

Radio Testing of the

Vayyar Imaging LTD

60GHz fixed field-disturbance sensor or a short-range device for interactive-motion sensing Model: vStraw_CTPB4

In accordance with FCC Part 15 Subpart C §15.255



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Vayyar Imaging LTD
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COMMERCIAL-IN-CONFIDENCE

Date: February 2020



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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorized Signatory	Alex Chang	February 19, 2020	<i>Alex Chang</i>

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.

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REPORT ON Radio Testing of the
Vayyar Imaging LTD
Model vStraw_CTPB4 60GHz fixed field-disturbance sensor or a
short-range device for interactive-motion sensing


TEST REPORT NUMBER 72156288

TEST REPORT DATE February 2020

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DATED February 19, 2020



Revision History

72156288 Vayyar Imaging LTD Model vStraw_CTPB4 60GHz fixed field-disturbance sensor or a short-range device for interactive-motion sensing					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
02/19/2020	—	Initial Release			Alex Chang
03/26/2020	Initial Release	Issue 2	Updated antenna gain from 5dBi to 5.7dbi based from extensive electromagnetic simulations performed by the manufacturer	5, 8 and 14	Ferdinand Custodio
04/13/2020	Issue 2	Issue 3	Included the frequency range the EUT operates (59-64GHz)	8, 13 and 14	Ferdinand Custodio



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SECTION 1

1 REPORT SUMMARY

Radio Testing of the
Vayyar Imaging LTD
vStraw_CTPB4 60GHz fixed field-disturbance sensor or a short-range device for interactive-
motion sensing



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Vayyar Imaging LTD vStraw_CTPB4 60GHz fixed field-disturbance sensor or a short-range device for interactive-motion sensing to the requirements of FCC Part 15 Subpart C §15.255.

Objective	To perform Radio testing to support Class II permissive change application to the original filing with model name vStraw_CTPB2. The manufacturer requested confidentiality on the details of the change (internal tuning) and will be <u>provided as a separate exhibit</u> .
Manufacturer	Vayyar Imaging LTD
EUT	60GHz fixed field-disturbance sensor or a short-range device for interactive-motion sensing
Trade Name	vStraw_CTPB4
Model Name	vStraw_CTPB4
FCC ID	2AHIS-V60G-HOME
IC Number	21498-V60GHOME
Serial Number(s)	STRBAB4N479U0047 (24 Transmitters) and STRA1B4N030U0070 (12 Transmitters)
Number of Samples Tested	2
Test Specification/Issue/Date	FCC Part 15 Subpart C §15.255 (October 1, 2019).
Start of Test	February 02, 2020
Finish of Test	February 12, 2020
Name of Engineer(s)	Ferdinand Custodio
Related Document(s)	<ul style="list-style-type: none">• 72152870A Vayyar vStraw FCC IC Part 15.255 Test Report (Issued by TÜV SÜD America on November 27, 2019)• ANSI C63.10-2013. American National Standard of Procedures for Compliance testing of Unlicensed Wireless Devices.• MPR for b2vStraw - Manual_23Oct19.pdf• vStraw_CTPB4 - antenna gain simulation.pdf• 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)	Transmitter Power	Compliant	
2.2	§15.207(a)	Conducted Emissions	N/A	
2.3	§15.255(f)	Frequency Stability	N/A	
2.4	§15.255(e)	Occupied Bandwidth	N/A	
2.5	§15.255(d)(1)(2) and (3)	Field Strength of Spurious Radiation	Compliant	

N/A Not performed as per C2PC test plan. Data collected from the original evaluation of the vStraw CTPB2 were leveraged (72152870A Vayyar vStraw FCC IC Part 15.255 Test Report (Issued by TÜV SÜD America on November 27, 2019)).



1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) is a Vayyar Imaging LTD vStraw_CTPB4 60GHz fixed field-disturbance sensor or a short-range device for interactive-motion sensing. The EUT is part of the V60GHOME family of modules operating at 60GHz - acting as either fixed field-disturbance sensor or a short-range device for interactive-motion sensing. The DUT was tested using two transmission profiles: one utilizing 12 simultaneous transmitters, and the other 24 simultaneous transmitters. The frequency modulation method and grid remain similar.

The models certified under this family are intended to be certified as modules, under modular approval, to be integrated in multiple products, or operated with a host-PC. The family will include, but not restricted to, the following members, having the same RF components, antennas type and array, RF layout and stack-up and same transmissions profile within 57-71GHz - differ only by their DC and digital interfaces:

- vBLU_OK_CTPB4, vBLU_MW_CTPB4 - SPI interface, 30-pin DC\digital connector (2 types)
- vStraw_CTPB4 - USB + SPI interface and connector

1.3.2 EUT General Description

EUT Description	60GHz fixed field-disturbance sensor or a short-range device for interactive-motion sensing
Trade Name	vStraw_CTPB4
Model Name	vStraw_CTPB4
Rated Voltage	USB powered (5VDC)
Mode Verified	60GHz radar
Capability	60GHz radar
Frequency Range	59-64GHz
Primary Unit (EUT)	<input type="checkbox"/> Production <input checked="" type="checkbox"/> Pre-Production <input type="checkbox"/> Engineering
Transmission Mode	MIMO (24 x 22)
Number of TX Outputs	8 – 24 (transmitting each time in parallel with 12 or 24 TX-ports each one connected to a separate TX-antennas (MIMO), switching the phase at a high-rate (~1usec rate), changing the momentary beam-form)
Antenna Type	PCB embedded
Manufacturer	Vayyar Imaging LTD.
Single Antenna Gain	5.7 dBi
Effective Gain	16.5 dBi (5.7 dBi + 10*log10(12)) for 12 TX configuration 19.5 dBi (5.7 dBi + 10*log10(24)) for 24 TX configuration

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	The EUT was connected to a support laptop via a short USB cable. Vayyar Multiport Recorder 2.1.10 was used to configure the EUT for verifications. The manufacturer provided detailed instructions to exercise the EUT (MPR for b2vStraw - Manual_23Oct19.pdf). For power measurement, the manufacturer provided a separate test profile transmitting a representing state of a fixed frequency and waveform at high duty-cycle. Default power setting used was -10dBm. The measurements were taken at DUT board-temperature of 60°C and 48°C for the 12-transmitters and 24-transmitters, respectively, referring to potential typical conditions of the PCB in a product.

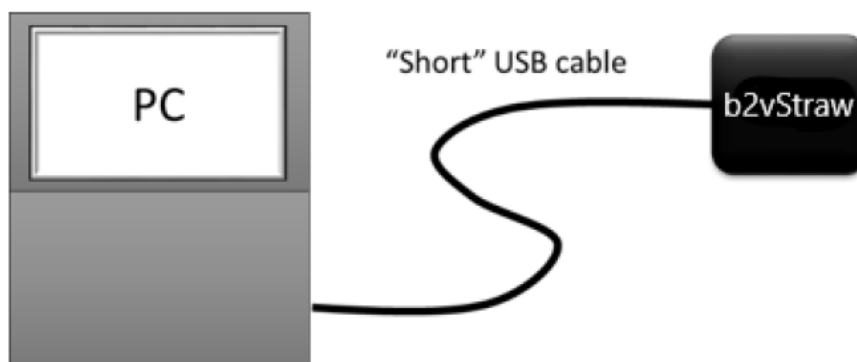
1.4.2 EUT Exercise Software

Vayyar Multiport Recorder 2.1.10

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Lenovo	Laptop Thinkpad T440S	Type: 20AR-S4250S S/N PC-03BBGR
Lenovo	Laptop Power Supply	Model ADLX45NCC2A S/N 10E75794C1SG7B84A60
Vention	USB Type A to Type B micro cable	2-meters, USB 2.0 cable

1.4.4 Simplified Test Configuration Diagram





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: STRBAB4N479U0047 and STRA1B4N030U0070		
None	—	—

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

For conducted and radiated emissions, the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.10-2013. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

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

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

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

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Designation No.: US1146

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



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

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

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

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

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

1.9.4 NCC (National Communications Commission - US0102)

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



SECTION 2

2 TEST DETAILS

Radio Testing of the
Vayyar Imaging LTD
vStraw_CTPB4 60GHz fixed field-disturbance sensor or a short-range device for interactive-motion
sensing



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 Equipment Under Test and Modification State

Serial No: STRBAB4N479U0047 and STRA1B4N030U0070 / Default Test Configuration

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

February 03, 2020 / FSC

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	23.5 °C
Relative Humidity	36.4 %
ATM Pressure	99.8 kPa

2.1.7 Additional Observations

- This is a radiated test.
- Test methodology is per Section 9.11 of ANSI C63.10-2013.
- The EUT is capable of both Chirp and Stepped CW transmission modes (59-64GHz). The sweep was stopped and only the worst transmission mode presented (single CW).
- The manufacturer provided a test profile with the highest possible duty cycle and the longest burst (10-100msec).
- Test performed using a RF detector, low noise amplifier, active multiplier chain, direct reading attenuator and corresponding horn antenna.



- 62GHz was used on the original filing as worst-case CW mode, for this C2PC investigation, 63GHz was used as worst-case power estimation per RFIC inherent slope of power vs frequency, affected by updated gain settings for this test to meet the required mask.
- 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.

2.1.8 Test Result (worst case stopped CW mode)

Frequency	Peak Power (EIRP)	Conducted Peak Power
63 GHz (12 Transmitters)	5.74 dBm	-10.06 dBm
63 GHz (24 Transmitters)	8.74 dBm	-10.06 dBm
EUT sweeps from 59GHz to 64GHz. Only the worst frequency presented using RF Detector method.		

	12 Transmitter	24 Transmitters	§15.255 Requirements
$P_{Conducted}$	-10.7 dBm	-10.7 dBm	≤ -10 dBm
$Gain_{Total}$	16.5 dBi	19.5 dBi	
$EIRP_{MAX}$	5.8 dBm	8.8 dBm	≤ 10 dBm

2.1.9 12 Transmitters Calculation

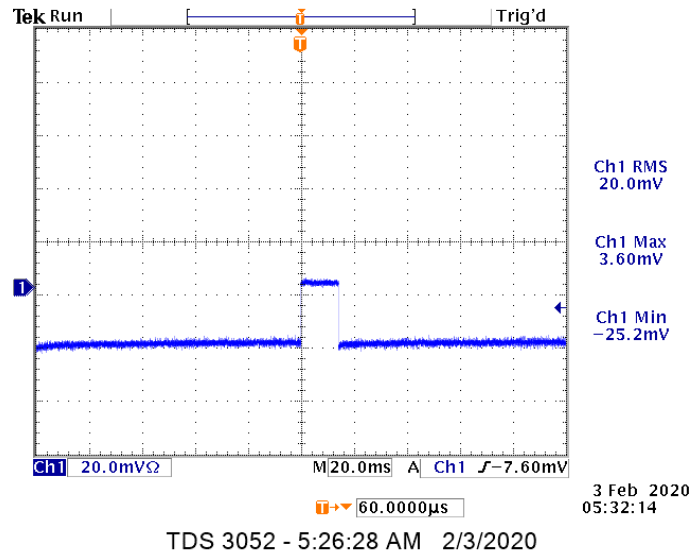
Active Multiplier Chain power output @ 63GHz = 13.00 dBm
 Gain Horn -WR15/HO15R (SDGE09004) = 23.24 dBi
 Direct Reading Attenuator setting to replicate EUT profile = 30.50 dB

Substitution Peak EIRP = 5.74 dBm

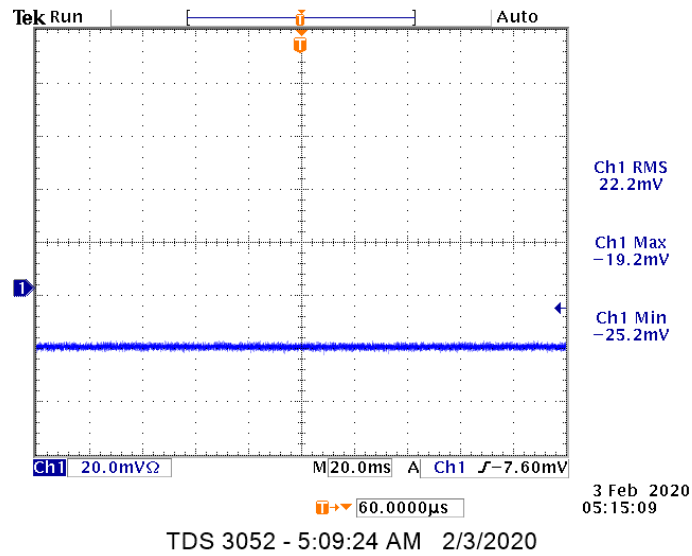
2.1.10 24 Transmitters Calculation

Active Multiplier Chain power output @ 63GHz = 13.00 dBm
 Gain Horn -WR15/HO15R (SDGE09004) = 23.24 dBi
 Direct Reading Attenuator setting to replicate EUT profile = 27.50 dB

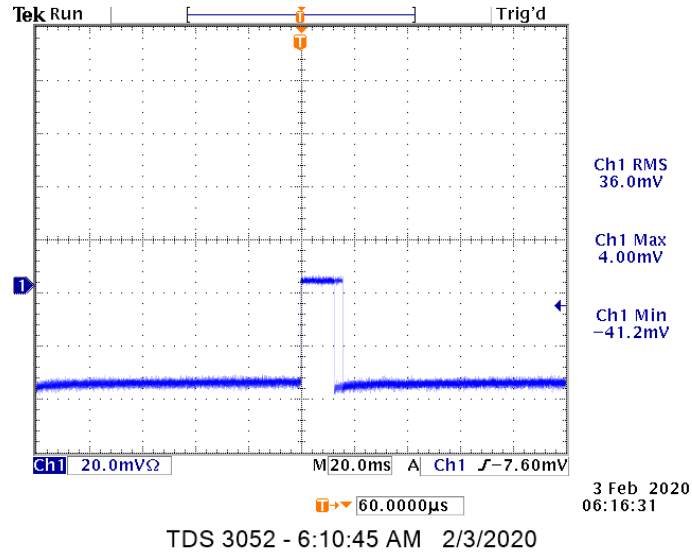
Substitution Peak EIRP = 8.74 dBm



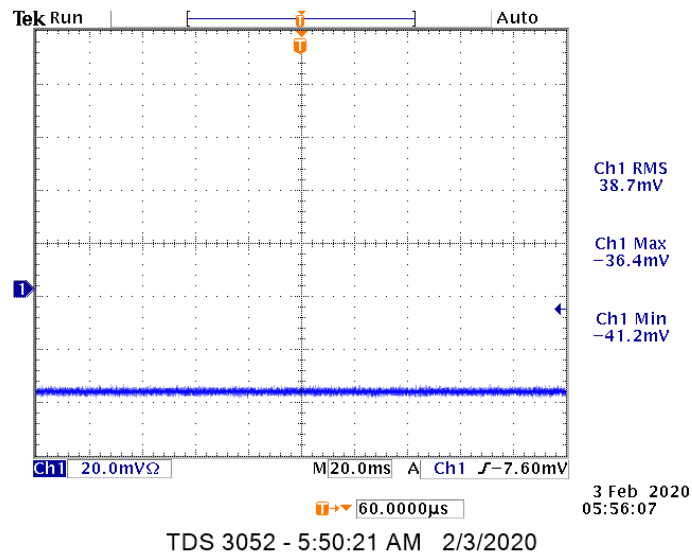
EUT (12 Transmitter) profile using a RF detector



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



EUT (24 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 μ H/50 ohms line impedance stabilization network (LISN).

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

*Decreases with the logarithm of the frequency.

2.2.3 Equipment Under Test and Modification State

Not performed as per C2PC test plan. Data collected from the original evaluation of the vStraw CTPB2 were leveraged (72152870A Vayyar vStraw FCC IC Part 15.255 Test Report (Issued by TÜV SÜD America on November 27, 2019)).



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

Not performed as per C2PC test plan. Data collected from the original evaluation of the vStraw CTPB2 were leveraged (72152870A Vayyar vStraw FCC IC Part 15.255 Test Report (Issued by TÜV SÜD America on November 27, 2019)).



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

Not performed as per C2PC test plan. Data collected from the original evaluation of the vStraw CTPB2 were leveraged (72152870A Vayyar vStraw FCC IC Part 15.255 Test Report (Issued by TÜV SÜD America on November 27, 2019)).



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/cm² (85.3dBμV/m / -9.93dBm EIRP) at a distance of 3 meters.

2.5.3 Equipment Under Test and Modification State

Serial No: STRA1B4N030U0070 / Default Test Configuration

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

September 12, 2020 / 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.
- Only the worst-case profile for spurious emissions presented (Stepped CW).
- Both 12 and 24 Transmitters data presented above 26GHz. Below 26GHz, the emission profile between the two configurations are identical. Only the worst configuration presented.
- In-band measurements are covered under Section 2.1 of this test report.
- 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 57 GHz	3 meters
57 GHz to 71 GHz	3 meters
71 GHz to 75 GHz	1 meter
75 GHz to 110 GHz	1 meter
110 GHz to 140 GHz	1 meter
140 GHz to 200 GHz	0.5 meter

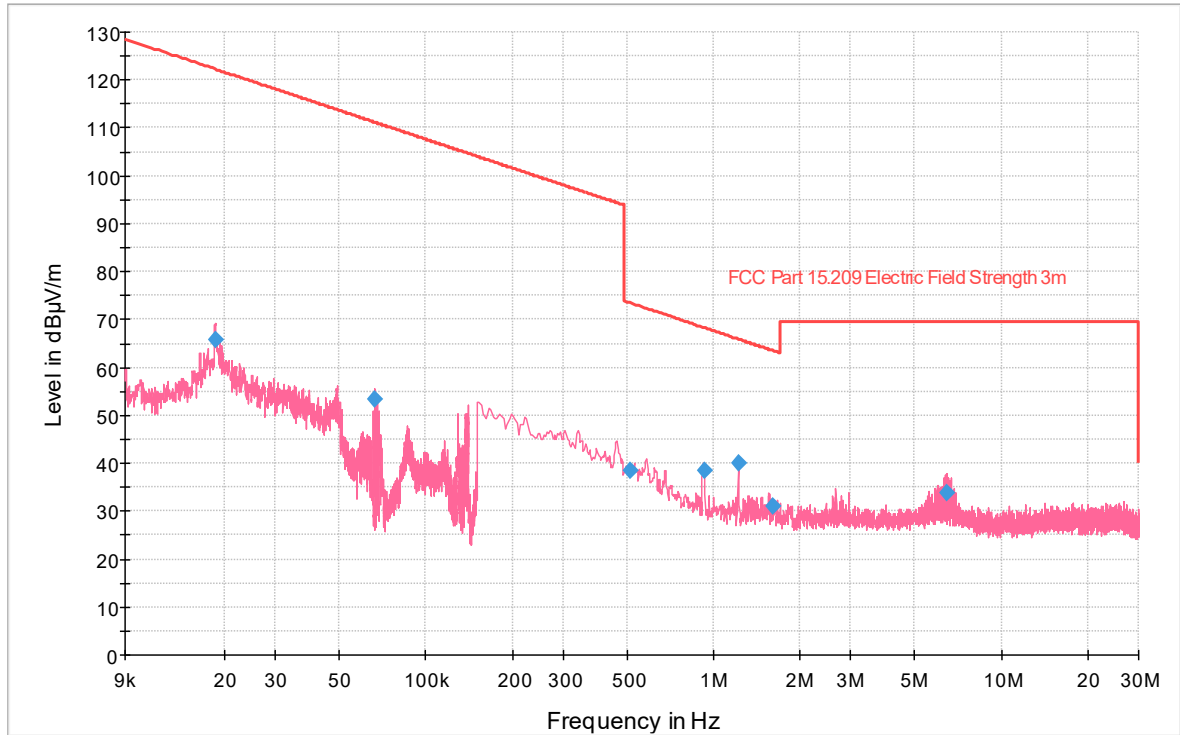
2.5.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbμV) @ 30 MHz		24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3
	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

Full Spectrum



- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15.209 Electric Field Strength 3m [.\EMI Radiated]
- ◆ Final_Result QPK [Final_Result.Result:4]

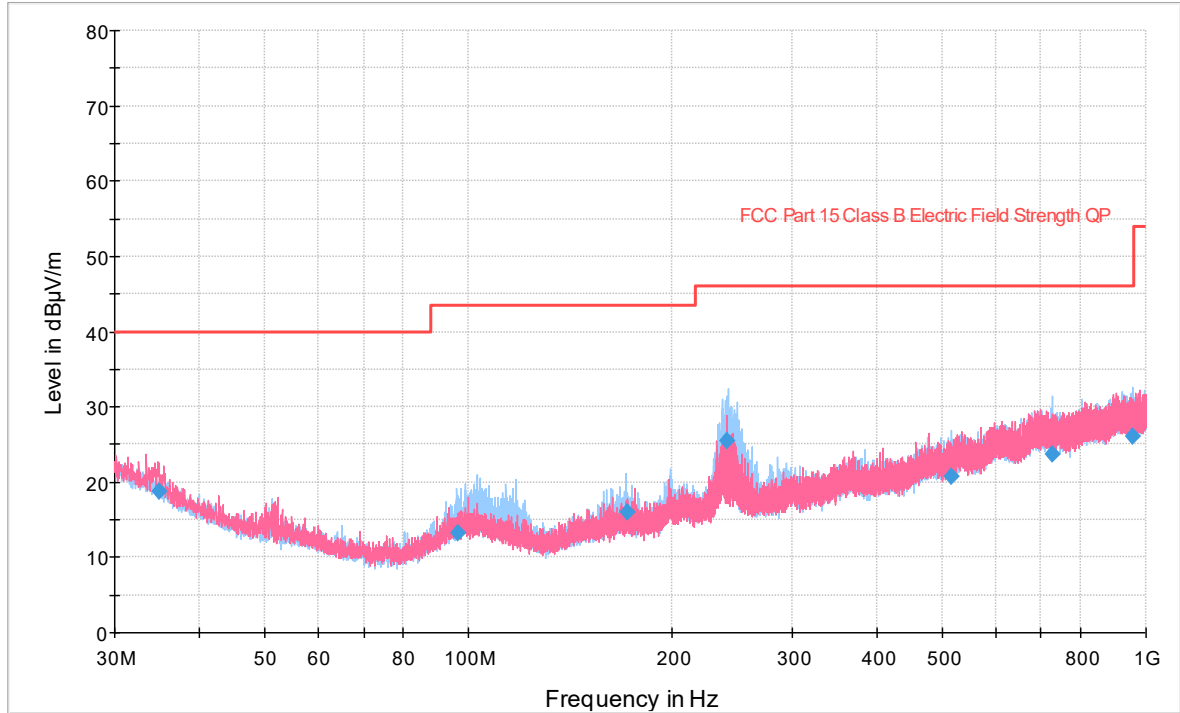
Quasi-Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
0.018570	65.74	1000.0	0.200	100.0	H	239.0	21	56.48	122.22
0.066502	53.40	1000.0	0.200	100.0	H	168.0	19	57.75	111.14
0.515310	38.37	1000.0	9.000	100.0	H	172.0	19	34.99	73.36
0.926480	38.54	1000.0	9.000	100.0	H	103.0	19	29.72	68.26
1.223502	39.87	1000.0	9.000	100.0	H	114.0	19	25.97	65.85
1.613846	31.02	1000.0	9.000	100.0	H	160.0	19	32.42	63.44
6.439019	33.94	1000.0	9.000	100.0	H	253.0	19	35.56	69.50



2.5.10 Below 1GHz Radiated Emission Test

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15 Class B Electric Field Strength QP [..\EMI Radiated\]
- ◆ Final_Result QPK [Final_Result.Result:4]

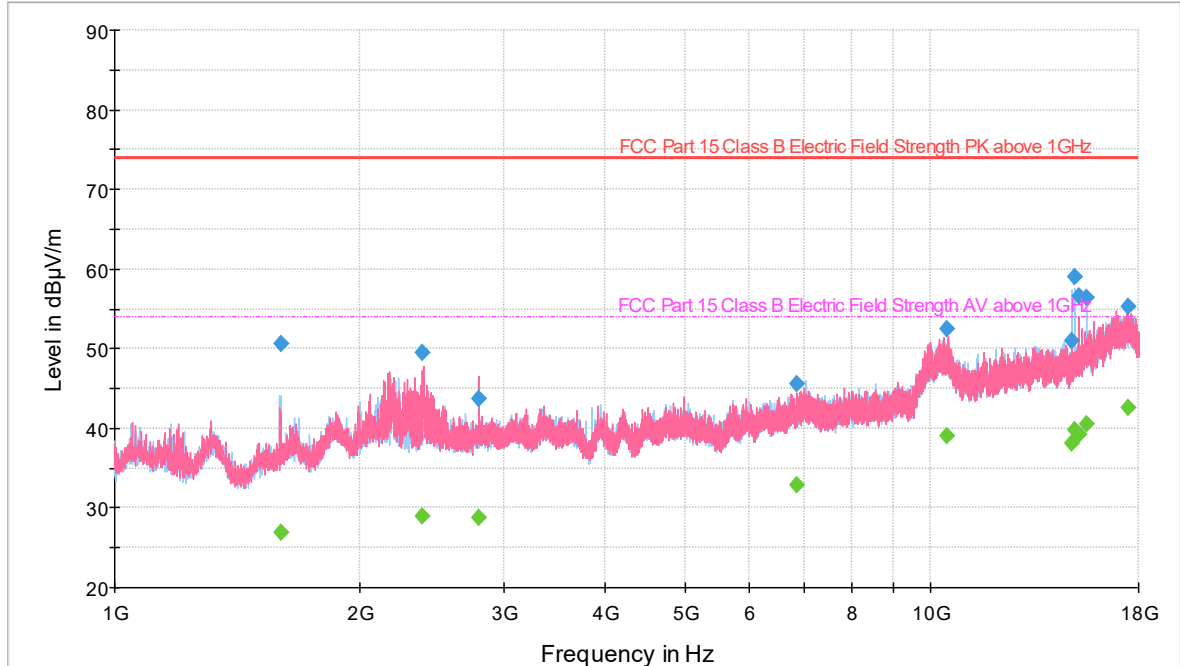
Quasi-Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
34.867333	18.72	40.00	21.28	1000.0	120.000	100.0	V	166.0	-11
96.601667	13.17	43.50	30.33	1000.0	120.000	206.0	H	37.0	-16
171.471333	16.02	43.50	27.48	1000.0	120.000	182.0	H	287.0	-14
240.012667	25.41	46.00	20.59	1000.0	120.000	219.0	H	-18.0	-12
515.927333	20.77	46.00	25.23	1000.0	120.000	325.0	H	70.0	-5
727.631667	23.70	46.00	22.30	1000.0	120.000	220.0	H	6.0	-2
955.286333	26.06	46.00	19.94	1000.0	120.000	183.0	H	248.0	1



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

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15 Class B Electric Field Strength PK above 1GHz [.\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [.\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

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)
1598.233333	50.68	73.90	23.22	1000.0	1000.000	139.0	H	219.0	0
2380.533333	49.44	73.90	24.46	1000.0	1000.000	253.0	V	97.0	3
2795.933333	43.68	73.90	30.22	1000.0	1000.000	369.0	V	147.0	4
6862.500000	45.54	73.90	28.36	1000.0	1000.000	175.0	V	74.0	11
10496.433333	52.48	73.90	21.42	1000.0	1000.000	175.0	V	109.0	19
14877.966667	50.91	73.90	22.99	1000.0	1000.000	126.0	H	7.0	18
15038.966667	58.99	73.90	14.91	1000.0	1000.000	175.0	H	24.0	19
15198.933333	56.66	73.90	17.24	1000.0	1000.000	257.0	V	17.0	19
15518.933333	56.34	73.90	17.56	1000.0	1000.000	328.0	H	316.0	19
17503.000000	55.27	73.90	18.63	1000.0	1000.000	330.0	V	236.0	22



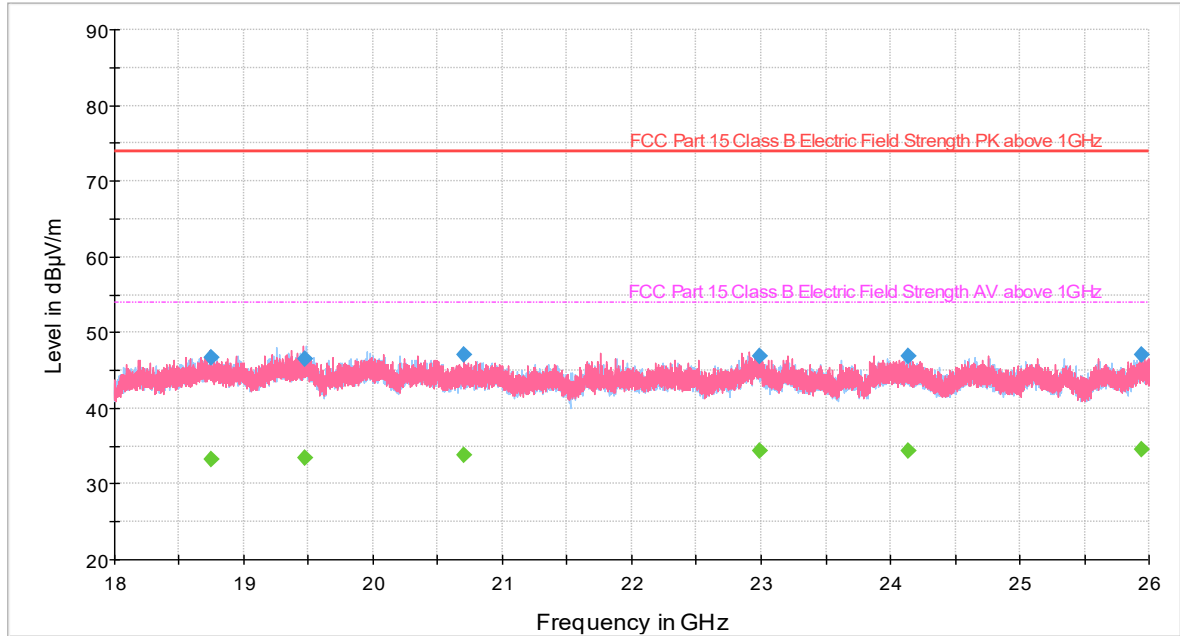
Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1598.233333	26.87	53.90	27.03	1000.0	1000.000	139.0	H	219.0	0
2380.533333	28.97	53.90	24.93	1000.0	1000.000	253.0	V	97.0	3
2795.933333	28.82	53.90	25.08	1000.0	1000.000	369.0	V	147.0	4
6862.500000	32.86	53.90	21.04	1000.0	1000.000	175.0	V	74.0	11
10496.433333	39.01	53.90	14.89	1000.0	1000.000	175.0	V	109.0	19
14877.966667	38.17	53.90	15.73	1000.0	1000.000	126.0	H	7.0	18
15038.966667	39.80	53.90	14.10	1000.0	1000.000	175.0	H	24.0	19
15198.933333	39.32	53.90	14.58	1000.0	1000.000	257.0	V	17.0	19
15518.933333	40.58	53.90	13.32	1000.0	1000.000	328.0	H	316.0	19
17503.000000	42.50	53.90	11.40	1000.0	1000.000	330.0	V	236.0	22



2.5.12 18GHz to 26GHz Radiated Emission Test

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15 Class B Electric Field Strength PK above 1GHz [.\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [.\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

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)
18750.580000	46.76	73.90	27.14	1000.0	1000.000	162.0	V	346.0	0
19467.052500	46.55	73.90	27.35	1000.0	1000.000	154.0	V	213.0	-1
20703.361500	47.11	73.90	26.79	1000.0	1000.000	263.0	H	47.0	0
22993.678000	46.90	73.90	27.00	1000.0	1000.000	301.0	H	67.0	2
24137.513500	46.93	73.90	26.97	1000.0	1000.000	187.0	H	131.0	2
25945.842500	47.06	73.90	26.84	1000.0	1000.000	262.0	V	110.0	2

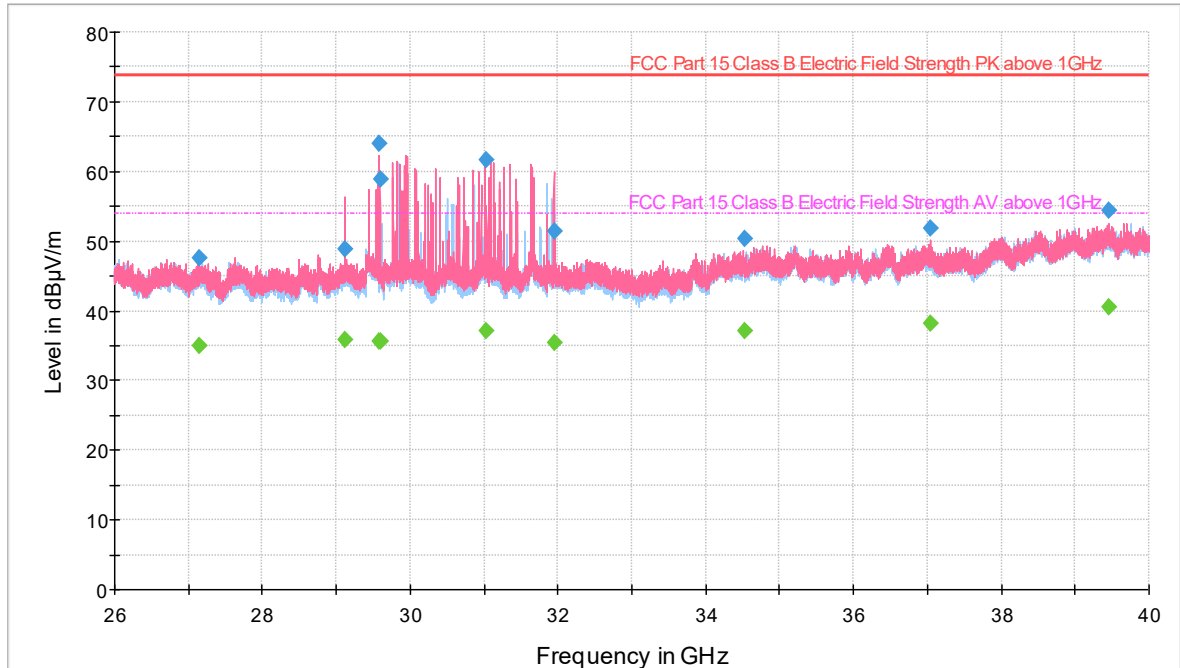
Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18750.580000	33.21	53.90	20.69	1000.0	1000.000	162.0	V	346.0	0
19467.052500	33.42	53.90	20.48	1000.0	1000.000	154.0	V	213.0	-1
20703.361500	33.75	53.90	20.15	1000.0	1000.000	263.0	H	47.0	0
22993.678000	34.45	53.90	19.45	1000.0	1000.000	301.0	H	67.0	2
24137.513500	34.38	53.90	19.52	1000.0	1000.000	187.0	H	131.0	2
25945.842500	34.49	53.90	19.41	1000.0	1000.000	262.0	V	110.0	2



2.5.13 26GHz to 40GHz Radiated Emission Test (12 Transmitters)

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15 Class B Electric Field Strength PK above 1GHz [.\EMI Radiated\]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [.\EMI Radiated\]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

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)
27137.578077	47.57	73.90	26.33	1000.0	1000.000	275.0	V	233.0	3
29122.739231	48.84	73.90	25.06	1000.0	1000.000	243.0	V	74.0	4
29590.338846	63.97	73.90	9.93	1000.0	1000.000	209.0	V	26.0	4
29590.784231	58.84	73.90	15.06	1000.0	1000.000	207.0	V	26.0	4
31020.262307	61.62	73.90	12.28	1000.0	1000.000	325.0	V	320.0	6
31954.308077	51.44	73.90	22.46	1000.0	1000.000	225.0	V	37.0	5
34520.133461	50.37	73.90	23.53	1000.0	1000.000	190.0	V	33.0	7
37038.680000	51.76	73.90	22.14	1000.0	1000.000	325.0	V	214.0	7
39461.146153	54.43	73.90	19.47	1000.0	1000.000	242.0	H	208.0	10



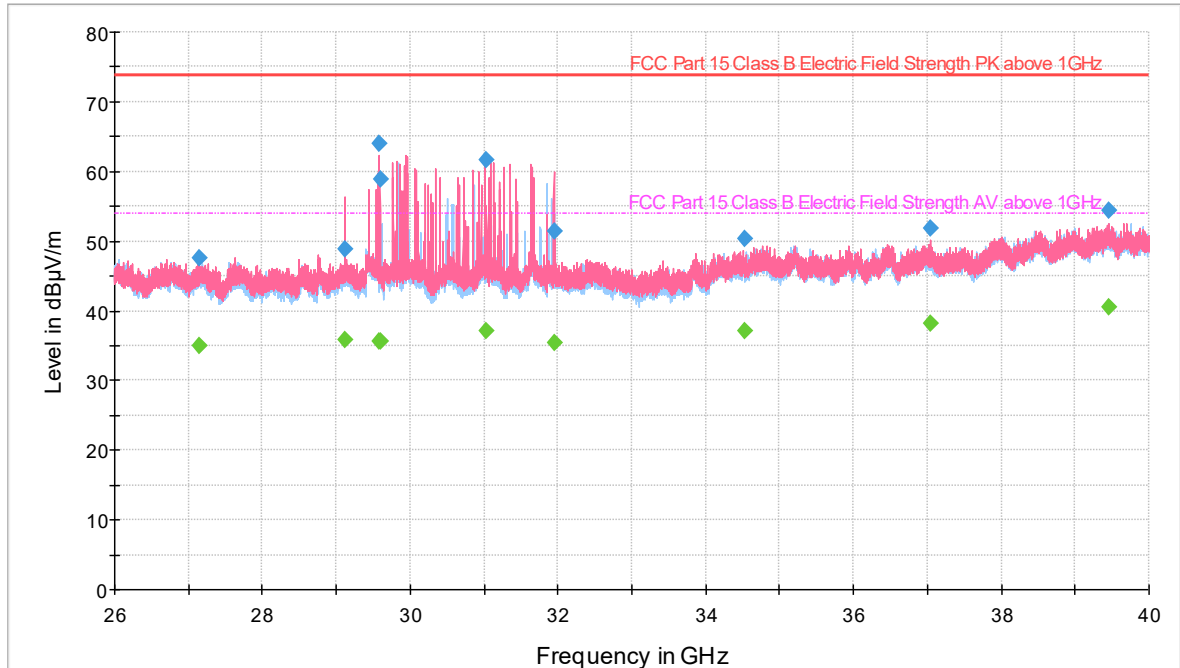
Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27137.578077	34.91	53.90	18.99	1000.0	1000.000	275.0	V	233.0	3
29122.739231	35.75	53.90	18.15	1000.0	1000.000	243.0	V	74.0	4
29590.338846	35.69	53.90	18.21	1000.0	1000.000	209.0	V	26.0	4
29590.784231	35.61	53.90	18.29	1000.0	1000.000	207.0	V	26.0	4
31020.262307	37.03	53.90	16.87	1000.0	1000.000	325.0	V	320.0	6
31954.308077	35.32	53.90	18.58	1000.0	1000.000	225.0	V	37.0	5
34520.133461	37.12	53.90	16.78	1000.0	1000.000	190.0	V	33.0	7
37038.680000	38.11	53.90	15.79	1000.0	1000.000	325.0	V	214.0	7
39461.146153	40.45	53.90	13.45	1000.0	1000.000	242.0	H	208.0	10



2.5.14 26GHz to 40GHz Radiated Emission Test (24 Transmitters)

Full Spectrum



- Preview Result 1H-PK+ [Preview Result 1H.Result:2]
- Preview Result 1V-PK+ [Preview Result 1V.Result:2]
- FCC Part 15 Class B Electric Field Strength PK above 1GHz [.\EMI Radiated]
- - - FCC Part 15 Class B Electric Field Strength AV above 1GHz [.\EMI Radiated]
- ◆ Final_Result PK+ [Final_Result.Result:4]
- ◆ Final_Result AVG [Final_Result.Result:5]

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)
26038.608462	48.12	73.90	25.78	1000.0	1000.000	320.0	H	14.0	3
29432.305385	48.92	73.90	24.98	1000.0	1000.000	194.0	V	60.0	4
29440.761538	49.08	73.90	24.82	1000.0	1000.000	192.0	V	36.0	4
30074.608847	63.03	73.90	10.87	1000.0	1000.000	275.0	V	82.0	4
30803.975385	50.86	73.90	23.04	1000.0	1000.000	176.0	V	105.0	5
31655.325000	65.24	73.90	8.66	1000.0	1000.000	256.0	V	318.0	6
34649.402693	49.96	73.90	23.94	1000.0	1000.000	175.0	V	191.0	7
36801.016922	49.82	73.90	24.08	1000.0	1000.000	227.0	V	315.0	7
39512.818462	52.71	73.90	21.19	1000.0	1000.000	179.0	V	288.0	10



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)
26038.608462	35.01	53.90	18.89	1000.0	1000.000	320.0	H	14.0	3
29432.305385	36.22	53.90	17.68	1000.0	1000.000	194.0	V	60.0	4
29440.761538	36.34	53.90	17.56	1000.0	1000.000	192.0	V	36.0	4
30074.608847	35.82	53.90	18.08	1000.0	1000.000	275.0	V	82.0	4
30803.975385	36.90	53.90	17.00	1000.0	1000.000	176.0	V	105.0	5
31655.325000	36.69	53.90	17.21	1000.0	1000.000	256.0	V	318.0	6
34649.402693	37.11	53.90	16.79	1000.0	1000.000	175.0	V	191.0	7
36801.016922	36.83	53.90	17.07	1000.0	1000.000	227.0	V	315.0	7
39512.818462	40.05	53.90	13.85	1000.0	1000.000	179.0	V	288.0	10



2.5.15 40GHz to 200GHz Maximized Plots



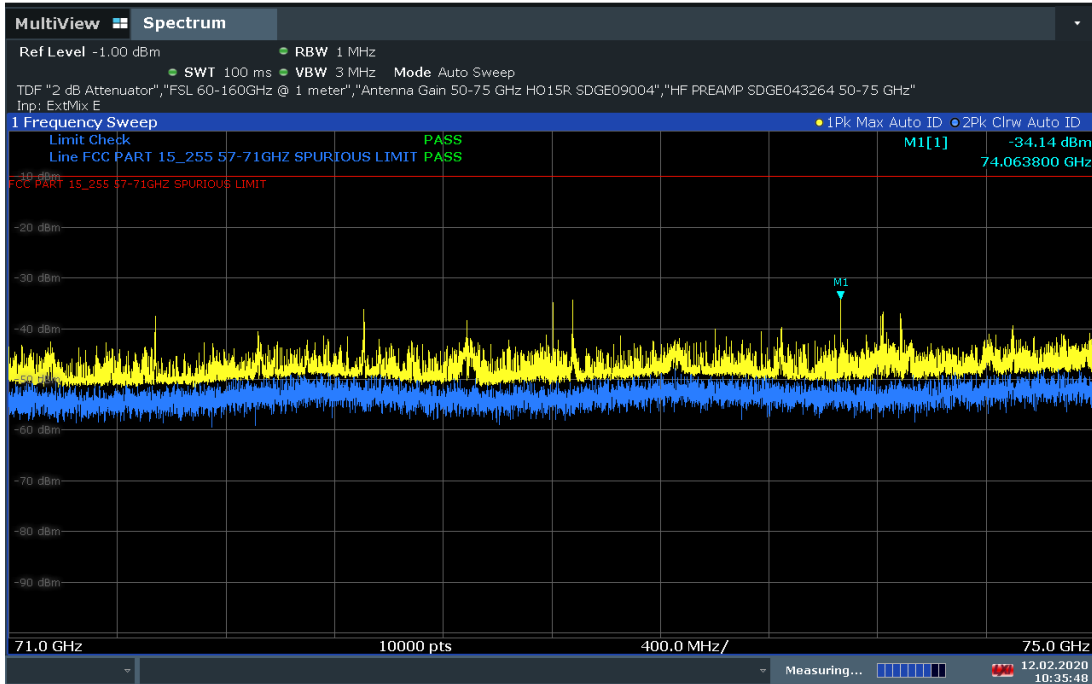
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40GHz to 57GHz Plot (12 Transmitters)



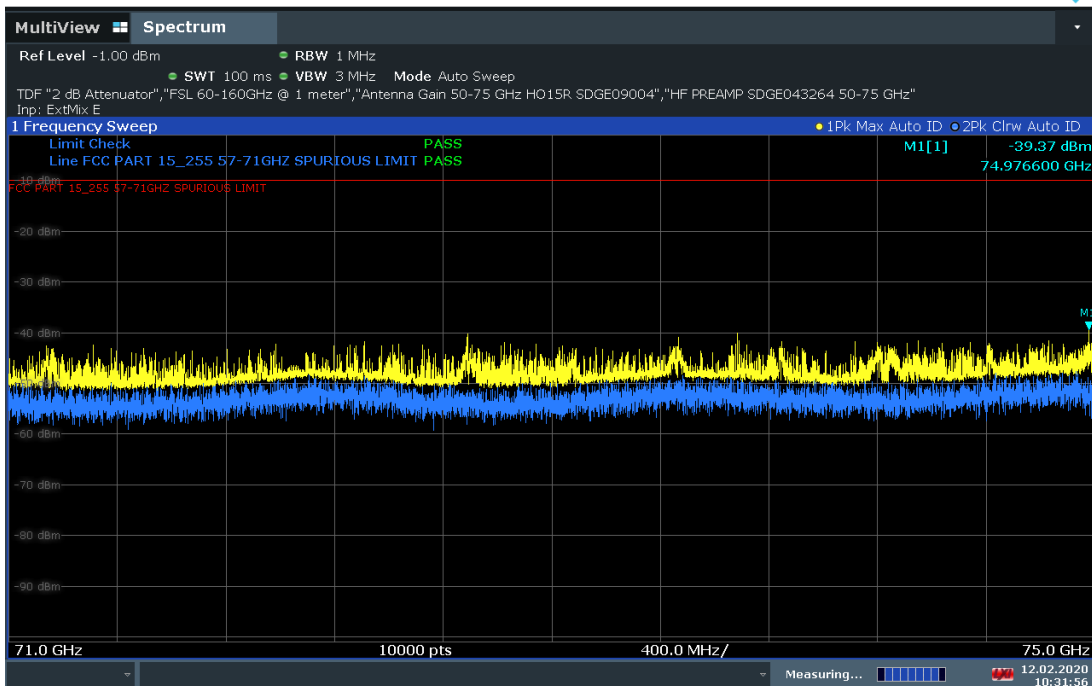
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40GHz to 57GHz Plot (24 Transmitters)



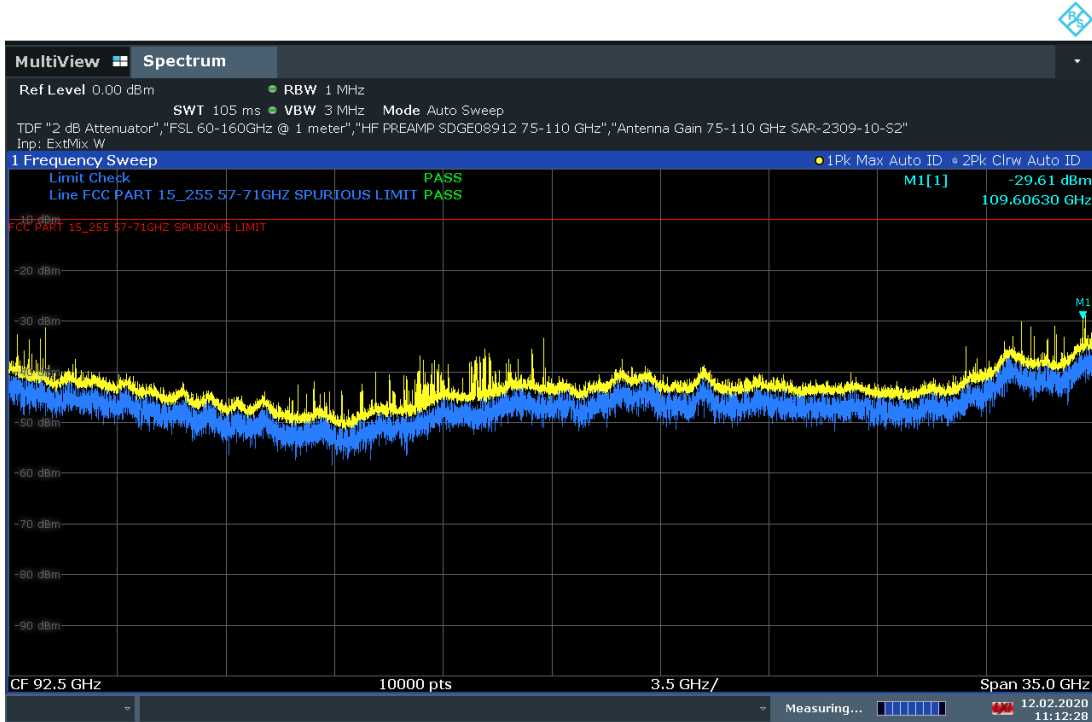
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71GHz to 75GHz Plot (12 Transmitters)



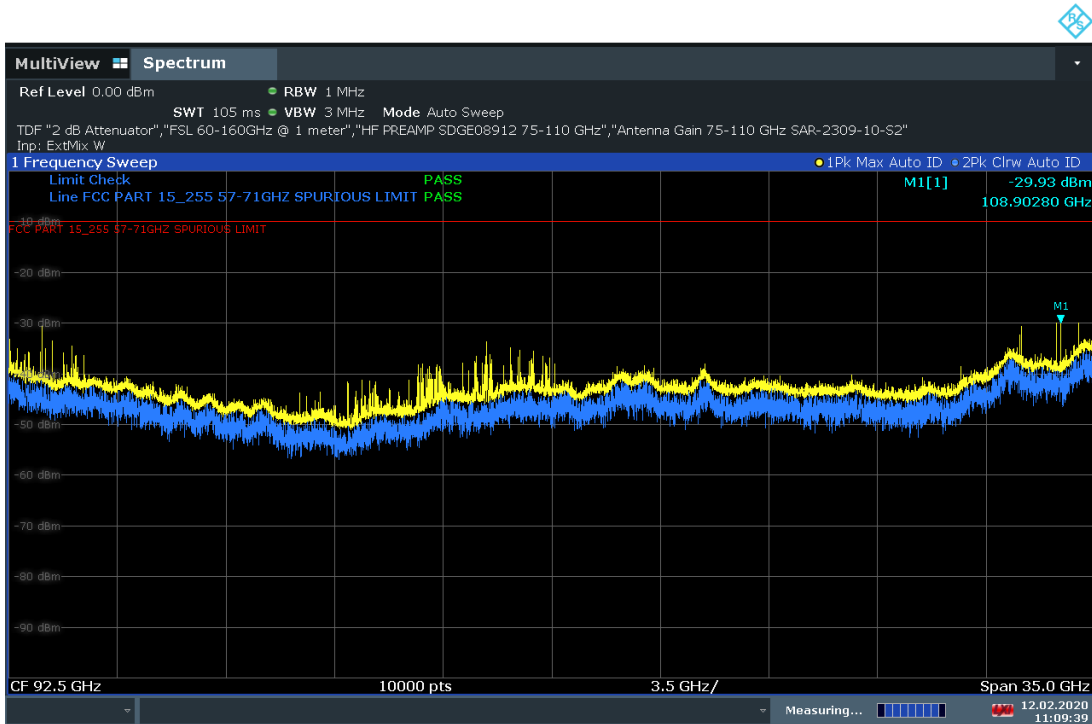
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71GHz to 75GHz Plot (24 Transmitters)



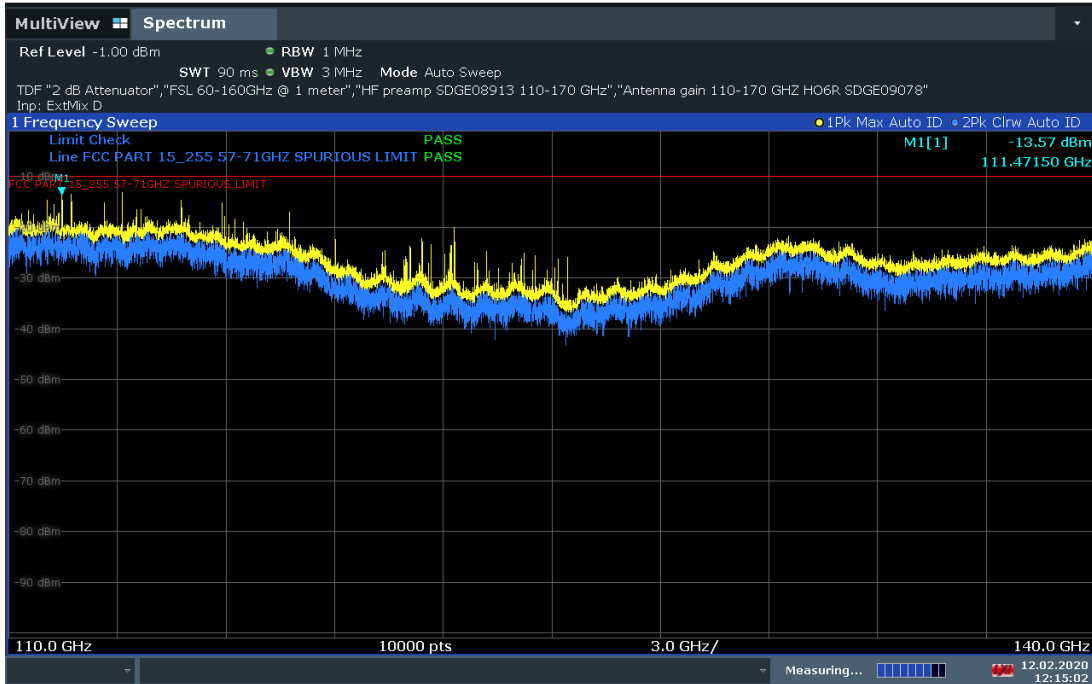
11:12:29 12.02.2020

75GHz to 110GHz Plot (12 Transmitters)



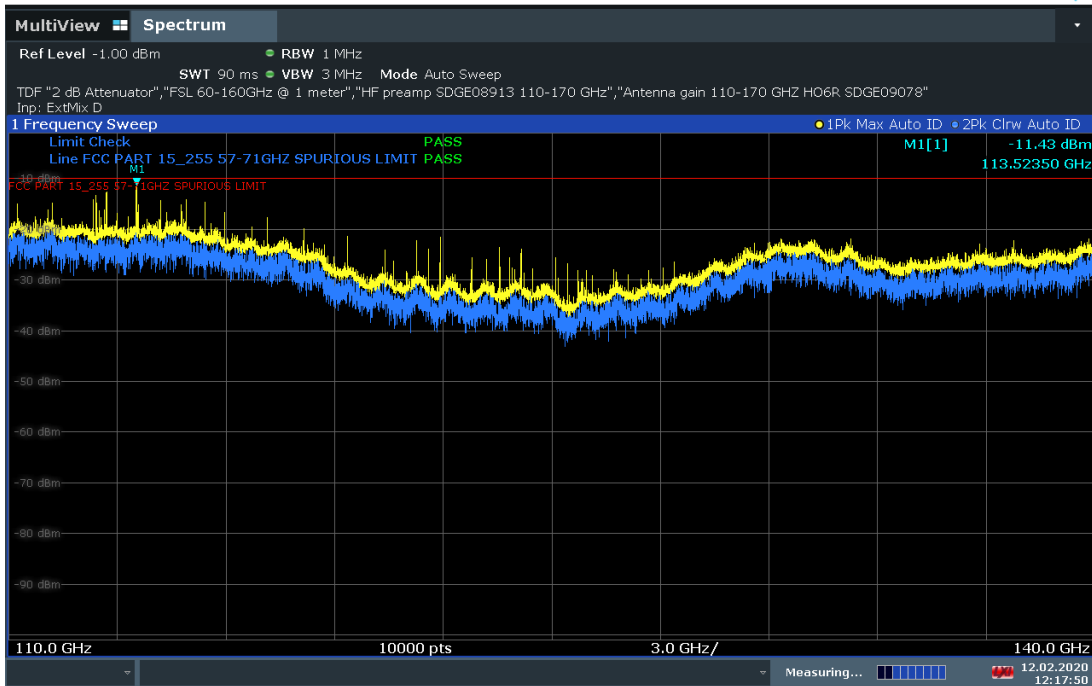
11:09:39 12.02.2020

75GHz to 110GHz Plot (24 Transmitters)



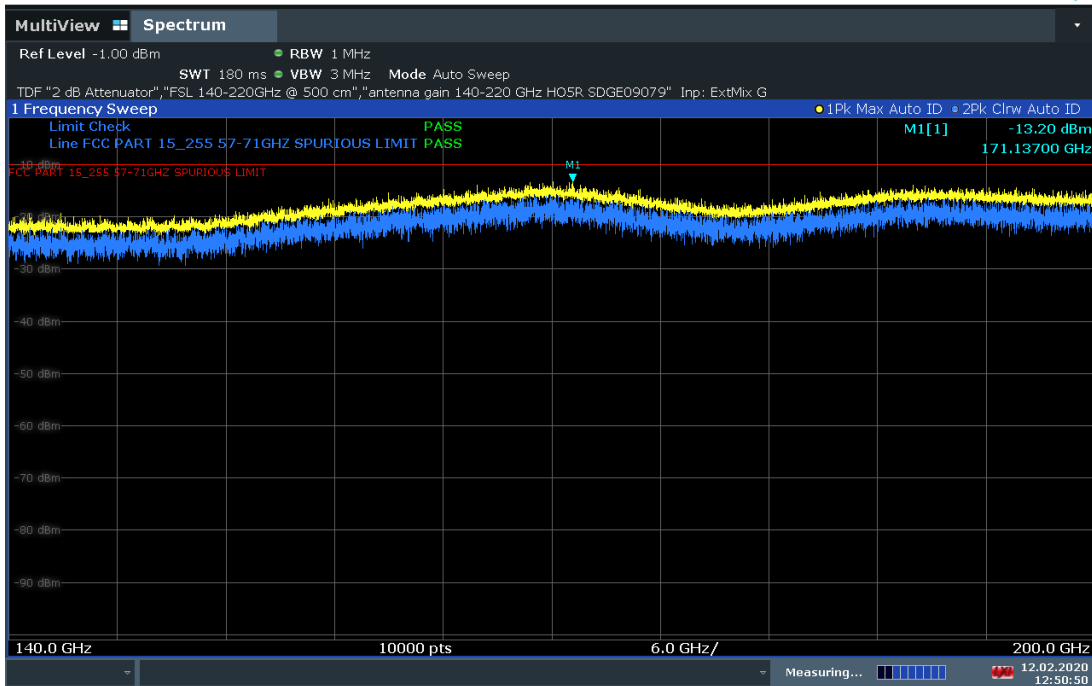
12:15:03 12.02.2020

110GHz to 140GHz Plot (12 Transmitters)



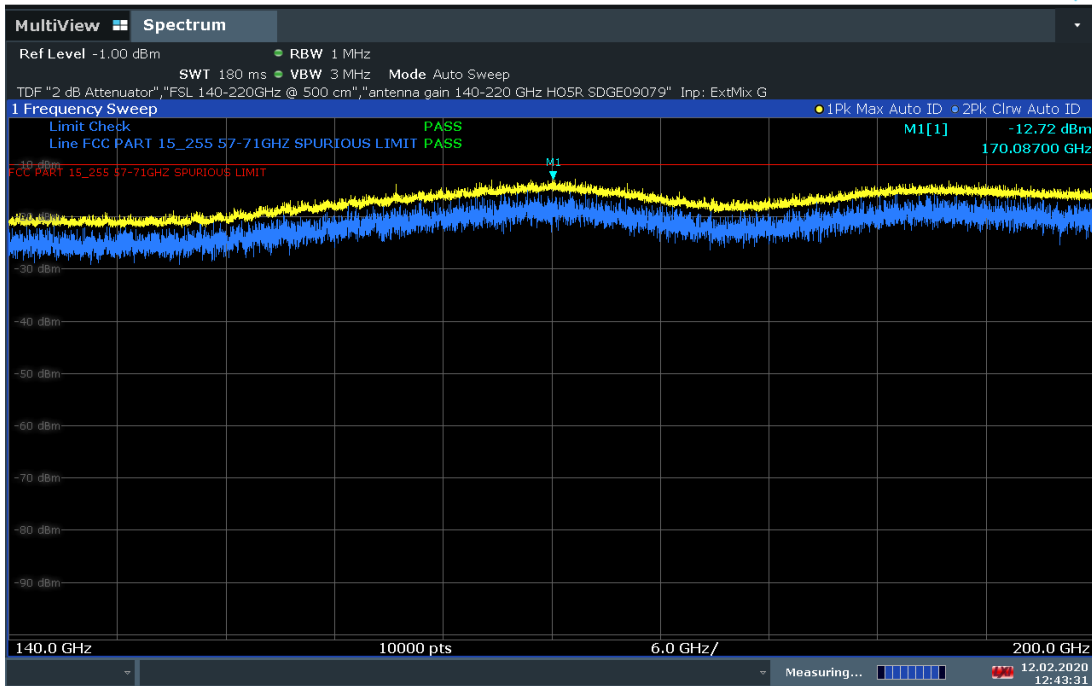
12:17:51 12.02.2020

110GHz to 140GHz Plot (24 Transmitters)



12:50:50 12.02.2020

140GHz to 200GHz Plot (12 Transmitters)



12:43:31 12.02.2020

140GHz to 200GHz Plot (24 Transmitters)



SECTION 3

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						
1033	Bilog Antenna	3142C	00044556	EMCO	11/06/18	11/06/20
7631	Double-ridged waveguide horn	3117	00205418	ETS-Lindgren	08/20/18	08/20/20
8628	Pre-amplifier	QLI-01182835-JO	8986002	Quinstar	03/07/19	03/07/20
9004	Horn antenna (50-75 GHz)	HO15R	104	Custom Microwaves	10/10/19	10/10/21
7628	Horn antenna (75-110 GHz)	SAR-2309-10-S2	13481-01	Sage Millimeter, Inc.	Verified by 7611 and corresponding antenna/Active multiplier combination	
9003	Horn antenna (40-60 GHz)	HO19R	103	Custom Microwaves		
9081	Horn antenna (110-170 GHz)	HO6R	N/A	Custom Microwaves		
9082	Horn antenna (140-220 GHz)	HO5R	N/A	Custom Microwaves		
9080	Horn antenna (220-325 GHz)	HO3R	N/A	Custom Microwaves		
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 7611 and corresponding antenna/mixer combination	
7634	Harmonics mixer (110-170 GHz)	HM-170	0062	Radiometer Physics		
7635	Harmonics mixer (170-220 GHz)	HM-220	020022	Radiometer Physics		
7632	Harmonics mixer (220-325 GHz)	HM-325	020075	Radiometer Physics		
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	Verified by 1003 and 7620	
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	Verified by 1003 and 7620	
40815	Pre-amplifier (18-40 GHz)	19D18	15G27	Spacek Labs	Verified by 1003 and 7620	
44137	V Band waveguide Detector	PE80T3002	V0011860417 20158046	Pasternack	Verified by 1003 and 7611	



ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
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.		
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.		
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
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	09/12/19	09/12/20
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	06/20/19	06/20/20
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	10/11/19	10/11/20
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	10/18/19	10/18/20
1016	Pre-Amplifier	PAM-0202	187	PAM	03/08/19	03/08/20
Miscellaneous						
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	11312	04/16/19	04/16/20
-	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	



3.2 Measurement Uncertainty

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

3.2.1 Radiated 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	0.45 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-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	2.95 dB
				Expanded uncertainty	Normal, k=2	5.90 dB



3.2.2 Radiated Emission Measurements (Above 1GHz)

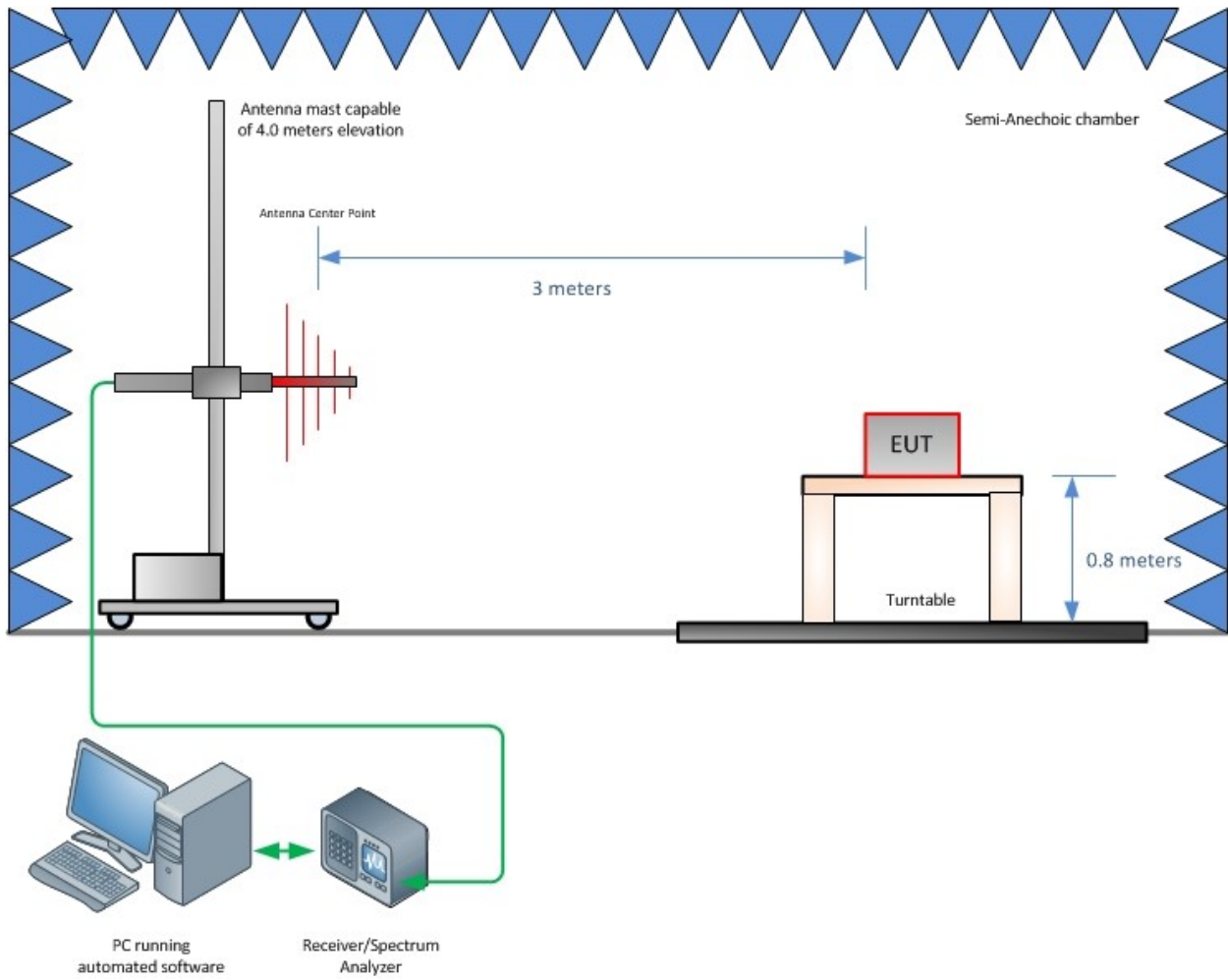
	Input Quantity (Contribution) X_i	Value	Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10 dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20 dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.75 dB	Normal, k=2	2.000	0.38	0.14
4	Receiver sinewave accuracy	0.45 dB	Normal, 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-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	3.25 dB	Triangular	2.449	1.33	1.76
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		2.85 dB	
Expanded uncertainty			Normal, k=2		5.70 dB	



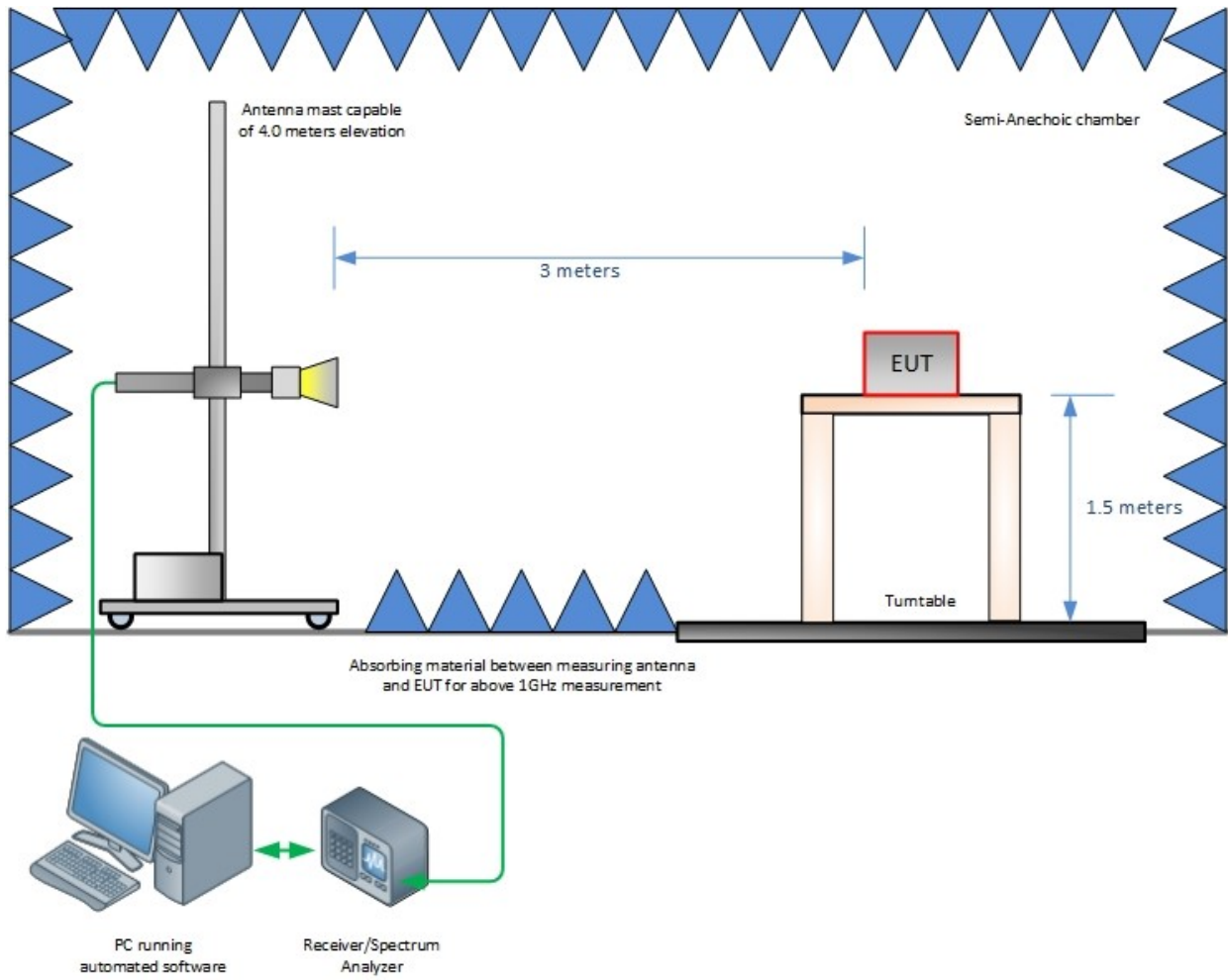
SECTION 4

4 Diagram of Test Setup

4.1 Test Setup Diagram

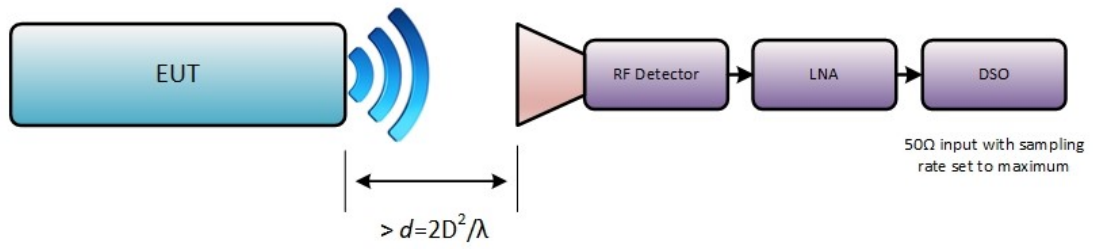


Radiated Emission Test Setup (Below 1GHz)

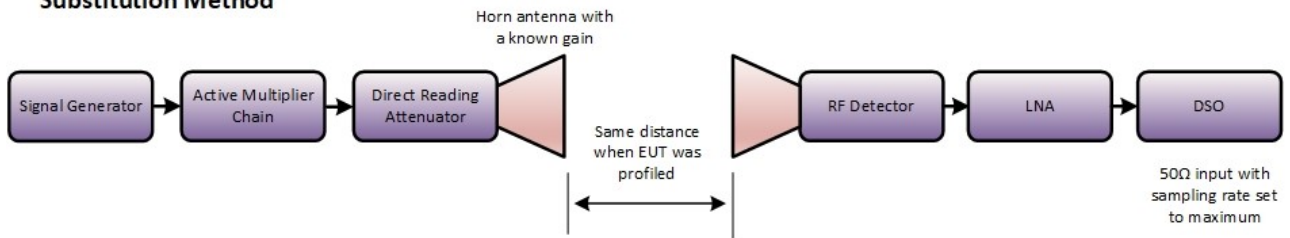


Radiated Emission Test Setup (Above 1GHz)

EUT Power Profile



Substitution Method



Power Measurement Block Diagram



SECTION 5

5 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



5.1 Accreditation, Disclaimers and Copyright

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