

TEST REPORT



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (1) / (48)
Pages

1. Client

- Name : SEONG JI INDUSTRIAL CO., LTD
- Address : 54-33, Dongtanhana 1-gil, Hwaseong-si, Gyeonggi-do, South Korea
- Date of Receipt : 2019-05-09

2. Manufacturer

- Name : SEONG JI INDUSTRIAL CO., LTD
- Address : 54-33, Dongtanhana 1-gil, Hwaseong-si, Gyeonggi-do, South Korea

3. Use of Report : For FCC / ISED Certification

4. Test Sample / Model: AUDIO TRANSCEIVER / ATM210



5. Date of Test : 2019-05-08 to 2019-06-28

6. Test Standard(method) used : FCC 47 CFR part 15 subpart E 15.407 RSS-247 & RSS-Gen

7. Testing Environment: Temp.: (24 ± 1) °C, Humidity: (48 ± 1) % R.H.

8. Test Results : Compliance

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Tested by  Ji-Hye Kim: (Signature)	Technical Manager  Won-Jae, Hwang: (Signature)
-------------	---	---

2019-06-28

Republic of KOREA **CTK Co., Ltd.**



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (2) / (48)
Pages

REPORT REVISION HISTORY

Date	Revision	Page No
2019-06-28	Issued (CTK-2019-02342)	all

This report shall not be reproduced except in full, without the written approval of CTK Co., Ltd. This document may be altered or revised by CTK Co., Ltd. personnel only, and shall be noted in the revision section of the document. Any alteration of this document not carried out by CTK Co., Ltd. will constitute fraud and shall nullify the document.



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (3) / (48)
Pages

CONTENTS

1. General Product Description	4
1.1 Client Information	4
1.2 Product Information.....	4
1.3 Peripheral Devices	4
2. Facility and Accreditations.....	5
2.1 Test Facility.....	5
2.2 Laboratory Accreditations and Listings	5
2.3 Calibration Details of Equipment Used for Measurement	5
3. Test Specifications	6
3.1 Standards.....	6
3.2 Mode of operation during the test	8
3.3 Maximum Measurement Uncertainty	9
3.4 Test Software.....	9
4. Technical Characteristic Test.....	10
4.1 6dB Bandwidth.....	10
4.2 99% Bandwidth.....	13
4.3 OUTPUT POWER	17
4.4 Power Spectral Density	21
4.5 Frequency Stability	25
4.6 Unwanted Emissions	26
4.7 AC Conducted Emissions	45
APPENDIX A – Test Equipment Used For Tests	48



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (4) / (48)
Pages

1. General Product Description

1.1 Client Information

Company	SEONG JI INDUSTRIAL CO., LTD
Contact Point	54-33, Dongtanhana 1-gil, Hwaseong-si, Gyeonggi-do, South Korea
Contact Person	Name : Lee Sang Young E-mail : sylee@seongji.co.kr Tel : +82-31-239-8194 Fax : +82-31-233-7048

1.2 Product Information

FCC ID	2AS8LATM210
Certification Number ISED	25119-ATM210
Product Description	AUDIO TRANSCEIVER
Model name	ATM210
Variant Model name	-
Operating Frequency	UNII 1 : 5 155.35 MHz – 5 247.35 MHz (2 MHz_BW) 5 156.35 MHz – 5 248.35 MHz (4 MHz_BW) UNII 3 : 5 728.35 MHz – 5 824.35 MHz (2 MHz_BW) 5 729.35 MHz – 5 825.35 MHz (4 MHz_BW)
RF Output Power	UNII 1 5 155.35 MHz – 5 247.35 MHz (2 MHz_BW) : 5.55 dBm (3.59 mW) 5 156.35 MHz – 5 248.35 MHz (4 MHz_BW) : 4.86 dBm (3.06 mW) UNII 3 5 728.35 MHz – 5 824.35 MHz (2 MHz_BW) : 7.91 dBm (6.18 mW) 5 729.35 MHz – 5 825.35 MHz (4 MHz_BW) : 6.79 dBm (4.78 mW)
Antenna Specification	ANT1, ANT2 type : PCB Antenna ANT1 Gain : 2.8 dBi ANT2 Gain : 2.2 dBi
Type of Modulation	PI/4 DQPSK
Power Source	DC 5 V
Hardware Rev	REV1.0
Software Rev	TX - 1.153.15 RX - 1.153.1

1.3 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Note Computer	HP	15-bs563TU	CND7253R6N
AC/DC Adapter	HP	HSTNN-CA40	-



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (5) / (48)
Pages

2. Facility and Accreditations

2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea.

2.2 Laboratory Accreditations and Listings

Country	Agency	Registration Number
USA	FCC	805871
CANADA	ISED	8737A-2
KOREA	NRRA	KR0025

2.3 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (6) / (48)
 Pages

3. Test Specifications

3.1 Standards

FCC Part Section(s)	Requirement(s)	Status (Note 1)	Test Condition
15.407(e)	6 dB Bandwidth	C	Conducted
15.407(a)	99% Bandwidth	C	
15.407(a)(1)	Conducted Output Power	C	
15.407(a)(1)	Power Spectral Density	C	
15.407(g)	Frequency Stability	C	
15.407 (b)	Undesirable emission	C	Radiated
15.205, 15.407 (b)(5),(6)	Radiated Spurious Emission	C	
15.207	AC Conducted Emissions	C	Line Conducted
<i>Note 1:</i> C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable			
<i>Note 2:</i> The data in this test report are traceable to the national or international standards.			
<i>Note 3:</i> The sample was tested according to the following specification: FCC Part 15.247, ANSI C63.10-2013			
<i>Note 4:</i> The tests were performed according to the method of measurements prescribed in KDB No.789033.			



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (7) / (48)
 Pages

ISED Part Section(s)	Requirement(s)	Status (Note 1)	Test Condition
RSS-Gen 6.7	6 dB Bandwidth	C	Conducted
RSS-Gen 6.7	99% Bandwidth	C	
RSS-247 6.2.1.1, 6.2.4.1	Conducted Output Power	C	
RSS-247 6.2.1.1, 6.2.4.1	Power Spectral Density	C	
RSS-Gen 6.11	Frequency Stability	C	
RSS-247 6.2.1.2, 6.2.4.2	Undesirable emission	C	Radiated
RSS-Gen 6.13	Radiated Spurious Emission	C	
RSS-Gen 5	Receiver Spurious Emissions	C	
RSS-Gen 8.8	AC Conducted Emissions	C	Line Conducted
<i>Note 1:</i> C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable			
<i>Note 2:</i> The data in this test report are traceable to the national or international standards.			
<i>Note 3:</i> The sample was tested according to the following specification: FCC Part 15.247, ANSI C63.10-2013, RSS-247 Issue 2, RSS-Gen Issue 5			
<i>Note 4:</i> The tests were performed according to the method of measurements prescribed in KDB No.789033.			



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (8) / (48)
Pages

3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments.
During at testing, system components were manipulated within the confines of typical usage to maximize each emission.

The engineering test program was provided and enabled to make EUT continuous transmit.
The results are only attached ANT1 as worst cases.

Test Frequency

- Digital Modulation_2MHz_BW

	Lowest channel	Middle channel	Highest channel
UNII 1	5 155.35 MHz	5 201.35 MHz	5 247.35 MHz
UNII 3	5 728.35 MHz	5 776.35 MHz	5 824.35 MHz

- Digital Modulation_4MHz_BW

	Lowest channel	Middle channel	Highest channel
UNII 1	5 156.35 MHz	5 202.35 MHz	5 248.35 MHz
UNII 3	5 729.35 MHz	5 777.35 MHz	5 825.35 MHz

Test mode	Duty Cycle
2MHz_BW	100%
4MHz_BW	100%



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (9) / (48)
Pages

3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter.
Coverage factor $k = 2$, Confidence levels of 95 %

Description	Uncertainty
Conducted RF Output Power	± 1.5 dB
Power Spectral Density	± 1.5 dB
Occupied Bandwidth	± 0.1 MHz
Unwanted Emission(conducted)	± 3.0 dB
Radiated Emissions ($f \leq 1$ GHz)	± 4.0 dB
Radiated Emissions ($f > 1$ GHz)	± 5.0 dB

3.4 Test Software

Conducted Test	Ics Pro Ver. 6.0.3
Radiated Test	TOYO EMI software EP5RE Ver. 5.1.0
Line Conducted Test	ESC17, ESC13 : EMC32 Ver. 8.50.0 ESR7 : EMC32 Ver. 8.53.0



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (10) / (48)
Pages

4. Technical Characteristic Test

4.1 6dB Bandwidth

Test Procedures

KDB 789033 – Section C.2
ANSI C63.10-2013 - Section 6.9.2
RSS-GES Issue 5 – Section 6.7

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Test Settings :

Center frequency = the highest, middle and the lowest channels

- a) RBW = 100 kHz
- b) VBW $\geq 3 \times$ RBW
- c) Detector = peak
- d) Trace mode = Max hold
- e) Sweep = auto couple
- f) Allow trace to fully stabilize
- g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Minimum Standard:

6 dB Bandwidth > 500 kHz



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (11) / (48)
Pages

Test Data:

	6 dB Bandwidth (MHz)
Mode	Digital Modulation_2MHz_BW
Frequency	
5 728.35 MHz	1.61
5 776.35 MHz	1.61
5 824.35 MHz	1.62
Measurement uncertainty	± 0.1 MHz

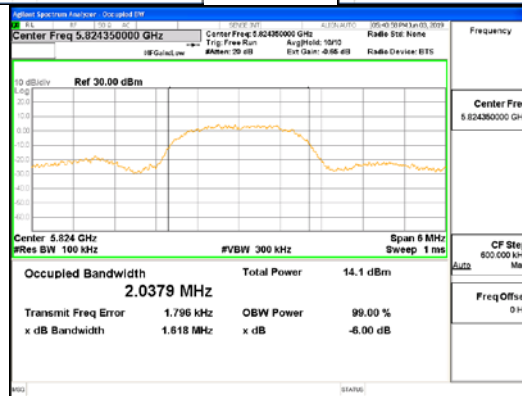
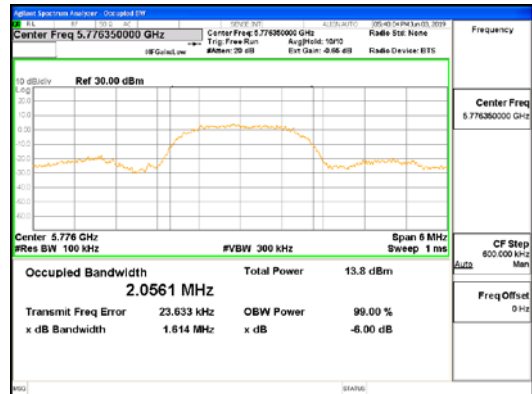
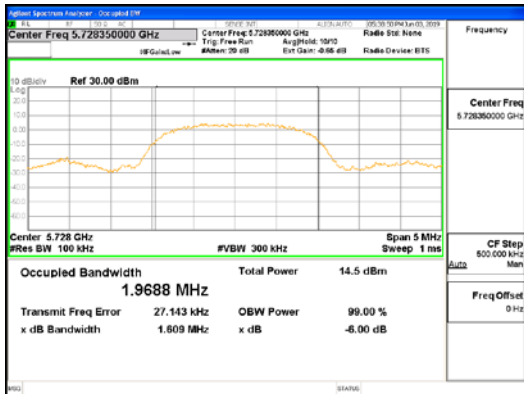
	6 dB Bandwidth (MHz)
Mode	Digital Modulation_4MHz_BW
Frequency	
5 729.35 MHz	3.52
5 777.35 MHz	3.51
5 825.35 MHz	3.50
Measurement uncertainty	± 0.1 MHz

See next pages for actual measured spectrum plots.

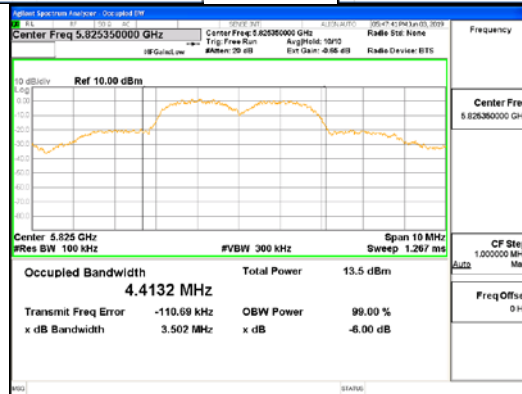
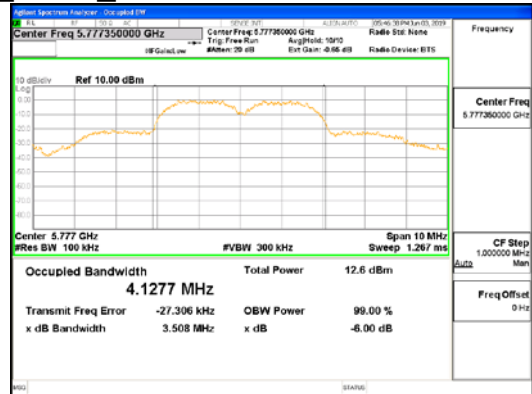
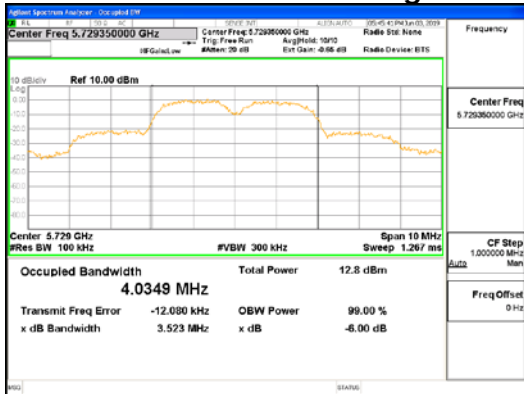


CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (12) / (48)
 Pages



Digital Modulation_2MHz_BW



Digital Modulation_4MHz_BW



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (13) / (48)
Pages

4.2 99% Bandwidth

Test Procedures

KDB 789033 – Section C.1
ANSI C63.10-2013 - Section 6.9.3
RSS-GEN Issue 5 – Section 6.7

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

Use the 99% power bandwidth function of the instrument and report the measured bandwidth.

Test Settings :

Center frequency = the highest, middle and the lowest channels

- a) RBW = approximately 1 % of the emission bandwidth
- b) VBW \geq RBW
- c) Detector = peak
- d) Trace mode = Max hold
- e) Measure the maximum width of the emission that is 26 dB down from the maximum of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

Minimum Standard:

NA

Test Data:



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (14) / (48)
 Pages

	99% Bandwidth (MHz)
Mode	Digital Modulation_2MHz_BW
Frequency	99%
5 155.35 MHz	1.91
5 201.35 MHz	1.91
5 247.35 MHz	1.91
5 728.35 MHz	2.56
5 776.35 MHz	2.90
5 824.35 MHz	2.88
Measurement uncertainty	± 0.1 MHz

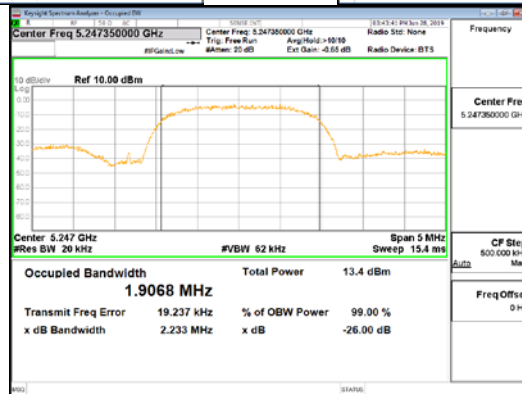
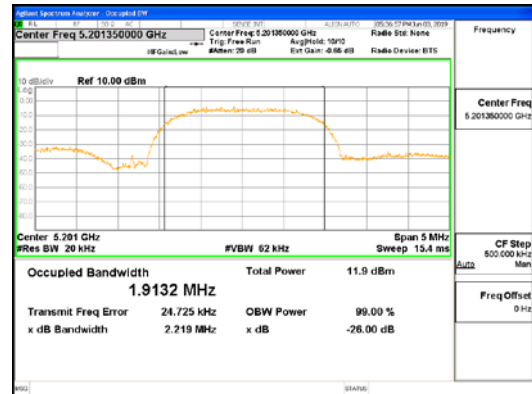
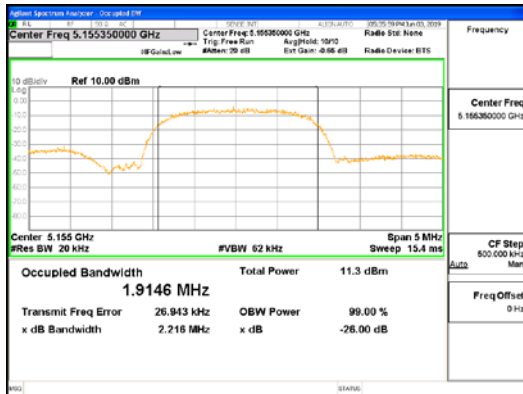
	99% Bandwidth (MHz)
Mode	Digital Modulation_4MHz_BW
Frequency	99%
5 156.35 MHz	3.83
5 202.35 MHz	3.81
5 248.35 MHz	3.84
5 729.35 MHz	4.54
5 777.35 MHz	4.73
5 825.35 MHz	4.99
Measurement uncertainty	± 0.1 MHz

See next pages for actual measured spectrum plots.

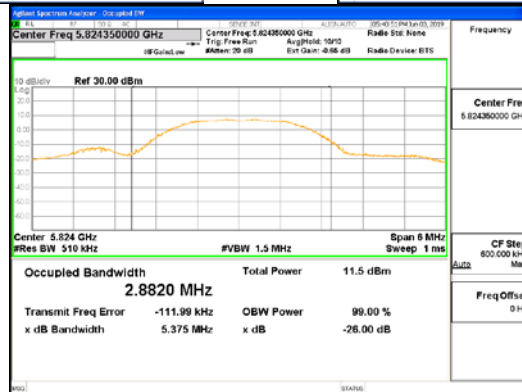
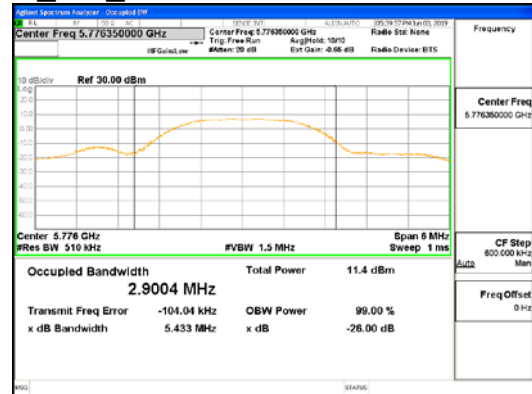
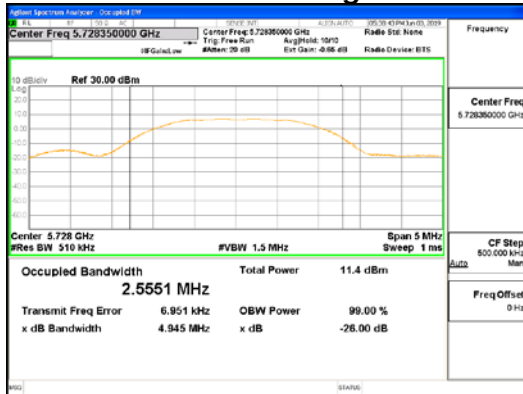


CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (15) / (48)
 Pages



Digital Modulation_2MHz_BW_UNII-1

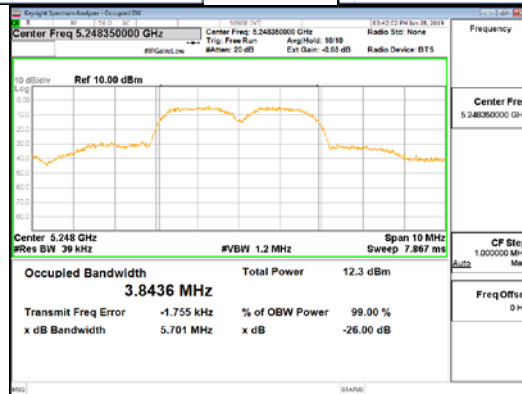
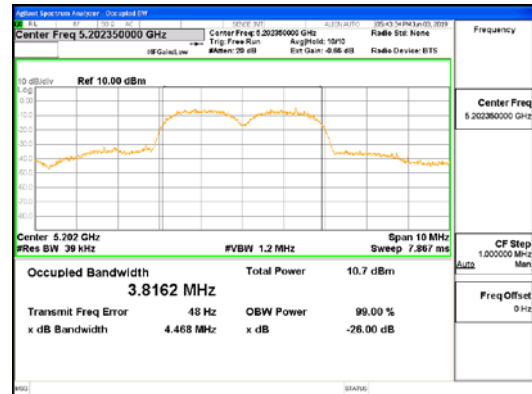
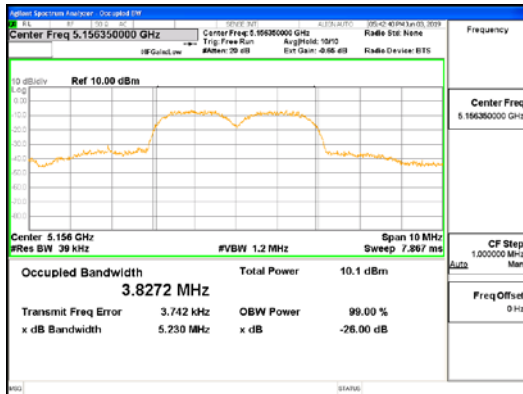


Digital Modulation_2MHz_BW_UNII-3

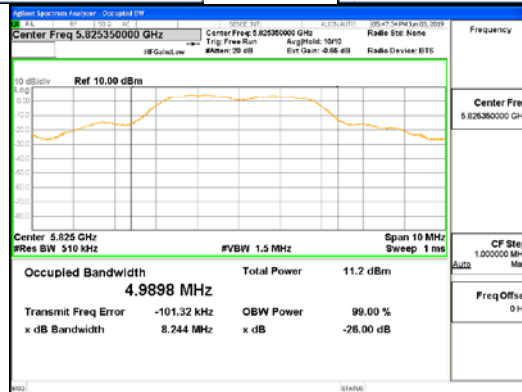
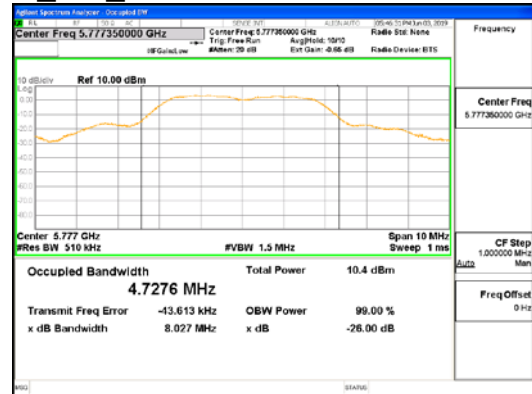
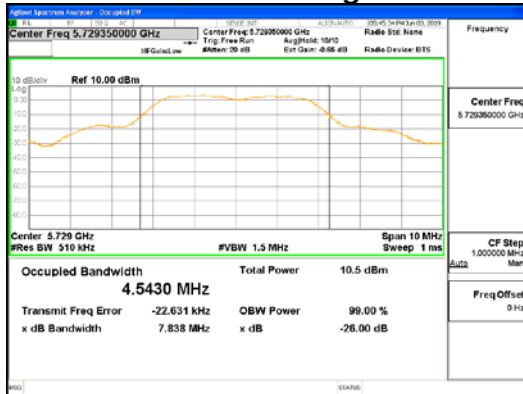


CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (16) / (48)
 Pages



Digital Modulation_4MHz_BW_UNII-1



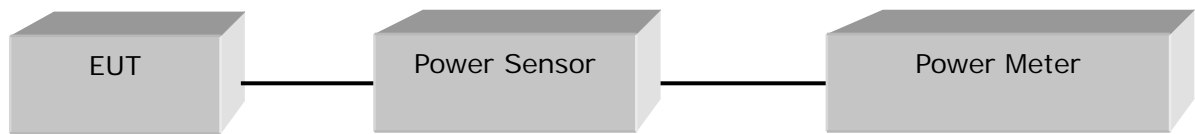
Digital Modulation_4MHz_BW_UNII-3

4.3 OUTPUT POWER

Test Procedures

KDB 789033 – Section E.3.a (Method PM, Maximum Conducted Output Power)
RSS-GEN Issue 5 – Section 6.12

The transmitter output is connected to a spectrum analyzer and the analyzer's internal channel power integration function is used to integrate the power over a bandwidth greater than or equal to the 99% bandwidth.



Limit

Band	Mode	ANT Configuration	ANT Gain (dBi)	Limit (dBm)
UNII 1	Digital Modulation	ANT1	2.8	24.00
UNII 3				30.00



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (18) / (48)
Pages

Test Data

Test Mode	Frequency (MHz)	Measured Output Power (dBm)	Limit (dBm)	Margin (dB)
Digital Modulation_2MHz_BW	5 155.35	4.43	24.00	19.57
	5 201.35	5.09	24.00	18.91
	5 247.35	5.55	24.00	18.45
	5 728.35	7.91	30.00	22.09
	5 776.35	7.67	30.00	22.33
	5 824.35	7.40	30.00	22.60
Digital Modulation_4MHz_BW	5 156.35	3.56	24.00	20.44
	5 202.35	3.80	24.00	20.20
	5 248.35	4.86	24.00	19.14
	5 729.35	6.79	30.00	23.21
	5 777.35	6.56	30.00	23.44
	5 825.35	6.66	30.00	23.34
Measurement uncertainty	± 1.5 dB			

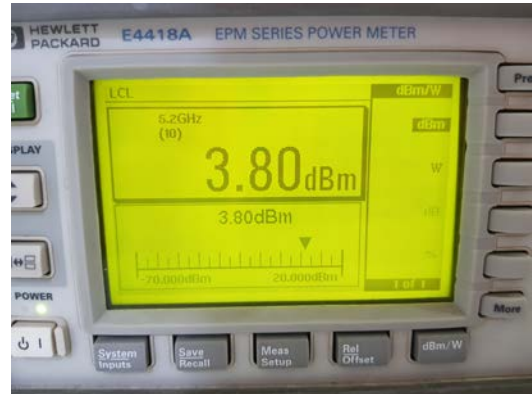
See next pages for actual measured spectrum plots.



Digital Modulation_2MHz_BW_UNII-1



Digital Modulation_2MHz_BW_UNII-3



Digital Modulation_4MHz_BW_UNII-1



Digital Modulation_4MHz_BW_UNII-3



4.4 Power Spectral Density

Test Procedures

KDB 789033 – Section F (Method SA-1, Maximum Power Spectral Density)
RSS-247 Issue 2 – Section 5.2(b)

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

Test Settings :

Center frequency = the highest, middle and the lowest channels

- a) RBW = 1 MHz, 500 KHz (UNII 3)
- b) VBW = 3 MHz, 1.5 MHz (UNII 3)
- c) Sweep time = auto
- d) Detector = power averaging (rms)
- e) Trace mode = Average at least 100

Limit

Band	Mode	ANT Configuration	ANT Gain (dBi)	Limit (dBm)
UNII 1	Digital Modulation	ANT1	2.8	11.00
UNII 3				30.00



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (22) / (48)
 Pages

Test Data

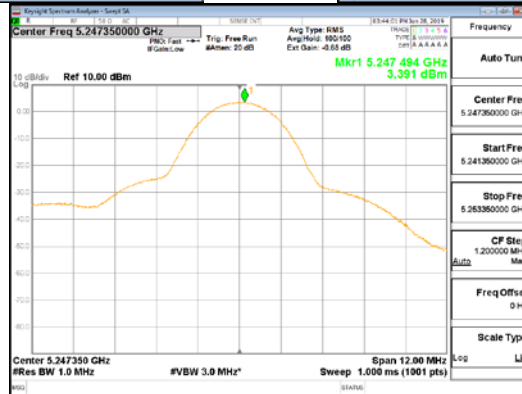
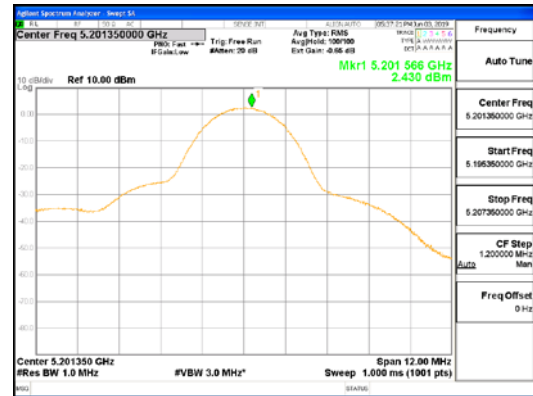
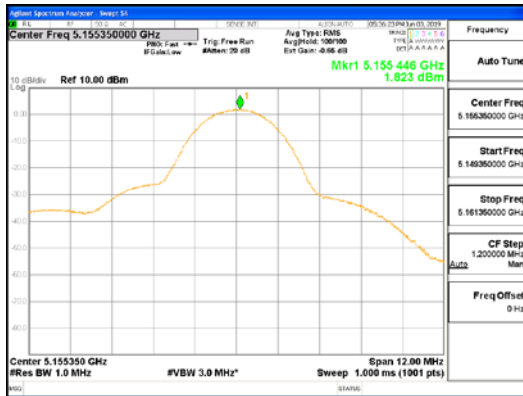
Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Margin (dB)
Digital Modulation_2MHz_BW	5 155.35	1.82	11.00	9.18
	5 201.35	2.43	11.00	8.57
	5 247.35	3.39	11.00	7.61
	5 728.35	3.05	30.00	26.95
	5 776.35	2.66	30.00	27.34
	5 824.35	2.86	30.00	27.14
Digital Modulation_4MHz_BW	5 156.35	-1.81	11.00	12.81
	5 202.35	-1.52	11.00	12.52
	5 248.35	0.21	11.00	10.79
	5 729.35	-0.86	30.00	30.86
	5 777.35	-0.98	30.00	30.98
	5 825.35	-0.29	30.00	30.29
Measurement uncertainty	± 1.5 dB			

See next pages for actual measured spectrum plots.

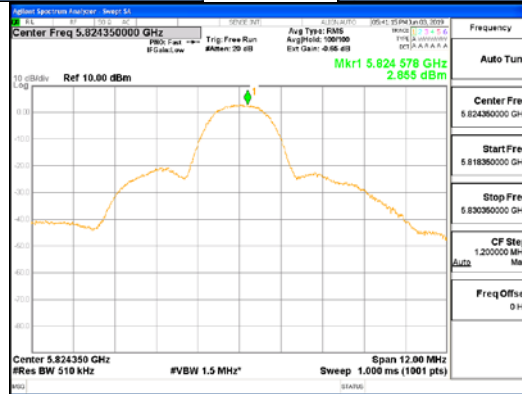
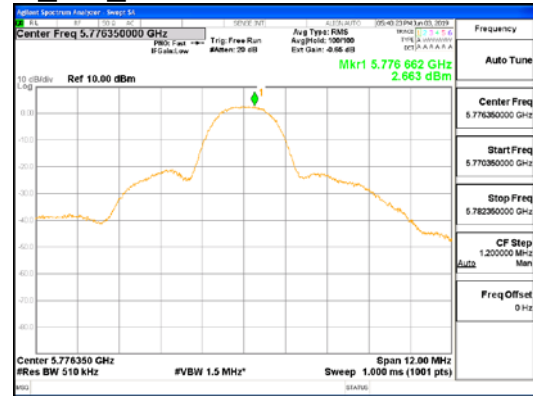
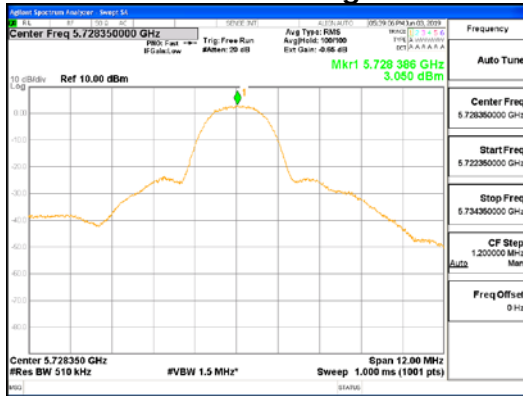


CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (23) / (48)
Pages



Digital Modulation_2MHz_BW_UNII-1

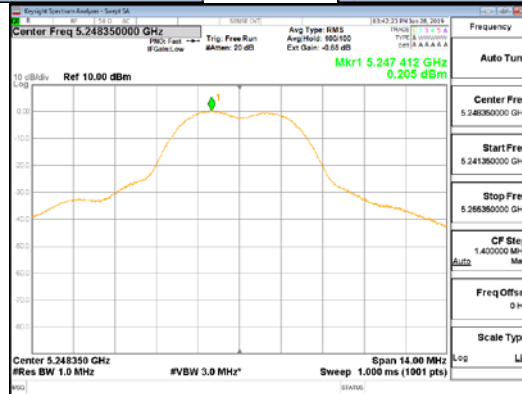
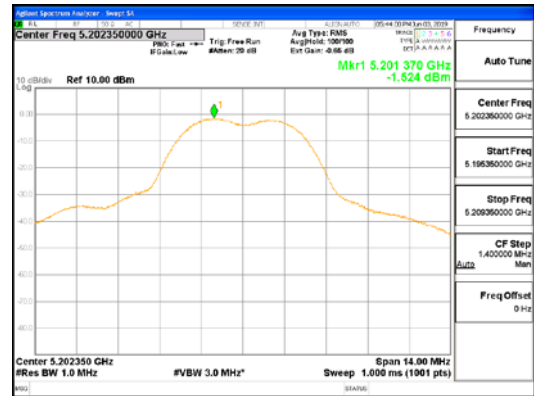
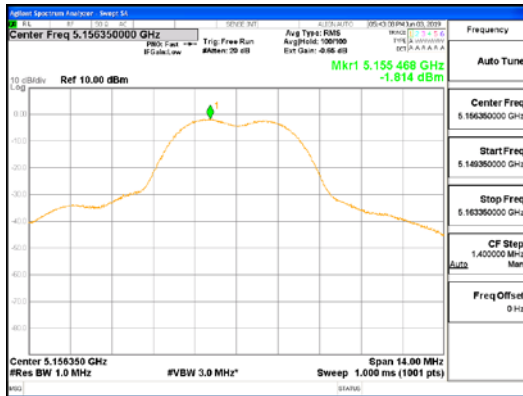


Digital Modulation_2MHz_BW_UNII-3

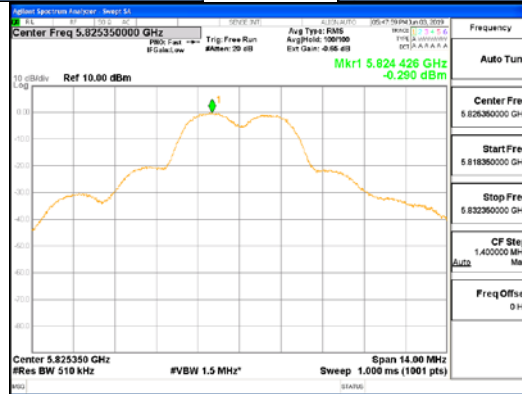
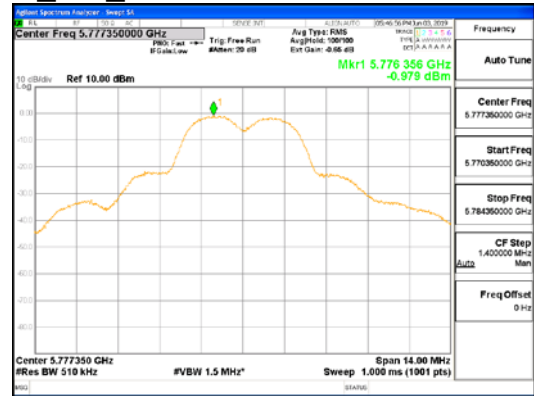
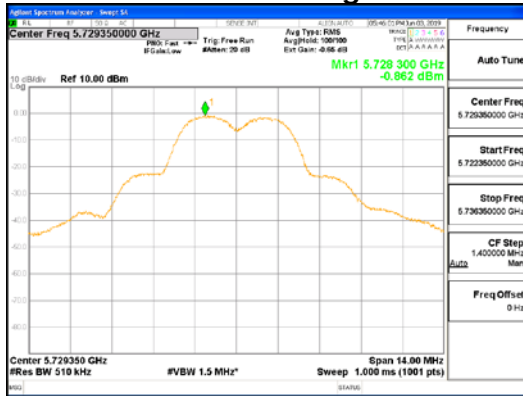


CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (24) / (48)
Pages



Digital Modulation_4MHz_BW_UNII-1



Digital Modulation_4MHz_BW_UNII-3

4.5 Frequency Stability

Test Procedures

The EUT was placed inside of an environmental chamber as the temperature in the chamber was varied between 0 °C and +60 °C (Declaration by the Manufacturer). The temperature was incremented by 10 °C (5 °C) intervals and the unit was allowed to stabilize at each temperature before each measurement. The center frequency of the transmitting channel was evaluated at each temperature and the frequency deviation from the channel's center frequency was recorded.

Data for the worst case channel is shown below.

Temperature (°C)	0	10	20	30	40	50	60
Frequency	Measured Frequency Error (kHz)						
5 155.35 MHz	42.710	42.310	32.129	26.401	23.254	17.962	20.893
5 201.35 MHz	43.501	41.610	34.848	26.910	25.764	16.360	24.732
5 247.35 MHz	38.908	42.298	32.376	29.403	19.959	15.054	17.897
5 728.35 MHz	48.055	47.668	37.827	33.220	25.255	20.857	26.155
5 776.35 MHz	32.010	35.867	31.950	30.204	22.090	20.040	28.233
5 824.35 MHz	-76.027	7.611	15.170	21.933	18.938	12.393	25.969

Note :

Based on the results of the frequency stability test shown above the frequency deviation results measured are very small. As such it is determined that the channels at the band edge would remain in-band when the maximum measured frequency deviation noted during the frequency stability tests is applied. Therefore the device is determined to remain operating in band over the temperature range as tested.

4.6 Unwanted Emissions

Test Location

- 10 m SAC (test distance : 10 m, 3 m)
 3 m SAC (test distance : 3 m)

Test Procedures

- 1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. The Test Antenna is positioned with its plane vertical at 1m distance from the EUT. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
- 2) In the frequency range above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) and Horn Test Antenna(above 1 GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.

Test Settings:

Frequency Range = 9 kHz ~ 1 GHz

- a) RBW = 100 kHz for $f < 1$ GHz, 9 kHz for $f < 30$ MHz
 b) VBW \geq RBW
 c) Detector = CISPR Quasi-peak
 d) Sweep time = auto couple

- Peak

Frequency Range = 1 GHz ~ 40 GHz

- a) RBW = 1 MHz
 b) VBW $\geq 3 \times$ RBW
 c) Detector = Peak
 d) Sweep time = auto
 e) Trace mode = max hold

- Average (duty cycle $\geq 98\%$)

Frequency Range = 1 GHz ~ 40 GHz

- a) RBW = 1 MHz
 b) VBW $\geq 3 \times$ RBW
 c) Detector = RMS
 d) Sweep time = auto
 e) Averaging type = power (i.e., RMS)
 f) Trace mode = average (at least 100 traces)



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (27) / (48)
Pages

Limit

- 15.209(a)

Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m	Deasurement Distance (meters)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705-30	30	-	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	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 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

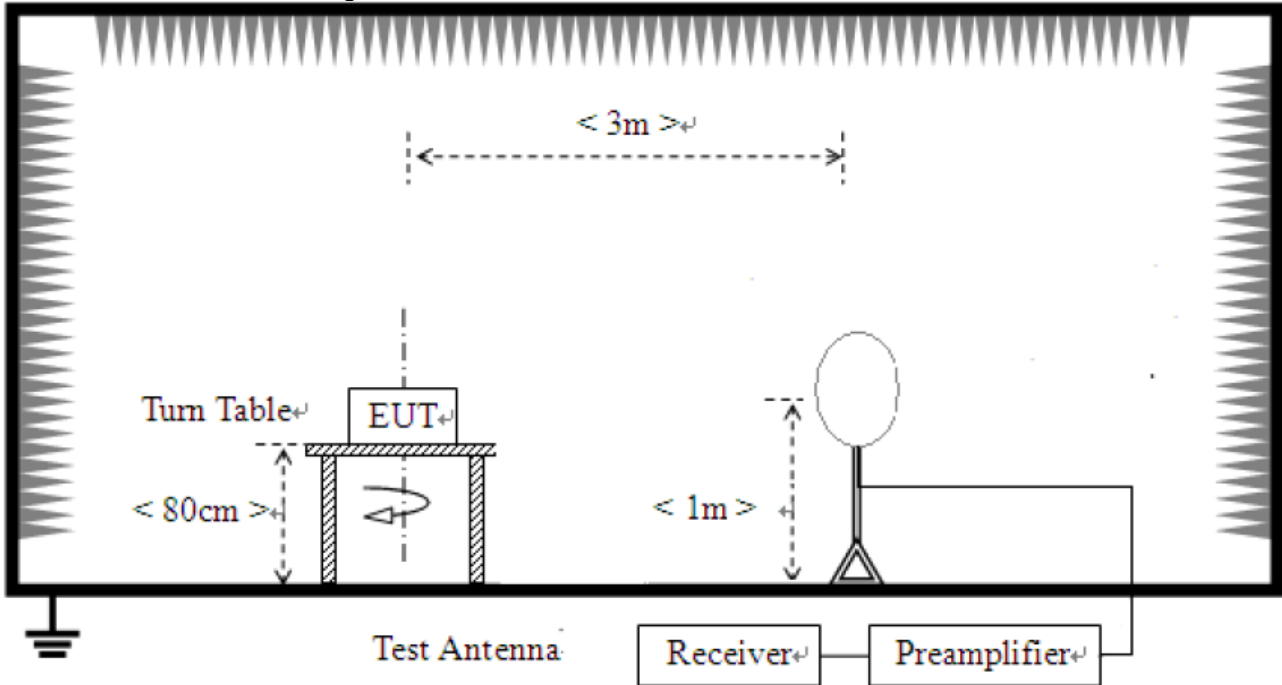
- 15.407, KDB 789033

E.I.R.P -27 dBm/MHz

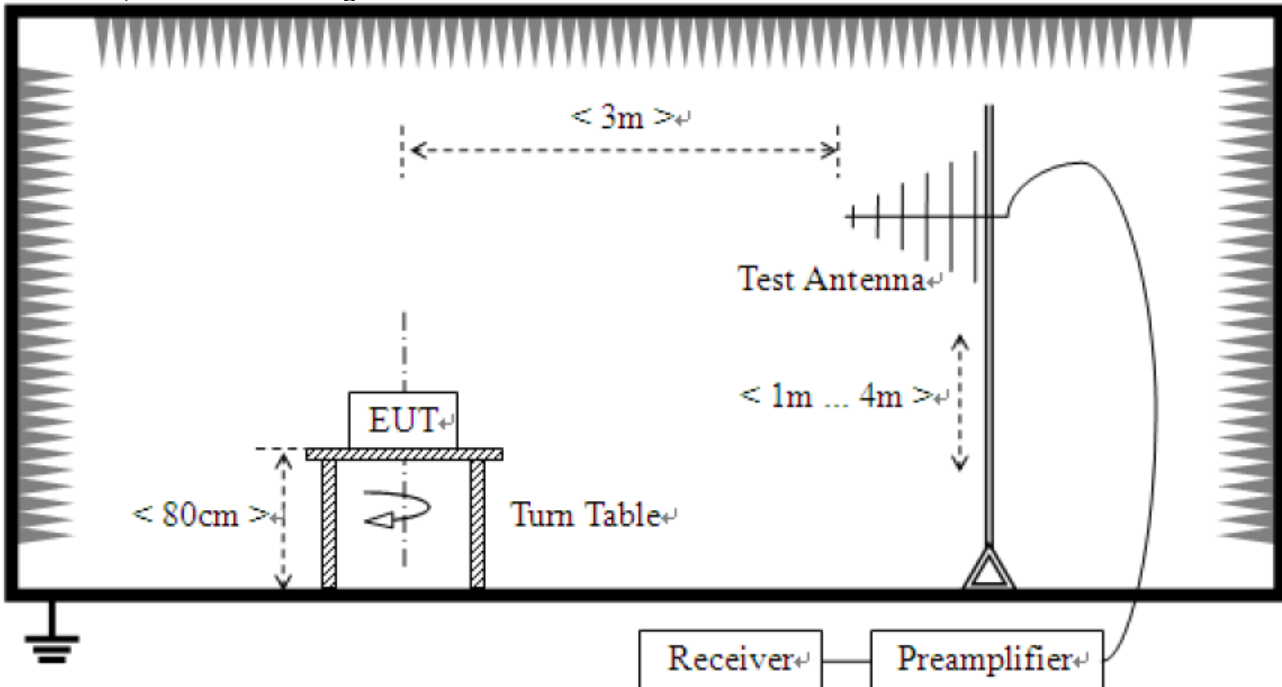
$E[\text{dBuV/m}] = \text{EIRP}[\text{dBm}] + 95.2$, for $d = 3\text{m}$

Test Setup:

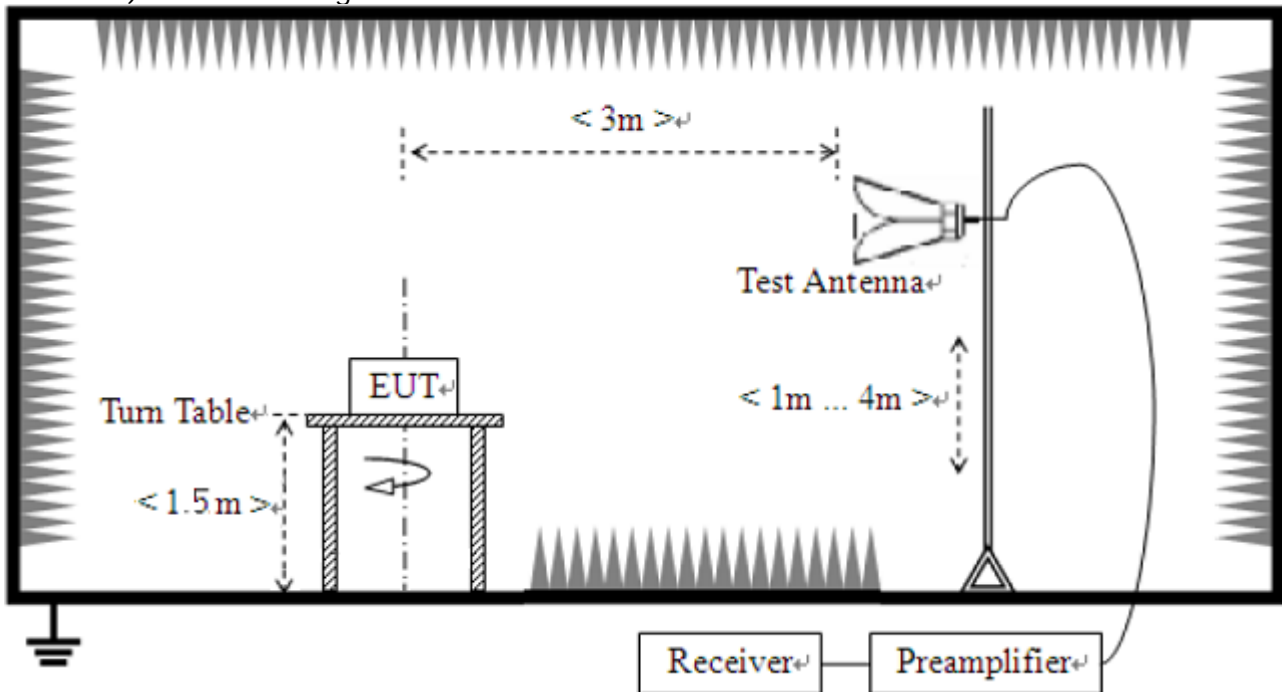
- 1) For field strength of emissions from 9 kHz to 30 MHz



- 2) For field strength of emissions from 30 MHz to 1 GHz



3) For field strength of emissions above 1 GHz





CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (30) / (48)
Pages

Test Results

1) 9 kHz to 30 MHz

The requirements are:

Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
-	-	-	See note

Note :

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = $40 \log (\text{specific distance} / \text{test distance})$ (dB)

2) 30 MHz to 1 GHz

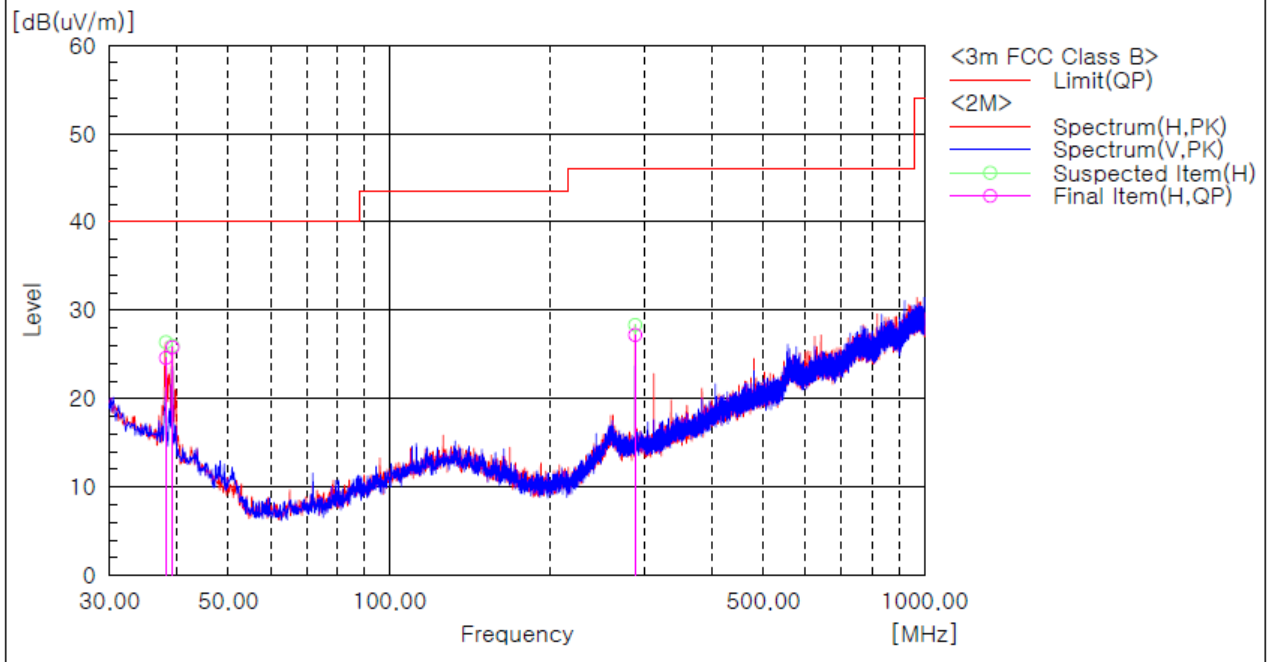
Test mode : Digital Modulation_2MHz_BW(Worst Case)

The requirements are:

Complies

Test Data

Test Model : ATM210
Test Mode : 2M
Tester : KIM JI HYE
Manufacturer : SEONG JI



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]
1	38.245	H	35.1	-10.5	24.6	40.0	15.4	100.0	332.0
2	39.336	H	36.8	-11.0	25.8	40.0	14.2	100.0	173.0
3	288.020	H	35.9	-8.7	27.2	46.0	18.8	100.0	226.0

Remark :

- The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand=up position(Z axis) and the worst case was recorded.
- Result = Reading + c.f(Correction factor)
- Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain
- We have done all test mode. The results are only attached worst cases.

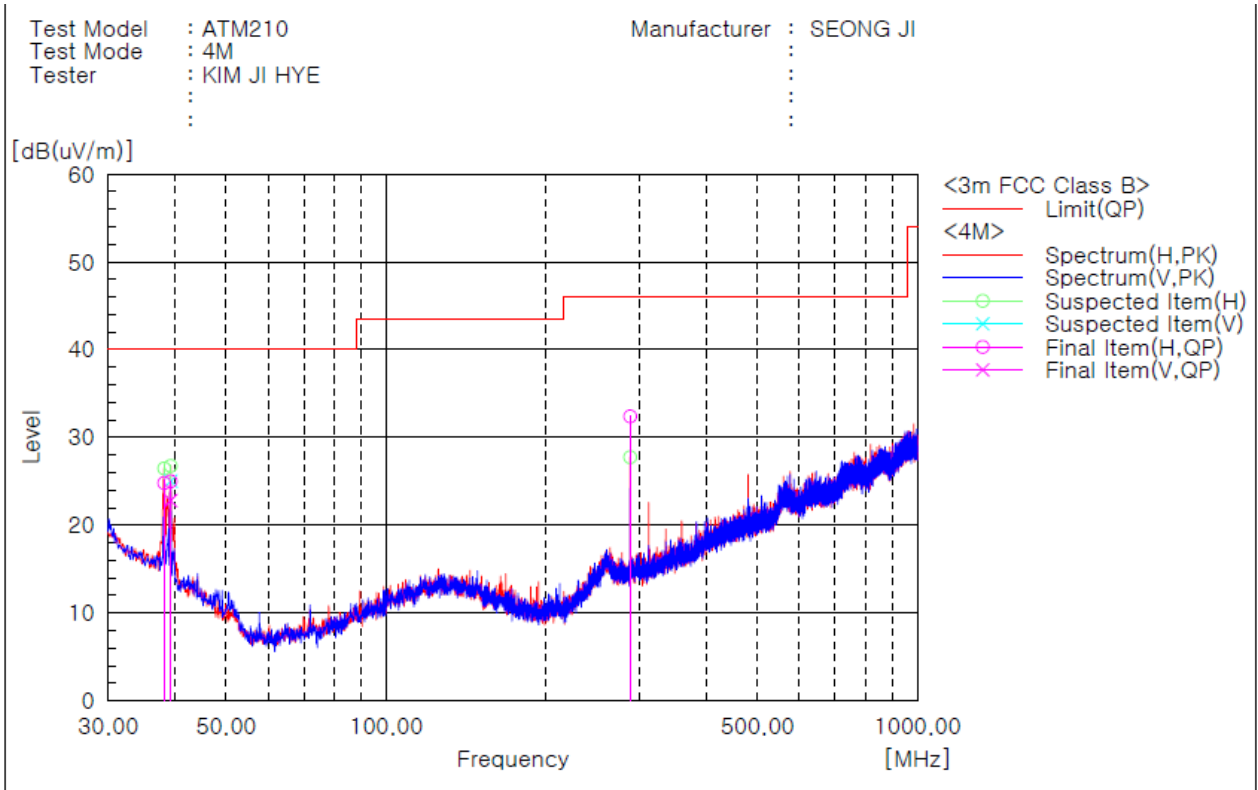


Test mode : Digital Modulation_4MHz_BW(Worst Case)

The requirements are:

Complies

Test Data



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]
1	38.245	H	35.3	-10.5	24.8	40.0	15.2	200.0	0.0
2	39.336	H	36.0	-11.0	25.0	40.0	15.0	200.0	0.0
3	39.336	V	33.8	-11.0	22.8	40.0	17.2	101.0	40.0
4	288.020	H	41.1	-8.7	32.4	46.0	13.6	101.0	160.0

Remark :

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand=up position(Z axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain
4. We have done all test mode. The results are only attached worst cases.

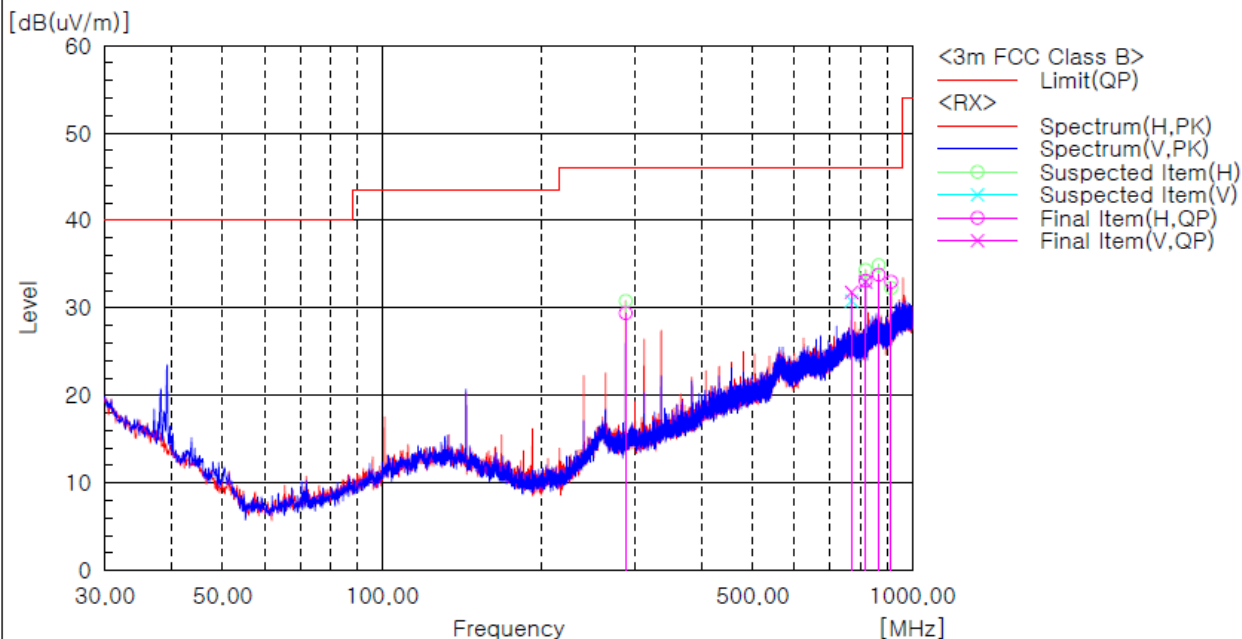
Test mode : Receiver mode

The requirements are:

Complies

Test Data

Test Model : ATM210	Manufacturer : SEONG JI
Test Mode : RX	
Tester : KIM JI HYE	
:	



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]
1	288.020	H	38.1	-8.7	29.4	46.0	16.6	101.0	160.0
2	768.049	V	28.6	3.2	31.8	46.0	14.2	100.0	359.0
3	816.064	H	30.0	3.1	33.1	46.0	12.9	101.0	187.0
4	816.064	V	29.9	3.1	33.0	46.0	13.0	100.0	0.0
5	864.079	H	29.0	4.8	33.8	46.0	12.2	101.0	187.0
6	912.094	H	27.3	5.7	33.0	46.0	13.0	101.0	187.0

Remark :

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand=up position(Z axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain
4. We have done all test mode. The results are only attached worst cases.



3) above 1 GHz

Test mode : Digital Modulation_2MHz_BW

The requirements are:

Complies

Test Data

5 155.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
5 149.94	H	54.00	74.00	52.90	59.60	1.10	14.40
5 149.98	V	54.00	74.00	52.20	61.00	1.80	13.00

5 201.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.							

5 247.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.							

5 728.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
5 623.60	H	-	68.20	-	44.70	-	23.50
5 574.78	V	-	68.20	-	44.40	-	23.80

5 776.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.							



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (35) / (48)
Pages

5 824.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
5 945.93	H	-	68.20	-	46.20	-	22.00
5 949.09	V	-	68.20	-	46.00	-	22.20

Remarks

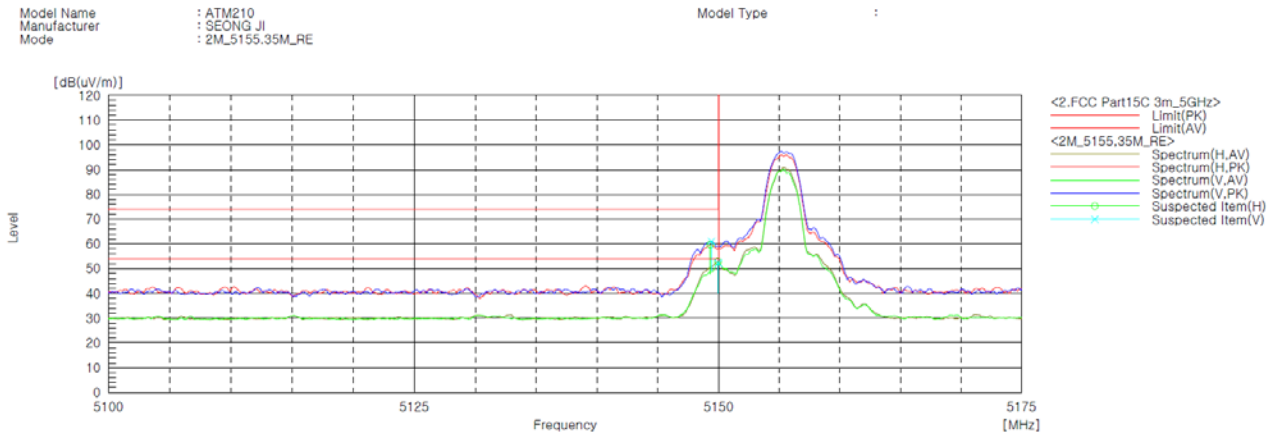
1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand=up position(Z axis) and the worst case was recorded.
2. Peak Result = Reading + c.f(Correction factor)
Average Result = Reading + c.f(Correction factor) + Duty cycle factor
3. Correction factor = Antenna factor + Cable loss - Amp Gain



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (36) / (48)
Pages

Worst Case Mode :	Digital Modulation_2MHz BW
Distance of Measurements :	3 Meters
Operating Frequency :	5 155.35 MHz



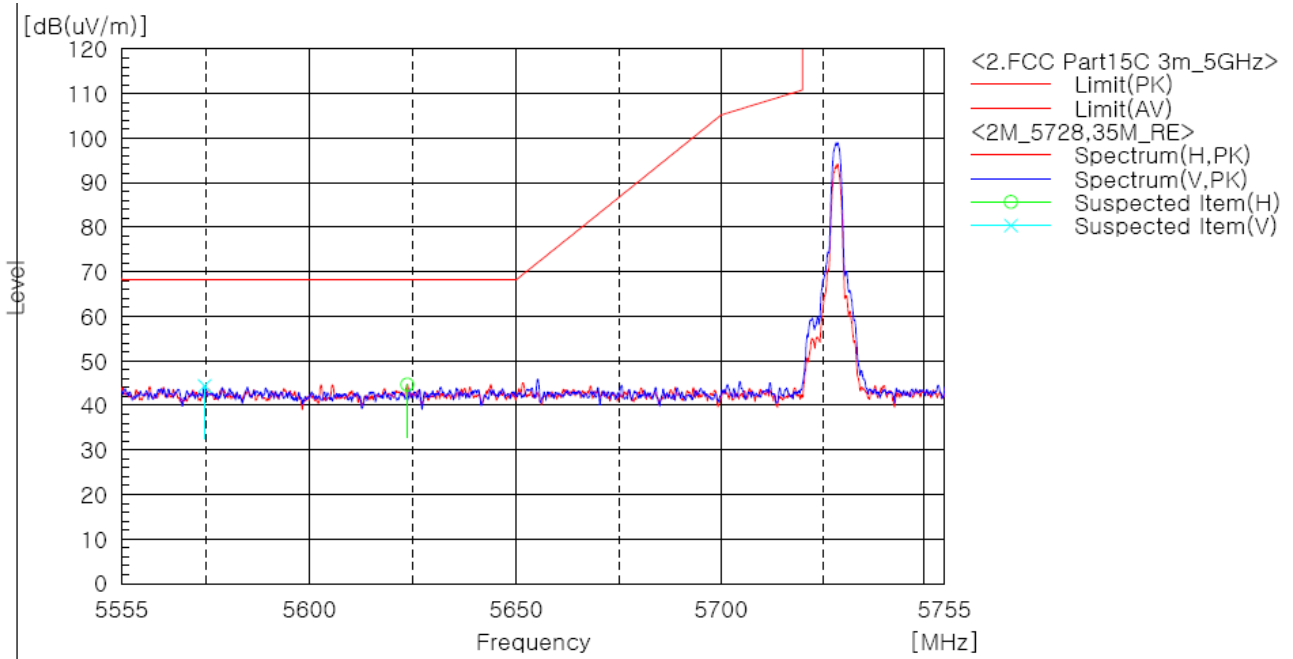
Radiated Restricted Lower Band Edge Plot



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (37) / (48)
Pages

Worst Case Mode :	Digital Modulation_2MHz BW
Distance of Measurements :	3 Meters
Operating Frequency :	5 728.35 MHz



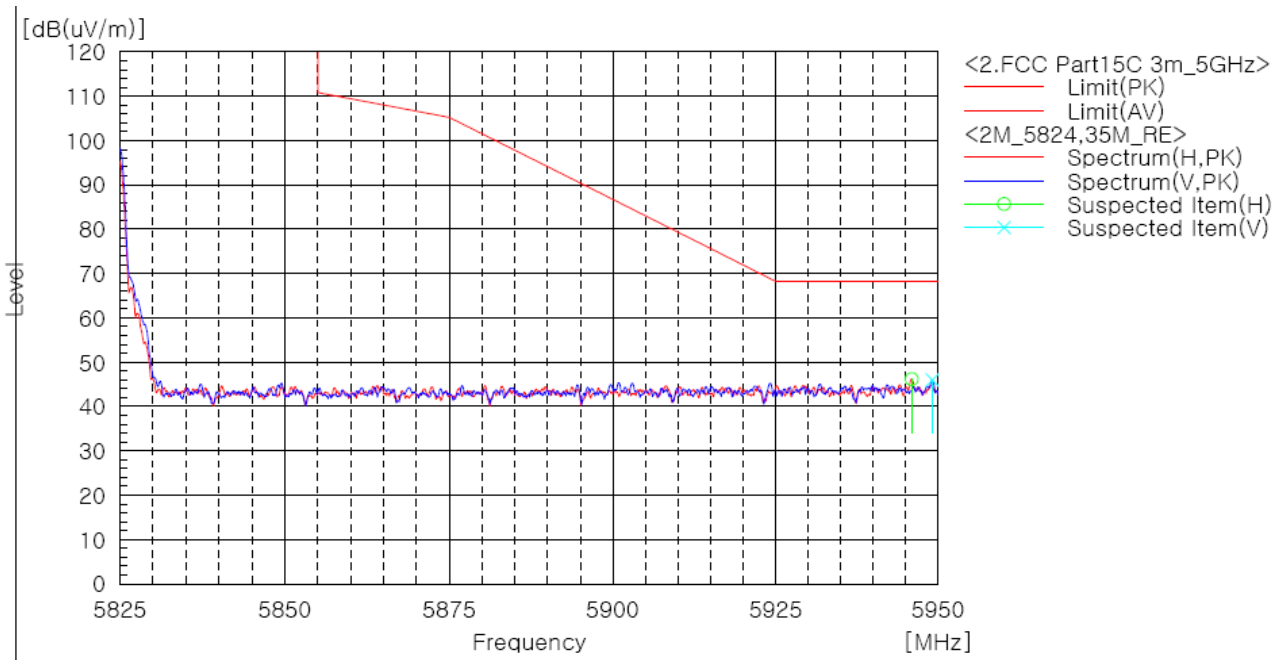
Radiated Restricted Lower Band Edge Plot



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (38) / (48)
 Pages

Worst Case Mode :	Digital Modulation_2MHz BW
Distance of Measurements :	3 Meters
Operating Frequency :	5 824.35 MHz



Radiated Restricted Upper Band Edge Plot



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (39) / (48)
 Pages

Test mode : Digital Modulation_4MHz_BW

The requirements are:

Complies

Test Data

5 156.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
5 147.07	H	54.00	74.00	46.20	55.30	7.80	18.70
5 147.52	V	54.00	74.00	49.70	60.00	4.30	14.00

5 202.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.							

5 248.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.							

5 729.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
5 571.75	H	-	68.20	-	45.30	-	22.90
5 570.51	V	-	68.20	-	45.00	-	23.20

5 777.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
No emissions were detected at a level greater than 20dB below limit.							



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (40) / (48)
Pages

5 825.35 MHz

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
5 935.02	H	-	68.20	-	45.70	-	22.50
5 933.55	V	-	68.20	-	45.50	-	22.70

Remarks

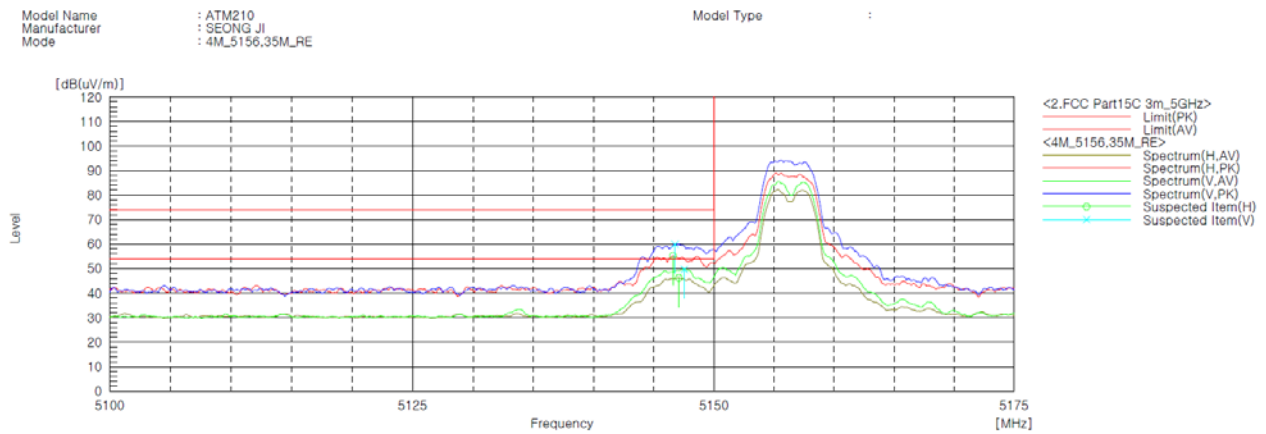
1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand=up position(Z axis) and the worst case was recorded.
2. Peak Result = Reading + c.f(Correction factor)
Average Result = Reading + c.f(Correction factor) + Duty cycle factor
3. Correction factor = Antenna factor + Cable loss - Amp Gain



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (41) / (48)
Pages

Worst Case Mode :	Digital Modulation_4MHz BW
Distance of Measurements :	3 Meters
Operating Frequency :	5 156.35 MHz



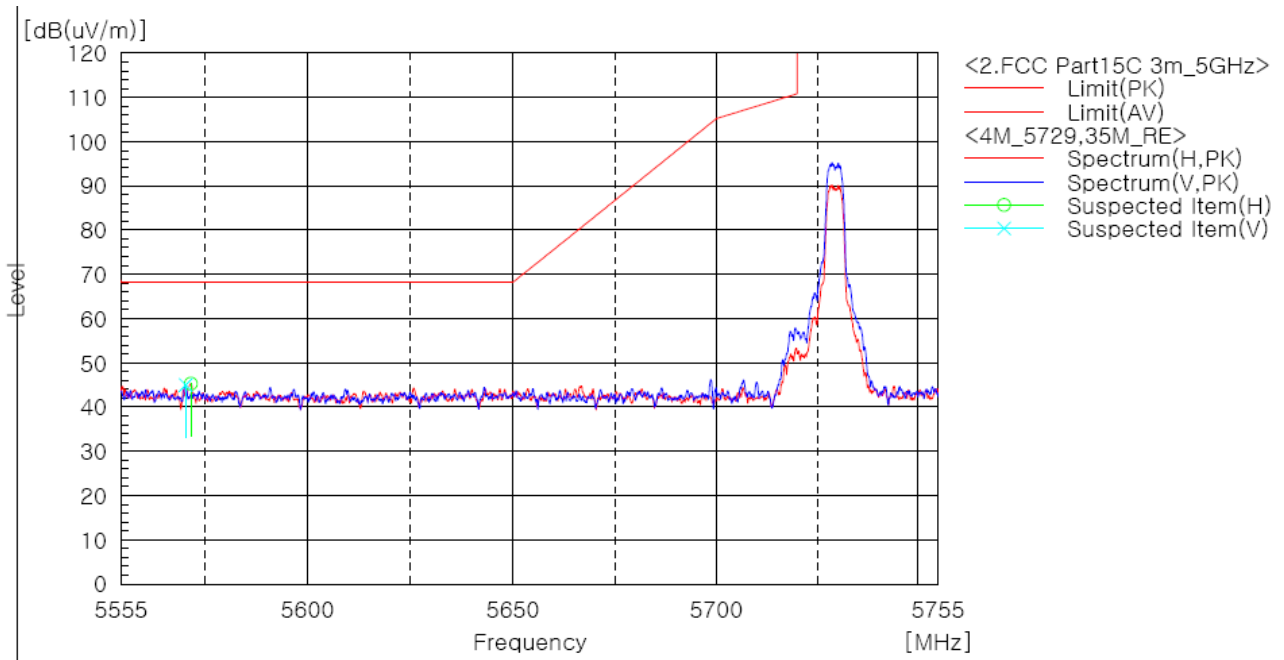
Radiated Restricted Lower Band Edge Plot



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (42) / (48)
 Pages

Worst Case Mode :	Digital Modulation_4MHz BW
Distance of Measurements :	3 Meters
Operating Frequency :	5 729.35 MHz



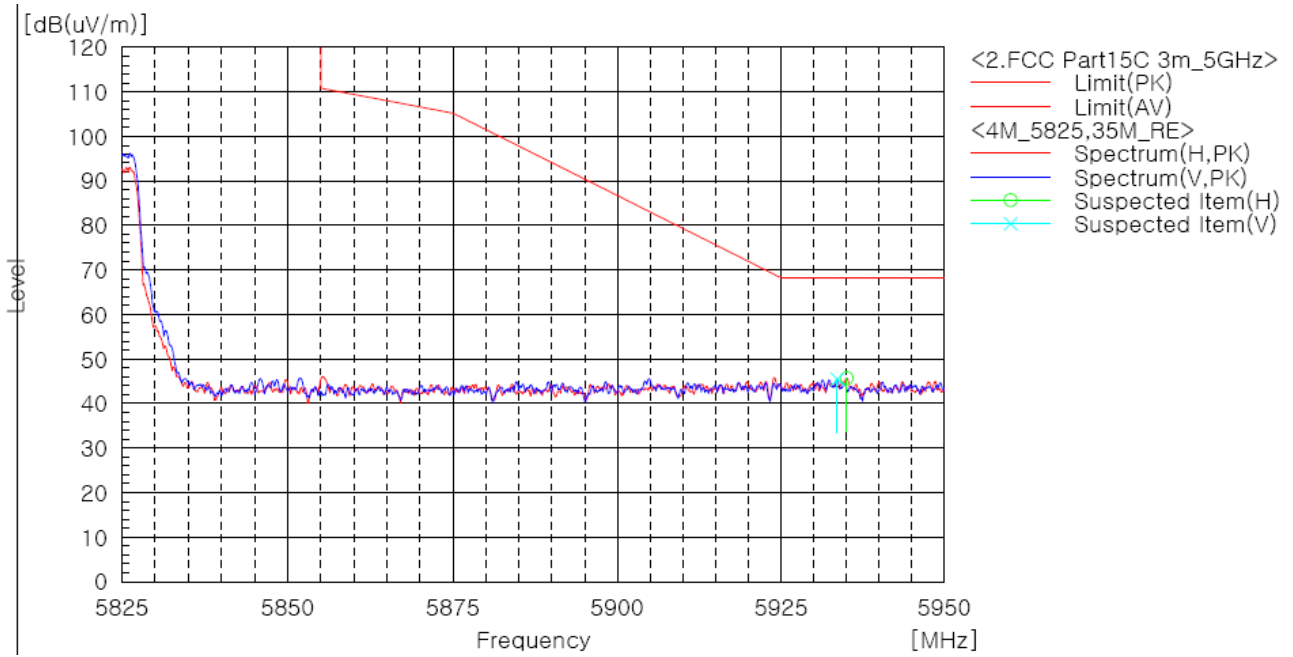
Radiated Restricted Lower Band Edge Plot



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (43) / (48)
 Pages

Worst Case Mode :	Digital Modulation_4MHz BW
Distance of Measurements :	3 Meters
Operating Frequency :	5 825.35 MHz



Radiated Restricted Upper Band Edge Plot



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (44) / (48)
Pages

Test mode : Receiver mode

Frequency [MHz]	(P)	Limit AV [dBuV/m]	Limit PK [dBuV/m]	Result AV [dBuV/m]	Result PK [dBuV/m]	Margin AV [dB]	Margin PK [dB]
--------------------	-----	-------------------------	-------------------------	--------------------------	--------------------------	----------------------	----------------------

No emissions were detected at a level greater than 20dB below limit.



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-02342
Page (45) / (48)
Pages

4.7 AC Conducted Emissions

Test Location

Shielded Room

Frequency Range of Measurement

150 kHz to 30 MHz

Instrument Settings

IF Band Width: 9 kHz

Test Procedures

The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m.

Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit

- 15.207(a)

Frequency (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 Results

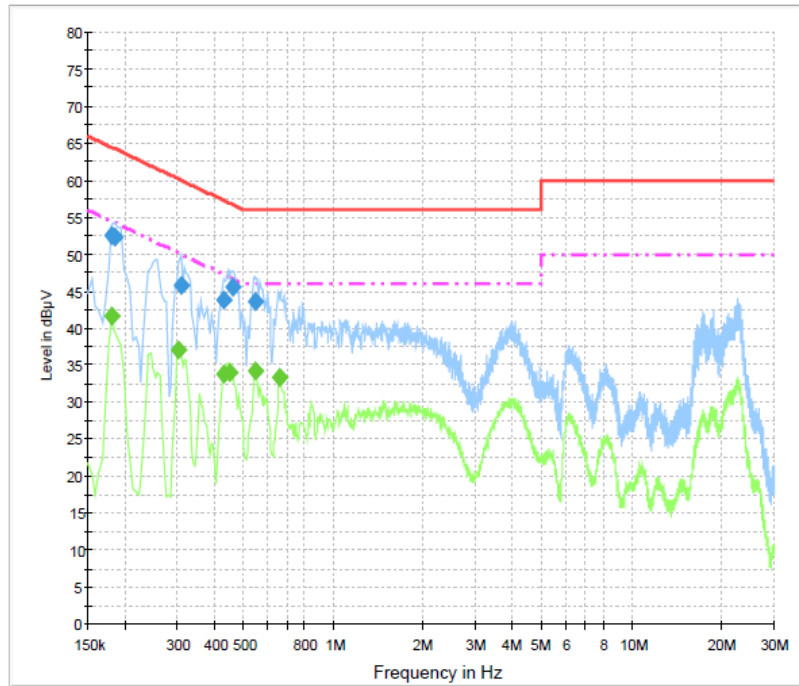
The requirements are:

Complies

Test Data

[LINE]

Class B_L1



Final Result 1

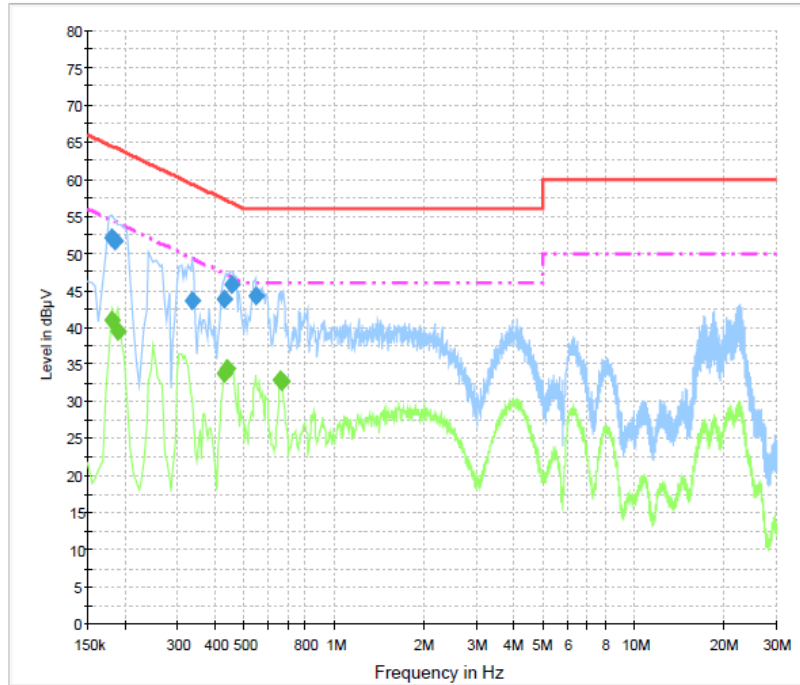
Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.181500	52.4	1000.0	9.000	On	L1	10.3	12.0	64.4
0.186000	52.3	1000.0	9.000	On	L1	10.2	12.0	64.2
0.307500	45.9	1000.0	9.000	On	L1	10.1	14.2	60.0
0.429000	43.9	1000.0	9.000	On	L1	10.1	13.4	57.3
0.460500	45.6	1000.0	9.000	On	L1	10.1	11.0	56.7
0.550500	43.7	1000.0	9.000	On	L1	10.2	12.3	56.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.181500	41.6	1000.0	9.000	On	L1	10.3	12.8	54.4
0.303000	37.0	1000.0	9.000	On	L1	10.1	13.2	50.2
0.429000	33.9	1000.0	9.000	On	L1	10.1	13.4	47.3
0.447000	34.0	1000.0	9.000	On	L1	10.1	12.9	46.9
0.546000	34.2	1000.0	9.000	On	L1	10.2	11.8	46.0
0.663000	33.4	1000.0	9.000	On	L1	10.2	12.6	46.0

[NEUTRAL]

Class B_N



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.181500	52.1	1000.0	9.000	On	N	10.6	12.3	64.4
0.186000	51.7	1000.0	9.000	On	N	10.5	12.5	64.2
0.334500	43.7	1000.0	9.000	On	N	10.4	15.6	59.3
0.429000	43.8	1000.0	9.000	On	N	10.5	13.4	57.3
0.456000	45.8	1000.0	9.000	On	N	10.5	11.0	56.8
0.546000	44.2	1000.0	9.000	On	N	10.6	11.8	56.0

Final Result 2

Frequency (MHz)	C Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.181500	41.0	1000.0	9.000	On	N	10.6	13.5	54.4
0.190500	39.4	1000.0	9.000	On	N	10.5	14.7	54.0
0.429000	33.7	1000.0	9.000	On	N	10.5	13.5	47.3
0.438000	34.5	1000.0	9.000	On	N	10.5	12.6	47.1
0.658500	32.9	1000.0	9.000	On	N	10.5	13.1	46.0
0.667500	32.7	1000.0	9.000	On	N	10.5	13.3	46.0



CTK Co., Ltd.
 (Ho-dong), 113, Yejik-ro, Cheoin-gu,
 Yongin-si, Gyeonggi-do, Korea
 Tel: +82-31-339-9970
 Fax: +82-31-624-9501

Report No.:
 CTK-2019-02342
 Page (48) / (48)
 Pages

APPENDIX A – Test Equipment Used For Tests

	Name of Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	Signal Analyzer	Agilent	N9020A	MY48011598	2018-10-25	2019-10-25
2	Signal Generator	Rohde & Schwarz	SMB100A	175528	2018-10-24	2019-10-24
3	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2018-10-25	2019-10-25
4	Bilog Antenna	Schaffner	CBL6111C	2551	2018-05-10	2020-05-10
5	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2018-05-27	2020-05-27
6	6dB Attenuator	R&S	DNF	272.4110.50-2	2018-10-25	2019-10-25
7	AMPLIFIER	SONOMA	310	291721	2019-01-28	2020-01-28
8	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2019-01-29	2020-01-29
9	Preamplifier	Agilent	8449B	3008A02011	2018-12-03	2019-12-03
10	Horn Antenna	ETS-Lindgren	3116	00062504	2017-12-04	2019-12-04
11	Horn Antenna	ETS-Lindgren	3117	00154525	2019-02-22	2021-02-22
12	Band Reject Filter	Micro Tronics	BRM50716	G184	2019-01-28	2020-01-28
13	LISN	Rohde & Schwarz	ENV216	101760	2019-01-29	2020-01-29
14	Singnal Canditioning Unit	R&S	SCU-40	10023	2018-10-24	2019-10-24
15	Temp&Humi Chamber	ESPEC CORP.	SH-241	92000872	2019-01-25	2020-01-25

	Cable	Manufacturer	Model No.	Serial No.	Check Date
1	RF Cable	Canare Corporation	L-5D2W	N/A	2018-12-19
2	RF Cable	Junkosha Inc.	MWX221	1510S087	2019-05-23
3	RF Cable	HUBER+SUHNER	SUCOFLEX 102	MY073/2	2018-12-19
4	RF Cable	HUBER+SUHNER	SUCOFLEX 102	MY4728/2	2018-12-19
5	RF Cable	HUBER+SUHNER	SUCOFLEX 104	MY27558/4	2018-12-19
6	RF Cable	HUBER+SUHNER	SUCOFLEX 104	N/A	2018-12-19
7	RF Cable	HUBER+SUHNER	SUCOFLEX 104	MY27573/4	2018-12-19
8	RF Cable	HUBER+SUHNER	SUCOFLEX 106	N/A	2018-12-19