Radio Testing of the

Clarion Corporation of America
Vehicle Radar Sensor Model: P11-DL0000

In accordance with FCC Part 15 Subpart C §15.255 and ISED RSS-210 Annex J

America

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Clarion Corporation of America
31440 Northwestern Highway Suite 185
Farmington Hills, MI 48334-5422

COMMERCIAL-IN-CONFIDENCE

Date: July 2020
Document Number: 72170261 Issue 01 | Version Number: 01

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorized Signatory	Xiaoying Zhang	August 20, 2021	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be in compliance with FCC Part 15 Subpart C §15.255 and ISED RSS-210 Annex J.

A2LA Cert. No. 2955.13

TÜV SÜD America, Inc.
10040 Mesa Rim Road
San Diego, CA 92121-2912

TÜV SÜD America, Inc.
Rancho Bernardo Facility
16936 Via Del Campo
San Diego, CA 92127

Phone: 858 678 1400
www.tuv-sud-america.com

REPORT ON	Radio Testing of the Clarion Corporation of America Model P11-DL0000 Vehicle Radar Sensor
TEST REPORT NUMBER	72170261
TEST REPORT DATE	July 2020
PREPARED FOR	Clarion Corporation of America 31440 Northwestern Highway Suite 185 Farmington Hills, MI 48334-5422
CONTACT PERSON	Sattar Niyaz Application Engineer sattar.niyaz@faurecia.com +248 912-8905
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: Senior EMC Test Engineer / Wireless Team Lead
APPROVED BY	Xiaoying Zhang **Name** Authorized Signatory Title: Senior RF Wireless Test Engineer
DATED	August 20, 2021

Revision History

72170261 Clarion Corporation of America Model P11-DL0000 Vehicle Radar Sensor					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
08/20/2021	—	Initial Release			Xiaoying Zhang

CONTENTS

SECTION 1

REPORT SUMMARY

Radio Testing of the
Clarion Corporation of America
P11-DL0000 Vehicle Radar Sensor

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Clarion Corporation of America P11-DL0000 Vehicle Radar Sensor to the requirements of FCC Part 15 Subpart C §15.255 per Waiver DA 21-811.

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	Clarion Corporation of America
EUT	Vehicle Radar Sensor
Trade Name	P11-DL0000
Model Name	P11-DL0000
FCC ID	A8DAIRGEN-1
IC Number	27376-AIRGEN
Serial Number(s)	0x00036C52 and 0x00036C47
Number of Samples Tested	2
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.255 (October 1, 2020) • ISED RSS-210 Annex J (Issue 10 April 2020)
Start of Test	June 29, 2021
Finish of Test	August 18, 2021
Name of Engineer(s)	Ferdinand Custodio
Related Document(s)	• DA 21-811 Waiver • ANSI C63.10-2013. American National Standard of Procedures for Compliance testing of Unlicensed Wireless Devices. • Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.255 are shown below:

Section	§15.247 Spec Clause	Test Description	Result	Comments/Base Standard
2.1	§15.255(c)(3) and (e) / DA 21-811 Waiver	Transmitter Power	Compliant	
2.2	§15.207(a)	Conducted Emissions	N/A	Vehicle Use Only
2.3	§15.255(f)	Frequency Stability	Compliant	
2.4	§15.255(e)	Occupied Bandwidth	Compliant	
2.5	§15.255(d)(1)(2) and (3)	Field Strength of Spurious Radiation	Compliant	
2.6	DA 21-811 Waiver	Duty Cycle	Compliant	
2.7	DA 21-811 Waiver	Power Spectral Density	Compliant	

1.3 DA 21-811 WAIVER CONDITIONS

- The radar shall be certified for compliance with all the technical specifications applicable to operation under 47 CFR Part 15, with the exception of the following provisions in 47 CFR §§ 15.255(a)(2) and (c)(3), which are waived to allow the device to operate as a radar on new passenger motor vehicles in the 57-64 GHz band at a maximum +13 dBm EIRP, +10 dBm transmitter conducted output power, and +13 dBm/MHz power spectral density.
- Each individual radar device shall not exceed a maximum transmit duty cycle of 10% in any 33 milliseconds (ms) interval (i.e., the device will not transmit longer than a total of 3.3 ms in any 33 ms time period).
- Any radar off-time period between two successive radar pulses that is less than 2 ms shall be considered “on time” for purposes of computing the duty cycle.
- The radar shall be restricted to factory installation in the interior of new passenger motor vehicles for the primary purpose of in-cabin monitoring functions and shall not be marketed in after-market add-on products. The grantee shall include clear and complete installation instructions that explain this restriction and a copy of these instructions shall be submitted along with the application for equipment authorization. If the radar is installed such that it is not visible (e.g., behind the headliner), then the required equipment labeling in accordance with the provisions of 47 CFR §§ 2.925 and 15.19 shall be provided in the vehicle’s Owner’s Manual. The certification grant shall specify these restrictions.

- Operations under this waiver may not be used to transmit data.
- Users of the radars must be made aware through a disclosure in the vehicle Owner's Manual or an equivalent means that the operation is subject to the conditions that no harmful interference is caused and that any interference must be accepted.
- This waiver and its conditions shall apply only to radars intended for installation in passenger motor vehicles as described herein and are not to be considered to apply generally to any other radars or field disturbance sensors that will operate in different environments where further analysis would be necessary to assess the potential for impact to other authorized users.
- The waiver conditions granted herein are not transferable to any third party via §2.933 or any other means of technology transfer.
- The waiver is explicitly conditioned on any changes to our rules that may be adopted in a future rulemaking proceeding in accordance with the terms of this order.

1.4 PRODUCT INFORMATION

1.4.1 Technical Description

The Equipment Under Test (EUT) is a Clarion Corporation of America P11-DL0000 Vehicle Radar Sensor. The EUT is a short-range Vehicle Millimeter wave Radar Sensor operating in 60 GHz band (60-64 GHz). The EUT is used to detect intruders, baby left in the car and seatbelt detection. It is mounted on the roof of the cabin and senses in all directions inside the cabin.

1.4.2 EUT General Description

EUT Description	Vehicle Radar Sensor
Trade Name	P11-DL0000
Model Name	P11-DL0000
Rated Voltage	12VDC
Mode Verified	60GHz radar
Capability	60GHz radar
Frequency Range	60-64GHz
Primary Unit (EUT)	☐ Production
	☒ Pre-Production
	☐ Engineering
PRF	50Hz
Frame Time	20ms
Duty Cycle	10%
Transmission Mode	MIMO (3x4)
Dimensions	63mm x 45mm x 13mm
Weight	0.05 kg
Antenna Type	Patch etched antennas
Manufacturer	Custom
TX Antenna Gain	4.0 dBi
RX Antenna Gain	4.0 dBi

1.5 EUT TEST CONFIGURATION

1.5.1 Test Configuration Description

Test Configuration	Description
Default	The EUT was provided as a plug-and-play unit. Once power is applied, the EUT starts transmitting continuously.

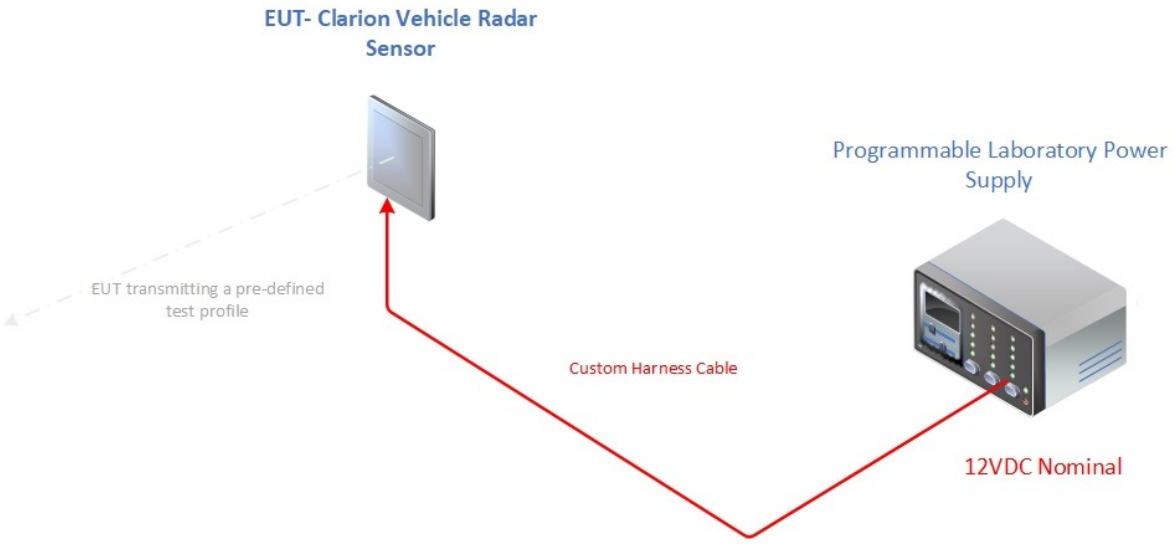
1.5.2 EUT Exercise Software

None

1.5.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Custom	Harness cable	5 conductors (BAT, GND, WAKE, CAN High and CAN Low)

1.5.4 Simplified Test Configuration Diagram



1.6 DEVIATIONS FROM THE STANDARD

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

1.7 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: 0x00036C52 and 0x00036C47		
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.

1.8 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.

1.9 TEST FACILITY LOCATION

1.9.1 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

1.9.2 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.

1.10 TEST FACILITY REGISTRATION

1.10.1 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.

1.10.2 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.

1.10.3 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.

1.10.4 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.

1.10.5 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.

1.10.6 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.

1.10.7 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
Clarion Corporation of America
P11-DL0000 Vehicle Radar Sensor

2.1 TRANSMITTER POWER

2.1.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.255(c)(3) and (e)

2.1.2 Standard Applicable

(c) Within the 57-71 GHz band, emission levels shall not exceed the following equivalent isotropically radiated power (EIRP):

(3) or fixed field disturbance sensors other than those operating under the provisions of paragraph (c)(2) of this section, and short-range devices for interactive motion sensing, the peak transmitter conducted output power shall not exceed −10 dBm and the peak EIRP level shall not exceed 10 dBm.

(e) Except as specified paragraph (e)(1) of this section, the peak transmitter conducted output power shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the EIRP limits specified in paragraph (c) of this section.

2.1.3 Waiver Condition

The radar shall be certified for compliance with all the technical specifications applicable to operation under 47 CFR Part 15, with the exception of the following provisions in 47 CFR §§ 15.255(a)(2) and (c)(3), which are waived to allow the device to operate as a radar on new passenger motor vehicles in the 57-64 GHz band at a maximum +13 dBm EIRP, +10 dBm transmitter conducted output power, and +13 dBm/MHz power spectral density.

2.1.4 Equipment Under Test and Modification State

Serial No: 0x00036C47 / Default Test Configuration

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

July 23, 2021 / FSC

2.1.6 Test Equipment Used

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

2.1.7 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	23.5 °C
Relative Humidity	36.4 %
ATM Pressure	99.8 kPa

2.1.8 Additional Observations

- This is a radiated test.
- Test methodology is per Section 9.11 of ANSI C63.10-2013.
- The manufacturer provided a test profile with the highest possible duty cycle.
- Test performed using a RF detector, low noise amplifier, active multiplier chain, direct reading attenuator and corresponding horn antenna.
- Initial prescan of the 60 to 64GHz band was used to determine the representative frequency for this test. Based from the profile observed, 62GHz was chosen as worst case for this investigation.
- Once the EUT profile was determined using a RF detector, The EUT was replaced with a known source with a variable attenuator. Starting at the max attenuation, the attenuator was adjusted until identical profile of the EUT was achieved. The EIRP at this point was calculated.

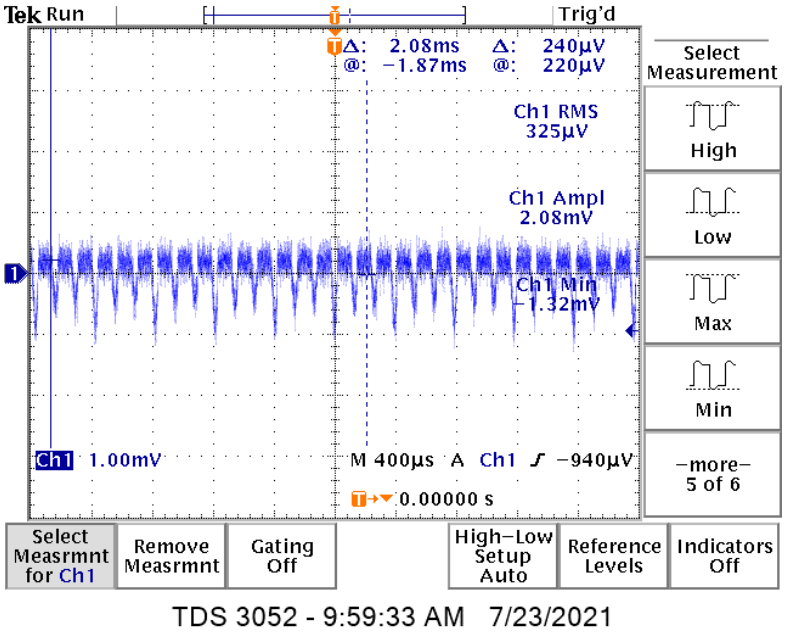
2.1.9 Test Results

Frequency	Peak Power (EIRP)	Conducted Peak Power
62 GHz	12.84 dBm	8.84 dBm

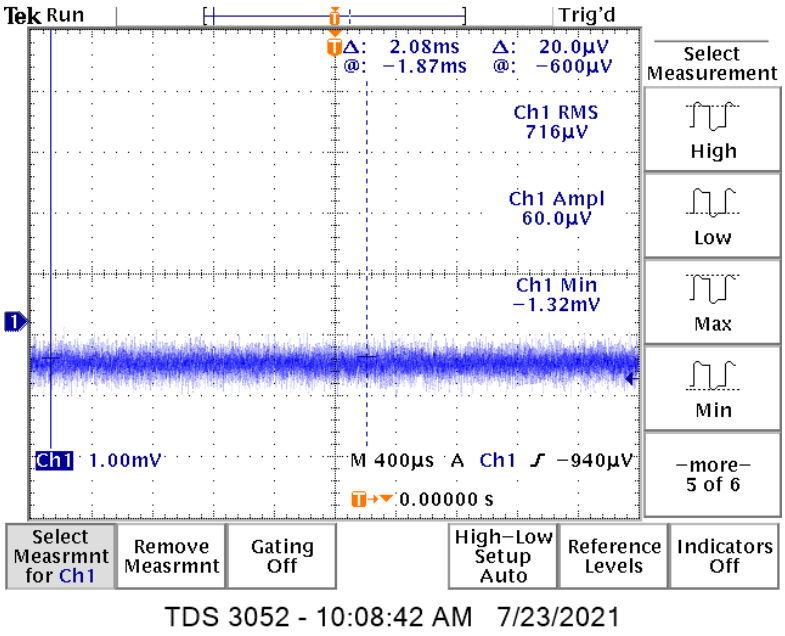
	EUT Profile	DA-21-811 Waiver Requirements
$P_{Conducted}$	8.84 dBm	≤ 10 dBm
$Gain_{Total}$	4.0 dBi	
$EIRP_{MAX}$	12.84 dBm	≤ 13 dBm

2.1.10 Sample Calculation

Active Multiplier Chain power output @ 62GHz	= 13.50 dBm
Gain Horn -WR15/HO15R (SDGE09004)	= 23.24 dBi
Direct Reading Attenuator setting to replicate EUT profile	= -23.90 dB
	_____
Substitution Peak EIRP	= 12.84 dBm



EUT (12 Transmitter) profile using a RF detector



Profile using a known source (active multiplier chain with a direct reading attenuator)

2.2 CONDUCTED EMISSIONS

2.2.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.207(a)

2.2.2 Standard Applicable

An intentional radiator 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 µH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	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.*

2.2.3 Equipment Under Test and Modification State

Not performed. The EUT is restricted for vehicular use only, therefore there is no provision for the unit to connect to public AC Mains.

2.3 FREQUENCY STABILITY

2.3.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.255(f)

2.3.2 Standard Applicable

(f) 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.

2.3.3 Equipment Under Test and Modification State

Serial No: 0x00036C52 / Default Test Configuration

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

July 04 and 05, 2021 / FSC

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	24.8 °C
Relative Humidity	12.7 %
ATM Pressure	99.5 kPa

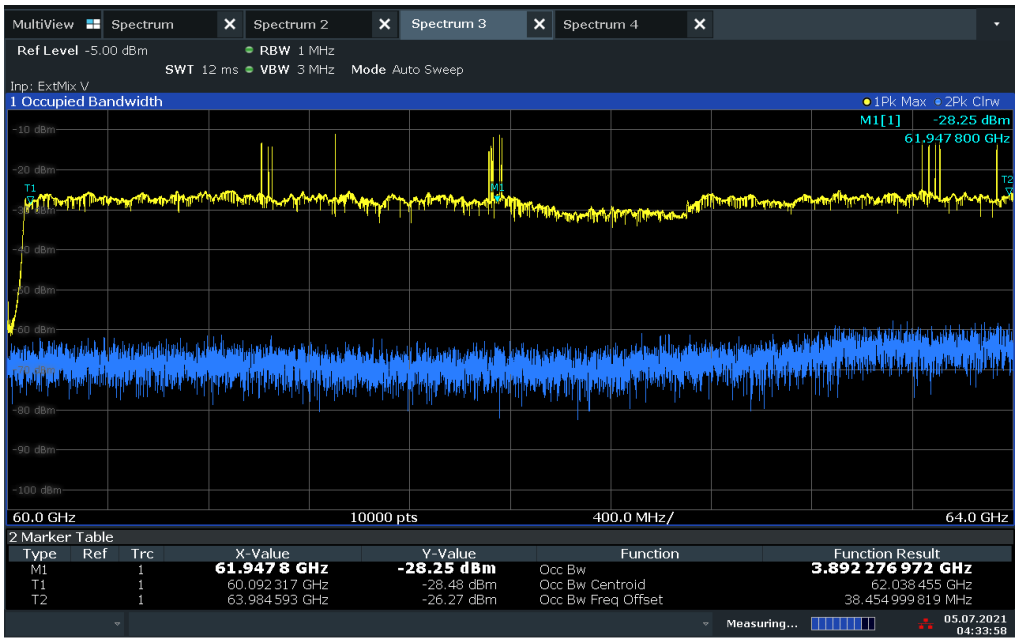
2.3.7 Additional Observations

- There is no difference in the test results when input voltage is varied from 85% to 115% of the nominal voltage as the EUT is designed to operate from that range (10.2VDC to 13.8VDC).
- The temperature chamber has a window, the receive antenna was placed outside the chamber at a distance greater than $2D^2/\lambda$. Where D is the longest single dimension of the receive antenna and λ is the wavelength.
- Due to reflections inside the environmental chamber, artifacts are visible on the test plots but will be ignored for this investigation.
- Test methodology is per Section 9.14 of ANSI C63.10-2013.

2.3.8 Test Results

EUT complies. The spectrum mask of the EUT emissions (max hold) stayed within the frequency band 60GHz to 64GHz on all conditions of operation. Operation of the EUT is >1GHz from the edge of the frequency band (57GHz-71GHz).

2.3.9 Sample Test Plots



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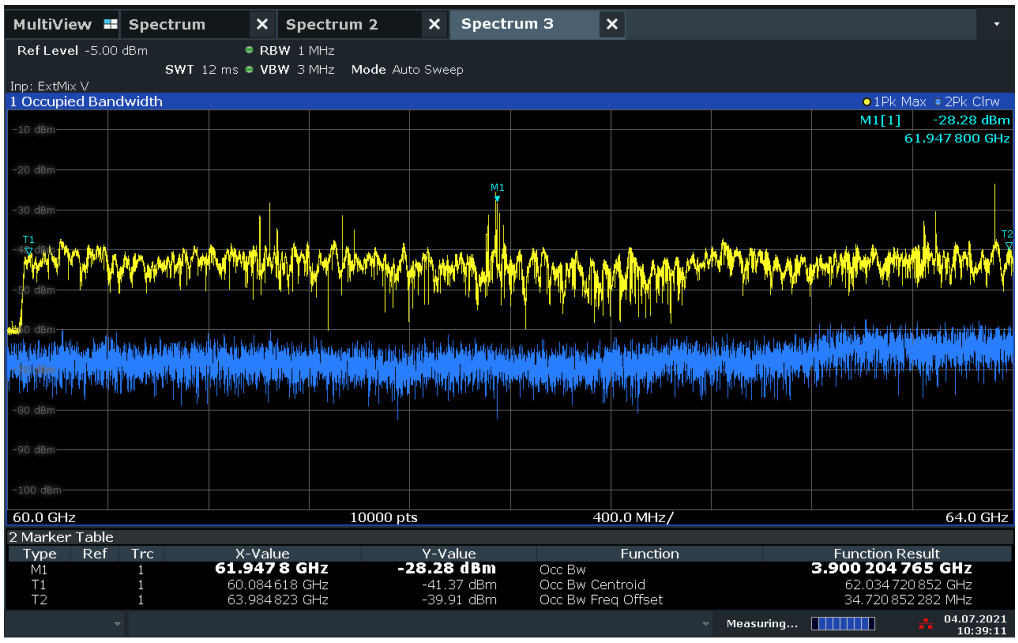
Spectrum Mask @ 50°C



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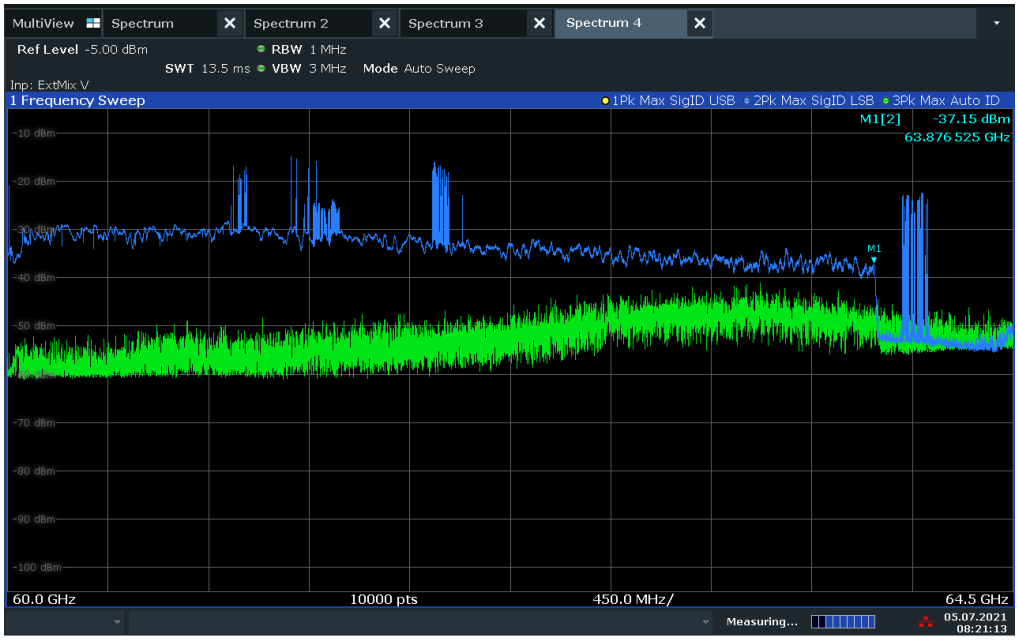
Spectrum Mask @ -20°C



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Upper Edge Verification @ 20°C

2.4 OCCUPIED BANDWIDTH

2.4.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.255(e)(1)

2.4.2 Standard Applicable

(1) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).

2.4.3 Equipment Under Test and Modification State

Serial No: 0x00036C52 / Default Test Configuration

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

July 02, 2021 / FSC

2.4.5 Test Equipment Used

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

2.4.6 Environmental Conditions

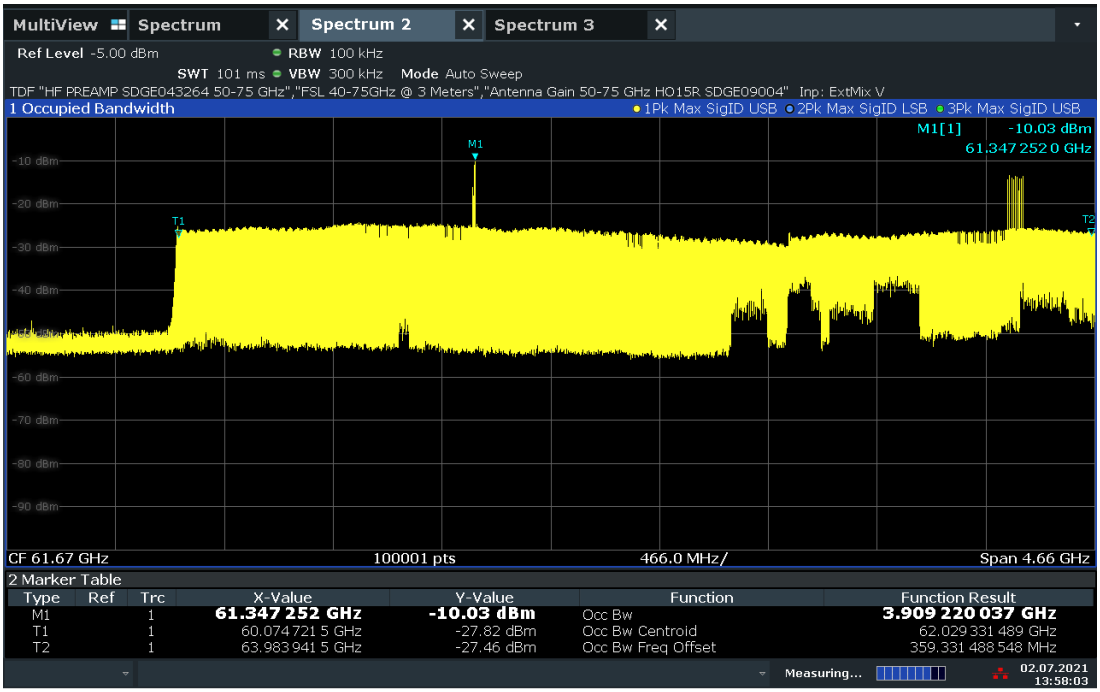
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.8 °C
Relative Humidity	23.9 %
ATM Pressure	99.6 kPa

2.4.7 Additional Observations

- 6dB BW of the EUT is >100MHz when measured using 100kHz RBW. Therefore, the additional bandwidth requirement per §15.255(e)(1) does not apply.
- Due to inherent bandwidth of the signal, the upper edge of the signal has to be close to edge of the plot. Otherwise, artifacts created by the mixing will be evident. A separate plot was provided to verify upper edge of the signal without artifacts.
- Worst case 99% OBW reported as 3.91GHz.
- Plots presented for reference only.

2.4.8 Test Verifications Plots



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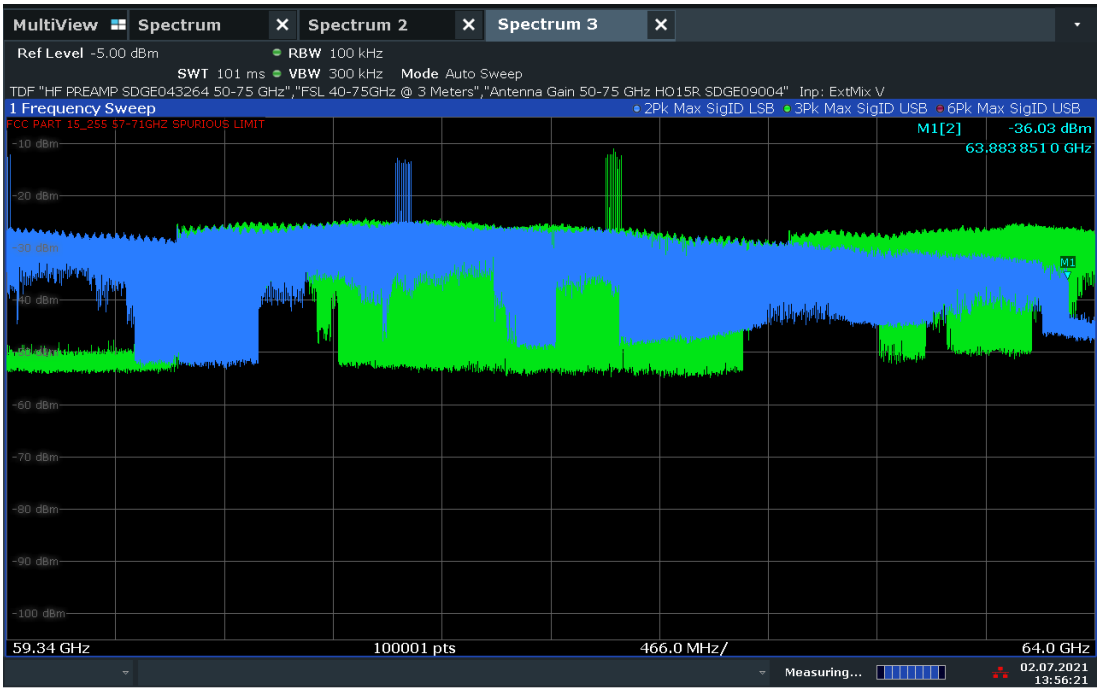
99% OBW



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Upper edge verification using Signal ID function

2.5 FIELD STRENGTH OF SPURIOUS RADIATION

2.5.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.255(d)(1)(2) and (3)

2.5.2 Standard Applicable

(d) Limits on spurious emissions:

(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.

(2) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.

(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 (85.3dBµV/m / -9.93dBm EIRP) at a distance of 3 meters.

2.5.3 Equipment Under Test and Modification State

Serial No: 0x00036C52/ Default Test Configuration

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

June 29 to July 02, 2021 / FSC

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	24.7 °C
Relative Humidity	37.7 %
ATM Pressure	100.6 kPa

2.5.7 Additional Observations

- This is a radiated test. The spectrum was searched from 9kHz to 200GHz.
- Measurements below 40GHz were 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.
- Measurement above 40GHz were done using harmonic mixers. Corresponding TDF (Transducer Factor) are programmed for each range.

- Tests distances and frequency ranges performed are summarized below:

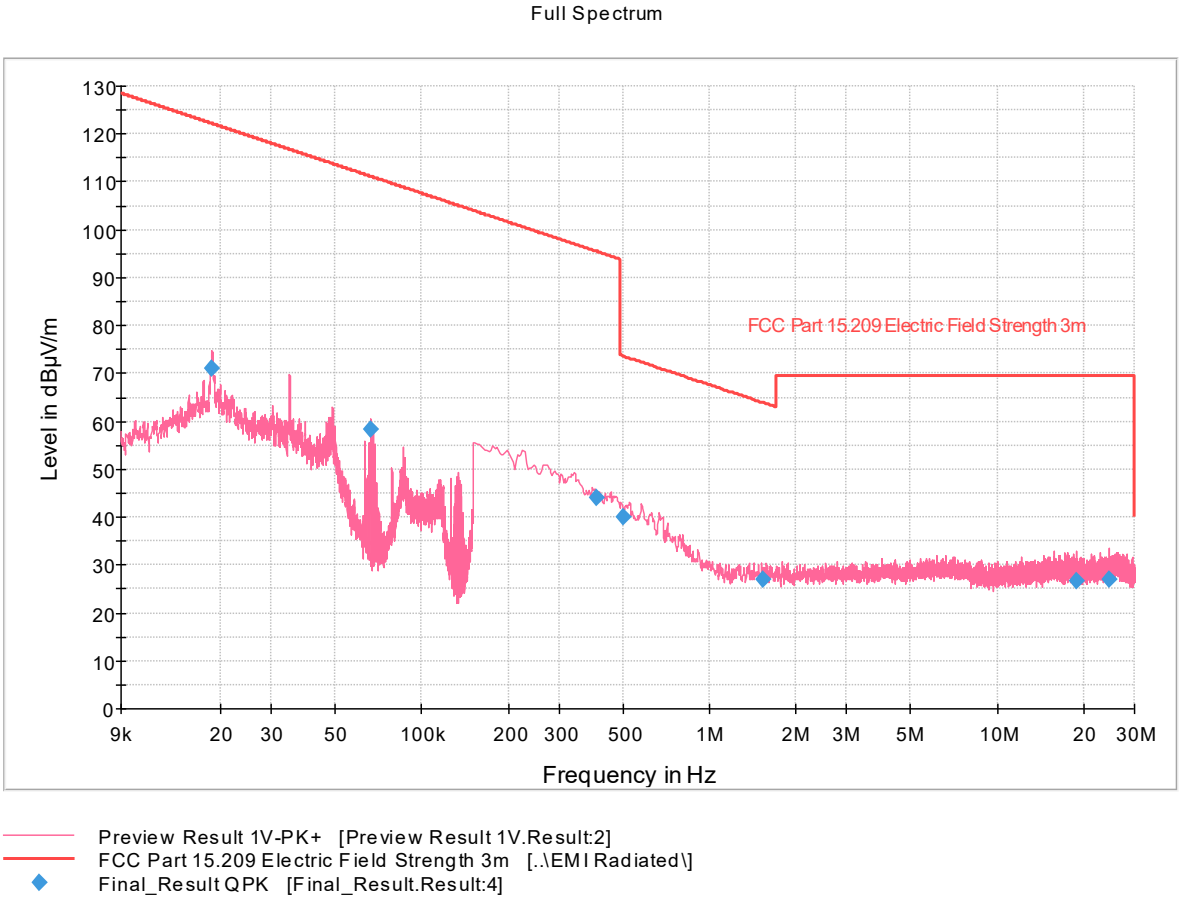
Frequency Range	Test Distance
9 kHz to 30 MHz	3 meters
30 MHz to 1GHz	3 meters
1 GHz to 18 GHz	3 meters
18 GHz to 26.5 GHz	3 meters
26 GHz to 40 GHz	3 meters
40 GHz to 60 GHz	3 meters
50 GHz to 75 GHz	3 meters
75 GHz to 110 GHz	1 meter
110 GHz to 140 GHz	1 meter
140 GHz to 200 GHz	0.5 meter

- Limits presented >75GHz is from 3 meters measurement distance (worst case). EUT complies with 3 meters limit when measured at 1 and 0.5 meter.

2.5.8 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**

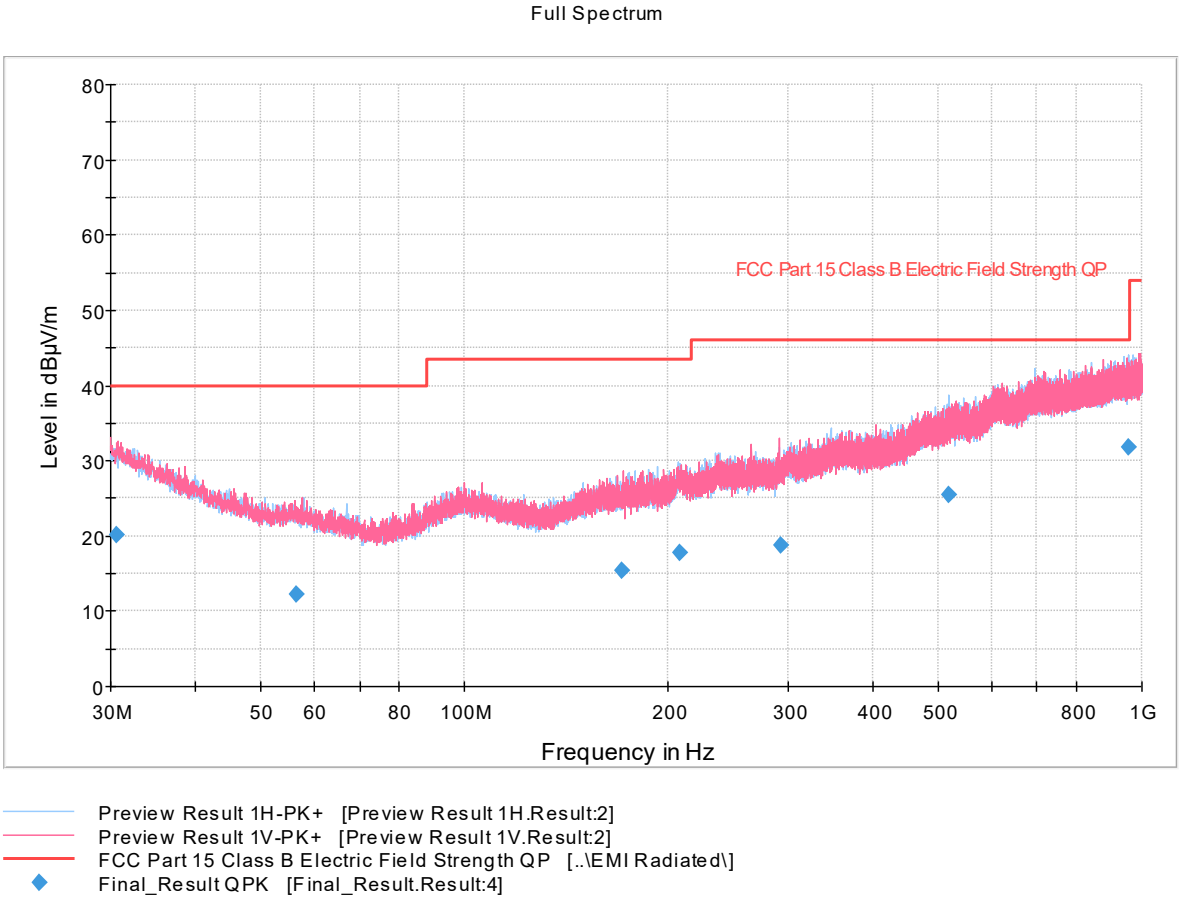
2.5.9 Below 30MHz Radiated Emission Test



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/m)
0.018634	71.05	122.19	51.14	1000.0	0.200	100.0	H	278.0	22
0.066557	58.20	111.14	52.94	1000.0	0.200	100.0	H	12.0	20
0.406790	43.92	95.42	51.50	1000.0	9.000	100.0	H	334.0	19
0.499340	40.04	73.64	33.60	1000.0	9.000	100.0	H	262.0	20
1.537156	26.88	63.86	36.98	1000.0	9.000	100.0	H	262.0	20
18.907957	26.69	69.50	42.81	1000.0	9.000	100.0	H	162.0	23
24.475633	26.93	69.50	42.57	1000.0	9.000	100.0	H	33.0	24

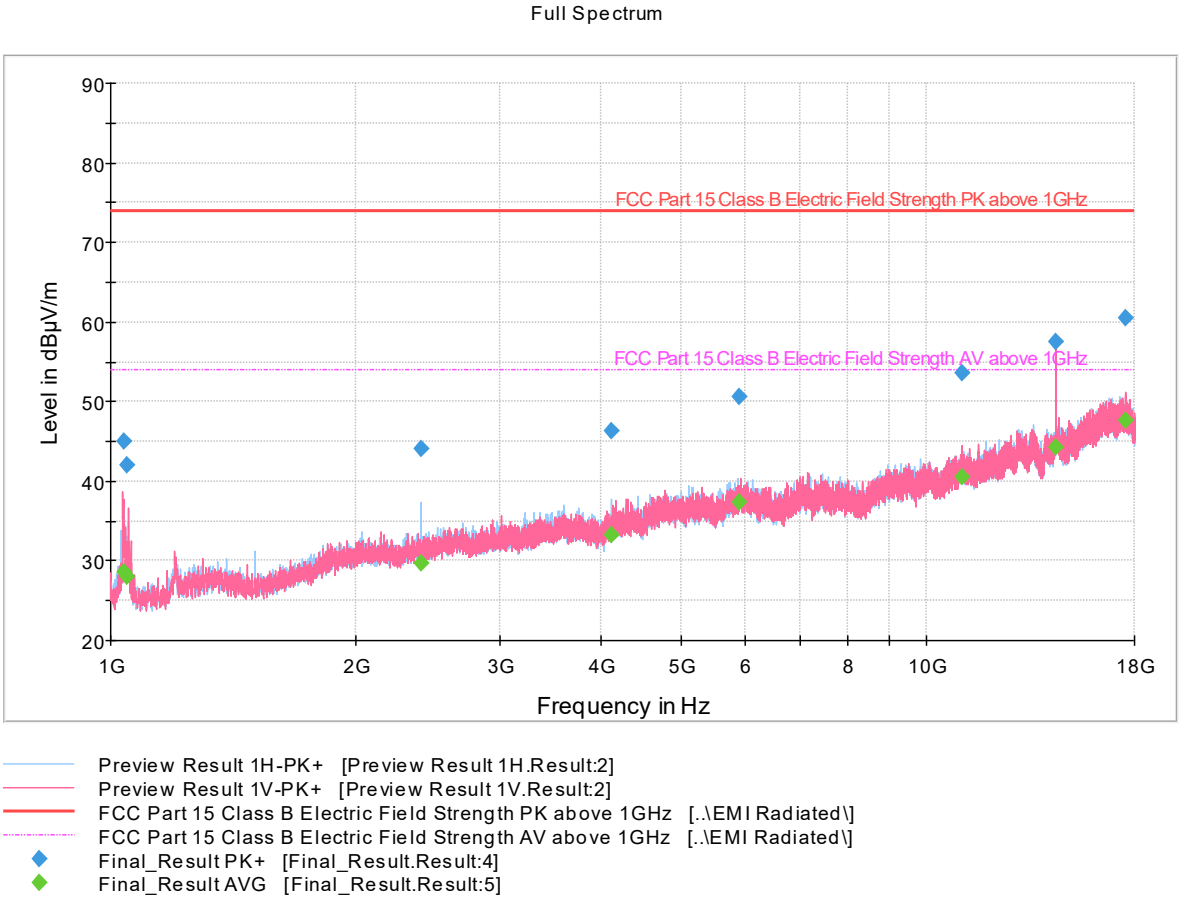
2.5.10 Below 1GHz Radiated Emission Test



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/m)
30.640000	20.23	40.00	19.77	1000.0	120.000	391.0	V	81.0	22
56.435667	12.19	40.00	27.81	1000.0	120.000	325.0	V	327.0	14
170.582667	15.38	43.50	28.12	1000.0	120.000	218.0	V	153.0	17
208.137333	17.81	43.50	25.69	1000.0	120.000	120.0	H	99.0	19
292.861667	18.74	46.00	27.26	1000.0	120.000	195.0	V	240.0	20
519.208333	25.54	46.00	20.46	1000.0	120.000	305.0	H	267.0	26
954.992667	31.71	46.00	14.29	1000.0	120.000	325.0	H	266.0	31

2.5.11 Above 1GHz (up to 18GHz) Radiated Emission Test



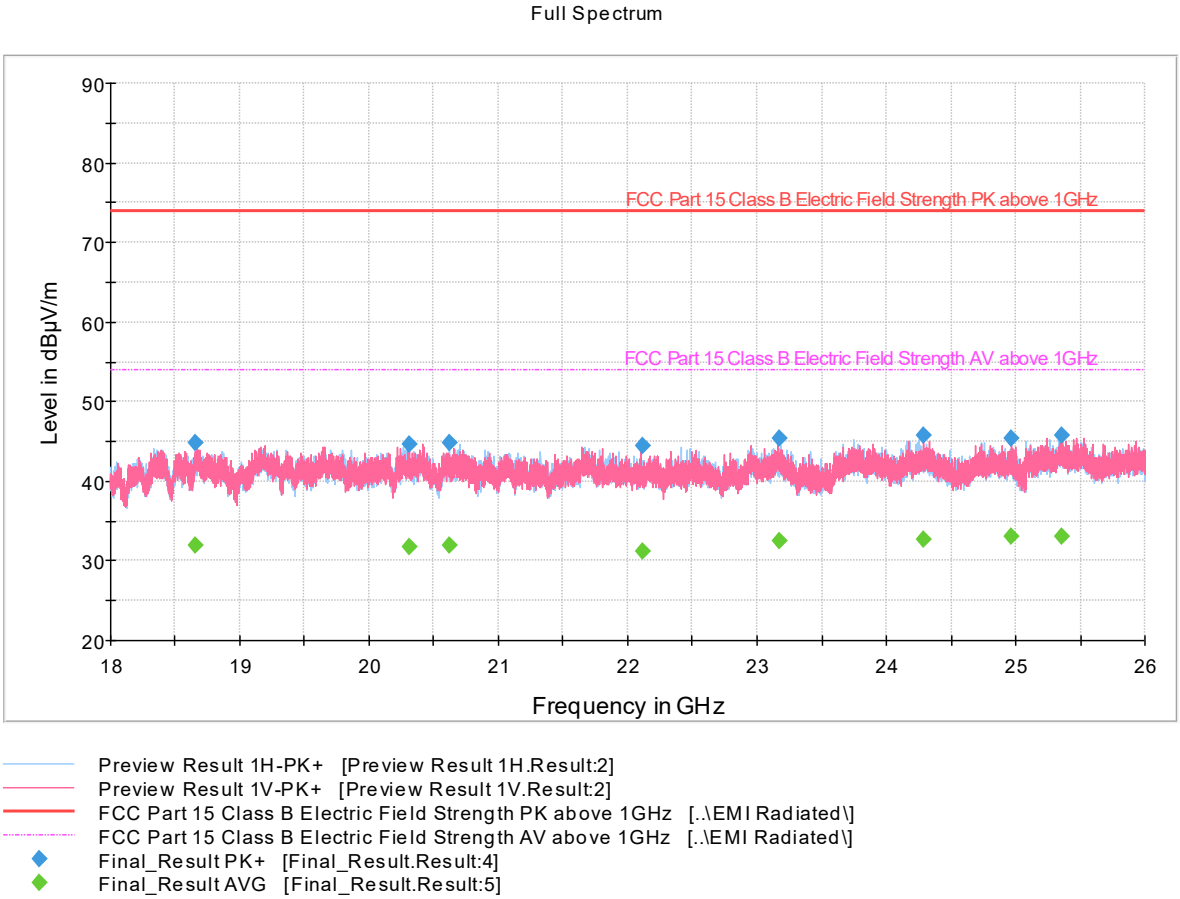
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1037.900000	45.03	73.90	28.87	1000.0	1000.000	138.0	V	21.0	-6
1048.166667	41.99	73.90	31.91	1000.0	1000.000	175.0	V	50.0	-7
2400.266667	44.12	73.90	29.78	1000.0	1000.000	304.0	H	68.0	1
4111.700000	46.23	73.90	27.67	1000.0	1000.000	285.0	H	7.0	5
5907.033333	50.58	73.90	23.32	1000.0	1000.000	365.0	V	322.0	6
11065.533333	53.64	73.90	20.26	1000.0	1000.000	255.0	V	42.0	14
14403.133333	57.49	73.90	16.41	1000.0	1000.000	365.0	V	344.0	13
17540.333333	60.42	73.90	13.48	1000.0	1000.000	335.0	V	38.0	19

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1037.900000	28.54	53.90	25.36	1000.0	1000.000	138.0	V	21.0	-6
1048.166667	27.97	53.90	25.93	1000.0	1000.000	175.0	V	50.0	-7
2400.266667	29.78	53.90	24.12	1000.0	1000.000	304.0	H	68.0	1
4111.700000	33.26	53.90	20.64	1000.0	1000.000	285.0	H	7.0	5
5907.033333	37.36	53.90	16.54	1000.0	1000.000	365.0	V	322.0	6
11065.533333	40.59	53.90	13.31	1000.0	1000.000	255.0	V	42.0	14
14403.133333	44.21	53.90	9.69	1000.0	1000.000	365.0	V	344.0	13
17540.333333	47.59	53.90	6.31	1000.0	1000.000	335.0	V	38.0	19

2.5.12 18GHz to 26GHz Radiated Emission Test



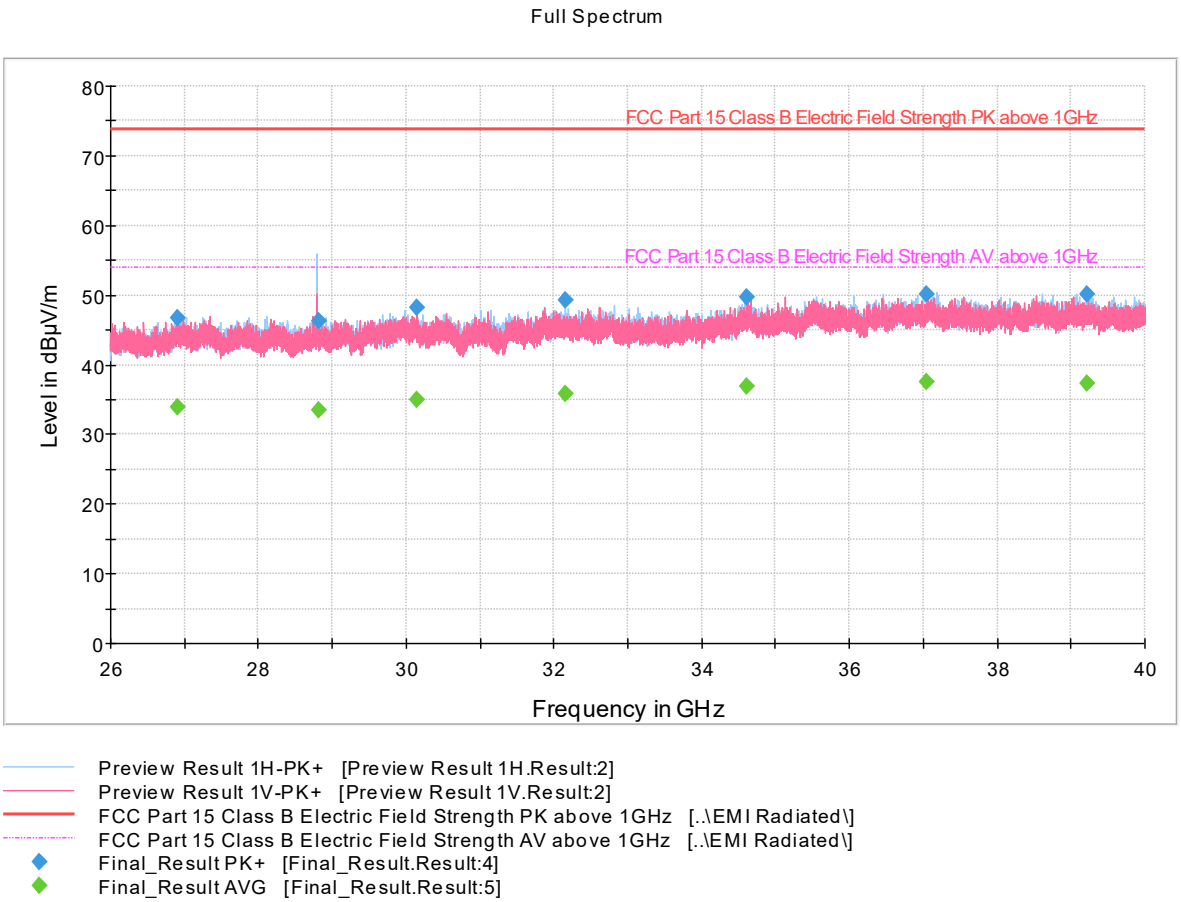
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18660.130000	44.87	73.90	29.03	1000.0	1000.000	213.0	H	41.0	-3
20306.827500	44.66	73.90	29.24	1000.0	1000.000	163.0	V	181.0	-3
20615.584500	44.91	73.90	28.99	1000.0	1000.000	140.0	H	85.0	-3
22109.787500	44.44	73.90	29.46	1000.0	1000.000	163.0	V	226.0	-2
23171.416000	45.30	73.90	28.60	1000.0	1000.000	163.0	H	22.0	0
24289.060500	45.68	73.90	28.22	1000.0	1000.000	213.0	V	311.0	0
24968.762000	45.42	73.90	28.48	1000.0	1000.000	202.0	V	26.0	0
25358.859500	45.76	73.90	28.14	1000.0	1000.000	137.0	V	25.0	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/m)
18660.130000	31.99	53.90	21.91	1000.0	1000.000	213.0	H	41.0	-3
20306.827500	31.83	53.90	22.07	1000.0	1000.000	163.0	V	181.0	-3
20615.584500	31.99	53.90	21.91	1000.0	1000.000	140.0	H	85.0	-3
22109.787500	31.16	53.90	22.74	1000.0	1000.000	163.0	V	226.0	-2
23171.416000	32.46	53.90	21.44	1000.0	1000.000	163.0	H	22.0	0
24289.060500	32.62	53.90	21.28	1000.0	1000.000	213.0	V	311.0	0
24968.762000	33.02	53.90	20.88	1000.0	1000.000	202.0	V	26.0	0
25358.859500	32.99	53.90	20.91	1000.0	1000.000	137.0	V	25.0	1

2.5.13 26GHz to 40GHz Radiated Emission Test



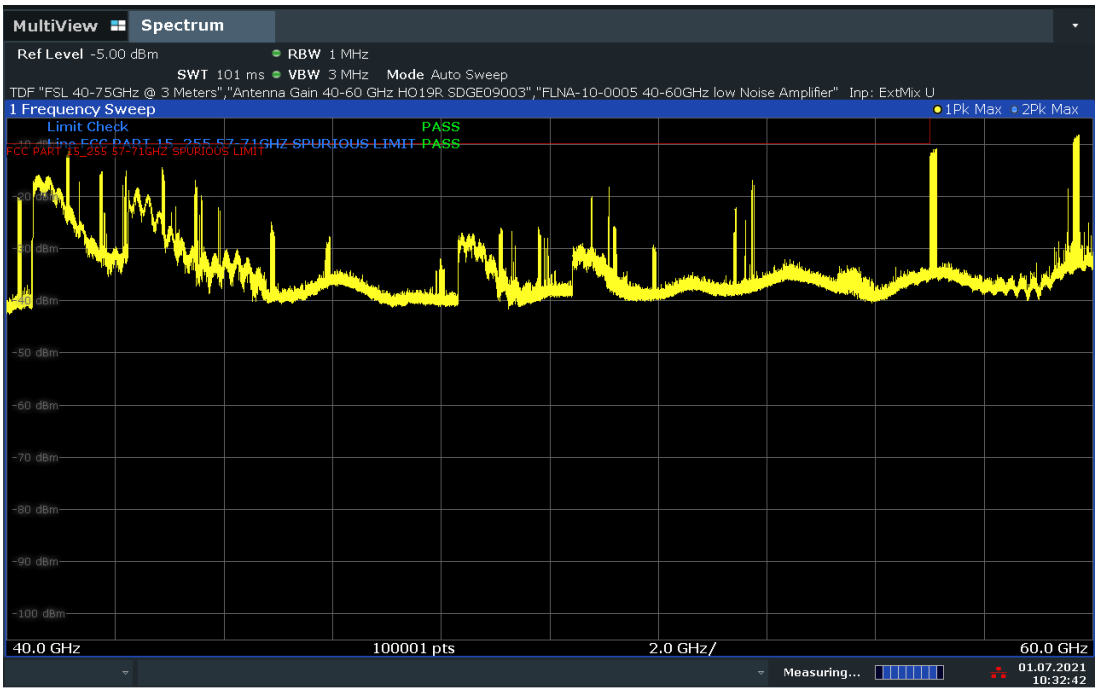
Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26896.135385	46.69	73.90	27.21	1000.0	1000.000	218.0	V	54.0	2
28809.085384	46.40	73.90	27.50	1000.0	1000.000	175.0	H	348.0	2
30136.700385	48.12	73.90	25.78	1000.0	1000.000	177.0	H	37.0	3
32150.416923	49.32	73.90	24.58	1000.0	1000.000	175.0	H	14.0	5
34603.142308	49.75	73.90	24.15	1000.0	1000.000	216.0	V	56.0	6
37050.744230	50.11	73.90	23.79	1000.0	1000.000	175.0	H	115.0	7
39221.684231	50.24	73.90	23.66	1000.0	1000.000	138.0	H	9.0	7

Average Data

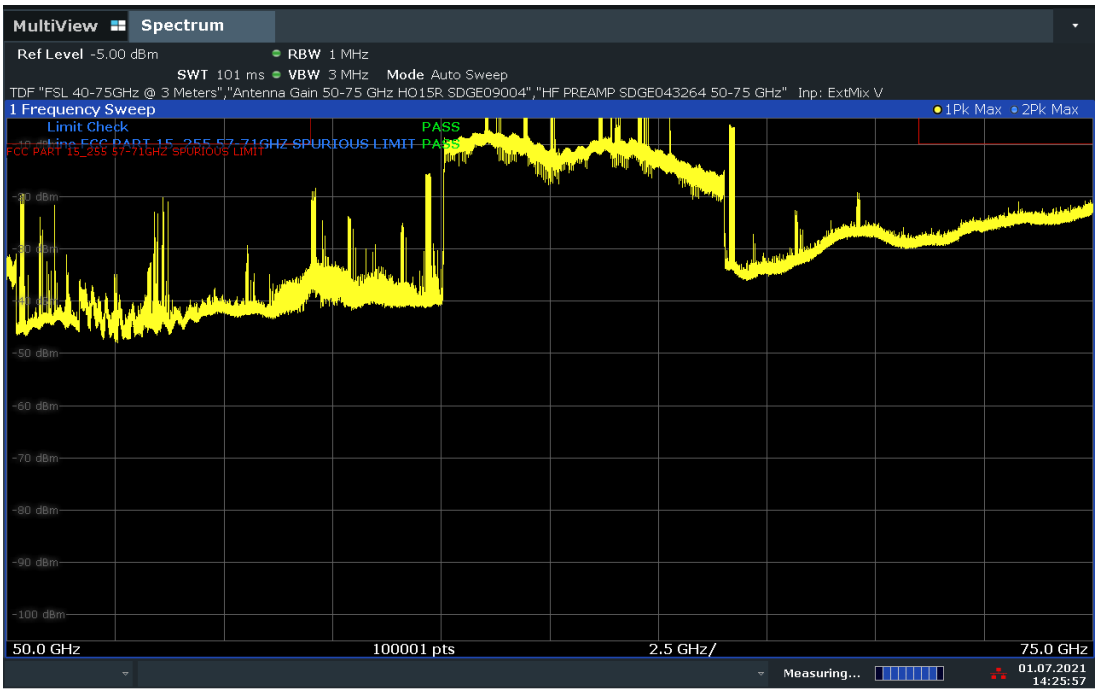
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
26896.135385	33.83	53.90	20.07	1000.0	1000.000	218.0	V	54.0	2
28809.085384	33.58	53.90	20.32	1000.0	1000.000	175.0	H	348.0	2
30136.700385	35.06	53.90	18.84	1000.0	1000.000	177.0	H	37.0	3
32150.416923	35.75	53.90	18.15	1000.0	1000.000	175.0	H	14.0	5
34603.142308	36.93	53.90	16.97	1000.0	1000.000	216.0	V	56.0	6
37050.744230	37.55	53.90	16.35	1000.0	1000.000	175.0	H	115.0	7
39221.684231	37.38	53.90	16.52	1000.0	1000.000	138.0	H	9.0	7

2.5.14 40GHz to 200GHz Maximized Plots



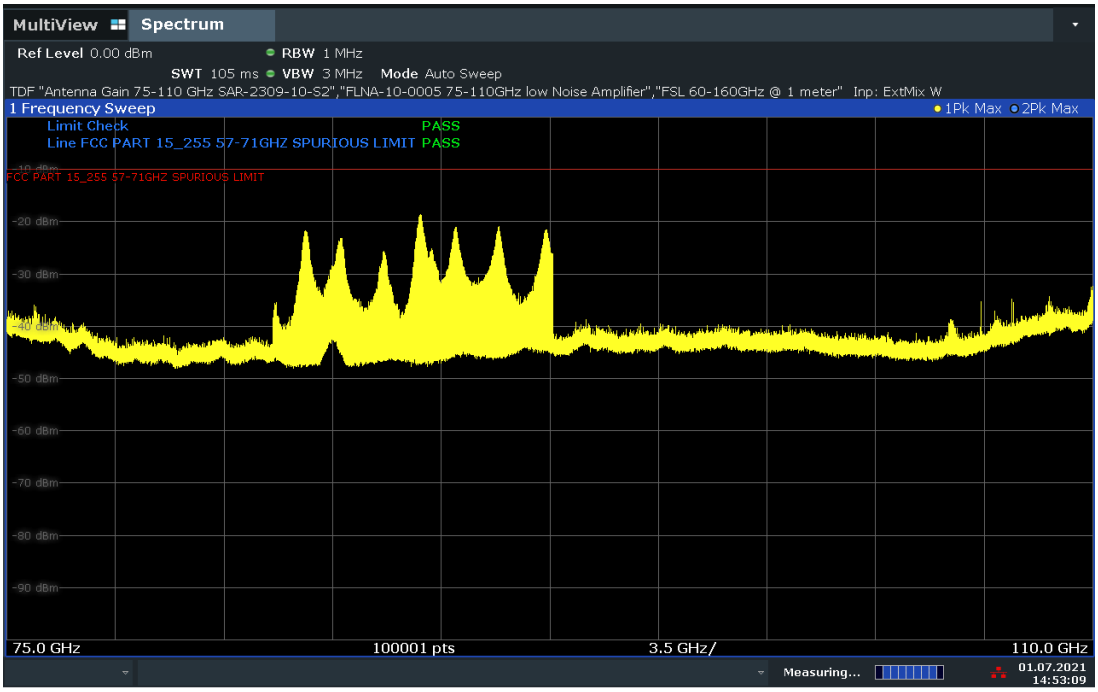
10:32:43 01.07.2021

40GHz to 60GHz Plot



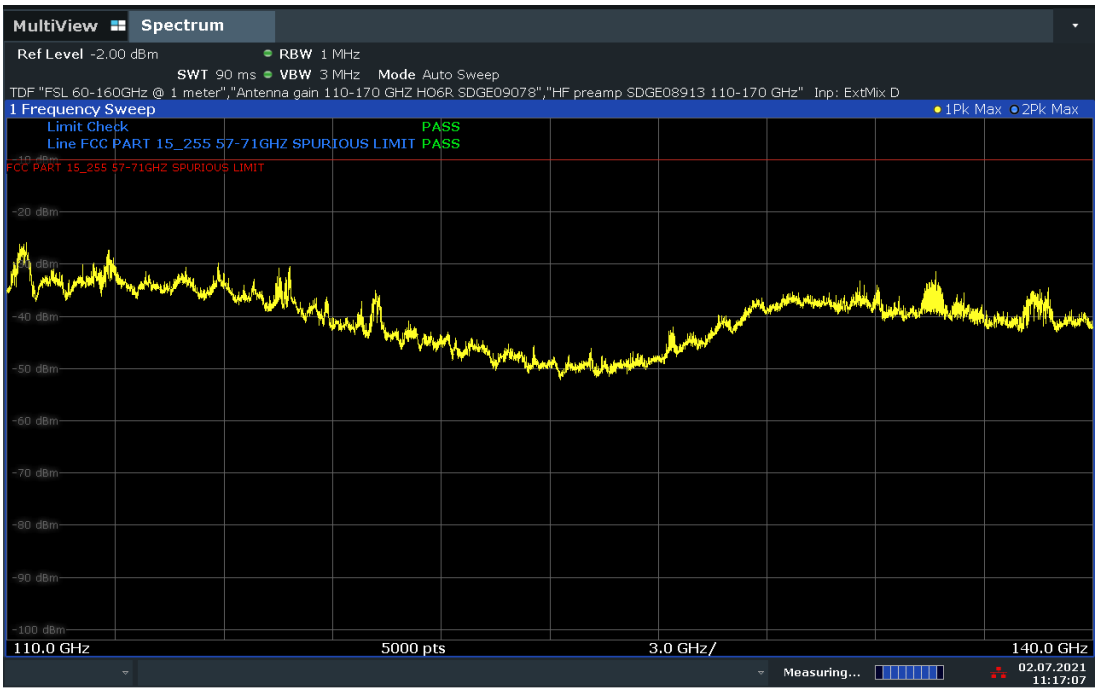
14:25:58 01.07.2021

50GHz to 75GHz Plot



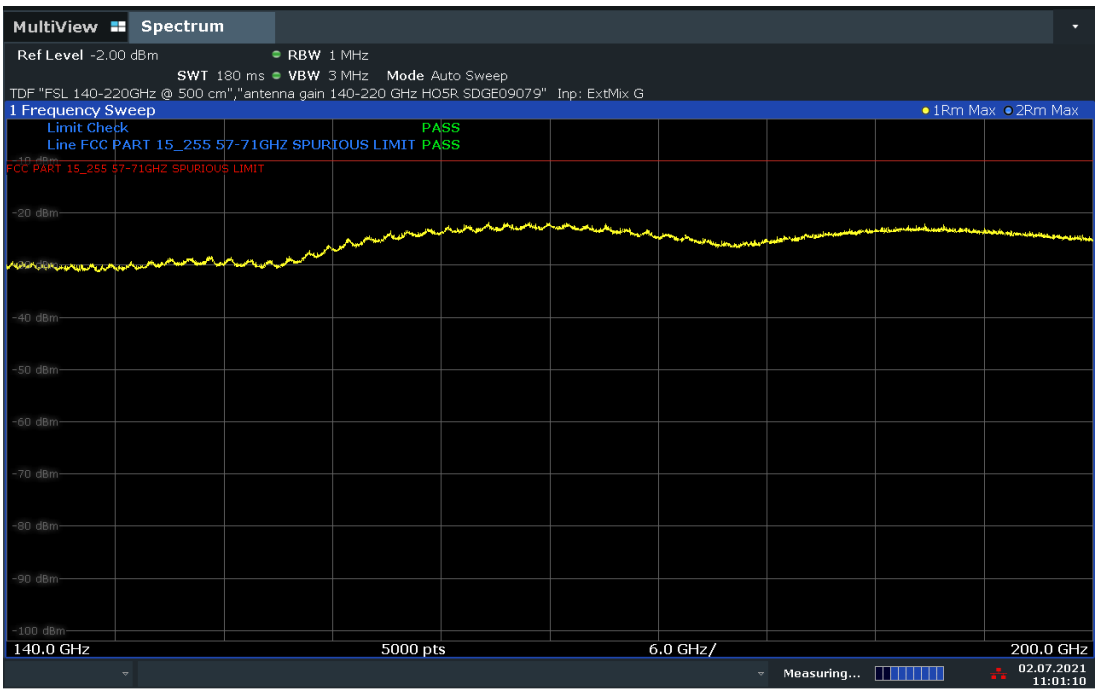
14:53:09 01.07.2021

75GHz to 110GHz Plot



11:17:07 02.07.2021

110GHz to 140GHz Plot



11:01:11 02.07.2021

140GHz to 200GHz Plot

2.6 DUTY CYCLE

2.6.1 Specification Reference

Waiver DA 21-811 (granted July 09, 2021)

2.6.2 Waiver Condition

- Each individual radar device shall not exceed a maximum transmit duty cycle of 10% in any 33 milliseconds (ms) interval (i.e., the device will not transmit longer than a total of 3.3 ms in any 33 ms time period).
- Any radar off-time period between two successive radar pulses that is less than 2 ms shall be considered “on time” for purposes of computing the duty cycle.

2.6.3 Equipment Under Test and Modification State

Serial No: 0x00036C47 / Default Test Configuration

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

August 18, 2021 / FSC

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 Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	27.4 °C
Relative Humidity	44.6 %
ATM Pressure	100.1 kPa

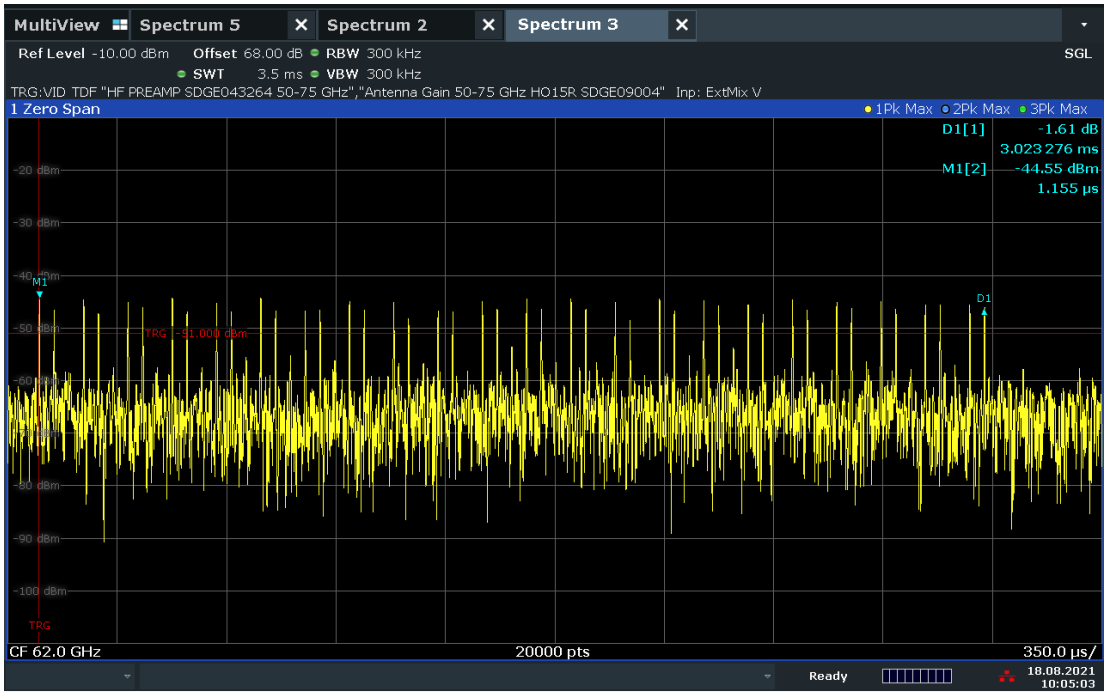
2.6.7 Additional Observations

- This is radiated test in time domain mode. 62GHz was chosen as representative frequency based from the observed emission profile of the entire radar sweep (worst case).
- Duty Cycle verification is based on the entire chirp compared to calculating the total on time per measured chirp.

2.6.8 Verification Test Results

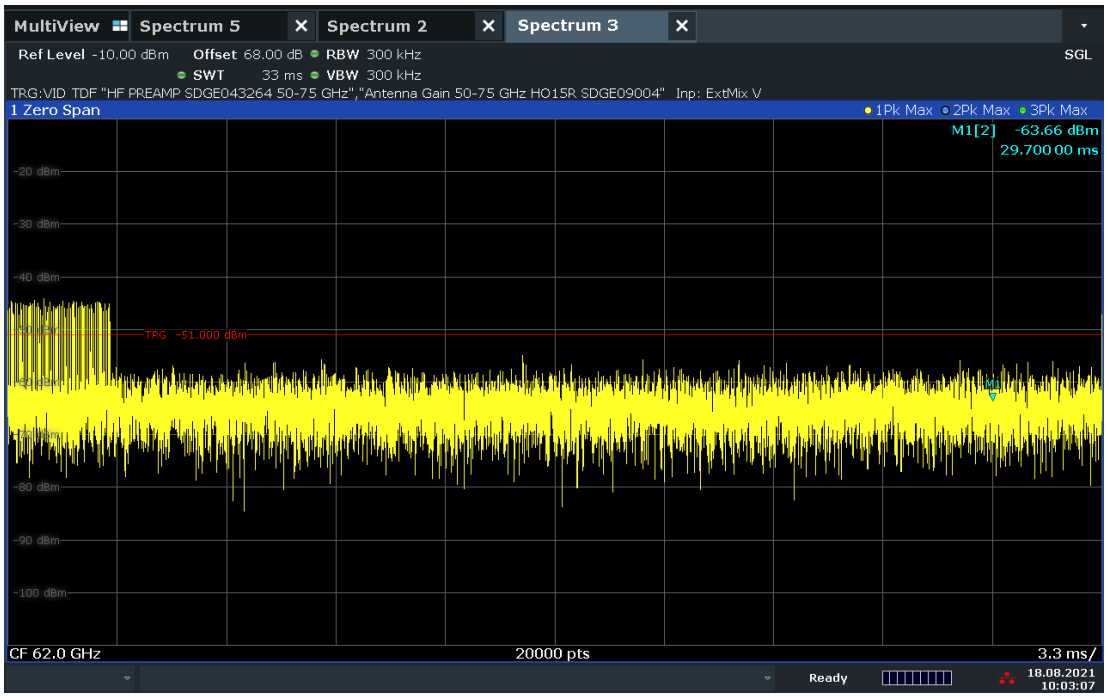
Measured chirp:	= 3.023 ms
Number of chirp/s per 33ms period	= 1 (one)
Observed Duty Cycle	= 9.16 % Complies with 10% Waiver condition

2.6.9 Sample Test Plots



10:05:04 18.08.2021

Single Chirp (3.02ms)



10:03:07 18.08.2021

33ms Observation Period (Duty Cycle < 10%)

2.7 POWER SPECTRAL DENSITY

2.7.1 Specification Reference

Waiver DA 21-811 (granted July 09, 2021)

2.7.2 Waiver Condition

The radar shall be certified for compliance with all the technical specifications applicable to operation under 47 CFR Part 15, with the exception of the following provisions in 47 CFR §§ 15.255(a)(2) and (c)(3), which are waived to allow the device to operate as a radar on new passenger motor vehicles in the 57-64 GHz band at a maximum +13 dBm EIRP, +10 dBm transmitter conducted output power, and +13 dBm/MHz power spectral density.

2.7.3 Equipment Under Test and Modification State

Serial No: 0x00036C52 / Default Test Configuration

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

July 03, 2021 / FSC

2.7.5 Test Equipment Used

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

2.7.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Mira Mesa facility

Ambient Temperature	25.8 °C
Relative Humidity	49.3 %
ATM Pressure	99.8 kPa

2.7.7 Additional Observations

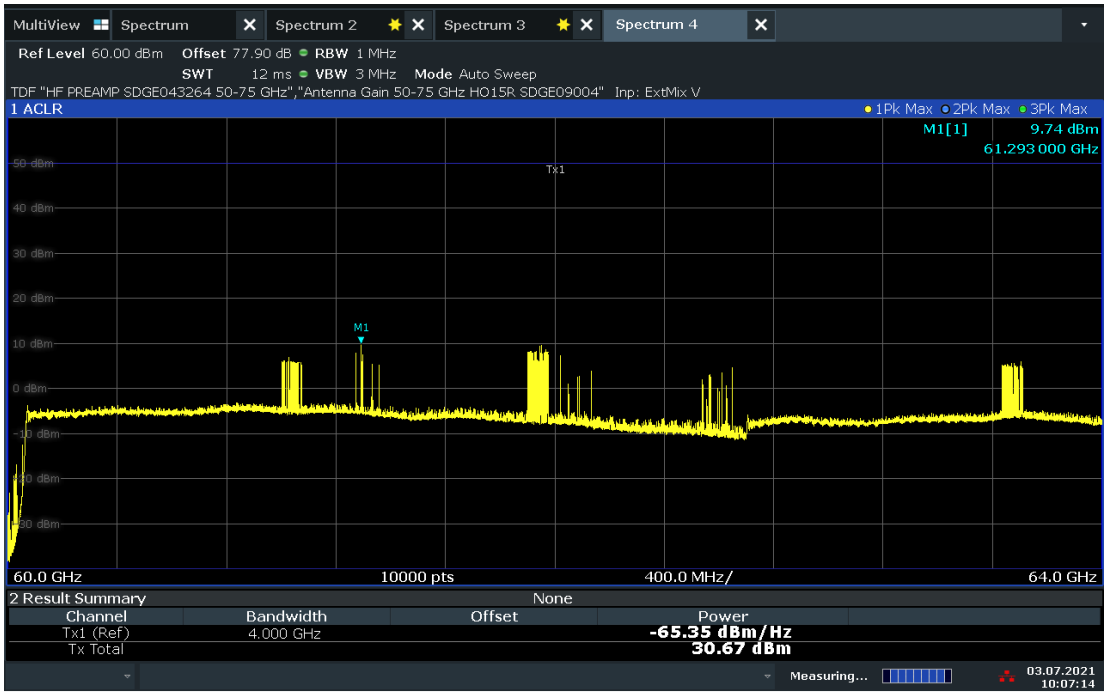
- This is a radiated test. Test setup is identical to Section 2.5 of this test report covering the frequency range of 60GHz to 64GHz.
- The Power Measurement function of the Spectrum Analyzer is used for this test.

2.7.8 Test Result

Frequency	Measured PSD	Calculated PSD
60 to 64 GHz	-65.35 dBm/Hz	-5.35 dBm/MHz

**dBm/Hz + 60 = dBm/MHz*

2.7.9 Test Result Plot



10:07:15 03.07.2021

Power Spectral Density

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 Emission						
1049	EMI Test Receiver	ESU40	100133	Rohde & Schwarz	09/25/20	09/25/21
7611	Signal/Spectrum Analyzer	FSW26	102017	Rohde & Schwarz	02/02/21	02/02/22
1002	Bilog Antenna	3142C	0058717	EMCO	10/09/19	10/09/21
7631	Double-ridged waveguide horn	3117	00205418	ETS-Lindgren	09/16/20	09/16/22
46797	Preamplifier	PA-122	181925	Com Power	10/28/20	10/28/21
6628	Loop Antenna	HFH2-Z2335.4711.52	FNr.800.458/25	Schwarbeck	05/22/20	05/20/22
9001	Horn antenna (18-26.5GHz)	HO42S	101	Custom Microwave	09/09/19	09/09/21
9003	Horn antenna (26-40 GHz)	HO28S	102	Custom Microwaves	09/09/19	09/09/21
40815	Pre-amplifier (18-40 GHz)	19D18	15G27	Spacek Labs	10/05/20	10/05/21
7637	Harmonics mixer (40-60 GHz)	FS-Z60	100009	Rhode & Schwarz	07/29/20	07/29/23
7636	Harmonics mixer (60-90 GHz)	FS-Z90	100092	Rhode & Schwarz	07/29/20	07/29/23
-	Harmonics mixer (50-75 GHz)	FS-Z75	100988	Rhode & Schwarz	02/25/21	02/25/22
7633	Harmonics mixer (75-110 GHz)	HM-110-7	101000	Radiometer Physics	02/22/21	07/29/23
7634	Harmonics mixer (110-170 GHz)	HM-170	0062	Radiometer Physics	02/22/21	07/29/23
7635	Harmonics mixer (170-220 GHz)	HM-220	020022	Radiometer Physics	02/22/21	07/29/23
7632	Harmonics mixer (220-325 GHz)	HM-325	020075	Radiometer Physics	02/22/21	07/29/23
9003	Horn antenna (40-60 GHz)	HO19R	103	Custom Microwaves	10/14/19	07/29/23
9004	Horn antenna (50-75 GHz)	HO15R	104	Custom Microwaves	10/10/19	07/29/23
9079	Horn antenna (140-220 GHz)	HO5R	HO5R	Custom Microwaves	06/10/19	07/29/23
9078	Horn antenna (110-170 GHz)	HO6R	HO6R	Custom Microwaves	06/10/19	07/29/23
7628	Horn antenna (75-110 GHz)	SAR-2309-10-S2	13481-01	Sage Millimeter, Inc.	Verified by 7611 and corresponding antenna/Active multiplier combination	
9082	Horn antenna (140-220 GHz)	HO5R	N/A	Custom Microwaves		
8872	Direct Reading Attenuator (40-60	STA-60-19-D1	11875-01	Sage Millimeter, Inc.	Verified by 7611 and corresponding antenna/mixer combination	
8860	Direct Reading Attenuator (50-75	STA-60-15-D1	11466-01	Sage Millimeter, Inc.		
8861	Direct Reading Attenuator (75-110	STA-60-10-D1	11466-01	Sage Millimeter, Inc.		

8919	Direct Reading Attenuator (90-140	STA-60-08-D1	12605-01	Sage Millimeter, Inc.	Verified by 7611 and corresponding antenna/mixer combination	
8909	Direct Reading Attenuator (140-220	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.		
Miscellaneous						
6805	Environmental Chamber	ESL-4CA	18021	Espec	01/13/21	01/13/22
7619	Temp/Humidity Sensor	iBTHX-W	15050268	Omega	03/09/21	03/09/22
43003	True RMS Multimeter	85 III	69880143	Fluke	10/23/20	10/23/21
-	Test Software	EMC32	V11.20.00	Rohde & Schwarz	N/A	

3.2 Measurement Uncertainty

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

3.2.1 Radiated Measurements (Below 1GHz)

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20	dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.75	dB	Normal, k=2	2.000	0.38	0.14
4	Receiver sinewave accuracy	0.15	dB	Normal, k=2	2.000	0.08	0.01
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50	dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95	dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10	dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12	dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00	dB	Rectangular	1.732	0.58	0.33
13	Cross-polarization	0.90	dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00	dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.76	dB	Triangular	2.449	1.54	2.36
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.77	dB	Rectangular	1.732	0.44	0.20
18	Table height at 3 m	0.10	dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00	dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00	dB				0.00
	Combined standard uncertainty			Normal	2.98	dB	
	Expanded uncertainty			**Normal, k=2**	**5.96**	**dB**	

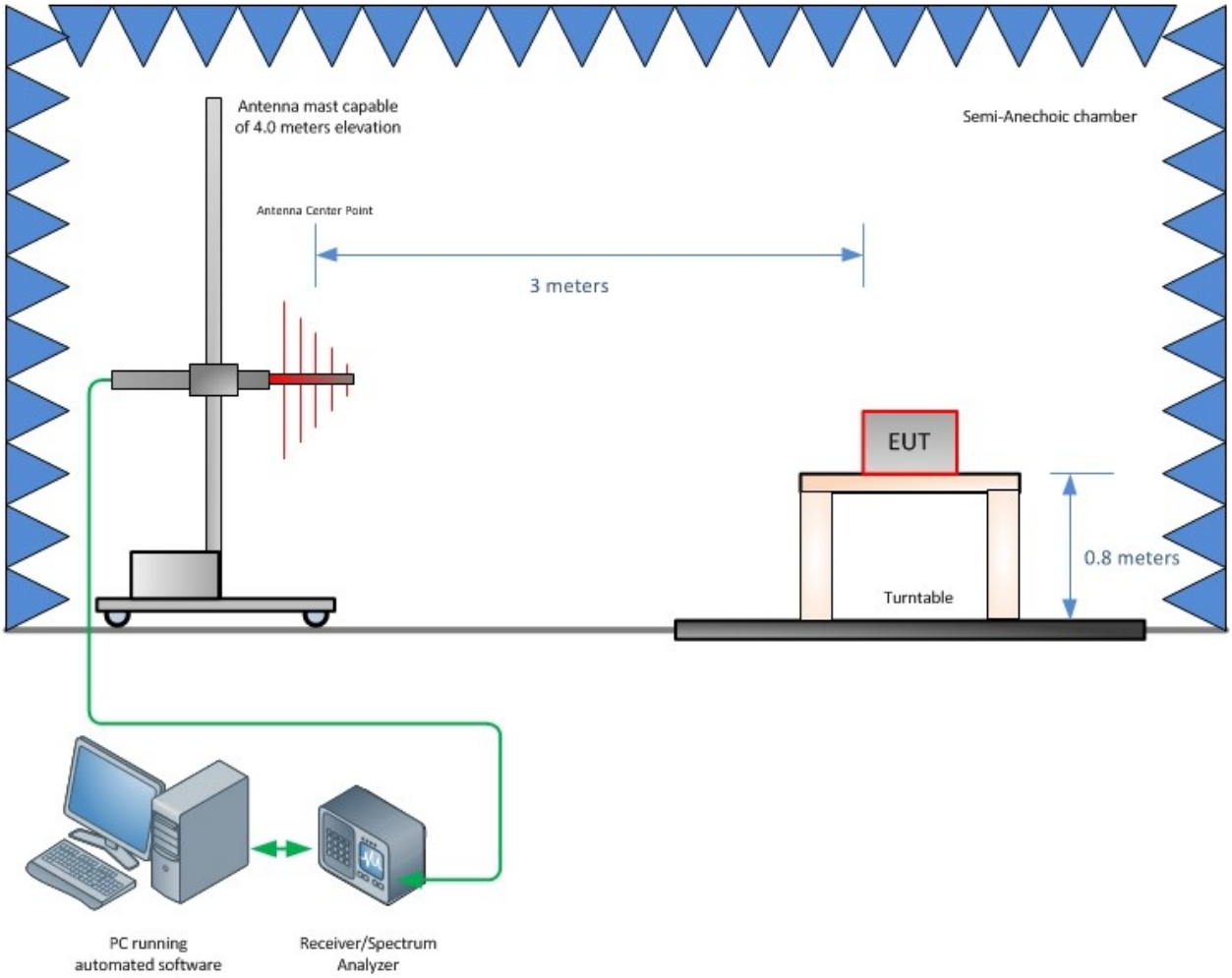
3.2.2 Radiated Emission Measurements (Above 1GHz)

	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	0.47	dB	Normal, k=2	2.000	0.24	0.06
5	Sinewave accuracy	0.15	dB	Normal, k=2	2.000	0.08	0.01
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)	5.53	dB	Triangular	2.000	4.89	1.13
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
18	Table height at 3 m	0.00	dB	Normal, k=2	2.000	0.05	0.00
	Combined standard uncertainty			Normal	2.38	dB	
	Expanded uncertainty			**Normal, k=2**	**4.76**	**dB**	

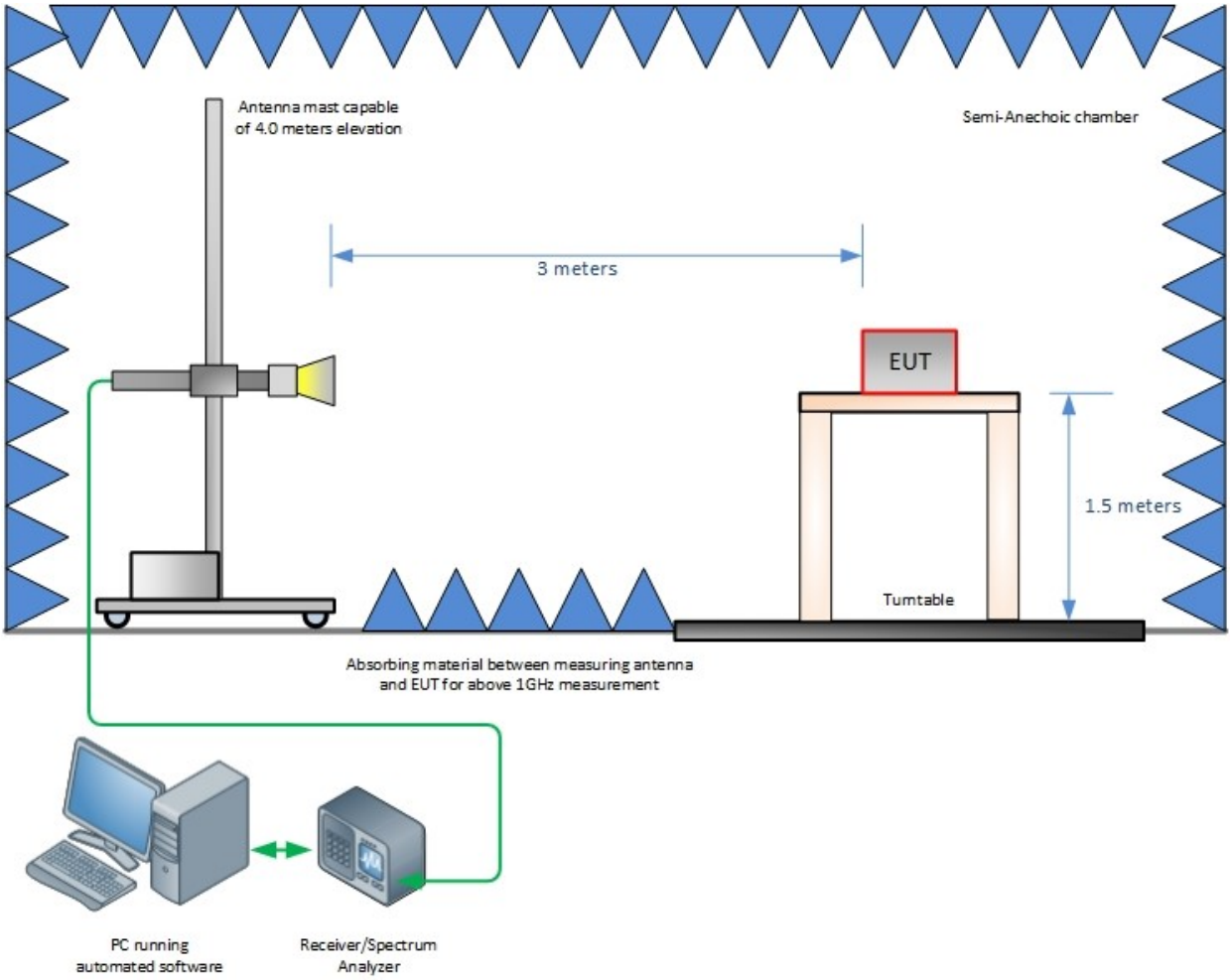
SECTION 4

Diagram of Test Setup

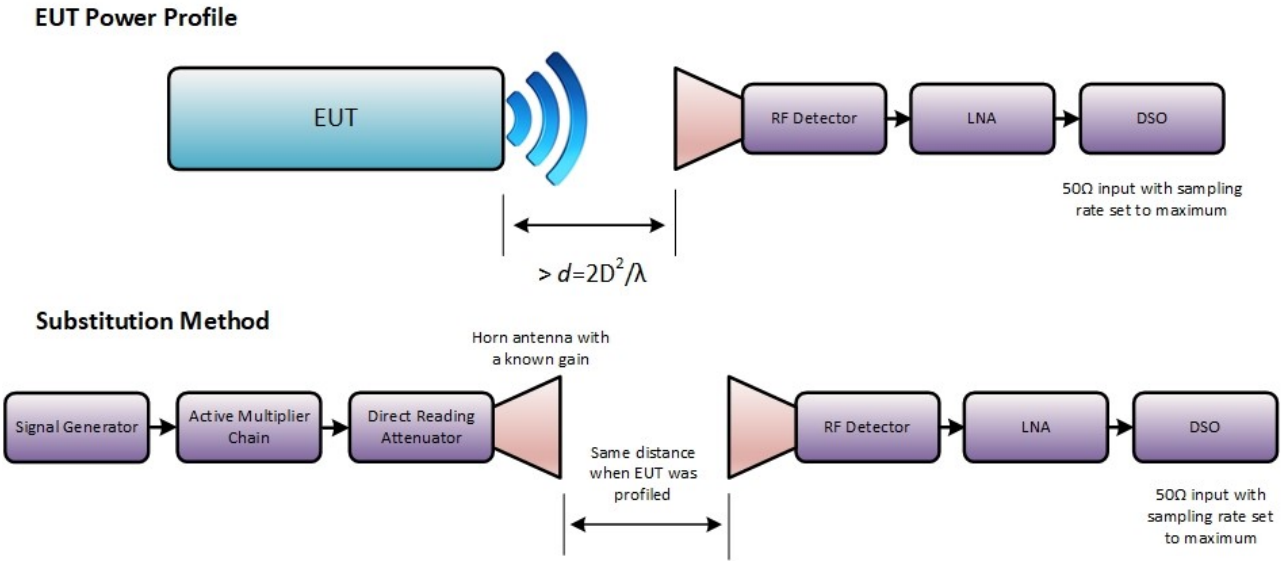
4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)



Power Measurement Block Diagram

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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