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Report On

Application for Grant of Equipment Authorization of the
u-blox AG
SARA-R410M LTE Cat-M1 Module

FCC CFR 47 Part 2, Part 22 and 24
ISED RSS-Gen and RSS-132 and RSS-133

Report No. SD72128174-0517B **May 2017**

REPORT ON	Radio Testing of the u-blox AG LTE Cat-M1 Module
TEST REPORT NUMBER	SD72128174-0517B
PREPARED FOR	u-blox AG Zuercherstrasse 68 8800 Thalwil, Switzerland
CONTACT PERSON	Jake Bascon Sr. Certification Engineer (858) 847-9611 x616 Jake.Bascon@u-blox.com
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: EMC/Senior Wireless Test Engineer
APPROVED BY	Juan Manuel Gonzalez Name Authorized Signatory Title: EMC SL Manager West Region
DATED	June 20, 2017

Revision History

SD72128174-0517B u-blox AG SARA-R410M LTE Cat-M1 Module					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
06/20/17	Initial Release				Juan M Gonzalez

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SECTION 1

REPORT SUMMARY

Radio Testing of the
u-blox AG
SARA-R410M LTE Cat-M1 Module

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the u-blox AG LTE Cat-M1 Module to the requirements of the following:

- FCC CFR 47 Part 2, Part 22 and 24
- ISED RSS-Gen and RSS-132 and RSS-133.

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	u-blox AG
Product Marketing Name	SARA-R410M
Model Number(s)	SARA-R410M
FCC ID Number	XPY2AGQN4NNN
IC Number	8595A-2AGQN4NNN
Serial Number(s)	357591080023101 and 357591080022319
Number of Samples Tested	2
Test Specification/Issue/Date	• FCC CFR 47 Part 2, Part 22 and 24 (October 1, 2016). • RSS-132 - Cellular Telephones Employing New Technologies Operating in the Bands 824-849 MHz and 869-894 MHz (Issue 3, January 2013). • RSS-133 – 2 GHz Personal Communications Services (Issue 6, January 2013). • RSS-Gen - General Requirements and Information for the Certification of Radio Apparatus (Issue 4, November 2014).
Start of Test	May 24, 2017
Finish of Test	June 05, 2017
Name of Engineer(s)	Ferdinand S. Custodio
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 • KDB412172 D01 Determining ERP and EIRP v01r01 (Guidelines for Determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of a RF Transmitting System. • SRSP-510 Issue 5 February 2009 Technical Requirements for Personal Communications Services (PCS) in the Bands 1850-1915 MHz and 1930-1995 MHz

- SARA-R410M_Tune_Up_Procedure.pdf
- 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 CFR 47 Part 2, Part 22 and 24 with cross-reference to the corresponding ISED RSS standard is shown below.

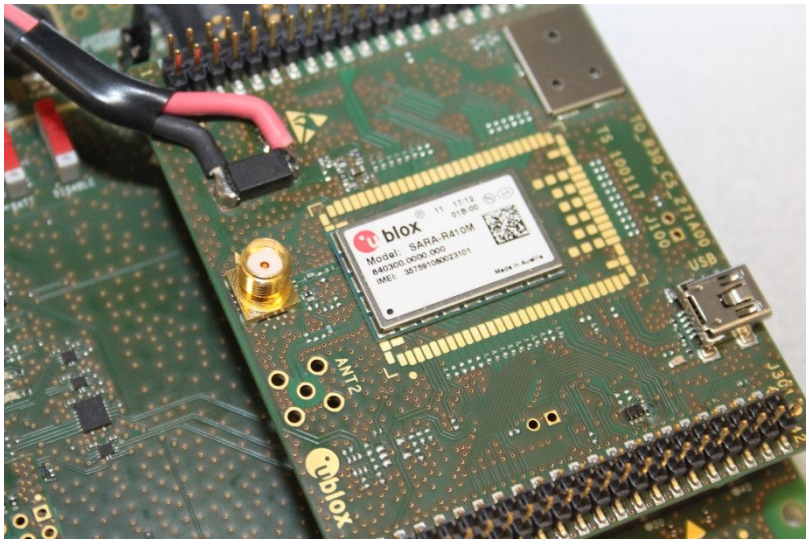
Section	FCC Part Sections(s)	RSS Section(s)	Test Description	Result
2.1	2.1046	RSS-132(5.4),RSS-133(6.4)	Transmitter Conducted Output Power	Compliant
2.2	22.913(a)(2), 2.1046		Effective Radiated Power	Compliant
2.3	24.232(c),2.1046	RSS-132(5.4), RSS-133(6.4), SRSP-510(5.1.2)	Equivalent Isotropic Radiated Power	Compliant
2.4	2.1049,22.917(b), 24.238(b)	RSS-Gen 6.6	Occupied Bandwidth	Compliant
2.5	24.232(d)	RSS-132(5.4),RSS-133(6.4)	Peak-Average Ratio	Compliant
2.6	2.1051,22.917(a), 24.238(a)	RSS-132(5.5),RSS-133(6.5)	Band Edge/Conducted Spurious Emissions	Compliant
2.7	Clause 7of KDB971168 D01 v02r02		Field Strength Of Spurious Radiation	Compliant
2.8	2.1055,22.355,24.235	RSS-132(5.3),RSS-133(6.3)	Frequency Stability	Compliant
2.9		RSS-132(5.6),RSS-133(6.6)	Receiver Spurious Emissions	N/A*
2.10		RSS-Gen 8.8	Power Line Conducted Emission	Compliant

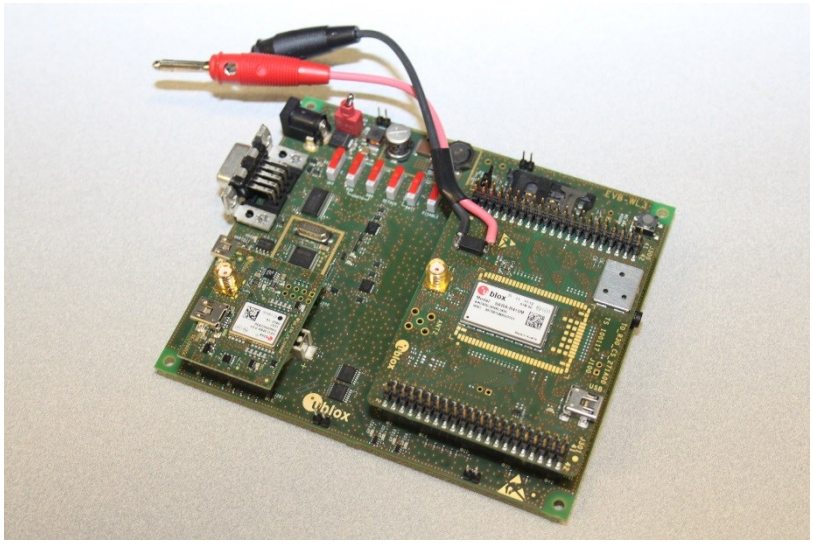
N/A - *Not applicable. EUT does not fall to any category defined as Receiver under Section 5 of RSS-Gen Issue 4.*

1.1 PRODUCT INFORMATION

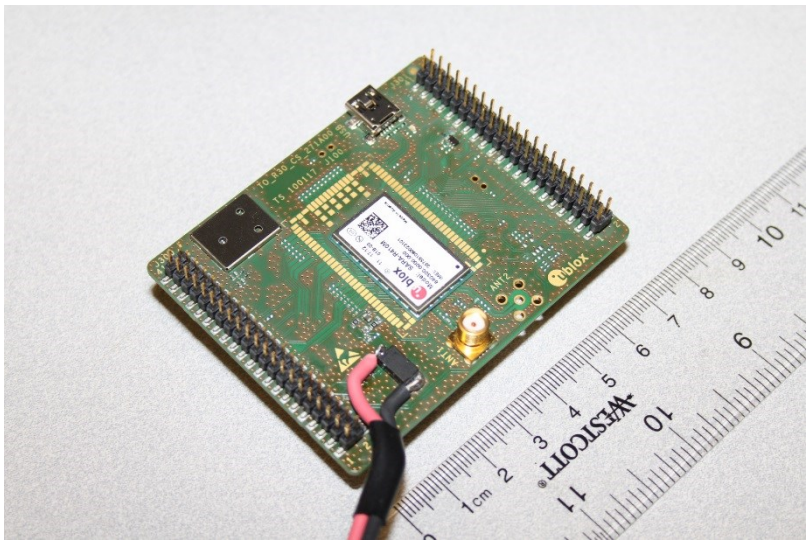
1.1.1 Technical Description

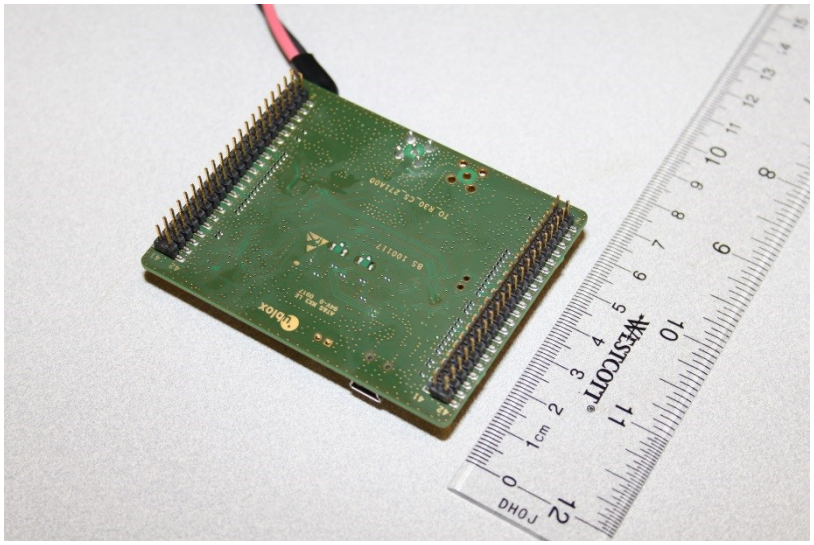
The Equipment Under Test (EUT) was a u-blox AG Model SARA-R410M™ LTE Cat-M1 Module as shown in the photographs below. The EUT is based on Qualcomm Technologies' MDM9206 LTE modem designed to allow a larger number of devices to connect to the Internet of Things (IoT). LTE Cat M1 is part of the new 3GPP Release 13 standard supporting low power wide area technologies in the licensed spectrum and specifically supports IoT applications with low to medium data throughput rates, as well as devices that require long battery lifetimes.





Equipment Under Test (installed on WL3 evaluation board)





Equipment Under Test

1.1.2 EUT General Description

EUT Description	LTE Cat-M1 Module
Model Name	SARA-R410M
Model Number(s)	SARA-R410M
Rated Voltage	4.2VDC using a programmable power supply
Mode Verified	LTE Band 2 and 5 with 1.4 MHz BW
Frequency Range	1850 MHz – 1910 MHz (Band 2) 824 MHz -849 MHz (Band 5)
Capability	LTE Band 5, 2, 4 and 12
Primary Unit (EUT)	☐ Production ☒ Pre-Production ☐ Engineering
Antenna Gain	**4.1 dBi** for Band 5 and **7.12 dBi** for band 2 (this is the maximum antenna gain that can be used with the EUT and still complies with all relevant requirements of the Equipment Authorization for mobile use).

1.1.3 Transmit Frequency Table

LTE Band	Channel	Frequency (MHz)	Emission Designators	Rated Power	
				Max. Power (dBm)	Max. Power (W)
2	18607	1850.7	1M12G7D/1M12W7D	25.00	0.316
	18900	1880.0			
	19193	1909.3			
5	20407	824.7	1M12G7D/1M11W7D		
	20525	836.5			
	20643	848.3			

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1.2 EUT TEST CONFIGURATION

1.2.1 Test Configuration Description

Test Configuration	Description
Default	The EUT was installed on a development board powered by a programmable power supply. Nominal voltage is 4.2VDC. RF configuration is through a support laptop running Qualcomm Radio Control Toolkit connected via USB.

1.2.2 EUT Exercise Software

Manufacturer provided a configuration software (Qualcomm Radio Control Toolkit Version 3.0.242.0) running from a support laptop where the EUT is connected via USB. Major configuration parameters provided by the manufacturer are shown in Section 1.4.5 of this test report.

1.2.3 Support Equipment and I/O cables

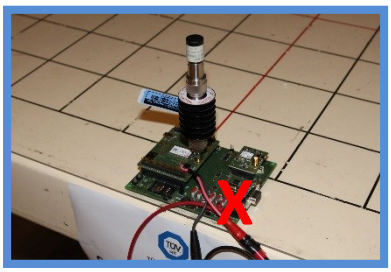
Manufacturer	Equipment/Cable	Description
Lenovo	Support Laptop (T410S)	P/N 0A31972 S/N R9-92MH0 10/11
LiteOn Technology Corporation	AC Adapter for Support Laptop	Model 42T4430 S/N 11S42T4430Z1ZGWE27AA9X REV G
Hewlett Packard	DC Power Supply	M/N E3610A S/N KR51311519
-	USB Cable (EUT to Support Laptop)	USB 2.0, 1.8 meters, USB A to Mini B connector
Pasternack	Support 20dB attenuator	M/N PE7017-20 25 watts DC-18GHz
Narda	Support 50Ω Termination	M/N 370BNM 50-Ohm Coaxial Termination DC-18GHz

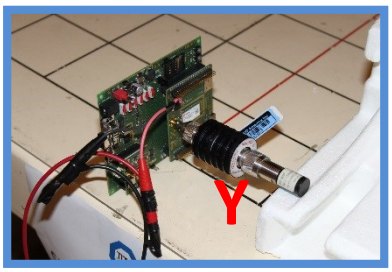
1.2.4 Worst Case Configuration

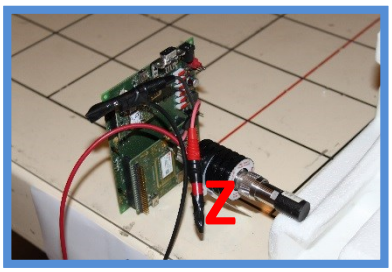
Worst-case configuration used in this test report as per maximum conducted output power measurements:

Modulation	Channel		PUSCH RBs	PA Range	TX Gain
QPSK	Low (Band 5)	Low (Band 2)	6	2	66

EUT is a RF module. For radiated measurements, the EUT was verified installed on a development board using the worst case axis (“X”) verified via prescan.

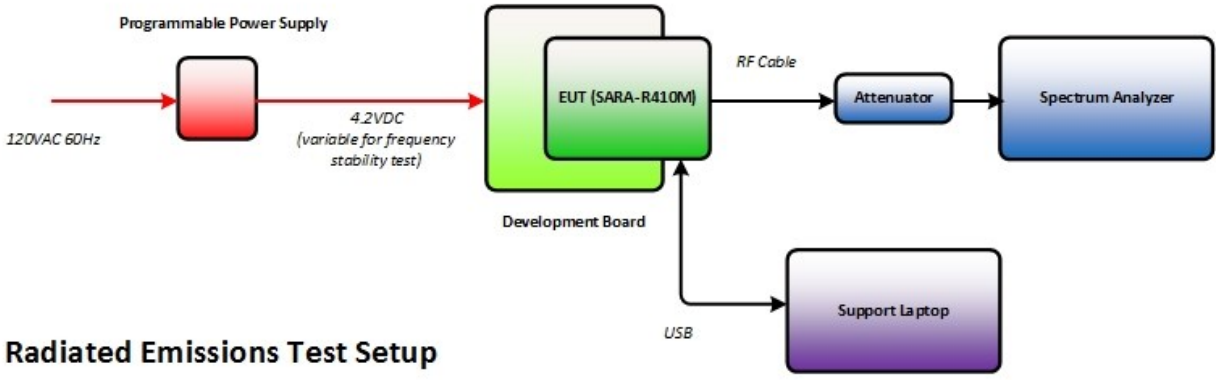




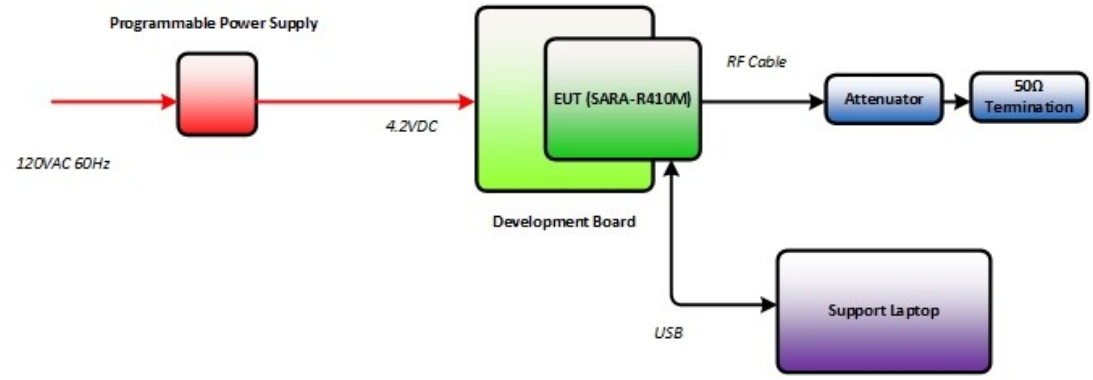


1.2.5 Simplified Test Configuration Diagram

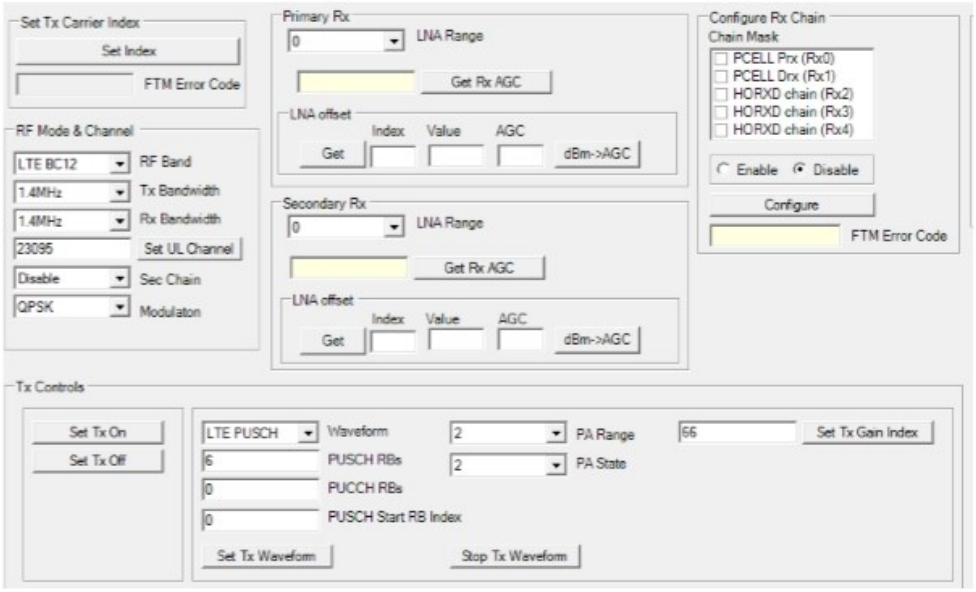
Antenna Conducted Port Test Setup



Radiated Emissions Test Setup



General RF Test Configuration (Manufacturer provided)



"FTM RF Verification" mode was also used during testing with identical test parameters.

1.3 DEVIATIONS FROM THE STANDARD

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

1.4 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number 357591080022319 and 357591080023101		
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.

1.5 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.26 2015 and American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services and ANSI/TIA-603-C-2004 – Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards.

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 C63.26-2015. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.6 TEST FACILITY LOCATION

1.6.1 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.

1.6.2 TÜV SÜD America Inc. (Rancho Bernardo)

16936 Via Del Campo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 678-1400 Fax: 858 546 0364.

1.7 TEST FACILITY REGISTRATION

1.7.1 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.

1.7.2 Innovation, Science and Economic Development 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 Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A.

1.7.3 BSMI – Laboratory Code: SL2-IN-E-028R (US0102)

TUV Product Service Inc. (San Diego) is a recognized EMC testing laboratory by the BSMI under the MRA (Mutual Recognition Arrangement) with the United States. Accreditation includes CNS 13438 up to 6GHz.

1.7.4 NCC (National Communications Commission - US0102)

TUV SUD America Inc. (San Diego) is listed as a Foreign Recognized Telecommunication Equipment Testing Laboratory and is accredited to ISO/IEC 17025 (A2LA Certificate No.2955.13) which under APEC TEL MRA Phase 1 was designated as a Conformity Assessment Body competent to perform testing of equipment subject to the Technical Regulations covered under its scope of accreditation including RTTE01, PLMN01 and PLMN08 for TTE type of testing and LP002 for Low-Power RF Device type of testing.

1.7.5 VCCI – Registration No. A-0230

TUV SUD America Inc. (San Diego) is a VCCI registered measurement facility which includes radiated field strength measurement, radiated field strength measurement above 1GHz, mains port interference measurement and telecommunication port interference measurement.

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1.8 SAMPLE CALCULATIONS

1.8.1 LTE Emission Designator (QPSK)

Emission Designator = 4M51G7D
G = Phase Modulation
7= Quantized/Digital Info
D = Combination (Audio/Data)

1.8.2 LTE Emission Designator (16QAM)

Emission Designator = 4M52W7D
W = Frequency Modulation
7= Quantized/Digital Info
D = Combination (Audio/Data

1.8.3 Spurious Radiated Emission (below 1GHz)

Measuring equipment raw measurement (dBµV/m) @ 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**

1.8.4 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
u-blox AG
SARA-R410M LTE Cat-M1 Module

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2.1 TRANSMITTER CONDUCTED OUTPUT POWER

2.1.1 Specification Reference

Part 2.1046 (a) and (c)

2.1.2 Standard Applicable

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.
(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

2.1.3 Equipment Under Test and Modification State

Serial No: 357591080022319/ Default Test Configuration

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

May 25, 2017/FSC

2.1.5 Test Equipment Used

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

2.1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	25.8 °C
Relative Humidity	41.0 %
ATM Pressure	98.6 kPa

2.1.7 Additional Observations

- This is a conducted test using an average power meter.
- The path loss was measured and entered as a level offset.

Frequency	Correction Factor
836.50 MHz	20.175 dB
1880.0 MHz	20.450 dB

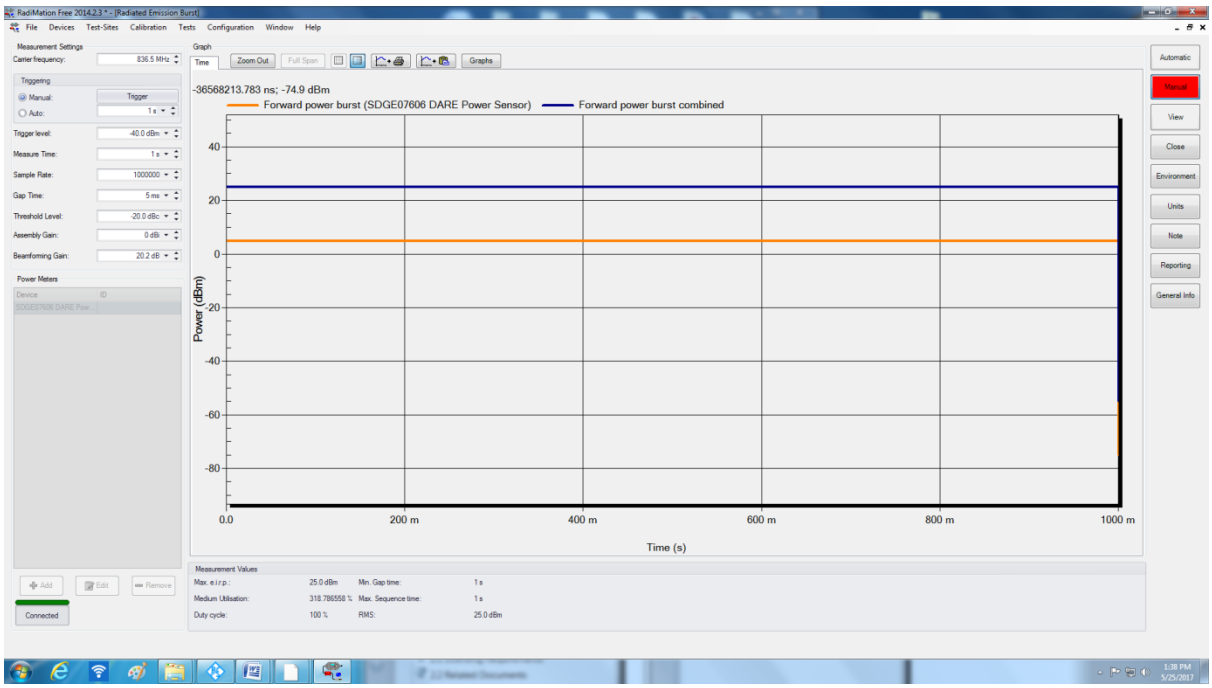
- Measurements were verified within the manufacturer declared Tune-Up procedure.

2.1.8 Test Results

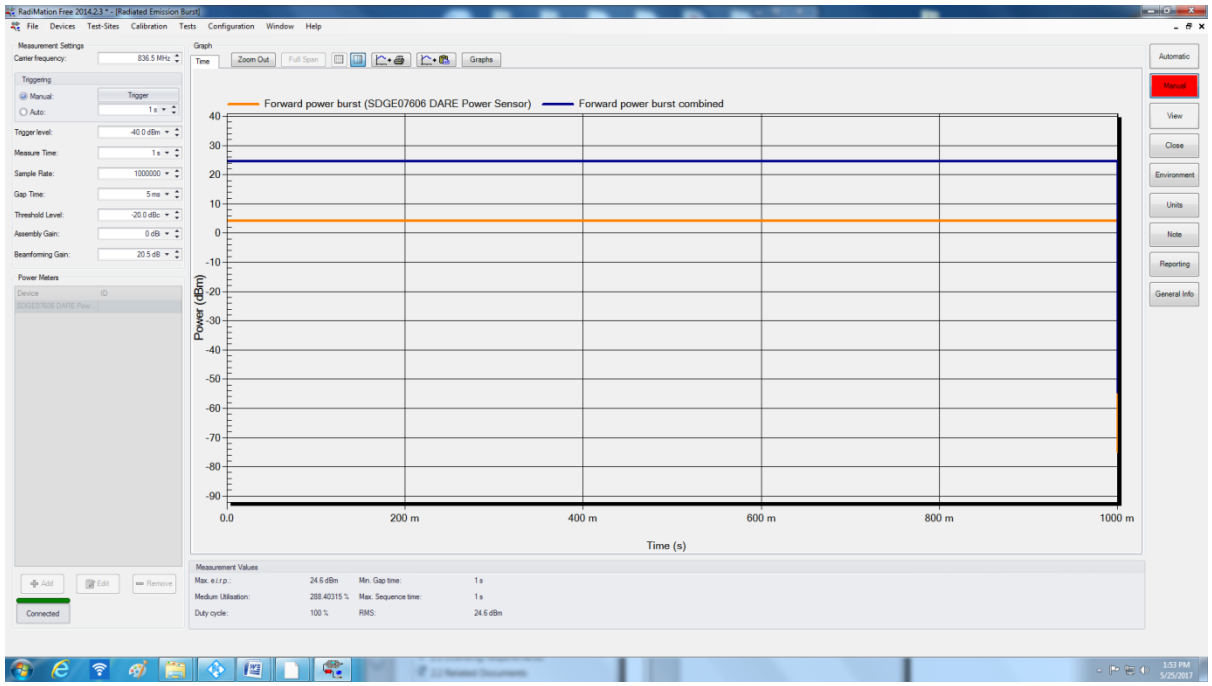
LTE Band 5 (70 Tx Gain Index)				
Modulation	**Bandwidth**	**Channels**	**Frequency**	**Tx Average (dBm)**
QPSK	1.4 MHz	20407	824.7	25.0
		20525	836.5	24.9
		20643	848.3	24.6
16QAM	1.4 MHz	20407	824.7	25.0
		20525	836.5	25.0
		20643	848.3	24.7

LTE Band 2 (68 Tx Gain Index)				
Modulation	**Bandwidth**	**Channels**	**Frequency**	**Tx Average (dBm)**
QPSK	1.4 MHz	18607	1850.7	24.8
		18900	1880.0	24.8
		19193	1909.3	24.5
16QAM	1.4 MHz	18607	1850.7	24.8
		18900	1880.0	24.8
		19193	1909.3	24.6

2.1.9 Sample Test Plot



Low Channel LTE Band 5 QPSK



High Channel LTE Band 2 16QAM

2.2 EFFECTIVE RADIATED POWER

2.2.1 Specification Reference

Part 22 Subpart H §22.913(a)(2)

2.2.2 Standard Applicable

The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

2.2.3 Equipment Under Test and Modification State

Serial No: 357591080022319 and 357591080023101

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

June 02, 2017/FSC

2.2.5 Additional Observations

- ERP was calculated as per Section 1.3.2 of KDB412172 D01 (Determining ERP and EIRP v01).
- Calculation formula in logarithmic terms:

$ERP = P_T + G_T - L_C - 2.15dB$

Where:

P_T = transmitter conducted output power dBm (Section 2.1 of this test report)
G_T = gain of the transmitting antenna, in dBi (EIRP: the -2.15 in the formula is to convert EIRP to ERP);
L_C = signal attenuation in the connecting cable between the transmitter and antenna, in dB.

2.2.6 Sample Computation

ERP = $P_T + G_T - L_C$ - 2.15dB
= 25.0 dBm (conducted output power) + 4.10 dBi (antenna gain) – 0 (cable loss was programmed as an offset in the power meter) -2.15
= 26.95 dBm

2.2.7 Test Results

LTE Band 5 Uplink (824 MHz -849 MHz) 1.4MHz BW							
Modulation	**Channel**	***Frequency (MHz)***	***Average Power (dBm)***	***Antenna Gain (dBi)***	**EIRP (dBm)**	**ERP (dBm)**	**Limit (dBm)**
QPSK	20407	824.7	25.0	4.10	-	26.95	38.45
	20525	836.5	24.9	4.10	-	26.85	38.45
	20643	848.3	24.6	4.10	-	26.55	38.45

16-QAM	20407	824.7	25.0	4.10	-	26.95	38.45
	20525	836.5	25.0	4.10	-	26.95	38.45
	20643	848.3	24.7	4.10	-	26.65	38.45

2.3 EQUIVALENT ISOTROPIC RADIATED POWER

2.3.1 Specification Reference

Part 24 Subpart E §24.234(c)
RSS 132, Clause 5.4

2.3.2 Standard Applicable

Part 24 Subpart E §24.234(c)
Mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.

RSS 132, Clause 5.4
The transmitter output power shall be measured in terms of average power. The equivalent isotropically radiated power (e.i.r.p.) for mobile equipment shall not exceed 11.5 watts. Refer to SRSP-503 for base station e.i.r.p. limits.

RSS 133, Clause 6.4
The equivalent isotropically radiated power (e.i.r.p.) for transmitters shall not exceed the limits given in SRSP-510. Moreover, base station transmitters operating in the band 1930-1995 MHz shall not have output power exceeding 100 watts

SRSP-510 5.1.2
Mobile stations and hand-held portables are limited to 2 watts maximum e.i.r.p. The equipment shall employ means to limit the power to the minimum necessary for successful communication.

2.3.3 Equipment Under Test and Modification State

Serial No: 357591080022319 and 357591080023101

2.3.4 Date of Calculation/Initial of test personnel who performed the calculation

June 02, 2017/FSC

2.3.5 Additional Observations

- EIRP was calculated as per Section 1.3.2 of KDB412172 D01 (Determining ERP and EIRP v01).
- Calculation formula in logarithmic terms:

$$\mathbf{EIRP = P_T + G_T - L_C}$$

Where:

$\mathbf{P_T}$ = transmitter conducted output power dBm (Section 2.1 of this test report)
$\mathbf{G_T}$ = gain of the transmitting antenna, in dBi (EIRP);
$\mathbf{L_C}$ = signal attenuation in the connecting cable between the transmitter and antenna, in dB.

2.3.6 Sample Computation

EIRP $= P_T + G_T - L_C$

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= 25.0 (conducted output power) + 4.10 (antenna gain) – 0 (cable loss was programmed as an offset in the power meter)
= 29.10 dBm

2.3.7 Test Results

LTE Band 5 Uplink (824 MHz -849 MHz) 1.4MHz BW							
Modulation	**Channel**	***Frequency (MHz)***	***Average Power (dBm)***	***Antenna Gain (dBi)***	**EIRP (dBm)**	**ERP (dBm)**	**Limit (dBm)**
QPSK	20407	824.7	25.0	4.10	29.1	-	40.60
	20525	836.5	24.9	4.10	29.0	-	40.60
	20643	848.3	24.6	4.10	28.7	-	40.60
16-QAM	20407	824.7	25.0	4.10	29.1	-	40.60
	20525	836.5	25.0	4.10	29.1	-	40.60
	20643	848.3	24.7	4.10	28.8	-	40.60

LTE Band 2 Uplink (1850 MHz – 1910 MHz) 1.4MHz BW							
Modulation	**Channel**	***Frequency (MHz)***	***Average Power (dBm)***	***Antenna Gain (dBi)***	**EIRP (dBm)**	**ERP (dBm)**	**Limit (dBm)**
QPSK	18607	1850.7	24.8	7.12	31.92	-	33.00
	18900	1880.0	24.8	7.12	31.92	-	33.00
	19193	1909.3	24.5	7.12	31.62	-	33.00
16-QAM	18607	1850.7	24.8	7.12	31.92	-	33.00
	18900	1880.0	24.8	7.12	31.92	-	33.00
	19193	1909.3	24.6	7.12	31.72	-	33.00

2.4 OCCUPIED BANDWIDTH

2.4.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1049
FCC 47 CFR Part 22, Clause 22.917(b)
FCC 47 CFR Part 24, Clause 24.238(b)
RSS-GEN 4.6.1

2.4.2 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.

2.4.3 Equipment Under Test and Modification State

Serial No: 357591080022319/ Default Test Configuration

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

May 25, 2017/FSC

2.4.5 Test Equipment Used

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

2.4.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	25.8 °C
Relative Humidity	41.0 %
ATM Pressure	98.6 kPa

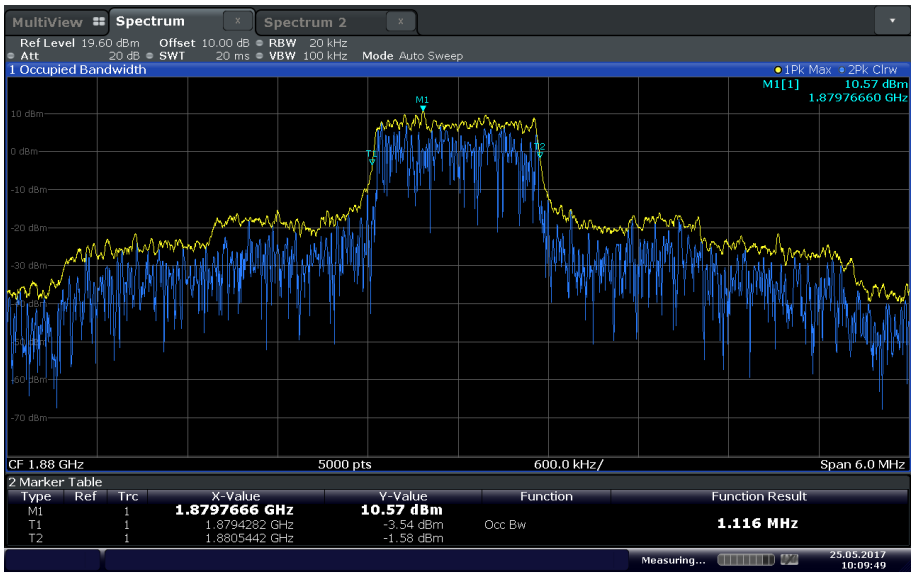
2.4.7 Additional Observations

- This is a conducted test. Both 26dB bandwidth and 99% bandwidth presented.
- Only the middle channels presented.
- The span is between two and five times the anticipated OBW.
- The RBW is set to 1% of the OBW while the VBW is ≥3X RBW (20kHz used, SA limitation for 14kHz).
- The detector is peak and the trace mode is max hold.
- The SA built-in emission bandwidth measurement feature is utilized. The power level setting is set to 99%
- For 26 dB BW, the “n dB down’ feature of the SA was used as a marker function.

2.4.8 Test Results (Reporting Purposes Only)

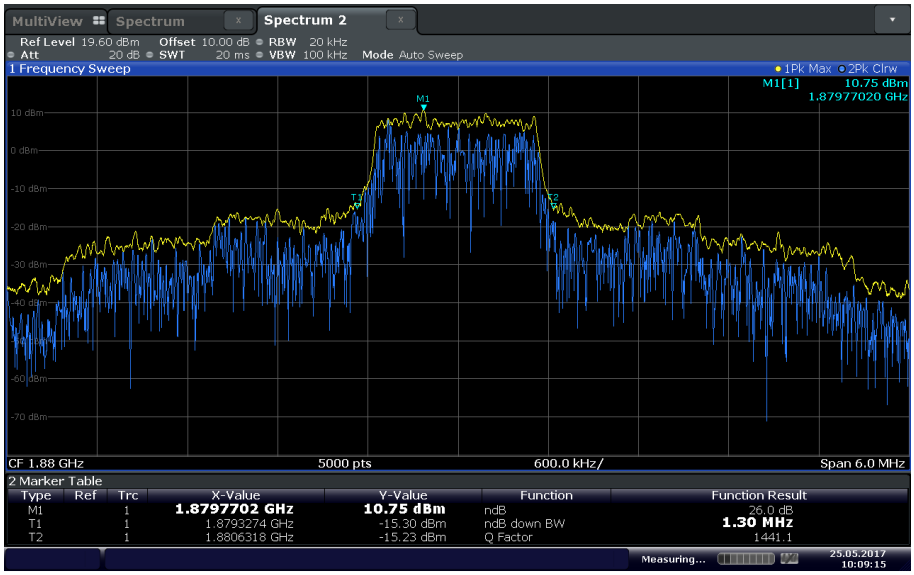
Band	Modulation	Channel	Frequency (MHz)	OBW (MHz)	-26dB BW (MHz)
2	QPSK	18900	1880.0	1.116	1.30
	16-QAM	18900	1880.0	1.115	1.30
5	QPSK	20525	836.5	1.115	1.33
	16-QAM	20525	836.5	1.113	1.27

Band 2 Mid Channel 99% OBW QPSK



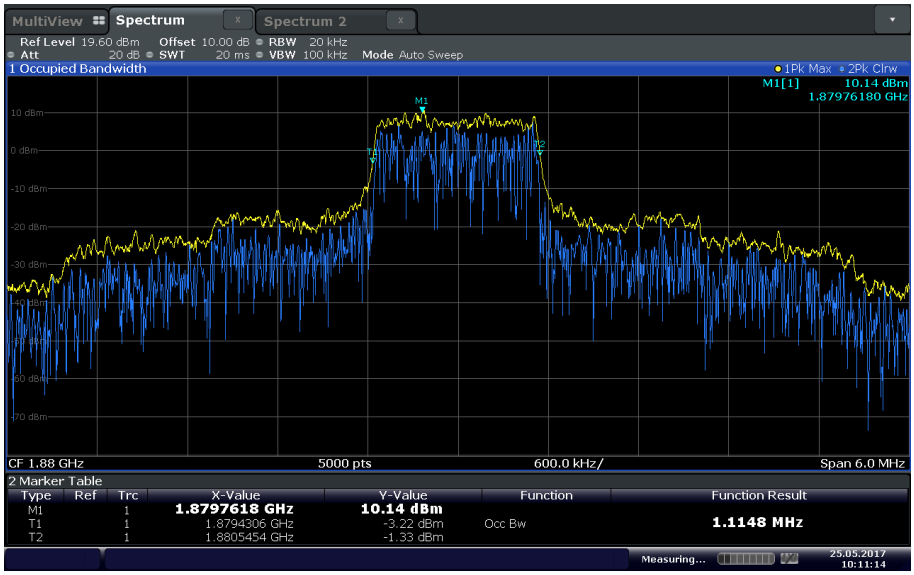
Date: 25.MAY.2017 10:09:50

Band 2 Mid Channel 26 dB BW QPSK



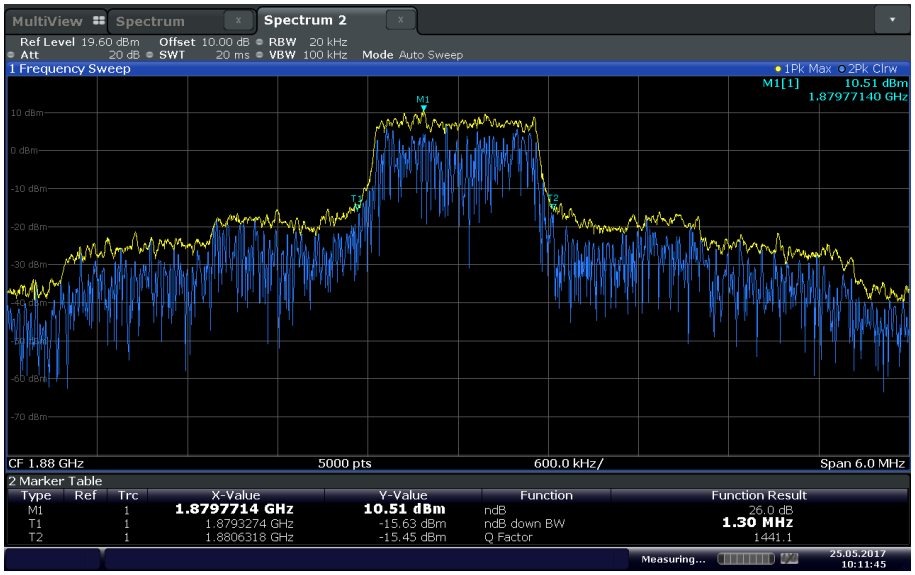
Date: 25.MAY.2017 10:09:15

Band 2 Mid Channel 99% OBW 16-QAM



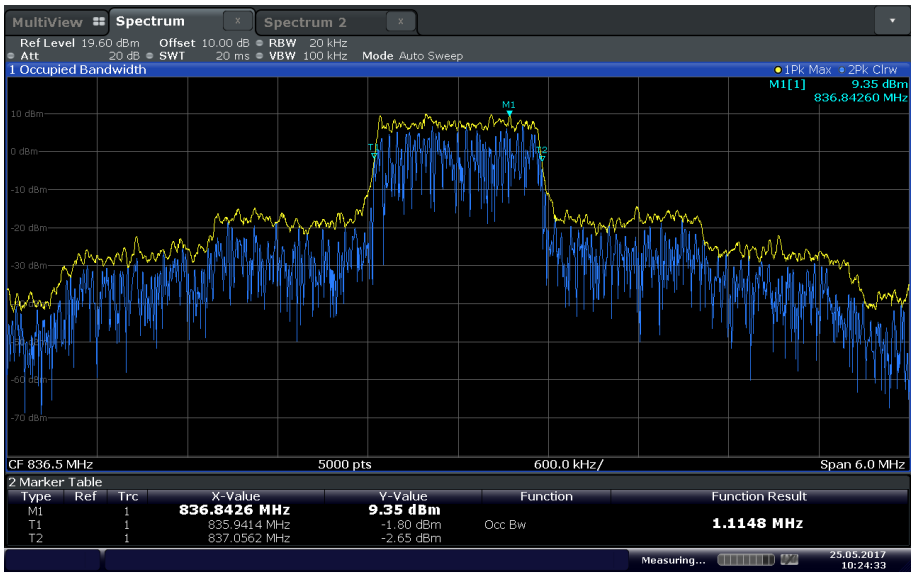
Date: 25.MAY.2017 10:11:13

Band 2 Mid Channel 26 dB BW 16-QAM



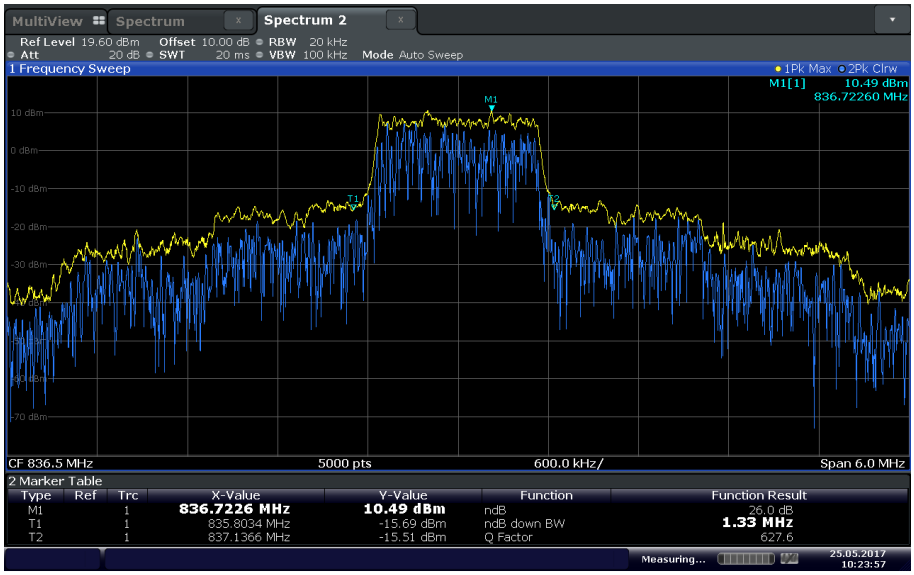
Date: 25.MAY.2017 10:11:45

Band 5 Mid Channel 99% OBW QPSK



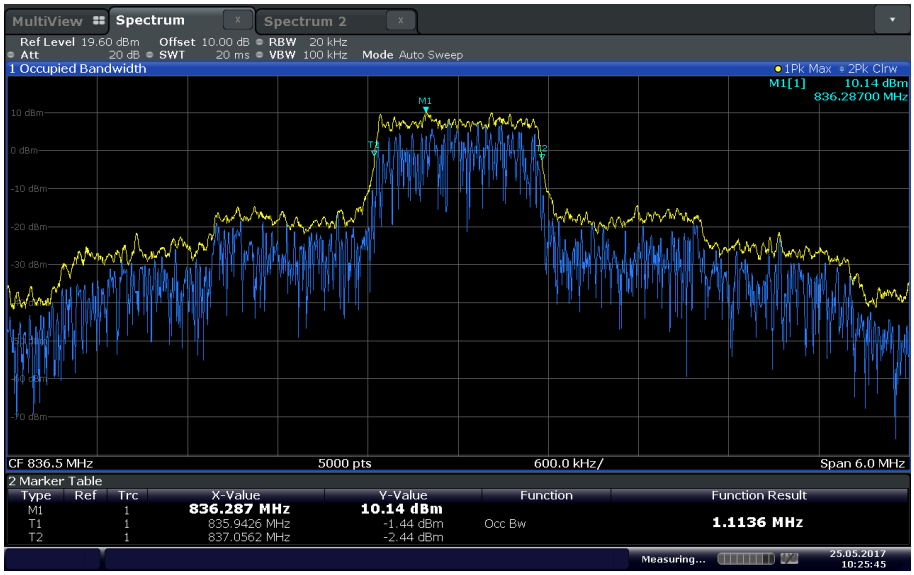
Date: 25.MAY.2017 10:24:33

Band 5 Mid Channel 26 dB BW QPSK



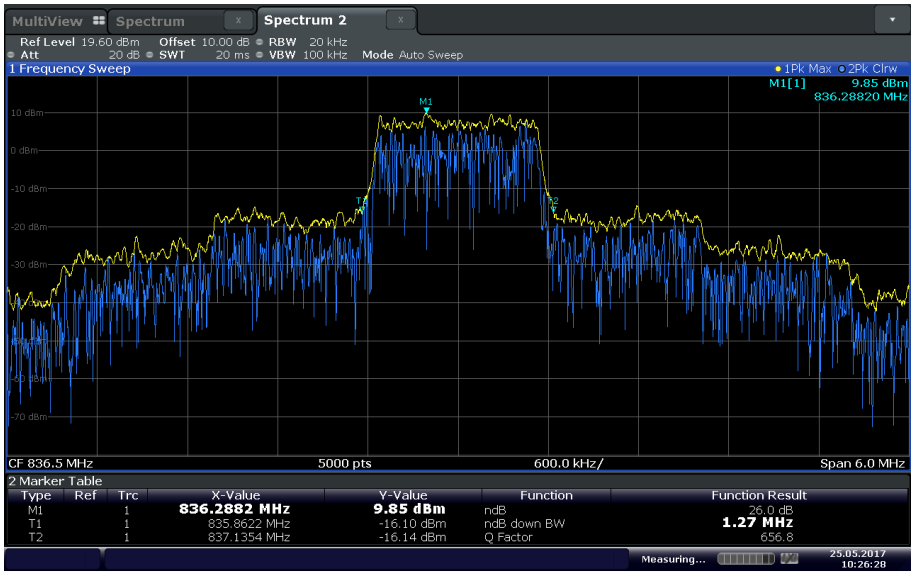
Date: 25.MAY.2017 10:23:57

Band 5 Mid Channel 99% OBW 16-QAM



Date: 25.MAY.2017 10:25:45

Band 5 Mid Channel 26 dB BW 16-QAM



Date: 25.MAY.2017 10:26:28

2.5 PEAK-AVERAGE RATIO

2.5.1 Specification Reference

Part 24 Subpart E §24.232(d)
RSS-132(5.4)
RSS-133(6.4)

2.5.2 Standard Applicable

Part 24 Subpart E §24.232(d)
Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB

RSS-133(5.4) and RSS-133(6.4)
In addition, the transmitter's peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.

2.5.3 Equipment Under Test and Modification State

Serial No: 357591080022319/ Default Test Configuration

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

June 01, 2017/FSC

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	25.5 °C
Relative Humidity	49.9 %
ATM Pressure	98.7 kPa

2.5.7 Additional Observations

- This is a conducted test. Guidance is per Section 5.7 of KDB971168 (D01 Power Meas License Digital Systems v02r02).
- Procedure is per Section 5.7.1 of KDB971168.

- RBW was set to maximum the SA can support (28MHz, minimum requirement is ≥ signal's occupied bandwidth)
- Number of samples was adjusted until the CCDF curve was stabilized (≥4500000 samples).
- Measurement was done using the Spectrum Analyzer's Complementary Cumulative Distribution Function (CCDF) measurement profile. The built-in function is used to determine the largest deviation between the average and the peak power of the EUT in a given bandwidth (crest factor or peak-to-average ratio) The CCDF curve shows how much time the peak waveform spends at or above a given average power level. The percent of time the signals spends at or above the level defines the probability for that particular power level.
- The maximum PAPR level associated with a probability of 0.1% was recorded.
- There are no measured PAPR levels greater than 13dB. EUT complies.

2.5.8 Test Results

LTE Band	Modulation	Channel	Frequency (MHz)	PAR (dB)
LTE Band 5 (5 MHz BW)	QPSK	20407	824.7	5.80
		20525	836.5	6.46
		20643	848.3	5.78
	16-QAM	20407	824.7	5.52
		20525	836.5	5.56
		20643	848.3	5.64
LTE Band 2 (10 MHz BW)	QPSK	18607	1850.7	5.98
		18900	1880.0	6.12
		19193	1909.3	6.68
	16-QAM	18607	1850.7	6.14
		18900	1880.0	6.34
		19193	1909.3	6.48

2.5.9 Sample Test Plots

LTE Band 5 1.4MHz Bandwidth 16-QAM Low Channel -PAR

Date: 1.JUN.2017 10:01:27

LTE Band 2 1.4MHz Bandwidth QPSK Low Channel -PAR

Date: 1.JUN.2017 10:15:38

2.6 BAND EDGE/CONDUCTED SPURIOUS EMISSIONS

2.6.1 Specification Reference

Part 22 Subpart H §22.917(a) and Part 24 Subpart E §24.238(a)
RSS-132, Clause 5.5
RSS-133, Clause 6.5.1

2.6.2 Standard Applicable

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-132, Clause 5.5
Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

(i) In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts).

(ii) After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

RSS-133, Clause 6.5.1
Equipment shall comply with the limits in (i) and (ii) below.

(i) In the 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the emission power per any 1% of the emission bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p(watts).

(ii) After the first 1.0 MHz, the emission power in any 1 MHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p(watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

2.6.3 Equipment Under Test and Modification State

Serial No: 357591080022319/ Default Test Configuration

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

May 31, 2017/FSC

2.6.5 Test Equipment Used

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

2.6.6 Environmental Conditions

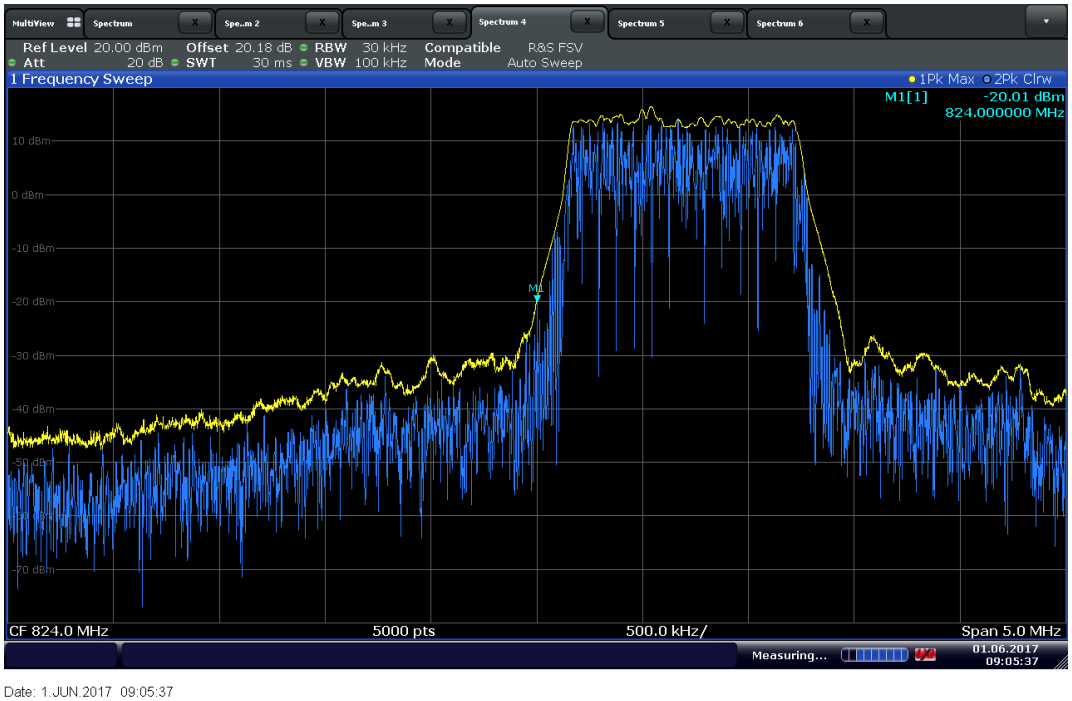
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	25.9 °C
Relative Humidity	37.3 %
ATM Pressure	99.0 kPa

2.6.7 Additional Observations

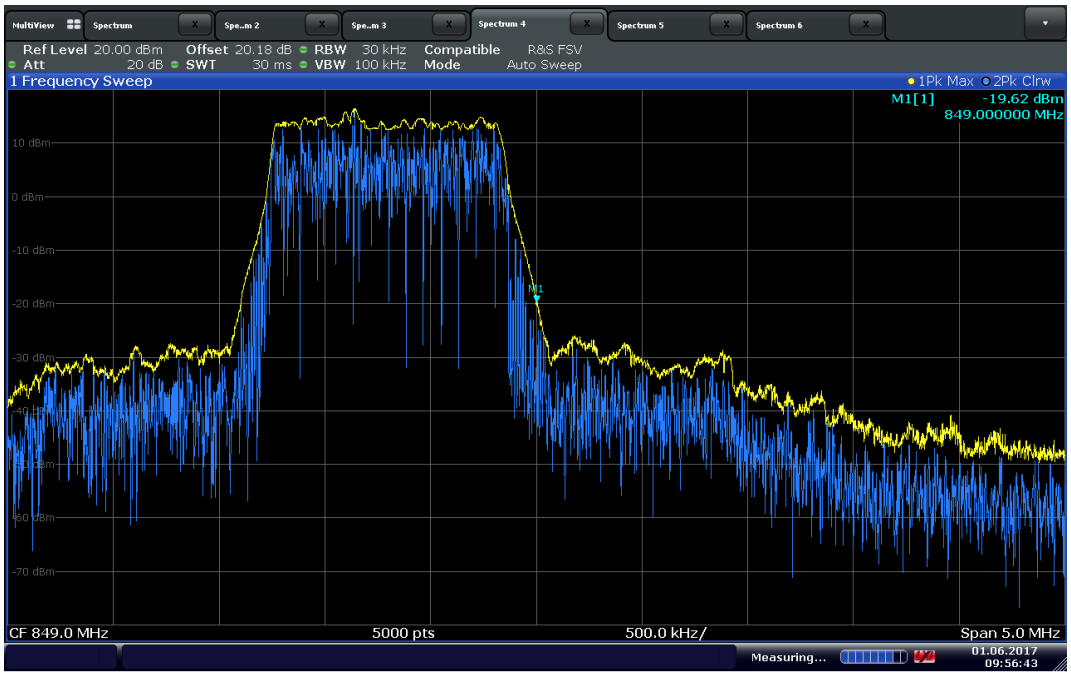
- This is a conducted test. Test guidance is per Section 6.0 of KDB971168 (D01 Power Meas License Digital Systems v02r02).
- Corresponding offset was used for the external attenuator and cable used.
- For Band edge measurements, RBW were set to minimum 1% of OBW or greater using Max Hold trace with Peak detector as worst case test configuration.
- The center frequency of the spectrum is the band edge frequency (824 MHz -849 MHz for Band 5 and 1850 MHz – 1910 MHz for Band 2).
- Resulting band edge measurements were verified against the manufacturer tune-up procedure with positive results.
- Conducted Spurious emissions verification were performed using 1MHz RBW for both bands (worst case).
- EUT complies.

2.6.8 Test Results Plots



Date: 1.JUN.2017 09:05:37

LTE Band 5 Band Edge @ 824MHz (QPSK)



Date: 1.JUN.2017 09:56:43

LTE Band 5 Band Edge @ 849MHz (QPSK)

Date: 1.JUN.2017 09:38:25

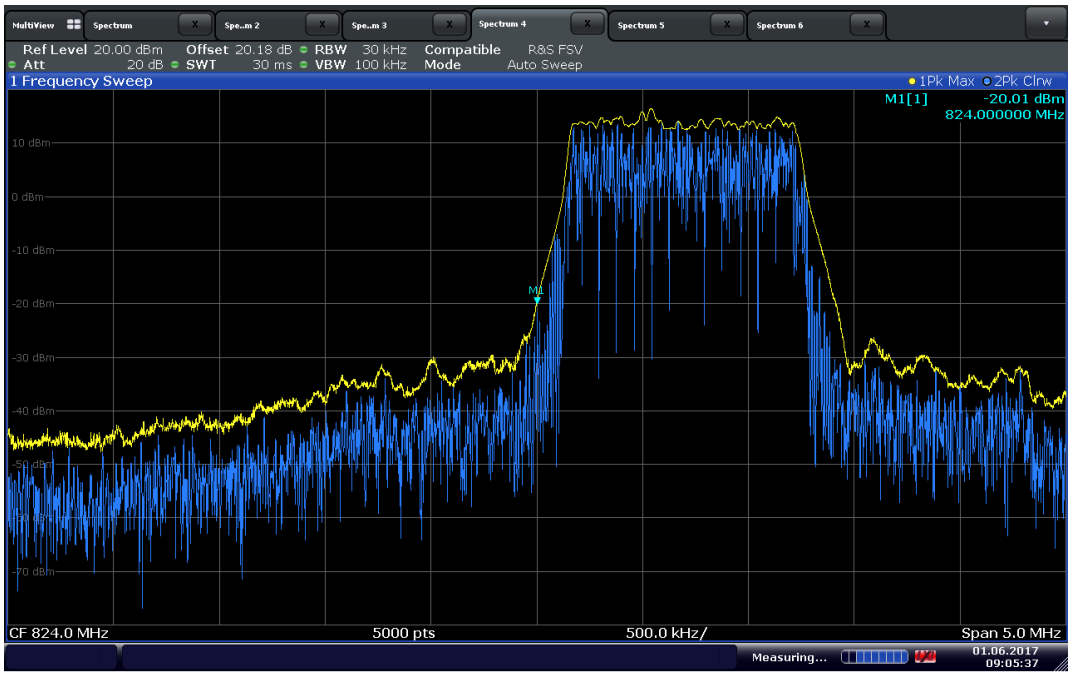
LTE Band 5 Low Channel (QPSK)

Date: 1.JUN.2017 09:47:18

LTE Band 5 Mid Channel (QPSK)

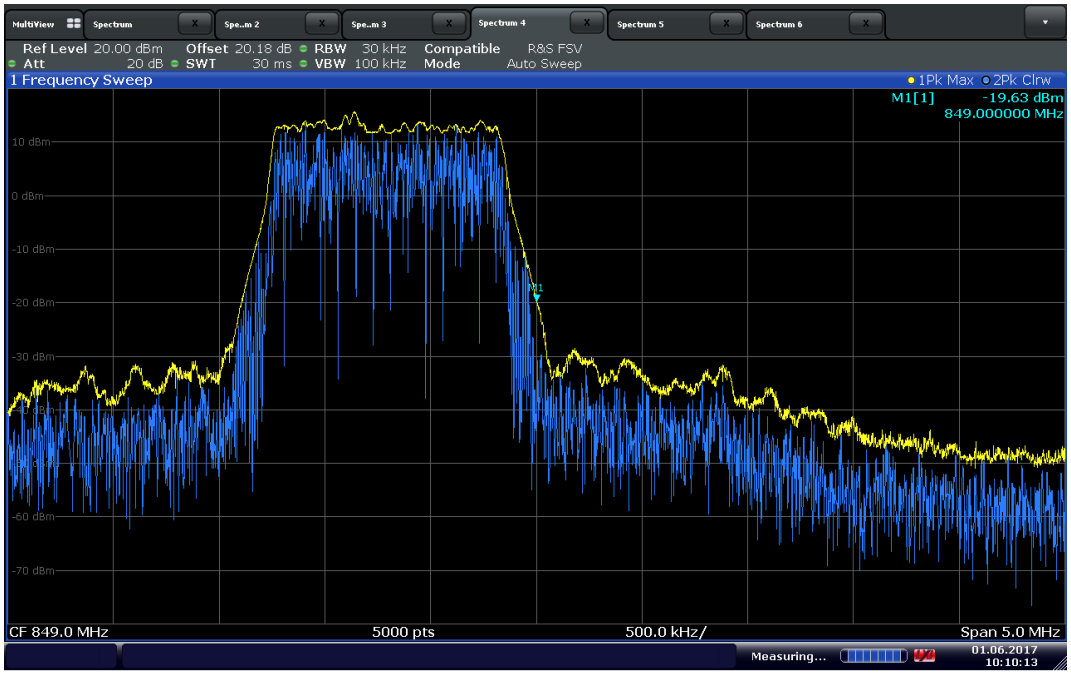
Date: 1.JUN.2017 09:54:05

LTE Band 5 High Channel (QPSK)



Date: 1.JUN.2017 09:05:37

LTE Band 5 Band Edge @ 824MHz (16-QAM)



Date: 1.JUN.2017 10:10:13

LTE Band 5 Band Edge @ 849MHz (16-QAM)

Date: 1.JUN.2017 10:05:25

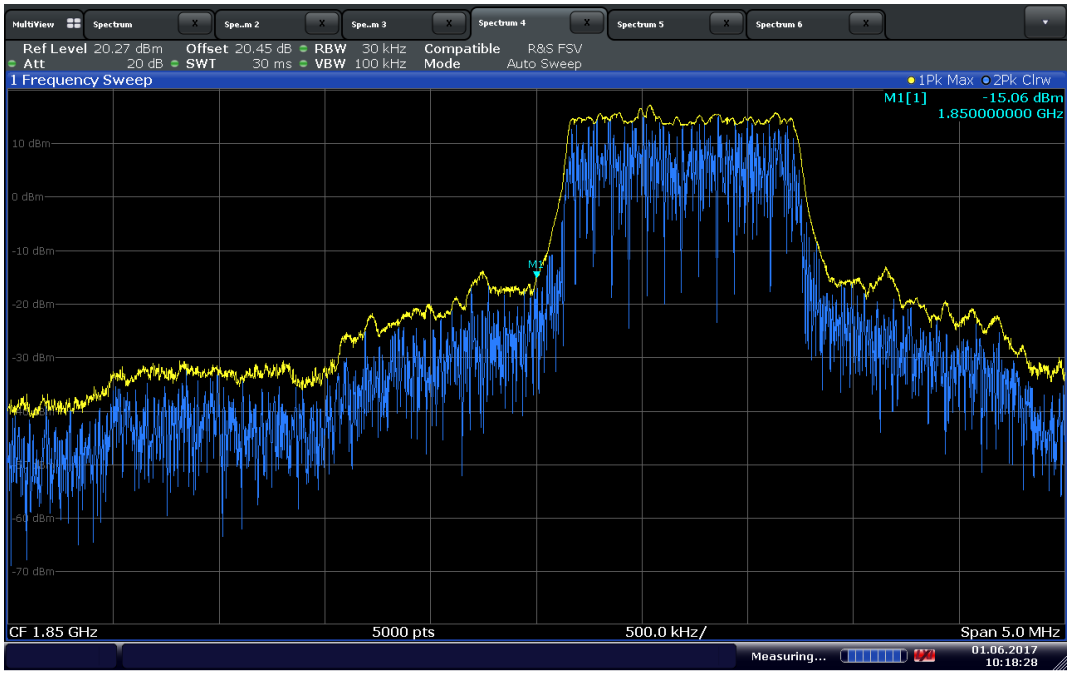
LTE Band 5 Low Channel (16-QAM)

Date: 1.JUN.2017 10:06:54

LTE Band 5 Mid Channel (16-QAM)

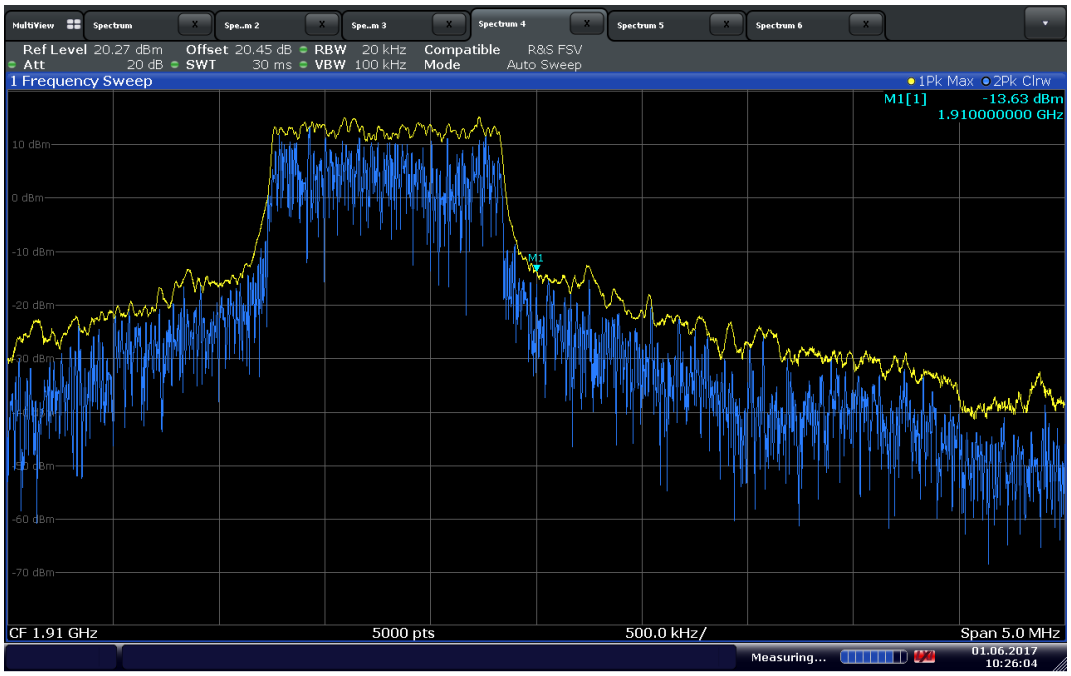
Date: 1.JUN.2017 10:11:27

LTE Band 5 High Channel (16-QAM)



Date: 1.JUN.2017 10:18:28

LTE Band 2 Band Edge @ 1850 MHz (QPSK)

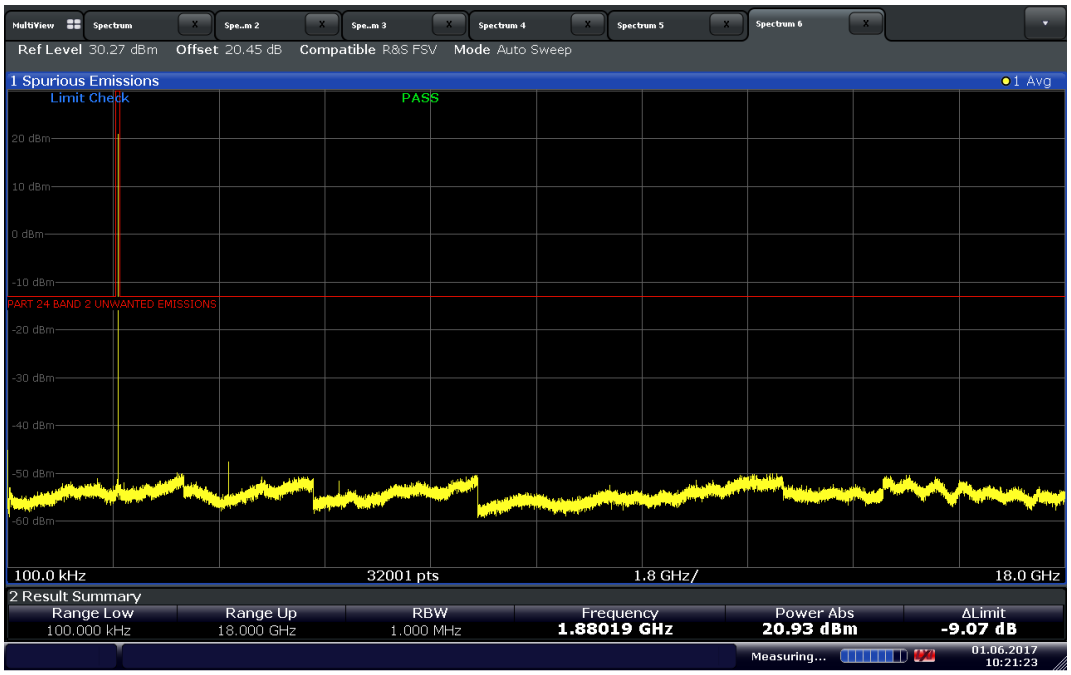


Date: 1.JUN.2017 10:26:05

LTE Band 2 Band Edge @ 1910 MHz (QPSK)

Date: 1.JUN.2017 10:19:26

LTE Band 2 Low Channel (QPSK)

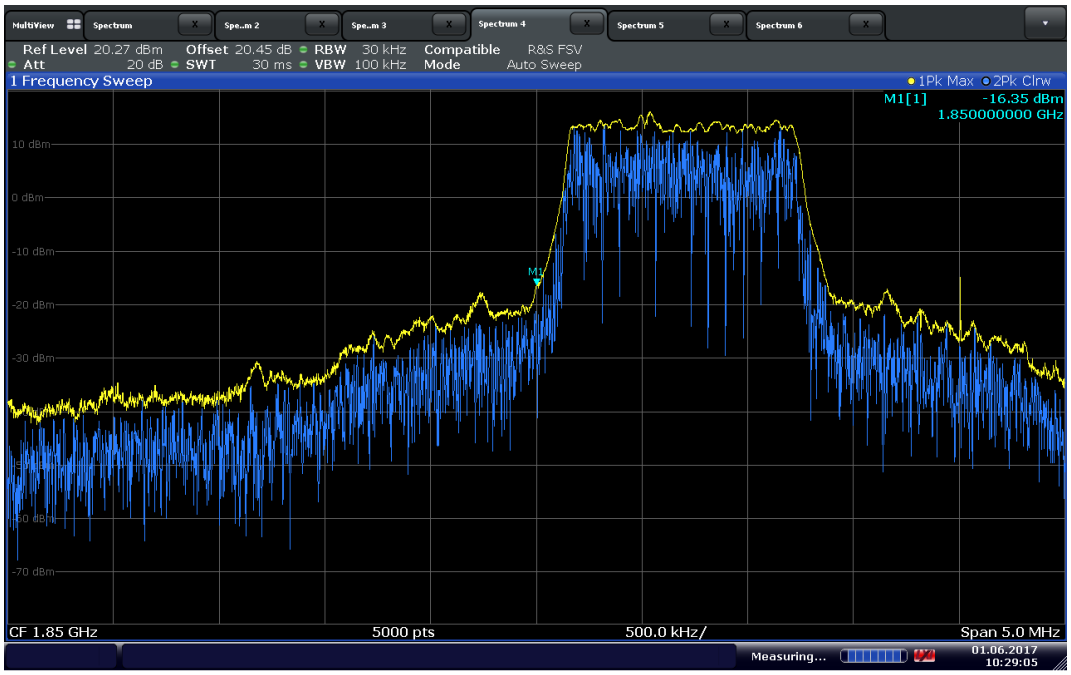


Date: 1.JUN.2017 10:21:23

LTE Band 2 Mid Channel (QPSK)

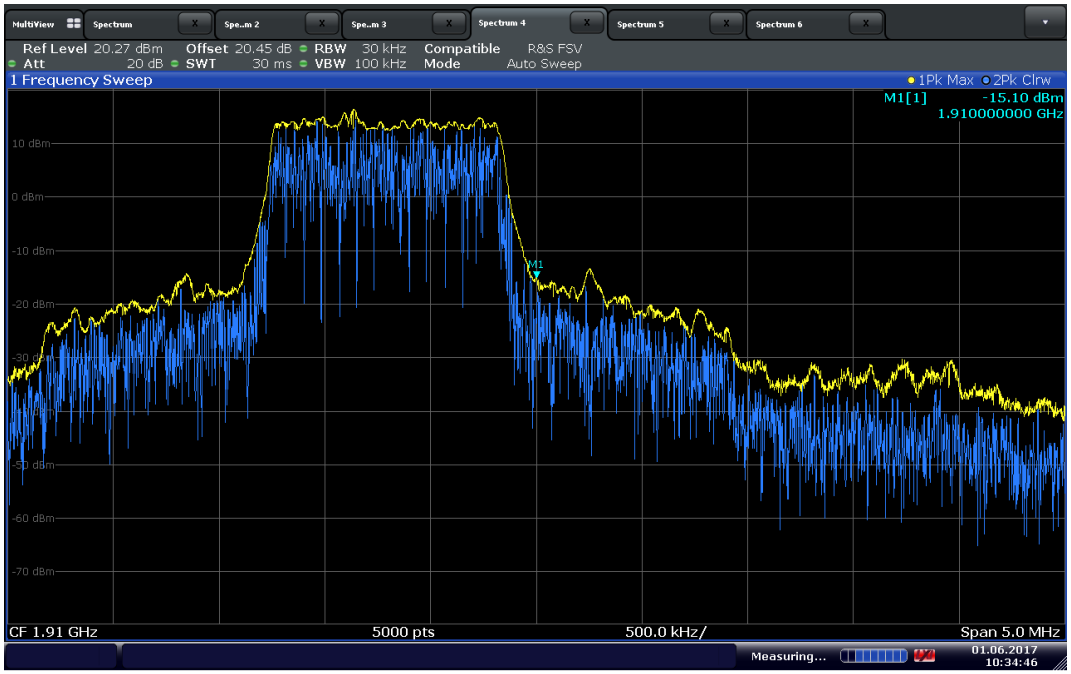
Date: 1.JUN.2017 10:26:58

LTE Band 2 High Channel (QPSK)



Date: 1.JUN.2017 10:29:05

LTE Band 2 Band Edge @ 1850 MHz (16-QAM)



Date: 1.JUN.2017 10:34:46

LTE Band 2 Band Edge @ 1910 MHz (16-QAM)

Date: 1.JUN.2017 10:30:05

LTE Band 2 Low Channel (16-QAM)

Date: 1.JUN.2017 10:32:28

LTE Band 2 Mid Channel (16-QAM)

Date: 1.JUN.2017 10:33:39

LTE Band 2 High Channel (16-QAM)

2.7 FIELD STRENGTH OF SPURIOUS RADIATION

2.7.1 Specification Reference

Clause 7of KDB971168 D01 v02r02

2.7.2 Standard Applicable

When antenna-port conducted measurements are performed to demonstrate compliance to the applicable unwanted emission limits, a separate radiated measurement is required to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Note that when radiated measurements are performed to demonstrate compliance to the unwanted emission limits (e.g., an EUT with integral transmit antenna), this measurement is not required.

These measurements may be performed with the transmit antenna port(s) terminated. Unless otherwise specified in the applicable rule section, the same limits applicable to spurious (unwanted) emissions at the antenna terminals also apply to radiated spurious emissions.

2.7.3 Equipment Under Test and Modification State

Serial No: 357591080022319/ Default Test Configuration

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

June 02, 2017 /FSC

2.7.5 Test Equipment Used

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

2.7.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	26.6 °C
Relative Humidity	49.5 %
ATM Pressure	98.6 kPa

2.7.7 Additional Observations

- This is a radiated measurement to detect spurious emissions that may be radiated directly from the cabinet of the EUT.
- Only the worst case channel/band presented to show compliance.
- Antenna port of the EUT was terminated with a suitable 50Ω load.
- Any emissions within 6db of the limit will be proven by substitution method as per Unwanted Emissions: Radiated Spurious method of measurement of ANSI/TIA/EIA-603-C 2004, August 17, 2004. However no such emissions observed.

- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.

2.7.8 Sample Computation (Radiated Emission)

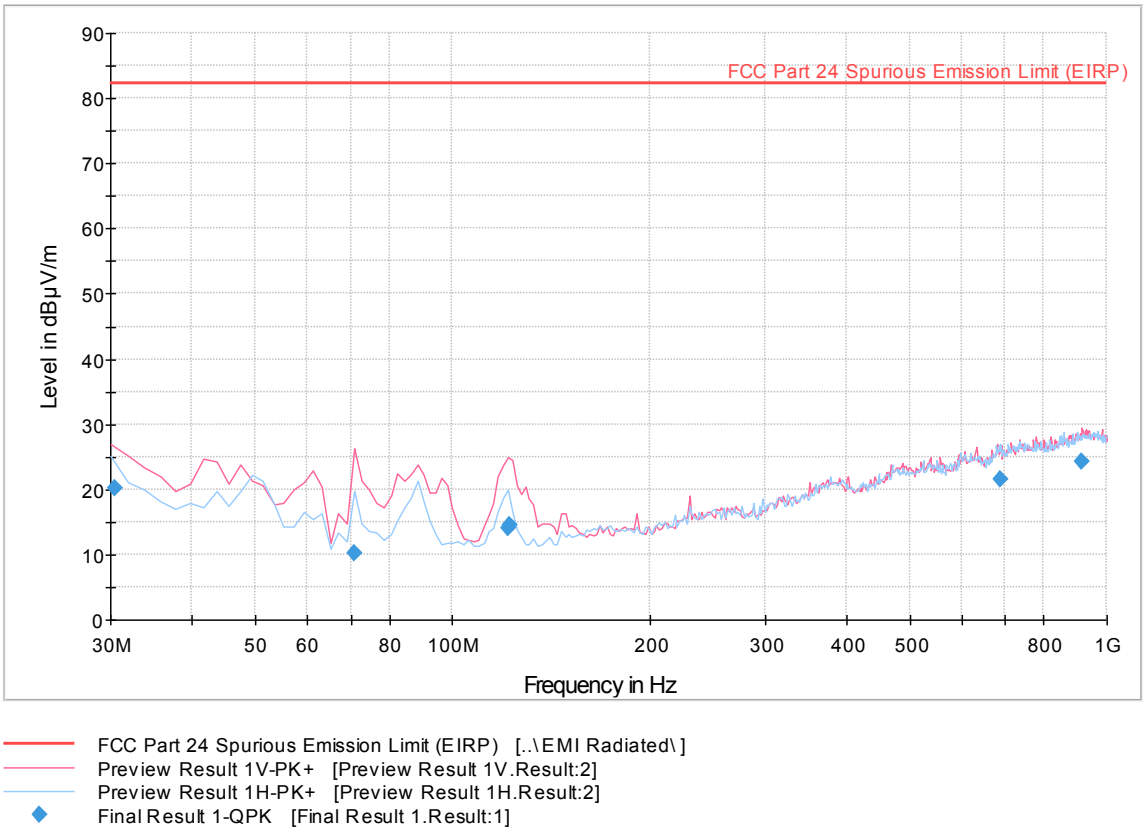
Measuring equipment raw measurement (dbµV) @ 30 MHz			**24.4**
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1033 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			**11.8**

2.7.9 Test Results

See attached plots.

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

2.7.10 Test Results Below 1GHz (Band 2 Worst Case Configuration)

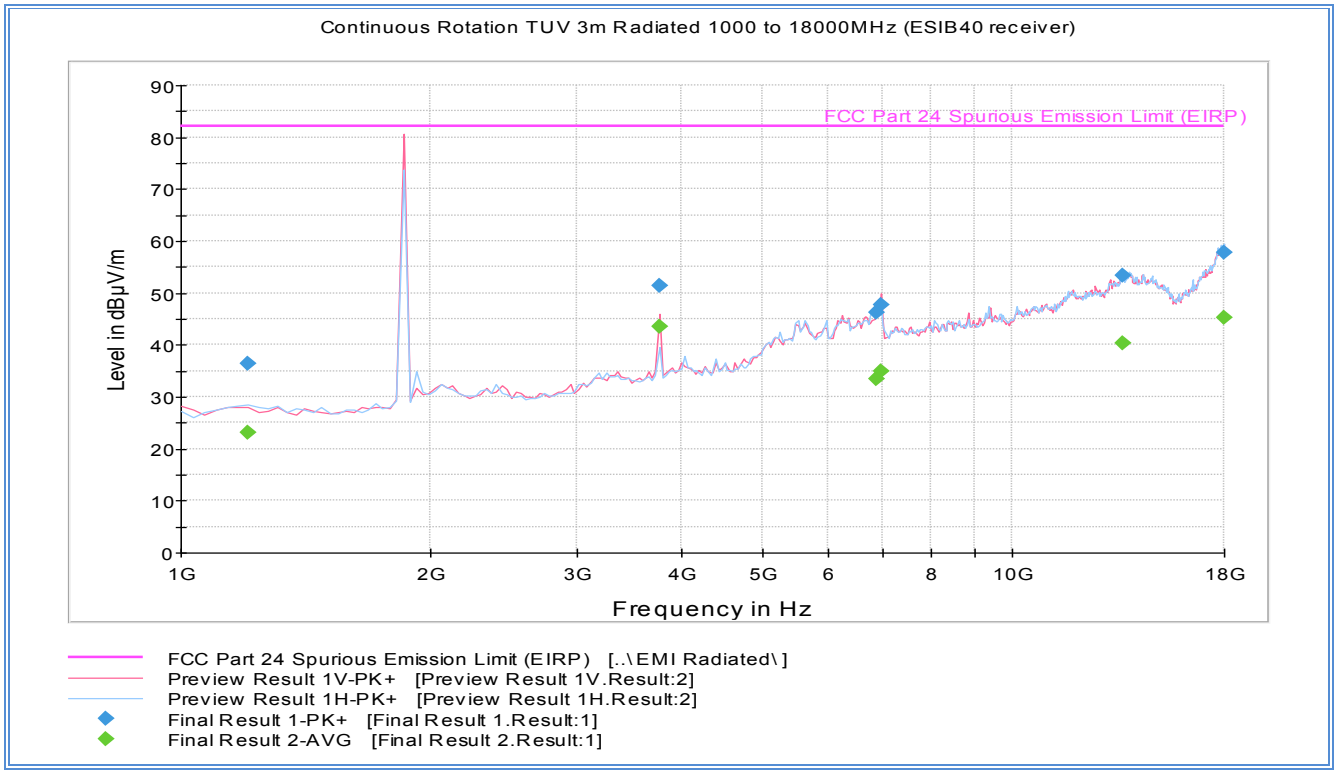


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.520000	20.2	1000.0	120.000	106.0	V	47.0	-6.3	64.2	84.4
70.941643	10.3	1000.0	120.000	100.0	V	-5.0	-16.9	74.1	84.4
121.402725	14.1	1000.0	120.000	105.0	V	18.0	-15.9	70.2	84.4
122.306613	14.4	1000.0	120.000	106.0	V	13.0	-15.9	69.9	84.4
687.017956	21.5	1000.0	120.000	200.0	H	88.0	2.6	62.9	84.4
916.852826	24.4	1000.0	120.000	306.0	V	325.0	6.1	60.0	84.4

Test Notes: Only worst case channel presented for cabinet spurious emissions verification.

2.7.11 Test Results Above 1GHz (Band 2 Worst Case Configuration)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1201.708818	36.4	1000.0	1000.000	138.0	H	40.0	-8.3	45.9	82.2
3760.019038	51.4	1000.0	1000.000	229.0	V	92.0	1.2	30.8	82.2
6856.619439	46.2	1000.0	1000.000	406.9	V	302.0	7.8	36.1	82.2
6959.223848	47.6	1000.0	1000.000	315.0	V	353.0	8.5	34.6	82.2
13599.710421	53.4	1000.0	1000.000	188.0	H	-9.0	20.1	28.9	82.2
17967.031864	57.8	1000.0	1000.000	243.0	H	336.0	27.9	24.5	82.2

Average Data

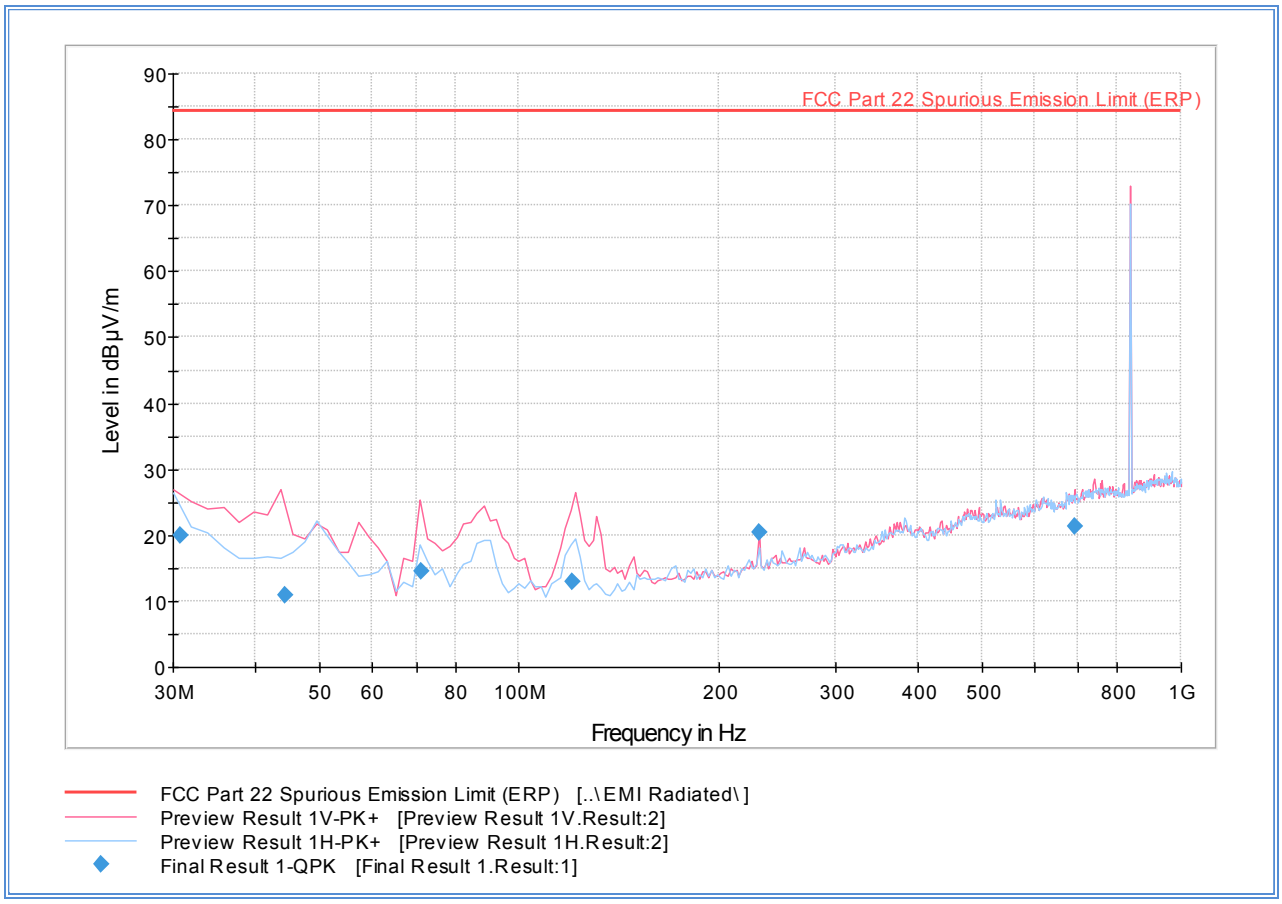
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1201.708818	23.0	1000.0	1000.000	138.0	H	40.0	-8.3	59.2	82.2
3760.019038	43.6	1000.0	1000.000	229.0	V	92.0	1.2	38.6	82.2
6856.619439	33.4	1000.0	1000.000	406.9	V	302.0	7.8	48.8	82.2
6959.223848	34.9	1000.0	1000.000	315.0	V	353.0	8.5	47.3	82.2
13599.710421	40.4	1000.0	1000.000	188.0	H	-9.0	20.1	41.9	82.2
17967.031864	45.2	1000.0	1000.000	243.0	H	336.0	27.9	37.0	82.2

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: Substitution data not required since margin is >20dB compared to the -13dBm limit (converted to field strength @ 3 meters).

2.7.12 Test Results Below 1GHz (Band 5 Worst Case Configuration)

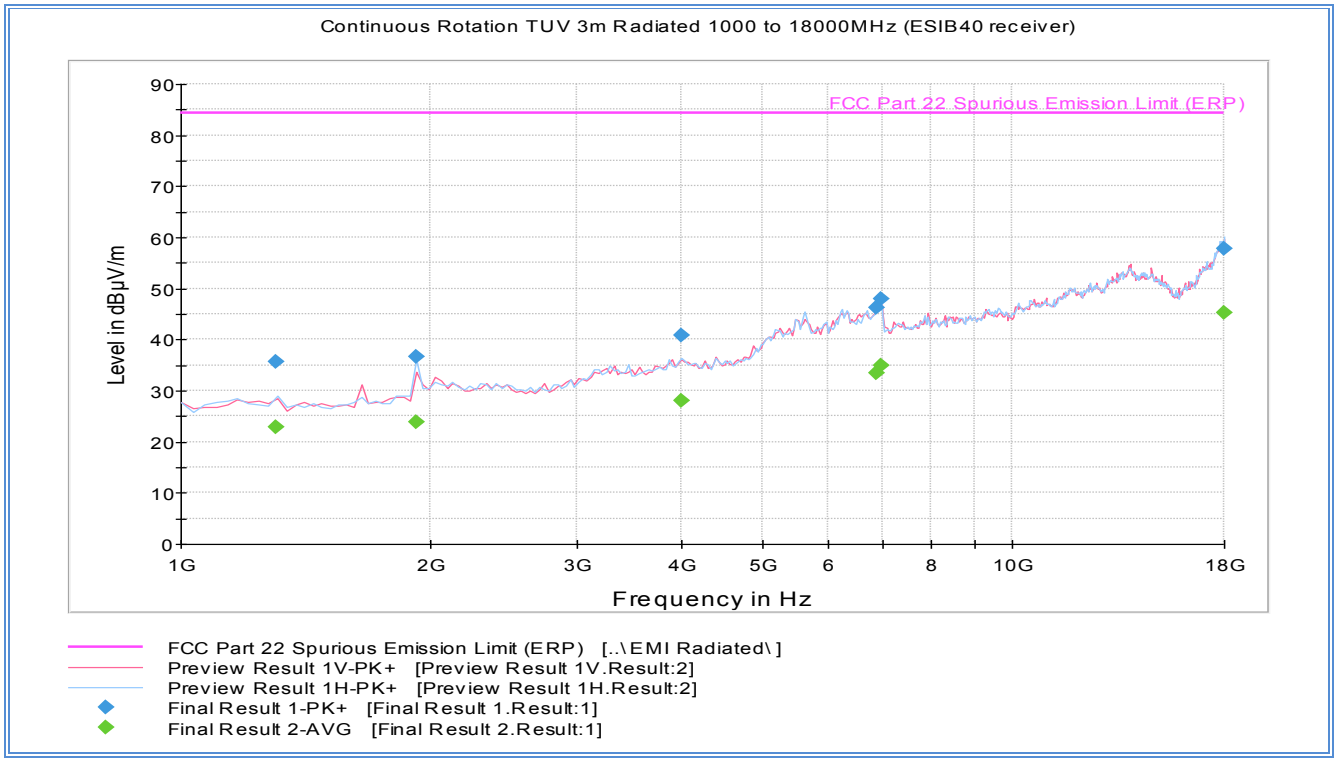


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.760000	20.0	1000.0	120.000	150.0	V	44.0	-6.5	64.4	84.4
44.367214	10.9	1000.0	120.000	115.0	V	75.0	-13.5	73.5	84.4
71.261643	14.4	1000.0	120.000	109.0	V	329.0	-16.9	70.0	84.4
120.642725	13.0	1000.0	120.000	100.0	V	18.0	-15.8	71.4	84.4
230.380441	20.4	1000.0	120.000	100.0	V	87.0	-10.0	64.0	84.4
691.321844	21.3	1000.0	120.000	388.0	V	152.0	2.6	63.0	84.4

Test Notes: Only worst case channel presented for cabinet spurious emissions verification.

2.7.13 Test Results Above 1GHz (Band 5 Worst Case Configuration)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1299.513226	35.6	1000.0	1000.000	150.0	H	223.0	-7.9	48.8	84.4
1922.739679	36.6	1000.0	1000.000	350.0	H	75.0	-4.7	47.8	84.4
3999.695992	40.8	1000.0	1000.000	300.0	H	262.0	2.3	43.6	84.4
6858.219439	46.2	1000.0	1000.000	350.0	V	153.0	7.8	38.2	84.4
6961.223848	47.9	1000.0	1000.000	374.0	V	20.0	8.6	36.5	84.4
17999.500000	57.9	1000.0	1000.000	150.0	H	262.0	28.1	26.5	84.4

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1299.513226	22.8	1000.0	1000.000	150.0	H	223.0	-7.9	61.6	84.4
1922.739679	23.8	1000.0	1000.000	350.0	H	75.0	-4.7	60.6	84.4
3999.695992	28.1	1000.0	1000.000	300.0	H	262.0	2.3	56.3	84.4
6858.219439	33.3	1000.0	1000.000	350.0	V	153.0	7.8	51.1	84.4
6961.223848	34.9	1000.0	1000.000	374.0	V	20.0	8.6	49.5	84.4
17999.500000	45.1	1000.0	1000.000	150.0	H	262.0	28.1	39.3	84.4

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: Substitution data not required since margin is >20dB compared to the -13dBm limit (converted to field strength @ 3 meters).

2.8 FREQUENCY STABILITY

2.8.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1055
FCC 47 CFR Part 22, Clause 22.355
FCC 47 CFR Part 24, Clause 24.235
RSS-132, Clause 5.3
RSS-133, Clause 6.3

2.8.2 Standard Applicable

FCC:
Part 22 Clause 22.355: Except as otherwise provided in this part, the carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table C–1 of this section.

Table C–1—Frequency Tolerance for Transmitters in the Public Mobile Services

Frequency range (MHz)	Mobile ≤3 watts (ppm)
821 to 896	2.5

Part 24, Clause 24.235: The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

ISED:
RSS-132 Clause 5.3: The carrier frequency shall not depart from the reference frequency in excess of ±2.5 ppm for mobile stations.
RSS-133 Clasue 6.3: The carrier frequency shall not depart from the reference frequency, in excess of ±2.5 ppm for mobile stations.

2.8.3 Equipment Under Test and Modification State

Serial No: 357591080022319 / Default Test Configuration

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

June 05, 2017/FSC

2.8.5 Test Equipment Used

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

2.8.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	26.3 °C
Relative Humidity	47.5 %
ATM Pressure	98.7 kPa

2.8.7 Additional Observations

- This is a conducted test. The EUT was operated at 4.2VDC nominal voltage and was placed in the temperature chamber for the series of evaluations performed.
- Test methodology is per Section 5.6 of ANSI C63.26-2015, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.
- Voltage variations from Nominal Voltage of 4.2VDC were performed @ 20°C.
- Reference measurements were performed on mid channels only.
- The Temperature was set to 50°C and allowed to sit for 1 hour to allow the equipment and chamber temperature to stabilize. Once stabilized, the EUT was turned on and the measurement performed. The temperature was then decreased by 10°C steps and allowed to settle before taking the next set of measurements.
- For PCS devices, the maximum frequency deviation was used as frequency offset to verify that the fundamental emission stay within the authorized bands of operation.
- For Cellular devices, the maximum frequency deviation in percent was used to calculate maximum frequency deviation in parts per million (ppm).

2.8.8 Sample Calculations (LTE Band 2)

Reference Center Frequency @ 20°C: $= \frac{T1+T2}{2}$

T_2 and T_1 are Marker Points on the plot based on 99% OBW)

$$= \frac{1879.4507\ \text{MHz} + 1880.5337\ \text{MHz}}{2}$$
$$= 1879.9922\ \text{MHz}$$

Reference Center Frequency @ 30°C: $= \frac{1879.4516\ \text{MHz} + 11880.5337\ \text{MHz}}{2}$

$= 1879.99265\ \text{MHz}$

Therefore Frequency Deviation: = 1879.9922 MHz – 1879.99265 MHz
= -0.00045 MHz (this number could be converted to % then ppm)

Reference F_L @ 20°C: 1850.1282 MHz (based from Low Channel lower edge 99% OBW)
Reference F_H @ 20°C: 1909.8442 MHz (based from High Channel upper edge 99% OBW)

Using Frequency Deviation as the offset for both F_L and F_H, we get the following:

F_L =1850.1282 MHz – 0.00045 MHz
= 1850.12775 MHz (within the 1850 MHz to 1910 MHz Band, complies)

F_H =1909.8442 MHz + 0.00045 MHz
= 1909.84465 MHz (within the 1850 MHz to 1910 MHz Band, complies)

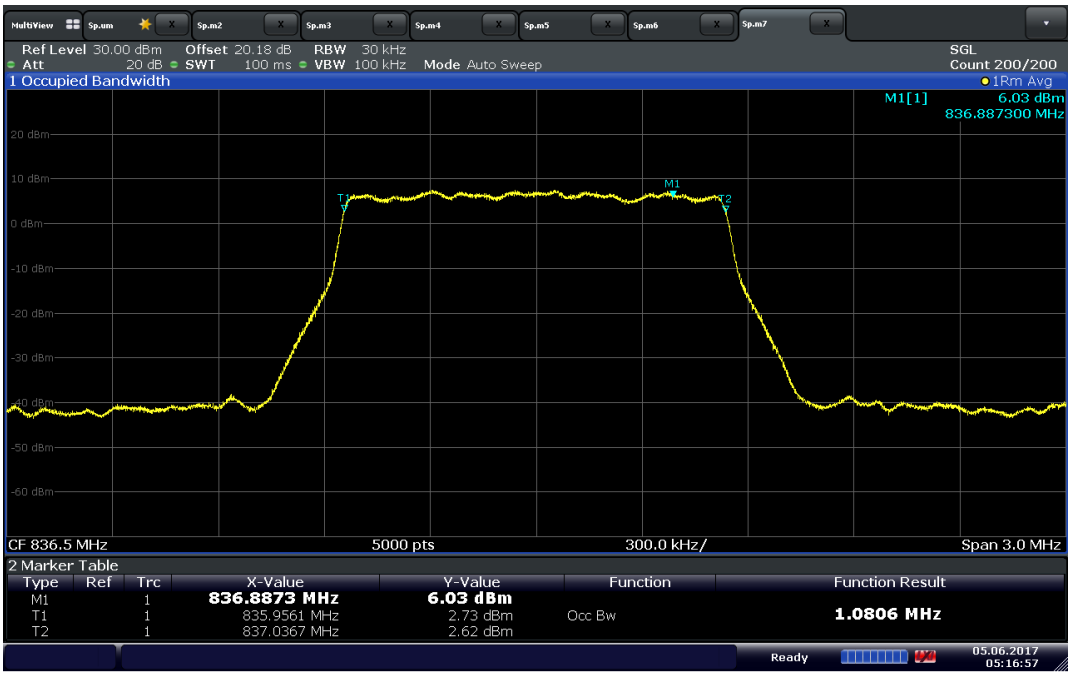
2.8.9 Test Results Summary

LTE Band 5					
Temperature	*F_L/T_1 (MHz)*	*F_H/T_2 (MHz)*	*Center Frequency (MHz)*	*Frequency Deviation (%)*	*Limit (<2.5 ppm)*
50°C	835.9561	837.0367	836.4964	0.000	0.00
40°C	835.9565	837.0360	836.49625	0.000	0.18
30°C	835.9571	837.0365	836.4968	0.000	-0.48
20°C (+15% NV)	835.9561	837.0367	836.4964	0.000	0.00
20°C (NV)	835.9561	837.0367	836.4964	0.000	0.00
20°C (-15% NV)	835.9561	837.0367	836.4964	0.000	0.00
10°C	835.9564	837.0370	836.4967	0.000	-0.36
0°C	835.9564	837.0372	836.4968	0.000	-0.48
-10°C	835.9567	837.0374	836.49705	0.000	-0.78
-20°C	835.9567	837.0380	836.49735	0.000	-1.14
-30°C	835.9567	837.0373	836.497	0.000	-0.72

LTE Band 2					
Temperature	*F_L/T_1 (MHz)*	*F_H/T_2 (MHz)*	*Center Frequency (MHz)*	*Frequency Deviation (%)*	*Limit (<2.5 ppm)*
50°C	1879.4519	1880.5355	1879.9937	0.000	-0.80
40°C	1879.4518	1880.5346	1879.9932	0.000	-0.53
30°C	1879.4516	1880.5337	1879.99265	0.000	-0.24
20°C (+15% NV)	1879.4507	1880.5337	1879.9922	0.000	0.00
20°C (NV)	1879.4507	1880.5337	1879.9922	0.000	0.00
20°C (-15% NV)	1879.4507	1880.5337	1879.9922	0.000	0.00
10°C	1879.451	1880.5335	1879.99225	0.000	-0.03
0°C	1879.4518	1880.5335	1879.99265	0.000	-0.24
-10°C	1879.4512	1880.5338	1879.9925	0.000	-0.16
-20°C	1879.4518	1880.5337	1879.99275	0.000	-0.29
-30°C	1879.4507	1880.5337	1879.9922	0.000	0.00

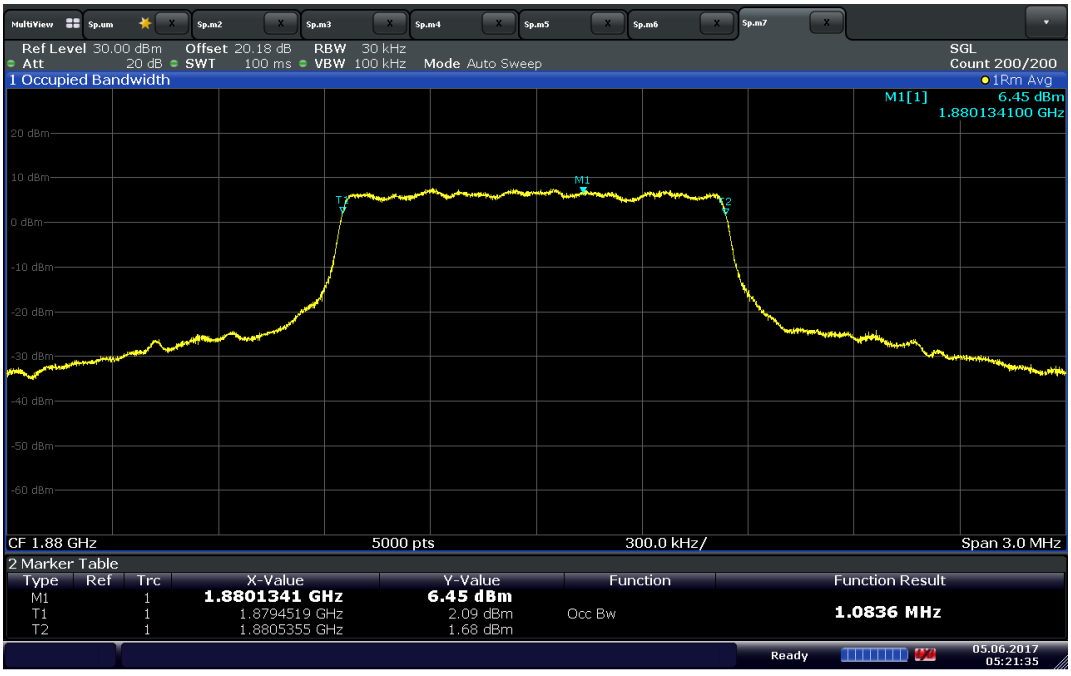
2.8.10 Sample Test Plots

LTE Band 5 @ 50°C



Date: 5.JUN.2017 05:16:57

LTE Band 2 @ 50°C



Date: 5.JUN.2017 05:21:35

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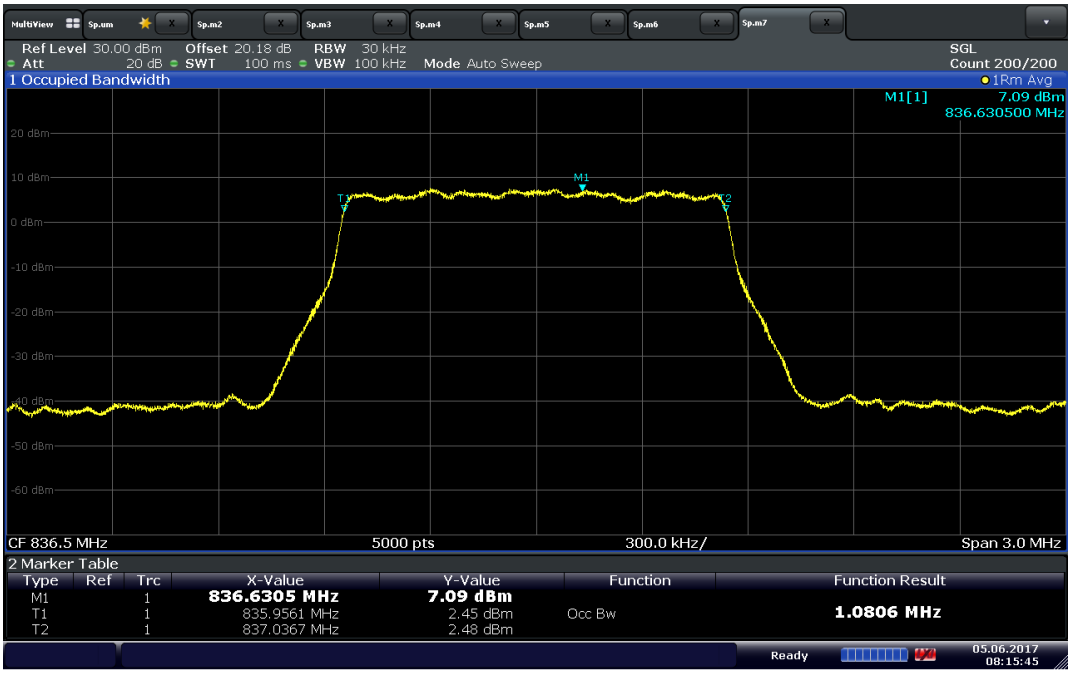
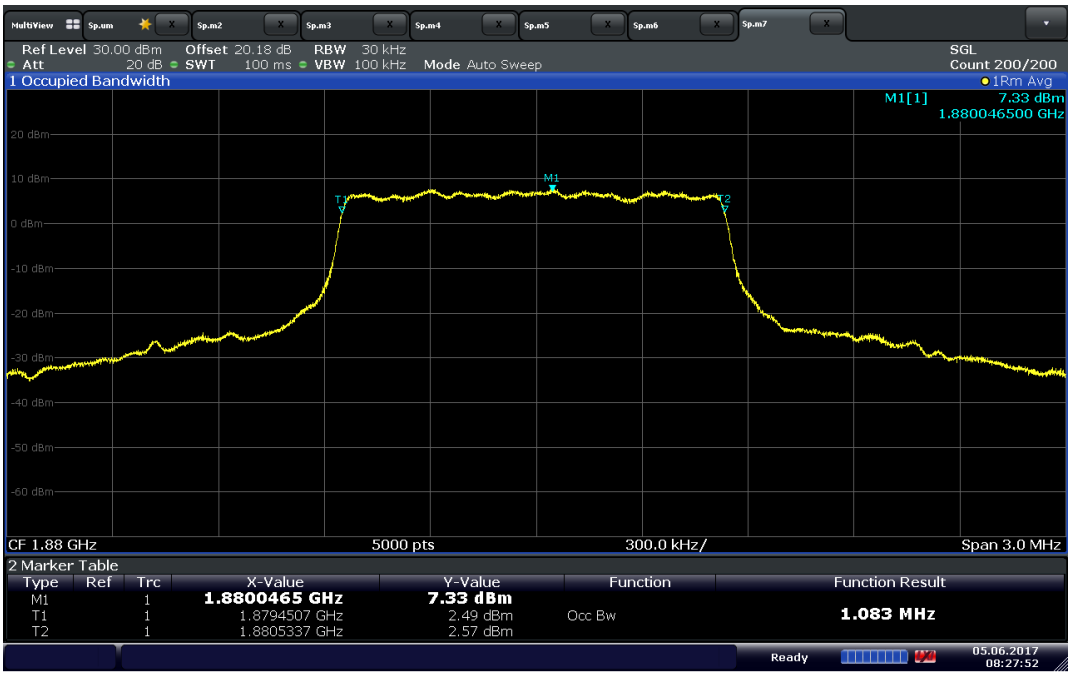
LTE Band 5 @ 20°C



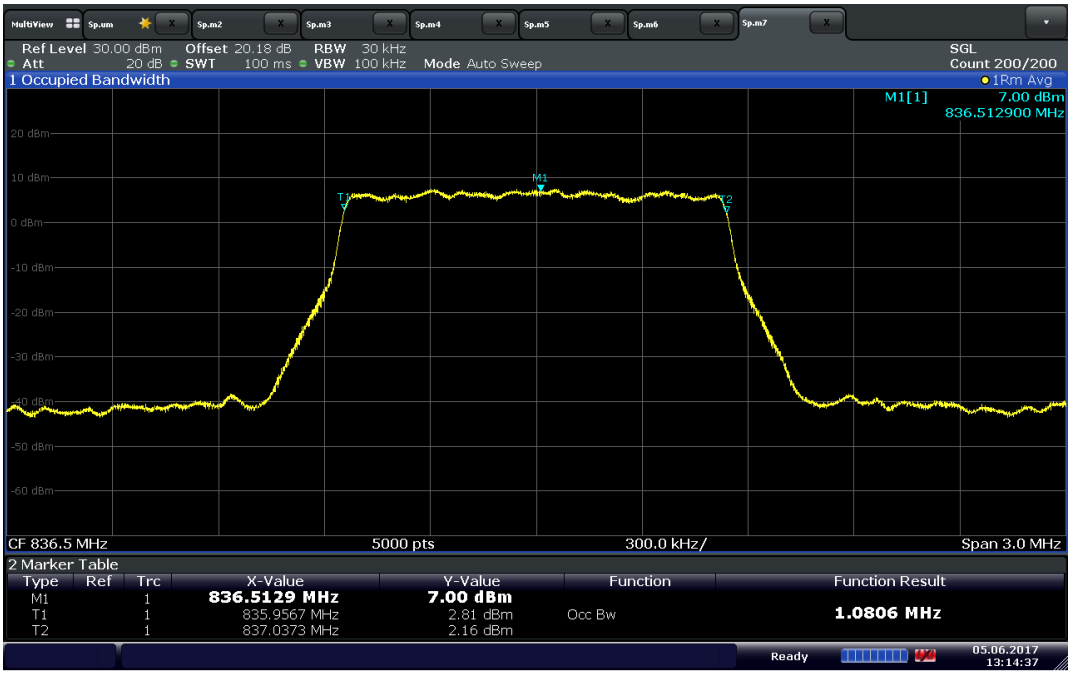
Date: 5.JUN.2017 08:15:45

LTE Band 2 @ 20°C



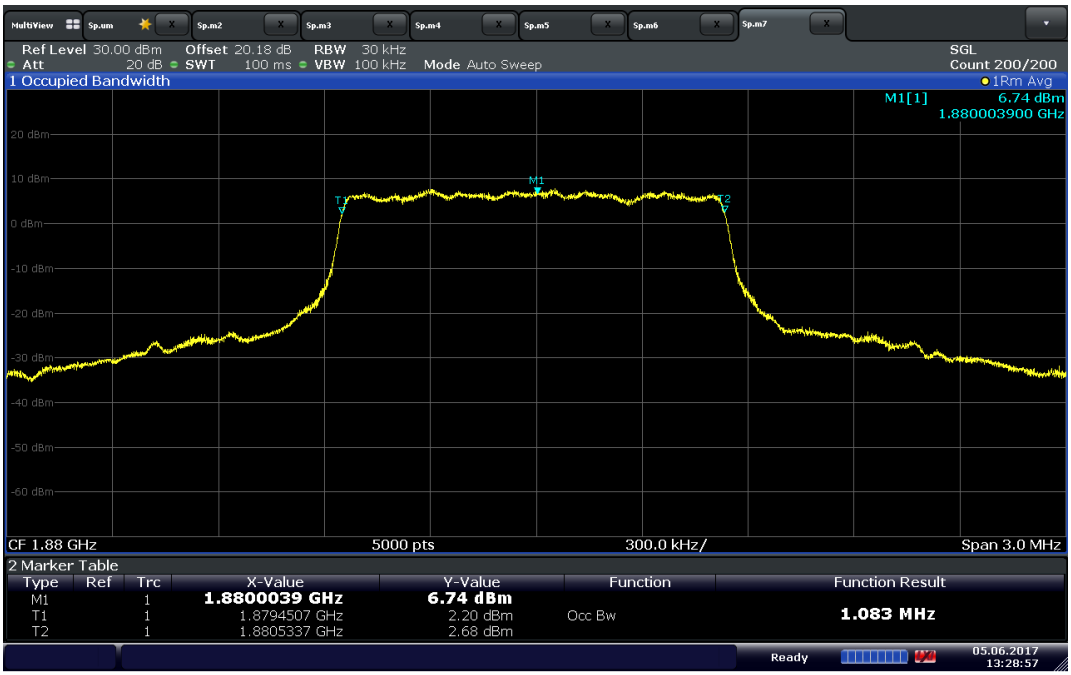
Date: 5.JUN.2017 08:27:52

LTE Band 5 @ -30°C



Date: 5.JUN.2017 13:14:37

LTE Band 2 @ -30°C



Date: 5.JUN.2017 13:28:57

2.9 RECEIVER SPURIOUS EMISSIONS

2.9.1 Specification Reference

RSS-132(4.6) and RSS-133(6.6)

2.9.2 Standard Applicable

Receiver spurious emissions shall comply with the limits specified in RSS-Gen.

2.9.3 Equipment Under Test and Modification State

Not performed. EUT does not fall to any category defined as Receiver under Section 5 of RSS-Gen Issue 4

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2.10 POWER LINE CONDUCTED EMISSIONS

2.10.1 Specification Reference

RSS-Gen 8.8

2.10.2 Standard Applicable

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz-30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

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.*

2.10.3 Equipment Under Test and Modification State

Serial No: 357591080022319/Default Test Configuration

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

May 24, 2017/FSC

2.10.5 Test Equipment Used

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

2.10.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	26.5 °C
Relative Humidity	45.0 %
ATM Pressure	98.5 kPa

2.10.7 Additional Observations

- The EUT is a module. Test was performed to show general compliance to RSS-Gen Power Line Conducted Emissions requirements. As a general rule, the EUT should be verified in the final host. It is the responsibility of the module integrator to verify compliance of the final host.
- EUT was verified using the test configuration provided by the manufacturer (EUT on a development board powered by a support programmable power supply).
- The EUT was transmitting worst case configuration with a representative antenna.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.10.8 for sample computation.

2.10.8 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# 7568 (LISN)	0.30	
Reported QuasiPeak Final Measurement (dbµV) @ 150kHz			**26.2**

2.10.9 Test Results

Compliant. See attached plots and tables.

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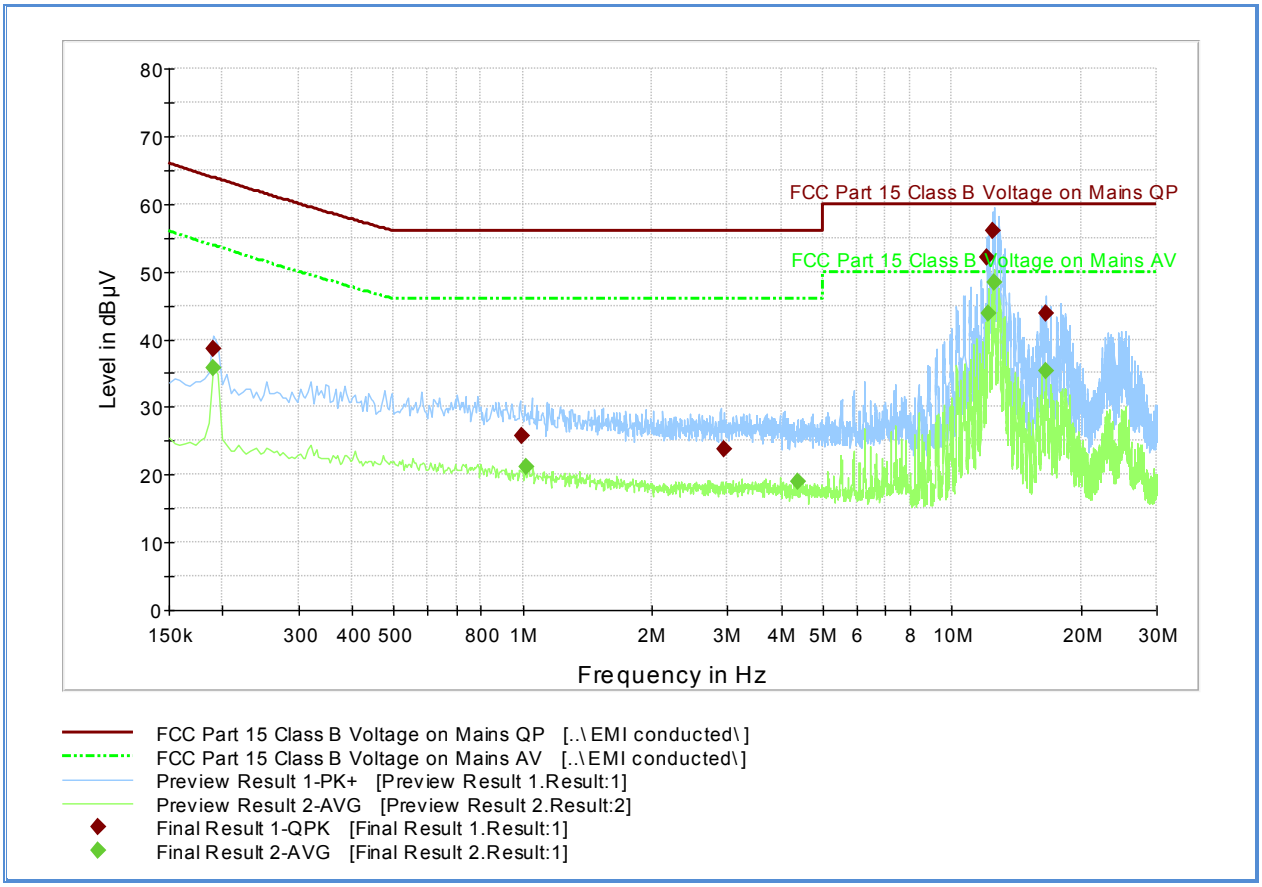
2.10.10 Test Results - Conducted Emissions Line 1



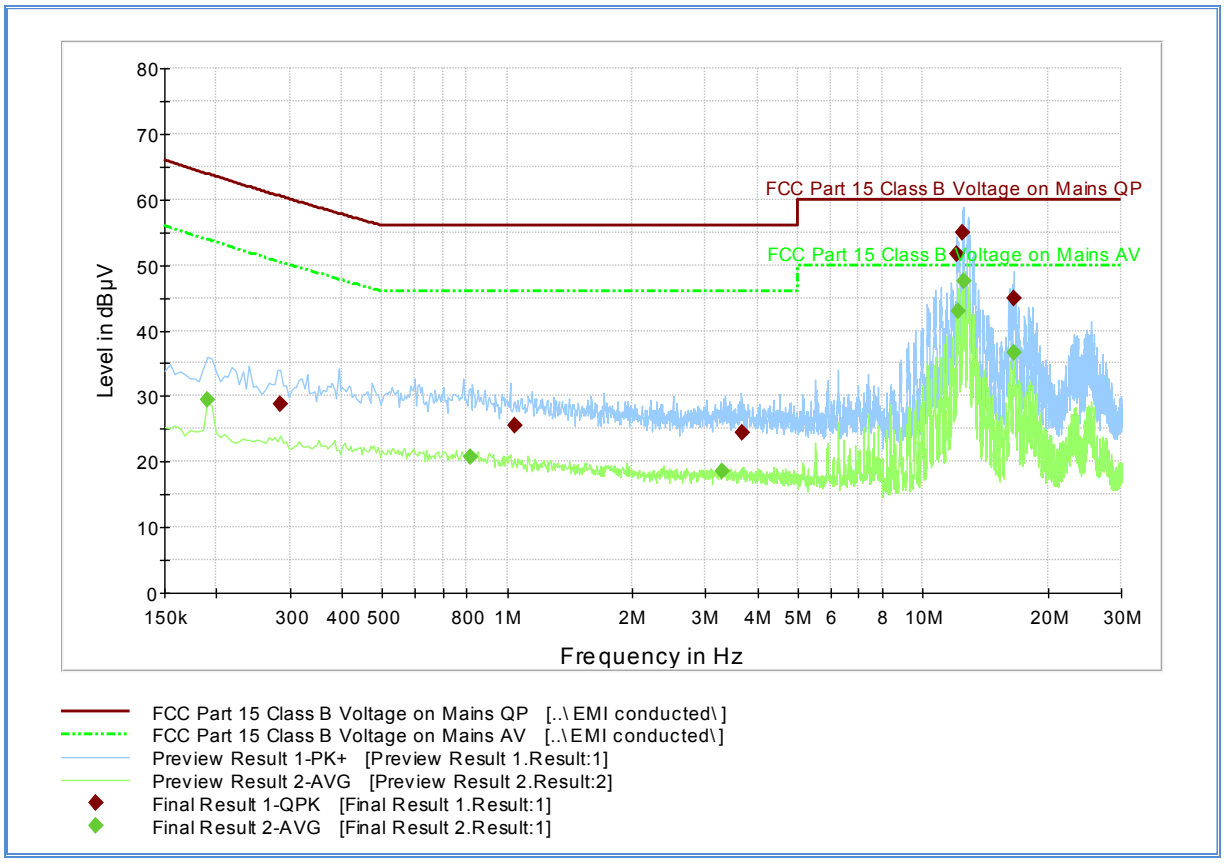
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.190500	38.5	1000.0	9.000	Off	N	19.9	25.3	63.9
0.996000	25.7	1000.0	9.000	Off	N	20.0	30.3	56.0
2.935500	23.7	1000.0	9.000	Off	N	20.3	32.3	56.0
12.084000	52.1	1000.0	9.000	Off	N	20.6	7.9	60.0
12.448500	56.1	1000.0	9.000	Off	N	20.6	3.9	60.0
16.579500	43.9	1000.0	9.000	Off	N	20.6	16.1	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.190500	35.7	1000.0	9.000	Off	N	19.9	18.1	53.9
1.018500	21.1	1000.0	9.000	Off	N	20.0	24.9	46.0
4.375500	19.0	1000.0	9.000	Off	N	20.3	27.0	46.0
12.160500	43.9	1000.0	9.000	Off	N	20.6	6.1	50.0
12.529500	48.4	1000.0	9.000	Off	N	20.6	1.6	50.0
16.579500	35.3	1000.0	9.000	Off	N	20.6	14.7	50.0

2.10.11 Test Results - Conducted Emissions Line 2



Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.285000	28.7	1000.0	9.000	Off	N	20.1	31.8	60.5
1.041000	25.5	1000.0	9.000	Off	N	20.0	30.5	56.0
3.691500	24.3	1000.0	9.000	Off	N	20.3	31.7	56.0
12.084000	51.6	1000.0	9.000	Off	N	20.6	8.4	60.0
12.448500	55.0	1000.0	9.000	Off	N	20.6	5.0	60.0
16.570500	45.0	1000.0	9.000	Off	N	20.6	15.0	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.190500	29.4	1000.0	9.000	Off	N	19.9	24.4	53.9
0.816000	20.7	1000.0	9.000	Off	N	20.1	25.3	46.0
3.300000	18.5	1000.0	9.000	Off	N	20.3	27.5	46.0
12.160500	42.9	1000.0	9.000	Off	N	20.6	7.1	50.0
12.529500	47.4	1000.0	9.000	Off	N	20.6	2.6	50.0
16.579500	36.6	1000.0	9.000	Off	N	20.6	13.4	50.0

SECTION 3

TEST EQUIPMENT USED

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

3.1 TEST EQUIPMENT USED

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

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Antenna Conducted Port Setup						
7606	USB RF Power Sensor	RadiPower RPR3006W	14I00048SNO 048	DARE!! Instruments	11/30/16	11/30/17
7582	Signal/Spectrum Analyzer	FSW26	101614	Rhode & Schwarz	10/26/16	10/26/17
7608	Vector Signal Generator	SMBV100A	259021	Rhode & Schwarz	09/02/16	09/02/17
8825	20dB Attenuator	46-20-34	BK5773	Weinschel Corp.	Verified by 7582 and 7608	
8832	20dB Attenuator	34-20-34	BP4150	MCE/Weinschel	Verified by 7582 and 7608	
Radiated Emissions						
1033	Bilog Antenna	3142C	00044556	EMCO	10/11/16	10/11/18
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	10/07/16	10/07/17
1016	Pre-amplifier	PAM-0202	187	PAM	02/09/17	02/09/18
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	07/05/16	07/05/17
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	04/26/17	04/26/18
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	02/09/17	02/09/18
7608	Vector Signal Generator	SMBV100A	259021	Rhode & Schwarz	09/02/16	09/02/17
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	06/29/16	06/29/17
AC Conducted Emissions						
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	04/26/17	04/26/18
7568	LISN	FCC-LISN-50-25-2-10	120305	Fischer Custom Comm.	11/05/16	11/05/17
8822	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	03/08/17	03/08/18
8824	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	03/08/17	03/08/18
Miscellaneous						
6792	Multimeter	3478A	2911A70964	Hewlett Packard	08/29/16	08/29/17
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	Sper Scientific	08/22/16	08/22/17
7539	DC Power Supply	6434B	1140A01866	Hewlett Packard	Verified by 6792	
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 Conducted Antenna Port Measurement

	Contribution	Probability Distribution Type	Probability Distribution xi	Standard Uncertainty u(xi)	[u(xi)]2
1	Receiver/Spectrum Analyzer	Rectangular	0.08	0.05	0.00
2	Cables	Rectangular	0.30	0.17	0.03
4	EUT Setup	Rectangular	0.50	0.29	0.08
				Combined Uncertainty (u_c):	0.34
				Coverage Factor (k):	1.96
				Expanded Uncertainty:	0.67

3.2.2 AC Conducted Emissions

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.36	0.21	0.04
2	Cables	Rectangular	0.50	0.29	0.08
3	LISN	Rectangular	0.66	0.38	0.15
4	Attenuator	Rectangular	0.30	0.17	0.03
5	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	0.80
				Coverage Factor (k):	2
				Expanded Uncertainty:	1.59

3.2.3 Radiated 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	Triangular	3.52	1.44	2.07
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	1.68
				Coverage Factor (k):	2
				Expanded Uncertainty:	3.36

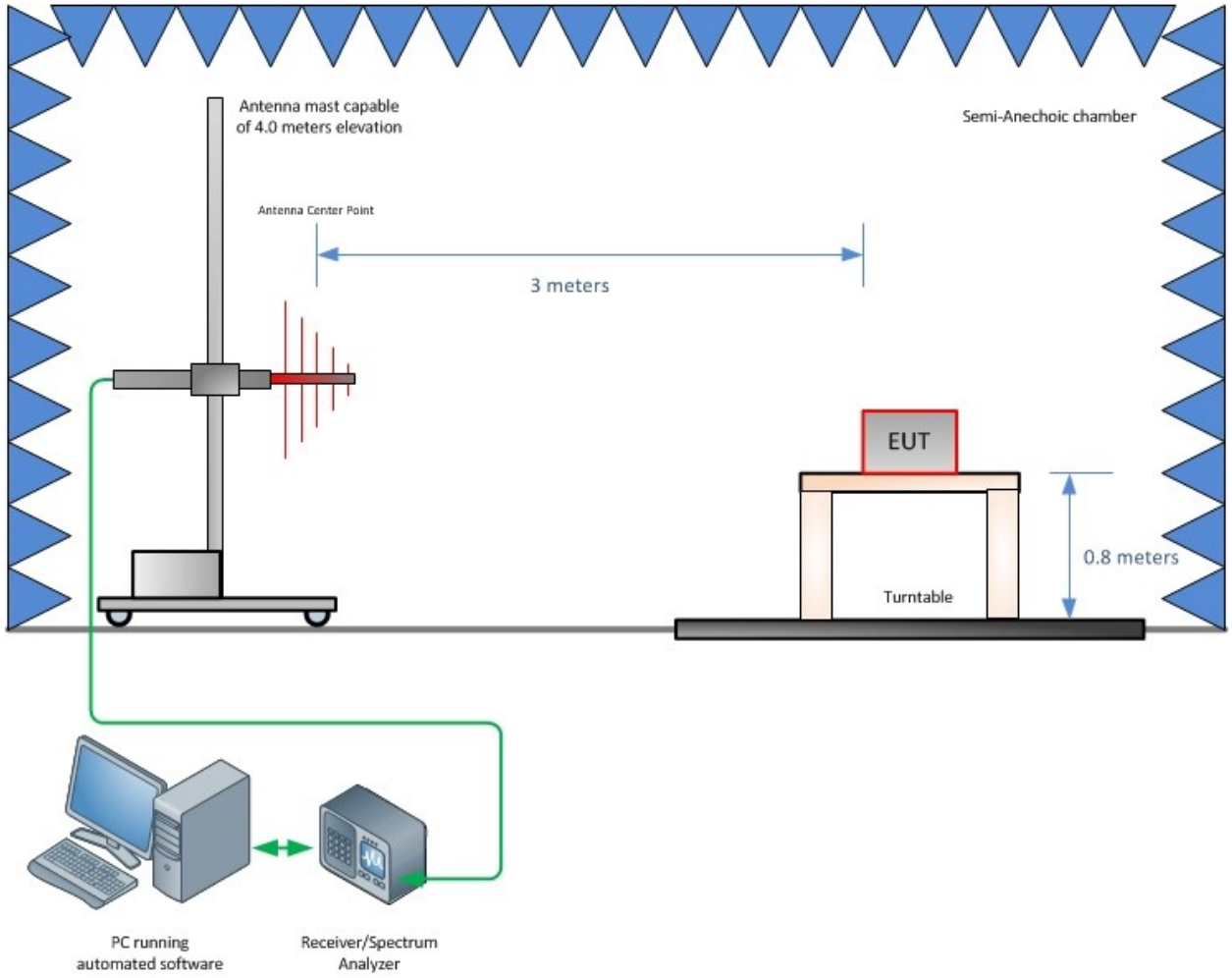
3.2.4 Radiated Measurements (Above 1GHz)

	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	Triangular	3.00	1.22	1.50
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	1.49
				Coverage Factor (k):	2
				Expanded Uncertainty:	2.99

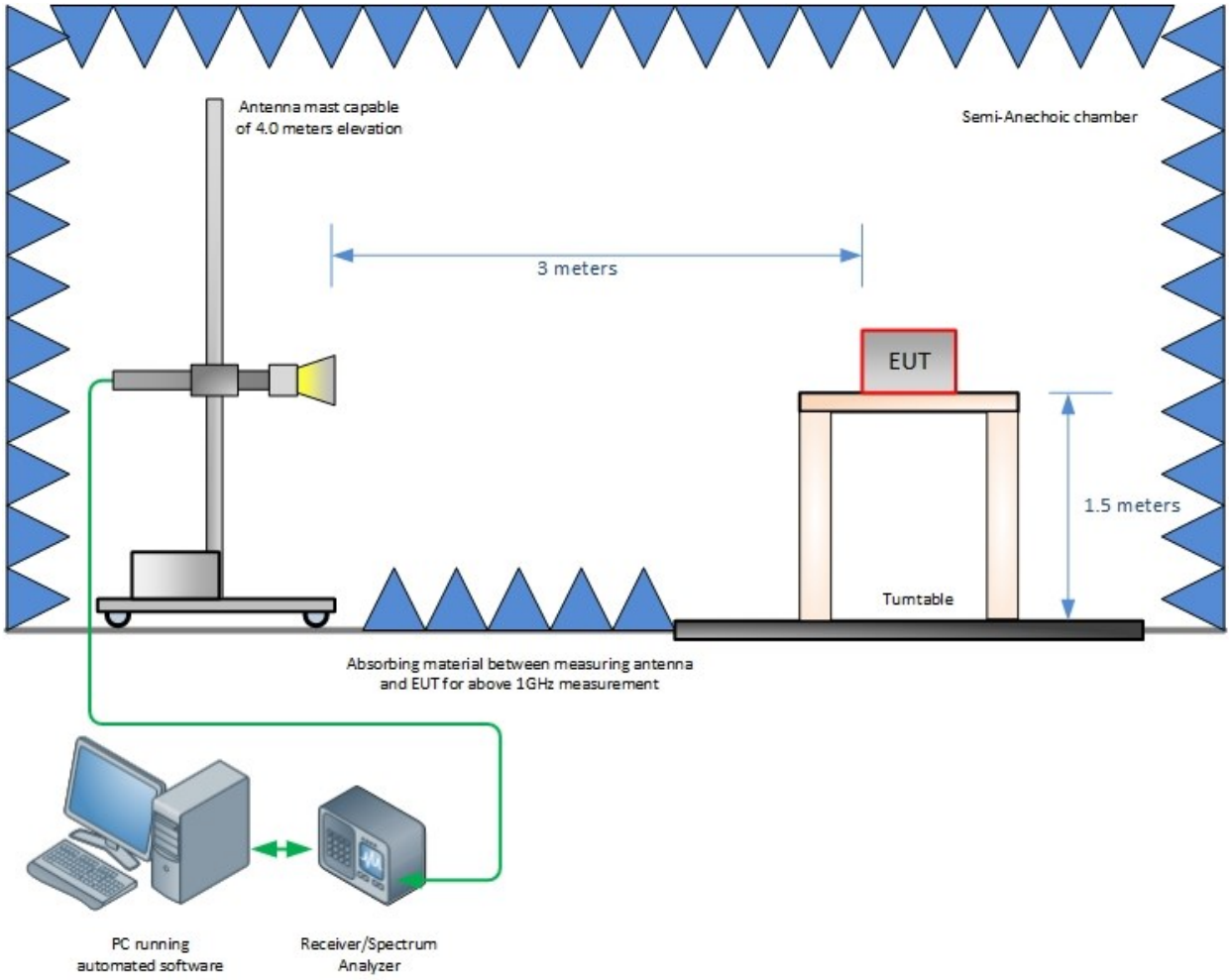
SECTION 4

DIAGRAM OF TEST SETUP

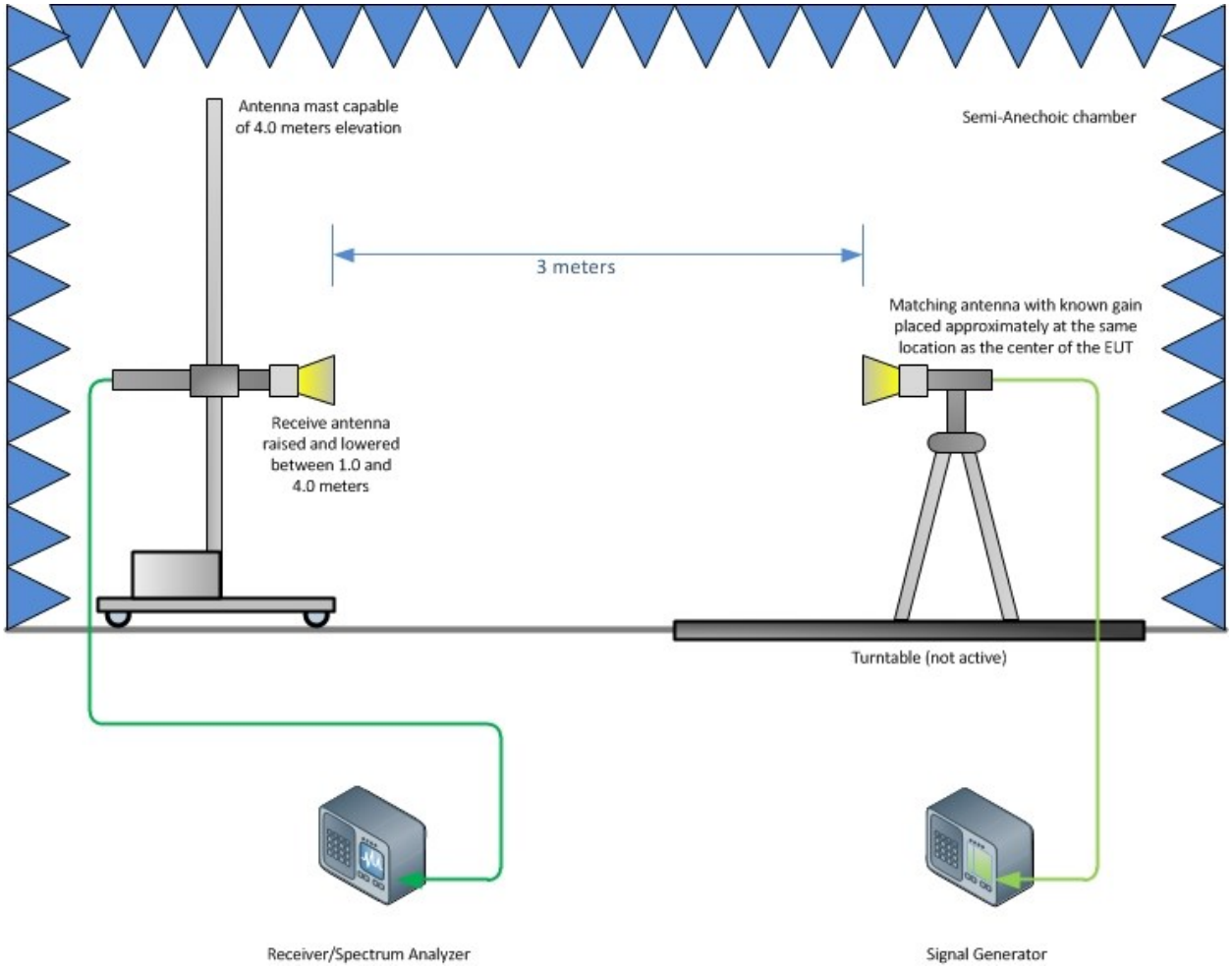
4.1 TEST SETUP DIAGRAM



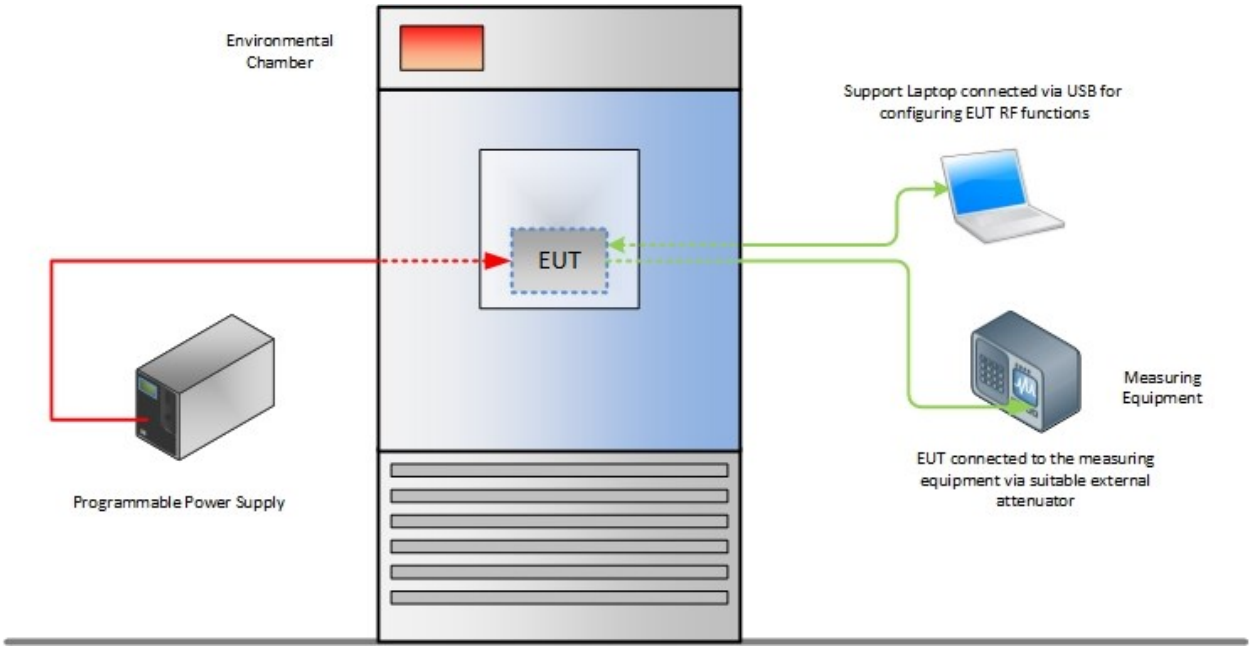
Radiated Emission Test Setup (Below 1GHz)



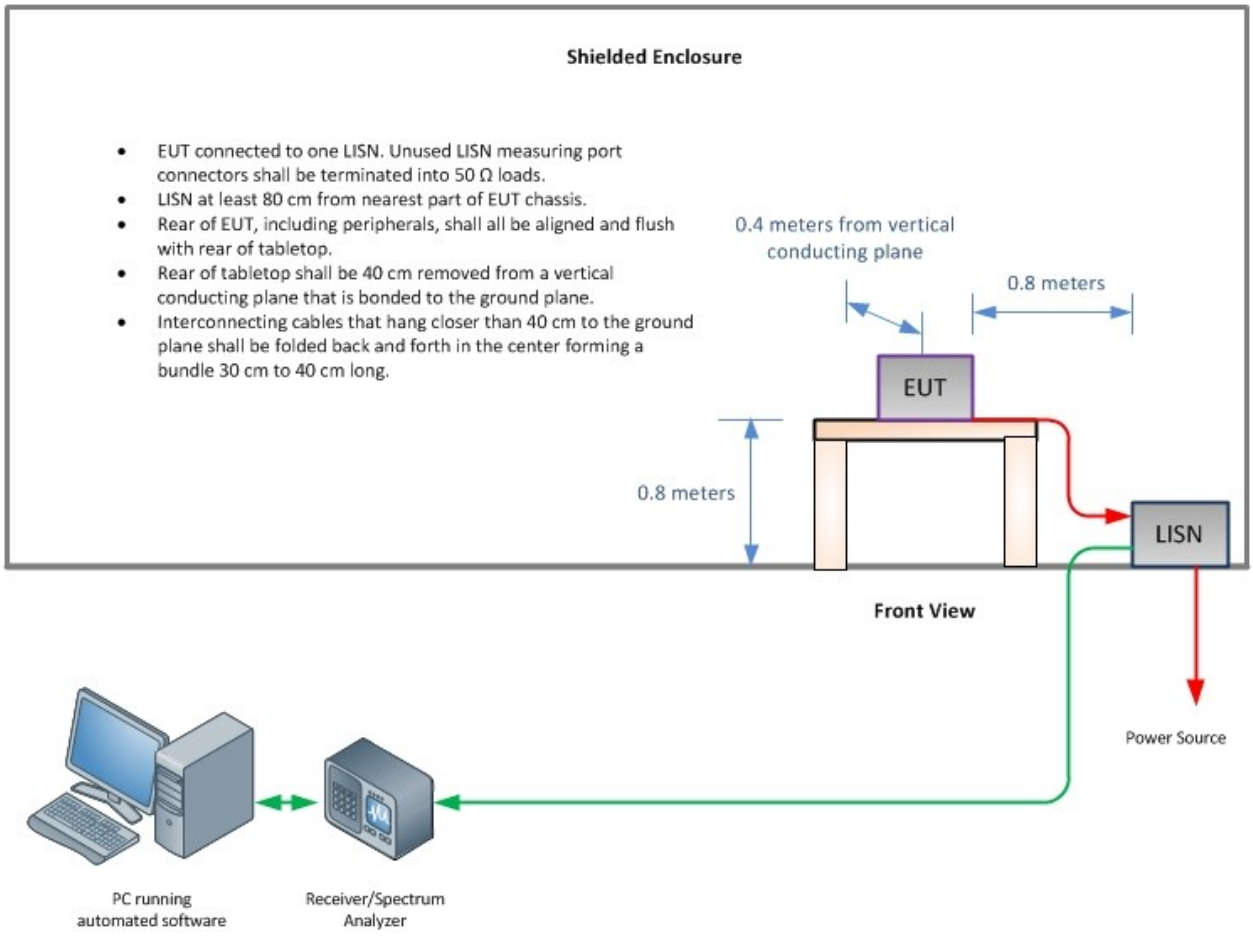
Radiated Emission Test Setup (Above 1GHz)



Substitution Test Method (Above 1GHz, if applicable)



Frequency Stability Test Configuration



Conducted Emissions Test Configuration (if applicable)

SECTION 5

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