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Report On

Application for Grant of Equipment Authorization of the
Harman Becker Automotive Systems, Inc.
VP3/VP4 Silverbox Automotive Infotainment Unit with
Bluetooth/WLAN

FCC Part 15 Subpart C §15.247
IC RSS-210 Issue 8 December 2010

Report No. SD72102589-0215B March 2015

REPORT ON	Radio Testing of the Harman Becker Automotive Systems, Inc. Automotive Infotainment Unit with Bluetooth/WLAN
TEST REPORT NUMBER	SD72102589-0215B
PREPARED FOR	Harman Becker Automotive Systems, Inc. 39001 West Twelve Mile Road Farmington Hills, MI 48331 USA
CONTACT PERSON	Shain E Chmura Regulatory Compliance Engineer (248) 592-3157 schmura@harman.com
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: EMC/Senior Wireless Test Engineer
APPROVED BY	Chip R. Fleury **Name** Authorized Signatory
DATED	March 05, 2015

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

Revision History

SD72102589-0215B Harman Becker Automotive Systems, Inc. VP3 Silverbox; VP4 Silverbox Automotive Infotainment Unit with Bluetooth/WLAN					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
03/05/2015	Initial Release				Chip R. Fleury

CONTENTS

Section **Page No**

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SECTION 1

REPORT SUMMARY

Radio Testing of the
Harman Becker Automotive Systems, Inc.
Automotive Infotainment Unit with Bluetooth/WLAN

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Harman Becker Automotive Systems, Inc. VP3 Silverbox; VP4 Silverbox Automotive Infotainment Unit with Bluetooth/WLAN to the requirements of FCC Part 15 Subpart C §15.247 and IC RSS-210 Issue 8 December 2010.

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	Harman Becker Automotive Systems, Inc.
Model Number(s)	VP3/VP4 Silverbox
FCC ID Number	QNGBE2813
IC Number	6434C-BE2813
Serial Number(s)	SN022
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2014). • RSS-210 - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment (Issue 8, December 2010). • 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	February 26, 2015
Finish of Test	February 28, 2015
Name of Engineer(s)	Ferdinand Custodio
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

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

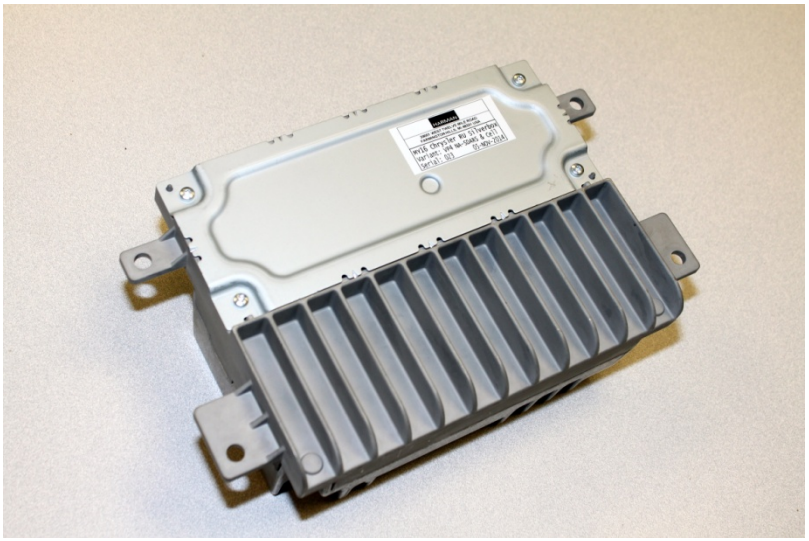
Section	§15.247 Spec Clause	RSS	Test Description	Result	Comments/ Base Standard
2.1	§15.207 (a)	RSS-Gen 8.8	Conducted Emissions	N/A	
2.2	§15.247(a)(1)	RSS-210 A8.1(b)	Carrier Frequency Separation	Compliant	
2.3	§15.247(a)(1)(iii)	RSS-210 A8.1(d)	Number of Hopping Frequencies	Compliant	
2.4	§15.247(a)(1)(iii)	RSS-210 A8.1(d)	Time of Occupancy (Dwell Time)	Compliant	
2.5	§15.215(c)	RSS-210 A8.1(a)	20 dB Bandwidth	Compliant	
2.6		RSS-Gen 6.6	99% Emission Bandwidth	Compliant	
2.7	§15.247(b)(1)	RSS-210 A8.4(2)	Peak Output Power	Compliant	
2.8	§15.247(d)	RSS-210 A8.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.9	§15.247(d)	RSS-210 A8.5	Spurious RF Conducted Emissions	Compliant	
2.10	§15.247(d)	RSS-210 2.2	Spurious Radiated Emissions	Compliant	
2.11	§15.247(d)	RSS-210 2.2	Radiated Immediate Restricted Bands	Compliant	
2.12		RSS-Gen 7.0	Receiver Spurious Emissions	Compliant	

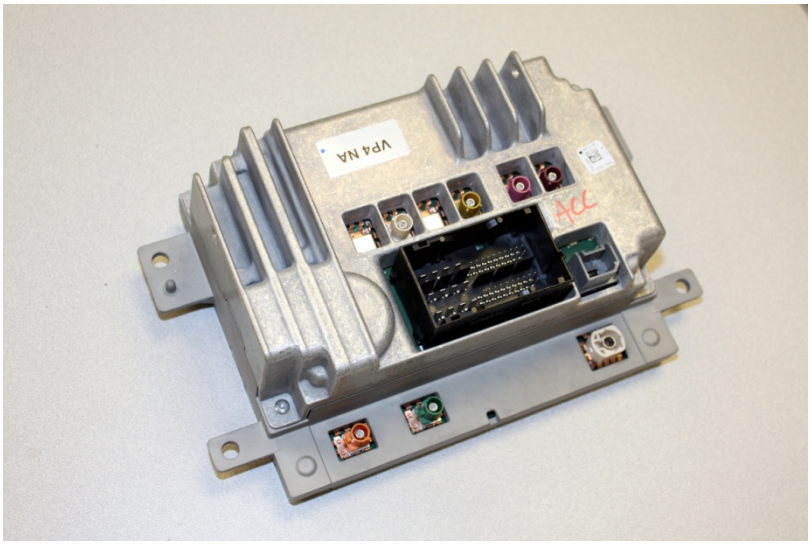
N/A *EUT is for automotive installation only and not designed to be connected to the public utility (AC) power line.*

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a Harman Becker Automotive Systems, Inc. VP3/VP4 Silverbox VP3 Silverbox; VP4 Silverbox Automotive Infotainment Unit with Bluetooth/WLAN as shown in the photograph below. The EUT is the main unit of an automotive radio system less the display. It houses the AM/FM receiver, GPS receiver, Satellite receiver, BT/WLAN module and CDMA radio. Two models are covered by this test report: VP3 Silverbox and VP4 Silverbox. The two models are identical except for the size of the flash MNAND where the main operating software is stored. VP3 Silverbox uses 8 GB flash MNAND while VP4 Sileverbox uses 16 GB flash MNAND. All verifications performed on the VP4 Silverbox. Only the Bluetooth function of the EUT was verified in this test report.





Equipment Under Test

1.3.2 EUT General Description

EUT Description	Automotive Infotainment Unit with Bluetooth/WLAN
Model Name	VP3 Silverbox; VP4 Silverbox
Model Number(s)	VP3/VP4 Silverbox
Rated Voltage	12VDC (Nominal)
Mode Verified	Bluetooth 3.0 + HS
Capability	802.11 b and g WLAN (DTS 2.4GHz), Bluetooth 3.0 + HS and CDMA2000 (1xRTT and 1xEVDO using BC0 and BC1)
Primary Unit (EUT)	☐ Production
	☒ Pre-Production
	☐ Engineering
Antenna Type	External PCB Antenna with FAKRA connector (automotive application/professionally installed)
Antenna Model	BT-WiFi 68227177AA - FC00AAL34255
Antenna Manufacturer	Laird Technologies
Antenna Gain	-0.22 dBi

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	-1.95	6.58	4.55
π/4-DQPSK	2402-2480	-5.12	6.08	4.06
8DPSK	2402-2480	-6.19	6.05	4.03

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Antenna conducted port test configuration. All measurements were performed on the Bluetooth (Orange) antenna connector. Bluetooth functions were controlled by a CMW500 Wideband Radio Communication Tester.
B	Radiated emissions test configuration. Antenna ports of radio not being verified are either terminated with a 50Ω load or the radio configured in "Receive" mode.

1.4.2 EUT Exercise Software

None. No special software was used to exercise the EUT during verification. The EUT however is programmed initially to be placed in Bluetooth test mode in order to accept signaling instructions from the support CMW500.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Protek	Laboratory DC Power Supply	M/N 35010M S/N D102007S
Chrysler	Main Wiring Harness	1.1 meters, custom connector with various cables such as power, CAN-C, CAN-HIS, speakers, mics and aux input
-	USB cable	0.8 meter, shielded Type A to Mini5B connector
Chrysler	Shark Fin Antenna Assembly	P05091352AC 600517 0794 AM/FM, Sirius XM, GPS and CDMA antenna with 0.8 meter shielded Fakra SMB connector coaxial cable (x3)
Chrysler	BT/WLAN Antenna	P68227177AA 200409 1414 Prototype antenna assembly with 0.3 meter shielded Fakra SMB connector coaxial cable (x2)
Chrysler	Custom Antenna Cable	0.15 meter, shielded with Fakra SMB connector
MCL	Coaxial SMA Fixed Attenuator	P/N BW-S20W5+ Precision fixed attenuator. 50Ω 5W 20 dB DC to 18GHz.
-	SMA 50Ω Termination	P/N R404101000/008269
Rhode & Schwarz	Wideband Radio Communication Tester	M/N CMW 500 S/N 1201.0002k50/103829
EMCO	Double-ridged waveguide horn antenna	M/N 3115 S/N 94124364

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) /DH1	Non-hopping
GFSK	DH1	Hopping

EUT is a mobile device. Final installation position is unknown at the time of verification. For radiated measurements X, Y and Z orientations were verified. No major variation in emissions observed between the three (3) orientations. Verifications performed using "X" configuration.

"X" Configuration

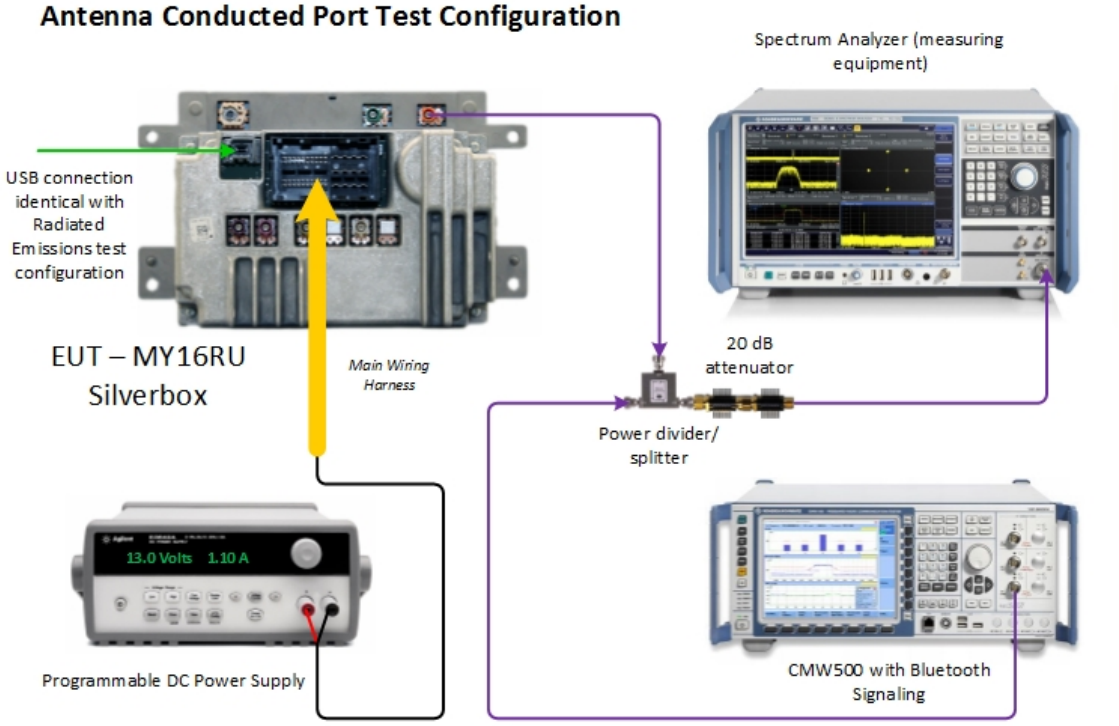
"Y" Configuration

"Z" Configuration

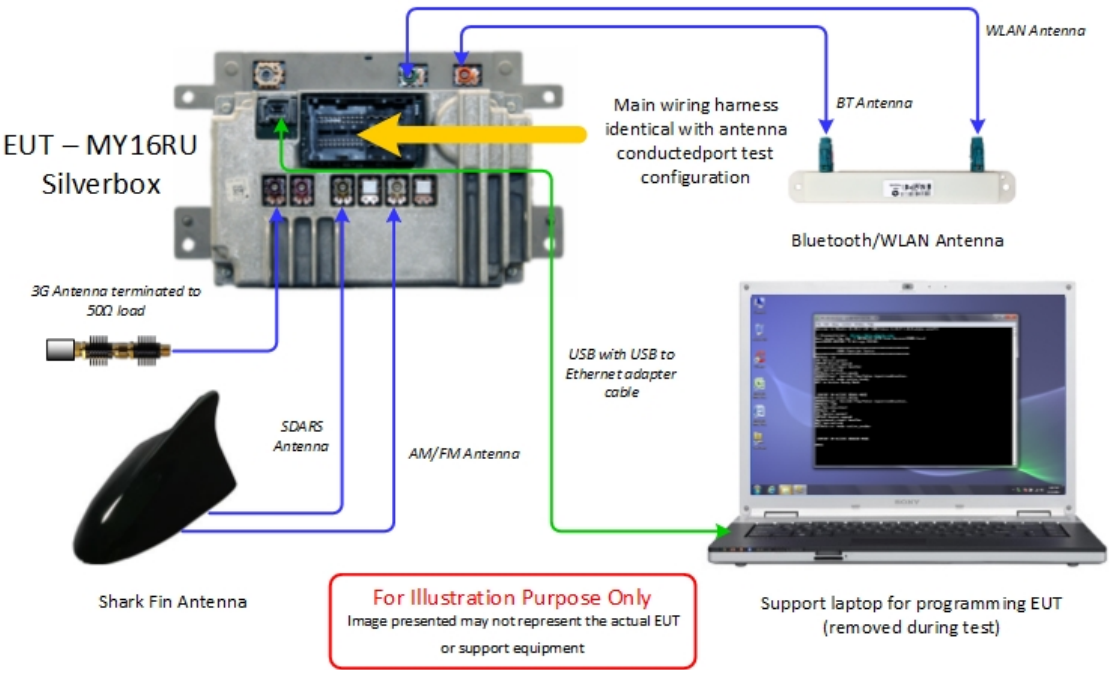
For illustration purposes only. Not the actual test configuration.

1.4.5 Simplified Test Configuration Diagram

Antenna Conducted Port Test Configuration



Radiated Emissions 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 SN022 and SN023		
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 C63.4-2009, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.
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 C63.4-2009. 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. Phone: 858 678 1400 FAX: 858 546 0364.

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

Sony Electronics Inc., Building #8 16530 Via Esprillo, San Diego, CA 92127. Phone: 858 942 5542 FAX: 858 546 0364.

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No.: US5296

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 §2.498 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US5296.

1.9.2 Industry Canada (IC) Registration No.: 3067A

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego) has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No. 3067A.

SECTION 2

TEST DETAILS

Radio Testing of the
Harman Becker Automotive Systems, Inc.
Automotive Infotainment Unit with Bluetooth/WLAN

2.1 CONDUCTED EMISSIONS

2.1.1 Specification Reference

Part 15 Subpart C §15.207(a) and RSS-Gen 8.8

2.1.2 Standard Applicable

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

**Decreases with the logarithm of the frequency.*

2.1.3 Equipment Under Test and Modification State

Not performed. EUT is not designed to be connected to the public utility (AC) power line. The EUT only employ battery power for operation (automotive application only). EUT does not include or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines

2.2 CARRIER FREQUENCY SEPARATION

2.2.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)

2.2.2 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.

2.2.3 Equipment Under Test and Modification State

Serial No: SN022 / Test Configuration A

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

February 26, 2015/FSC

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

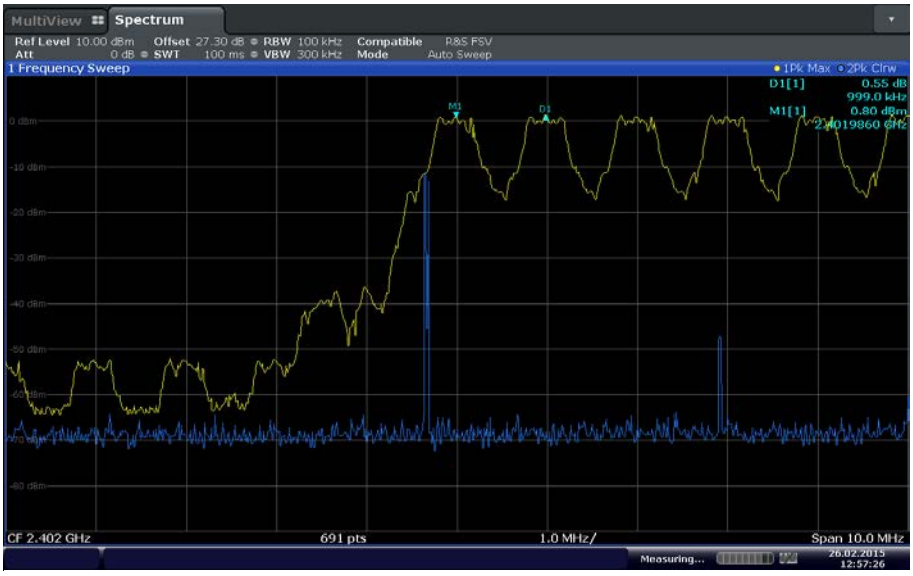
Ambient Temperature	23.8°C
Relative Humidity	26.6%
ATM Pressure	99.4 kPa

2.2.7 Additional Observations

- 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 27.30dB was added to compensate for the external attenuator, power divider/combiner and cable used.
- Marker-delta function is used between the peaks of the adjacent channels.
- Limit used is >866.67 kHz (2/3 of worst case 20dB BW).

2.2.8 Test Results



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Observed carrier frequency separation between Channel 0 and Channel 1 = 999 kHz (**Complies**. Greater than 866.67 kHz which is 2/3 of worst case 20 dB BW [Mid and High channel 20 dB BW of π/4-DQPSK is 1.30MHz])

2.3 NUMBER OF HOPPING FREQUENCIES

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: SN022 / Test Configuration A

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

February 26, 2015/FSC

2.3.5 Test Equipment Used

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

2.3.6 Environmental Conditions

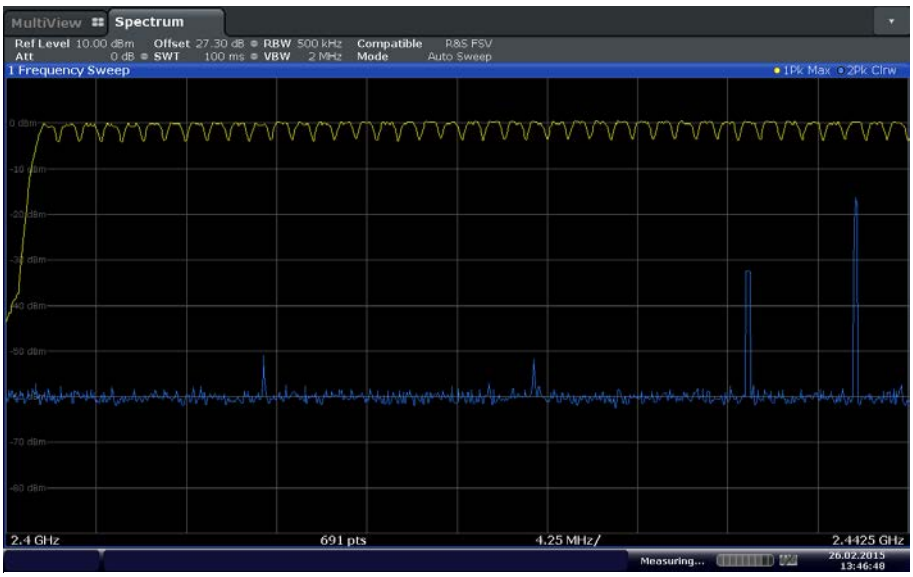
Ambient Temperature	23.8°C
Relative Humidity	26.6%
ATM Pressure	99.4 kPa

2.3.7 Additional Observations

- 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.
- RBW is 1% of the span, VBW is 3x RBW
- Sweep is auto
- Detector is peak, trace is max hold.
- An offset of 27.30dB was added to compensate for the external attenuator, power divider/combiner and cable used.

2.3.8 Test Results

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



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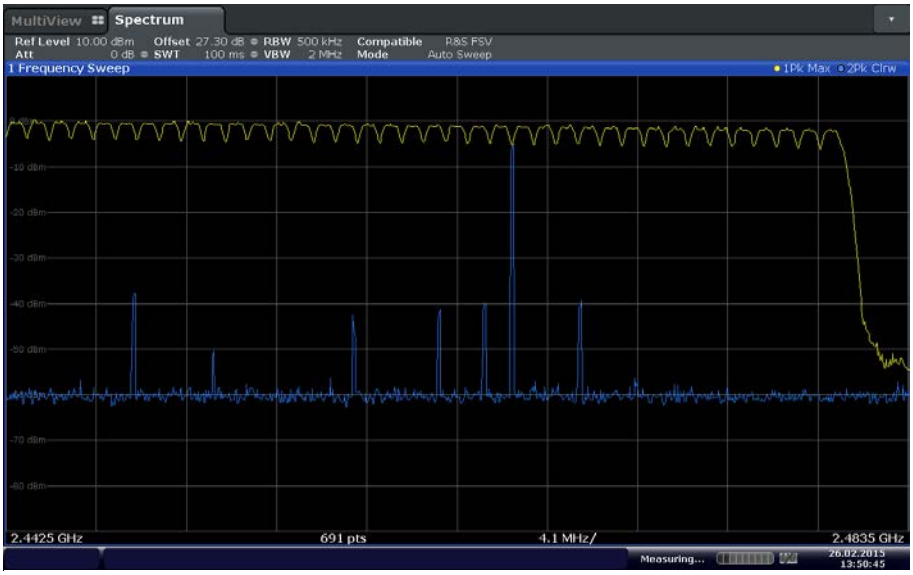
Plot #1



Date: 26.FEB.2015 13:50:45

Plot #2

2.4 TIME OF OCCUPANCY (DWELL TIME)

2.4.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)(iii)

2.4.2 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.

2.4.3 Equipment Under Test and Modification State

Serial No: SN022 / Test Configuration A

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

February 26, 2015/FSC

2.4.5 Test Equipment Used

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

2.4.6 Environmental Conditions

Ambient Temperature	23.8°C
Relative Humidity	26.6%
ATM Pressure	99.4 kPa

2.4.7 Additional Observations

- 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).
- All packet types verified.

2.4.8 Test Results

Modulation	Packet Type	Measured time of occupancy	Requirement
GFSK	DH1	129.392 ms	<400 ms
	DH3	317.218 ms	<400 ms

	DH5	232.696 ms	<400 ms
π/4-DQPSK	2-DH1	126.697 ms	<400 ms
	2-DH3	182.695 ms	<400 ms
	2-DH5	232.580 ms	<400 ms
8DPSK	3-DH1	128.928 ms	<400 ms
	3-DH3	265.739 ms	<400 ms
	3-DH5	262.174 ms	<400 ms

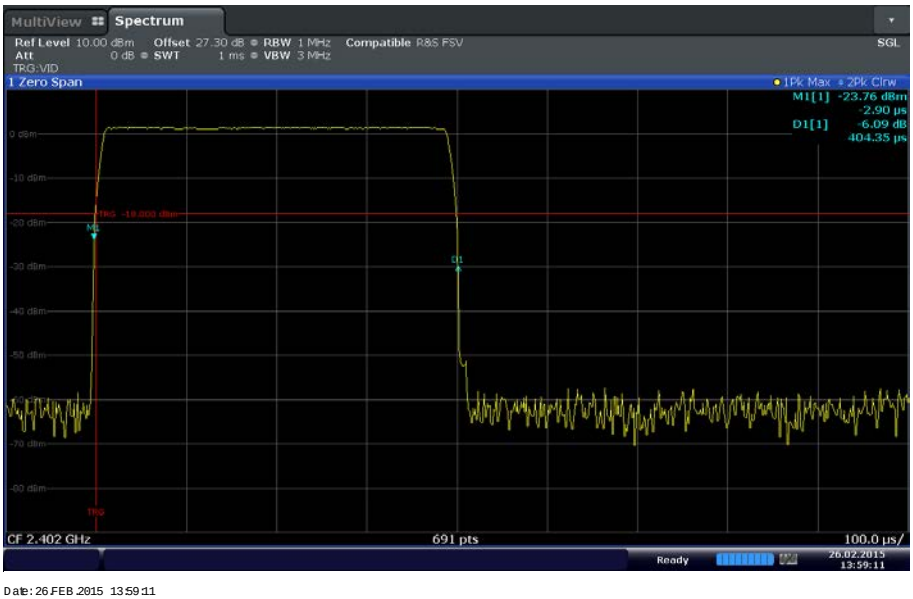
2.4.9 Sample Computation (GFSK DH3)

Width of single pulse = 0.00166957 second
Observed occurrence = 19 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
= 0.00166957 second x 19x 10
= 0.3172 second

Compliance = **Complies.** 0.3172 second < 0.4 second

2.4.10 Test Results Plots



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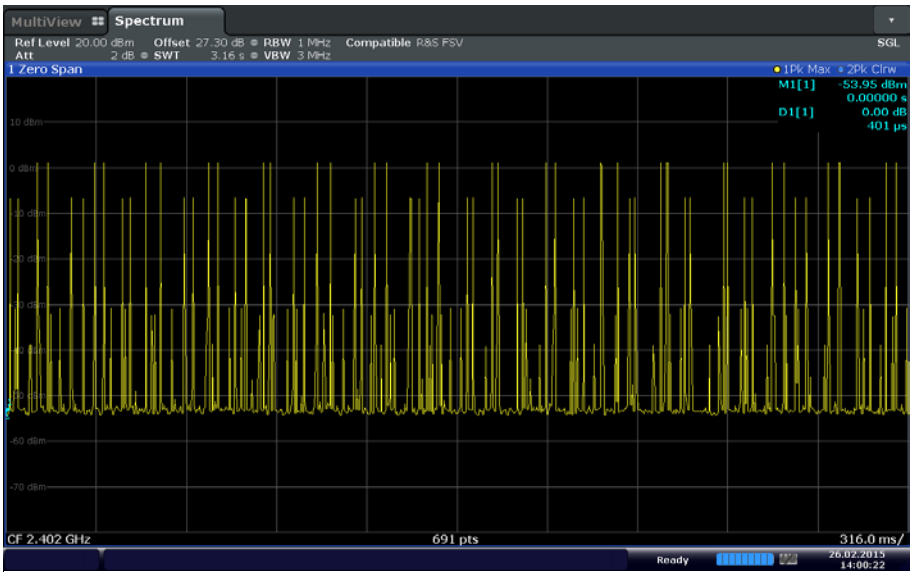
GFSK DH1 width of single pulse (0.40435ms)



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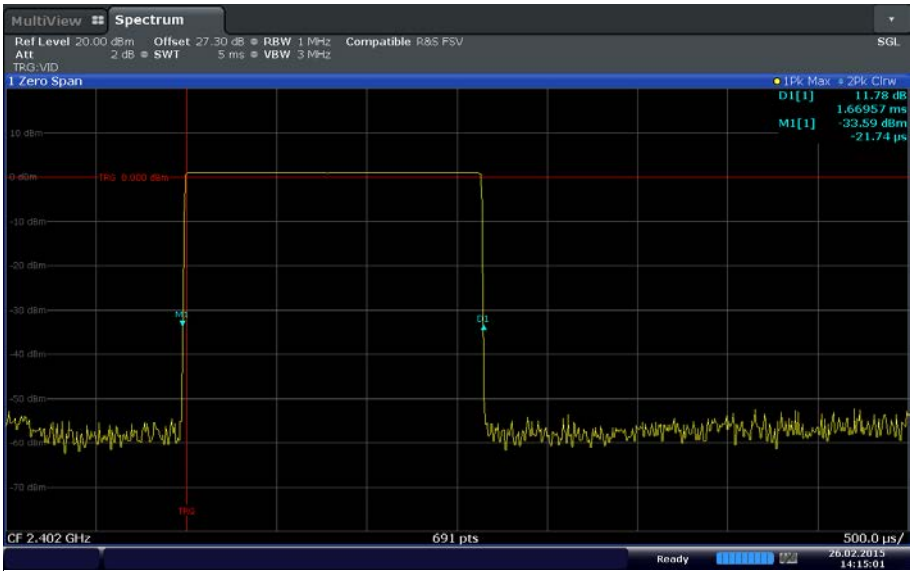
32 pulses/3.16 seconds (DH1)



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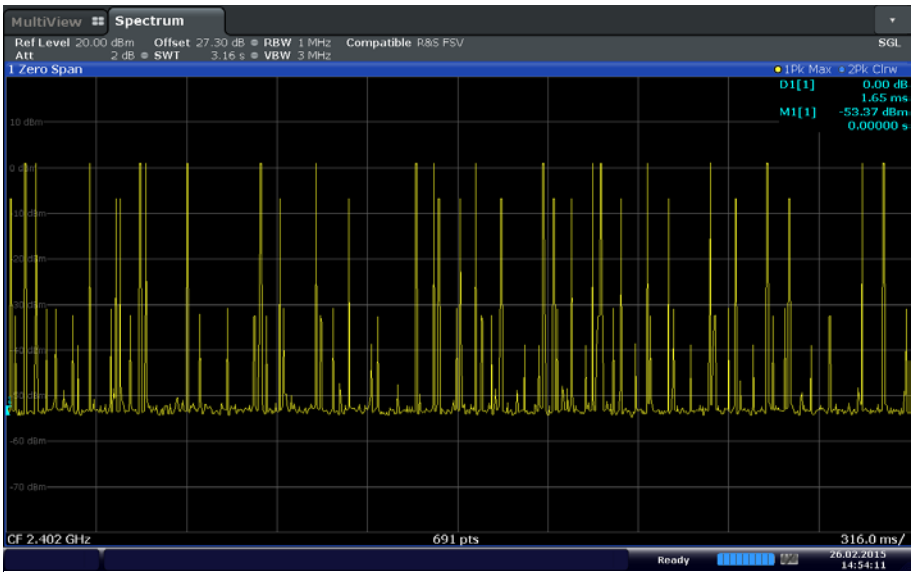
GFSK DH3 width of single pulse (1.66957ms)



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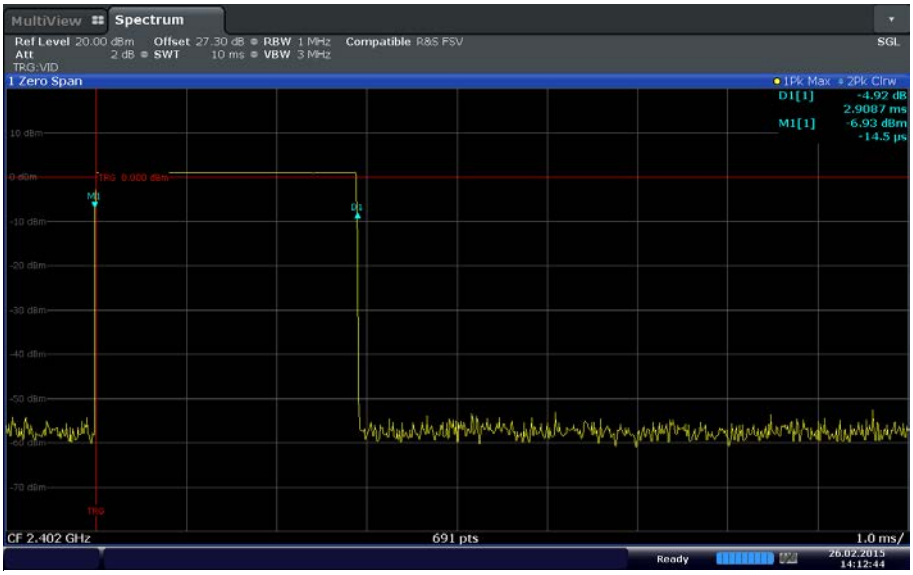
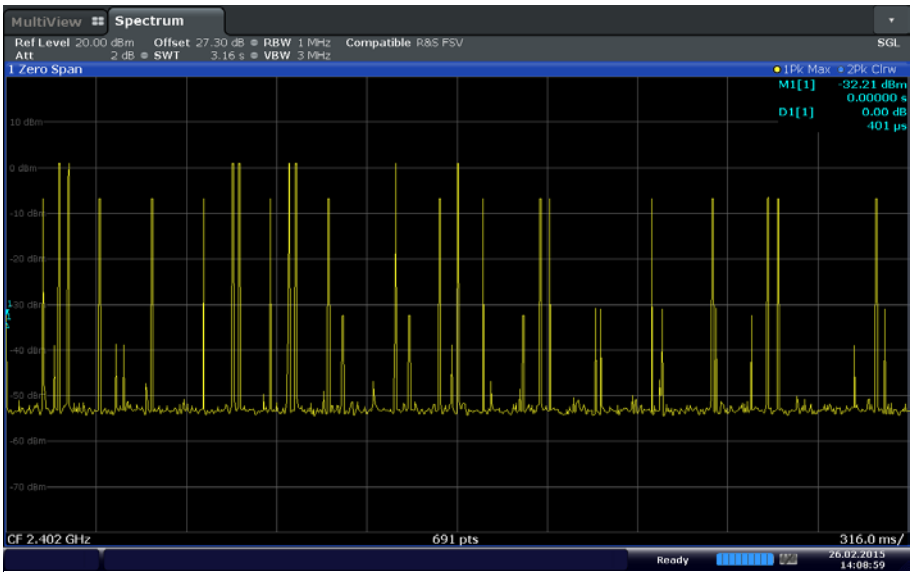
19 pulses/3.16 seconds (DH3)



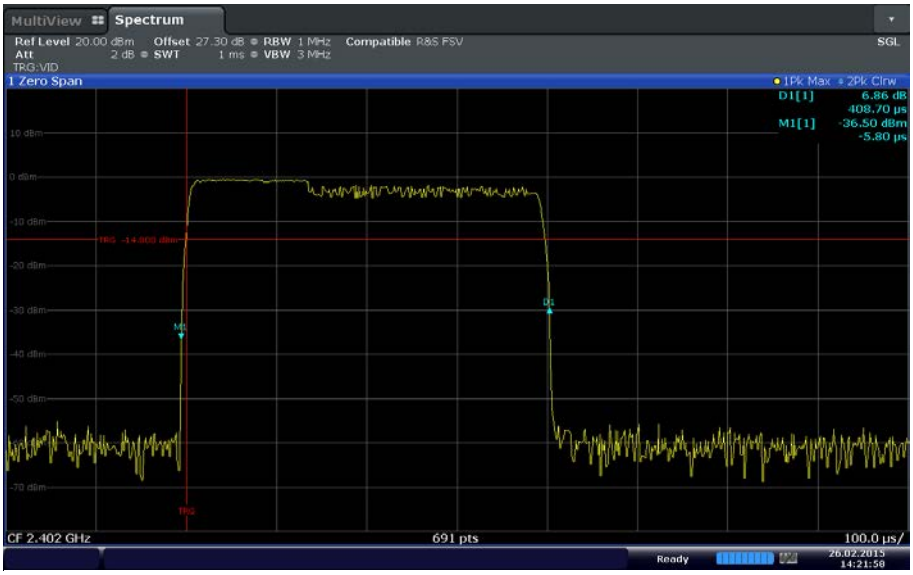
Date: 26.FEB.2015 14:12:44

GFSK DH5 width of single pulse (2.9087ms)



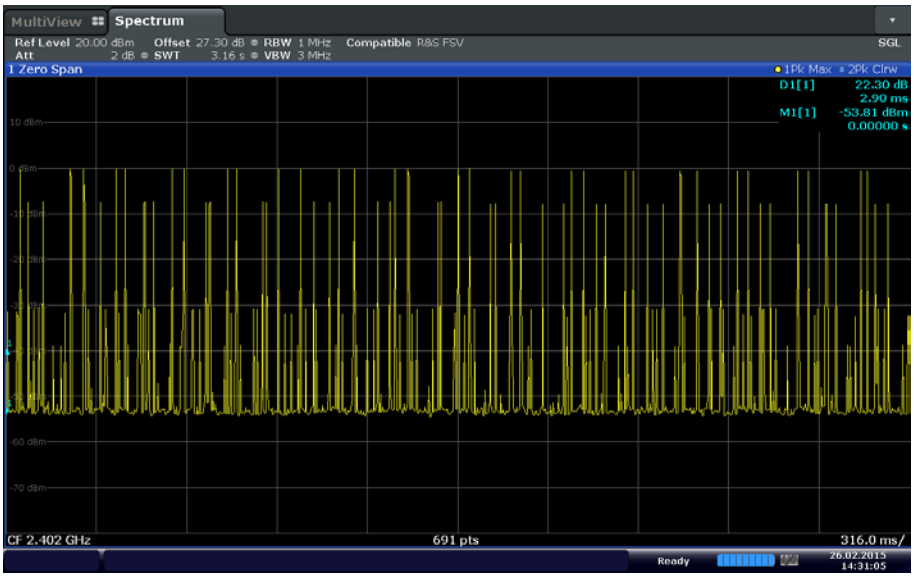
Date: 26.FEB.2015 14:08:59

8 pulses/3.16 seconds (DH5)



Date: 26.FEB.2015 14:21:58

π/4-DQPSK 2-DH1 width of single pulse (0.40870ms)



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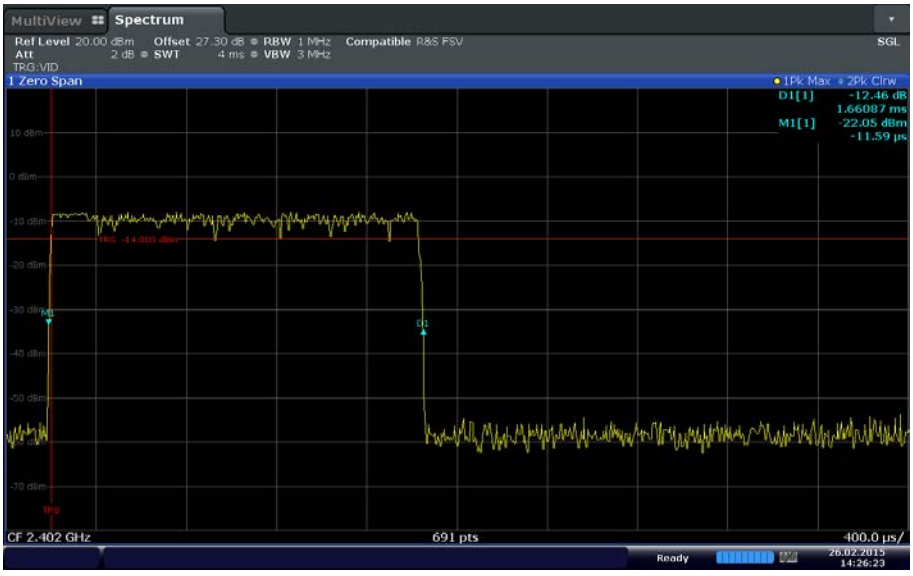
31 pulses/3.16 seconds (2-DH1)



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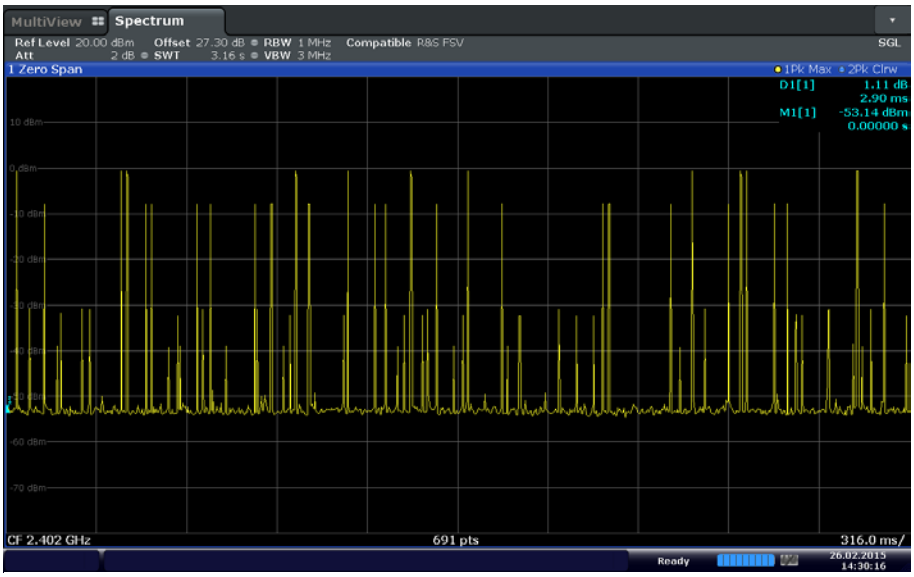
π/4-DQPSK 2-DH3 width of single pulse (1.66087ms)



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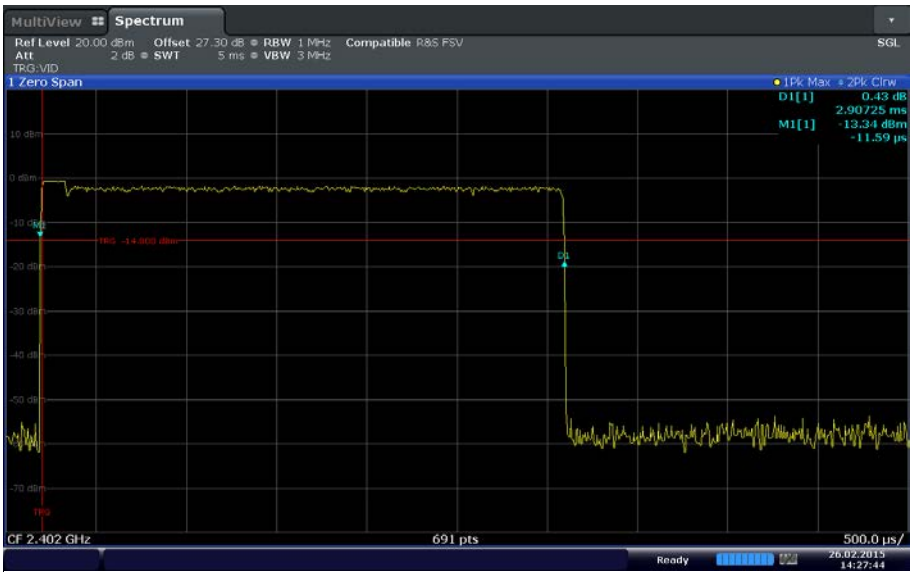
11 pulses/3.16 seconds (2-DH3)



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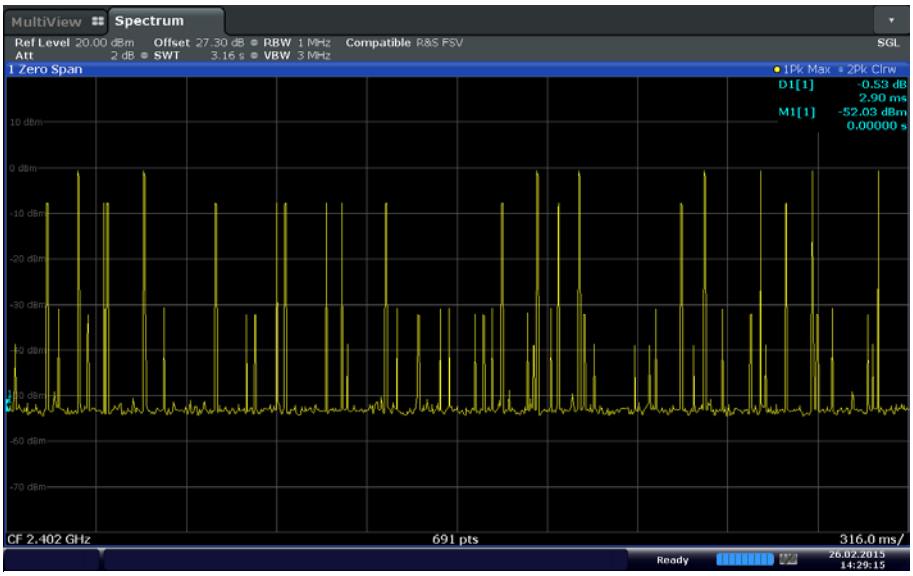
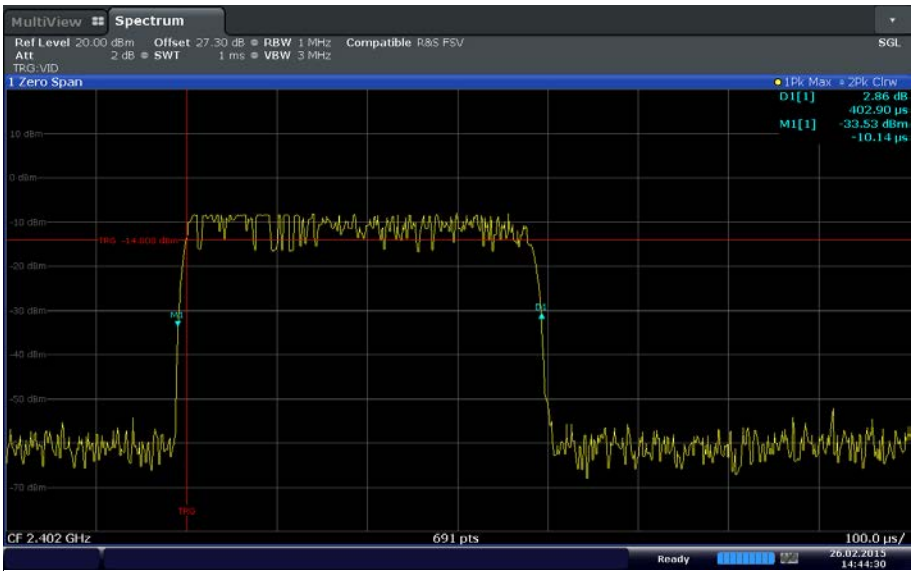
π/4-DQPSK 2-DH5 width of single pulse (2.90725ms)



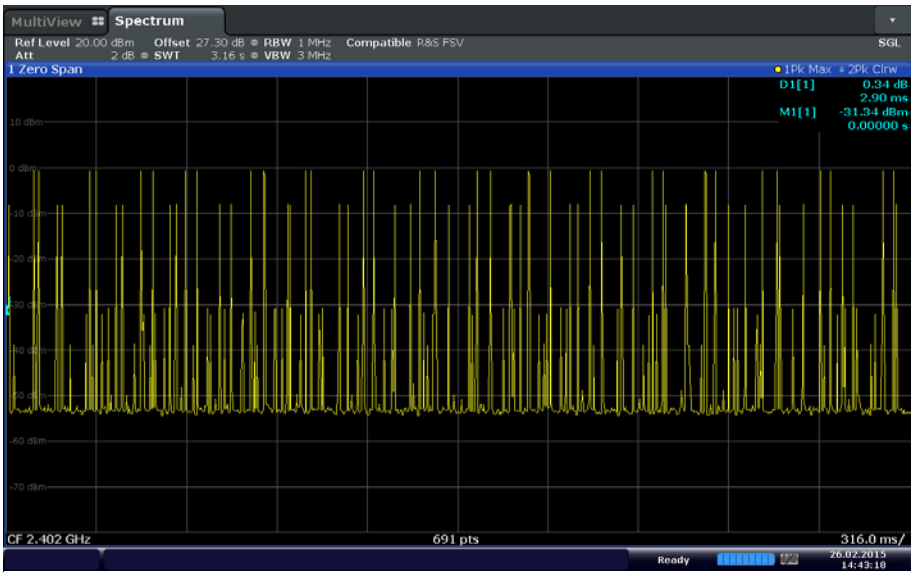
Date: 26.FEB.2015 14:29:15

8 pulses/3.16 seconds (2-DH5)



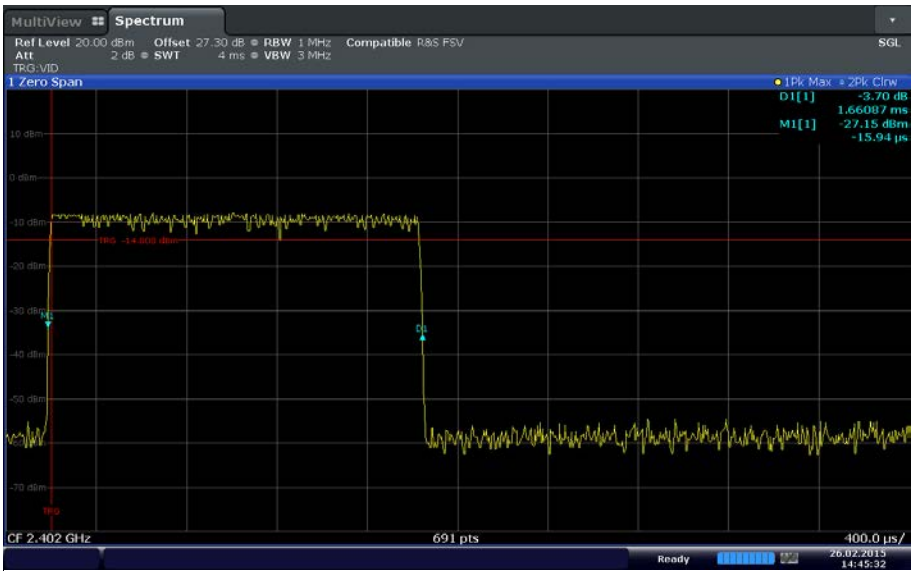
Date: 26.FEB.2015 14:44:31

8DPSK 3-DH1 width of single pulse (0.4029ms)



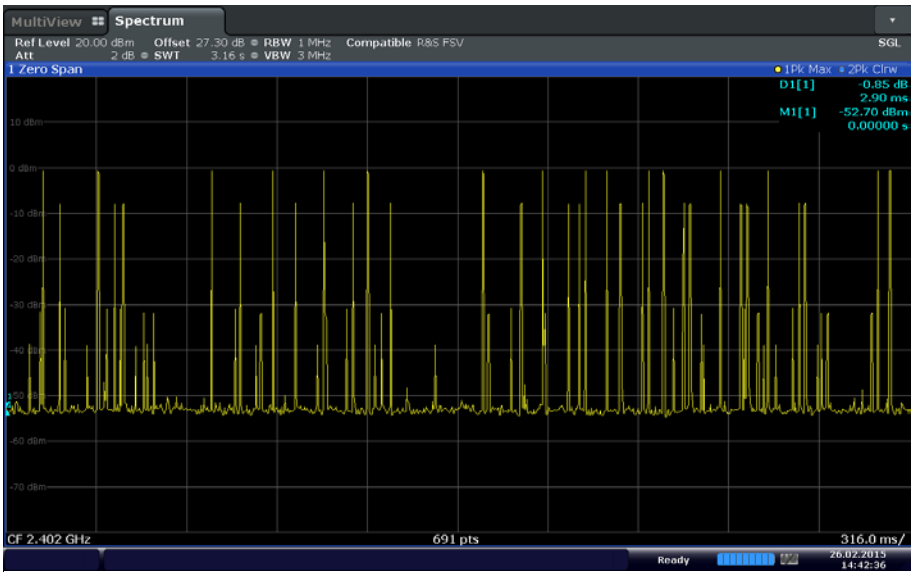
Date: 26.FEB.2015 14:43:18

32 pulses/3.16 seconds (3-DH1)



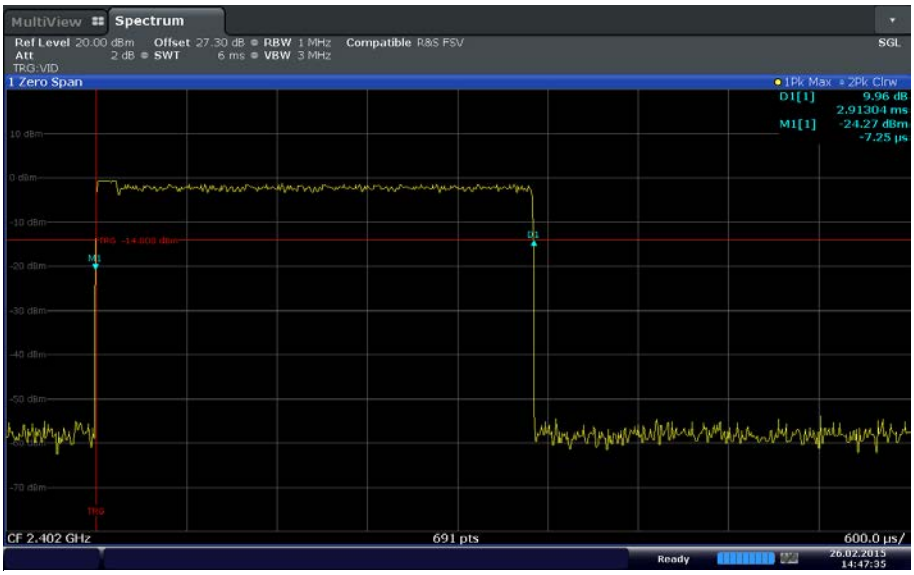
Date: 26.FEB.2015 14:45:32

8DPSK 3-DH3 width of single pulse (1.66087ms)



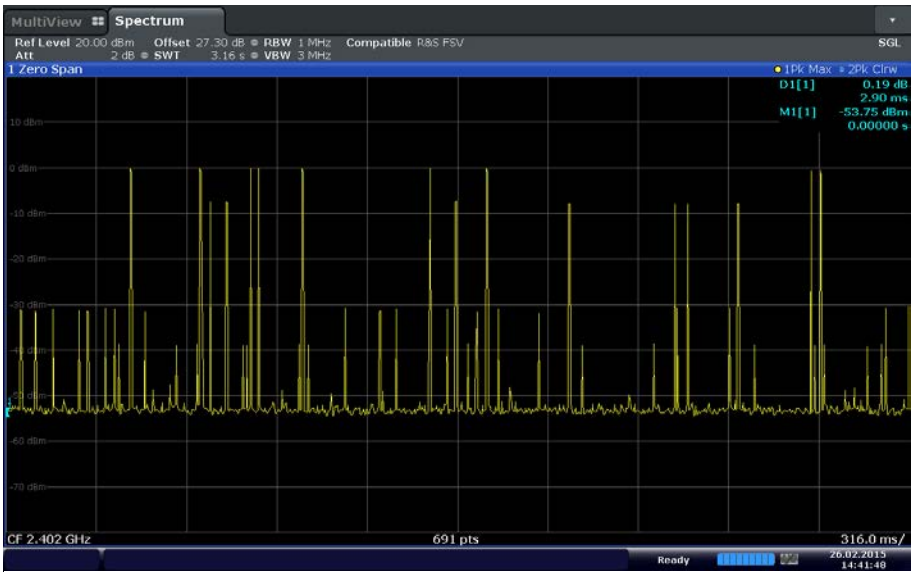
Date: 26.FEB.2015 14:42:36

16 pulses/3.16 seconds (3-DH3)



Date: 26.FEB.2015 14:47:35

8DPSK 3-DH5 width of single pulse (2.91304ms)



Date: 26.FEB.2015 14:41:48

9 pulses/3.16 seconds (3-DH5)

2.5 20 dB BANDWIDTH

2.5.1 Specification Reference

Part 15 Subpart C §15.215(c)

2.5.2 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.

2.5.3 Equipment Under Test and Modification State

Serial No: SN022 / Test Configuration A

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

February 26, 2015/FSC

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions

Ambient Temperature	23.8°C
Relative Humidity	26.6%
ATM Pressure	99.4 kPa

2.5.7 Additional Observations

- This is a conducted test.
- An offset of 27.30dB was added to compensate for the external attenuator, power divider/splitter and cable used.
- 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.

2.5.8 Test Results

Modulation	Channel	Frequency (MHz)	Measured 20dB Bandwidth (MHz)
GFSK	0	2402	1.12
	38	2440	1.11
	78	2480	1.11
π/4-DQPSK	0	2402	1.29
	38	2440	1.30
	78	2480	1.30
8DPSK	0	2402	1.29
	38	2440	1.29
	78	2480	1.29

Worst case configuration (Mid/High Channel π/4-DQPSK)
2402 MHz – (20dB BW/2) = 2401.35 MHz (within the frequency band - **Compliant**)

Worst case configuration (Mid/High Channel π/4-DQPSK)
2480 MHz + (20dB BW/2) = 2480.65 MHz (within the frequency band - **Compliant**)

2.5.9 Test Results Plots

Date: 26.FEB.2015 13:08:22

GFSK Low Channel

Date: 26.FEB.2015 13:09:17

GFSK Mid Channel

Date: 26.FEB.2015 13:10:07

GFSK High Channel

Date: 26.FEB.2015 13:13:22

π/4-DQPSK Low Channel

Date: 26.FEB.2015 13:12:45

π/4-DQPSK Mid Channel

Date: 26.FEB.2015 13:11:57

π/4-DQPSK High Channel

Date: 26.FEB.2015 13:14:28

8DPSK Low Channel

Date: 26.FEB.2015 13:15:08

8DPSK Mid Channel

Date: 26.FEB.2015 13:15:55

8DPSK High Channel

2.6 99% EMISSION BANDWIDTH

2.6.1 Specification Reference

RSS-Gen Clause 6.6

2.6.2 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.

2.6.3 Equipment Under Test and Modification State

Serial No: SN022 / Test Configuration A

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

February 26, 2015/FSC

2.6.5 Test Equipment Used

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

2.6.6 Environmental Conditions

Ambient Temperature	23.8°C
Relative Humidity	26.6%
ATM Pressure	99.4 kPa

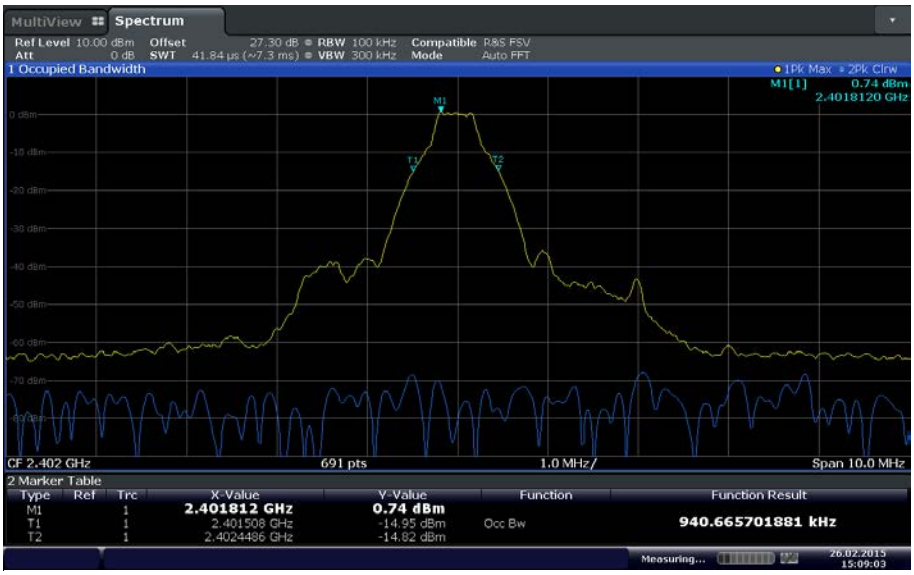
2.6.7 Additional Observations

- This is a conducted test.
- An offset of 27.30dB was added to compensate for the external attenuator, power divider/splitter and cable used.
- 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.

2.6.8 Test Results (For reporting purposes only)

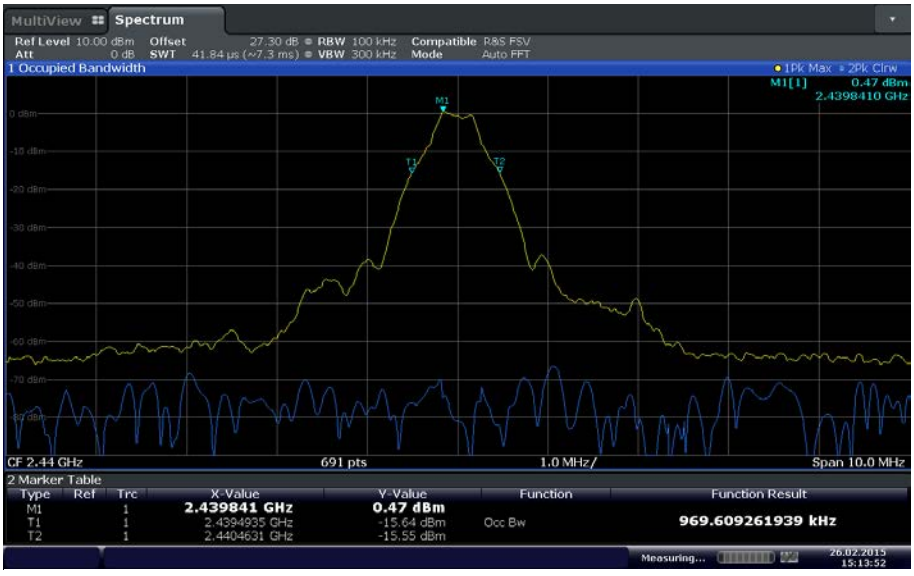
Modulation	Channel	Frequency (MHz)	Measured 20dB Bandwidth (MHz)
GFSK	0	2402	0.941
	38	2440	0.970
	78	2480	0.970
π/4-DQPSK	0	2402	1.172
	38	2440	1.172
	78	2480	1.129
8DPSK	0	2402	1.187
	38	2440	1.187
	78	2480	1.201

2.6.9 Test Results Plots



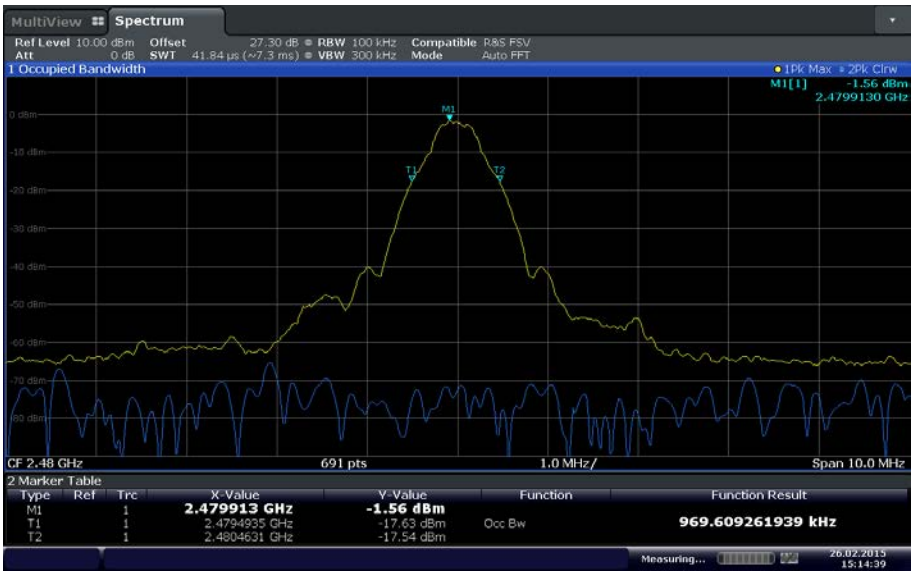
Date: 26.FEB.2015 15:09:03

GFSK Low Channel



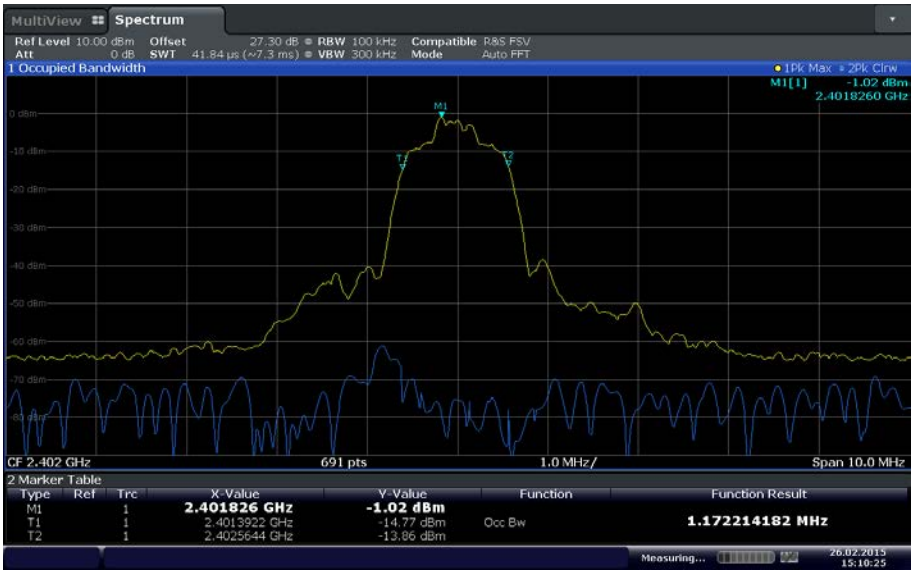
Date: 26.FEB.2015 15:13:52

GFSK Mid Channel



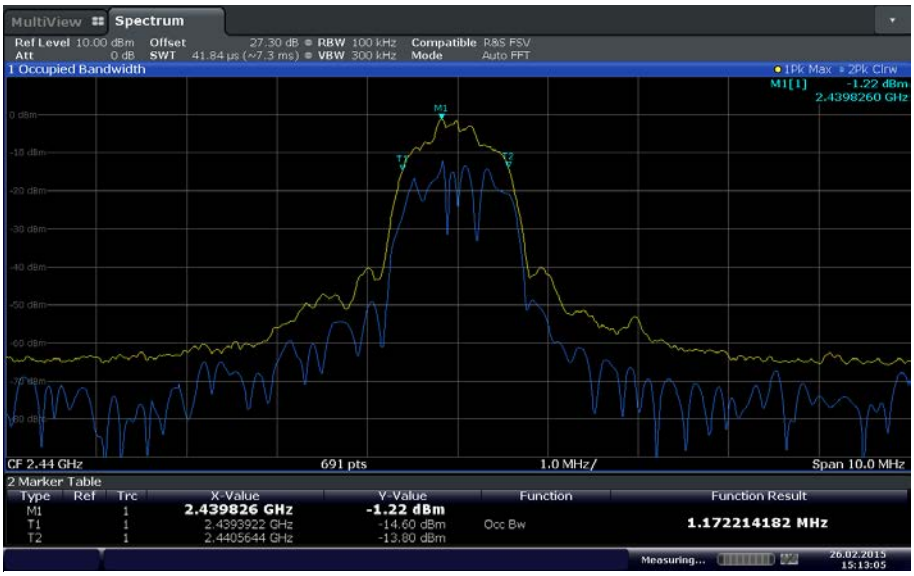
Date: 26.FEB.2015 15:14:39

GFSK High Channel



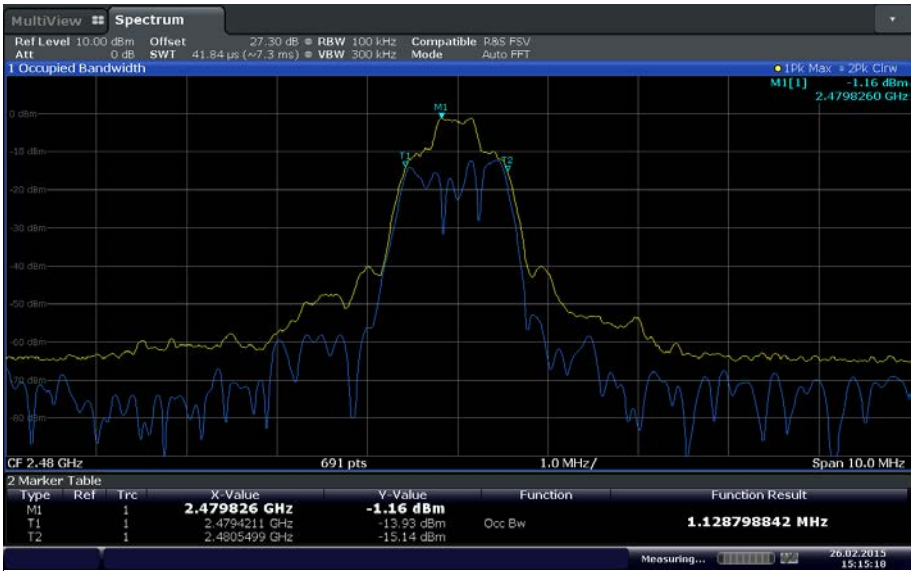
Date: 26.FEB.2015 15:10:25

π/4-DQPSK Low Channel



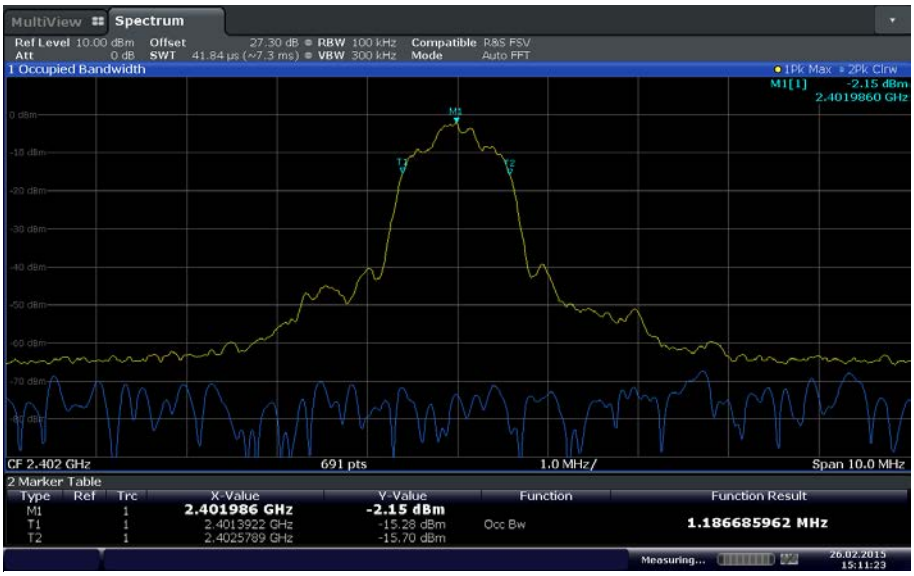
Date: 26.FEB.2015 15:13:05

π/4-DQPSK Mid Channel



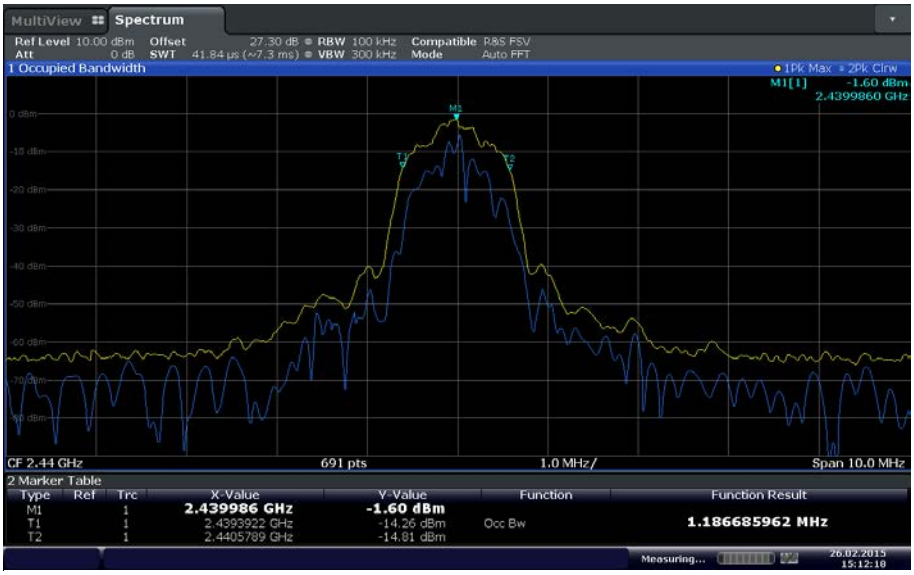
Date: 26.FEB.2015 15:15:18

π/4-DQPSK High Channel



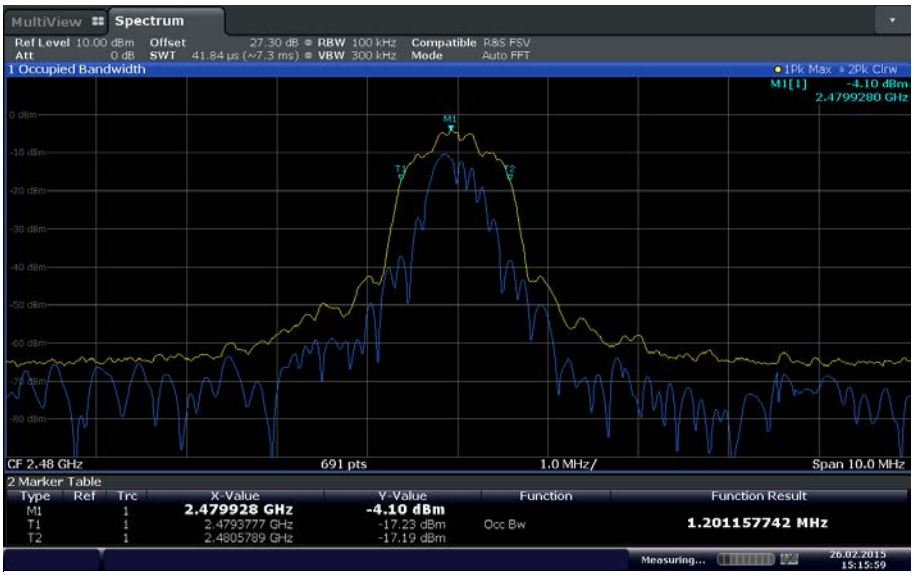
Date: 26.FEB.2015 15:11:22

8DPSK Low Channel



Date: 26.FEB.2015 15:12:19

8DPSK Mid Channel



Date: 26.FEB.2015 15:15:59

8DPSK High Channel

2.7 PEAK OUTPUT POWER

2.7.1 Specification Reference

Part 15 Subpart C §15.247(b)(1)

2.7.2 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.

2.7.3 Equipment Under Test and Modification State

Serial No: SN022 / Test Configuration A

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

February 26, 2015/FSC

2.7.5 Test Equipment Used

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

2.7.6 Environmental Conditions

Ambient Temperature	23.8°C
Relative Humidity	26.6%
ATM Pressure	99.4 kPa

2.7.7 Additional Observations

This is a conducted test using a Peak Power Meter.

2.7.8 Test Results (Conducted)

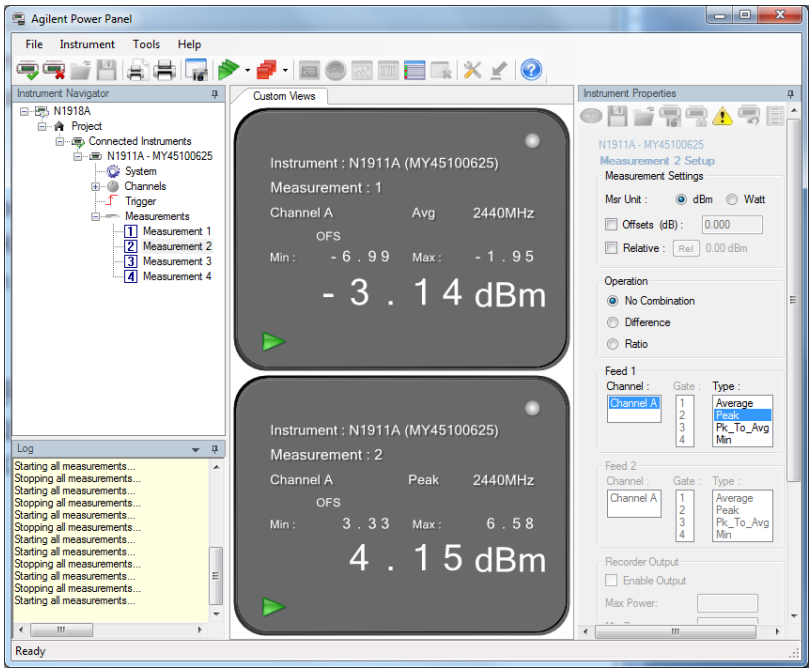
Modulation	Channel	Frequency (MHz)	Measured Average Output Power (dBm)	Measured Peak Output Power (dBm)	Measured Peak Output Power (mW)	Limit (mW)
GFSK	0	2402	-4.99	6.21	4.18	1000.0
	38	2440	-1.95	6.58	4.55	1000.0
	78	2480	-3.29	6.09	4.06	1000.0
π/4-DQPSK	0	2402	-5.93	5.88	3.87	1000.0
	38	2440	-5.12	6.08	4.06	1000.0
	78	2480	-7.00	5.78	3.78	1000.0
8DPSK	0	2402	-5.79	5.60	3.63	1000.0

	38	2440	-6.19	6.05	4.03	1000.0
	78	2480	-7.93	5.11	3.24	1000.0

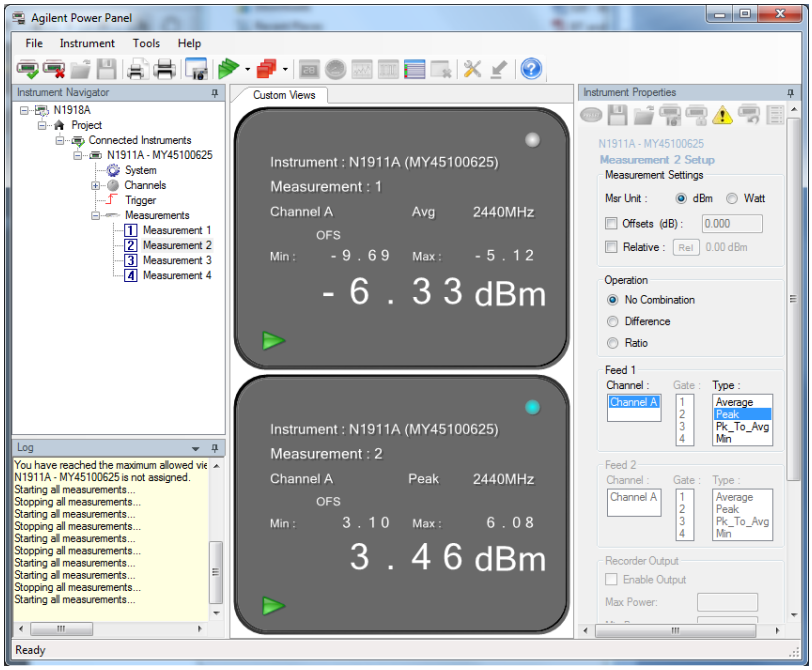
2.7.9 Test Results (*De Facto* EIRP Limit)

Modulation	Channel	Frequency (MHz)	Measured Peak Output Power (dBm))	Antenna Gain (dBi)	Calculated Peak Output Power EIRP (dBm))	Limit (dBm))
GFSK	38	2440	6.58	-0.22	6.36	30
π/4-DQPSK	38	2440	6.08	-0.22	5.86	30
8DPSK	38	2440	6.05	-0.22	5.83	30

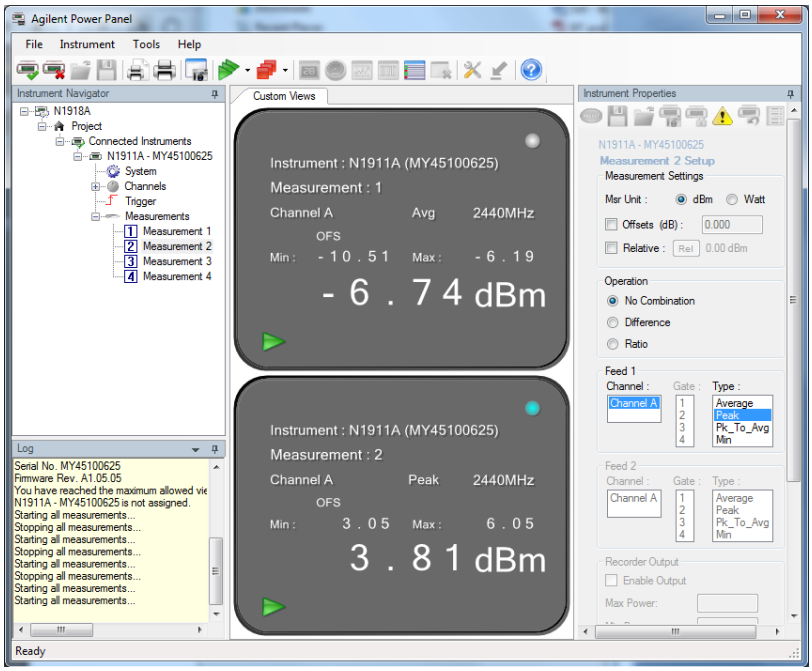
2.7.10 Sample Test Display



GFSK mid channel (Channel 38 2440 MHz)



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



8DPSK mid channel (Channel 38 2440 MHz)

2.8 BAND-EDGE COMPLIANCE OF 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: SN022 / Test Configuration A

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

February 27,2015/FSC

2.8.5 Test Equipment Used

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

2.8.6 Environmental Conditions

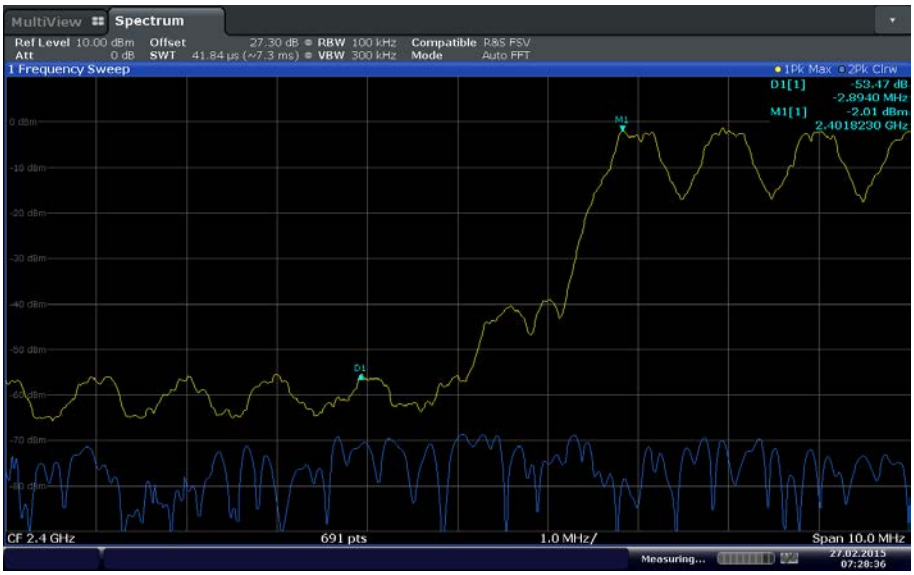
Ambient Temperature	23.8°C
Relative Humidity	26.6%
ATM Pressure	99.4 kPa

2.8.7 Additional Observations

- This is a conducted test.
- An offset of 27.30dB was added to compensate for the external attenuator, power divider/splitter and cable used.
- 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.

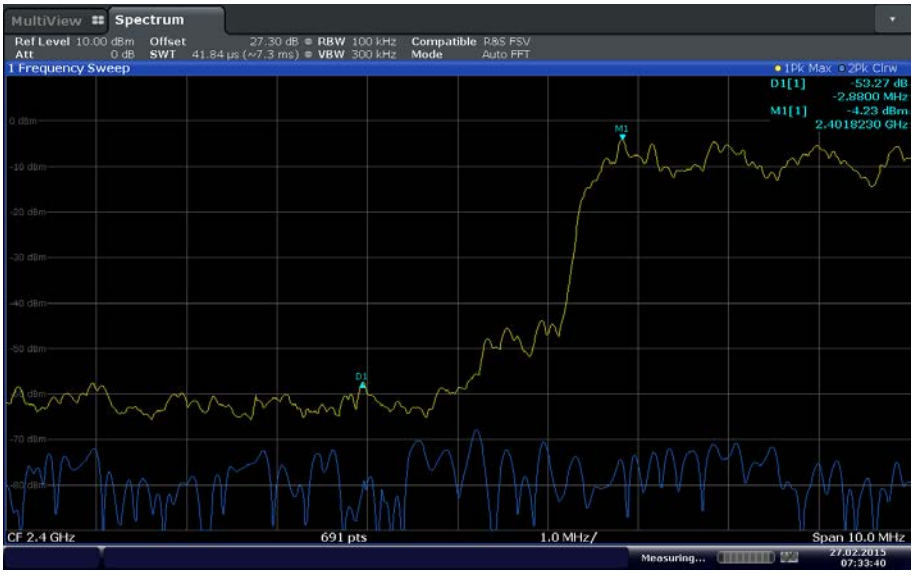
- Limit is 20dBc.
- Both Hopping and Non-Hopping mode verified.
- Band edges verified were all >20dBc, EUT complies.

2.8.8 Test Results



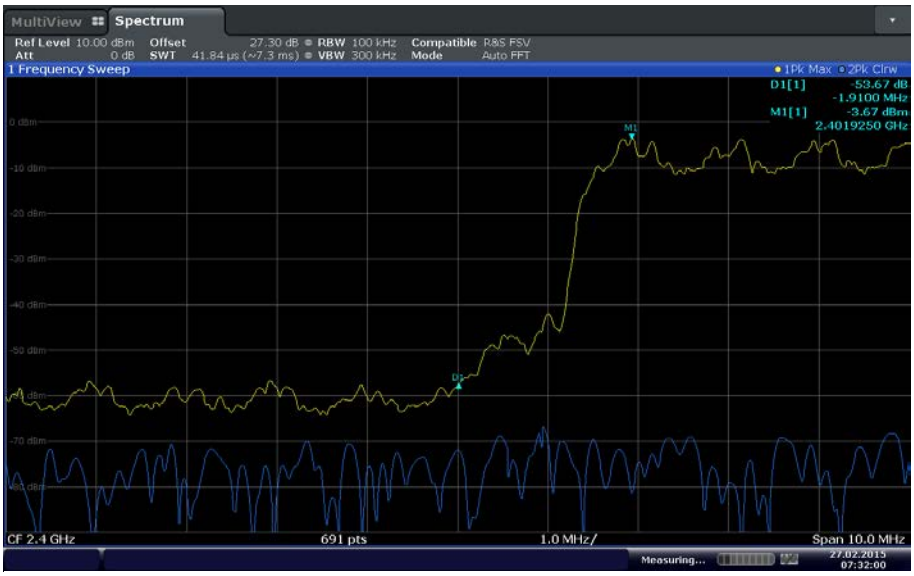
Date: 27.FEB.2015 07:28:36

Hopping lower bandedge (GFSK)



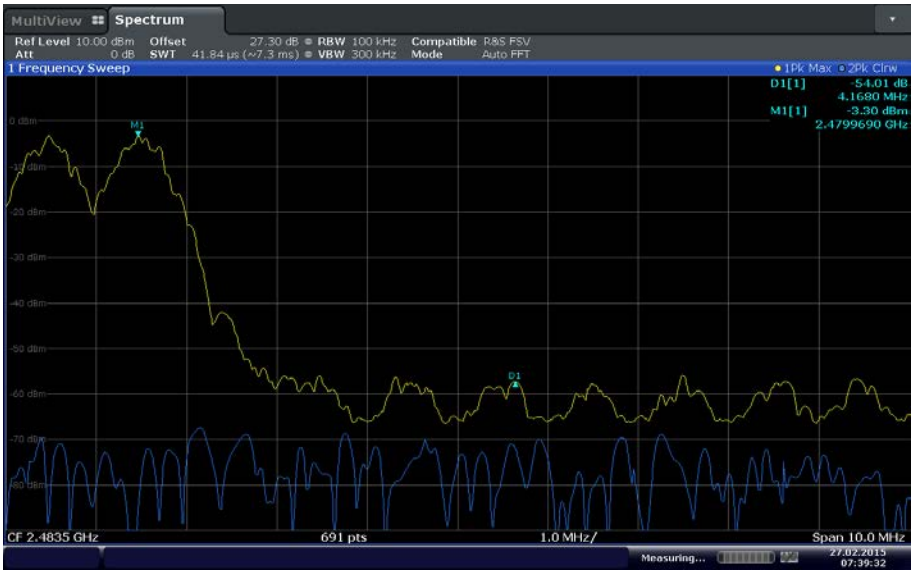
Date: 27.FEB.2015 07:33:39

Hopping lower bandedge (π/4-DQPSK)



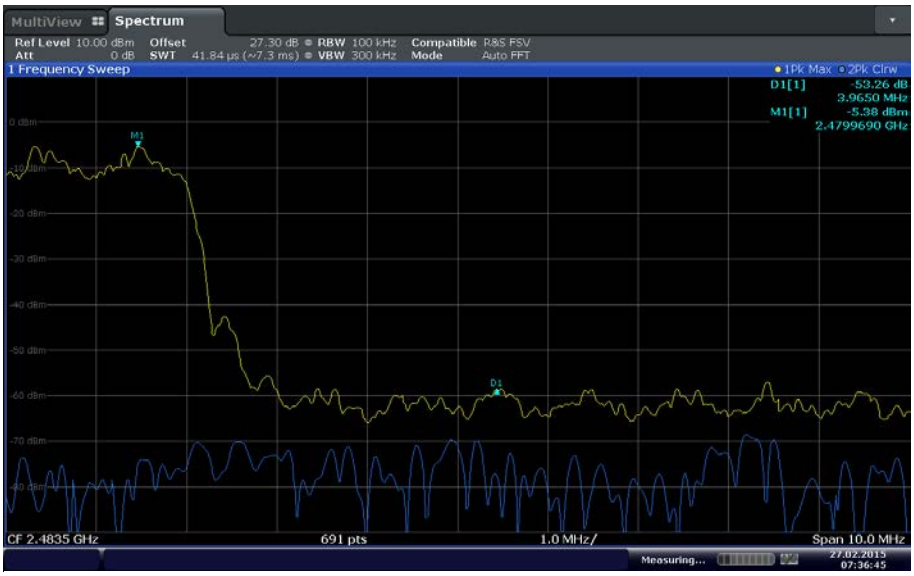
Date: 27.FEB.2015 07:32:01

Hopping lower bandedge (8DPSK)



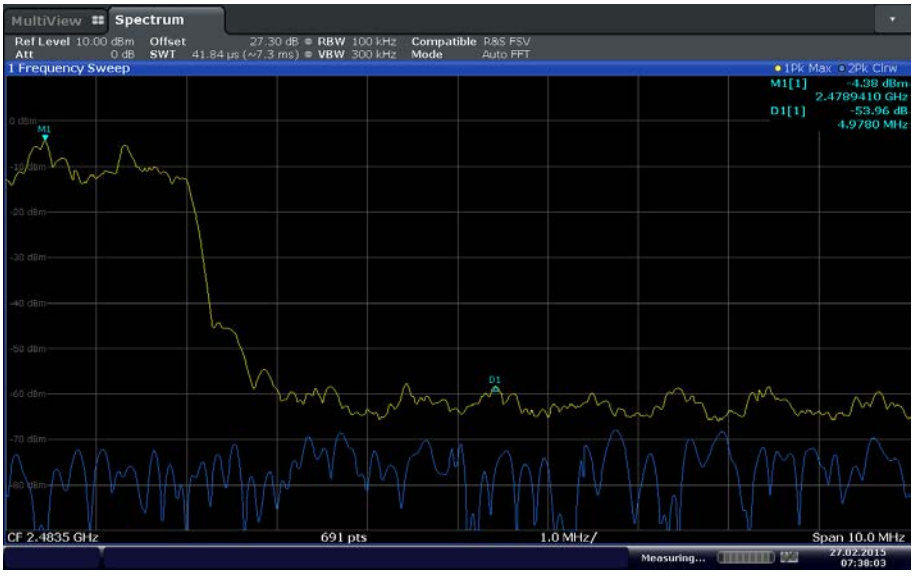
Date: 27.FEB.2015 07:39:32

Hopping upper bandedge (GFSK)



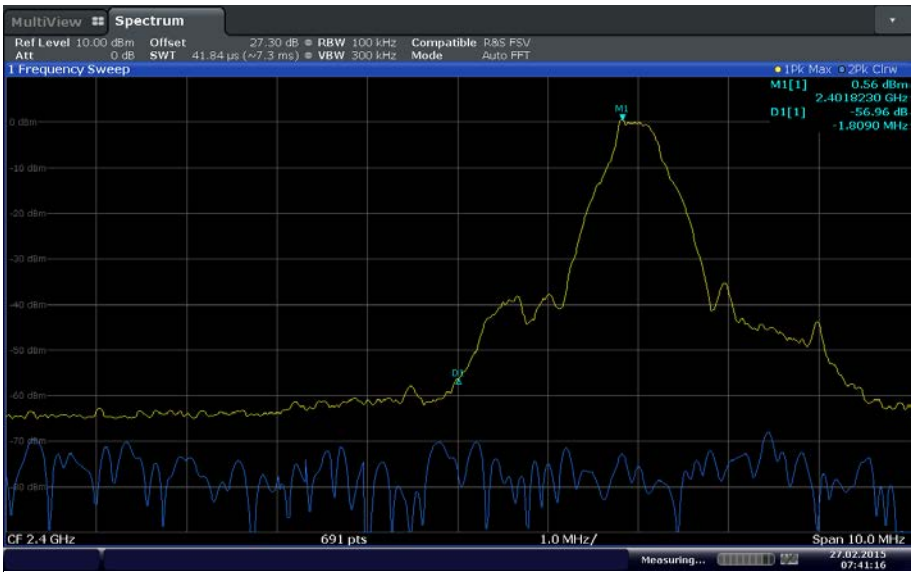
Date: 27.FEB.2015 07:36:45

Hopping upper bandedge (π/4-DQPSK)



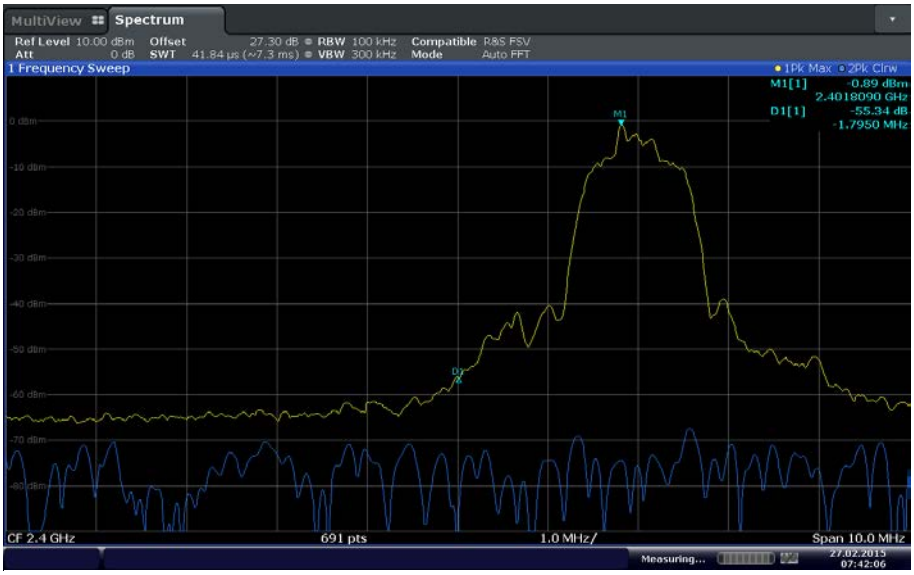
Date: 27.FEB.2015 07:38:03

Hopping upper bandedge (8DPSK)



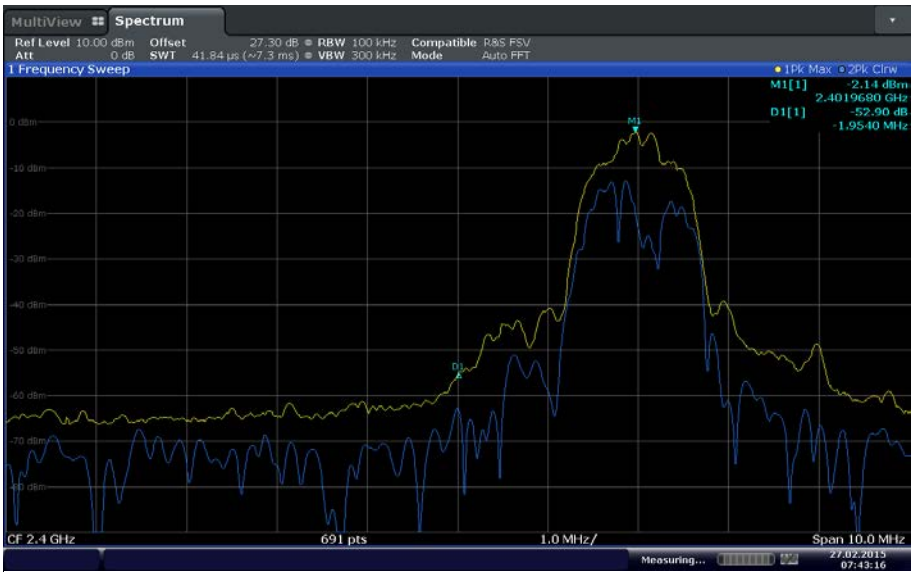
Date: 27.FEB.2015 07:41:16

Non-hopping lower bandedge (GFSK)



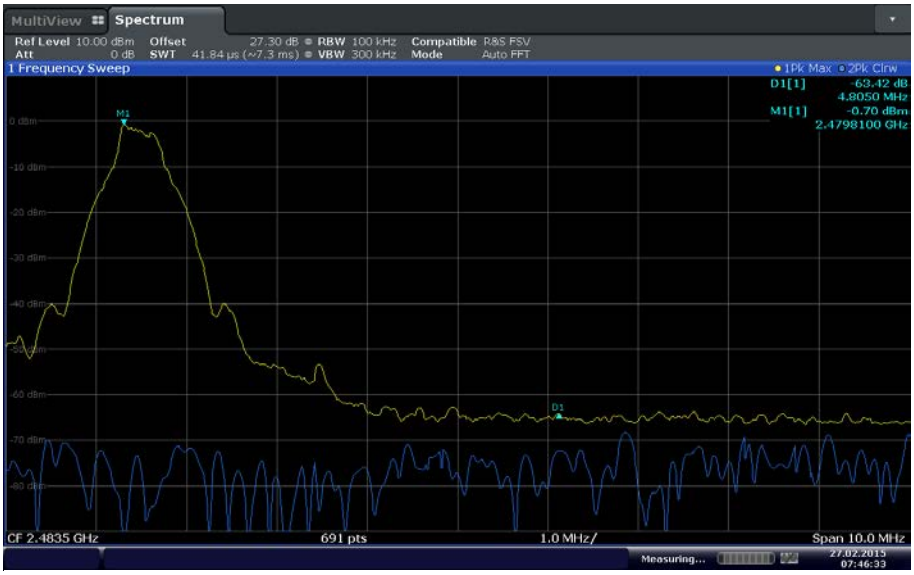
Date: 27.FEB.2015 07:42:05

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



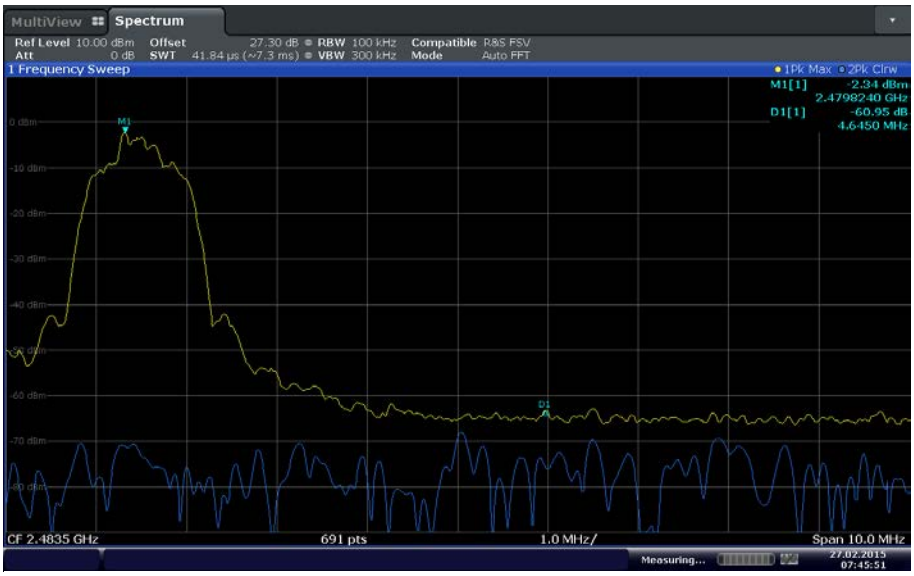
Date: 27.FEB.2015 07:43:16

Non-hopping lower bandedge (8DPSK)



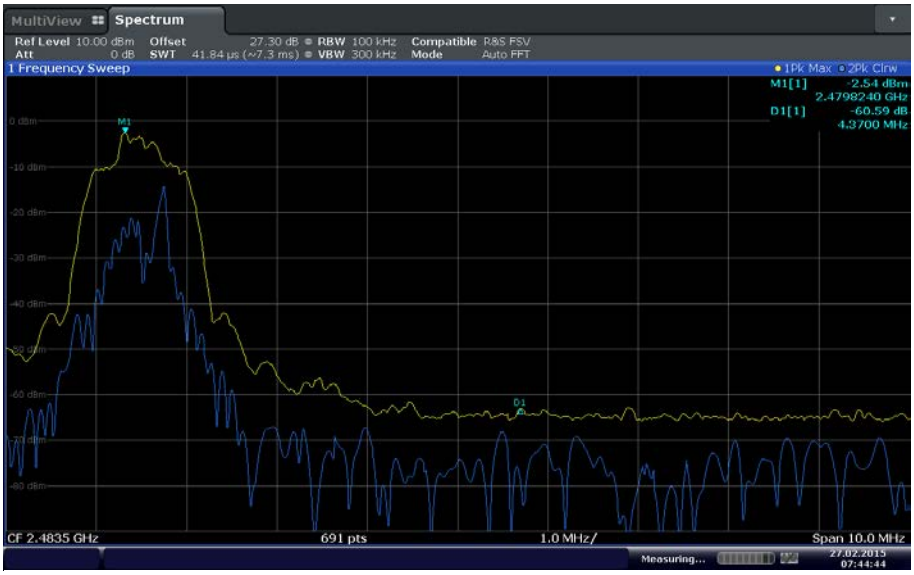
Date: 27.FEB.2015 07:46:33

Non-hopping upper bandedge (GFSK)



Date: 27.FEB.2015 07:45:51

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



Date: 27.FEB.2015 07:44:44

Non-hopping upper bandedge (8DPSK)

2.9 SPURIOUS RF CONDUCTED 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: SN022 / Test Configuration A

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

February 27,2015/FSC

2.9.5 Test Equipment Used

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

2.9.6 Environmental Conditions

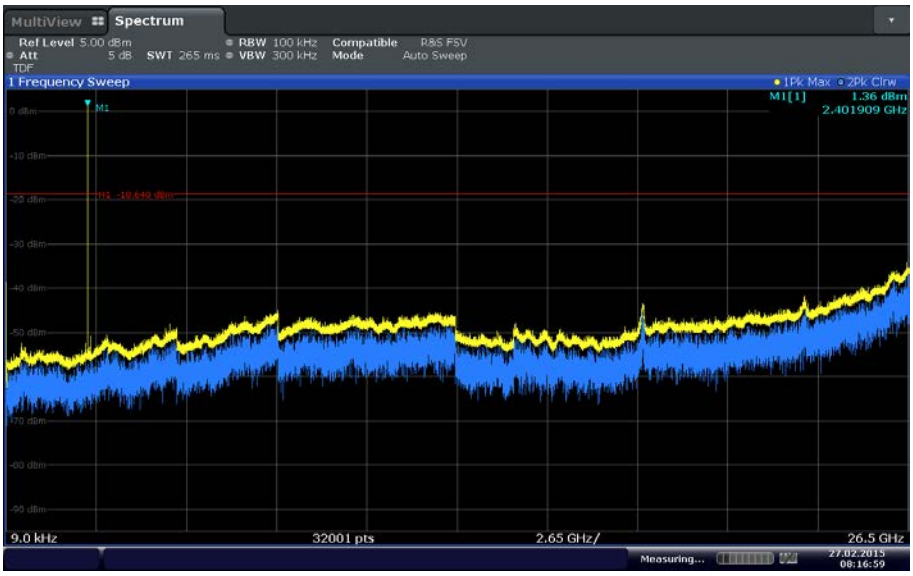
Ambient Temperature	23.8°C
Relative Humidity	26.6%
ATM Pressure	99.4 kPa

2.9.7 Additional Observations

- This is a conducted test.
- A transducer factor (TDF) was used to compensate for the external attenuator, power divider/splitter and cable used.
- Span is from 30MHz up to 26GHz (to cover 10th 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.

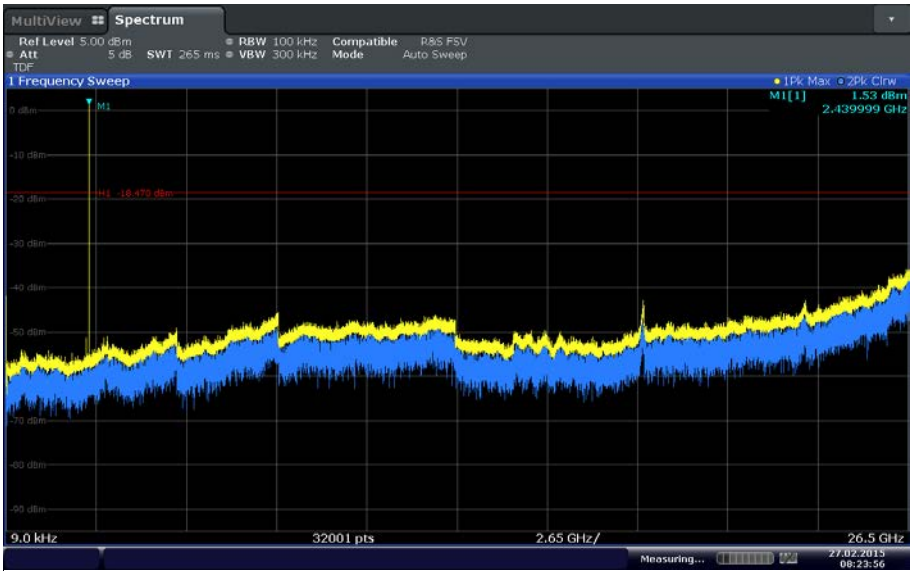
- Trace allowed to stabilize. Maximum spurious emission compared to limit.
- Limit is 20dBc.

2.9.8 Test Results Plots



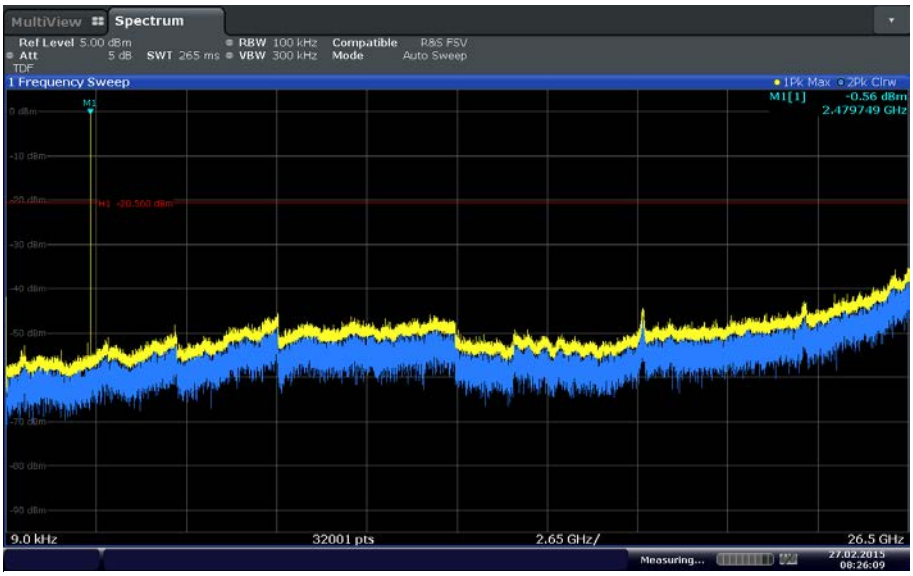
Date: 27.FEB.2015 08:16:59

Low Channel (GFSK)



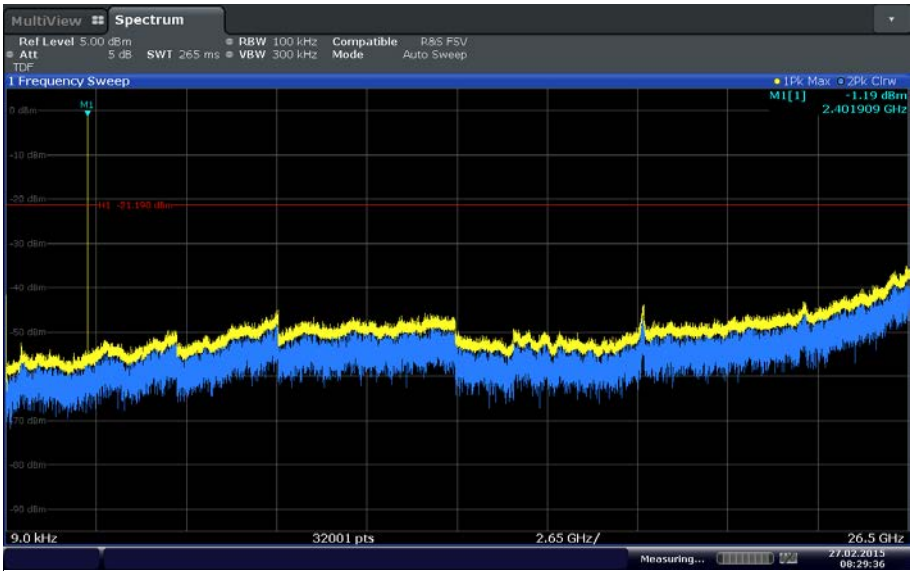
Date: 27.FEB.2015 08:23:56

Mid Channel (GFSK)



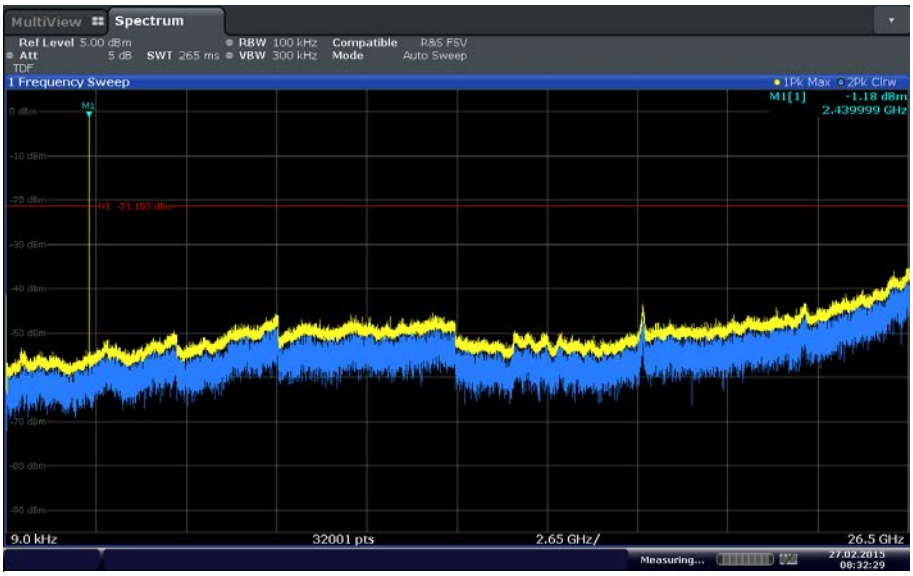
Date: 27.FEB.2015 08:26:09

High Channel (GFSK)



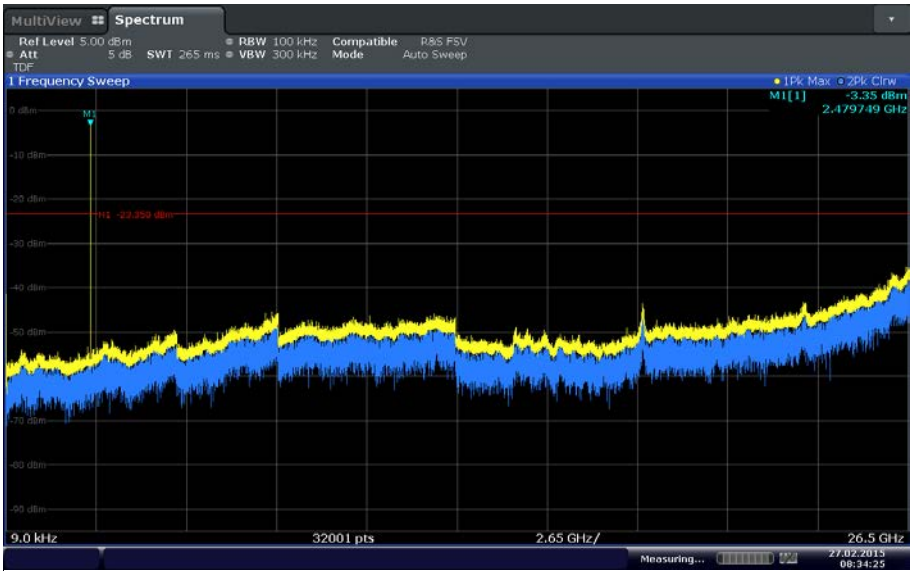
Date: 27.FEB.2015 08:29:36

Low Channel (π/4-DQPSK)



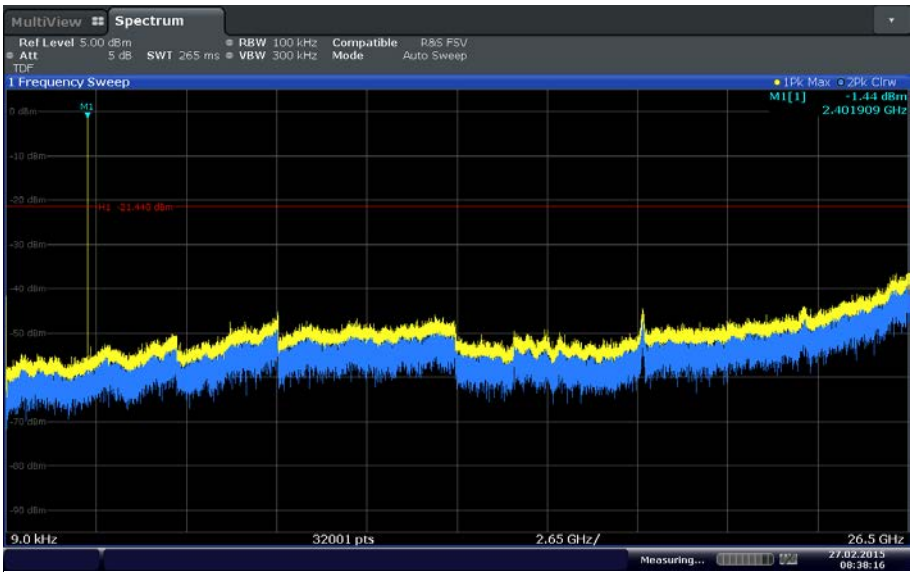
Date: 27.FEB.2015 08:32:30

Mid Channel (π/4-DQPSK)



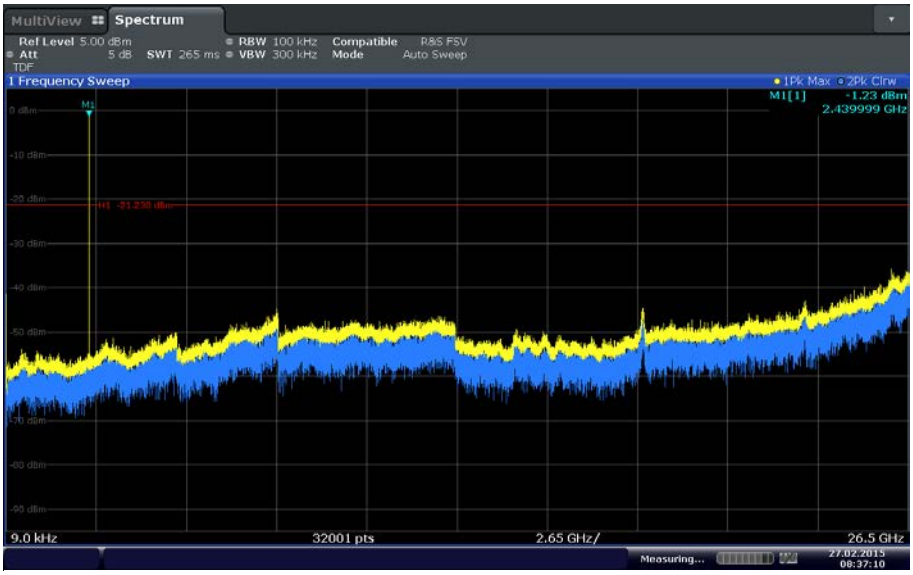
Date: 27.FEB.2015 08:34:25

High Channel (π/4-DQPSK)



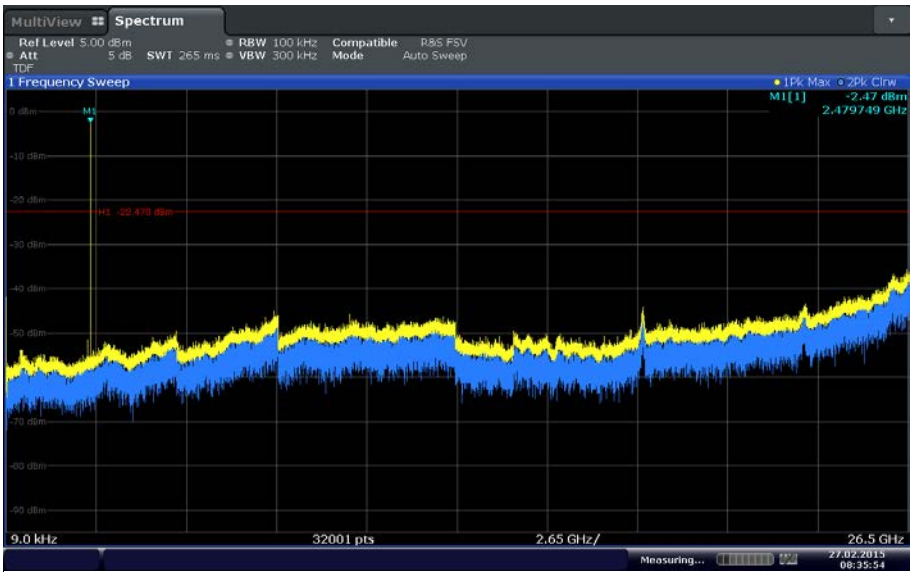
Date: 27.FEB.2015 08:38:17

Low Channel (8DPSK)



Date: 27.FEB.2015 08:37:10

Mid Channel (8DPSK)



Date: 27.FEB.2015 08:35:55

High Channel (8DPSK)

2.10 SPURIOUS RADIATED EMISSIONS

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: SN022 / Test Configuration B

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

February 28, 2015/FSC

2.10.5 Test Equipment Used

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

2.10.6 Environmental Conditions

Ambient Temperature	25.8°C
Relative Humidity	44.5%
ATM Pressure	99.0 kPa

2.10.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic (25GHz).
- 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. There are no significant differences in radiated emissions between the three modulation types.

- 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.

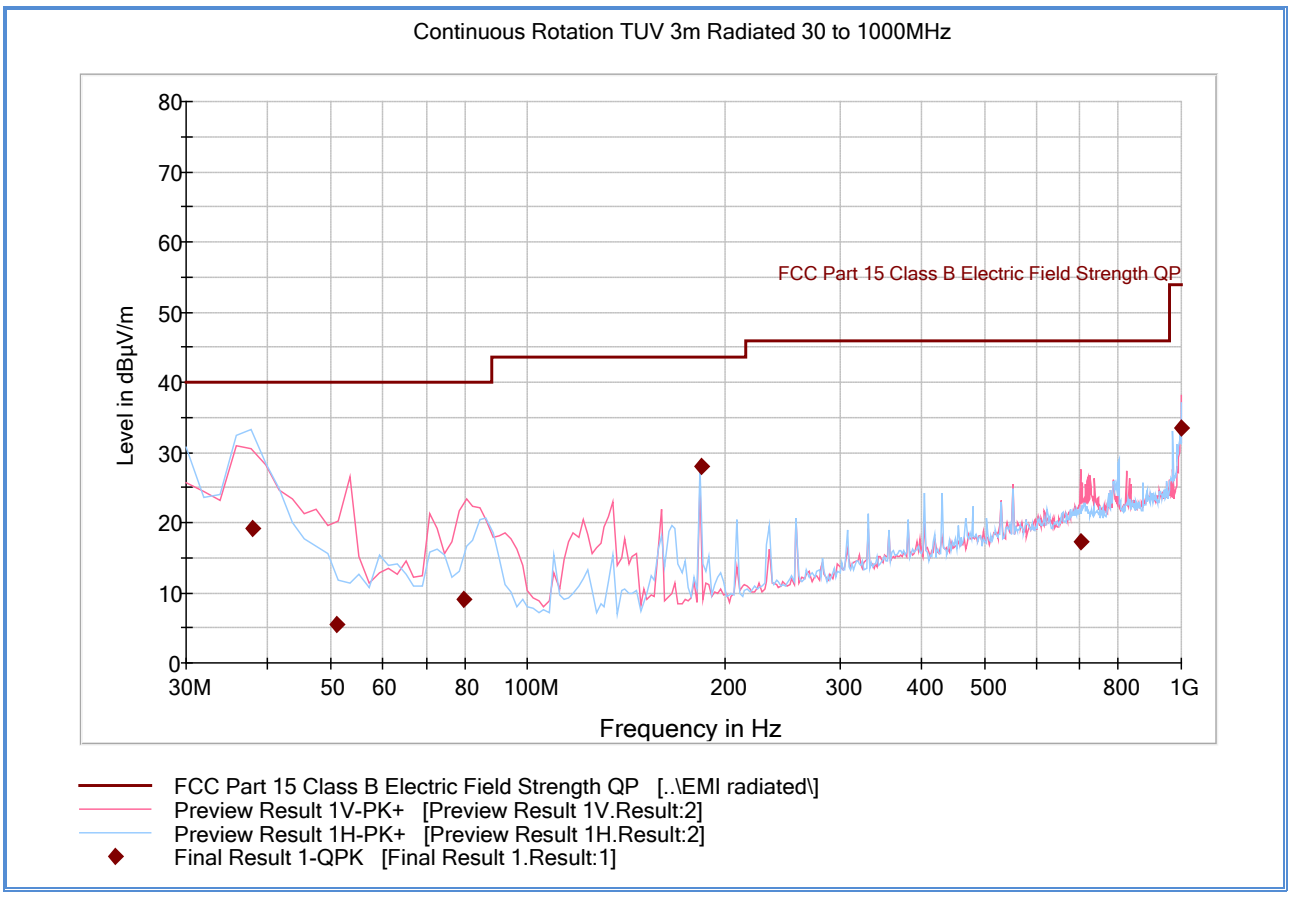
2.10.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbµV) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			**11.8**

2.10.9 Test Results

See attached plots.

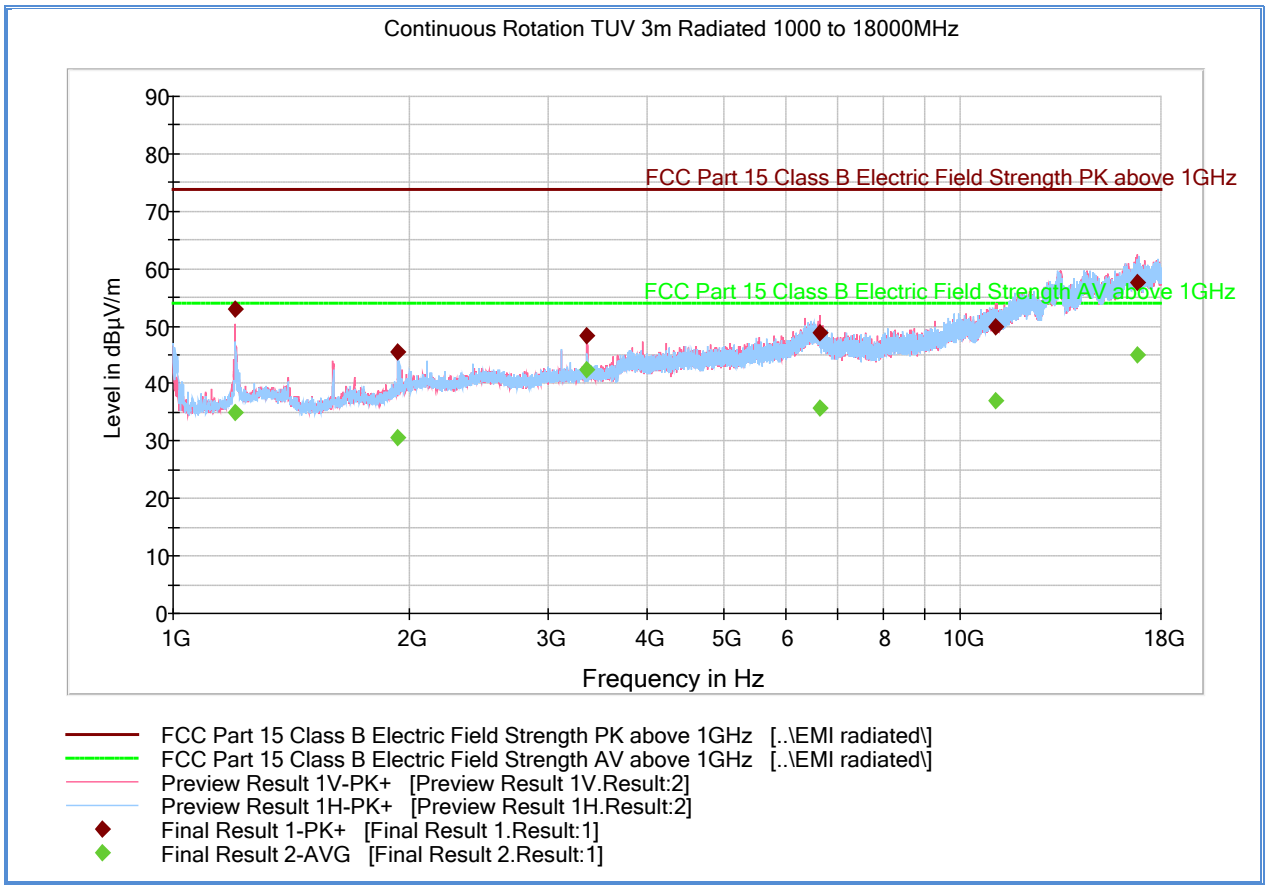
2.10.10 Test Results Below 1GHz (Receive Mode)



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)
37.815551	19.1	1000.0	120.000	400.0	H	15.0	-15.1	20.9	40.0
51.006653	5.5	1000.0	120.000	150.0	V	106.0	-19.7	34.5	40.0
79.981082	9.1	1000.0	120.000	100.0	V	232.0	-21.6	30.9	40.0
184.287134	28.0	1000.0	120.000	177.0	H	157.0	-16.8	15.5	43.5
700.321283	17.2	1000.0	120.000	122.0	V	338.0	-1.4	28.8	46.0
999.560000	33.5	1000.0	120.000	212.0	V	220.0	1.7	20.4	53.9

2.10.11 Test Results Above 1GHz (Receive Mode)



Peak Data

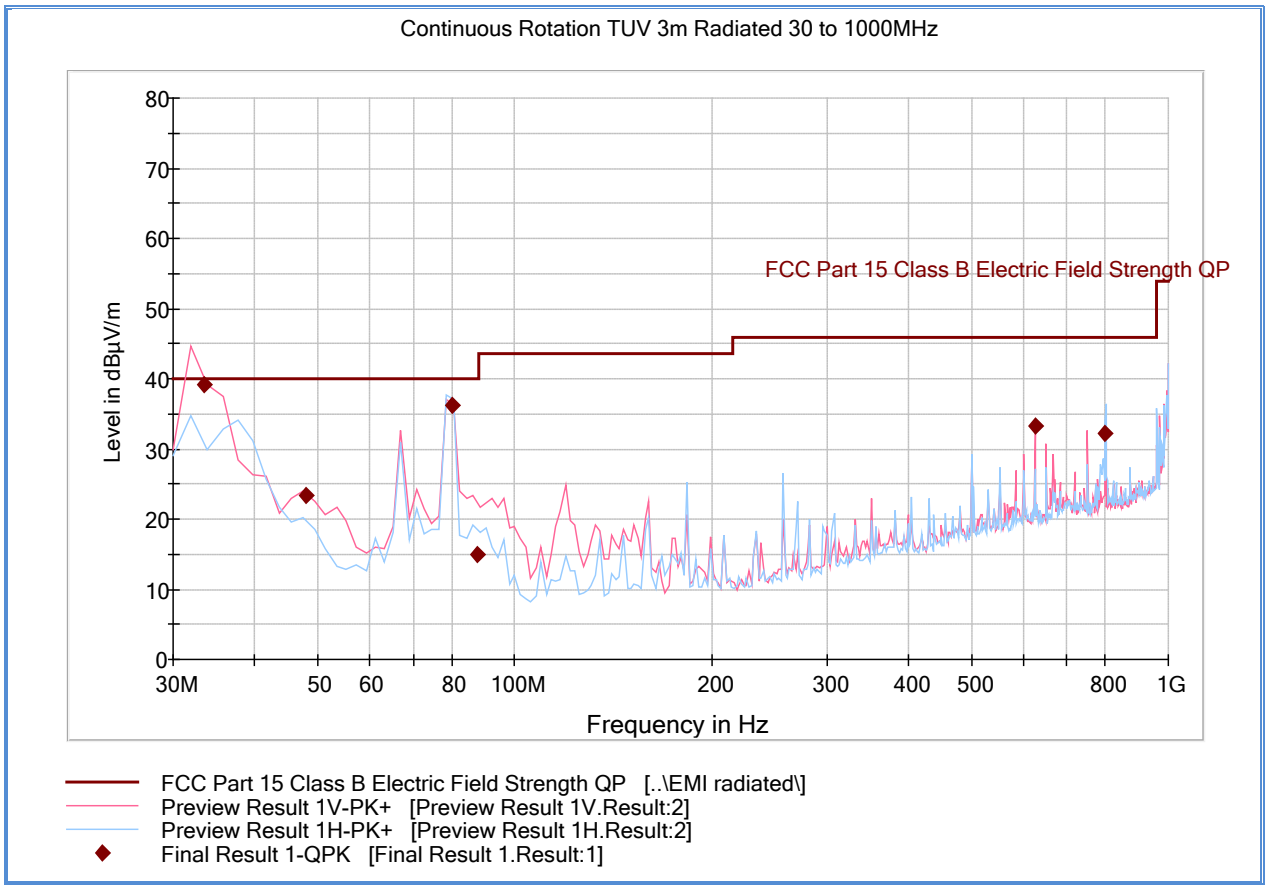
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1200.600000	52.9	1000.0	1000.000	206.5	V	85.0	-6.2	21.0	73.9
1932.566667	45.6	1000.0	1000.000	277.3	H	88.0	-2.0	28.3	73.9
3359.600000	48.3	1000.0	1000.000	200.5	V	188.0	1.5	25.6	73.9
6631.933333	48.8	1000.0	1000.000	155.7	V	74.0	10.9	25.1	73.9
11092.13333	50.0	1000.0	1000.000	139.7	V	167.0	14.5	23.9	73.9
16814.90000	57.7	1000.0	1000.000	375.1	V	-20.0	23.5	16.2	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)
1200.600000	35.1	1000.0	1000.000	206.5	V	85.0	-6.2	18.8	53.9
1932.566667	30.7	1000.0	1000.000	277.3	H	88.0	-2.0	23.2	53.9
3359.600000	42.4	1000.0	1000.000	200.5	V	188.0	1.5	11.5	53.9
6631.933333	35.7	1000.0	1000.000	155.7	V	74.0	10.9	18.2	53.9
11092.13333	36.9	1000.0	1000.000	139.7	V	167.0	14.5	17.0	53.9
16814.90000	44.9	1000.0	1000.000	375.1	V	-20.0	23.5	9.0	53.9

Test Notes: No significant emissions observed above 8GHz.

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

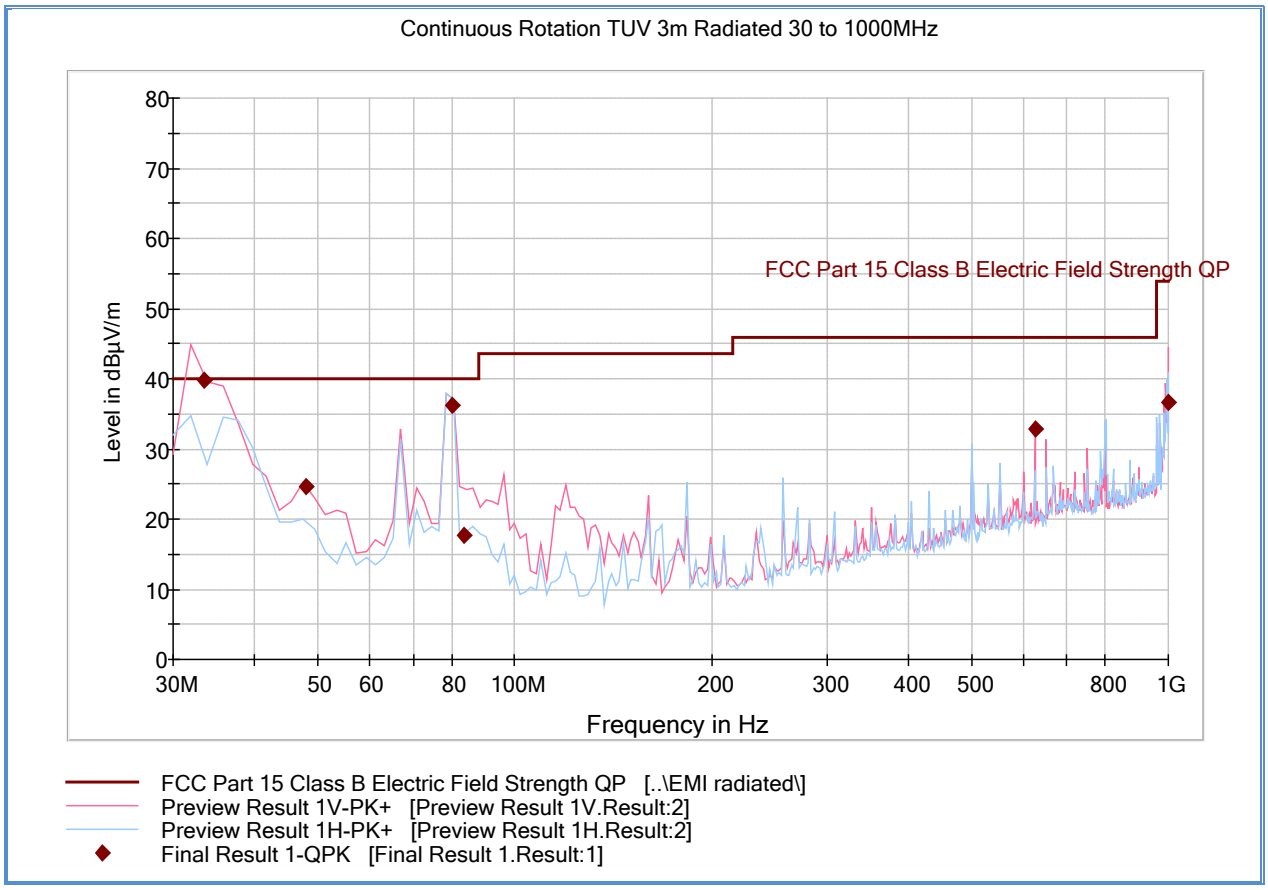


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
33.400000	39.1	1000.0	120.000	100.0	V	-8.0	-12.8	0.9	40.0
47.974990	23.3	1000.0	120.000	160.0	V	297.0	-19.0	16.7	40.0
79.997194	36.3	1000.0	120.000	122.0	H	101.0	-21.6	3.7	40.0
87.492745	15.0	1000.0	120.000	100.0	V	231.0	-20.9	25.0	40.0
625.029659	33.3	1000.0	120.000	115.0	V	38.0	-3.2	12.7	46.0
800.163447	32.3	1000.0	120.000	100.0	H	9.0	-1.5	13.7	46.0

Test Notes: Only worst case channel presented for spurious emissions below 1GHz.

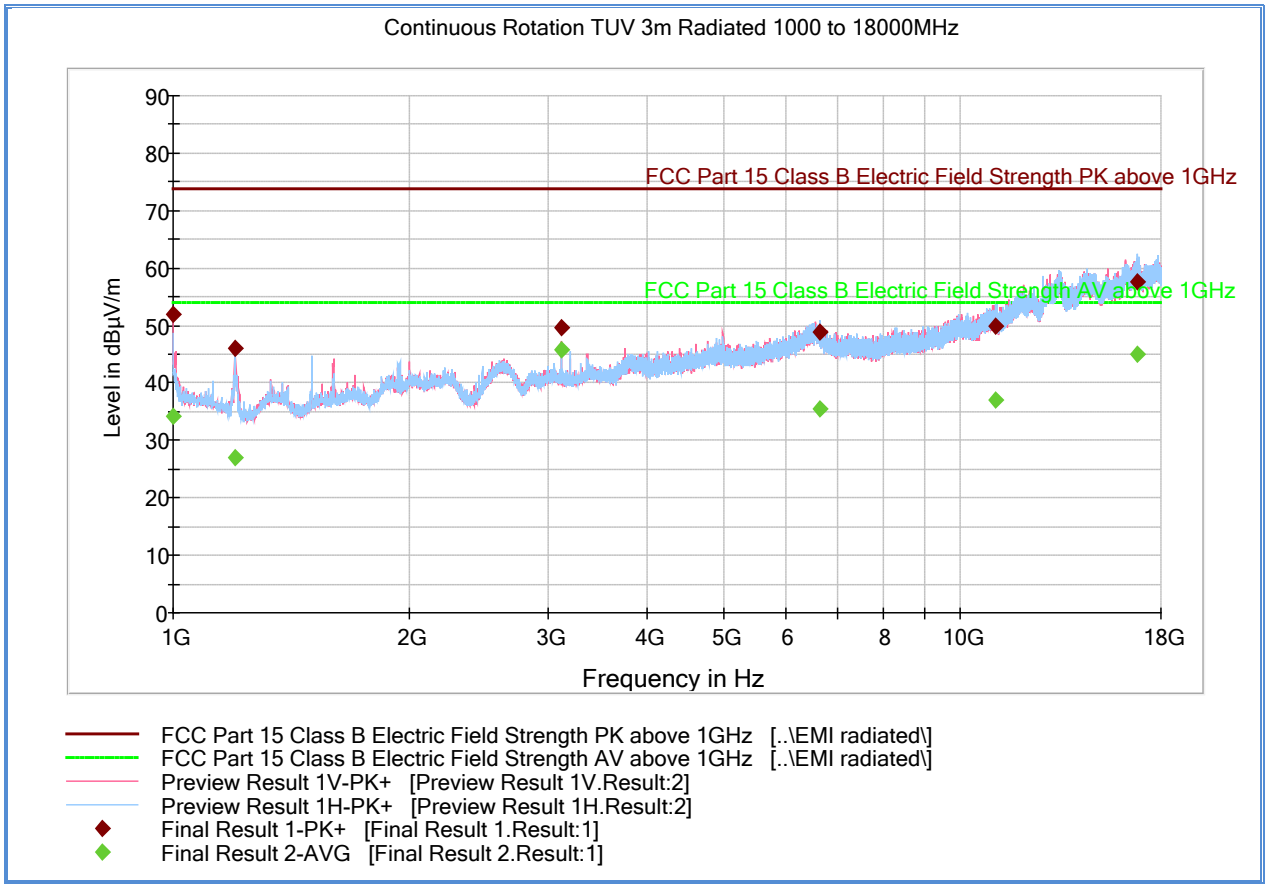
2.10.13 Test Results Below 1GHz (Bluetooth TX Worst Case – Hopping)



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)
33.400000	39.8	1000.0	120.000	100.0	V	208.0	-12.8	0.2	40.0
47.974990	24.6	1000.0	120.000	150.0	V	245.0	-19.0	15.4	40.0
79.997194	36.2	1000.0	120.000	100.0	H	172.0	-21.6	3.8	40.0
83.732745	17.7	1000.0	120.000	100.0	V	228.0	-21.4	22.3	40.0
625.029659	32.8	1000.0	120.000	110.0	V	47.0	-3.2	13.2	46.0
999.120000	36.7	1000.0	120.000	115.0	V	150.0	1.7	17.2	53.9

2.10.14 Test Results Above 1GHz (Bluetooth TX Worst Case - Hopping)



Peak Data

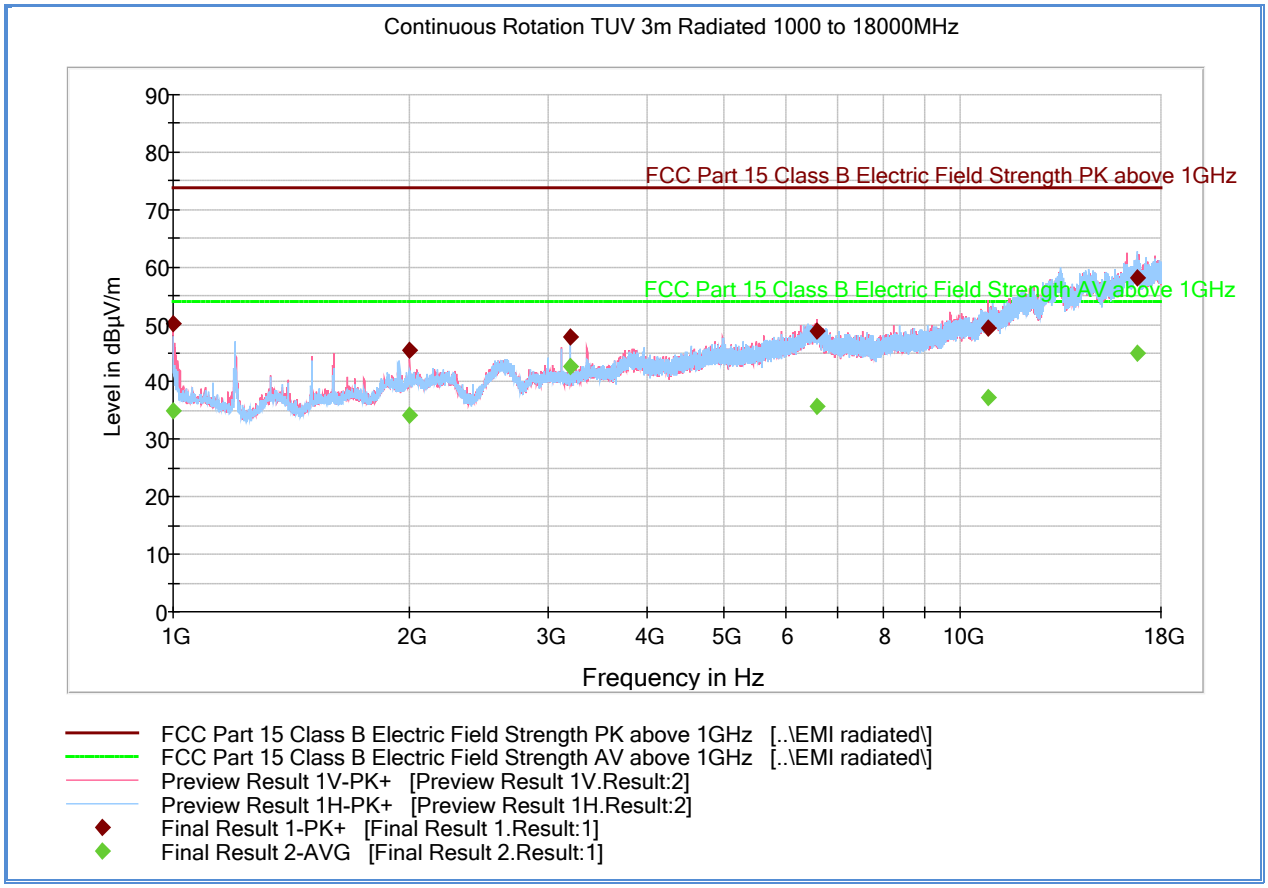
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.400000	52.0	1000.0	1000.000	259.3	V	19.0	-7.4	21.9	73.9
1200.266667	46.0	1000.0	1000.000	342.2	H	10.0	-6.2	27.9	73.9
3118.400000	49.6	1000.0	1000.000	103.7	V	201.0	1.0	24.3	73.9
6630.366667	48.7	1000.0	1000.000	200.5	H	152.0	10.9	25.2	73.9
11088.166667	49.9	1000.0	1000.000	407.9	H	60.0	14.5	24.0	73.9
16769.000000	57.7	1000.0	1000.000	401.7	H	104.0	23.5	16.2	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)
1000.400000	34.3	1000.0	1000.000	259.3	V	19.0	-7.4	19.6	53.9
1200.266667	27.1	1000.0	1000.000	342.2	H	10.0	-6.2	26.8	53.9
3118.400000	45.8	1000.0	1000.000	103.7	V	201.0	1.0	8.1	53.9
6630.366667	35.6	1000.0	1000.000	200.5	H	152.0	10.9	18.3	53.9
11088.166667	37.0	1000.0	1000.000	407.9	H	60.0	14.5	16.9	53.9
16769.000000	45.0	1000.0	1000.000	401.7	H	104.0	23.5	8.9	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.

2.10.15 Test Results Above 1GHz Low Channel (Bluetooth TX Worst Case)



Peak Data

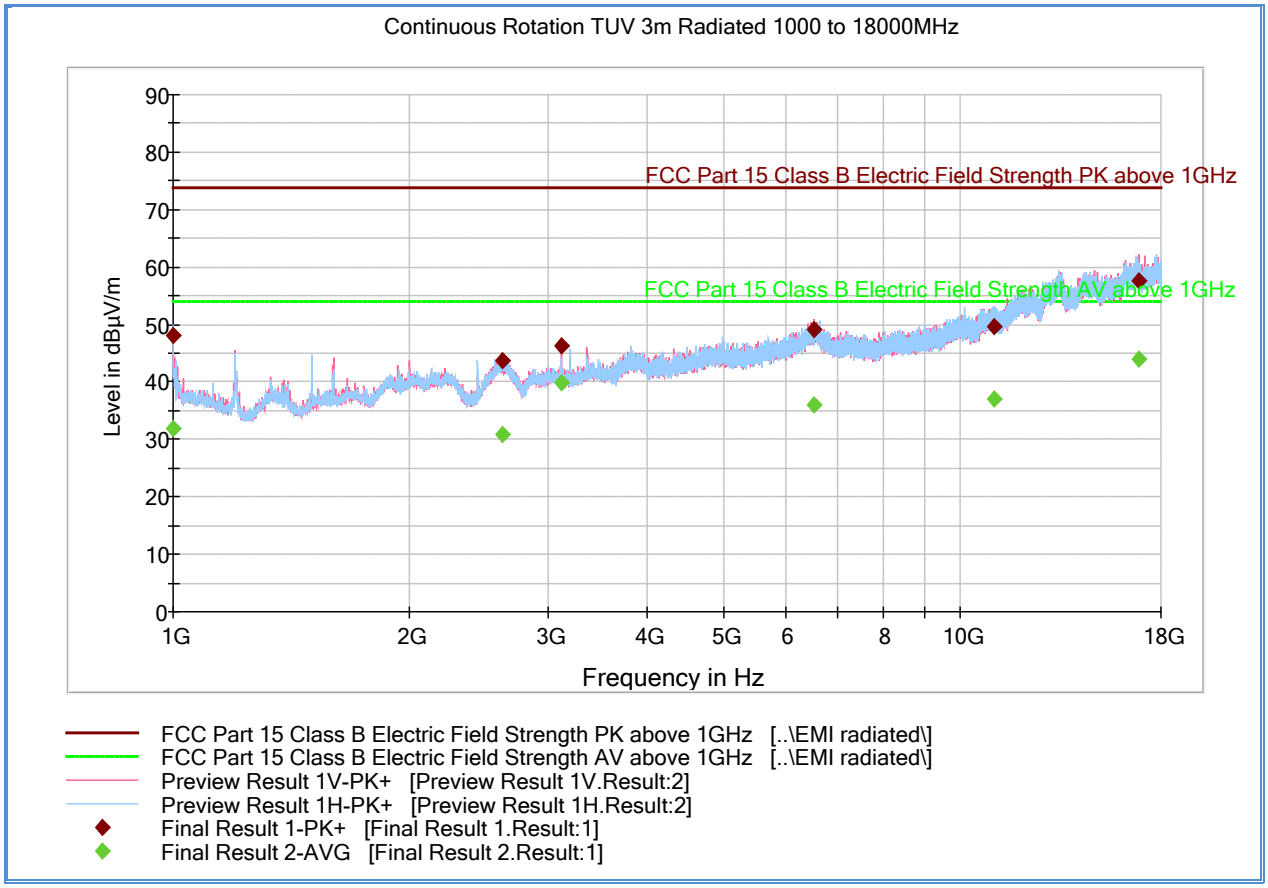
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	50.2	1000.0	1000.000	238.4	V	12.0	-7.4	23.7	73.9
1999.966667	45.5	1000.0	1000.000	165.6	V	47.0	-1.6	28.4	73.9
3200.000000	47.7	1000.0	1000.000	102.7	H	106.0	1.0	26.2	73.9
6584.166667	48.9	1000.0	1000.000	402.7	V	20.0	11.2	25.0	73.9
10862.133333	49.4	1000.0	1000.000	367.1	V	193.0	14.4	24.5	73.9
16787.866667	58.2	1000.0	1000.000	189.5	H	186.0	23.6	15.7	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	34.9	1000.0	1000.000	238.4	V	12.0	-7.4	19.0	53.9
1999.966667	34.3	1000.0	1000.000	165.6	V	47.0	-1.6	19.6	53.9
3200.000000	42.7	1000.0	1000.000	102.7	H	106.0	1.0	11.2	53.9
6584.166667	35.8	1000.0	1000.000	402.7	V	20.0	11.2	18.1	53.9
10862.133333	37.3	1000.0	1000.000	367.1	V	193.0	14.4	16.6	53.9
16787.866667	45.0	1000.0	1000.000	189.5	H	186.0	23.6	8.9	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.

2.10.16 Test Results Above 1GHz Mid Channel (Bluetooth TX Worst Case)



Peak Data

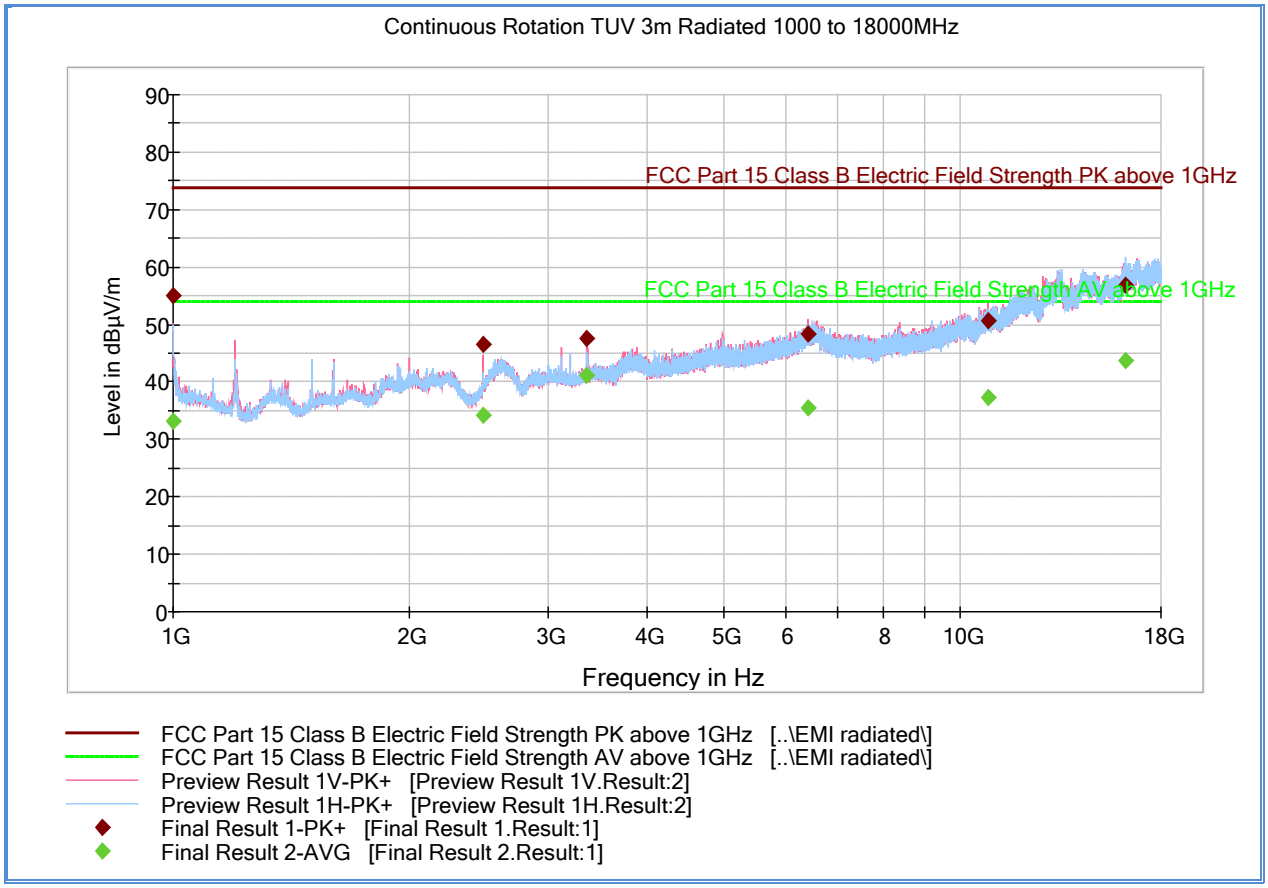
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.500000	48.0	1000.0	1000.000	202.3	H	268.0	-7.4	25.9	73.9
2617.633333	43.7	1000.0	1000.000	259.3	V	263.0	0.0	30.2	73.9
3118.000000	46.3	1000.0	1000.000	113.7	V	199.0	1.0	27.6	73.9
6531.600000	49.1	1000.0	1000.000	390.1	V	60.0	11.2	24.8	73.9
11069.466667	49.6	1000.0	1000.000	191.5	H	106.0	14.6	24.3	73.9
16863.066667	57.5	1000.0	1000.000	103.7	V	157.0	23.0	16.4	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)
1000.500000	31.8	1000.0	1000.000	202.3	H	268.0	-7.4	22.1	53.9
2617.633333	31.0	1000.0	1000.000	259.3	V	263.0	0.0	22.9	53.9
3118.000000	39.9	1000.0	1000.000	113.7	V	199.0	1.0	14.0	53.9
6531.600000	35.9	1000.0	1000.000	390.1	V	60.0	11.2	18.0	53.9
11069.466667	37.0	1000.0	1000.000	191.5	H	106.0	14.6	16.9	53.9
16863.066667	44.1	1000.0	1000.000	103.7	V	157.0	23.0	9.8	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.

2.10.17 Test Results Above 1GHz High Channel (Bluetooth TX Worst Case)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.400000	55.0	1000.0	1000.000	124.7	V	-16.0	-7.4	18.9	73.9
2480.166667	46.4	1000.0	1000.000	103.7	V	278.0	-0.1	27.5	73.9
3359.800000	47.6	1000.0	1000.000	103.7	V	-3.0	1.5	26.3	73.9
6401.433333	48.4	1000.0	1000.000	350.6	V	60.0	11.2	25.5	73.9
10869.033333	50.5	1000.0	1000.000	406.7	V	259.0	14.5	23.4	73.9
16229.400000	56.7	1000.0	1000.000	219.4	H	206.0	22.2	17.2	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)
1000.400000	33.1	1000.0	1000.000	124.7	V	-16.0	-7.4	20.8	53.9
2480.166667	34.2	1000.0	1000.000	103.7	V	278.0	-0.1	19.7	53.9
3359.800000	41.2	1000.0	1000.000	103.7	V	-3.0	1.5	12.7	53.9
6401.433333	35.5	1000.0	1000.000	350.6	V	60.0	11.2	18.4	53.9
10869.033333	37.3	1000.0	1000.000	406.7	V	259.0	14.5	16.6	53.9
16229.400000	43.7	1000.0	1000.000	219.4	H	206.0	22.2	10.2	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.

2.11 RADIATED IMMEDIATE RESTRICTED BANDS

2.11.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.11.2 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)).

2.11.3 Equipment Under Test and Modification State

Serial No: SN022 / Test Configuration B

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

February 28, 2015/FSC

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

Ambient Temperature	25.8°C
Relative Humidity	44.5%
ATM Pressure	99.0 kPa

2.11.7 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.
- Both Non-hopping and Hopping modes 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 2.11.8 for sample computation.

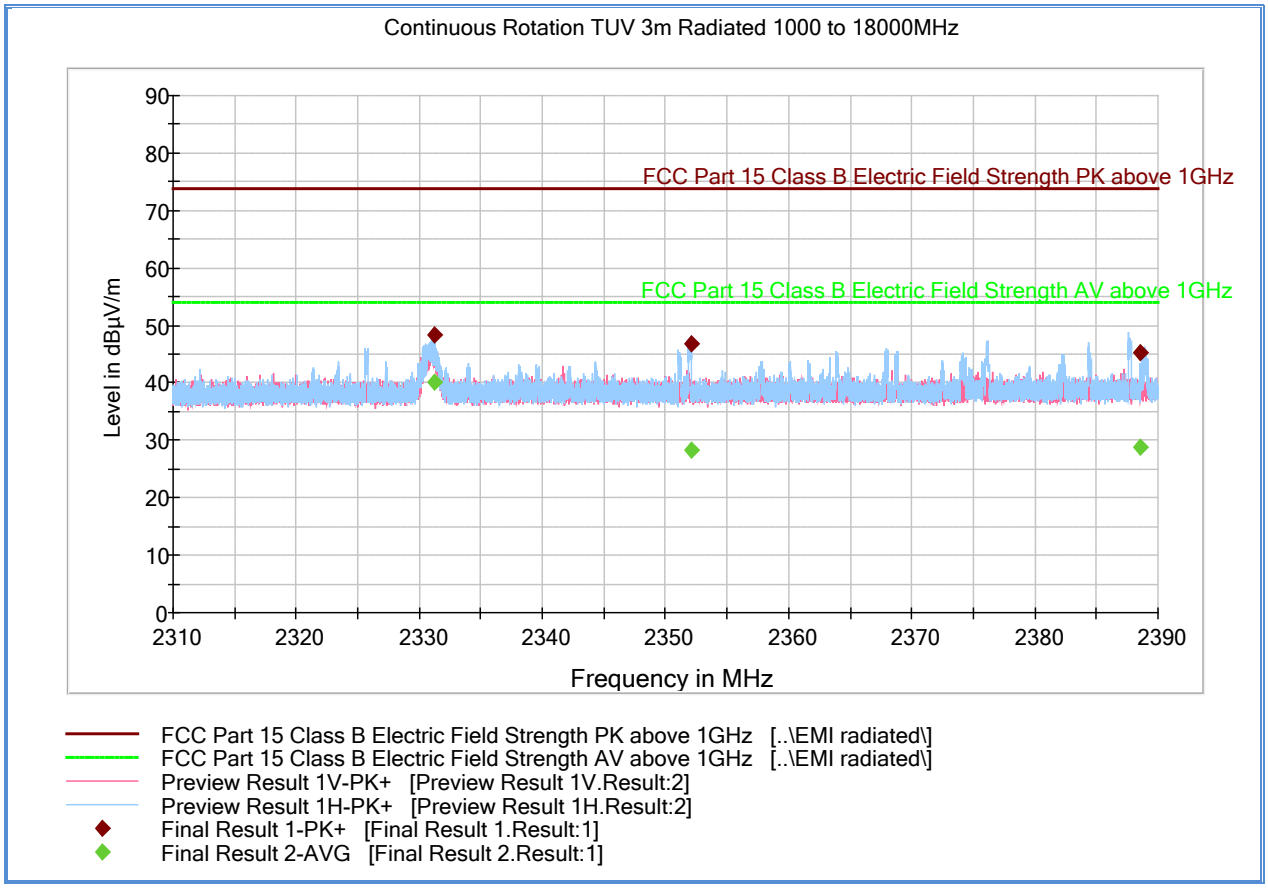
2.11.8 Sample Computation (Radiated Emission)

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**

2.11.9 Test Results

See attached plots.

2.11.10 Test Results Restricted Band 2310MHz to 2390MHz (Hopping)



Peak Data

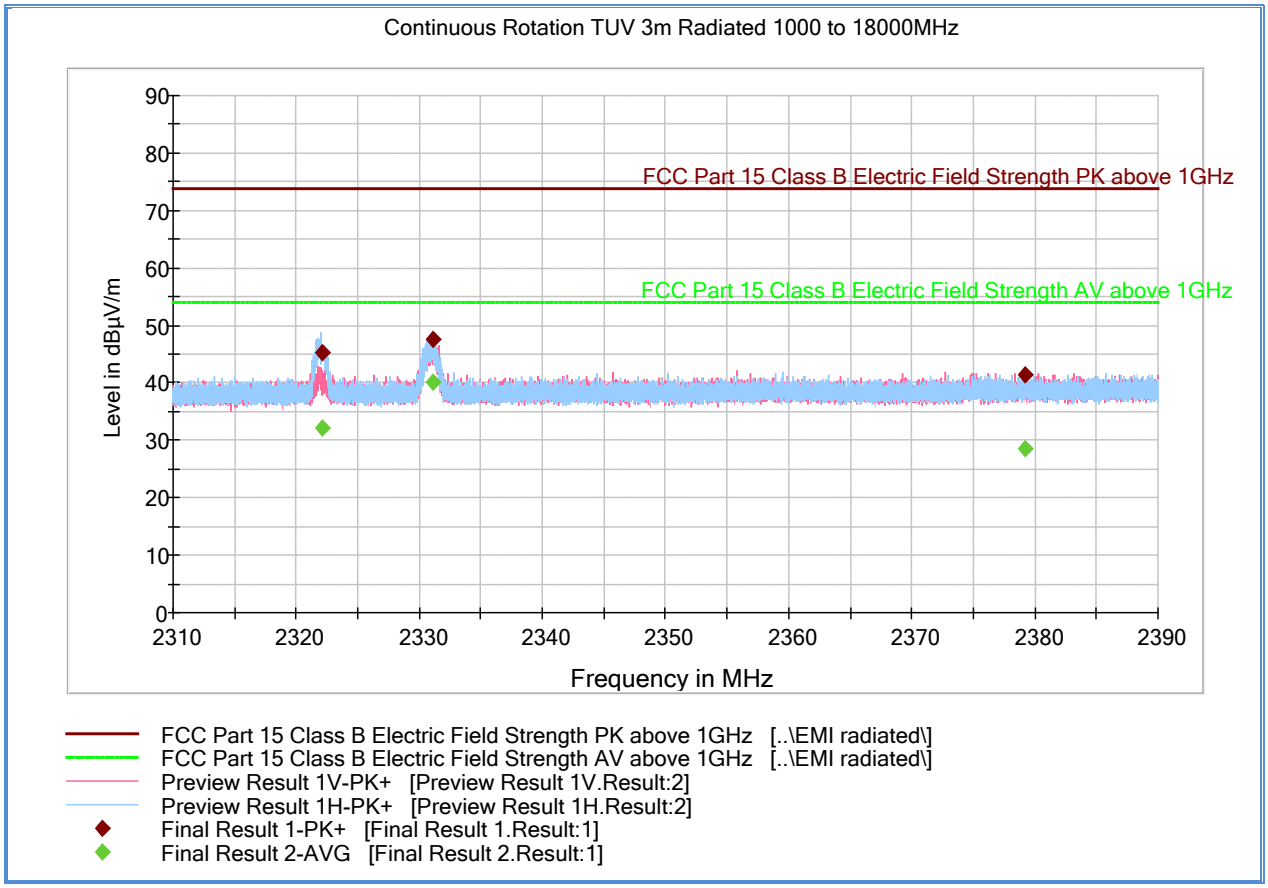
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2331.234667	48.3	1000.0	1000.000	122.7	H	100.0	-0.9	25.6	73.9
2352.058667	46.8	1000.0	1000.000	139.7	H	307.0	-0.8	27.1	73.9
2388.565333	45.2	1000.0	1000.000	139.7	H	91.0	-0.6	28.7	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)
2331.234667	40.2	1000.0	1000.000	122.7	H	100.0	-0.9	13.7	53.9
2352.058667	28.3	1000.0	1000.000	139.7	H	307.0	-0.8	25.6	53.9
2388.565333	28.8	1000.0	1000.000	139.7	H	91.0	-0.6	25.1	53.9

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

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



Peak Data

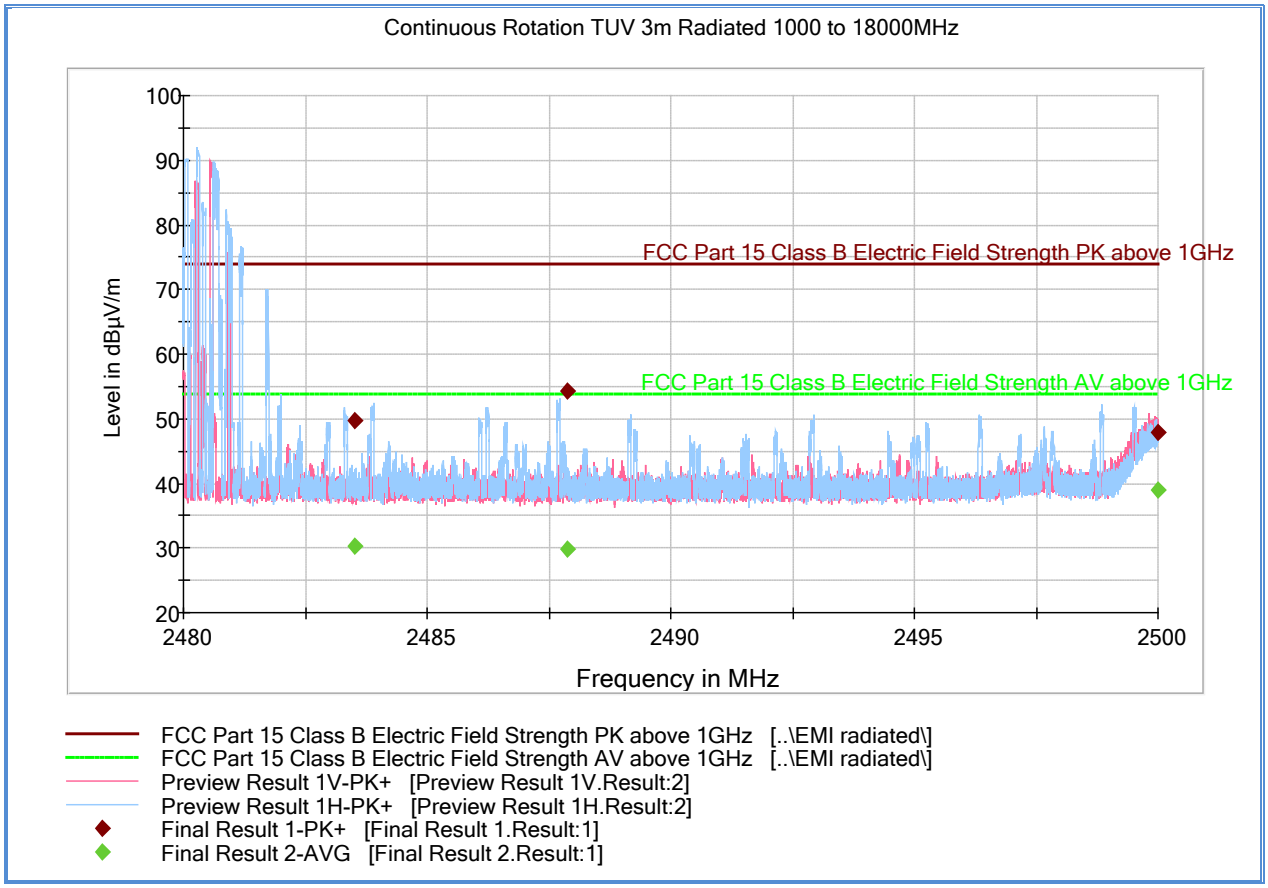
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2322.138667	45.4	1000.0	1000.000	116.7	H	301.0	-1.0	28.5	73.9
2331.104000	47.5	1000.0	1000.000	138.7	H	105.0	-0.9	26.4	73.9
2379.162667	41.4	1000.0	1000.000	191.5	V	278.0	-0.7	32.5	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)
2322.138667	32.1	1000.0	1000.000	116.7	H	301.0	-1.0	21.8	53.9
2331.104000	40.1	1000.0	1000.000	138.7	H	105.0	-0.9	13.8	53.9
2379.162667	28.6	1000.0	1000.000	191.5	V	278.0	-0.7	25.3	53.9

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

2.11.12 Test Results Restricted Band 2483.5MHz to 2500MHz (Hopping)



Peak Data

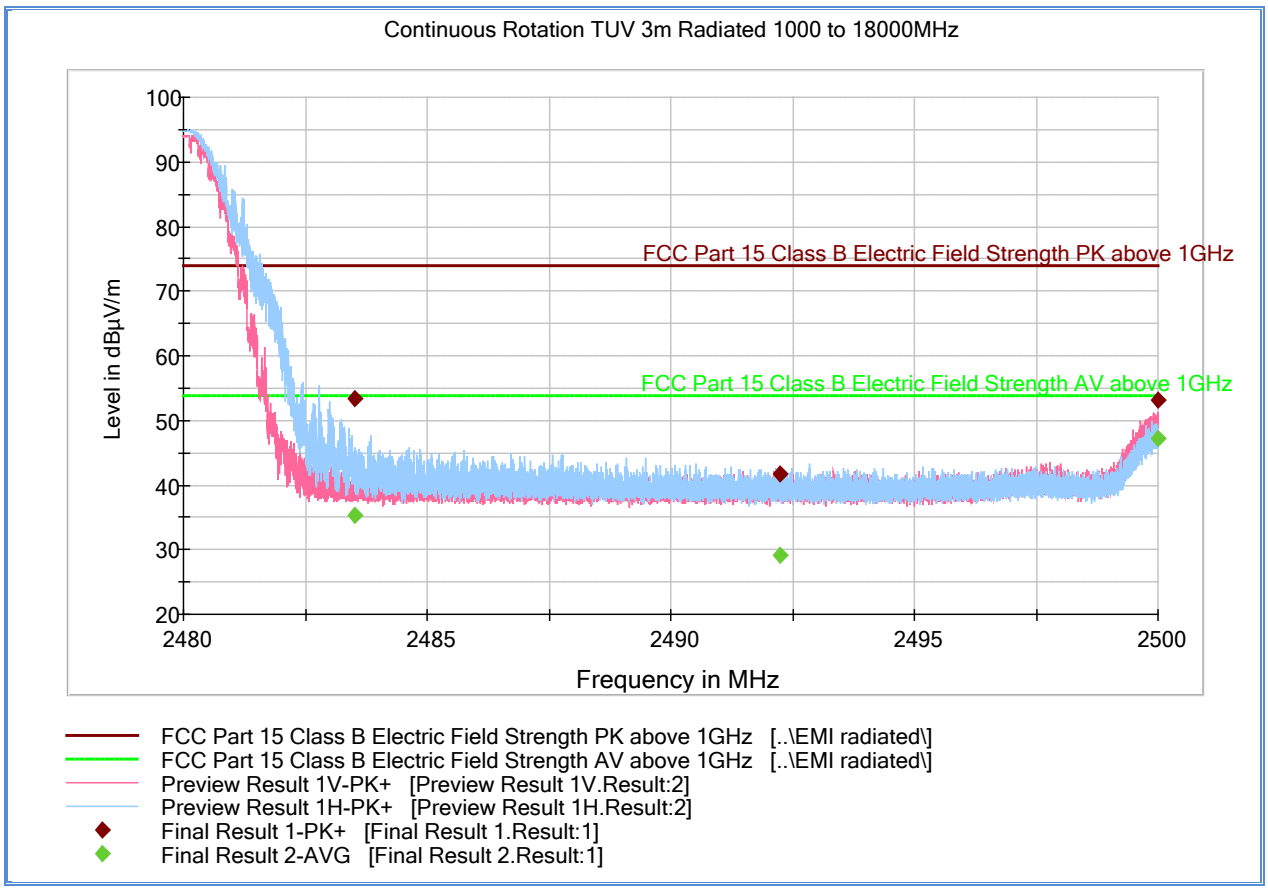
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.504000	49.8	1000.0	1000.000	102.7	H	316.0	-0.1	24.1	73.9
2487.872000	54.2	1000.0	1000.000	101.7	H	76.0	-0.1	19.7	73.9
2500.000000	47.9	1000.0	1000.000	181.6	V	84.0	-0.1	26.0	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)
2483.504000	30.2	1000.0	1000.000	102.7	H	316.0	-0.1	23.7	53.9
2487.872000	29.8	1000.0	1000.000	101.7	H	76.0	-0.1	24.1	53.9
2500.000000	39.0	1000.0	1000.000	181.6	V	84.0	-0.1	14.9	53.9

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

2.11.13 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)
2483.508667	53.3	1000.0	1000.000	105.7	H	72.0	-0.1	20.6	73.9
2492.246667	41.6	1000.0	1000.000	161.6	H	88.0	-0.1	32.3	73.9
2500.000000	53.0	1000.0	1000.000	113.7	V	85.0	-0.1	20.9	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)
2483.508667	35.3	1000.0	1000.000	105.7	H	72.0	-0.1	18.6	53.9
2492.246667	29.2	1000.0	1000.000	161.6	H	88.0	-0.1	24.7	53.9
2500.000000	47.3	1000.0	1000.000	113.7	V	85.0	-0.1	6.6	53.9

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

2.12 RECEIVER SPURIOUS EMISSIONS

2.12.1 Specification Reference

RSS-Gen 7.0

2.12.2 Standard Applicable

Receiver Emission Limits

Receivers are required to comply with the limits of spurious emissions as set out in this section. For emissions at frequencies below 1 GHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. At frequencies above 1 GHz, measurements shall be performed using a linear average detector with a minimum resolution bandwidth of 1 MHz.

As an alternative to CISPR quasi-peak or average measurements, compliance with the emission limit can be demonstrated using measuring equipment employing a peak detector function properly adjusted for factors such as pulse desensitization, as required, with a measurement bandwidth equal to, or greater than, the applicable CISPR quasi-peak bandwidth or 1 MHz bandwidth, respectively.

Receiver Radiated Limits

Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna terminals. The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least 5x the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz.

Spurious emissions from receivers shall not exceed the radiated limits shown in the following table:

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.

2.12.3 Equipment Under Test and Modification State

Serial No: SN022 / Test Configuration B

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

February 28, 2015/FSC

2.12.5 Test Equipment Used

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

2.12.6 Environmental Conditions

Ambient Temperature	25.8°C
Relative Humidity	44.5%
ATM Pressure	99.0 kPa

2.12.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to at least 5x the highest tunable or local oscillator frequency (12.5GHz).
- Result identical to Section 2.10.10 and 2.10.11 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						
7569	Series Power Meter	N1911A P-	MY45100625	Agilent	04/22/14	04/22/15
7570	50MHz-18GHz Wideband Power Sensor	N1921A	MY45240588	Agilent	04/09/14	04/09/15
7582	Signal/Spectrum Analyzer	FSW26	101614	Rhode & Schwarz	12/22/14	12/22/15
7562	Wideband Radio Communication Tester		1201.0002k50 /103829	Rhode & Schwarz	10/09/13	10/09/15
7608	Vector Signal Generator	SMBV100A	259021	Rhode & Schwarz	06/06/14	06/06/15
8825	20dB Attenuator	46-20-34	BK5773	Weinschel Corp.	Verified by 7582 and 7608	
8832	20dB Attenuator	34-20-34	BP4150	MCE/Weinschel	Verified by 7582 and 7608	
Radiated Emissions						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	01/30/14	01/30/16
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	04/08/14	04/08/15
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	04/03/14	04/03/15
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	08/29/14	08/29/15
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/14	03/17/15
1016	Pre-amplifier	PAM-0202	187	PAM	12/10/14	12/10/15
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	04/03/14	04/03/15
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	09/04/14	09/04/15
1150	Horn antenna	3160-09	012054-004	ETS	04/26/13	04/26/15
1151	Pre-amplifier	TS-PR26	100026	Rhode & Schwarz	05/02/13	05/02/15
6815	2.4GHz Band Notch Filter	BRM50702	008	Micro-Tronics	Verified by 1049	
Miscellaneous						
6792	Multimeter	3478A	2911A70964	Hewlett Packard	08/12/14	08/12/15
7560	Barometer/Temperature /Humidity Transmitter	iBTHX-W	1240476	Omega	01/30/14	02/30/15
	DC Power Supply	35010M	D102007S	Protek	Verified by 6792	
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 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	3.55	2.05	4.20
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	2.23
				Coverage Factor (k):	2
				Expanded Uncertainty:	4.45

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	3.55	2.05	4.20
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	2.22
				Coverage Factor (k):	2
				Expanded Uncertainty:	4.44

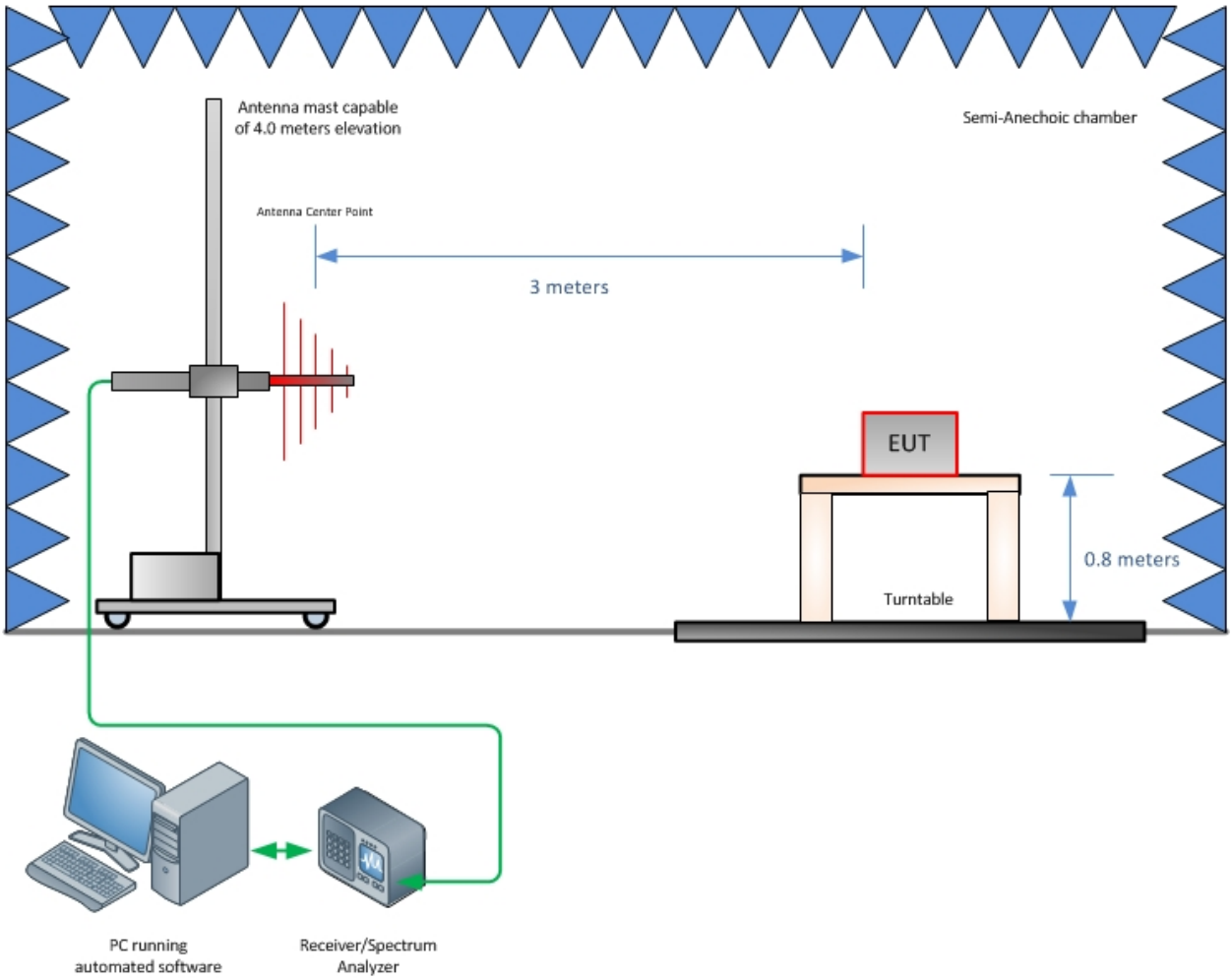
3.2.3 Conducted Antenna Port Measurement

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.50	0.29	0.08
3	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	0.72
				Coverage Factor (k):	2
				Expanded Uncertainty:	1.45

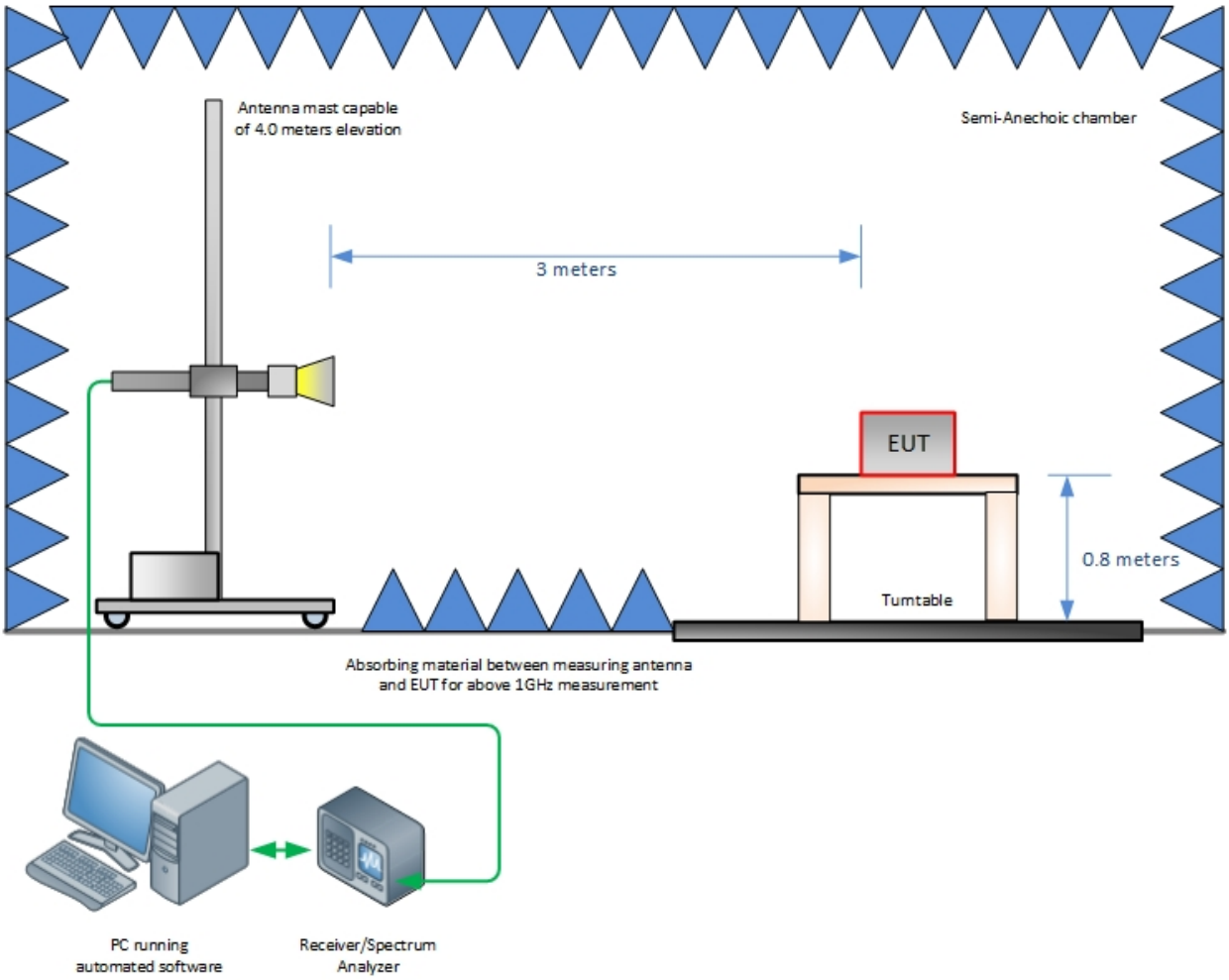
SECTION 4

DIAGRAM OF TEST SETUP

4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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