Test Report

Test Report No.: CQC-IVTS-2023-00311

Product Name	Millimeter Wave Corner Radar Sensor
Model Number	SRD3523/18
Applicant	Huizhou Desay SV Automotive Co., Ltd.
Approval Types	FCC ID: 2AEQT-DSRDT001

CQC Internet of Vehicles Technical Service (Shenzhen) Co., Ltd.

National Quality Inspection and Testing Center for Internet of Vehicles Products

TEST REPORT DECLARATION

Equipment under Test	:	**Millimeter Wave Corner Radar Sensor**
Model /Type	:	SRD3523/18
Listed Models	:	N/A
Applicant	:	**Huizhou Desay SV Automotive Co., Ltd.**
Address	:	NO.103, Hechang 5th Road West, Zhongkai National Hi-tech Industrial Development Zone, Huizhou, Guangdong, P.R. China
Manufacturer	:	**Huizhou Desay SV Automotive Co., Ltd.**
Address	:	NO.103, Hechang 5th Road West, Zhongkai National Hi-tech Industrial Development Zone, Huizhou, Guangdong, P.R. China

The EUT described above is tested by CQC Internet of Vehicles Technical Service (Shenzhen) Co., Ltd. to determine the maximum emissions from the EUT. CQC Internet of Vehicles Technical Service (Shenzhen) Co., Ltd. is assumed full responsibility for the accuracy of the test results.

Project Engineer:	Yankun Wang (Yankun Wang 王炎坤)	Date: 2023-8-8
Checked by:	Haohao Li (Haohao Li 李昊昊)	Date: 2023-8-8
Approved by:	Wenliang Li (Wenliang Li 李文亮)	Date: 2023-8-8

Contents

1. TEST STANDARDS

The tests were performed according to following standards: The equipment under test (EUT) has been tested at CQC-IVTS's (own or subcontracted) laboratories according to the leading reference documents giving table below:

No	Identify	Document Title	Version/Date
1	FCC Part 95M	The 76 – 81 GHz Band Radar Service	07/13/2023
2	ANSI C63.4	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz	2014
3	ANSI C63.10	American National Standard for Testing Unlicensed Wireless Devices	2013
4	ANSI C63.26	American National Standard for Compliance Testing of Transmitters Used in Lincensed Radio Services	2015
5	KDB 653005 D01, V01, R02	Equipment Authorization Guidance for 71 – 81 GHz Radar Devices	

2 . SUMMARY

2.1. General Remarks

Date of receipt of test sample	:	June 30, 2023
Testing commenced on	:	July 4, 2023
Testing concluded on	:	August 4, 2023

2.2. Product Description*

Product Name:	Millimeter Wave Corner Radar Sensor
Trade Mark	DESAY SV
Model/Type reference:	SRD3523/18
FCC ID:	2AEQT-DSRDT001
Hardware Version:	0.0.1
Software Version:	00.00.03
Frequency Range:	76.00 – 78.00 GHz
Technology:	Radar
Modulation Type:	FMCW
Channel Bandwidth:	< 2 GHz
Channel Spacing:	N/A
Receiver Category:	N/A
Receiver Bandwidth:	N/A
Antenna:	Microstrip Antenna
Antenna Gain:	15.00 dBi
Specified Rated Output Power E.R.I.P.):	≤ 10.00 dBm
Power Supply:	DC 12V From Vehicle Battery
Temperature Range:	-40℃ to +85℃
Difference Declaration	n/a

*: declared by the applicant. CQC-IVTS not responsible for accuary.

2.3. EUT Operation Mode*

EUT operating mode no	Description of operating modes	Additional information
op. 1	Continuously transmitting and receiving mode	Carrier modulation (normal mode). 76 – 77 GHz, a continuous wave with 100% duty cycle

*: declared by the applicant

2.4. Modifications

No modifications were implemented to meet testing criteria

2.5. Test Item (Equipment Under Test) Description*

Short designation	EUT Name	EUT Description	Serial number	Hardware status	Software status
EUT A	SRD3523/18	Millimeter Wave Corner Radar Sensor	P06001352318	0.0.1	00.00.03

*: declared by the applicant.

2.6. Auxiliary Equipment (AE) Description*

AE short designation	EUT Name (if available)	EUT Description	Serial number (if available)	Software (if used)
AE 1	**-/-**	DC Power Source	-/-	-/-
AE 2	DC Power Cable	Length: 5m	-/-	-/-
			-/-	-/-

*: declared by the applicant.

2.7. Test Item Set-ups Description

set. 1	EUT A + AE 1 + AE2	EUT operating mode 1

2.8. Test Conditions*

Temperature, [°C]		Voltage, [V]	
T_{nom}	+25.0	V_{nom}	DC 12.0 V
T_{min}	-40.0	V_{min}	DC 10.8 V
T_{max}	+85.0	V_{max}	DC 13.8 V

*: declared by the applicant

2.9. Additional Information

Test items differences	None
Additional application considerations to test a component or sub-assembly	Laptop with test software

2.10. Test Location

Location 1

Company:	CQC Internet of Vehicles Technical Service (Shenzhen) Co., Ltd.
Address:	Building G5, TCL International E City, Xili Street, Nanshan District, Shenzhen, China
Post code:	518112
Contact Person:	Wenliang Li
Telephone:	+86-755-8618 9654
e-Mail:	liwenliang@cqc.com.cn

2.11. Abnormalities from Standard Conditions

None

2.12. Possible verdicts of the results

Test sample meets the requirements	P (PASS) ± the measured value is below the acceptance limit, AL = TL
Test sample does not meet the requirements	F (FAIL) ± the measured value is above the acceptance limit, AL = TL
Test case does not apply to the test sample	N/A (Not applicable)
Test case not performed	N/P (Not performed)

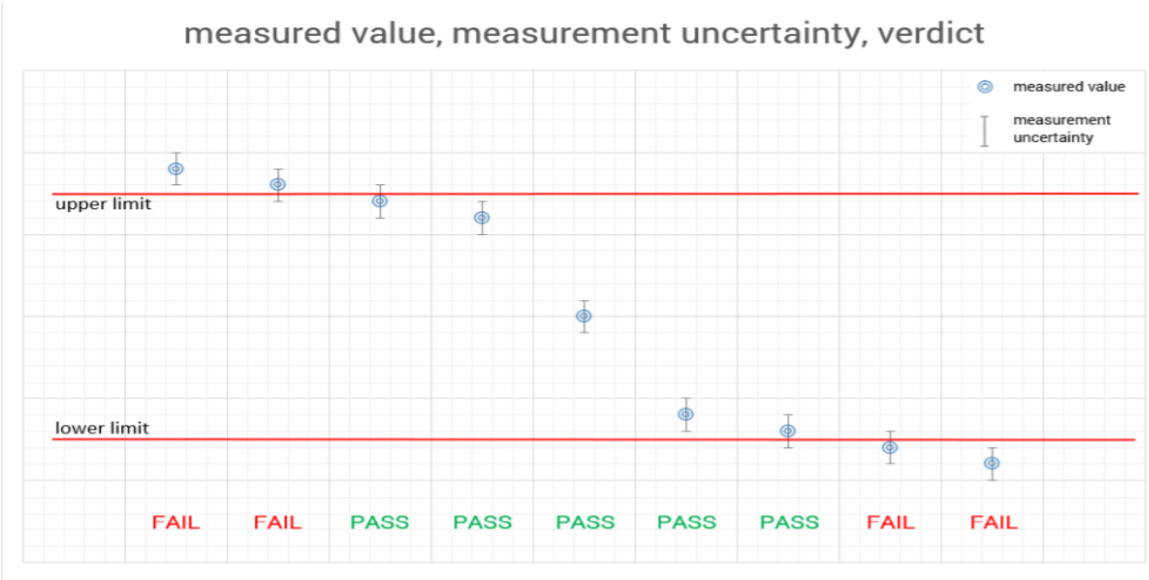
2.13. Formula for Determination of Correction Values (E_C)

$E_C = E_R + AF + C_L + D_F - G_A$ (1)
$M = L_T - E_C$ (2)

E_C = Electrical field ± corrected value
E_R = Receiver reading
M = Margin
L_T = Limit
AF = Antenna factor
C_L = Cable loss
D_F = Distance correction factor (if used)
G_A = Gain of pre-amplifier (if used)
All units are dB-units, positive margin means value is below limit.

2.14. Reporting Statements of Conformity – Decision Rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed. The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



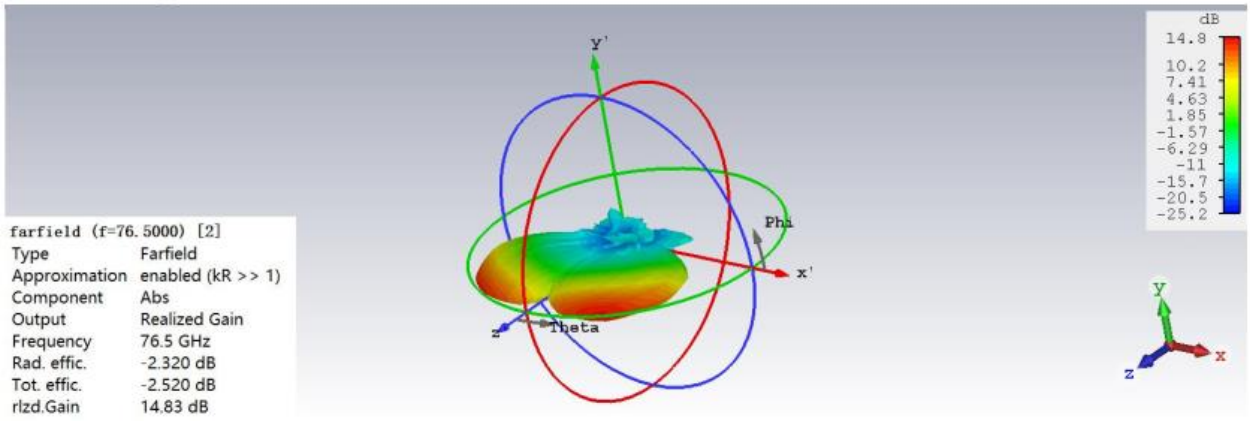
2.15. Radiated Emission Measurement Distance

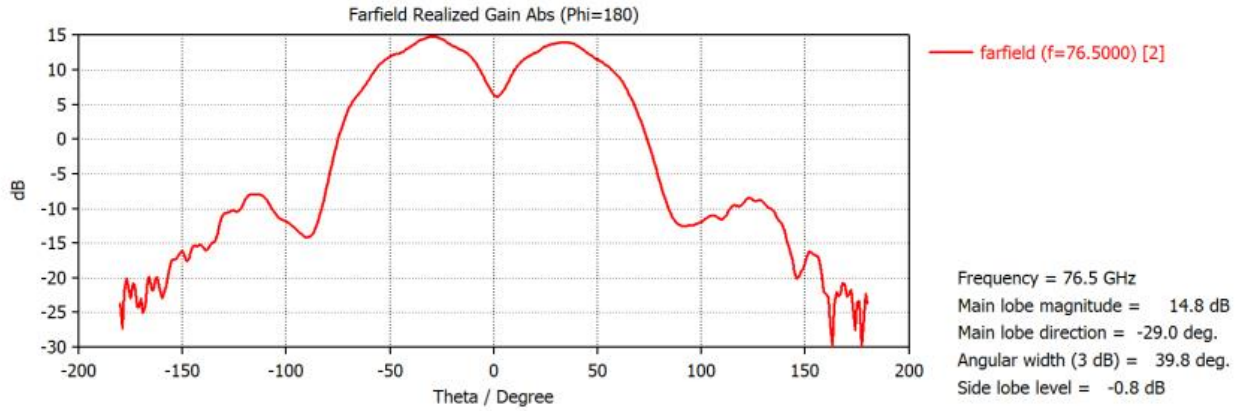
The measurement antenna is in the far field of the EUT per formula $2D^2/\lambda$, where D is the larger between the dimension of the measurement antenna and the transmitting antenna of the EUT. In this case, “D” is the largest dimension of the measurement antenna. The EUT is manipulated through all orthogonal planes representative of its typical use and for both polarities of the measurement antenna in order to achieve the highest signal level. The worst-case position found was used for all radiated testing.

Frequency Range [GHz]	Wavelength [centimetres]	Far Field Distance [meters]	Measurement Distance [meters]
18 – 40	0.750	0.65	1.00
40 – 60	0.522	0.97	1.00
60 – 90	0.322	0.69	1.00
90 – 140	0.210	0.52	1.00
140 – 220	0.148	0.37	1.00
220 – 325	0.101	0.24	1.00

2.16. Antenna Characteristics

Following information is derived from documents “Antenna Specification” provided by applicant.





3. TEST ENVIRONMENT

3.1. Address of the test laboratory

CQC Internet of Vehicles Technical Service (Shenzhen) Co., Ltd.
Building G5, TCL International E City, Xili Street, Nanshan District, Shenzhen, China
CQC-IVTS A2LA Certification Number: 6645.01;

3.2. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature:	25°C
Lative Humidity	55 %
Air Pressure	989 hPa

3.3. Test Description

Test Specification Clause	Test Case	Temperature Condition	Power Supply	PASS	FAIL	NA	NP	Results
§ 2.1046 § 95.3367 (a) (b)	RF Output Power	Nominal	Nominal	☒	☐	☐	☐	
§ 2.1047*	Modulation Characteristics	Nominal	Nominal	☒	☐	☐	☐	
§2.1049 § 95.3379 (b)	Occupied bandwidth (99%)	Nominal	Nominal	☒	☐	☐	☐	
§2.1051**	Spurious Emissions at Antenna Terminals	Nominal	Nominal	☐	☐	☒	☐	
§2.1053 § 95.3379 (a) (1) § 95.3379 (a) (2) § 95.3379 (a) (3)	Field Strength of Spurious Radiation	Nominal	Nominal	☒	☐	☐	☐	
§15.207	AC Power-Line Conducted Emissions Limits	Nominal	Nominal	☐	☐	☒	☐	
§2.1055 § 95.3379 (b)	Frequency Stability	Nominal Extreme	Nominal Extreme	☒	☐	☐	☐	

Note 1: NA means “not applicable”; NP means Not Performed;
Note 2: The measurement uncertainty is not included in the test result.
Note 3: FCC’s Millimeter Wave Test Procedures: I. A radiated method of measurements in order to demonstrate compliance with the various regulatory requirements has been choose in consideration of test equipment availability and the limitations of many external harmonic mixers and lower-power amplifier. A conducted method of measurement could be employed if EUT and mixer waveguides both are accessible and of the same type (WG number) and if waveguide sections and transitions cab be found. Another potential problem is that the peak power output may exceed the +20 dBm input power limit of many commercially available mixers. For these reasons a radiated method is preferred.

3.4. Statement of The Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01” Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1” and TR-100028-02 “Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2 “ and is documented in the CQC Internet of Vehicles Technical Service (Shenzhen) Co., Ltd..quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested

may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for CQC Internet of Vehicles Technical Service (Shenzhen) Co., Ltd.:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	4.90 dB	(1)
Radiated Emission	1~6GHz	4.20 dB	(1)
Radiated Emission	6~18GHz	4.50 dB	(1)
Radiated Emission	18-40GHz	5.42 dB	(1)
Radiated Emission	Above 40 GHz	5.50 dB	(1)
Conducted Disturbance	0.15~30MHz	3.30 dB	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

3.5. Equipments Used during the Test

Radiated Emission						
Item	Test Equipment	Manufacturer	Model No.	Equipment No.	Last Cal.	Cal.Due
1	EMI Test Receiver	R&S	ESW26	103003	2022/08/25	2023/08/24
2	Spectrum Analyzer	R&S	FSW43	10182	2022/08/25	2023/08/24
3	Ultra-Broadband Antenna	Schwarzbeck	VULB9168	1291	2021/09/05	2024/09/04
4	Horn Antenna	ETS-Lindgren	3117	102732	2021/09/05	2024/09/04
5	Amplifier	R&S	SCU01F	100369	2022/08/25	2023/08/24
6	Amplifier	R&S	SCU18F	100868	2022/08/25	2023/08/24
7	Amplifier	R&S	SCU26F	100781	2022/08/25	2023/08/24
8	Amplifier	R&S	SCU40F	102713	2022/08/25	2023/08/24
8	Horn Antenna	A-INFO	LB-180500H-2.4F	2110081000089	2021/09/05	2024/09/04
9	EMI Test Software	R&S	EMC32	N/A	N/A	N/A
10	TC-RX60	Tonscond	Receive Unit	1551	N/A	N/A
11	TC-RX75	Tonscond	Receive Unit	1545	N/A	N/A
12	TC-RX90	Tonscond	Receive Unit	1552	N/A	N/A
13	TC-RX140	Tonscond	Receive Unit	1553	N/A	N/A
14	TC-RX220	Tonscond	Receive Unit	1554	N/A	N/A
15	TC-RX40	Tonscond	Receive Unit	1543	N/A	N/A
16	Antenna Mast	Maturo	BAM4.0	N/A	N/A	N/A
17	Turntable	Maturo	TT3.5	N/A	N/A	N/A
18	Loop Antenna	R&S	HFH2-Z2E	101066	2021/09/05	2024/09/04
19	Thermal chamber	ESPEC	GFS-800-15	0050-001161	2022/07/26	2023/07/25

4. TEST CONDITIONS AND RESULTS

4.1. RF Output Power [§2.1046 & 95.3367]

4.1.1. LIMITS

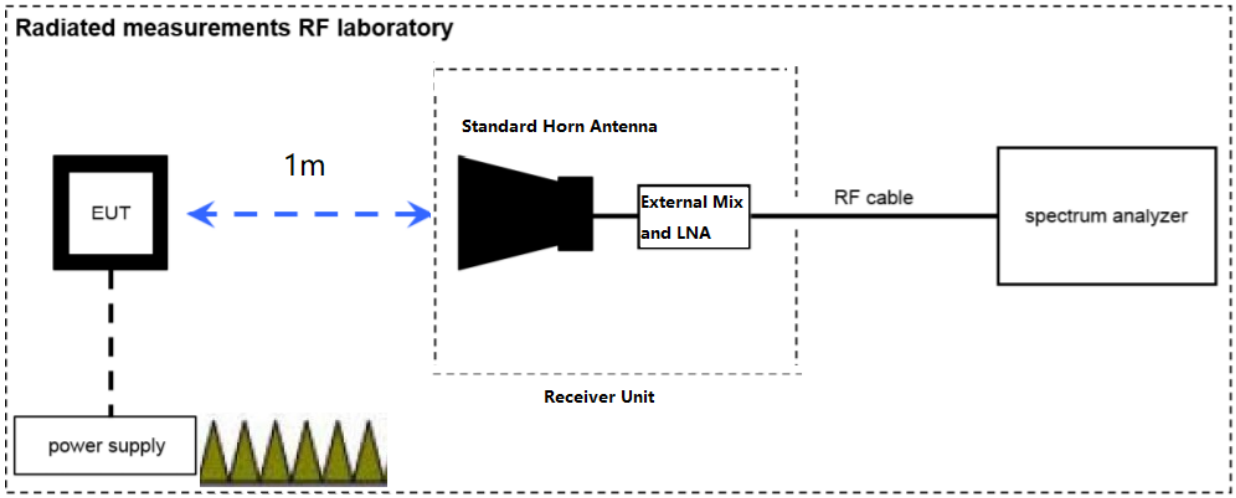
According to § 95.3367: 71 – 81 GHz Band Radar Service Radiated Power Limits
The fundamental radiated emission limits within the 76 – 81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:

(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.

According to § 2.1046: Measurements required: RF Power Output

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033 (c) (8). The electrical characteristics of the radio frequency load attached to the output terminals.

4.1.2. TEST CONFIGURATION



4.1.3. TEST PROCEDURE

Mean Power
Method with spectrum analyser with external mixer

A spectrum analyser with the following settings is used as measuring receiver in the test setup:

- Start frequency: lower than the lower edge of the operating frequency range.
- Stop frequency: higher than the upper edge of the operating frequency range.
- Resolution bandwidth: 1 MHz
- Video bandwidfh: 3 MHz
- Detector mode: RMS
- Display mode: clear write
- Averaging time: averaging time x number of sweep points

Channel Power Function needs to be used to calculate the average power. Boundaries for the calculation needs to be defined. This is typically the operating frequency range.

Method with Power Meter

The power meter shall be connected to the measurement antenna. The frequency correction factor shall be taken into account. The power meter shall be a true RMS power meter. The measurement time shall be equal or longer than the EUT cycle time.

KDB 653005 D01 76 – 81 GHz Radar v01r02, 4.b)

The maximum fundamental emission power (EIRP) shall be measured using a power averaging (rms) detector with a 1 MHz resolution bandwidth (RBW) and integrated over the full 99% occupied bandwidth (OBW) to obtain the data necessary to demonstrate compliance to the 50 dBm limit.

Peak Power
Method with spectrum analyser with external mixer

- Start frequency: lower than the lower edge of the operating frequency range.
- Stop frequency: higher than the upper edge of the operating frequency range.
- Resolution bandwidth: 1 MHz
- Video bandwidfh: 3 MHz
- Detector mode: Peak detector
- Display mode: Maxhold
- Sweep time: EUT cycle time x number of sweep points
- Measurement is done until trace us stabilised.

The peak power to be considered us the maximum value recorded.

KDB 653005 D01 76 – 81 GHz Radar v01r02, 4.b)
The maximum peak fundamental emission power (EIRP) measurement shall be performed by sweeping over the transmitted occupied bandwidth using a positive peak power detector with peak hold activated and a 1 MHz RMW. Power integration is not to be used in performing this measurement. The resultant peak power spectral density (maximum in any 1 MHz) data shall be used to demonstrate compliance to the 55 dBm/MHz limit.
Peak power measurements of swept frequency radar implementations (e.g. higher sweep rate FMCW) may require a desensitization correction factor to be applied to the measurement results.

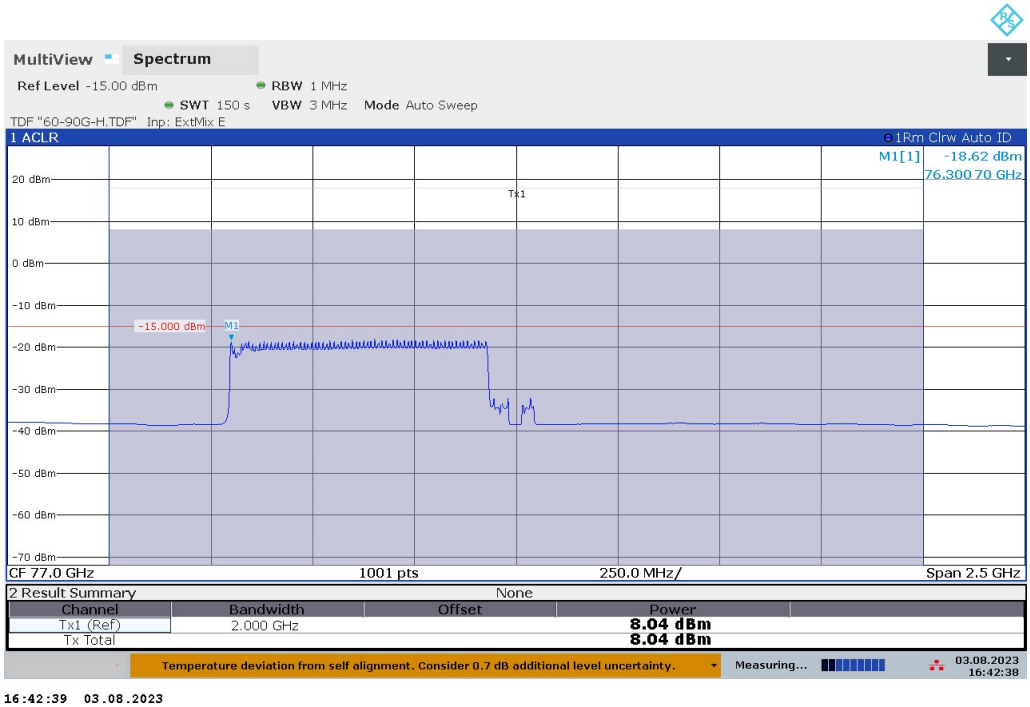
The test report used test procedure: Method with spectrum analyser with external mixer.

4.1.4. TEST RESULTS

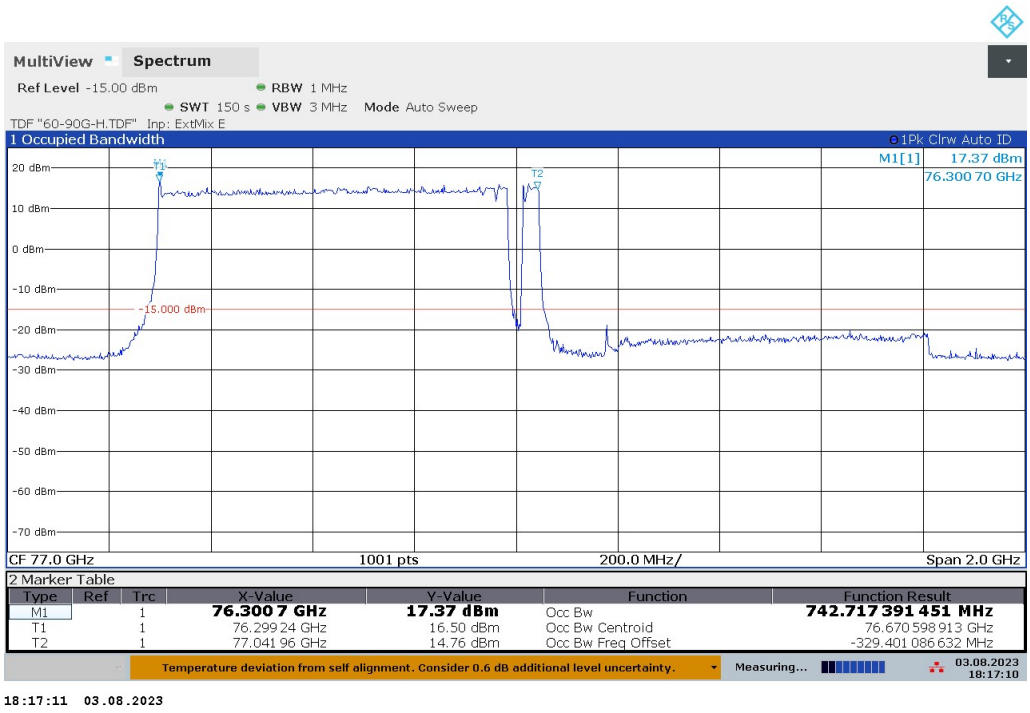
EIRP measurements were ensured to be taken in the Far-Field test distance are shown in Section 2.15.

EUT Mode	Test Distance [m]	Radiated Mean Power (EIRP) [dBm]	Radiated Mean Power Limit (EIRP) [dBm]	Radiated Peak Power (EIRP) [dBm]	Radiated Peak Power Limit (EIRP) [dBm]	Verdict
Corner	1	8.04	50.00	17.37	55.00	PASS

Plots No. 1: Mean Power EIRP, RMS detector / Channel Power, Horizontal / Vertical Polarization



Plots No. 2: Peak Power EIRP, Peak detector, Horizontal / Vertical Polarization



4.2. Modulation Characteristic [§2.1047 & KDB 653005 D01 76 – 81 GHz Radars]

4.2.1. LIMITS

According to §2.1047 Modulation Characteristics

(d) Other types of equipment. A curve or equivalent data which shows that the equipment will meet the moduation requirements of the rules under which the equipment is to be licensed.

KDB 653005 D01 76 – 81 GHz Radars v01r02, 3.g)

Concerning the Section 2.1047 modulation characteristics requirement, the following information should be provided:

1) Pulsed radar: pulse width and pulse repletion frequency (if PRF is variable, then report maximum and minimum values).
2) Non-pulsed radar (e.g., FMCW): modulation type (i.e., sawtooth, sinusoid, triangle, or square wave) and sweep characteristics (sweep bandwidth, sweep rate, sweep time).

4.2.2. VERDICT

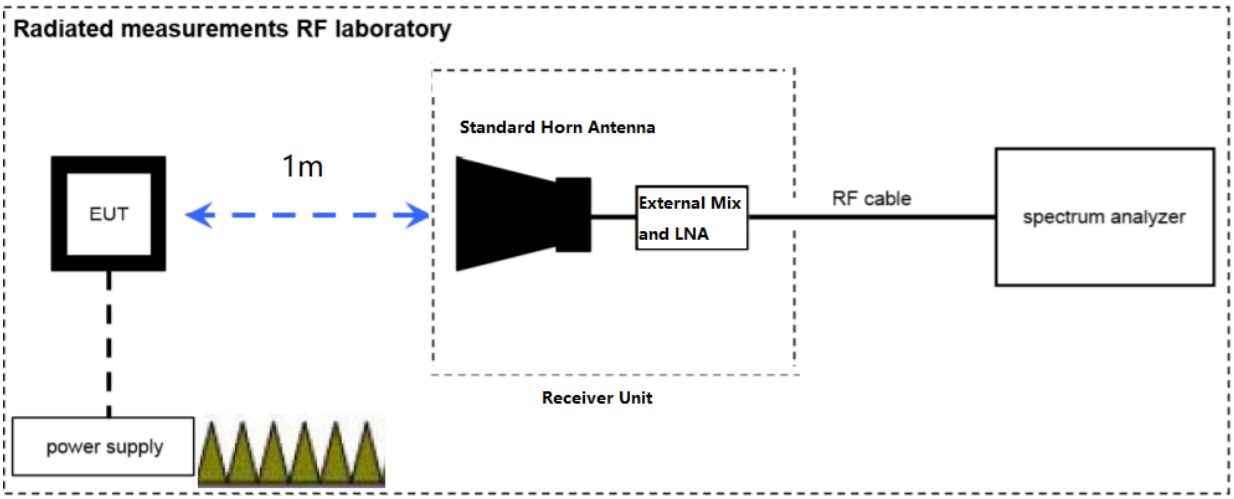
The EUT meets §2.1047 Modulation Characteristics requirement as declared by the applicant (applicant provide technical documents).

4.3. Occupied Bandwidth [§2.1049 & §95.3379]

4.3.1. LIMITS

According to § 95.3379 (b): Fundamental emission (i.e. 99% emission bandwidth) must be contained within the frequency bands specfied in this section during all conditions of operation.
According to § 2.1049: Measurements required: Occupied bandwidth: The occupied bandwdith, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

4.3.2. TEST CONFIGURATION



4.3.3. TEST PROCEDURE

According to ANSI C63.26:2015 section 5.4.4: The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are equal to 0.5% of the total mean power of the given emission.
The following procedure shall be used for measuring 99% power bandwdith:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
b) The nominal IF filter bandwidth (3dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [$10\log_{10}$(OBW/RBW] below the reference level. Specific guidance is given in 4.1.5.2.
d) Set the detection mode to peak, and the trace mode to maxhold.
e) If the instrument does not have 99% OBW function, recover the trace data points and sum directly in linear power terms. Placce the recovered amplitude data points, beginning at the lowest frequency, in a running sum until 0.5% of the total is reached. Recorded that frequency as the lower OBW frequency. Repeat the process until 99.5% of the total is reached and record that frequency as the upper OBW frequency. The 99% power OBW can be determined by computing the difference these two frequencies.
f) The OBW shall be reported and plots of the measuring instrument display shall be provided with the test report. The frequency and amplitude axis and scale shall be clearly labelled. Tabular data can be reported in addition to the plots.

KDB 653005 D01 76 – 81 GHz Radar v01r02, 4.d)

The occuipied bandwidth of the radar device shall be measured, reported, and shown to be fully contained within the designated 76 – 81 GHz frequency band under normal operating conditions as well as under those extreme ambient temperature and input voltage conditions as described in Section 2.1057.
The OBW measurement of an FMCW radar shall be performed with the transmitter operating in normal mode (i.e. with frequency sweep or step active).

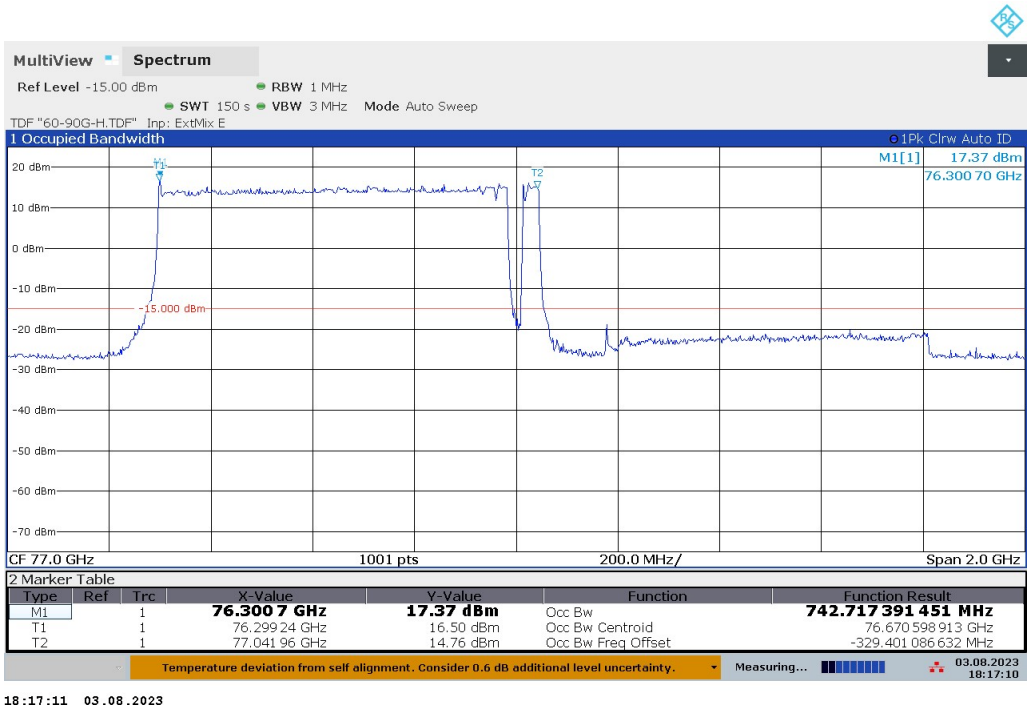
Measurement with the peak detector are also suitable to demonstrate compliance of an EUT, as long as the required resolution bandwidth is used, because peak detection will yield amplitudes equal to or greater than amplitudes measured with RMS detector. The measurement data from a spectrum analyser peak detector will represent the worst-case results.

4.3.4. TEST RESULTS

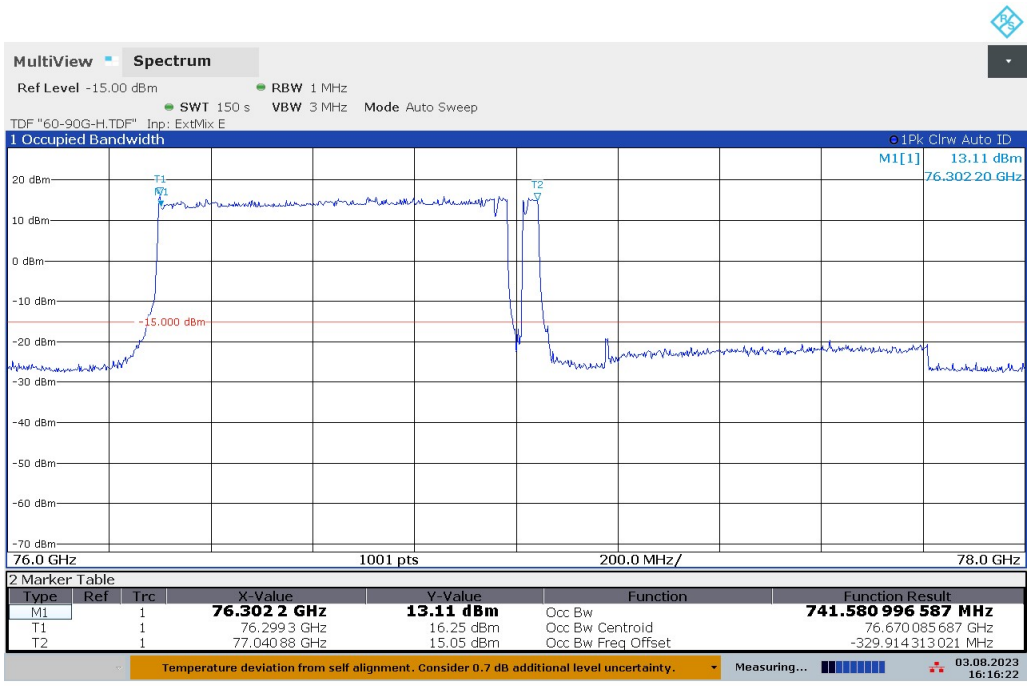
EUT Mode	Test Conditions	f_L [GHz]	f_H [GHz]	99% OBW [MHz]
Corner	50℃	76.29961	77.04215	742.54
Corner	40℃	76.29986	77.04218	742.32
Corner	30℃	76.29986	77.04218	742.32
Corner	20℃ (V_{nor})	76.29924	77.04196	742.72
Corner	20℃ (V_{max})	76.29930	77.04088	741.58
Corner	20℃ (V_{min})	76.29936	77.04107	741.71
Corner	10℃	76.29944	77.04092	741.48
Corner	0℃	76.29961	77.04177	742.16
Corner	-10℃	76.29938	77.04225	742.87
Corner	-20℃	76.29962	77.04196	742.34
Corner	-30℃	76.29962	77.04225	742.63

Note 1: With voltage variation, Input voltage variation does not affect the transmitted signal (see plots for ambient /normal temperature).
Note 2: Test plots only provide V_{nor}/T_{nor}, V_{nor}/T_{max}, V_{nor}/T_{min}, V_{max}/T_{nor}, V_{min}/T_{nor} modes,

Plots No. 3: 99% OBW, Peak detector, Horizontal / Vertical Polarization, V_{nor}/T_{nor}



Plots No. 4: 99% OBW, Peak detector, Horizontal / Vertical Polarization, V_{min}/T_{nor}



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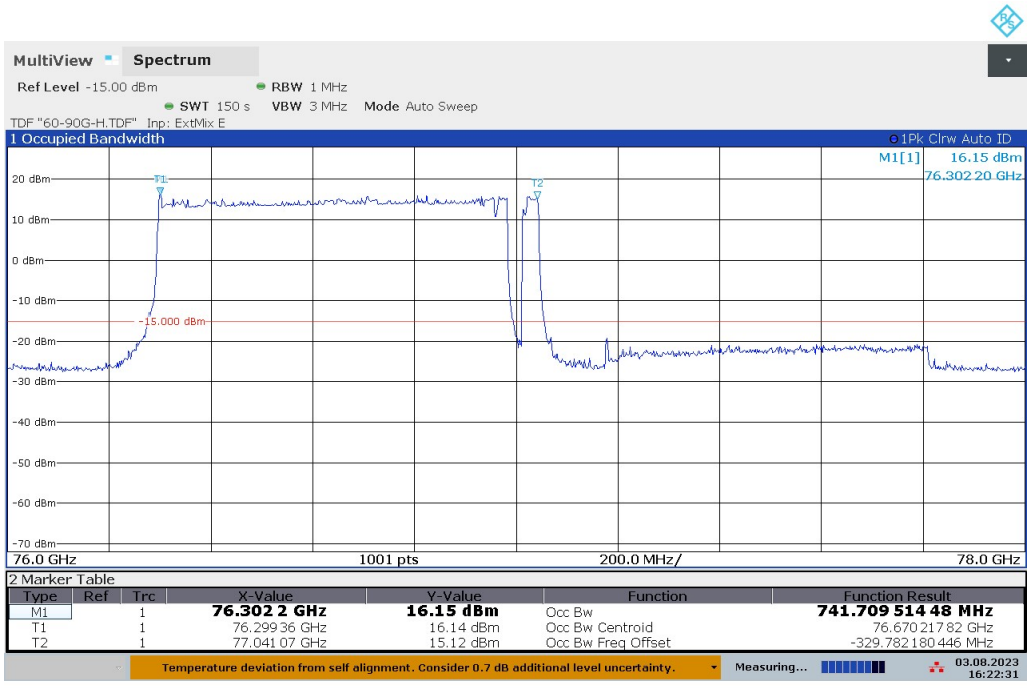
Plots No. 5: 99% OBW, Peak detector, Horizontal / Vertical Polarization, V_{max}/T_{nor}



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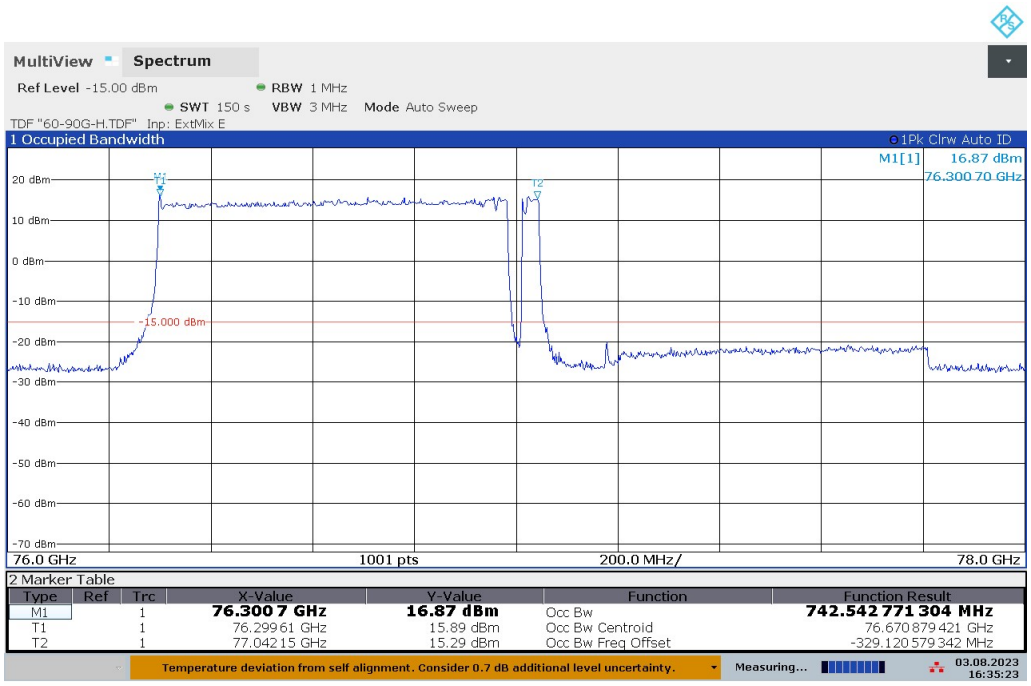
Plots No. 6: 99% OBW, Peak detector, Horizontal / Vertical Polarization, V_{nor}/T_{max}



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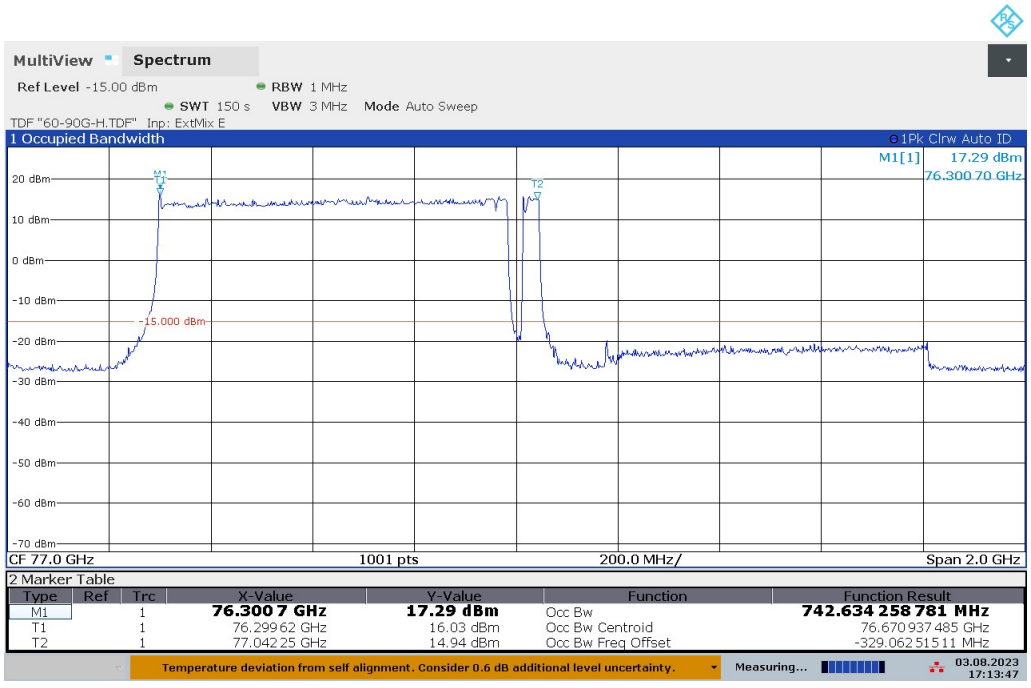
Plots No. 7: 99% OBW, Peak detector, Horizontal / Vertical Polarization, V_{nor}/T_{max}



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4.4. Field Strength of Spurious Radiation [§2.1053 & §95.3379]

4.4.1. LIMITS

According to § 95.3379 76 – 81 GHz Band Radar Service unwanted emissions limits.

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

Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(30/3)	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

(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/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) 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/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

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

Frequency Range [GHz]	Power Density / EIRP at Measurement Distance 3 [m]	Power Density / EIRP at Measurement Distance 1 [m]
40 – 200	600 pW/cm^2 / -1.686 dBm	-6.457 dBm
200 – 243	1000 pW/cm^2 / 0.532 dBm	-4.239 dBm

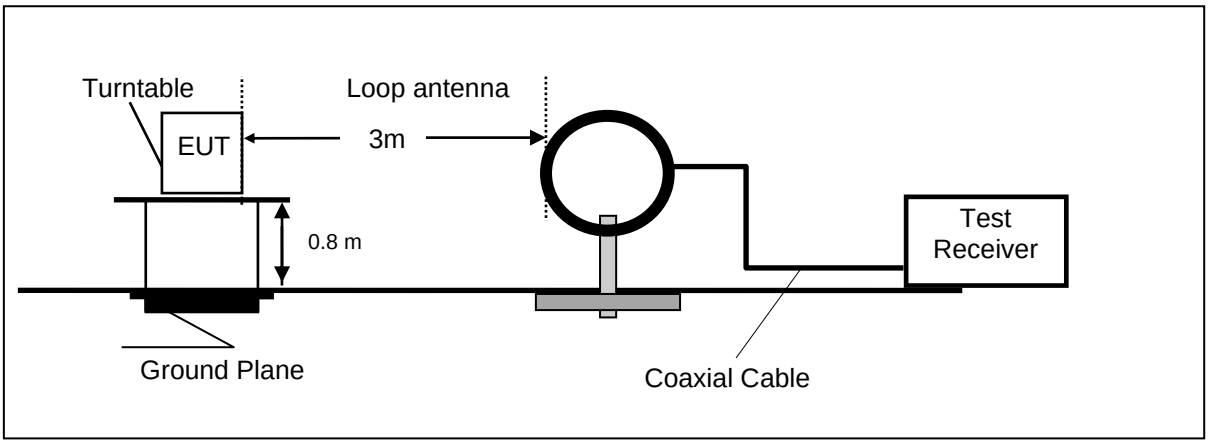
According to § 2.1053 Measurements required: Field strength of spurious radiation.

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.

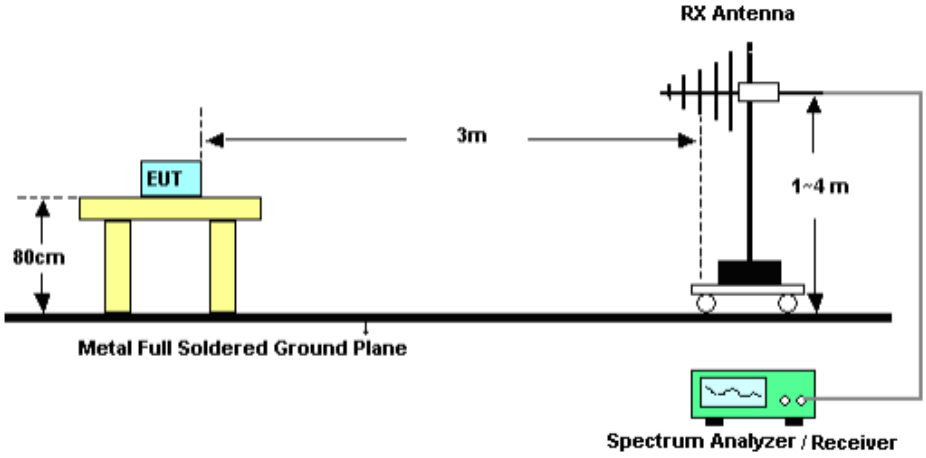
Measurements with the peak detector are also suitable to demonstate compliance of an EUT, as long as the required resolution bandwdith is used, because peak detection will yield ampliudes equal to or greater than ampliudes measured with RMS detector. The measurement data from a spectrum analyser peak detector will represent the worst-case results.

4.4.2. TEST RESULTS

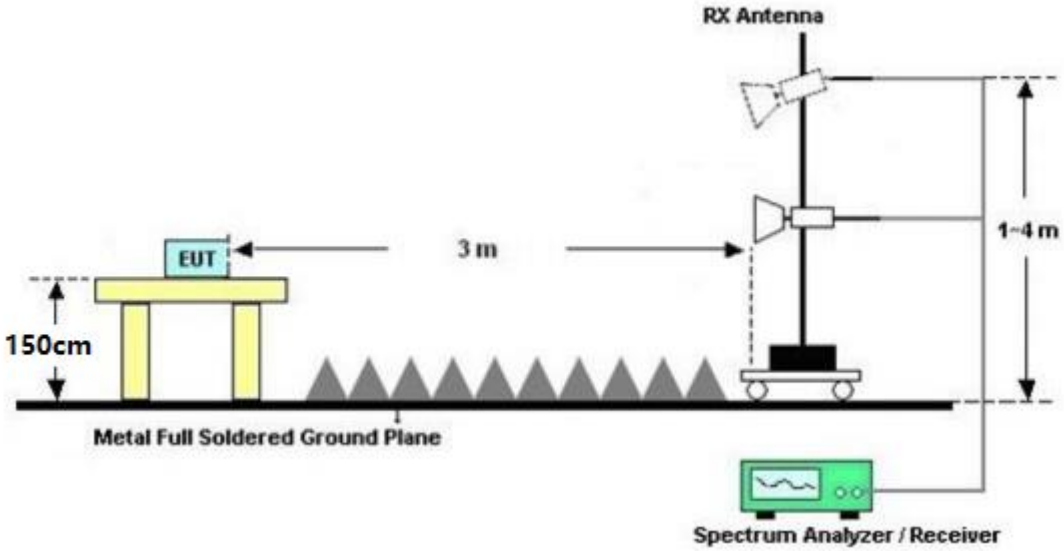
(a) Frequency range 9 KHz – 30MHz



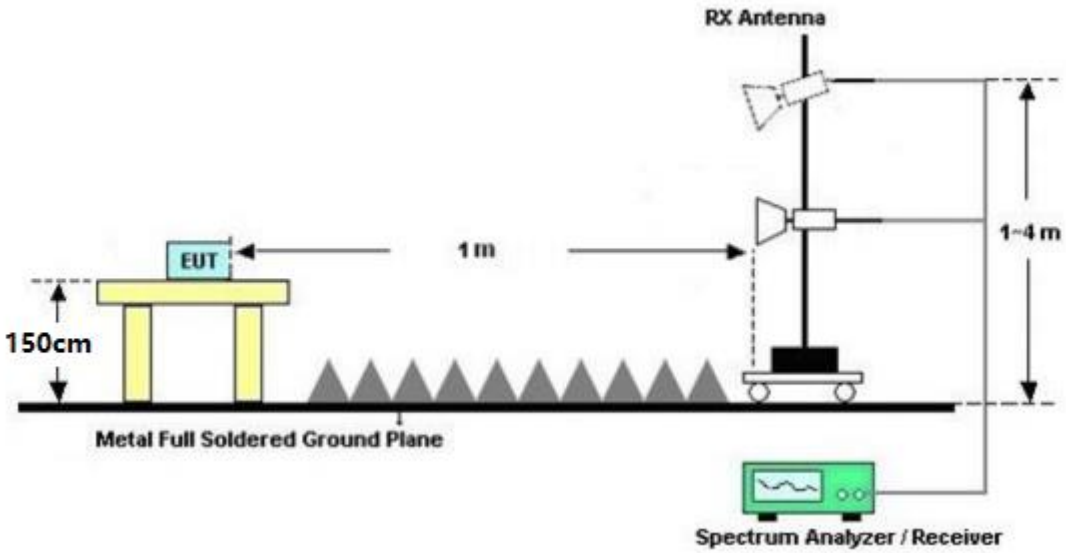
(b) Radiated emission test set-up, frequency range: 30 - 1000MHz



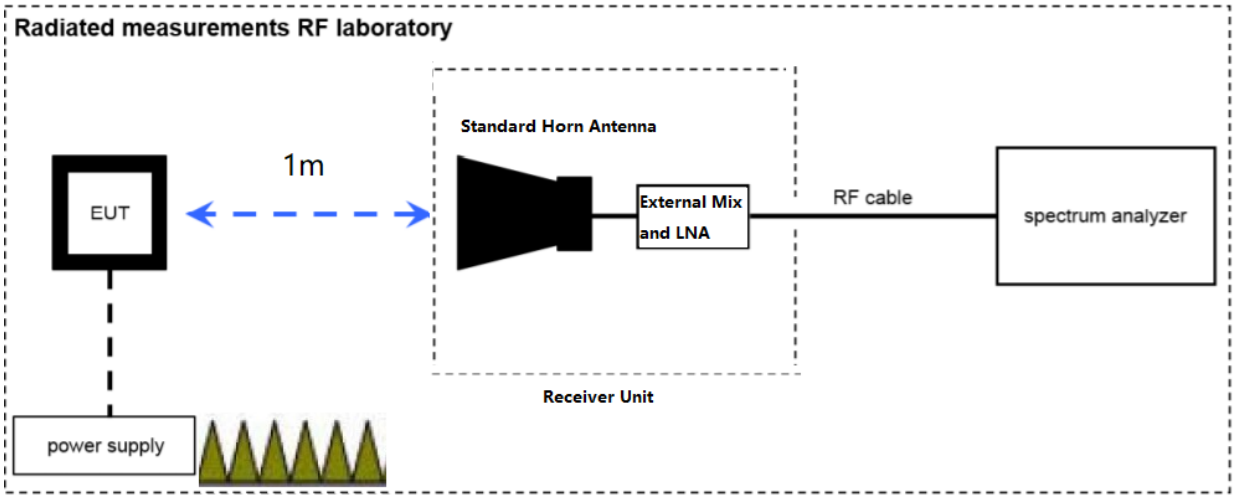
(c) Radiated emission test set-up, frequency range 1GHz – 18 GHz



(d) Radiated emission test set-up, frequency range 18GHz – 42 GHz



(e) Radiated emission test set-up, frequency range 42GHz – 240 GHz



4.4.3. TEST PROCEDURE

4.1.3.1 Sequence of testing radiated spurious 9 KHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer
- If the EUT is a tabletop system, 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measuremet distance is 3m (see ANSI C63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0 degree to 360 degree.
- The antenna height is 1m.
- Set RBW = 200 Hz / VBW = 1 KHz, sweep time: Auto
- At each turntable position the anzlyer sweeps with position-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the premeaurement are maximized by the software by rotating the turntable from 0 degree to 360 degree.
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, conrrection factor, margin to the limit and limit will be recorded. A plot with the graph of the measurement and the limit is stored.

4.1.3.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup
- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer
- If the EUT is a tabletop system, 0.8 m height is used, which is placed on the ground plance.
- If the EUT is a floor standing device, it is placed directly on the ground plane.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measuremet distance is 3m (see ANSI C63.4) – see test details.
- EUT is set into operation.

Premeasurement
- The turntable rotates from 0 degree to 360 degree.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1m to 4m.
- Set RBW = 120 KHz / VBW = 1 MHz, sweep time: Auto
- At each turntable position the anzlyer sweeps with position-peak detector to find the maximum of all emissions.

Final measurement
- The final neasurement is perormed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, conrrection factor, margin to the limit and limit will be recorded. A plot with the graph of the measurement and the limit is stored.

4.1.3.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup
- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer
- If the EUT is a tabletop system, 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turntable.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measuremet distance is 3m (see ANSI C63.4) – see test details.
- EUT is set into operation.

Premeasurement
- The turntable rotates from 0 degree to 360 degree.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1m to 4m.
- Set RBW = 1 MHz / VBW = 3 MHz, sweep time: Auto, detector: Peak for Peak, RBW = 1 MHz / VBW = 3 MHz, sweep time: Auto, detector: Average for Average.
- At each turntable position the anzlyer sweeps with position-peak detector to find the maximum of all emissions.

Final measurement
- The final neasurement us perormed for at least six highest peaks according to the requirements of the ANSI C63.4.

- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable and antenna height between 1 and 4 m.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the height emissions with Peak and Average detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, conrrection factor, margin to the limit and limit will be recorded. A plot with the graph of the measurement and the limit is stored.

4.1.3.4 Sequence of testing radiated spurious 18 GHz – 42 GHz

Setup
- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer
- If the EUT is a tabletop system, 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turntable.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measuremet distance is 1m (see ANSI C63.4) – see test details.
- EUT is set into operation.

Premeasurement
- The turntable rotates from 0 degree to 360 degree.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1m to 4m.
- Set RBW = 1 MHz / VBW = 3 MHz, sweep time: Auto, detector: Peak for Peak, RBW = 1 MHz / VBW = 3 MHz, sweep time: Auto, detector: Average for Average.
- At each turntable position the anzlyer sweeps with position-peak detector to find the maximum of all emissions.

Final measurement
- The final neasurement is perormed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable and antenna height between 1 and 4 m.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the height emissions with Peak and RMS detector (as described in ANSI C 63.4).
- All final levels should consider distance conversion factor as format: Final values (3 m) = Measurement values (1 m) + Distance conversion factor
  Distance conversion factor = 20 x Log_{10} (d/3), where d = measurement distance in m
  - Distance conversion factor = 20 x Log_{10} (1/3) = -9.54 [dB]
- Final levels, frequency, measuring time, bandwidth, turntable position, conrrection factor, margin to the limit and limit will be recorded. A plot with the graph of the measurement and the limit is stored.

4.1.3.5 Sequence of testing radiated spurious above 42 GHz with external mixers

Setup
- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer
- If the EUT is a tabletop system, 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turntable.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measuremet distance is 1m (see ANSI C63.4) – see test details.
- EUT is set into operation.

Premeasurement
- The turntable rotates from 0 degree to 360 degree.
- The antenna with external mixer is polarized vertical and horizontal.
- The antenna height changes from 1m to 4m.
- Set RBW = 1 MHz / VBW = 3 MHz, sweep time: Auto, detector: Peak for Peak, RBW = 1 MHz / VBW = 3 MHz, sweep time: Auto, detector: Average for Average.
- At each turntable position the anzlyer sweeps with position-peak detector to find the maximum of all emissions.

Final measurement

- The final neasurement is perormed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable and antenna height between 1 and 4 m.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the height emissions with Peak and RMS detector (as described in ANSI C 63.4).
- All final levels should consider distance conversion factor as format: Final values (3 m) = Measurement values (1 m) + Distance conversion factor
  Distance conversion factor = 20 x Log_{10} (d/3), where d = measurement distance in m
  - Distance conversion factor = 20 x Log_{10} (1/3) = -9.54 [dB]
- Final levels, frequency, measuring time, bandwidth, turntable position, conrrection factor, margin to the limit and limit will be recorded. A plot with the graph of the measurement and the limit is stored.

4.4.4. FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS (dBuV/m) = RA (dBuV) + AF (dB/m) + CL (dB) – AG (dB)

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

4.4.5. TEST RESULTS

EIRP measurements were ensured to be taken in the Far-Field test distance are shown in Section 2.15.

Sample Calculations

Calculating Field Strength from substitution power:

$$\mathbf{E(dBuV/m) = 126.8 - 20\log(\lambda) + P - G}$$

Where;
E is the field strength of the emission at the measurement distance, in dBuV/m
P is the power measured at the output of the test antenna, in dBm; where P includes all applicable instrument correction factors up to the connections to the test antenna.
λ is the wavelength of the emission under investigation [300 / f_{MHz}], in m.
G is the gain of the test antenna, in dBi.

Calculating EIRP from Field Strength;

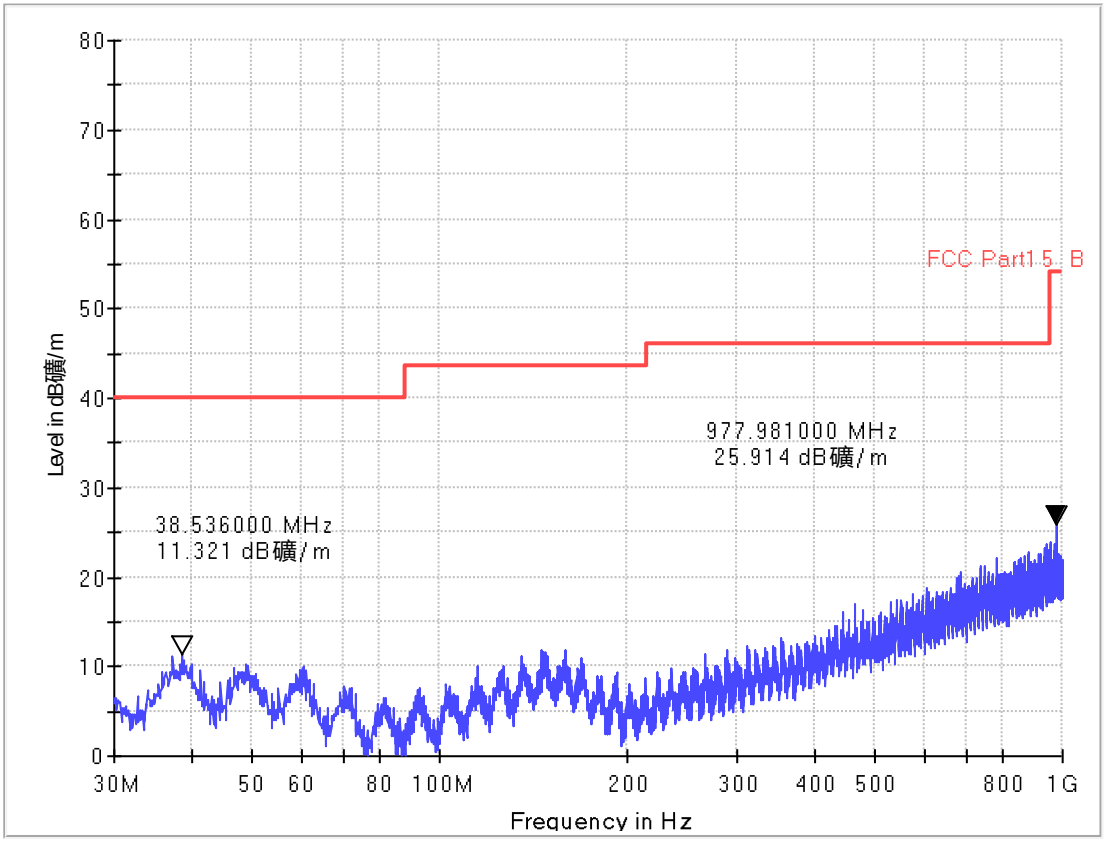
$$\mathbf{EIRP_{[dBm]} = E_{measurement} + 20\log (D_{measured}) - 104.7}$$

Where;
EIRP is the equivalent isotropic radiated power in dBm
$E_{measured}$ is the field strength of the emission at the measurement distance, in dBuV/m
$D_{measure}$d is the measurement distance in meters.

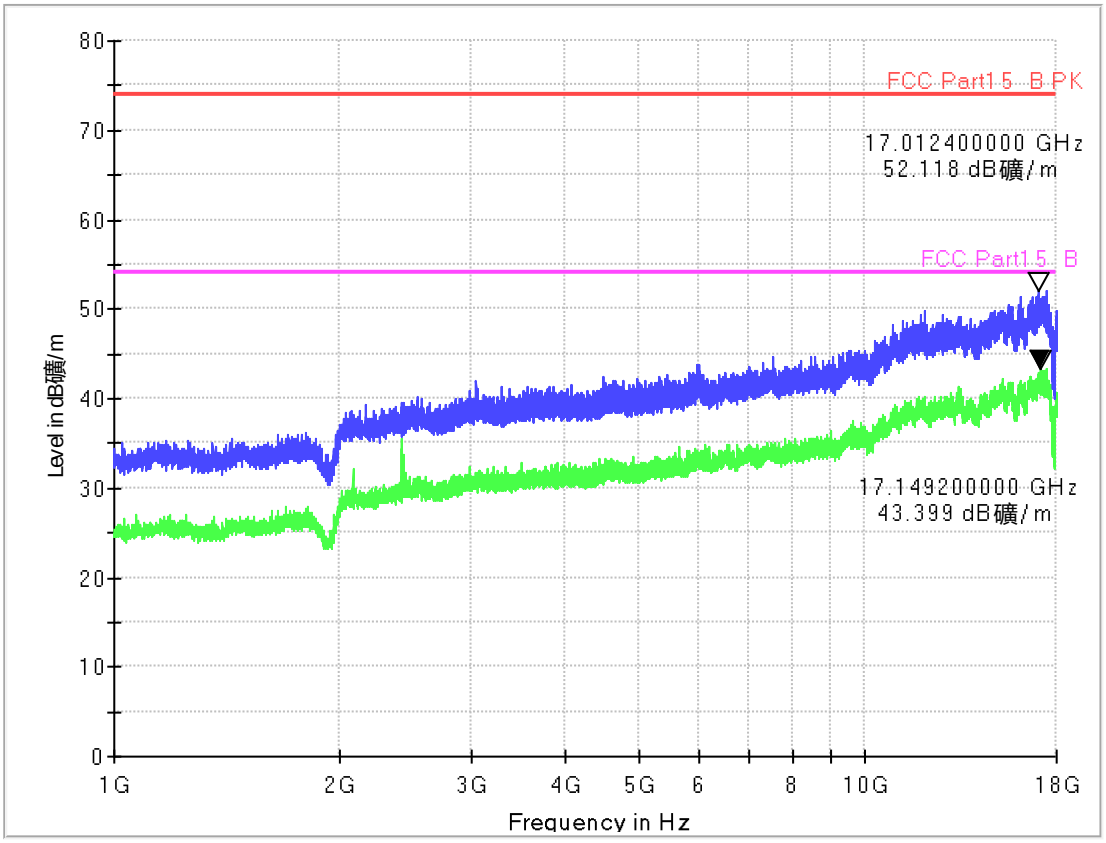
PASS

Note 1: Not recorded values after pre-test below 30 MHz (9 KHz – 30 MHz), values at least 20 dB below limit.

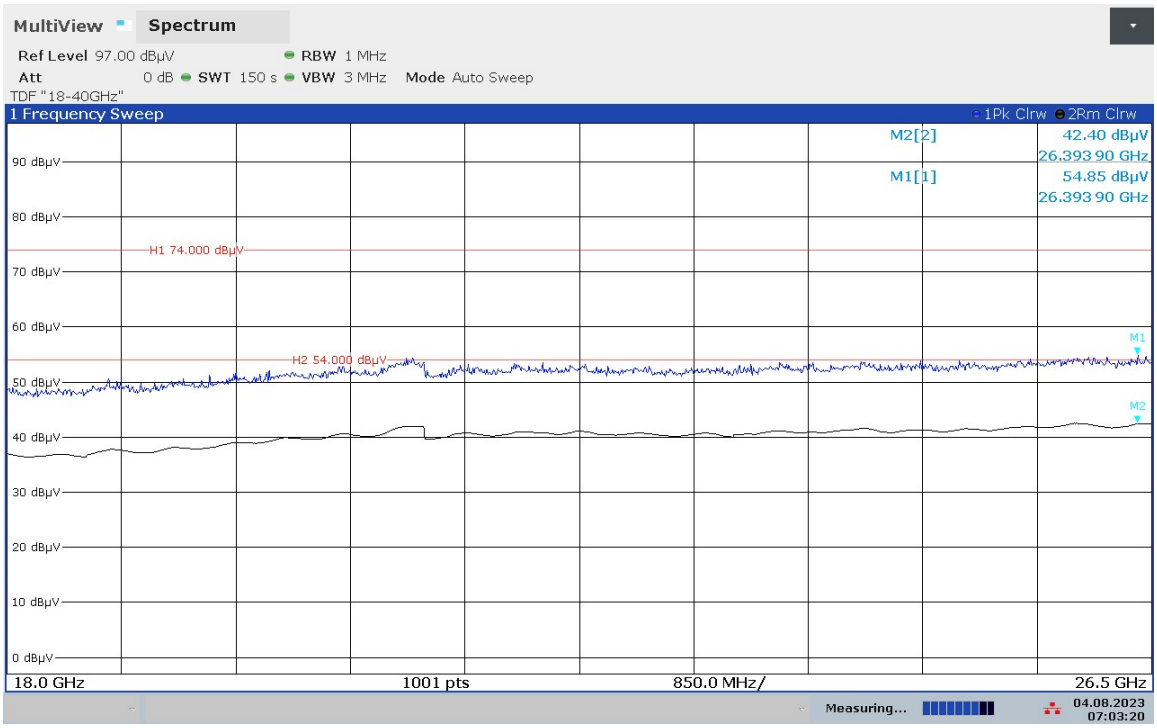
Plots No. 8: Radiated Emission, 30 MHz to 1 GHz, Horizontal / Vertical Polarization



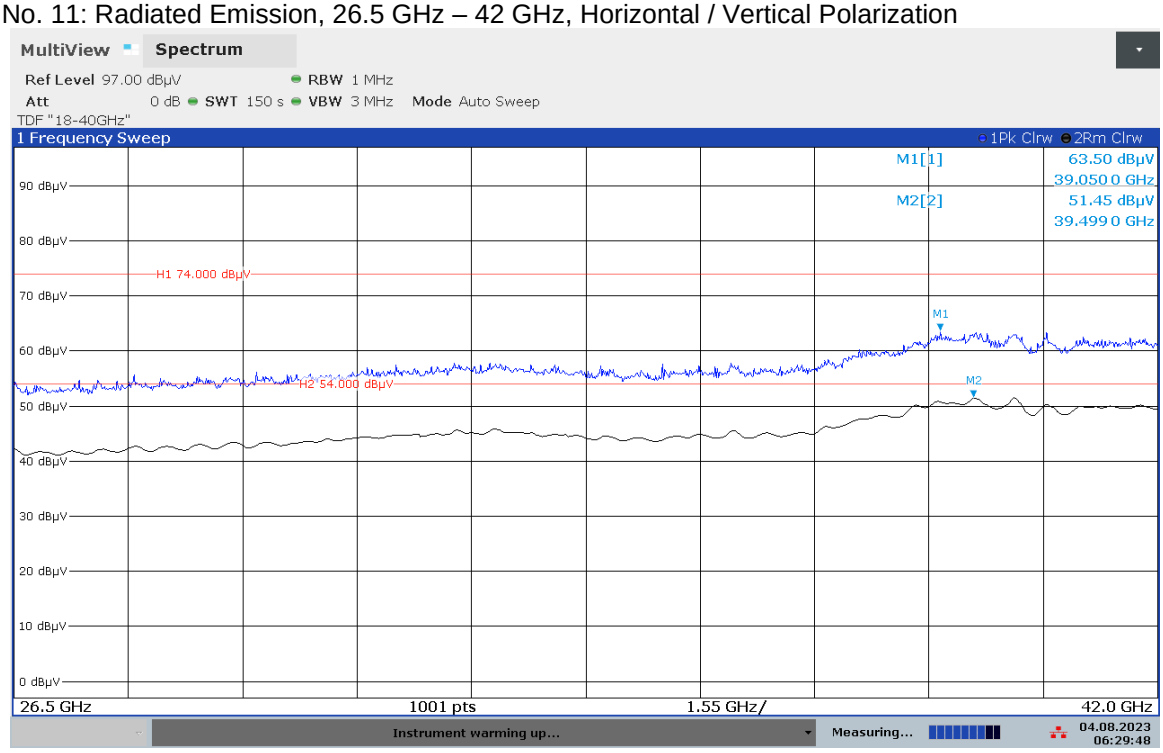
Plots No. 9: Radiated Emission, 1 GHz to 18 GHz, Horizontal / Vertical Polarization



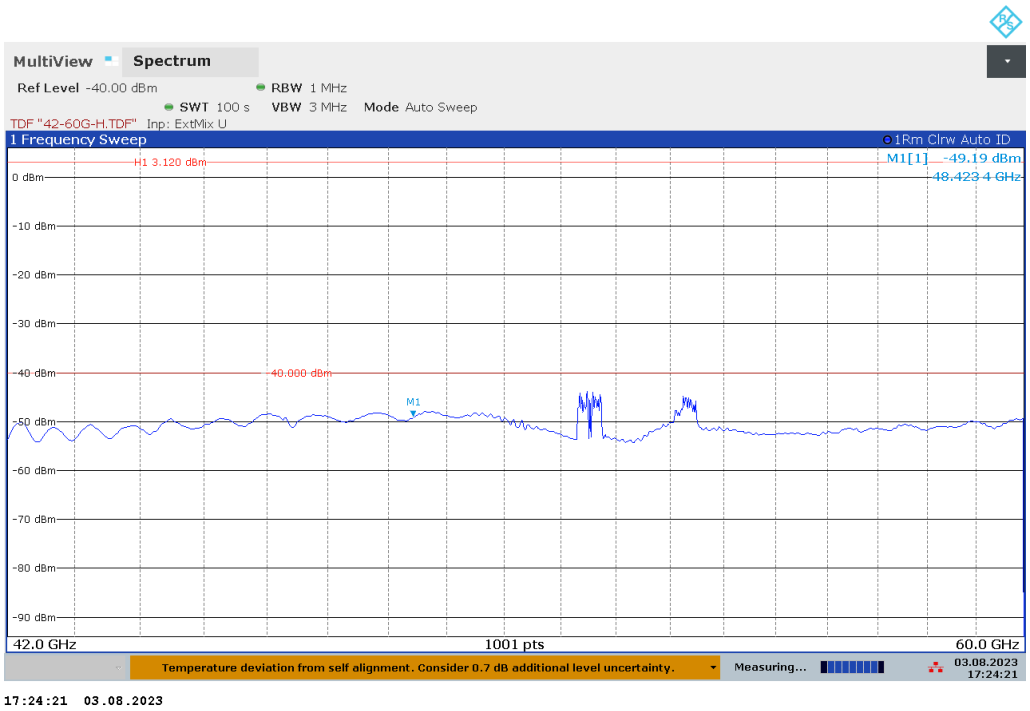
Plots No. 10: Radiated Emission, 18 GHz – 26.5 GHz, Horizontal / Vertical Polarization



Plots No. 11: Radiated Emission, 26.5 GHz – 42 GHz, Horizontal / Vertical Polarization



Plots No. 12: Radiated Emission, 42 GHz – 60 GHz, Horizontal / Vertical Polarization



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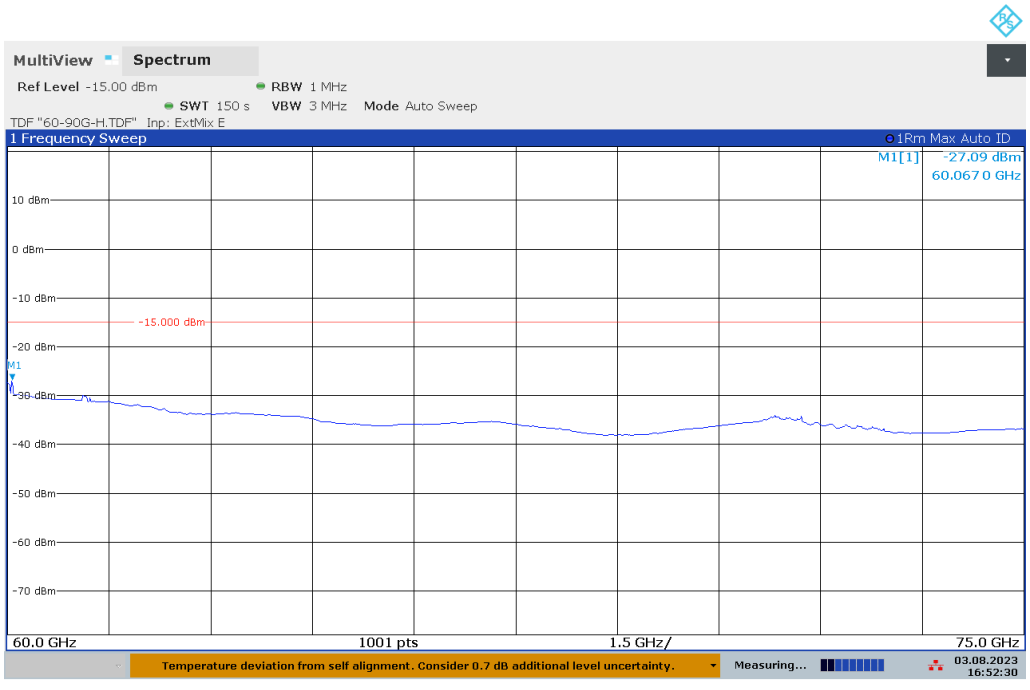
Plots No. 13: Radiated Emission, 60 GHz to 75 GHz, Horizontal / Vertical Polarization



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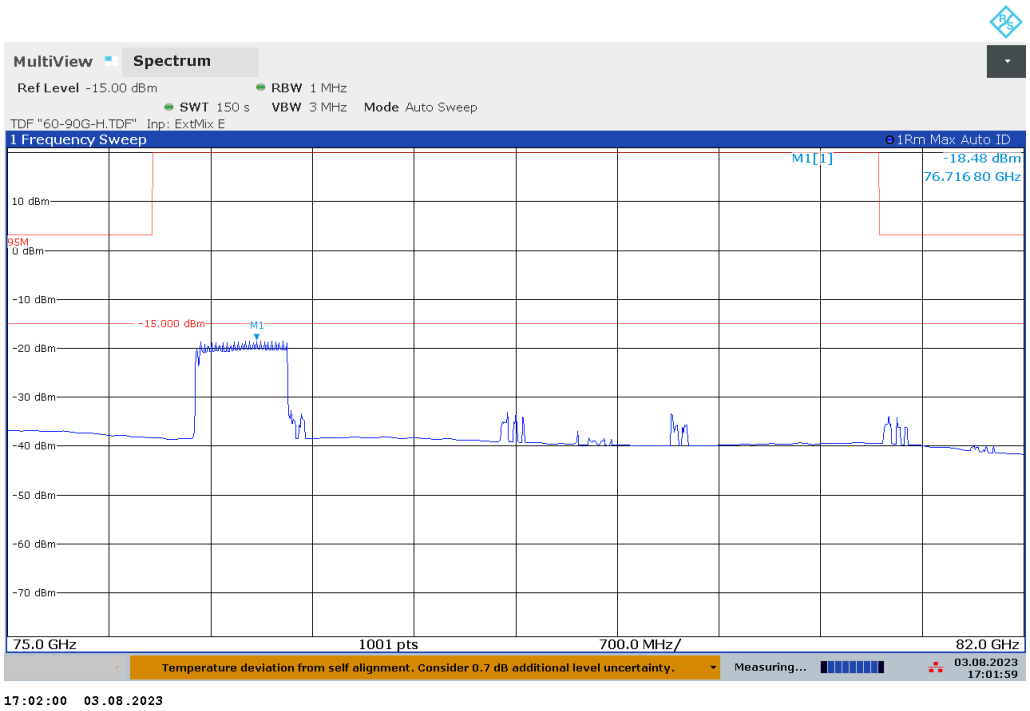
Plots No. 14: Radiated Emission, BEC, Horizontal / Vertical Polarization



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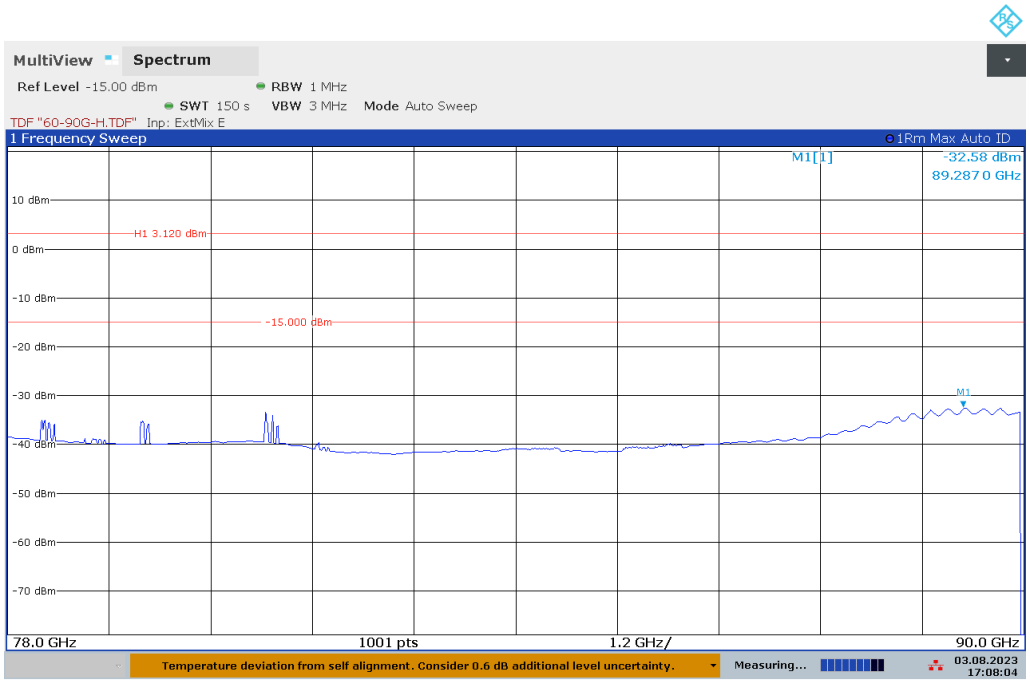
Plots No. 15: Radiated Emission, 78 GHz to 90 GHz, Horizontal / Vertical Polarization



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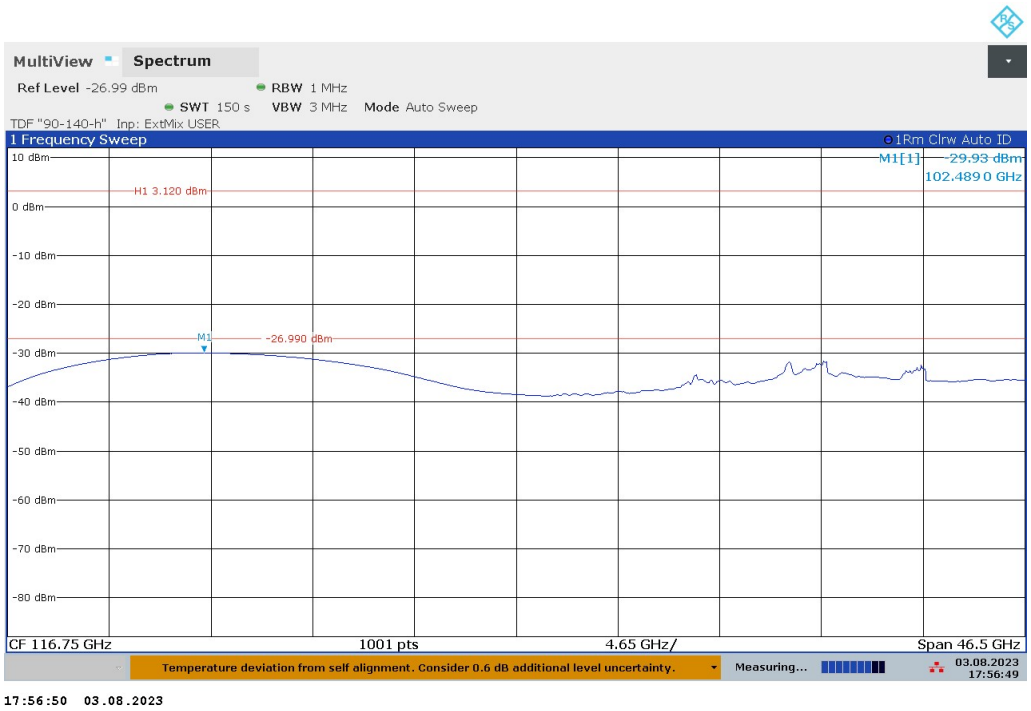
Plots No. 16: Radiated Emission, 90 GHz to 140 GHz, Horizontal / Vertical Polarization



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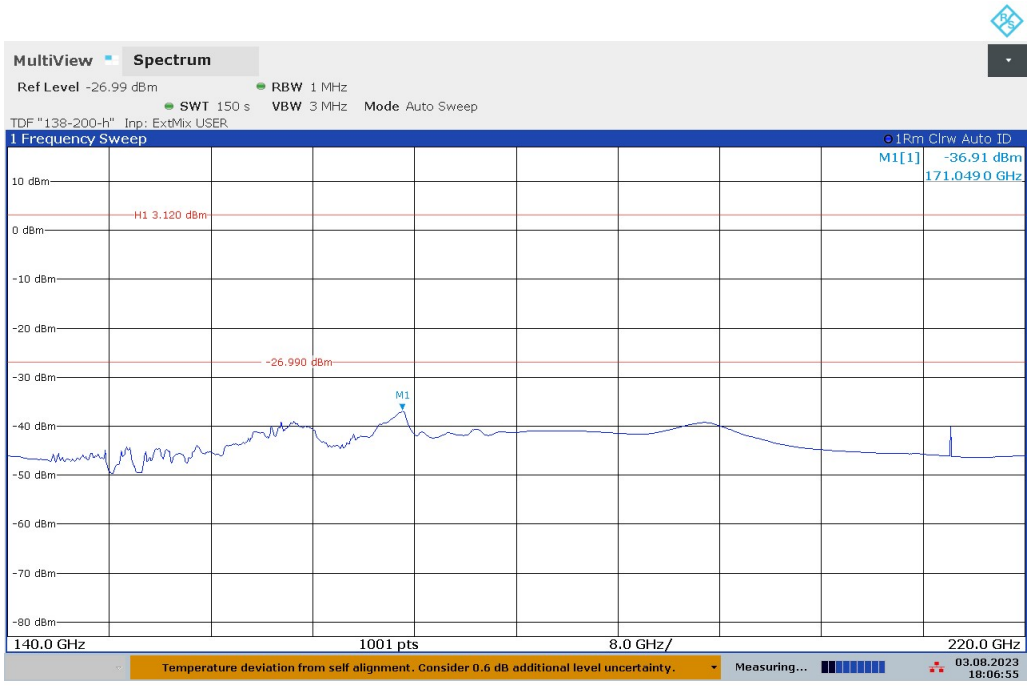
Plots No. 17: Radiated Emission, 140 GHz to 220 GHz, Horizontal / Vertical Polarization



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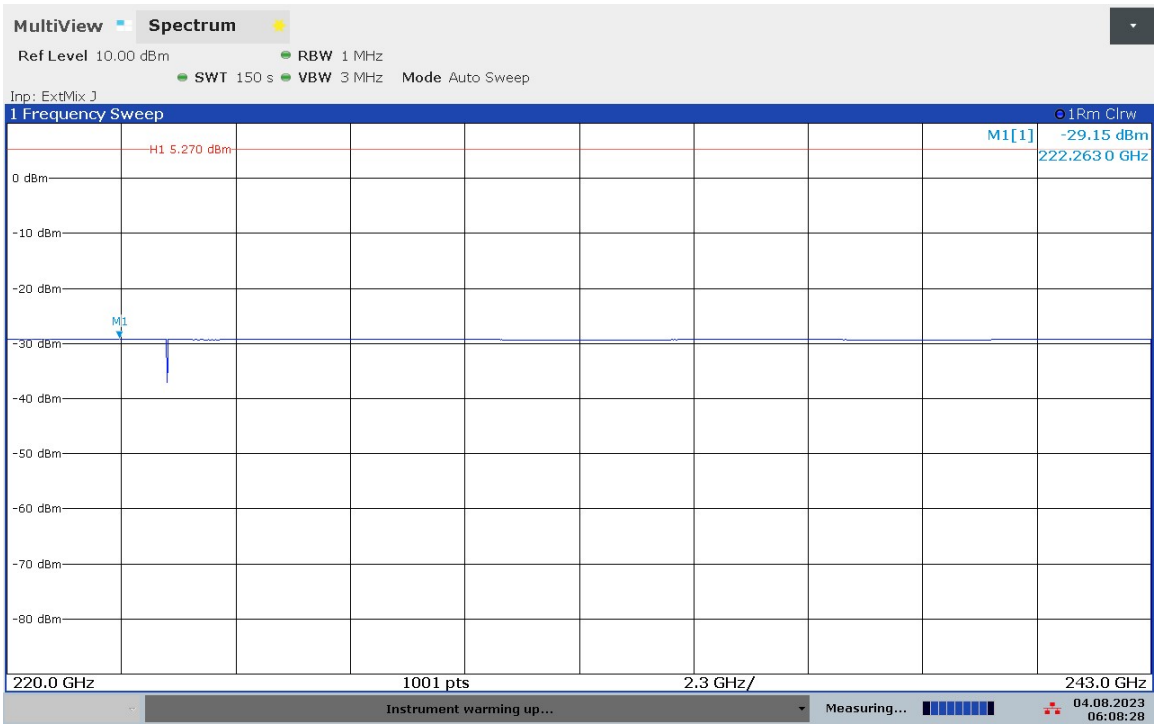
Plots No. 18: Radiated Emission, 220 GHz to 243 GHz, Horizontal / Vertical Polarization



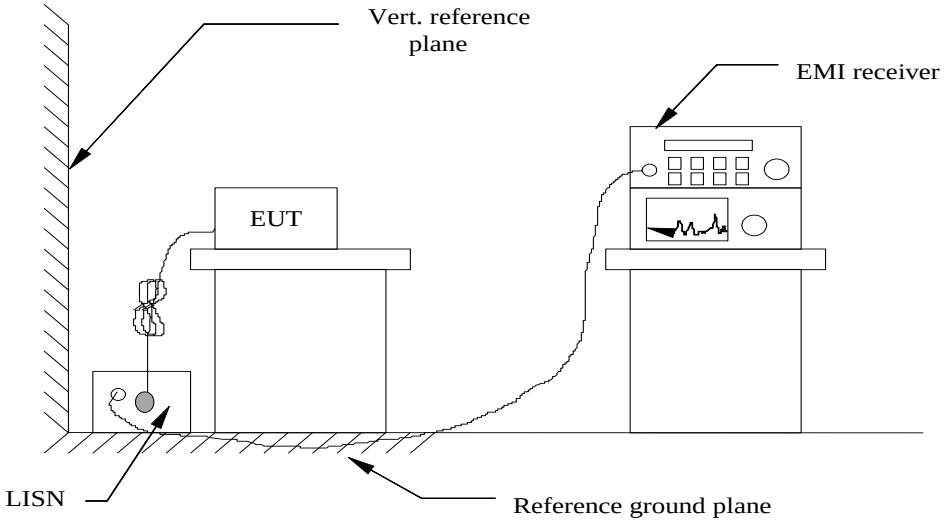
4.5. AC Conducted Emission

4.5.1. LIMITS OF DISTURBANCE

According to RSS Gen 8.8 and § 15.207(a) Line Conducted Emission Limits is as following:

Frequency range (MHz)	Limit (dBuV)	
	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.		

4.5.2. TEST CONFIGURATION



4.5.3. TEST PROCEDURE

1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2013.
2. Support equipment, if needed, was placed as per ANSI C63.10-2013
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013
4. The EUT received DC 12V power from adapter, the adapter received AC120V/60Hz and AC 240V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5. All support equipment received AC power from a second LISN, if any.
6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50-ohm load; the second scan had Line 1 connected to a 50-ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8. During the above scans, the emissions were maximized by cable manipulation.

4.5.4. DISTURBANCE CALCULATION

The AC mains conducted disturbance is calculated by adding the 10dB Pulse Limiter and Cable Factor and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

CD (dBuV) = RA (dBuV) + PL (dB) + CL (dB)

Where CD = Conducted Disturbance	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	PL = 10 dB Pulse Limiter Factor

4.5.5. TEST RESULTS

N/A*

Not Applicable as powered by DC Vehicle Battery.

4.6. Frequency Stability

4.6.1. LIMITS

According to § 95.3379 76 – 81 GHz Band Radar Service unwanted emission limits.

(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.

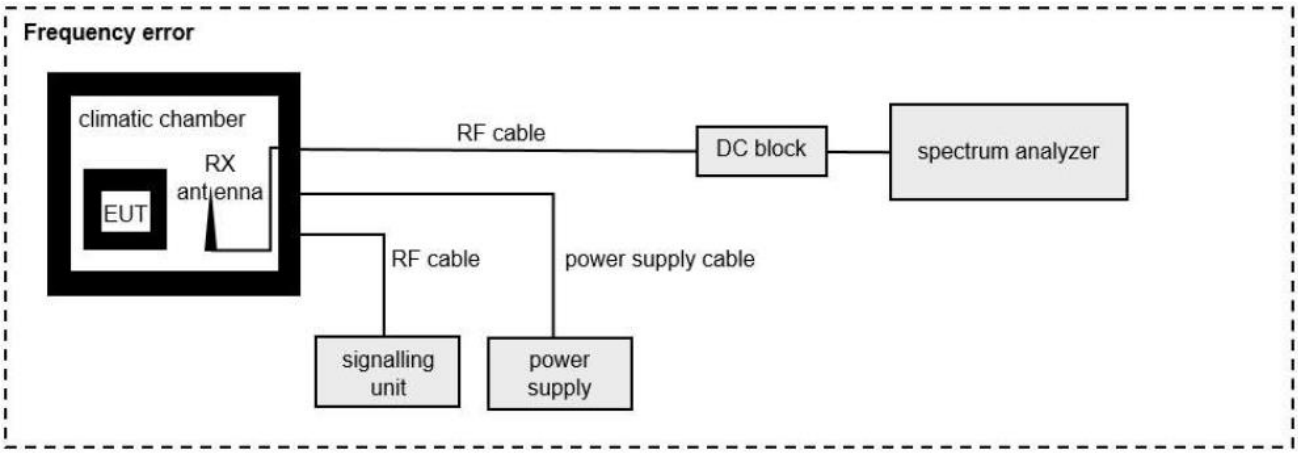
According to § 2.1055 Measurement required: Frequency Stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
  (1) From −30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
  (2) From −20° to + 50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.
  (3) From 0° to + 50° centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(c) The frequency stability shall be measured with variation of primary supply voltage as follows:
  (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
  (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
  (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

4.6.2. TEST CONFIGURATION



4.6.3. TEST PROCEDURE

According to ANSI C63.26:2015 section 5.4.4: The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are equal to 0.5% of the total mean power of the given emission.

The following procedure shall be used for measuring 99% power bandwdith:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
b) The nominal IF filter bandwidth (3dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [$10\log_{10}$(OBW/RBW] below the reference level. Specific guidance is given in 4.1.5.2.
d) Set the detection mode to peak, and the trace mode to maxhold.
e) If the instrument does not have 99% OBW function, recover the trace data points and sum directly in linear power terms. Placce the recovered amplitude data points, beginning at the lowest frequency, in a running sum until 0.5% of the total is reached. Recorded that frequency as the lower OBW frequency. Repeat the process until 99.5% of the total is reached and record that frequency as the upper OBW frequency. The 99% power OBW can be determined by computing the difference these two frequencies.
f) The OBW shall be reported and plots of the measuring instrument display shall be provided with the test report. The frequency and amplitude axis and scale shall be clearly labelled. Tabular data can be reported in addition to the plots.

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The occuipied bandwidth of the radar device shall be measured, reported, and shown to be fully contained within the designated 76 – 81 GHz frequency band under normal operating conditions as well as under those extreme ambient temperature and input voltage conditions as described in Section 2.1057.
The OBW measurement of an FMCW radar shall be performed with the transmitter operating in normal mode (i.e. with frequency sweep or step active).

Measurement with the peak detector are also suitable to demonstrate compliance of an EUT, as long as the required resolution bandwidth is used, because peak detection will yield amplitudes equal to or greater than amplitudes measured with RMS detector. The measurement data from a spectrum analyser peak detector will represent the worst-case results.

4.6.4. TEST RESULTS

PASS

Please refer to measurement results for Occupied Bandwidth.