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TEST REPORT

FCC 77 GHz Radar Report

APPLICANT
HYUNDAI MOBIS CO., LTD.

REPORT NO.
HCT-RF-1907-FC001-R1

DATE OF ISSUE
July 29, 2019

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Applicant	**HYUNDAI MOBIS CO., LTD.** 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, South Korea
Product Name Model Name	UNIT ASSY-FR RADAR MAR320
FCC ID	TQ8-MAR320
Date of Test	April 19, 2019 ~ July 29, 2019
Test Standard Used	Part 95(m)
Frequency Range	76 GHz ~ 77 GHz
FCC Classification	Vehicular Radar Systems (VRD)
Max. RF Output Power	Peak: 28.90 dBm (Short Distance Device) Aver: 23.38 dBm (Short Distance Device) Peak: 35.28 dBm (Long Distance Device) Aver: 27.73 dBm (Long Distance Device)

Tested by Kwang Il Yoon	(signature)
Technical Manager Jong Seok Lee	(signature)

HCT CO., LTD.
Soo Chan Lee
SooChan Lee / CEO

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	July 05, 2019	Initial Release
1	July 29, 2019	We retested the OBW and corrected the typos.

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Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them HCT CO., LTD.
Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)

CONTENTS

1. EUT DESCRIPTION

Model	MAR320		
EUT Type	UNIT ASSY-FR RADAR		
Power Supply	DC 12.0 V		
Frequency Range	76 GHz ~ 77 GHz		
EIRP	Short Distance	Peak	28.90 dBm
		Average	23.38 dBm
	Long Distance	Peak	35.28 dBm
		Average	27.73 dBm
Modulation Type	FMCW		
Antenna Specification	Antenna type: PCB antenna Peak Gain(dBi): Long Distance Device: 17.86 / Short Distance Device: 14.76 Maximum Dimension(㎜): 47.886		
Date(s) of Tests	April 19, 2019 ~ July 03, 2019		

2. TEST METHODOLOGY

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) Operating Under §95(m)" were used in the measurement.

2.1 EUT CONFIGURATION

The EUT configuration for testing is installed on EIRP measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx Frequency that was for the purpose of the measurements.

2.3 GENERAL TEST PROCEDURES

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1 GHz. Above 1 GHz with 1.5 m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set far-field distance away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

2.4 DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards.
Especially, all antenna(Up to 40 GHz) for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).

4. FACILITIES AND ACCREDITATIONS

4.1 FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032)

4.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.
Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4:2014.

All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

Parameter	Expanded Uncertainty (± dB)
Radiated Disturbance (9 ㎑ ~ 30 ㎒)	3.40
Radiated Disturbance (30 ㎒ ~ 1 ㎓)	4.80
Radiated Disturbance (1 ㎓ ~ 18 ㎓)	5.70
Radiated Disturbance (18 ㎓ ~ 40 ㎓)	5.05
Radiated Disturbance (40 ㎓ ~ 243 ㎓)	4.59

6. SUMMARY TEST OF RESULTS

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
Occupied Bandwidth	§2.1049	N/A	RADIATED	PASS
Radiated Power	§95.3367(a)(b)	< EIRP 50 dBm (Average) < EIRP 55 dBm (Peak)		PASS
Unwanted emissions	§95.3379(a)(1)(2)	0.009 – 0.490 MHz: 2400/F[kHz] 0.490 – 1.705 MHz: 24000/F[kHz] 1.705 – 30.0 MHz: 30 dBuV/m 30 – 88 MHz: 30.0 dBuV/m 88 – 216 MHz: 33.5 dBuV/m 216 – 960 MHz: 36.0 dBuV/m 960 – 40 000 MHz: 54 dBuV/m 40 – 200 GHz: -1.7 dBm 200 – 243 GHz: +0.5 dBm		PASS
Fundamental Emissions(Frequency stability)	§95.3379(b)	76 – 81 GHz		PASS

- All tests is performed by radiated measurement and applied below conditions.

: Used measurement distance with far field of test such as EIRP, OBW and Band edge are as follow.

Wavelength = Speed of light / Measurement frequency = 30 / 7 700 = 0.0038

(2 X (Max antenna length of EUT)^2) / Wavelength = (2 X 0.047886)^2 / 0.0038 = 1.17 m

: Spurious emissions measurement distance is shown in table below. (Far field)

Frequency Rage (GHz)	Wavelength (cm)	Far Field Distance (m)	Measured Distance (m)
18 ~ 40	0.75	0.61	1.0
40 ~ 60	0.50	0.92	1.0
60 ~90	0.33	1.37	1.5
90 ~ 140	0.21	2.14	2.5
140 ~ 220	0.13	3.36	3.5
220 ~ 243	0.12	3.71	4.0

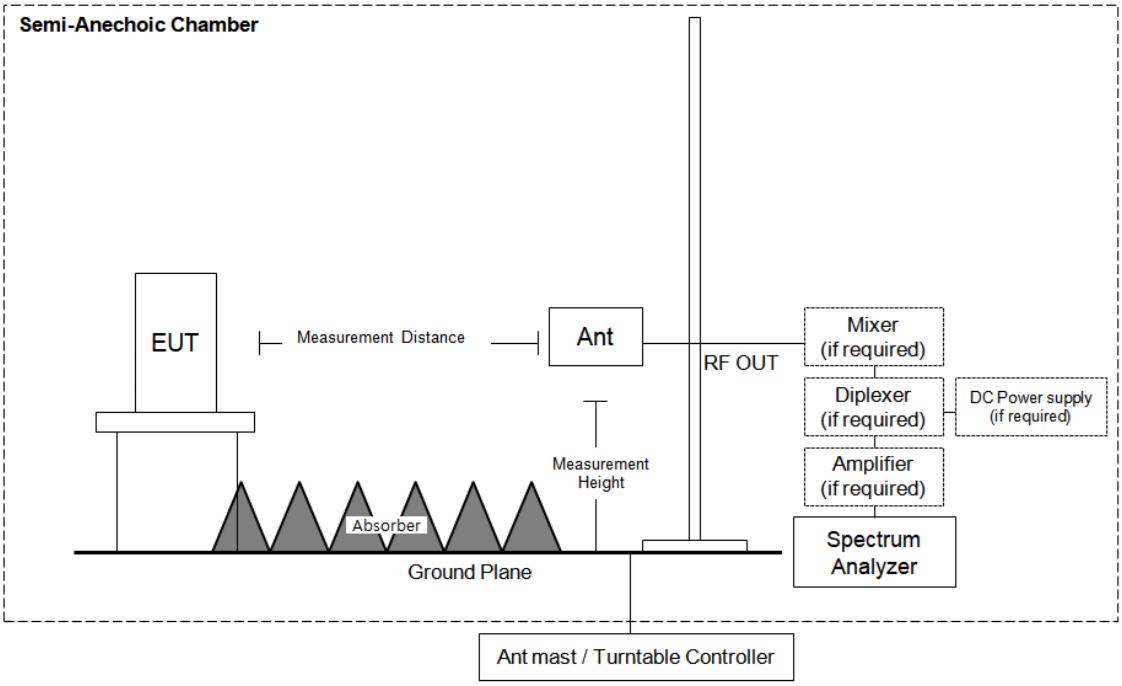
7. TEST RESULT

7.1 OCCUPIED BANDWIDTH MEASUREMENT

Test Requirements and limit, §2.1049

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

▣ **TEST CONFIGURATION**



▣ **TEST PROCEDURE**

The transmitter output is connected to the Spectrum Analyzer.

RBW = 1% to 3% of the 99% bandwidth.

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Note : 1. We tested Occupied Bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer.

▣ **RESULT PLOTS**

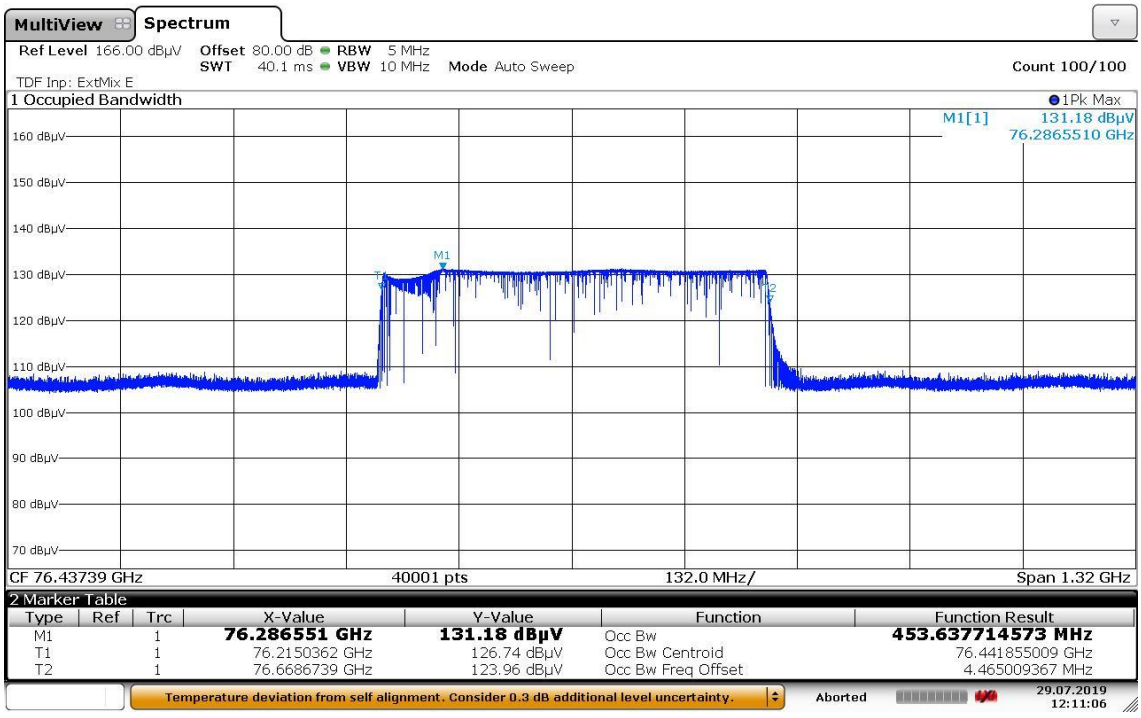
TEST CONDITIONS:		Occupied Channel Bandwidth
T nom	V nom	453.637 MHz

*** Short Distance Device**

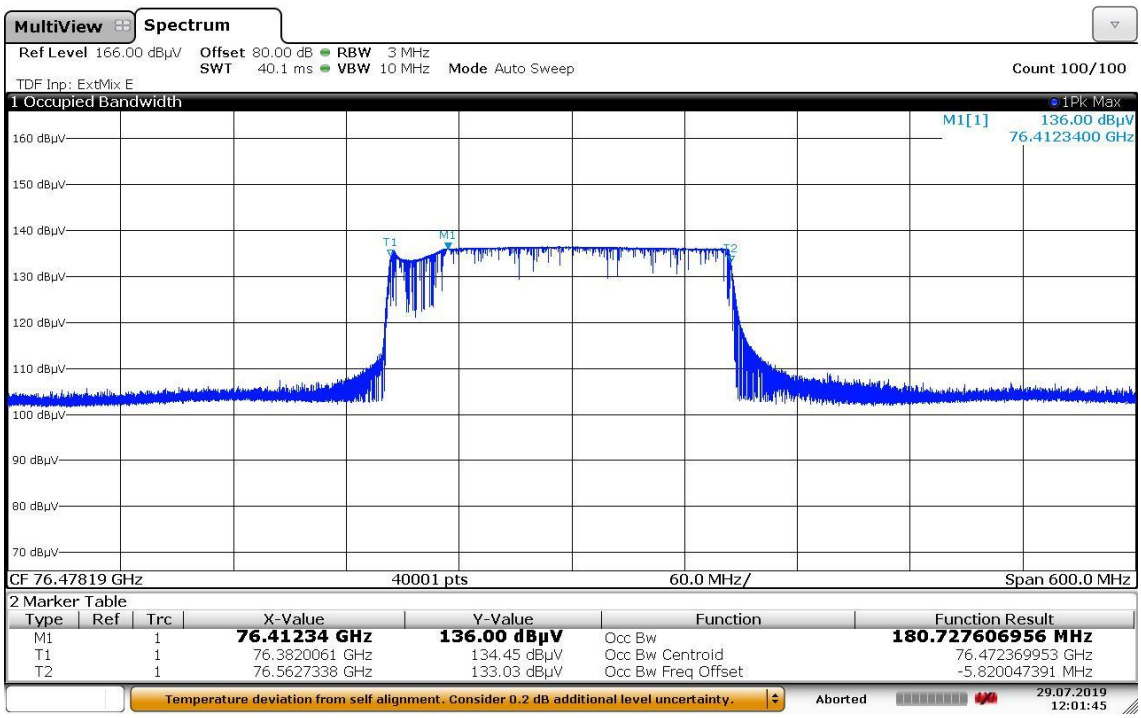
TEST CONDITIONS:		Occupied Channel Bandwidth
T nom	V nom	180.727 MHz

*** Long Distance Device**

Occupied Bandwidth plot (Short Distance Device)



Occupied Bandwidth plot (Long Distance Device)



7.2 Radiated Power

Test Requirements and limit, §95.3367

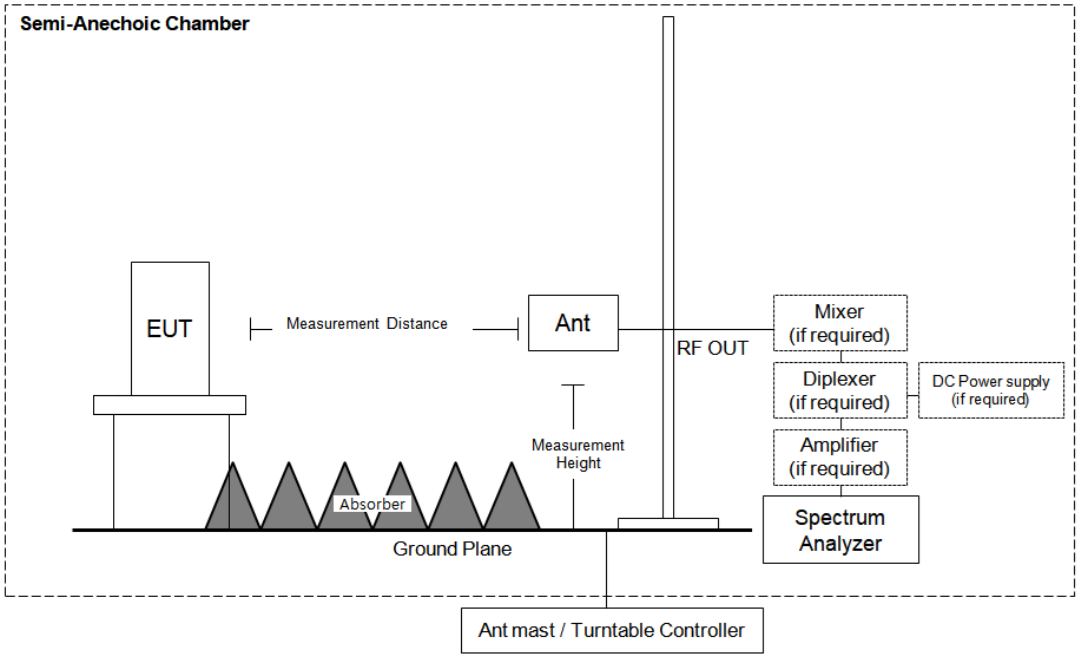
The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:

(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.

Test Configuration

40 GHz – 243 GHz



▣ TEST RESULTS

Short Distance Device

Frequency [GHz]	Measured Level [dBm]	AFCL [dB]	Ant. Pol. [H/V]	Total [dBm]	Limit [dBm]	Margin [dB]	Measurement Type
76.442	-55.77	84.67	H	28.90	55	26.10	PK
76.442	-61.29	84.67	H	23.38	50	26.62	AV

Long Distance Device

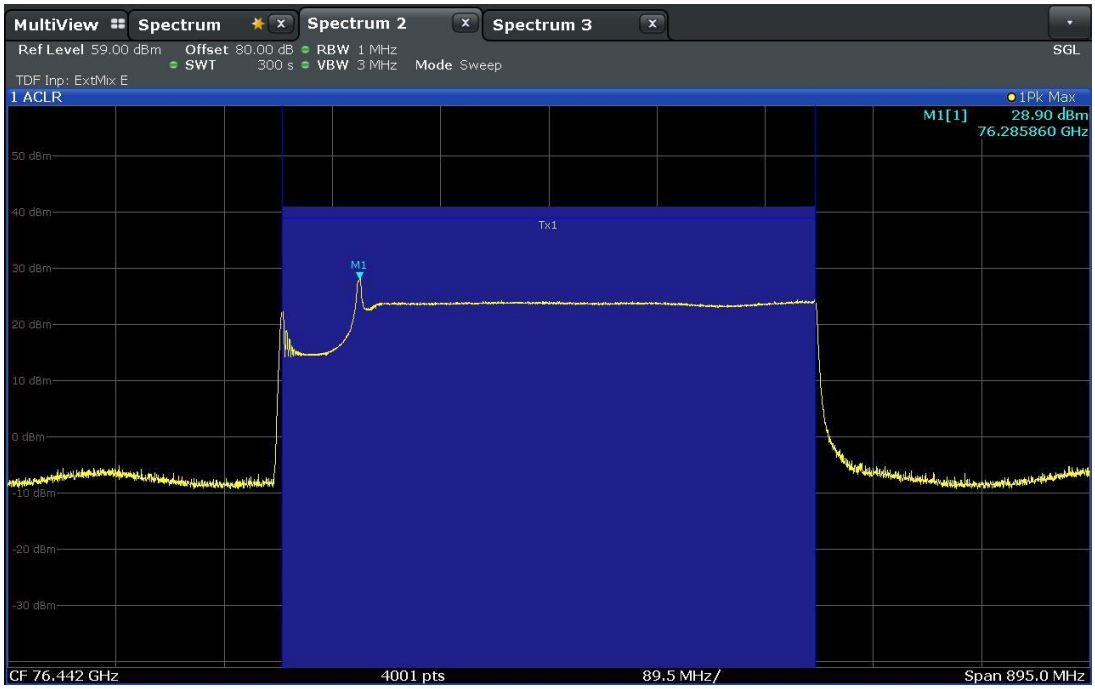
Frequency [GHz]	Measured Level [dBm]	AFCL [dB]	Ant. Pol. [H/V]	Total [dBm]	Limit [dBm]	Margin [dB]	Measurement Type
76.46	-49.39	84.67	H	35.28	55	19.72	PK
76.46	-56.94	84.67	H	27.73	50	22.27	AV

Note :

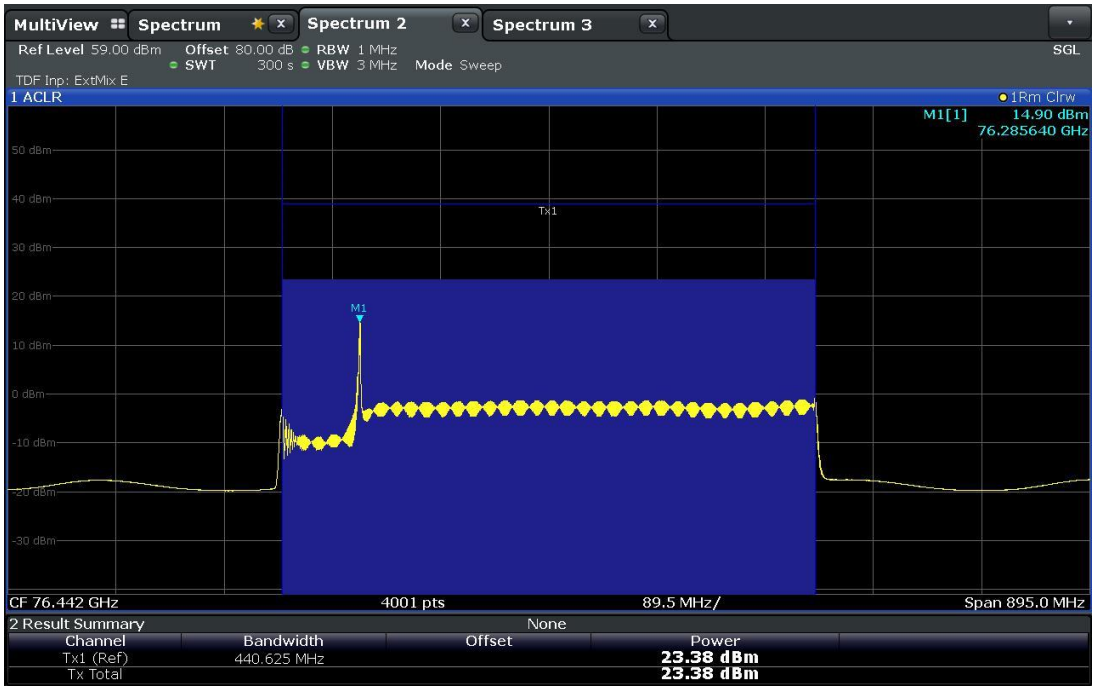
1. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

RESULT PLOTS

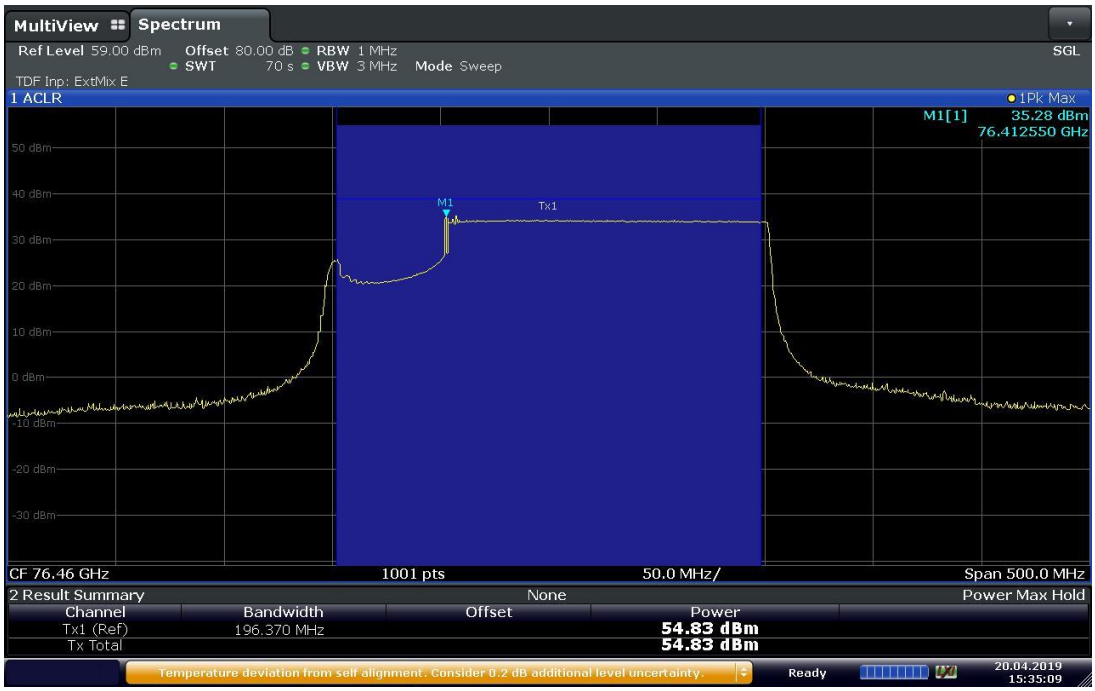
Plot (Peak) _ Short Distance Device



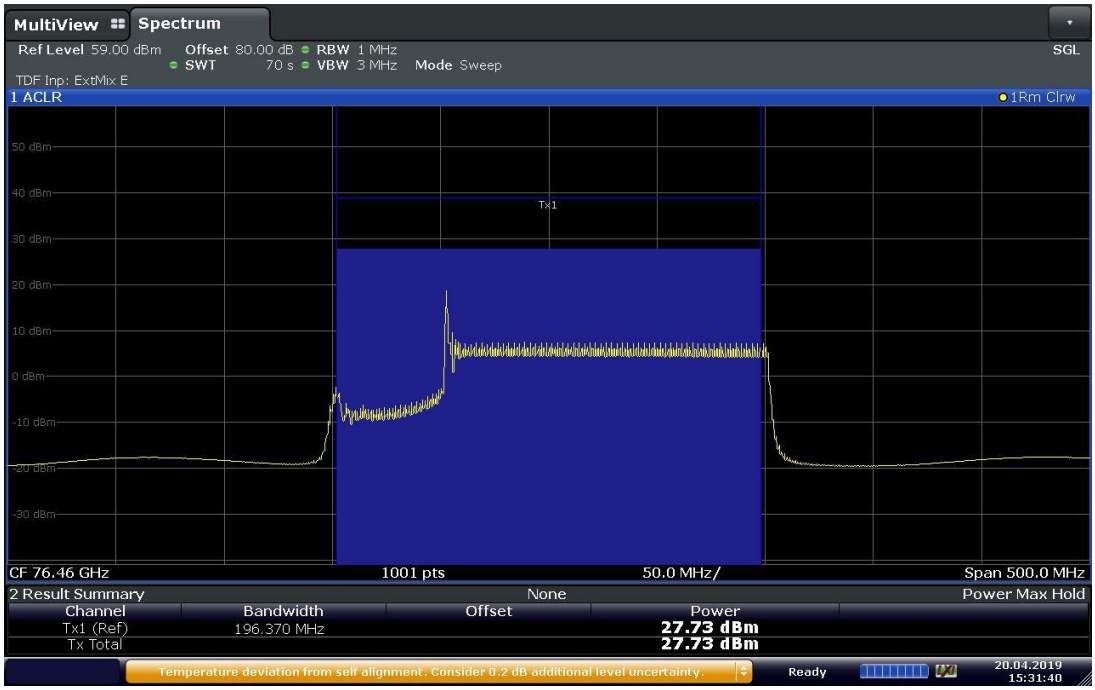
Plot (Average) _ Short Distance Device



Plot (Peak) _Long Distance Device



Plot (Average) _ Long Distance Device



7.3 Unwanted emissions

Test Requirements and limit, §95.3379

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

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

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

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

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

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

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

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

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

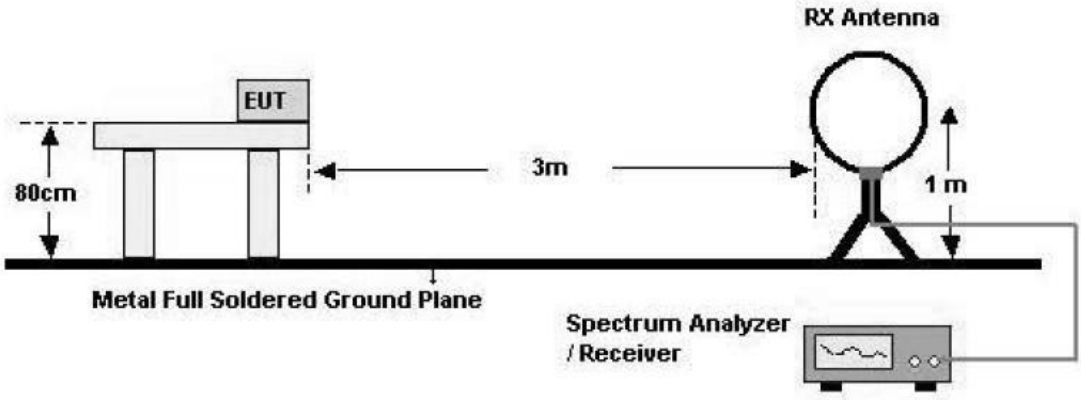
Test Procedure

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

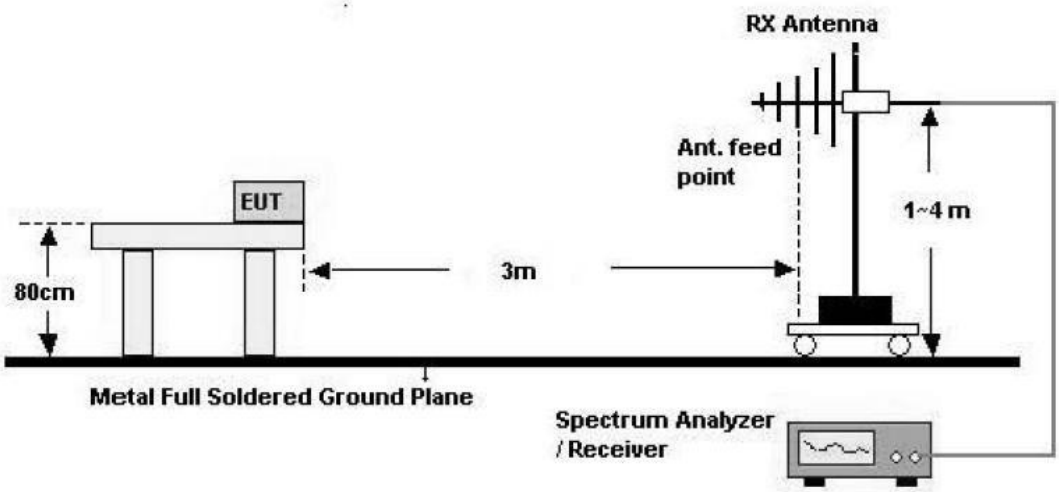
3. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
4. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
5. Repeat above procedures until the measurements for all frequencies are complete.

Test Configuration

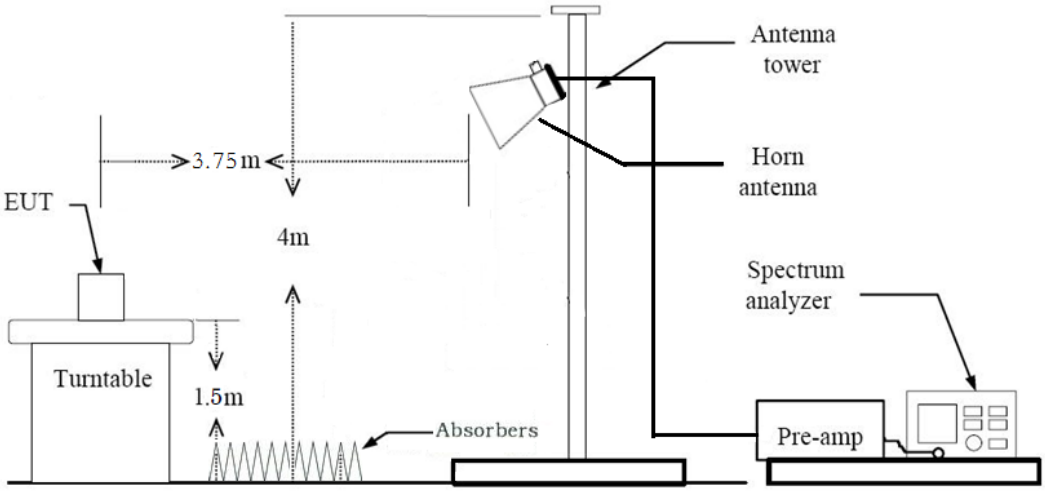
Below 30 MHz



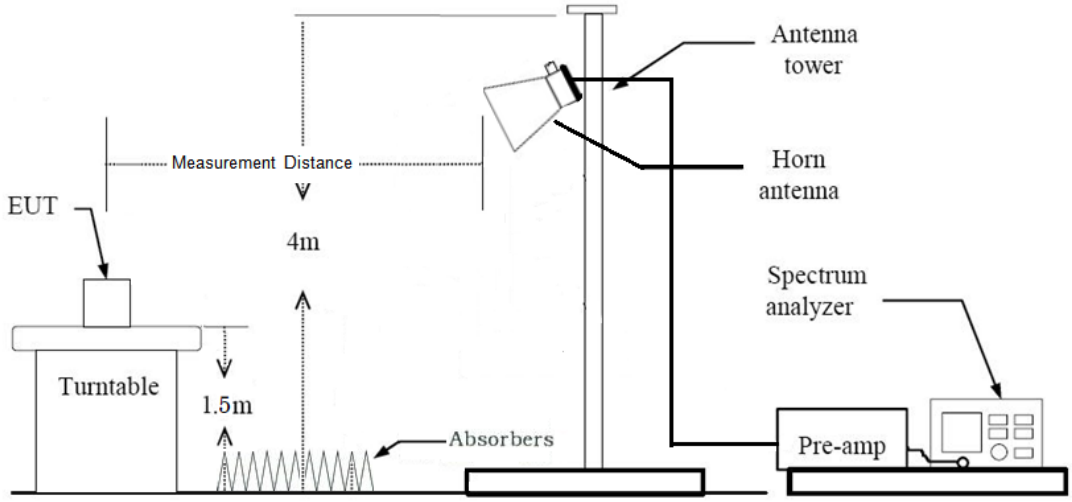
30 MHz - 1 GHz



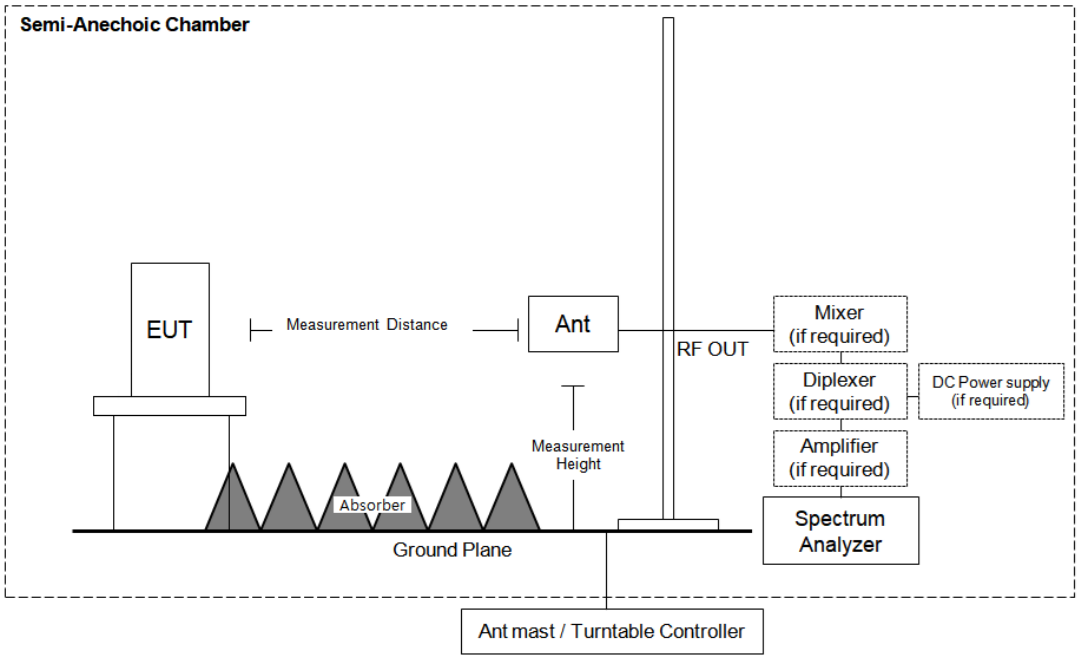
1 GHz – 18 GHz



18 GHz – 40 GHz



40 GHz – 243 GHz



▣ **TEST RESULTS**

9 kHz – 30MHz

Operation Mode: Continuous TX Mode_Short Distance Device

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Operation Mode: Continuous TX Mode_Long Distance Device

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
6. The test results for below 30 MHz is correlated to an open site.
   The result on OFTS is about 2 dB higher than semi-anechoic chamber(10 m chamber)

Below 1 GHz

Operation Mode: Continuous TX Mode_ Short Distance Device

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Operation Mode: Continuous TX Mode_ Long Distance Device

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

1 GHz – 18 GHz

Operation Frequency: Continuous TX Mode_ Short Distance Device

Frequency [MHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G +D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found							

Operation Frequency: Continuous TX Mode_ Long Distance Device

Frequency [MHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G +D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found							

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss – Amplifier Gain + Distance Factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

18 GHz – 40 GHz

Operation Frequency: Continuous TX Mode_ Short Distance Device

Frequency [GHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G [dB]	Ant. Pol. [H/V]	D.E.F [dB]	Ducy Cycle Factor	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
25.428	56.08	-4.70	V	-9.54	1.86	43.70	53.98	10.28	AV

Operation Frequency: Continuous TX Mode_ Long Distance Device

Frequency [GHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G [dB]	Ant. Pol. [H/V]	D.E.F [dB]	Ducy Cycle Factor	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
25.470	63.94	-4.70	V	-9.54	1.86	51.56	53.98	2.42	AV

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Note :

1. Total = Reading Value + Antenna Factor + Cable Loss + Distance Factor – Amp Gain
2. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
   Worst case is y plane and vertical polarization.

40 GHz – 90 GHz

Operation Frequency: Continuous TX Mode_Short Distance Device

Frequency [GHz]	Measured Level [dBm]	AFCL [dB]	Ant. Pol. [H/V]	Total [dBm]	Limit [dBm]	Margin [dB]	Measurement Type
75.85904	-102.6	84.67	H	-17.93	-1.68	16.23	AV
77.10783	-101.99	84.67	H	-17.32	-1.68	15.62	AV

Operation Frequency: Continuous TX Mode_Long Distance Device

Frequency [GHz]	Measured Level [dBm]	AFCL [dB]	Ant. Pol. [H/V]	Total [dBm]	Limit [dBm]	Margin [dB]	Measurement Type
75.8721	-102.98	84.67	H	-18.31	-1.68	16.61	AV
77.1427	-101.97	84.67	H	-17.30	-1.68	15.60	AV

Note :

1. Total(dBμV/m) = Reading Value(dBm) + AFCL(dB)
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna. Worst case is y plane and horizontal polarization.
3. In this test, AFCL factor consists of antenna factor, cable loss, mixer loss, amplifier gain
4. AV: Average

90 GHz – 243 GHz

Operation Frequency: Continuous TX Mode_ Short Distance Device

Frequency [MHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G +D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found							

Operation Frequency: Continuous TX Mode_ Long Distance Device

Frequency [MHz]	Reading [dBuV/m]	A.F.+C.L.-AMP G +D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found							

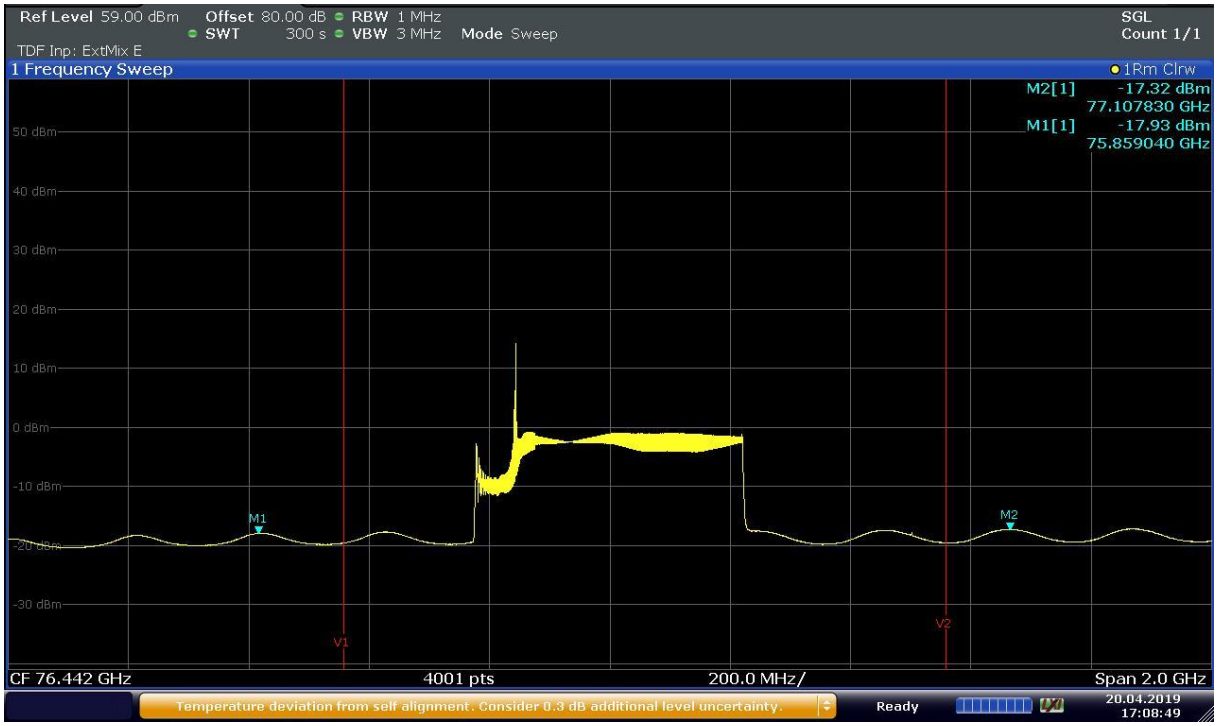
※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Notes:

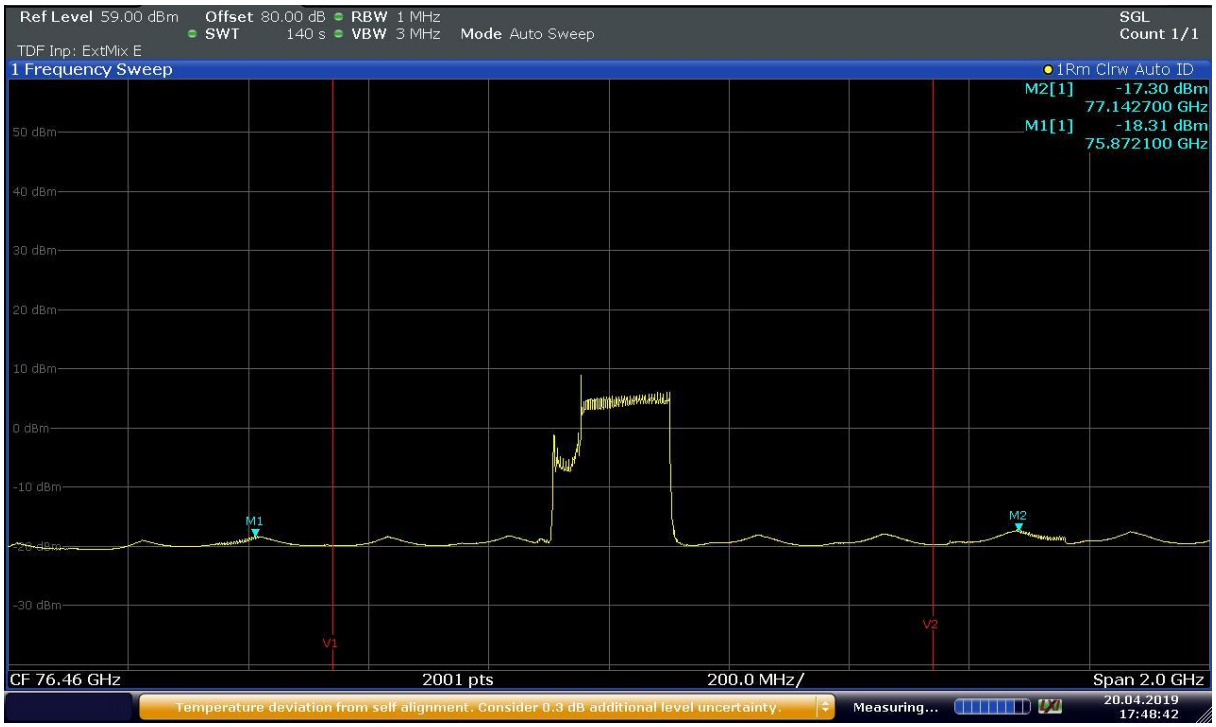
1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss – Amplifier Gain + Distance Factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

▣ RESULT PLOTS

Band Edge Plot(average, y-V)_ Short Distance Device

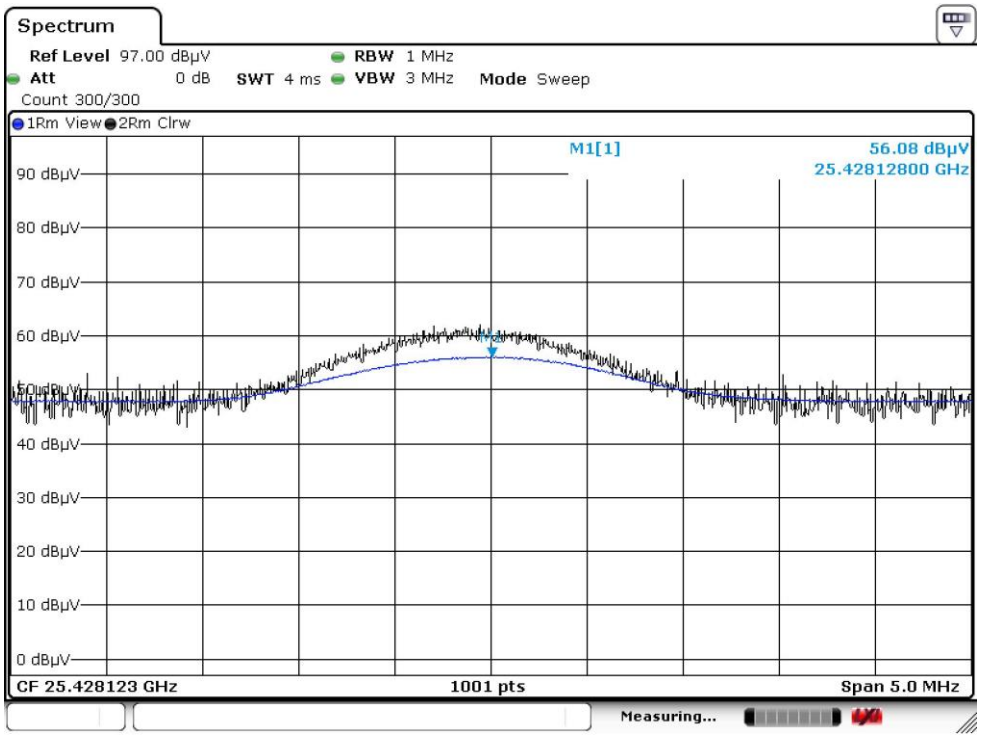


Band Edge Plot(average, y-V)_ Long Distance Device

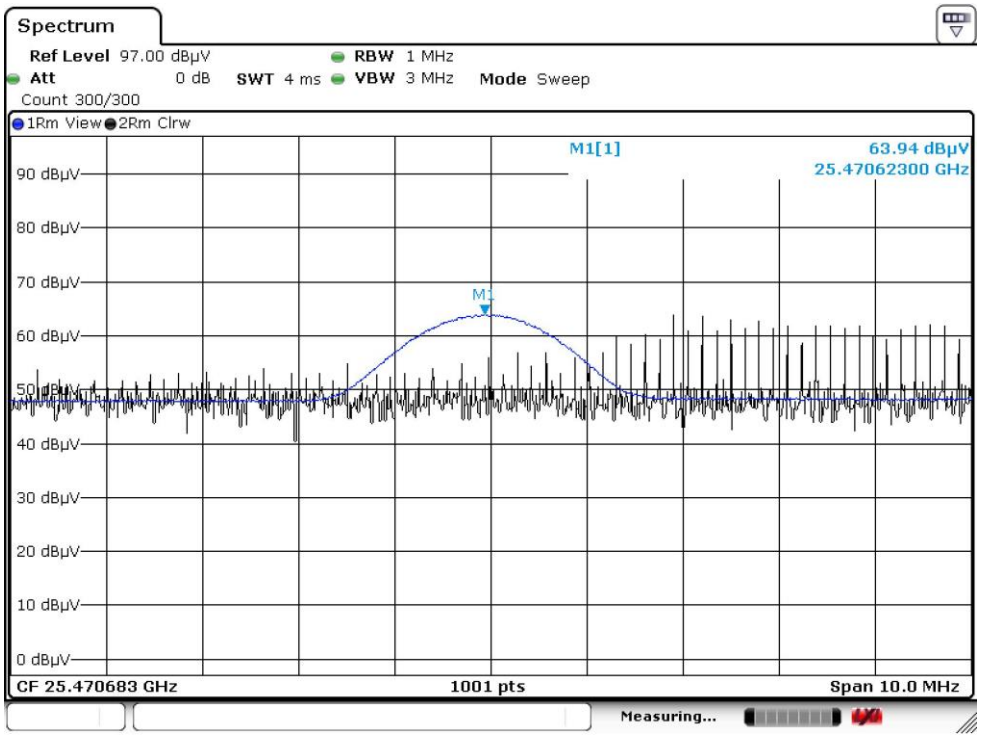


Note : Only the worst case plots for Radiated Spurious Emissions.

18 GHz – 40 GHz Plot(average, y-V)_ Short Distance Device



18 GHz – 40 GHz Plot(average, y-V)_ Long Distance Device



7.4 Fundamental emissions (Frequency Stability)

§95.3379 76 ~ 81 GHz Band Radar Service unwanted emissions 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.

▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

RBW = 1% to 3% of the 99% bandwidth.

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

The frequency drift was investigated for every 10 °C increment until the unit is stabilized then recorded the reading in tabular format with the temperature range of -40 to 85 °C.(Manufacturer declaration)

Voltage supplied to EUT is 12 V reference temperature was done at 20°C.

The voltage was varied by ± 15 % of nominal

▣ TEST RESULTS

Reference: 12 V at 20°c **Freq.** = 76.46 GHz

Voltage	Temp. (℃)	Frequency Rage (GHz)	Limit (GHz)	Result
12 V	+20(Ref)	76.221 ~ 76.662	76 ~ 81	Pass
	-40	76.238 ~ 76.657		Pass
	-30	76.235 ~ 76.655		Pass
	-20	76.232 ~ 76.651		Pass
	-10	76.233 ~ 76.660		Pass
	0	76.227 ~ 76.658		Pass
	+10	76.230 ~ 76.659		Pass
	+30	76.228 ~ 76.660		Pass
	+40	76.230 ~ 76.664		Pass
	+50	76.239 ~ 76.670		Pass
	+60	76.237 ~ 76.664		Pass
	+70	76.236 ~ 76.667		Pass
	+80	76.234 ~ 76.663		Pass
	+85	76.235 ~ 76.660		Pass
16 V	+20	76.230 ~ 76.668		Pass
9 V	+20	76.221 ~ 76.672		Pass

***Short Distance Device**

Reference: 12 V at 20°c **Freq.** = 76.46 GHz

Voltage	Temp. (℃)	Frequency Rage (GHz)	Limit (GHz)	Result
12 V	+20(Ref)	76.364 ~ 76.561	76 ~ 81	Pass
	-40	76.377 ~ 76.563		Pass
	-30	76.375 ~ 76.558		Pass
	-20	76.368 ~ 76.555		Pass
	-10	76.367 ~ 76.556		Pass
	0	76.369 ~ 76.562		Pass
	+10	76.362 ~ 76.564		Pass
	+30	76.362 ~ 76.565		Pass
	+40	76.371 ~ 76.549		Pass
	+50	76.383 ~ 76.564		Pass
	+60	76.374 ~ 76.552		Pass
	+70	76.389 ~ 76.572		Pass
	+80	76.369 ~ 76.585		Pass
	+85	76.370 ~ 76.560		Pass
16 V	+20	76.360 ~ 76.574		Pass
9 V	+20	76.356 ~ 76.569		Pass

***Long Distance Device**

8. LIST OF TEST EQUIPMENT

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Schwarzbeck	BBHA 9170 / Horn Antenna	12/04/2017	Biennial	BBHA9170541
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
Innco system	MA4640/800-XP-EP / Antenna Position Tower	N/A	N/A	N/A
Rohde&Schwarz	FSW / Spectrum Analyzer	09/27/2018	Annual	101256
Rohde&Schwarz	FSP / Spectrum Analyzer	09/19/2018	Annual	836650/016
Emco	2090 / Controller	N/A	N/A	060520
Ets	Turn Table	N/A	N/A	N/A
Rohde & Schwarz	Loop Antenna	01/18/2019	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	08/31/2018	Biennial	9168-0895
Schwarzbeck	BBHA 9120D / Horn Antenna	10/04/2017	Biennial	9120D-1298
OML INC.	WR-19 Horn Antenna / Horn Antenna	04/23/2018	Biennial	18042301
OML INC.	WR-19 Horn Antenna / Horn Antenna	04/23/2018	Biennial	18042302
OML INC.	WR-12 Horn Antenna / Horn Antenna	04/23/2018	Biennial	18042301
OML INC.	WR-12 Horn Antenna / Horn Antenna	04/23/2018	Biennial	18042302
OML INC.	WR-08 Horn Antenna / Horn Antenna	05/01/2018	Biennial	18050101
OML INC.	WR-08 Horn Antenna / Horn Antenna	05/01/2018	Biennial	18050102
OML INC.	WR-05 Horn Antenna / Horn Antenna	05/01/2018	Biennial	18050101
OML INC.	WR-05 Horn Antenna / Horn Antenna	05/01/2018	Biennial	18050102
OML INC.	WR-03 Horn Antenna / Horn Antenna	04/23/2018	Biennial	18042301
OML INC.	WR-03 Horn Antenna / Horn Antenna	04/23/2018	Biennial	18042302
OML INC.	OML WR19 / Harmonic Mixer	09/27/2018	Annual	W19HWD
OML INC.	OML WR12 / Harmonic Mixer	09/27/2018	Annual	W12HWD
OML INC.	OML WR08 / Harmonic Mixer	09/27/2018	Annual	W08HWD
OML INC.	OML WR05 / Harmonic Mixer	07/11/2018	Annual	M05HWD
OML INC.	OML WR03 / Harmonic Mixer	07/11/2018	Annual	M03HWD
OML INC.	WR-19 / Source Module	09/27/2018	Annual	S19MS-A-160516-1
OML INC.	WR-12 / Source Module	09/27/2018	Annual	S12MS-A-160419-1
OML INC.	WR-08 / Source Module	09/27/2018	Annual	S08MS-A-160419-1
OML INC.	WR-05 / Source Module	07/11/2018	Annual	S05MS-A-160419-1
OML INC.	WR-03 / Source Module	07/11/2018	Annual	S03MS-A-160419-1
OML INC.	Diplexer L.O / Diplexer	07/24/2018	Annual	DPL518-160419-1
CERNEX	CBLU1183540 / Power Amplifier	07/10/2018	Annual	22964
CERNEX	CBL26405040 / Power Amplifier	06/18/2019	Annual	25956

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.