

TEST REPORT

Report Number: 102555312MPK-001

Project Number: G102555312

June 17, 2016

**Testing performed on
IOSiX OBD-II Datalogger v4.2**

Model: IOS-2042

FCC ID: 2AICQ-2042

IC: 21520-2042

to

**FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247 Issue 1
FCC Part 15, Subpart B
Industry Canada ICES-003**

For

IOSiX, LLC

Test Performed by:

Intertek

1365 Adams Court

Menlo Park, CA 94025 USA

Test Authorized by:

IOSiX, LLC

389 Airport Industrial Drive

Ypsilanti, MI 48198 USA

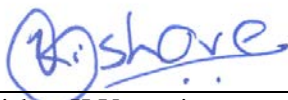
Prepared by:



Anderson Soungpanya

Date: June 17, 2016

Reviewed by:



Krishna K Vemuri

Date: June 17, 2016

This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to copy or distribute this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program. This report must not be used to claim product endorsement by A2LA, NIST nor any other agency of the U.S. Government.

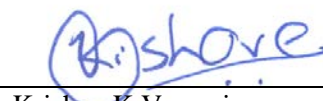
Report No. 102555312MPK-001

Equipment Under Test:	IOSiX OBD-II Datalogger v4.2
Trade Name:	IOSiX, LLC
Model Number:	IOS-2042
Serial Number:	77
Applicant:	IOSiX, LLC
Contact:	Robert Vogt
Address:	389 Airport Industrial Drive Ypsilanti, MI 48198
Country	USA
Tel. Number:	(734) 730-9690
Email:	robert@iosix.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 1 FCC Part 15, Subpart B Industry Canada ICES-003
Date of Test:	April 29 – May 31, 2016

We attest to the accuracy of this report:



Anderson Soungpanya
Project Engineer



Krishna K Vemuri
Engineering Team Lead

TABLE OF CONTENTS

1.0	Summary of Tests	5
2.0	General Information.....	6
2.1	Product Description	6
2.2	Related Submittal(s) Grants.....	7
2.3	Test Facility	7
2.4	Test Methodology.....	7
2.5	Measurement Uncertainty.....	7
3.0	System Test Configuration.....	8
3.1	Support Equipment	8
3.2	Block Diagram of Test Setup.....	8
3.3	Justification.....	9
3.4	Software Exercise Program.....	9
3.5	Mode of Operation during Test.....	9
3.6	Modifications Required for Compliance	9
3.7	Additions, Deviations and Exclusions from Standards.....	9
4.0	Measurement Results.....	10
4.1	6-dB Bandwidth and Occupied Bandwidth	10
4.1.1	Requirement.....	10
4.1.2	Procedure	10
4.1.3	Test Result	10
4.2	Maximum Peak Conducted Output Power at Antenna Terminals	17
4.2.1	Requirement.....	17
4.2.2	Procedure	17
4.2.3	Test Result	17
4.3	Maximum Power Spectral Density	21
4.3.1	Requirement.....	21
4.3.2	Procedure	21
4.3.3	Test Result	21
4.4	Unwanted Conducted Emissions	25
4.4.1	Requirement.....	25
4.4.2	Procedure	25
4.4.3	Test Result	25
4.5	Transmitter Radiated Emissions	30
4.5.1	Requirement.....	30
4.5.2	Procedure	30
4.5.3	Field Strength Calculation	31
4.6	Radiated Emissions.....	40
4.6.1	Requirement.....	40
4.6.2	Procedures.....	41
4.6.3	Test Results.....	41
4.7	AC Line Conducted Emission	44
4.7.1	Requirement.....	44
4.7.2	Procedure	44

4.7.3	Test Results.....	44
5.0	RF Exposure Evaluation	45
6.0	List of Test Equipment	46
7.0	Document History	47
Annex A	- Duty Cycle Measurement.....	48

1.0 Summary of Tests

Test	Reference FCC	Reference Industry Canada	Result
Radiated Emissions	15.109	ICES-003	Complies
AC Line Conducted Emission	15.107	ICES-003	Complies
RF Output Power	15.247(b)(3)	RSS-247, 5.4.4	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-247, 5.2.1	Complies
Power Density	15.247(e)	RSS-247, 5.2.2	Complies
Out of Band Antenna Conducted Emission	15.247(d)	RSS-247, 5.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-247, 5.5	Complies
AC Line Conducted Emission	15.207	RSS-GEN	Not Applicable*
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)
RF Exposure	15.247(i), 2.1093(d)	RSS-102	Complies

*EUT is designed to be installed in an automobile. Battery powered only.

EUT receive date: April 27, 2016

EUT receive condition: The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.

Test start date: April 29, 2016

Test completion date: May 31, 2016

The test results in this report pertain only to the item tested.

2.0 General Information

2.1 Product Description

The EUT plugs into a light- or medium-duty vehicle and receives data, analyzes the data, and records the data locally and/or transmits data via Bluetooth Low Energy.

Information about the 2.4 GHz radio is presented below:

Applicant	IOSiX, LLC
Model No.	IOS-2042
FCC Identifier	2AICQ-2042
IC Identifier	21520-2042
Type of transmission	Digital Transmission System (DTS)
Rated RF Conducted Output	4.06 dBm or 2.55 mW
Antenna(s) & Gain	Internal, 3dBi
Frequency Range	2402 – 2480 MHz
Type of modulation/data rate	GFSK 1MB
Number of Channel(s)	40, Channels 0-39
Applicant Name & Address	IOSiX, LLC 389 Airport Industrial Drive Ypsilanti, MI 48198 USA

2.2 Related Submittal(s) Grants

None.

2.3 Test Facility

The test site used to collect the radiated data is site 1 (10-m semi-anechoic chamber). This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

2.4 Test Methodology

Antenna conducted measurements were performed according to the FCC documents “Guidance for Performing Compliance Measurement on Digital Transmission Systems (DTS) Operating under §15.247” (KDB 558074 D01 DTS Meas Guidance v03r04 January 7, 2016), and RSS-247, RSS-GEN.

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10-2013. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Data Sheet" of this report.

2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn't take into account the measurement uncertainty.

Estimated Measurement Uncertainty

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 1 GHz	1 GHz – 2.5 GHz	> 2.5 GHz
RF Power and Power Density – antenna conducted	-	0.7 dB	-
Unwanted emissions - antenna conducted	1.1 dB	1.3 dB	1.9 dB
Bandwidth – antenna conducted	-	30 Hz	-
Radiated emissions	4.2 dB	3.4 dB	4.4 dB
AC mains conducted emissions	2.4 dB	-	-

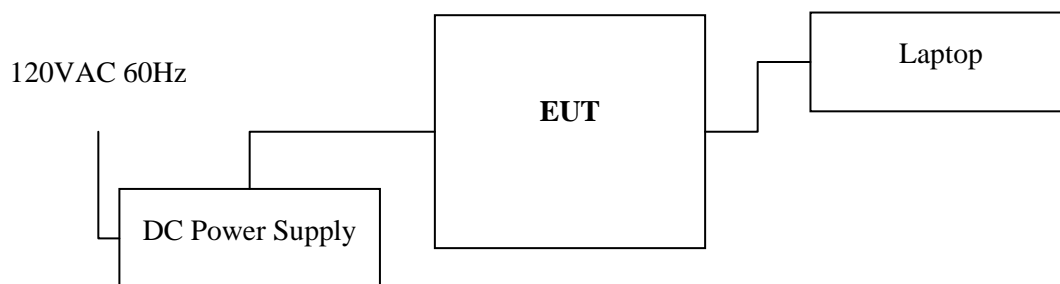
3.0 System Test Configuration

3.1 Support Equipment

Description	Manufacturer	Model No./ Part No.
Laptop	HP	Elitebook 8470p

3.2 Block Diagram of Test Setup

Antenna was used for Radiated Measurements.



S = Shielded	F = With Ferrite
U = Unshielded	m = Length in Meters

3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT is programmed to transmit full power.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by IOSiX, LLC

3.5 Mode of Operation during Test

During transmitter testing, the transmitter was setup to transmit at maximum RF power on low, middle and high frequencies/channels.

3.6 Modifications Required for Compliance

Intertek installed no modifications during compliance testing in order to bring the product into compliance.

3.7 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

4.0 Measurement Results

4.1 6-dB Bandwidth and Occupied Bandwidth FCC Rule: 15.247(a)(2); RSS-247 A8.2 and RSS-GEN;

4.1.1 Requirement

The minimum 6-dB bandwidth shall be at least 500 kHz

4.1.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter.

For FCC 6dB Channel Bandwidth the Procedure described in the FCC Publication 558074 D01 DTS Meas Guidance v03r04 January 7, 2016 was used to determine the DTS occupied bandwidth. Section 8.1 Option 1 was used.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. 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.

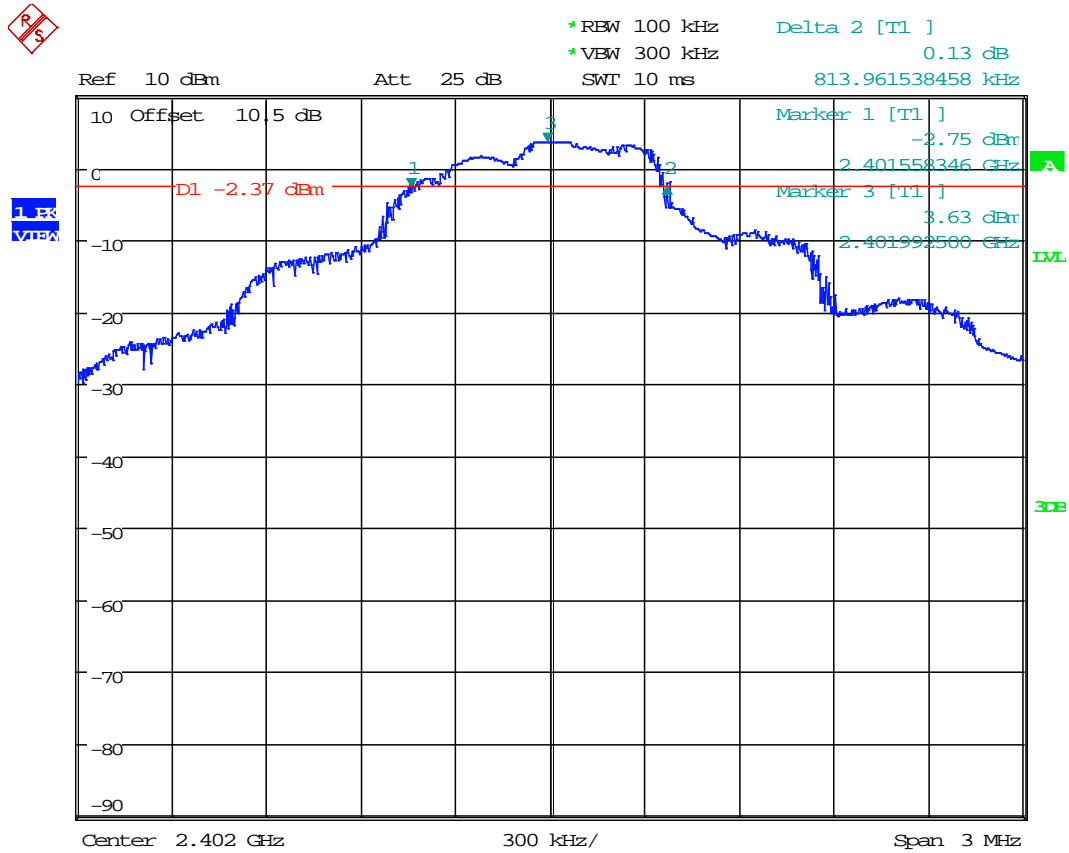
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, MHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	0.814	--	1.1
	--	1.565	1.4
2442	0.672	--	1.2
	--	1.513	1.5
2480	0.697	--	1.3
	--	1.538	1.6

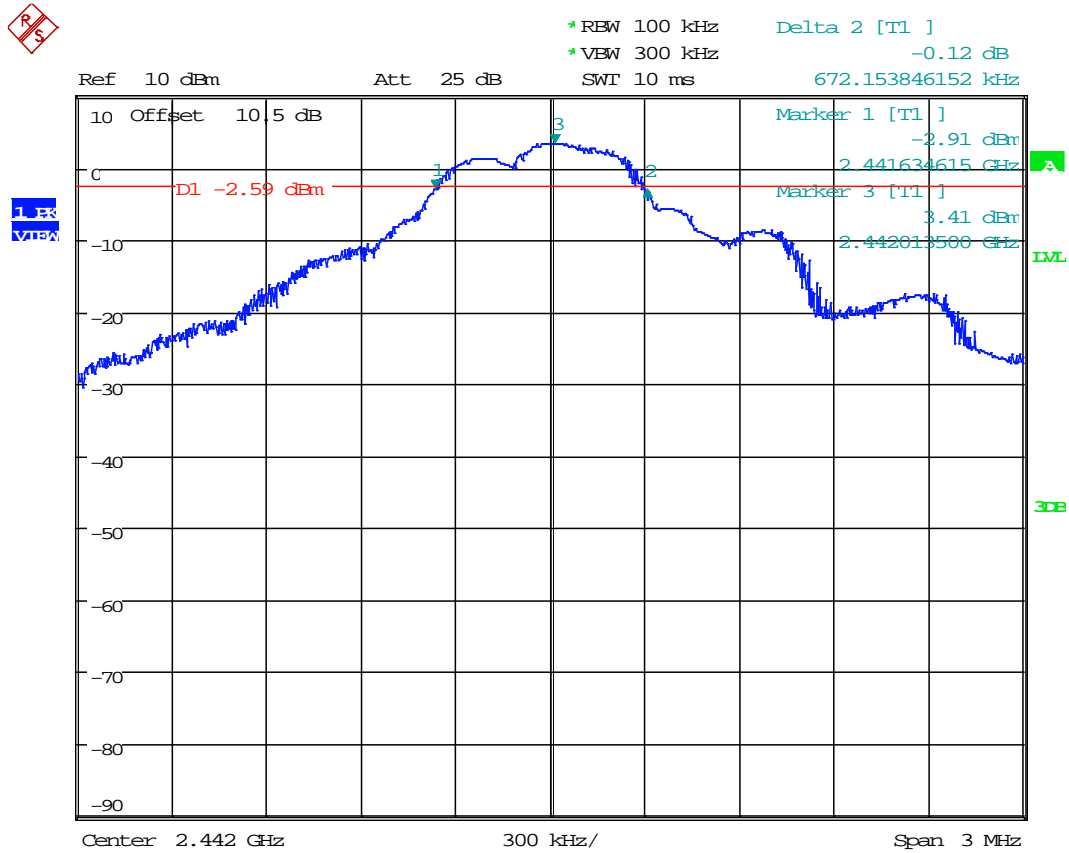
Results	Complies
----------------	-----------------

Plot 1. 1



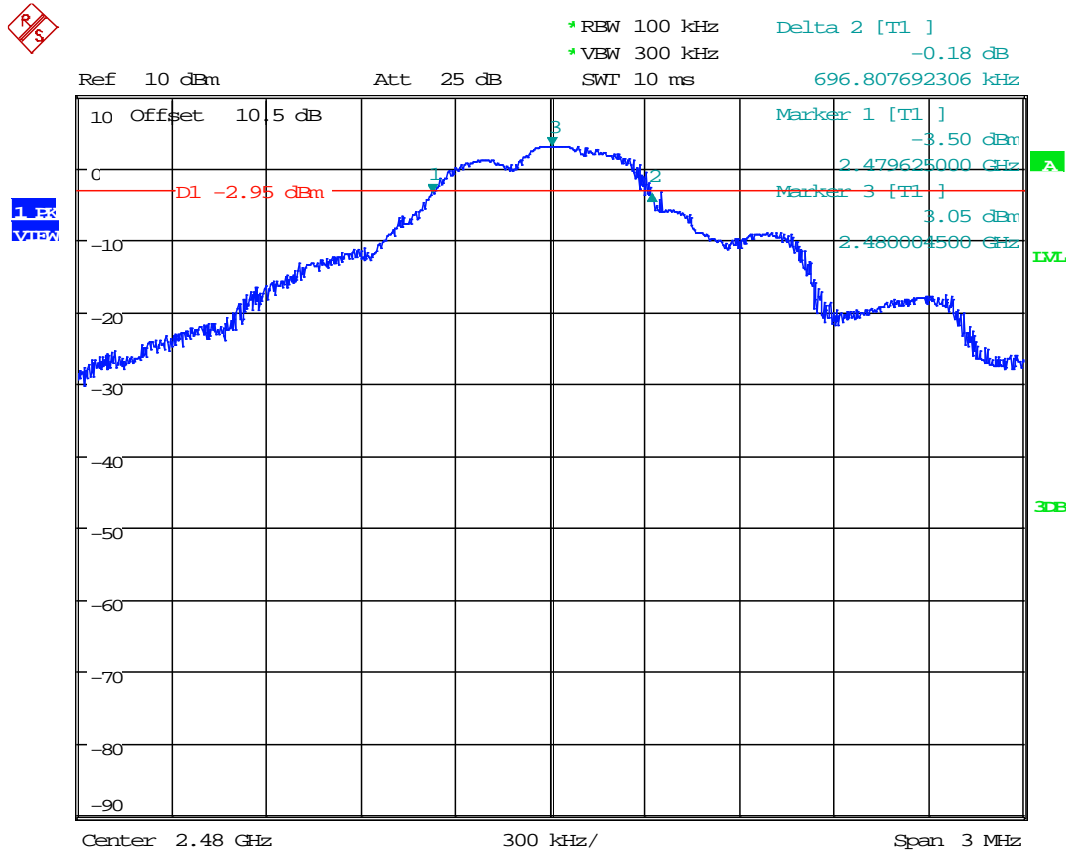
Date: 23.MAY.2016 10:16:48

Plot 1.2



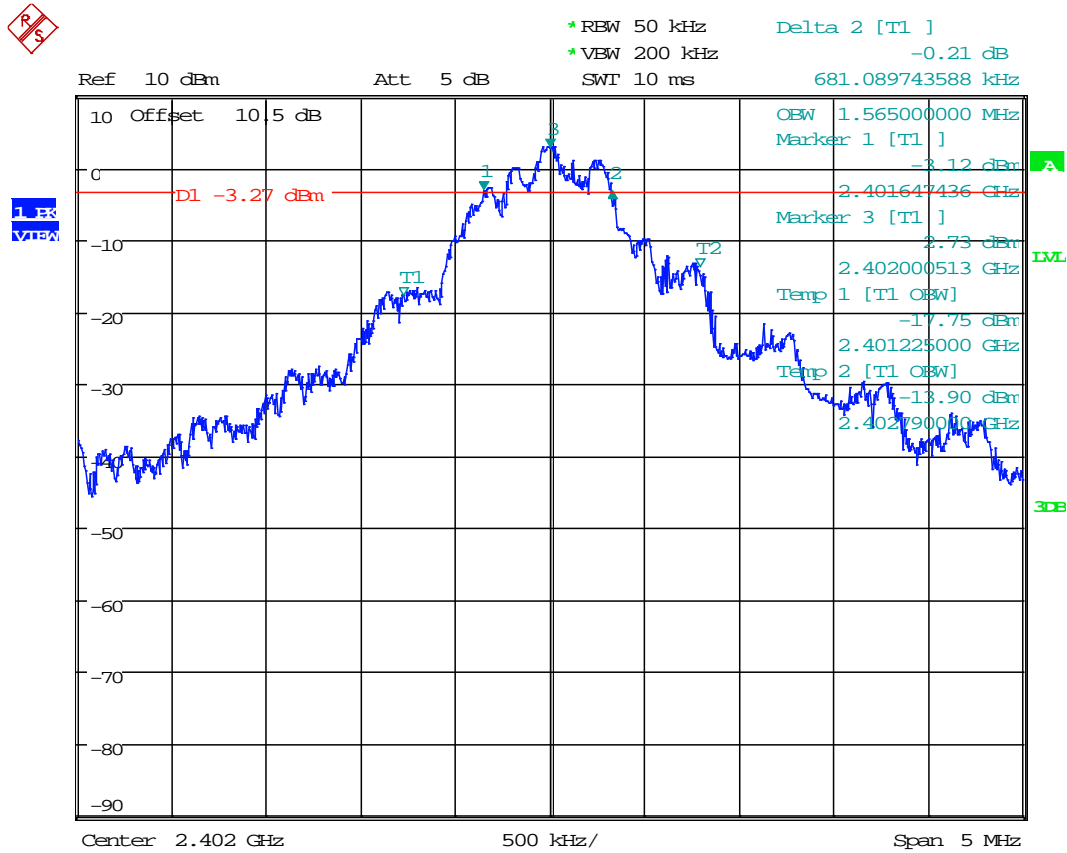
Date: 23.MAY.2016 10:19:29

Plot 1.3



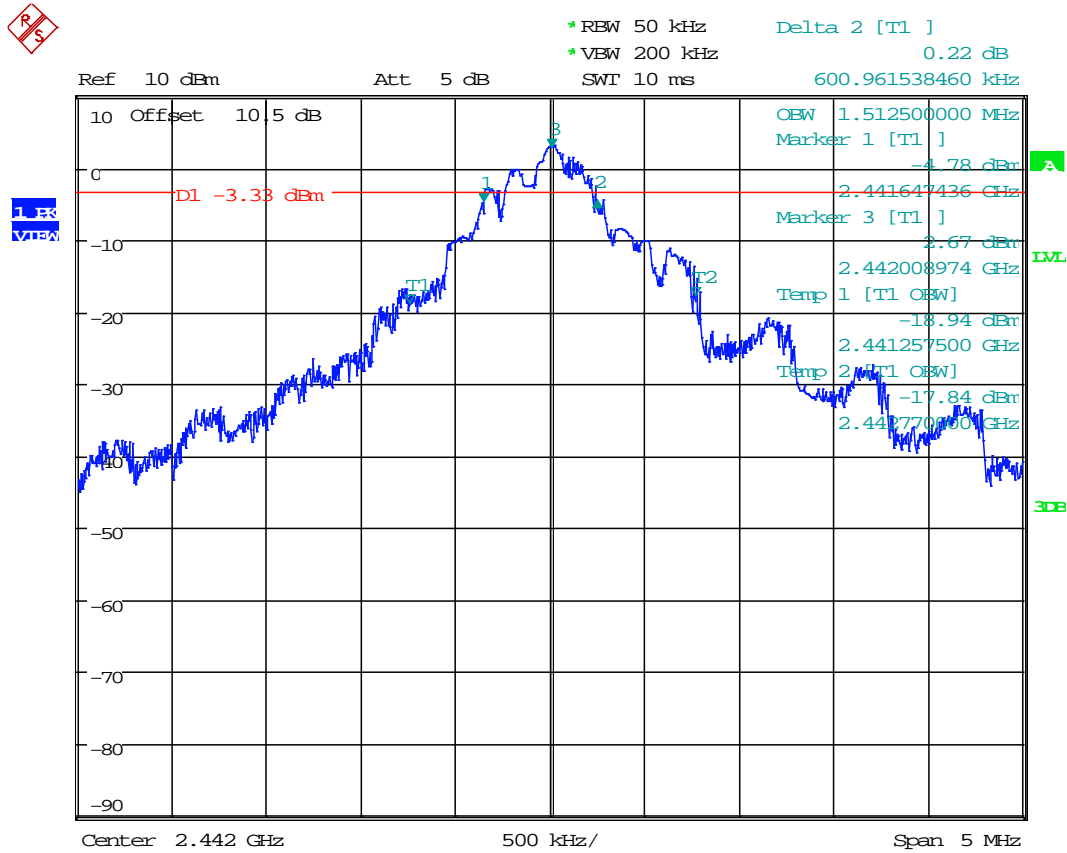
Date: 23.MAY.2016 10:21:26

Plot 1.4



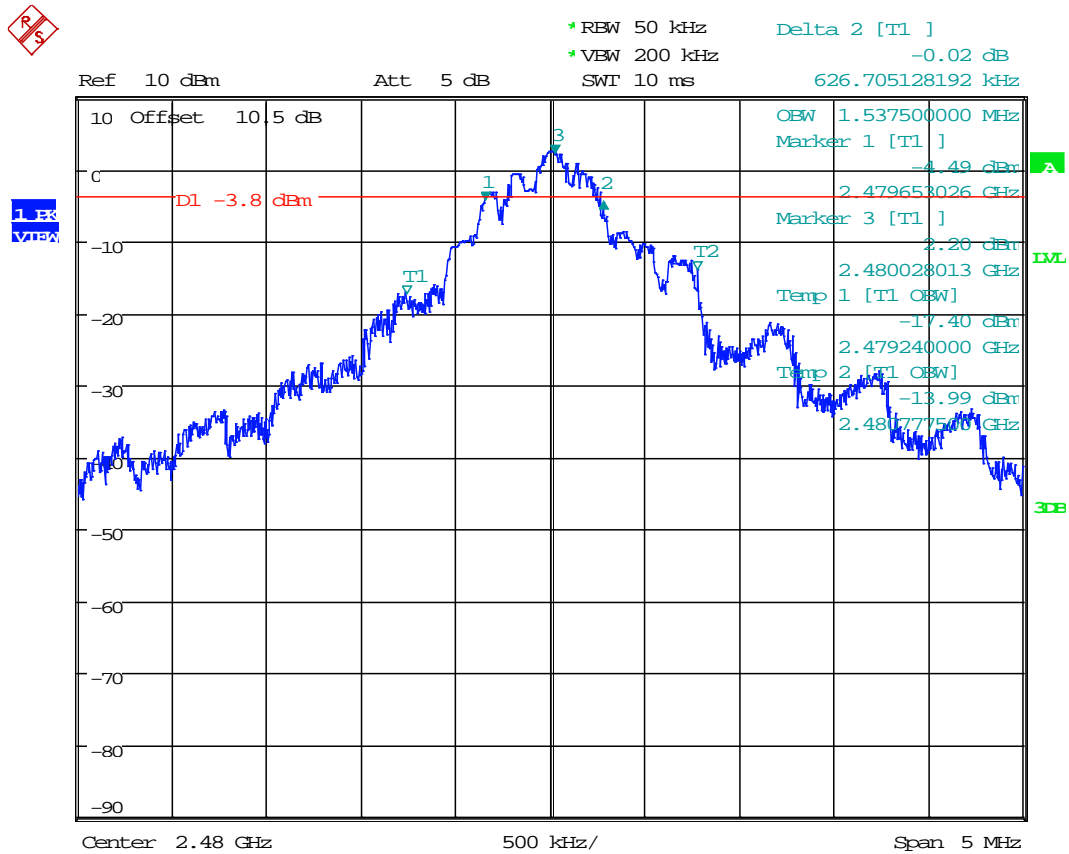
Date: 23.MAY.2016 10:57:57

Plot 1.5



Date: 23.MAY.2016 10:55:56

Plot 1.6



Date: 23.MAY.2016 10:52:21

4.2 Maximum Peak Conducted Output Power at Antenna Terminals FCC Rule: 15.247(b)(3); RSS-247 A8.4;

4.2.1 Requirement

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt or 30 dBm.
For antennas with gains greater than 6 dBi, transmitter output level must be decreased appropriately, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2.2 Procedure

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r04 January 7, 2016 was used. Specifically, section 9.1.1 RBW \geq DTS Bandwidth was utilized as the spectrum analyzer's resolution bandwidth was greater than the DTS bandwidth.

1. Set the RBW \geq DTS Bandwidth
2. Set the VBW $\geq 3 \times$ RBW
3. Set the span $\geq 3 \times$ RBW
4. Detector = Peak
5. Sweep time = Auto couple
6. Trace mode = Max Hold
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level.

A spectrum analyzer was connected to the antenna port of the transmitter.

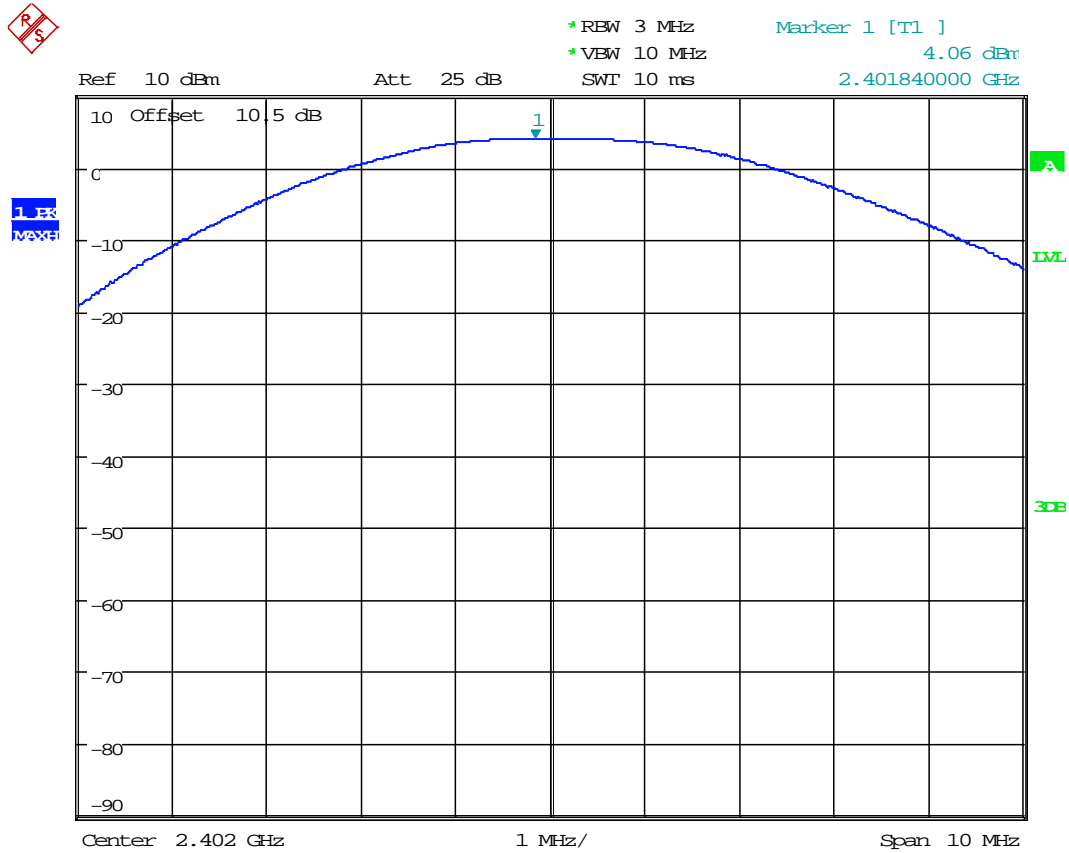
4.3.3 Test Result

Refer to the following plots 2.1 – 2.3 for the test details.

Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
2402	4.06	2.55	2.1
2442	3.84	2.42	2.2
2480	3.47	2.22	2.3

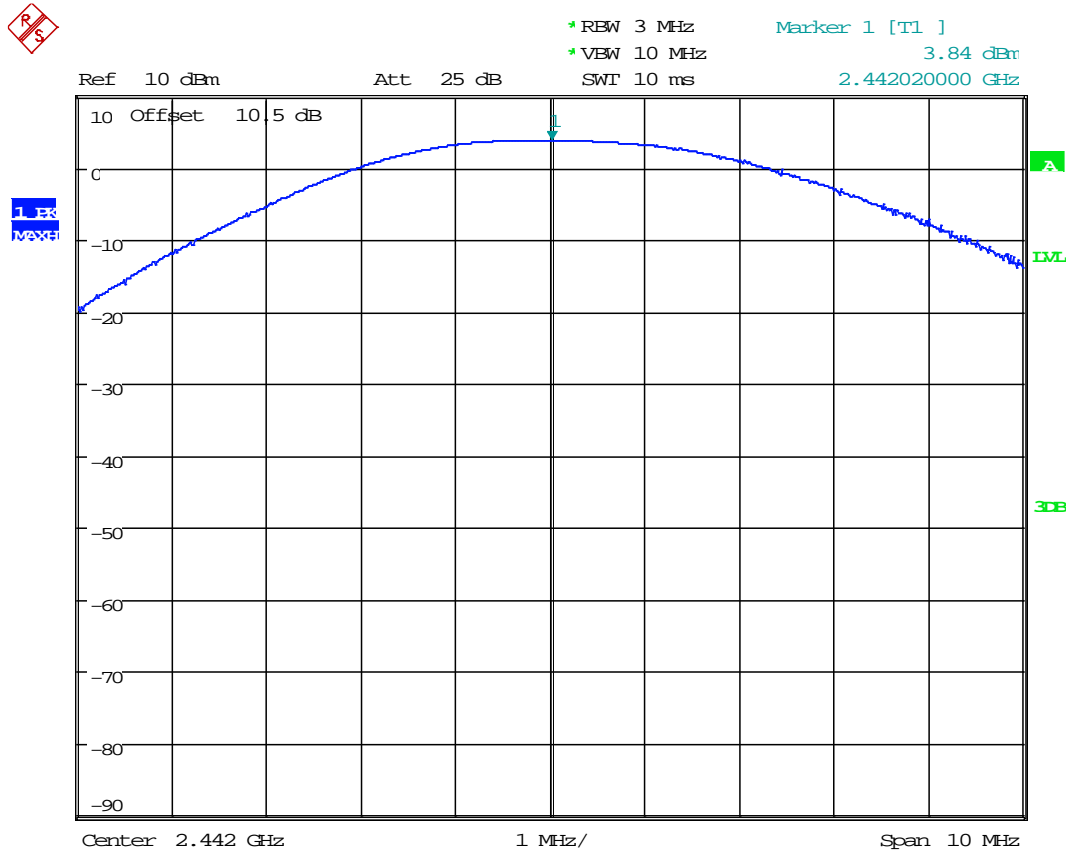
Results	Complies
----------------	-----------------

Plot 2. 1



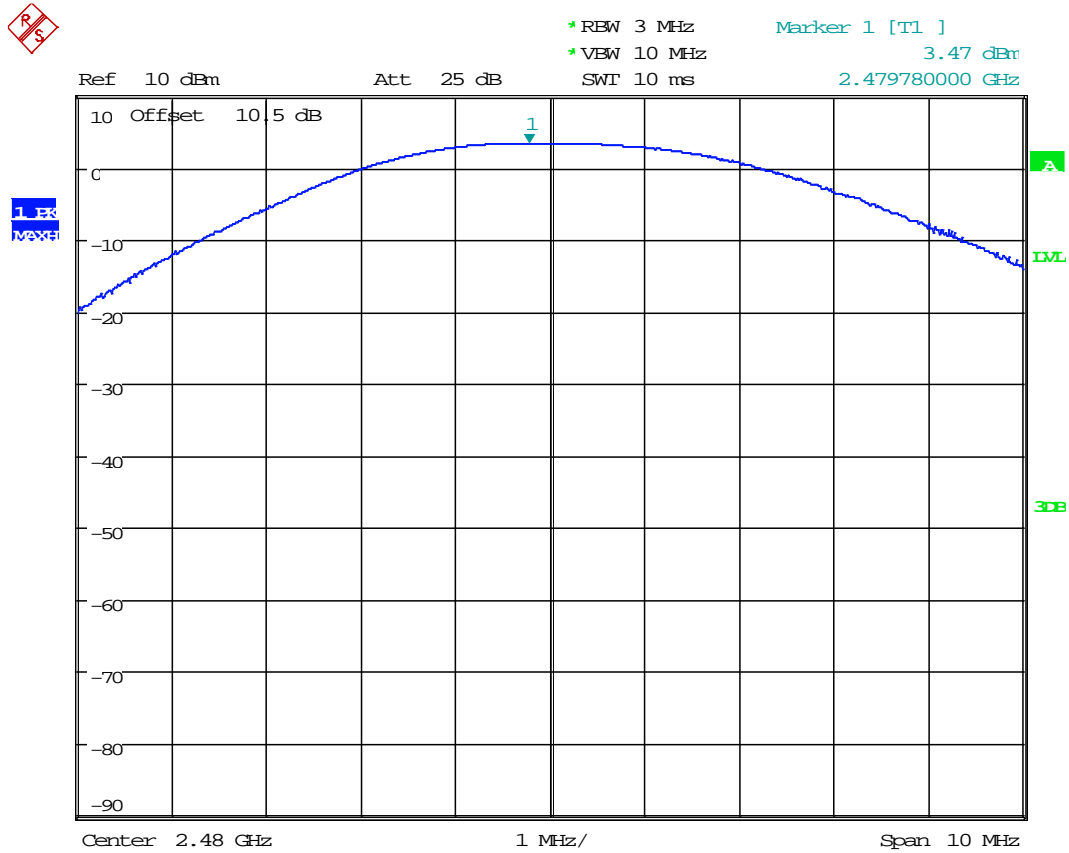
Date: 23.MAY.2016 10:07:44

Plot 2. 2



Date: 23.MAY.2016 10:09:08

Plot 2.3



Date: 23.MAY.2016 10:10:12

4.3 Maximum Power Spectral Density FCC: 15.247 (e); RSS-247 A8.2b;

4.3.1 Requirement

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

4.3.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter.

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r04 January 7, 2016, specifically section 10.2 Method PKPSD (peak PSD).

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the *DTS bandwidth*.
3. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
4. Set the VBW $\geq 3 \times \text{RBW}$.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

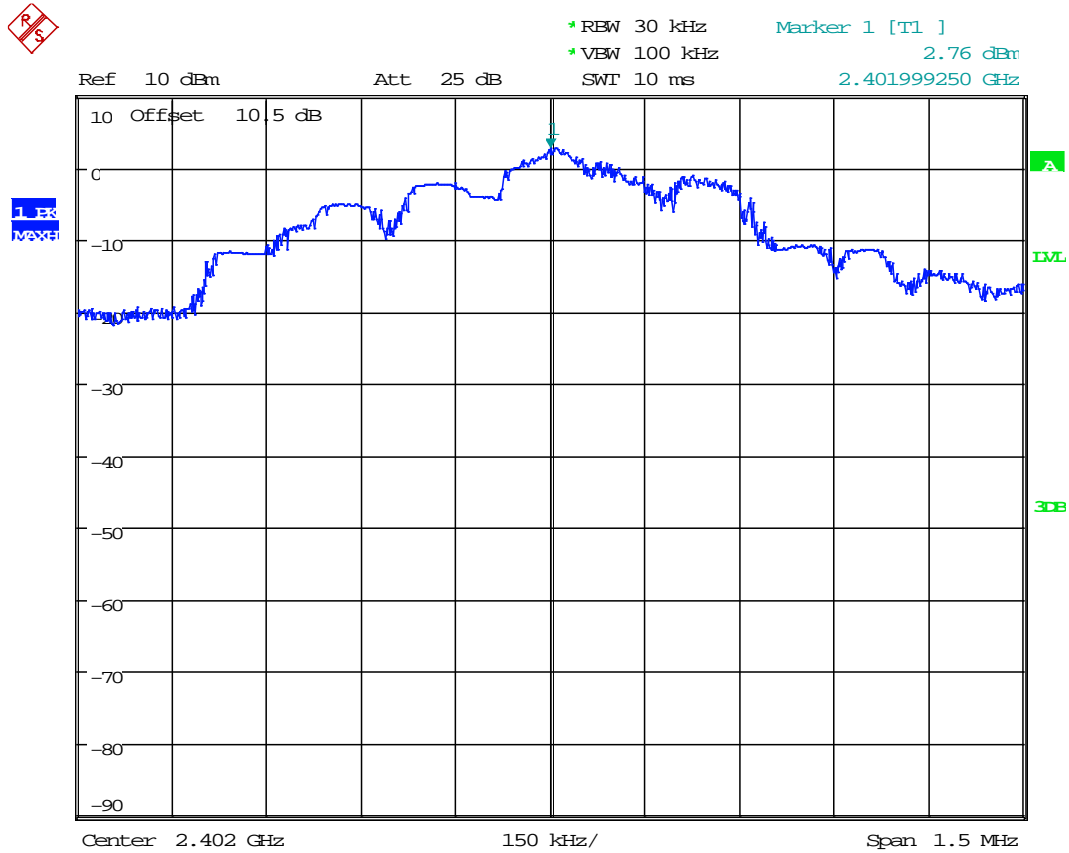
4.3.3 Test Result

Refer to the following plots for the test result

Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
2402	2.76	8	-5.24	3.1
2442	2.29	8	-5.71	3.2
2480	2.19	8	-5.81	3.3

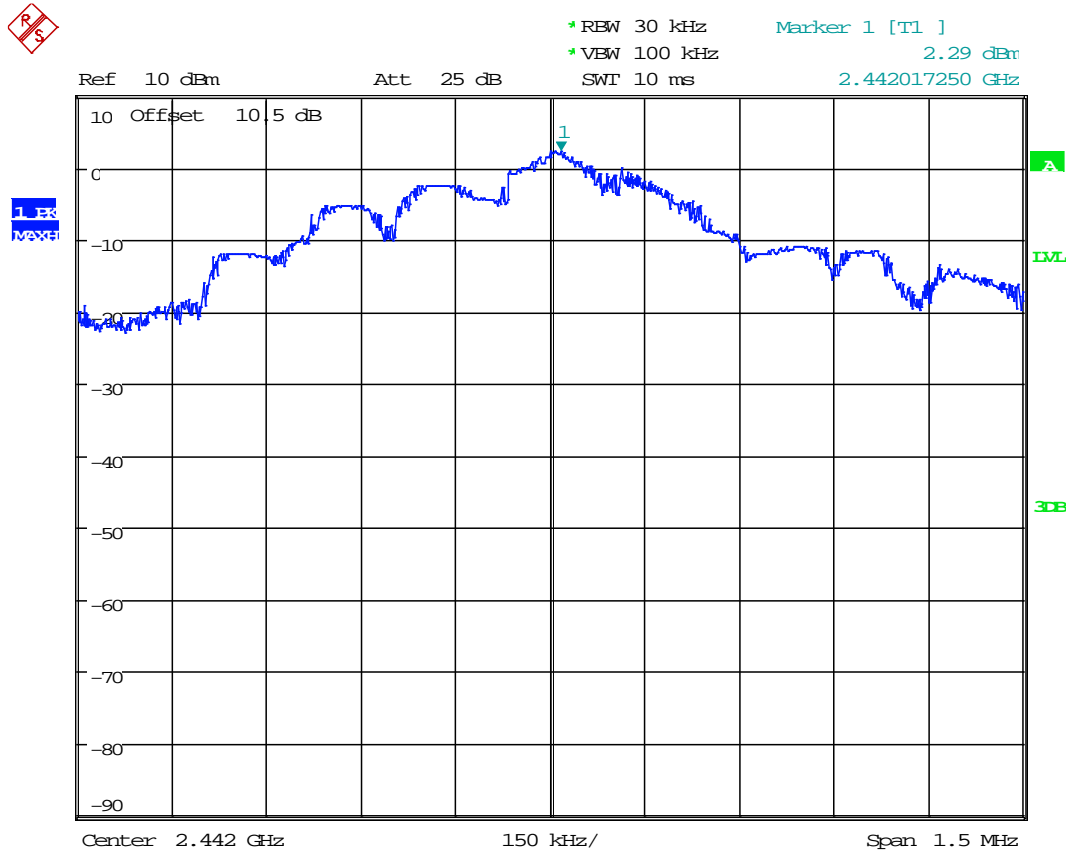
Results	Complies
----------------	-----------------

Plot 3. 1



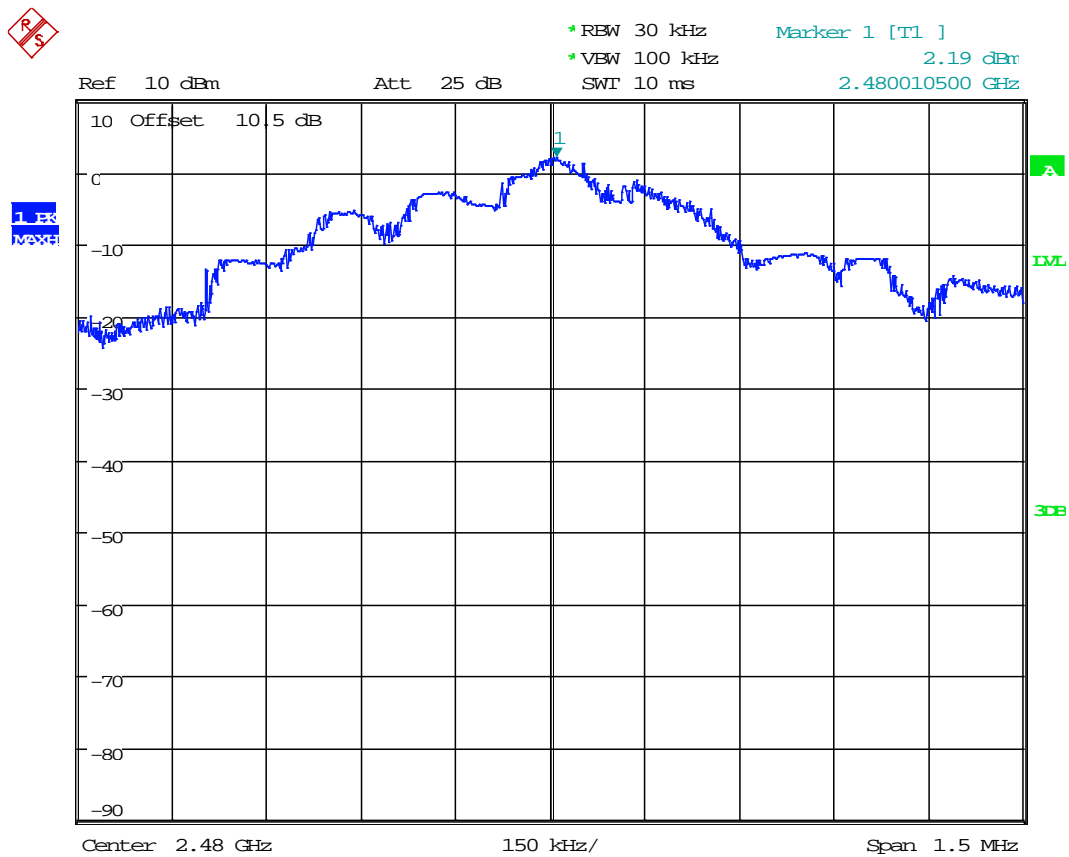
Date: 23.MAY.2016 10:14:35

Plot 3.2



Date: 23.MAY.2016 10:12:59

Plot 3.3



Date: 23.MAY.2016 10:11:53

4.4 Unwanted Conducted Emissions FCC: 15.247(d); RSS-247 A8.5;

4.4.1 Requirement

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be below the maximum in-band 100 kHz emissions by at least 20 dB (if peak power of in-band emission is measured) or 30 dB (if average power of in-band emission is measured).

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)

4.4.2 Procedure

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r04 January 7, 2016, specifically section 11.0 Emissions in non-restricted frequency bands.

A spectrum analyzer was connected to the antenna port of the transmitter.

1. Set the RBW = 100 kHz.
2. Set the VBW $\geq 3 \times$ RBW.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

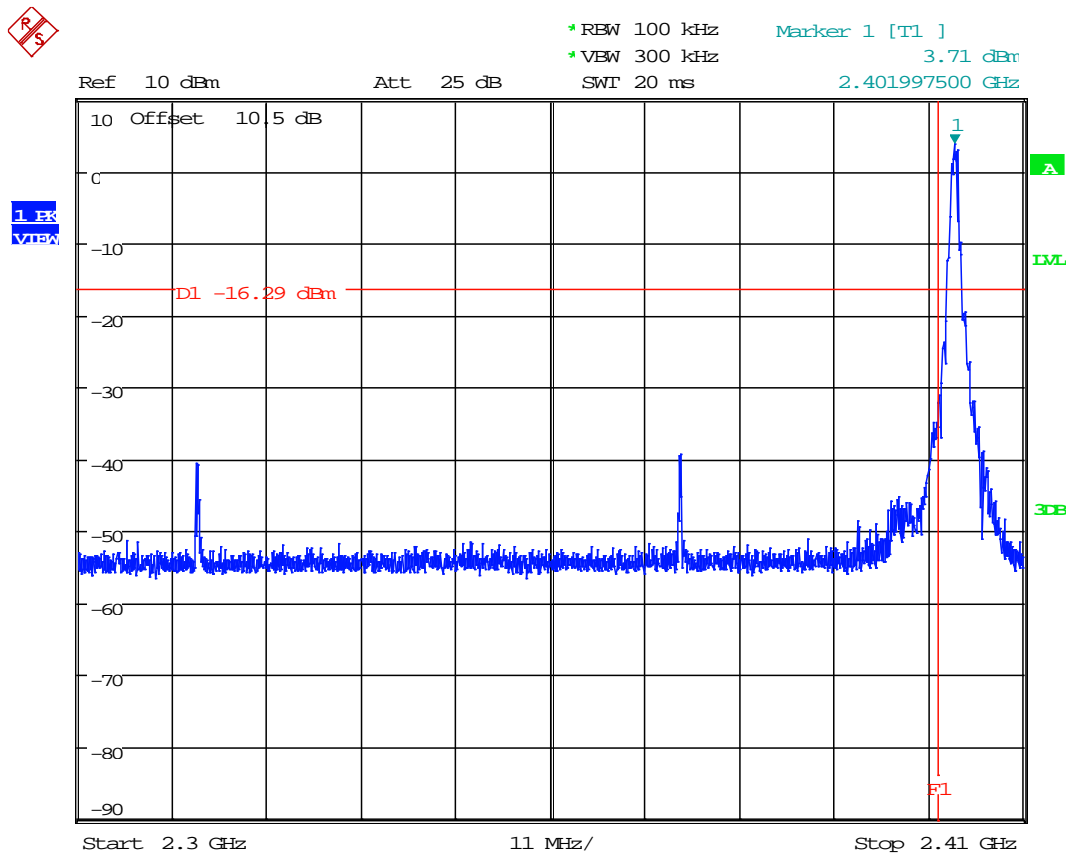
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

4.4.3 Test Result

Refer to the following plots 4.1 – 4.5 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

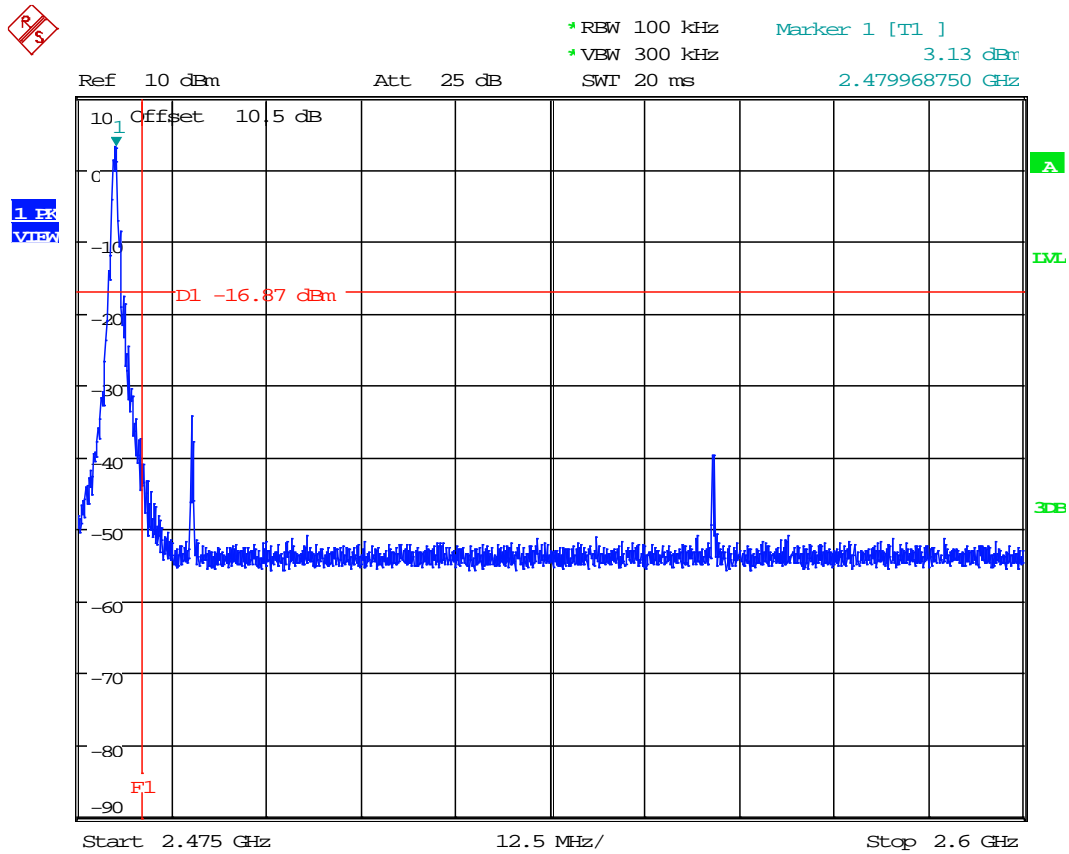
Results	Complies
----------------	-----------------

Tx @ Low Channel, 2400 MHz Band Edge
Plot 4.1



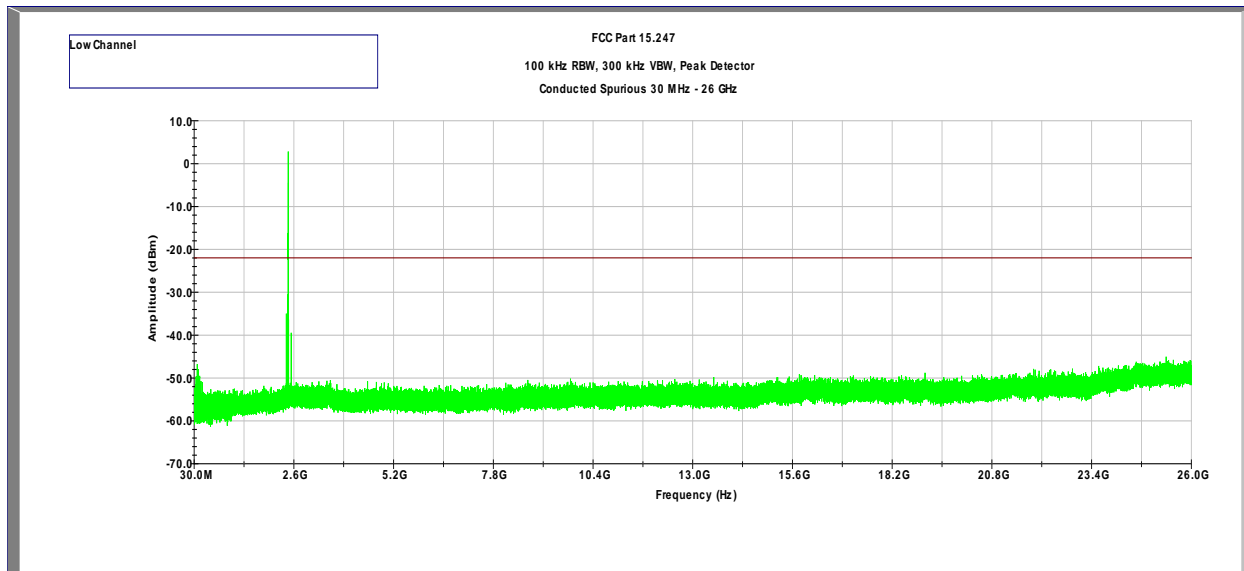
Date: 23.MAY.2016 11:01:18

Tx @ Low Channel, 2483.5 MHz Band Edge
Plot 4.2

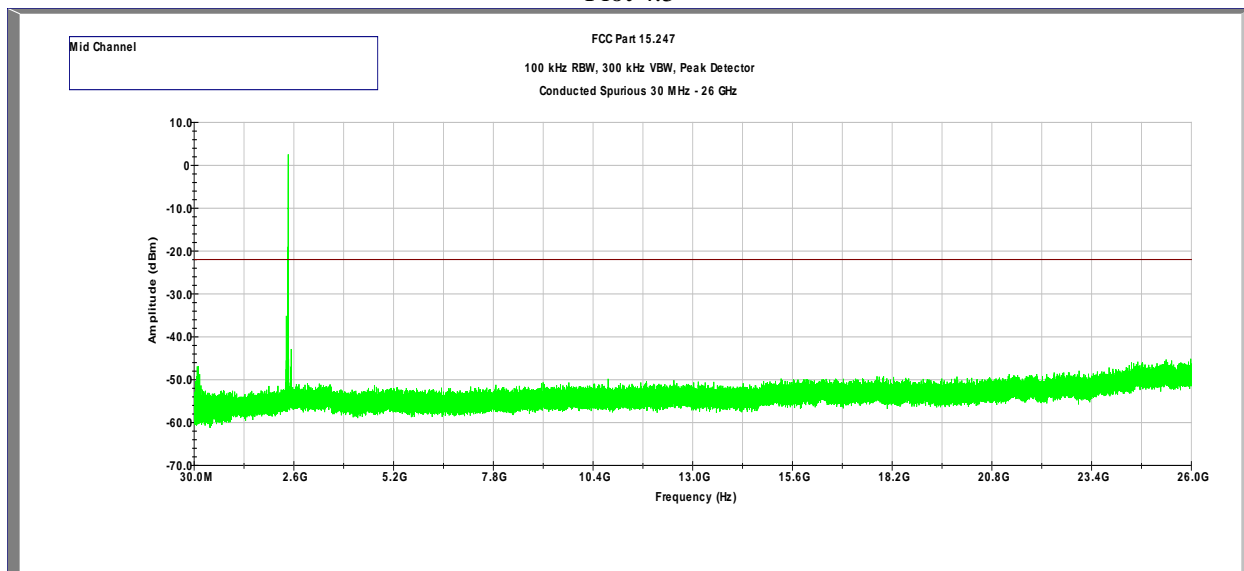


Date: 23.MAY.2016 11:02:38

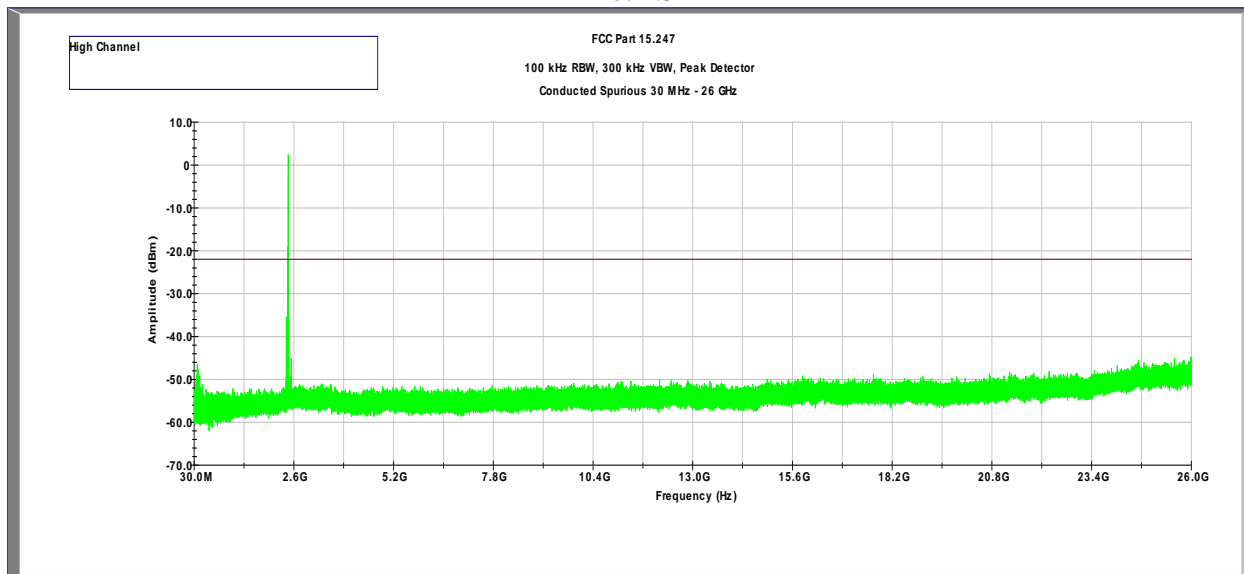
Tx @ Low Channel, 2402 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3



Tx @ Mid Channel, 2442 MHz
30MHz -26GHz Conducted Spurious
Plot 4.5



Tx @ High Channel, 2480 MHz
30MHz -26GHz Conducted Spurious
Plot 4.5



4.5 Transmitter Radiated Emissions

FCC Rules: 15.247(d), 15.209, 15.205; RSS-247;

4.5.1 Requirement

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)).

For out of band radiated emissions (except for frequencies in restricted bands), in any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

4.5.2 Procedure

Radiated emission measurements were performed from 30 MHz to 25 GHz according to the procedure described in ANSI C64.10. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz for frequencies above 1000 MHz. Above 1000 MHz Peak and Average measurements were performed.

The EUT is placed on a plastic turntable that is 80 cm in height for below 1000MHz and 1.5m in height for above 1GHz. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst-case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at 3 meters for frequencies above 1 GHz and at 10 meters for frequencies below 1 GHz.

Measurements made from 1 GHz to 18GHz had a 2.4-2.5GHz notch filter in place. A preamp was used from 30MHz to 26GHz. Measurements were made with the EUT's antenna in place.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average limits for 1GHz – 26GHz.

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels).

4.5.3 Field Strength Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$FS = RA + AF + CF - AG$; if measurement is performed at a distance other than specified in the rule, a Distance Correction Factor (DCF) shall be added.

Where FS = Field Strength in dB(μ V/m)

RA = Receiver Amplitude (including preamplifier) in dB(μ V); AF = Antenna Factor in dB(1/m)

CF = Cable Attenuation Factor in dB; AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μ V) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving field strength of 32 dB(μ V/m). This value in dB(μ V/m) was converted to its corresponding level in μ V/m.

RA = 52.0 dB(μ V)

AF = 7.4 dB(1/m)

CF = 1.6 dB

AG = 29.0 dB

$FS = 52.0 + 7.4 + 1.6 - 29.0 = 32 \text{ dB}(\mu\text{V/m})$.

Level in μ V/m = Common Antilogarithm $[(32 \text{ dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}$.

4.5.4 Antenna-port conducted measurements

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

4.5.6 General Procedure for conducted measurements in restricted bands

- a) Measure the conducted output power (in dBm) using the detector specified for determining quasi-peak, peak, and average conducted output power, respectively.
- b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)
- c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
- d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (*e.g.*, Watts, mW).
- e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:
$$E = \text{EIRP} - 20\log D + 104.8$$
where:
E = electric field strength in dB μ V/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.
- f) Compare the resultant electric field strength level to the applicable limit.
- g) Perform radiated spurious emission test

4.5.7 Test Results

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance where emissions are within 3dB of the limit.

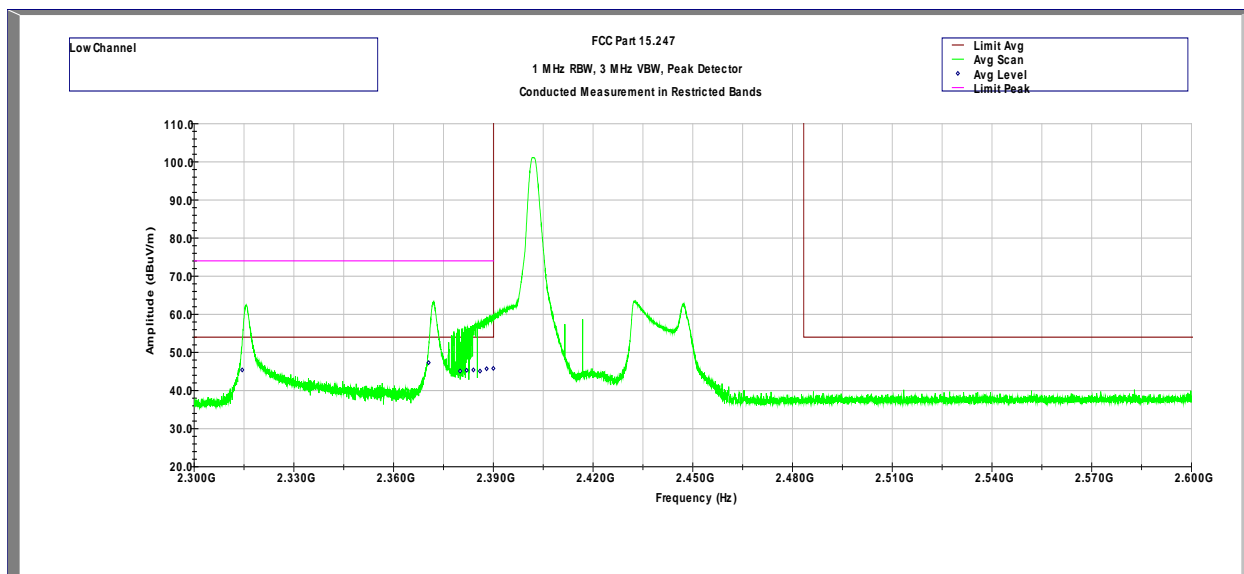
Measurements were carried out in accordance to the procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r04 January 7, 2016, specifically section 13.3.2. All conducted antenna port plots are corrected with the consideration of a 3.0dBi Antenna Gain. Average measurements were corrected with a 6.4 dB duty cycle correction factor. See Annex A in this report for duty cycle calculations.

Radiated emission measurements were performed up to 26GHz. No Emissions were identified when scanned from 18-25 GHz.

Date of Test:	May 16, 2016
----------------------	--------------

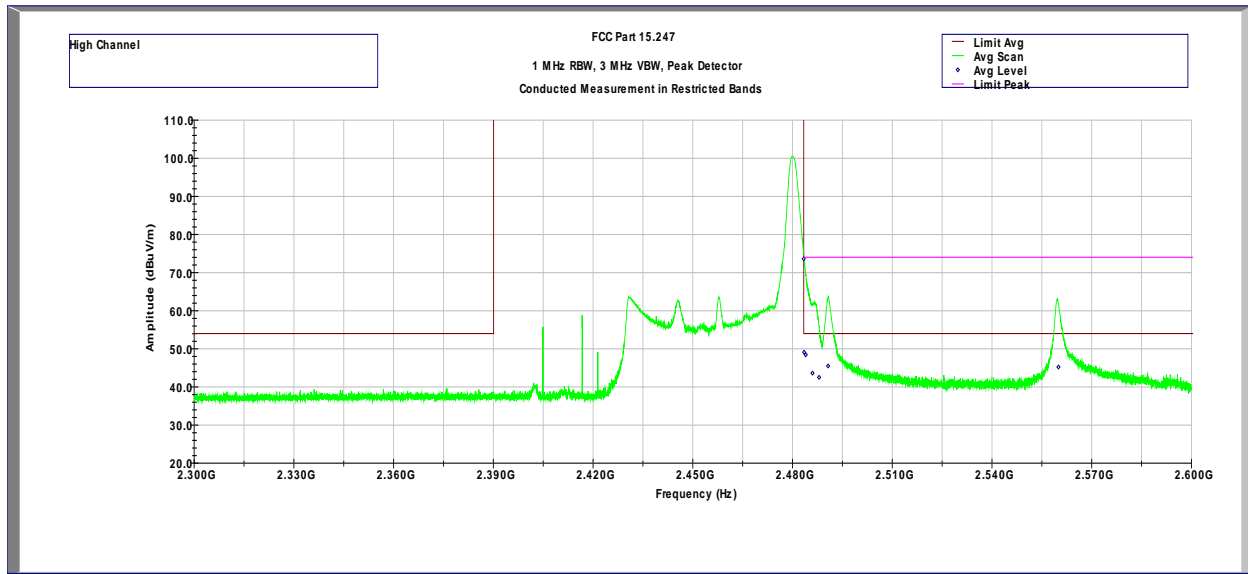
Test Results: 15.209/15.205 Restricted Band Emissions at Antenna Port

Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2402 MHz



Frequency	Corrected Amplitude	Avg Limit	Margin	Detector	Results
GHz	dBμV/m	dBμV/m	dB		
2.3140	45.4	54	-8.6	Avg	Pass
2.3710	47.3	54	-6.7	Avg	Pass
2.3800	45.1	54	-8.9	Avg	Pass
2.3820	45.3	54	-8.7	Avg	Pass
2.3840	45.4	54	-8.6	Avg	Pass
2.3860	45.1	54	-8.9	Avg	Pass
2.3880	45.7	54	-8.3	Avg	Pass
2.3900	45.8	54	-8.2	Avg	Pass

Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2480 MHz



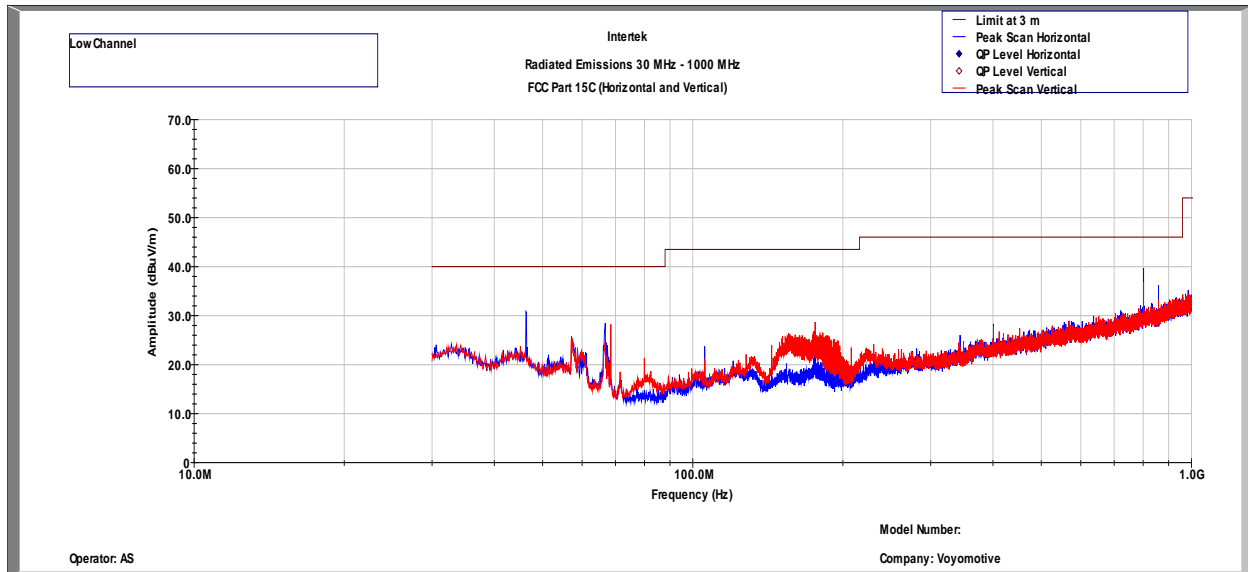
Frequency	Corrected Amplitude	Peak Limit	Margin	Detector	Results
GHz	dBμV/m	dBμV/m	dB		
2.4835	73.6	74	-0.4	Peak	Pass

Frequency	Corrected Amplitude	Avg Limit	Margin	Detector	Results
GHz	dBμV/m	dBμV/m	dB		
2.4835	49.1	54	-4.9	Avg	Pass
2.4840	48.4	54	-5.6	Avg	Pass
2.4860	43.6	54	-10.4	Avg	Pass
2.4880	42.5	54	-11.5	Avg	Pass
2.4910	45.5	54	-8.5	Avg	Pass
2.5600	45.2	54	-8.8	Avg	Pass

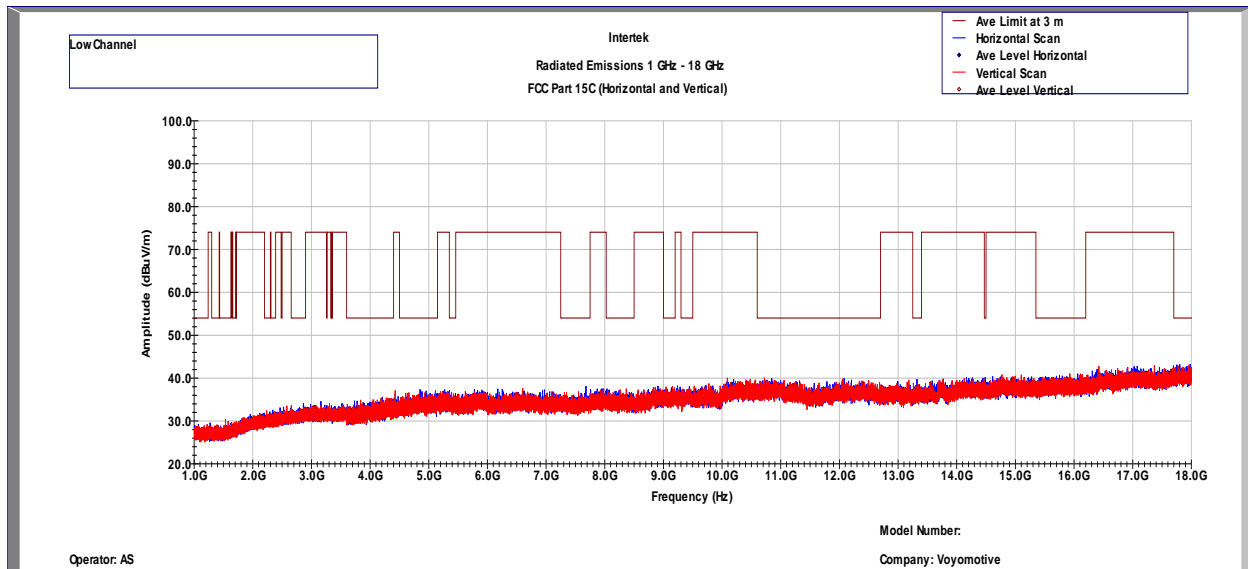
Out-of-Band Radiated Spurious Emissions

Date of Test: May 27, 2016

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz
Radiated Spurious Emissions 30 - 1000 MHz, Peak Scan



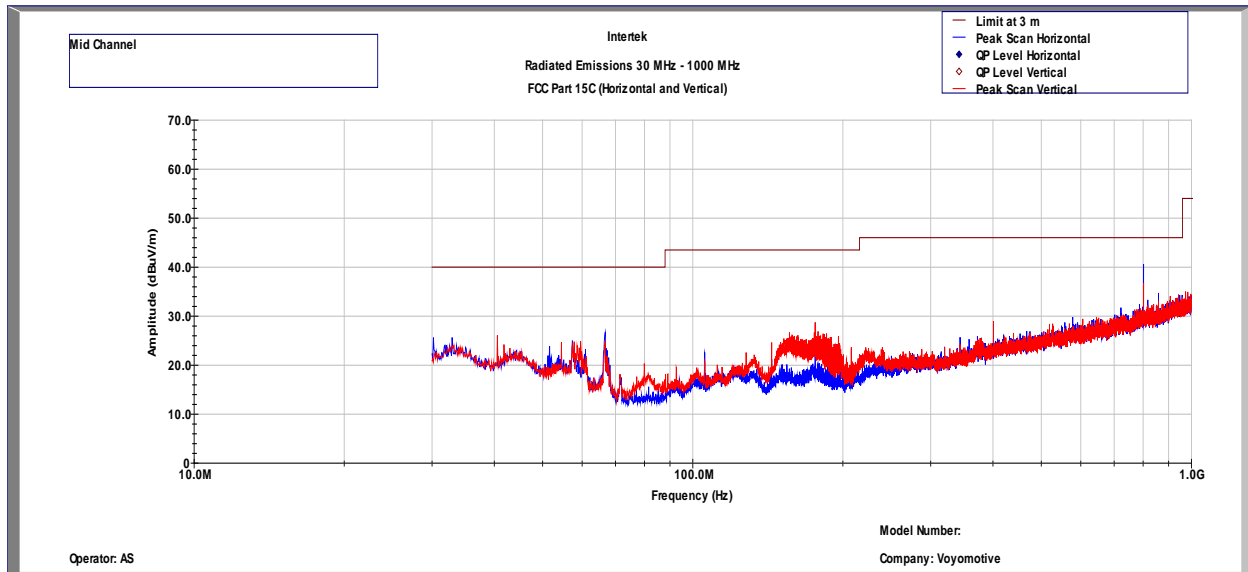
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



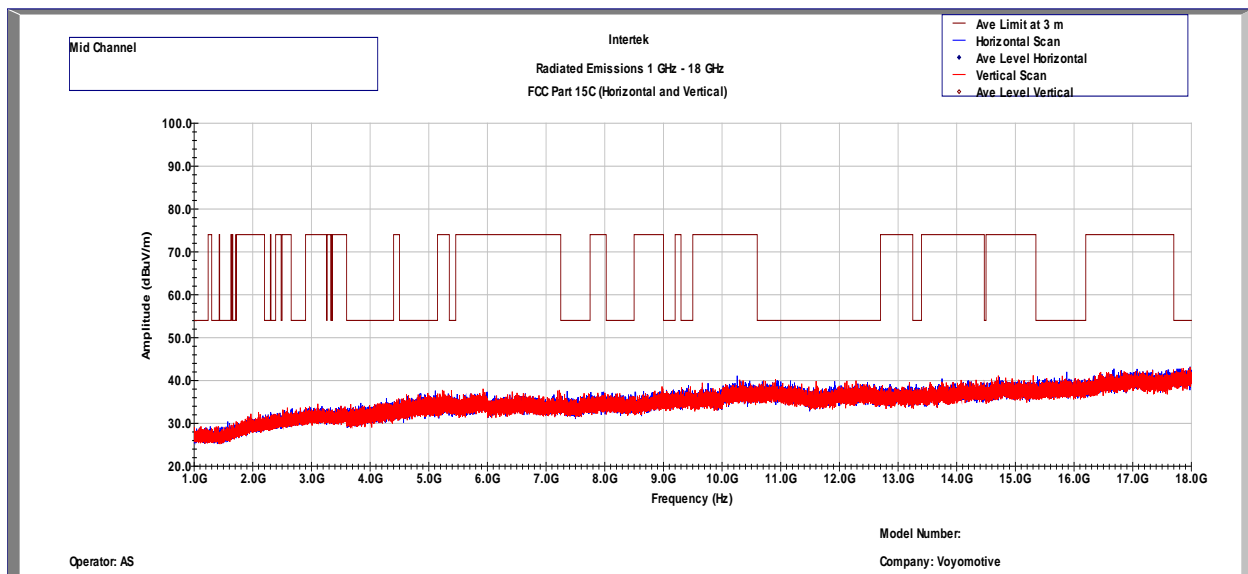
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: $FS@3m = RA + AF + CF - \text{Preamp, (Peak)}$
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2442MHz Radiated Spurious Emissions 30 - 1000 MHz, Peak Scan



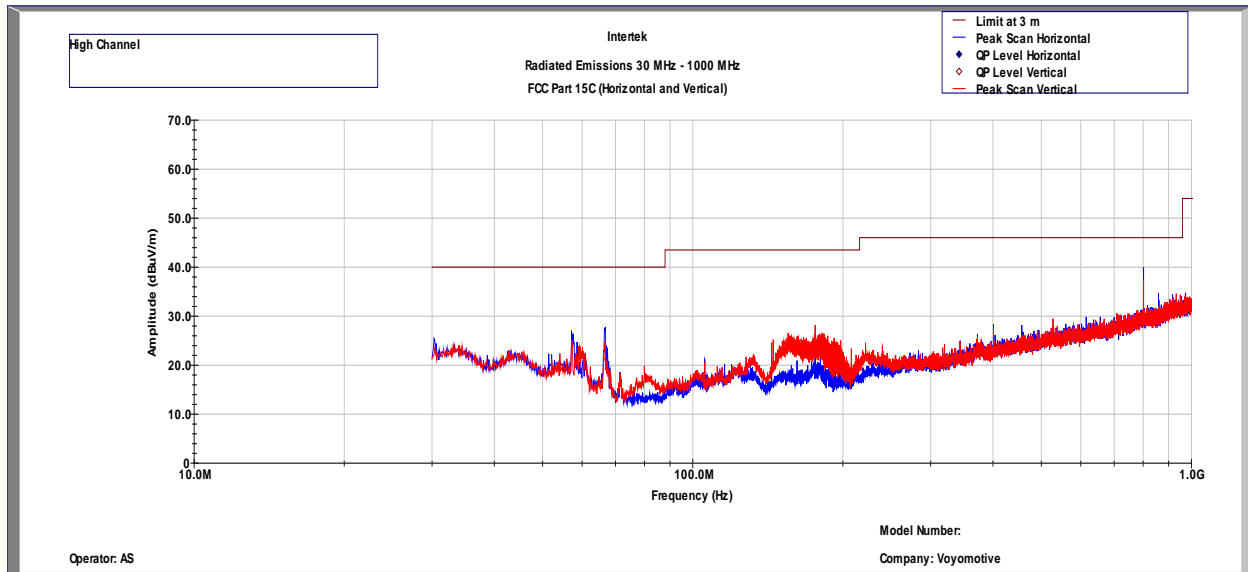
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



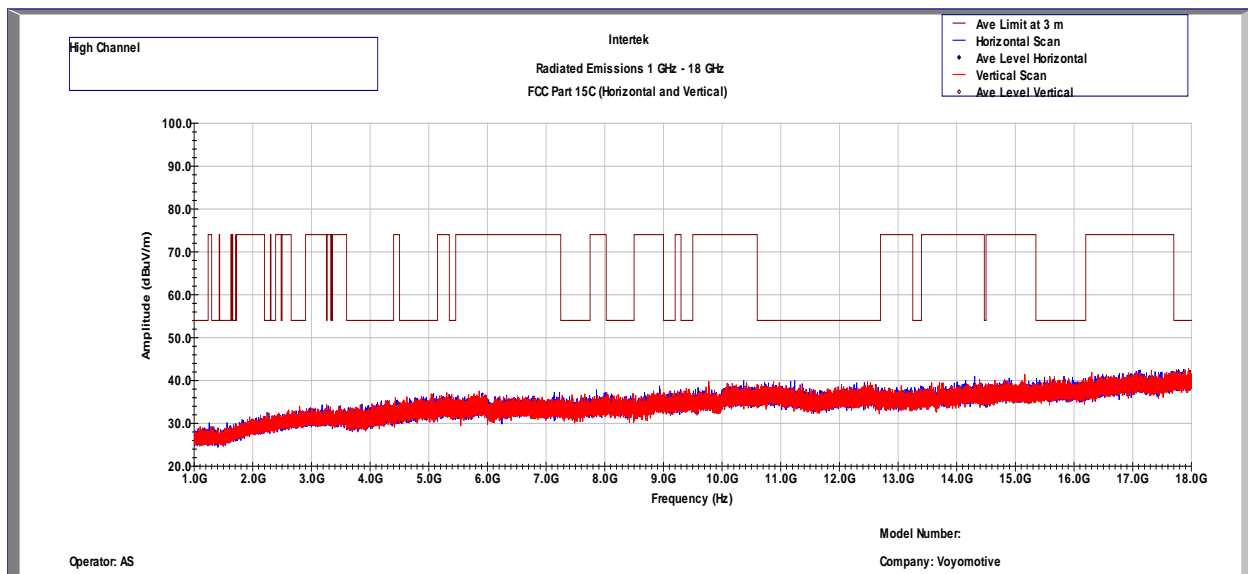
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: $FS@3m = RA + AF + CF - \text{Preamp, (Peak)}$
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz Radiated Spurious Emissions 30 - 1000 MHz, Peak Scan



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



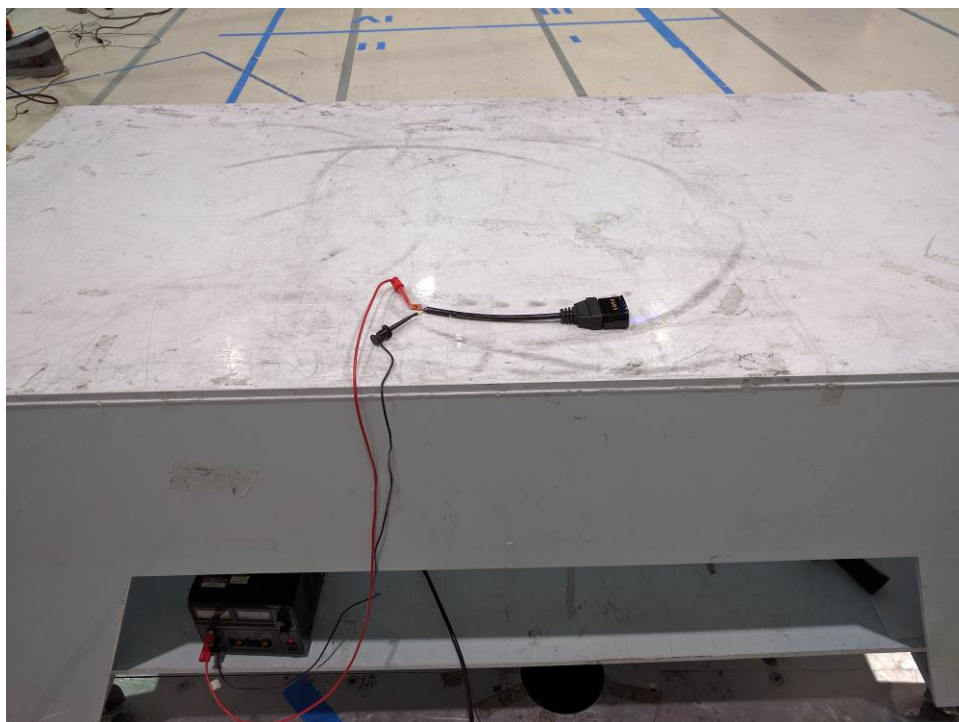
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: $FS@3m = RA + AF + CF - \text{Preamp, (Peak)}$
Corrected Peak Scans are under the Average Limit of 54.

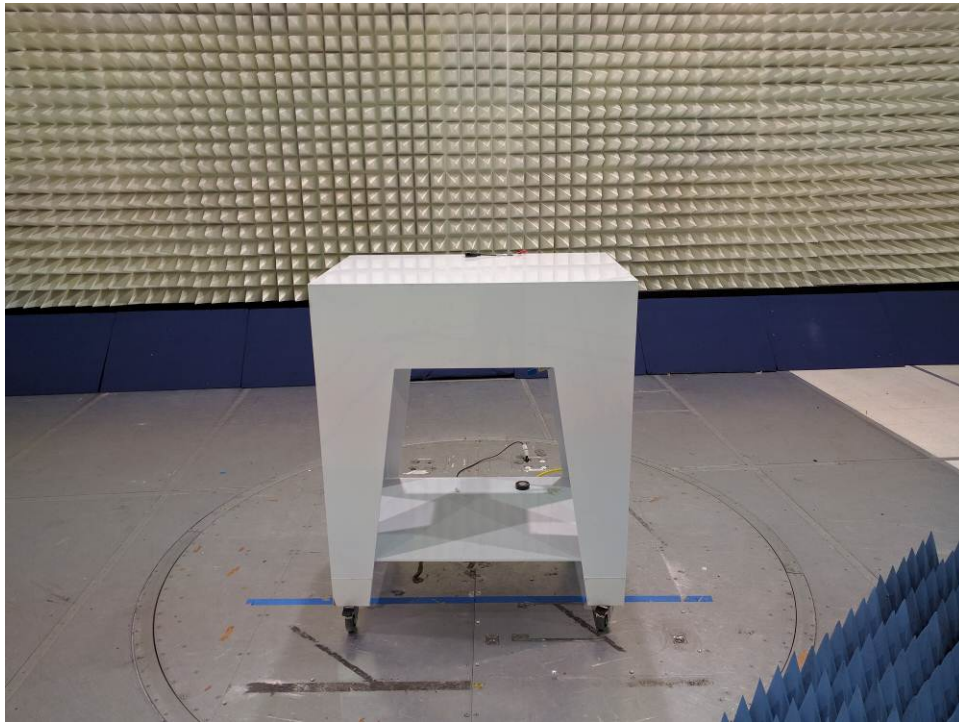
Results	Complies
---------	----------

4.5.4 Test Configuration Photographs

The following photographs show the testing configurations used.



4.6.4 Test Setup Photographs



4.6 Radiated Emissions

FCC Ref: 15.109, ICES 003

4.6.1 Requirement

Limits for Electromagnetic Radiated Emissions FCC Section 15.109(b), ICES 003*, RSS GEN

Frequency (MHz)	Class A at 10m dB(μV/m)	Class B at 3m dB(μV/m)
30-88	39	40.0
88-216	43.5	43.5
216-960	46.4	46.0
Above 960	49.5	54.0

* According to FCC Part 15.109(g) an alternative to the radiated emission limits shown above, digital devices may be shown to comply with the limit of CISPR Pub. 22

4.6.2 Procedures

Measurements are conducted with a quasi-peak detector instrument in the frequency range of 30 MHz to 1000 MHz and with the average detector instrument in the frequency range above 1000 MHz. The measuring receiver meets the requirements of Section One of CISPR 16 and the measuring antenna correlates to a balanced dipole.

Measurements of the radiated field are made with the antenna located at a distance of 10 meters from the EUT. If the field-strength measurements at 10m cannot be made because of high ambient noise level or for other reasons, measurements of Class B equipment may be made at a closer distance, for example 3m. An inverse proportionality factor of 20 dB per decade should be used to normalize the measured data to the specified distance for determining compliance.

The antenna is adjusted between 1m and 4m in height above the ground plane for maximum meter reading at each test frequency.

The antenna-to-EUT azimuth is varied during the measurement to find the maximum field-strength readings.

The antenna-to-EUT polarization (horizontal and vertical) is varied during the measurements to find the maximum field-strength readings.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for a larger EUT.

Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material.

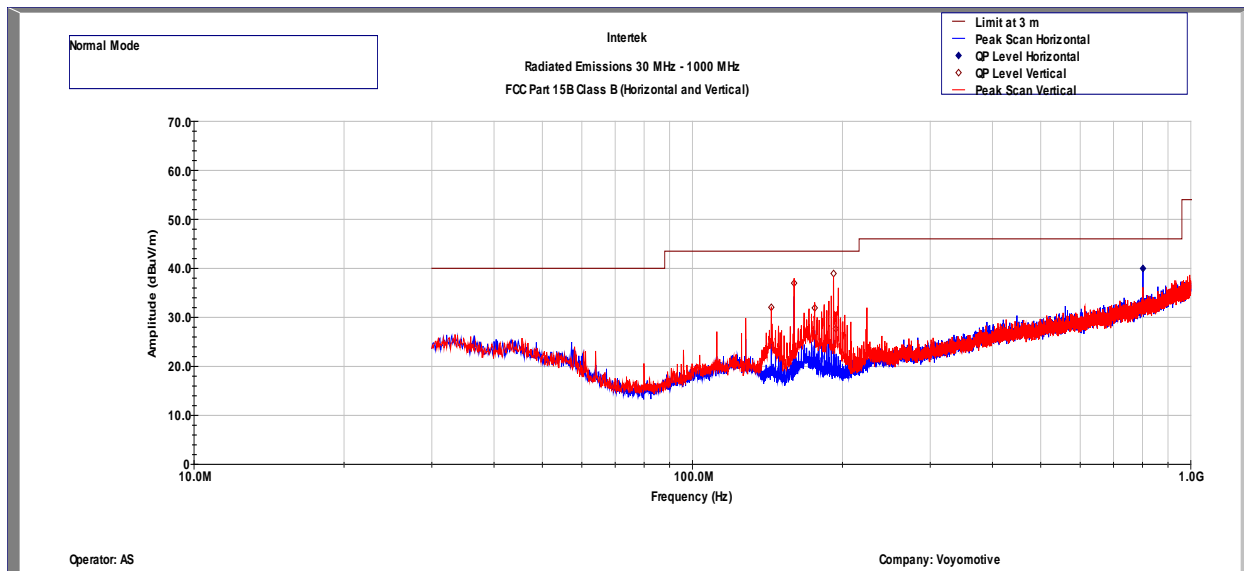
Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4 and EN 55022.

4.6.3 Test Results

The highest clock frequency used in the EUT is 80 MHz; therefore testing for Radiated Emissions need be tested up to 1 GHz for FCC 15B. Radiated emission measurements were performed from 30 MHz to 1000 MHz. The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

Date of Test:	April 29, 2016
----------------------	-----------------------

Test Results: Radiated Emissions 30 MHz – 1000 MHz
 Test Results: 15.109 Radiated Spurious Emissions Class B



Vertical Polarity

Frequency	Quasi Pk FS	Limit@3m	Margin	RA	Cable	AG	DCF	AF	Azimuth	Height
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)	deg	cm
144.000	32.1	43.5	-11.4	43.5	1.3	31.9	10.5	8.6	310	108
160.000	37.0	43.5	-6.5	48.9	1.4	31.9	10.5	8.1	221	205
176.000	31.9	43.5	-11.6	42.6	1.5	31.9	10.5	9.3	322	187
192.000	38.9	43.5	-4.6	49.3	1.5	31.9	10.5	9.5	60	100
194.000	27.6	43.5	-15.9	38.0	1.6	31.9	10.5	9.5	350	132

Horizontal Polarity

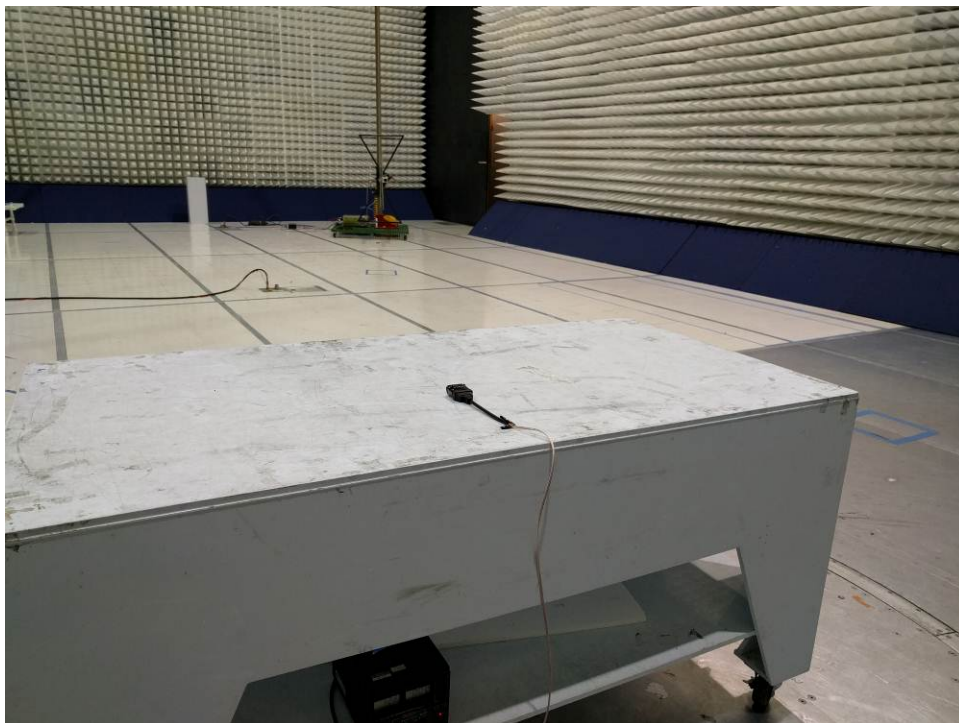
Frequency	Quasi Pk FS	Limit@3m	Margin	RA	Cable	AG	DCF	AF	Azimuth	Height
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)	deg	cm
801.800	40.0	46.0	-6.0	36.5	3.8	31.9	10.5	21.1	10	100

Results

Complies by 4.6dB

4.6.4 Test Configuration Photographs

The following photographs show the testing configurations used.



4.7 AC Line Conducted Emission FCC: 15.207, 15.107; RSS-GEN;

4.7.1 Requirement

Frequency Band MHz	Class B Limit dB(μ V)		Class A Limit dB(μ V)	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15-0.50	66 to 56 *	56 to 46 *	79	66
0.50-5.00	56	46	73	60
5.00-30.00	60	50	73	60

*Note: *Decreases linearly with the logarithm of the frequency. At the transition frequency the lower limit applies.*

4.7.2 Procedure

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4.

4.7.3 Test Results

Testing for 15.207 is not applicable. The EUT is only battery operated and installed in an automobile.

5.0 RF Exposure Evaluation

MPE Evaluation

The EUT is a wireless device used in a mobile application, at least 20 cm from any body part of the user or nearby persons.

The maximum Peak EIRP calculated is 7.06 dBm or 5.08 mW; therefore, to comply with RF Exposure Requirement, the MPE is calculated.

The Power Density can be calculated using the formula

$$S = \text{EIRP} / 4\pi D^2$$

Where: S is Power Density in mW/cm²
D is the distance from the antenna.

It is considered that 20 cm is the minimum distance that user can go closest to the EUT.

At 20 cm, S = 0.0101 W/m², which is below the MPE Limit of 10 W/m²

Date of Test:	May 31, 2016
Results	Complies

6.0 List of Test Equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

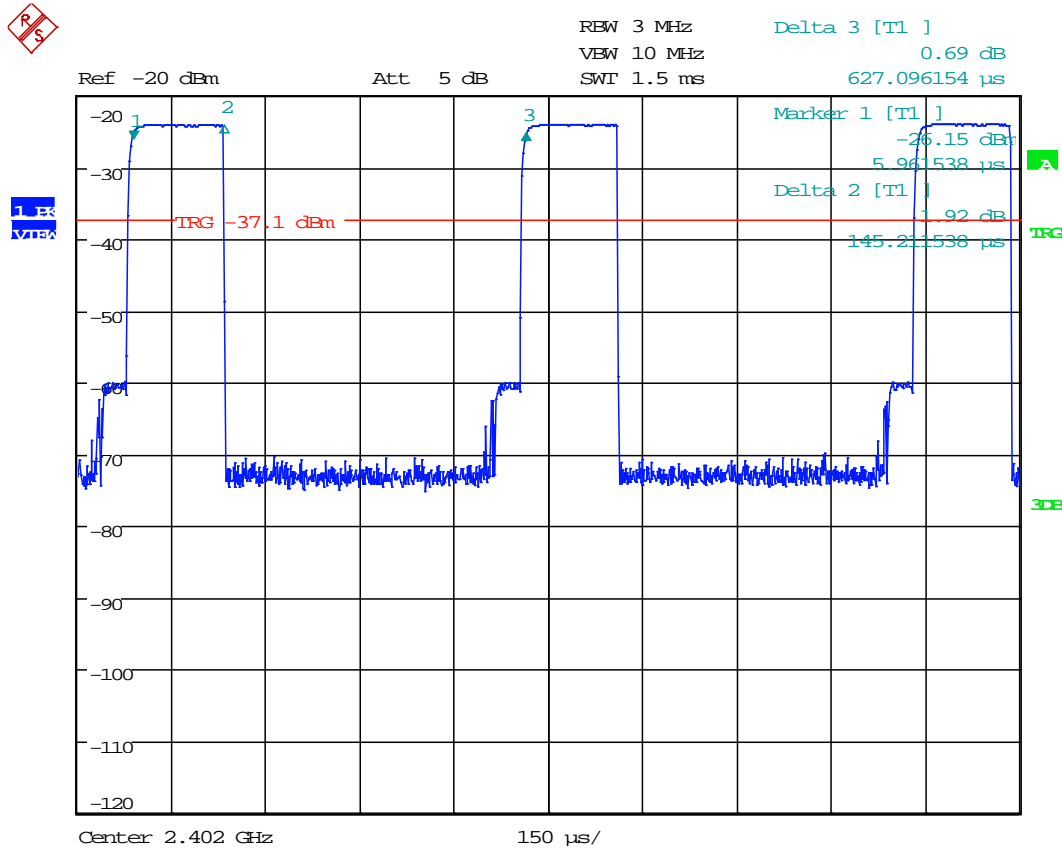
Equipment	Manufacturer	Model/Type	Asset #	Cal Int	Cal Due
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	06/02/16
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	01/05/17
BI-Log Antenna	Antenna Research	LPB-2513	ITS 00355	12	08/11/16
Pre-Amplifier	Sonoma Instrument	310	ITS 00942	12	01/07/17
Horn Antenna/Preamp	EMCO	3117PA	ITS 01325	12	11/23/16
Pre-Amplifier (18-40GHz)	Miteq	JSD44-18004000-305P	ITS 00921	12	06/18/16
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#

No Calibration required

7.0 Document History

Revision/ Job Number	Writer Initials	Reviewers Initials	Date	Change
1.0 / G102555312	AS	KV	June 17, 2016	Original document

Annex A - Duty Cycle Measurement



Date: 31.MAY.2016 10:41:03

Duty Cycle: $DC = 145.2 / 627.1 = 0.232$ or 23.2%

Duty Cycle Correction Factor δ (dB) = $10 \log (145.2 / 627.1) = 6.4\text{dB}$