

FCC Test Report

Product Name	Radar Sensor
Model No	TK0020
FCC ID	2A6LN-TK0020

Applicant	Biological Sensing System Co., Ltd.
Address	2F., NO. 4, S. 3RD RD.CIANJHEN DIST.KAOHSIUNG CITY 806011, TAIWAN

Date of Receipt	Apr. 12, 2022
Issued Date	May 24, 2022
Report No.	2240312R-RFUSOTHV12-A
Report Version	V1.0



The test results relate only to the samples tested.

The test results shown in the test report are traceable to the national/international standard through the calibration report of the equipment and evaluated measurement uncertainty herein.

This report must not be used to claim product endorsement by TAF or any agency of the government.

The test report shall not be reproduced without the written approval of DEKRA Testing and Certification Co., Ltd.

Measurement uncertainties evaluated for each testing system and associated connections are given here to provide the system information for reference. Compliance determinations do not take into account measurement uncertainties for each testing system, but are based on the results of the compliance measurement.

Test Report

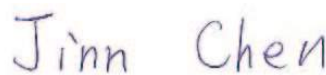
Issued Date: May 24, 2022

Report No.: 2240312R-RFUSOTHV12-A



Product Name	Radar Sensor
Applicant	Biological Sensing System Co., Ltd.
Address	2F., NO. 4, S. 3RD RD.CIANJHEN DIST.KAOHSIUNG CITY 806011, TAIWAN
Manufacturer	Biological Sensing System Co., Ltd.
Model No.	TK0020
FCC ID.	2A6LN-TK0020
EUT Rated Voltage	DC 5V by USB
EUT Test Voltage	DC 5V by USB
Trade Name	Biological Sensing System Co., Ltd.
Applicable Standard	FCC CFR Title 47 Part 95 Subpart M: 2019 ANSI C63.10: 2013
Test Result	Complied

Documented By :



(Supervisor / Jinn Chen)

Tested By :



(Senior Engineer / Nova Chu)

Approved By :



(Senior Engineer / Alan Chen)

TABLE OF CONTENTS

Description	Page
1. GENERAL INFORMATION.....	5
1.1. EUT Description.....	5
1.2. Tested System Details.....	6
1.3. Configuration of tested System	6
1.4. EUT Exercise Software	7
1.5. Test Facility	8
1.6. List of Test Equipment	9
1.7. Uncertainty	11
2. Maximun output power (EIRP).....	12
2.1. Test Setup	12
2.2. Limits	12
2.3. Test Procedure	13
2.4. Far field distance (R).....	14
2.5. Test Result of Maximum conducted output power (EIRP)	15
3. Radiated Emission.....	16
3.1. Test Setup	16
3.2. Limits	17
3.3. Test Procedure	19
3.4. Test Result of Radiated Emission.....	20
4. Occupied Bandwidth.....	22
4.1. Test Setup	22
4.2. Limits	22
4.3. .Test Procedure	22
4.4. Test Result of Occupied Bandwidth	23
5. Frequency Stability	24
5.1. Test Setup	24
5.2. Limit	24
5.3. Test Procedure	25
5.4. Test Result of Frequency Stability.....	26
6. EMI Reduction Method During Compliance Testing	27

Appendix 1: EUT Test Photographs

Appendix 2: Product Photos-Please refer to the file: 2240312R-Product Photos

Revision History

Report No.	Version	Description	Issued Date
2240312R-RFUSOTHV12-A	V1.0	Initial issue of report.	May 24, 2022

1. GENERAL INFORMATION

1.1. EUT Description

Product Name	Radar Sensor
Trade Name	Biological Sensing System Co., Ltd.
FCC ID.	2A6LN-TK0020
Model No.	TK0020
Frequency Range	76 – 81GHz
Channel Control	Auto
Type of Modulation	FMCW

Antenna List

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	MTK	MT2706	Integrated Antenna	5 dBi

Test Mode	Mode 1: Transmit mode
-----------	-----------------------

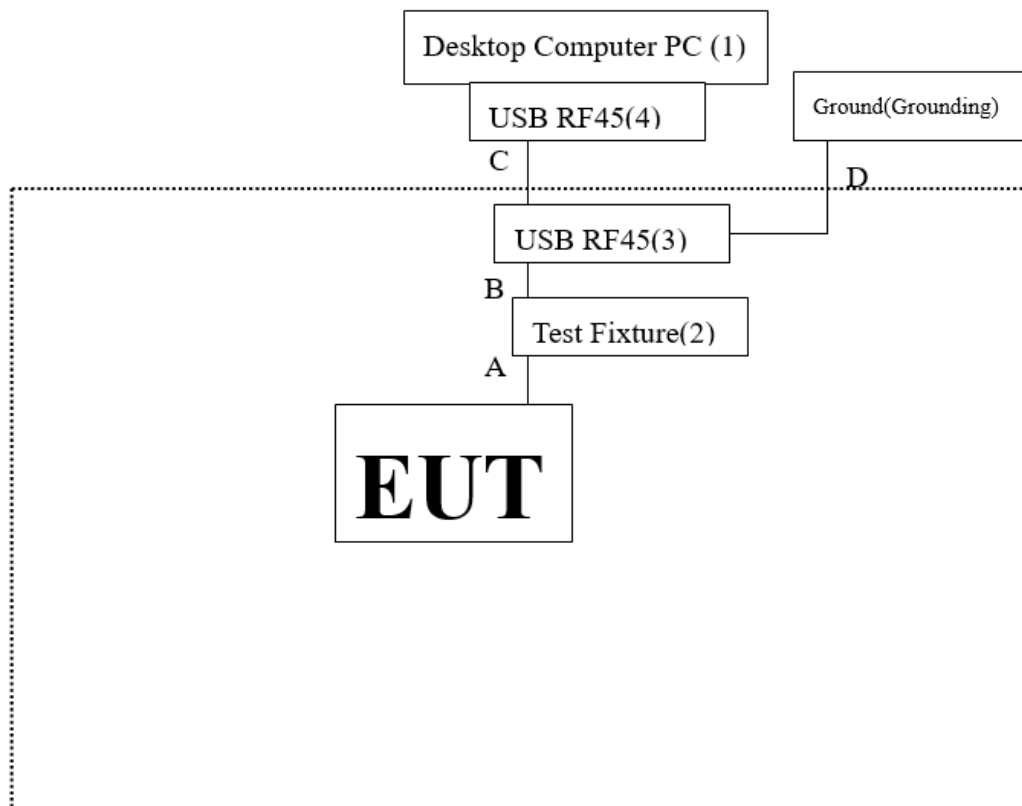
1.2. Tested System Details

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Product	Manufacturer	Model No.	Serial No.	Power Cord
1 Desktop Computer PC	JONSBO	C2S	N/A	N/A
2 Test Fixture	Biological Sensing System	MT3608	N/A	N/A
3 USB RF45	SNLLMZI	LNU47	N/A	N/A
4 USB RF45	SNLLMZI	LNU47	N/A	N/A

Signal Cable Type	Signal cable Description
A Single Cable	Shielded, 2.9m, with twelve cores bonded.
B USB Cable	Shielded, 0.3m, with three cores bonded.
C Lan Cable	Shielded, 10m
D Grounding Cable	Shielded, 2m

1.3. Configuration of tested System



1.4. EUT Exercise Software

1. Setup the EUT as shown in Section 1.3.
2. Execute software “Test.exe” on the Notebook PC.
3. Verify that the EUT works properly.

1.5. Test Facility

Ambient conditions in the laboratory:

Performed Item	Items	Required	Actual
Radiated Emission	Temperature (°C)	10~40 °C	21.5 °C
	Humidity (%RH)	10~90 %	57.8 %
Conductive	Temperature (°C)	10~40 °C	22.5 °C
	Humidity (%RH)	10~90 %	55.6%

USA : **FCC Registration Number: TW0033**

Canada : **CAB Identifier Number: TW3023 / Company Number: 26930**

Site Description : Accredited by TAF
Accredited Number: 3023

Test Laboratory : DEKRA Testing and Certification Co., Ltd
Address : No. 5-22, Ruishukeng Linkou District, New Taipei City,
24451, Taiwan

Performed Location : No. 26, Huaya 1st Rd., Guishan Dist., Taoyuan City
333411, Taiwan, R.O.C.

Phone number : +886-3-275-7255
Fax number : +866-3-327-8031
Email address : info.tw@dekra.com
Website : <http://www.dekra.com.tw>

1.6. List of Test Equipment

For Test Site number: SH03

	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due. Date
X	Temperature Chamber	KSON	THS-D4T-100	A0606	2021/08/24	2022/08/23
X	DC Power Supply	GW Instek	SPD-3606	GEQ820915	2021/07/09	2022/07/08
X	Signal Analyzer	R&S	FSV40	101149	2022/02/18	2023/02/17
X	Spectrum Analyzer	Keysight	N9030B	MY56320509	2021/08/06	2022/08/05
X	Horn Antenna	VDI	RCH015 (50-75GHz)	N/A	2020/11/02	2023/11/01
	Horn Antenna	VDI	RCH010(75-110GHz)	N/A	2020/11/02	2023/11/01
	Horn Antenna	VDI	RCH06(110-170GHz)	N/A	2020/11/02	2023/11/01
	Horn Antenna	VDI	RCH08(90-140GHz)	N/A	2020/11/02	2023/11/01
	Horn Antenna	VDI	RCH05(140-220GHz)	N/A	2020/11/02	2023/11/01

Note:

1. The mm-Wave equipment (above 50GHz) is calibrated every three years, the other equipments are calibrated every one year.
2. The test instruments marked with “X” are used to measure the final test results.

For Radiated measurements / 966-2

	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due. Date
X	Signal Analyzer	R&S	FSV3044	101115	2022/01/10	2023/01/09
X	Spectrum Analyzer	Keysight	N9030B	MY56320509	2021/08/06	2022/08/05
X	Horn Antenna	VDI	RCH015 (50-75GHz)	N/A	2020/11/02	2023/11/01
X	Horn Antenna	VDI	RCH010(75-110GHz)	N/A	2020/11/02	2023/11/01
X	Horn Antenna	VDI	RCH08(90-140GHz)	N/A	2020/11/02	2023/11/01
X	Horn Antenna	VDI	RCH05(140-220GHz)	N/A	2020/11/02	2023/11/01
X	Horn Antenna	VDI	RCH03(220-325GHz)	N/A	2020/11/02	2023/11/01
X	Down Convertor(SAX093)	VDI	N9029AV15(AT0-55847)	US54250106	2020/11/02	2023/11/01
X	Down Convertor(SAX092)	VDI	N9029AV10(AT0-74929)	US53250010	2020/11/02	2023/11/01
X	Down Convertor(SAX091)	VDI	N9029AV08(AT0-59571)	US53250004	2020/11/02	2023/11/01
X	Down Convertor(SAX090)	VDI	N9029AV05(AT0-60029)	US53250004	2020/11/02	2023/11/01
X	Down Convertor(SAX214)	VDI	N9029AV03(AT0-57775)	US53250006	2020.11/02	2023/11/01
	Loop Antenna	AMETEK	HLA6121	56736	2022/04/14	2023/04/13
X	Bi-Log Antenna	SCHWARZBECK	VULB9168	9168-675	2021/08/11	2022/08/10
X	Horn Antenna	ETS-Lindgren	3117	00203799	2021/12/27	2022/12/26
X	Horn Antenna	Com-Power	AH-840	101087	2021/06.16	2022/06/15
X	Pre-Amplifier	EMCI	EMC001330	980302	2021/07.06	2022/07/05
X	Pre-Amplifier	EMCI	EMC051835SE	980632	2021/09/07	2022/09/06
X	Pre-Amplifier	EMCI	EMC05820SE	980285	2021/07/02	2022/07/01
X	Pre-Amplifier	EMCI	EMC184045SE	980369	2022/05/12	2023/05/11
X	Coaxial Cable	EMCI	EMC102-KM-KM-600	1160314		
X	Coaxial Cable	EMCI	EMC102-KM-KM-7000	170242		
X	EMI Test Receiver	R&S	ESR	102793	2021/12/15	2022/12/14
X	Coaxial Cable	SGH	HA800	GD20110223-2	2022/03/17	2023/03/16
		SGH	HA800	GD20110222-4		
		SGH	SGH18	2021005-2		
		SGH	SGH18	202108-5		
	Fixed Attenuator	VDI	WR15ATT2R1	1-10	2019/09/03	2022/09/02
	Direct reading Attenuator	Elmika	DA-02E	804E90-01	2019/09/03	2022/09/02
	Direct reading Attenuator	Elmika	DA-02E	803E90-21	2019/09/03	2022/09/02
	Direct reading Attenuator	Elmika	DA-02E	802E90-31	2019/09/03	2022/09/02

Note:

1. The mm-Wave equipment (above 50GHz) is calibrated every three years, the other equipments are calibrated every one year.
2. The test instruments marked with "X" are used to measure the final test results.
3. Test Software version: AUDIX e3 V9.

1.7. Uncertainty

Uncertainties have been calculated according to the DEKRA internal document.

The reported expanded uncertainties are based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

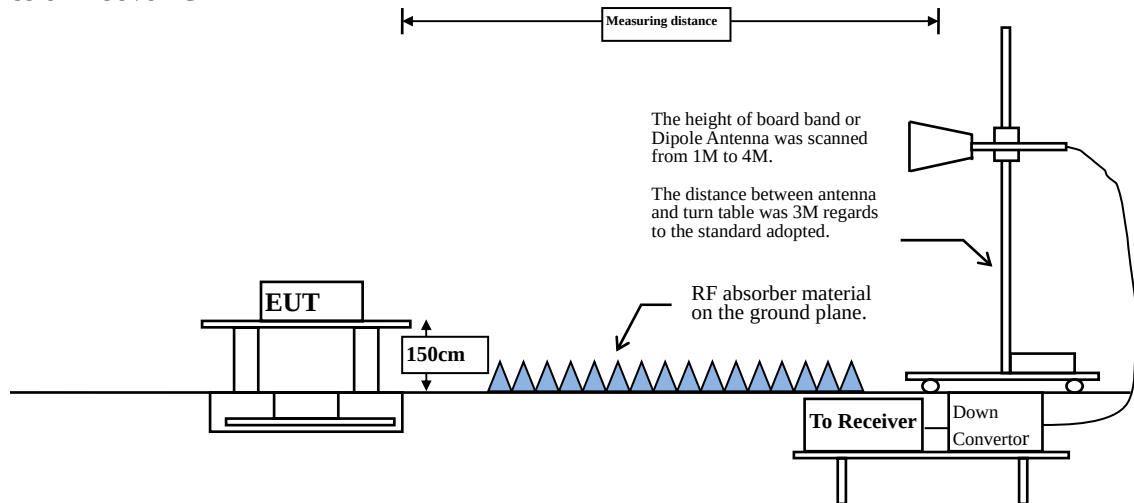
Measurement uncertainties evaluated for each testing system and associated connections are given here to provide the system information for reference. Compliance determinations do not take into account measurement uncertainties for each testing system, but are based on the results of the compliance measurement.

Test item	Uncertainty	
Maximun output power (EIRP)	± 0.91 dB	
Radiated Emission	Under 1GHz ± 4.06 dB	Above 1GHz ± 3.73 dB
Occupied Bandwidth	± 682.83 Hz	
Frequency Stability	± 682.83 Hz	

2. Maximun output power (EIRP)

2.1. Test Setup

Radiated Emission Above 1GHz



2.2. Limits

§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.

2.3. Test Procedure

Maximum power(EIRP) –Averaging detector

Note: The maximum power(averaging detector) measurements are performed using the “channel power” measurement capability and integrated over the 99% OBW to obtain the result.

1. Measurement capability of instrument = channel power
2. Set RBW = 1MHz
3. Set VBW $\geq 3 \times$ RBW
4. span to 2 x to 3 x the OBW
5. Channel bandwidth setting of instrument $\geq$ OBW
6. Detector = power averaging (rms)
7. Set number of points in sweep $\geq 2 \times$ span / RBW
8. Sweep time=auto-couple
9. Trace = averaging

Maximum peak power(EIRP) –Peak detector

1. Set RBW = 1MHz
2. Set VBW $\geq 3 \times$ RBW
3. span to 2 x to 3 x the OBW
4. Detector = Peak
5. Set number of points in sweep $\geq 2 \times$ span / RBW
6. Sweep time=auto-couple
7. Trace = max-hold

Measuring the frequency range above 1GHz, the EUT is placed on a turn table which is 1.5 meter above ground.

The turn table is rotated 360 degrees to determine the position of the maximum emission level.

The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna is scanned between 1 meter and 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.26: 2015-Section 5.5 on radiated measurement.

The resolution bandwidth below 30MHz setting on the field strength meter is above 1GHz is 1MHz. Radiated emission measurements above 1GHz are made using Horn Antennas.

The measurement is divided into the Preliminary Measurement and the Final Measurement.

The suspected frequencies are searched for in Preliminary Measurement with the measurement antenna kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. The antenna is pointed at an angle towards the source of the emission, and the EUT is rotated in both height and polarization to maximize the measured emission. The emission is kept within the illumination area of the 3 dB bandwidth of the antenna.

2.4. Far field distance (R)

$$R = \frac{2D^2}{\lambda}$$

, where, D=the largest dimension of the antenna

λ =the wavelength of the emissions

Frequency Range(GHz)	λ (m)	D (m)	R (m)	Measurement Distance(m)
77	0.0039	0.025	0.32	1.5

2.5. Test Result of Maximum conducted output power (EIRP)

Product : Radar Sensor
 Test Item : Maximum conducted output power
 Test Mode : Mode 1: Transmit mode
 Test Date : 2022/04/28

Test Frequency (GHz)	Test Conditions	EIRP (dBm)		EIRP Limit (dBm)	
		Peak	Average	Peak	Average
76-77	Tnom (25°C)/ Vnom (12V)	19.94	8.31	55	50

Step 1: $E = 126.8 - 20\log(\lambda) + P - G$

E is the field strength of the emission at the measurement distance, in dBμV/m

P is the power measured at the output of the test antenna, in dBm

λ is the wavelength of the emission under investigation [300/fMHz], in m

G is the gain of the test antenna, in dBi

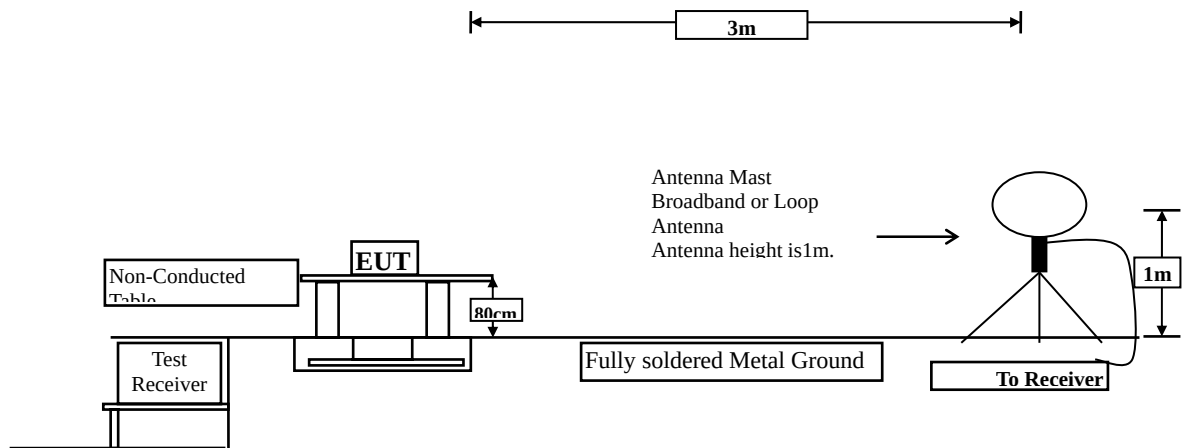
Step 2: $EIRP (dBm) = E + 20\log(D) - 104.8$

where D is the measurement distance (in the far field region) in m.

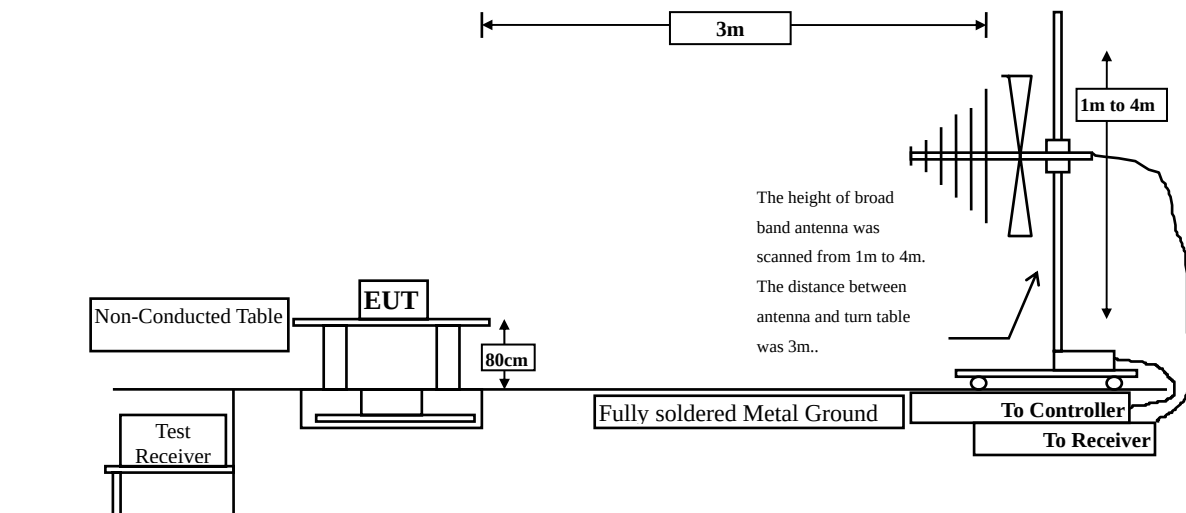
3. Radiated Emission

3.1. Test Setup

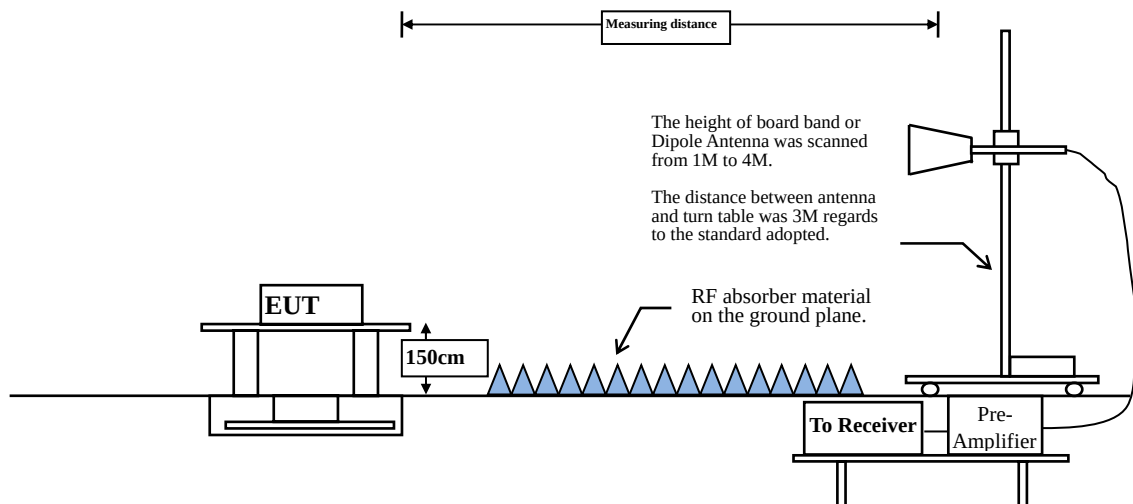
Radiated Emission Under 30MHz



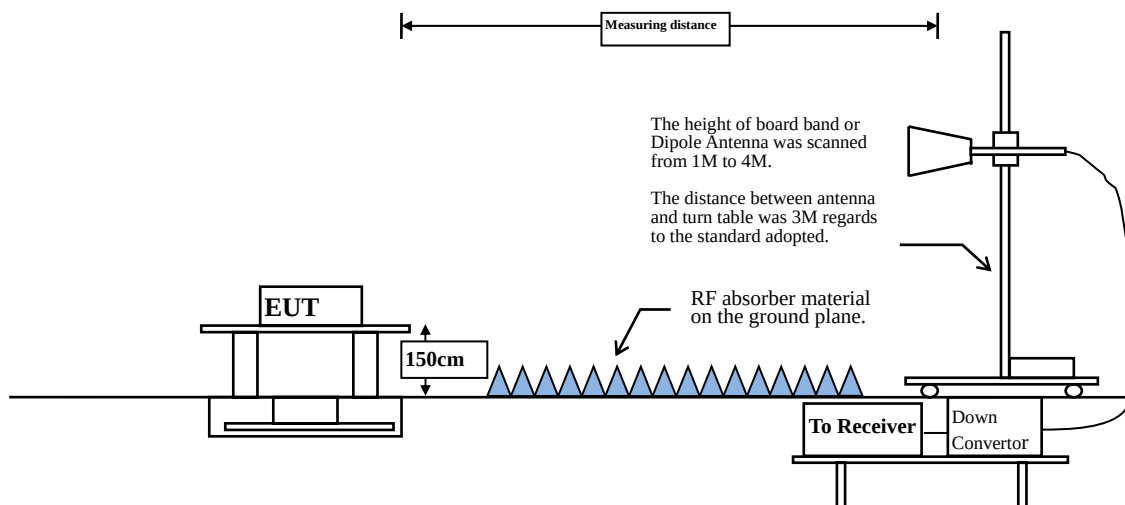
Radiated Emission Below 1GHz



Radiated Emission Above 1GHz



Radiated Emission Above 50GHz



3.2. 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.

FCC Part 15 Subpart C Paragraph 15.209(a) Limits		
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	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remarks: E field strength (dBμV/m) = 20 log E field strength (uV/m)

(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.

3.3. Test Procedure

Measuring the frequency range below 1GHz, the EUT is placed on a turn table which is 0.8 meter above ground, when measuring the frequency range above 1GHz, the EUT is placed on a turn table which is 1.5 meter above ground.

The turn table is rotated 360 degrees to determine the position of the maximum emission level.

The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna is scanned between 1 meter and 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10: 2013 on radiated measurement.

The resolution bandwidth below 30MHz setting on the field strength meter is 9kHz and 30MHz~1GHz is 120kHz and above 1GHz is 1MHz.

Radiated emission measurements below 30MHz are made using Loop Antenna and 30MHz~1GHz are made using broadband Bilog antenna and above 1GHz are made using Horn Antennas.

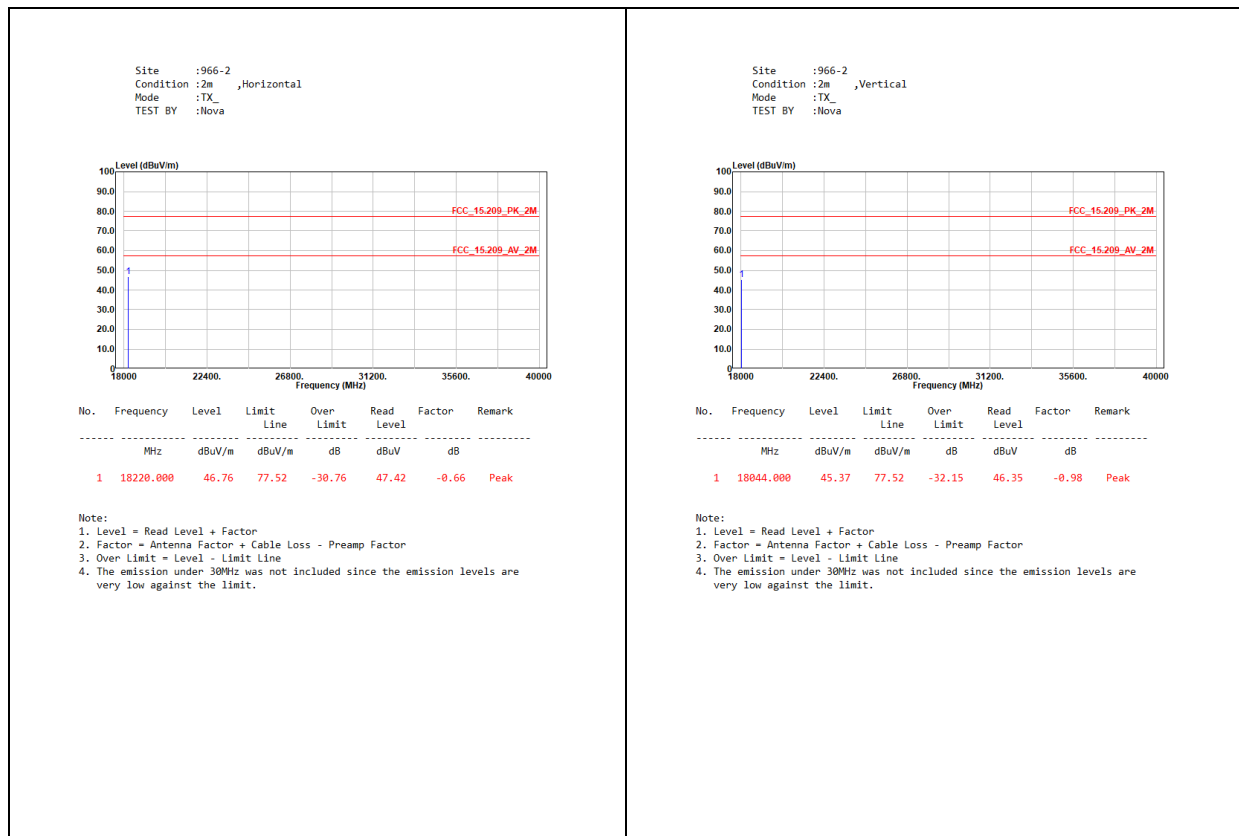
The measurement is divided into the Preliminary Measurement and the Final Measurement.

The suspected frequencies are searched for in Preliminary Measurement with the measurement antenna kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. The antenna is pointed at an angle towards the source of the emission, and the EUT is rotated in both height and polarization to maximize the measured emission. The emission is kept within the illumination area of the 3 dB bandwidth of the antenna.

The measurement frequency range from 9kHz – 231GHz was investigated.

3.4. Test Result of Radiated Emission



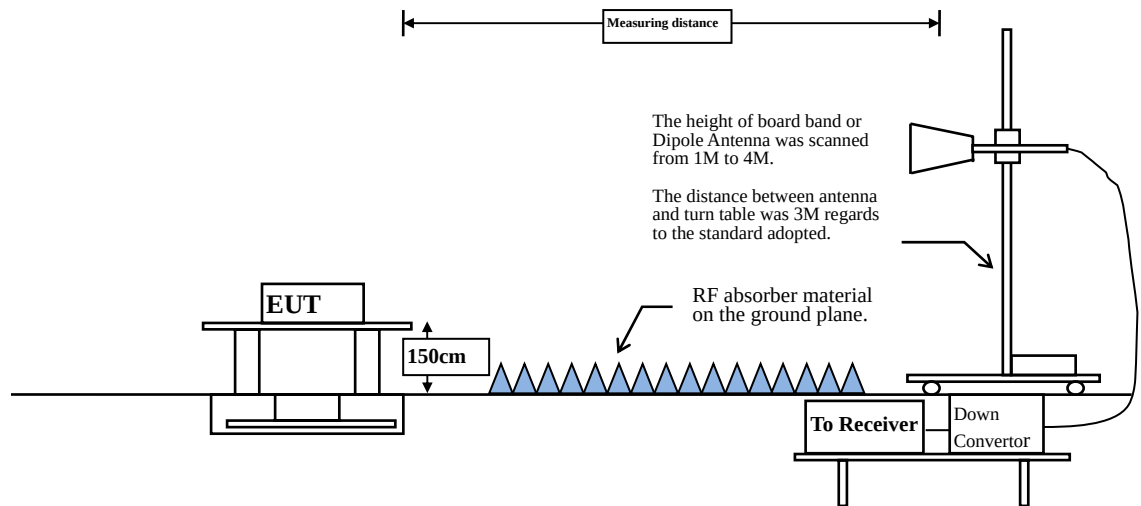


Above 50GHz

Frequency (GHz)	EIRP (dBm)	Power Density (pW / cm2)	Limit (pW / cm2)
220.396	-30.59	16.53	1000

4. Occupied Bandwidth

4.1. Test Setup



4.2. Limits

Within the designated 76~81GHz frequency band

4.3. Test Procedure

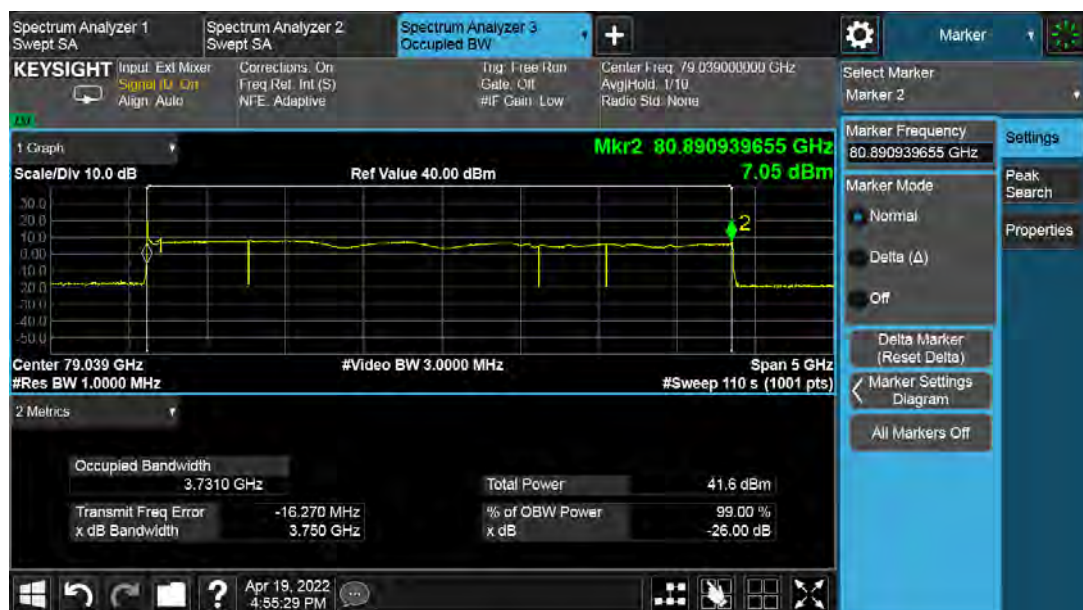
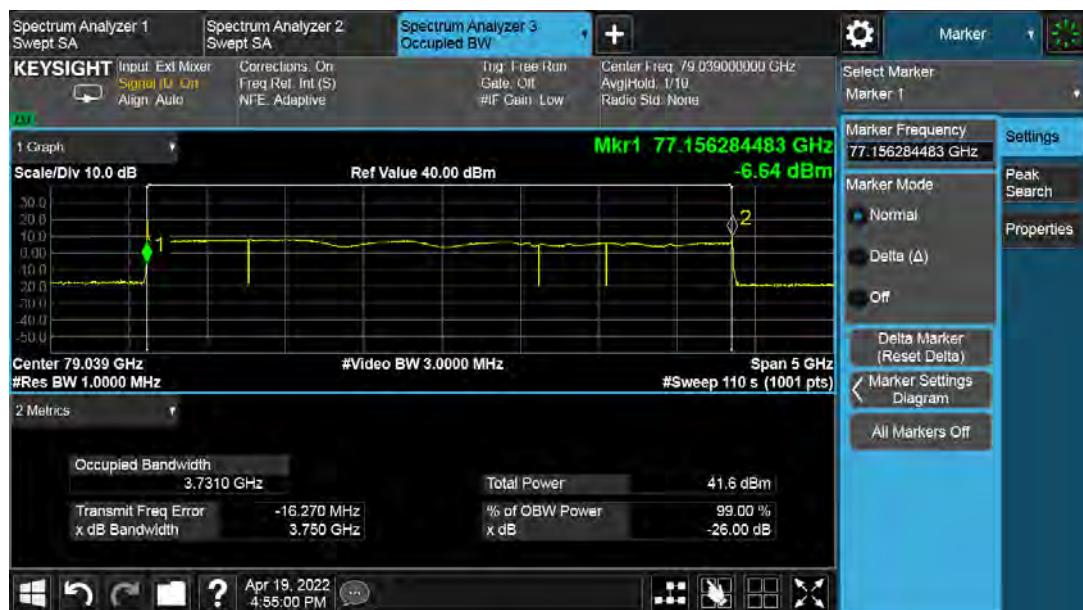
- 1.The signal analyzer`s automatic bandwidth measurement capability was used to perform the 99 % occupied bandwidth and the 26 dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
- 2.RBW = 1 ~ 5 % of the expected OBW & VBW $\geq 3 \times$ RBW.
- 3.Detector = Peak.
- 4.Trace mode = Max hold.
- 5.Sweep = Auto couple.
- 6.The trace was allowed to stabilize.
- 7.If necessary, step 2 ~ 6 were repeated after changing the RBW such that it would be within 1 ~ 5 % of the 99 % occupied bandwidth observed in step 6.

Note: The RBW and VBW were setting up to the limitations of the test equipment.

4.4. Test Result of Occupied Bandwidth

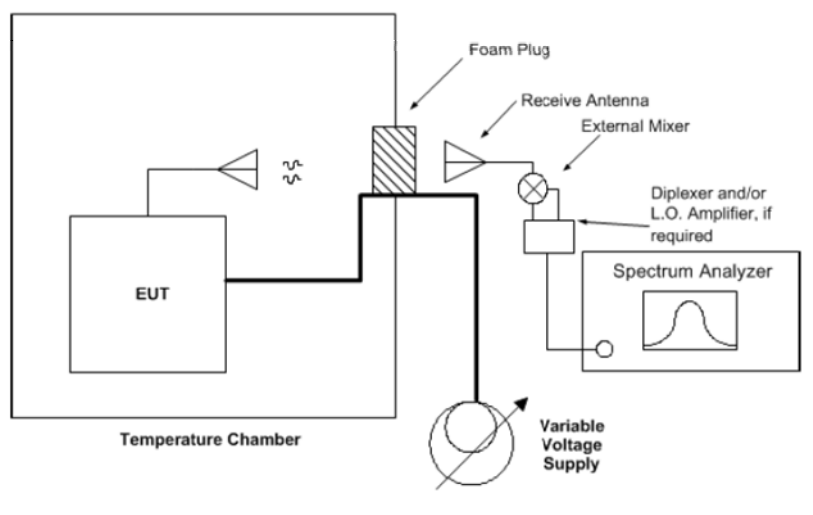
Product : Radar Sensor
 Test Item : Occupied Bandwidth Data
 Test Mode : Mode 1: Transmit mode
 Test Date : 2022/04/19

Frequency (GHz)	Measurement Level (GHz)
76~81	3.7310



5. Frequency Stability

5.1. Test Setup



5.2. Limit

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation.

5.3. Test Procedure

The carrier frequency of the transmitter is measured at room temperature. (20°C to provide a reference)

At 10 °C intervals of temperatures between –30 °C and +50 °C at the manufacturer's rated supply voltage, and

At +20 °C temperature and ±15% supply voltage variations. If a product is specified to operate over a range of input voltage then the –15% variation is applied to the lowermost voltage and the +15% is applied to the uppermost voltage.

Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0° centigrade and + 30° centigrade with no primary power applied.

Beginning at each temperature level , the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10° centigrade above the respective beginning ambient temperature level

5.4. Test Result of Frequency Stability

Product : Radar Sensor
 Test Item : Frequency Stability
 Test Mode : Transmit

Temperature (°C)	Voltage (V)	Measurement Frequency (MHz)	Operating Frequency (MHz)	Limit
20 °C	13.8 (V)	79032.5	79000000	Within band
	12 (V)	79025	79000000	Within band
	10.2 (V)	79032.5	79000000	Within band

Voltage (V)	Temperature (°C)	Measurement Frequency (MHz)	Operating Frequency (MHz)	Limit
12 (V)	50	79027.5	79000000	Within band
	40	79030	79000000	Within band
	30	79022.5	79000000	Within band
	20	79025	79000000	Within band
	10	79037.5	79000000	Within band
	0	79047.5	79000000	Within band
	-10	79057.5	79000000	Within band
	-20	79077.5	79000000	Within band

6. EMI Reduction Method During Compliance Testing

No modification was made during testing.