America

Choose certainty.
Add value.

Report On

Radio Testing of the
On-Ramp Wireless
eNode RF Module Model ULPN120

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

Report No. SC1108236 September 2011

REPORT ON	Radio Testing of the On-Ramp Wireless eNode RF Module
TEST REPORT NUMBER	SC1108236
	September 2011
PREPARED FOR	On-Ramp Wireless 10920 Via Frontera. San Diego, CA 92127
PREPARED BY	Ferdinand S. Custodio **Name** Title: EMC/Wireless Test Engineer
APPROVED BY	Chip R. Fleury **Name** Authorized Signatory
DATED	October 3, 2011

CONTENTS

Section **Page No**

SECTION 1

REPORT SUMMARY

Radio Testing of the
On-Ramp Wireless
eNode RF Module

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the On-Ramp Wireless eNode RF Module to the requirements of FCC Part 15 Subpart C §15.247 and IC 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	On-Ramp Wireless
Model Number(s)	ULPN120
FCC ID Number	XTE-ULPENODE120
IC Number	8655A-ULPENODE120
Serial Number(s)	261B0014
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2010). • 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	September 19, 2011
Finish of Test	September 21, 2011
Name of Engineer(s)	Ferdinand S. Custodio Kathy MacKenzie
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

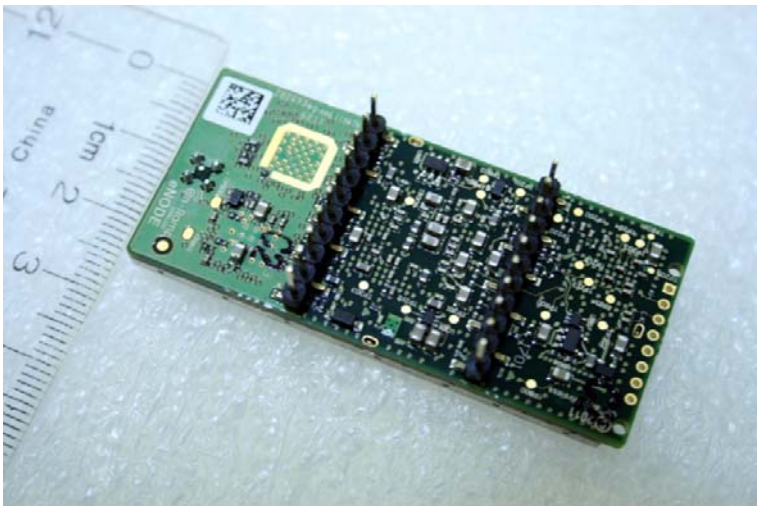
A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 with cross-reference to the corresponding IC RSS standard is shown below.

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	§15.215(c)	RSS-Gen 4.6.3	20 dB Bandwidth	Compliant	
2.4		RSS-Gen 4.6.1	99% Emission Bandwidth	Compliant	
2.5	§15.247(a)(2)	RSS-210 A8.2(a)	Minimum 6 dB RF Bandwidth	Compliant	
2.6	§15.247(d)	RSS-210 A8.5	Out-of-Band Emissions - Conducted	Compliant	
2.7	§15.247(d)	RSS-210 A8.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.8	§15.247(d)	RSS-210 A8.5	Spurious Radiated Emissions	Compliant	
2.8		RSS-Gen 4.10	Receiver Spurious Emissions	Compliant	
2.9	§15.247(e)	RSS-210 A8.2(b)	Power Spectral Density for Digitally Modulated Device	Compliant	

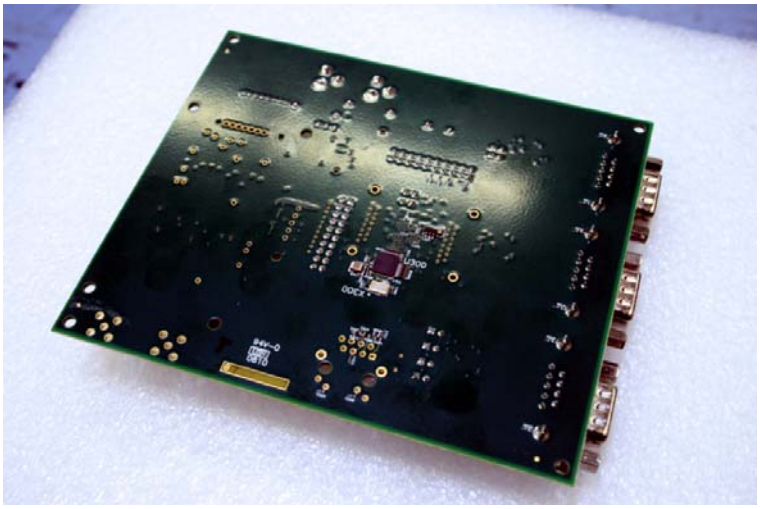
1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was an On-Ramp Wireless eNode RF Module as shown in the photograph below. The EUT is a wireless module primarily for smart grid and remote monitoring application. Typical install requires soldering into the host PCB. For testing purposes, the EUT was installed in an eHost developer board (proprietary to the client). This board provides command and control interface, power supplies, indicator LEDs, and a sturdy mounting base.



Equipment Under Test



Equipment Under Test (installed in an eHost developer board)

1.3.2 EUT General Description

EUT Description	eNode RF Module
Model Number(s)	ULPN120
Rated Voltage	EUT is a RF module, operates between 2.5VDC to 5.5VDC. Nominal voltage is 5VDC.
Output Power	151 mW
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)
Antenna Type (used during evaluation)	2.4 GHz Wireless LAN antenna.
Antenna Gain	2 dBi
EUT Antenna Connector	Type “MMCX”. Adapter provided to adapt with the test antenna.
Modulation Used	DSSS-DBPSK

1.3.3 Test Antenna Details

Model	HG2402RDR-RSP
Manufacturer	L-COM Global Connectivity
Antenna Connector	RP-SMA Connector Crimped and Soldered
General Description	Compact 2.4GHz Omni-directional “Rubber Duck” WiFi antenna
Design	Coaxial sleeve with an Omni-directional pattern
Length	79.5mm

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	EUT transmitting max power through the test antenna.
B	EUT transmitting max power, antenna port connected to the spectrum analyzer through a 20dB external attenuator.

1.4.2 EUT Exercise Software

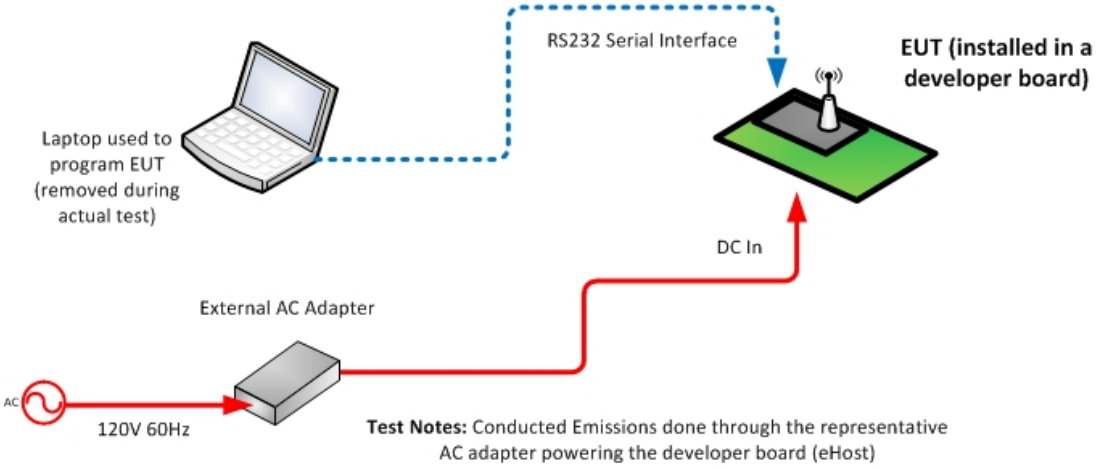
"Python Commands" software provided by the client was used to exercise the EUT. The line commands are typed and executed one at a time. Simplified example: Reset, Frequency, TX power, TX ON. Once set the EUT will continue in its configured mode until new commands are sent. Each time the EUT must change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

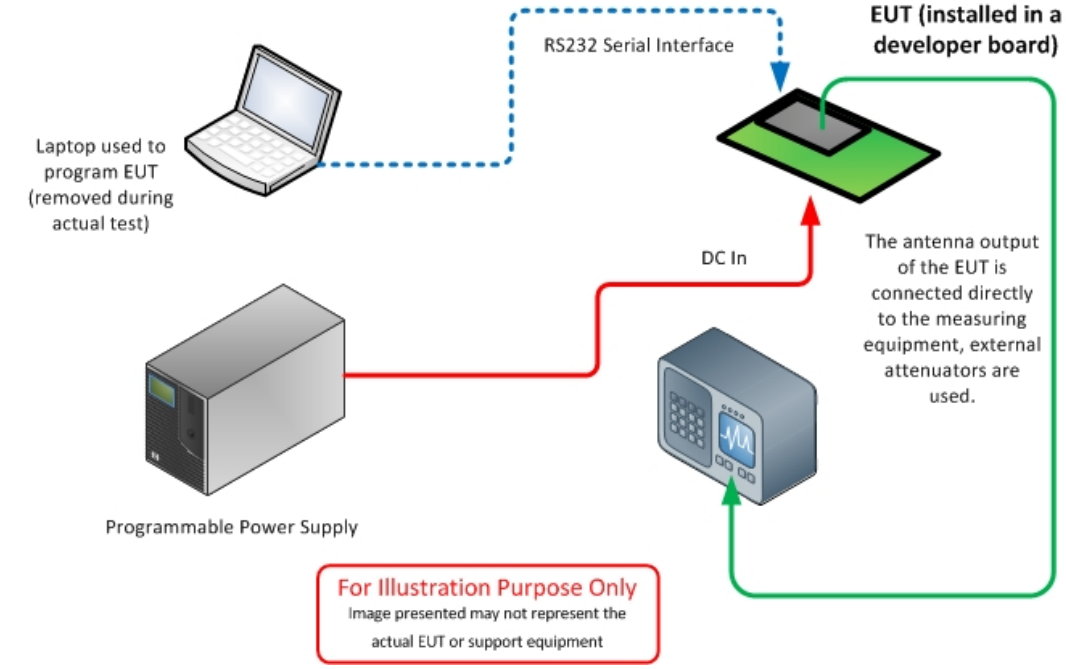
Manufacturer	Equipment/Cable	Description
On-Ramp	Support Developer Board	eHost PCA 510-0005-05/ PCB 405-0005-05 SN: 80
Dell	Support Laptop	Latitude E5500 SN: GRMMMK1 36499111345
CUI Inc.	Support AC Adapter	Model 3A-211DN05 5VDC Output 4A
-	Crossover serial cable (Between eHost and Support PC)	1.8m, standard RS232 serial cable

1.4.4 Simplified Test Configuration Diagram

Radiated/Conducted Emission Test Setup



Conducted Port Measurement Test Setup



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 261B0014		
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.: US5281

TUV SUD America Inc. (San Diego), a §2.498 listed test firm operates the EMC Laboratory registered under Sony Electronics Inc. Product Quality Division EMC. This laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files and the Registration is US5281.

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
On-Ramp Wireless
eNode RF 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: 261B0014 / Test Configuration B

2.1.4 Date of Test/Verification

September 21, 2011

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	22.2°C
Relative Humidity	63.5%
ATM Pressure	99.13 kPa

2.1.7 Additional Observations

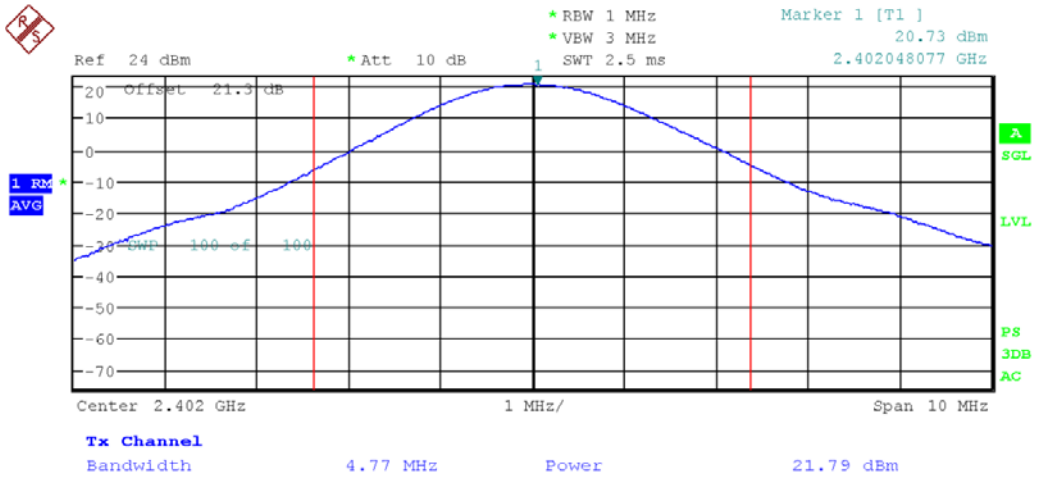
- This is a conducted test using Power Output Option 2 Method #1 FCC KDB Publication Number 558074 (Measurement of Digital Transmission System under Section 15.247 March 23, 2005).
- An offset of 21.3dB was added to compensate for the external attenuator and cable used.
- Measurements were verified at 85% of nominal (4.25VDC), nominal and 115% of nominal (5.75VDC) voltage. Nominal voltage is defined as 5VDC. However there are no significant deviations in measurement observed.
- Span was set to encompass the entire emission bandwidth of the signal.
- RBW=1MHz while VBW=3MHz.

- Sample detector used since bin width < 0.5RBW.
  = 10000000 (span)/625 (sweep points) < 0.5 (1000000)
  = 16kHz < 500kHz
- Trigger is set to “free run” as the EUT transmits continuously.
- 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 4.77MHz.

2.1.8 Test Results

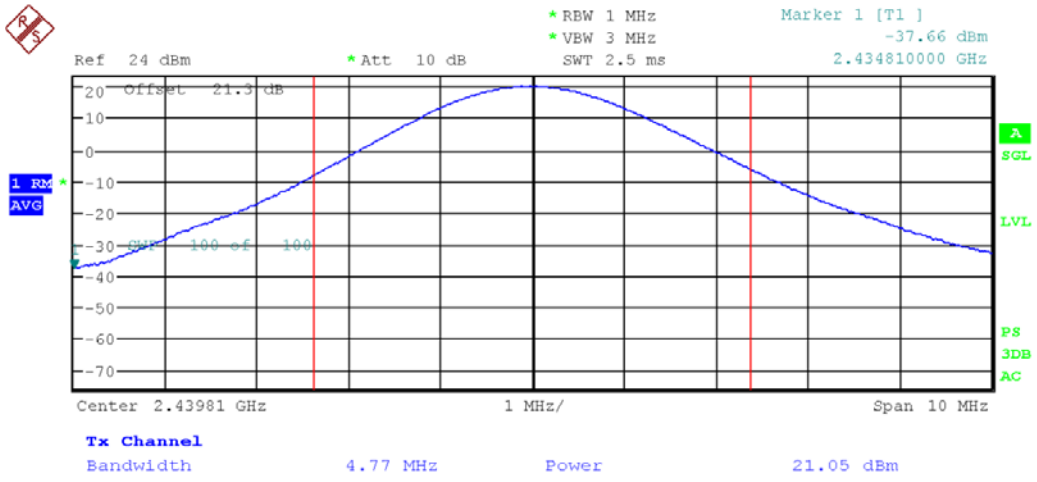
See attached table and plots

Voltage Input	Measured Power (Low Channel) dBm	Measured Power (Mid Channel) dBm	Measured Power (High Channel) dBm
4.25VDC	21.79	21.05	20.49
5.00VDC	21.79	21.05	20.49
5.75VDC	21.79	21.05	20.49



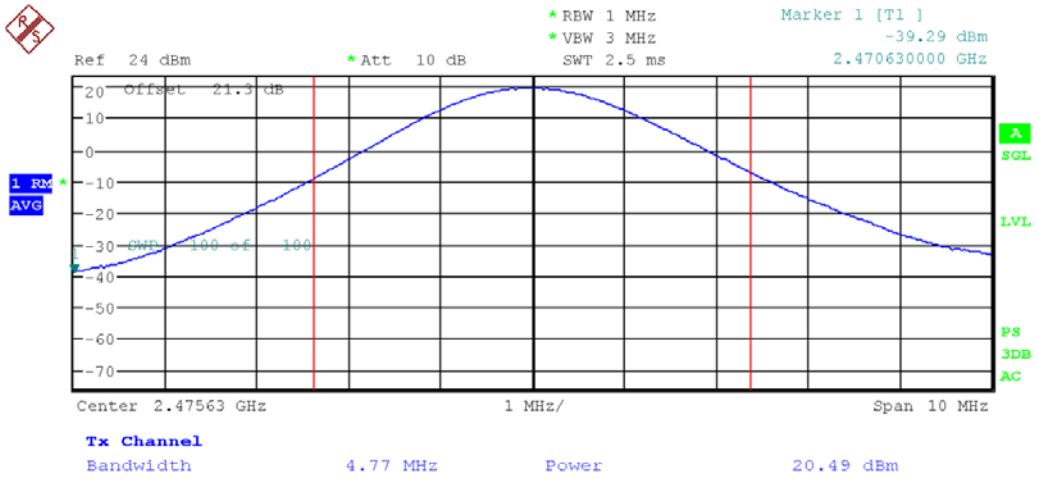
Date: 21.SEP.2011 10:07:06

Low Channel (2402 MHz)



Date: 21.SEP.2011 10:08:50

Mid Channel (2439.81 MHz)



Date: 21.SEP.2011 10:10:49

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: 261B0014 / Test Configuration A

2.2.4 Date of Test

September 20, 2011

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	22.3°C
Relative Humidity	61.2%
ATM Pressure	99.23 kPa

2.2.7 Additional Observations

- The EUT is a RF module and is not AC powered.
- To show general compliance to the present requirement, the EUT was powered by a representative AC adapter and verified.
- The EUT was verified using worst case configuration. The EUT was set to transmit max. power while plugged into the AC adapter. Only the worst channel presented.

- Measurement was done using EMC32 V8.51 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)

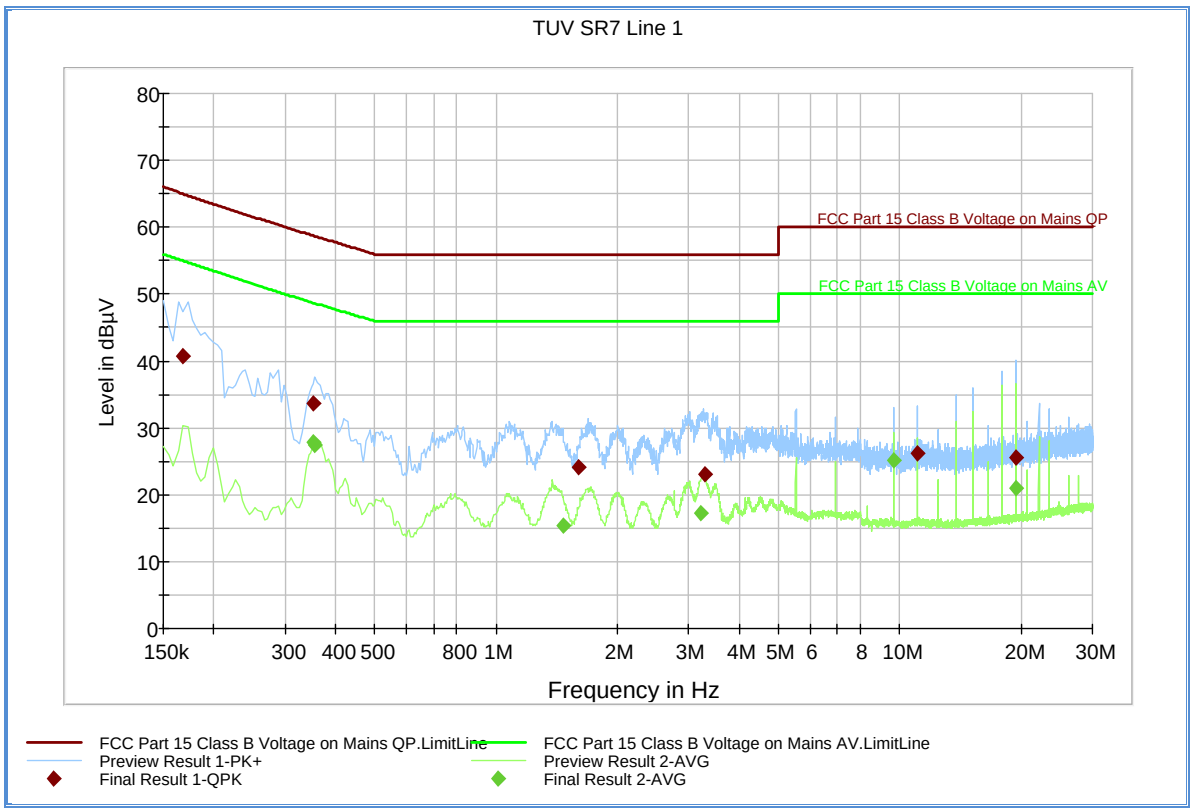
Measuring equipment raw measurement (dbµV) @ 150kHz			5.5
Correction Factor (dB)	Asset# 8607 (20 dB attenuator)	19.9	20.7
	Asset# 1177 (cable)	0.15	
	Asset# 1176 (cable)	0.35	
	Asset# 1171 (LISN)	0.30	
Reported QuasiPeak Final Measurement (dbµV) @ 150kHz			**26.2**

2.2.9 Test Results

Compliant. See attached plots and tables.

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

2.2.10 Line 1 (Hot)



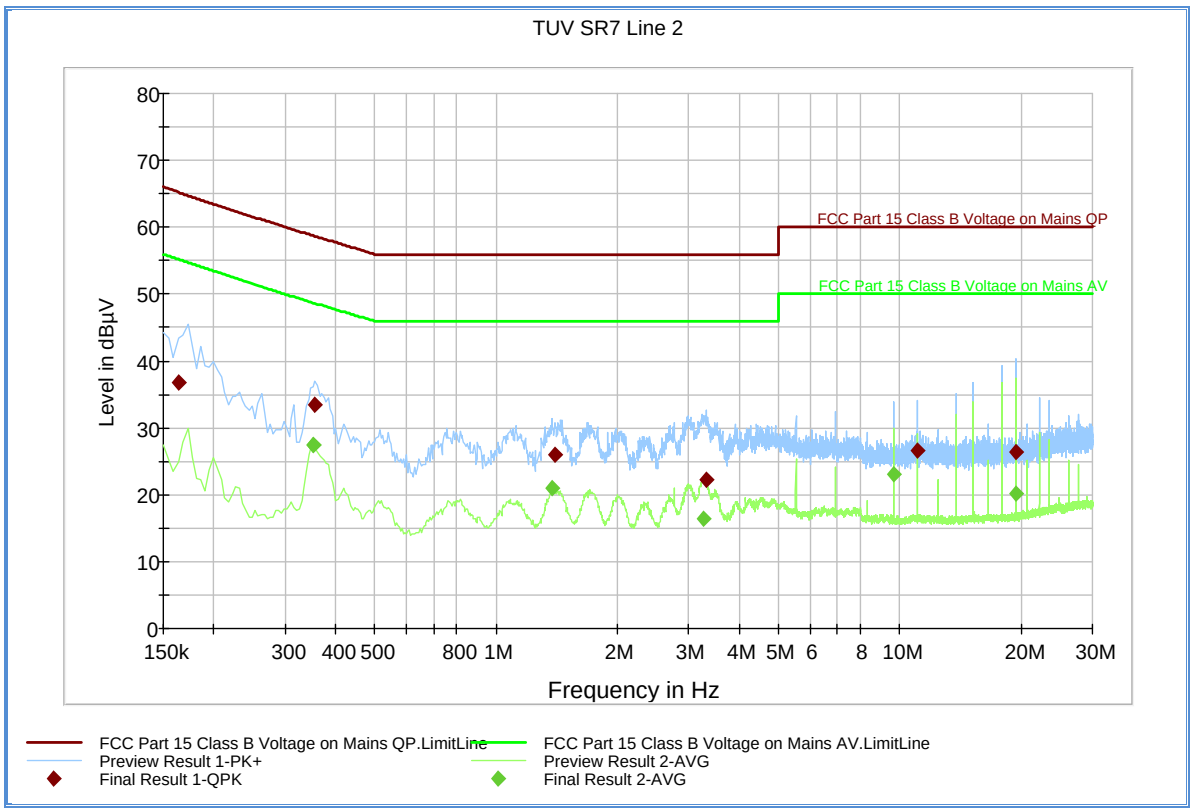
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.168000	40.6	1000.0	9.000	Off	L1	20.6	24.4	65.0
0.352500	33.6	1000.0	9.000	Off	L1	20.3	25.1	58.7
1.603500	24.2	1000.0	9.000	Off	L1	20.1	31.8	56.0
3.300000	23.1	1000.0	9.000	Off	L1	20.2	32.9	56.0
11.071500	26.1	1000.0	9.000	Off	L1	20.4	33.9	60.0
19.374000	25.5	1000.0	9.000	Off	L1	20.7	34.5	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit – Ave (dBµV)
0.352500	27.8	1000.0	9.000	Off	L1	20.3	20.9	48.7
0.357000	27.5	1000.0	9.000	Off	L1	20.3	21.1	48.6
1.468500	15.5	1000.0	9.000	Off	L1	20.1	30.5	46.0
3.214500	17.2	1000.0	9.000	Off	L1	20.2	28.8	46.0
9.685500	25.1	1000.0	9.000	Off	L1	20.4	24.9	50.0
19.374000	21.1	1000.0	9.000	Off	L1	20.7	28.9	50.0

2.2.11 Line 2 (Neutral)



Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.163500	36.8	1000.0	9.000	Off	N	21.0	28.4	65.2
0.357000	33.4	1000.0	9.000	Off	N	20.7	25.3	58.6
1.401000	26.0	1000.0	9.000	Off	N	20.5	30.0	56.0
3.331500	22.3	1000.0	9.000	Off	N	20.6	33.7	56.0
11.067000	26.7	1000.0	9.000	Off	N	20.8	33.3	60.0
19.369500	26.4	1000.0	9.000	Off	N	21.1	33.6	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit – Ave (dBµV)
0.352500	27.3	1000.0	9.000	Off	N	20.7	21.4	48.7
0.352500	27.4	1000.0	9.000	Off	N	20.7	21.3	48.7
1.383000	21.0	1000.0	9.000	Off	N	20.5	25.0	46.0
3.255000	16.5	1000.0	9.000	Off	N	20.6	29.5	46.0
9.681000	23.1	1000.0	9.000	Off	N	20.8	26.9	50.0
19.374000	20.1	1000.0	9.000	Off	N	21.1	29.9	50.0

2.3 20 dB BANDWIDTH

2.3.1 Specification Reference

Part 15 Subpart C §15.215(c)

2.3.2 Standard Applicable

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

2.3.3 Equipment Under Test and Modification State

Serial No: 261B0014 / Test Configuration B

2.3.4 Date of Test/Verification

September 21, 2011

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	22.2°C
Relative Humidity	63.5%
ATM Pressure	99.13 kPa

2.3.7 Additional Observations

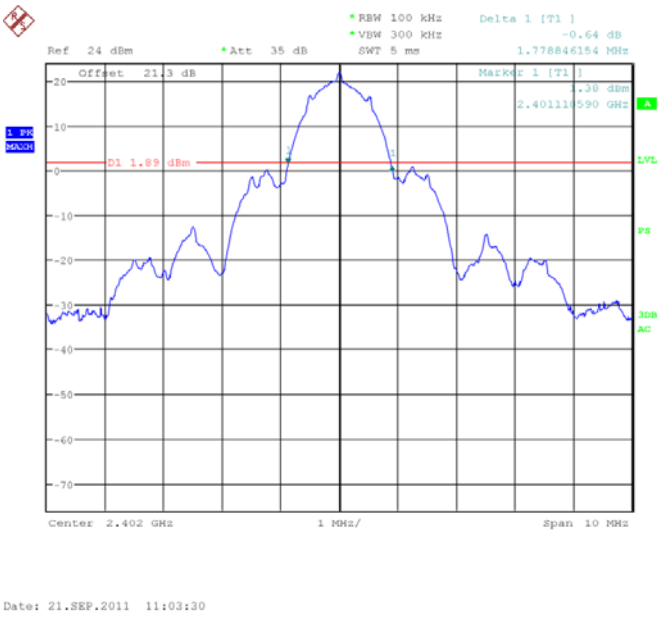
- This is a conducted test.
- An offset of 21.3dB was added to compensate for the external attenuator and cable used.
- A peak output reading was taken. A display line was drawn 20dB below the peak level.
- 20dB bandwidth verified using delta-marker measurements from the line drawn.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.
- Sweep is auto.

- Detector is peak.
- Trace is max hold.

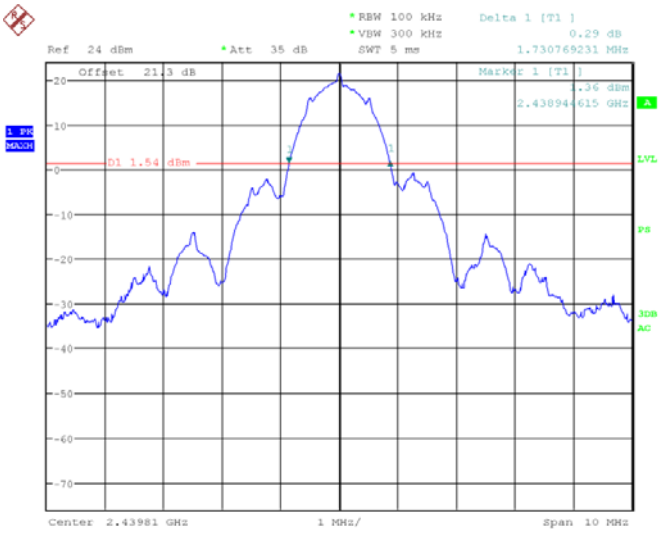
2.3.8 Test Results

Low Channel (2402 MHz)	Mid Channel (2439.81 MHz)	High Channel (2475.63 MHz)
1.78 MHz	1.73 MHz	1.71 MHz

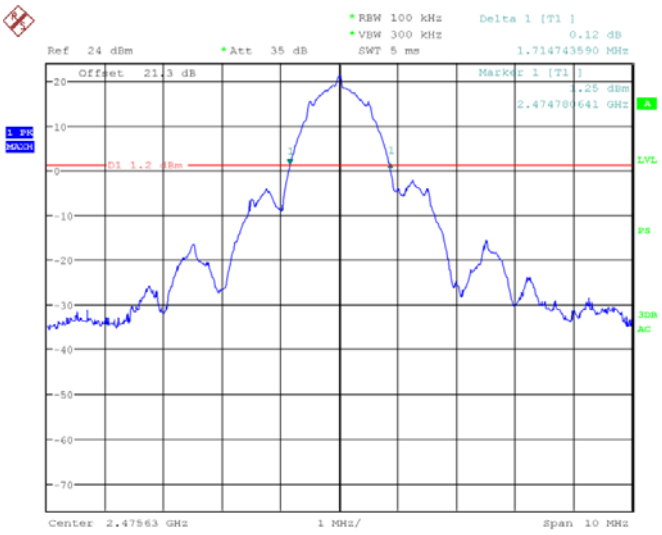
2402.00 MHz – (20dB BW/2) = 2401.11MHz (within the frequency band - **Compliant**)
2475.63 MHz + (20dB BW/2) = 2476.52 MHz (within the frequency band - **Compliant**)



Low Channel



Mid Channel



High Channel

2.4 99% EMISSION BANDWIDTH

2.4.1 Specification Reference

RSS-Gen Clause 4.6.1

2.4.2 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.

2.4.3 Equipment Under Test and Modification State

Serial No: 261B0014 / Test Configuration B

2.4.4 Date of Test/Verification

September 21, 2011

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	22.2°C
Relative Humidity	63.5%
ATM Pressure	99.13 kPa

2.4.7 Additional Observations

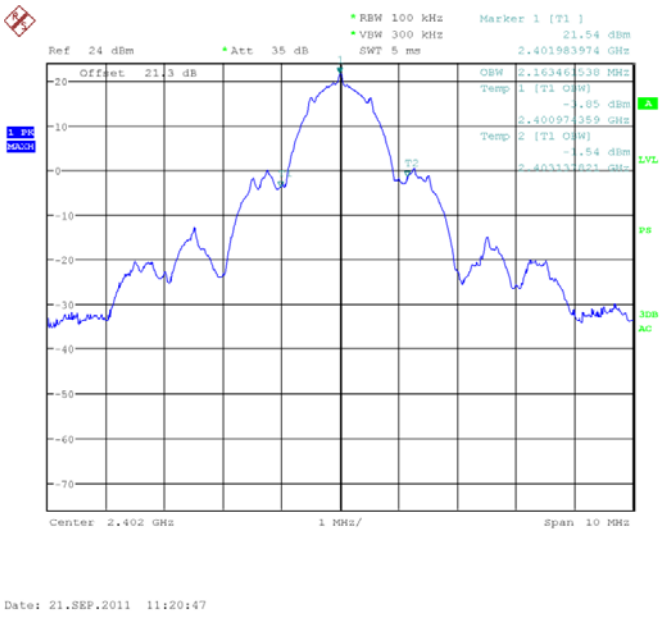
- This is a conducted test.
- An offset of 21.3dB was added to compensate for the external attenuator and cable used.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.

- The % Power Bandwidth setting in the spectrum analyzer was set to 99% (default).
- The Channel Bandwidth measurement function of the spectrum analyzer was used for this test.

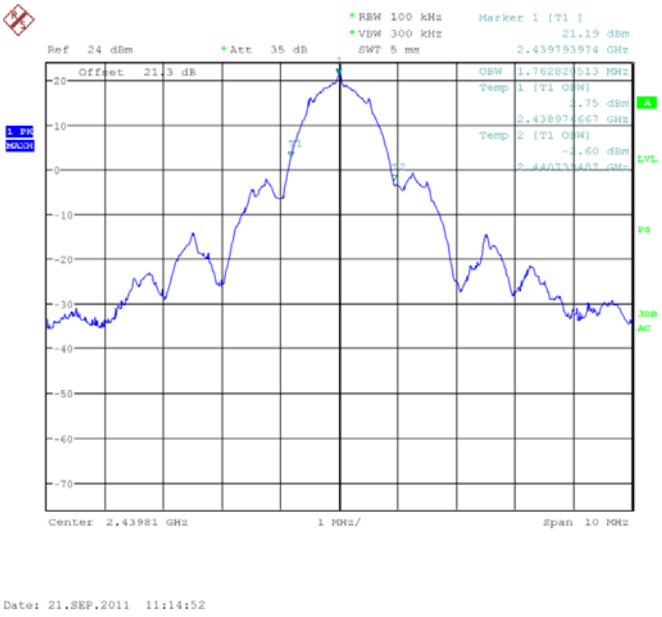
2.4.8 Test Results

Low Channel (2402 MHz)	Mid Channel (2439.81 MHz)	High Channel (2475.63 MHz)
2.16 MHz	1.76 MHz	1.63 MHz

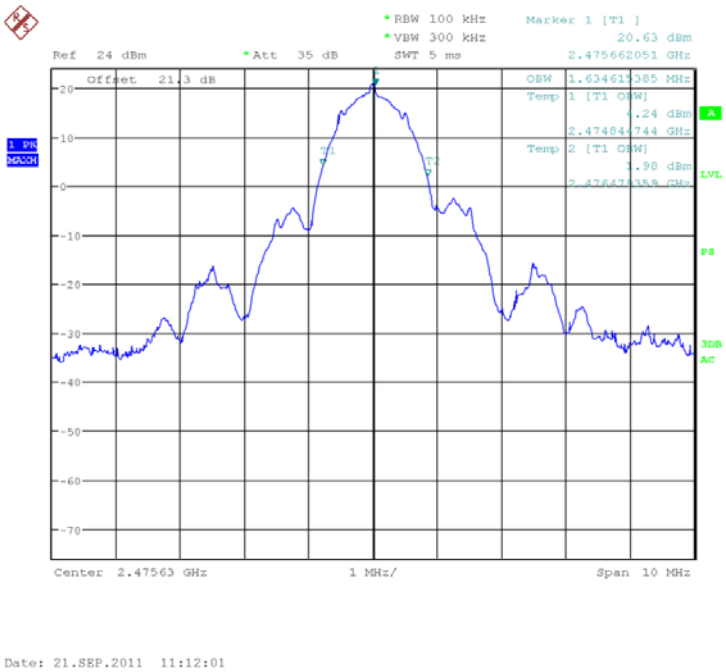
2402.00 MHz – (20dB BW/2) = 2400.92MHz (within the frequency band - **Compliant**)
2475.63 MHz + (20dB BW/2) = 2476.71 MHz (within the frequency band - **Compliant**)



Low Channel



Mid Channel



High Channel

2.5 MINIMUM 6 dB RF BANDWIDTH

2.5.1 Specification Reference

Part 15 Subpart C §15.247(a)(2)

2.5.2 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.

2.5.3 Equipment Under Test and Modification State

Serial No:261B0014 / Test Configuration B

2.5.4 Date of Test/Verification

September 21, 2011

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

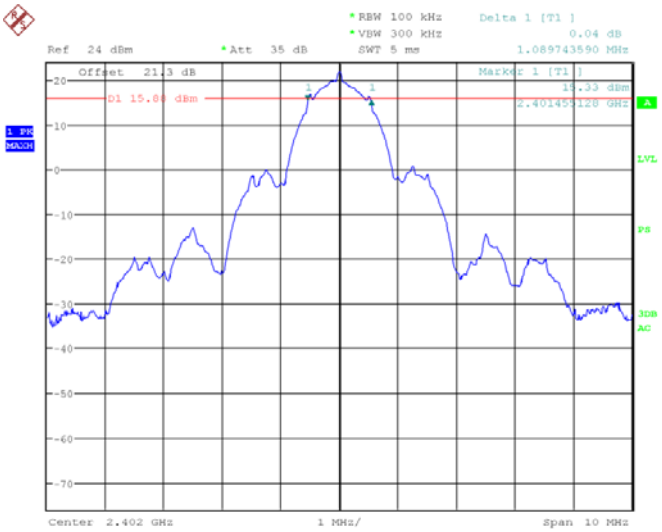
Ambient Temperature	22.2°C
Relative Humidity	63.5%
ATM Pressure	99.13 kPa

2.5.7 Additional Observations

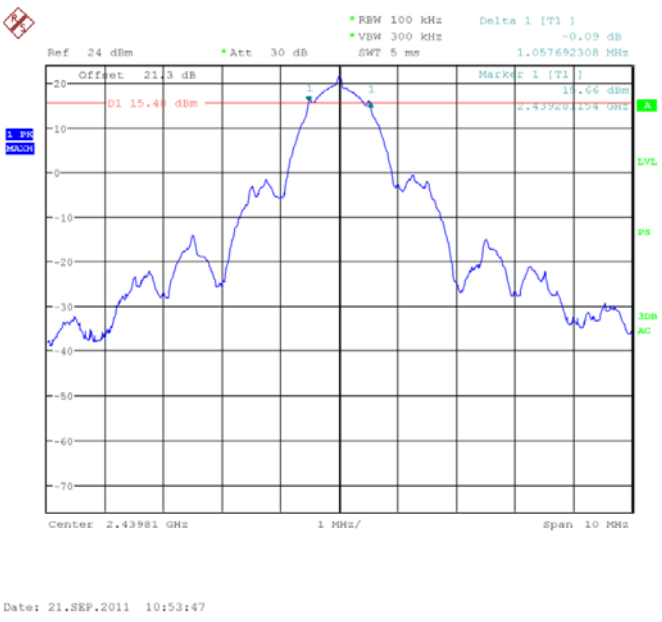
- This is a conducted test.
- An offset of 21.3dB was added to compensate for the external attenuator and cable used.
- A peak output reading was taken. A display line was drawn 6dB below the peak level.
- 6dB bandwidth verified using delta-marker measurements from the line drawn.
- Span is wide enough to capture the channel transmission.
- RBW is 100kHz.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- Trace is max hold.

2.5.8 Test Results

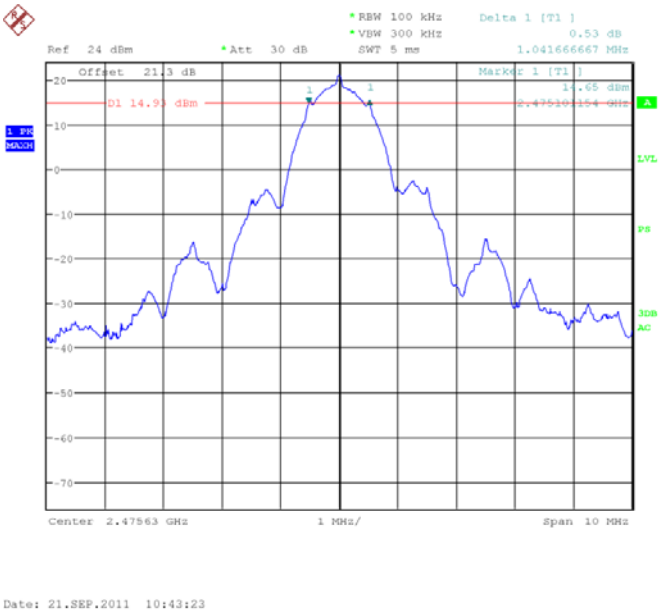
Low Channel (2402 MHz)	Mid Channel (2439.81 MHz)	High Channel (2475.63 MHz)
1.09 MHz	1.06 MHz	1.04 MHz



Low Channel



Mid Channel



High Channel

2.6 OUT-OF-BAND EMISSIONS - CONDUCTED

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.6.2 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)).

2.6.3 Equipment Under Test and Modification State

Serial No:261B0014 / Test Configuration B

2.6.4 Date of Test/Verification

September 21, 2011

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	22.2°C
Relative Humidity	63.5%
ATM Pressure	99.13 kPa

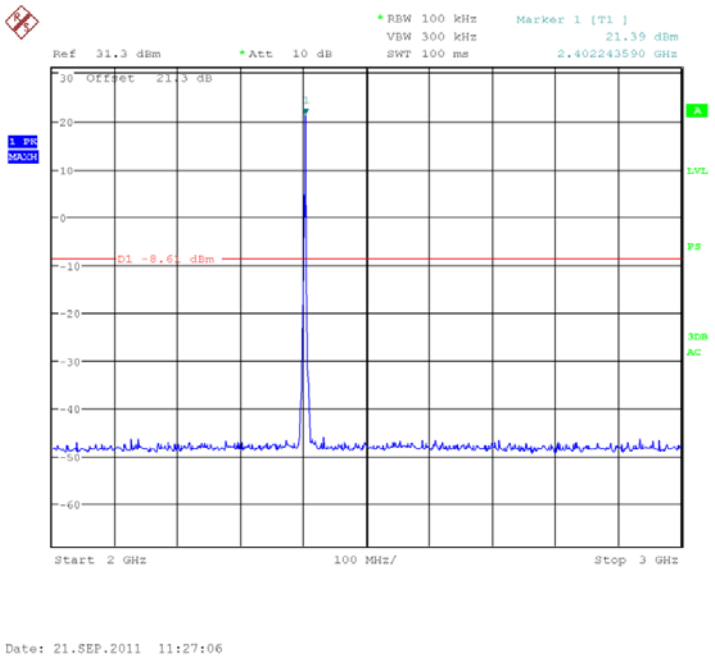
2.6.7 Additional Observations

- This is a conducted test.
- An offset of 21.3dB 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.

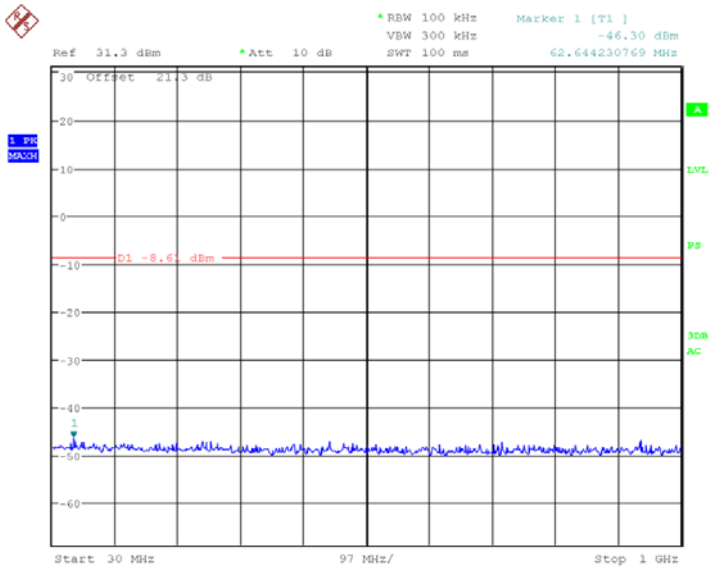
- Initial scan was performed to determine the highest level of the desired power within the band. Limit (display line) was drawn 30dB below this level.
- Spectrum was searched from 30MHz up to 26.5GHz.

2.6.8 Test Results

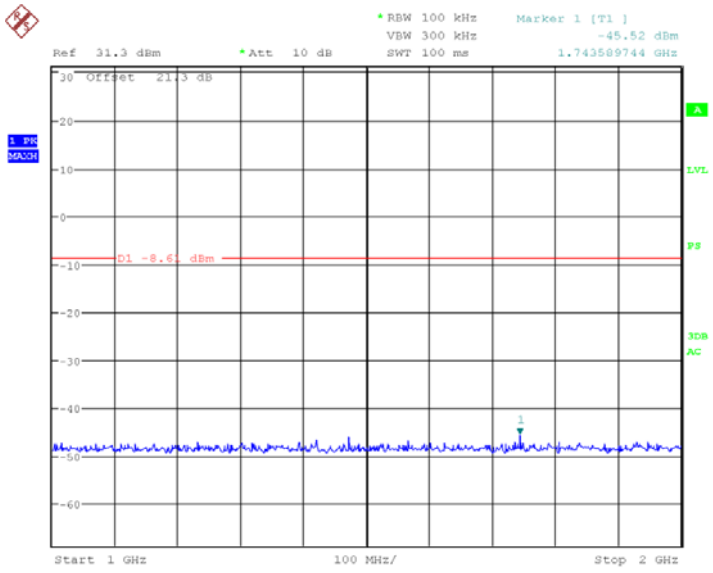
See attached plots.



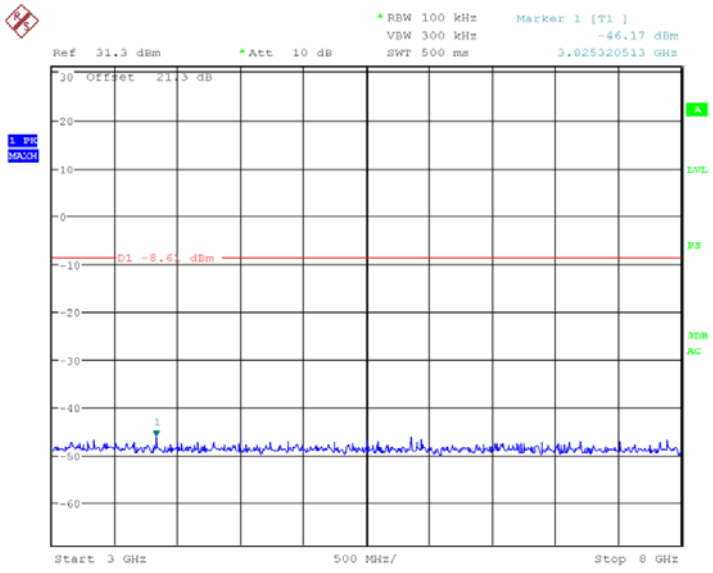
Low Channel (2 to 3GHz)



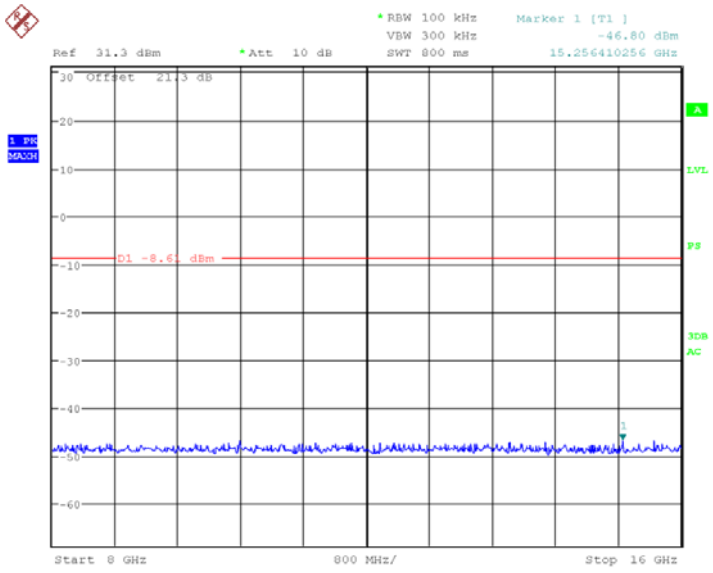
Low Channel (30MHz to 1GHz)



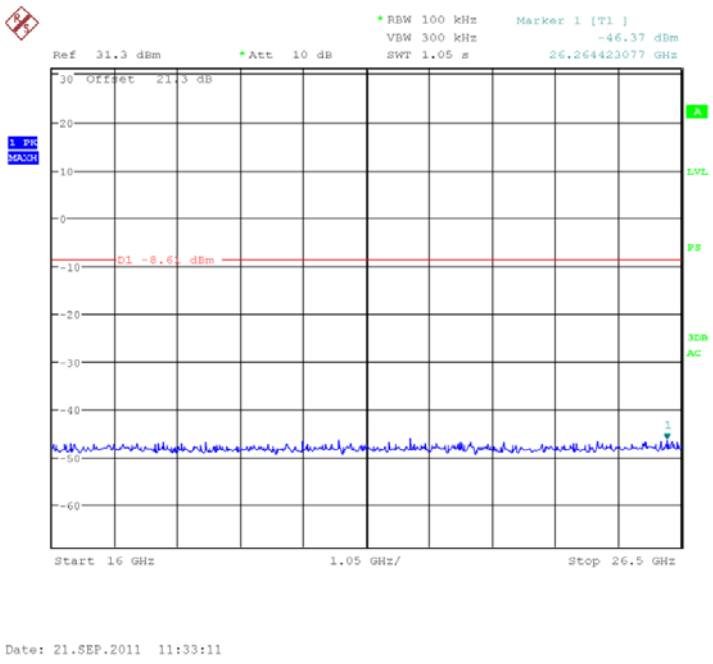
Low Channel (1GHz to 2GHz)



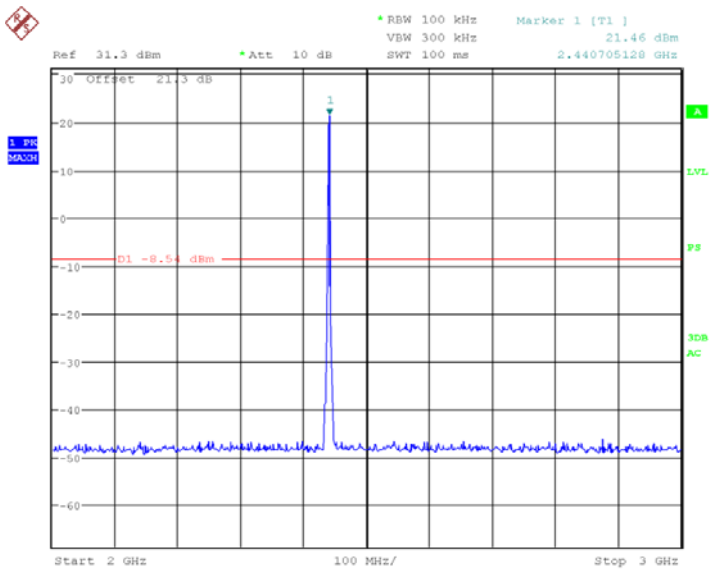
Low Channel (3GHz to 8GHz)



Low Channel (8GHz to 16GHz)

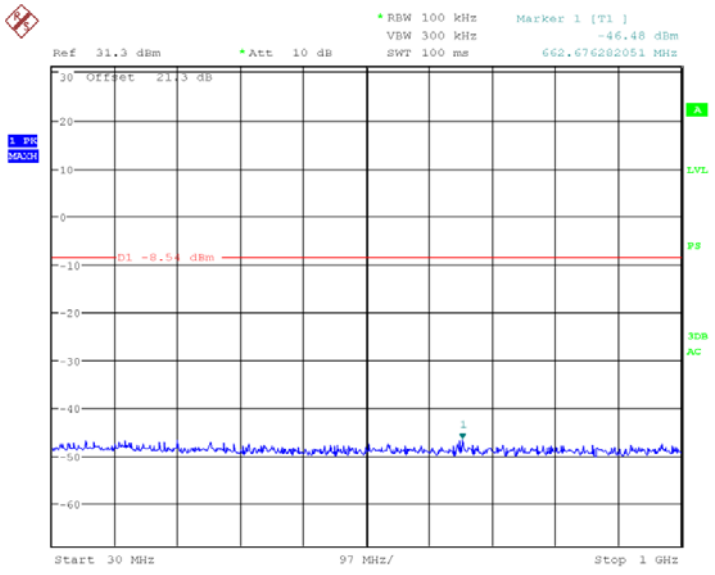


Low Channel (16GHz to 26.5GHz)



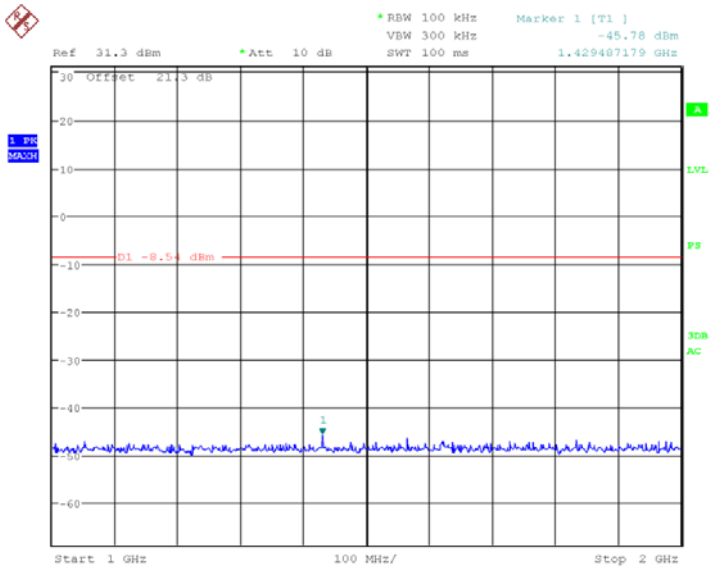
Date: 21.SEP.2011 11:35:10

Mid Channel (2GHz to 3GHz)

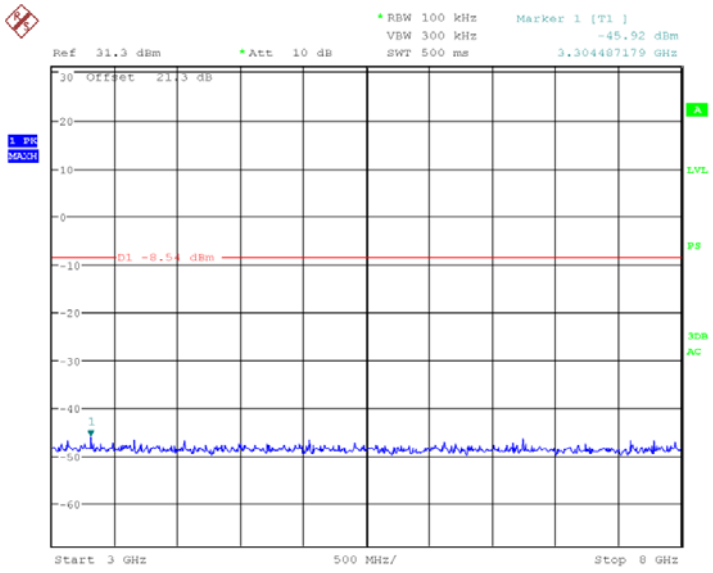


Date: 21.SEP.2011 11:36:15

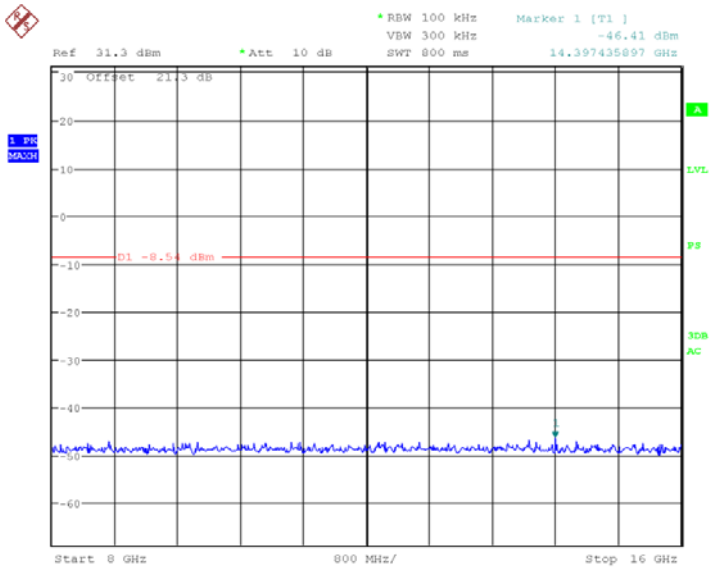
Mid Channel (30MHz to 1GHz)



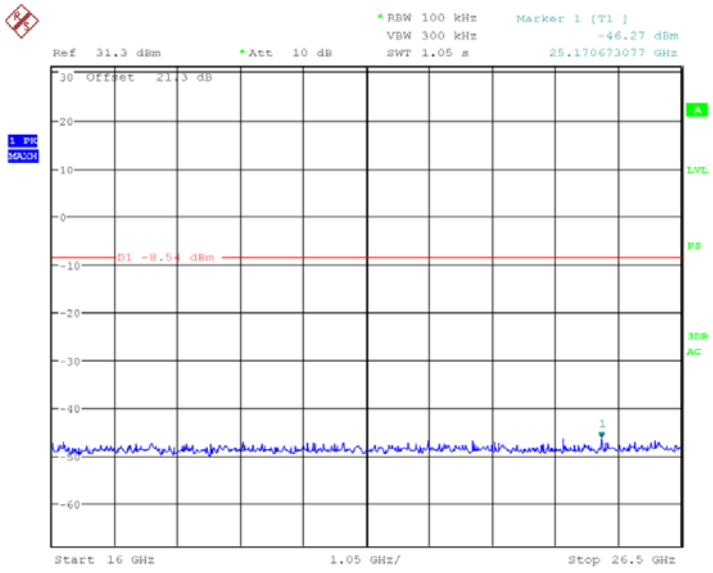
Mid Channel (1GHz to 2GHz)



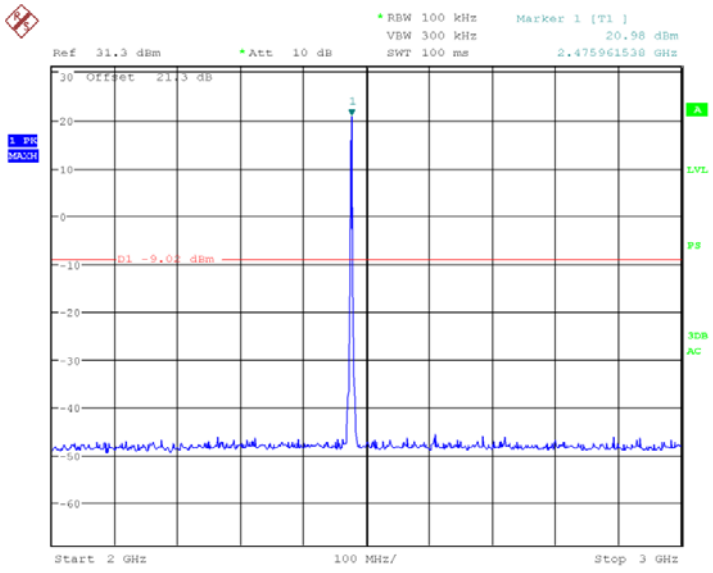
Mid Channel (3GHz to 8GHz)



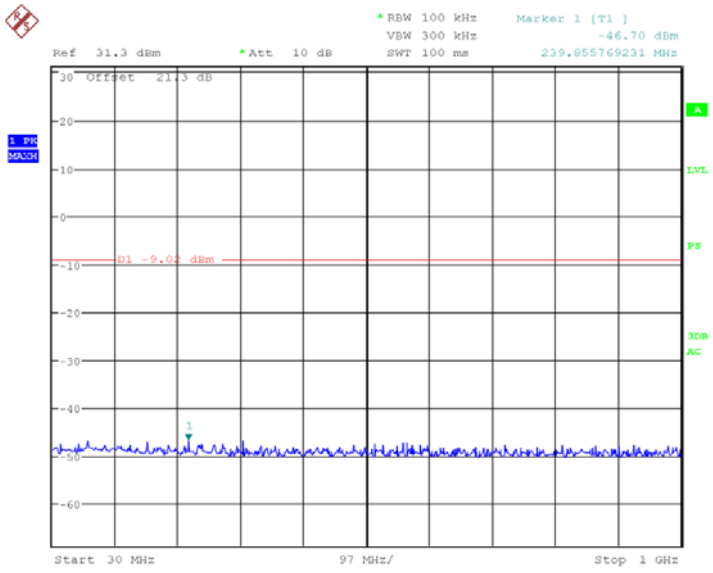
Mid Channel (8GHz to 16GHz)



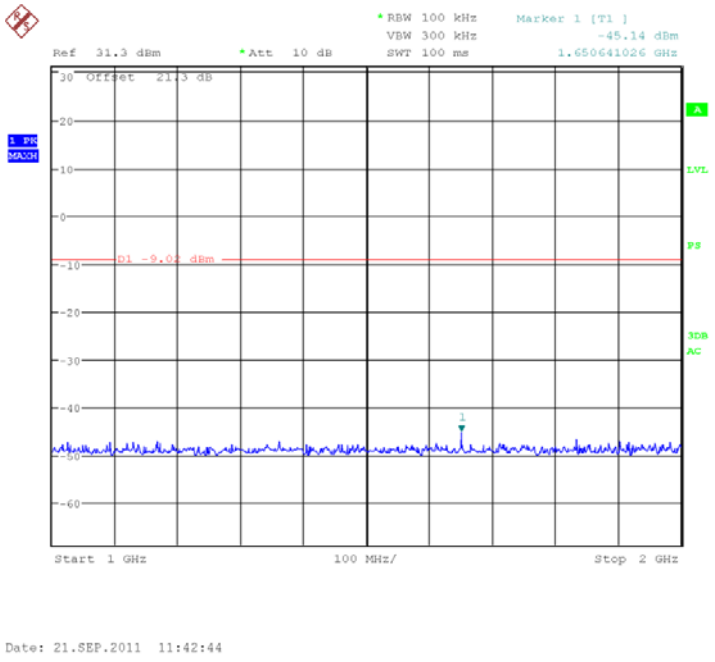
Mid Channel (16GHz to 26.5GHz)



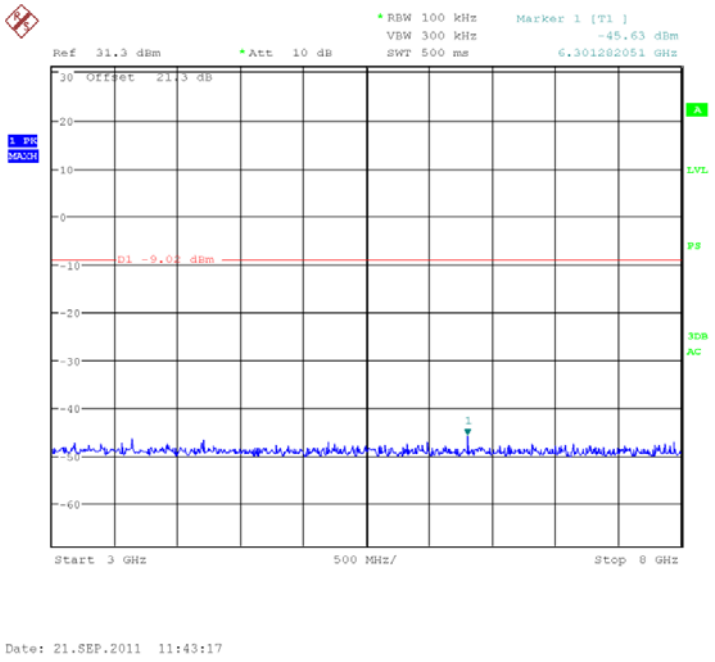
High Channel (2GHz to 3GHz)



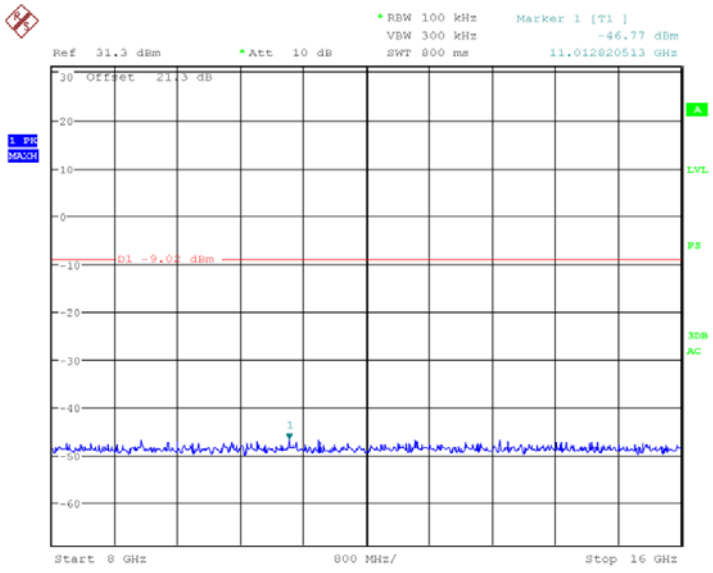
High Channel (30MHz to 1GHz)



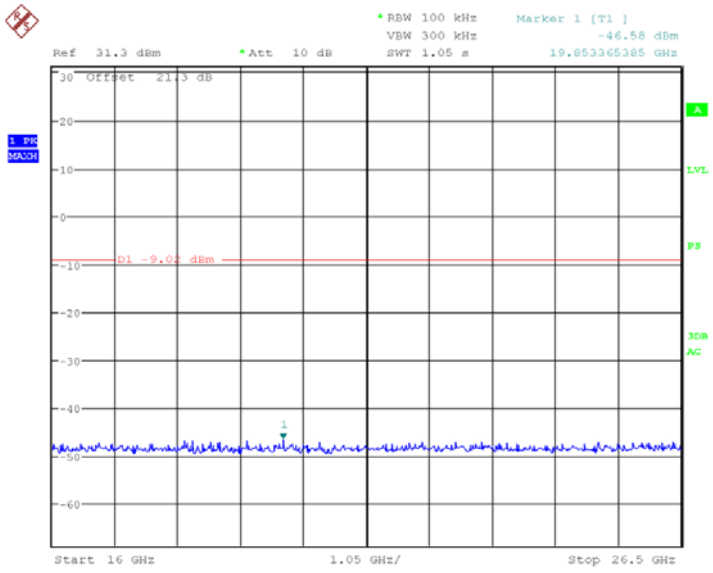
High Channel (1GHz to 2GHz)



High Channel (3GHz to 8GHz)



High Channel (8GHz to 16GHz)



High Channel (16GHz to 26.5GHz)

2.7 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.7.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.7.2 Standard Applicable

See previous test.

2.7.3 Equipment Under Test and Modification State

Serial No:261B0014 / Test Configuration B

2.7.4 Date of Test/Verification

September 21, 2011

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

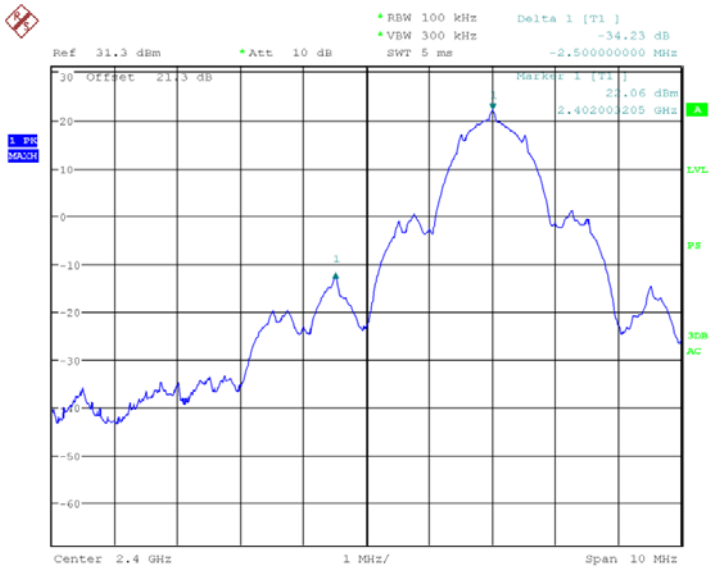
Ambient Temperature	22.2°C
Relative Humidity	63.5%
ATM Pressure	99.13 kPa

2.7.7 Additional Observations

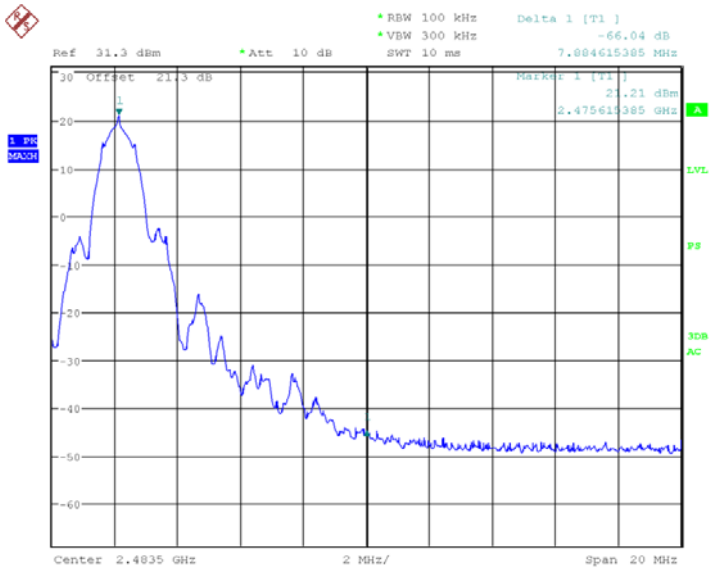
- Setup is identical to “Out-of-Band Emissions – Conducted“ test (previous test).
- Band-edge (2400MHz and 2483.5MHz) emissions were verified in this test.
- The spectrum analyzer was centred on the band-edge frequency while setting the EUT to the corresponding transmit channel (i.e. Low Channel for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

2.7.8 Test Results

Complies. See attached plots.



Lower Band-Edge



Higher Band-Edge

2.8 SPURIOUS RADIATED EMISSIONS

2.8.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.8.2 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)).

2.8.3 Equipment Under Test and Modification State

Serial No: 261B0014 / Test Configuration A

2.8.4 Date of Test/Verification

September 19 and 21, 2011

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	22.5°C
Relative Humidity	63.8%
ATM Pressure	99.05 kPa

2.8.7 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 V8.51 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 2.8.8 for sample computation.

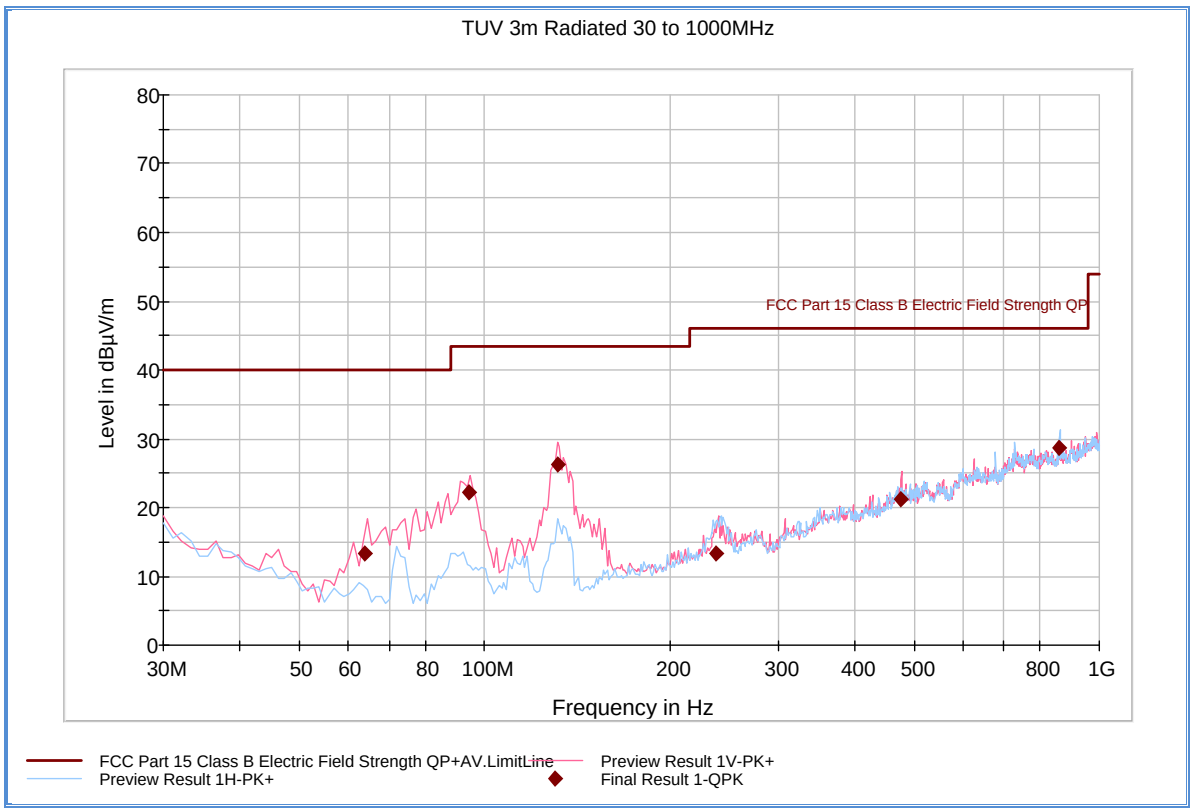
2.8.8 Sample Computation (Radiated Emission)

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**

2.8.9 Test Results

See attached plots.

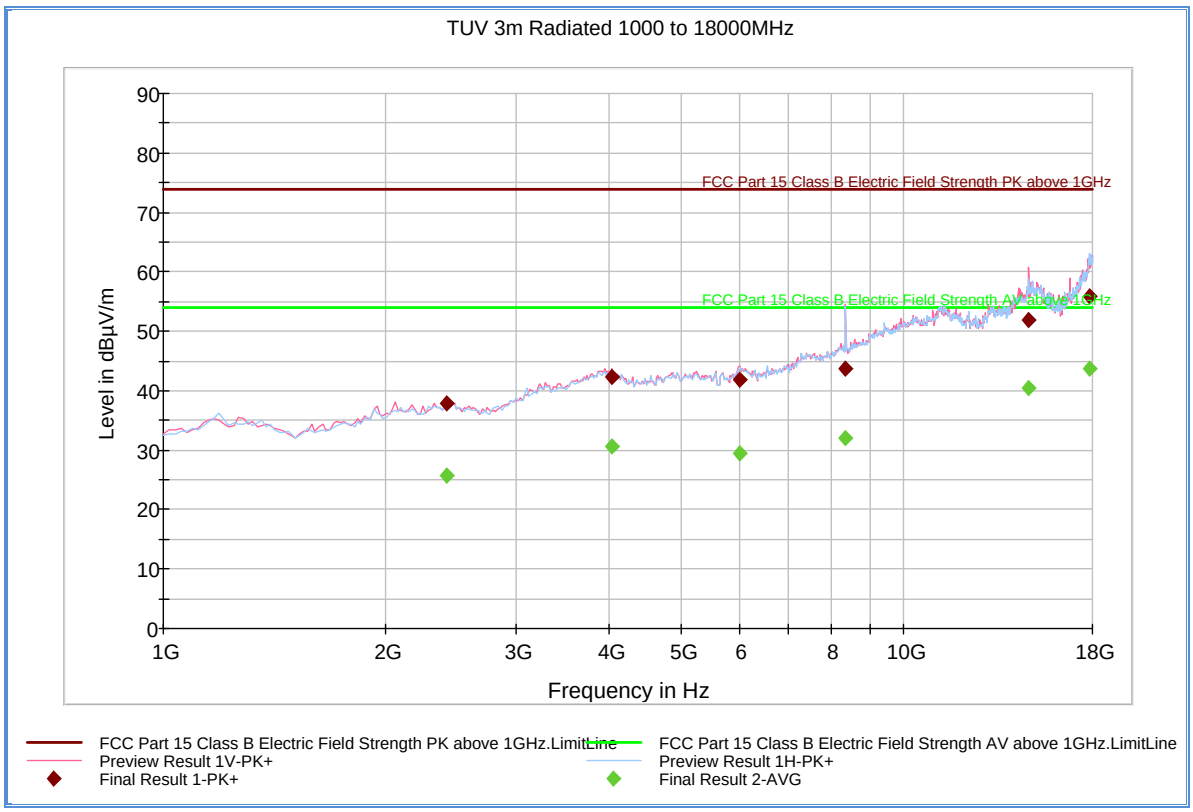
2.8.10 Test Results Below 1GHz (Receive Mode)



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)
63.928889	13.2	1000.0	120.000	100.0	V	245.0	-22.4	26.8	40.0
94.386667	22.3	1000.0	120.000	147.0	V	315.0	-21.0	21.2	43.5
131.671111	26.3	1000.0	120.000	100.0	V	112.0	-21.3	17.2	43.5
238.126667	13.2	1000.0	120.000	113.0	V	324.0	-14.4	32.8	46.0
475.037778	21.3	1000.0	120.000	100.0	V	74.0	-6.8	24.7	46.0
861.682222	28.7	1000.0	120.000	264.0	H	317.0	-1.5	17.3	46.0

2.8.11 Test Results Above 1GHz (Receive Mode)



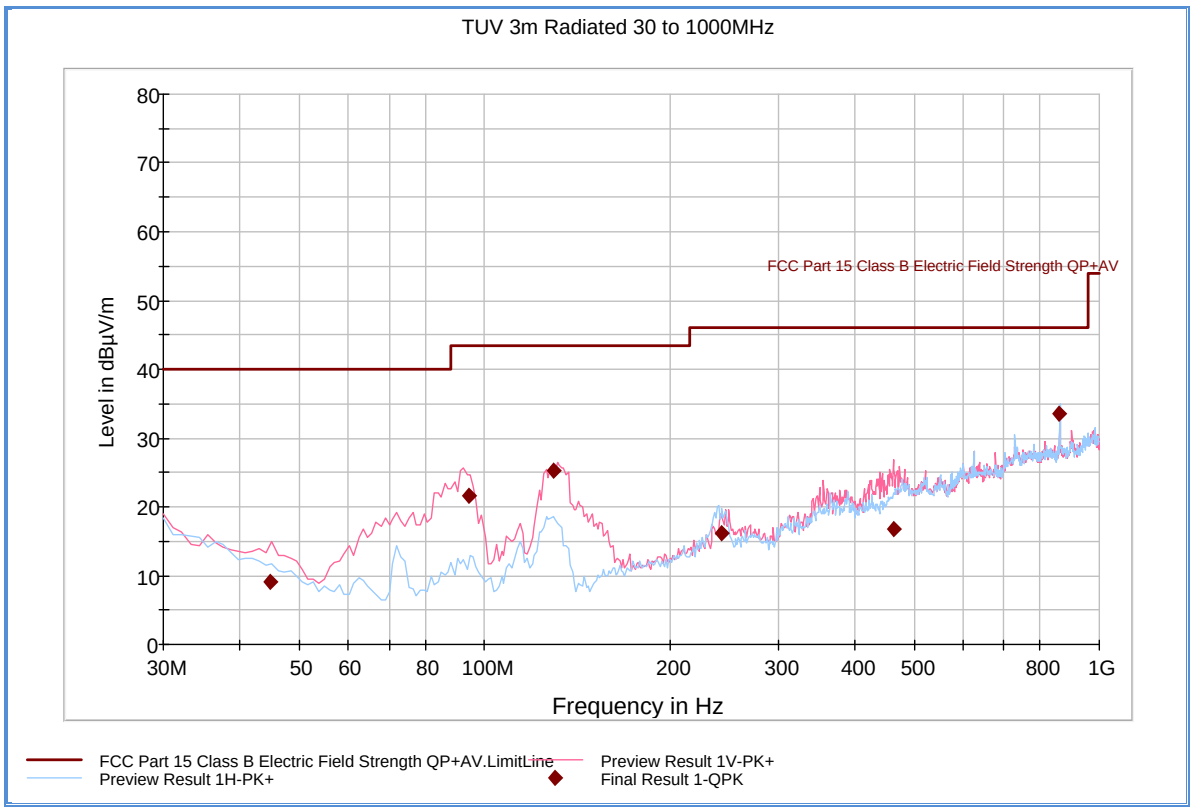
Peak Data

Frequency (MHz)	Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2415.846667	37.8	100.0	1000.000	258.0	H	214.0	-3.2	36.1	73.9
4042.651111	42.4	100.0	1000.000	336.0	V	309.0	5.2	31.5	73.9
6007.295556	41.9	100.0	1000.000	284.0	V	160.0	7.4	32.0	73.9
8348.477778	43.8	100.0	1000.000	374.0	V	277.0	12.6	30.1	73.9
14775.38000	51.8	100.0	1000.000	100.0	V	175.0	27.8	22.1	73.9
17817.61111	55.9	100.0	1000.000	100.0	H	215.0	35.0	18.0	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)
2415.846667	25.6	100.0	1000.000	258.0	H	214.0	-3.2	28.3	53.9
4042.651111	30.7	100.0	1000.000	336.0	V	309.0	5.2	23.2	53.9
6007.295556	29.6	100.0	1000.000	284.0	V	160.0	7.4	24.3	53.9
8348.477778	32.0	100.0	1000.000	374.0	V	277.0	12.6	21.9	53.9
14775.38000	40.4	100.0	1000.000	100.0	V	175.0	27.8	13.5	53.9
17817.61111	43.8	100.0	1000.000	100.0	H	215.0	35.0	10.1	53.9

2.8.12 Test Results Below 1GHz (Low Channel – Worst Case Configuration)

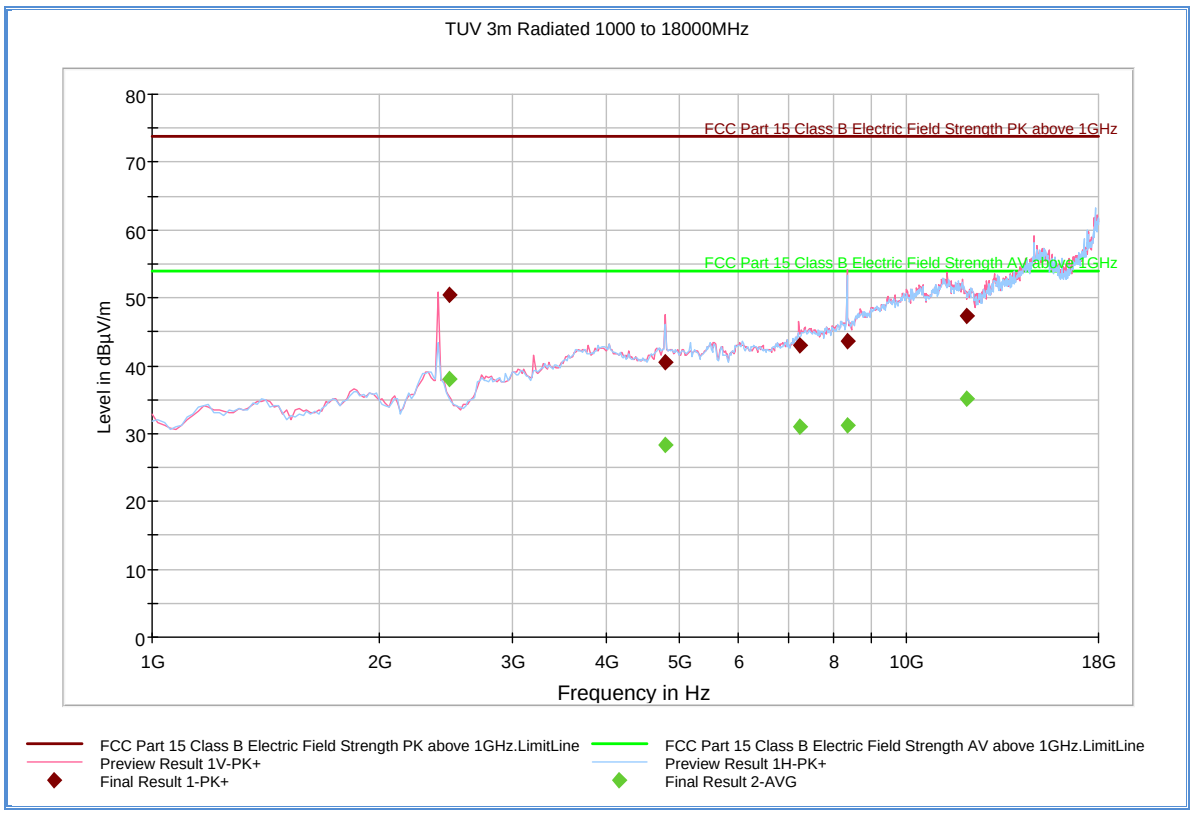


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
44.848889	9.1	1000.0	120.000	111.0	V	308.0	-19.3	30.9	40.0
94.468889	21.6	1000.0	120.000	132.0	V	314.0	-21.0	21.9	43.5
129.231111	25.2	1000.0	120.000	106.0	V	103.0	-21.4	18.3	43.5
242.486667	16.3	1000.0	120.000	185.0	H	223.0	-14.2	29.7	46.0
462.268889	16.7	1000.0	120.000	134.0	V	110.0	-8.0	29.3	46.0
861.680000	33.6	1000.0	120.000	287.0	H	266.0	-1.5	12.4	46.0

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

2.8.13 Test Results Above 1GHz (Low Channel including Band Edges)



Peak Data

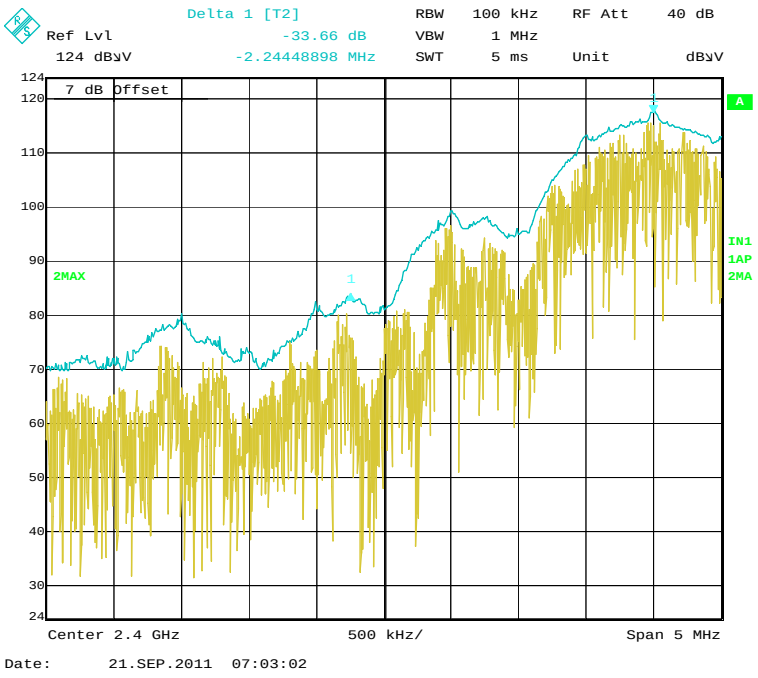
Frequency (MHz)	Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	50.5	100.0	1000.000	104.0	V	110.0	7.8	23.4	73.9
4795.926667	40.5	100.0	1000.000	107.0	V	237.0	4.8	33.4	73.9
7216.264444	43.0	100.0	1000.000	174.0	V	111.0	10.4	30.9	73.9
8351.037778	43.5	100.0	1000.000	130.0	V	179.0	12.6	30.4	73.9
12013.28222	47.3	100.0	1000.000	375.0	V	15.0	20.8	26.6	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	38.0	100.0	1000.000	104.0	V	110.0	7.8	15.9	53.9
4795.926667	28.3	100.0	1000.000	107.0	V	237.0	4.8	25.6	53.9
7216.264444	31.0	100.0	1000.000	174.0	V	111.0	10.4	23.0	53.9
8351.037778	31.3	100.0	1000.000	130.0	V	179.0	12.6	22.6	53.9
12013.28222	35.2	100.0	1000.000	375.0	V	15.0	20.8	18.7	53.9

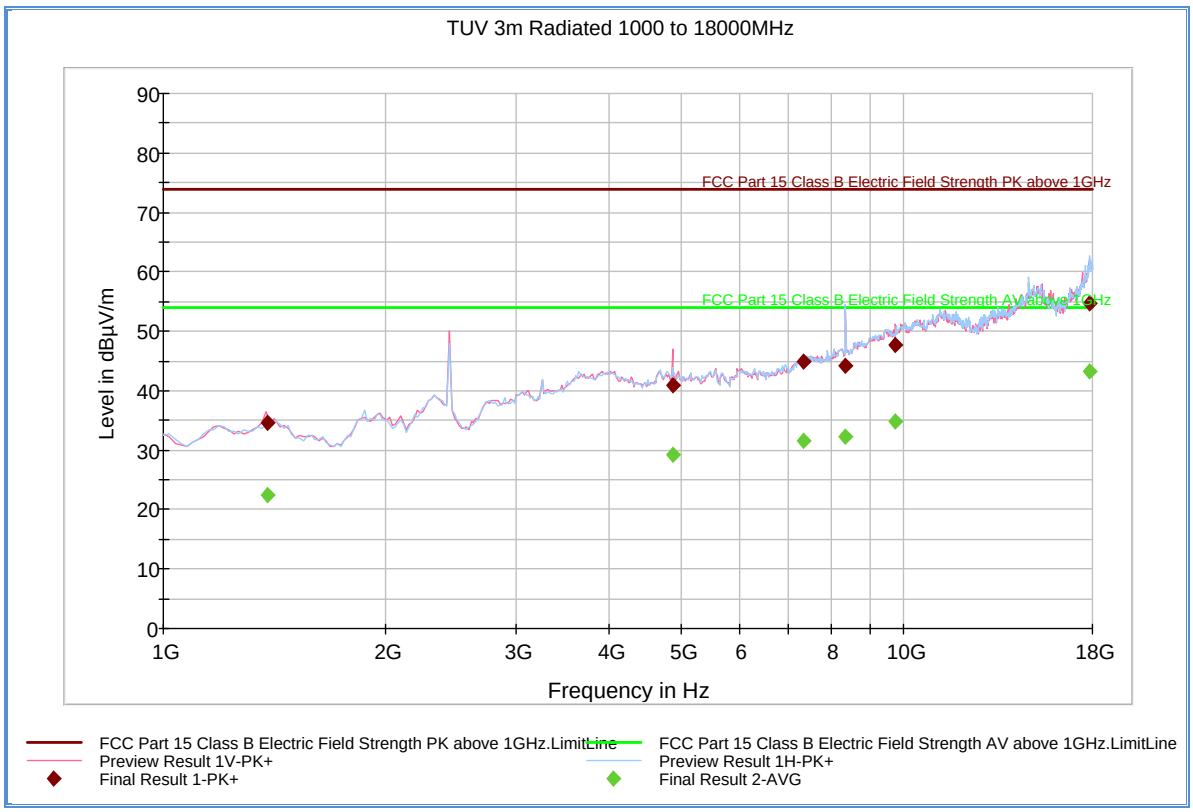
Test Notes: Measurement was performed with a 2.4GHz notch filter. Band edge measurements were performed with the notch filter removed. Lower band edge was verified manually using 100kHz RBW (see attached plot Section 2.8.14).

2.8.14 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 7dB 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 -33.66dBc. EUT complies.

2.8.15 Test Results Above 1GHz (Mid Channel)



Peak Data

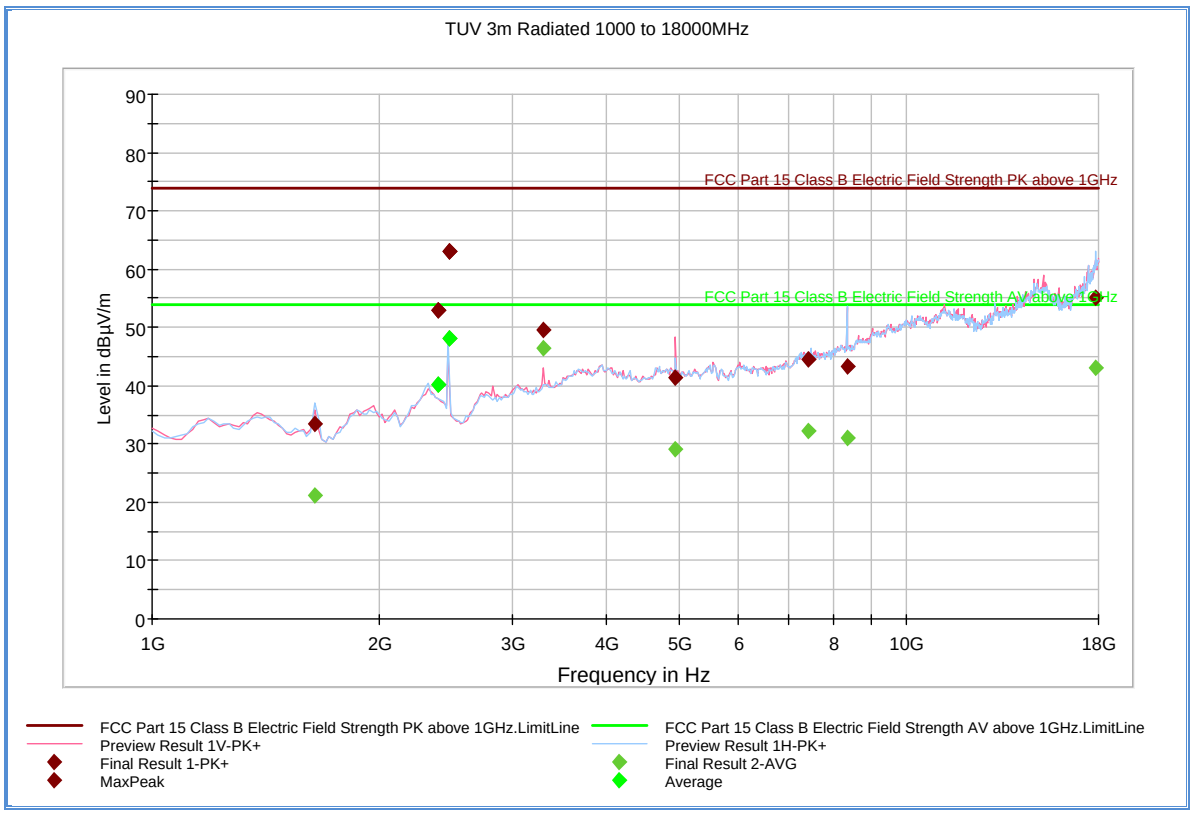
Frequency (MHz)	Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1382.717778	34.6	100.0	1000.000	290.0	V	323.0	-7.7	39.3	73.9
4872.082222	41.0	100.0	1000.000	296.0	V	202.0	4.8	32.9	73.9
7330.677778	44.9	100.0	1000.000	125.0	V	133.0	11.0	29.0	73.9
8350.997778	44.2	100.0	1000.000	355.0	H	359.0	12.6	29.7	73.9
9765.504444	47.6	100.0	1000.000	217.0	V	261.0	16.4	26.3	73.9
17827.34000	54.6	100.0	1000.000	100.0	H	212.0	35.0	19.3	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)
1382.717778	22.4	100.0	1000.000	290.0	V	323.0	-7.7	31.5	53.9
4872.082222	29.2	100.0	1000.000	296.0	V	202.0	4.8	24.7	53.9
7330.677778	31.6	100.0	1000.000	125.0	V	133.0	11.0	22.3	53.9
8350.997778	32.3	100.0	1000.000	355.0	H	359.0	12.6	21.6	53.9
9765.504444	34.9	100.0	1000.000	217.0	V	261.0	16.4	19.0	53.9
17827.34000	43.3	100.0	1000.000	100.0	H	212.0	35.0	10.6	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. Band edge measurements were performed with the notch filter removed, however no emissions were observed (noise floor).

2.8.16 Test Results Above 1GHz (High Channel including Band Edges)



Peak Data

Frequency (MHz)	Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1639.962222	33.5	100.0	1000.000	153.0	V	135.0	-7.5	40.4	73.9
2400.000000	53.0	100.0	1000.000	100.0	V	17.0	7.0	20.9	73.9
2483.500000	63.0	100.0	1000.000	212.0	V	308.0	7.8	10.9	73.9
3300.864444	49.6	100.0	1000.000	153.0	V	158.0	1.4	24.3	73.9
4947.317778	41.4	100.0	1000.000	306.0	V	33.0	5.0	32.5	73.9
7425.362222	44.5	100.0	1000.000	103.0	H	208.0	11.1	29.4	73.9
8349.157778	43.3	100.0	1000.000	146.0	H	243.0	12.6	30.6	73.9
17831.38000	55.1	100.0	1000.000	100.0	H	14.0	35.1	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)
1639.962222	21.2	100.0	1000.000	153.0	V	135.0	-7.5	32.7	53.9
2400.000000	40.2	100.0	1000.000	100.0	V	17.0	7.0	13.7	53.9
2483.500000	48.1	100.0	1000.000	212.0	V	308.0	7.8	5.8	53.9
3300.864444	46.4	100.0	1000.000	153.0	V	158.0	1.4	7.5	53.9
4947.317778	29.1	100.0	1000.000	306.0	V	33.0	5.0	24.8	53.9
7425.362222	32.3	100.0	1000.000	103.0	H	208.0	11.1	21.6	53.9
8349.157778	31.0	100.0	1000.000	146.0	H	243.0	12.6	22.9	53.9
17831.38000	43.0	100.0	1000.000	100.0	H	14.0	35.1	10.9	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. Band edge measurements were performed with the notch filter removed.

2.9 POWER SPECTRAL DENSITY

2.9.1 Specification Reference

Part 15 Subpart C §15.247(e)

2.9.2 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.

2.9.3 Equipment Under Test and Modification State

Serial No:261B0014 / Test Configuration B

2.9.4 Date of Test/Verification

September 21, 2011

2.9.5 Test Equipment Used

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

2.9.6 Environmental Conditions

Ambient Temperature	22.2°C
Relative Humidity	63.5%
ATM Pressure	99.13 kPa

2.9.7 Additional Observations

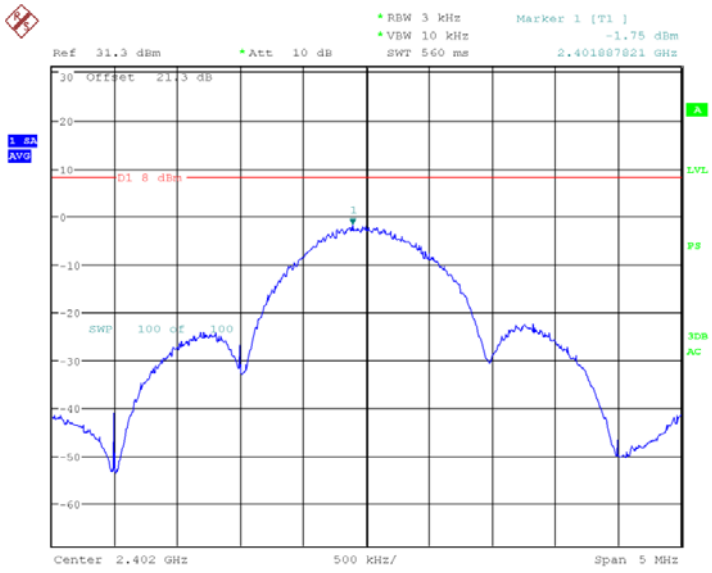
- This is a conducted test using PSD Option 2 of FCC KDB Publication Number 558074 (Measurement of Digital Transmission System under Section 15.247 March 23, 2005).
- An offset of 21.3dB was added to compensate for the external attenuator and cable used.
- RBW is 3kHz.
- VBW is 3X RBW.
- Sweep time is auto.
- Sample detector was used since bin width < 0.5RBW and the transmission pulse remains at maximum transmit power throughout each sweep.
- Trigger is set to “free run” since the EUT transmits continuously.
- Initial scan to encompass the entire emission bandwidth was first performed.
- From this scan the peak emission is determined.
- The peak is centred and zoomed in.

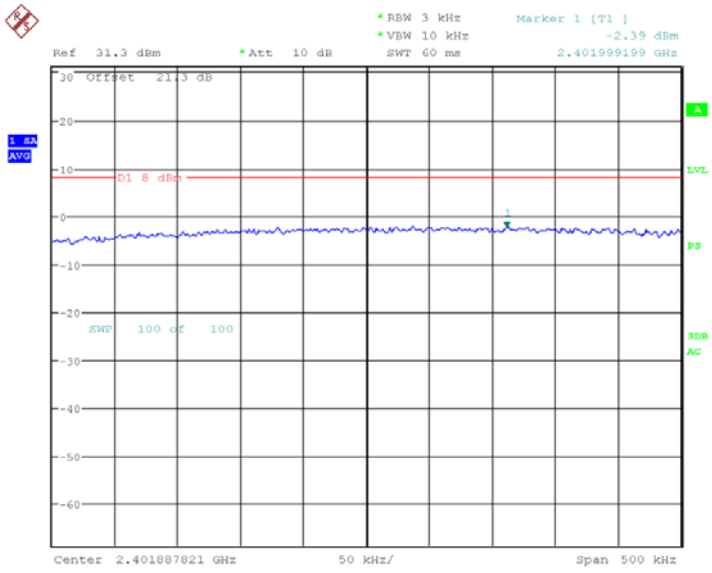
- Trace was averaged 100 times in “Power Averaging Mode”.
- PSD is the max peak measured during this scan.

2.9.8 Test Results

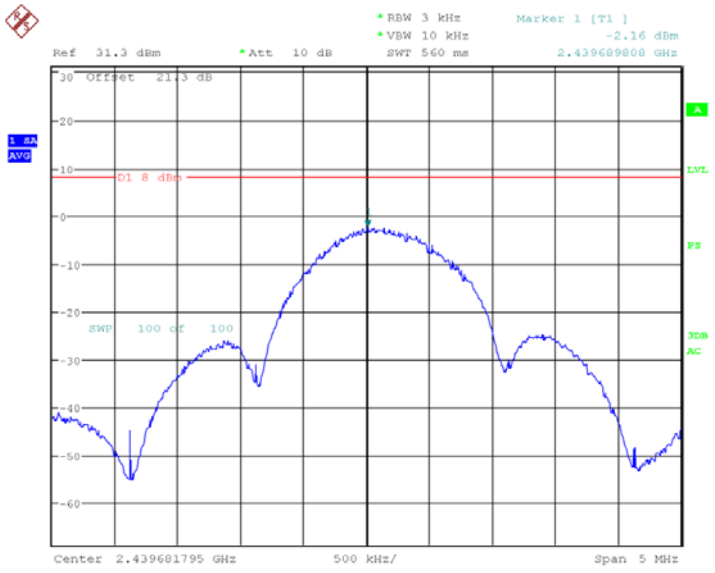
See attached table and plots.

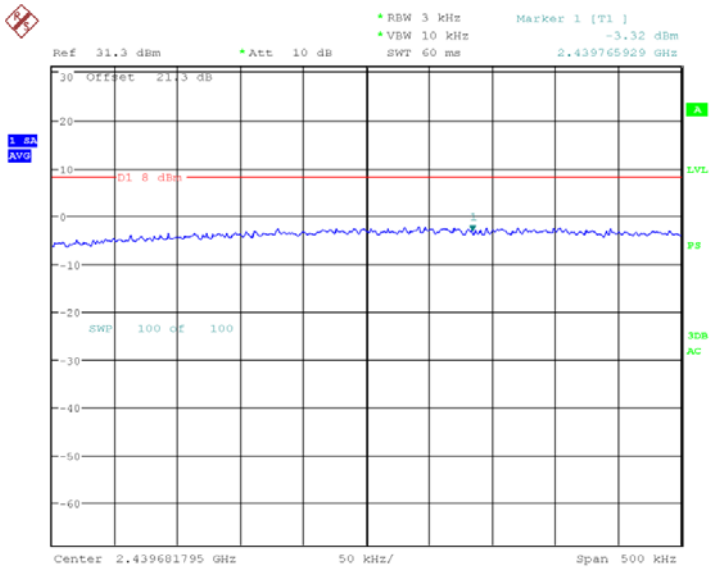
Channel Frequency (MHz)	RF Power Spectral Density (dBm)	Limit (dBm)	Pass/Fail
2402.00	-2.39	8	Pass
2439.81	-3.32	8	Pass
2475.63	-2.39	8	Pass


RBW 3 kHz
VBW 10 kHz
SWT 560 ms
Marker 1 [T1]
-1.75 dBm
2.401887021 GHz
Ref 31.3 dBm
Att 10 dB
Offset 21.3 dB
D1 8 dBm
SWP 100 of 100
Center 2.402 GHz
500 kHz/
Span 5 MHz
Date: 21.SEP.2011 13:15:45

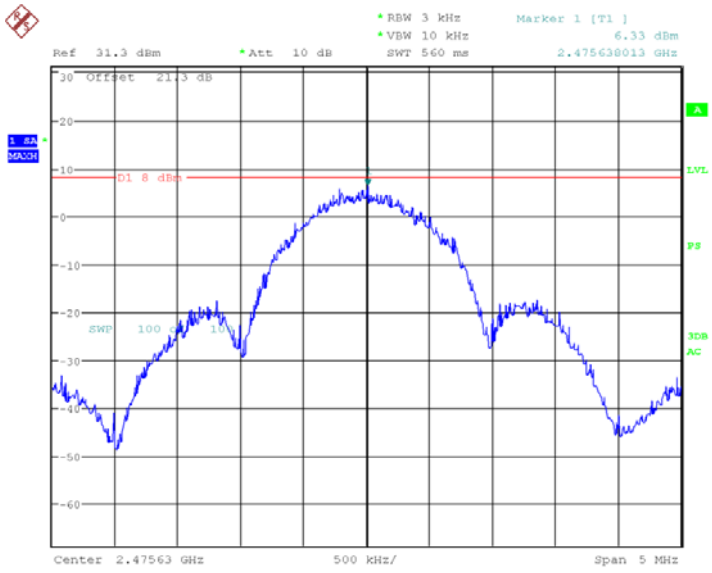

RBW 3 kHz
VBW 10 kHz
SWT 60 ms
Marker 1 [T1]
-2.39 dBm
2.401999199 GHz
Ref 31.3 dBm
Att 10 dB
Offset 21.3 dB
D1 8 dBm
SWP 100 of 100
Center 2.401887021 GHz
50 kHz/
Span 500 kHz
Date: 21.SEP.2011 13:16:51

Low Channel

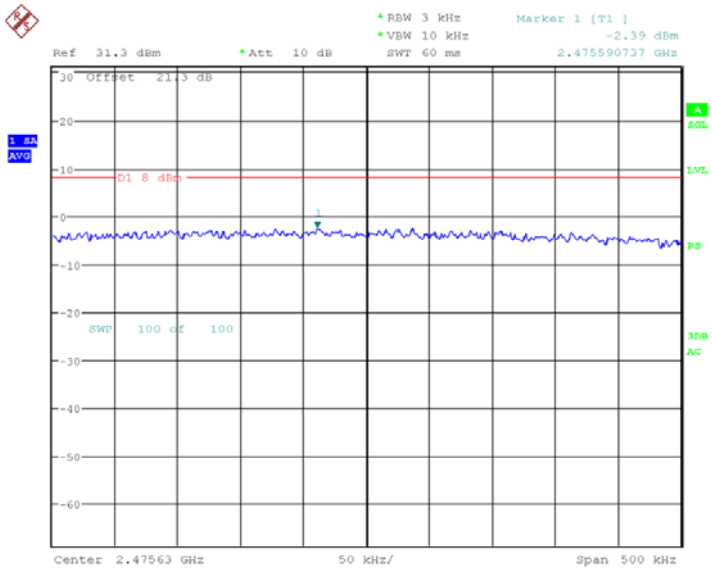

RBW 3 kHz
VBW 10 kHz
SWT 560 ms
Marker 1 [T1]
-2.16 dBm
2.439689800 GHz
Ref 31.3 dBm
Att 10 dB
Offset 21.3 dB
D1 8 dBm
SWP 100 of 100
Center 2.439681795 GHz
500 kHz/
Span 5 MHz
Date: 21.SEP.2011 13:10:15


RBW 3 kHz
VBW 10 kHz
SWT 60 ms
Marker 1 [T1]
-3.32 dBm
2.439765929 GHz
Ref 31.3 dBm
Att 10 dB
Offset 21.3 dB
D1 8 dBm
SWP 100 of 100
Center 2.439681795 GHz
50 kHz/
Span 500 kHz
Date: 21.SEP.2011 13:08:29

Mid Channel



Date: 21.SEP.2011 13:03:20



Date: 21.SEP.2011 13:00:40

High Channel

SECTION 3

TEST EQUIPMENT USED

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
1002	Bilog Antenna	3142C	00058717	EMCO	11/04/10	11/04/11
1027/1028	EMI Test Receiver	ESMI	848926/003	Rhode & Schwarz	03/30/11	03/30/12
6528	EMI Test Receiver	ESCS 30	847793/001	Rhode & Schwarz	02/25/11	02/25/12
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	08/10/11	08/10/12
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	06/15/11	06/15/12
6815	2.4GHz Band Notch Filter	BRM50702	008	Micro-Tronics	Verified by 1040	
1051	Double-ridged waveguide horn antenna	3115	94084329	EMCO	11/02/10	11/02/11
1016	Pre-amplifier	PAM-0202	187	PAM	08/17/11	08/17/12
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	09/29/10	09/29/11
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	
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	08/17/11	08/17/12
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	08/17/11	08/17/12
1173	Low-loss coaxial cable	Nokia Kabel RG213	N/A	Chase London	04/15/11	04/15/12
8607	20dB Attenuator	CAT-20	N/A	MCL HAT-20	07/29/11	07/29/12
8609	20dB Attenuator	CAT-20	N/A	MCL HAT-20	07/29/11	07/29/12
1171	LISN	FCC-LISN-50-25-2	0871	Fischer Custom Comm.	03/03/11	03/03/12
6785	LISN	FCC-LISN-50-25-2	112	Fischer Custom Comm.	03/22/11	03/22/12
1123	DC Power Supply	E3631A	N/A	Hewlett Packard	Verified by 7514	
7514	Multimeter	34410A	MY45002624	Agilent	08/01/11	08/01/12
	Test Software	EMC32	V8.51	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 Conducted Port Measurements

	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	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	0.67
				Coverage Factor (k):	2
				Expanded Uncertainty:	1.39

3.2.2 Conducted Emission Measurements

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.30	0.17	0.03
2	Cables	Rectangular	0.50	0.29	0.08
3	LISN	Rectangular	0.30	0.17	0.03
4	Attenuator	Rectangular	0.30	0.17	0.03
5	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	0.71
				Coverage Factor (k):	2
				Expanded Uncertainty:	1.42

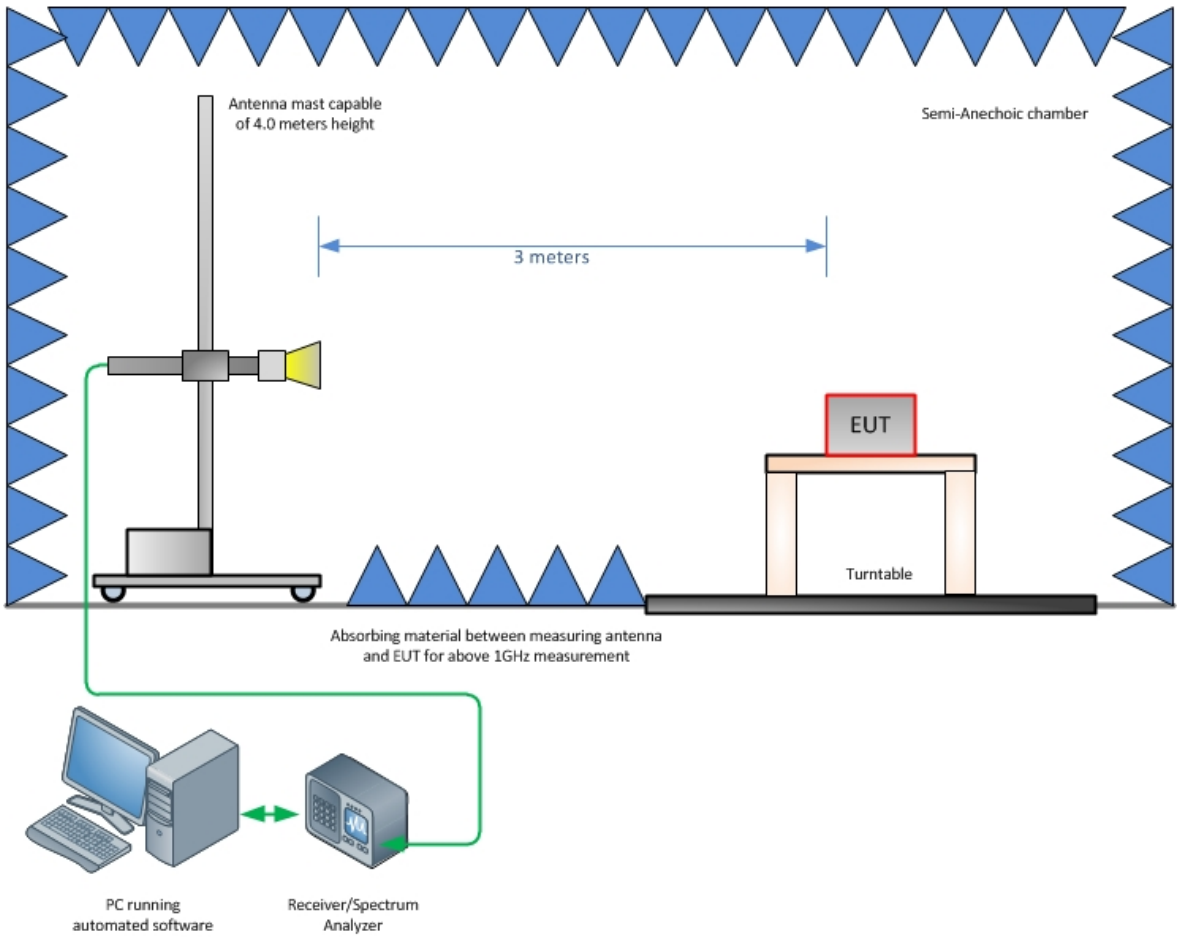
3.2.3 Radiated Emission Measurements

	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	0.41	0.24	0.06
5	Site	Rectangular	2.00	1.15	1.33
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	1.38
				Coverage Factor (k):	2
				Expanded Uncertainty:	2.79

SECTION 4

DIAGRAM OF TEST SETUP

4.1 TEST SETUP DIAGRAM



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

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

TÜV SÜD America Inc.'s reports apply only to the specific sample tested under stated test conditions. It is the manufacturer's responsibility to assure the continued compliance of production units of this model. TÜV SÜD America, Inc. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD America, Inc.'s issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and TÜV SÜD America, Inc., extracts from the test report shall not be reproduced, except in full without TÜV SÜD America, Inc.'s written approval.

This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

TÜV SÜD America, Inc. and its professional staff hold government
and professional organization certifications for
AAMI, ACIL, AEA, ANSI, IEEE, NVLAP, NIST and VCCI.

NVLAP Lab Code: 100268-0

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