Ke Mei Ou Lab Corp.

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FCC ID TEST REPORT

Under:
FCC 15 Subpart C, Paragraph 15.255
Operation within the band
☒57-71GHz
☒FDS - Part 15 Field Disturbance Sensor

Prepared for:

AiWave Technologies

ul. Niska 3, 27-200 Starachowice Poland

FCC ID: 2BCCA-FALCON8G2RM1

EUT: Falcon Eye

Model: FALCON8G2RM1

December 11, 2023
Issue Date:

Original Report
Report Type:

Prepared by: Jacky Huang / Engineer

Reviewed & Approved by: Apollo Liu / Manager

Table of Contents

Report Revision History

Report #	Version	Description	Issued Date
KSZ2023053101J05	Rev.01	Initial issue of report	December 11, 2023

1. General Information

1. 1 Notes

The test results of this report relate exclusively to the test item specified in 1.6. The Ke Mei Ou Laboratory does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the Ke Mei Ou Laboratory.

1. 2 Testing Laboratory

Test Firm Name:	**Ke Mei Ou Lab Co., Ltd.**
Test Firm Address:	2013-2016, 20th Floor, Business Center, Jiahui Xin Cheng, No 3027, Shen Nan Road, Fu Tian, Shen Zhen, Guang Dong, P. R. China
FCC Designation Number:	CN1532
Test Firm Registration Number:	344480
Internet:	www.kmolab.com
Email:	kmo@kmolab.com
ANSI-ASQ National Accreditation Board/ACLASS ISO/IEC 17025 Accredited Lab for telecommunication standards. The Registration Number is AT-1532. The testing quality system meets with ISO/IEC-17025 requirements, This approval results is accepted by MRA of ILAC.	

1. 3 Details of Applicant

Name	**AiWave Technologies**
Address	**ul. Niska 3, 27-200 Starachowice Poland**

1. 41. 4 Application Details

Date of Receipt of Application	: May 31, 2023
Date of Receipt of Test Item	: October 13, 2023
Date of Test	: October 13, 2023 ~ December 11, 2023

1. 5 Details of Manufacturer

Name	**AiWave Technologies**
Address	**ul. Niska 3, 27-200 Starachowice Poland**

1. 6 Test Item

EUT Feature	
EUT Description:	Falcon Eye
Brand Name:	N/A
Basic Mode:	FALCON8G2RM1
Family Model:	N/A
HW Version:	1.3
SW Version:	1.0
Equipment Class:	☒FDS - Part 15 Field Disturbance Sensor
EUT Stage:	☒Identical Prototype
Note:	The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

Additional Information

Standard Product Specification					
Tx/Rx Frequency Range	☒57-71GHz				
Number of Channels	Channel		Frequency (GHz)	BW (MHz)	
	☒	1	57-64	350	
	☒	2	57-64	300	
	☒	3	57-64	1300	
	☒	4	57-64	5100	
Antenna Type / Gain	Chain Number	Ant Gain (dBi)	Internal	External	
	1	7.0	☒PCB	☐-	
Type of Modulation	☒FMCW				
EUT Operational Condition	☐AC **à** ☐Other				
	☒DC **à** ☒External AC/DC adapter **à** ☐From Battery ☐-				
Specification of Accessory					
☒AC/DC Adapter # (Charger)	**Brand Name**	Raspberry Pi	**Model Name**	27W USB-C Power Supply EU	
	Power Rating	IP: 100-240Vac~50/60Hz 0.8A; OP: 5.1Vdc/5.0A 25.5W, 9.0Vdc/3.0A 27.0W, 12.0Vdc/2.25A 27.0W, 15.0Vc/1.8A 27.0W			

1. 7 Applicable Standards

Applicable Standards	
According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards: FCC Part 15 Subpart C 15.255 FCC KDB 414788 D01 Radiated Test Site v01r01 ANSI C63.10-2013	
Note:	1)All test items were verified and recorded according to the standards and without any deviation during the test. 2)This EUT has also been tested and complied with the requirements of FCC 15 Part 15, Subpart B, recorded in a separate test report.

2. Technical Test

2. 1 Summary of Test Results

The EUT has been tested according to the following specifications:

FCC Rules	Test Type	Limit	Result	Notes
15.255(e)(1)	Occupied Bandwidth	N/A	Pass	Complies.
15.255(c)	EIRP Power	15.255(c)	Pass	Complies.
15.255(c)	Peak Conducted Output Power	15.255(c)	Pass	Complies.
15.255(d)	Tx Spurious Emissions	FCC 15.209(a) & 15.255(d)	Pass	Complies
15.255(f)	Frequency Stability	15.255(f)	Pass	Complies
15.255(a)(h)	Operation Restriction and Group Installation	15.255(a)(h)	Pass	Complies
15.207	AC Power Conducted Emission	FCC15.207(a)	Pass	Complies
15.203	Antenna Requirement	N/A	Pass	Complies
15.255(g) & 2.1091	Maximum Permissible Exposure (MPE)	< 1mW/cm^2	Pass	Complies

2. 2 Antenna Requirement

Per § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall 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 manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Result	☒EUT has an embedded-in antenna design is used, which was permanently attached. ☒EUT has not any provisions for connect to an external antenna. Therefore, the EUT complies with Section 15.203 of the FCC rules.

2. 3 Measurement Uncertainty

Measurement	Frequency	Uncertainty
Conducted emissions	0.15MHz ~ 30MHz	3.20
Radiated emissions	9kHz ~ 30MHz	4.20
Radiated emissions	30MHz ~ 300MHz	4.62
Radiated emissions	300MHz ~1000MHz	4.62
Radiated emissions	1GHz ~ 18GHz	4.86
Radiated emissions	18GHz ~ 40GHz	3.80
Radiated emissions	40GHz ~ 220GHz	5.22
Note:	This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2	

Conformity Decision Rule
The applied conformity decision rule is based on ILAC G8:09/2019 clause 4.2.1 Binary Statement for Simple Acceptance Rule (w = 0).

2. 4 Test Configuration

Tx Test Mode

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary Tables of Test Mode			
Test Item	**Modulation**	**Data Rate**	**Channel Plan**
Conducted Cases	☐-	☐N/A	☐1~4
Radiated Cases	☒FMCW	☐N/A	☒1~4
AC Conducted Emission	Test Mode: EUT link with Controller (DC Power)		
Note:	1)The worst case of conducted emission is channel 1; only the worst case was reported. 2)For Radiated case, the tests were performed with PCB antenna.		

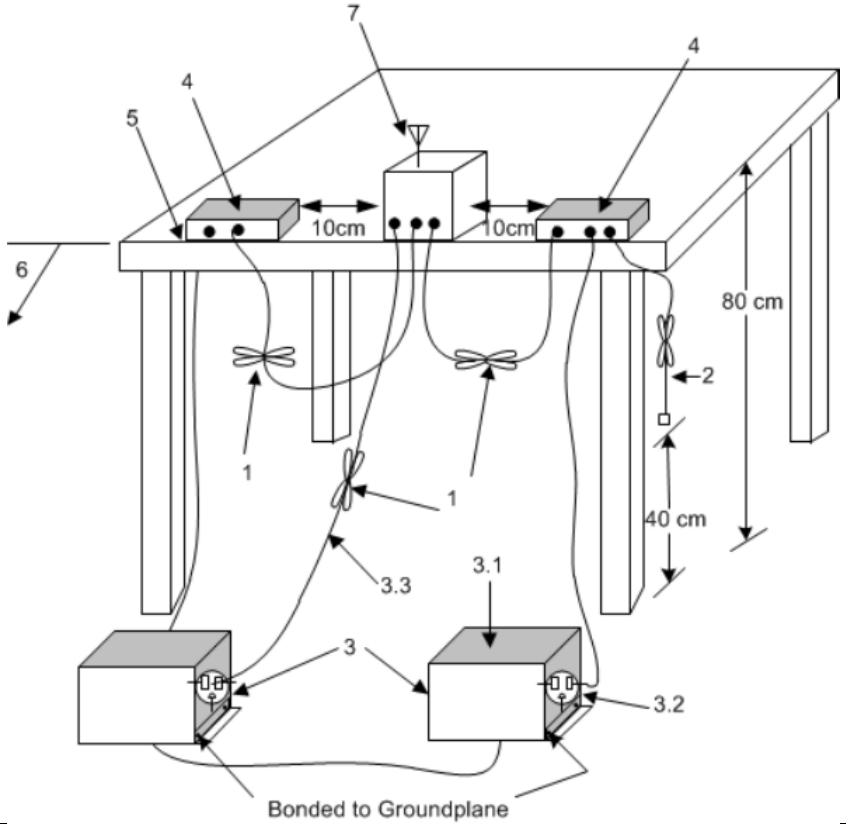
EUT Operation Test Setup		
Pre-Scan has been conducted to determine the worst-case mode from all possible combinations. Only the worst test mode data was reported. For Tx function, the engineering test program was provided and enabled to make EUT link with controller to continuous transmit/receive. For AC power line conducted emissions, the EUT was set to working normal.		
Pre-Scan Mode		
Test Mode	**Operating Description**	
1	Channel 1	
2	Channel 2	
3	Channel 3	
4	Channel 4	
Technical Rule à Final		
Occupied Bandwidth	**Test Mode**	1 & 2 & 3 & 4
EIRP Power		1 & 2 & 3 & 4
Peak Conducted Output Power		1 & 2 & 3 & 4
Frequency Stability		1 & 3
☒AC Conducted Emissions à Final		
Test Mode	1	
☒Tx Spurious Emissions à Final		
Test Mode	1 & 2 & 3 & 4	
☐Rx Spurious Emissions à Final		
Test Mode	1	
Note: The test modes were carried out for all operation modes (include link and idle). The final test mode of the EUT was the worst test mode for Mode 1, and its test data was reported.		

Far field consideration for measurements above 40GHz -> Spurious emision measurement				
Antenna frequency range in GHz	**Wavelength(λ)(m)**	**L (m)**	**$R_{Far\ Field}$ (m)**	**Measurement Distance (m)**
40-60	0.005000	0.04625	0.856	0.86
60-90	0.003333	0.03002	0.541	0.55
90-140	0.002143	0.01969	0.362	0.50
140-220	0.001364	0.01255	0.231	0.50
Note:	For radiated emission measurements, calculate the distance to the far field boundary of the fundamental emission using following equation: $R_{far\ field} = (2 * L^2) / \lambda$ where: L = Largest Antenna Dimension, including the reflector, in meters λ= wavelength in meters			

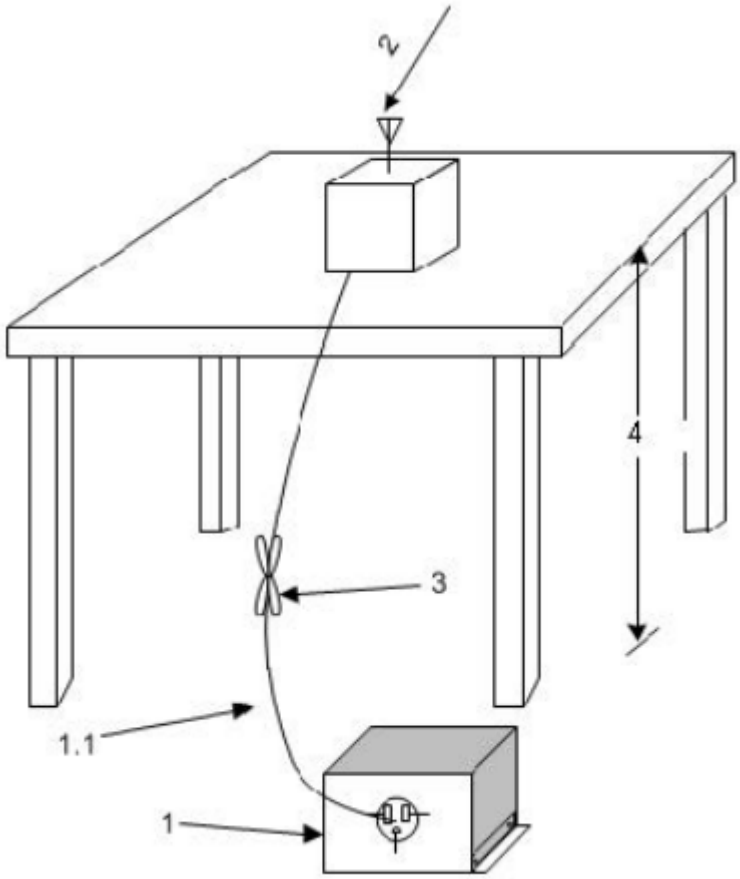
EUT Duty Cycle	
☒Continuous Duty: 100 %	☐Intermittent Duty: 8.7 %

Support Unit				
Device	**Manufacturer**	**Model # / Serial #**	**FCC ID / DoC**	**Cable**
Notebook	HP	EliteBook 2560p	DoC	1.5m unshielded power cord
AC/DC Adapter	HP	PA-1650-02HC	DoC	1.5m unshielded power cord

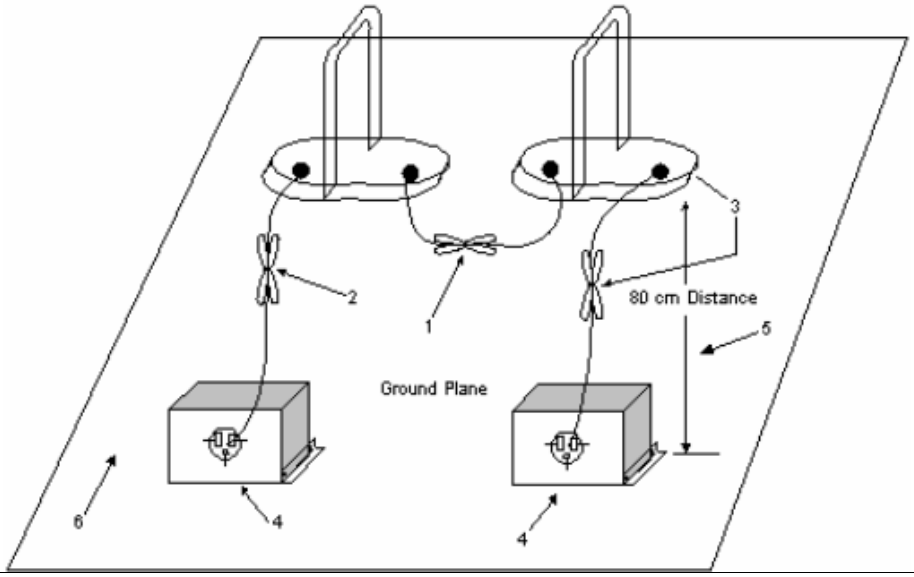
☒ANSI C63.10:2013 - Test arrangement for power-line conducted emissions (product with accessories)



1—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long.
2—The I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
3—EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN may be placed on top of, or immediately beneath, reference ground plane.
3.1—All other equipment powered from additional LISN(s).
3.2—A multiple-outlet strip may be used for multiple power cords of non-EUT equipment.
3.3—LISN at least 80 cm from nearest part of EUT chassis.
4—Non-EUT components of EUT system being tested.
5—Rear of EUT, including peripherals, shall all be aligned and flush with edge of tabletop.
6—Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane.
7—Antenna can be integral or detachable. If detachable, then the antenna shall be attached for this test.

☒ANSI C63.10:2013 - Test arrangement for radiated emissions (tabletop product)

1—A LISN is optional for radiated measurements between 30 MHz and 1000 MHz but not allowed for measurements below 30 MHz and above 1000 MHz. If used, then connect EUT to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. The LISN may be placed on top of, or immediately beneath, the reference ground plane. 1.1—LISN spaced at least 80 cm from the nearest part of the EUT chassis. 2—Antenna can be integral or detachable, depending on the EUT. 3—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long. 4—For emission measurements at or below 1 GHz, the table height shall be 80 cm. For emission measurements above 1 GHz, the table height shall be 1.5 m for measurements, except as otherwise specified.

☐ANSI C63.10:2013 - Test arrangement for radiated and conducted emissions for floor-standing unlicensed wireless devices



1—Excess I/O cables shall be bundled in the center. If bundling is not possible, then the cables shall be arranged in serpentine fashion. Bundling shall not exceed 40 cm in length.
2—Excess power cords shall be bundled in the center or shortened to an appropriate length.
3—EUT and all cables shall be insulated, if required, from the ground plane by up to 12 mm of insulating material.
4—EUT connected to one LISN. LISN may be placed on top of, or immediately beneath, the ground plane.
i All other equipment powered from a second LISN or additional LISN(s).
ii A multiple-outlet strip may be used for multiple power cords of non-EUT equipment.
5—Horizontal projection from the closest point of EUT to the nearest point of the LISN. For radiated emission testing, the LISNs shall be removed.
6—Ground reference plane.

3. EUT Modifications

No modification by test lab.

4. Conducted Power Line Test

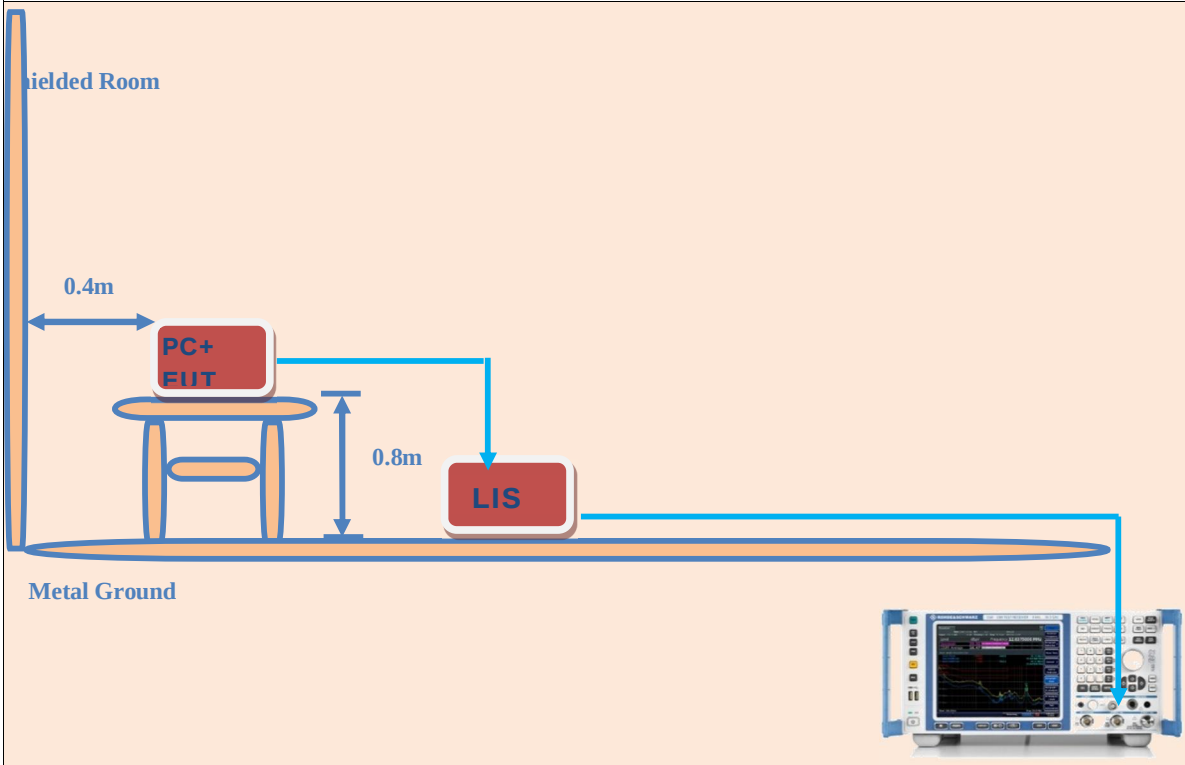
4. 1 Test Equipment

Please refer to Section 10 this report.

4. 2 Test Procedure

Test Method	
☒	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/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. 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 invested over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9kHz.

4. 3 Test Setup

Test Setup
AC Line Conducted Emissions

This test is applicable for radio equipment and/or ancillary equipment for fixed use powered by the AC mains. This test shall be performed on a representative configuration of the radio equipment, the associated ancillary equipment, or a representative configuration of the combination of radio and ancillary equipment. This test assesses the level of internally generated electrical noise present on the AC power input/output ports.

4. 4 Configuration of the EUT

Refer to section 2.4 of this test report.

4. 5 EUT Operating Condition

Refer to section 2.4 of this test report.

4. 6 Conducted Power Line Emission Limits

FCC Part 15 Paragraph 15.207 (dBuV)	
Frequency Range (MHz)	**QP/AV**
0.15 – 0.5	66-56/56-46
0.5 – 5.0	56/46
5.0 - 30	60/50

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

4. 7 Conducted Power Line Test Result

Test Results:	Refer to Appendix

5. FCC Part 15.255 Technical Requirements

5. 1 Occupied Bandwidth

5. 1.1 Test Equipment

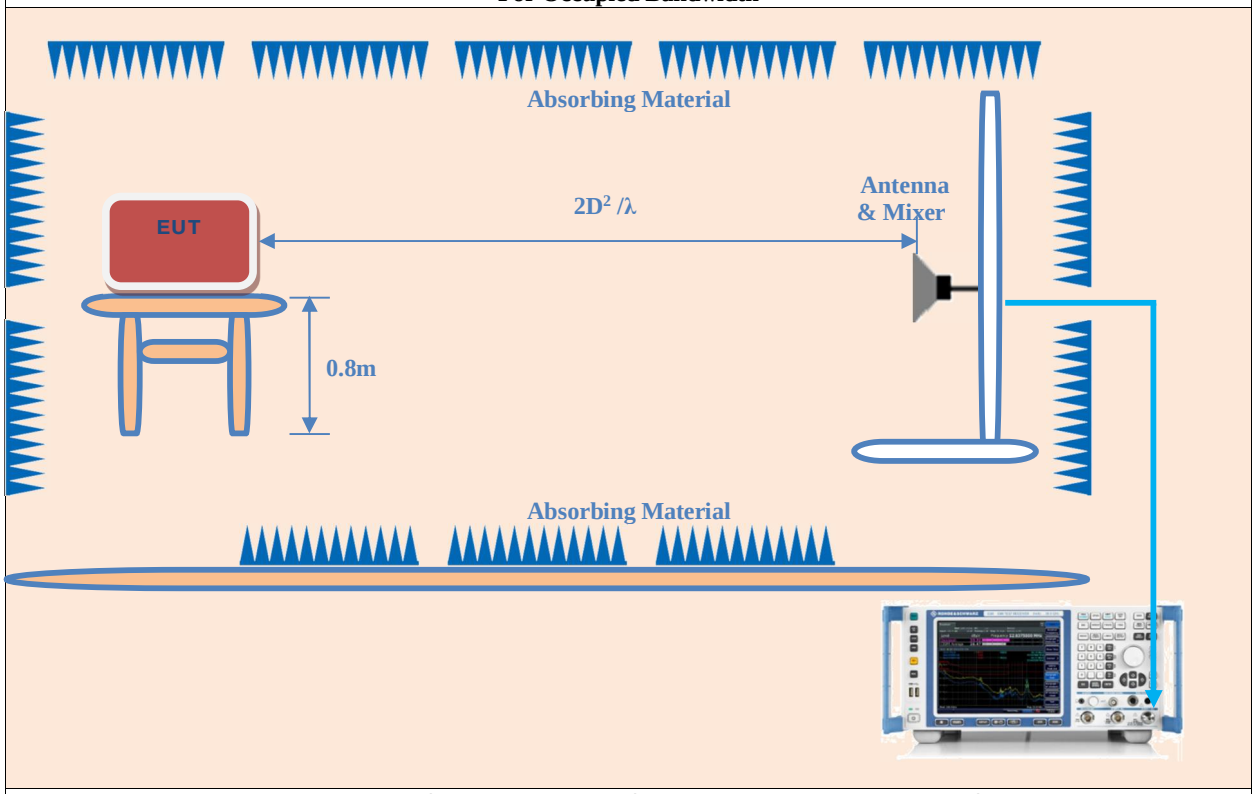
Refer to Section 10 this report.

5. 1.2 Test Procedure

Refer to ANSI C63.10-2013, Clauses 9.3.

5. 1.3 Radiated Test Setup

For Occupied Bandwidth

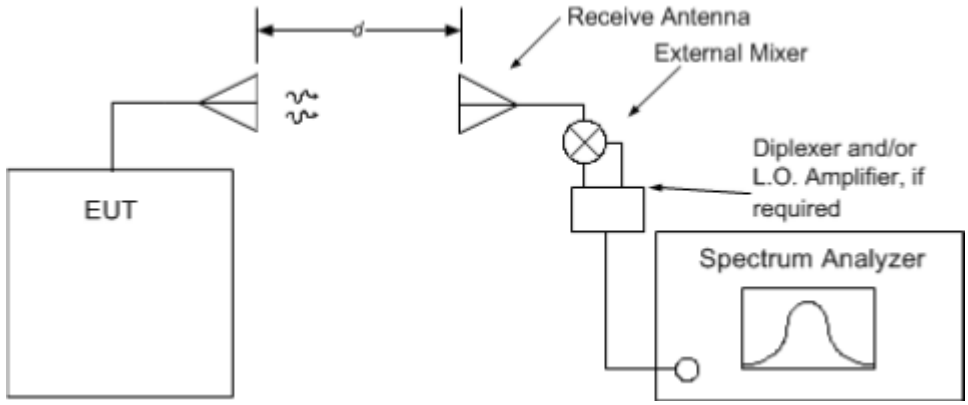


For the actual test configuration, please refer to the related items – Photos of Testing

Although it is preferred that measurements are made in the far field or at the distance at which the applicable limit is specified (e.g., 3 m), this is not always practicable. The far-field boundary distance formula (λ/2π) presented elsewhere in this document for measurements below 30 MHz is applicable where D (largest antenna dimension) << λ (wavelength). For many mm-wave measurements, D >> λ and a more suitable formula for the far-field boundary distance is $2D^2/\lambda$. Even for mm-wave measurements not made in the far field, a linear distance attenuation factor (field strength decay of 20 dB/decade of distance) has been determined to be generally representative and is the default specified by regulatory authorities.

5. 1.4 Configuration of the EUT

☒ANSI C63.10:2013 - Emission bandwidth setup configuration



The following procedure shall be used for measurement of the bandwidth for millimeter-wave devices:
a)Use the following spectrum analyzer settings:
1)Span equal to approximately two times to three times the EBW, centered on the carrier frequency.
2)RBW, as specified in the requirement.
3)VBW, as specified in the requirement, or VBW≥RBW if not specified.
4)Sweep = auto.
5)Detector function = peak.
6)Trace = max hold.
b)The EUT shall be transmitting at its maximum data rate. Allow the trace to stabilize.
c)Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure the specified dB down one side of the emission.
d)Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.
e)If this value varies with different modes of operation (data rate, modulation format, etc.), then repeat this test for each variation.

5. 1.5 EUT Operating Condition

Same as section 2.4 of this report.

5. 1.6 Occupied Bandwidth Limit

Test Item	Limit
6dBc Bandwidth	N/A
99% Occupied Bandwidth	N/A

5. 1.7 Occupied Bandwidth Test Result

Test Results:	Refer to Appendix

5. 2 EIRP Power

5. 2.1 Test Equipment

Refer to Section 10 this report.

5. 2.2 Test Procedure

☒ANSI C63.10:2013 - Clauses 9.11

a)Place the EUT in a continuous transmission mode.
b)For radiated emission measurements, attach a test receive antenna for the fundamental frequency band to the RF input of an RF detector or a downconverter with an RF detector at the output.
c)Connect the video output of the detector to the 50 ohm input of the DSO.
d)Place the test receive antenna in the main beam of the EUT at a distance which will provide a signal within the operating range of the RF detector.
e)Set the sampling rate of the DSO to the required value. Adjust the memory depth, the triggering and the sweep speed to obtain a display which is representative of the signal considering the type of modulation.
f)For radiated emission measurements, calculate the distance to the far field boundary of the fundamental emission using following equation:

$R_{far\ field} = (2 * L^2) / \lambda$
where:
L = Largest Antenna Dimension, including the reflector, in meters
λ= wavelength in meters

Far Field (m)				
Test Mode	**Frequency (GHz)**	**Wavelength(λ)(m)**	**L (m)**	**$R_{Far\ Field}$ (m)**
1	61.650	0.004866	0.030	0.370
2	62.720	0.004783	0.030	0.377
3	62.400	0.004808	0.030	0.375
4	62.850	0.004773	0.030	0.378

☒Minimum test distance is 0.55m > $R_{Far\ Field}$

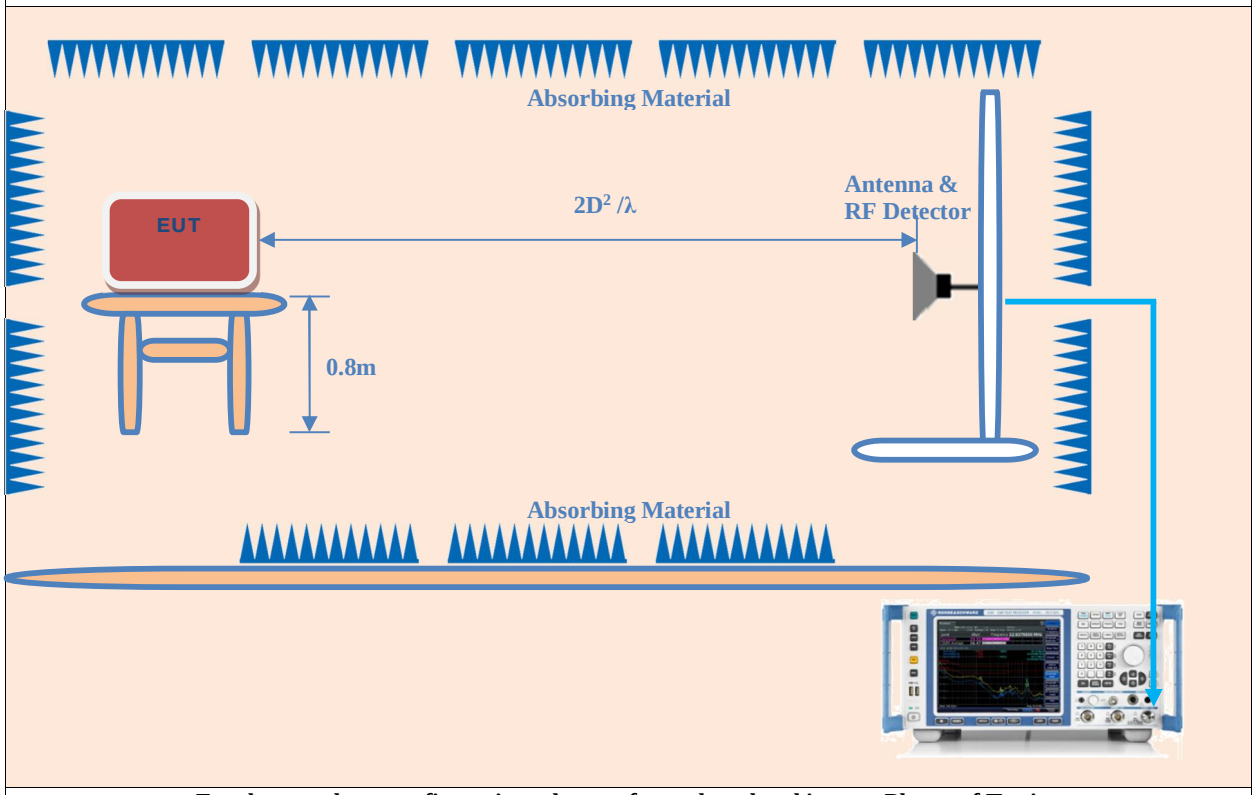
Note: Follow ANSI C63.10, when far-field measurements are not practical, and the test laboratory intends to use a distance attenuation factor other than 20 dB/decade of distance.

g)Perform radiated emission measurements to keep maximize the received signal from the EUT in the far field.
h)Record the average and peak from the DSO and the measurement distance.
i)Disconnect the EUT fromthe RF input port of the instrumentation system.
j)Connect a mm-wave source to the RF input port of the instrumentation system via a waveguide variable attenuator. The mm-wave source is unmodulated.
k)Using substitution measurement.
l)Measure and note the power.
m)For conducted power measurements, calculate the conducted power using following equation

$P_{cond} = EIRP\text{-}G_{dBi}$

5. 2.3 Radiated Test Setup

For EIRP Power



For the actual test configuration, please refer to the related items – Photos of Testing

Although it is preferred that measurements are made in the far field or at the distance at which the applicable limit is specified (e.g., 3 m), this is not always practicable. The far-field boundary distance formula ($\lambda/2\pi$) presented elsewhere in this document for measurements below 30 MHz is applicable where D (largest antenna dimension) << λ (wavelength). For many mm-wave measurements, D >> λ and a more suitable formula for the far-field boundary distance is $2D^2/\lambda$. Even for mm-wave measurements not made in the far field, a linear distance attenuation factor (field strength decay of 20 dB/decade of distance) has been determined to be generally representative and is the default specified by regulatory authorities.

5. 2.4 Configuration of the EUT

Same as section 2.4 of this report.

5. 2.5 EUT Operating Condition

Same as section 2.4 of this report.

5. 2.6 EIRP Power Limit

EIRP Power Limit			
EUT Type		**Peak**	**Average**
§ 15.255 (c)(2)Field disturbance sensors/radars shall not exceed −10 dBm peak conducted output power and 10 dBm peak EIRP except that field disturbance sensors/radars that limit their operation to all or part of the specified frequency band may operate without being subject to a transmitter conducted output power limit if they operate in compliance with paragraph (b)(3) of this section or with one or more of the provisions below:			
☐	Fixed field disturbance sensors at within band 57.0–59.4 GHz for indoor operation	20 dBm	N/A
☐	Fixed field disturbance sensors at within band 57.0–59.4 GHz for outdoor operation	30 dBm	N/A
☐	Fixed field disturbance sensors at within band 57.0–61.56 GHz	3 dBm	N/A
☐	Fixed field disturbance sensors at within band 57.0–61.56 GHz (the sum of continuous transmitter off-times of at least two milliseconds equals at least 16.5 milliseconds within any contiguous interval of 33 milliseconds)	20 dBm	N/A
☐	Fixed field disturbance sensors at within band 57.0–64.0 GHz (the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 25.5 milliseconds within any contiguous interval of 33 milliseconds, except as specific in paragraph (c)(2)(iii)(B) of this section;)	14 dBm	N/A
☐	Fixed field disturbance sensors at within band 57.0–64.0 GHz, and the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 16.5 milliseconds within any contiguous interval of 33 milliseconds when operated outdoors: (1) As part of a temporary or permanently fixed application; or (2) When being used in vehicular applications to perform specific tasks of moving something or someone, except for in-cabin applications;	20 dBm	N/A
☐	Fixed field disturbance sensors at within the frequency band 61-61.5GHz	43 dBm	40 dBm
☐	Fixed field disturbance sensors at outside of the band 61-61.5GHz	13 dBm	10 dBm
☒	Except fixed field disturbance sensors at 61-61.5GHz	10 dBm	N/A
Note:	1)For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. 2)The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.		

5. 2.7 EIRP Power Test Result

Test Results:	**Refer to Appendix**

5. 3 Peak Conducted Power

5. 3.1 Test Equipment

Refer to Section 10 this report.

5. 3.2 Test Procedure

Refer to ANSI C63.10-2013, Clauses 9.5.

5. 3.3 Peak Conducted Power Limit

Peak Conducted Power Limit
§ 15.255 (c)(2) For fixed field disturbance sensors other than those operating under the provisions of paragraph (c)(2) of this section, and short-range devices for interactive motion sensing, the peak transmitter conducted output power shall not exceed -10 dBm and the peak EIRP level shall not exceed 10 dBm.
§ 15.255 (e) Limits on transmitter conducted output power.
(1) Except as specified in paragraph (e)(2) of this section, the peak transmitter conducted output power of devices other than field disturbance sensors/radars shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the EIRP limits specified in paragraph (c) of this section. (2) Devices other than field disturbance sensors/radars with an emission bandwidth of less than 100 megahertz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 megahertz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kilohertz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).
Note: For details refer to § 15.255 (c)(2) & (e)

Peak Conducted Power Limit				
EUT Type		**6dBc Bandwidth**	**OBW**	**Peak**
☐	Fixed field disturbance sensors at within the frequency band 61-61.5GHz	> 100MHz	≤500MHz	500mW
☐		≤ 100MHz		500mW x (BW/100)
☐	Fixed field disturbance sensors at outside of the band 61-61.5GHz and within 57 -71 GHz	> 100MHz	N/A	500mW
☐		≤ 100MHz		500mW x (BW/100)
☒	Except fixed field disturbance sensors at 61-61.5GHz	N/A	> 500MHz	-10 dBm
☐	Except outdoor fixed Point to Point,	> 100MHz	N/A	500mW
☐	Outdoor fixed Point to Point	≤ 100MHz	N/A	500mW x (BW/100)
Note:	For details refer to § 15.255 (c) & (e).			

5. 3.4 Peak Conducted Power Test Result

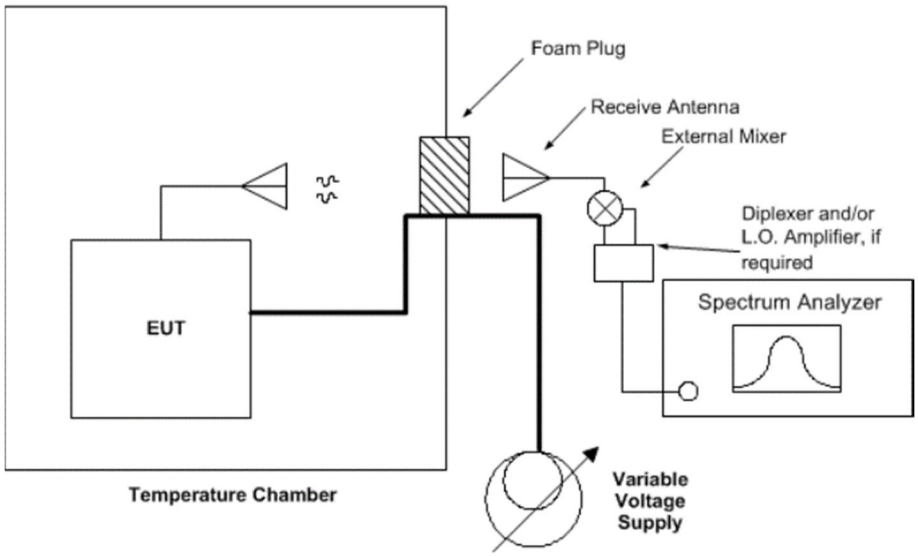
Test Results:	**Refer to Appendix**

5. 4 Frequency Stability

5. 4.1 Test Equipment

Refer to Section 10 this report.

5. 4.2 Test Procedure

☒ANSI C63.10:2013 - Frequency stability instrumentation and measurement procedures for millimeter-wave devices

The following procedure shall be used for determining frequency stability of millimeter-wave systems: a)Arrange EUT and test equipment as shown in Figure 21. Some temperature chambers have a window or other opening that permits locating the receive antenna outside the chamber. b)With the EUT at ambient temperature (approximately 25 °C) and voltage source set to the EUT nominal operating voltage (100%), record the spectrum mask of the EUT emission on the spectrum analyzer. c)Vary EUT power supply between 85% and 115% of nominal, and record the frequency excursion of the EUT emission mask. d)Set the power supply to 100% nominal setting, and raise EUT operating temperature to 50 °C. Record the frequency excursion of the EUT emission mask. e)Repeat step d) at each 10 °C increment down to −20 °C.

5. 4.3 Frequency Stability Limit

Frequency Stability Limit	
§ 15.255 - Operation within the band 57-71 GHz (f)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.	
Note:	For details refer to § 15.255 (f).

5. 4.4 Frequency Stability Test Result

Test Results:	Refer to Appendix

5. 5 Operation Restriction and Group Installation

5. 5.1 Limit

Assessment for Operation Restriction and Group Installation	
FCC 15.255 Rule	**Requirement**
Operation Restriction	(a) Operation under the provisions of this section is not permitted for the following products: (1) Equipment used on satellites. (2) Field disturbance sensors, including vehicle radar systems, unless the field disturbance sensors are employed for fixed operation, or used as short-range devices for interactive motion sensing. For the purposes of this section, the reference to fixed operation includes field disturbance sensors installed in fixed equipment, even if the sensor itself moves within the equipment. (b) Operation on aircraft is permitted under the following conditions: (1) When the aircraft is on the ground. (2) While airborne, only in closed exclusive on-board communication networks within the aircraft, with the following exceptions: (i) Equipment shall not be used in wireless avionics intra-communication (WAIC) applications where external structural sensors or external cameras are mounted on the outside of the aircraft structure. (ii) Equipment shall not be used on aircraft where there is little attenuation of RF signals by the body/fuselage of the aircraft. These aircraft include, but are not limited to, toy/model aircraft, unmanned aircraft, crop-spraying aircraft, aerostats, etc.
Group Installation	(h) Any transmitter that has received the necessary FCC equipment authorization under the rules of this chapter may be mounted in a group installation for simultaneous operation with one or more other transmitter(s) that have received the necessary FCC equipment authorization, without any additional equipment authorization. However, no transmitter operating under the provisions of this section may be equipped with external phase-locking inputs that permit beam-forming arrays to be realized.
Note:	For details refer to § 15.255 (a) & (b) & (h).

5. 5.2 Assessment Result

Test Results:	**Refer to Appendix**

6. Radiated Emission Test for FCC Part 15.255

6. 1 Test Equipment

Please refer to Section 10 this report.

6. 2 Test Procedure

The radiated emissions test below 30 MHz is performed in the following steps:					
Frequency (MHz)	**RBW(kHz)**	**Step Size(kHz)**	**Pre-Scan**	**Pre-Scan with FFT**	**Final Scan**
0.009 ~ 0.15	0.2	≤0.1	Peak, Average	Peak Quasi-Peak, Average	Peak Quasi-Peak, Average
0.15 ~ 30	9	≤4.5	Peak, Average	Peak Quasi-Peak, Average	Peak Quasi-Peak, Average

The EUT was tested according to ANSI C63.10:2013.
a) The loop antenna is positioned with its plane perpendicular to the ground with the lowest height of the antenna 1 m above the ground.
b) The EUT is placed in its standard position on a turntable capable of rotation through 360° in the horizontal plane and arranged as tabletop or floor-standing equipment, as applicable. The EUT is switched on.
c) The measurement equipment is connected to the loop antenna and set-up according to the specifications of the test.
d) The EUT is turned to a position likely to get the maximum and the test antenna is rotated to detect the maximum of the fundamental in this EUT position.
e) Then the EUT is rotated in a horizontal plane through 360° in steps of 45°. Starting at 0°, at each table position the spectrum for the full frequency range is recorded. If the emission at a certain frequency is higher than the levels already recorded, the current table position is noted as the maximum position.
f) After the last pre-scan, the significant maximum emissions and their table positions are determined and collected in a list.
g) With the test receiver set to the first frequency of the list, the EUT is rotated by ±45° around the table position found during pre-scans while measuring the emission level continuously. For final scan, the worst-case table position is set and the maximum emission level is recorded.
h) Step g) is repeated for all other frequencies in the list.
i) Finally, for frequencies with critical emissions the loop antenna is rotated again to find the maximum of emission. At least, frequency and level of the six highest emissions relative to the limit have to be recorded. However, emissions more than 20 dB below the limit do not need to be reported.
If the EUT may be used in various positions, steps a) to i) are repeated in two other orthogonal positions. If the EUT may be used in one position only, steps a) to i) are repeated in one orthogonal position.

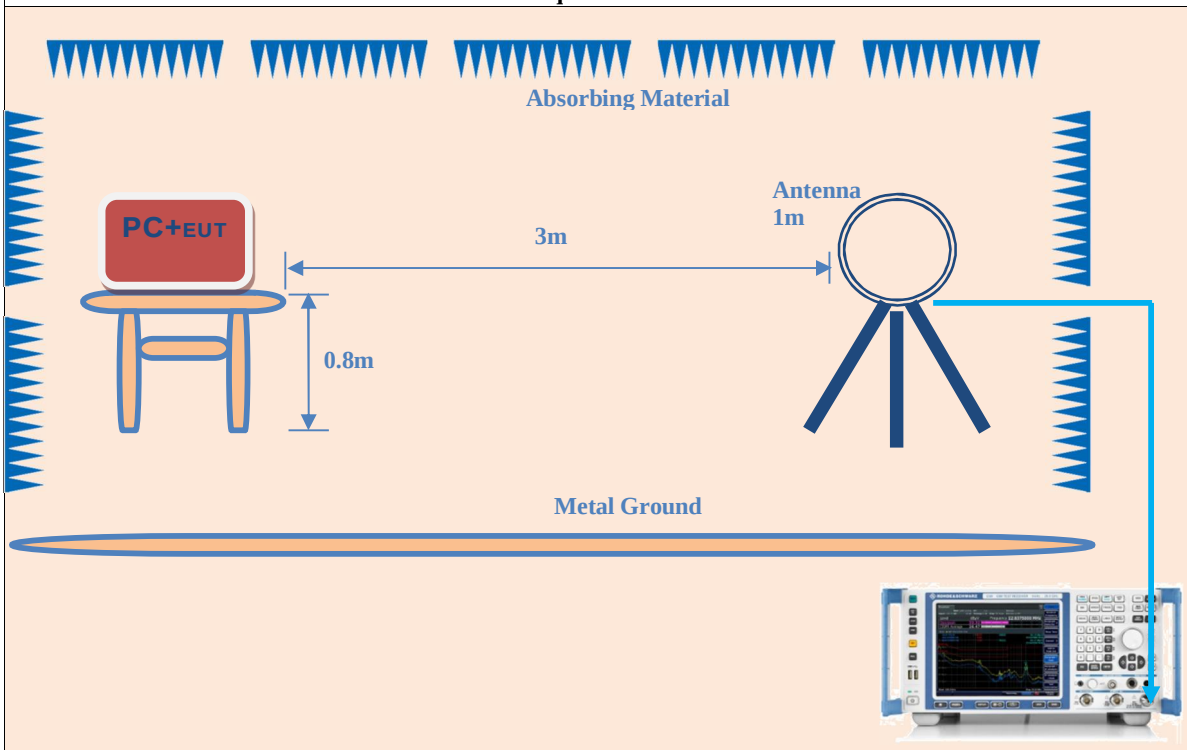
The radiated emissions test from 30 MHz to 960 MHz is performed in the following steps:					
Frequency (MHz)	**RBW(kHz)**	**Step Size(kHz)**	**Pre-Scan**	**Pre-Scan with FFT**	**Final Scan**
30 ~ 960	120	≤60	Peak	Quasi-Peak	Quasi-Peak

The EUT was tested according to ANSI C63.10:2013.
a) The measurement antenna is oriented initially for vertical polarization.
b) The EUT is placed in its standard position on a turntable capable of rotation through 360° in the horizontal plane and arranged as tabletop or floor-standing equipment, as applicable. The EUT is switched on.
c) The measurement equipment is connected to the measurement antenna and set-up according to the specifications of the test
d) The table position is set to 0°.
e) The antenna height is set to 1 m.
f) The spectrum for the full frequency range is recorded. If the emission at a certain frequency is higher than the levels already recorded, the polarization and height of the measurement antenna as well as the current table position are noted as the maximum position.
g) The antenna height is increased to 4 m in steps of 50 cm. At each height, step f) is repeated.
h) The polarization of the measurement antenna is changed to horizontal.
i) The antenna height is decreased from 4 m to 1 m in steps of 50 cm. At each height, step f) is repeated.
j) The EUT is rotated in a horizontal plane through 360° in steps of 60°. At each table position, steps e) to i) are repeated.
k) After the last pre-scan, the significant maximum emissions with their polarizations and heights of the measurement antenna as well as their table positions are determined and collected in a list.
l) With the test receiver set to the first frequency of the list, the measurement antenna is set to the polarization and height and the table is moved to the position as determined during pre-scans.
m) The antenna is moved by ±50 cm around this height and the EUT is rotated by ±60° around this table position while measuring the emission level continuously.
n) For final scan, the worst-case positions of antenna and table are set and the maximum emission level is recorded.
o) Steps l) to n) are repeated for all other frequencies in the list. At least, frequency and level of the six highest emissions relative to the limit have to be recorded. However, emissions more than 20 dB below the limit do not need to be reported.
If the EUT may be used in various positions, steps a) to o) are repeated in two other orthogonal positions.

The radiated emissions test above 960 MHz to 40 GHz is performed in the following steps:					
Frequency (MHz)	**RBW(kHz)**	**VBW(kHz)**	**Sweep Time**	**Detector**	**Trace Mode**
960~40000	1000	3000	AUTO	PK/AV	Max Hold
Radiated emissions above 960 MHz are measured according to clause 6.6 of ANSI C63.10 by conducting exploratory and final radiated emission tests. According to clause 6.6.4.1 of ANSI C63.10, measurements may be performed at a distance closer than that specified in the requirements. However, an attempt shall be made to avoid making final measurements in the near field of both the measurement antenna and the EUT. Final radiated emissions above 1 GHz are measured in a semi-anechoic chamber (SAC) with RF absorbing material on the floor between measurement antenna and EUT. The measurement distance is shown in the appropriate tests. The emissions of the EUT are recorded with an EMI test receiver.					

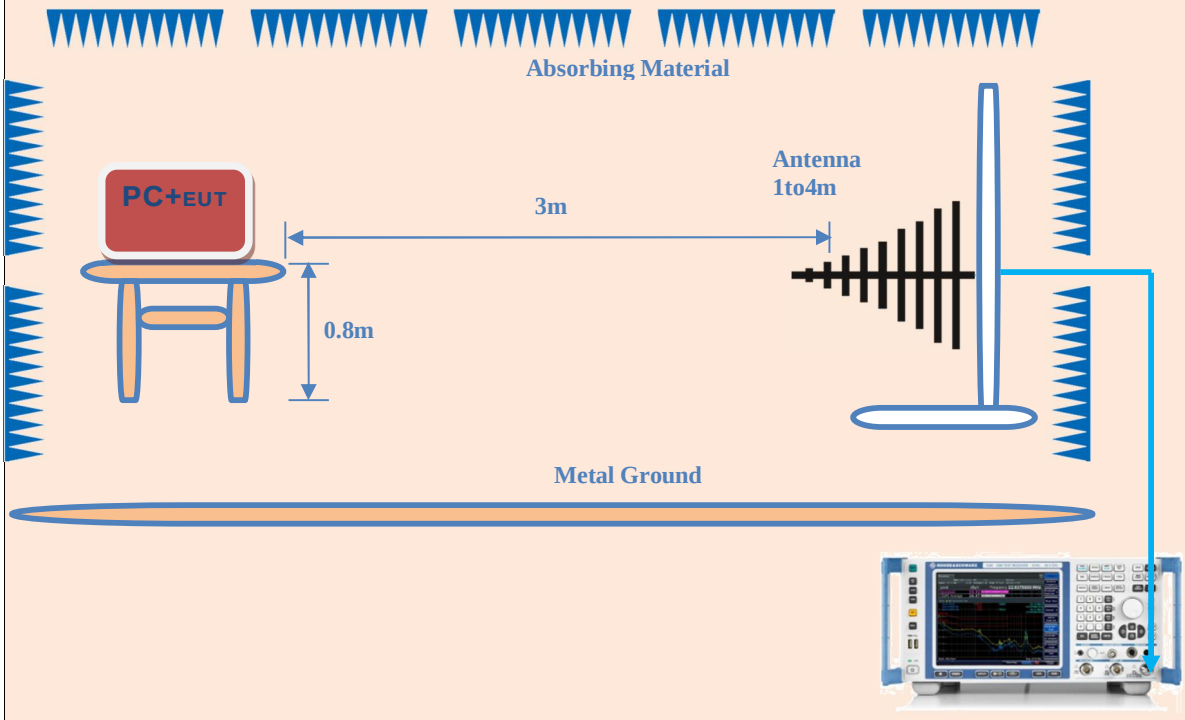
6. 3 Radiated Test Setup

For Frequencies below 30MHz



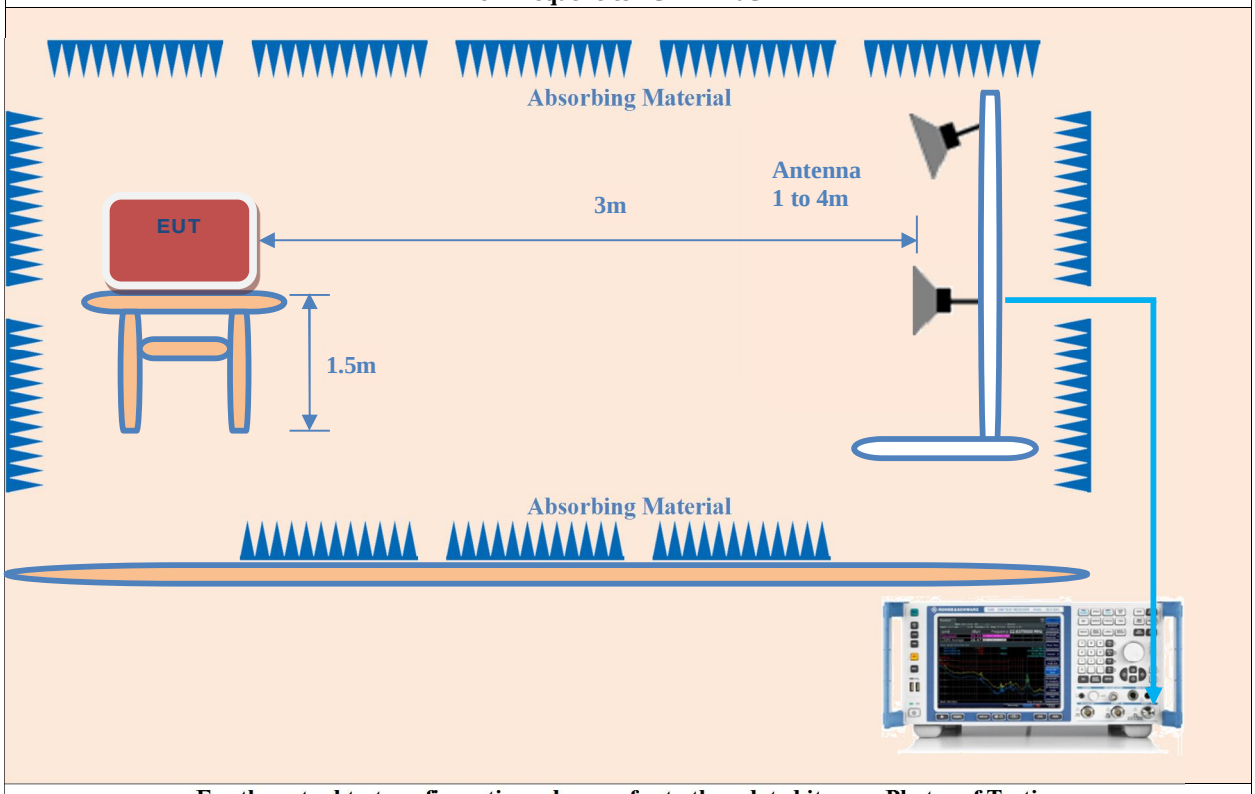
For the actual test configuration, please refer to the related items – Photos of Testing

For Frequencies below 1GHz



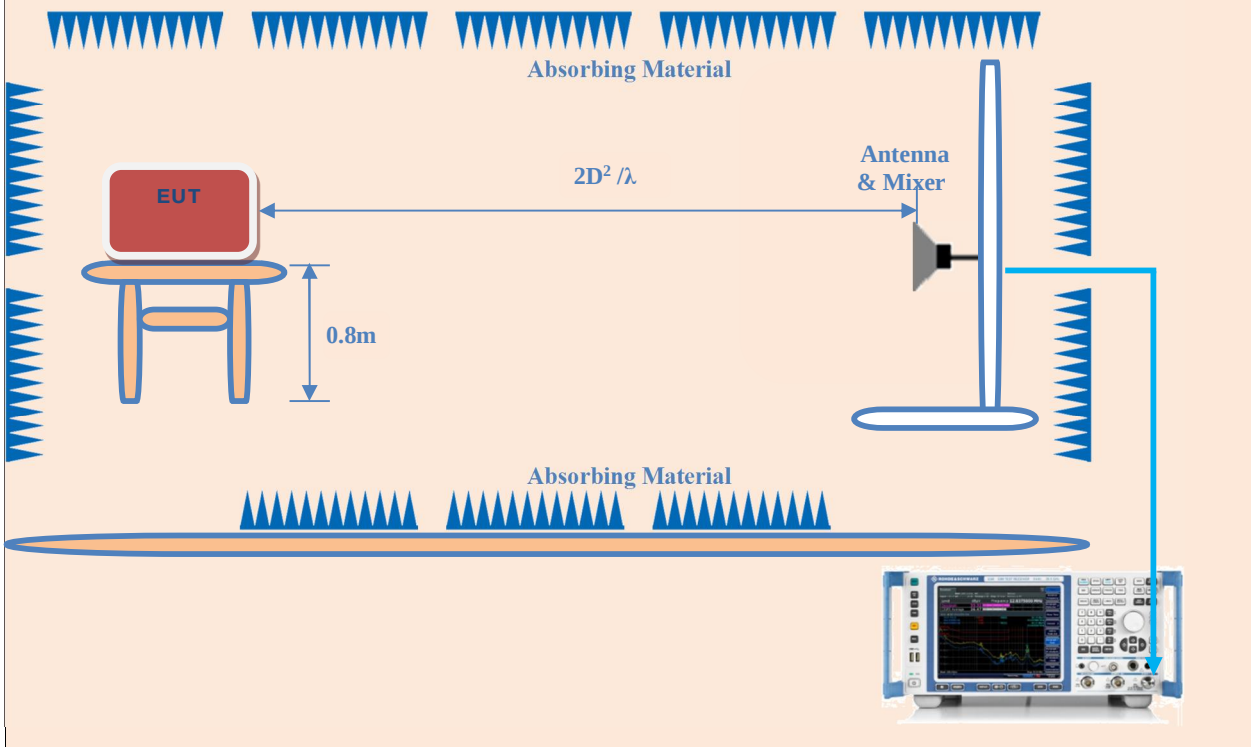
For the actual test configuration, please refer to the related items – Photos of Testing

For Frequencies 1GHz ~ 40GHz



For the actual test configuration, please refer to the related items – Photos of Testing

For Frequencies Above 40GHz



For the actual test configuration, please refer to the related items – Photos of Testing

Although it is preferred that measurements are made in the far field or at the distance at which the applicable limit is specified (e.g., 3 m), this is not always practicable. The far-field boundary distance formula ($\lambda/2\pi$) presented elsewhere in this document for measurements below 30 MHz is applicable where D (largest antenna dimension) << λ (wavelength). For many mm-wave measurements, D >> λ and a more suitable formula for the far-field boundary distance is $2D^2/\lambda$. Even for mm-wave measurements not made in the far field, a linear distance attenuation factor (field strength decay of 20 dB/decade of distance) has been determined to be generally representative and is the default specified by regulatory authorities.

6. 4 Configuration of the EUT

Same as section 2.4 of this report

6. 5 EUT Operating Condition

Same as section 2.4 of this report

6. 6 Radiated Emission Limit

FCC 47 CFR, Part 15.255 Field Strength Limits

Frequency (GHz)	Limit of Field Strength @3m
< 40	FCC 15.209 Limit
40 ~ 200	90 pW/cm^2 (Equivalent EIRP 102uW, -9.91 dBm)

§ 15.255 Operation within the band 57-71 GHz.
(d) Limits on spurious emissions:
(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.
(2) Radiated emissions below 40 GHz shall not exceed the general limits in § 15.209.
(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 at a distance of 3 meters.
(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

FCC 47 CFR, Part 15.209(a) – Field Strength Limits within Restricted Frequency Bands

Frequency (MHz)	Field Strength (μV/m)	Field Strength @3m (dBuV/m)
0.009 ~ 0.490	2,400/F (F in kHz)	128.5 ~ 93.8
0.490 ~ 1.705	24,000/F (F in kHz)	73.8 ~ 63
1.705 ~ 30	30	69.5
30 ~ 88	100	40
88 ~ 216	150	43.5
216 ~ 960	200	46
Above 960	500	53.9

FCC 47 CFR, Part 15.255 Field Strength Limits for 40GHz ~ 200GHz

Frequency (GHz)	Power density @3m distance pW/cm^2	Test Distance (m)	Field Strength (dBuV/m)	
			Peak	Average
40 ~ 200	90.0	3.0	105.3	85.3
90 ~ 140	90.0	0.05	140.9	120.9
140 ~ 200	90.0	0.01	154.8	134.8

FCC 47 CFR, Part 15.33 – Frequency range of radiated measurements.

(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:	
☐	(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
☐	(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.
☒	(3) If the intentional radiator operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.
☐	(4) If the intentional radiator operates at or above 95 GHz: To the third harmonic of the highest fundamental frequency or to 750 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.
☐	(5) If the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to the range specified in paragraphs (a)(1) through (4) of this section or the range applicable to the digital device, as shown in paragraph (b)(1) of this section, whichever is the higher frequency range of investigation.

6. 7 Radiated Emission Test Result

Test Results:	Refer to Appendix

7. Photographs - Test Setup

Refer to below setup

8. Photographs - EUT

Refer to Exhibits _ External Photos & Internal Photos

9. Label

Refer to Exhibits _ Label & Location Info

10. Test Equipment

Equipment/ Facilities	Manufacturer	Model #	Serial No.	Cal/Char Date	Due Date
Artificial Mains: Two Line V-Network	Rohde & Schwarz	EM5040A	KMO-SZ009M	2022/5/12	2024/5/12
EMI Test Receiver	Rohde & Schwarz	ESR7	KMO-SZ026M	2022/5/12	2024/5/12
Test Software	Rohde & Schwarz	ESR7	N/A	NCR	NCR
Loop Antenna	SCHWARZBECK	FMZB1519B	KMO-SZ411	2022/7/20	2025/7/20
Trilog-Super Broadband Antenna	SCHWARZBECK	VULB 9168	KMO-SZ412	2022/5/5	2025/5/5
Broad-Band Horn Antenna 1-18 GHz	SCHWARZBECK	BBHA 9120D	KMO-SZ413	2022/5/5	2025/5/5
Pre-Amplifier 1-18 GHz	SCHWARZBECK	BBV9718	KMO-SZ415	2022/10/15	2025/10/15
Pre-Amplifier 18-40 GHz	SCHWARZBECK	BBV9721	KMO-SZ416	2022/5/4	2025/5/4
Broad-Band Horn Antenna 18-40 GHz	SCHWARZBECK	BBHA 9170	KMO-SZ414	2022/7/20	2025/7/20
Spectrum Analyzer	Rohde & Schwarz	FSP40	KMO-SZ003	2020/12/14	2023/12/14
Spectrum Analyzer	Rohde & Schwarz	FSV40	KMO-SZ025M	2021/11/22	2024/11/22
Mixer	OML INC.	M19HWD	KMO-SZ360	NCR	NCR
Antenna, Horn	OML INC.	M19RH WR-19	KMO-SZ361	NCR	NCR
Mixer	OML INC.	M12HWD	KMO-SZ362	NCR	NCR
Antenna, Horn	OML INC.	M12RH WR-12	KMO-SZ363	NCR	NCR
Mixer	OML INC.	M08HWD	KMO-SZ364	NCR	NCR
Antenna, Horn	OML INC.	M08RH WR-08	KMO-SZ365	NCR	NCR
Frequency Multiplier	SAGE	SFP-152KF-S2	KMO-SZ366	NCR	NCR
Antenna, Horn	SAGE	SAR-2408-15-S2	KMO-SZ367	NCR	NCR
RF Detector	SAGE	STD-15SF-PI	KMO-SZ368	NCR	NCR
Digital Storage Oscilloscope	Tektronix	TDS2022B	KMO-SZ372	2022/12/14	2025/12/14
Temperature & Humidity Chamber	HNLX	SPX-150-B	KMO-SZ296	2022/1/14	2024/1/14
3m Anechoic Chamber	SAEMC	966	KMO-SZ419	2022/10/17	2025/10/17

----------**End of Report** ----------

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