TEST REPORT

Dt&C

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 : DRTFCC2201-0024

2. Customer

- Name : THINKWARE Corporation
- Address : A, 9FL., Samwhan Hipex,240, Pangyoyeok-ro, Bundang Seongnam-si, Gyeonggi-do South Korea

3. Use of Report : FCC Original Grant

4. Product Name / Model Name : Car Dash Cam Front Camera / Advanced Car Eye 3.0 PRO

FCC ID : 2ADTG-ACE3PROF

5. FCC Regulation(s): Part 15.249

Test Method used: ANSI C63.10-2013

6. Date of Test : 2021.12.22 ~ 2022.01.10

7. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing

8. Testing Environment : See appended test report.

9. 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 : ChangWon Lee (Signature)	Reviewed by Name : JaeJin Lee (Signature)

2022 . 01 . 21 .

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
DRTFCC2201-0024	Jan. 21, 2022	Initial issue	ChangWon Lee	JaeJin Lee

Table of Contents

1. General Information

1.1. Description of EUT

Equipment Class	Part 15 Low Power Communication Device Transmitter
Product Name	Car Dash Cam Front Camera
Model Name	Advanced Car Eye 3.0 PRO
Add Model Name	-
Firmware Version Identification Number	Rev 0.1
EUT Serial Number	Not defined
Power Supply	DC 12 V
Declared Frequency Range	24.05 GHz ~ 24.25 GHz
Modulation Type	FMCW
Antenna Specification	Antenna Type: Integrated antenna Gain: 2.00 dBi (PK)

1.2. Declaration by the applicant / manufacturer

- NA

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 ℃ ~ +24 ℃
▪ Relative Humidity	35 % ~ 39 %

1.5 Measurement Uncertainty

Test items	Measurement uncertainty
Radiated emission (1 GHz Below)	4.9 dB (The confidence level is about 95 %, k = 2)
Radiated emission (1 GHz ~ 18 GHz)	5.0 dB (The confidence level is about 95 %, k = 2)
Radiated emission (18 GHz Above)	5.3 dB (The confidence level is about 95 %, k = 2)

1.6. EUT CAPABILITIES

This EUT contains the following capabilities:
24 GHz RADAR, Bluetooth LE and WLAN

2. Information about test items

2.1 Test Mode and Frequency

Test Mode	Power Supply	Description	Tested Frequency
TM 1	12 V	Sweep stop Note1	Lowest: 24.06 GHz
			Middle: 24.15 GHz
			Highest: 24.24 GHz
TM 2	12 V	Sweep enable	24.15 GHz
-	-	-	

Note1: This device is swept frequency equipment. The sweep is stopped during the test in accordance with part 15.31(c).

2.2 EMI Suppression Device(s)/Modifications

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

2.3 Test Equipment List

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Rohde Schwarz	FSW85	21/12/16	22/12/16	101530
Spectrum Analyzer	Agilent Technologies	N9020A	21/06/24	22/06/24	US47360812
DC Power Supply	Agilent Technologies	66332A	21/06/24	22/06/24	MY43000211
DC Power Supply	SM techno	SDP30-5D	21/06/24	22/06/24	305DMG305
DC Power Supply	SM techno	SDP30-5D	21/06/24	22/06/24	305DMG288
Multimeter	FLUKE	17B+	21/12/16	22/12/16	36390701WS
Signal Generator	Rohde Schwarz	SMBV100A	21/12/16	22/12/16	255571
Signal Generator	ANRITSU	MG3695C	21/12/16	22/12/16	173501
Thermohygrometer	BODYCOM	BJ5478	21/12/16	22/12/16	120612-2
Thermohygrometer	XIAOMI	MHO-C201	21/12/16	22/12/16	00089675
Loop Antenna	ETS-Lindgren	6502	21/01/28	23/01/28	00226186
Hybrid Antenna	Schwarzbeck	VULB9163	21/06/24	23/06/24	9163-572
Horn Antenna	ETS-Lindgren	3117	21/12/16	22/12/16	00140394
Horn Antenna	A.H.Systems Inc.	SAS-574	21/06/24	22/06/24	155
Horn Antenna	MI Wave	RX ANT-5 261U+410U	21/06/24	22/06/24	108
Horn Antenna	MI Wave	RX ANT-7 261E	21/06/24	22/06/24	112
Horn Antenna	MI Wave	RX ANT-8 261F	21/06/24	22/06/24	114
PreAmplifier	tsj	MLA-0118-B01-40	21/12/16	22/12/16	1852267
PreAmplifier	tsj	MLA-1840-J02-45	21/06/24	22/06/24	16966-10728
PreAmplifier	H.P	8447D	21/12/16	22/12/16	2944A07774
PreAmplifier	Norden Millimeter Inc.	NA4060G50N8P12	21/02/18	23/02/18	1003
Harmonic Mixers	Rohde Schwarz	FS-Z90	21/08/20	22/08/20	101714
Harmonic Mixers	Rohde Schwarz	FS-Z140	21/08/20	22/08/20	101009
High Pass Filter	Wainwright Instruments	WHKX12-935-1000-15000-40SS	21/06/24	22/06/24	7
High Pass Filter	Wainwright Instruments	WHKX10-2838-3300-18000-60SS	21/06/24	22/06/24	2
High Pass Filter	Wainwright Instruments	WHKX6-6320-8000-26500-40CC	21/06/24	22/06/24	2
Cable	Junkosha	MWX241	21/01/08	22/01/08	mmW-1
Cable	Junkosha	MWX241	21/01/08	22/01/08	mmW-4
Cable	Junkosha	MWX241	21/01/08	22/01/08	mmW-7
Cable	Junkosha	MWX241	21/01/08	22/01/08	mmW-8
Cable	Junkosha	MWX241	21/01/08	22/01/08	mmW-9
Cable	Radiall	TESTPRO3	21/01/08	22/01/08	M-01
			22/01/04	23/01/04	
Cable	DT&C	Cable	21/01/08	22/01/08	M-02
			22/01/04	23/01/04	
Cable	HUBER+SUHNER	SUCOFLEX 104	21/01/08	22/01/08	M-03
			22/01/04	23/01/04	
Cable	Junkosha	MWX221	21/01/08	22/01/08	M-07
			22/01/04	23/01/04	
Cable	HUBER+SUHNER	SUCOFLEX106	21/01/08	22/01/08	M-09
			22/01/04	23/01/04	
Test Software	tsj	Radiated Emission Measurement	NA	NA	Version 2.00.0177

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.

3. Antenna requirements

"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.(Refer to Internal Photo file.)
Therefore this E.U.T Complies with the requirement of §15.203

4. Summary of tests

FCC part section(s)	Test Description	Limit	Test Condition	Status Note 1
15.249 (a)	Field Strength of Fundamental	Part 15.249(a) (See section 5.2)	Radiated	C Note2
15.249(a),(d),(e) 15.209	Field Strength of Unwanted emissions	Part 15.249(a),(d),(e) Part 15.209 (See section 5.2)		C Note2
15.215(c)	20 dB Bandwidth	NA		C
15.207	AC Power-Line Conducted Emissions	Part 15.207 limits (See section 5.3)	AC Line Conducted	NA Note3
15.203	Antenna Requirements	Part 15.203 (See 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.

Note 3: This device is installed in a car. Therefore the power source is a battery of car.

5. Test Result

5.1. 20dB bandwidth

▣ Test Requirements

Part 15.215

Part 15.215(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in Part 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that 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

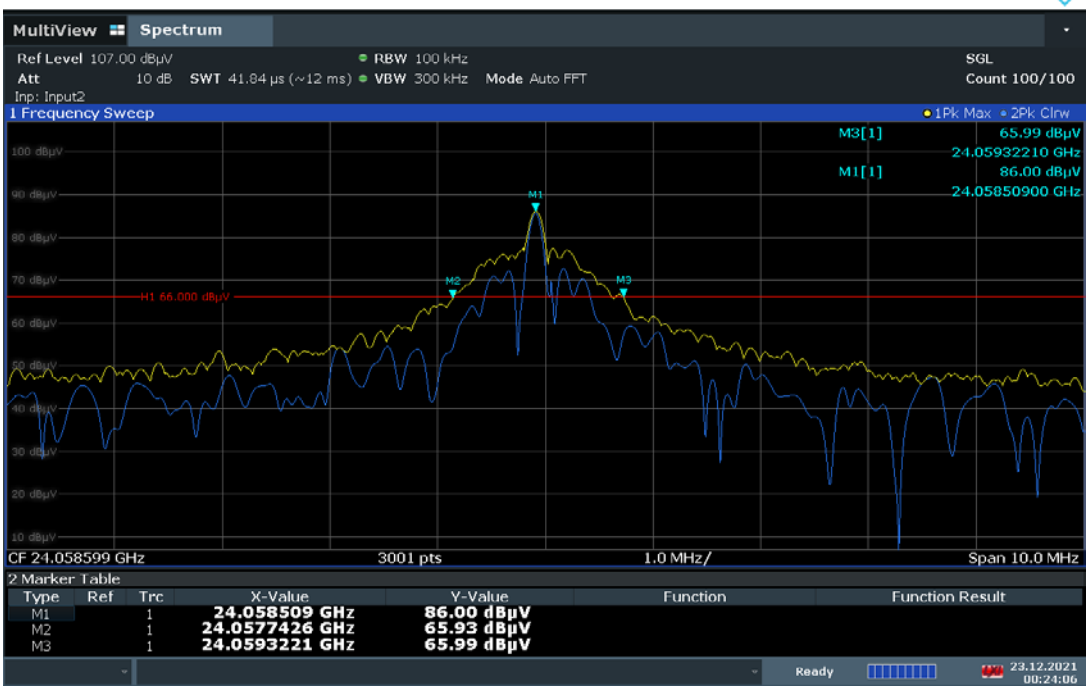
- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Actually, the RBW setting was used 100 kHz. (The RBW setting cannot satisfy the 1.5 % to 5 % of the OBW due to signal characteristics.)

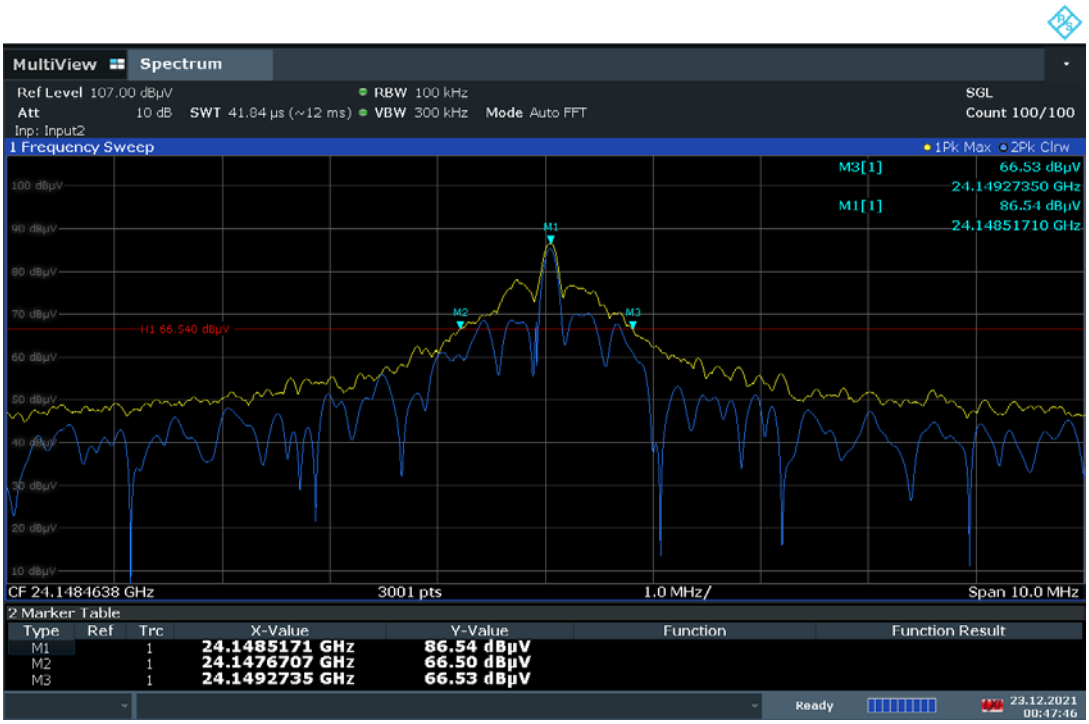
▣ Test Results: Comply

Test Mode	Frequency	20 dB BW (MHz)
TM 1	Lowest	1.579
	Middle	1.603
	Highest	**1.690**

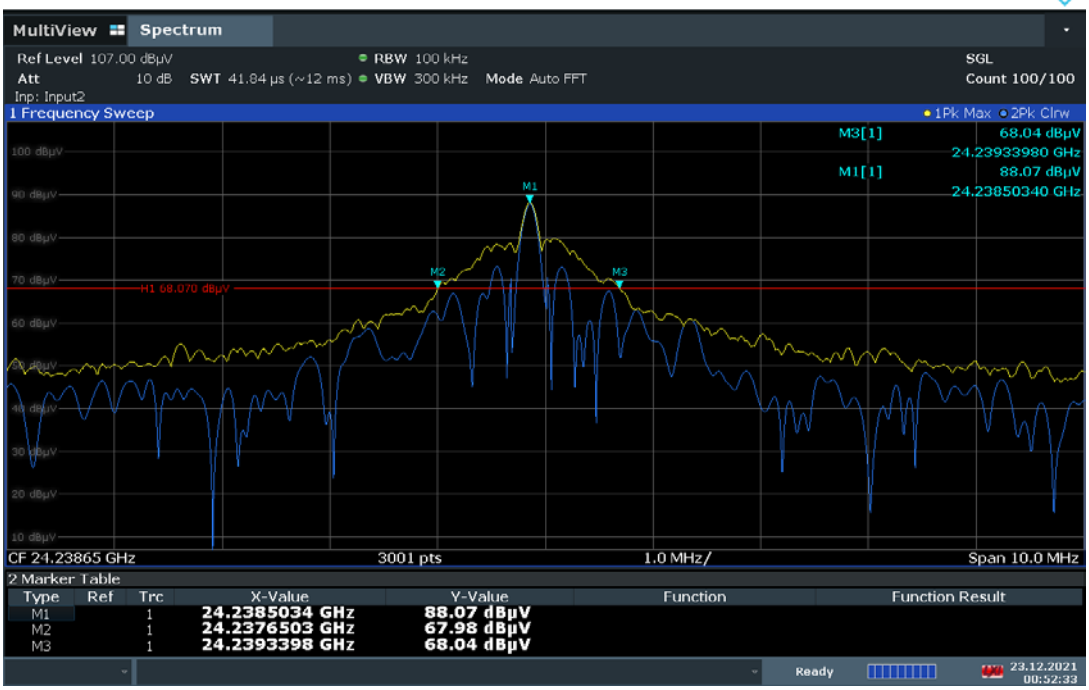
20dB Bandwidth **TM 1 & Lowest**



20dB Bandwidth **TM 1 & Middle**



20dB Bandwidth **TM 1 & Highest**



5.2. Field strength

▣ **Requirements and limit,**

- Part 15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Frequency (MHz)	Limit @ 3m	
	Field strength of fundamental (mV/m)	Field strength of harmonics (uV/m)
902 ~ 908	50	500
2 400 ~ 2 483.5	50	500
5 725 ~ 5 825	50	500
24 000 ~ 24 250	250	2 500

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Part 15.209, whichever is the lesser attenuation.

(e) As shown in Part 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

- Part 15.209: General field strength limits

Frequency (MHz)	FCC Limit (uV/m)	Measurement Distance (m)
0.009 – 0.490	2 400 / F (kHz)	300
0.490 – 1.705	2 4000 / F (kHz)	30
1.705 – 30.0	30	30

Frequency (MHz)	FCC Limit (uV/m)	Measurement Distance (m)
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

**Except as provided in paragraph (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., Part 15.231 and 15.241.

▣ Test Configuration

Refer to the APENDIX I

▣ Test Procedures

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 above 1 GHz, the table height is 1.5 m.
   The table was rotated 360 degrees to determine the position of the highest radiation.
2. 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 1 or 3 meter away from the interference-receiving antenna.
3. For measurements above 1 GHz 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.
4. 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.
5. 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.
6. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Measurement Instrument Setting

- Frequency Range Below 1GHz
RBW = 100 or 120 kHz, VBW ≥ 3 X RBW, Detector = Peak or Quasi Peak
- Frequency Range Range > 1 GHz
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 = 1MHz, 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.
(Actual VBW setting: 1 kHz)
Detector = Peak, Sweep Time = Auto, Trace Mode = Max Hold until the trace stabilizes

Note1: The EUT was configured to operate at 100 % duty cycle during the test.
Note2: When measuring fundamental emission, the RBW was set greater than occupied bandwidth of fundamental.

▣ Test Results:

▪ Test Notes.

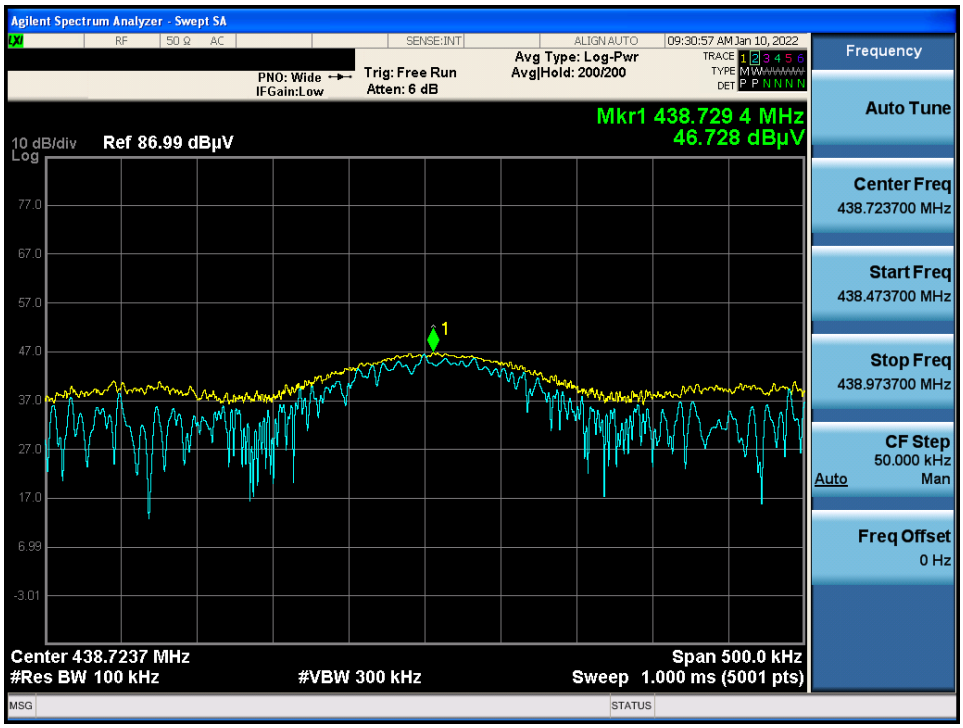
1. The radiated emissions were investigated 9 kHz to 1 GHz and the worst case data was reported.
2. Information of Distance Correction Factor
   For finding emissions, measurements may be performed at a distance closer than that specified in the regulations.
   In this case, the distance correction factor is applied to the result.
   - Calculation of distance 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 “N/A”, the measurements were performed at the specified distance and distance factor is not applied.
3. Sample Calculation.
   Margin = Limit – Result / Result = Reading + TF+ DCCF + DCF / TF = AF + CL + HL + AL – AG
   Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain, HL = High pass filter Loss,
   AL = Attenuator Loss, DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor

9 kHz ~ 1 GHz Data

▪ TM 2

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
189.080	H	X	PK	48.9	-11.9	NA	NA	37.0	43.5	6.5
438.729	H	X	PK	46.7	-5.0	NA	NA	41.7	46.0	4.3
900.002	H	X	PK	38.5	3.0	NA	NA	41.5	46.0	4.5
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

TM 2 & X & Hor **Detector Mode : PK**



▪ Test Notes.

1. The radiated emissions were investigated 1 GHz to 100 GHz. No other spurious and harmonic emissions were found below listed frequencies.
2. Information of 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 correction factor is applied to the result.
   - Calculation of distance 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 “N/A”, the measurements were performed at the specified distance and distance factor is not applied.
3. Sample Calculation.
   Margin = Limit – Result / Result = Reading + TF+ DCCF + DCF / TF = AF + CL + HL + AL – AG
   Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain, HL = High pass filter Loss,
   AL = Attenuator Loss, DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor
4. * = Fundamental emission
5. Please refer to the appendix II for the worst case test plots.

1 GHz ~ 100 GHz Data

▪ TM 1 & Lowest

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
23 904.53	V	X	PK	41.22	9.51	N/A	N/A	50.73	74.00	23.27
23 959.80	V	X	AV	29.54	9.49	N/A	N/A	39.03	54.00	14.97
*24 058.45	V	X	PK	87.37	9.50	N/A	N/A	96.87	127.96	31.09
*24 058.68	V	X	AV	86.89	9.50	N/A	N/A	96.39	107.96	11.57
48 116.97	V	X	PK	59.63	-2.43	N/A	-6.02	51.18	87.96	36.78
48 116.98	V	X	AV	55.67	-2.43	N/A	-6.02	47.22	67.96	20.74

▪ TM 1 & Middle

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
*24 148.49	V	X	PK	87.22	9.54	N/A	N/A	96.76	127.96	31.20
*24 148.50	V	X	AV	86.93	9.54	N/A	N/A	96.47	107.96	11.49
48 297.10	V	X	PK	58.47	-2.50	N/A	-6.02	49.95	87.96	38.01
48 296.99	V	X	AV	53.85	-2.50	N/A	-6.02	45.33	67.96	22.63
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

▪ TM 1 & Highest

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
*24 238.80	V	X	PK	88.53	9.57	N/A	N/A	98.10	127.96	29.86
*24 238.48	V	X	AV	88.41	9.57	N/A	N/A	97.98	107.96	9.98
24 250.18	V	X	PK	54.85	9.58	N/A	N/A	64.43	74.00	9.57
24 250.04	V	X	AV	40.32	9.58	N/A	N/A	49.90	54.00	4.10
48 477.26	V	X	PK	59.67	-2.56	N/A	-6.02	51.09	87.96	36.87
48 477.11	V	X	AV	55.13	-2.56	N/A	-6.02	46.55	67.96	21.41

5.3. AC Power-Line Conducted Emissions

▣ Requirements and limit, Part 15.207

For an intentional radiator that 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 μH/50 ohms 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

▣ Test Configuration: NA

▣ Test Procedure

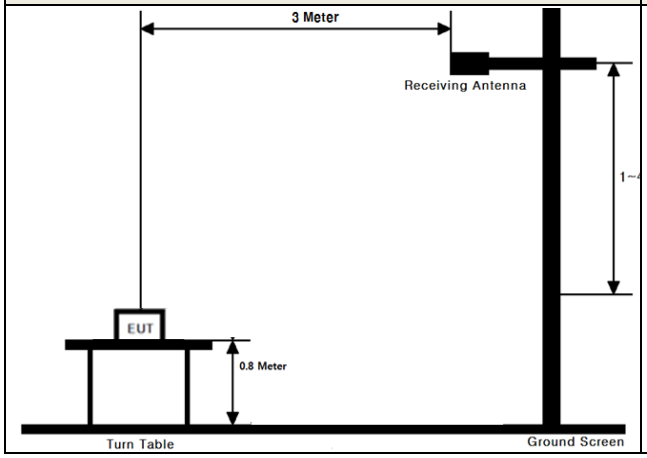
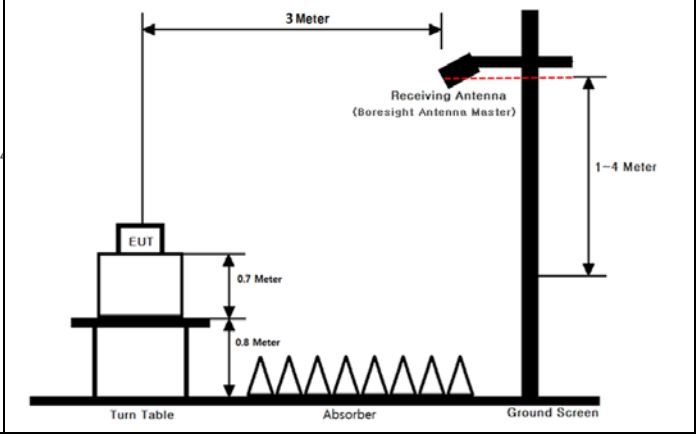
1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

▣ Test Results: NA

APPENDIX I

Test set up diagrams

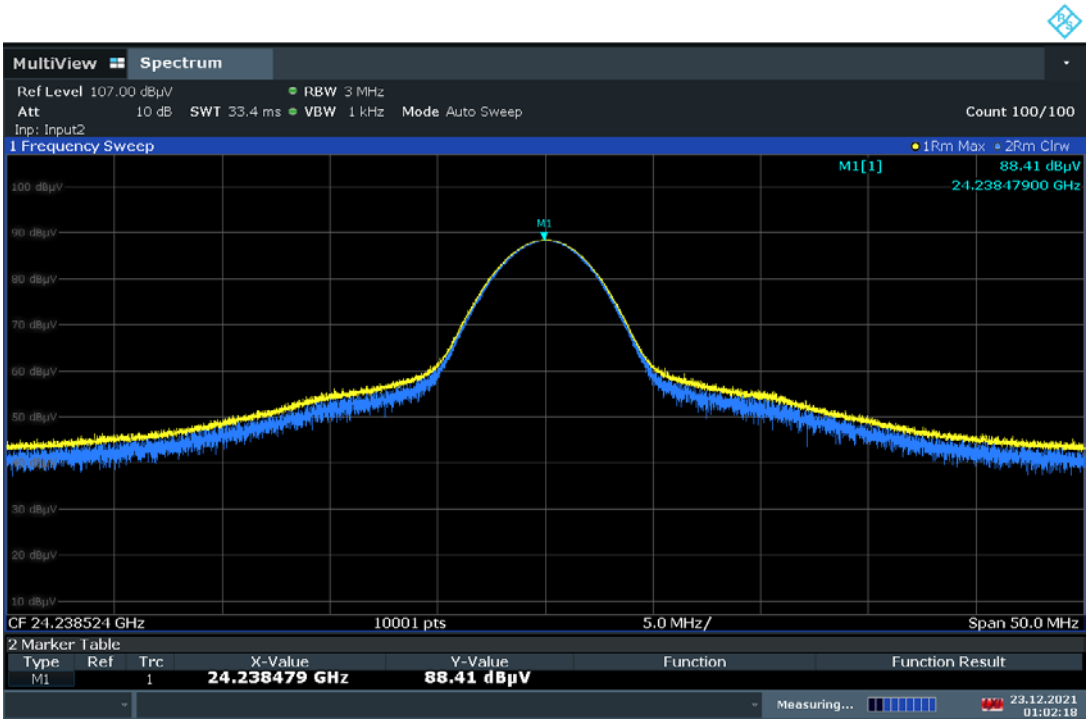
- **Radiated Measurement**

Below 1GHz	Above 1GHz
	

APPENDIX II

Worst data plot of radiated test

Highest & X & Ver **Detector Mode : AV**



Highest & X & Ver **Detector Mode : AV**