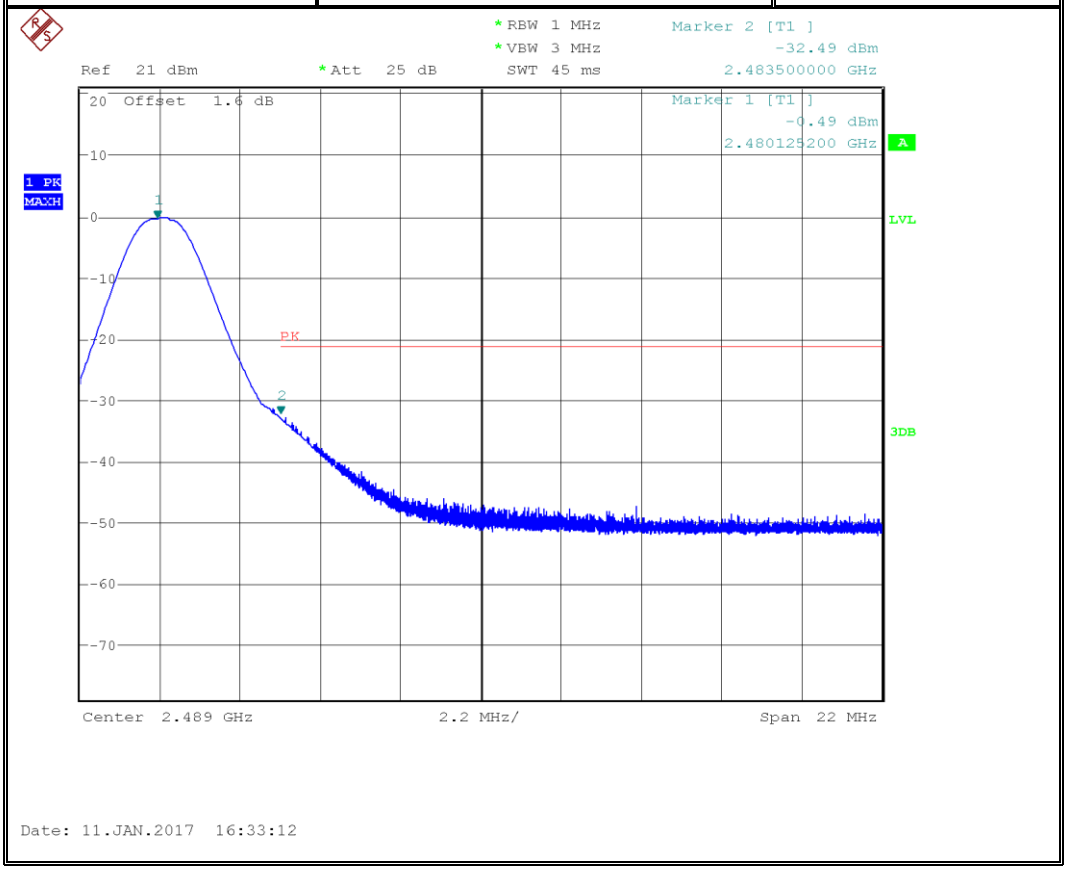
8.3.5.2 BT LE Lower Non-Restricted Band Edge

Fundamental Emission Reference Level		
Ch. 0 / 2402 MHz	**Mode: BT LE**	**Modulation: GFSK**



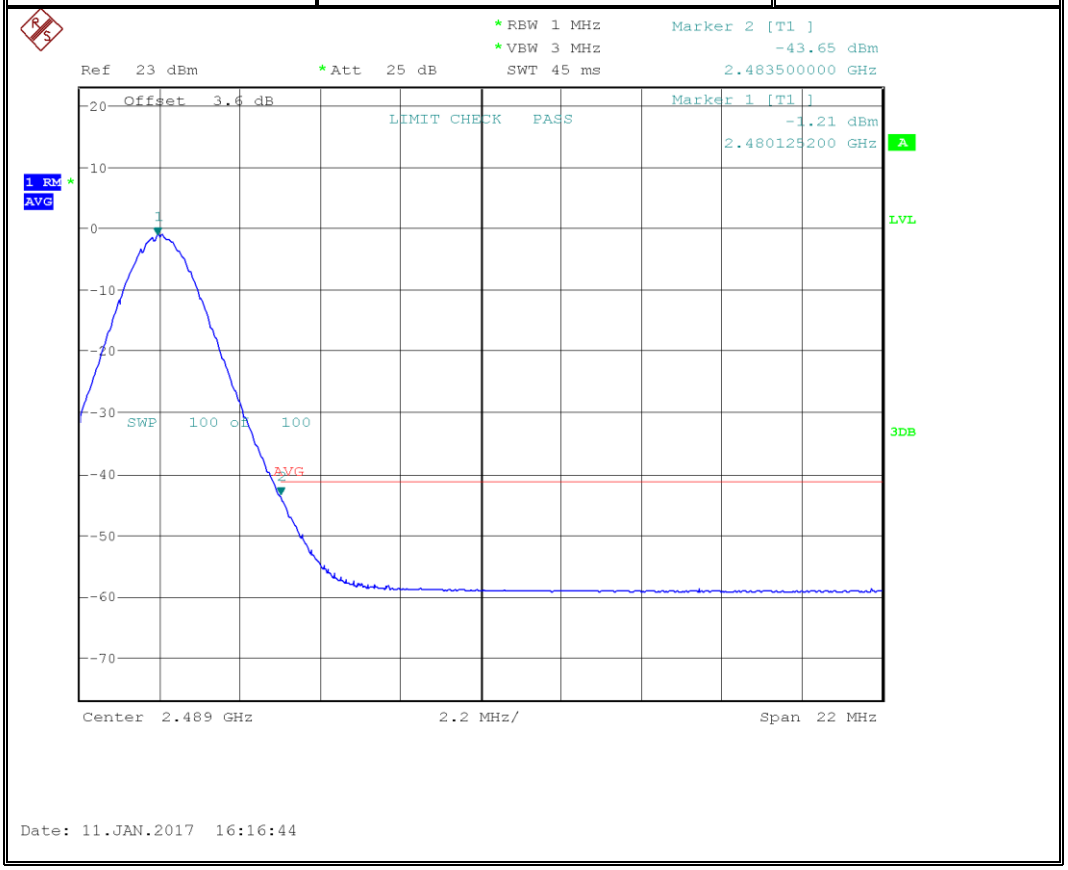
8.3.5.3 BT LE Upper Restricted Band Edge

Upper Restricted Band Edge (2.4GHz) Peak Detector		
Ch. 39 / 2480 MHz	Mode: BT LE	Modulation: GFSK



Note: Offset should be 2.9 dB, rather than 1.6 dB. The corrected measurement is -31.2

Upper Restricted Band Edge (2.4GHz) RMS Detector		
Ch. 39 / 2480 MHz	**Mode: BT LE**	**Modulation: GFSK**



Note: Offset should be 4.9 dB, rather than 3.6 dB. The corrected measurement is -31.2

8.4 DTS Bandwidth and Occupied Bandwidth

8.4.1 Limits:

§15.247 (a) (2)
Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

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

8.4.2 Test Conditions:

Tnom: 22 °C; Vnom: 3.7V

8.4.3 Measurement procedure:

Conducted measurements were taken according to ANSI C63.10-2013 Section 11.8 for DTS Bandwidth and 6.9 for Occupied Bandwidth using a spectrum analyzer (Equipment number 18 in section 9).

8.4.4 Test Result: 2.4 GHz Band

DTS Bandwidth (kHz)			
Mode	**2402 Channel 0**	**2440 Channel 19**	**2480 Channel 39**
BT LE	709	698	717

Occupied Bandwidth (MHz)			
Mode	**2402 Channel 0**	**2440 Channel 19**	**2480 Channel 39**
BT LE	1.05	1.05	1.05

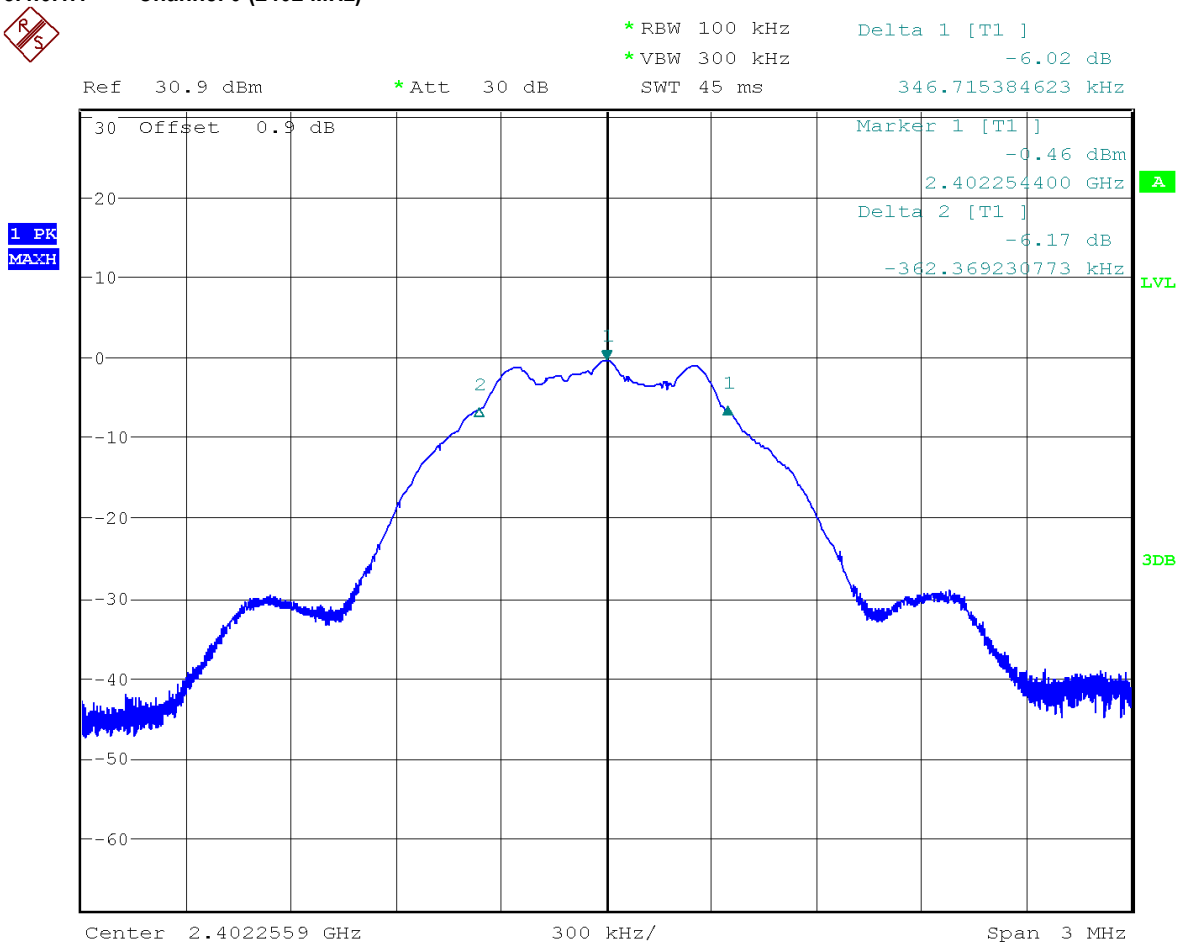
8.4.5 Measurement Result

Pass.

8.4.6 Measurement Plots

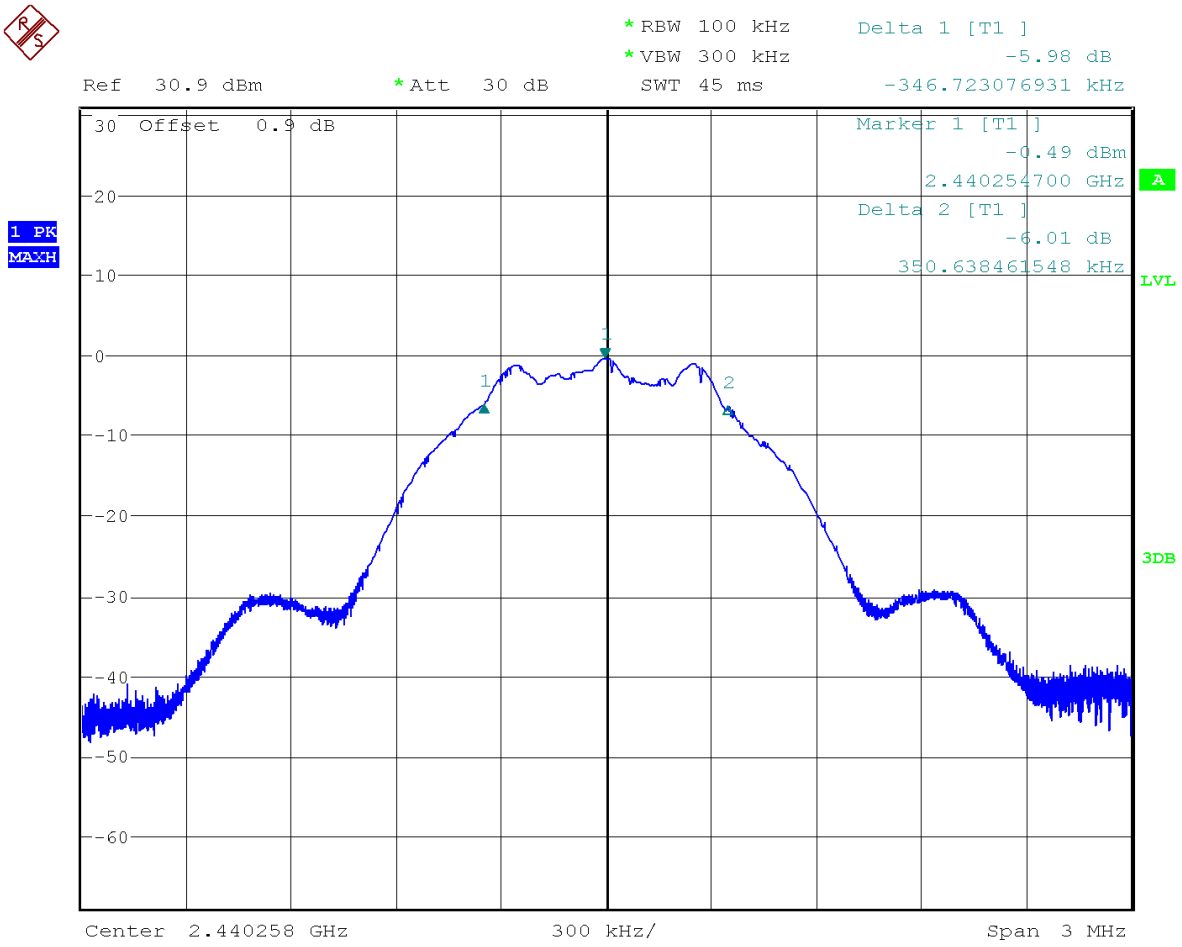
8.4.6.1 DTS Bandwidth

8.4.6.1.1 Channel 0 (2402 MHz)



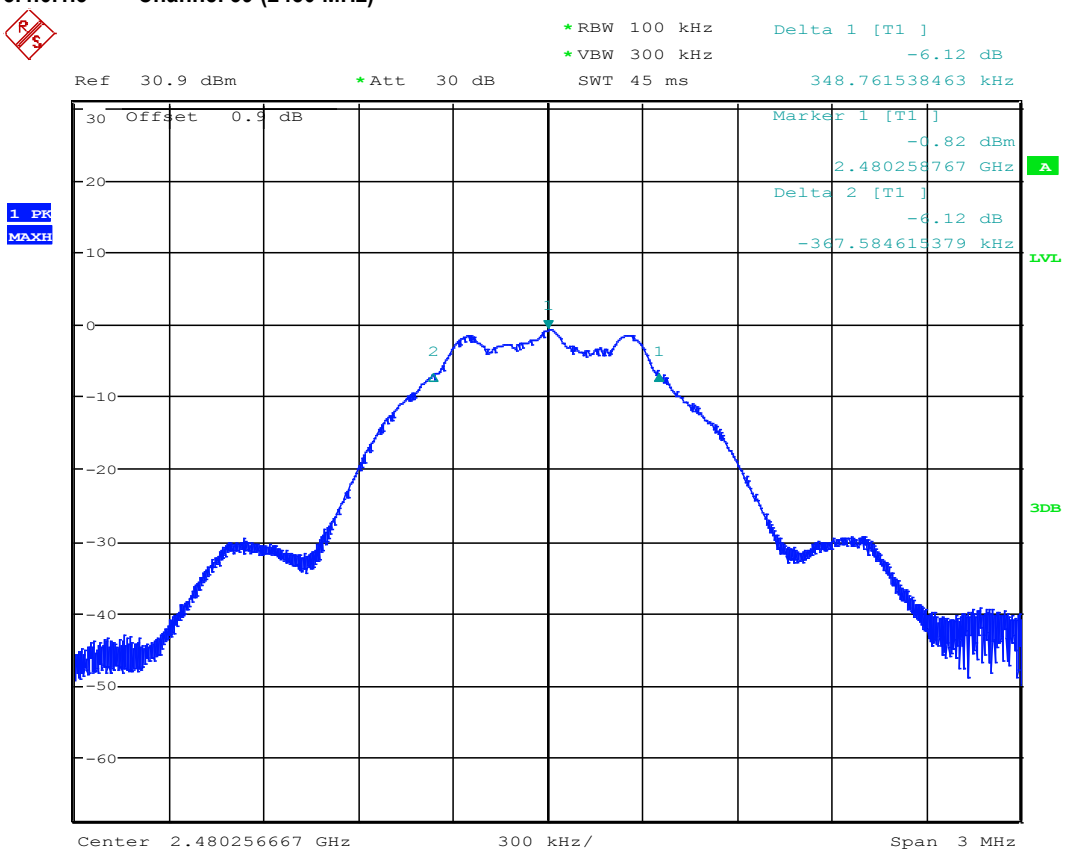
Date: 5.JAN.2017 18:06:31

8.4.6.1.2 Channel 19 (2440 MHz)



Date: 5.JAN.2017 18:04:35

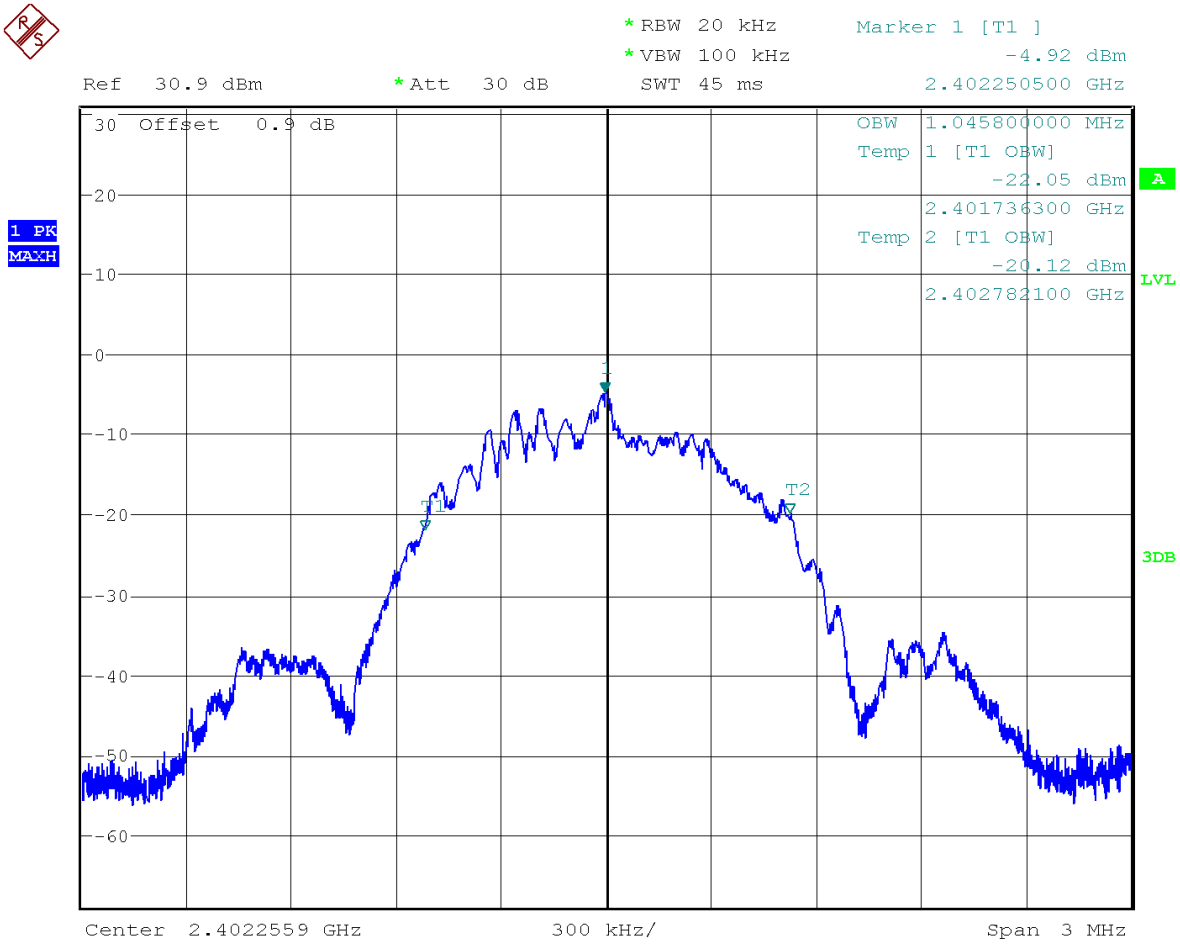
8.4.6.1.3 Channel 39 (2480 MHz)



Date: 1.FEB.2017 16:56:59

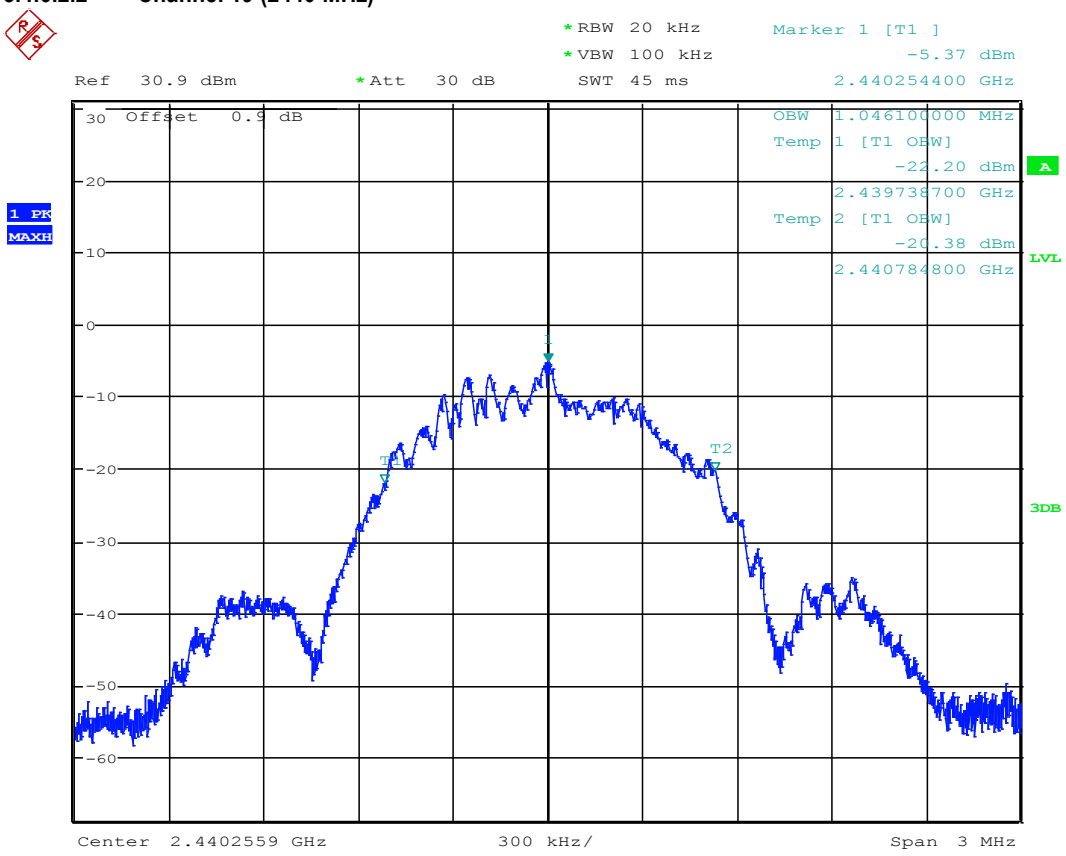
8.4.6.2 Occupied Bandwidth

8.4.6.2.1 Channel 0 (2402 MHz)



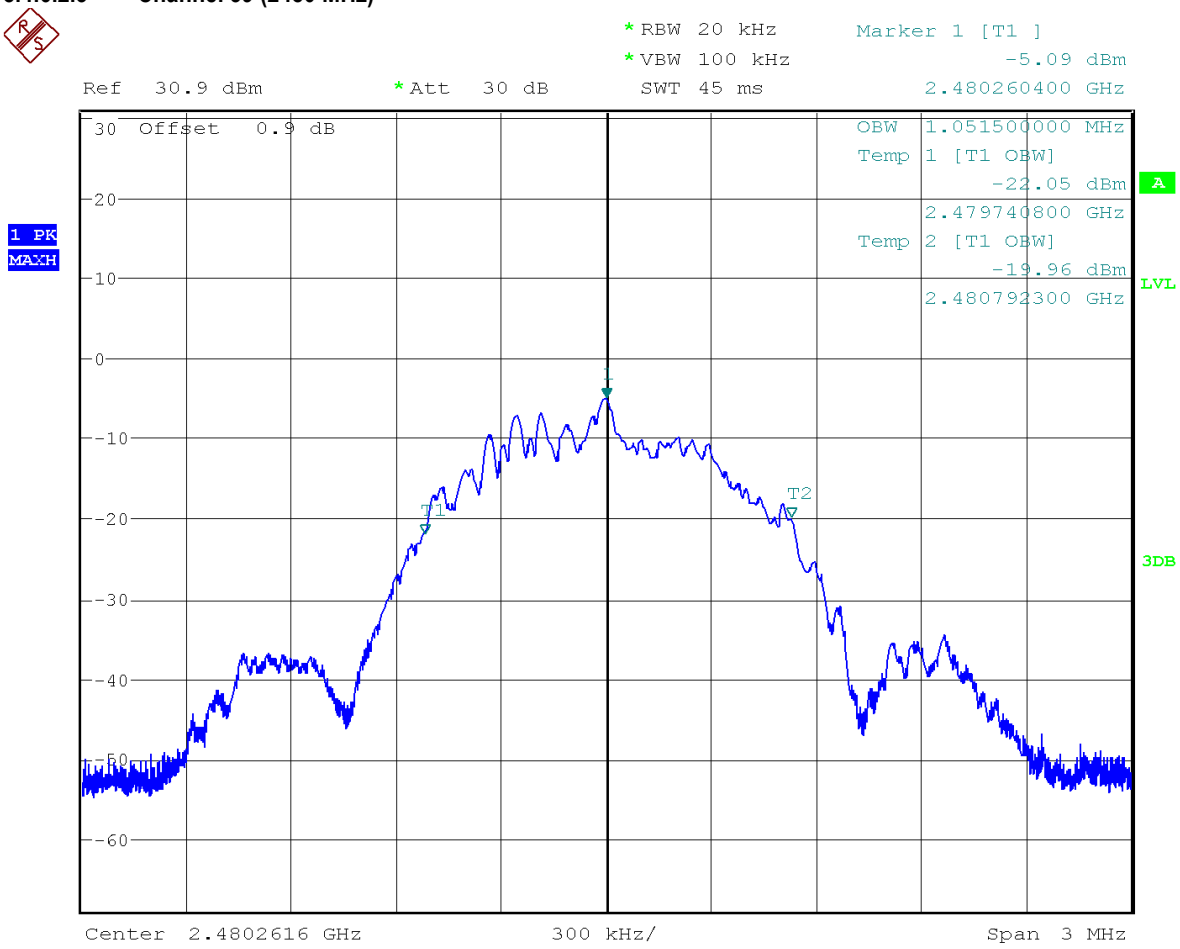
Date: 5.JAN.2017 18:50:30

8.4.6.2.2 Channel 19 (2440 MHz)



Date: 1.FEB.2017 17:01:07

8.4.6.2.3 Channel 39 (2480 MHz)



Date: 5.JAN.2017 18:55:30

8.5 Radiated Transmitter Spurious Emissions and Restricted Bands

8.5.1 Measurement according to ANSI C63.10 (2013)

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

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

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

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

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

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

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

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

Table 1:

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

Table 2:

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

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

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

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

8.5.3 Test conditions and setup:

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

Ambient Temperature	EUT Set-Up #	EUT operating mode
22° C	1	GFSK continuous fixed channel

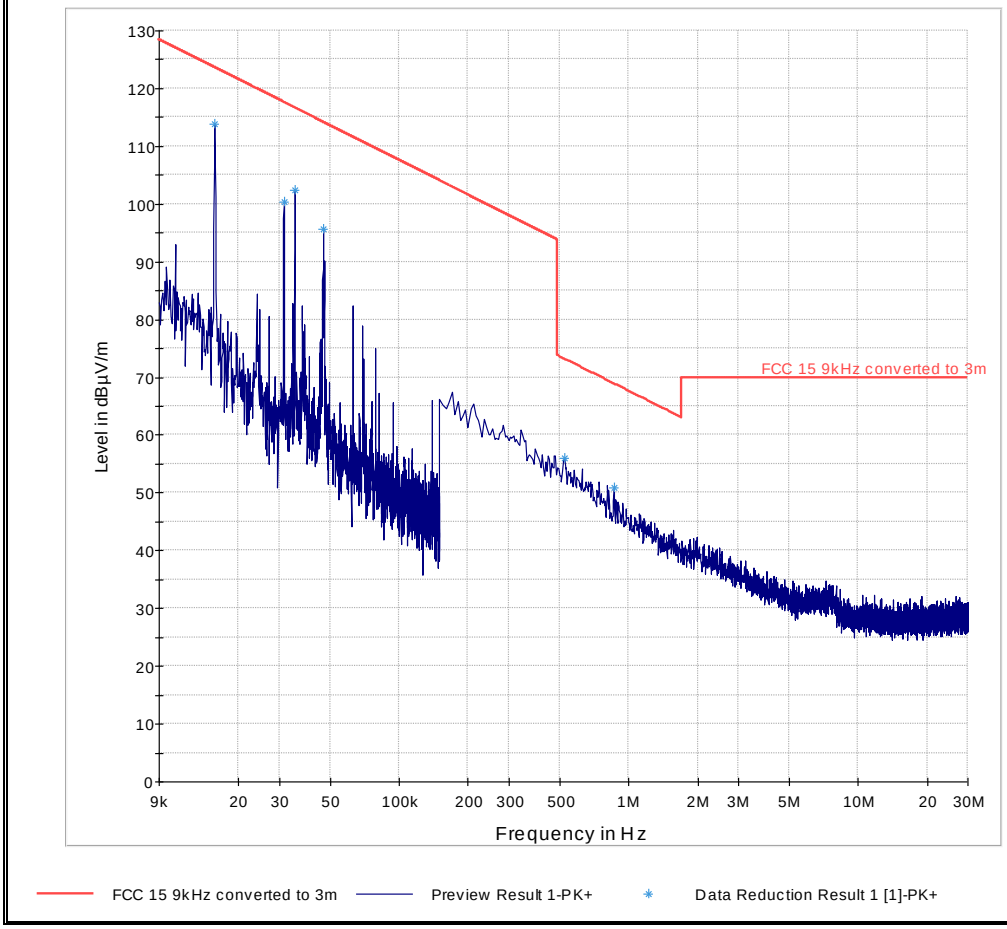
8.5.4 Measurement result:

Channel #	Scan Frequency	Limit	Result
Low (0)	30 MHz-18 GHz	See section 8.5.2	Pass
Mid (19)	9 kHz – 26 GHz	See section 8.5.2	Pass
High (39)	30 MHz-18 GHz	See section 8.5.2	Pass

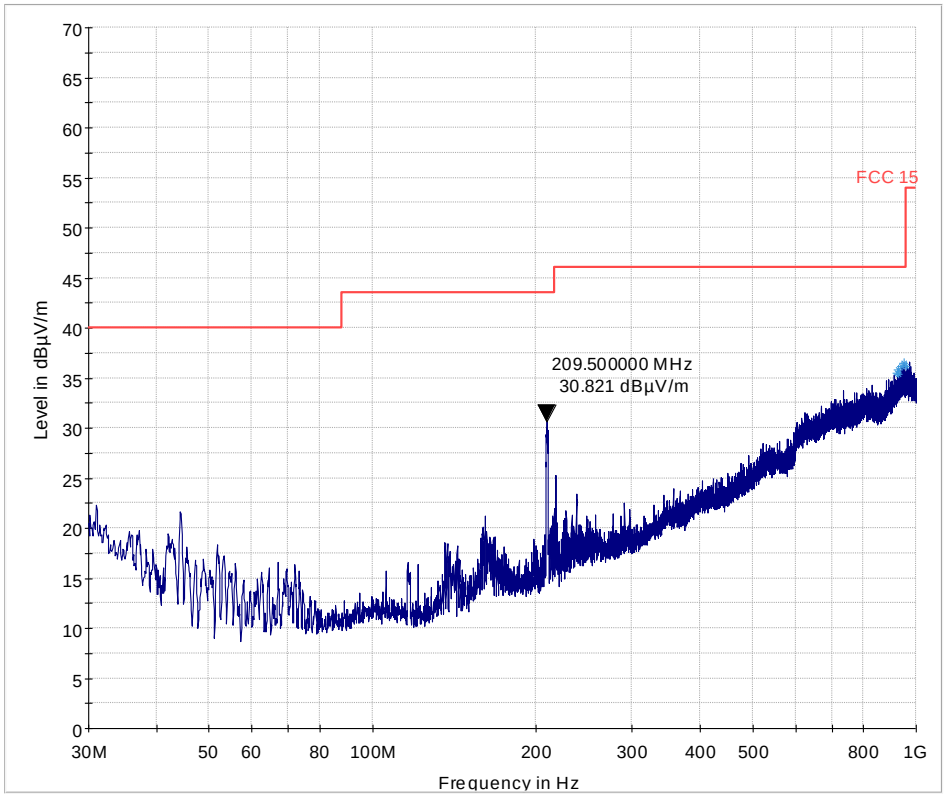
8.5.5 Measurement Plots:

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

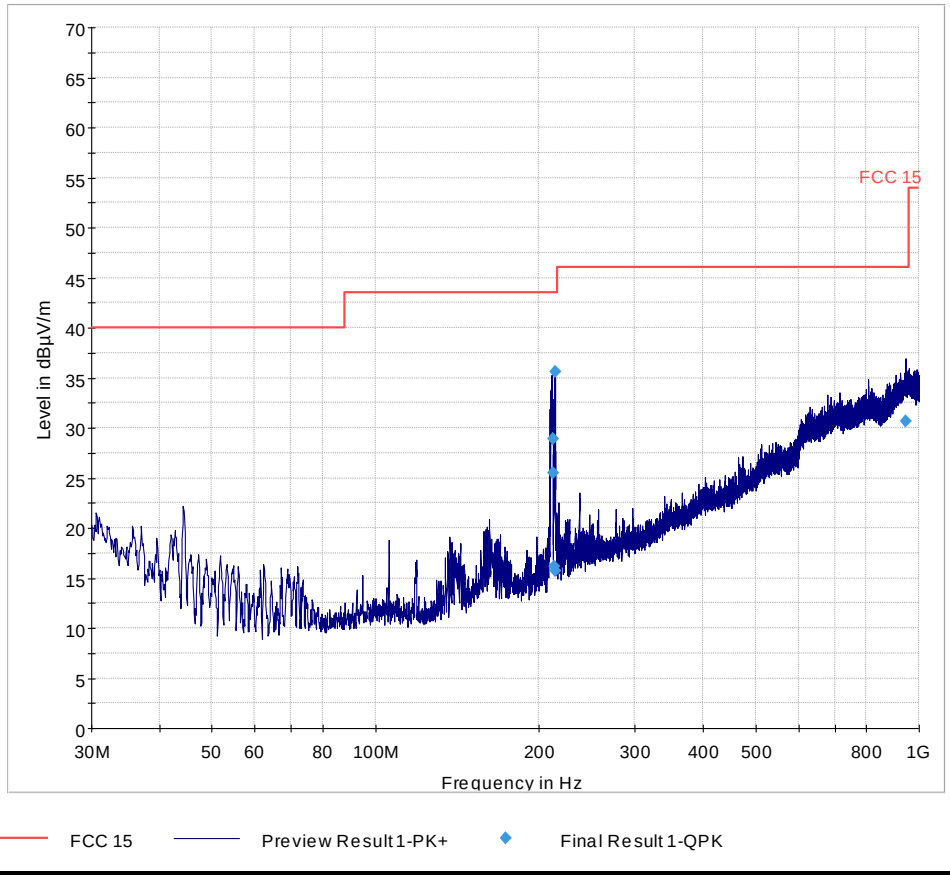
TX Radiated Spurious Emissions: 9kHz – 30MHz			
Ch. 19	Mode: Bluetooth LE	Modulation: GFSK	Data Rate: 1 Mbps



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

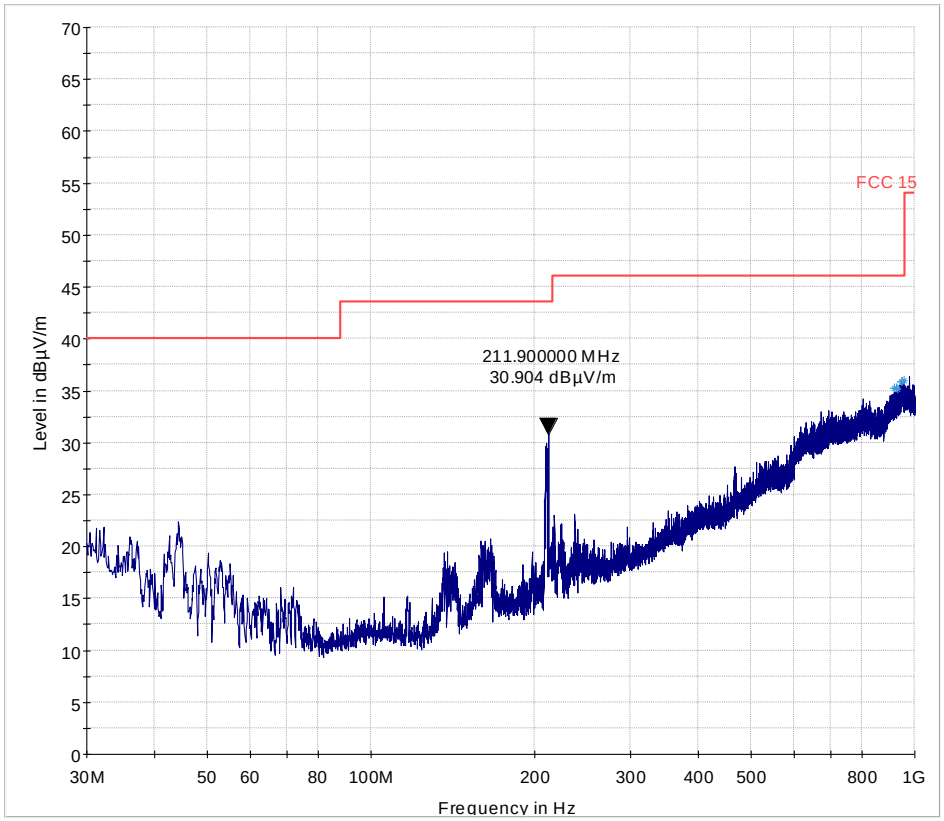


TX Radiated Spurious Emission: 30 MHz – 1GHz			
Ch. 19	Mode: Bluetooth LE	Modulation: GFSK	Data Rate: 1 Mbps

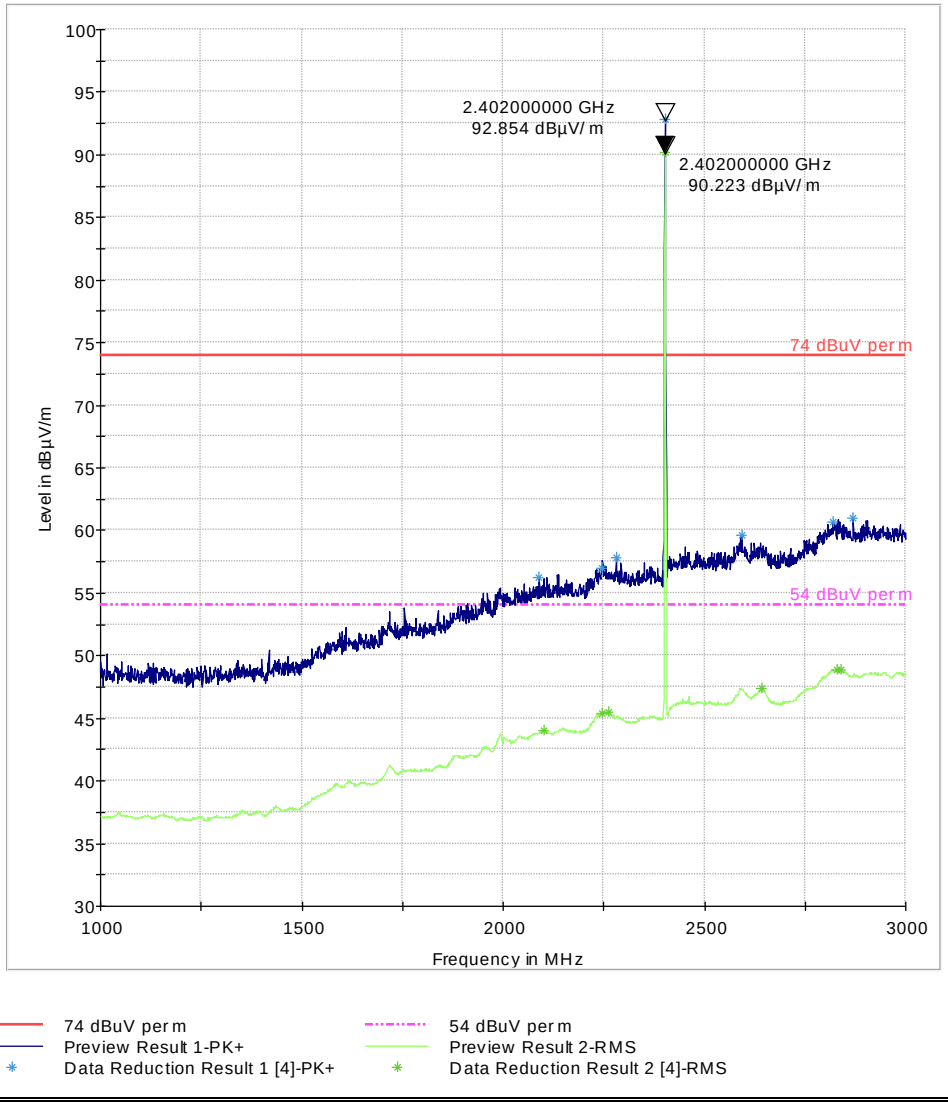


Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
211.800000	28.9	300.0	120.000	150.0	H	161.0	13.4	14.6	43.5
212.190000	25.4	300.0	120.000	140.0	H	227.0	13.5	18.1	43.5
213.670000	16.2	300.0	120.000	232.0	V	167.0	13.5	27.4	43.5
213.890000	15.8	300.0	120.000	233.0	V	166.0	13.5	27.8	43.5
213.940000	35.6	300.0	120.000	204.0	V	90.0	13.5	7.9	43.5
945.480000	30.7	300.0	120.000	140.0	V	140.0	30.5	15.3	46.0

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

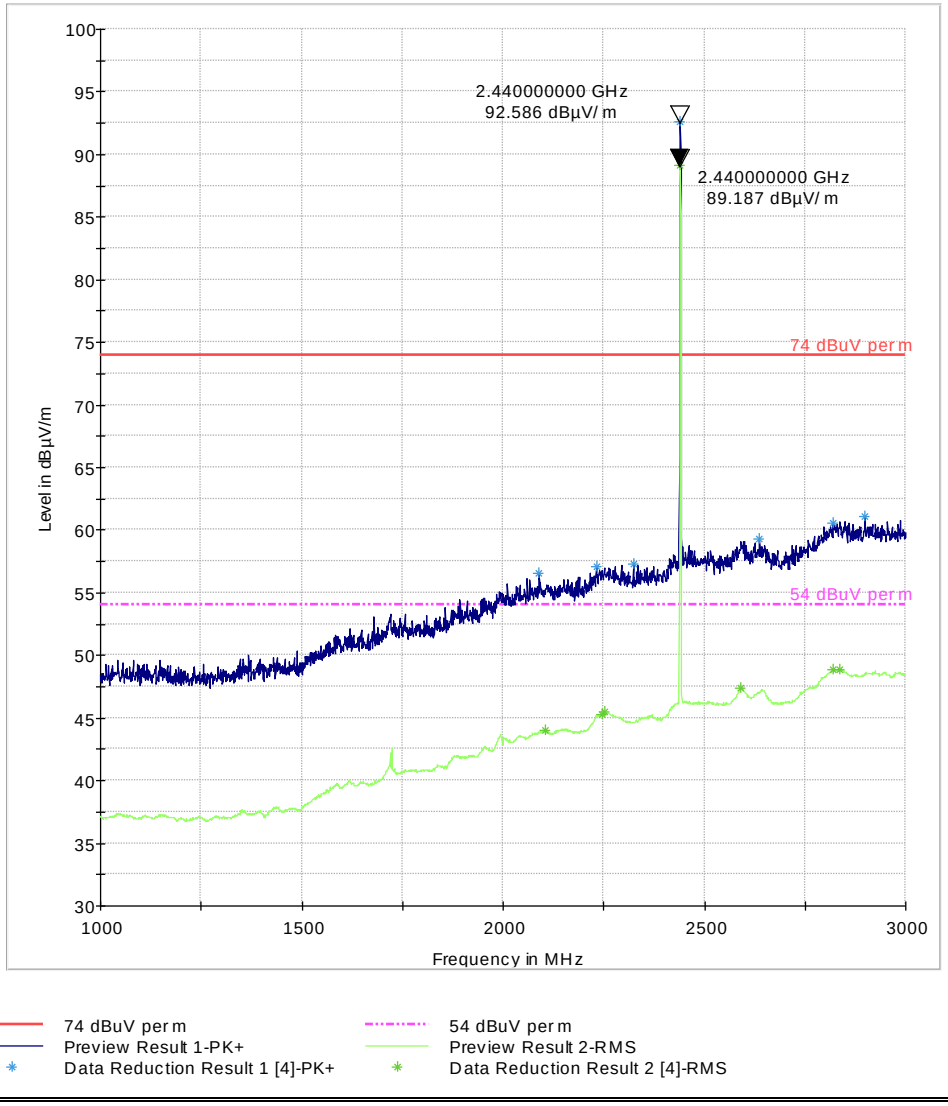


TX Radiated Spurious Emission: 1 GHz – 3 GHz			
Ch. 0	Mode: Bluetooth LE	Modulation: GFSK	Data Rate: 1 Mbps



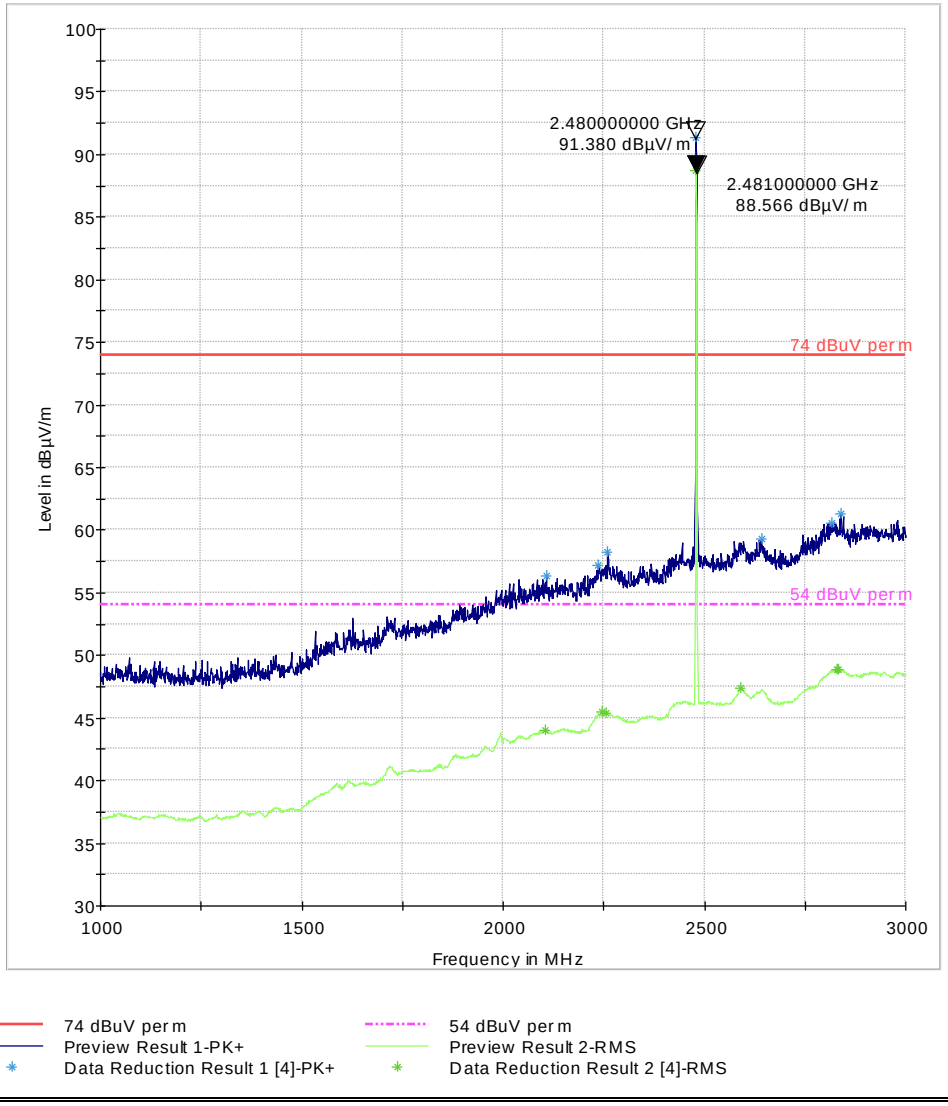
Note: Emission above limit is the Transmit Signal

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



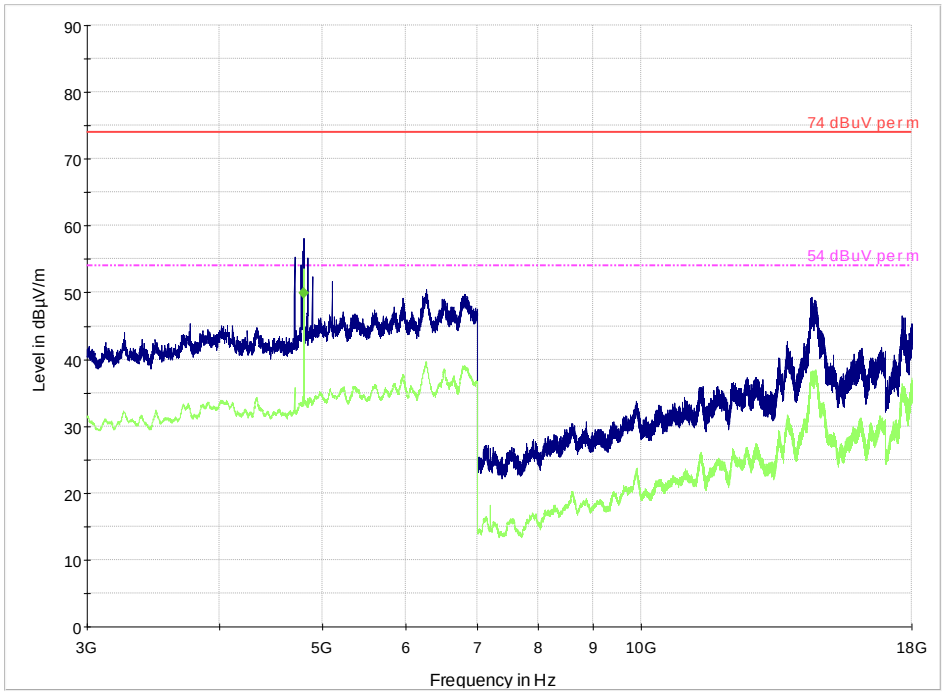
Note: Emission above limit is the Transmit Signal

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



Note: Emission above limit is the Transmit Signal

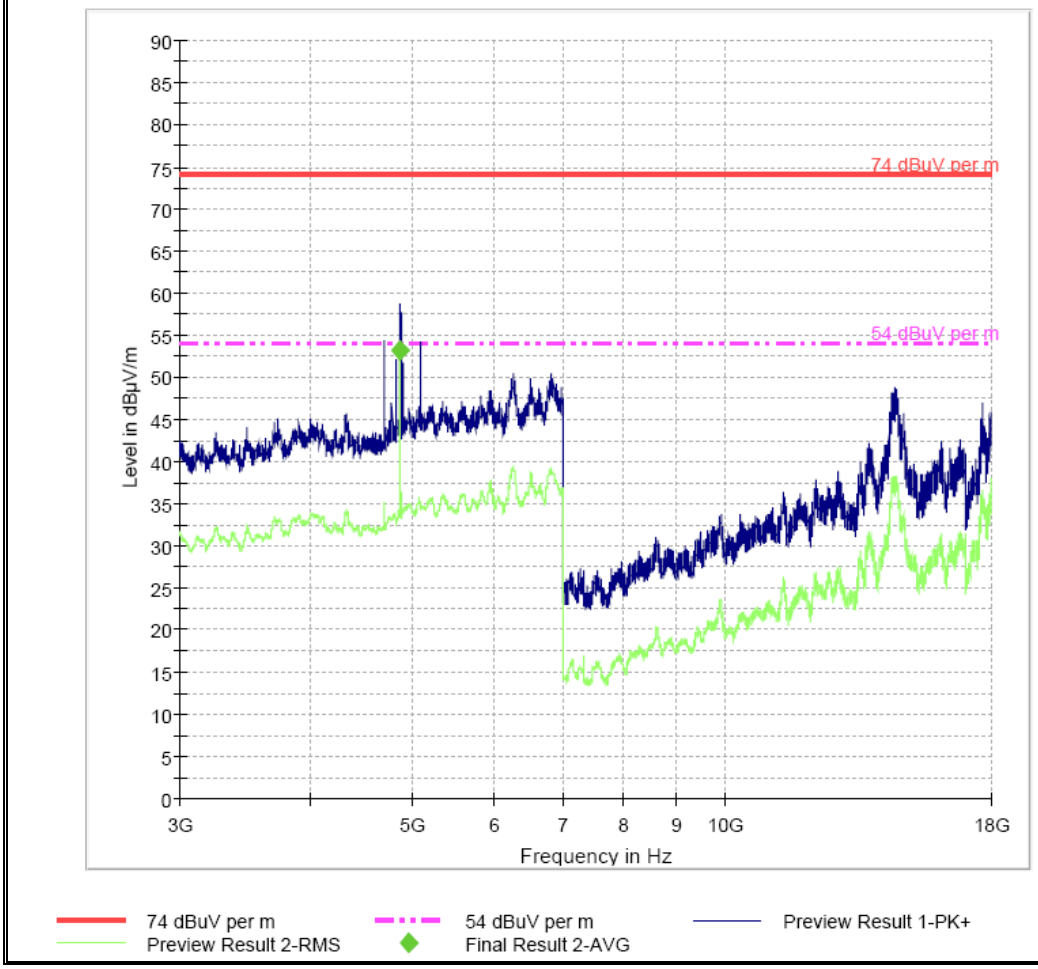
TX Radiated Spurious Emission: 3 GHz – 18 GHz			
Ch. 0	Mode: Bluetooth LE	Modulation: GFSK	Data Rate: 1 Mbps



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

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4804.000000	49.9	100.0	1000.000	140.0	H	0.0	-16.6	4.1	54.0

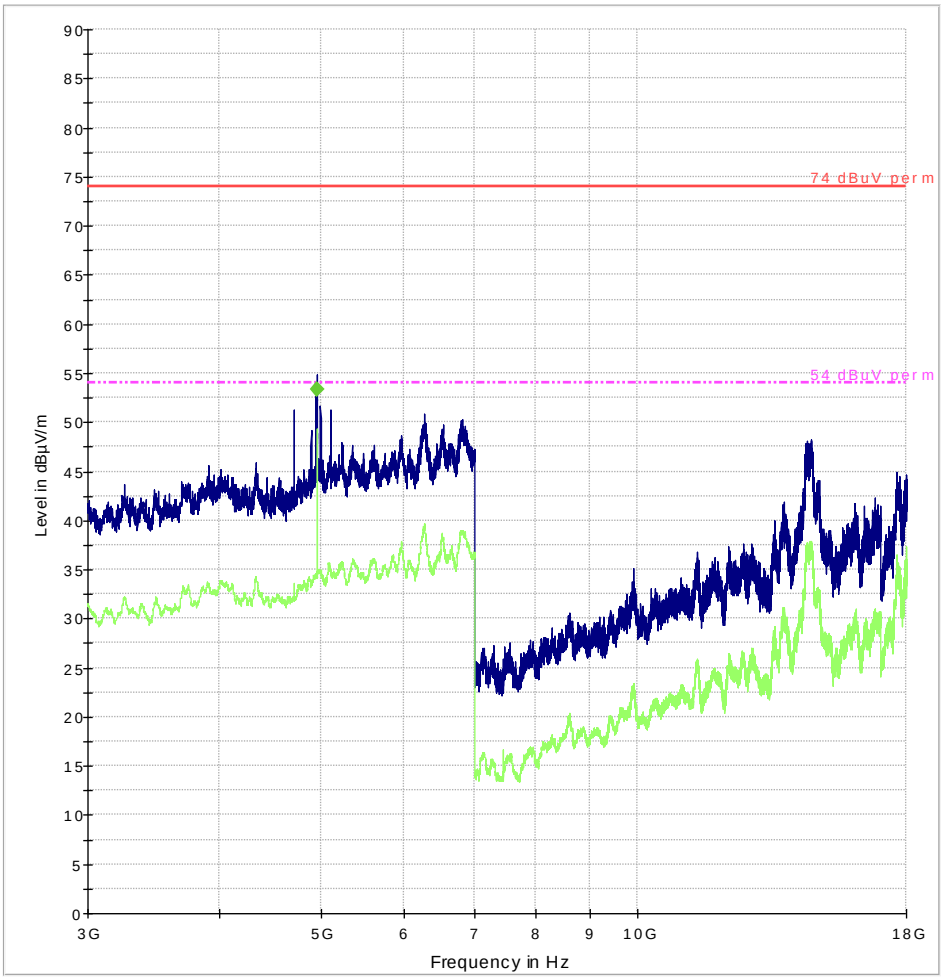
TX Radiated Spurious Emission: 3 GHz – 18 GHz			
Ch. 19	Mode: Bluetooth LE	Modulation: GFSK	Data Rate: 1 Mbps



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

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4881.000000	53.2	100.0	1000.000	320.0	V	264.0	-15.4	0.8	54.0

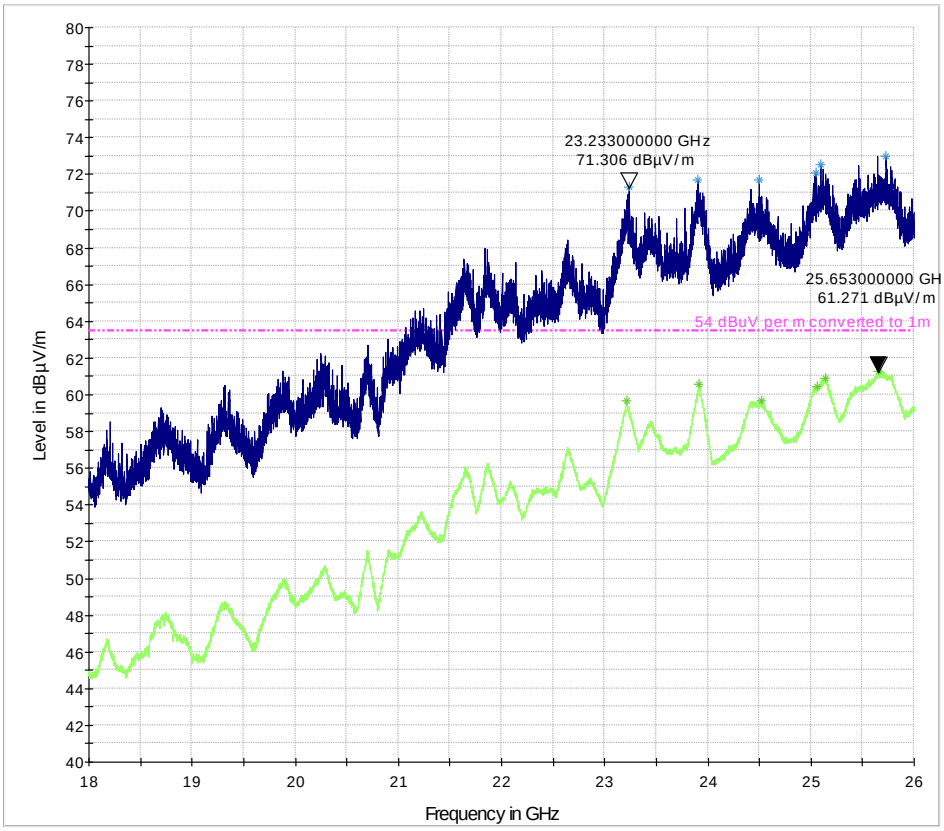
TX Radiated Spurious Emission: 3 GHz – 18 GHz			
Ch. 39	Mode: Bluetooth LE	Modulation: GFSK	Data Rate: 1 Mbps



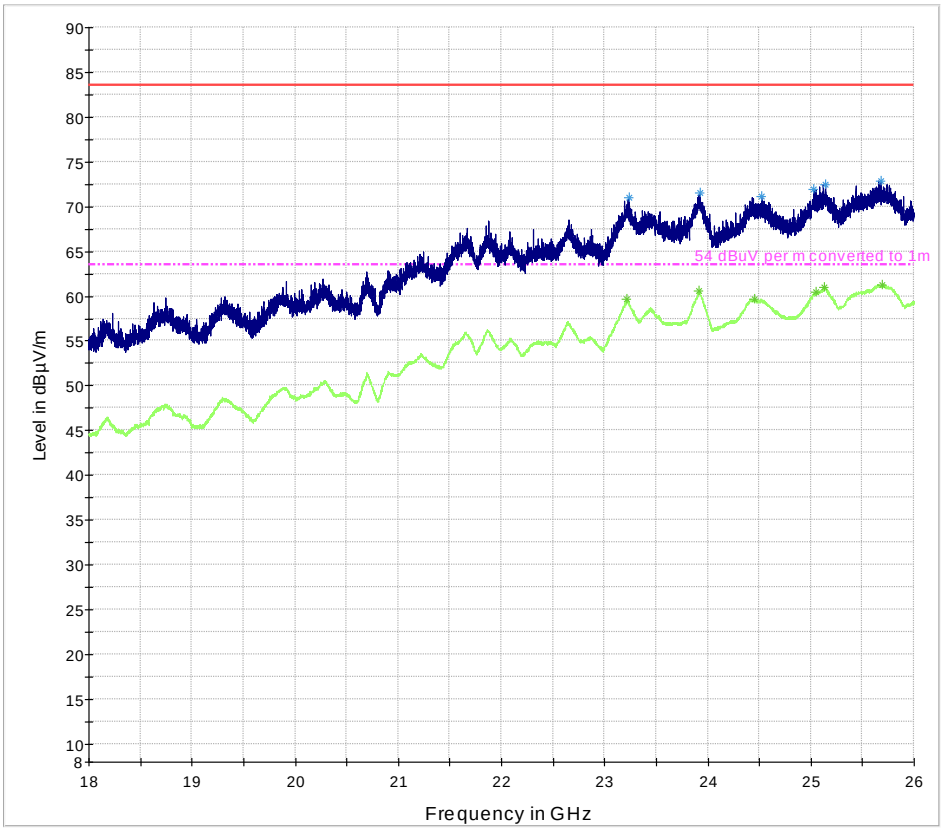
Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
4961.000000	53.3	100.0	1000.000	140.0	V	-53.0	-15.3	0.7	54.0

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



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



8.6 AC Power Line Conducted Emissions

8.6.1 Measurement according to ANSI C63.10 (2013)

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

8.6.2 Limits: §15.207 & RSS-Gen 8.8

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

Table 1:

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

*Decreases with the logarithm of the frequency.

8.6.3 Test conditions and setup:

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

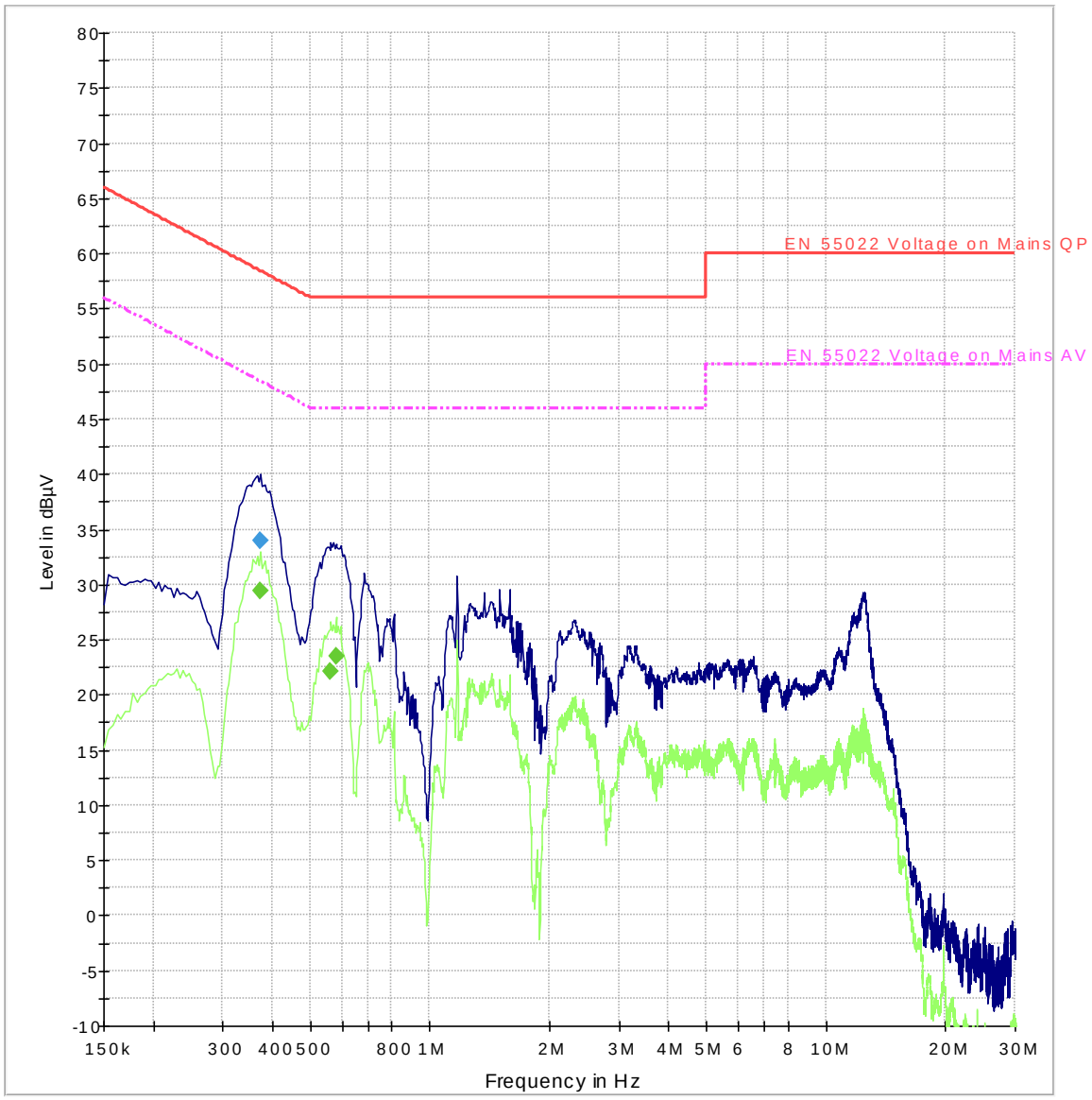
Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power line (L1, L2, L3, N)	Power Input
22	1	GFSK continuous fixed channel	Line & Neutral	110V / 60Hz

8.6.4 Measurement Result:

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

8.6.5 Measurement Plots:

Plot #1



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.374000	34.0	500.0	9.000	GND	L1	3.2	24.4	58.4	

9 Test Equipment And Ancillaries Used For Testing

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
1	Turn table	EMCO	2075	N/A	N/A	N/A
2	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
3	Antenna Mast	EMCO	2075	N/A	N/A	N/A
4	High Pass Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
5	High Pass Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
6	6GHz High Pass Filter	HPM50106	Microtronics	001	Part of system calibration	
7	Pre-Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
8	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
9	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	June 2015	3 Years
10	1500MHz HP Filter	Filtek	HP12/1700	14c48	N/A	N/A
11	2800 MHZ HP Filter	Filtek	HP12/2800	14C47	N/A	N/A
12	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
13	Binconilog Antenna	ETS	3142E	166067	Jun 2014	3 years
14	Horn Antenna	EMCO	3115	35111	Jul 2015	3 Years
15	Horn Antenna	EMCO	3116	00070497	Jul 2015	3 Years
16	Loop Antenna	EMCO	6512	00049838	Mar 2014	3 years
17	LISN	FCC	FCC-LISN-50-25-2-08	08014	Mar 2015	2 Years
18	Spectrum Analyzer	Rohde&Schwarz	FSU 26	100189	Jul 2015	3 Years

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

10 Revision History

Date	Report Name	Changes to report	Report prepared by
2017-02-23	EMC_ARROW-001-16501_15.247_BT_LE	Initial Version	Douglas Antioco
2017-03-28	EMC_ARROW-001-16501_15.247_BT_LE_Rev1	Changing Hykso company address Changing the marketing name to Hykso Wearable Sensor	Douglas Antioco