KOSTEC Co., Ltd.
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TEST REPORT

Report No: KST-FCR-120002

Applicant	Name	Benchsoft.
	Address	# 901-936, Da-seung Plaza, 538-7, Sang-dong, Wonmi-gu, Bucheon-si, Gyeonggi-do, KOREA
Manufacturer	Name	Benchsoft.
	Address	# 901-936, Da-seung Plaza, 538-7, Sang-dong, Wonmi-gu, Bucheon-si, Gyeonggi-do, KOREA
Equipment	Name	Bluetooth Speaker
	Model No	BN749-X
	Brand	None
	FCC ID	PMCBN749-X
Test Standard	FCC CFR 47, Part 15. Subpart C-15.247	
Test Date(s)	2012. 08. 06 ~ 2012. 08. 09	
Issue Date	2012. 08. 10	
Test Result	Compliance	
Note	Request for enter a multi list of model name by manufacturer. X : letter A ~ Z(Letter X means the Charictoristic of each color without a difference between circuits.)	

Supplementary Information

The device bearing the brand name and FCC ID specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with measurement procedures specified in ANSI C 63.4-2003.

We attest to the accuracy of data and all measurements reported herein were performed by KOSTEC Co., Ltd. and were made under Chief Engineer's supervision. We assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested by Mi Young, Lee Approved by Gyeong Hyeon, Park

Signature  Signature 

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1. GENERAL INFORMATION

1.1 Test Facility

Test laboratory and address

KOSTEC Co., Ltd.

180-254, Annyeong-dong, Hwaseong-si, Gyeonggi-do, South Korea

The open area field test site and conducted measurement facility are used for these testing. This site at was fully described in a reports submitted to the Federal Communications Commission (FCC).

The details of these reports have been found to be in complies with the requirements of Section 2.948 of the FCC Rules on November 14, 2002. The facility also complies with the radiated and conducted test site criteria set forth in ANSI C63.4-2003.

The Federal Communications Commission (FCC) has the reports on file and KOSTEC Co., Ltd. is listed under FCC Registration No.525762. The test site has been approved by the FCC for public use and is List in the FCC Public Access Link CORES (Commission Registration System)

Registration information

KCC (Korea Communications Commission) Number : KR0041

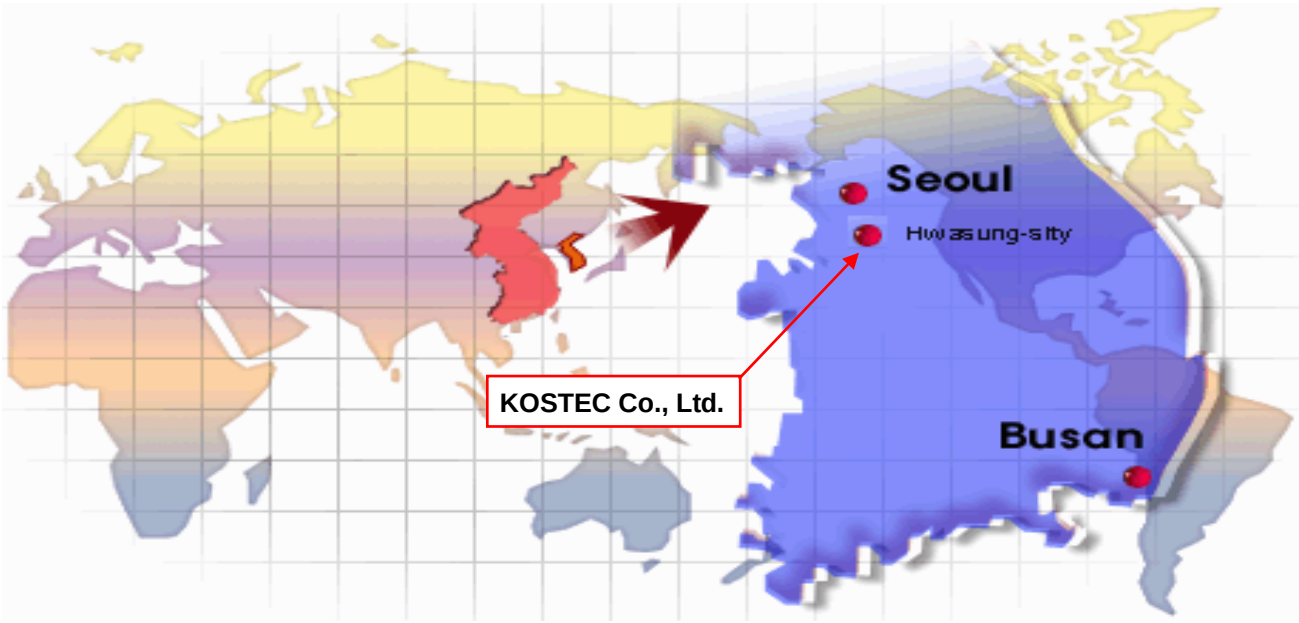
KOLAS(Korea Laboratory Accreditation Scheme) Number : 232

FCC Registration Number(FRN) : 525762

VCCI Registration Number : R-1657 / C –1763

IC Registration Site Number : 8305A-1

1.2 Location



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2. EQUIPMENT DESCRIPTION

The product specification described herein was declared by manufacturer. And refer to user's manual for the details.

1) Equipment Name	Bluetooth Speaker
2) Model No	BN749-X
3) Brand Name	None
4) Usage	Wireless speaker
5) Serial Number	Prototype
6) ITU emission Code	1M00F1D
7) Oscillation Type	PLL (Phase Local Loop)
8) Modulation Type	FHSS (Frequency Hopping Spread Spectrum), GFSK
9) Emission Type	F1D
10) Maximum Power	9.47 dBm**
11) Operated Frequency	TX : 2 402 ㎒ ~ 2 480 ㎒ RX : 2 402 ㎒ ~ 2 480 ㎒
12) Channel spacing / Number	1 ㎒ / 79 Ch
13) Communication Type	Half duplex
14) Final Amplifier	U2
15) Dimension	155(W) X 42(D) X 60(H) ㎜
16) Operation temperature	- 20℃ - + 60℃
17) Power Source	DC 3.6 V (Lithium -ion recharge battery)
18) Antenna Description	Fixed on PCB, Length: 24.4 ㎜, Gain: -1.0 dBi
19) Bluetooth Profile	A2DP
20) FCC ID	PMCBN749-X

** it is maximum peak conducted power in band

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3. SYSTEM CONFIGURATION FOR TEST

3.1 Characteristics of equipment

This equipment is Bluetooth speaker. If connect to this equipment wirelessly via Bluetooth(wireless audio) or 3.5mm stereo input(wired audio), it can wirelessly stream audio from any Bluetooth device within 10 meters.

Also this equipment can be used as a wireless speakerphone. If speak in the direction of the top cover.

The built-in microphone works when connected via Bluetooth. It's used for voice transceiver. Bluetooth chip Communication type is frequency hopping spread spectrum system(FHSS), and it does not support the EDR mode (Enhanced data rate), used frequency band is 2 402 ㎒ - 2 480 ㎒ Power source is supplied 3.6 Vd,c. from Lithium polymer recharge battery inside of equipment.

3.2 Used peripherals list

Description	Model No.	Serial No.	Manufacture	Remark
PC	LS40	1402KIAW215672	LG-IBM	
Test JIG	None	None	BenchSoft.	

3.3 Product Modification

N/A

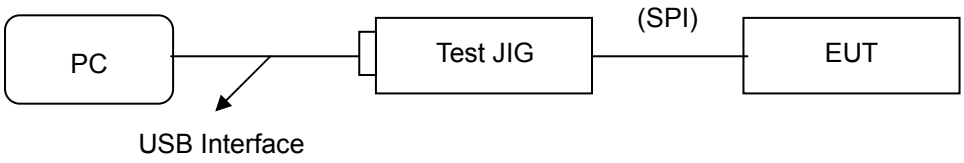
3.4 Operating Mode

All measurements were intended to emit maximum RF signal from EUT continuously.

3.5 Test Setup of EUT

The measurements were taken in continuous transmit / receive mode using the TEST MODE.

For controlling the EUT as TEST MODE, the test program and the test Jig were provided by the applicant.



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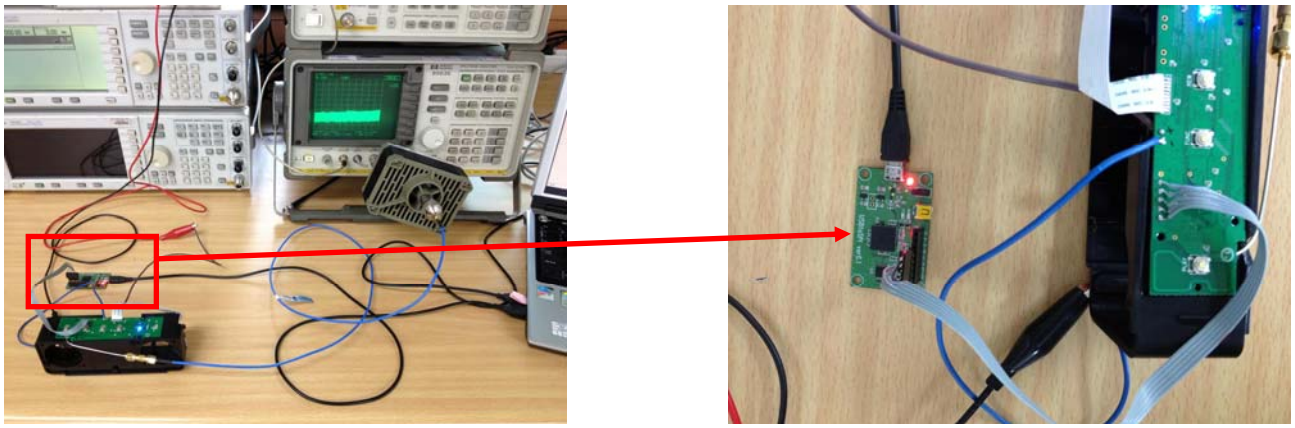
3.6 Parameters of Test Software Setting

During testing, for channel & mode and un-mod, hopping setting is controlled Test Jig with S/W program provided by manufacturer and is going to be fixed on the firmware of the final end product.

Description	Model & Serial No.	Manufacture	Remark
Test Jig*	None	BenchSoft.	It is perform to connection for Control command data between Bluetooth S/W on PC and RF chip board
Test Software		InstallBlueSuite2_4_13	

▣ Test Jig photos



3.7 Table for Test condition

Test Items	Channel No	Frequency (㎒)	Operated Condition
Carrier frequency separation	1, 2	2 402, 2 403	Hopping on and continuous modulation setting mode
	40, 41	2 441, 2 442	
	78, 79	2 479, 2 480	
Number of hopping frequencies	1 ~ 79	2 402 ~ 2 480	Hopping on mode
Time of occupancy (Dwell Time)	40	2 441	Hopping on mode
Conducted peak output power	1	2 402	Hopping off and continuous modulation setting mode
	40	2 441	
	79	2 480	
Band-edge Compliance	1	2 402	Hopping off and continuous modulation setting mode
	79	2 480	
Spurious RF conducted emissions	-	-	Frequency band setting by required standard (FCC Rules)*
Spurious radiated emissions	-	-	

*Note: Channel number is selected lowest, middle, highest channel and also hopping on/off mode operation

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3.8 Used Test Equipment List

No.	Instrument	Model	Serial No.	Manufacturer	Due to Cal. Date	Used
1	Tem & Hum Chamber	EY-101	90E14260	TABAI ESPEC	2012.10.06	☐
2	Spectrum Analyzer	8563E	3846A10662	Agilent Technology	2013.01.27	☒
3	Spectrum Analyzer	FSP	100083	Rohde & Schwarz	2013.03.02	☒
4	Vector signal Analyzer	89441A	3416A02620	Agilent Technology	2013.05.18	☐
5	Radio communication Analyzer	MT8815A	6200429622	ANRITSU	2013.03.02	☐
6	CDMA Mobile Station Test Set	E8285A	US40081298	Agilent Technology	2013.03.02	☐
7	Test Receiver	ESPI3	100109	Rohde & Schwarz	2013.03.02	☒
8	EMI Test receiver	ESCS30	100111	Rohde & Schwarz	2013.05.18	☐
9	Modulation analyzer	8901A	3538A07071	Agilent Technology	2013.05.18	☐
10	Audio analyzer	8903B	3514A16919	Agilent Technology	2013.05.18	☐
11	EPM Series Power meter	E4418B	GB39512547	Agilent Technology	2013.05.18	☐
12	RF Power Sensor	ECP-E18A	US37181768	Agilent Technology	2013.05.18	☐
13	Microwave Frequency Counter	5352B	2908A00480	Agilent Technology	2013.05.18	☐
14	Digital storage Oscilloscope	TDS3052	B015962	Tektronix	2012.10.06	☐
15	Multi meter	DM-313	S60901832	LG Precision Co.,Ltd.	2013.05.18	☐
16	Digital Signal Generator	E4436B	US39260458	H.P	2013.05.18	☐
17	Digital Signal Generator	E4438C	MY42083133	Agilent Technology	2012.10.06	☐
18	Signal Generator	SML03	100692	Agilent Technology	2013.03.13	☐
19	Tracking CW Signal Source	85645A	070521-A1	H.P	2013.05.18	☒
20	Ultra broadband Antenna	HL562	100075	Rohde & Schwarz	2014.04.13	☒
21	Ultra broadband Antenna	HL562	100076	Rohde & Schwarz	2012.12.08	☐
22	Dipole Antenna	HZ-12	100005	Rohde & Schwarz	2014.04.19	☐
23	Dipole Antenna	HZ-13	100007	Rohde & Schwarz	2014.04.19	☐
24	Horn Antenna	3115	2996	EMCO	2014.07.04	☐
25	Horn Antenna	3115	9605-4834	EMCO	2014.05.15	☒
26	Loop Antenna	6502	9203-0493	EMCO	2013.06.03	☒
27	AMPLIFIER	8447D	2944A07881	HP	2013.03.02	☒
28	AMPLIFIER	TK-PA6S	12009	TESTEK	2013.05.18	☒
29	Dummy Load	8173	3780	Bird Electronic	2013.05.18	☐
30	Attenuator	8498A	3318A09485	H.P	2013.05.18	☐
31	Attenuator	50FH-030-500	1404109433	JEW Industries Inc.	2013.05.18	☐
32	Attenuator	UFA-20NPJ-20	IF836	TAMAGAWA Electronic	2013.05.18	☐
33	Band rejection filter	3TNF-0006	26	Dover Tech	2013.05.18	☐
34	Band rejection filter	3TNF-0007	311	Dover Tech	2013.05.18	☐
35	Band rejection filter	3TNF-0008	317	Dover Tech	2013.05.18	☐
36	High pass filter	WHJS1100-10EF	1	Wainwright Instrument Gmbh.	2013.05.18	☐
37	High pass filter	WHJS3000-10EF	1	Wainwright Instrument Gmbh.	2013.05.18	☐
38	Directional coupler	779D	07271	H.P	2013.05.18	☐
39	3 Way power divider	KPDSU3W	00070365	KMW	2013.03.02	☐
40	SLIDAC	None	0207-4	Myoung-Sung Electronic Co., Ltd.	2013.05.18	☐
41	DC Power supply	DRP-5030	9028029	Digital Electronic Co.,Ltd	2013.05.18	☐
42	DC Power supply	UP-3005T	68	Unicon Co.,Ltd	2013.05.18	☐
43	DC Power supply	E3610A	KR24104505	Agilent Technology	2013.05.18	☐
44	Thermo Hygrometer	PC-7800W	None	SATO	2012.10.06	☒
45	HYGRO-Thermograph	NSII-Q	1611545	SATO	2012.10.06	☒
46	Barometer	7612	81134	SATO	2012.12.12	☒

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4. SUMMARY TEST RESULTS

Description of Test	FCC Rule	Reference Clause	Used	Test Result
Carrier frequency separation (20 ㏈ bandwidth)	15.247(a)(1)	Clause 5.1	☒	Compliance
Number of hopping frequencies	15.247(a)(1)(iii)	Clause 5.2	☒	Compliance
Time of occupancy (Dwell Time)	15.247(a)(1)(iii)	Clause 5.3	☒	Compliance
Max. Conducted peak output power	15.247(b)(1)	Clause 5.4	☒	Compliance
Conducted peak output power spectrum density	15.247(e)	Clause 5.5	☒	Compliance
Band edge compliance of RF conducted emissions	15.247(d)	Clause 5.6	☒	Compliance
Band edge compliance of RF radiated emissions	15.247(d) 15.205 & 15.209	Clause 5.7	☒	Compliance
Spurious RF conducted emissions	15.247(d)	Clause 5.8	☒	Compliance
Spurious RF radiated emissions	15.247(d), 15.209	Clause 5.9	☒	Compliance
Antenna requirement	15.203, 15.247	Clause 5.10	☒	Compliance
AC Power line Conducted emission	15.207	Clause 5.10	☒	Compliance
Compliance/pass : The EUT complies with the essential requirements in the standard. Not Compliance : The EUT does not comply with the essential requirements in the standard. N/A : The test was not applicable in the standard.				

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5. MEASUREMENT RESULTS

5.1 Carrier Frequency Separation

5.1.1 Standard Applicable [FCC §15.247(a),(1)]

Frequency hopping systems operating in the (2 400 ~ 2 483.5) ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater.

5.1.2 Test Environment conditions

• Ambient temperature : 26 ℃,
• Relative Humidity : (50 - 51) % R.H.

5.1.3 Measurement Procedure

After place the EUT on the table and set it in transmitting mode, remove the antenna from EUT and then connect a RF cable from the antenna port to the spectrum analyzer.
The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal while EUT had its hopping function enabled. After the trace being stable, the reading value between the peak of the adjacent channels using the marker- Delta function was recorded as the measurement results.

The spectrum analyzer is set to the as follows :

- Span : wide enough to capture the peak of two adjacent channels
- RBW : ≥ 1% of the span
- VBW : ≥ RBW
- Sweep : auto
- Detector function : peak
- Trace : max hold

5.1.4 Measurement Result

Channel No.	Frequency (㎒)	Test Results		
		Measured Value [㎒]	Result	Limit
1, 2	2 402 ㎒, 2 403 ㎒	1.010	Compliance	≥ 25 ㎑ or 20 ㏈ bandwidth
39, 40	2 440 ㎒, 2 441 ㎒	1.025	Compliance	
78, 79	2 479 ㎒, 2 480 ㎒	1.015	Compliance	

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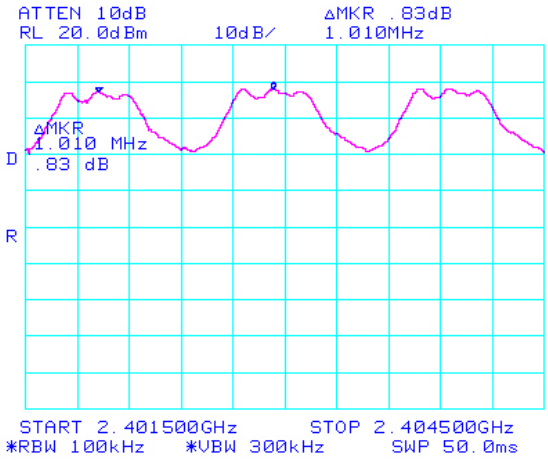
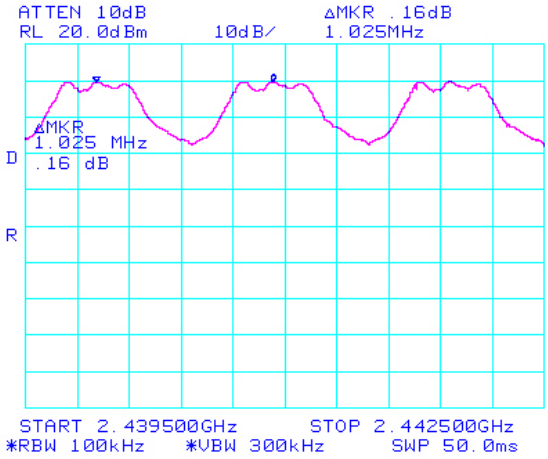
5.1.5 Test Plot (Carrier Frequency Separation)

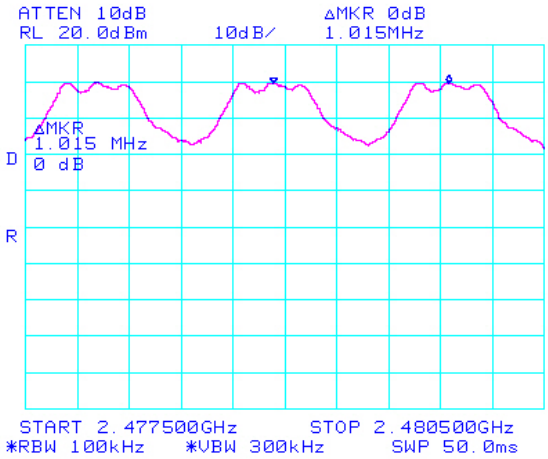
Channel 1, 2 (2 402 ㎒, 2 403 ㎒)



Channel 39, 40 (2 440 ㎒, 2 441 ㎒)



Channel 78, 79 (2 479 ㎒, 2 480 ㎒)



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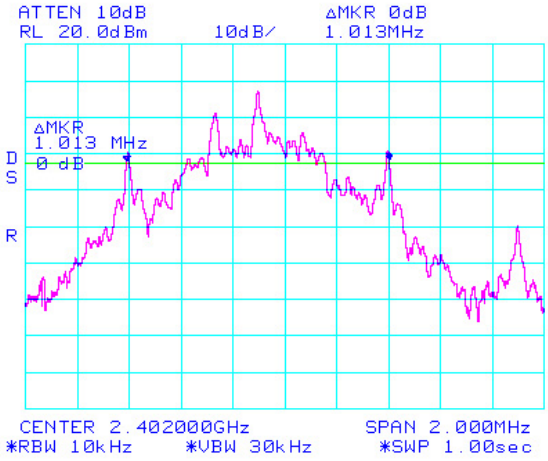
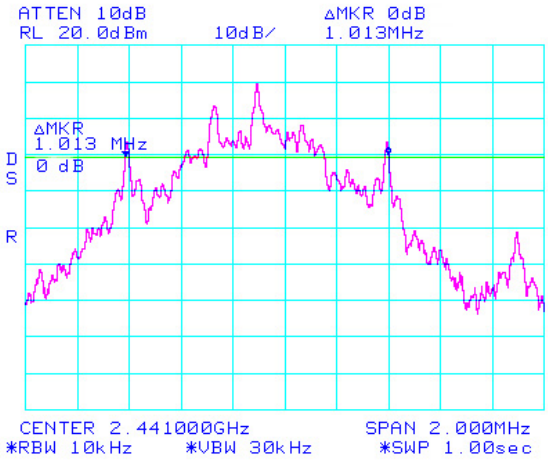
5.1.6 Test Plot (20 dB Occupied bandwidth)

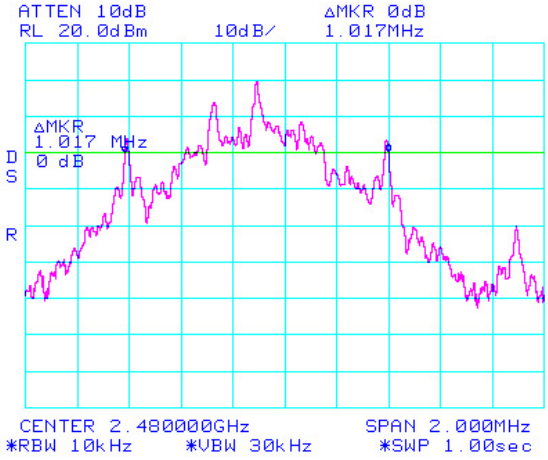
CH Low (2 402 MHz)



CH Middle (2 441 MHz)



CH High (2 480 MHz)



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* Note : above the 20 ㏈ Bandwidth measurement method is described FCC Public Notice(DA 00-705), and setting method on spectrum analyzer is as follows ;

- Span : approximately 2 to 3 times the 20 ㏈ bandwidth, centered on a hopping channel
- RBW : 10 ㎑ (≥ 1% of bandwidth)
- VBW : ≥ RBW
- Sweep : auto
- Detector function : peak
- Trace : max hold

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5.2 Number of hopping frequencies

5.2.1 Standard Applicable [FCC §15.247(a),(1)(iii)]

Frequency hopping systems in the (2 400 ~ 2 483.5) ㎒ band shall use at least 15 channels

5.2.2 Test Environment conditions

• Ambient temperature : 26 ℃,
• Relative Humidity : (50 - 51) % R.H.

5.2.3 Measurement Procedure

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna Terminal to get higher resolution, two frequency ranges within the (2 400 ~ 2 483.5) ㎒ Frequency hopping band were examined. The EUT must have its hoping function enabled. After the trace being stable, it may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies.

The spectrum analyzer is set to the as follows :

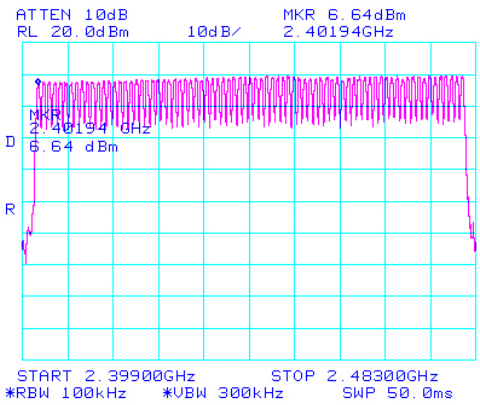
• Span : the frequency band of operation
• Resolution (or IF) Bandwidth(RBW) : ≥ 1% of the span
• Video (or Average) Bandwidth(VBW) : ≥ RBW
• Sweep : auto
• Detector function : peak
• Trace : max hold

5.2.4 Measurement Result

Channel Number	Hopping frequency band (㎒)	Test Results		
		Measured total number of Hopping Channels	Limit	Result
1 ~ 79	(2 402 ~ 2 480) ㎒	79	≥ 15	Compliance

5.2.5 Test Plot

Hopping channel number / ch1 ~ ch 79



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5.3 Time of occupancy (Dwell Time)

5.3.1 Standard Applicable [FCC §15.247(a),(1)(iii)]

According to §15.247(a),(1)(iii), Frequency hopping systems operating in the 2 400 ㎒ – 2 483.5 ㎒.
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

5.3.2 Test Environment conditions

• Ambient temperature : 26 ℃,
• Relative Humidity : (50 - 51) % R.H.

5.3.3 Measurement Procedure

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled. After used the marker-delta function to determine the dwell time.

The spectrum analyzer is set to the as follows :

• Span : Zero , Centered on a hopping channel
• Resolution (or IF) Bandwidth(RBW) : 1 ㎒
• Video (or Average) Bandwidth(VBW) : ≥ RBW
• Sweep : auto
• Detector function : peak
• Trace : max hold

5.3.4 Measurement Result

Bust width per one hop (㎲) (Time slot)		Test Results		
		Measured dwell time (㎳)	Limit	Result
CH Low	386.8	123.52	≤ 0.4	Compliance
CH Middle	383.5	122.56	≤ 0.4	Compliance
CH High	383.5	122.56	≤ 0.4	Compliance

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625㎲ with 79 channels. a one Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/2 = 800 hops per second with 79 channels. so have a each channel 800/79 = 10.13 times. and a period of 0.4 seconds multiplies by the number of hopping channels employed.

Time of occupancy = time slot x hop rate / number of hopping channels x 31.6 s
CH Low : Time of occupancy = 0.386 ㎳ x (1600/(2 x 79)) x 31.6 = 123.52 ㎳
CH Middle : Time of occupancy = 0.383 ㎳ x (1600/(2 x 79)) x 31.6 = 122.56 ㎳
CH High : Time of occupancy = 0.383 ㎳ x (1600/(2 x 79)) x 31.6 = 122.56 ㎳

※This product is have a only DH 1 Time slot

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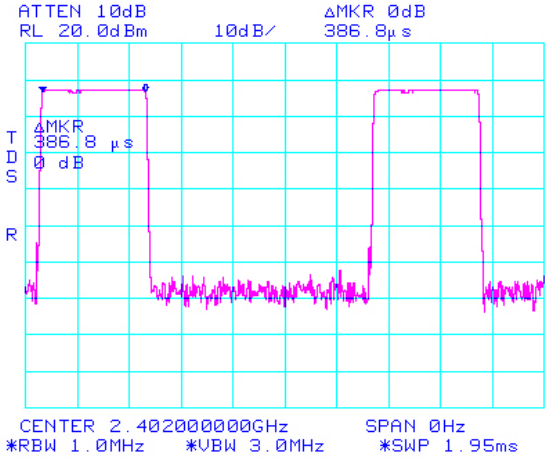
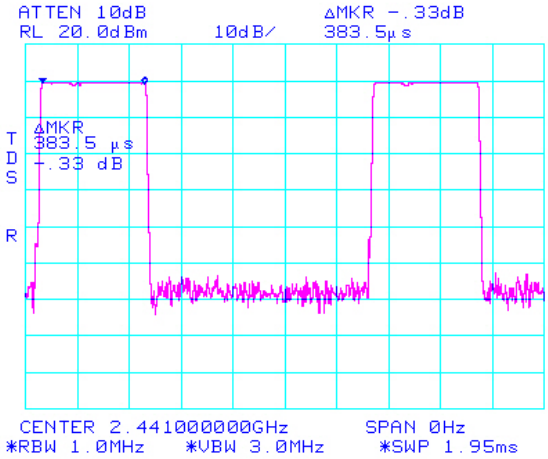
5.3.5 Test Plot (Time slot)

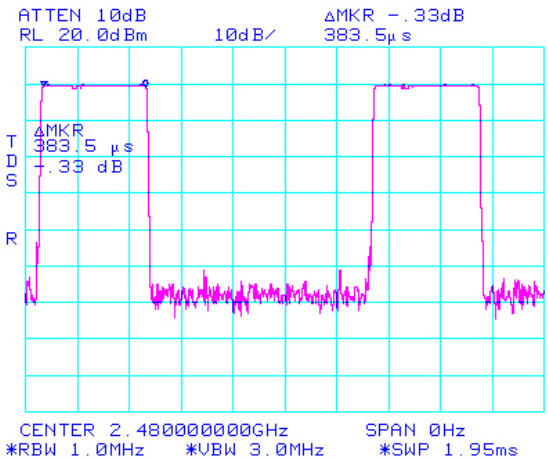
CH Low (2 402 ㎒)



CH Middle (2 441 ㎒)



CH High (2 480 ㎒)



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5.4 Max. Conducted peak output power

5.4.1 Standard Applicable [FCC §15.247(b)(1)]

For frequency hopping systems operating in the 2 400 - 2 483.5 ㎒ band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 850 ㎒ band : 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.

5.4.2 Test Environment conditions

• Ambient temperature : 26 ℃,
• Relative Humidity : (50 - 51) % R.H.

5.4.3 Measurement Procedure

① Reference frequency generated from the signal generator is supply to spectrum analyzer input port via RF cable and attenuator, and then, it's apply to offset value on spectrum analyzer as follows ;on spectrum analyzer [Amplitude→1 More of 3→REF LVL OFFSET(measured loss ㏈)]

② Remove the antenna from the EUT and then connected to spectrum analyzer via a suitable low loss RF cable and attenuator.

③ Place the EUT on the table and set it hopping function disable at the lowest, middle and the highest available channels.

④ Spectrum analyzer was used to directly measure the output power from RF output port on the EUT in continuously transmitting modulation

⑤ After the trace being stable, Record the max. reading.

⑥ Refer to the detailed procedure method FCC Public Notice(DA 00-705)

*The spectrum analyzer is set to the as follows ;

• Span : approximately 5 times the 20 ㏈ bandwidth
• RBW : > 20 ㏈ bandwidth of the emission being measured
• VBW : ≥ RBW
• Sweep : auto
• Detector function : peak
• Trace : max hold
* Above measurement frequency is selected to the lowest, Middle and Highest channel

5.4.4 Measurement Result

Channel No.	Frequency [㎒]	Test Results		
		Measured power [㏈m]	Limit [㏈m]	Result
CH Low 1	2 402	6.97**	≤ 30	Compliance
CH Middle 40	2 441	9.30**		Compliance
CH High 79	2 480	9.47**		Compliance

** It's conducted power

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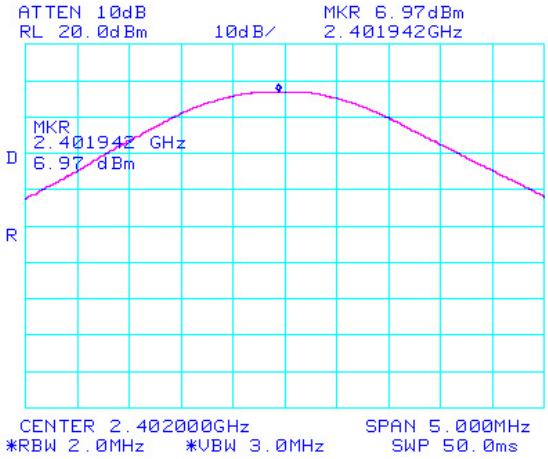
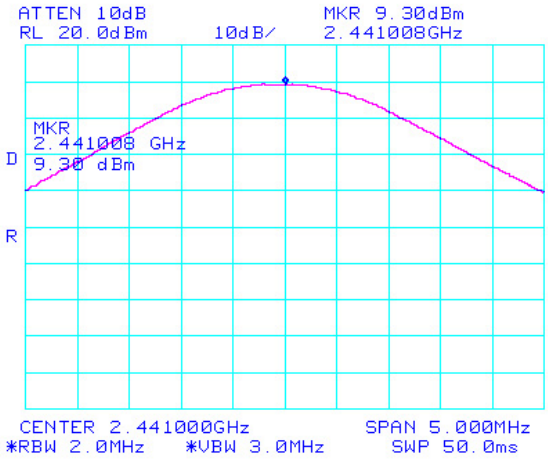
5.4.6 Test Plot

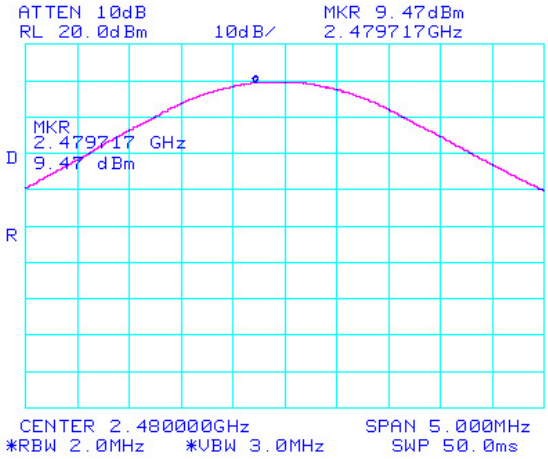
CH Low (2 402 ㎒)



CH Middle (2441 ㎒)



CH High (2 480 ㎒)



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5.5 Conducted peak power spectral density

5.5.1 Standard Applicable [FCC §15.247(e)]

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈m in any 3 ㎑ band during any time interval of continuous transmit

5.5.2 Test Environment conditions

• Ambient temperature : 26 ℃,
• Relative Humidity : (50 ~ 51) % R.H.

5.5.3 Measurement Procedure

The power spectral density conducted from the intentional radiator was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function disable at the highest , middle and the lowest available channels. After the trace being stable, Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak power spectral density.

The spectrum analyzer is set to the as follows :

• Span : 900 ㎑
• RBW : 3 ㎑
• VBW : 10 ㎑ (≥ RBW)
• Sweep : auto
• Detector function : peak
• Trace : max hold

5.5.4 Measurement Result

Ch.	Frequency [㎒]	Test Results		
		Measured Value [㏈m]	Limit	Result
CH Low1	2 402	4.67	8 ㏈m	Compliance
CH Middle 40	2 441	7.17		Compliance
CH High 79	2 480	7.50		Compliance

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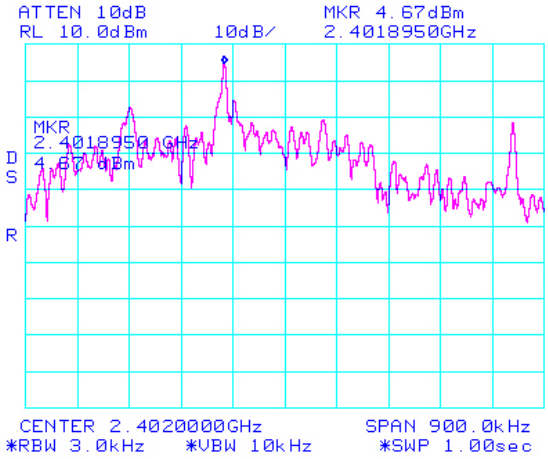
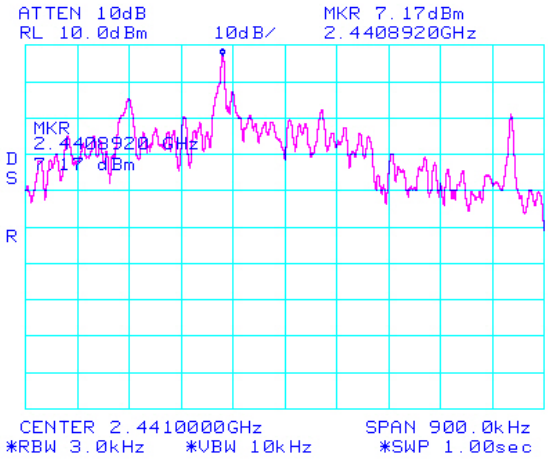
5.5.5 Test Plot

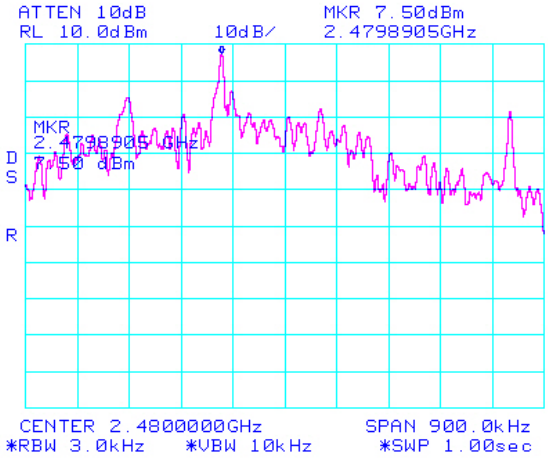
CH Low (2 402 ㎒)



CH Middle (2441 ㎒)



CH High (2 480 ㎒)



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5.6 Band-edge Compliance of RF Conducted emissions

5.6.1 Standard Applicable [FCC §15.247(d)]

In any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power, based on RF conducted.

5.6.2 Test Environment conditions

• Ambient temperature : 26 ℃,
• Relative Humidity : (50 ~ 51) % R.H.

5.6.3 Measurement Procedure

① Pre-calibration for the spectrum analyzer has to be done first through a reference CW signal from CAL OUT(-10 ㏈m)
② Reference frequency generated from the signal generator is supply to spectrum analyzer input port via RF cable and attenuator, and then, it's apply to offset value on spectrum analyzer as follows ; on spectrum analyzer [Amplitude→1 More of 3→REF LVL OFFSET(measured loss ㏈)]
③ Remove the antenna from the EUT and then, connected to spectrum analyzer via a dc Block, suitable low loss RF cable and attenuator.
④ Place the EUT on the table and set on the emission at the band-edge,
⑤ After the trace being stable, Use the marker-to-peak function to move the marker to the peak of the in-band emission.
⑥ The marker-delta value now displayed must comply with the limit specified in above standard.
⑦ please refer to the detailed procedure method FCC Public Notice(DA 00-705)

The spectrum analyzer is set to the as follows :

- Span : Wide enough to capture the peak level of the emission operating on the channel closet to the Band-edge, as well as any modulation products which fall outside of the authorized band of operation
- RBW : 100 ㎑ (≥ 1 % of the span)
- VBW : ≥ RBW
- Sweep : auto
- Detector function : peak
- Trace : Max hold

5.6.5 Measurement Result

Setting Channel		Test Results		
		Measured value [㏈c]	Limit [㏈c]	Result
CH Low (2 402 ㎒)	~ 2 400 ㎒	45.16	≤ 20	Compliance
CH High (2 480 ㎒)	2 483.5 ㎒ ~	54.00		Compliance

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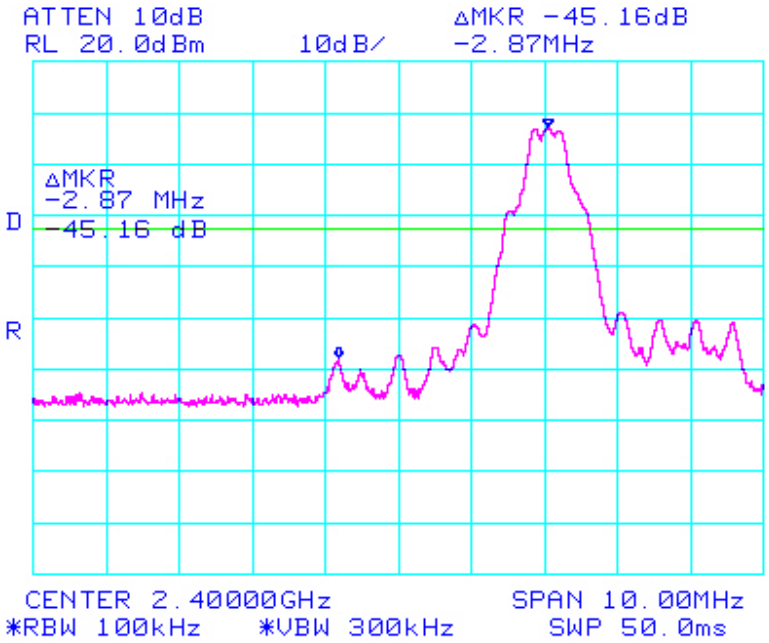
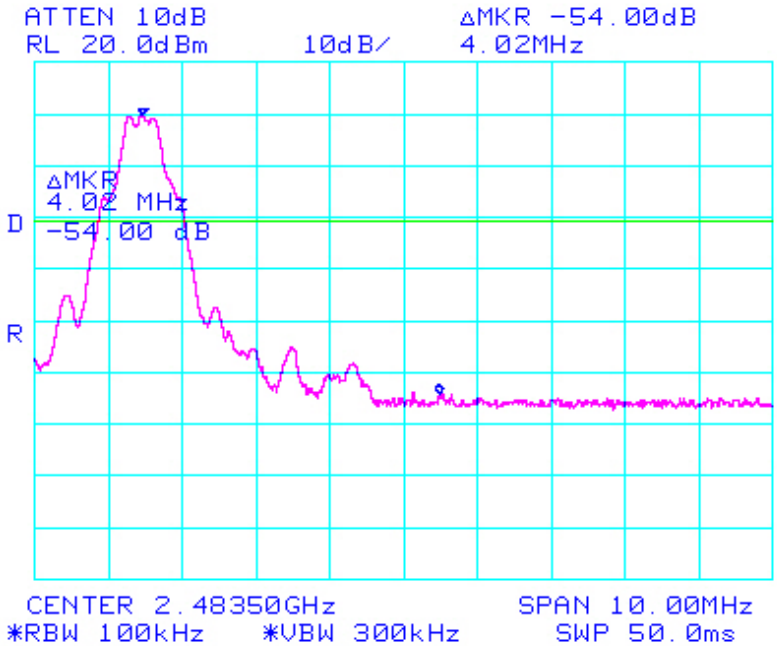
5.6.6 Test Plot

CH Low (2 402 ㎒)



CH High (2 480 ㎒)



※ Above measured delta value is displayed at band edge point from lowest and highest frequency

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5.7 Band-edge Compliance of RF Radiated emissions

5.7.1 Standard Applicable [FCC §15.247]

The band-edge emissions outside these bands(2 400 ~ 2 483.5) ㎒ in which operating the hopping modulated intentional radiator is required comply with the provisions in above Required standard with respect to emission falling within restricted frequency bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) Above limitation value is refer to Table [1] & [2] of Clause 5.9.1

5.7.2 Test Environment conditions

• Ambient temperature : 27 ℃,
• Relative Humidity : (50 - 52) % R.H.

5.7.3 Measurement Procedure

Refer to the clause 5.9.3

5.7.4 Test Setup Configuration

Refer to the clause 5.9.5

5.7.5 Measurement Result

▣ Frequency band (2 310 ~ 2 400) ㎒

Freq. (㎒)	Reading (dB㎶/m)	Table (Deg)	Antenna			CL (dB)	Pre AMP (dB)	Meas Result (dB㎶/m)	Limit (dB㎶/m)	Mgn (dB)	Result
			Height (m)	Pol. (H/V)	Fctr. (dB/m)						
-	-										Compliance
-	-										Compliance
The signal is not detection within Band-edge											

▣ Frequency band (2 483.5 ~ 2 500) ㎒

Freq. (㎒)	Reading (dB㎶/m)	Table (Deg)	Antenna			CL (dB)	Pre AMP (dB)	Meas Result (dB㎶/m)	Limit (dB㎶/m)	Mgn. (dB)	Result
			Height (m)	Pol. (H/V)	Fctr. (dB/m)						
-	-							-			Compliance
-	-							-			Compliance
The signal is not detection within Band-edge											

※Above Limit value is required FCC Rule part 15 subpart C 15.209 based on 15.205

Freq.(㎒) : Measurement frequency, Reading(dB㎶/m) : Indicated value for test receiver,
Table (Deg) : Directional degree of Turn table, Antenna (Height, Pol, Fctr) : Antenna Height, Polarization and Factor
Cbl(dB) : Cable loss, Pre AMP(dB) : Preamplifier gain(dB)
Meas Result (dB㎶/m) :Reading(dB㎶/m)+ Antenna factor.(dB/m)+ CL(dB) - Pre AMP(dB)
Limit(dB㎶/m): Limit value specified with FCC Rule, Mgn(dB) : FCC Limit (dB㎶/m) – Meas Result(dB㎶/m),

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※Note

(1) Data of measurement within this frequency range shown "-" in the above table means the reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.

(2) Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak detector mode and average detector mode

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5.8 Spurious RF Conducted emissions

5.8.1 Standard Applicable [FCC §15.247(d)]

In any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power.

5.8.2 Test Environment conditions

• Ambient temperature : 25.5 ℃,
• Relative Humidity : (55 - 56) % R.H.

5.8.3 Measurement Procedure

① Pre-calibration for the spectrum analyzer has to be done first through a reference CW signal from CAL OUT(-10 ㏈m)

② Reference frequency generated from the signal generator is supply to spectrum analyzer input port via RF cable and attenuator, and then, it's apply to offset value on spectrum analyzer as follows ; on spectrum analyzer [Amplitude→1 More of 3→REF LVL OFFSET(measured loss ㏈)]

③ Remove the antenna from the EUT and then, connected to spectrum analyzer via a dc Block, suitable low loss RF cable and attenuator.

④ Place the EUT on the table and set on the emission at the out band

⑤ After the trace being stable, Use the marker-to-peak function to move the marker to the peak of the in-band emission.

⑥ The marker-delta value now displayed spurious emission must comply with the limit specified in above standard.

⑦ please refer to the detailed procedure method FCC Public Notice(DA 00-705)

The spectrum analyzer is set to the as follows :

• Span : wide enough to capture the peak level of the in-band emission and all spurious emissions from the Lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
• RBW : 100 ㎑
• VBW : ≥ RBW
• Sweep : Auto
• Detector function : Peak
• Trace : Max hold

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5.8.4 Measurement Result

Hopping mode	Channel Range	Frequency band [㎒]	Test Results		
			Measured value [㏈c]	Limit [㏈c]	Result
Hopping off	CH Low (2 402 ㎒)	30 ㎒ – 3 ㎓	Below than Limit Value	≤ 20	Compliance
		3 ㎓ – 26.5 ㎓			Compliance
	CH Middle (2 441 ㎒)	30 ㎒ – 3 ㎓			Compliance
		3 ㎓ – 26.5 ㎓			Compliance
	CH High (2 480 ㎒)	30 ㎒ – 3 ㎓			Compliance
		3 ㎓ – 26.5 ㎓			Compliance
Hopping on	Hopping ch (1~ 79)	30 ㎒ – 3 ㎓	Below than Limit Value		Compliance
		3 ㎓ – 26.5 ㎓			Compliance

*Note: Hopping mode and Harmonic level is 20㏈ below within the band that contains the highest level of the desired power

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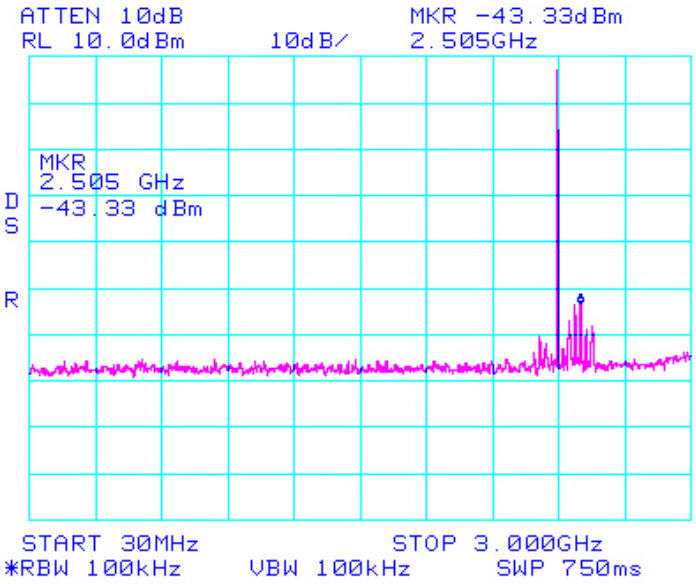
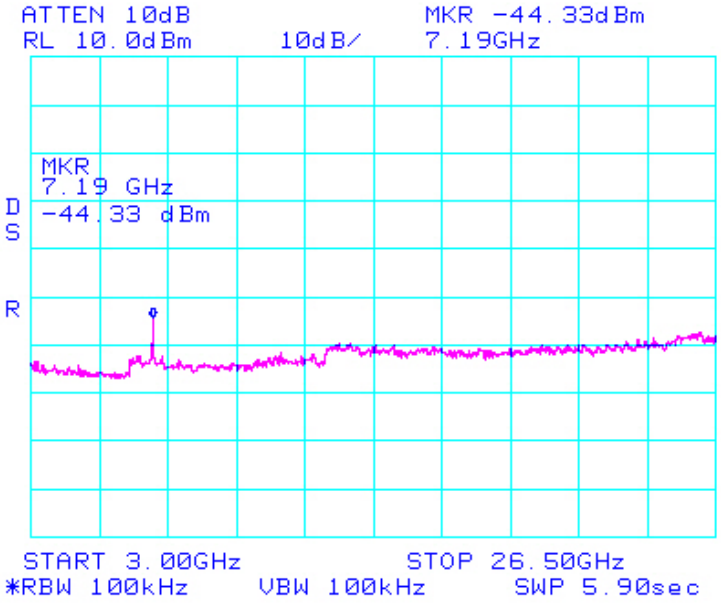
5.8.5 Test Plot (Hopping off)

▣ CH Low (2 402 ㎒)

Frequency Range (30 ㎒ ~ 3 ㎓)



Frequency Range (3 ㎓ ~ 26.5 ㎓)



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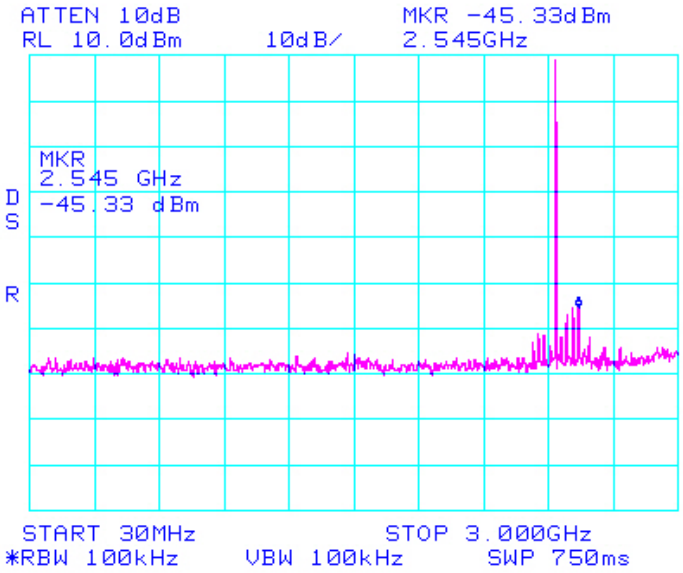
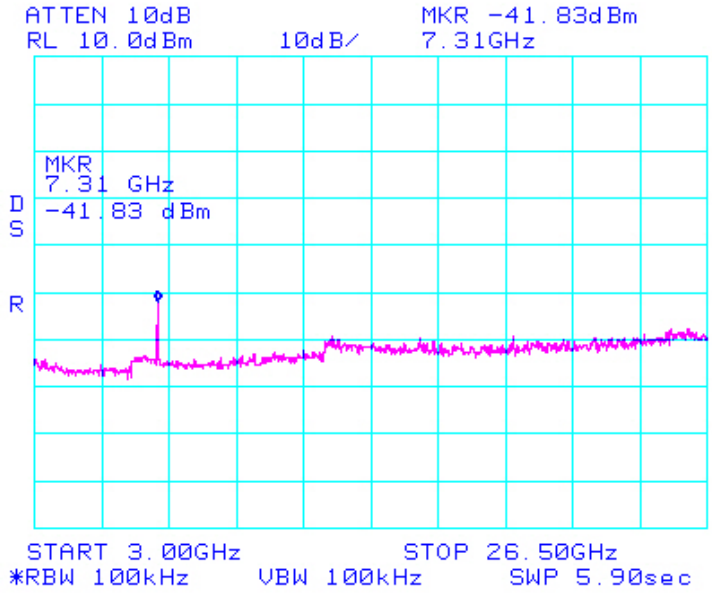
▣ CH Middle (2 441 ㎒)

Frequency Range (30 ㎒ ~ 3.0 ㎓)



Frequency Range (3 ㎓ ~ 26.5 ㎓)



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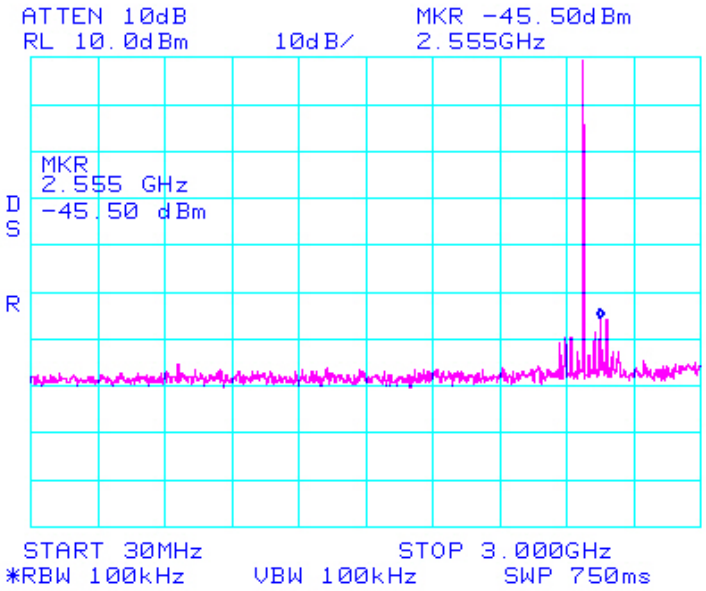
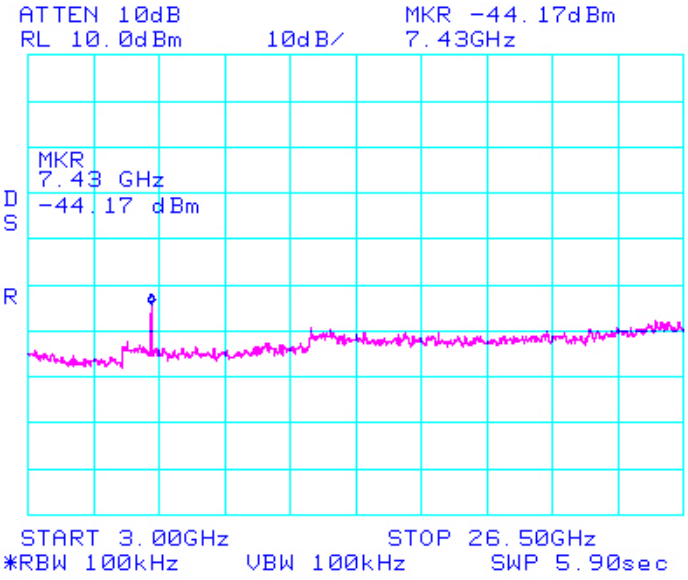
▣ CH High (2 480 ㎒)

Frequency Range (30 ㎒ ~ 3.0 ㎓)



Frequency Range (3 ㎓ ~ 26.5 ㎓)



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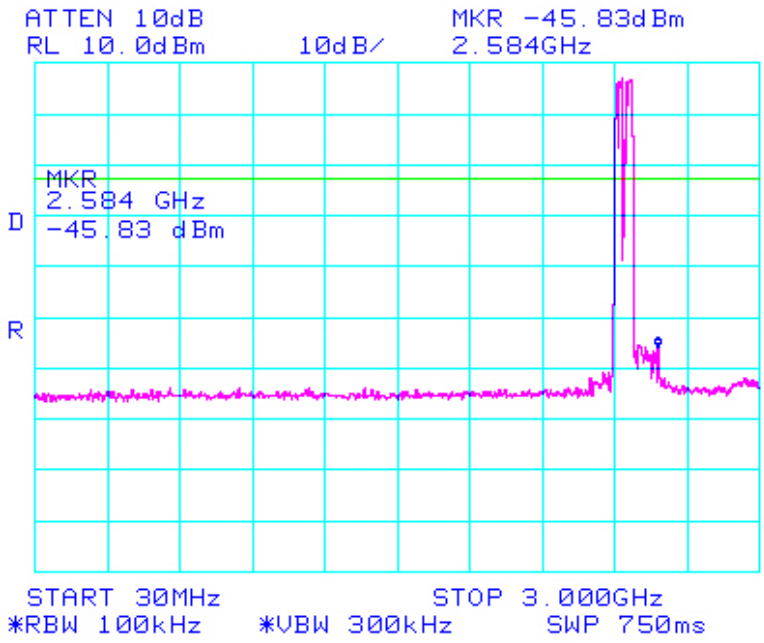
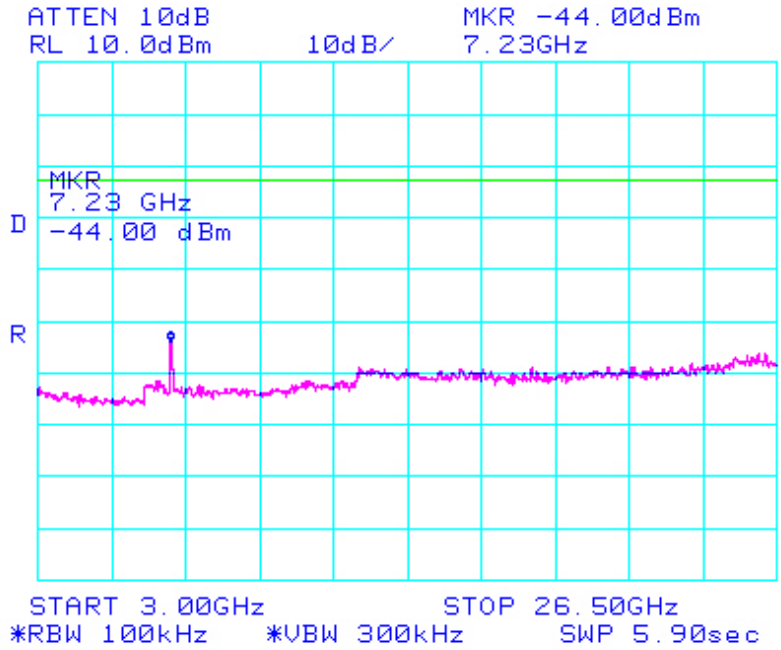
5.8.7 Test Plot (Hopping on)

Frequency band (30 ㎒ ~ 3 ㎓)



Frequency band (3 ㎓ ~ 26.5 ㎓)



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5.9 Spurious RF Radiated emissions

5.9.1 Standard Applicable [FCC §15.247(d)]

All other emissions outside these bands shall not exceed the general radiated emission limits specified in §15.209(a). And according to §15.33(a)(1), for an intentional radiator operates below 10 ㎓, the frequency Range of measurements : to the tenth harmonic of the highest fundamental frequency or to 40 ㎓, Whichever is lower. In addition, radiated emissions which fall in the restricted bands, as defined in Sec.15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a)

§15.209. [Table 1] limits for radiated emissions measurements (distance at 3m)

Frequency Band [㎒]	Limit [㎶/m]	Limit [dB㎶/m]	Detector
30 - 88	100 **	40.00	Quasi peak
88 - 216	150 **	43.52	Quasi peak
216 - 960	200 **	46.02	Quasi peak
Above 960	500	54.00	Average

** fundamental emissions from intentional radiators operation under this Section shall not be located in the frequency bands 54-72 ㎒, 76-88 ㎒, 174-216 ㎒, or 470-806 ㎒. However, operation within these Frequency bands is permitted under other sections of this Part Section 15.231 and 15.241

§15.205. [Table 2] Restrict Band of Operation

Only spurious emissions are permitted in any of the frequency bands listed below ;			
[㎒]	[㎒]	[㎒]	[㎓]
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505**	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 – 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 – 1 427	8.025 - 8.
4.177 25 - 4.177 75	37.5 -38.25	1 435 – 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 – 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 – 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 -1 722.2	13.25 - 13.
6.311 75 - 6.312 25	123 - 138	2 200 – 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 – 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525 25	2 483.5 – 2 500	17.7 - 21.4
8.376 25 - 8.38 6 75	156.7 - 156.9	2 690 – 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 – 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 – 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 – 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 – 4 400	Above 38.6

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

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5.9.2 Test Environment conditions

• Ambient temperature : 27 ℃,
• Relative Humidity : (50 ~ 52) % R.H.

5.9.3 Measurement Procedure

The measurements procedure of the transmitter radiated E-field is as following describe method.

The test is performed in a Shield chamber to determine the accurate frequencies, after maximum emissions level will be checked on a test chamber and measuring distance is 3 m from EUT to test antenna.
(The chamber is ensured that comply with at least 6 dB above the ambient noise level)

① The EUT was powered ON with continuously operating mode and placed on a 0.8 meter high non-conductive table on the reference ground plane.

② The test antenna was used on Horn antenna for above 1 GHz, and if the below 1 GHz, broad-band antenna and Loop antenna were used for below 30 MHz and it's antenna positioned in both the horizontal and vertical plane was location at EUT during the test for maximized the emission measurement.

③ The output of the test antenna will be connected to a measuring receiver, and it is set to tuned over the frequency range according to required standard

④ The measuring detector type of the measurement receiver is based on average value of measurement instrumentation employing a CISPR Quasi Peak detector according to required standard and for above 1 GHz, set the spectrum analyzer on a average and peak detector for the provisions in §15.35 or RSS-Gen 4.9(b) and investigated frequency range is set the spectrum analyzer according to §15.33 and RSS-Gen 4.9(a)(b)

⑤ The fundamental frequency at which a relevant radiated signal component is detected, the test antenna will be raised and lowered through the specified range of heights in horizontal and vertical polarized orientation, until an maximum signal level is detected on the measuring receiver.

⑥ The transmitter is position x, y, z axis on rotating through 360 degrees, until the maximum signal level is detected by the measuring receiver.

⑦ The receiver is scanned from requested measuring frequency band and then the maximum meter reading is recorded. The radiated emissions were measured with required standard.

• The measurement results are obtained as described below:
Result(dBμV/m) = Reading(dBμV) + Antenna factor(dB/m)+ CL(dB) + other applicable factor (dB)
• According to §15.33 (a)(1), Frequency range of radiated measurement is performed the tenth harmonic.

※ if necessary, additionally receiver is adopted high-pass filter and preamp because lower radiated signal

※ The transmitter radiated spectrum was investigated from 9 kHz to 26.5 GHz

5.9.4 Measurement Uncertainty

All measurements involve certain levels of uncertainties. The factors contributing to uncertainties are test receiver, Cable loss, Antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, Antenna frequency interpolation, measurement distance variation, Site imperfection, mismatch, and system repeatability based on NIS 80,81, The measurement uncertainty level with a 95 % confidence level were apply to Uncertainty of a radiation emissions measurement at Chamber of KOSTEC is ± 6.0 dB

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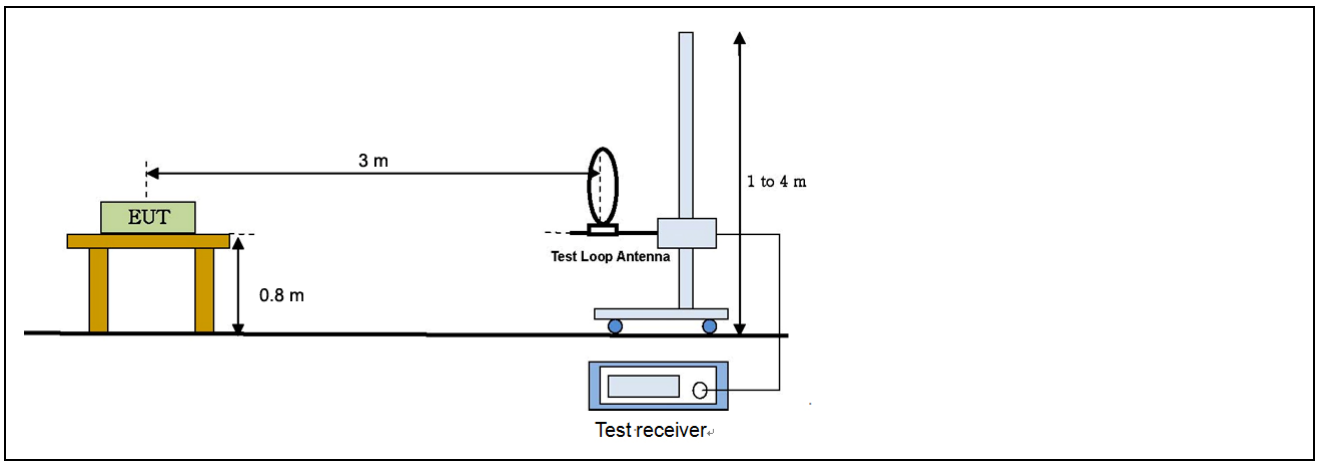
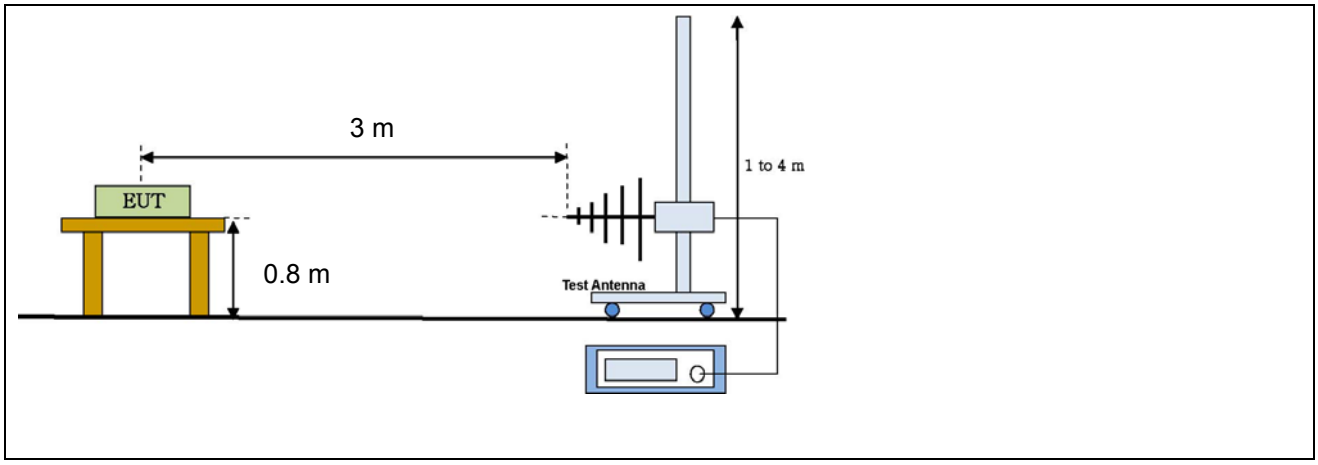
5.9.5 Test Configuration

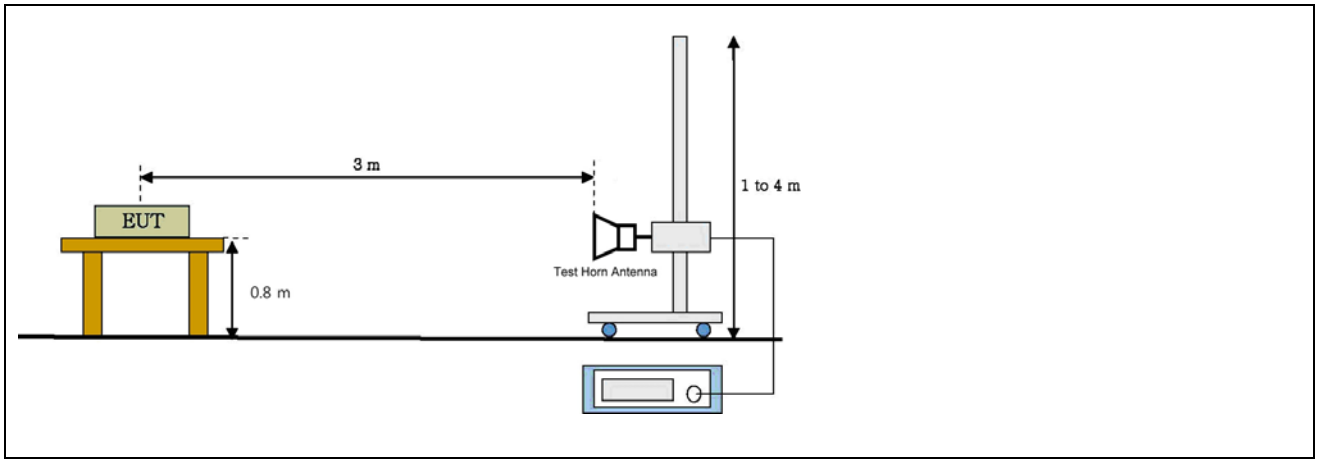
Radiated emission setup, Below 30 MHz



Radiated emission setup, Below 1 000 MHz



Radiated emission setup, Above 1 GHz



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5.9.6 Measurement Result

▣ CH Low (2 402 ㎒)

Below 1 ㎓

Freq. (㎒)	Reading (dB㎶/m)	Table (Deg)	Antenna			CL (dB)	Pre AMP (dB)	Meas Result (dB㎶/m)	Limit (dB㎶/m)	Mgn (dB)	Result
			Height (m)	Pol. (H/V)	Fctr. (dB/m)						
272.06	6.70	100	3.8	H	10.82	2.97	-	20.49	46.02	25.53	Compliance
689.60	12.02	130	3.0	H	19.07	4.11	-	35.20	46.02	10.82	Compliance
870.02	1.81	120	2.0	H	21.09	6.03	-	28.94	46.02	17.08	Compliance
Below 30㎒, Above 870.02 ㎒ Nil emission											

Above 1 ㎓

Freq. (㎓)	Reading (dB㎶/m)		Table (Deg)	Antenna			CL (dB)	Pre AMP (dB)	Meas Result (dB㎶/m)		Limit (dB㎶/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)			PK	AV	PK	AV	PK	AV	
1.730	-3.41	-15.44	130	1.2	V	26.05	5.79	-	28.43	16.40	74	54	45.57	37.60	Compliance
1.768	-4.05	-15.78	260	1.5	V	26.19	5.87	-	28.01	16.28	74	54	45.99	37.72	Compliance
Above 1.768 ㎓ Nil emission															

▣ CH Middle (2 441 ㎒)

Below 1 ㎓

Freq. (㎒)	Reading (dB㎶/m)	Table (Deg)	Antenna			CL (dB)	Pre AMP (dB)	Meas Result (dB㎶/m)	Limit (dB㎶/m)	Mgn (dB)	Result
			Height (m)	Pol. (H/V)	Fctr. (dB/m)						
283.20	9.96	320	3.0	H	11.16	2.68	-	23.80	46.02	22.22	Compliance
712.58	8.73	120	1.5	H	19.35	5.72	-	33.80	46.02	12.22	Compliance
883.00	4.71	320	1.2	H	21.23	5.25	-	31.20	46.02	14.82	Compliance
Below 30㎒, Above 890.28 ㎒ Nil emission											

Above 1 ㎓

Freq. (㎓)	Reading (dB㎶/m)		Table (Deg)	Antenna			CL (dB)	Pre AMP (dB)	Meas Result (dB㎶/m)		Limit (dB㎶/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)			PK	AV	PK	AV	PK	AV	
1.812	-1.11	-13.11	120	1.5	V	26.35	5.96	-	31.20	19.20	74	54	42.80	34.80	Compliance
1.847	0.42	-13.68	320	1.5	V	26.47	6.01	-	32.90	18.80	74	54	41.10	35.20	Compliance
Above 1.847 ㎓ Nil emission															

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▣ CH High (2 480 ㎒)

Below 1 ㎓

Freq. (㎒)	Reading (dB㎶/m)	Table (Deg)	Antenna			CL (dB)	Pre AMP (dB)	Meas Result (dB㎶/m)	Limit (dB㎶/m)	Mgn (dB)	Result
			Height (m)	Pol. (H/V)	Fctr. (dB/m)						
307.20	8.64	120	3.0	H	11.85	3.71	-	24.20	46.02	21.82	Compliance
736.25	12.77	100	2.1	H	19.62	4.44	-	36.83	46.02	9.19	Compliance
907.83	2.62	120	1.8	V	21.47	7.11	-	31.20	46.02	14.82	Compliance
Below 30㎒, Above 907.83 ㎒ Nil emission											

Above 1 ㎓

Freq. (㎓)	Reading (dB㎶/m)		Table (Deg)	Antenna			CL (dB)	Pre AMP (dB)	Meas Result (dB㎶/m)		Limit (dB㎶/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)			PK	AV	PK	AV	PK	AV	
1.830	0.81	-13.39	180	1.5	V	26.41	5.99	-	33.20	19.00	74	54	40.80	35.00	Compliance
1.867	-0.75	-14.69	320	1.5	V	26.54	6.04	-	31.83	17.89	74	54	42.17	36.11	Compliance
Above 1.867 ㎓ Nil emission															

※Note

- Above 1 ㎓ is measured average and peak detector mode on Spectrum analyzer in accordance with FCC Rule15.35
- Limit: 54 dB㎶/m(Average), 74 dB㎶/m(Peak), Attenuated more than 20 dB below the permissible value.
- For the below 30 ㎒, measured any other signal is not detected on test receiver
- It is not recorded on the report that the reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to measured.
- The transmitter radiated spectrum was investigated from 9 ㎑ to 26.5 ㎓

Freq.(㎒) : Measurement frequency, Reading(dB㎶/m) : Indicated value for test receiver,
Table (Deg) : Directional degree of Turn table,
Antenna (Height, Pol, Fctr) : Antenna Height, Polarization and Factor
Cbl(dB) : Cable loss, Pre AMP(dB) : Preamplifier gain(dB)
Meas Result (dB㎶/m) :Reading(dB㎶/m)+ Antenna factor.(dB/m)+ CL(dB) - Pre AMP(dB)
Limit(dB㎶/m): Limit value specified with FCC Rule, Mgn(dB) : FCC Limit (dB㎶/m) – Meas Result(dB㎶/m)

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5.10 AC Power Conducted emissions

5.10.1 Standard Applicable [FCC §15.207(a)]

For intentional radiator that is designed to be connected to the public utility(AC)power line, the radio frequency. Voltage that is conducted back onto the AC power line on any frequencies hopping mode within the band 150 ㎑ to 30 ㎒ shall not exceed the limits in the following table, as measured using a 50 uH/50 ohms line Impedance stabilization network(LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

§15.207 limits for AC line conducted emissions;

Frequency of Emission(㎒)	Conducted Limit (㏈㎶)	
	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

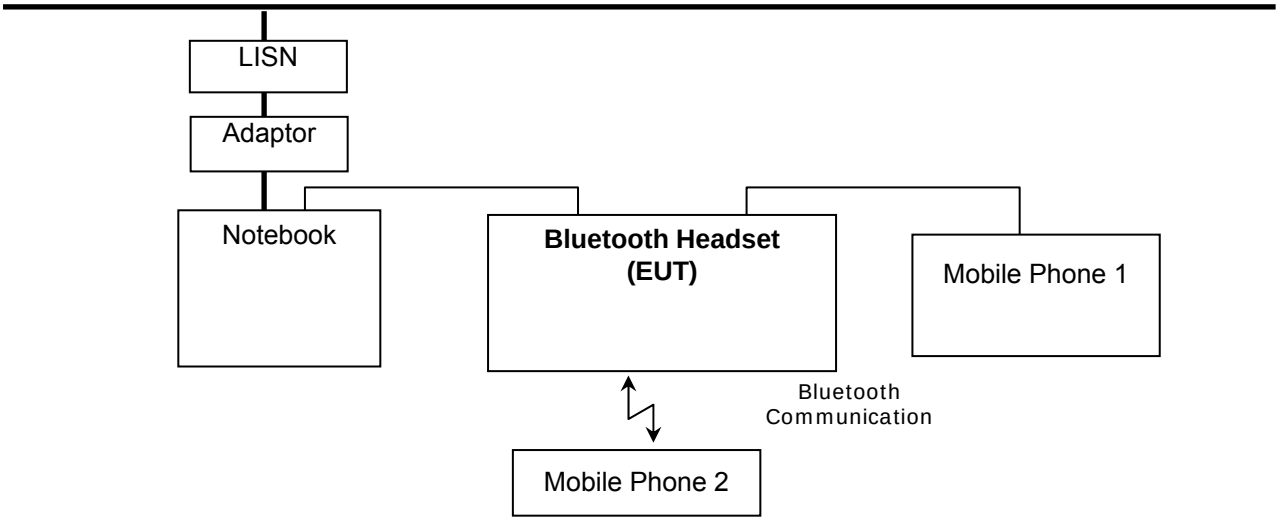
5.10.2 Test Environment conditions

• Ambient temperature : 27 ℃,
• Relative Humidity : (50 - 52) % R.H.

5.10.3 Measurement Procedure

EUT was placed on a non- metallic table height of 0.8 m above the reference ground plane. Cables connected to EUT were fixed to cause maximum emission. Test was made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna was varied in height above the conducting ground plane to obtain the Maximum signal strength.

5.10.4 Test Setup Configuration



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5.10.5 Used equipment

Equipment	Model No.	Serial No.	Manufacturer	Next cal date	Used
Test receiver	ESCS30	100111	R&S	2013.05.18	●
L.I.S.N.	ESH2-Z5	100044	R&S	2013.03.13	-
	ESH3-Z5	100147	R&S	2013.05.18	●

Measurement uncertainty : Conducted Emission measurement: ±2.4 dB (*K*=2)

5.10.5 Measurement Result

< Class B >

Freq. [㎒]	Factor [dB]		POL	QP			AV		
	LISN	CABLE		Limit [dB㎶]	Reading [dB㎶]	Result [dB㎶]	Limit [dB㎶]	Reading [dB㎶]	Result [dB㎶]
0.16	0.09	0.1	N	65.58	44.65	44.84	55.58	35.34	35.53
0.17	0.09	0.1	L	64.98	44.60	44.79	54.98	33.00	33.19
0.33	0.09	0.1	N	59.56	43.87	44.06	49.56	35.32	35.51
0.36	0.09	0.1	L	58.71	48.07	48.26	48.71	37.85	38.04
0.38	0.09	0.1	N	58.18	50.00	50.19	48.18	40.04	40.23
0.40	0.09	0.1	L	57.93	49.38	49.57	47.93	39.88	40.07
0.53	0.10	0.1	L	56.00	38.46	38.66	46.00	27.62	27.82
0.65	0.10	0.1	N	56.00	34.33	34.53	46.00	29.14	29.34
0.88	0.11	0.1	N	56.00	31.63	31.84	46.00	27.64	27.85
2.06	0.13	0.2	N	56.00	32.24	32.57	46.00	29.89	30.22
3.83	0.13	0.2	N	56.00	29.30	29.63	46.00	26.60	26.93
4.42	0.13	0.2	N	56.00	30.07	30.40	46.00	28.08	28.41
5.01	0.20	0.2	N	60.00	32.29	32.69	50.00	28.04	28.44
9.71	0.27	0.2	L	60.00	31.70	32.17	50.00	25.82	26.29
12.07	0.31	0.2	N	60.00	35.18	35.73	50.00	33.14	33.69
13.24	0.31	0.3	L	60.00	35.66	36.23	50.00	28.57	29.14
13.25	0.31	0.3	N	60.00	38.62	39.19	50.00	33.88	34.45
16.19	0.44	0.3	N	60.00	32.66	33.40	50.00	29.01	29.75

* LISN: LISN insertion Loss, Cable: Cable Loss
* Reading: test receiver reading value
* Result = LISN + Cable + Reading

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5.10.6 Test Plot

Line. Live

Kostec Co., Ltd. 21 Aug 2012 21:26

Conducted Emission

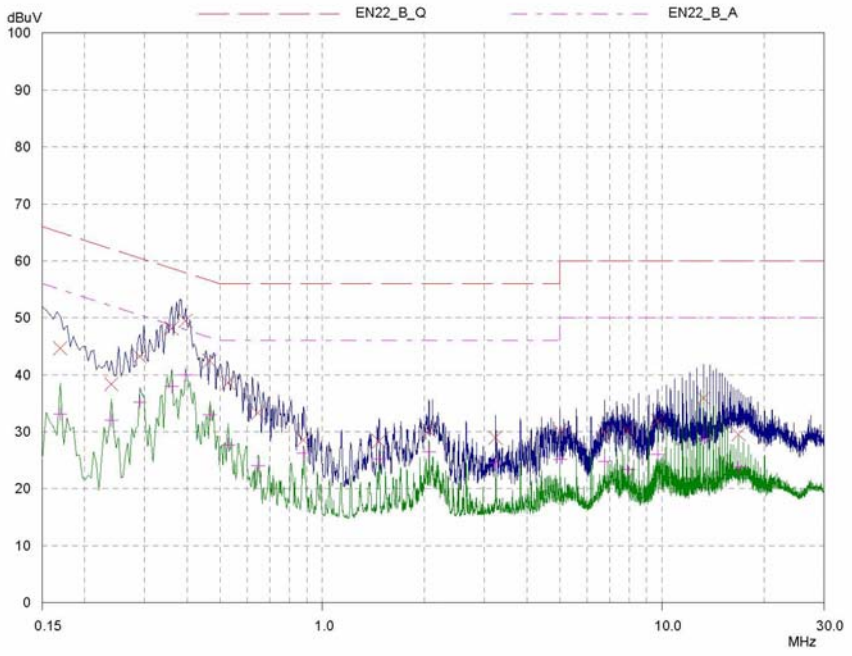
EUT:	BN749-X
Manuf:	BENCH-SOFT
Op Cond:	AC 120 V / 60 Hz
Operator:	J.H. Lee
Test Spec:	FCC
Comment:	Live
	BT
Result File:	o0060_l.dat : New Measurement

Scan Settings (1 Range)

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
150kHz	30MHz	3.9063kHz	9kHz	PK+AV	10msec	15 dB	OFF	60dB

Transducer	No.	Start	Stop	Name
	12	9kHz	30MHz	CNEFactor

Final Measurement:		
	Detectors:	X QP / + AV
	Meas Time:	1sec
	Subranges:	25
	Acc Margin:	50 dB



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Line. Neutral

Kostec Co., Ltd. 21 Aug 2012 21:18

Conducted Emission

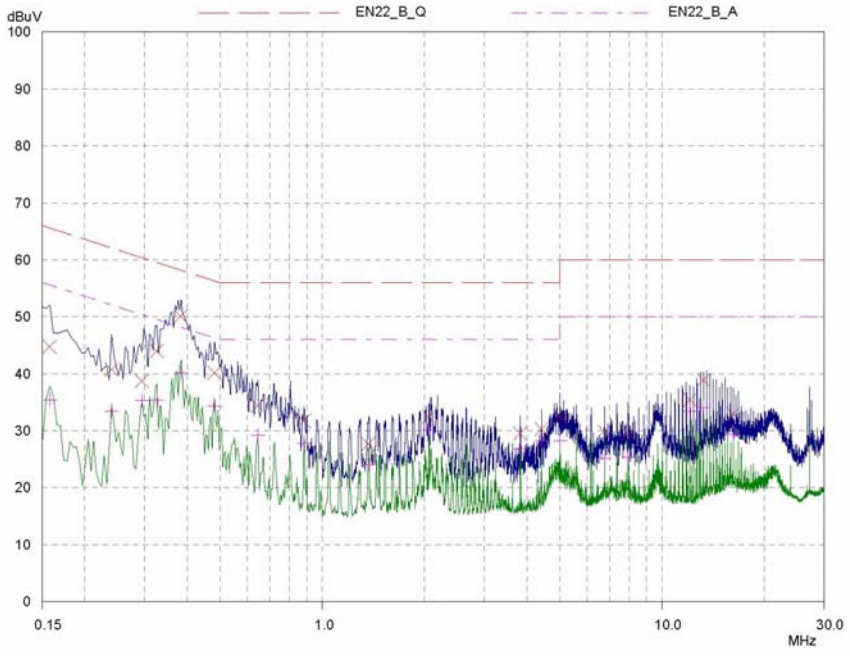
EUT:	BN749-X
Manuf:	BENCH-SOFT
Op Cond:	AC 120 V / 60 Hz
Operator:	J.H. Lee
Test Spec:	FCC
Comment:	Neutral
	BT
Result File:	o0060_n.dat : New Measurement

Scan Settings (1 Range)

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
150kHz	30MHz	3.9063kHz	9kHz	PK+AV	10msec	15 dB	OFF	60dB

Transducer	No.	Start	Stop	Name
	12	9kHz	30MHz	CNEFactor

Final Measurement:		
	Detectors:	X QP / + AV
	Meas Time:	1sec
	Subranges:	25
	Acc Margin:	50 dB



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5.11 Antenna requirement

5.11.1 Standard applicable [FCC §15.203, §15.247(4)(1)]

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by responsible party shall be used with the device.

The use of a permanently attached antenna or of an antenna that user a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

The manufacturer may design the unit So that broken antenna can be replaced by the user, but the Use of a standard antenna jack or electrical connector is prohibited.

And according to §15.247(4)(1), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

According to above requirement standard's This product's antenna type is an PCB type and it's gain is -1.0 dBi, So radiated emission field strength from EUT is below requirement standard limit

5.11.2 Antenna gain

Frequency Band	Gain [dBi]	Limit [dBi]	Results
(2 400 ~ 2 485) MHz	-1.0	≤ 6	Compliance