TEST REPORT

Report Number: 102078038MPK-004
Project Number: G102078038
August 28, 2015

Testing performed on
Wearable Bluetooth communications device
Model: ONX-002
FCC ID: 2AFBMONX2
IC: 20381-ONX2
to

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

For

Orion Labs, Inc.

Test Performed by:	Test Authorized by:
Intertek	Orion Labs, Inc.
1365 Adams Court	2125 Mission Street
Menlo Park, CA 94025 USA	San Francisco, CA 94110 USA

Prepared by: _____ **Date:** August 28, 2015
Anderson Soungpanya

Reviewed by: _____ **Date:** August 28, 2015
Krishna K Vemuri

Report No. 102078038MPK-004

Equipment Under Test:	Wearable Bluetooth communications device
Trade Name:	Onyx
Model Number:	ONX-002
Serial Numbers:	MPK1508051354-002 EUT (Radiated Sample) MPK1508201722-001 (Conducted Sample)
Applicant:	Orion Labs, Inc.
Contact:	Andy Sherman
Address:	Orion Labs, Inc. 2125 Mission Street San Francisco, CA 94110
Country	USA
Tel. Number:	(415) 800-2035 ext. 709
Email:	asherman@orionlabs.co
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:	August 20 – 28, 2015

We attest to the accuracy of this report:

Anderson Soungpanya
Project Engineer

Krishna K Vemuri
EMC Senior Staff Engineer

TABLE OF CONTENTS

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	Complies
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)
RF Exposure	15.247(i), 2.1093(d)	RSS-102	Complies

EUT receive date: August 20, 2015
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: August 20, 2015
Test completion date: August 28, 2015
The test results in this report pertain only to the item tested.

2.0 General Information

2.1 Product Description

The Model: ONX-002 is Bluetooth speaker that is worn by the user. The unit is battery powered and it charged using a micro USB.

Information about the 2.4 GHz radio is presented below:

Applicant	Orion Labs, Inc.
Model No.	ONX-002
FCC Identifier	2AFBMONX2
IC Identifier	20381-ONX2
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	3.26 dBm (2.12 mW)
Antenna(s) & Gain	Internal Surface Mount Antenna, Gain: +1.72 dBi
EIRP	3.26 dBm + 1.72 dBi = 4.98 dBm (3.15 mW)
Frequency Range	2402 – 2480 MHz
Type of modulation/data rate	GFSK 1Mb
Number of Channel(s)	40
Applicant Name & Address	Orion Labs, Inc. 2125 Mission Street San Francisco, CA 94110 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 v03r03 June 9, 2015), 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	-	-

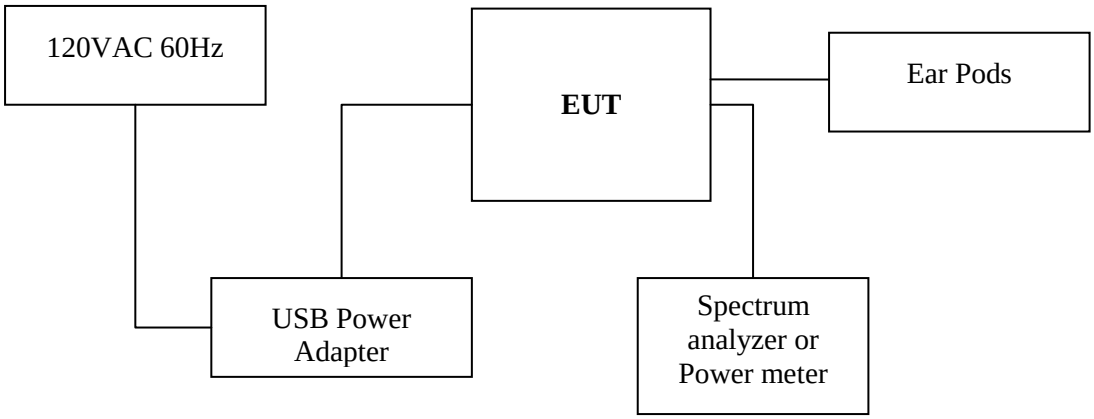
3.0 System Test Configuration

3.1 Support Equipment

Item #	Description	Manufacturer	Model No./ Part No.	Serial No.
1	5W USB Power Adapter	Apple	A1265	1X142WNDC8QZ
2	Ear Pods	Apple	Not Marked	Not Marked

3.2 Block Diagram of Test Setup

Antenna was removed and co-axial connector with a cable was installed for Conducted Measurements.
Internal antenna was used for Radiated Measurements.



S = Shielded **U** = Unshielded	**F** = With Ferrite **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 Orion Labs, Inc.

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.

3.5 Modifications Required for Compliance

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

3.6 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 v03r03 June 9, 2015 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) ≥ 3 x 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.

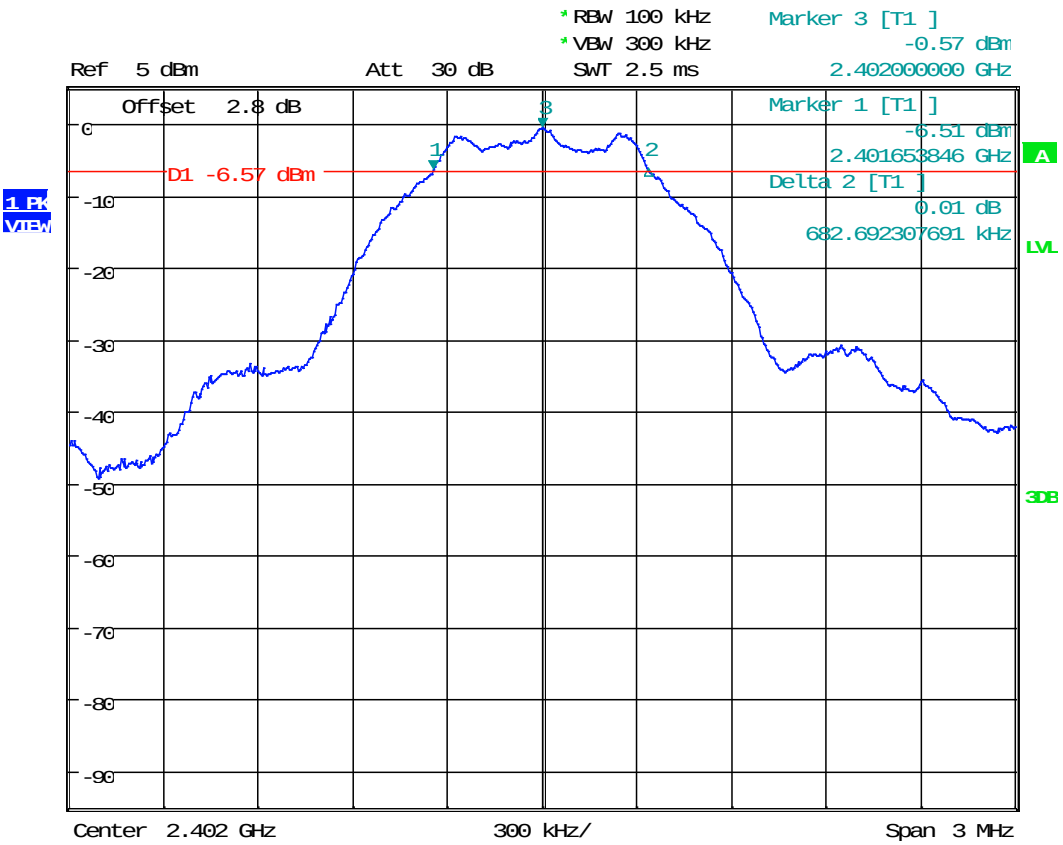
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

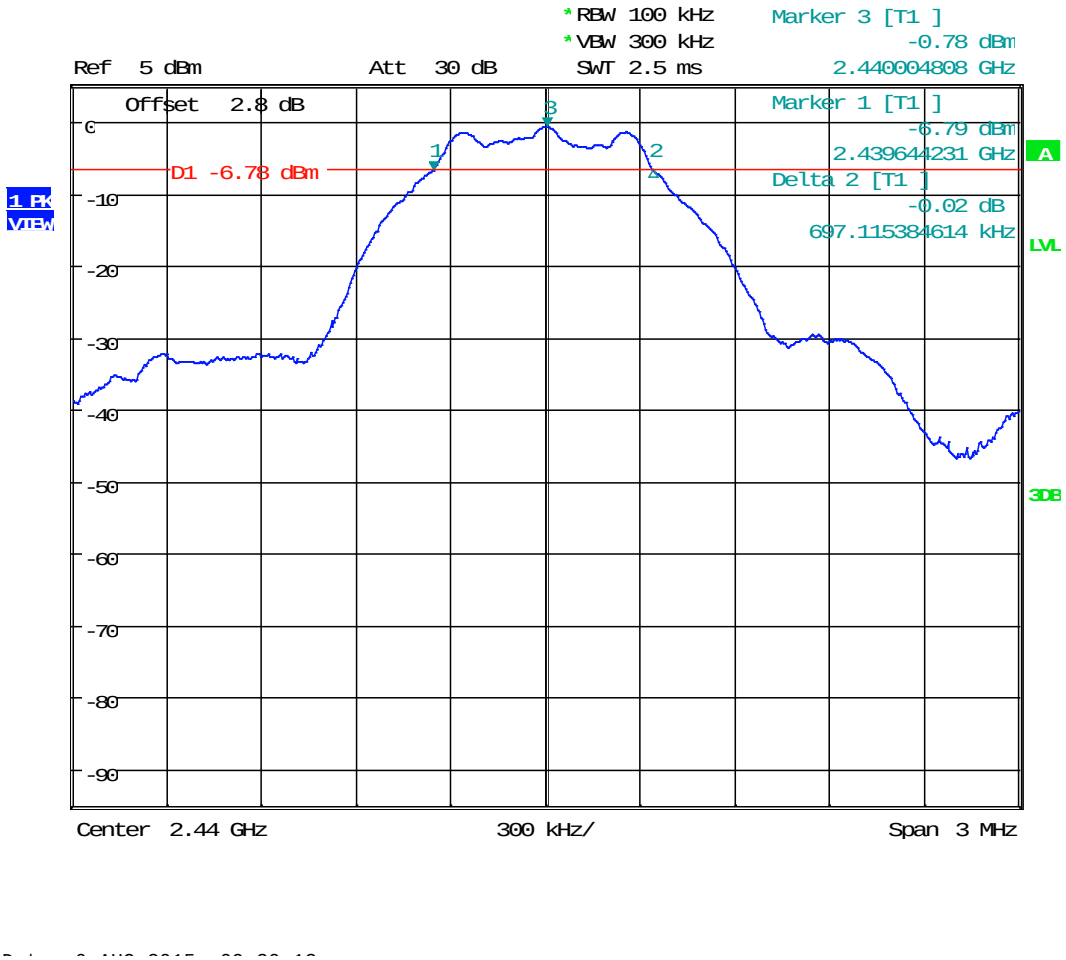
Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, MHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	0.683	--	1.1
	--	1.038	1.4
2440	0.697	--	1.2
	--	1.032	1.5
2480	0.702	--	1.3
	--	1.045	1.6

Date of Test:	August 21, 2015
Results	**Complies**

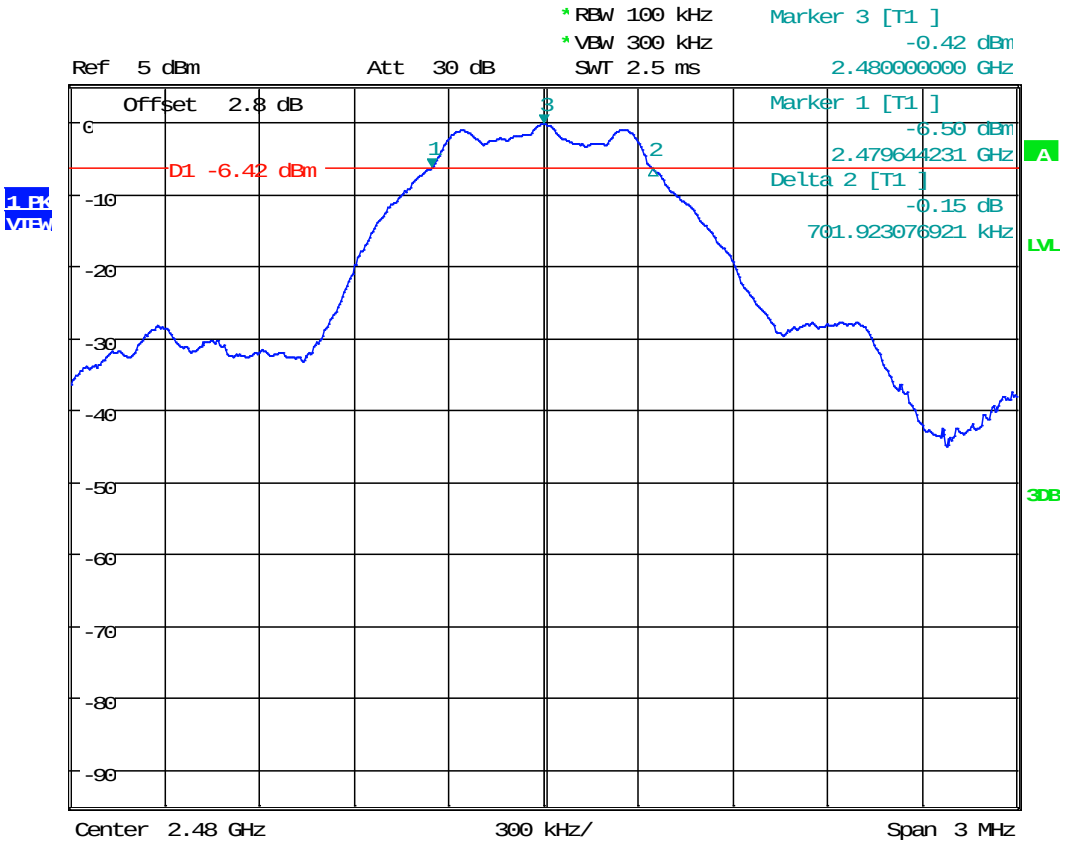
Plot 1. 1


RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 3 [T1]
-0.57 dBm
2.402000000 GHz
Ref 5 dBm
Att 30 dB
Offset 2.8 dB
Marker 1 [T1]
-6.51 dBm
2.401653846 GHz
Delta 2 [T1]
0.01 dB
682.692307691 kHz
D1 -6.57 dBm
1 PK
VIEW
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.402 GHz
300 kHz/
Span 3 MHz

Plot 1. 2


*RBW 100 kHz
*VBW 300 kHz
Ref 5 dBm
Att 30 dB
SWT 2.5 ms
Marker 3 [T1]
-0.78 dBm
2.440004808 GHz
Offset 2.8 dB
Marker 1 [T1]
-6.79 dBm
2.439644231 GHz
D1 -6.78 dBm
Delta 2 [T1]
-0.02 dB
697.115384614 kHz
1 PK
VIEW
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.44 GHz
300 kHz/
Span 3 MHz

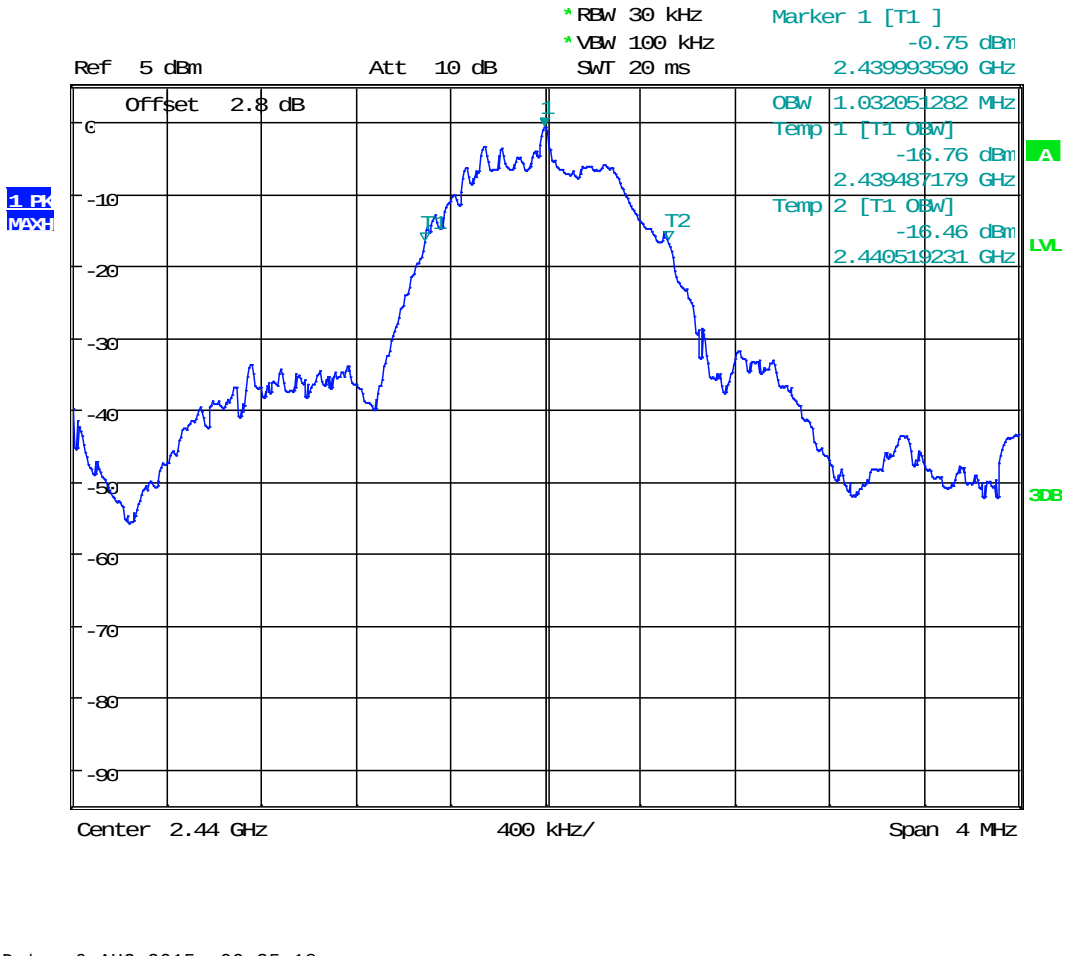
Plot 1. 3


*RBW 100 kHz
*VBW 300 kHz
SWT 2.5 ms
Marker 3 [T1]
-0.42 dBm
2.480000000 GHz
Ref 5 dBm
Att 30 dB
Offset 2.8 dB
Marker 1 [T1]
-6.50 dBm
2.479644231 GHz
Delta 2 [T1]
-0.15 dB
701.923076921 kHz
D1 -6.42 dBm
1 PK
VIEW
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.48 GHz
300 kHz/
Span 3 MHz

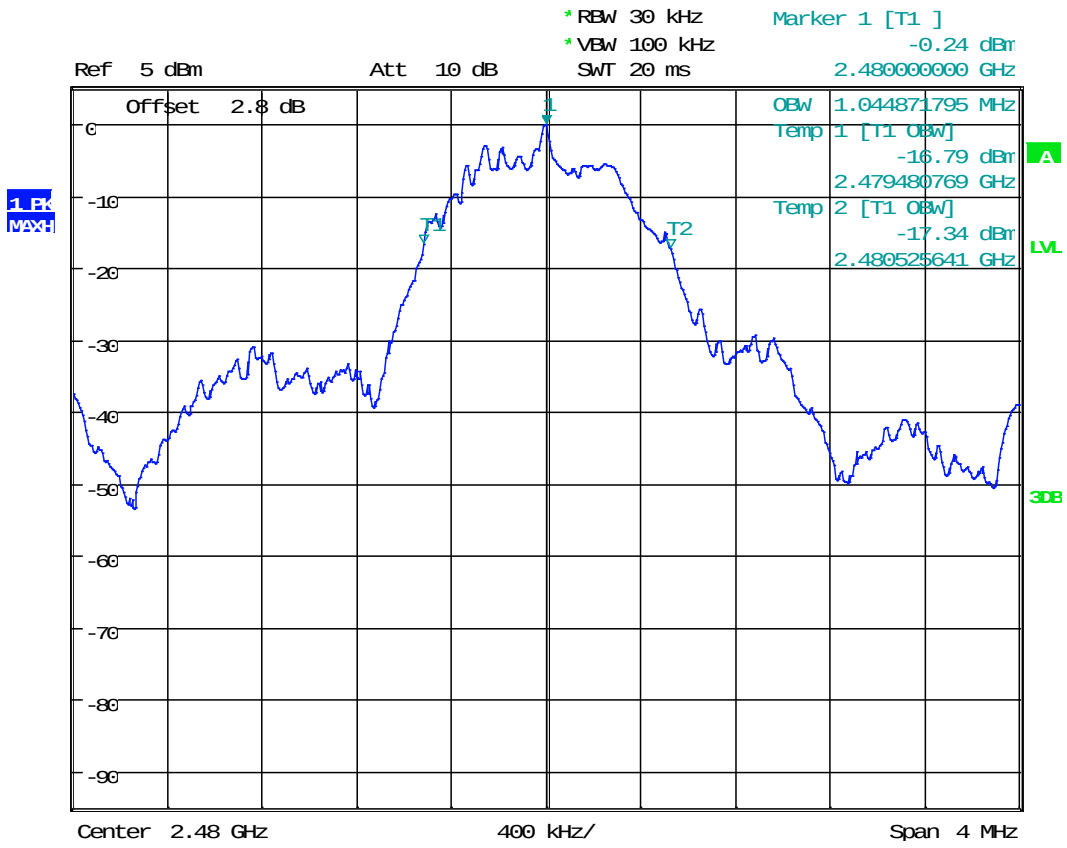
Plot 1. 4


*RBW 30 kHz
*VBW 100 kHz
Ref 5 dBm
Att 10 dB
SWT 20 ms
Marker 1 [T1]
-1.77 dBm
2.402000000 GHz
Offset 2.8 dB
OBW 1.038461538 MHz
Temp 1 [T1 OBW]
-17.74 dBm
2.401487179 GHz
Temp 2 [T1 OBW]
-17.71 dBm
2.402525641 GHz
1 PK
MAXH
A
LVL
3DB
T1
T2
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.402 GHz
400 kHz/
Span 4 MHz

Plot 1.5


*RBW 30 kHz
*VBW 100 kHz
Ref 5 dBm
Att 10 dB
SWT 20 ms
Marker 1 [T1]
-0.75 dBm
2.439993590 GHz
Offset 2.8 dB
OBW 1.032051282 MHz
Temp 1 [T1 OBW]
-16.76 dBm
2.439487179 GHz
Temp 2 [T1 OBW]
-16.46 dBm
2.440519231 GHz
1 PK
MAXH
A
LVL
3DB
T1
T2
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.44 GHz
400 kHz/
Span 4 MHz

Plot 1.6


RBW 30 kHz
VBW 100 kHz
SWT 20 ms
Marker 1 [T1]
-0.24 dBm
2.480000000 GHz
Ref 5 dBm
Att 10 dB
Offset 2.8 dB
OBW 1.044871795 MHz
Temp 1 [T1 OBW]
-16.79 dBm
2.479480769 GHz
Temp 2 [T1 OBW]
-17.34 dBm
2.480525641 GHz
1 PK
MAXH
A
LVL
3DB
T1
T2
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.48 GHz
400 kHz/
Span 4 MHz

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 v03r03 June 9, 2015 was used. Specifically, section 9.1.1 RBW ≥ DTS Bandwidth was utilized as the spectrum analyzer's resolution bandwidth was greater than the DTS bandwidth.

1. Set the RBW ≥ DTS Bandwidth
2. Set the VBW ≥ 3 x RBW
3. Set the span ≥ 3 x 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.

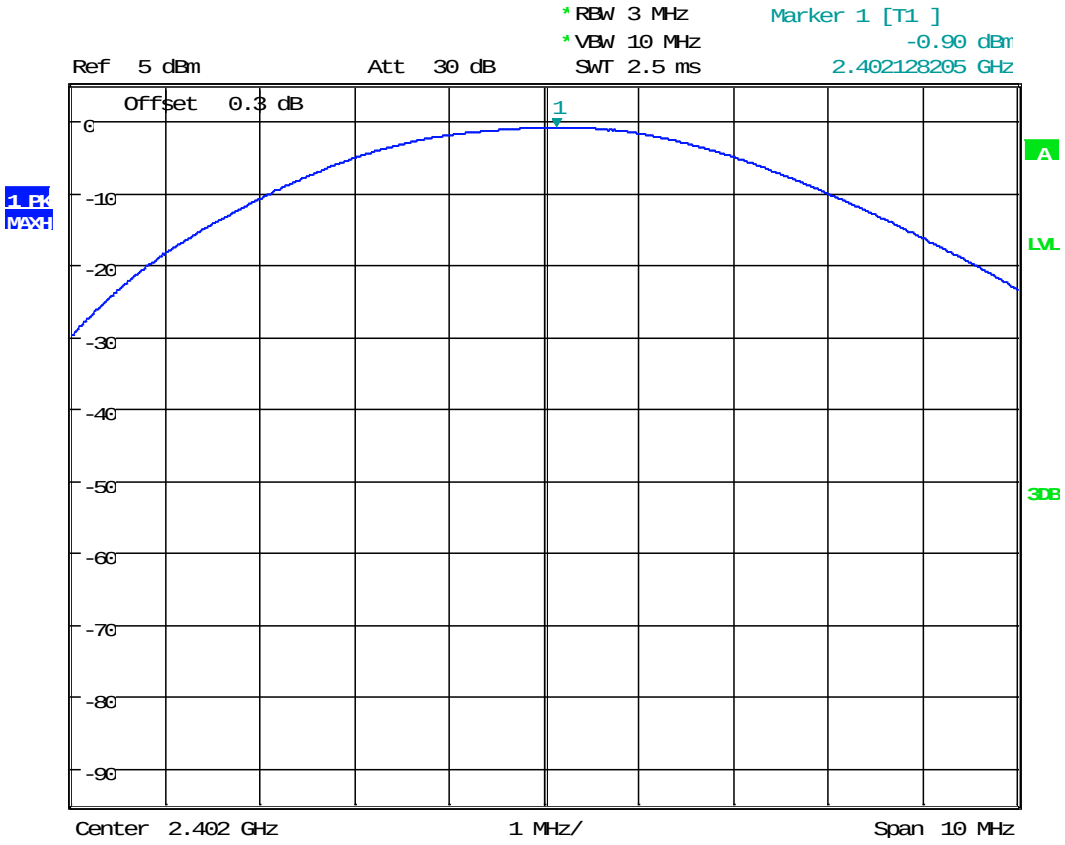
4.3.3 Test Result

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

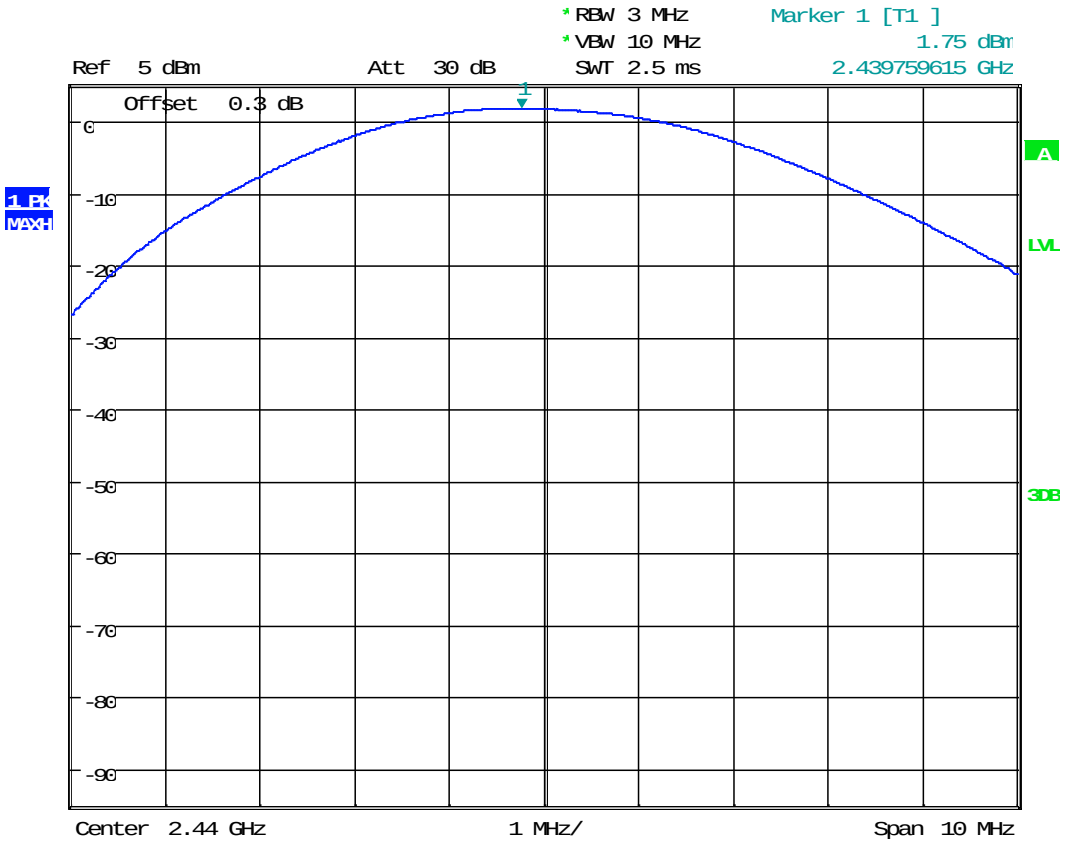
Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
2402	-0.90	0.81	2.1
2440	1.75	1.50	2.2
2480	3.26	2.12	2.3

Date of Test:	August 27, 2015
Results	**Complies**

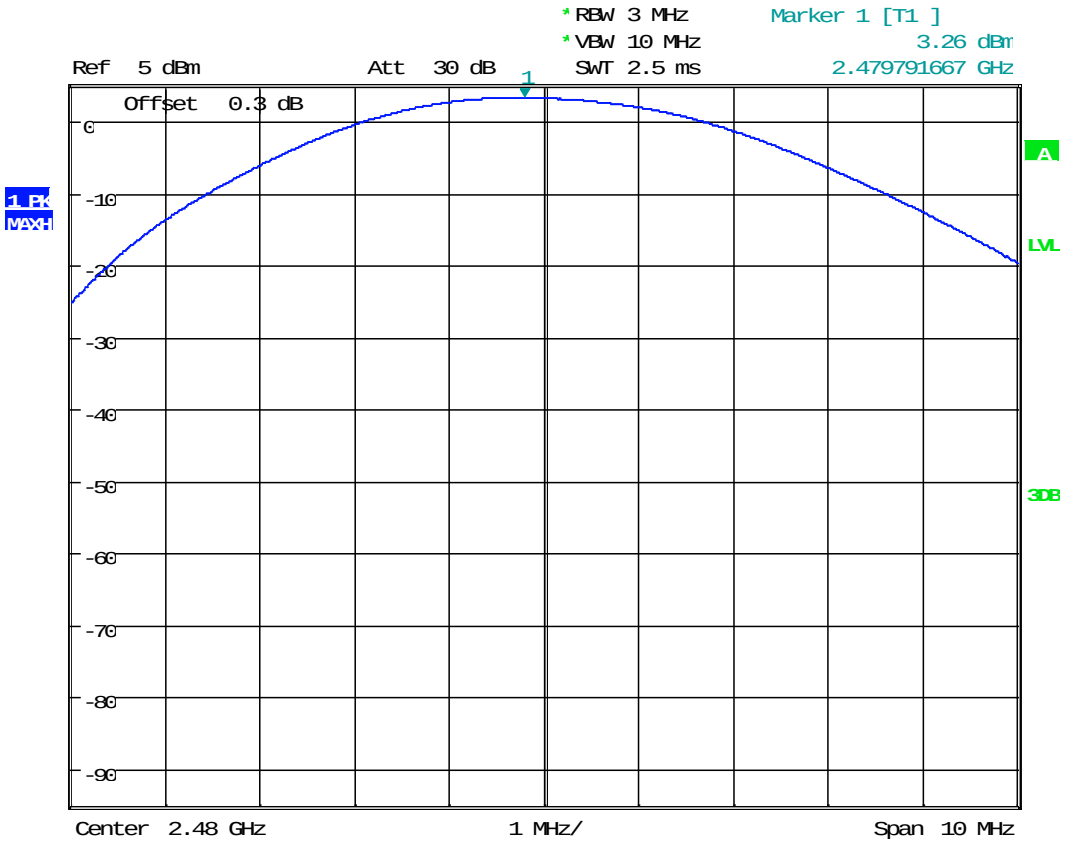
Plot 2. 1


RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
-0.90 dBm
2.402128205 GHz
Ref 5 dBm
Att 30 dB
Offset 0.3 dB
1
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.402 GHz
1 MHz/
Span 10 MHz

Plot 2. 2


RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
1.75 dBm
2.439759615 GHz
Ref 5 dBm
Att 30 dB
Offset 0.3 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.44 GHz
1 MHz/
Span 10 MHz

Plot 2. 3


RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
3.26 dBm
2.479791667 GHz
Ref 5 dBm
Att 30 dB
Offset 0.3 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.48 GHz
1 MHz/
Span 10 MHz

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 v03r03 June 9, 2015, 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 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x 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.

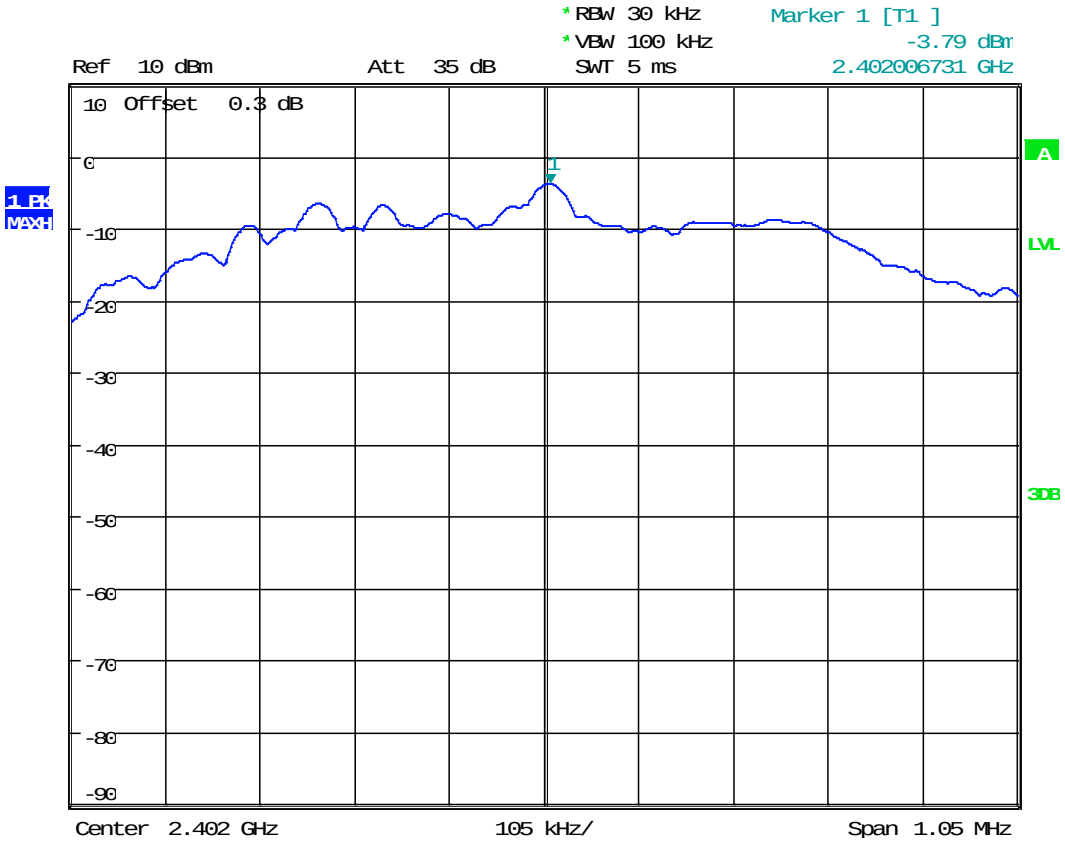
4.3.3 Test Result

Refer to the following plots for the test result

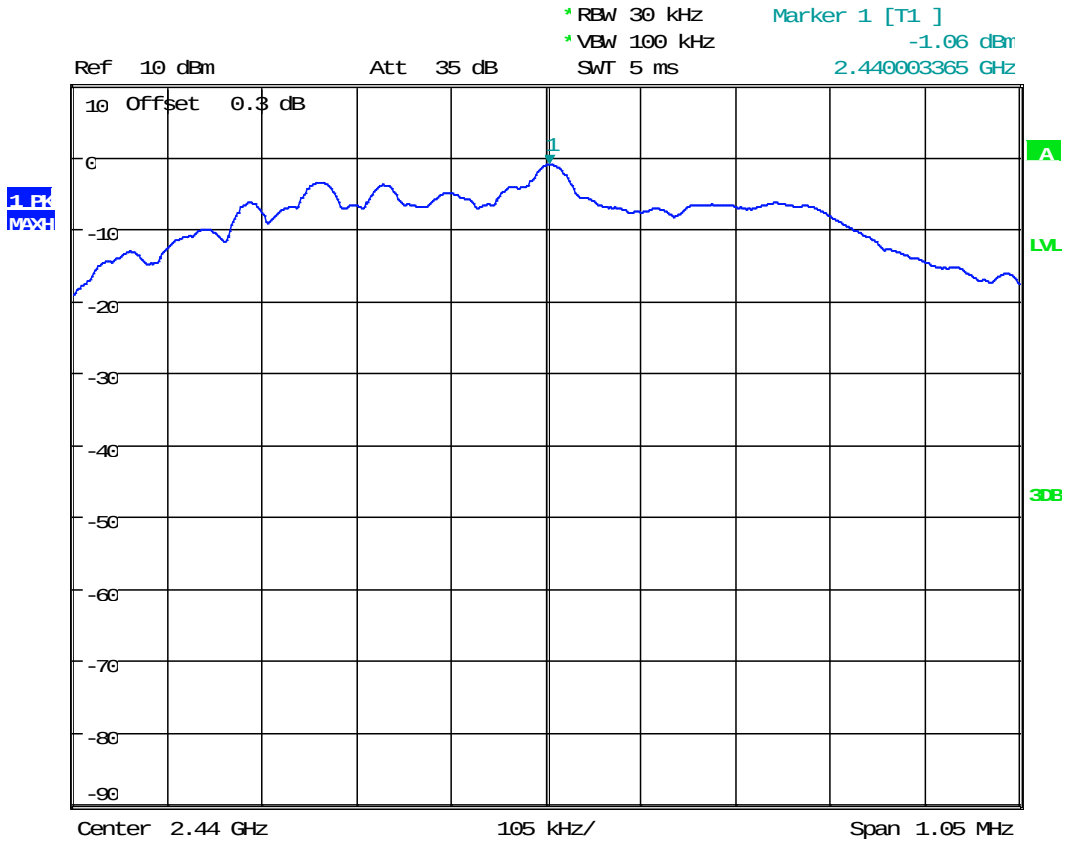
Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
2402	-3.79	8.0	-11.79	3.1
2440	-1.06	8.0	-9.06	3.2
2480	0.43	8.0	-7.57	3.3

Date of Test:	August 27, 2015
Results	**Complies**

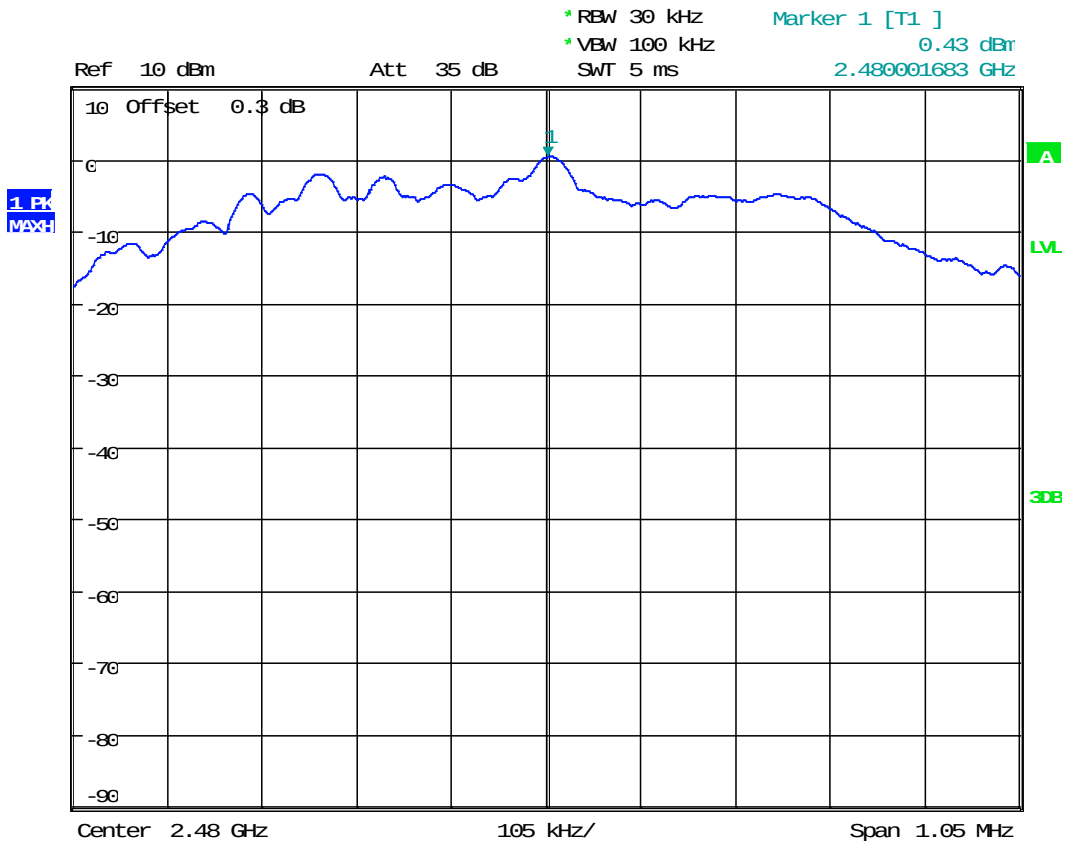
Plot 3. 1


RBW 30 kHz
VBW 100 kHz
SWT 5 ms
Marker 1 [T1]
-3.79 dBm
2.402006731 GHz
Ref 10 dBm
Att 35 dB
10 Offset 0.3 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.402 GHz
105 kHz/
Span 1.05 MHz

Plot 3. 2


RBW 30 kHz
VBW 100 kHz
SWT 5 ms
Marker 1 [T1]
-1.06 dBm
2.440003365 GHz
Ref 10 dBm
Att 35 dB
10 Offset 0.3 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
A
LVL
3DB
1 PK
MAXH
Center 2.44 GHz
105 kHz/
Span 1.05 MHz

Plot 3. 3


RBW 30 kHz
VBW 100 kHz
SWT 5 ms
Marker 1 [T1]
0.43 dBm
2.480001683 GHz
Ref 10 dBm
Att 35 dB
10 Offset 0.3 dB
1 Pk
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.48 GHz
105 kHz/
Span 1.05 MHz

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 v03r03 June 9, 2015, 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 ≥ 3 x 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.

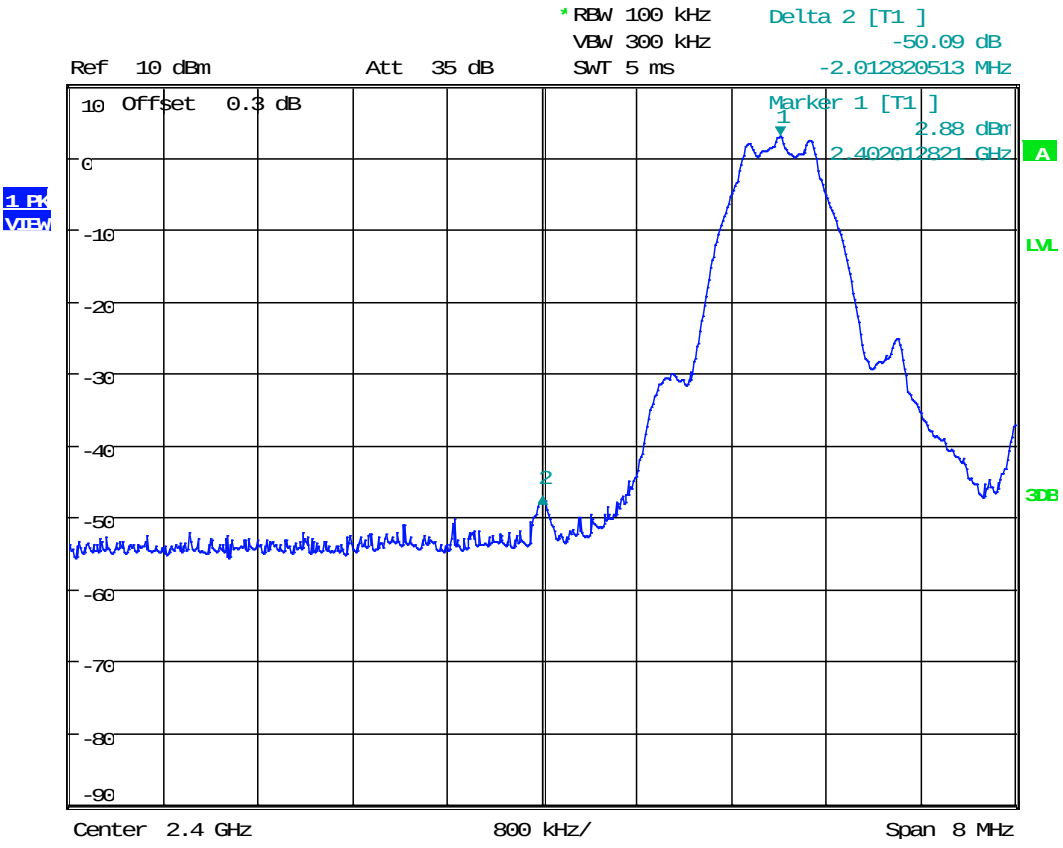
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

4.4.3 Test Result

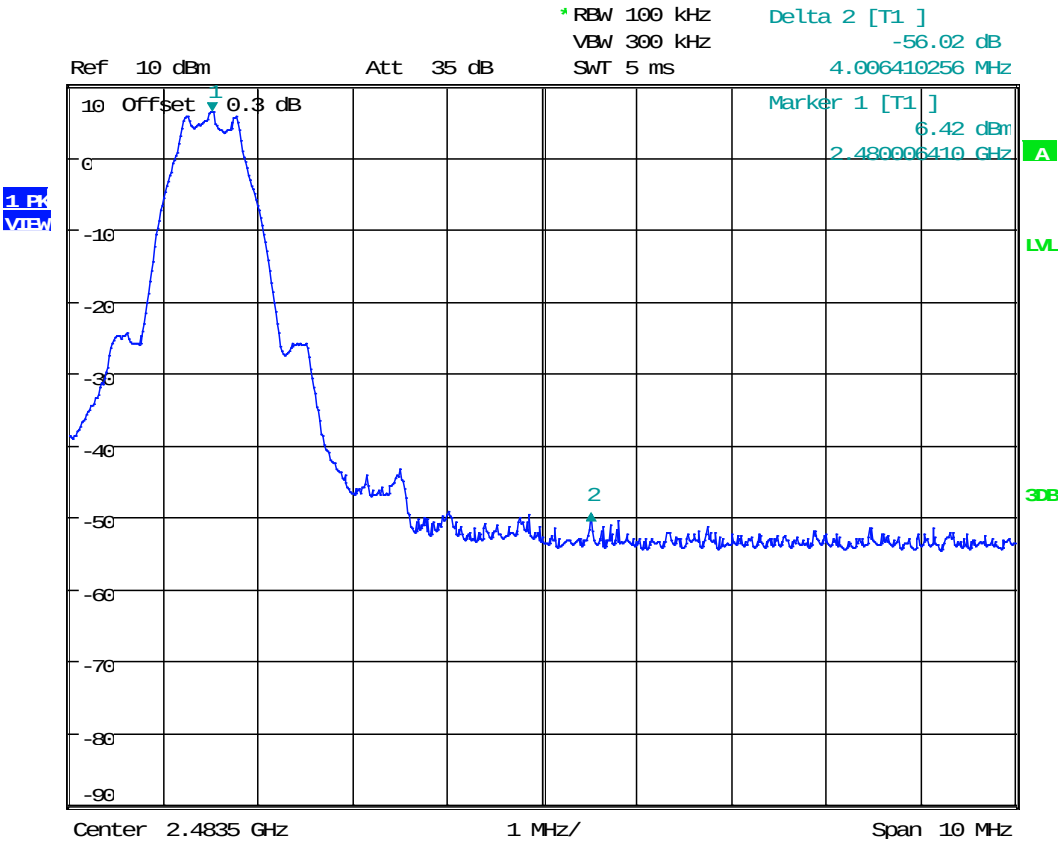
Refer to the following plots 4.1 – 4.5 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

Date of Test:	August 24, 2015
Results	**Complies**

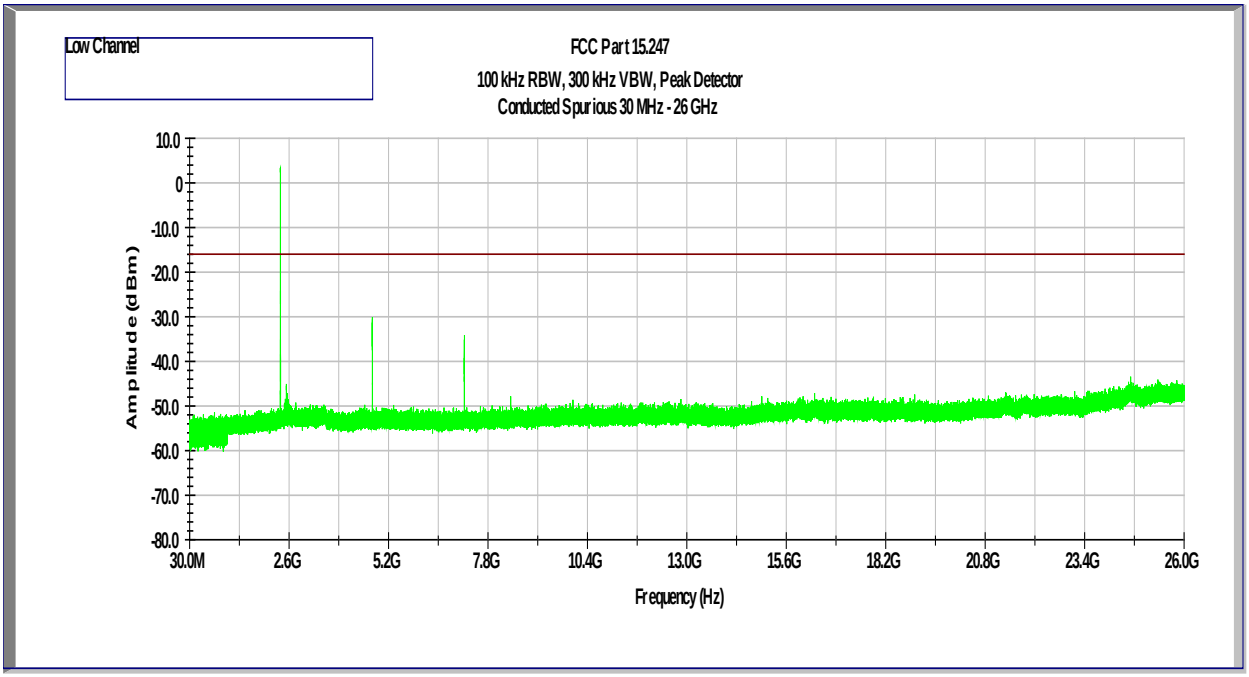
Tx @ Low Channel, 2400 MHz Band Edge
Plot 4.1



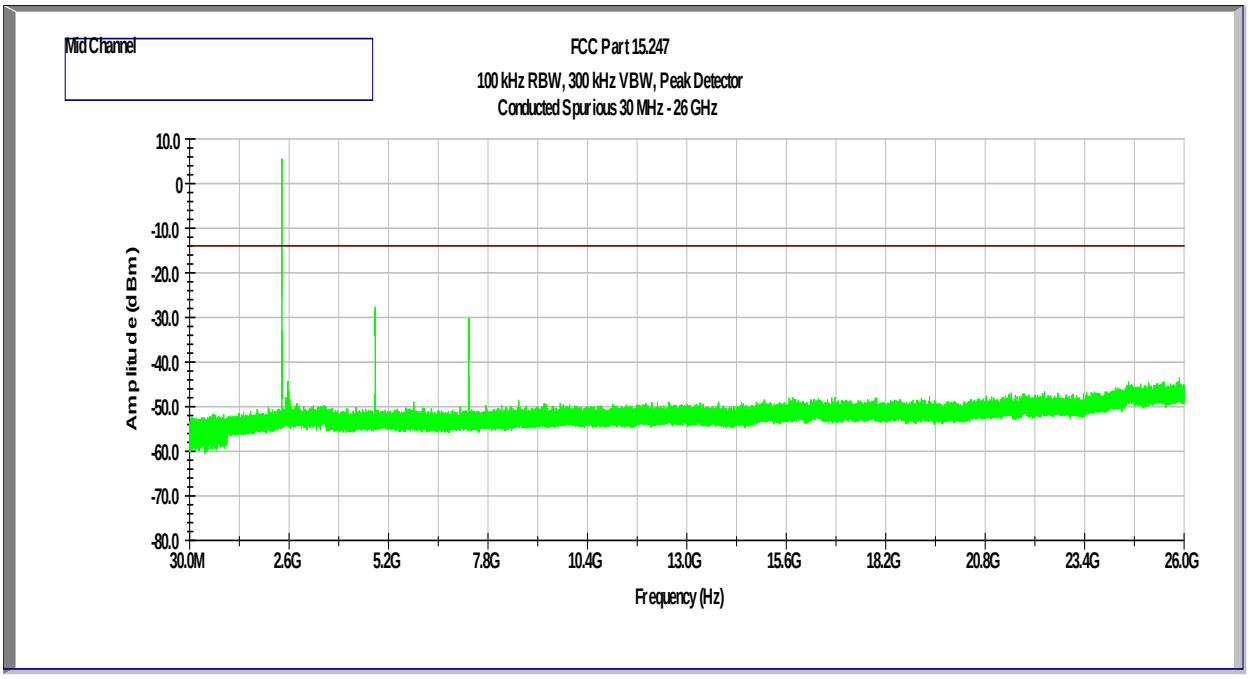
Tx @ Low Channel, 2483.5 MHz Band Edge
Plot 4.2



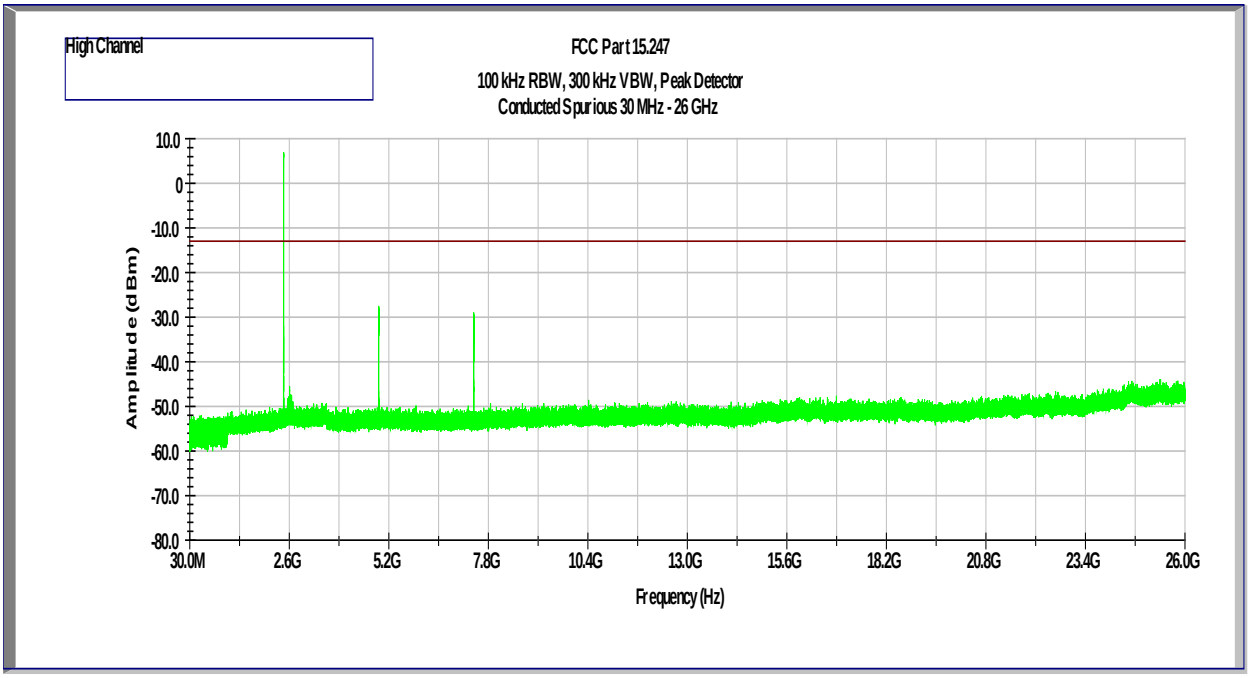
Tx @ Low Channel, 2402 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3



Tx @ Mid Channel, 2440 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 comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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).

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 1GHz scans & 1.5m for measurements made 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.

Guidance for Performing Compliance Measurements on DTS Operating under §15.247 refers to ANSI C63.10. In sec. 7.5 of ANSI C63.10 the procedure for determining the average value of pulsed emissions is described.
Following this procedure, the Peak Field Strength (FS_{peak}) is measured and the Duty Cycle Correction Factor (δ) is applied. The Duty Cycle is defined as transmitter time-on (t) in T=100 ms interval.

$$\delta = t/T \text{ or in decibels } \delta(dB) = 20 \text{ Log } \delta$$
$$FS_{average} \text{ [in dB}(\mu V/m)] = FS_{peak} \text{ [in dB}(\mu V/m)] + \delta(dB)$$

Unless other wises specified in test results below, radiated emissions are taken at 10 meters for frequencies below 1 GHz and at 3 meters for frequencies above 1 GHz.

Data included is representative 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(μV/m)
RA = Receiver Amplitude (including preamplifier) in dB(μV); 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(μV) 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(μV/m). This value in dB(μV/m) was converted to its corresponding level in μV/m.
RA = 52.0 dB(μV)
AF = 7.4 dB(1/m)
CF = 1.6 dB
AG = 29.0 dB
FS = 52.0+7.4+1.6-29.0 = 32 dB(μV/m).
Level in μV/m = Common Antilogarithm [(32 dBμV/m)/20] = 39.8 μV/m.

4.5.4 Test Results

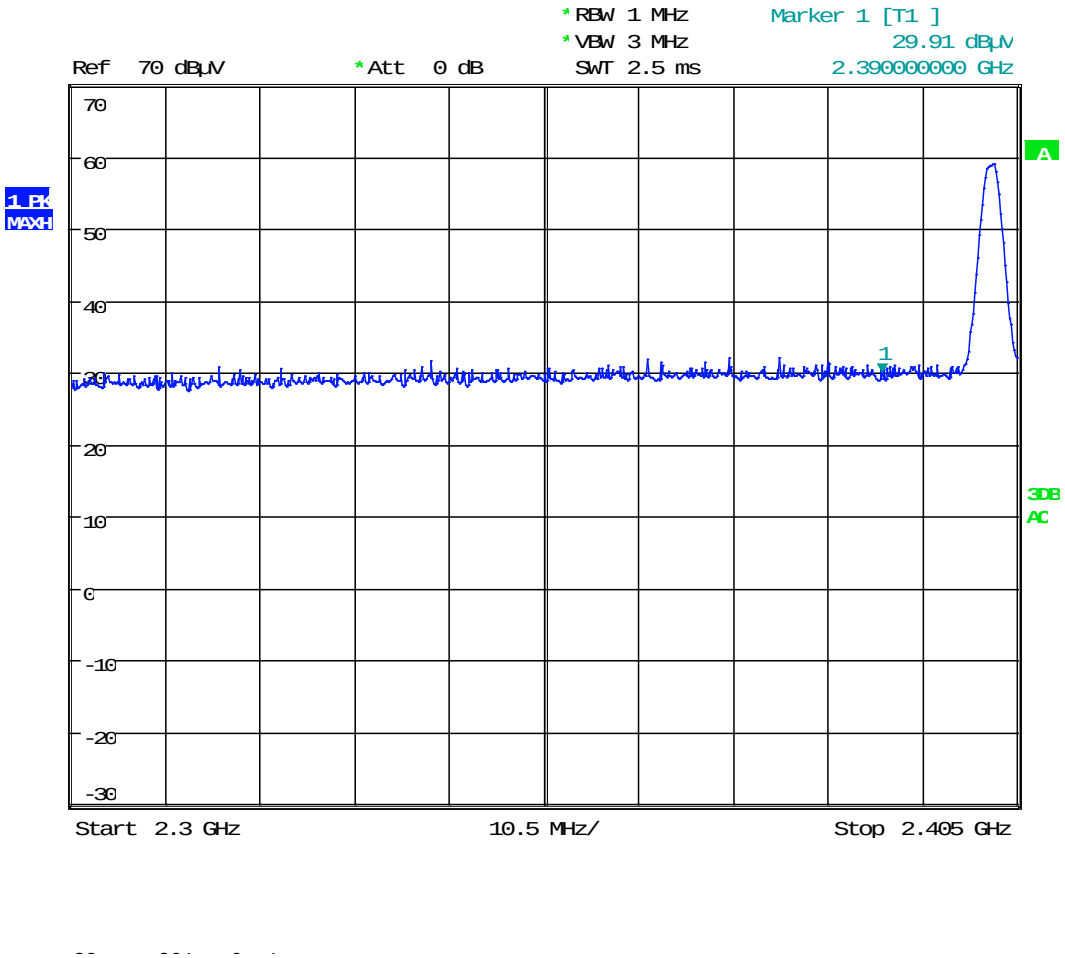
The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

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

Date of Test:	August 21 & 28, 2015
Results	**Complies**

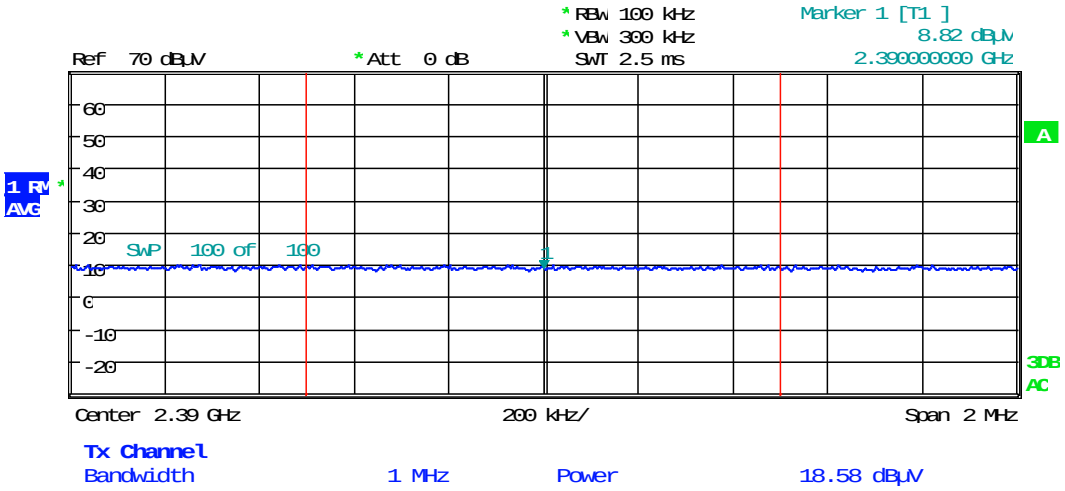
Test Results: 15.209/15.205 Restricted Band Emissions

Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2310–2390 MHz



Frequency	Detector	Raw Amplitude @ 3 m	Antenna Factor	CF + Attenuator	Corr. FS @ 3 m	Average FS Limit @ 3 m	Margin
MHz	Peak / Avg	dB(uV)	dB(1/m)	dB	dB(uV/m)	dB(uV/m)	dB
2390	Peak	29.9	28.2	1.6	59.7	74	-14.3

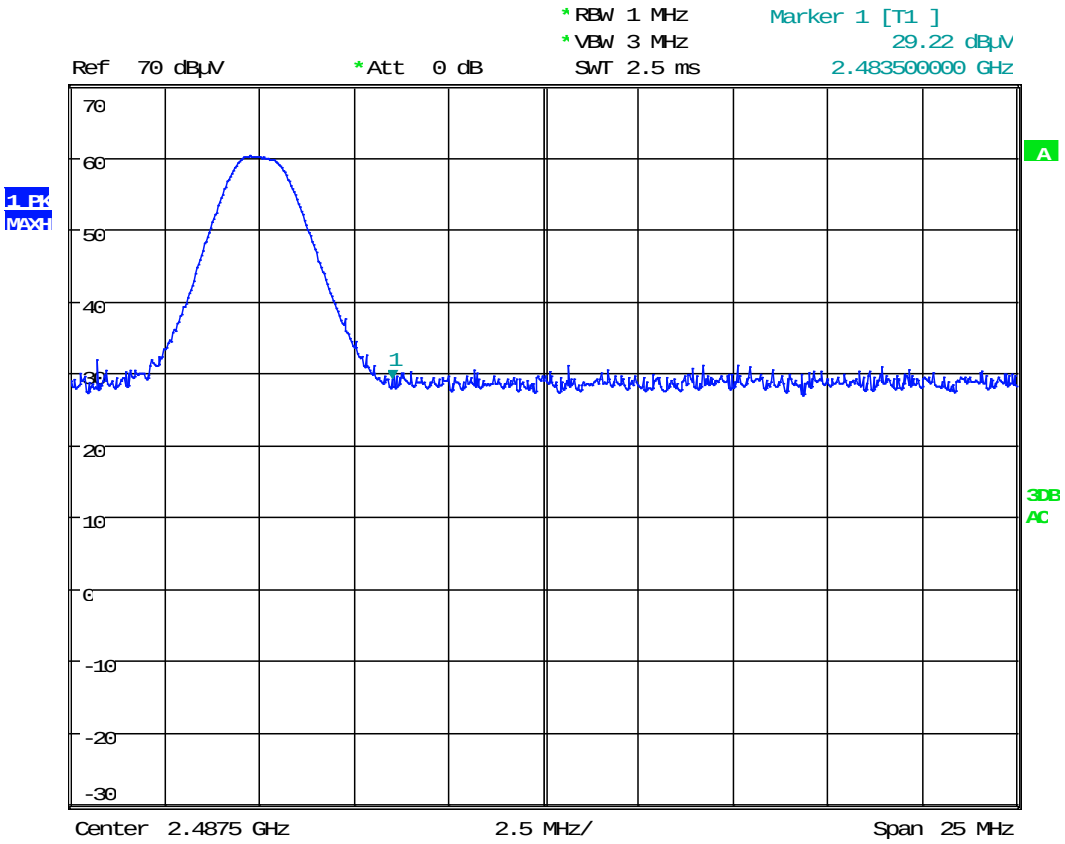
Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2310–2390 MHz



Frequency	Detector	Raw Amplitude @ 3 m	Antenna Factor	CF + Attenuator	δ(dB)*	Corr. FS @ 3 m	Average FS Limit @ 3 m	Margin
MHz	Peak / Avg	dB(uV)	dB(1/m)	dB	dB	dB(uV/m)	dB(uV/m)	dB
2390	Avg	18.6	28.2	1.6	2.2	50.6	54	-3.4

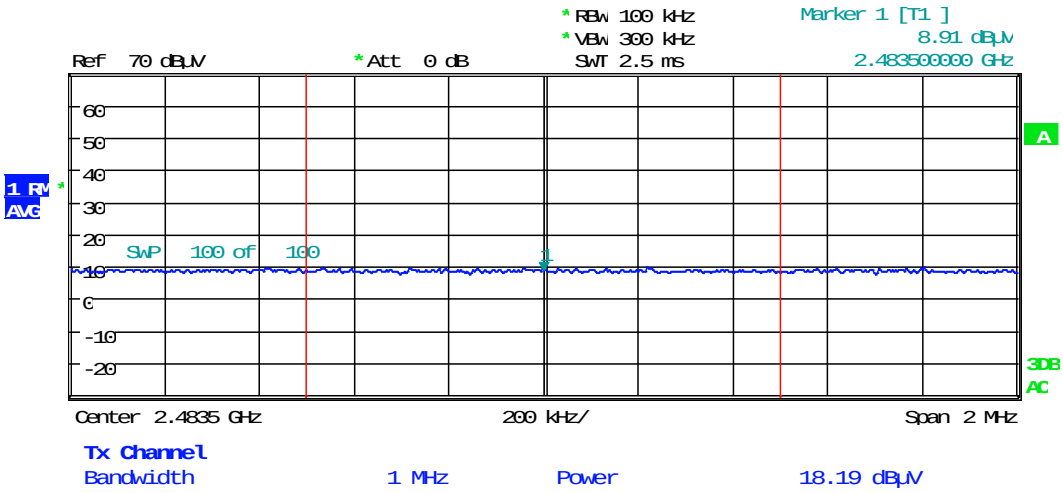
* **δ(dB) -** Duty Cycle Correction Factor. See Appendix A for Duty Cycle measurement and calculation. Duty cycle Correction Factor was applied for Average Field Strength (FS).

Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2483.5–2500 MHz



Frequency	Detector	Raw Amplitude @ 3 m	Antenna Factor	CF + Attenuator	Corr. FS @ 3 m	Average FS Limit @ 3 m	Margin
MHz	Peak / Avg	dB(uV)	dB(1/m)	dB	dB(uV/m)	dB(uV/m)	dB
2483.5	Peak	29.2	28.2	1.6	59	74	-15.0

Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2483.5–2500 MHz

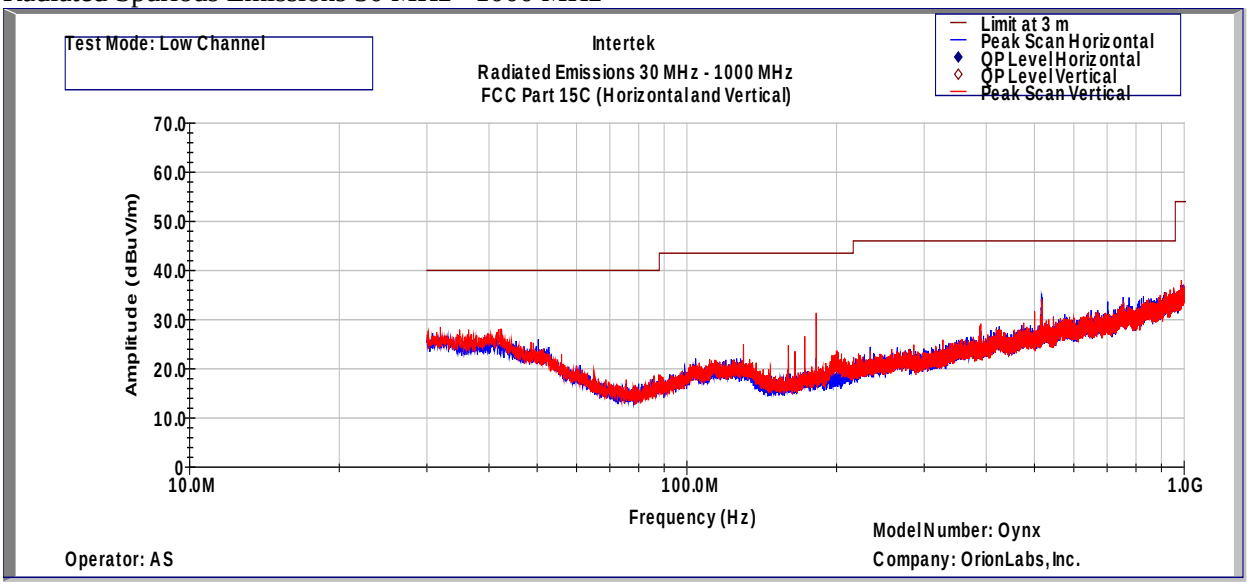


Frequency	Detector	Raw Amplitude @ 3 m	Antenna Factor	CF + Attenuator	δ(dB)*	Corr. FS @ 3 m	Average FS Limit @ 3 m	Margin
MHz	Peak / Avg	dB(uV)	dB(1/m)	dB	dB	dB(uV/m)	dB(uV/m)	dB
2483.5	Avg	18.2	28.2	1.6	2.2	50.2	54	-3.8

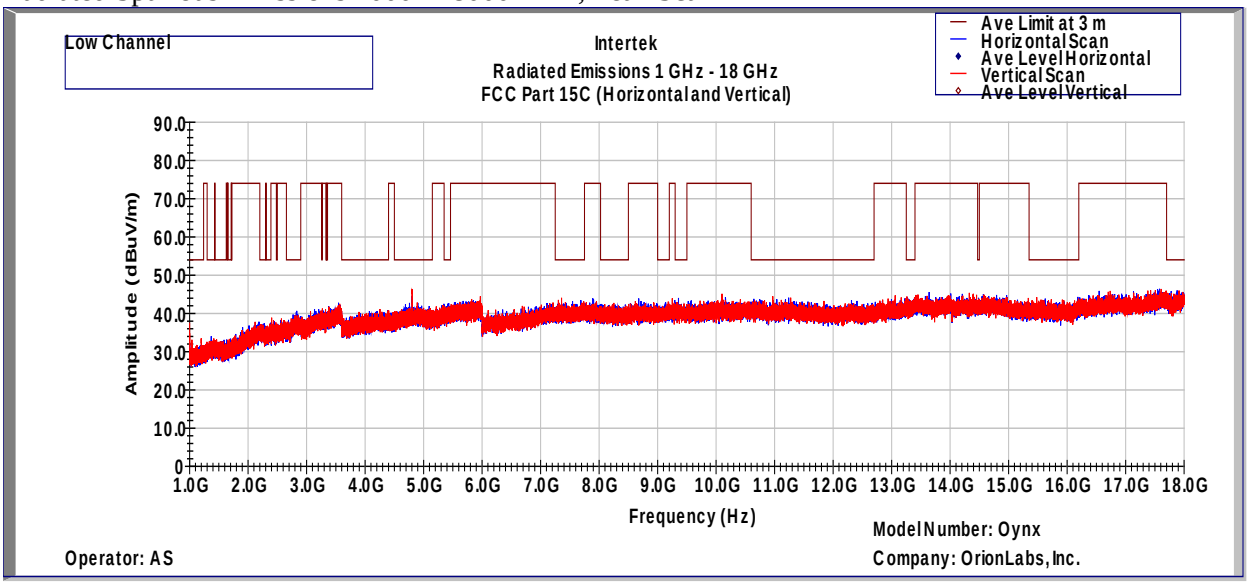
* **δ(dB) -** Duty Cycle Correction Factor. See Appendix A for Duty Cycle measurement and calculation. Duty cycle Correction Factor was applied for Average Field Strength (FS).

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan

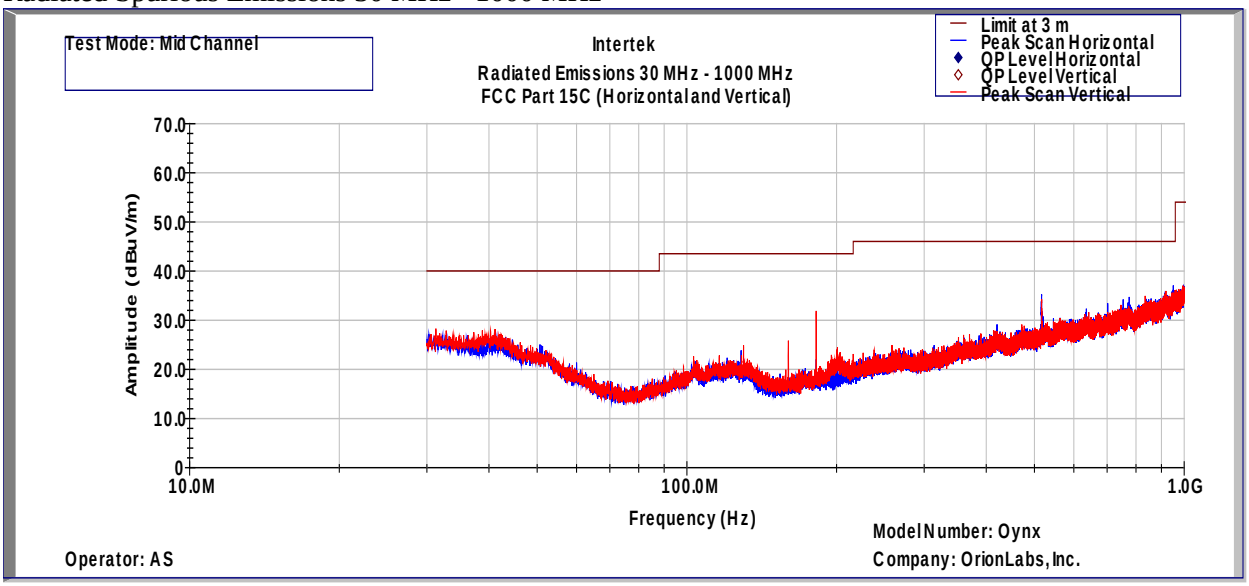


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

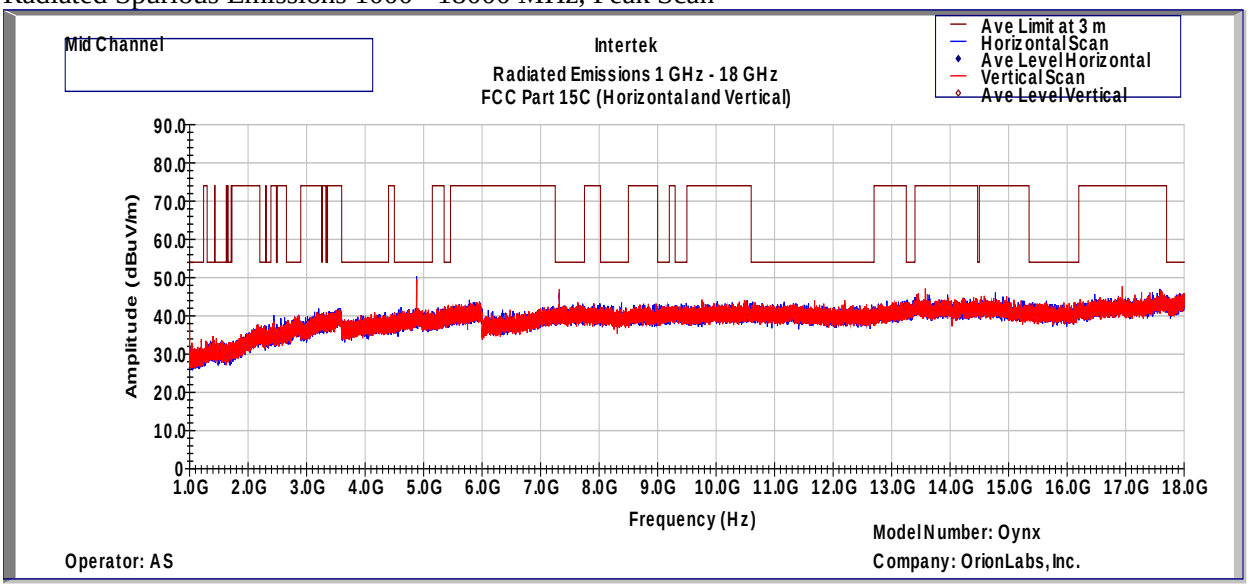
Note: FS@3m = RA + AF + δ + CF - Preamp, (Peak)
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan

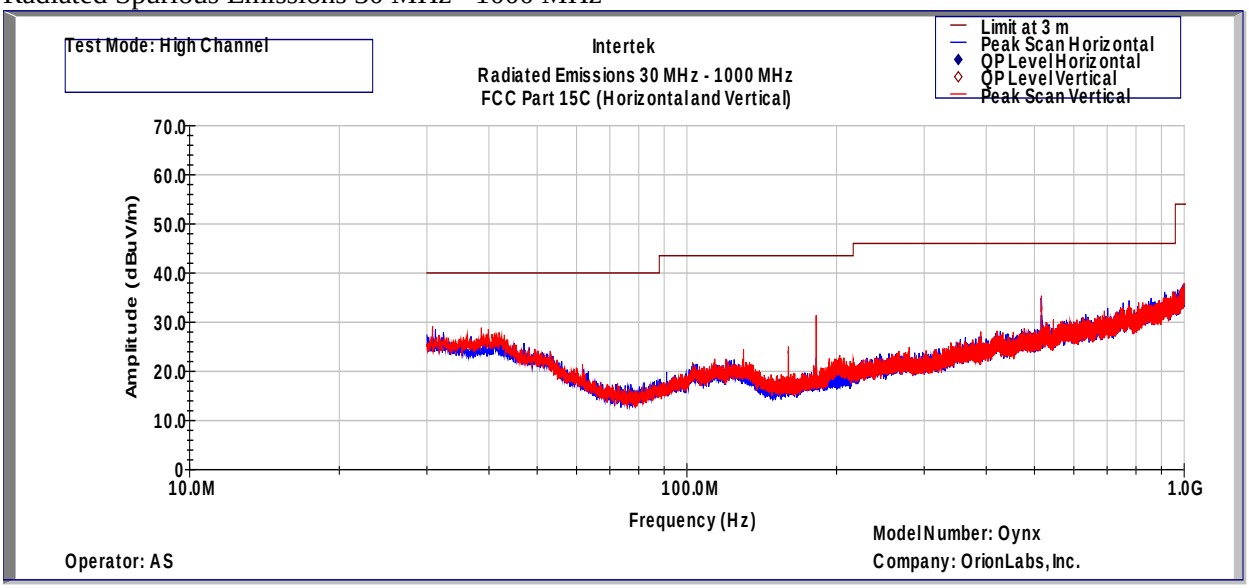


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

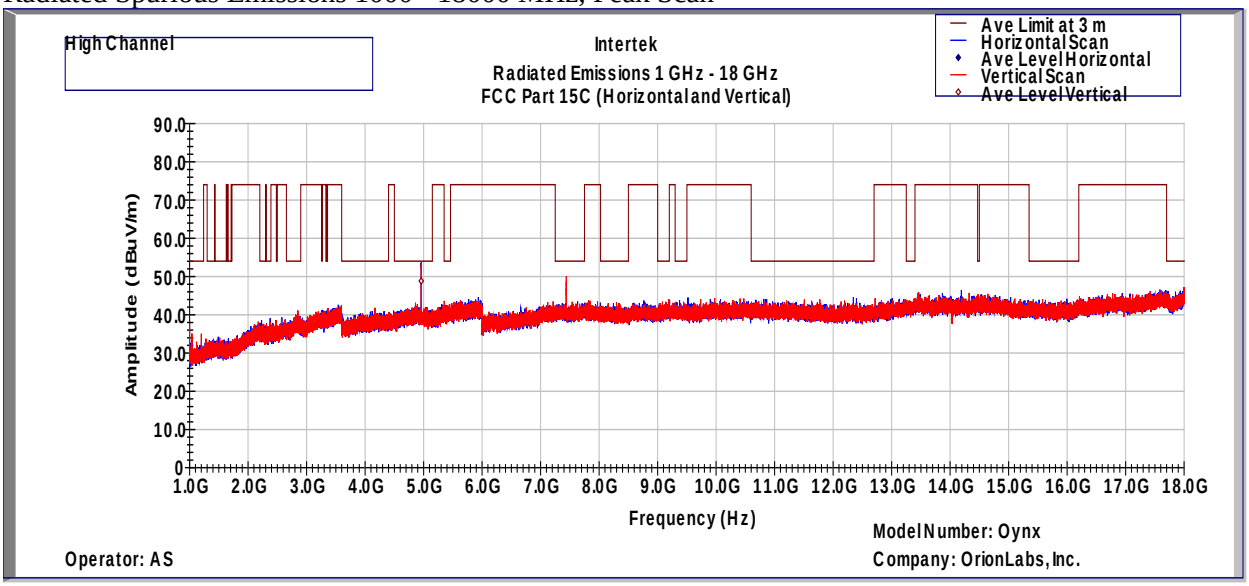
Note: FS@3m = RA + AF + δ + CF - Preamp, (Peak)
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



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

Frequency	Antenna Polarity	Detector	Raw Amplitude @ 3 m	Preamp	Antenna Factor	CF + Attenuator	δ(dB)*	Corr. FS @ 3 m	Average FS Limit @ 3 m	Margin
GHz	H/V	Peak / Avg	dB(uV)	dB	dB(1/m)	dB	dB	dB(uV/m)	dB(uV/m)	dB
4960.0	H	Avg	46.5	34.4	32.8	4.6	2.2	51.7	54	-2.3
4960.0	V	Avg	46.1	34.4	32.8	4.6	2.2	51.3	54	-2.7

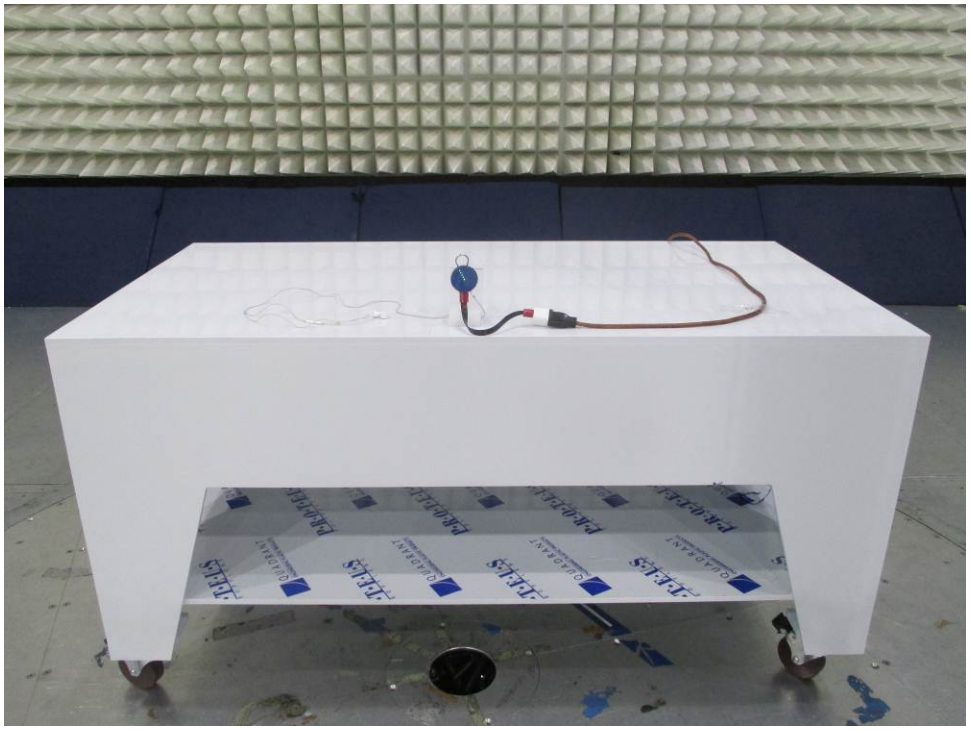
* **δ(dB) -** Duty Cycle Correction Factor. See Appendix A for Duty Cycle measurement and calculation. Duty cycle Correction Factor was applied for Average Field Strength (FS).

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

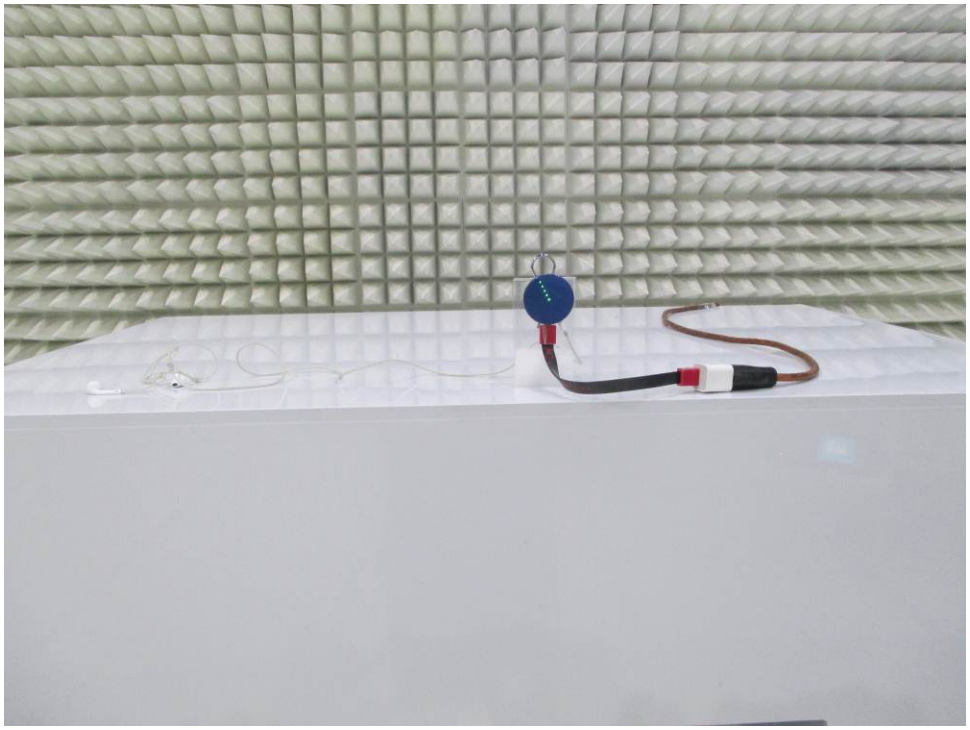
Results	**Complies**

4.5.5 Test setup photographs

The following photographs show the testing configurations used.



4.5.5 Test setup photographs (Continued)



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.

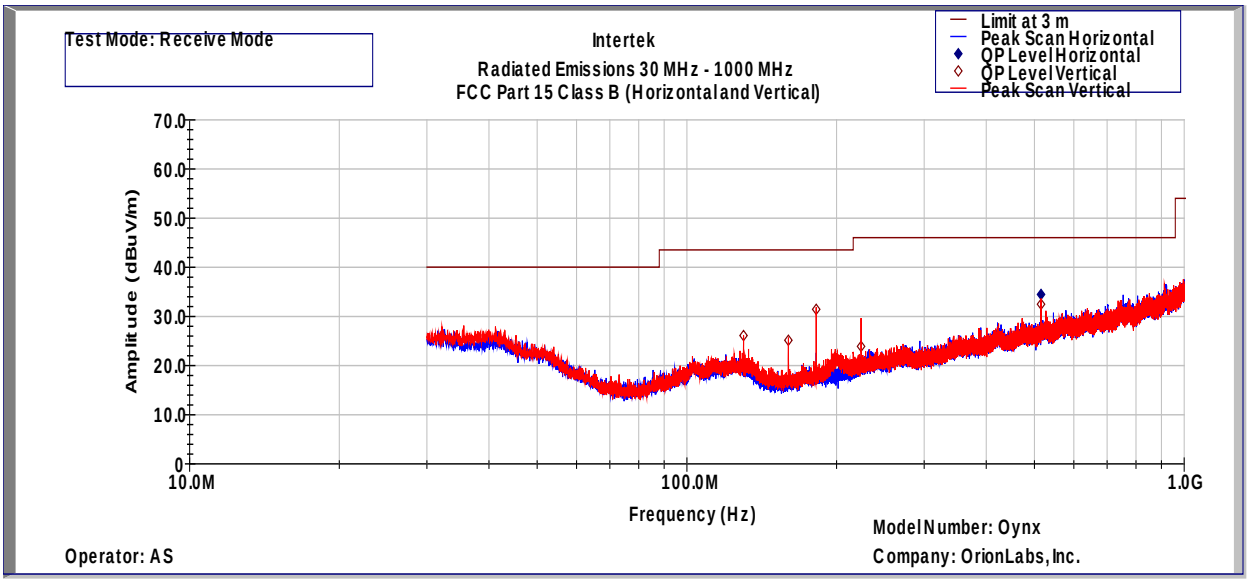
Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4 and EN 55022.

4.6.3 Test Results

The highest clock frequency used in the EUT is 72 MHz; therefor 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:	August 21, 2015
Results	**Complies**

Test Results: Radiated Emissions 30 MHz – 1000 MHz



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Vertical)

Model Number: Onyx
Company: Orion Labs, Inc.

FCC Part 15 Class B (QP-Vertical)										
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**
130.000	26.1	43.5	-17.4	35.1	1.2	32.0	10.5	11.3	314	102
160.000	25.1	43.5	-18.4	37.1	1.2	32.0	10.5	8.3	223	100
182.000	31.4	43.5	-12.1	42.3	1.2	32.0	10.5	9.4	195	100
224.000	23.9	46.0	-22.1	32.5	1.4	32.0	10.5	11.5	125	100
515.480	32.5	46.0	-13.5	34.2	2.5	32.1	10.5	17.3	295	110

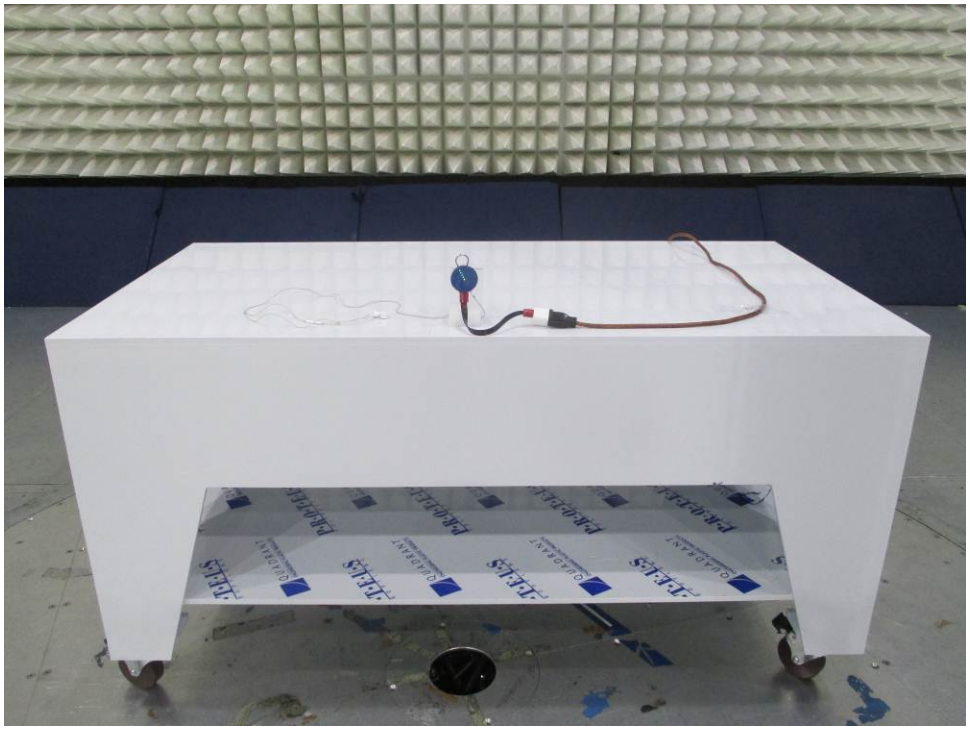
FCC Part 15 Class B (QP-Horizontal)										
Frequency	**Quasi Pk FS**	**Limit@3m**	**Margin**	**RA**	**CF**	**AG**	**DCF**	**AF**	**Azimuth**	**Height**
MHz	**dB(uV/m)**	**dB(uV/m)**	**dB**	**dB(uV)**	**dB**	**dB**	**dB**	**dB(1/m)**	**deg**	**cm**
515.480	34.5	46	-11.5	36.2	2.5	32.1	10.5	17.3	215	154

Test Mode: Charging Mode/Receive Mode
Temp.: 23C
Humidity: 51.6%

Result: **Complies** by 11.5 dB

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(μV)		Class A Limit dB(μV)	
	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.

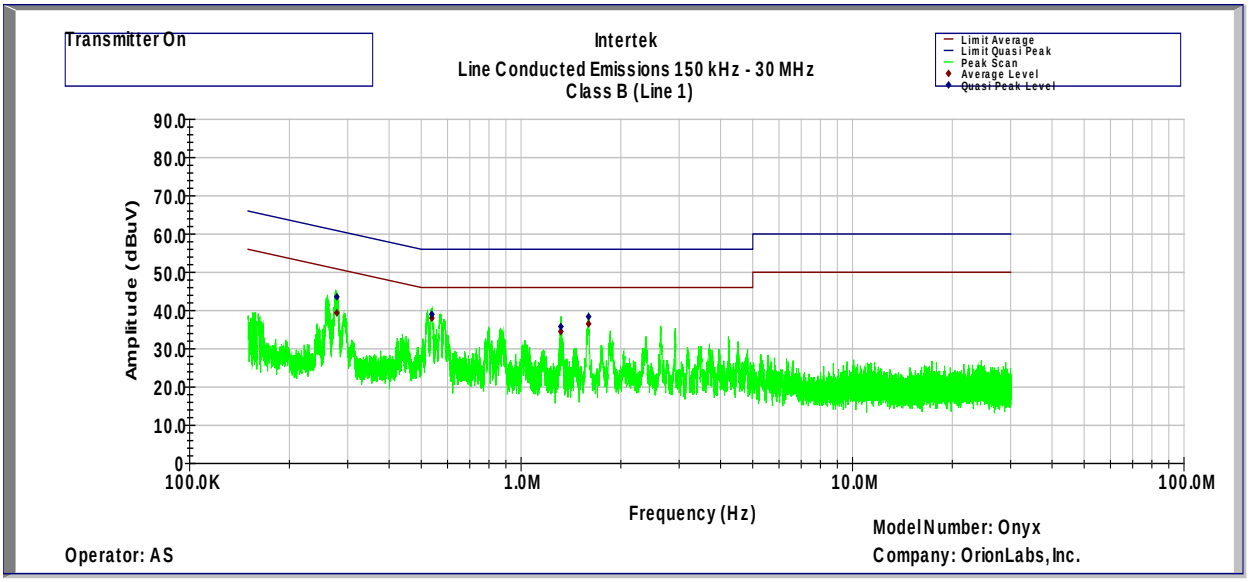
Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4.

4.7.3 Test Result

Date of Test:	August 21, 2015
Results	**Complies**

4.7.3 Test Result

AC Line Conducted Emission Data, EUT in transmitting mode



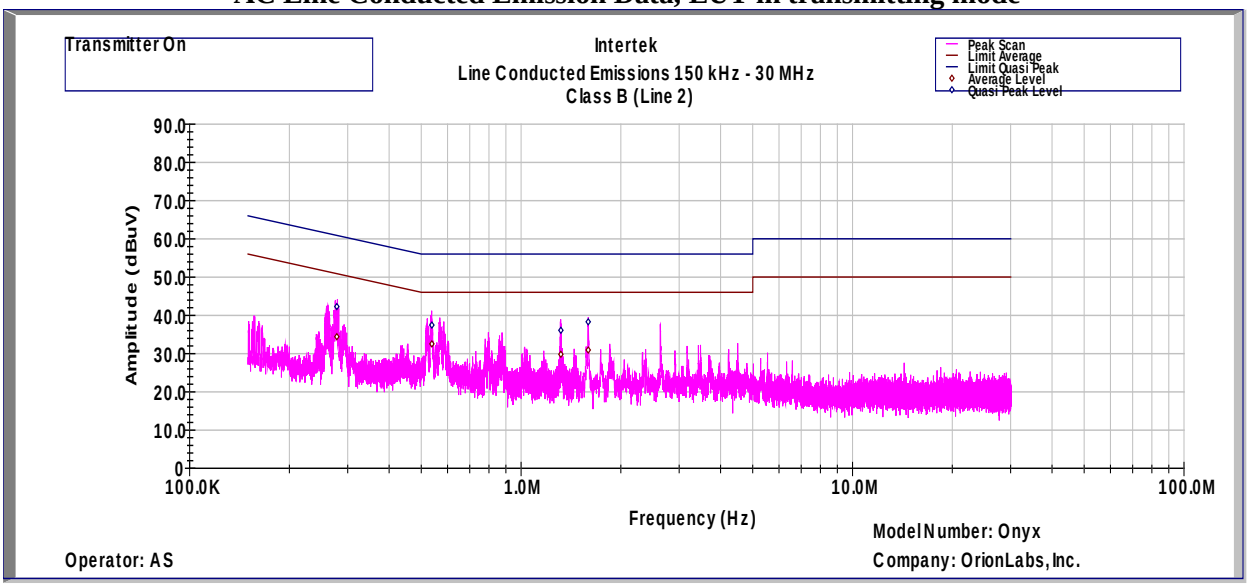
Intertek Testing Services
Line Conducted Emissions 150 kHz - 30 MHz
FCC Class B (Line 1)
Operator: AS

Model Number: Onyx
Company: Orion Labs, Inc.

Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
MHz	dBuV	dBuV	dBuV	dBuV	dB	dB
0.278	39.4	43.6	52.3	62.3	-12.9	-18.7
0.538	38.0	39.0	46.0	56.0	-8.0	-17.0
1.318	34.5	35.8	46.0	56.0	-11.5	-20.2
1.598	36.5	38.4	46.0	56.0	-9.5	-17.6

Test Mode: Transmitter On
Temp.: 23C
Humidity: 51.6%

AC Line Conducted Emission Data, EUT in transmitting mode



Intertek Testing Services
Line Conducted Emissions 150 kHz - 30 MHz
FCC Class B (Line 2)
Operator: AS

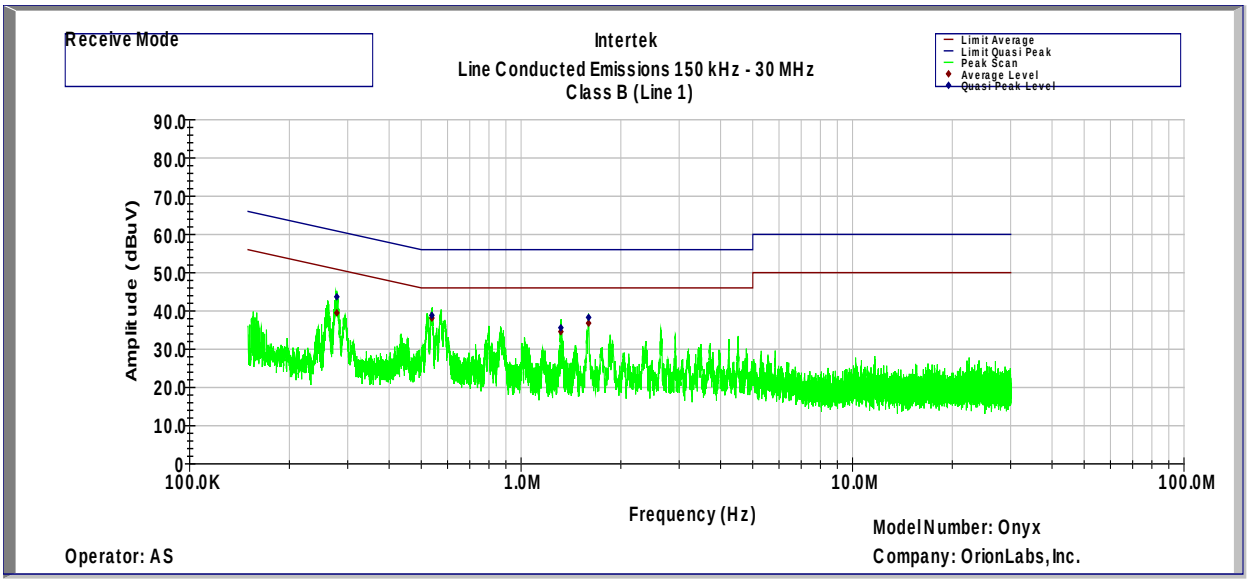
Model Number: Onyx
Company: Orion Labs, Inc.

Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
MHz	dBuV	dBuV	dBuV	dBuV	dB	dB
0.278	34.4	42.3	52.3	62.3	-17.9	-20.0
0.538	32.5	37.4	46.0	56.0	-13.5	-18.6
1.318	29.8	36.1	46.0	56.0	-16.2	-19.9
1.594	30.9	38.3	46.0	56.0	-15.1	-17.7

Test Mode: Transmitter On
Temp.: 23C
Humidity: 51.6%

Results	**Complies** by 8.0 dB

AC Line Conducted Emission Data, EUT in Receive mode



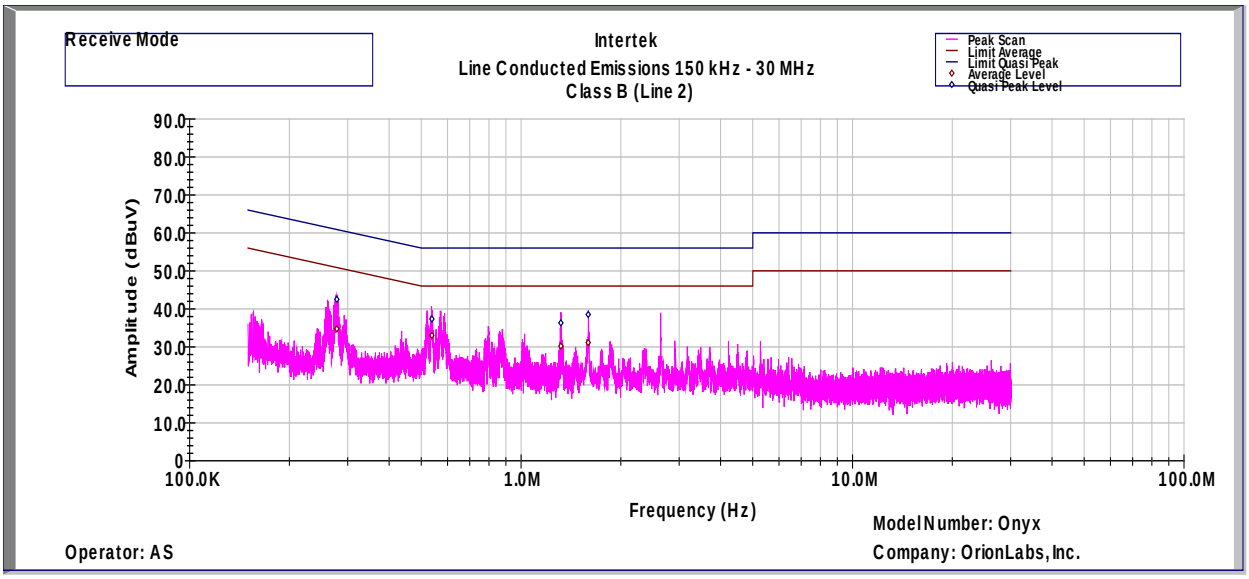
Intertek Testing Services
Line Conducted Emissions 150 kHz - 30 MHz
FCC Class B (Line 1)
Operator: AS

Model Number: Onyx
Company: Orion Labs, Inc.

Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
MHz	dBuV	dBuV	dBuV	dBuV	dB	dB
0.278	39.5	43.7	52.3	62.3	-12.8	-18.6
0.538	38.1	38.8	46.0	56.0	-7.9	-17.2
1.318	34.6	35.6	46.0	56.0	-11.4	-20.4
1.598	36.8	38.3	46.0	56.0	-9.2	-17.7

Test Mode: Receive Mode
Temp.: 23C
Humidity: 51.6%

AC Line Conducted Emission Data, EUT in Receive mode



Intertek Testing Services
Line Conducted Emissions 150 kHz - 30 MHz
FCC Class B (Line 2)
Operator: AS

Model Number: Onyx
Company: Orion Labs, Inc.

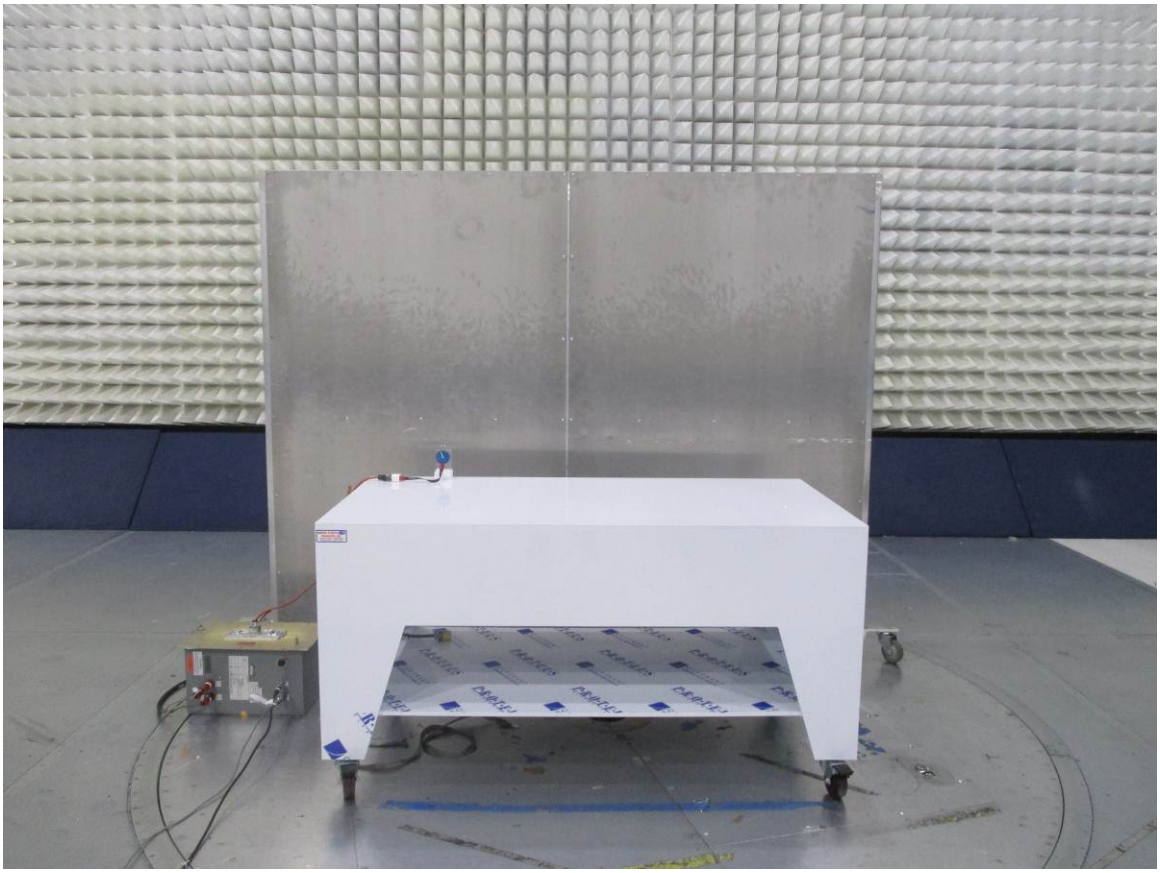
Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
MHz	dBuV	dBuV	dBuV	dBuV	dB	dB
0.278	34.7	42.5	52.3	62.3	-17.6	-19.8
0.538	33.0	37.3	46.0	56.0	-13.0	-18.7
1.318	30.2	36.3	46.0	56.0	-15.8	-19.7
1.594	31.1	38.5	46.0	56.0	-14.9	-17.5

Test Mode: Receive Mode
Temp.: 23C
Humidity: 51.6%

Results	**Complies** by 7.9 dB

4.7.4 Test Configuration Photographs

The following photographs show the testing configurations used.



5.0 RF Exposure

SAR test exclusion threshold formula according to FCC KDB 447898 D01 v05r02 is

$P^*\sqrt{f}/d < 3$

where
P is *max. power of channel, including tune-up tolerance, mW*
f is operating frequency in GHz
d is *min. test separation distance, mm*

The maximum measured conducted output power is 2.12 mW (3.26 dBm). The antenna gain, G is 1.72 dBi. Therefore, the maximum power of channel (P) is 2.12 mW.

At 5mm distance the condition for SAR exclusion threshold is

$2.12 \times \sqrt{2.480} \div 5 = 0.67$ which is less than 3.

Therefore, SAR testing is not required as the SAR Test Exclusion Threshold condition is satisfied.

Therefore, SAR testing is not required as the SAR Test Exclusion Threshold condition is satisfied.

SAR Exemption limit according to IC RSS-102 Issue 5, at 5 mm separation distance = 4 mW

Routine evaluation is not required since the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time averaged output power is below the exemption limit.

Date of Test:	August 27, 2015
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
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	12/16/15
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	11/10/15
BI-Log Antenna	Antenna Research	CBL 6111D	ITS 01058	12	11/21/15
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
Pre-Amplifier	Sonoma Instrument	310	ITS 00942	12	11/26/15
Pre-Amplifier (1-18GHz)	Miteq	AMF-4D-001180-24-10P	ITS 00526	12	10/01/15
Pre-Amplifier (18-40GHz)	Miteq	JSD44-18004000-305P	ITS 00921	12	06/18/16
Horn Antenna	ETS Lindgren	3115	ITS 00982	12	11/21/15
LISN	FCC	FCC-LISN-50-50-M-H	ITS 00552	12	09/04/15
Digital Barometer	Conex	JDB-1	ITS 00735	12	11/21/15
Hygro Thermometer	Control Co.	4085	ITS 00322	12	11/14/15

No Calibration required

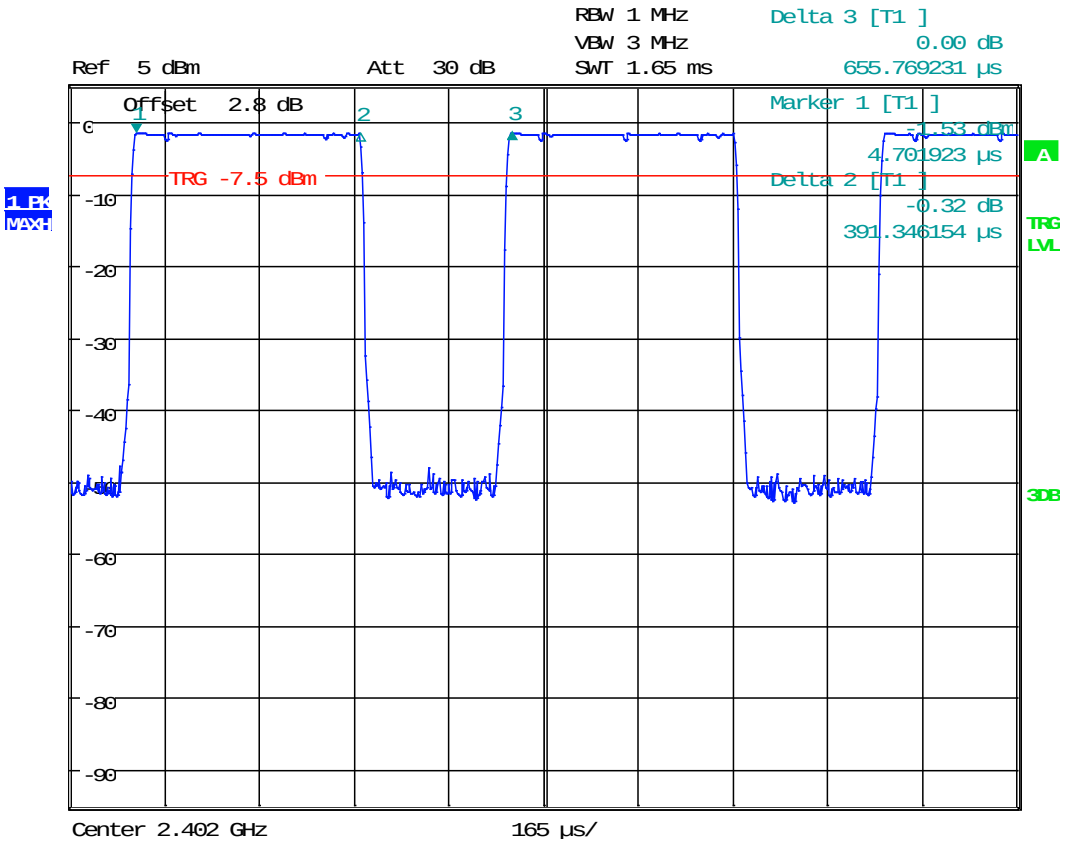
7.0 Document History

Revision/ Job Number	Writer Initials	Reviewers Initials	Date	Change
1.0 / G102078038	AS	KV	August 28, 2015	Original document

Annex A - Duty Cycle Measurement

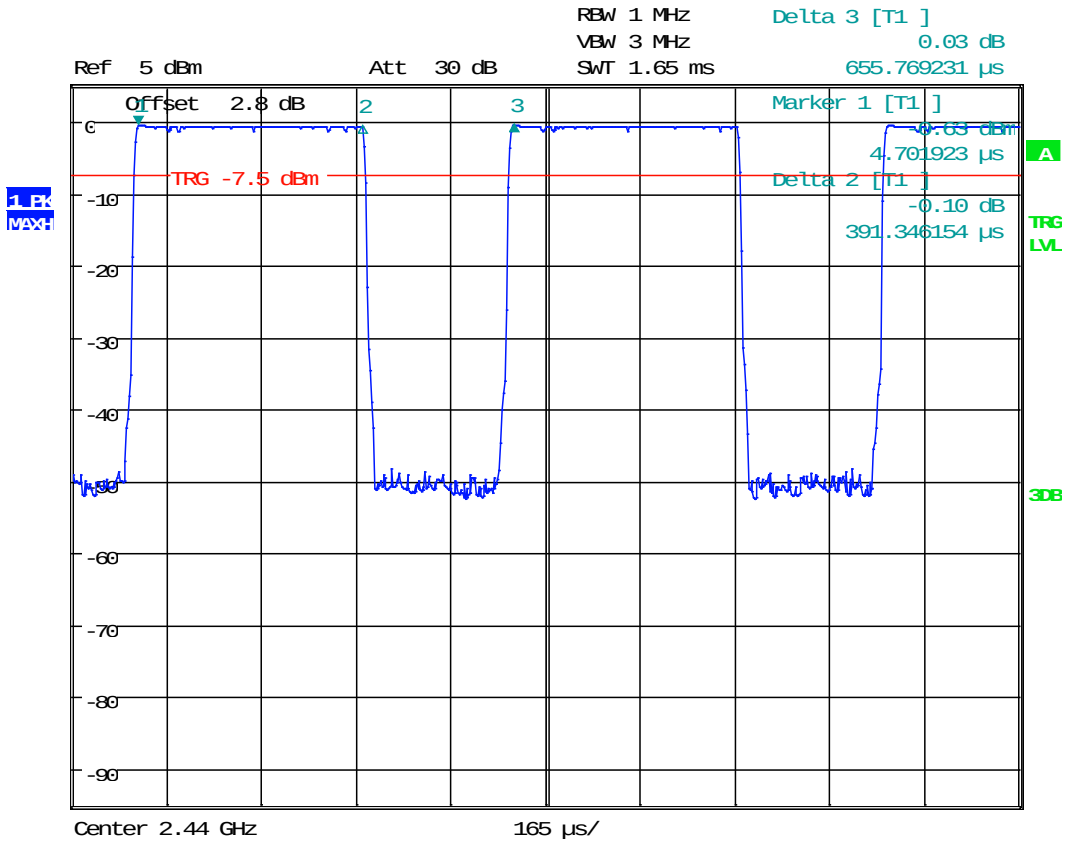
Date of Test:	August 21, 2015

Low Channel @ 2402 MHz



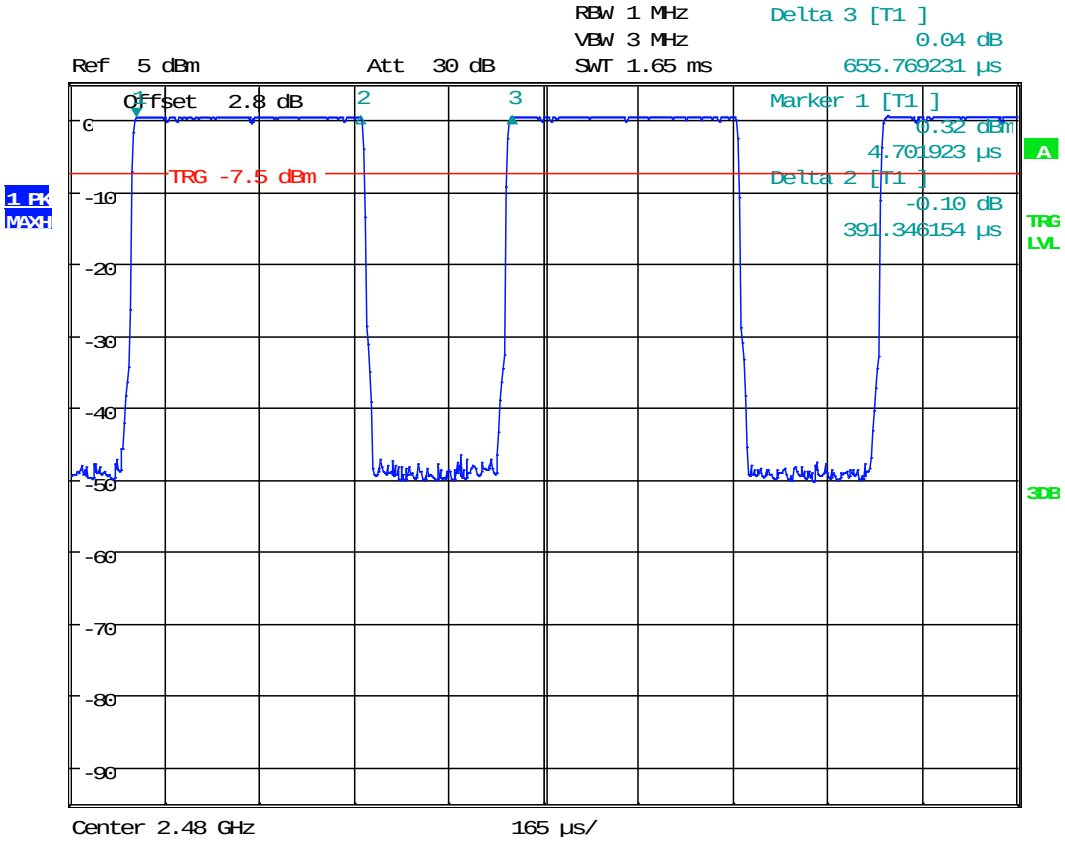
Duty Cycle: DC = 391.3 / 655.8 = 0.597 or 59.7%
Duty Cycle Correction Factor **δ (dB)** = 10 log (391.3 / 655.8) = 2.2dB

Mid Channel @ 2440 MHz



Duty Cycle: DC = 391.3 / 655.8 = 0.597 or 59.7%
Duty Cycle Correction Factor **δ (dB)** = 10 log (391.3 / 655.8) = 2.2dB

High Channel @ 2480 MHz



Duty Cycle: DC = 391.3 / 655.8 = 0.597 or 59.7%
Duty Cycle Correction Factor **δ (dB)** = 10 log (391.3 / 655.8) = 2.2dB