

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-2020-00935
Page (1) / (39) Pages

1. Client

- Name : SOLUM CO.,LTD.
- Address : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
- Date of Receipt : 2020-02-04

2. Manufacturer

- Name #1 : SOLUM CO.,LTD.
- Address #1 : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
- Name #2 : SOLUM VINA CO., LTD
- Address #2 : Plot B3, Ba Thien 2 Industrial park, Thien Ke Ward, Binh Xuyen District, Vinh Phuc Province, 281200., People's Republic of Vietnam

3. Use of Report : For FCC Certification & Canadian Certification

4. Test Sample / Model : ESL Gateway / SLG-EP101S


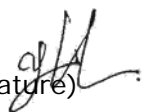
5. Date of Test : 2020-02-08 to 2020-02-25

6. Test Standard(method) used : FCC 47 CFR part 15 subpart C 15.247,
ANSI C63.10-2013,
RSS-247, RSS-Gen

7. Testing Environment : Temp.: (23 ± 1) °C, Humidity: (51 ± 3) % 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	Technical Manager
	Bong-seok Kim: (Signature) 	Young-taek Lee: (Signature) 

2020-02-25

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-2020-00935
Page (2) / (39) Pages

REPORT REVISION HISTORY

Date	Revision	Page No
2020-02-25	Issued (CTK-2020-00935)	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-2020-00935
Page (3) / (39) 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	6
3.3 Maximum Measurement Uncertainty	7
4. Technical Characteristic Test.....	8
4.1 6dB Bandwidth & 99% Bandwidth.....	8
4.2 Maximum peak Conducted Output Power	13
4.3 Power Spectral Density	16
4.4 Band Edge & Conducted Spurious emission.....	19
4.5 Radiated Emission	24
4.6 AC Power Line Conducted Emissions	34
APPENDIX A – Test Equipment Used For Tests	39



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-2020-00935
Page (4) / (39) Pages

1. General Product Description

1.1 Client Information

Company	SOLUM CO.,LTD.
Contact Point	4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
Contact Person	Name : YANG CHANG SOO E-mail : cs.yang@solu-m.com Tel : +82-31-8006-7650

1.2 Product Information

FCC ID	2AFWN-SLG-EP101S
IC	22800-SLGEP101S
Product Description	ESL Gateway
Model name	SLG-EP101S
Variant Model name	SLG-EN101S, SLG-ES101S (Variant models have no technical differences with each model except for the model name and color for marketing purposes.)
Operating Frequency	2 402 MHz - 2 480 MHz
RF Output Power	Antenna1 : 19.56 dBm (90.365 mW) Antenna 2: 19.87 dBm (97.051 mW) Antenna 3: 19.92 dBm (98.175 mW)
Antenna Specification	Antenna 1: Type(PCB Antenna), Peak Gain(3.4 dBi) Antenna 2: Type(PCB Antenna), Peak Gain(3.2 dBi) Antenna 3: Type(PCB Antenna), Peak Gain(3.4 dBi)
Number of channels	40
Channel Spacing	2 MHz
Type of Modulation	GFSK(BLE)
Power Source	DC 48 V(PoE), DC 5 V(Adaptor)
Firmware Version Id Number(FVIN)	V1.0
RF Power setting in Test SW	Initial value

1.3 Peripheral Devices

-For Conducted Measurement and Radiated Measurement

Device	Manufacturer	Model No.	Serial No.
Notebook	HP Inc.	HP Probook 650 G1	5CG5114K13
AC Adapter	HP Inc.	PPP012D-S	677777-003
PoE	NEXT NETWORK	NEXT-PEG4806JT	-
AC Adapter	SAMSUNG	ETA-U90KBK	DK4F528TS/B-E



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-2020-00935
Page (5) / (39) Pages

2. Facility and Accreditations

2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yong-in-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-2020-00935
 Page (6) / (39) Pages

3. Test Specifications

3.1 Standards

Section in FCC	Section in RSS	Requirement(s)	Status (Note 1)	Test Condition
15.247(a)	RSS-247 5.2(a)	6 dB Bandwidth	C	Conducted
15.247(e)	RSS-247 5.2(b)	Transmitter power spectral density	C	
15.247(b)	RSS-247 5.4(d)	Maximum peak conducted output power	C	
15.247(d)	RSS-247 5.5	Unwanted emission	C	
15.209	RSS-Gen 6.13	Transmitter emission	C	Radiated
15.207(a)	RSS-Gen 8.8	AC Conducted Emission	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.558074.				

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. All modulation modes were tests.
 The results are only attached worst cases.

Test Frequency

Lowest channel	Middle channel	Highest channel
2 402 MHz	2 440 MHz	2 480 MHz

Test antenna

Antenna 1	Antenna 2	Antenna 2
ANT1	ANT2	ANT3

Test mode

Modulation	Duty Cycle
ANT1, GFSK	86 %
ANT2, GFSK	86 %
ANT3, GFSK	86 %



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-2020-00935
Page (7) / (39) 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
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



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-2020-00935
Page (8) / (39) Pages

4. Technical Characteristic Test

4.1 6dB Bandwidth & 99% Bandwidth

Test Procedures(ANSI C63.10-2013 6.9.2)

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 Procedures(ANSI C63.10-2013 6.9.3)

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 = 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.

Limit :

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-2020-00935
Page (9) / (39) Pages

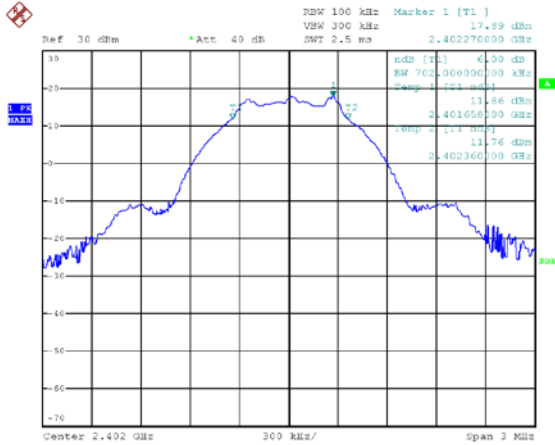
Test Data :

Mode	Channel	Frequency [MHz]	6 dB Bandwidth [MHz]	99 % Bandwidth [MHz]	Result
ANT1	Low	2 402	0.702	1.062	Complies
	Middle	2 440	0.696	1.062	
	High	2 480	0.702	1.062	
ANT2	Low	2 402	0.714	1.068	
	Middle	2 440	0.714	1.062	
	High	2 480	0.702	1.062	
ANT3	Low	2 402	0.702	1.056	
	Middle	2 440	0.702	1.062	
	High	2 480	0.696	1.062	

See next pages for actual measured spectrum plots.

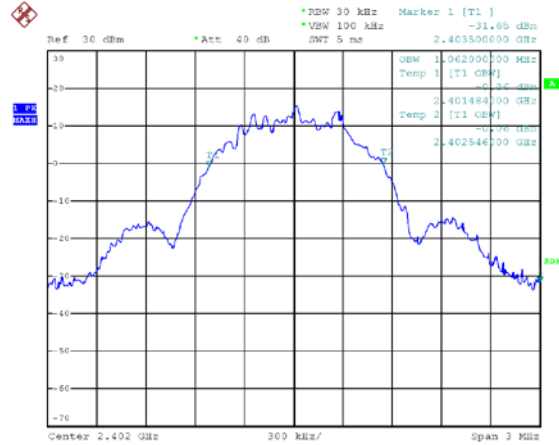
Test Mode : ANT1

6 dB Bandwidth[MHz]
Low channel



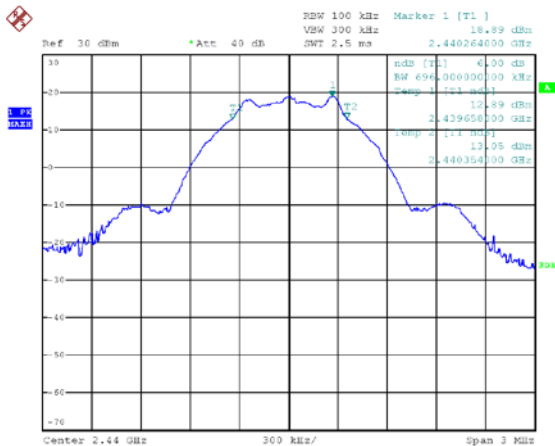
Date: 9.FEB.2020 19:30:50

99% Bandwidth[MHz]
Low channel



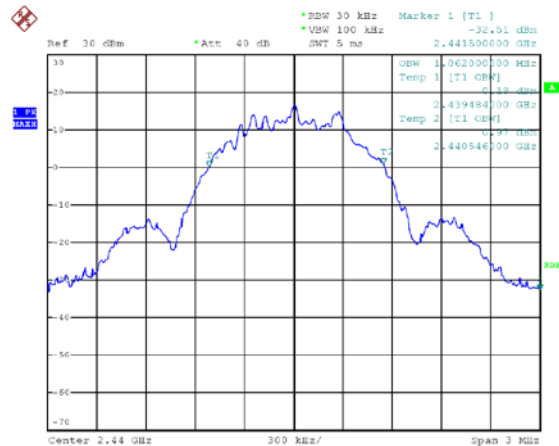
Date: 9.FEB.2020 19:31:04

Middle channel



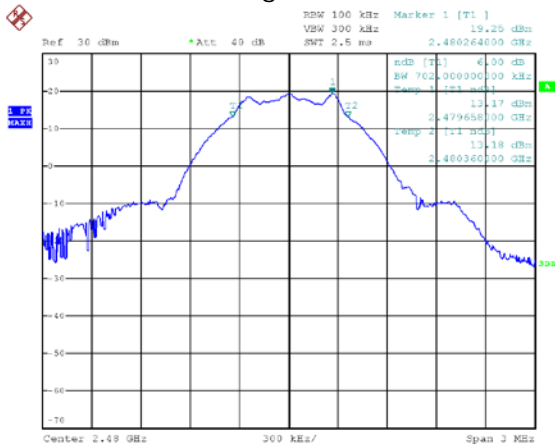
Date: 9.FEB.2020 19:33:27

Middle channel



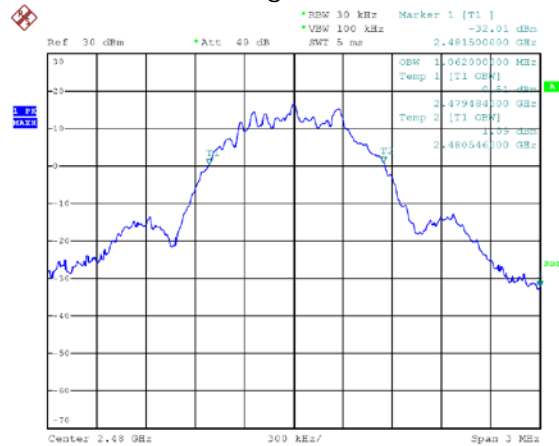
Date: 9.FEB.2020 19:33:41

High channel



Date: 9.FEB.2020 19:38:43

High channel

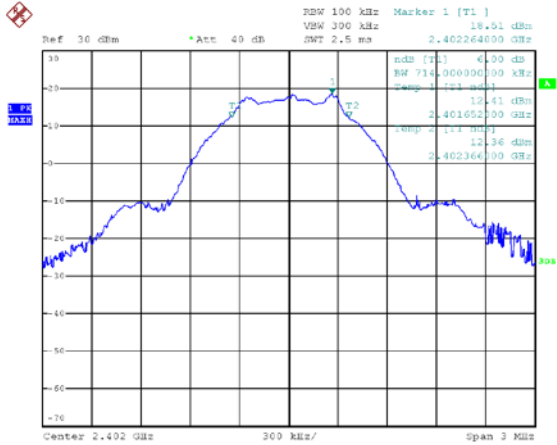


Date: 9.FEB.2020 19:38:57



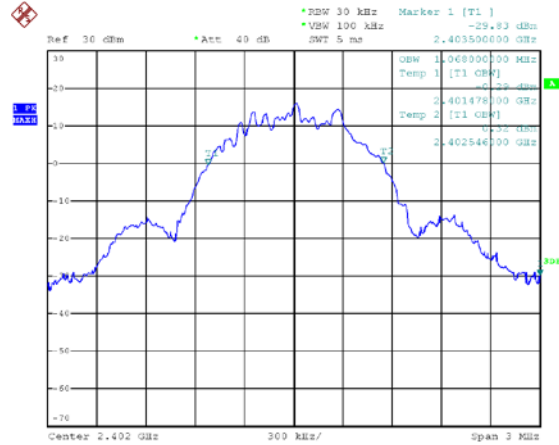
Test Mode : ANT2

6 dB Bandwidth[MHz]
 Low channel



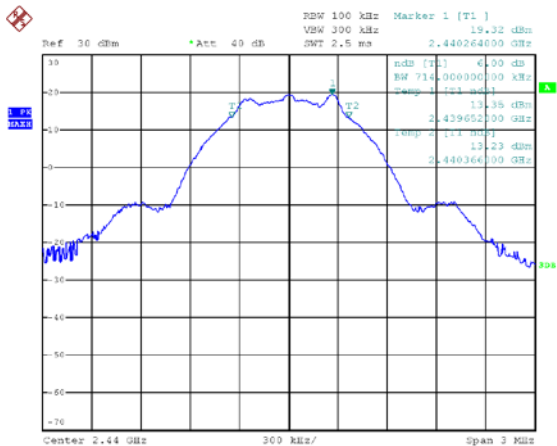
Date: 9.FEB.2020 19:43:53

99% Bandwidth[MHz]
 Low channel



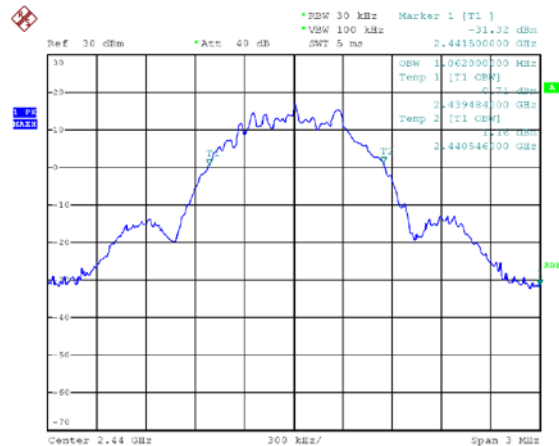
Date: 9.FEB.2020 19:44:07

Middle channel



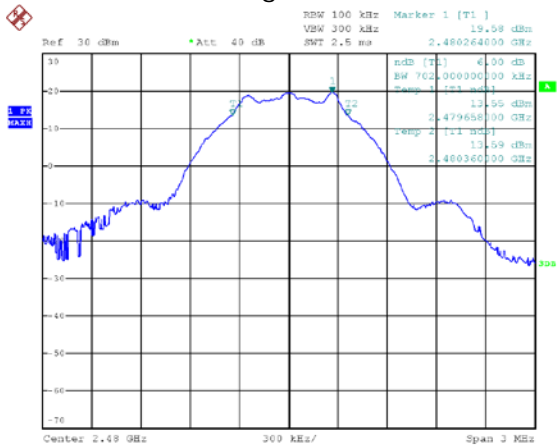
Date: 9.FEB.2020 19:46:52

Middle channel



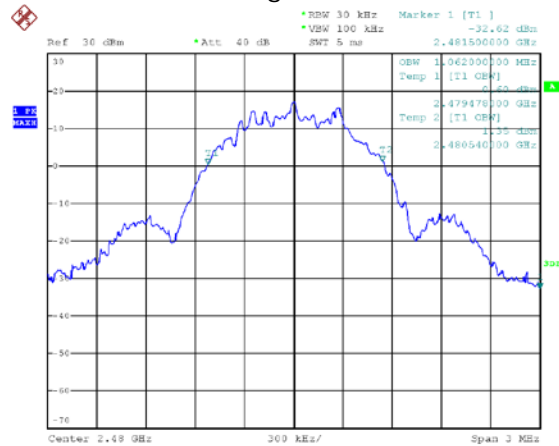
Date: 9.FEB.2020 19:47:06

High channel



Date: 9.FEB.2020 19:49:33

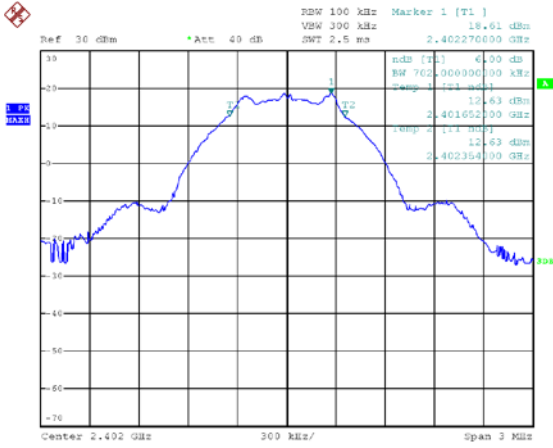
High channel



Date: 9.FEB.2020 19:49:47

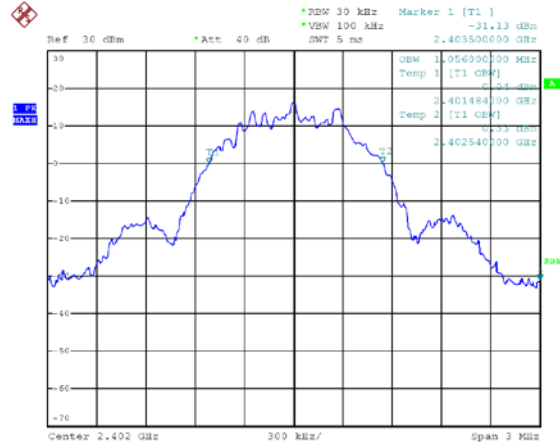
Test Mode : ANT3

6 dB Bandwidth[MHz]
Low channel



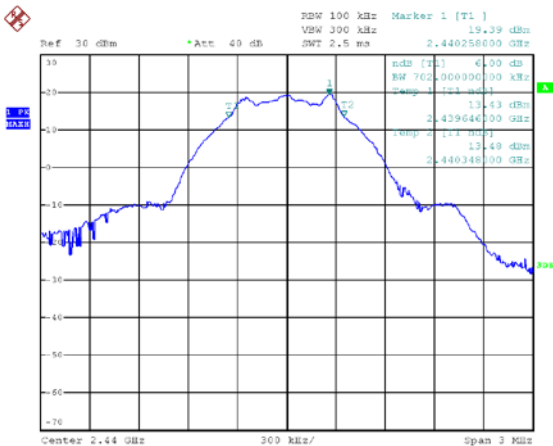
Date: 9.FEB.2020 19:54:50

99% Bandwidth[MHz]
Low channel



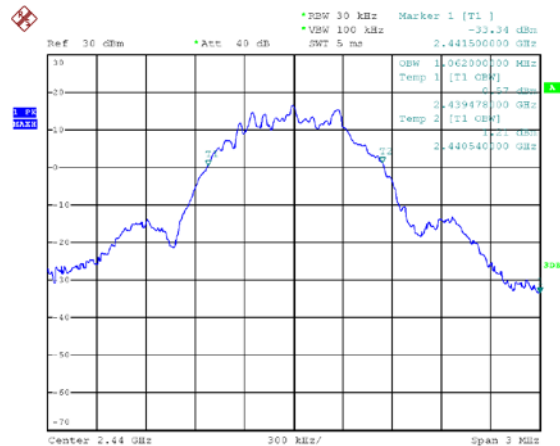
Date: 9.FEB.2020 19:55:12

Middle channel



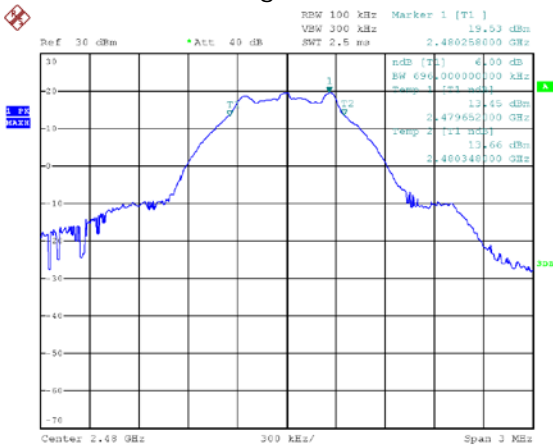
Date: 9.FEB.2020 19:57:42

Middle channel



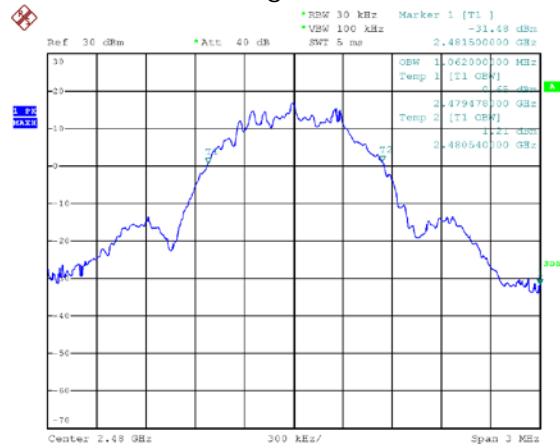
Date: 9.FEB.2020 19:57:56

High channel



Date: 9.FEB.2020 20:00:26

High channel



Date: 9.FEB.2020 20:00:40



4.2 Maximum peak Conducted Output Power

Test Procedures(ANSI C63.10-2013 11.9.1)

The following procedure can be used when the maximum available RBW of the instrument is less than the DTS bandwidth:

Test Settings:

Center frequency = the highest, middle and the lowest channels

- a) RBW \geq DTS Bandwidth
- b) VBW \geq 3 x RBW
- c) span \geq 3 x RBW
- d) Sweep time = auto couple
- e) Detector = peak
- f) Trace mode= max hold
- g) Allow trace to fully stabilize
- h) Use peak marker function to determine the peak amplitude level.

Limit :

Maximum Output Power < 1 W (30 dBm)

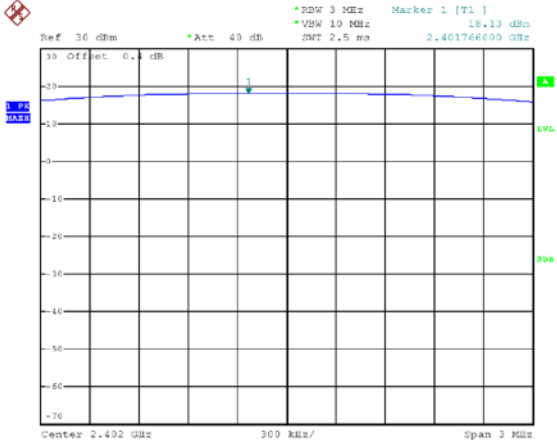
Test Data :

Mode	Channel	Frequency [MHz]	Measurement data [dBm]	Limit [dBm]	Result
ANT1	Low	2 402	18.13	30	Complies
	Middle	2 440	19.13		
	High	2 480	19.56		
ANT2	Low	2 402	18.71		
	Middle	2 440	19.59		
	High	2 480	19.87		
ANT3	Low	2 402	18.98		
	Middle	2 440	19.68		
	High	2 480	19.87		

See next pages for actual measured spectrum plots.

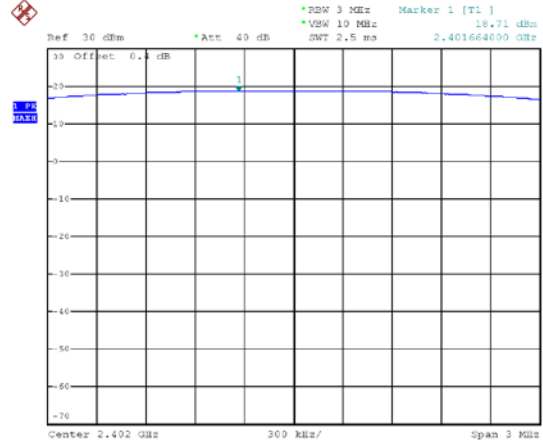
Output Power

Test Mode : ANT1
Low channel



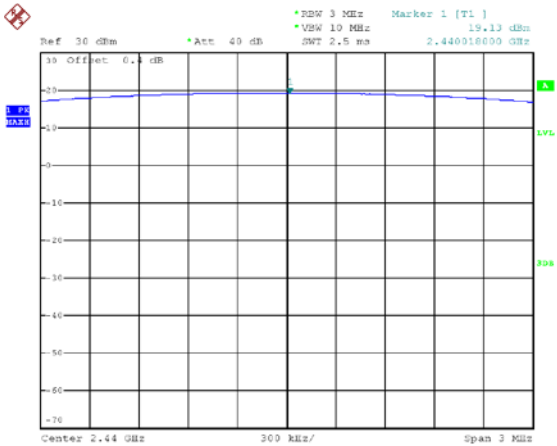
Date: 9.FEB.2020 19:30:19

Test Mode : ANT2
Low channel



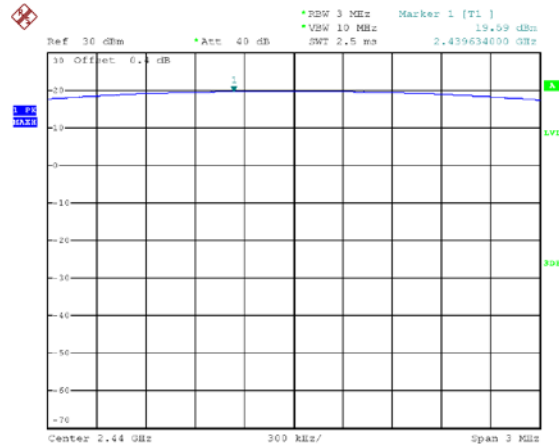
Date: 9.FEB.2020 19:43:22

Middle channel



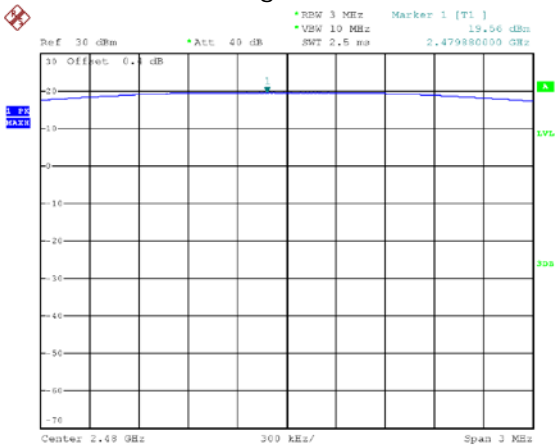
Date: 9.FEB.2020 19:32:56

Middle channel



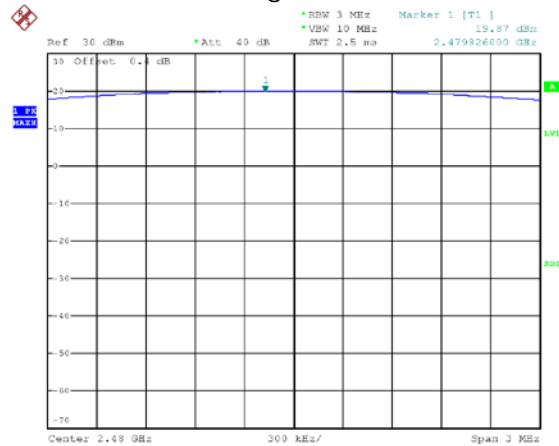
Date: 9.FEB.2020 19:46:21

High channel



Date: 9.FEB.2020 19:38:12

High channel



Date: 9.FEB.2020 19:49:02

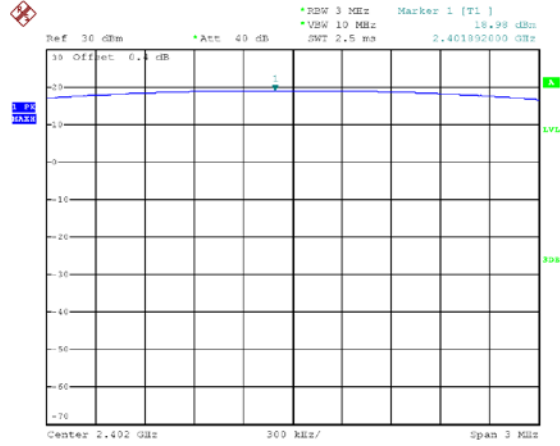


CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2020-00935
Page (15) / (39) Pages

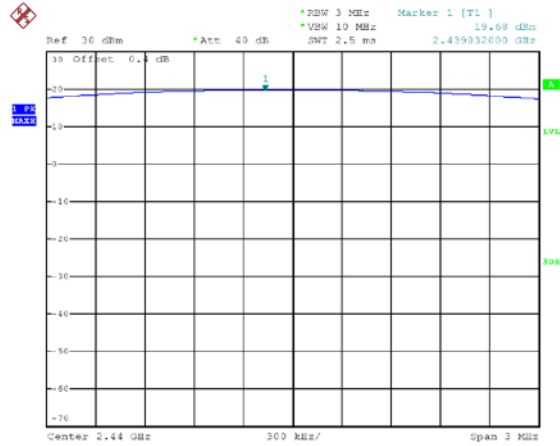
Test Mode : ANT3

Low channel



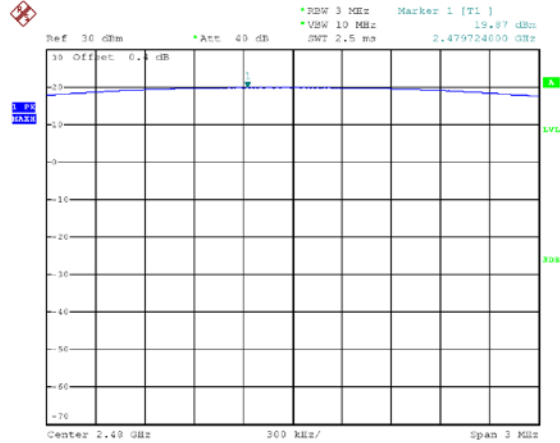
Date: 9.FEB.2020 19:54:27

Middle channel



Date: 9.FEB.2020 19:57:11

High channel



Date: 9.FEB.2020 19:59:55

4.3 Power Spectral Density

Test Procedures(ANSI C63.10-2013 11.10.2)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance.

Test Settings:

Center frequency = the highest, middle and the lowest channels

- a) RBW : $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$
- b) VBW $\geq 3 \times \text{RBW}$
- c) span $\geq 1.5 \times \text{DTS bandwidth}$
- d) Sweep time = auto couple
- e) Detector = peak
- f) Trace mode= max hold
- g) Allow trace to fully stabilize
- h) Use the peak marker function to determine the maximum amplitude level within the RBW.

Limit :

Power Spectral Density < 8 dBm @ 3 kHz BW

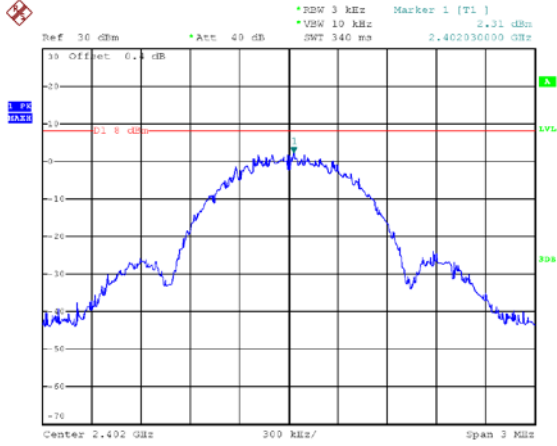
Test Data :

Mode	Channel	Frequency [MHz]	Measurement data [dBm]	Limit [dBm]	Result
ANT1	Low	2 402	2.31	8	Complies
	Middle	2 440	3.29		
	High	2 480	3.30		
ANT2	Low	2 402	3.07		
	Middle	2 440	3.96		
	High	2 480	4.39		
ANT3	Low	2 402	3.33		
	Middle	2 440	4.17		
	High	2 480	3.52		

See next pages for actual measured spectrum plots.

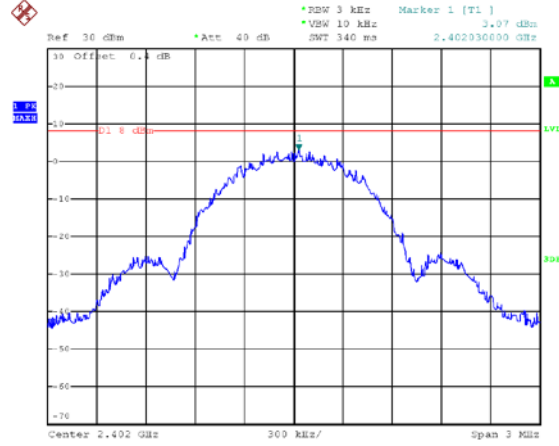
Power Spectral Density

Test Mode : ANT1
Low channel



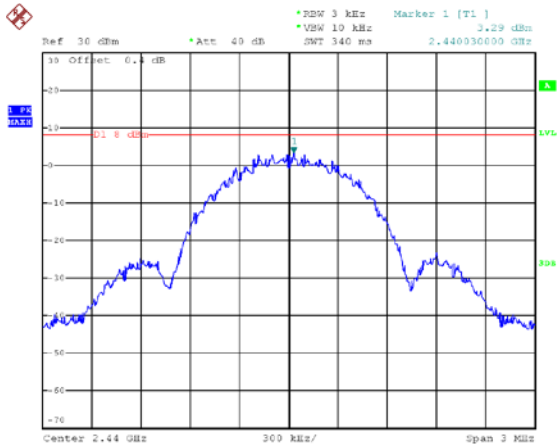
Date: 9.FEB.2020 19:30:36

Test Mode : ANT2
Low channel



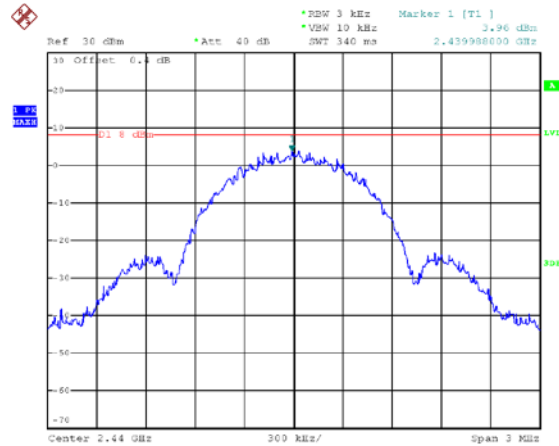
Date: 9.FEB.2020 19:43:39

Middle channel



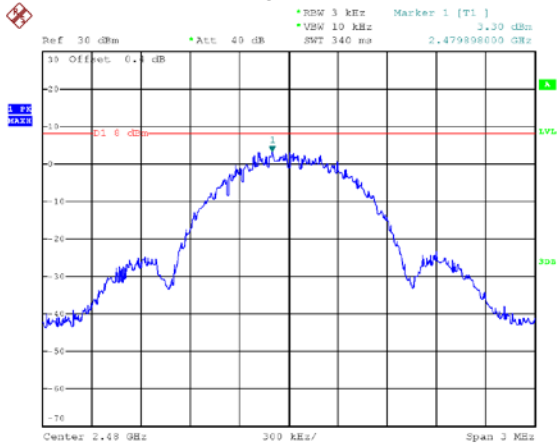
Date: 9.FEB.2020 19:33:13

Middle channel



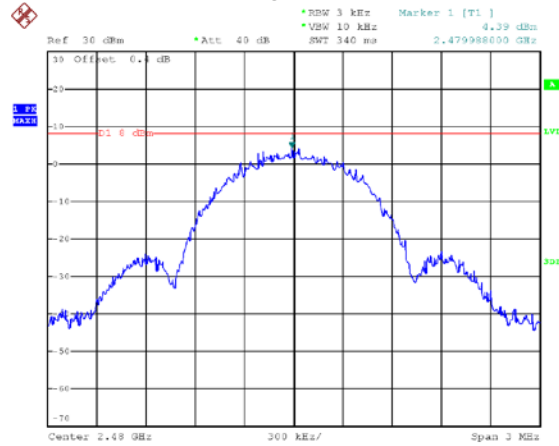
Date: 9.FEB.2020 19:46:38

High channel



Date: 9.FEB.2020 19:38:29

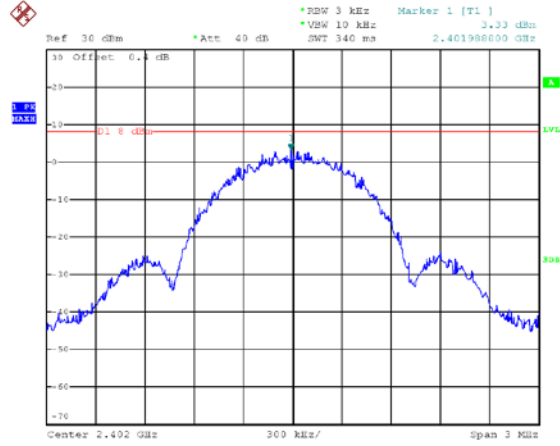
High channel



Date: 9.FEB.2020 19:49:19

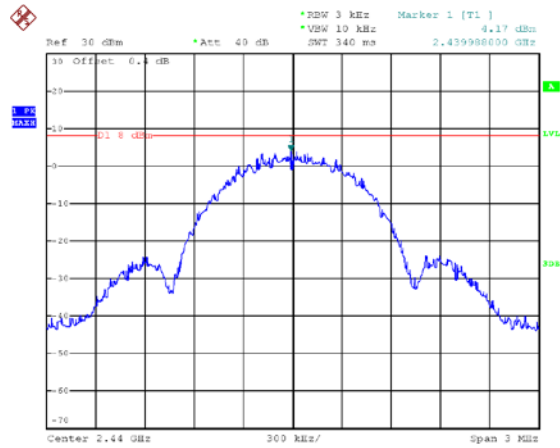
Test Mode : ANT3

Low channel



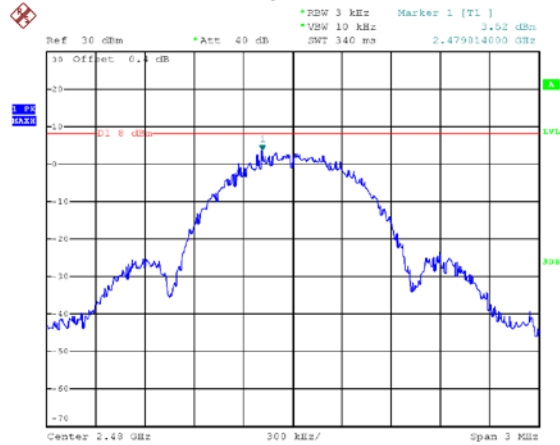
Date: 9.FEB.2020 19:54:44

Middle channel



Date: 9.FEB.2020 19:57:20

High channel



Date: 9.FEB.2020 20:00:12



4.4 Band Edge & Conducted Spurious emission

Test Procedures(ANSI C63.10-2013 11.11.3)

The Unwanted emission from the EUT were measured according to the dictates PKPSD measurement procedure in section 11.11 of ANSI C63.10-2013.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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) Sweep time = auto couple
- e) Trace mode= max hold
- f) Allow trace to fully stabilize
- g) Use the peak marker function to determine the maximum amplitude level.

Limit :

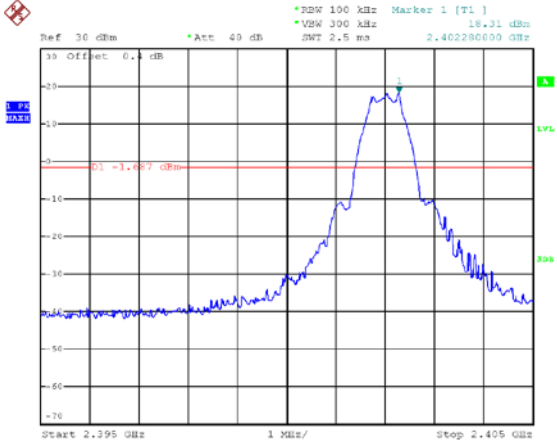
Emission level < 20 dBc

Test results: Complies

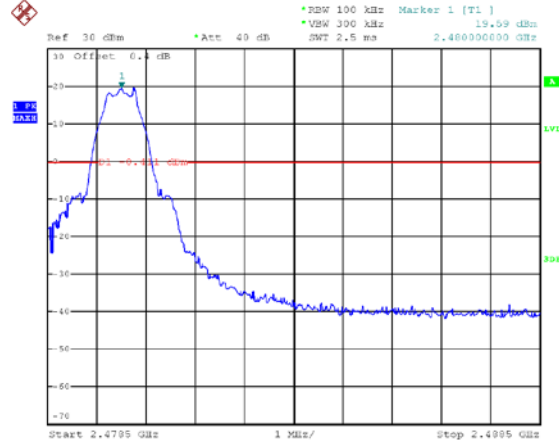
- All conducted emission in any 100kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest in-band spectral density. Therefore the applying equipment meets the requirement.

See next pages for actual measured spectrum plots.

**Conducted Band-Edge
Test Mode : ANT1**

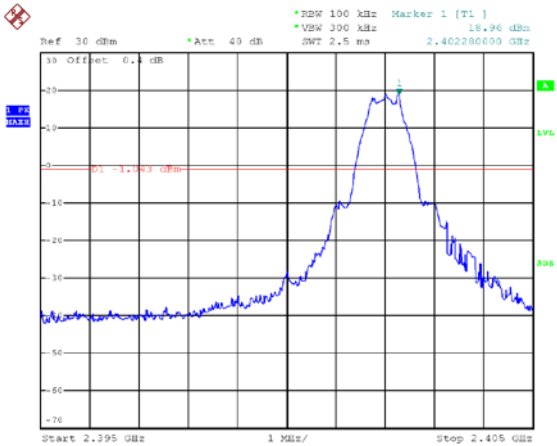


Date: 9.FEB.2020 19:31:50

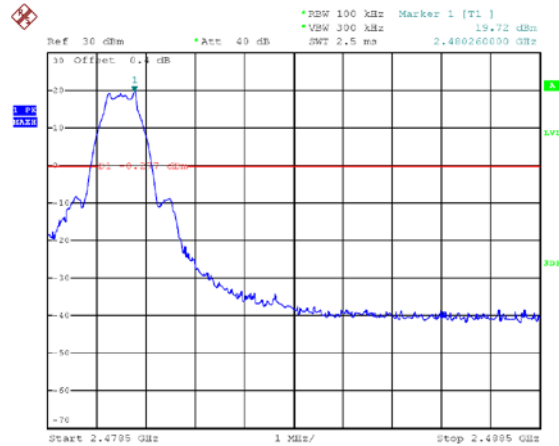


Date: 9.FEB.2020 19:39:43

Test Mode : ANT2

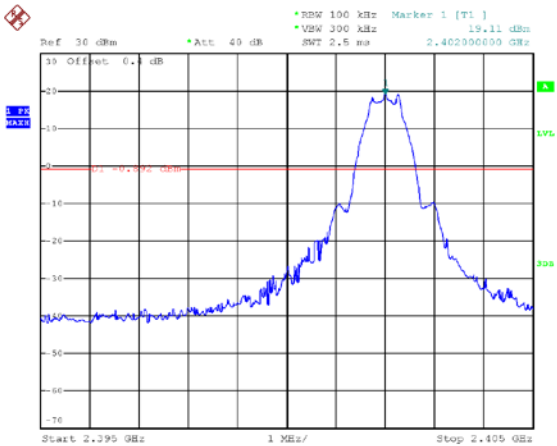


Date: 9.FEB.2020 19:44:53

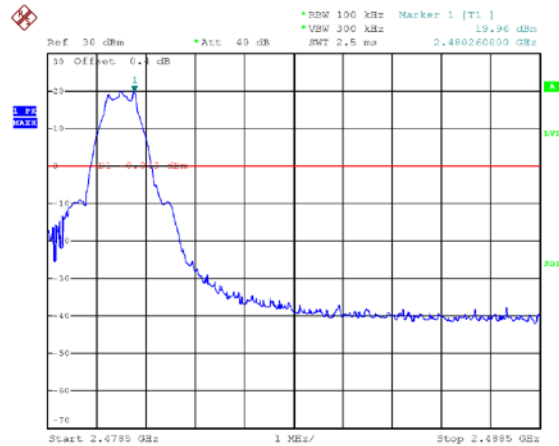


Date: 9.FEB.2020 19:50:33

Test Mode : ANT3



Date: 9.FEB.2020 19:55:58

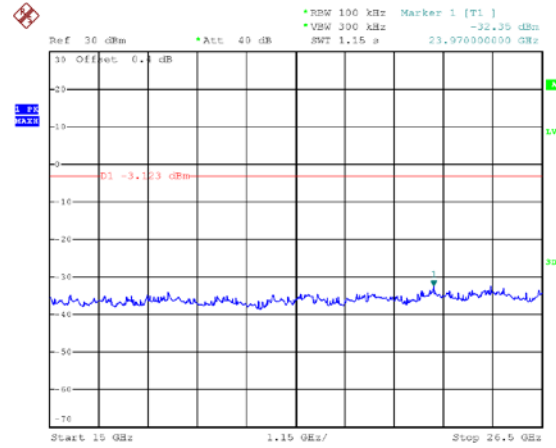
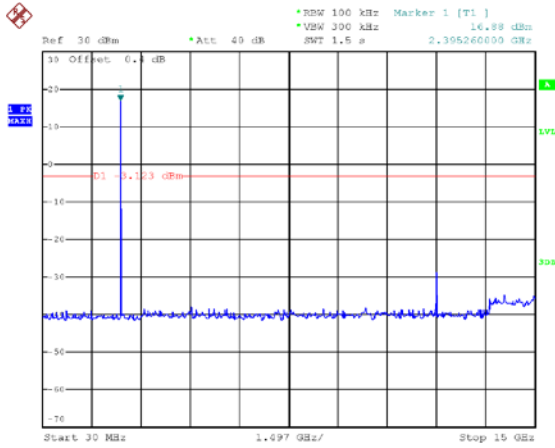


Date: 9.FEB.2020 20:01:26



Conducted Spurious Emission
Test Mode : ANT1

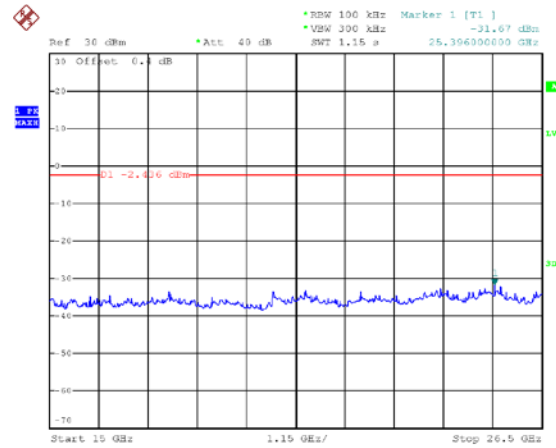
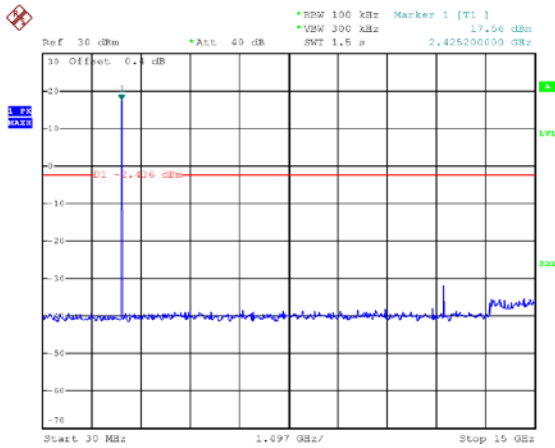
Low channel



Date: 9.FEB.2020 19:31:20

Date: 9.FEB.2020 19:31:34

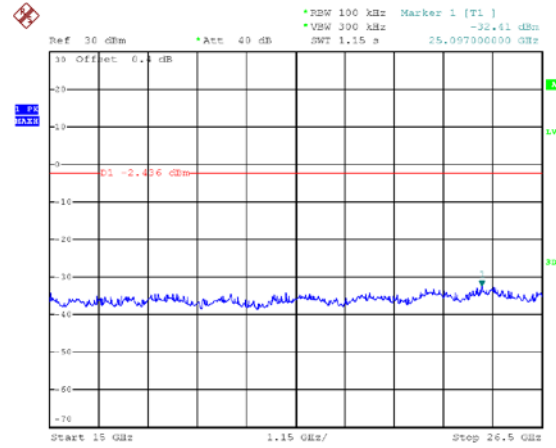
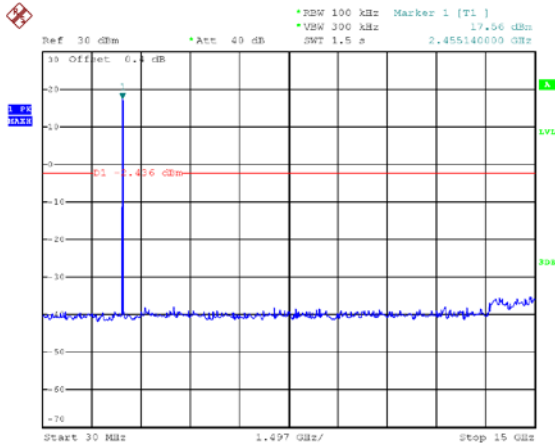
Middle channel



Date: 9.FEB.2020 19:33:57

Date: 9.FEB.2020 19:34:11

High channel

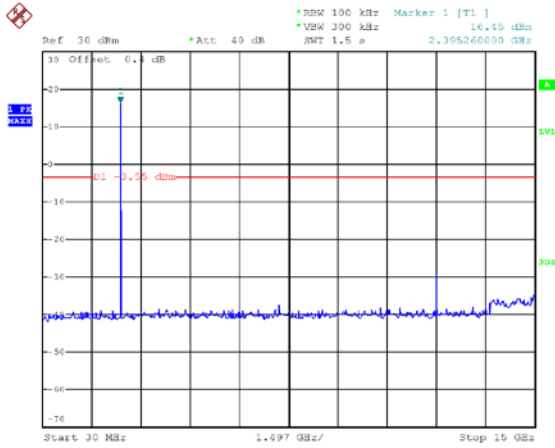


Date: 9.FEB.2020 19:39:13

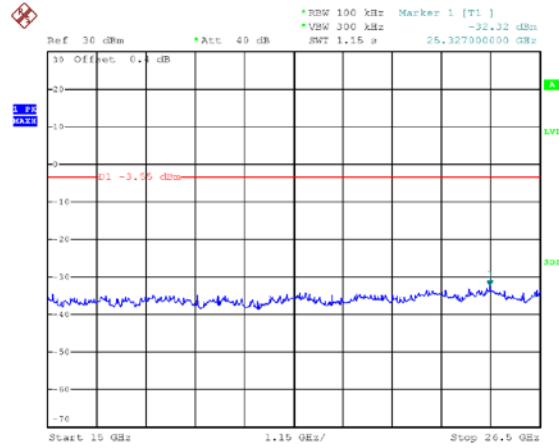
Date: 9.FEB.2020 19:39:27

Conducted Spurious Emission Test Mode : ANT2

Low channel

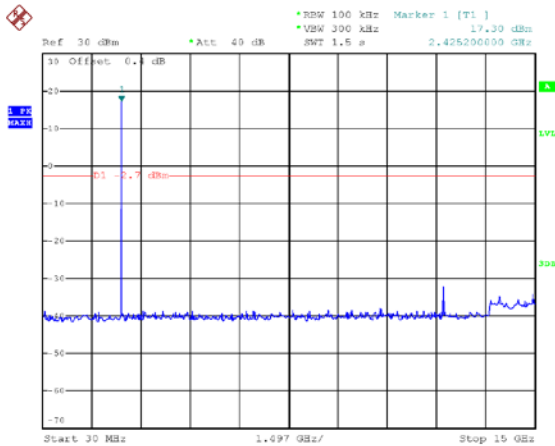


Date: 9.FEB.2020 19:44:23

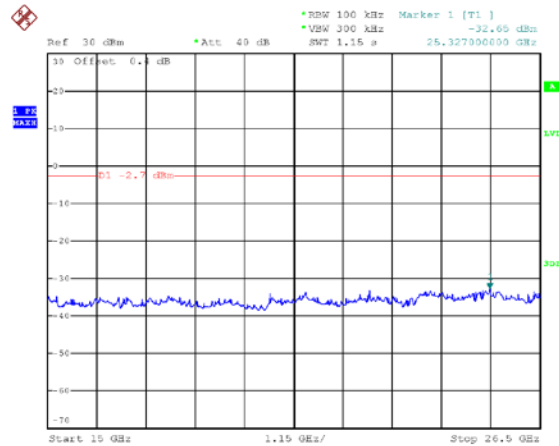


Date: 9.FEB.2020 19:44:37

Middle channel

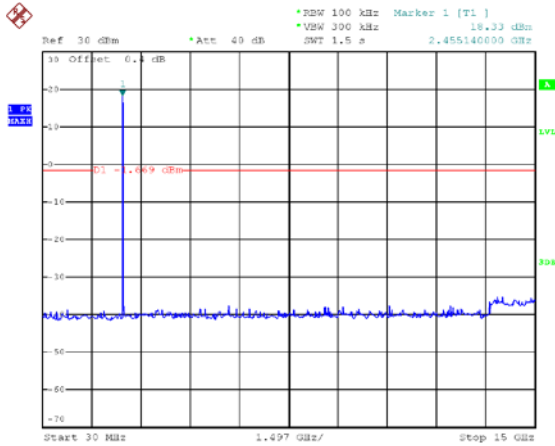


Date: 9.FEB.2020 19:47:22

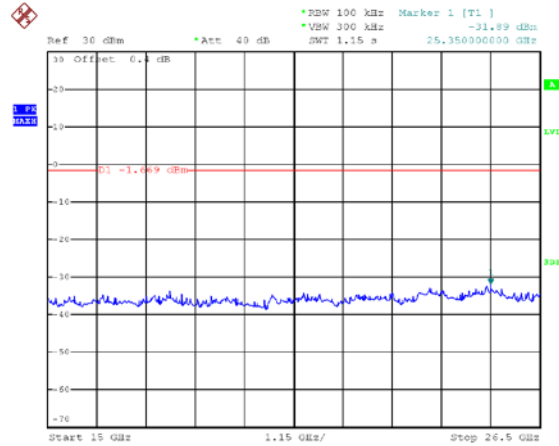


Date: 9.FEB.2020 19:47:36

High channel



Date: 9.FEB.2020 19:50:03

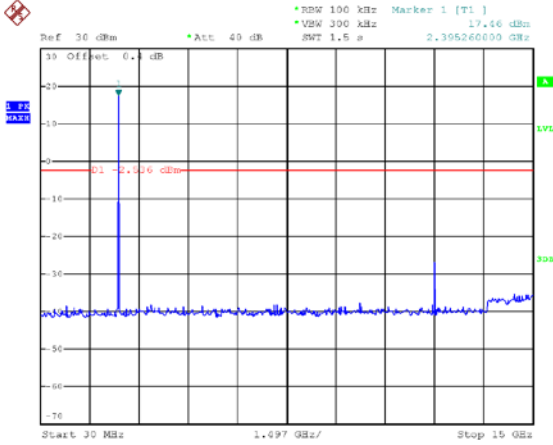


Date: 9.FEB.2020 19:50:17

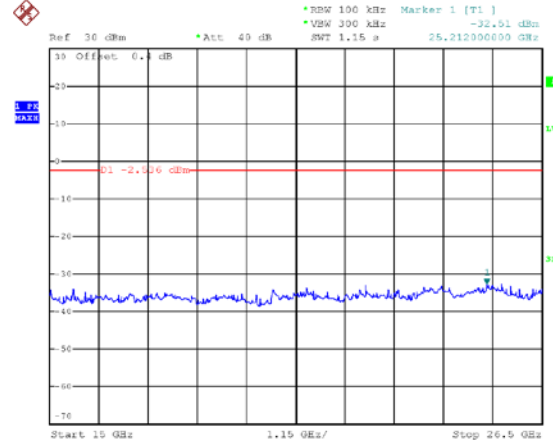


Conducted Spurious Emission Test Mode : ANT3

Low channel

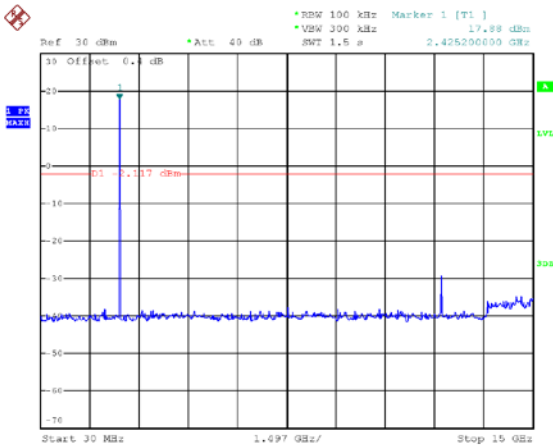


Date: 9.FEB.2020 19:55:28

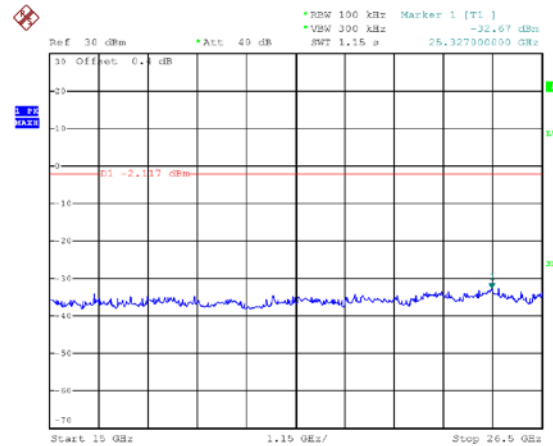


Date: 9.FEB.2020 19:55:42

Middle channel

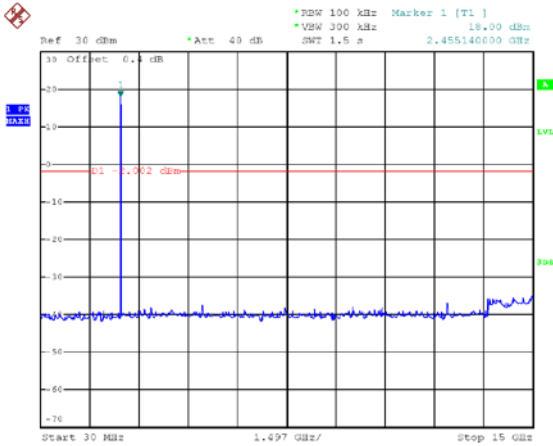


Date: 9.FEB.2020 19:58:12

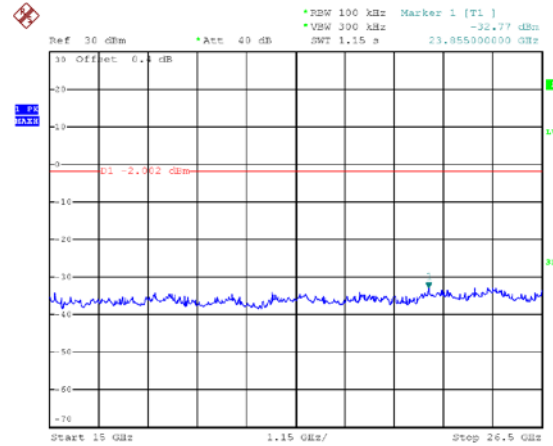


Date: 9.FEB.2020 19:58:26

High channel



Date: 9.FEB.2020 20:00:56



Date: 9.FEB.2020 20:01:10



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-2020-00935
Page (24) / (39) Pages

4.5 Radiated Emission

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 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.

Instrument Settings

Frequency Range = 9 kHz ~ 25 GHz (2.4 GHz 10th harmonic)

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



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-2020-00935
 Page (25) / (39) Pages

Limit :

FCC Part 15 § 15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

Table 1. Restricted Frequency Bands

MHz	MHz	MHz	MHz	MHz	GHz
0.09-0.11	8.37626-8.38675	73-74.6	399.9-410	2690-2900	10.6-12.7
¹ 0.495-0.505	8.41425-8.41475	74.8-75.2	608-614	3260-3267	13.25-13.4
2.1735-2.1905	12.29-12.293	108-121.94	960-1240	3332-3339	14.47-14.5
4.125-4.128	12.51975-12.52025	123-138	1300-1427	3345.8-3358	15.35-16.2
4.17725-4.17775	12.57675-12.57725	149.9-150.05	1435-1626.5	3600-4400	17.7-21.4
4.20725-4.20775	13.36-13.41	156.52475-156.52525	1645.5-1646.5	4500-5150	22.01-23.12
6.215-6.218	16.42-16.423	156.7-156.9	1660-1710	5350-5460	23.6-24
6.26775-6.26825	16.69475-16.69525	162.0125-167.17	1718.8-1722.2	7250-7750	31.2-31.8
6.31175-6.31225	16.80425-16.80475	167.72-173.2	2200-2300	8025-8500	36.43-36.5
8.291-8.294	25.5-25.67	240-285	2310-2390	9000-9200	² Above 38.6
8.362-8.366	37.5-38.25	322-335.4	2483.5-2500	9300-9500	

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

§ 15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.



FCC Part 15 § 15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 2. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 2. General Field Strength Limits for Licence-Exempt Transmitters

Frequency(MHz)	Field Strength uV/m	Field Strength dBuV/m	Measurement 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

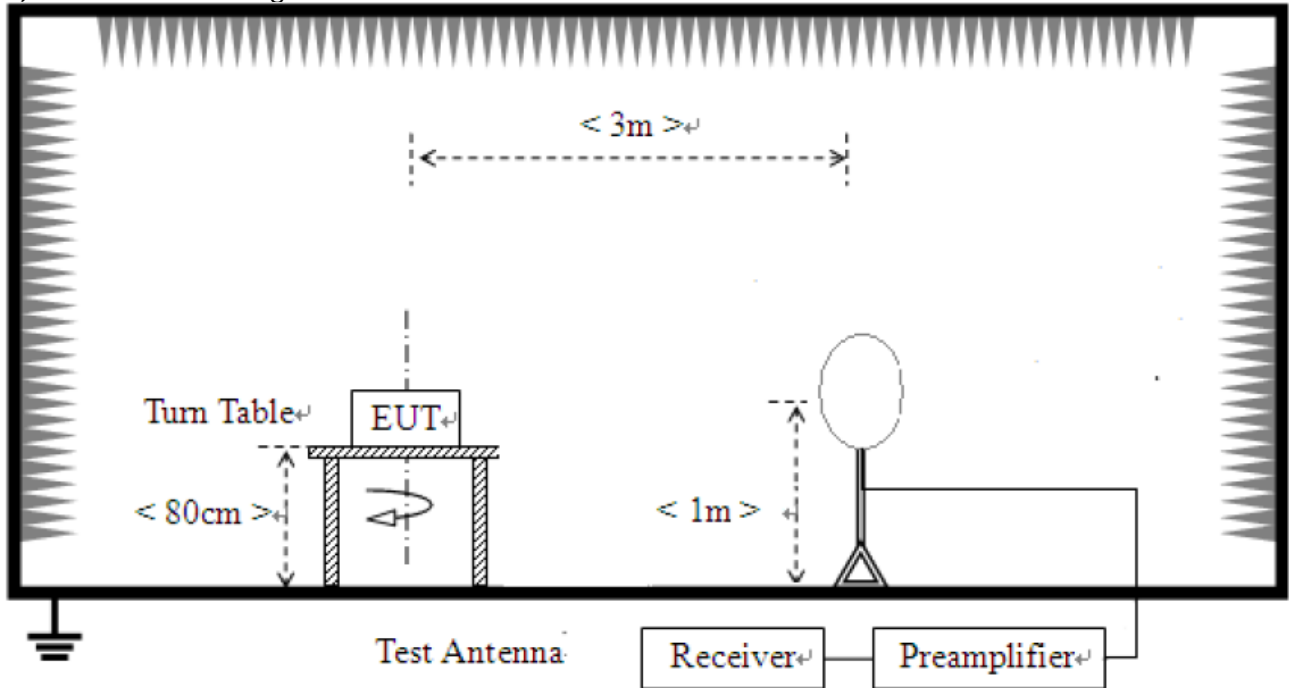
** Except as provided in 15.209(g).fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231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

Note :

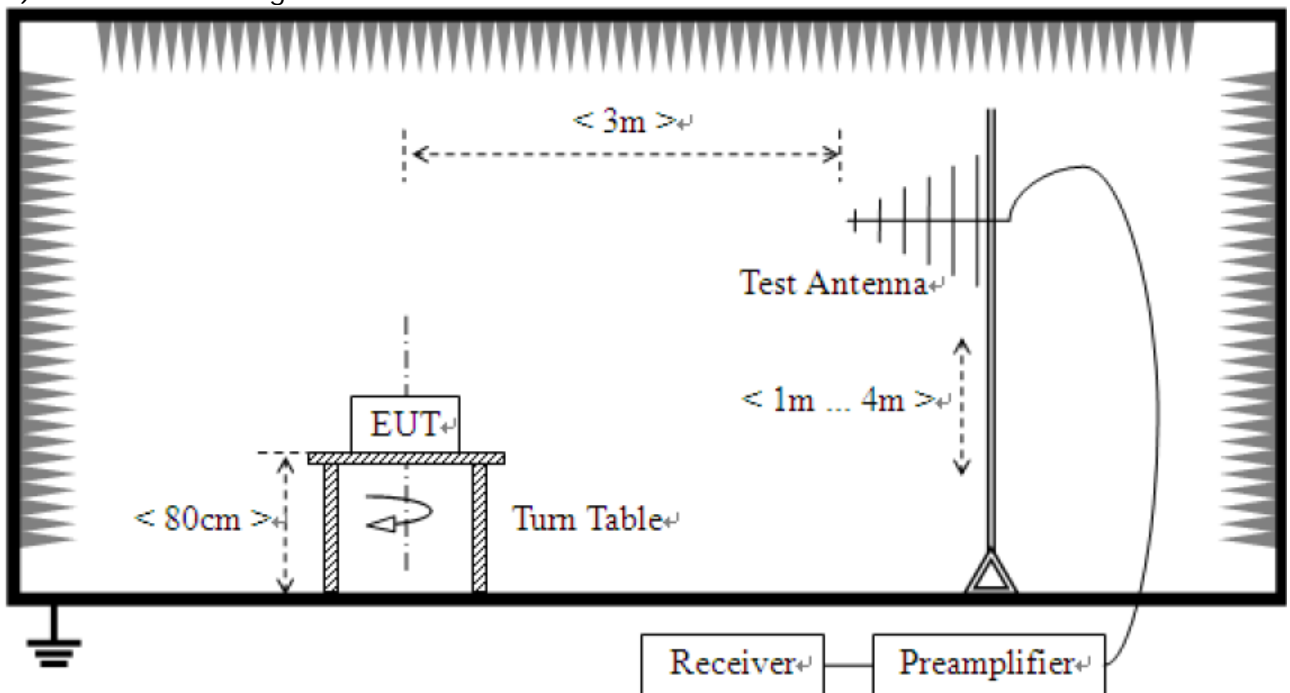
- 1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
- 2) For above 1 GHz, limit field strength of harmonics : 54 dBuV/m (AV) and 74 dBuV/m (PK)

Test Setup:

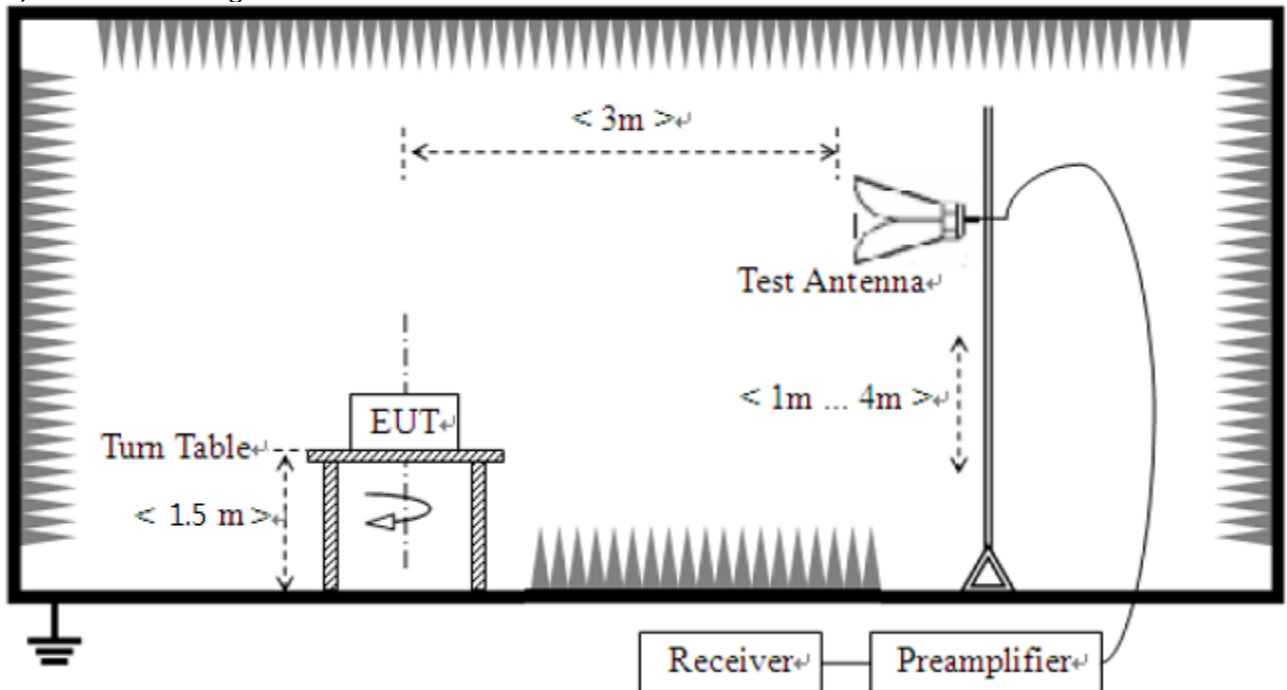
- 1) For field strength of emissions from 9 kHz to 30 MHz



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



3) For field strength of emissions above 1 GHz

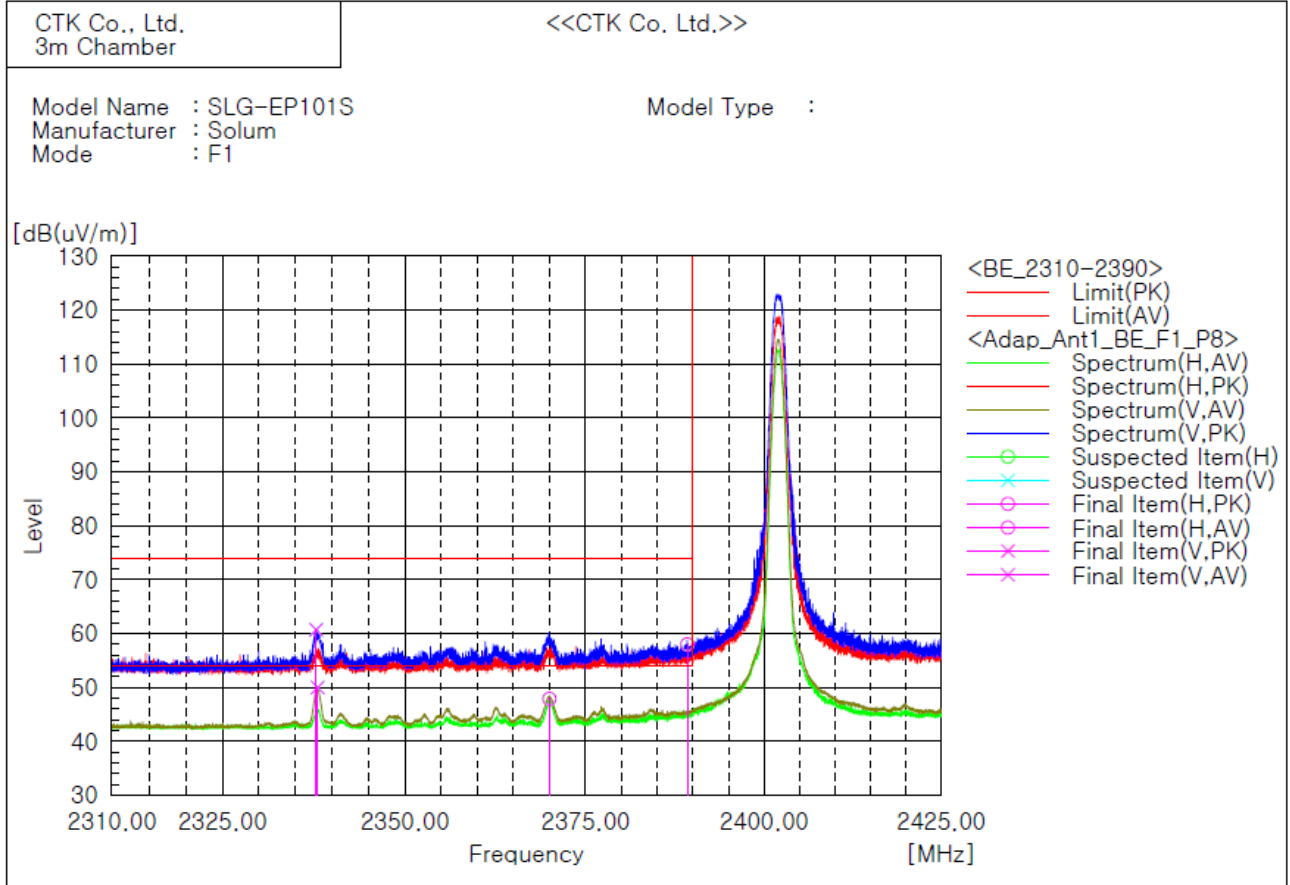


Test results

1) Restricted Frequency Bands

1. 2 310 MHz to 2 390 MHz

Test mode : Adaptor, ANT3(Worst case)

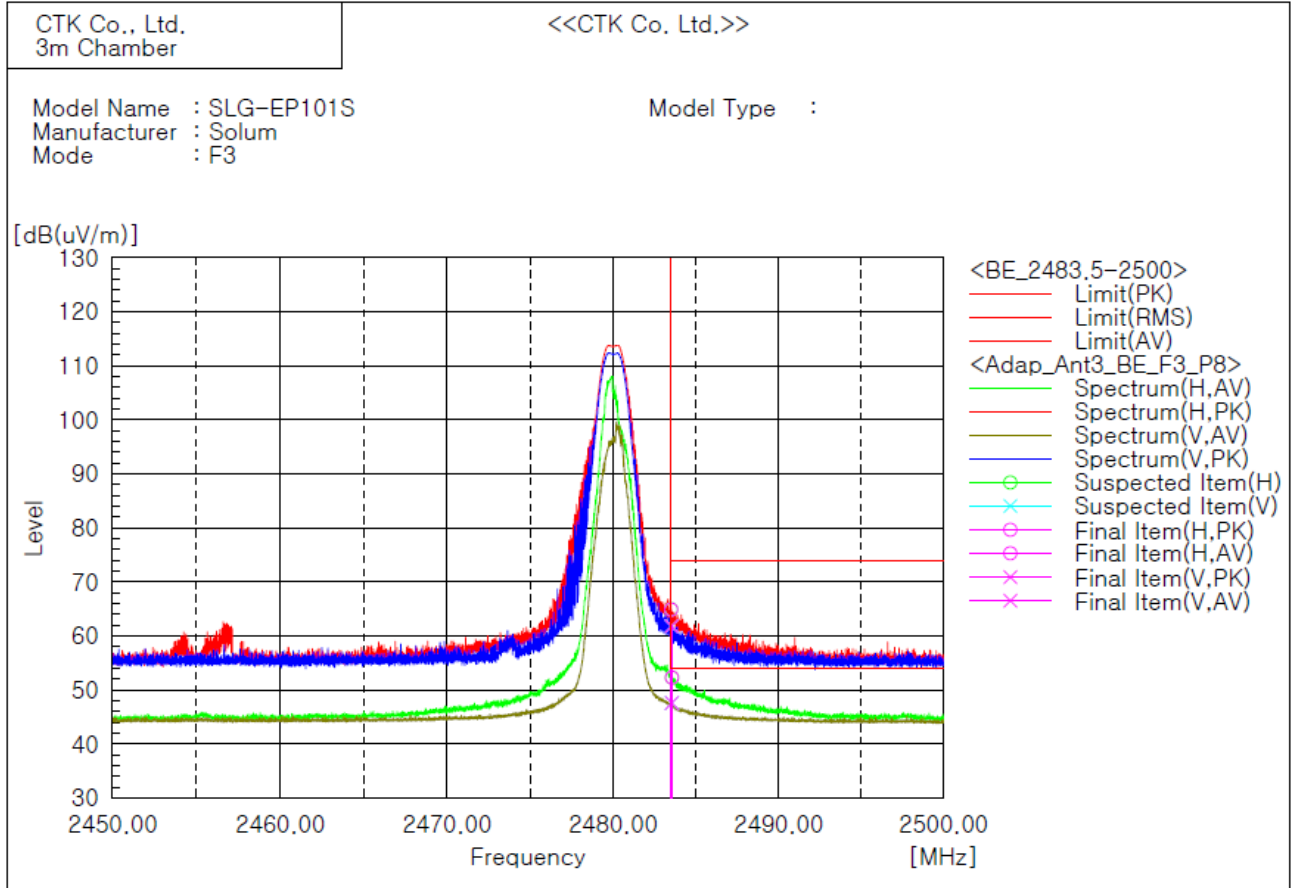


Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(uV)]	Reading AV [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Result AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [deg]
1	2338.031	V	45.0	5.0	5.0	50.0	74.0	74.0	54.0	4.0	235.2	95.4	
2	2337.816	V	55.7	5.0	5.0	60.7	74.0	74.0	54.0	13.3	235.2	207.9	
3	2370.001	H	42.8	5.1	5.1	47.9	74.0	74.0	54.0	6.1	464.0	0.1	
4	2389.221	H	52.7	5.3	5.3	58.0	74.0	74.0	54.0	16.0	464.0	0.1	

2. 2 483.5 MHz – 2 500 MHz

Test mode : Adaptor, ANT2(Worst case)



Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(uV)]	Reading AV [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Result AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [deg]
1	2483.506	H	58.1		6.8	64.9		74.0	54.0	9.1		464.1	0.1
2	2483.556	H		45.5	6.8		52.3	74.0	54.0		1.7	464.1	0.1
3	2483.531	V	55.0		6.8	61.8		74.0	54.0	12.2		464.2	35.3
4	2483.550	V		40.8	6.8		47.6	74.0	54.0		6.4	234.7	278.8

Remark :

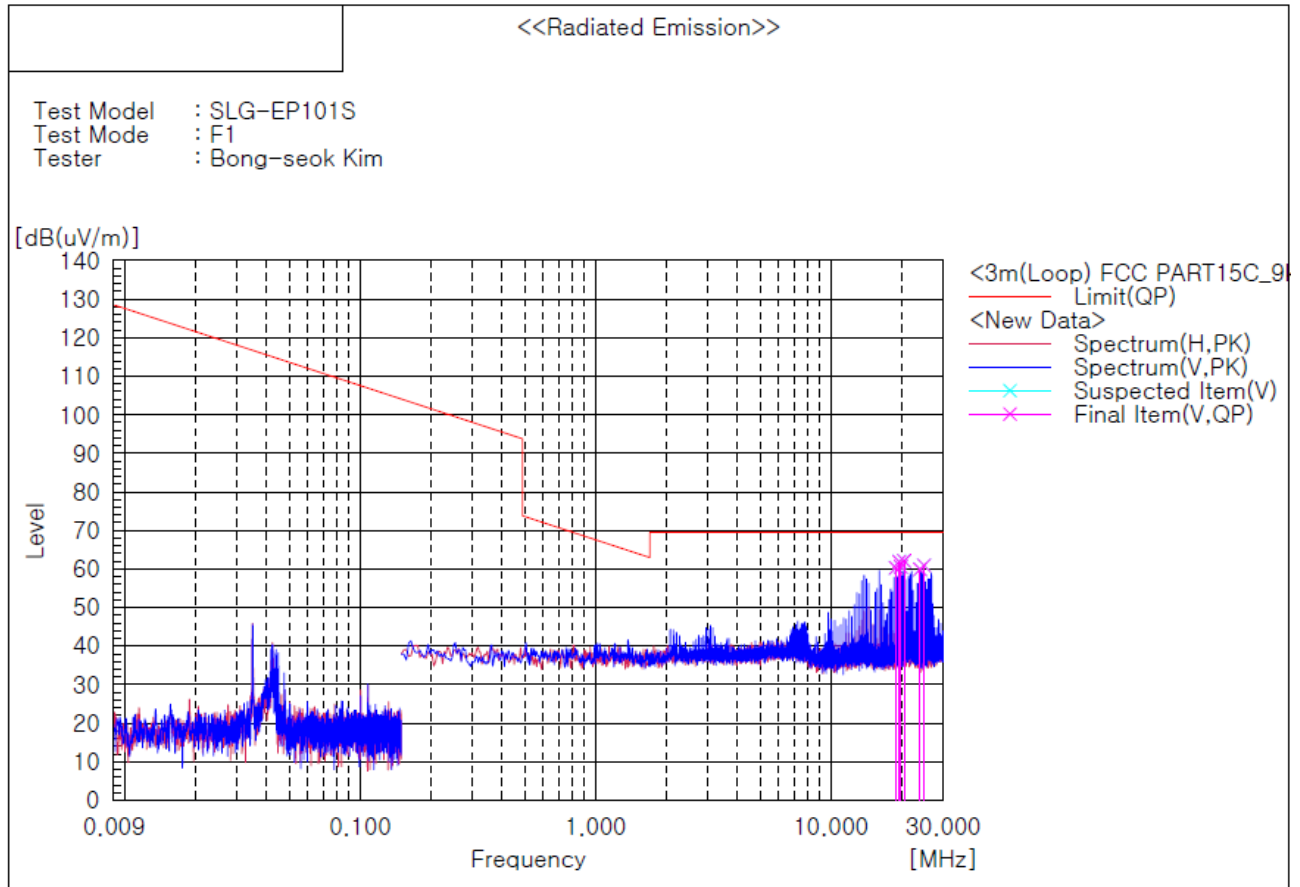
1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + c.f(correction factor)
3. Correction factor = Antenna factor +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

2) Spurious
1. 9 kHz to 30 MHz

Test mode : PoE, ANT1, Lowest Channel(Worst case)

The requirements are:

Complies



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	18.914	V	33.8	26.5	60.3	69.5	9.2	100.0	84.0
2	19.545	V	35.4	26.5	61.9	69.5	7.6	100.0	84.0
3	19.862	V	34.0	26.6	60.6	69.5	8.9	100.0	312.0
4	20.489	V	35.5	26.6	62.1	69.5	7.4	100.0	279.0
5	23.959	V	33.0	26.9	59.9	69.5	9.6	100.0	345.0
6	24.903	V	33.9	27.0	60.9	69.5	8.6	100.0	345.0

Note :

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 lie-down position(X 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. This data is the Quasi-Peak value.
5. Radiation emission was considered in the co-located mode of 2.4 GHz and 900 MHz.

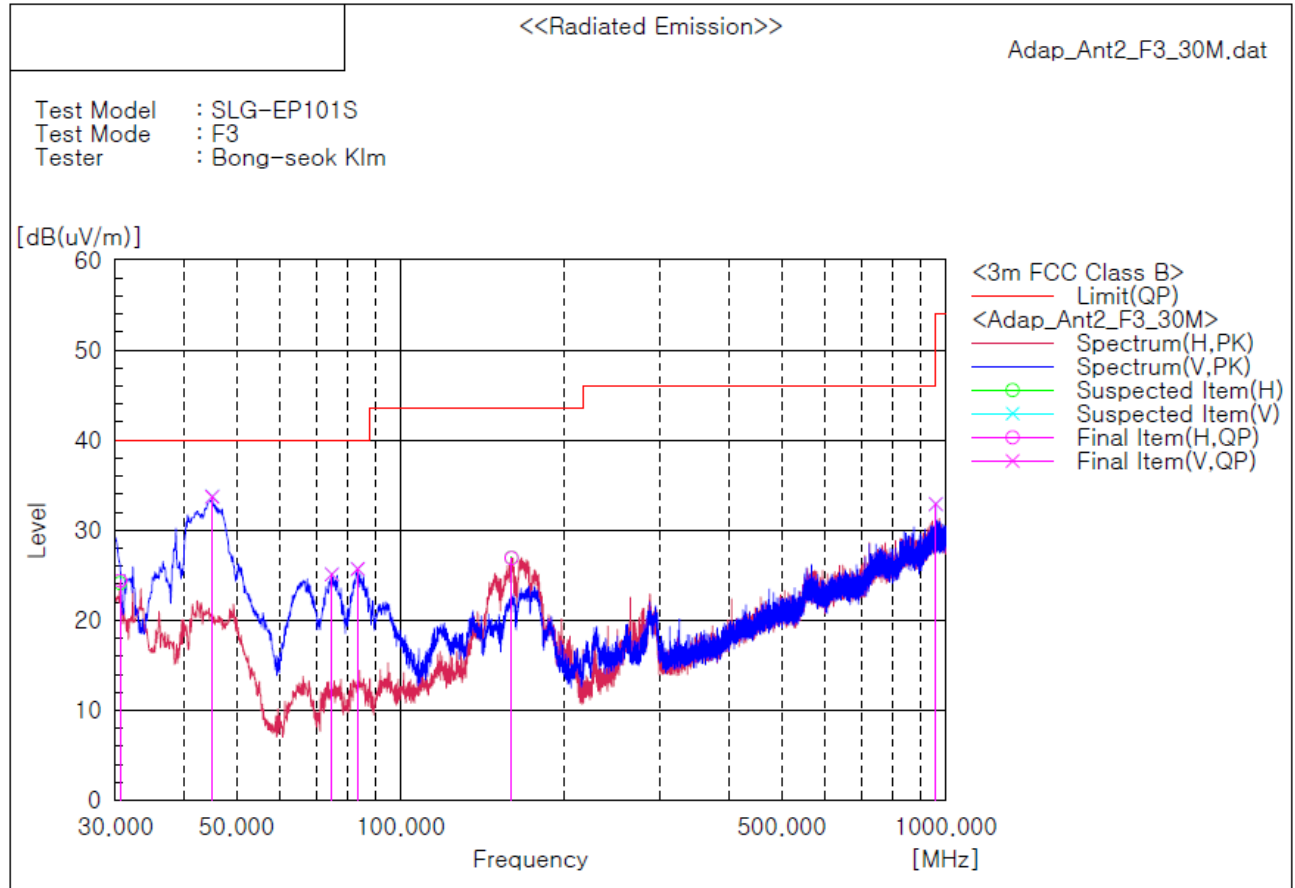
2. 30 MHz to 1 GHz

Test mode : Adaptor, ANT2, Highest Channel(Worst case)

The requirements are:

Complies

Test Data



Final Result

No.	Frequency (P) [MHz]	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	30.806	H 31.1	-6.7	24.4	40.0	15.6	209.0	5.0
2	45.156	V 47.5	-13.8	33.7	40.0	6.3	100.0	10.0
3	74.863	V 42.4	-17.3	25.1	40.0	14.9	100.0	169.0
4	83.471	V 41.6	-15.9	25.7	40.0	14.3	100.0	274.0
5	159.859	H 39.6	-12.7	26.9	43.5	16.6	209.0	280.0
6	959.139	V 24.7	8.2	32.9	46.0	13.1	399.0	95.0

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 lie-down position(X 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. This data is the Quasi-Peak value.
5. Radiation emission was considered in the co-located mode of 2.4 GHz and 900 MHz.

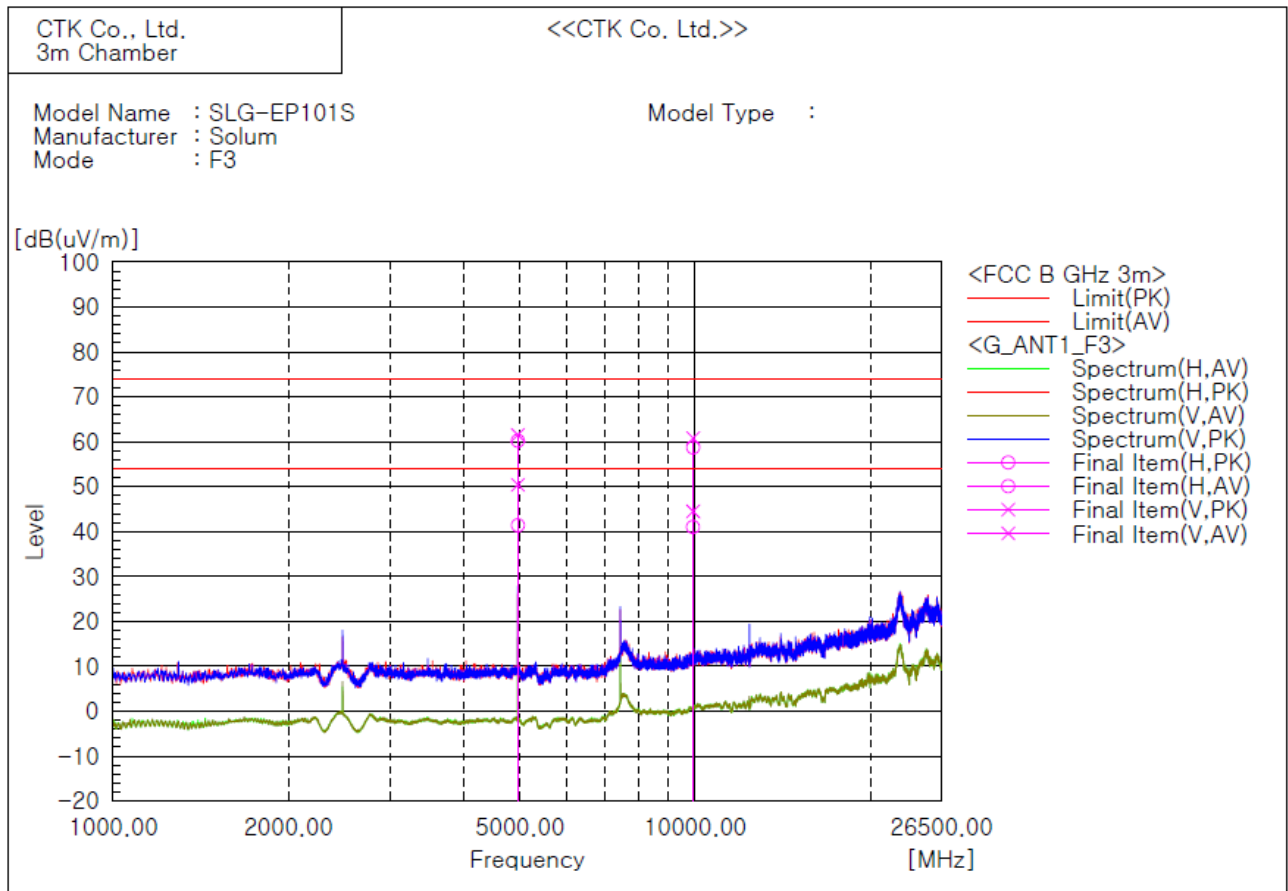
3. 1 GHz to 26.5 GHz

Test mode : Adaptor, ANT1, Highest Channel(Worst case)

The requirements are:

Complies

Test Data



Final Result

No.	Frequency [MHz]	(P)	Reading PK [dB(uV)]	Reading AV [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Result AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Margin PK [dB]	Margin AV [dB]	Height [cm]	Angle [deg]
1	4958.875	V	59.7	48.6	1.8	61.5	50.4	74.0	54.0	12.5	3.6	223.7	345.4
2	4958.875	V	59.7	39.6	1.8	61.5	41.4	74.0	54.0	12.5	12.6	223.7	82.0
3	4961.000	H	59.7	39.6	1.8	61.5	41.4	74.0	54.0	12.5	12.6	235.0	356.8
4	4958.875	H	58.4	38.7	1.8	60.2	44.5	74.0	54.0	13.8	9.5	235.0	236.2
5	9920.749	V	55.0	35.2	5.8	60.8	41.0	74.0	54.0	13.2	13.0	223.7	99.0
6	9920.749	V	55.0	35.2	5.8	60.8	41.0	74.0	54.0	13.2	13.0	223.7	197.7
7	9918.624	H	52.9	35.2	5.8	58.7	41.0	74.0	54.0	15.3	13.0	235.0	258.6
8	9920.749	H	52.9	35.2	5.8	58.7	41.0	74.0	54.0	15.3	13.0	235.0	224.3

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 lie-down position(X axis) and the worst case was recorded.
2. Result = Reading + c.f(correction factor)
3. Correction factor = Antenna factor + Cable loss - Amp Gain
4. Radiation emission was considered in the co-located mode of 2.4 GHz and 900 MHz.



4.6 AC Power Line Conducted Emissions

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz-30 MHz, shall not exceed the limits.

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

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

* The level decreases linearly with the logarithm of the frequency.

** A linear average detector is required.

Test Results

The requirements are:

Complies

Test mode : Transmit, PoE, ANT1, lowest channel(Worst case)

Frequency [MHz]	Measured Data [dBuV]	Margin [dB]	Remark
0.717	44.4	1.6	Average

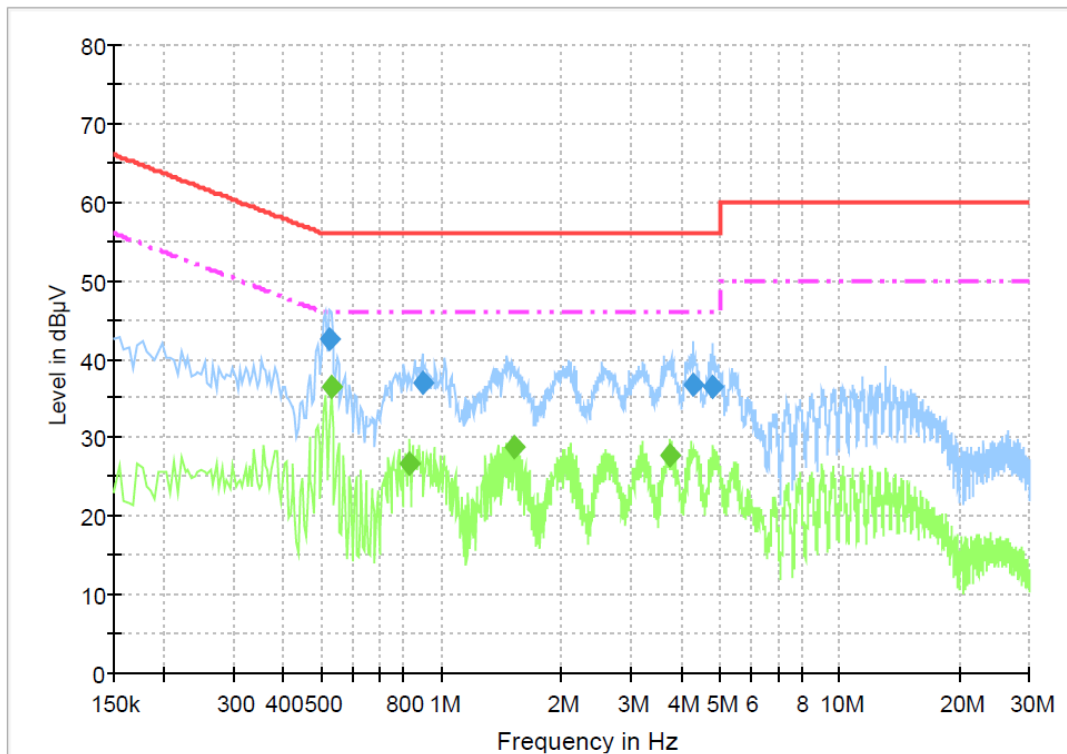
Test Results

The requirements are:

Complies

Test Data

Test mode : Adaptor, Transmit
[L1]



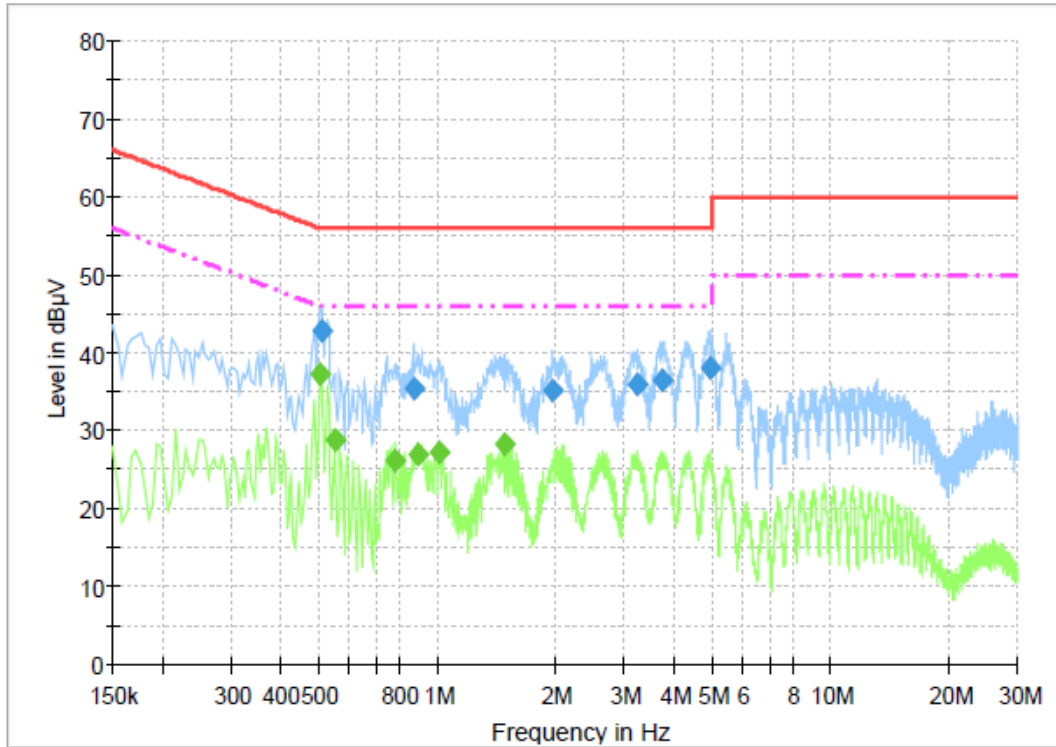
Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.523500	42.6	1000.0	9.000	On	L1	10.0	13.4	56.0
0.892500	36.8	1000.0	9.000	On	L1	9.8	19.2	56.0
4.267500	36.6	1000.0	9.000	On	L1	9.9	19.4	56.0
4.785000	36.4	1000.0	9.000	On	L1	9.9	19.6	56.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.528000	36.5	1000.0	9.000	On	L1	10.0	9.5	46.0
0.829500	26.6	1000.0	9.000	On	L1	9.8	19.4	46.0
1.527000	28.9	1000.0	9.000	On	L1	9.8	17.1	46.0
3.754500	27.8	1000.0	9.000	On	L1	9.9	18.2	46.0

[NEUTRAL]



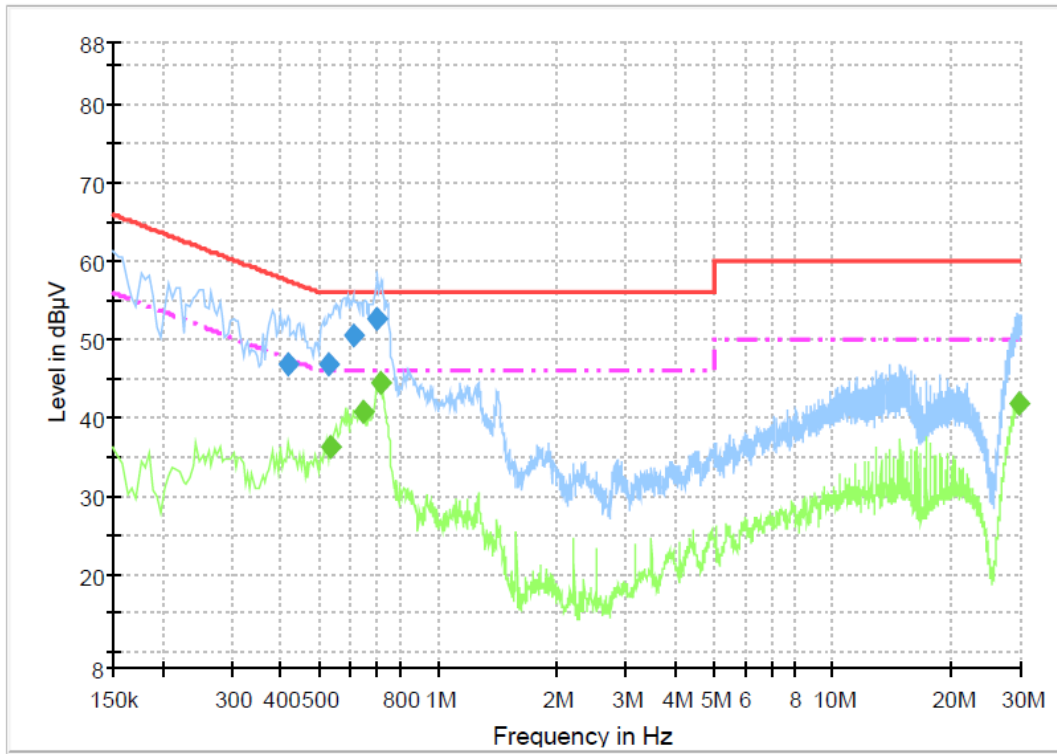
Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.510000	42.7	1000.0	9.000	On	N	10.0	13.3	56.0
0.874500	35.4	1000.0	9.000	On	N	9.8	20.6	56.0
1.972500	35.2	1000.0	9.000	On	N	9.8	20.8	56.0
3.250500	35.9	1000.0	9.000	On	N	9.8	20.1	56.0
3.727500	36.3	1000.0	9.000	On	N	9.9	19.7	56.0
4.933500	37.9	1000.0	9.000	On	N	9.9	18.1	56.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.505500	37.3	1000.0	9.000	On	N	10.0	8.7	46.0
0.550500	28.8	1000.0	9.000	On	N	10.0	17.2	46.0
0.784500	26.2	1000.0	9.000	On	N	9.9	19.8	46.0
0.901500	26.9	1000.0	9.000	On	N	9.8	19.1	46.0
1.018500	27.3	1000.0	9.000	On	N	9.8	18.7	46.0
1.486500	28.4	1000.0	9.000	On	N	9.8	17.6	46.0

Test mode : PoE, Transmit
[L1]



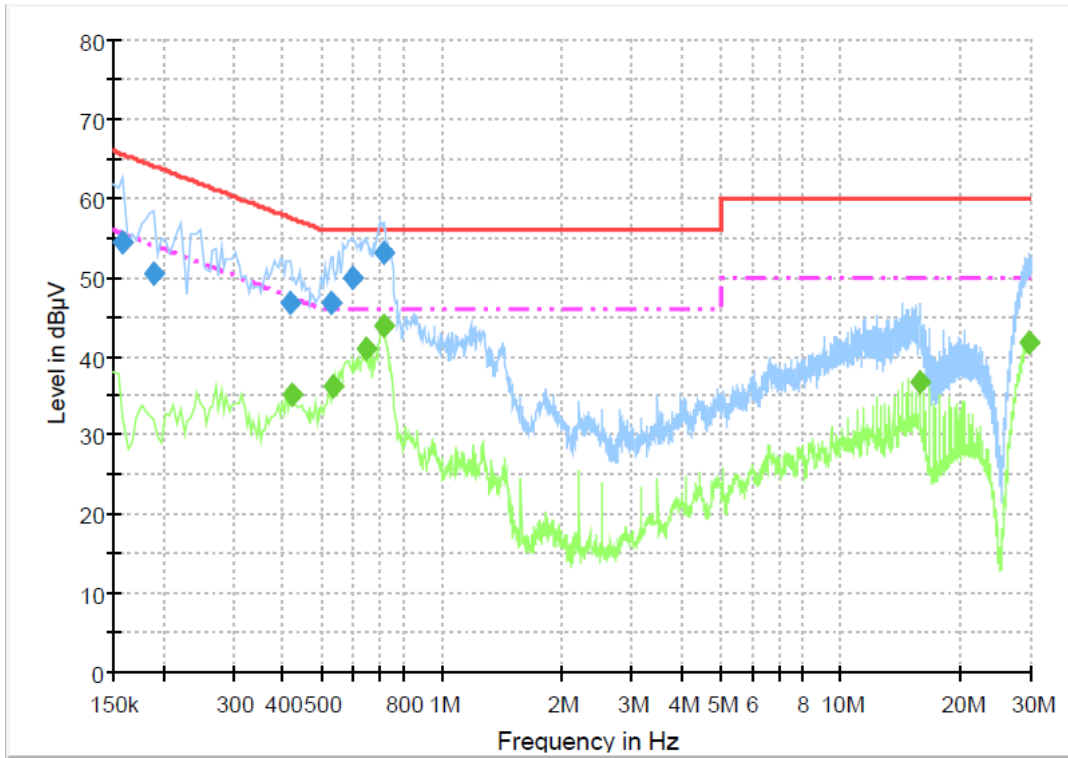
Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.415500	46.8	1000.0	9.000	On	L1	10.0	10.7	57.5
0.528000	46.7	1000.0	9.000	On	L1	10.0	9.3	56.0
0.609000	50.4	1000.0	9.000	On	L1	9.9	5.6	56.0
0.703500	52.6	1000.0	9.000	On	L1	9.9	3.4	56.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.532500	36.4	1000.0	9.000	On	L1	10.0	9.6	46.0
0.649500	40.6	1000.0	9.000	On	L1	9.9	5.4	46.0
0.717000	44.4	1000.0	9.000	On	L1	9.9	1.6	46.0
29.652000	41.8	1000.0	9.000	On	L1	10.1	8.2	50.0

[NEUTRAL]



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.159000	54.4	1000.0	9.000	On	N	9.8	11.1	65.5
0.190500	50.5	1000.0	9.000	On	N	9.8	13.5	64.0
0.415500	46.6	1000.0	9.000	On	N	10.0	10.9	57.5
0.528000	46.6	1000.0	9.000	On	N	10.0	9.4	56.0
0.595500	49.8	1000.0	9.000	On	N	9.9	6.2	56.0
0.717000	52.9	1000.0	9.000	On	N	9.9	3.1	56.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.424500	35.2	1000.0	9.000	On	N	10.0	12.2	47.4
0.532500	36.3	1000.0	9.000	On	N	10.0	9.7	46.0
0.649500	40.8	1000.0	9.000	On	N	9.9	5.2	46.0
0.717000	43.8	1000.0	9.000	On	N	9.9	2.2	46.0
15.792000	36.7	1000.0	9.000	On	N	10.0	13.3	50.0
29.575500	41.8	1000.0	9.000	On	N	10.2	8.2	50.0



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-2020-00935
 Page (39) / (39) Pages

APPENDIX A – Test Equipment Used For Tests

No.	Name of Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	SPECTRUM ANALYZER	R&S	FSP-30	100994	2019-10-16	2020-10-16
2	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2019-10-22	2020-10-22
3	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2019-01-17	2021-01-17
4	Bilog Antenna	Schaffner	CBL6111C	2551	2019-04-17	2021-04-17
5	AMPLIFIER	SONOMA	310	291721	2020-01-22	2021-01-22
6	6dB Attenuator	R&S	DNF	272.4110.50-2	2019-10-25	2020-10-25
7	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2020-01-17	2021-01-17
8	Double Ridged Guide Antenna	ETS-Lindgren	3117	00154525	2019-02-22	2021-02-22
9	Double Ridged Guide Antenna	ETS-Lindgren	3116	00062916	2019-04-22	2021-04-22
10	Preamplifier	Agilent	8449B	3008A02011	2018-11-25	2020-11-25
11	Band Reject Filter	Micro Tronics	BRM50702	G233	2020-01-21	2021-01-21
12	Signal Generator	R&S	SMB100A	175528	2019-10-16	2020-10-16
13	LISN	Rohde & Schwarz	ENV216	101235	2020-01-17	2021-01-17

No.	Name of Equipment	Manufacturer	Model No.	Serial No.	Check Date
1	RF Cable (conducted)	Junkosha Inc.	MWX221	1510S087	2020-02-02
2	RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	MY27558/4	2020-02-02
3	RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	N/A (below 1GHz)	2020-02-02
4	RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	MY27573/4	2019-11-30