LTA
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Dates of Tests: October 4~27, 2011
Test Report S/N: LR500111110C
Test Site : LTA CO., LTD.

YEONHWA

CERTIFICATION OF COMPLIANCE

FCC ID. **VSOXR-2400**

APPLICANT **Yeonhwa M Tech Co., Ltd.**

Equipment Class	**:**	**Digital Transmission System (DTS)**
Manufacturing Description	**:**	**Zigbee UHF Transceiver**
Manufacturer	**:**	**Yeonhwa M Tech Co., Ltd.**
Model name	**:**	**XR-2400**
Variant Model name	**:**	**XR-2400D**
Test Device Serial No.:	**:**	**Identical prototype**
Rule Part(s)	**:**	**FCC Part 15.247 Subpart C ; ANSI C-63.4-2003**
Frequency Range	**:**	**2405MHz ~ 2480MHz**
Max. Output Power	**:**	**Max 26.70dBm – Conducted**
Data of issue	**:**	**October 27, 2011**

This test report is issued under the authority of:

Hyun-Chae You, Manager

The test was supervised by:

Ki-Hun Cho, Test Engineer

NVLAP LAB Code.: 200723-0

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1. General information's

1-1 Test Performed

Company name : LTA Co., Ltd.

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Quality control in the testing laboratory is implemented as per ISO/IEC 17025 which is the "General requirements for the competents of calibration and testing laboratory".

1-2 Accredited agencies

LTA Co., Ltd. is approved to perform EMC testing by the following agencies:

Agency	Country	Accreditation No.	Validity	Reference
NVLAP	U.S.A	200723-0	2012-09-30	ECT accredited Lab.
KCC	KOREA	KR0049	2013-04-24	EMC accredited Lab.
FCC	U.S.A	610755	2014-04-27	FCC filing
FCC	U.S.A	649054	2013-04-13	FCC CAB
VCCI	JAPAN	R-2133, C-2307	2014-06-21	VCCI registration
VCCI	JAPAN	T-2009	2013-12-23	VCCI registration
IC	CANADA	5799A	2012-05-14	IC filing

2. Information's about test item

2-1 Client & Manufacturer

Company name	:	Yeonhwa M Tech Co., Ltd.
Address	:	3F, Yukyong B/D, 544-6, Gasan-dong, Geumcheon-gu, Seoul, Korea
Tel / Fax	:	+82-70-7434-7274 / +82-2-3281-7271

2-2 Equipment Under Test (EUT)

Trade name	:	Zigbee UHF Transceiver
FCC ID	:	VSOXR-2400
Model name	:	XR-2400
Variant Model name	:	XR-2400D
Serial number	:	Identical prototype
Date of receipt	:	October 4, 2011
EUT condition	:	Pre-production, not damaged
Antenna type	:	Dipole antenna (M/N: HS11-YH24) Max Gain 1.10 dBi
Frequency Range	:	2405MHz ~ 2480MHz (DSSS)
RF output power	:	Max 26.70dBm - Conducted
Number of channels	:	16
Type of Modulation	:	O-QPSK
Channel spacing	:	5MHz
Power Source	:	3.7Vdc
Firmware Version	:	V0.1.1

2-3 Tested frequency

	LOW	MID	HIGH
Frequency (MHz)	2405	2445	2480

2-4 Ancillary Equipment

Equipment	Model No.	Serial No.	Manufacturer
-	-	-	-

2-5 Model Description

Model No.	Difference
XR-2400	Same RF Circuit, Graphic LCD, Audio and Data Communication
XR-2400D	Same RF Circuit, Graphic LCD, Only Data Communication

3. Test Report

3.1 Summary of tests

FCC Part Section(s)	Parameter	Limit	Test Condition	Status (note 1)
15.247(a)	6 dB Bandwidth	> 500kHz	Conducted	C
15.247(b)	Transmitter Peak Output Power	< 1Watt		C
15.247(d)	Transmitter Power Spectral Density	< 8dBm @ 3kHz		C
15.247(d)	Band Edge & Spurious	> 20 dBc		C
15.209	Field Strength of Harmonics	Emission	Radiated	C
15.207	AC Conducted Emissions	Emissions	Conducted	C
15.203	Antenna requirement	-	-	C

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

Note 2: The data in this test report are traceable to the national or international standards.

→ Antenna Requirement
The Firmtech co., Ltd. FCC ID:VSOXR-2400 unit complies with the requirement of §15.203.
The antenna connector is the reverse SMA connector.
The sample was tested according to the following specification:
FCC Parts 15.247; ANSI C-63.4-2003

3.2 Technical Characteristics Test

3.2.1 6 dB Bandwidth

Procedure:

The bandwidth at 6dB below the highest in-band spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate frequencies.

After the trace being stable, Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 6dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 6 dB bandwidth of the emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 100 kHz — Span = 10 MHz

VBW = 100 kHz (VBW ≥ RBW) — Sweep = auto

Trace = max hold — Detector function = peak

Measurement Data:

Frequency (MHz)	Test Results	
	Measured Bandwidth (MHz)	Result
2405	**1.360**	Complies
2445	**1.375**	Complies
2480	**1.331**	Complies

- See next pages for actual measured spectrum plots.

Minimum Standard:

6 dB Bandwidth > 500kHz

Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

Low Channel

Mid Channel

High Channel

3.2.2 Peak Output Power Measurement

Procedure:

The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT. The spectrum analyzer's internal channel power integration function is used to integrate the power over a bandwidth greater than or equal to the 99% bandwidth. The EUT was operating in transmit mode at the appropriate center frequency.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 1MHz Span = auto

VBW = 1MHz (VBW ≥ RBW) Sweep = auto

Detector function = peak

Measurement Data:

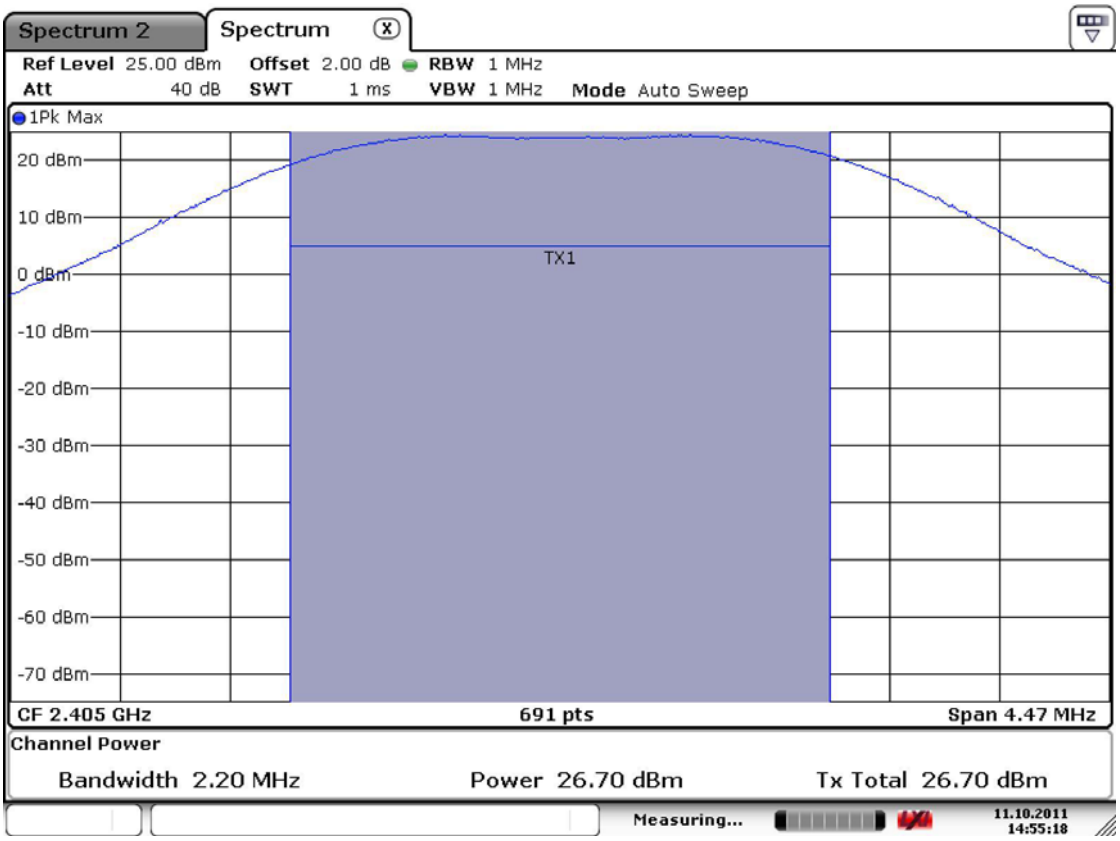
Frequency (MHz)	Test Results		
	dBm	mW	Result
2405	**26.70**	**467.73**	Complies
2445	**26.23**	**419.76**	Complies
2480	**26.04**	**401.79**	Complies

- See next pages for actual measured spectrum plots.

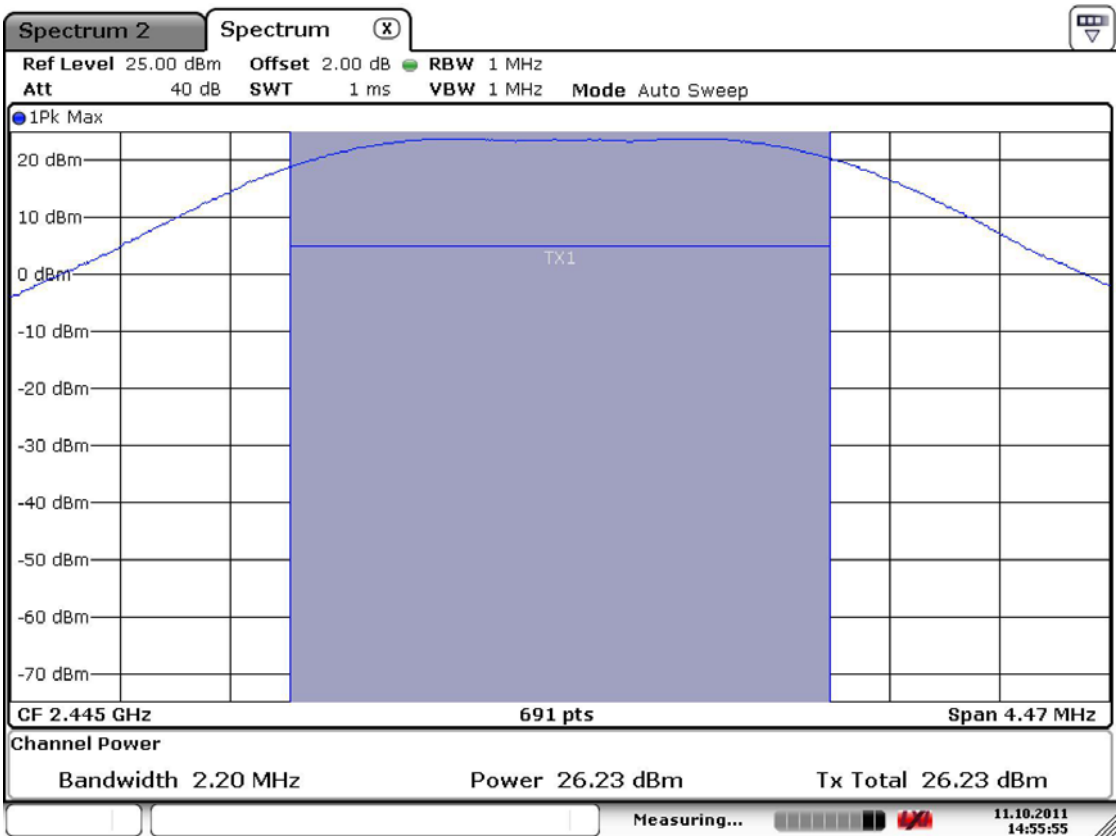
Minimum Standard:

Peak output power	< 1W

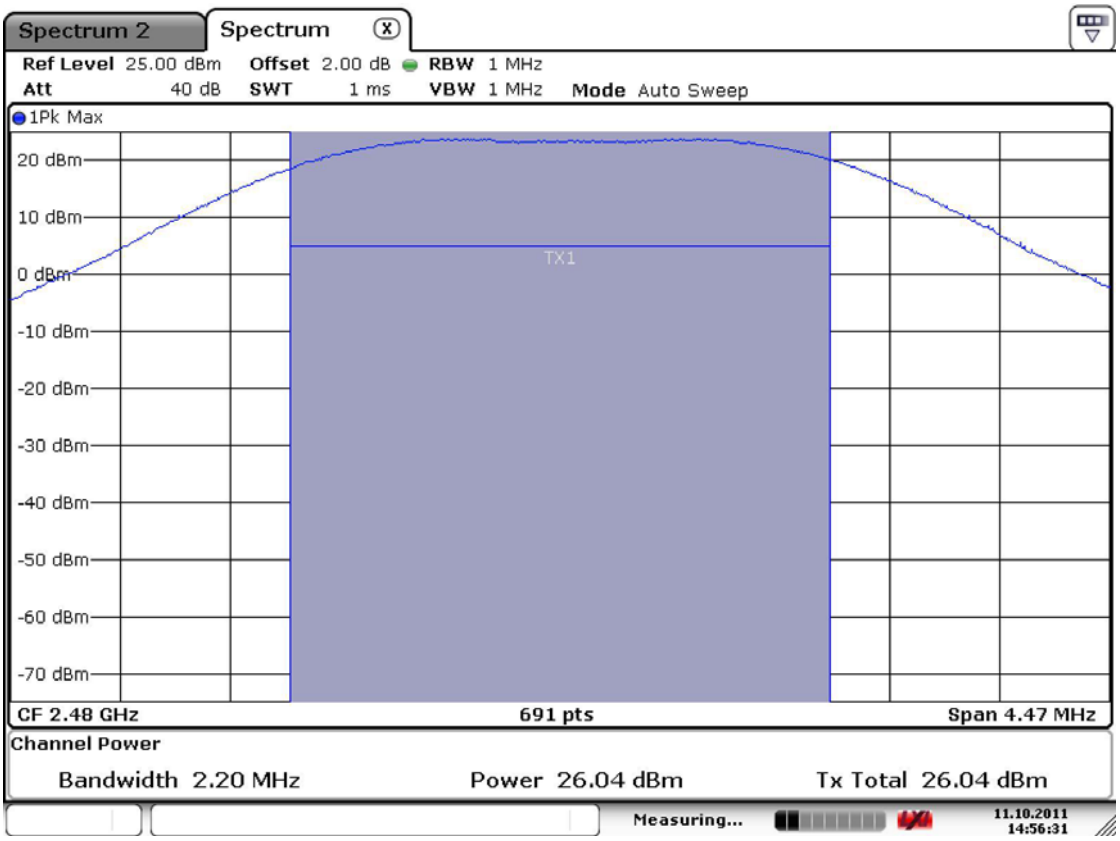
Low Channel



Mid Channel



High Channel



3.2.3 Power Spectral Density

Procedure:

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

The spectrum analyzer is set to:

RBW = 3 kHz	Span = 300 kHz
VBW = 10 kHz	Sweep = 100 sec
Detector function = peak	Trace = max hold

Measurement Data:

Frequency (MHz)	Test Results	
	dBm	Result
2405	**6.41**	Complies
2445	**5.65**	Complies
2480	**5.17**	Complies

- See next pages for actual measured spectrum plots.

Minimum Standard:

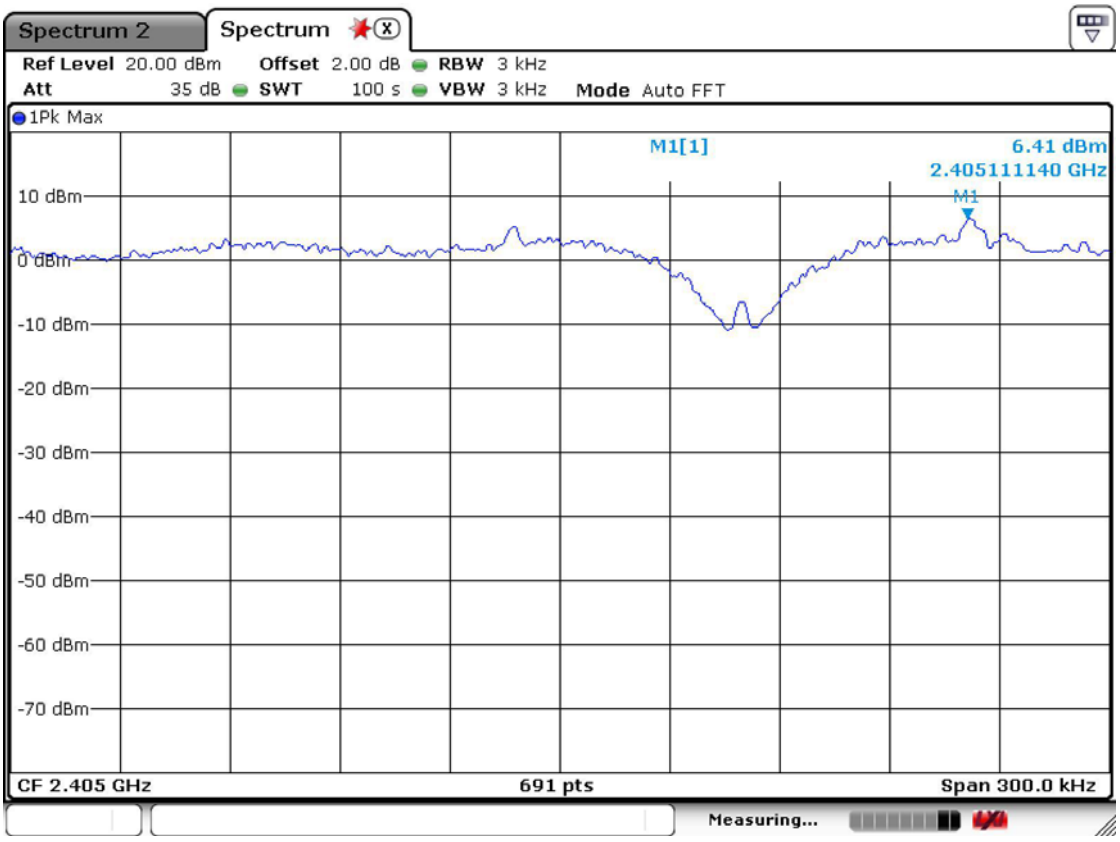
Power Spectral Density	< 8dBm @ 3kHz BW

Measurement Setup

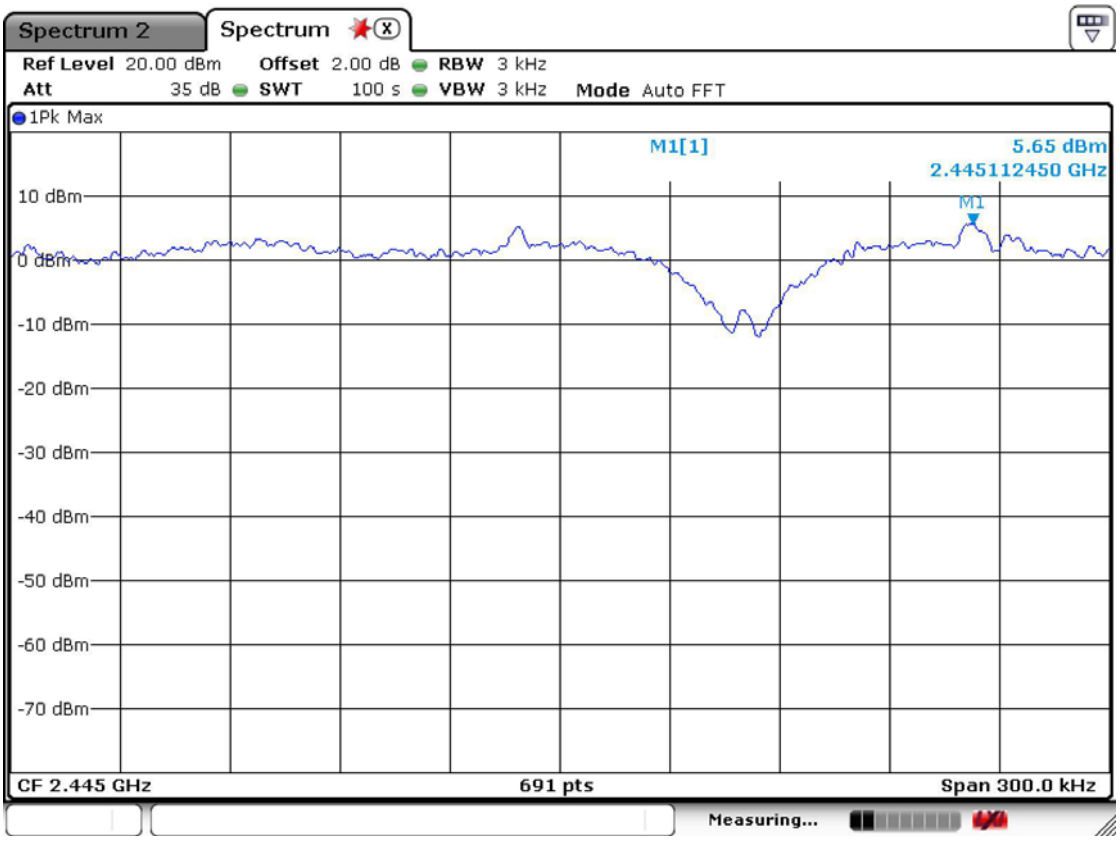
Same as the Chapter 3.2.1 (Figure 1)

Power Density Measurement

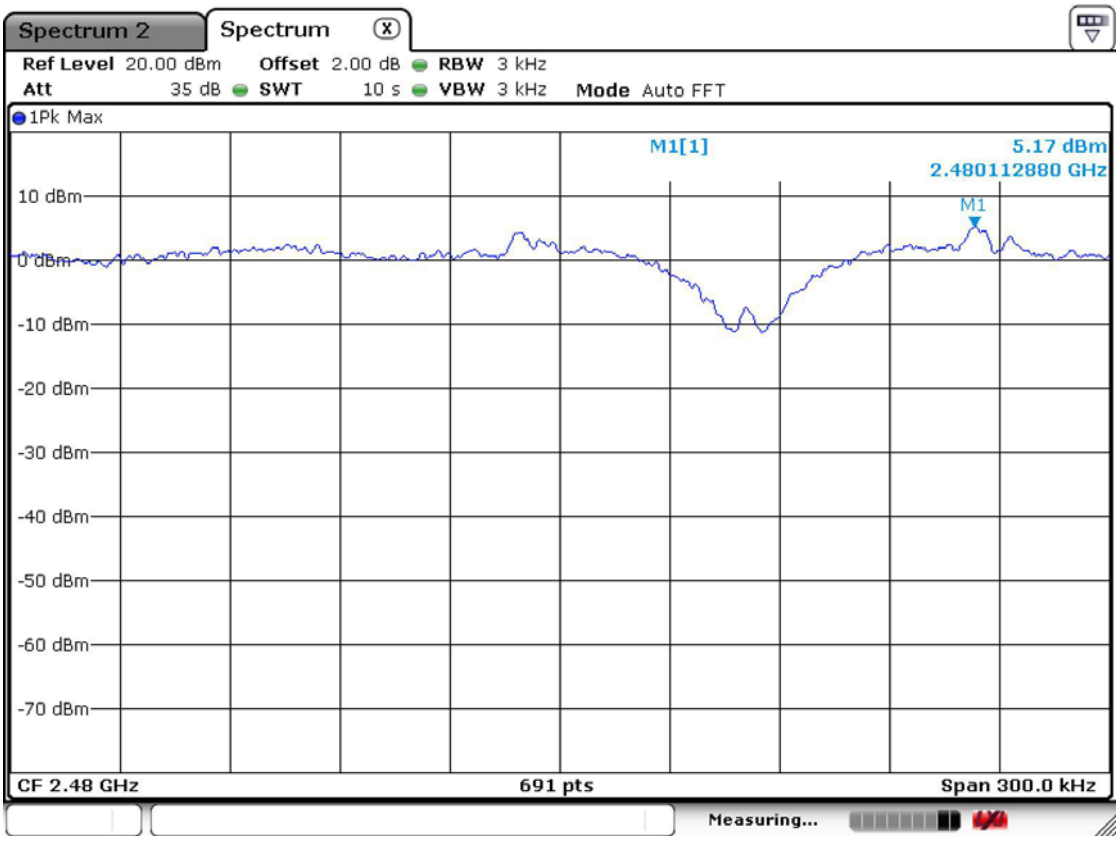
Low Channel



Mid Channel



High Channel



3.2.4 Band - edge & Spurious

Procedure:

The bandwidth at 20dB down from the highest inband spectral density is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate frequencies.

After the trace being stable, Use the marker-to-peak function to measure 20 dB down both sides of the intentional emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 100 kHz	VBW = 100 kHz
Span = 50 MHz	Detector function = peak
Trace = max hold	Sweep = auto

Radiated emissions which fall in the restricted bands, as defined in 15.205(a), must also comply with the radiated emission limits specified in 15.209(a)

The spectrum analyzer is set to:

Center frequency = the highest, the lowest channels

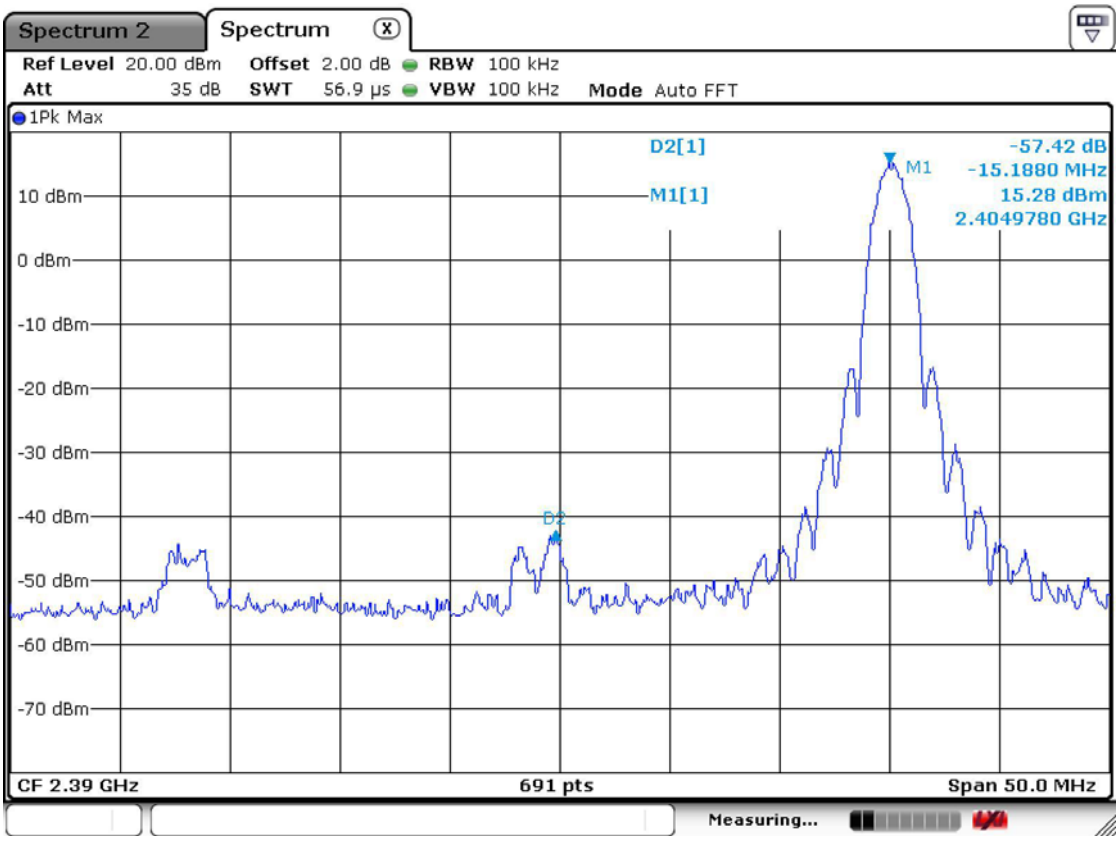
PEAK:	RBW = VBW = 1MHz, Sweep=Auto
Average:	RBW = 1MHz, VBW=10Hz, Sweep=Auto
Measurement Distance:	3m
Polarization:	Horizontal / Vertical

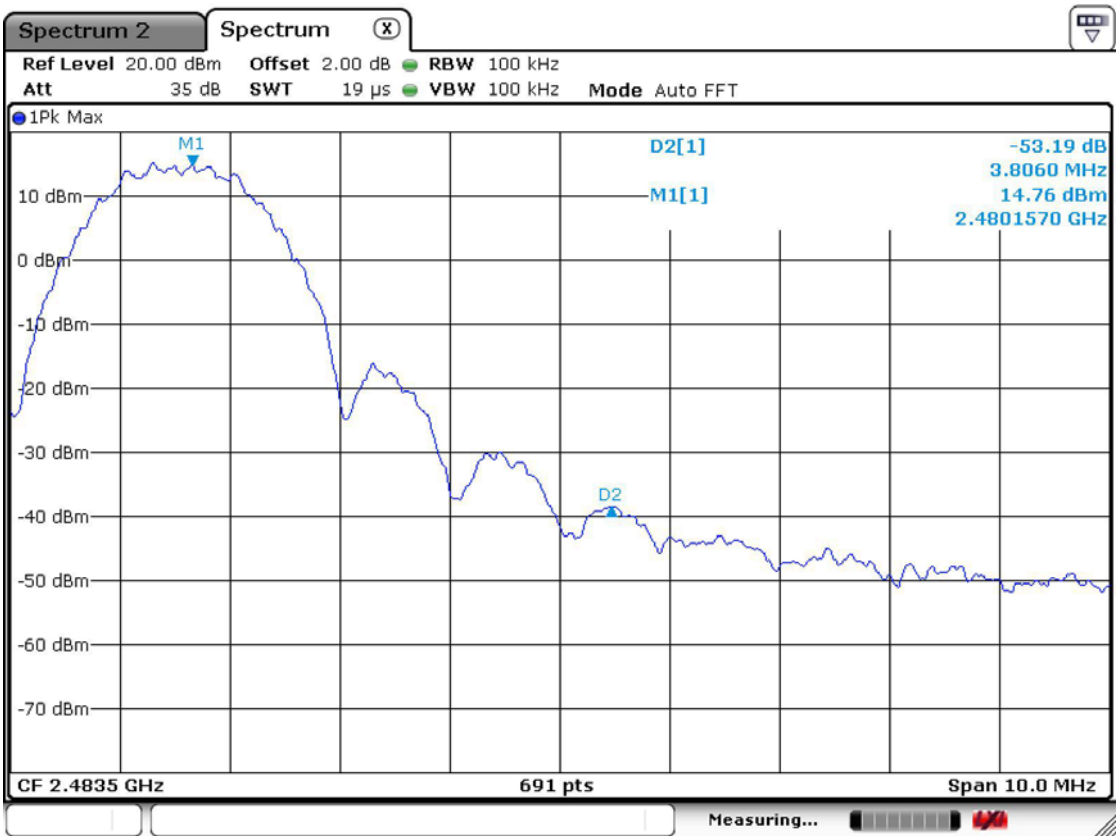
Measurement Data: Complies

- All conducted emission in any 100kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest inband spectral density. Therefore the applying equipment meets the requirement.
- See next pages for actual measured spectrum plots.

Minimum Standard:	> 20 dBc

Band–edge





Band-edges in the restricted band 2310-2390 MHz measurement

Frequency [MHz]	Reading [dBuV/m] AV	Reading [dBuV/m] Peak	Pol.	Correction Factor Antenna	Correction Factor Amp. Gain	Correction Factor Cable	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] Peak
2390	52.6	66.2	V	25.4	37.1	4.0	54.0	74.0	44.9	58.4	9.2	15.6

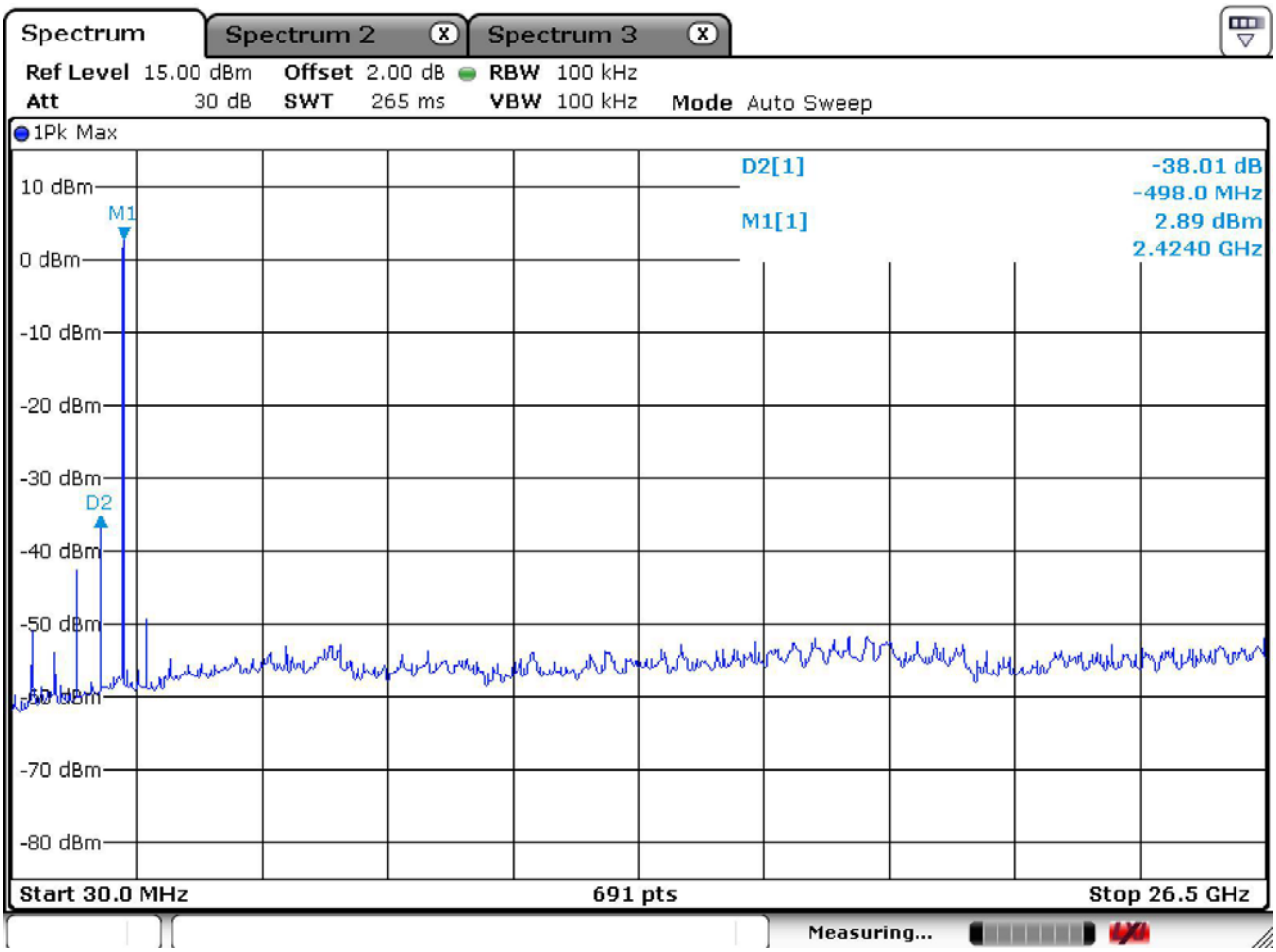
Band-edges in the restricted band 2483.5-2500 MHz measurement

Frequency [MHz]	Reading [dBuV/m] AV	Reading [dBuV/m] Peak	Pol.	Correction Factor Antenna	Correction Factor Amp. Gain	Correction Factor Cable	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] Peak
2483.5	58.8	66.2	V	25.4	37.1	4.0	54.0	74.0	51.0	58.5	3.0	15.5

Note : This EUT was tested in 3 orthogonal positions and the worst-case data was presented.

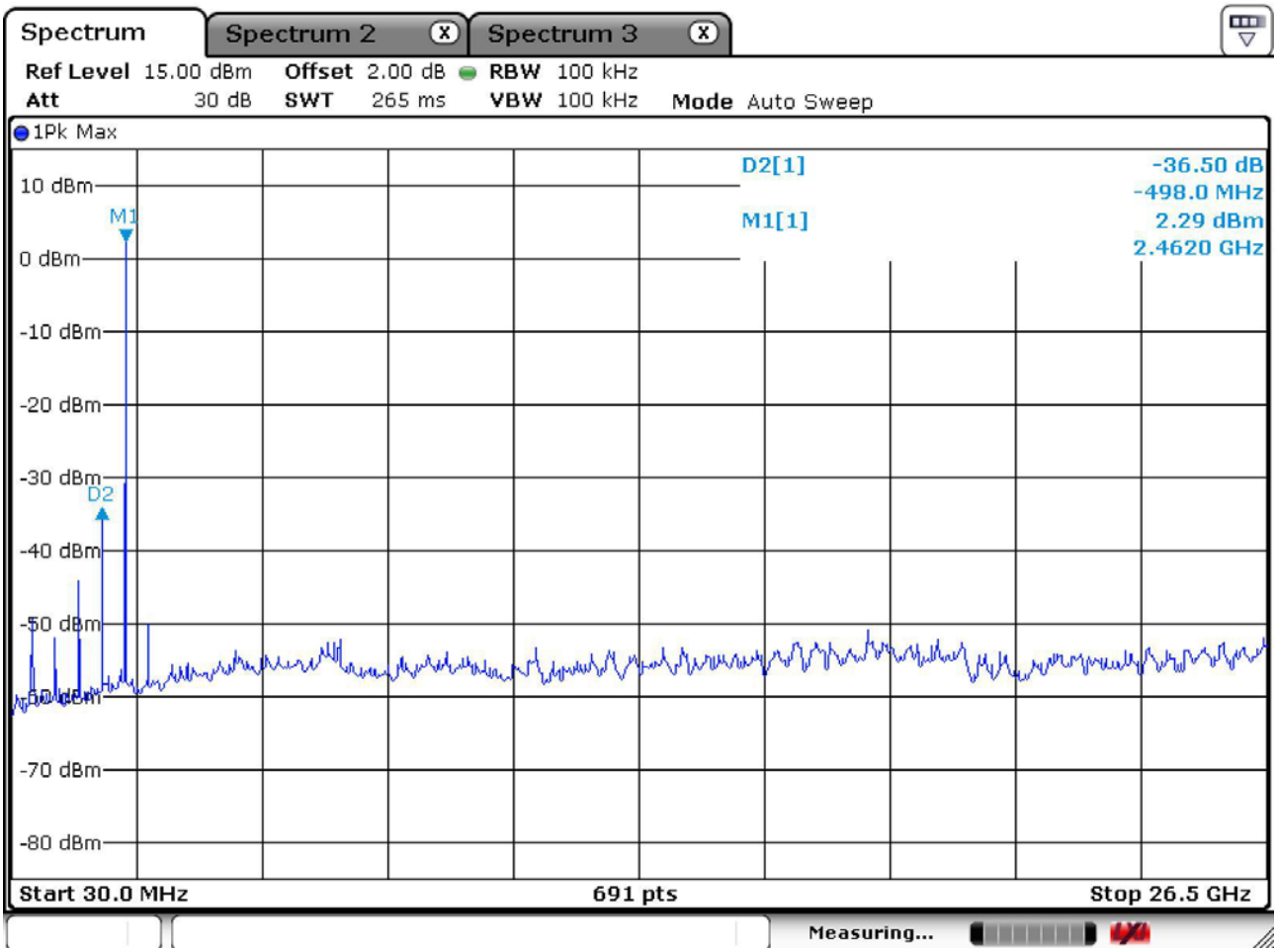
Low channel

Frequency Range = 30 MHz ~ 10th harmonic.



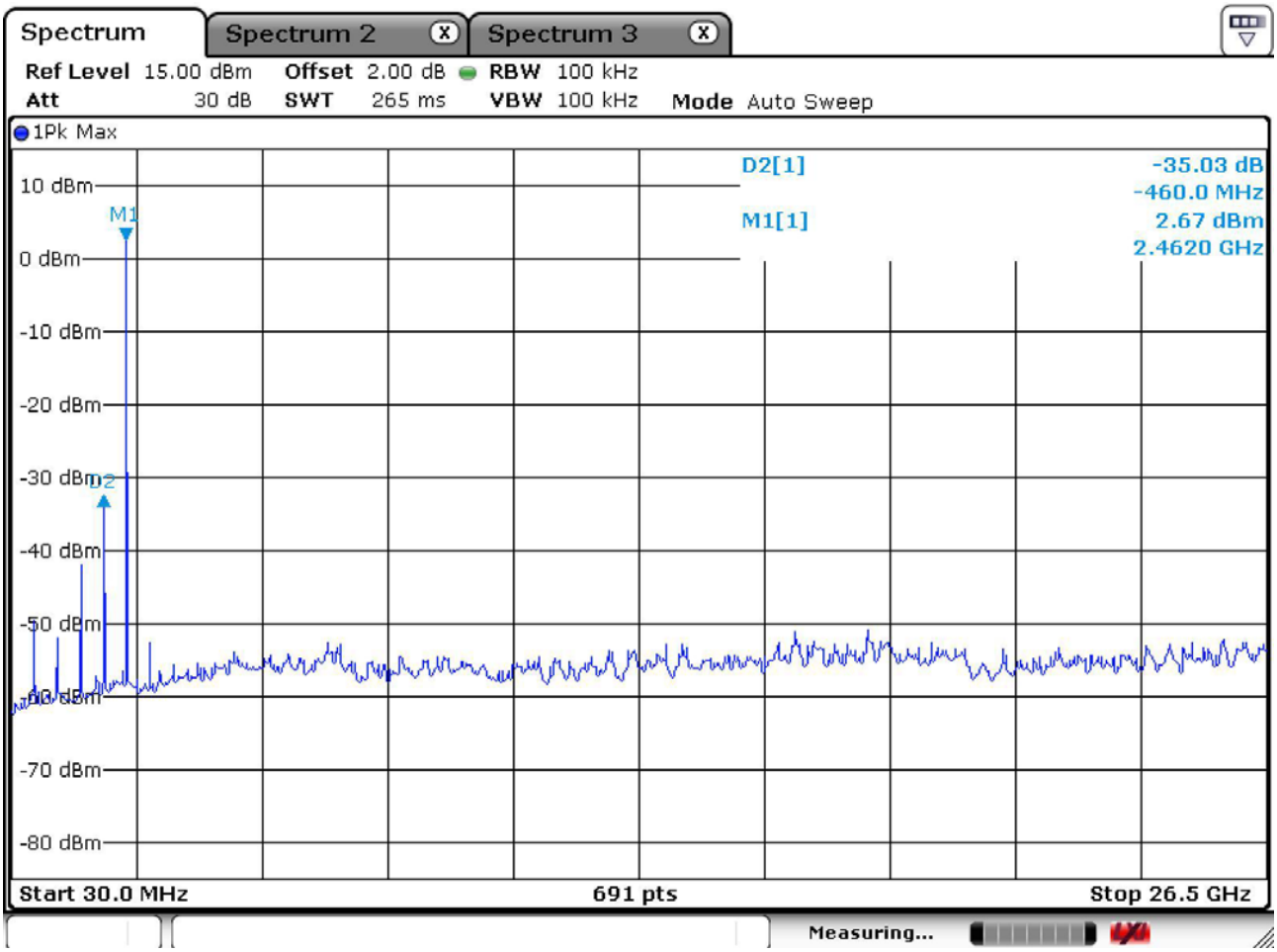
Mid channel

Frequency Range = 30 MHz ~ 10th harmonic.



High channel

Frequency Range = 30 MHz ~ 10th harmonic.



3.2.5 Field Strength of Harmonics

Procedure:

The EUT was placed on a 0.8m high wooden table inside a shielded enclosure. An antenna was placed near the EUT and measurements of frequencies and amplitudes of field strengths were recorded for reference during final measurements. For final radiated testing, measurements were performed in OATS. Measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst-case orientation for maximum emissions.

The spectrum analyzer is set to:

Center frequency = the worst channel

Frequency Range = 30 MHz ~ 10th harmonic.

RBW = 100 kHz (30MHz ~ 1 GHz) VBW ≥ RBW

= 1 MHz (1 GHz ~ 10th harmonic)

Span = 100 MHz Detector function = peak

Trace = max hold Sweep = auto

Measurement Data: Complies

- See next pages for actual measured data.

Minimum Standard: FCC Part 15.209(a)

Frequency (MHz)	Limit (uV/m) @ 3m
0.009 ~ 0.490	2400/F(kHz) **(@ 300m)**
0.490 ~ 1.705	24000/F(kHz) **(@ 30m)**
1.705 ~ 30	30**(@ 30m)**
30 ~ 88	100 **
88 ~ 216	150 **
216 ~ 960	200 **
Above 960	500

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

Measurement Data:

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Correction Factor Antenna	Amp. Gain	Cable	Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
4810.0	48.2	58.2	V	31.4	36.5	5.7	54.0	74.0	48.9	58.9	5.1	15.1
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Correction Factor Antenna	Amp. Gain	Cable	Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
4890.0	46.8	57.2	V	31.4	36.5	5.7	54.0	74.0	47.5	54.9	6.5	16.1
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Correction Factor Antenna	Amp. Gain	Cable	Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
4960.00	46.1	57.3	V	31.4	36.5	5.7	54.0	74.0	46.8	58.0	7.2	16.0
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

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

Radiated Emissions – Zigbee

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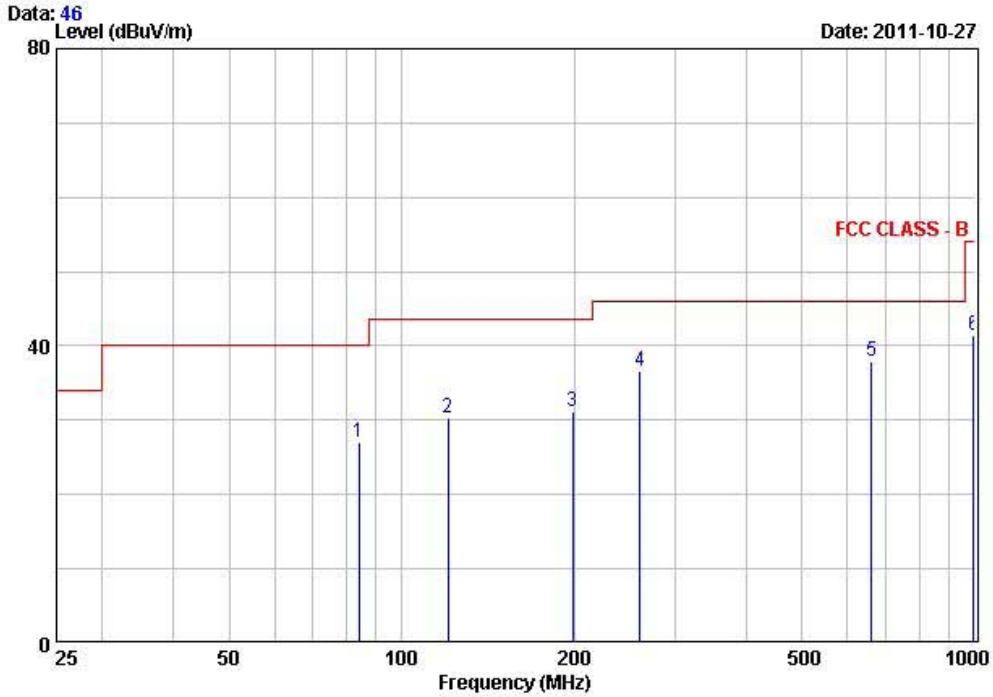
EUT/Model No.: XR-2400 TEST MODE: Wireless mode

Temp Humi : 17 / 28 Tested by: PARK H W



	Freq	Reading	C.F	Result	Limit QP	Margin	Height	Angle	Polarity
	MHz	dBuV/m	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	84.27	46.48	-19.54	26.94	40.00	13.06	141	27	HORIZONTAL
2	120.40	46.98	-16.65	30.33	43.50	13.17	138	21	HORIZONTAL
3	198.81	46.60	-15.41	31.19	43.50	12.31	270	50	HORIZONTAL
4	260.49	48.80	-12.28	36.52	46.00	9.48	150	219	VERTICAL
5	660.90	39.60	-1.69	37.91	46.00	8.09	105	290	VERTICAL
6	995.50	35.40	6.03	41.43	54.00	12.57	100	89	VERTICAL

Remarks: C.F (Correction Factor) = Antenna factor + Cable loss - Preamp gain

3.2.6 AC Conducted Emissions

Procedure:

The conducted emissions are measured in the shielded room with a spectrum analyzer in peak hold. While the measurement, EUT had its hopping function disabled at the middle channels in line with Section 15.31(m). Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation and Exerciser operation. The highest emissions relative to the limit are listed.

Measurement Data: Complies

- See next pages for actual measured spectrum plots.
- No emissions were detected at a level greater than 20dB below limit.

Minimum Standard: FCC Part 15.207(a)/EN 55022

Class B

Frequency Range	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

AC Conducted Emissions – Zigbee – Line

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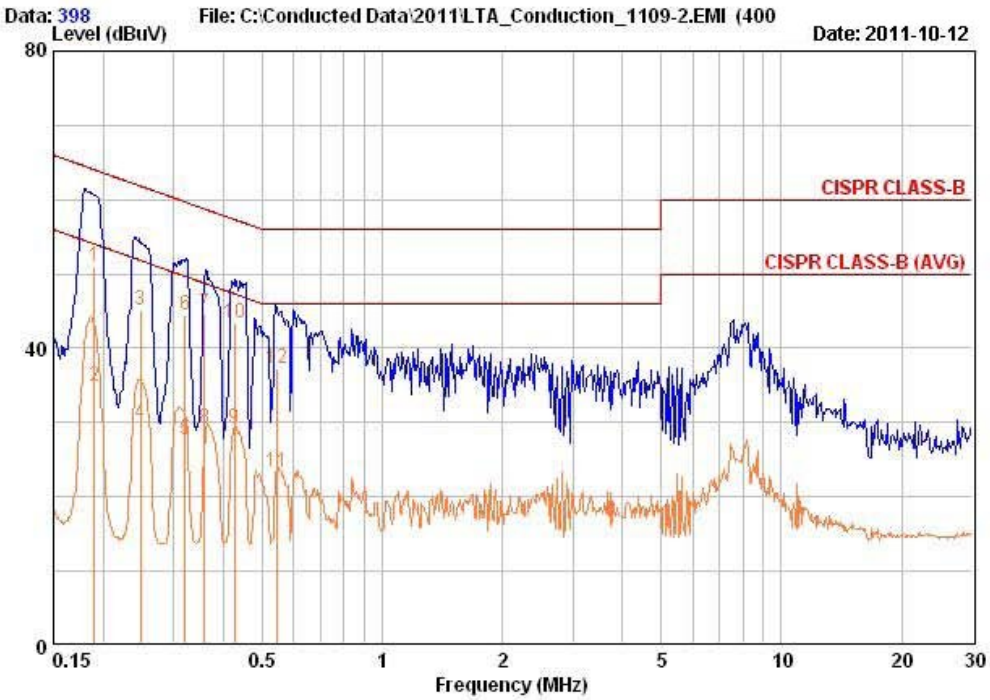
EUT / Model No.	: XR-2400	Phase	: LINE
Test Mode	: Wireless mode	Test Power	: 120 / 60
Temp./Humi.	: 23 / 46	Test Engineer	: PARK.H.W



Freq	RD QP	RD AV	C.F	Result QP	Result AV	Limit QP	Limit AV	Margin QP	Margin AV
MHz	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dBuV	dB	dB
0.190	41.44	25.34	9.64	51.08	34.98	64.04	54.04	12.95	19.05
0.248	35.53	20.23	9.64	45.17	29.87	61.82	51.82	16.65	21.95
0.320	34.83	17.93	9.65	44.48	27.58	59.71	49.71	15.22	22.12
0.358	35.13	19.63	9.66	44.79	29.29	58.77	48.77	13.98	19.48
0.427	33.63	19.63	9.67	43.30	29.30	57.31	47.31	14.01	18.01
0.547	27.52	13.62	9.67	37.19	23.29	56.00	46.00	18.81	22.71

Remarks: C.F (Correction Factor) = Insertion loss + Cable loss

AC Conducted Emissions – Zigbee – Neutral

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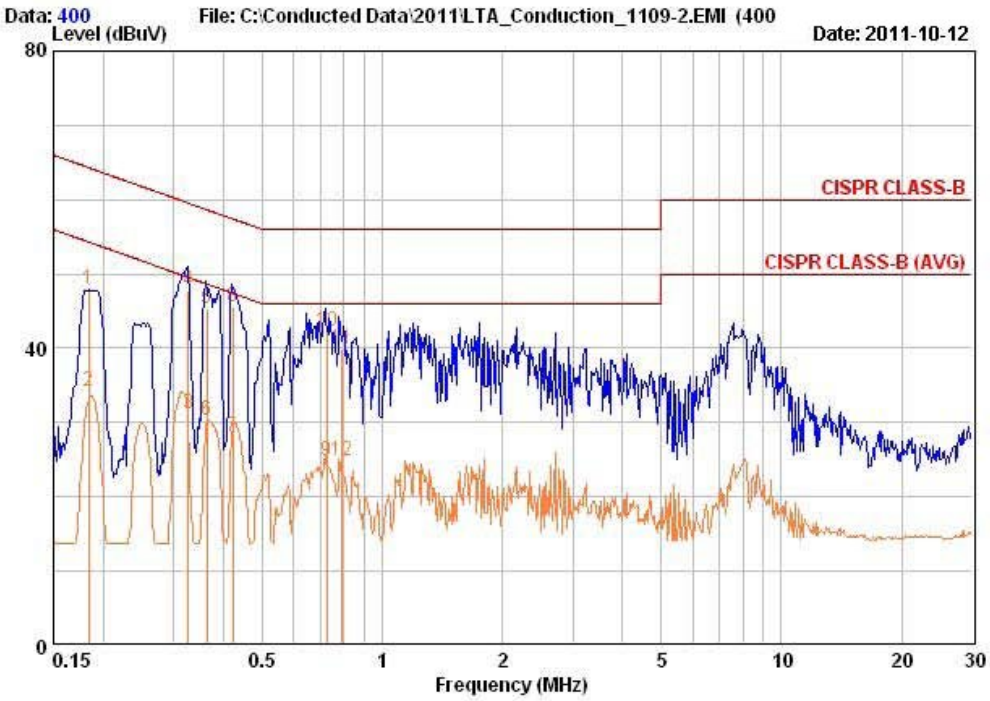
Fax:+82-31-3236010

EUT / Model No.	: XR-2400	Phase	: NEUTRAL
Test Mode	: Wireless mode	Test Power	: 120 / 60
Temp./Humi.	: 23 / 46	Test Engineer	: PARK.H.W



Freq	RD QP	RD AV	C.F	Result QP	Result AV	Limit QP	Limit AV	Margin QP	Margin AV
MHz	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dBuV	dB	dB
0.184	38.24	24.64	9.65	47.89	34.29	64.30	54.30	16.41	20.01
0.326	38.13	21.63	9.65	47.78	31.28	59.55	49.55	11.77	18.27
0.364	35.63	20.63	9.65	45.28	30.28	58.64	48.64	13.36	18.36
0.422	35.83	18.53	9.65	45.48	28.18	57.41	47.41	11.93	19.23
0.725	32.72	15.22	9.66	42.38	24.88	56.00	46.00	13.62	21.12
0.788	30.32	15.12	9.66	39.99	24.79	56.00	46.00	16.01	21.21

Remarks: C.F (Correction Factor) = Insertion loss + Cable loss

APPENDIX

TEST EQUIPMENT USED FOR TESTS

	Description	Model No.	Serial No.	Manufacturer	Interval	Last Cal. Date
1	Spectrum Analyzer (~30GHz)	FSV-30	100757	R&S	1 year	2011-01-24
2	Signal Generator (~3.2GHz)	8648C	3623A02597	HP	1 year	2011-03-30
3	Signal Generator (1~20GHz)	83711B	US34490456	HP	1 year	2011-03-30
4	Attenuator (3dB)	8491A	37822	HP	2 year	2010-10-08
5	Attenuator (10dB)	8491A	63196	HP	2 year	2010-10-08
6	Attenuator (30dB)	8498A	3318A10929	HP	2 year	2011-01-05
7	Test Receiver (~30MHz)	ESHS10	828404/009	R&S	1 year	2011-03-30
8	EMI Test Receiver (~1GHz)	ESCI7	100722	R&S	1 year	2011-10-07
9	RF Amplifier (~1.3GHz)	8447D	2439A09058	HP	2 year	2010-10-08
10	RF Amplifier (1~18GHz)	8449B	3008A02126	HP	2 year	2010-03-29
11	Horn Antenna (1~18GHz)	BBHA 9120D	9120D122	SCHWARZBECK	2 year	2010-12-24
12	Horn Antenna (18 ~ 40GHz)	SAS-574	154	Schwarzbeck	2 year	2010-11-25
13	Horn Antenna (18 ~ 40GHz)	SAS-574	155	Schwarzbeck	2 year	2010-11-25
14	TRILOG Antenna	VULB 9160	9160-3172	SCHWARZBECK	2 year	2010-10-07
15	Dipole Antenna	VHA9103	2116	SCHWARZBECK	2 year	2010-11-25
16	Dipole Antenna	VHA9103	2117	SCHWARZBECK	2 year	2010-11-25
17	Dipole Antenna	VHA9105	2261	SCHWARZBECK	2 year	2010-11-25
18	Dipole Antenna	VHA9105	2262	SCHWARZBECK	2 year	2010-11-25
19	Hygro-Thermograph	THB-36	0041557-01	ISUZU	2 year	2010-04-12
20	Splitter (SMA)	ZFSC-2-2500	SF617800326	Mini-Circuits	-	-
21	Power Divider	11636A	6243	HP	2 year	2010-10-08
22	DC Power Supply	6622A	3448A03079	HP	-	-
23	Frequency Counter	5342A	2826A12411	HP	1 year	2011-03-30
24	Power Meter	EPM-441A	GB32481702	HP	1 year	2011-03-30
25	Power Sensor	8481A	US41030291	HP	1 year	2011-10-07
26	Audio Analyzer	8903B	3729A18901	HP	1 year	2011-10-07
27	Modulation Analyzer	8901B	3749A05878	HP	1 year	2011-10-07
28	TEMP & HUMIDITY Chamber	YJ-500	LTAS06041	JinYoung Tech	1 year	2011-10-07
29	Stop Watch	HS-3	601Q09R	CASIO	2 year	2010-03-31
30	LISN	ENV216	100408	R&S	1 year	2011-10-07
31	UNIVERSAL RADIO COMMUNICATION TESTER	CMU200	106243	R&S	2 year	2010-05-13
32	Highpass Filter	WHKX1.5/15G-10SS	74	Wainwright Instruments	-	-
33	Highpass Filter	WHKX3.0/18G-10SS	118	Wainwright Instruments	-	-