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 : DRTFCC2012-0399
2. Customer
   - Name : Miliwave Co., Ltd.
   - Address : 423, 105, Gwanggyo-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, South Korea
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : IEEE802.11ad 60GHz Module / MWC-713
   FCC ID : 2AVCWMWC-713
5. Test Method Used : ANSI C63.10-2013
   Test Specification : Part 15.255
6. Date of Test : 2020.12.11 ~ 2020.12.28
7. Testing Environment : Refer to appended test report.
8. Test Result : Refer to the attached test result.

Affirmation	Tested by Name : Inhee bae (Signature)	Reviewed by Name : Geunki Son (Signature)

2020 . 12 . 31 .

DT&C Co., Ltd.

This test report is a general report that does not use the KOLAS accreditation mark and is not related to KS Q ISO/IEC 17025 and KOLAS accreditation.

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
DRTFCC2012-0399	Dec. 31, 2020	Initial issue	Inhee bae	Geunki Son

Table of Contents

1. EUT DESCRIPTION

FCC Equipment Class	DXX – Part 15 Low Power communication Device Transmitter
Product	IEEE802.11ad 60GHz Module
Model Name	MWC-713
Add Model Name	-
Power Supply	DC 5 V
Frequency Range	802.11ad: 58.32 ~ 64.80 GHz
Max. RF Output Power (EIRP)	802.11ad : 36.02 dBm
Modulation Type	Spread spectrum, PHY modulation
Data Rate	MCS 0 ~ 12 (up to 4620 Mbps)
Antenna Specification	**Antenna type**: Broad band array **Antenna gain(Max)**: 19.9 dBi

2. INFORMATION ABOUT TESTING

2.1 Transmitting configuration of EUT

Test Mode	Worst case data rate	Test Frequency(GHz)
802.11ad	MCS 1 (385 Mbps)	58.32 GHz (ch.1)
		60.48 GHz (ch.2)
		64.80 GHz (ch.4)

Note 1: The worst case data rate is determined as above test mode according to the power measurements.

Operation test setup for EUT

- Software: Tera term

2.2 Auxiliary equipment

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

2.3 Tested environment

Temperature	:	20 ºC ~ 23 ºC
Relative humidity content	:	41 % ~ 45 %
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)	4.9 dB (The confidence level is about 95 %, k = 2)
Radiated spurious emission (1 GHz ~ 18 GHz)	5.1 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)	Equivalent Isotropic Radiated Power	Peak < 43 dBm Average < 40 dBm		C
15.255(d) 15.209	Radiated Spurious Emissions	Below 40GHz < Part 15.209 limits (see section 8.3) 40 ~ 200GHz < 90 pW/cm^2		C
15.255(f)	Frequency Stability	Within the 57 ~71GHz band		C
15.207	AC Line Conducted Emissions	< Part 15.207 limits (see section 8.5)	AC Line Conducted	C
15.203	Antenna Requirements	Part 15.203 (see section 7)	-	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.dtnc.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;

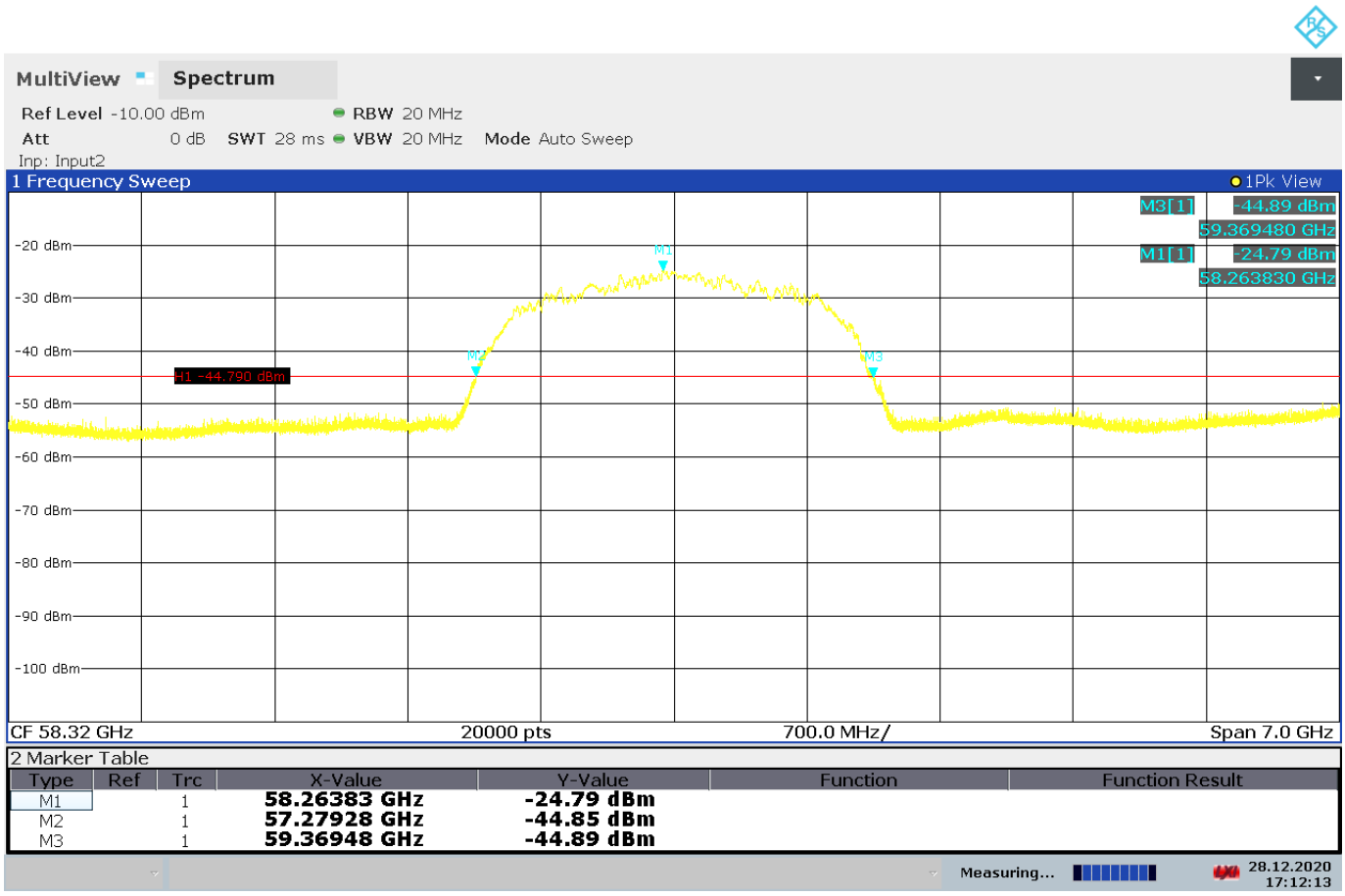
- Spectrum analyzer settings:
  1) Span equal to approximately two times to three times the EBW, centered on the carrier frequency.
  2) RBW, as specified in the requirement.
  3) VBW, as specified in the requirement, or VBW ≥ RBW if not specified.
  4) Sweep = auto.
  5) Detector function = peak.
  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

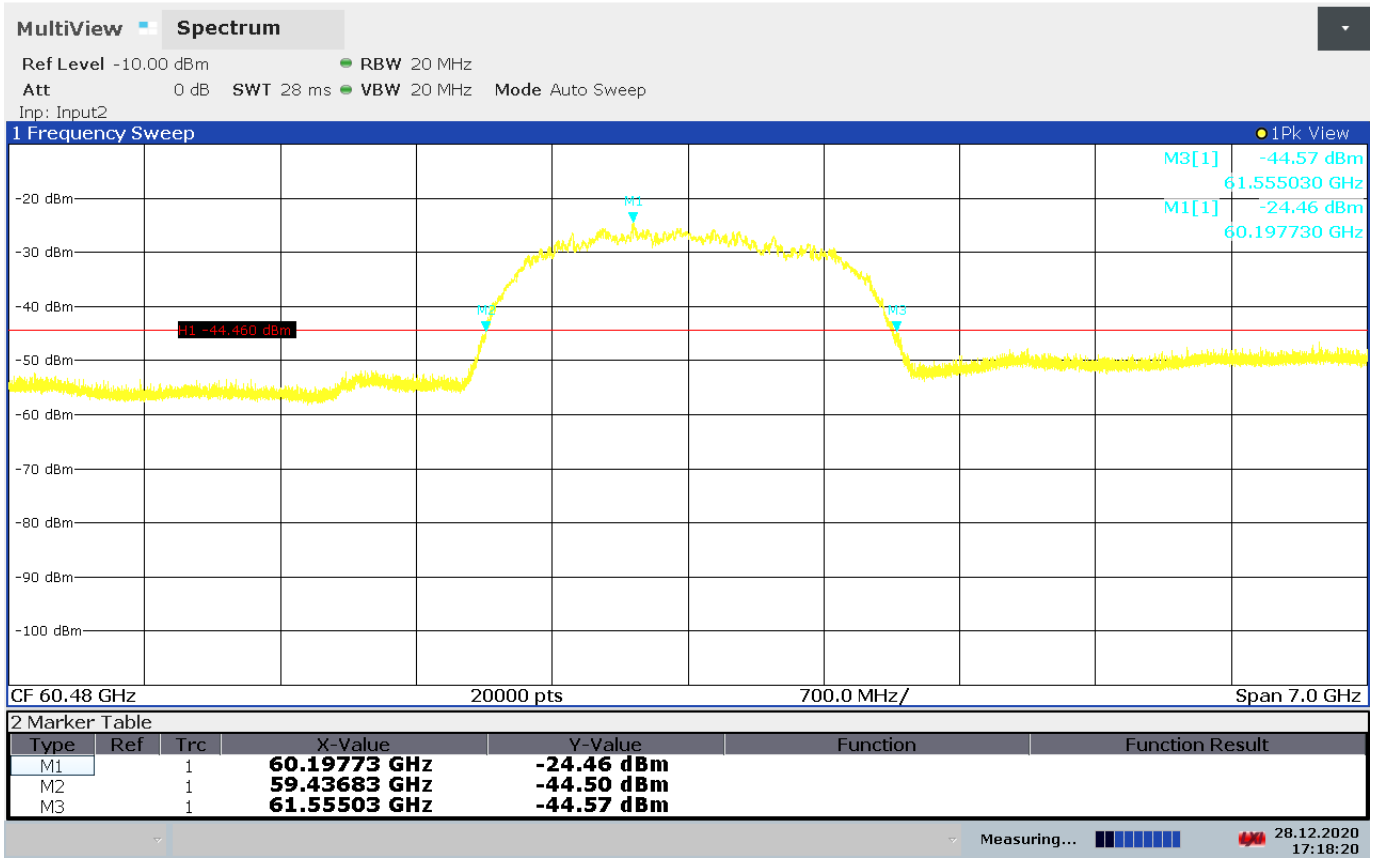
Test Mode	Data Rate	Frequency[GHz]	Test Results[MHz]
802.11ad	MCS1	58.32	2090.2
		60.48	2118.2
		64.80	2121.7

▣ Result plots

20 dB Bandwidth MCS 1 & 58.32GHz

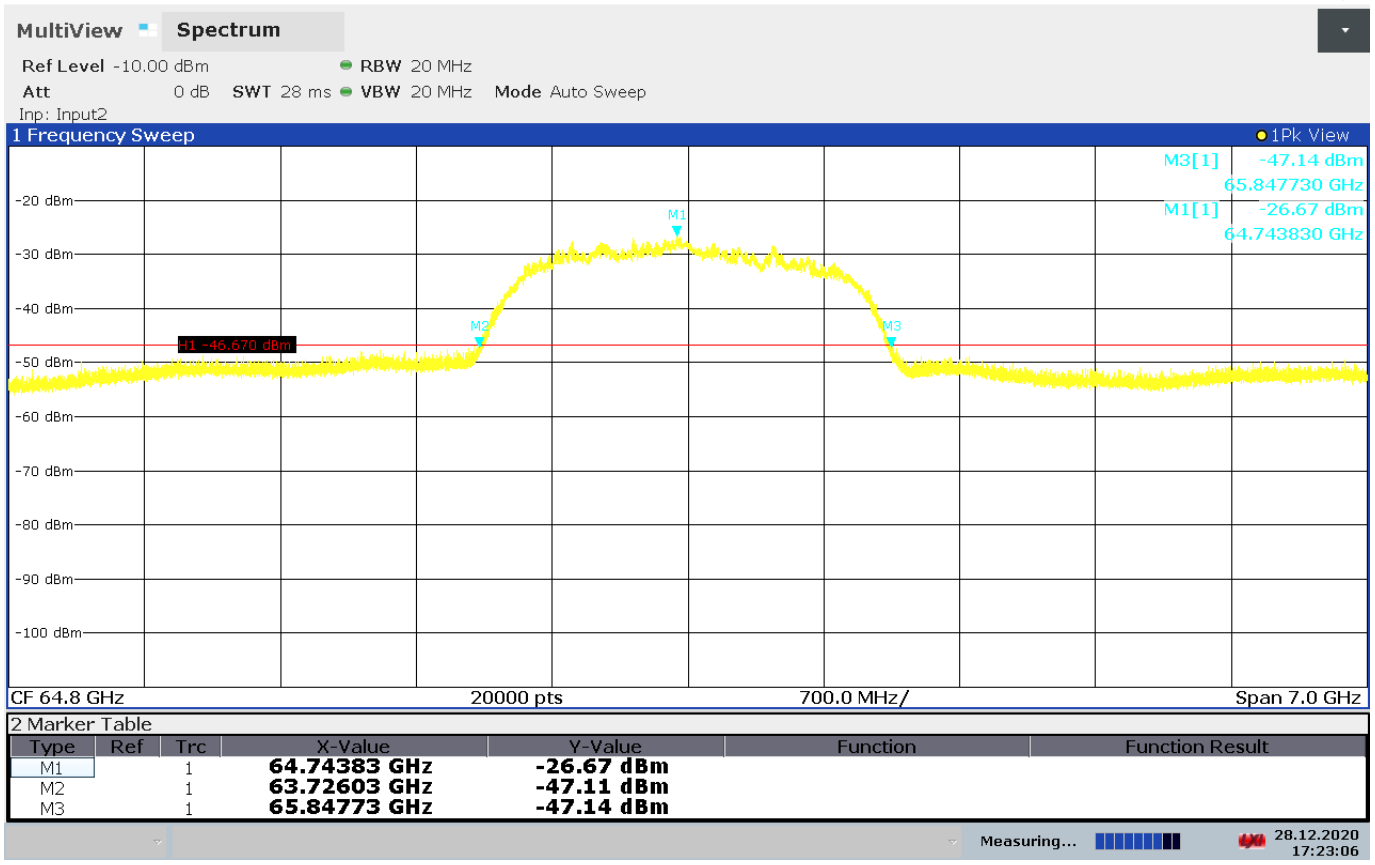


20 dB Bandwidth MCS 1 & 60.48GHz



20 dB Bandwidth

MCS 1 & 64.80GHz



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):

(1) Products other than fixed field disturbance sensors and short-range devices for interactive motion sensing shall comply with one of the following emission limits, as measured during the transmit interval:

(i) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or

(ii) 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. 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.

▣ 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)	Rm (m)	Measurement Distance(m)
58.32 ~ 64.80	0.463	5.68	1.39	1.60

▣ Test Results: Comply

Peak power: MCS 1

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	58.32	H	92	-10.93	24.90	136.74	36.02	43.00	6.98
1.6m	60.48	H	112	-11.45	25.05	136.39	35.67	43.00	7.33
1.6m	64.80	H	54	-13.61	25.10	134.78	34.06	43.00	8.94

Average power: MCS 1

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	58.32	H	89	-10.96	24.90	136.71	35.99	40.00	4.01
1.6m	60.48	H	108	-11.51	25.05	136.33	35.61	40.00	4.39
1.6m	64.80	H	47	-13.96	25.10	134.43	33.71	40.00	6.29

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

▪ **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	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
Test Frequency: 60.48 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)
33.09	V	QP	50.71	-17.10	NA	33.61	40.00	6.39
60.07	V	PK	36.60	-13.80	NA	22.80	40.00	17.20
82.38	H	PK	40.80	-19.50	NA	21.30	40.00	18.70
90.21	V	QP	45.21	-17.00	NA	28.21	43.50	15.29
95.96	H	PK	43.00	-15.40	NA	27.60	43.50	15.90
127.00	V	PK	34.30	-17.40	NA	16.90	43.50	26.60
221.09	H	PK	37.40	-14.10	NA	23.30	46.00	22.70
296.75	V	PK	32.30	-12.70	NA	19.60	46.00	26.40
890.38	V	PK	28.90	-1.40	NA	27.50	46.00	18.50
-	-	-	-	-	-	-	-	-

Note.

1. No other spurious and harmonic emissions were found above listed frequencies.
2. Information of Distance Factor

   This test item was performed at 3 m and the data were extrapolated to the specified measurement distance of 30 m using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)2.

   ▪ Extrapolation Factor = 20 log10(30/3)2 = 40 dB

   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 = 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), Y axis & Ver

Frequency Range: 1 ~ 40 GHz

Test Frequency (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)
58.32	3 m	7 040.31	H	PK	43.47	8.75	NA	52.22	74.00	21.79
	3 m	7 040.04	H	AV	33.45	8.75	NA	42.20	54.00	11.80
	1.5 m	10 559.97	H	PK	44.82	12.79	-6.02	51.59	74.00	22.41
	1.5 m	10 560.21	H	AV	37.19	12.79	-6.02	43.96	54.00	10.04
	1.5 m	14 080.36	H	PK	41.36	17.26	-6.02	52.60	74.00	21.40
	1.5 m	14 080.23	H	AV	31.53	17.26	-6.02	42.77	54.00	11.23
60.48	3 m	7 039.93	H	PK	42.78	8.75	NA	51.53	74.00	22.47
	3 m	7 040.17	H	AV	33.36	8.78	NA	42.14	54.00	11.86
	1.5 m	10 560.29	H	PK	44.86	12.79	-6.02	51.63	74.00	22.37
	1.5 m	10 560.21	H	AV	37.07	12.79	-6.02	43.84	54.00	10.16
	1.5 m	14 080.26	H	PK	40.92	17.26	-6.02	52.16	74.00	21.84
	1.5 m	14 080.20	H	AV	31.46	17.26	-6.02	42.70	54.00	11.30
64.80	3 m	7 039.74	H	PK	43.51	8.75	NA	52.26	74.00	21.74
	3 m	7 040.11	H	AV	33.28	8.75	NA	42.03	54.00	11.97
	1.5 m	10 560.27	H	PK	44.58	12.79	-6.02	51.35	74.00	22.65
	1.5 m	10 560.15	H	AV	36.64	12.79	-6.02	43.41	54.00	10.59
	1.5 m	14 080.31	H	PK	41.23	17.26	-6.02	52.47	74.00	21.53
	1.5 m	14 080.32	H	AV	31.02	17.26	-6.02	42.26	54.00	11.74

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.

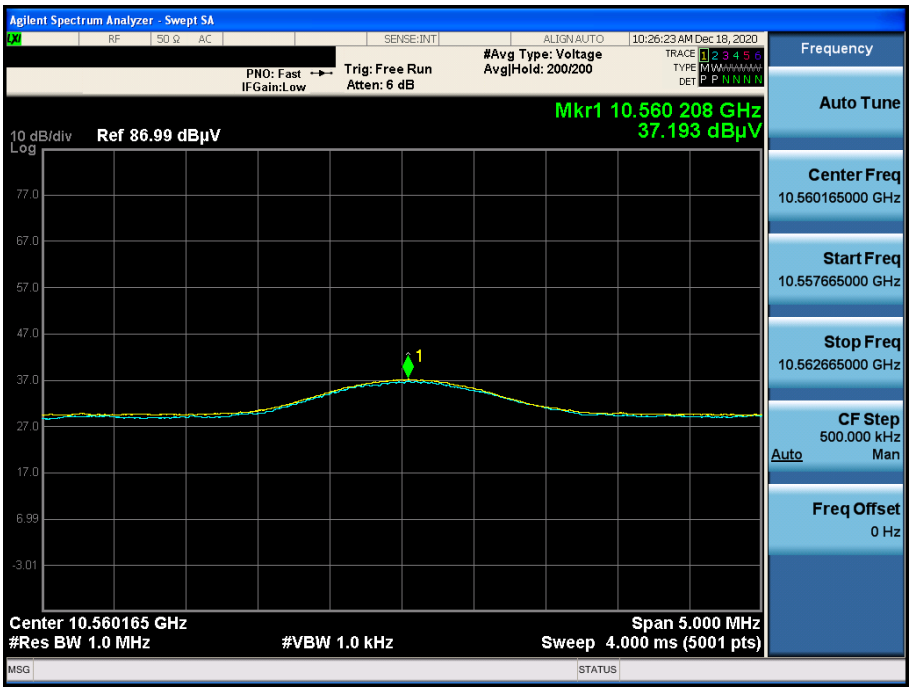
   - Calculation of distance factor = 20 log(applied distance / required distance)

   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.
3. Sample Calculation.

   Margin = Limit – Result / Result = 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), Y axis & Hor



Frequency Range: 40 ~ 200 GHz

Test Frequency (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)
58.32	1.6m	*56 698.58	H	-39.35	-8.10	59.55	-41.17	0.068	90.000
	1.6m	*86 804.63	H	-73.03	47.91	81.88	-18.84	11.549	90.000
	0.5 m	*90 125.08	H	-68.84	51.41	89.57	-21.25	6.631	90.000
	0.7 m	*127 759.17	H	-64.36	52.82	95.46	-12.44	50.414	90.000
	0.7 m	*151 278.77	H	-70.35	55.96	92.61	-15.29	26.155	90.000
60.48	1.6m	*55 741.24	H	-57.71	-8.88	40.41	-60.31	0.001	90.000
	1.6m	*82 102.13	H	-65.74	47.43	88.69	-12.03	55.405	90.000
	0.5 m	*90 500.24	H	-69.75	51.45	88.70	-22.12	5.427	90.000
	0.7 m	*128 364.04	H	-64.14	52.80	95.66	-12.24	52.790	90.000
	0.7 m	*151 198.47	H	-70.68	55.96	92.28	-15.62	24.241	90.000
64.80	1.6m	*56 039.79	H	-57.24	-8.70	41.06	-59.66	0.001	90.000
	1.6m	*88 092.42	H	-80.36	48.28	74.92	-25.8	2.326	90.000
	0.5 m	*90 107.91	H	-69.03	51.41	89.38	-21.44	6.347	90.000
	0.7 m	*128 171.43	H	-63.73	52.81	96.08	-11.82	58.150	90.000
	0.7 m	*151 175.41	H	-70.63	55.96	92.33	-15.57	24.522	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(dBuV/m) = Measured level (dBuV) + 107 + AF.CL.AG(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.

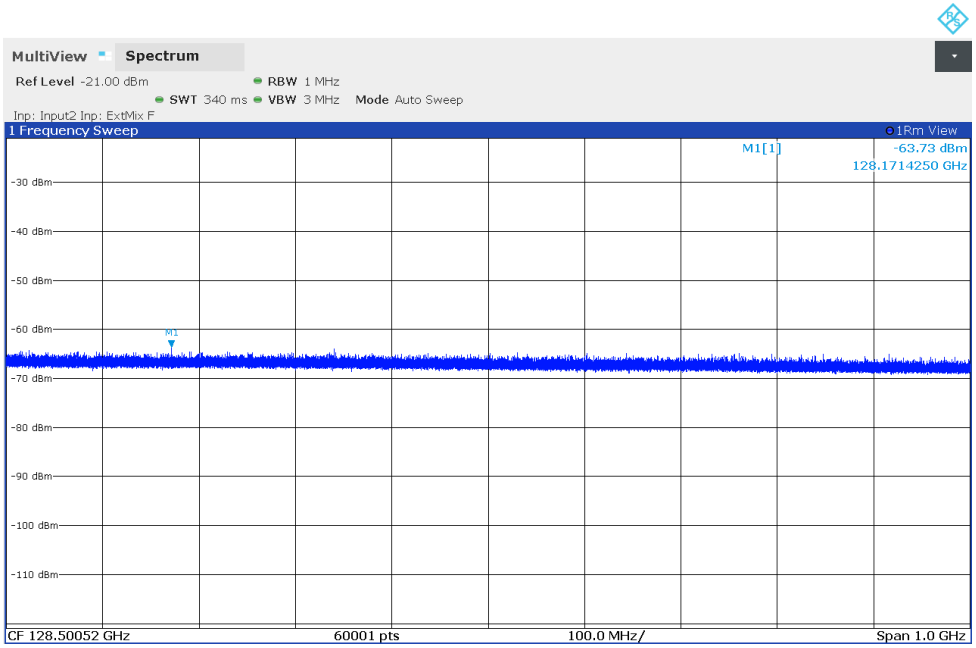
   $PD = EIRP_{Linear} / 4\pi d^2$

   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
3. * Noise floor

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



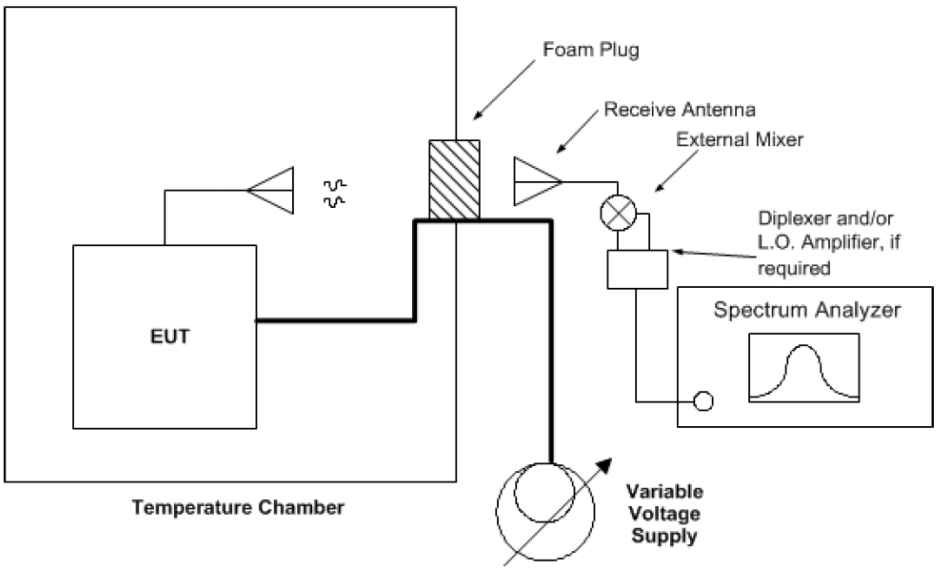
8.4 Frequency stability

▣ 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:

Frequency stability



▣ 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 (℃)	Tested Frequency: 58.32 GHz	Tested Frequency: 64.80 GHz
			Measured low frequency(F_L)(GHz), 20dBC	Measured high frequency(F_L)(GHz), 20dBC
100%	5.00	+25(Ref)	57279.63	65830.58
100%		-20	57273.91	65851.32
100%		-10	57282.88	65848.22
100%		0	57271.23	65841.67
100%		+10	57268.72	65844.57
100%		+20	57266.22	65835.22
100%		+30	57280.08	65831.92
100%		+40	57269.48	65844.85
100%		+50	57274.11	65839.28
115%	5.75	+25	57274.58	65838.83
85%	4.25	+25	57276.92	65834.41

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 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:

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

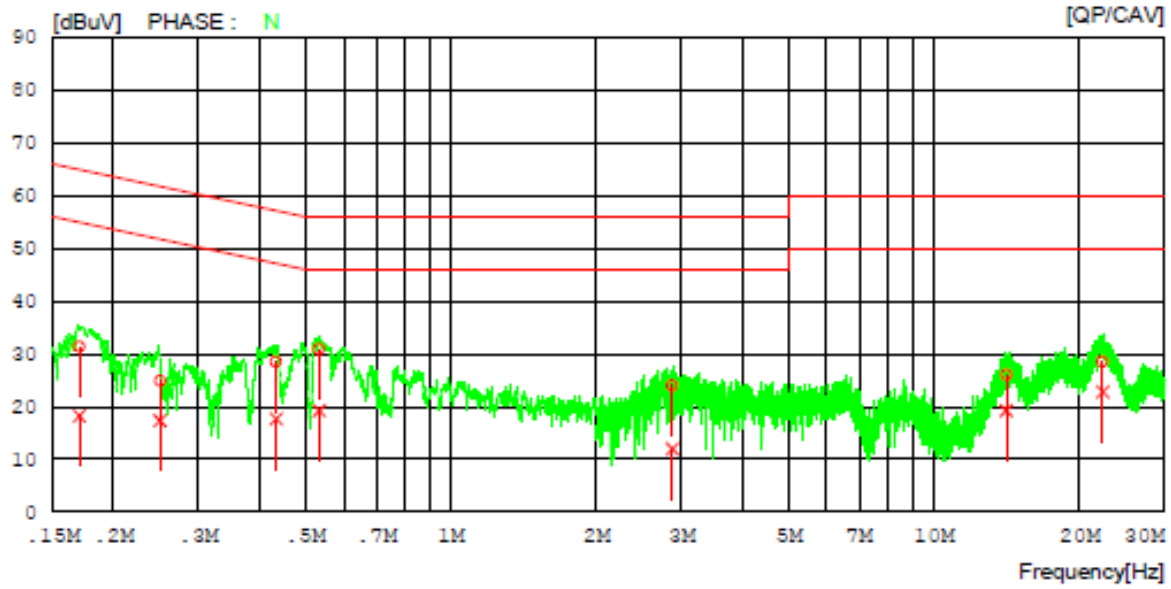
AC Line Conducted Emissions (Graph)

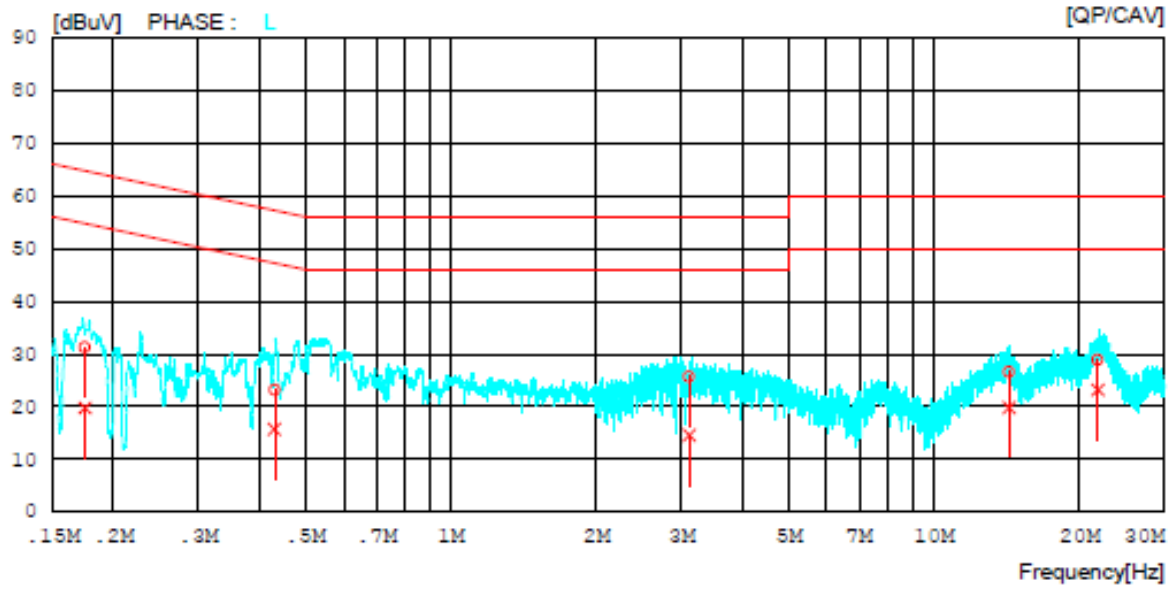
MCS 1 & 60.48 GHz

Order No.		Referrence No.	
Model No.	MWC-713	Power Supply	120 V, 60 Hz
Serial No.		Temp/Humi.	23 'C / 42 %
Test Condition	60GHZ 802.11AD	Operator	IN HEE BAE

Memo

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





AC Line Conducted Emissions (List)

MCS 1 & 60.48 GHz

Order No.		Referrence No.	
Model No.	MWC-713	Power Supply	120 V, 60 Hz
Serial No.		Temp/Humi.	23 'C / 42 %
Test Condition	60GHZ 802.11AD	Operator	IN HEE BAE

Memo

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

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	0.17011	21.41	8.34	9.95	31.36	18.29	64.96	54.96	33.60	36.67	N
2	0.24988	14.91	7.35	9.95	24.86	17.30	61.76	51.76	36.90	34.46	N
3	0.43447	18.52	7.71	9.98	28.50	17.69	57.17	47.17	28.67	29.48	N
4	0.53364	20.90	9.29	9.98	30.88	19.27	56.00	46.00	25.12	26.73	N
5	2.86813	13.88	1.91	10.07	23.95	11.98	56.00	46.00	32.05	34.02	N
6	14.10372	15.61	8.84	10.44	26.05	19.28	60.00	50.00	33.95	30.72	N
7	22.30356	18.00	12.27	10.56	28.56	22.83	60.00	50.00	31.44	27.17	N
8	0.17460	21.27	9.79	9.94	31.21	19.73	64.74	54.74	33.53	35.01	L
9	0.43112	13.18	5.75	9.96	23.14	15.71	57.23	47.23	34.09	31.52	L
10	3.11080	15.57	4.52	10.07	25.64	14.59	56.00	46.00	30.36	31.41	L
11	14.29282	16.11	9.39	10.43	26.54	19.82	60.00	50.00	33.46	30.18	L
12	21.80015	18.27	12.61	10.53	28.80	23.14	60.00	50.00	31.20	26.86	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	20/10/21	21/10/21	MY48010133
Signal Analyzer	Rohde Schwarz	FSW85	20/02/02	21/02/02	101530
Spectrum Analyzer	KEYSIGHT	N9030B	20/04/01	21/04/01	MY55480168
Signal Generator	ANRITSU	MG3695C	19/12/16	20/12/16	173501
			20/12/16	21/12/16	
Thermohygrometer	BODYCOM	BJ5478	20/07/01	21/07/01	NA
Thermohygrometer	BODYCOM	BJ5478	19/12/18	20/12/18	120612-1
			20/12/16	21/12/16	
HYGROMETER	TESTO	608-H1	20/01/21	21/01/21	34862883
BILOG ANTENNA	Schwarzbeck	VULB 9160	19/04/23	21/04/23	9160-3362
HORN ANT	ETS	3117	20/10/23	21/10/23	00143278
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	108
*Horn Antenna	MI Wave	RX ANT-6 261V+410V	19/08/05	21/08/05	110
*Horn Antenna	MI Wave	261W-25/387	20/07/30	21/07/30	743
*Horn Antenna	MI Wave	RX ANT-7 261E	19/06/26	21/06/26	112
*Horn Antenna	MI Wave	RX ANT-8 261F	19/06/26	21/06/26	114
PreAmplifier	H.P	8447D	19/12/16	20/12/16	2944A07774
			20/12/16	21/12/16	
PreAmplifier	Agilent	8449B	20/06/24	21/06/24	3008A02108
PreAmplifier	tsj	MLA-1840-J02-45	20/06/24	21/06/24	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	KEYSIGHT	M1971W	20/04/22	22/04/22	MY56390126
*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
			20/12/16	21/12/16	
*Power meter & Power sensor	Rohde Schwarz	NRP2,	20/02/19	21/02/19	106060,
		NRP110T	20/02/20	21/02/20	101002
mmW Multiplier	OML, Inc.	S15MS	19/08/19	21/08/19	170821-1
DC Power Supply	SM techno	SDP30-5D	19/12/16	20/12/16	305DKA013
			20/12/16	21/12/16	
Multimeter	FLUKE	17B+	19/12/17	20/12/17	36390701WS
			20/12/16	21/12/16	
Temp & Humi Test Chamber	SJ Science	SJ-TH-S50	20/06/24	21/06/24	SJ-TH-S50-130930
EMI Test Receiver	Rohde Schwarz	ESU40	20/11/26	21/11/26	100525
PULSE LIMITER	Rohde Schwarz	ESH3-Z2	20/08/25	21/08/25	101333
LISN	SCHWARZBECK	NNLK 8121	20/03/13	21/03/13	6183

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

Below 1GHz	Above 1GHz