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Report On

Radio Testing of the
Abbott Medical

DBS EPG (External Pulse Generator) (with Bluetooth)

SCS EPG (External Pulse Generator) (with Bluetooth)

DRG EPG (External Pulse Generator) (with Bluetooth)



Telecom Technical Regulations Test Regulations LP0002

Report No. 72153296A

March 2020

REPORT ON Radio Testing of the
Abbott Medical
DBS EPG (External Pulse Generator) (with Bluetooth)
SCS EPG (External Pulse Generator) (with Bluetooth)
DRG EPG (External Pulse Generator) (with Bluetooth)

TEST REPORT NUMBER 72153296A

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Revision History

72153296A Abbott Medical DBS EPG (External Pulse Generator) (with Bluetooth) SCS EPG (External Pulse Generator) (with Bluetooth) DRG EPG (External Pulse Generator) (with Bluetooth)					
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SECTION 1

REPORT SUMMARY

Radio Testing of the
Abbott Medical
DBS EPG (External Pulse Generator) (with Bluetooth)
SCS EPG (External Pulse Generator) (with Bluetooth)
DRG EPG (External Pulse Generator) (with Bluetooth)

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Abbott Medical EPG External Pulse Generator Models 3599, 6599 and 7599 to the requirements of Telecom Technical Regulations Test Regulations LP0002.

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	Abbott Medical
Model Name	DBS EPG (External Pulse Generator) (with Bluetooth) SCS EPG (External Pulse Generator) (with Bluetooth) DRG EPG (External Pulse Generator) (with Bluetooth)
Model Number(s)	DBS EPG (External Pulse Generator): 6599 SCS EPG (External Pulse Generator): 3599 DRG EPG (External Pulse Generator): 7599
Serial Number(s)	142500148 with EPG Header 142200170
Number of Samples Tested	1
Test Specification/Issue/Date	Telecom Technical Regulations Test Regulations LP0002. Low-power Radio-frequency Devices Technical Regulations (10 January 2018 revised)
Name of Engineer(s)	Alex Chang
Related Document(s)	TUV SUD test report SD7211802-0616 Rev.01_St Jude_EPG_LP0002 (BLE)_Test Report.pdf.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with Telecom Technical Regulations Test Regulations LP0002 standard is shown below.

Section	LP0002 Spec Clause	Test Description	Result	Comments/Base Standard
2.1	3.10.1.2(1)(C)	Peak Output Power	Compliant*	See Notes
2.2	3.10.1.6(2)(A)	Minimum 6 dB RF Bandwidth	Compliant*	See Notes
2.3	3.10.1.5	Spurious RF Conducted Emissions	N/A*	
2.4	3.10.1.5	Band-edge Compliance of RF Conducted Emissions	N/A*	
2.5	3.10.1.5	Spurious Radiated Emissions	Compliant*	See Notes
2.6	3.10.1.5	Radiated Band Edge Measurements And Immediate Restricted Bands	Compliant*	See Notes
2.7	3.10.1.6(2)(B)	Peak Power Spectral Density	N/A***	See Notes
2.8	2.3	Conducted Emissions	N/A**	
2.9	2.2	Antenna Requirement	Compliant*	

N/A* Not performed since the EUT does not have a conducted port.

N/A** Not applicable. EUT is a battery-operated device.

N/A*** Not performed. EUT complies with the requirement since the measured total output power (peak conducted output power or maximum conducted output power) complies with the PSD limits.

Compliance* The device was originally evaluated previously in 2017 under TÜV SÜD test reports ref. no. SD7211802-0616 Rev.01. The EUT is being evaluated with the January 10, 2018 version of the standard. Original evaluation was made using the August 23, 2016 version. Technical requirements that applies to the EUT remained unchanged between the two versions, therefore no additional testing was deemed necessary. There were no modifications done on the EUT and all models covered by the original test report, the EUT was unchanged since the original evaluation.

The product specification of EPG with Abbott brand and St. Jude Medical brand is identical; therefore, no further evaluation was considered necessary.

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was an Abbott Medical External Pulse Generator model 3599, 6599 and 7599 as shown below. The External Pulse Generator (EPG) is an external trial generator that when connected to trial neurostimulation leads delivers therapeutic stimulation to parts of the body. The EPG communicates wirelessly with system programmers and controllers. The EPG header connects directly to the EPG for a neurostimulation trial. The EPG header can hold one or more leads or extensions with up to 16 electrodes total. The Bluetooth LE function was verified in this test report (originally evaluated under TÜV SÜD test reports ref. no. SD7211802-0616 Rev.01).

The model differences between 3599, 6599 and 7599 are the following:

- Model 3599 is an external pulse generator dedicated to provide therapy via Spinal Cord Stimulation.
- Model 6599 provides therapy via Deep Brain Stimulation.
- Model 7599 provides therapy via Dorsal Root Ganglion.

RF portion between the three models are identical. Only model 3599 was presented for evaluation by the manufacturer.



Equipment Under Test

1.3.2 EUT General Description

EUT Description	External Pulse Generator
Model Name	DBS EPG (External Pulse Generator) (with Bluetooth) SCS EPG (External Pulse Generator) (with Bluetooth) DRG EPG (External Pulse Generator) (with Bluetooth)
Model Number(s)	DBS EPG (External Pulse Generator) (with Bluetooth): 6599 SCS EPG (External Pulse Generator) (with Bluetooth): 3599 DRG EPG (External Pulse Generator) (with Bluetooth): 7599
Rated Voltage	6VDC supplied by 2 non-rechargeable Panasonic CR2450 3V coin cell batteries
Mode Verified	Bluetooth LE
Capability	Bluetooth LE
Primary Unit (EUT)	☒ Production ☐ Pre-Production ☐ Engineering
Antenna Type	Antenova M2M Fusca 2.4GHz SMD Embedded Ceramic
Antenna Part Number	A10192
Antenna Gain	0.8 dBi (Peak)

1.3.3 Maximum Conducted Average Output Power

Data Rate	Frequency Range (MHz)	Average Output Power (dBm)	Average Output Power (mW)
Bluetooth LE	2402 – 2480	0.2	1.05

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	The EUT (equipment under test) is programmed using an EPG Breakout (also known as "Bob-Lite") Board STJ0000588 connected via a STJ0000580 flex cable to the EPG test connector. Radio commands are programmed using Terminal v1.9b client software.

1.4.2 EUT Exercise Software

HQTS Software in EUT; Abbott part number 75-0206;
Terminal v1.9b in laptop used to program channel and test mode into EUT.

1.4.3 Support Equipment and I/O cables

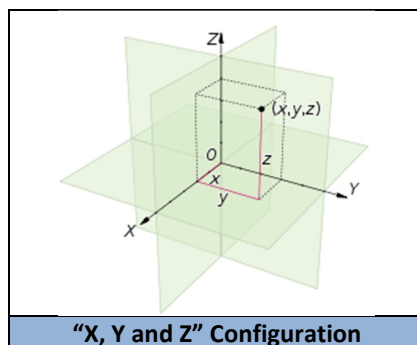
Manufacturer	Equipment/Cable	Description
IBM	Support Laptop	Think Pad X60 S/N LV-B7085 06/08
Abbott	Break Out Board Lite	Abbott Part # 95-0851
Abbott	Resistance Load Box	Abbott part # 95-0506-03
-	(2) Octrode Leads	90cm; Abbott Part # 45-0041

1.4.4 Worst Case Configuration

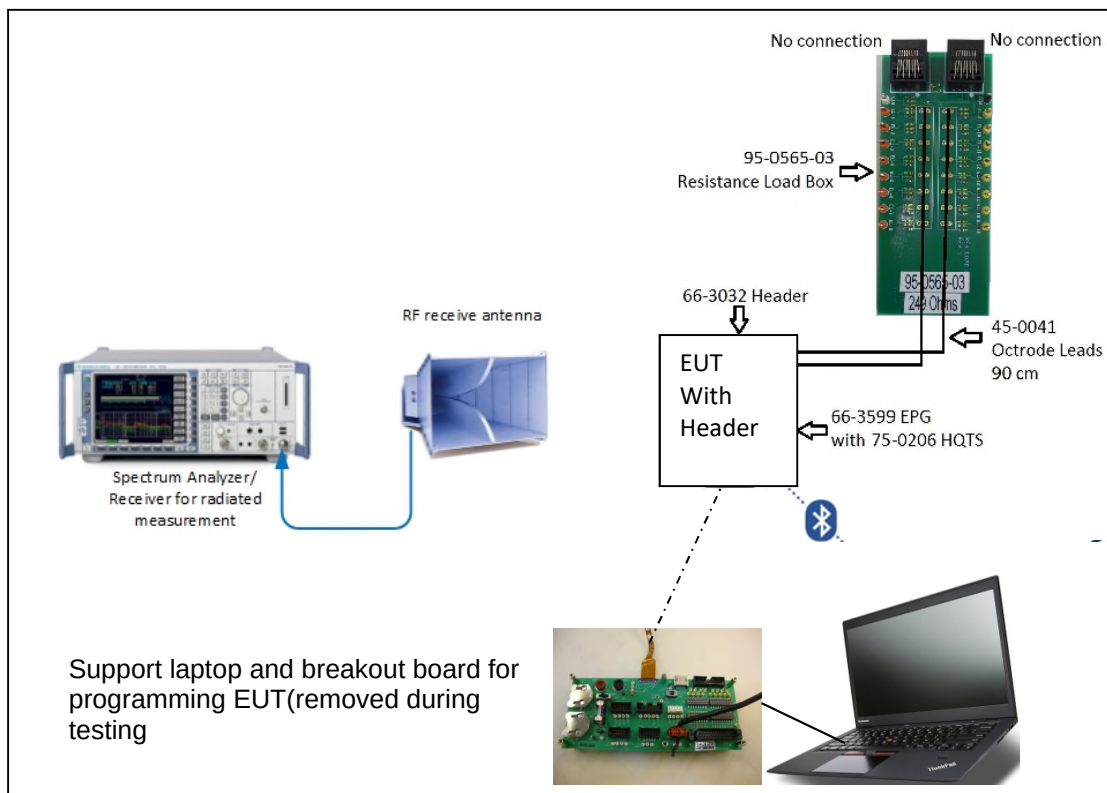
Worst-case configuration used in this test report as per maximum conducted output power measurements:

Mode	Channel	Data Rate
Bluetooth LE	Low Channel	1Mbps

EUT is a mobile device. For radiated measurements X, Y and Z orientations were verified. Worst case position is "X".



1.4.5 Simplified Test Configuration Diagram (Radiated Test Configuration)



1.5 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: 142500148 with EPG Header 142200170		
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 LP0002 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.

SECTION 2

TEST DETAILS

Radio Testing of the
Abbott Medical
DBS EPG (External Pulse Generator) (with Bluetooth)
SCS EPG (External Pulse Generator) (with Bluetooth)
DRG EPG (External Pulse Generator) (with Bluetooth)

2.1 PEAK OUTPUT POWER

2.1.1 Specification Reference

Section 3.10.1.2(1)(C)

2.1.2 Standard Applicable

For systems using digital modulation in the 2400-2483.5MHz, and 5725-5850MHz bands: below 1 Watt.

In addition to the peak output power described in Appendix 2 for measurement, the maximum conducted output power may also be used.

Maximum Conducted Output Power is defined as the average of all symbols of the signaling alphabet delivered to all antennas and antenna when the transmitter is operating at its maximum power level. 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

Default Test Configuration (Please refer to original test reports ref. no SD7211802-0616 Rev.01 for the actual S/N used)

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

Please refer to original test reports ref. no: SD7211802-0616 Rev.01 for actual test date and initial of test engineer who performed the test

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	25.1 °C
Relative Humidity	47.8 %
ATM Pressure	99.1 kPa

2.1.7 Additional Observations

- This is a radiated test
- 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 2.1.8 for sample computation.
- Substitution method was used to determine final power measurement in dBm.

2.1.8 Sample Computation (Radiated Emission)

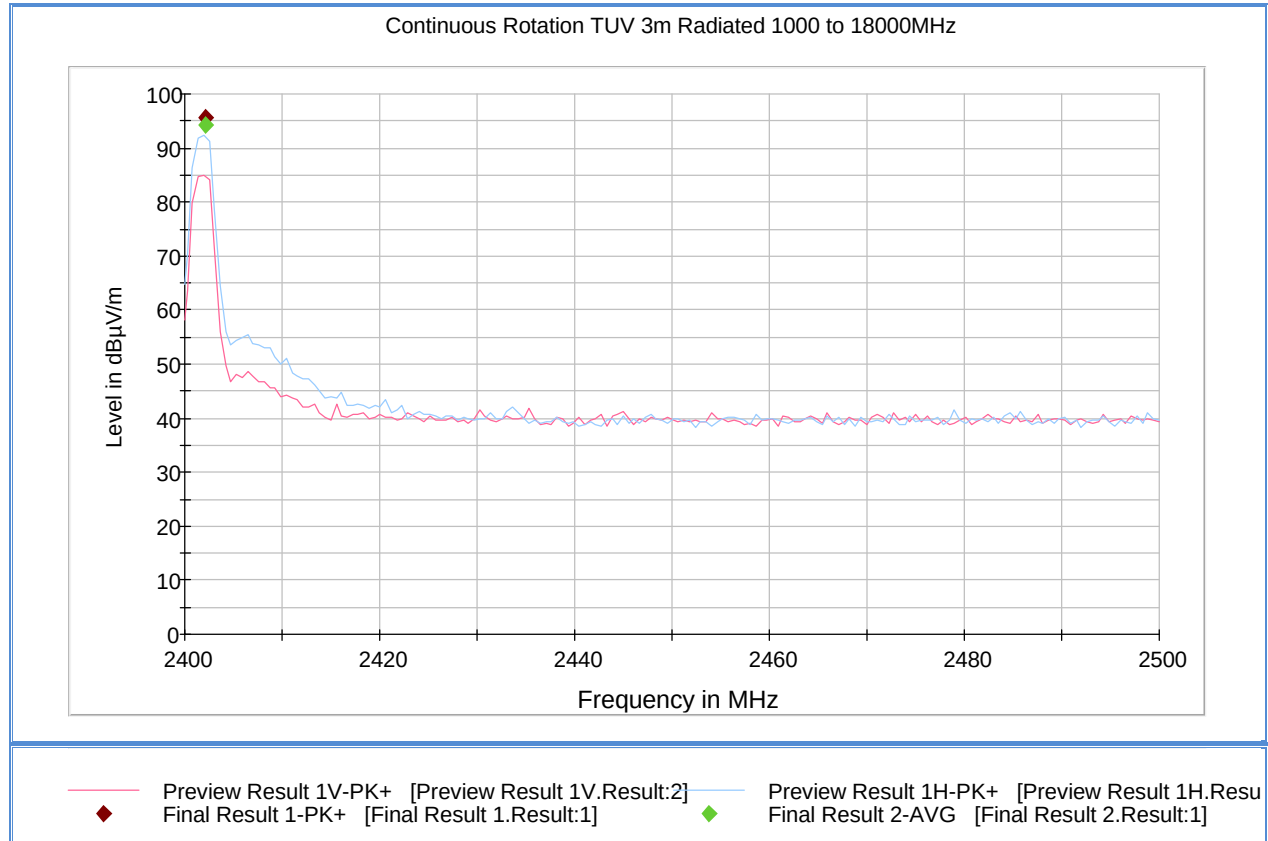
Measuring equipment raw measurement (dB μ V) @ 2400 MHz			53.9
Correction Factor (dB)	Asset# 1153 (cable)	3.4	-0.4
	Asset# 8628(preamplifier)	-36.5	
	Asset#7575 (antenna)	32.7	
Reported Max Peak Final Measurement (dBμV/m) @ 2400 MHz			53.5

2.1.9 Test Results

Bluetooth Low Energy (LE)	Channel	Modulation	Measured Average Power (dBm)	Calculated Average Power (mW)
	2402 MHz	GFSK @ 1Mbps	0.2	1.05
	2440 MHz		-3.4	0.46
	2480 MHz		-3.8	0.42

Channel numbers used were manufacturer programmed channels and not of the standard BLE channels

2.1.10 Peak Output Power Test Results (Bluetooth LE_Low Channel 1Mbps)



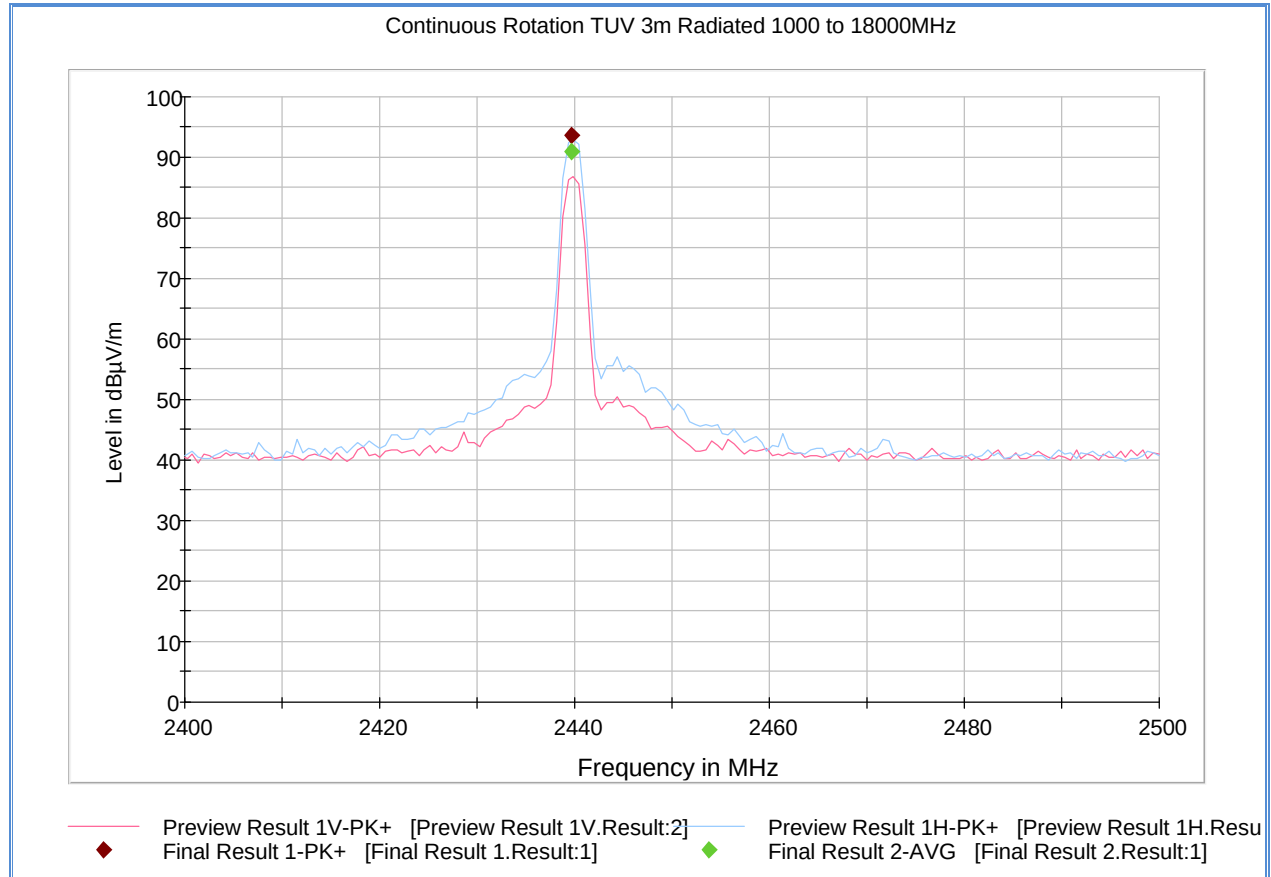
Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2402.133333	94.3	1000.0	1000.000	116.7	H	351.0	-0.2

Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dBμV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance
2402.133333	94.3	3.7	9.503	-6.0	0.2	30	Compliant

2.1.11 Peak Output Power Test Results (Bluetooth LE_Mid Channel 1Mbps)



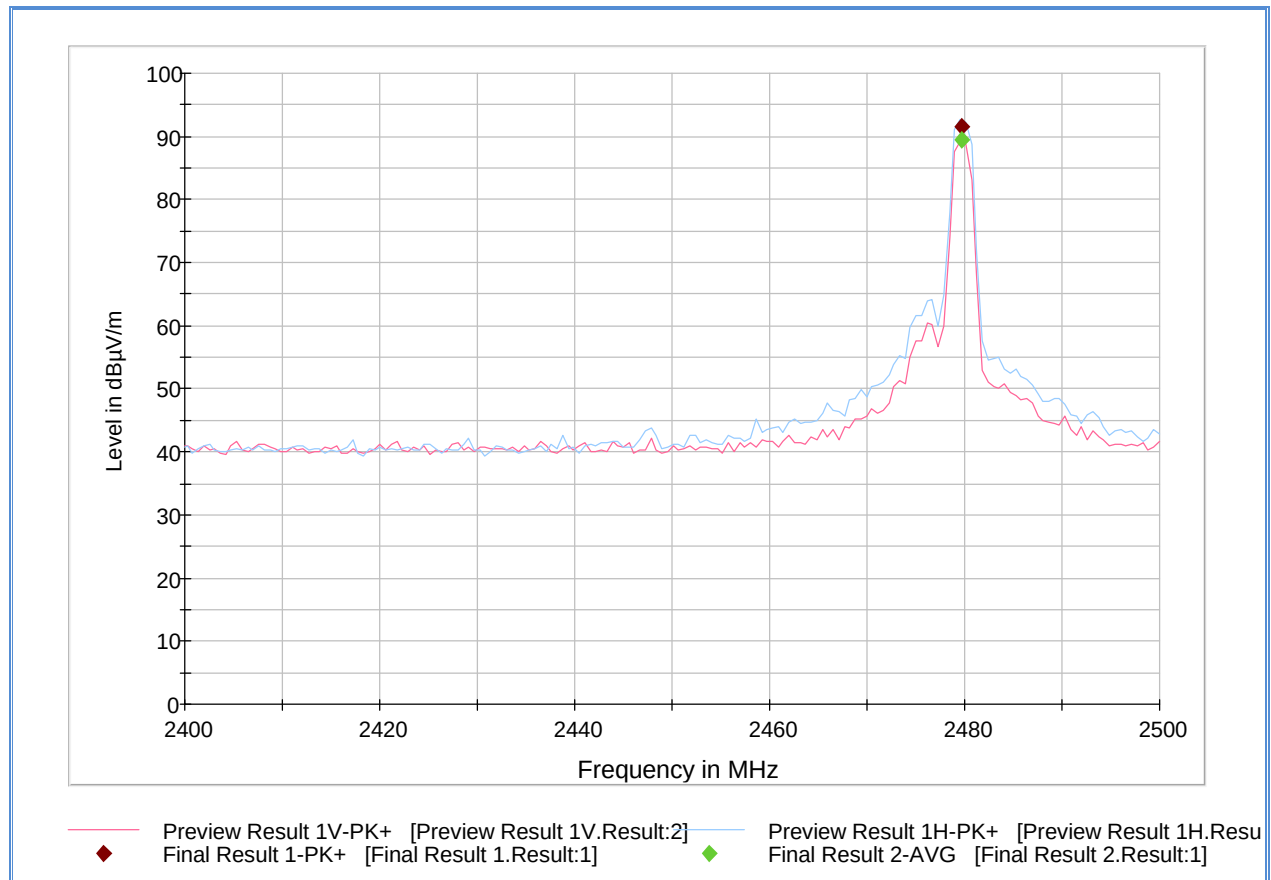
Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2439.700000	91.0	1000.0	1000.000	113.7	H	86.0	0.0

Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dBμV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance
2439.700000	91.0	3.7	9.503	-9.2	-3.4	30	Compliant

2.1.12 Peak Output Power Test Results (Bluetooth LE_High Channel 1Mbps)



Average Data

Frequency (MHz)	Average (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2479.766667	89.5	1000.0	1000.000	203.3	H	228.0	0.1

Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dB μ V/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance
2479.766667	89.5	3.8	9.503	-9.5	-3.8	30	Compliant

2.2 MINIMUM 6 DB RF BANDWIDTH

2.2.1 Specification Reference

Section 3.10.1.6(2)(A)

2.2.2 Standard Applicable

For digitally modulated systems, the minimum 6dB bandwidth shall be at least 500 kHz.

2.2.3 Equipment Under Test and Modification State

Default Test Configuration (Please refer to original test reports ref. no SD7211802-0616 Rev.01 for the actual S/N used)

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

Please refer to original test reports ref. no: SD7211802-0616 Rev.01 for actual test date and initial of test engineer who performed the test

2.2.5 Test Equipment Used

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

2.2.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.5 °C
Relative Humidity	52.7 %
ATM Pressure	99.2 kPa

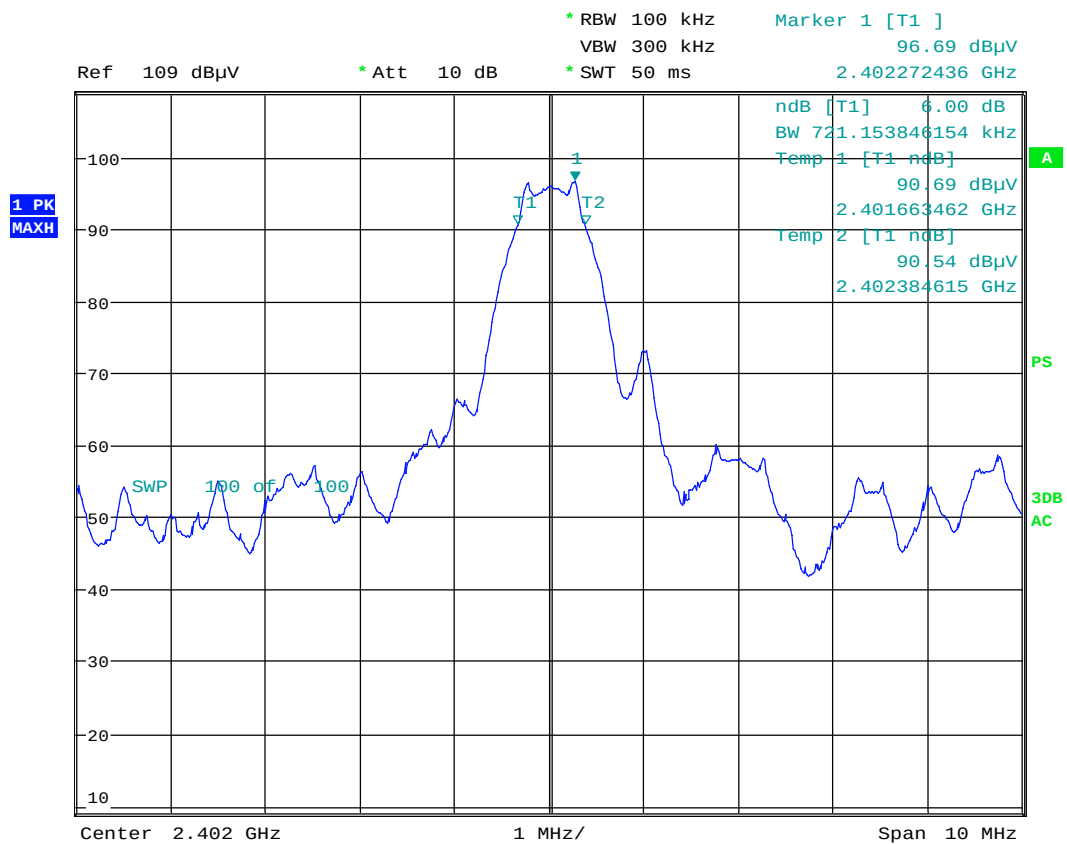
2.2.7 Additional Observations

- This is a radiated test.
- Span is wide enough to capture the channel transmission.
- RBW is set to 100 kHz.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- The “n” dB down marker function of the spectrum analyzer was used for this test.
- For signal modulation where “n” dB down marker function is not practical, a peak measurement is performed while the trace is in max hold.

2.2.8 Test Results

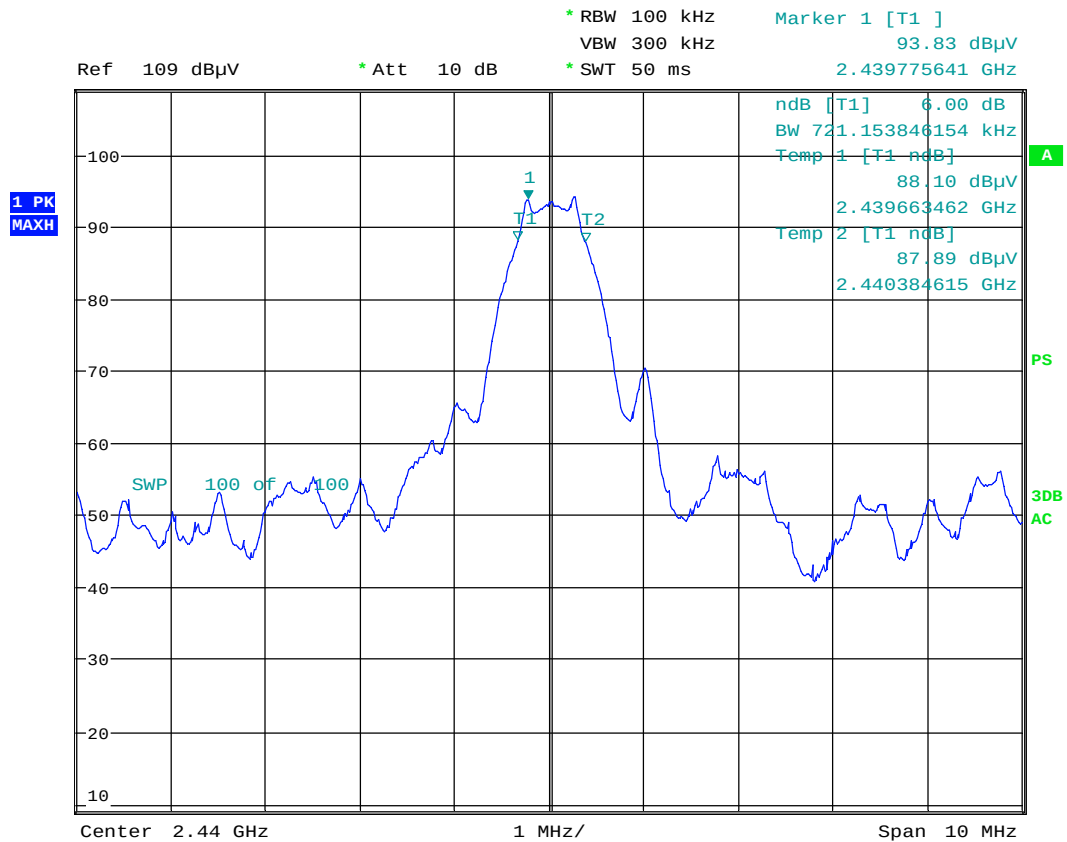
Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
Bluetooth LE	2402 MHz	0.721	0.500	Complies
	2440 MHz	0.721	0.500	Complies
	2480 MHz	0.721	0.500	Complies

2.2.9 Test Results Plots



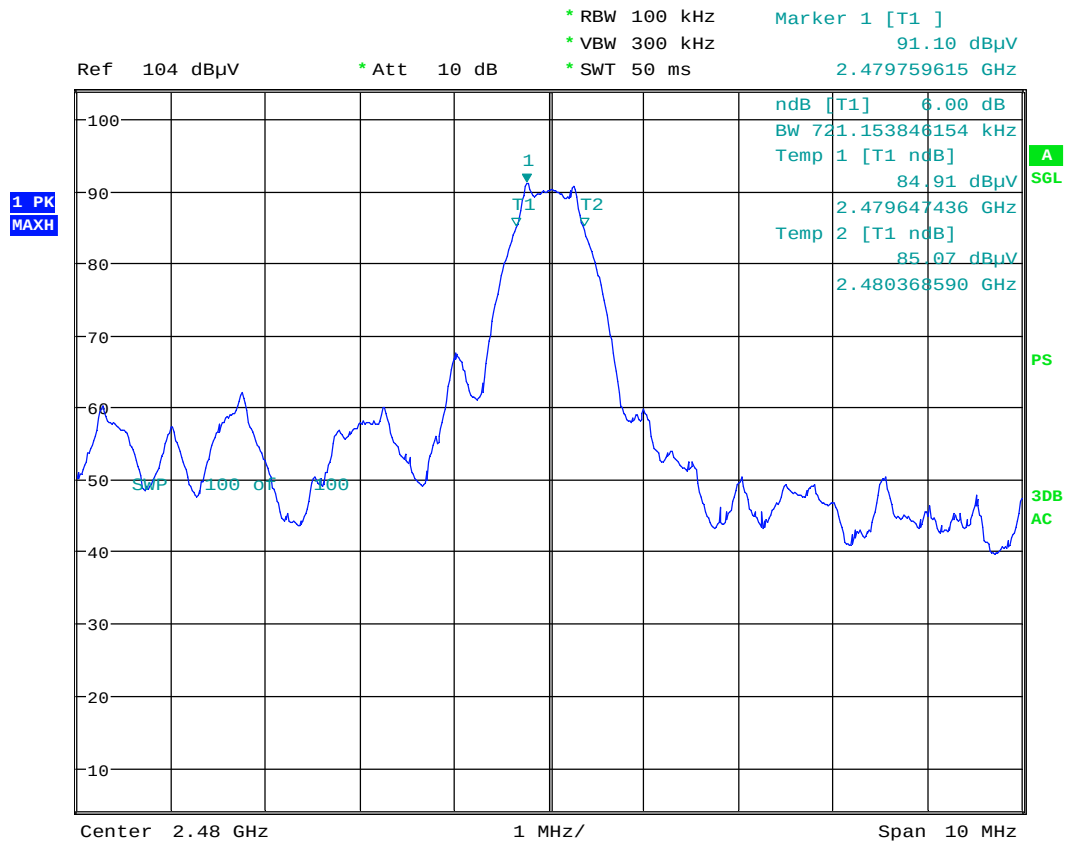
Date: 22.JUL.2014 15:56:28

Bluetooth LE Low Channel



Date: 22.JUL.2014 15:45:47

Bluetooth LE Mid Channel



Date: 22.JUL.2014 15:29:05

Bluetooth LE High Channel

2.3 SPURIOUS RF CONDUCTED EMISSIONS

2.3.1 Specification Reference

Section 3.10.1.5

2.3.2 Standard Applicable

In any 100kHz 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 below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, the attenuation shall be as below:

- (1) The attenuation shall be at least 20dB when the conducted power is measured according to the Appendix II of this part, based on either an RF conducted or a radiated measurement.
- (2) The attenuation shall be at least 30dB when the conducted power is measured according to the section 3.10.1.2(1)(C) of the standard.

In addition, radiated emissions which fall in section 2.6 the restricted bands must also comply with the radiated emission limit specified in section 2.5.

2.3.3 Equipment Under Test and Modification State

Not performed. Since the EUT does not have a conducted port, the test results from the section 2.5 apply.

2.4 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.4.1 Specification Reference

Section 3.10.1.5

2.4.2 Standard Applicable

In any 100kHz 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 below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, the attenuation shall be as below:

- (1) The attenuation shall be at least 20dB when the conducted power is measured according to the Appendix II of this part, based on either an RF conducted or a radiated measurement.
- (2) The attenuation shall be at least 30dB when the conducted power is measured according to the section 3.10.1.2(1)(C) of the standard.

In addition, radiated emissions which fall in section 2.6 the restricted bands must also comply with the radiated emission limit specified in section 2.5.

2.4.3 Equipment Under Test and Modification State

Not performed. All band edge measurements were performed using radiated measurements. Test results are presented in Section 2.6 of this test report

2.5 SPURIOUS RADIATED EMISSIONS

2.5.1 Specification Reference

Section 3.10.1.5

2.5.2 Standard Applicable

In any 100kHz 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 below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, the attenuation shall be as below:

- (1) The attenuation shall be at least 20dB when the conducted power is measured according to the Appendix II of this part, based on either an RF conducted or a radiated measurement.
- (2) The attenuation shall be at least 30dB when the conducted power is measured according to the section 3.10.1.2(1)(C) of the standard.

In addition, radiated emissions which fall in section 2.7 the restricted bands must also comply with the radiated emission limit specified in section 2.8.

2.5.3 Equipment Under Test and Modification State

Default Test Configuration (Please refer to original test reports ref. no SD7211802-0616 Rev.01 for the actual S/N used)

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

Please refer to original test reports ref. no: SD7211802-0616 Rev.01 for actual test date and initial of test engineer who performed the test

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	25.0 °C
Relative Humidity	48.8 %
ATM Pressure	99.1 kPa

2.5.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- Only considered worst case configuration presented for radiated emissions below 1GHz. There are no significant differences in emissions between all models and channels below 1GHz.
- FCC limit presented are identical to the limit under Section 2.8 of the present standard (LP0002).
- 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 2.5.8 for sample computation.

2.5.8 Sample Computation (Radiated Emission)

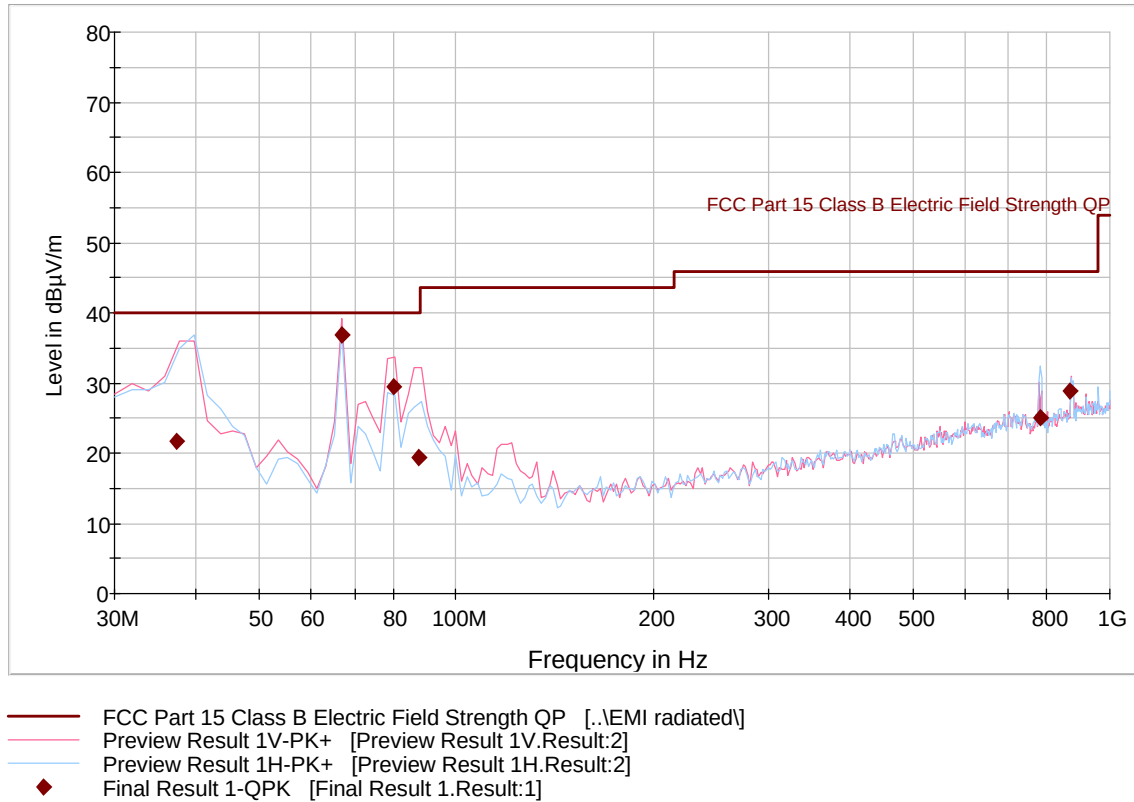
Measuring equipment raw measurement (dB μ V) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported Quasi Peak Final Measurement (dB μ V/m) @ 30MHz			11.8

2.5.9 Test Results

See attached plots.

2.5.10 Test Results Below 1GHz (Receive Mode)

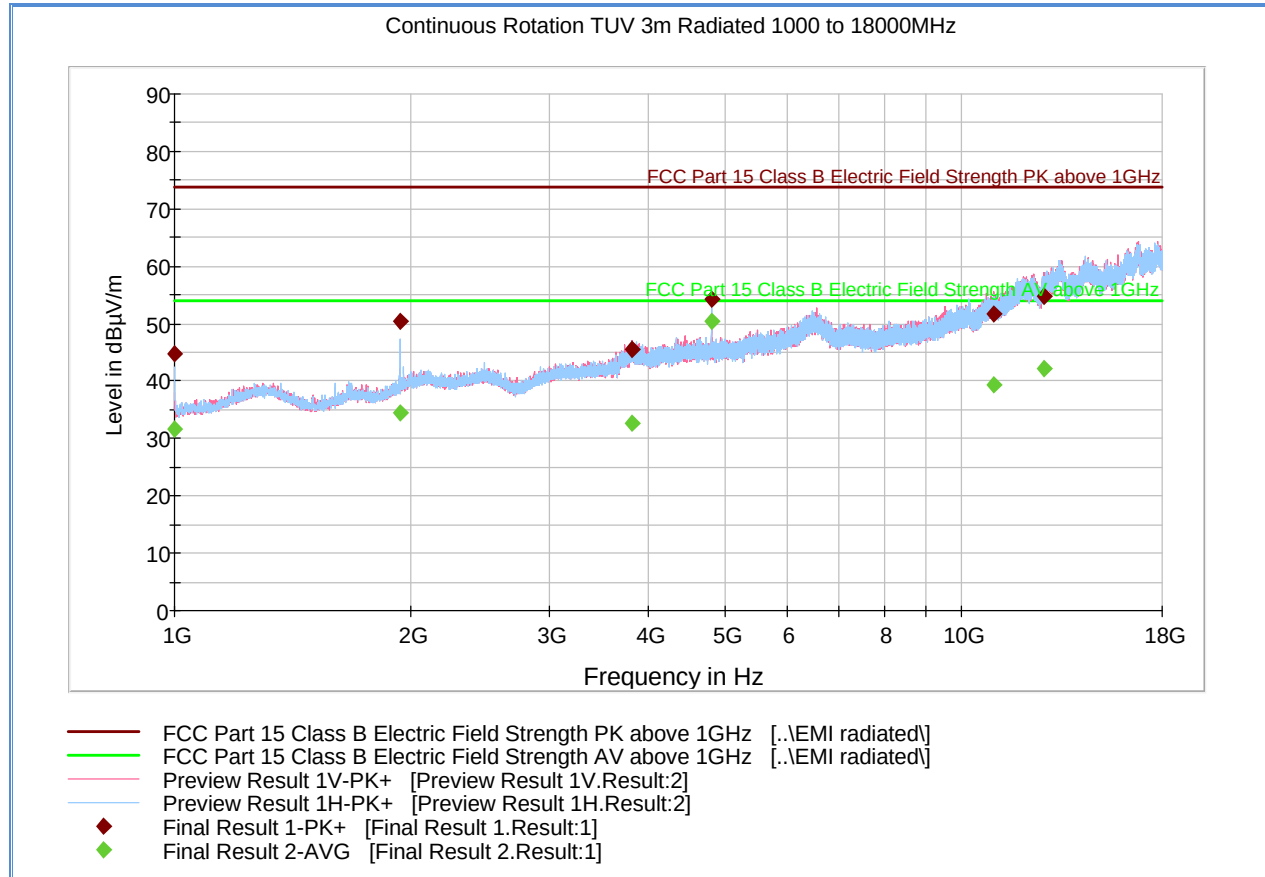
Continuous Rotation TUV 3m Radiated 30 to 1000MHz



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dB μ V/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dB μ V/m)
37.239439	21.8	1000.0	120.000	250.0	H	11.0	-14.3	18.2	40.0
66.773868	36.9	1000.0	120.000	100.0	V	318.0	-21.4	3.1	40.0
80.021082	29.4	1000.0	120.000	170.0	V	73.0	-21.0	10.6	40.0
87.452745	19.3	1000.0	120.000	300.0	V	-4.0	-20.4	20.7	40.0
782.684569	25.0	1000.0	120.000	100.0	H	112.0	-0.2	21.0	46.0
870.863407	28.8	1000.0	120.000	250.0	H	38.0	0.8	17.2	46.0

2.5.11 Test Results Above 1GHz (Receive Mode)



Peak Data

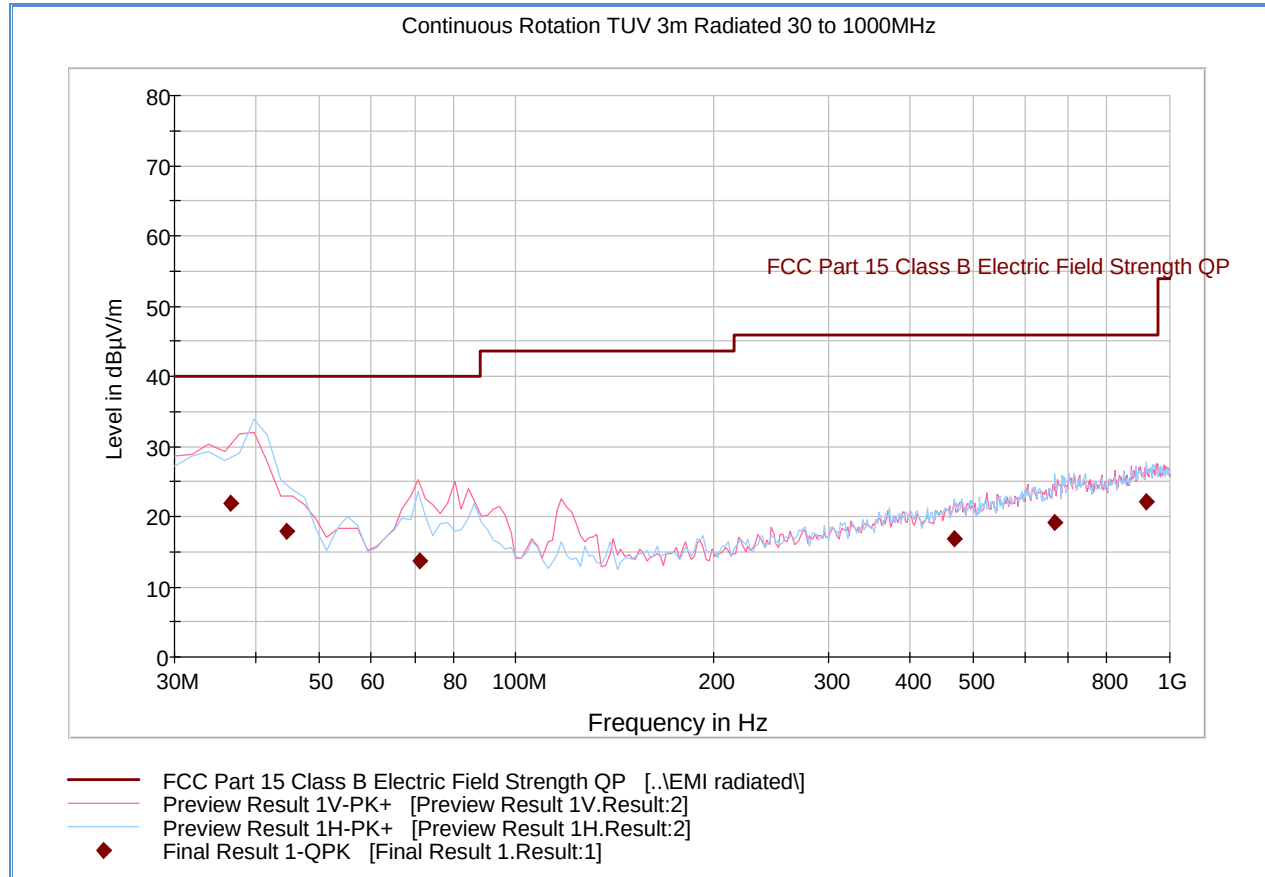
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.000000	44.7	1000.0	1000.000	100.0	H	320.0	-7.0	29.2	73.9
1937.500000	50.3	1000.0	1000.000	410.0	H	264.0	-1.4	23.6	73.9
3823.133333	45.5	1000.0	1000.000	102.0	V	204.0	6.0	28.4	73.9
4809.900000	54.2	1000.0	1000.000	100.1	H	148.0	6.8	19.7	73.9
11007.53333	51.6	1000.0	1000.000	406.9	V	339.0	17.0	22.3	73.9
12746.96666	54.8	1000.0	1000.000	400.0	V	204.0	19.9	19.1	73.9

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.000000	31.7	1000.0	1000.000	100.0	H	320.0	-7.0	22.2	53.9
1937.500000	34.4	1000.0	1000.000	410.0	H	264.0	-1.4	19.5	53.9
3823.133333	32.8	1000.0	1000.000	102.0	V	204.0	6.0	21.1	53.9
4809.900000	50.5	1000.0	1000.000	100.1	H	148.0	6.8	3.4	53.9
11007.53333	39.3	1000.0	1000.000	406.9	V	339.0	17.0	14.6	53.9
12746.96666	42.2	1000.0	1000.000	400.0	V	204.0	19.9	11.7	53.9

Test Notes: No significant emissions observed above 18GHz.

2.5.12 Test Results Below 1GHz (Bluetooth LE)

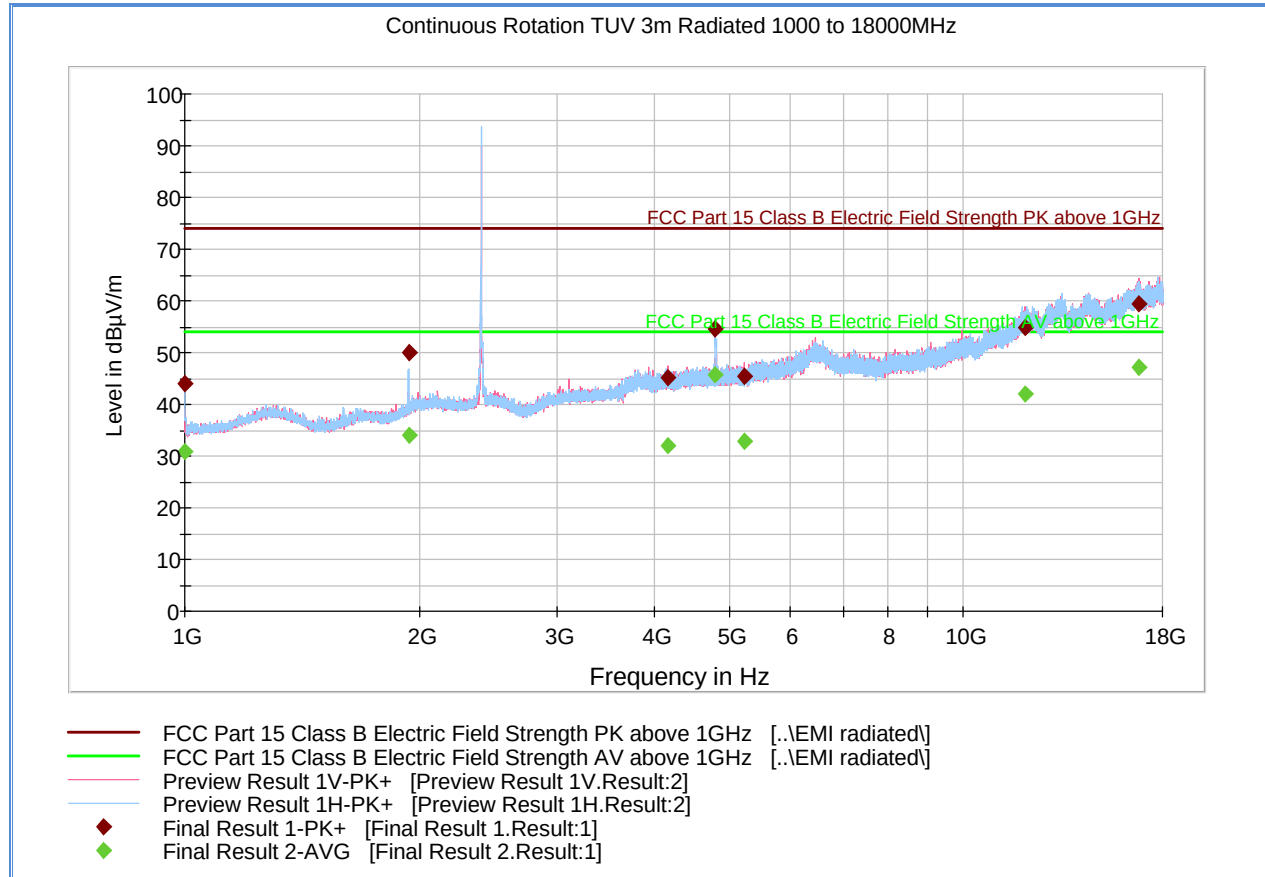


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
36.479439	21.9	1000.0	120.000	366.0	H	3.0	-14.0	18.1	40.0
44.647214	18.0	1000.0	120.000	238.0	H	15.0	-17.3	22.0	40.0
71.301643	13.6	1000.0	120.000	100.0	V	18.0	-21.4	26.4	40.0
467.334749	16.8	1000.0	120.000	122.0	H	10.0	-6.6	29.2	46.0
667.755190	19.1	1000.0	120.000	360.0	H	183.0	-1.9	26.9	46.0
920.964489	22.2	1000.0	120.000	400.0	H	201.0	2.2	23.8	46.0

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

2.5.13 Test Results Above 1GHz (Bluetooth LE Low Channel)



Peak Data

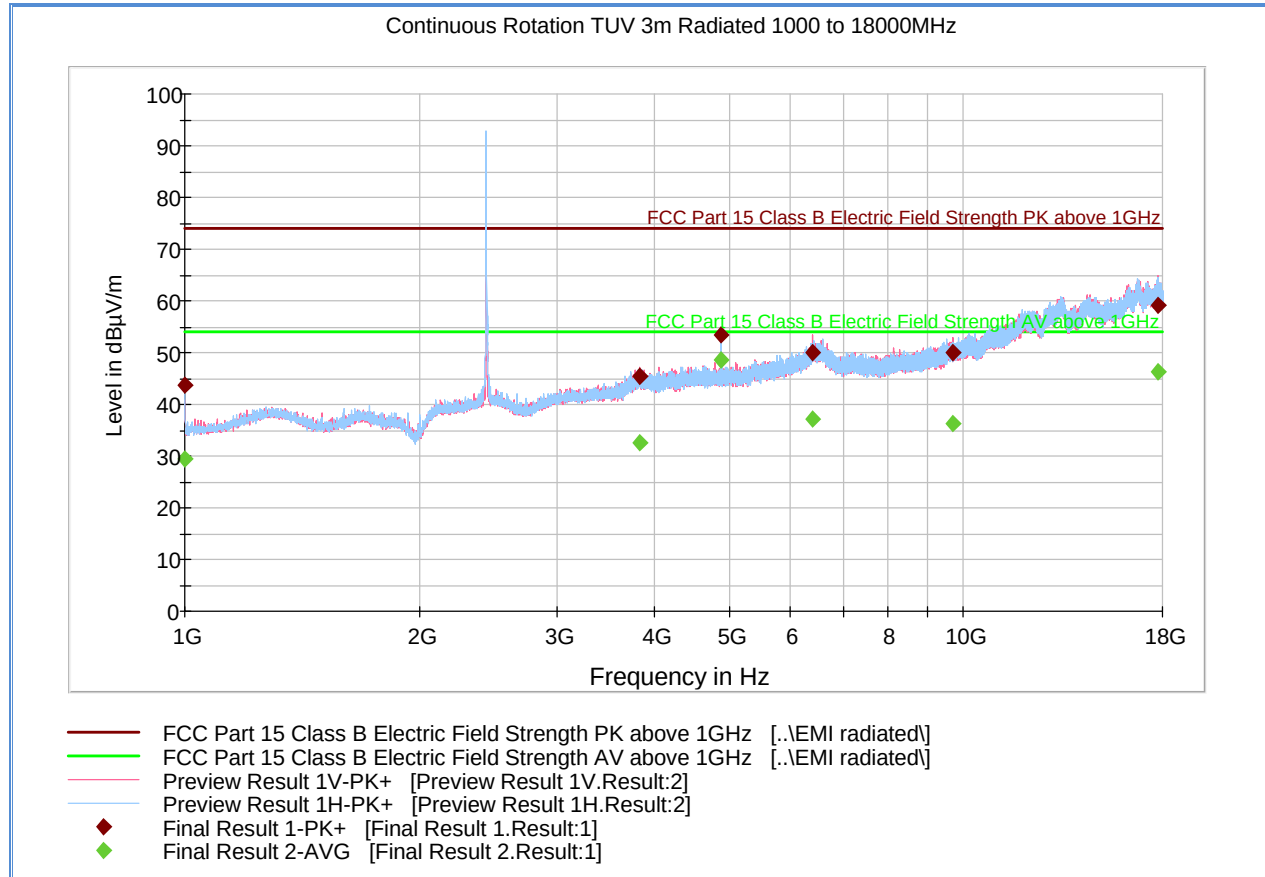
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.000000	43.9	1000.0	1000.000	124.0	H	40.0	-7.0	30.0	73.9
1937.633333	49.9	1000.0	1000.000	400.0	H	147.0	-1.4	24.0	73.9
4167.066667	45.3	1000.0	1000.000	100.0	V	102.0	6.2	28.6	73.9
4804.633333	54.6	1000.0	1000.000	333.0	H	204.0	6.8	19.3	73.9
5229.266667	45.4	1000.0	1000.000	300.0	V	267.0	7.9	28.5	73.9
12012.066667	54.8	1000.0	1000.000	230.0	V	220.0	20.4	19.1	73.9
16785.466667	59.5	1000.0	1000.000	344.0	V	49.0	25.9	14.4	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	30.9	1000.0	1000.000	124.0	H	40.0	-7.0	23.0	53.9
1937.633333	33.9	1000.0	1000.000	400.0	H	147.0	-1.4	20.0	53.9
4167.066667	32.1	1000.0	1000.000	100.0	V	102.0	6.2	21.8	53.9
4804.633333	45.8	1000.0	1000.000	333.0	H	204.0	6.8	8.1	53.9
5229.266667	32.9	1000.0	1000.000	300.0	V	267.0	7.9	21.0	53.9
12012.066667	42.0	1000.0	1000.000	230.0	V	220.0	20.4	11.9	53.9
16785.466667	47.1	1000.0	1000.000	344.0	V	49.0	25.9	6.8	53.9

Test Notes: No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.

2.5.14 Test Results Above 1GHz (Bluetooth LE Mid Channel)



Peak Data

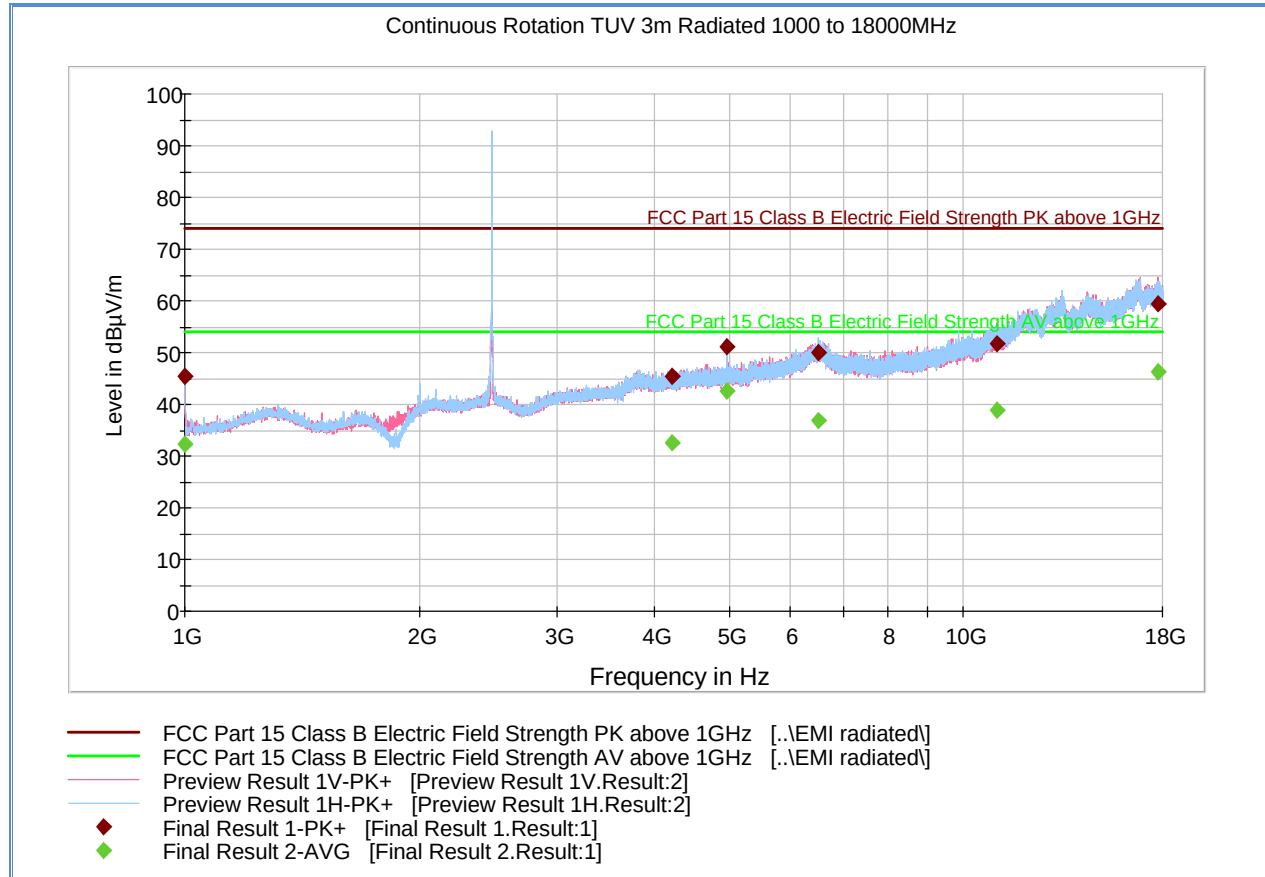
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.400000	43.7	1000.0	1000.000	99.7	H	184.0	-7.0	30.2	73.9
3835.966667	45.5	1000.0	1000.000	344.1	V	25.0	6.1	28.4	73.9
4881.866667	53.4	1000.0	1000.000	190.5	V	76.0	7.1	20.5	73.9
6394.466667	49.9	1000.0	1000.000	103.7	V	39.0	12.7	24.0	73.9
9671.133333	50.1	1000.0	1000.000	302.2	V	130.0	13.6	23.8	73.9
17730.266667	59.2	1000.0	1000.000	302.2	V	321.0	25.7	14.7	73.9

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.400000	29.5	1000.0	1000.000	99.7	H	184.0	-7.0	24.4	53.9
3835.966667	32.6	1000.0	1000.000	344.1	V	25.0	6.1	21.3	53.9
4881.866667	48.7	1000.0	1000.000	190.5	V	76.0	7.1	5.2	53.9
6394.466667	37.0	1000.0	1000.000	103.7	V	39.0	12.7	16.9	53.9
9671.133333	36.3	1000.0	1000.000	302.2	V	130.0	13.6	17.6	53.9
17730.266667	46.3	1000.0	1000.000	302.2	V	321.0	25.7	7.6	53.9

Test Notes: No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.

2.5.15 Test Results Above 1GHz (Bluetooth LE High 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	45.4	1000.0	1000.000	120.7	H	254.0	-7.0	28.5	73.9
4229.433333	45.5	1000.0	1000.000	302.2	H	198.0	6.2	28.4	73.9
4958.600000	51.2	1000.0	1000.000	103.7	V	67.0	7.4	22.7	73.9
6499.366667	49.9	1000.0	1000.000	159.6	H	283.0	12.7	24.0	73.9
11038.333333	51.8	1000.0	1000.000	405.7	V	55.0	16.9	22.1	73.9
17777.266667	59.4	1000.0	1000.000	279.3	V	249.0	25.8	14.5	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)
1000.000000	32.2	1000.0	1000.000	120.7	H	254.0	-7.0	21.7	53.9
4229.433333	32.6	1000.0	1000.000	302.2	H	198.0	6.2	21.3	53.9
4958.600000	42.5	1000.0	1000.000	103.7	V	67.0	7.4	11.4	53.9
6499.366667	36.9	1000.0	1000.000	159.6	H	283.0	12.7	17.0	53.9
11038.333333	38.9	1000.0	1000.000	405.7	V	55.0	16.9	15.0	53.9
17777.266667	46.3	1000.0	1000.000	279.3	V	249.0	25.8	7.6	53.9

Test Notes: No significant emissions observed above 6GHz. Measurements above 6GHz are noise floor figures.

2.6 RADIATED BAND EDGE MEASUREMENTS AND IMMEDIATE RESTRICTED BANDS

2.6.1 Specification Reference

Section 3.10.1.5

2.6.2 Standard Applicable

In any 100kHz 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 below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, the attenuation shall be as below:

- (1) The attenuation shall be at least 20dB when the conducted power is measured according to the Appendix II of this part, based on either an RF conducted or a radiated measurement.
- (2) The attenuation shall be at least 30dB when the conducted power is measured according to the section 3.10.1.2(1)(C) of the standard.

2.6.3 Equipment Under Test and Modification State

Default Test Configuration (Please refer to original test reports ref. no SD7211802-0616 Rev.01 for the actual S/N used)

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

Please refer to original test reports ref. no: SD7211802-0616 Rev.01 for actual test date and initial of test engineer who performed the test

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	25.1 °C
Relative Humidity	48.5 %
ATM Pressure	99.1 kPa

2.6.7 Additional Observations

- This is a radiated test. The spectrum was searched from 2310MHz to 2390MHz for lower immediate restricted band and 2483.5MHz to 2500MHz for the upper immediate restricted band.
- FCC limit presented are identical to the limit under Section 2.8 of the present standard (LP0002).

- 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.

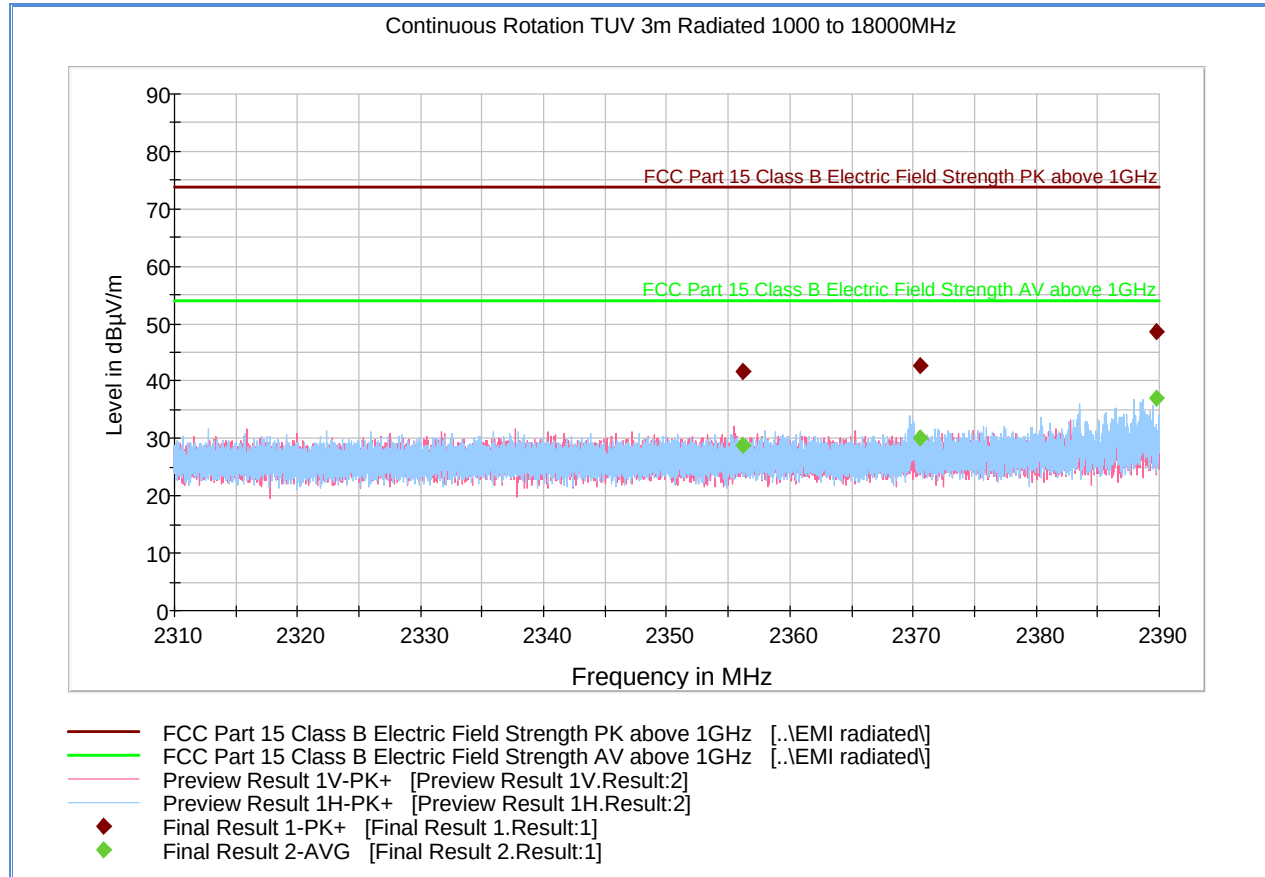
2.6.8 Sample Computation (Radiated Emission)

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

2.6.9 Test Results

See attached plots.

2.6.10 Test Results Restricted Band 2310MHz to 2390MHz (Bluetooth LE Low Channel)



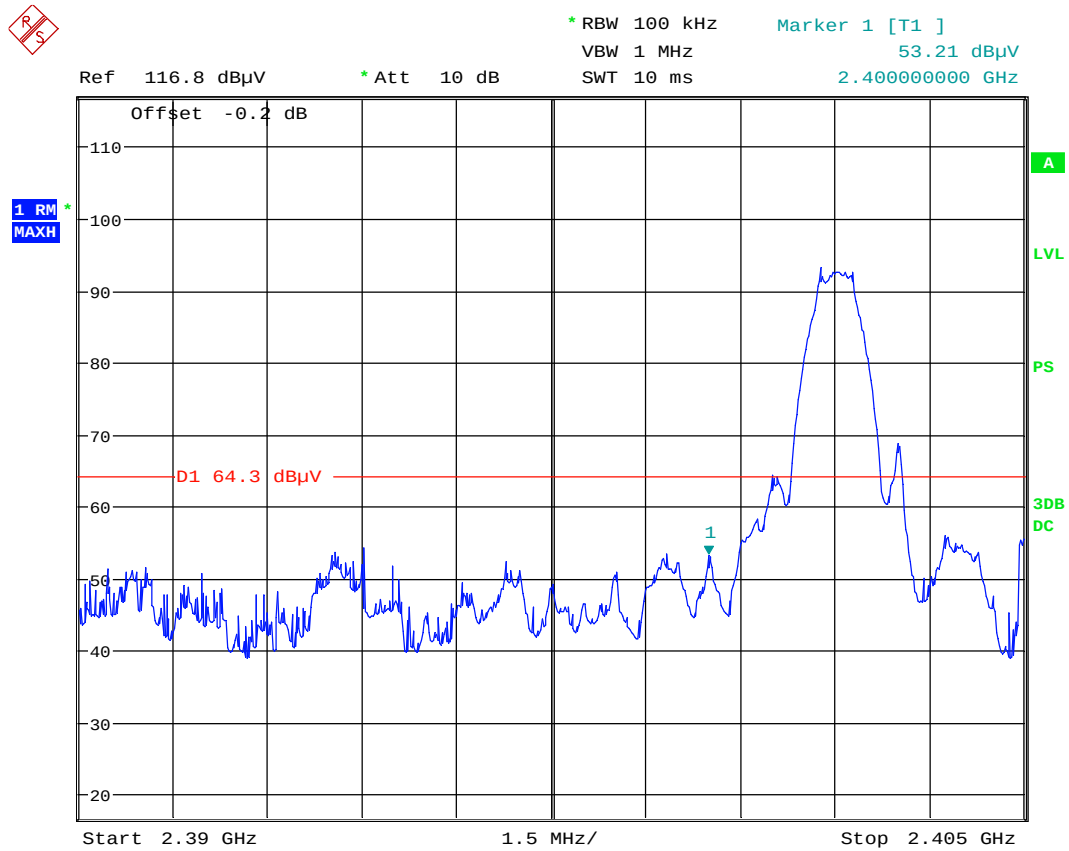
Peak Data

Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2356.221333	41.6	1000.0	1000.000	405.7	V	20.0	-0.4	32.3	73.9
2370.584000	42.8	1000.0	1000.000	124.7	H	4.0	-0.3	31.1	73.9
2389.701333	48.7	1000.0	1000.000	115.7	H	351.0	-0.2	25.2	73.9

Average Data

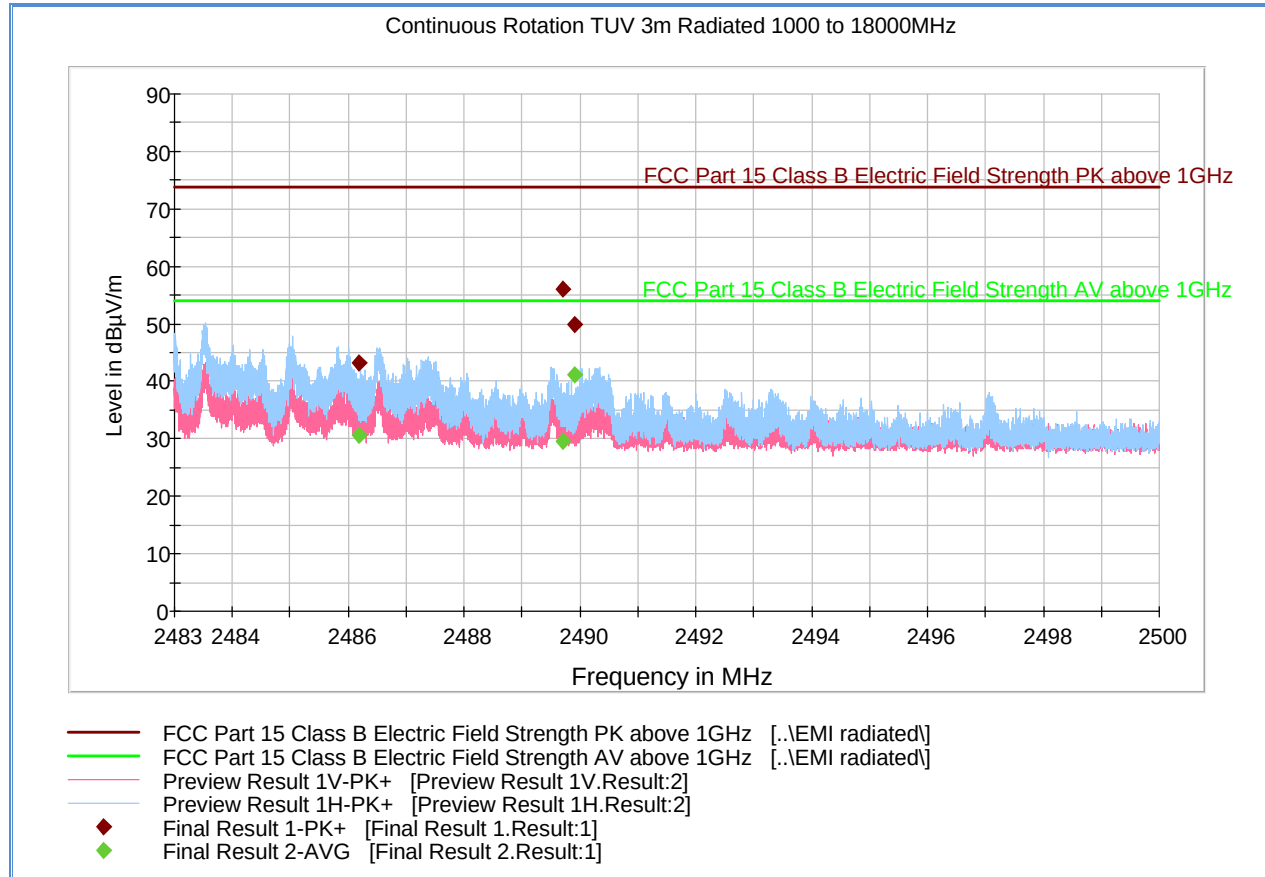
Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2356.221333	28.9	1000.0	1000.000	405.7	V	20.0	-0.4	25.0	53.9
2370.584000	30.0	1000.0	1000.000	124.7	H	4.0	-0.3	23.9	53.9
2389.701333	37.0	1000.0	1000.000	115.7	H	351.0	-0.2	16.9	53.9

2.6.11 Test Results Band Edge 2400MHz using 100kHz RBW (Bluetooth LE Low Channel)



Date: 30.JUL.2014 16:32:09

2.6.12 Test Results Restricted Band 2483.5MHz to 2500MHz (Bluetooth LE High 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)
2486.198233	43.3	1000.0	1000.000	114.7	H	237.0	0.2	30.6	73.9
2489.697400	56.0	1000.0	1000.000	200.5	H	232.0	0.2	17.9	73.9
2489.897400	49.9	1000.0	1000.000	101.7	H	226.0	0.2	24.0	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)
2486.198233	30.5	1000.0	1000.000	114.7	H	237.0	0.2	23.4	53.9
2489.697400	29.5	1000.0	1000.000	200.5	H	232.0	0.2	24.4	53.9
2489.897400	41.1	1000.0	1000.000	101.7	H	226.0	0.2	12.8	53.9

2.7 PEAK POWER SPECTRAL DENSITY

2.7.1 Specification Reference

Section 3.10.1.6(2)(B)

2.7.2 Standard Applicable

For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

2.7.3 Equipment Under Test and Modification State

Default Test Configuration (Please refer to original test reports ref. no SD7211802-0616 Rev.01 for the actual S/N used)

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

Not Performed. EUT complies with the requirement since the measured total power (peak conducted output power or maximum conducted output power) complies with the PSD limit, therefore the actual measurement of PSD is not required (per Section 10.1 of KDB 558074 D01 DTS Meas Guidance v03r02,(June 5,2014) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

2.8 CONDUCTED EMISSIONS

2.8.1 Specification Reference

Section 2.3

2.8.2 Standard Applicable

For Low-power radio-frequency devices that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). The lower limit applies at the boundary between the frequency ranges.

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

**Decreases with the logarithm of the frequency.*

2.8.3 Equipment Under Test and Modification State

Not performed. EUT is a battery operated device.

2.9 ANTENNA REQUIREMENTS

2.9.1 Specification Reference

Section 2.2

2.9.2 Standard Applicable

Antenna requirement: Low-power radio frequency transmitter or transceiver (receiver) shall utilize a permanently, half- permanently attached antenna or uses a unique coupling at the antenna and at any cable connector between the transmitter and the antenna. The antenna shall be omni-directional type. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector or other than authorized is prohibited. Such standard connectors are for example: BNC, F type, N type, M type, UG type, RCA, SMA, SMB, and other standard type antenna connectors.

2.9.3 Verification Results

The EUT complies with this requirement by implementing an integral antenna (permanently attached). The manufacturer provided a separate exhibit "Fusca 2.4GHz SMD Antenna Specification.pdf" detailing the antenna used. The radiation pattern plots from the measurement test report are attached on the following pages for reference.



Fusca 2.4 GHz SMD Antenna

Part No. A10192

Product Specification

1 Features

- Designed for 2.4 GHz applications: Bluetooth®, Wi-Fi® (802.11a/b/g/n), ZigBee®, etc. as well as 2.3 GHz WiMAX™, 2.5 GHz WiMAX™ and WiBro.
- Easy to integrate
- Low profile design for use with no ground beneath the antenna
- High efficiency
- Light weight
- Intended for SMD mounting
- Supplied in tape on reel

2 Description

Fusca is intended for use with all 2.4 GHz applications. The antenna uses a ground plane in order to radiate efficiently, but this ground plane must not extend underneath the antenna itself.

3 Applications

- Mobile phones
- PDAs
- PNDs
- Headsets
- PMPs / MP3s
- Laptops
- PC-Cards
- Medical devices
- Sensors



Antennas for Wireless M2M Applications

1

Product Specification 06MD-0002-8-PS

Fusca 2.4 GHz SMD Antenna
Part No. A10192

4 Part number

Fusca: A10192



5 General data

Product name	Fusca 2.4 GHz
Part Number	A10192
Frequency	2.4 – 2.5 GHz
Polarization	Linear
Operating temperature	-40 °C to +85 °C
Impedance with matching	50 Ω
Weight	< 0.03 g
Antenna type	SMD
Dimensions	4 x 3 x 1.1 [mm]

6 Electrical characteristics

	Typical performance	Conditions
Peak gain	0.8 dBi	All data measured on Antenova's reference board, part number A10192-U1 Data given for the 2.4 – 2.5 GHz frequency range
Average gain	-1.9 dBi	
Average efficiency	65%	
Maximum Return Loss	-10 dB	
Maximum VSWR	2:1	

Antennas for Wireless M2M Applications

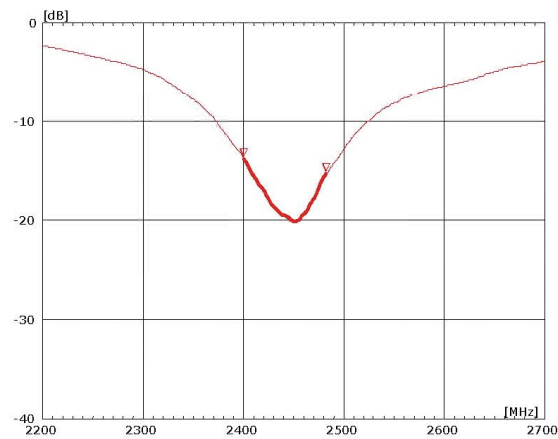
2

Product Specification 06MD-0002-8-PS

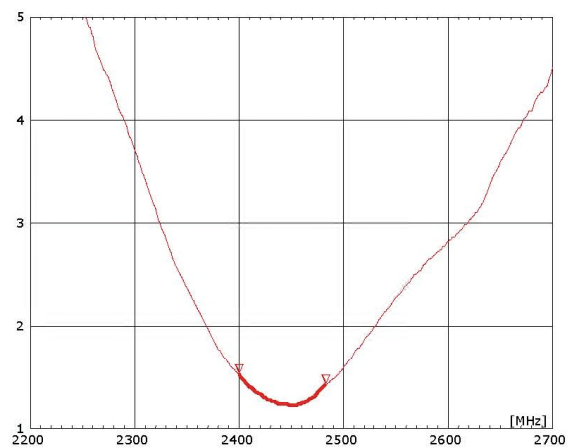
Fusca 2.4 GHz SMD Antenna
Part No. A10192

7 Electrical performance

7-1 Return Loss



7-2 VSWR



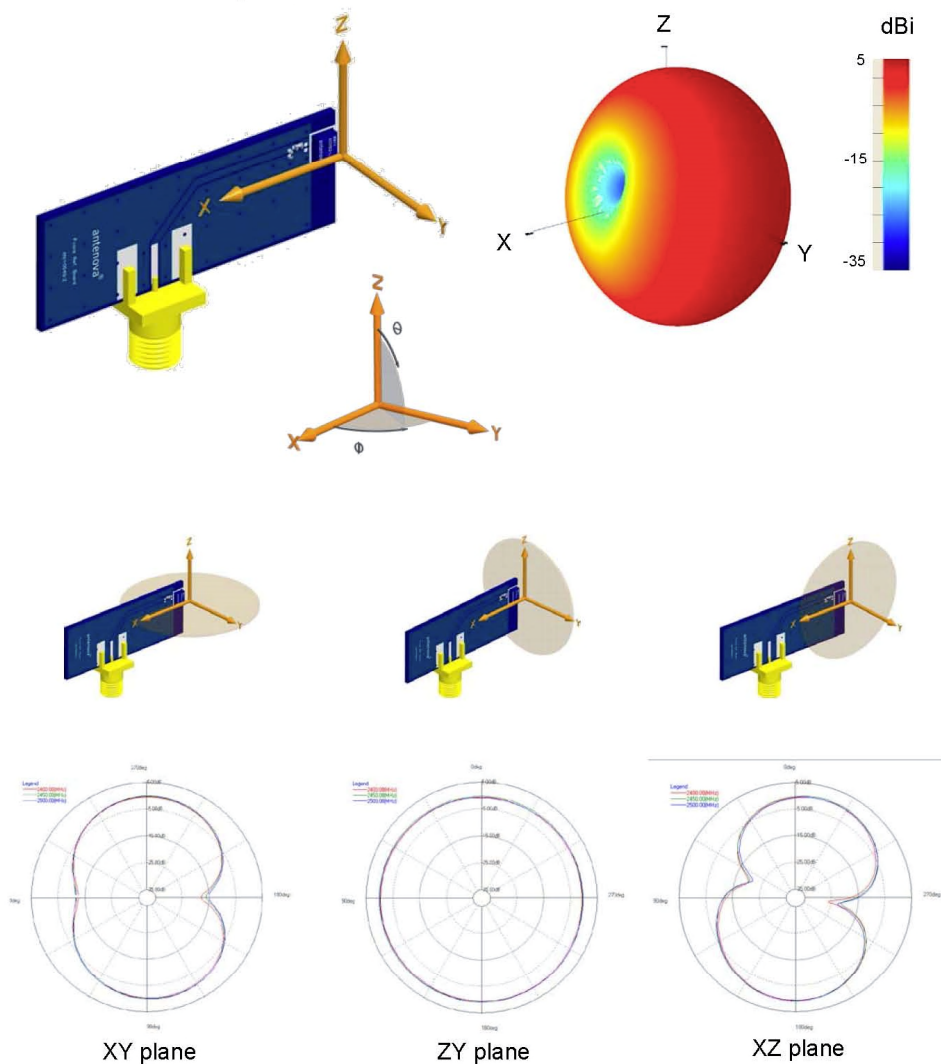
Antennas for Wireless M2M Applications

3

Product Specification 06MD-0002-8-PS

Fusca 2.4 GHz SMD Antenna
Part No. A10192

7-3 Antenna patterns



Patterns show combined polarisations
measured on reference board A10192-U1

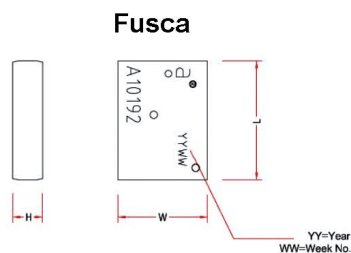
Antennas for Wireless M2M Applications

4

Product Specification 06MD-0002-8-PS

Fusca 2.4 GHz SMD Antenna
Part No. A10192

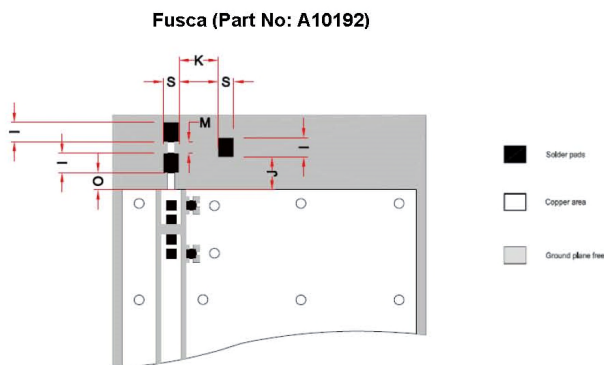
8 Antenna dimensions



L	W	H
Length	Width	Height
4.0 ± 0.2	3.0 ± 0.2	1.1 ± 0.2

Dimensions in mm

9 Antenna footprint



* CAD files of the antenna footprint are available from Antenova M2M on request.
Please contact sales@antenova-m2m.com for further details.

I	S	O	J	M	K
1.0 ± 0.1	0.8 ± 0.1	$\geq 0.9 \pm 0.1$	1.7 ± 0.1	0.6 ± 0.1	2.0 ± 0.1

Dimensions in mm

Antennas for Wireless M2M Applications

5

Product Specification 06MD-0002-8-PS

Fusca 2.4 GHz SMD Antenna
Part No. A10192

10 Electrical interface

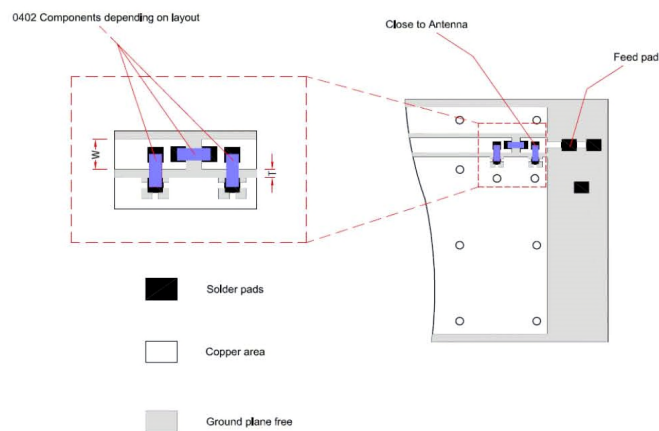
10-1 Transmission lines

- All transmission lines should be designed to have a characteristic impedance of $50\ \Omega$
- The length of the transmission lines should be kept to a minimum
- Any other parts of the RF system like transceivers, power amplifiers, etc. should also be designed to have an impedance of $50\ \Omega$

Once the material for the PCB has been chosen (PCB thickness and dielectric constant), a coplanar transmission line can easily be designed using any of the commercial software packages for transmission line design. For the chosen PCB thickness, copper thickness and substrate dielectric constant, the program will calculate the appropriate transmission line width and gaps on either side of the track so the characteristic impedance of the coplanar transmission line is $50\ \Omega$.

10-2 Matching circuit

The antenna requires a matching circuit that must be optimized for each customer's product. The matching circuit will require up to three components and the following pad layout should be designed into the device so the correct circuit can be installed:



The antenna feed pad is indicated in the drawing above. Additional pads are for mechanical attachment only and should not be grounded.

Antennas for Wireless M2M Applications

6

Product Specification 06MD-0002-8-PS

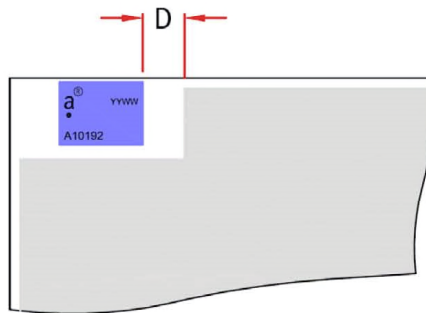
Fusca 2.4 GHz SMD Antenna
Part No. A10192

In addition to the matching circuit, a separate DC blocking capacitor will also be required between the radio and the antenna matching circuit.

Note: The component values for the matching circuit will vary depending on the size of the PCB and surrounding components. The impedance of the antenna should be measured before selecting suitable matching components. Antenova M2M offers this service on request. Contact sales@antenova-m2m.com for further information.

10-3 Antenna placement

Antenova M2M strongly recommends placing the antenna near the edge of the board. Maximum antenna performance is achieved by placing the antenna towards one of the corners of the PCB and with the feed point of the antenna as close to same corner of the PCB as possible.

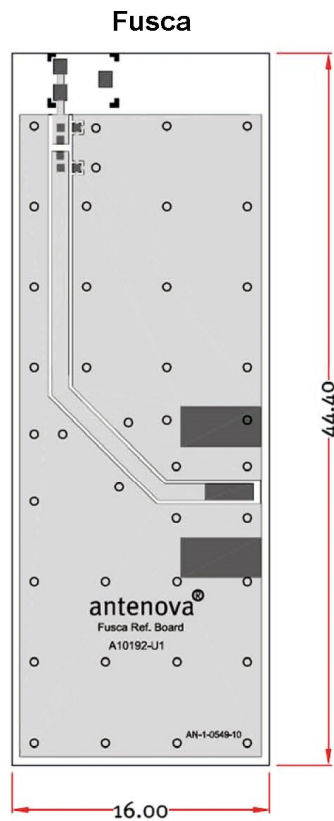


Additional ground and components near the antenna should be at a distance of at least 2 mm. Where possible the antenna should be clear of ground from both sides, although the antenna can work well with a minimum clearance of $D \geq 2$ mm as shown in the drawing above.

Fusca 2.4 GHz SMD Antenna
Part No. A10192

10-4 Reference boards

The reference board has been designed for evaluation purposes of Fusca 2.4 GHz and it includes a SMA female connector



Dimensions in mm

To order a reference board contact sales@antenova-m2m.com.

Antennas for Wireless M2M Applications

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Product Specification 06MD-0002-8-PS

Fusca 2.4 GHz SMD Antenna
Part No. A10192

11 Soldering

This antenna is suitable for lead free soldering.

The reflow profile should be adjusted to suit the device, oven and solder paste, while observing the following conditions:

- The maximum temperature should not exceed 240 °C
- However for lead free soldering, a maximum temperature of 255 °C for no more than 20 seconds is permitted.
- The antenna should not be exposed to temperatures exceeding 120 °C more than 3 times during the soldering process.

12 Hazardous material regulation conformance

The antenna has been tested to conform to RoHS requirements. A certificate of conformance is available from Antenova M2M's website.

13 Packaging

13-1 Optimal storage conditions for packaged reels

Temperature	-10°C to 40°C
Humidity	Less than 75% RH
Shelf Life	18 Months
Storage place	Away from corrosive gas and direct sunlight
Packaging	Reels should be stored in unopened sealed manufacturer's plastic packaging.

Note: Storage of open reels of antennas is not recommended due to possible oxidation of pads on antennas. If short term storage is necessary, then it is highly recommended that the bag containing the antenna reel is re-sealed and stored in like storage conditions as in above table.

Antennas for Wireless M2M Applications

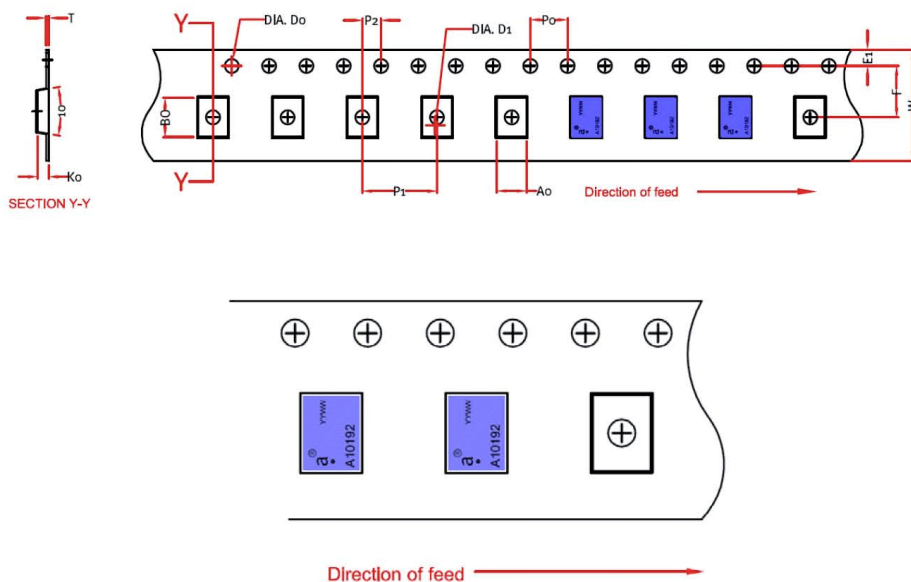
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Fusca 2.4 GHz SMD Antenna
Part No. A10192

13-2 Tape characteristics

Fusca



W	F	E1	P0	P1	P2	A0	B0	K0	T	D0	D1
12 ± 0.2	5.5 ± 0.1	1.75 ± 0.1	4 ± 0.1	8 ± 0.1	2 ± 0.1	3.2 ± 0.1	4.2 ± 0.1	1.3 ± 0.1	0.3 ± 0.05	Min 1.5	Min 1.5

Dimensions in mm

Quantity	Leading Space	Trailing Space
1000 pcs / reel	50 blank antenna holders	37 blank antenna holders

Antennas for Wireless M2M Applications

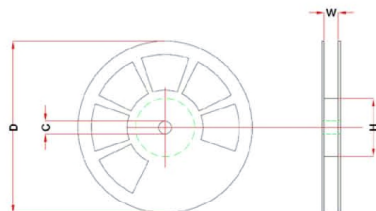
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Product Specification 06MD-0002-8-PS

Fusca 2.4 GHz SMD Antenna

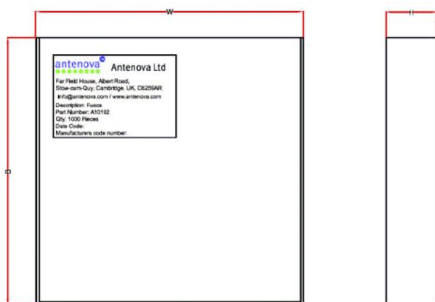
Part No. A10192

13-3 Reel dimensions



Width	Reel Diameter	Hub Diameter	Shaft Diameter
14 mm	178 mm	60 mm	13.2 mm

13-4 Box dimensions

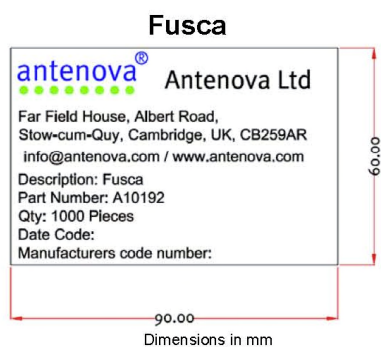


Width W	Breadth B	Thickness H
195 mm	195 mm	37 mm

13-5 Bag properties

Reels are supplied in protective plastic packaging

13-6 Reel label information



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Fusca 2.4 GHz SMD Antenna
Part No. A10192



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Certificate No: 4598

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Product Specification 06MD-0002-8-PS
Release Date 07 February 2013

SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

(Originally evaluated under TÜV SÜD test reports ref. no. SD7211802-0616 Rev.01)
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
Radiated Test Setup						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	01/30/14	01/30/16
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	01/30/14	01/30/16
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	04/03/14	04/03/15
1150	Horn antenna	3160-09	012054-004	ETS	04/26/13	04/26/15
1151	Pre-amplifier	TS-PR26	100026	Rhode & Schwarz	05/02/13	05/02/15
1051	Double-ridged waveguide horn antenna	3115	9408-4329	EMCO	02/28/14	02/28/16
8760	Pre-amplifier	ZKL-2	1001	Mini-Circuits	09/03/13	09/03/14
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	04/03/14	04/03/15
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	09/03/13	09/03/14
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	07/31/13	07/31/14
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/14	03/17/15
1016	Pre-amplifier	PAM-0202	187	PAM	10/08/13	10/08/14
Miscellaneous						
6452	Multimeter	3478A	2911A52177	Hewlett Packard	08/02/13	08/02/14
7560	Barometer/Temperature/Hu midity Transmitter	iBTHX-W	1240476	Omega	01/30/14	01/30/15
-	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

Calculation of Measurement Uncertainty per CISPR 16-4-2:2011 with Corr. 1

3.2.1 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	1.10 dB	Normal, k=2	2.000	0.55	0.30
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	3.91 dB	Triangular	2.449	1.60	2.55
16	Separation distance at 3 m	0.30 dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.40 dB	Rectangular	1.732	0.23	0.05
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	3.00	dB	
		Expanded uncertainty	Normal, k=2	6.00	dB	

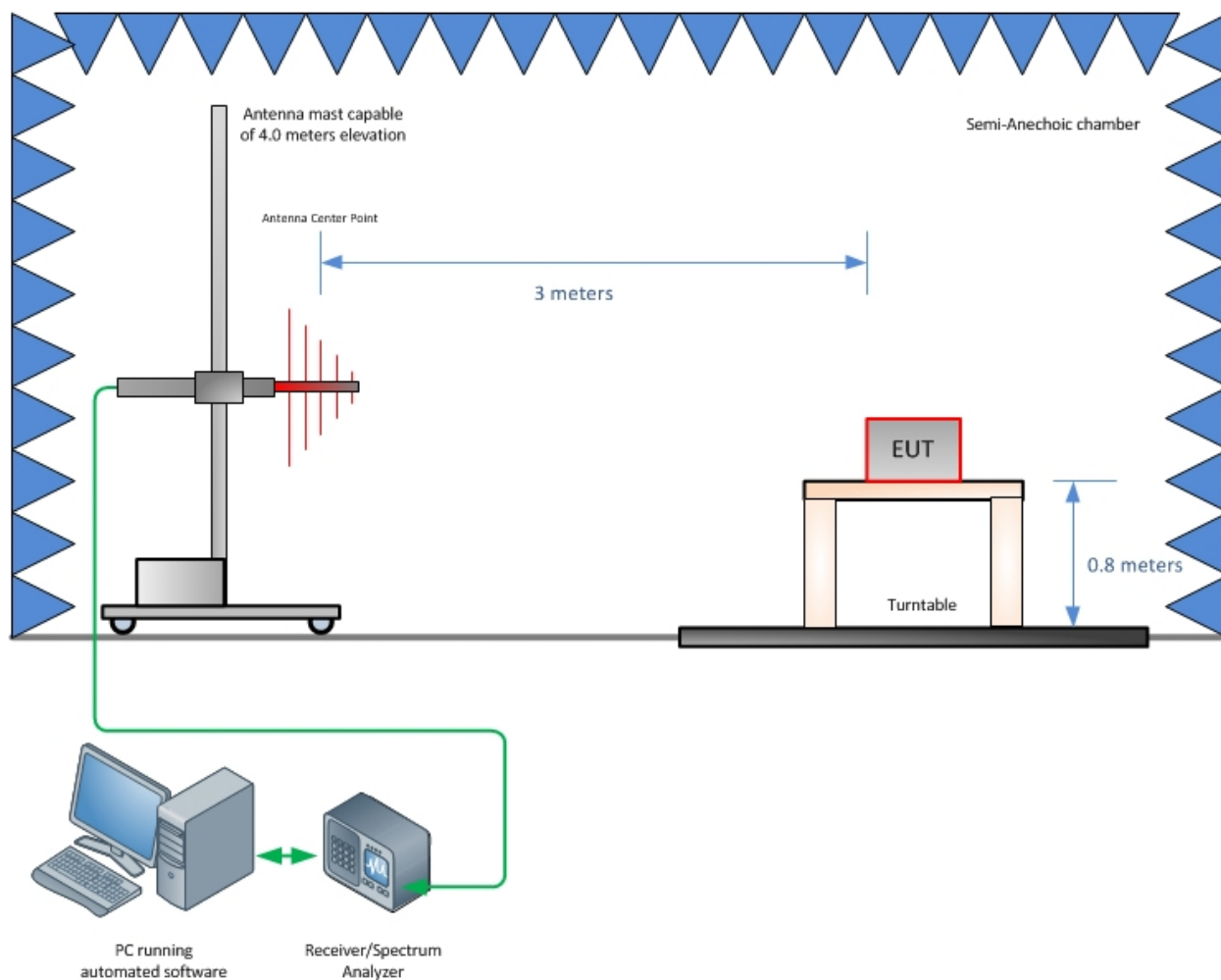
3.2.2 Radiated Emission Measurements Above 1GHz at a distance of 3 m

	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)	5.30 dB	Triangular	2.449	2.16	4.68
15	Effect of setup table material	1.15 dB	Rectangular	1.732	0.66	0.44
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	2.98	dB	
		Expanded uncertainty	Normal, k=2	5.96	dB	

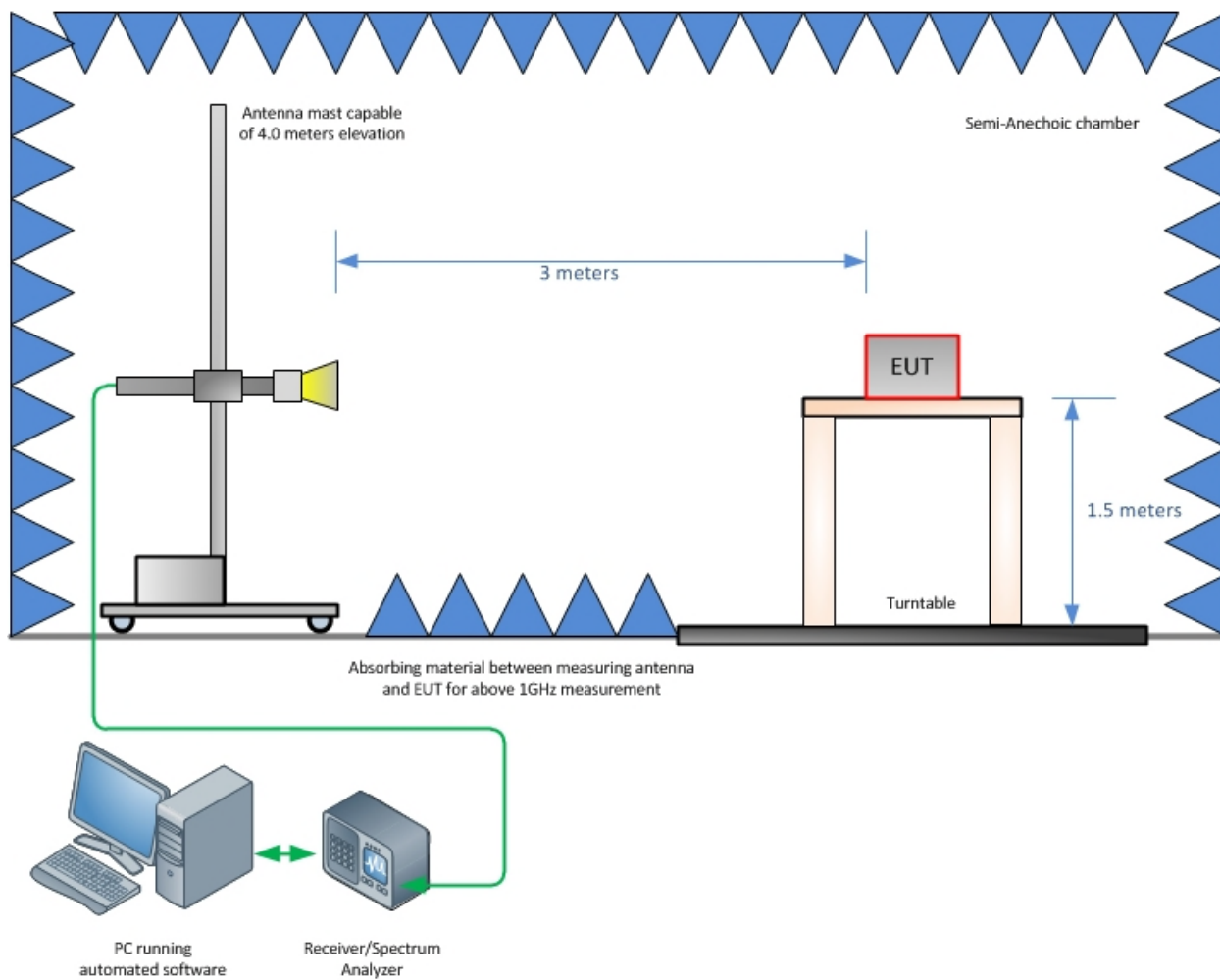
SECTION 4

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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