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Report On

C2PC Application for Grant of Equipment Authorization of the
ViaSat, Inc.
L-Band Satellite Mobile Terminal MT2220
L-Band Satellite Aviation Terminal AT2220

FCC Part 15 Subpart C §15.247 (FHSS)
IC RSS-247 Issue 1 May 2015
IC RSS-Gen Issue 4 November 2014

Report No. SD72116127-0416B May 2016

REPORT ON	C2PC Radio Testing of the ViaSat, Inc. L-Band Satellite Mobile Terminal MT2220 L-Band Satellite Aviation Terminal AT2220
TEST REPORT NUMBER	SD72116127-0416B
REPORT DATA	May 2016
PREPARED FOR	ViaSat, Inc. 6155 El Camino Real Carlsbad, CA 92009 USA
CONTACT PERSON	Waiman Wong Compliance Engineer (760) 893-3704 Waiman.Wong@viasat.com
PREPARED BY	Alex Chang **Name** Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	Juan Manuel Gonzalez Name Authorized Signatory Title: Commercial/Wireless EMC Lab Manager
DATED	May 25, 2016

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

Revision History

SD72116127-0416B ViaSat, Inc. L-Band Satellite Mobile Terminal MT2220 L-Band Satellite Aviation Terminal AT2220					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
05/25/2016	Initial Release				Juan M. Gonzalez

CONTENTS

SECTION 1

REPORT SUMMARY

C2PC Radio Testing of the
ViaSat, Inc.
L-Band Satellite Mobile Terminal MT2220
L-Band Satellite Aviation Terminal AT2220

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the ViaSat, Inc. L-Band Satellite Mobile Terminal, model MT2220 and L-Band Satellite Aviation Terminal, model AT2220 to the requirements of FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 1 May 2015.

Objective	To perform C2PC Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	ViaSat, Inc.
Model Number(s)	MT2220 and AT2220
Model Name(s)	Aviation Terminal 2220 Mobile Terminal 2220
FCC ID Number	2ABLPAT2220
IC Number	20546-AT2220
Serial Number(s)	E70016120011 (MT2220) C20015440005 (AT2220)
Number of Samples Tested	2
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2015). • RSS-247 - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment (Issue 1, May 2015). • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 4, November 2014). • Public Notice (DA 00-705 Released March 30, 2000) Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.
Start of Test	April 25, 2016
Finish of Test	May 05, 2016
Name of Engineer(s)	Alex Chang
Related Document(s)	• None. Supporting documents for EUT certification are separate exhibits. • Conducted port measurement leveraged from previously evaluated under TÜV SÜD test report ref No. SD72111016-1015B BT test report.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 with cross-reference to the corresponding IC RSS standard is shown below.

Section	§15.247 Spec Clause	RSS	Test Description	Result	Comments/ Base Standard
—	§15.207 (a)	RSS-Gen 8.8	Conducted Emissions	N/A	
2.1	§15.247(a)(1)	RSS-247 Sec. 5.1(2)	Carrier Frequency Separation	N/P	See notes
2.2	§15.247(a)(1)(iii)	RSS-247 Sec. 5.1(4)	Number of Hopping Frequencies	N/P	See notes
2.3	§15.247(a)(1)(iii)	RSS-247 Sec. 5.1(4)	Time of Occupancy (Dwell Time)	N/P	See notes
2.4	§15.215(c)	RSS-247 Sec. 5.1(1)	20 dB Bandwidth	N/P	See notes
2.5		RSS-Gen 6.6	99% Emission Bandwidth	N/P	See notes
2.6	§15.247(b)(1)	RSS-247 Sec. 5.4(2)	Peak Output Power	N/P	See notes
2.7	§15.247(d)	RSS-247 Sec. 5.5	Band-edge Compliance of RF Conducted Emissions	N/P	See notes
2.8	§15.247(d)	RSS-247 Sec. 5.5	Spurious RF Conducted Emissions	N/P	See notes
2.9	§15.247(d)	RSS-247 Sec. 5.5	Spurious Radiated Emissions	Compliant	
2.10	§15.247(d)	RSS-247 Sec. 5.5	Radiated Immediate Restricted Bands	Compliant	
2.11		RSS-Gen 7.1	Receiver Spurious Emissions	Compliant	

N/A EUT is a DC voltage operated device.
N/P BT conducted port test results were leveraged from original BT module which was previously evaluated under TÜV SÜD test report ref. No. SD72111016-1015B. No further evaluation considered necessary.

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a ViaSat, Inc. Aviation Terminal 2220 (L-Band Satellite Mobile Terminal) model no. AT2220. The ViaSat AT2220 Terminal enables reliable and instant IP-based communications via satellite for rotor and fixed-wing aircraft. Powered by ViaSat L-band Managed Service (VMS), this satcom terminal's two-way networking capability enables both real-time monitoring of position location information using built in GPS receiver, and data and voice communications. AES-256 encrypted data link layer encryption is employed to ensure the integrity of user data is protected. The terminal features easy-to-use interfaces and provides flexibility to configure to nearly any sensor system or IP data application. Examples of operational scenarios that the AT2220 Terminal supports range from fleet management, emergency first responders, homeland security forces, disaster aid workers, corresponders, mobile workforce management and tracking of high-valued assets. This is all within an integrated single assembly package that is optimized for airborne data transmission. A single cable provides DC power and Ethernet for wired connections to an IP device, eliminating the need of RF cable typically required for connection between modem and antenna. The transceiver also supports Wi-Fi and Bluetooth for wireless connections to multiple tablets or smart-phones. The AT2220 Terminal is powered by ViaSat advanced waveform that allows for a low latency and highest capacity of users to operate on a single L-band channel.

The Equipment Under Test (EUT) was a ViaSat Inc. Mobile Terminal 2220 (L-Band Satellite Mobile Terminal) model no. MT2220. The ViaSat MT2220 Terminal enables reliable and instant IP-based communications via satellite for mobile vehicular environments. Powered by ViaSat L-band Managed Service (VMS), this satcom terminal's two-way networking capability enables both real-time monitoring of position location information using built in GPS receiver, and data and voice communications. AES-256 data link layer encryption is employed to ensure the integrity of user data is protected. The terminal features easy-to-use interfaces and provides IP data and voice connectivity, including Push-To-Talk and GPS tracking. Examples of operational scenarios that the MT2220 Terminal supports range from fleet management, emergency first responders, homeland security forces, disaster aid workers, and mobile workforce management. This is all within an integrated single assembly package that is optimized for mobile data transmission. A single cable provides DC power and Ethernet for wired connections to an IP device, eliminating the need of RF cable typically required for connection between modem and antenna. The transceiver also supports Wi-Fi and Bluetooth for wireless connections to multiple tablets or smart-phones. The MT2220 Terminal is powered by ViaSat advanced waveform that allows for a low latency and highest capacity of users to operate on a single L-band channel.

The WiFi/BT antenna gain was increased from previous evaluated model AT2220; the model MT2220 was provided for spurious emission evaluation. Test results applied to both models AT2220 and MT2220 which were conducted into this test report.

1.3.2 EUT General Description

EUT Description	L-Band Satellite Mobile Terminal L-Band Satellite Aviation Terminal
Model Name	Aviation Terminal 2220 Mobile Terminal 2220
Model Number(s)	MT2220 and AT2220
Rated Voltage	10-32 VDC
Mode Verified	Bluetooth EDR (FHSS)
Capability	802.11 b/g WLAN and Bluetooth 3.0 + HS (w/out BLE)
Primary Unit (EUT)	☐ Production ☒ Pre-Production ☐ Engineering
Antenna Type	Integral PCB trace type (multilayer chip antenna)
Manufacturer	ViaSat
Antenna Gain	-2.98 dBi (2.412 GHz) -2.76 dBi (2.437 GHz) -2.84 dBi (2.472 GHz)

1.3.3 Maximum Conducted Output Power

Modulation	Frequency Range (MHz)	AverageOutput Power (dBm)	Peak Output Power (dBm)	Peak Output Power (mW)
GFSK	2402-2480	7.25	7.99	6.30
π/4-DQPSK	2402-2480	5.06	7.76	5.97
8DPSK	2402-2480	5.06	8.20	6.61

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Antenna conducted port test configuration. A conducted test sample was provided for this setup. The integral antenna was removed and an on-board surface mount coaxial connector was made accessible. EUT configuration was set to BT test mode via Ethernet connection using SSH/Telnet client application. Manufacturer provided the instructions for EUT configuration.
B	Radiated emissions test configuration. Identical programming procedure as Test Configuration A. EUT transmitting through the integral antenna.

1.4.2 EUT Exercise Software

EUT is configured via TCP/IP (Ethernet). EUT IP address is set to 192.168.100.1. This address is used to connect to the EUT via SSH/Telnet client application (PuTTY). Once connected, corresponding programming commands were issued in order to set the EUT in Bluetooth test mode. Afterwards the EUT has been connected to CMW500 wireless communications tester, which was used to control the EUT modulation, data rate and operational channel.

1.4.3 Support Equipment and I/O cables

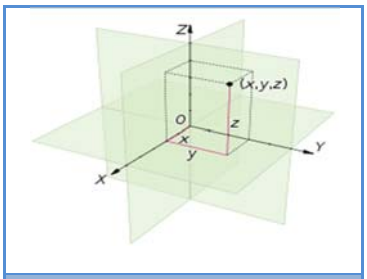
Manufacturer	Equipment/Cable	Description
Sony	Support Laptop	Model PCG-31311L
Sony	Support AC-DC Power Adapter	Model: ACDP-120E03
—	Ethernet EUT to Laptop	2.1 meters, shielded CAT5 cable w/ RJ-45 connectors

1.4.4 Worst Case Configuration

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

Modulation	Channel/Packet Type	Mode
GFSK	38 (Mid Channel)	Non-hopping
GFSK	-	Hopping

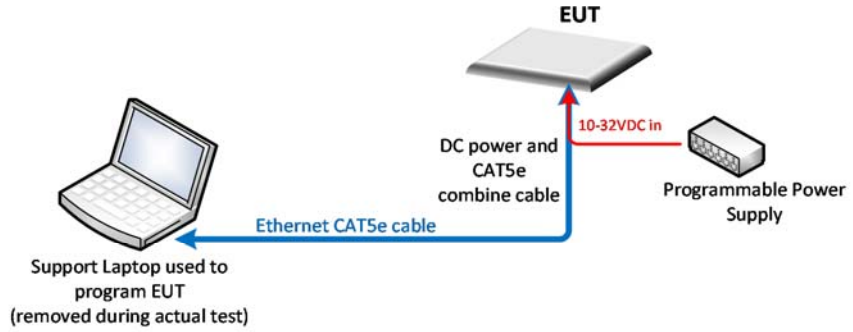
For radiated measurements X, Y and Z orientations were verified. No major variation in emissions observed between the three (3) orientations. Verifications performed using “Y” configuration.



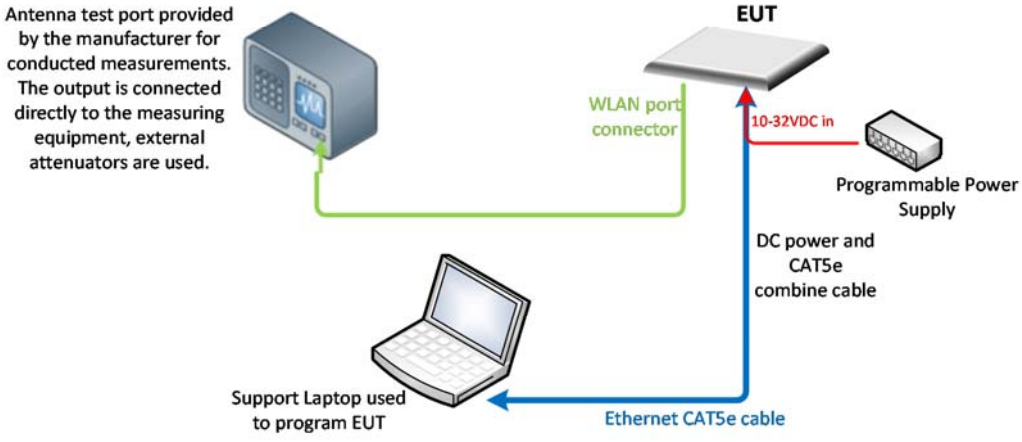
"X, Y, Z" Configuration

1.4.5 Simplified Test Configuration Diagram

Radiated Emission Test Setup



Conducted Port Measurement Test Setup



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

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: E70016120011 and C20015440005		
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 C63.10-2013, America National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
For conducted 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 C63.10-2013. 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)

16530 Via Esprillo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 942 5542 FAX: 858-546 0364

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No.: US1146

TUV SUD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US1146.

1.9.2 Innovation, Science and Economic Development Canada (ISED) 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 (ISED) for radio equipment testing with Registration No. 3067A.

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

SECTION 2

TEST DETAILS

C2PC Radio Testing of the
ViaSat, Inc.
L-Band Satellite Mobile Terminal MT2220
L-Band Satellite Aviation Terminal AT2220

2.1 CARRIER FREQUENCY SEPARATION

2.1.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)

2.1.2 Standard Applicable

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

2.1.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration A

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

August 03, 2015 / NS

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.

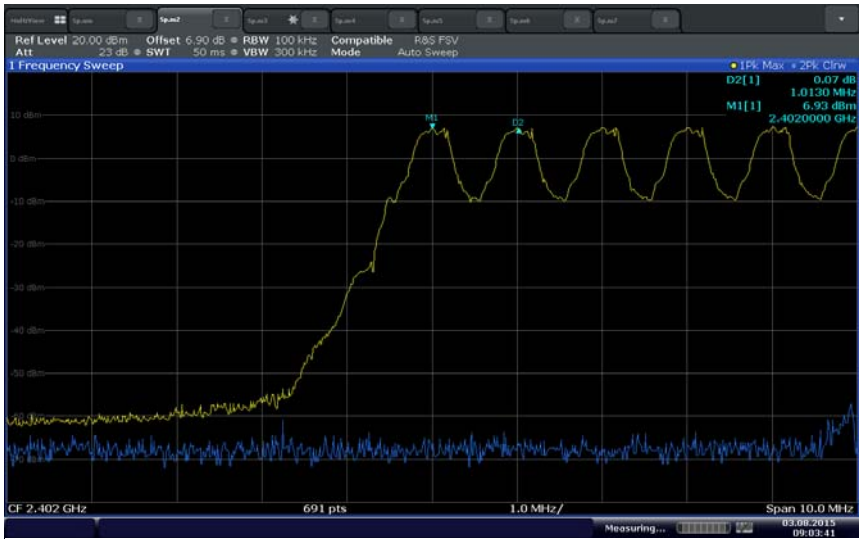
Ambient Temperature	24.8 °C
Relative Humidity	57.1 %
ATM Pressure	99.1 kPa

2.1.7 Additional Observations

- This Section of test data was leveraged from previous test report under TÜV SÜD test report ref. No. SD72111016-1015B.
- Hopping function enabled.
- Span is wide enough to capture the peaks of two adjacent channels.
- RBW is 1% of the span.
- VBW is 3x RBW
- Sweep is auto
- Detector is peak.
- Trace is max hold.
- An offset of 6.9 dB was added to compensate the power splitter and coaxial cable attenuation.

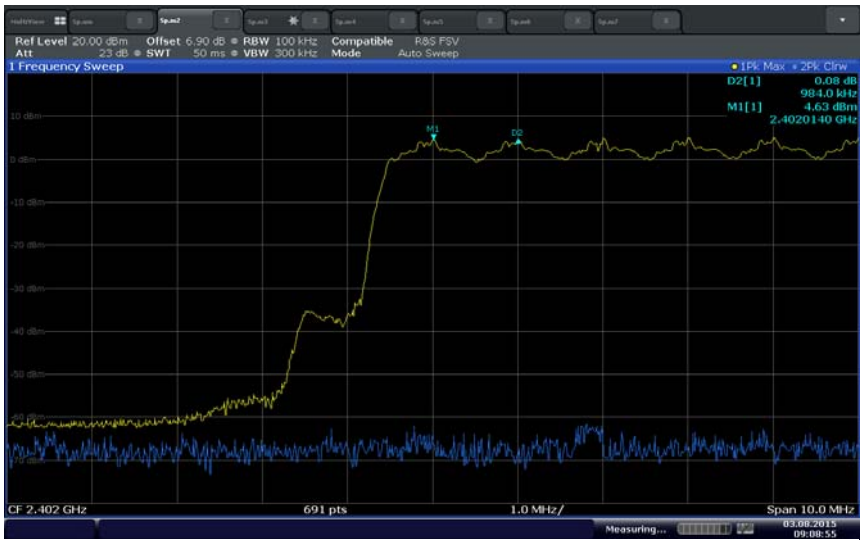
- Marker-delta function is used between the peaks of the adjacent channels.
- Limit used is >946.67 kHz (2/3 of worst case 20dB BW).

2.1.8 Test Results



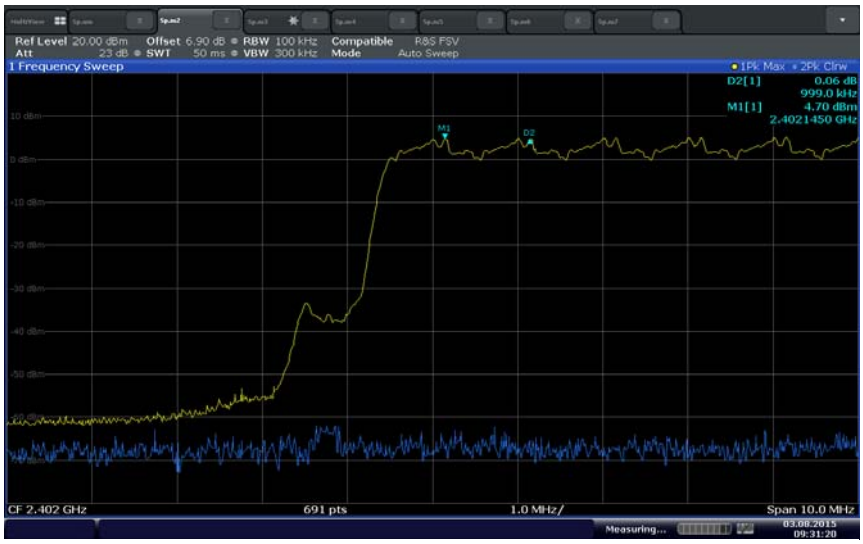
Date: 3.AUG.2015 09:03:40

GFSK, observed carrier frequency separation between Ch0 and Ch1 is 1.013 MHz (**Complies**. Greater than 946.67 kHz, this is 2/3 of 1.42MHz 20 dB BW)



Date: 3.AUG.2015 09:08:55

π/4-DQPSK, observed carrier frequency separation between Ch0 and Ch1 is 0.984 MHz (**Complies**. Greater than 946.67 kHz, this is 2/3 of 1.42MHz 20 dB BW)



Date: 3.AUG.2015 09:31:20

8DPSK, observed carrier frequency separation between Ch0 and Ch1 is 0.999 MHz (**Complies**. Greater than 946.67 kHz, this is 2/3 of 1.42MHz 20 dB BW)

2.2 NUMBER OF HOPPING FREQUENCIES

2.2.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)(iii)

2.2.2 Standard Applicable

(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

2.2.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration A

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

August 03, 2015 / NS

2.2.5 Test Equipment Used

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

2.2.6 Environmental Conditions

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

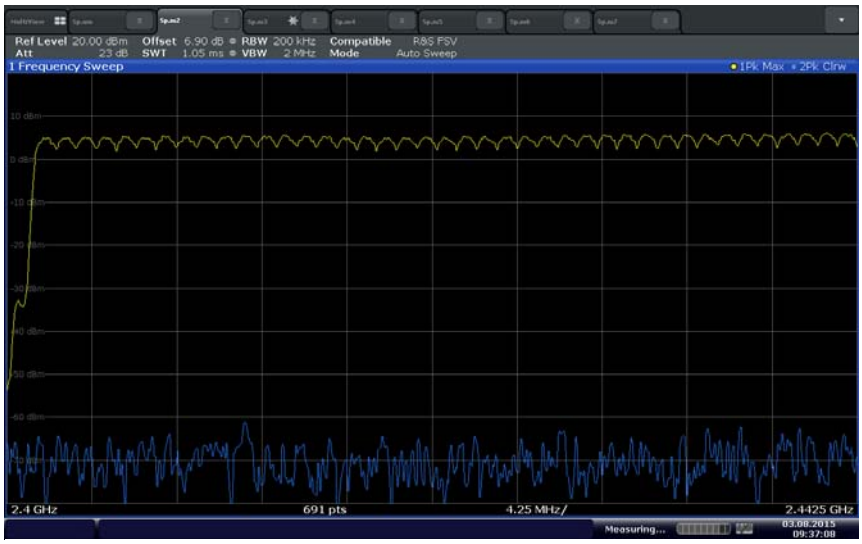
Ambient Temperature	24.8 °C
Relative Humidity	64.1 %
ATM Pressure	99.1 kPa

2.2.7 Additional Observations

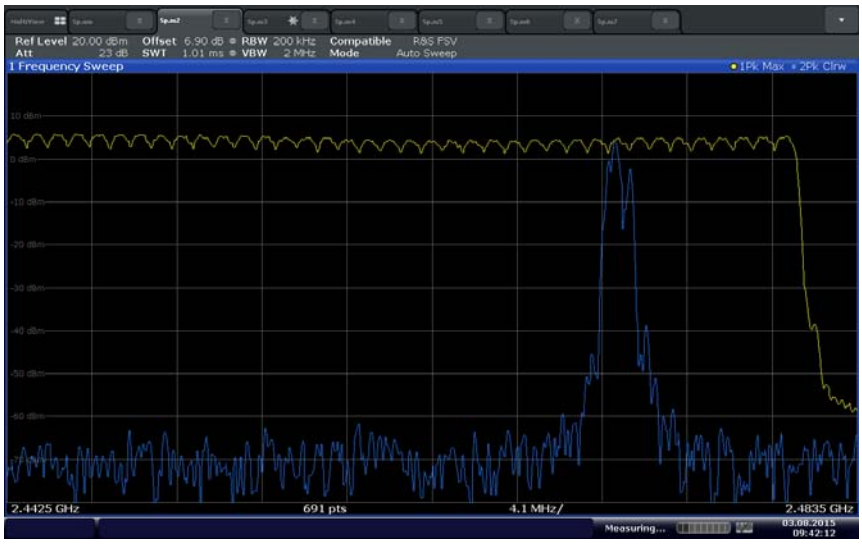
- This Section of test data was leveraged from previous test report under TÜV SÜD test report ref. No. SD72111016-1015B.
- Hopping function enabled.
- Span is wide enough to capture the channels of interests.
- The span was broken up to two sections in order to clearly show all of the hopping frequencies.
- Sweep is auto
- Detector is peak, trace is max hold.
- An offset of 6.9dB was added to compensate for the external attenuator and cable used.

2.2.8 Test Results

Observed Number of Hopping Frequencies is = **79 (Complies)**
= Plot #1 + Plot #2
= 41 + 38


Ref Level 20.00 dBm Offset 6.90 dB RBW 200 kHz Compatible R&S FSV
Att 23 dB SWT 1.05 ms VBW 2 MHz Mode Auto Sweep
1 Frequency Sweep
1Pk Max 2Pk Clrw
2.4 GHz
691 pts
4.25 MHz/
2.4425 GHz
Measuring...
03.08.2015
09:37:08
Date: 3.AUG.2015 09:37:08

Plot #1


Ref Level 20.00 dBm Offset 6.90 dB RBW 200 kHz Compatible R&S FSV
Att 23 dB SWT 1.01 ms VBW 2 MHz Mode Auto Sweep
1 Frequency Sweep
1Pk Max 2Pk Clrw
2.4425 GHz
691 pts
4.1 MHz/
2.4835 GHz
Measuring...
03.08.2015
09:42:12
Date: 3.AUG.2015 09:42:12

Plot #2

2.3 TIME OF OCCUPANCY (DWELL TIME)

2.3.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)(iii)

2.3.2 Standard Applicable

(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

2.3.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration A

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

August 03, 2015 / NS

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	24.8 °C
Relative Humidity	64.1 %
ATM Pressure	99.1 kPa

2.3.7 Additional Observations

- This Section of test data was leveraged from previous test report under TÜV SÜD test report ref. No. SD72111016-1015B.
- Hopping function enabled.
- Span = zero span, centered on a hopping channel.
- RBW is 1MHz.
- VBW is 3x RBW
- Detector is peak.
- A single pulse is first measured. This measurement is then used to compute the average time of occupancy in the required period (no. of channels x 0.4 second).
- The EUT was configured using the instructions provided by the manufacturer. Modulation type was PRBS9, logical channel were between ACL EDR and ACL Basic, packet type used were DH1, 2DH3 and 3DH1. Packet length was set to default value of 1000.

2.3.8 Test Results

Modulation	Measured time of occupancy	Requirement
GFSK	122.44 ms	<400 ms
π/4-DQPSK	262.49 ms	<400 ms
8DPSK	123.36 ms	<400 ms

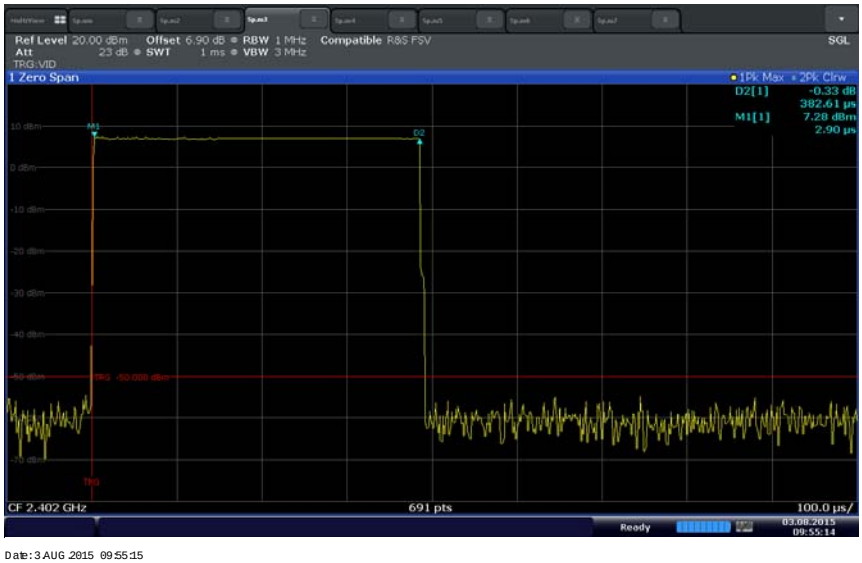
2.3.9 Sample Computation (8DPSK)

Width of single pulse = 0.0003855 second
Observed occurrence = 32 pulses/3.16 seconds
Required period = 79 channels x 0.4 second
= 31.6 seconds

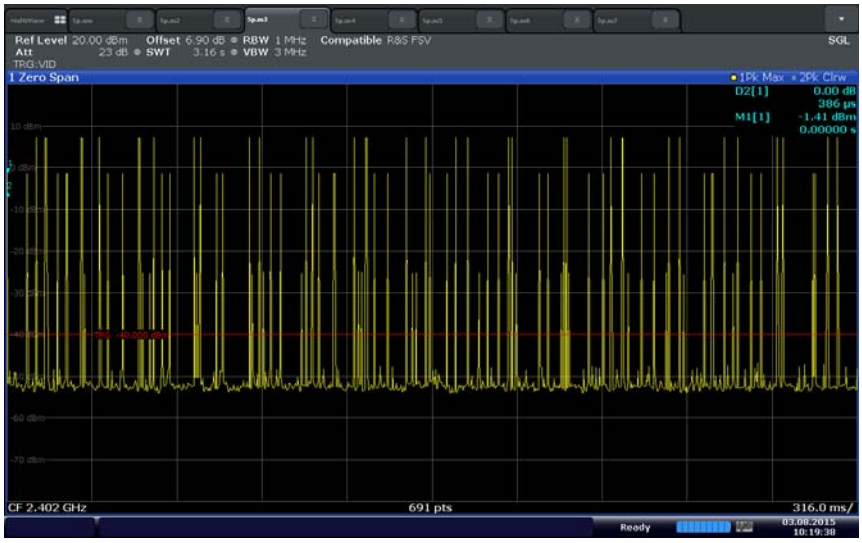
Average time of occupancy = Pulse width x #pulses in 3.16 seconds# x 10
= 0.0003855 second x 32x 10
= 0.12336 second

Compliance = Complies. 0.12336 second < 0.4 second

2.3.10 Test Results Plots

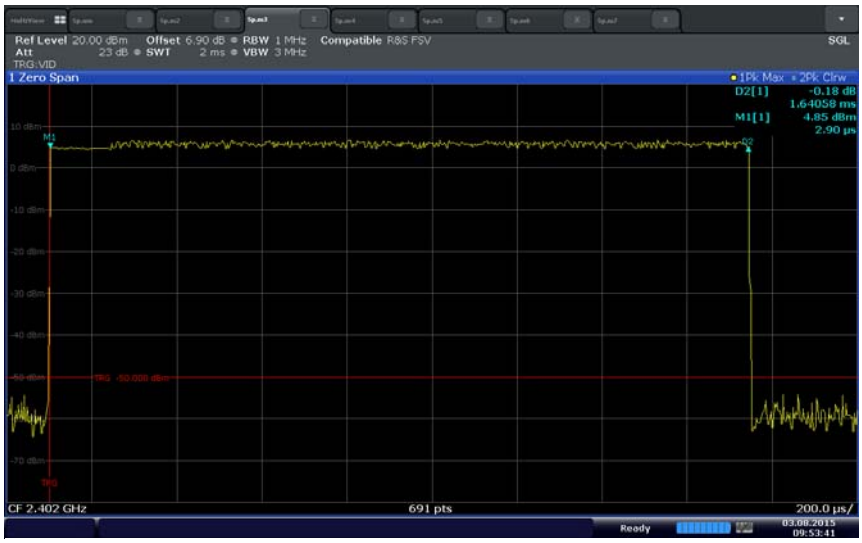


GFSK width of single pulse (0.38261ms)



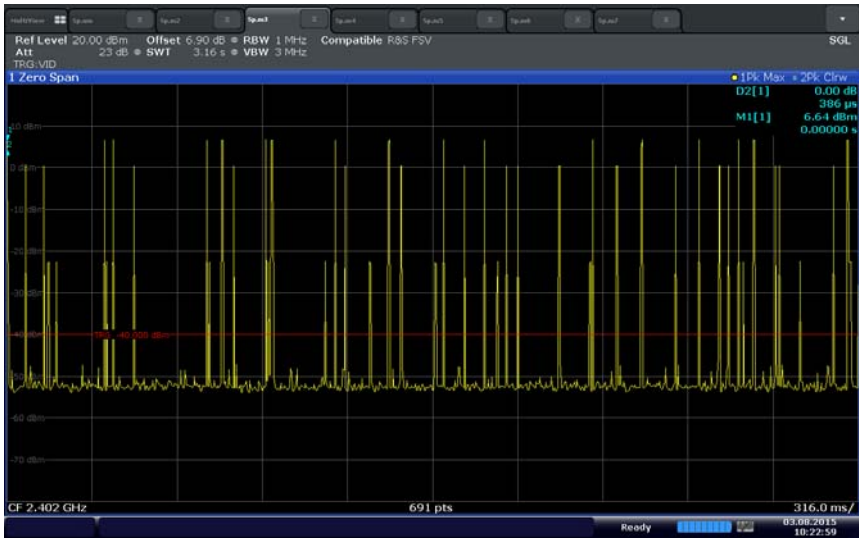
Date: 3.AUG.2015 10:19:38

32 pulses/3.16 seconds (DH1)



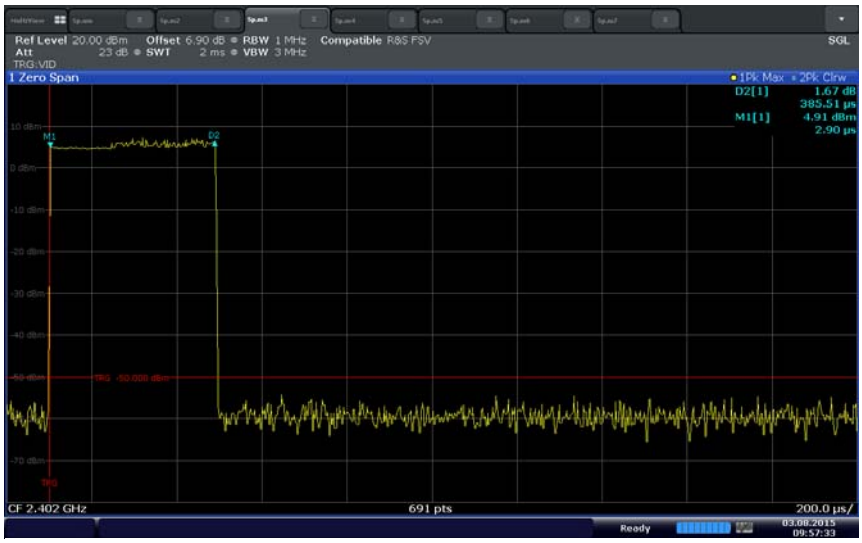
Date: 3.AUG.2015 09:53:41

π/4-DQPSK width of single pulse (1.64058 ms)



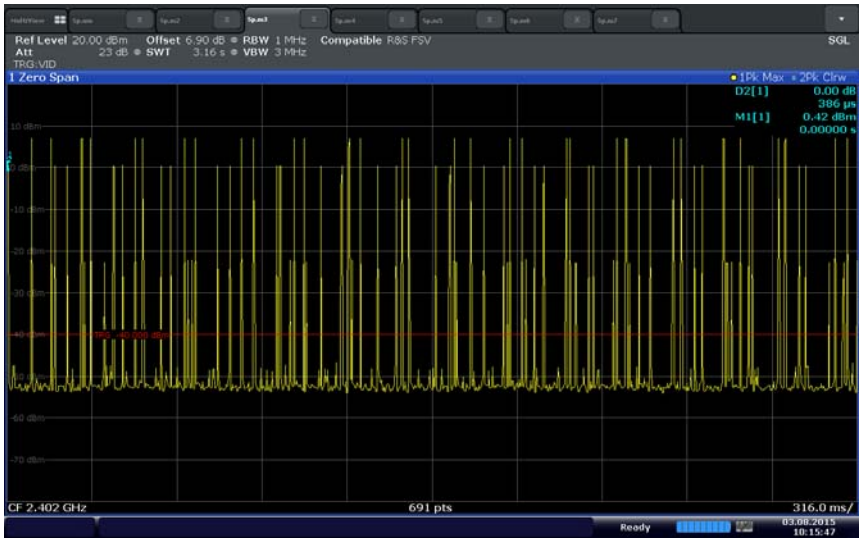
Date: 3.AUG.2015 10:22:59

16 pulses/3.16 seconds (π/4-DQPSK, 2 DH3)



Date: 3.AUG.2015 09:57:34

8DPSK width of single pulse (0.38551 ms)



Date: 3.AUG.2015 10:15:48

32 pulses/3.16 seconds (8DPSK, 3 DH1)

2.4 20 dB BANDWIDTH

2.4.1 Specification Reference

Part 15 Subpart C §15.215(c)

2.4.2 Standard Applicable

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

2.4.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration A

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

July 23, 2015 / NS

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	24.8 °C
Relative Humidity	64.1 %
ATM Pressure	99.1 kPa

2.4.7 Additional Observations

- This Section of test data was leveraged from previous test report under TÜV SÜD test report ref. No. SD72111016-1015B.
- This is a conducted test.
- An offset of 6.9 dB was added to compensate the power splitter and coaxial cable attenuation.
- Span is approximately 2 to 3 times the expected 20dB bandwidth.
- RBW is ≥ 1% of the expected 20dB bandwidth while VBW is ≥ RBW.
- Sweep is auto.
- Detector is peak.
- Max hold function activated.

- "n dB down" marker function (20dB) of the spectrum analyzer was used for this test.

2.4.8 Test Results

Modulation	Channel	Frequency (MHz)	Measured 20dB Bandwidth (MHz)
GFSK	0	2402	1.13
	38	2440	1.13
	78	2480	1.13
π/4-DQPSK	0	2402	1.42
	38	2440	1.42
	78	2480	1.42
8DPSK	0	2402	1.41
	38	2440	1.41
	78	2480	1.41

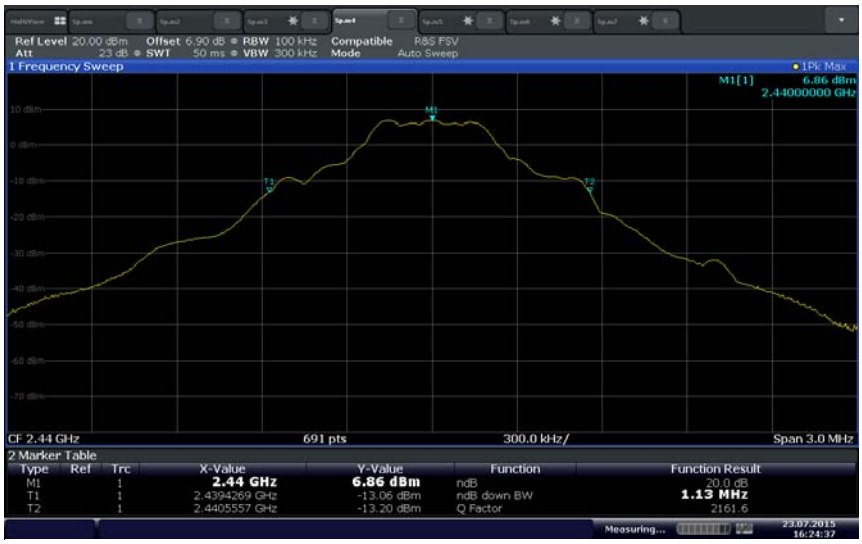
Worst case configuration (π/4-DQPSK)
2402 MHz – (20dB BW/2) = 2401.29 MHz (within the frequency band - **Compliant**)

Worst case configuration (π/4-DQPSK)
2480 MHz + (20dB BW/2) = 2480.71 MHz (within the frequency band - **Compliant**)

2.4.9 Test Results Plots

Date: 23.JUL.2015 16:00:24

GFSK Low Channel



Date: 23.JUL.2015 16:24:38

GFSK Mid Channel

Date: 23.JUL.2015 16:40:41

GFSK High Channel

Date: 23.JUL.2015 16:06:12

π/4-DQPSK Low Channel

Date: 23.JUL.2015 16:30:51

π/4-DQPSK Mid Channel

Date: 23.JUL.2015 16:45:13

π/4-DQPSK High Channel

Date: 23.JUL.2015 16:22:11

8DPSK Low Channel

Date: 23.JUL.2015 16:37:21

8DPSK Mid Channel

Date: 23.JUL.2015 16:48:33

8DPSK High Channel

2.5 99% EMISSION BANDWIDTH

2.5.1 Specification Reference

RSS-Gen Clause 6.6

2.5.2 Standard Applicable

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.
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- 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 approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.
The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.
The difference between the two recorded frequencies is the 99% occupied bandwidth.

2.5.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration A

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

July 23, 2015 / NS

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	24.8 °C
Relative Humidity	64.1 %
ATM Pressure	99.1 kPa

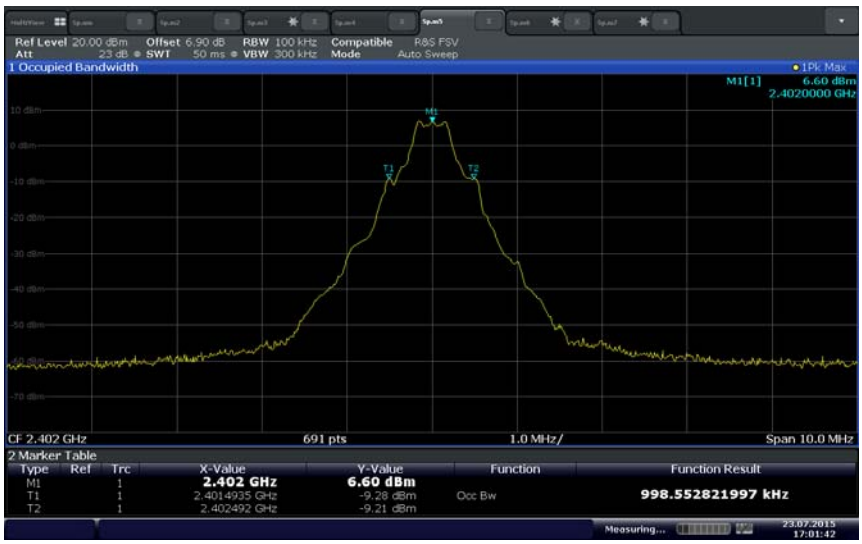
2.5.7 Additional Observations

- This Section of test data was leveraged from previous test report under TÜV SÜD test report ref. No. SD72111016-1015B.
- This is a conducted test.
- An offset of 6.9 dB was added to compensate the power splitter and coaxial cable attenuation.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- The % Power Bandwidth setting in the spectrum analyzer was set to 99% (default).
- The OBW power measurement function of the spectrum analyzer was used for this test.

2.5.8 Test Results (For reporting purposes only)

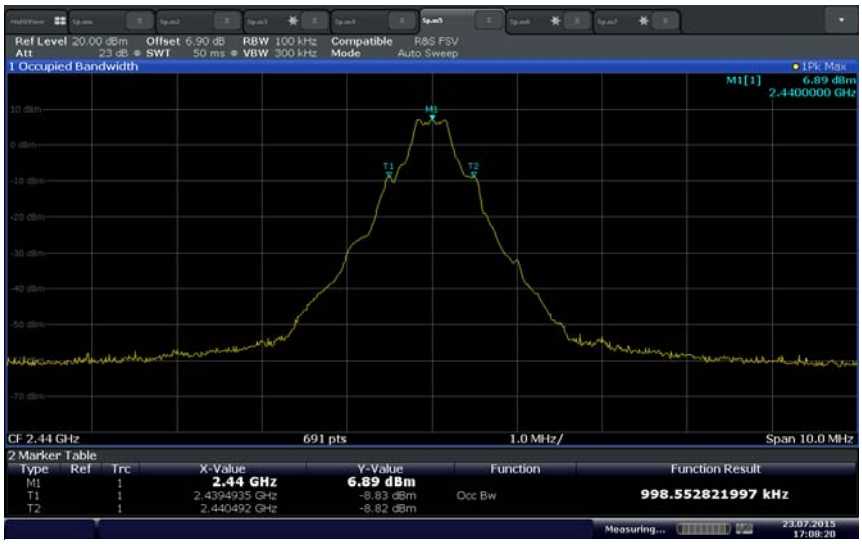
Modulation	Channel	Frequency (MHz)	Measured 20dB Bandwidth (MHz)
GFSK	0	2402	0.998
	38	2440	1.013
	78	2480	0.998
π/4-DQPSK	0	2402	1.230
	38	2440	1.216
	78	2480	1.230
8DPSK	0	2402	1.230
	38	2440	1.216
	78	2480	1.230

2.5.9 Test Results Plots



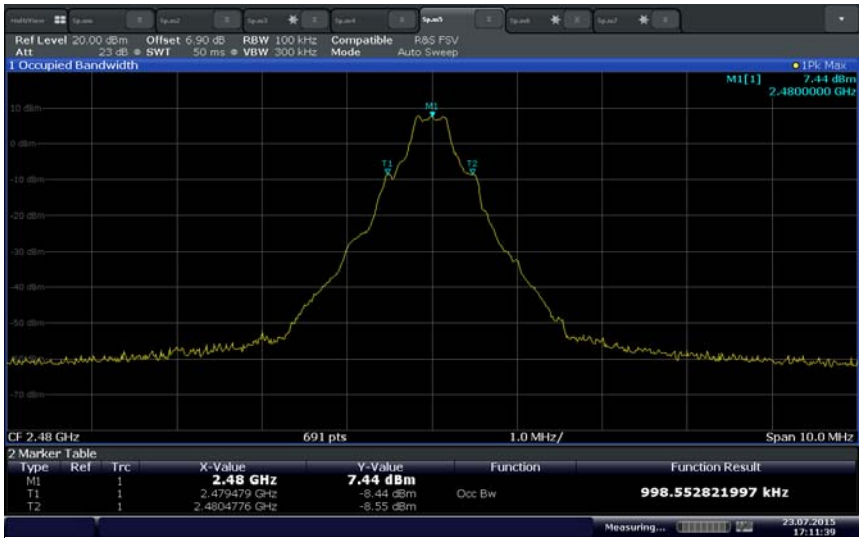
Date: 23.JUL.2015 17:01:42

GFSK Low Channel



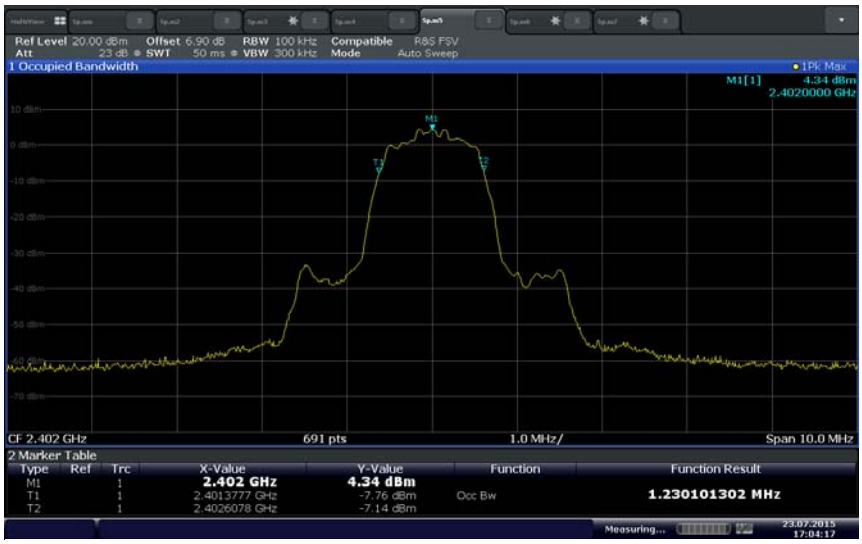
Date: 23.JUL.2015 17:08:20

GFSK Mid Channel



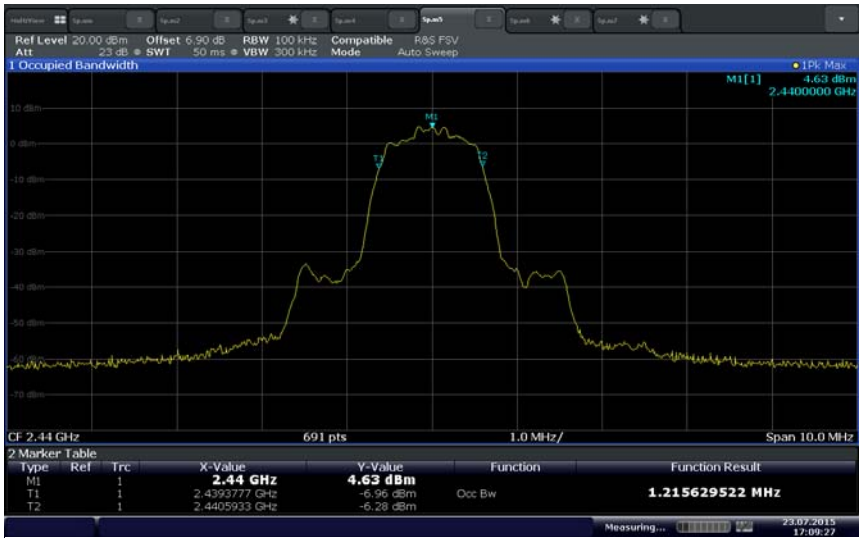
Date: 23.JUL.2015 17:11:39

GFSK High Channel



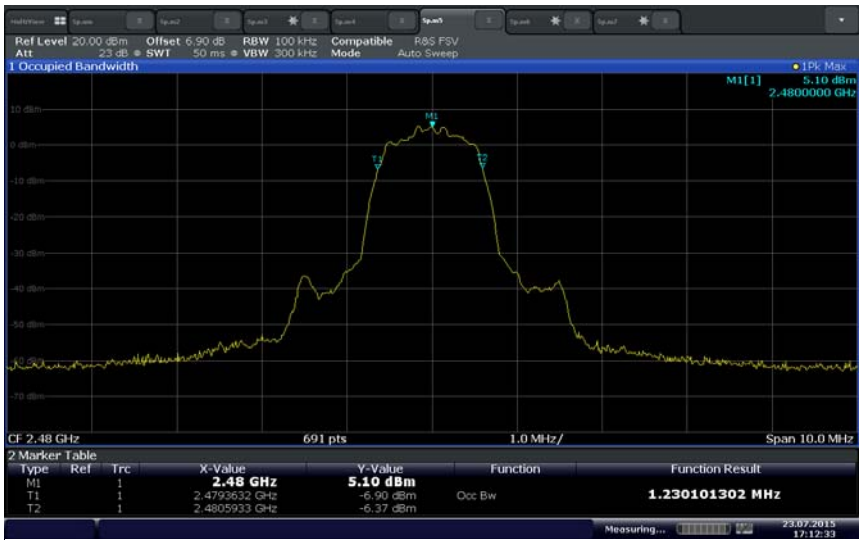
Date: 23.JUL.2015 17:04:17

π/4-DQPSK Low Channel



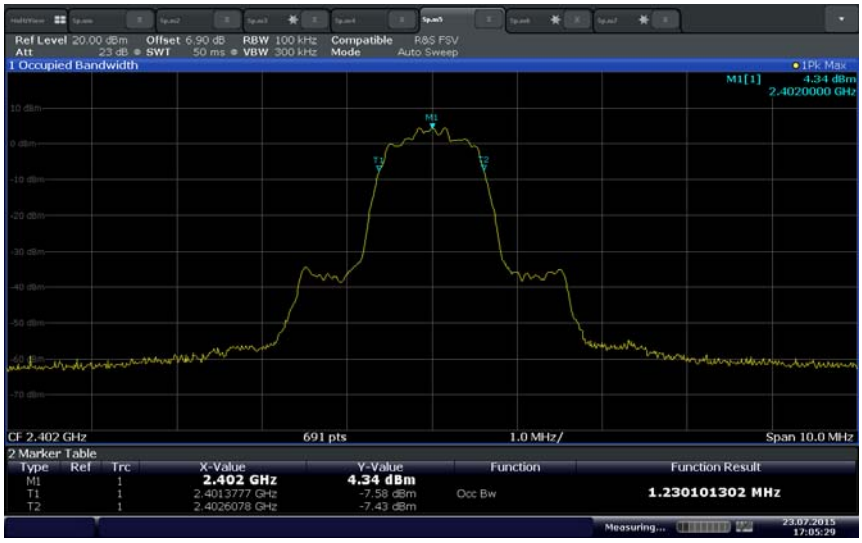
Date: 23.JUL.2015 17:09:28

π/4-DQPSK Mid Channel



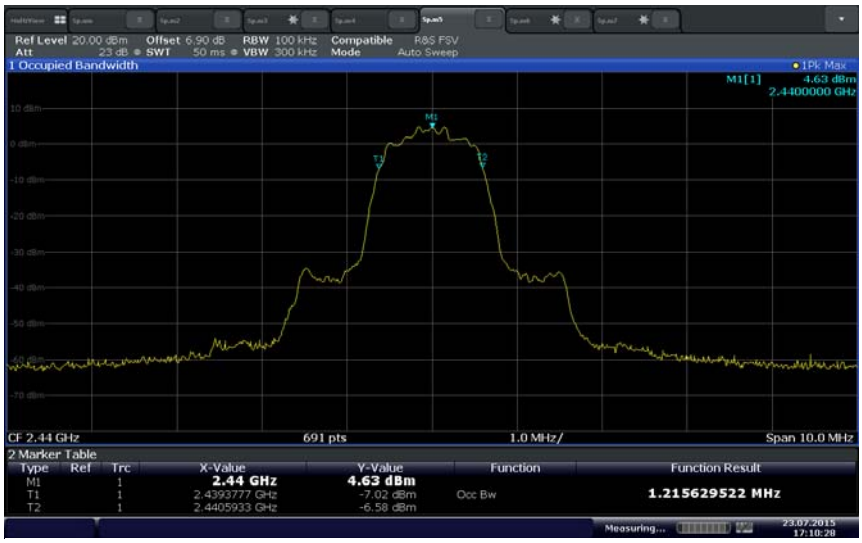
Date: 23.JUL.2015 17:12:33

π/4-DQPSK High Channel



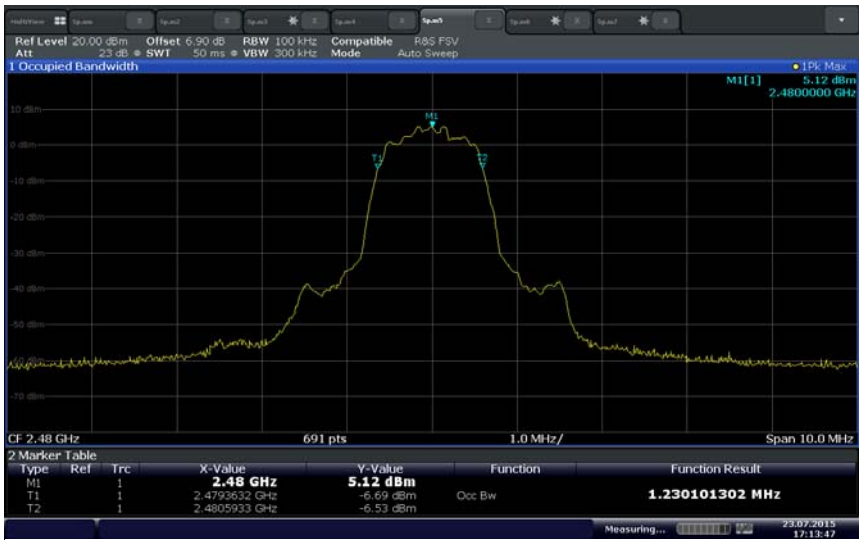
Date: 23.JUL.2015 17:05:29

8DPSK Low Channel



Date: 23.JUL.2015 17:10:28

8DPSK Mid Channel



Date: 23.JUL.2015 17:13:47

8DPSK High Channel

2.6 PEAK OUTPUT POWER

2.6.1 Specification Reference

Part 15 Subpart C §15.247(b)(1)

2.6.2 Standard Applicable

(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

2.6.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration A

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

July 16, 2015 / NS

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	24.8 °C
Relative Humidity	64.1 %
ATM Pressure	99.1 kPa

2.6.7 Additional Observations

- This Section of test data was leveraged from previous test report under TÜV SÜD test report ref. No. SD72111016-1015B.
- This is a conducted test using a Peak Power Meter.

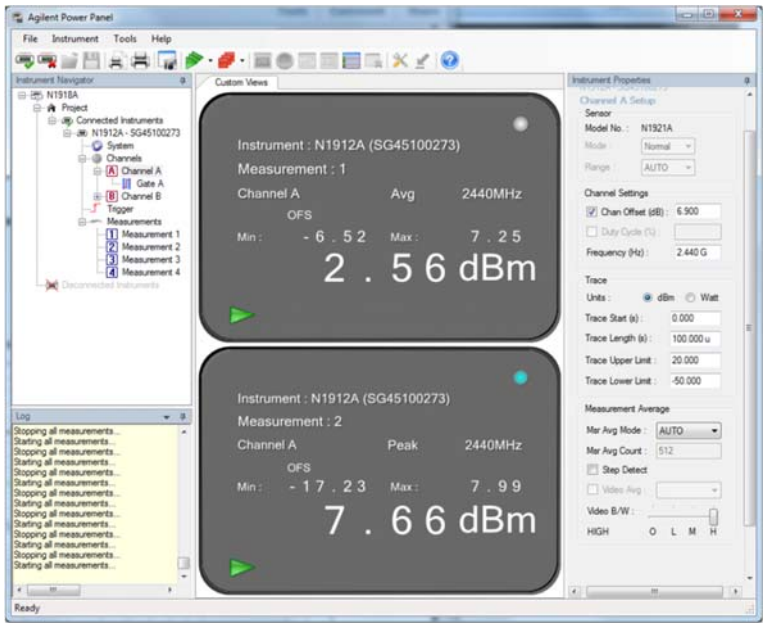
2.6.8 Test Results (Conducted)

Modulation	Channel	Frequency (MHz)	Measured Average Output Power (dBm)	Measured Peak Output Power (dBm)	Measured Peak Output Power (mW)	Limit (mW)
GFSK	0	2402	6.60	7.26	5.32	1000.0
	38	2440	***7.25***	7.99	6.30	1000.0
	78	2480	7.11	7.86	6.11	1000.0
π/4-DQPSK	0	2402	4.46	7.19	5.24	1000.0
	38	2440	5.06	7.76	5.97	1000.0
	78	2480	4.89	7.68	5.86	1000.0
8DPSK	0	2402	4.46	7.65	5.82	1000.0
	38	2440	5.06	8.20	6.61	1000.0
	78	2480	4.90	8.14	6.52	1000.0

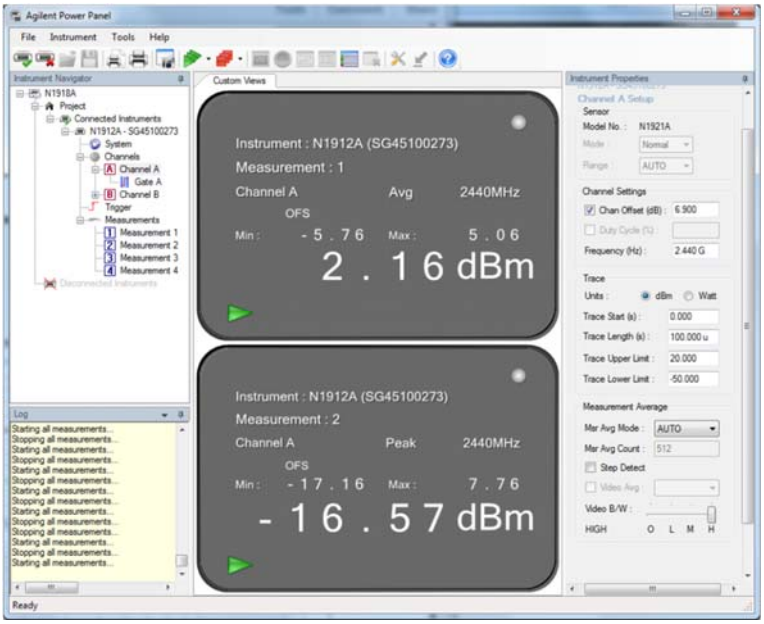
2.6.9 Test Results (*De Facto* EIRP Limit)

Modulation	Channel	Frequency (MHz)	Measured Peak Output Power (dBm)	Antenna Gain (dBi)	Calculated Peak Output Power EIRP (dBm)	Limit (dBm)
GFSK	38	2440	7.99	-2.76	5.23	30
π/4-DQPSK	38	2440	7.76	-2.76	5.0	30
8DPSK	38	2440	8.20	-2.76	5.44	30

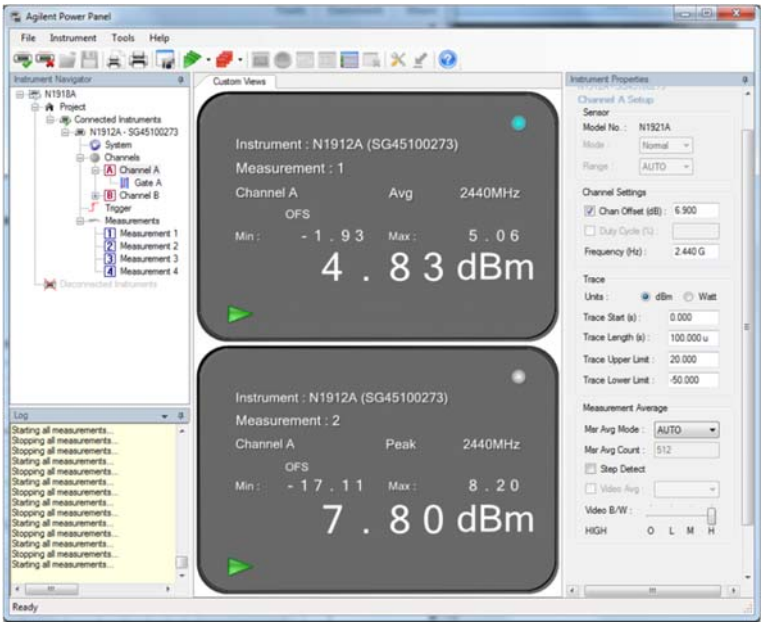
2.6.10 Sample Test Display



GFSK mid channel (Channel 38 2440 MHz)



π/4-DQPSK mid channel (Channel 38 2440 MHz)



8DPSK mid channel (Channel 38 2440 MHz)

2.7 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.7.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.7.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.7.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration A

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

July 23, 2015 / NS

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.

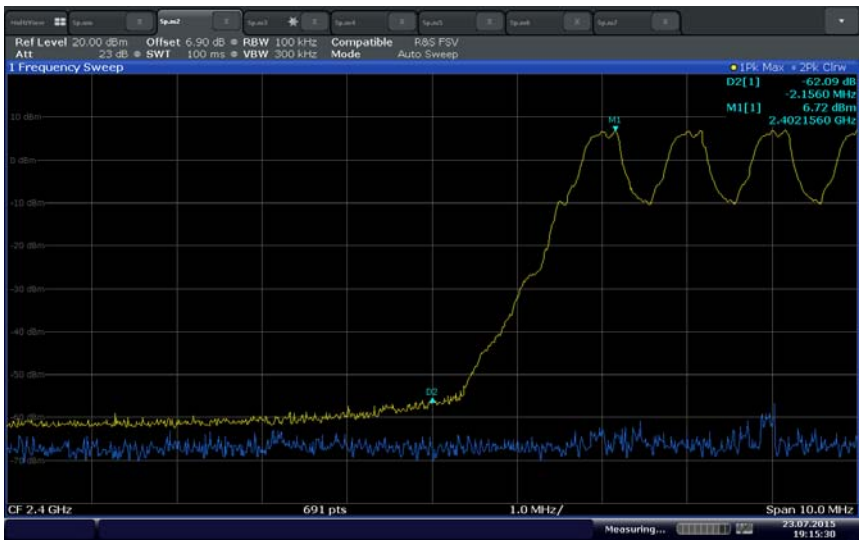
Ambient Temperature	24.8 °C
Relative Humidity	64.1 %
ATM Pressure	99.1 kPa

2.7.7 Additional Observations

- This Section of test data was leveraged from previous test report under TÜV SÜD test report ref. No. SD72111016-1015B.
- This is a conducted test.
- An offset of 6.9 dB was added to compensate the power splitter and coaxial cable attenuation.
- Span is wide enough to capture the peak level of the emission operating on the channel closest to the band edge.
- RBW is ≥ 1% of the span, VBW is ≥ RBW.
- Sweep is auto, detector is peak, trace is max hold.
- Trace allowed to stabilize. Marker-delta function used to verify compliance.

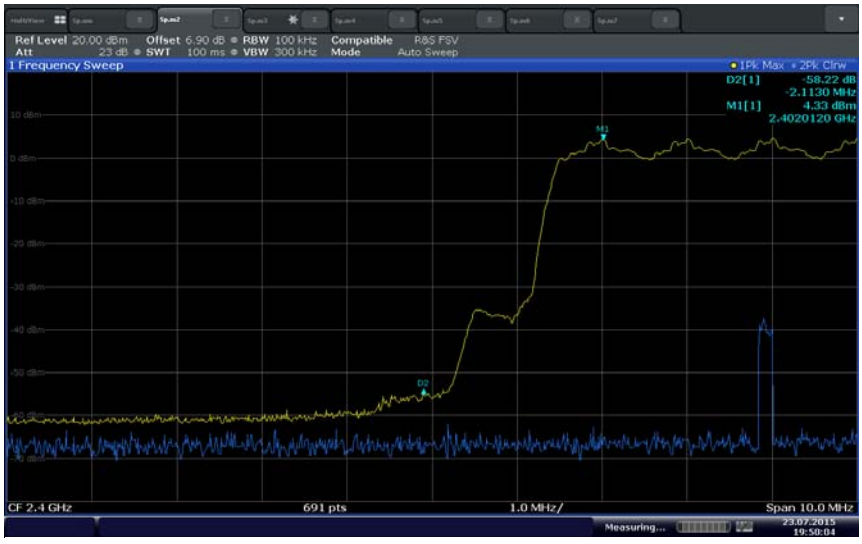
- Limit is 20dBc.
- Both Hopping and Non-Hopping mode verified.

2.7.8 Test Results



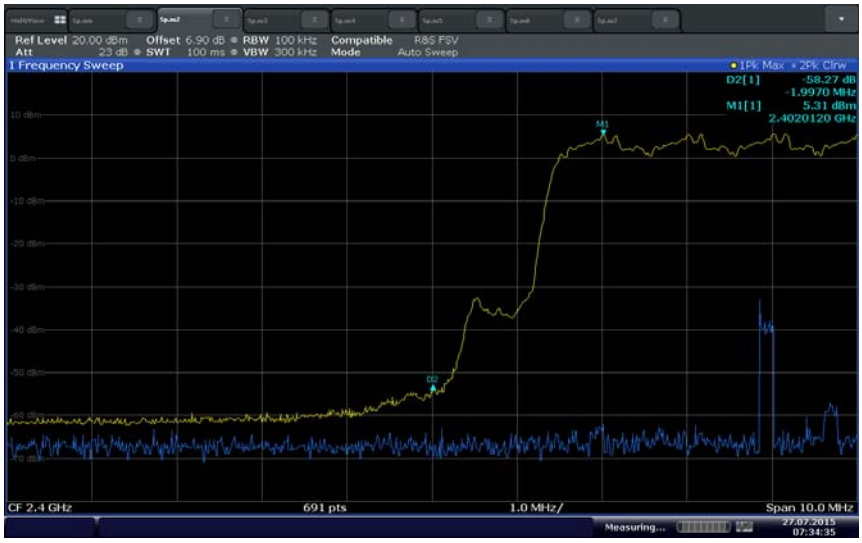
Date: 23.JUL.2015 19:15:30

Hopping lower bandedge (GFSK)



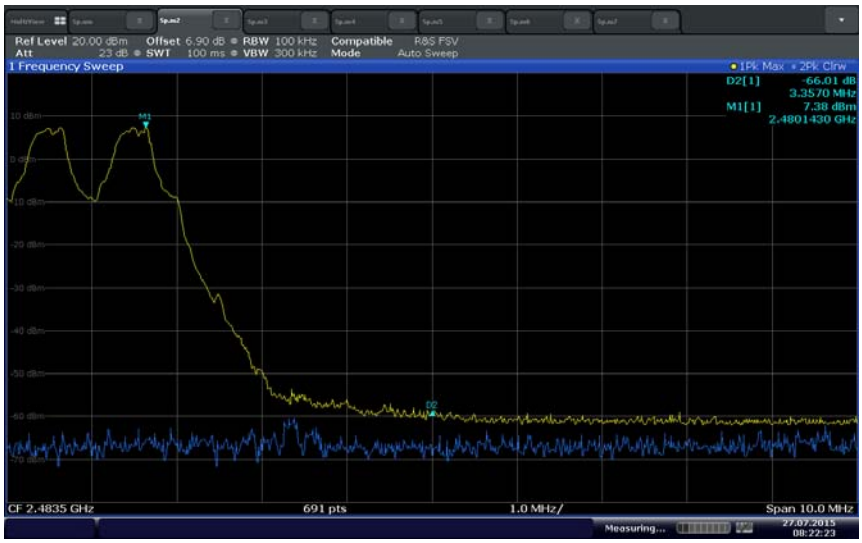
Date: 23.JUL.2015 19:50:04

Hopping lower bandedge (π/4-DQPSK)



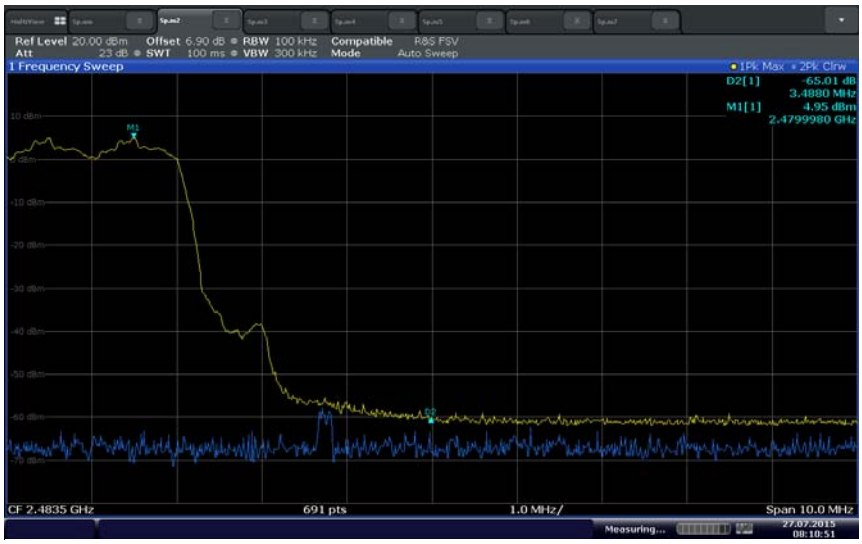
Date: 27.JUL.2015 07:34:35

Hopping lower bandedge (8DPSK)



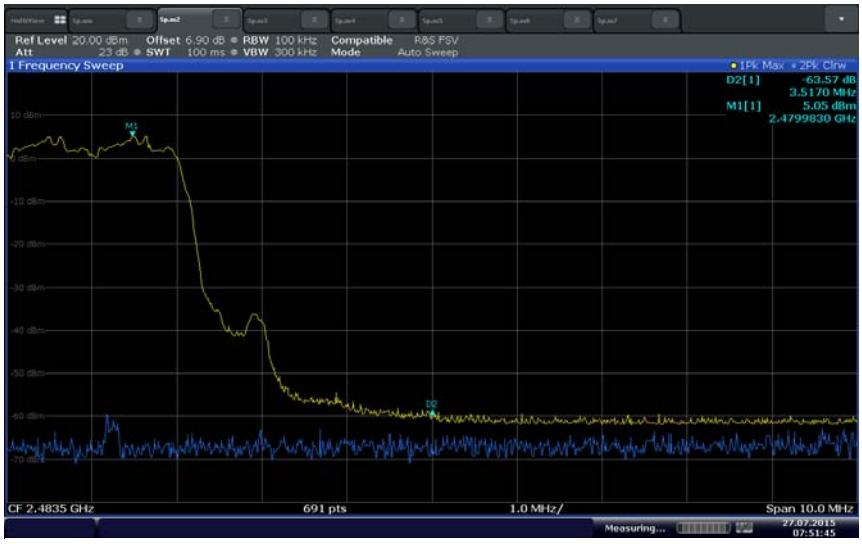
Date: 27.JUL.2015 08:22:23

Hopping upper bandedge (GFSK)



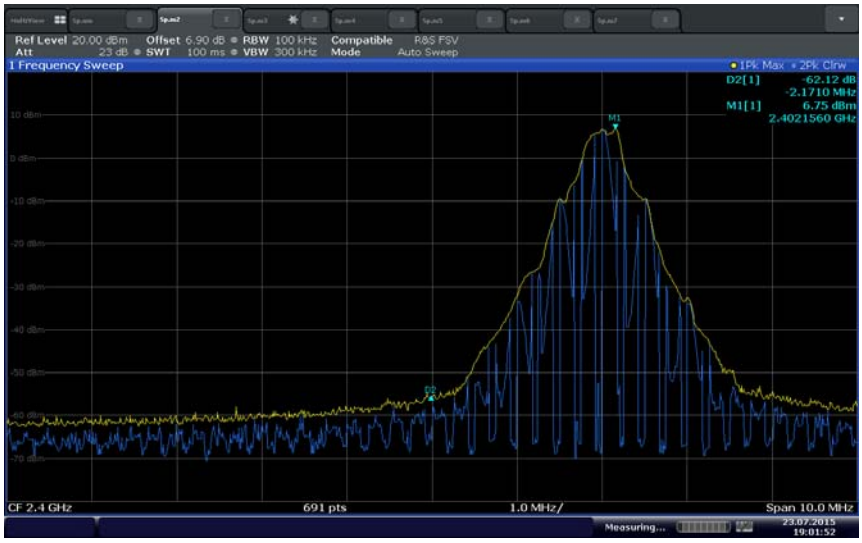
Date: 27.JUL.2015 08:10:51

Hopping upper bandedge (π/4-DQPSK)



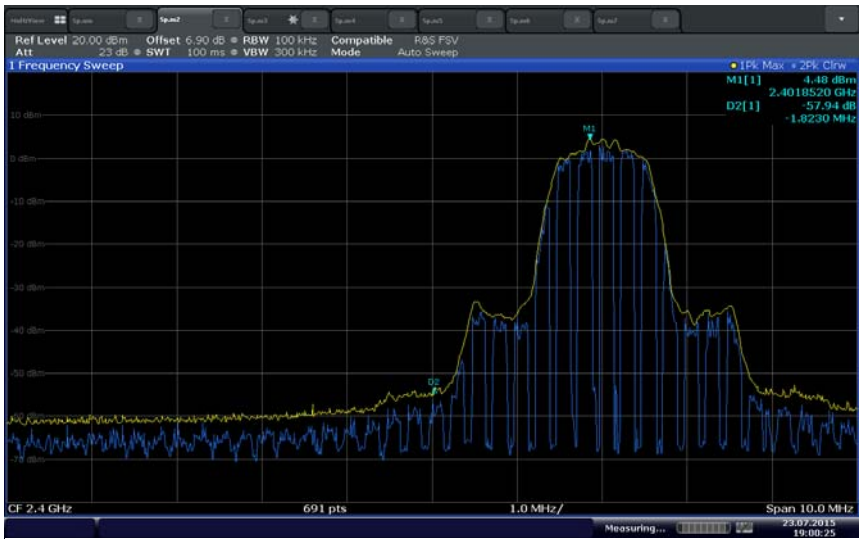
Date: 27.JUL.2015 07:51:46

Hopping upper bandedge (8DPSK)



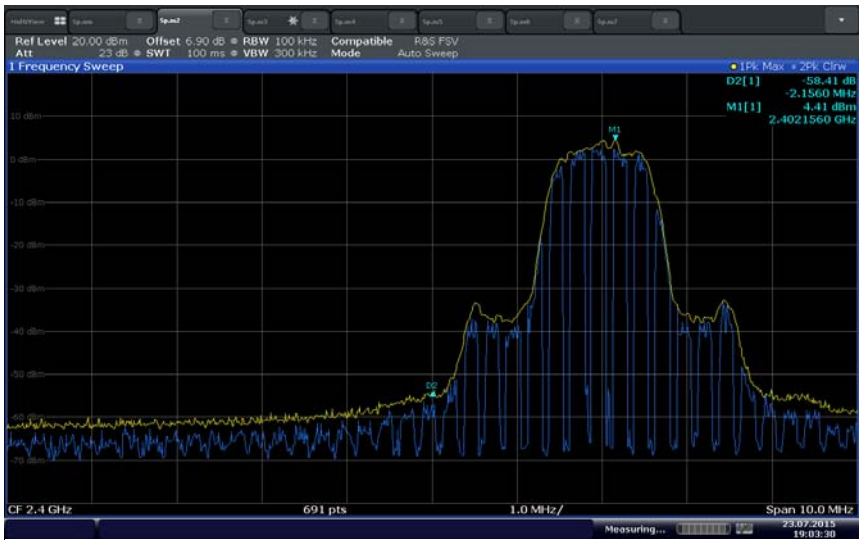
Date: 23.JUL.2015 19:01:51

Non-hopping lower bandedge (GFSK)



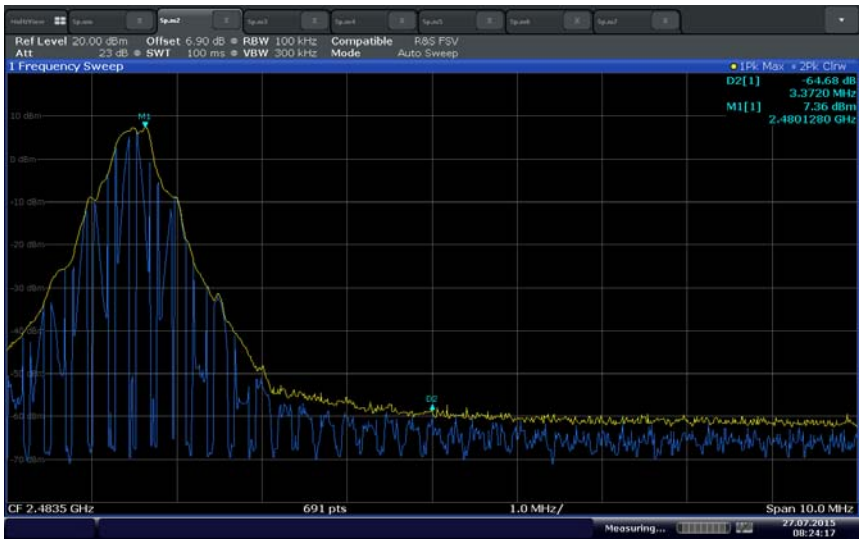
Date: 23.JUL.2015 19:00:25

Non-hopping lower bandedge (π/4-DQPSK)



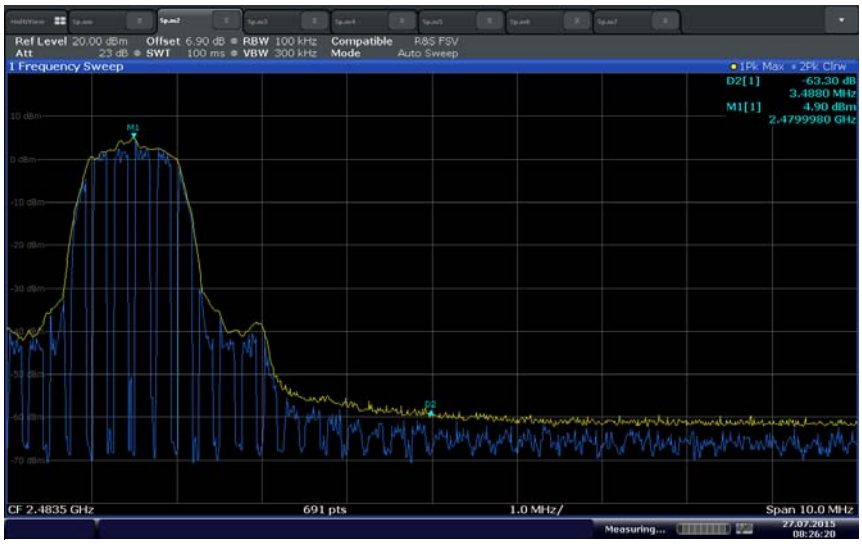
Date: 23.JUL.2015 19:03:30

Non-hopping lower bandedge (8DPSK)



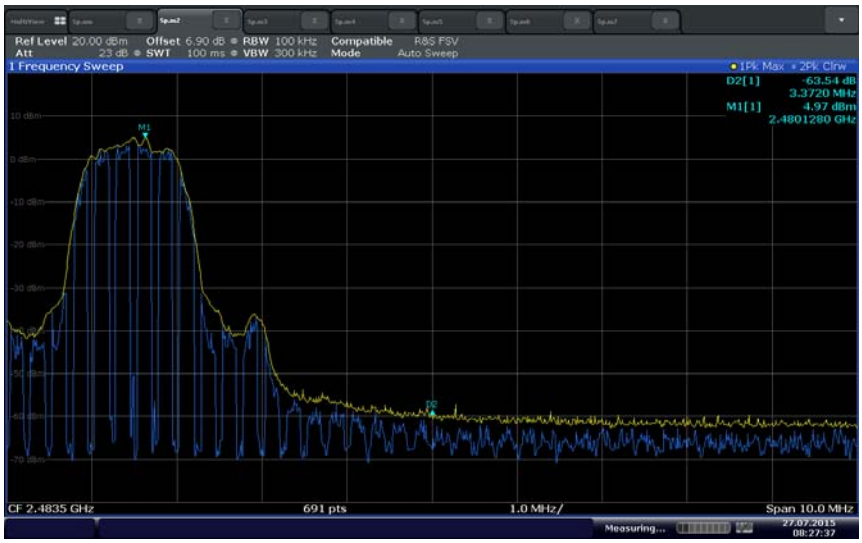
Date: 27.JUL.2015 08:24:18

Non-hopping upper bandedge (GFSK)



Date: 27.JUL.2015 08:26:20

Non-hopping upper bandedge (π/4-DQPSK)



Date: 27.JUL.2015 08:27:37

Non-hopping upper bandedge (8DPSK)

2.8 SPURIOUS RF CONDUCTED EMISSIONS

2.8.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.8.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.8.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration A

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

August 4, 2015 / NS

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.

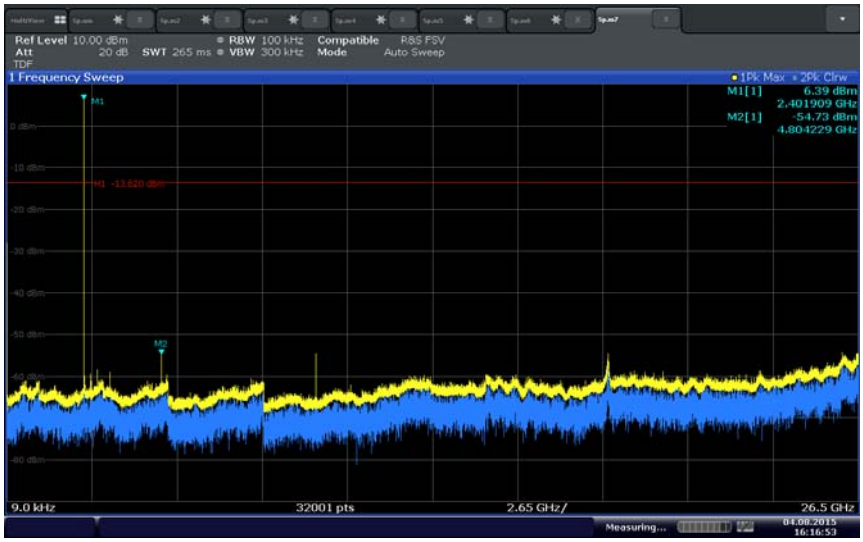
Ambient Temperature	24.8 °C
Relative Humidity	57.1 %
ATM Pressure	99.1 kPa

2.8.7 Additional Observations

- This Section of test data was leveraged from previous test report under TÜV SÜD test report ref. No. SD72111016-1015B.
- This is a conducted test.
- A TDF factor was used to compensate the power splitter and coaxial cable attenuation.
- Span is from 9 kHz up to 26.5GHz (to cover 1^{0th} harmonic of the High Channel).
- Sweep point setting of the spectrum analyzer is set to maximum (32001).
- RBW is 100 kHz, VBW is ≥ RBW.
- Sweep is auto, detector is peak.
- Trace is max hold.

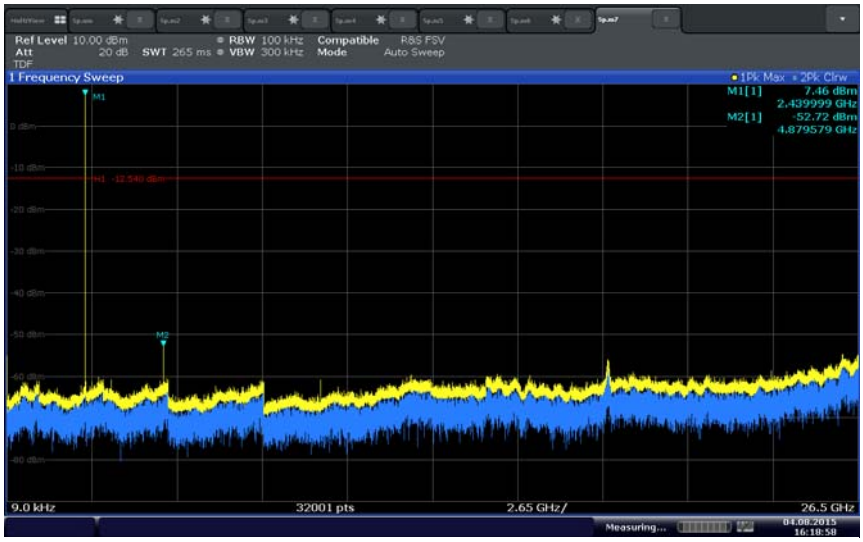
- Trace allowed to stabilize. Maximum spurious emission compared to limit.
- Limit is 20dBc.

2.8.8 Test Results Plots



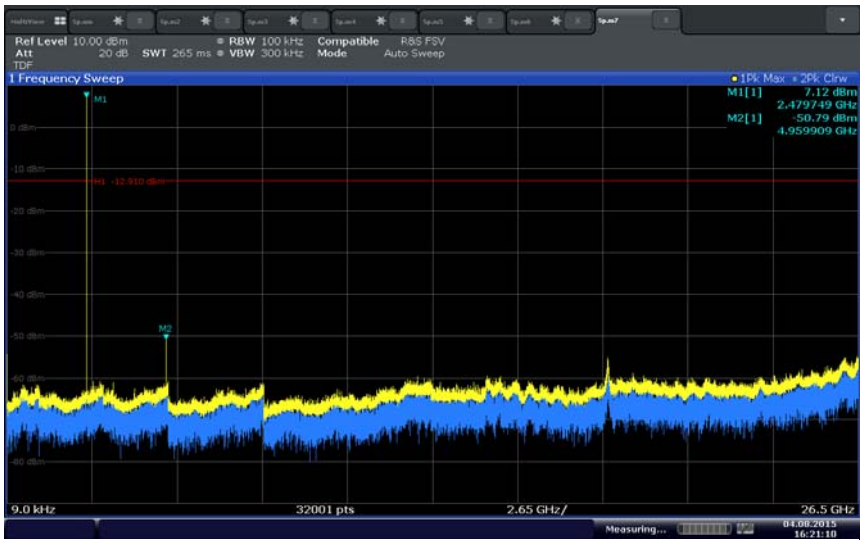
Date: 4.AUG.2015 16:16:54

Low Channel (GFSK)



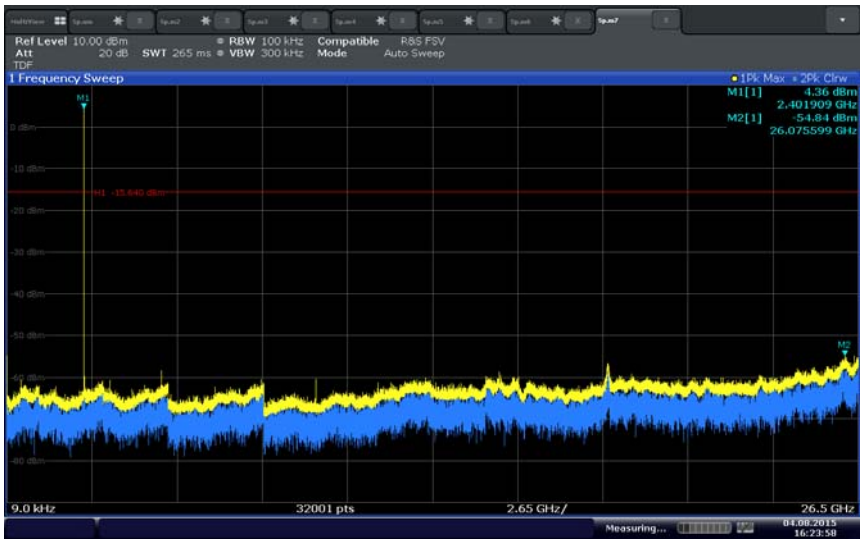
Date: 4.AUG.2015 16:18:58

Mid Channel (GFSK)



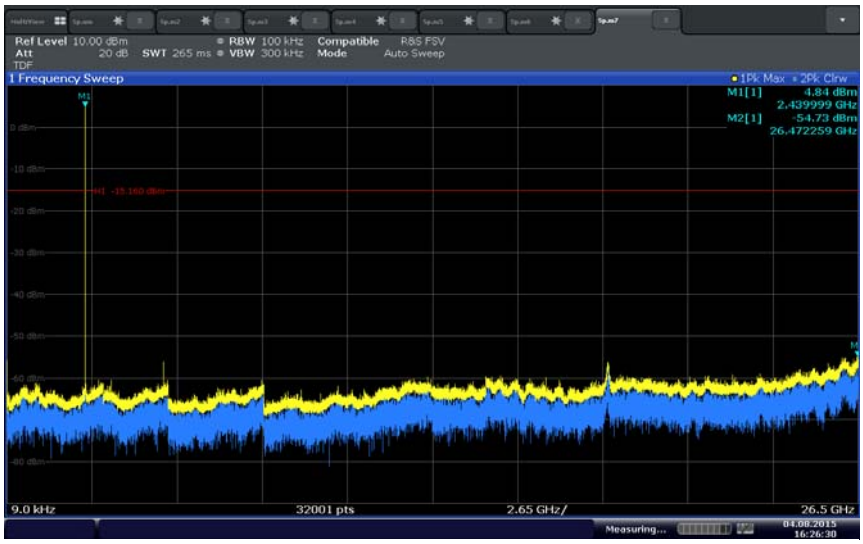
Date: 4.AUG.2015 16:21:10

High Channel (GFSK)



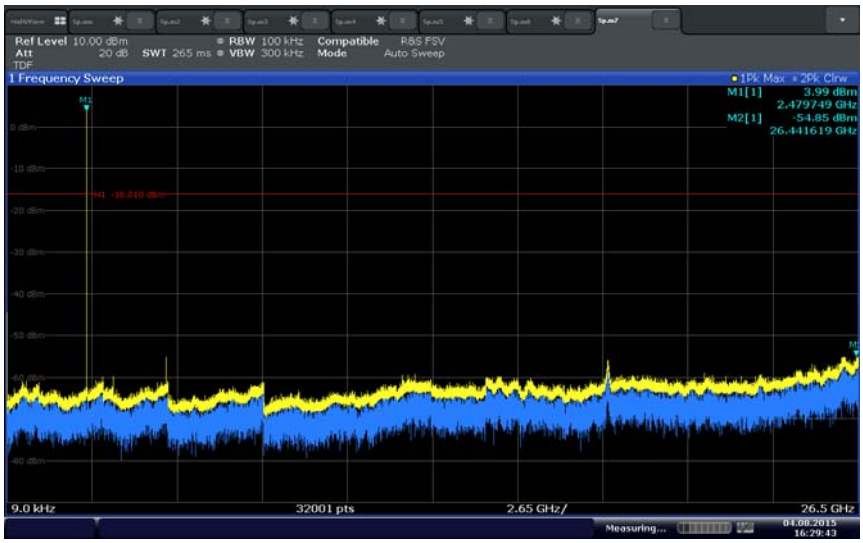
Date: 4.AUG.2015 16:23:58

Low Channel (π/4-DQPSK)



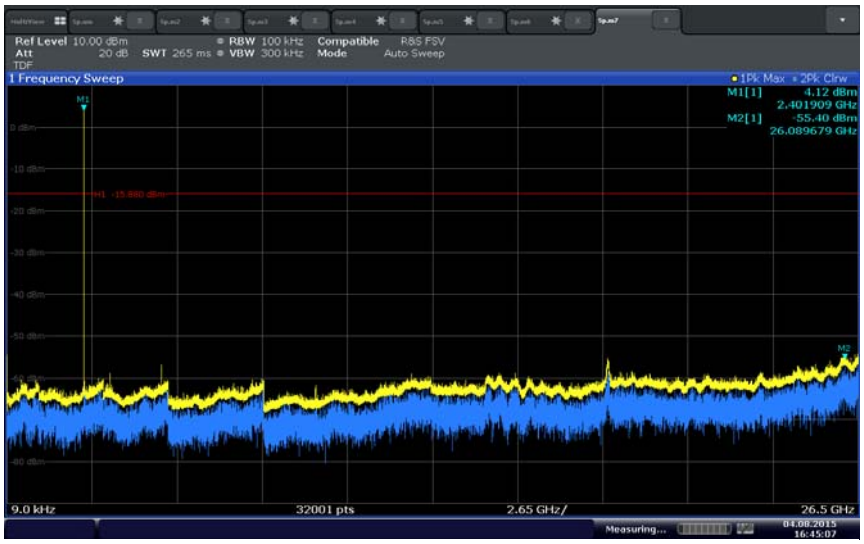
Date: 4.AUG.2015 16:26:30

Mid Channel (π/4-DQPSK)



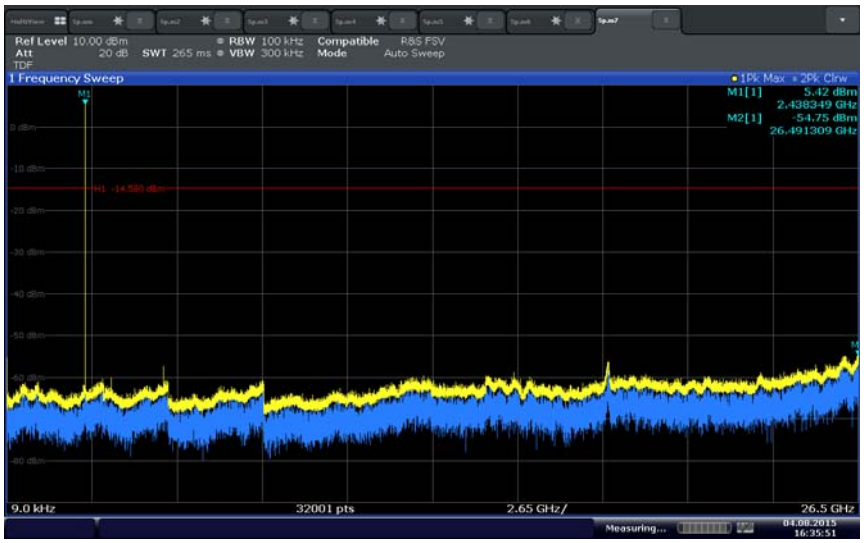
Date: 4.AUG.2015 16:29:44

High Channel (π/4-DQPSK)



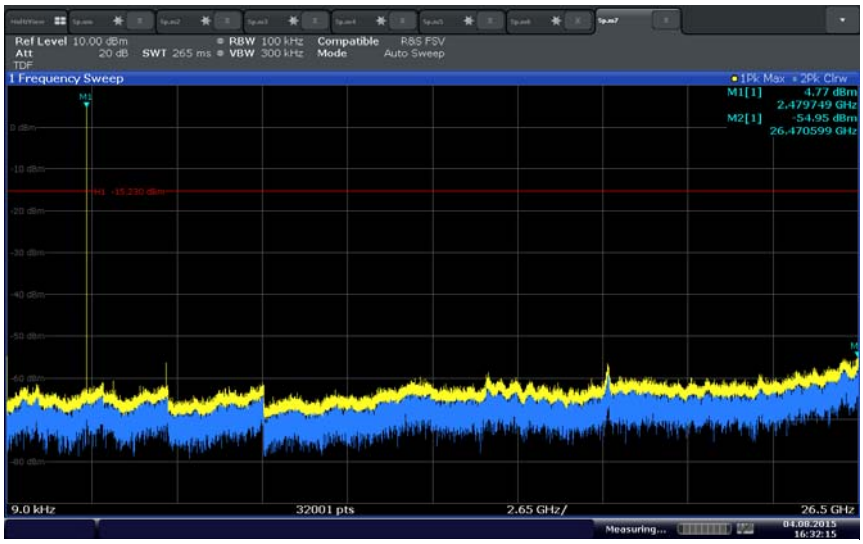
Date: 4.AUG.2015 16:45:07

Low Channel (8DPSK)



Date: 4.AUG.2015 16:35:51

Mid Channel (8DPSK)



Date: 4.AUG.2015 16:32:16

High Channel (8DPSK)

2.9 SPURIOUS RADIATED EMISSIONS

2.9.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.9.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.9.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration B

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

December 15 and 16, 2015 / AC

2.9.5 Test Equipment Used

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

2.9.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	21.6 °C
Relative Humidity	35.1 %
ATM Pressure	99.1 kPa

2.9.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Only the considered worst case configuration (mid channel GFSK) presented for radiated emissions when not hopping below 1GHz. There are no significant differences in radiated emissions between the three modulation types.

- Only noise floor measurements observed above 18GHz.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.9.8 for sample computation.

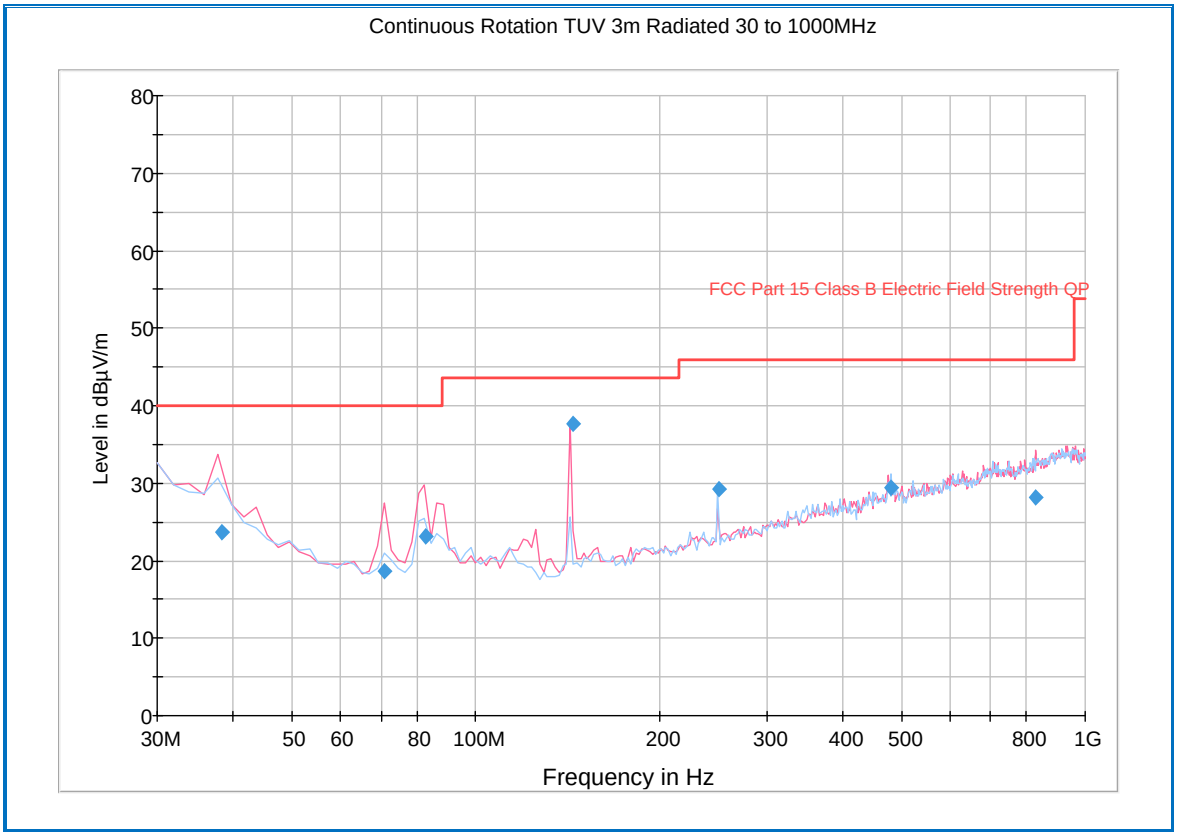
2.9.8 Sample Computation (Radiated Emission)

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# 1002 (antenna)	17.2	
Reported Quasi Peak Final Measurement (dBµV/m) @ 30MHz			**11.8**

2.9.9 Test Results

See attached plots.

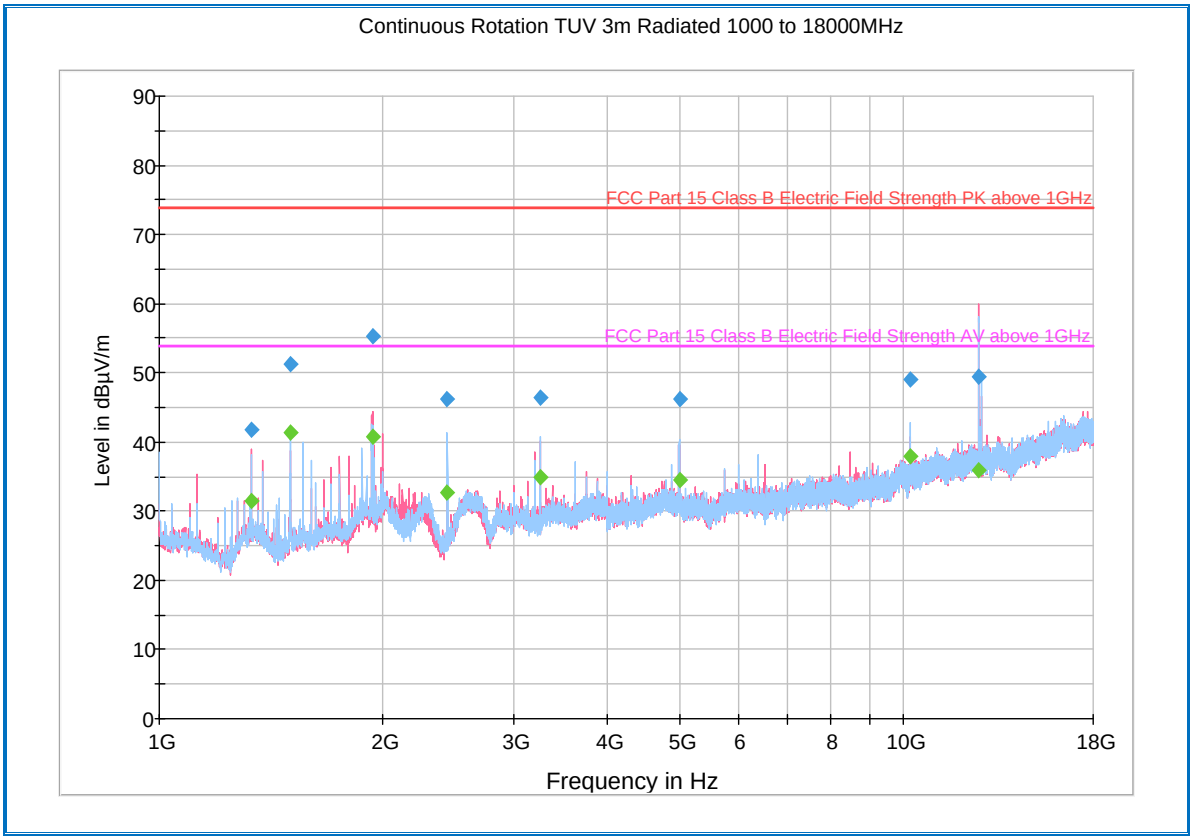
2.9.10 Test Results Below 1GHz (Bluetooth TX Worst Case – Non-hopping)



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)
38.255551	23.7	1000.0	120.000	100.0	V	118.0	-10.2	16.3	40.0
70.821643	18.7	1000.0	120.000	109.0	V	216.0	-16.8	21.3	40.0
82.684970	23.1	1000.0	120.000	105.0	V	-12.0	-16.3	16.9	40.0
144.025491	37.7	1000.0	120.000	100.0	V	73.0	-14.0	5.8	43.5
250.019319	29.2	1000.0	120.000	100.0	H	182.0	-9.2	16.8	46.0
480.061964	29.4	1000.0	120.000	150.0	H	23.0	-1.6	16.6	46.0
830.161764	28.2	1000.0	120.000	150.0	V	81.0	4.8	17.8	46.0

2.9.11 Test Results Above 1GHz (Bluetooth TX Worst Case – Non-hopping)



Peak Data

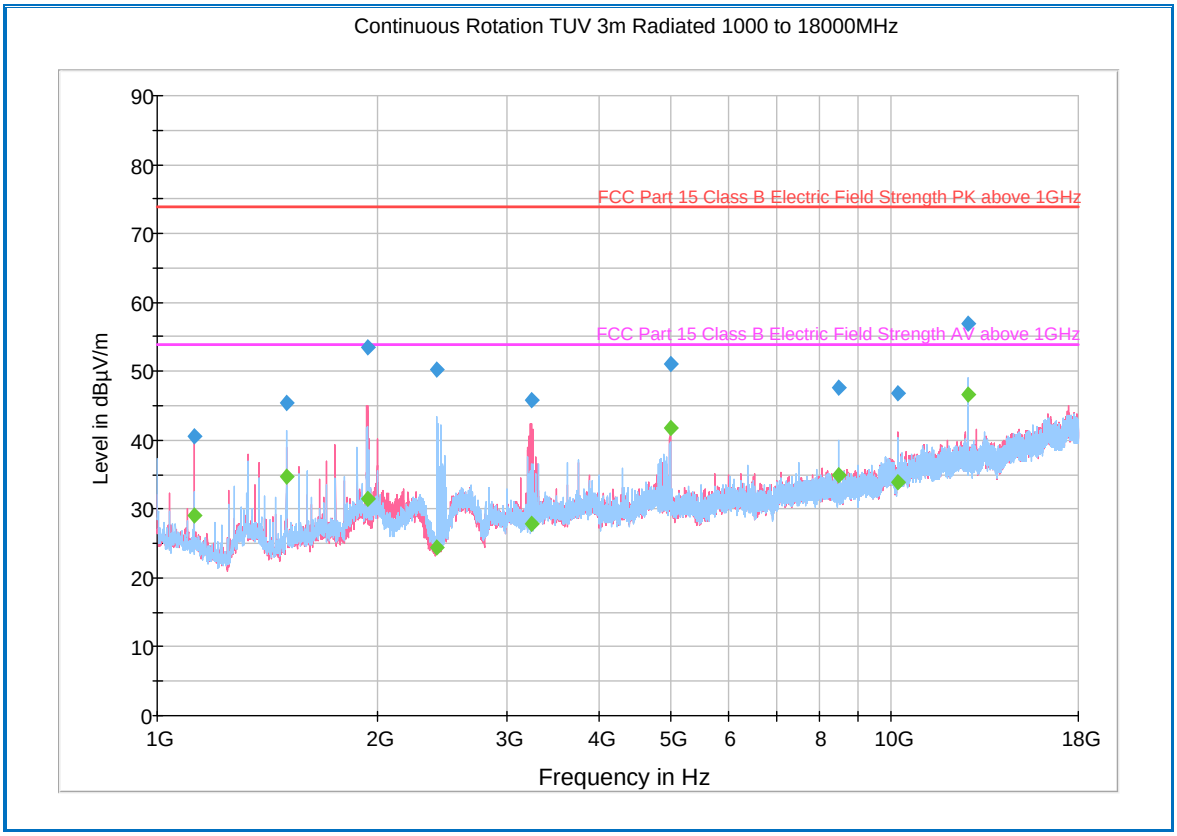
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1331.900000	41.8	1000.0	1000.000	183.5	V	263.0	-5.2	32.1	73.9
1500.000000	51.3	1000.0	1000.000	116.7	H	332.0	-6.2	22.6	73.9
1936.566667	55.3	1000.0	1000.000	397.2	V	241.0	-1.1	18.6	73.9
2440.300000	46.3	1000.0	1000.000	164.6	H	158.0	-0.9	27.7	73.9
3253.266667	46.4	1000.0	1000.000	102.7	H	336.0	0.7	27.5	73.9
5000.500000	46.3	1000.0	1000.000	124.7	H	116.0	3.3	27.6	73.9
10200.03333	49.0	1000.0	1000.000	301.6	H	6.0	11.1	24.9	73.9
12615.36666	49.5	1000.0	1000.000	301.6	V	56.0	14.4	24.4	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1331.900000	31.4	1000.0	1000.000	183.5	V	263.0	-5.2	22.5	53.9
1500.000000	41.4	1000.0	1000.000	116.7	H	332.0	-6.2	12.5	53.9
1936.566667	40.7	1000.0	1000.000	397.2	V	241.0	-1.1	13.2	53.9
2440.300000	32.8	1000.0	1000.000	164.6	H	158.0	-0.9	21.1	53.9
3253.266667	34.9	1000.0	1000.000	102.7	H	336.0	0.7	19.0	53.9
5000.500000	34.6	1000.0	1000.000	124.7	H	116.0	3.3	19.3	53.9
10200.03333	38.0	1000.0	1000.000	301.6	H	6.0	11.1	15.9	53.9
12615.36666	36.0	1000.0	1000.000	301.6	V	56.0	14.4	17.9	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 18GHz.

2.9.12 Test Results Below 1GHz (Bluetooth TX Worst Case – hopping)



Peak Data

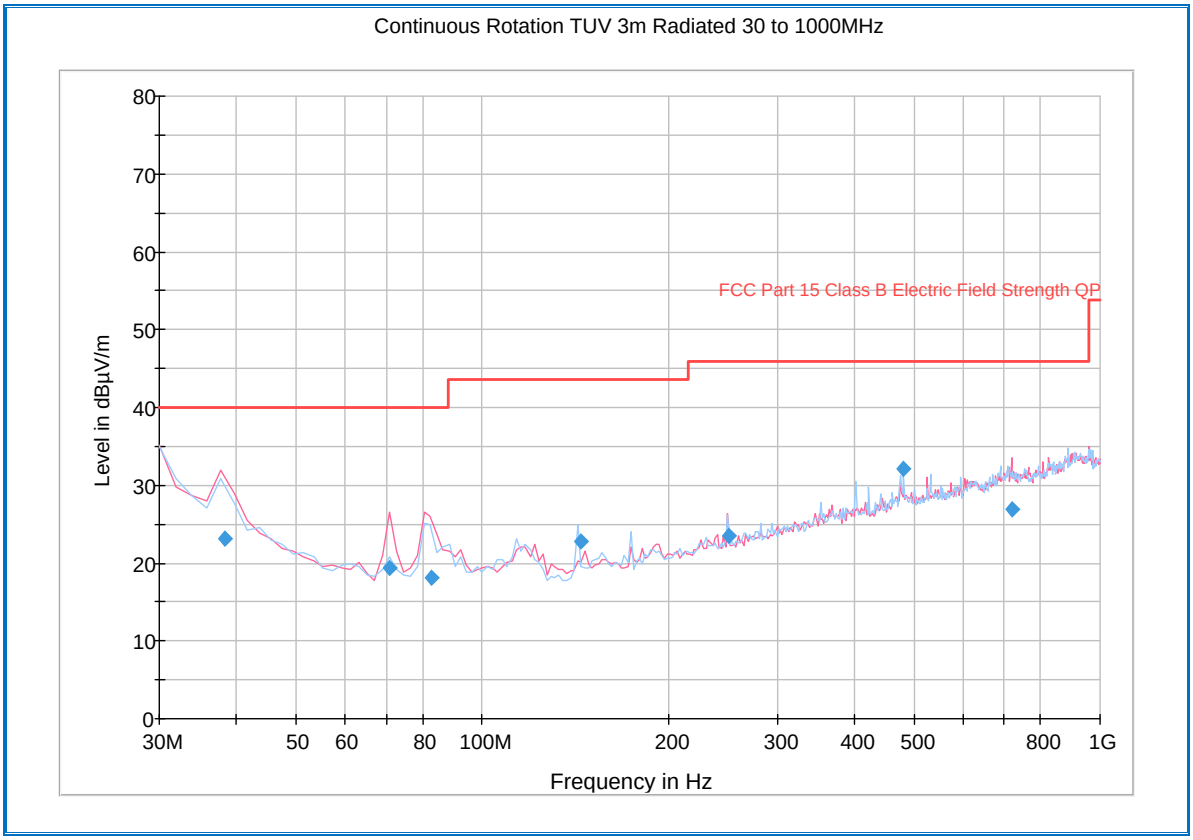
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1125.066667	40.5	1000.0	1000.000	153.7	V	9.0	-7.6	33.4	73.9
1500.000000	45.5	1000.0	1000.000	193.5	H	321.0	-6.2	28.4	73.9
1935.033333	53.4	1000.0	1000.000	303.2	V	112.0	-1.1	20.5	73.9
2407.266667	50.3	1000.0	1000.000	103.7	H	338.0	-1.1	23.6	73.9
3243.800000	45.8	1000.0	1000.000	149.6	V	10.0	0.7	28.1	73.9
5000.300000	51.1	1000.0	1000.000	117.7	V	-9.0	3.3	22.8	73.9
8499.633333	47.7	1000.0	1000.000	250.3	H	57.0	8.0	26.2	73.9
10200.833333	46.9	1000.0	1000.000	101.7	V	196.0	11.1	27.0	73.9
12762.100000	56.8	1000.0	1000.000	182.6	H	-9.0	14.4	17.1	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1125.066667	29.0	1000.0	1000.000	153.7	V	9.0	-7.6	24.9	53.9
1500.000000	34.7	1000.0	1000.000	193.5	H	321.0	-6.2	19.2	53.9
1935.033333	31.5	1000.0	1000.000	303.2	V	112.0	-1.1	22.4	53.9
2407.266667	24.5	1000.0	1000.000	103.7	H	338.0	-1.1	29.4	53.9
3243.800000	27.8	1000.0	1000.000	149.6	V	10.0	0.7	26.1	53.9
5000.300000	41.8	1000.0	1000.000	117.7	V	-9.0	3.3	12.1	53.9
8499.633333	34.9	1000.0	1000.000	250.3	H	57.0	8.0	19.0	53.9
10200.833333	34.0	1000.0	1000.000	101.7	V	196.0	11.1	19.9	53.9
12762.100000	46.7	1000.0	1000.000	182.6	H	-9.0	14.4	7.2	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 18GHz.

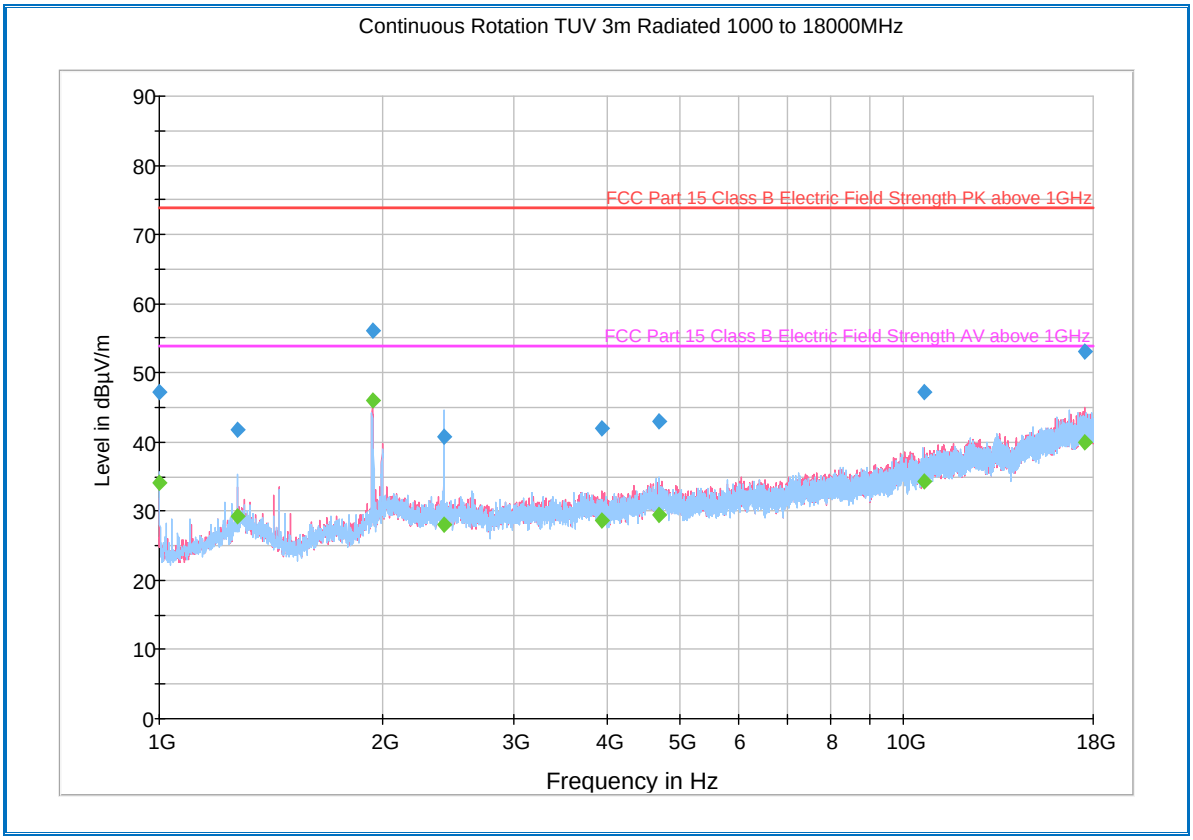
2.9.13 Test Results Below 1GHz (Receive / Standby mode)



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)
38.375551	23.2	1000.0	120.000	127.0	V	18.0	-10.3	16.8	40.0
70.861643	19.3	1000.0	120.000	100.0	V	-12.0	-16.8	20.7	40.0
82.741082	18.2	1000.0	120.000	165.0	V	344.0	-16.3	21.8	40.0
144.025491	22.7	1000.0	120.000	178.0	H	268.0	-14.0	20.8	43.5
249.979319	23.6	1000.0	120.000	100.0	V	230.0	-9.2	22.4	46.0
480.021964	32.1	1000.0	120.000	171.0	H	298.0	-1.6	13.9	46.0
718.760160	26.9	1000.0	120.000	150.0	V	39.0	3.1	19.1	46.0

2.9.14 Test Results Above 1GHz (Receive / Standby mode)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	47.3	1000.0	1000.000	269.3	H	20.0	-7.8	26.6	73.9
1275.633333	41.7	1000.0	1000.000	132.7	H	95.0	-5.2	32.2	73.9
1932.933333	56.2	1000.0	1000.000	301.2	V	-3.0	-1.1	17.7	73.9
2413.833333	40.7	1000.0	1000.000	362.1	H	135.0	-1.1	33.2	73.9
3940.966667	41.9	1000.0	1000.000	228.4	V	272.0	2.3	32.0	73.9
4688.666667	43.0	1000.0	1000.000	202.5	H	28.0	3.0	30.9	73.9
10655.46666	47.2	1000.0	1000.000	125.7	V	64.0	12.2	26.7	73.9
17556.83333	53.1	1000.0	1000.000	165.6	V	235.0	20.0	20.8	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	34.0	1000.0	1000.000	269.3	H	20.0	-7.8	19.9	53.9
1275.633333	29.3	1000.0	1000.000	132.7	H	95.0	-5.2	24.6	53.9
1932.933333	46.0	1000.0	1000.000	301.2	V	-3.0	-1.1	7.9	53.9
2413.833333	28.0	1000.0	1000.000	362.1	H	135.0	-1.1	26.0	53.9
3940.966667	28.8	1000.0	1000.000	228.4	V	272.0	2.3	25.1	53.9
4688.666667	29.5	1000.0	1000.000	202.5	H	28.0	3.0	24.4	53.9
10655.46666	34.4	1000.0	1000.000	125.7	V	64.0	12.2	19.5	53.9
17556.83333	39.9	1000.0	1000.000	165.6	V	235.0	20.0	14.0	53.9

Test Notes: No significant emissions observed above 18GHz.

2.10 RADIATED IMMEDIATE RESTRICTED BANDS

2.10.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.10.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.10.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration B

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

May 05, 2016 / AC

2.10.5 Test Equipment Used

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

2.10.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	27.1 °C
Relative Humidity	37.8 %
ATM Pressure	98.7 kPa

2.10.7 Additional Observations

- This is a radiated test. The spectrum was searched from 2310MHz to 2390MHz for lower immediate restricted band and 2483.5MHz to 2500MHz for the upper immediate restricted band.
- There are no emissions found that do not comply with the restricted bands defined in FCC Part 15 Subpart C, 15.205.
- Only Non-hopping considered as worst case mode and presented.

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

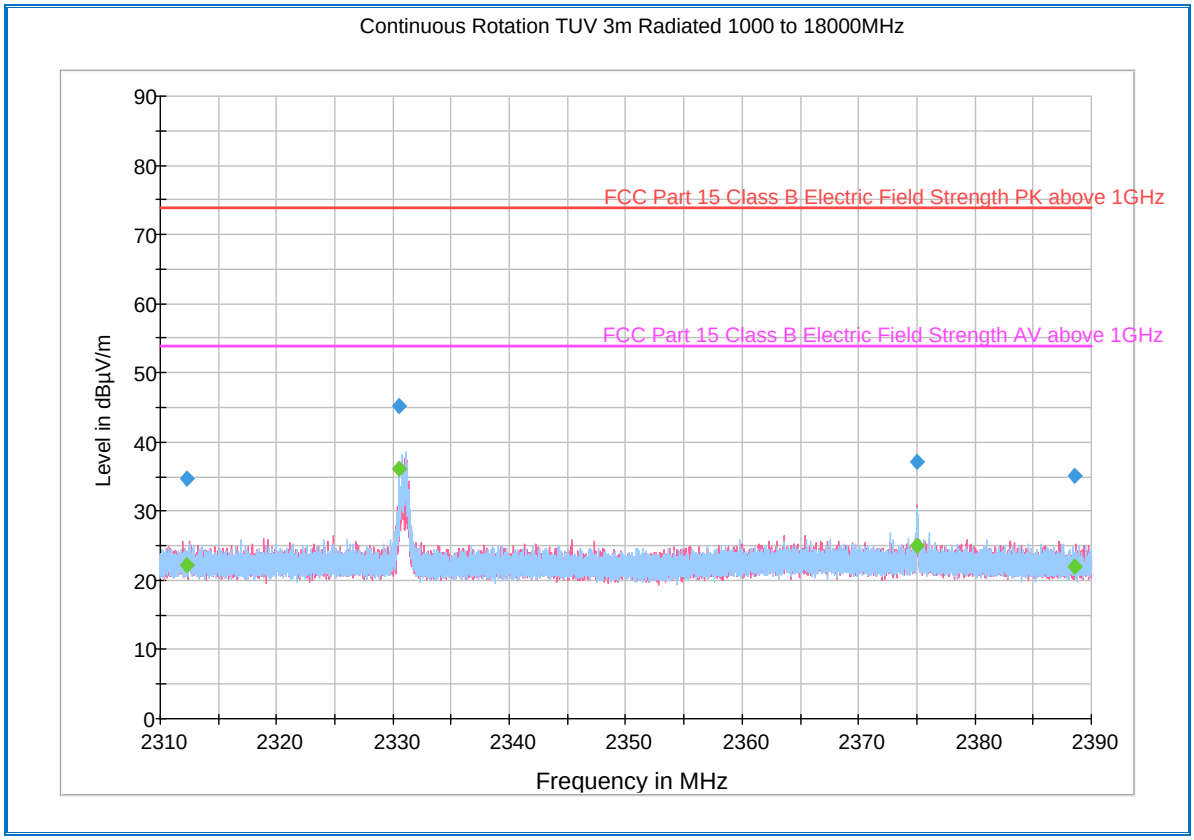
2.10.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dBµV) @ 2400 MHz			53.9
Correction Factor (dB)	Asset# 1153 (cable)	3.4	-0.4
	Asset# 8628(preamplifier)	-36.5	
	Asset#7575 (antenna)	32.7	
Reported Max Peak Final Measurement (dBµV/m) @ 2400 MHz			**53.5**

2.10.9 Test Results

See attached plots.

2.10.10 Test Results Restricted Band 2310MHz to 2390MHz (Non-Hopping)



Peak Data

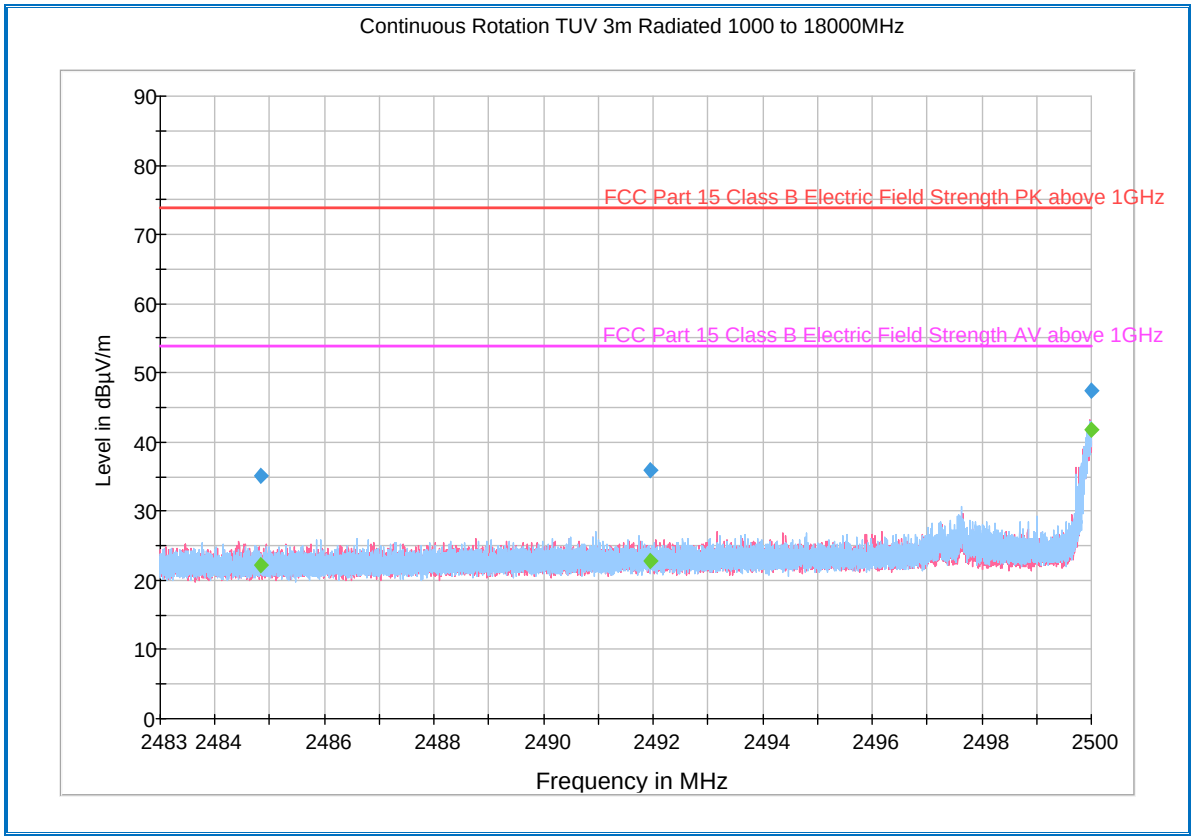
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2312.309333	34.7	1000.0	1000.000	191.5	V	0.0	-7.5	39.2	73.9
2330.504000	45.2	1000.0	1000.000	139.7	H	10.0	-7.4	28.7	73.9
2374.997333	37.1	1000.0	1000.000	174.6	V	48.0	-7.4	36.8	73.9
2388.573333	35.1	1000.0	1000.000	328.2	H	348.0	-7.4	38.8	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2312.309333	22.2	1000.0	1000.000	191.5	V	0.0	-7.5	31.7	53.9
2330.504000	36.1	1000.0	1000.000	139.7	H	10.0	-7.4	17.8	53.9
2374.997333	25.1	1000.0	1000.000	174.6	V	48.0	-7.4	28.8	53.9
2388.573333	21.9	1000.0	1000.000	328.2	H	348.0	-7.4	32.0	53.9

Test Notes: 2.4GHz notch filter removed for this test.

2.10.11 Test Results Restricted Band 2483.5MHz to 2500MHz (Non-Hopping)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2484.839900	35.2	1000.0	1000.000	132.7	V	-20.0	-6.5	38.7	73.9
2491.946367	36.0	1000.0	1000.000	269.3	H	141.0	-6.4	37.9	73.9
2500.000000	47.5	1000.0	1000.000	133.7	V	318.0	-6.4	26.4	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2484.839900	22.1	1000.0	1000.000	132.7	V	-20.0	-6.5	31.8	53.9
2491.946367	22.7	1000.0	1000.000	269.3	H	141.0	-6.4	31.2	53.9
2500.000000	41.7	1000.0	1000.000	133.7	V	318.0	-6.4	12.2	53.9

Test Notes: 2.4GHz notch filter removed for this test.

2.11 RECEIVER SPURIOUS EMISSIONS

2.11.1 Specification Reference

RSS-Gen 7.1

2.11.2 Standard Applicable

Spurious emissions from receivers shall not exceed the radiated limits shown in Table 2 below:

Table 2: Receiver Radiated Limits

Frequency (MHz)	Field Strength (microvolts/m at 3 metres)*
30-88	100
88-216	150
216-960	200
Above 960	500

*Measurements for compliance with limits in the above table may be performed at distances other than 3 metres, in accordance with Section 6.5 of RSS-Gen.

2.11.3 Equipment Under Test and Modification State

Serial No: E70016120011 / Test Configuration B

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

April 25, 2016 / AC

2.11.5 Test Equipment Used

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

2.11.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	21.6 °C
Relative Humidity	35.1 %
ATM Pressure	99.1 kPa

2.11.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 3rd harmonic (up to 10th performed).
- Result identical to Section 2.9.13 and 2.9.14 of this test report.
- EUT in RX (Receive) mode configuration.

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						
7604	P-Series Power Meter	N1912A	SG45100273	Agilent	05/27/15	05/27/16
7605	50MHz-18GHz Wideband Power Sensor	N1921A	MY51100054	Agilent	04/10/15	04/10/16
7582	Signal/Spectrum Analyzer	FSW26	101614	Rhode & Schwarz	12/22/14	12/22/15
1189	Signal Generator	8648C	3623A03059	Hewlett Packard	10/14/14	10/14/15
7608	Vector Signal Generator	SMBV100A	259021	Rhode & Schwarz	07/29/15	07/29/16
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	09/29/15	09/29/16
1033	Bilog Antenna	3142C	00044556	EMCO	09/25/14	09/25/16
1016	Pre-amplifier	PAM-0202	187	PAM	12/15/15	12/15/16
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	01/11/16	01/11/17
1051	Double-ridged waveguide horn antenna	3115	9408-4329	EMCO	03/21/16	03/21/17
Miscellaneous						
6792	Multimeter	3478A	2911A70964	Hewlett Packard	08/14/15	08/14/16
7560	Barometer/Temperature/Humidity Transmitter	iBTHX-W	1240476	Omega	10/19/15	10/19/16
1123	DC Power Supply	E3631A	N/A	Hewlett Packard	Verified by 6792	
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 Radiated Emission Measurements (Below 1GHz)

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.75	0.43	0.19
5	Site	Rectangular	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

3.2.2 Radiated Emission Measurements (Above 1GHz)

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	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:	3.56

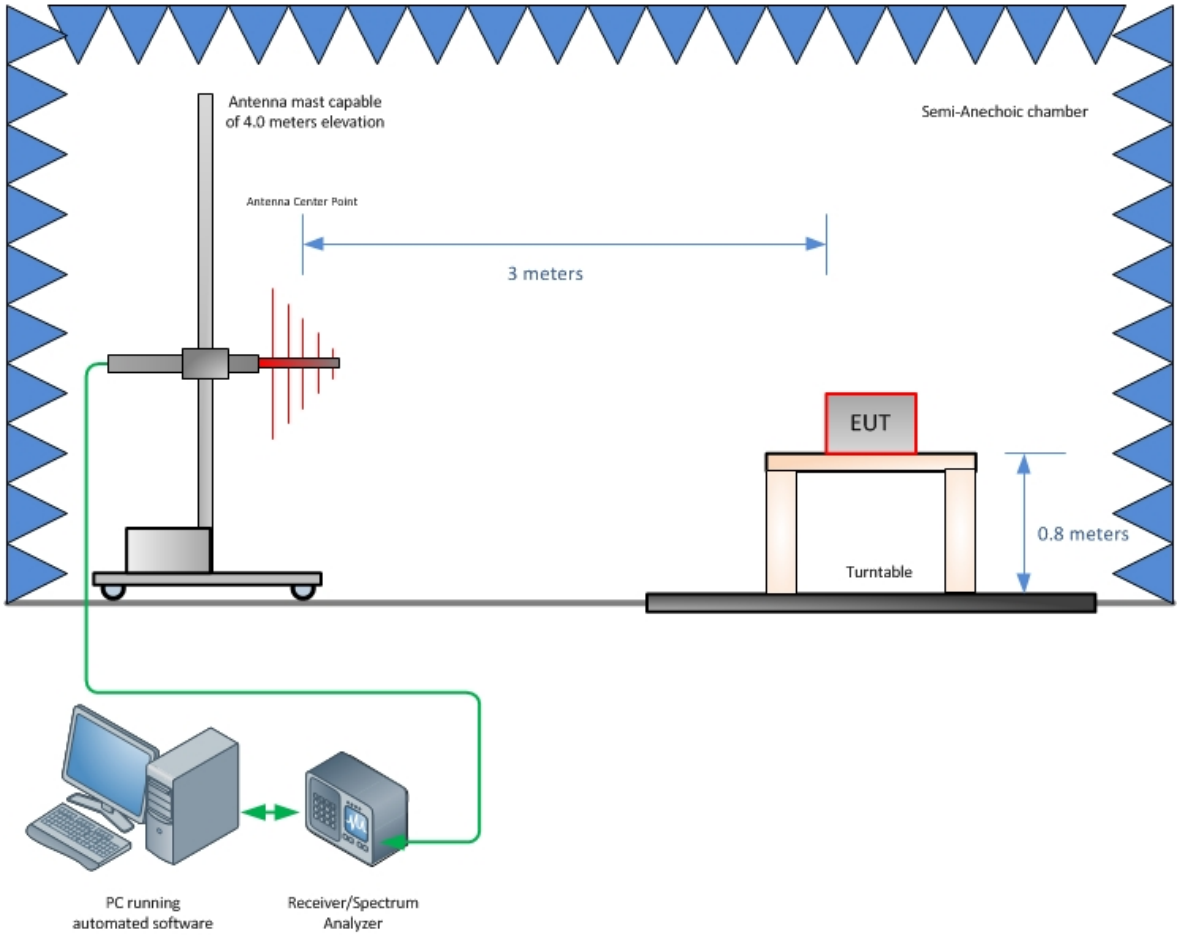
3.2.3 Conducted Antenna Port Measurement

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.34	0.20	0.04
2	Cables	Rectangular	1.00	0.58	0.33
3	EUT Setup	Rectangular	0.50	0.29	0.08
				Combined Uncertainty (u_c):	0.67
				Coverage Factor (k):	1.96
				Expanded Uncertainty:	1.32

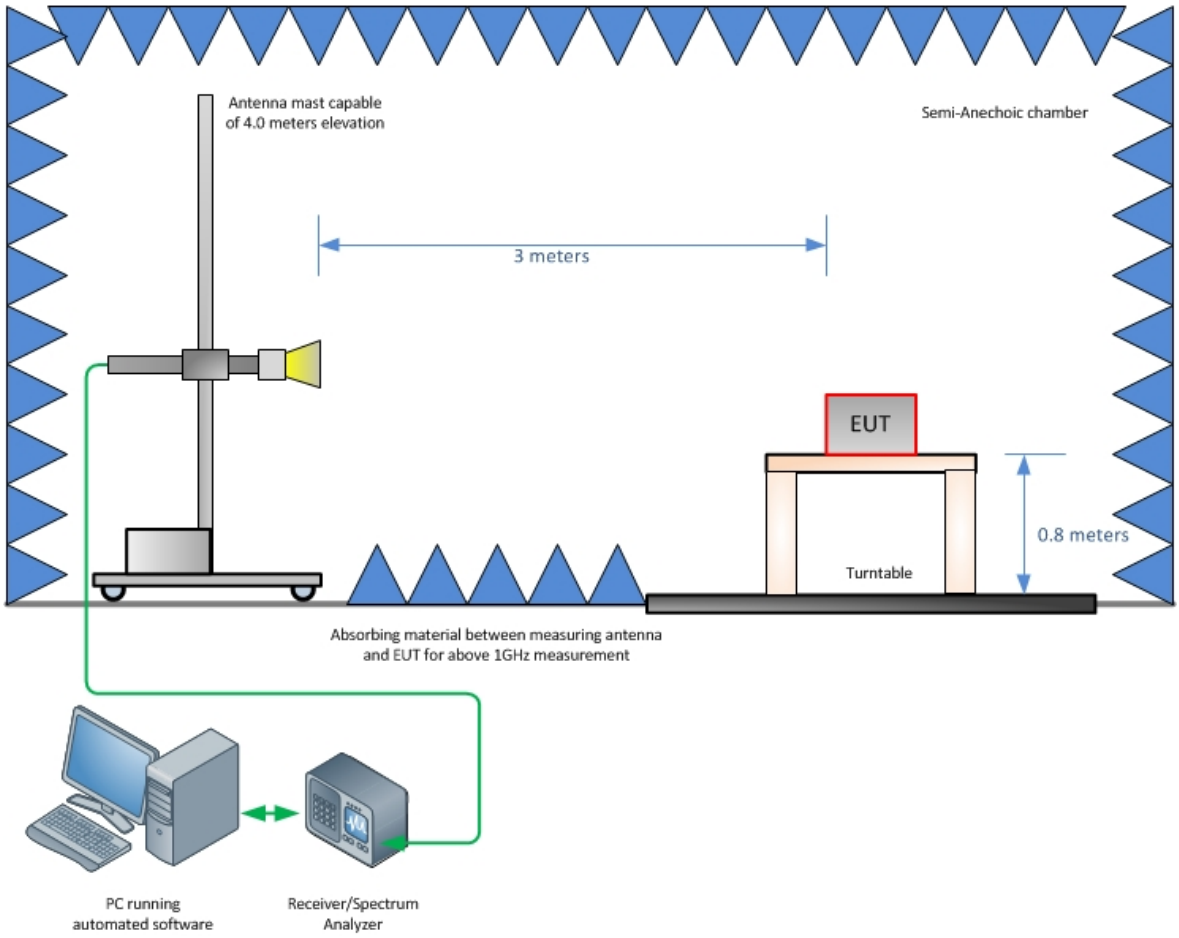
SECTION 4

DIAGRAM OF TEST SETUP

4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

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5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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