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Report On

Radio Testing of the
Vayyar Imaging LTD
VCTA1_42LS Short Range Vehicular Radar

FCC Part 95 Subpart M

Report No. 72144801A **April 2019**

REPORT ON	Radio Testing of the Vayyar Imaging LTD V80G Short Range Vehicular Radar
TEST REPORT NUMBER	72144801A
PREPARED FOR	Vayyar Imaging LTD 3 Avramham Giron Yehud TA 5621717
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APPROVED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: Senior EMC Test Engineer/Wireless Team Lead
DATED	April 02, 2019

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Revision History

72144801A Vayyar Imaging LTD VCTA1_42LS Short Range Vehicular Radar					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
04/02/2019		Initial Release			Ferdinand S. Custodio

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SECTION 1

REPORT SUMMARY

Radio Testing of the
Vayyar Imaging LTD
VCTA1_42LS Short Range Vehicular Radar

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Vayyar Imaging LTD VCTA1_42LS Short Range Vehicular Radar to the requirements of FCC Part 95 Subpart M.

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	Vayyar Imaging LTD
Model Number(s)	V80G
FCC ID Number	2AHIS-V80G
IC Number	21498-V80G
Serial Number(s)	VITOGD1851N0081
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 95 Subpart M (October 01, 2018). • KDB 653005 D01 Determining ERP And EIRP V01r01 (April 06, 2018) Guidelines For Determining The Effective Radiated Power (ERP) and Equivalent Isotopically Radiated Power (EIRP) of an RF Transmitting System
Start of Test	Januray 25, 2019
Finish of Test	February 15, 2019
Name of Engineer(s)	Sandipan Basu
Related Document(s)	• Supporting documents for EUT certification are separate exhibits. • Rhode & Schwarz FSW Manual (FSW_UserManual_en_41_web.pdf)

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 95 Subpart M is shown below.

Section	FCC Part 95 Spec Clause	Test Description	Result	Comments/Base Standard
2.1	§95.3367	Transmitter Output Power	Compliant	
2.2	§2.202 (a)	Occupied Bandwidth	Compliant	
2.3	§95.3379 (a)	Transmitter Unwanted Emissions	Compliant	
2.4	§95.3379 (b)	Frequency Stability	Compliant	

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1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a Vayyar Imaging LTD VCTA1_42LS Short Range Vehicular Radar in 77-81GHz range. The EUT are multi-antenna sensors for characterizing the environment in the vicinity of the EUT by collecting and analyzing propagation information between the antennas, which is affected by the environment. The information is gathered by sequentially transmitting from the available antennas and collecting the received information at the rest of the antennas.

1.3.2 EUT General Description

EUT Description	Short Range Vehicular Radar
Model Name	VCTA1_42LS
Model Number(s)	V80G
Power Source	USB Power
Dimensions	101X81X12 mm
Weight	140 grams
Mode Verified	Operational Worst Case mode- Stepped Frequency CW
Capability	Short Range Automotive Radar
Transmitter Output Power	-16 dBm at antenna input
Primary Unit (EUT)	☐ Production
	☒ Pre-Production
	☐ Engineering
Antenna Type	An array of 42 PCB embedded slot antennas. Peak gain of the antennas = 5 dBi (The power levels are adjusted so as not to exceed the limits on EIRP and on the power at the antenna port, taking into account both antenna gain and the trace loss).
Antenna Part Number	NA

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	EUT is run by a software on a Test PC called Multiport Recorder. There is just one profile and one configuration for the EUT which is set by a script in the software. The EUT is connected to the PC by a USB cable and the configuration is set by running the software from the PC.

1.4.2 EUT Exercise Software

Multiport Recorder (MPR) software program on the support laptop.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Vayyar	USB cable	Cable to connect the EUT to the Laptop.
Lenovo Laptop	Laptop	Lenovo Thinkpad T61
Lenovo AC adapter	Power Cable	AC Adapter 90W 20V

1.4.4 Worst Case Configuration

N/A. There is only one test configuration provided by the manufacturer when the EUT is in transmit mode.

1.4.5 Simplified Test Configuration Diagram

N/A. EUT verified on stand alone 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: VITOGD1851N0081		
N/A	—	—

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.26-2015, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.

For conducted and radiated emissions, the equipment under test (EUT) was configured to measure its highest possible emission level. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY REGISTRATION

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

1.9.1 FCC – Designation No.: US1146

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

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

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

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

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

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

1.9.4 NCC (National Communications Commission - US0102)

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

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

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

1.9.6 RRA – Identification No. US0102

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

1.9.7 OFCA – U.S. Identification No. US0102

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

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SECTION 2

TEST DETAILS

Radio Testing of the
Vayyar Imaging LTD
VCTA1_42LS Short Range Vehicular Radar

2.1 RADIATED POWER LIMITS

2.1.1 Specification Reference

Part 95 Subpart M §95.3367.

2.1.2 Standard Applicable

The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically 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: VITOGD1851N0081 / Default Test Configuration

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

February 04, 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. Rancho Bernardo facility

Ambient Temperature	17.0 °C
Relative Humidity	35.0 %
ATM Pressure	99.1 kPa

2.1.7 Additional Observations

- This is a radiated test with a test distance of 3m.
- The average power was measured as in-band power (ref:- KDB 653005).
- Rhode & Schwarz Spectrum Analyzer was set to Signal ID = ON and Auto ID = OFF under External mixer settings to avoid mixer ghosting or inclusion of mixer products in the measurements.
- The avoidance of mixer ghosting in accordance to Rhode & Schwarz FSW Manual under Section Automatic Signal Identification (Page 411). In the plot below the part of the graph which has both yellow and blue signal graph is the real signal area and the parts where the yellow or blue is there should be avoided.
- RBW is 1MHz of the span.VBW is 3X RBW.

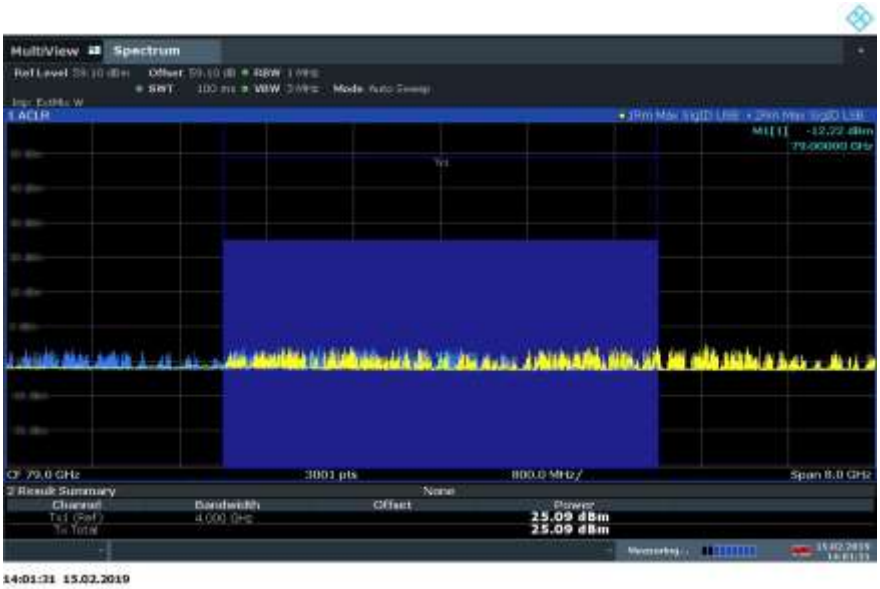
2.1.8 Test Results

Frequency of emission (GHz)	Radiated limit	
	Peak EIRP (dBm)	Peak EIRP limit (dBm)
77-81	4.31/MHz	55

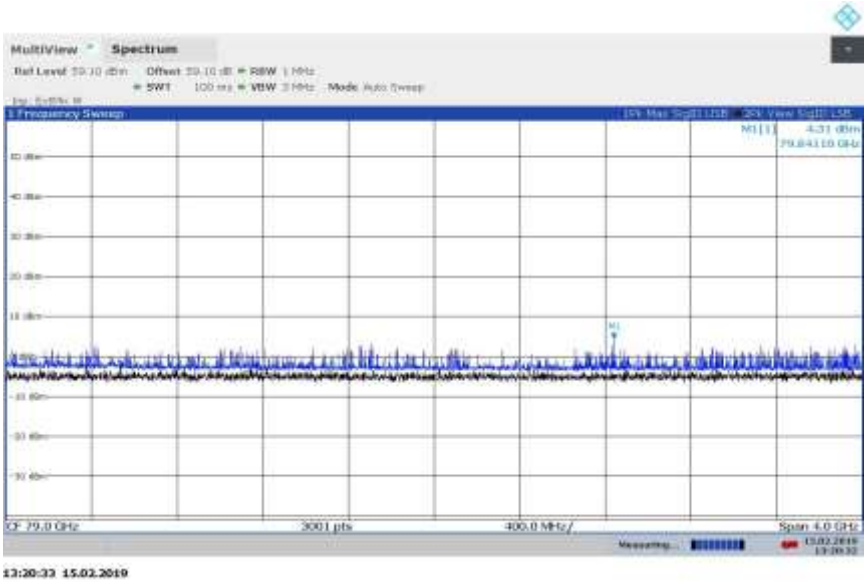
Frequency of emission (GHz)	Radiated limit	
	Average EIRP (dBm)	Average EIRP limit (dBm)
77-81	25.09dBm band power (4GHz)*	50

**25.09dBm -10 log 4000 = -10.9dBm (using 1MHz RBW)*

2.1.9 Test Plots



Maximum Average EIRP



Peak EIRP

2.2 OCCUPIED BANDWIDTH

2.2.1 Specification Reference

FCC Title 47 Chapter 1 Subpart A Part 2 Subpart C §2.202 (a)

2.2.2 Standard Applicable

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. In some cases, for example multichannel frequency-division systems, the percentage of 0.5 percent may lead to certain difficulties in the practical application of the definitions of occupied and necessary bandwidth; in such cases a different percentage may prove useful.

2.2.3 Equipment Under Test and Modification State

Serial No: VITOGD1851N0081 / Default Test Configuration

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

February 15, 2019 / 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 Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	18.3 °C
Relative Humidity	66.0%
ATM Pressure	101.6 kPa

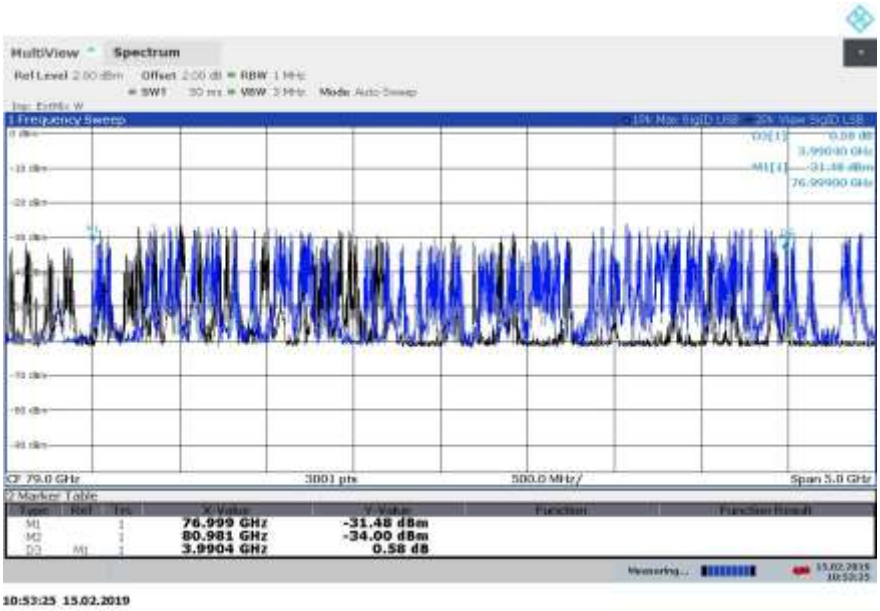
2.2.7 Additional Observations

- This is a radiated test. EUT was about 0.5 m distance from the Receiver to get appreciable power in the Analyzer and good SNR.
- Rhode & Schwarz Spectrum Analyzer was set to Signal ID = ON and Auto ID = OFF under External mixer settings to avoid mixer ghosting or inclusion of mixer products in the measurements.
- The avoidance of mixer ghosting in accordance to Rhode & Schwarz FSW Manual under Section Automatic Signal Identification (Page 411). In the plot below the part of the graph which has both yellow and blue signal graph is the real signal area and the parts where the yellow or blue is there should be avoided..
- RBW is 1MHz of the span. VBW is 3X RBW
- The OBW function in the analyser was not used as the signal continues forever for both traces due to mixer ghosting. Where there is a overlap of the two traces and where the signal level is well above noise level the markers were used to measure the OBW.

2.2.8 Test Results (For reporting purposes only)

Channel	Measured 99% OBW (GHz)
Default (77-81 GHz)	3.99

2.2.9 Test Results Plots



OBW Plot

2.3 SPURIOUS EMISSIONS

2.3.1 Specification Reference

Part 95 Subpart D §95.3379

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: VITOGD1851N0081 / Default Test Configuration

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

February 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. Rancho Bernardo facility

Ambient Temperature	18.3 °C
Relative Humidity	66.0%
ATM Pressure	101.7 kPa

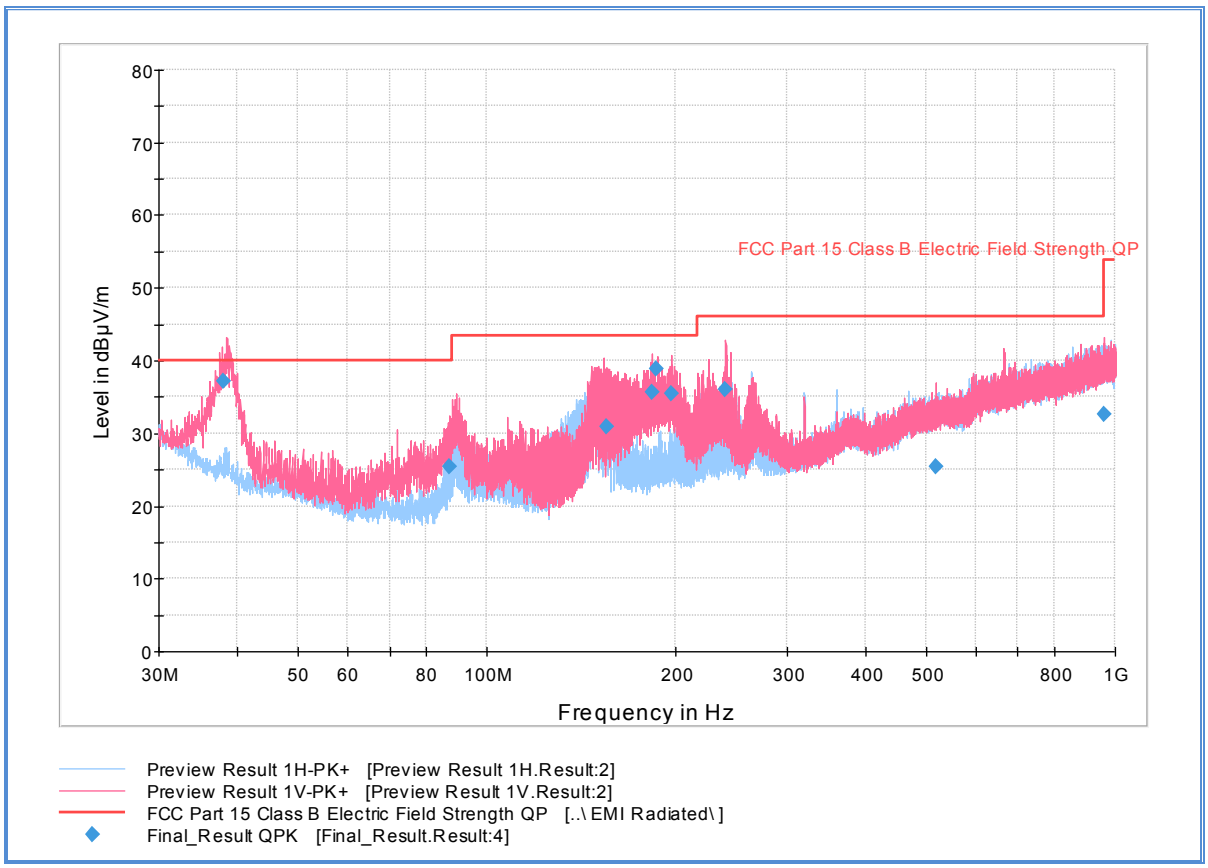
2.3.7 Additional Observations

- This is a radiated test.
- RBW is set to approximately 1MHz.
- VBW is ≥3X RBW.
- 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.
- 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.
- All the emissions below 40 GHz comply with the general radiated emission limits of §15.209.

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**

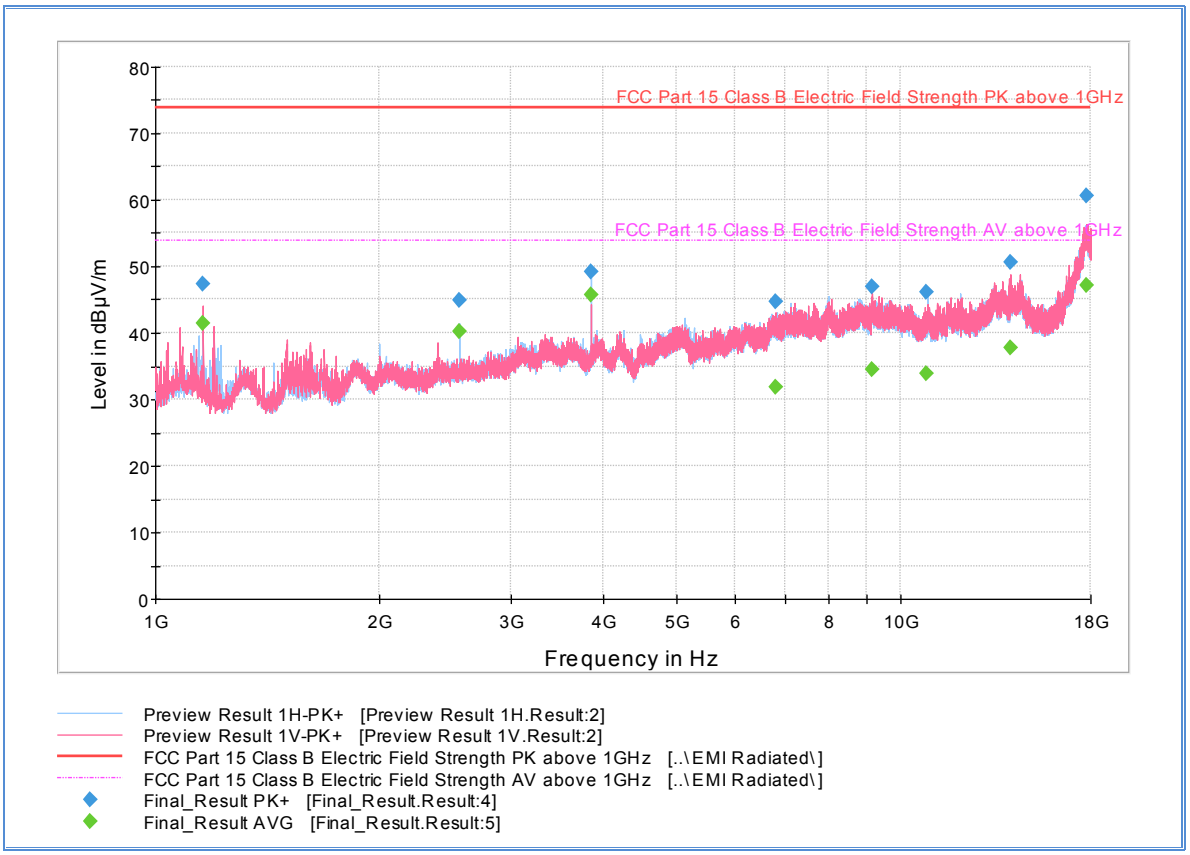
2.3.9 Test Results Plots



30 MHz to 1 GHz Spurious Emissions

Final_Result_QPK

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
37.983667	37.12	40.00	2.88	1000.0	120.000	104.5	V	208.0	18.0
87.053667	25.32	40.00	14.68	1000.0	120.000	104.2	V	20.0	13.0
155.035000	30.93	43.50	12.57	1000.0	120.000	125.3	V	115.0	16.1
183.404667	35.72	43.50	7.78	1000.0	120.000	99.9	V	201.0	17.1
186.277000	38.87	43.50	4.63	1000.0	120.000	109.8	V	206.0	17.3
196.697000	35.37	43.50	8.13	1000.0	120.000	125.3	V	247.0	16.8
239.915667	36.06	46.00	9.94	1000.0	120.000	225.2	V	286.0	19.4
517.431667	25.47	46.00	20.53	1000.0	120.000	225.3	V	99.0	27.2
958.695667	32.58	46.00	13.42	1000.0	120.000	316.0	V	298.0	33.3



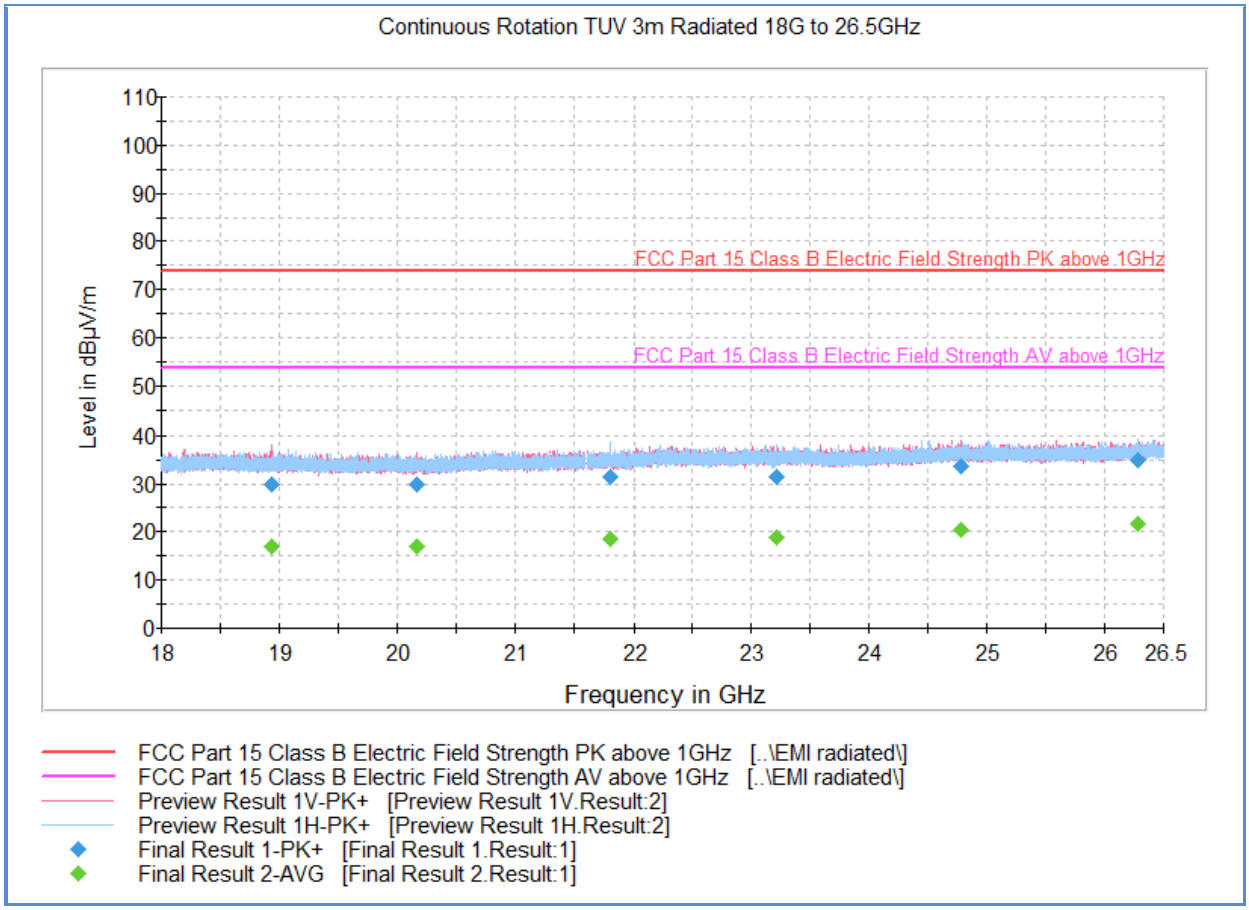
1 GHz – 18 GHz Spurious Emissions

Final_Result_PK+

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1160.000000	47.35	73.90	26.55	1000.0	1000.000	101.3	V	230.0	-5.4
2559.833333	44.87	73.90	29.03	1000.0	1000.000	107.2	H	357.0	-1.4
3839.766667	49.19	73.90	24.71	1000.0	1000.000	176.2	H	292.0	2.9
6810.366667	44.65	73.90	29.25	1000.0	1000.000	125.0	V	234.0	9.8
9142.500000	46.96	73.90	26.94	1000.0	1000.000	125.2	V	215.0	13.2
10853.100000	46.20	73.90	27.70	1000.0	1000.000	274.2	H	178.0	13.4
14041.666667	50.68	73.90	23.22	1000.0	1000.000	210.5	V	89.0	17.5
17767.533333	60.58	73.90	13.32	1000.0	1000.000	125.1	V	60.0	26.9

Final_Result_AVG

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1160.000000	41.37	53.90	12.53	1000.0	1000.000	101.3	V	230.0	-5.4
2559.833333	40.21	53.90	13.69	1000.0	1000.000	107.2	H	357.0	-1.4
3839.766667	45.77	53.90	8.13	1000.0	1000.000	176.2	H	292.0	2.9
6810.366667	31.88	53.90	22.02	1000.0	1000.000	125.0	V	234.0	9.8
9142.500000	34.48	53.90	19.42	1000.0	1000.000	125.2	V	215.0	13.2
10853.100000	33.80	53.90	20.10	1000.0	1000.000	274.2	H	178.0	13.4
14041.666667	37.74	53.90	16.16	1000.0	1000.000	210.5	V	89.0	17.5
17767.533333	47.16	53.90	6.74	1000.0	1000.000	125.1	V	60.0	26.9



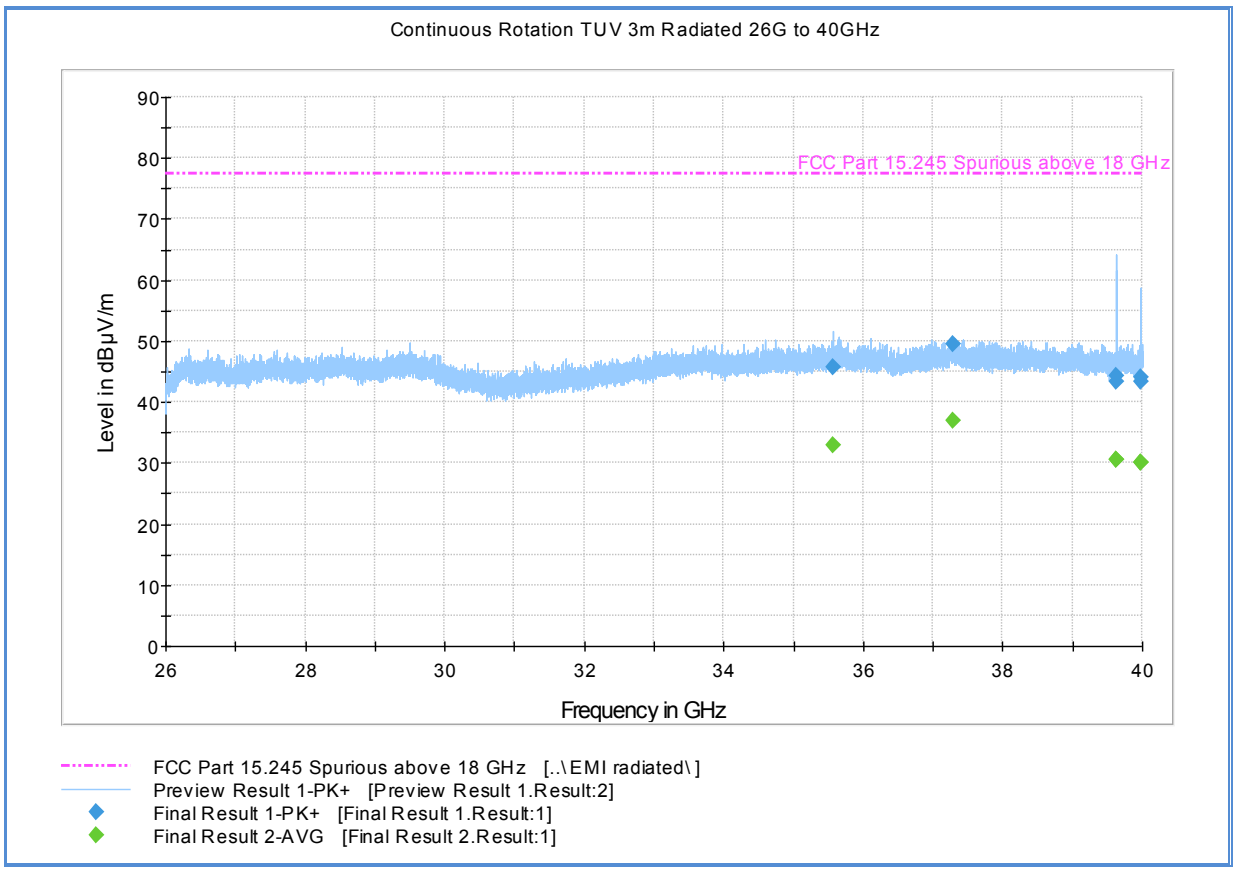
18 GHz – 26 GHz Spurious Emissions

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin - PK+ (dB)	Limit - PK+ (dBµV/m)
18932.283333	30.0	1000.0	1000.000	158.7	V	0.0	-0.7	43.9	73.9
20170.850000	29.9	1000.0	1000.000	141.7	V	215.0	-0.5	44.0	73.9
21803.183333	31.6	1000.0	1000.000	156.7	H	152.0	0.3	42.3	73.9
23209.333333	31.4	1000.0	1000.000	148.7	H	28.0	1.0	42.5	73.9
24780.816667	33.5	1000.0	1000.000	144.7	V	342.0	1.9	40.4	73.9
26286.933333	35.0	1000.0	1000.000	107.7	H	93.0	2.0	38.9	73.9

Average

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin - AVG (dB)	Limit - AVG (dBµV/m)
18932.283333	17.0	1000.0	1000.000	158.7	V	0.0	-0.7	36.9	53.9
20170.850000	17.1	1000.0	1000.000	141.7	V	215.0	-0.5	36.8	53.9
21803.183333	18.4	1000.0	1000.000	156.7	H	152.0	0.3	35.5	53.9
23209.333333	18.9	1000.0	1000.000	148.7	H	28.0	1.0	35.0	53.9
24780.816667	20.4	1000.0	1000.000	144.7	V	342.0	1.9	33.5	53.9
26286.933333	21.6	1000.0	1000.000	107.7	H	93.0	2.0	32.3	53.9



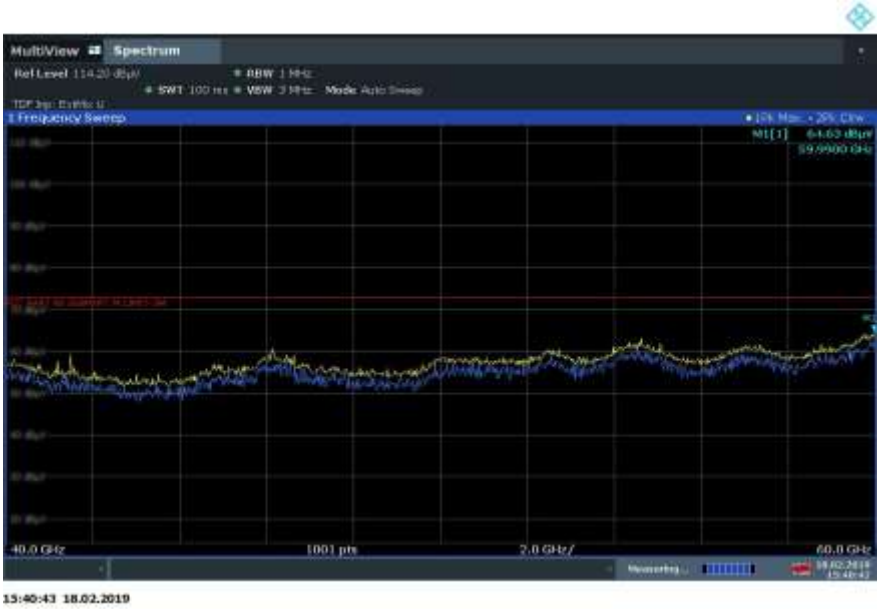
26 GHz – 40 GHz Spurious Emissions

Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
35559.066667	45.8	1000.0	1000.000	109.7	H	175.0	6.6	31.7	77.5
37281.200000	49.5	1000.0	1000.000	102.8	H	341.0	7.0	28.0	77.5
39625.933333	44.3	1000.0	1000.000	110.8	H	334.0	7.5	33.2	77.5
39630.200000	43.4	1000.0	1000.000	114.7	H	317.0	7.5	34.1	77.5
39980.733333	43.2	1000.0	1000.000	110.8	H	288.0	6.7	34.3	77.5
39985.400000	44.0	1000.0	1000.000	110.8	H	288.0	6.8	33.5	77.5

Average

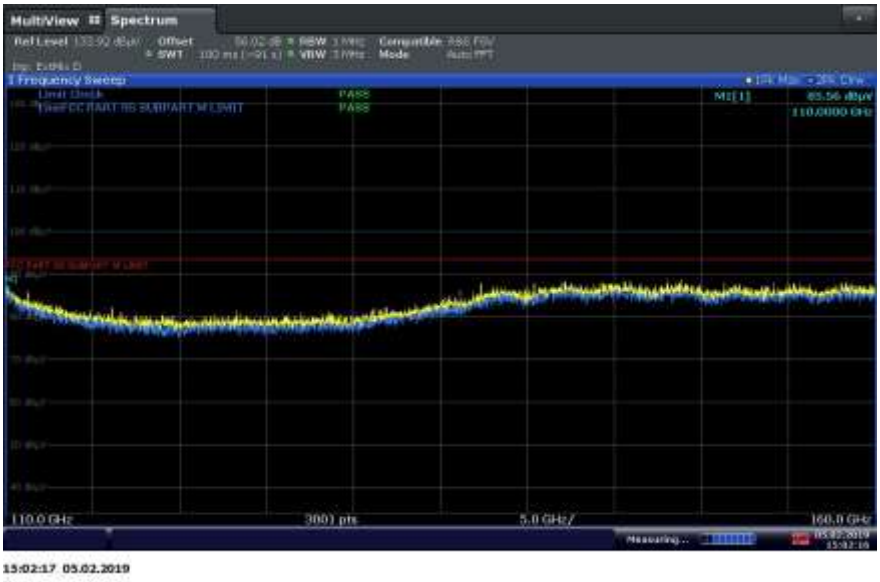
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
35559.066667	33.0	1000.0	1000.000	109.7	H	175.0	6.6	44.5	77.5
37281.200000	37.0	1000.0	1000.000	102.8	H	341.0	7.0	40.5	77.5
39625.933333	30.5	1000.0	1000.000	110.8	H	334.0	7.5	47.0	77.5
39630.200000	30.5	1000.0	1000.000	114.7	H	317.0	7.5	47.0	77.5
39980.733333	30.0	1000.0	1000.000	110.8	H	288.0	6.7	47.5	77.5
39985.400000	30.1	1000.0	1000.000	110.8	H	288.0	6.8	47.4	77.5



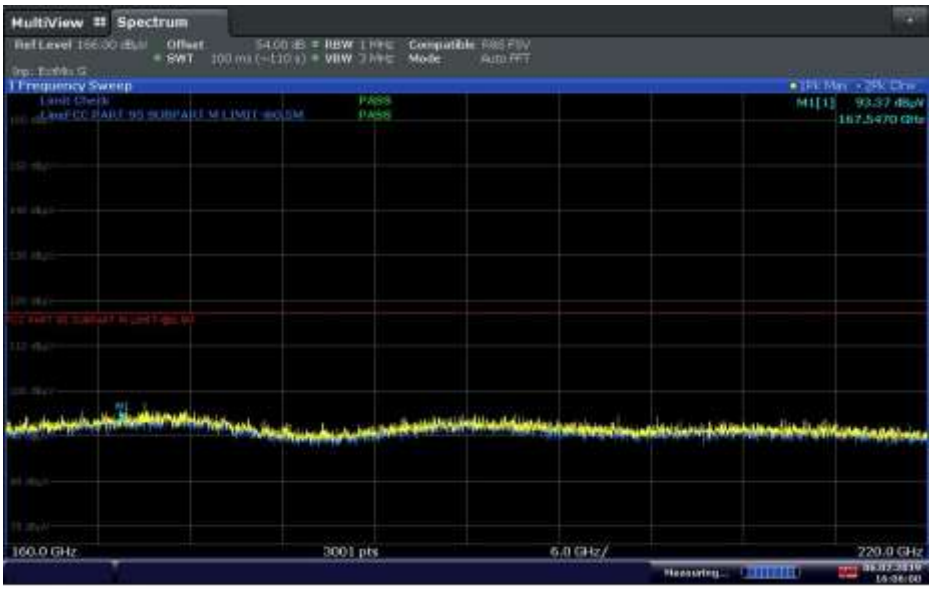
40-60 GHz Spurious Emissions

60-75 GHz Spurious Emissions

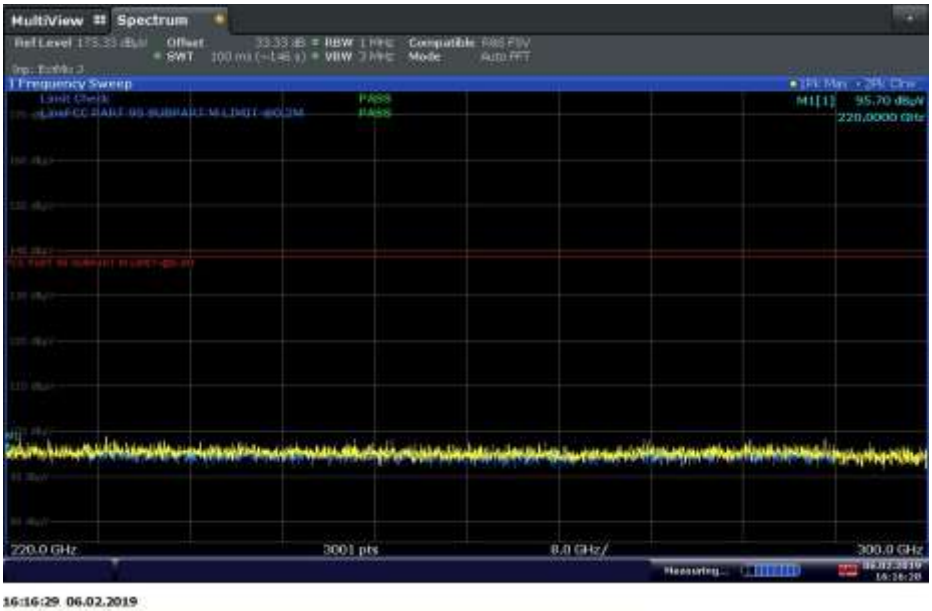
75-110 GHz Spurious Emissions



110-160 GHz Spurious Emissions



160-220 GHz Spurious Emissions



220-300 GHz Spurious Emissions

2.4 FREQUENCY STABILITY

2.4.1 Specification Reference

Part 95 Subpart E §95.633(e) and RSS-243 Section 5.1

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: VITOGD1851N0081 / Default Test Configuration

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

February 18, 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 TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	14.4 °C
Relative Humidity	66.0 %
ATM Pressure	101.7 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 could not be tested for (85 % and 115 % of nominal voltage) as the EUT is powered by USB cable and there is no scope for power variation.
- RBW is 1 MHz while VBW is 3 MHz
- Detector is Peak
- Trace is Max Hold
- During the test low and high frequencies (fL and fH) of the signal spectrum were monitored. The applicable spurious emissions limit was used to define fL and fH.
- Rhode & Schwarz Spectrum Analyzer was set to Signal ID = ON and Auto ID = OFF under External mixer settings to avoid mixer ghosting or inclusion of mixer products in the measurements.

- The avoidance of mixer ghosting in accordance to Rhode & Schwarz FSW Manual under Section Automatic Signal Identification (Pages 201-205). In the plot below the part of the graph which has both yellow and blue signal graph is the real signal area and the parts where the yellow or blue is there should be avoided.
- The BW function in the analyser was not used as the signal continues forever for both traces due to mixer ghosting. Where there is a overlap of the two traces and where the signal level is well above noise level the markers were used to measure the BW and upper frequency and lower frequency.

2.4.8 Test Results

Temperature variation

Modulation BW	Temperature	Frequency Low f_L (GHz)	Frequency High f_H (GHz)
77-81 GHz	50°C	**77.17**	80.59
	40°C	77.002	81.01
	30°C	77.002	80.98
	20°C	76.98	80.70
	10°C	77.08	80.74
	0°C	77.02	81.07
	-10°C	77.09	80.78
	-20 C	77.07	**80.99**
f_L=77.17 GHz > 77.0 GHz f_H=80.99 GHz < 81.0 GHz EUT Complies			

2.4.9 Test Results Plots

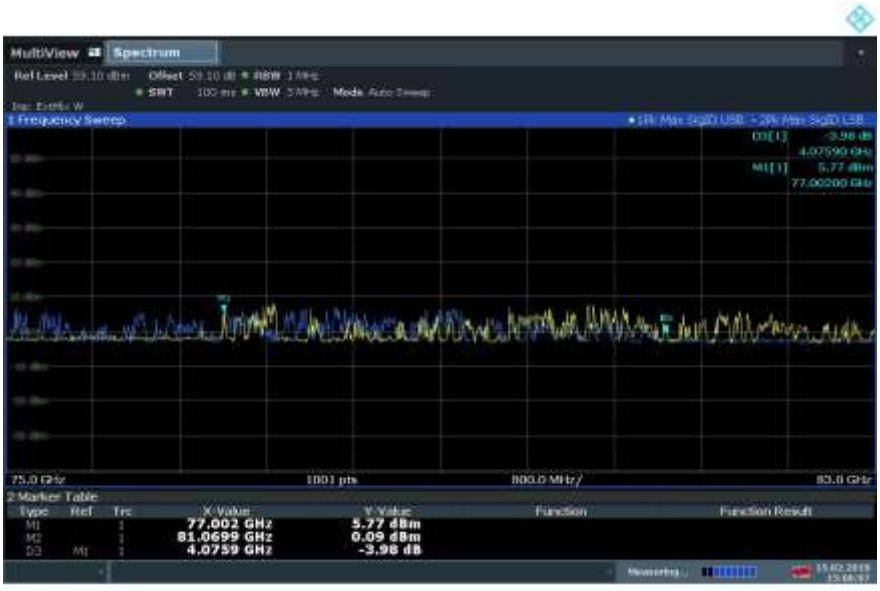
Spectrum at 50 °C

Spectrum at 40°C

Spectrum at 30 °C

Spectrum at 20 °C

Spectrum at 10 °C



Spectrum at 0 °C

Spectrum at -10 °C

Spectrum at -20 °C

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	06/08/18	06/08/19
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	05/09/18	05/09/19
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	11/20/17	11/20/19
8891	Pre-Amplifier	PE15A3262	1012	TUV SUD America	09/18/18	09/18/19
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	08/20/18	08/20/20
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 by 8920 and 8919	
9082	Horn antenna (140-220 GHz)	HO5R	N/A	Custom Microwaves	Verified by 8909	
9080	Horn antenna (220-325 GHz)	HO3R	N/A	Custom Microwaves	Verified by 8909	
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	10/18/2018	10/18/2019
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	03/06/18	03/06/19
8893	Pre-amplifier (18-40 GHz)	SLKKa-30-6	15G27	Spacek Labs	Verified by 7620 and 1003	
7637	Harmonics mixer (40-60 GHz)	FS-Z60	100009	Rhode & Schwarz	05/31/18	05/31/20
7636	Harmonics mixer (60-90 GHz)	FS-Z90	100092	Rhode & Schwarz	04/11/18	04/11/20
7633	Harmonics mixer (75-110 GHz)	HM-110-7	101000	Radiometer Physics	Verified by 8861 and 8915	
7634	Harmonics mixer (110-170 GHz)	HM-170	0062	Radiometer Physics	Verified by 8920 and 8919	
7635	Harmonics mixer (170-220 GHz)	HM-220	020022	Radiometer Physics	Verified by 8909	
7632	Harmonics mixer (220-325 GHz)	HM-325	020075	Radiometer Physics	Verified by 8909	
8872	Direct Reading Attenuator (40-60 GHz)	STA-60-19-D1	11875-01	Sage Millimeter, Inc.	Verified by 7611 and corresponding antenna/mixer combination	
8860	Direct Reading Attenuator (50-75 GHz)	STA-60-15-D1	11466-01	Sage Millimeter, Inc.		
8861	Direct Reading Attenuator (75-110 GHz)	STA-60-10-D1	11466-01	Sage Millimeter, Inc.		
8919	Direct Reading Attenuator (90-140 GHz)	STA-60-08-D1	12605-01	Sage Millimeter, Inc.		
8909	Direct Reading Attenuator (140-220 GHz)	STA-60-05-D1	12020-01	Sage Millimeter, Inc.		
8873	Active Multiplier (40-60 GHz)	AMC-19-RFH00	124	Millitech, Inc.		
8914	Active Multiplier (50-75 GHz)	AMC-15-RFH00	283	Millitech, Inc.		
8915	Active Multiplier (75-110 GHz)	AMC-10-RFH00	606	Millitech, Inc.		
8920	Active Multiplier (90-140 GHz)	AMC-08-RFH00	58	Millitech, Inc.		
8909	Active Multiplier (140-220 GHz)	MCA-05-150096	13	Millitech, Inc.		
8922	High-frequency cable	R90-088-200	N/A	Teledyne	Verified by 7620 and 1003	
1026	High-frequency cable	3M-7/C2	N/A	MicroCoax	Verified by 7620 and 1003	
8849	High-frequency cable (1-18 GHz)	SAC-26G-6.1	363	A.H.Systems	Verified by 7620 and 1003	
8771	6dB attenuator	606-06-1F4/DR	N/A	MECA	Verified by 7620 and 1003	

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
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 Measurements (Below 1GHz)

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 Measurements (Above 1GHz)

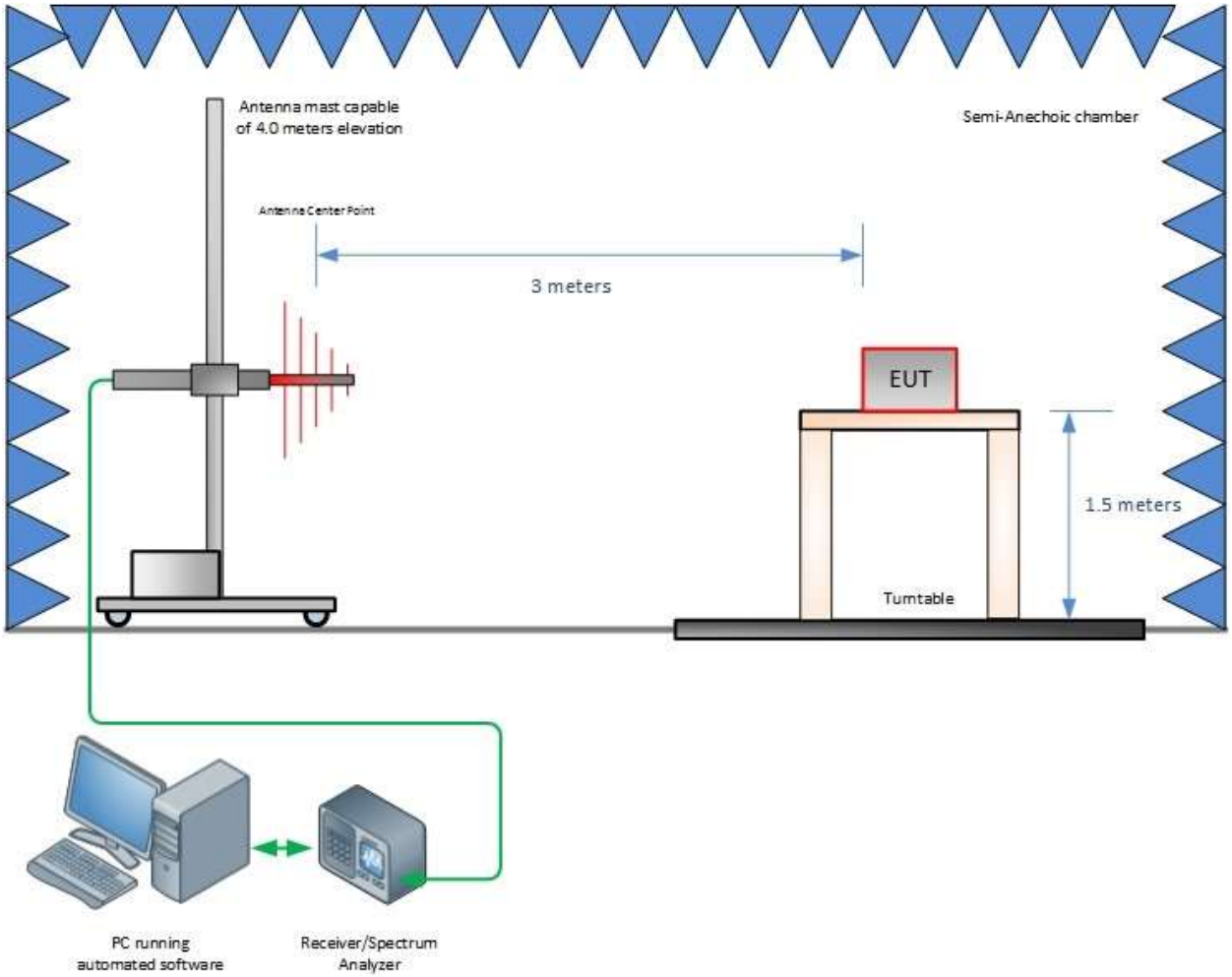
Radiated Measurement (1 GHz-18 GHz) at a distance of 3 m

	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**		

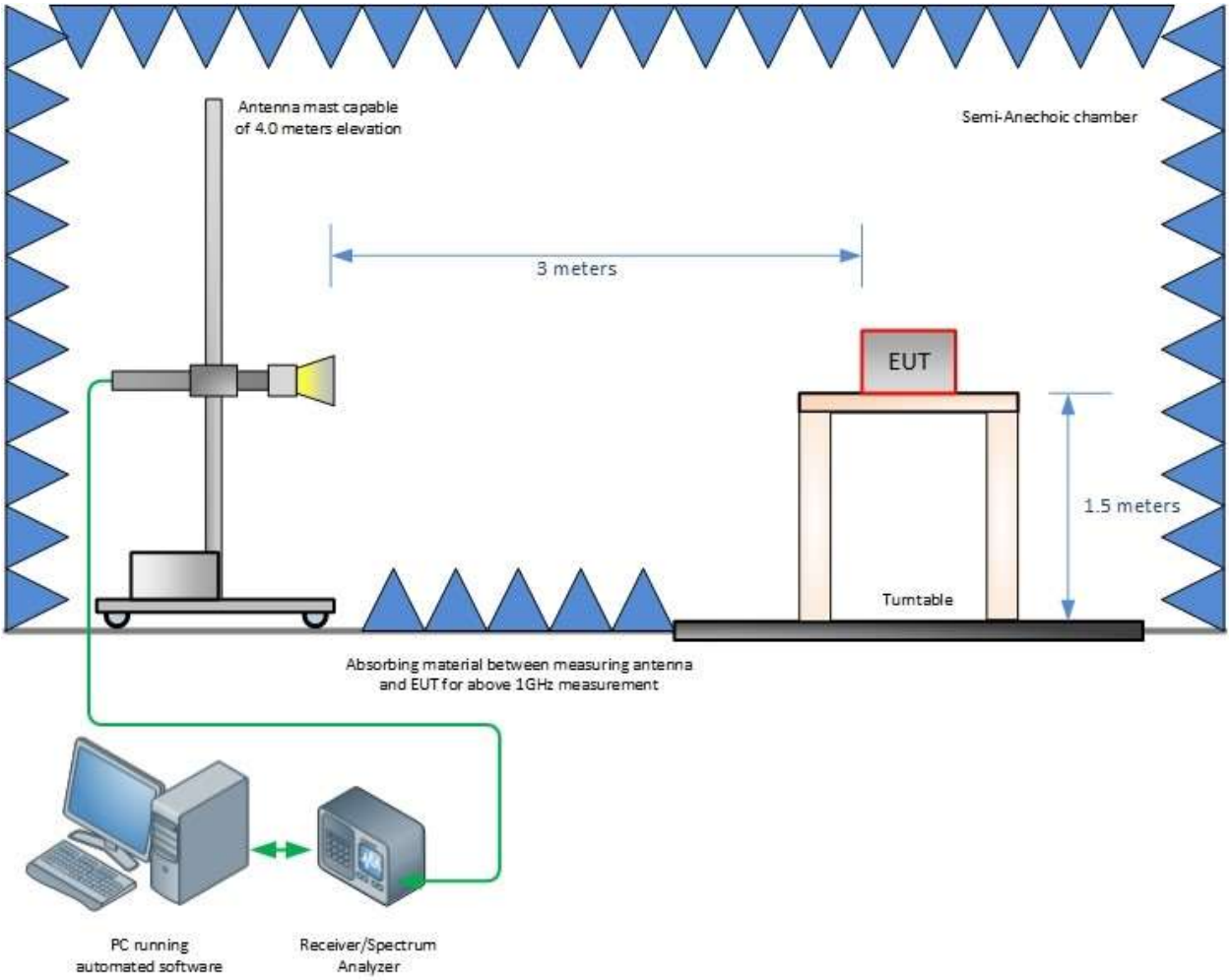
SECTION 4

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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