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# Report On

Application for Grant of Equipment Authorization of the
Novatel Wireless Inc.
MIFI7000 Wireless Hotspot Modem

FCC CFR 47 Part 2 and 27
RSS-139 Issue 3: 2015

**Report No. SD72131191-0917** **October 2017**

| | |
|---|---|
| **REPORT ON** | Radio Testing of the<br>Novatel Wireless Inc.<br>MIFI7000 Wireless Hotspot Modem |
| **TEST REPORT NUMBER** | SD72131191-0917 |
| **PREPARED FOR** | Novatel Wireless Inc.<br>9645 Scranton Road, Suite 205<br>San Diego, CA 92121<br>USA |
| **CONTACT PERSON** | Roman Olmos<br>Senior Regulatory Engineer<br>(858) 812-3400<br>rolmos@nvtl.com |
| **PREPARED BY** | Alex Chang<br>**Name**<br>Authorized Signatory<br>Title: EMC/Wireless Test Engineer |
| **APPROVED BY** | Ferdinand S. Custodio<br>**Name**<br>Authorized Signatory<br>Title: EMC/Senior Wireless Test Engineer |
| **DATED** | October 16, 2017 |



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

**Revision History**

| SD72131191-0917<br>Novatel Wireless Inc.<br>MIFI7000 Wireless Hotspot Modem | | | | | |
|---|---|---|---|---|---|
| DATE | OLD REVISION | NEW REVISION | REASON | PAGES AFFECTED | APPROVED BY |
| 10/16/2017 | — | Initial Release | | | Ferdinand Custodio |
| | | | | | |
| | | | | | |
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**CONTENTS**

**Section** **Page No**





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**SECTION 1**

**REPORT SUMMARY**

Radio Testing of the
Novatel Wireless Inc.
MIFI7000 Wireless Hotspot Modem



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## 1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Novatel Wireless Inc. MIFI7000 Wireless Hotspot Modem to the requirements of the following:

- FCC CFR 47 Part 2 and 27
- RSS-Gen Issue 4: 2014
- RSS-139 Issue 3: 2015

| | |
|---|---|
| Objective | To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out. |
| Manufacturer | Novatel Wireless Inc. |
| Product Marketing Name | MiFi 7000 |
| Model Number(s) | MIFI7000 |
| FCC ID Number | PKRNVWMIFI7000 |
| IC Number | 3229A-MIFI7000 |
| Serial Number(s) | SZ1901179000375 |
| Number of Samples Tested | 1 |
| Test Specification/Issue/Date | • FCC CFR 47 Part 2 and 27 (October 1, 2016)<br>• RSS-139 Issue 3: July 2015 – Advanced Wireless Services (AWS) Equipment Operating in the Bands 1710-1780 MHz and 2110-2180 MHz<br>• RSS-Gen Issue 4: November 2014 - General Requirements for Compliance of Radio Apparatus<br>• ANSI/TIA-603-C-2004 – Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards<br>• KDB 971168 D01 Power Meas License Digital Systems v02r02 (October 17, 2014) - Measurement Guidance For Certification Of Licensed Digital Transmitters<br>• KDB 412172 D01 Determining ERP and EIRP v01r01 (August 07, 2105) – Guidelines For Determining The Effective Radiated Power (ERP) And Equivalent Isotropically Radiated Power (EIRP) Of An RF Transmitting System |
| Start of Test | September 19, 2017 |
| Finish of Test | September 25, 2017 |
| Name of Engineer(s) | Xiaoying Zhang<br>Alex Chang |
| Related Document(s) | Supporting documents for EUT certification are separate exhibits. |



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## 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 | FCC Part Sections(s) | RSS Section(s) | Test Description | Result |
|---|---|---|---|---|
| 2.1 | 2.1046 (a) and (c) | RSS-139 (6.5) | Transmitter Conducted Output Power | Compliant |
| 2.2 | 2.1046<br>27.50 (d)(4) | RSS-139 (6.5) | Equivalent Isotropic Radiated Power | Compliant |
| 2.3 | 2.1049<br>27.53 (h)(3) | RSS-Gen (6.6) | Occupied Bandwidth | Compliant |
| 2.4 | 27.50 (d)(5) | RSS-139 (6.5) | Peak-Average Ratio | Compliant |
| 2.5 | 2.1053<br>27.53 (h)(1) and (3) | RSS-139 (6.6) | Band Edge | Compliant |
| 2.6 | 2.1053<br>27.53 (h)(1) and (3) | RSS-139 (6.6) | Conducted Spurious Emissions | Compliant |
| 2.7 | 27.53 (c)(2), (g)(h)(1) and (m)(4) | RSS-139 (6.6) | Field Strength Of Spurious Radiation | Compliant |
| 2.8 | 2.1055<br>27.54 | RSS-139 (6.4) | Frequency Stability | Compliant |
| - | - | RSS-Gen 7.0 | Receiver Spurious Emissions | N/A |

N/A: Not Applicable. Not a stand-alone receiver.



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## 1.3 PRODUCT INFORMATION

### 1.3.1 EUT General Description

The Equipment Under Test (EUT) was a Novatel Wireless Inc. MiFi 7000 Wireless Hotspot Modem. The EUT is a Wireless Hotspot Modem supporting 2G/3G/4G Technologies. The EUT comes with a USB Port. WCDMA Band 4 was verified and evaluated only in this test report.

### 1.3.2 Technical Description

| | |
|---|---|
| EUT Description | Wireless Hotspot Modem |
| Model Number(s) | MIFI7000 |
| Rated Voltage | 3.8V, 4400mAh (Rechargeable Li-Ion battery pack) |
| Mode Verified | WCDMA Band 4: 1710-1755 MHz |
| Capability | CDMA1xRTT, EvDO Rev.0/Rev.A<br>GPRS/EGPRS<br>WCDMA<br>LTE |
| Primary Unit (EUT) | ☒ Production<br>☐ Pre-Production<br>☐ Engineering |

(Client declaration, max. antenna gain covered under this test report)

| WCDMA Bands | Frequency(ies) | Antenna Gains |
|---|---|---|
| Band 4 | 1710-1755 MHz | 1.3 dBi |

### 1.3.3 Transmit Frequency Table

| WCDMA Band 4 | | | | | |
|---|---|---|---|---|---|
| Technology/Mode | Transmit Channel(s) | Transmit Frequency (MHz) | Emission Designator | EIRP * | |
| | | | | Max Power (dBm) | Max Power (Watts) |
| WCDMA | 1312 | 1710-1750 | 4M16F9W | 24.80 | 0.3 |
| | 1413 | 1710-1750 | 4M16F9W | 24.80 | 0.3 |
| | 1513 | 1710-1750 | 4M14F9W | 24.80 | 0.3 |

* EIRP data were documented based on manufacture declared max output power tune up procedure.

## 1.4 EUT TEST CONFIGURATION

### 1.4.1 Test Configuration Description

| Test Configuration | Description |
|---|---|
| A | Conducted antenna port measurement. EUT Tx at a max power and powered by the internal battery and/or USB via AC Adapter. |
| B | Radiated test setup/case spurious emissions. Antenna port terminated by the call box. |

### 1.4.2 EUT Exercise Software

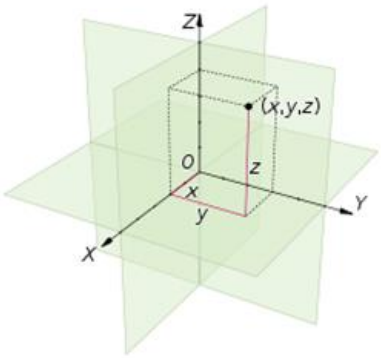
EUT is controlled by a CMW 500 Wideband Radio Communication Tester. There are no other test software used during verification.

### 1.4.3 Support Equipment and I/O cables

| Manufacturer | Equipment/Cable | Description |
|---|---|---|
| — | — | — |

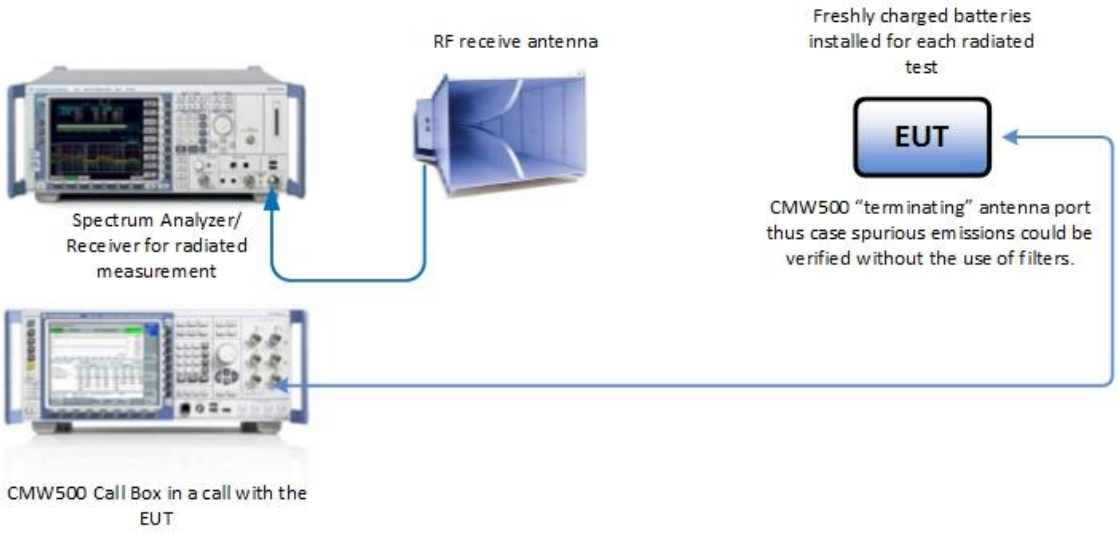
### 1.4.4 Worst Case Configuration

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

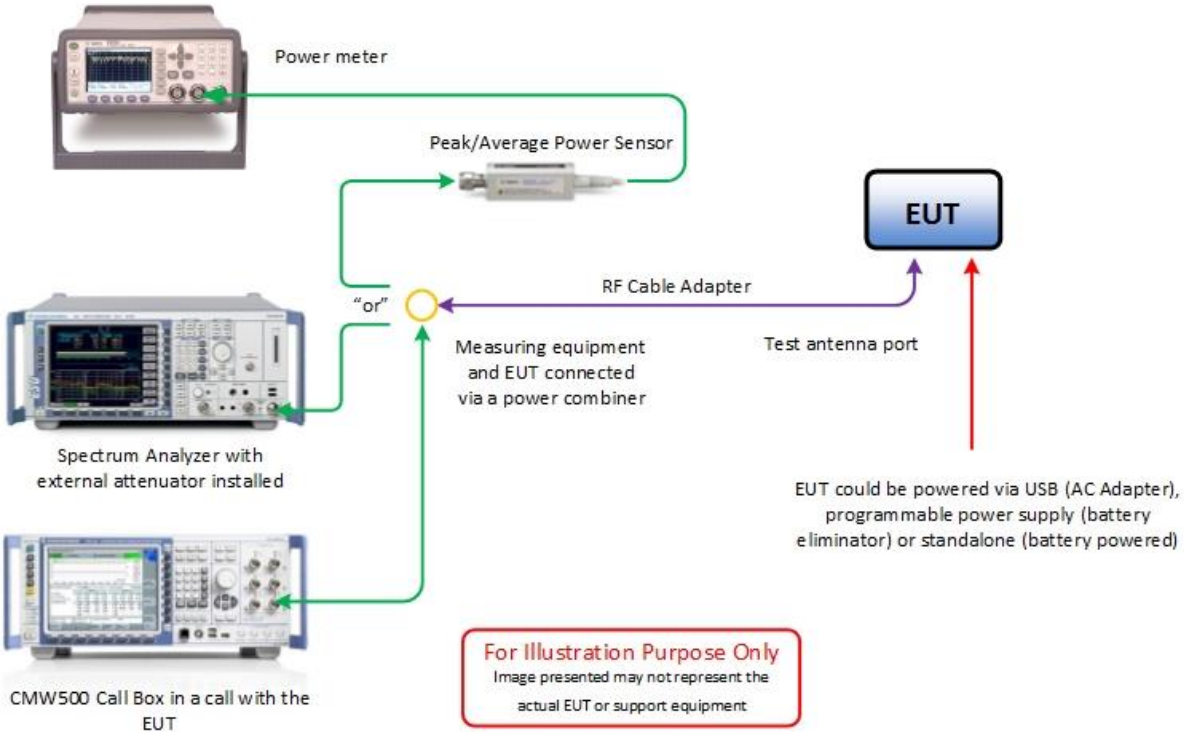


### 1.4.5 Simplified Test Configuration Diagram

## Radiated Test Configuration




## Conducted (Antenna Port) Test Configuration



## 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: SZ1901179000375 | | |
| None | — | — |

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.

For conducted and radiated emissions, the equipment under test (EUT) was configured to measure its highest possible emission level. 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 – Designation 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 Designation is US1146.

### 1.9.2 Innovation, Science and Economic Development Canada (ISED) Registration No.: 3067A-1 & 22806-1

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego Rancho Bernardo) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A-1.

The 3m Semi-anechoic chamber of TUV SUD America Inc. (San Diego Mira Mesa) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 22806-1.



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## 1.10 SAMPLE CALCULATIONS

### 1.10.1 WCDMA Emission Designator

Emission Designator = 4M15F9W
WCDMA BW = 4.15 MHz
F = Frequency Modulation
9 = Composite Digital Info
W = Combination (Audio/Data)

### 1.10.2 Spurious Radiated Emission (below 1GHz)

| | | | |
|---|---|---|---|
| Measuring equipment raw measurement (dBµV) @ 30 MHz | | | 24.4 |
| Correction Factor (dB) | Asset# 1066 (cable) | 0.3 | -12.6 |
| | Asset# 1172 (cable) | 0.3 | |
| | Asset# 1016 (preamplifier) | -30.7 | |
| | Asset# 1175(cable) | 0.3 | |
| | Asset# 1002 (antenna) | 17.2 | |
| **Reported Quasi Peak 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 Inc.
MIFI7000 Wireless Hotspot Modem

## 2.1 TRANSMITTER CONDUCTED POWER MEASUREMENTS

### 2.1.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1046 (a) and (c)
RSS-139, Clause 6.5

### 2.1.2 Standard Applicable

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

### 2.1.3 Equipment Under Test and Modification State

Serial No: SZ1901179000375 / Test Configuration A

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

September 19, 2017 / XYZ

### 2.1.5 Test Equipment Used

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

### 2.1.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 26.1 °C |
| Relative Humidity | 49.0 % |
| ATM Pressure | 98.7 kPa |

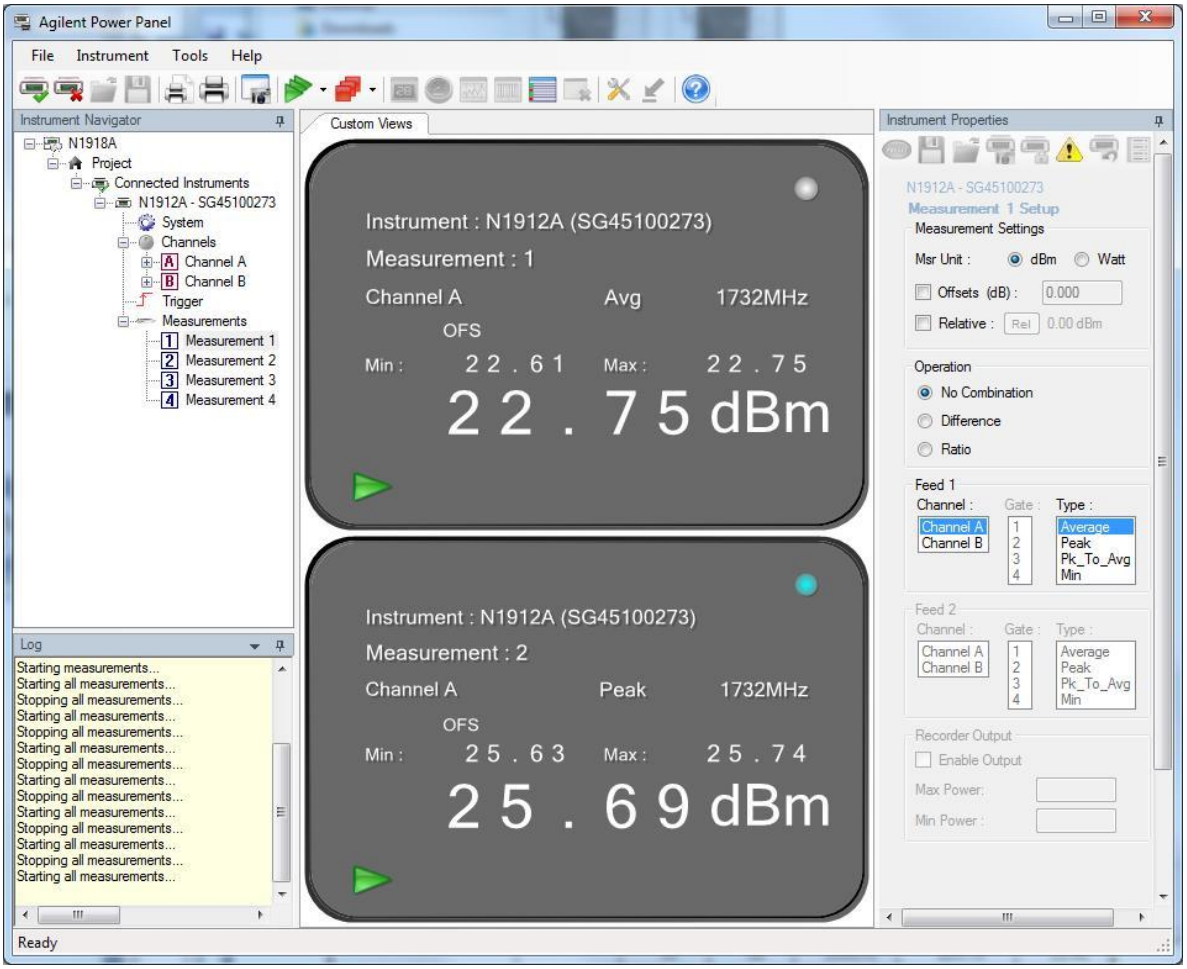
### 2.1.7 Additional Observations

- This is a conducted test using an average power meter.
- The path loss for WCDMA Band 4 were measured and entered as a level offset.

### 2.1.8 Test Results

| Channels | Frequency (MHz) | Tx Average (dBm) | Tx Peak (dBm) |
|---|---|---|---|
| 1312 | 1712.4 | 22.14 | 24.96 |
| 1413 | 1732.6 | 22.75 | 25.69 |
| 1513 | 1752.6 | 21.84 | 25.07 |

### 2.1.9 Sample Test Measurement Screen




**Middle Channel 1732.6 MHz Output Power**

## 2.2 EQUIVALENT ISOTROPIC RADIATED POWER

### 2.2.1 Specification Reference

FCC Part 2, Clause 2.1046
FCC Part 27, Clause 27.50 (d)(4),
RSS-139, Clause 6.5

### 2.2.2 Standard Applicable

(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. Fixed stations operating in the 1710-1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum necessary for successful communications.
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.

### 2.2.3 Equipment Under Test

Serial No: SZ1901179000375, Test Configuration (N/A, calculation only)

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

October 04, 2017 / AC

### 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:

$$EIRP = P_T + G_T - L_C$$

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 (Power measurement performed directly at the primary antenna port. The loss between the LTE module and the primary antenna port is considered negligible).

### 2.2.6 Test Results

See attached table.

| Channels | Frequency (MHz) | Antenna Gain (dBi) | EIRP | | | |
|---|---|---|---|---|---|---|
| | | | (dBm) | (W) | Limit (dBm) | Margin (dB) |
| 1312 | 1712.4 | 1.3 | 23.44 | 0.22 | 30 | 6.56 |
| 1413 | 1732.6 | 1.3 | 24.05 | 0.25 | 30 | 5.95 |
| 1513 | 1752.6 | 1.3 | 23.14 | 0.21 | 30 | 6.86 |

## 2.3 OCCUPIED BANDWIDTH

### 2.3.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1049
FCC 47 CRF Part 27, Clause 27.53 (h) (3)
RSS-Gen Clause 6.6

### 2.3.2 Standard Applicable

The transmitted signal bandwidth shall be reported as the 99% emission bandwidth, that is the frequency bandwidth suuch that, below its lower and above its upper frequency limits, the mean powers radiated are eqch equal to 0.5 percent of the total mean power radiated by a give emission. 26dB Bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated by at least 26 dB below the transmitter power.

Using the occupied bandwidth meansurement function in the spectrum analyzer, the 99% occupied bandwith was measured.

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

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be at least 3x RBW.

### 2.3.3 Equipment Under Test and Modification State

Serial No: SZ1901179000375 / Test Configuration A

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

September 19, 2017 / XYZ

### 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 Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 26.1 °C |
| Relative Humidity | 49.0 % |
| ATM Pressure | 98.7 kPa |

### 2.3.7 Additional Observations

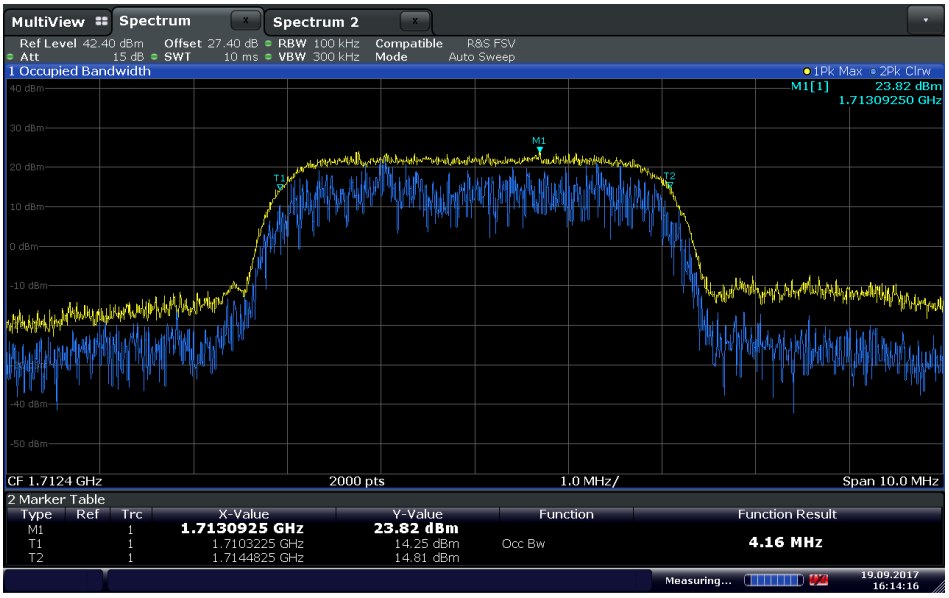
- This is a conducted test. Test procedure is per Section 4.0 of KDB971168 D01 (Power Meas License Digital Systems v02r02).
- Both relative 26dB BW and 99% OBW presented.
- All channels were verified and presented.

### 2.3.8 Test Results

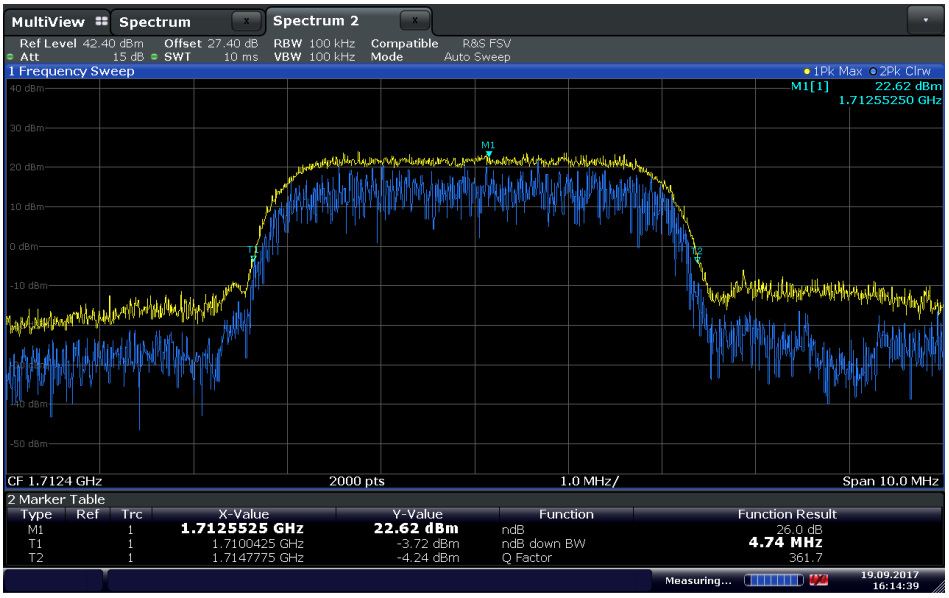
| Channels | Frequency (MHz) | 99% OBW (MHz) | 26dB BW (MHz) |
|---|---|---|---|
| 1312 | 1712.4 | 4.16 | 4.74 |
| 1413 | 1732.6 | 4.16 | 4.76 |
| 1513 | 1752.6 | 4.145 | 4.70 |

### 2.3.9 Test Measurement Plots

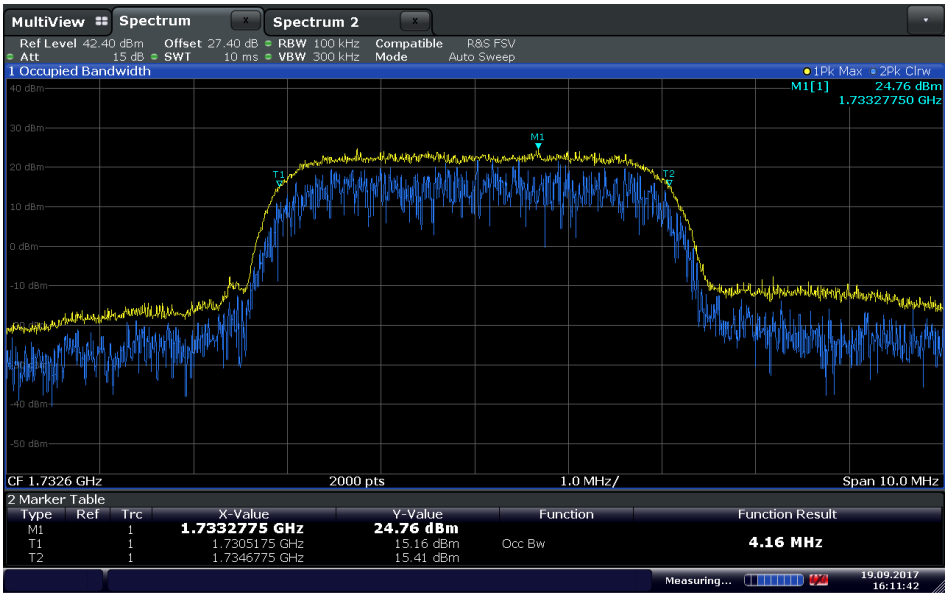
**Low Channel 1712.4 MHz 99%OBW**



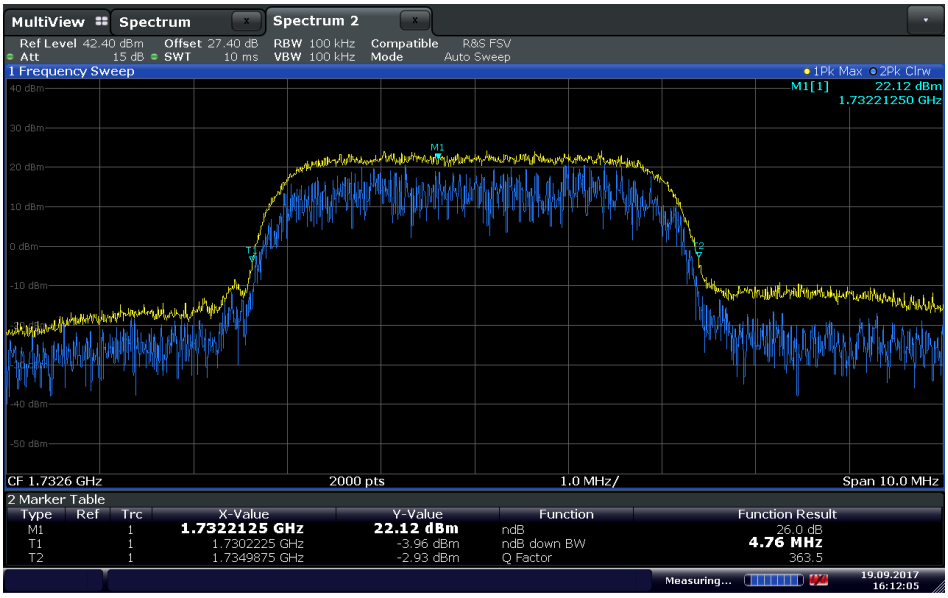

**Low Channel 1712.4 MHz 26dB BW**



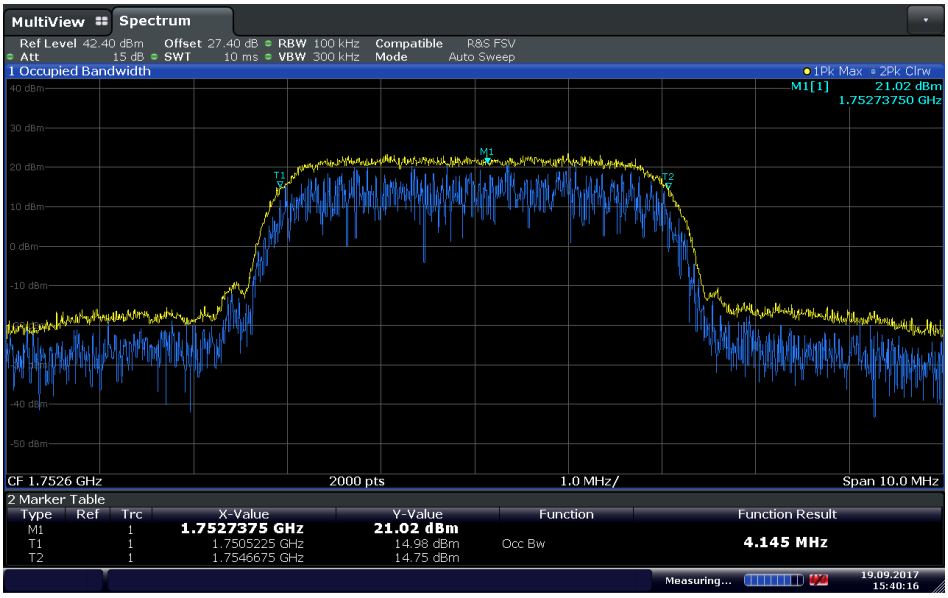
## Middle Channel 1732.6 MHz 99%OBW



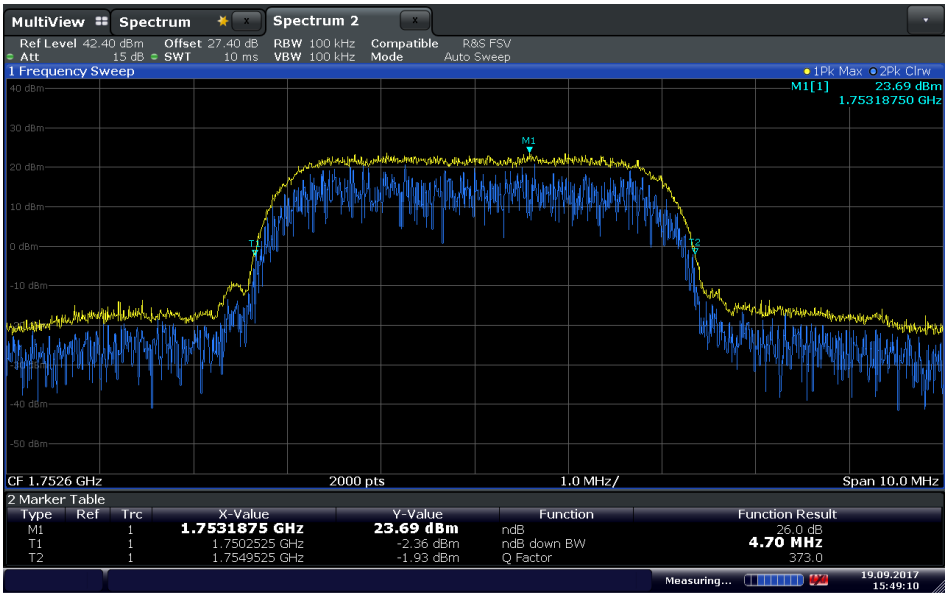

## Middle Channel 1732.6 MHz 26dB BW



| High Channel 1752.6 MHz 99%OBW |
|---|




| High Channel 1752.6 MHz 26dB BW |
|---|



## 2.4 PEAK-AVERAGE POWER RATIO

### 2.4.1 Specification Reference

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

### 2.4.2 Standard Applicable

In measuring transmissions in this band using an average power technique,the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB.

### 2.4.3 Equipment Under Test and Modification State

Serial No: SZ1901179000375 / Test Configuration A

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

September 19, 2017 / XYZ

### 2.4.5 Test Equipment Used

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

### 2.4.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 26.1 °C |
| Relative Humidity | 49.0 % |
| ATM Pressure | 98.7 kPa |

### 2.4.7 Additional Observations

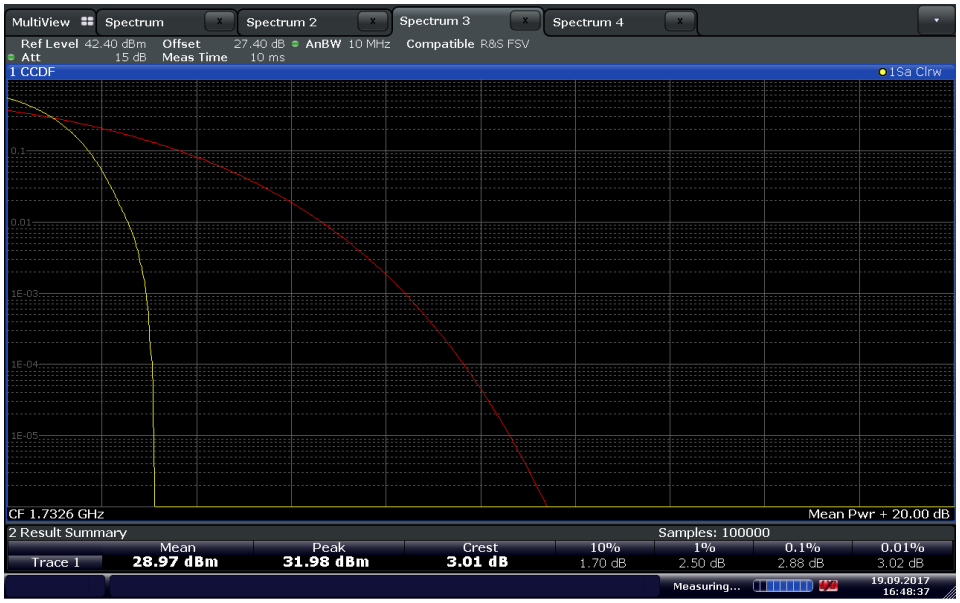
- This is a conducted test. Test procedure is per Section 5.7.1 of KDB971168 (D01 Power Meas License Digital Systems v02r02).
- Measurement was done using the Spectrum Analyzer's Complementary Cumulative Distribution Function (CCDF) measurement profile. The built-in function is used to determine the largest deviation between the average and the peak power of the EUT in a given bandwidth (crest factor or peak-to-average ratio) A CCDF curve depicts the probability of the peak signal amplitude exceeding the average power level. Most contemporary measurement instrumentation include the capability to produce CCDF curves for an input signal provided that the instrument's resolution bandwidth can be set wide enough to accommodate the entire input signal bandwidth.
- There are no measured PAR levels greater than 13dB.

### 2.4.8 Test Results

| Channels | Frequency (MHz) | PAR (dB) | Limit (dB |
|---|---|---|---|
| 1312 | 1712.4 | 2.74 | 13 |
| 1413 | 1732.6 | 3.01 | 13 |
| 1513 | 1752.6 | 3.45 | 13 |

### 2.4.9 Sample Test Plots

**Middle Channel 1732.6 MHz PAR**



## 2.5 BAND EDGE

### 2.5.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1053
FCC 47 CFR Part 27, Clause 27.53 (h)(1), (3)
RSS-139, Clause 6.6

### 2.5.2 Standard Applicable

(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 $43 + 10 \log_{10}$ (P) dB.

### 2.5.3 Equipment Under Test and Modification State

Serial No: SZ1901179000375 / Test Configuration A

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

September 19, 2017 / XYZ

### 2.5.5 Test Equipment Used

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

### 2.5.6 Environmental Conditions/ Test Location

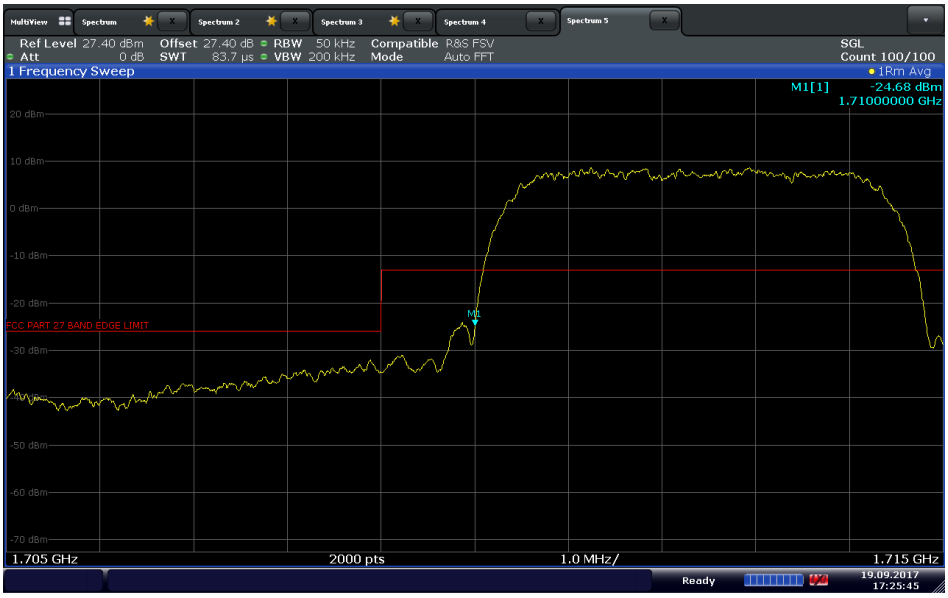
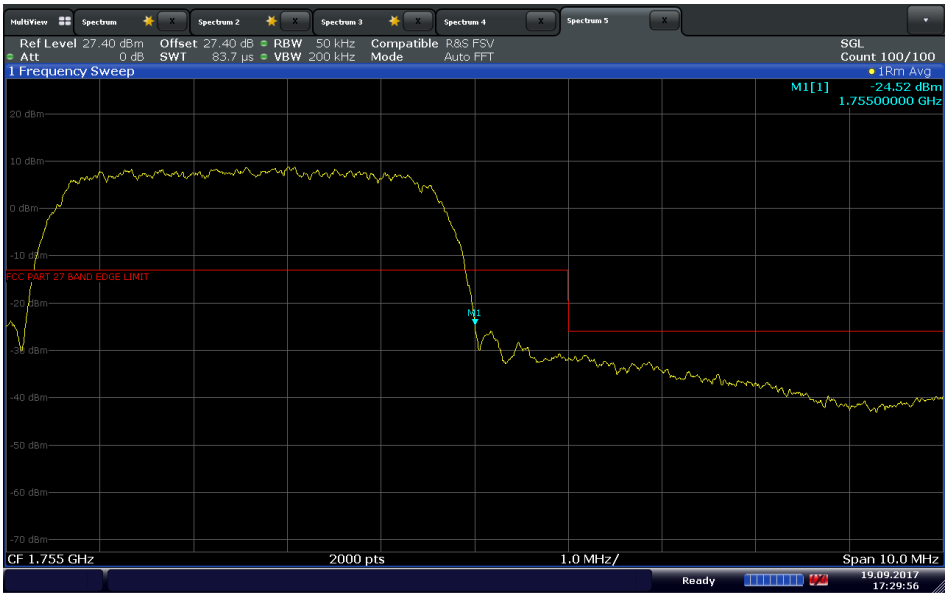
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 26.1 °C |
| Relative Humidity | 49.0 % |
| ATM Pressure | 98.7 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).
- The center frequency of the spectrum is the band edge frequency.
- RBW is set to 50 kHz (1% of EBW) and VBW is set to 3X RBW.

### 2.5.8 Test Results

| Low Channel 1712.4MHz Band Edge @ 1710 MHz |
|---|
|  |
| **High Channel 1752.5MHz Band Edge @ 1755 MHz** |
|  |

## 2.6 CONDUCTED SPURIOUS EMISSIONS

### 2.6.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1053
FCC 47 CFR Part 27, Clause 27.53 (h)(1), (3)
RSS-139, Clause 6.6

### 2.6.2 Standard Applicable

(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 $43 + 10 \log_{10}$ (P) dB.

### 2.6.3 Equipment Under Test and Modification State

Serial No: SZ1901179000375 / Test Configuration A

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

September 19, 2017 / XYZ

### 2.6.5 Test Equipment Used

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

### 2.6.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

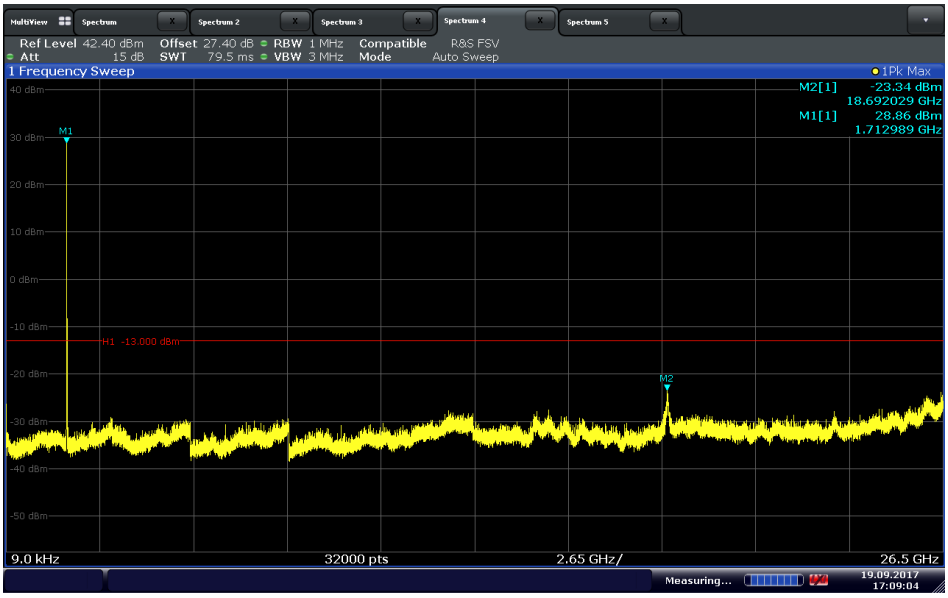
| | |
|---|---|
| Ambient Temperature | 26.1 °C |
| Relative Humidity | 49.0 % |
| ATM Pressure | 98.7 kPa |

### 2.6.7 Additional Observations

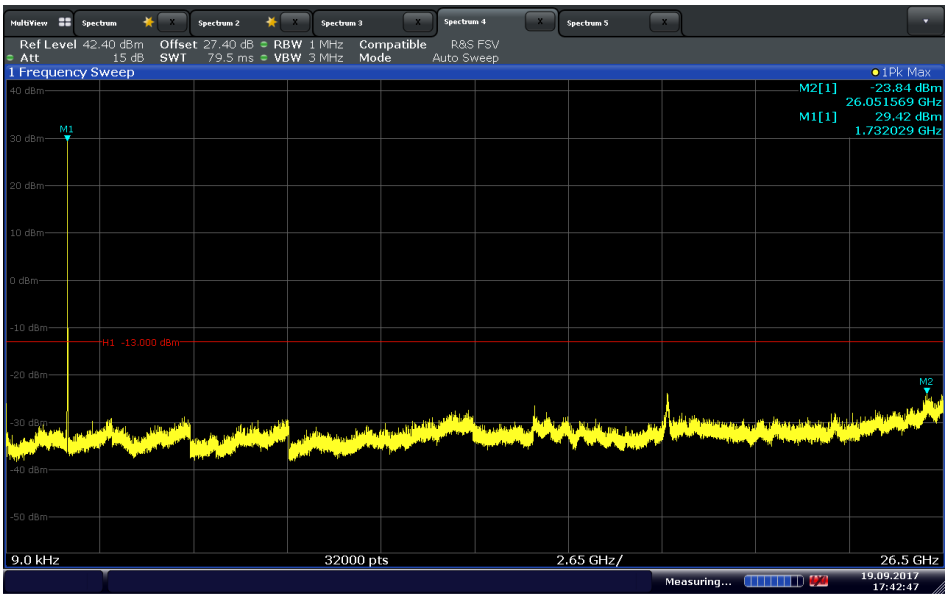
- This is a conducted test.
- The spectrum was searched from 30MHz to at least the $10^{th}$ harmonic up to 26.5GHz.
- The detector was set to Peak, trace was set to max hold as the worst case.
- Low, Middle and High channels were verified and presented.

### 2.6.8 Test Results

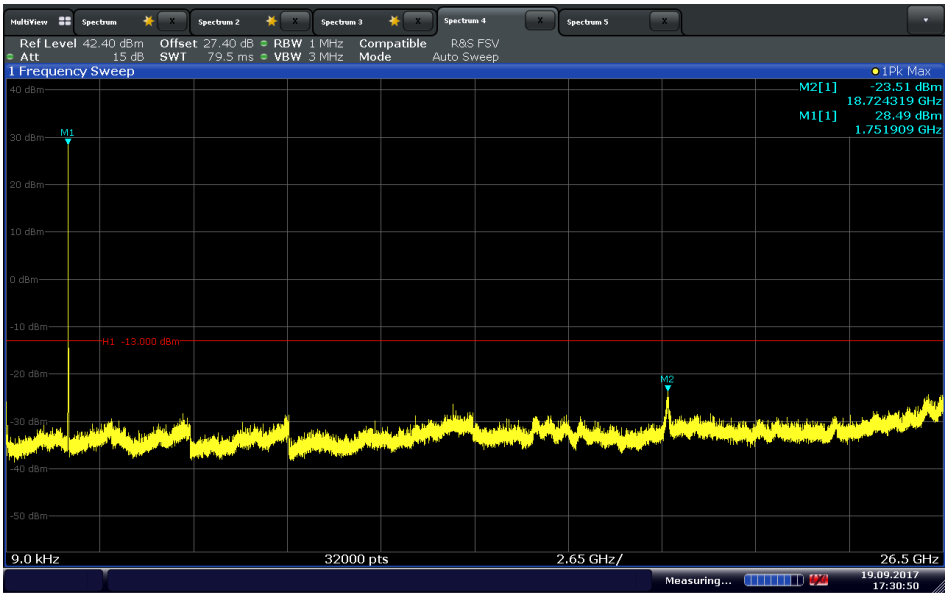
**Low Channel 1712.4MHz Conducted Spurious Emissions**




**Middle Channel 1732.6MHz Conducted Spurious Emissions**



| High Channel 1752.6MHz Conducted Spurious Emissions |
|---|



## 2.7 FIELD STRENGTH OF SPURIOUS RADIATION

### 2.7.1 Specification Reference

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

### 2.7.2 Standard Applicable

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

### 2.7.3 Equipment Under Test and Modification State

Serial No: SZ1901179000375 / Test Configuration B

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

September 25, 2017 / AC

### 2.7.5 Test Equipment Used

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

### 2.7.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 26.5 °C |
| Relative Humidity | 43.5 % |
| ATM Pressure | 98.6 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.
- Only the worst case configuration presented below 1GHz in this test report.
- There are no emissions found that doesn't comply with -13dBW limit in the 1710-1755 MHz frequency range. This limit corresponds to 84.4dBµV/m @ 3 meters.
- There are no emissions found that do not comply with the restricted bands defined in FCC Part 15 Subpart C, 15.205.
- 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 2.7.8 for sample computation.

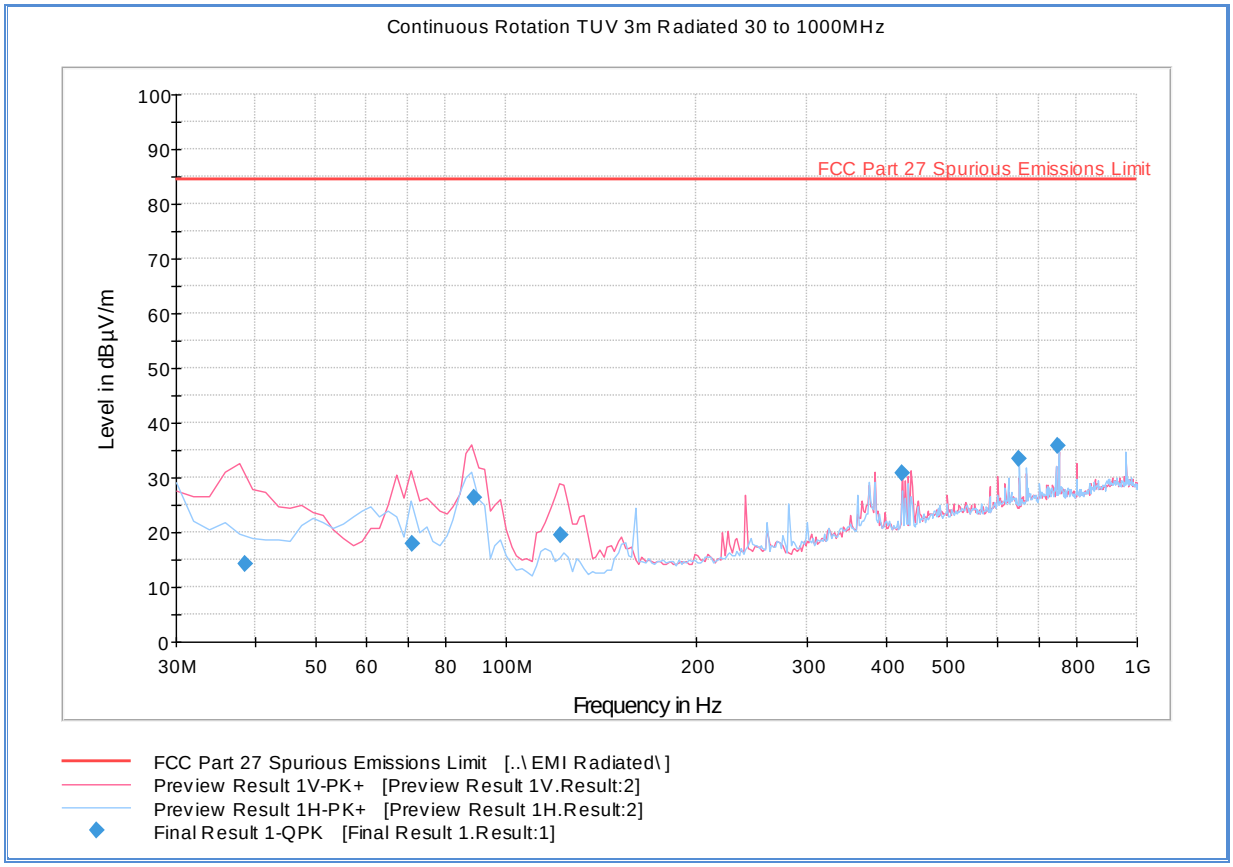
### 2.7.8 Sample Computation (Radiated Emission)

| | | | |
|---|---|---|---|
| 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 Quasi Peak Final Measurement (dBµV/m) @ 30MHz** | | | **11.8** |

### 2.7.9 Test Results

See attached plots.

### 2.7.10 Radiated Emission Test Results Below 1GHz – Worst Case_Mid Channel




**Quasi Peak Data**

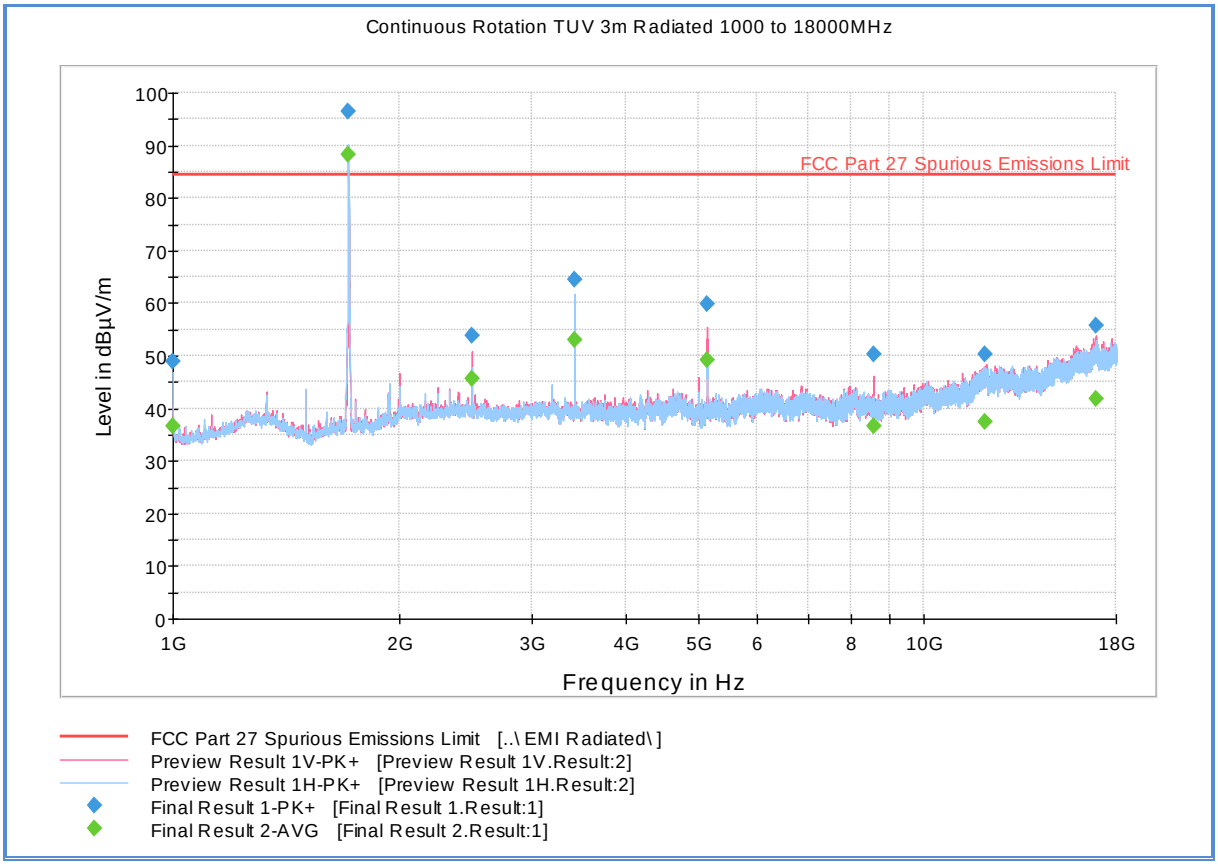
| Frequency (MHz) | QuasiPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 38.575551 | 14.1 | 1000.0 | 120.000 | 100.0 | V | 221.0 | -11.7 | 70.3 | 84.4 |
| 71.021643 | 18.0 | 1000.0 | 120.000 | 300.0 | V | 160.0 | -17.0 | 66.4 | 84.4 |
| 89.156633 | 26.3 | 1000.0 | 120.000 | 106.0 | V | -11.0 | -16.1 | 58.1 | 84.4 |
| 122.282725 | 19.4 | 1000.0 | 120.000 | 100.0 | V | 257.0 | -15.9 | 65.0 | 84.4 |
| 425.009218 | 30.9 | 1000.0 | 120.000 | 100.0 | V | 113.0 | -4.2 | 53.5 | 84.4 |
| 650.020200 | 33.4 | 1000.0 | 120.000 | 100.0 | H | 183.0 | 1.2 | 51.0 | 84.4 |
| 749.982365 | 35.8 | 1000.0 | 120.000 | 100.0 | H | 180.0 | 3.5 | 48.6 | 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 presented for spurious emissions below 1GHz. Substitution data not required since margin is >20dB compared to the -13dBm limit (converted to field strength @ 3 meters).

### 2.7.11 Radiated Emission Test Results Above 1GHz – Low Channel




**Peak Data**

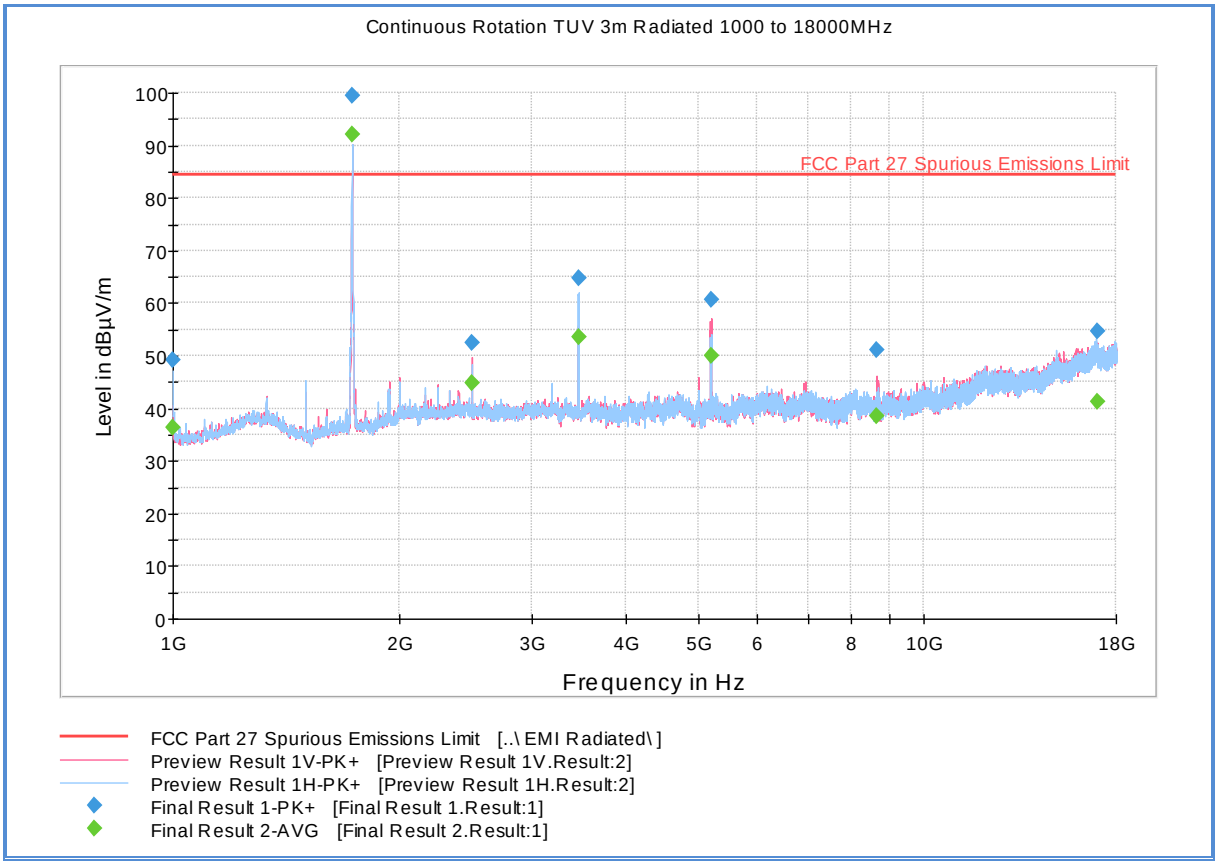
| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Peak Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1000.000000 | 49.0 | 1000.0 | 1000.000 | 158.4 | H | 13.0 | -7.2 | 35.4 | 84.4 |
| 1711.166667 | 96.5 | 1000.0 | 1000.000 | 350.1 | V | 310.0 | -4.6 | * Fundamental Freq. | |
| 2500.200000 | 53.7 | 1000.0 | 1000.000 | 99.4 | V | 350.0 | -0.3 | 30.7 | 84.4 |
| 3422.333333 | 64.5 | 1000.0 | 1000.000 | 164.4 | H | 268.0 | 0.8 | 19.9 | 84.4 |
| 5134.366667 | 59.8 | 1000.0 | 1000.000 | 245.2 | V | 332.0 | 4.0 | 24.6 | 84.4 |
| 8556.133333 | 50.3 | 1000.0 | 1000.000 | 379.0 | V | 77.0 | 8.5 | 34.2 | 84.4 |
| 12023.500000 | 50.3 | 1000.0 | 1000.000 | 327.1 | V | 25.0 | 16.9 | 34.1 | 84.4 |
| 16948.400000 | 55.7 | 1000.0 | 1000.000 | 311.1 | V | -1.0 | 23.0 | 28.7 | 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 |
|---|---|---|---|---|---|---|---|
| 3422.333333 | 64.5 | -4.2 | 9.82 | -36.0 | -30.38 | -13 | Complies |

***** This is the fundamental frequency not part of spurious emission evaluation. Data provided for information purpose only.

### 2.7.12 Radiated Emission Test Results Above 1GHz – Mid Channel




**Peak Data**

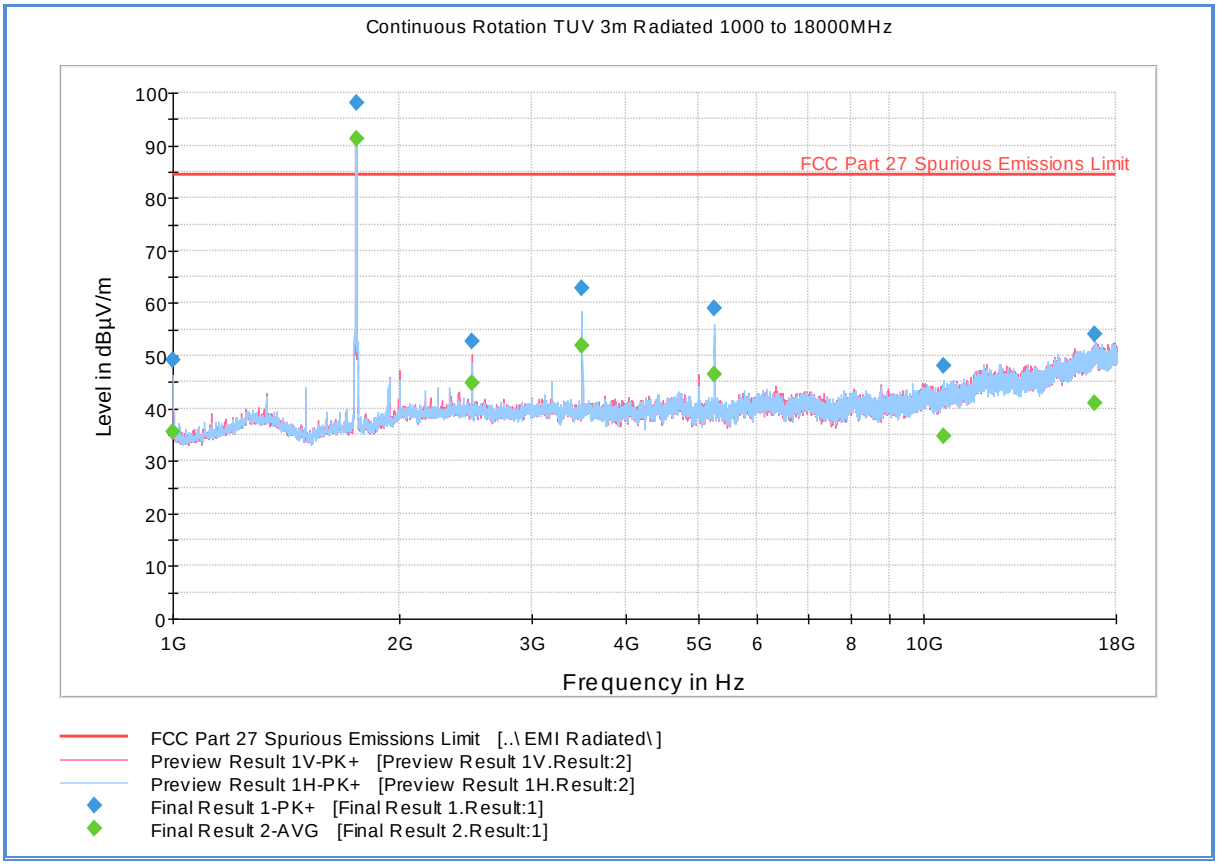
| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Peak Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1000.000000 | 49.1 | 1000.0 | 1000.000 | 164.4 | H | 132.0 | -7.2 | 35.3 | 84.4 |
| 1733.666667 | 99.5 | 1000.0 | 1000.000 | 191.3 | H | 338.0 | -4.5 | * Fundamental Freq. | |
| 2499.766667 | 52.5 | 1000.0 | 1000.000 | 99.4 | V | 348.0 | -0.3 | 31.9 | 84.4 |
| 3467.500000 | 64.7 | 1000.0 | 1000.000 | 161.4 | H | 258.0 | 0.9 | 19.7 | 84.4 |
| 5200.700000 | 60.6 | 1000.0 | 1000.000 | 357.0 | V | 221.0 | 4.0 | 23.8 | 84.4 |
| 8658.466667 | 51.2 | 1000.0 | 1000.000 | 99.4 | V | 46.0 | 8.7 | 33.2 | 84.4 |
| 16970.033333 | 54.5 | 1000.0 | 1000.000 | 328.1 | H | 82.0 | 22.9 | 29.9 | 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 |
|---|---|---|---|---|---|---|---|
| 3467.500000 | 64.7 | -4.2 | 9.82 | -36.0 | -30.38 | -13 | Complies |

***** This is the fundamental frequency not part of spurious emission evaluation. Data provided for information purpose only.

### 2.7.13 Radiated Emission Test Results Above 1GHz – High Channel




**Peak Data**

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Peak Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1000.400000 | 49.1 | 1000.0 | 1000.000 | 155.4 | H | 261.0 | -7.2 | 35.3 | 84.4 |
| 1753.500000 | 98.0 | 1000.0 | 1000.000 | 191.3 | H | 254.0 | -3.9 | * Fundamental Freq. | |
| 2500.166667 | 52.7 | 1000.0 | 1000.000 | 100.4 | V | 348.0 | -0.3 | 31.7 | 84.4 |
| 3502.966667 | 62.8 | 1000.0 | 1000.000 | 100.4 | H | 332.0 | 1.2 | 21.6 | 84.4 |
| 5261.533333 | 58.9 | 1000.0 | 1000.000 | 323.1 | H | 316.0 | 4.7 | 25.5 | 84.4 |
| 10616.200000 | 48.0 | 1000.0 | 1000.000 | 380.0 | H | 12.0 | 14.2 | 36.4 | 84.4 |
| 16886.466667 | 54.0 | 1000.0 | 1000.000 | 151.4 | H | 338.0 | 23.1 | 30.4 | 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 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

***** This is the fundamental frequency not part of spurious emission evaluation. Data provided for information purpose only.

**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 CFR Part 2, Clause 2.1055
FCC CFR Part 27, Clause 27.54
RSS-139, Clause 6.4

### 2.8.2 Standard Applicable

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

### 2.8.3 Equipment Under Test and Modification State

Serial No: SZ1901179000375 / Test Configuration A

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

September 20, 2017 / XYZ

### 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 Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 26.2 °C |
| Relative Humidity | 49.3 % |
| ATM Pressure | 98.8 kPa |

### 2.8.7 Additional Observations

- This is a conducted test. The EUT was operated at 3.7 VDC nominal voltage and was placed in the temperature chamber for this evaluation. The EUT was controlled by a CMW500 and utilizing a spectrum analyser for measurement.
- The Temperature was reduced to -30°C and allowed to sit for 1 hour to allow the equipment and chamber temperature to stabilize. The temperature was set increased by 10°C steps and allowed to settle before taking the next set of measurements.
- Voltage variation was also performed at voltage 3.3VDC and higher 4.3VDC of the nominal voltage at 20°C.
- The maximum frequency deviation was verified against the frequency band edges using the EBW data. Sample calculation:

### 2.8.8 Test Results

| *Voltage (VDC)* | *Temperature (°C)* | *Frequency Deviation (Hz/ppm)* |
|---|---|---|
| **3.7** | -30 | -10.64 |
| | -20 | -4.10 |
| | -10 | -4.66 |
| | 0 | 11.13 |
| | +10 | -5.02 |
| | +20 | -4.76 |
| | +30 | -6.75 |
| | +40 | -7.50 |
| | +50 | -5.33 |

| *Temperature (°C)* | *Voltage (VAC)* | *Frequency Deviation (Hz/ppm)* |
|---|---|---|
| **20** | 3.3 | -6.14 |
| | 4.3 | -6.34 |

### 2.8.9 Sample Calculation and plot

Variables (from test plot): M1 = (Peak value of the power envelope)
T1 = (-26 dBc point)
T2 = (+26 dBc point)

Center Frequency Formula: = (T1+T2) / 2
= (1710.0425+1714.7775) / 2
= .1712.41 MHz

***Low Channel Sample Calculation:***
*Worst Case 26dB BW* *4.76 MHz*
*Edge of fundamental emission (1712.41-(4.76/2)):* *1710.03 MHz*
*EUT complies. 1710.03 MHz > 1710 MHZ (edge of authorized band)*

***High Channel Sample Calculation:***
*Worst case 26dB BW* *4.76 MHz*
*Edge of fundamental emission (1752.6025+(4.76/2)):* *1754.9825 MHz*
*EUT complies. 1754.9825 MHz <1755 MHZ (edge of authorized band)*

**SECTION 3**

**TEST EQUIPMENT USED**

## 3.1 TEST EQUIPMENT USED

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

| ID Number (SDGE/SDRB) | Test Equipment | Type | Serial Number | Manufacturer | Cal Date | Cal Due Date |
|---|---|---|---|---|---|---|
| ***Conducted Port Setup*** | | | | | | |
| 7582 | Signal/Spectrum Analyzer | FSW26 | 101614 | Rhode & Schwarz | 10/26/16 | 10/26/17 |
| 7604 | P-Series Power Meter | N1912A | SG45100273 | Agilent | 08/14/17 | 08/14/18 |
| 7605 | 50MHz-18GHz Wideband Power Sensor | N1921A | MY51100054 | Agilent | 05/19/17 | 05/19/18 |
| 7608 | Vector Signal Generator | SMBV100A | 259021 | Rhode & Schwarz | 09/19/17 | 09/19/19 |
| 7578 | Wideband Radio Communication Tester | CMW 500 | 1201.0002K50-116735-rQ | Rhode & Schwarz | 08/10/17 | 08/10/18 |
| - | Power Splitter | ZFRSC-42 | 15542 | Mini-Circuits | Verified by 7582 and 7608 | |
| 8825 | 20dB Attenuator | 46-20-34 | BK5773 | Weinschel Corp. | Verified by 7582 and 7608 | |
| ***Radiated Test Setup*** | | | | | | |
| 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 |
| 1033 | Bilog Antenna | 3142C | 00044556 | EMCO | 10/11/16 | 10/11/18 |
| 1049 | EMI Test Receiver | ESU | 100133 | Rhode & Schwarz | 07/13/17 | 07/13/18 |
| 7575 | Double-ridged waveguide horn antenna | 3117 | 00155511 | EMCO | 06/01/17 | 06/01/18 |
| 8628 | Pre-amplifier | QLJ 01182835-JO | 8986002 | QuinStar Technologies Inc. | 02/09/17 | 02/09/18 |
| 7578 | Wideband Radio Communication Tester | CMW 500 | 1201.0002K50-116735-rQ | Rhode & Schwarz | 08/10/17 | 08/10/18 |
| ***Miscellaneous*** | | | | | | |
| - | Test Software | EMC32 | V8.53 | Rhode & Schwarz | N/A | |
| 1123 | DC Power Supply | E3631A | N/A | Hewlett Packard | Verified by 6452 | |
| 6792 | Multimeter | 3478A | 2911A70964 | Hewlett Packard | 08/29/17 | 08/29/18 |
| 7579 | Temperature Chamber | 115 | 151617 | TestQuity | 08/22/17 | 08/22/18 |
| 7560 | Barometer/Temperature/Humidity Transmitter | iBTHX-W | 1240476 | Omega | 01/17/17 | 01/17/18 |

## 3.2 MEASUREMENT UNCERTAINTY

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

### 3.2.1 Radiated Measurements (30 MHz to 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 |

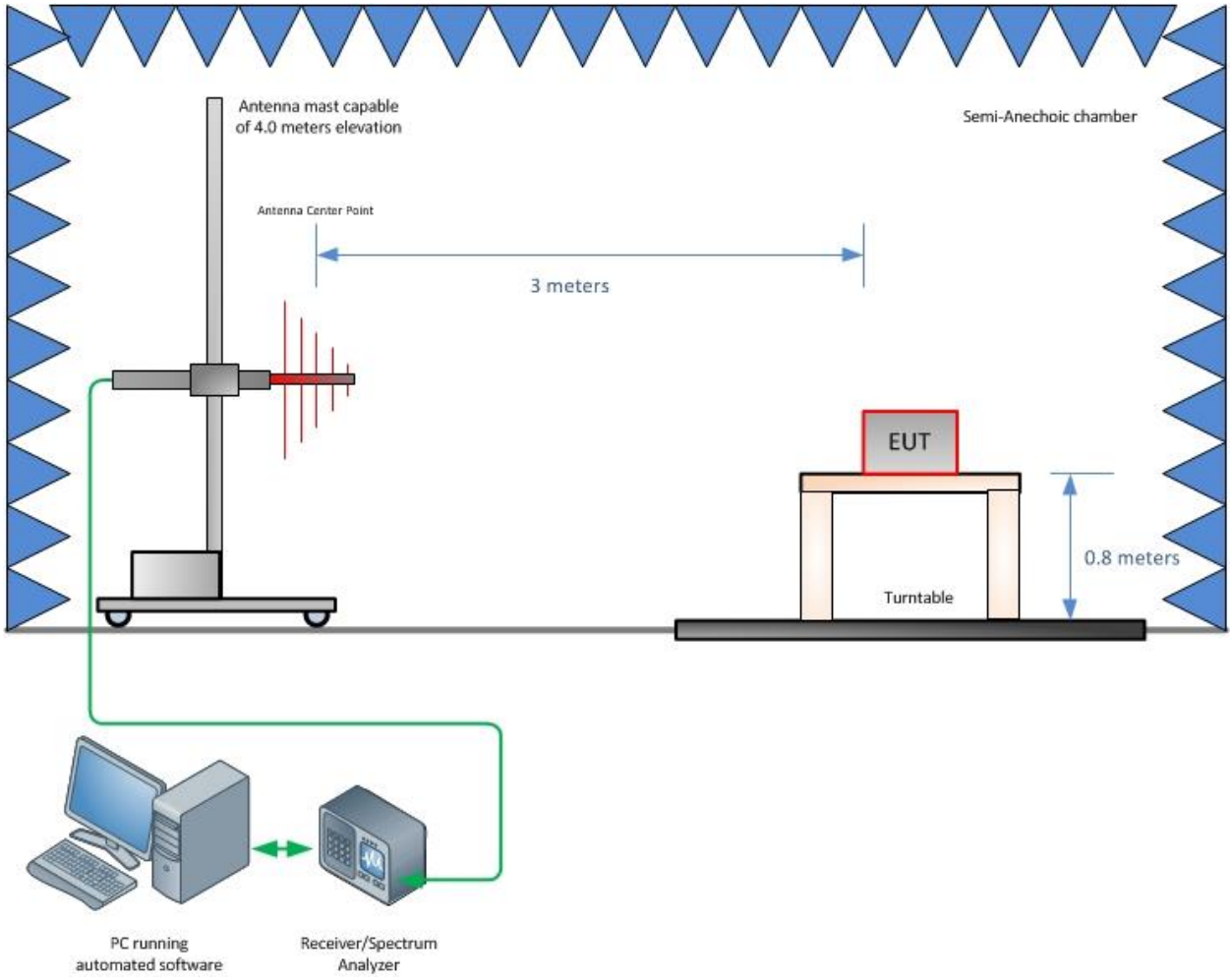
### 3.2.1 Radiated Measurements (1GHz to 18GHz)

| | Contribution | Probability Distribution Type | Probability Distribution $x_i$ | Standard Uncertainty $u(x_i)$ | $[u(x_i)]^2$ |
|---|---|---|---|---|---|
| 1 | Receiver/Spectrum Analyzer | Rectangular | 0.57 | 0.33 | 0.11 |
| 2 | Cables | Rectangular | 0.70 | 0.40 | 0.16 |
| 3 | Preamp | Rectangular | 0.50 | 0.29 | 0.08 |
| 4 | Antenna | Rectangular | 0.37 | 0.21 | 0.05 |
| 5 | Site | Triangular | 3.00 | 1.22 | 1.50 |
| 6 | EUT Setup | Rectangular | 1.00 | 0.58 | 0.33 |
| | | | | Combined Uncertainty ($u_c$): | 1.49 |
| | | | | Coverage Factor (k): | 2 |
| | | | | Expanded Uncertainty: | 2.99 |

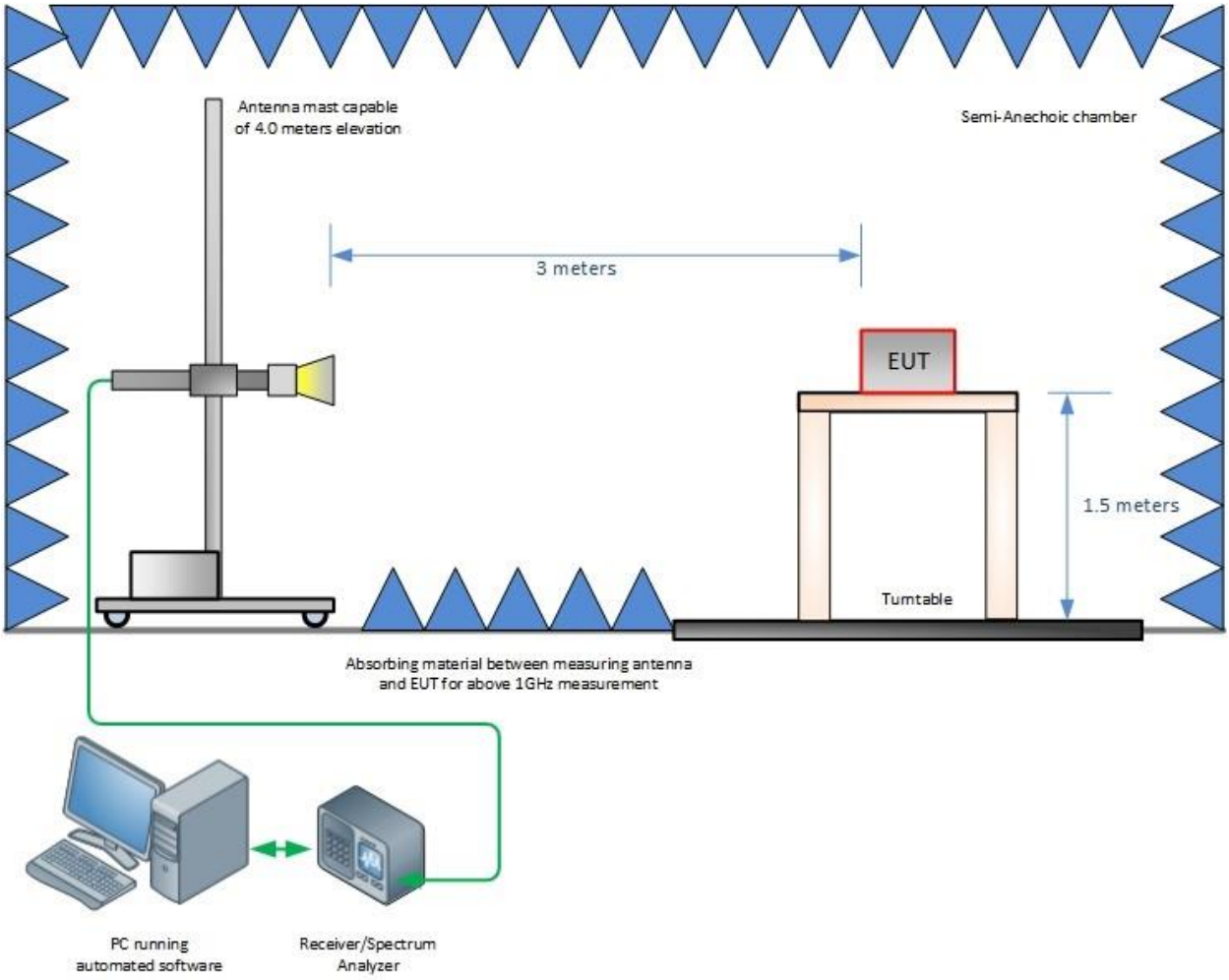
**SECTION 4**

**DIAGRAM OF TEST SETUP**

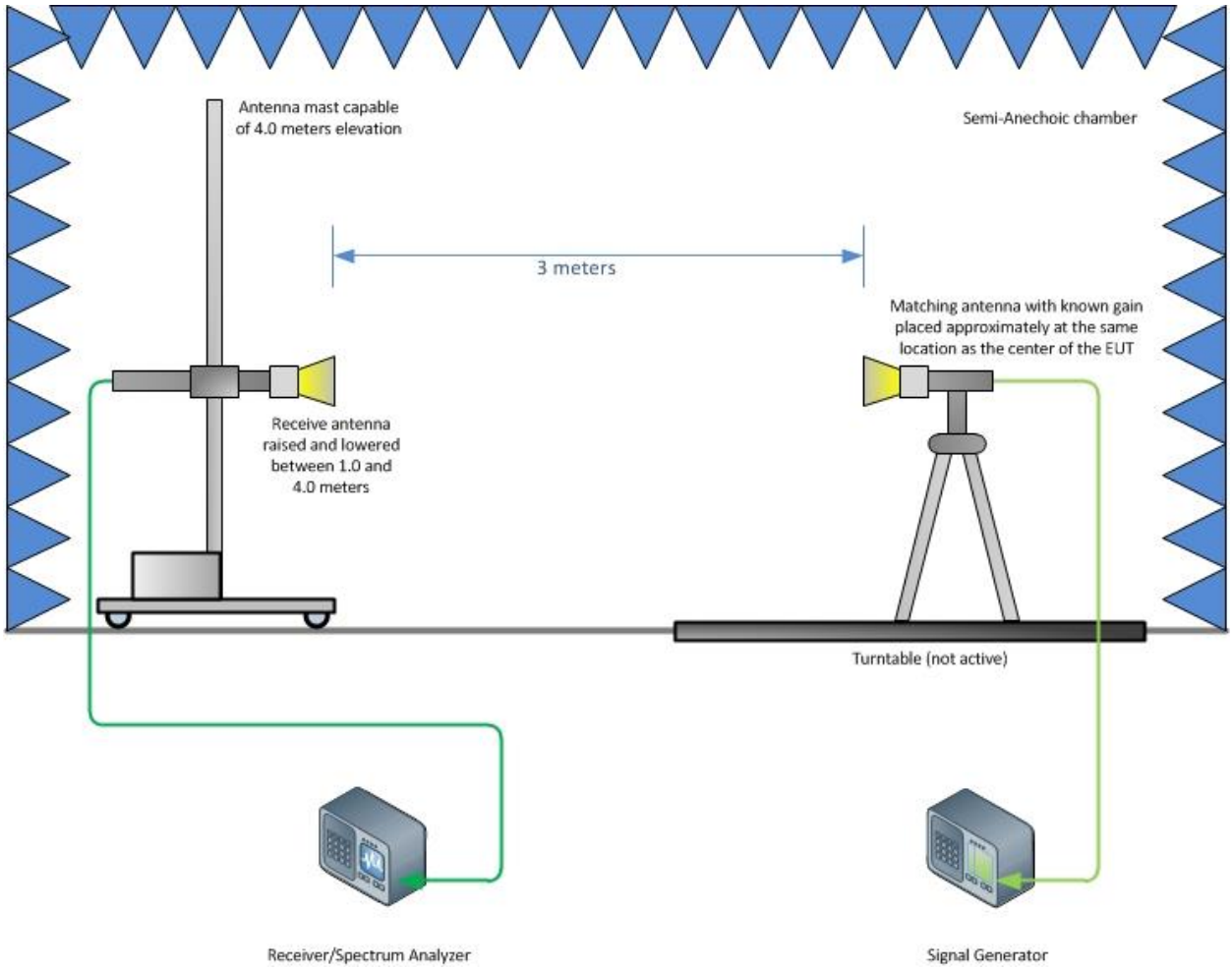
## 4.1 TEST SETUP DIAGRAM



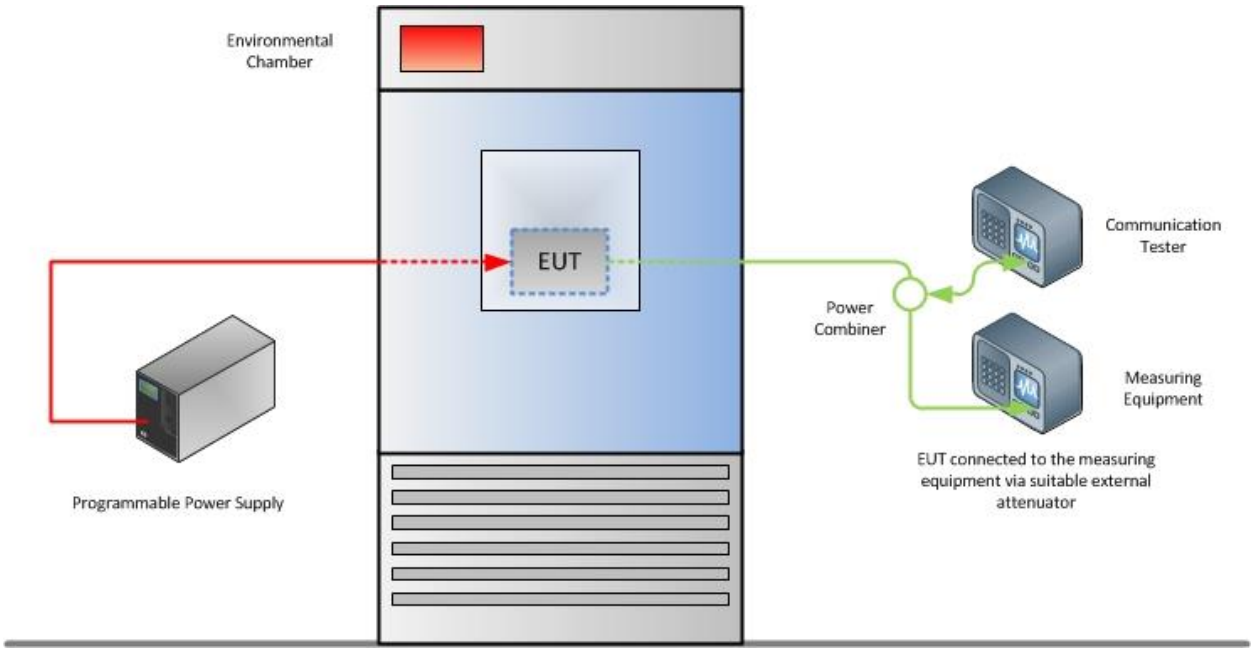

**Radiated Emission Test Setup (Below 1GHz)**




**Radiated Emission Test Setup (Above 1GHz)**




**Substitution Test Method (Above 1GHz)**




**Frequency Stability Test Comfiguration**

**SECTION 5**

**ACCREDITATION, DISCLAIMERS AND COPYRIGHT**

## 5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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