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Report On

Radio Testing of the
Aptiv Services Deutschland GmbH
A3TR Short Range Radar

FCC Part 95 Subpart M
ISED RSS-251 Issue 2 July 2018

Report No. 1271449A **April 2019**

TÜV SÜD America Inc., 10040 Mesa Rim Road, San Diego, CA 92121
Tel: (858) 678-1400. Website: www.TUVamerica.com

REPORT ON	Radio Testing of the Aptiv Services Deutschland GmbH A3TR Short Range Radar
TEST REPORT NUMBER	1271449A
PREPARED FOR	Aptiv Services Deutschland GmbH Am Technologiepark 1 42119 Wuppertal, Germany
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PREPARED BY	Sandipan Basu Name Authorized Signatory Title: Wireless Engineer
APPROVED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: EMC Service Line Manager Western Region
DATED	May 15, 2019

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

Revision History

1271449AA Aptiv Services Deutschland GmbH A3TR Short Range Radar					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
5/14/18		Initial Release			Ferdinand S. Custodio

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

SECTION 1

REPORT SUMMARY

Radio Testing of the
Aptiv Services Deutschland GmbH
A3TR Short Range Radar

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 Aptiv Services Deutschland GmbH Short Range Radar to the requirements of FCC Part 95 Subpart M and ISED RSS-251 Issue 2 July 2018.

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	Aptiv Services Deutschland GmbH
Product Name	A3TR
Model Number(s)	A3TR
FCC ID Number	LTQA3TR
IC Number	3659A-A3TR
Serial Number(s)	120-00441.A.3, 120-00441.A.5
Number of Samples Tested	2
Test Specification/Issue/Date	• FCC Part 95 Subpart M (October, 2018). • RSS-251 – Field Disturbance Sensors in the Bands 46.7-46.9 GHz (Vehicular Radar) and 76-77 GHz (Vehicular and Airport Fixed Radar) (Issue 2, July 2018). • RSS-Gen - General Requirements and Information for the Certification of Radio Apparatus (Issue 5, March 2019).
Start of Test	March 27, 2019
Finish of Test	May 1, 2019
Name of Engineer(s)	Sandipan Basu
Related Document(s)	KDB 653005 76-81 GHz Radars v01

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 95 Subpart M with cross-reference to the corresponding ISED RSS standard is shown below.

Section	FCC Spec Clause	RSS	Test Description	Result	Comments/Base Standard
2.1	§95.3367(a) and (b)	RSS-251 8 & 9	Power Density Limits	Compliant	
2.2	FCC 47 CFR Part 2 2.1049 and 2.202(a)	RSS-GEN 6.7	99% Emission Bandwidth	Compliant	
2.3	§95.3379(a)	RSS-251 10	Spurious Emissions	Compliant	
2.4	§95.3379(b)	RSS-251 11	Frequency stability	Compliant	

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a Aptiv Services Deutschland GmbH A3TR. The EUT is a Short Range Radar The EUT operates in the 76-77 GHz band. The device employs a dynamic chirp modulated transmit array. The device is intended to be mounted at the front and rear corners of a vehicle. The EUT nominal operating voltage is 12.0 VDC or 24.0 VDC.

1.3.2 EUT General Description

EUT Description	Third Generation Short Range Radar
Product Name	SRR3T Short Range Radar
Model Number(s)	A3TR
Rated Voltage	24.0 VDC
Output Power	21.88 dBm Peak EIRP
Frequency Range	76.0 GHz to 77.0 GHz band.
Number of Operating Frequencies	7

Channels Verified

Low Channel	76.050 GHz for 175, 300, 425 MHz BW
Mid Channel	76.413, 76.350, 76.288 GHz for 175, 300, 425 MHz BW
High Channel	76.760, 76.575, 76.425 GHz for 175, 300, 425 MHz BW

**Test scripts were provided by the manufacturer to exercise each channel.*

Antenna Type (used during evaluation)	Integral

1.3.3 Antenna Details

Manufacturer	Aptiv Services Deutschland GmbH
Antenna Type	Planar Array Antenna
Antenna Gain	14 dBi
EUT Antenna Connector	N/A
Maximum Dimensions	97 mm x 99 mm x 45 mm

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configurations	Description
Default	Radiated configuration. EUT transmitting modulated signal continuously through the integral antenna.

1.4.2 EUT Exercise Software

Before each test, the EUT is configured using ScaniaCalFlasher v3.01. The tool allows configuration of operating channel and modulation bandwidth.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Dell	Support Laptop	Dell Precision PP04X
Dell	PA-12 AC Adapter	M/N: LA65NS2-01
Vector	Double channel CAN HW	Used for communication between EUT and Support Laptop
-	Harness with pins for power supply and CAN connector.	Connects the EUT to a 12 VDC power supply and to the CAN HW

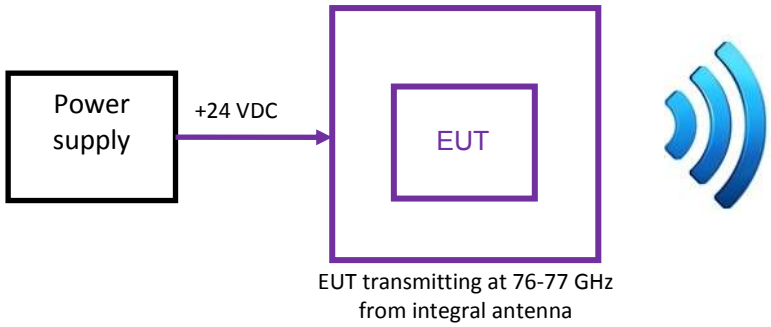
1.4.4 Single Case Configuration

Single-case configuration used in this test report.

Channel	Modulation BW
Low	175 MHz
Low	300 MHz
Low	425 MHz

EUT is mobile device designed to be installed on a vehicular, for radiated spurious measurement only default configuration was evaluated (See test setup picture exhibit).

1.4.5 Simplified Test Configuration Diagram



EUT transmitting at 76-77 GHz
from integral antenna

For Illustration Purpose Only
Image presented may not represent the actual EUT or support equipment

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: 120-00441.A.3 120-00441.A.5		
Used Far-rites and isolated laptop for shielding during spurious testing. Refer to Sec.2.3	SB	3/14/2019-4/14/2019

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 for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.
For conducted and radiated emissions, the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.10-2013. 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 – Registration No.: US1146

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

1.9.2 Innovation, Science and Economic Development Canada (IC) Registration 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 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 for radio equipment testing with Registration No. 22806-1.

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

TUV 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)

TUV SUD 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

TUV SUD 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

TUV SUD 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

TUV SUD 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
Aptiv Services Deutschland GmbH
A3TR

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

2.1 POWER DENSITY LIMITS

2.1.1 Specification Reference

Part 95 Subpart M §95.3367(a) and (b) and RSS-251 Issue 2 Sec. 8.0 and Section 9.0

2.1.2 Standard Applicable

The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotopically Radiated Power (EIRP) and are as follows:

(a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).

(b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW

2.1.3 Equipment Under Test and Modification State

Serial No: 120-00441.A.5 / Default Test Configuration

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

April 09, 2019/SB

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 Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	22.22°C
Relative Humidity	65 %
ATM Pressure	101.12 kPa

2.1.7 Additional Observations

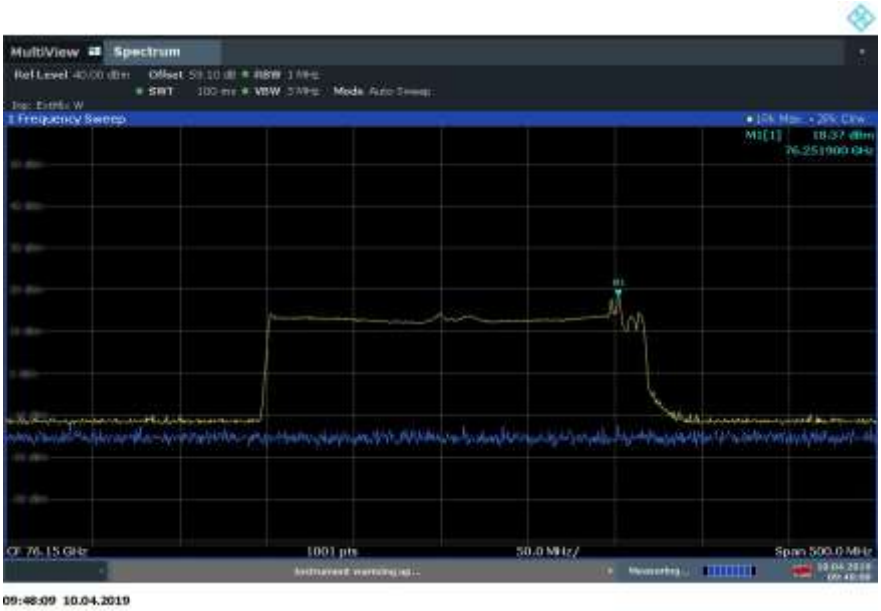
- This is a radiated test.
- Test distance of 3 m was used for the fundamental emissions measurement.
- A correction factor of 59.1 dB and mixer conversion loss table were used to account for the test antenna gain, free-space loss and external mixer loss and was directly entered as adjustments in the Analyzer.
- Sample correction factor calculation @ 76.5 GHz:

Correction Factor (dB)	Asset# 7628 (antenna)	-22.5	59.1
	External 2 dB attenuator	2.0	
	Free space loss	79.6	

2.1.8 Test Results

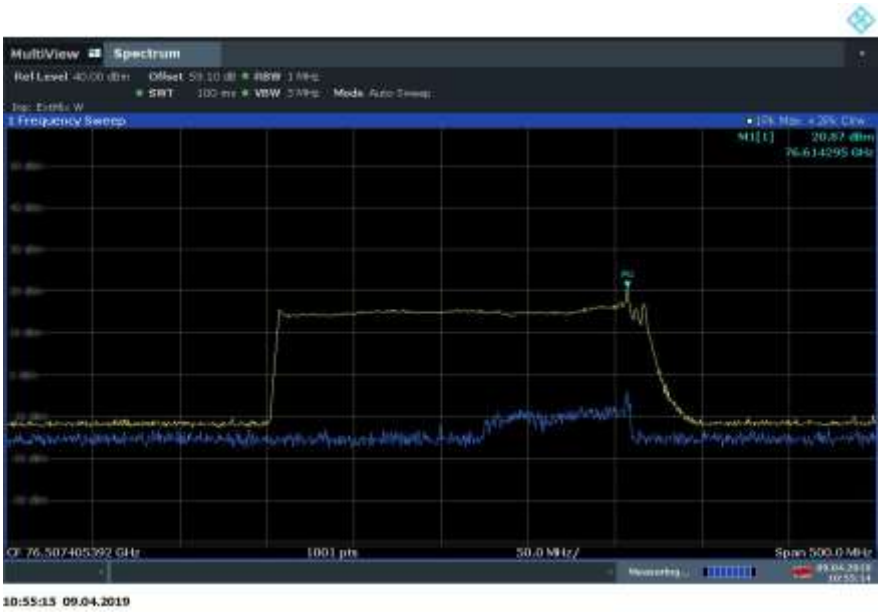
Peak EIRP			
Modulation BW	**Channel**	**Measured EIRP (dBm)**	**Limit (dBm)**
175 MHz	Low (76.050 GHz)	18.37	55
	Mid (76.413GHz)	20.87	
	High (76.760 GHz)	19.16	
300 MHz	Low (76.050 GHz)	19.29	
	Mid (76.350 GHz)	20.30	
	High (76.575 GHz)	21.88	
425 MHz	Low (76.050 GHz)	20.87	
	Mid (76.288 GHz)	21.66	
	High (76.405 GHz)	21.48	
Average EIRP			
Modulation BW	**Channel**	**Measured EIRP (dBm)**	**Limit (dBm)**
175 MHz	Low (76.005 GHz)	9.58	50
	Mid (76.413GHz)	12.93	
	High (76.760 GHz)	12.41	
300 MHz	Low (76.005 GHz)	8.56	
	Mid (76.350 GHz)	12.55	
	High (76.575 GHz)	12.32	
425 MHz	Low (76.005 GHz)	10.16	
	Mid (76.288 GHz)	11.96	
	High (76.405 GHz)	12.68	
Result: EUT complies			

2.1.9 Test plots



Low Channel 175 MHz BW (Peak detector)

Low Channel 175 MHz BW (RMS detector)



Mid Channel 175 MHz BW (Peak detector)

Mid Channel 175 MHz BW (RMS detector)

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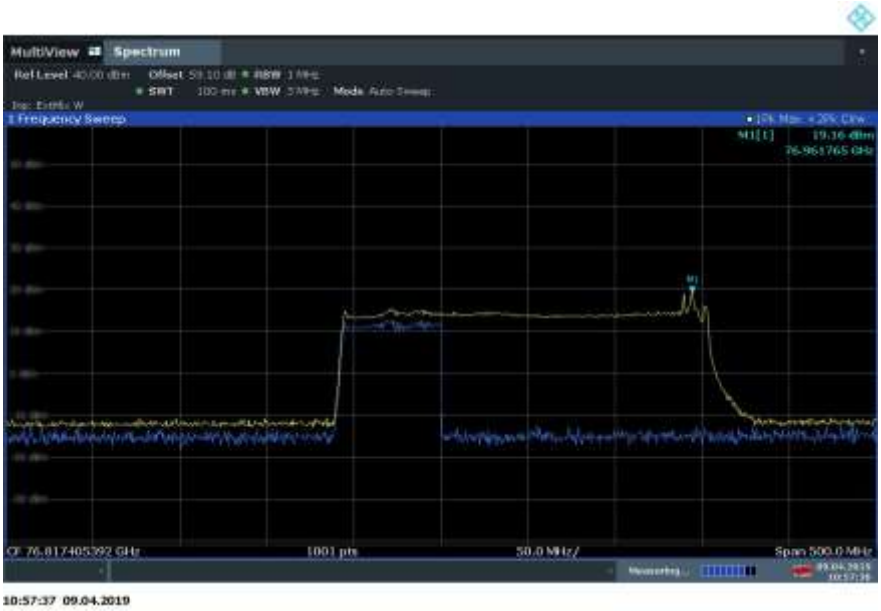


High Channel 175 MHz BW (Peak detector)

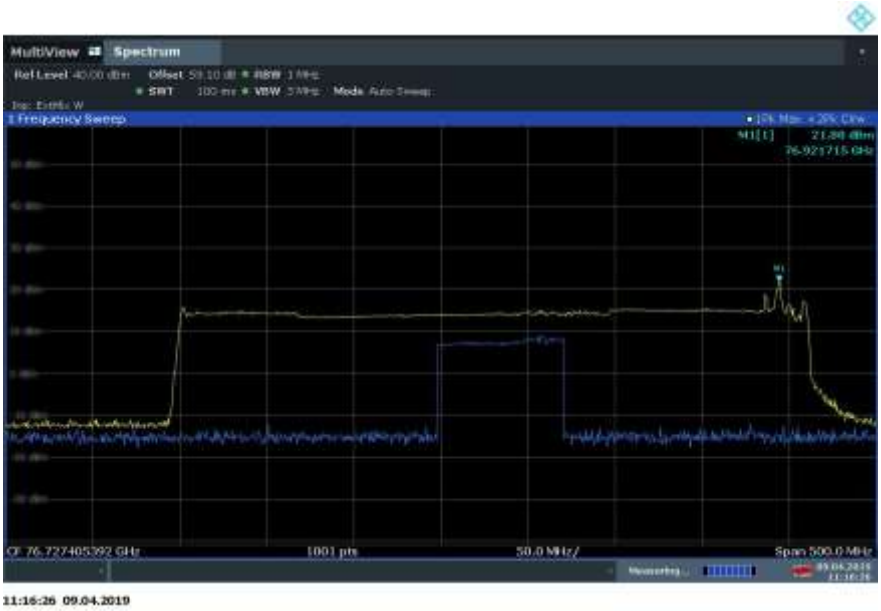
High Channel 175 MHz BW (RMS detector)

Low Channel 300 MHz BW (Peak detector)

Low Channel 300 MHz BW (RMS detector)

Mid Channel 300 MHz BW (Peak detector)

Mid Channel 300 MHz BW (RMS detector)



High Channel 300 MHz BW (Peak detector)

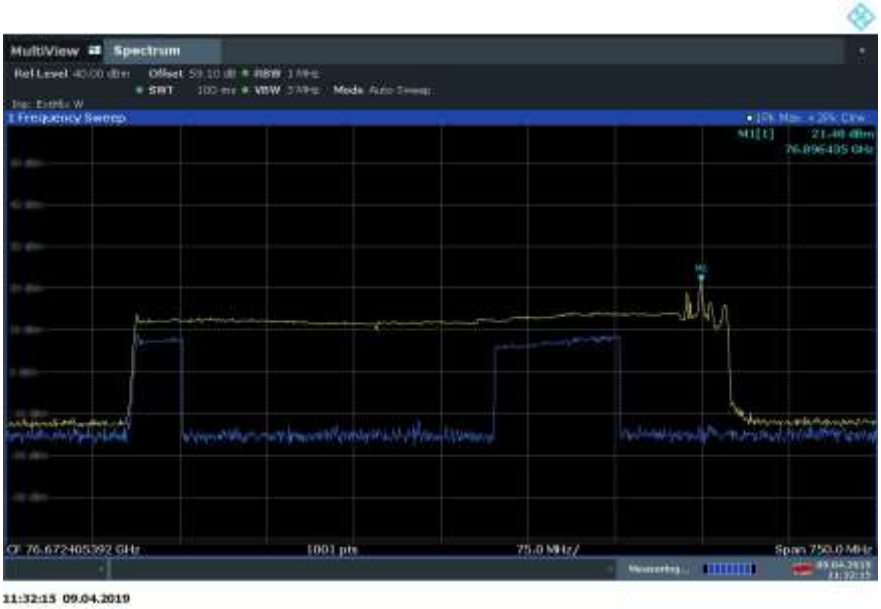
High Channel 300 MHz BW (RMS detector)

Low Channel 425 MHz BW (Peak detector)

Low Channel 425 MHz BW (RMS detector)

Mid Channel 425 MHz BW (Peak detector)

Mid Channel 425 MHz BW (RMS detector)



High Channel 425 MHz BW (Peak detector)

High Channel 425 MHz BW (RMS detector)

2.2 OCCUPIED BANDWIDTH

2.2.1 Specification Reference

FCC 47 CFR Part 2, Clause 2.1049 and 2.202(a)
RSS-GEN Issue 5 Section 6.7

2.2.2 Standard Applicable

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

2.2.3 Equipment Under Test and Modification State

Serial No: 120-00441.A.3 / Default Test Configuration

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

October 23, 2018/SB

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	22.22°C
Relative Humidity	72%
ATM Pressure	101.12 kPa

2.2.7 Additional Observations

- This is a radiated test.
- Span is wide enough to capture the channel transmission.
- VBW > RBW.
- Trace is max hold.
- Detector is peak.

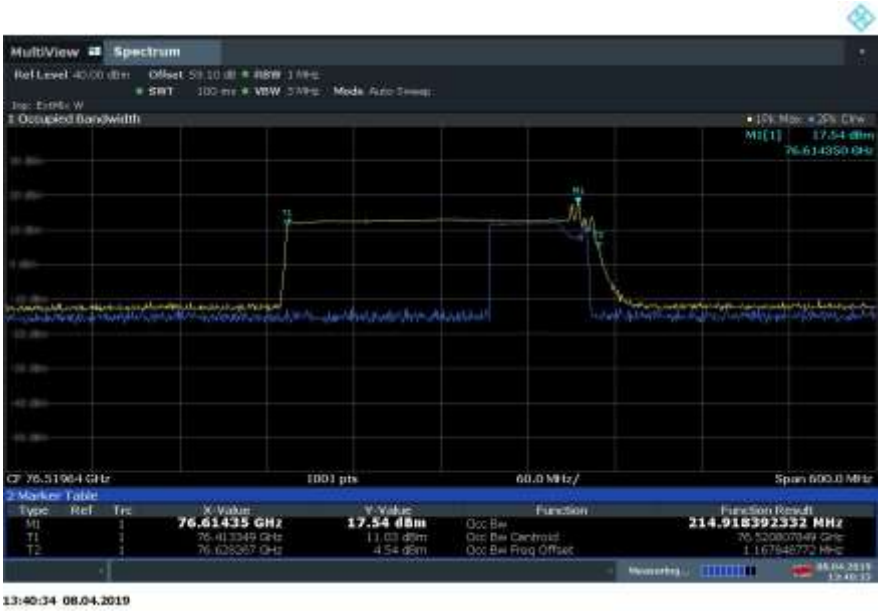
- Sweep time is set to Auto.
- 99% OBW measurement function of the spectrum analyzer was used for this test.
- RBW adjusted until RBW/EBW ratio is approximately 1% or as the SA setting permits (i.e next setting after 3 MHz RBW is limited to 5 MHz).

2.2.8 Summary Test Results (as reported)

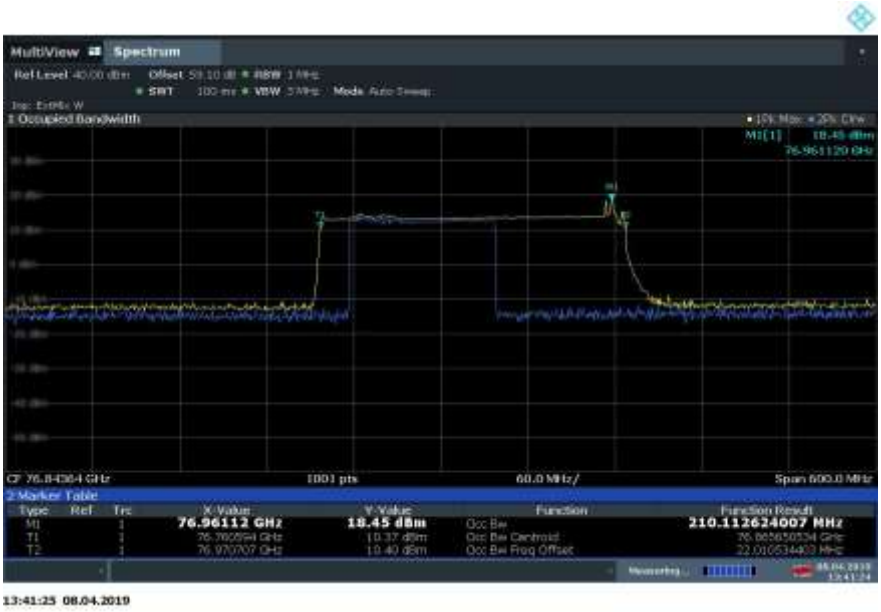
Occupied Bandwidth			
Modulation BW	**Low Channel**	**Mid Channel**	**High Channel**
175 MHz	228.96 MHz	214.92 MHz	210.11 MHz
300 MHz	364.43 MHz	360.49 MHz	359.15 MHz
425 MHz	512.35 MHz	508.43 MHz	507.77 MHz

2.2.9 Test Plots

Low channel 175 MHz BW



Mid channel 175 MHz BW



High channel 175 MHz BW

Low channel 300 MHz BW

Mid channel 300 MHz BW

High channel 300 MHz BW

Low channel 425 MHz BW

Mid channel 425 MHz BW

High channel 425 MHz BW

2.3 SPURIOUS RADIATED EMISSIONS

2.3.1 Specification Reference

FCC Part 95 Subpart M §95.3379(a) and RSS-251 Issue 2 Sec. 10.

2.3.2 Standard Applicable

(a) The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

(i) In the emissions table in paragraph (a)(1) of this section, the tighter limit applies at the band edges.

(ii) The limits in the table in paragraph (a)(1) of this section are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(iii) The emissions limits shown in the table in paragraph (a)(1) of this section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW.

(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm2 at a distance of 3 meters from the exterior surface of the radiating structure.

(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

2.3.3 Equipment Under Test and Modification State

Serial No: 120-00441.A.3 / Default Test Configuration

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

April 10-18, 2019 /SB

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. Mira Mesa and Rancho Berando facility

Ambient Temperature	21.0-23.8°C
Relative Humidity	70.0 -89.0%
ATM Pressure	100.5-102.0 kPa

2.3.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30 MHz to 300 GHz. There are no significant spurious emissions observed from EUT
- For profiles from 30 MHz to 1 GHz some emissions were seen crossing the limit at around 50 MHz which was found to be from the PCAN connector. Each of the allied test equipment's were introduced in the chamber and ESU 40 was checked in live mode to see if any of the individual components were causing the limit cross. One by one each of the components like the chamber, Power Supply, laptop and CAN connectors were introduced one by one to check which one was causing this. Eventually it was found that the PCAN connector was the reason behind it, but since the EUT wont function without the laptop or the CAN connectors the laptop was moved to an underground panel with a lid and RF shielding on top of it. Also Fair-rites were used to cover the CAN cables. Snap on Fair-rites were used. With proper shielding the results were much better and free from failure at 30 MHz-1 GHz Spurious.
- Test distance of 3 m was used for the spurious emissions measurement below 60 GHz. The emissions in the range from 60 GHz to 160 GHz were evaluated at 1.0 m distance. For the measurements in the ranges from 160 GHz to 220 GHz and 220 GHz to 300 GHz, the test distance was respectively reduced to 0.5 m and 0.2 m to assure that the noise floor is at least 10 dB below the applicable limit.
- Corrections factors of 9.54 dB, 15.56 dB and 23.52 dB were used to extrapolate the field strengths measured at 1.0 metres, 0.5 meters and 0.2 meters to the 3 meters distance as specified in § 15.31.
- All the emissions below 40 GHz comply with the general radiated emission limits of §15.209.
- Measurements below 40 GHz were done using EMC32 V9.26.0 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 2.3.8 for sample computation.

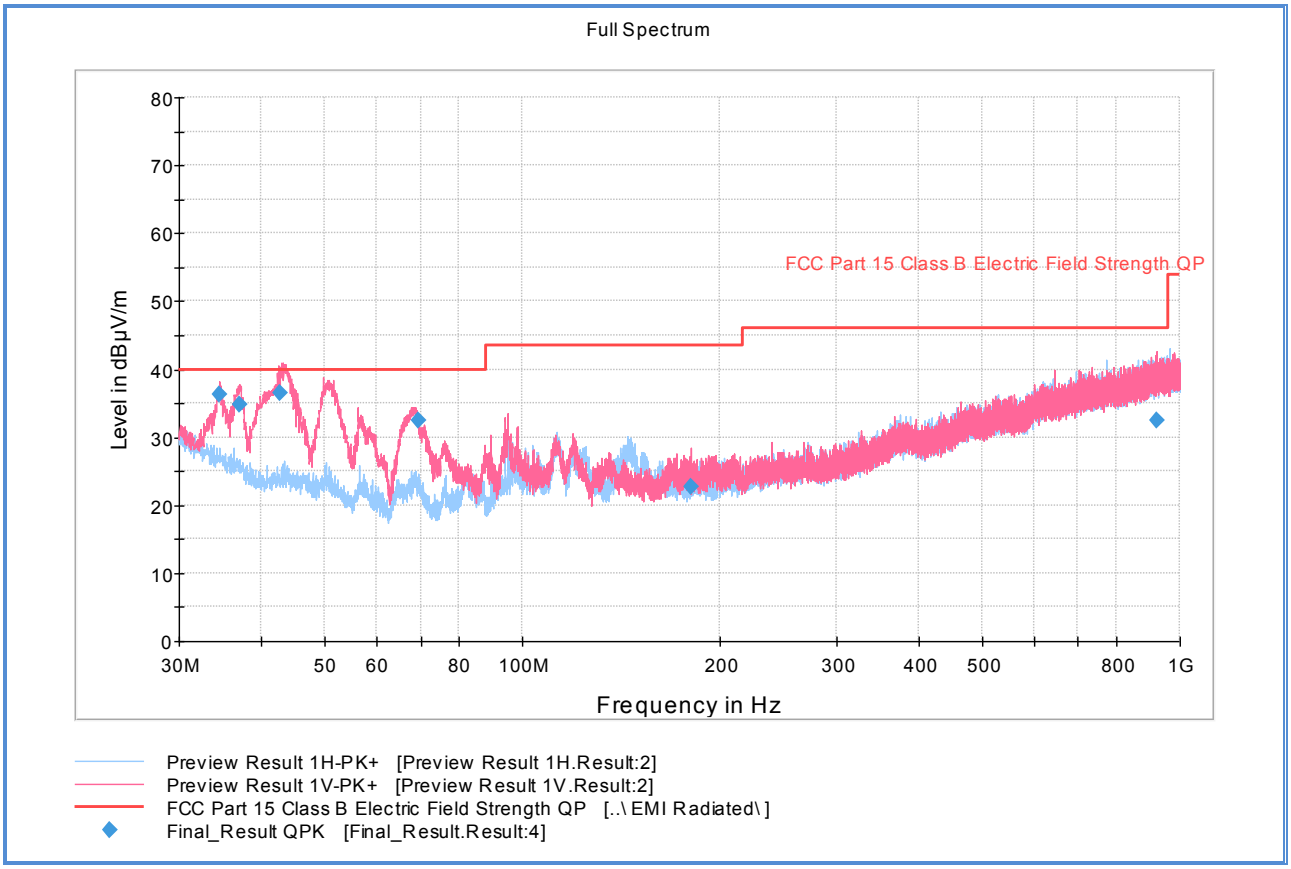
2.3.8 Sample Computation (Radiated Emission)

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**

2.3.9 Test Results

Compliant. See attached plots.

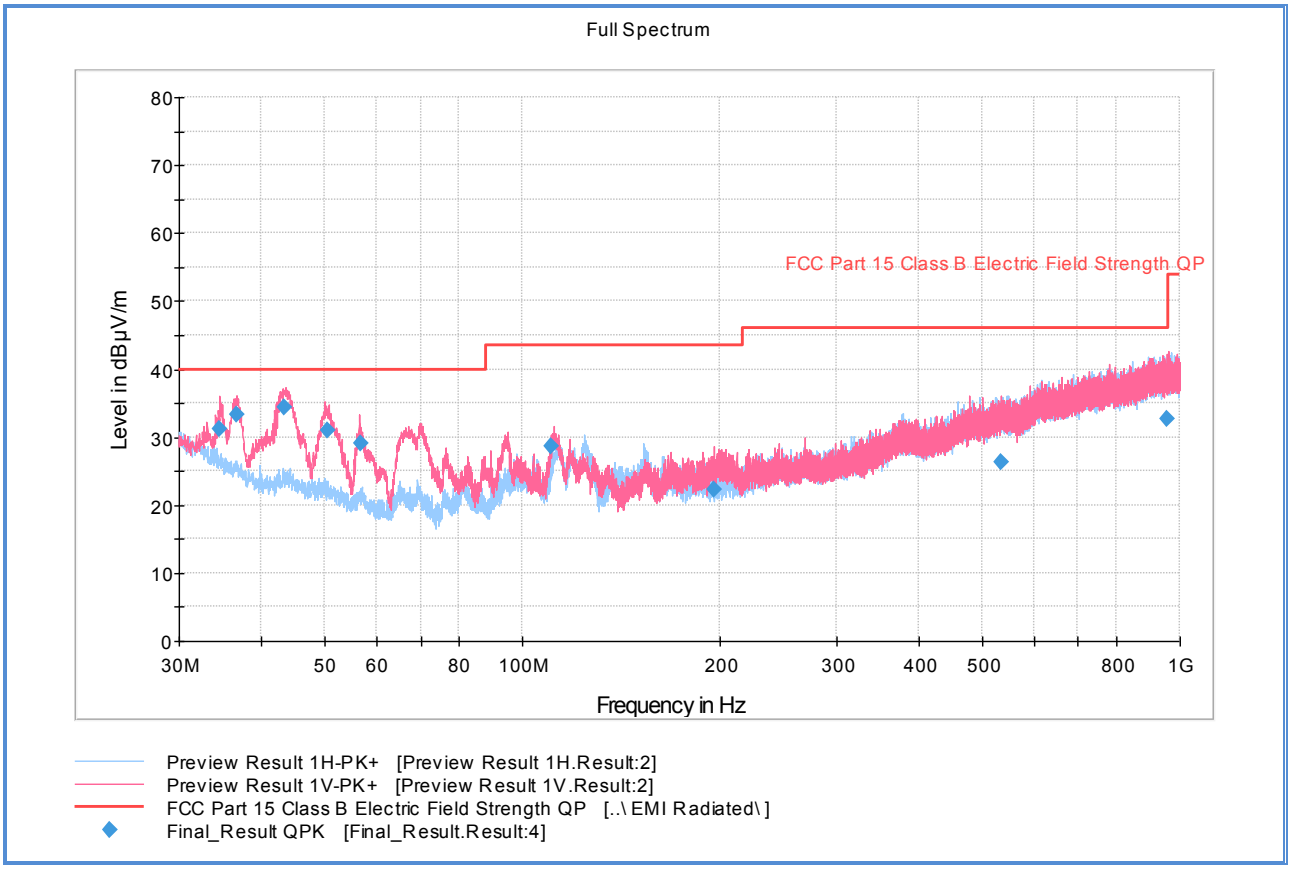
2.3.10 Test Results Below 1GHz Low Channel 175 MHz BW



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.479000	36.35	40.00	3.65	1000.0	120.000	103.6	V	145.0	20.0
37.041000	34.78	40.00	5.22	1000.0	120.000	105.2	V	20.0	18.4
42.632000	36.50	40.00	3.50	1000.0	120.000	106.2	V	133.0	16.6
69.238333	32.37	40.00	7.63	1000.0	120.000	125.2	V	213.0	12.6
180.441000	22.63	43.50	20.87	1000.0	120.000	99.9	V	155.0	16.9
921.701667	32.40	46.00	13.60	1000.0	120.000	125.3	V	22.0	33.0

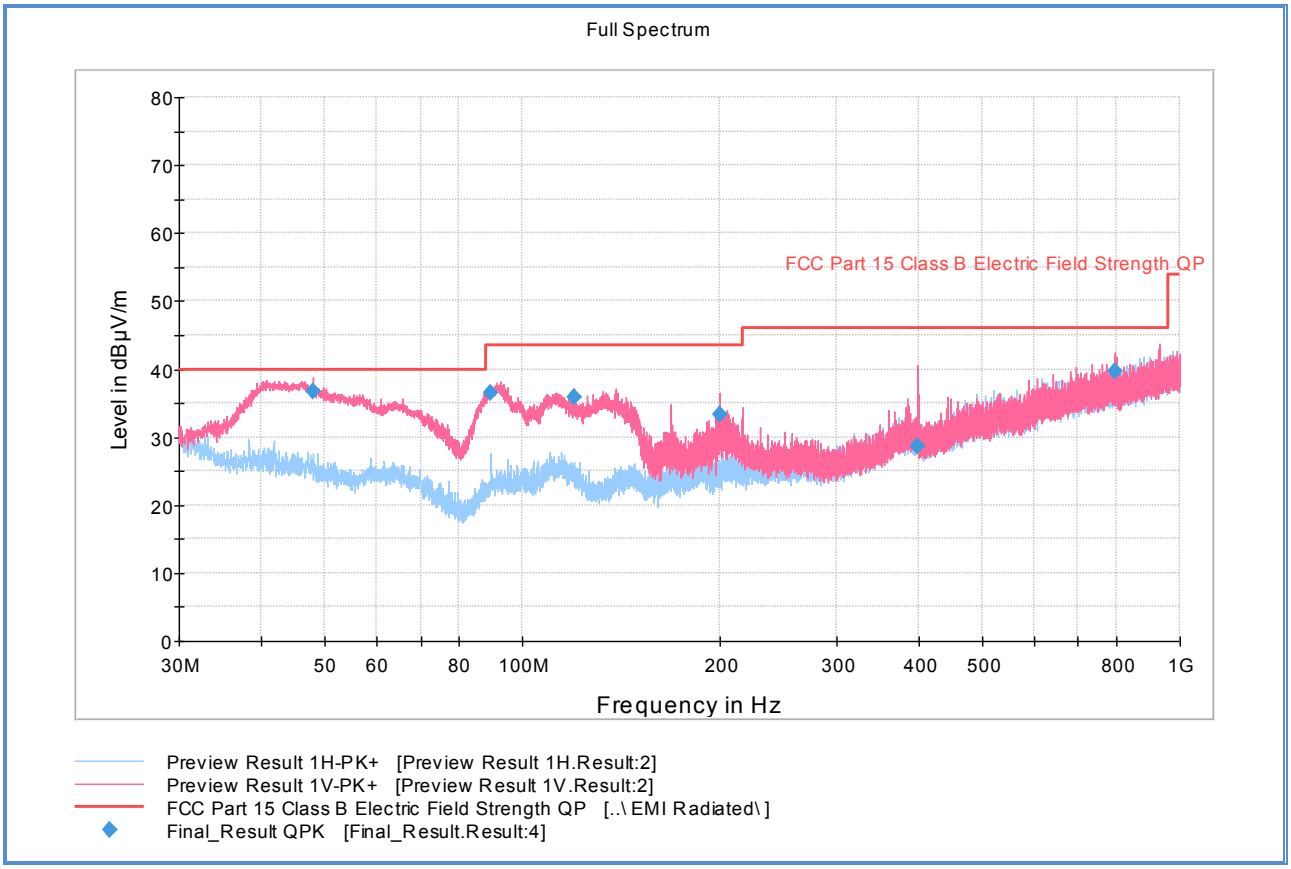
2.3.11 Test Results Below 1GHz Low Channel 300 MHz BW



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.623667	31.19	40.00	8.81	1000.0	120.000	99.9	V	344.0	19.9
36.677667	33.33	40.00	6.67	1000.0	120.000	125.2	V	85.0	18.6
43.435333	34.38	40.00	5.62	1000.0	120.000	105.5	V	2.0	16.5
50.422000	31.07	40.00	8.93	1000.0	120.000	99.7	V	20.0	15.5
56.753333	29.14	40.00	10.86	1000.0	120.000	104.4	V	215.0	13.7
110.657000	28.74	43.50	14.76	1000.0	120.000	179.4	V	278.0	14.1
195.874333	22.31	43.50	21.19	1000.0	120.000	105.5	V	167.0	16.8
534.842333	26.21	46.00	19.79	1000.0	120.000	125.2	V	7.0	27.8
956.592667	32.68	46.00	13.32	1000.0	120.000	325.0	V	274.0	33.3

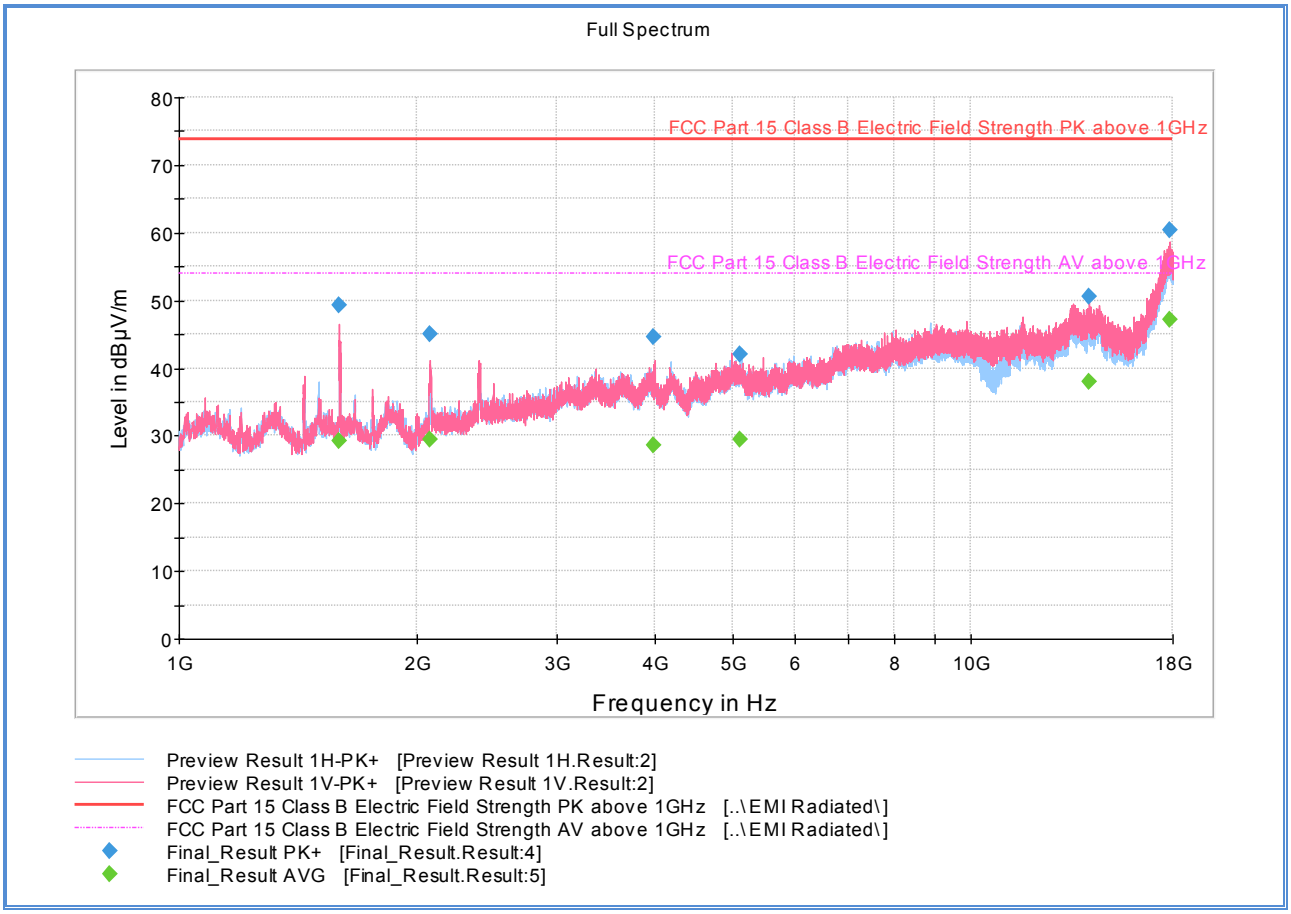
2.3.12 Test Results Below 1GHz Low Channel 425 MHz BW



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
47.977333	36.81	40.00	3.19	1000.0	120.000	99.9	V	302.0	16.0
89.459667	36.57	43.50	6.93	1000.0	120.000	109.3	V	183.0	13.5
119.983667	35.81	43.50	7.69	1000.0	120.000	99.8	V	172.0	13.6
199.902333	33.39	43.50	10.11	1000.0	120.000	104.2	V	258.0	16.9
398.193000	28.69	46.00	17.31	1000.0	120.000	99.9	V	262.0	24.3
796.406333	39.64	46.00	6.36	1000.0	120.000	99.8	V	232.0	31.2

2.3.13 Test Results 1 GHz to 18 GHz Low Channel 175 MHz BW



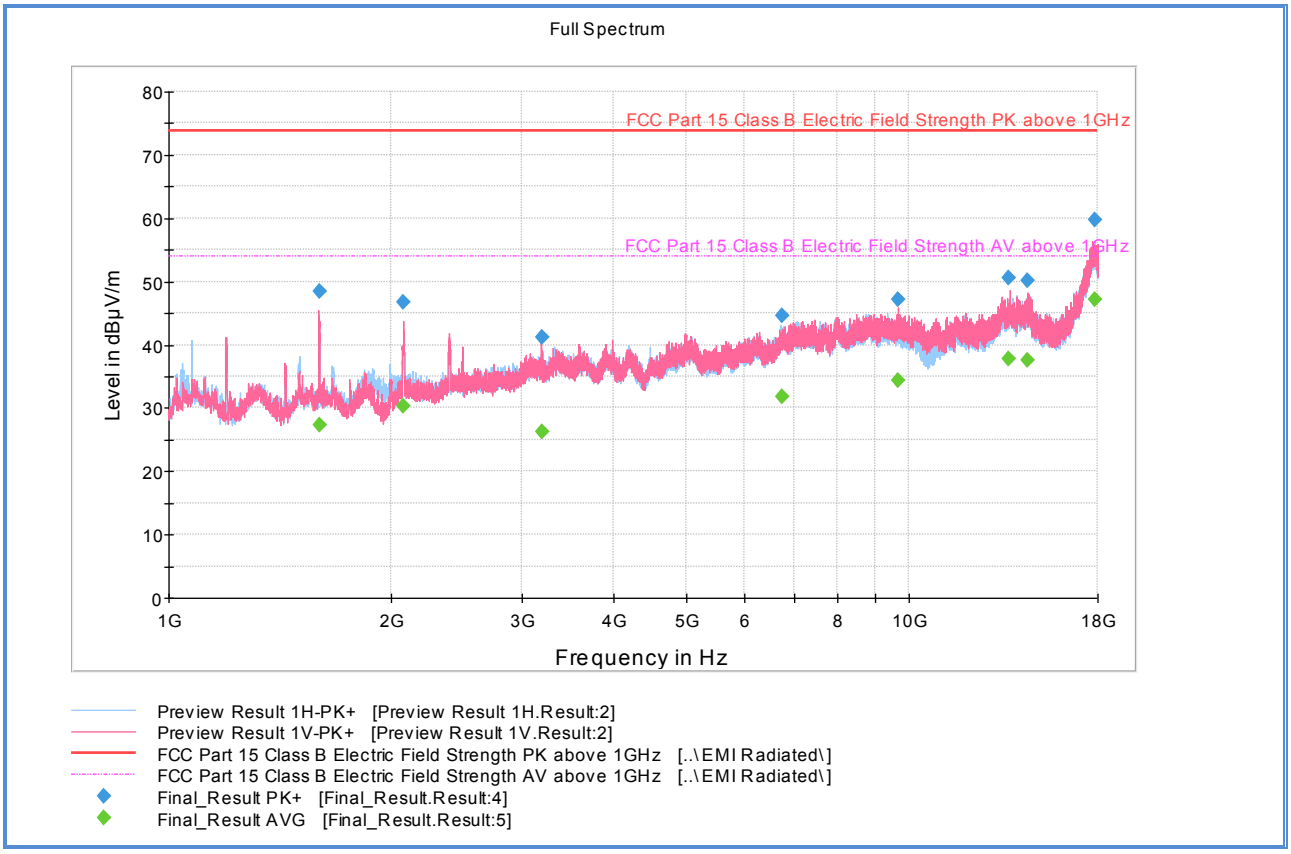
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1593.666667	49.31	73.90	24.59	1000.0	1000.000	225.0	V	203.0	-5.1
2077.633333	45.07	73.90	28.83	1000.0	1000.000	398.7	V	194.0	-2.4
3981.800000	44.63	73.90	29.27	1000.0	1000.000	104.8	V	183.0	3.2
5118.833333	41.96	73.90	31.94	1000.0	1000.000	274.1	H	230.0	5.9
14121.566667	50.62	73.90	23.28	1000.0	1000.000	125.1	V	66.0	17.6
17842.133333	60.46	73.90	13.44	1000.0	1000.000	325.0	V	6.0	26.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1593.666667	29.25	53.90	24.65	1000.0	1000.000	225.0	V	203.0	-5.1
2077.633333	29.46	53.90	24.44	1000.0	1000.000	398.7	V	194.0	-2.4
3981.800000	28.60	53.90	25.30	1000.0	1000.000	104.8	V	183.0	3.2
5118.833333	29.42	53.90	24.48	1000.0	1000.000	274.1	H	230.0	5.9
14121.566667	37.94	53.90	15.96	1000.0	1000.000	125.1	V	66.0	17.6
17842.133333	47.09	53.90	6.81	1000.0	1000.000	325.0	V	6.0	26.9

2.3.14 Test Results 1 GHz to 18 GHz Low Channel 300 MHz BW



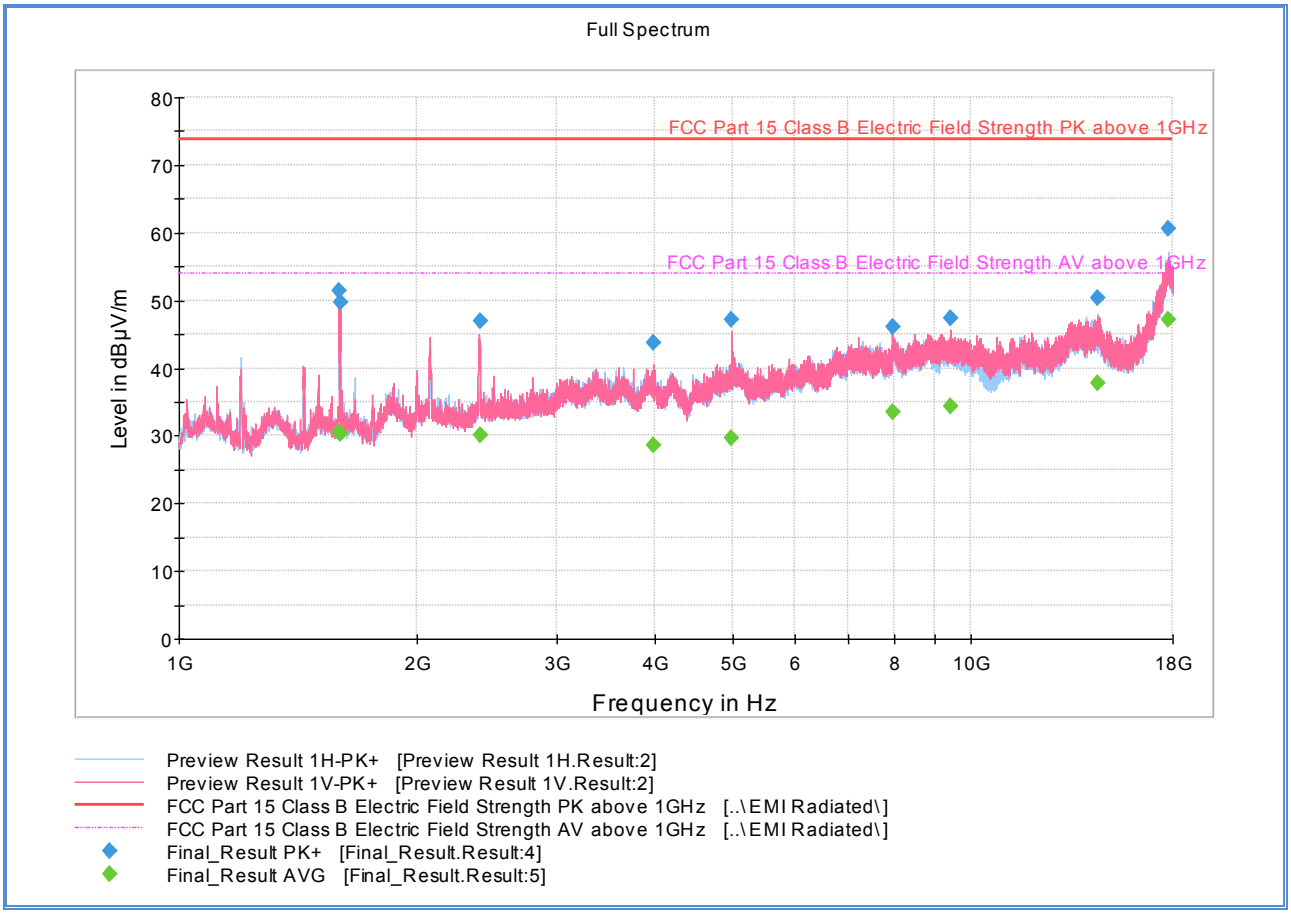
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1599.433333	48.42	73.90	25.48	1000.0	1000.000	378.3	V	197.0	-5.1
2079.100000	46.74	73.90	27.16	1000.0	1000.000	378.5	V	179.0	-2.4
3195.800000	41.23	73.90	32.67	1000.0	1000.000	298.9	V	226.0	1.1
6735.000000	44.69	73.90	29.21	1000.0	1000.000	179.6	H	277.0	9.7
9691.466667	47.12	73.90	26.78	1000.0	1000.000	99.8	V	6.0	13.4
13668.400000	50.60	73.90	23.30	1000.0	1000.000	125.0	V	48.0	16.9
14497.233333	50.13	73.90	23.77	1000.0	1000.000	408.8	V	166.0	17.2
17821.466667	59.74	73.90	14.16	1000.0	1000.000	176.2	H	184.0	27.0

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1599.433333	27.27	53.90	26.63	1000.0	1000.000	378.3	V	197.0	-5.1
2079.100000	30.20	53.90	23.70	1000.0	1000.000	378.5	V	179.0	-2.4
3195.800000	26.17	53.90	27.73	1000.0	1000.000	298.9	V	226.0	1.1
6735.000000	31.80	53.90	22.10	1000.0	1000.000	179.6	H	277.0	9.7
9691.466667	34.26	53.90	19.64	1000.0	1000.000	99.8	V	6.0	13.4
13668.400000	37.77	53.90	16.13	1000.0	1000.000	125.0	V	48.0	16.9
14497.233333	37.60	53.90	16.30	1000.0	1000.000	408.8	V	166.0	17.2
17821.466667	47.13	53.90	6.77	1000.0	1000.000	176.2	H	184.0	27.0

2.3.15 Test Results 1 GHz to 18 GHz Low Channel 425 MHz BW



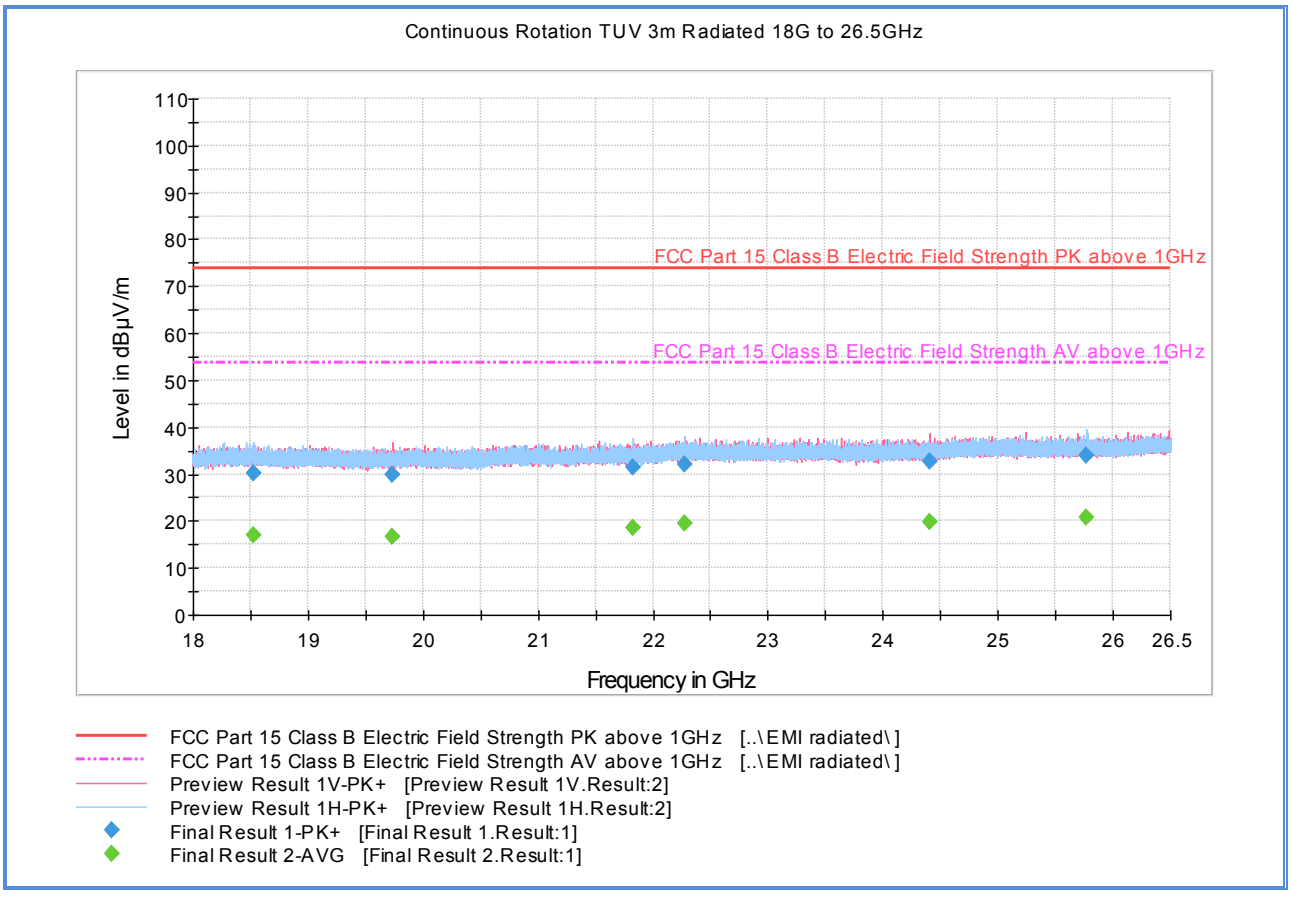
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1594.800000	51.46	73.90	22.44	1000.0	1000.000	224.9	V	206.0	-5.1
1596.933333	49.75	73.90	24.15	1000.0	1000.000	301.5	V	196.0	-5.1
2398.166667	46.90	73.90	27.00	1000.0	1000.000	288.3	V	178.0	-1.9
3982.400000	43.77	73.90	30.13	1000.0	1000.000	211.2	V	205.0	3.2
4993.533333	47.25	73.90	26.65	1000.0	1000.000	325.0	V	173.0	5.9
7976.366667	46.16	73.90	27.74	1000.0	1000.000	408.7	V	114.0	11.6
9423.500000	47.28	73.90	26.62	1000.0	1000.000	324.9	V	319.0	13.7
14495.600000	50.34	73.90	23.56	1000.0	1000.000	376.4	H	130.0	17.2
17804.666667	60.50	73.90	13.40	1000.0	1000.000	125.1	H	67.0	27.1

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1594.800000	30.54	53.90	23.36	1000.0	1000.000	224.9	V	206.0	-5.1
1596.933333	30.24	53.90	23.66	1000.0	1000.000	301.5	V	196.0	-5.1
2398.166667	30.06	53.90	23.84	1000.0	1000.000	288.3	V	178.0	-1.9
3982.400000	28.56	53.90	25.34	1000.0	1000.000	211.2	V	205.0	3.2
4993.533333	29.56	53.90	24.34	1000.0	1000.000	325.0	V	173.0	5.9
7976.366667	33.52	53.90	20.38	1000.0	1000.000	408.7	V	114.0	11.6
9423.500000	34.40	53.90	19.50	1000.0	1000.000	324.9	V	319.0	13.7
14495.600000	37.68	53.90	16.22	1000.0	1000.000	376.4	H	130.0	17.2
17804.666667	47.18	53.90	6.72	1000.0	1000.000	125.1	H	67.0	27.1

2.3.16 Test Results from 18 GHz to 26 GHz Low Channel 175 MHz BW



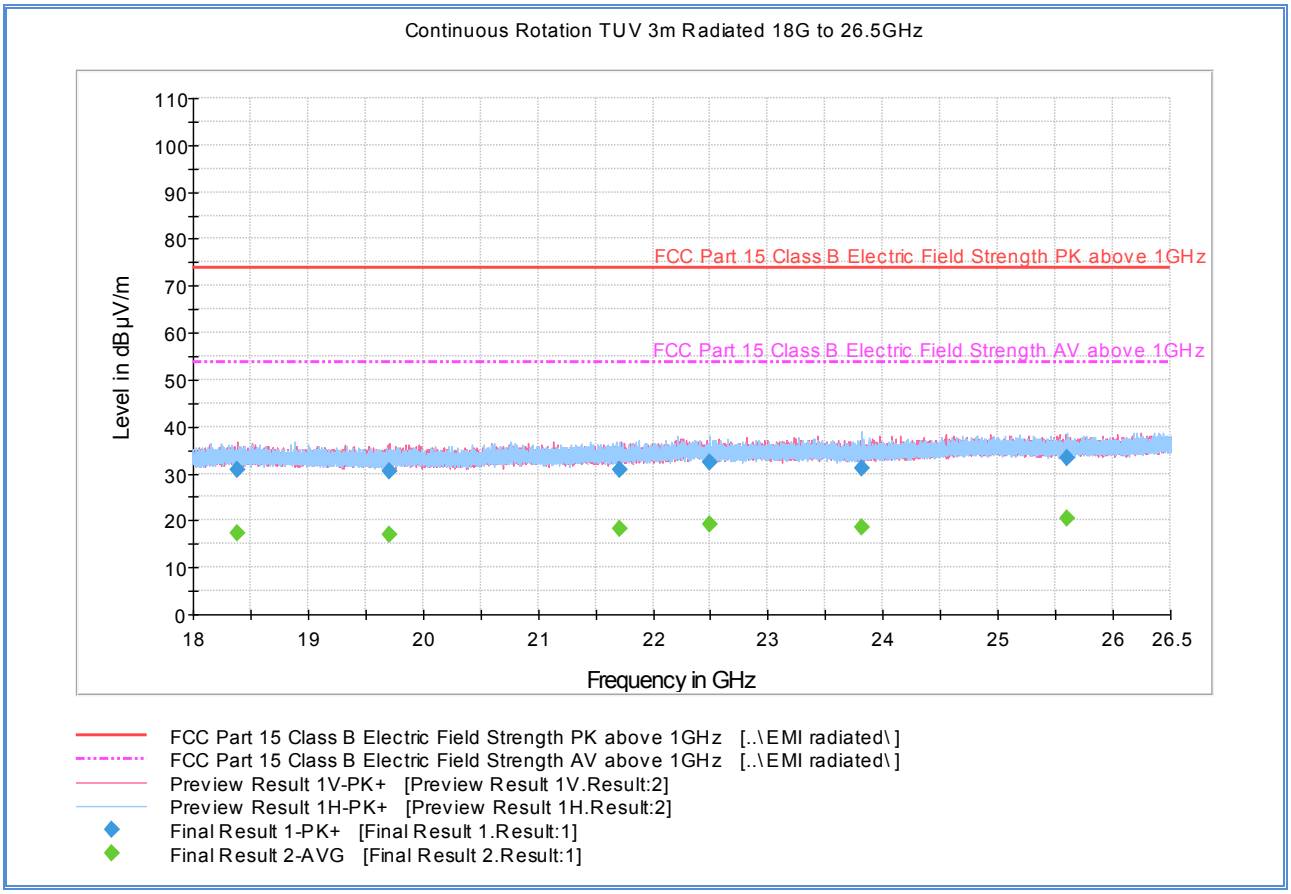
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
18527.48333	30.1	1000.	1000.000	103.0	H	317.0	-0.4	43.8	73.9
19728.41666	29.9	1000.	1000.000	113.0	V	223.0	-0.8	44.0	73.9
21824.10000	31.4	1000.	1000.000	98.0	H	5.0	0.3	42.5	73.9
22277.11666	32.0	1000.	1000.000	98.0	H	19.0	0.9	41.9	73.9
24412.20000	32.8	1000.	1000.000	103.0	V	-10.0	1.5	41.1	73.9
25768.66666	34.1	1000.	1000.000	103.0	H	163.0	1.9	39.8	73.9

Average Data

Frequency (MHz)	Average (dBµV/)	Meas. Time ( )	Bandwidth (kHz)	Height ( )	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV)
18527.483333	17.1	1000.0	1000.000	103.0	H	317.0	-0.4	36.8	53.9
19728.416667	16.7	1000.0	1000.000	113.0	V	223.0	-0.8	37.2	53.9
21824.100000	18.4	1000.0	1000.000	98.0	H	5.0	0.3	35.5	53.9
22277.116667	19.3	1000.0	1000.000	98.0	H	19.0	0.9	34.6	53.9
24412.200000	19.7	1000.0	1000.000	103.0	V	-10.0	1.5	34.2	53.9
25768.666667	20.9	1000.0	1000.000	103.0	H	163.0	1.9	33.0	53.9

2.3.17 Test Results from 18 GHz to 26 GHz Low Channel 300 MHz BW



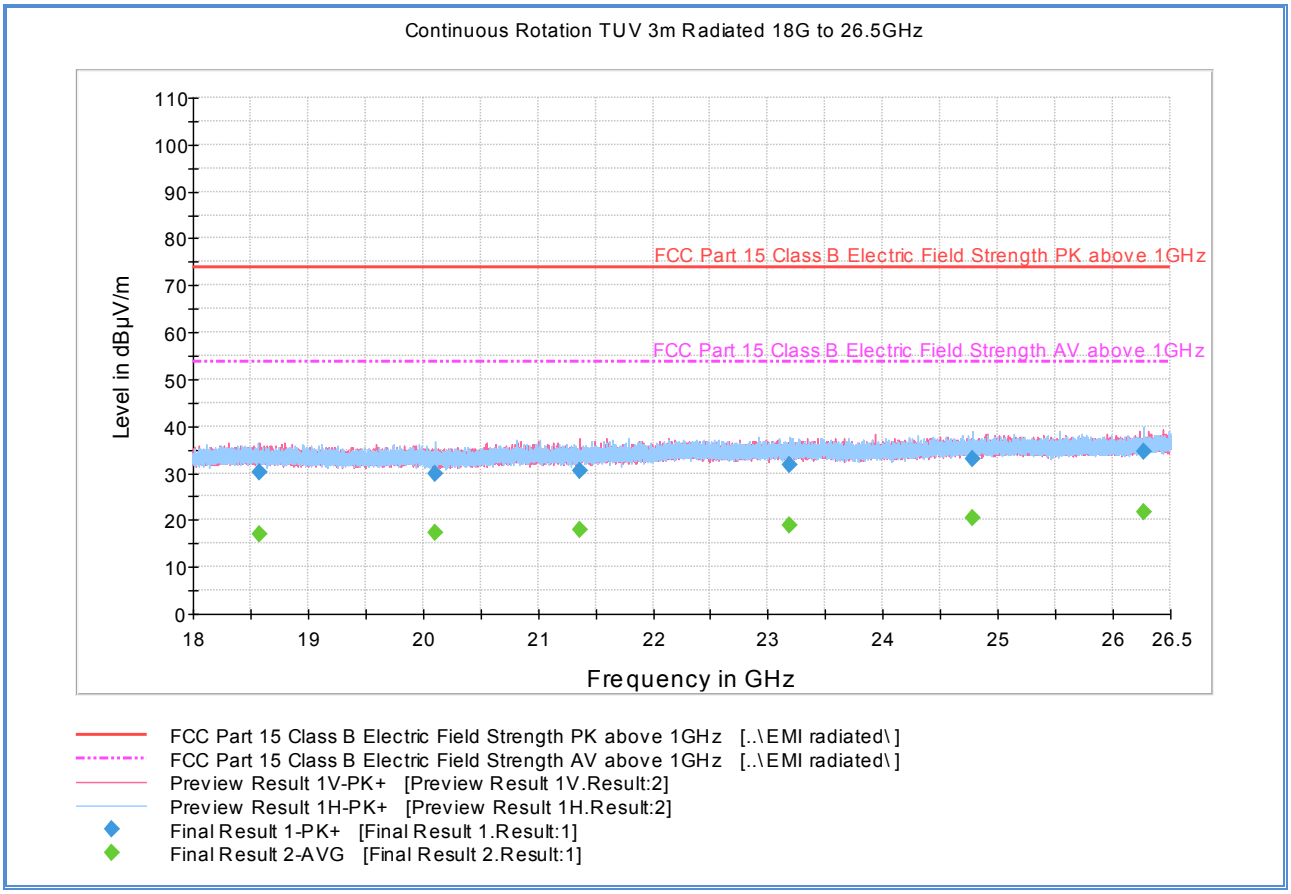
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
18389.50000	30.6	1000.	1000.000	106.0	V	271.0	-0.4	43.3	73.9
19704.08333	30.4	1000.	1000.000	106.0	V	126.0	-0.8	43.5	73.9
21707.95000	30.8	1000.	1000.000	107.0	H	5.0	0.3	43.1	73.9
22490.35000	32.4	1000.	1000.000	104.0	H	48.0	0.8	41.5	73.9
23814.53333	31.1	1000.	1000.000	100.0	H	-10.0	1.1	42.8	73.9
25606.31666	33.5	1000.	1000.000	103.0	H	252.0	1.9	40.4	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)
18389.50000	17.3	1000.	1000.000	106.0	V	271.0	-0.4	36.6	53.9
19704.08333	16.9	1000.	1000.000	106.0	V	126.0	-0.8	37.0	53.9
21707.95000	18.3	1000.	1000.000	107.0	H	5.0	0.3	35.6	53.9
22490.35000	19.0	1000.	1000.000	104.0	H	48.0	0.8	34.9	53.9
23814.53333	18.4	1000.	1000.000	100.0	H	-10.0	1.1	35.5	53.9
25606.31666	20.5	1000.	1000.000	103.0	H	252.0	1.9	33.4	53.9

2.3.18 Test Results from 18 GHz to 26 GHz Low Channel 425 MHz BW



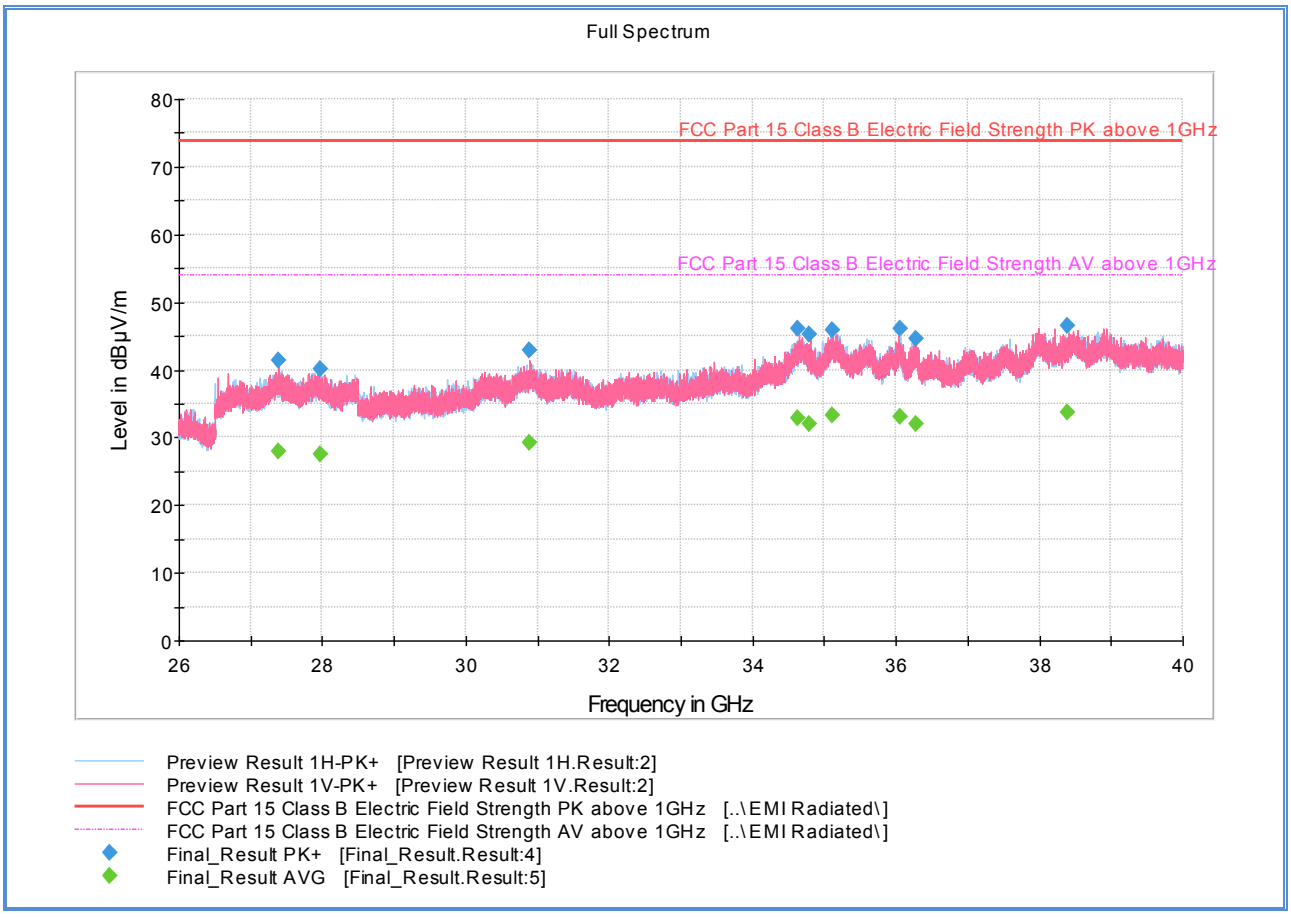
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
18580.06666	30.2	1000.	1000.000	115.0	V	64.0	-0.4	43.7	73.9
20106.33333	29.8	1000.	1000.000	109.0	H	211.0	-0.6	44.1	73.9
21369.20000	30.6	1000.	1000.000	100.0	V	42.0	0.2	43.3	73.9
23187.30000	31.7	1000.	1000.000	100.0	H	138.0	1.0	42.2	73.9
24783.53333	33.1	1000.	1000.000	100.0	H	273.0	1.9	40.8	73.9
26266.78333	34.5	1000.	1000.000	115.0	H	203.0	2.0	39.4	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)
18580.06666	17.0	1000.	1000.000	115.0	V	64.0	-0.4	36.9	53.9
20106.33333	17.2	1000.	1000.000	109.0	H	211.0	-0.6	36.7	53.9
21369.20000	18.0	1000.	1000.000	100.0	V	42.0	0.2	35.9	53.9
23187.30000	18.9	1000.	1000.000	100.0	H	138.0	1.0	35.0	53.9
24783.53333	20.4	1000.	1000.000	100.0	H	273.0	1.9	33.5	53.9
26266.78333	21.6	1000.	1000.000	115.0	H	203.0	2.0	32.3	53.9

2.3.19 Test Results from 26 GHz to 40 GHz Low Channel 175 MHz BW



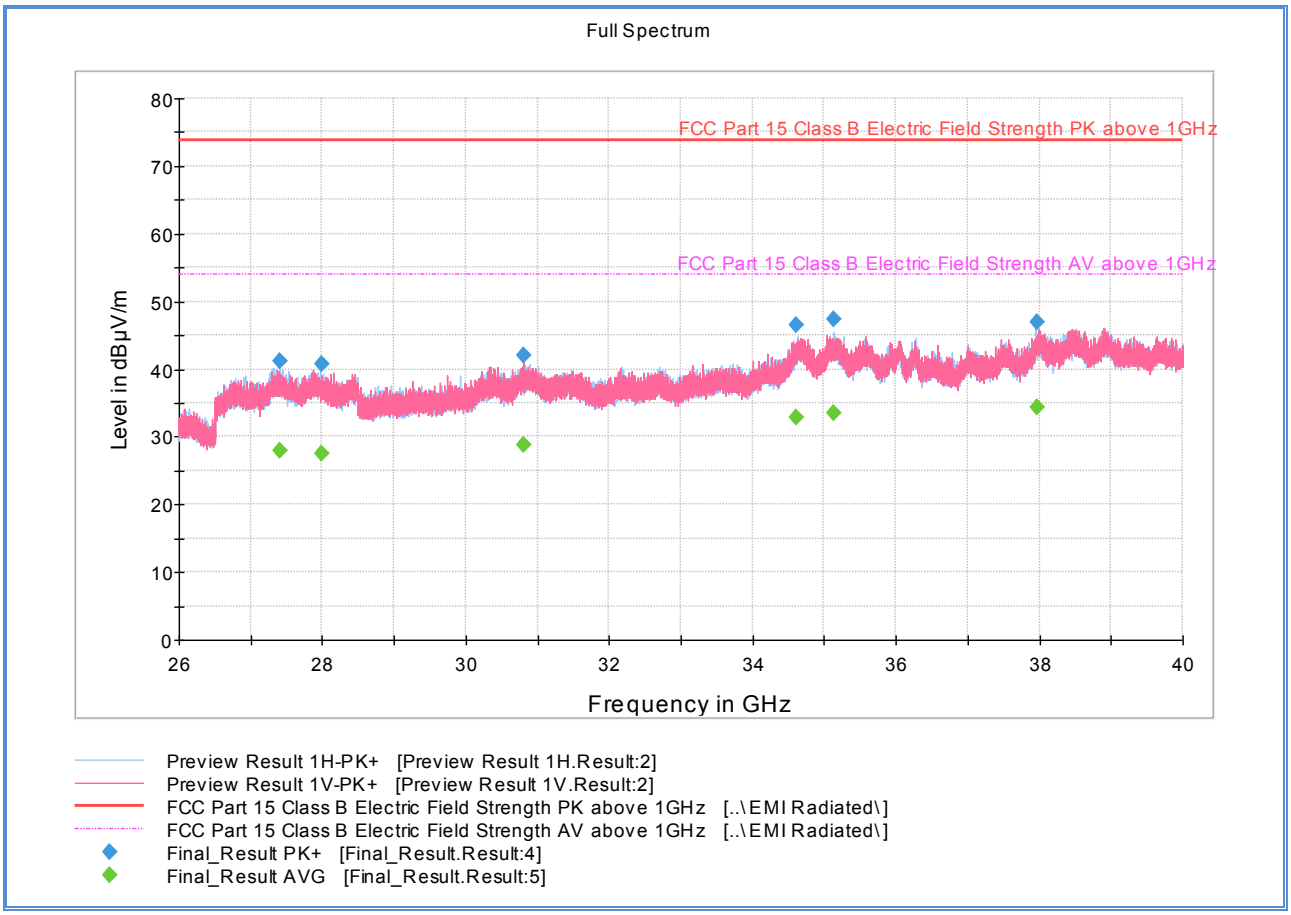
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
27392.331153	41.31	73.90	32.59	1000.	1000.000	162.0	V	230.0	2.8
27966.850385	40.16	73.90	33.74	1000.	1000.000	157.6	H	338.0	3.2
30891.818461	42.83	73.90	31.07	1000.	1000.000	119.7	V	265.0	4.5
34630.822307	45.99	73.90	27.91	1000.	1000.000	175.1	H	260.0	6.3
34794.715385	45.22	73.90	28.68	1000.	1000.000	174.9	V	36.0	6.4
35114.851923	45.86	73.90	28.04	1000.	1000.000	126.4	H	97.0	6.5
36050.033077	45.99	73.90	27.91	1000.	1000.000	125.1	H	168.0	6.7
36277.148077	44.68	73.90	29.22	1000.	1000.000	125.1	H	242.0	6.4
38398.846922	46.51	73.90	27.39	1000.	1000.000	101.4	H	316.0	8.2

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
27392.331153	28.00	53.90	25.90	1000.0	1000.000	162.0	V	230.0	2.8
27966.850385	27.56	53.90	26.34	1000.0	1000.000	157.6	H	338.0	3.2
30891.818461	29.14	53.90	24.76	1000.0	1000.000	119.7	V	265.0	4.5
34630.822307	32.95	53.90	20.95	1000.0	1000.000	175.1	H	260.0	6.3
34794.715385	32.05	53.90	21.85	1000.0	1000.000	174.9	V	36.0	6.4
35114.851923	33.36	53.90	20.54	1000.0	1000.000	126.4	H	97.0	6.5
36050.033077	33.10	53.90	20.80	1000.0	1000.000	125.1	H	168.0	6.7
36277.148077	32.10	53.90	21.80	1000.0	1000.000	125.1	H	242.0	6.4
38398.846922	33.72	53.90	20.18	1000.0	1000.000	101.4	H	316.0	8.2

2.3.20 Test Results from 26 GHz to 40 GHz Low Channel 300 MHz BW



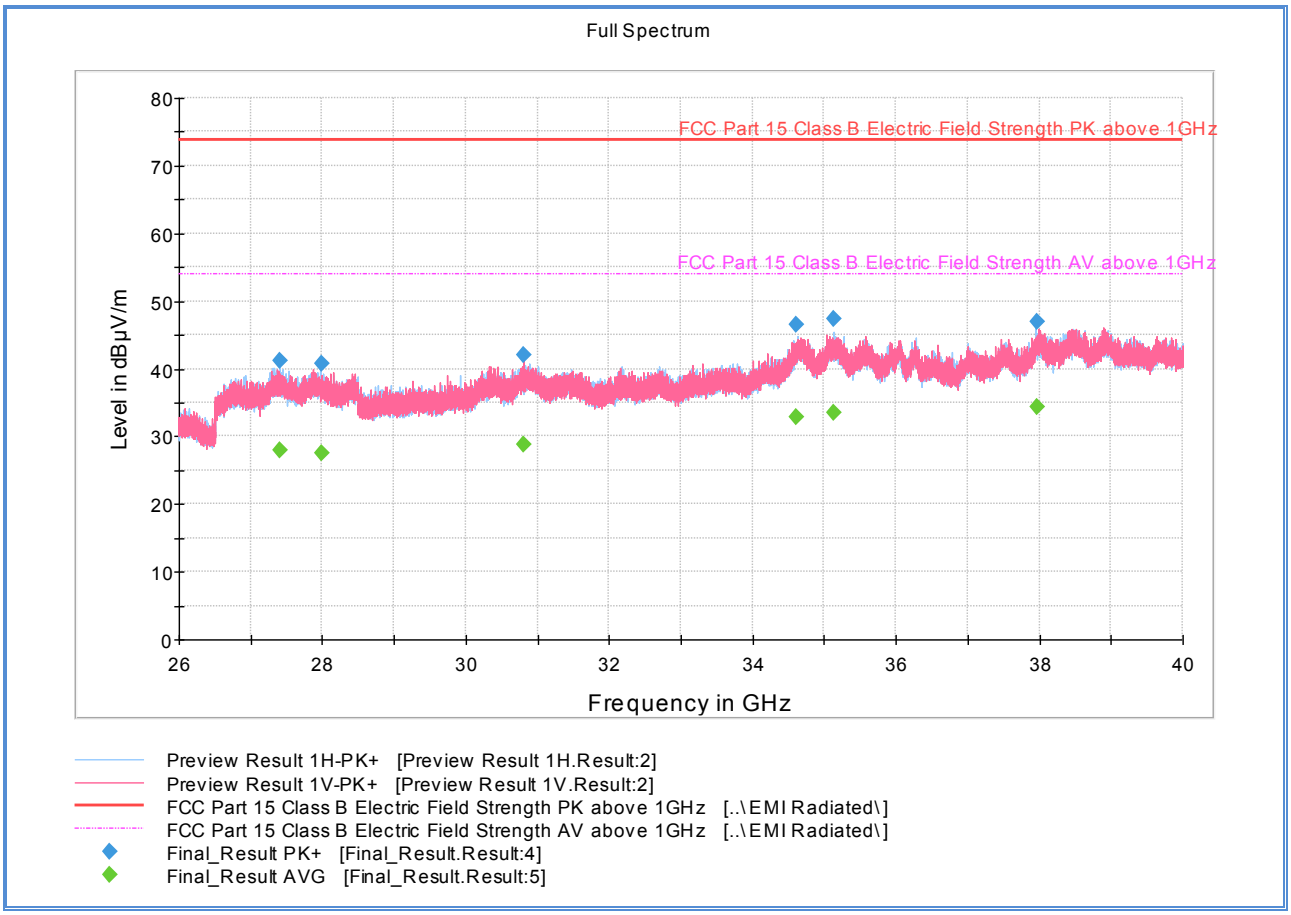
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
27408.731922	41.24	73.90	32.66	1000.0	1000.000	119.0	H	10.0	2.9
27981.469616	40.78	73.90	33.12	1000.0	1000.000	140.2	H	45.0	3.2
30815.610769	41.99	73.90	31.91	1000.0	1000.000	113.1	V	206.0	4.5
34618.536538	46.52	73.90	27.38	1000.0	1000.000	157.5	H	250.0	6.3
35130.870000	47.36	73.90	26.54	1000.0	1000.000	130.2	H	174.0	6.5
37965.568846	46.91	73.90	26.99	1000.0	1000.000	141.8	H	343.0	7.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
27408.731922	28.00	53.90	25.90	1000.0	1000.000	119.0	H	10.0	2.9
27981.469616	27.50	53.90	26.40	1000.0	1000.000	140.2	H	45.0	3.2
30815.610769	28.82	53.90	25.08	1000.0	1000.000	113.1	V	206.0	4.5
34618.536538	32.75	53.90	21.15	1000.0	1000.000	157.5	H	250.0	6.3
35130.870000	33.43	53.90	20.47	1000.0	1000.000	130.2	H	174.0	6.5
37965.568846	34.27	53.90	19.63	1000.0	1000.000	141.8	H	343.0	7.9

2.3.21 Test Results from 26 GHz to 40 GHz Low Channel 425 MHz BW



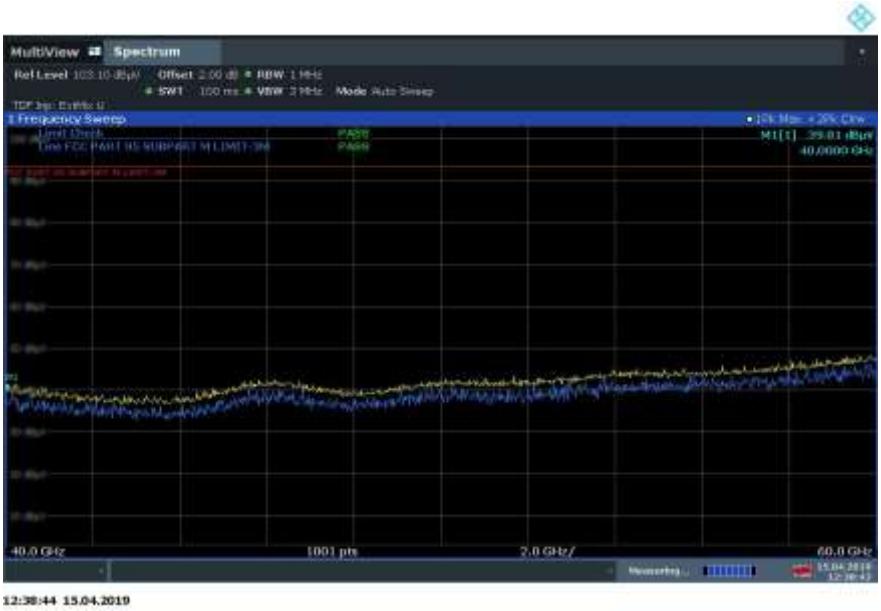
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
27408.731922	41.24	73.90	32.66	1000.0	1000.000	119.0	H	10.0	2.9
27981.469616	40.78	73.90	33.12	1000.0	1000.000	140.2	H	45.0	3.2
30815.610769	41.99	73.90	31.91	1000.0	1000.000	113.1	V	206.0	4.5
34618.536538	46.52	73.90	27.38	1000.0	1000.000	157.5	H	250.0	6.3
35130.870000	47.36	73.90	26.54	1000.0	1000.000	130.2	H	174.0	6.5
37965.568846	46.91	73.90	26.99	1000.0	1000.000	141.8	H	343.0	7.9

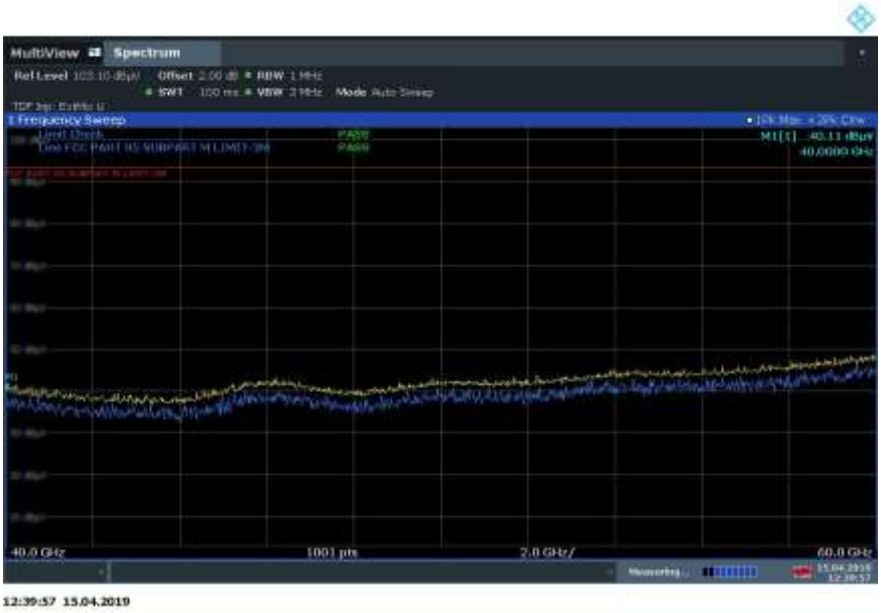
Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
27408.731922	28.00	53.90	25.90	1000.0	1000.000	119.0	H	10.0	2.9
27981.469616	27.50	53.90	26.40	1000.0	1000.000	140.2	H	45.0	3.2
30815.610769	28.82	53.90	25.08	1000.0	1000.000	113.1	V	206.0	4.5
34618.536538	32.75	53.90	21.15	1000.0	1000.000	157.5	H	250.0	6.3
35130.870000	33.43	53.90	20.47	1000.0	1000.000	130.2	H	174.0	6.5
37965.568846	34.27	53.90	19.63	1000.0	1000.000	141.8	H	343.0	7.9

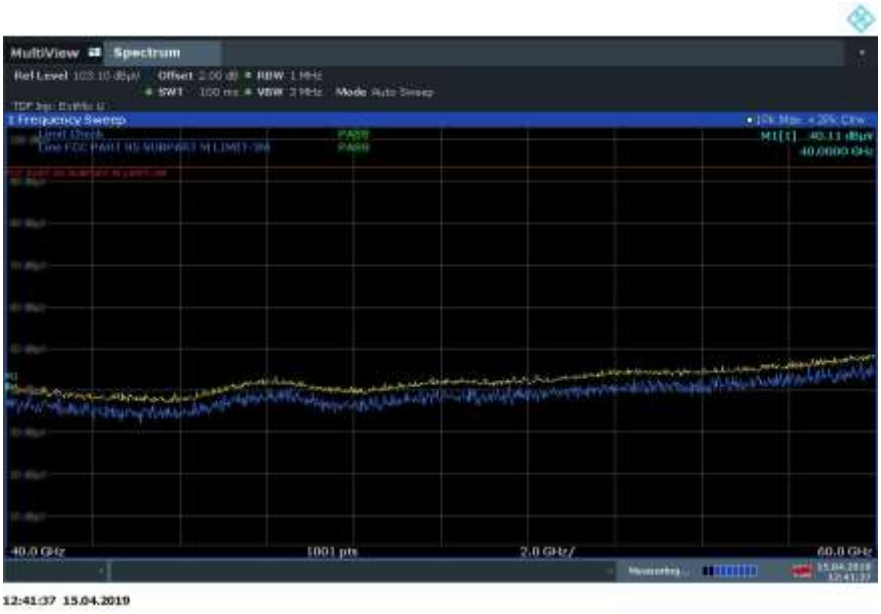
2.3.22 Test Results 40 GHz to 300 GHz



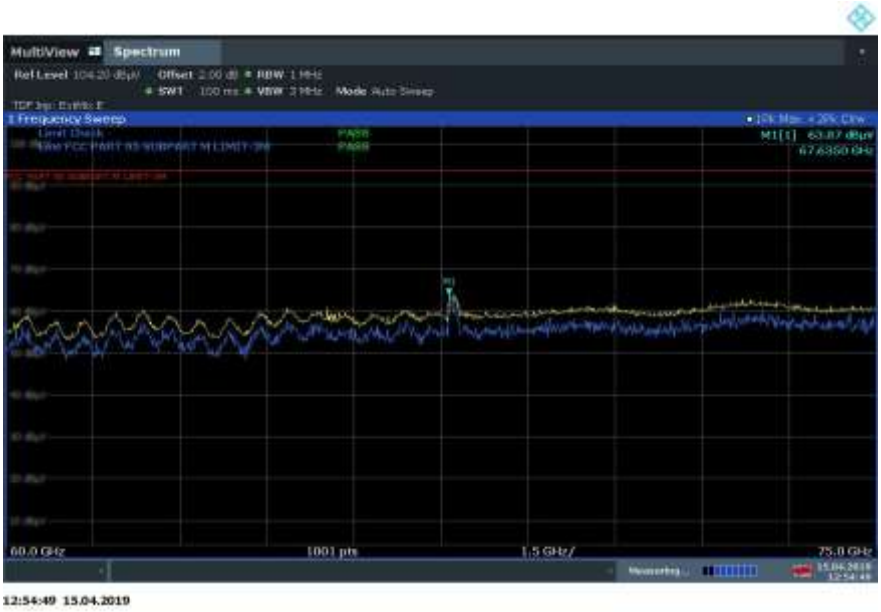
40 to 60 GHz Low Channel 175 MHz BW



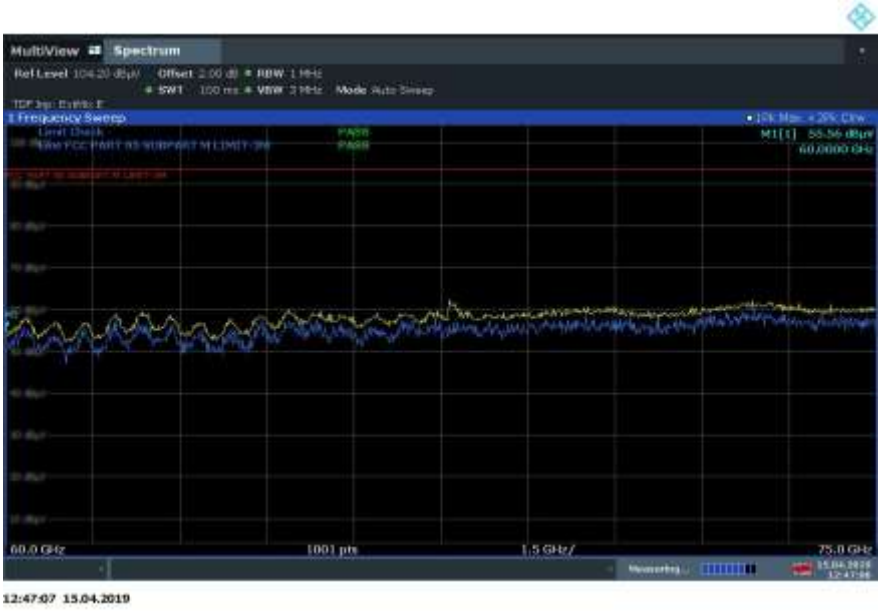
40 to 60 GHz Low Channel 300 MHz BW



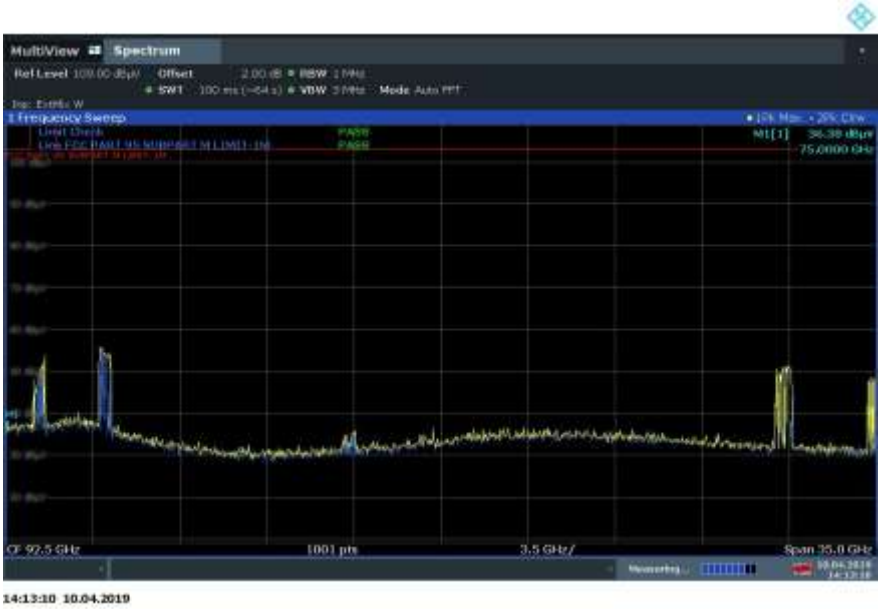
40 to 60 GHz Low Channel 425 MHz BW



60 to 75 GHz Low Channel 175 MHz BW



60 to 75 GHz Low Channel 300 MHz BW

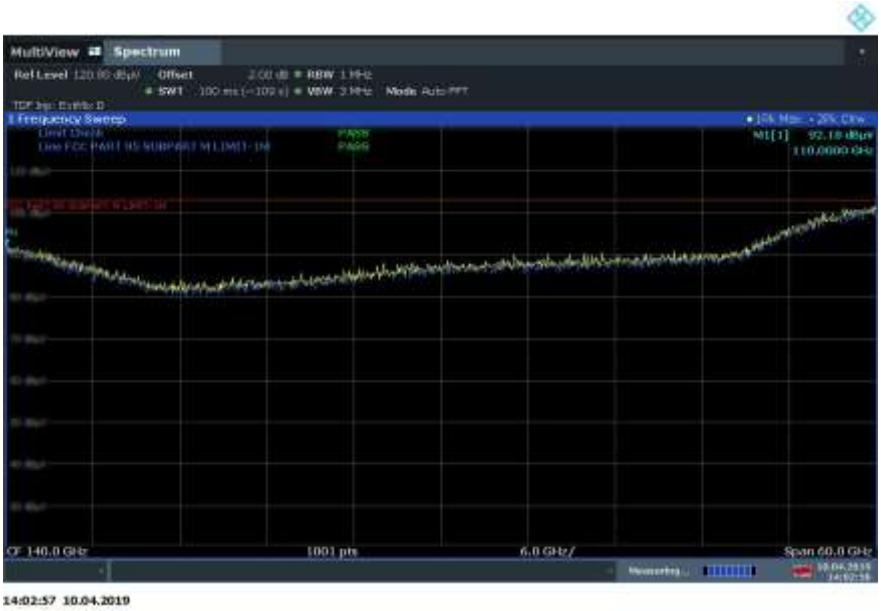


60 to 75 GHz Low Channel 425 MHz BW

75 to 110 GHz Low Channel 175 MHz BW

75 to 110 GHz Low Channel 300 MHz BW

75 to 110 GHz Low Channel 425 MHz BW



110 to 160 GHz Low Channel 175 MHz BW

110 to 160 GHz Low Channel 300 MHz BW

110 to 160 GHz Low Channel 425 MHz BW

160 to 220 GHz Low Channel 175 MHz BW

160 to 220 GHz Low Channel 300 MHz BW

160 to 220 GHz Low Channel 425 MHz BW

220 to 300 GHz Low Channel 175 MHz BW

220 to 300 GHz Low Channel 300 MHz BW

220 to 300 GHz Low Channel 425 MHz BW

2.4 FREQUENCY STABILITY

2.4.1 Specification Reference

FCC Part 95 Subpart M §95.3379(b) and RSS-251 Issue 2 Sec. 11

2.4.2 Standard Applicable

(b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise

2.4.3 Equipment Under Test and Modification State

Serial No: 120-00441.A.5/ Default Test Configuration

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

April 16, 2019/SB

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 TUV SUD America. Rancho Bernardo Facility.

Ambient Temperature	21°C
Relative Humidity	63%
ATM Pressure	101.56 kPa

2.4.7 Additional Observations

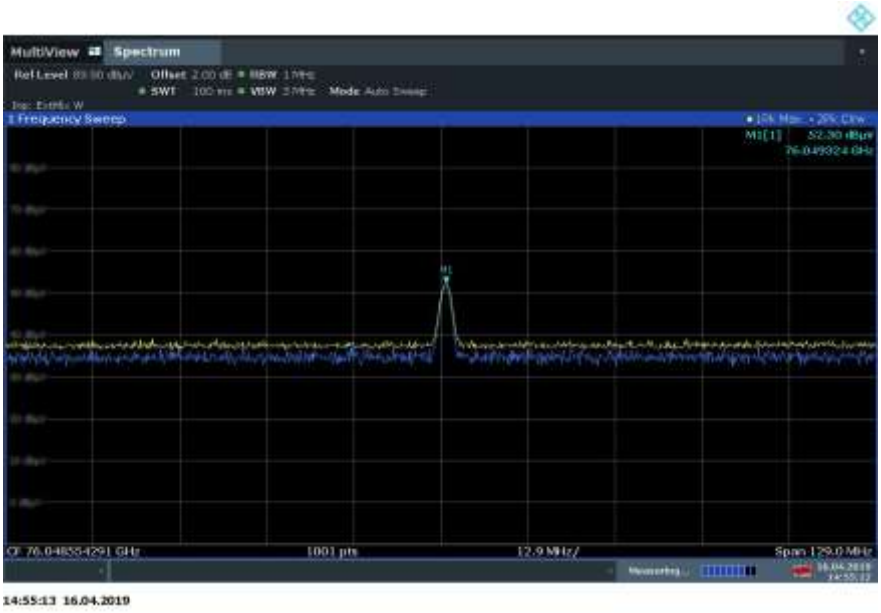
- EUT has no antenna port available. The measurements under this section were performed using radiated measurement method.
- Temperature range used is -20°C to +50°C. During test the EUT spectrum was monitored in the entire temperature range at 10 °C intervals.
- Extreme test source voltage used is 20.4 VDC and 27.6 VDC (85 % and 115 % of nominal voltage). No considerable frequency variations were observed at extreme supply voltages.
- An offset of 2.0 dB was added to account for the test setup loss.
- RBW is 1 MHz while VBW is 3 MHz
- Detector is Peak
- Trace is Max Hold
- During the test the frequencies peak of the signal spectrum were monitored. EUT was tested for the lowest channel CW modulation.

2.4.8 Test Results

Temperature variation

Modulation BW	Temperature	Frequency f (GHz)
CW 76.050 GHz	50°C	**76.049324**
	40°C	76.048684
	30°C	76.048684
	20°C	76.048294
	10°C	76.048684
	0°C	76.048814
	-10°C	76.049074
	-20 C	**76.049714**
f_L=76.049324 GHz > 76.0 GHz f_H=76.049714 GHz < 77.0 GHz EUT Complies		

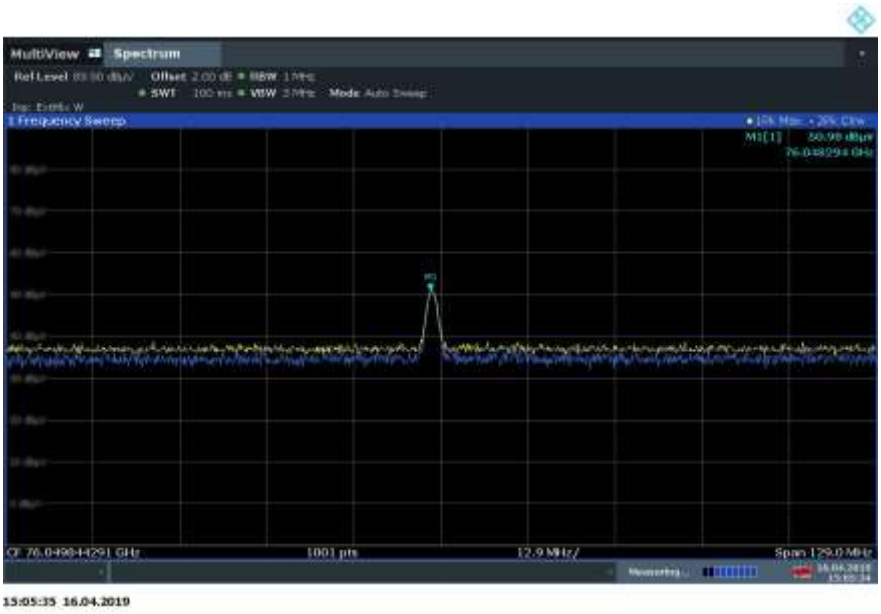
2.4.9 Test Plots



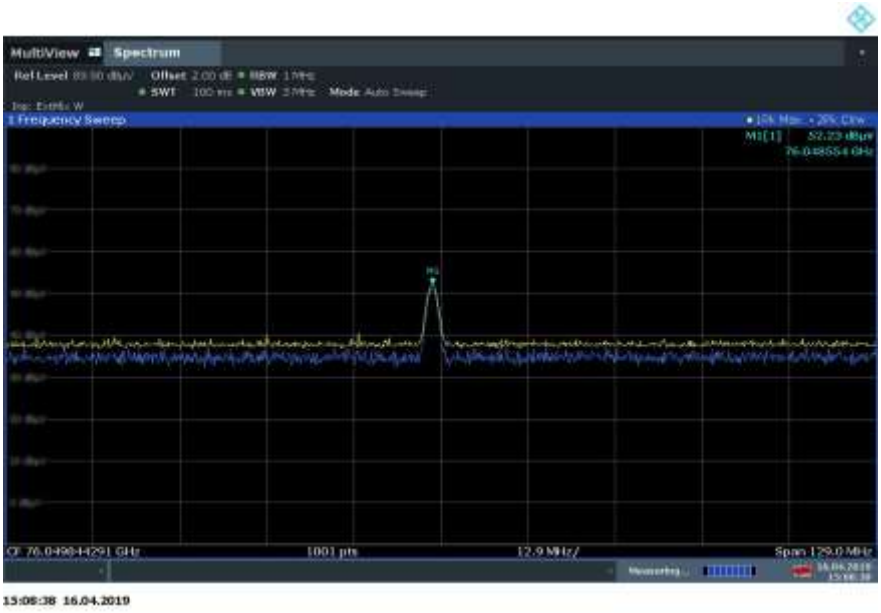
50 ˚C 24.0V CW 76.050 GHz

40 ˚C 24.0V CW 76.050 GHz

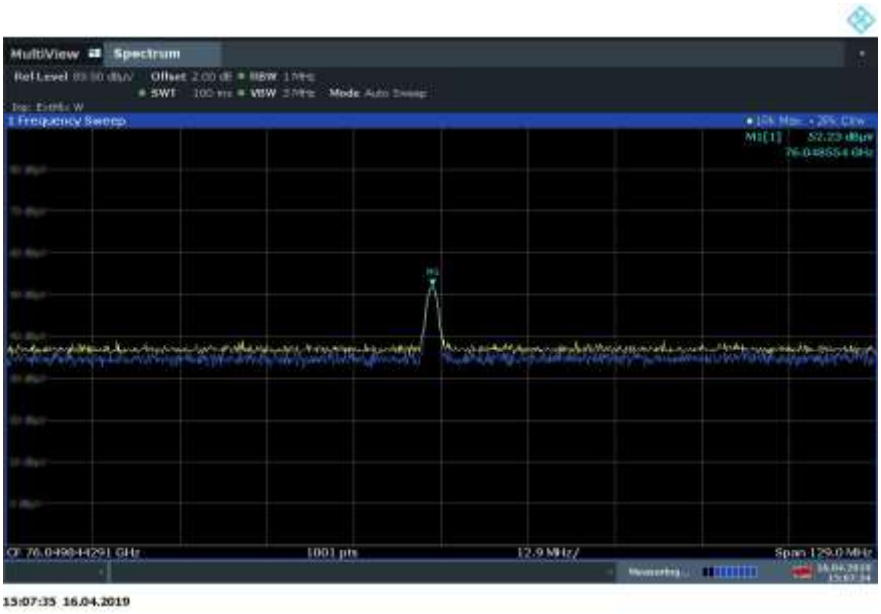
30 ˚C 24.0V CW 76.050 GHz



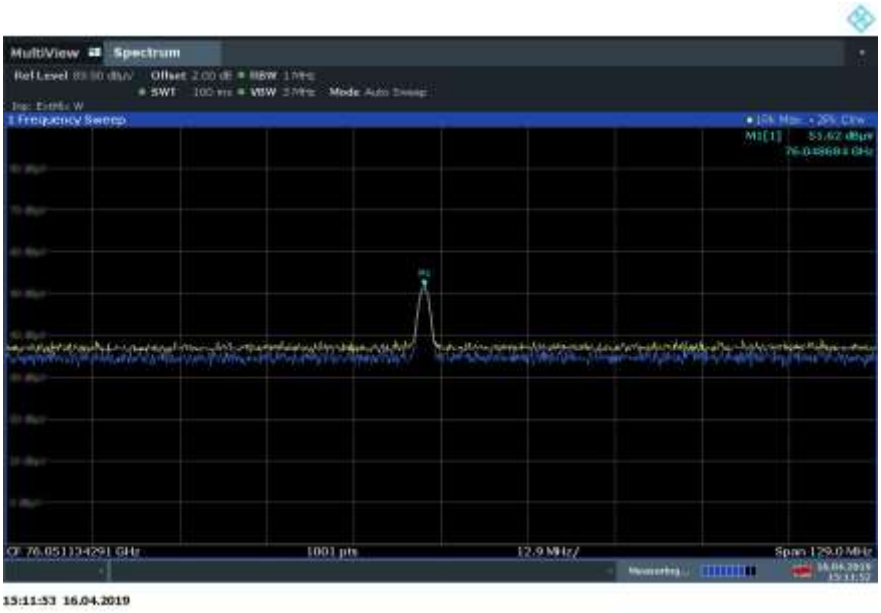
20 ˚C 24.0V CW 76.050 GHz



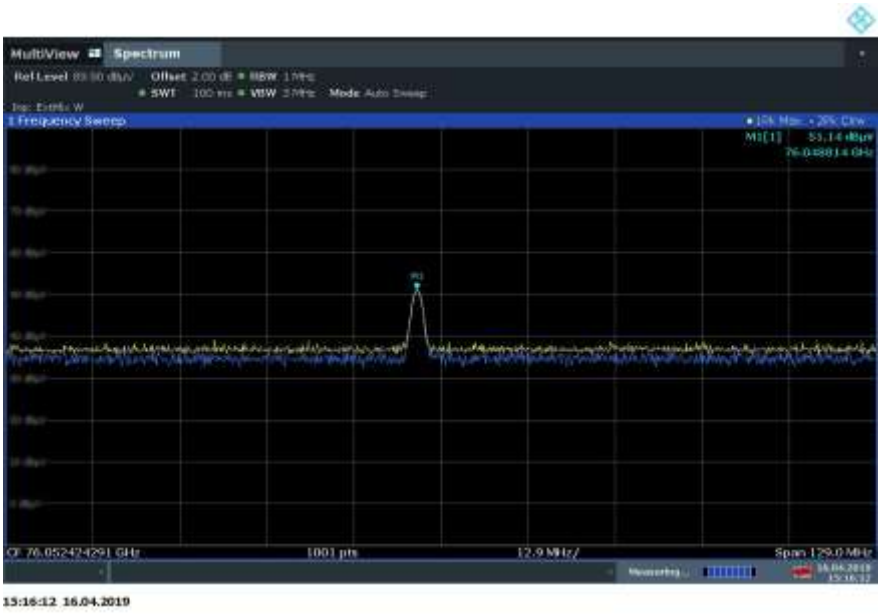
20 ˚C 20.4V (85% of 24V) CW 76.050 GHz



20 ˚C 27.6V(110% of 24V) CW 76.050 GHz



10 ˚C 24.0V CW 76.050 GHz



0 ˚C 24.0V CW 76.050 GHz

-10 ˚C 24.0V CW 76.050 GHz

-20 ˚C 24.0V CW 76.050 GHz

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
Radiated Test Setup						
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	06/08/2018	06/08/2019
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	05/09/2018	05/09/2019
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	11/20/17	11/20/19
8891	Pre-Amplifier	PE15A3262	1012	TUV SUD America	09/28/2018	09/28/2019
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	08/20/2018	08/20/2020
9001	Horn antenna (18-26 GHz)	HO42S	101	Custom Microwaves	08/18/17	08/18/19
9002	Horn antenna (26-40 GHz)	HO28S	102	Custom Microwaves	07/14/17	07/14/19
9003	Horn antenna (40-60 GHz)	HO19R	103	Custom Microwaves	07/19/17	07/19/19
9004	Horn antenna (50-75 GHz)	HO15R	104	Custom Microwaves	07/19/17	07/19/19
7628	Horn antenna (75-110 GHz)	SAR-2309-10-S2	13481-01	Sage Millimeter, Inc.	08/16/17	08/16/19
9081	Horn antenna (110-170 GHz)	HO6R	N/A	Custom Microwaves	Verified	
9082	Horn antenna (140-220 GHz)	HO5R	N/A	Custom Microwaves	Verified	
9080	Horn antenna (220-325 GHz)	HO3R	N/A	Custom Microwaves	Verified	
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	10/18/2018	10/18/2019
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	03/06/2018	03/06/2019
8893	Pre-amplifier (18-40 GHz)	SLKKa-30-6	15G27	Spacek Labs	Verified by 1003 and 7611	
7637	Harmonics mixer (40-60 GHz)	FS-Z60	100009	Rhode & Schwarz	05/31/2018	05/31/2020
7636	Harmonics mixer (60-90 GHz)	FS-Z90	100092	Rhode & Schwarz	Verified	
7633	Harmonics mixer (75-110 GHz)	HM-110-7	101000	Radiometer Physics	Verified	
7634	Harmonics mixer (110-170 GHz)	HM-170	0062	Radiometer Physics	Verified by 1003 & 7611	
7635	Harmonics mixer (170-220 GHz)	HM-220	020022	Radiometer Physics	Verified by 1003 & 7611	
7632	Harmonics mixer (220-325 GHz)	HM-325	020075	Radiometer Physics	Verified by 1003 & 7611	
8872	Direct Reading Attenuator	STA-60-19-D1	11875-01	Sage Millimeter, Inc.	Verified	
8860	Direct Reading Attenuator	STA-60-15-D1	11466-01	Sage Millimeter, Inc.	Verified	
8861	Direct Reading Attenuator	STA-60-10-D1	11466-01	Sage Millimeter, Inc.	Verified	
8873	Active Multiplier (40-60 GHz)	AMC-19-RFH00	124	Millitech, Inc.	Verified	
8914	Active Multiplier (50-75 GHz)	AMC-15-RFH00	283	Millitech, Inc.	Verified	
8915	Active Multiplier (75-110 GHz)	AMC-10-RFH00	606	Millitech, Inc.	Verified	
8922	High-frequency cable	R90-088-200	N/A	Teledyne	Verified	
1026	High-frequency cable	3M-7/C2	N/A	MicroCoax	Verified	
8849	High-frequency cable (1-18 GHz)	SAC-26G-6.1	363	A.H.Systems	Verified	
8771	6dB attenuator	606-06-1F4/DR	N/A	MECA	Verified	

Miscellaneous						
6708	Multimeter	34401A	US36086974	Hewlett Packard	07/18/18	07/18/19
7554	Barometer/Temperature/Humidity Transmitter	iBTHX-W	0400706	Omega	05/25/18	05/25/19
7579	Temperature Chamber	115	151617	TestQuity	08/24/18	08/24/19
118208	DC Power Supply	Pad 250-4.5L	29051058	Kikusui Electronics Corp.	Verified by 6708	
9076	DC Power Supply	18020M	P802039	Protek	Verified by 6708	
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 Radiated Emission Measurements (Below 1 GHz)

Radiated Measurement 30 - 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	0.58 dB	Normal, k=2	2.000	0.29	0.08
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-polarisation	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	3.55 dB	Triangular	2.449	1.45	2.10
16	Separation distance at 3 m	0.30 dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.57 dB	Rectangular	1.732	0.33	0.11
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	2.88 dB		
	Expanded uncertainty		Normal, k=2	**5.77 dB**		

3.2.2 Radiated Emission Measurements (1 GHz to 18 GHz)

Radiated Measurement (1 GHz-18 GHz) 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-polarisation	0.90 dB	Rectangular	1.732	0.52	0.27
14	Site imperfections VSWR (Method 2)	5.40 dB	Triangular	2.000	4.89	1.10
15	Effect of setup table material	1.57 dB	Rectangular	1.732	0.91	0.82
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	2.38 dB		
	Expanded uncertainty		Normal, k=2	**4.77 dB**		

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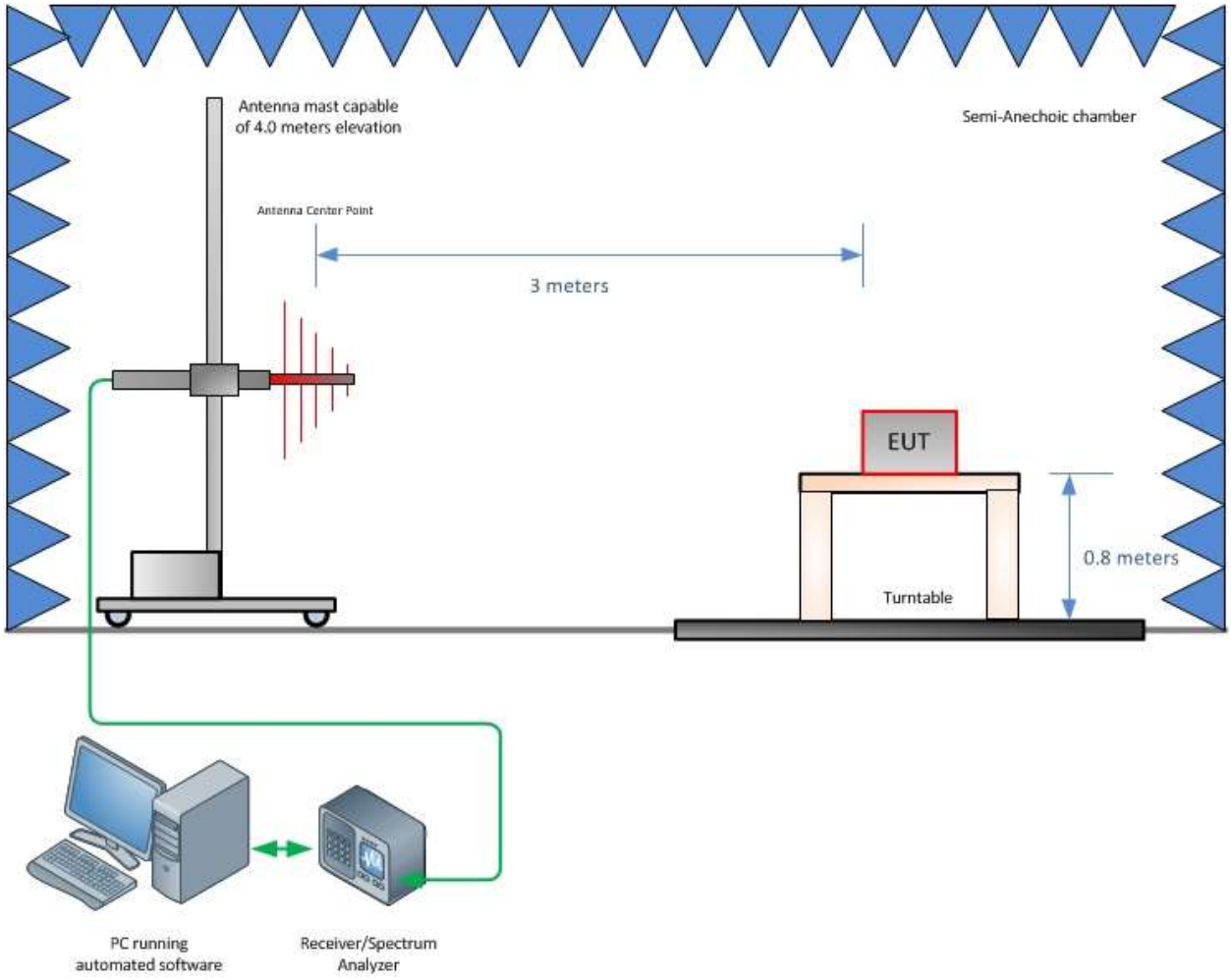
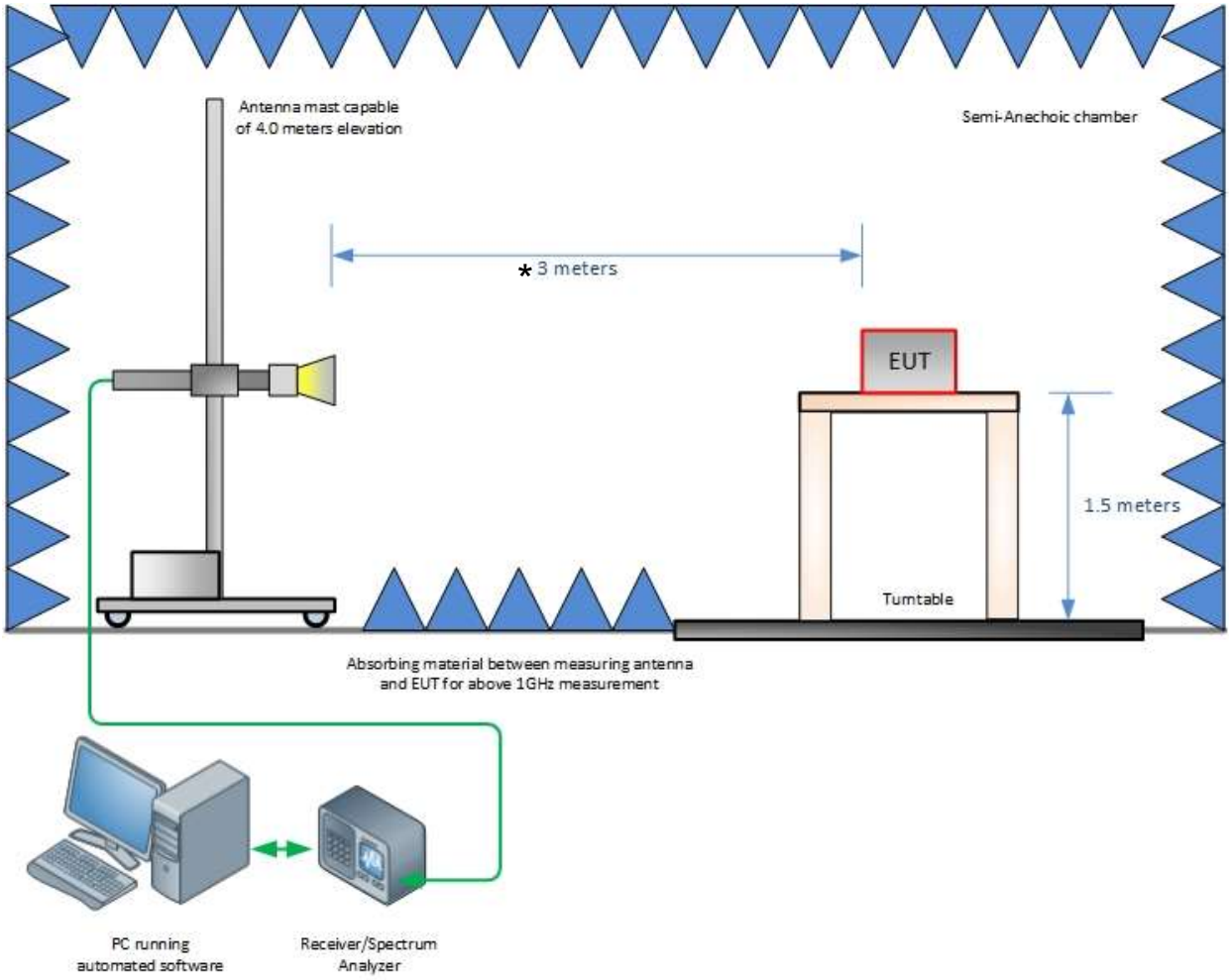
SECTION 4

DIAGRAM OF TEST SETUP

4.1 RADIATED EMISSION TEST SETUP (BELOW 1 GHZ)



4.2 RADIATED EMISSION TEST SETUP (ABOVE 1 GHZ)



*A test distance of 3 m was used for measurements below 75 GHz. The emissions in the range from 75 GHz to 160 GHz were evaluated at 1.0 m distance. For the measurements from 160 GHz to 220 GHz, the test distance was reduced to 0.5 m to assure that the noise floor is at least 10 dB below the applicable limit. Measurements above 220 GHz were taken at 0.2 m distance.

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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