TEST REPORT

Dt&C Co., Ltd.
42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042
Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC2409-0113

2. Customer

   • Name (FCC) : Smart Radar System, Inc.

   • Address (FCC) : 3rd Floor, Fine Venture Bldg, 41 Seongnam-daero 925gil, Bundang-gu Seongnam-si, Gyeonggi-do South Korea 13496

3. Use of Report : FCC Original Grant

4. Product Name / Model Name : RADAR Module / RM68-51

   FCC ID : 2AVKZRM68-51B

5. FCC regulation(s): Part 15.255

   Test Method Used: ANSI C63.10-2020, KDB 364244 D01v01

6. Date of Test : 2024.09.13 ~ 2024.09.27

7. Testing Environment : Refer to appended test report.

8. Test Result : Refer to the attached test result.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test report is not related to KOLAS accreditation.

Affirmation	Tested by Name : SeokHo Han (Signature)	Technical Manager Name : JaeJin Lee (Signature)

2024. 09. 27.

Dt&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

Test Report Version

Test Report No.	Date	Description	Revised By	Reviewed By
DRTFCC2409-0113	Sep. 27 2024	Initial issue	Seokho Han	JaeJin Lee

Table of Contents

1. General Information

1.1. Description of EUT

FCC Equipment Class	Part 15 Field Disturbance Sensor (FDS)
Product	RADAR Module
Model Name	RM68-51
Add Model Name	-
Serial Number	No Specified
Power Supply	DC 5 V
Frequency Range	60 ~ 62 GHz
Max. RF Output Power (EIRP)	11.74 dBm (0.0149W)
Modulation Type	FMCW
Antenna Specification	**Antenna type**: Patch Antenna **Antenna gain(Max)**: 7.1 dBi

RADAR CERTIFICATION OPTIONS

☐ a. Any terrestrial radar transmitting in the 57-71 GHz frequency band can be certified under §15.255(c)(2) with a peak conducted output power limit of -10 dBm and a peak EIRP limit of 10 dBm.
☐ b. Any terrestrial radar transmitting within the 61.0-61.5 GHz ISM band segment, with a maximum EIRP output of 40 dBm (average) and 43 dBm (peak), can be certified under the §15.255(c)(2)(v) rules.
☐ c. Radars intended for operation onboard unmanned aircraft in the 60.0-64.0 GHz band segment can be certified under §15.255(b)(3) with a peak EIRP limit of 20 dBm and a required off-time of at least 16.5 milliseconds within any contiguous 33.0 millisecond interval.
☐ d. Terrestrial, including vehicular (in-cabin) radar devices in the 57.0-59.4 GHz band segment, can be certified under §15.255(c)(2)(i), with peak EIRP limits of 20 dBm for indoor operation and 30 dBm for outdoor operation.
☐ e. All terrestrial radar within the 57.0-61.56 GHz band segment can be certified under §15.255(c)(2)(ii), with a peak EIRP limit of 3 dBm with no off-time requirement, or 20 dBm with a corresponding off-time requirement of 16.5 milliseconds within any 33.0-millisecond interval.
☒ f. Any terrestrial radar operating within the 57.0-64.0 GHz band segment can be certified under §15.255(c)(2)(iii)(A), with a peak EIRP limit of 14 dBm and a corresponding off-time requirement of 25.5 milliseconds within any 33.0-millisecond interval.
☐ g. Permanent or temporary fixed radar intended solely for outdoor or other than in-cabin vehicular applications can be certified under §15.255(c)(2)(iii)(B) with a peak EIRP limit of 20 dBm and a corresponding off-time requirement of 16.5 milliseconds within any contiguous 33.0 millisecond interval.
☐ h. Pulsed radar applications with a maximum pulse duration of 6 nanoseconds and transmitting within the 57-64 GHz band segment can be certified under §15.255(c)(3), with an average EIRP limit of 13 dBm, a peak EIRP limit of 33 dBm, and a transmit duty cycle limit of 10%; in addition, the average integrated EIRP within the 61.5-64.0 GHz band must not exceed 5 dBm in any 0.3-microsecond interval.

1.2. Declaration by the applicant / manufacturer

N/A

1.3. Testing Laboratory

Dt&C Co., Ltd.		
The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042. The test site complies with the requirements of Part 2.948 according to ANSI C63.4-2014. **- FCC & IC MRA Designation No. : KR0034** **- ISED#: 5740A**		
www.dtnc.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

1.4. Testing Environment

Ambient Condition	
▪ Temperature	+21 ℃ ~ +23 ℃
▪ Relative Humidity	+42 % ~ +45 %

1.5. Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C63.10-2020. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

Parameter	Measurement uncertainty
AC power-line conducted emission	3.4 dB (The confidence level is about 95 %, k = 2)
Radiated emission (1 GHz Below)	5.0 dB (The confidence level is about 95 %, k = 2)
Radiated emission (1 GHz ~ 18 GHz)	4.8 dB (The confidence level is about 95 %, k = 2)
Radiated emission (18 GHz Above)	5.2 dB (The confidence level is about 95 %, k = 2)

1.6. Test Equipment List

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal. Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent	N9020A	23/12/15	24/12/15	MY50110097
Spectrum Analyzer	Rohde Schwarz	FSW85	24/06/14	25/06/14	101778
EMI Receiver	Rohde Schwarz	ESCI3	24/06/04	25/06/04	100798
Thermohygrometer	XIAOMI	MHO-C201	23/12/15	24/12/15	00089675
Thermohygrometer	BODYCOM	BJ5478	23/12/15	24/12/15	120612-2
Multimeter	FLUKE	17B+	23/12/15	24/12/15	36390701WS
Signal Generator	Rohde Schwarz	SMBV100A	23/12/15	24/12/15	255571
Signal Generator	ANRITSU	MG3695C	23/12/15	24/12/15	173501
DC Power Supply	Agilent Technologies	6654A	24/06/05	25/06/05	MY40000801
DC Power Supply	SM techno	SDP30-5D	24/06/05	25/06/05	305DMG291
Loop Antenna	ETS-Lindgren	6502	23/11/09	24/11/09	00060496
Hybrid Antenna	Schwarzbeck	VULB 9160	23/12/15	24/12/15	3362
PreAmplifier	H.P	8447D	23/12/15	24/12/15	2944A07774
HORN ANT	ETS	3117	24/06/04	25/06/04	00143278
PreAmplifier	tsj	MLA-0118-B01-40	23/12/15	24/12/15	1852267
HORN ANT	A.H.Systems	SAS-574	24/06/11	25/06/11	154
PreAmplifier	tsj	MLA-1840-J02-45	24/06/03	25/06/03	16966-10728
Horn Antenna	MI Wave	RX ANT-5 261U+410U	24/06/18	25/06/18	108
PreAmplifier	Norden Millimeter Inc.	NA4060G50N8P12	22/12/16	24/12/16	1003
Horn Antenna	MI Wave	RX ANT-6 261V+410V	24/06/18	25/06/18	110
PreAmplifier	ERAVABT	SBL-5037533550-151-E1-ET	23/12/15	24/12/15	10394-01
Horn Antenna	MI Wave	RX ANT-7 261E	24/06/18	25/06/18	112
PreAmplifier	Norden Millimeter Inc.	NN6090G40N5P-2	22/12/16	24/12/16	1001
Harmonic mixer	Rohde Schwarz	FS-Z90	24/06/14	25/06/14	101714
Horn Antenna	MI Wave	RX ANT-8 261F	24/06/18	25/06/18	114
Harmonic mixer	Rohde Schwarz	FS-Z140	24/06/14	25/06/14	101009
Horn Antenna	MI Wave	RX ANT-9 261G	24/06/18	25/06/18	116
Harmonic mixer	Rohde Schwarz	FS-Z220	24/06/14	25/06/14	101012
Level setting Attenuator	SAGE Millimeter	STA-30-12-M3-2	23/12/15	24/12/15	10391-01
Temp & Humi Test Chamber	SJ Science	SJ-TH-S50	23/12/14	24/12/14	U5542113
Multiplier	OML, Inc.	S12MS	24/06/14	25/06/14	170821-1
EMI Test Receiver	ROHDE&SCHWARZ	ESCI7	24/01/29	25/01/29	100910
PULSE LIMITER	Rohde Schwarz	ESH3-Z2	24/08/21	25/08/21	101333
LISN	SCHWARZBECK	NNLK 8128 RC	23/10/26	24/10/26	8128 RC-387
Thermo HygroMeter	CAS	TE-303N	24/02/07	25/02/07	220502518
High Pass Filter	Wainwright Instruments	WHKX12-935-1000-15000-40SS	24/06/12	25/06/12	8
High Pass Filter	Wainwright Instruments	WHKX10-2838-3300-18000-60SS	24/06/12	25/06/12	1
High Pass Filter	Wainwright Instruments	WHNX8.0/26.5-6SS	24/06/12	25/06/12	3
Cable	DT&C	Cable	24/01/03	25/01/03	G-2
Cable	HUBER+SUHNER	SUCOFLEX 100	24/01/03	25/01/03	G-3
Cable	DT&C	Cable	24/01/03	25/01/03	G-4
Cable	OMT	YSS21S	24/01/03	25/01/03	G-5
Cable	Junkosha	MWX241	24/01/03	25/01/03	mmW-1
Cable	Junkosha	MWX241	24/01/03	25/01/03	mmW-4
Cable	HUBER+SUHNER	SUCOFLEX100	24/01/03	25/01/03	M-1
Cable	HUBER+SUHNER	SUCOFLEX100	24/01/03	25/01/03	M-2

Cable	JUNKOSHA	MWX241/B	24/01/03	25/01/03	M-3
Cable	JUNKOSHA	J12J101757-00	24/01/03	25/01/03	M-7
Cable	HUBER+SUHNER	SUCOFLEX106	24/01/03	25/01/03	M-9
Cable	DTNC	Cable	24/01/03	25/01/03	RFC-69
Cable	Junkosha	MWX241	24/01/03	25/01/03	mmW-1
Cable	Junkosha	MWX241	24/01/03	25/01/03	mmW-4
Cable	Junkosha	MWX261	24/01/03	25/01/03	mmW-7
Cable	Junkosha	MWX261	24/01/03	25/01/03	mmW-15
Cable	SAGE MILLIMETER Inc	SCW-1M1M024-F1	24/01/03	25/01/03	mmW-10
Cable	HUBER+SUHNER	SUCOFLEX 104	24/01/03	25/01/03	mmW-8
Cable	HUBER+SUHNER	SUCOFLEX 104	24/01/03	25/01/03	mmW-9
Test Software	tsj	Radiated Emission Measurement	NA	NA	Version 2.00.0185
Test Software	tsj	Noise Terminal Measurement	NA	NA	Version 2.00.0190

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017.
Note2: The cable is not a regular calibration item, so it has been calibrated by DT & C itself.

2. Test Methodology

The measurement procedures described in the ANSI C63.10-2020 was used in measurement of the EUT.

2.1. EUT configuration

The EUT configuration for testing is installed on RF field strength 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 test mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.255 under the FCC Rules Part 15 Subpart C.

2.3. General test procedures

Conducted Emissions

The EUT is placed on the wooden table, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and Average detector

Radiated Emissions

The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m 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 highest emission, the relative positions of the EUT were rotated through three orthogonal axes.

2.4. 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, which is traceable to recognized national standards.

2.5. Description of test modes

The EUT has been tested with all modes of operating conditions to determine the worst case emission characteristics. A test program is used to control the EUT for staying in continuous transmitting mode.

Test Mode	Description	Test Frequency(GHz)
FMCW	Sweep Active	61.05

3. Antenna Requirements

▣ **According to Part 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 antenna is permanently attached on the device.
Therefore this E.U.T complies with the requirement of Part 15.203

4. Summary of Test Results

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Status Note 1
2.1049 (KDB 36244 D01 Section 6)	Occupied Bandwidth (99%)	NA	Radiated	C
15.255(c)(2)(iii)(A)	Equivalent Isotropic Radiated Power	< 14 dBm (Peak)		C Note2
15.255(c)(2)(iii)(A)	Off-time requirement	25.5 ms off time per 33 ms		C Note2
15.255(d) 15.209	Unwanted emissions	Refer to the section 5.3		C Note2
15.255(f)	Frequency Stability	Within the frequency band		C
15.207	AC Line Conducted Emissions	< Part 15.207 limits (Refer to the section 5.5)	AC Line Conducted	C
15.203	Antenna Requirements	Part 15.203 (Refer to the section 3)	-	C

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable
Note 2: This test item was performed in three orthogonal EUT positions and the worst case data was reported.

5. Test Results

5.1. Occupied Bandwidth (99%)

▣ Test Requirements and limit

KDB 364244 D01 Section 6

For other than pulsed radar transmitters, the fundamental emission bandwidth is presumed to be *"…the width of a frequency band such that, below the lower and above the upper-frequency limits, the mean powers emitted are each equal to a specified percentage β/2 of the total mean power of a given emission. Unless otherwise specified in an ITU–R Recommendation for the appropriate class of emission, the value of β/2 should be taken as 0.5%*," as defined in §2.1(c) of the FCC rules. This is also known as the 99% occupied bandwidth (OBW).

▣ Test Configuration:

Refer to the APPENDIX I.

▣ Test Procedure:

ANSI C63.10-2020 – Section 9.4

The following procedure shall be used for measuring 99% power bandwidth:

Use the following spectrum analyzer settings:

1) Span equal to approximately 1.5 times the OBW, centered on the carrier frequency

2) RBW, prefer 1% to 5% of OBW, or a minimum of 1 MHz if this is not possible due to a large OBW

3) VBW approximately 3 × RBW

4) Set the reference level of the instrument as required to reduce the chance of the signal amplitude exceeding the maximum spectrum analyzer input mixer level for linear operation.

5) Sweep = No faster than coupled (auto) time.

6) Detector function = peak.

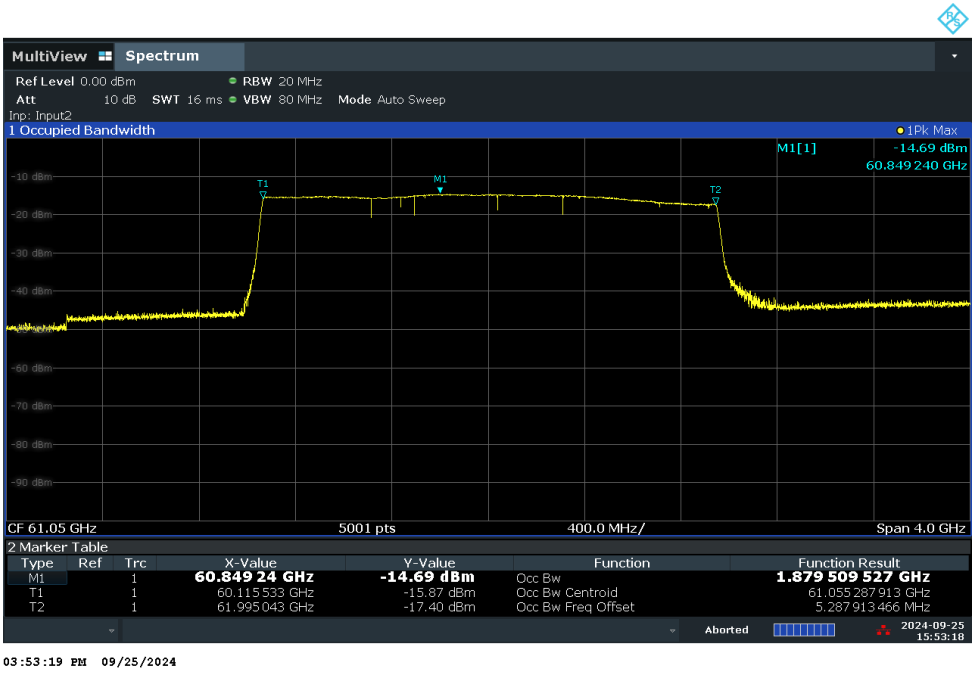
7) Trace = max-hold.

▣ Test Results: Comply

Frequency(GHz)	Occupied Bandwidth(MHz)
61.05	1879.51

▣ Result plots

Occupied Bandwidth Tested Frequency: 61.05 GHz



5.2. Equivalent Isotropic Radiated Power

▣ Test Requirements and limit

FCC Part 15.255(2)(iii) 57.0-64.0GHz:

(A) The peak EIRP shall not exceed 14 dBm, and 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;

(B) The peak EIRP shall not exceed 20 dBm, 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;

▣ Test Configuration:

Refer to the APPENDIX I.

▣ Test Procedure:

ANSI C63.10-2020 – Section 9.8

For radiated measurements:

1) Place the measurement antenna at a measurement distance that is in the far-field of the measurement antenna, in the far-field of the EUT antenna, and meets the measurement distance requirements for final radiated measurements as specified in 9.1.4 of ANSI C63.10-2020.

Place the measurement antenna in the main beam of the EUT then maximize the fundamental emission using the procedures of 9.7 of ANSI C63.10-2020 , noting that multiple peaks can be found at different beam orientations and/or polarizations.

2) Place the measurement antenna in the main beam of the EUT then maximize the fundamental emission using the procedures of 9.7 of ANSI C63.10-2020, noting that multiple peaks can be found at different beam orientations and/or polarizations.

3) Correct the power reading from the spectrum analyzer for any external gain and/or attenuation between the measurement antenna and the spectrum analyzer. This is the power at the output of the measurement antenna

4) Calculate the EIRP from the power at the output of the measurement antenna using Equation (22), and then convert to linear form using Equation (24).

ANSI C63.10-2020 – Section 9.2.2

Calculate the EIRP from the radiated measurement in the far-field using Equation (22):

$EIRP = 21.98 - 20\log(\lambda) + 20\log(d_{Mea}) + P - G$ (22)

EIRP is the equivalent isotropic radiated power, in dBm

λ is the wavelength of the emission under investigation [300/*f*(MHz)], in m

d_{Meas} is the measurement distance, in m

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

G is the gain of the measurement antenna, in dBi

Far field distance (R_m)

$R_m = 2D^2 / \lambda$,

Where, D=the largest dimension of the antenna / λ=the wavelength of the emissions

Frequency Range(GHz)	λ (cm)	D (cm)	Rm (m)	Measurement Distance(m)
60.0 ~ 62.0	0.4484	5.68	1.38	1.60

▣ Test Results: Comply

Peak EIRP

Test Note.

1. The EIRP was measured in each axis EUT positions and the worst case data was reported.
2. For peak power measurement, a desensitization correction factor was applied to the measurement result.
3. Sample Calculation.

EIRP = 21.98 - 20log(λ) + 20 log(d_{Mea}) + P – G + DCF

P(dBm) = Measured level(dBm) + CF(dB)

Where,

λ is the wavelength of the emission under investigation [300/f(MHz)], in m

d_{Meas} is the measurement distance, in m

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

G is the gain of the measurement antenna, in dBi

CF = Correction factor up to the connection to the measurement antenna / CF(dB) = Cable Loss(dB) + Attenuator Loss(dB) – Amplifier Gain(dB)

DCF = Desensitization Correction Factor

DCF Calculation

$$\alpha = \frac{1}{\sqrt{1+\left(\frac{2\ln(2)}{\pi}\right)^2\left(\frac{BW_{Chirp}}{T_{Chirp}B^2}\right)^2}}$$

α is the reduction in amplitude

BW_{Chirp} is the FMCW Chirp Bandwidth

T_{Chirp} is the FMCW Chirp Time

B is the 3 dB IF Bandwidth = RBW

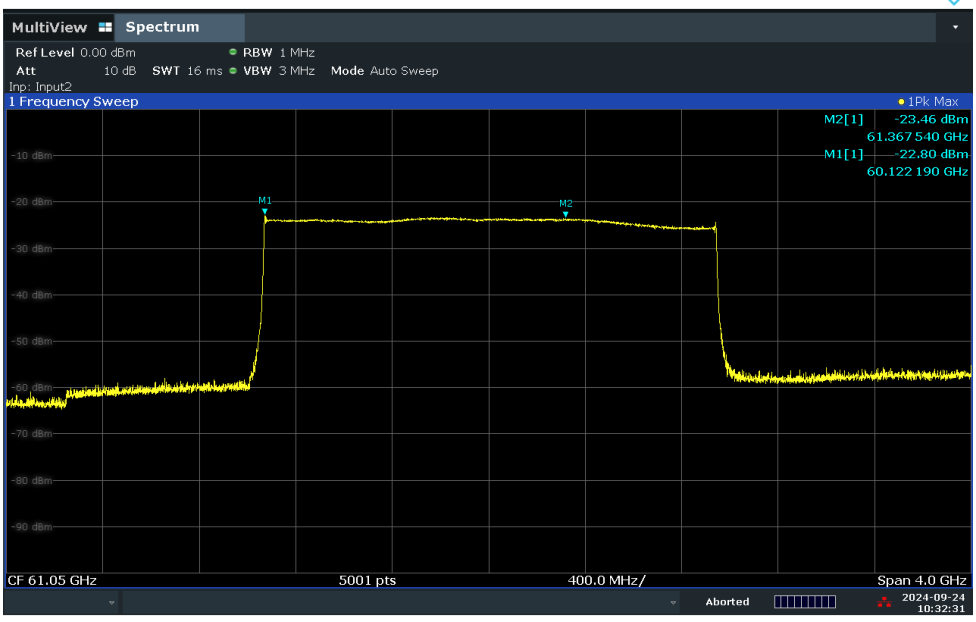
Chirp Bandwidth = 2 GHz, Chirp time = 50 us, RBW = 1 MHz, reduction in amplitude = 0.057

Desensitization Correction Factor = 12.47 dB

Tested Frequency: 61.05 GHz

Measurement distance(D)	Frequency (GHz)	ANT Pol	λ (m)	Detector	Measured level (dBm)	CF (dB)	P (dBm)	G (dBi)	DCF (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1.6 m	60.122	V	0.00499	PK	-22.80	-25.42	-48.22	24.61	12.47	11.74	14.00	2.26
1.6 m	61.368	V	0.00489	PK	-23.46	-24.89	-48.35	24.77	12.47	11.63	14.00	2.37

Result plot (Measured Level) Y axis & Ver

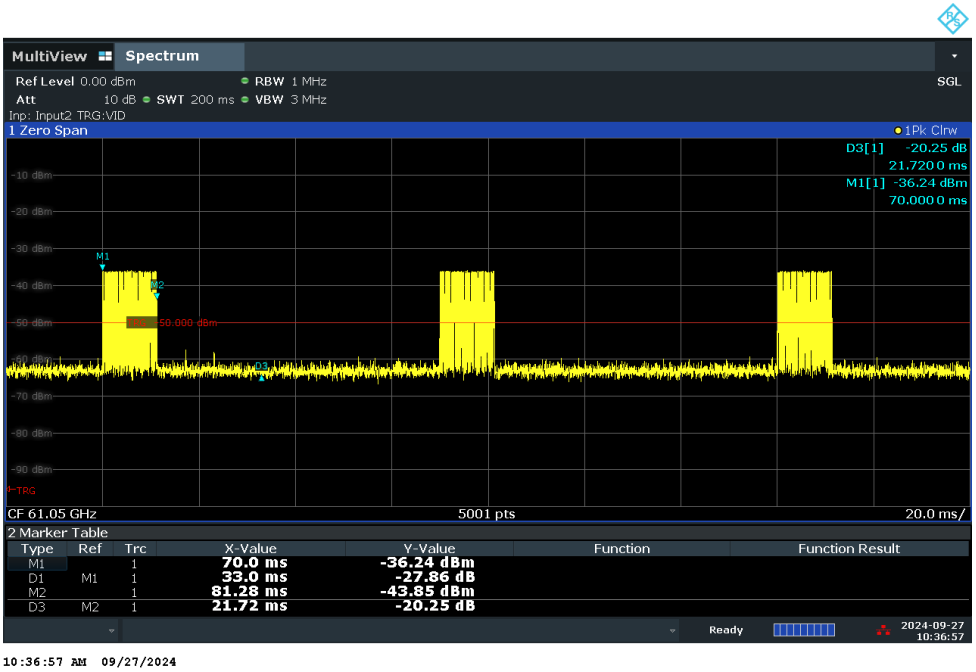


Off-time requirement

Frequency(GHz)	Off-time per 33 ms	Limit
61.05	21.72 ms	25.5 ms off time per 33 ms

▣ Result plots

Off-time Tested Frequency: 61.05 GHz



5.3. Unwanted emissions

▣ Test Requirements and limit

FCC Part 15.255(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 Part 15.209(a): the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Limit (uV/m)	Measurement Distance (meter)
0.009 – 0.490	2 400/F (kHz)	300
0.490 – 1.705	2 4000/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

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

▣ Test Configuration:

Refer to the APPENDIX I.

▣ Test Procedure:

ANSI C63.10-2020 – Section 9.10 & 9.11

The following procedure was used for measurement of the radiated spurious emissions.

1) The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements at above 1 GHz, the table height is 1.5 m

2) The table was rotated 360 degrees to determine the position of the highest radiation.

3) During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 0.5 ~ 3 meter away from the interference-receiving antenna.

4) For measurements above 1GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 GHz, the absorbers are removed.

5) The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

6) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.

7) The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Spectrum analyzer settings:

1. Frequency Range: Below 1GHz
RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak

2. Frequency Range: 1 ~ 40GHz
Peak Measurement
RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes
Average Measurement
RBW = 1 MHz, VBW ≥ Reduce the video bandwidth until no significant variations in the displayed signal are observed in subsequent traces, provided the video bandwidth is no less than 1 Hz.
Detector = Peak, Sweep Time = Auto, Trace Mode = Max Hold until the trace stabilizes

3. Frequency Range: Above 40GHz
RBW = 1 MHz, VBW = 3 MHz, Detector = RMS, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes

Far field distance (R_m)

$R_m = 2D^2 / \lambda$

Where, D=the largest dimension of the measurement antenna / λ=the wavelength of the emissions

Frequency Range(GHz)	λ (cm)	D(cm)	Rm (m)	Measurement Distance(m)
40 ~ 60	0.500	6.24	1.56	1.60
60 ~ 90	0.333	4.82	1.39	1.60
90 ~ 140	0.214	2.74	0.70	0.70
140 ~ 200	0.150	1.89	0.48	0.50

▣ Test Results: Comply

Frequency Range: 9 kHz ~ 1 GHz

Test Note.

1. Radiated emissions below 30 MHz below 30 MHz were greater than 20 dB below limit.
2. Information of DCF(Distance Correction Factor)
   For finding emissions, measurements may be performed at a distance closer than that specified in the regulations.
   In this case, the distance factor is applied to the result.
   - Calculation of distance correction factor
   At frequencies below 30 MHz = 40 log(tested distance / specified distance)
   At frequencies at or above 30 MHz = 20 log(tested distance / specified distance)
   When distance factor is “NA”, the measurements were performed at the specified distance and distance factor is not applied.
3. Sample Calculation.
   Margin = Limit – Result / Result = Measured Level + TF + Distance factor / TF = AF + CL – AG
   Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain
4. * Noise floor.

Tested Frequency: 61.05 GHz

Frequency (MHz)	ANT Pol	Detector Mode	Measured Level(dBuV)	TF (dB/m)	DCF(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
51.66	V	QP	37.80	-8.43	NA	29.37	40.00	10.63
68.44	V	QP	43.10	-10.06	NA	33.04	40.00	6.96
77.72	V	QP	36.90	-11.66	NA	25.24	40.00	14.76
148.57	H	QP	44.40	-6.90	NA	37.50	43.50	6.00
-	-	-	-	-	-	-	-	-

Worst data plot (Measured Level), X axis & Hor

Frequency Range: 1 ~ 40 GHz

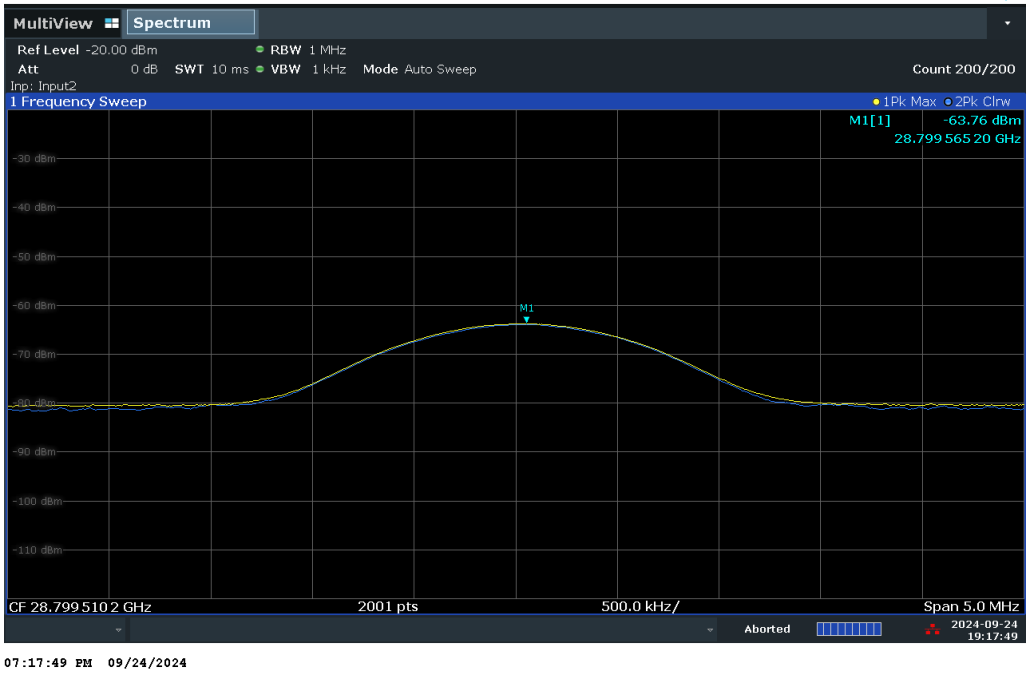
Test Note.

1. No other spurious and harmonic emissions were found above listed frequencies.
2. Information of DCF(Distance Factor)
   For finding emissions, the test distance might be reduced. In this case, the distance factor is applied to the result.
   - Calculation of distance factor = 20 log(applied distance / required distance)
   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
3. Sample Calculation.
   Margin = Limit – Result / Result(dBuV/m) = Measured Level(dBm) + 107 + TF + Distance factor / TF = AF + CL – AG
   Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain
4. * Noise floor.

Tested Frequency: 61.05 GHz

Frequency (MHz)	ANT Pol	Detector Mode	Measured Level (dBm)	TF (dB/m)	DCF(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
*12846.00	V	PK	-61.47	10.64	NA	56.17	74.00	17.83
*12906.00	V	AV	-72.25	10.60	NA	45.35	54.00	8.65
28799.44	V	PK	-59.38	9.49	-5.46	51.65	74.00	22.35
28799.57	V	AV	-63.76	9.49	-5.46	47.27	54.00	6.73
*39246.83	V	PK	-62.18	14.76	-5.46	54.12	74.00	19.88
*39276.82	V	AV	-74.66	14.86	-5.46	41.74	54.00	12.26
-	-	-	-	-	-	-	-	-

Worst data plot (Measured Level) Y axis & Ver



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Frequency Range: 40 ~ 90 GHz

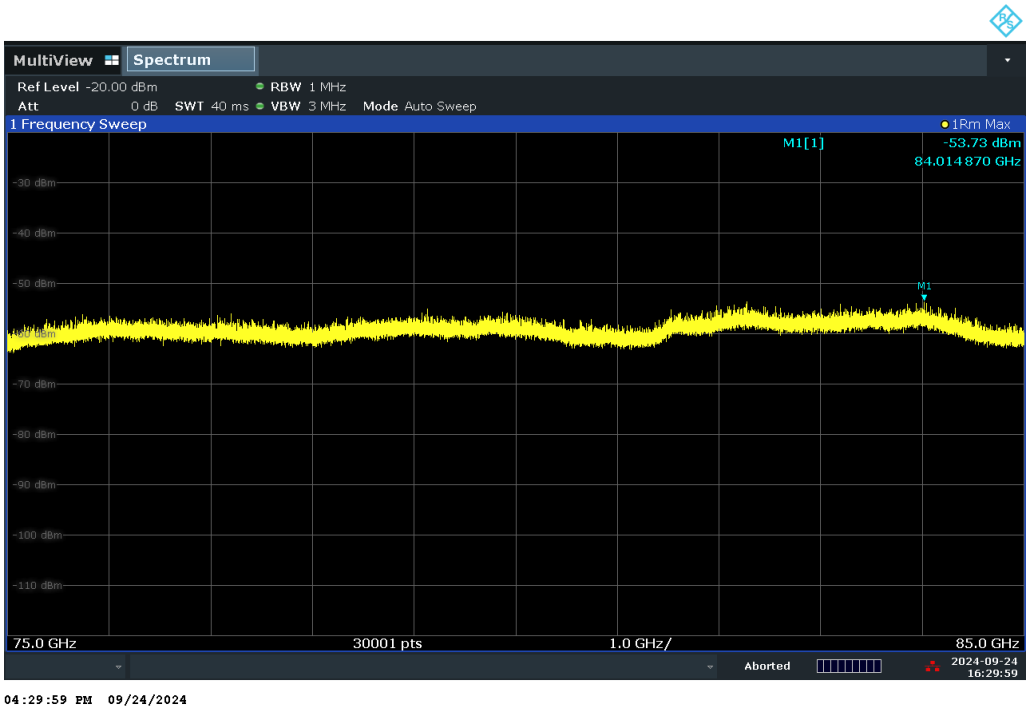
Note.

1. No other spurious and harmonic emissions were found above listed frequencies.
2. Information of DCF(Distance Factor)
   For finding emissions, the test distance might be reduced. In this case, the distance factor is applied to the result.
   - Calculation of distance factor = 20 log(applied distance / required distance)
   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
3. Sample Calculation.
   E(dBuV/m) = Measured level (dBm) + 107 + TF(dB/m)
   where, E=field strength / TF(Total Factor) = Antenna Factor(dB/m) + Cable Loss(dB/m) + Attenuator Loss(dB) – Amplifier Gain(dB)
   EIRP(dBm) = E(dBuV/m) + 20log(D) - 104.7; where, D is measurement distance (in the far field region) in m.
   $PD = EIRP_{Linear} / 4\pi d^2$
   Where, PD = the power density at the distance specified by the limit, in W/m^2
   $EIRP_{Linear}$ = EIRP, in watts
   D = is the distance at which the power density limit is specified, in m
   If the mixer is used, mixer loss was applied to the measured level by SA correction factor.
4. * Noise floor.

Tested Frequency: 61.05 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Measured Level(dBm)	TF (dB/m)	E (dBuV/m)	EIRP (dBm)	Power Density (pW/cm^2)	Limit (pW/cm^2)
1.6 m	*41350.83	V	-57.56	-3.64	45.80	-54.82	0.003	90.00
1.6 m	*74661.76	V	-59.68	21.76	69.08	-31.54	0.620	90.00
1.6 m	*84014.87	V	-53.73	27.14	80.41	-20.21	8.425	90.00
-	-	-	-	-	-	-	-	-

Worst data plot (Measured Level: Noise floor) Y axis & Ver



Frequency Range: 90 ~ 200 GHz

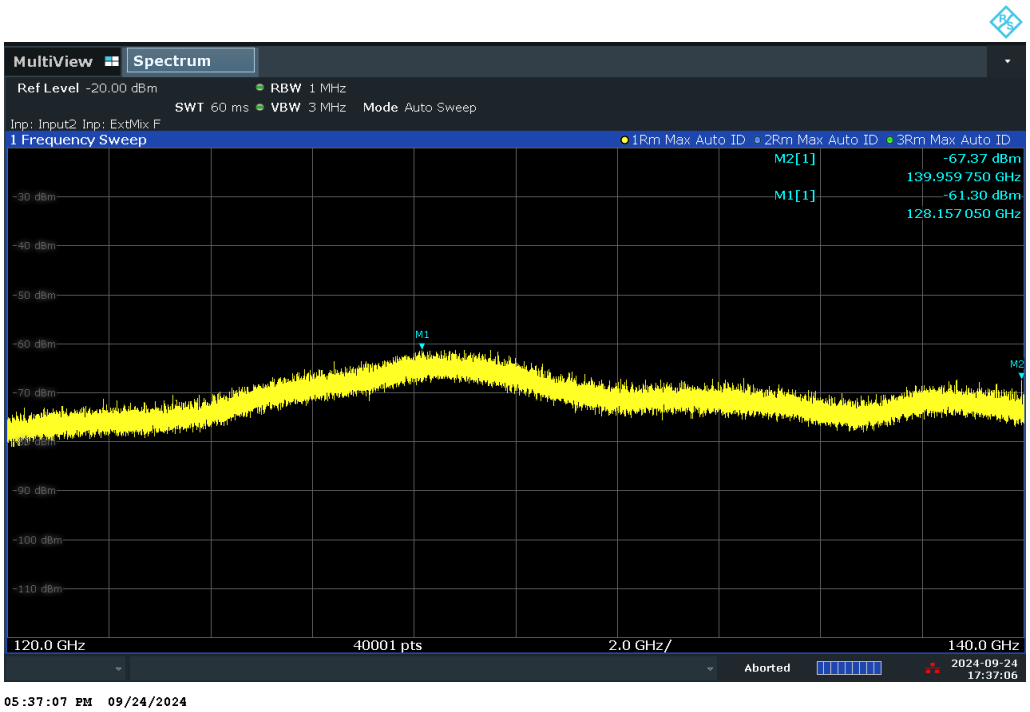
Test Note.

1. The radiated emissions were investigated up to 200GHz. And no other spurious and harmonic emissions were found above listed frequencies.
2. Information of DCF(Distance Factor)
   For finding emissions, the test distance might be reduced. In this case, the distance factor is applied to the result.
   - Calculation of distance factor = 20 log(applied distance / required distance)
   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
3. Sample Calculation.
   E(dBuV/m) = Measured level (dBm) + 107 + TF(dB/m)
   where, E=field strength / TF(Total Factor) = Antenna Factor(dB/m) + Cable Loss(dB/m) + Attenuator Loss(dB) – Amplifier Gain(dB)
   EIRP(dBm) = E(dBuV/m) + 20log(D) - 104.7; where, D is measurement distance (in the far field region) in m.
   $PD = EIRP_{Linear} / 4\pi d^2$
   Where, PD = the power density at the distance specified by the limit, in W/m^2
   $EIRP_{Linear}$ = EIRP, in watts
   D = is the distance at which the power density limit is specified, in m
   If the mixer is used, mixer loss was applied to the measured level by SA correction factor.
4. * Noise floor.

Tested Frequency: 61.05 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Measured Level(dBm)	TF (dB/m)	E (dBuV/m)	EIRP (dBm)	Power Density (pW/cm^2)	Limit (pW/cm^2)
0.7 m	*128157.05	V	-61.30	47.87	93.57	-14.23	33.38	90.00
0.7 m	*139959.75	V	-67.37	48.37	88.00	-19.80	9.26	90.00
0.5 m	*191652.89	V	-66.39	51.95	92.56	-18.16	13.51	90.00
-	-	-	-	-	-	-	-	-

Worst data plot (Measured Level: Noise floor) Y axis & Ver



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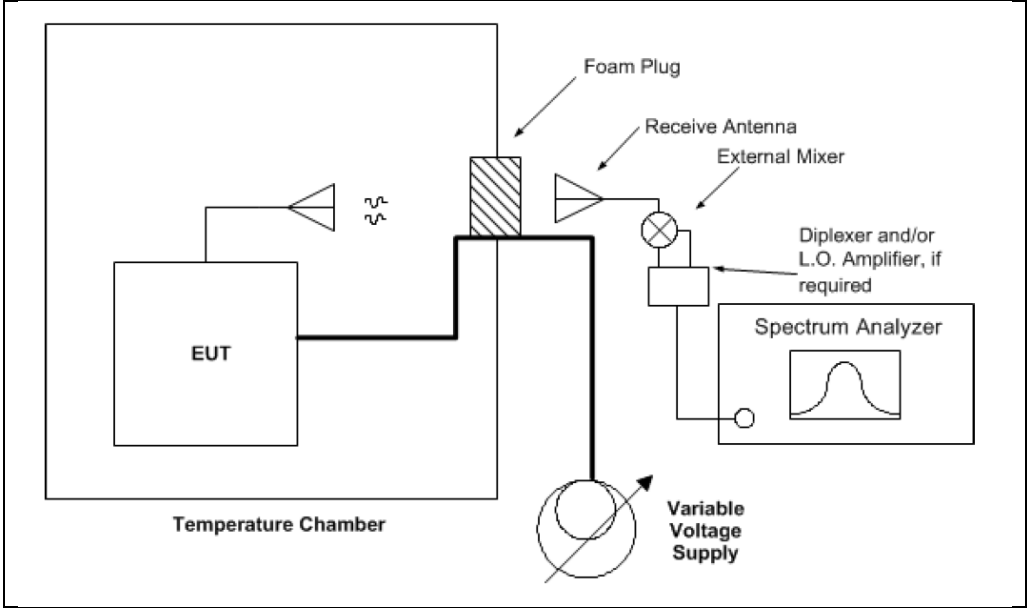
5.4. Frequency stability

▣ Test Requirements and limit

FCC Part 15.255(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.

▣ Test Configuration:

Frequency stability



▣ Test Procedure:

ANSI C63.10-2020 – Section 9.5

1) 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.

2) Vary EUT power supply between 85% and 115% of nominal, and record the frequency excursion of the EUT emission mask.

3) 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.

4) Repeat step 3) at each 10 °C increment down to −20 °C.

▣ Test Results: Comply

Tested Frequency: 61.05 GHz

VOLTAGE (%)	POWER (V DC)	TEMP (℃)	Measured low frequency(F_L)(GHz)	Measured high frequency(F_H)(GHz)
100%	5.00	+20(Ref)	60.115533	61.995043
100%		-30	60.116990	61.995095
100%		-20	60.113518	61.996368
100%		-10	60.115750	61.993862
100%		0	60.115450	61.994095
100%		+10	60.114518	61.995348
100%		+20	60.115533	61.995043
100%		+30	60.115021	61.993862
100%		+40	60.116450	61.995368
100%		+50	60.113818	61.994295
115%	5.75	+20	60.114750	61.995368
85%	4.25	+20	60.116021	61.996480

Note: Fundamental emissions were contained within the frequency band.

5.5. AC line conducted emissions

▣ Test Requirements and limit, Part 15.207

For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network(LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

▣ Test Configuration:

See test photographs for the actual connections between EUT and support equipment.

▣ Test Procedure:

Conducted emissions from the EUT were measured according to the ANSI C63.20-2013.

1. The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

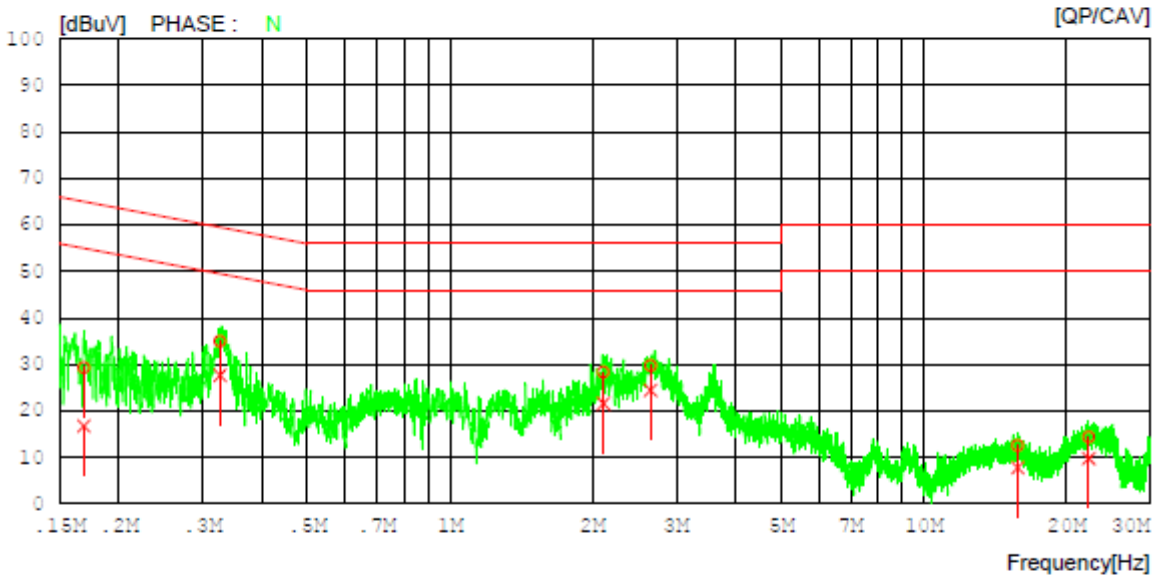
▣ Test Results: Comply

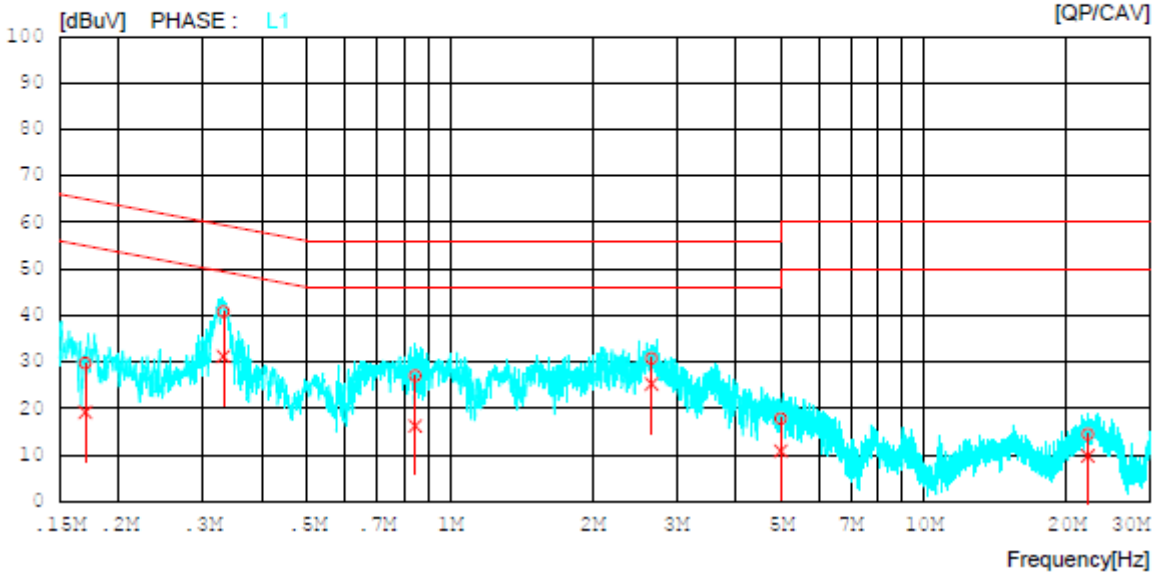
AC Line Conducted Emissions (Graph) Tested Frequency: 61.05 GHz

Order No.			
Model Name	RM68-51	Voltage	DC 5V
Temp/Humi/Atm	21 ºC / 43%		
Test Condition	mmW		

LIMIT : FCC P15.207 AV
FCC P15.207 QP

Lisn Factor
1. NSLK 8128 RC-387_N_23.10.26
2. NSLK 8128 RC-387_L1_23.10.26
Cable Loss
1. C1_LISN TO RECEIVER_2023-12-11
Pulse Lmitter
1. PULSE LIMITER_ESH3-Z2_101333_2024.08.21





AC Line Conducted Emissions (List) **Tested Frequency: 61.05 GHz**

Results of Conducted Emission

Date 2024-09-20

Order No.
Model Name RM68-51 Voltage DC 5V
Temp/Humi/Atm 21 ºC / 43%
Test Condition mmW

LIMIT : FCC P15.207 AV
FCC P15.207 QP

Lisn Factor
1. NSLK 8128 RC-387_N_23.10.26
2. NSLK 8128 RC-387_L1_23.10.26
Cable Loss
1. C1_LISN TO RECEIVER_2023-12-11
Pulse Limitter
1. PULSE LIMITER_ESH3-Z2_101333_2024.08.21

NO	FREQ	READING QP	READING CAV	C.FACTOR	RESULT QP	RESULT CAV	LIMIT QP	LIMIT CAV	MARGIN QP	MARGIN CAV	PHASE
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	
1	0.16865	19.30	6.74	9.99	29.29	16.73	65.03	55.03	35.74	38.30	N
2	0.32679	24.98	17.67	9.99	34.97	27.66	59.53	49.53	24.56	21.87	N
3	2.10560	18.28	11.56	10.06	28.34	21.62	56.00	46.00	27.66	24.38	N
4	2.64960	19.66	14.37	10.07	29.73	24.44	56.00	46.00	26.27	21.56	N
5	15.77040	2.01	-2.78	10.54	12.55	7.76	60.00	50.00	47.45	42.24	N
6	22.26760	3.82	-0.81	10.58	14.40	9.77	60.00	50.00	45.60	40.23	N
7	0.16979	19.75	9.17	9.99	29.74	19.16	64.97	54.97	35.23	35.81	L1
8	0.33232	30.61	21.17	9.99	40.60	31.16	59.39	49.39	18.59	18.23	L1
9	0.84334	16.87	6.10	10.11	26.98	16.21	56.00	46.00	29.02	29.79	L1
10	2.65960	20.55	15.06	10.17	30.72	25.23	56.00	46.00	25.28	20.77	L1
11	4.98440	7.55	0.61	10.22	17.77	10.83	56.00	46.00	38.23	35.17	L1
12	22.15280	3.85	-0.84	10.60	14.45	9.76	60.00	50.00	45.55	40.24	L1

APPENDIX I

Test set up diagrams

Below 1GHz	Above 1GHz