KES Co., Ltd.
C-3701 Dongil Techno Town, 889-1, Gwanyang 2-dong,
Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

TEST REPORT

Part 15 Subpart C 15.247

Equipment under test	TWSN
Model name	SC-100
FCC ID	PBUSC-100
Applicant	Jcast Network Korea, Inc.
Manufacturer	Jcast Network Korea, Inc.
Date of test(s)	2012.08.13 ~ 2012.08.17
Date of issue	2012.08.17

Issued to

Jcast Network Korea, Inc.
Anyang Mega Velly, 605, 268, Gwanyang-dong, Hagui-ro, Dong-an-gu Anyang-si,
Gyeonggi-do, Korea

Issued by

KES Co., Ltd.
C3701 Dongil Techno Town, 889-1, Gwanyang 2-dong, Dongan-gu, Anyang-si,
Gyeonggi-do, 431-716, Korea
477-6, Hageo-ri, Yeoju-eup, Yeoju-gun, Gyeonggi-do, 469-803, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450

Test and report completed by :	**Report approval by :**
	
Jae Jun Lee Test engineer	Gyu-cheol Shin Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2012.08.17	KES-RF-120060	Initial

TABLE OF CONTENTS

1.0 General product description

Equipment under test	TWSN
Model name	SC-100
Serial number	N/A
Frequency Range	2 405 ㎒ ~ 2 480 ㎒
Modulation technique	DSSS
Number of channels	16
Antenna type & gain	Patch Antenna // 2.9 dBi
Power source	DC 3.6 V

1.1 Test frequency

	Low channel	**Middle channel**	**High channel**
Frequency (㎒)	2 405	2 440	2 480

1.2 Model differences

N/A

1.3 Device modifications

N/A

1.4 Test facility

C3701 Dongil Techno Town, 889-1, Gwanyang 2-dong, Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea
477-6, Hageo-ri, Yeoju-eup, Yeoju-gun, Gyeonggi-do, 469-803, Korea

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

1.5 Laboratory accreditations and listings

Country	Agency	Scope of accreditation	Certificate No.
USA	FCC	3 & 10 meter Open Area Test Sites and one conducted site to perform FCC Part 15/18 measurements.	343818
KOREA	KC	EMI (10 meter Open Area Test Site and two conducted sites) Radio (3 & 10 meter Open Area Test Sites and one conducted site)	KR0100
Canada	IC	3 & 10 meter Open Area Test Sites and one conducted site	4769B-1

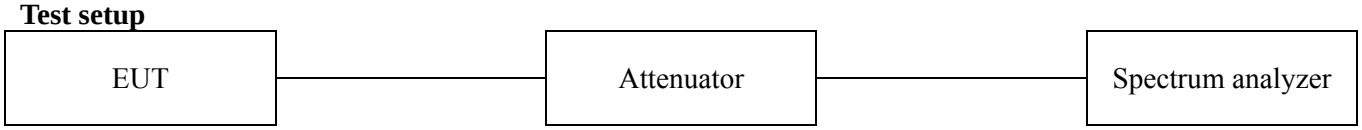
2.0 Summary of tests

Section	Parameter	Status
15.247(a)(2) ANSI C63.4-2003 KDB558074 D01 DTS Meas Guidance v01	6 dB bandwidth	C
15.247(b)(3) ANSI C63.4-2003 KDB558074 D01 DTS Meas Guidance v01	Output power	C
15.247(e) ANSI C63.4-2003 KDB558074 D01 DTS Meas Guidance v01	Power spectral density	C
15.205(a), 15.209(a), 15.247(d) ANSI C63.4-2003 KDB558074 D01 DTS Meas Guidance v01	Radiated spurious emission and conducted spurious emission	C
Note: C=Complies NC=Not complies NT=Not tested NA=Not applicable		

2.1 Test data

2.1.1 6 dB bandwidth

Test setup



Test procedure

The testing follows KDB publication No. 558074 D01 DTS measurement.

1. Set resolution bandwidth (RBW) = 1~5 % of the emission bandwidth (EBW).
2. Set the video bandwidth (VBW) ≥ 3 × RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission. Compare the resultant bandwidth with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is 1~5 %.

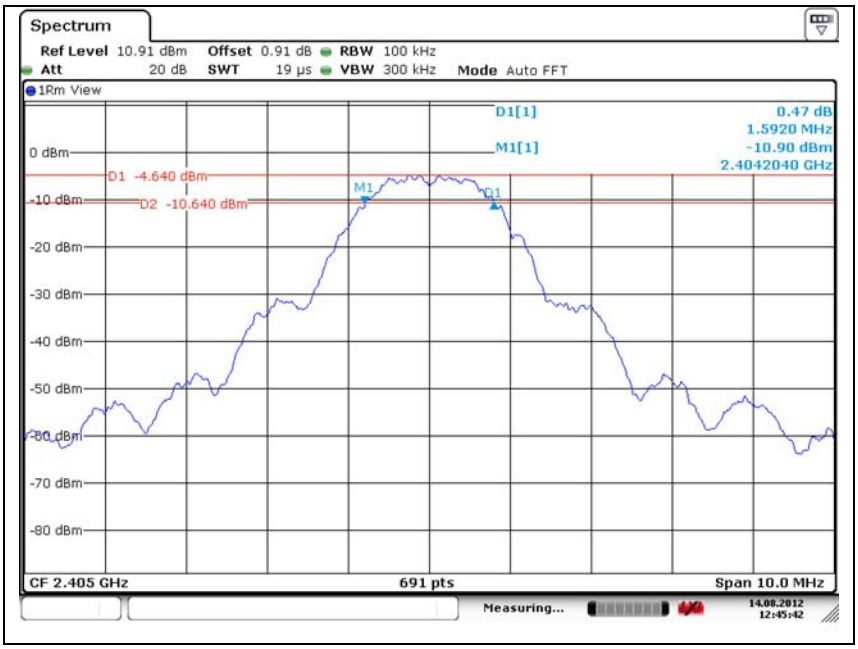
Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate 902 ~ 928 ㎒, 2 400 ~ 2 483.5 ㎒, and 5 725 ~ 5 850 ㎒ bands. The minimum 6 dB bandwidth shall be at least 500 ㎑.

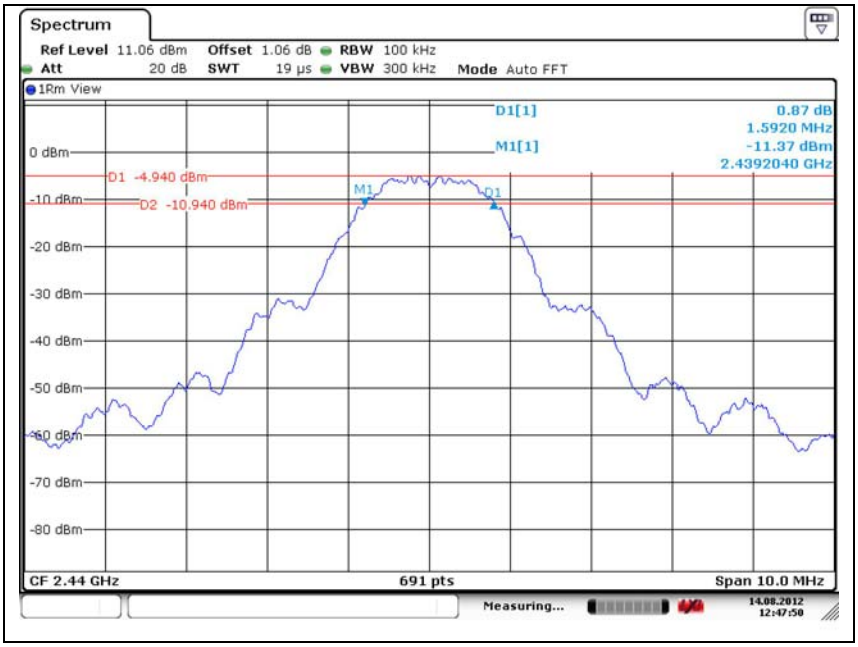
Test results

Operation mode	Frequency(㎒)	6 ㏈ bandwidth(㎒)	Limit(㎒)
DSSS	2 405	1.592	0.5
	2 440	1.592	
	2 480	1.664	

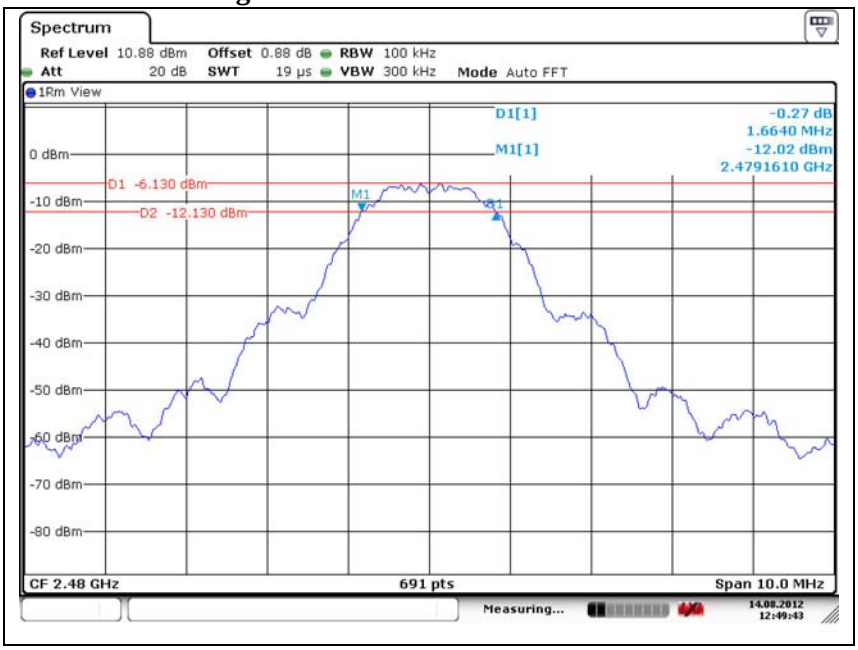
Low channel // 6 ㏈ bandwidth



Middle channel // 6 dB bandwidth

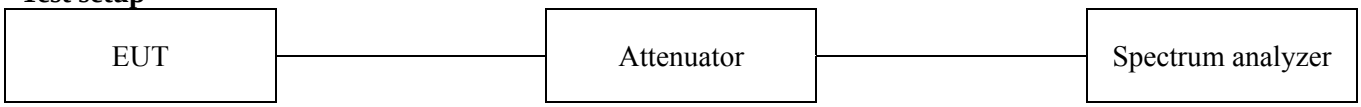


High channel // 6 dB bandwidth



2.1.3 Output power

Test setup



Test procedure

The testing follows KDB publication No. 558074 D01 DTS measurement.

Measurement procedure PK1

1. This procedure requires availability of a spectrum analyzer resolution bandwidth that is ≥ EBW.
2. Set the RBW ≥ EBW.
3. Set the VBW ≥ 3 × RBW.
4. Set span = zero.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use peak marker function to determine the peak amplitude level within the fundamental emission.

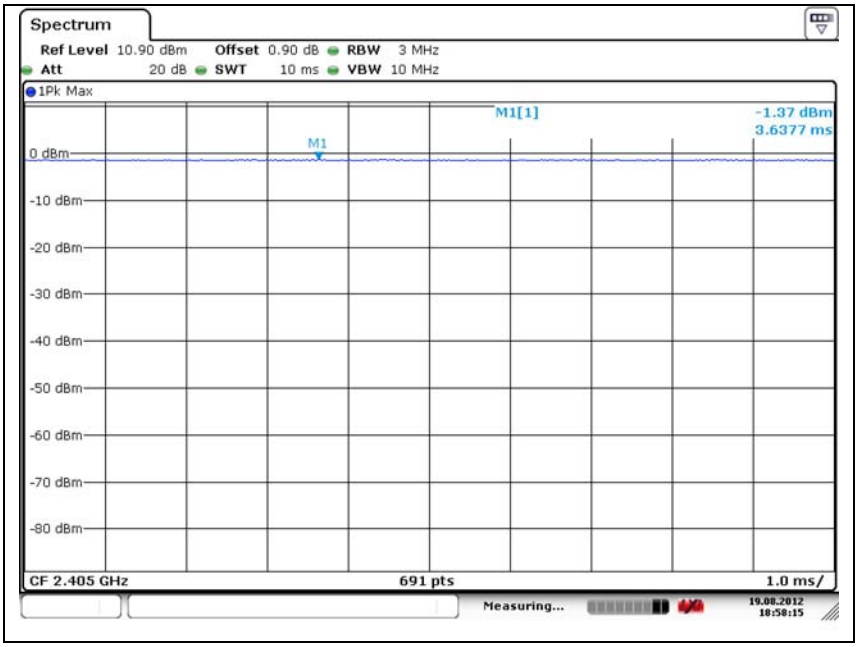
Limit

According to §15.247(b)(3), For systems using digital modulation in the 902~928 ㎒, 2 400~2 483.5 ㎒, and 5 725~5 850 ㎒ 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 out-put power. Maximum Conducted Out-put Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.
According to §15.247(b)(4), 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 ㏈i. Except as shown in paragraph (c) of this section, if transmit-ting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 ㏈i.

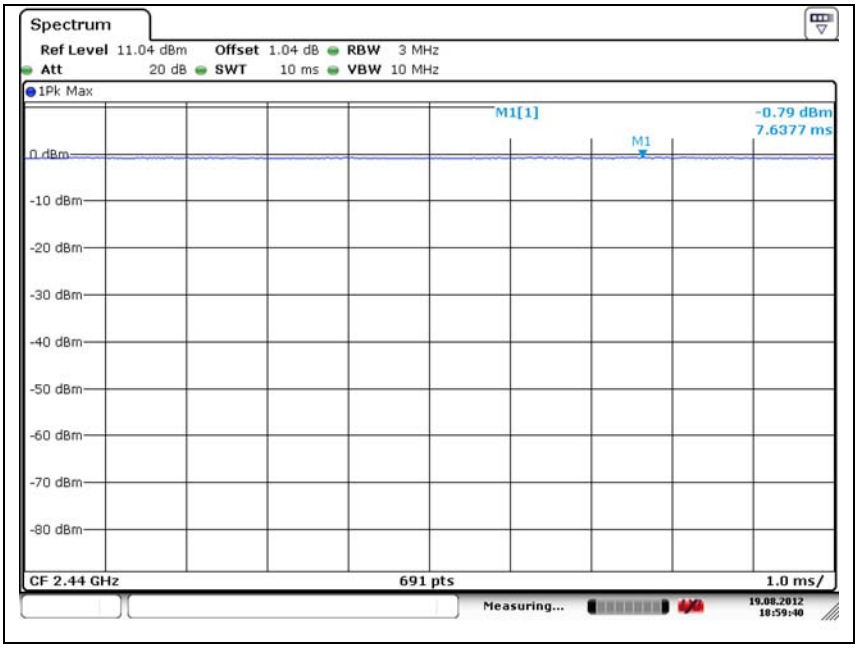
Test results

Operation mode	Frequency(㎒)	Output power(dBm)	Limit(dBm)
DSSS	2 405	-1.37	30
	2 440	-0.79	
	2 480	-2.51	

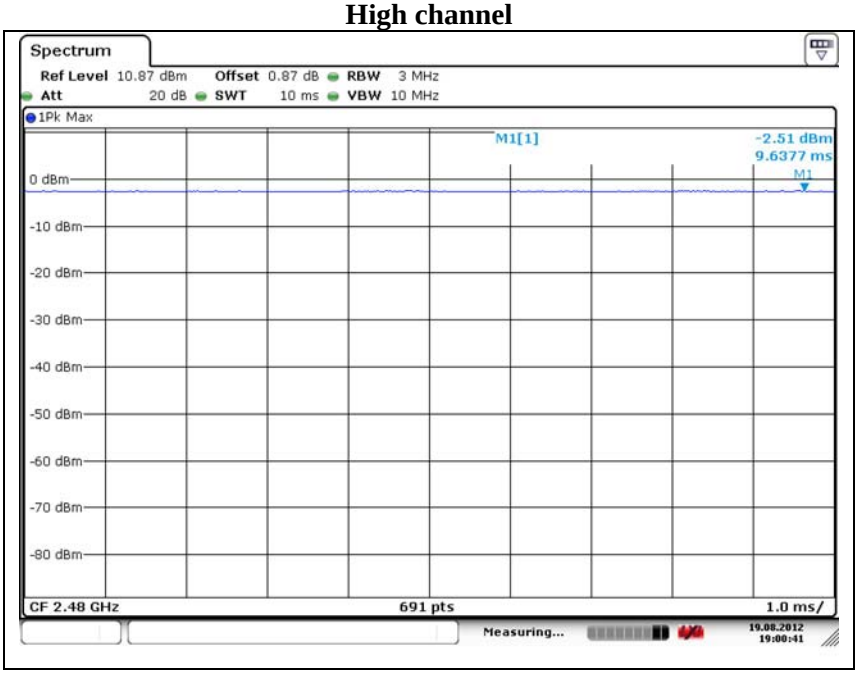
Low channel



Middle channel

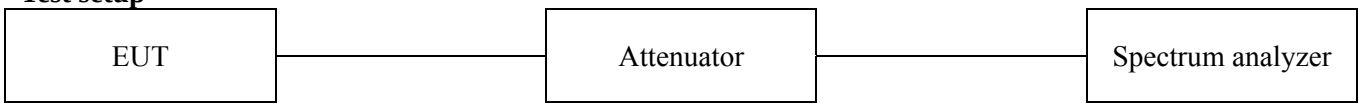


High channel



2.1.4 Power spectral density

Test setup



Test procedure

The testing follows KDB publication No. 558074 D01 DTS measurement.

Measurement procedure PKPSD

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW = 100 ㎑.
3. Set the VBW ≥ 300 ㎑.
4. Set the span to 5-30 % greater than the EBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum power level in any 100 ㎑ band segment within the fundamental EBW.
10. Scale the observed power level to an equivalent value in 3 ㎑ by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(3 ㎑/100 ㎑= -15.2 ㏈).
11. The resulting peak PSD level must be ≤ 8 ㏈m.

Limit

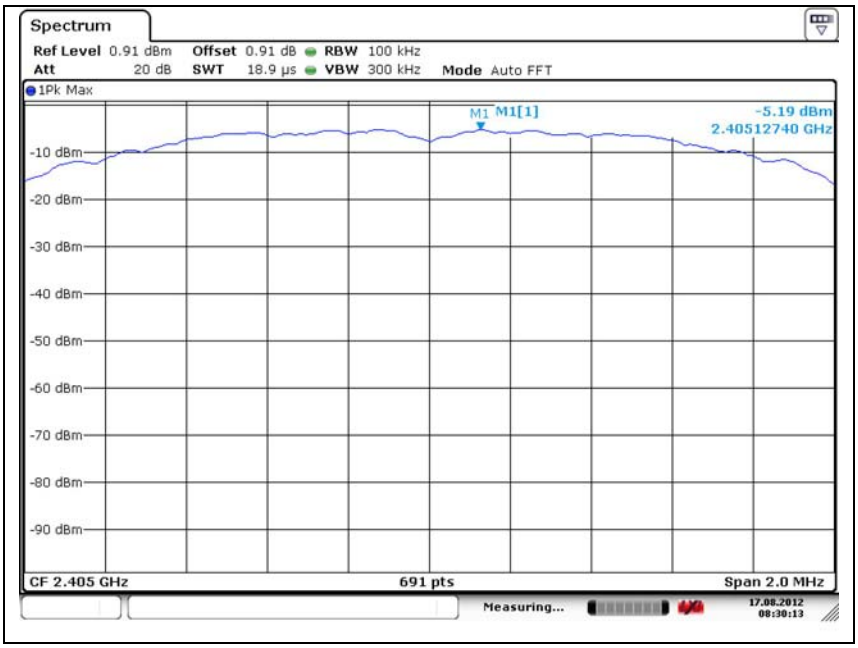
According to §15.247(e), For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈m in any 3 ㎑ band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test results

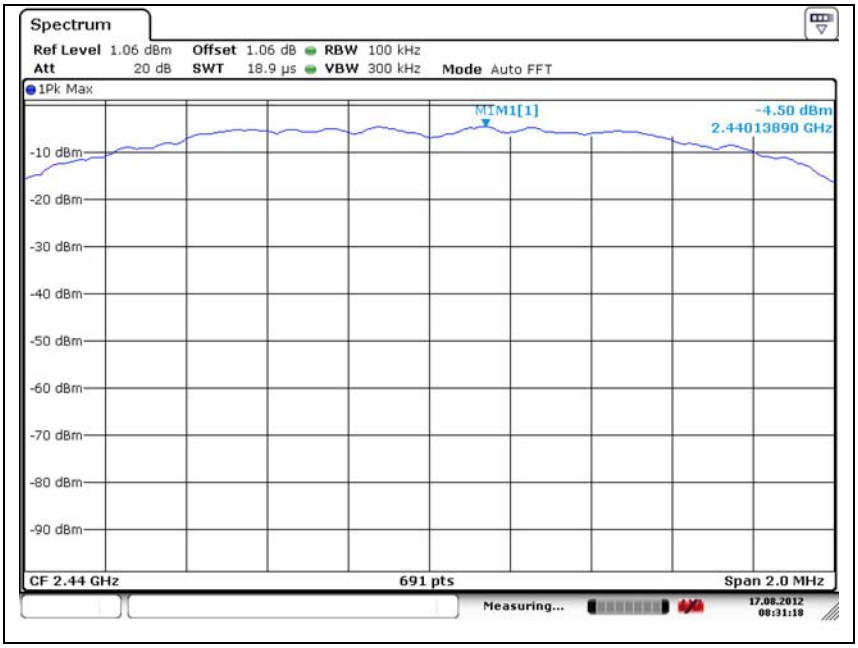
Operation mode	Frequency(㎒)	Measured PSD(dBm)	BWCF(dB)	Corrected PSD(dBm)	Limit(dBm)
DSSS	2 412	-5.19	-15.2	-20.39	8
	2 442	-4.50		-19.70	
	2 462	-6.17		-21.37	

Note;
Corrected PSD(dBm) =Measure PSD(dBm) + BWCF(dB)

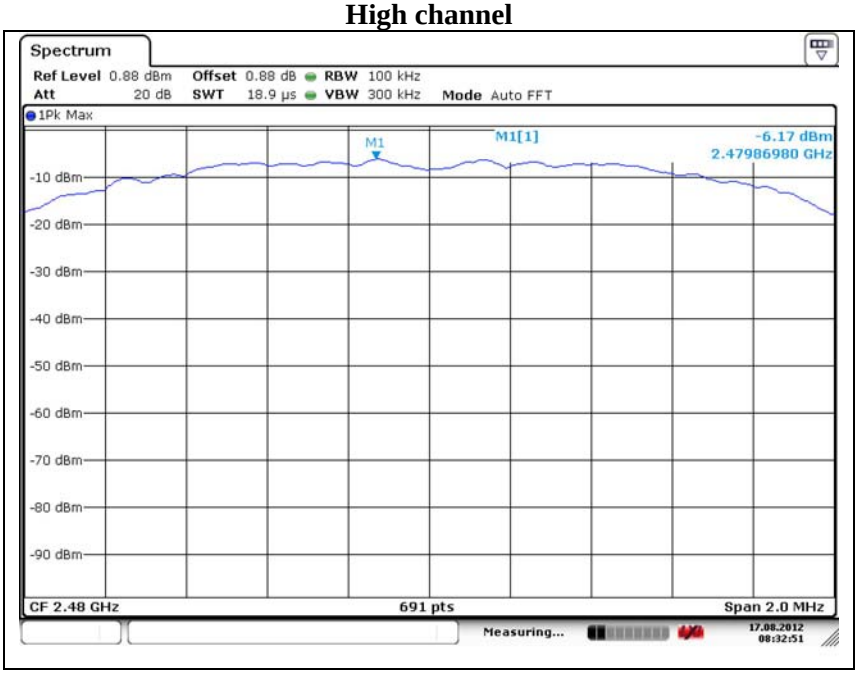
Low channel



Middle channel



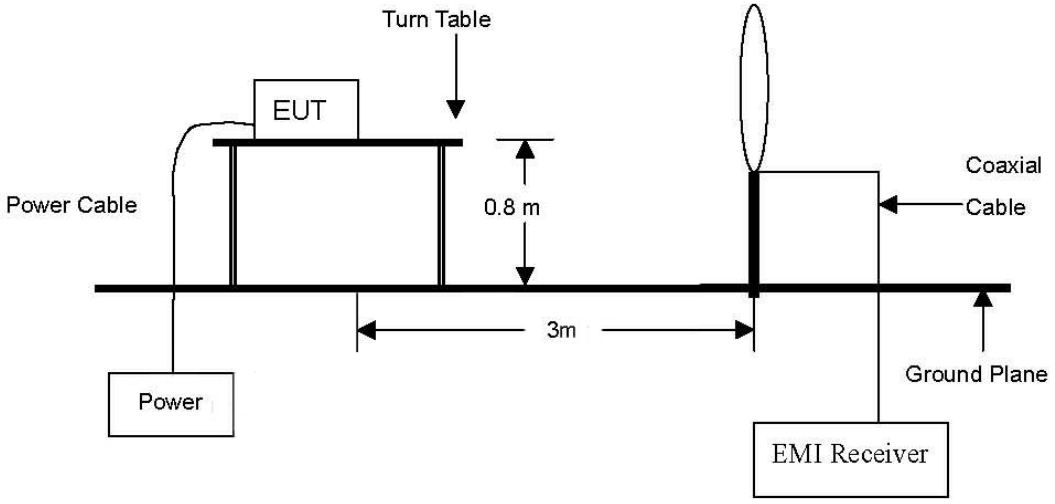
High channel



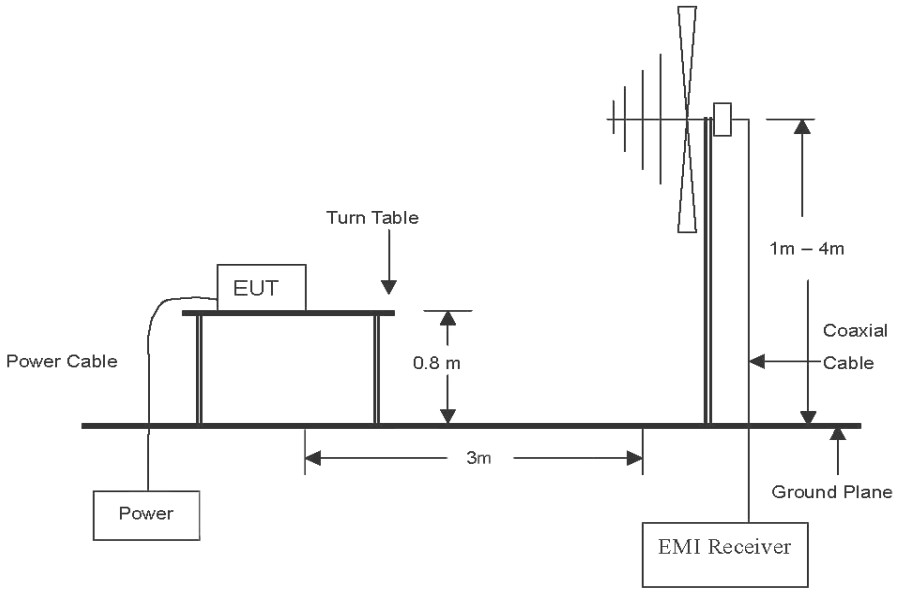
2.1.5 Radiated spurious emissions and conducted spurious emissions

Test setup for radiated spurious emissions

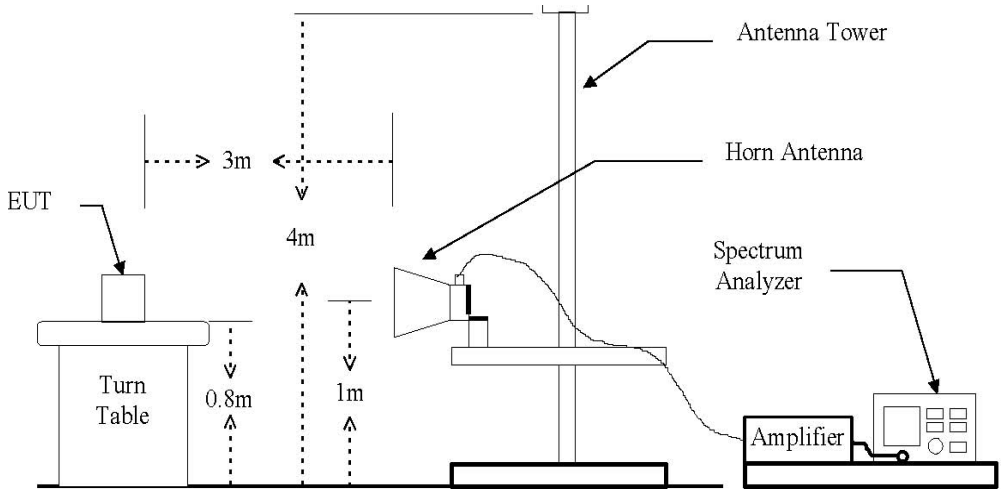
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



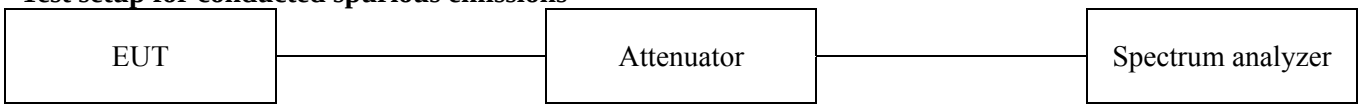
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to 24 ㎓ emissions.



Test setup for conducted spurious emissions



Test procedures for radiated spurious emissions

Radiated emissions from the EUT were measured according to the dictates in section 5.4 of KDB 558074

[9 ㎑ to 30 ㎒]

The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to Quasi-peak function and specified bandwidth with maximum hold mode.

The spectrum analyzer is set to:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 200 ㎐ for Quasi-peak detection (QP) at frequency below 9 ㎑~ 150 ㎑.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 9 ㎑ for Quasi-peak detection (QP) at frequency below 150 ㎑~ 30 ㎒.

[30 ㎒ to 1 ㎓ and 1 ㎓ to 24 ㎓]

The height of the measuring antenna was varied between 1 to 4 m and the table was rotated a full revolution in order to obtain maximum values of the electric field intensity.

The measurement was made in both the vertical and horizontal polarization, and the maximum value is presented in the report.

The spectrum analyzer is set to:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 120 ㎑ for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 ㎓.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection at frequency above 1 ㎓.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 10 ㎐ for Average detection (AV) at frequency above 1 ㎓.

Note;

All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

Test procedure for conducted spurious emissions

Per the guidance of KDB 558074, section 5.4.1.1, the reference level for out of band emissions is established from the plots of this section since the band edge emissions are measured with a RBW of 100 ㎑. This reference level is then used as the limit in subsequent plots for out of band spurious emissions shown in page 48 of the test report. The limit for out of band spurious emission at the band edge is 20㏈ below the fundamental emission level measured in a 100 ㎑ bandwidth.

Limit for radiated spurious emissions

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values：

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2400 / F(㎑)
0.490 ~ 1.705	30	24000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

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

Limit for conduced spurious emission

According to 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 either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval , as permitted under paragraph(b)(3) of this section , the attenuation required under this paragraph shall be 30 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section 15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section 15.205(a), must also comply the radiated emission limits specified in section 15.209(a) (see section 15.205(c))

Test results (Below 30 ㎒) – Worst case configuration: Middle Channel

The frequency spectrum from 9 ㎑ to 30 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈.

Radiated emissions		Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Pol.	Ant. factor (㏈/m)	Cable loss (㏈)	F_d (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
Below 30	Not detected							

※ Remark

1. All spurious emission at channels are almost the same below 30 ㎒, so that Middle channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Cable loss + F_d
3. $F_d = 40\log(D_m / D_s)$
   Where:
   F_d = Distance factor in ㏈
   D_m = Measurement distance in meters
   D_s = Specification distance in meters

Test results (Below 1 000 ㎒) – Worst case configuration: Middle Channel

The frequency spectrum from 30 ㎒ to 1 000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈.

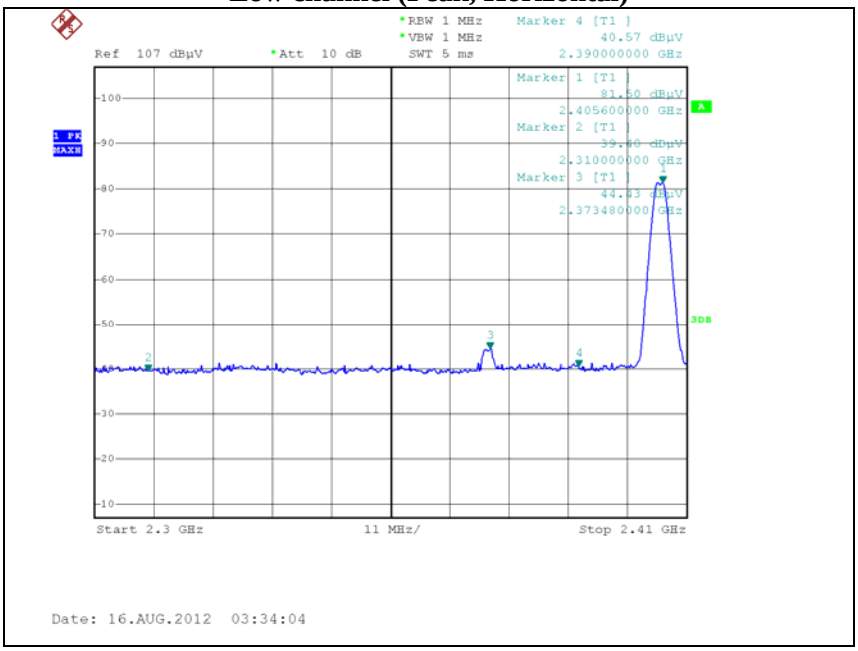
Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Pol.	Ant. factor (㏈/m)	Cable loss (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
39.7	16.26	H	13.19	0.83	30.28	40.00	9.72
42.1	21.50	V	13.37	0.86	35.73	40.00	4.27
66.4	16.92	H	12.11	1.03	30.06	40.00	9.94
66.4	20.14	V	12.11	1.03	33.27	40.00	6.73
146.4	16.98	H	12.88	1.45	31.31	43.50	12.19
197.3	23.47	H	10.17	1.75	35.39	43.50	8.11
197.3	25.42	V	10.17	1.75	37.34	43.50	6.16
432.6	12.70	H	16.30	2.31	31.31	46.00	14.69
432.6	11.81	V	16.30	2.31	30.42	46.00	15.58
529.6	10.67	V	18.32	2.65	31.64	46.00	14.36

※ Remark

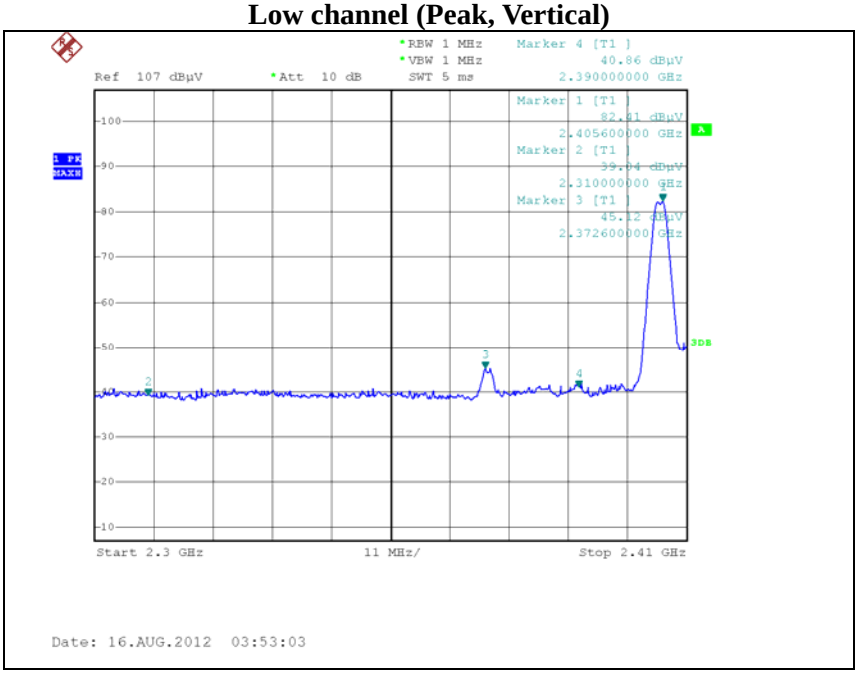
1. All spurious emission at channels are almost the same below 1 ㎓, so that Middle channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Cable loss
3. Detector mode: Quasi peak
4. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

Test results (Above 1 000 ㎒)

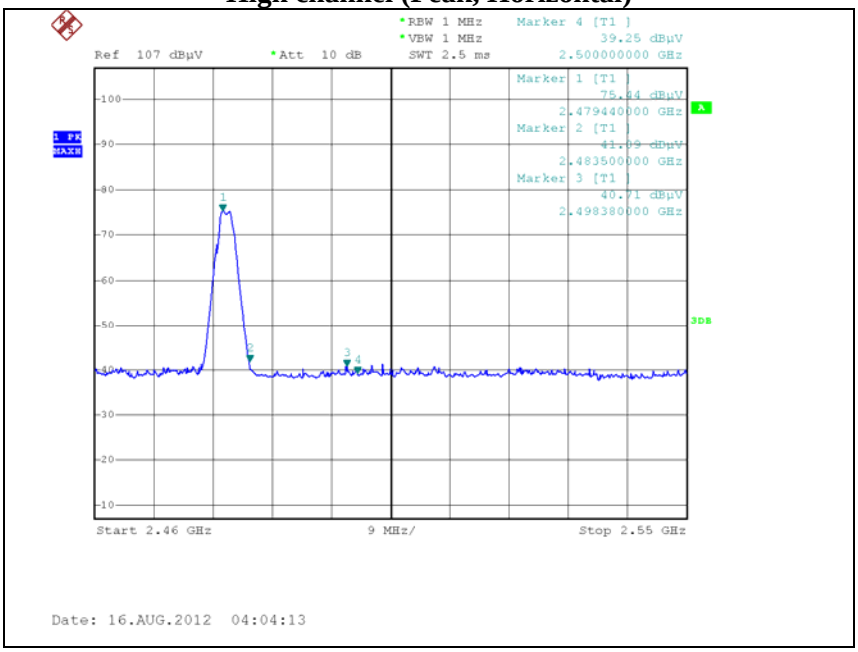
Low channel (Peak, Horizontal)



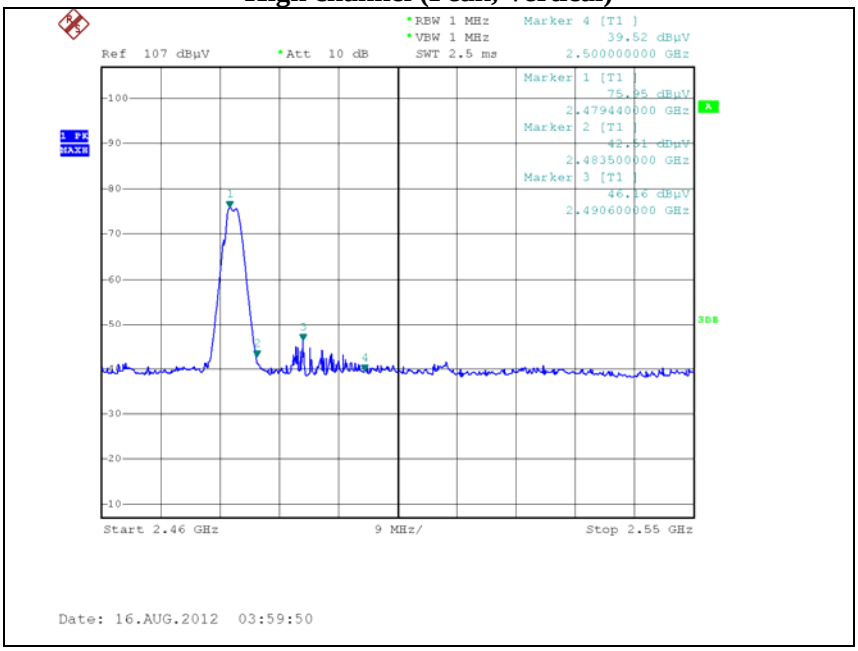
Low channel (Peak, Vertical)



High channel (Peak, Horizontal)



High channel (Peak, Vertical)



Low channel

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2 390.0	40.57	Peak	H	28.31	-38.88	30.00	74.00	44.00
2 390.0	40.86	Peak	V	28.31	-38.88	30.29	74.00	43.71

Middle channel

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Above 1 000	Not detected							

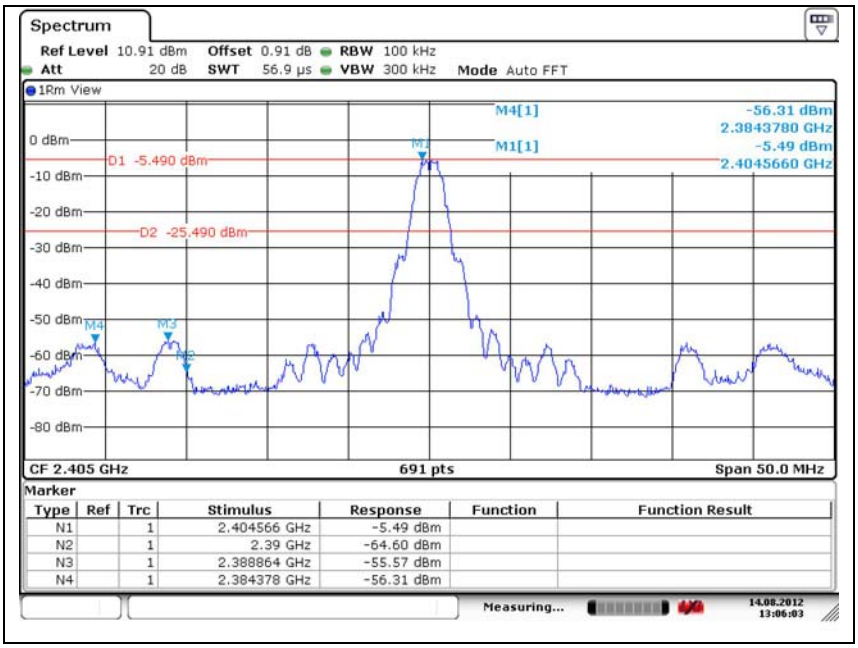
High channel

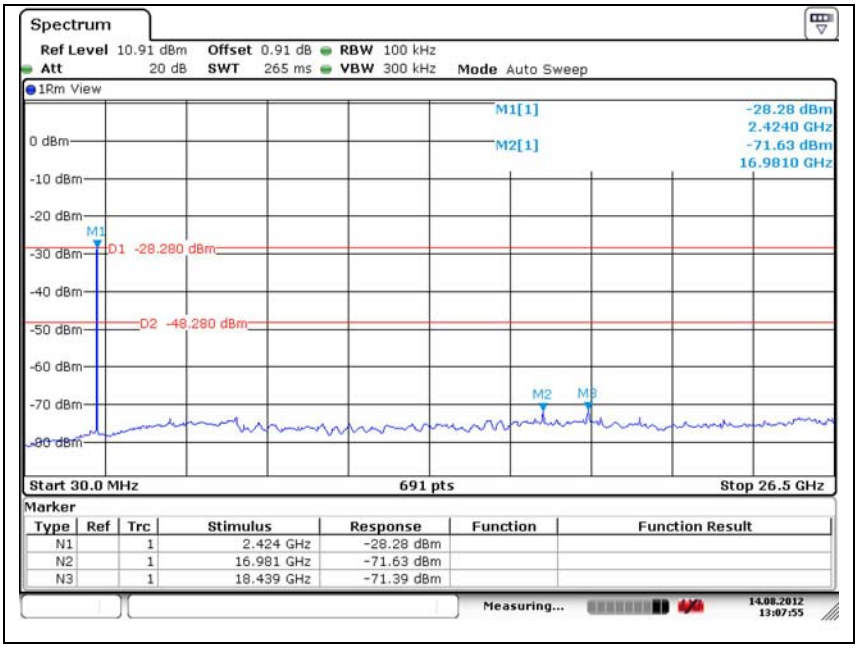
Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
2 483.5	41.09	Peak	H	28.50	-38.73	30.86	74.00	43.14
2 483.5	42.51	Peak	V	28.50	-38.73	32.28	74.00	41.72

※ Remark

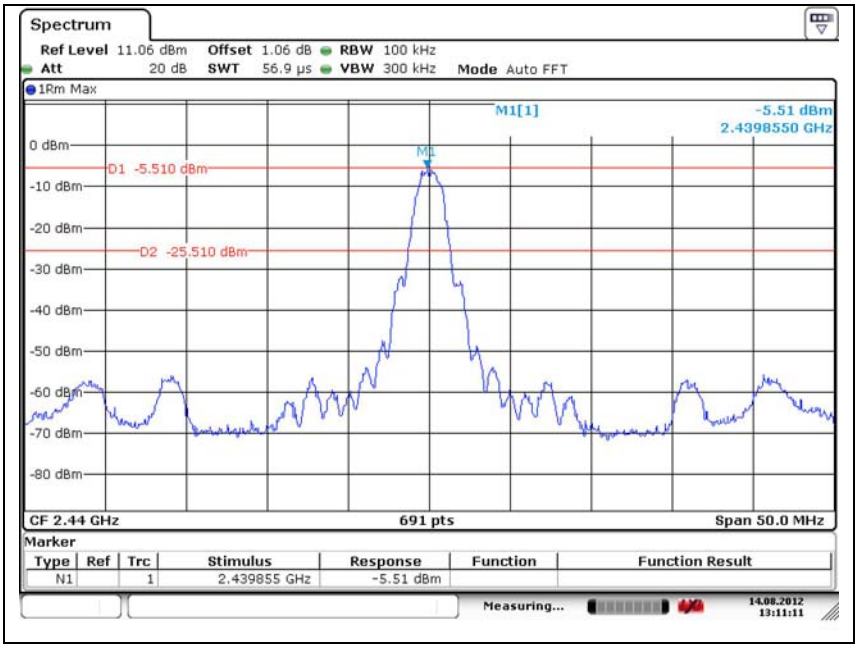
1. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
2. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit.
4. Actual = Reading + Ant. factor + Amp + CL (Cable loss)
5. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

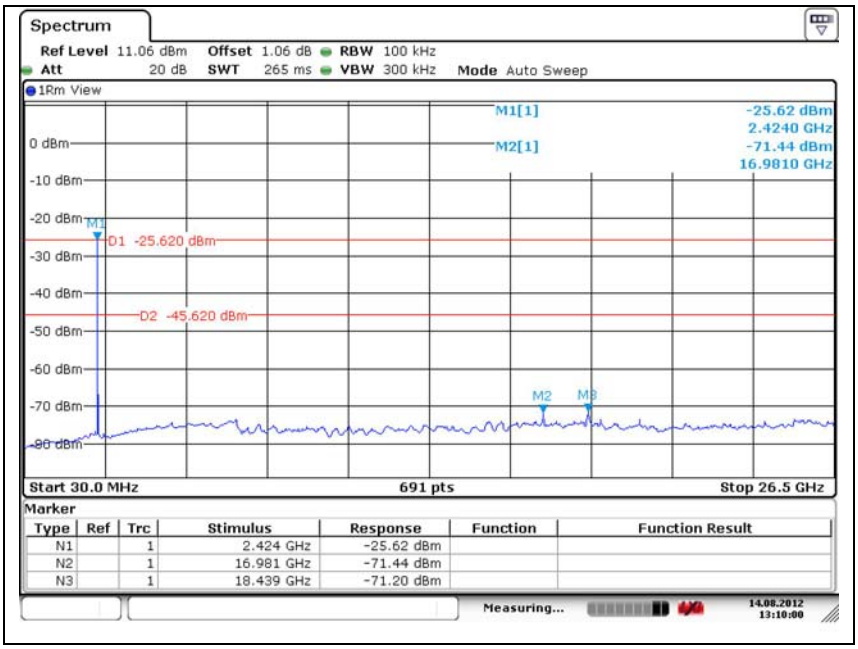
Low channel



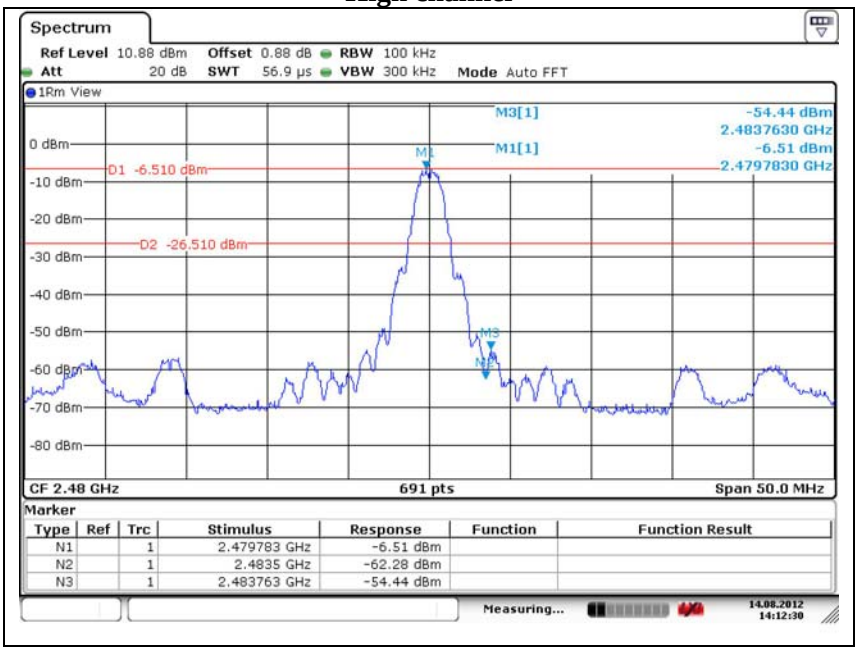


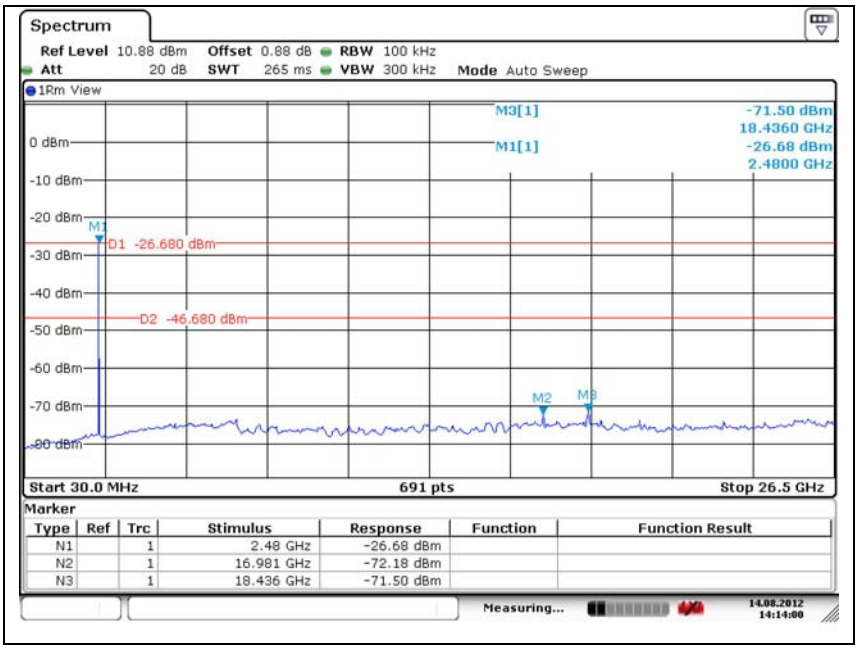
Middle channel





High channel





Appendix A. Test equipment used for test

Equipment	Manufacturer	Model	Calibration due.
Spectrum Analyzer	R&S	FSV30	2013.01.10
Spectrum Analyzer	R&S	FSP	2013.05.04
Vector Signal Generator	R&S	SMBV2100A	2013.01.10
Signal Generator	HP	83630B	2013.06.06
DC Power Supply	Agilent	6632B	2013.05.04
Loop Antenna	R&S	HFH2-Z2.335.4711.52	2013.03.10
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	2013.10.25
Horn Antenna	A.H. System	SAS-571	2013.03.22
High Pass Filter	Wainwright Instrument	WHJS3000-10TT	2013.01.10
Preamplifier	HP	8449B	2013.08.02
EMC Analyzer	Agilent	E7405A	2013.08.16
EMI TEST Receiver	R & S	ESHS10	2013.05.04
LISN	R & S	ENV216	2013.02.27
LISN	EMCO	3810/2	2013.04.18

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook	Samsung electronics	NT-R410Y	Z9YJ93CS300631H

Appendix B. Test setup photos

Radiated field emissions