

TEST REPORT



DT&C Co., Ltd.

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Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC2002-0037
2. Customer
 - Name : Smart Radar System, Inc.
 - Address : A-7F, 253, Pangyo-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : Millimeter Wave Radar Module / RM68-NTA
FCC ID : 2AVKZRM68-NTA
5. Test Method Used : ANSI C63.10-2013
Test Specification : Part 15.255
6. Date of Test : 2020.01.10 ~ 2020.02.12
7. Testing Environment : Refer to appended test report.
8. Test Result : Refer to the attached test result.

Affirmation	Tested by		Reviewed by	
	Name : Inhee bae		Name : JaeJin Lee	

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2020 . 02 . 12 .

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
DRTFCC2002-0037	Feb. 12, 2020	Initial issue	Inhee bae	JaeJin Lee

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1. EUT DESCRIPTION

FCC Equipment Class	DXX – Part 15 Low Power communication Device Transmitter
Product	Millimeter Wave Radar Module
Model Name	RM68-NTA
Add Model Name	-
Serial Number	20A030013
Power Supply	DC 5 V
Frequency Range	60~61.5GHz
Max. RF Output Power (EIRP)	802.11ad : 28.33 dBm
Modulation Type	FMCW
Antenna Specification	Antenna type: Serial Feeding Antenna Max Antenna gain: 22 dBi

Note: This EUT supports 60~61.5GHz FMCW radar.

2. INFORMATION ABOUT TESTING

2.1 Transmitting configuration of EUT

Test Mode	Description	Test Frequency(GHz)
Sweep Stop	Lowest Frequency	61.02 GHz
Sweep Stop	Middle Frequency	61.25 GHz
Sweep Stop	Highest Frequency	61.48 GHz
-	-	-

Note: The EUT has been tested with the frequency sweep stopped at those frequency chosen.

2.2 Auxiliary equipment

Equipment	Model No.	Serial No.	Manufacturer	Note
-	-	-	-	-
-	-	-	-	-

2.3 Tested environment

Temperature	: 21 °C ~ 25 °C
Relative humidity content	: 35 % ~ 42 %
Details of power supply	: DC 5.0 V

2.4 EMI suppression Device(s) / Modifications

EMI suppression device(s) added and/or modifications made during testing
→ None

2.5 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C 63.4-2014 and ANSI C 63.10-2013. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

Test items	Measurement uncertainty
AC conducted emission	2.4 dB (The confidence level is about 95 %, $k = 2$)
Radiated spurious emission (1 GHz Below)	5.1 dB (The confidence level is about 95 %, $k = 2$)
Radiated spurious emission (1 GHz ~ 18 GHz)	5.4 dB (The confidence level is about 95 %, $k = 2$)
Radiated spurious emission (18 GHz Above)	5.3 dB (The confidence level is about 95 %, $k = 2$)

3 SUMMARY OF TEST RESULTS

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Status Note 1
15.215(c)	20dB Bandwidth	NA	Radiated	C
15.255(c)(2)	Equivalent Isotropic Radiated Power	Refer to the section 8.2		C
15.255(d) 15.255(c)(2) 15.209	Radiated Spurious Emissions	Refer to the section 8.3		C
15.255(f)	Frequency Stability	Within the 57 ~71GHz band		C
15.207	AC Line Conducted Emissions	< Part 15.207 limits	AC Line Conducted	C
15.203	Antenna Requirements	Part 15.203	-	C
Note 1: C=Comply NC=Not Comply NT=Not Tested NA=Not Applicable				

4. TEST METHODOLOGY

The measurement procedures described in the ANSI C63.10-2013 was used in measurement of the EUT.

4.1 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.

4.2 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.

4.3 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.

4.4 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.

5. 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.

6. FACILITIES AND ACCREDITATIONS

6.1 Facilities

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 § 2.948 according to ANSI C63.4-2014.		
- FCC & ISED MRA Designation No.: KR0034		
- ISED#: 5740A		
www.dtnet.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

6.2 Equipment

Radiated emissions are measured with one or more of the following types of linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, loop, horn. Spectrum analyzers with pre-selectors and peak, quasi-peak detectors are used to perform radiated measurements.

Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

7. ANTENNA REQUIREMENTS

7.1 According to FCC 47 CFR §15.203

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

The antenna is permanently attached on the main PCB.

Therefore this E.U.T Complies with the requirement of §15.203

8 TEST RESULTS

8.1 20dB Bandwidth

■ Test Requirements and limit, §15.215

The 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

■ Test Configuration:

Refer to the APPENDIX I.

■ Test Procedure:

ANSI C63.10-2013 – Section 9.3

The following procedure was used for measurement of the bandwidth for millimeter-wave devices;

- 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 $\geq$ RBW if not specified.
- 4) Sweep = auto.
- 5) Detector function = peak.
- 6) Trace = max hold. Allow the trace to stabilize.
- 7) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

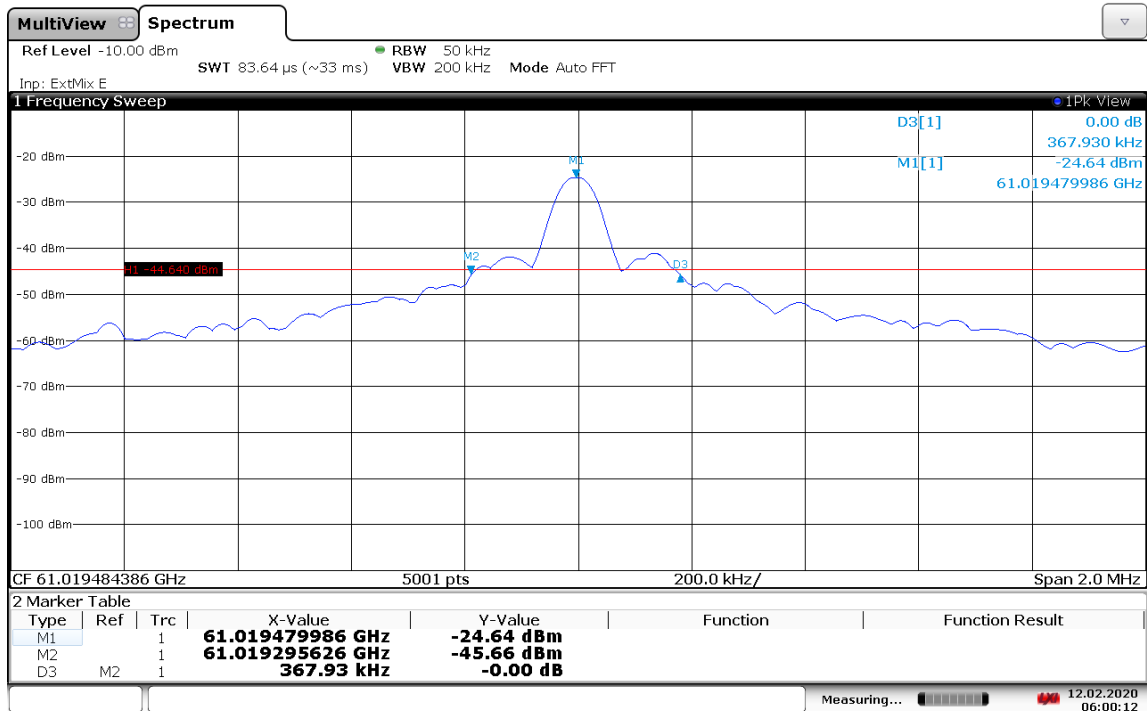
■ Test Results: **Comply**

Test Mode	Frequency[GHz]	Test Results[MHz]
Sweep Stop	61.02	0.368
	61.25	0.420
	61.48	0.356

■ Result plots

20 dB Bandwidth

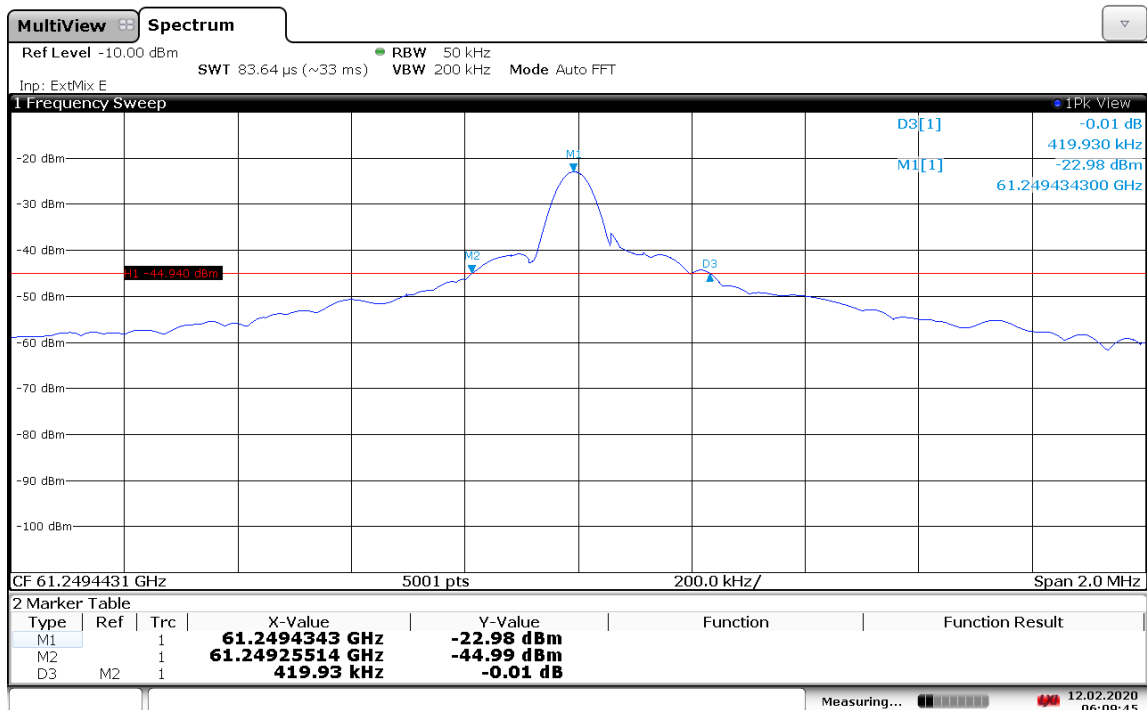
Tested Frequency: 61.02GHz



06:00:13 12.02.2020

20 dB Bandwidth

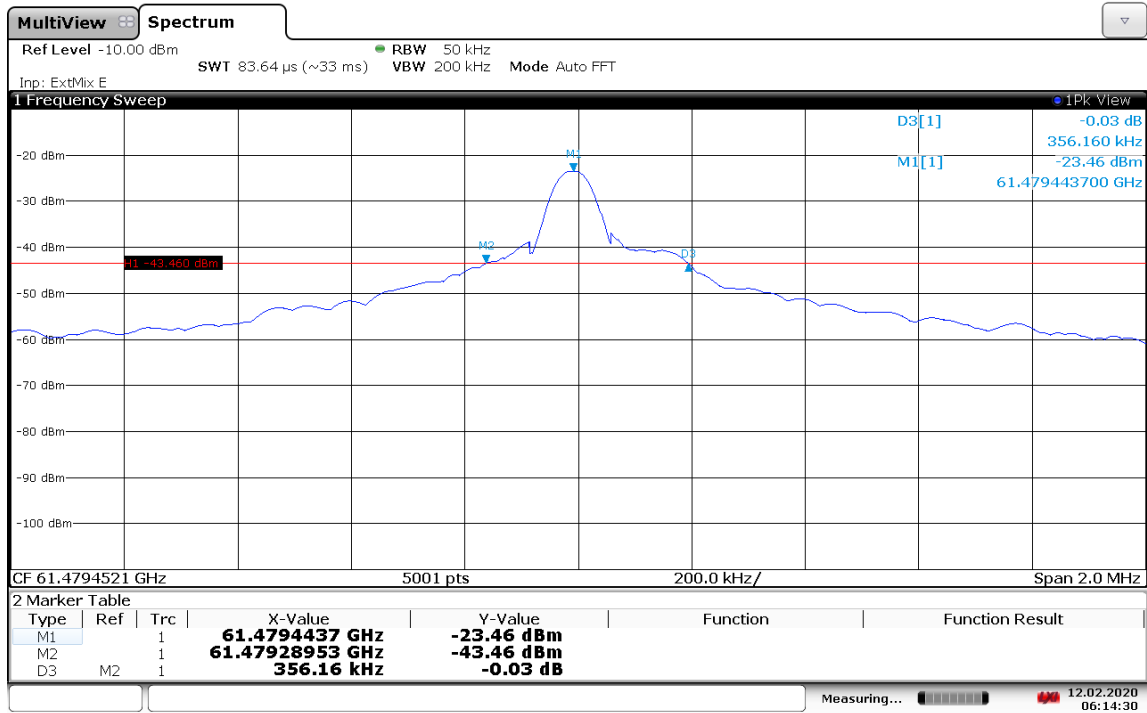
Tested Frequency: 61.25GHz



06:09:46 12.02.2020

20 dB Bandwidth

Tested Frequency: 61.48GHz



06:14:31 12.02.2020

8.2 Equivalent Isotropic Radiated Power

■ Test Requirements and limit, §15.255(c)

• **FCC Part 15.255(c):** Within the 57-71 GHz band, emission levels shall not exceed the following equivalent isotropically radiated power (EIRP):

-Part 15.255(C)(2): For fixed field disturbance sensors that occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0-61.5 GHz, the average power of any emission, measured during the transmit interval, shall not exceed 40 dBm, and the peak power of any emission shall not exceed 43 dBm. In addition, the average power of any emission outside of the 61.0-61.5 GHz band, measured during the transmit interval, but still within the 57-71 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.

-Part 15.255(C)(3): 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.

■ Test Configuration:

Refer to the APPENDIX I.

■ Test Procedure:

ANSI C63.10-2013 – Section 9.11

The following procedure was used for measurement of the output power for millimeter-wave devices;

- 1) The measurements were performed at 3m test site.
- 2) The EUT is placed on a non-conductive table is 1.5 meter above test site ground plane.
- 3) The measurement procedure described in ANSI C63.10-2013 Section 9.9 was followed, to find maximum signal.
- 4) The average and peak voltages was recorded from the DSO.
- 5) Replace the EUT with mm-wave source to the RF input port of the instrumentation system.
- 6) The mm-wave source is unmodulated.
- 7) Adjust the amplitude of the mm-wave source such that the DSO indicates a voltage equal to the peak voltage recorded in step 4).
- 8) Without changing any settings, replace the DSO with the mm-wave power meter.
- 9) Measure and note the power.

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)	R_m (m)	Measurement Distance(m)
61.0 ~ 61.5	0.488	5.68	1.32	1.60

Test Results: **Comply**

Peak power:

Measurement distance(D)	Frequency (GHz)	ANT Pol	DSO Reading [mV]	Power Meter Level[dBm]	Antenna Gain [dBi]	E (dBuV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1.6m	61.02	H	21.6	-19.85	25.10	128.02	27.30	43.00	15.70
1.6m	61.25	H	22.1	-19.03	25.10	128.87	28.15	43.00	14.85
1.6m	61.48	H	21.2	-18.88	25.10	129.05	28.33	43.00	14.67

Average power:

Measurement distance(D)	Frequency (GHz)	ANT Pol	DSO Reading [mV]	Power Meter Level[dBm]	Antenna Gain [dBi]	E (dBuV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)
1.6m	61.02	H	19.7	-20.25	25.10	127.62	26.90	40.00	13.10
1.6m	61.25	H	19.3	-19.41	25.10	128.49	27.77	40.00	12.23
1.6m	61.48	H	19.4	-19.45	25.10	128.48	27.76	40.00	12.24

Note.

1. The EIRP was investigated under all data rate and the worst case data was reported.

2. Sample calculation.

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

where

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

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

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

G is the gain of the test antenna, in dBi

$$EIRP = E_{Meas} + 20\log(d_{Meas}) - 104.7$$

where

EIRP is the equivalent isotropically radiated power, in dBm

E_{Meas} is the field strength of the emission at the measurement distance, in dBμV/m

d_{Meas} is the measurement distance, in m

8.3 Radiated spurious emissions

■ Test Requirements and limit, §15.255(d), §15.209, §15.255(c)(2)

▪ 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/cm² at a distance of 3 meters.
- (4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

▪ **FCC Part 15.255(C)(2):** For fixed field disturbance sensors that occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0-61.5 GHz, the average power of any emission, measured during the transmit interval, shall not exceed 40 dBm, and the peak power of any emission shall not exceed 43 dBm. In addition, the average power of any emission outside of the 61.0-61.5 GHz band, measured during the transmit interval, but still within the 57-71 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.

▪ **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	2400/F (kHz)	300
0.490 – 1.705	24000/F (kHz)	30
1.705 – 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

** 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 C63.10-2013 – Section 9.12 & 9.13

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: ≤ 40GHz

Peak Measurement

RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes

Average Measurement> 1GHz

RBW = 1 MHz, VBW ≥ 1/T, Detector = Peak, Sweep Time = Auto, Trace Mode = Max Hold until the trace stabilizes

3. Frequency Range: Above 40GHz

RBW = 1 MHz, VBW = 1 or 3 MHz, Detector = Peak or average, 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	0.50	6.24	1.56	1.60
60 ~ 90	0.33	4.82	1.39	1.60
90 ~ 100	0.30	2.74	0.50	0.50
100 ~ 140	0.21	2.74	0.70	0.70
140 ~ 200	0.15	1.89	0.48	0.70

■ Test Results: **Comply**

Frequency Range: 9 kHz ~ 1 GHz
Sweep Stop & 61.25 GHz

Frequency (MHz)	ANT Pol	Detector Mode	Measured Level(dBuV)	T.F (dB/m)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
169.94	V	QP	43.10	-7.40	NA	35.70	43.50	7.80
173.92	V	QP	45.30	-7.60	NA	37.70	43.50	5.80
177.99	V	QP	49.00	-8.10	NA	40.90	43.50	2.60
222.51	H	QP	46.60	-8.90	NA	37.70	46.00	8.30
226.56	V	QP	46.90	-8.70	NA	38.20	46.00	7.80
267.02	V	QP	44.40	-7.60	NA	36.80	46.00	9.20

Note.

1. The worst case data was reported. No other spurious and harmonic emissions were found above listed frequencies.

2. Information of 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 = $20 \log(\text{applied distance} / \text{required distance})$

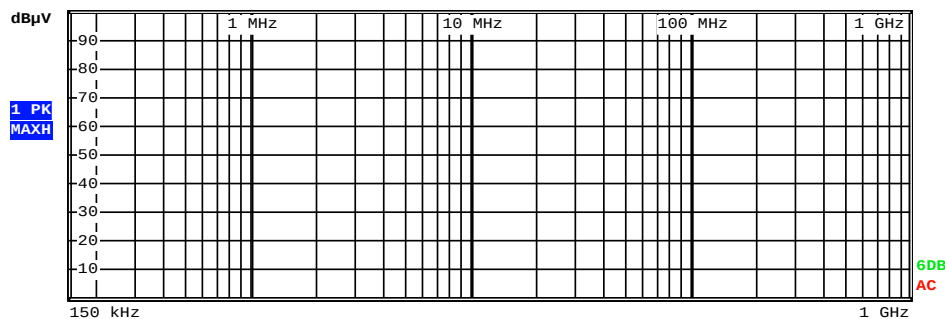
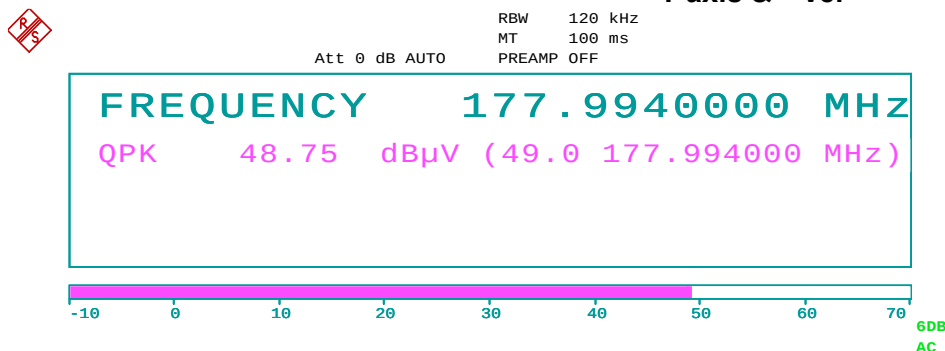
When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. Sample Calculation.

Margin = Limit – Result / Result = Measured Level + T.F + Distance factor / T.F = AF + CL – AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain

**Worst data plot (Measured Level), Tested frequency: 61.25 GHz
Y axis & Ver**



Date: 12.FEB.2020 15:24:06

Frequency Range: 1 ~ 40 GHz
Sweep Stop & Tested frequency: 61.02 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Detector Mode	Measured Level(dBuV)	T.F (dB/m)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
3 m	5400.00	V	PK	45.29	8.17	NA	53.46	74.00	20.54
3 m	8999.37	V	PK	44.06	11.99	NA	56.05	74.00	17.95
3 m	8997.81	V	AV	33.56	11.99	NA	45.55	54.00	8.45
1.6 m	14400.12	H	PK	46.38	19.48	-5.46	60.40	74.00	13.60
1.6 m	14399.98	H	AV	37.27	19.48	-5.46	51.29	54.00	2.71
1.6 m	28800.02	V	PK	51.33	7.73	-5.46	53.60	74.00	20.40
1.6 m	28800.02	V	AV	49.56	7.73	-5.46	51.83	54.00	2.17
-	-	-	-	-	-	-	-	-	-

Sweep Stop & Tested frequency: 61.25 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Detector Mode	Measured Level(dBuV)	T.F (dB/m)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
3 m	5400.46	V	PK	45.00	8.17	NA	53.17	74.00	20.83
3 m	9000.99	V	PK	44.33	11.99	NA	56.32	74.00	17.68
3 m	8999.63	V	AV	33.73	11.99	NA	45.72	54.00	8.28
1.6 m	14399.86	H	PK	46.17	19.48	-5.46	60.19	74.00	13.81
1.6 m	14399.95	H	AV	37.86	19.48	-5.46	51.88	54.00	2.12
1.6 m	28800.07	V	PK	51.10	7.73	-5.46	53.37	74.00	20.63
1.6 m	28800.05	V	AV	49.07	7.73	-5.46	51.34	54.00	2.66
-	-	-	-	-	-	-	-	-	-

Sweep Stop & Tested frequency: 61.48 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Detector Mode	Measured Level(dBuV)	T.F (dB/m)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
3 m	5398.98	V	PK	44.10	8.17	NA	52.27	74.00	21.73
3 m	8999.94	V	PK	44.26	11.99	NA	56.25	74.00	17.75
3 m	8999.88	V	AV	33.62	11.99	NA	45.61	54.00	8.39
1.6 m	14400.24	H	PK	46.17	19.48	-5.46	60.19	74.00	13.81
1.6 m	14399.92	H	AV	37.88	19.48	-5.46	51.90	54.00	2.10
1.6 m	28800.06	V	PK	51.23	7.73	-5.46	53.50	74.00	20.50
1.6 m	28800.03	V	AV	49.39	7.73	-5.46	51.66	54.00	2.34
-	-	-	-	-	-	-	-	-	-

Note.

1. No other spurious and harmonic emissions were found above listed frequencies.

2. Information of 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 = $20 \log(\text{applied distance} / \text{required distance})$

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. Sample Calculation.

Margin = Limit – Result / Result = Measured Level + T.F + Distance factor / T.F = AF + CL – AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

4. * Noise floor.

X axis & Ver

Frequency Range: 40 ~ 200 GHz

Sweep Stop & Tested frequency: 61.02 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Measured Level(dBm)	AF.CL.AG (dB/m)	E (dBuV/m)	EIRP (dBm)	Power Density (pW/cm ²)	Limit (pW/cm ²)
0.7m	122053.25	H	-69.01	47.31	85.30	-22.60	4.859	90.000
0.7m	127608.18	H	-60.29	47.39	94.10	-13.80	36.859	90.000
0.7m	151208.18	H	-67.20	50.70	90.50	-17.40	16.090	90.000
-	-	-	-	-	-	-	-	-

Sweep Stop & Tested frequency: 61.25 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Measured Level(dBm)	AF.CL.AG (dB/m)	E (dBuV/m)	EIRP (dBm)	Power Density (pW/cm ²)	Limit (pW/cm ²)
0.7m	122485.24	H	-68.94	47.31	85.37	-22.53	4.938	90.000
0.7m	126982.65	H	-60.21	47.39	94.18	-13.72	37.545	90.000
0.7m	151089.09	H	-66.58	50.70	91.12	-16.78	18.559	90.000
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

Sweep Stop & Tested frequency: 61.48 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Measured Level(dBm)	AF.CL.AG (dB/m)	E (dBuV/m)	EIRP (dBm)	Power Density (pW/cm ²)	Limit (pW/cm ²)
0.7m	122970.85	H	-69.36	47.31	84.95	-22.95	4.483	90.000
0.7m	128094.84	H	-59.48	47.42	94.94	-12.96	44.725	90.000
0.7m	151367.85	H	-66.35	50.70	91.35	-16.55	19.568	90.000
-	-	-	-	-	-	-	-	-

Note.

1. The radiated emissions were investigated up to 200GHz. And no other spurious and harmonic emissions were found above listed frequencies.

2. Sample Calculation.

$$E(\text{dBuV/m}) = \text{Measured level (dBuV)} + 107 + \text{AF.CL.AG}(\text{dB/m})$$

The mixer loss was applied to the measured level by SA correction factor.

where, E=field strength / AF.CL.AG = Antenna Factor(dB/m) + Cable Loss(dB/m) – Amplifier Gain(dB)

EIRP(dBm) = E(dBuV/m) + 20log(D) - 104.8; where, D is measurement distance (in the far field region) in m.

$$PD = \text{EIRP}_{\text{Linear}} / 4\pi d^2$$

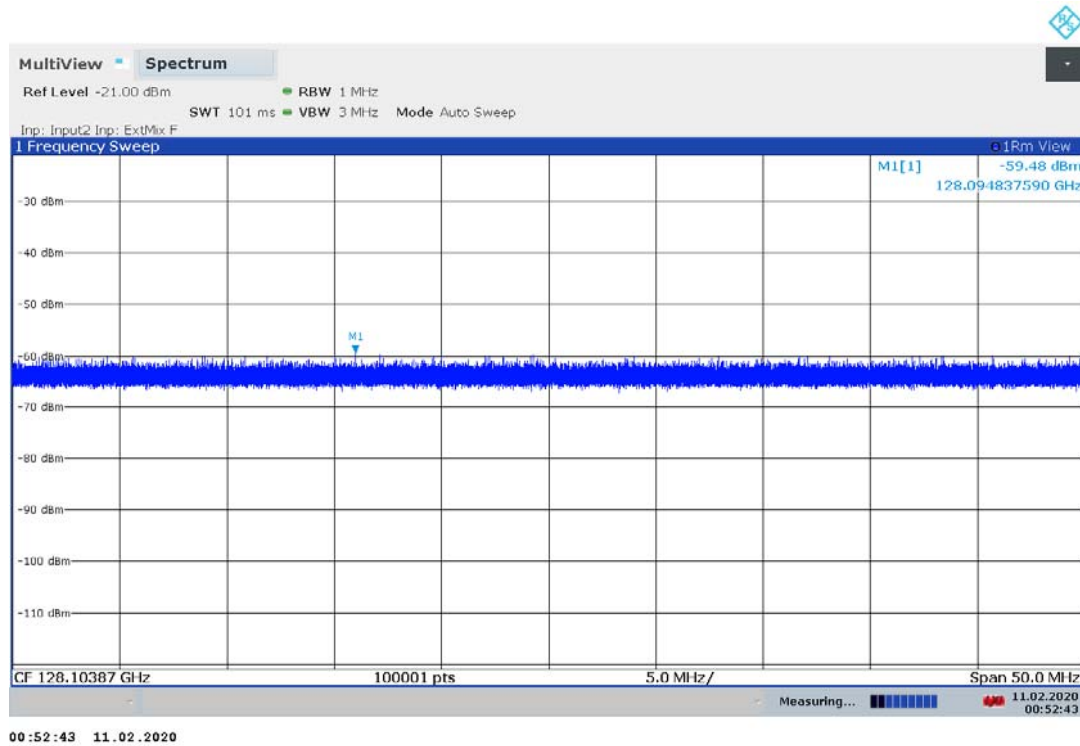
Where, PD = the power density at the distance specified by the limit, in W/m²

$$\text{EIRP}_{\text{Linear}} = \text{EIRP, in watts}$$

D = is the distance at which the power density limit is specified, in m

3. * Noise floor

Worst data plot (Measured Level) **Tested frequency: 61.48 GHz**
Z axis & Hor



Frequency Range: 57 ~ 61.0GHz & 61.0 ~ 61.5GHz
Sweep Stop & 61.02 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Measured Level(dBm)	AF.CL.AG (dB/m)	E (dBuV/m)	EIRP-Peak (dBm)	Limit - Peak (dBm)	Limit - Average (dBm)
1.6m	57599.98	H	-41.88	-5.54	59.58	-41.14	13.00	10.00
1.6m	60997.32	H	-59.68	42.84	90.16	-10.56	13.00	10.00

Sweep Stop & 61.25 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Measured Level(dBm)	AF.CL.AG (dB/m)	E (dBuV/m)	EIRP-Peak (dBm)	Limit - Peak (dBm)	Limit - Average (dBm)
1.6m	57599.96	H	-42.50	-5.54	58.96	-41.76	13.00	10.00
-	-	-	-	-	-	-	-	-

Sweep Stop & 61.48 GHz

Measurement distance(D)	Frequency (MHz)	ANT Pol	Measured Level(dBm)	AF.CL.AG (dB/m)	E (dBuV/m)	EIRP-Peak (dBm)	Limit - Peak (dBm)	Limit - Average (dBm)
1.6m	57600.15	H	-43.37	-5.54	58.09	-42.63	13.00	10.00
1.6m	61500.44	H	-59.69	42.89	90.20	-10.52	13.00	10.00

Note.

1. The Peak results meets the average limit.

2. Sample Calculation.

$$E(\text{dBuV/m}) = \text{Measured level (dBuV)} + 107 + \text{AF.CL.AG}(\text{dB/m})$$

The mixer loss was applied to the measured level by SA correction factor.

where, E=field strength / AF.CL.AG = Antenna Factor(dB/m) + Cable Loss(dB/m) – Amplifier Gain(dB)

EIRP(dBm) = E(dBuV/m) + 20log(D) - 104.8; where, D is measurement distance (in the far field region) in m.

$$PD = \text{EIRP}_{\text{Linear}} / 4\pi d^2$$

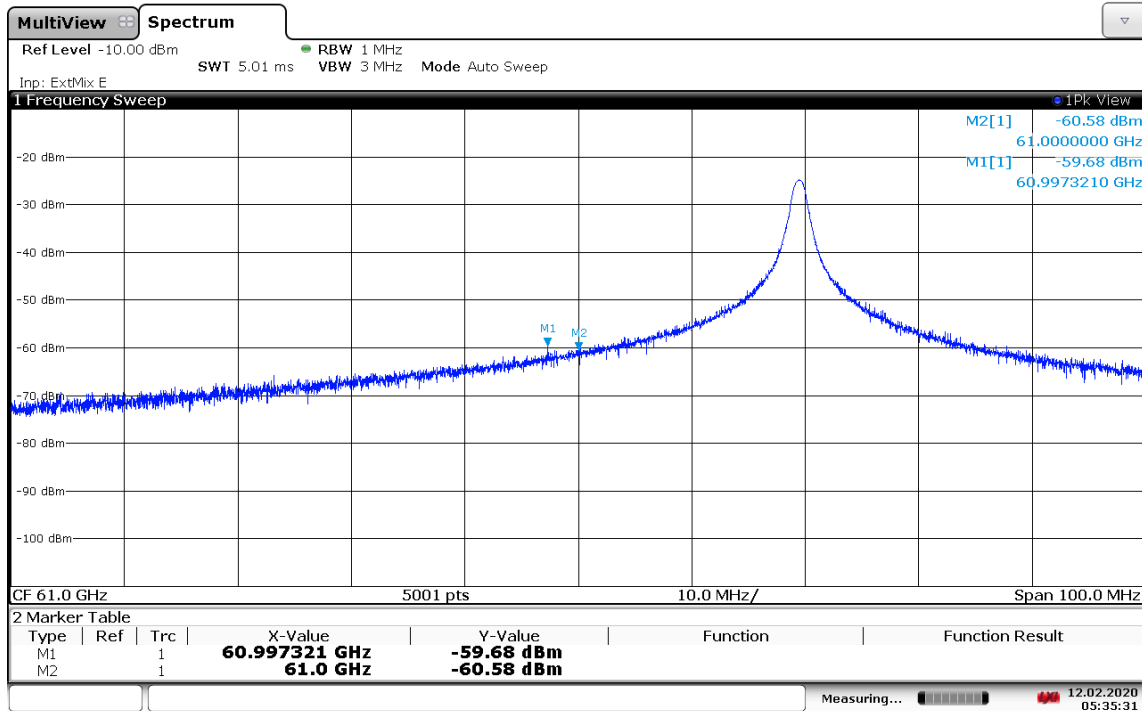
Where, PD = the power density at the distance specified by the limit, in W/m²

$$\text{EIRP}_{\text{Linear}} = \text{EIRP, in watts}$$

D = is the distance at which the power density limit is specified, in m

3. * Noise floor

Worst data plot (Measured Level) Tested frequency: 61.02 GHz Z axis & Hor



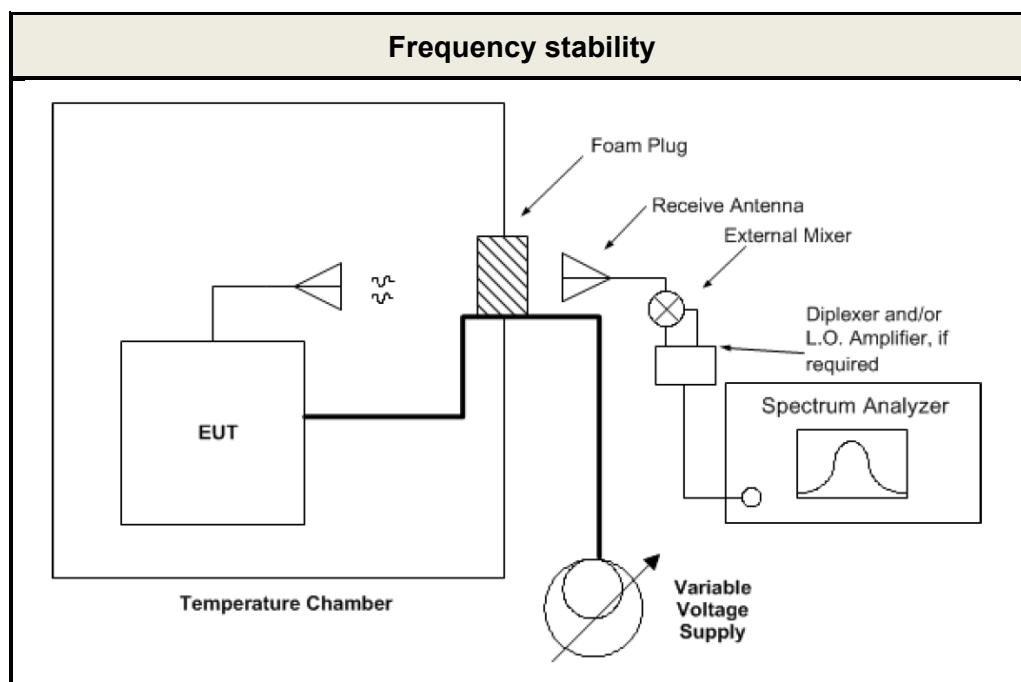
05:35:31 12.02.2020

8.4 Frequency stability

■ Test Requirements and limit, §15.255(f)

- **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:



■ Test Procedure:

ANSI C63.10-2013 – Section 9.14

- 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**

VOLTAGE (%)	POWER (V DC)	TEMP (°C)	Tested Frequency : 61.02 GHz	Tested Frequency : 61.48 GHz
			Measured low frequency(F_L)(GHz), 20dBC	Measured high frequency(F_L)(GHz), 20dBC
100%	5.00	+25(Ref)	61.019296	61.479290
100%		-20	61.021395	61.481814
100%		-10	61.020746	61.481435
100%		0	61.019755	61.480256
100%		+10	61.019485	61.480878
100%		+20	61.019321	61.480110
100%		+30	61.019416	61.479672
100%		+40	61.019409	61.479830
100%		+50	61.019138	61.479524
115%	5.75	+25	61.019268	61.479573
85%	4.25	+25	61.019234	61.479608

Note: Fundamental emissions were contained within the frequency bands.

8.5 AC line conducted emissions

■ Test Requirements and limit, §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 μ H/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:

ANSI C63.10-2013 – Section 6.2

- 1) The EUT is placed on a wooden table 80 cm above the reference ground plane.
- 2) The EUT is connected via LISN to the test power supply.
- 3) The measurement results are obtained as described below:
- 4) Detectors – Quasi Peak and Average Detector.

■ Test Results: **Comply**

AC Line Conducted Emissions (Graph)

Tested Frequency: 60.25 GHz

Results of Conducted Emission

DTNC

Date 2020-02-03

Order No.
Model No.
Serial No.
Test Condition

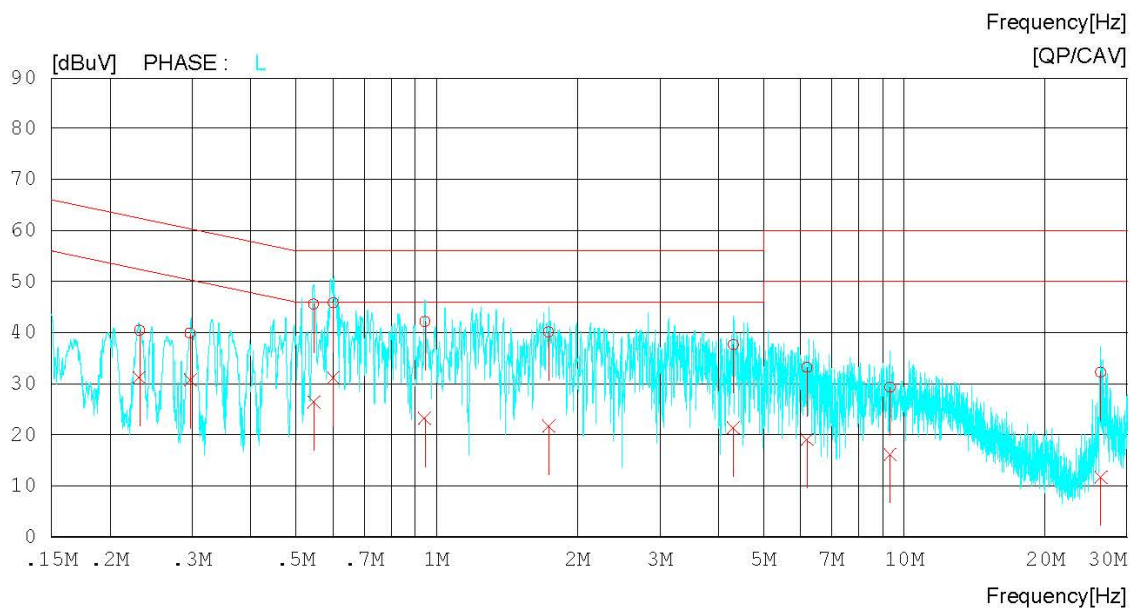
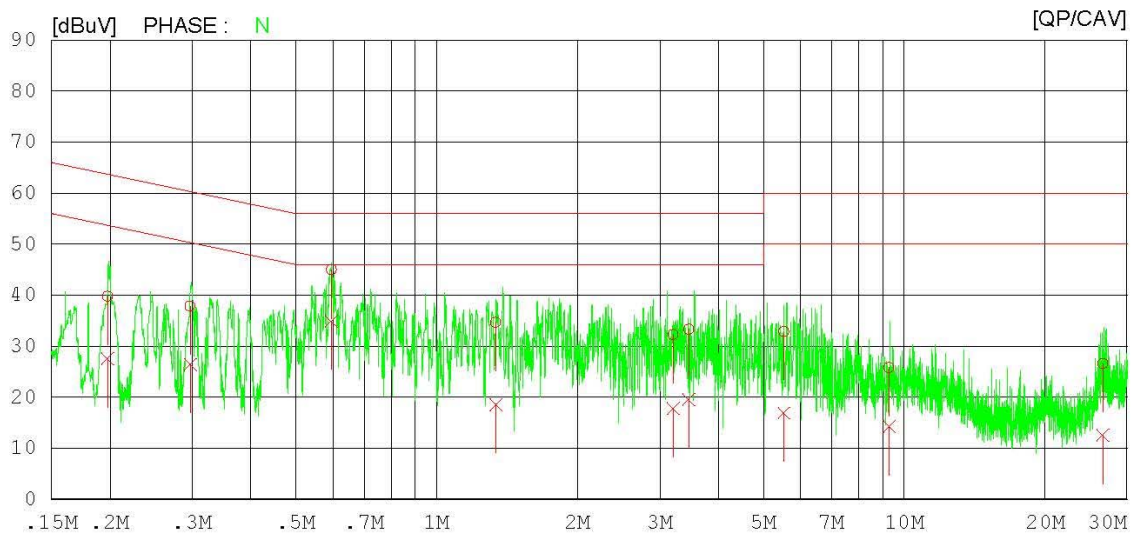
RM68-NTA
20A030013
Middle

Reference No.
Power Supply
Temp/Humi.
Operator

120 V, 60 Hz
23 'C / 35 %
Inhee Bae

Memo

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



AC Line Conducted Emissions (List)

Tested Frequency: 60.25 GHz

Results of Conducted Emission

DTNC

Date 2020-02-03

Order No.
Model No. RM68-NTA
Serial No. 20A030013
Test Condition Middle

Reference No.
Power Supply 120 V, 60 Hz
Temp/Humi. 23 'C / 35 %
Operator Inhee Bae

Memo

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

NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	CAV [dBuV]		QP [dBuV]	CAV [dBuV]	QP [dBuV]	CAV [dBuV]	QP [dBuV]	CAV [dBuV]	
1	0.19774	29.86	17.58	9.94	39.80	27.52	63.70	53.70	23.90	26.18	N
2	0.29724	27.93	16.47	9.94	37.87	26.41	60.32	50.32	22.45	23.91	N
3	0.59526	35.04	24.93	9.95	44.99	34.88	56.00	46.00	11.01	11.12	N
4	1.33821	24.63	8.62	9.99	34.62	18.61	56.00	46.00	21.38	27.39	N
5	3.20815	22.26	7.68	10.07	32.33	17.75	56.00	46.00	23.67	28.25	N
6	3.45696	23.24	9.53	10.09	33.33	19.62	56.00	46.00	22.67	26.38	N
7	5.52828	22.68	6.76	10.18	32.86	16.94	60.00	50.00	27.14	33.06	N
8	9.28501	15.49	3.92	10.32	25.81	14.24	60.00	50.00	34.19	35.76	N
9	26.56837	15.93	1.85	10.69	26.62	12.54	60.00	50.00	33.38	37.46	N
10	0.23142	30.46	21.28	9.94	40.40	31.22	62.40	52.40	22.00	21.18	L
11	0.29702	29.90	20.73	9.94	39.84	30.67	60.33	50.33	20.49	19.66	L
12	0.54582	35.59	16.42	9.95	45.54	26.37	56.00	46.00	10.46	19.63	L
13	0.60134	35.75	21.15	9.96	45.71	31.11	56.00	46.00	10.29	14.89	L
14	0.94332	32.12	13.21	9.97	42.09	23.18	56.00	46.00	13.91	22.82	L
15	1.73608	30.09	11.66	10.01	40.10	21.67	56.00	46.00	15.90	24.33	L
16	4.30967	27.45	11.28	10.13	37.58	21.41	56.00	46.00	18.42	24.59	L
17	6.19135	22.91	8.83	10.20	33.11	19.03	60.00	50.00	26.89	30.97	L
18	9.33109	18.98	5.80	10.32	29.30	16.12	60.00	50.00	30.70	33.88	L
19	26.33994	21.56	1.04	10.65	32.21	11.69	60.00	50.00	27.79	38.31	L

9 LIST OF TEST EQUIPMENT

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal. Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent	N9020A	19/03/11	20/03/11	MY48010133
Spectrum Analyzer	Rohde Schwarz	FSW67	19/07/11	20/07/11	104037
Spectrum Analyzer	Rohde Schwarz	FSW85	20/02/02	21/02/02	101530
Thermohygrometer	BODYCOM	BJ5478	19/07/03	20/07/03	NA
Thermohygrometer	BODYCOM	BJ5478	19/12/18	20/12/18	120612-1
Loop Antenna	ETS-Lindgren	6502	19/09/18	21/09/18	00226186
BILOG ANTENNA	Schwarzbeck	VULB 9160	19/04/23	21/04/23	9160-3362
HORN ANT	ETS	3117	18/05/10	20/05/10	140394
HORN ANT	A.H.Systems	SAS-574	19/07/03	21/07/03	155
*Horn Antenna	MI Wave	RX ANT-5 261U+410U	19/08/26	21/08/26	4
*Horn Antenna	MI Wave	RX ANT-6 261V+410V	19/08/26	21/08/26	5
*Horn Antenna	MI Wave	261W-25/387	18/11/29	20/11/29	743
*Horn Antenna	MI Wave	RX ANT-7 261E	19/08/26	21/08/26	1
*Horn Antenna	MI Wave	RX ANT-8 261F	19/08/26	21/08/26	2
*Horn Antenna	MI Wave	RX ANT-9 261G	19/08/26	21/08/26	3
PreAmplifier	H.P	8447D	19/12/16	20/12/16	2944A07774
PreAmplifier	Agilent	8449B	19/06/27	20/06/27	3008A02108
PreAmplifier	tsj	MLA-1840-J02-45	19/06/27	20/06/27	16966-10728
*PreAmplifier	Norden Millimeter Inc.	NA4060G50N8P12	18/12/21	20/12/21	1003
*Harminoc mixer	Rohde Schwarz	FS-Z90	19/08/27	21/08/27	101714
*Harminoc mixer	Rohde Schwarz	FS-Z140	19/10/14	21/10/14	101009
*Harminoc mixer	Rohde Schwarz	FS-Z220	19/10/14	21/10/14	101012
*RF Detector	Millitech	DET-15-RPFW0	19/08/14	21/08/14	3000
DIGITAL STORAGE OSCILLOSCOPE	Tektronix	TDS2022B	19/12/17	20/12/17	C058651
Power meter & Power sensor	Rohde Schwarz	NRP2, NRP110T	19/02/12	20/02/12	106060, 101002
mmW Multiplier	OML, Inc.	S15MS	19/08/19	20/08/19	170821-1
DC Power Supply	SM techno	SDP30-5D	19/12/16	20/12/16	305DKA013
Multimeter	FLUKE	17B+	19/12/17	20/12/17	36390701WS
Temp & Humi Test Chamber	SJ Science	SJ-TH-S50	19/06/25	20/06/25	SJ-TH-S50-130930
EMI Test Receiver	Rohde Schwarz	ESC17	20/01/20	21/01/20	100910
PULSE LIMITER	Rohde Schwarz	ESH3-Z2	19/09/17	20/09/17	101333
LISN	SCHWARZBECK	NNLK 8121	19/05/23	20/05/23	6183
Thermohygrometer	TESTO	608-H1	20/01/21	21/01/21	34862883

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.

Note3: * The mm-wave instruments were calibrated by the manufacturer.

APPENDIX I

Test set up diagrams

