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Report On

Application for Grant of Equipment Authorization of the
Novatel Wireless
MC730 USB Modem

FCC CFR 47 Part 2 and 27
ISED RSS-Gen, RSS-130 and RSS-139

Report No. SD72123529-0117B **April 2017**

REPORT ON	Radio Testing of the Novatel Wireless USB Modem
TEST REPORT NUMBER	SD72123529-0117B
PREPARED FOR	Novatel Wireless 9605 Scranton Rd., Suite 300 San Diego, CA 92121
CONTACT PERSON	Roman Olmos Senior Regulatory Engineer (858) 320-8837 rolmos@nvtl.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	April 10, 2017

Revision History

SD72123529-0117B Novatel Wireless USB730L USB Modem					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
04/10/2017	Initial Release				Juan M Gonzalez

CONTENTS

SECTION 1

REPORT SUMMARY

Radio Testing of the
Novatel Wireless
MC730 USB Modem

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Novatel Wireless USB Modem to the requirements of the following:

- 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	Novatel Wireless
Product Marketing Name	USB730L
Model Number(s)	MC730
FCC ID	3229A-MC730
IC Number	PKRNVWMC730
Serial Number(s)	1073-0319 and 1073-0286
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	February 15, 2017
Finish of Test	March 14, 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. • MC730_Tune Up Procedure_NA_Rev1.0.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 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		
2.1	2.1046	27.50 (b)(10)		Transmitter Conducted Output Power	Compliant
2.2	-	27.50 (b)(10) and (d)(4)	RSS-130 4.4 RSS-139 6.5	Equivalent Isotropic Radiated Power	Compliant
			-	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)	RSS-130 4.4 RSS-139 6.5	Peak-Average Ratio	Compliant
2.5	2.1051	27.53 (c)(2) and (5), (h)(1) and (3)(i)	RSS-130 4.6.1 RSS-139 6.6	Band Edge	Compliant
2.6	2.1051	27.53 (c)(1),(2),(4),(5),(6) and (f), (h)(1),(2) and (3)(i)	RSS-130 4.6 RSS-139 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	RSS-130 4.3 RSS-139 6.4	Frequency Stability	Compliant
2.9	-	-	RSS-Gen 7.0	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.*

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a Novatel Wireless MC730 USB730L USB Modem as shown in the photograph below. The EUT supports 2G, 3G and 4G technologies.

Equipment Under Test

1.3.2 EUT General Description

EUT Description	USB Modem
Model Number(s)	MC730
Rated Voltage	5 ±0.25 VDC (USB)
Mode Verified	LTE Band 4 and 13

Capability

LTE	Band 2, 4, 5 and 13
CDMA 1xRTT	BC0 and BC1
1xEvDO	BC0 and BC1
GPRS	850 and 1900
EGPRS	850 and 1900
WCDMA/HSPA	Band 2 and 5

Primary Unit (EUT)

☐ Production

☒ Pre-Production

Antenna Type	Monopole
Manufacturer	NVTL
Part Number	12023208

Antenna Gain

Band Class	Frequency Band	Reference Frequency	Antenna Gain
LTE B13	700MHz	780MHz	0.83 dBi
LTE B4	1700Mhz	1720MHz	1.21 dBi

1.3.3 Transmit Frequency Table

Technology / Mode	Modulation	Bandwidth (MHz)	Tx Frequency (MHz)	Emission Designator	Max. Conducted Power (dBm)	Calculated Power (dBm)
LTE Band 4	QPSK	1.4	Bandwidth not supported by the carrier			
		3				
		5	1710-1755	4M51G7D	23.0	24.21 EIRP
		10	1710-1755	8M97G7D	23.0	24.21 EIRP
		15	1710-1755	13M4G7D	23.0	24.21 EIRP
		20	1710-1755	17M9G7D	23.0	24.21 EIRP
LTE Band 4	16QAM	1.4	Bandwidth not supported by the carrier			
		3				
		5	1710-1755	4M51W7D	23.0	24.21 EIRP
		10	1710-1755	8M97W7D	23.0	24.21 EIRP
		15	1710-1755	13M4W7D	23.0	24.21 EIRP
		20	1710-1755	17M9W7D	23.0	24.21 EIRP
LTE Band 13	QPSK	5	777-787	4M51G7D	24.0	22.68 ERP 24.83 EIRP
		10	777-787	8M96G7D	24.0	22.68 ERP 24.83 EIRP
	16QAM	5	777-787	4M51W7D	24.0	22.68 ERP 24.83 EIRP
		10	777-787	8M96W7D	24.0	22.68 ERP 24.83 EIRP

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1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Conducted antenna port measurement. The EUT has an optional external antenna port, this port was used for all antenna conducted port measurements.
B	Radiated test setup. Since the EUT is a computer peripheral, the test was performed with the integral antenna. This configuration also ensures connectivity with the call box.

1.4.2 EUT Exercise Software

EUT is controlled by a CMW 500 Wideband Radio Communication Tester. There are no other test software used during verification.

1.4.3 Support Equipment and I/O cables

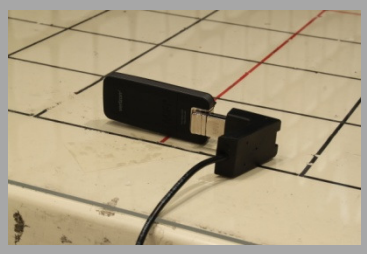
Manufacturer	Equipment/Cable	Description
DLink	USB Dock Stand	1.0 meter USB 2.0 extension dock stand cradle cable USB A to A male to female
htc	AC Adapter	Model TC U50 P/N79H00098-01M Output: 5VDC @1A (USB)
Rhode & Schwarz	Support Wideband Radio Communication Tester	M/N CMW500 S/N 1201.0002k50/103829
Lenovo	Support Laptop (T410S)	P/N 0A31972 S/N R9-92MH0 10/11 (used for AC Conducted Emissions test)
LiteOn Technology Corporation	AC Adapter for Support Laptop	Model 42T4430 S/N 11S42T4430Z1ZGWE27AA9X REV G (used for AC Conducted Emissions test)

1.4.4 EUT Worst Case Configuration

There is no specific worst-case configuration for the LTE device tested. However only the worst case test results are normally presented for each test case (e.g. worst case channel, worst case bandwidth or worst case modulation). Worst case configuration however was established for the settings of the call box (CMW500) used for establishing connection with the EUT and is summarized below:

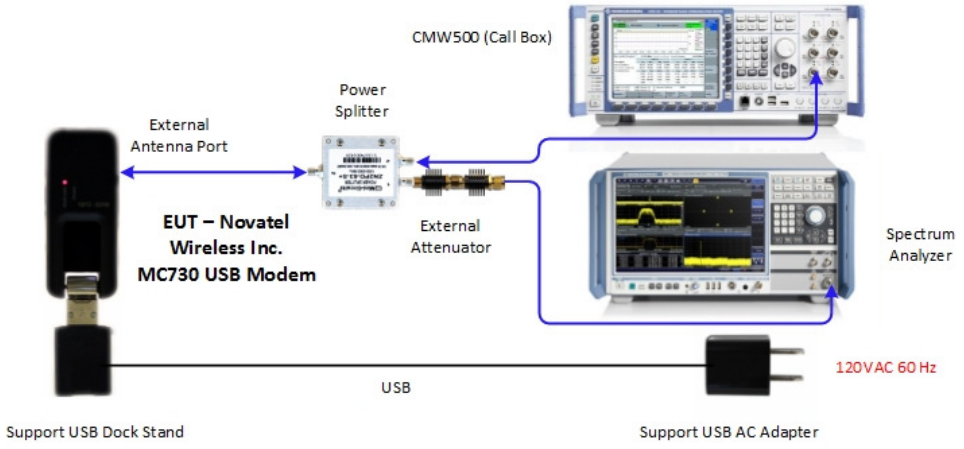
Mode	Configuration
LTE Band 4 and 13	Active TPC Setup is Max Power, scheduling is RMC

EUT is a computer peripheral. For radiated measurements X, Y and Z orientations were verified. Worst case transmit pattern was observed when EUT is in “Z” configuration. Verifications performed using “Z” configuration.

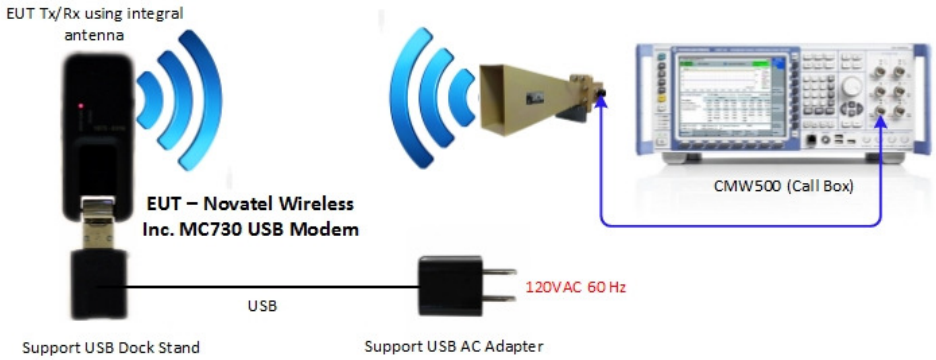
		
"X" Configuration	*"Y" Configuration*	*"Z" Configuration*

1.4.5 Simplified Test Configuration Diagram

Antenna Conducted Port Test Configuration



Radiated Emissions Test Configuration



For Illustration Purpose Only
Not to scale and images presented may not represent the actual EUT or support equipment

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 1073-0319 and 1073-0286		
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, 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

Emission Designator = 1M30F9W
F = Frequency Modulation
9= Composite Digital Info
W = Combination (Audio/Data)

1.10.2 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**

1.10.3 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

SECTION 2

TEST DETAILS

Radio Testing of the
Novatel Wireless
MC730 USB Modem

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)

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: 1073-0319 and 1073-0286 / Test Configuration A

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

February 15 to 17, 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	24.7 - 25.3 °C
Relative Humidity	41.2 – 44.5 %
ATM Pressure	99.1 – 99.9 kPa

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2.1.7 Additional Observations

- This is a conducted test using an average power meter.
- Please refer to Section 1.4.4 for details regarding call box connection configuration.
- The following correction factors were used as a power meter offset for the power splitter, external attenuator, RF Cable Assembly Path Loss (provided by the manufacturer) and cable used:

Frequency	Correction Factor
782 MHz	26.4 dB
1730 MHz	26.9 dB

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

2.1.8 Test Results

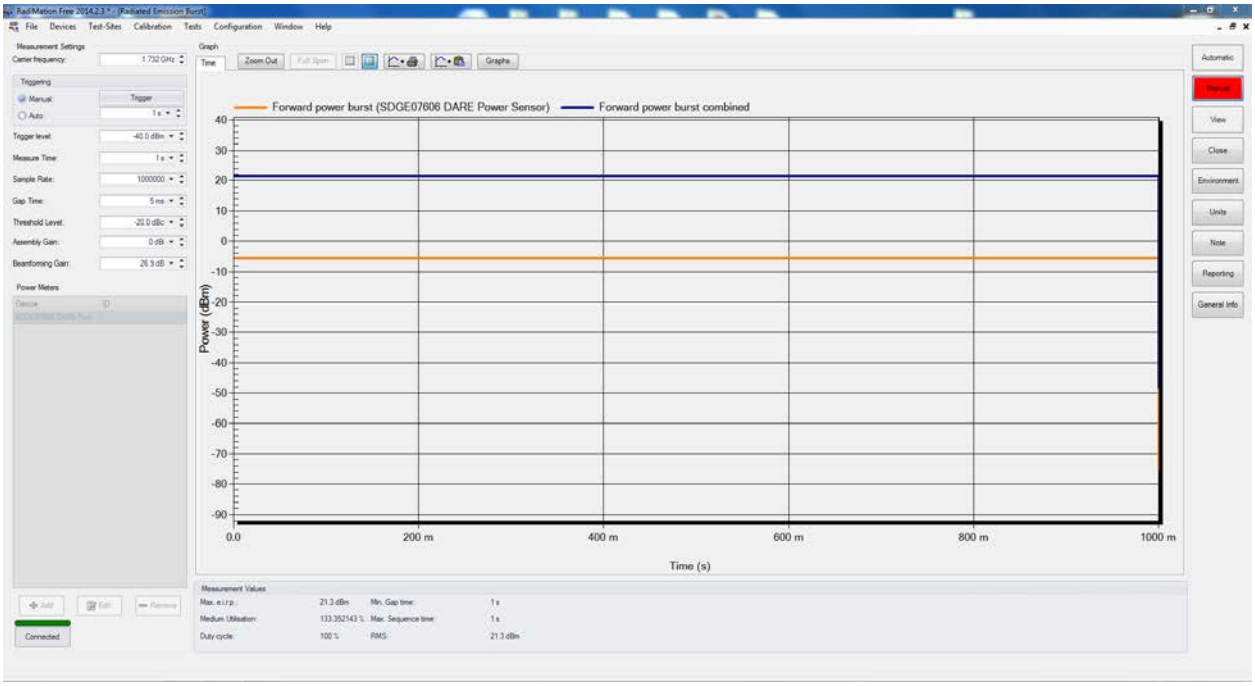
LTE Band 4						
Modulation	**Bandwidth**	**RB Size**	**RB Offset**	**Channels**	**Frequency**	**Tx Average (dBm)**
QPSK	1.4 MHz	1	0	19957	1710.7	22.5
		1	0	20175	1732.5	22.4
		1	0	20393	1754.3	22.7
	3 MHz	1	0	19965	1711.5	22.7
		1	0	20175	1732.5	22.5
		1	0	20385	1753.5	22.8
	5 MHz	1	0	19975	1712.5	22.6
		1	0	20175	1732.5	22.6
		1	0	20375	1752.5	22.8
	10 MHz	1	0	20000	1715.0	22.6
		1	0	20175	1732.5	22.6
		1	0	20350	1750.0	22.9
	15 MHz	1	0	20025	1717.5	22.2
		1	0	20175	1732.5	22.0
		1	0	20325	1747.5	22.4
	20 MHz	1	0	20050	1720.0	22.4
		1	0	20175	1732.5	22.4
		1	0	20300	1745.0	22.5

LTE Band 4						
Modulation	Bandwidth	RB Size	RB Offset	Channels	Frequency	Tx Average (dBm)
16QAM	1.4 MHz	1	0	19957	1710.7	21.6
		1	0	20175	1732.5	21.4
		1	0	20393	1754.3	21.6
	3 MHz	1	0	19965	1711.5	21.7
		1	0	20175	1732.5	21.6
		1	0	20385	1753.5	21.7
	5 MHz	1	0	19975	1712.5	21.9
		1	0	20175	1732.5	21.7
		1	0	20375	1752.5	21.9
	10 MHz	1	0	20000	1715.0	21.8
		1	0	20175	1732.5	21.7
		1	0	20350	1750.0	22.0
	15 MHz	1	0	20025	1717.5	21.4
		1	0	20175	1732.5	21.3
		1	0	20325	1747.5	21.3
	20 MHz	1	0	20050	1720.0	21.5
		1	0	20175	1732.5	21.6
		1	0	20300	1745.0	21.6

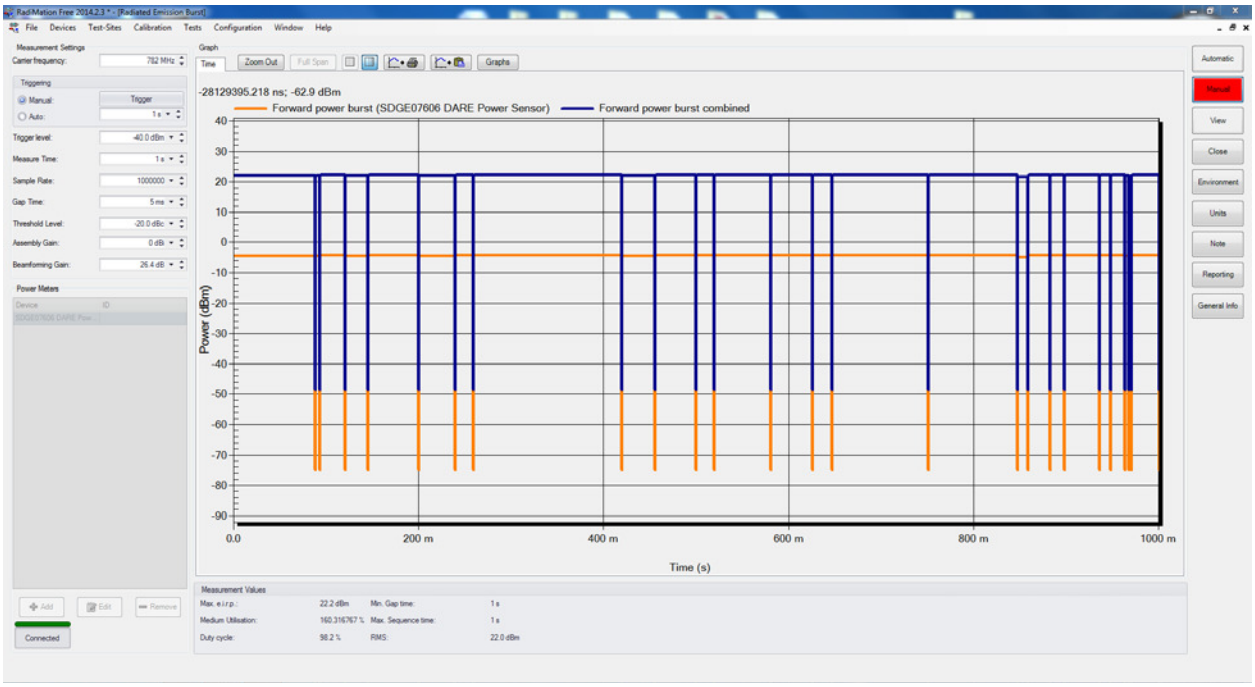
LTE Band 13						
Modulation	Bandwidth	RB Size	RB Offset	Channels	Frequency	Tx Average (dBm)
QPSK	5 MHz	1	0	23205	779.5	22.8
		1	0	23230	782.0	22.6
		1	0	23255	784.5	22.6
	10 MHz	-	-	-	-	-
		1	0	23230	782.0	22.8
		-	-	-	-	-

LTE Band 13						
Modulation	**Bandwidth**	**RB Size**	**RB Offset**	**Channels**	**Frequency**	**Tx Average (dBm)**
16QAM	5 MHz	1	0	23205	779.5	22.2
		1	0	23230	782.0	21.9
		1	0	23255	784.5	21.8
	10 MHz	-	-	-	-	
		1	0	23230	782.0	22
		-	-	-	-	-

2.1.9 Sample Test Plot



LTE Band 4 15MHz BW Mid Channel (16-QAM)



LTE Band 13 5MHz BW Low Channel (QPSK)

2.2 RADIATED POWER

2.2.1 Specification Reference

FCC 47 CFR Part 27, Clause 27.50 (b)(10)
FCC 47 CFR Part 27, Clause 27.50 (d)(4)
RSS-130, Clause 4.4
RSS-139, Clause 6.5

2.2.2 Standard Applicable

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.

FCC 47 CFR Part 27, Clause 27.50 (d)(4)
(d) The following power and antenna height requirements apply to stations transmitting 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 MHz bands:
(4) Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP. The average equivalent isotropically radiated power (e.i.r.p.) for fixed, mobile and portable transmitters in the 1710-1755 MHz shall not exceed 1 watt.

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: 1073-0319 and 1073-0286/ Test Configuration A

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

March 15, 2017/FSC

2.2.5 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:

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

- 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

EIRP = $P_T + G_T - L_C$
= 23.0 (conducted output power) + 1.21 (antenna gain) – 0 (cable loss was programmed as an offset in the power meter)
= 24.21 dBm

ERP = $P_T + G_T - L_C$ - 2.15dB
= 24.0 dBm (conducted output power) + 0.83 dBi (antenna gain) – 0 (cable loss was programmed as an offset in the power meter) -2.15
= 22.68 dBm

2.2.7 Test Results

Compliant. See attached table.

Technology	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	ERP (dBm)	Limit (dBm)
LTE Band 4	23.0	1.21	24.21		30.0 (EIRP)
LTE Band 13	24.0	0.83	24.83	22.68	37.0 (EIRP) 34.8 (ERP)

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: 1073-0319/ Test Configuration A

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

March 09, 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	24.1 °C
Relative Humidity	38.8 %
ATM Pressure	99.3 kPa

2.3.7 Additional Observations

- This is a conducted test. Both 26dB bandwidth and 99% bandwidth presented.
- The RBW was set between 1% to 5% of the anticipated OBW while the VBW was 3X RBW.
- The detector is peak and the trace mode is max hold.
- Only the worst case bandwidth between 16QAM and QPSK presented.

- 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)

Mode	Bandwidth	Channel	Frequency (MHz)	OBW (MHz)	-26dB BW (MHz)
LTE Band 13	5 MHz	23205	779.5	4.4860	4.870
		23230	782.0	4.5060	4.910
		23255	784.5	4.5020	4.890
	10 MHz	-	-		
		23230	782.0	8.9600	9.790
		-	-		
LTE Band 4	1.4 MHz	19957	1710.7	Not supported by the Carrier	
		20175	1732.5		
		20393	1754.3		
	3 MHz	19965	1711.5		
		20175	1732.5		
		20385	1753.5		
	5 MHz	19975	1712.5	4.5120	4.910
		20175	1732.5	4.4960	4.930
		20375	1752.5	4.4960	4.870
	10 MHz	20000	1715.0	8.9760	9.770
		20175	1732.5	8.9720	9.670
		20350	1750.0	8.9560	9.740
	15 MHz	20025	1717.5	13.412	14.47
		20175	1732.5	13.428	14.42
		20325	1747.5	13.376	14.46
	20 MHz	20050	1720.0	17.856	19.07
		20175	1732.5	17.848	18.86
		20300	1745.0	17.816	18.86

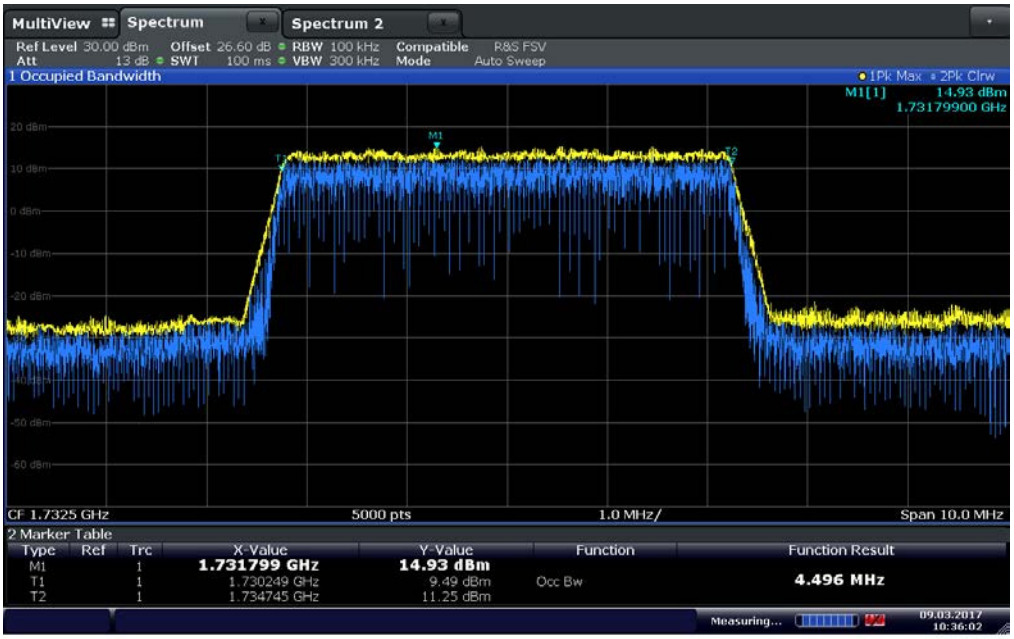
2.3.9 Sample Test Plots

Date: 9.MAR.2017 10:32:52

LTE Band 13 5MHz 99% Power Bandwidth

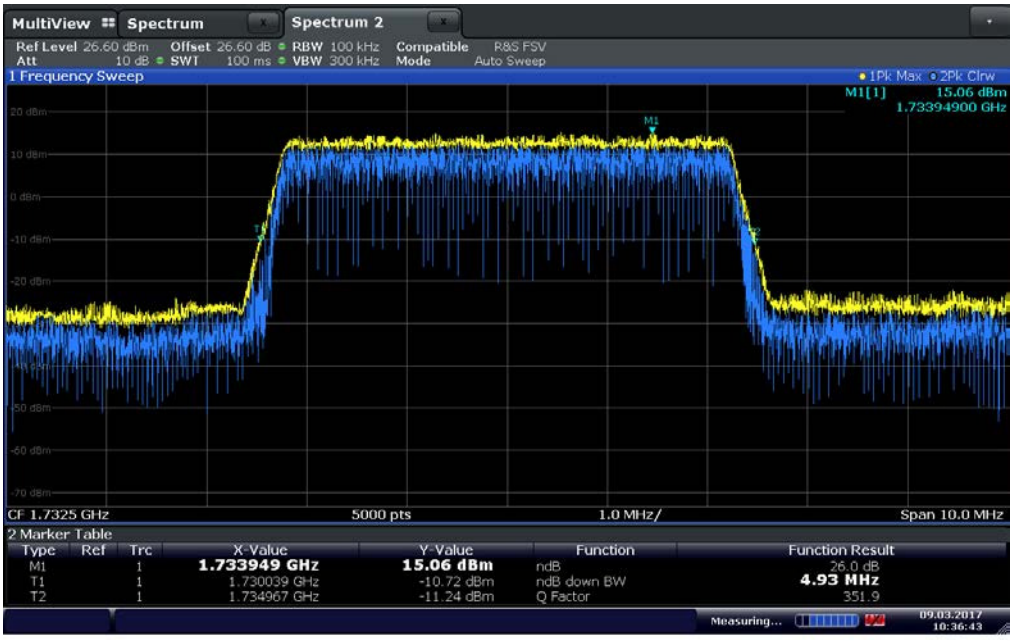
Date: 9.MAR.2017 10:33:28

LTE Band 13 5MHz OBW (-26 dB)



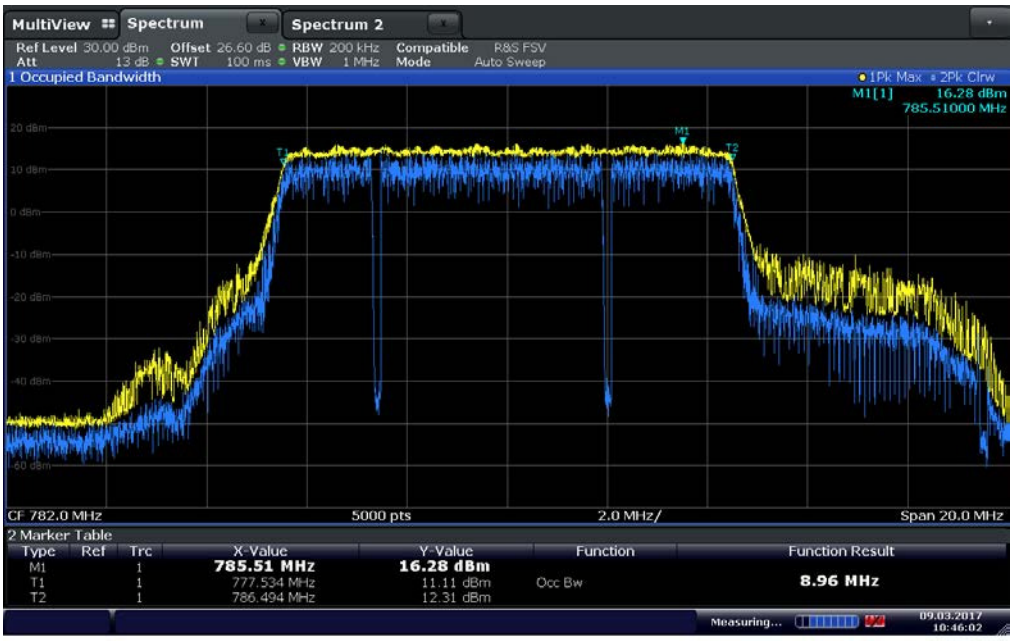
Date: 9.MAR.2017 10:36:02

LTE Band 4 5MHz 99% Power Bandwidth



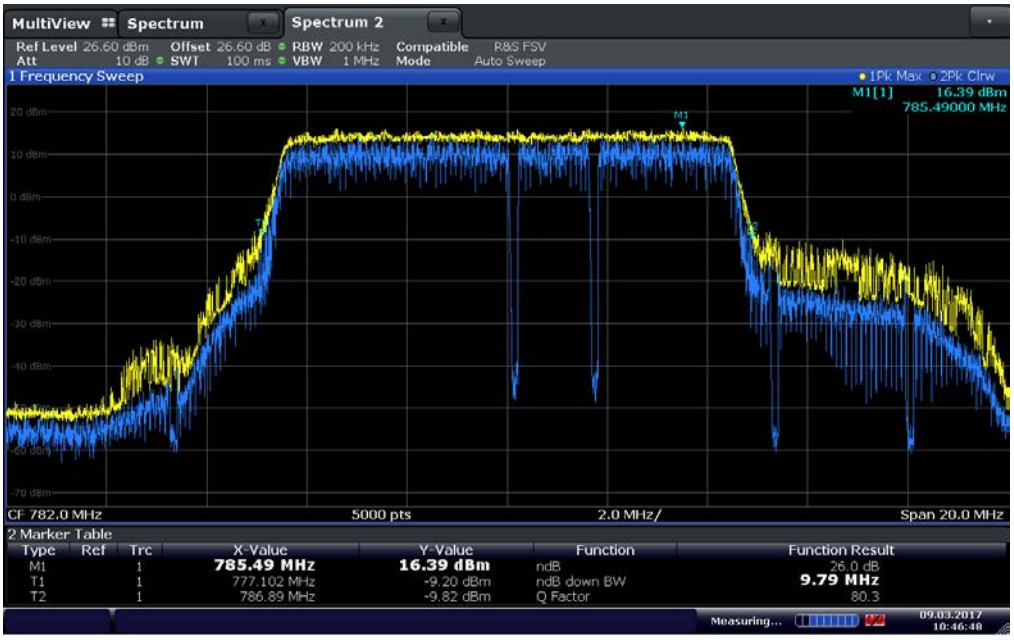
Date: 9.MAR.2017 10:36:44

LTE Band 4 5MHz OBW (-26 dB)



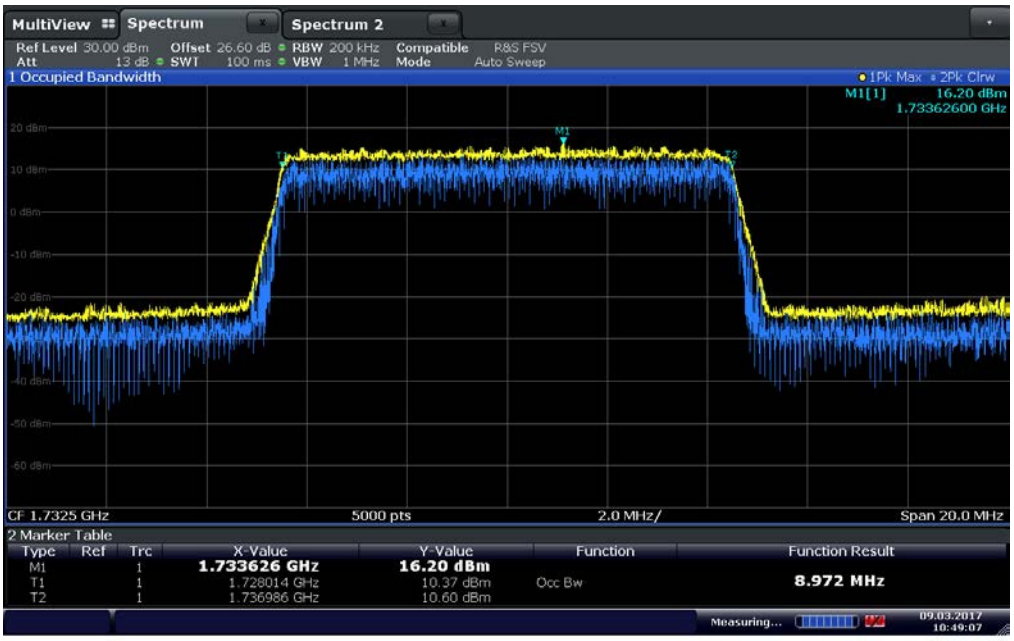
Date: 9.MAR.2017 10:46:02

LTE Band 13 10MHz 99% Power Bandwidth



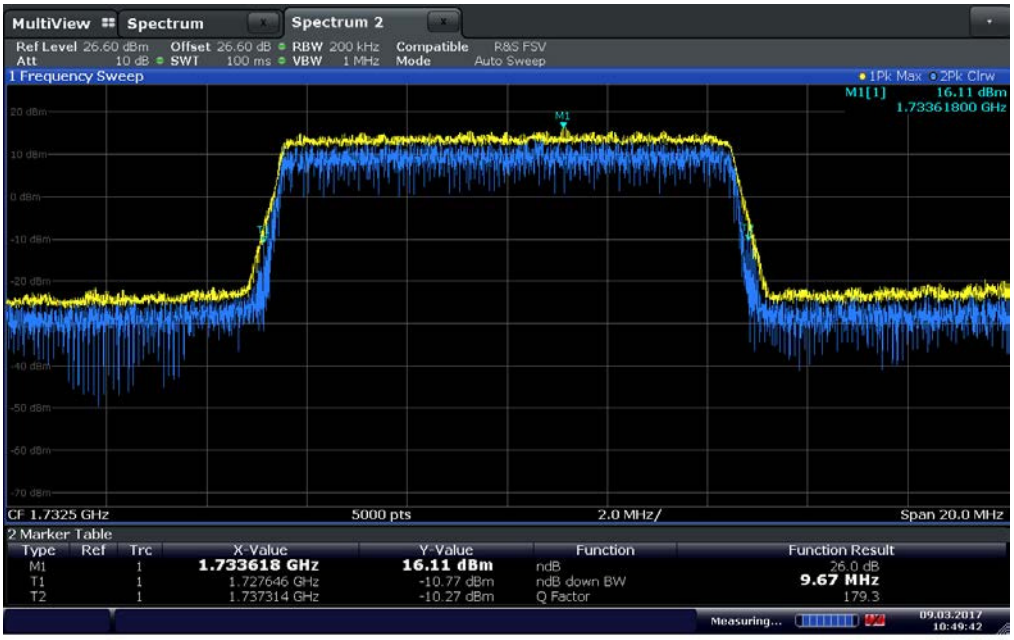
Date: 9.MAR.2017 10:46:48

LTE Band 13 10MHz OBW (-26 dB)



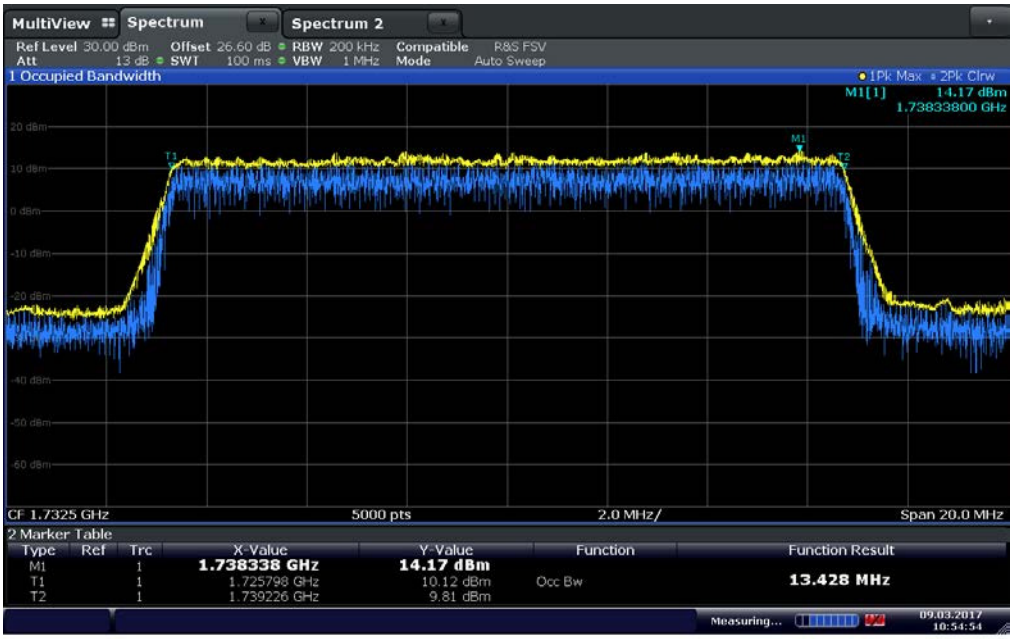
Date: 9.MAR.2017 10:49:07

LTE Band 4 10MHz 99% Power Bandwidth



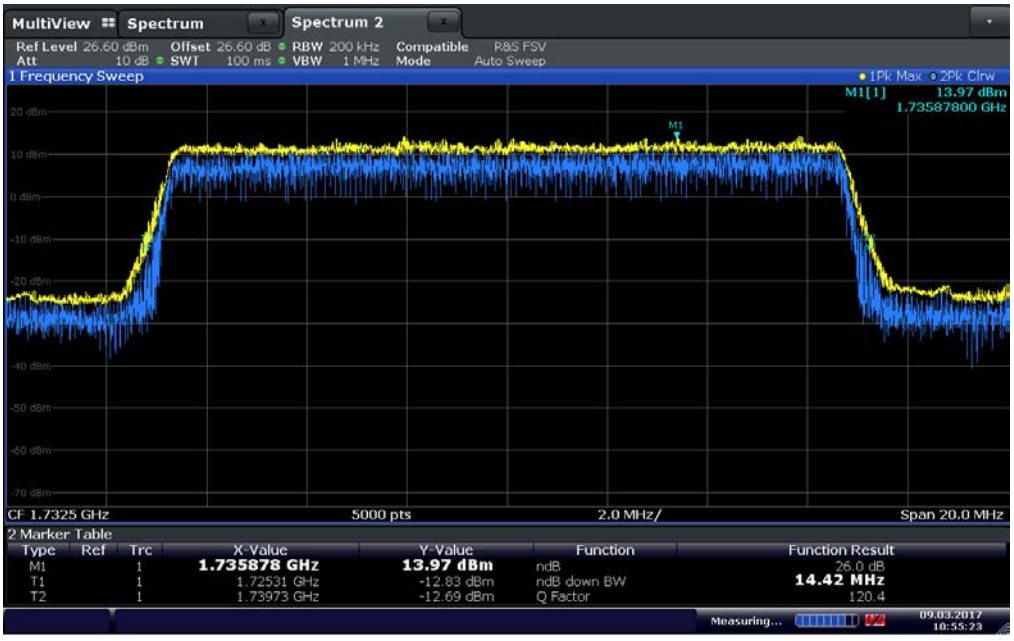
Date: 9.MAR.2017 10:49:42

LTE Band 4 10MHz OBW (-26 dB)



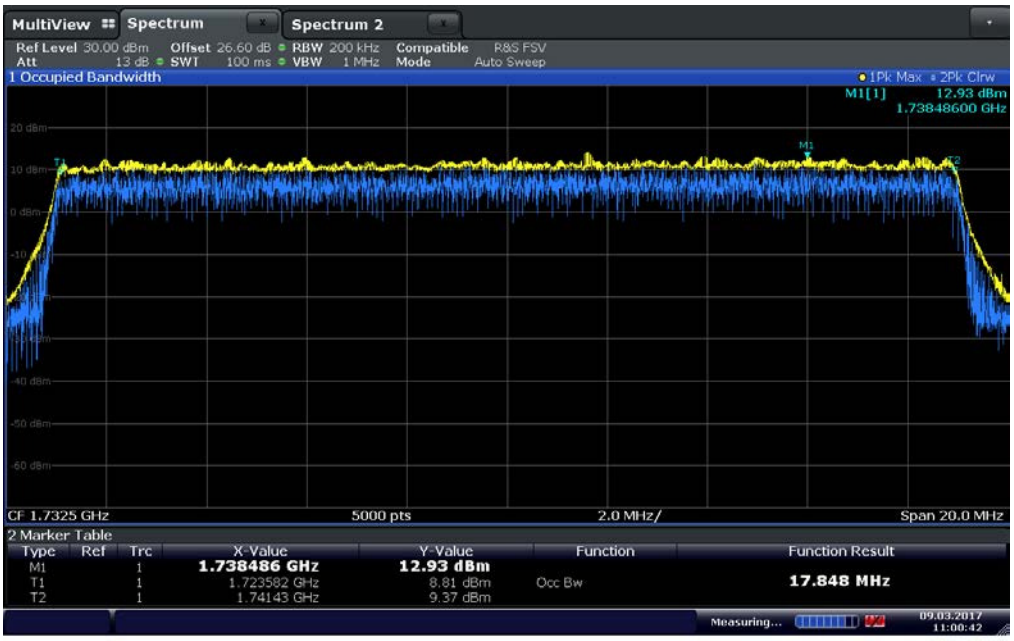
Date: 9.MAR.2017 10:54:55

LTE Band 4 15MHz 99% Power Bandwidth



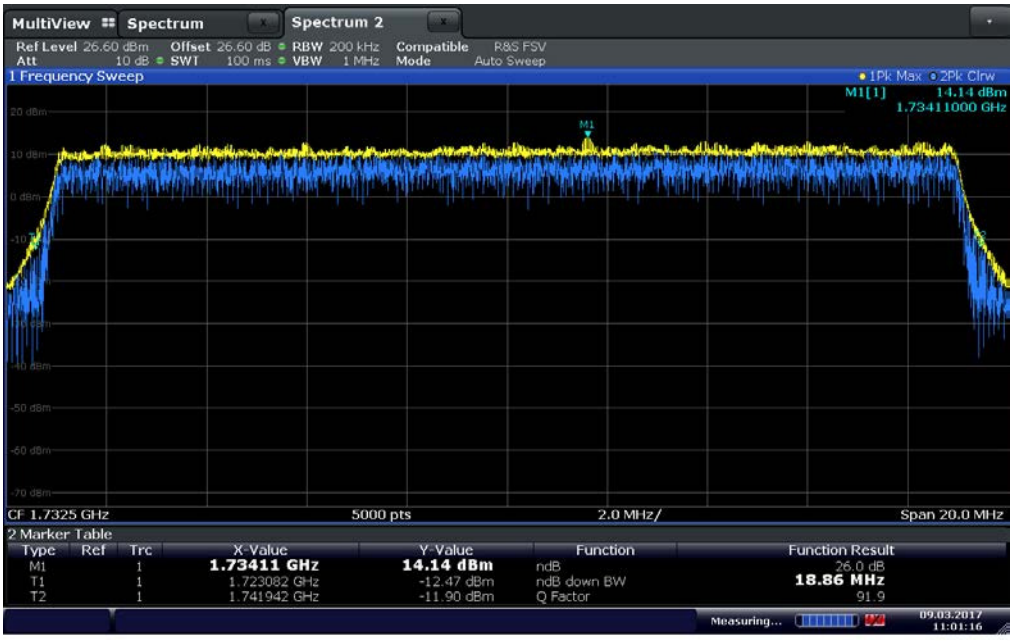
Date: 9.MAR.2017 10:55:23

LTE Band 4 15MHz OBW (-26 dB)



Date: 9.MAR.2017 11:00:43

LTE Band 4 20MHz 99% Power Bandwidth



Date: 9.MAR.2017 11:01:16

LTE Band 4 20MHz OBW (-26 dB)

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 6.5

2.4.2 Standard Applicable

RSS-130, Clause 4.4
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: 1073-0319/ Test Configuration A

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

March 09, 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	24.1 °C
Relative Humidity	38.8 %
ATM Pressure	99.3 kPa

2.4.7 Additional Observations

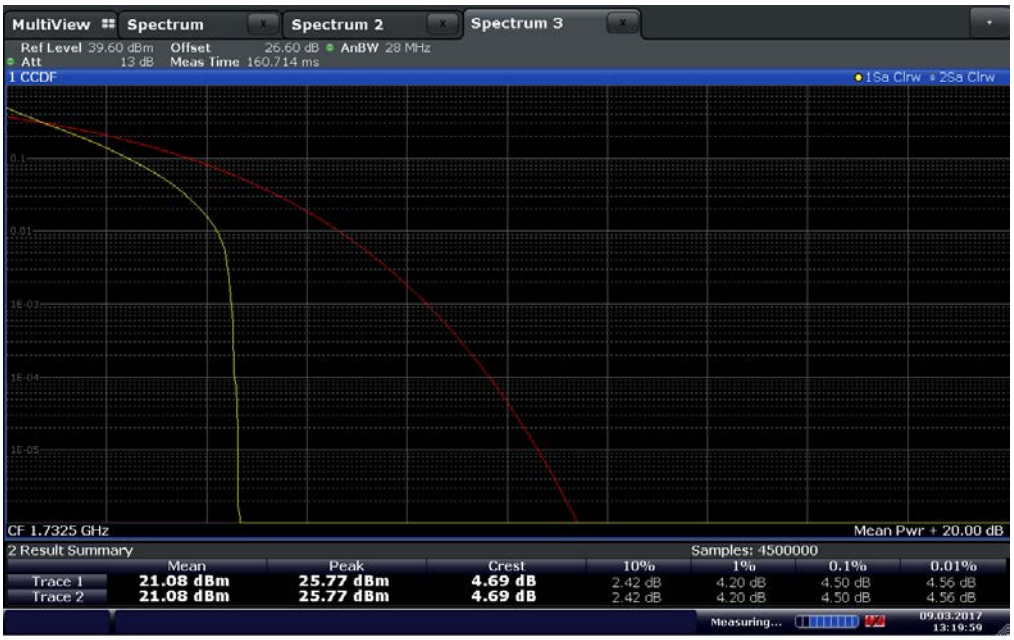
- This is a conducted test. Guidance is per Section 5.7 of KDB971168 (D01 Power Meas License Digital Systems v02r02).
- Procedure is per Section 5.7.1 of KDB971168.
- RBW was set to maximum the SA can support (28MHz, minimum requirement is ≥ signal's occupied bandwidth)
- Number of samples was adjusted 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.
- Only the worst case PAPR recorded associated with a particular bandwidth are presented.
- There are no measured PAPR levels greater than 13dB. EUT complies.

2.4.8 Test Results

Band	Modulation	Channel	Frequency (MHz)	PAR (dB)
LTE Band 4 (10 MHz BW)	QPSK	20000	1715.0	4.20
		20175	1732.5	4.50
		20350	1750.0	4.14
	16-QAM	20000	1715.0	5.18
		20175	1732.5	5.60
		20350	1750.0	5.30
LTE Band 13 (10 MHz BW)	QPSK	23230	782.0	5.10
	16-QAM	23230	782.0	5.90

2.4.9 Sample Test Plots



Date: 9.MAR.2017 13:19:59

LTE Band 4 10MHz OBW Mid Channel QPSK PAPR

Date: 9.MAR.2017 13:26:37

LTE Band 4 10MHz OBW Low Channel 16-QAM PAPR

Date: 9.MAR.2017 14:08:39

LTE Band 13 10MHz OBW Mid Channel QPSK PAPR

Date: 9.MAR.2017 14:07:33

LTE Band 13 10MHz OBW Mid Channel 16-QAM PAPR

2.5 BAND EDGE

2.5.1 Specification Reference

FCC 47 CFR Part 27, Clause 27.53(c)(2) and (5), (h)(1) and (3)
RSS-130, Clause 4.6.1
RSS-139, Clause 6.6

2.5.2 Standard Applicable

FCC 47 CFR Part 27, Clause 27.53(c)(2) and (5), (h)(1) and (3)(i)
(c)(2) On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;
(c)(5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed.
(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.

RSS-130, Clause 4.6.1
The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside thefrequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

RSS-139, Clause 6.6
Identical requirements as FCC 47 CFR Part 27, Clause 27.53(h)(1) and (3)

2.5.3 Equipment Under Test and Modification State

Serial No: 1073-0319/ Test Configuration A

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

March 09 and 10, 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

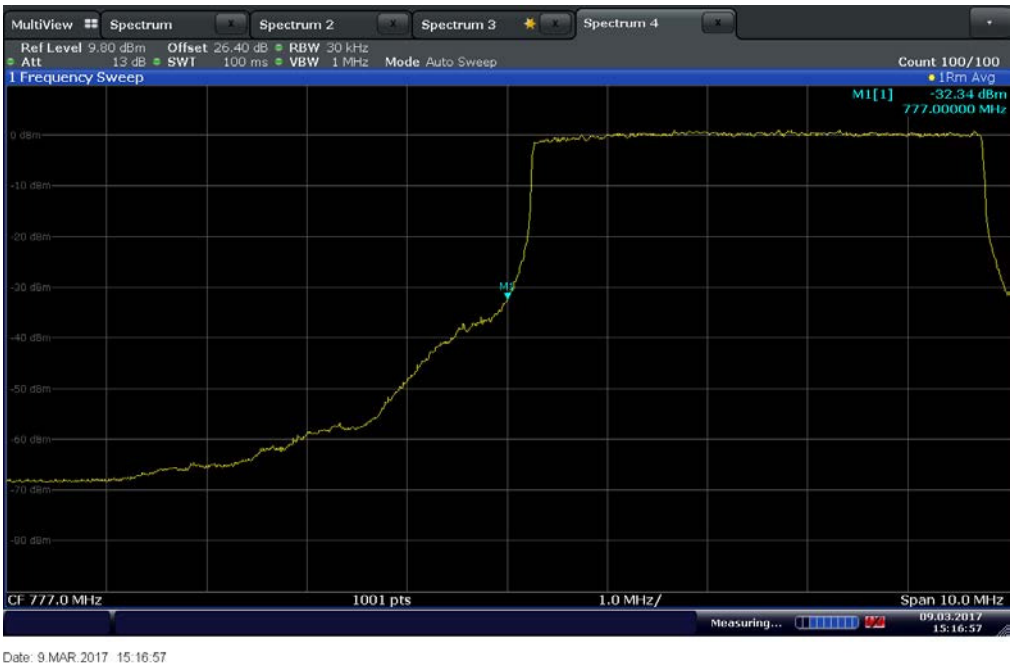
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	24.1 °C
Relative Humidity	38.8 %
ATM Pressure	99.3 kPa

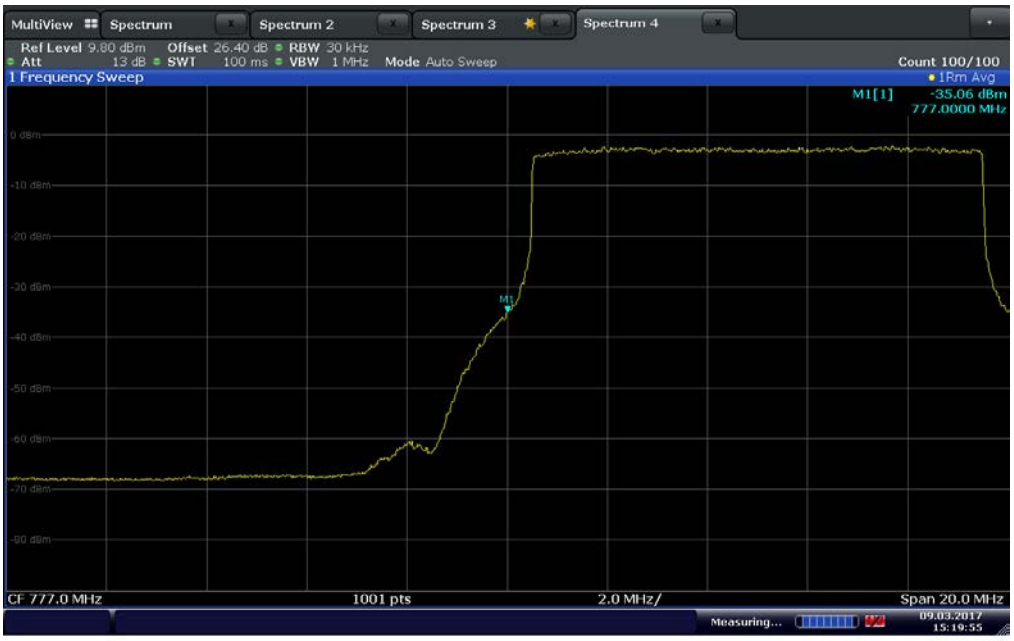
2.5.7 Additional Observations

- 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.
- For Band 4, all bandwidth complies however only the widest and most narrow bandwidth utilized by the EUT were presented.
- Only the worst case modulation (QPSK or 16-QAM) presented for both bands.

2.5.8 Test Results

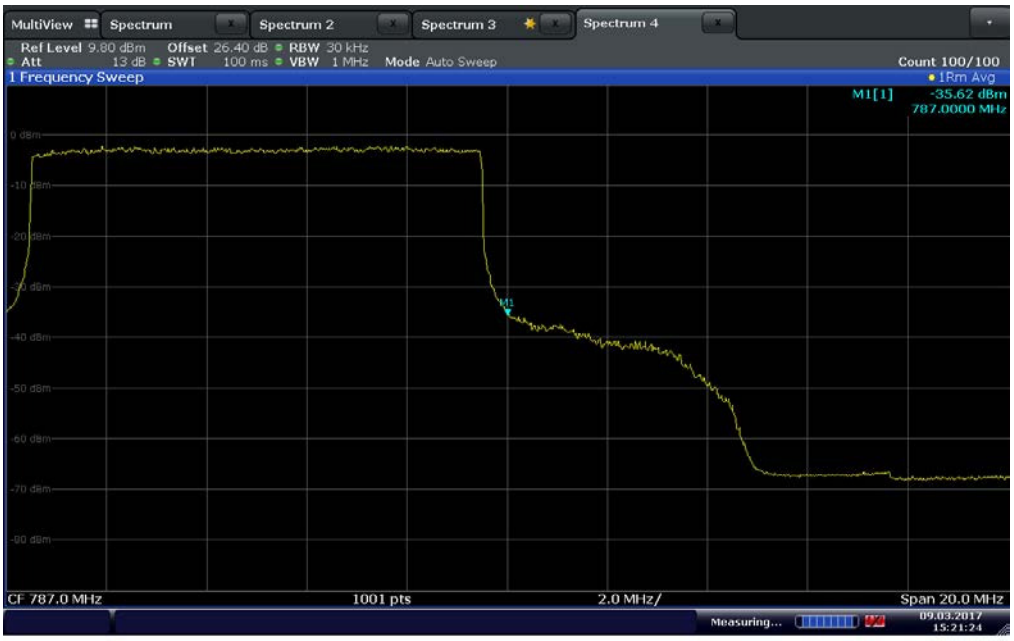


LTE Band 13 Low Channel 5MHz BW



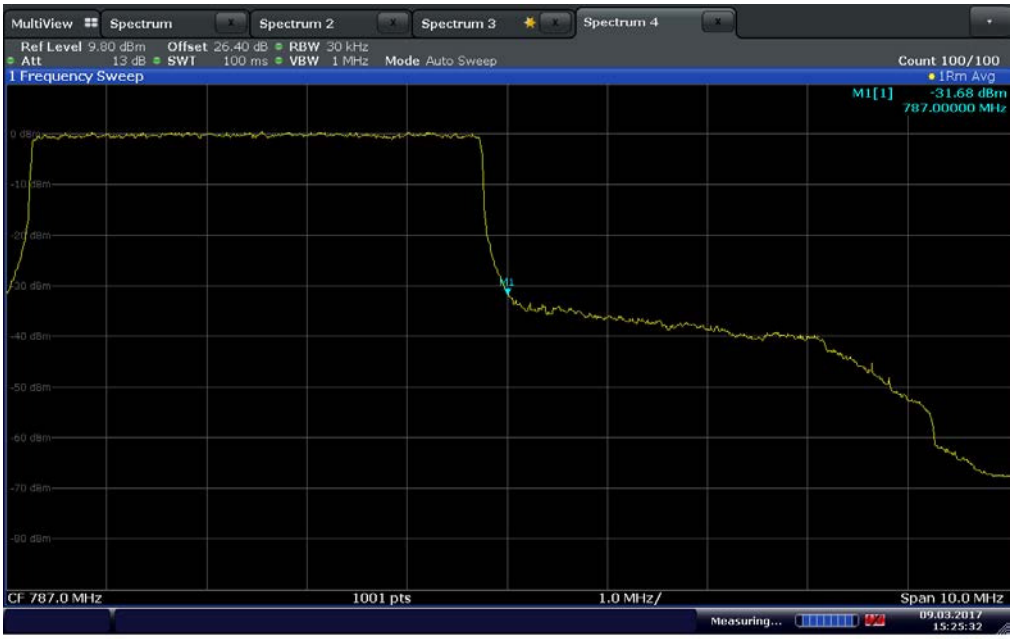
Date: 9.MAR.2017 15:19:55

LTE Band 13 Mid Channel 10MHz BW



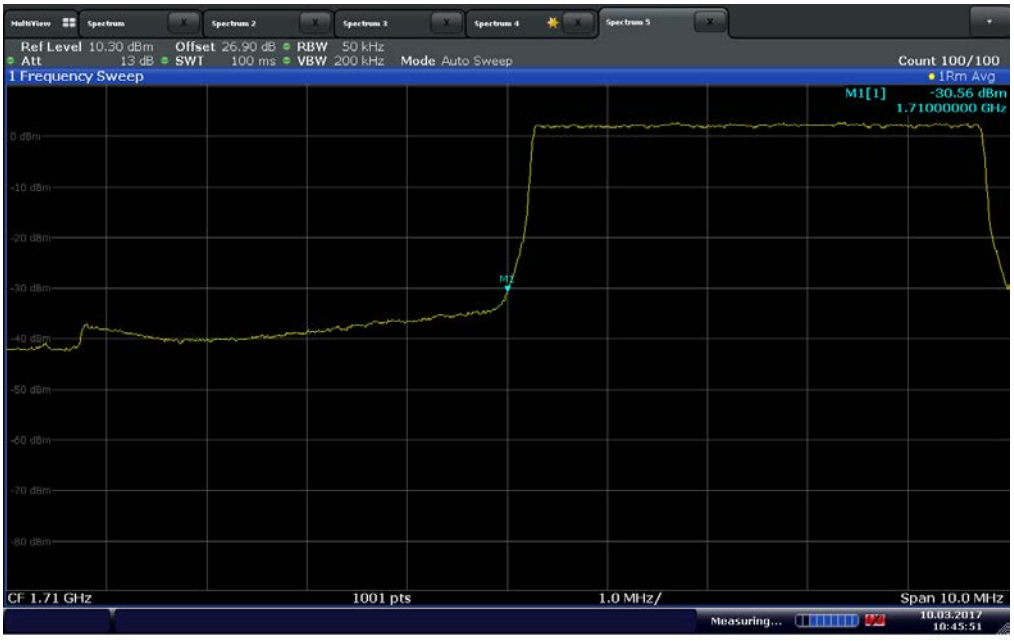
Date: 9.MAR.2017 15:21:25

LTE Band 13 Mid Channel 10MHz BW



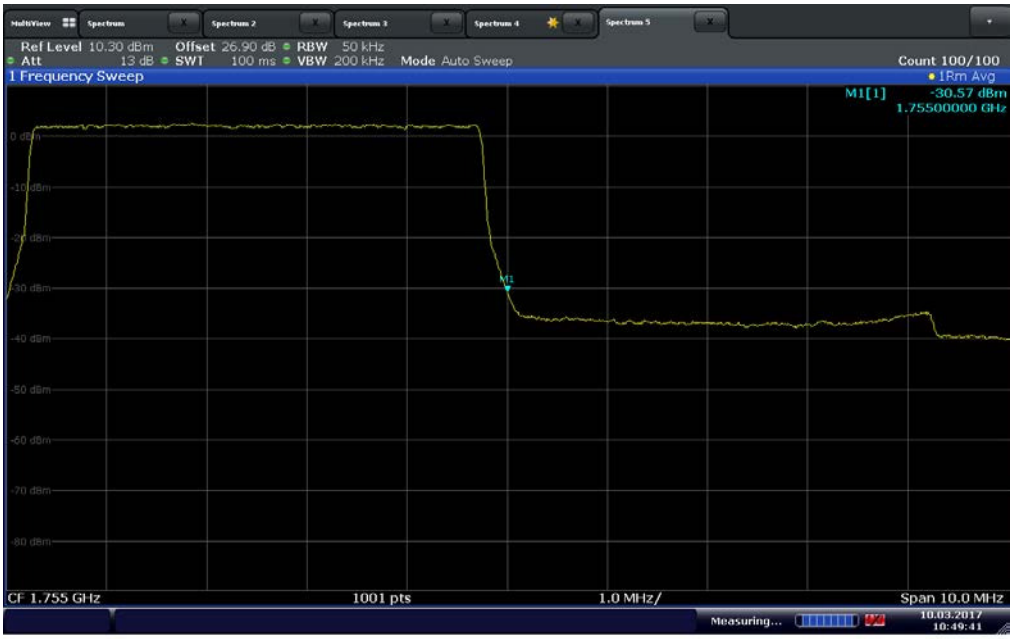
Date: 9.MAR.2017 15:25:32

LTE Band 13 High Channel 5MHz BW



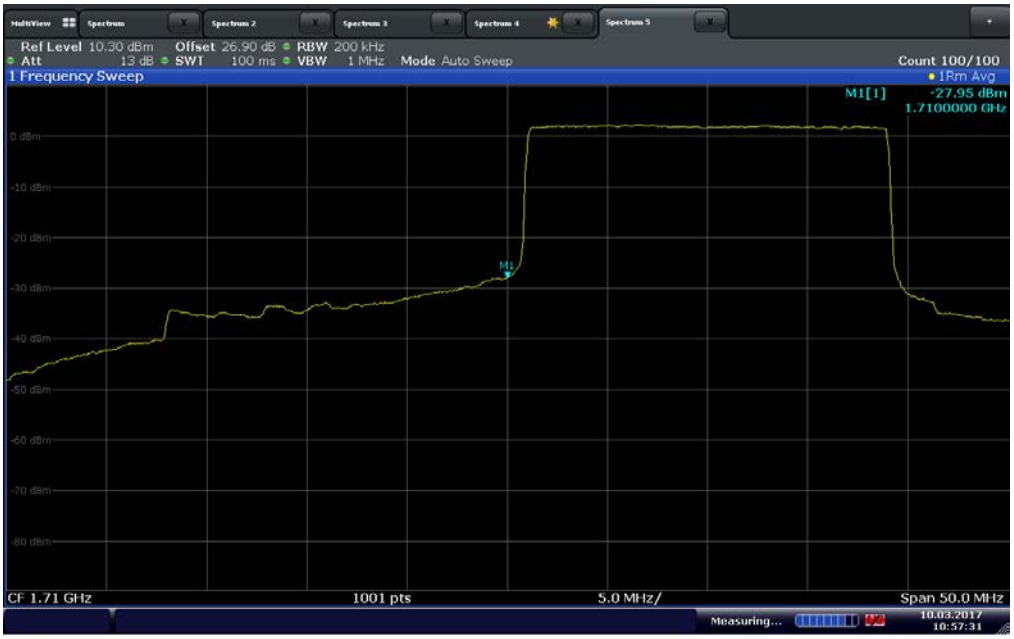
Date: 10.MAR.2017 10:45:51

LTE Band 4 Low Channel 5MHz BW



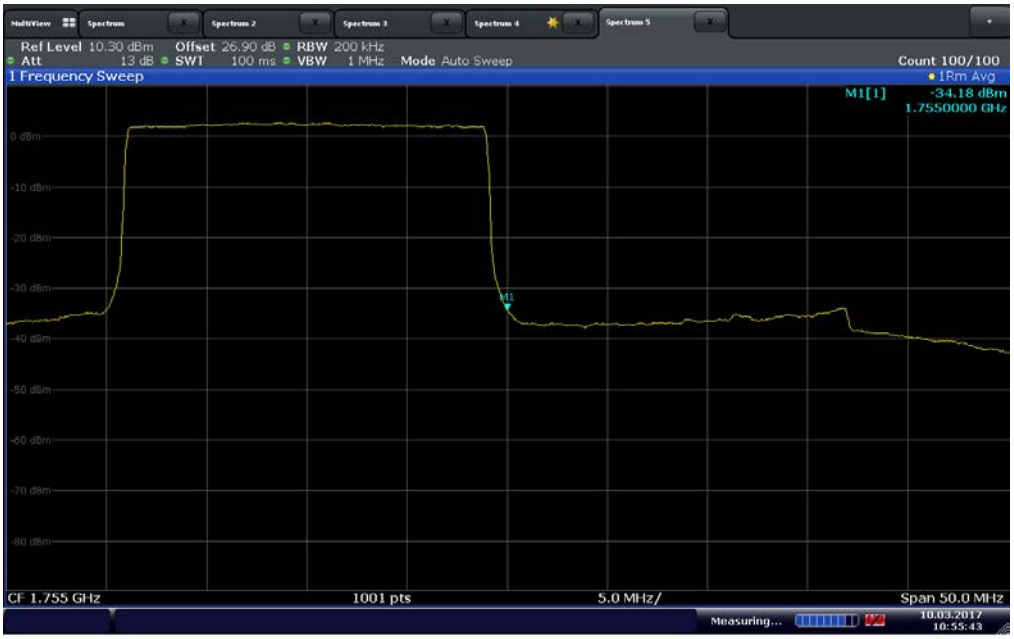
Date: 10.MAR.2017 10:49:42

LTE Band 4 High Channel 5MHz BW



Date: 10.MAR.2017 10:57:31

LTE Band 4 Low Channel 20MHz BW



Date: 10.MAR.2017 10:55:43

LTE Band 4 High Channel 20MHz BW

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(c)(1),(2),(4),(5),(6) and (f), (h)(1),(2) and (3)(i)
RSS-130, Clause 4.6
RSS-139, Clause 6.6

2.6.2 Standard Applicable

FCC 47 CFR Part 27, Clause 27.53 (c)
For operations in the 746-758 MHz band and the 776-788 MHz band, the power of any emission outside the 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, in accordance with the following:

(1) On any frequency outside the 746-758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;
(2) (2) On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;
(3) (4) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations;
(4) (5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;
(5) (6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

FCC 47 CFR Part 27, Clause 27.53 (f)
For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

(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.

(2) Additional protection levels. Notwithstanding the foregoing paragraph (h)(1) of this section:
- (i) Operations in the 2180-2200 MHz band are subject to the out-of-band emission requirements set forth in §27.1134 for the protection of federal government operations operating in the 2200- 2290 MHz band.
- (ii) For operations in the 2000-2020 MHz band, the power of any emissions below 2000 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB.

(iii) For operations in the 1915-1920 MHz band, the power of any emission between 1930-1995 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB.

(iv) For operations in the 1995-2000 MHz band, the power of any emission between 2005-2020 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB.

2.6.3 Equipment Under Test and Modification State

Serial No: 1073-0319/ Test Configuration A

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

March 10, 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

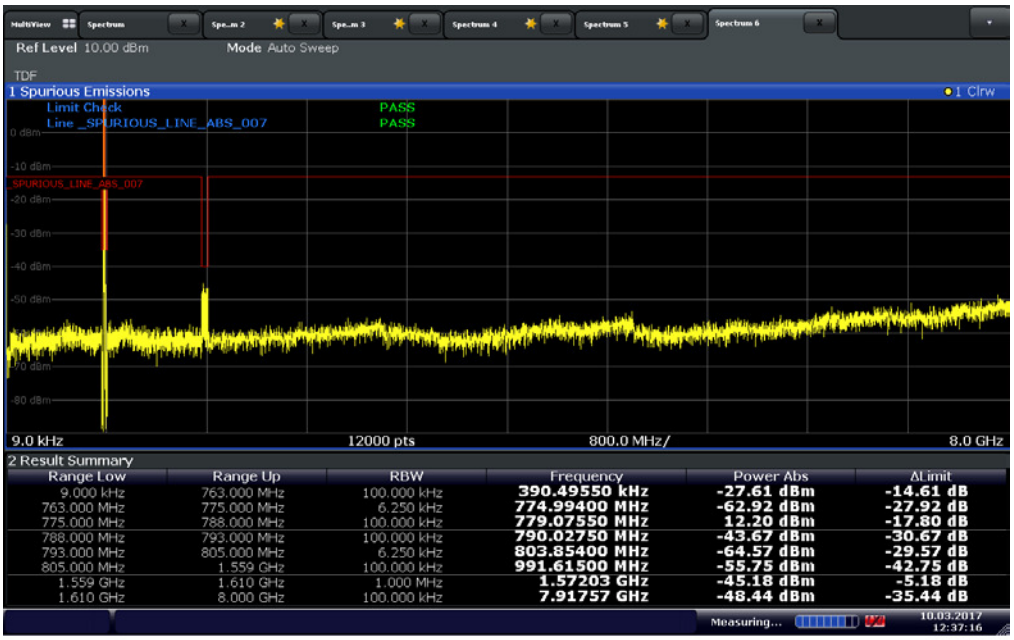
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	24.5 °C
Relative Humidity	38.5 %
ATM Pressure	99.2 kPa

2.6.7 Additional Observations

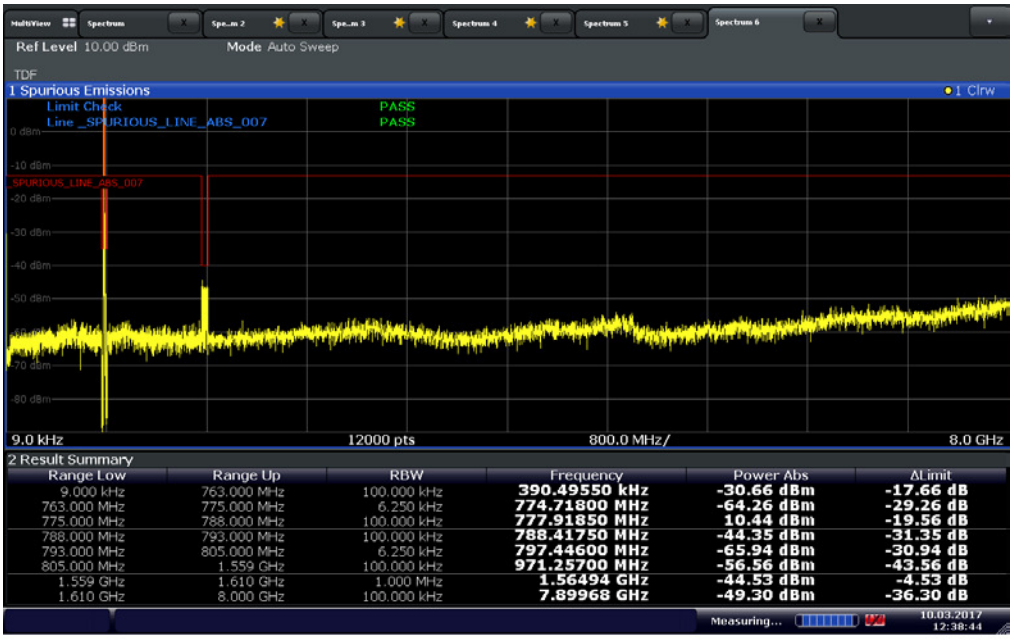
- This is a conducted test.
- Corresponding transducer factor (TDF) was used for the external attenuator and cable used.
- The spectrum was searched from 9 kHz to 8GHz for LTE Band 13 and from 9 kHz to 18GHz for LTE Band 4.
- The Spurious Emissions Measurement function of the SA was used for this test.
- Measurement guidance is per Clause 6 of KDB971168 D01 v02r02.
- Only the worst case bandwidth presented for each band.

2.6.8 Test Results



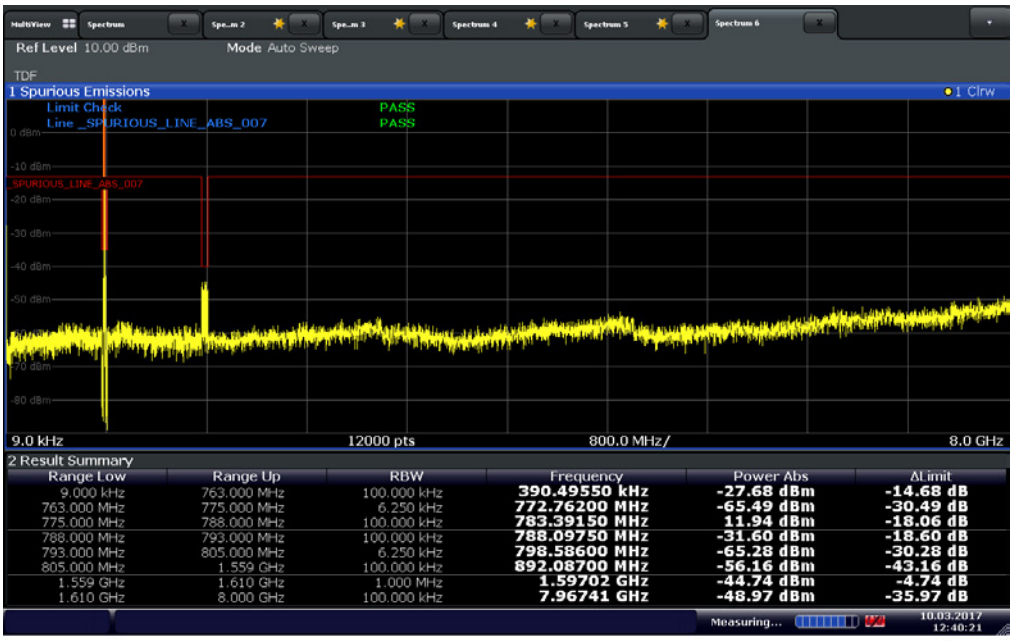
Date: 10.MAR.2017 12:37:16

LTE Band 13 Low Channel QPSK



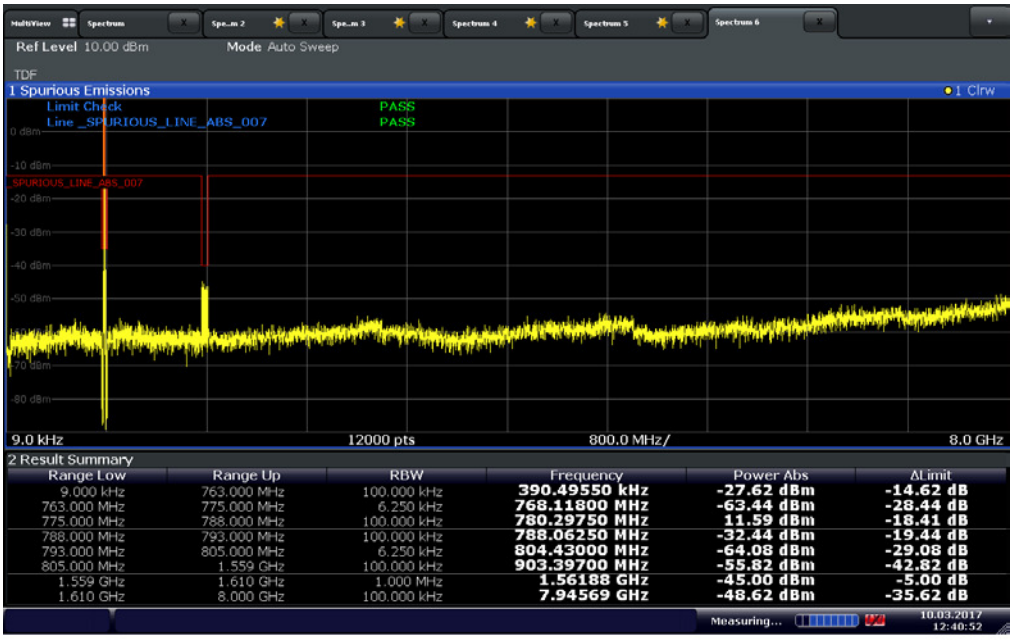
Date: 10.MAR.2017 12:38:45

LTE Band 13 Low Channel 16-QAM



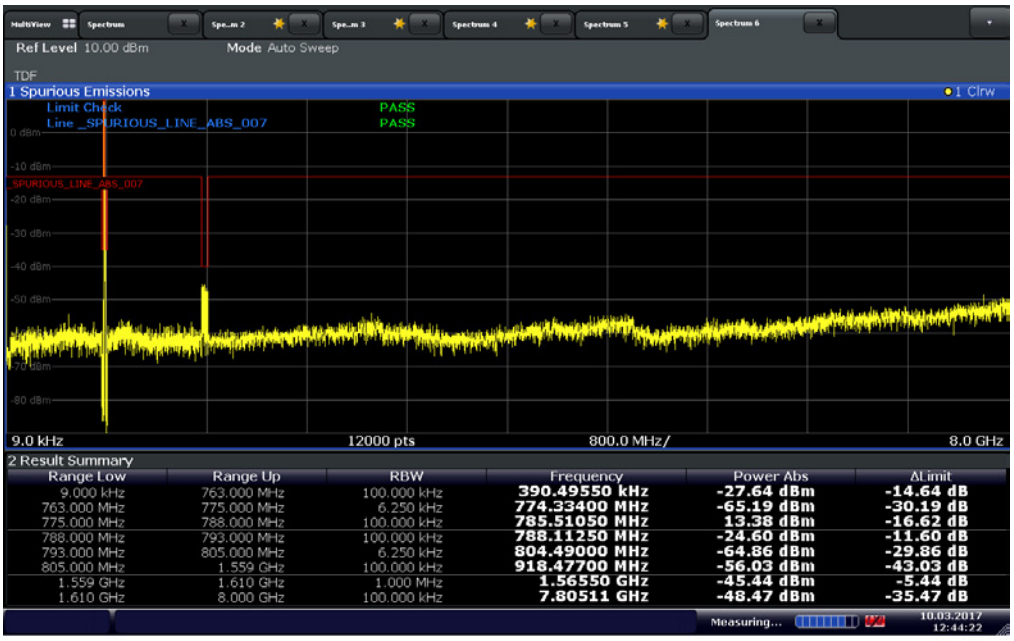
Date: 10.MAR.2017 12:40:21

LTE Band 13 Mid Channel QPSK



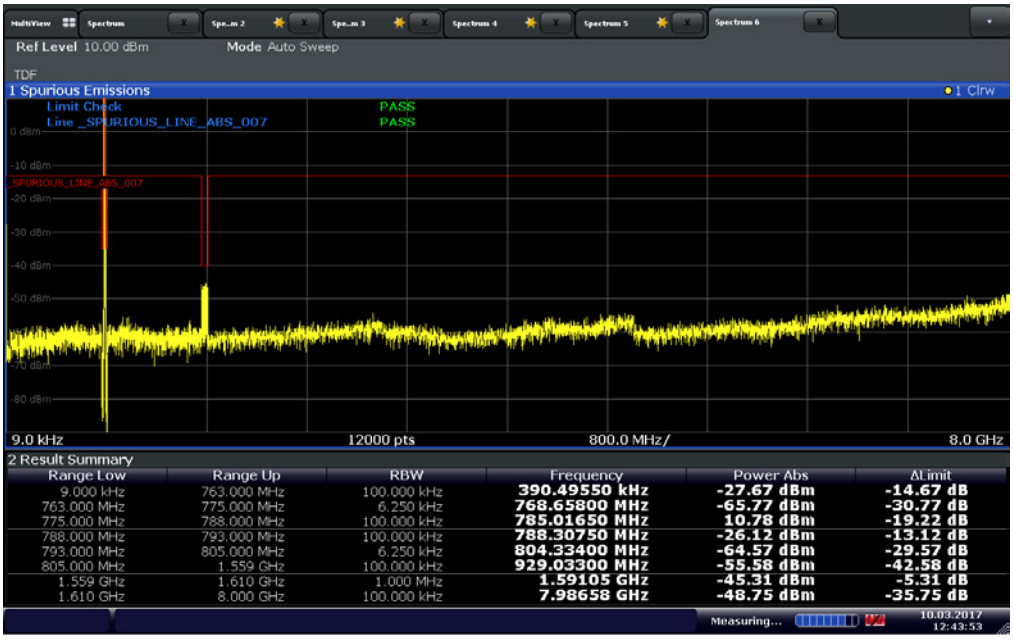
Date: 10.MAR.2017 12:40:52

LTE Band 13 Mid Channel 16-QAM



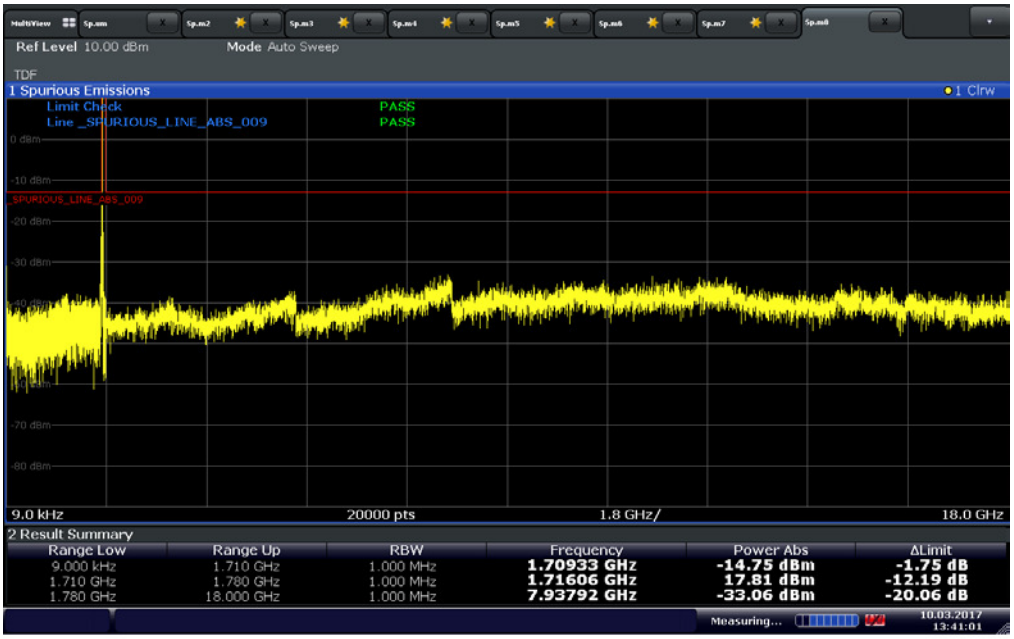
Date: 10.MAR.2017 12:44:22

LTE Band 13 High Channel QPSK



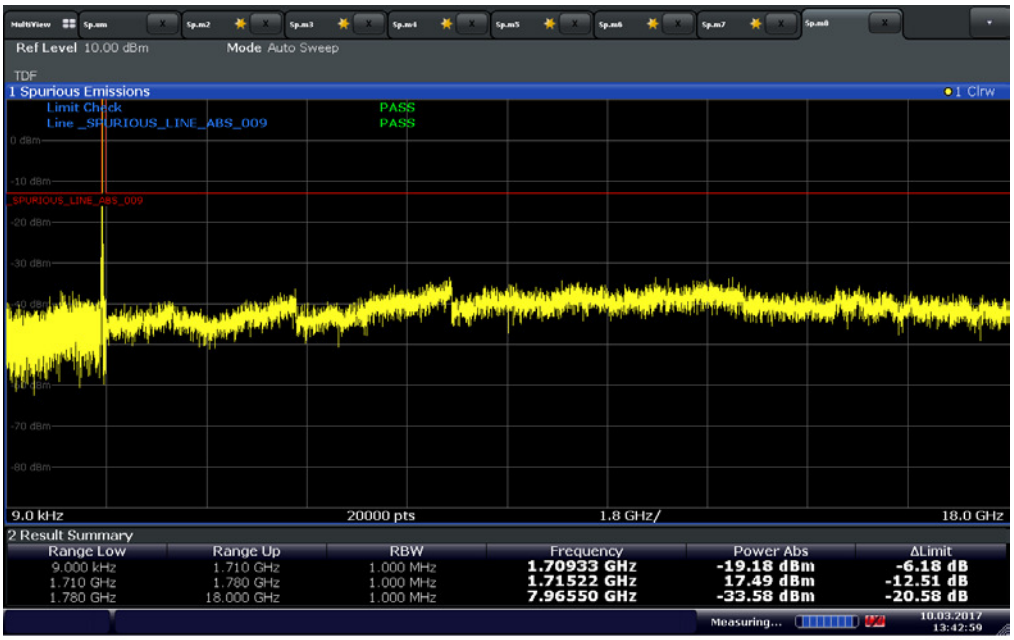
Date: 10.MAR.2017 12:43:53

LTE Band 13 High Channel 16-QAM



Date: 10.MAR.2017 13:41:01

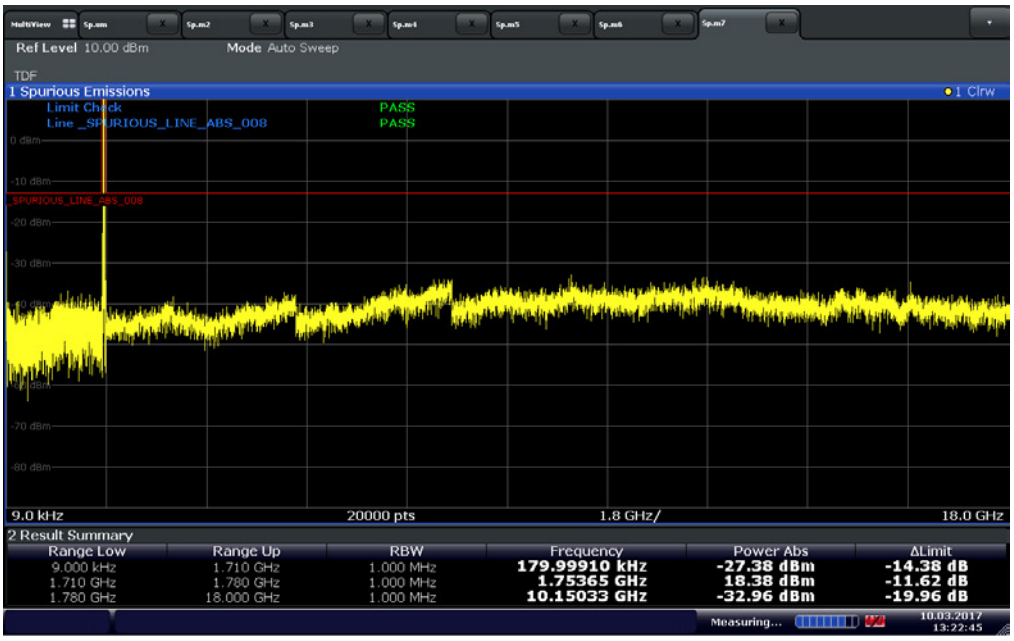
LTE Band 4 Low Channel QPSK



Date: 10.MAR.2017 13:42:59

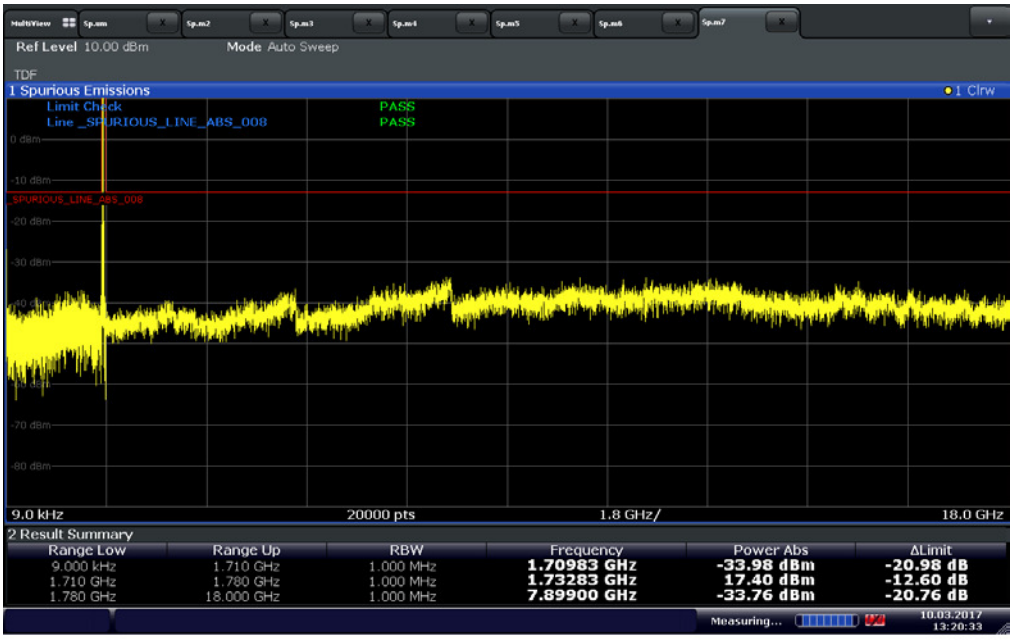
LTE Band 4 Low Channel 16-QAM

Test Note: Start frequency was set equal to the block edge frequency ± RBW/2 for Low channel verification.



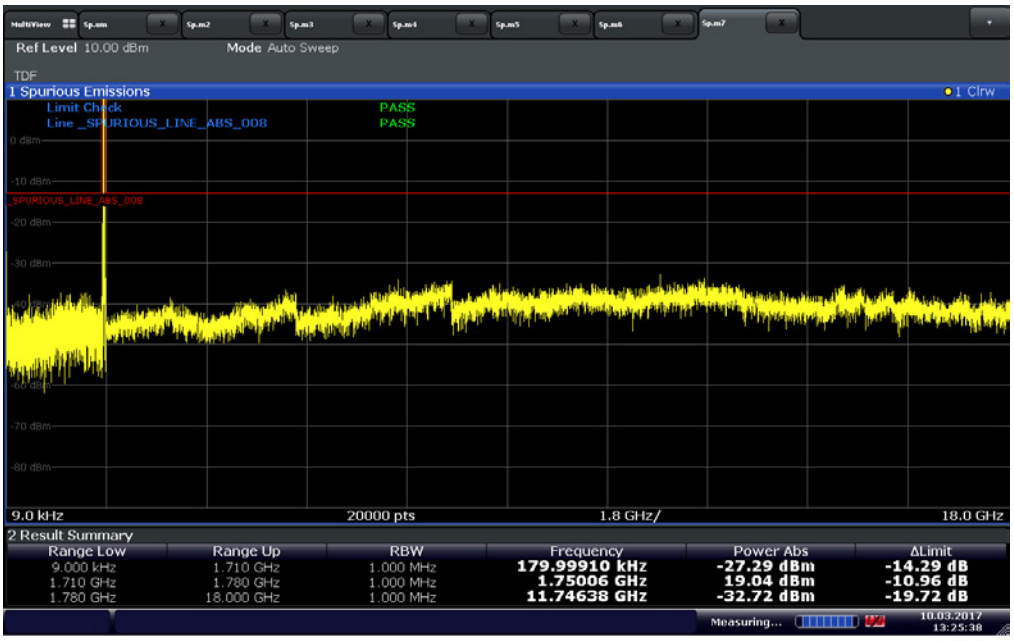
Date: 10.MAR.2017 13:22:45

LTE Band 4 Mid Channel QPSK



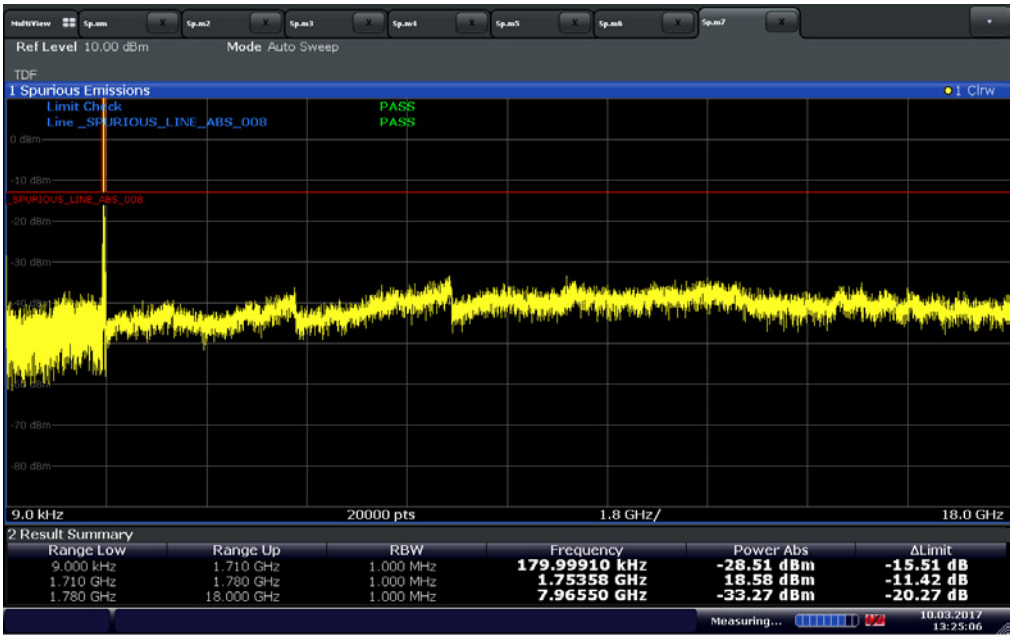
Date: 10.MAR.2017 13:20:34

LTE Band 4 Mid Channel 16-QAM



Date: 10.MAR.2017 13:25:39

LTE Band 4 High Channel QPSK



Date: 10.MAR.2017 13:25:06

LTE Band 4 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: 1073-0286 / Test Configuration B

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

February 22 to 24, 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	26.7 °C
Relative Humidity	40.7%
ATM Pressure	99.4 kPa

2.7.7 Additional Observations

- This is a radiated test using substitution method as per Unwanted Emissions: Radiated Spurious method of measurement of ANSI/TIA/EIA-603-C 2004, August 17, 2004.
- To reduce report size, only the deemed worst case configuration and channel presented in this test report.
- The test was performed using the EUT integral antenna.

- Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only.

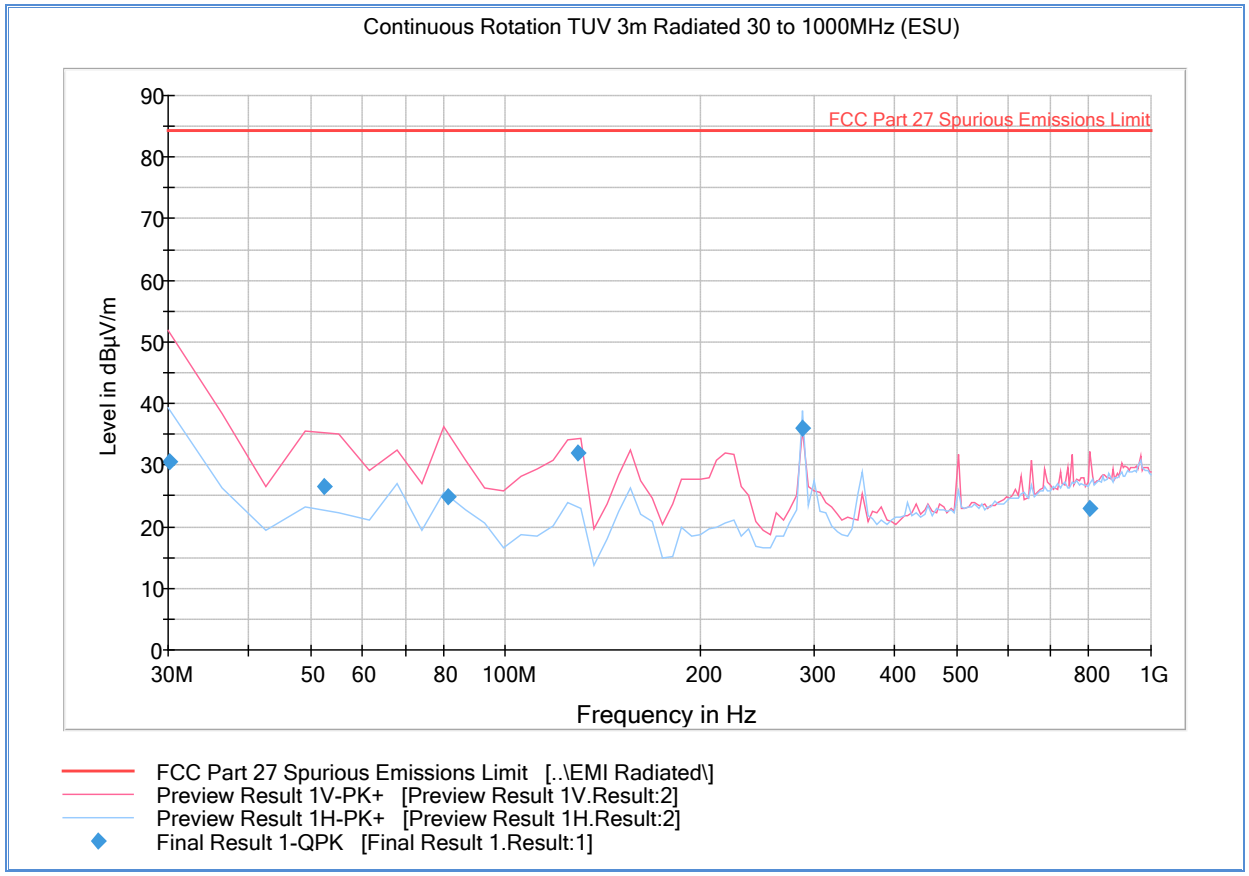
2.7.8 Sample Computation (Radiated Emission)

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

Complies. See attached plots.

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

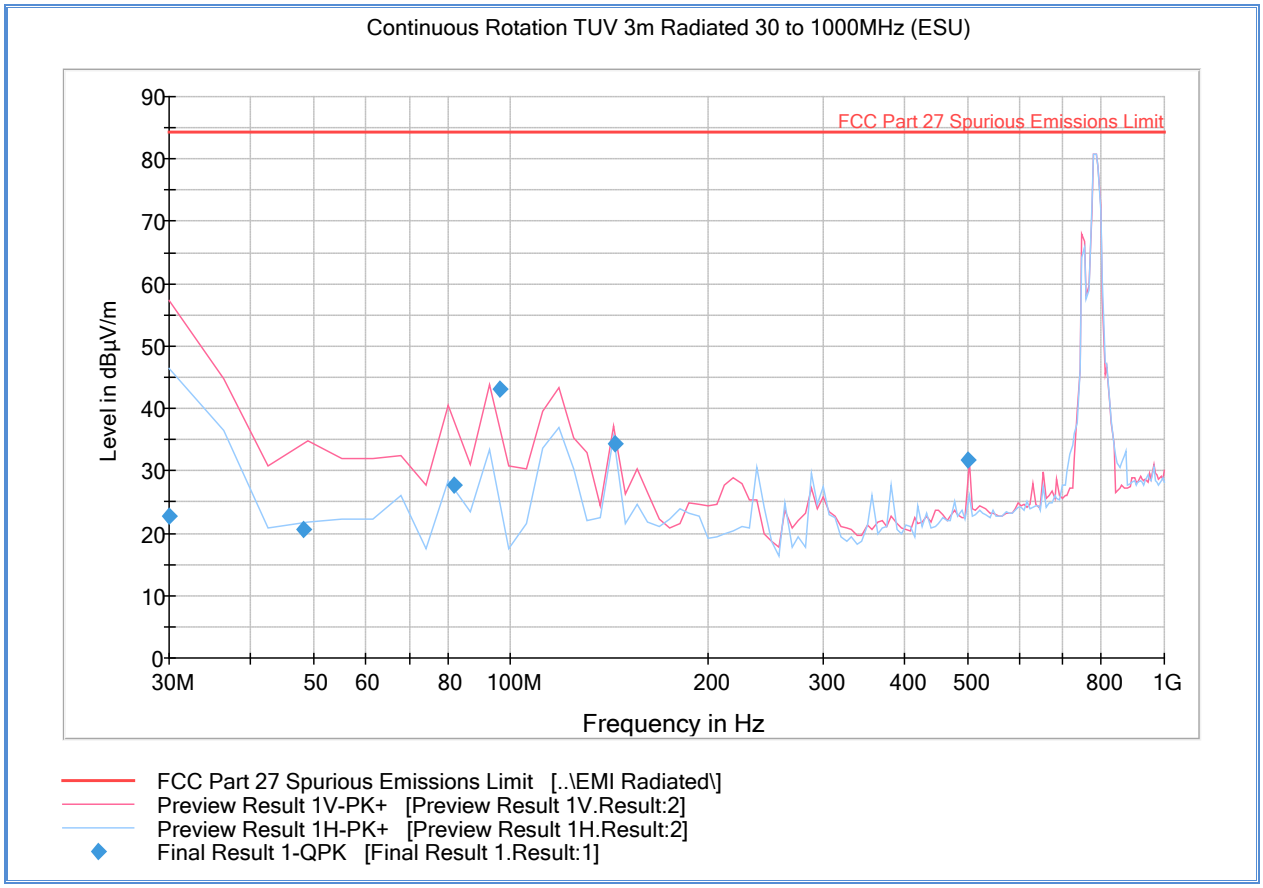


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.080000	30.6	1000.0	120.000	100.0	V	265.0	-6.9	53.8	84.4
52.296104	26.4	1000.0	120.000	106.0	V	185.0	-15.7	58.0	84.4
81.629610	24.8	1000.0	120.000	120.0	V	153.0	-17.8	59.6	84.4
129.619221	31.9	1000.0	120.000	106.0	V	141.0	-16.6	52.4	84.4
288.526753	36.1	1000.0	120.000	100.0	H	83.0	-9.5	48.3	84.4
802.620260	23.0	1000.0	120.000	115.0	V	192.0	3.4	61.4	84.4

Test Notes: Only worst case channel presented for spurious emissions below 1GHz. Only case spurious emissions within 20db of the calculated limit will be proven by substitution method.

2.7.11 Test Results Below 1GHz (LTE Band 13 Worst Case Configuration)

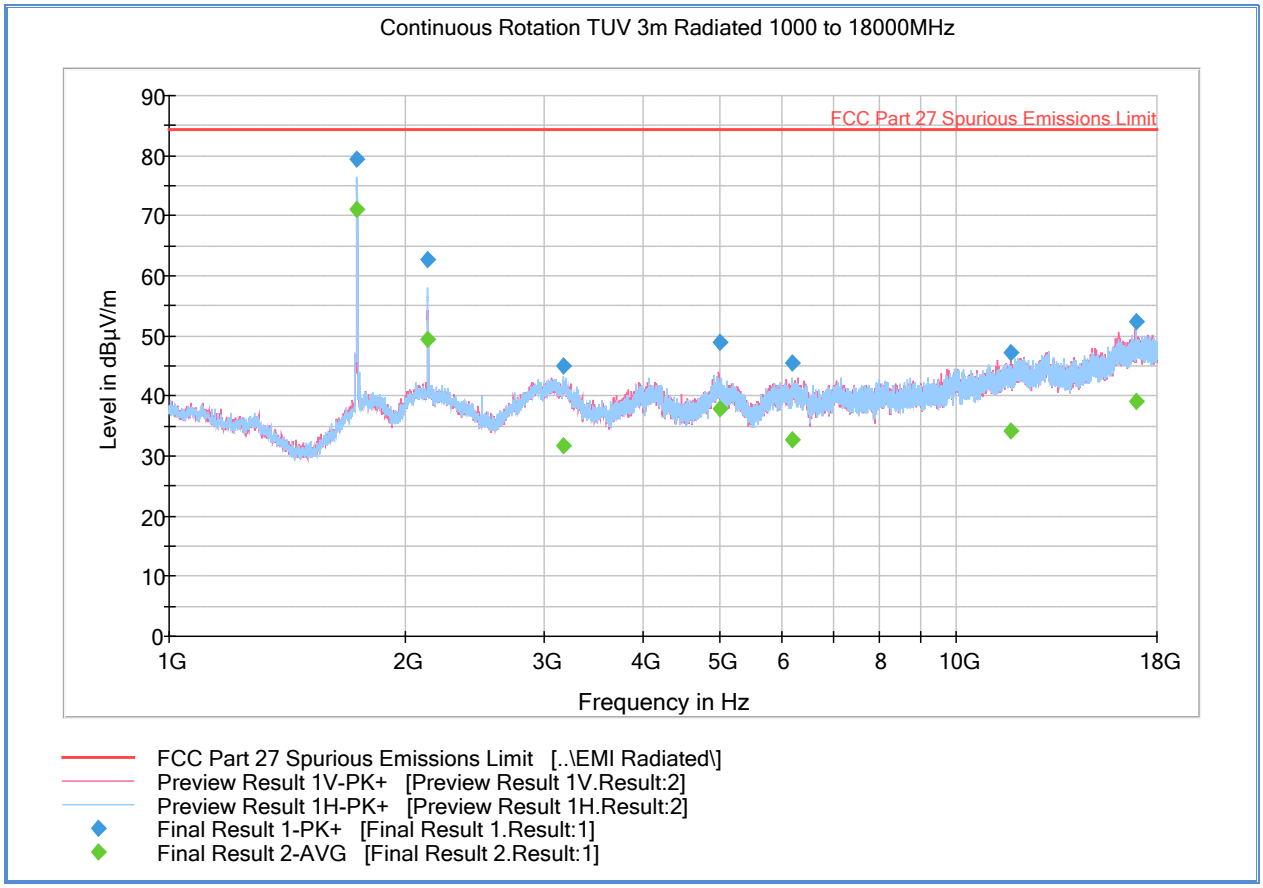


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.040000	22.8	1000.0	120.000	100.0	V	309.0	-6.9	61.5	84.4
48.176104	20.6	1000.0	120.000	100.0	V	191.0	-14.9	63.8	84.4
81.749610	27.7	1000.0	120.000	150.0	V	97.0	-17.8	56.7	84.4
96.387013	43.2	1000.0	120.000	100.0	V	118.0	-15.7	41.2	84.4
144.216623	34.4	1000.0	120.000	100.0	V	15.0	-15.4	50.0	84.4
500.042597	31.6	1000.0	120.000	105.0	V	25.0	-2.0	52.7	84.4

Test Notes: Only worst case channel presented for spurious emissions below 1GHz. Only case spurious emissions within 20db of the calculated limit will be proven by substitution method.

2.7.12 Test Results Above 1GHz (LTE Band 4 Middle Channel)



Peak Data

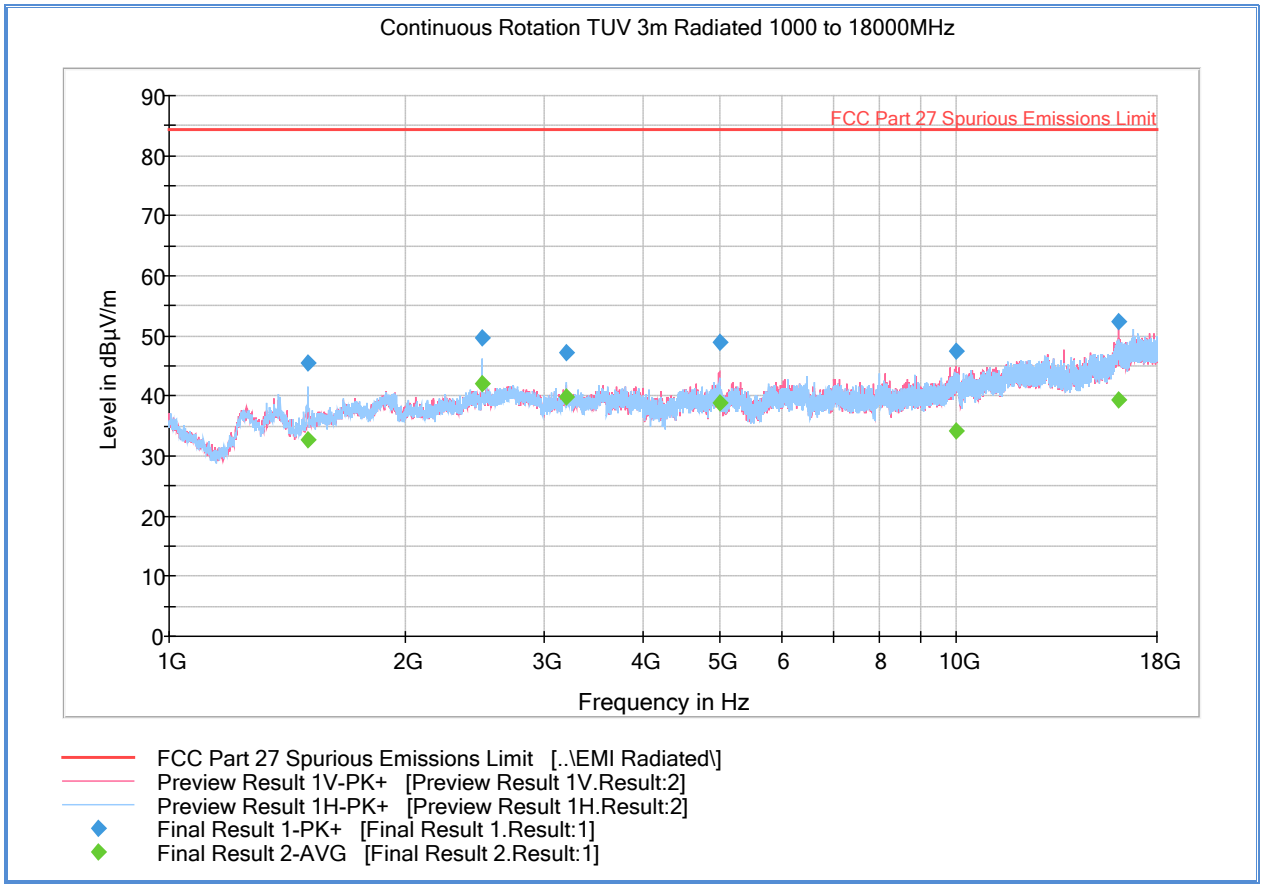
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1731.233333	79.3	1000.0	1000.000	174.6	H	230.0	-4.2	5.0	84.4
2133.000000	62.8	1000.0	1000.000	262.3	H	92.0	-2.1	21.6	84.4
3167.300000	45.1	1000.0	1000.000	173.6	H	-13.0	1.2	39.3	84.4
4999.933333	48.8	1000.0	1000.000	371.1	V	78.0	3.8	35.6	84.4
6203.000000	45.5	1000.0	1000.000	376.1	H	17.0	6.0	38.9	84.4
11731.166667	47.2	1000.0	1000.000	350.6	V	97.0	13.2	37.2	84.4
16964.533333	52.3	1000.0	1000.000	410.7	H	299.0	19.5	32.1	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: Only worst case channel presented for spurious emissions above 1GHz. Substitution data not required since margin is >20dB compared to the -13dBm limit (converted to field strength @ 3 meters). Notched carrier is ignored.

2.7.13 Test Results Above 1GHz (LTE Band 13 High Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1499.800000	45.4	1000.0	1000.000	239.4	H	90.0	-6.2	39.0	84.4
2500.166667	49.6	1000.0	1000.000	143.7	H	196.0	-0.5	34.8	84.4
3200.000000	47.3	1000.0	1000.000	151.6	H	70.0	1.2	37.1	84.4
4999.900000	49.0	1000.0	1000.000	215.5	V	259.0	3.8	35.4	84.4
9997.333333	47.5	1000.0	1000.000	390.1	V	216.0	10.1	36.9	84.4
16097.933333	52.4	1000.0	1000.000	350.6	V	16.0	18.6	32.0	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: Only worst case channel presented for spurious emissions above 1GHz. 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 and 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: 1073-0319 and 1073-0286 / Test Configuration A

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

February 27 and 28, 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	23.5 – 23.7 °C
Relative Humidity	40.9 -47.1 %
ATM Pressure	98.7 – 99.2 kPa

2.8.7 Additional Observations

- This is a conducted test. The EUT was operated at 5.0VDC nominal USB 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 @ 20°C was performed at the manufacturer declared rated voltage of 5 ±0.25 VDC.
- Reference measurements were performed on mid channels only.
- The maximum frequency deviation was used as frequency offset to verify that the fundamental emission stay within the authorized bands of operation.

2.8.8 Sample Calculation

LTE Band 13 (777 MHz to 787 MHz)

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

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

$$= \frac{779.75775\ \text{MHz} + 784.25004\ \text{MHz}}{2}$$
$$= 782.003895\ \text{MHz}$$

Reference Center Frequency @ 0°C: $= \frac{779.7533\ \text{MHz} + 784.25066\ \text{MHz}}{2}$

$= 782.00198\ \text{MHz}$

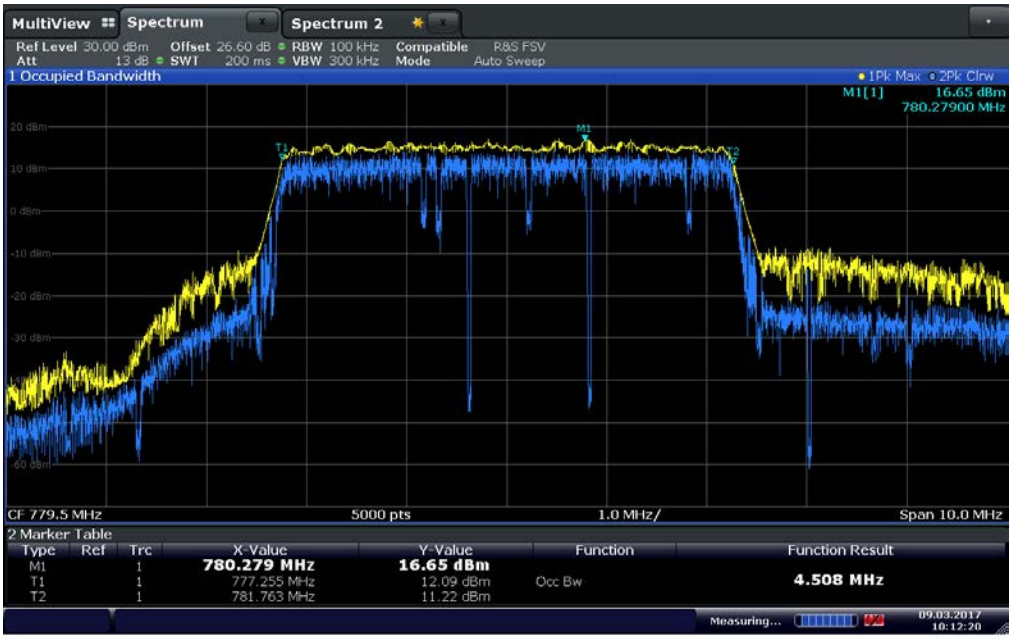
Therefore Frequency Deviation: = 782.003895 MHz – 782.00198 MHz
= 0.001915 MHz

Reference F_L @ 20°C: 777.255 MHz (based from Low Channel lower edge 99% OBW)
Reference F_H @ 20°C: 786.747 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:

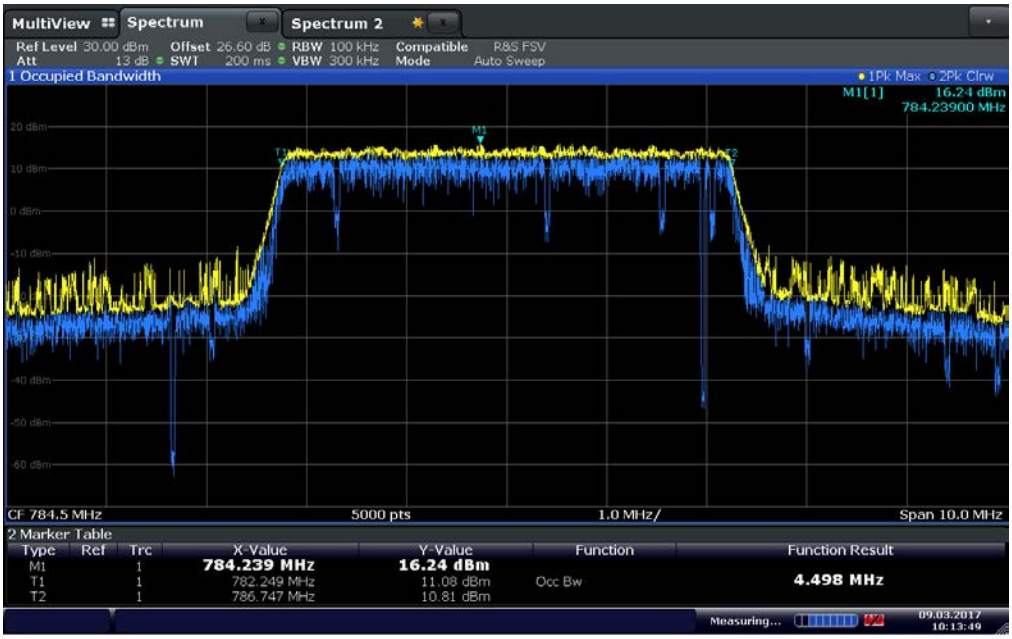
F_L =777.255 MHz – 0.001915 MHz
= 777.253 MHz (within the 777 MHz to 787 MHz Band, complies)

F_H =786.747 MHz + 0.001915 MHz
= 786.749 MHz (within the 777 MHz to 787 MHz Band, complies)



Date: 9.MAR.2017 10:12:20

LTE Band 13 Low Channel 99% OBW showing T_1 (F_L)



Date: 9.MAR.2017 10:13:49

LTE Band 13 High Channel 99% OBW showing T_2 (F_H)

2.8.9 Test Results Summary

Mode	Frequency (MHz)	Deviation (Hz)	Deviation (ppm)	Requirement	Compliance
LTE Band 4	1732.5	0.000166	1.66	Stays within the authorized bands of operation	Complies
LTE Band 13	782.0	0.000245	2.45		Complies

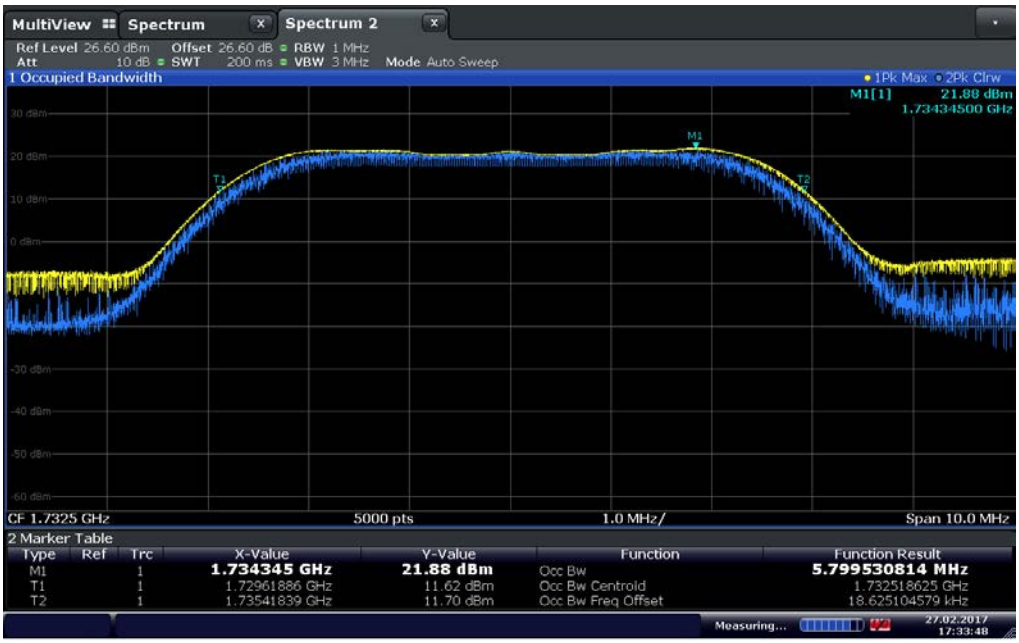
2.8.10 Test Results Table

LTE Band 4					
Temperature	*F_L/T1 (MHz)*	*F_H/T2 (MHz)*	*Center Frequency (MHz)*	*Frequency Deviation (MHz)*	*ppm*
50°C	1729.61883	1735.4193	1732.52	-0.000010	-0.10
40°C	1729.61895	1735.4194	1732.52	-0.000017	-0.17
30°C	1729.61902	1735.4158	1732.52	0.000085	0.85
20°C (+15% NV)	1729.6191	1735.4192	1732.52	-0.000015	-0.15
20°C (NV)	1729.61889	1735.4189	1732.52	0.000000	0.00
20°C (-15% NV)	1729.61895	1735.419	1732.52	-0.000003	-0.03
10°C	1729.61892	1735.4184	1732.52	0.000016	0.16
0°C	1729.61873	1735.4133	1732.52	0.000166	1.66
-10°C	1729.6181	1735.4178	1732.52	0.000056	0.56
-20°C	1729.61706	1735.4192	1732.52	0.000044	0.44
-30°C	1729.61886	1735.4184	1732.52	0.000016	0.16

LTE Band 13					
Temperature	*F_L/T1 (MHz)*	*F_H/T2 (MHz)*	*Center Frequency (MHz)*	*Frequency Deviation (MHz)*	*ppm*
50°C	779.75717	784.25002	782.00	0.000038	0.38
40°C	779.75777	784.25078	782.00	-0.000049	-0.49
30°C	779.75805	784.25156	782.00	-0.000116	-1.16
20°C (+15% NV)	779.75794	784.25134	782.00	-0.000095	-0.95

20°C (NV)	779.75775	784.25004	782.00	0.000000	0.00
20°C (-15% NV)	779.75734	784.24987	782.00	0.000037	0.37
10°C	779.75689	784.25098	782.00	-0.000005	-0.05
0°C	779.7533	784.25066	782.00	0.000245	2.45
-10°C	779.75745	784.25123	782.00	-0.000057	-0.57
-20°C	779.75705	784.24965	782.00	0.000070	0.70
-30°C	779.75774	784.25034	782.00	-0.000019	-0.19

2.8.11 Sample Test Plots



17:33:49 27.02.2017

LTE Band 4 @ -30°C

13:20:15 27.02.2017

LTE Band 13 @ 20°C

2.9 RECEIVER SPURIOUS EMISSIONS

2.9.1 Specification Reference

RSS-Gen 7.0

2.9.2 Standard Applicable

Receivers, as defined in Section 5 of RSS-Gen., are required to comply with the limits of spurious emissions as set out in this section. Receiver emission measurements are to be performed as per the normative test method referenced in Section 3 of 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

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: 1073-0319/ Test Configuration A

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

March 06, 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 Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	23.5 °C
Relative Humidity	34.4 %
ATM Pressure	99.7 kPa

2.10.7 Additional Observations

- Verification performed on the host support laptop.
- Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.10.8 for sample computation

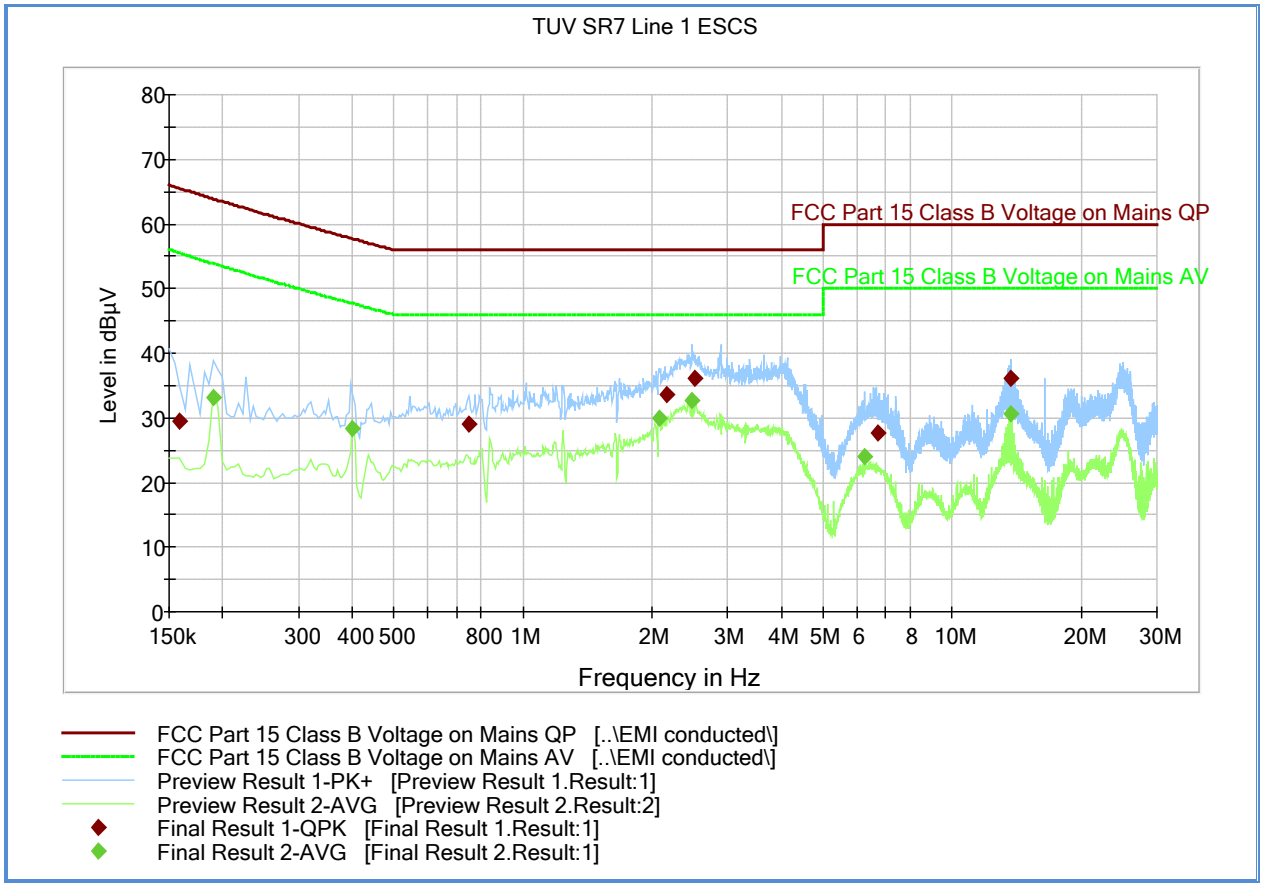
2.10.8 Sample Computation (Conducted Emission – Quasi Peak)

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.

2.10.10 120VAC 60Hz (Line 1)



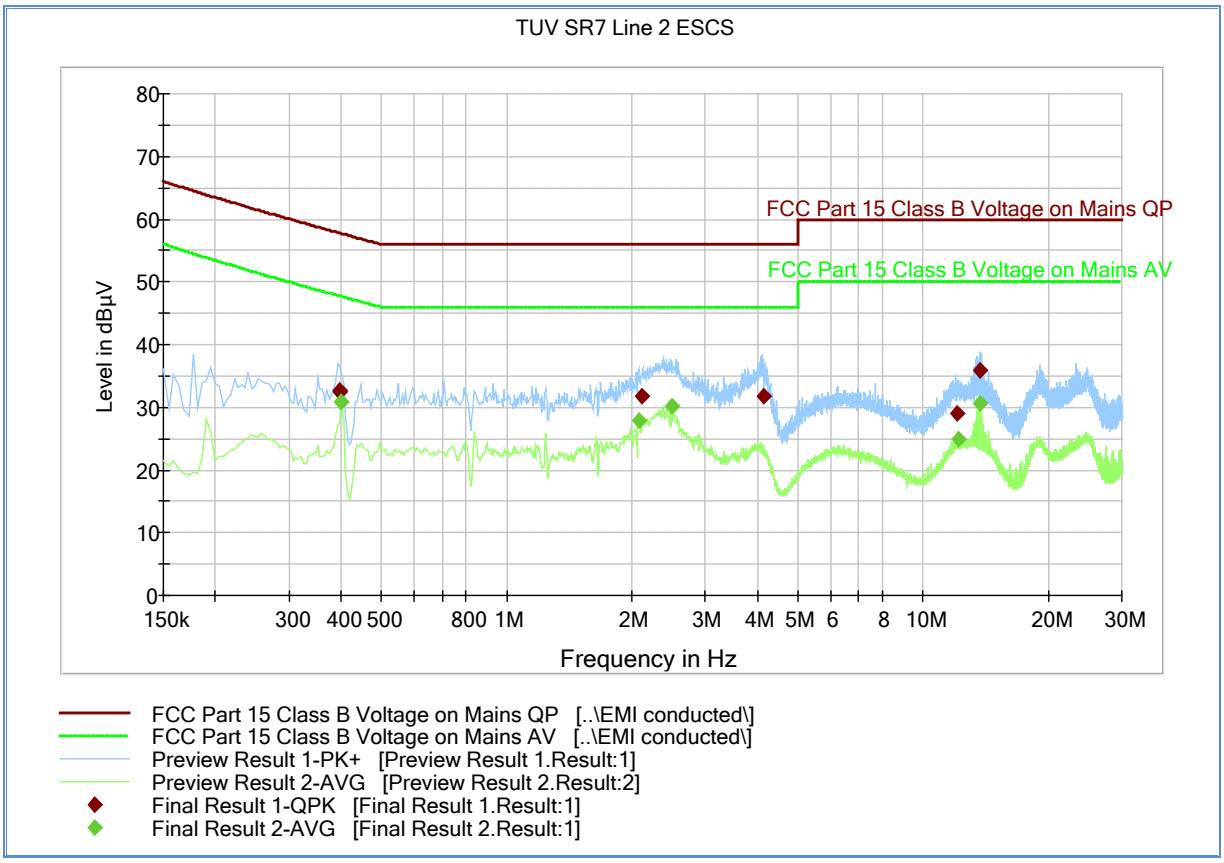
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.159000	29.5	1000.0	9.000	Off	L1	20.2	36.0	65.5
0.748500	29.1	1000.0	9.000	Off	L1	20.0	26.9	56.0
2.166000	33.6	1000.0	9.000	Off	L1	20.0	22.4	56.0
2.512500	36.2	1000.0	9.000	Off	L1	20.1	19.8	56.0
6.706500	27.7	1000.0	9.000	Off	L1	20.1	32.3	60.0
13.659000	36.0	1000.0	9.000	Off	L1	20.2	24.0	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.190500	33.1	1000.0	9.000	Off	L1	20.1	20.7	53.9
0.402000	28.3	1000.0	9.000	Off	L1	20.0	19.4	47.7
2.080500	30.0	1000.0	9.000	Off	L1	20.0	16.0	46.0
2.481000	32.8	1000.0	9.000	Off	L1	20.1	13.2	46.0
6.265500	24.0	1000.0	9.000	Off	L1	20.1	26.0	50.0
13.659000	30.7	1000.0	9.000	Off	L1	20.2	19.3	50.0

2.10.11 120VAC 60Hz (Line 2)



Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.397500	32.7	1000.0	9.000	Off	N	20.0	25.0	57.8
0.397500	32.6	1000.0	9.000	Off	N	20.0	25.2	57.8
2.121000	31.8	1000.0	9.000	Off	N	20.0	24.2	56.0
4.155000	31.7	1000.0	9.000	Off	N	20.1	24.3	56.0
12.066000	29.1	1000.0	9.000	Off	N	20.2	30.9	60.0
13.659000	35.9	1000.0	9.000	Off	N	20.2	24.1	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.402000	30.9	1000.0	9.000	Off	N	20.0	16.8	47.7
0.402000	30.9	1000.0	9.000	Off	N	20.0	16.8	47.7
2.080500	27.9	1000.0	9.000	Off	N	20.0	18.1	46.0
2.485500	30.2	1000.0	9.000	Off	N	20.1	15.8	46.0
12.165000	24.9	1000.0	9.000	Off	N	20.2	25.1	50.0
13.659000	30.5	1000.0	9.000	Off	N	20.2	19.5	50.0

SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

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

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
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
7562	Wideband Radio Communication Tester	CMW 500	1201.0002k50 /103829	Rhode & Schwarz	NCR. For signalling purposes only	
8800	Broadband Resistive Power Divider	1506A	RR002	Weinschel Corp.	Verified by 7582 and 7608	
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
1051	Double-ridged waveguide horn antenna	3115	9408-4329	EMCO	03/21/16	03/21/17
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	02/09/17	02/09/18
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	05/16/16	05/16/17
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	06/29/16	06/29/17
8817	800 MHz to 1GHz Notch Filter	BRM50706	019	Micro-Tronics	Verified by 1003 and 7582	
8806	1.8GHz to 2.0GHz Notch Filter	BRM50707	005	Micro-Tronics	Verified by 1003 and 7582	
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	Verified by 1003 and 7582	
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	Verified by 1003 and 7582	
AC Conducted Emissions						
1024	EMI Test Receiver	ESCS 30	847793/001	Rhode & Schwarz	09/07/16	09/07/17
7567	LISN	FCC-LISN-50-25-2-10	120304	Fischer Custom Comm.	11/05/16	11/05/17
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	Verified by 7582 and 7608	
8824	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	Verified by 7582 and 7608	
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
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
	DC Power Supply	35010M	D102007S	Protek	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	0.57	0.33	0.11
2	Cables	Rectangular	0.50	0.29	0.08
3	Combiners	Rectangular	1.20	0.69	0.48
4	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	0.77
				Coverage Factor (k):	1.96
				Expanded Uncertainty:	1.51

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	Rectangular	2.70	1.56	2.43
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	1.78
				Coverage Factor (k):	2
				Expanded Uncertainty:	3.57

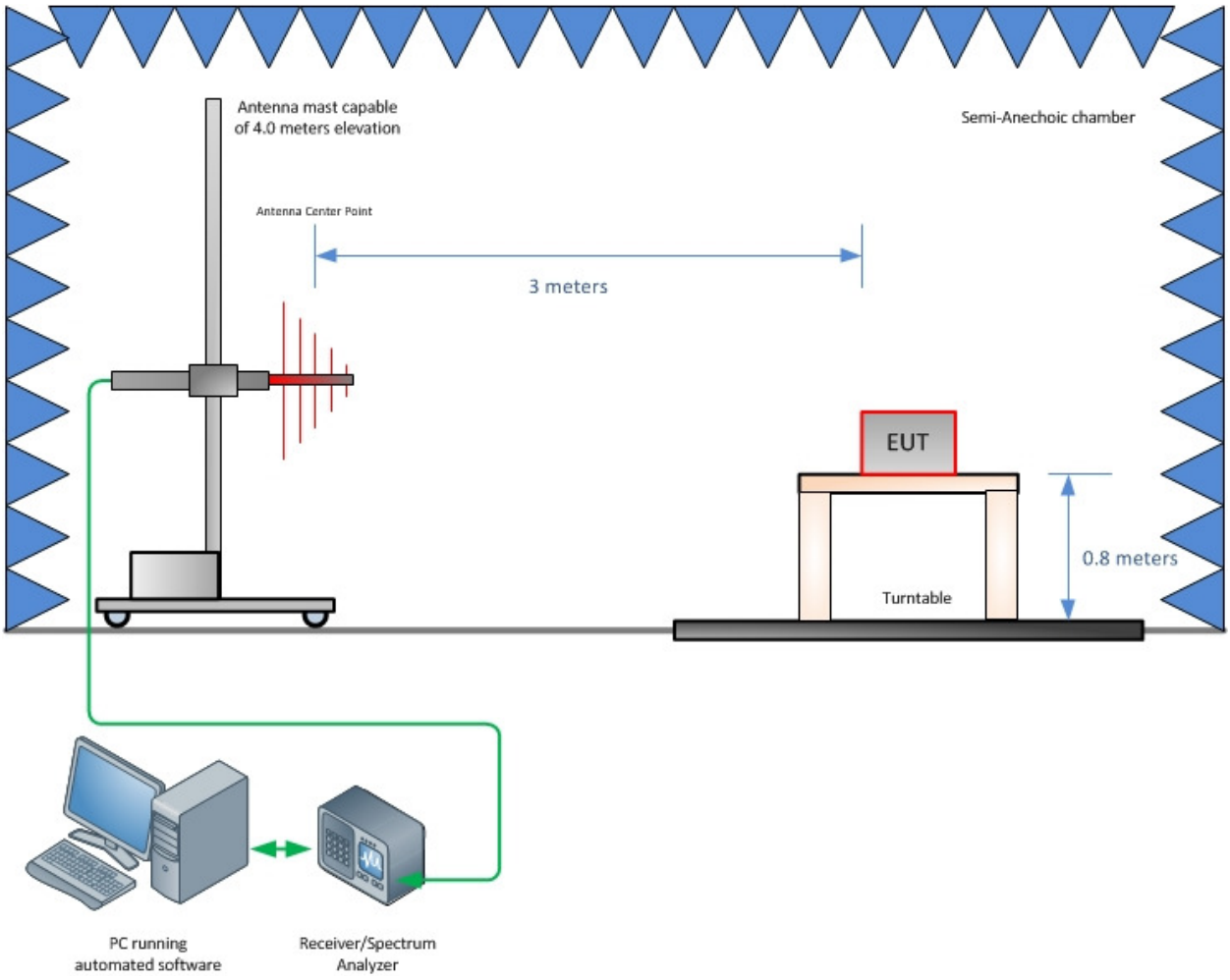
3.2.4 Radiated Measurements (Above 1GHz)

	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	Rectangular	2.70	1.56	2.43
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	1.78
				Coverage Factor (k):	2
				Expanded Uncertainty:	3.57

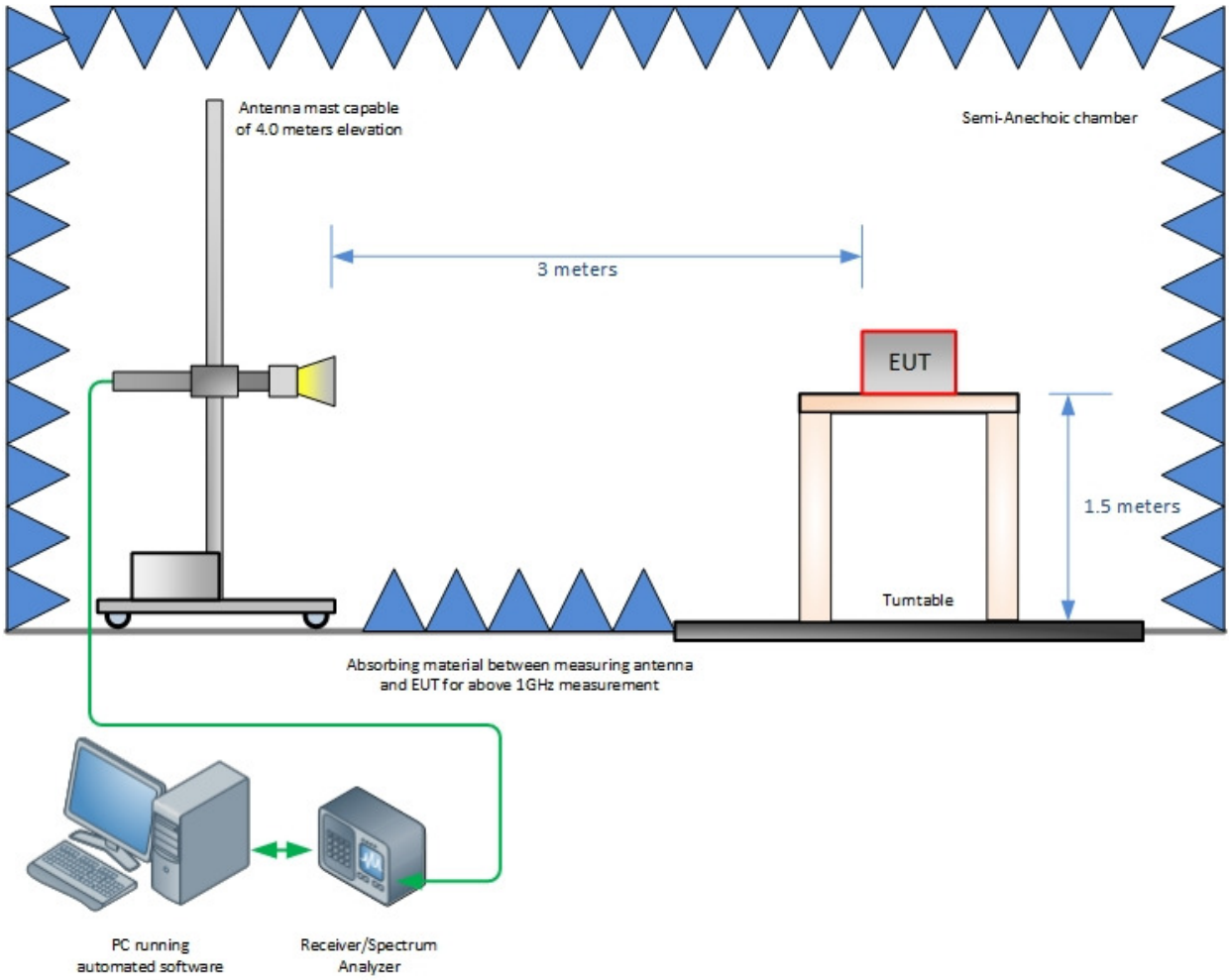
SECTION 4

DIAGRAM OF TEST SETUP

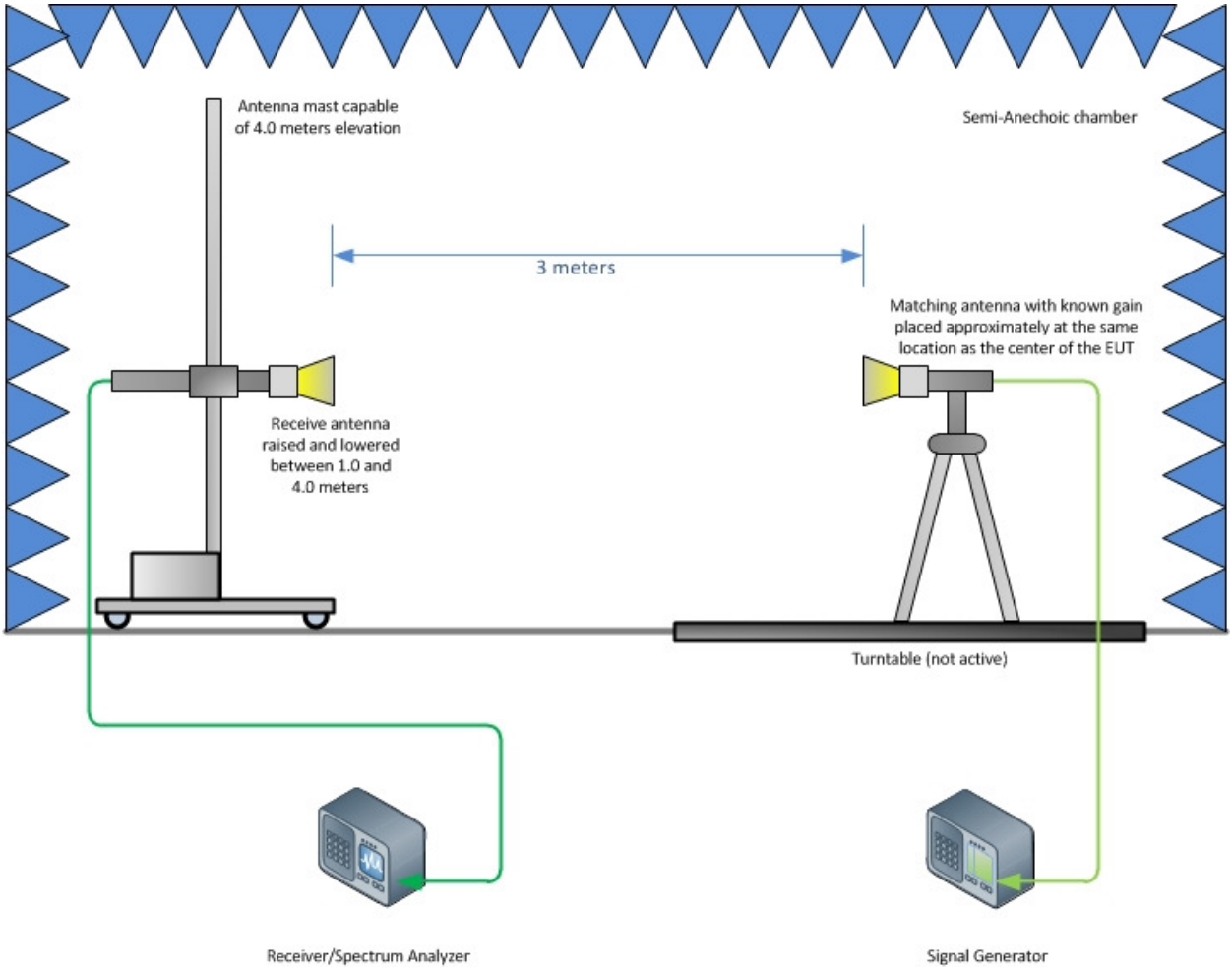
4.1 TEST SETUP DIAGRAM



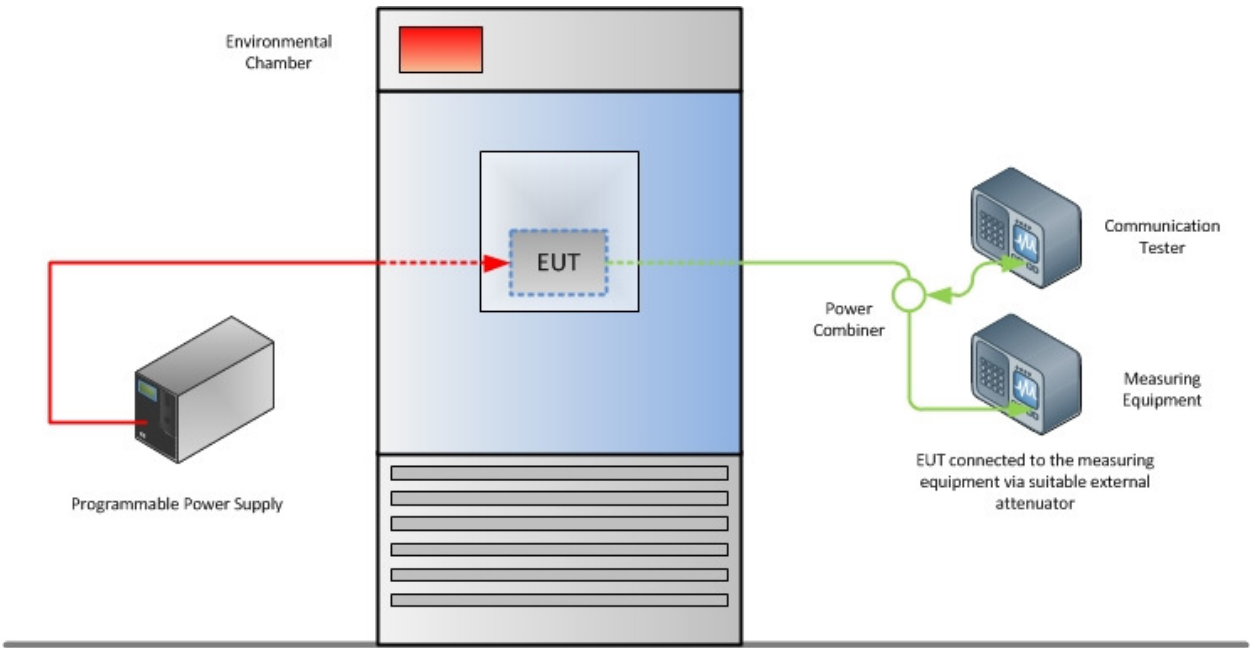
Radiated Emission Test Setup (Below 1GHz)



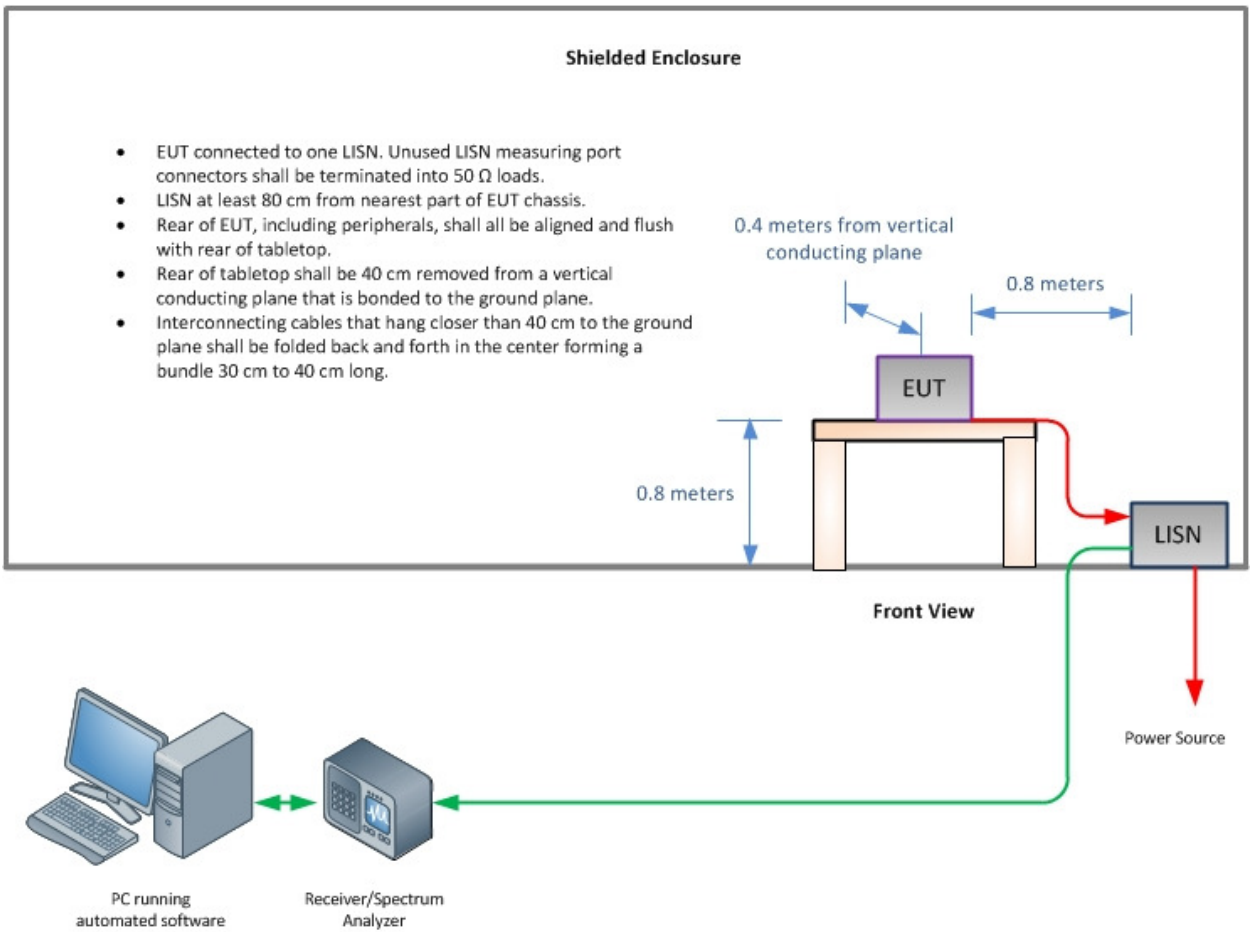
Radiated Emission Test Setup (Above 1GHz)



Substitution Test Method (Above 1GHz, if applicable)



Frequency Stability Test Comfiguration



Conducted Emissions Test Configuration (if applicable)

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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