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Report On

Application for Grant of Equipment Authorization of the
OnRamp Wireless
Kite TRN-2013 Electric Meter Communications Module

FCC Part 15 Subpart C §15.247
IC RSS-Gen and RSS-210 Issue 8 December 2010

Report No. SC1300093 **January 2013**

REPORT ON	Radio Testing of the OnRamp Wireless Electric Meter Communications Module
TEST REPORT NUMBER	SC1300093
PREPARED FOR	OnRamp Wireless 10920 Via Frontera San Diego, CA 92127
CONTACT PERSON	Alain Charles Hardware Engineer (858) 592-6008 Alain.Charles@onrampwireless.com
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	Chip R. Fleury **Name** Authorized Signatory
DATED	January 24, 2012

CONTENTS

SECTION 1

REPORT SUMMARY

Radio Testing of the
OnRamp Wireless
Electric Meter Communications Module

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the OnRamp Wireless Electric Meter Communications Module to the requirements of FCC Part 15 Subpart C §15.247 and IC RSS-Gen and RSS-210 Issue 8 December 2010.

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	OnRamp Wireless
Model Name	Kite
Model Number(s)	TRN-2013
FCC ID Number	XTE-TRN-2013
IC Number	8655A-TRN-2013
Serial Number(s)	83820062
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2011). • RSS-210 - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment (Issue 8, December 2010). • RSS-Gen - General Requirements and Information for the Certification of Radio Apparatus (Issue 3, December 2010).
Start of Test	January 21, 2013
Finish of Test	January 24, 2013
Name of Engineer(s)	Ferdinand S. Custodio
Related Document(s)	• FCC KDB Publication Number 558074 D01 DTS Meas Guidance v02 (Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (10/04/2012)). • Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

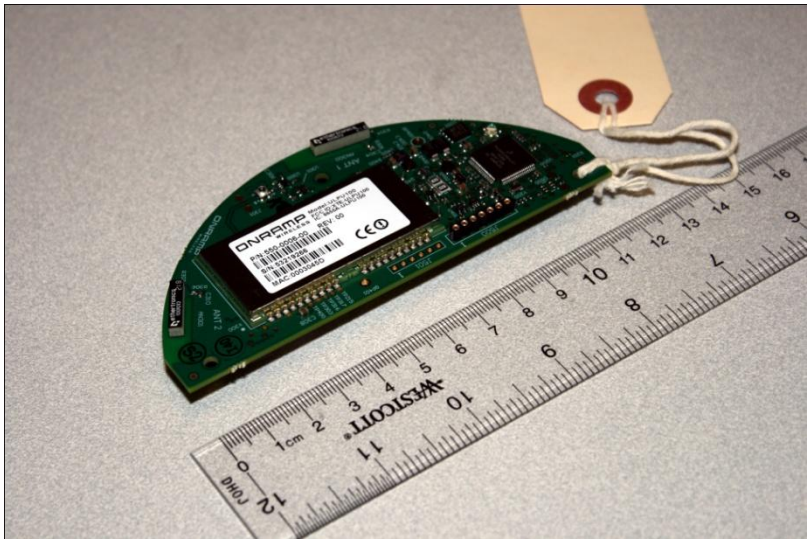
A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 with cross-reference to the corresponding IC RSS standard is shown below.

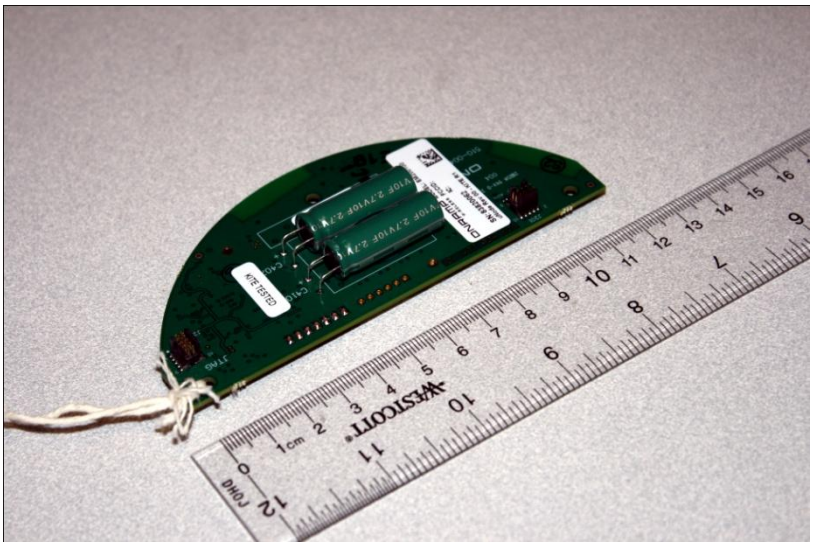
Section	§15.247 Spec Clause	RSS	Test Description	Result	Comments/ Base Standard
2.1	§15.247(b)(3)	RSS-210 A8.4 (4)	Peak Output Power	Compliant	
2.2	§15.207(a)	RSS-Gen 7.2.4	Conducted Emissions	Compliant	
2.3		RSS-Gen 4.6.1	99% Emission Bandwidth	Compliant	
2.4	§15.247(a)(2)	RSS-210 A8.2(a)	Minimum 6 dB RF Bandwidth	Compliant	
2.5	§15.247(d)	RSS-210 A8.5	Out-of-Band Emissions - Conducted	Compliant	
2.6	§15.247(d)	RSS-210 A8.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.7	§15.247(d)	RSS-210 A8.5	Spurious Radiated Emissions	Compliant	
2.7		RSS-Gen 4.10	Receiver Spurious Emissions	Compliant	
2.8	§15.247(e)	RSS-210 A8.2(b)	Power Spectral Density for Digitally Modulated Device	Compliant	

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was an OnRamp Wireless Kite Electric Meter Communications Module as shown in the photograph below. The EUT contains an OnRamp uNode RF module (XTE-ULPU100) along with a power supply, microprocessor, and two antennas. It is used in electric power meters to transmit and receive information from the power meter to an access point.





Equipment Under Test

1.3.2 EUT General Description

EUT Description	Electric Meter Communications Module
Model Number(s)	Kite
Rated Voltage	3.3VDC Nominal voltage.
Output Power	126mW (21.02 dBm) conducted 205mW(23.12 dBm) EIRP
Frequency Range	2402 MHz to 2475.63 MHz
Number of Operating Frequencies	38
Channels Verified	Channel 1 (Low Channel 2402 MHz) Channel 20 (Mid Channel 2439.81 MHz) Channel 38 (High Channel 2475.63 MHz)
Modulation Used	DSSS-DBPSK

1.3.3 Antenna Details

Model	Prestta™ Part No. 1001013
Manufacturer	ethertronics
Antenna Type	Isolated Magnetic Dipole (IMD).
Antenna Gain	2.1 dBi
Polarization	Linear
EUT Antenna Connector	Integral embedded antenna.
Maximum Dimensions	15.0x3.2x3.3mm
Mechanical Mounting	Antenna Assembly is Surface Mounted into main PCB
RF Mounting	RF and Ground feed pads are Surface Mounted into main PCB. No Ground Clearance is required under antenna

TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configurations	Description
A	EUT in transmit/receive mode transmitting through the integral antenna.
B	EUT in transmit mode transmitting through the antenna service port connected to a spectrum analyzer via a 20dB external attenuator.
C	EUT in transmit mode, EUT installed inside representative electric meter simulating real world installation and accurate AC conducted emissions profile.

1.4.2 EUT Exercise Software

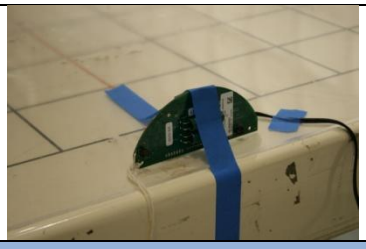
"Python Commands" software provided by the client was used to exercise the EUT. The line commands are typed and executed one at a time. Simplified example: Reset, Frequency, TX power, TX ON. Once set the EUT will continue in its configured mode until new commands are sent. Each time the EUT must change its channel, TX power, or mode (RX or TX), operator intervention is required to send commands.

1.4.3 Support Equipment and I/O cables

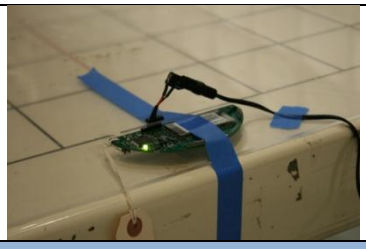
Manufacturer	Equipment/Cable	Description
Dell	Support Laptop	Latitude E5500 SN: GRMMMK1 36499111345
CUI Inc.	Support AC Adapter (Support Laptop)	Model 3A-211DN05 5VDC Output 4A
Volgen	Support AC Adapter (EUT)	Model KTPS10-03320WA 3.3VDC Output 2.0A
ULINX	Support USB to USB Isolator	Model UH401
Generic	Support USB to Serial Adapter	Model TTL-232RG
Vision Metering	Support Electric Meter	Model 10062810 Cat. 2E3K2P 240V CL200 3W FM2S Kh10.0 TA30

1.4.4 Worst Case Configuration

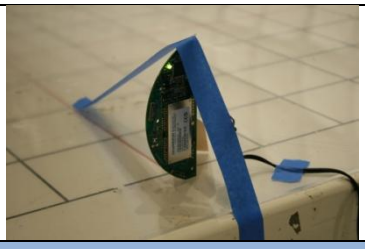
Worst-case configuration used in this test report based from Peak Output Power measurements: Low Channel (2402MHz @ 21.02dBm). For radiated measurements X, Y and Z orientations were verified. Worst case position is "X" which is the typical install position when inside an electric meter.



"X" Configuration



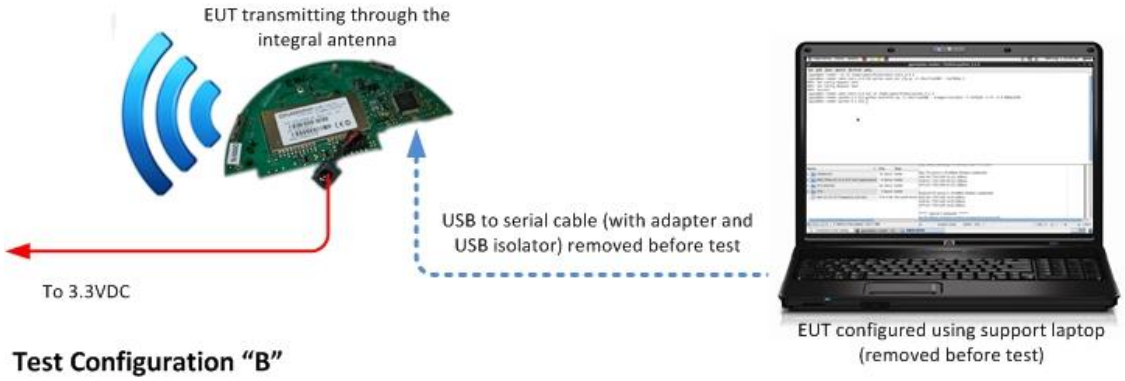
"Y" Configuration



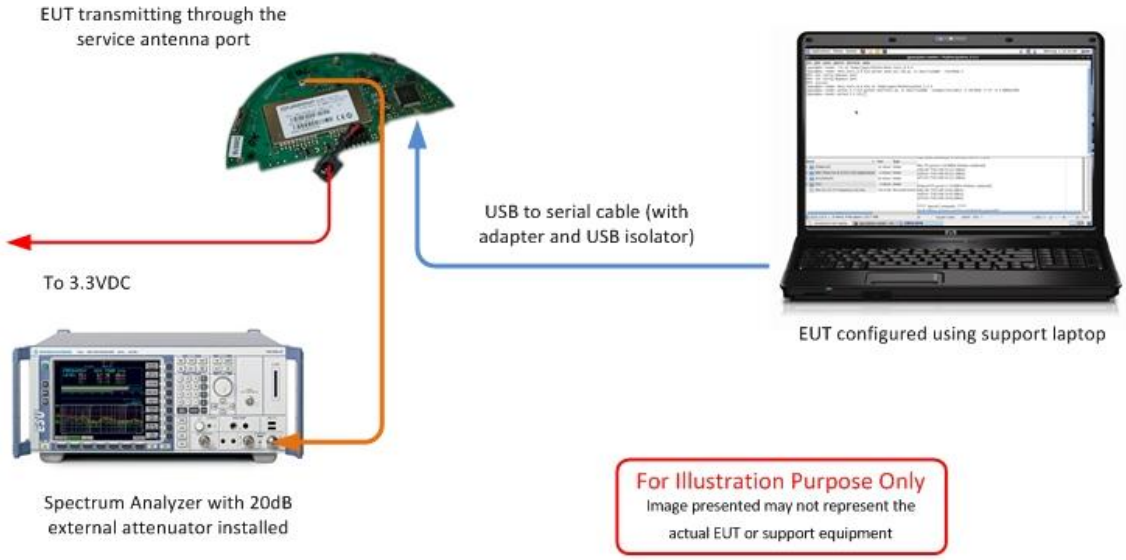
"Z" Configuration

1.4.5 Simplified Test Configuration Diagram

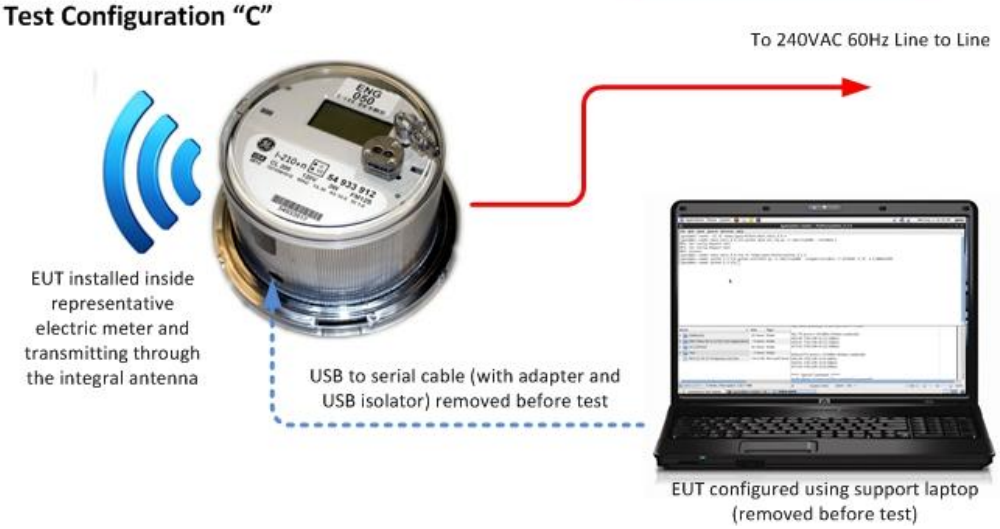
Test Configuration "A"



Test Configuration "B"



Test Configuration "C"



1.5 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number 83820062		
N/A		

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.4-2009, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.
For conducted and radiated emissions the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.4-2009. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY

1.8.1 FCC – Registration No.: US5296

TUV SUD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.498 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US5296.

1.8.2 Industry Canada (IC) Registration No.: 3067A

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego), has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No. 3067A.

SECTION 2

TEST DETAILS

Radio Testing of the
OnRamp Wireless
Electric Meter Communications Module

2.1 PEAK OUTPUT POWER

2.1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3)

2.1.2 Standard Applicable

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

2.1.3 Equipment Under Test and Modification State

Serial No: 83820062 / Test Configuration B

2.1.4 Date of Test/Initial of test personnel who performed the test

January 22, 2012/FSC

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions

Ambient Temperature	23.6°C
Relative Humidity	12.7%
ATM Pressure	99.4 kPa

2.1.7 Additional Observations

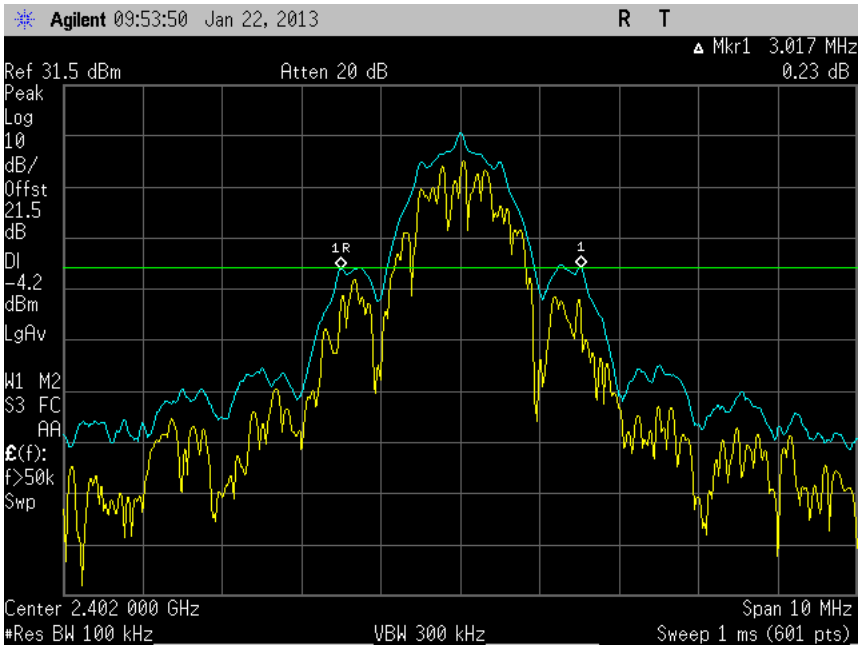
- This is a conducted test using Option 1 under Section 8.2.1 of FCC KDB Publication Number 558074 D01 DTS Meas Guidance v02(Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (10/04/2012)).
- An offset of 21.5dB was added to compensate for the external attenuator and cable used.
- EUT is configured to transmit continuously (100% duty cycle).
- Span was set to encompass the entire emission bandwidth of the signal.
- RBW=1MHz while VBW=3MHz.
- Measurement points verified > 2X span/RBW. 601 points > 10.
- Sweep time = auto couple.

- Detector = power averaging (RMS).
- Trace was averaged 100 times in power averaging mode.
- Power was measured using the spectrum analyzer built-in power measurement function by integrating the spectrum across the 26 dB emission bandwidth of the signal.
- Measured 26 dB emission bandwidth of the EUT is 3.017MHz.

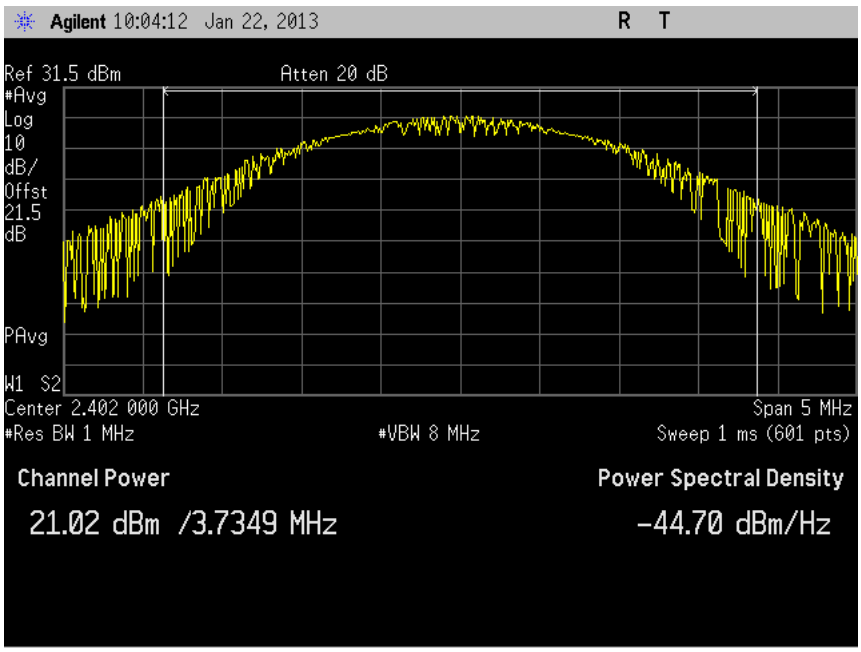
2.1.8 Test Results

See attached table and plots

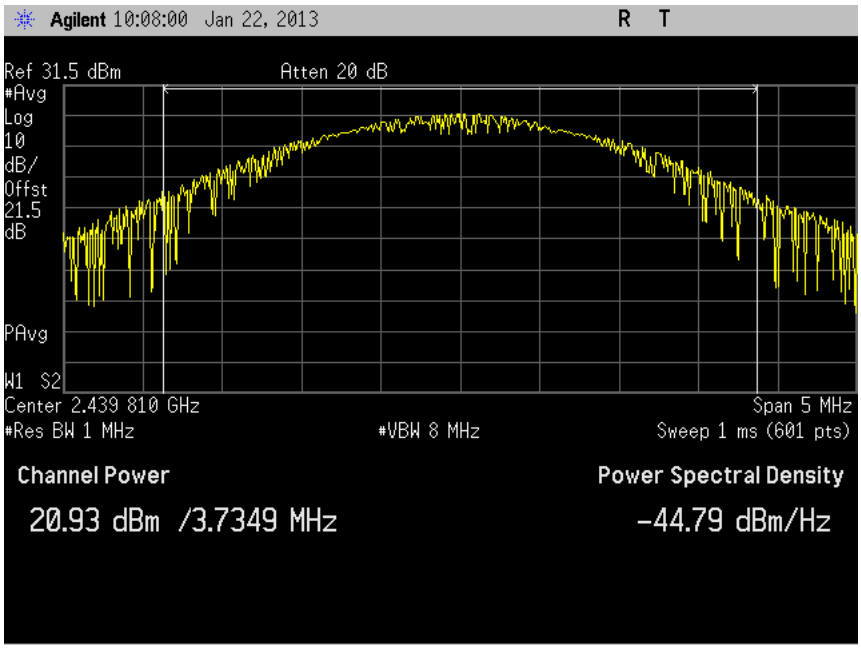
Low Channel (2402 MHz)	Mid Channel (2439.81 MHz)	High Channel (2475.63 MHz)
21.02 dBm	20.93 dBm	20.82 dBm
EUT complies with 30 dBm limit (maximum conducted output power)		



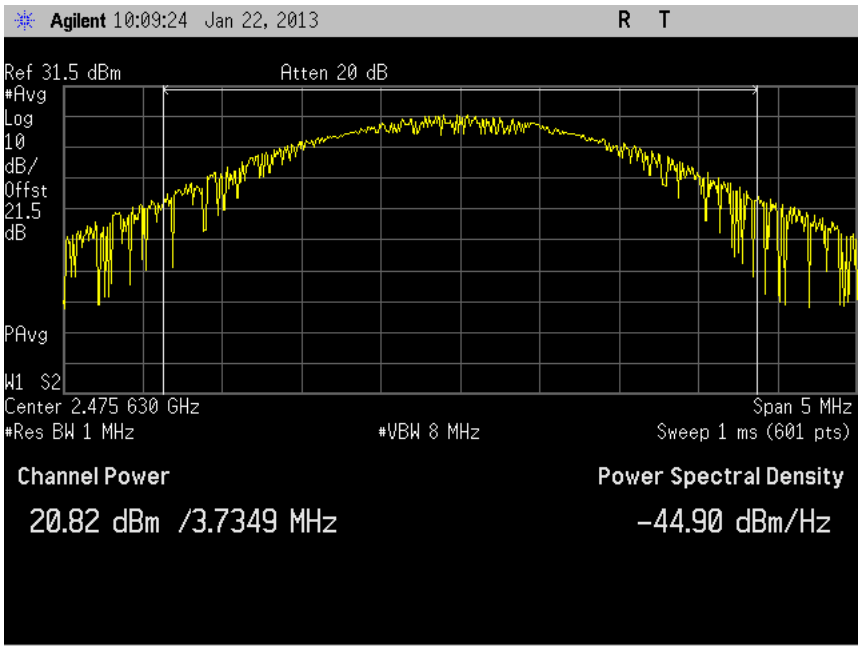
EUT EBW (26 dB BW) = 3.017MHz



Low Channel (2402 MHz)



Mid Channel (2439.81 MHz)



High Channel (2475.63 MHz)

2.2 CONDUCTED EMISSIONS

2.2.1 Specification Reference

Part 15 Subpart C §15.207(a)

2.2.2 Standard Applicable

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

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

**Decreases with the logarithm of the frequency.*

2.2.3 Equipment Under Test and Modification State

Serial No: 83820062 / Test Configuration C

2.2.4 Date of Test/Initial of test personnel who performed the test

January 23, 2012/FSC

2.2.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions

Ambient Temperature	25.3°C
Relative Humidity	20.2%
ATM Pressure	99.3 kPa

2.2.7 Additional Observations

- The EUT is a RF board and is not AC powered.
- To show general compliance to the present requirement, the EUT was installed inside an electric meter representing real world installation.
- The EUT was set to transmit mode. Only the worst channel presented.

- Measurement was done using Teseq Compliance 5 V5.26.43 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.2.8 for sample computation.

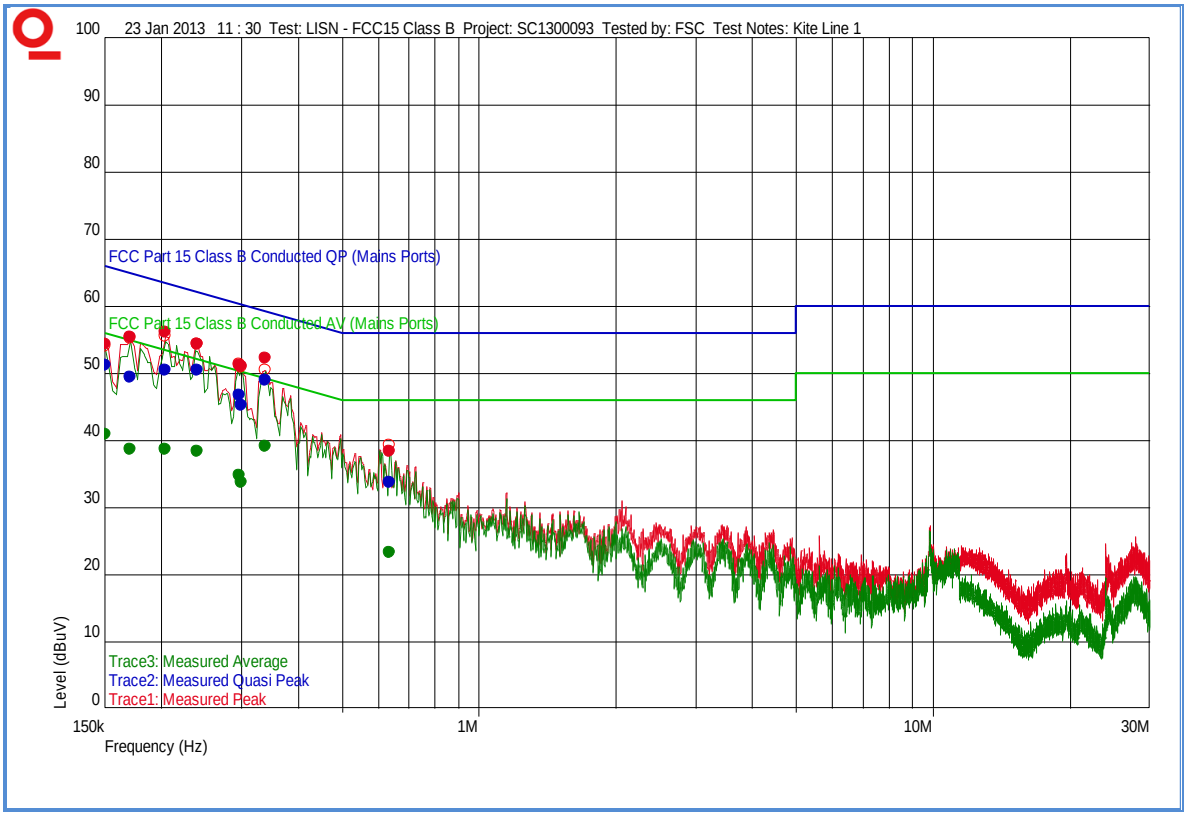
2.2.8 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (dbµV) @ 150kHz			5.5
Correction Factor (dB)	Asset# 8607 (20 dB attenuator)	19.9	20.7
	Asset# 1177 (cable)	0.15	
	Asset# 1176 (cable)	0.35	
	Asset# 7567 (LISN)	0.30	
Reported QuasiPeak Final Measurement (dbµV) @ 150kHz			**26.2**

2.2.9 Test Results

Compliant. See attached plots and tables.

2.2.10 Line 1 (Phase A)



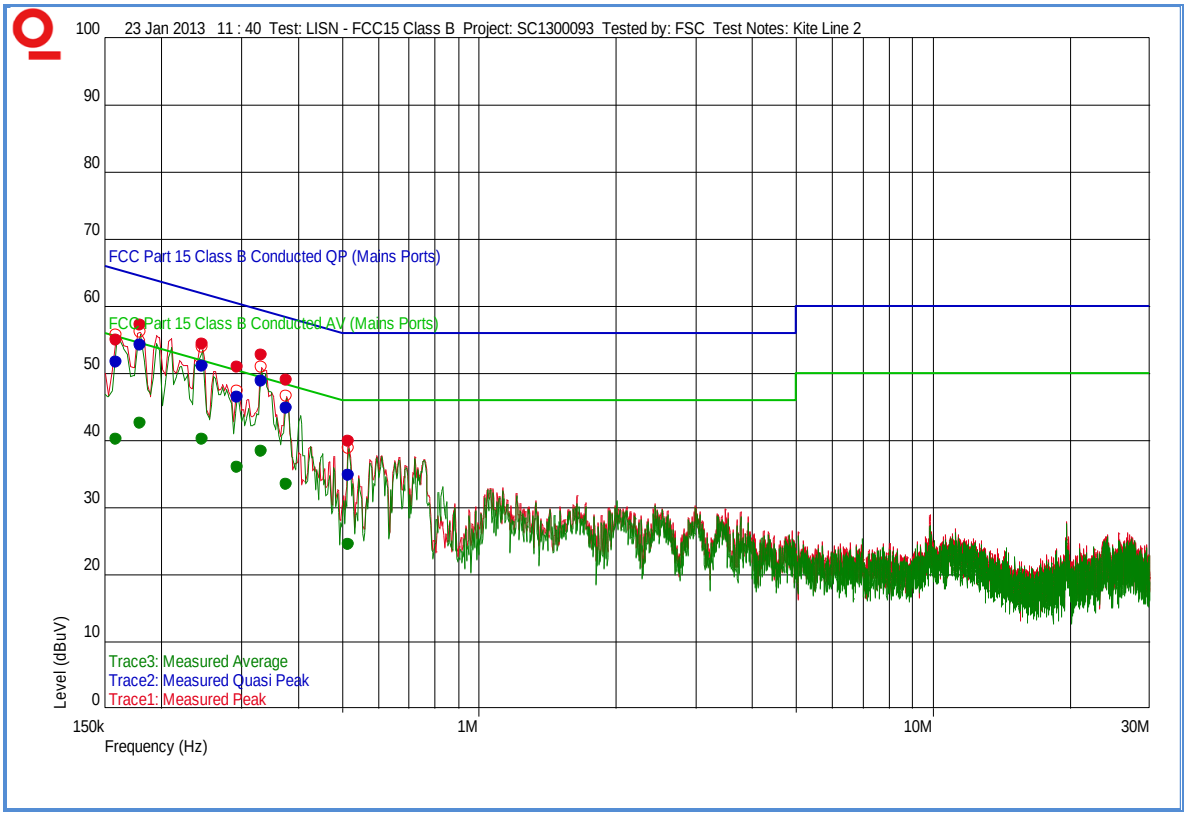
Quasi Peak

Frequency (Hz)	Level(dBuV)	TF	PA+CL	Limit (dBuV)	Margin (dBuV)	RBW(Hz)	LINE
636.0 k	33.88	0.000	20.834	56.000	-22.12	9 k	L1
171.0 k	49.54	0.258	21.051	64.912	-15.37	9 k	L1
300.0 k	45.29	0.100	21.006	60.243	-14.96	9 k	L1
150.0 k	51.31	0.300	21.058	66.000	-14.69	9 k	L1
297.0 k	46.75	0.103	21.007	60.326	-13.57	9 k	L1
204.0 k	50.58	0.196	21.040	63.446	-12.87	9 k	L1

Average

Frequency (Hz)	Level(dBuV)	TF	PA+CL	Limit (dBuV)	Margin (dBuV)	RBW(Hz)	LINE
636.0 k	23.39	0.000	20.834	46.000	-22.61	9 k	L1
300.0 k	33.82	0.100	21.006	50.243	-16.42	9 k	L1
171.0 k	38.78	0.258	21.051	54.912	-16.13	9 k	L1
297.0 k	34.90	0.103	21.007	50.326	-15.42	9 k	L1
150.0 k	41.02	0.300	21.058	56.000	-14.98	9 k	L1
204.0 k	38.66	0.196	21.040	53.446	-14.78	9 k	L1

2.2.11 Line 2 (Phase B)



Quasi Peak

Frequency (Hz)	Level(dBuV)	TF	PA+CL	Limit (dBuV)	Margin (dBuV)	RBW(Hz)	LINE
517.155 k	34.84	0.083	20.931	56.000	-21.16	9 k	N
293.28 k	46.54	0.107	21.009	60.431	-13.89	9 k	N
158.955 k	51.66	0.282	21.055	65.518	-13.86	9 k	N
376.86 k	44.83	0.100	20.902	58.348	-13.51	9 k	N
245.52 k	51.11	0.154	20.955	61.907	-10.80	9 k	N
332.085 k	48.94	0.100	20.895	59.399	-10.46	9 k	N

Average

Frequency (Hz)	Level(dBuV)	TF	PA+CL	Limit (dBuV)	Margin (dBuV)	RBW(Hz)	LINE
517.155 k	24.56	0.083	20.931	46.000	-21.44	9 k	N
158.955 k	40.24	0.282	21.055	55.518	-15.28	9 k	N
376.86 k	33.46	0.100	20.902	48.348	-14.89	9 k	N
293.28 k	36.10	0.107	21.009	50.431	-14.33	9 k	N
179.85 k	42.62	0.240	21.048	54.493	-11.87	9 k	N
245.52 k	40.21	0.154	20.955	51.907	-11.70	9 k	N

2.3 99% EMISSION BANDWIDTH

2.3.1 Specification Reference

RSS-Gen Clause 4.6.1

2.3.2 Standard Applicable

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.
The transmitter shall be operated at its maximum carrier power measured under normal test conditions. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.
The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth.

2.3.3 Equipment Under Test and Modification State

Serial No: 83820062 / Test Configuration B

2.3.4 Date of Test/Initial of test personnel who performed the test

January 22, 2012/FSC

2.3.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.6 Environmental Conditions

Ambient Temperature	23.6°C
Relative Humidity	12.7%
ATM Pressure	99.4 kPa

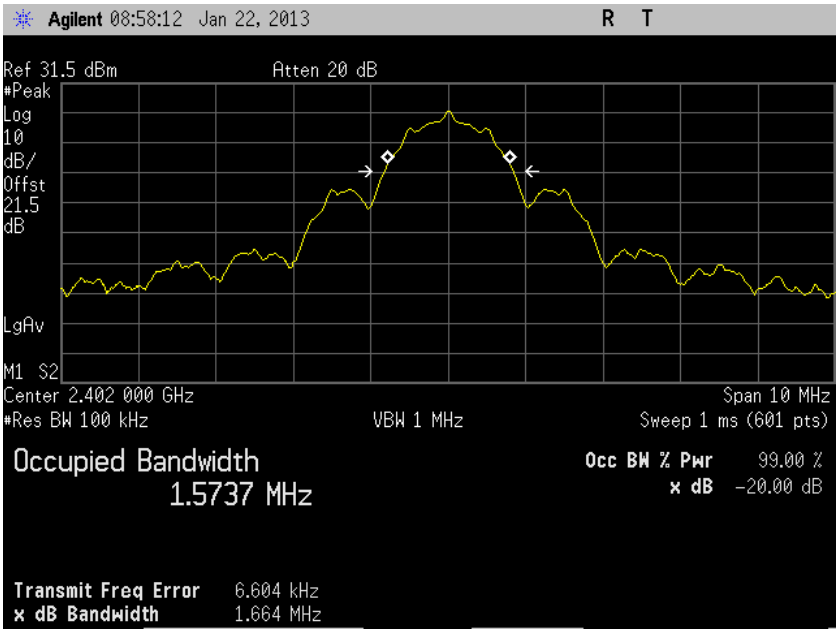
2.3.7 Additional Observations

- This is a conducted test.
- An offset of 21.5dB was added to compensate for the external attenuator and cable used.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.
- Sweep is auto.

- Detector is peak.
- Trace is set to max hold.
- Trace was allowed to stabilize.
- The % Power Bandwidth setting in the spectrum analyzer was set to 99% (default).
- The automatic bandwidth measurement capability of a spectrum analyzer was employed using the X dB bandwidth mode with X set to 20 dB (Not required under Part 15 Subpart C §15.227. For reporting purposes only).

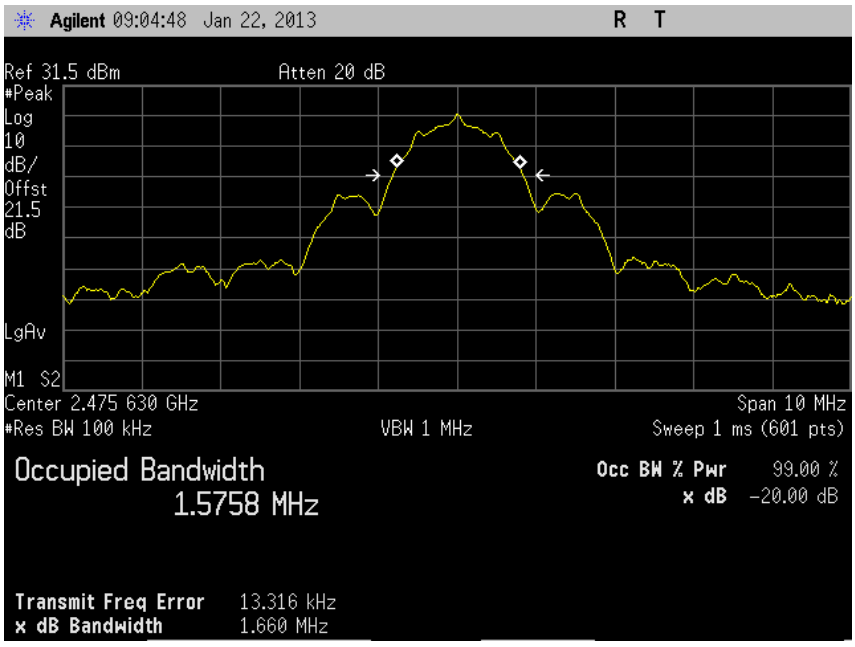
2.3.8 Test Results

99% Bandwidth (for reporting purposes only)		
Low Channel (2402 MHz)	**Mid Channel (2439.81 MHz)**	**High Channel (2475.63 MHz)**
1.5737 MHz	1.6031 MHz	1.5758 MHz
20dB Bandwidth (Part 15 Subpart C §15.215(c))		
Low Channel (2402 MHz)	**Mid Channel (2439.81 MHz)**	**High Channel (2475.63 MHz)**
1.6640 MHz	1.6750 MHz	1.6600MHz
Frequency Band = 2400.00 MHz to 2483.50 MHz		
2402.00 MHz – (20dB BW/2) = 2401.1625MHz (within the frequency band - **Compliant**)		
2475.63 MHz + (20dB BW/2) = 2476.4675 MHz (within the frequency band - **Compliant**)		



Low Channel

Mid Channel



High Channel

2.4 MINIMUM 6 dB RF BANDWIDTH

2.4.1 Specification Reference

Part 15 Subpart C §15.247(a)(2)

2.4.2 Standard Applicable

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

2.4.3 Equipment Under Test and Modification State

Serial No: 83820062 / Test Configuration B

2.4.4 Date of Test/Initial of test personnel who performed the test

January 22, 2012/FSC

2.4.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.4.6 Environmental Conditions

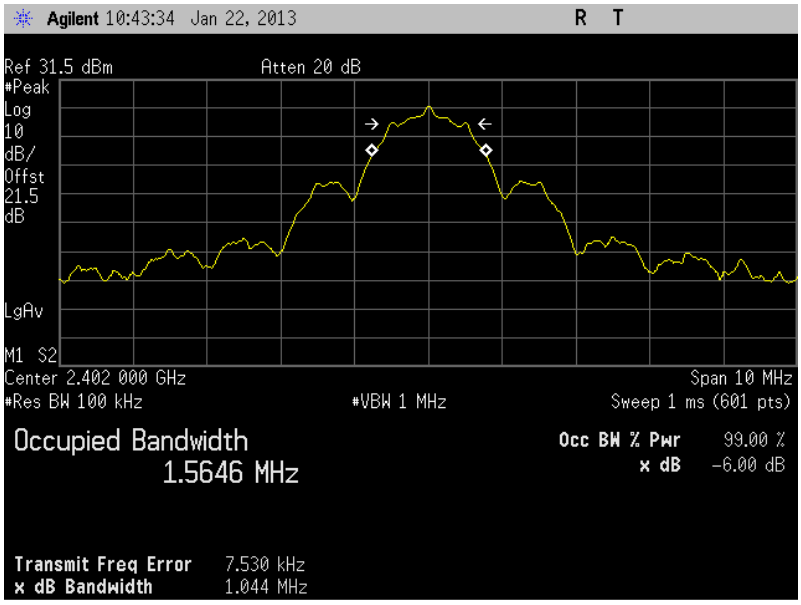
Ambient Temperature	23.6°C
Relative Humidity	12.7%
ATM Pressure	99.4 kPa

2.4.7 Additional Observations

- This is a conducted test.
- An offset of 21.5dB was added to compensate for the external attenuator and cable used.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span (not to exceed 100kHz).
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- Trace is set to max hold.
- Trace was allowed to stabilize.
- The automatic bandwidth measurement capability of a spectrum analyzer was employed using the X dB bandwidth mode with X set to 6 dB.

2.4.8 Test Results

Low Channel (2402 MHz)	Mid Channel (2439.81 MHz)	High Channel (2475.63 MHz)
1.044 MHz	1.067 MHz	1.042 MHz
All measured 6dB bandwidths > 500kHz. EUT complies.		



Low Channel

Mid Channel

High Channel

2.5 OUT-OF-BAND EMISSIONS - CONDUCTED

2.5.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.5.2 Standard Applicable

(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)).

2.5.3 Equipment Under Test and Modification State

Serial No: 83820062 / Test Configuration B

2.5.4 Date of Test/Initial of test personnel who performed the test

January 22, 2012/FSC

2.5.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.5.6 Environmental Conditions

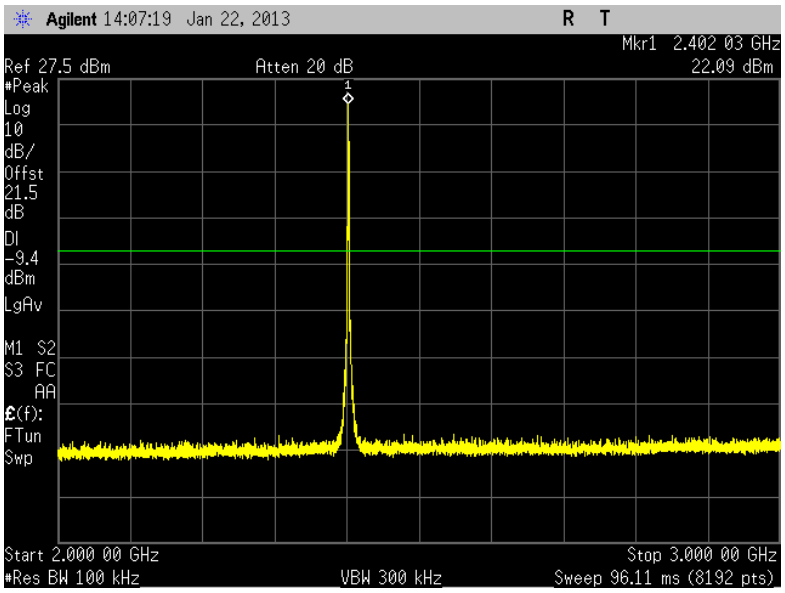
Ambient Temperature	23.6°C
Relative Humidity	12.7%
ATM Pressure	99.4 kPa

2.5.7 Additional Observations

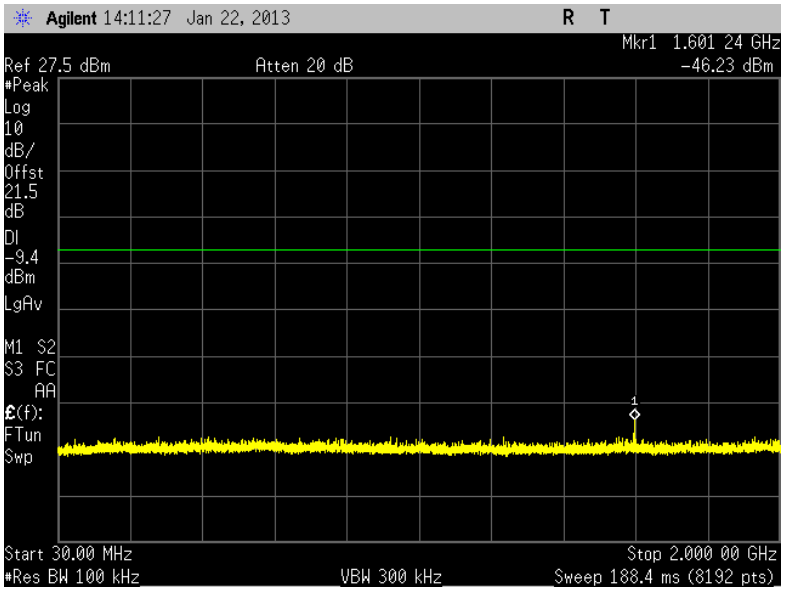
- This is a conducted test.
- An offset of 21.5dB was added to compensate for the external attenuator and cable used.
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold.
- Initial scan was performed to determine the highest level of the desired power within the band. Limit (display line) was drawn 30dB below this level.
- Spectrum was searched from 30MHz up to 26.5GHz.

2.5.8 Test Results

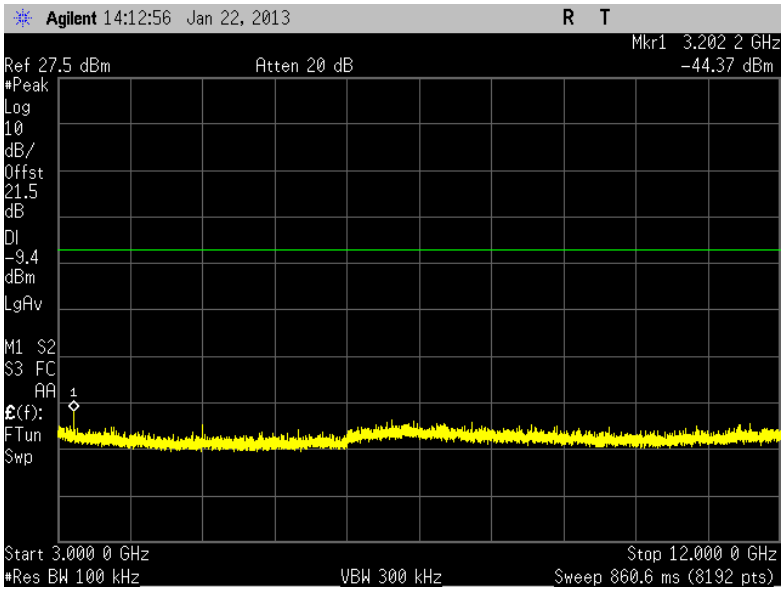
See attached plots.



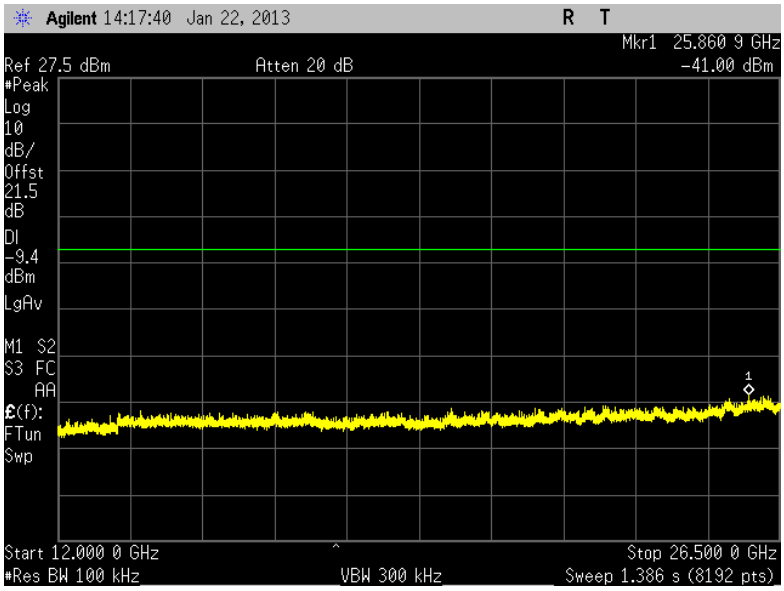
Low Channel (2 to 3GHz)



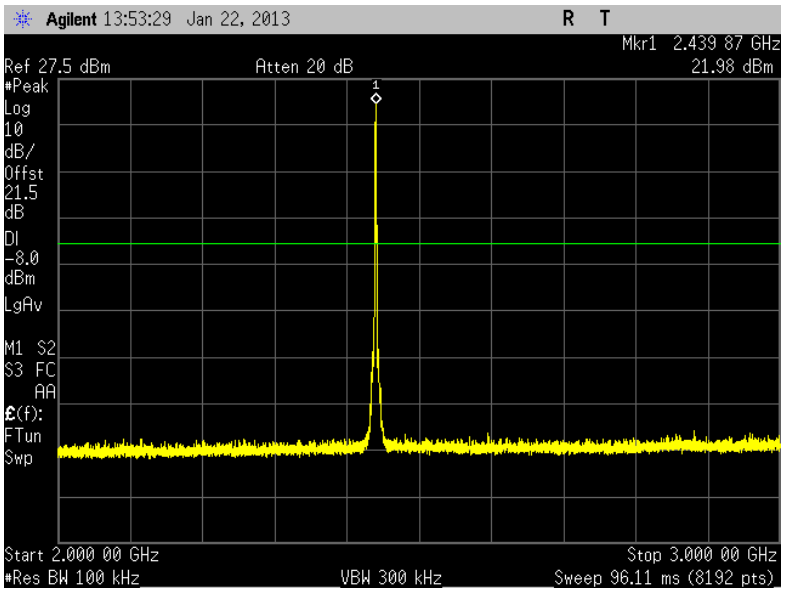
Low Channel (30MHz to 2GHz)



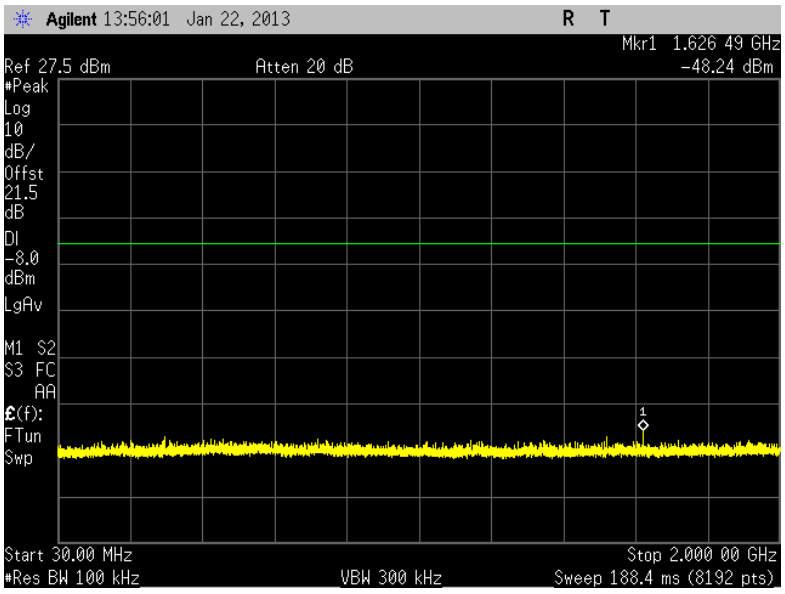
Low Channel (3GHz to 12GHz)



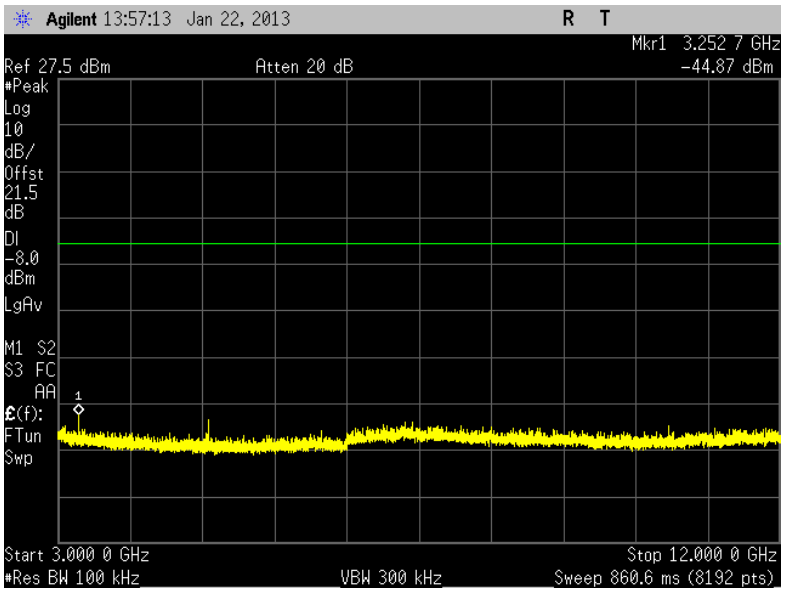
Low Channel (12GHz to 26.5GHz)



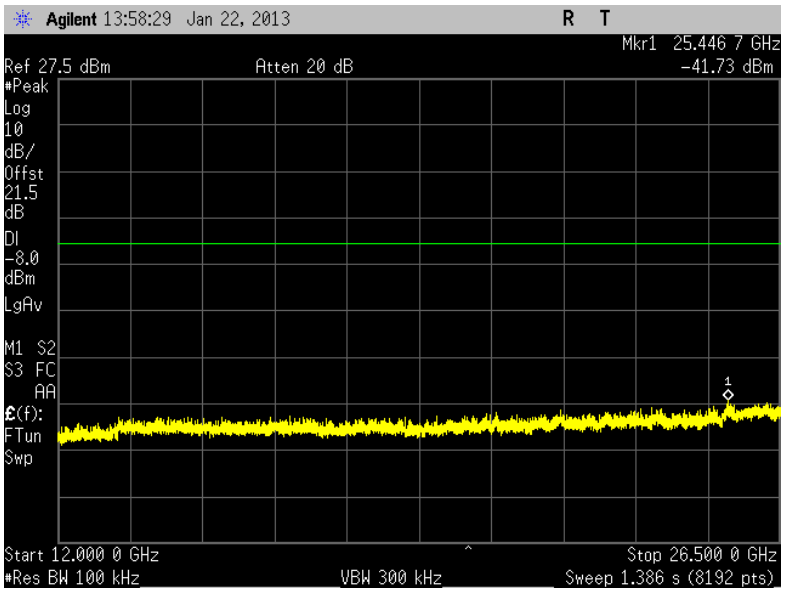
Mid Channel (2GHz to 3GHz)



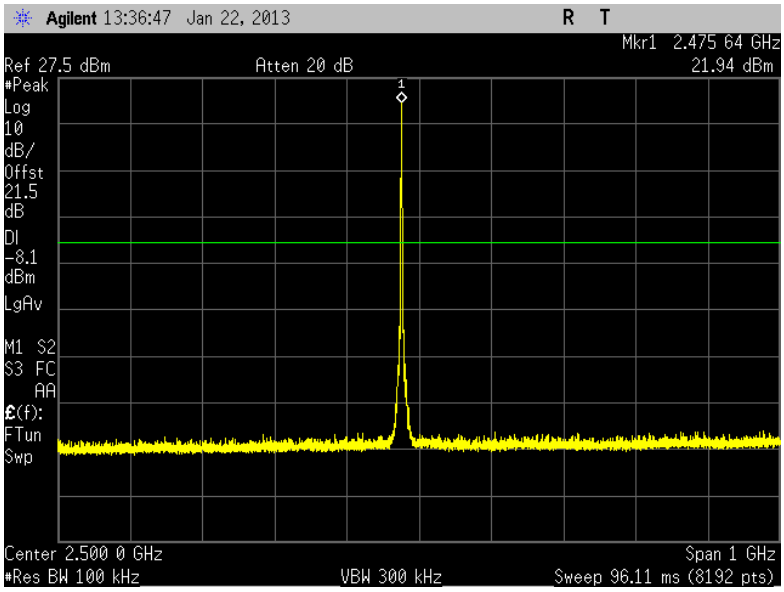
Mid Channel (30MHz to 2GHz)



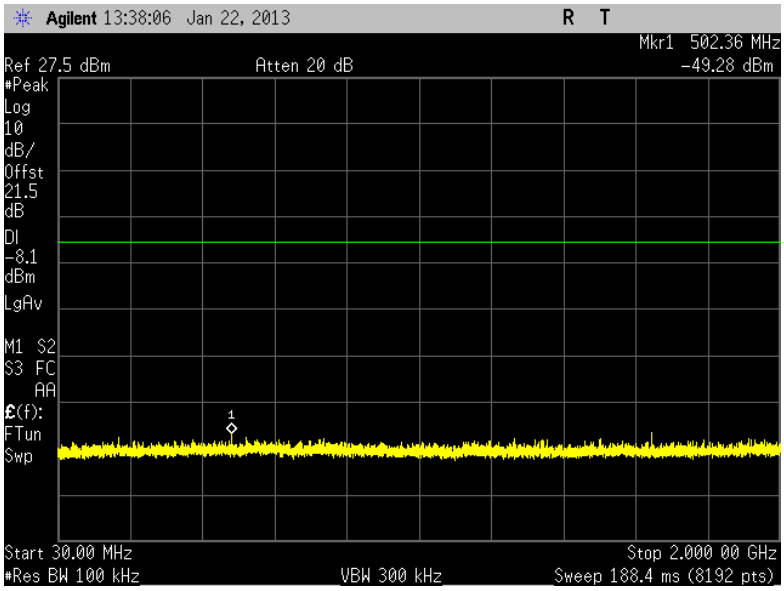
Mid Channel (3GHz to 12GHz)



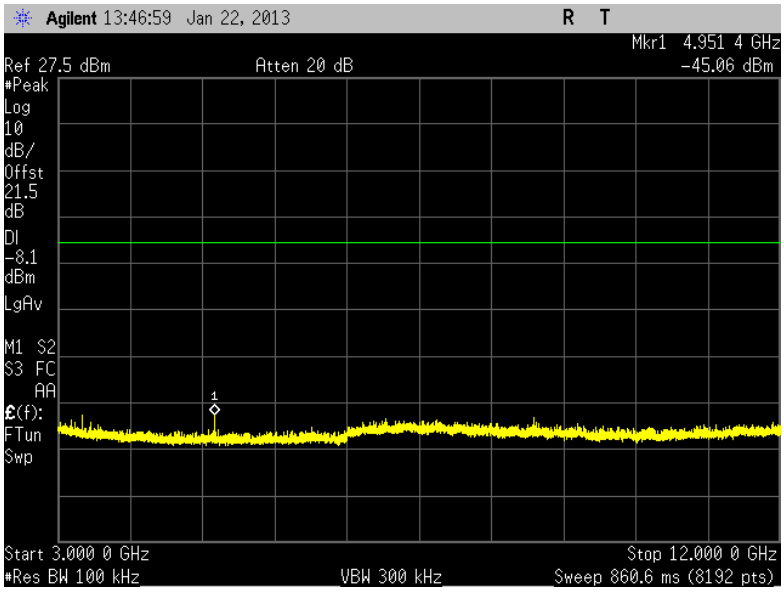
Mid Channel (12GHz to 26.5GHz)



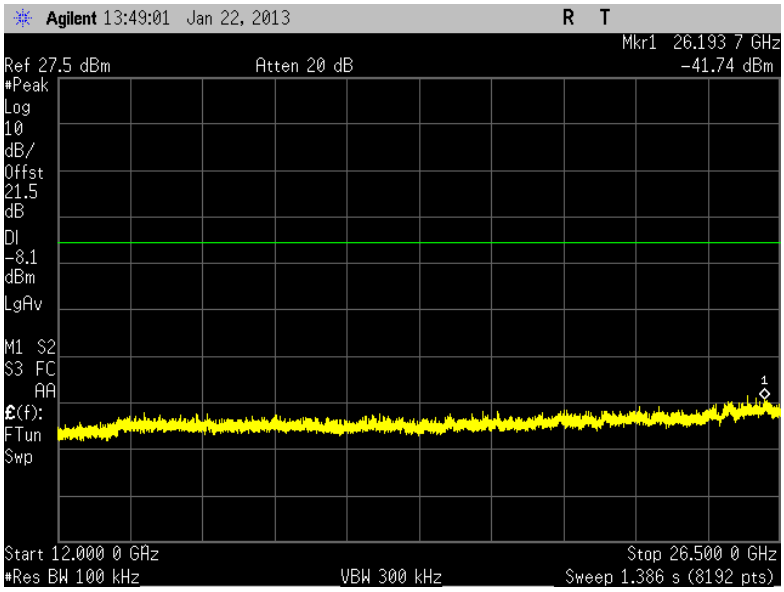
High Channel (2GHz to 3GHz)



High Channel (30MHz to 2GHz)



High Channel (3GHz to 12GHz)



High Channel (12GHz to 26.5GHz)

2.6 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.6.2 Standard Applicable

See previous test.

2.6.3 Equipment Under Test and Modification State

Serial No: 83820062/ Test Configuration B

2.6.4 Date of Test/Initial of test personnel who performed the test

January 22, 2012/FSC

2.6.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.6 Environmental Conditions

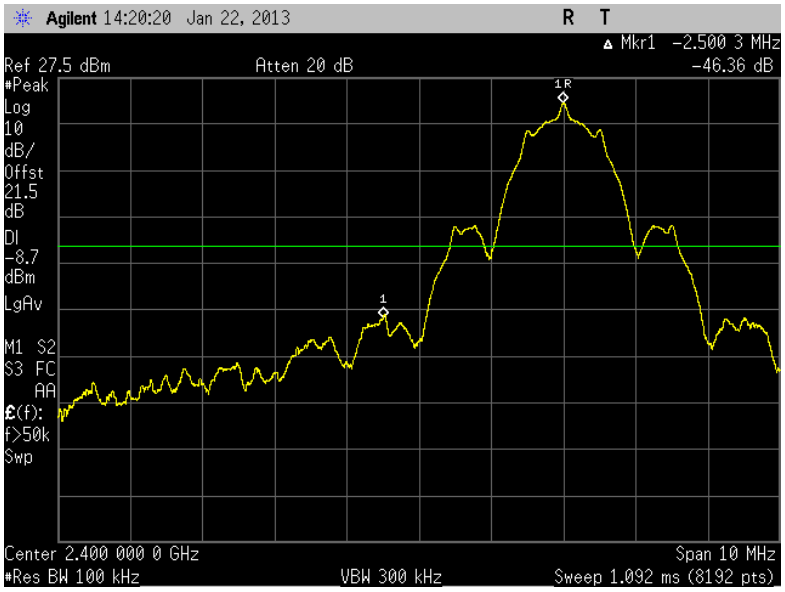
Ambient Temperature	23.6°C
Relative Humidity	12.7%
ATM Pressure	99.4 kPa

2.6.7 Additional Observations

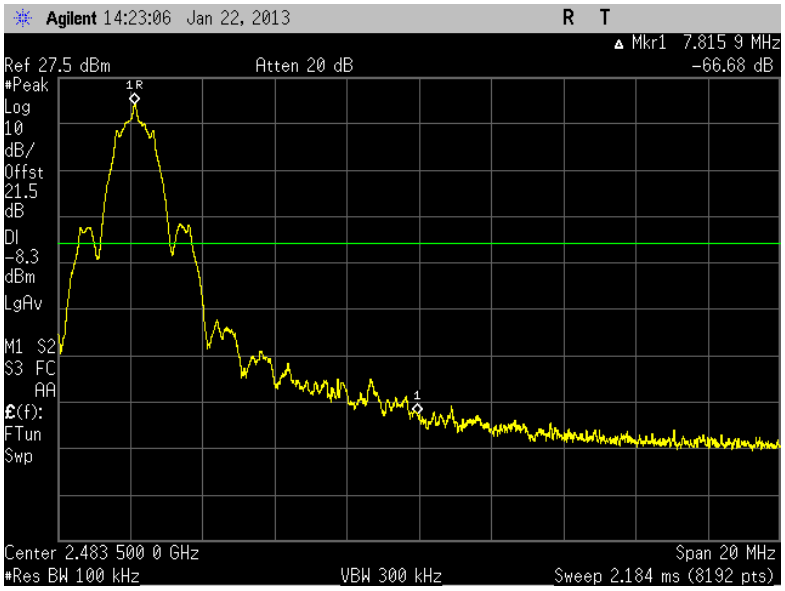
- Setup is identical to “Out-of-Band Emissions – Conducted“ test (previous test).
- Band-edge (2400MHz and 2483.5MHz) emissions were verified in this test.
- The spectrum analyzer was centred on the band-edge frequency while setting the EUT to the corresponding transmit channel (i.e. Low Channel for lower band-edge).
- Limit is 30dB below the highest level of the desired power within the band.

2.6.8 Test Results

Complies. See attached plots.



Lower Band-Edge



Higher Band-Edge

2.7 SPURIOUS RADIATED EMISSIONS

2.7.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.7.2 Standard Applicable

(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)).

2.7.3 Equipment Under Test and Modification State

Serial No: 83820062 / Test Configuration A

2.7.4 Date of Test/Initial of test personnel who performed the test

January 21, 2013/FSC

2.7.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.7.6 Environmental Conditions

Ambient Temperature	23.9°C
Relative Humidity	15.1%
ATM Pressure	99.2 kPa

2.7.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic (25GHz).
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.

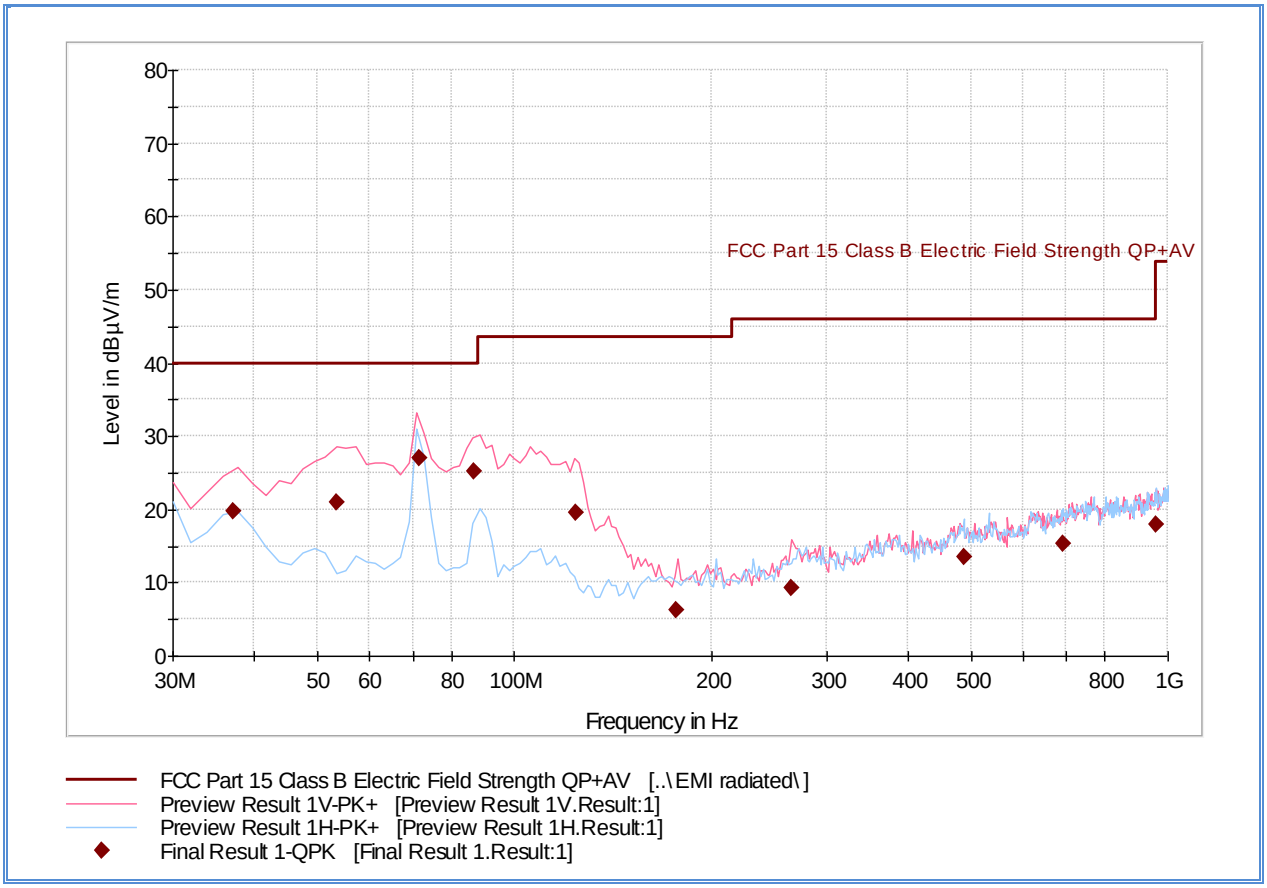
2.7.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbµV) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			**11.8**

2.7.9 Test Results

See attached plots.

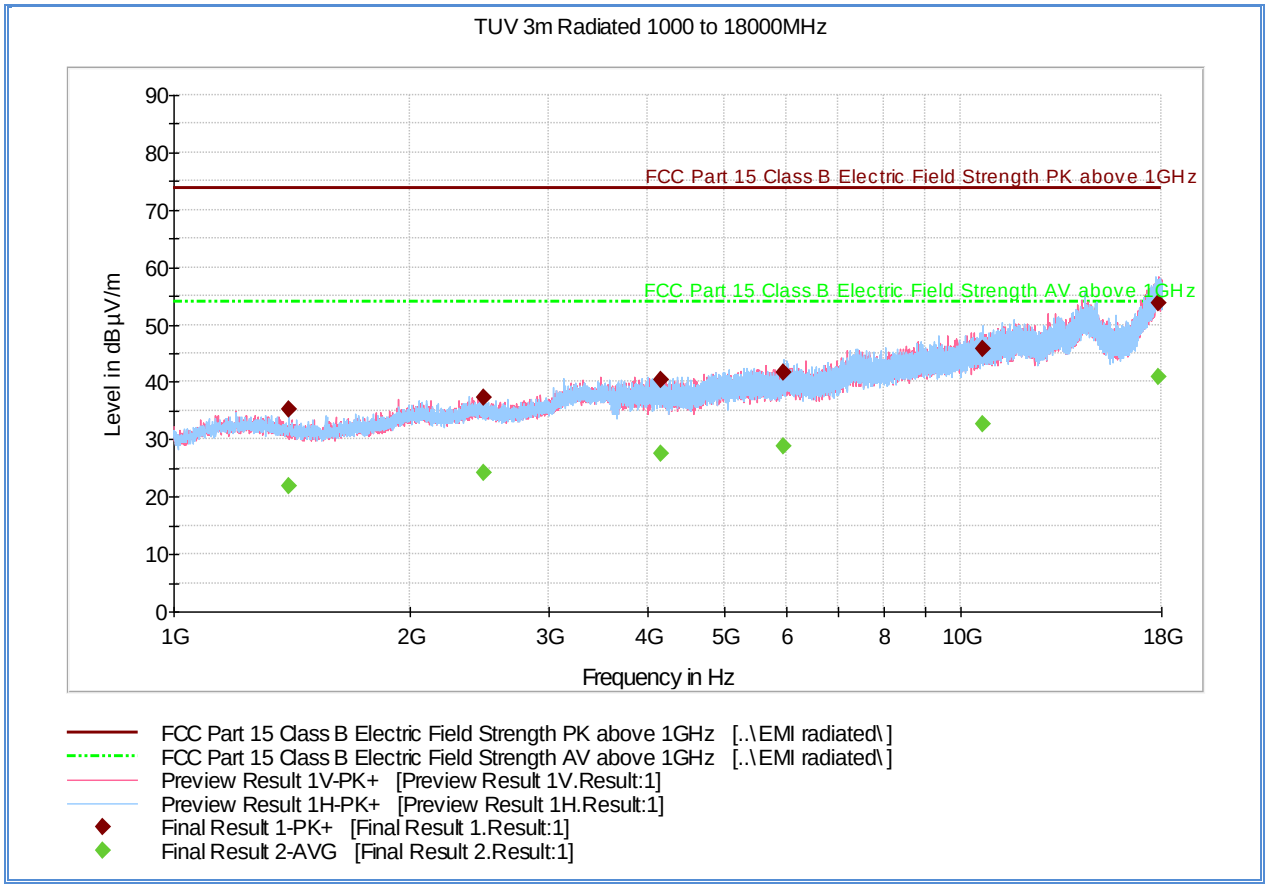
2.7.10 Test Results Below 1GHz (Receive Mode)



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
37.135551	19.7	1000.0	120.000	100.0	V	247.0	-15.7	20.3	40.0
53.486653	21.0	1000.0	120.000	247.0	V	275.0	-20.8	19.0	40.0
71.581643	27.0	1000.0	120.000	100.0	V	338.0	-21.9	13.0	40.0
86.652745	25.2	1000.0	120.000	100.0	V	253.0	-21.1	14.8	40.0
123.986613	19.5	1000.0	120.000	100.0	V	352.0	-20.7	24.0	43.5
176.975471	6.3	1000.0	120.000	154.0	V	15.0	-17.2	37.2	43.5
265.890421	9.2	1000.0	120.000	147.0	V	155.0	-13.1	36.8	46.0
488.973627	13.5	1000.0	120.000	141.0	H	37.0	-6.4	32.5	46.0
691.641844	15.3	1000.0	120.000	400.0	H	193.0	-3.4	30.7	46.0
960.258357	18.0	1000.0	120.000	251.0	V	332.0	0.5	35.9	53.9

2.7.11 Test Results Above 1GHz (Receive Mode)



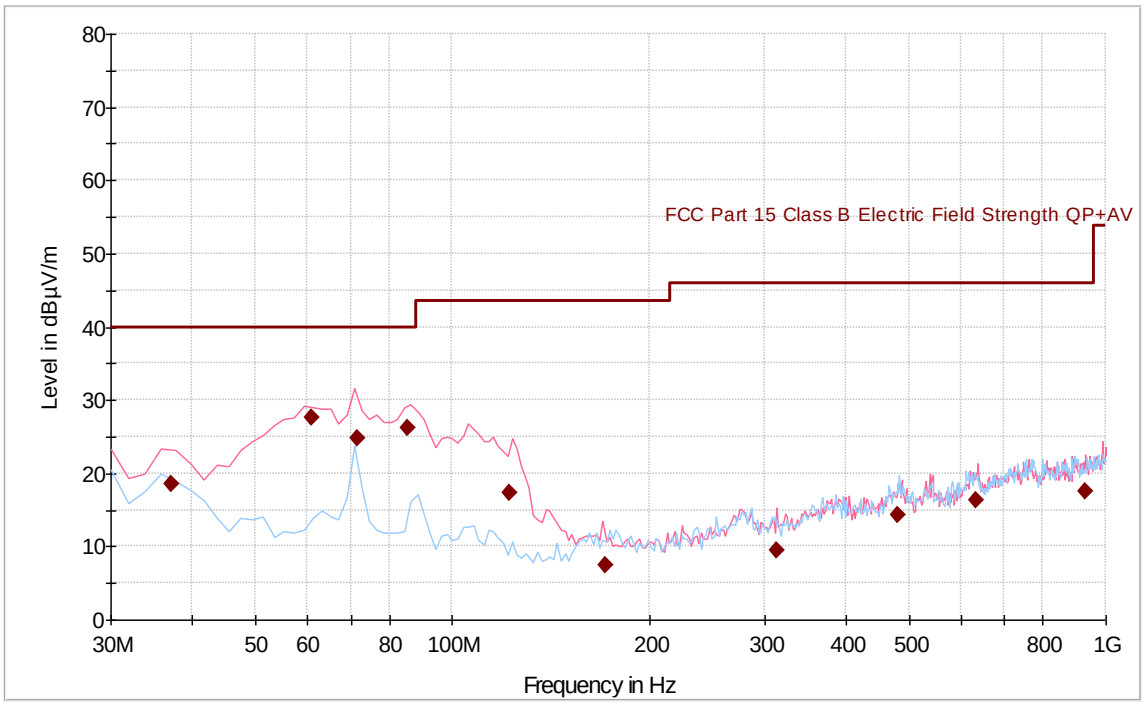
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1399.966667	35.3	1000.0	1000.000	130.0	H	286.0	-9.2	38.6	73.9
2472.386667	37.4	1000.0	1000.000	196.0	V	44.0	-4.7	36.5	73.9
4159.313333	40.4	1000.0	1000.000	143.0	V	226.0	0.6	33.5	73.9
5963.420000	41.8	1000.0	1000.000	255.0	H	268.0	4.5	32.1	73.9
10688.00000	45.9	1000.0	1000.000	307.0	H	37.0	11.1	28.0	73.9
17816.00666	53.9	1000.0	1000.000	335.0	V	44.0	21.1	20.0	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1399.966667	22.0	1000.0	1000.000	130.0	H	286.0	-9.2	31.9	53.9
2472.386667	24.1	1000.0	1000.000	196.0	V	44.0	-4.7	29.8	53.9
4159.313333	27.4	1000.0	1000.000	143.0	V	226.0	0.6	26.5	53.9
5963.420000	28.9	1000.0	1000.000	255.0	H	268.0	4.5	25.0	53.9
10688.00000	32.7	1000.0	1000.000	307.0	H	37.0	11.1	21.2	53.9
17816.00666	41.0	1000.0	1000.000	335.0	V	44.0	21.1	12.9	53.9

2.7.12 Test Results Below 1GHz (Low Channel – Worst Case Configuration Transmit Mode)



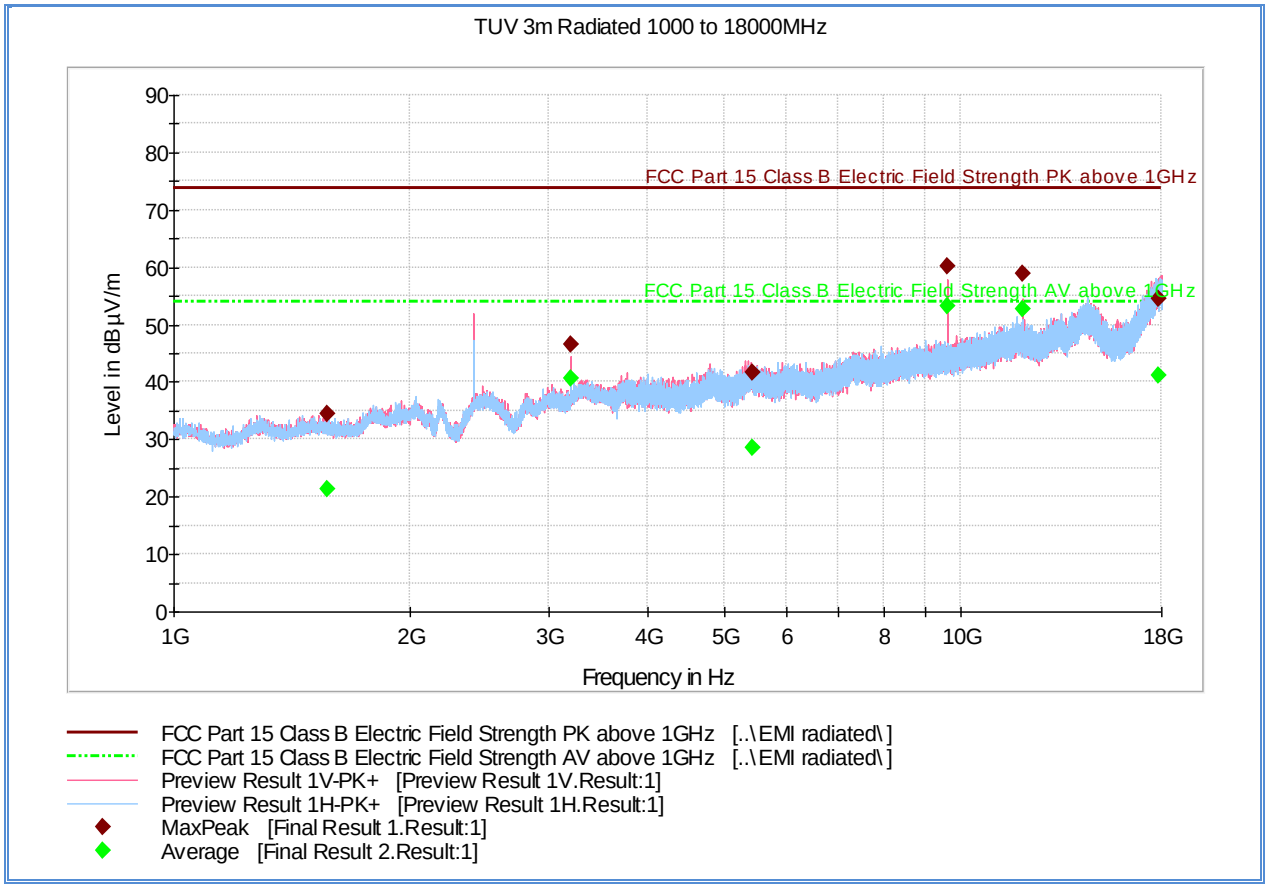
FCC Part 15 Class B Electric Field Strength QP+AV [..\EMI radiated\]
Preview Result 1V-PK+ [Preview Result 1V.Result:1]
Preview Result 1H-PK+ [Preview Result 1H.Result:1]
Final Result 1-QPK [Final Result 1.Result:1]

Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
37.151663	18.6	1000.0	120.000	102.0	V	45.0	-15.7	21.4	40.0
60.958317	27.5	1000.0	120.000	102.0	V	203.0	-21.6	12.5	40.0
71.581643	24.9	1000.0	120.000	106.0	V	107.0	-21.9	15.1	40.0
85.532745	26.3	1000.0	120.000	102.0	V	1.0	-21.2	13.7	40.0
122.426613	17.4	1000.0	120.000	102.0	V	177.0	-20.7	26.1	43.5
171.807695	7.4	1000.0	120.000	400.0	H	245.0	-17.3	36.1	43.5
313.247615	9.4	1000.0	120.000	400.0	V	310.0	-12.2	36.6	46.0
480.165852	14.4	1000.0	120.000	158.0	H	112.0	-6.3	31.6	46.0
633.932986	16.3	1000.0	120.000	385.0	V	39.0	-3.2	29.7	46.0
928.963928	17.5	1000.0	120.000	209.0	V	40.0	-0.4	28.5	46.0

Test Notes: Only worst case channel presented for spurious emissions below 1GHz.

2.7.13 Test Results Above 1GHz (Transmit Mode Low Channel)



Peak Data

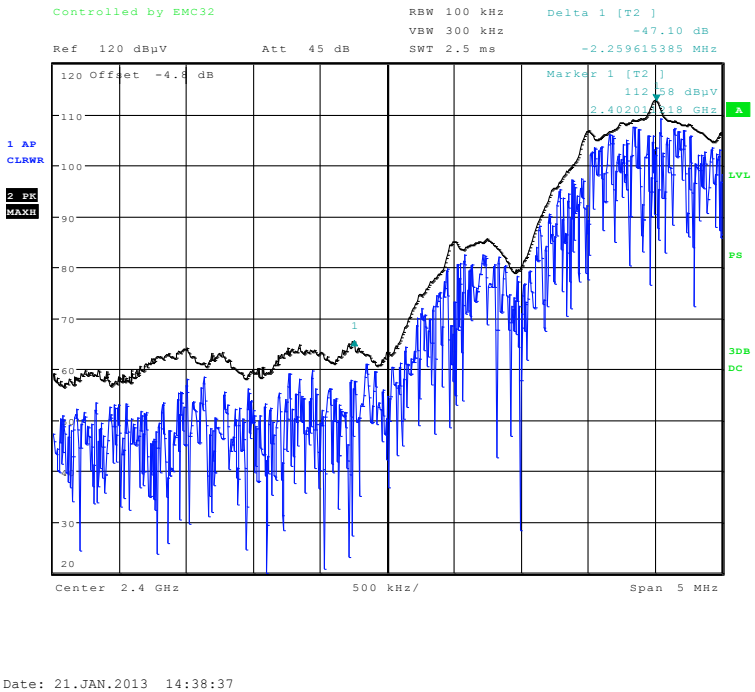
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1564.100000	34.5	1000.0	1000.000	100.0	V	263.0	-8.9	39.4	73.9
3202.653333	46.5	1000.0	1000.000	100.0	V	286.0	-1.5	27.4	73.9
5439.966667	41.6	1000.0	1000.000	223.0	V	93.0	4.0	32.3	73.9
9608.006667	60.2	1000.0	1000.000	100.0	V	10.0	9.2	13.7	73.9
12009.993333	58.8	1000.0	1000.000	154.0	V	29.0	12.7	15.1	73.9
17828.393333	54.4	1000.0	1000.000	326.0	V	290.0	21.2	19.5	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1564.100000	21.3	1000.0	1000.000	100.0	V	263.0	-8.9	32.6	53.9
3202.653333	40.6	1000.0	1000.000	100.0	V	286.0	-1.5	13.3	53.9
5439.966667	28.5	1000.0	1000.000	223.0	V	93.0	4.0	25.4	53.9
9608.006667	53.3	1000.0	1000.000	100.0	V	10.0	9.2	0.6	53.9
12009.993333	52.7	1000.0	1000.000	154.0	V	29.0	12.7	1.2	53.9
17828.393333	41.2	1000.0	1000.000	326.0	V	290.0	21.2	12.7	53.9

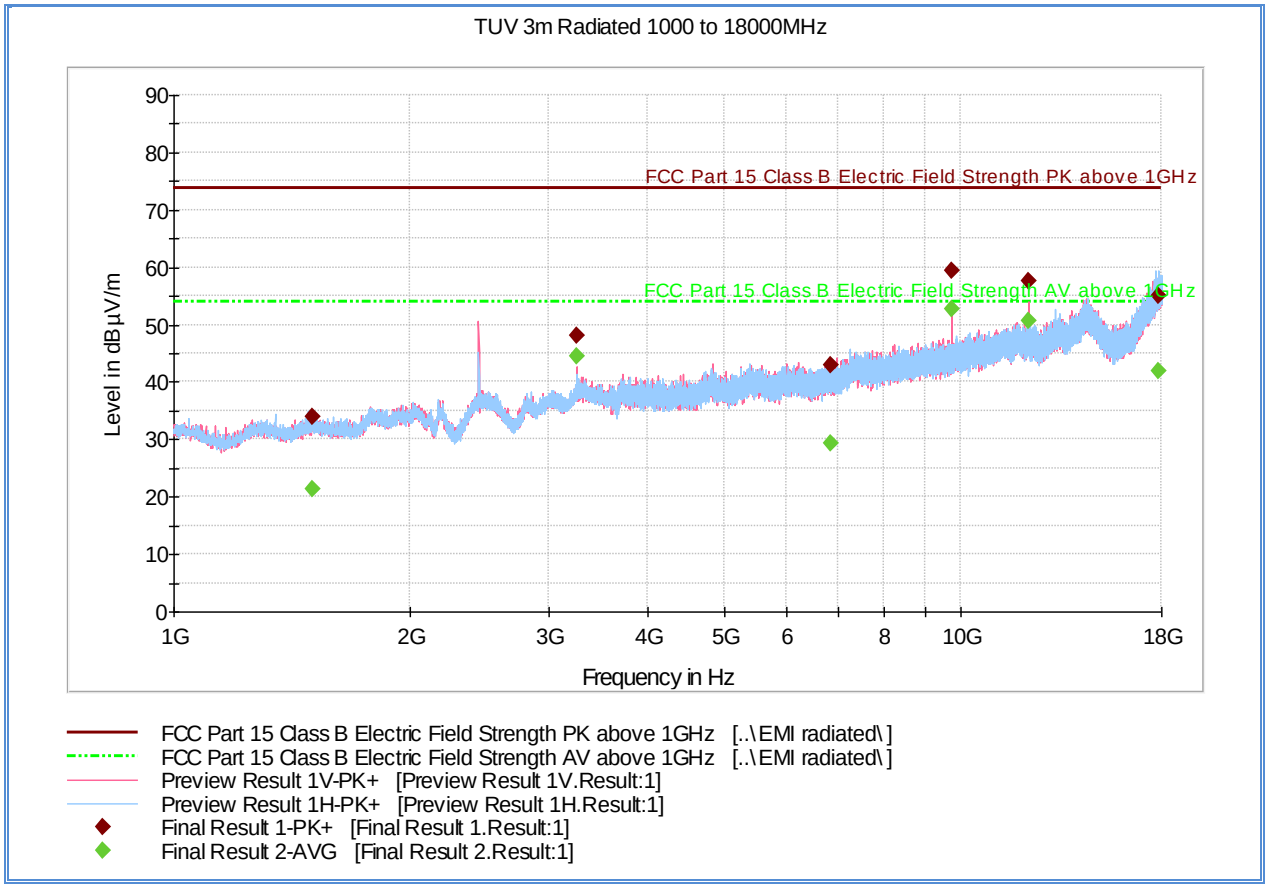
Test Notes: Measurement was performed with a 2.4GHz notch filter. Band edge measurement was performed with the notch filter removed. Lower band edge was verified manually using 100 kHz RBW (see attached plot Section 2.8.14).

2.7.14 Test Results Lower Band Edge (Radiated - Low Channel using 100 kHz RBW)



Test Notes: Carrier frequency (Low Channel) was maximized for this test. Correction factor of -4.8dB is from the cable, antenna and preamp used. The EUT complies with the conducted power limits based on the use of RMS averaging over a time interval therefore the limit for this test is -30dBc. The highest measured emission close to the lower band edge is -47.10. EUT complies.

2.7.15 Test Results Above 1GHz (Transmit Mode Mid Channel)



Peak Data

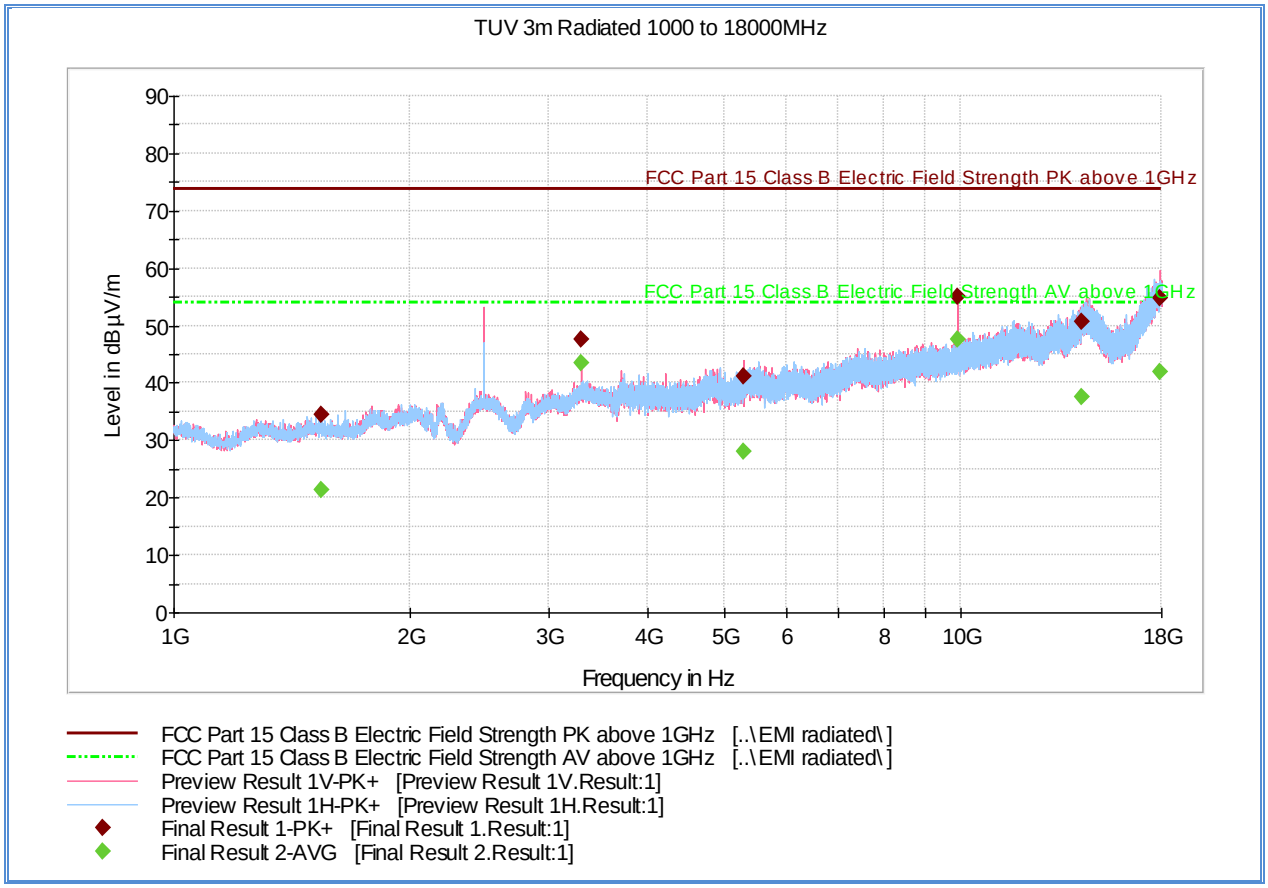
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1498.120000	34.0	1000.	1000.000	205.0	V	136.0	-9.0	39.9	73.9
3253.086667	48.2	1000.	1000.000	100.0	V	290.0	-1.3	25.7	73.9
6825.193333	43.0	1000.	1000.000	256.0	H	111.0	5.3	30.9	73.9
9759.226667	59.3	1000.	1000.000	100.0	V	14.0	9.4	14.6	73.9
12199.053333	57.6	1000.	1000.000	168.0	V	44.0	12.3	16.3	73.9
17872.853333	55.1	1000.	1000.000	400.0	H	265.0	21.3	18.8	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1498.120000	21.4	1000.	1000.000	205.0	V	136.0	-9.0	32.5	53.9
3253.086667	44.4	1000.	1000.000	100.0	V	290.0	-1.3	9.5	53.9
6825.193333	29.2	1000.	1000.000	256.0	H	111.0	5.3	24.7	53.9
9759.226667	52.7	1000.	1000.000	100.0	V	14.0	9.4	1.2	53.9
12199.053333	50.7	1000.	1000.000	168.0	V	44.0	12.3	3.2	53.9
17872.853333	41.8	1000.	1000.000	400.0	H	265.0	21.3	12.1	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter.

2.7.16 Test Results Above 1GHz (Transmit Mode High Channel)



Peak Data

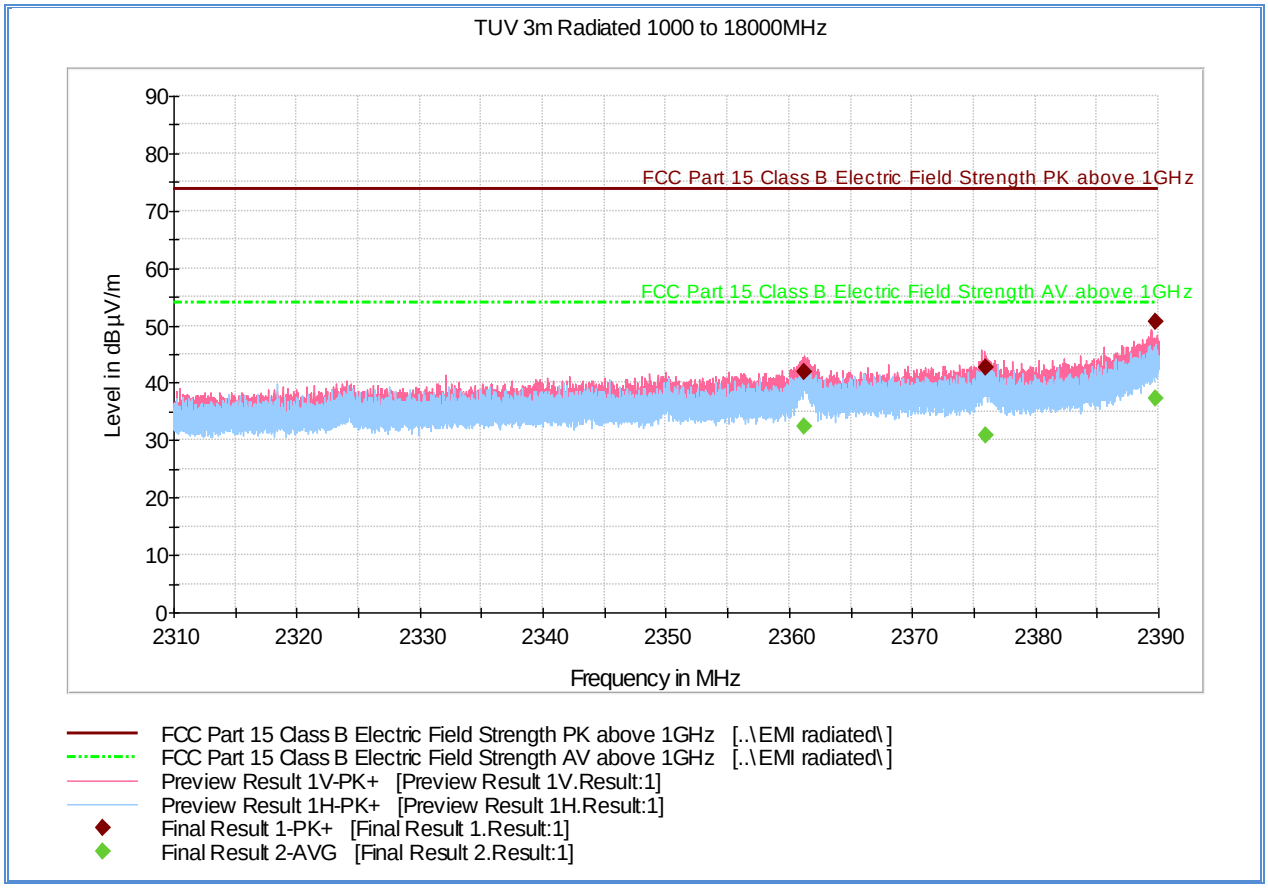
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1538.193333	34.4	1000.0	1000.000	155.0	H	274.0	-9.0	39.5	73.9
3300.846667	47.5	1000.0	1000.000	100.0	V	290.0	-1.1	26.4	73.9
5301.346667	41.1	1000.0	1000.000	143.0	V	342.0	3.6	32.8	73.9
9902.513333	55.0	1000.0	1000.000	180.0	V	26.0	9.9	18.9	73.9
14273.460000	50.7	1000.0	1000.000	220.0	V	356.0	16.6	23.2	73.9
17942.620000	54.7	1000.0	1000.000	400.0	V	234.0	21.5	19.2	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1538.193333	21.4	1000.0	1000.000	155.0	H	274.0	-9.0	32.5	53.9
3300.846667	43.5	1000.0	1000.000	100.0	V	290.0	-1.1	10.4	53.9
5301.346667	28.0	1000.0	1000.000	143.0	V	342.0	3.6	25.9	53.9
9902.513333	47.6	1000.0	1000.000	180.0	V	26.0	9.9	6.3	53.9
14273.460000	37.5	1000.0	1000.000	220.0	V	356.0	16.6	16.4	53.9
17942.620000	41.9	1000.0	1000.000	400.0	V	234.0	21.5	12.0	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter.

2.7.17 Test Results Above 1GHz (Low Channel Transmit Mode - Restricted Band from 2310 MHz to 2390 MHz)



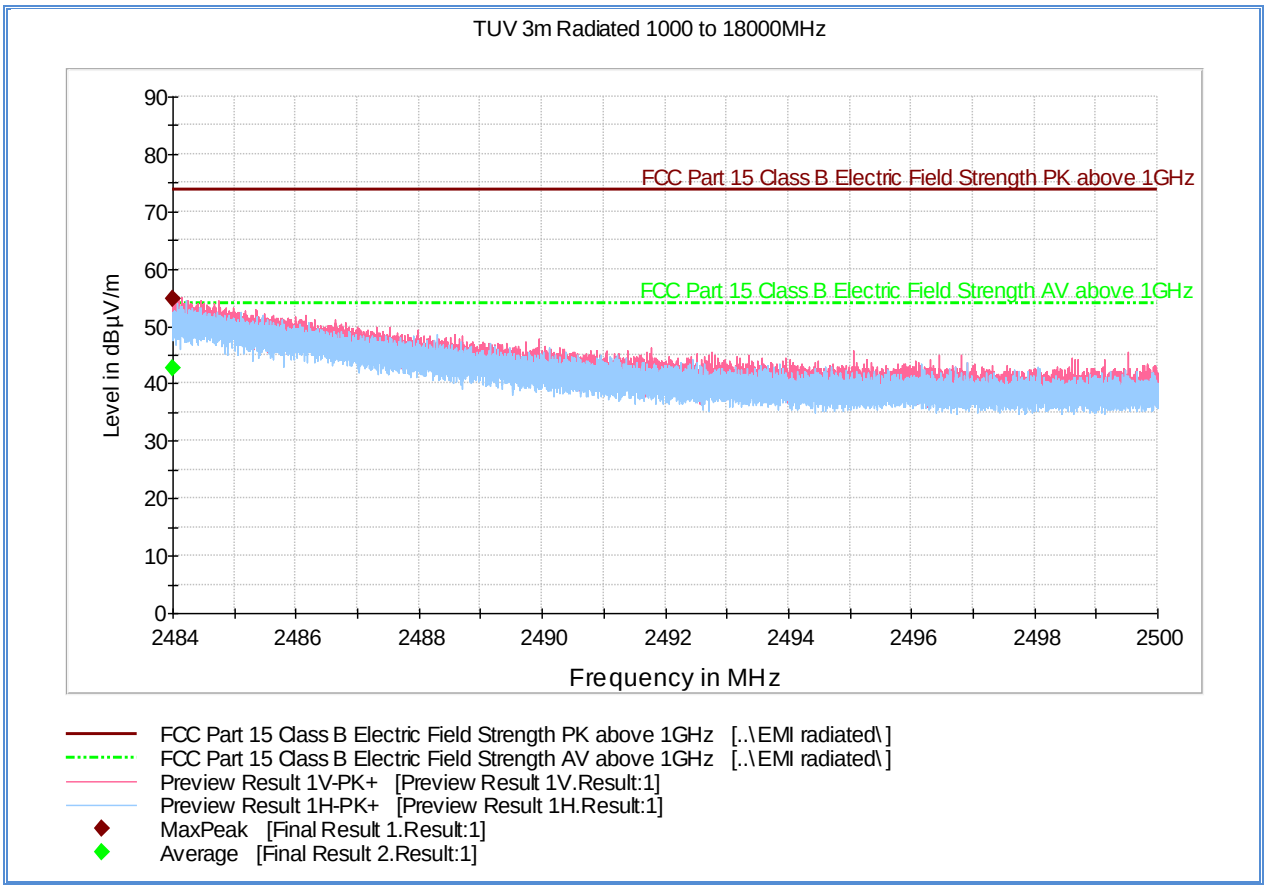
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2361.190667	42.0	1000.0	1000.000	130.0	V	208.0	-5.1	31.9	73.9
2375.985333	42.8	1000.0	1000.000	117.0	V	243.0	-5.0	31.1	73.9
2389.782667	50.6	1000.0	1000.000	129.0	V	249.0	-4.9	23.3	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2361.190667	32.5	1000.0	1000.000	130.0	V	208.0	-5.1	21.4	53.9
2375.985333	30.9	1000.0	1000.000	117.0	V	243.0	-5.0	23.0	53.9
2389.782667	37.4	1000.0	1000.000	129.0	V	249.0	-4.9	16.5	53.9

2.7.18 Test Results Above 1GHz (High Channel Transmit Mode - Restricted Band from 2483.5 MHz to 2500 MHz including upper bandedge)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	54.8	1000.0	1000.000	125.0	V	251.0	-4.7	19.1	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	42.6	1000.0	1000.000	125.0	V	251.0	-4.7	11.3	53.9

2.8 POWER SPECTRAL DENSITY

2.8.1 Specification Reference

Part 15 Subpart C §15.247(e)

2.8.2 Standard Applicable

(e) For digitally modulated systems, the 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

2.8.3 Equipment Under Test and Modification State

Serial No: 83820062 / Test Configuration B

2.8.4 Date of Test/Initial of test personnel who performed the test

January 22, 2012/FSC

2.8.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.8.6 Environmental Conditions

Ambient Temperature	23.6°C
Relative Humidity	12.7%
ATM Pressure	99.4 kPa

2.8.7 Additional Observations

- This is a conducted test using Option 2 under Section 9.2 of FCC KDB Publication Number 558074 D01 DTS Meas Guidance v02(Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (10/04/2012)).
- An offset of 21.5dB was added to compensate for the external attenuator and cable used.
- Span set to >1.5 times the DTS (6dB BW) channel bandwidth.
- RBW ≥ 3kHz.
- VBW ≥ 3X RBW.
- Detector = power averaging (RMS).
- The number of measurement points in the sweep was verified ≥ 2 x span/RBW. 601 points > 400.
- Sweep time = auto couple.
- Trace was averaged 100 times in “Power Averaging Mode”.

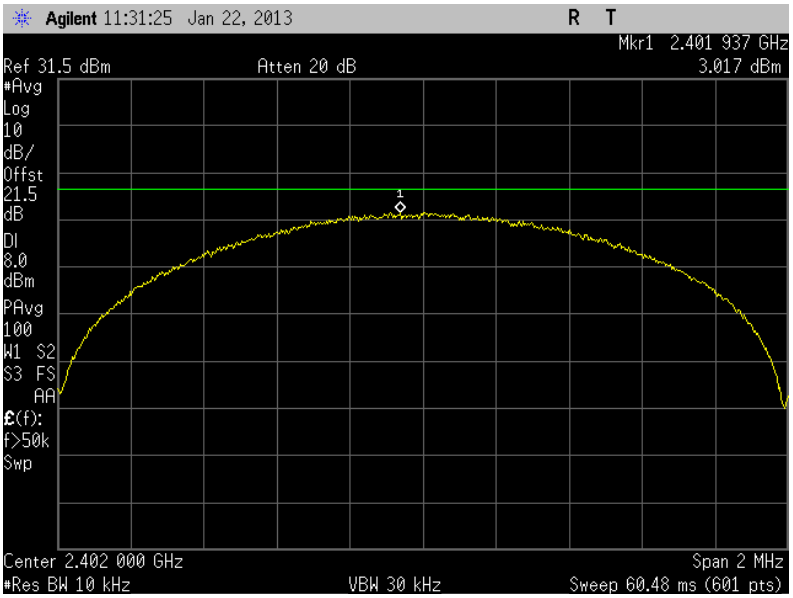
- Use the peak marker function to determine the maximum amplitude level.
- Measured value exceeds the limit when using 100 kHz RBW, RBW was reduced (but not less than 3 kHz) until EUT complied. EUT complied using 10 kHz RBW.

2.8.8 Test Results

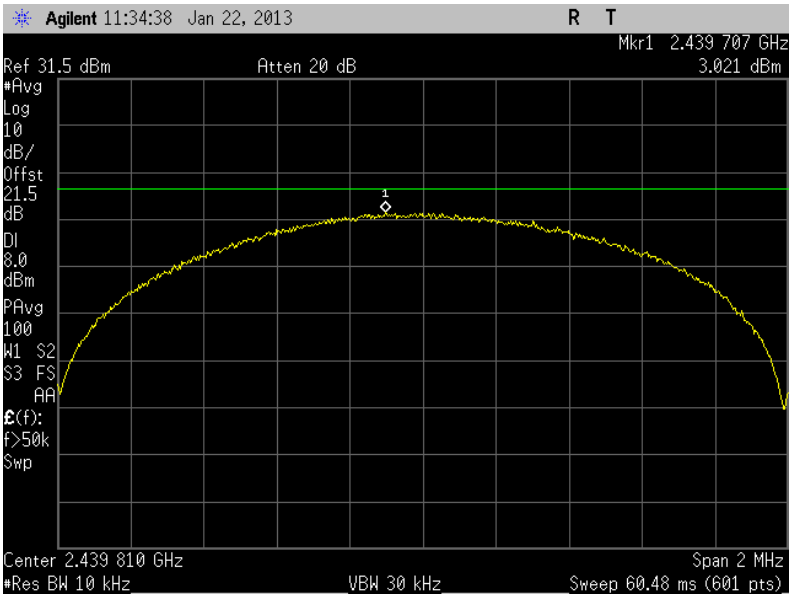
See attached table and plots.

Channel Frequency (MHz)	RF Power Spectral Density (dBm)	Limit (dBm)	Pass/Fail
2402.00	3.017 @ 10kHz RBW	8	Pass
2439.81	3.021 @ 10kHz RBW	8	Pass
2475.63	2.927 @ 10kHz RBW	8	Pass

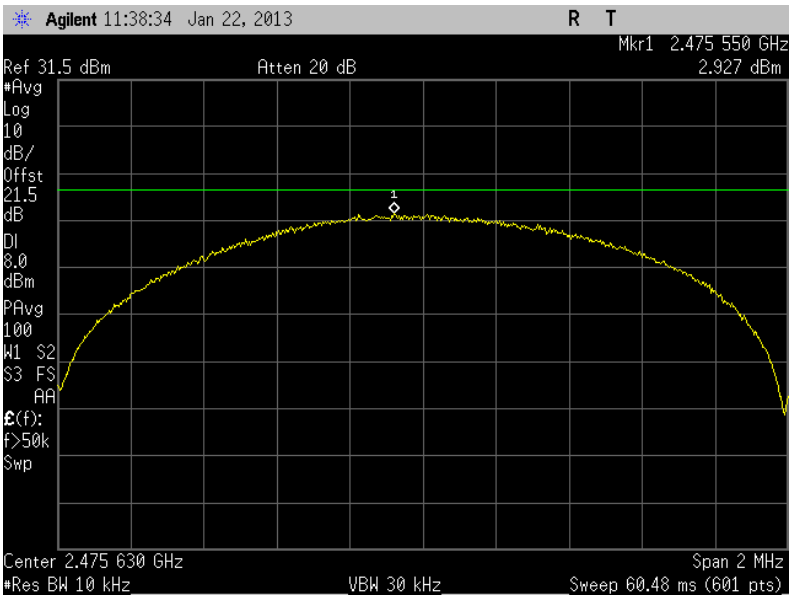
2.8.9 Test Plots



Low Channel



Mid Channel



High Channel

SECTION 3

TEST EQUIPMENT USED

TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Conducted Port Setup						
6814	PSA Series Spectrum Analyzer	E4440A	MY42510441	Agilent	11/07/12	11/07/13
8772	10dB Attenuator	606-10-1F4/DR	N/A	Meca	01/18/13	01/18/13
8773	10dB Attenuator	606-10-1F4/DR	N/A	Meca	01/18/13	01/18/13
Conducted Emissions Test Setup						
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	06/13/12	06/13/13
7567	LISN	FCC-LISN-50-25-2-10	120304	Fischer Custom Comm.	05/24/12	05/24/13
7568	LISN	FCC-LISN-50-25-2-10	120305	Fischer Custom Comm.	05/24/12	05/24/13
8607	20dB Attenuator	CAT-20	N/A	MCL HAT-20	08/21/12	08/21/13
8609	20dB Attenuator	CAT-20	N/A	MCL HAT-20	08/21/12	08/21/13
Radiated Test Setup						
1033	Bilog Antenna	3142C	00044556	EMCO	05/23/12	05/23/13
1051	Double-ridged waveguide horn antenna	3115	9408-4329	EMCO	05/24/12	05/24/13
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	09/21/12	09/21/13
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	09/21/12	09/21/13
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	08/10/12	08/10/13
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	06/13/12	06/13/13
1016	Pre-amplifier	PAM-0202	187	PAM	09/24/12	09/24/13
6815	2.4GHz Band Notch	Filter	BRM50702 008	Micro-Tronics	Verified by 1040	
1003	Signal Generator	SMR-40	1104.0002.4 0	Rhode & Schwarz	11/12/12	11/12/13
1150	Horn antenna	RA42-K-F-4B-C	012054-004	CMT	Verified by 1003 and 1049	
1151	Pre-amplifier	TS-PR26	100026	Rhode & Schwarz	Verified by 1003 and 1049	
Miscellaneous						
1003	Signal Generator	SMR-40	1104.0002.4 0	Rhode & Schwarz	11/12/12	11/12/13
7560	Barometer/Temperature /Humidity Transmitter	iBTHX-W	1240476	Omega	11/19/12	11/19/13
	Test Software	EMC32	V8.52	Rhode & Schwarz	N/A	
	Test Software	Compliance 5	V5.26.43	Teseq	N/A	

3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:

3.2.1 Radiated Emission Measurements (Below 1GHz)

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.75	0.43	0.19
5	Site	Rectangular	3.55	2.05	4.20
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	2.23
				Coverage Factor (k):	2
				Expanded Uncertainty:	4.45

3.2.2 Radiated Emission Measurements (Above 1GHz)

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	3.55	2.05	4.20
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	2.22
				Coverage Factor (k):	2
				Expanded Uncertainty:	4.44

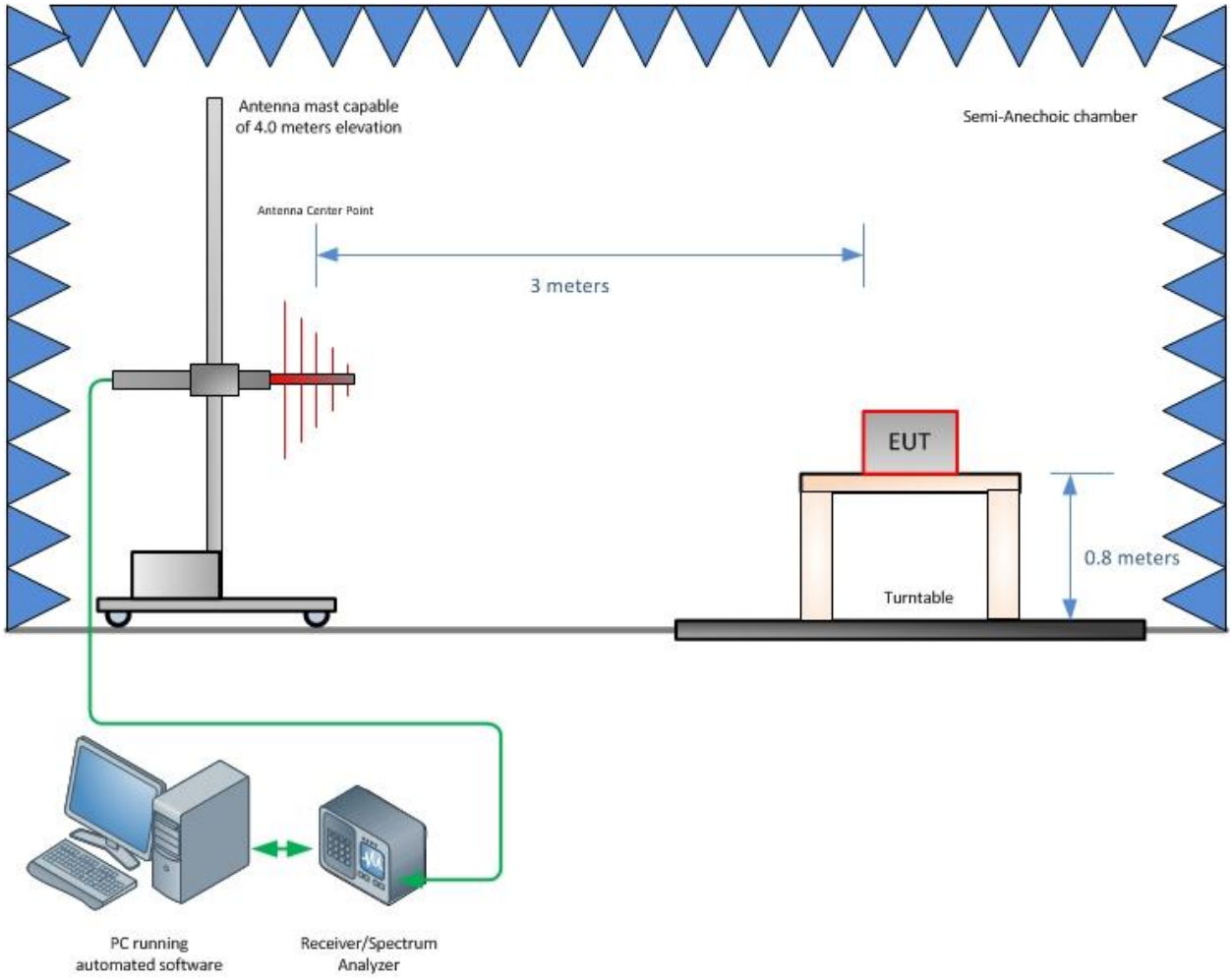
3.2.3 Conducted Antenna Port Measurement

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.50	0.29	0.08
3	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	0.72
				Coverage Factor (k):	2
				Expanded Uncertainty:	1.45

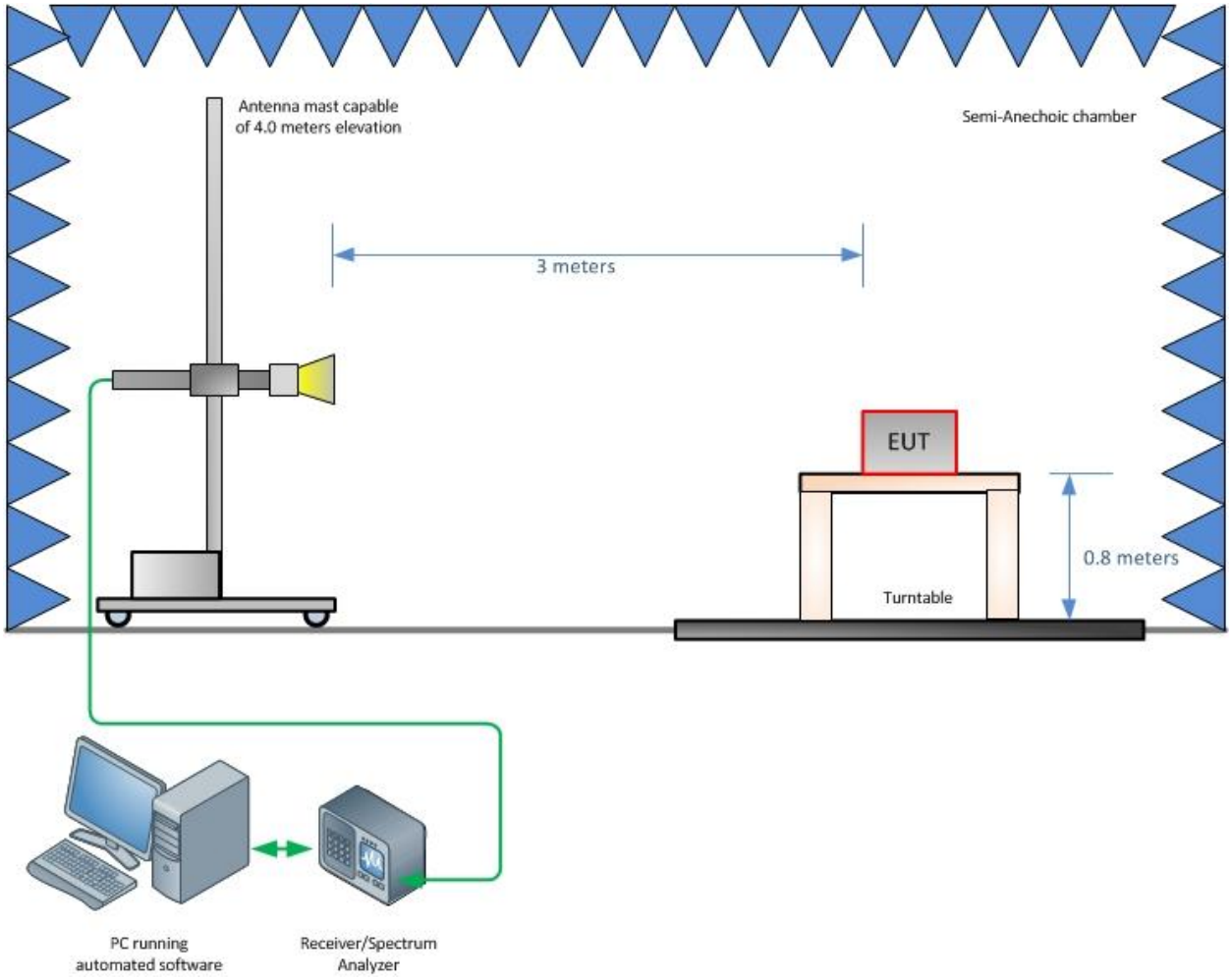
SECTION 4

DIAGRAM OF TEST SETUP

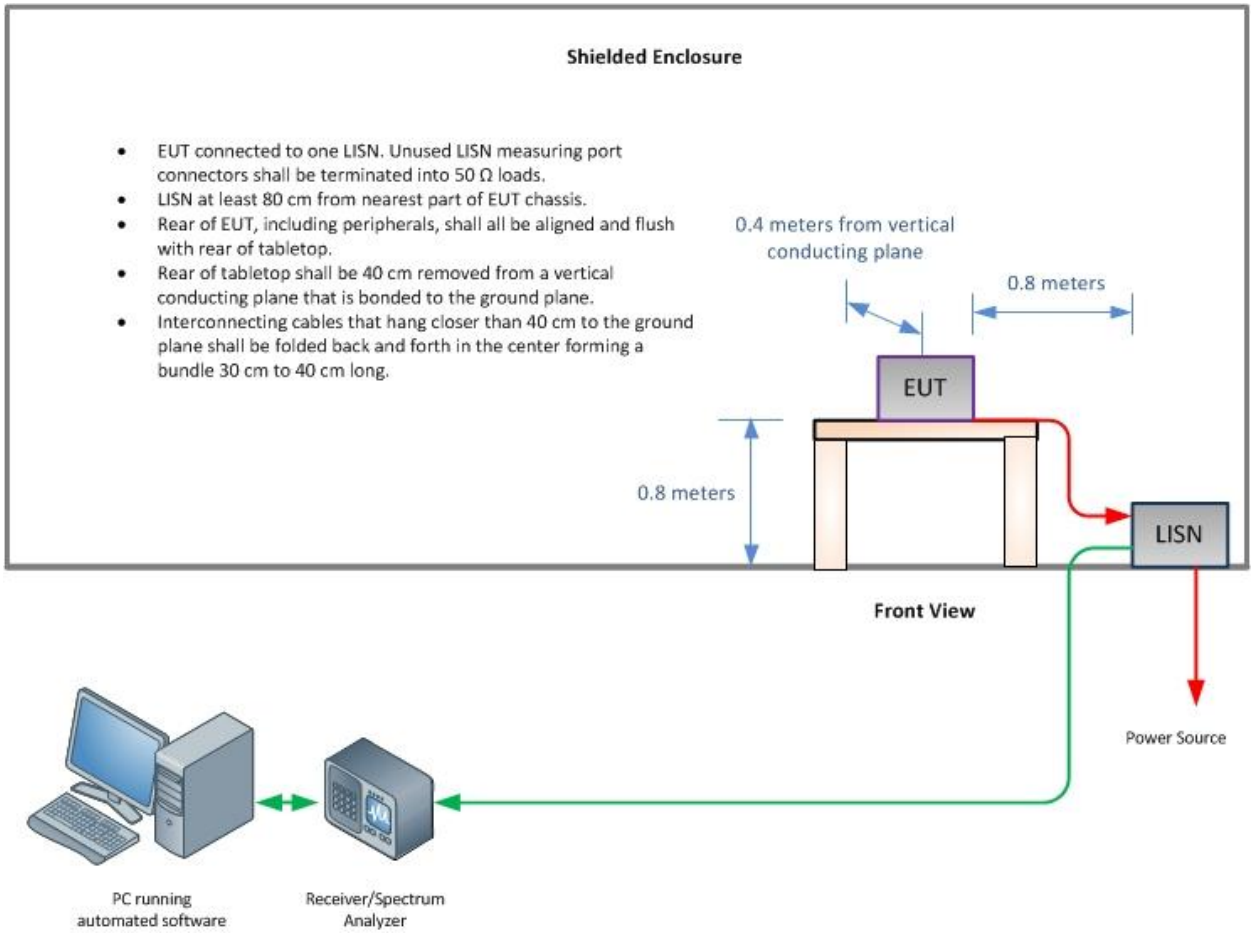
4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)



Conducted Emission Test Setup

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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