

# TEST REPORT

Report No: KST-FCR-150004

<b>Applicant</b>	Name	YL Co., Ltd.
	Address	#85404 Sungkyunkwan University 2066, Seobu-ro, jangan-gu, Suwon-si, Gyeonggi-do, Korea
<b>Manufacturer</b>	Name	YL Co., Ltd.
	Address	#85404 Sungkyunkwan University 2066, Seobu-ro, jangan-gu, Suwon-si, Gyeonggi-do, Korea
<b>Equipment</b>	Name	LED Engine for HBE
	Model No	YLRK120_HBE_Engine-130W
	Brand	None
	FCC ID	2AGMP-YLRK120-130
<b>Test Standard</b>	FCC CFR 47, Part 15. Subpart C-15.247 558074 D01 DTS Meas. Guidance v03r03	
<b>Test Date(s)</b>	2015. 11. 19 - 2015. 11. 20	
<b>Issue Date</b>	2015. 11. 23	
<b>Test Result</b>	Compliance	
<b>Note</b>	None	

## 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 63.10-2013.

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.

128(175-20,Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeonggi-do, 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 C 63.10-2013.

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

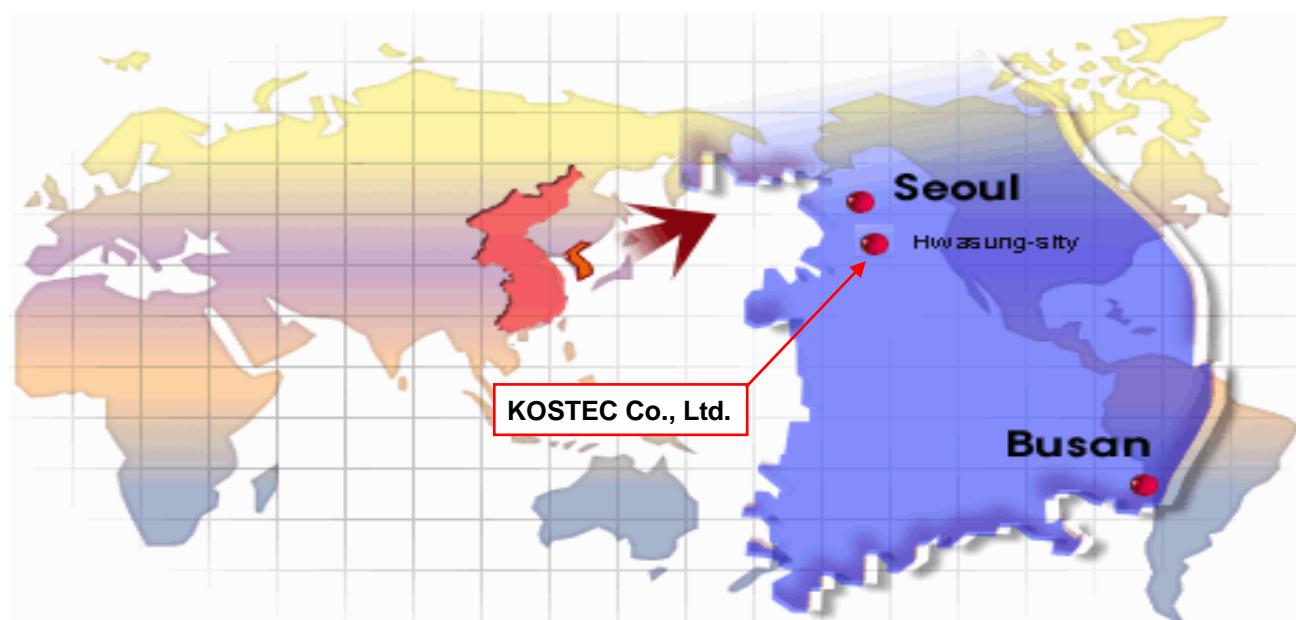
KCC (Korea Communications Commission) Number : KR0041

KOLAS(Korea Laboratory Accreditation Scheme) Number : 232

FCC Registration Number(FRN) : 525762

IC Registration Site Number : 8305A

### 1.2 Location



## Revision History of test report

Rev.	Revisions	Effect page	Reviewed	Date
-	Initial issue	All	Gyeong Hyeon, Park	2015. 11. 23
1	Add spurious graph	22 - 26	Gyeong Hyeon, Park	2015. 11. 26

## 2. EQUIPMENT DESCRIPTION

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

Equipment Name	LED Engine for HBE
Model No	YLRK120_HBE_Engine-130W
Usage	BT LED light
Serial Number	Proto type
Modulation type	GFSK
Emission Type	F1D
Maximum output power	-2.56 dBm
Operated Frequency	2 402 MHz - 2 480 MHz
Channel Number	40
Operation temperature	0 °C ~ + 40 °C
Power Source	DC 39.5 V
Antenna Description	Internal chip Antenna, Max gain: 1.99 dBj
Remark	<p>1. The data rates used when evaluating the EUT were the lowest data rates. The device was operating at its maximum output power at the lowest data rate for all measurements.</p> <p>2. Regarding to the operation frequency, the lowest, middle and highest frequency are selected to perform the test.</p> <p>3. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case (X) is shown in the report.</p> <p>4. The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description.</p>
FCC ID	2AGMP-YLRK120-130

### 3. SYSTEM CONFIGURATION FOR TEST

#### 3.1 Characteristics of equipment

The equipment under test was an wireless LED controller with the functions of bluetooth operating in the 2.4 GHz bands.

#### 3.2 Used peripherals list

Description	Model No.	Serial No.	Manufacture	Remark
Notebook	BCM-1063	2Z7S1Z1	Dell Inc	
Adapter	DA65NM111-00	None	Dell Inc	For notebook

#### 3.3 Product Modification

N/A

#### 3.4 Operating Mode

\* Constantly transmitting with a modulated carrier at maximum power on the bottom, middle and top channels.

#### 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 and cables were provided by the applicant.



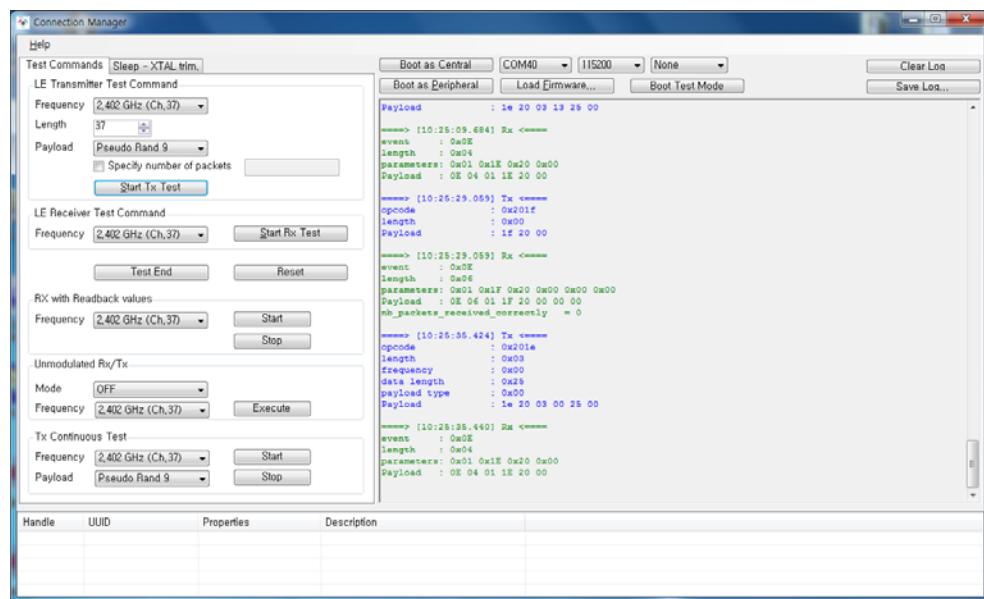
### 3.6 Parameters of Test Software Setting

During testing, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

#### ■ TX Power setting value during test

Band	Rate	TX Power setting value		
		Low CH	Middle CH	High CH
2.4 GHz band	1 Byte	0	0	0

#### ■ Test Program



#### ■ Test Program Version



### 3.7 Table for Carrier Frequencies

Channel	Frequency (MHz)						
0	2 402	10	2 422	20	2 442	30	2 462
1	2 404	11	2 424	21	2 444	31	2 464
2	2 406	12	2 426	22	2 446	32	2 466
3	2 408	13	2 428	23	2 448	33	2 468
4	2 410	14	2 430	24	2 450	34	2 470
5	2 412	15	2 432	25	2 452	35	2 472
6	2 414	16	2 434	26	2 454	36	2 474
7	2 416	17	2 436	27	2 456	37	2 476
8	2 418	18	2 438	28	2 458	38	2 478
9	2 420	19	2 440	29	2 460	39	2 480

### 3.8 Used Test Equipment List

No.	Instrument	Model	S/N	Manufacturer	Due to cal date	Cal interval	used
1	T & H Chamber	EY-101	90E14260	TABAI ESPEC	2016.09.17	1 year	<input type="checkbox"/>
2	Constant switch Tester	DS-COT	None	Dong sung Ele.	N/A	N/A	<input type="checkbox"/>
3	Vibration Tester	70UA	L90016	INDEX Co.,Ltd	N/A	N/A	<input type="checkbox"/>
4	Vibration Meter	VM-6360	N225098	LANDTEK	2016.04.07	1 year	<input type="checkbox"/>
5	Falling Tester	SWD-8000	None	Sinwoo	N/A	N/A	<input type="checkbox"/>
6	Spectrum Analyzer	8563E	3846A10662	Agilent Technology	2016.02.05	1 year	<input type="checkbox"/>
7	Spectrum Analyzer	8593E	3710A02859	Agilent Technology	2016.02.05	1 year	<input type="checkbox"/>
8	Spectrum Analyzer	FSV30	20-353063	Rohde & Schwarz	2016.02.05	1 year	<input checked="" type="checkbox"/>
9	EMI Test Receiver	ESCI7	100823	Rohde & Schwarz	2016.02.02	1 year	<input checked="" type="checkbox"/>
10	EMI Test Receiver	ESI	834000/002	Rohde & Schwarz	2016.02.05	1 year	<input checked="" type="checkbox"/>
11	Vector Signal Analyzer	89441A	3416A02620	Agilent Technology	2016.02.05	1 year	<input type="checkbox"/>
12	Network Analyzer	8753ES	US39172348	AGILENT	2016.09.16	1 year	<input type="checkbox"/>
13	EPM Series Power meter	E4418B	GB39512547	Agilent Technology	2016.02.05	1 year	<input type="checkbox"/>
14	RF Power Sensor	E9300A	MY41496631	Agilent Technology	2016.02.05	1 year	<input type="checkbox"/>
15	Microwave Frequency Counter	5352B	2908A00480	Agilent Technology	2016.02.02	1 year	<input type="checkbox"/>
16	Modulation Analyzer	8901A	3538A07071	Agilent Technology	2016.02.05	1 year	<input type="checkbox"/>
17	Audio Analyzer	8903B	3514A16919	Agilent Technology	2016.02.02	1 year	<input type="checkbox"/>
18	Audio Telephone Analyzer	DD-5601CID	520010281	CREDIX	2016.02.02	1 year	<input type="checkbox"/>
19	Digital storage Oscilloscope	TDS3052	B015962	Tektronix	2016.09.16	1 year	<input type="checkbox"/>
20	ESG-D Series Signal Generator	E4436B	US39260458	Agilent Technology	2016.02.04	1 year	<input checked="" type="checkbox"/>
21	ESG Vector Signal Generator	E4438C	MY42083133	Agilent Technology	2016.09.16	1 year	<input checked="" type="checkbox"/>
22	Vector Signal Generator	SMBV100A	257557	Rohde & Schwarz	2016.01.10	1 year	<input type="checkbox"/>
23	Tracking Source	85645A	070521-A1	Agilent Technology	2016.02.05	1 year	<input type="checkbox"/>
24	SLIDAC	None	0207-4	Myoung sung Ele.	2016.02.02	1 year	<input type="checkbox"/>
25	DC Power supply	DRP-5030	9028029	Digital Electronic Co.,Ltd	2016.02.03	1 year	<input type="checkbox"/>
26	DC Power supply	6038A	3440A12674	Agilent Technology	2016.02.02	1 year	<input checked="" type="checkbox"/>
27	DC Power supply	E3610A	KR24104505	Agilent Technology	2016.02.02	1 year	<input type="checkbox"/>
28	DC Power supply	UP-3005T	68	Unicon Co.,Ltd	2016.02.02	1 year	<input type="checkbox"/>
29	DC Power Supply	SM 3004-D	114701000117	DELTA ELEKTRONIKA	2016.02.02	1 year	<input type="checkbox"/>
30	Dummy Load	8173	3780	Bird Electronic Co., Corp	2016.02.04	1 year	<input type="checkbox"/>
31	Attenuator	50FH-030-500	140410 9433	JEW Industries Inc.	2016.02.04	1 year	<input type="checkbox"/>
32	Attenuator	765-20	9703	Narda	2016.09.16	1 year	<input type="checkbox"/>
33	Attenuator	8498A	3318A09485	HP	2016.02.04	1 year	<input type="checkbox"/>
34	Step Attenuator	8494B	3308A32809	HP	2016.02.05	1 year	<input type="checkbox"/>
35	Step Attenuator	8495D	3308A01464	HP	2016.02.05	1 year	<input checked="" type="checkbox"/>
36	Power divider	11636B	51212	HP	2016.02.04	1 year	<input type="checkbox"/>
37	3Way Power divider	KPDSU3W	00070365	KMW	2016.09.16	1 year	<input type="checkbox"/>
38	Band rejection filter	WTR-BRF2442-84NN	09020001	WAVE TECH Co.,LTD	2016.02.04	1 year	<input type="checkbox"/>
39	White noise audio filter	ST31EQ	101902	SoundTech	2016.09.16	1 year	<input type="checkbox"/>
40	Dual directional coupler	778D	17693	HEWLETT PACKARD	2016.02.04	1 year	<input type="checkbox"/>
41	Dual directional coupler	772D	2839A00924	HEWLETT PACKARD	2016.02.04	1 year	<input type="checkbox"/>
42	Band rejection filter	3TNF-0006	26	DOVER Tech	2016.02.04	1 year	<input type="checkbox"/>
43	Band rejection filter	3TNF-0008	317	DOVER Tech	2016.02.04	1 year	<input type="checkbox"/>
44	Band rejection filter	3TNF-0007	311	DOVER Tech	2016.02.04	1 year	<input type="checkbox"/>
45	Highpass Filter	WHJS1100-10EF	1	WAINWRIGHT	2016.02.04	1 year	<input type="checkbox"/>
46	Highpass Filter	WHJS3000-10EF	1	WAINWRIGHT	2016.02.04	1 year	<input type="checkbox"/>
47	Radio Communication Analyzer	MT8815A	6200429622	ANRITSU	2016.02.04	1 year	<input type="checkbox"/>
48	CDMA Mobile Station Test Set	E8285A	US40081298	AGILENT	2016.02.05	1 year	<input type="checkbox"/>
49	WideBand Radio Communication Tester	CMW500	102276	Rohde & Schwarz	2016.04.02	1 year	<input type="checkbox"/>



No.	Instrument	Model	S/N	Manufacturer	Due to cal date	Cal interval	used
50	RF Up/Down Converter	DCP-1780	980901003	CREDIX	2016.02.04	1 year	<input type="checkbox"/>
51	DECT Test set	8923B	3829U00364	HP	2016.02.05	1 year	<input type="checkbox"/>
52	DECT Test set	CMD60	840677/005	Rohde & Schwarz	2016.09.16	1 year	<input type="checkbox"/>
53	Loop Antenna	6502	9203-0493	EMCO	2017.06.04	2 year	<input checked="" type="checkbox"/>
54	Dipole Antenna	HZ-12	100005	Rohde & Schwarz	2016.07.01	2 year	<input type="checkbox"/>
55	Dipole Antenna	HZ-13	100007	Rohde & Schwarz	2016.07.01	2 year	<input type="checkbox"/>
56	BiconiLog Antenna	3142B	1745	EMCO	2016.06.16	2 year	<input checked="" type="checkbox"/>
57	Horn Antenna	3115	9605-4834	EMCO	2016.06.16	2 year	<input checked="" type="checkbox"/>
58	Horn Antenna	3115	2996	EMCO	2016.02.26	2 year	<input type="checkbox"/>
59	Horn Antenna	BBHA9170	BBHA9170152	SCHWARZBECK	2017.04.10	2 year	<input type="checkbox"/>
60	Signal Generator	SMT-06	100552	Rohde & Schwarz	2016.02.04	1 year	<input type="checkbox"/>
61	HYGRO-Thermograph	NSII-Q	1611545	SATO	2016.09.21	1 year	<input type="checkbox"/>
62	Barometer	7612	81134	SATO	2016.01.20	2 year	<input type="checkbox"/>
63	Multi meter	DM-313	S60901832	LG Precision Co.,Ltd	2016.02.02	1 year	<input type="checkbox"/>
64	Antenna Mast(OSA)	AT14	None	Daeil EMC	N/A	N/A	<input type="checkbox"/>
65	Turn table(OSA)	None	None	Daeil EMC	N/A	N/A	<input type="checkbox"/>
66	RF Amplifier(OSA)	8447D	2944A07881	AGILENT	2016.02.04	1 year	<input type="checkbox"/>
67	Antenna Master(3)	AT13	None	AUDIX	N/A	N/A	<input checked="" type="checkbox"/>
68	Turn Table(3)	None	None	AUDIX	N/A	N/A	<input checked="" type="checkbox"/>
69	PREAMPLIFIER(3)	8449B	3008A02577	Agilent	2016.02.05	1 year	<input checked="" type="checkbox"/>
70	Antenna Master(10)	MA4000-EP	None	inno systems GmbH	N/A	N/A	<input checked="" type="checkbox"/>
71	Turn Table(10)	None	None	inno systems GmbH	N/A	N/A	<input checked="" type="checkbox"/>
72	AMPLIFIER(10)	TK-PA6S	120009	TESTEK	2016.02.02	1 year	<input checked="" type="checkbox"/>
73	Vernier Calipers	None	8280373	Mitutoyo	2016.09.17	1 year	<input type="checkbox"/>

## 4. SUMMARY TEST RESULTS

Description of Test	FCC Rule	Reference Clause	Used	Test Result
Max. Conducted output power	15.247(b)(3)	Clause 5.1	<input checked="" type="checkbox"/>	Compliance
Power spectral density	15.247(e)	Clause 5.2	<input checked="" type="checkbox"/>	Compliance
6 dB spectrum Bandwidth	15.247(a)(2)	Clause 5.3	<input checked="" type="checkbox"/>	Compliance
Band edge of RF conducted emissions	15.247(d)	Clause 5.4	<input checked="" type="checkbox"/>	Compliance
Spurious RF radiated emissions	15.247(d), 15.209	Clause 5.5	<input checked="" type="checkbox"/>	Compliance
Antenna requirement	15.203, 15.247	Clause 5.6	<input checked="" type="checkbox"/>	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.				

## 5. MEASUREMENT RESULTS

### 5.1 Max. Conducted output power

#### 5.1.1 Standard Applicable [FCC §15.247(b)(3)]

For systems using digital modulation in the 902 – 928 MHz, 2 400 – 2 483.5 MHz, and 5 725 – 5 850 MHz bands: 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.

#### 5.1.2 Test Environment conditions

- Ambient temperature : (20 - 22) °C
- Relative Humidity : (55 - 57 ) % R.H.

#### 5.1.3 Measurement Procedure

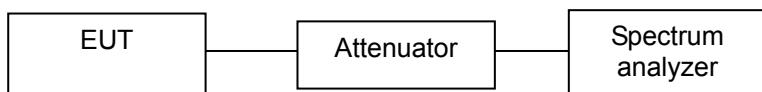
The transmitter output was connected to the spectrum analyzer with an attenuator. The maximum peak output power was measured and recorded with the spectrum analyzer. EUT was programmed to be in continuously transmitting mode.

All conducted power tests were performed using a test receiver in accordance with FCC KDB 558074 v03r03 Section 9.1.1 Measurement Procedure RBW  $\geq$  DTS bandwidth

The spectrum analyzer is set to the as follows :

- Set RBW $\geq$ DTS bandwidth
- Set the VBW  $\geq$  3 x RBW.
- Set the span 3 x RBW.
- Sweep time = auto couple.
- Detector = peak.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level.

#### 5.1.4 Test setup

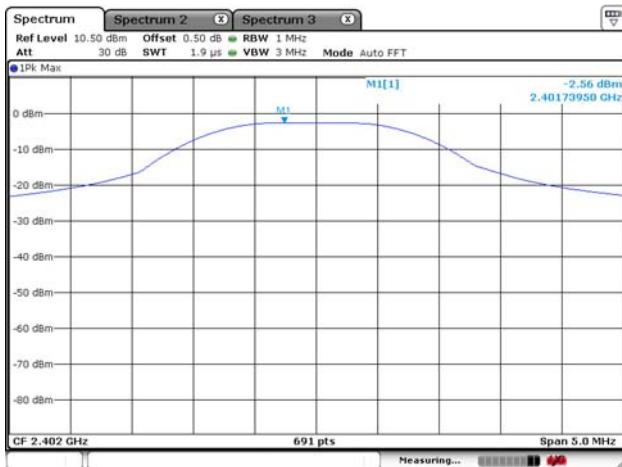


#### 5.1.5 Measurement Result

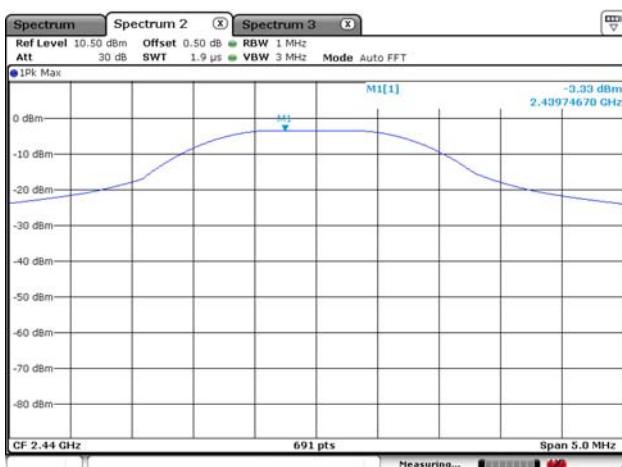
Channel	Frequency [MHz]	Conducted Power		Limit [dBm]	Test Results
		[dBm]	[mW]		
0	2 402	-2.56	0.56	30	Compliance
19	2 440	-3.33	0.47	30	Compliance
39	2 480	-3.02	0.50	30	Compliance

### 5.1.6 Test Plot

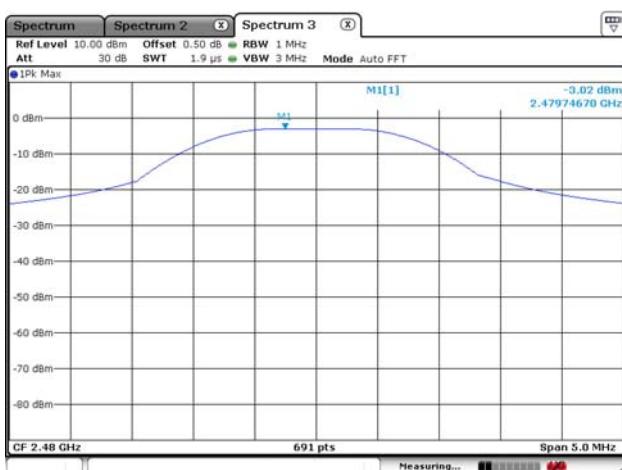
#### CH Low



#### CH Middle



#### CH High



## 5.2 Power spectral density

### 5.2.1 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 dB m in any 3 kHz band during any time interval of continuous transmit

### 5.2.2 Test Environment conditions

- Ambient temperature : (20 - 22) °C
- Relative Humidity : (55 - 57 ) % R.H.

### 5.2.3 Measurement Procedure

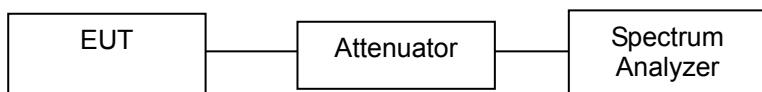
The power spectral density conducted from the intentional radiator was measured with a spectrum analyzer connected to the antenna terminal, while EUT had the highest, middle and the lowest available channels. After the trace being stable, Use the marker-to-peak function to set the marker to the peak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

All conducted power tests were performed using a test receiver in accordance with FCC KDB 558074 v03r03 Section 10.1

The spectrum analyzer is set to the as follows :

- Set analyzer center frequency to DTS channel center frequency.
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- Set the VBW  $\geq 3 \times \text{RBW}$ .
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
- If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 5.2.4 Test setup

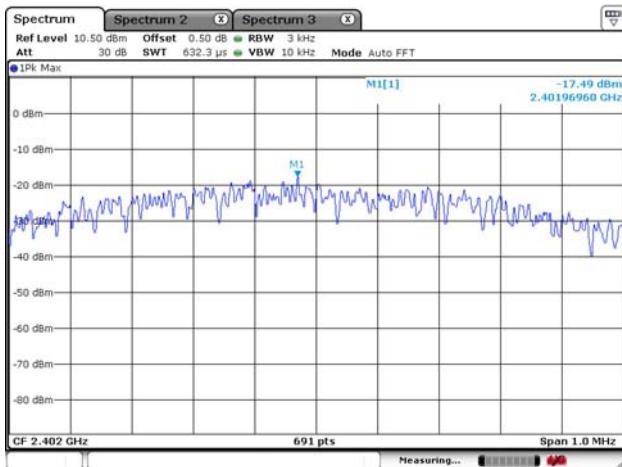


### 5.2.5 Measurement Result

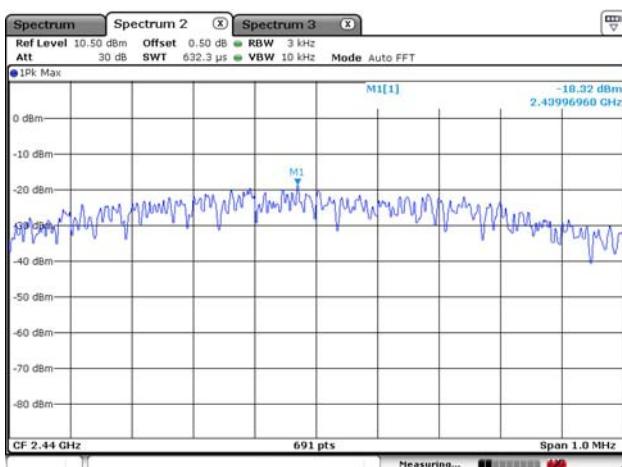
Channel	Frequency [MHz]	Result Value [dBm]	Limit [dBm]	Test Results
0	2 402	-17.49	8	Compliance
19	2 440	-18.32	8	Compliance
39	2 480	-17.86	8	Compliance

## 5.2.6 Test Plot

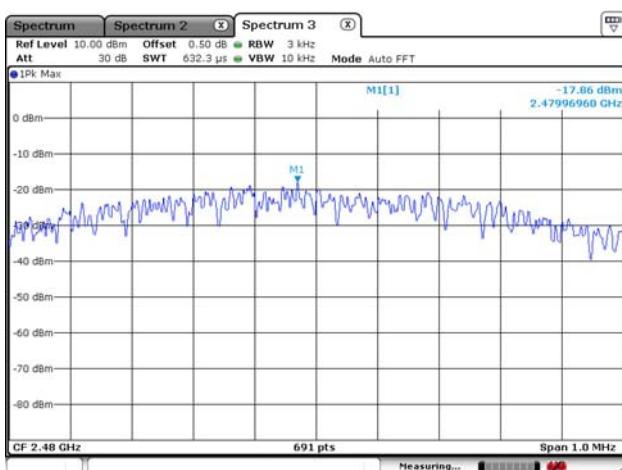
### CH Low



### CH Middle



### CH High





## 5.3 6 dB spectrum Bandwidth

### 5.3.1 Standard Applicable [FCC §15.247(a)(2)]

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 5.3.2 Test Environment conditions

- Ambient temperature : (20 - 22) °C
- Relative Humidity : (55 - 57 ) % R.H.

### 5.3.3 Measurement Procedure

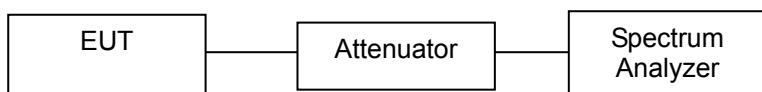
1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
2. The resolution bandwidth of 100 kHz and the video bandwidth of 100 kHz were used.

3. Measured the spectrum width with power higher than 6 dB below carrier.

The spectrum analyzer is set to the as follows :

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- 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.

### 5.3.4 Test setup

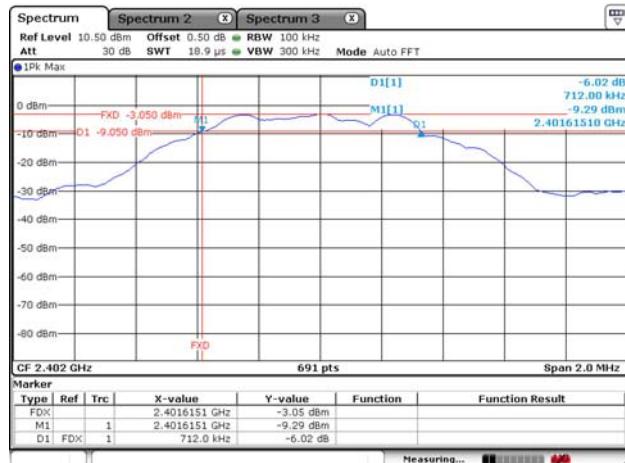


### 5.3.5 Measurement Result

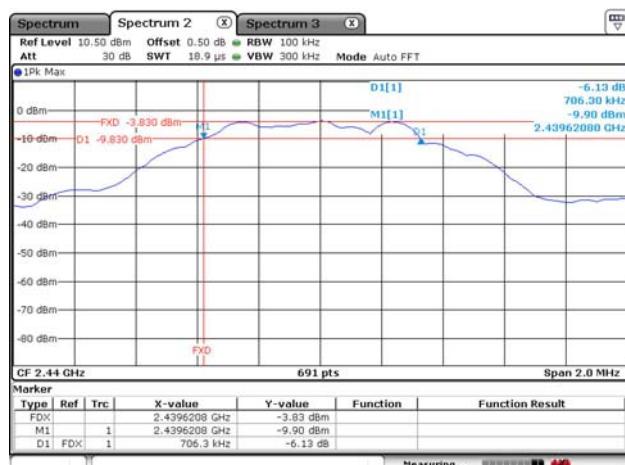
Channel	Frequency [MHz]	6 dB Bandwidth [MHz]	99% Bandwidth [MHz]	Limit [MHz]	Test Results
0	2 402	0.712	1.12	>0.5	Compliance
19	2 440	0.706	1.12	>0.5	Compliance
39	2 480	0.705	1.12	>0.5	Compliance

### 5.3.6 Test Plot (6 dB bandwidth)

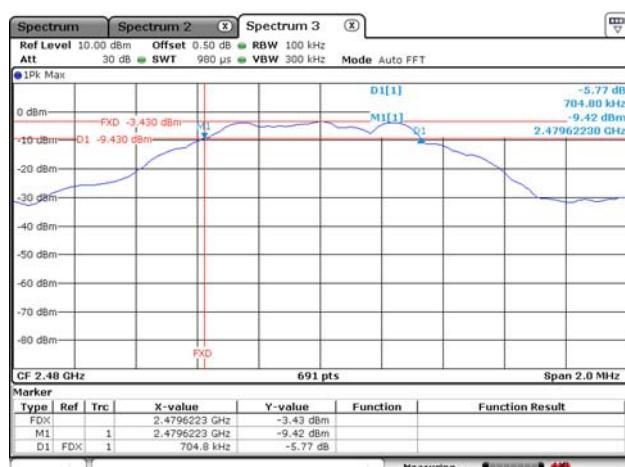
CH Low



CH Middle

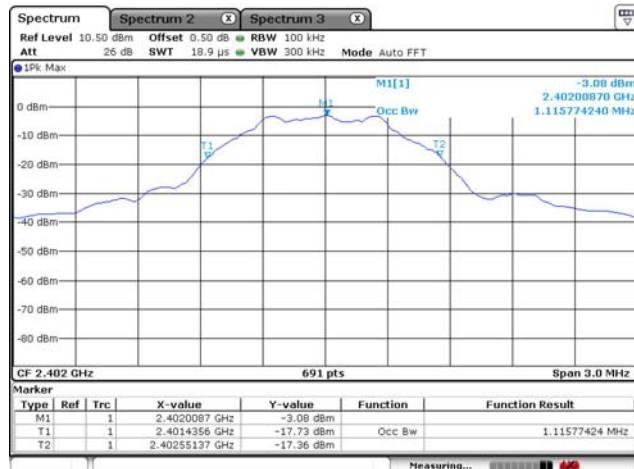


CH High

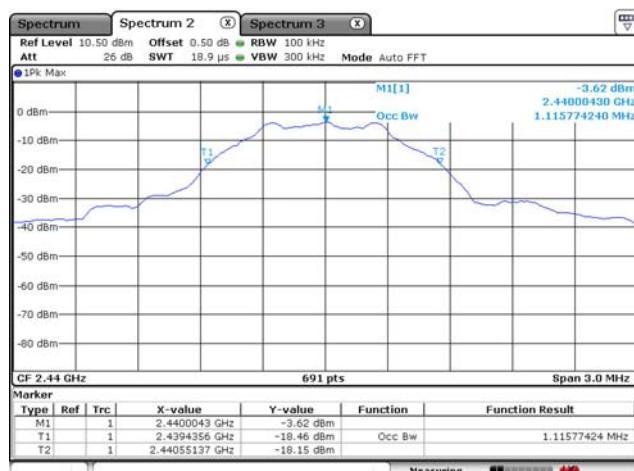


## Test Plot (99 % band width)

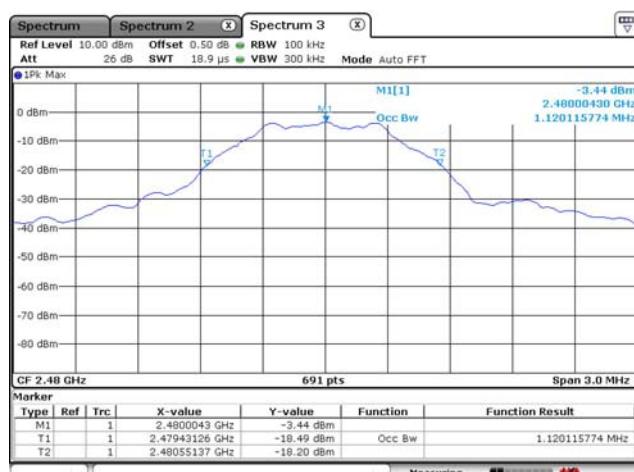
### CH Low



### CH Middle



### CH High



## 5.4 Band-edge Compliance of RF Conducted emissions

### 5.4.1 Standard Applicable [FCC §15.247(d)]

In any 100 kHz 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 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on RF conducted.

### 5.4.2 Test Environment conditions

- Ambient temperature : (20 - 22) °C
- Relative Humidity : (55 - 57) % R.H.

### 5.4.3 Measurement Procedure

- ① Pre-calibration for the spectrum analyzer has to be done first through a reference CW signal from signal generator.
- 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.
- 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 KDB 558074 v03r03.

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 kHz ( $\geq 1\%$  of the span)
- VBW :  $\geq$  RBW
- Sweep : auto
- Detector function : peak
- Trace : Max hold

### 5.4.4 Test setup

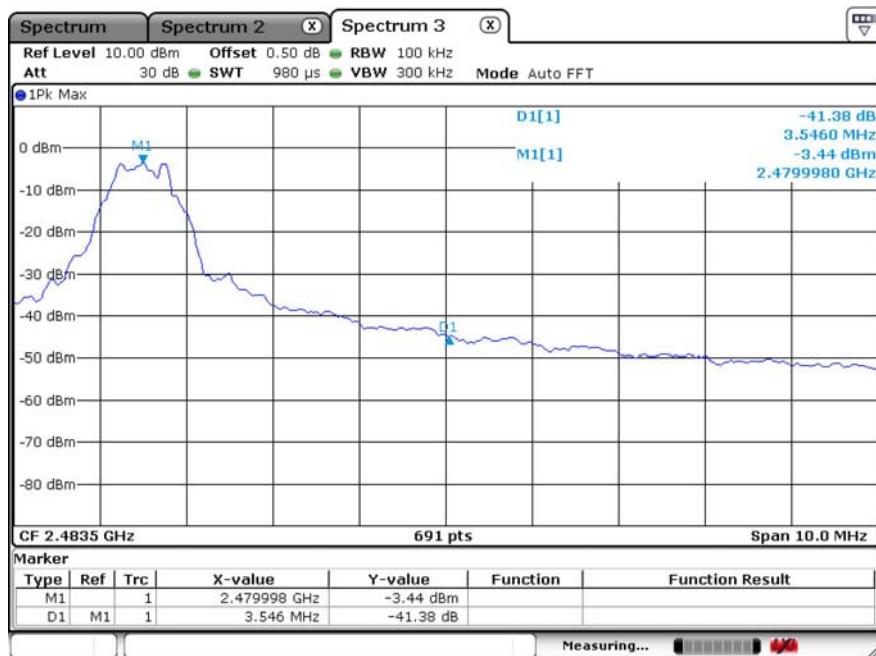
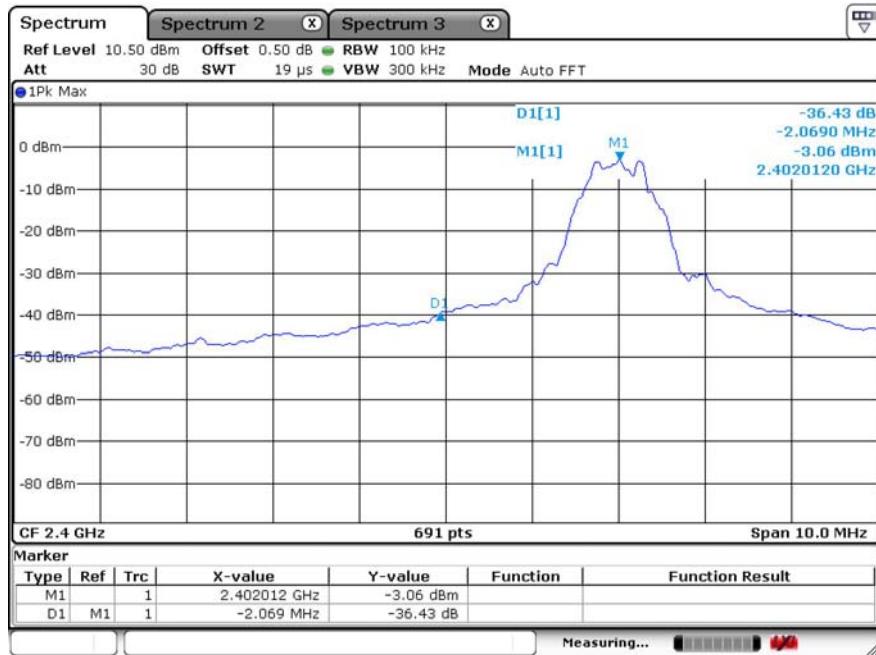
Please refer 5.3.4

### 5.4.5 Measurement Result

Setting Channel		Test Results		
		Measured value [dB]	Limit [dB]	Result
0	$\sim 2400$ MHz	-36.43	$\leq 20$ than PSD level	Compliance
39	2483.5 MHz ~	-41.38		Compliance



#### 5.4.6 Test Plot (Band-edge)



## 5.5 Spurious RF Radiated emissions

### 5.5.1 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 GHz, the frequency Range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, 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 3 m)

Frequency Band [MHz]	DISTANCE[Meters]	Limit [ $\mu\text{V}/\text{m}$ ]	Limit [ $\text{dB}(\mu\text{V}/\text{m})$ ]	Detector
0.009 ~ 0.490	300	2400/F(kHz)	67.6-20log(F)	Peak
0.490 ~ 1.705	30	24000/F(kHz)	87.6-20log(F)	Peak
1.705 ~ 30.0	30	30	29.54	Peak
30 - 88	3	100 **	40.00	Quasi peak
88 - 216	3	150 **	43.52	Quasi peak
216 - 960	3	200 **	46.02	Quasi peak
Above 960	3	500	54.00	Average
Above 1000	3	74.0 dB( $\mu\text{V}/\text{m}$ ) (Peak), 54.0 dB( $\mu\text{V}/\text{m}$ ) (Average)		

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

[MHz]	[MHz]	[MHz]	[GHz]
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

### 5.5.2 Test Environment conditions

- Ambient temperature : (20 - 22) °C
- Relative Humidity : (55 - 57 ) % R.H.

### 5.5.3 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 for below 1 GHz and a 1.5 m for above 1 GHz 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 resolution bandwidth below 30 MHz setting on the field strength meter is 9 kHz and 30 MHz ~ 1 GHz is 120 kHz and above 1 GHz, both Peak and Average level were measured with Spectrum Analyzer, and the RBW is set at 1 MHz, VBW is set at 3 MHz for Peak measure; RBW is set at 1 MHz, VBW is set at 10 Hz for Average measure(according ANSI C63.10:2013 clause 4.2.3.2.3 procedure for average measure). Both PK and AV level test, PK detector is used.
- 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:  

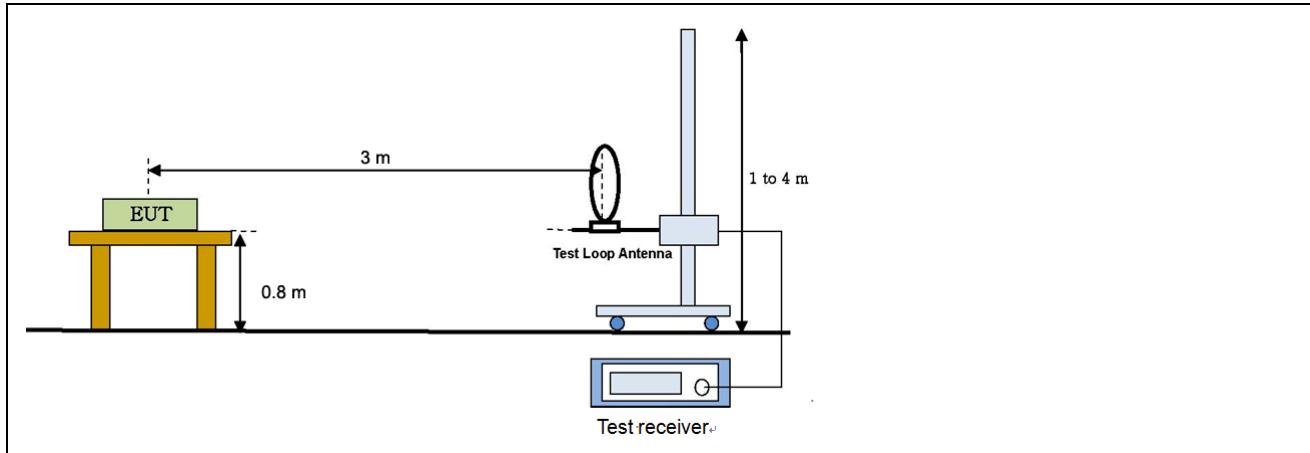
$$\text{Result(dB } \mu\text{V/m)} = \text{Reading(dB } \mu\text{V)} + \text{Antenna factor(dB/m)} + \text{CL(dB)} + \text{other applicable factor (dB)}$$
  - According to §15.33 (a)(1), Frequency range of radiated measurement is performed the tenth harmonic.

### 5.5.4 Measurement Uncertainty

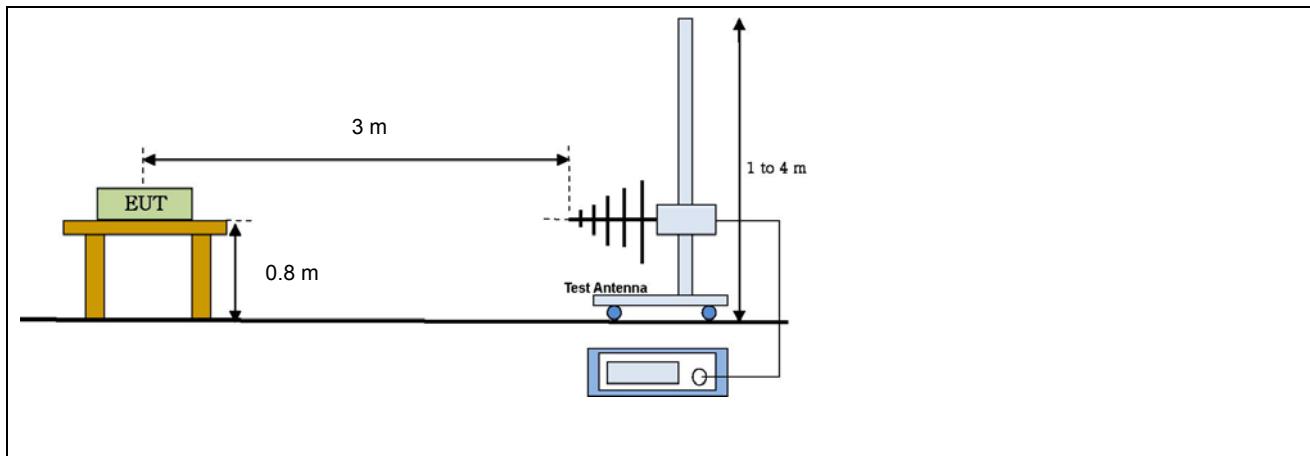
All measurements involve certain levels of uncertainties. The factors contributing to uncertainties are test receiver, Cable loss, Antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, Antenna frequency interpolation, measurement distance 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  $\pm 6.0$  dB

### 5.5.5 Test Configuration

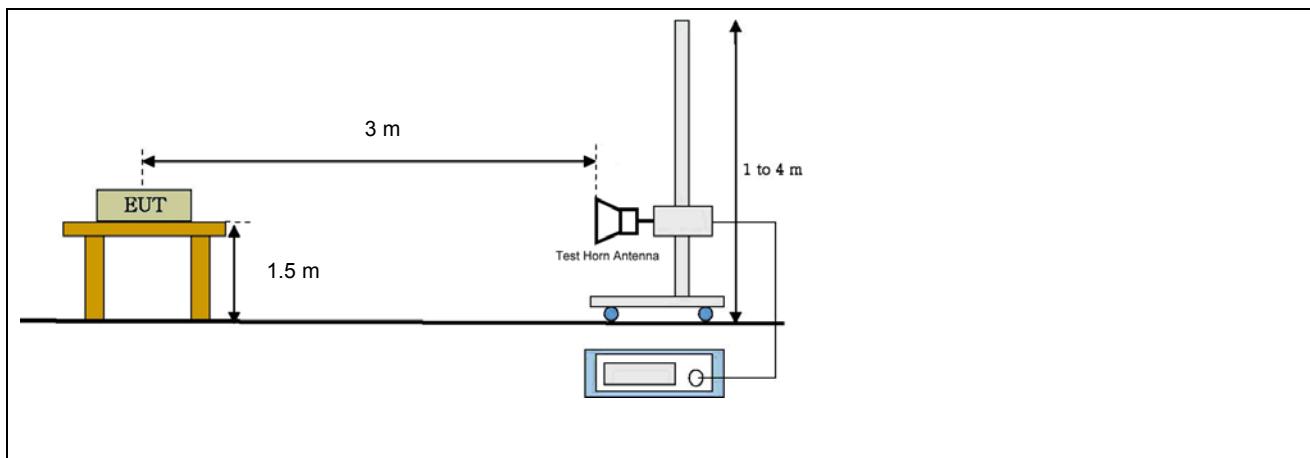
Radiated emission setup, Below 30 MHz



Radiated emission setup, Below 1 000 MHz



Radiated emission setup, Above 1 GHz



### 5.5.6 Measurement Result

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available data rates. Following channel(s) was (were) selected for the final test as listed below.

Band	Tested channel	Modulation	Data rate	Tested frequency band
2.4 GHz	0, 19, 39	GFSK	1 Byte	Above 1 GHz
	19	GFSK	1 Byte	Below 1 GHz

Above 1 GHz

CH 0(2 402 MHz)

Freq. (GHz)	Reading (dB $\mu$ V/m)		Table (Deg)	Antenna			CL+AMP (dB)	Meas Result (dB $\mu$ V/m)		Limit (dB $\mu$ V/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)		PK	AV	PK	AV	PK	AV	
2.142	48.32	38.00	170	1.5	H	27.88	-32.05	44.15	33.83	74	54	29.85	20.17	Compliance

There are no emissions above 2.142 GHz.

CH 19(2 440 MHz)

Freq. (GHz)	Reading (dB $\mu$ V/m)		Table (Deg)	Antenna			CL+AMP (dB)	Meas Result (dB $\mu$ V/m)		Limit (dB $\mu$ V/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)		PK	AV	PK	AV	PK	AV	
2.142	47.54	35.87	170	1.5	H	27.88	-32.05	43.37	31.70	74	54	30.63	22.30	Compliance

There are no emissions above 2.142 GHz.

CH 39(2 480 MHz)

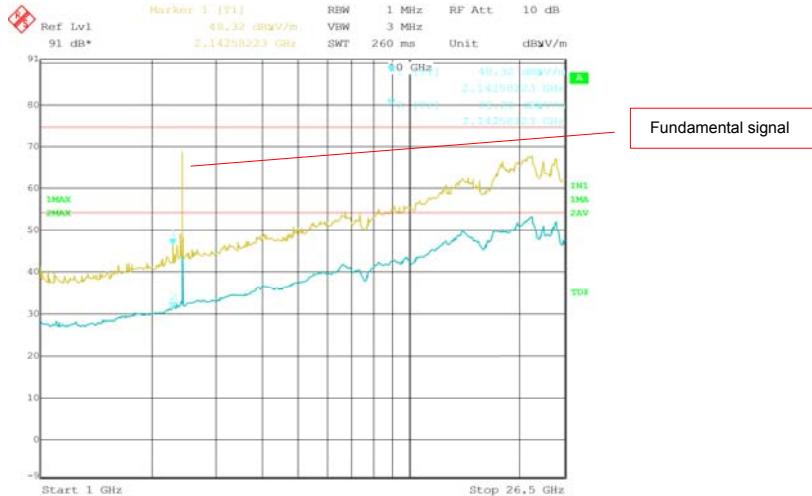
Freq. (GHz)	Reading (dB $\mu$ V/m)		Table (Deg)	Antenna			CL+AMP (dB)	Meas Result (dB $\mu$ V/m)		Limit (dB $\mu$ V/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)		PK	AV	PK	AV	PK	AV	
2.142	48.00	36.13	170	1.5	H	27.88	-32.05	43.83	31.96	74	54	30.17	22.04	Compliance

There are no emissions above 2.142 GHz.

**\*Note**

- Above 1 GHz is measured average and peak detector mode on Spectrum analyzer in accordance with FCC Rule15.35
- Limit: 54 dB $\mu$ V/m(Average), 74 dB $\mu$ V/m(Peak), Attenuated more than 20 dB below the permissible value.
- 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.
- For the below 30 MHz and above 2.142 GHz, measured any other signal is not detected on test receiver
- The transmitter radiated spectrum was investigated from 9 kHz to 26.5 GHz.

\* Worst case only.



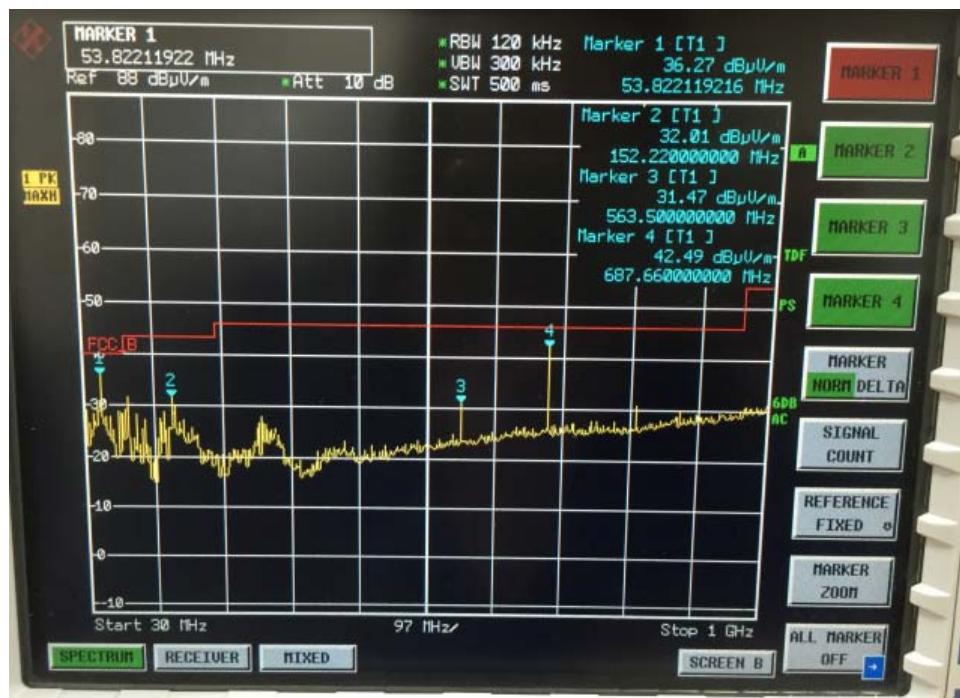


Below 1 GHz

CH 19(2 440 MHz)

Freq. (MHz)	Reading (dB $\mu$ V/m)	Table (Deg)	Antenna			CL (dB)	AMP (dB)	Meas Result (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Mgn (dB)	Result
			Height (m)	Pol. (H/V)	Fctr. (dB/m)						
53.82	3.77	160	1.5	V	20.96	0.49	8.01	33.23	40.00	6.77	Compliance
152.22	6.10	160	1.5	V	14.17	1.15	8.44	29.86	43.52	13.66	Compliance
563.50	-10.34	170	1.5	V	18.16	2.65	19.79	30.25	46.02	15.77	Compliance
687.66	-5.75	160	1.5	V	19.73	2.94	21.93	38.85	46.02	7.17	Compliance

Freq.(MHz) : Measurement frequency, Reading(dB $\mu$ V/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 $\mu$ V/m) : Reading(dB $\mu$ V/m) + Antenna factor.(dB/m) + CL(dB) - Pre AMP(dB)  
Limit(dB $\mu$ V/m) : Limit value specified with FCC Rule, Mgn(dB) : FCC Limit (dB $\mu$ V/m) - Meas Result(dB $\mu$ V/m)



## 5.6 Antenna requirement

### 5.6.1 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 dB<sub>i</sub>.

### 5.6.2 Antenna gain

Frequency Band	Antenna Type	Gain [dB <sub>i</sub> ]	Limit [dB <sub>i</sub> ]	Results
2.4 GHz	Chip Antenna (Permanently attached antenna)	1.99	≤ 6	Compliance