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Report On

Application for Grant of Equipment Authorization of the
NX35-C200 Vehicle Tracking System

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

Report No. JT72130952-0817B **October 2017**

REPORT ON	Radio Testing of the NX35-C200 Vehicle Tracking System
TEST REPORT NUMBER	JT72130952-0817B
PREPARED FOR	Novatel Wireless Inc 9605 Scranton Rd. Ste 300 San Diego, CA 92121 USA
CONTACT PERSON	Roman Olmos Senior Regulatory Engineer (858) 812-3400 rolmos@nvtl.com
PREPARED BY	Ivan Retana **Name** Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	Ferdinand S. Custodio Name Authorized Signatory Title: EMC/Senior Wireless Test Engineer
DATED	October 17, 2017

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

Revision History

JT72130952-0817B NX35-C200 Vehicle Tracking System					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
10/17/2017		Initial Release			Ferdinand S. Custodio

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

CONTENTS

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SECTION 1

REPORT SUMMARY

Radio Testing of the
NX35-C200 Vehicle Tracking System

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

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the NX35-C200 Vehicle Tracking System 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	Ctrack
Model Number(s)	NX35-C200
FCC ID Number	PKRNVWNX35C200
IC Number	3229A-NX35C200
Serial Number(s)	EMC Sample 1
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2016). • RSS-247 Issue 2 February 2017 - Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices. • RSS-Gen Issue 4 November 2014 – General Requirements for Compliance of Radio Apparatus. • 558074 D01 DTS Meas Guidance v04 (April 05, 2017) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247. • ANSI C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Start of Test	October 04, 2017
Finish of Test	October 05, 2017
Name of Engineer(s)	Ivan Retana
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	§15.247(b)(3)	RSS-247 5.4(d)	Maximum Conducted Output Power	**Compliant**	
2.2	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	N/A[1]	
2.3		RSS-Gen 6.6	99% Emission Bandwidth	**Compliant**	
2.4	§15.247(a)(2)	RSS-247 5.2(a)	Minimum 6 dB RF Bandwidth	**Compliant**	
2.5	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Conducted	**Compliant**	
2.6	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	**Compliant**	
2.7	§15.247(d)	RSS-Gen 8.9 and 8.10	Spurious Radiated Emissions	**Compliant**	
2.8	§15.247(e)	RSS-247 5.2(b)	Power Spectral Density for Digitally Modulated Device	**Compliant**	

Test Notes:

1 *Test Not Applicable. EUT is a battery-operated device.*

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a NX35-C200 Vehicle Tracking System. The NX35 device is designed to accurately track position and other data of vehicles or assets and report this data to a data centre. The NX35 is used to gather information relevant to fleet management services, to plot a vehicle position on a map and also to follow the route taken by a vehicle during a journey. The position and speed of the vehicle is sampled using GNSS (Global Navigation Satellite System) and reported through a GSM modem data link with industry standard communication protocols.

1.3.2 EUT General Description

EUT Description	NX35-C200 Vehicle Tracking System
Model Number(s)	NX35-C200
Rated Voltage	6.0 – 32.0VDC
Mode Verified	Bluetooth Low Energy (BT LE)
Capability	CDMA 1xRTT 800/1900MHz, GPS/GNSS, and Bluetooth/BLE
Primary Unit (EUT)	☒ Production
	☐ Pre-Production
	☐ Engineering
Antenna Gain	2.3 dBi

1.3.3 Maximum Peak Conducted Output Power

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
Bluetooth LE	2402 – 2480	5.4	3.47

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	EUT connected to a support laptop via a USB to RS232 cable to enable BLE transmit mode. Tools and software were provided by the manufacturer and was used to configure RF parameter of the EUT.

1.4.2 EUT Exercise Software

None. No special software used to exercise the EUT.
Commands where sent throughout a Terminal applications, TeraTerm and CMD.

1.4.3 Support Equipment and I/O cables

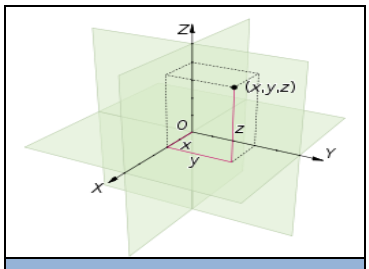
Manufacturer	Equipment/Cable	Description
Apple	Support Laptop	Support laptop used to configure EUT RF parameter setting
Treadnet	USB to RS232	Interface communication board between EUT and support laptop

1.4.4 Worst Case Configuration

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

Mode	Channel	Data Length
Bluetooth LE	2440 MHz (Mid Channel)	10

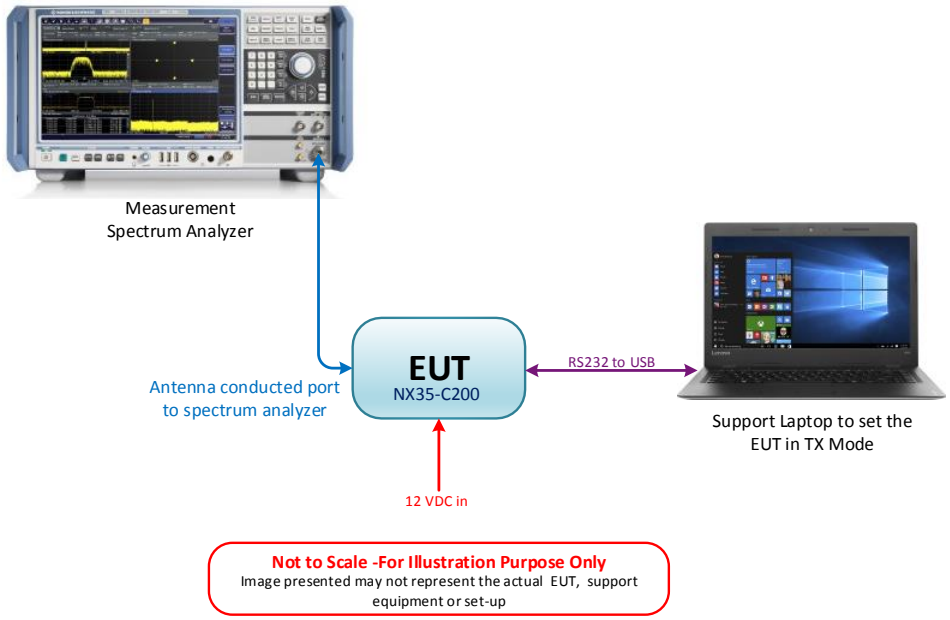
For radiated measurements X, Y and Z orientations were verified. Worst case position is “X”.



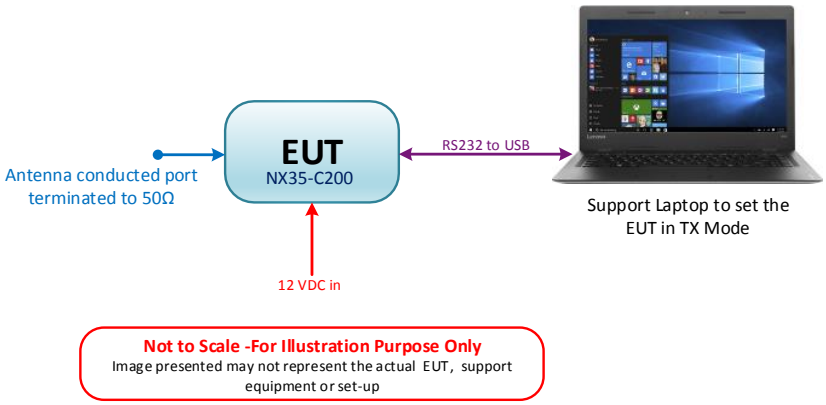
“X, Y, Z” Configuration

1.4.5 Simplified Test Configuration Diagram

Conducted Port Setup



Radiated Spurious Emissions Setup



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: EMC Sample 1		
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 C63.4-2014. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: 858 678 1400 Fax: 858-546 0364

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

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

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Designation No.: US1146

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

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

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

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

SECTION 2

TEST DETAILS

Radio Testing of the
NX35-C200 Vehicle Tracking System

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

2.1 MAXIMUM CONDUCTED OUTPUT POWER

2.1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3) and RSS-247 5.4(d)

2.1.2 Standard Applicable

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 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: EMC Sample 1 / Default Test Configuration

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

October 04, 2017 / IR

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	25.2 °C
Relative Humidity	48.2%
ATM Pressure	99.0 kPa

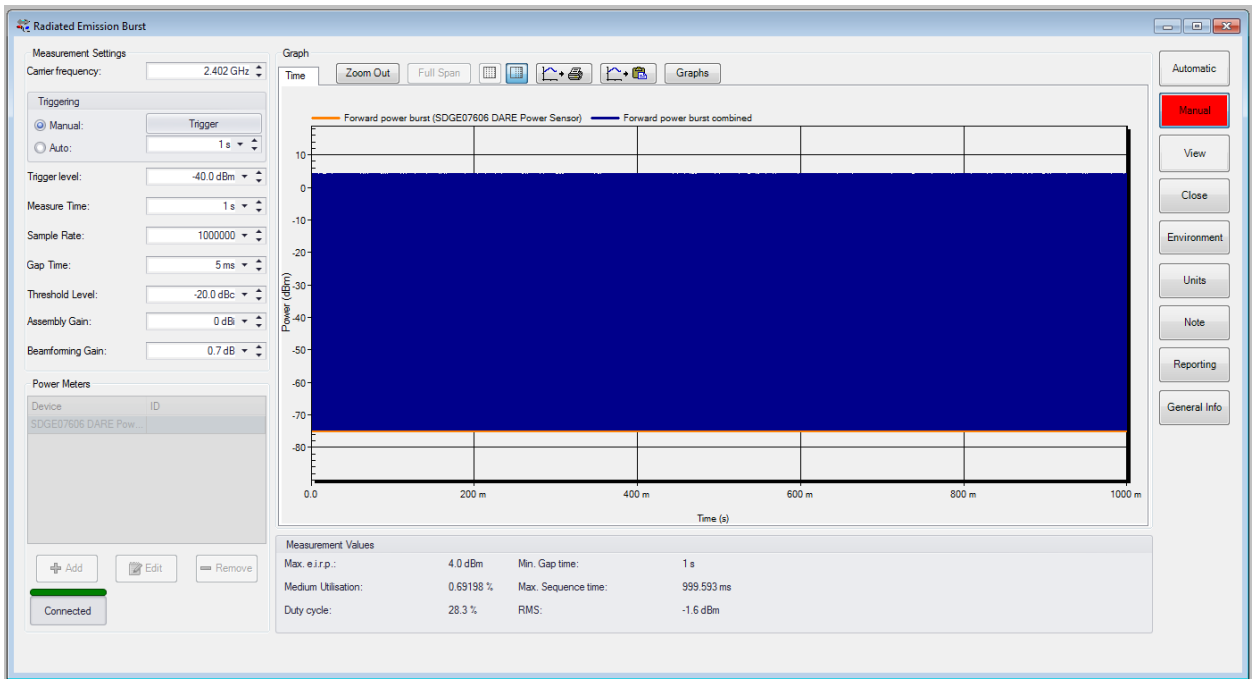
2.1.7 Additional Observations

- This is a conducted test (Maximum peak conducted output power) using direct connection to a power meter.
- An offset of 0.7dB was added to compensate for the cable used from the antenna port to the power sensor.
- Test methodology is per Clause 9.1.2 of KDB 558074 D01 DTS Meas Guidance v03r05 (April 08, 2016) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

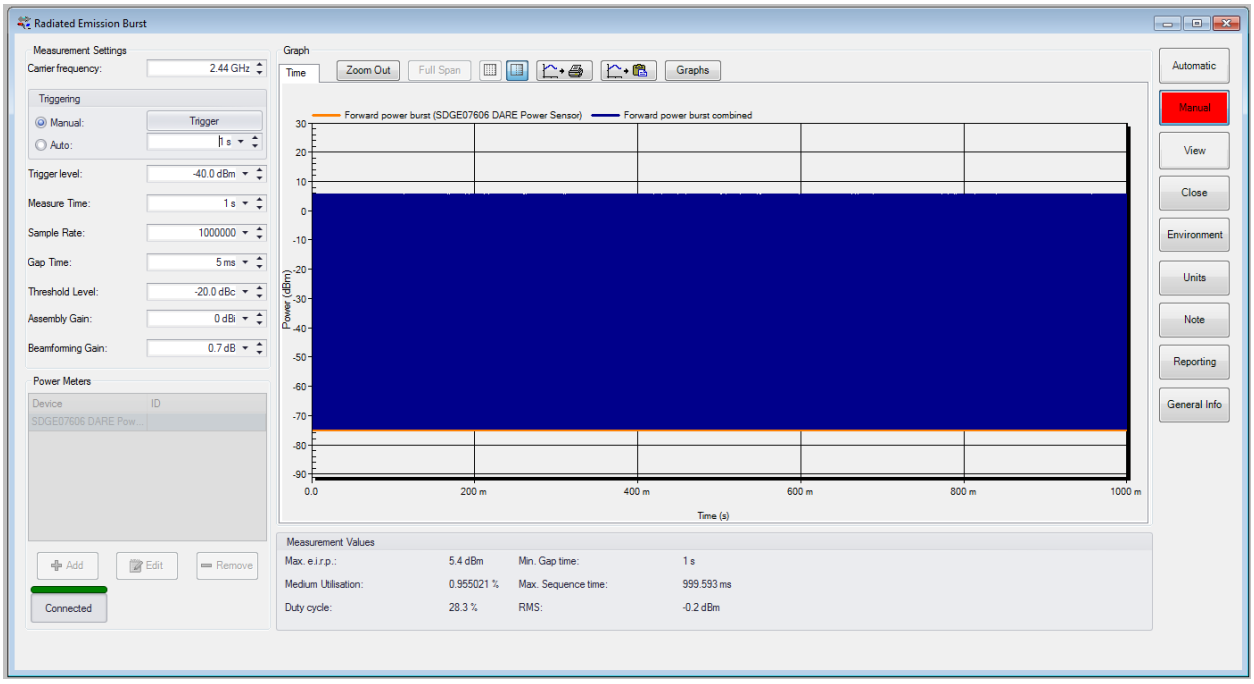
2.1.8 Test Results

Bluetooth Low Energy (LE)	Channel	Modulation	Measured Average Power (dBm)
	2402 MHz	GFSK	4.0
	2440 MHz		**5.4**
	2480 MHz		5.0

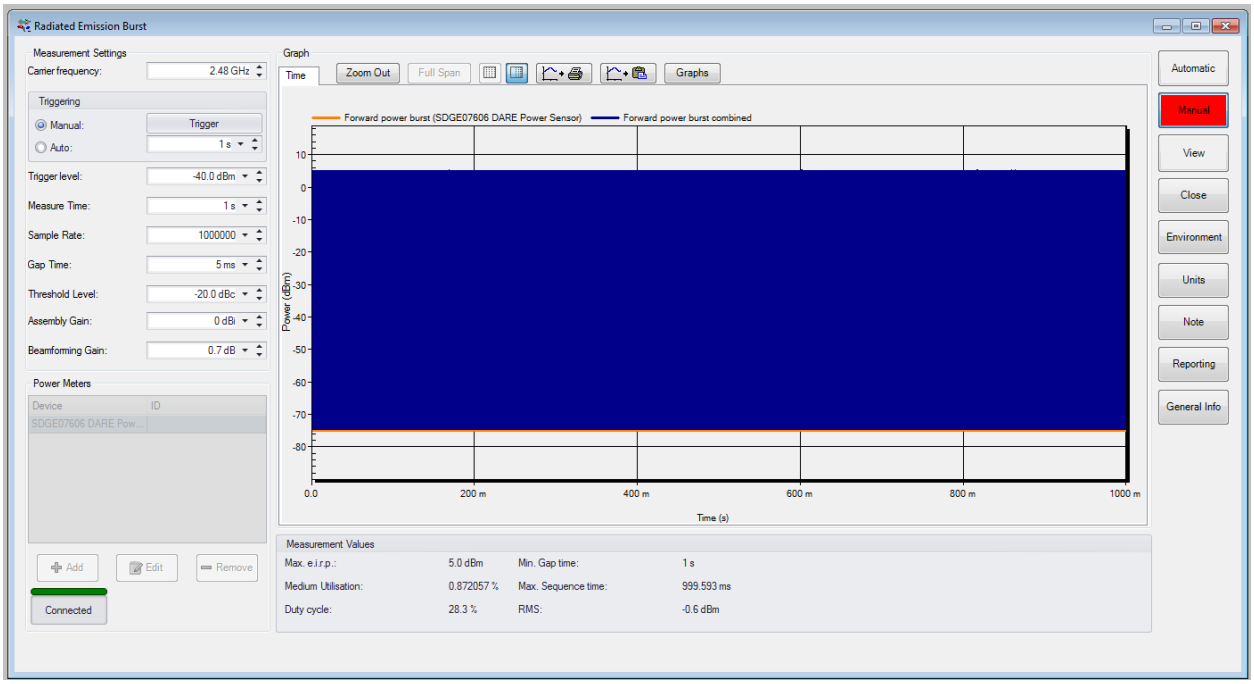
2.1.9 Test Plots



Low Channel BT LE



Mid Channel BT LE



High Channel BT LE

2.2 99% EMISSION BANDWIDTH

2.2.1 Specification Reference

RSS-Gen Clause 6.6

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: EMC Sample 1 / Default Test Configuration

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

October 04, 2017 / IR

2.2.5 Test Equipment Used

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

2.2.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.2 °C
Relative Humidity	48.2%
ATM Pressure	99.0 kPa

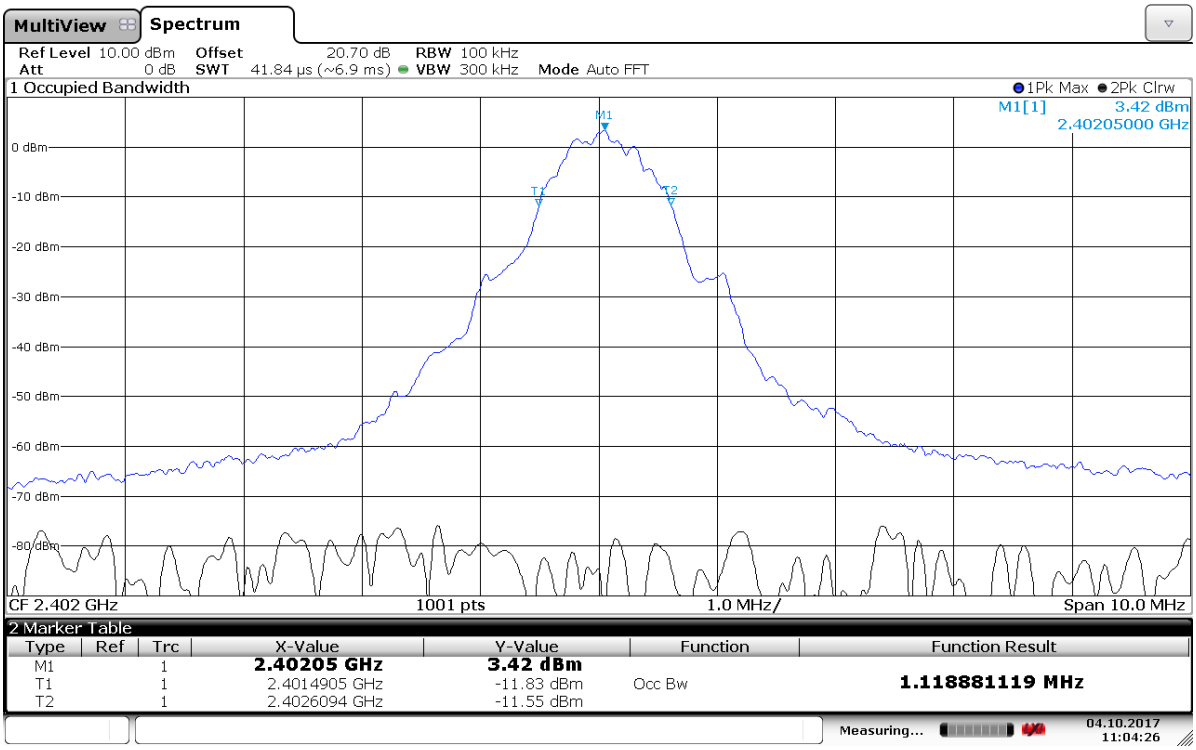
2.2.7 Additional Observations

- This is a conducted test.
- An offset of 20.7dB was added to compensate for the external attenuator and cable used from the antenna port to the spectrum analyzer.
- 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 Channel Bandwidth measurement function of the spectrum analyzer was used for this test.

2.2.8 Test Results (For reporting purposes only)

Mode	Channel	Measured 99% Bandwidth (MHz)
Bluetooth LE	2402 MHz	1.118
	2440 MHz	1.138
	2480 MHz	1.138

2.2.9 Test Results Plots



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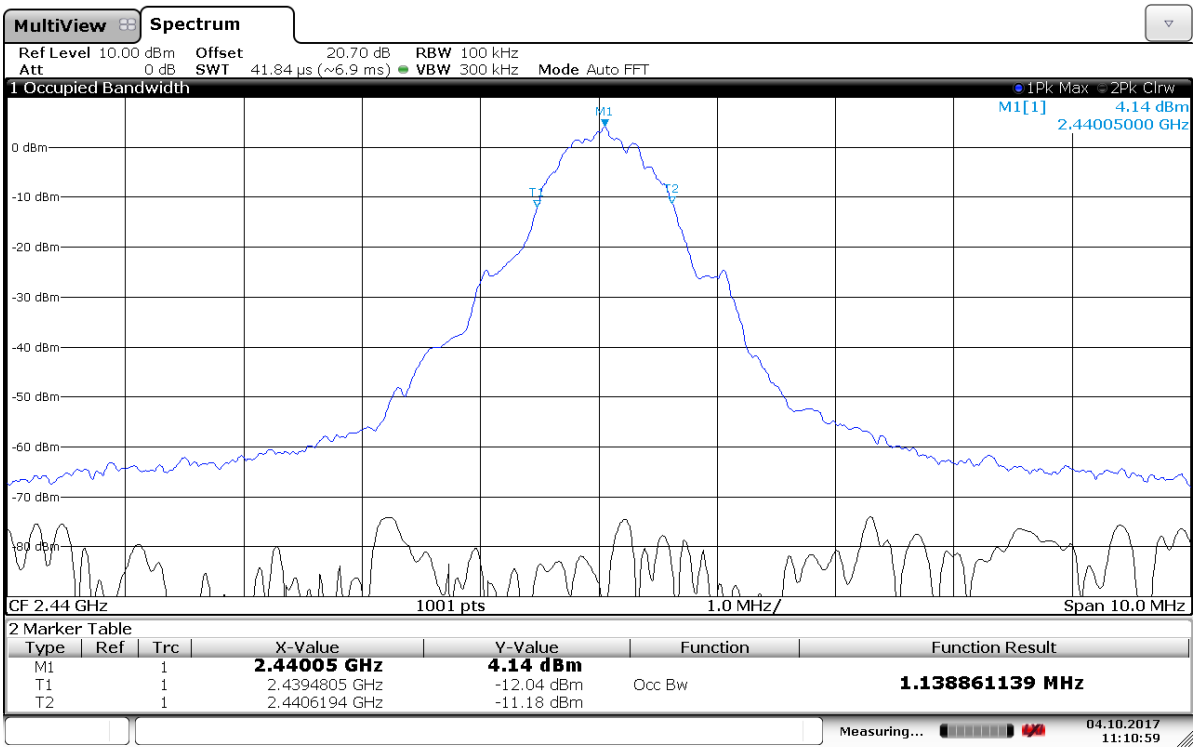
Low Channel BT LE



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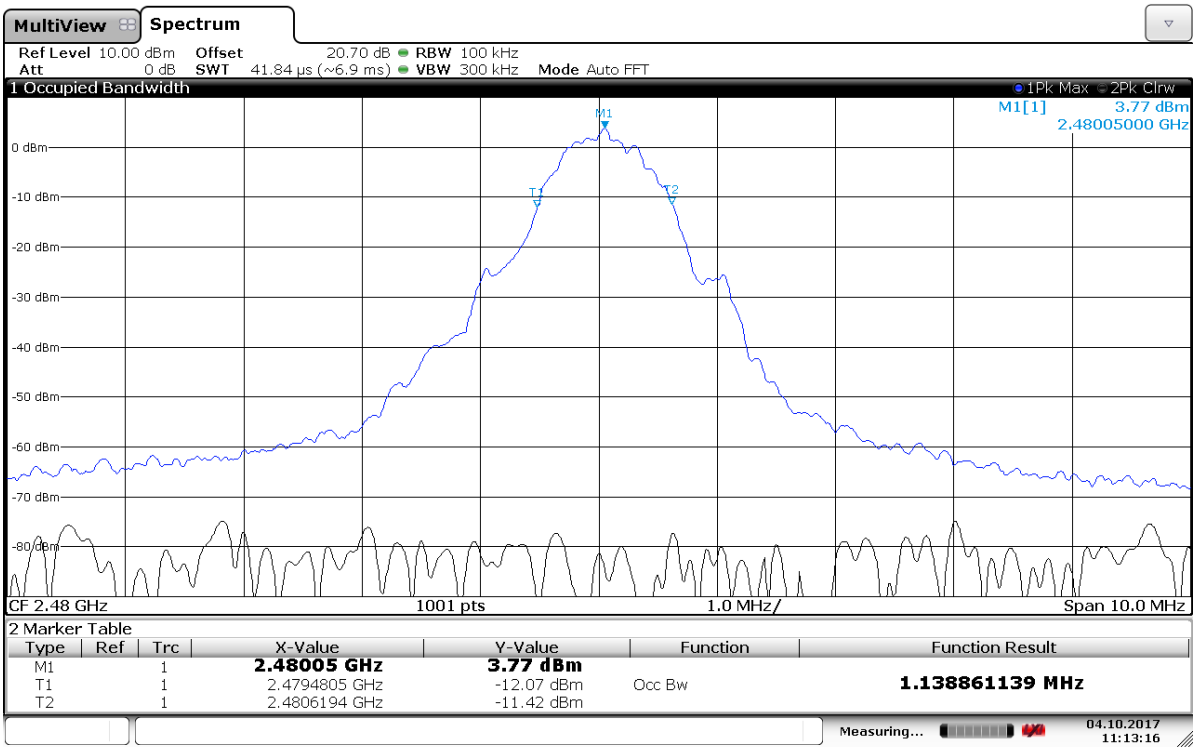

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High Channel BT LE

2.3 MINIMUM 6 dB RF BANDWIDTH

2.3.1 Specification Reference

Part 15 Subpart C §15.247(a)(2) and RSS-247 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: EMC Sample 1 / Default Test Configuration

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

October 04, 2017 / IR

2.3.5 Test Equipment Used

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

2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.2 °C
Relative Humidity	48.2%
ATM Pressure	99.0 kPa

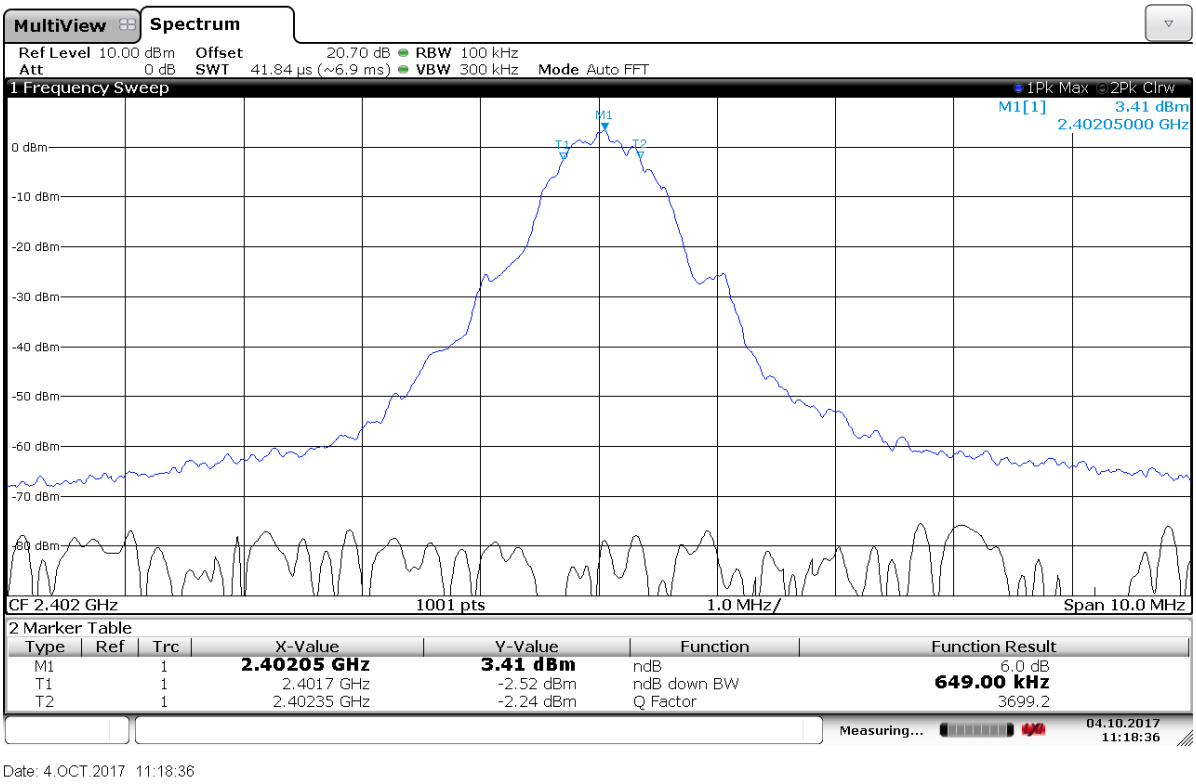
2.3.7 Additional Observations

- This is a conducted test.
- An offset 20.7dB was added to compensate for the external attenuator and cable used from the antenna port to the spectrum analyser.
- Span is wide enough to capture the channel transmission.
- RBW was set to 100 kHz while VBW is ≥3X RBW.
- Sweep is auto while Detector used is peak.
- The “n” dB down marker function of the spectrum analyzer was used for this test.

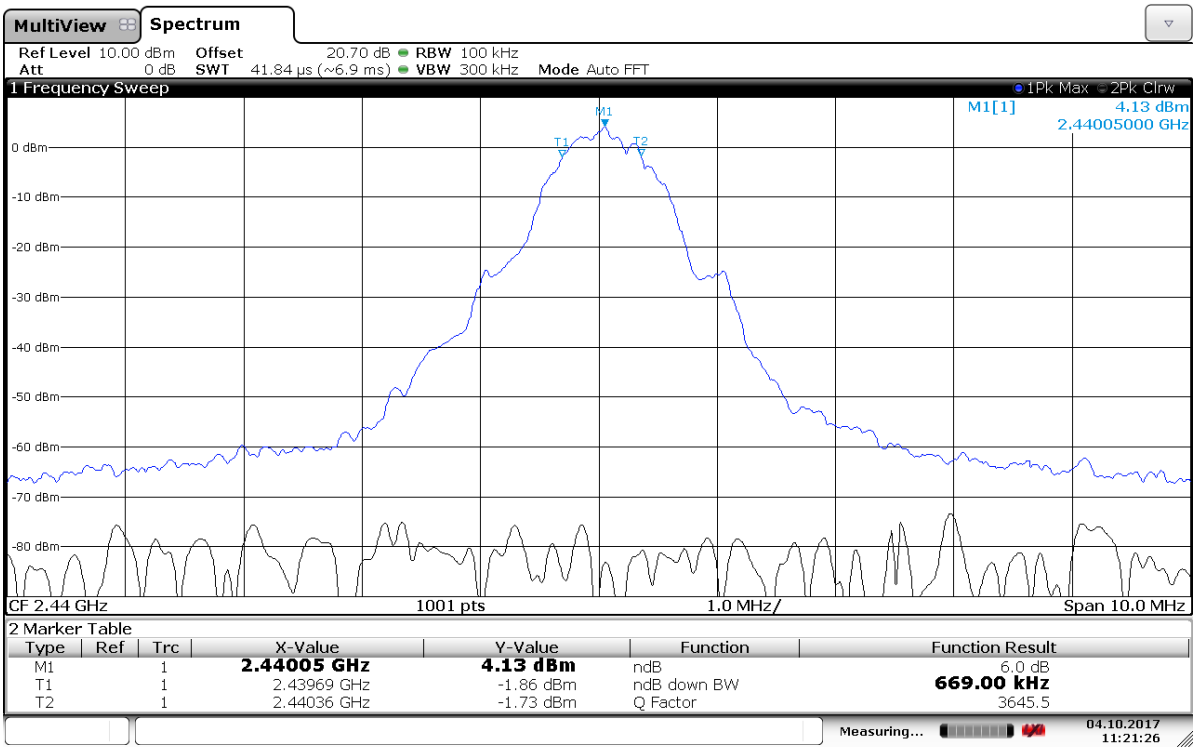
2.3.8 Test Results

Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
Bluetooth LE	2402 MHz	0.649	0.500	Complies
	2440 MHz	0.669	0.500	Complies
	2480 MHz	0.699	0.500	Complies

2.3.9 Test Results Plots



Low Channel BT LE



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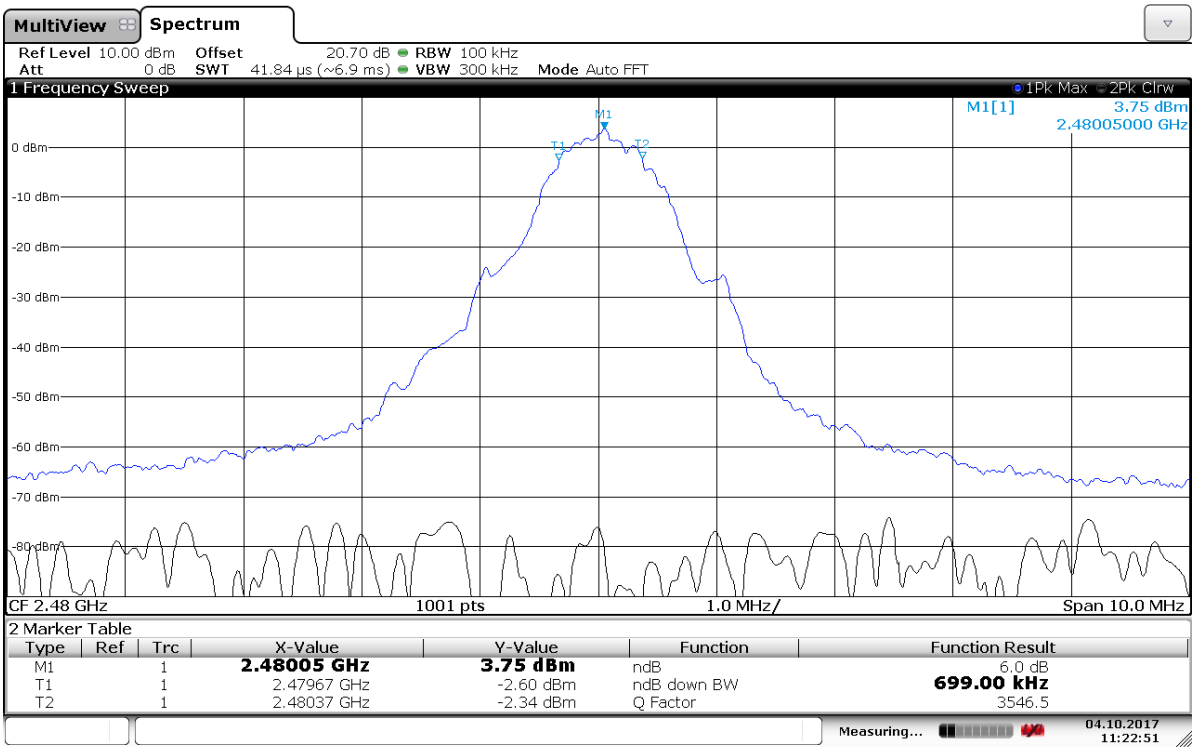
Mid Channel BT LE



Date: 4.OCT.2017 11:22:51

High Channel BT LE

2.4 OUT-OF-BAND EMISSIONS - CONDUCTED

2.4.1 Specification Reference

Part 15 Subpart C §15.247(d) and RSS-247 5.5

2.4.2 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)).

2.4.3 Equipment Under Test and Modification State

Serial No: EMC Sample 1 / Default Test Configuration

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

October 04, 2017 / IR

2.4.5 Test Equipment Used

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

2.4.6 Environmental Conditions/ Test Location

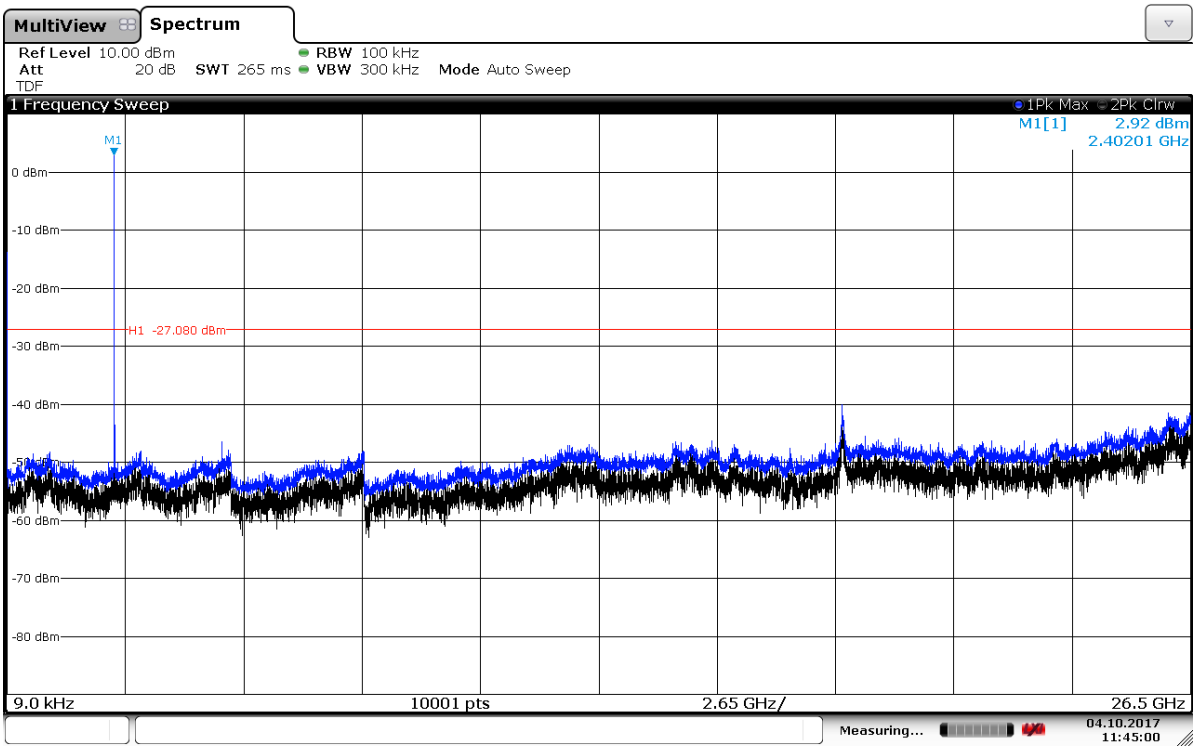
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.2 °C
Relative Humidity	48.2%
ATM Pressure	99.0 kPa

2.4.7 Additional Observations

- This is a conducted test.
- A Transducer Factor (TDF) was set for the external attenuator and cable used from the antenna port to the spectrum analyzer.
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold.
- Initial scan was performed to determine the highest level of the desired power within the band. Limit (display line) was drawn 30dB below this level (worst case).
- Spectrum was searched from 9 kHz up to 26.5GHz.

2.4.8 Test Results Plots



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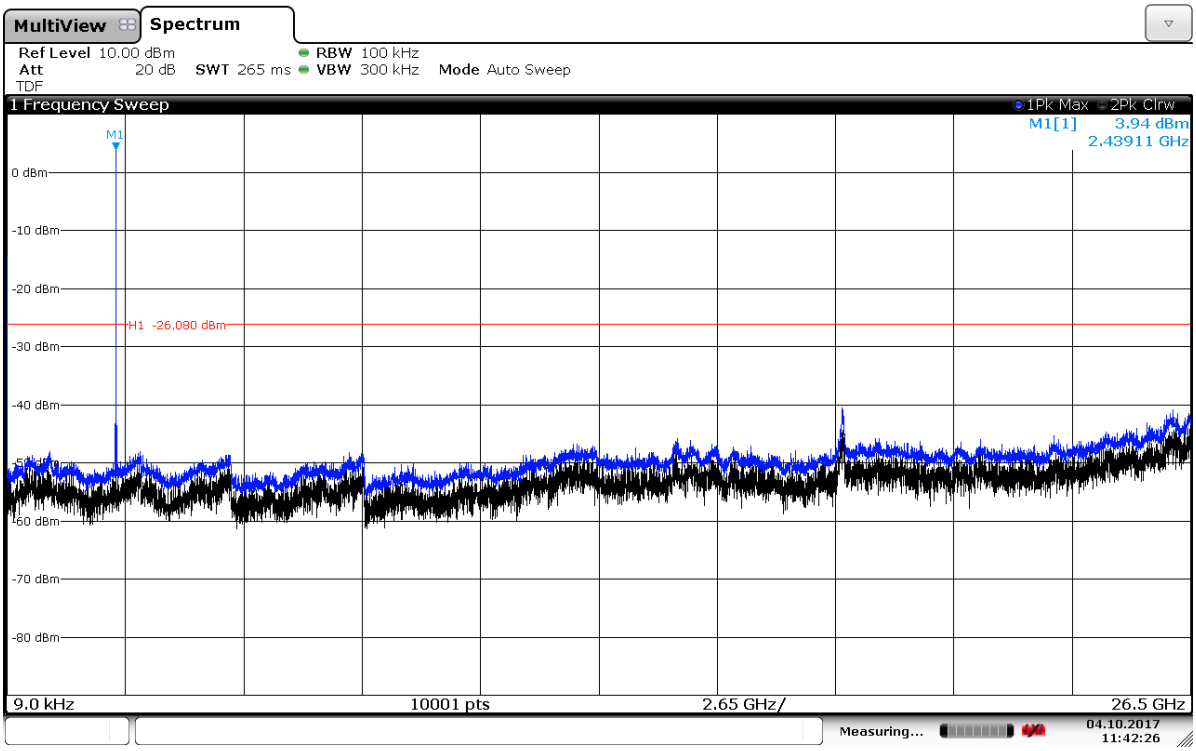
Low Channel BT LE



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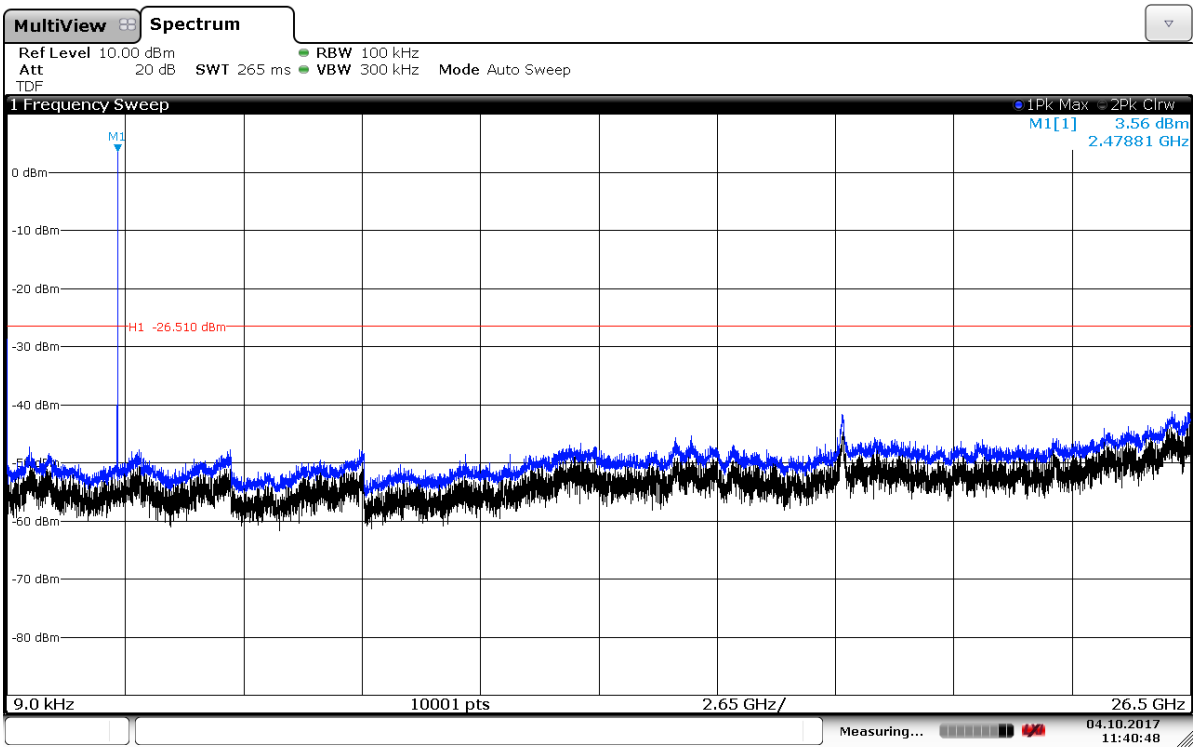
Mid Channel BT LE



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High Channel BT LE

2.5 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.5.1 Specification Reference

Part 15 Subpart C §15.247(d) and RSS-247 5.5

2.5.2 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)).

2.5.3 Equipment Under Test and Modification State

Serial No: EMC Sample 1 / Default Test Configuration

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

October 05, 2017 / IR

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.9 °C
Relative Humidity	42.6%
ATM Pressure	98.5 kPa

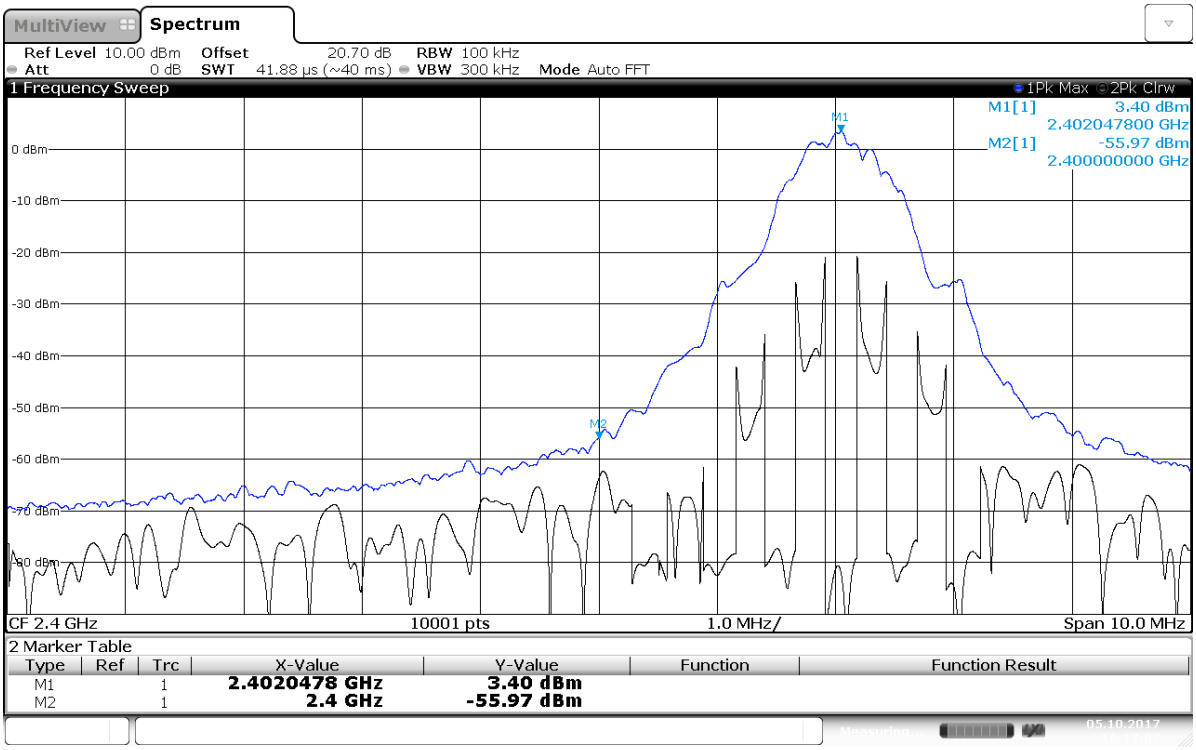
2.5.7 Additional Observations

- This is a conducted test.
- An offset of 20.7dB was added to compensate for the external attenuator and cable used from the antenna port to the spectrum analyzer
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold.
- Trace was centered on the band-edge frequency.
- Span was set to encompass the band-edge frequency and the peak of the emission.

- Using Marker function, peak of the emission was determined and the delta to the band-edge frequency measured (for EUT OBW edge not within 2MHz of the authorized band edge).

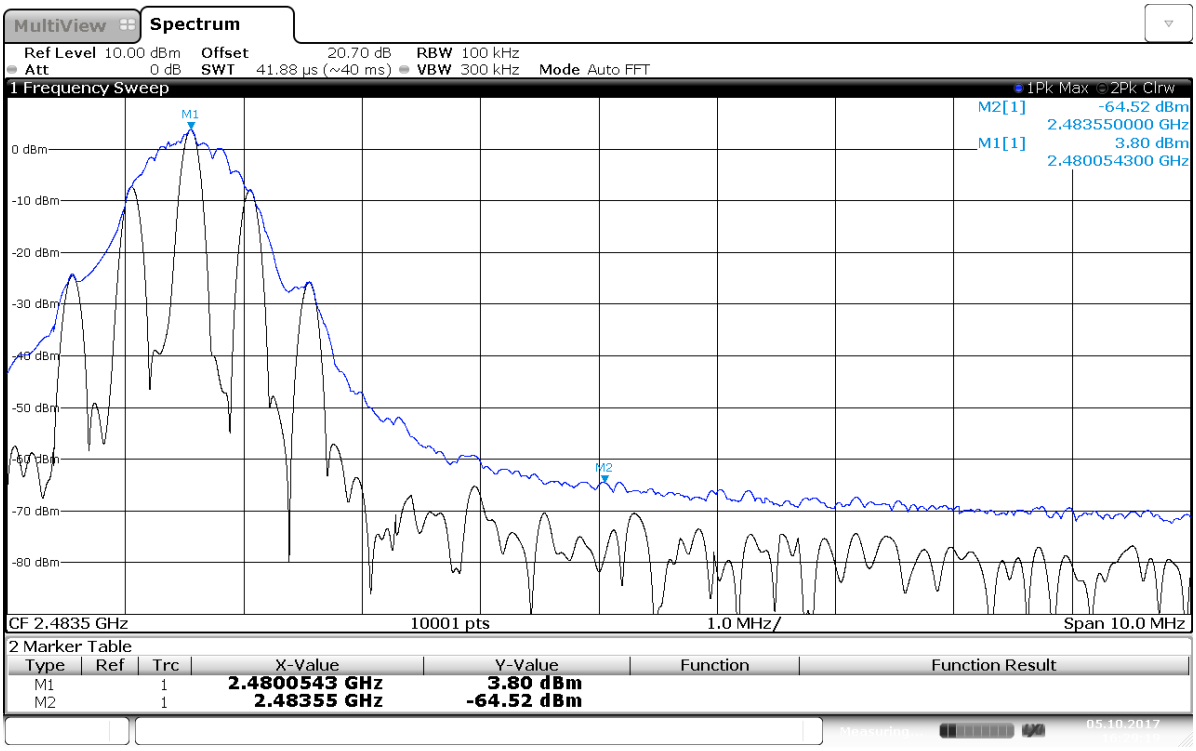
2.5.8 Test Results

Complies. See attached plots.



Date: 5.OCT.2017 16:17:06

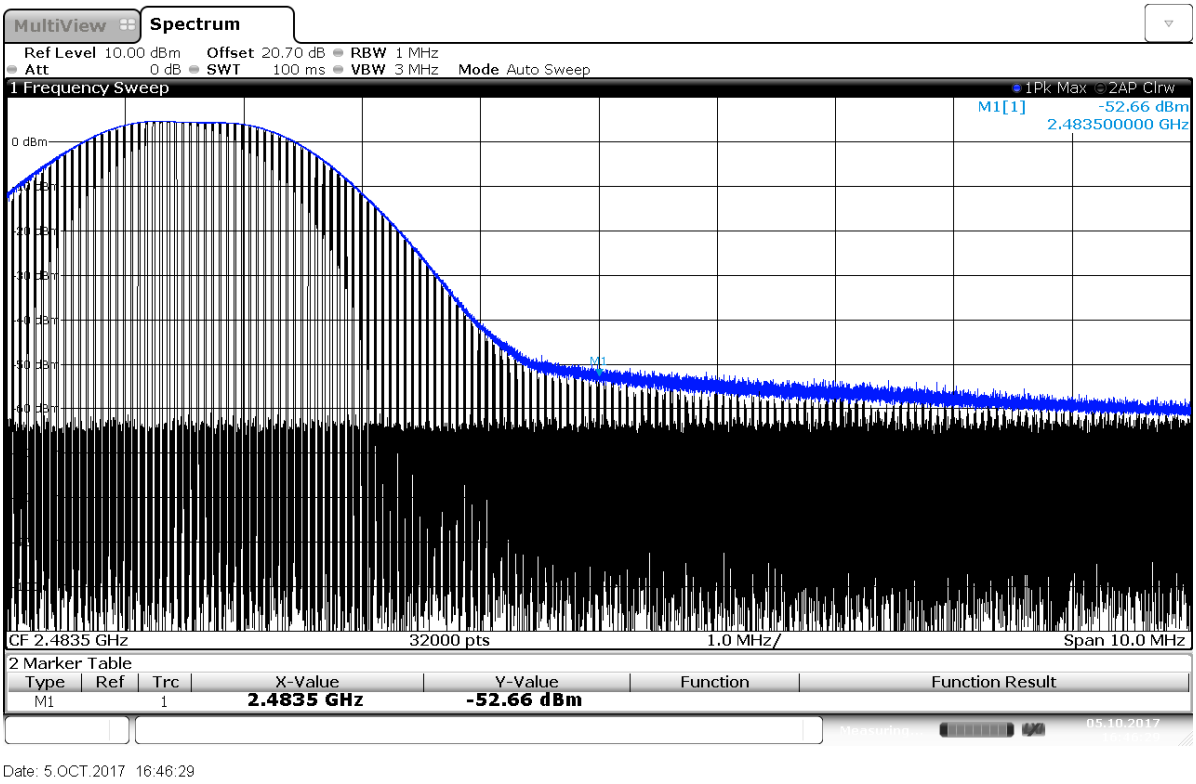
Low Channel BT LE (2402 MHz)



Date: 5.OCT.2017 16:29:19

High Channel BT LE (2480 MHz)

2.5.9 Band Edge Verification in the Restricted Band (Conducted Method)



Date: 5.OCT.2017 16:46:29

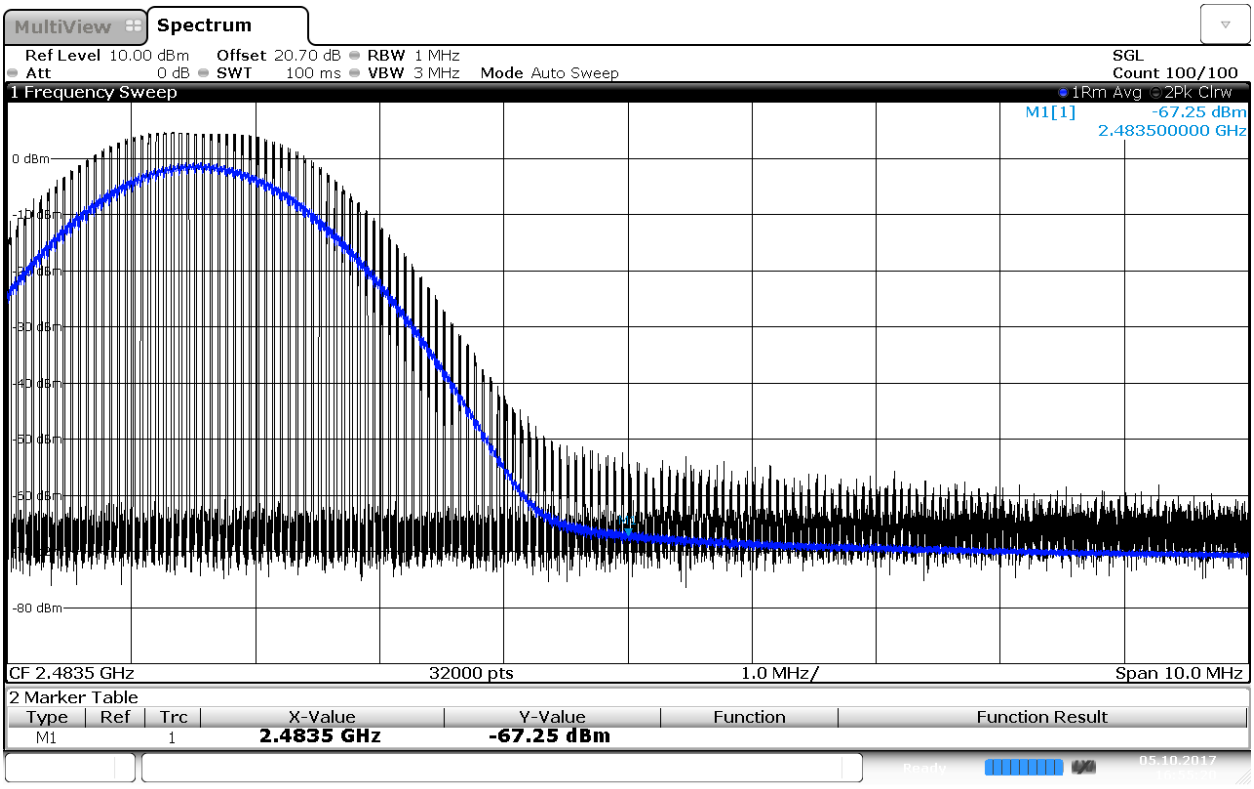
Upper Band Edge (in Restricted Band) measurement using Peak Power measurement procedure as per Clause 12.2.4 of KDB 558074

Measured Peak = -56.66 dBm, since antenna gain is 2.3dBi then EIRP is -54.66. Using the formula:

$$E = EIRP - 20\log D + 104.8$$

Where: E = electric field strength in dBµV/m
EIRP = equivalent isotropic radiated power in dBm
D = specific measurement distance in meters

E is therefore = -54.66 dBm – (20log 3 meters) + 104.8
= 40.59 dBµV/m @ 3 meters (**Complies** with the limit of 74 dBµV/m)



Date: 5.OCT.2017 16:55:20

Upper Band Edge (in Restricted Band) measurement using Average Power measurement procedure as per Clause 12.2.5 of KDB 558074

Measured RMS = -67.25 dBm, since antenna gain is 2.3 dBi then EIRP is:-64.95 . Using the formula:

$$E = EIRP - 20\log D + 104.8$$

Where: E = electric field strength in dBµV/m
EIRP = equivalent isotropic radiated power in dBm
D = specific measurement distance in meters

E is therefore = -64.95 dBm – (20log 3 meters) + 104.8
= 30.30 dBµV/m @ 3 meters (**Complies** with the limit of 54 dBµV/m)

2.6 RADIATED SPURIOUS EMISSIONS

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d) and RSS-Gen 8.9 and 8.10

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: EMC Sample 1 / Default Test Configuration

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

October 04, 2017 / IR

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	25.2 °C
Relative Humidity	48.2%
ATM Pressure	99.0 kPa

2.6.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- Test Methodology is per Clause 12.2.7 of KDB558074 D01 DTS Meas Guidance v03r05.
- 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 channel presented. Conducted port sample was presented for radiated emission test and the antenna port was terminated with 50ohm termination during evaluation for cabinet spurious emissions.

- 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.

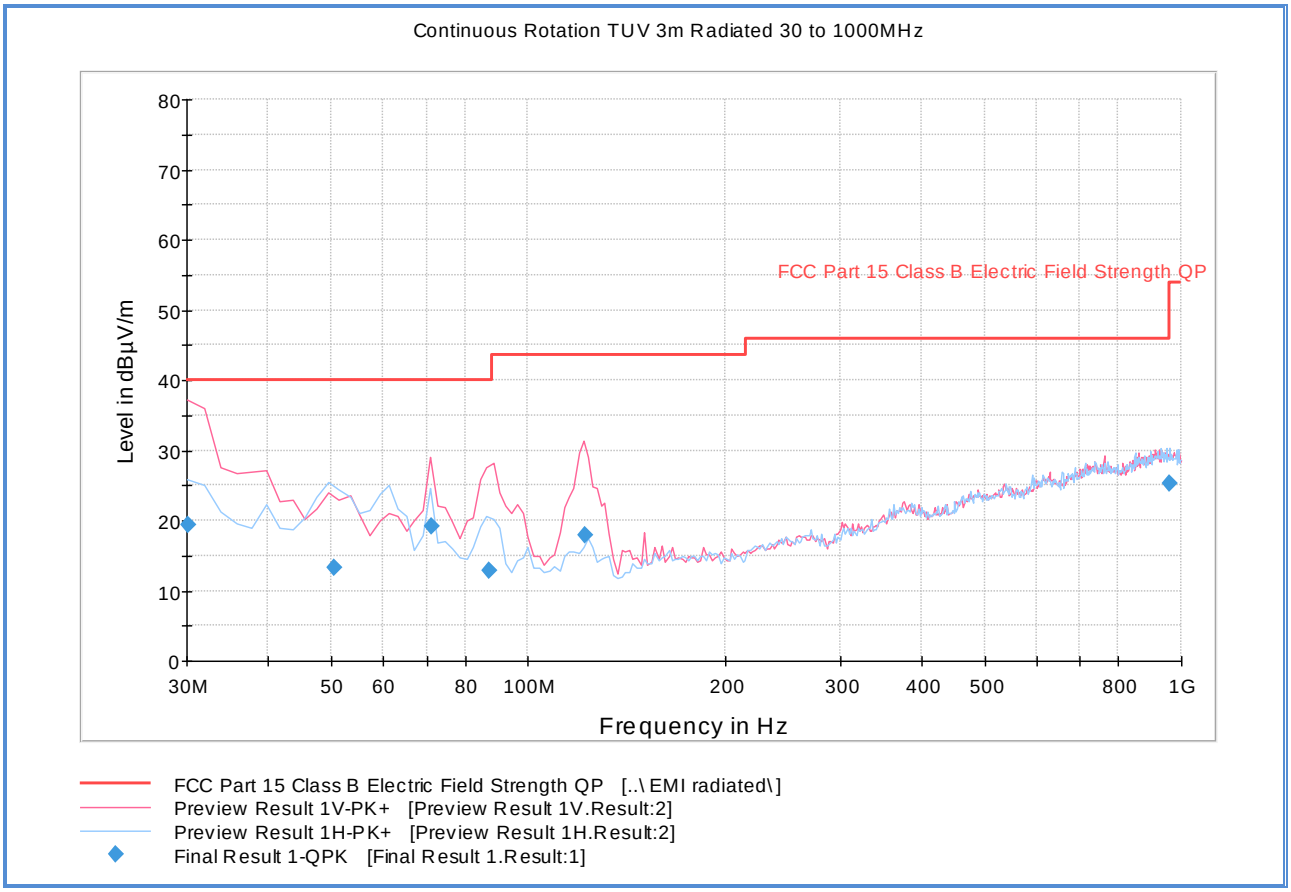
2.6.8 Sample Computation (Radiated Emission)

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

2.6.9 Test Results

See attached plots.

2.6.10 Test Results Below 1GHz (Worst Case Channel – Mid Channel)

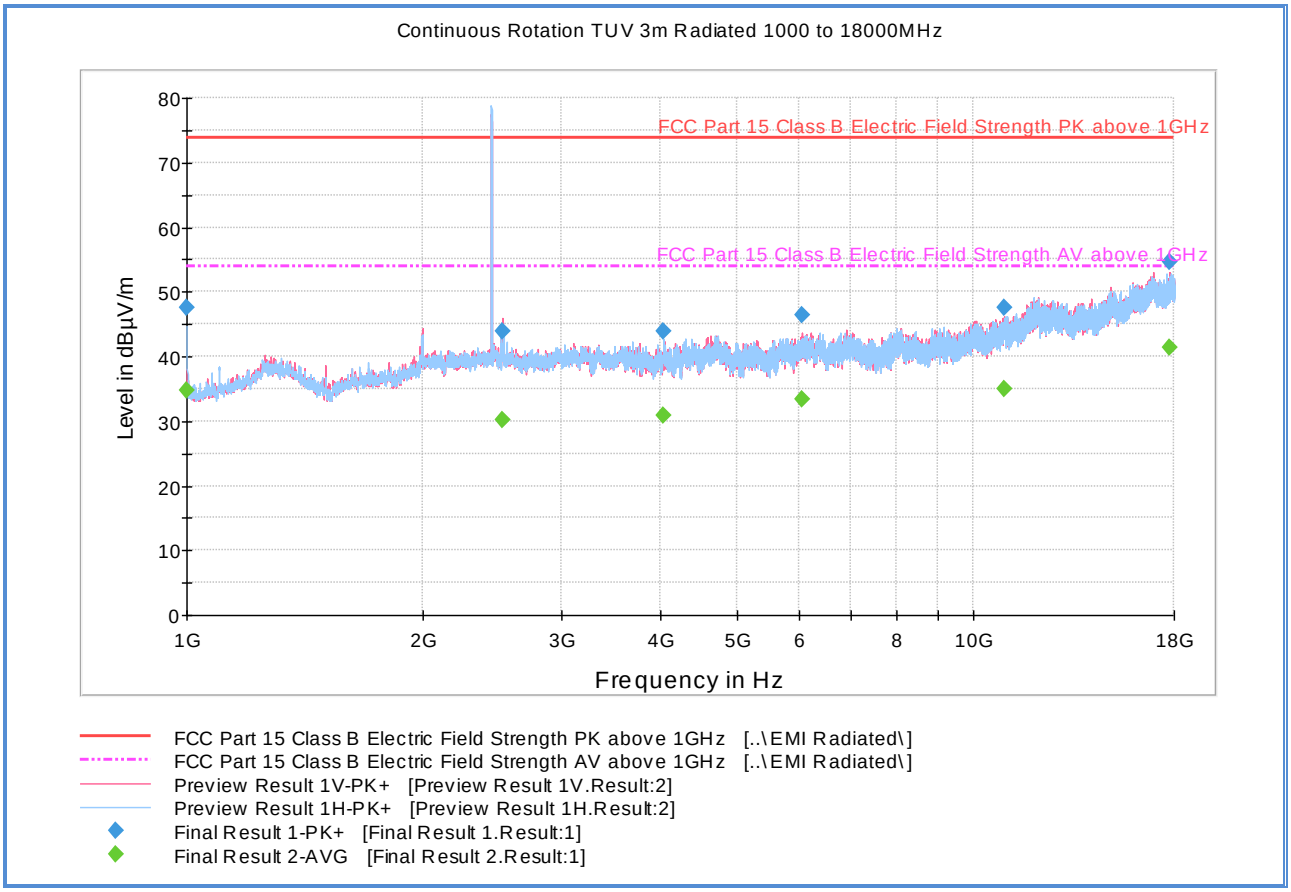


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.120000	19.3	1000.0	120.000	106.0	V	45.0	-6.0	20.7	40.0
50.438878	13.2	1000.0	120.000	400.0	H	-15.0	-14.4	26.8	40.0
70.981643	19.1	1000.0	120.000	400.0	V	186.0	-17.0	20.9	40.0
87.036633	12.7	1000.0	120.000	200.0	V	355.0	-16.5	27.3	40.0
122.402725	17.9	1000.0	120.000	200.0	V	349.0	-15.9	25.6	43.5
959.258357	25.3	1000.0	120.000	195.0	H	19.0	6.3	20.7	46.0

Test Notes: Only worst case channel presented for cabinet spurious emissions.

2.6.11 Test Results Above 1GHz (Worst Case Channel – Mid Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	47.5	1000.0	1000.000	131.4	H	36.0	-7.2	26.4	73.9
2520.733333	43.9	1000.0	1000.000	384.1	V	185.0	-0.3	30.0	73.9
4031.466667	43.8	1000.0	1000.000	384.1	H	-7.0	3.3	30.1	73.9
6054.066667	46.3	1000.0	1000.000	100.4	V	55.0	7.1	27.6	73.9
10936.300000	47.5	1000.0	1000.000	117.4	V	102.0	14.0	26.4	73.9
17776.566667	54.5	1000.0	1000.000	367.1	V	174.0	23.0	19.4	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)
1000.000000	34.7	1000.0	1000.000	131.4	H	36.0	-7.2	19.2	53.9
2520.733333	30.2	1000.0	1000.000	384.1	V	185.0	-0.3	23.7	53.9
4031.466667	30.8	1000.0	1000.000	384.1	H	-7.0	3.3	23.1	53.9
6054.066667	33.4	1000.0	1000.000	100.4	V	55.0	7.1	20.5	53.9
10936.300000	34.9	1000.0	1000.000	117.4	V	102.0	14.0	19.0	53.9
17776.566667	41.3	1000.0	1000.000	367.1	V	174.0	23.0	12.6	53.9

Test Notes: Fundamental at 2.4GHz. No significant emissions observed above 10GHz. Measurements above 10GHz were noise floor figures.

2.7 POWER SPECTRAL DENSITY

2.7.1 Specification Reference

Part 15 Subpart C §15.247(e) and RSS-247 5.2(b)

2.7.2 Standard Applicable

(e) 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: EMC Sample 1 / Default Test Configuration

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

October 05, 2017 / IR

2.7.5 Test Equipment Used

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

2.7.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.9 °C
Relative Humidity	42.6%
ATM Pressure	98.5 kPa

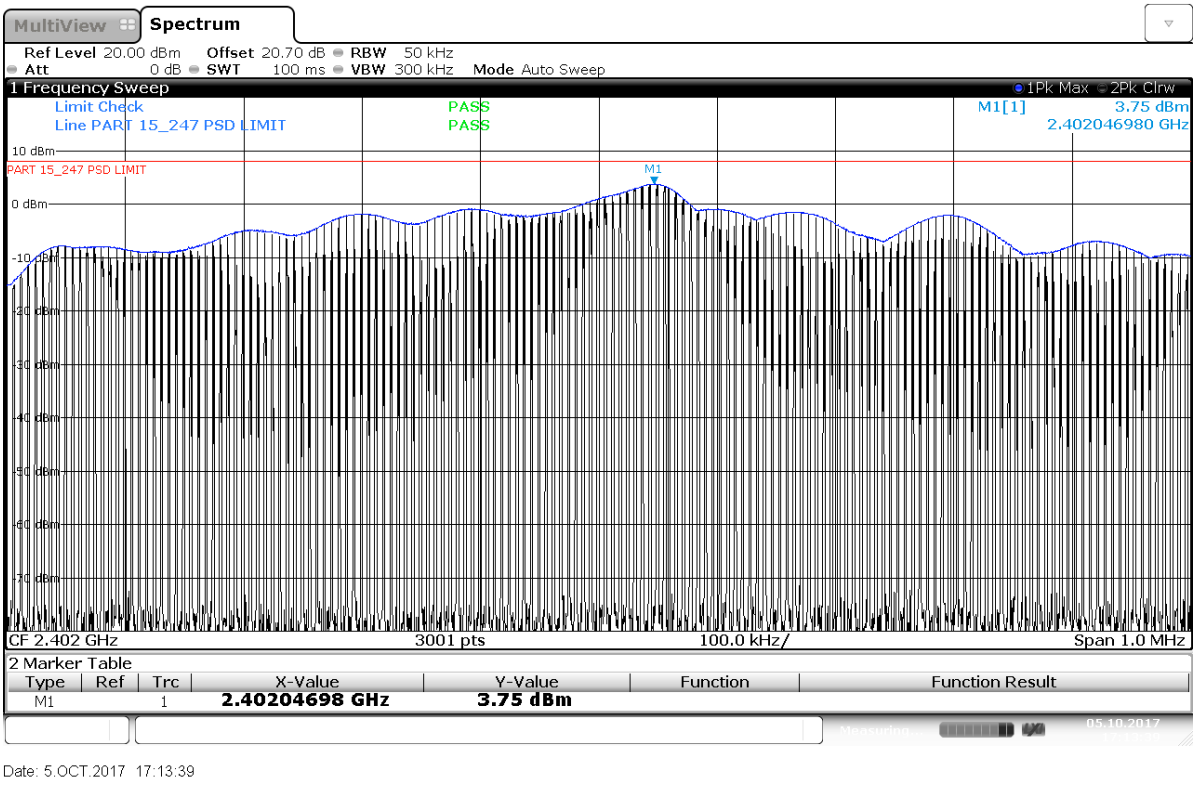
2.7.7 Additional Observations

- This is a conducted test.
- Test procedure is per Section 10.2 of KDB 558074.
- Span is 1.5 times the DTS bandwidth.
- An offset of 20.7dB was added to compensate for the external attenuator and cable used from the antenna port to the spectrum analyzer.
- Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz
- Set the VBW ≥ 3 x RBW
- Detector is Peak
- Sweep time is Auto Couple.
- Trace mode is max hold
- Trace allowed to fully stabilize.
- EUT complies with 50 kHz RBW.

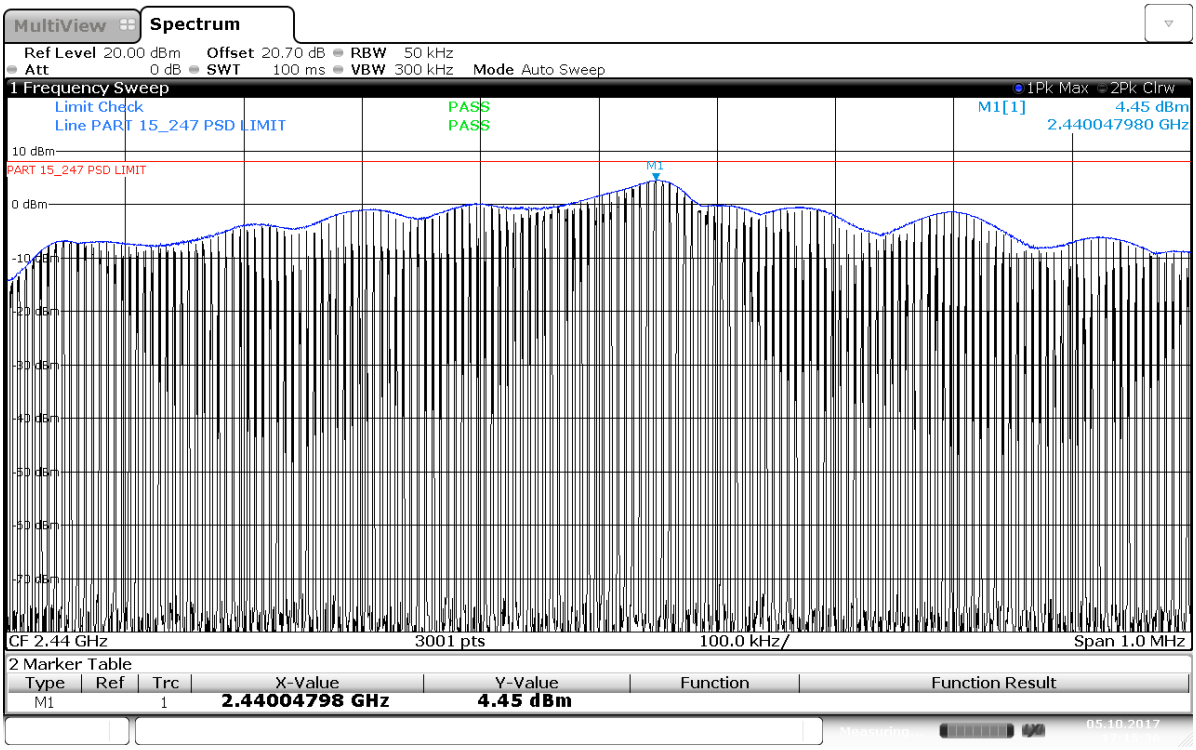
2.7.8 Test Results Summary

Mode	Channel	Marker Reading using 50 kHz RBW (dBm)	PSD Limit (dBm)	Margin (dB)	Compliance
Bluetooth LE	2402 MHz	3.75	8	4.25	Complies
	2440 MHz	4.45	8	3.55	Complies
	2480 MHz	3.76	8	4.24	Complies

2.7.9 Test Results Plots



Low Channel BT LE



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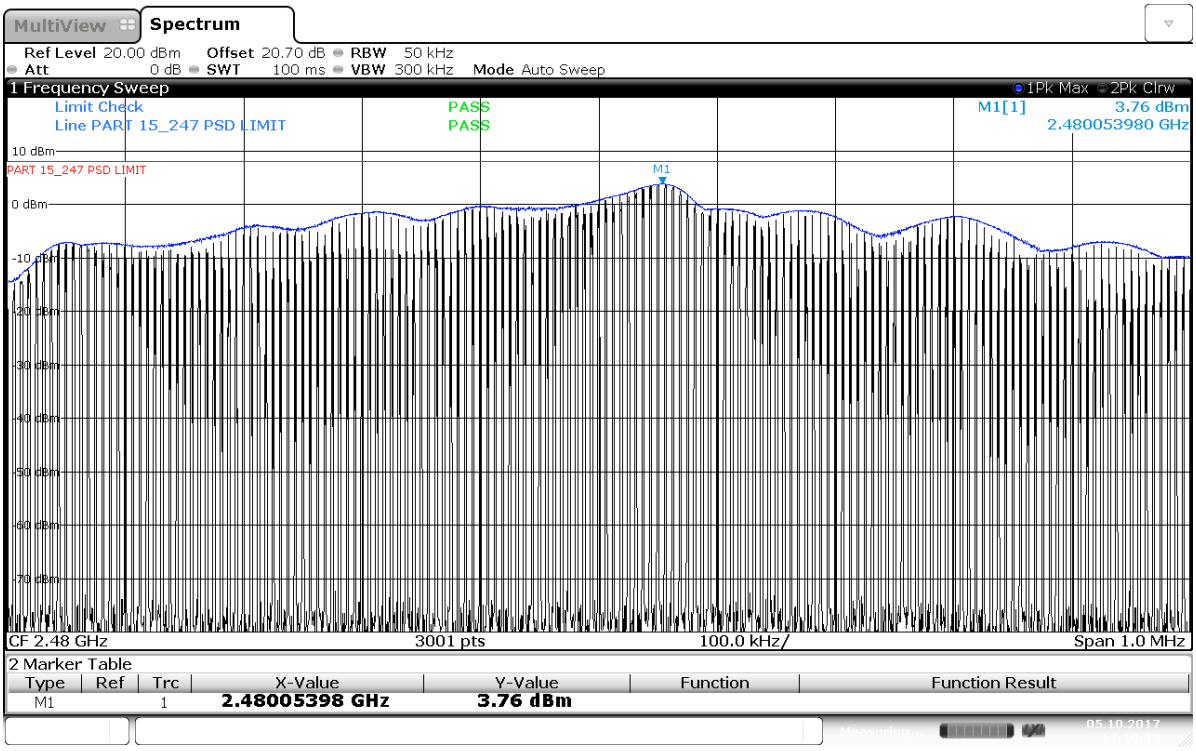
Mid Channel BT LE



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High Channel BT LE

SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

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

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Antenna Conducted Port Setup						
7606	USB RF Power Sensor	RadiPower RPR3006W	14I00048SNO048	DARE!! Instruments	11/30/16	11/30/17
7582	Signal/Spectrum Analyzer	FSW26	101614	Rhode & Schwarz	10/26/16	10/26/17
8871	20dB Attenuator	CAT-20	N/A	MCL HAT-20	04/26/17	04/26/18
Radiated Test Setup						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	11/06/15	11/06/17
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	10/07/16	10/07/17
1016	Pre-amplifier	PAM-0202	187	PAM	02/09/17	02/09/18
1051	Double-ridged waveguide horn antenna	3115	9408-4329	EMCO	07/17/17	07/17/18
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	07/13/17	07/13/18
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	02/09/17	02/09/18
Miscellaneous						
6708	Multimeter	34401A	US36086974	Hewlett Packard	07/05/17	07/05/18
7554	Barometer/Temperature/Humidity Transmitter	iBTHX-W	0400706	Omega	01/17/17	01/17/18
-	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	
-	Test Software	RadiMotion	V2014.2.3	Dare Instruments	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 Radiated Measurements (Below 1GHz)

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.75	0.43	0.19
5	Site	Triangular	3.52	1.44	2.07
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	1.68
				Coverage Factor (k):	2
				Expanded Uncertainty:	3.36

3.2.2 Radiated Emission Measurements (Above 1GHz)

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

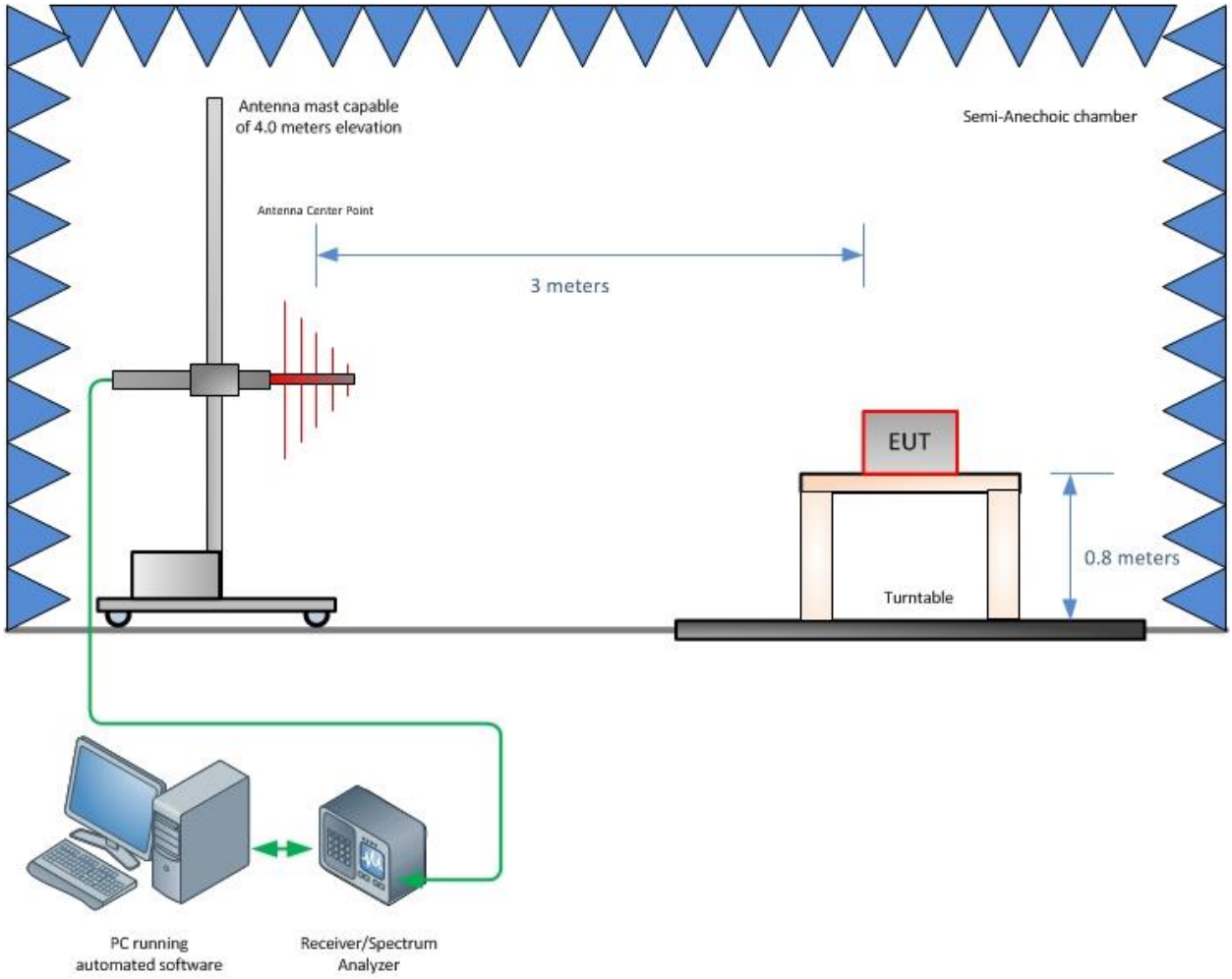
3.2.3 Conducted Antenna Port Measurement

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.34	0.20	0.04
2	Cables	Rectangular	0.30	0.17	0.03
3	EUT Setup	Rectangular	0.50	0.29	0.08
				Combined Uncertainty (u_c):	0.39
				Coverage Factor (k):	1.96
				Expanded Uncertainty:	0.76

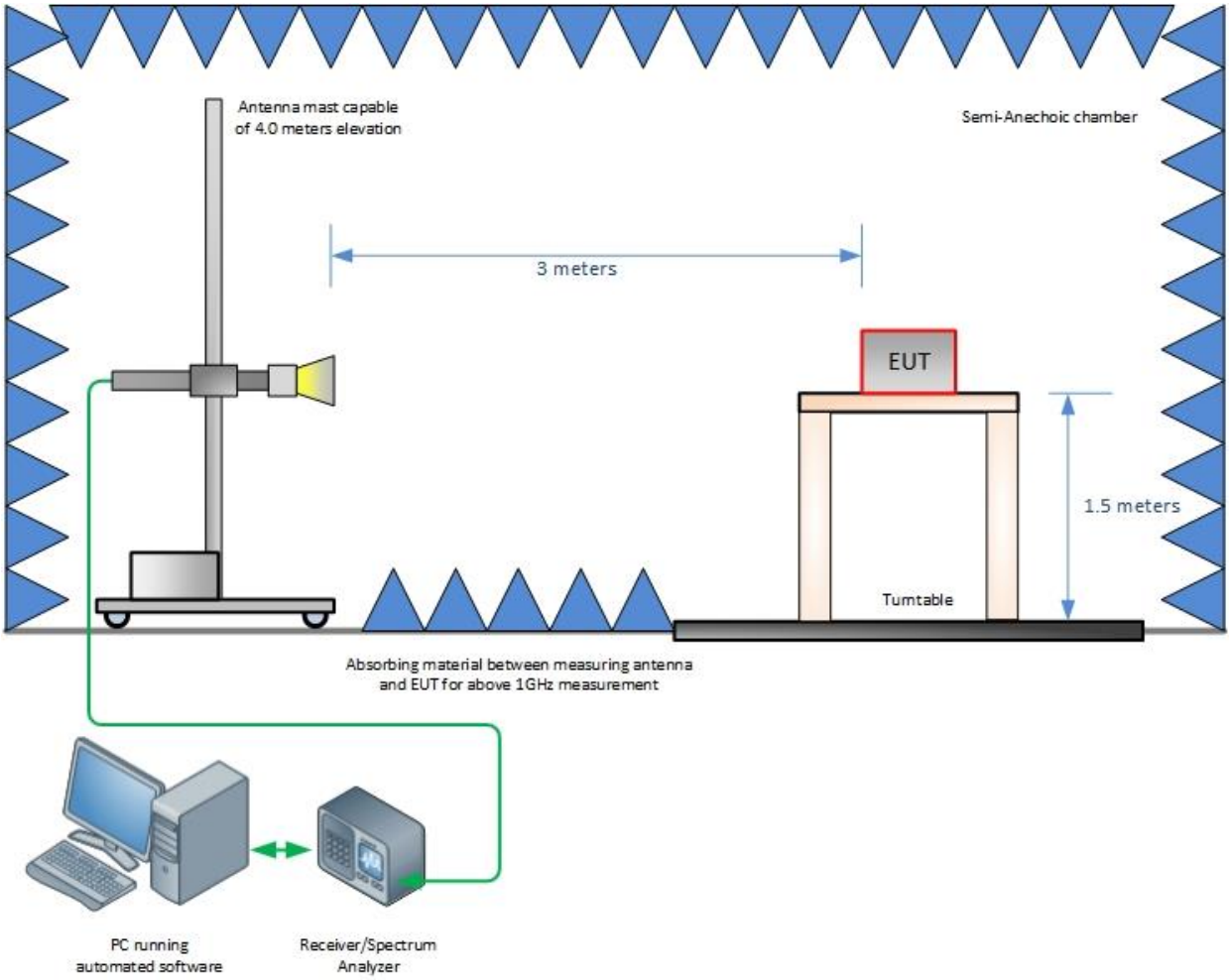
SECTION 4

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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