TEST REPORT

FCC Test for MAR130
Certification

APPLICANT
Hyundai Mobis Co., Ltd

REPORT NO.
HCT-RF-2410-FC070-R1

DATE OF ISSUE
November 28, 2024

Tested by
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Technical Manager
Jong Seok Lee

Accredited by KOLAS, Republic of KOREA

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Applicant	**Hyundai Mobis Co., Ltd** 203, Teheran-ro, Gangnam-gu, Seoul, Republic of Korea
Product Name Model Name	UNIT ASSY-RR CORNER RADAR MAR130
FCC ID	TQ8-MAR130
Date of Test	October 01, 2024 ~ October 28, 2024
Location of Test	■ Permanent Testing Lab ☐ On Site Testing (Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea)
Test Standard Used	Part 95(m)
Test Results	PASS
Brand	HYUNDAI MOBIS

REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	October 30, 2024	Initial Release
1	November 28, 2024	We modified the EIRP value in the EUT Description.

Notice

Content
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. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules under normal use and maintenance. The results shown in this test report only apply to the sample(s), as received, provided by the applicant, unless otherwise stated. The test results have only been applied with the test methods required by the standard(s). The laboratory is not accredited for the test results marked *. Information provided by the applicant is marked **. Test results provided by external providers are marked ***. When confirmation of authenticity of this test report is required, please contact www.hct.co.kr This test report provides test result(s) under the scope accredited by the Korea Laboratory Accreditation Scheme (KOLAS), which signed the ILAC-MRA. (KOLAS (KS Q ISO/IEC 17025) Accreditation No. KT197)

CONTENTS

1. EUT DESCRIPTION

Model	MAR130	
Additional Model	-	
EUT Type	UNIT ASSY-RR CORNER RADAR	
EUT Serial Number	N/A	
Power Supply	12.0 V	
Frequency Range	76 GHz ~ 77 GHz	
Modulation Type	FMCW	
EIRP	Peak	28.19 dBm
	Average	19.24 dBm
Antenna Specification	Antenna type: Micro-strip Patch Antenna Peak Gain(dBi): 13.35 dBi	
Date(s) of Tests	October 01, 2024 ~ October 28, 2024	

2. TEST METHODOLOGY

The measurement procedure described in the “American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices” (ANSI C63.10-2020) Operating Under 47 CFR § 15.255 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 the ground plane below 1 GHz and 1.5 m above 1 GHz with absorbers between the EUT and receiving 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: 2020)

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 antennas(Up to 40 GHz) for measurement are 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, 17383, Rep. of 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 March 11, 2024 (CAB identifier: 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. ANTENNA REQUIREMENTS

According to FCC 47 CFR § 15.203:

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

The antennas of this E.U.T are permanently attached.

6. 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 kHz ~ 30 MHz)	4.14 (Confidence level about 95 %, k=2)
Radiated Disturbance (30 MHz ~ 1 GHz)	5.82 (Confidence level about 95 %, k=2)
Radiated Disturbance (1 GHz ~ 18 GHz)	5.74 (Confidence level about 95 %, k=2)
Radiated Disturbance (18 GHz ~ 40 GHz)	5.76 (Confidence level about 95 %, k=2)
Radiated Disturbance (Above 40 GHz)	5.52 (Confidence level about 95 %, k=2)

7. SUMMARY TEST OF RESULTS

Test Description	FCC Part	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 dBµV/m 30 – 88 MHz: 30.0 dBµV/m 88 – 216 MHz: 33.5 dBµV/m 216 – 960 MHz: 36.0 dBµV/m 960 – 40 000 MHz: 54 dBµV/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 / 7 625 = 0.0039

(2 X (Max antenna length of EUT)^2) / Wavelength = 2 X (0.04273)^2 / 0.0039 = 0.93 m

Measurement Antenna's far-field distance = 0.93 m

So, the measurement distance is 1.0 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	3.154	3.50
40 ~ 60	0.50	1.354	1.50
60 ~90	0.33	0.856	1.50
90 ~ 140	0.21	0.572	1.50
140 ~ 220	0.13	0.365	1.50
220 ~ 243	0.12	0.187	1.50

8. TEST RESULT

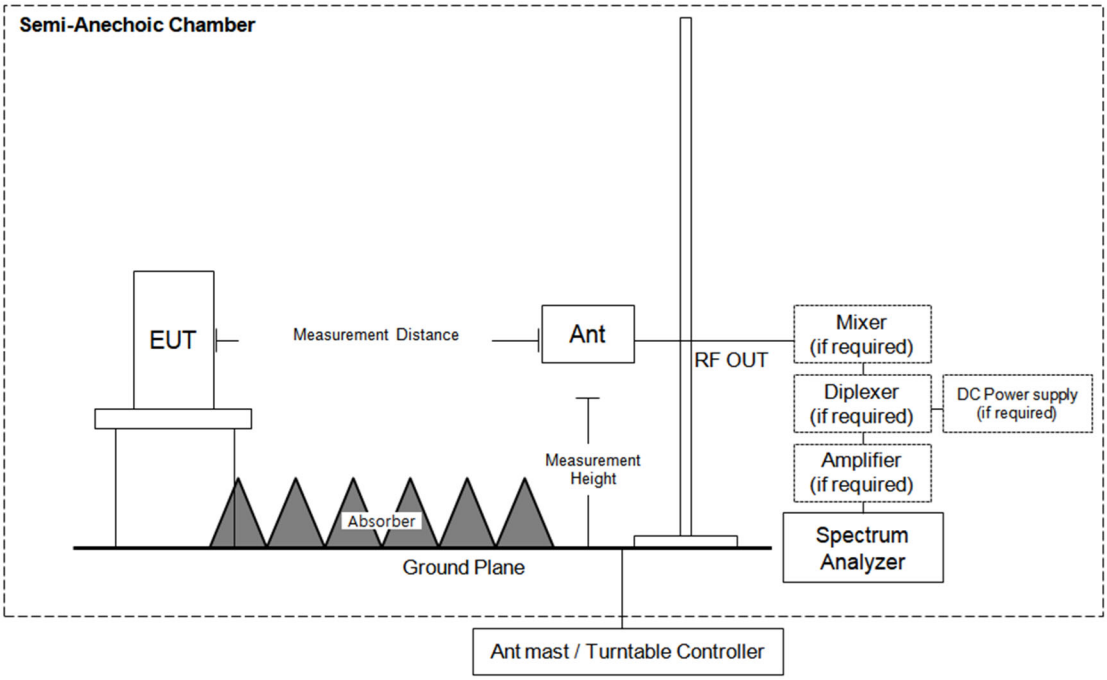
8.1 OCCUPIED BANDWIDTH MEASUREMENT

▣ TEST REQUIREMENTS AND LIMITS

§ 2.1049 Measurements required: Occupied bandwidth.

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

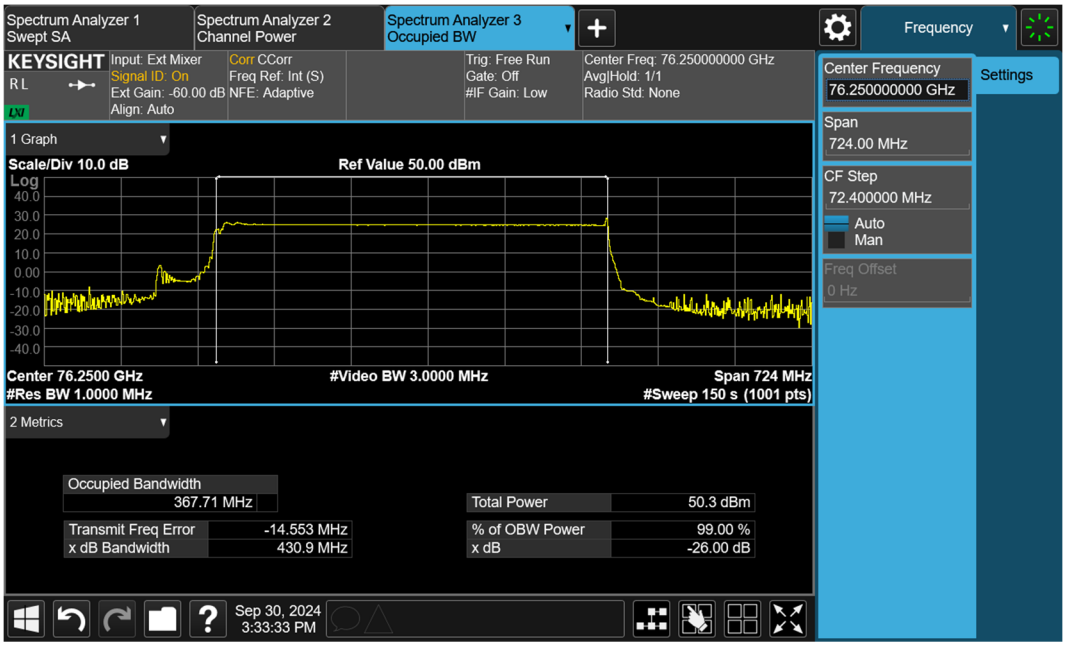
Note : We tested Occupied Bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer.

▣ TEST RESULTS

TEST CONDITIONS:		Occupied Channel Bandwidth [MHz]
T nom	V nom	367.71

▣ RESULT PLOTS

Occupied Bandwidth plot



8.2 RADIATED POWER

▣ TEST REQUIREMENTS AND LIMITS

FCC Rules

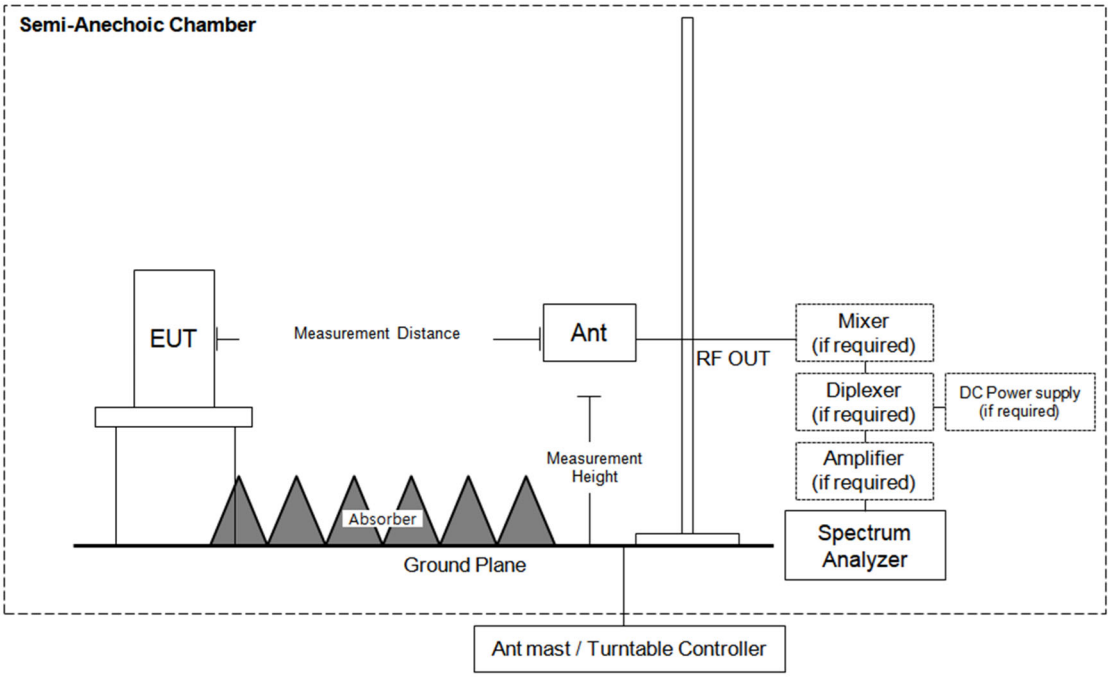
§ 95.3367 76–81 GHz Band Radar Service radiated power limits.

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.

▣ TEST CONFIGURATION



▣ TEST RESULTS

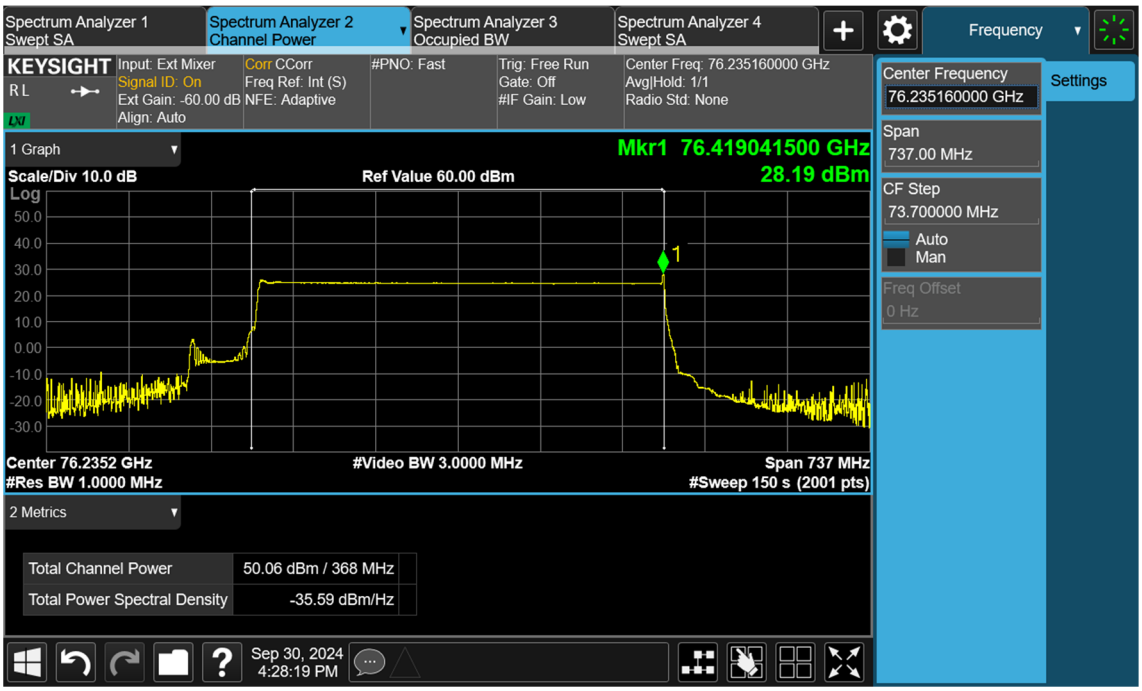
Frequency	Measured Level	AFCL	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[dBm]	[dB]	[H/V]	[dBm]	[dBm]	[dB]	
76.2352	-65.43	84.67	H	28.19	55	26.81	PK
76.2352	-56.48	84.67	H	19.24	50	30.76	AV

Note :

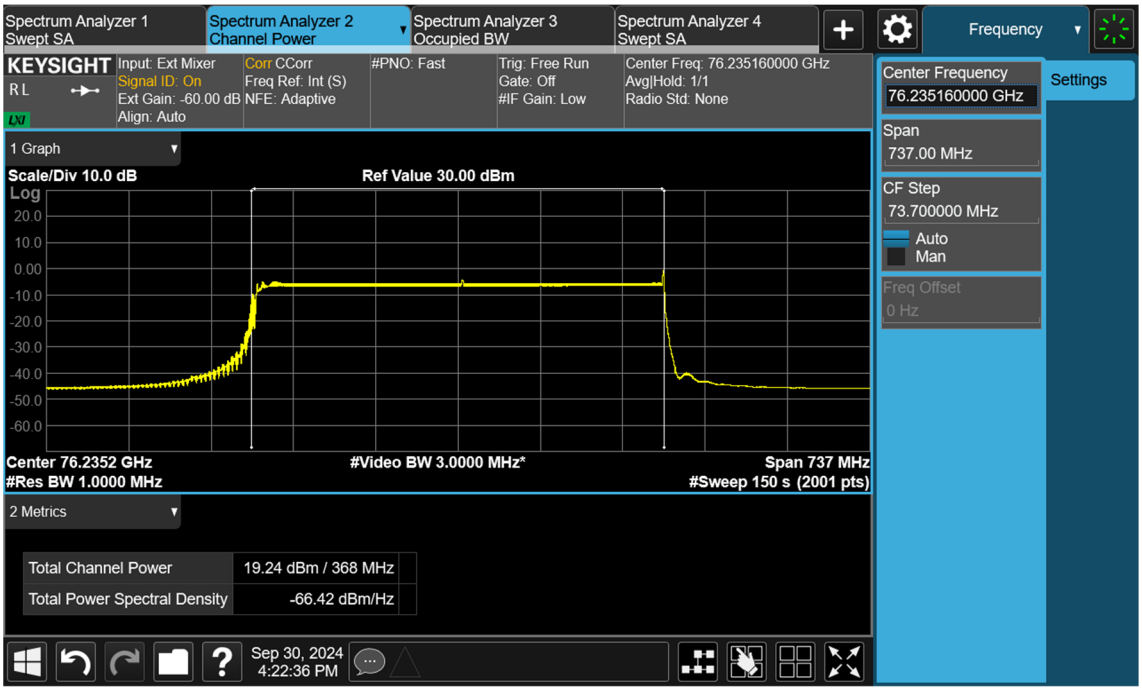
1. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

▣ RESULT PLOTS

Plot (Peak) _ Normal Resolution



Plot (Average) _ Normal Resolution



8.3 UNWANTED EMISSIONS

▣ TEST REQUIREMENTS AND LIMITS

§ 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 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/cm2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm2 at a distance of 3 meters from the exterior surface of the radiating structure.

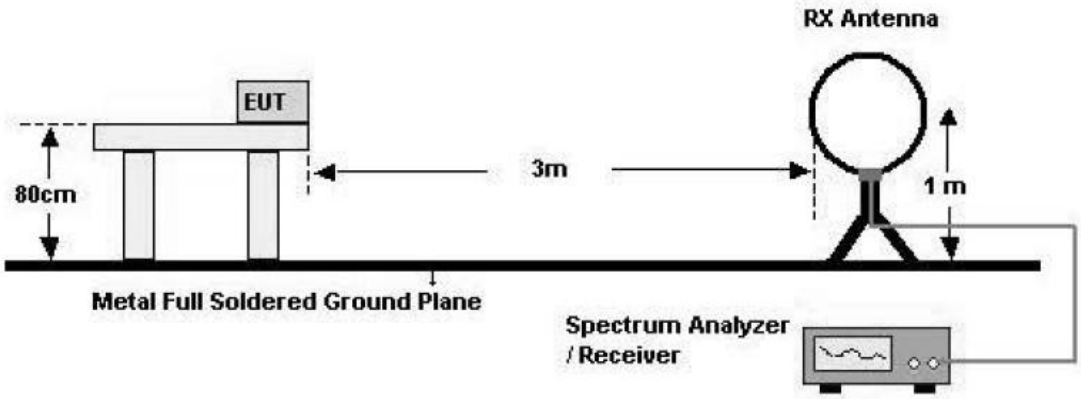
(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

▣ TEST PROCEDURE

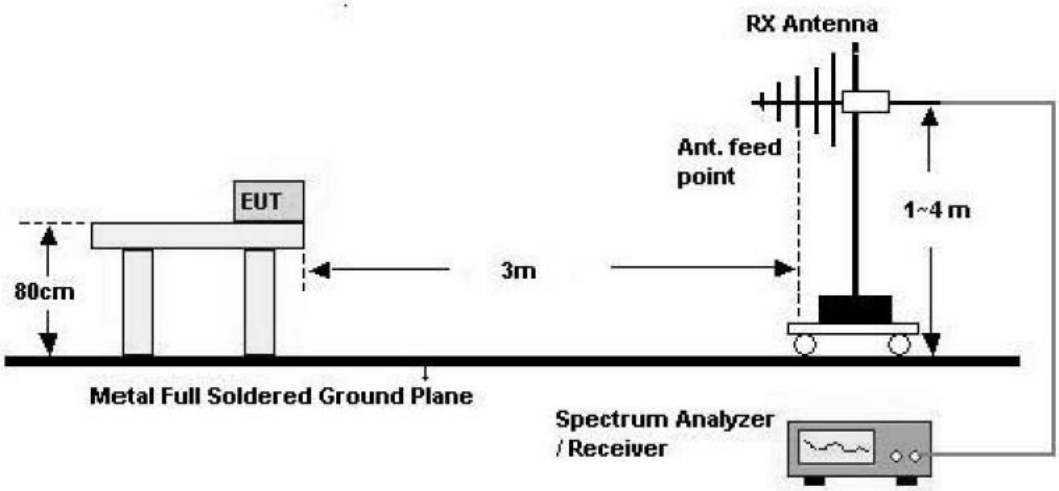
1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
4. And also, each emission was to be 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

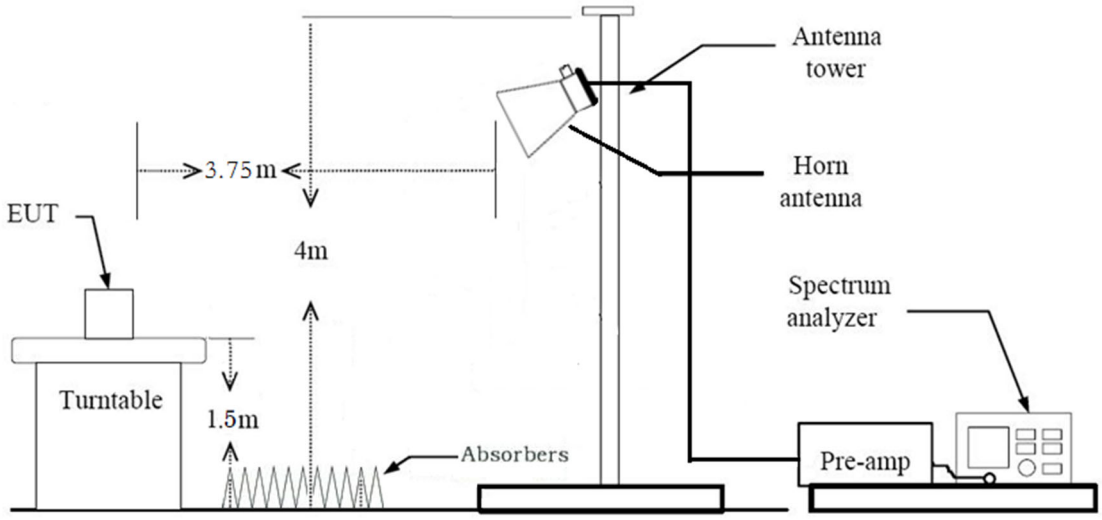
Below 30 MHz



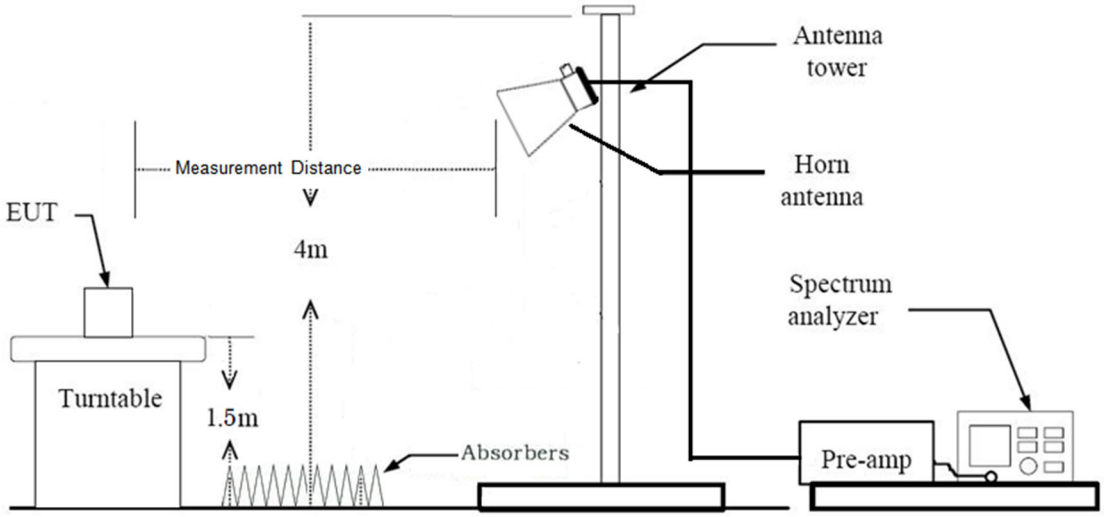
30 MHz - 1 GHz



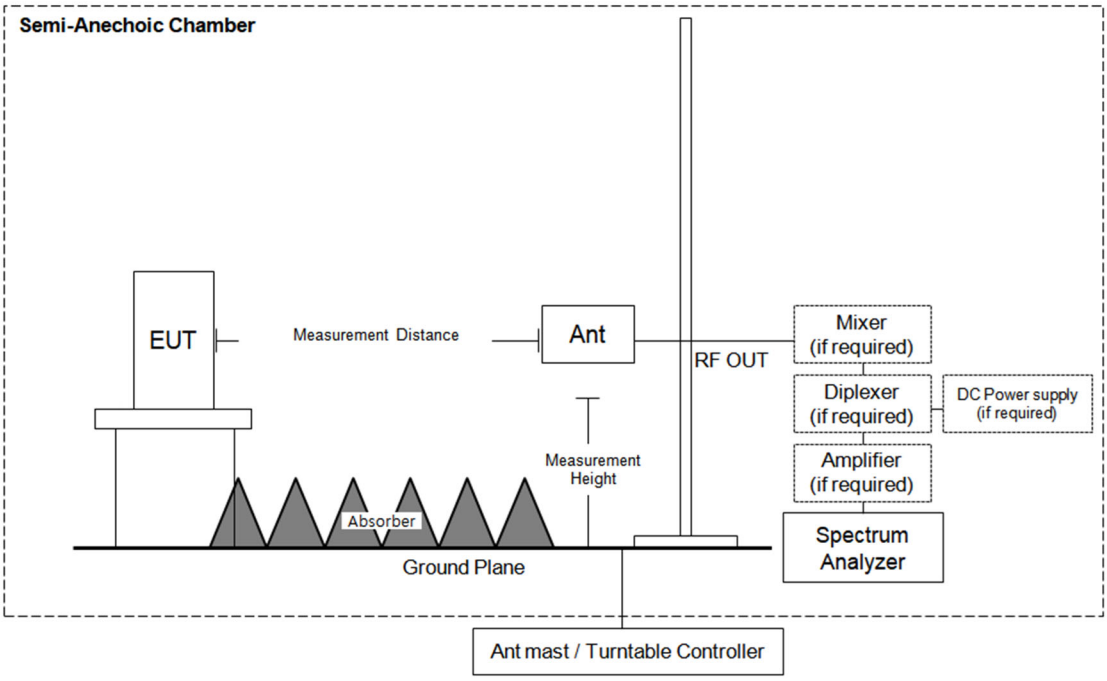
1 GHz – 18 GHz



18 GHz – 40 GHz



40 GHz – 243 GHz



▣ TEST RESULTS

9 kHz – 30MHz

Frequency	Measured Level	Ant. factor	Cable loss	Ant. Pol.	Total	Limit	Margin
No Critical peaks found							

Notes:

1. Measuring frequencies from 9 kHz to the 30 MHz.
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 (dBμV) + 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

Frequency	Measured Level	Ant. factor	Cable loss	Ant. Pol.	Total	Limit	Margin
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

Frequency	Measured Level	Ant. factor	Cable loss	Amp. Gain	Ant. Pol.	Total	Limit	Margin
No Critical peaks found								

Notes:

1. Measuring frequencies from 1 GHz to the 18 GHz.
2. 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.
3. Total = Measured Level + Antenna Factor + Cable Loss – Amplifier Gain + Distance Factor
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

18 GHz – 40 GHz

Frequency [MHz]	Measured Level [dBµV]	A.F. + C.L. - A.G. + D.F. [dB/m]	Ant. Pol. (H/V)	Total [dBµV/m]	Limit [dBµV/m]	Margin [dB]
No Critical peaks found						

Note :

1. Measuring frequencies from 18 GHz to the 40 GHz.
2. Total = Measured Value + Antenna Factor + Cable Loss - Amplifier Gain + Distance Factor
3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
4. 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

Frequency	Measured Level	Ant. factor	Cable loss	Mixer Loss	Amp. Gain	Ant. Pol.	Total	Limit	Margin
No Critical peaks found									

Note :

1. Measuring frequencies from 40 GHz to the 90 GHz.
2. Total = Measured Value + Antenna Factor + Cable Loss + Mixer Loss - Amplifier Gain
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

90 GHz – 243 GHz

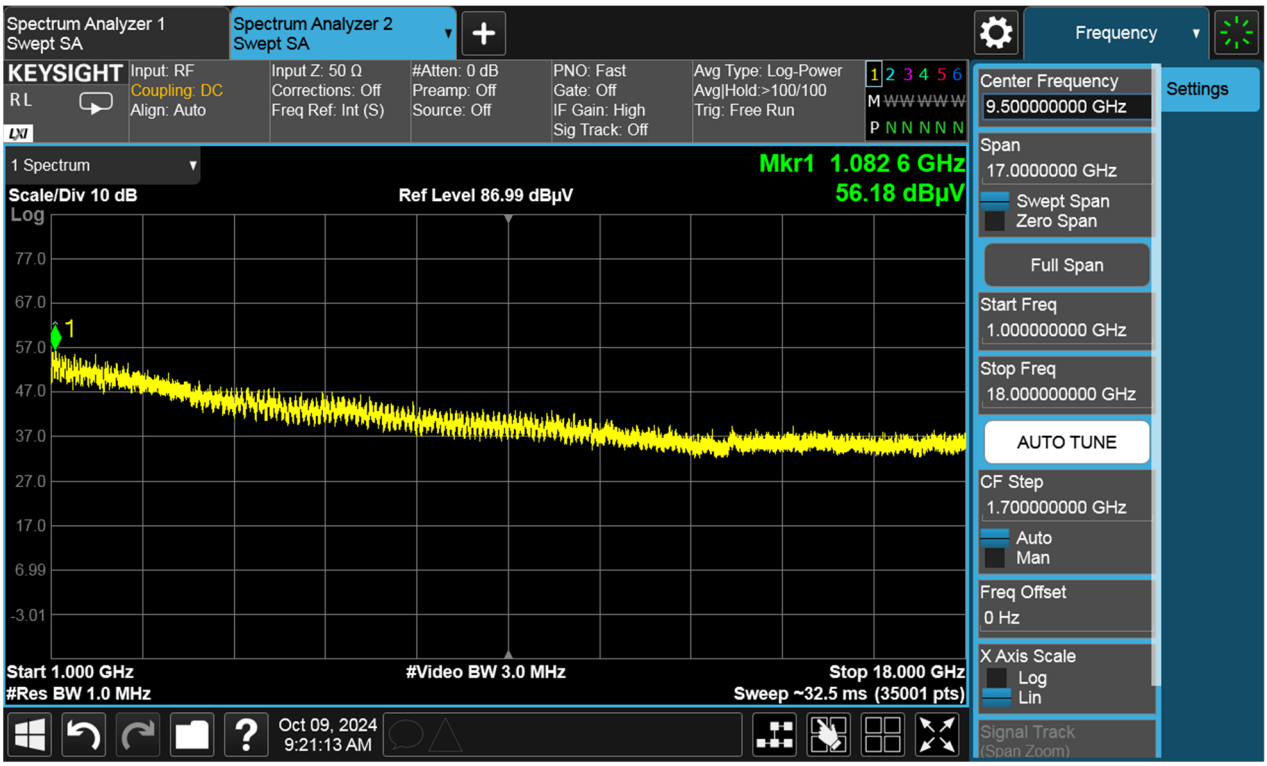
Frequency	Measured Level	Ant. factor	Cable loss	Mixer Loss	Amp. Gain	Ant. Pol.	Total	Limit	Margin
No Critical peaks found									

Notes:

1. Measuring frequencies from 90 GHz to the 243 GHz.
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. Total = Measured Value + Antenna Factor + Cable Loss + Mixer Loss - Amplifier Gain
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

▣ RESULT PLOTS

Unwanted Emission Plot



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

8.4 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.

Tested it with the voltage provided by the manufacturer.

▣ TEST RESULTS

Reference: 12 V at 20°C **Freq.** = 76.250 GHz

Voltage	Temp.	Low Frequency	High Frequency	Limit	Result
(V)	(°C)	(GHz)	(GHz)	(GHz)	
12	+20(Ref)	76.075	76.339	76 ~ 81	Pass
	-40	76.121	76.438		Pass
	-30	76.154	76.430		Pass
	-20	76.085	76.393		Pass
	-10	76.073	76.355		Pass
	0	76.150	76.445		Pass
	10	76.145	76.498		Pass
	30	76.080	76.496		Pass
	40	76.055	76.376		Pass
	50	76.072	76.349		Pass
	60	76.077	76.820		Pass
	70	76.110	76.321		Pass
	80	76.101	76.498		Pass
	85	76.076	76.513		Pass
9	20	76.055	76.418		Pass
16	20	76.058	76.423		Pass

9. LIST OF TEST EQUIPMENT

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
Spectrum Analyzer	N9030B	Keysight	MY60070602	04/26/2025	Annual
Spectrum Analyzer	FSW85	Rohde & Schwarz	101256	10/02/2025	Annual
Controller (Antenna mast)	CO3000	Innco system	CO3000-4p	N/A	N/A
Antenna Position Tower	MA4640/800-XP-EP	Innco system	S4AM	08/07/2025	N/A
Temperature and Humidity Chamber	SH-242	ESPEC	93010360	06/13/2025	Annual
Turn Table	DS2000-S	Innco system	N/A	N/A	N/A
Loop Antenna	FMZB 1513	Rohde & Schwarz	1513-175	01/16/2025	Biennial
Hybrid Antenna	VULB 9168	Schwarzbeck	9168-0895	03/09/2025	Biennial
Horn Antenna	BBHA 9120D	Schwarzbeck	02296	09/11/2025	Biennial
Horn Antenna	BBHA 9170	Schwarzbeck	BBHA9170541	11/01/2025	Biennial
Horn Antenna	WR-19 Horn Antenna	OML INC.	M19RH-180423-2	03/07/2026	Biennial
Horn Antenna	WR-12 Horn Antenna	OML INC.	M12RH-180423-2	03/07/2026	Biennial
Horn Antenna	WR-08 Horn Antenna	OML INC.	M08RH-180501-2	03/07/2026	Biennial
Horn Antenna	WR-05 Horn Antenna	OML INC.	M05RH-180501-2	03/07/2026	Biennial
Spectrum Analyzer Extension Module	WR19SAX-M	VDI	SAX 771	03/06/2025	Annual
Spectrum Analyzer Extension Module	WR12SAX-M	VDI	SAX 773	03/06/2025	Annual
Spectrum Analyzer Extension Module	WR8.0SAX-M	VDI	SAX 779	03/06/2025	Annual
Spectrum Analyzer Extension Module	WR5.1SAX-M	VDI	SAX 774	03/06/2025	Annual

Note:

1. All equipment is calibrated with traceable calibrations.
2. Each calibration is traceable to the national or international standards.
3. Equipment listed above that calibrated during the testing period was set for test after the calibration.
4. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date, or will be test after the calibration is completed.

10. ANNEX A_TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-2410-FC070-P