



Test Report No:
23C0817R-RFUSV14S-A

TEST REPORT

FCC Rules&Regulations

Product Name	zūmo R1 Radar
Brand Name	GARMIN
Model No.	A04811
FCC ID	IPH-04811
Applicant's Name / Address	Garmin International Inc. 1200 E. 151st. Street, Olathe, KS 66062, United States
Manufacturer's Name	GARMIN Corporation
Test Method Requested, Standard	FCC CFR Title 47 Part 95 Subpart M ANSI C63.10-2013
Verdict Summary	IN COMPLIANCE
Documented by Jinn Chen	<i>Jinn Chen</i>
Tested by Ivan Chuang	<i>Ivan Chuang</i>
Approved by Alan Chen	<i>Alan Chen</i>
Date of Receipt	2023/12/26
Date of Issue	2024/07/09
Report Version	V1.0

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Competences and Guarantees

DEKRA is a testing laboratory competent to carry out the tests described in this report.

In order to assure the traceability to other national and international laboratories, DEKRA has a calibration and maintenance program for its measurement equipment.

DEKRA guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated in the report and it is based on the knowledge and technical facilities available at DEKRA at the time of performance of the test.

DEKRA is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA.

General Conditions

1. The test results relate only to the samples tested.
2. 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.
3. This report must not be used to claim product endorsement by TAF or any agency of the government.
4. The test report shall not be reproduced without the written approval of DEKRA Testing and Certification Co., Ltd.
5. 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.

Revision History

Version	Description	Issued Date
V1.0	Initial issue of report	2024/07/09

Summary of Test Result

Report Clause	Test Items	Result (PASS/FAIL)	Remark
3	AC Power Line Conducted Emission	N/A	-
4	Occupied Bandwidth	PASS	-
5	Maximum output power (EIRP)	PASS	-
6	Radiated Emission	PASS	-
7	Frequency Stability	PASS	-

Comments and Explanations

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1. General Information

1.1. EUT Description

Frequency Band	76.00 ~ 81.00 GHz
Operating Frequency / Channel Number	78.11 GHz, 78.957 GHz, 79.805 GHz / 3 Channels
Type of Modulation	FMCW

Accessories Information		
No.	Equipment Name	Description
1	TTL FTDI Cable	Non-shielded, 3m

Antenna Information				
Item	Brand Name	Part No.	Type	Gain (dBi)
1	Texas Instruments	IWR1843AOP	Patch array on chip	5

Working Frequency of Each Channel					
Channel	Frequency	Channel	Frequency	Channel	Frequency
01	78.11 GHz	02	78.957 GHz	03	79.805 GHz

1.2. EUT Information

EUT Power Type	From Battery
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1.3. Testing Location Information

USA	FCC Designation 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.
	Linkou Laboratory
Address	No.5-22, Ruishukeng Linkou District, New Taipei City, 24451, Taiwan, R.O.C.
Performed Location	No. 26, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan, R.O.C.
Phone Number	+886-3-275-7255
Fax Number	+886-3-327-8031

Ambient conditions in the laboratory:

Performed Item	Items	Required	Actual	Test Date
Radiated Emission	Temperature (°C)	10~40 °C	24.8 °C	2024/01/15~2024/02/23
	Humidity (%RH)	10~90 %	65.0 %	
RF Conducted Emission	Temperature (°C)	10~40 °C	24.6 °C	2024/02/23~2023/03/01
	Humidity (%RH)	10~90 %	66.2 %	

1.4. Measurement Uncertainty

Uncertainties have been calculated according to the DEKRA internal document with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor ($k=2$)).

Test item	Uncertainty
AC Power Line Conducted Emission	± 3.50 dB
Occupied Bandwidth	± 1580.61 Hz
Maximum output power (EIRP)	± 4.02 dB
Radiated Emission	9kHz~30MHz: ± 3.88 dB 30MHz~1GHz: ± 4.42 dB 1GHz~18GHz: ± 4.28 dB 18GHz~40GHz: ± 3.90 dB 40GHz~50GHz: ± 5.06 dB 50GHz~325GHz: ± 5.71 dB
Frequency Stability	± 1580.61 Hz

1.5. List of Test Equipment

For Test Site number: HY-SR03

	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
V	Temperature Chamber	KSON	THS-D4T-100	A0606	2023/08/10	2024/08/09
V	DC Power Supply	GW Instek	SPD-3606	GEQ820915	2023/07/07	2024/07/06
V	Spectrum Analyzer	Keysight	N9030B	MY56320509	2023/07/20	2024/07/19
V	Horn Antenna	VDI	RCH012RL (60-90GHz)	N/A	2022/03/10	2025/03/09

Note:

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

For Radiated Measurements / HY-CB02

	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
V	Signal Analyzer	R&S	FSV3044	101113	2024/02/05	2025/02/04
V	Spectrum Analyzer	Keysight	N9030B	MY56320509	2023/07/20	2024/07/19
V	Horn Antenna	VDI	RCH015RL (50-75GHz)	--	2022/03/10	2025/03/09
V	Horn Antenna	VDI	RCH012RL(60-90GHz)	--	2022/03/10	2025/03/09
V	Horn Antenna	VDI	RCH08RL(90-140GHz)	--	2022/03/10	2025/03/09
V	Horn Antenna	VDI	RCH05RL(140-220GHz)	--	2022/03/10	2025/03/09
	Horn Antenna	VDI	2-43/2-44(220-330GHz)	--	2022/03/10	2025/03/09
V	Down Converter(SAX405)	VDI	N9029AV15(AT0-55847)	US54250164	2022/03/10	2025/03/09
V	Down Converter(SAX404)	VDI	N9029AV12(AT0-59570)	US54250170	2022/03/10	2025/03/09
V	Down Converter(SAX403)	VDI	N9029AV08(AT0-59571)	US53250012	2022/03/10	2025/03/09
V	Down Converter(SAX402)	VDI	N9029AV05(AT0-60029)	US53250019	2022/03/10	2025/03/09
	Down Converter(SAX401)	VDI	N9029AV03(AT0-57775)	US53250021	2022/03/10	2025/03/09
V	Loop Antenna	AMETEK	HLA6121	56736	2023/05/23	2024/05/22
V	Bi-Log Antenna	SCHWARZBECK	VULB9168	9168-0675	2023/08/09	2025/08/08
V	Horn Antenna	RF SPIN	DRH18-E	210802A18ES	2023/03/23	2024/03/22
V	Horn Antenna	Com-Power	AH-840	101100	2023/10/02	2025/10/01
V	Pre-Amplifier	SGH	SGH0301-9	20211007-8	2024/01/10	2025/01/09
V	Pre-Amplifier	SGH	SGH118-HS	20211102-2	2024/01/10	2025/01/09
V	Pre-Amplifier	EMCI	EMC05820SE	980285	2024/01/10	2025/01/09
V	Pre-Amplifier	EMCI	EMC184045SE	980369	2024/01/10	2025/01/09
V	Coaxial Cable	EMCI	EMC102-KM-KM-600	1160314	2024/01/10	2025/01/09
V	Coaxial Cable	EMCI	EMC102-KM-KM-7000	170242	2024/01/10	2025/01/09
V	EMI Test Receiver	R&S	ESR3	102792	2024/01/05	2025/01/04
V	Coaxial Cable	SGH	HA800	GD20110223-2	2024/01/10	2025/01/09
V	Coaxial Cable	SGH	HA800	GD20110222-4	2024/01/10	2025/01/09
V	Coaxial Cable	SGH	SGH18	202108-5	2024/01/10	2025/01/09
V	Coaxial Cable	SGH	SGH18	2021005-2	2023/11/27	2024/11/26

Note:

1. Bi-Log Antenna and Horn Antenna(AH-840) is calibrated every two years, VDI and Millitech equipments is calibrated every three years, the other equipments are calibrated every one year.
2. The test instruments marked with "V" are used to measure the final test results.
3. Test Software version: e3 230303 dekra V9.

2. Test Configuration of EUT

2.1. Test Condition

EUT Operational Condition	
Testing Voltage	DC 12V

2.2. Test Software

Test Software Version	iMonitor Properties Version 1.0.0.0
-----------------------	-------------------------------------

Modulation	Frequency (GHz)	Power Setting
FMCW	78.11	N/A
	78.957	N/A
	79.805	N/A

2.3. Duty Cycle

Modulation	On Times (ms)	On+Off Times (ms)	Duty Cycle (%)
FMCW	5.1	24.9	20.48



2.4. The Worst Case Measurement Configuration

Test Mode	Mode 1: Transmit
	Mode 2: Receive
	Mode 3: Co-location

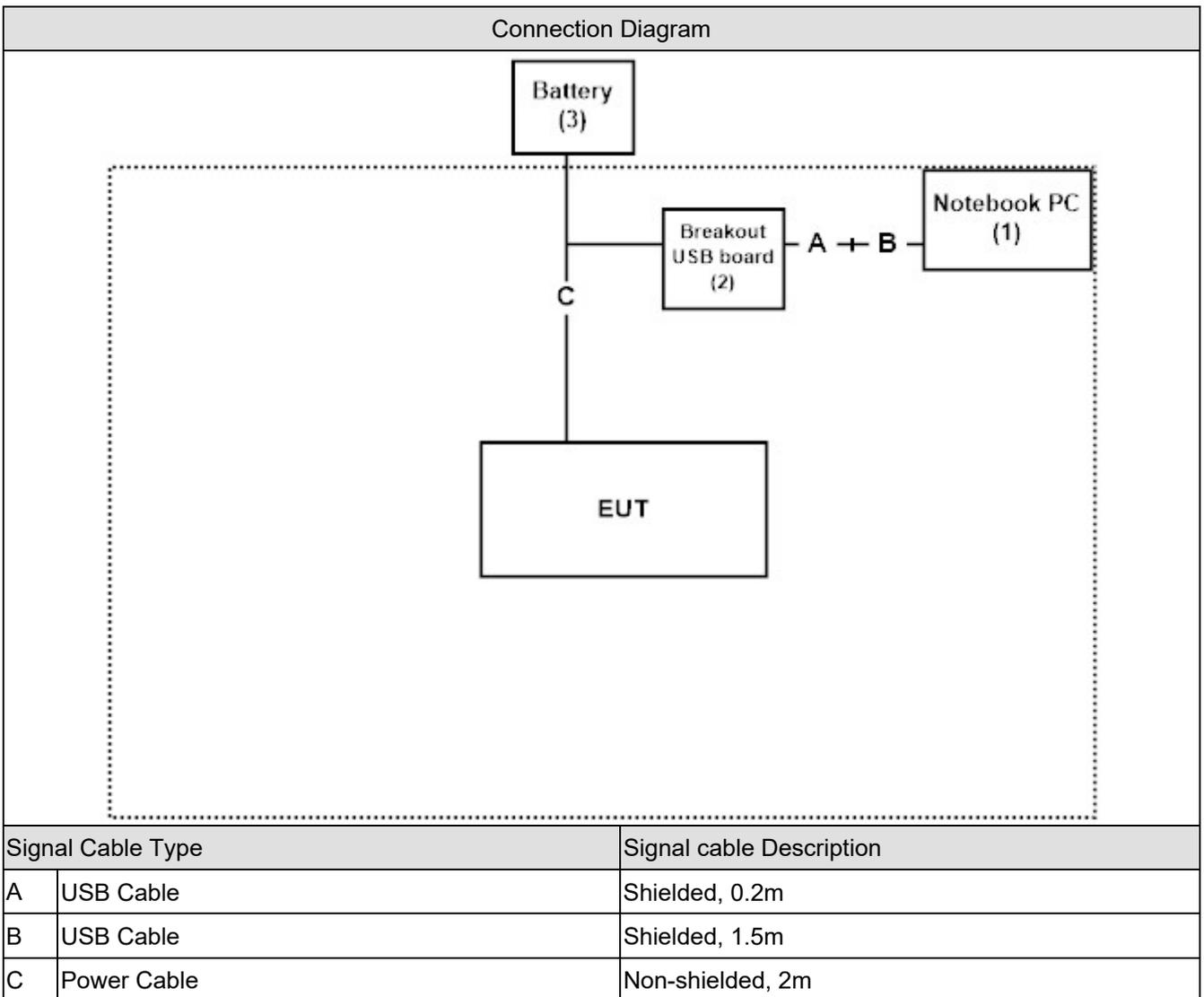
Note:

1. Determining compliance shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.
2. For radiated emission below 1 GHz and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
3. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case is shown in the report.

2.5. Tested System Details

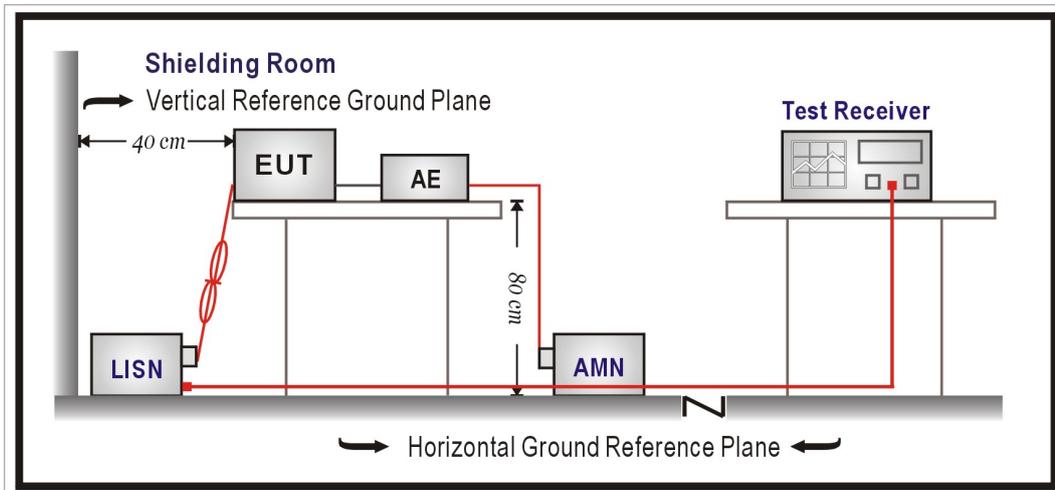
No.	Equipment	Brand Name	Model No.	Serial No.	Power Cord
1	Notebook PC	Lenovo	TP00135A	RF-3ZD0E9	N/A
2	Breakout USB board	N/A	N/A	N/A	N/A
3	Battery	BOSCH	60044	N/A	N/A

2.6. Configuration of tested System



3. AC Power Line Conducted Emission

3.1. Test Setup



3.2. Test Limit

Frequency (MHz)	QP (dBuV)	AV (dBuV)
0.15 - 0.50	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30	60	50

Remarks: In the above table, the tighter limit applies at the band edges.

3.3. Test Procedure

The EUT and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50 ohm /50 uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50 ohm /50 uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs.) Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10: 2013 on conducted measurement.

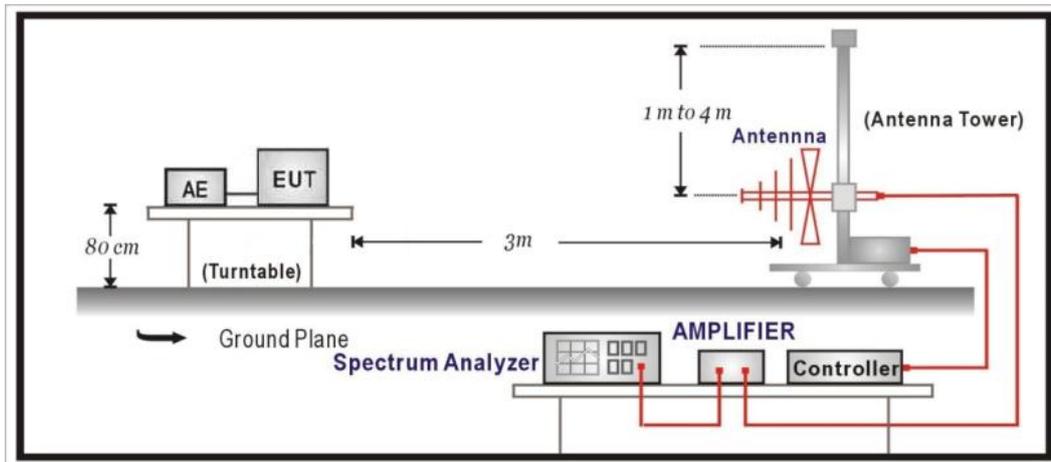
Conducted emissions were investigated over the frequency range from 0.15 MHz to 30 MHz using a receiver bandwidth of 9 kHz.

3.4. Test Result of AC Power Line Conducted Emission

Refer as Appendix A

4. Occupied Bandwidth

4.1. Test Setup



4.2. Test Limit

Within the designated 76~81GHz frequency band.

4.3. Test Procedures

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. $RBW = 1 \sim 5 \%$ 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.

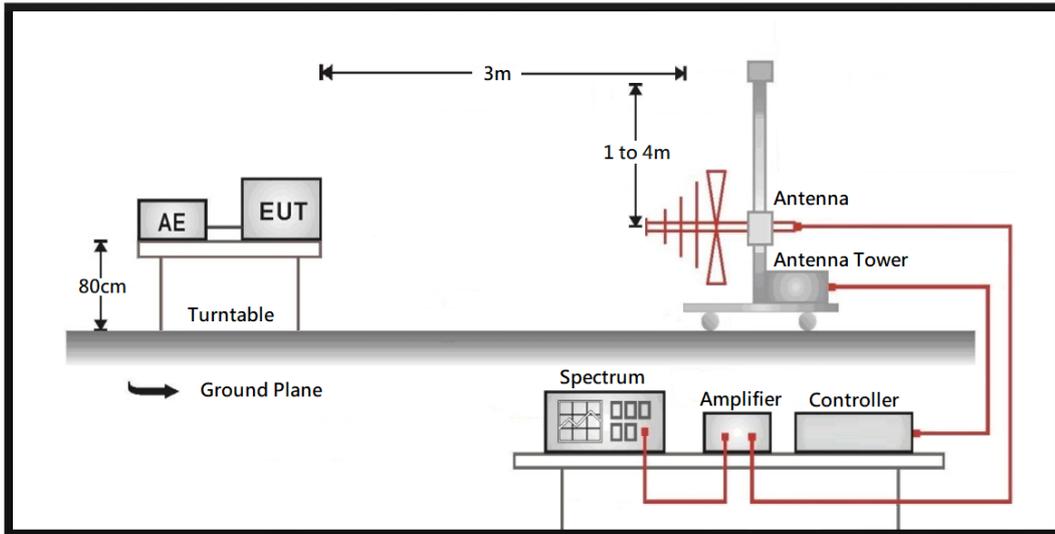
Note: The RBW and VBW were setting up to the limitations of the test equipment.

4.4. Test Result of Occupied Bandwidth

Refer as Appendix B

5. Maximum output power (EIRP)

5.1. Test Setup



5.2. Test Limit

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.

5.3. Test Procedures

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.

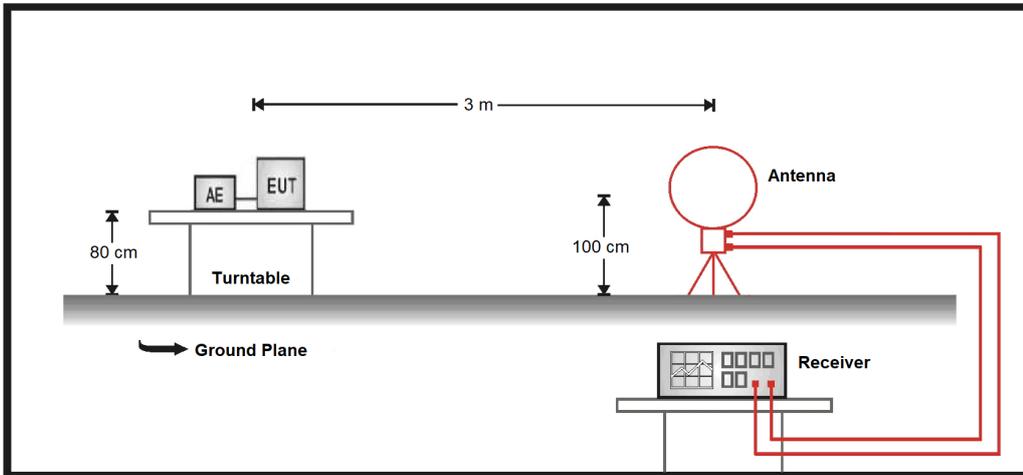
5.4. Test Result of Maximum output power (EIRP)

Refer as Appendix C

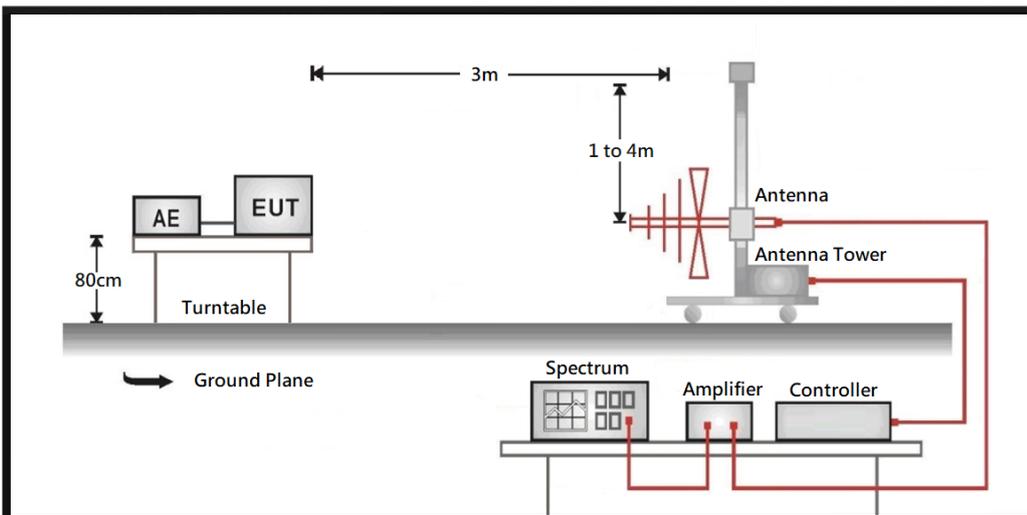
6. Radiated Emission

6.1. Test Setup

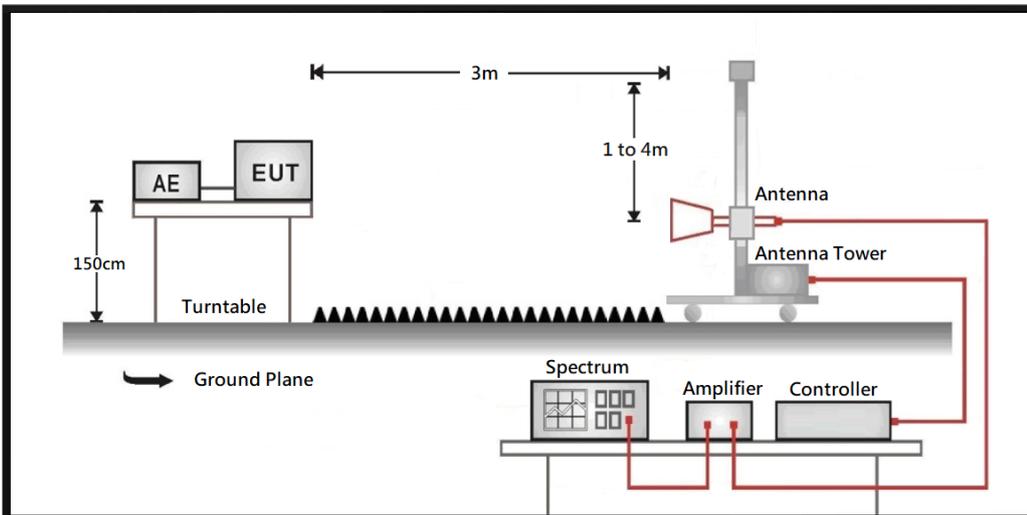
9 kHz ~ 30 MHz



30 MHz ~ 1 GHz



Above 1 GHz



6.2. Test Limit

Frequency (MHz)	Field strength (uV/m)	Field strength (dBuV/m)	Measurement distance (m)
0.009 – 0.490	2400/F(kHz)	20 log (2400/F(kHz))	300
0.490 – 1.705	24000/F(kHz)	20 log (24000/F(kHz))	30
1.705 - 30	30	29.5	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

Remarks:

1. Field strength (dBuV/m) = 20 log Field strength (uV/m)
2. In the Above Table, the tighter limit applies at the band edges.
3. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

(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.

6.3. 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.

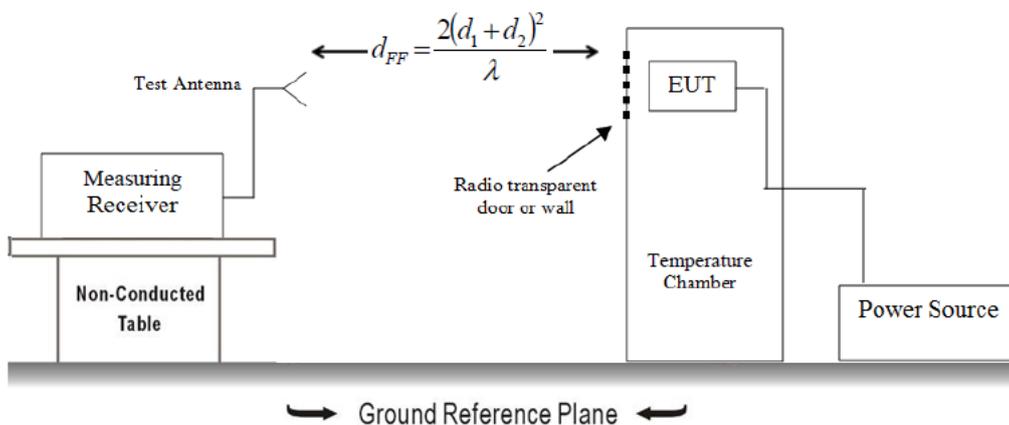
The measurement frequency range from 9kHz – 231GHz was investigated.

6.4. Test Result of Radiated Emissions

Refer as Appendix D

7. Frequency Stability

7.1. Test Setup



7.2. Limit

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

7.3. 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.

7.4. Test Result of Frequency Stability

Refer as Appendix E