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Report On

Application for Grant of Equipment Authorization of the
Novatel Wireless Inc.
MIFI6630 Wireless Hotspot Modem

FCC CFR 47 Part 2 and 27 October 2014
IC RSS-Gen and RSS-199 Issue 2 October 2014

Report No. 72101251C **March 2015**

REPORT ON	Radio Testing of the Novatel Wireless Inc. MIFI6630 Wireless Hotspot Modem
TEST REPORT NUMBER	72101251C
PREPARED FOR	Novatel Wireless Inc. 9645 Scranton Road, Suite 205 San Diego, CA 92121
CONTACT PERSON	Roman Olmos Hardware Engineer II & ISO-17025 Technical Manager (858) 812-3400 rolmos@nvtl.com
PREPARED BY	**Name:** Xiaoying Zhang Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	Juan Manuel Gonzalez **Name** Authorized Signatory Title: Commercial/Wireless EMC Lab Manager
DATED	March 28, 2015

Revision History

72101251C Novatel Wireless Inc. MIFI6630 Wireless Hotspot Modem					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
03/30/2015	Initial Release				Juan M. Gonzalez

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SECTION 1

REPORT SUMMARY

Radio Testing of the
Novatel Wireless Inc.
MIFI6630 Wireless Hotspot Modem

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1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Novatel Wireless Inc. MIFI6630 Wireless Hotspot Modem to the requirements of the following:

- FCC CFR 47 Part 2 and 27 October 2014
- IC RSS-Gen and RSS-199 Issue 2 October 2014.

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	Novatel Wireless Inc.
Model Number(s)	MIFI6630
FCC ID Number	PKRNVWMIFI6630
IC Number	3229A-MIFI6630
Serial Number(s)	FID: SH181214900141
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC CFR 47 Part 2 and 27 October 2014 (October 01, 2014). • RSS-199 - Broadband Radio Services (BRS) Equipment Operating in the Frequency Bands 2500 - 2690 MHz (Issue 2, October 2014). • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 4, November 2014).
Start of Test	March 24, 2015
Finish of Test	March 27, 2015
Name of Engineer(s)	Xiaoying Zhang
Related Document(s)	• ANSI/TIA-603-C-2004 – Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards. • KDB971168 (D01 Power Meas License Digital Systems v02r02) Measurement Guidance for Certification of Licensed Digital Transmitters, October 17, 2014. • KDB412172 D01 Determining ERP and EIRP v01 (Guidelines for Determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of a RF Transmitting System, November 31, 2010.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC CFR 47 Part 2 and 27 October 2014with cross-reference to the corresponding IC RSS standard is shown below.

Section	FCC Part Sections(s)	RSS Section(s)	Test Description	Result
2.1	2.1046	RSS-199 (4.4)	Transmitter Conducted Output Power	Compliant
2.2	2.1046, 27.50 (h) (2)	RSS-199 (4.4)	Equivalent Isotropic Radiated Power	Compliant
-			Effective Radiated Power	N/A
2.3	2.1049 and 27.53(m) (6)	RSS-199 (4.2) RSS-Gen (6.6)	Occupied Bandwidth	Compliant
2.4	27.53(m) (4)	RSS-199 (4.6)	Band Edge	Compliant
2.5	2.1051 27.53(m) (4)	RSS-199 (4.6)	Conducted Spurious Emissions	Compliant
2.6	2.1053 27.53(m)	RSS-199 (4.6)	Field Strength Of Spurious Radiation	Compliant
2.7	2.1055 (a)(1) and (d)(1), 27.54	RSS-199 (4.3)	Frequency Stability	Compliant
2.8		RSS-Gen 7.1.2	Receiver Spurious Emissions	N/A

1.3 PRODUCT INFORMATION

1.3.1 EUT General Description

The Equipment Under Test (EUT) was a Novatel Wireless Inc. MIFI6630 Wireless Hotspot Modem. The EUT creates a personal Wi-Fi cloud, capable of sharing high speed 4G LTE and 3G Mobile Broadband Internet connectivity with up to 15 Wi-Fi enabled devices simultaneously.

1.3.2 Technical Description

EUT Description	Wireless Hotspot Modem
Model Number(s)	MIFI6630
Rated Voltage	Nominal 3.8VDC Li-Ion Battery AC Power Adaptor Input: 100-240VAC/0.3A/50-60Hz Output: 5.0VDC/2.0A
Mode Verified	LTE Band 7
Capability	GSM850/1900, WCDMA850/1900, LTE Band 2/3/4/5/7/12/17/29, WLAN 802.11 a/b/g/n
Antenna Type	Monopole
Manufacturer	NVTL
Part Number	NVTL DA-01020345
Antenna Gain	2500MHz = 0.25dBi

1.3.3 Transmit Frequency Table

LTE Band 7					
Bandwidth	Modulation	Tx Frequency (MHz)	Emission Designator	EIRP	
				Max. Power (dBm)	Max. Power (W)
5.0 MHz	QPSK	2500 -2570	4M46G7D	29.54	0.90
5.0 MHz	16QAM	2500 -2570	4M46W7D	29.47	0.89
10.0 MHz	QPSK	2500 -2570	8M92G7D	29.54	0.90
10.0 MHz	16QAM	2500 -2570	8M92W7D	29.48	0.89
15.0 MHz	QPSK	2500 -2570	13M4G7D	29.66	0.92
15.0 MHz	16QAM	2500 -2570	13M4W7D	29.68	0.93
20.0 MHz	QPSK	2500 -2570	17M8G7D	29.80	0.95
20.0 MHz	16QAM	2500 -2570	17M8W7D	29.57	0.91

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Conducted antenna port measurement. EUT Tx at a max power and connected to the CMW500 for communication.
B	Radiated test measurement. EUT Tx through integral antenna and connected to the CMW500 for communication.

1.4.2 EUT Exercise Software

EUT is controlled by a CMW500 Wideband Radio Communication Tester. There are no other test softwares used during verification.

1.4.3 Support Equipment and I/O cables

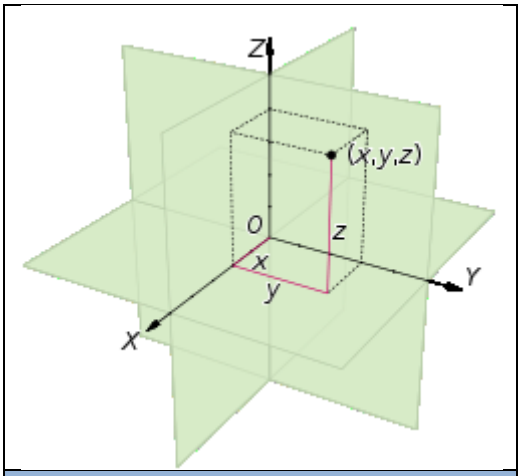
Manufacturer	Equipment/Cable	Description
Novatel Wireless	USB Cable	Micro USB Type B to Standard USB Type B

1.4.4 Worst Case Configuration

Worst-case configuration used in this test report as per output power measurements:

Band	Channel BW	Modulation
LTE Band 7	15.0 MHz	QPSK

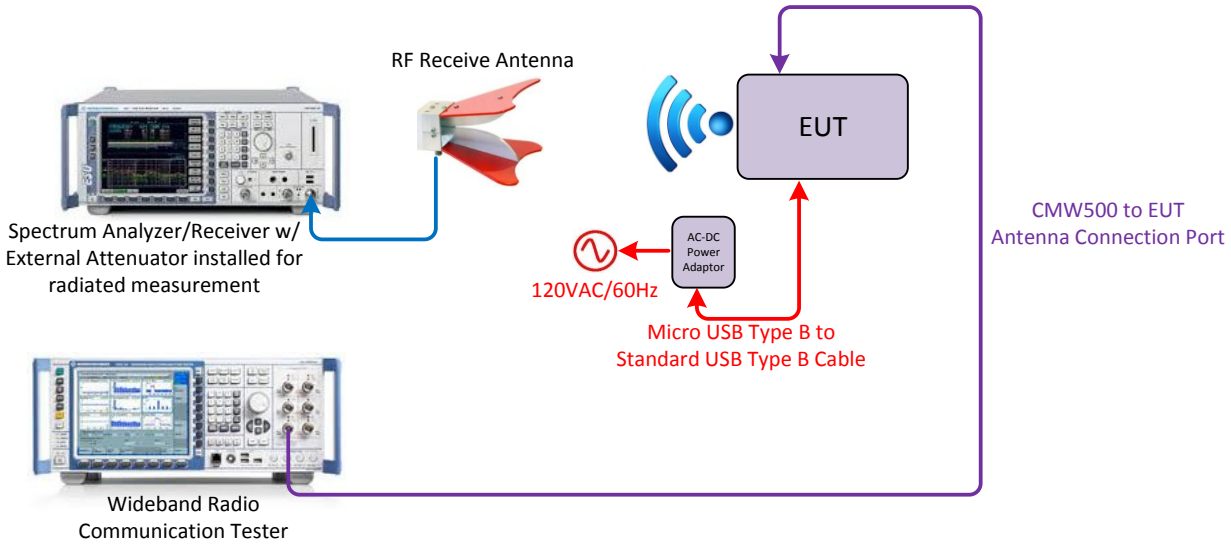
For radiated measurements X, Y, and Z orientations were verified. The verification was determined “Y” as worst case configuration.



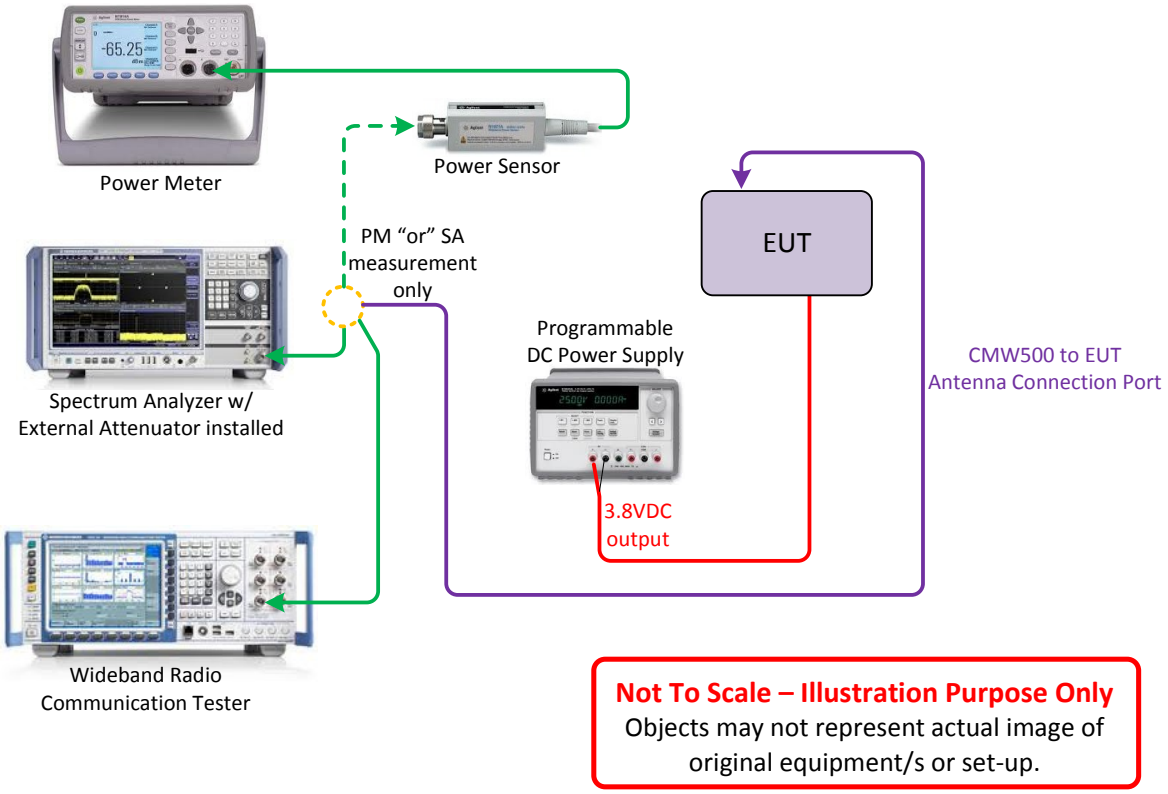
“X, Y and Z” Configuration

1.4.5 Simplified Test Configuration Diagram

Radiated/Conducted Emission Test Configuration via Conducted Port



Conducted (Antenna Port) Test Configuration



Not To Scale – Illustration Purpose Only
Objects may not represent actual image of original equipment/s or set-up.

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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 FID: SH181214900141		
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 C63.4-2014, 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 (if applicable) 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 C63.4-2014. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: 858 678 1400 FAX: 858-546 0364

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

Sony Electronics Inc., Building #8 16530 Via Esprillo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 942 5542 FAX: 858-546 0364

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No.: US1146

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 §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US1146.

1.9.2 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.

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1.10 SAMPLE CALCULATIONS

1.10.1 LTE Emission Designator (QPSK)

Emission Designator = 4M51G7D
G = Phase modulation
7= Two or more channels containing quantized or digital information
D = Data transmission, telemetry, telecommand

1.10.2 LTE Emission Designator (16QAM)

Emission Designator = 4M50W7D
W = Frequency modulation
7= Two or more channels containing quantized or digital information
D = Data transmission, telemetry, telecommand

1.10.3 Spurious Radiated Emission (below 1GHz)

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**

1.10.4 Spurious Radiated Emission – Substitution Method

Example = 84dBµV/m @ 1413 MHz (numerical sample only)

The field strength reading of 84dBµV/m @ 1413 MHz (2nd Harmonic of 706.5 MHz) is the maximized measurement when the EUT is on the turntable measured at 3 meters. The gain of the substituted antenna is 7.8dBi while the transmit cable loss is 1.0 dB (cable between signal generator and the substituted antenna). The signal generator level is adjusted until the 84dBµV/m level at the receiving end is replicated (identical test setup, i.e. same antenna, cable/s and preamp). If the adjusted signal generator level is -18dBm, then we have the following for both EIRP and ERP as required:

P_{EIRP} = -18 dBm + 7.8 dBi – 1dB
= 11.2 dBm
P_{ERP} = P_{EIRP} – 2.15 dB
= 11.2 dBm – 2.15 dB
= 9.05 dBm

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SECTION 2

TEST DETAILS

Radio Testing of the
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2.1 TRANSMITTER CONDUCTED POWER MEASUREMENTS

2.1.1 Specification Reference

FCC CFR 47 Part 2, Clause 2.1046 (a) and (c)
Industry Canada RSS-199, Clause 4.4

2.1.2 Standard Applicable

The transmitter output power shall be measured using a peak detector.
For mobile subscriber equipment, the e.i.r.p. shall not exceed 2 watts.

2.1.3 Equipment Under Test and Modification State

Serial No: FID: SH181214900141 / Test Configuration A

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

March 24, 2015 / XYZ

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/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	22.8 °C
Relative Humidity	40.1%
ATM Pressure	99.7 kPa

2.1.7 Additional Observations

- This is a conducted test using a peak/average power meter.
- The 18.5dB LTE Band 7 offset on the power meter was used for the power splitter, external attenuator and cable used.

2.1.8 Test Results

Modulation	Bandwidth	Channels	Frequency	Tx Average (dBm)	Tx Peak (dBm)
QPSK	5 MHz	20755	2502.5	22.60	29.29
		21100	2535.0	22.42	29.06
		21425	2567.5	22.30	28.79
	10 MHz	20800	2505.0	22.57	29.29
		21100	2535.0	22.42	29.83
		21400	2565.0	22.23	28.63
	15 MHz	20825	2507.5	22.71	29.41
		21100	2535.0	22.45	28.78
		21375	2562.5	22.20	28.73
	20 MHz	20850	2510.0	22.58	29.55
		21100	2535.0	22.43	29.01
		21350	2560.0	22.17	28.94

Modulation	Bandwidth	Channels	Frequency	Tx Average (dBm)	Tx Peak (dBm)
16QAM	5 MHz	20755	2502.5	21.72	29.22
		21100	2535.0	22.40	28.97
		21425	2567.7	21.43	28.82
	10 MHz	20800	2505.0	21.69	29.23
		21100	2535.0	21.54	29.01
		21400	2565.0	21.41	28.61
	15 MHz	20825	2507.5	21.78	29.43
		21100	2535.0	21.74	29.02
		21375	2562.5	21.28	28.54
	20 MHz	20850	2510.0	21.72	29.32
		21100	2535.0	21.55	28.92
		21350	2560.0	21.30	28.86

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2.2 EFFECTIVE ISOTROPICALLY RADIATED POWER

2.2.1 Specification Reference

FCC CFR Part 2, Clause 2.1046
FCC CFR Part 27, Clause 27.50 (h) (2)
Industry Canada RSS-199, Clause 4.4

2.2.2 Standard Applicable

The transmitter output power shall be measured using a peak detector.
For mobile subscriber equipment, the e.i.r.p. shall not exceed 2 watts.

2.2.3 Equipment Under Test

Serial No: FID: SH181214900141, Test Configuration (N/A, calculation only)

2.2.4 Date of Verification/Initial of test personnel who performed the calculation

March 24, 2015 / XYZ

2.2.5 Additional Observations

- EIRP was calculated.
- Calculation formula in logarithmic terms:

$$EIRP = P_T + G_T - L_C$$

Where:

P_T = transmitter conducted output power dBm (Section 2.1 of this test report)
G_T = gain of the transmitting antenna, in dBi
L_C = signal attenuation in the connecting cable between the transmitter and antenna, in dB (Power measurement performed directly at the primary antenna port. The loss between the LTE module and the primary antenna port is considered negligible).

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2.2.6 Test Results

Modulation	Bandwidth	Channels	Frequency	EIRP (dBm)	EIRP (Watt)	Limit (Watt)
QPSK	5 MHz	20755	2502.5	29.54	0.90	2
		21100	2535.0	29.31	0.85	2
		21425	2567.7	29.04	0.80	2
	10 MHz	20800	2505.0	29.54	0.90	2
		21100	2535.0	30.08	1.02	2
		21400	2565.0	28.88	0.77	2
	15 MHz	20825	2507.5	29.66	0.92	2
		21100	2535.0	29.03	0.80	2
		21375	2562.5	28.98	0.79	2
	20 MHz	20850	2510.0	29.80	0.95	2
		21100	2535.0	29.26	0.84	2
		21350	2560.0	29.19	0.83	2

Modulation	Bandwidth	Channels	Frequency	EIRP (dBm)	EIRP (Watt)	Limit (Watt)
16QAM	5 MHz	20755	2502.5	29.47	0.89	2
		21100	2535.0	29.22	0.84	2
		21425	2567.7	29.07	0.81	2
	10 MHz	20800	2505.0	29.48	0.89	2
		21100	2535.0	29.26	0.84	2
		21400	2565.0	28.86	0.77	2
	15 MHz	20825	2507.5	29.68	0.93	2
		21100	2535.0	29.27	0.85	2
		21375	2562.5	28.79	0.76	2
	20 MHz	20850	2510.0	29.57	0.91	2
		21100	2535.0	29.17	0.83	2
		21350	2560.0	29.11	0.81	2

2.3 OCCUPIED BANDWIDTH

2.3.1 Specification Reference

FCC CFR 47 Part 2, Clause 2.1049
FCC CFR 47 Part 27, Clause 27.53 (m) (6)
Industry Canada RSS-199, Clause 4.2
Industry Canada RSS-GEN , Clause 6.6

2.3.2 Standard Applicable

The transmitted signal bandwidth shall be reported as the 99% emission bandwidth, that is the frequency bandwidth suuch that, below its lower and above its upper frequency limits, the mean powers radiated are eqch equal to 0.5 percent of the total mean power radiated by a give emission.

26dB Bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated by at least 26 dB below the transmitter power.

Using the occupied bandwidth meansurement function in the spectrum analyzer, the 99% occupied bandwith was measured.
In addition, the 26dB bandwidth was measured in accorance with FCC KDB 971168 D01 V0202 Clause 4.1 using the ndB measurement function in the spectrum analyzer.

- 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 (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be at least 3x RBW.

2.3.3 Equipment Under Test and Modification State

Serial No: FID: SH181214900141 / Test Configuration A

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

March 24 and 27, 2015 / XYZ

2.3.5 Test Equipment Used

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

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2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	22.8 - 23.5°C
Relative Humidity	38.9 - 40.1%
ATM Pressure	99.5 - 99.7 kPa

2.3.7 Additional Observations

- This is a conducted test.
- The 18.5 dB LTE Band 7 offset on the spectrum analyzer was used for the power splitter, external attenuator and cable used.
- The RBW is set to 1% of the emission bandwidth while the VBW is at least 3 x RBW.
- Only QPSK plots were listed as the representative modulation.

2.3.8 Test Results

LTE Band	Channel	Frequency (MHz)	BW (MHz)	Modulation	99% OBW (MHz)	-26dBc BW (MHz)
B7	21100	2535.0	5.0	QPSK	4.46	4.78
				16QAM	4.46	4.80
			10.0	QPSK	8.92	9.36
				16QAM	8.92	9.36
			15.0	QPSK	13.38	14.04
				16QAM	13.38	14.04
			20.0	QPSK	17.76	18.56
				16QAM	17.76	18.56

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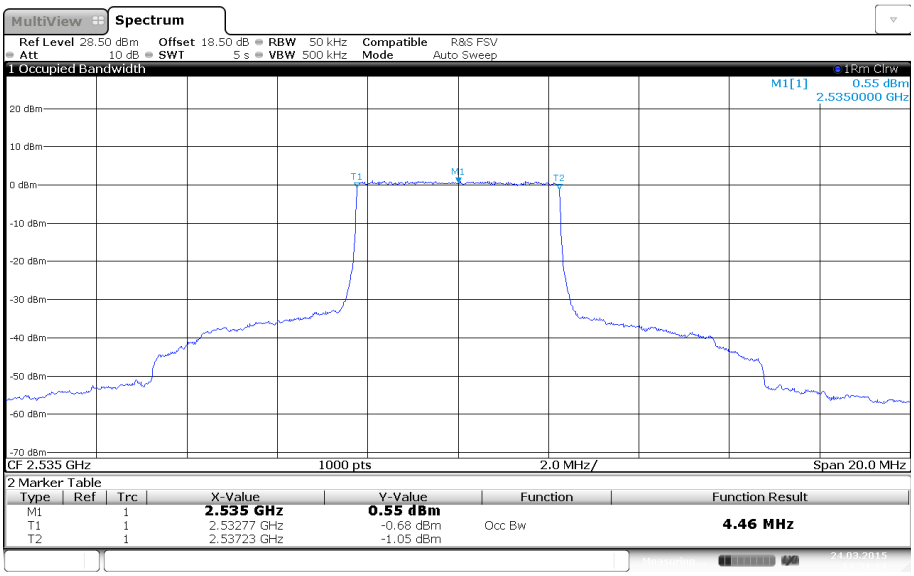
LTE Band 7 Channel 21100 @ 2535.0MHz (5 MHz BW) QPSK 99% OBW



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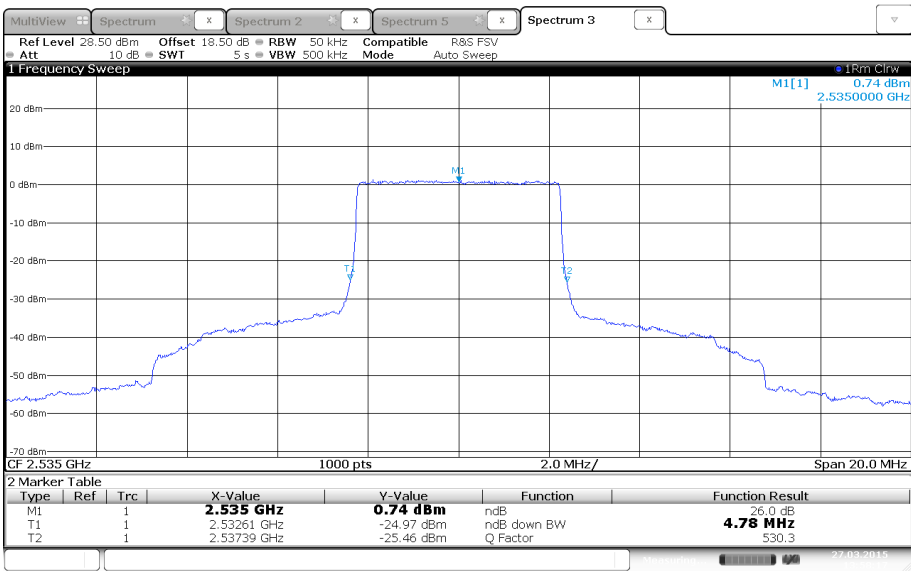
LTE Band 7 Channel 21100 @ 2535.0MHz (5 MHz BW) QPSK -26dBc BW



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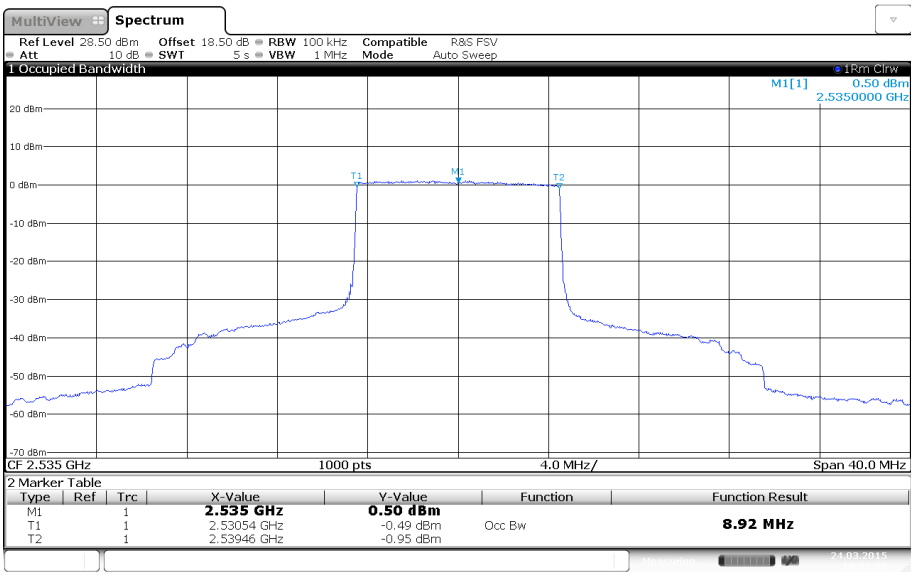
LTE Band 7 Channel 21100 @ 2535.0MHz (10 MHz BW) QPSK 99% OBW



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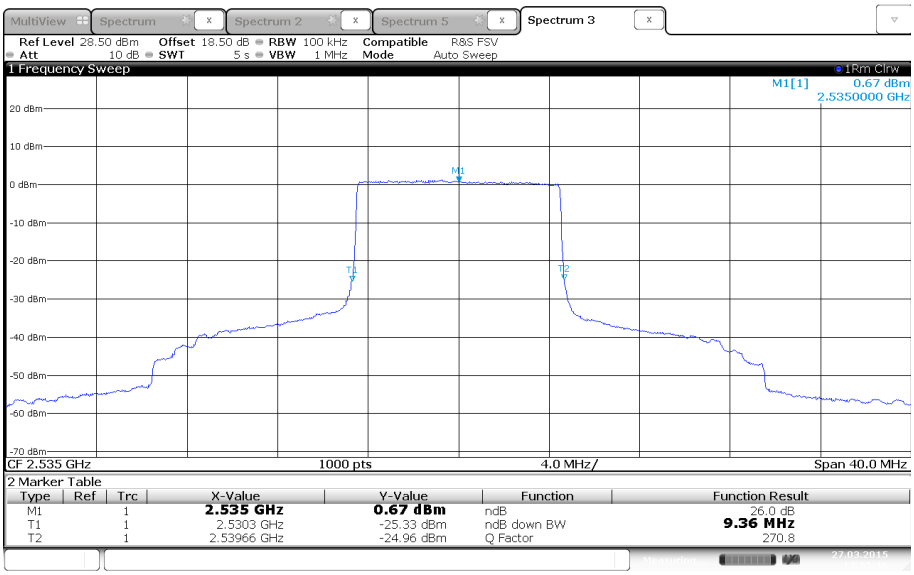
LTE Band 7 Channel 21100 @ 2535.0MHz (10 MHz BW) QPSK -26dBc BW



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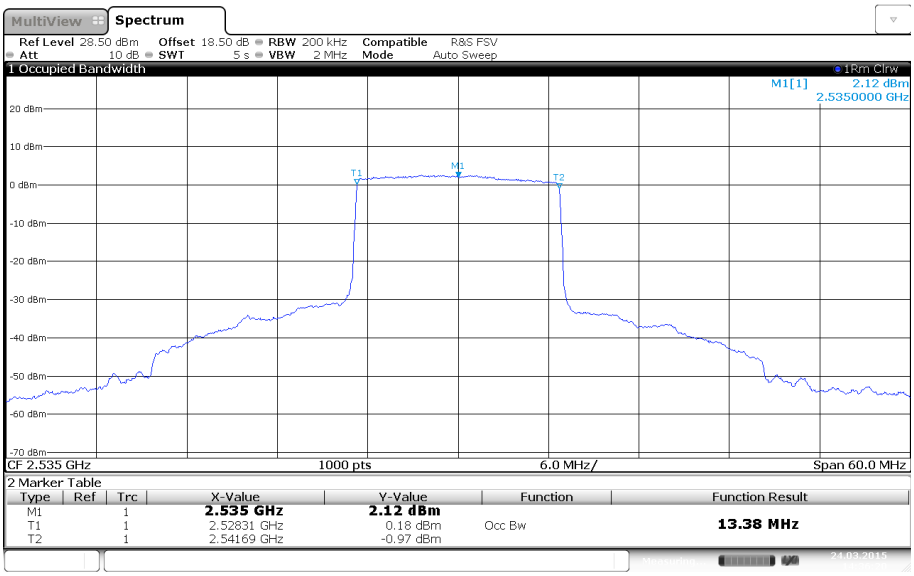
LTE Band 7 Channel 21100 @ 2535.0MHz (15 MHz BW) QPSK 99% OBW



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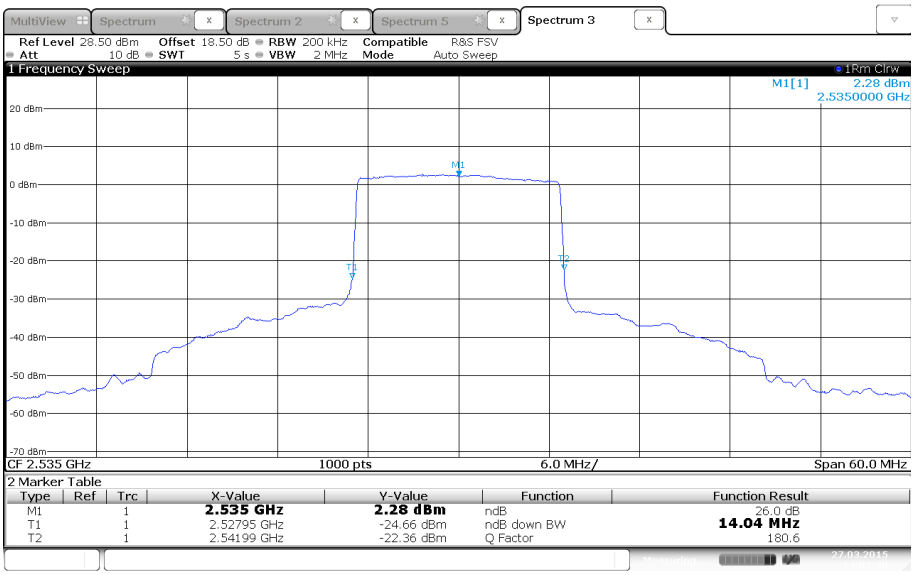
LTE Band 7 Channel 21100 @ 2535.0MHz (15 MHz BW) QPSK -26dBc BW



Date: 27.MAR.2015 14:01:30

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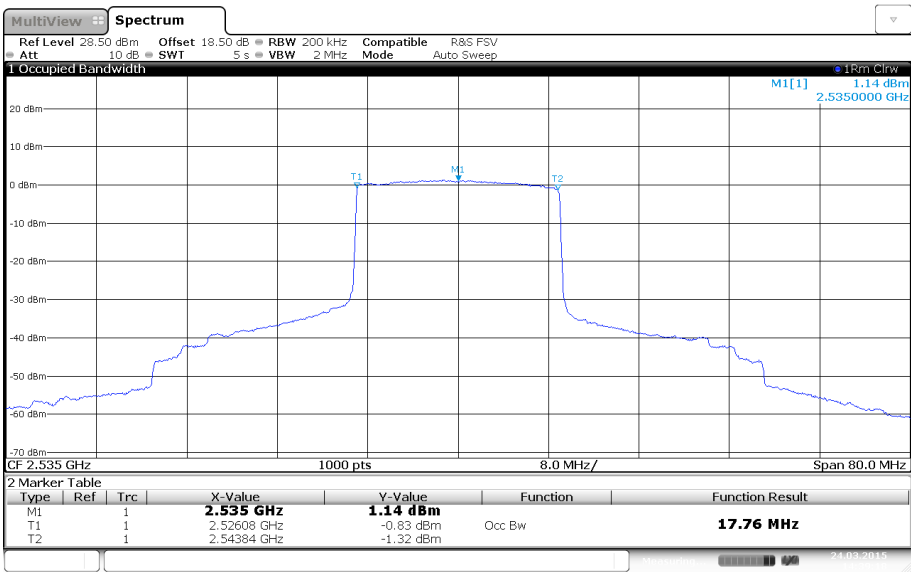
LTE Band 7 Channel 21100 @ 2535.0MHz (20 MHz BW) QPSK 99% OBW



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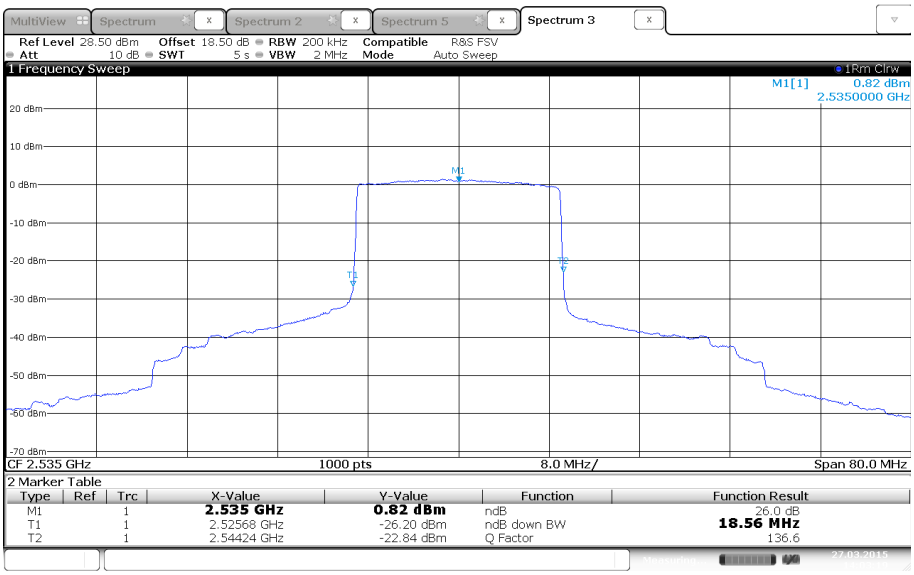
LTE Band 7 Channel 21100 @ 2535.0MHz (20 MHz BW) QPSK -26dBc BW



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2.4 SPURIOUS EMISSION AT BAND EDGE

2.4.1 Specification Reference

FCC CRF Part 27, Clasue 27.53 (m) (4)
Industry Canada RSS-199, Clause 4.6

2.4.2 Standard Applicable

In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth is allowed to be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz or 1%/2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emissions limits:

According RSS-199, for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

i) 40 + 10 log10 p from the channel edges to 5 MHz away,
ii) 43 + 10 log10 p between 5 MHz and X MHz from the channel edges, and
iii) 55 + 10 log10 p at X MHz and beyond from the channel edges.
iv) in addition, the attenuation shall be not be less than 43 + 10 log10 p on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log10 p at or below 2490.5 MHz.

where p in (a) and (b) is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

According to FCC CFR 47 Part 27, For mobile digital stations, the attenuation factor shall be not less than 43 + 10 log (P) dB at the channel edge and 55 + 10 log (P) dB at 5.5 megahertz from the channel edges.

2.4.3 Equipment Under Test and Modification State

Serial No: FID: SH181214900141 / Test Configuration A

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

March 25 and 26, 2015 / AC

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/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.5°C
Relative Humidity	39.7%
ATM Pressure	99.7 kPa

2.4.7 Additional Observations

- This is a conducted test.
- The 18.5dB LTE Band 12 offset on the spectrum analyzer was used for the power splitter, external attenuator and cable used.
- The center frequency of the spectrum is the band edge frequency (worst case 2500 MHz, and 2570 MHz).
- RBW is set to minimum 2% of OBW) and VBW is set to >3 x RBW in the 1 MHz band immediately outside and adjacent to the channel edge.
- RBW should be 1MHz for the channel edges to 5 MHz away, a narrower RBW was used and the Limit line was adjusted accordingly.
- Only QPSK plots were listed as the representative modulation.

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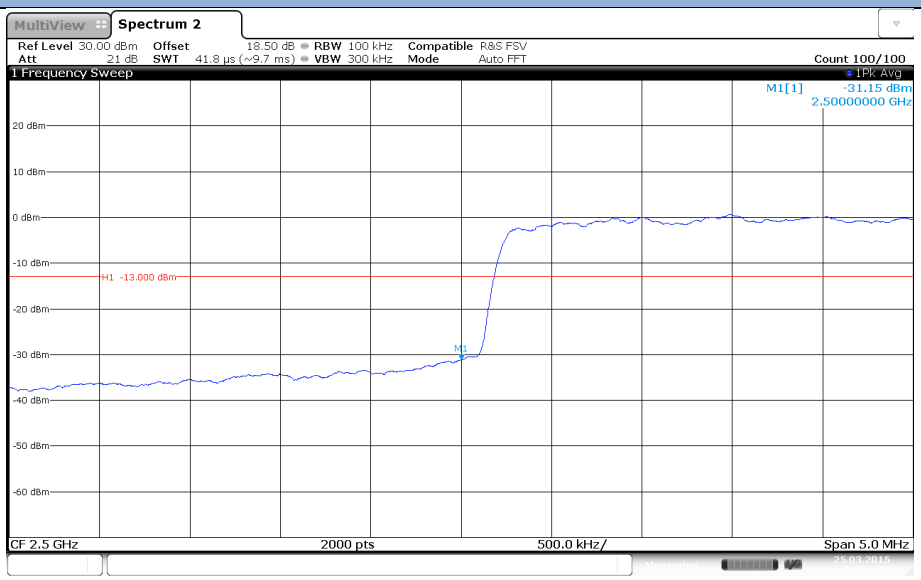
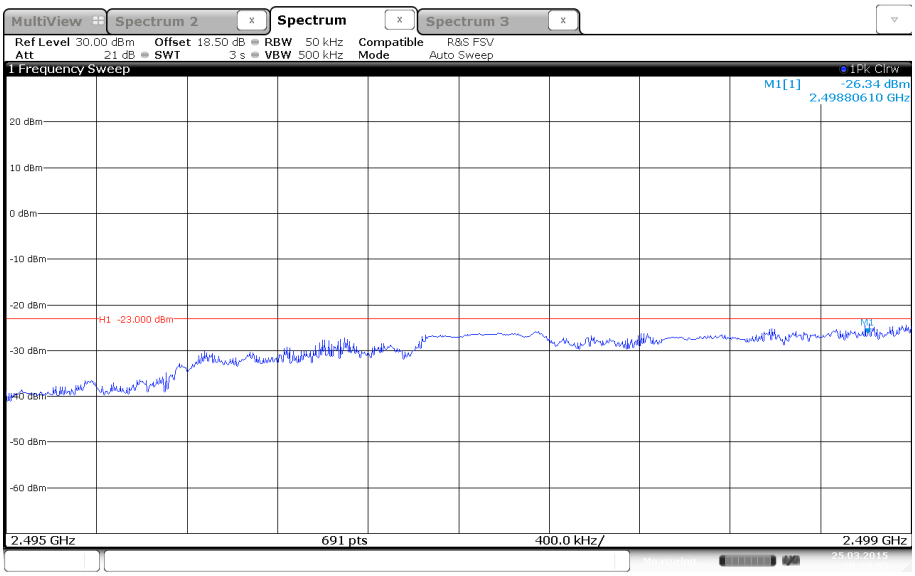
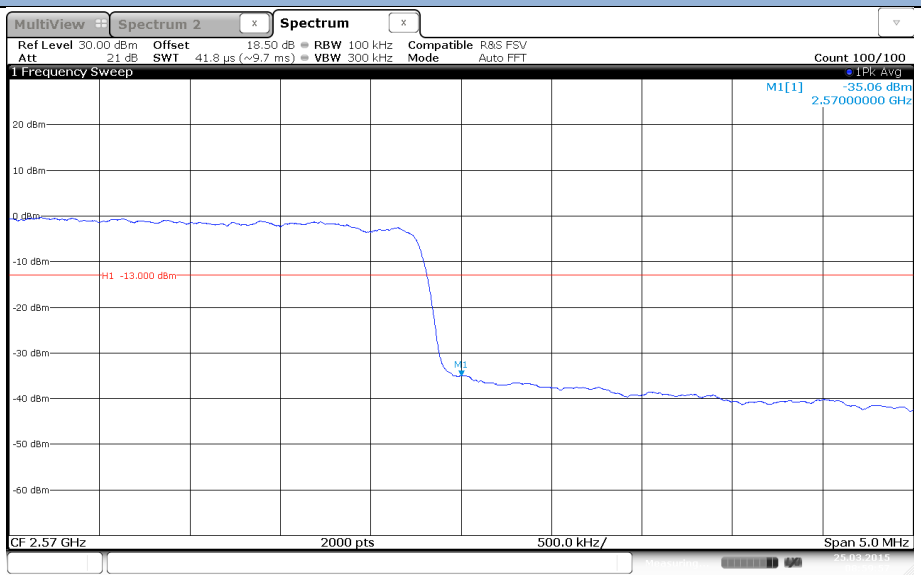
2.4.8 Test Results

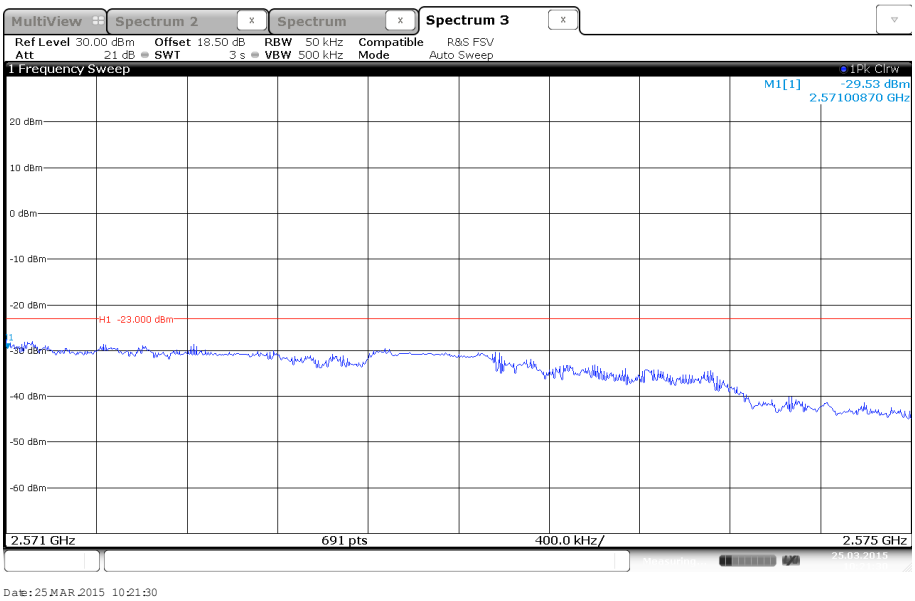
LTE Band 7 Low Channel 20775 (5 MHz BW) QPSK Band Edge @ 2500 MHz





LTE Band 7 High Channel 21425 (5 MHz BW) QPSK Band Edge @ 2570 MHz





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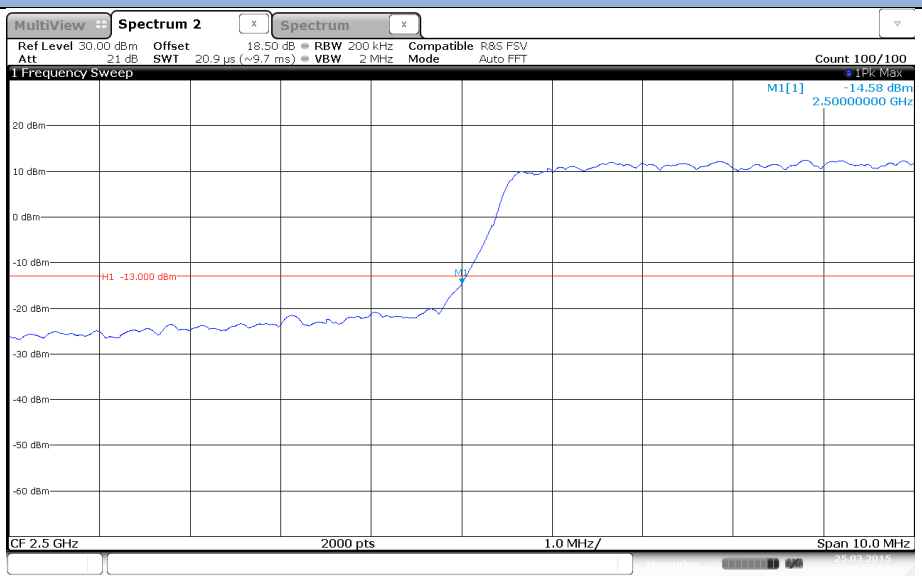
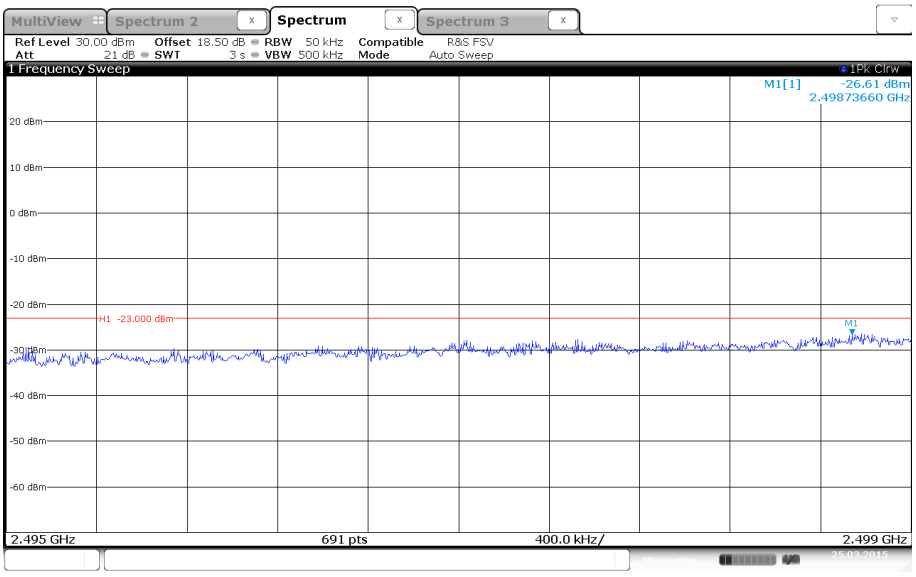
LTE Band 7 Low Channel 20800 (10 MHz BW) QPSK Band Edge @ 2500 MHz





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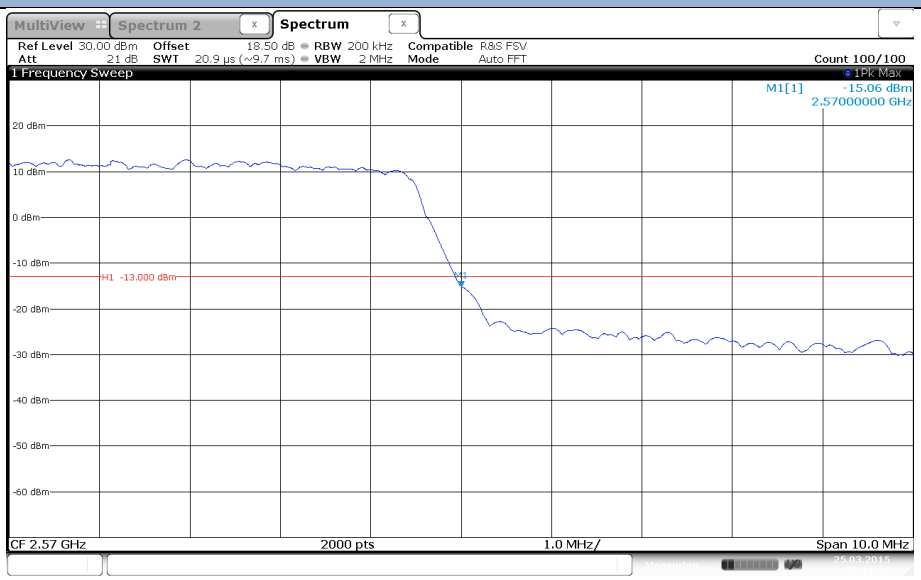
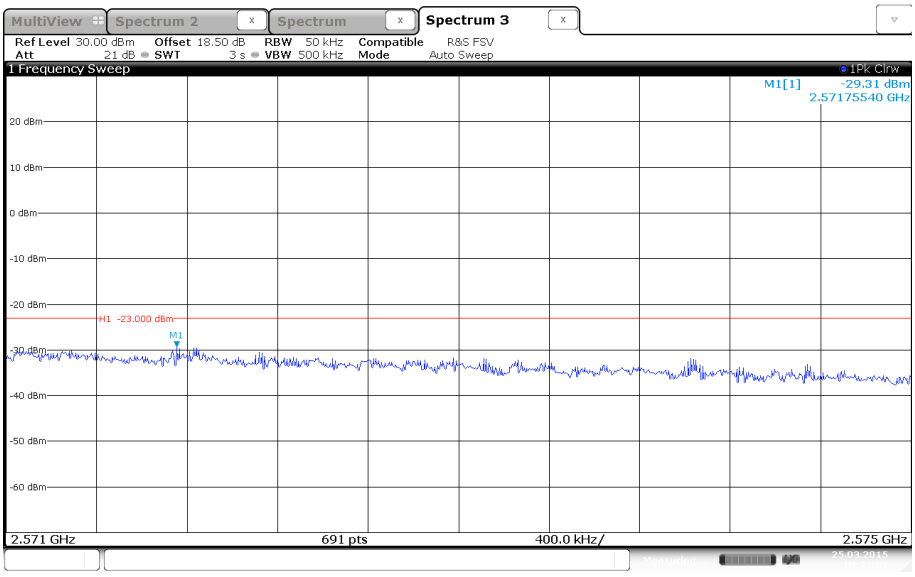
LTE Band 7 High Channel 21400 (10 MHz BW) QPSK Band Edge @ 2570 MHz





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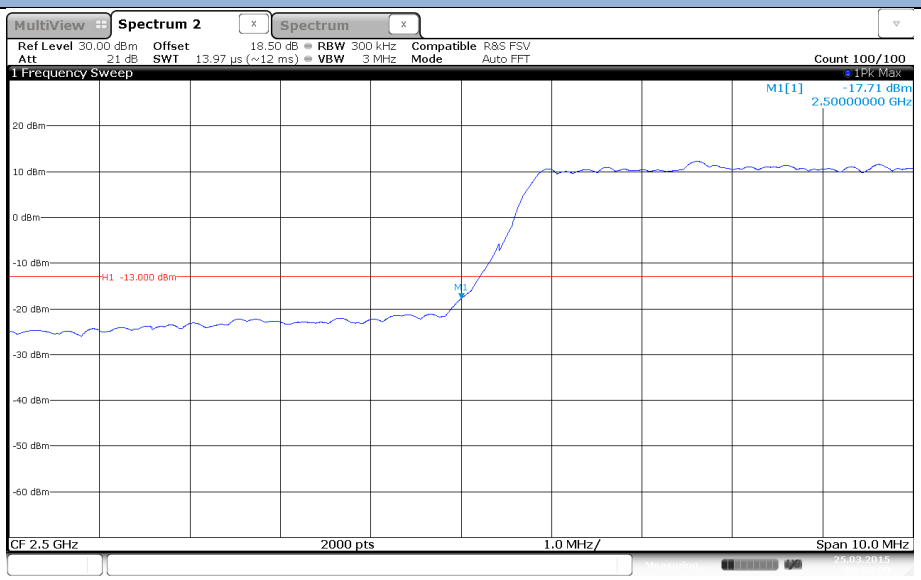
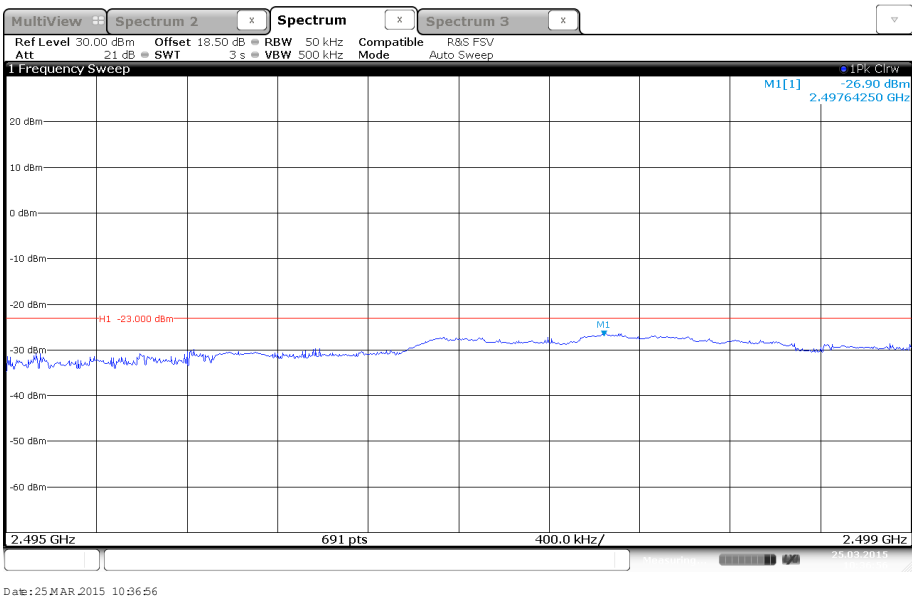
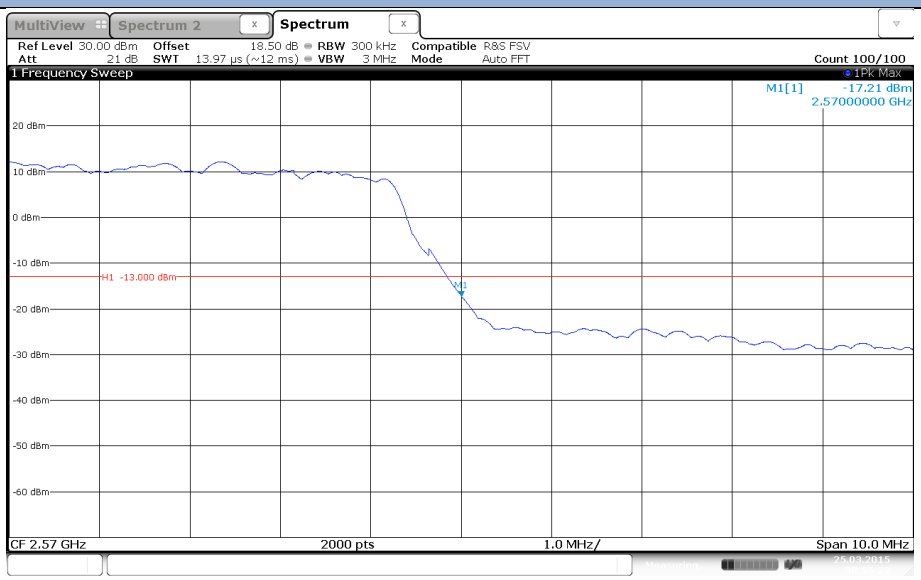
LTE Band 7 Low Channel 20825 (15 MHz BW) QPSK Band Edge @ 2500 MHz

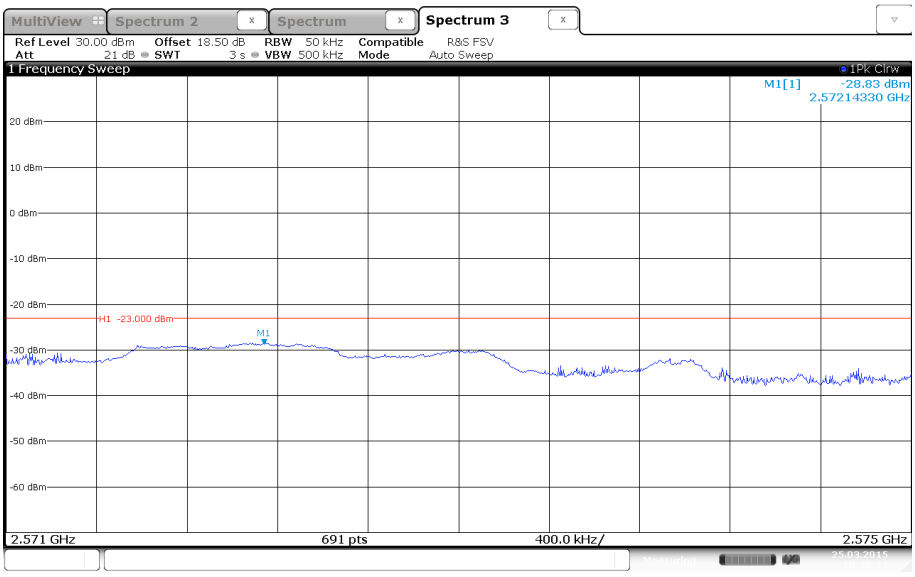




LTE Band 7 High Channel 21375 (15 MHz BW) QPSK Band Edge @ 2570 MHz



Date: 25.MAR.2015 08:55:22



Date: 25.MAR.2015 10:35:14

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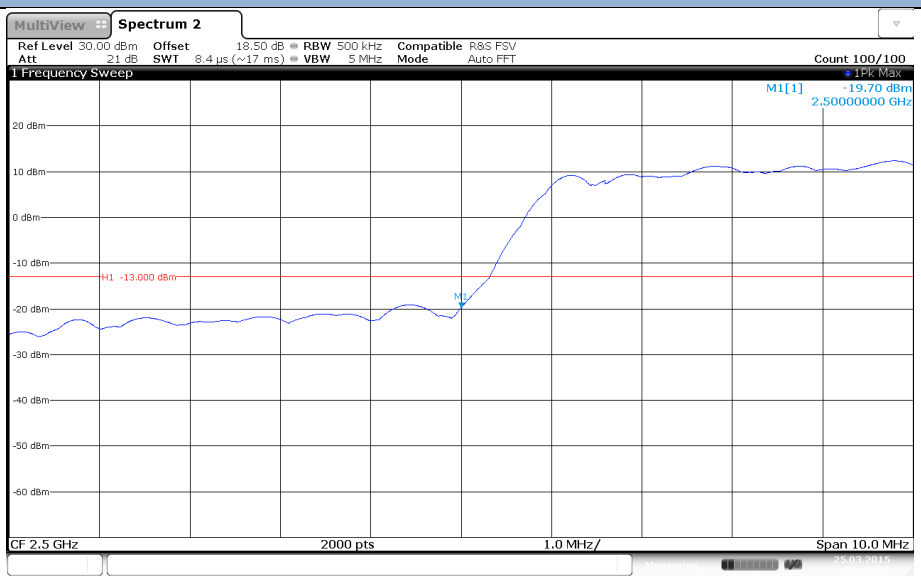
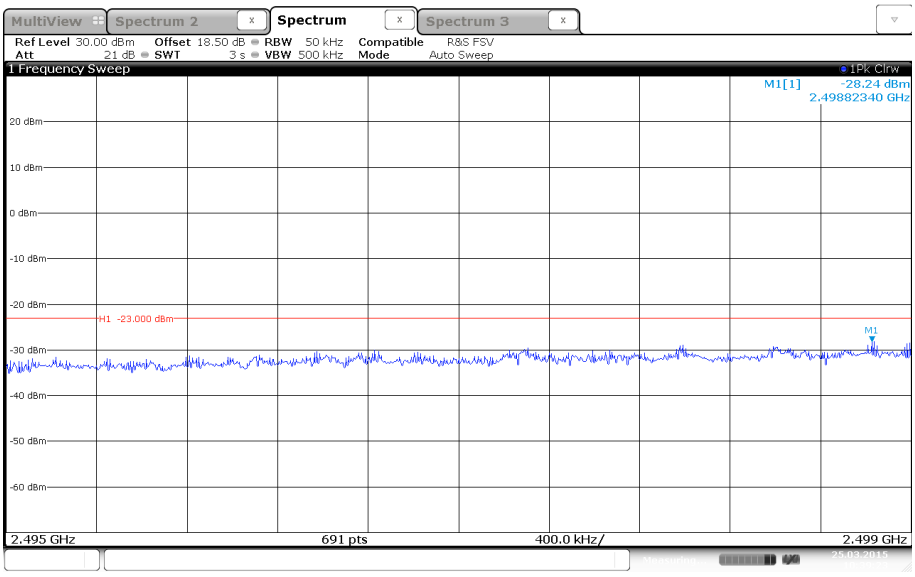
LTE Band 7 Low Channel 20850 (20 MHz BW) QPSK Band Edge @ 2500 MHz



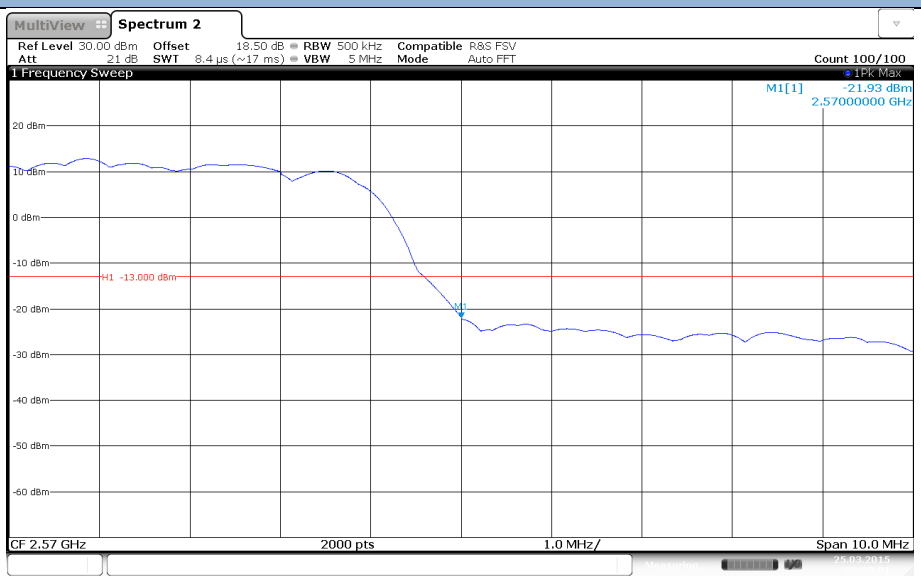
Date: 25.MAR.2015 09:12:22



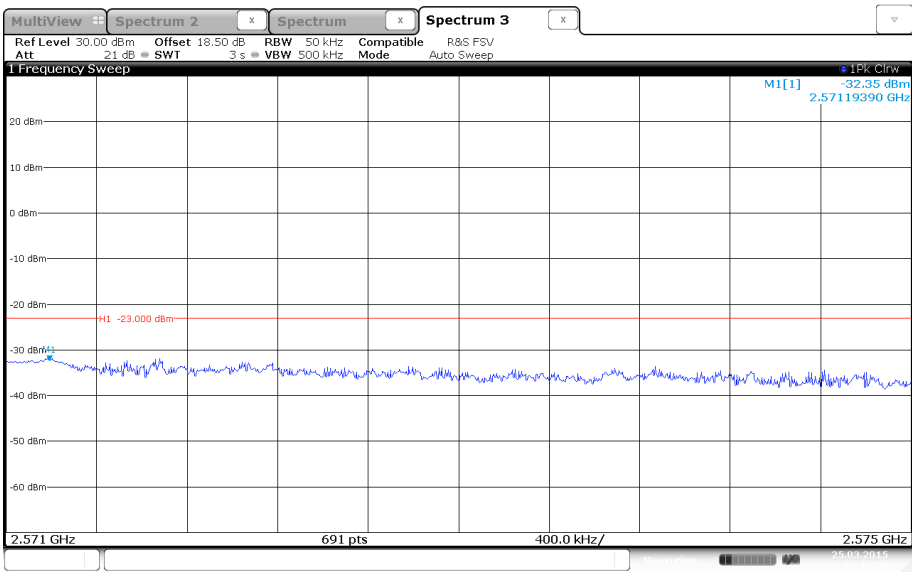
Date: 25.MAR.2015 10:39:23

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

LTE Band 7 High Channel 21350 (20 MHz BW) QPSK Band Edge @ 2570 MHz



Date: 25.MAR.2015 09:09:01



Date: 25.MAR.2015 10:40:57

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2.5 CONDUCTED SPURIOUS EMISSIONS

2.5.1 Specification Reference

FCC CFR 47 Part 2, Clause 2.1051
FCC CFR 47 Part 27, Clause 2.53 (m) (4)
Industry Canada RSS-199, Clause 4.6

2.5.2 Standard Applicable

In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth is allowed to be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz or 1%/2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emissions limits:

According RSS-199, for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

i) 40 + 10 log10 p from the channel edges to 5 MHz away,
ii) 43 + 10 log10 p between 5 MHz and X MHz from the channel edges, and
iii) 55 + 10 log10 p at X MHz and beyond from the channel edges.
iv) in addition, the attenuation shall be not be less than 43 + 10 log10 p on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log10 p at or below 2490.5 MHz.

where p in (a) and (b) is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

According to FCC CFR 47 Part 27, For mobile digital stations, the attenuation factor shall be not less than 43 + 10 log (P) dB at the channel edge and 55 + 10 log (P) dB at 5.5 megahertz from the channel edges.

2.5.3 Equipment Under Test and Modification State

Serial No: FID: SH181214900141 / Test Configuration A

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

March 26, 2015 / AC

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/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	23.5°C
Relative Humidity	39.9%
ATM Pressure	99.6 kPa

2.5.7 Additional Observations

- This is a conducted test. The spectrum was searched from 9 kHz to 25.7GHz (requirement is up to the 10^{th} harmonic (≤8GHz)).
- The 18.5 dB LTE Band 7 offset on the spectrum analyzer was used for the power splitter, external attenuator and cable used.
- Low channel, Mid channel and High channel and all channel bandwidths were verified.
- Only the worst case presented in this test report.

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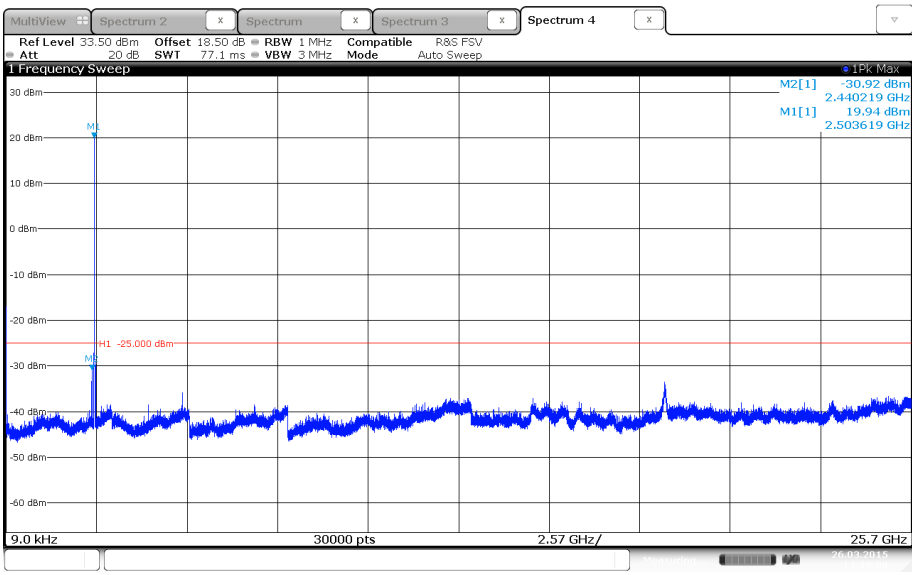
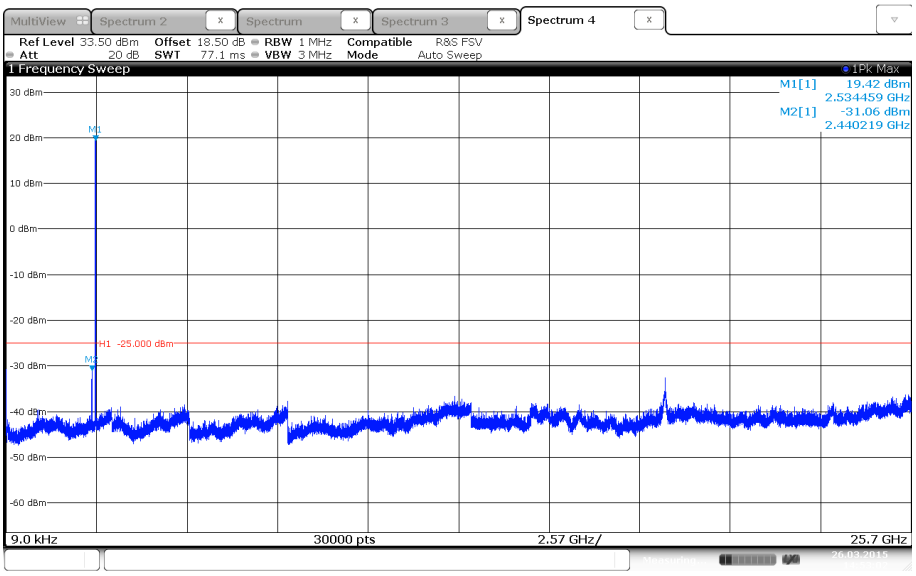
2.5.8 Test Results

LTE Band 7 Low Channel 20775 (5 MHz BW) QPSK @ 2502.5 MHz


LTE Band 7 Mid Channel 21100 (5 MHz BW) QPSK @ 2535.0 MHz


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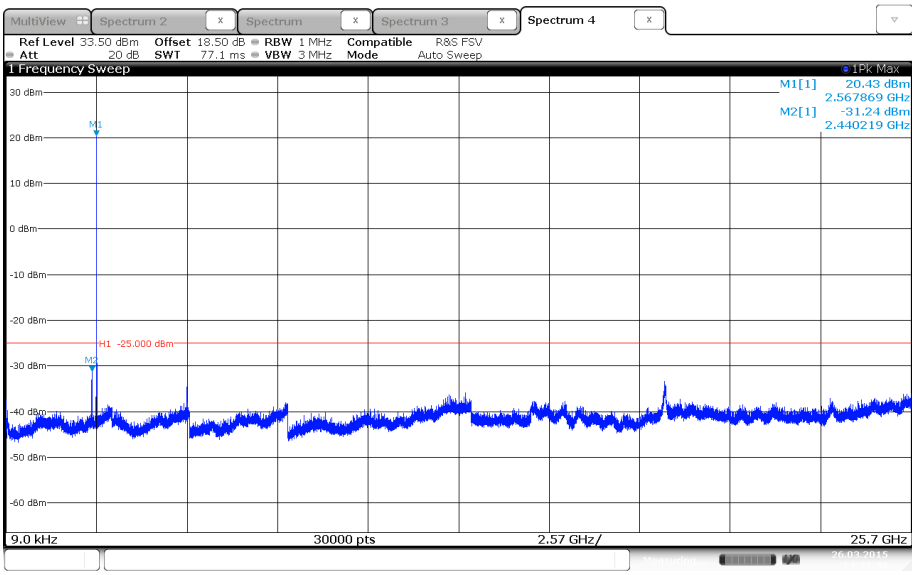
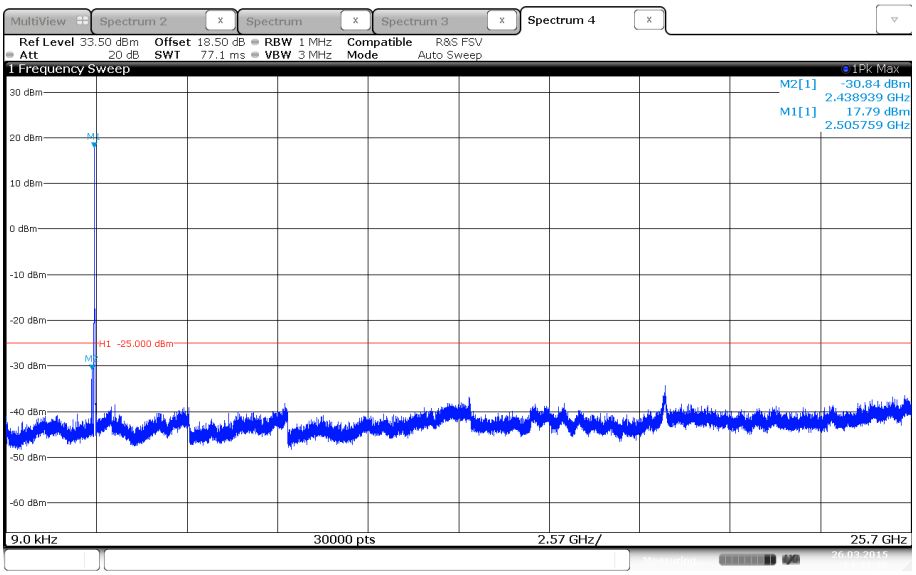
LTE Band 7 High Channel 21425 (5 MHz BW) QPSK @ 2567.5 MHz

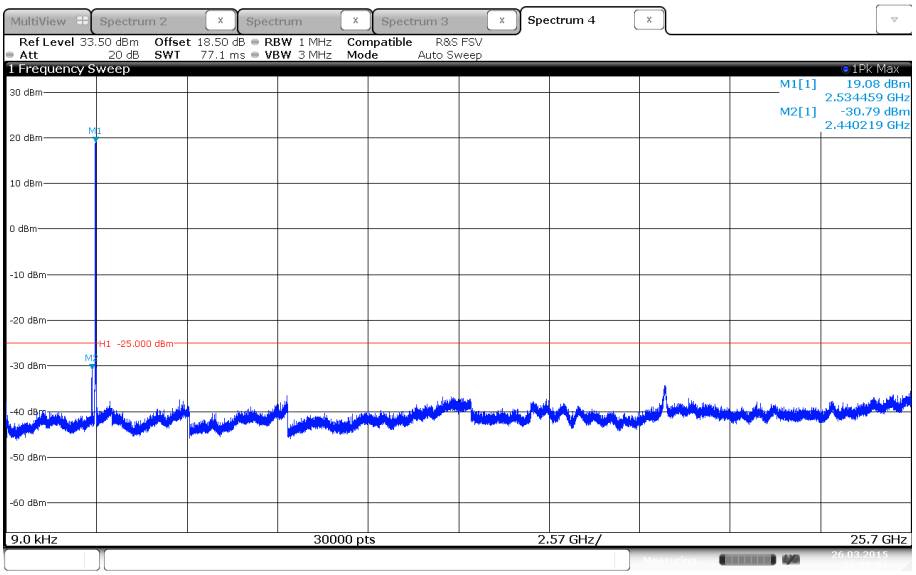


LTE Band 7 Low Channel 20800 (10 MHz BW) QPSK @ 2505.0 MHz



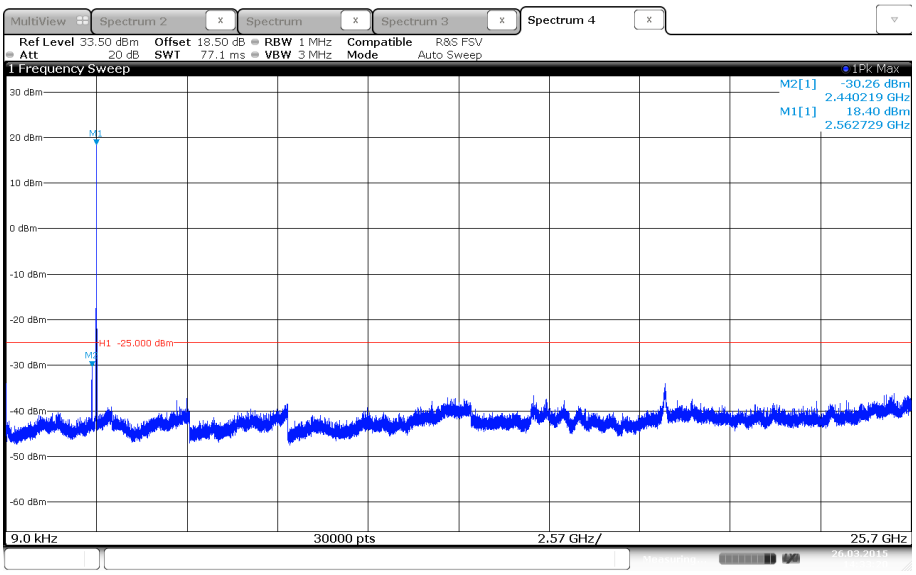
TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

LTE Band 7 Mid Channel 21100 (10 MHz BW) QPSK @ 2535.0 MHz



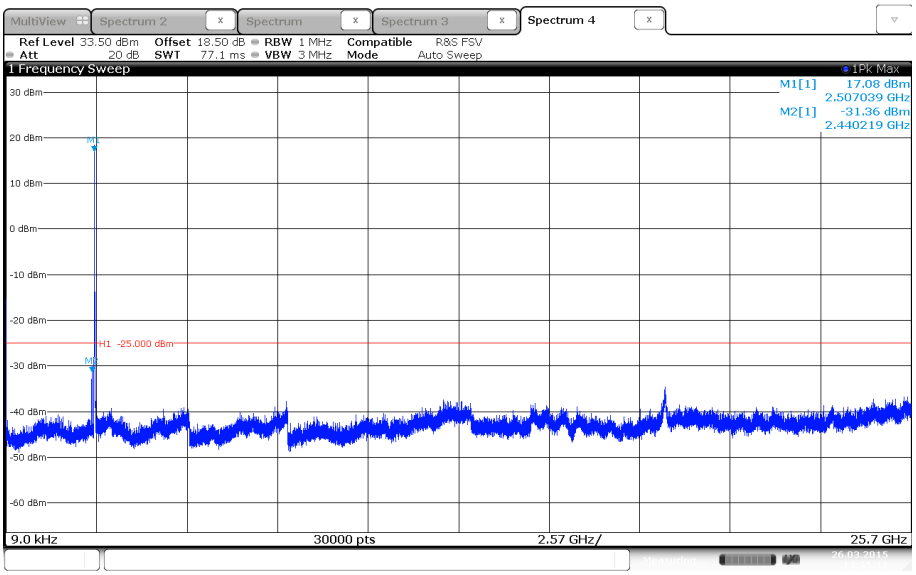
Date: 26.MAR.2015 14:58:54

LTE Band 7 High Channel 21400 (10 MHz BW) QPSK @ 2565.0 MHz



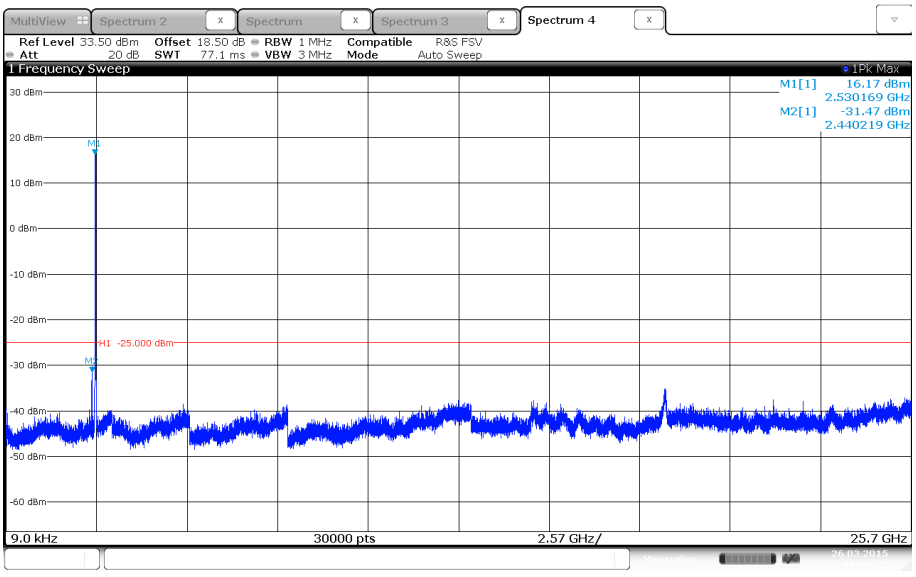
Date: 26.MAR.2015 14:33:20

LTE Band 7 Low Channel 20825 (15 MHz BW) QPSK @ 2507.5 MHz



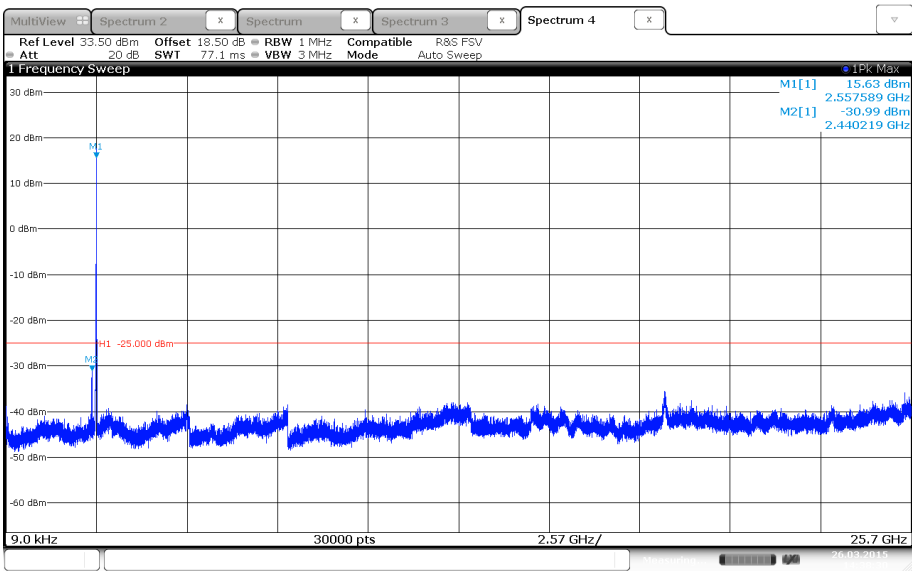
Date: 26.MAR.2015 14:35:42

LTE Band 7 Mid Channel 21100 (15 MHz BW) QPSK @ 2535.0 MHz



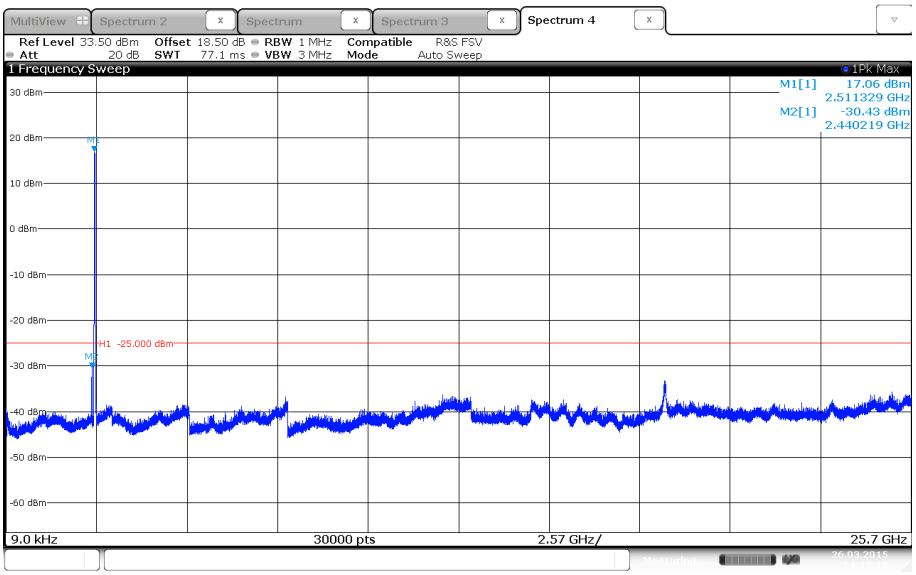
Date: 26.MAR.2015 15:01:22

LTE Band 7 High Channel 21375 (15 MHz BW) QPSK @ 2562.5 MHz



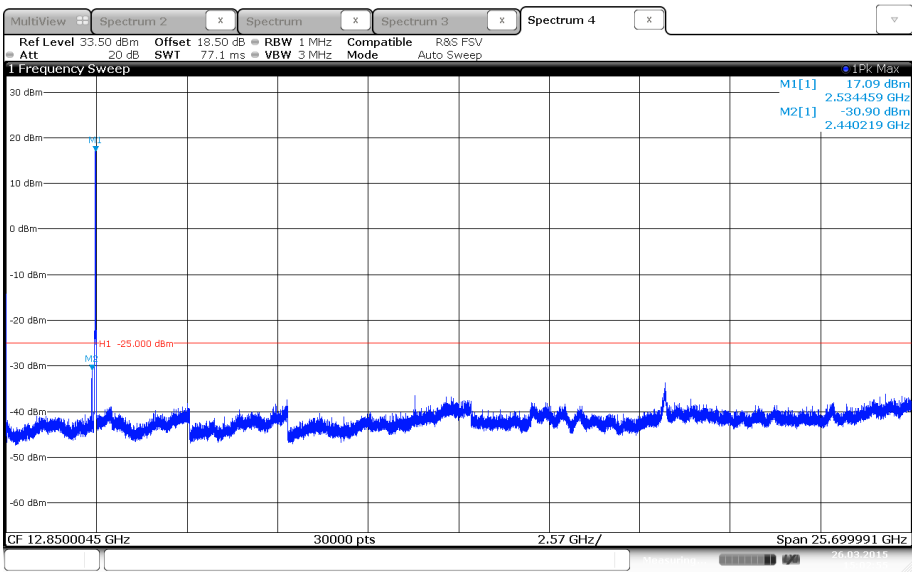
Date: 26.MAR.2015 14:38:30

LTE Band 7 Low Channel 20850 (20 MHz BW) QPSK @ 2510.0 MHz

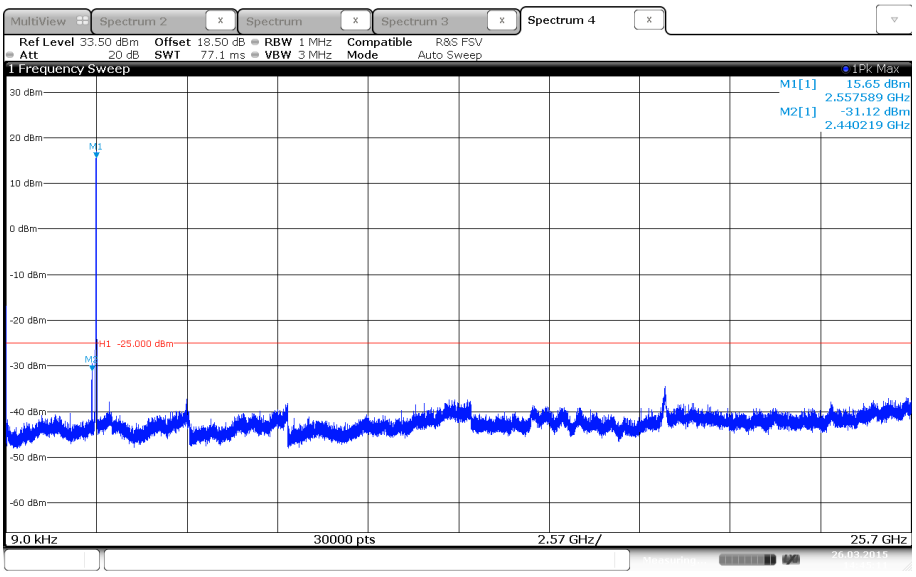


Date: 26.MAR.2015 14:42:49

LTE Band 7 Mid Channel 21100 (20 MHz BW) QPSK @ 2535.0 MHz



LTE Band 7 High Channel 21350 (20 MHz BW) QPSK @ 2560.0 MHz



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2.6 FIELD STRENGTH OF SPURIOUS RADIATION

2.6.1 Specification Reference

FCC CFR 47 Part 2, Clause 2.1053
FCC CFR 47 Part 27, Clause 2.53 (m) (4)
Industry Canada RSS-199, Clause 4.6

2.6.2 Standard Applicable

For the unwanted emissions beyond the 1 MHz outside the channel edge, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth is allowed to be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz.

Equipment shall comply with the following unwanted emissions limits:

According RSS-199, for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

i) 40 + 10 log10 p from the channel edges to 5 MHz away,
ii) 43 + 10 log10 p between 5 MHz and X MHz from the channel edges, and
iii) 55 + 10 log10 p at X MHz and beyond from the channel edges.
iv) in addition, the attenuation shall be not be less than 43 + 10 log10 p on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log10 p at or below 2490.5 MHz.

where p in (a) and (b) is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

According to FCC CFR 47 Part 27, For mobile digital stations, the attenuation factor shall be not less than 43 + 10 log (P) dB at the channel edge and 55 + 10 log (P) dB at 5.5 megahertz from the channel edges.

2.6.3 Equipment Under Test and Modification State

Serial No: FID: SH181214900141 / Test Configuration B

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

March 28, 2015 / XYZ

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/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

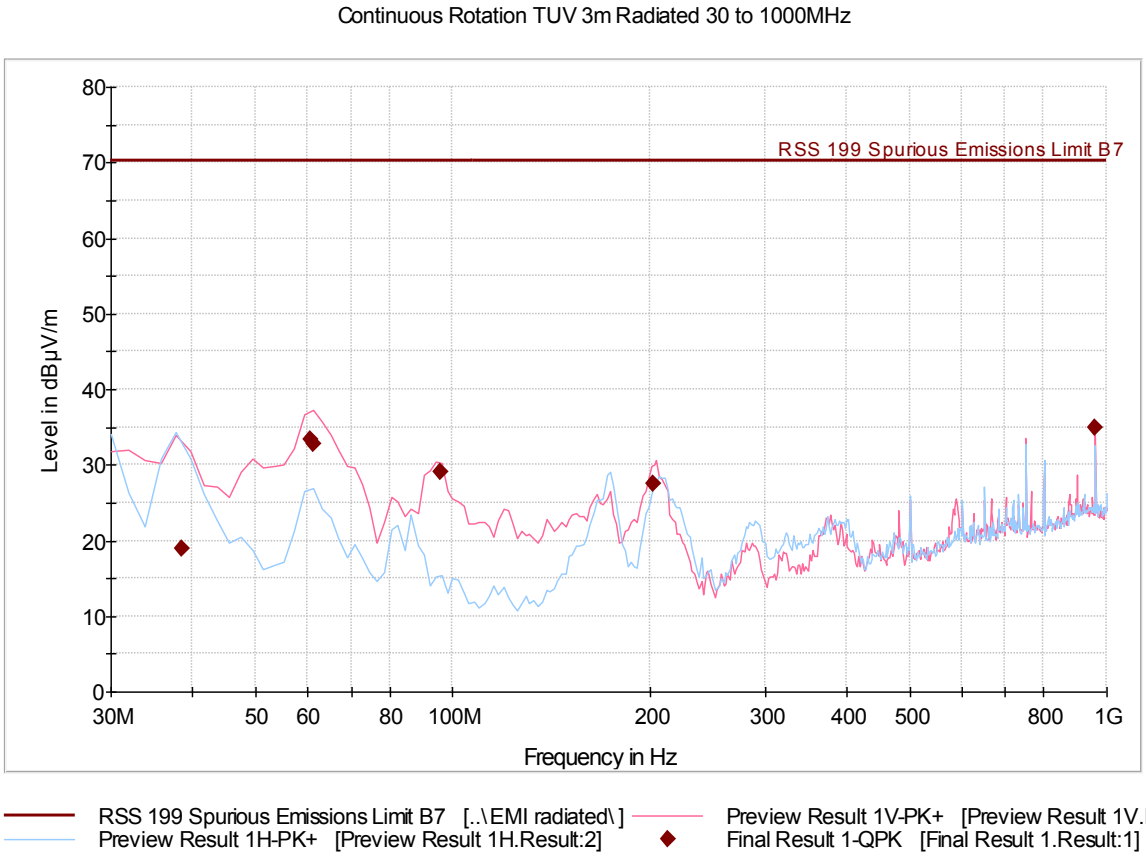
Ambient Temperature	23.7°C
Relative Humidity	40.1%
ATM Pressure	99.5 kPa

2.6.7 Additional Observations

- This is a radiated test using substitution method as per Unwanted Emissions: Radiated Spurious method of measurement of ANSI/TIA/EIA-603-C 2004, August 17, 2004.

- Only the worst case configuration presented in this test report.
- The spectrum was searched from 30 MHz to 18 GHz (requirement is up to the 10th harmonic (≤8GHz)).
- Frequency range from 18 GHz to 25.7 GHz was verified and there were no emissions greater than 20dB below the limt.
- There are no emissions found that doesn't comply with -25dBm limit in the 2500 - 2560 MHz frequency range. This limit corresponds to 70.2 dBµV/m @ 3 meters.
- Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only.

2.6.8 Test Results Below 1GHz (LTE Band7_15M BW_QPSK_Channel 20825 @ Frequency 2507.5)



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)
38.455551	18.9	1000.0	120.000	256.0	H	355.0	-15.9	51.3	70.2
60.622204	33.4	1000.0	120.000	100.0	V	116.0	-21.9	36.8	70.2
61.198317	32.8	1000.0	120.000	100.0	V	125.0	-22.0	37.4	70.2
95.708297	29.1	1000.0	120.000	100.0	V	333.0	-20.1	41.1	70.2
202.549900	27.6	1000.0	120.000	100.0	V	169.0	-16.8	42.7	70.2
960.082244	34.9	1000.0	120.000	100.0	V	51.0	1.4	35.3	70.2

Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dbµV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance

Test Notes: Only worst case configuration presented for spurious emissions below 1GHz. Substitution data not needed since Peak data > 20dB in all peaks.

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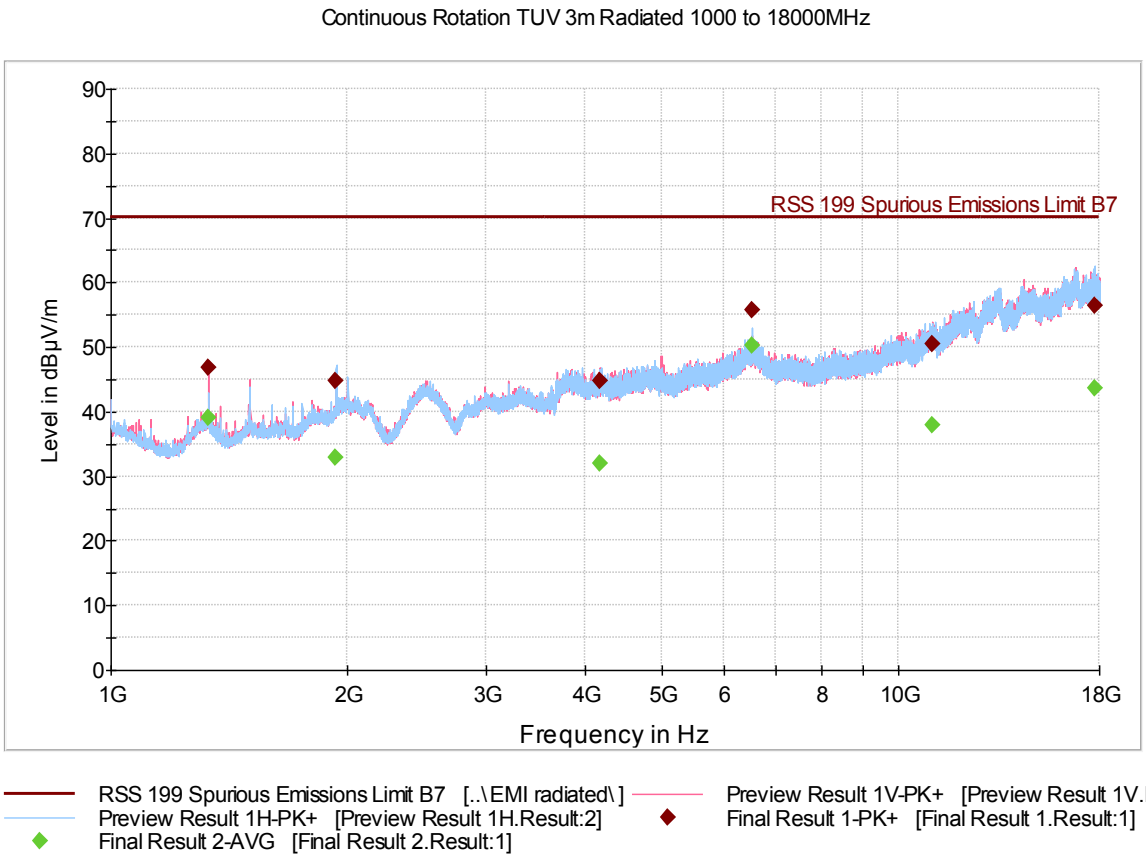
2.6.9 Test Results Above 1GHz (LTE Band7_15M BW_QPSK_Channel 20825 @ Frequency 2507.5MHz)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1332.100000	46.8	1000.0	1000.000	166.6	V	186.0	-5.5	23.4	70.2
1932.533333	44.9	1000.0	1000.000	381.0	H	273.0	-2.0	25.3	70.2
4180.533333	44.9	1000.0	1000.000	403.3	V	179.0	5.0	25.3	70.2
6527.466667	55.7	1000.0	1000.000	201.5	H	219.0	11.2	14.5	70.2
11052.666667	50.5	1000.0	1000.000	403.3	V	23.0	14.7	19.7	70.2
17731.633333	56.4	1000.0	1000.000	201.5	H	179.0	23.1	13.8	70.2

Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dbµV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance

Test Notes: Only worst case configuration presented for spurious emissions above 1GHz. Substitution data not needed since Peak data > 20dB in all peaks.

2.7 TRANSMITTER FREQUENCY STABILITY

2.7.1 Specification Reference

FCC CFR Part 2, Clause 2.1055 (a) (1) and (d)(1)
FCC CRF Part 27, Clause 27.54
Industry Canada RSS-199, Clause 4.3
Industry Canada RSS-GEN, Clause 6.11

2.7.2 Standard Applicable

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

The transmitter frequency stability limit shall be determined as follows:
(a) The frequency offset shall be measured according to the procedure described in RSS-Gen and recorded;
(b) Using a resolution bandwidth equal to that permitted within the 1MHz band immediately outside the channel edge, reference points at the unwanted emission level which complies with the attenuation of 43 + 10 log10 p (watts) on the emission mask of the lowest and highest channel shall be selected, and the frequency at these points shall be recorded as fL and fH respectively.
The applicant shall ensure frequency stability by showing that fL minus the frequency offset and fH plus the frequency offset shall be within the frequency range in which the equipment is designed to operate.

2.7.3 Equipment Under Test and Modification State

Serial No: FID: SH181214900141 / Test Configuration A

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

March 25, 2015 / XYZ

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/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.5°C
Relative Humidity	39.7%
ATM Pressure	99.7 kPa

2.7.7

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2.7.8 Additional Observations

- This is a conducted test. The EUT was operated at 3.8VDC nominal voltage and was placed in the temperature chamber for this evaluation. The EUT was controlled by a CMW500 and the maximum frequency error was monitored through the Wideband Radio Communication Tester Frequency Error measurement function under LTE Tx Measurement.

- The Temperature was set to -30°C, 20°C and then 50°C and allowed to sit for 1 hour to allow the equipment and chamber temperature to stabilize. The measurements were then performed.
- Voltage variation was also performed at 85% and 115% of the nominal voltage at 20°C.
- Only worst case configuration presented.
- The maximum frequency deviation was verified against the frequency band edges using the OBW data. Sample calculation:

  LTE Band 7 worst case frequency error: *18.67 Hz*
  Worst case OBW of LTE Band 7 5MHz BW: *4.46 MHz*

  Low Channel Sample Calculation:

  Edge of fundamental emission (2502.5-(4.46/2)): *2500.27 MHz*
  Max. fundamental frequency error (2500.27 - 0.00001867): *2500.26998133 MHz*
  EUT complies. 2500.26998133 MHz > 2500 MHZ (edge of authorized band)

  High Channel Sample Calculation:

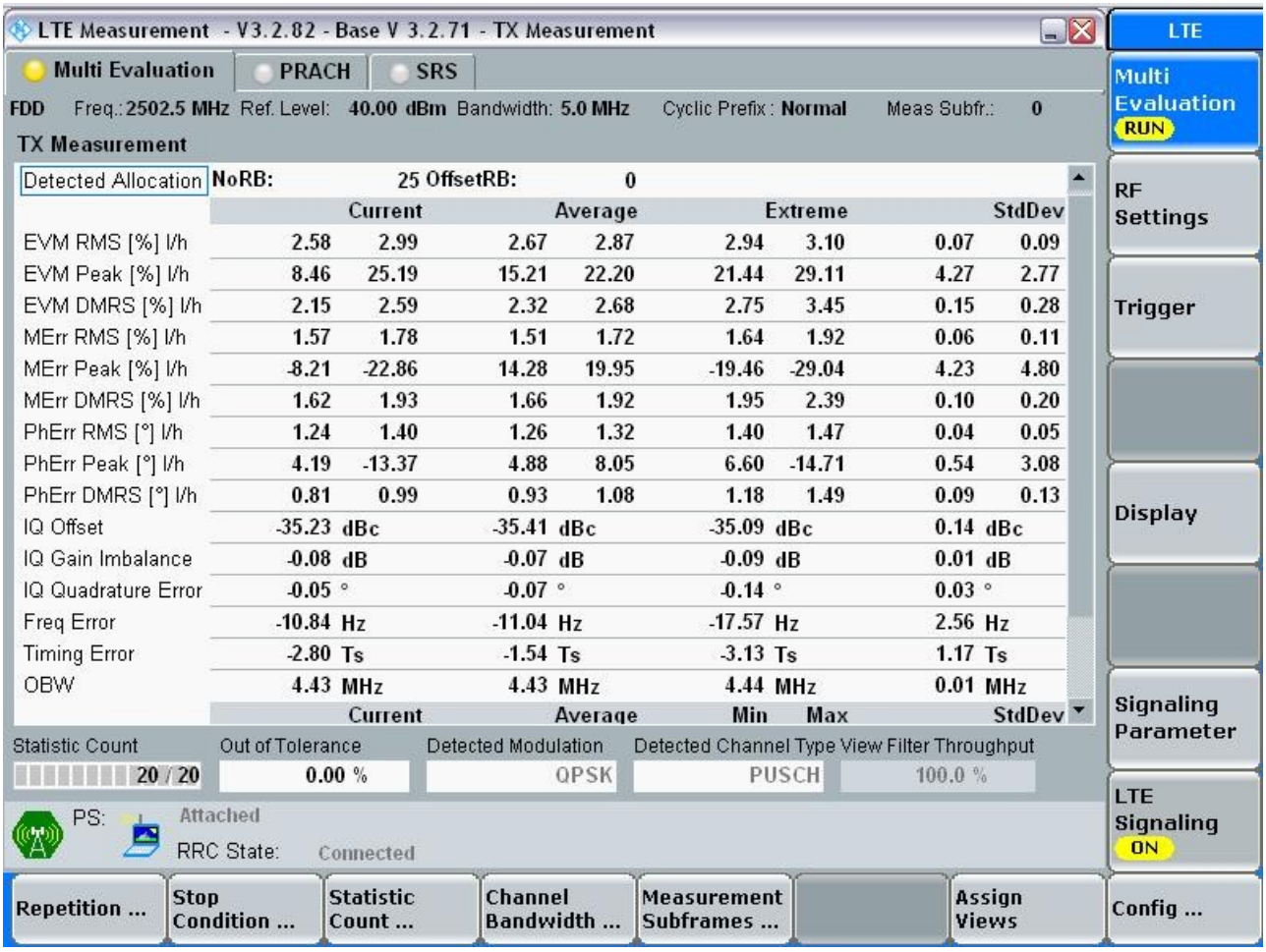
  Edge of fundamental emission (2567.5+ (4.46/2)): *2569.73 MHz*
  Max. fundamental frequency error (2569.73 + 0.00001867): *2569.73001867 MHz*
  EUT complies. 2569.73001867 MHz < 2570 MHZ (edge of authorized band)

2.7.9 Test Results Summary

LTE Band 7 High Channel 21100 (5 MHz BW) QPSK @ 2535.0 MHz		
Voltage (VDC)	***Temperature (°C)***	***Frequency Deviation (Hz)***
3.8	-30	18.67
	-20	17.4
	-10	-15.7
	0	-16.5
	+10	17.9
	+20	17.57
	+30	18.3
	+40	-16.9
	+50	17.25

LTE Band 7 High Channel 21100 (5 MHz BW) QPSK @ 2535.0 MHz		
Temperature (°C)	***Voltage (VDC)***	***Frequency Deviation (Hz)***
20	3.23	15.61
	4.37	-18.11

2.7.10 Sample Test Plot



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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
Conducted Port Setup						
7582	Signal/Spectrum Analyzer	FSW26	101614	Rhode & Schwarz	12/22/14	12/22/15
7570	50MHz-18GHz Wideband Power Sensor	N1921A	MY45240588	Agilent	04/09/14	04/09/15
7569	Series Power Meter	N1911A P-	MY45100625	Agilent	04/22/14	04/22/15
7579	Temperature Chamber	115	151617	TestQuity	07/21/14	07/21/15
7608	Vector Signal Generator	SMBB100A	259021	Rhode & Schwarz	06/06/14	06/06/15
7562	Wideband Radio Communication Tester	CMW 500	1201.0002k50/103829	Rhode & Schwarz	10/09/14	10/09/15
-	Power Divider/Splitter	1506A	RR003	Weinschel	Verified by 7608 and 7569	
-	10dB Attenuator	PE7010-10	-	PASTERNACK	Verified by 7608 and 7569	
Radiated Test Setup						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	01/30/14	01/30/16
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	08/29/14	08/29/15
1016	Pre-amplifier	PAM-0202	187	PAM	12/10/14	12/10/15
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	04/08/14	04/08/15
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/14	03/17/15
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	04/03/14	04/03/15
1150	Horn antenna	RA42-K-F-4B-C	012054-004	CMT	04/26/13	04/26/2015
1151	Pre-amplifier	TS-PR26	100026	Rhode & Schwarz	05/02/13	05/02/2015
7562	Wideband Radio Communication Tester	CMW 500	1201.0002k50/103829	Rhode & Schwarz	10/09/13	10/09/15
8815	Notch Filter	BRM50702	008	Micro-Tronics	N/A	
Miscellaneous						
7560	Barometer/Temperature /Humidity Transmitter	iBTHX-W	1240476	Omega	01/30/14	01/30/15
6792	Multimeter	3478A	2911A70964	Hewlett Packard	08/12/14	08/12/15
1072	DC Power Supply	E3610A	KR51311519	Hewlett Packard	Verified by 6792	
	Test Software	EMC32	V8.52	Rhode & Schwarz	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	3.89	2.25	5.04
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	2.41
				Coverage Factor (k):	2
				Expanded Uncertainty:	4.82

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	3.89	2.25	5.04
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	2.40
				Coverage Factor (k):	2
				Expanded Uncertainty:	4.81

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

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SECTION 4

DIAGRAM OF TEST SETUP

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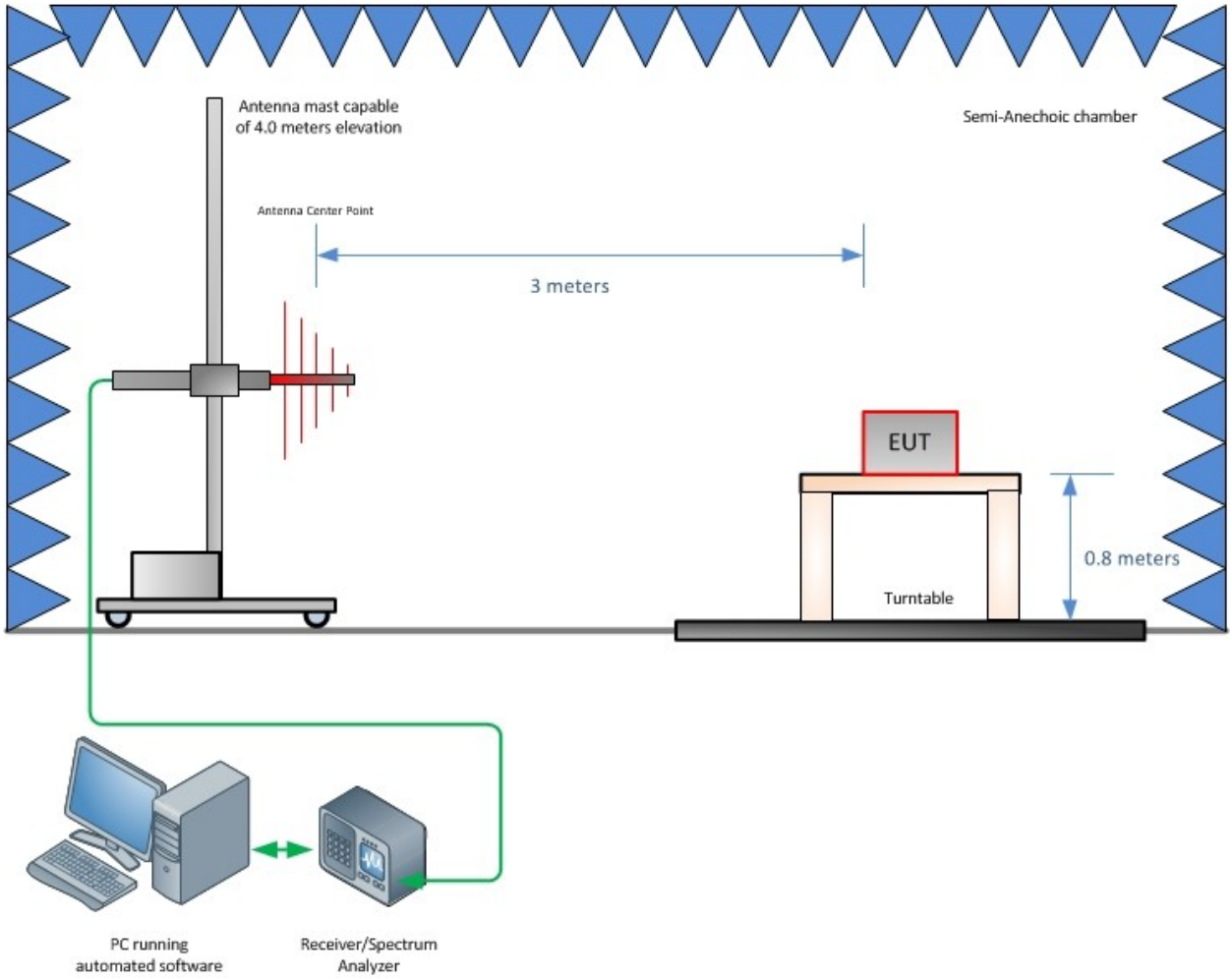
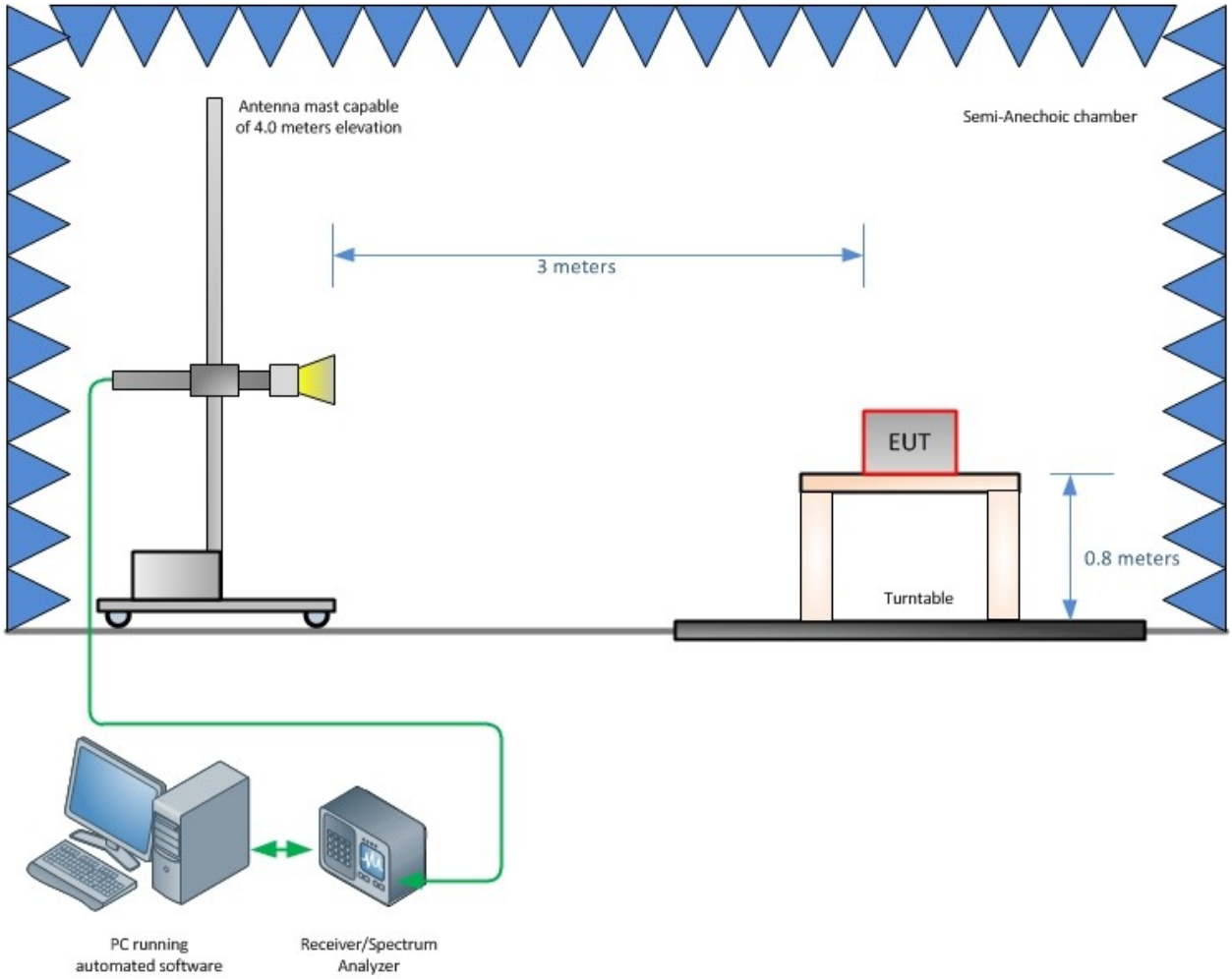
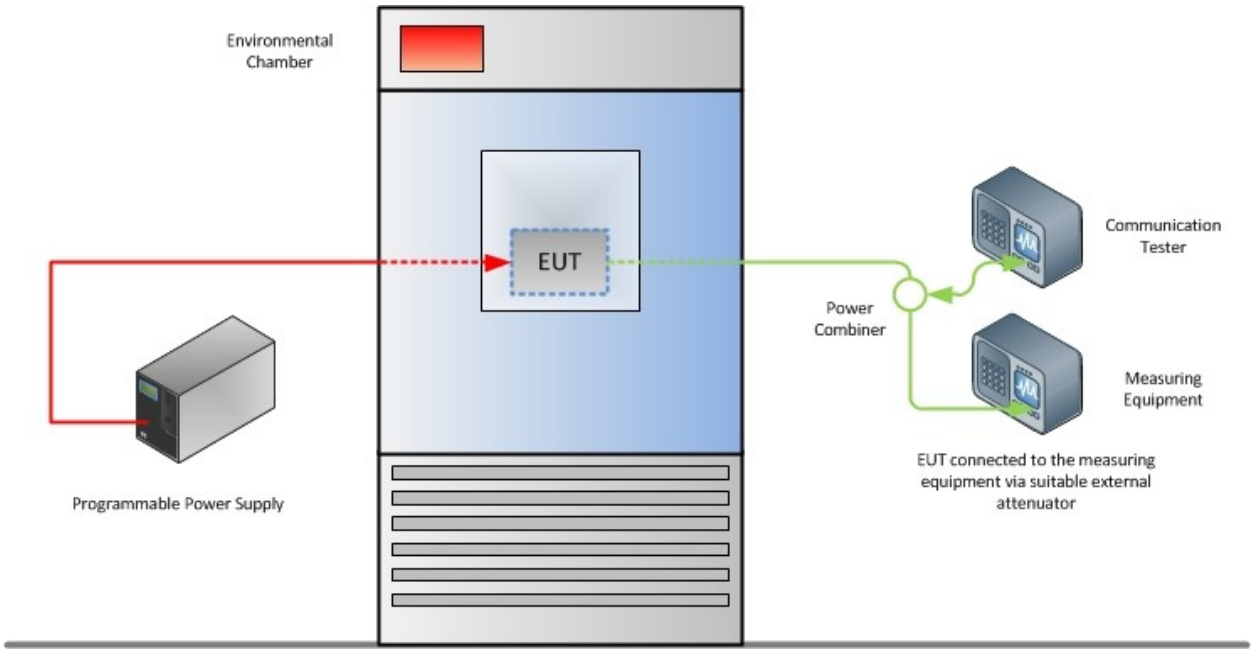
4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)



Frequency Stability Test Comfiguration

SECTION 5

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