



FCC / IC Test Report

FOR:

Zipcar

Model #:

Z001

Product Description:

Automotive access and telematics system

FCC ID: 2AHNP-Z00102

IC ID: 21726-Z00102

Per:

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

Test Report #: EMC_ZIPCA-006-16001_15.247_BTLE_rev1

Date: September 23, 2016



CETECOM Inc.

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Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 2 of 49	

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	IDENTIFICATION OF THE EQUIPMENT UNDER TEST (EUT).....	7
3.3	IDENTIFICATION OF ACCESSORY EQUIPMENT	7
3.4	TEST SAMPLE CONFIGURATION	7
3.5	ENVIRONMENTAL CONDITIONS DURING TEST:	7
3.6	SOFTWARE TOOL USED TO CONTROL EUT.....	7
3.7	WORST CASE CONDITION FOR EMISSION MEASUREMENT	8
3.8	DUTY CYCLE	9
4	SUBJECT OF INVESTIGATION	10
5	MEASUREMENT RESULTS SUMMARY	11
6	MEASUREMENT UNCERTAINTY	12
7	DATES OF TESTING:	12
8	MEASUREMENT PROCEDURES.....	13
8.1	RADIATED MEASUREMENT	13
8.2	SAMPLE CALCULATIONS FOR FIELD STRENGTH MEASUREMENTS	15
8.3	POWER LINE CONDUCTED MEASUREMENT PROCEDURE.....	15
8.4	RF CONDUCTED MEASUREMENT SETUP.....	16
9	MAXIMUM PEAK CONDUCTED OUTPUT POWER	17
9.1	MEASUREMENT ACCORDING TO FCC KDB 558074 D01 V03R04	17
9.2	LIMITS:.....	17
9.3	TEST CONDITIONS AND SETUP:	17
9.4	MEASUREMENT RESULT:	17
9.5	MEASUREMENT PLOTS:	18
10	SPECTRAL DENSITY	21
10.1	MEASUREMENT ACCORDING TO FCC KDB 558074 D01 V03R03	21
10.2	LIMITS: §15.247 & RSS-247	21
10.3	TEST CONDITIONS AND SETUP:.....	21
10.4	MEASUREMENT RESULT:	21
10.5	MEASUREMENT PLOTS:	22
11	BAND EDGE COMPLIANCE	25
11.1	MEASUREMENT ACCORDING TO FCC KDB 558074 D01 V03R04	25
11.2	LIMITS RESTRICTED BAND §15.205 AND RSS-GEN 8.10.....	25
11.3	LIMITS NON RESTRICTED BAND §15.247 AND RSS-247 5.5.....	26
11.4	TEST CONDITIONS AND SETUP:.....	26
11.5	MEASUREMENT RESULT:	27
11.6	MEASUREMENT PLOTS:	28
12	EMISSION BANDWIDTH 6DB AND 99% OCCUPIED BANDWIDTH.....	31

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 3 of 49	
		IC ID: 21726-Z00102	

12.1	MEASUREMENT ACCORDING TO FCC KDB 558074 D01 v03R04	31
12.2	LIMITS: §15.247	31
12.3	TEST CONDITIONS AND SETUP:.....	31
12.4	MEASUREMENT RESULT:	31
12.5	MEASUREMENT PLOTS:	32
13	RADIATED TRANSMITTER SPURIOUS EMISSIONS AND RESTRICTED BANDS	33
13.1	MEASUREMENT ACCORDING TO ANSI C63.10 (2013)	33
13.2	LIMITS: §15.247/15.205/15.209 & RSS-GEN 8.9/ 8.10 (RESTRICTED BANDS)	33
13.3	TEST CONDITIONS AND SETUP:.....	34
13.4	MEASUREMENT RESULT:	34
13.5	MEASUREMENT PLOTS:	35
14	SETUP PICTURES	46
15	EUT PICTURES.....	47
16	TEST EQUIPMENT AND ANCILLARIES USED FOR TESTING	48
17	REVISION HISTORY	49

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 4 of 49	

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 #
Zipcar	Automotive access and telematics system	Z001


Report reviewed by: TCB Evaluator

September 23, 2016	Compliance	James Donnellan (Senior EMC Engineer)	
Date	Section	Name	Signature

Responsible for the Report:

September 23, 2016	Compliance	Yu-Chien Ho (EMC Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section 3.
CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 5 of 49	

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:	Zipcar
Street Address:	15 N Ellsworth Ave Ste 100
City/Zip Code:	San Mateo, CA 94401
Country:	USA

2.3 Identification of the Manufacturer

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

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 6 of 49	

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model #:	Z001
HW Version :	2
SW Version :	22.9
FCC-ID :	2AHNP-Z00102
IC-ID:	21726-Z00102
HVIN:	Z001
PMN:	Z001
FVIN:	N/A
Product Description:	Automotive access and telematics system
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 ceramic 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 = 0.5 dBi
Max. Measured Conducted Output	-0.95 dBm
Rated Operating Voltage Range:	Vehicle 12VDC
Operating Temperature Range:	Tlow: -40° C/ Tnom: 30° C/ Tmax: 85° C
Other Radios included in the Device:	Cellular GPS RFID/NFC
Sample Revision:	<input type="checkbox"/> Prototype; <input checked="" type="checkbox"/> Production; <input type="checkbox"/> Pre-Production

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	CETECOM™
Date of Report	September 23, 2016	Page 7 of 49	
		IC ID: 21726-Z00102	

3.2 Identification of the Equipment under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	320009	2	22.9	

3.3 Identification of Accessory equipment

AE #	Type	Model	Manufacturer	Serial Number
1	N/A			

3.4 Test Sample Configuration

EUT Set-Up #	Combination of AE used for test set up	Comments
1	EUT#1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected.

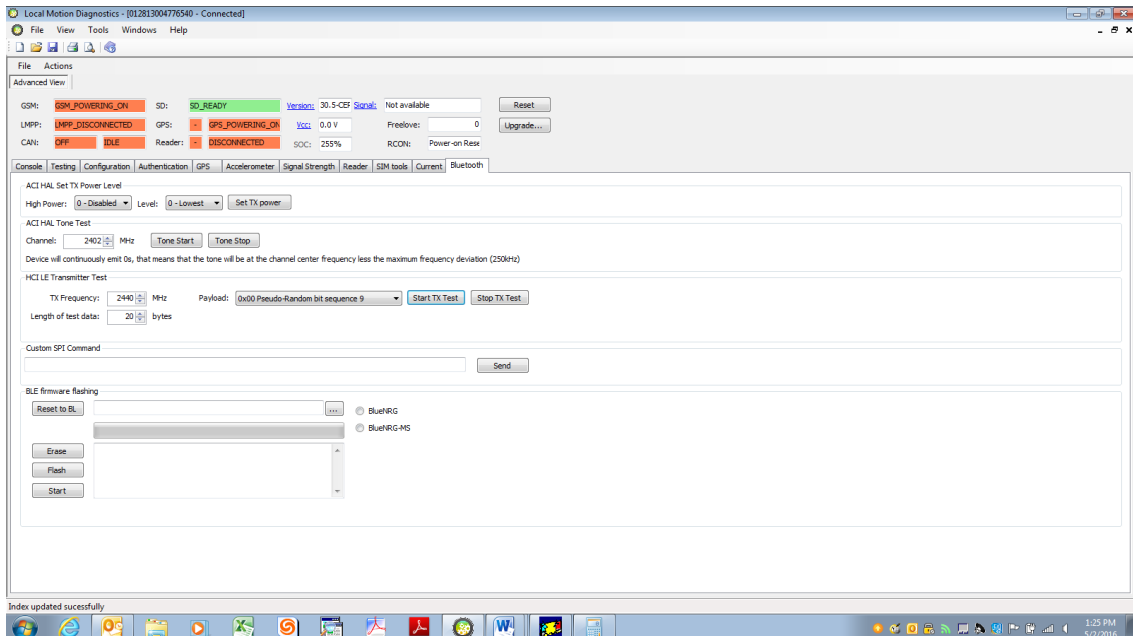
3.5 Environmental conditions during Test:


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

Ambient Temperature: 20-25°C

Relative humidity: 40-60%

3.6 Software tool used to control EUT



Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 8 of 49	
		IC ID: 21726-Z00102	

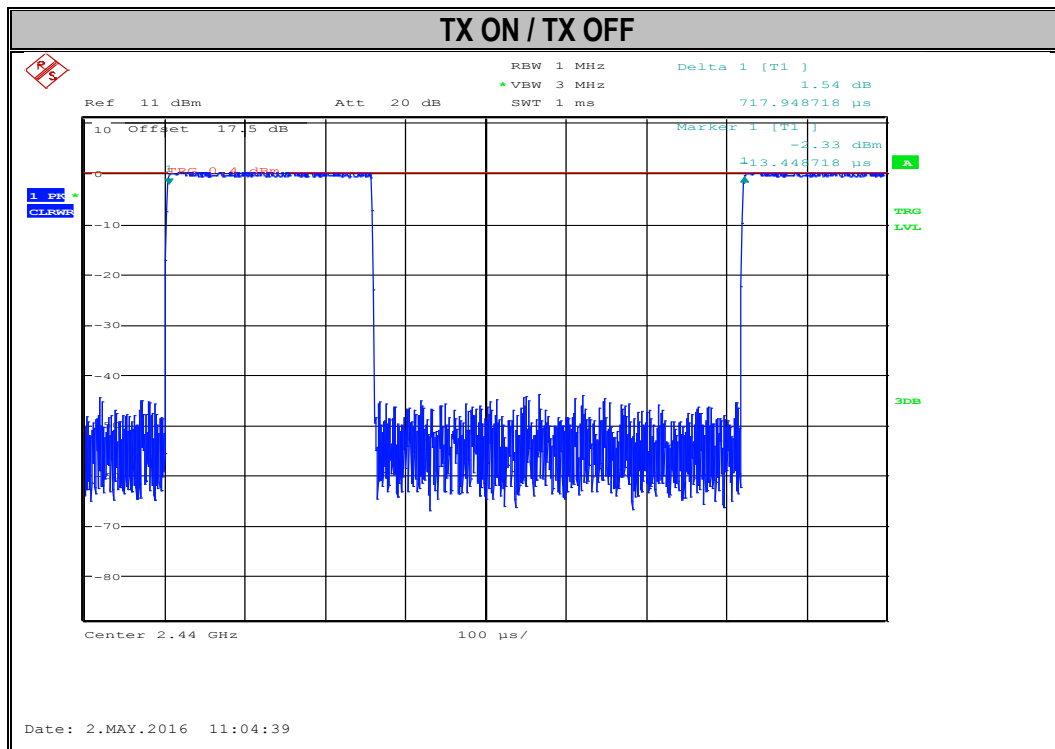
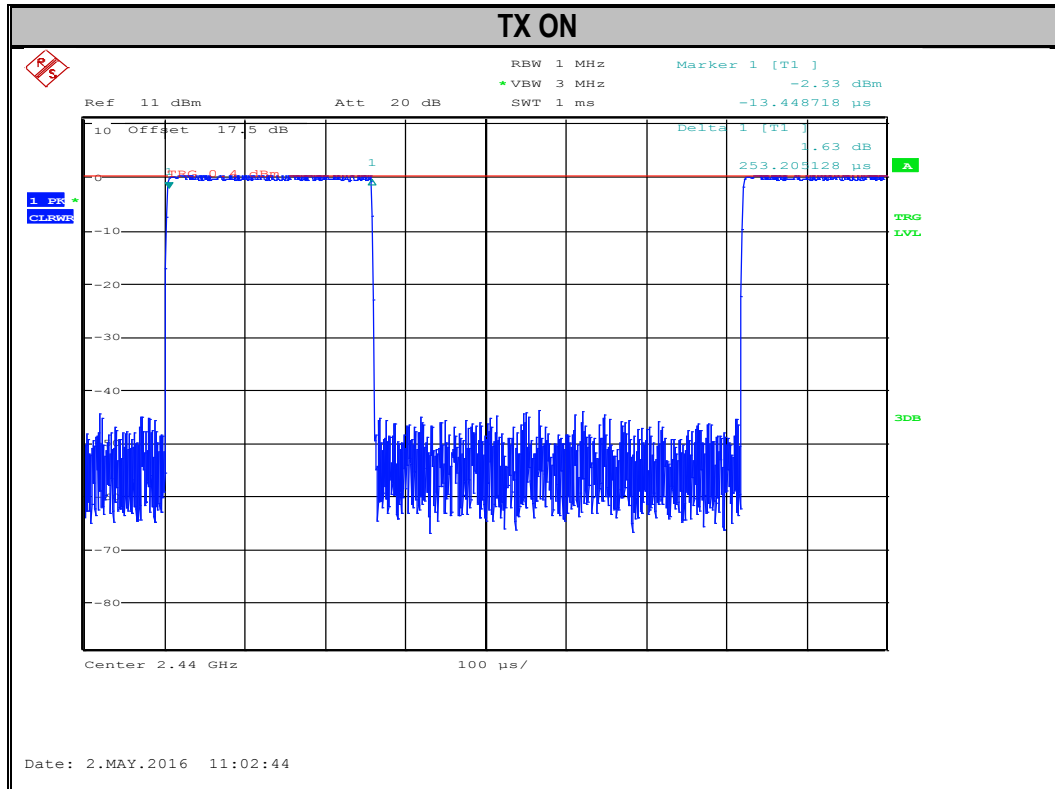
3.7 Worst case condition for emission measurement


All results are based on the EUT operating at its maximum peak envelope power.

To achieve this condition the EUT was set to the following Power Setting / Key value of 6: -0.95 dB.

3.8 Duty Cycle

Mode	Duty Cycle	Correction Factor
GFSK	253 us / 718 us = 35%	4.6 dB



Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 10 of 49	
		IC ID: 21726-Z00102	

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: 2AHNP-Z00102. IC ID: 21726-Z00102.

Testing procedures are based on
558074 D01 DTS Meas Guidance v03r03
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) 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	Power Line 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 Dates of Testing:

April 15, 2016 – May 6, 2016

8 Measurement Procedures

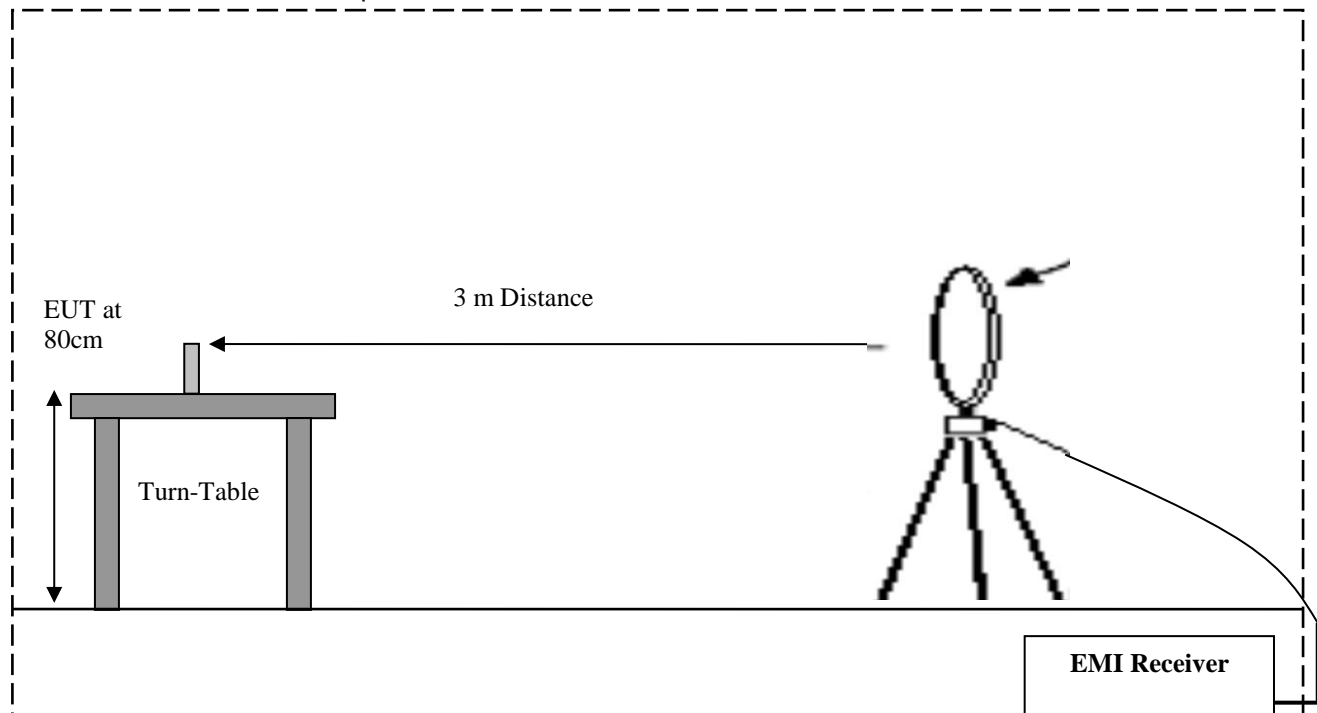
8.1 Radiated Measurement

The radiated measurement is performed according to:

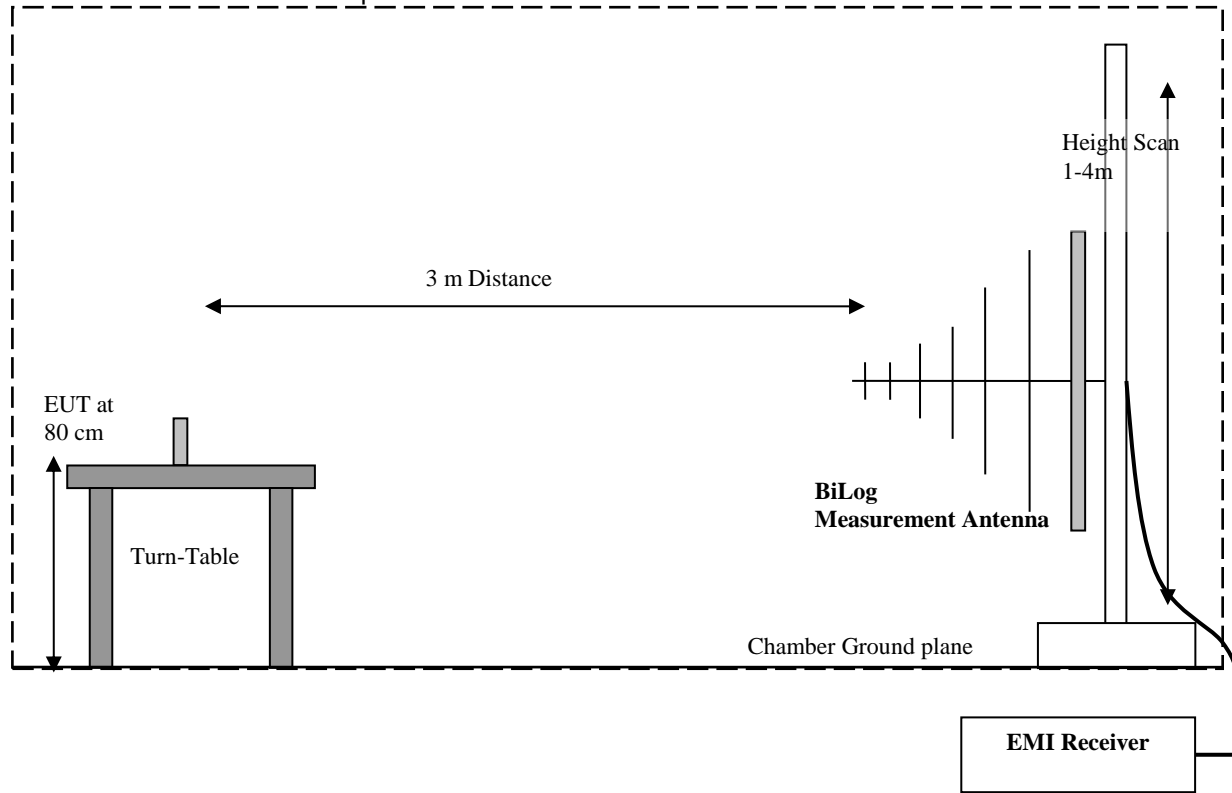
ANSI C63.10 (2013)

- 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 than 10deg.
- 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.

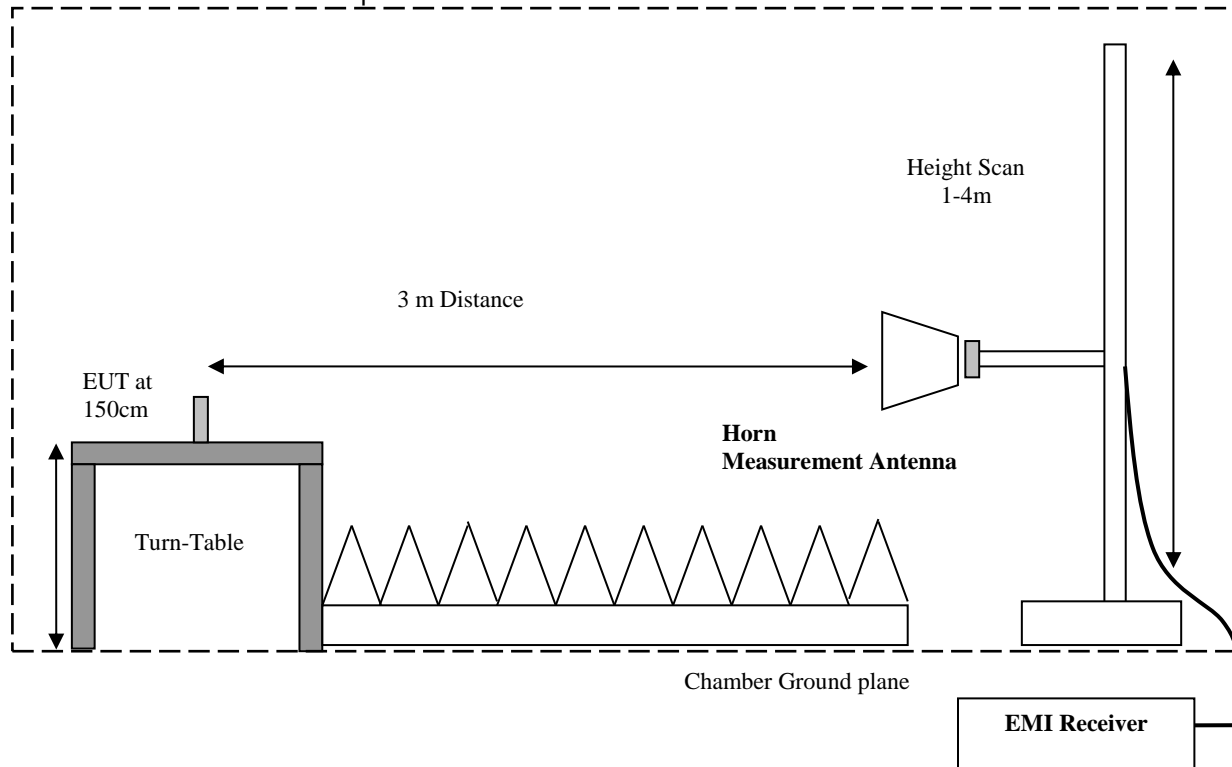
Radiated Emissions Test Setup Below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup Above 1GHz Measurements



8.2 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 dB μ V
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

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

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

Example:

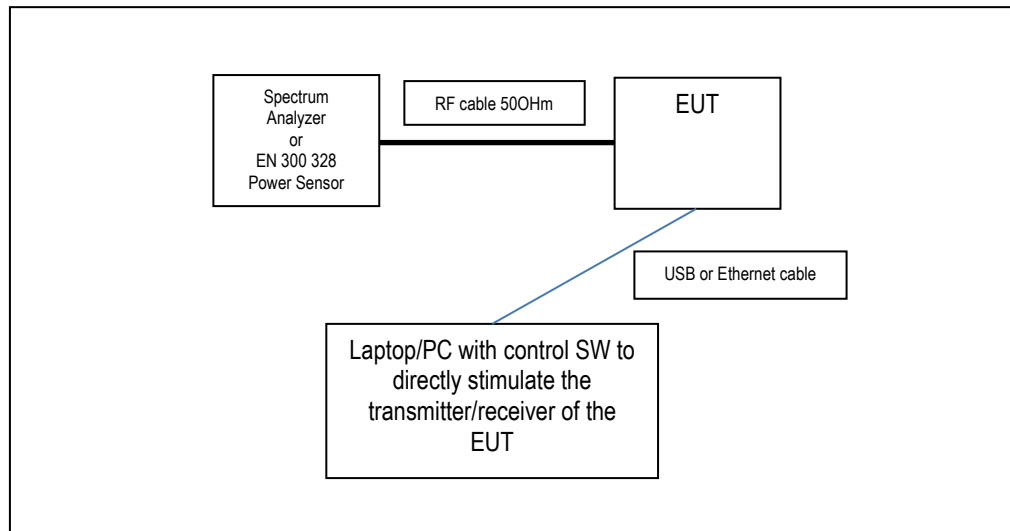
Frequency (MHz)	Measured SA (dB μ V)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dB μ V/m)
1000	80.5	3.5	14	98.0


8.3 Power Line Conducted Measurement Procedure

Power Line conducted emissions measurements performed according to:

ANSI C63.4 (2014)

8.4 RF Conducted Measurement Setup



Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 17 of 49	

9 Maximum Peak Conducted Output Power

9.1 Measurement according to FCC KDB 558074 D01 V03R04

Spectrum Analyzer settings:

According to KDB section 9.1.1 RBW \geq DTS bandwidth

9.2 Limits:

Maximum Peak Output Power:

FCC §15.247 (b)(1): 1W

IC RSS-247: 1W

EIRP:

IC RSS-247: 4W

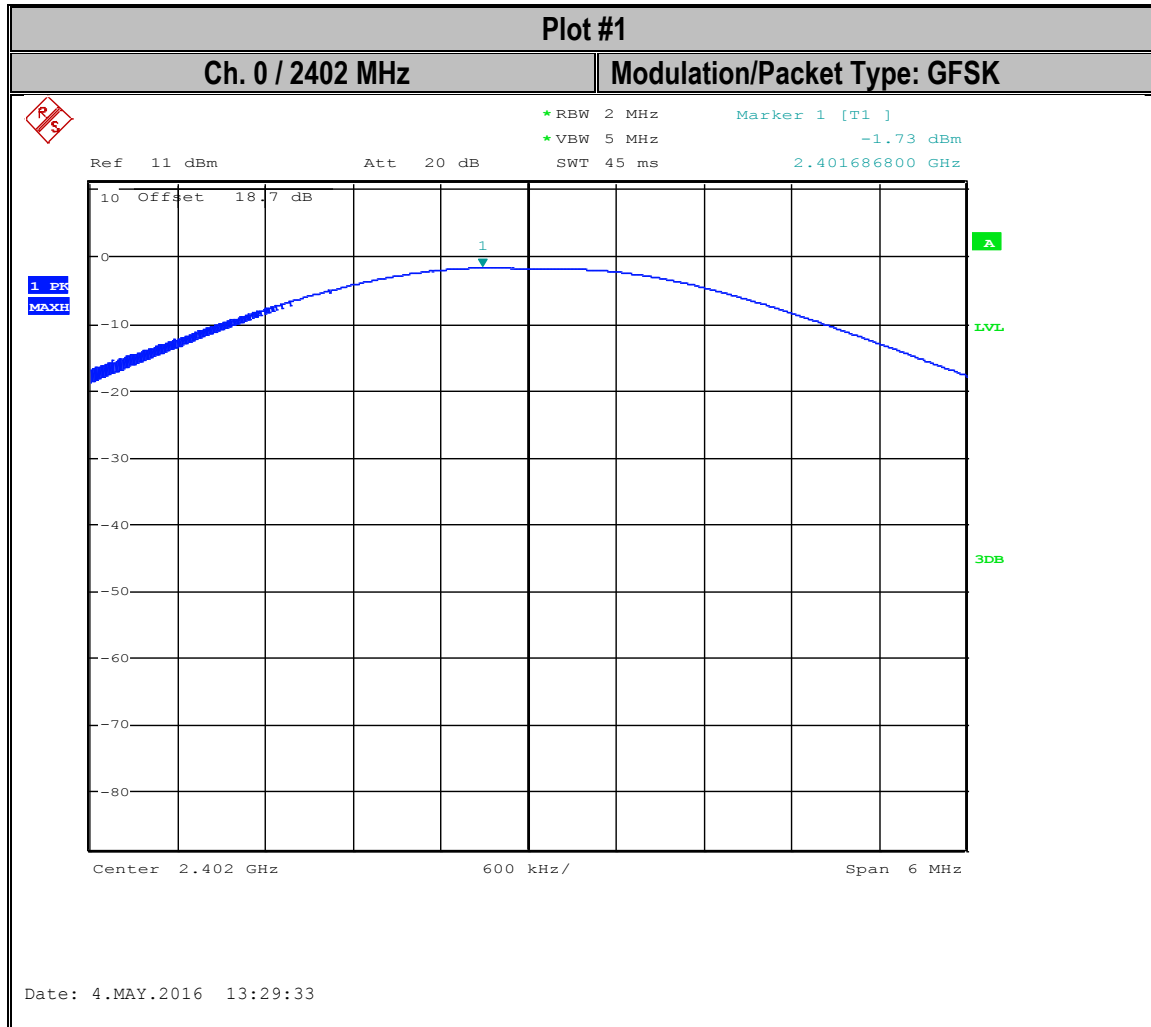
9.3 Test conditions and setup:

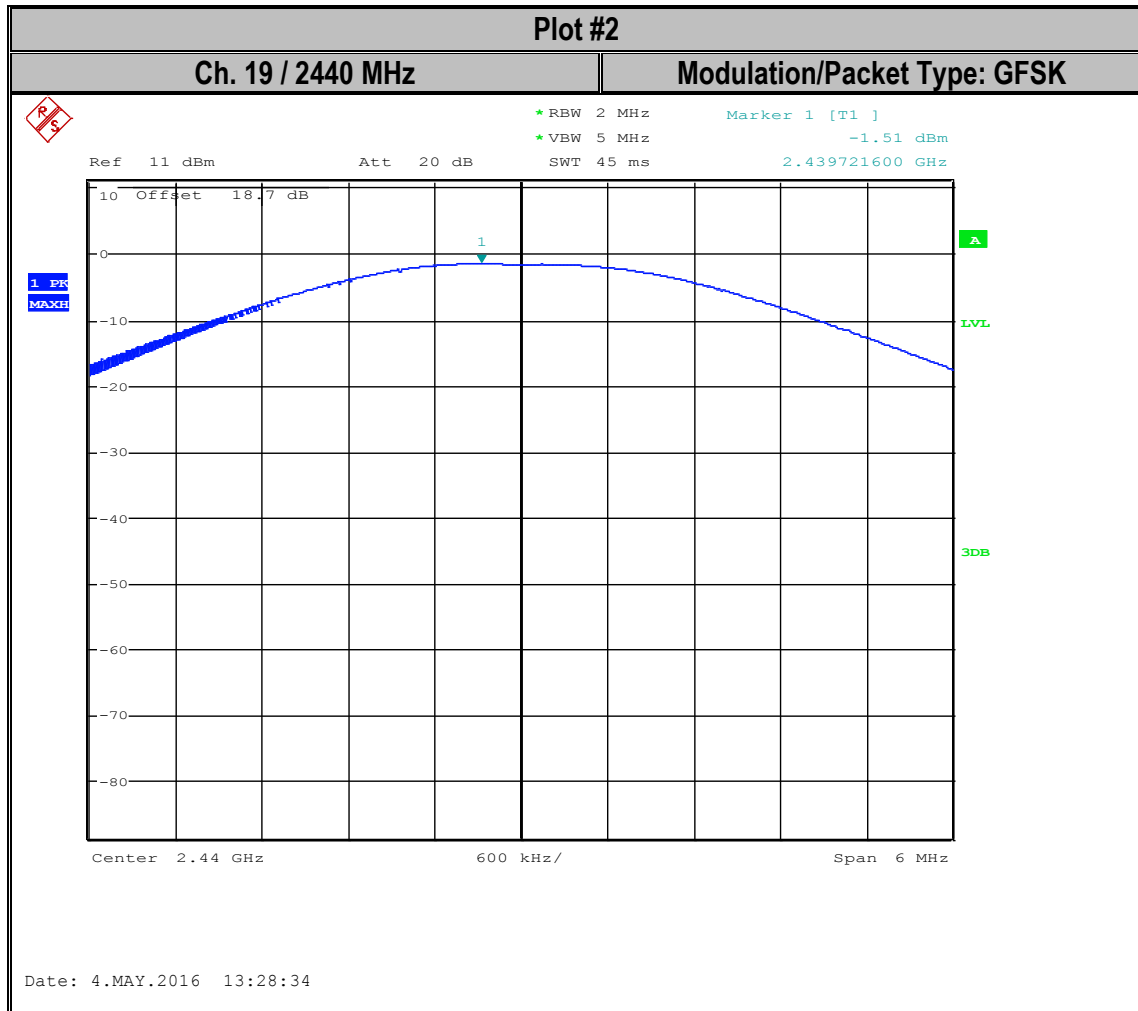
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	Tx	12V DC

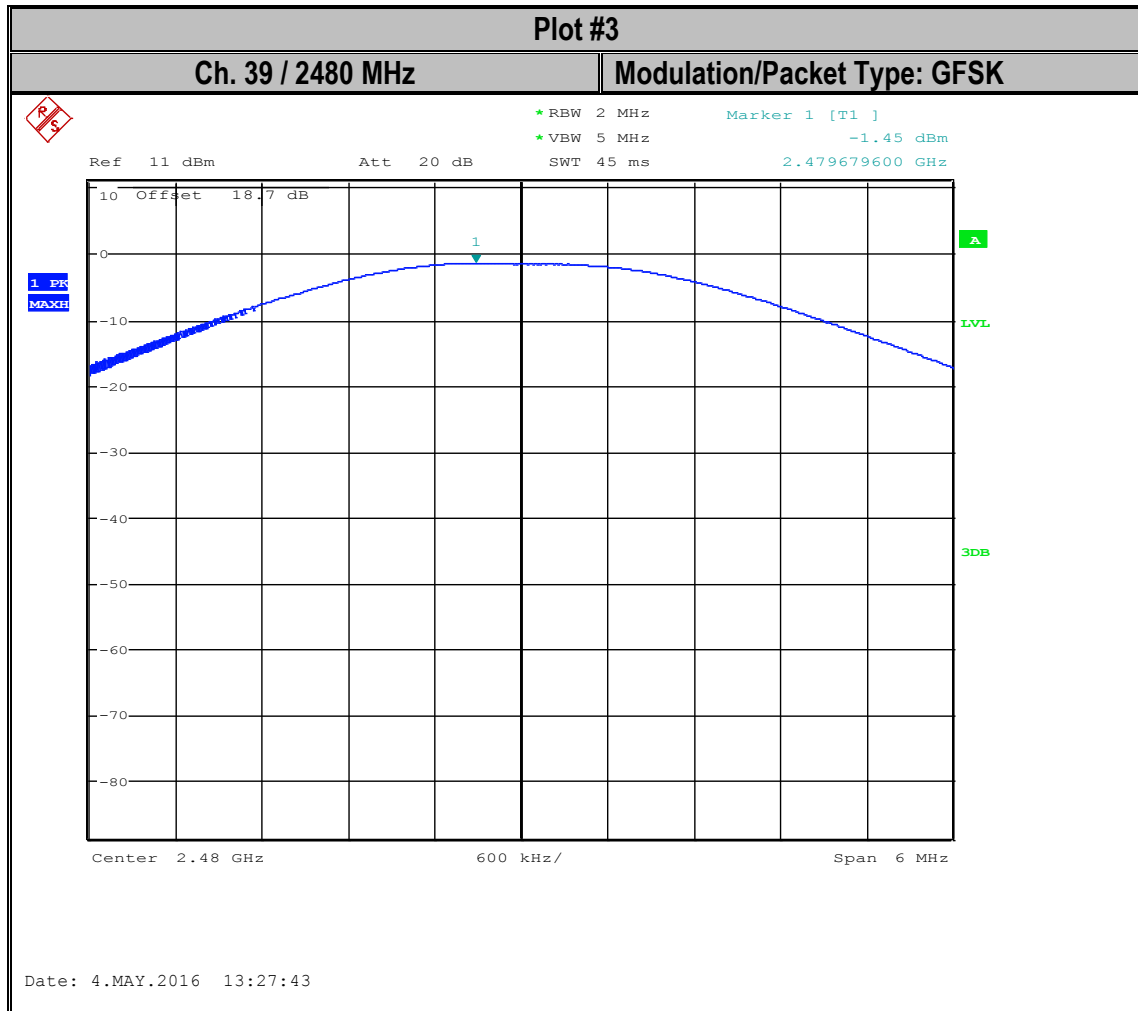
9.4 Measurement result:


Plot #	Frequency (MHz)	Maximum Average Conducted Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	Result
1	2402	-1.73	0.5	-1.23	30(Pk) / 36(EIRP)	Pass
2	2440	-1.51	0.5	-1.01	30(Pk) / 36(EIRP)	Pass
3	2480	-1.45	0.5	-0.95	30(Pk) / 36(EIRP)	Pass

9.5 Measurement Plots:







Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 21 of 49	

10 Spectral Density

10.1 Measurement according to FCC KDB 558074 D01 V03R03

Spectrum Analyzer settings:

According to KDB section 10.2 Method PKPSD (peak PSD)

10.2 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.

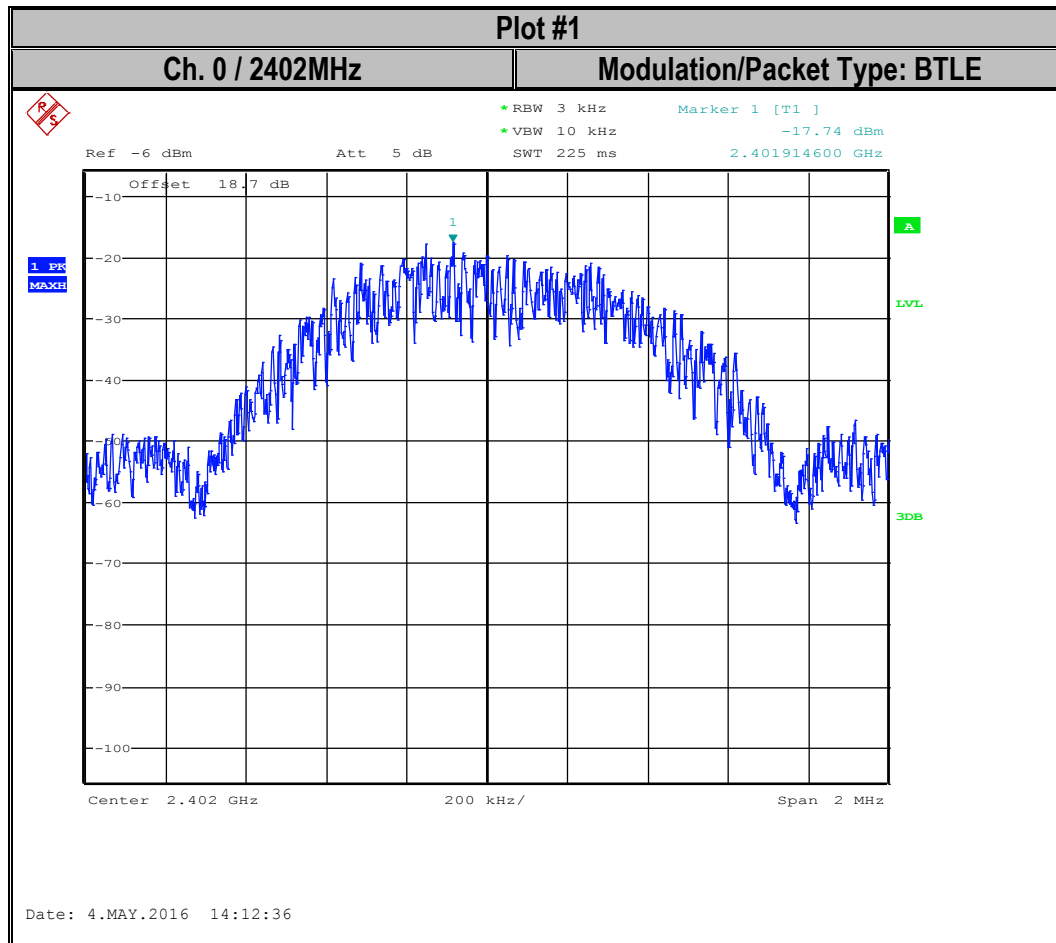
10.3 Test conditions and setup:

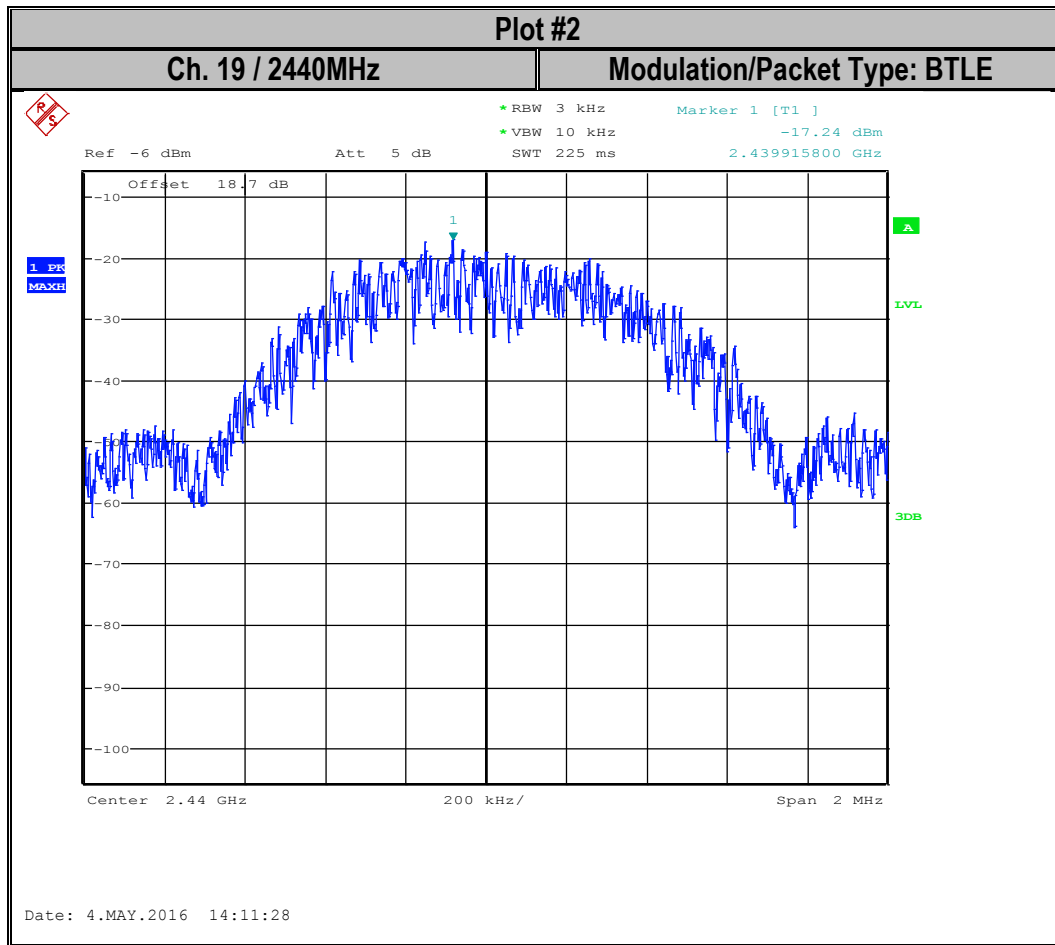
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	Tx	12V DC

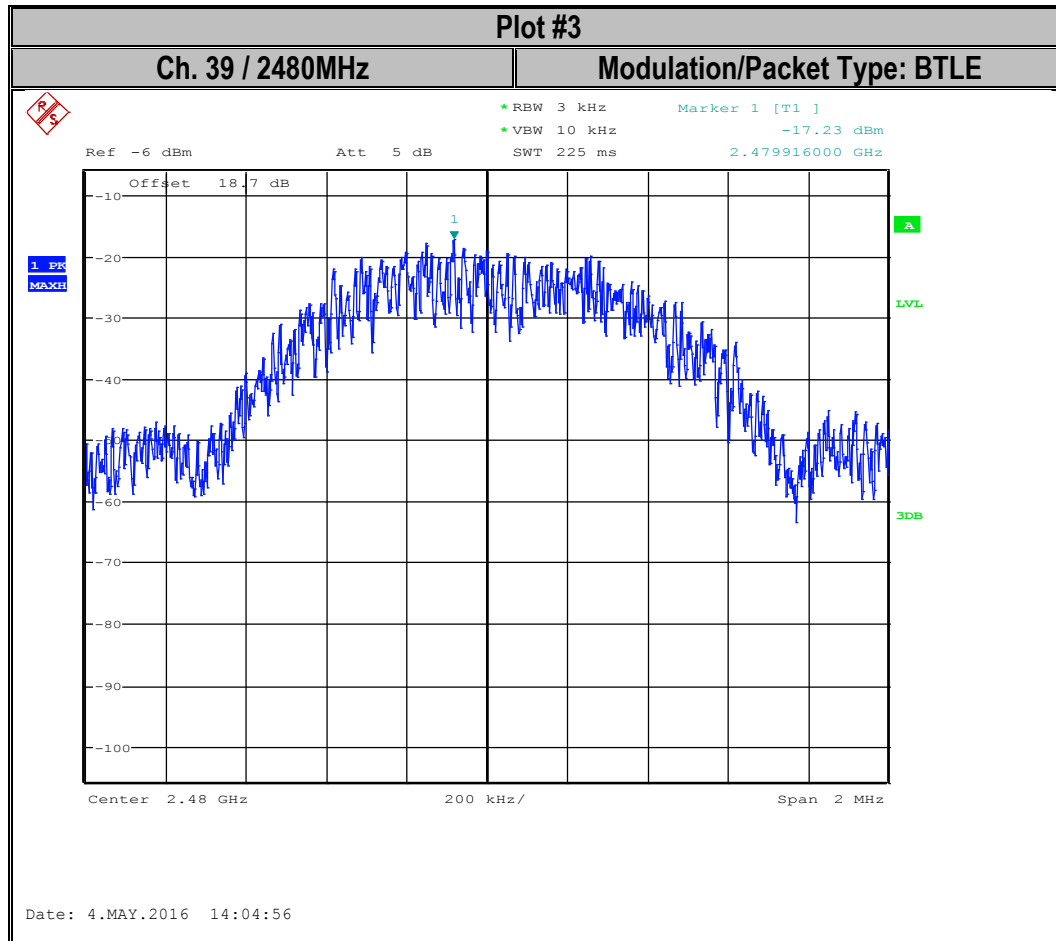
10.4 Measurement result:

Plot #	Frequency (MHz)	Maximum Power Spectral Density (dBm/3kHz)	Limit (dBm / 3 KHz)	Result
1	2402	-17.74	8	Pass
2	2440	-17.24	8	Pass
3	2480	-17.23	8	Pass

10.5 Measurement Plots:







11 Band Edge Compliance

11.1 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 \geq 100 kHz

VBW \geq 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.

11.2 Limits restricted band §15.205 and RSS-Gen 8.10

*PEAK LIMIT= 74dB μ V/m @3m =-21.23dBm


*AVG. LIMIT= 54dB μ V/m @3m =-41.23dBm

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

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

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

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
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			

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 26 of 49	

11.3 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.

11.4 Test conditions and setup:

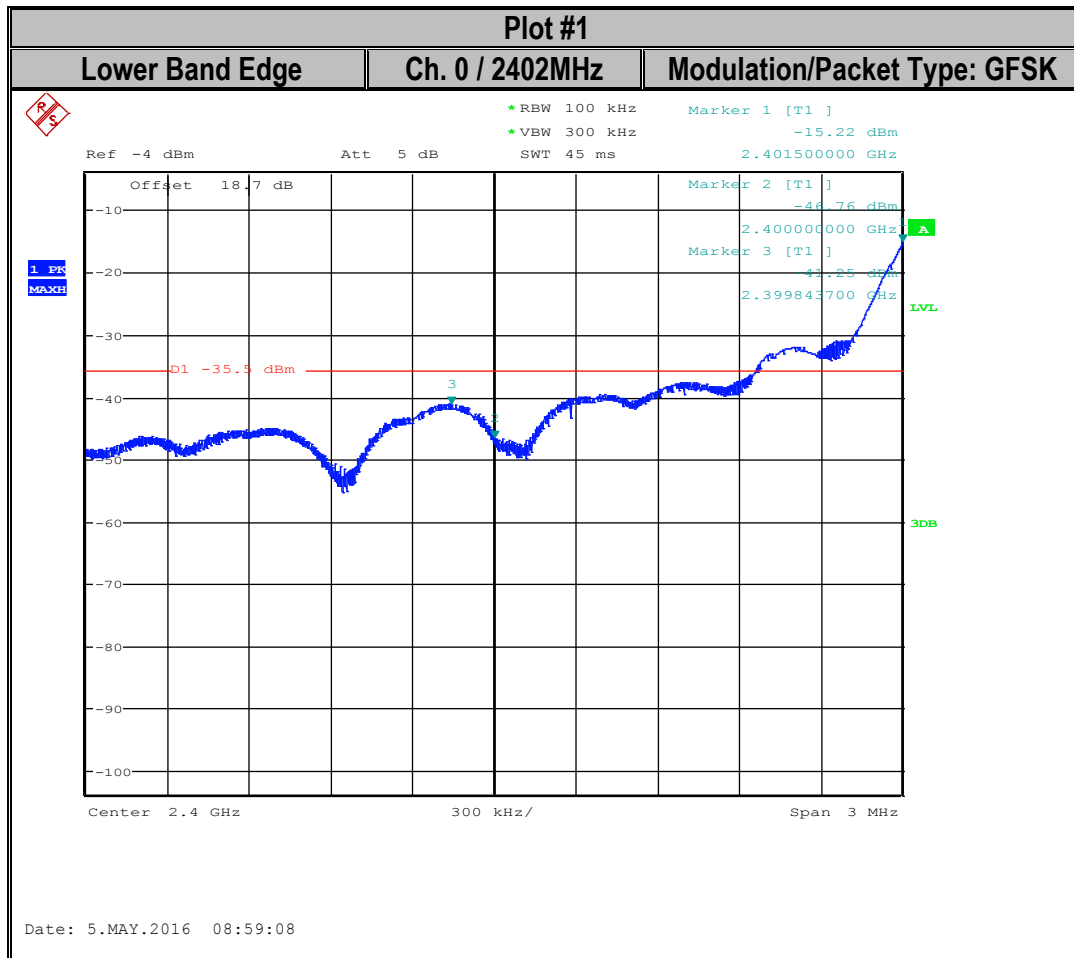
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	Tx	12V DC

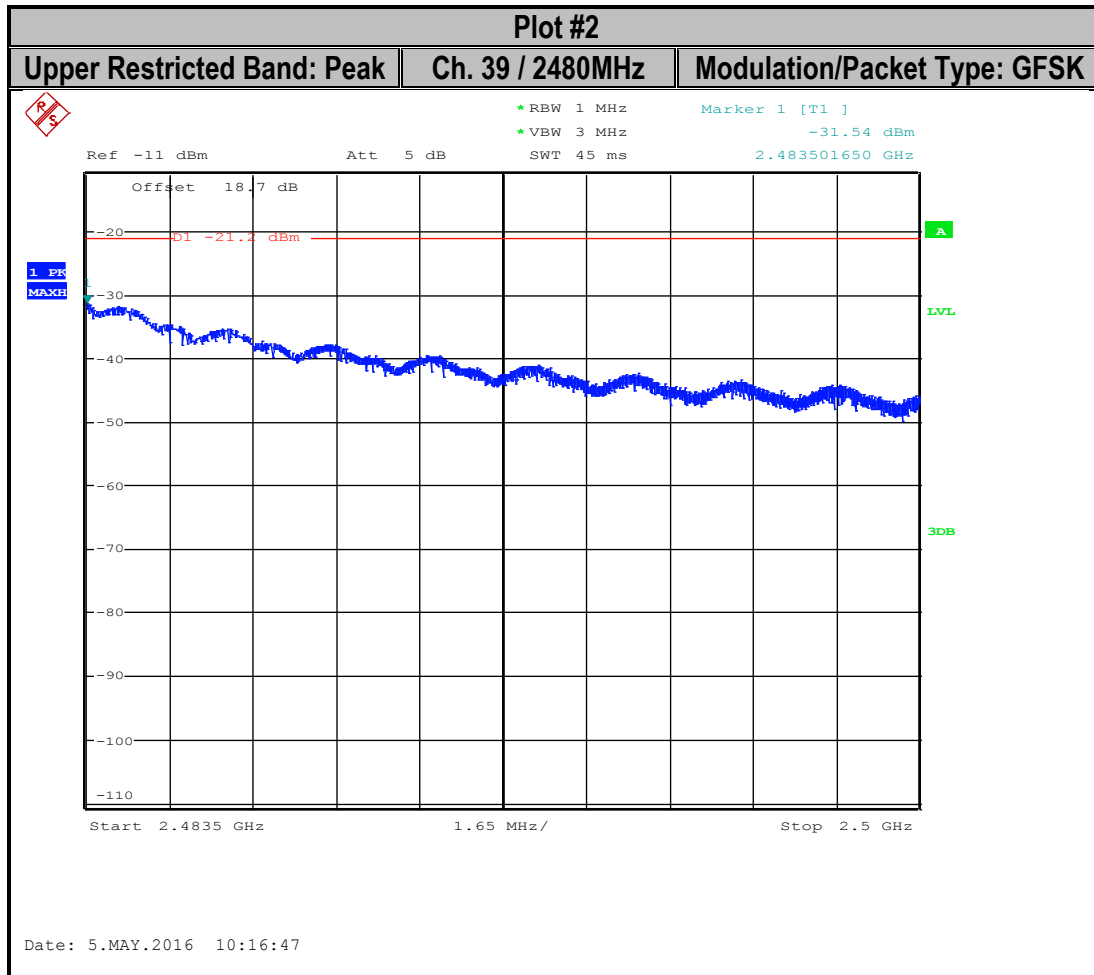
11.5 Measurement result:

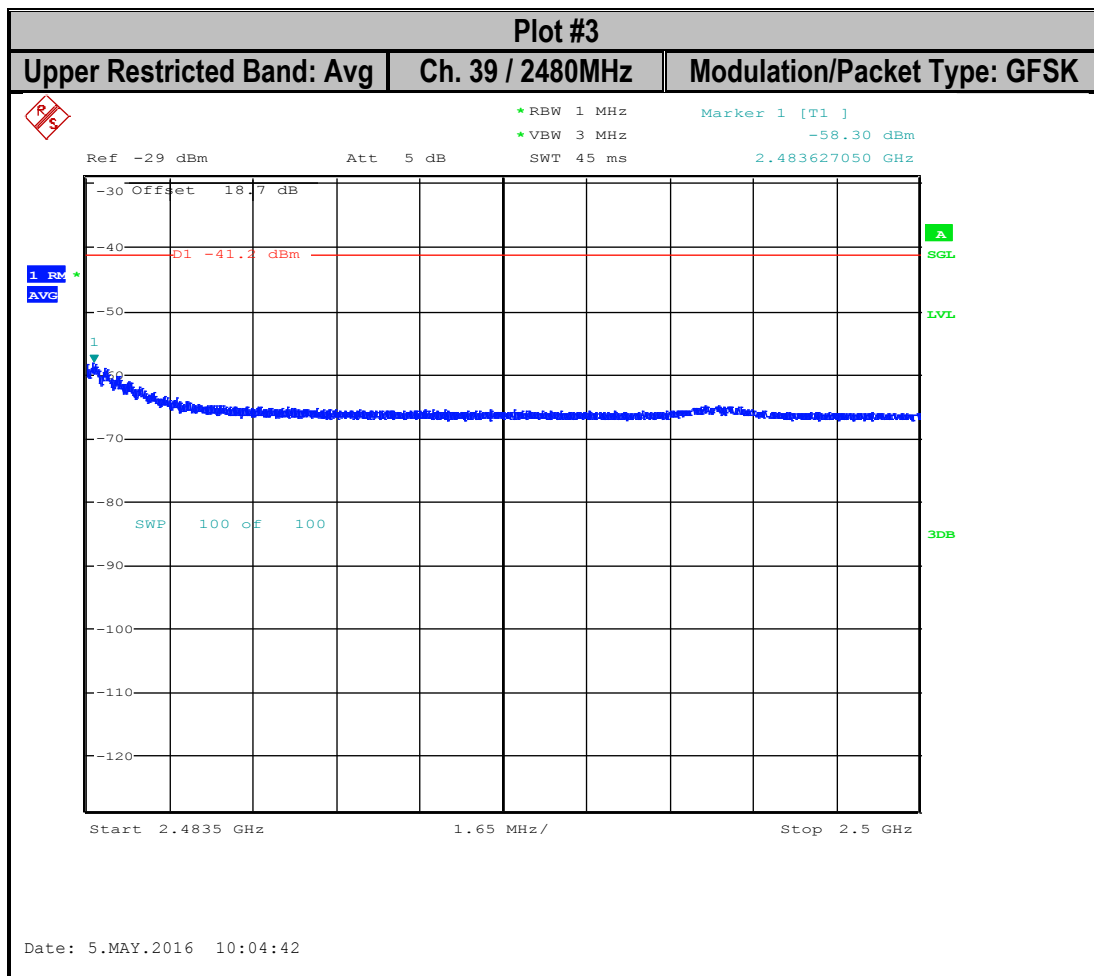
Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc) in case peak output power was measured	Result
1	BTLE	Lower, non-restricted	-41.25	-20	Pass


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	-31.54	4.6	0.5	-21.23 peak	Pass
3	BTLE	Upper restricted average	-58.3	4.6	0.5	-41.23 average	Pass

11.6 Measurement Plots:







Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 31 of 49	

12 Emission Bandwidth 6dB and 99% Occupied Bandwidth

12.1 Measurement according to FCC KDB 558074 D01 v03r04

Spectrum Analyzer settings:

Set RBW = 100 kHz

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

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

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

12.2 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.

12.3 Test conditions and setup:

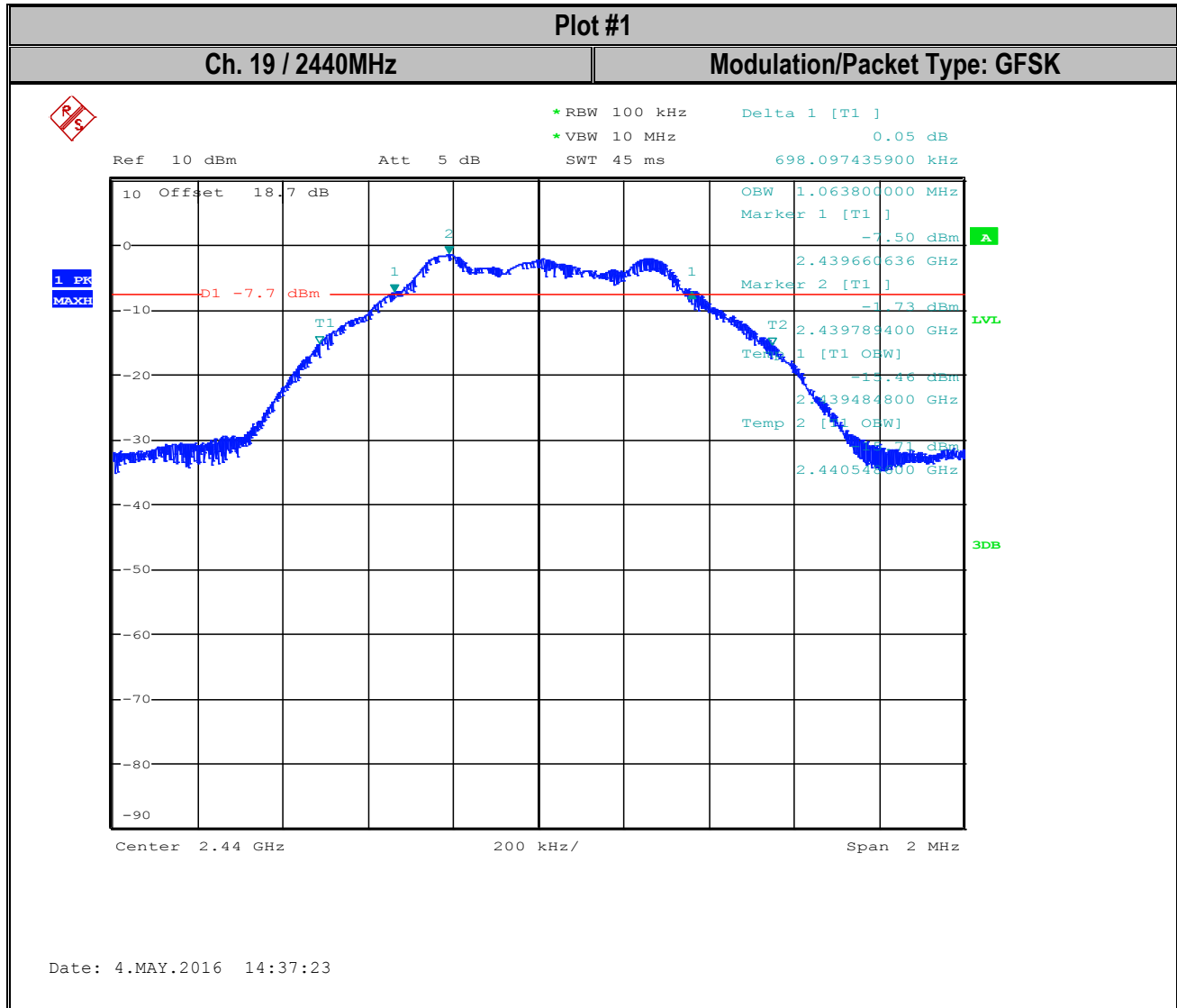
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
°21 C	1	Tx	12V DC

12.4 Measurement result:

Plot #	Frequency (MHz)	Modulation / Bandwidth	6dB Emissions Bandwidth (MHz)	Limit (MHz)	Result
1	2440	GFSK	0.698	> 0.5	Pass

Plot #	Frequency (MHz)	99% Occupied Bandwidth (MHz)
1	2440	1.064

12.5 Measurement Plots:



13 Radiated Transmitter Spurious Emissions and Restricted Bands

13.1 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.

13.2 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= 54dB μ V/m

Table 1:

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

Table 2:

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

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

The highest (or worst-case) data rate shall be recorded for each measurement.

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

Conversion factor (CF) = $40 \log (D/d) = 40 \log (300\text{m} / 3\text{m}) = 80\text{dB}$

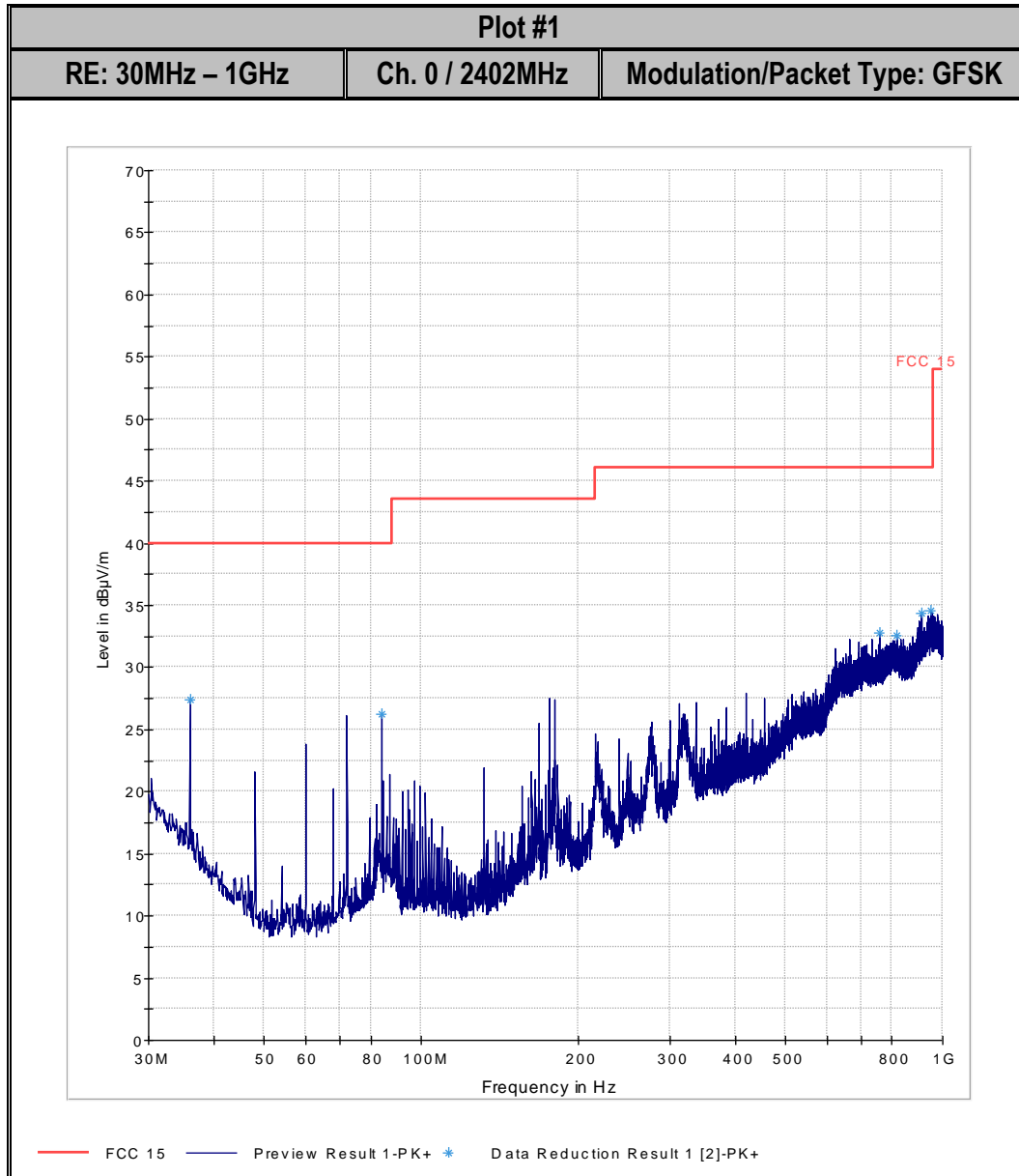
13.3 Test conditions and setup:

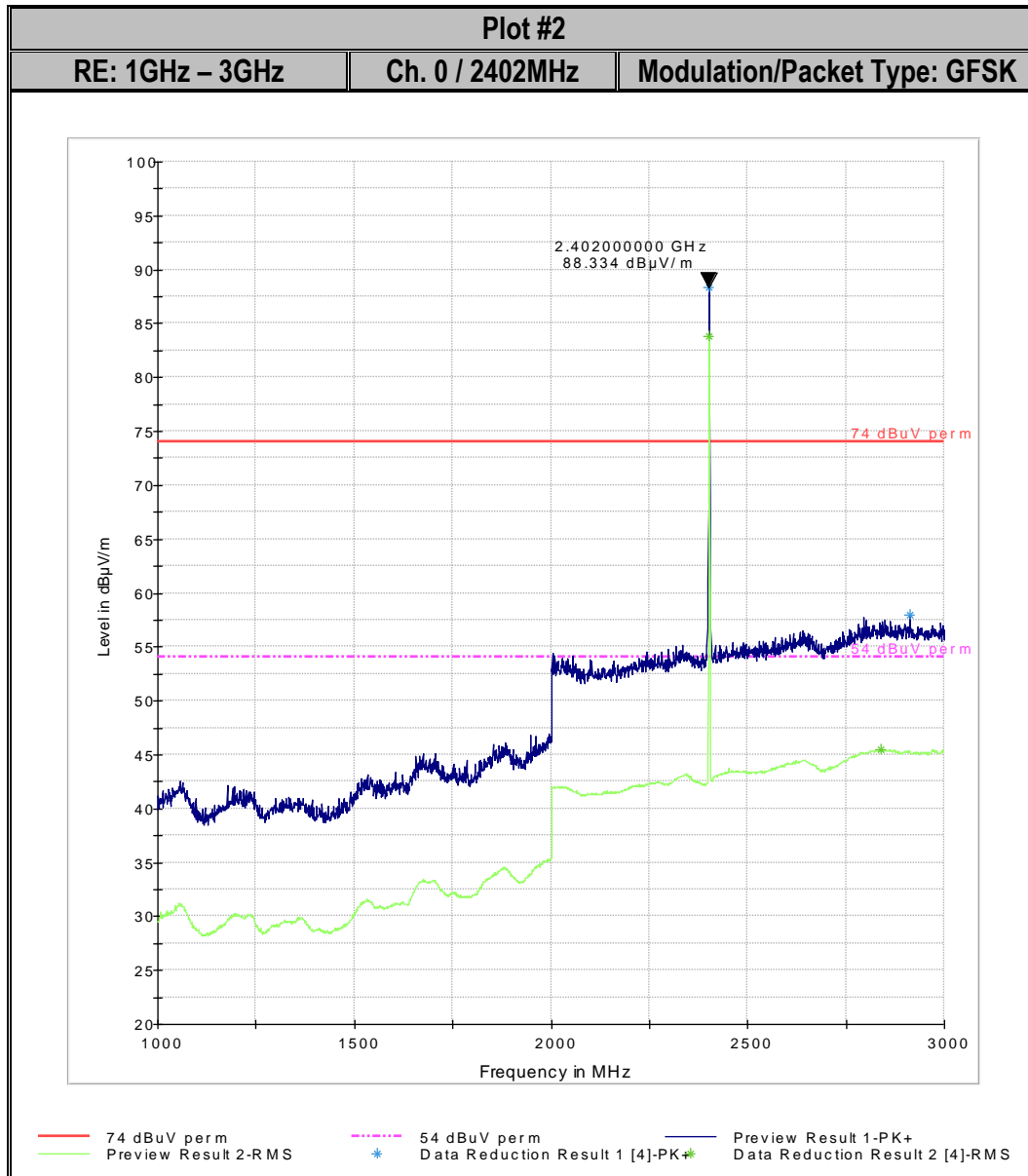
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	Tx	Battery

13.4 Measurement result:

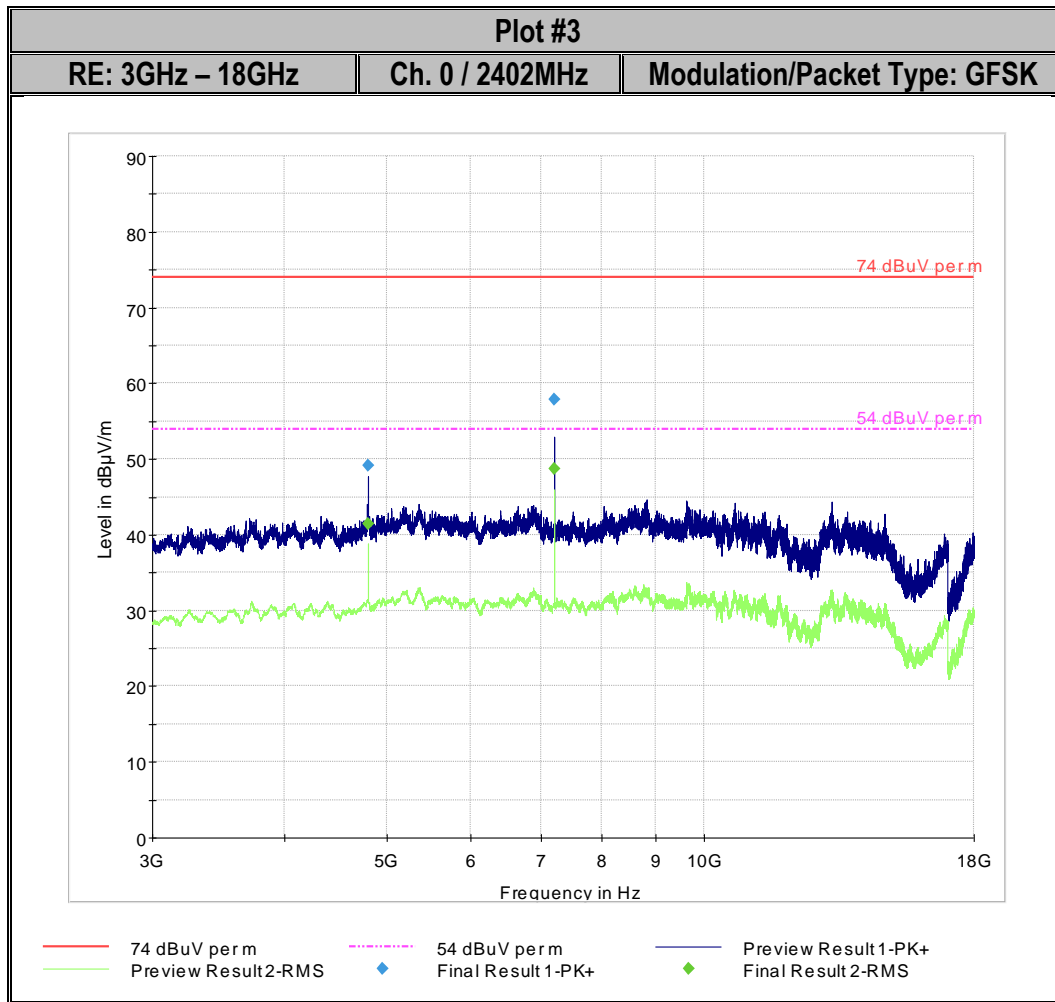
Plot #	Channel #	Scan Frequency	Limit	Result
1-3	0	30MHz – 18GHz	See section 8.7.2	Pass
4-8	19	9kHz – 26GHz	See section 8.7.2	Pass
9-12	39	30MHz – 18GHz	See section 8.7.2	Pass

13.5 Measurement Plots:

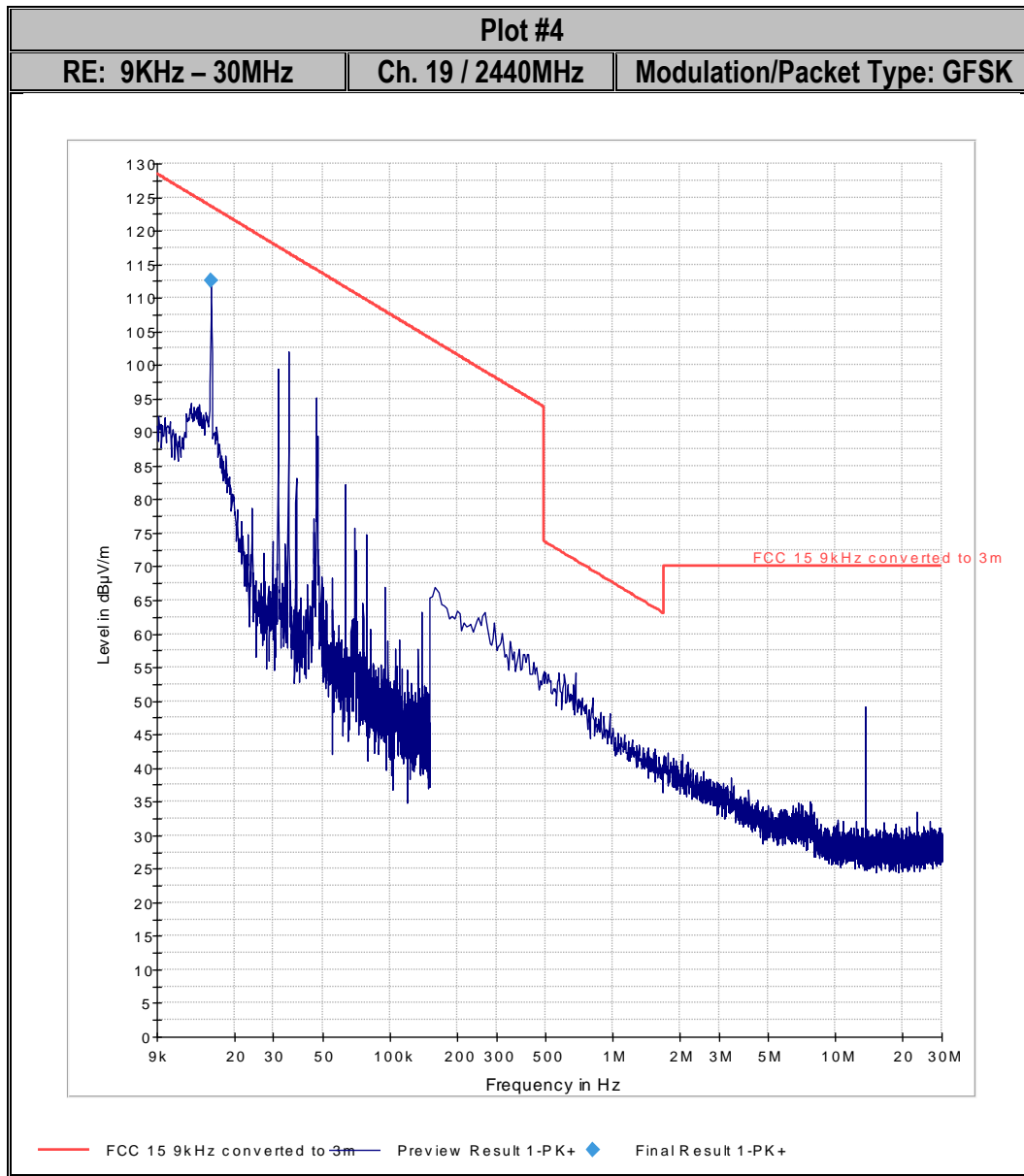


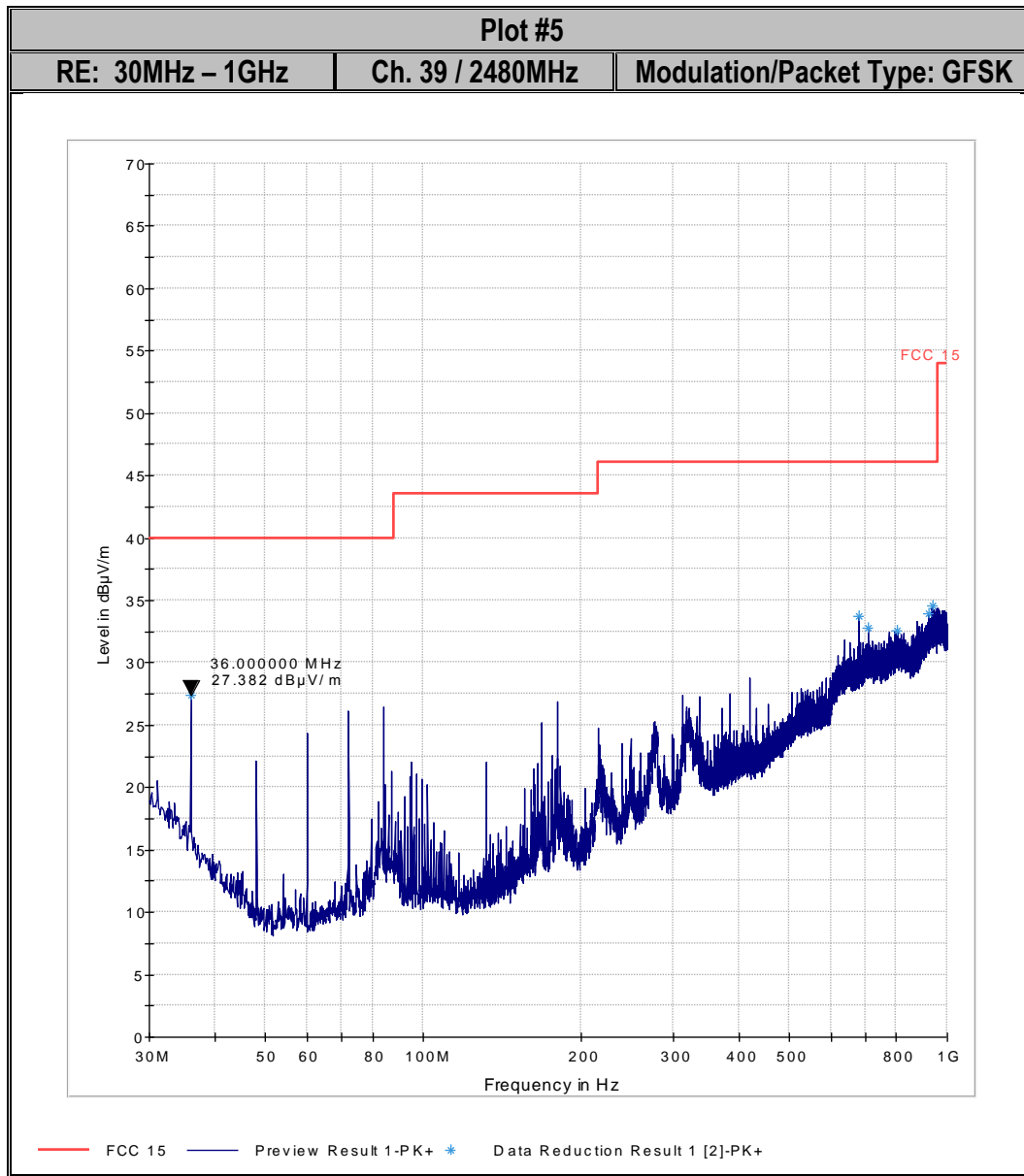


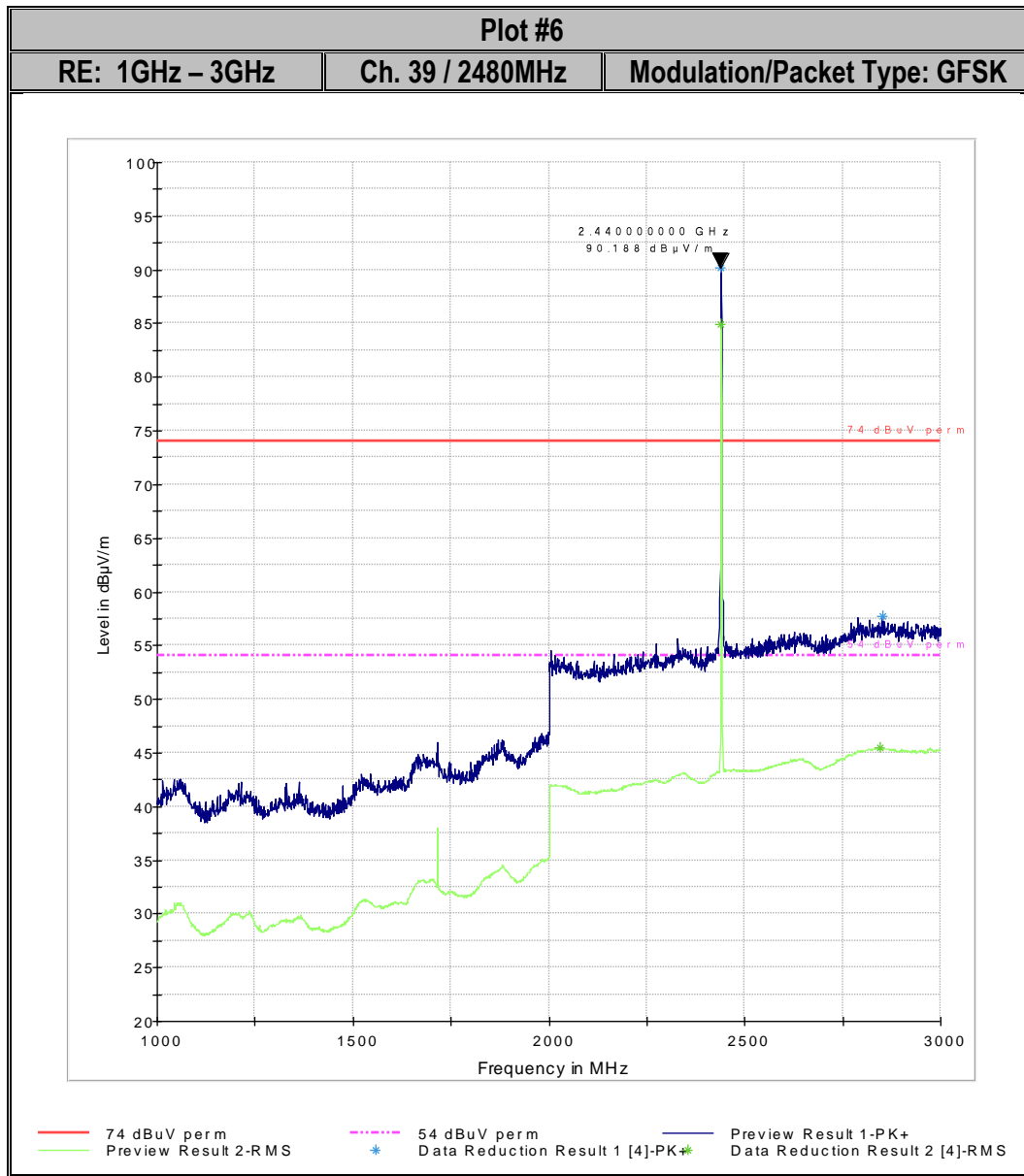
*Note: The peak signal is the Tx Ch. Low.



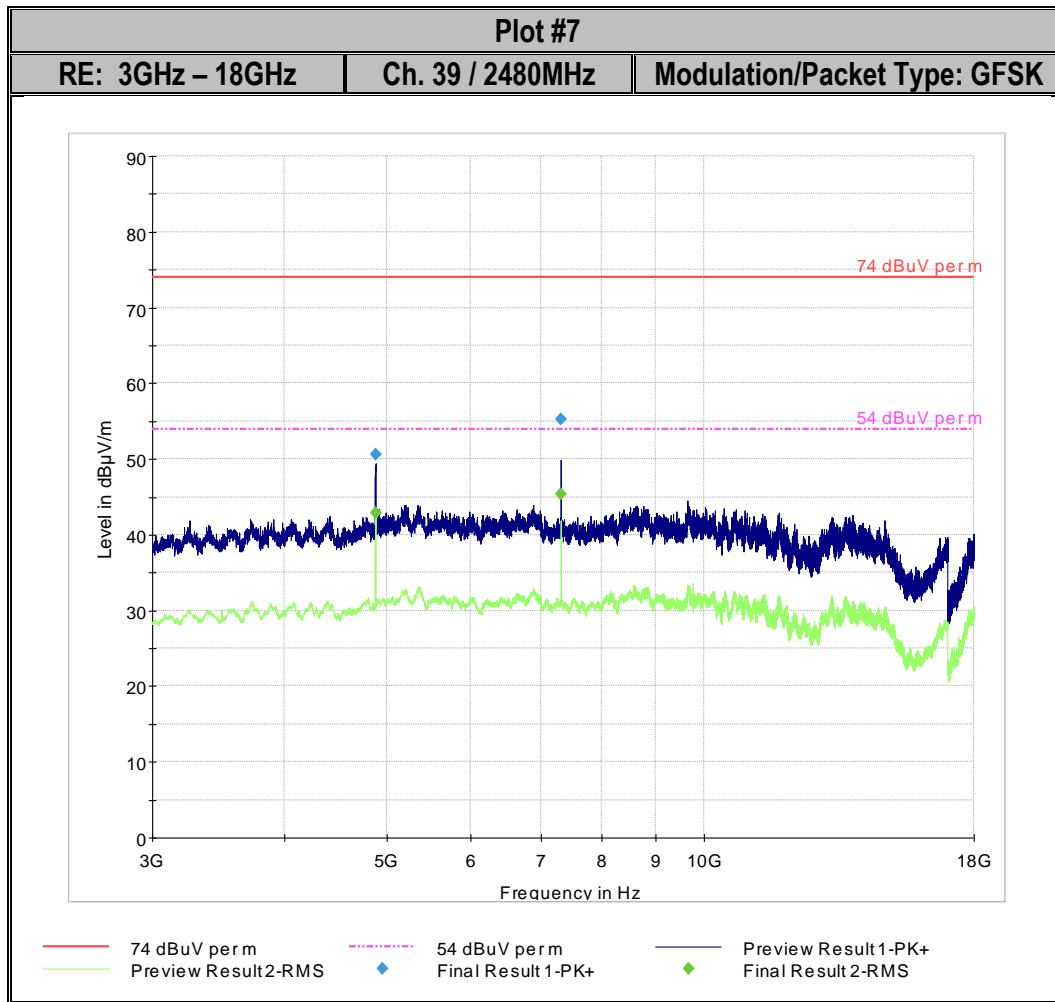
*Note: The peak signal at 7.205 GHz is not in the restricted bands.



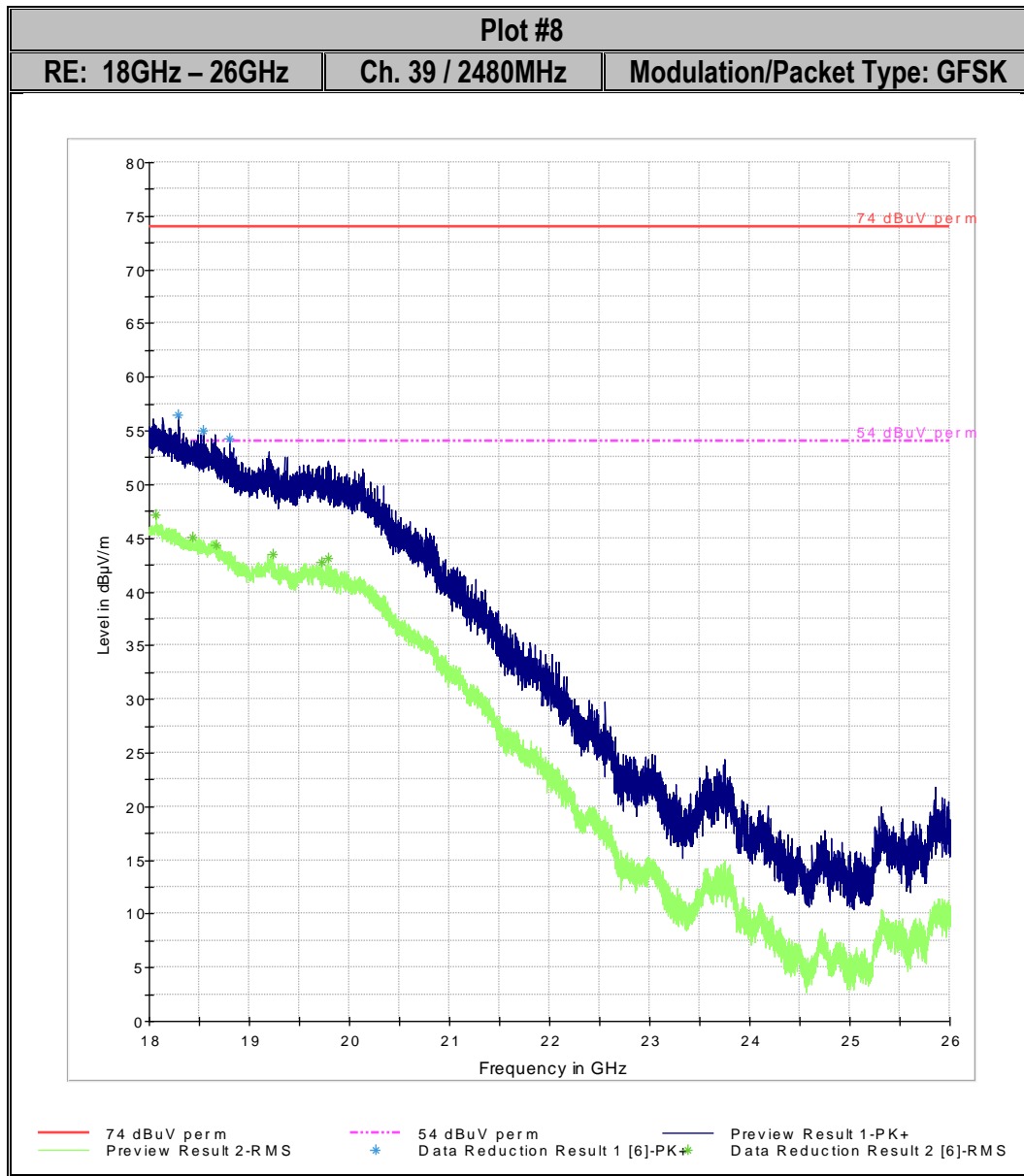


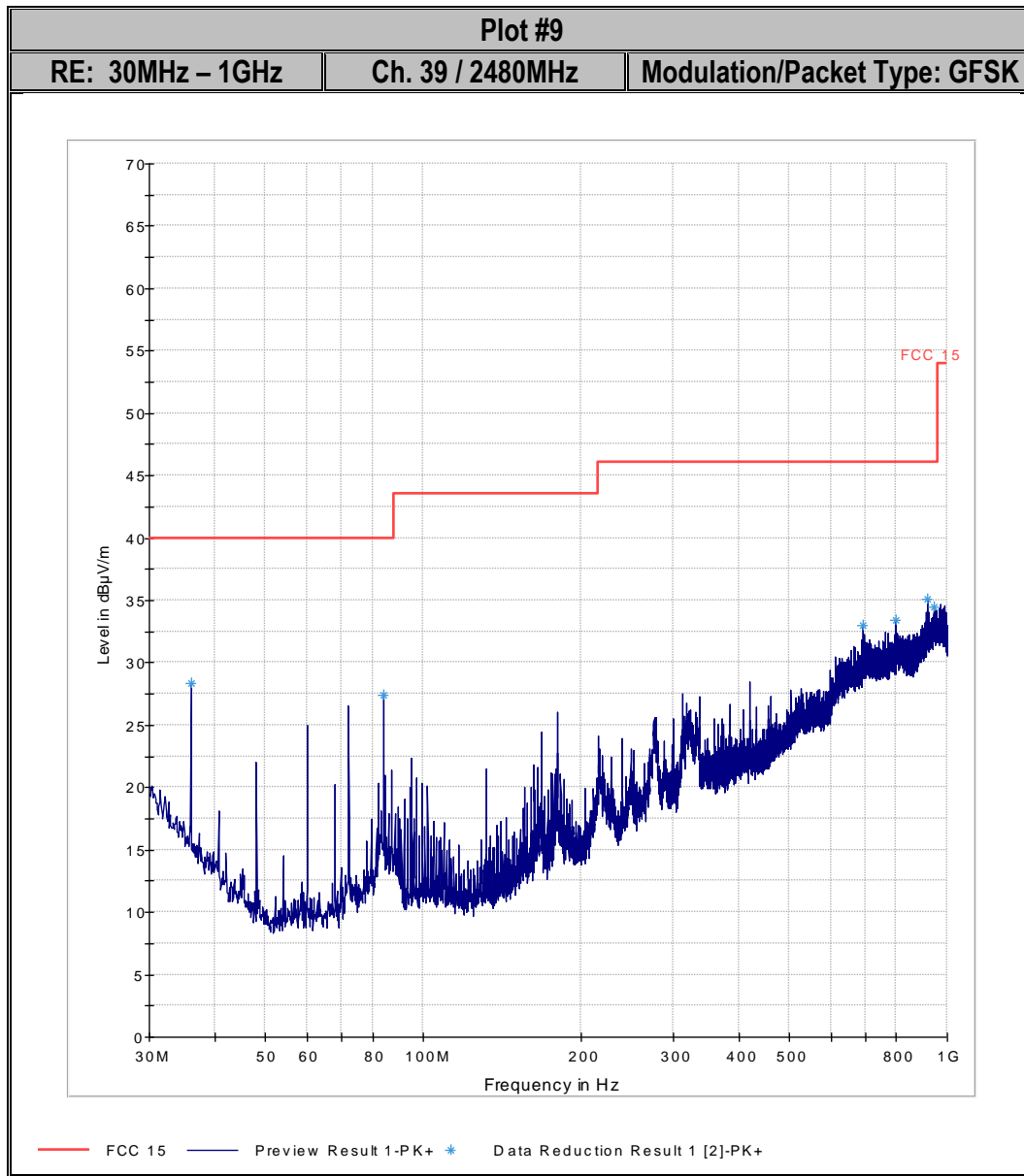


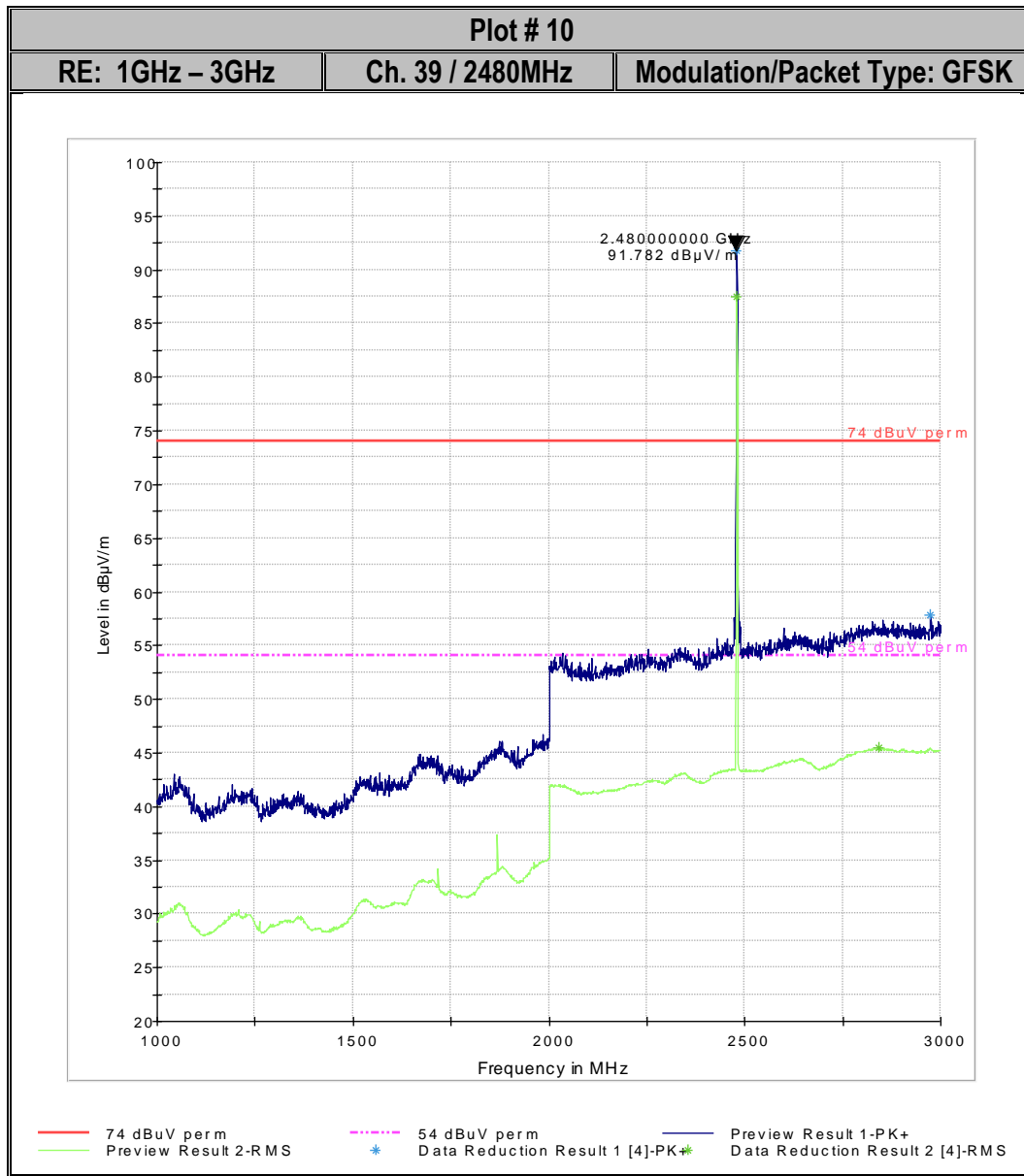
*Note: The peak signal is the Tx Ch. Mid.



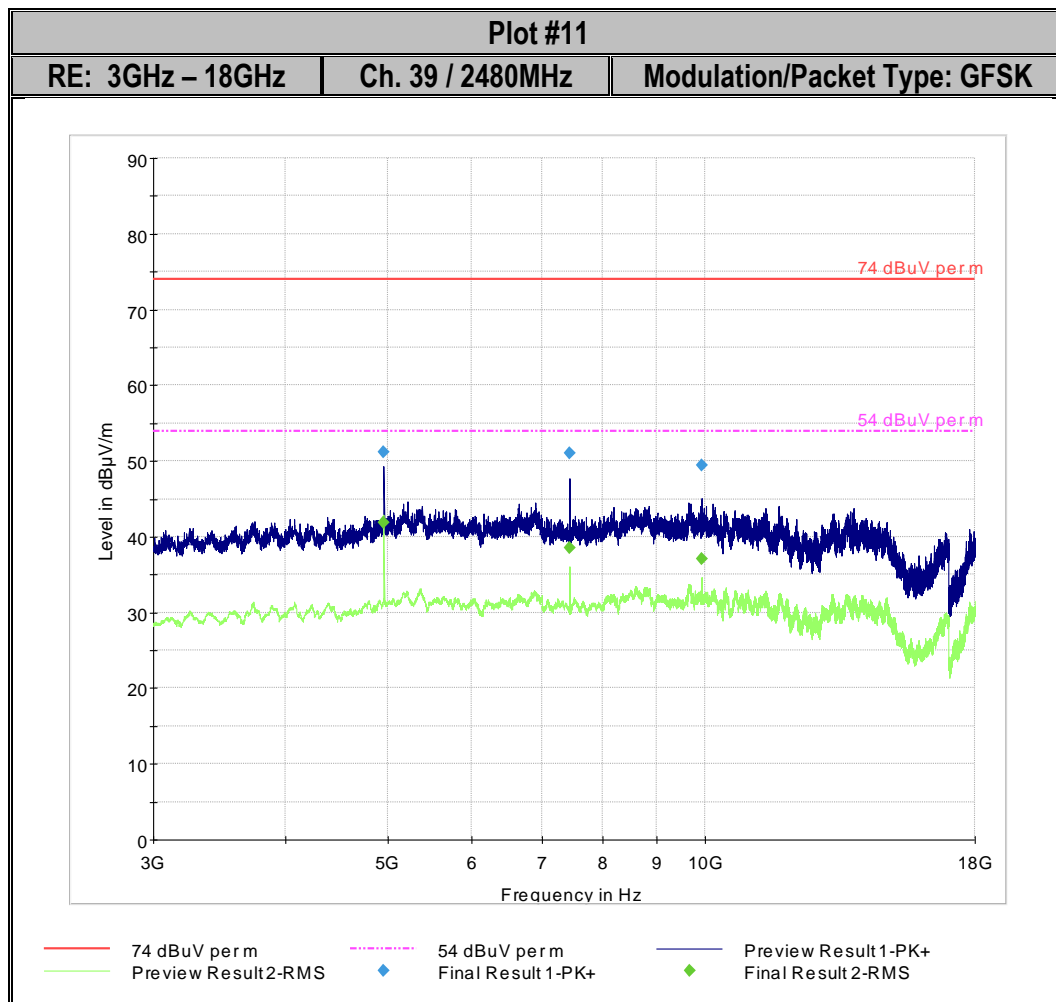
*Note: The peak signal at 7.319 GHz is not in the restricted bands.








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




*Note: The peak signal at 7.441 GHz is not in the restricted bands.

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 46 of 49	
		IC ID: 21726-Z00102	


14 Setup Pictures

See EMC_ZIPCA-006-16001_TestSetupPhotos.pdf

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 47 of 49	
		IC ID: 21726-Z00102	

15 EUT Pictures

See EMC_ZIPCA-006-16001_TestSetupPhotos.pdf

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	
Date of Report	September 23, 2016	Page 48 of 49	

16 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.

Test Report #:	EMC_ZIPCA-006-16001_15.247_BTLE_rev1	FCC ID: 2AHNP-Z00102	CETECOM TM <small>EMC Test Laboratory</small>
Date of Report	September 23, 2016	Page 49 of 49	
		IC ID: 21726-Z00102	

17 Revision History

Date	Report Name	Changes to report	Report prepared by
June 2, 2016	EMC_ZIPCA-006-16001_15.247_BTLE	Initial Version	Yu-Chien Ho
September 23, 2016	EMC_ZIPCA-006-16001_15.247_BTLE	Updated Standard reference	Yu-Chien Ho