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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 and 27
ISED RSS-Gen, RSS-130 and RSS-139

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

REPORT ON	Radio Testing of the u-blox AG LTE Cat-M1 Module
TEST REPORT NUMBER	SD72128174-0517A
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

SD72128174-0517A u-blox AG M/N SARA-R410M SARA-R410M LTE Cat-M1 Module					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
06/20/2017	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 FCC CFR 47 Part 2 and 27, ISED RSS-Gen, RSS-130 and RSS-139.

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
Model Number(s)	SARA-R410M
FCC ID	XPY2AGQN4NNN
IC Number	8595A-2AGQN4NNN
Serial Number(s)	357591080022319 and 357591080023101
Number of Samples Tested	2
Test Specification/Issue/Date	• FCC CFR 47 Part 2 and 27 (October 1, 2016). • RSS-130 – Mobile Broadband Services (MBS) Equipment Operating in the Frequency Bands 698-756 MHz and 777-787 MHz (Issue 1, October 2013). • RSS-139 – Advanced Wireless Services (AWS) Equipment Operating in the Bands 1710-1780 MHz and 2110-2180 MHz (Issue 3, July 2015). • RSS-Gen - General Requirements and Information for the Certification of Radio Apparatus (Issue 4, November 2014).
Start of Test	May 23, 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 v0101 (Guidelines for Determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of a RF Transmitting System. • 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 and 27 with cross-reference to the corresponding IC RSS standard is shown below.

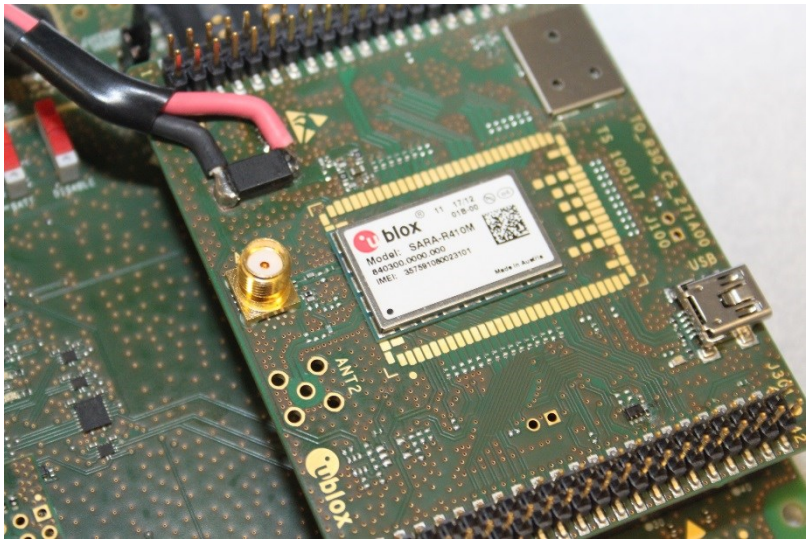
Section	Spec Clause				Test Description	Result
	FCC Part 2	FCC Part 27	RSS-130	RSS-139		
2.1	2.1046	27.50 (b)(9) and (10)	4.4	6.5	Transmitter Conducted Output Power	Compliant
2.2	-	-	4.4	6.5	Equivalent Isotropic Radiated Power	Compliant
		27.50 (b)(9) and (10)	-		Effective Radiated Power	Compliant
2.3	2.1049	27.53	RSS-Gen 6.6		Occupied Bandwidth	Reporting Purposes Only
2.4	-	27.50 (d)(5)	4.4	6.5	Peak-Average Ratio	Compliant
2.5	2.1051	27.53 (c)(2) and (5)	4.6.1	6.6	Band Edge	Compliant
2.6	2.1051	27.53 (c)(1),(2),(4),(5) ,(6) and (f)	4.6	6.6	Conducted Spurious Emissions	Compliant
2.7	Clause 7of KDB971168 D01 v02r02		-		Field Strength Of Spurious Radiation	Compliant
2.8	2.1055	27.54	4.3	6.4	Frequency Stability	Compliant
-	-	-	RSS-Gen 7.0		Receiver Spurious Emissions	N/A*
2.9	-	-	RSS-Gen 8.8		Power Line Conducted Emission	Compliant

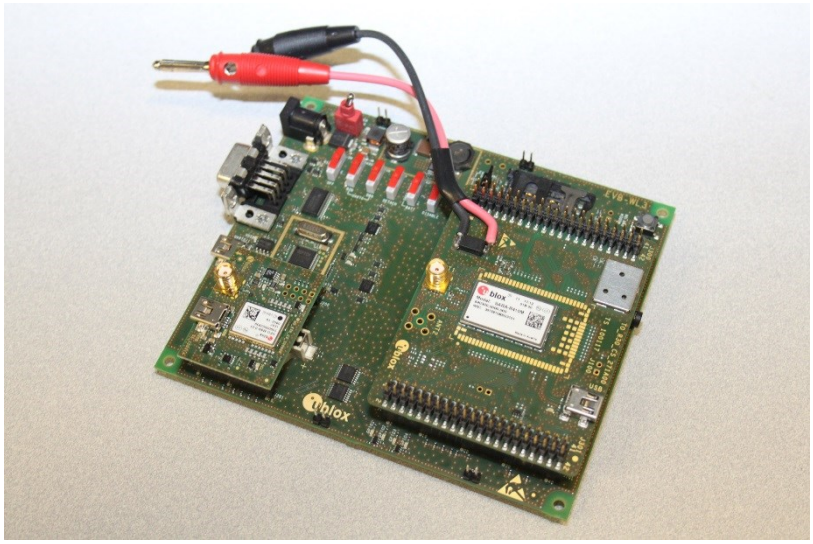
N/A - *Not applicable. EUT does not fall to any category defined as Receiver under Section 5 of RSS-Gen Issue 4.*

1.3 PRODUCT INFORMATION

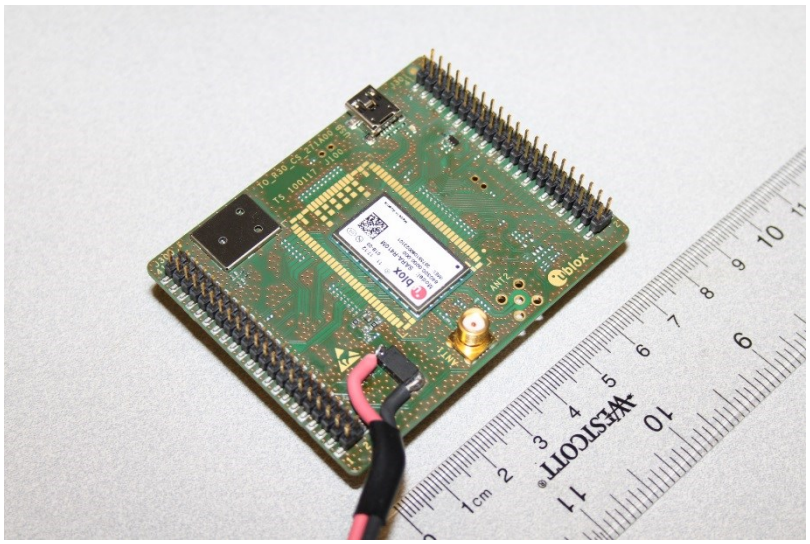
1.3.1 Technical Description

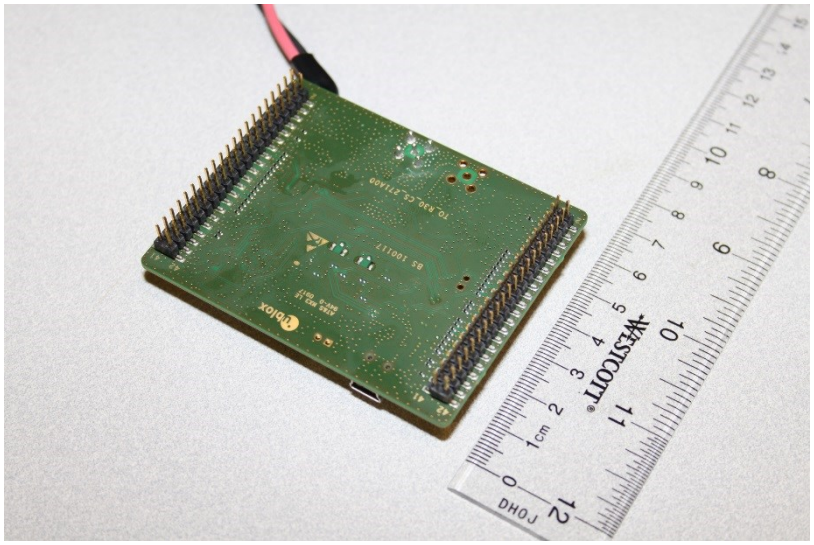
The Equipment Under Test (EUT) was a u-blox AG Model SARA-R410M™ LTE Cat-M1 Module as shown in the photographs below. The EUT is based on Qualcomm Technologies' MDM9206 LTE modem designed to allow a larger number of devices to connect to the Internet of Things (IoT). LTE Cat M1 is part of the new 3GPP 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

1.3.2 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 4 and 12 with 1.4 MHz BW
Frequency Range	1710 MHz – 1755 MHz (Band 4) 699 MHz -716 MHz (Band 12)
Capability	LTE Band 5, 2, 4 and 12
Primary Unit (EUT)	☐ Production ☒ Pre-Production ☐ Engineering
Antenna Gain	**6.74 dBi** for Band 4 and **3.67 dBi** for band 12 (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)

1.3.3 Transmit Frequency Table

LTE Band	Channel	Frequency (MHz)	Emission Designators	Rated Power	
				Max. Power (dBm)	Max. Power (W)
4	19957	1710.7	1M23G7D/1M12W7D	25.00	0.316
	20175	1732.5			
	20393	1754.3			
12	23017	699.7	1M13G7D/1M13W7D		
	23095	707.5			
	23173	715.3			

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1.4 EUT TEST CONFIGURATION

1.4.1 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.

1.4.2 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.

1.4.3 Support Equipment and I/O cables

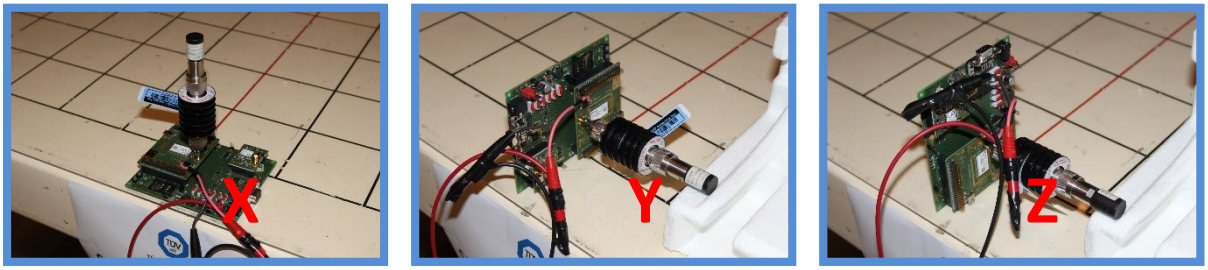
Manufacturer	Equipment/Cable	Description
Lenovo	Support Laptop (T410S)	P/N 0A31972 S/N R9-92MH0 10/11
LiteOn Technology Corporation	AC Adapter for Support Laptop	Model 42T4430 S/N 11S42T4430Z1ZGWE27AA9X REV G
Hewlett Packard	DC Power Supply	M/N E3610A S/N KR51311519
-	USB Cable (EUT to Support Laptop)	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

1.4.4 Worst Case Configuration

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

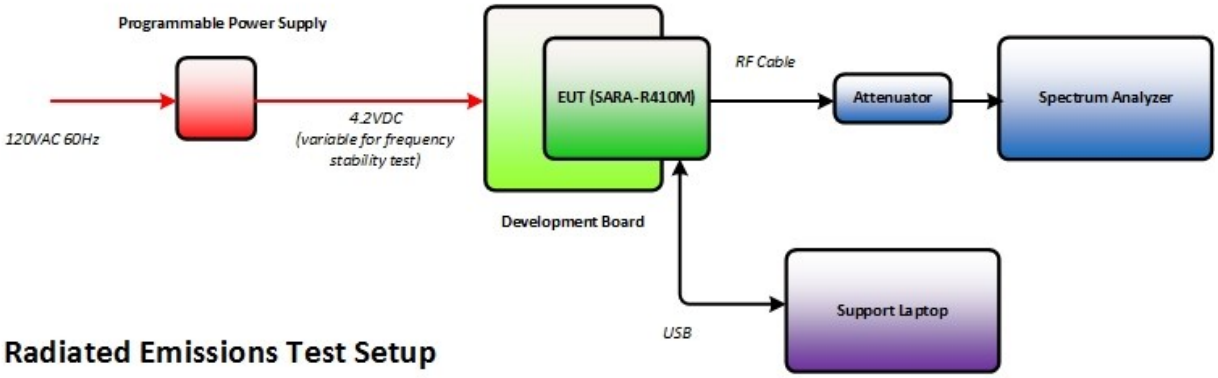
Modulation	Channel		PUSCH RBs	PA Range	TX Gain
QPSK	Low (Band 4)	Mid (Band 12)	6	2	66

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.

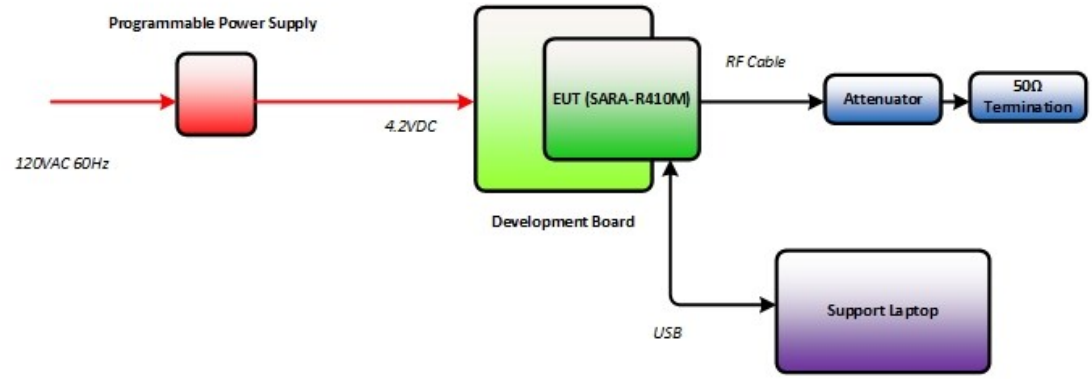


1.4.5 Simplified Test Configuration Diagram

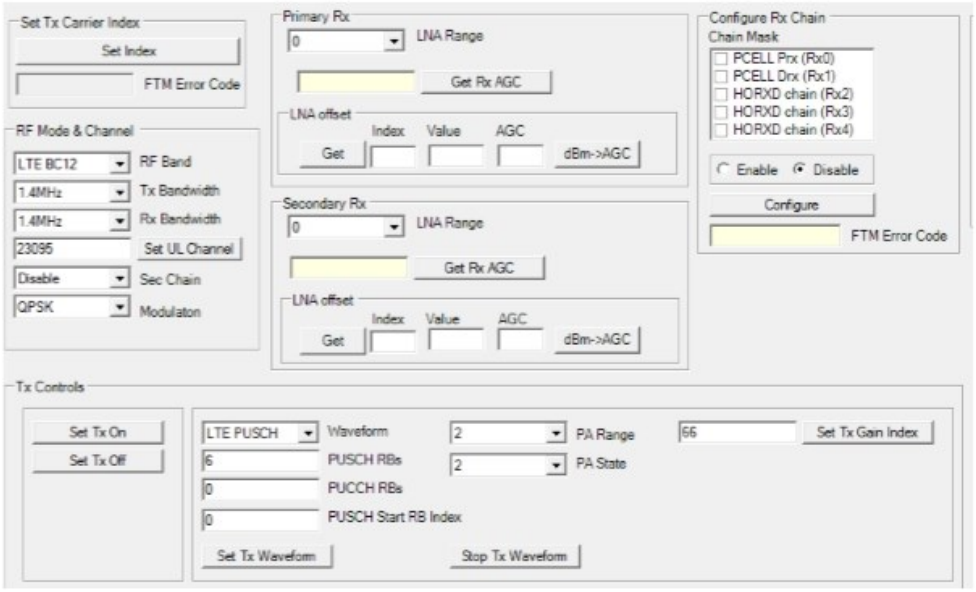
Antenna Conducted Port Test Setup



Radiated Emissions Test Setup



General RF Test Configuration (Manufacturer provided)



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

1.5 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 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.

1.7 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.

1.8 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)

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

1.9.3 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.

1.9.4 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.

1.9.5 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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1.10 SAMPLE CALCULATIONS

1.10.1 LTE Emission Designator (QPSK)

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

1.10.2 LTE Emission Designator (16QAM)

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

1.10.3 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**

1.10.4 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
u-blox AG
SARA-R410M LTE Cat-M1 Module

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2.1 TRANSMITTER CONDUCTED OUTPUT POWER

2.1.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1046 (a) and (c)
FCC 47 CFR Part 27, Clause 27.50 (b)(9) and (10)
RSS-130, Clause 4.4
RSS-139, Clause 6.5

2.1.2 Standard Applicable

FCC 47 CFR Part 2, Clause 2.1046:
(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.

FCC 47 CFR Part 27, Clause 27.50 (b)(9):
Control stations and mobile stations transmitting in the 746–757 MHz, 776–788 MHz, and 805–806 MHz bands and fixed stations transmitting in the 787–788 MHz and 805–806 MHz bands are limited to 30 watts ERP.

FCC 47 CFR Part 27, Clause 27.50 (b)(10):
Portable stations (hand-held devices) transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP.

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 26, 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	25.9 °C
Relative Humidity	37.3 %
ATM Pressure	99.0 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
707.50 MHz	20.175 dB
1732.5 MHz	20.380 dB

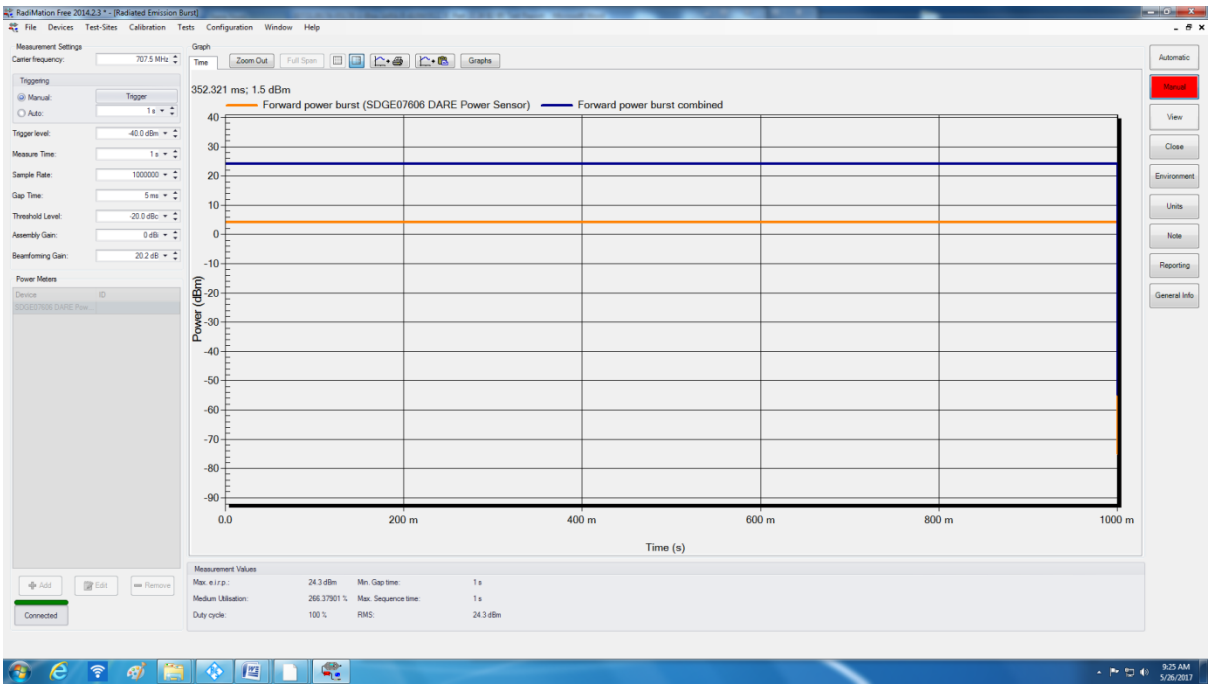
- Measurements were verified within the manufacturer declared Tune-Up procedure.

2.1.8 Test Results

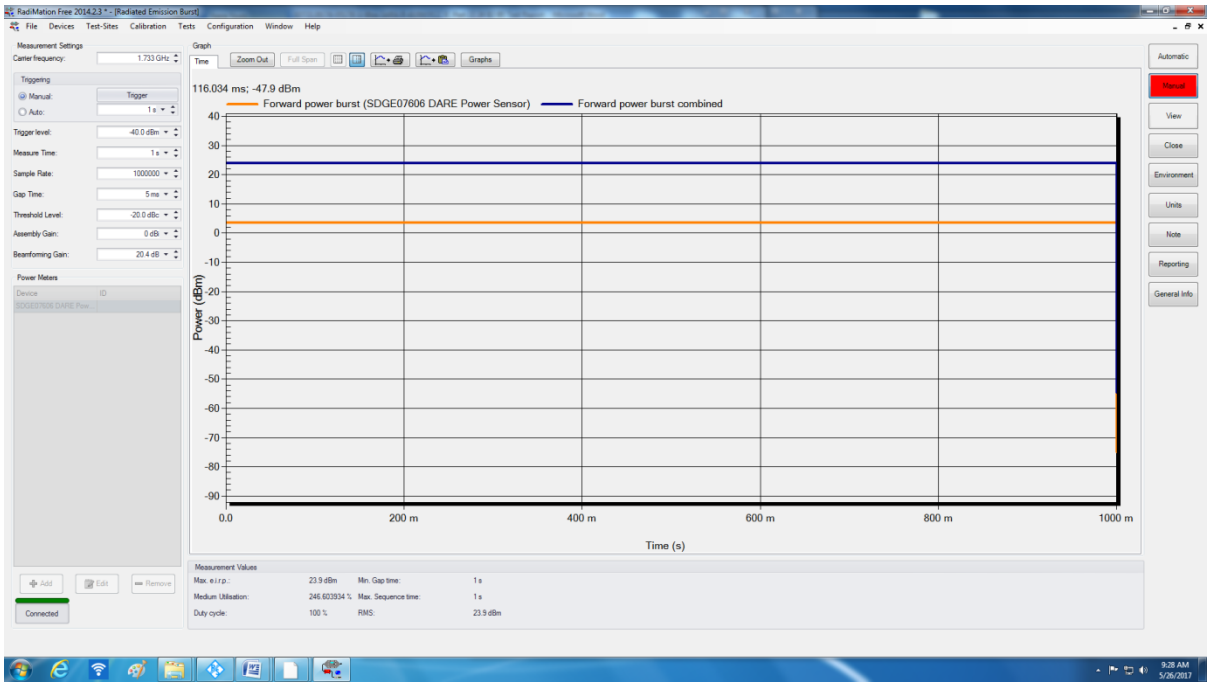
LTE Band 12 (69 Tx Gain Index)				
Modulation	**Bandwidth**	**Channels**	**Frequency**	**Tx Average (dBm)**
QPSK	1.4 MHz	23017	699.7	23.4
		23095	707.5	23.8
		23173	715.3	24.0
16QAM	1.4 MHz	23017	699.7	23.5
		23095	707.5	23.8
		23173	715.3	24.3

LTE Band 4 (65 Tx Gain Index)				
Modulation	**Bandwidth**	**Channels**	**Frequency**	**Tx Average (dBm)**
QPSK	1.4 MHz	19957	1710.7	23.9
		20175	1732.5	23.8
		20393	1754.3	23.5
16QAM	1.4 MHz	19957	1710.7	23.9
		20175	1732.5	23.8
		20393	1754.3	23.5

2.1.9 Sample Test Plot



Hi Channel LTE Band 12 16QAM



Low Channel LTE Band 4 QPSK

2.2 RADIATED POWER

2.2.1 Specification Reference

FCC 47 CFR Part 27, Clause 27.50 (b)(9) and (10)
RSS-130, Clause 4.4

2.2.2 Standard Applicable

FCC 47 CFR Part 27, Clause 27.50 (b)(9):
Control stations and mobile stations transmitting in the 746–757 MHz, 776–788 MHz, and 805–806 MHz bands and fixed stations transmitting in the 787–788 MHz and 805–806 MHz bands are limited to 30 watts ERP.

FCC 47 CFR Part 27, Clause 27.50 (b)(10):
Portable stations (hand-held devices) transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP.

RSS-130, Clause 4.4:
The e.i.r.p. shall not exceed 50 watts for mobile equipment or for outdoor fixed subscriber equipment, nor shall it exceed 5 watts for portable equipment or for indoor fixed subscriber equipment.

RSS-139, Clause 6.5:
The equivalent isotropically radiated power (e.i.r.p.) for mobile and portable transmitters shall not exceed one watt. The e.i.r.p. for fixed and base stations in the band 1710-1780 MHz shall not exceed one watt.

2.2.3 Equipment Under Test and Modification State

Serial No: 357591080022319 and 357591080023101 / Calculation Only

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

June 02, 2017/FSC

2.2.5 Additional Observations

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

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

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 for EIRP or dBd for ERP.
$\mathbf{L_C}$ = signal attenuation in the connecting cable between the transmitter and antenna, in dB.

- Maximum antenna gain relationship between ERP and EIRP could be determined by the following equation:

$$\mathbf{ERP = EIRP - 2.15}$$

2.2.6 Sample Computation

ERP = $P_T + G_T - L_C$ - 2.15dB
= 23.4 dBm (Average) + 3.67dBi (EIRP) – 0 (transmitter conducted power presented has an offset already) -2.15 (ERP/EIRP relationship factor)
= 24.92 dBm (high channel/QPSK)

2.2.7 Test Results

LTE Band 12 Uplink (699 MHz -716 MHz) 1.4MHz BW							
Modulation	**Channel**	***Frequency (MHz)***	***Average Power (dBm)***	***Antenna Gain (dBi)***	**EIRP (dBm)**	**ERP (dBm)**	**Limit (dBm)**
QPSK	23017	699.7	23.4	3.67	27.07	-	37.00
	23095	707.5	23.8	3.67	27.47	-	37.00
	23173	715.3	24.0	3.67	27.67	-	37.00
16-QAM	23017	699.7	23.5	3.67	27.17	-	37.00
	23095	707.5	23.8	3.67	27.47	-	37.00
	23173	715.3	24.3	3.67	27.97	-	37.00
QPSK	23017	699.7	23.4	3.67	-	24.92	30.00
	23095	707.5	23.8	3.67	-	25.32	30.00
	23173	715.3	24.0	3.67	-	25.52	30.00
16-QAM	23017	699.7	23.5	3.67	-	25.02	30.00
	23095	707.5	23.8	3.67	-	25.32	30.00
	23173	715.3	24.3	3.67	-	25.82	30.00

LTE Band 4 Uplink (1710 MHz – 1755 MHz) 1.4MHz BW							
Modulation	**Channel**	***Frequency (MHz)***	***Average Power (dBm)***	***Antenna Gain (dBi)***	**EIRP (dBm)**	**ERP (dBm)**	**Limit (dBm)**
QPSK	19957	1710.7	23.9	6.74	30.64	-	37.00
	20175	1732.5	23.8	6.74	30.54	-	37.00
	20393	1754.3	23.5	6.74	30.24	-	37.00

16-QAM	19957	1710.7	23.9	6.74	30.64	-	37.00
	20175	1732.5	23.8	6.74	30.54	-	37.00
	20393	1754.3	23.5	6.74	30.24	-	37.00
QPSK	19957	1710.7	23.9	6.74	-	28.49	30.00
	20175	1732.5	23.8	6.74	-	28.39	30.00
	20393	1754.3	23.5	6.74	-	28.09	30.00
16-QAM	19957	1710.7	23.9	6.74	-	28.49	30.00
	20175	1732.5	23.8	6.74	-	28.39	30.00
	20393	1754.3	23.5	6.74	-	28.09	30.00

2.3 OCCUPIED BANDWIDTH

2.3.1 Specification Reference

FCC 47 CFR Part 2. Clause 2.1049
FCC 47 CFR Part 27, Clause 27.53(h)
RSS-GEN Issue 4, Clause 6.6

2.3.2 Standard Applicable

FCC 47 CFR Part 27, Clause 27.53
The emission 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 at least 26 dB below the transmitter power.

RSS-GEN Issue 4, Clause 6.6
The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.

2.3.3 Equipment Under Test and Modification State

Serial No: 357591080022319/ Default Test Configuration

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

May 25, 2017/FSC

2.3.5 Test Equipment Used

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

2.3.6 Environmental Conditions

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

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

2.3.7 Additional Observations

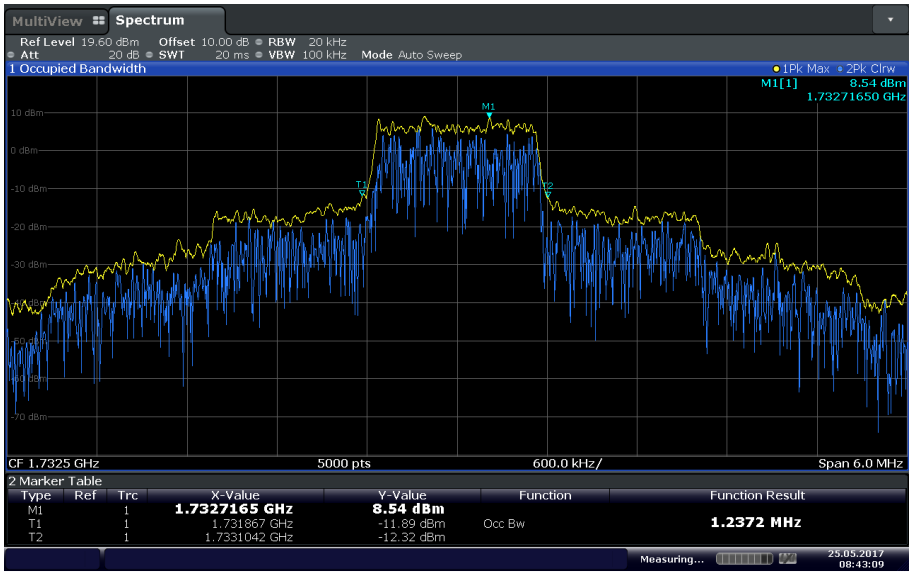
- This is a conducted test. Both 26dB bandwidth and 99% bandwidth presented.
- Only the middle channels presented.
- The span is between two and five times the anticipated OBW.
- The RBW is set to 1% of the OBW while the VBW is ≥3X RBW (20kHz used, SA limitation for 14kHz).

- 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.

2.3.8 Test Results (Reporting Purposes Only)

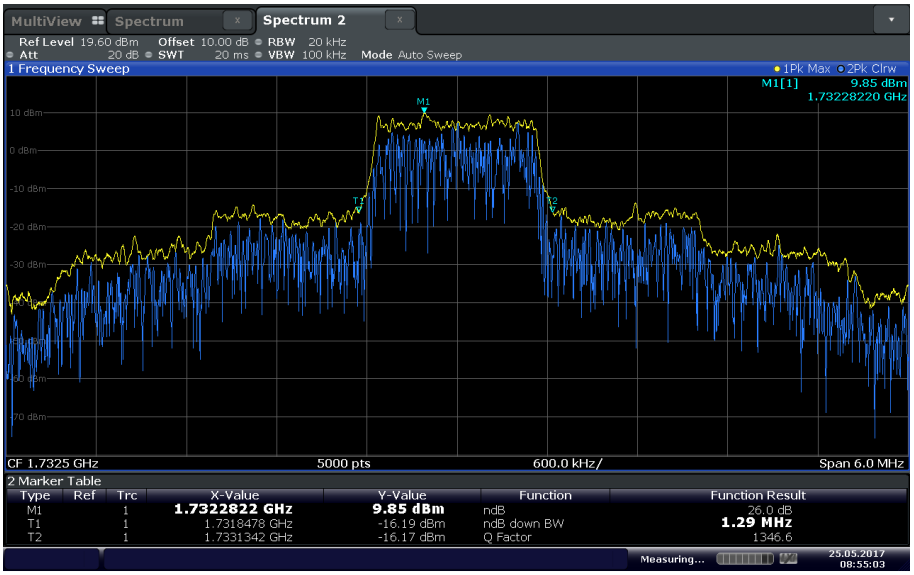
Band	Modulation	Channel	Frequency (MHz)	OBW (MHz)	-26dB BW (MHz)
4	QPSK	20175	1732.5	1.2372	1.29
	16-QAM	20175	1732.5	1.1268	1.29
12	QPSK	23095	707.5	1.1364	1.40
	16-QAM	23095	707.5	1.1376	1.35

Band 4 Mid Channel 99% OBW QPSK



Date: 25.MAY.2017 08:43:09

Band 4 Mid Channel 26 dB BW QPSK



Date: 25.MAY.2017 08:55:03

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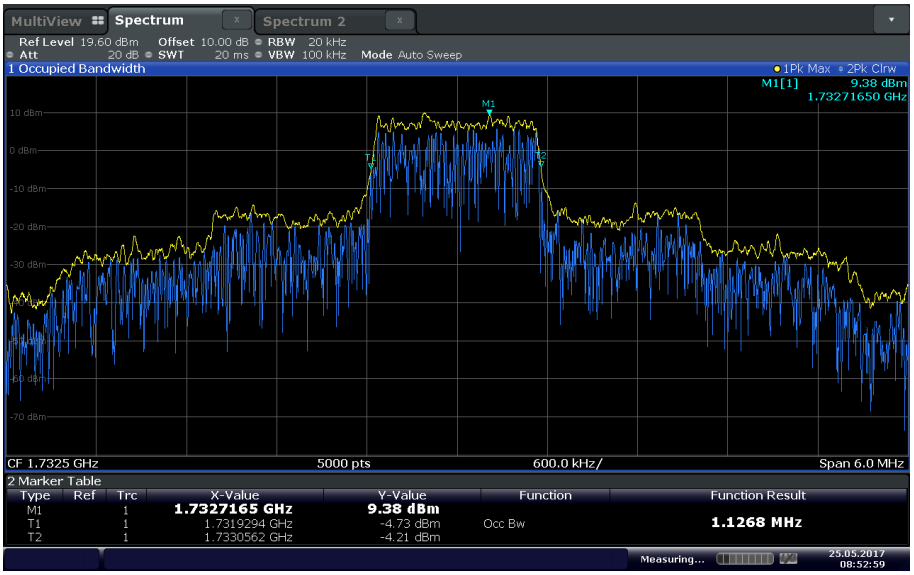
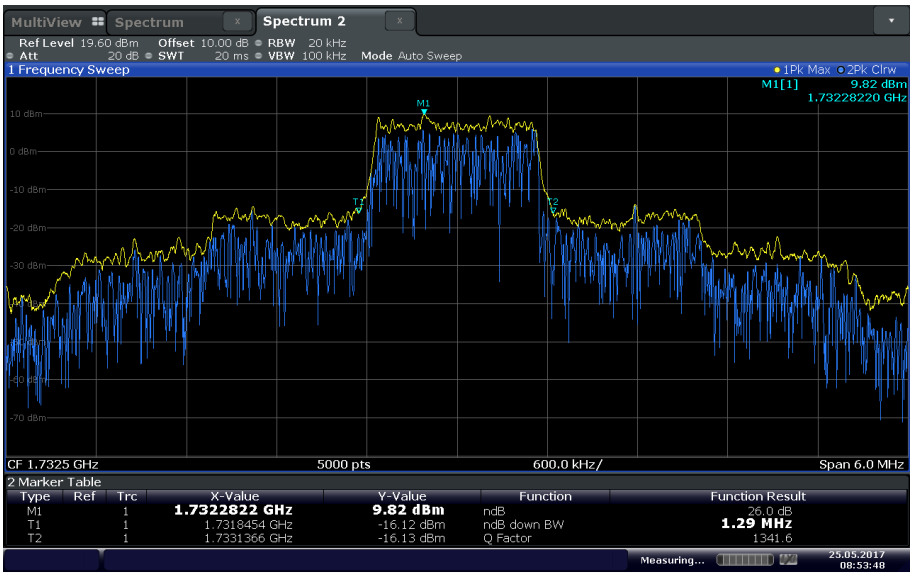
Band 4 Mid Channel 99% OBW 16-QAM



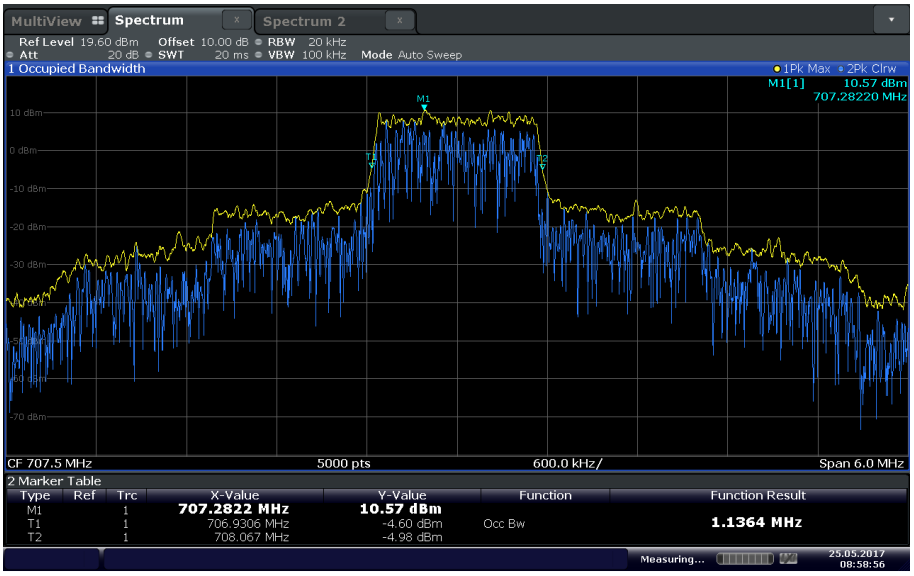
Date: 25.MAY.2017 08:52:59

Band 4 Mid Channel 26 dB BW 16-QAM



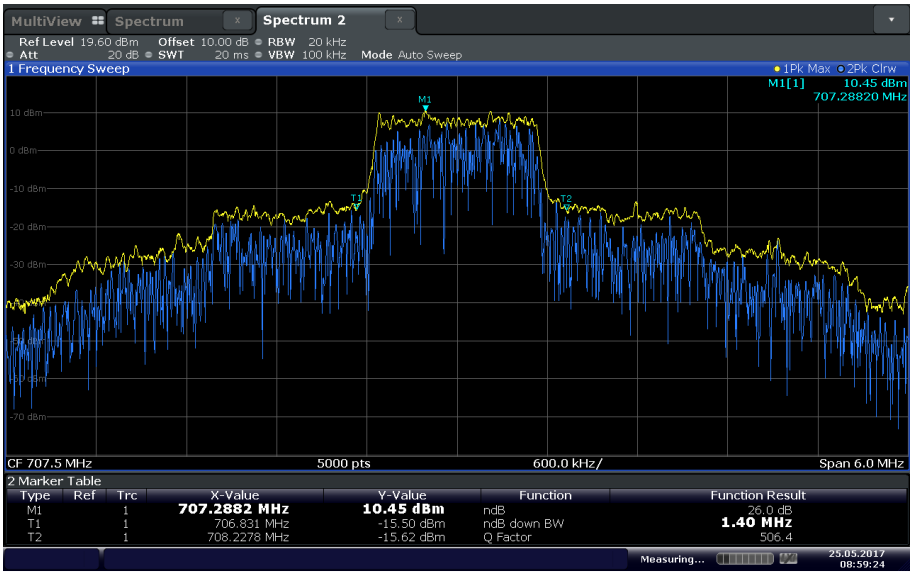
Date: 25.MAY.2017 08:53:48

Band 12 Mid Channel 99% OBW QPSK



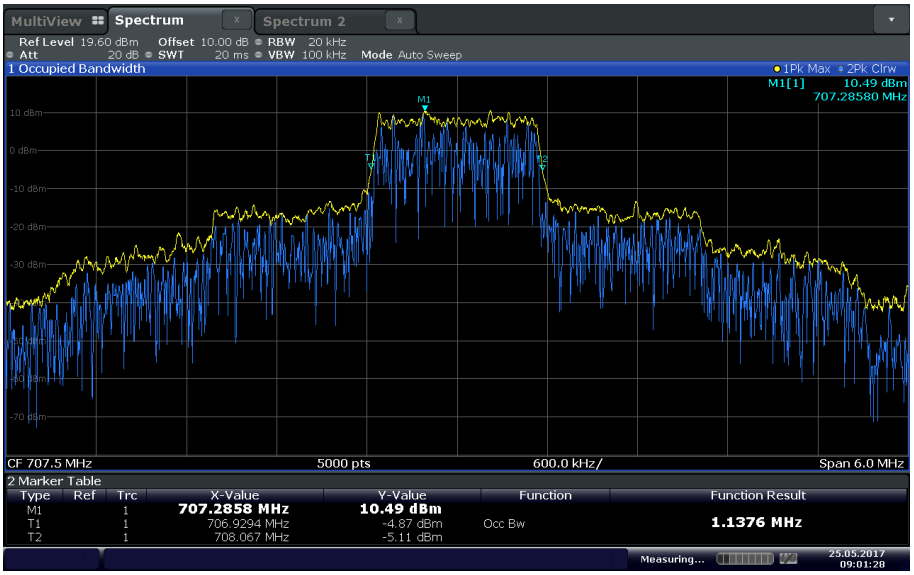
Date: 25.MAY.2017 08:58:56

Band 12 Mid Channel 26 dB BW QPSK



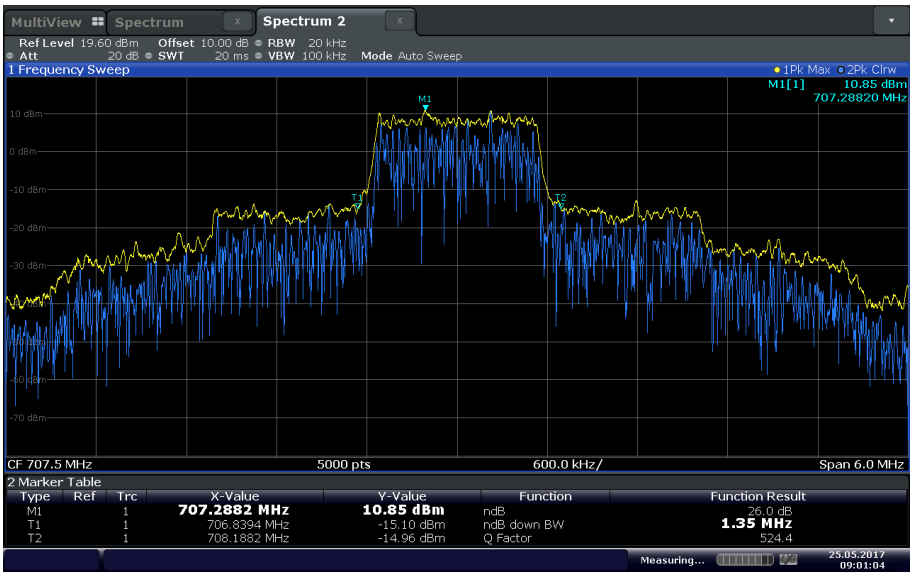
Date: 25.MAY.2017 08:59:24

Band 12 Mid Channel 99% OBW 16-QAM



Date: 25.MAY.2017 09:01:29

Band 12 Mid Channel 26 dB BW 16-QAM



Date: 25.MAY.2017 09:01:04

2.4 PEAK-AVERAGE RATIO

2.4.1 Specification Reference

FCC 47 CFR Part 27, Clause 27.50 (d)(5)
RSS-130, Clause 4.4
RSS-139, Clause 6.5

2.4.2 Standard Applicable

RSS-130, Clause 4.4 and RSS-139, Clause 6.5
In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for morethan 0.1% of the time and shall use a signal corresponding to the highest PAPR during periods of continuous transmission.

FCC 47 CFR Part 27, Clause 27.50 (d)(5)
Equipment employed must be authorized in accordance with the provisions of §24.51. 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 (d)(6) of this section. 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.

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

June 01, 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	25.5 °C
Relative Humidity	49.9 %
ATM Pressure	98.7 kPa

2.4.7 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 (minimum requirement is ≥ signal's occupied bandwidth of 1.4 MHz)
- Measurement interval was set to 1ms (10000 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 PAR levels greater than 13dB. EUT complies.

2.4.8 Test Results

Band	Modulation	Channel	Frequency (MHz)	PAR (dB)
LTE Band 12 (1.4 MHz BW)	QPSK	23017	699.7	5.60
		23095	707.5	5.58
		23173	715.3	6.28
	16QAM	23017	699.7	5.70
		23095	707.5	5.70
		23173	715.3	5.54
LTE Band 4 (1.4 MHz BW)	QPSK	19957	1710.7	5.70
		20175	1732.5	5.66
		20393	1754.3	5.96
	16QAM	19957	1710.7	5.58
		20175	1732.5	5.62
		20393	1754.3	5.70

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2.4.9 Sample Test Plots

LTE Band 12 1.4MHz Bandwidth 16-QAM Low Channel -PAR

Date: 1.JUN.2017 07:16:07

LTE Band 4 1.4MHz Bandwidth QPSK Low Channel -PAR

Date: 1.JUN.2017 06:37:33

2.5 BAND EDGE

2.5.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1051
FCC 47 CFR Part 27, Clause 27.53(g) and (h)
RSS-130, Clause 4.6
RSS-139, Clause 6.6

2.5.2 Standard Applicable

FCC 47 CFR Part 27, Clause 27.53 (g)
(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

FCC 47 CFR Part 27, Clause 27.53 (h)
(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB

(3) Measurement procedure. (i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission 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 at least 26 dB below the transmitter power.

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

May 31, 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.

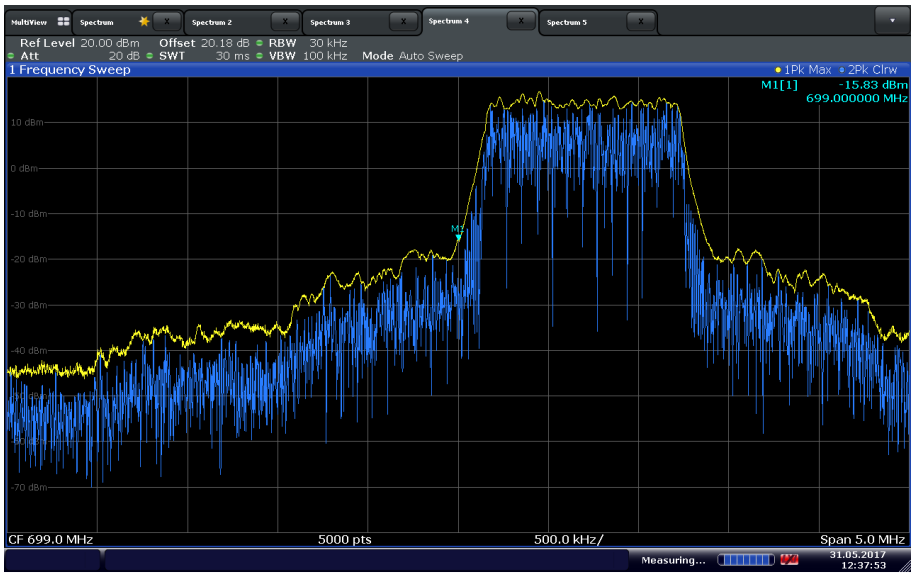
Ambient Temperature	25.9 °C
Relative Humidity	37.3 %
ATM Pressure	99.0 kPa

2.5.7 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.
- The center frequency of the spectrum is the band edge frequency (699 MHz -716 MHz for Band 12 and 1710 MHz – 1755 MHz for Band 4).
- RBW was set to 30 kHz and VBW to 3X RBW (approx. due to SA limitation) for Band12.
- RBW was set to 1% of the EBW or OBW (whichever is worst) with VBW 3X RBW for Band 4.
- Trace Mode was Max Hold using Peak Detector for worst case test configuration.
- Resulting band edge measurements were verified against the manufacturer tune-up procedure with positive results.
- EUT complies.

2.5.8 Test Results

Band 12(699 MHz -716 MHz) Low Channel QPSK



Date: 31.MAY.2017 12:37:53

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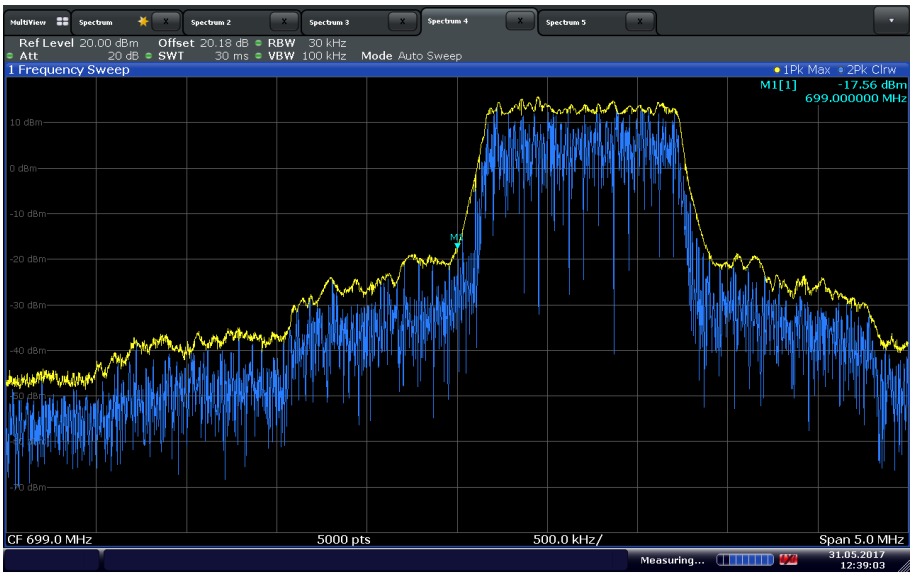
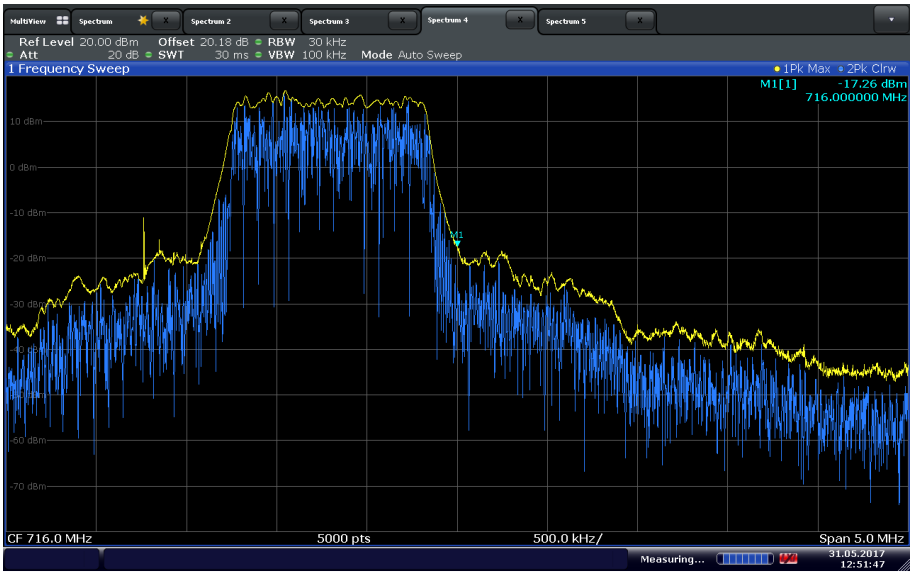
Band 12 (699 MHz -716 MHz) Low Channel 16-QAM



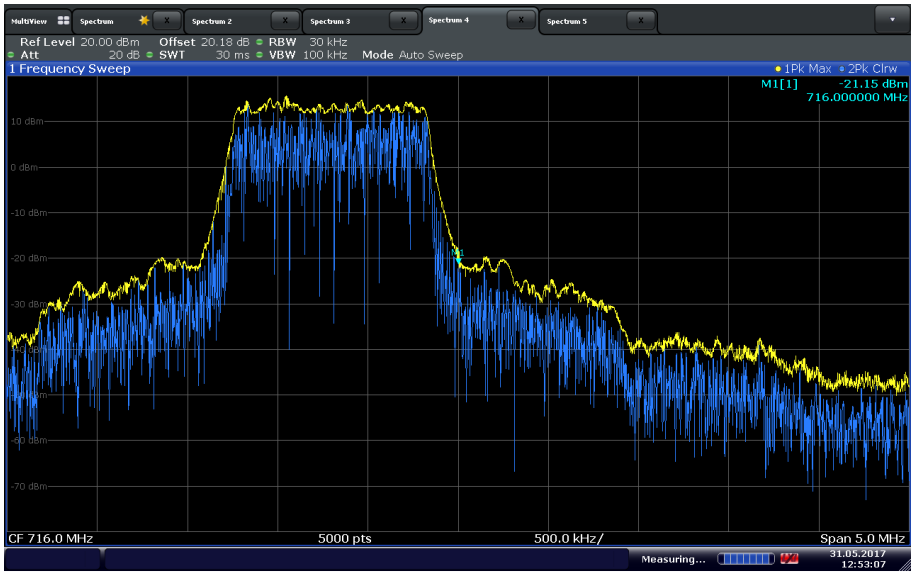
Date: 31.MAY.2017 12:39:03

Band 12 (699 MHz -716 MHz) High Channel QPSK



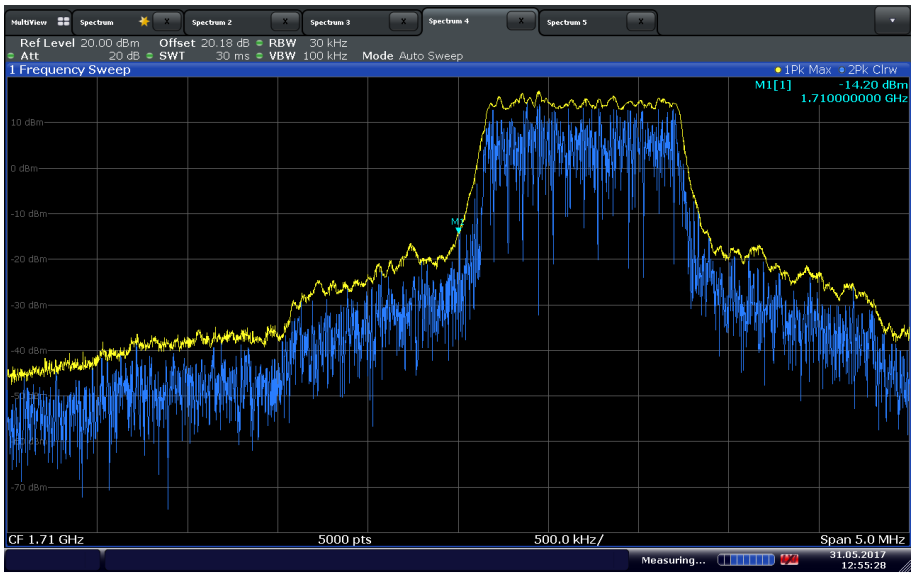
Date: 31.MAY.2017 12:51:47

Band 12 (699 MHz -716 MHz) High Channel 16-QAM



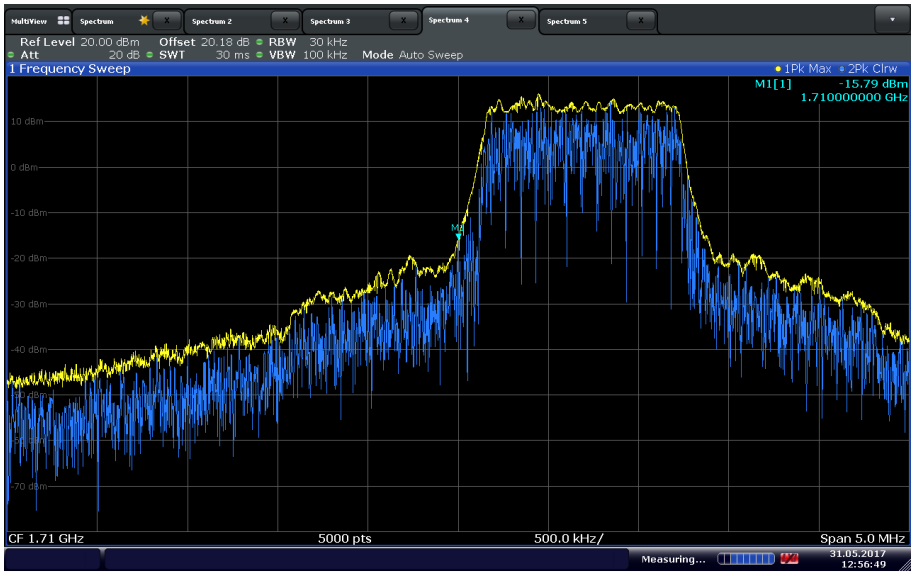
Date: 31.MAY.2017 12:53:07

Band 4 (1710 MHz – 1755 MHz) Low Channel QPSK



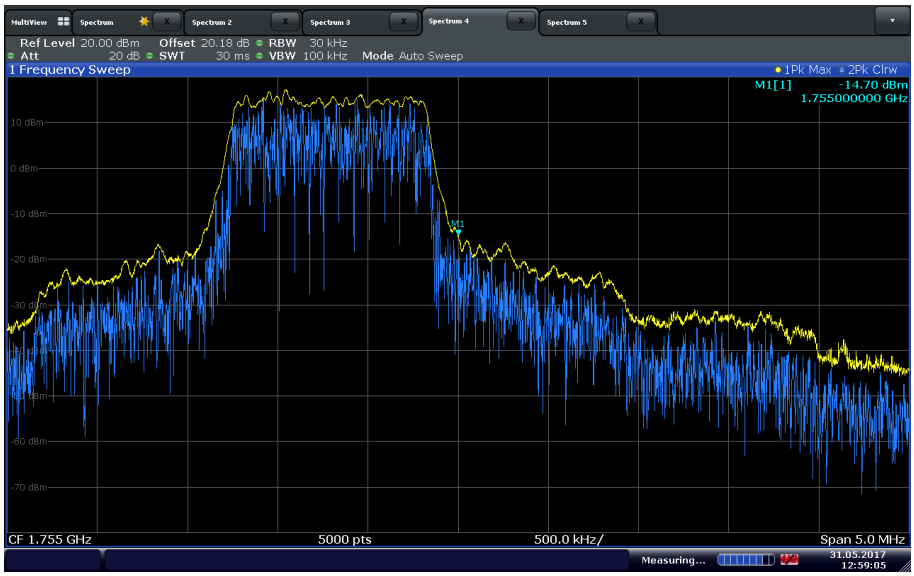
Date: 31.MAY.2017 12:55:28

Band 4 (1710 MHz – 1755 MHz) Low Channel 16-QAM



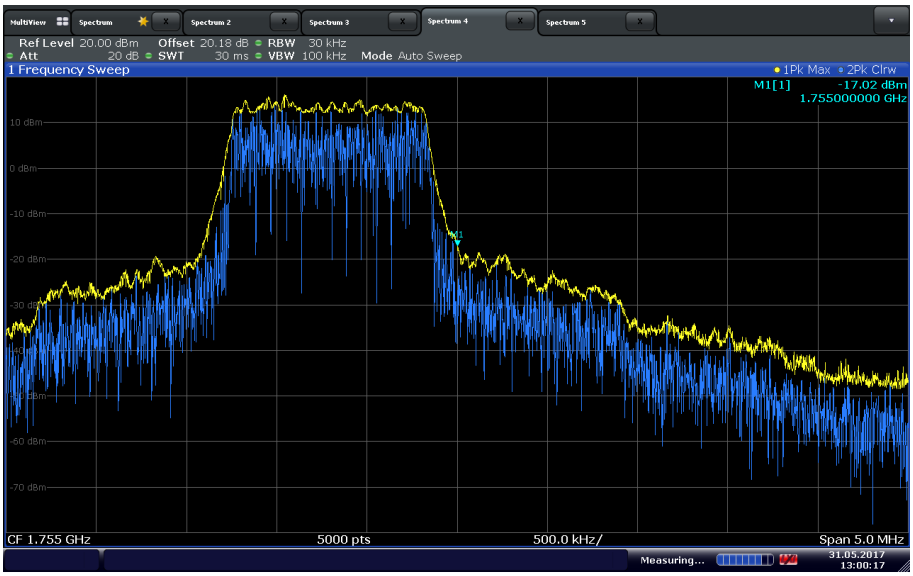
Date: 31.MAY.2017 12:56:50

Band 4 (1710 MHz – 1755 MHz) Low Channel QPSK



Date: 31.MAY.2017 12:59:06

Band 4 (1710 MHz – 1755 MHz) High Channel 16-QAM



Date: 31.MAY.2017 13:00:17

2.6 CONDUCTED SPURIOUS EMISSIONS

2.6.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1051
FCC 47 CFR Part 27, Clause 27.53(g) and (h)
RSS-130, Clause 4.6
RSS-139, Clause 6.6

2.6.2 Standard Applicable

FCC 47 CFR Part 27, Clause 27.53 (g)
(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

FCC 47 CFR Part 27, Clause 27.53 (h)
(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB

(3) Measurement procedure. (i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission 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 at least 26 dB below the transmitter power

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

June 01, 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	25.7 °C
Relative Humidity	48.9 %
ATM Pressure	98.6 kPa

2.6.7 Additional Observations

- This is a conducted test.
- Corresponding offset was used for the external attenuator and cable used.
- The spectrum was searched from 9 kHz to 8GHz. 9kHz to 100kHz was separate verification (not presented).
- The Spurious Emissions Measurement function of the SA was used for this test.
- Measurement guidance is per Clause 6 of KDB971168 D01 v02r02.
- Conducted Spurious emissions verification were performed using 1MHz RBW for both bands (worst case).
- EUT complies.

2.6.8 Test Results

Band 4 QPSK Low Channel

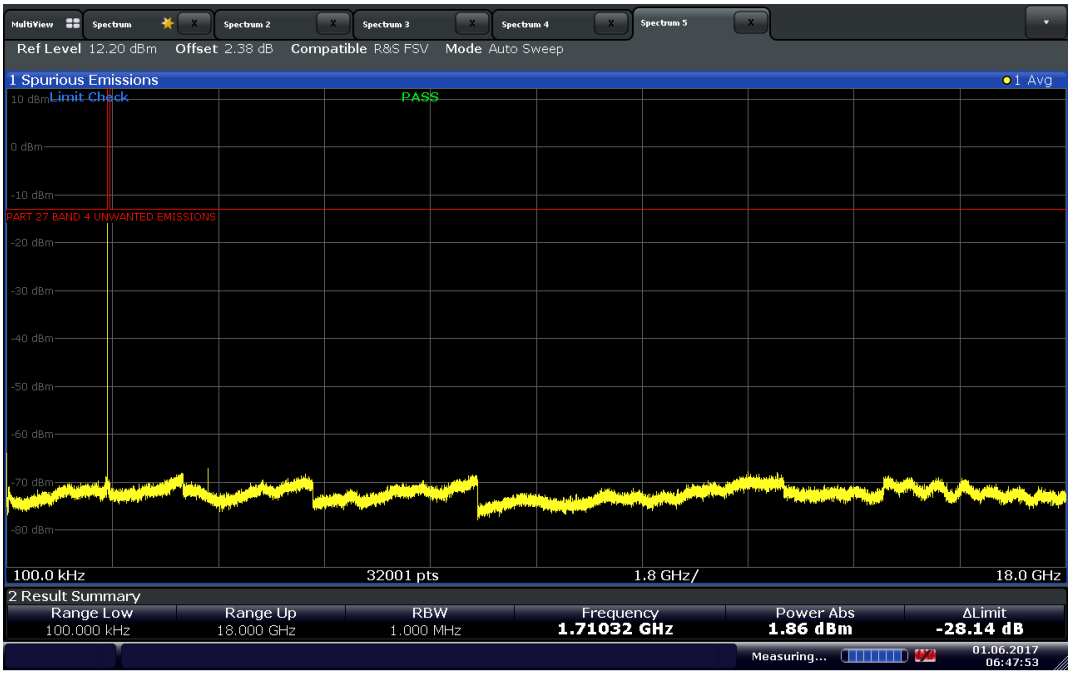
Band 4 QPSK Mid Channel

Date: 1.JUN.2017 06:40:52

Band 4 QPSK High Channel

Date: 1.JUN.2017 06:45:13

Band 4 16-QAM Low Channel



Date: 1.JUN.2017 06:47:53

Band 4 16-QAM Mid Channel

Date: 1.JUN.2017 06:50:45

Band 4 16-QAM High Channel

Date: 1.JUN.2017 06:52:34

Band 12 QPSK Low Channel

Date: 1.JUN.2017 07:04:14

Band 12 QPSK Mid Channel

Date: 1.JUN.2017 07:06:04

Band 12 QPSK High Channel

Date: 1.JUN.2017 07:12:12

Band 12 16-QAM Low Channel

Date: 1.JUN.2017 07:15:02

Band 12 16-QAM Mid Channel

Date: 1.JUN.2017 07:19:49

Band 12 16-QAM High Channel

Date: 1.JUN.2017 07:21:37

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.

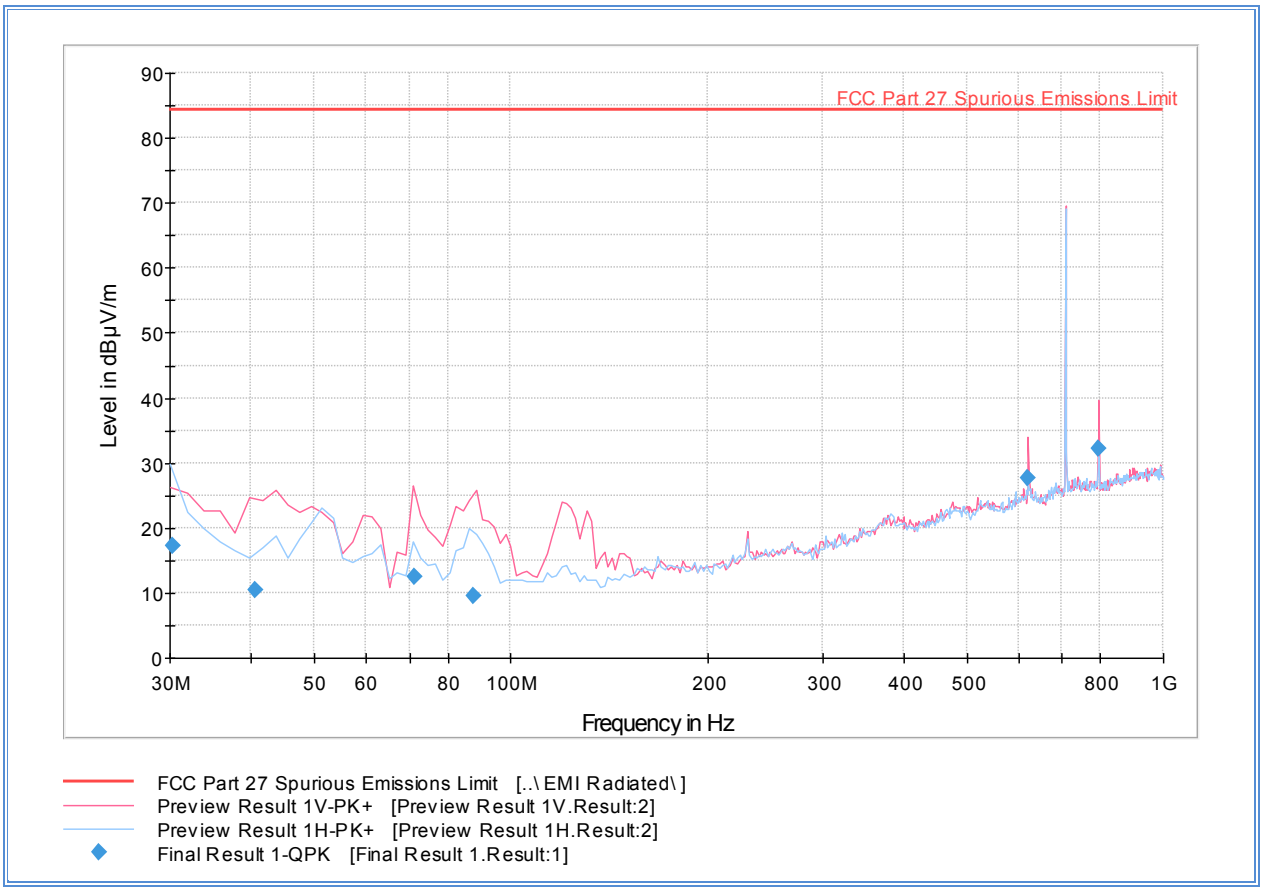
2.7.8 Sample Computation (Radiated Emission)

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.

2.7.10 Test Results Below 1GHz (Band 12 Worst Case Configuration)

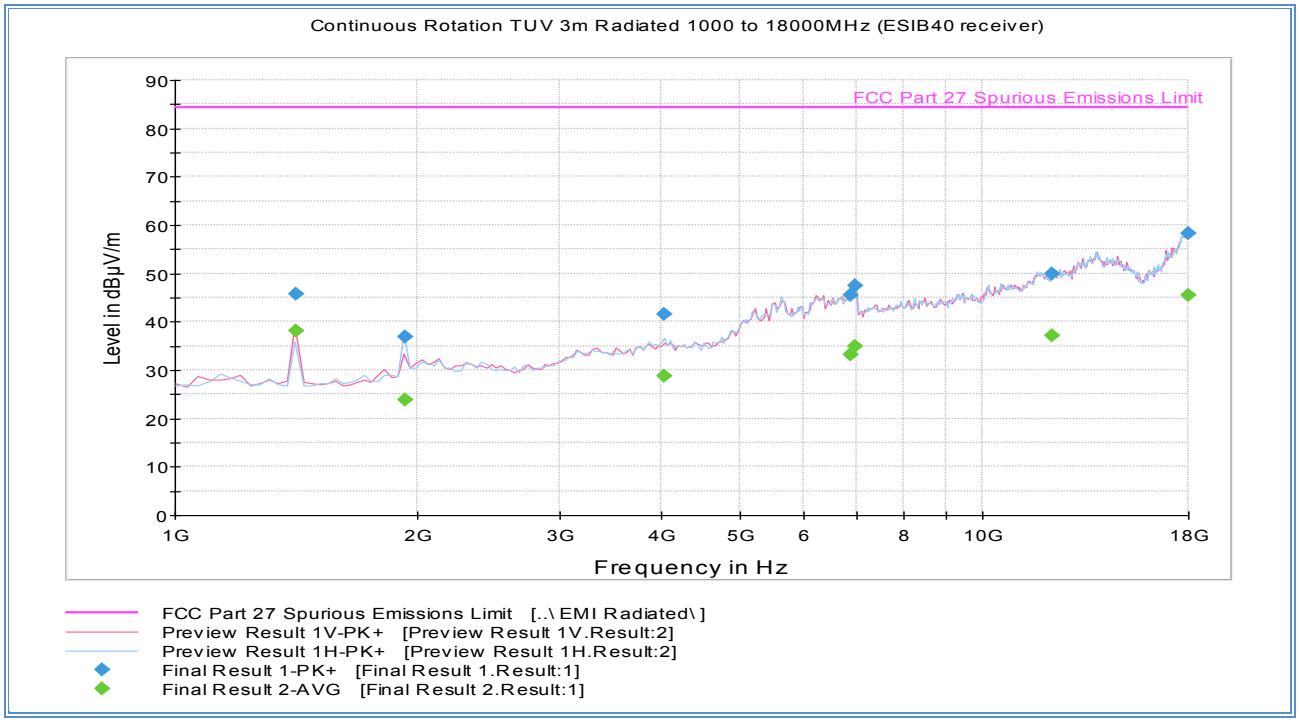


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.240000	17.2	1000.0	120.000	213.0	H	15.0	-6.1	67.2	84.4
40.607214	10.4	1000.0	120.000	116.0	V	77.0	-12.6	74.0	84.4
71.021643	12.5	1000.0	120.000	100.0	V	37.0	-16.9	71.9	84.4
87.636633	9.6	1000.0	120.000	100.0	V	29.0	-16.3	74.8	84.4
620.981884	27.7	1000.0	120.000	100.0	V	4.0	1.5	56.7	84.4
794.651784	32.2	1000.0	120.000	115.0	V	15.0	3.9	52.2	84.4

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

2.7.11 Test Results Above 1GHz (Band 12 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)
1414.917635	45.8	1000.0	1000.000	343.0	V	82.0	-7.9	38.6	84.4
1924.539679	36.8	1000.0	1000.000	388.0	H	78.0	-4.9	47.6	84.4
4034.964128	41.7	1000.0	1000.000	389.0	H	139.0	2.6	42.7	84.4
6861.819439	45.6	1000.0	1000.000	302.0	V	96.0	7.8	38.8	84.4
6959.223848	47.5	1000.0	1000.000	250.0	V	11.0	8.5	36.9	84.4
12208.516834	49.9	1000.0	1000.000	150.0	V	20.0	16.1	34.5	84.4
17998.900000	58.3	1000.0	1000.000	250.0	V	87.0	28.1	26.1	84.4

Average Data

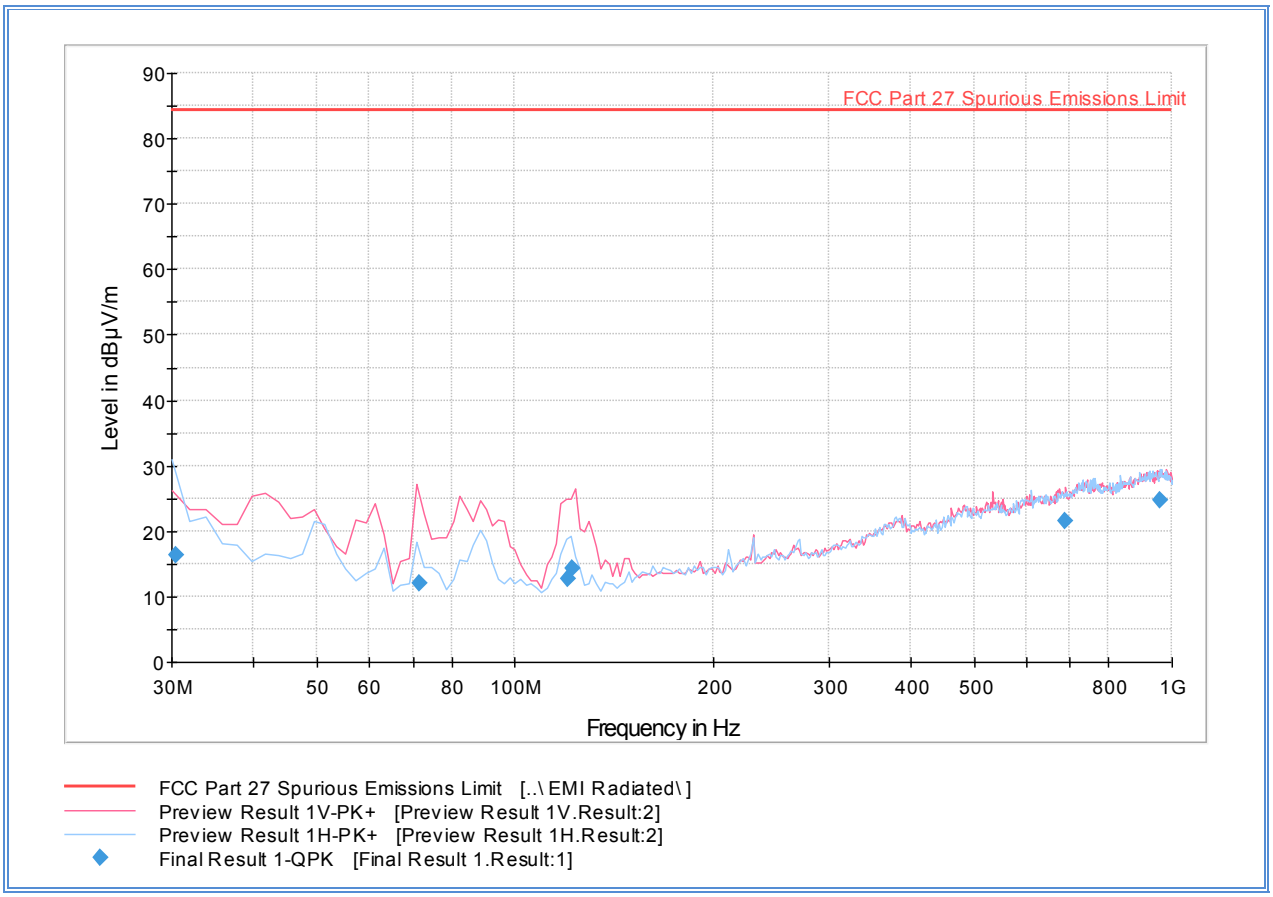
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1414.917635	38.0	1000.0	1000.000	343.0	V	82.0	-7.9	46.4	84.4
1924.539679	23.9	1000.0	1000.000	388.0	H	78.0	-4.9	60.5	84.4
4034.964128	28.9	1000.0	1000.000	389.0	H	139.0	2.6	55.5	84.4
6861.819439	33.2	1000.0	1000.000	302.0	V	96.0	7.8	51.2	84.4
6959.223848	34.8	1000.0	1000.000	250.0	V	11.0	8.5	49.6	84.4
12208.516834	37.2	1000.0	1000.000	150.0	V	20.0	16.1	47.2	84.4
17998.900000	45.5	1000.0	1000.000	250.0	V	87.0	28.1	38.9	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).

2.7.12 Test Results Below 1GHz (Band 4 Worst Case Configuration)

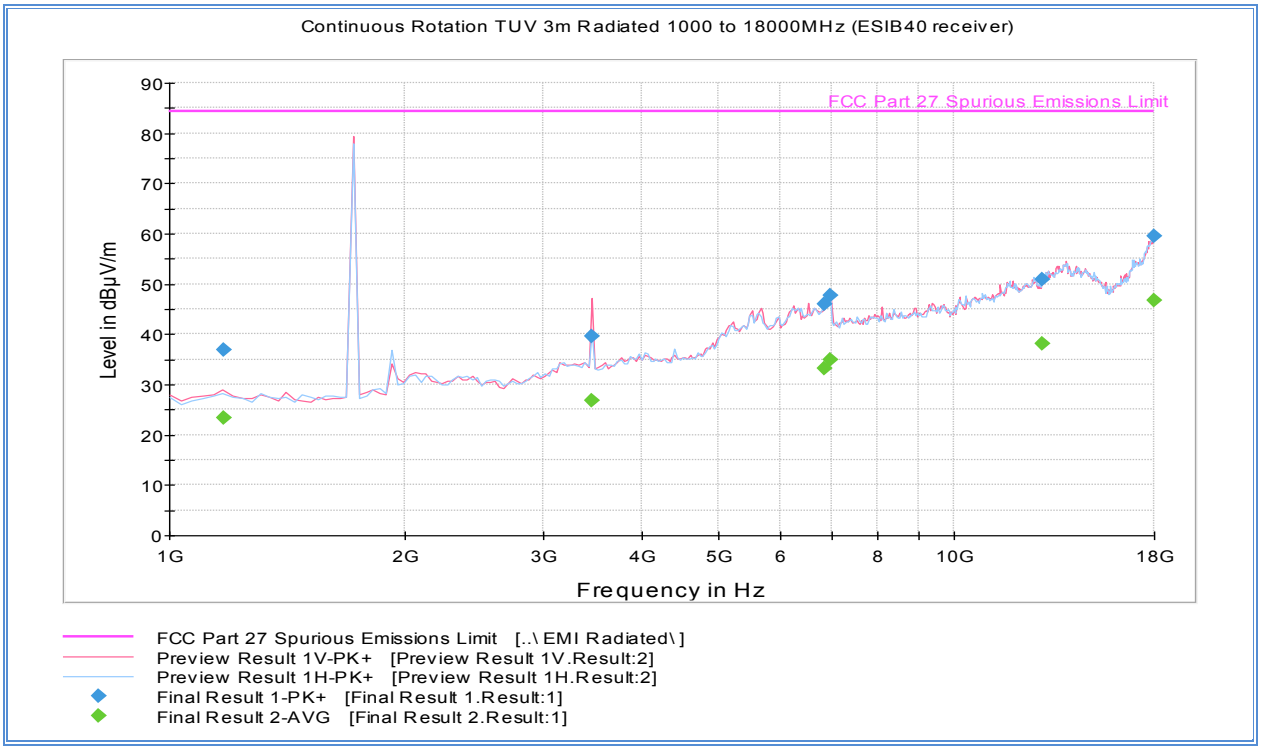


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.440000	16.4	1000.0	120.000	214.0	H	18.0	-6.2	68.0	84.4
71.341643	12.0	1000.0	120.000	100.0	V	25.0	-16.9	72.4	84.4
120.498838	12.8	1000.0	120.000	100.0	V	19.0	-15.8	71.6	84.4
122.466613	14.3	1000.0	120.000	105.0	V	13.0	-15.9	70.1	84.4
688.657956	21.5	1000.0	120.000	155.0	V	15.0	2.6	62.9	84.4
959.098357	24.7	1000.0	120.000	100.0	H	151.0	6.4	59.7	84.4

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

2.7.13 Test Results Above 1GHz (Band 4 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)
1170.840681	37.0	1000.0	1000.000	100.0	V	135.0	-8.3	47.4	84.4
3455.205812	39.7	1000.0	1000.000	328.0	V	19.0	-0.2	44.7	84.4
6852.619439	45.9	1000.0	1000.000	200.0	H	296.0	7.8	38.5	84.4
6958.423848	47.7	1000.0	1000.000	350.0	V	74.0	8.5	36.7	84.4
12957.215832	51.0	1000.0	1000.000	138.0	V	257.0	17.3	33.4	84.4
17996.100000	59.5	1000.0	1000.000	400.0	V	60.0	28.1	24.9	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)
1170.840681	23.4	1000.0	1000.000	100.0	V	135.0	-8.3	61.0	84.4
3455.205812	26.7	1000.0	1000.000	328.0	V	19.0	-0.2	57.7	84.4
6852.619439	33.3	1000.0	1000.000	200.0	H	296.0	7.8	51.1	84.4
6958.423848	34.9	1000.0	1000.000	350.0	V	74.0	8.5	49.5	84.4
12957.215832	38.0	1000.0	1000.000	138.0	V	257.0	17.3	46.4	84.4
17996.100000	46.6	1000.0	1000.000	400.0	V	60.0	28.1	37.8	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 27, Clause 27.54
RSS-130, Clause 4.3
RSS-139, Clause 6.4

2.8.2 Standard Applicable

FCC 47 CFR Part 27, Clause 27.54
The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

RSS-130, Clause 4.3
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 of 1% of the occupied bandwidth, a reference point 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 f_L and f_H respectively.

The applicant shall ensure frequency stability by showing that f_L minus the frequency offset and f_H plus the frequency offset shall be within the frequency range in which the equipment is designed to operate.

RSS-139, Clause 6.4
The frequency stability shall be sufficient to ensure that the occupied bandwidth stays within the operating frequency block when tested to the temperature and supply voltage variations specified in RSS-Gen.

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.
- Voltage variation was also performed at 85% and 115% of the nominal voltage.
- Frequency offsets were calculated based from the reference carrier @ 20°C nominal voltage.
- Once the worst case frequency offset was determined, the offset was applied to FL and FH to verify compliance.
- FL and FH are 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.
- Frequency stability compliance is determined by showing that fL minus the frequency offset and fH plus the frequency offset is within the frequency range in which the equipment is designed to operate.

2.8.8 Sample Calculations (LTE Band 4)

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

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

$$= \frac{1731.9561\ \text{MHz} + 1733.0403\ \text{MHz}}{2}$$
$$= 1732.4982\ \text{MHz}$$

Reference Center Frequency @ 50°C: $= \frac{1731.9453\ \text{MHz} + 1733.0289\ \text{MHz}}{2}$

$= 1732.4871\ \text{MHz}$

Therefore Frequency Deviation: $= 1732.4982\ \text{MHz} - 1732.4871\ \text{MHz}$

$= -0.0111\ \text{MHz}$

Reference F_L @ 20°C: 1710.067 MHz (based from Low Channel lower edge 99% OBW)
Reference F_H @ 20°C: 1754.904 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 =1710.067 MHz – 0.0111 MHz
= 1710.0559 MHz (within the 1710 MHz – 1755 MHz Band, complies)

F_H =1754.904 MHz + 0.0111 MHz
= 1754.9151 MHz (within the 1710 MHz – 1755 MHz Band, complies)

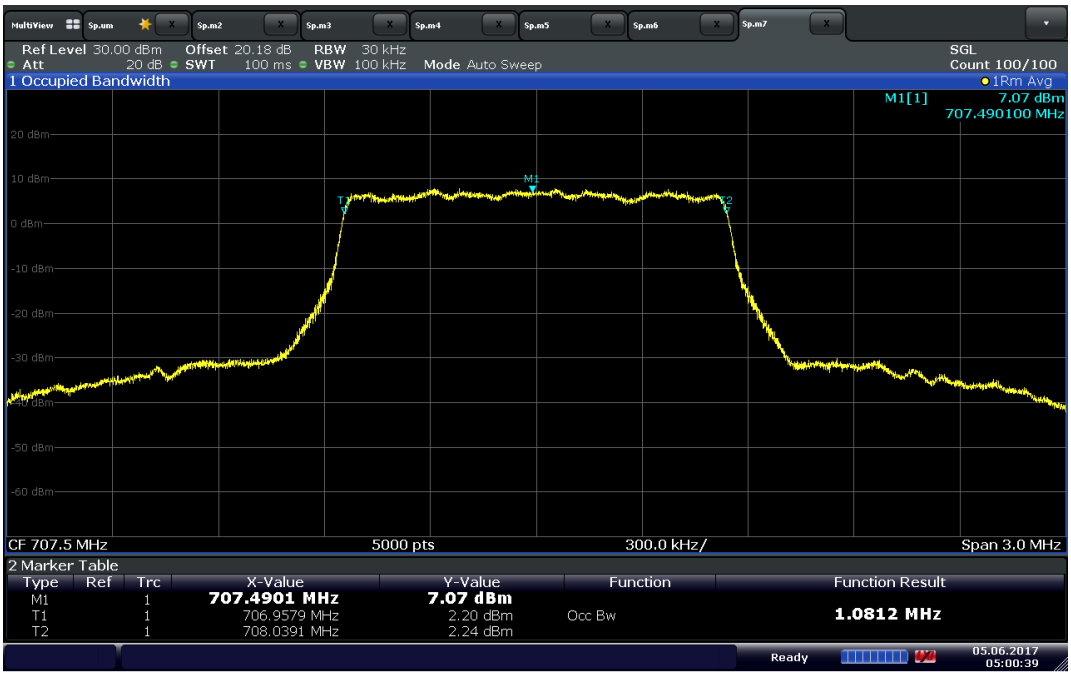
2.8.9 Frequency Offsets Summary

LTE Band 12				
Temperature	***F_L/T_1 (MHz)***	***F_H/T_2 (MHz)***	***Center Frequency (MHz)***	***Frequency Deviation (MHz)***
50°C	706.9579	708.0391	707.4985	-0.001800
40°C	706.957	708.0380	707.4975	-0.000800
30°C	706.9565	708.0375	707.497	-0.000300
20°C (+15% NV)	706.9561	708.0373	707.4967	0.000000
20°C (NV)	706.9561	708.0373	707.4967	0.000000
20°C (-15% NV)	706.9561	708.0373	707.4967	0.000000
10°C	706.9565	708.0375	707.497	-0.000300
0°C	706.9572	708.0385	707.49785	-0.001150
-10°C	706.9577	708.0380	707.49785	-0.001150
-20°C	706.9561	708.0370	707.49655	0.000150
-30°C	706.9561	708.0373	707.4967	0.000000

LTE Band 4				
Temperature	***F_L/T_1 (MHz)***	***F_H/T_2 (MHz)***	***Center Frequency (MHz)***	***Frequency Deviation (MHz)***
50°C	1731.9453	1733.0289	1732.4871	0.011100
40°C	1731.946	1733.0412	1732.4936	0.004600
30°C	1731.951	1733.0422	1732.4966	0.001600
20°C (+15% NV)	1731.9561	1733.0403	1732.4982	0.000000
20°C (NV)	1731.9561	1733.0403	1732.4982	0.000000
20°C (-15% NV)	1731.9561	1733.0403	1732.4982	0.000000
10°C	1731.9561	1733.0382	1732.49715	0.001050
0°C	1731.962	1733.0394	1732.5007	-0.002500
-10°C	1731.958	1733.0365	1732.49725	0.000950
-20°C	1731.958	1733.0373	1732.49765	0.000550
-30°C	1731.9543	1733.0373	1732.4958	0.002400

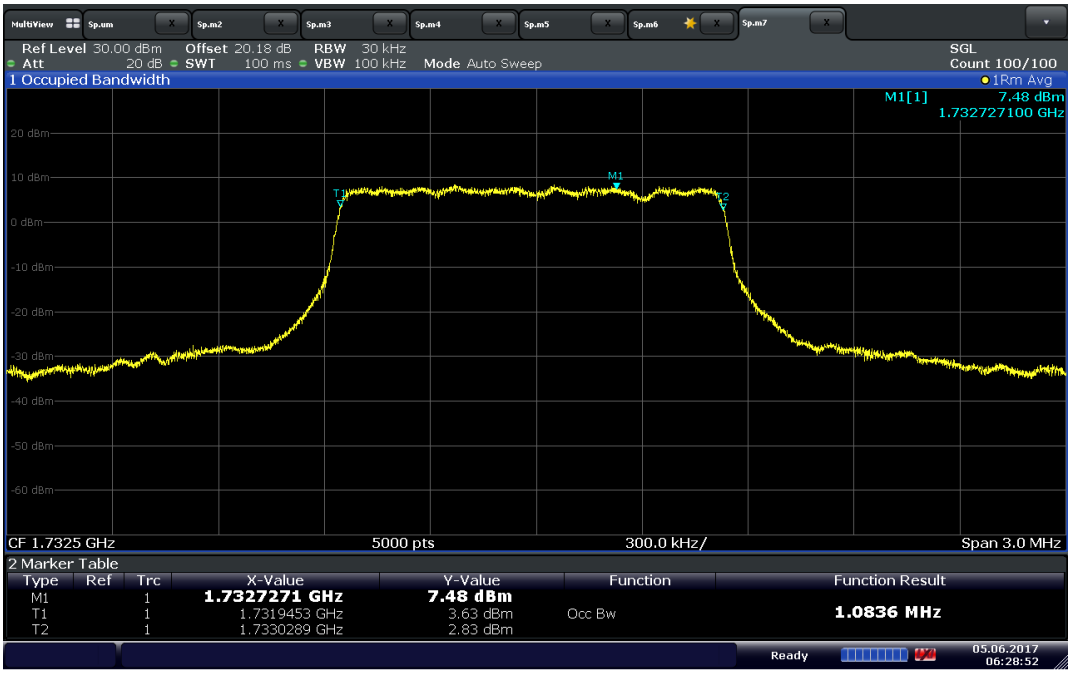
2.8.10 Frequency Offset Test Plots

LTE Band 12 @ 50°C



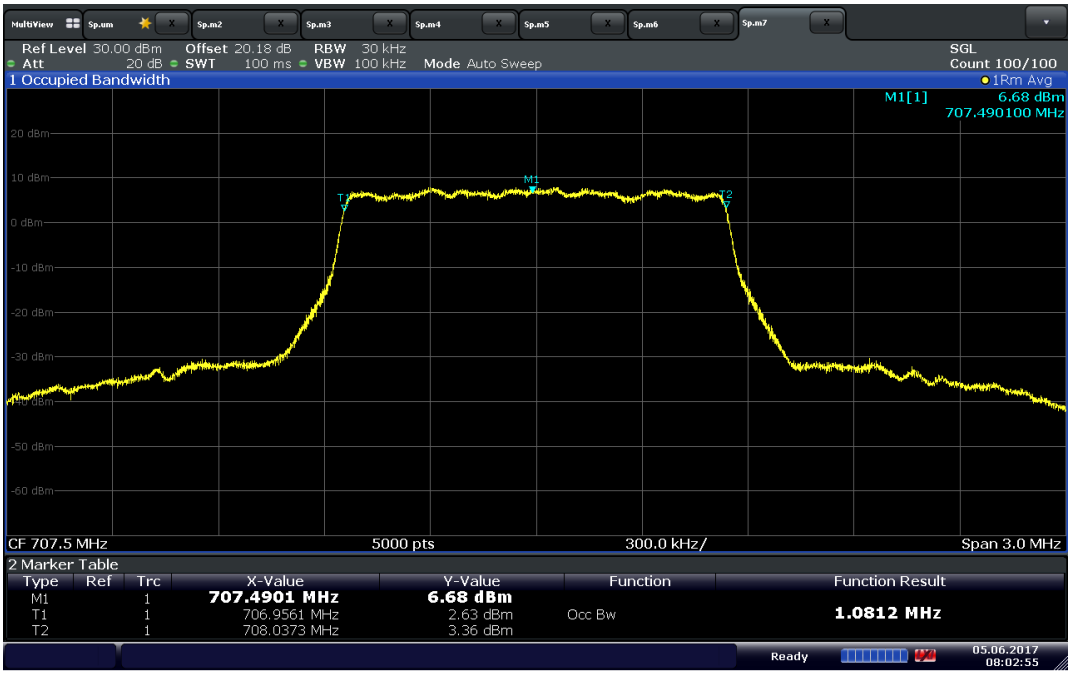
Date: 5.JUN.2017 05:00:39

LTE Band 4 @ 50°C



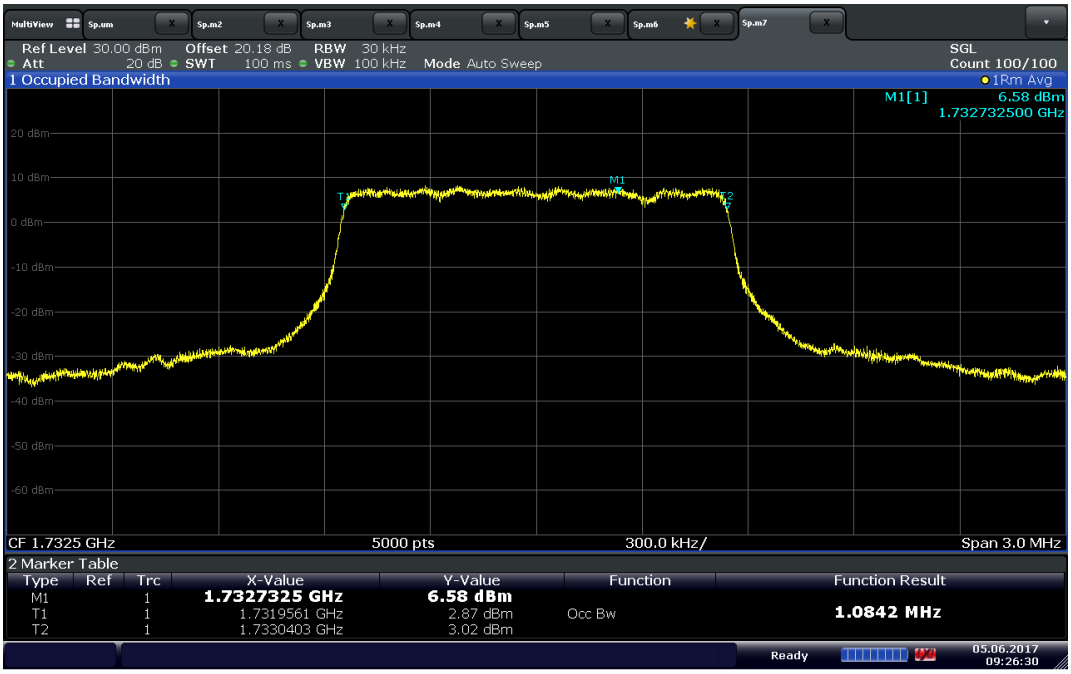
Date: 5.JUN.2017 06:28:52

LTE Band 12 @ 20°C



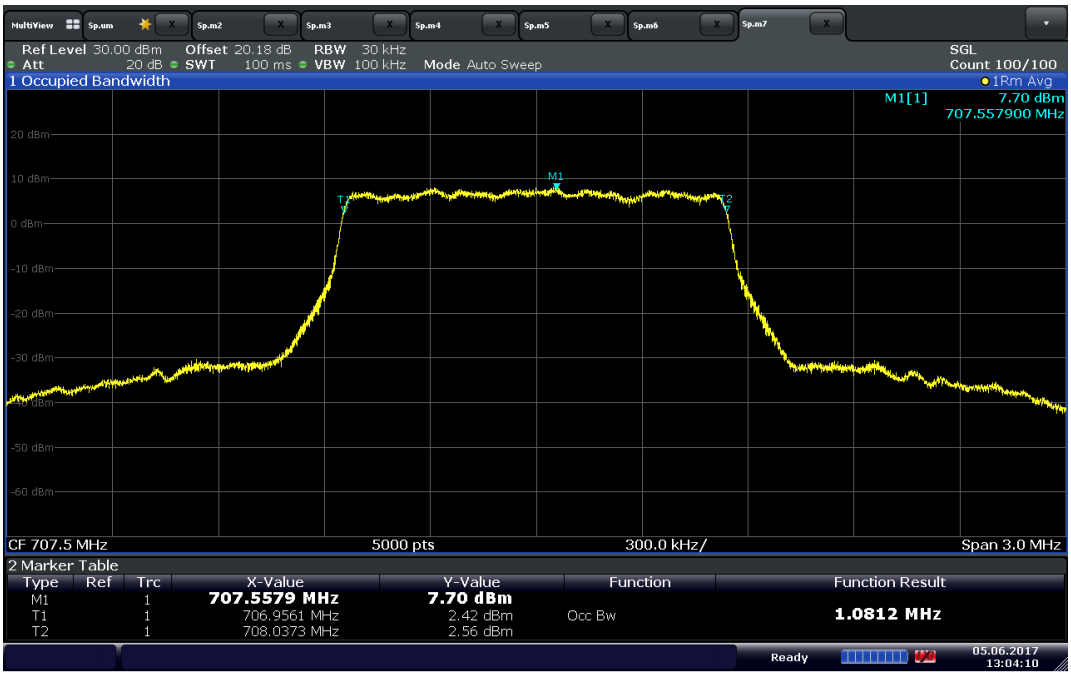
Date: 5.JUN.2017 08:02:55

LTE Band 4 @ 20°C



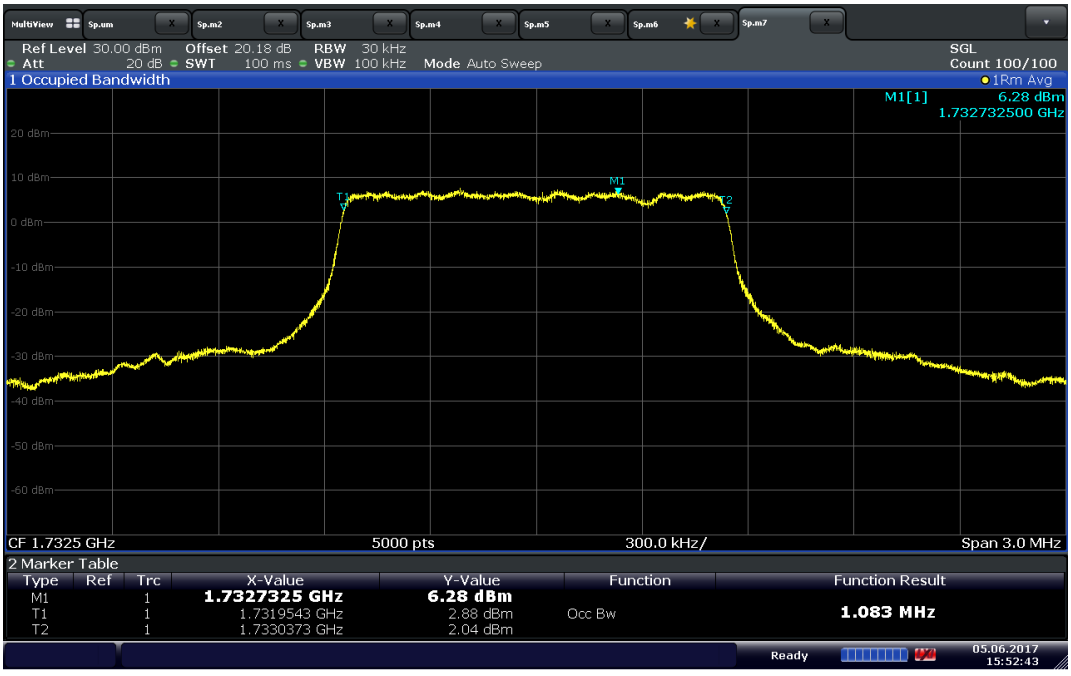
Date: 5.JUN.2017 09:26:30

LTE Band 12 @ -30°C



Date: 5.JUN.2017 13:04:10

LTE Band 4 @ -30°C



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2.9 POWER LINE CONDUCTED EMISSIONS

2.9.1 Specification Reference

RSS-Gen 8.8

2.9.2 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

* *The level decreases linearly with the logarithm of the frequency.*
** *A linear average detector is required.*

2.9.3 Equipment Under Test and Modification State

Serial No: 357591080022319/ Default Test Configuration

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

May 24, 2017/FSC

2.9.5 Test Equipment Used

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

2.9.6 Environmental Conditions

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

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

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2.9.7 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 2.9.8 for sample computation.

2.9.8 Sample Computation (Conducted Emission – Quasi Peak)

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

2.9.9 Test Results

Compliant. See attached plots and tables.

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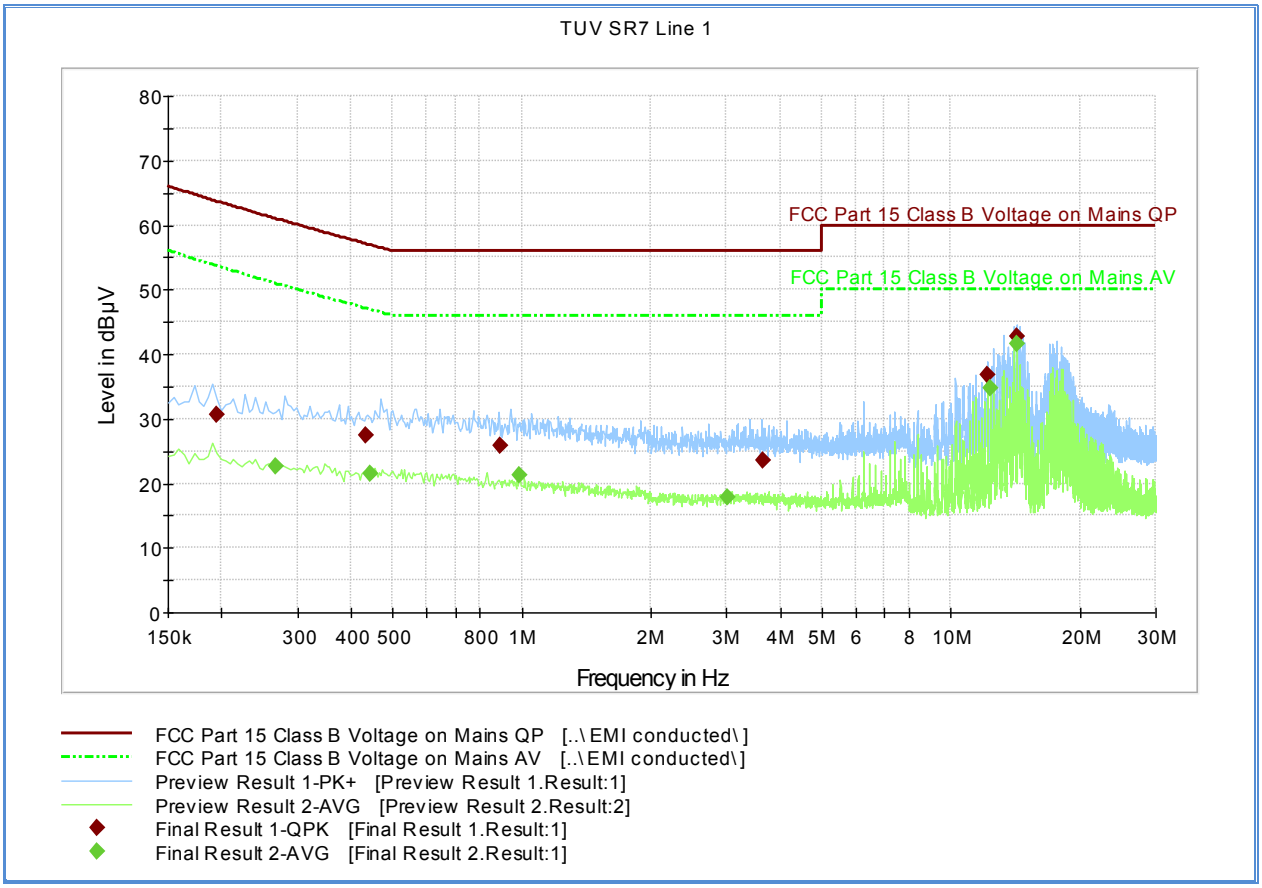
2.9.10 Test Results - Conducted Emissions Line 1



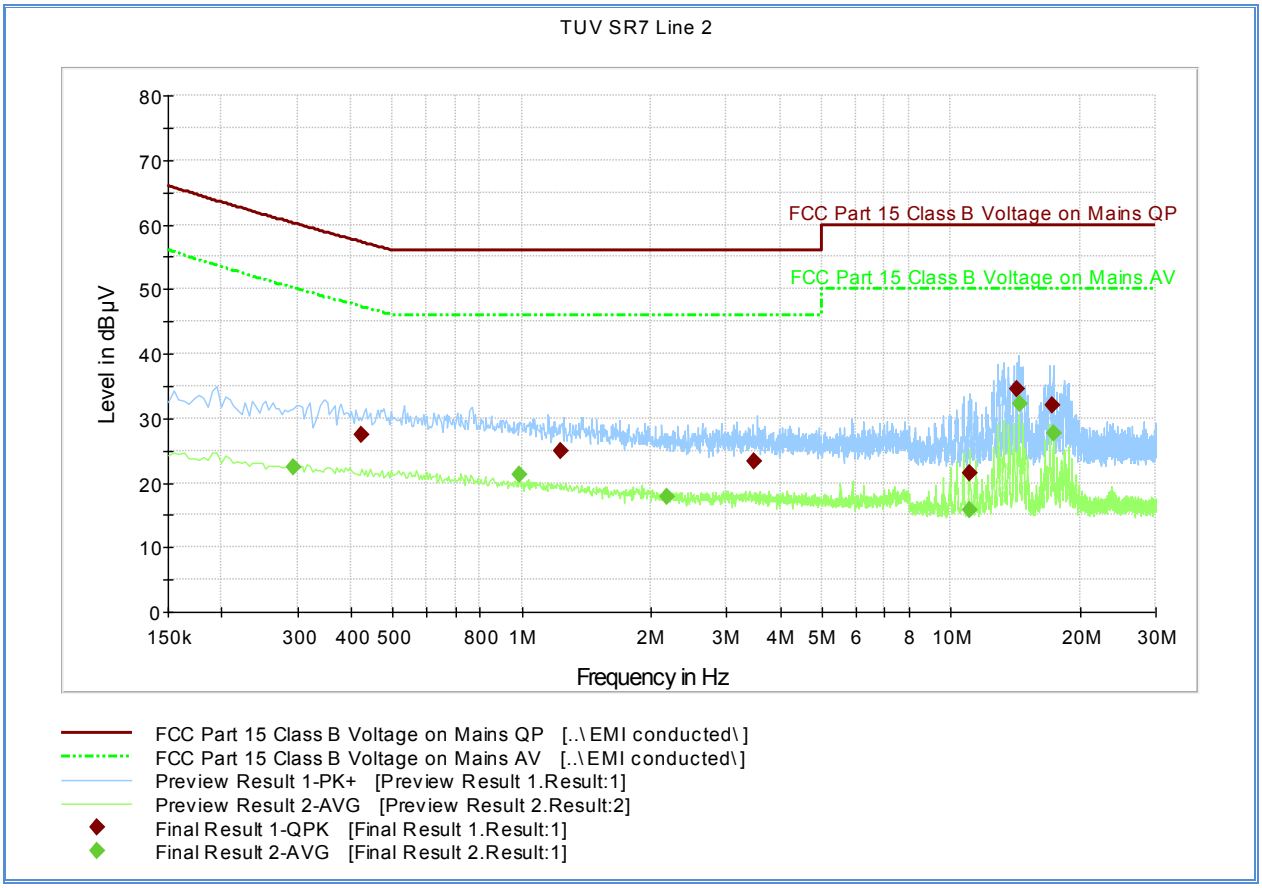
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.195000	30.6	1000.0	9.000	Off	L1	20.1	33.1	63.7
0.433500	27.3	1000.0	9.000	Off	L1	20.0	29.8	57.1
0.892500	25.8	1000.0	9.000	Off	L1	20.0	30.2	56.0
3.651000	23.6	1000.0	9.000	Off	L1	20.1	32.4	56.0
12.165000	36.9	1000.0	9.000	Off	L1	20.2	23.1	60.0
14.253000	42.8	1000.0	9.000	Off	L1	20.3	17.2	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.267000	22.6	1000.0	9.000	Off	L1	20.0	28.4	51.0
0.442500	21.6	1000.0	9.000	Off	L1	20.0	25.4	46.9
0.987000	21.3	1000.0	9.000	Off	L1	20.0	24.7	46.0
3.021000	17.7	1000.0	9.000	Off	L1	20.1	28.3	46.0
12.349500	34.7	1000.0	9.000	Off	L1	20.2	15.3	50.0
14.253000	41.5	1000.0	9.000	Off	L1	20.3	8.5	50.0

2.9.11 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)
0.424500	27.4	1000.0	9.000	Off	N	20.0	29.8	57.3
1.234500	25.0	1000.0	9.000	Off	N	20.0	31.0	56.0
3.475500	23.4	1000.0	9.000	Off	N	20.1	32.6	56.0
11.044500	21.4	1000.0	9.000	Off	N	20.2	38.6	60.0
14.298000	34.5	1000.0	9.000	Off	N	20.2	25.5	60.0
17.295000	31.9	1000.0	9.000	Off	N	20.3	28.1	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.294000	22.4	1000.0	9.000	Off	N	20.0	27.7	50.2
0.987000	21.2	1000.0	9.000	Off	N	20.0	24.8	46.0
2.184000	17.7	1000.0	9.000	Off	N	20.1	28.3	46.0
11.076000	15.8	1000.0	9.000	Off	N	20.2	34.2	50.0
14.437500	32.3	1000.0	9.000	Off	N	20.2	17.7	50.0
17.313000	27.6	1000.0	9.000	Off	N	20.4	22.4	50.0

SECTION 3

TEST EQUIPMENT USED

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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

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SECTION 4

DIAGRAM OF TEST SETUP

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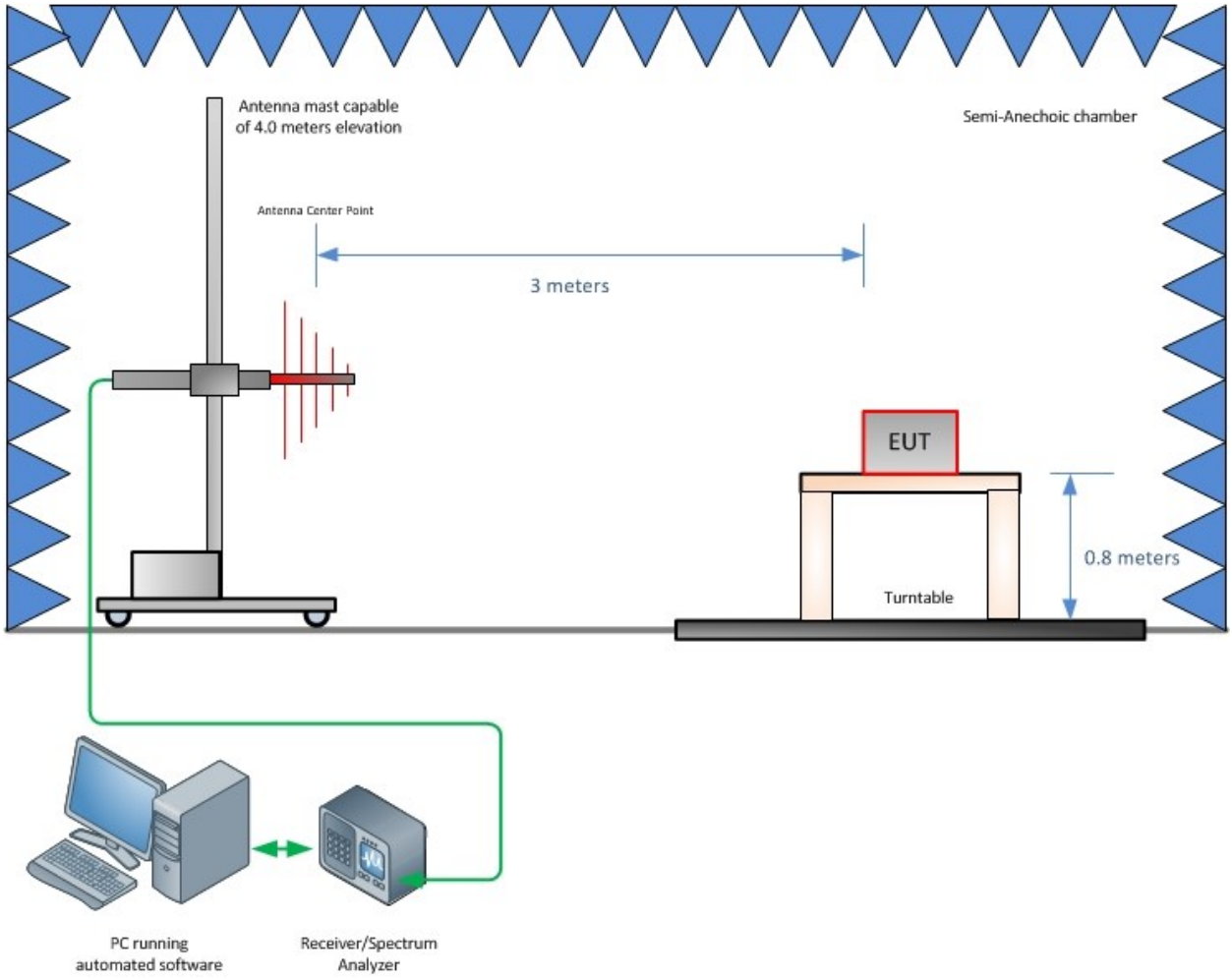
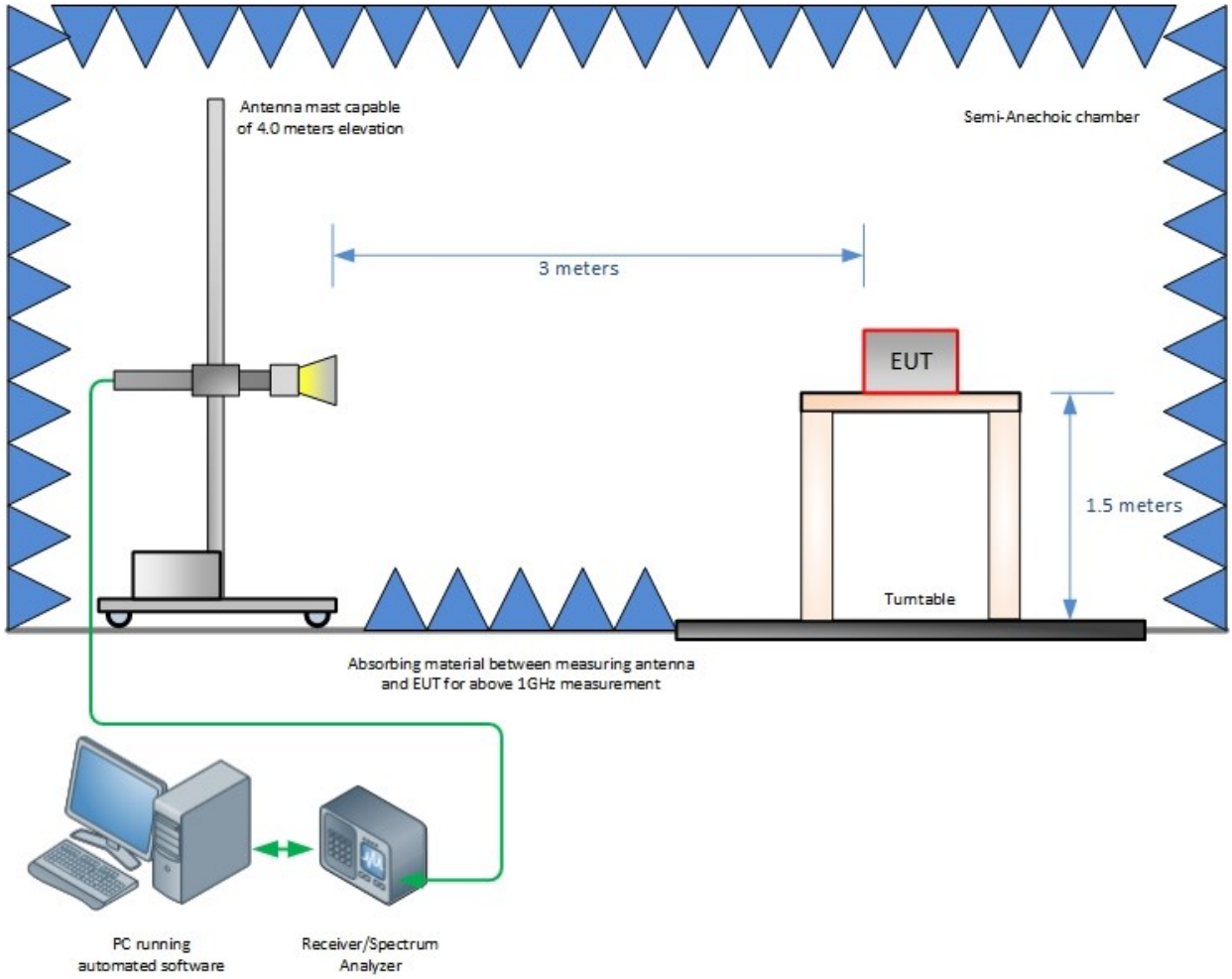
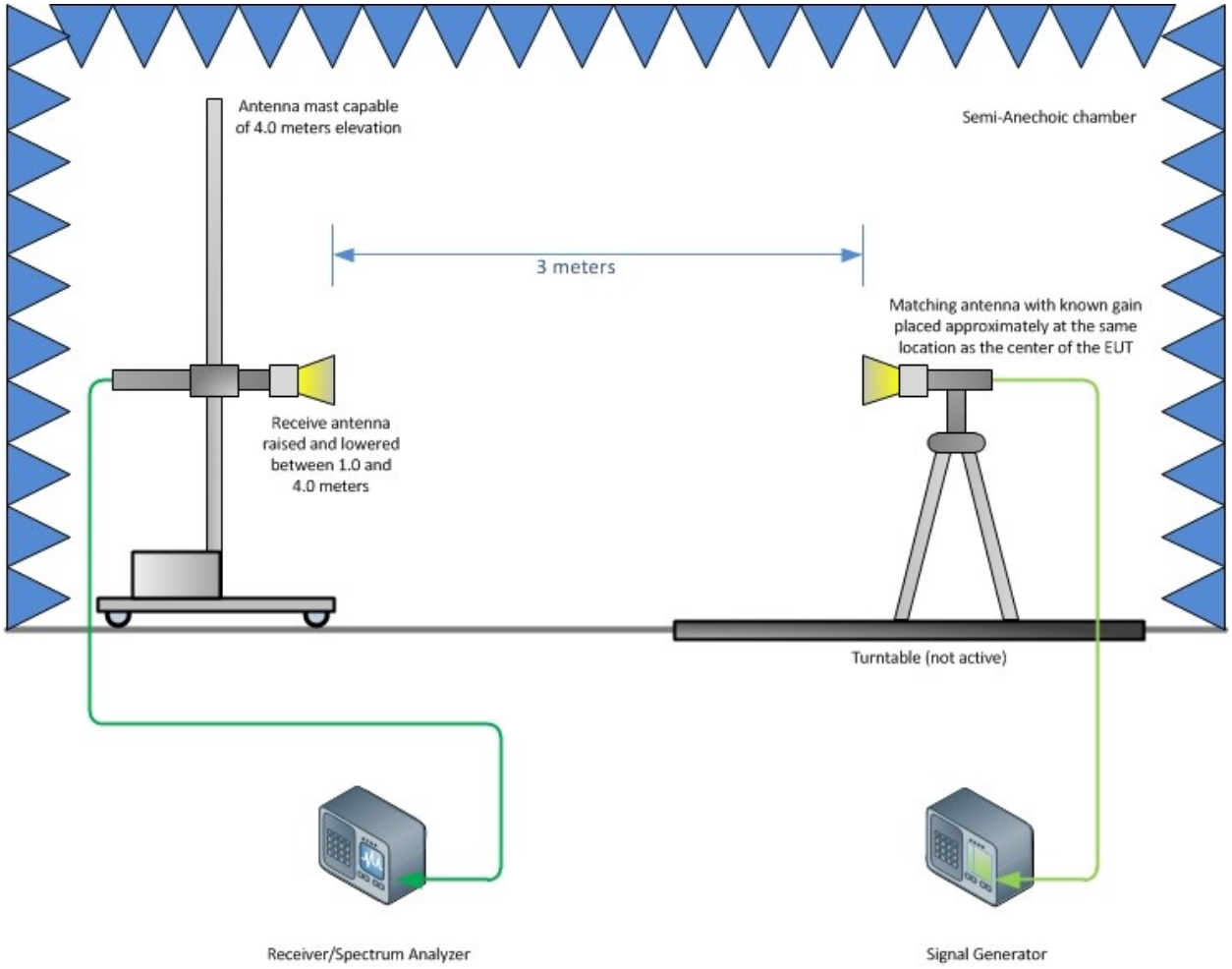
4.1 TEST SETUP DIAGRAM



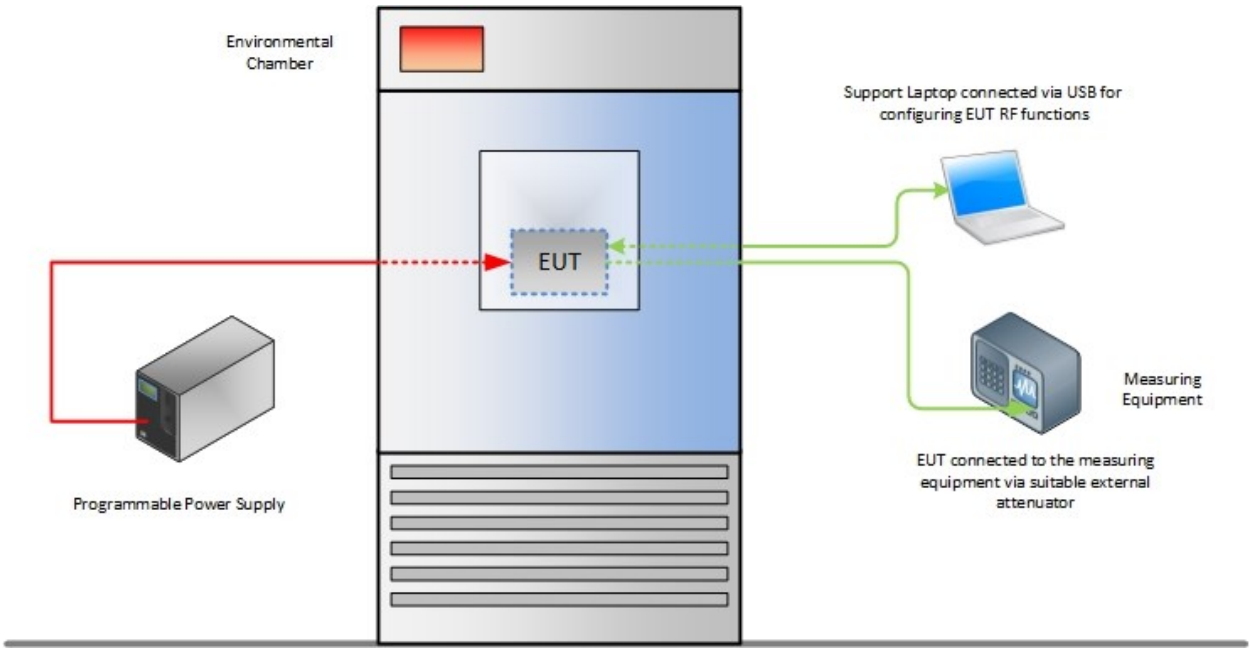
Radiated Emission Test Setup (Below 1GHz)



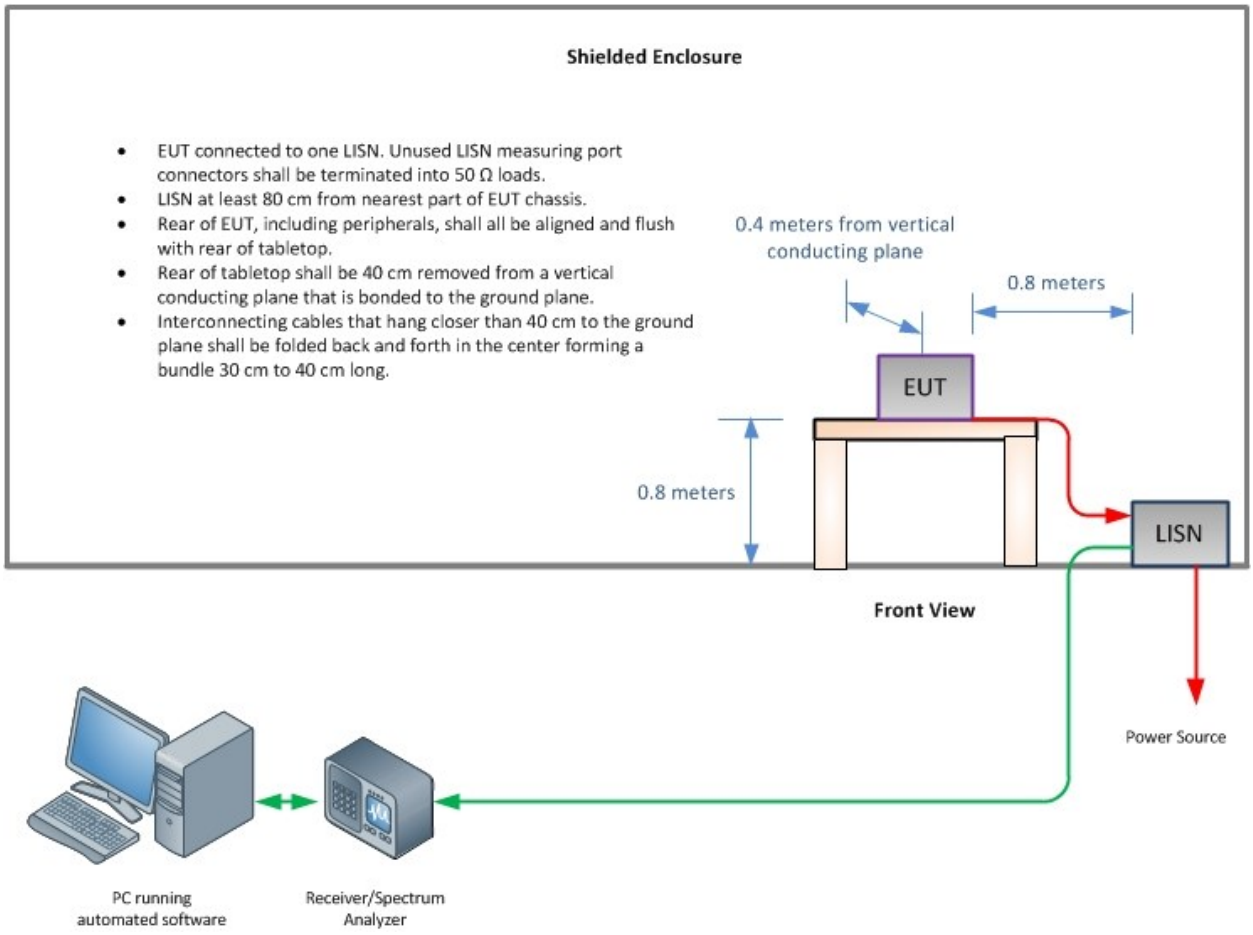
Radiated Emission Test Setup (Above 1GHz)



Substitution Test Method (Above 1GHz, if applicable)



Frequency Stability Test Configuration



Conducted Emissions Test Configuration (if applicable)

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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