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Report On

Application for Grant of Equipment Authorization of the
St. Jude Medical
Avant
Implantable Cardioverter Defibrillator Device

FCC Part 15 Subpart C §15.247
RSS-247 Issue 2 February 2017

Report No.72146326B **July 2019**

REPORT ON	Radio Testing of the St. Jude Medical Avant Implantable Cardioverter Defibrillator Device
TEST REPORT NUMBER	72146326B
TEST REPORT DATE	July 2019
PREPARED FOR	St. Jude Medical 15900 Valley View Court Sylmar, CA 91342 USA
CONTACT PERSON	Perry Li Staff Engineer perry.li@abbott.com (818) 493-3793
PREPARED BY	Alex Chang **Name** Authorized Signatory Title: Senior EMC/RF Wireless Test Engineer
APPROVED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: Senior EMC Test Engineer / Wireless Team Lead
DATED	July 29, 2019

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

Revision History

72146326B St. Jude Medical Avant Implantable Cardioverter Defibrillator Device					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
07/29/2019	—	Initial Release			Ferdinand Custodio

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SECTION 1

REPORT SUMMARY

Radio Testing of the
St. Jude Medical
Avant
Implantable Cardioverter Defibrillator Device

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1.1 INTRODUCTION

The information contained in this report is intended to show verification of the St. Jude Medical Avant Implantable Cardioverter Defibrillator Device to the requirements of FCC Part 15 Subpart C §15.247 and RSS-247 Issue 2 February 2017.

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	St. Jude Medical
EUT	Implantable Cardioverter Defibrillator Device
Trade Name	Avant
Model Name	Avant VR – CDVRA700Q (1 chamber) Avant DR – CDDRA700Q (2 chambers) Avant HF – CDHFA700Q (3 chambers)
FCC ID	RIAICDRFNGQ
IC Number	7067A-ICDRF
FCC Classification	Low power Communications Device Transmitter (DTS)
Serial Number(s)	8007869, 8007908 and 8007910 (Radiated Sample) BBZ301.1 (Conducted Sample)
Number of Samples Tested	4
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2018). • RSS-247–Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices (Issue 2, February 2017). • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 5, March 2019 Amendment 1).
Start of Test	April 10, 2019
Finish of Test	May 09, 2019
Name of Engineer(s)	Alex Chang
Related Document(s)	• KDB 558074 D01 (DTS Meas Guidance v05r02, April 02, 2019). Guidance for Compliance Measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under §15.247 of the FCC Rules. • Abbott document 60093379 RevA • Supporting documents for EUT certification are separate exhibits.

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1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 and RSS-247 Issue 2 February 2017 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	§15.247(b)(3)	RSS-247 5.4(d)	Peak Output Power	Compliant	
-	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	N/A	
2.2	-	RSS-Gen 6.7	99% Emission Bandwidth	Compliant	
2.3	§15.247(a)(2)	RSS-247 5.2(a)	Minimum 6 dB RF Bandwidth	Compliant	
2.4	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Radiated	Compliant	
2.5	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.4	§15.247(d)	RSS-247 5.5	Radiated Spurious Emissions	Compliant	
2.6	-	RSS-Gen 7.3 and 7.4	Receiver Spurious Emissions	Compliant	
2.7	§15.247(e)	RSS-247 5.2(b)	Power Spectral Density for Digitally Modulated Device	Compliant	

N/A The EUT only employ battery power for operation and do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines

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1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a St. Jude Medical Avant Implantable Cardioverter Defibrillator Device as shown in the photograph below. The EUT is a battery-powered device placed under the skin that monitors the heart rate. Special wires connect the EUT to the heart. If an abnormal heart rhythm is detected, the EUT will deliver either pacing therapy if the heart rate is too slow or an electric shock if the heart rate is chaotic or beating too fast.

The Gallant and Entrant series have the same hardware as Avant. The only difference is the firmware for therapy. So, RF functionality is identical. The Neutrino series are the Japanese name and models for Avant and Gallant. Therefore, same exact hardware and firmware as Avant and Gallant. Avant series models were provided as worst case of all other models for evaluation. These determinations were made per Abbott document 60093379 RevA.

Variant models list below:

Product Name	NGQ Device Models		
	VR	DR	CRT-D (HF)
Avant™	CDVRA700Q	CDDRA700Q	CDHFA700Q
Neutrino™ NxT	CDVRA800Q	CDDRA800Q	CDHFA800Q
Gallant™	CDVRA500Q	CDDRA500Q	CDHFA500Q
Neutrino™ NxT	CDVRA600Q	CDDRA600Q	CDHFA600Q
Entrant™	CDVRA300Q	CDDRA300Q	CDHFA300Q

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1.3.2 EUT General Description

EUT Description	Implantable Cardioverter Defibrillator Device
Model Name	Avant
Model Number(s)	Avant VR – CDVRA700Q (1 chamber) Avant DR – CDDRA700Q (2 chambers) Avant HF – CDHFA700Q (3 chambers)
Rated Voltage	Internal Battery (3.0VDC)
Mode Verified	BT LE
Capability	BT LE
Primary Unit (EUT)	☐ Production ☒ Pre-Production ☐ Engineering
Manufacturer Declared Temperature Range	20°C to 37°C
Antenna Type	Wire Monopole Antenna
Manufacturer	St. Jude Medical
Antenna Model	N/A
Maximum Antenna Gain	-12 dBi

1.3.3 Maximum Conducted Output Power

Bluetooth Low Energy (LE)	Frequency Range (MHz)	RMS Output Power (dBm)
	2402-2480	3.0

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1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Conducted sample configuration – For the conducted configuration, the EUT is an Avant Implantable Cardiac Defibrillator device with the header (including the antenna) removed and wires connected to the interior PCB of the device. Instead of the antenna, an exterior PCB with SMA connector is attached to allow a conducted RF path for connecting to external measurement equipment. The wires allow for downloading of test software using a JTAG interface and controlling the device using a UART interface. A laptop loaded with a Python test script is connected to the UART interface via a UART to Serial converter and the commands to the EUT are executed using the Python script.
B	Radiated sample configuration – For the radiated configuration, the EUT is the final device product with test software loaded instead of the standard product software. The test software allows for the EUT's Bluetooth radio to be controlled by an external device (eg. Apple iPod Touch). The iPod Touch can configure the EUT for CW or modulated transmit modes covering Low, Mid, and High channels. During radiated testing, the EUT must reside in a phantom cylinder filled with tissue simulating liquid to simulate the human body. Due to the physical dimensions of the cylinder including size and weight, some test requirements cannot be practically performed such as extreme temperature testing and the actual height requirement of the EUT in reference to the floor.

1.4.2 EUT Exercise Software

For the RF testing (Radiated and Conducted) test firmware was used to control the RF parameters (CW, Mod, RX, channels, etc).

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Dell	Support Laptop	Model Precision 4100
Linear	Support D-Sub9(RS-232) PCB adaptor	PN: LTC2803CDHC/LTC2804CDHC board
Apple	iPod Touch	Model MKH62LL/A

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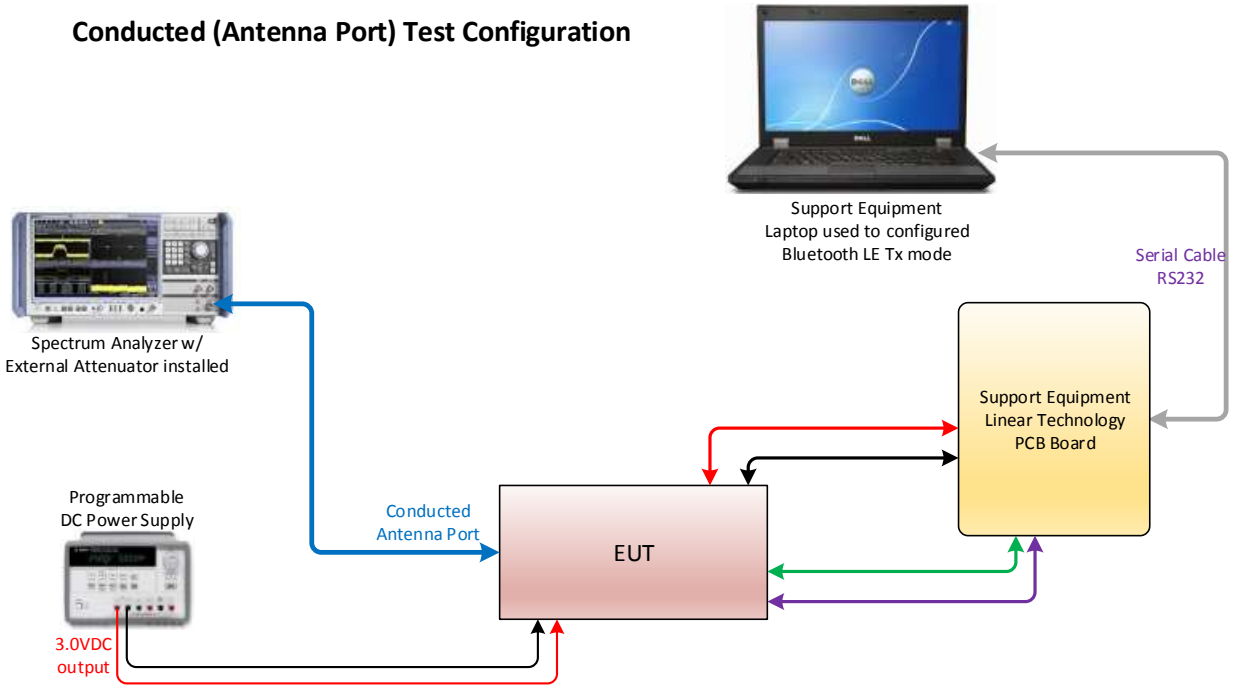
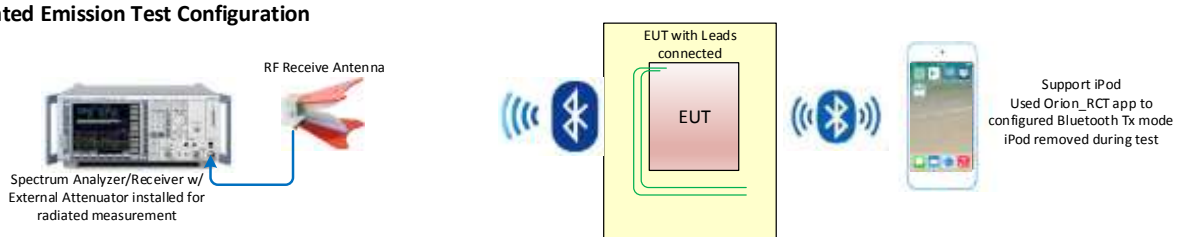
1.4.4 Simplified Test Configuration Diagram

Conducted (Antenna Port) Test Configuration



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

Radiated Emission Test Configuration



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

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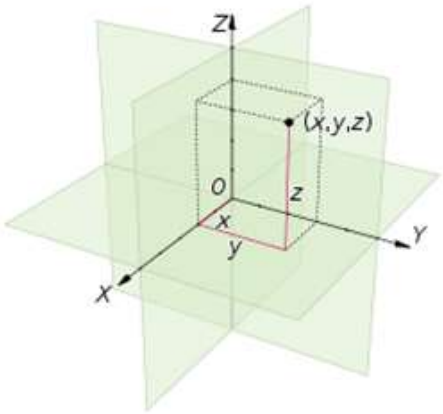
1.4.5 Worst Case Configuration

Worst-case configuration used in this test report as per Peak Output Power measurements:

Mode	Channel	Data Rate
Bluetooth LE	19 (Mid Channel)	1Mbps

EUT is a mobile device. Final installation position is only at Y orientation. For radiated measurements verifications performed using "X" configuration.



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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: 8007869, 8007908 and 8007910 (Radiated Sample) and BBZ301.1 (Conducted Sample)		
None	—	—

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American 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)

16936 Via Del Campo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 678 1400 Fax: 858 546 0364.

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Designation No.: US1146

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

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

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

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

1.9.3 BSMI – Laboratory Code: SL2-IN-E-028R (US0102)

TÜV Product Service Inc. (San Diego) is a recognized EMC testing laboratory by the BSMI under the MRA (Mutual Recognition Arrangement) with the United States. Accreditation includes CNS 13438 up to 6GHz.

1.9.4 NCC (National Communications Commission - US0102)

TÜV SÜD America Inc. (San Diego) is listed as a Foreign Recognized Telecommunication Equipment Testing Laboratory and is accredited to ISO/IEC 17025 (A2LA Certificate No.2955.13) which under APEC TEL MRA Phase 1 was designated as a Conformity Assessment Body competent to perform testing of equipment subject to the Technical Regulations covered under its scope of accreditation including RTTE01, PLMN01 and PLMN08 for TTE type of testing and LP002 for Low-Power RF Device type of testing.

1.9.5 VCCI – Registration No. A-0280 and A-0281

TÜV SÜD America Inc. (San Diego) is a VCCI registered measurement facility which includes radiated field strength measurement, radiated field strength measurement above 1GHz, mains port interference measurement and telecommunication port interference measurement.

1.9.6 RRA – Identification No. US0102

TÜV SÜD America Inc. (San Diego) is National Radio Research Agency (RRA) recognized laboratory under Phase I of the APEC Tel MRA.

1.9.7 OFCA – U.S. Identification No. US0102

TÜV SÜD America Inc. (San Diego) is recognized by Office of the Communications Authority (OFCA) under Appendix B, Phase I of the APEC Tel MRA.

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SECTION 2

TEST DETAILS

Radio Testing of the
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Implantable Cardioverter Defibrillator Device

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2.1 PEAK OUTPUT POWER

2.1.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(b)(3)
RSS-247, Clause 5.4 (d)

2.1.2 Standard Applicable

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands, the maximum peak conducted output shall not exceed 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

2.1.3 Equipment Under Test and Modification State

Serial No: BBZ301.1 (Conducted Sample) / Test Configuration A

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

April 10, 2019 / AC

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	22.2°C
Relative Humidity	27.6 %
ATM Pressure	99.6 kPa

2.1.7 Additional Observations

- This is a conducted test through the EUT antenna port.
- Test performed on Low, Mid and High channels configured for 0 dBm.
- Rohde & Schwarz TS8997 Test System was used for this test.

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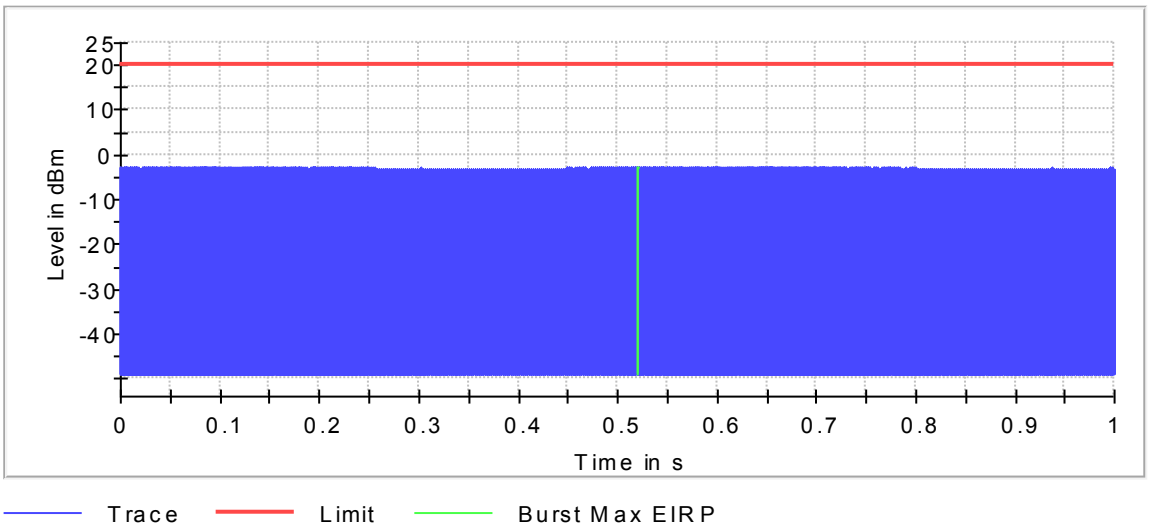
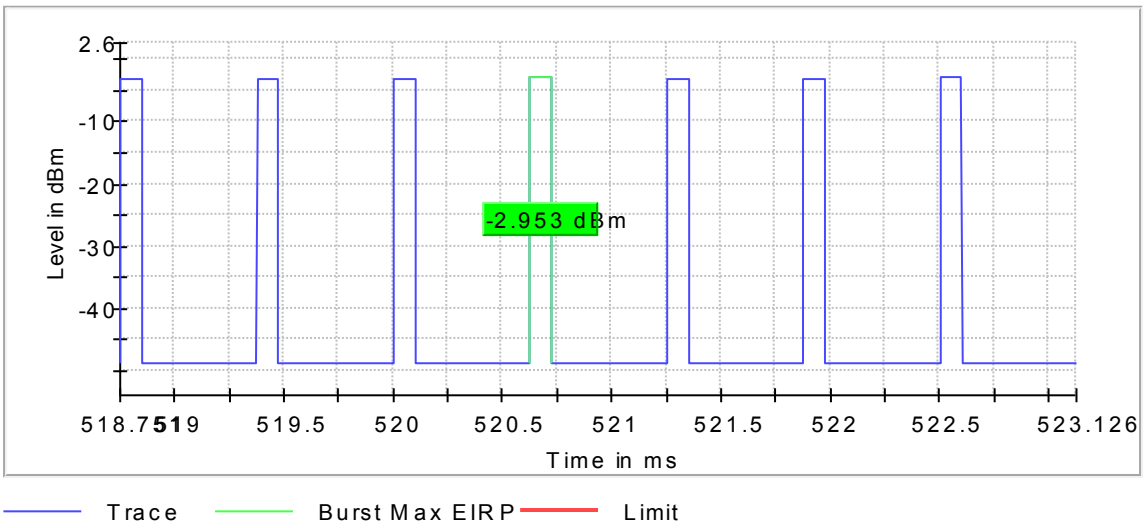
2.1.8 Test Results

Bluetooth Low Energy (LE)	Channel	Modulation	Measured RMS Power (dBm)
	00 (2402 MHz)	GFSK @ 1Mbps	-3.0
	17 (2440 MHz)		3.0
	39 (2480 MHz)		2.0

2.1.9 Test Plots





Bluetooth LE. Low Channel (2402MHz) RMS Power

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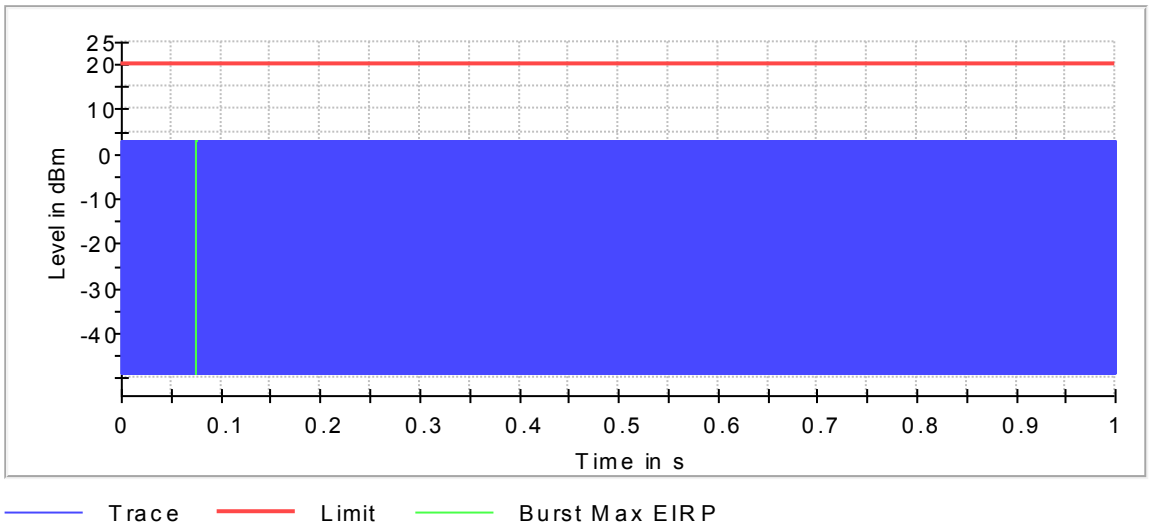

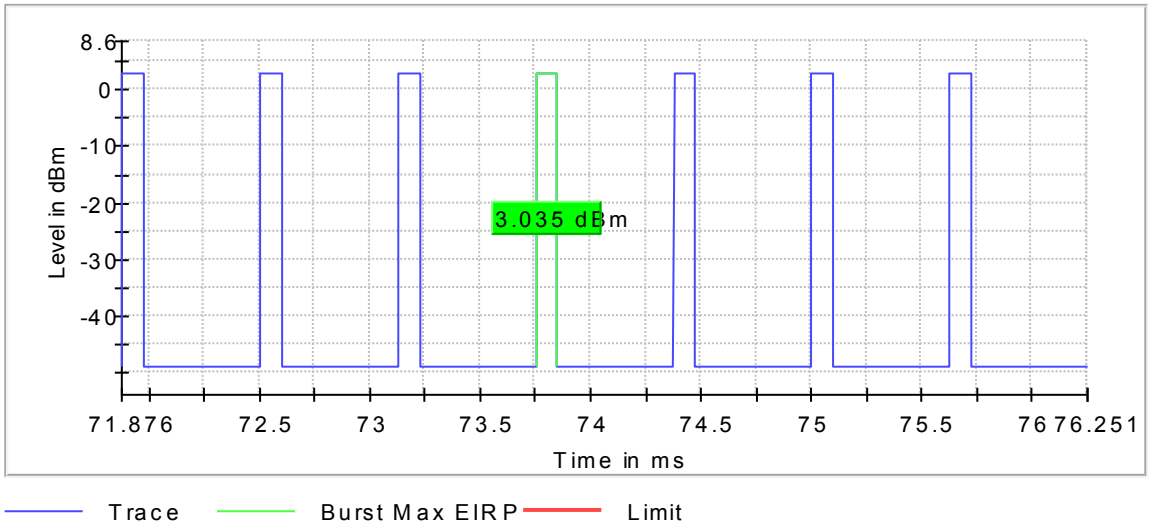

Bluetooth LE. Mid Channel (2440MHz) RMS Power

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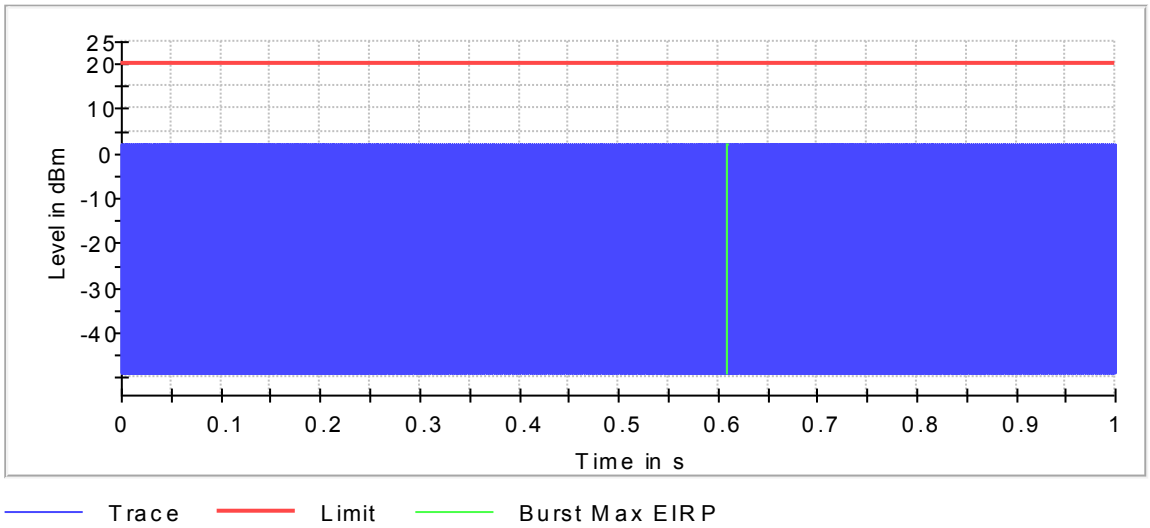

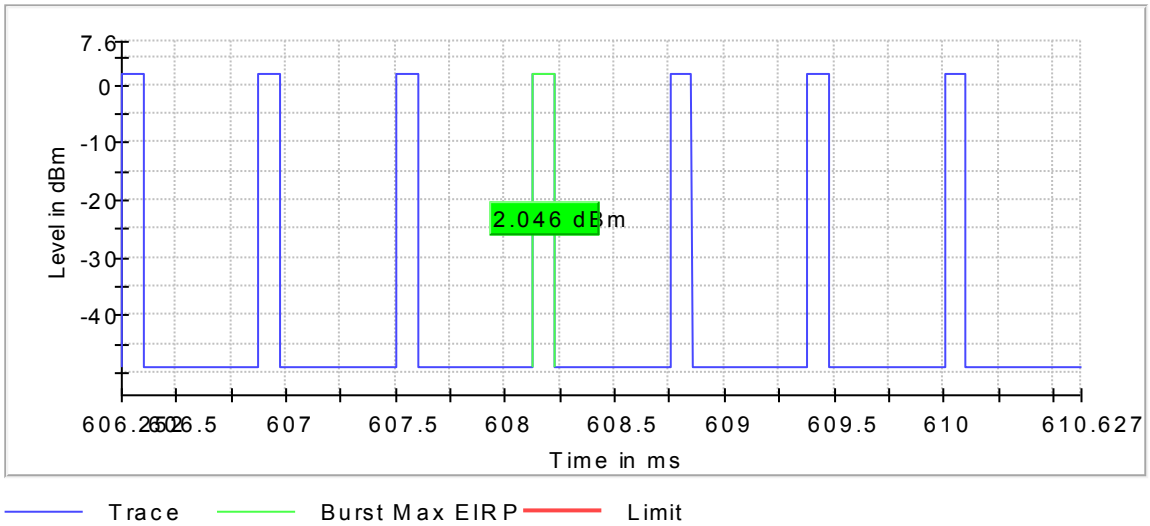

Bluetooth LE. High Channel (2480MHz) RMS Power

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2.2 99% EMISSION BANDWIDTH

2.2.1 Specification Reference

RSS-Gen Clause 6.7

2.2.2 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.

2.2.3 Equipment Under Test and Modification State

Serial No: BBZ301.1 (Conducted Sample) / Test Configuration A

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

April 10, 2019 / AC

2.2.5 Test Equipment Used

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

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2.2.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	22.2 °C
Relative Humidity	27.6 %
ATM Pressure	99.6 kPa

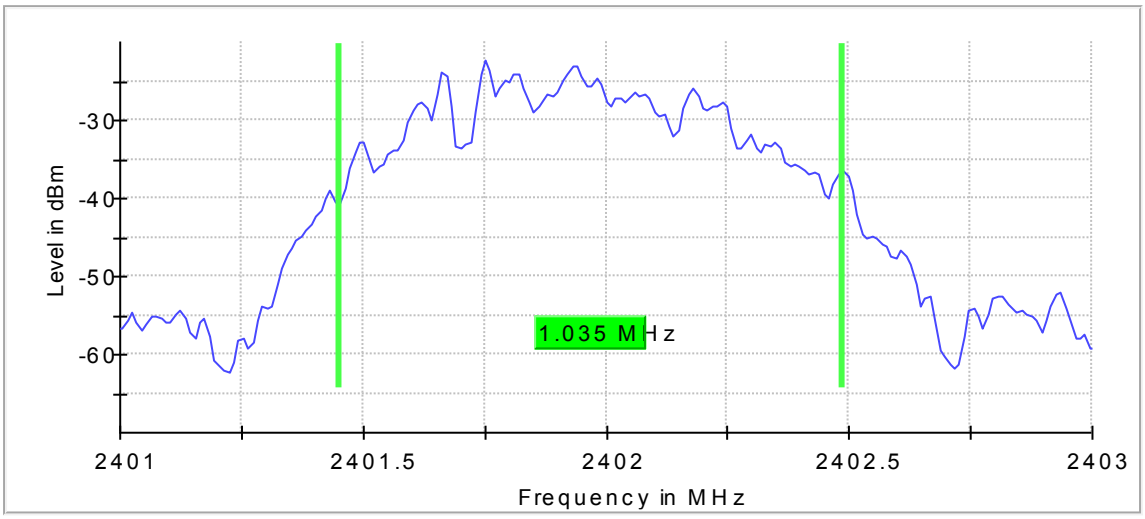
2.2.7 Additional Observations

- This is a conducted test.
- Test methodology is according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10
- Rohde & Schwarz TS8997 Test System was used for this test.

2.2.8 Test Results (For reporting purposes only)

Mode	Channel	Measured 99% Bandwidth (MHz)
	00 (2402 MHz)	1.035
	17 (2440 MHz)	1.035
	39 (2480 MHz)	1.035

2.2.9 Test Results Plots



Bluetooth LE Low Channel (2402MHz)

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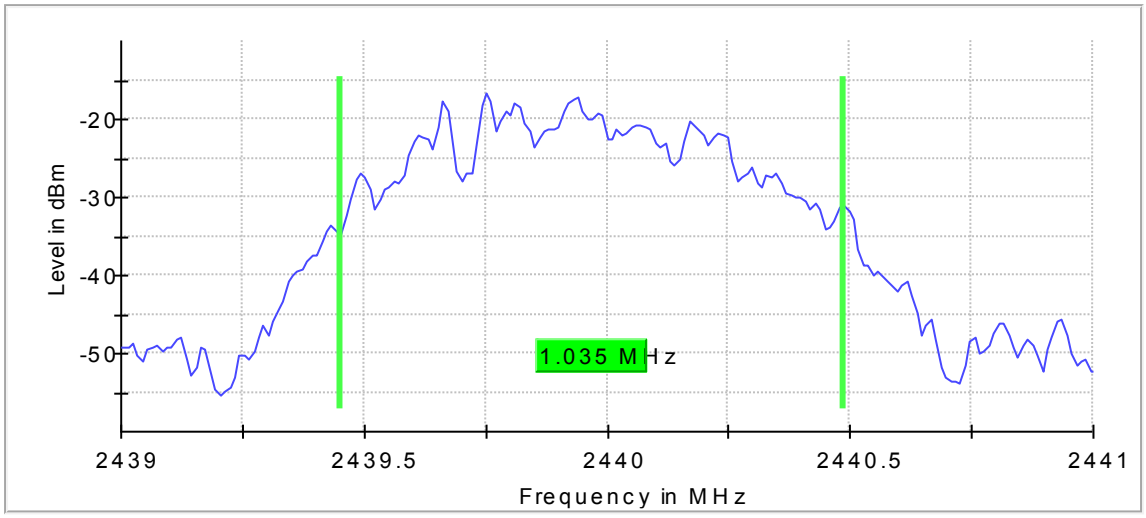
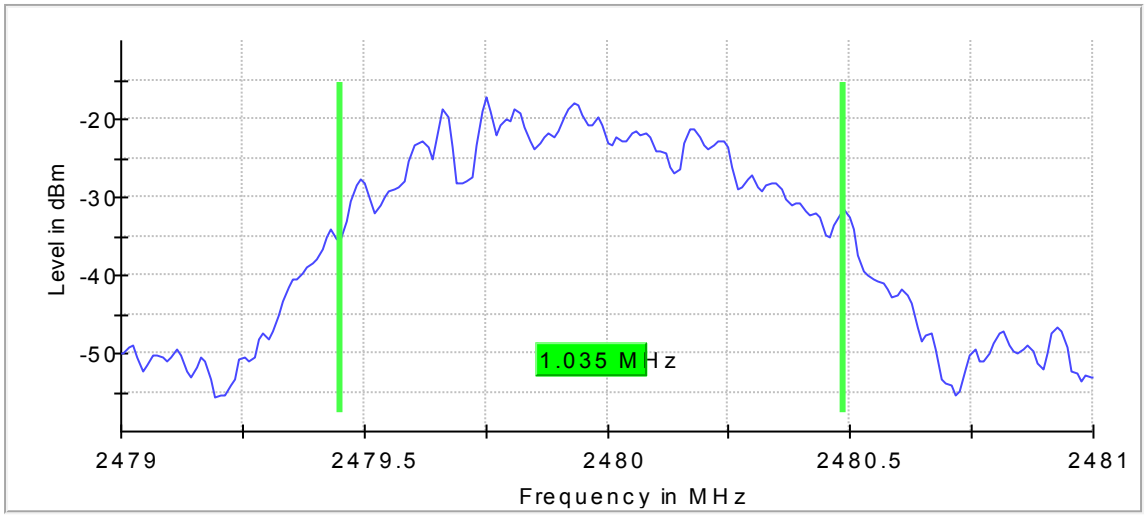


Bluetooth LE Mid Channel (2440MHz)



Bluetooth LE High Channel (2480MHz)

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2.3 MINIMUM 6 dB RF BANDWIDTH

2.3.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(a)(2)
RSS-247, Clause 5.2 (a)

2.3.2 Standard Applicable

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.3.3 Equipment Under Test and Modification State

Serial No: BBZ301.1 (Conducted Sample) / Test Configuration A

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

April 10, 2019 / AC

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	22.2 °C
Relative Humidity	27.6 %
ATM Pressure	99.6 kPa

2.3.7 Additional Observations

- This is a conducted test.
- Test methodology is according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10
- Rohde & Schwarz TS8997 Test System was used for this test.

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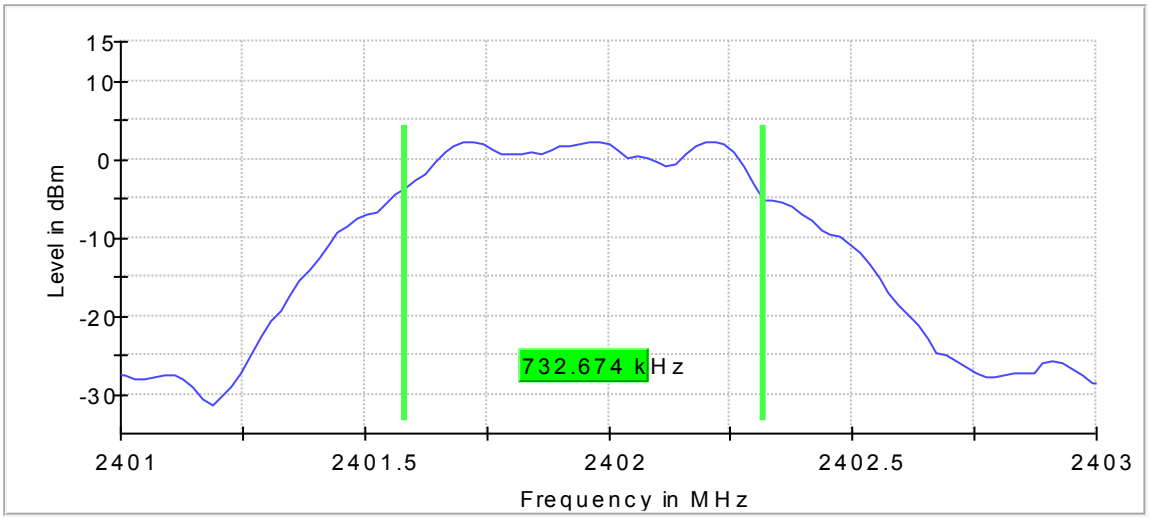
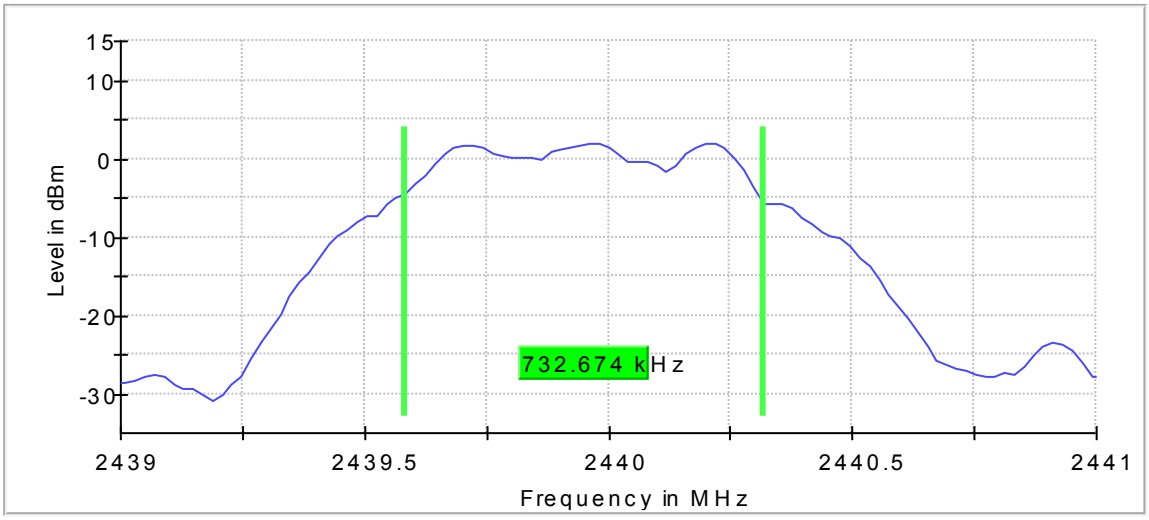
2.3.8 Test Results

Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
	00 (2402 MHz)	0.732674	0.500	Complies
	17 (2440 MHz)	0.732674	0.500	Complies
	39 (2480 MHz)	0.712872	0.500	Complies

2.3.9 Test Results Plots



Bluetooth LE Low Channel (2402MHz)



Bluetooth LE Middle Channel (2440MHz)

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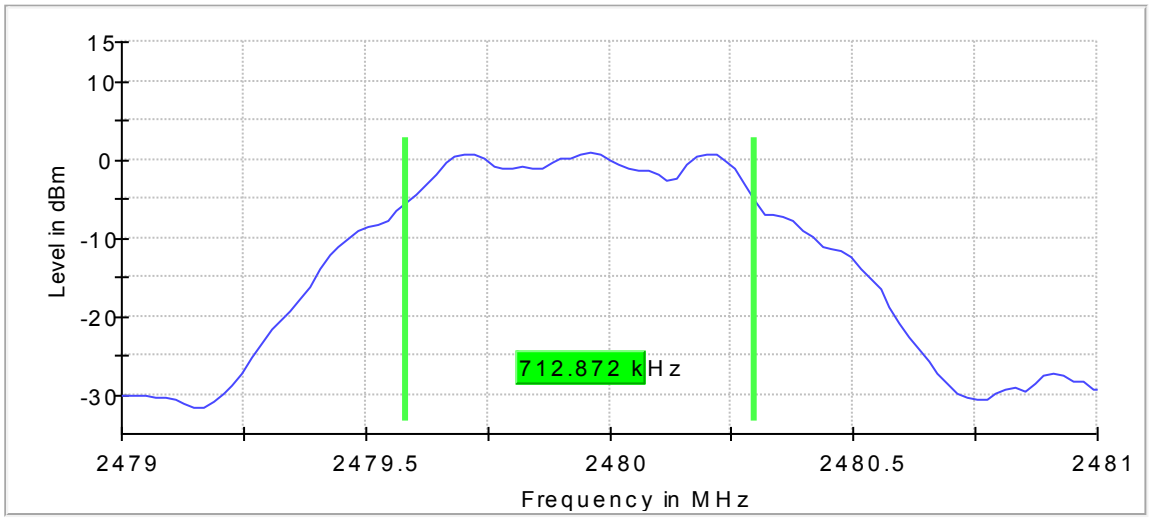

Bluetooth LE High Channel (2480MHz)

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2.4 OUT-OF-BAND EMISSIONS - RADIATED AND RADIATED SPURIOUS EMISSION

2.4.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
RSS-247, Clause 5.5

2.4.2 Standard Applicable

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)).

2.4.3 Equipment Under Test and Modification State

Serial No: 8007869, 8007908 and 8007910 (Radiated Sample) / Test Configuration B

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

April 11 and 27, 2019 / AC

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	21.7 °C
Relative Humidity	33.7 %
ATM Pressure	99.2 kPa

2.4.7 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 worst case BLE (Mid Channel) presented of each model for below 1GHz. There are no significant differences in emissions between all channels.
- Only noise floor measurements observed above 18GHz.

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- 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 2.4.8 for sample computation.

2.4.8 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**

2.4.9 Test Results

See attached plots

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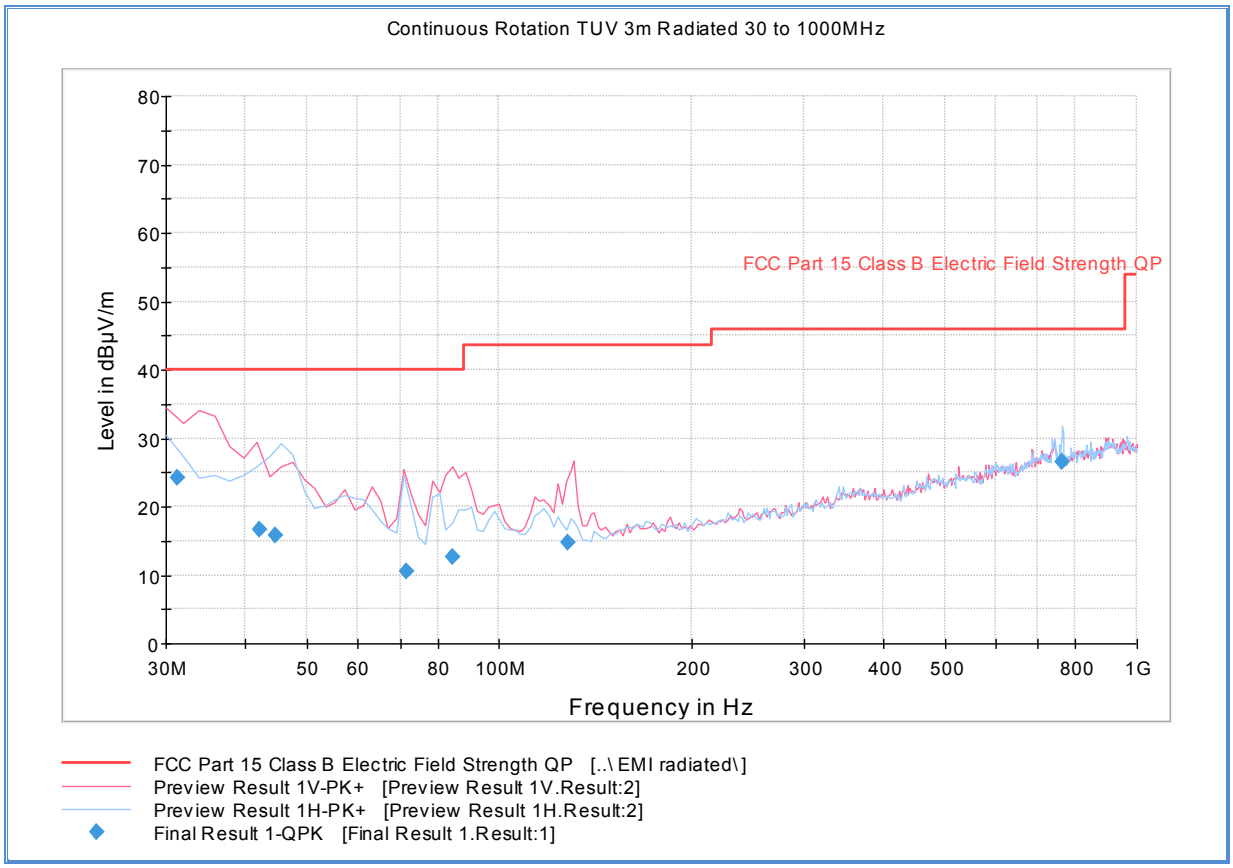
2.4.10 Worst case Test Results for Below 1GHz – Mid Channel (Avant VR-CDVRA700Q) 1 chamber



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)
31.327776	24.3	1000.0	120.000	106.0	V	188.0	-8.3	15.7	40.0
42.063327	16.6	1000.0	120.000	127.0	V	185.0	-12.5	23.4	40.0
44.551102	15.7	1000.0	120.000	295.0	H	15.0	-13.3	24.3	40.0
71.541643	10.5	1000.0	120.000	140.0	V	169.0	-17.0	29.5	40.0
84.668858	12.5	1000.0	120.000	144.0	V	7.0	-15.9	27.5	40.0
128.002164	14.7	1000.0	120.000	100.0	V	19.0	-14.3	28.8	43.5
763.149579	26.6	1000.0	120.000	195.0	H	90.0	3.1	19.4	46.0

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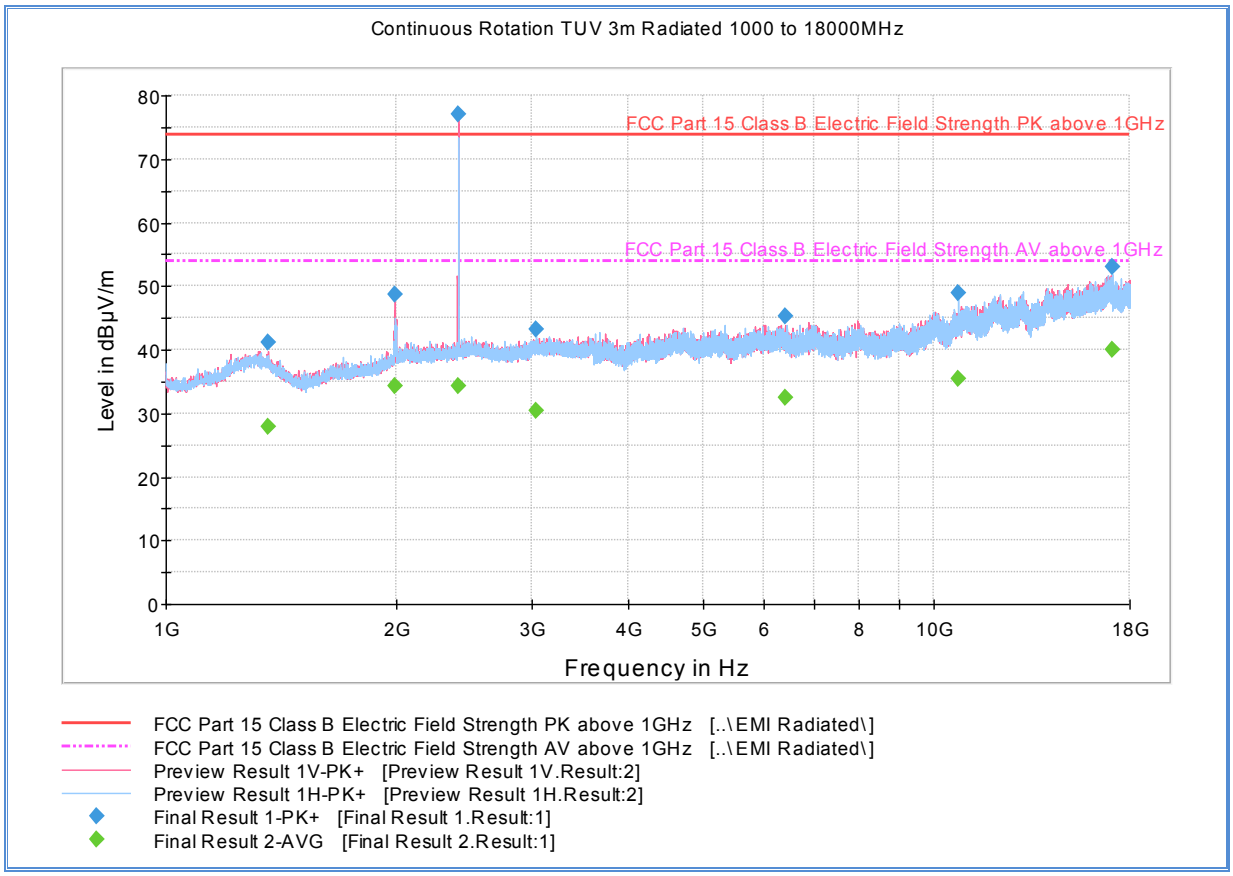
2.4.11 Test Results for Above 1GHz - Low Channel (Avant VR-CDVRA700Q) 1 chamber



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1359.466667	41.1	1000.0	1000.000	244.0	V	253.0	-5.2	32.8	73.9
1989.366667	48.7	1000.0	1000.000	399.0	V	20.0	-2.3	25.2	73.9
2402.166667	77.1	1000.0	1000.000	399.1	V	160.0	Test Notes		
3034.933333	43.3	1000.0	1000.000	150.0	H	298.0	0.9	30.6	73.9
6396.000000	45.3	1000.0	1000.000	406.9	V	175.0	6.4	28.6	73.9
10786.33333	48.9	1000.0	1000.000	250.0	H	309.0	11.7	25.0	73.9
17069.73333	52.9	1000.0	1000.000	224.0	H	65.0	17.7	21.0	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)
1359.466667	27.9	1000.0	1000.000	244.0	V	253.0	-5.2	26.0	53.9
1989.366667	34.4	1000.0	1000.000	399.0	V	20.0	-2.3	19.5	53.9
2402.166667	34.3	1000.0	1000.000	399.1	V	160.0	Test Notes		
3034.933333	30.3	1000.0	1000.000	150.0	H	298.0	0.9	23.6	53.9
6396.000000	32.5	1000.0	1000.000	406.9	V	175.0	6.4	21.4	53.9
10786.33333	35.5	1000.0	1000.000	250.0	H	309.0	11.7	18.4	53.9
17069.73333	39.9	1000.0	1000.000	224.0	H	65.0	17.7	14.0	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures.

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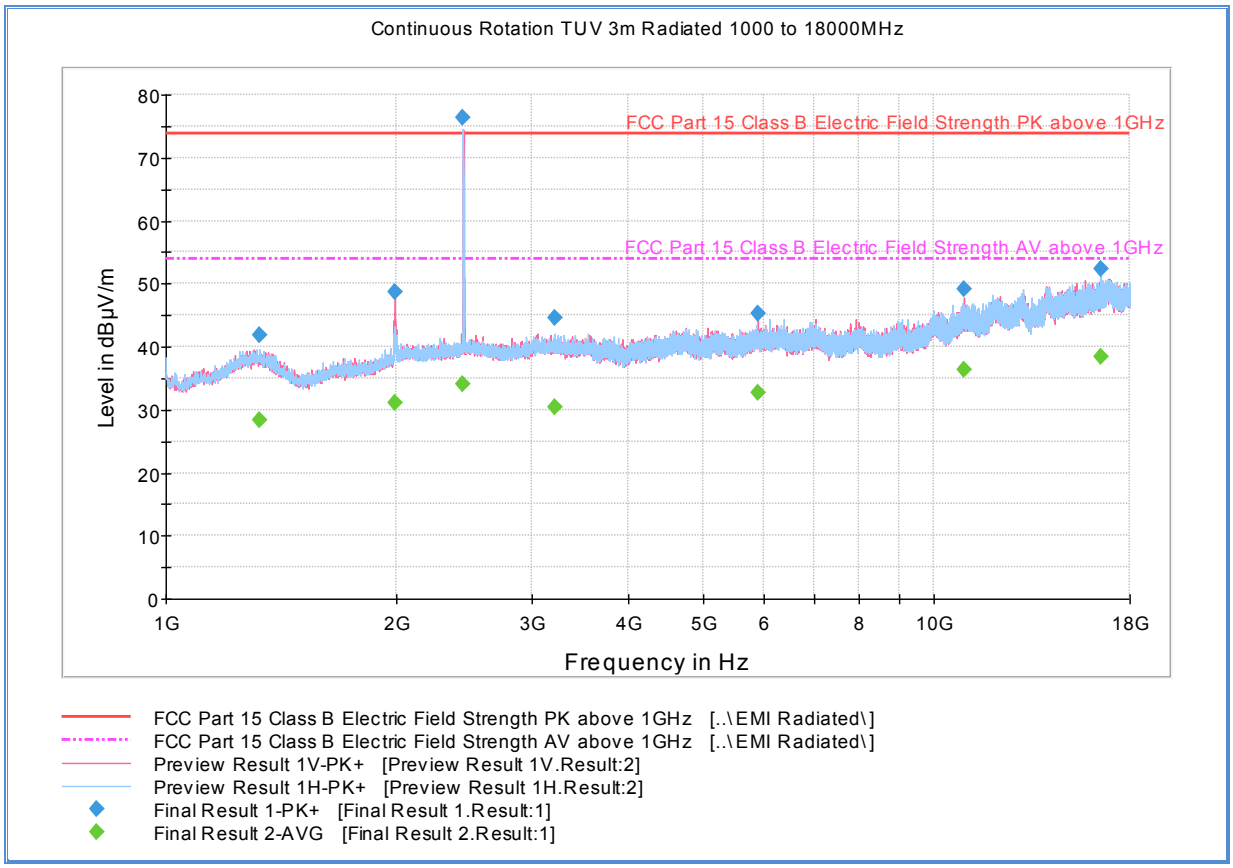
2.4.12 Test Results for Above 1GHz - Mid Channel (Avant VR-CDVRA700Q) 1 chamber



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1323.800000	41.8	1000.0	1000.000	238.0	H	239.0	-5.1	32.1	73.9
1990.200000	48.7	1000.0	1000.000	399.0	V	24.0	-2.3	25.2	73.9
2440.100000	76.4	1000.0	1000.000	299.0	H	125.0	Test Notes		
3215.533333	44.6	1000.0	1000.000	250.0	H	40.0	1.2	29.3	73.9
5910.400000	45.3	1000.0	1000.000	380.0	V	306.0	5.7	28.6	73.9
10936.50000	49.1	1000.0	1000.000	350.0	V	33.0	11.9	24.8	73.9
16474.93333	52.4	1000.0	1000.000	410.0	H	292.0	17.2	21.5	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)
1323.800000	28.5	1000.0	1000.000	238.0	H	239.0	-5.1	25.4	53.9
1990.200000	31.1	1000.0	1000.000	399.0	V	24.0	-2.3	22.8	53.9
2440.100000	34.1	1000.0	1000.000	299.0	H	125.0	Test Notes		
3215.533333	30.4	1000.0	1000.000	250.0	H	40.0	1.2	23.5	53.9
5910.400000	32.6	1000.0	1000.000	380.0	V	306.0	5.7	21.3	53.9
10936.50000	36.3	1000.0	1000.000	350.0	V	33.0	11.9	17.6	53.9
16474.93333	38.4	1000.0	1000.000	410.0	H	292.0	17.2	15.5	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures

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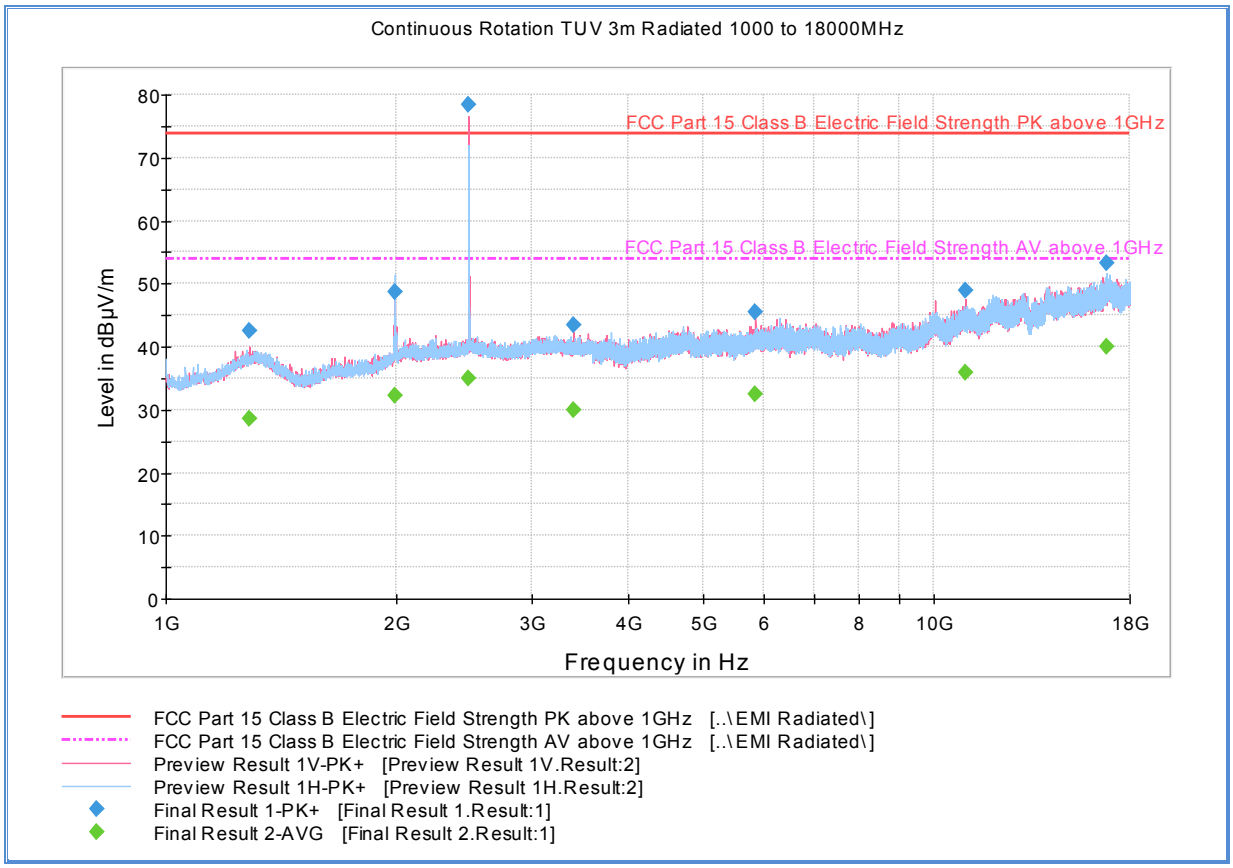
2.4.13 Test Results for Above 1GHz - High Channel (Avant VR-CDVRA700Q) 1 chamber



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1284.100000	42.4	1000.0	1000.000	350.0	V	187.0	-5.3	31.5	73.9
1989.400000	48.6	1000.0	1000.000	367.0	H	-19.0	-2.3	25.3	73.9
2479.766667	78.5	1000.0	1000.000	300.0	V	133.0	Test Notes		
3401.900000	43.5	1000.0	1000.000	350.0	V	269.0	0.8	30.4	73.9
5865.600000	45.5	1000.0	1000.000	312.0	V	145.0	5.7	28.4	73.9
11019.80000	49.0	1000.0	1000.000	250.0	V	6.0	11.8	24.9	73.9
16792.43333	53.2	1000.0	1000.000	373.0	H	100.0	17.9	20.7	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)
1284.100000	28.5	1000.0	1000.000	350.0	V	187.0	-5.3	25.4	53.9
1989.400000	32.2	1000.0	1000.000	367.0	H	-19.0	-2.3	21.7	53.9
2479.766667	35.0	1000.0	1000.000	300.0	V	133.0	Test Notes		
3401.900000	29.9	1000.0	1000.000	350.0	V	269.0	0.8	24.0	53.9
5865.600000	32.5	1000.0	1000.000	312.0	V	145.0	5.7	21.4	53.9
11019.80000	36.0	1000.0	1000.000	250.0	V	6.0	11.8	17.9	53.9
16792.43333	39.9	1000.0	1000.000	373.0	H	100.0	17.9	14.0	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures

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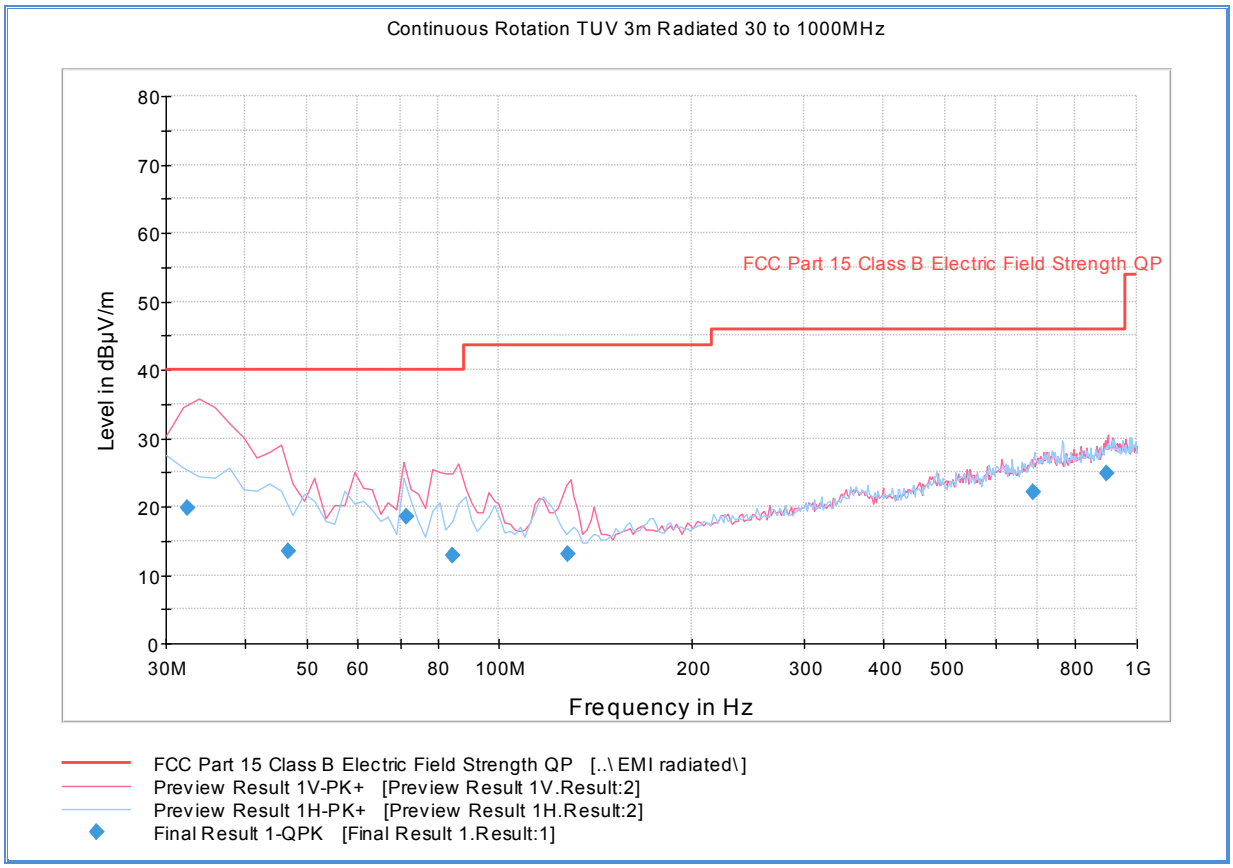
2.4.14 Worst case Test Results for Below 1GHz – Mid Channel (Avant DR-CDDRA700Q) 2 chamber



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)
32.487776	19.7	1000.0	120.000	138.0	V	17.0	-8.9	20.3	40.0
46.591102	13.6	1000.0	120.000	114.0	V	15.0	-14.0	26.4	40.0
71.701643	18.5	1000.0	120.000	100.0	V	215.0	-17.0	21.5	40.0
84.572745	12.9	1000.0	120.000	100.0	V	-11.0	-15.9	27.1	40.0
128.378277	13.1	1000.0	120.000	100.0	V	-5.0	-14.3	30.4	43.5
688.681844	22.0	1000.0	120.000	178.0	H	23.0	2.4	24.0	46.0
897.837836	24.8	1000.0	120.000	214.0	V	109.0	5.7	21.2	46.0

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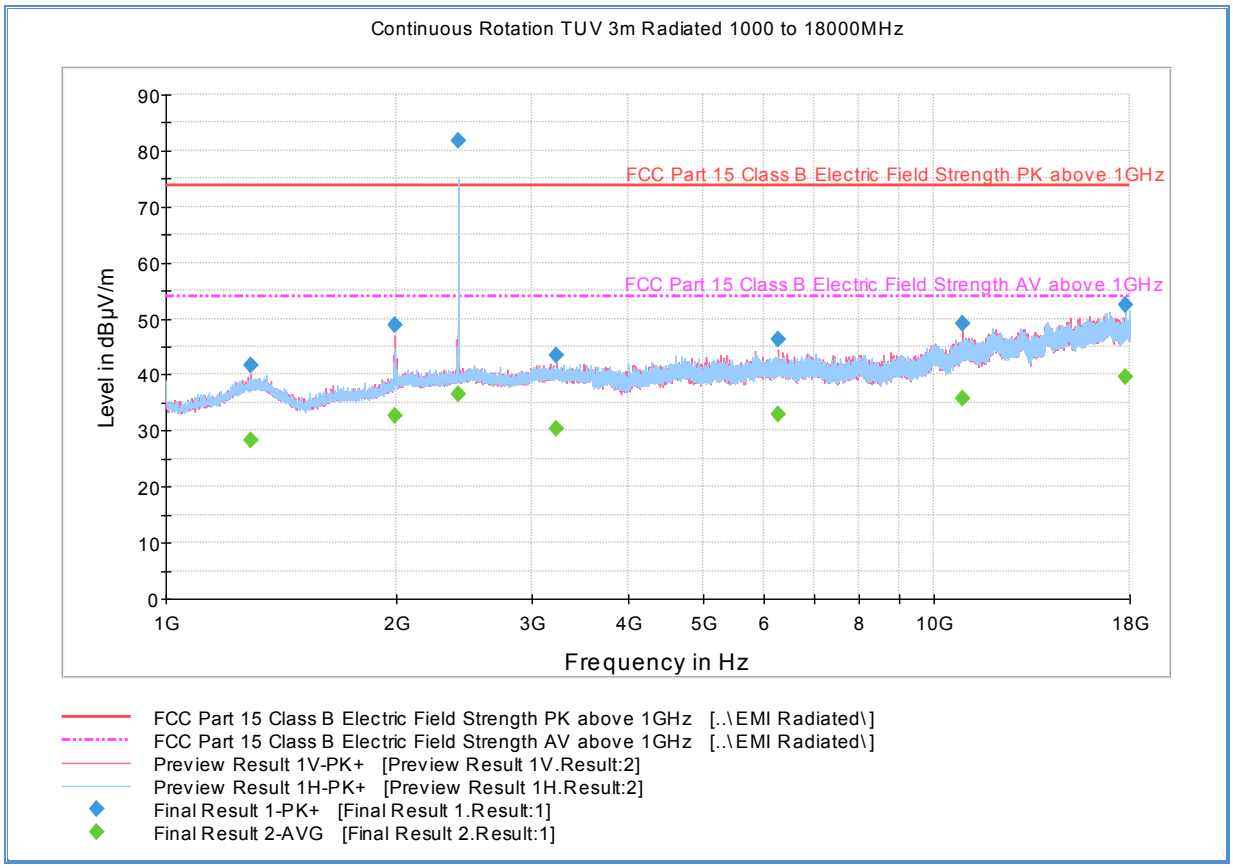
2.4.15 Test Results for Above 1GHz - Low Channel (Avant DR-CDDRA700Q) 2 chamber



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1289.033333	41.6	1000.0	1000.000	130.0	V	209.0	-5.3	32.3	73.9
1989.833333	48.8	1000.0	1000.000	399.0	V	128.0	-2.3	25.1	73.9
2402.133333	81.7	1000.0	1000.000	250.0	H	213.0	Test Notes		
3226.800000	43.4	1000.0	1000.000	387.0	V	145.0	1.1	30.5	73.9
6265.300000	46.4	1000.0	1000.000	300.0	V	340.0	6.3	27.5	73.9
10926.53333	49.2	1000.0	1000.000	150.0	V	174.0	11.9	24.7	73.9
17791.10000	52.4	1000.0	1000.000	250.0	V	334.0	17.9	21.5	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)
1289.033333	28.4	1000.0	1000.000	130.0	V	209.0	-5.3	25.5	53.9
1989.833333	32.5	1000.0	1000.000	399.0	V	128.0	-2.3	21.4	53.9
2402.133333	36.4	1000.0	1000.000	250.0	H	213.0	Test Notes		
3226.800000	30.3	1000.0	1000.000	387.0	V	145.0	1.1	23.6	53.9
6265.300000	33.0	1000.0	1000.000	300.0	V	340.0	6.3	20.9	53.9
10926.53333	35.9	1000.0	1000.000	150.0	V	174.0	11.9	18.0	53.9
17791.10000	39.7	1000.0	1000.000	250.0	V	334.0	17.9	14.2	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures.

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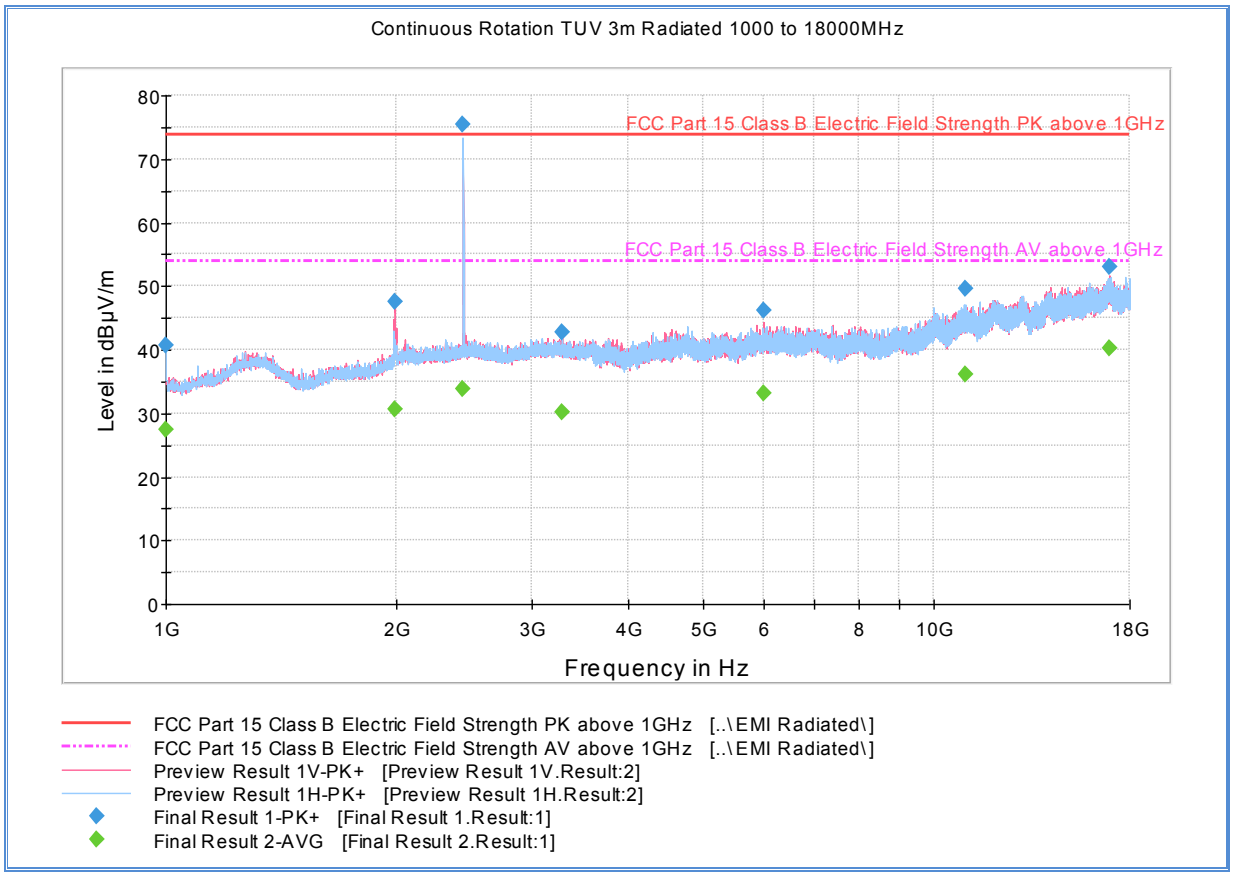
2.4.16 Test Results for Above 1GHz - Mid Channel (Avant DR-CDDRA700Q) 2 chamber



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	40.8	1000.0	1000.000	238.0	H	162.0	-6.9	33.1	73.9
1990.166667	47.6	1000.0	1000.000	399.0	V	199.0	-2.3	26.3	73.9
2440.100000	75.5	1000.0	1000.000	287.0	H	14.0	Test Notes		
3276.900000	42.8	1000.0	1000.000	325.0	V	127.0	1.0	31.1	73.9
6001.233333	46.2	1000.0	1000.000	406.9	V	-9.0	5.7	27.7	73.9
11011.16666	49.6	1000.0	1000.000	150.0	H	341.0	11.8	24.3	73.9
16947.16666	53.0	1000.0	1000.000	150.0	V	67.0	18.0	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)
1000.000000	27.4	1000.0	1000.000	238.0	H	162.0	-6.9	26.5	53.9
1990.166667	30.6	1000.0	1000.000	399.0	V	199.0	-2.3	23.3	53.9
2440.100000	33.8	1000.0	1000.000	287.0	H	14.0	Test Notes		
3276.900000	30.3	1000.0	1000.000	325.0	V	127.0	1.0	23.6	53.9
6001.233333	33.1	1000.0	1000.000	406.9	V	-9.0	5.7	20.8	53.9
11011.16666	36.2	1000.0	1000.000	150.0	H	341.0	11.8	17.7	53.9
16947.16666	40.2	1000.0	1000.000	150.0	V	67.0	18.0	13.7	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures

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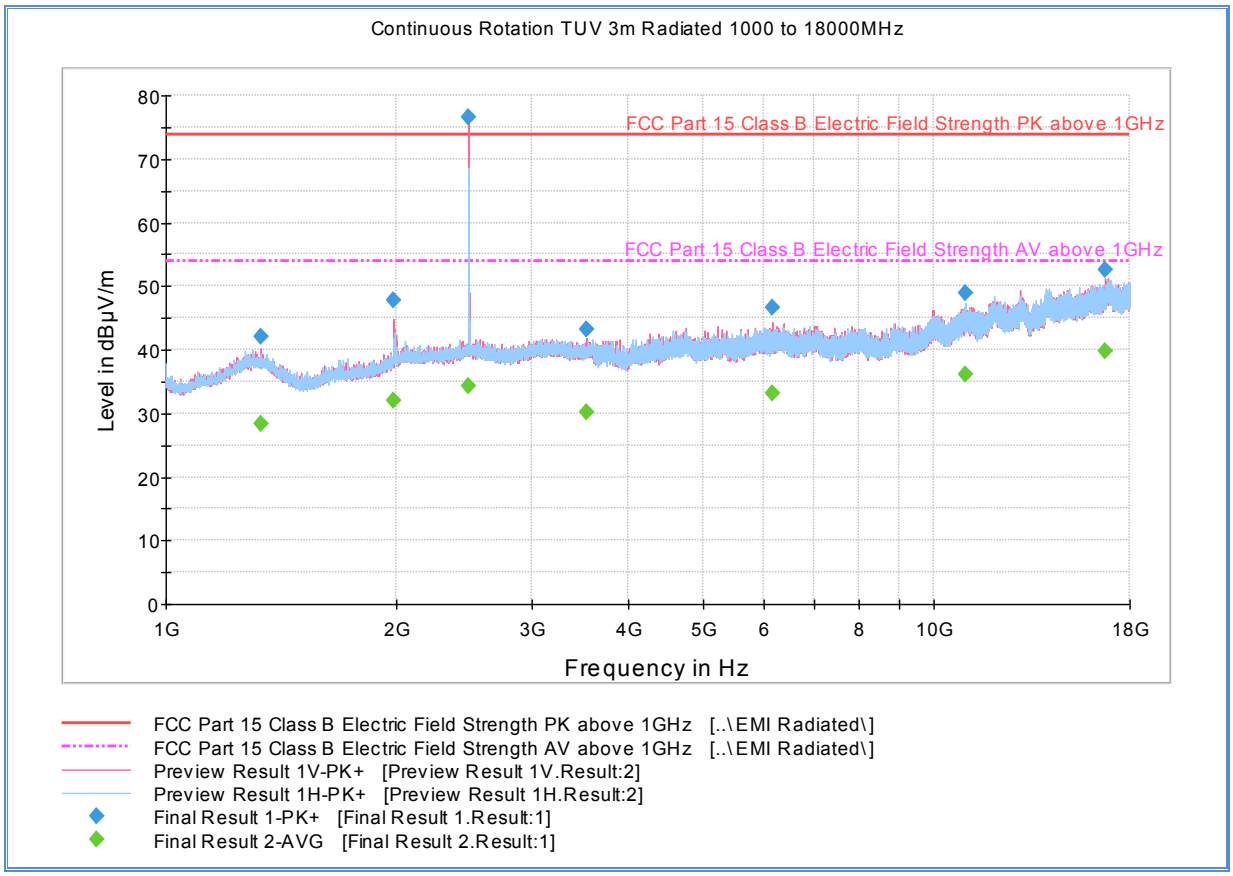
2.4.17 Test Results for Above 1GHz - High Channel (Avant DR-CDDRA700Q) 2 chamber



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1330.900000	42.1	1000.0	1000.000	193.0	V	253.0	-5.1	31.8	73.9
1981.700000	47.8	1000.0	1000.000	286.0	V	297.0	-2.3	26.1	73.9
2479.966667	76.6	1000.0	1000.000	100.0	V	258.0	Test Notes		
3536.066667	43.2	1000.0	1000.000	225.0	V	124.0	1.4	30.7	73.9
6172.166667	46.6	1000.0	1000.000	250.0	V	316.0	6.1	27.3	73.9
11015.13333	49.0	1000.0	1000.000	292.0	H	203.0	11.8	24.9	73.9
16714.93333	52.5	1000.0	1000.000	193.0	V	297.0	17.7	21.4	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)
1330.900000	28.4	1000.0	1000.000	193.0	V	253.0	-5.1	25.5	53.9
1981.700000	31.9	1000.0	1000.000	286.0	V	297.0	-2.3	22.0	53.9
2479.966667	34.3	1000.0	1000.000	100.0	V	258.0	Test Notes		
3536.066667	30.1	1000.0	1000.000	225.0	V	124.0	1.4	23.8	53.9
6172.166667	33.2	1000.0	1000.000	250.0	V	316.0	6.1	20.7	53.9
11015.13333	36.2	1000.0	1000.000	292.0	H	203.0	11.8	17.7	53.9
16714.93333	39.7	1000.0	1000.000	193.0	V	297.0	17.7	14.2	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures

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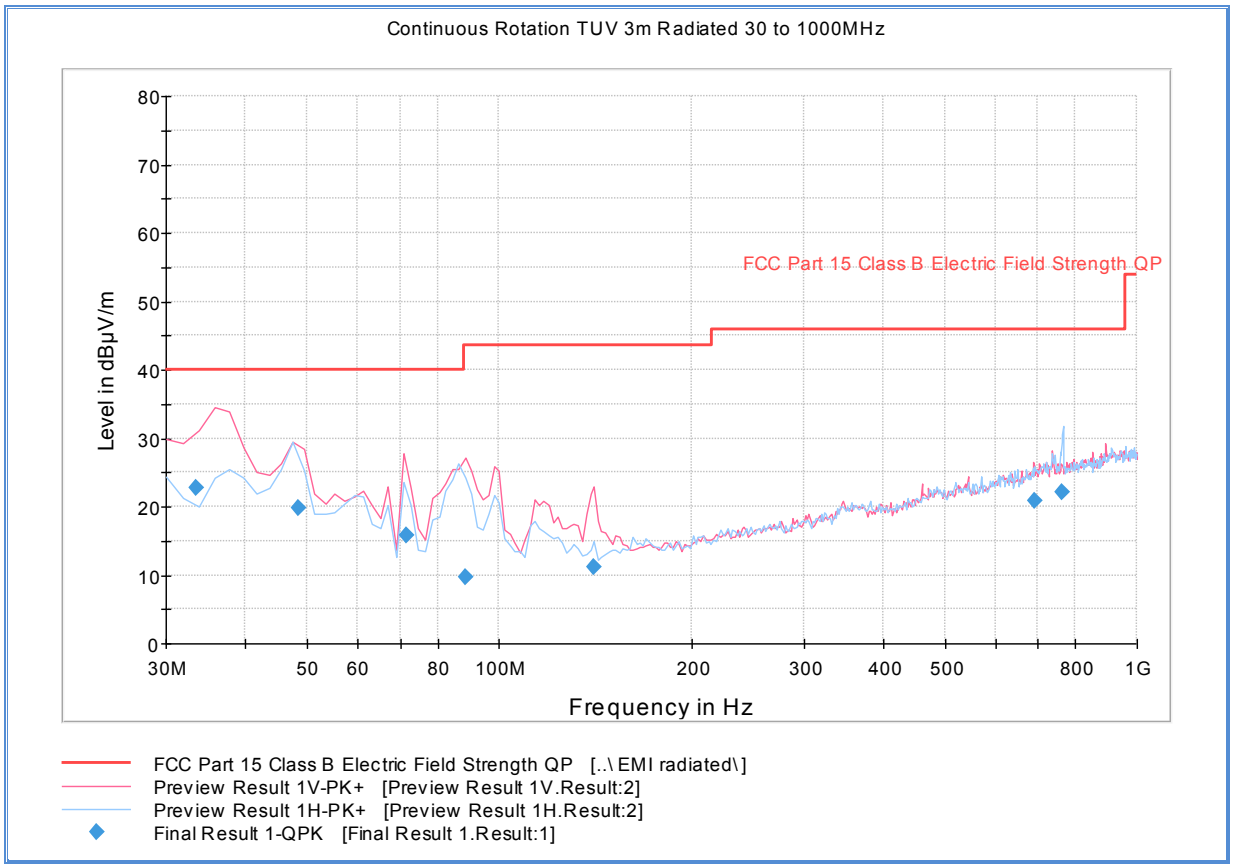
2.4.18 Worst case Test Results for Below 1GHz – Mid Channel (Avant HF-CDHFA700Q) 3 chamber



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)
33.511663	22.7	1000.0	120.000	100.0	V	268.0	-9.3	17.3	40.0
48.334990	19.9	1000.0	120.000	100.0	V	207.0	-14.7	20.1	40.0
71.581643	15.8	1000.0	120.000	100.0	V	-10.0	-17.2	24.2	40.0
88.412745	9.8	1000.0	120.000	360.0	H	2.0	-15.3	33.7	43.5
140.721603	11.1	1000.0	120.000	100.0	V	99.0	-14.1	32.4	43.5
689.577956	20.9	1000.0	120.000	379.0	V	31.0	2.0	25.1	46.0
764.173467	22.1	1000.0	120.000	214.0	H	66.0	2.7	23.9	46.0

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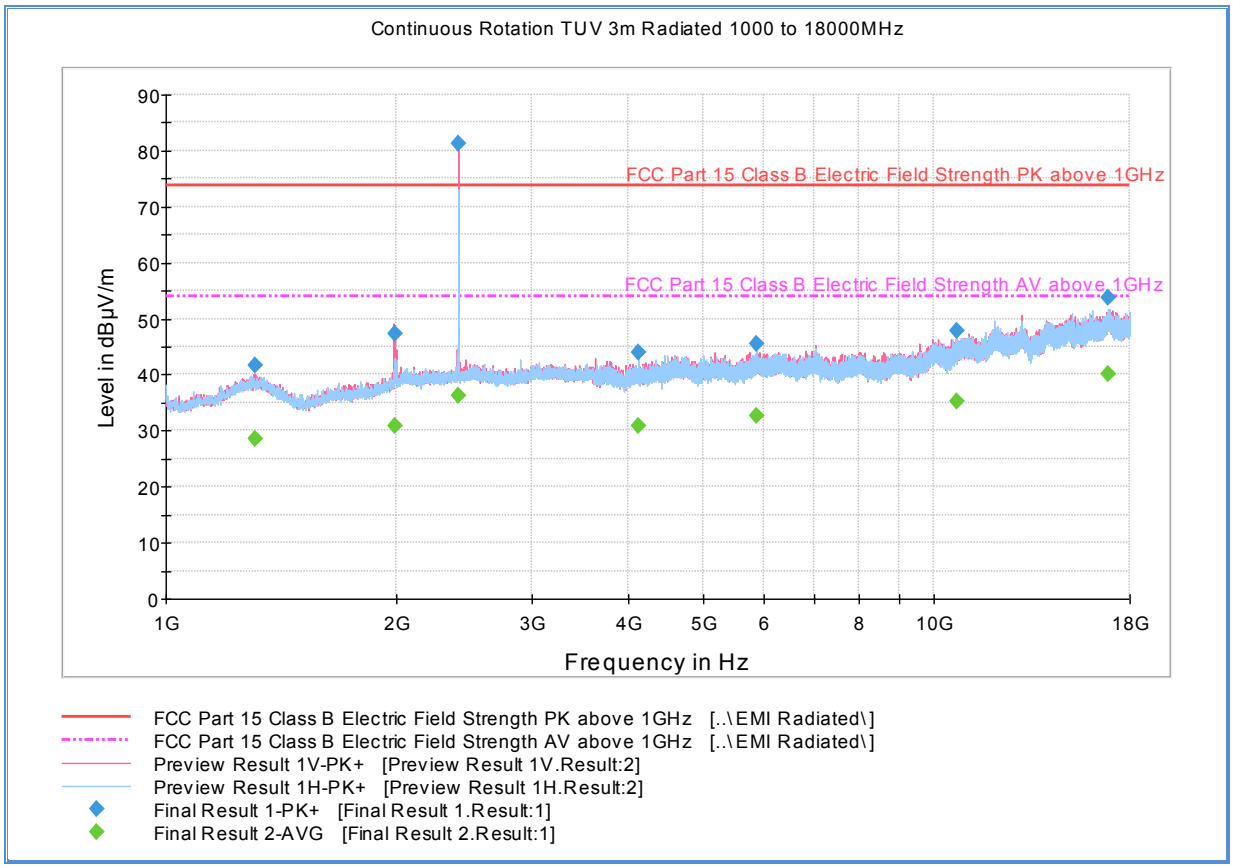
2.4.19 Test Results for Above 1GHz - Low Channel (Avant HF-CDHFA700Q) 3 chamber



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1307.100000	41.6	1000.0	1000.000	150.0	V	167.0	-5.1	32.3	73.9
1989.966667	47.3	1000.0	1000.000	406.9	V	282.0	-2.3	26.6	73.9
2402.133333	81.3	1000.0	1000.000	136.0	V	250.0	Test Notes		
4118.566667	43.9	1000.0	1000.000	338.0	H	20.0	2.7	30.0	73.9
5886.333333	45.5	1000.0	1000.000	250.0	H	17.0	5.7	28.4	73.9
10706.56666	47.9	1000.0	1000.000	267.0	H	319.0	11.5	26.0	73.9
16857.03333	53.6	1000.0	1000.000	213.0	H	26.0	18.0	20.3	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)
1307.100000	28.5	1000.0	1000.000	150.0	V	167.0	-5.1	25.4	53.9
1989.966667	30.7	1000.0	1000.000	406.9	V	282.0	-2.3	23.2	53.9
2402.133333	36.3	1000.0	1000.000	136.0	V	250.0	Test Notes		
4118.566667	30.9	1000.0	1000.000	338.0	H	20.0	2.7	23.0	53.9
5886.333333	32.5	1000.0	1000.000	250.0	H	17.0	5.7	21.4	53.9
10706.56666	35.2	1000.0	1000.000	267.0	H	319.0	11.5	18.7	53.9
16857.03333	40.1	1000.0	1000.000	213.0	H	26.0	18.0	13.8	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures.

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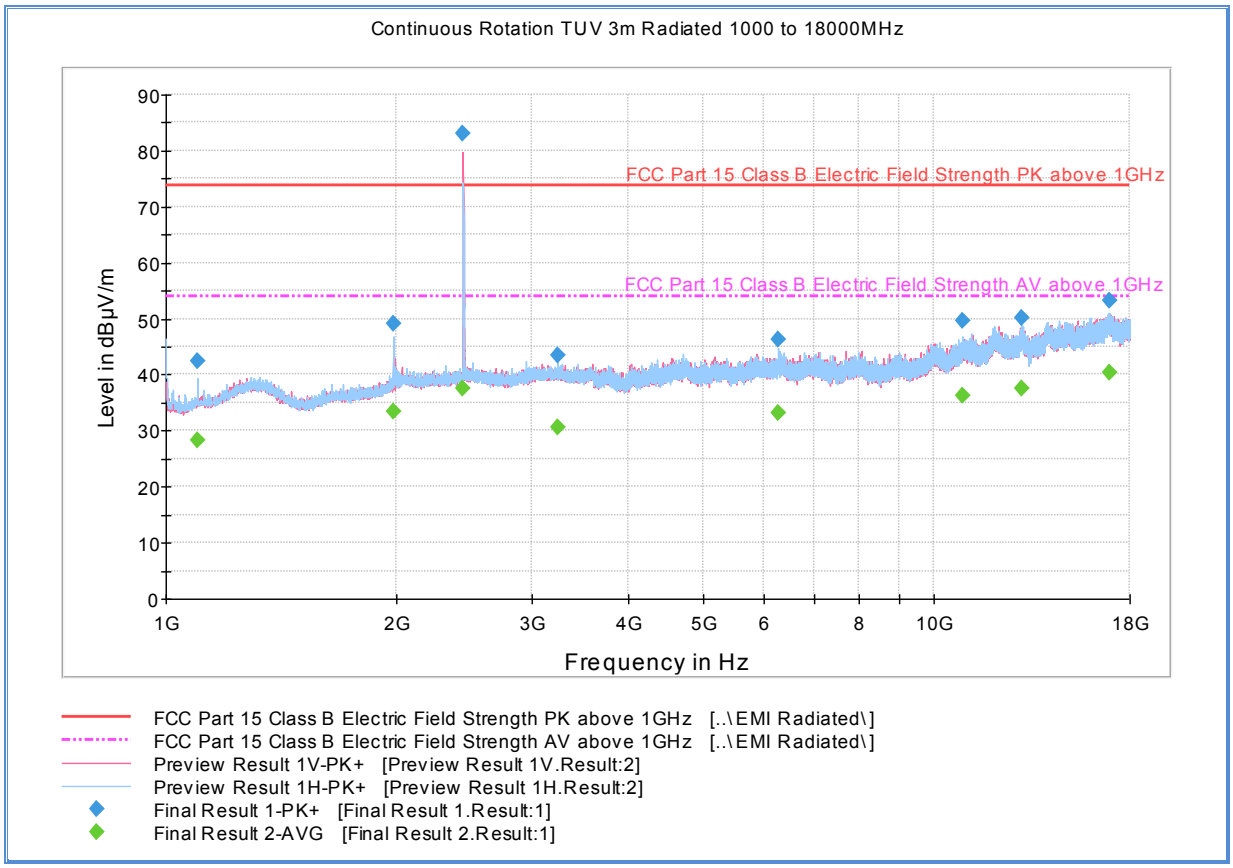
2.4.20 Test Results for Above 1GHz - Mid Channel (Avant HF-CDHFA700Q) 3 chamber



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1099.366667	42.4	1000.0	1000.000	100.0	H	174.0	-6.9	31.5	73.9
1976.566667	49.0	1000.0	1000.000	399.0	H	105.0	-2.3	24.9	73.9
2440.133333	83.1	1000.0	1000.000	102.0	V	230.0	Test Notes		
3232.500000	43.5	1000.0	1000.000	150.0	H	48.0	1.1	30.4	73.9
6268.100000	46.3	1000.0	1000.000	386.0	H	16.0	6.3	27.6	73.9
10909.86666	49.6	1000.0	1000.000	250.0	H	149.0	11.9	24.3	73.9
13013.13333	50.1	1000.0	1000.000	410.0	H	11.0	13.6	23.8	73.9
16972.06666	53.2	1000.0	1000.000	250.0	H	268.0	17.9	20.7	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)
1099.366667	28.2	1000.0	1000.000	100.0	H	174.0	-6.9	25.7	53.9
1976.566667	33.5	1000.0	1000.000	399.0	H	105.0	-2.3	20.4	53.9
2440.133333	37.5	1000.0	1000.000	102.0	V	230.0	Test Notes		
3232.500000	30.5	1000.0	1000.000	150.0	H	48.0	1.1	23.4	53.9
6268.100000	33.2	1000.0	1000.000	386.0	H	16.0	6.3	20.7	53.9
10909.86666	36.2	1000.0	1000.000	250.0	H	149.0	11.9	17.7	53.9
13013.13333	37.4	1000.0	1000.000	410.0	H	11.0	13.6	16.5	53.9
16972.06666	40.4	1000.0	1000.000	250.0	H	268.0	17.9	13.5	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures

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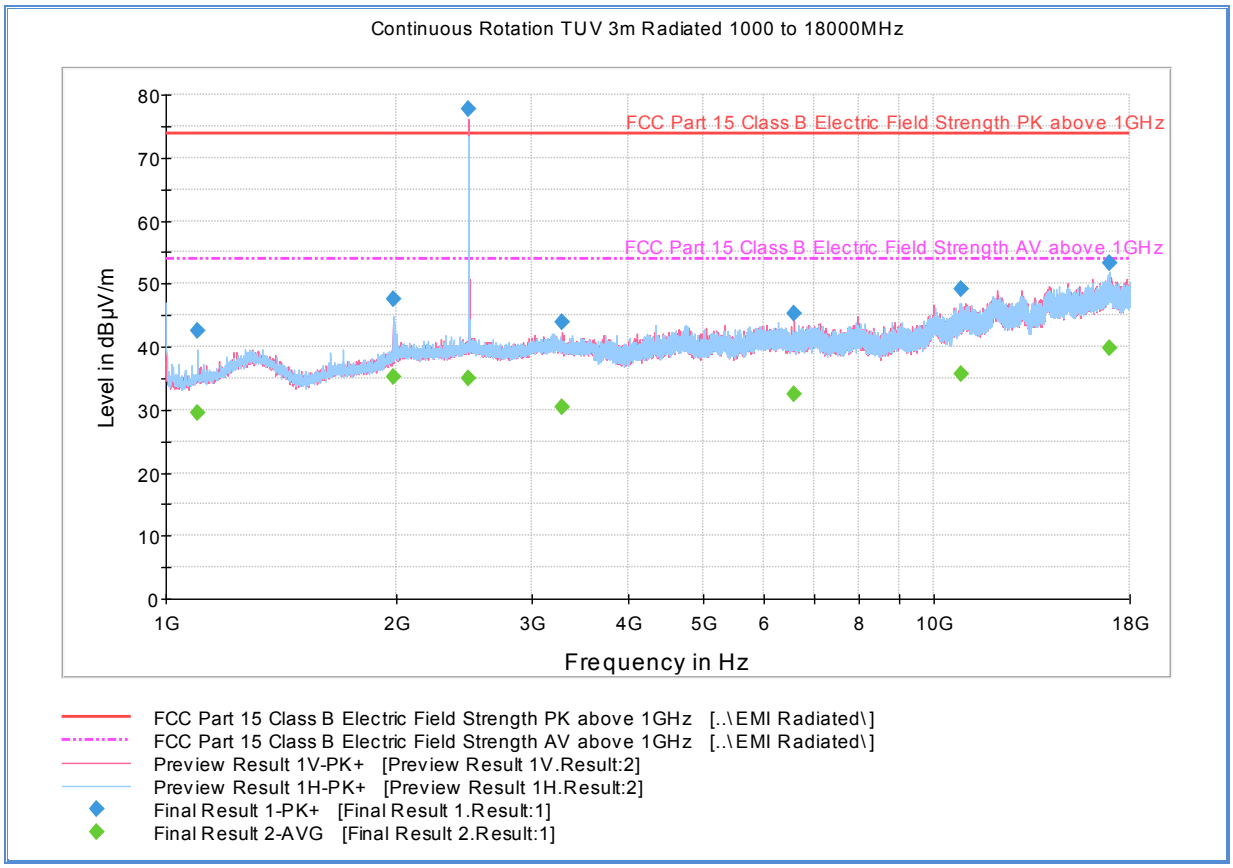
2.4.21 Test Results for Above 1GHz - High Channel (Avant HF-CDHFA700Q) 3 chamber



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1099.966667	42.6	1000.0	1000.000	100.0	H	193.0	-6.9	31.4	73.9
1976.166667	47.5	1000.0	1000.000	150.0	H	146.0	-2.3	26.4	73.9
2479.966667	77.8	1000.0	1000.000	350.0	V	350.0	Test Notes		
3276.666667	43.9	1000.0	1000.000	332.0	V	5.0	1.0	30.0	73.9
6566.366667	45.4	1000.0	1000.000	293.0	V	-7.0	6.6	28.5	73.9
10863.36666	49.0	1000.0	1000.000	410.0	H	284.0	11.9	24.9	73.9
16920.90000	53.3	1000.0	1000.000	150.0	H	85.0	18.0	20.6	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)
1099.966667	29.4	1000.0	1000.000	100.0	H	193.0	-6.9	24.5	53.9
1976.166667	35.2	1000.0	1000.000	150.0	H	146.0	-2.3	18.7	53.9
2479.966667	35.0	1000.0	1000.000	350.0	V	350.0	Test Notes		
3276.666667	30.3	1000.0	1000.000	332.0	V	5.0	1.0	23.6	53.9
6566.366667	32.6	1000.0	1000.000	293.0	V	-7.0	6.6	21.3	53.9
10863.36666	35.6	1000.0	1000.000	410.0	H	284.0	11.9	18.3	53.9
16920.90000	39.8	1000.0	1000.000	150.0	H	85.0	18.0	14.1	53.9

Test Notes: Fundamental will be ignored for this test. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures

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2.5 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.5.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
FCC 47 CFR Part 15, Clause 15.205
RSS-247, Clause 5.5

2.5.2 Standard Applicable

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)).

2.5.3 Equipment Under Test and Modification State

Serial No: BBZ301.1 (Conducted Sample) / Test Configuration A

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

April 10, 2019 / AC

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	22.2 °C
Relative Humidity	27.6 %
ATM Pressure	99.6 kPa

2.5.7 Additional Observations

- This is a conducted test.
- Test methodology is according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10.
- Rohde & Schwarz TS8997 Test System was used for this test.

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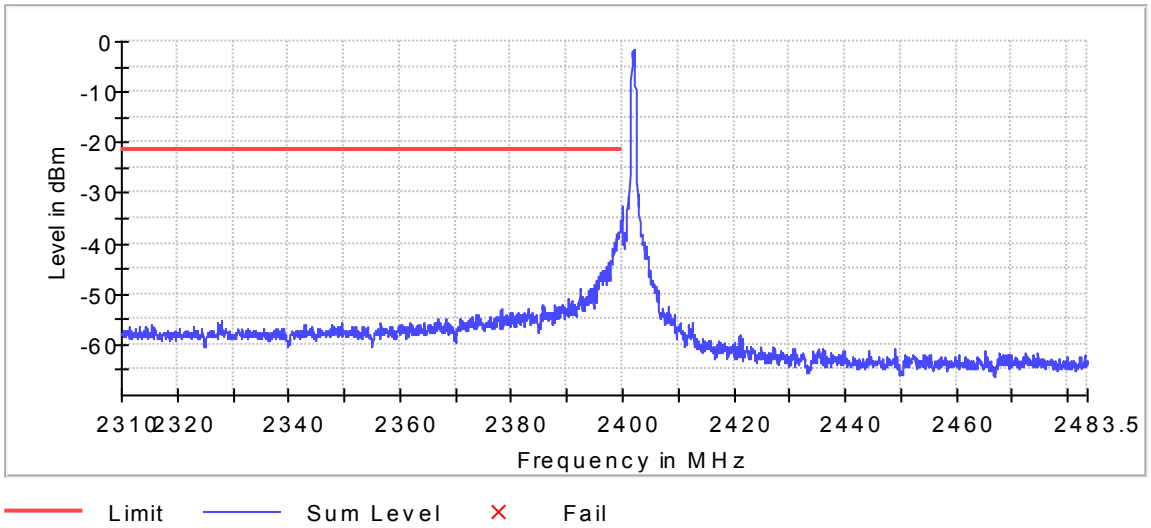
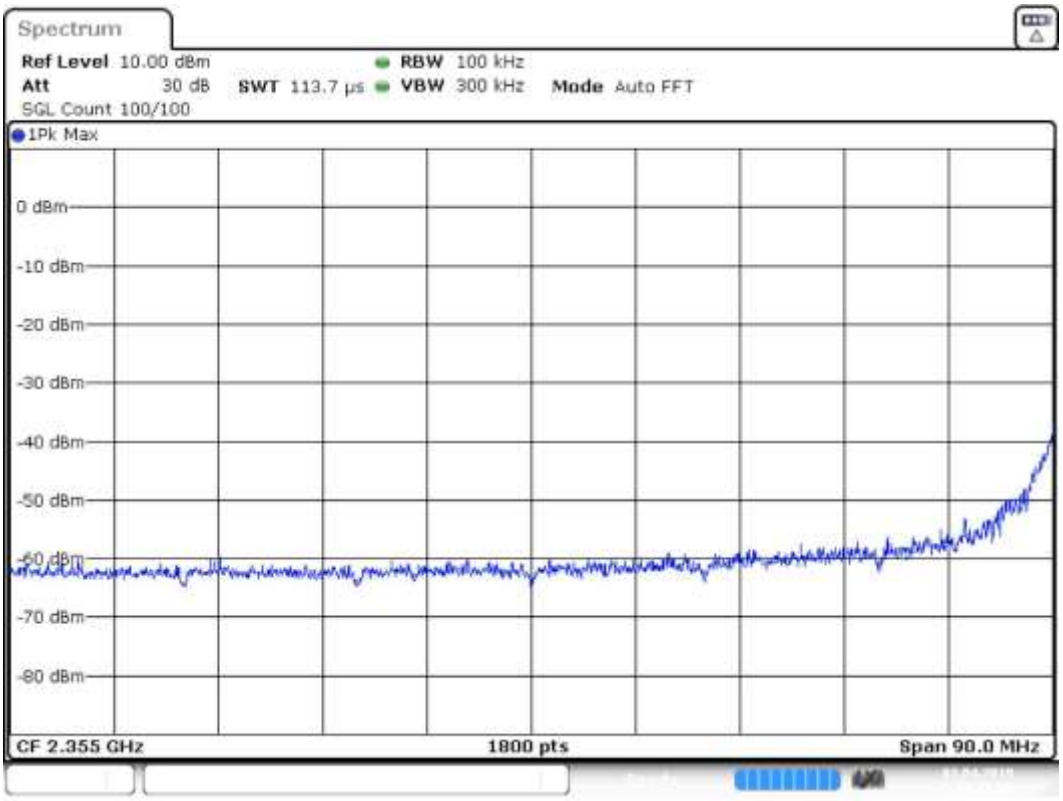
2.5.8 Test Results for Lower Band Edge



Bluetooth LE Low Band Edge transmit in 2402MHz at Peak measurement level 1.7dBm



Bluetooth LE Low Band Edge transmit in 2402MHz

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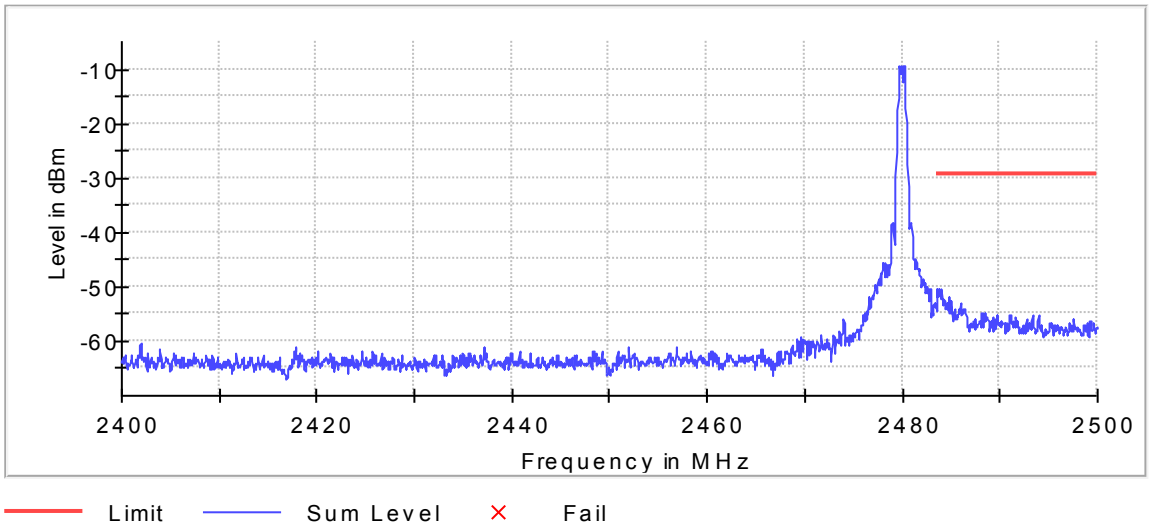
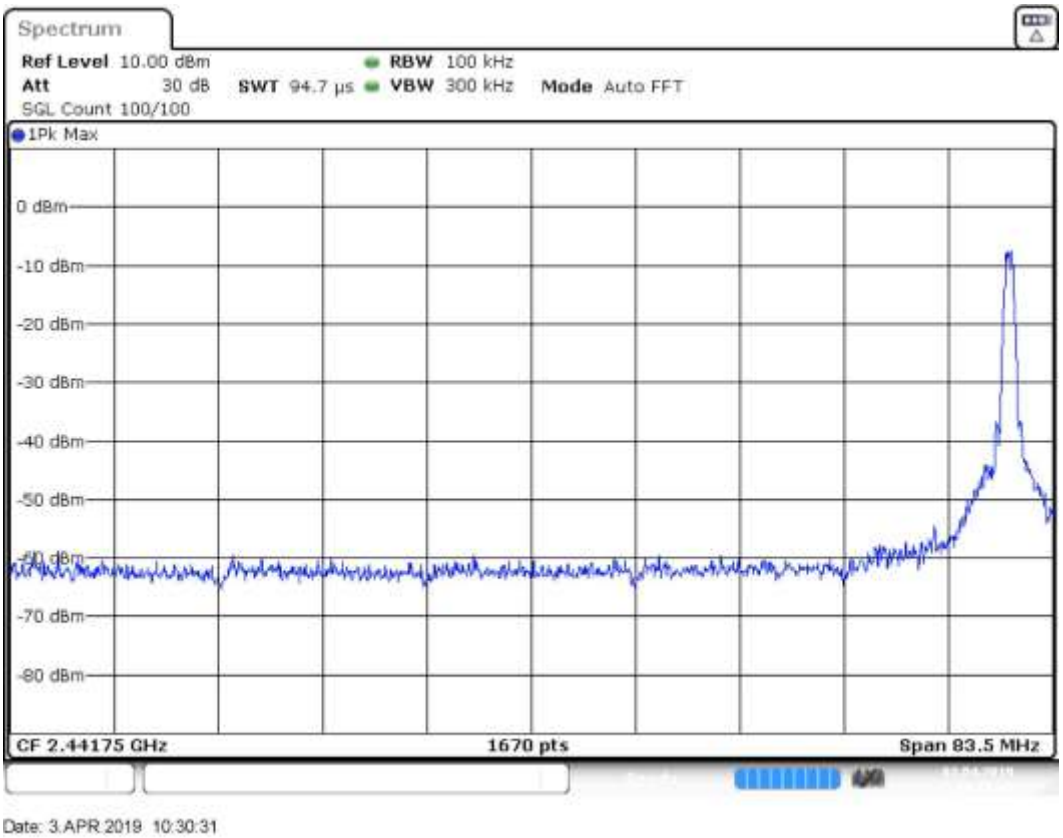


Bluetooth LE High Band Edge transmit in 2480MHz at Peak measurement level -9.3dBm



Bluetooth LE High Band Edge transmit in 2480MHz

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2.6 RECEIVER SPURIOUS EMISSIONS – RADIATED

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.6.2 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)).

2.6.3 Equipment Under Test and Modification State

Serial No: 8007869, 8007908 and 8007910 (Radiated Sample) / Test Configuration B

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

April 11 and 27, 2019 / AC

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	21.7 °C
Relative Humidity	33.7 %
ATM Pressure	99.2 kPa

2.6.7 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 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 2.6.8 for sample computation.

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2.6.8 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**

2.6.9 Test Results

See attached plots.

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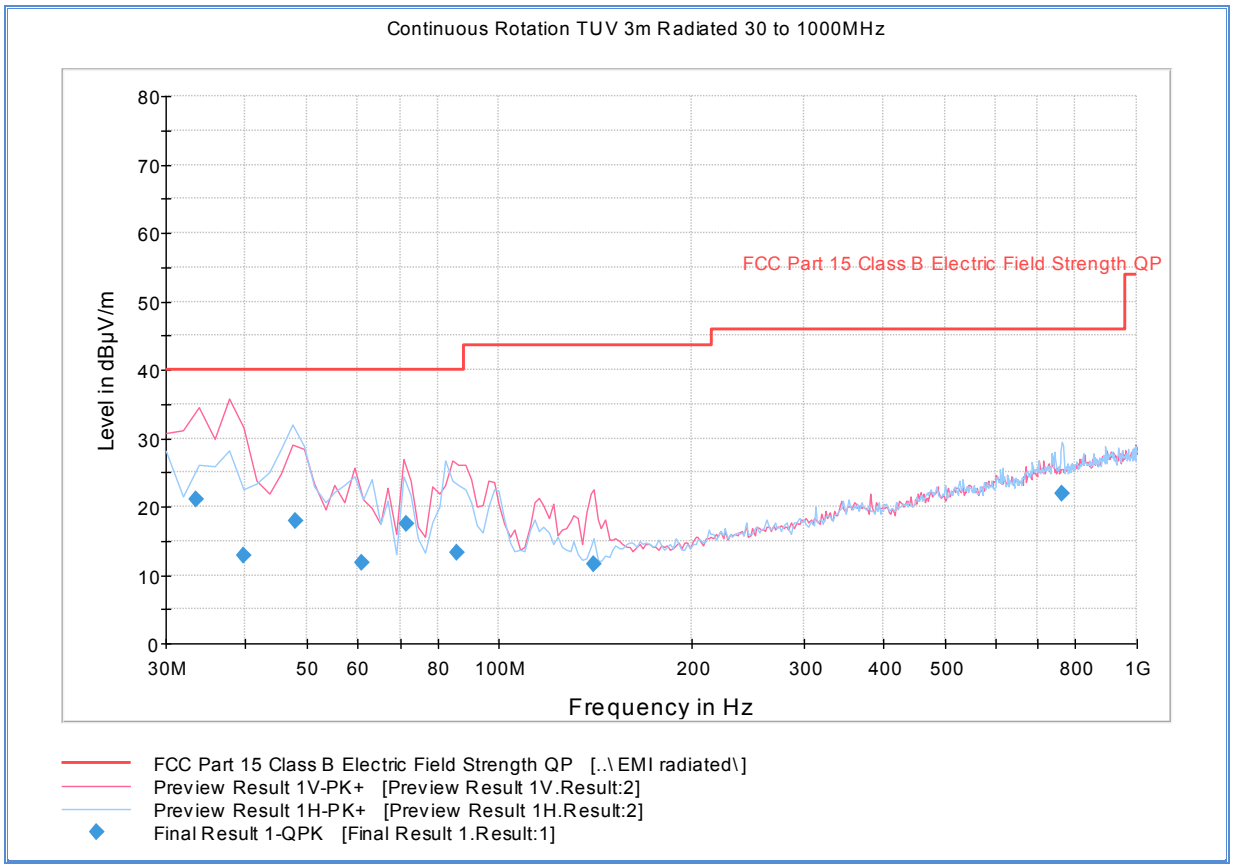
2.6.10 Test Results Below 1GHz (Receive Mode) – Avant VR-CDVRA700Q (1 chamber)



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)
33.407776	21.0	1000.0	120.000	122.0	V	128.0	-9.3	19.0	40.0
39.695551	12.9	1000.0	120.000	128.0	V	155.0	-11.9	27.1	40.0
47.974990	17.9	1000.0	120.000	400.0	H	15.0	-14.5	22.1	40.0
60.758317	11.8	1000.0	120.000	100.0	V	11.0	-16.9	28.2	40.0
71.581643	17.4	1000.0	120.000	100.0	V	149.0	-17.2	22.6	40.0
85.852745	13.3	1000.0	120.000	165.0	V	354.0	-15.8	26.7	40.0
140.841603	11.6	1000.0	120.000	100.0	V	48.0	-14.1	31.9	43.5
763.245691	22.0	1000.0	120.000	213.0	H	93.0	2.7	24.0	46.0

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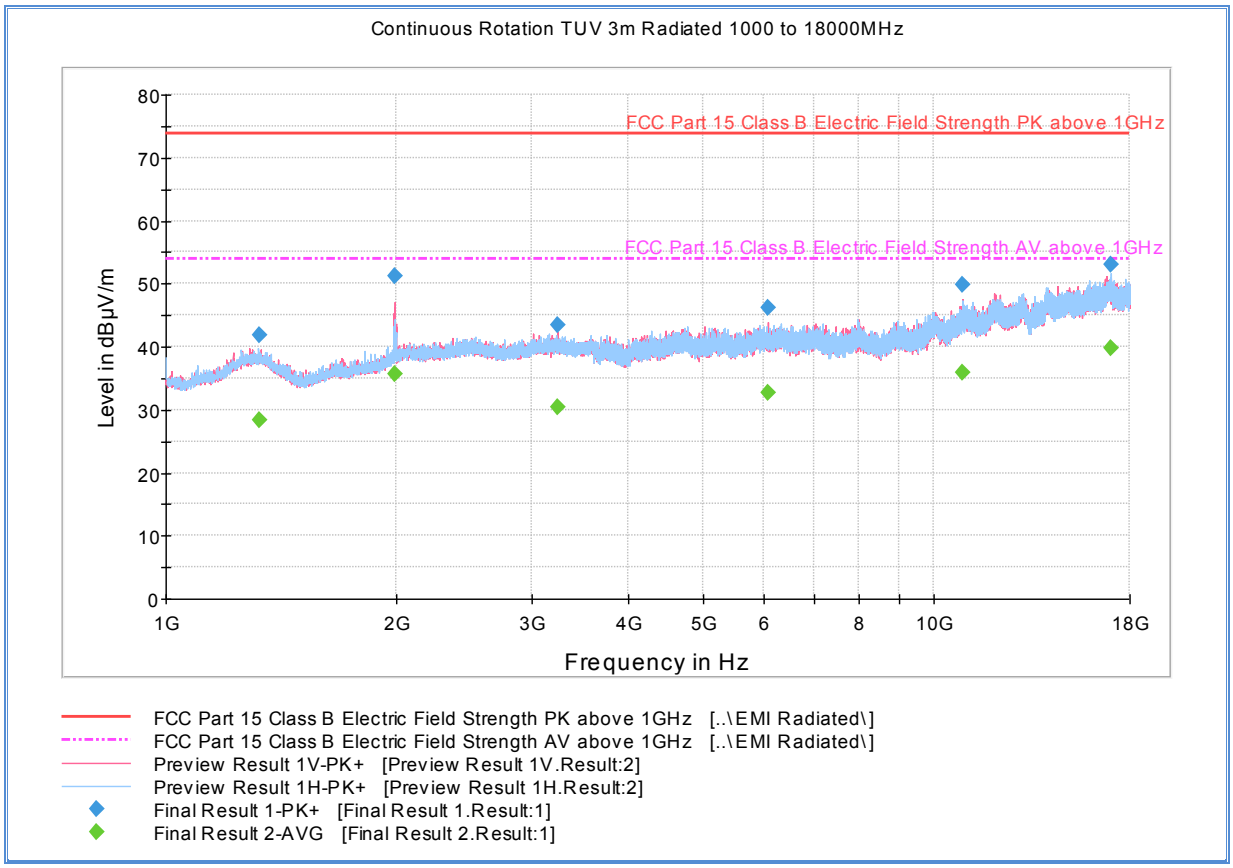
2.6.11 Test Results Above 1GHz (Receive Mode) – Avant VR-CDVRA700Q (1 chamber)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1321.500000	41.8	1000.0	1000.000	167.1	H	206.0	-5.1	32.1	73.9
1990.366667	51.1	1000.0	1000.000	399.0	V	25.0	-2.3	22.8	73.9
3233.033333	43.5	1000.0	1000.000	150.0	V	255.0	1.1	30.4	73.9
6095.466667	46.2	1000.0	1000.000	350.0	V	10.0	6.0	27.7	73.9
10908.16666	49.8	1000.0	1000.000	225.0	V	124.0	11.9	24.1	73.9
17000.76666	52.9	1000.0	1000.000	410.0	H	121.0	17.9	21.0	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)
1321.500000	28.4	1000.0	1000.000	167.1	H	206.0	-5.1	25.5	53.9
1990.366667	35.7	1000.0	1000.000	399.0	V	25.0	-2.3	18.2	53.9
3233.033333	30.4	1000.0	1000.000	150.0	V	255.0	1.1	23.5	53.9
6095.466667	32.8	1000.0	1000.000	350.0	V	10.0	6.0	21.1	53.9
10908.16666	35.8	1000.0	1000.000	225.0	V	124.0	11.9	18.1	53.9
17000.76666	39.9	1000.0	1000.000	410.0	H	121.0	17.9	14.0	53.9

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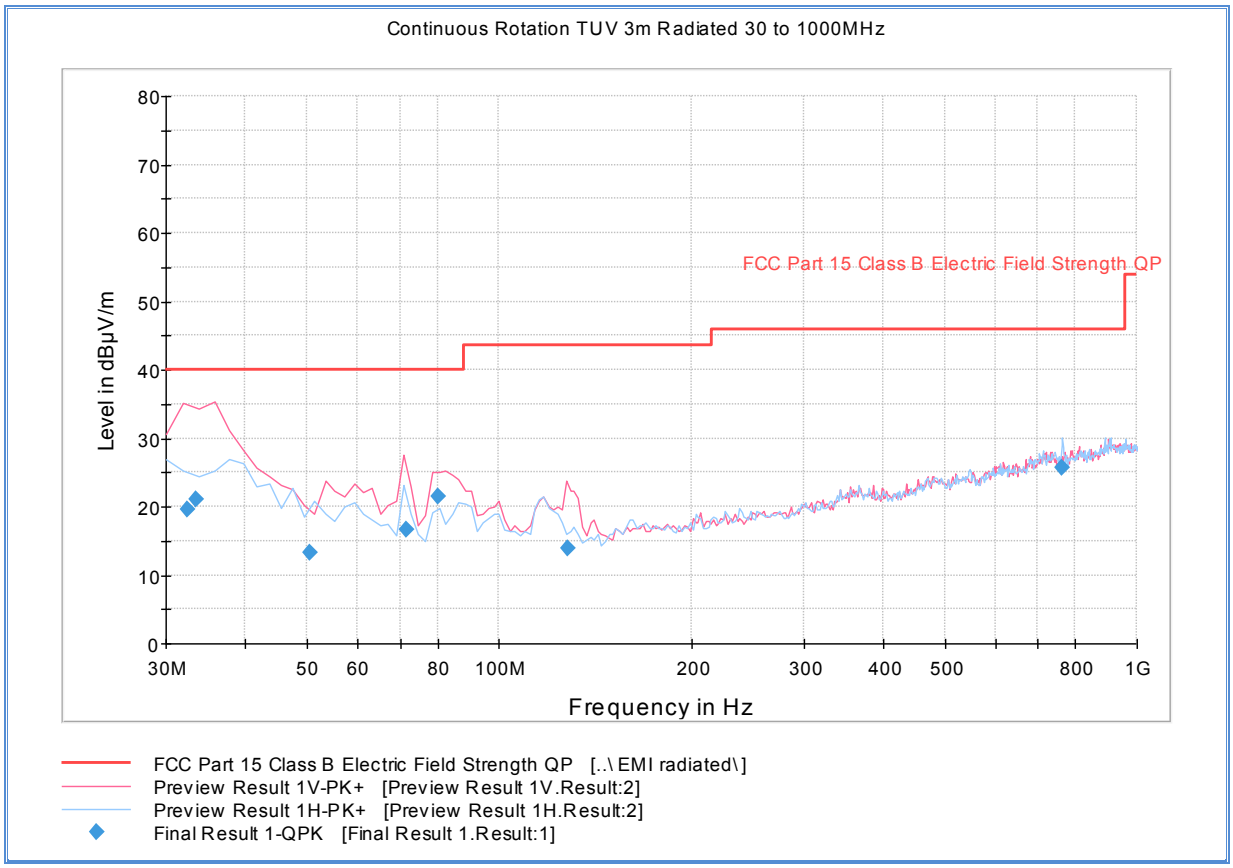
2.6.12 Test Results Below 1GHz (Receive Mode) – Avant DR-CDDRA700Q (2 chamber)



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)
32.471663	19.6	1000.0	120.000	106.0	V	167.0	-8.8	20.4	40.0
33.520000	21.1	1000.0	120.000	121.0	V	285.0	-9.3	18.9	40.0
50.366653	13.2	1000.0	120.000	122.0	V	234.0	-15.3	26.8	40.0
71.541643	16.7	1000.0	120.000	127.0	V	0.0	-17.0	23.3	40.0
79.997194	21.4	1000.0	120.000	109.0	V	166.0	-17.0	18.6	40.0
127.994389	13.9	1000.0	120.000	100.0	V	15.0	-14.3	29.6	43.5
761.949579	25.6	1000.0	120.000	200.0	H	336.0	3.1	20.4	46.0

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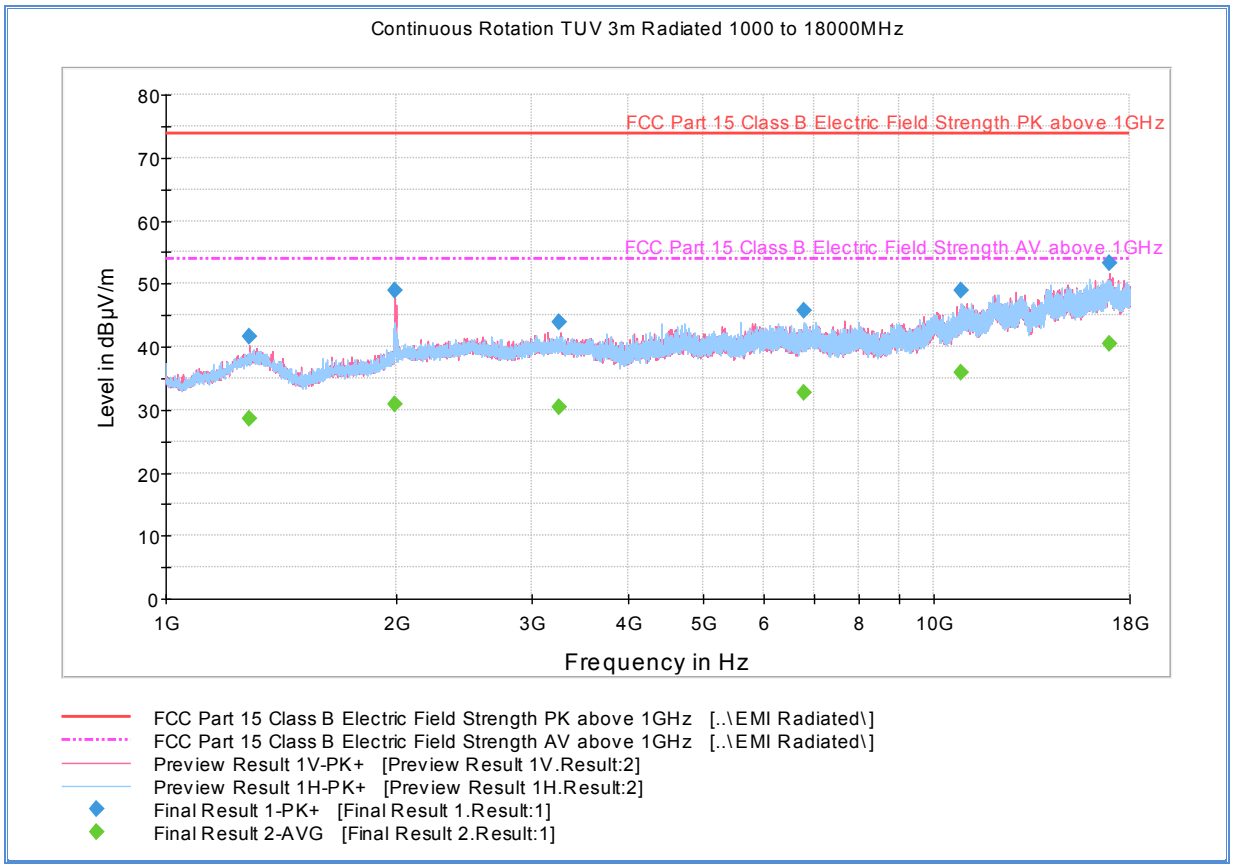
2.6.13 Test Results Above 1GHz (Receive Mode) – Avant DR-CDDRA700Q (2 chamber)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1284.333333	41.7	1000.0	1000.000	350.0	V	329.0	-5.3	32.2	73.9
1990.200000	48.8	1000.0	1000.000	399.0	V	16.0	-2.3	25.1	73.9
3259.266667	43.9	1000.0	1000.000	406.9	V	16.0	1.0	30.0	73.9
6790.000000	45.8	1000.0	1000.000	136.0	H	277.0	6.4	28.1	73.9
10869.83333	48.9	1000.0	1000.000	332.0	V	152.0	11.9	25.0	73.9
16977.73333	53.3	1000.0	1000.000	180.0	V	232.0	17.9	20.6	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)
1284.333333	28.5	1000.0	1000.000	350.0	V	329.0	-5.3	25.4	53.9
1990.200000	30.8	1000.0	1000.000	399.0	V	16.0	-2.3	23.1	53.9
3259.266667	30.4	1000.0	1000.000	406.9	V	16.0	1.0	23.5	53.9
6790.000000	32.7	1000.0	1000.000	136.0	H	277.0	6.4	21.2	53.9
10869.83333	36.0	1000.0	1000.000	332.0	V	152.0	11.9	17.9	53.9
16977.73333	40.4	1000.0	1000.000	180.0	V	232.0	17.9	13.5	53.9

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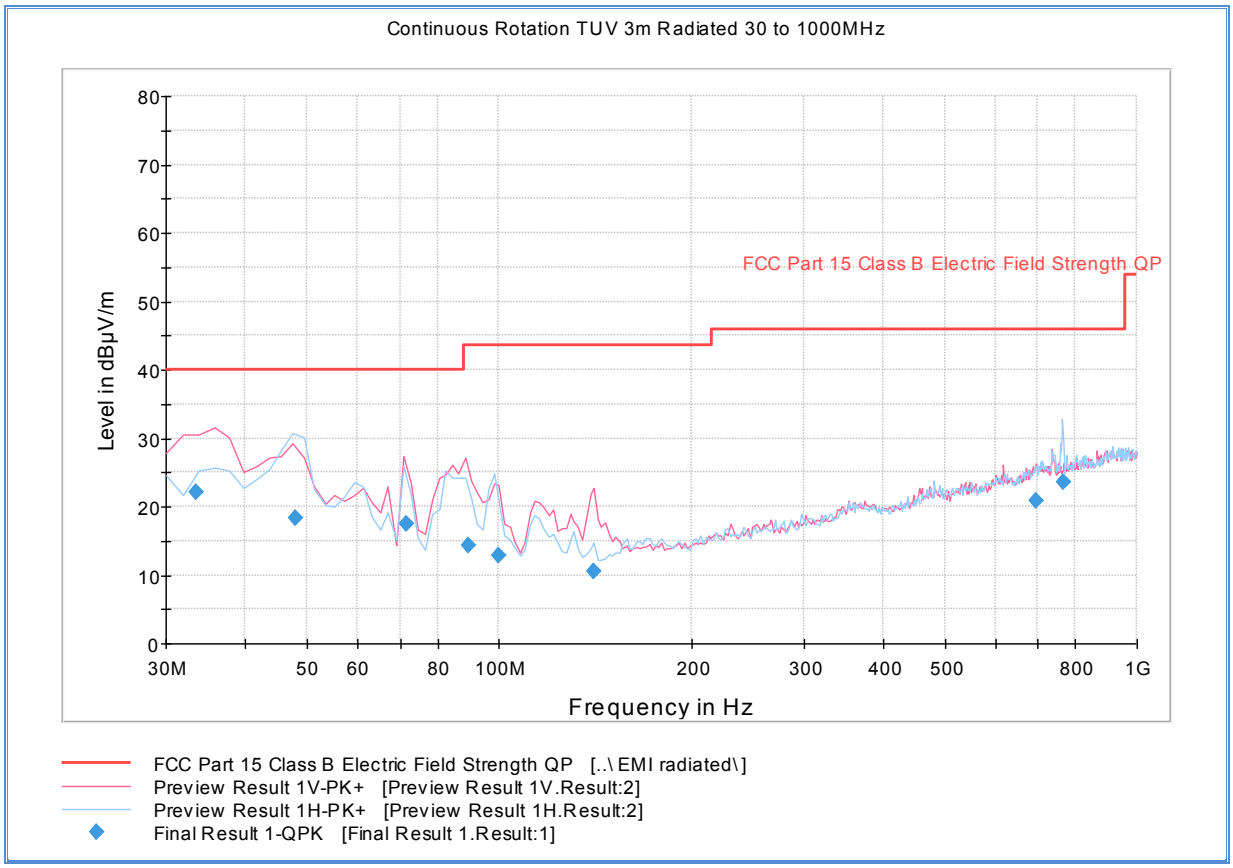
2.6.14 Test Results Below 1GHz (Receive Mode) – Avant HF-CDHFA700Q (3 chamber)



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)
33.431663	22.0	1000.0	120.000	100.0	V	277.0	-9.3	18.0	40.0
48.014990	18.4	1000.0	120.000	400.0	H	15.0	-14.5	21.6	40.0
71.661643	17.4	1000.0	120.000	105.0	V	150.0	-17.2	22.6	40.0
89.276633	14.3	1000.0	120.000	100.0	V	166.0	-15.2	29.2	43.5
99.636072	12.9	1000.0	120.000	384.0	H	4.0	-13.3	30.6	43.5
140.521603	10.5	1000.0	120.000	100.0	V	224.0	-14.1	33.0	43.5
693.409619	20.8	1000.0	120.000	100.0	V	312.0	2.2	25.2	46.0
764.989579	23.5	1000.0	120.000	172.0	H	287.0	2.7	22.5	46.0

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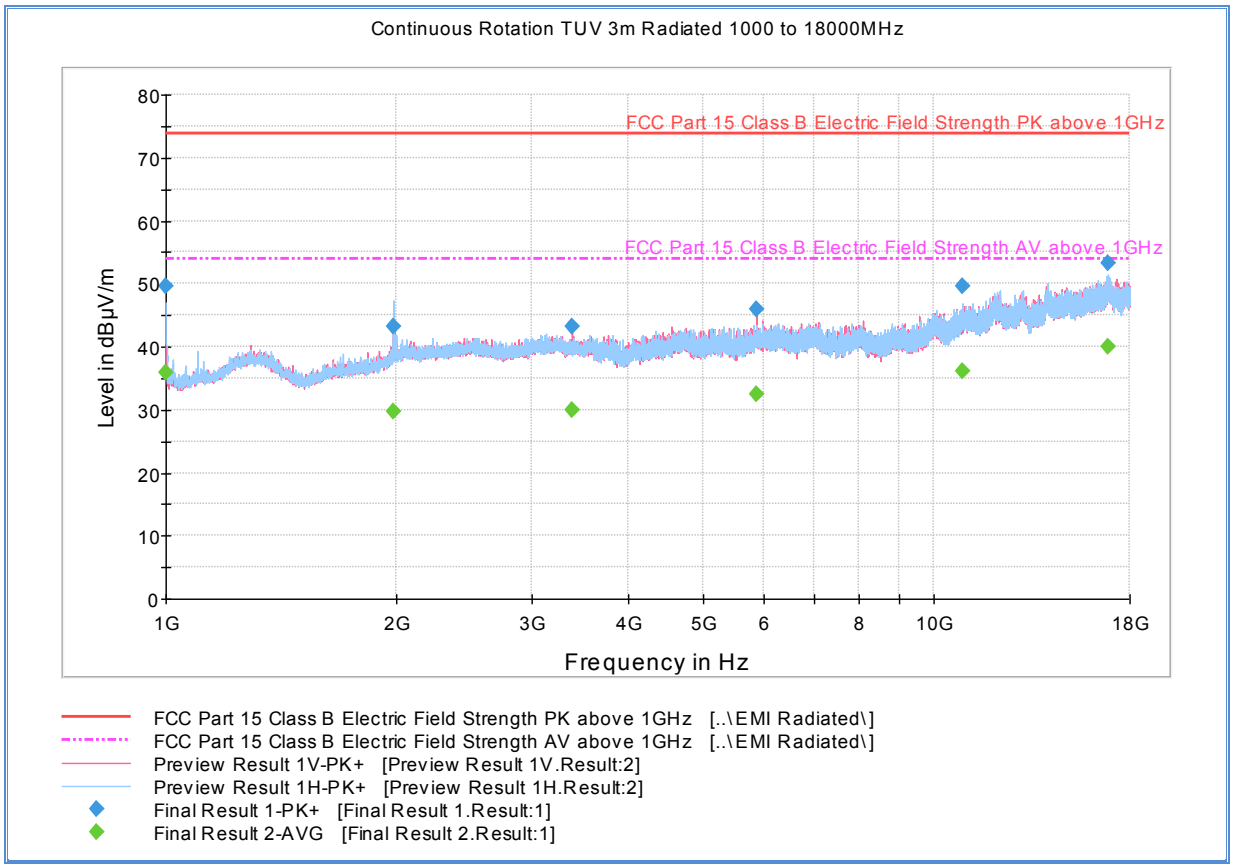
2.6.15 Test Results Above 1GHz (Receive Mode) – Avant HF-CDHFA700Q (3 chamber)



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	49.6	1000.0	1000.000	100.0	H	222.0	-6.9	24.3	73.9
1976.566667	43.2	1000.0	1000.000	393.0	H	289.0	-2.3	30.7	73.9
3386.466667	43.2	1000.0	1000.000	267.0	V	77.0	0.8	30.7	73.9
5883.966667	45.9	1000.0	1000.000	250.0	V	94.0	5.7	28.0	73.9
10913.66666	49.6	1000.0	1000.000	239.0	H	98.0	11.9	24.3	73.9
16900.30000	53.1	1000.0	1000.000	400.0	H	189.0	18.0	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)
1000.400000	35.9	1000.0	1000.000	100.0	H	222.0	-6.9	18.0	53.9
1976.566667	29.8	1000.0	1000.000	393.0	H	289.0	-2.3	24.1	53.9
3386.466667	30.0	1000.0	1000.000	267.0	V	77.0	0.8	24.0	53.9
5883.966667	32.6	1000.0	1000.000	250.0	V	94.0	5.7	21.3	53.9
10913.66666	36.2	1000.0	1000.000	239.0	H	98.0	11.9	17.7	53.9
16900.30000	40.0	1000.0	1000.000	400.0	H	189.0	18.0	13.9	53.9

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2.7 POWER SPECTRAL DENSITY

2.7.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(e)
RSS-247, Clause 5.2(2)

2.7.2 Standard Applicable

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

2.7.3 Equipment Under Test and Modification State

Serial No: BBZ301.1 (Conducted Sample) / Test Configuration A

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

April 10, 2019 / AC

2.7.5 Test Equipment Used

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

2.7.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	22.2 °C
Relative Humidity	27.6 %
ATM Pressure	99.6 kPa

2.7.7 Additional Observations

- This is a conducted test.
- Test methodology is according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10.
- Rohde & Schwarz TS8997 Test System was used for this test.

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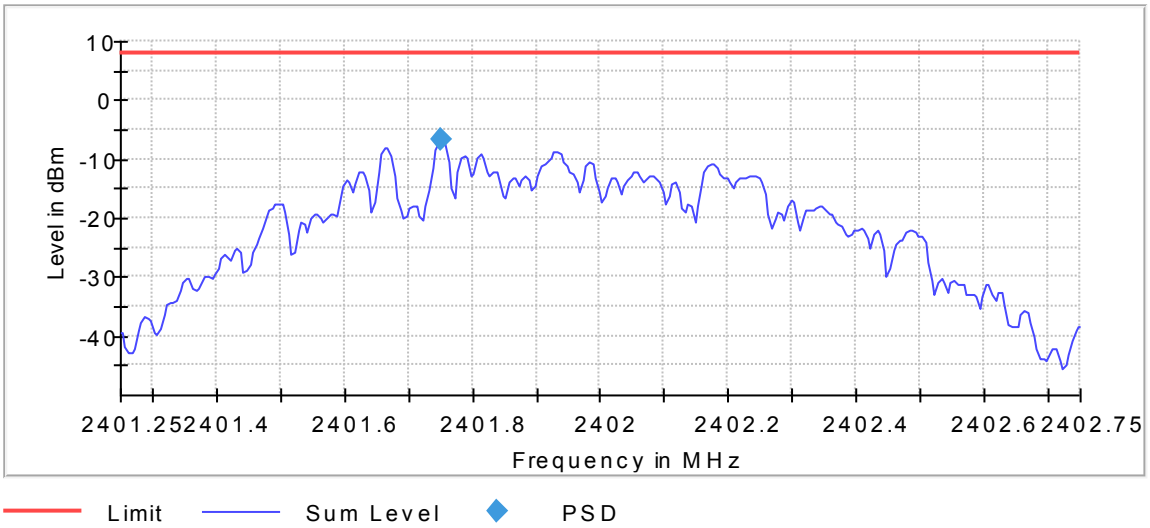
2.7.8 Test Results Summary

Mode	Channel	Data Rates (Mbps)	Peak Marker Reading using 100 kHz RBW (dBm)	PSD Limit (dBm)	Margin (dB)	Compliance
	00 (2402 MHz)	GFSK @ 1Mbps	-6.766	8	14.766	Complies
	17 (2440 MHz)	GFSK @ 1Mbps	-7.180	8	15.18	Complies
	39 (2480 MHz)	GFSK @ 1Mbps	-14.470	8	22.47	Complies

2.7.9 Test Results Plots



Bluetooth LE Low Channel (2402MHz)

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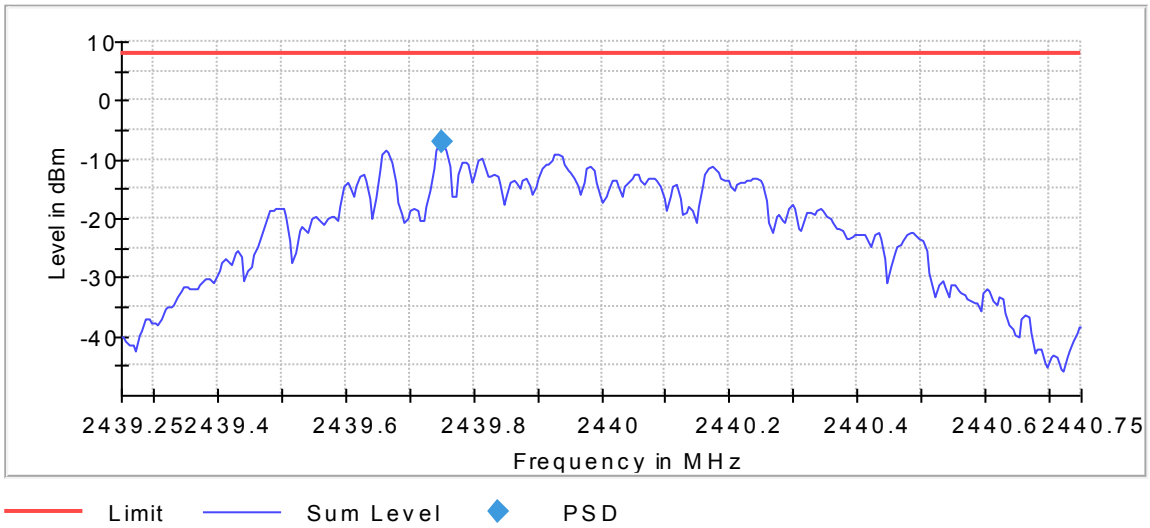
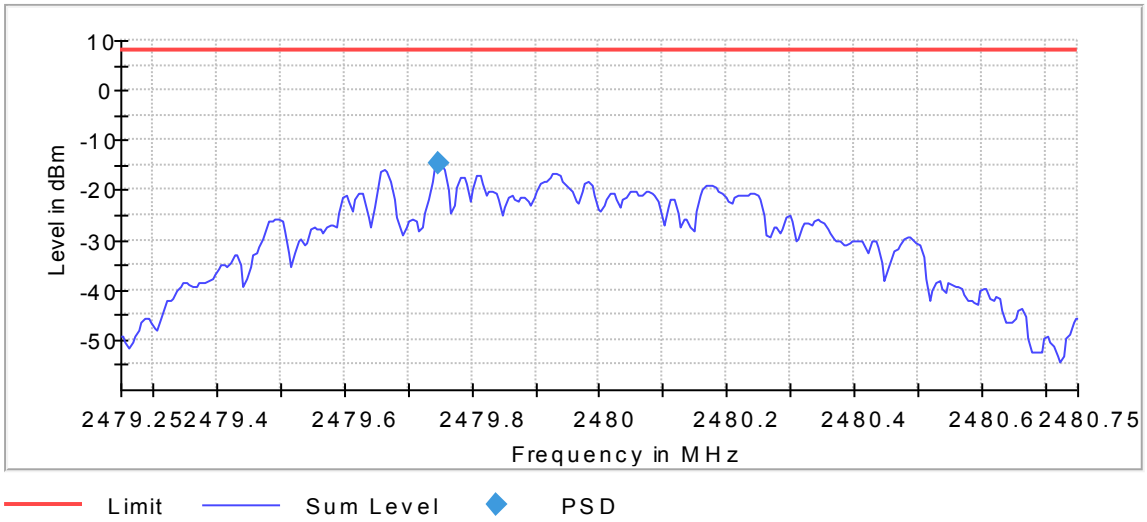


Bluetooth LE Mid Channel (2440MHz)



Bluetooth LE High Channel (2480MHz)

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SECTION 3

TEST EQUIPMENT USED

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3.1 TEST EQUIPMENT USED

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

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Conducted Port Setup						
7643	Signal/Spectrum Analyzer	FSV30	1321.3008K30/ 103166	Rhode & Schwarz	04/04/19	04/04/20
7655	Vector Signal Generator	SMBV100A	260734	Rhode & Schwarz	11/19/18	11/19/19
7654	Signal Generator	SMB 100A	175750	Rhode & Schwarz	11/16/18	11/16/19
7656	OSP with B157	OSP120	101310	Rhode & Schwarz	01/23/19	01/23/20
8825	20dB Attenuator	46-20-34	BK5773	Weinschel Corp.	Verified by 7643 and 7654	
8832	20dB Attenuator	34-20-34	BP4150	MCE/Weinschel	Verified by 7643 and 7654	
Radiated Emission						
1033	Bilog Antenna	3142C	00044556	EMCO	11/06/18	11/06/20
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	06/16/18	06/16/20
8628	Pre-amplifier	QLJ-01182835-JO	8986002	Quinstar	03/07/19	03/07/20
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	10/15/18	10/15/19
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	07/13/18	07/13/19
1016	Pre-amplifier	PAM-0202	187	PAM	03/08/19	03/08/20
Miscellaneous						
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	Sper Scientific	04/16/19	04/16/20
-	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

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3.1 MEASUREMENT UNCERTAINTY

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

3.1.1 Radiated Emission Measurement 30 MHz – 1000 MHz at a distance of 3 m

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20	dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.75	dB	Normal, k=2	2.000	0.38	0.14
4	Receiver sinewave accuracy	0.45	dB	Normal, k=2	2.000	0.23	0.05
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50	dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95	dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10	dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12	dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00	dB	Rectangular	1.732	0.58	0.33
13	Cross-polarization	0.90	dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00	dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.76	dB	Triangular	2.449	1.54	2.36
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.77	dB	Rectangular	1.732	0.44	0.20
18	Table height at 3 m	0.10	dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00	dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00	dB				0.00
		Combined standard uncertainty		Normal	2.95	dB	
		Expanded uncertainty		Normal, k=2	5.90	dB	

3.1.2 Radiated Emission Measurements Above 1GHz at a distance of 3 m

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.30	dB	Normal, k=2	2.000	0.15	0.02
3	Preamplifier Gain	0.20	dB	Normal, k=2	2.000	0.10	0.01
4	Antenna factor AF	0.37	dB	Normal, k=2	2.000	0.19	0.03
5	Sinewave accuracy	0.57	dB	Normal, k=2	2.000	0.29	0.08
6	Instability of preamp gain	1.21	dB	Rectangular	1.732	0.70	0.49
7	Noise floor proximity	0.70	dB	Rectangular	1.732	0.40	0.16
8	Mismatch: antenna-preamplifier	1.41	dB	U-shaped	1.414	1.00	0.99
9	Mismatch: preamplifier-receiver	1.30	dB	U-shaped	1.414	0.92	0.85
10	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
11	Directivity difference at 3 m	1.50	dB	Rectangular	1.732	0.87	0.75
12	Phase center location at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
13	Cross-polarization	0.90	dB	Rectangular	1.732	0.52	0.27
14	Site imperfections VSWR (Method 2)	3.00	dB	Triangular	2.449	1.22	1.50
15	Effect of setup table material	1.50	dB	Rectangular	1.732	0.87	0.75
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Table height at 3 m	0.00	dB	Normal, k=2	2.000	0.00	0.00
		Combined standard uncertainty		Normal	2.45	dB	
		Expanded uncertainty		Normal, k=2	4.90	dB	

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3.1.3 Conducted Antenna Port Measurement

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Cable attenuation	1.00	dB	Normal, k=2	2.000	0.50	0.25
3	Receiver sinewave accuracy	0.08	dB	Normal, k=2	2.000	0.04	0.00
4	Receiver pulse amplitude	0.00	dB	Rectangular	1.732	0.00	0.00
5	Receiver pulse repetition rate	0.00	dB	Rectangular	1.732	0.00	0.00
6	Noise floor proximity	0.00	dB	Rectangular	1.732	0.00	0.00
7	Frequency interpolation	0.10	dB	Rectangular	1.732	0.06	0.00
8	Mismatch	0.07	dB	U-shaped	1.414	0.05	0.00
		Combined standard uncertainty		Normal	0.52	dB	
		Expanded uncertainty		Normal, k=2	1.03	dB	

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SECTION 4

DIAGRAM OF TEST SETUP

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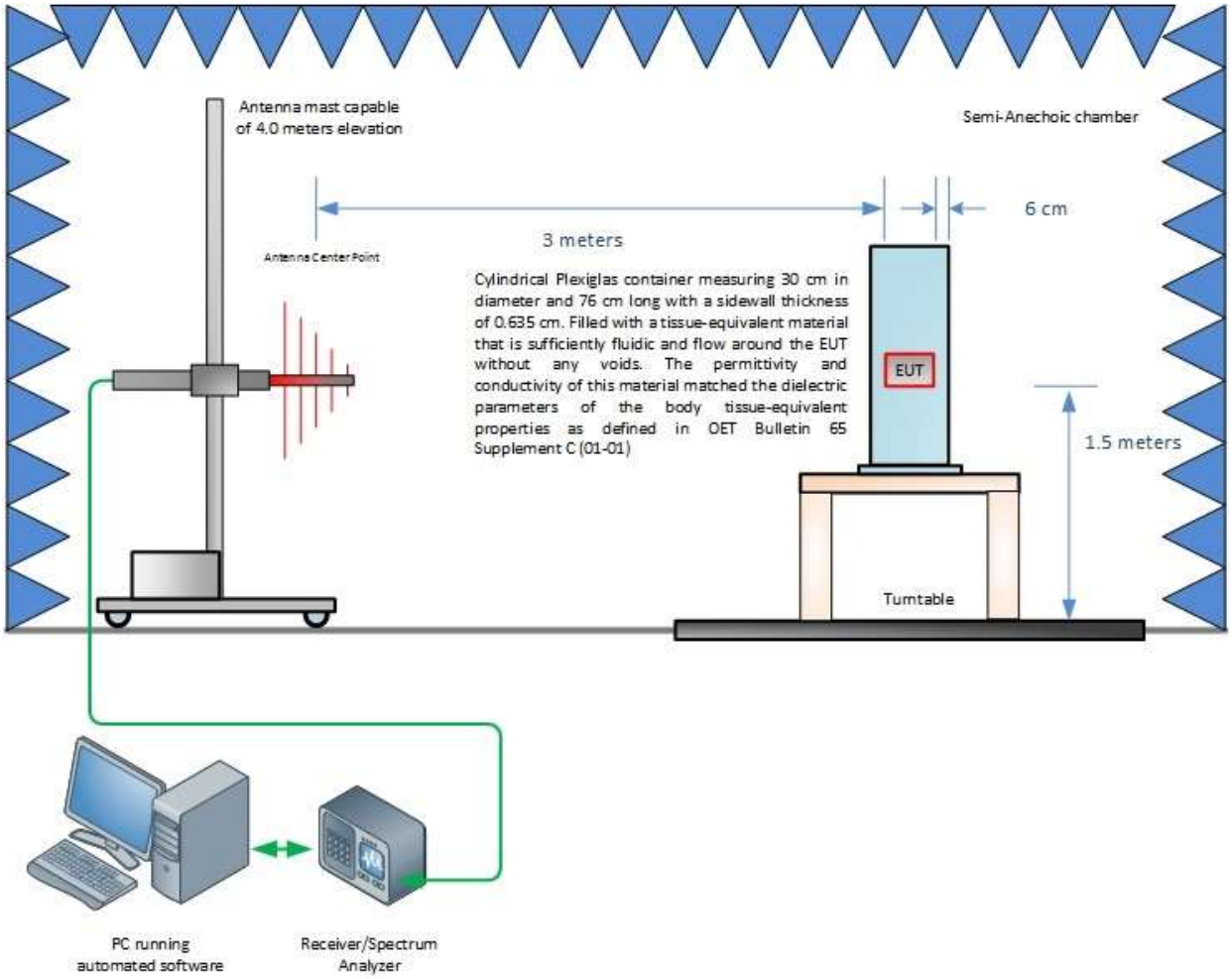
4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)

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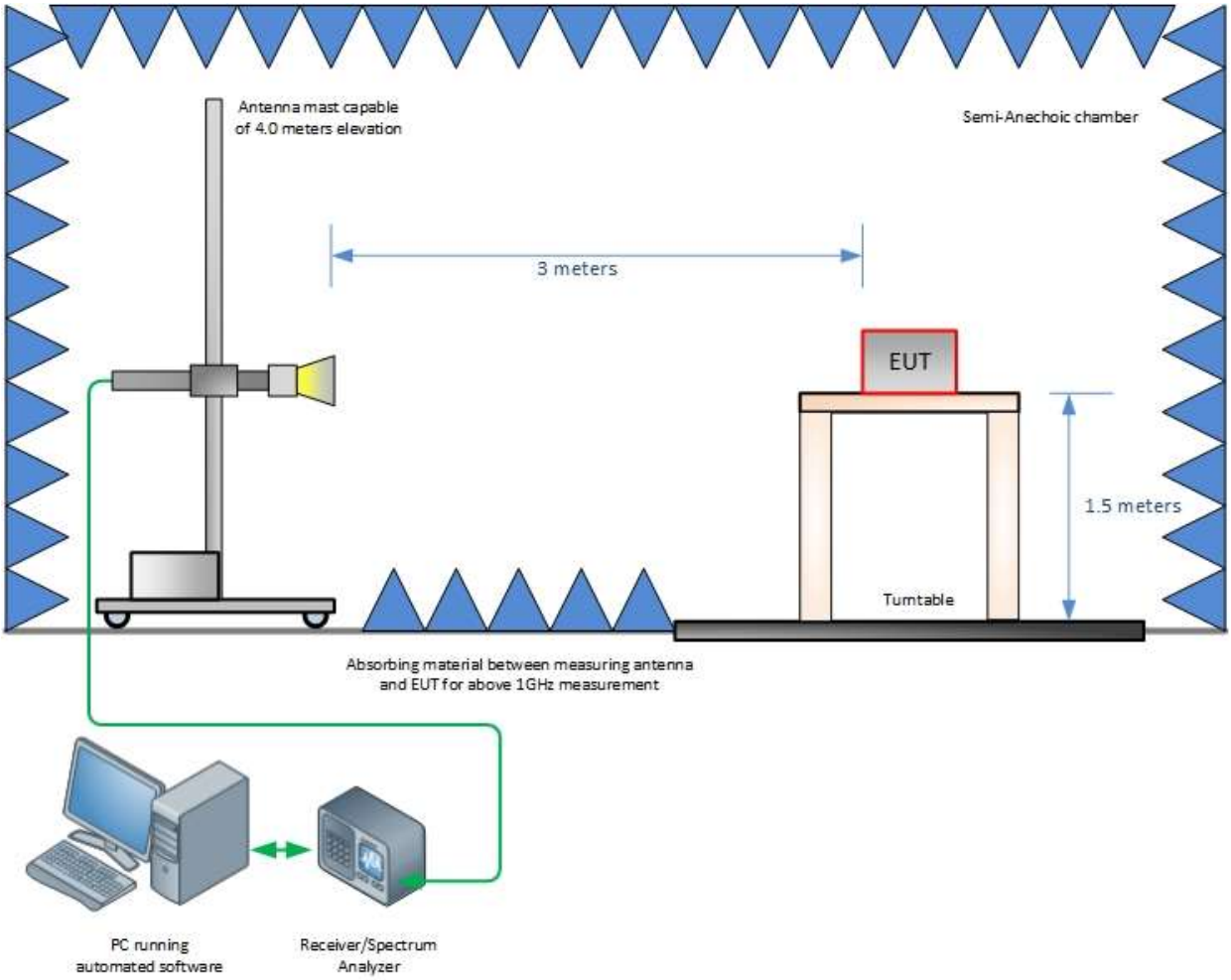

Radiated Emission Test Setup (Above 1GHz)

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SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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