



Dates of Tests: October 20 ~ November 03, 2014

Test Report S/N: LR500111411A

Test Site : LTA CO., LTD.

CERTIFICATION OF COMPLIANCE

FCC ID.

UNTLM2471-EM

APPLICANT

RadioPulse Inc.

Equipment Class	:	Digital Transmission System (DTS)
Manufacturing Description	:	Zigbee Module
Manufacturer	:	RadioPulse Inc.
Model name	:	LM2471-EM
Test Device Serial No.:	:	Identical prototype
Rule Part(s)	:	FCC Part 15.247 Subpart C ; ANSI C-63.4-2009
Frequency Range	:	2405MHz ~ 2475MHz
Max. Output Power	:	Max 11.75dBm – Conducted
Data of issue	:	November 03, 2014

This test report is issued under the authority of:



Jae-Ho Lee, Manager

The test was supervised by:



Young-Jin Lee, Test Engineer

This test result only responds to the tested sample. It is not allowed to copy this report even partly without the allowance of the test laboratory. The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.



NVLAP LAB Code.: 200723-0

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1. General information

1-1 Test Performed

Company name : LTA Co., Ltd.
 Address : 243, Jubug-ri, Yangji-Myeon, Youngin-Si, Kyunggi-Do, Korea. 449-822
 Web site : <http://www.ltalab.com>
 E-mail : chahn@ltalab.com
 Telephone : +82-31-323-6008
 Facsimile : +82-31-323-6010

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	2015-09-30	ECT accredited Lab.
RRA	KOREA	KR0049	2015-03-06	EMC accredited Lab.
FCC	U.S.A	610755	2017-04-21	FCC filing
FCC	U.S.A	649054	2015-04-17	FCC CAB
VCCI	JAPAN	R2133(10 m), C2307	2017-06-21	VCCI registration
VCCI	JAPAN	T-2009	2016-12-23	VCCI registration
VCCI	JAPAN	G-563	2015-05-28	VCCI registration
IC	CANADA	5799A-1	2015-06-21	IC filing
KOLAS	KOREA	NO.551	2017-01-08	KOLAS accredited Lab.

2. Information about test item

2-1 Client & Manufacturer

Company name : RadioPulse Inc.
 Address : 3rd Fl., Hans B/D II, 111-6 Seongnae-Dong,
 Gangdong-Gu, Seoul, Korea, 134-883, Korea
 Tel / Fax : TEL No : +82-2-478-2963 / FAX No : +82-2-478-2966

2-2 Equipment Under Test (EUT)

Trade name : Zigbee Module
 Model name : LM2471-EM
 Serial number : Identical prototype
 Date of receipt : October 14, 2014
 EUT condition : Pre-production, not damaged
 Antenna type : Dipole antenna (M/N: WE-2400TO) Max Gain 2.5 dBi
 Frequency Range : 2405MHz ~ 2475MHz
 RF output power : Max 11.75dBm – Conducted
 Number of channels : 15
 Type of Modulation : O-QPSK
 Channel spacing : 5MHz
 Power Source : 3.0Vdc
 Firmware Version : V1.0.0

2-3 Tested frequency

	LOW	MID	HIGH
Frequency (MHz)	2405	2440	2475

2-4 Ancillary Equipment

Equipment	Model No.	Serial No.	Manufacturer
Notebook	Vostro 1015	DN9RBN1	DELL

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	> 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 RadioPulse Inc FCC ID: UNTLM2471-EM 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-63.4-2009
- *FCC KDB Publication No. 558074 v03r02
- *FCC TCB Workshop 2012, April

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 = 5 MHz

VBW = 100 kHz (VBW \geq RBW)

Sweep = auto

Trace = max hold

Detector function = peak

Measurement Data:

Frequency (MHz)	Test Results	
	Measured Bandwidth (MHz)	Result
2405	1.65	Complies
2440	1.69	Complies
2475	1.65	Complies

- See next pages for actual measured spectrum plots.

Minimum Standard:

6 dB Bandwidth > 500kHz

Measurement Setup

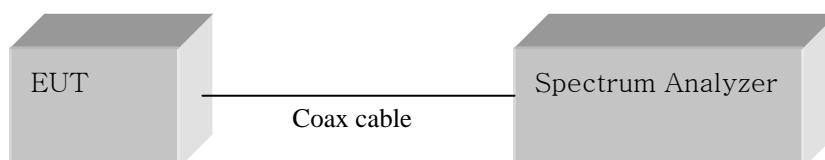
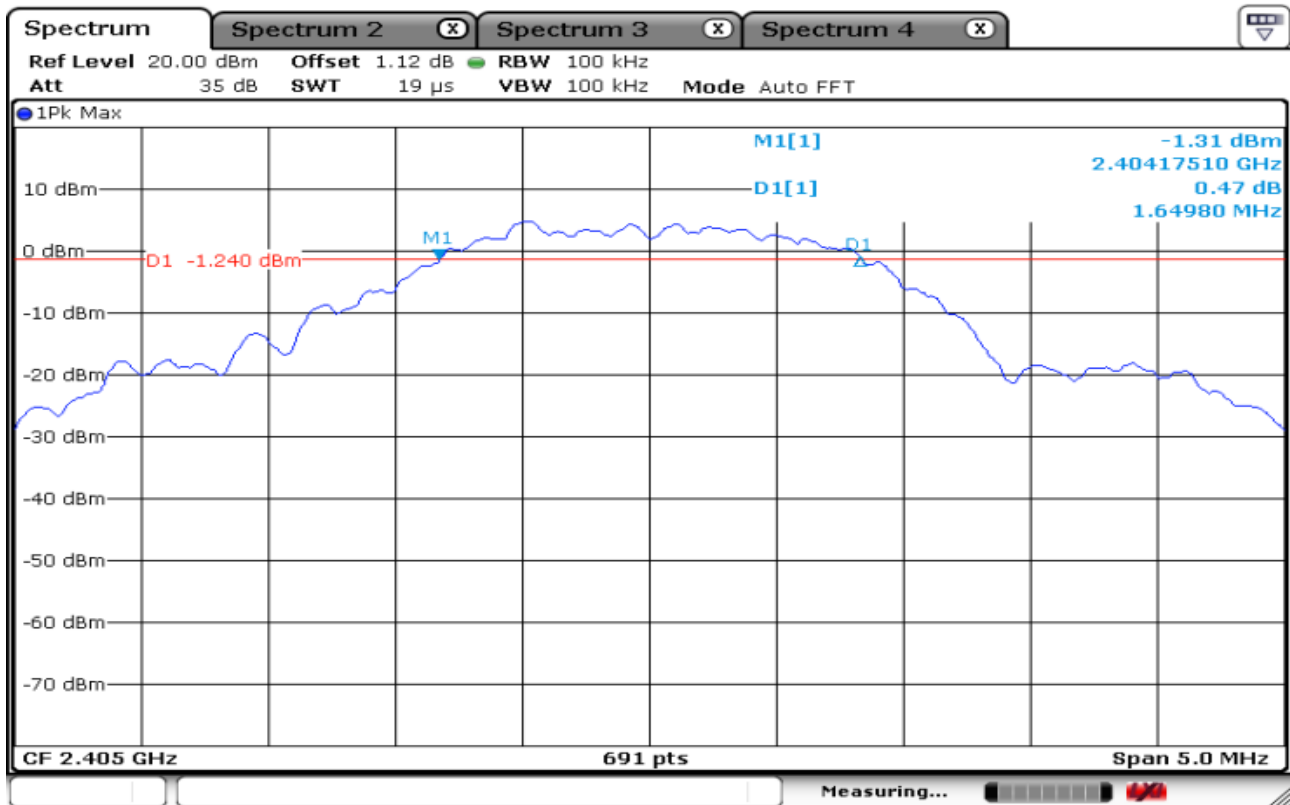
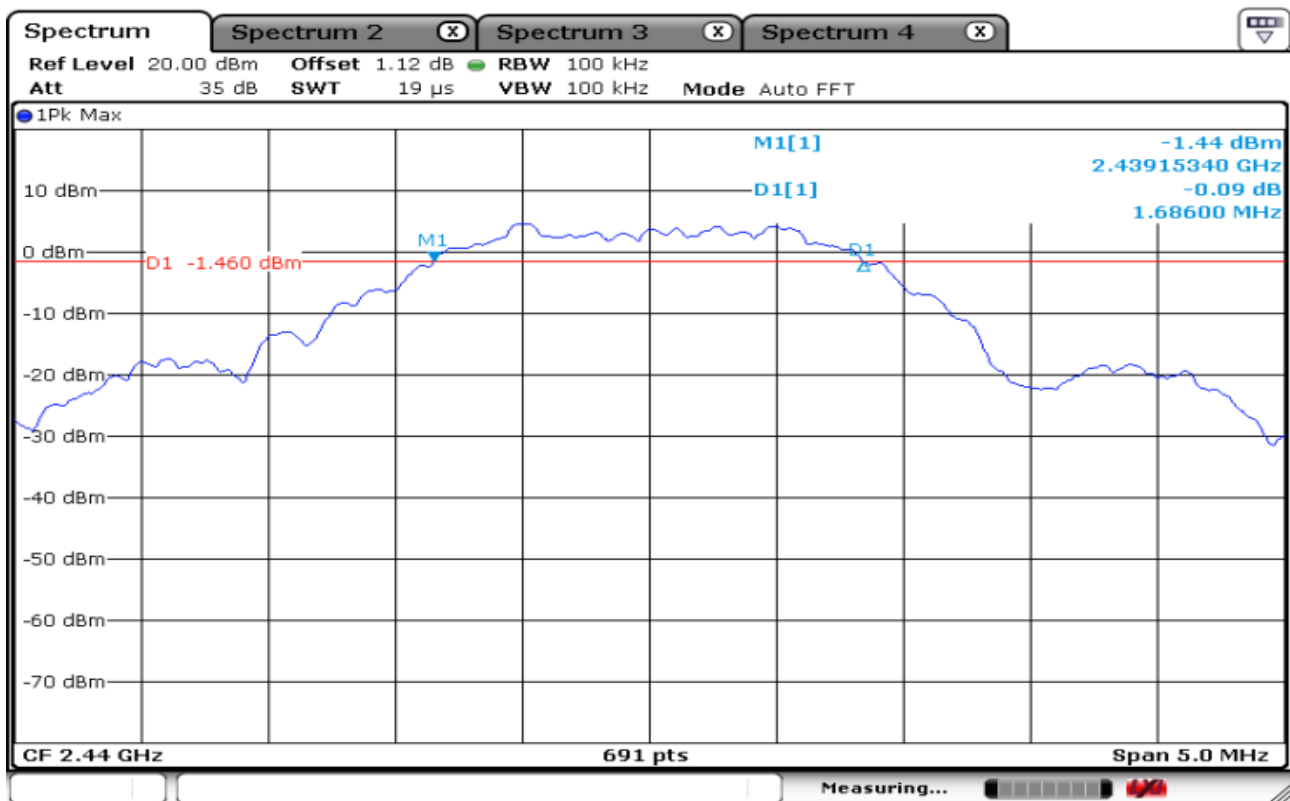


Figure 1: Measurement setup for the carrier frequency separation

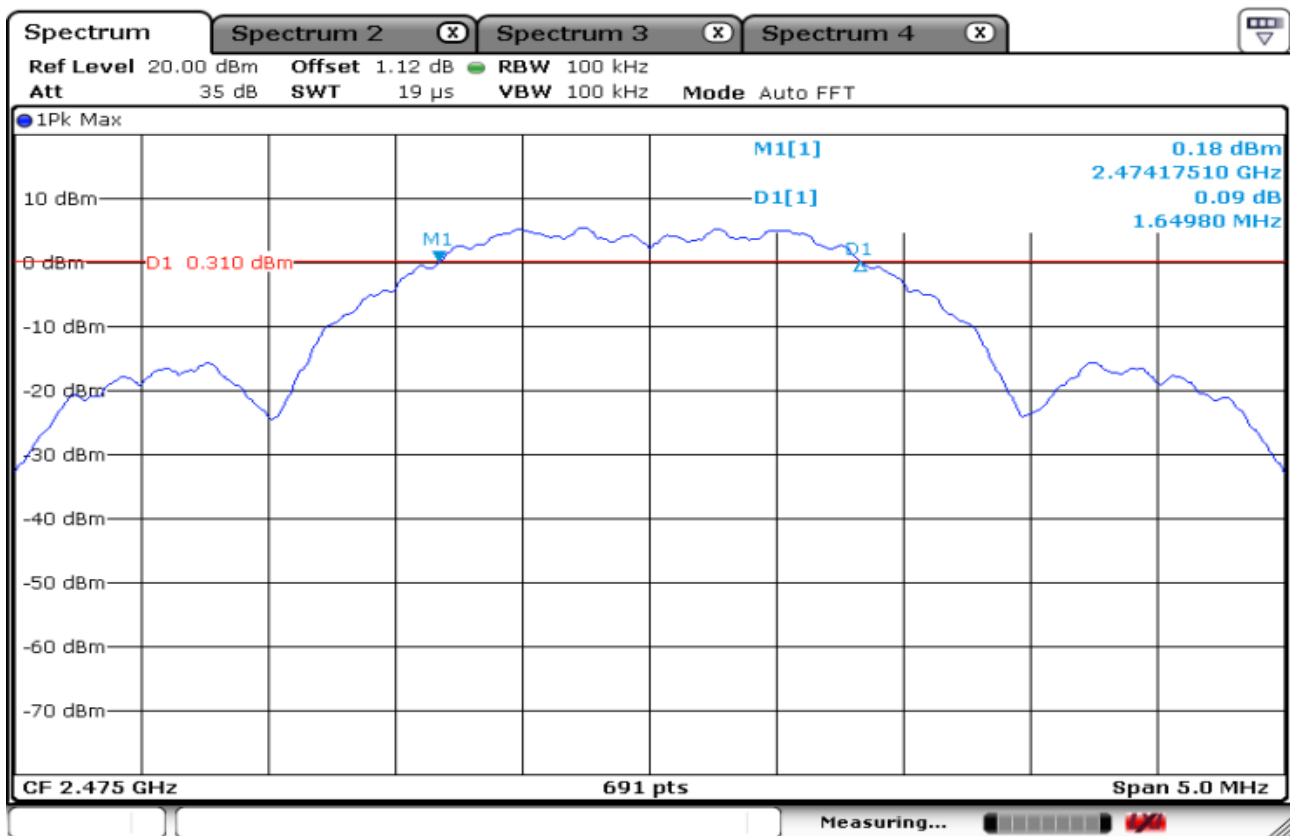
Low Channel



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 \geq RBW)

Sweep = auto

Detector function = peak

Measurement Data:

Frequency (MHz)	Test Results		
	dBm	mW	Result
2405	11.47	14.03	Complies
2440	11.19	13.15	Complies
2475	11.75	14.96	Complies

- See next pages for actual measured spectrum plots.

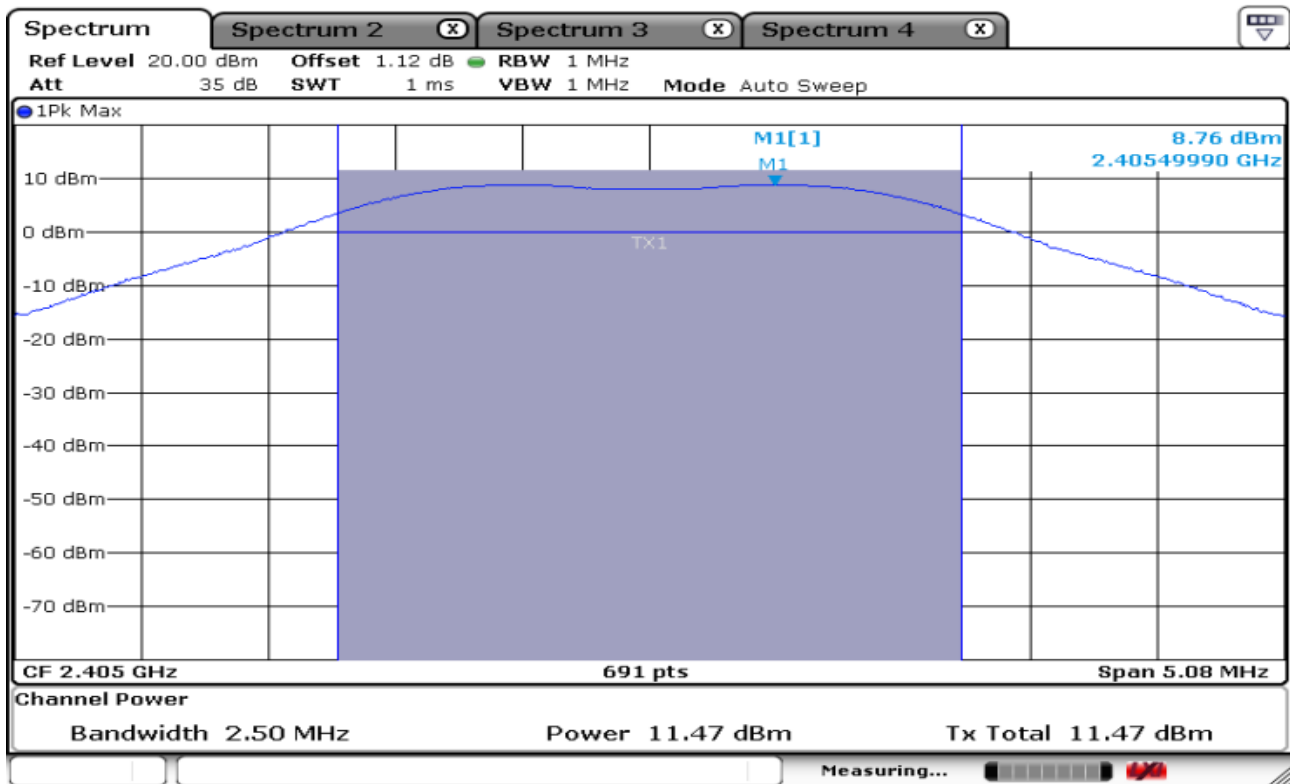
Minimum Standard:

Peak output power	< 1W
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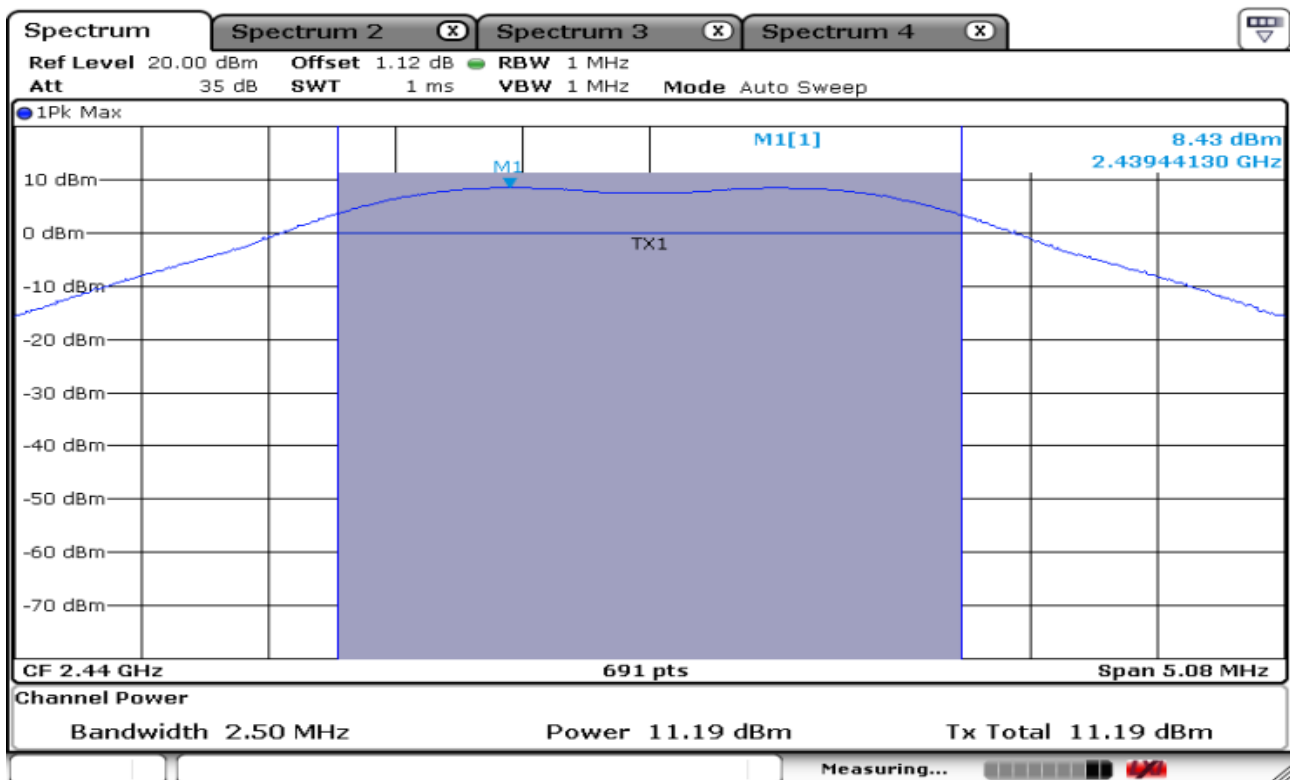
Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

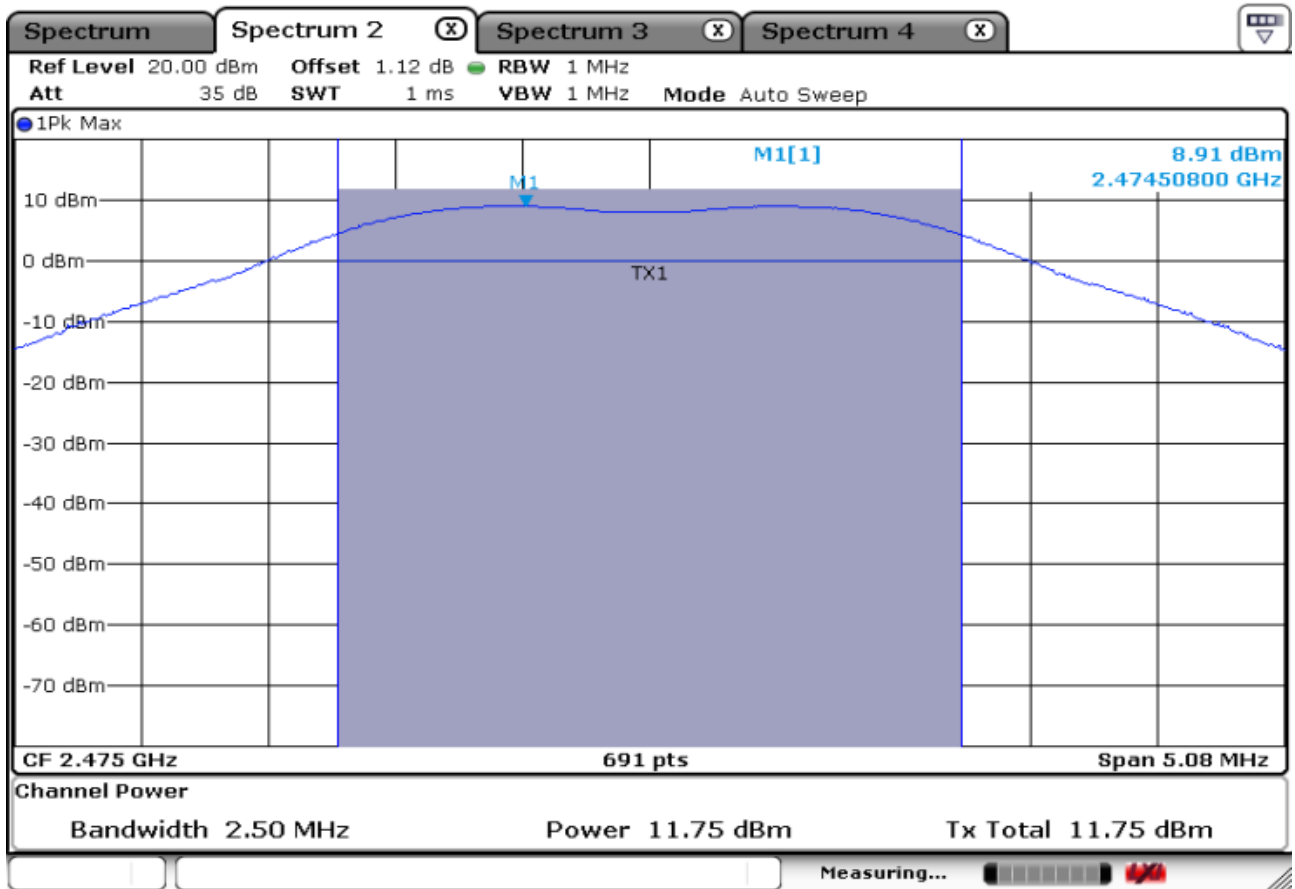
Low Channel



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 = 3 kHz

Sweep = auto

Detector function = peak

Trace = max hold

Measurement Data:

Frequency (MHz)	Test Results	
	dBm	Result
2405	-7.35	Complies
2440	-7.80	Complies
2475	-6.69	Complies

- See next pages for actual measured spectrum plots.

Minimum Standard:

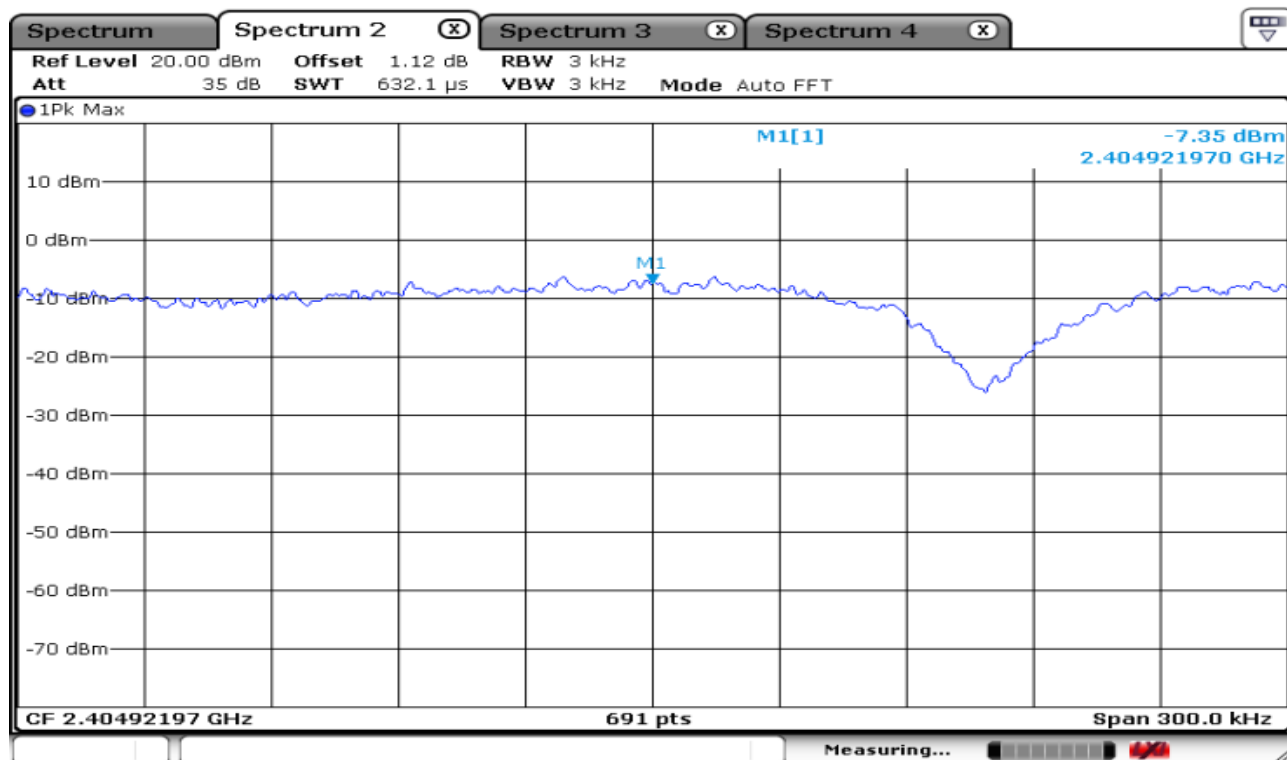
Power Spectral Density	< 8dBm @ 3kHz BW
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Measurement Setup

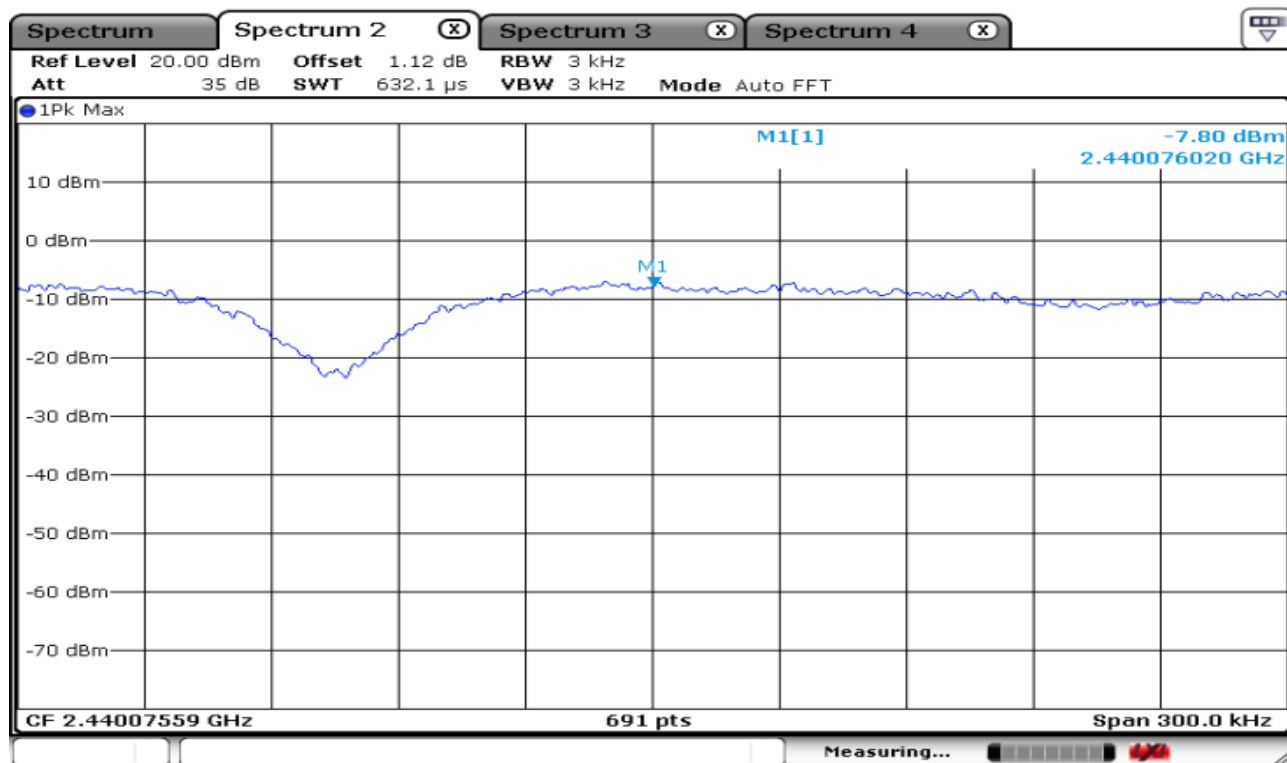
Same as the Chapter 3.2.1 (Figure 1)

Power Density Measurement

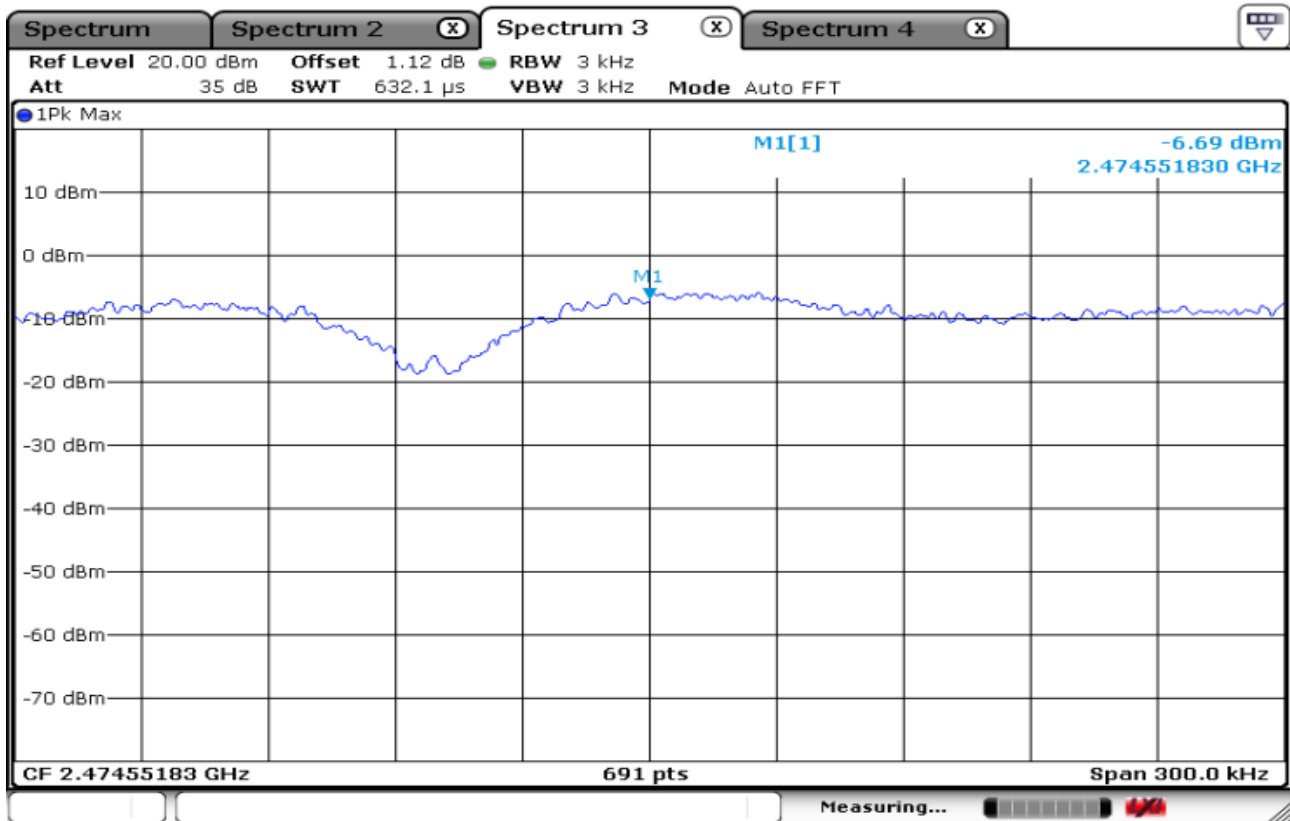
Low Channel



Mid Channel



High Channel



3.2.4 Band - edge

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 = 40MHz

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:

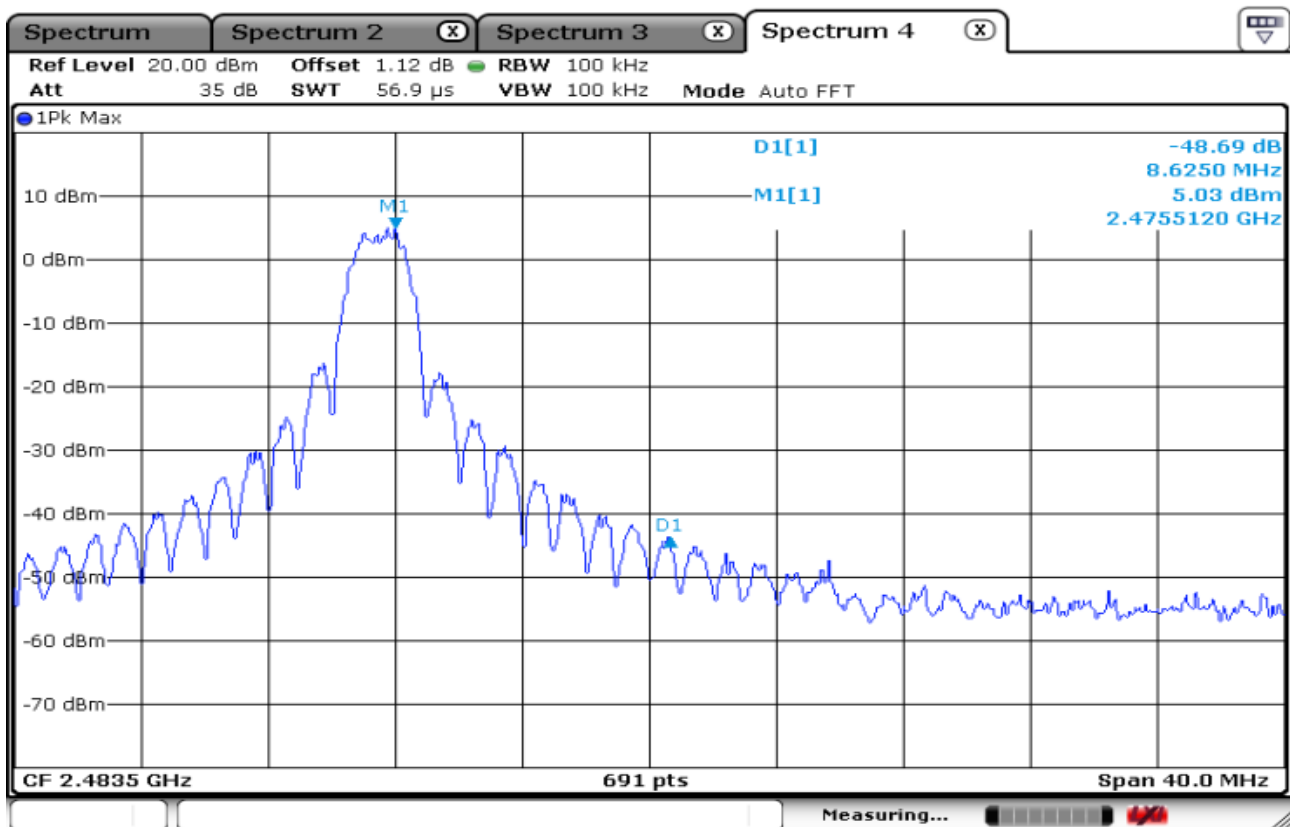
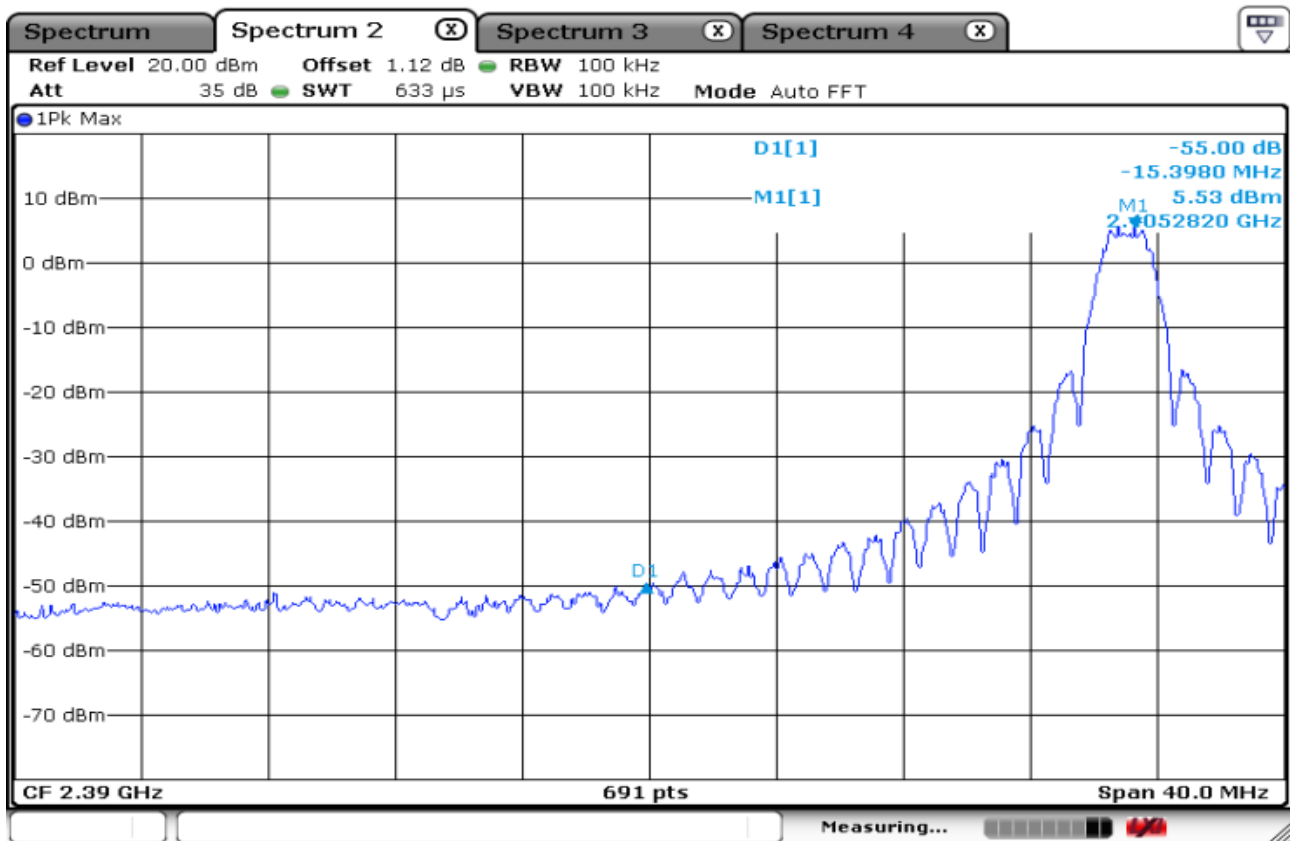
Horizontal / Vertical

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
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Band-edge



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

Frequency [MHz]	Reading [dBuV/m]		Pol.	Correction Factor		Limits [dBuV/m]		Result [dBuV/m]		Margin [dB]	
	AV / Peak			Antenna	Amp. Gain + Cable Loss	AV / Peak	AV / Peak	AV / Peak	AV / Peak		
2323.0	42.8	53.7	V	27.5	21.7	54.0	74.0	48.6	59.5	5.4	14.5

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

Frequency [MHz]	Reading [dBuV/m]		Pol.	Correction Factor		Limits [dBuV/m]		Result [dBuV/m]		Margin [dB]	
	AV / Peak			Antenna	Amp. Gain + Cable Loss	AV / Peak		AV / Peak		AV / Peak	
2484.5	40.7	51.6	V	27.5	21.7	54.0	74.0	46.5	57.4	7.5	16.6

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

3.2.5 Conducted Spurious Emissions

Procedure:

The test follows KDB558074. The conducted spurious emissions were measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function disabled at the highest, middle and the lowest available channels..

After the trace being stable, set the marker on the peak of any spurious emission recorded.

The spectrum analyzer is set to:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions

RBW = 100 kHz

Sweep = auto

VBW = 100 kHz

Detector function = peak

Trace = max hold

Measurement Data: Complies

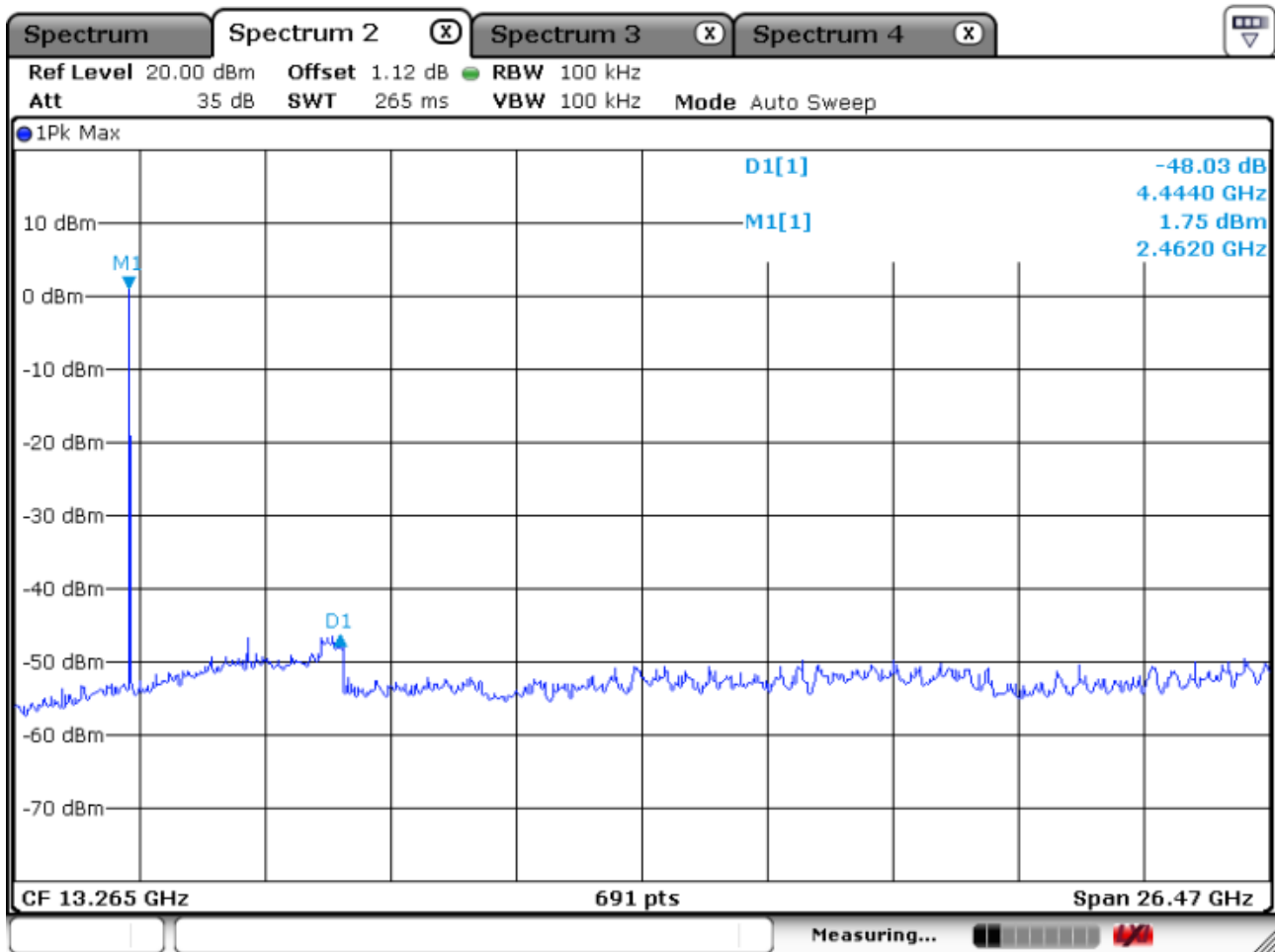
- All conducted emission in any 100kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest inband spectral density. Therefore the applying equipment meets the requirement.
- See next pages for actual measured spectrum plots.

Minimum Standard:	> 20 dBc
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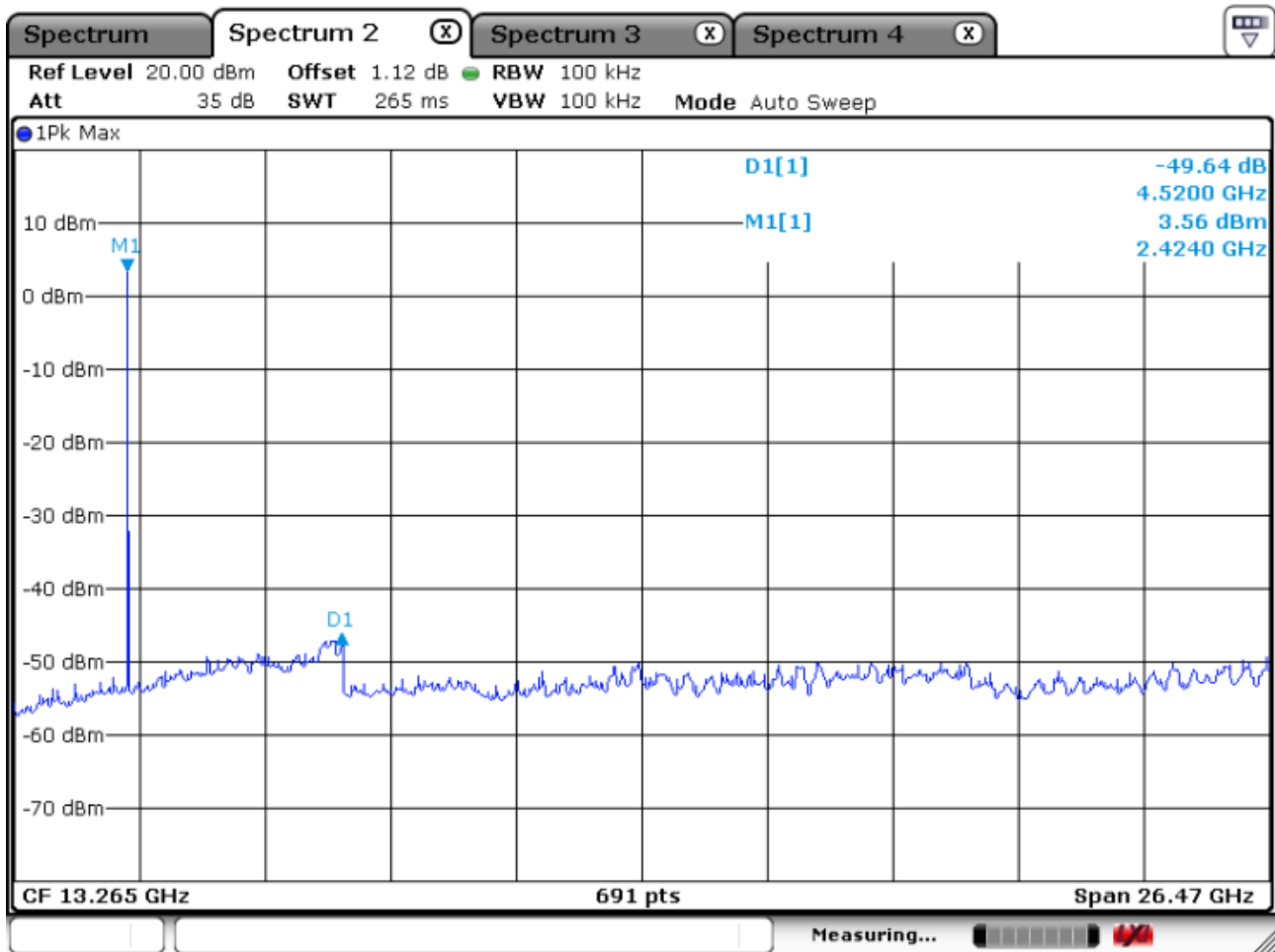
Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

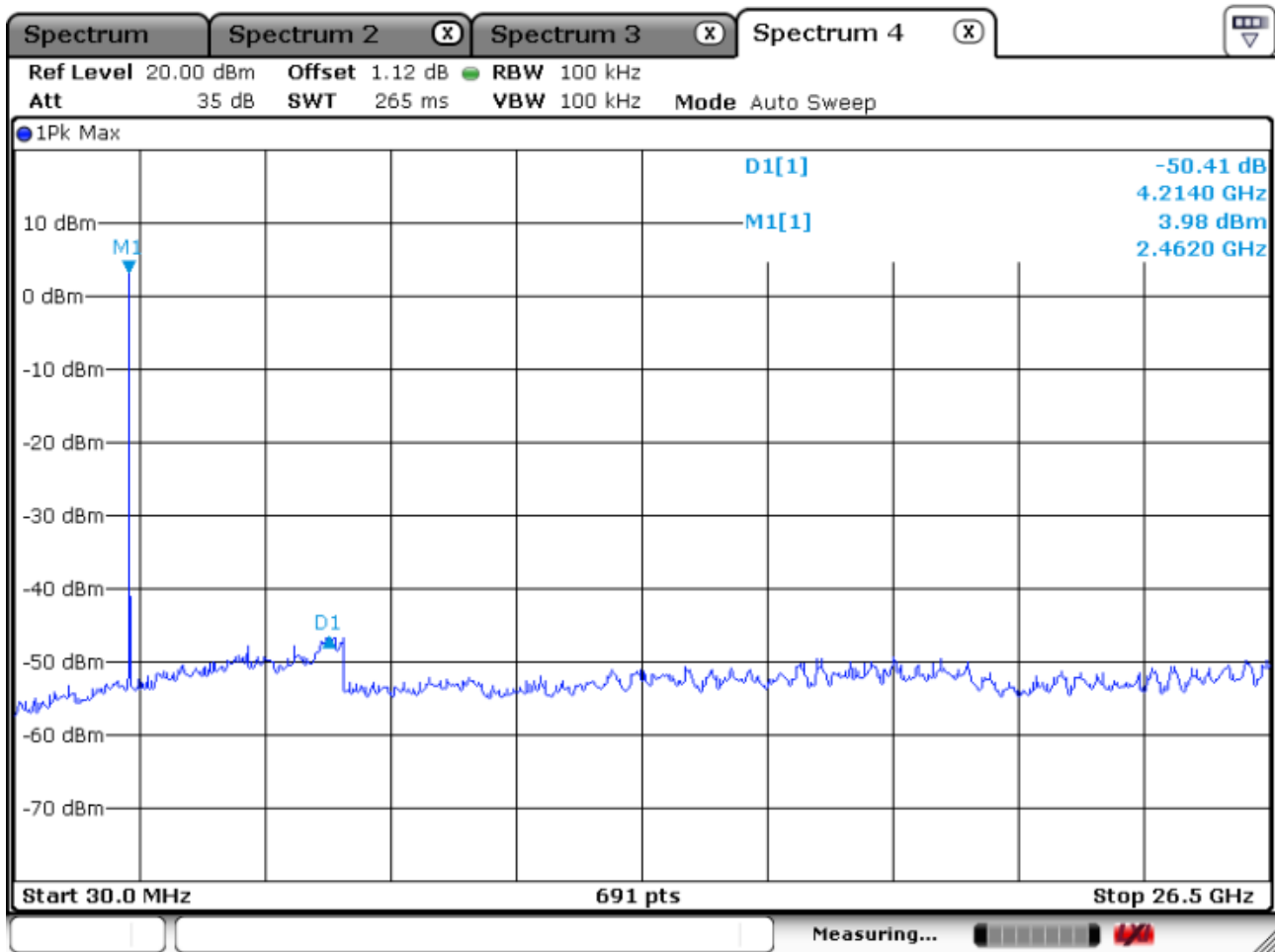
Unwanted Emission – Low channel
Frequency Range = 30 MHz ~ 26.5 GHz



Unwanted Emission – Middle channel
Frequency Range = 30 MHz ~ 26.5 GHz



Unwanted Emission – High channel
Frequency Range = 30 MHz ~ 26.5 GHz



3.2.6 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 \geq 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
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		Limits [dBuV/m] AV/Peak		Result [dBuV/m] AV/Peak		Margin [dB] AV / Peak	
				Antenna	Amp.Gain+Cable						
1322.7	43.7	60.4	V	24.8	21.8	54.0	74.0	46.7	63.4	7.3	10.6
Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Correction Factor		Limits [dBuV/m] AV/Peak		Result [dBuV/m] AV/Peak		Margin [dB] AV / Peak	
				Antenna	Amp.Gain+Cable						
1332.7	43.7	63.4	V	24.8	21.8	54.0	74.0	46.7	66.4	7.3	7.6
Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Correction Factor		Limits [dBuV/m] AV/Peak		Result [dBuV/m] AV/Peak		Margin [dB] AV / Peak	
				Antenna	Amp.Gain+Cable						
1327.1	44.6	63.6	V	24.8	21.8	54.0	74.0	47.6	66.6	6.4	7.4

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

Radiated Emissions – Zigbee

4, Songjuro236Beon-gil, Yangju-myeon,
Cheoin-gu, Youngin-si, Gyeonggi-do,
449-822 Korea
Tel :+82-31-3236008,9
Fax:+82-31-3236010

EUT/Model No.: LM2471-EM

TEST MODE: zig bee mode

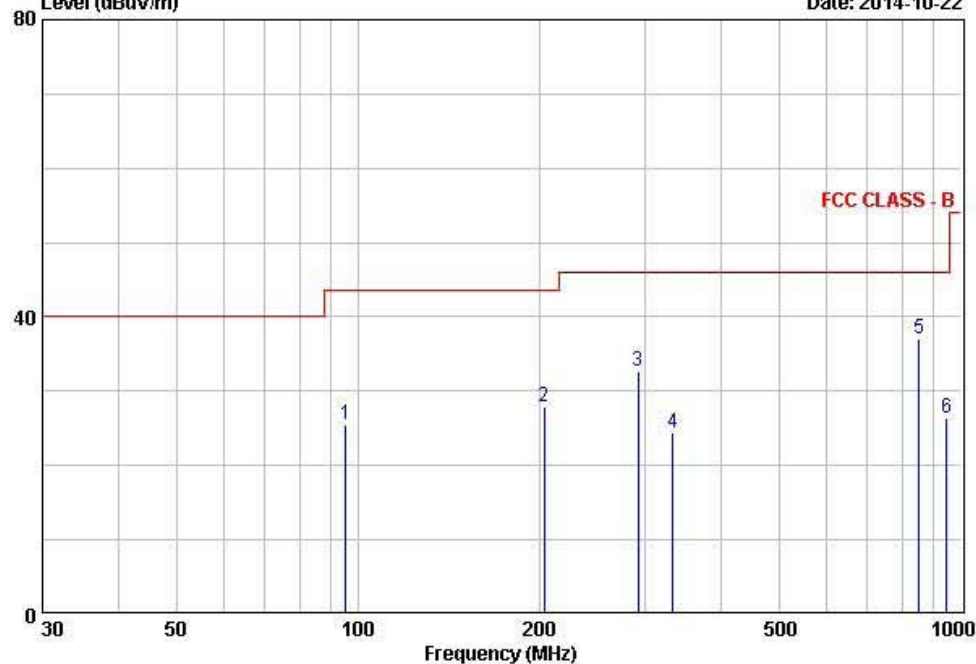
Temp Humi : 22 / 43

Tested by: SIN S U

Data: 63

Level (dBuV/m)

Date: 2014-10-22



	Freq	Reading	C.F	Result	Limit QP	Margin	Height	Angle	Polarity
	MHz	dBuV/m	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	95.40	47.80	-22.25	25.55	43.50	17.95	100	190	VERTICAL
2	203.70	48.20	-20.35	27.85	43.50	15.65	120	155	HORIZONTAL
3	291.50	49.70	-16.96	32.74	46.00	13.26	100	256	VERTICAL
4	332.60	40.50	-16.06	24.44	46.00	21.56	100	120	VERTICAL
5	852.30	43.90	-6.95	36.95	46.00	9.05	100	200	VERTICAL
6	948.70	31.90	-5.58	26.32	46.00	19.68	157	35	HORIZONTAL

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

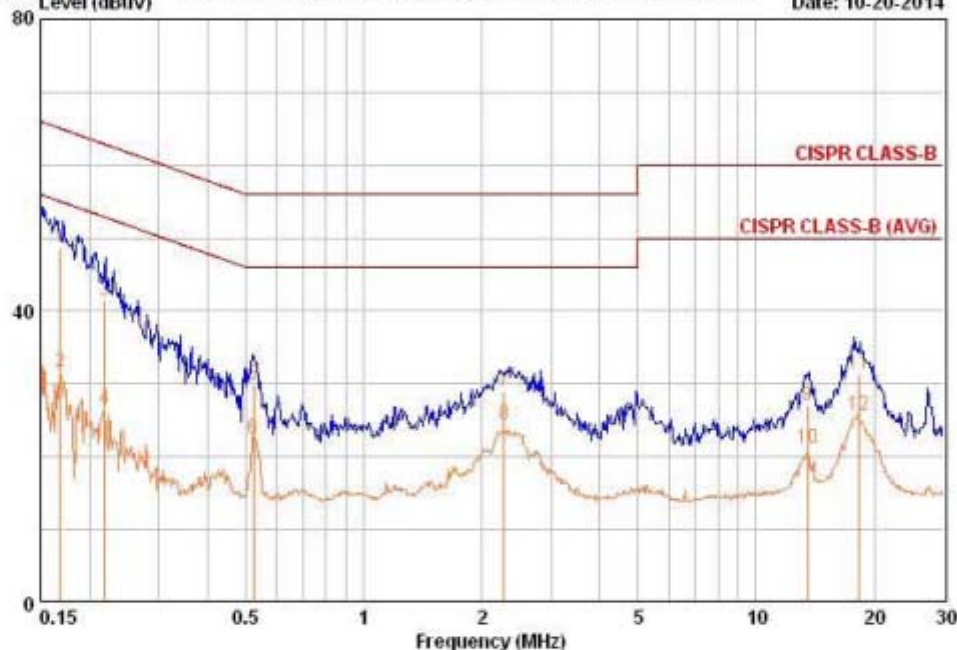
* Decreases with the logarithm of the frequency

AC Conducted Emissions – Zigbee – Line

4, Songhwa236Beon-gil, Yangji-myeon
Cheoin-gu, Youngin-si, Gyeonggi-do
449-822 Korea
Tel :+82-31-3236008,9
Fax:+82-31-3236010

EUT / Model No. : LM2471-EM	Phase : LINE
Test Mode : zig bee mode	Test Power : 120 / 60
Temp./Humid. : 26 / 47	Test Engineer : SIN S U

Data: 218 File: C:\Conducted Data\2014\LTA_Conduction_1410-2.EMI (314) Date: 10-20-2014
Level (dBuV)



Freq	RD	RD	C.F	Result	Result	Limit	Limit	Margin	Margin
MHz	QP	AV	dB	QP	AV	QP	AV	QP	AV
	dBuV	dBuV		dBuV	dBuV	dBuV	dBuV	dB	dB
0.168	38.95	21.95	9.65	48.60	31.60	65.06	55.06	16.46	23.46
0.218	31.75	16.95	9.72	41.47	26.67	62.89	52.89	21.43	26.23
0.524	20.34	12.94	9.58	29.93	22.53	56.00	46.00	26.07	23.47
2.284	19.26	14.76	9.68	28.94	24.44	56.00	46.00	27.06	21.56
13.552	17.24	11.34	9.75	26.99	21.09	60.00	50.00	33.01	28.91
18.232	21.47	15.97	9.84	31.31	25.81	60.00	50.00	28.69	24.19

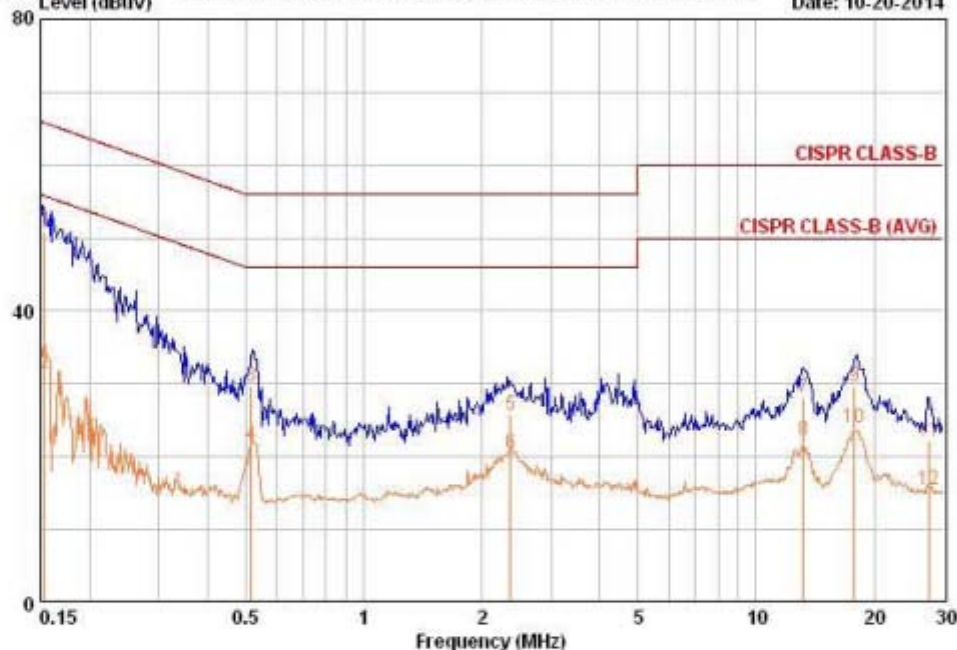
Remarks: C.F (Correction Factor) = Insertion loss + Cable loss

AC Conducted Emissions – Zigbee – Neutral

4, Songhwa236Beon-gil, Yangji-myeon
Cheoin-gu, Youngin-si, Gyeonggi-do
449-822 Korea
Tel :+82-31-3236008,9
Fax:+82-31-3236010

EUT / Model No. : LM2471-EM	Phase : NEUTRAL
Test Mode : zig bee mode	Test Power : 120 / 60
Temp./Humid. : 26 / 47	Test Engineer : SIN S U

Data: 220 Level (dBuV) File: C:\Conducted Data\2014\LTA_Conduction_1410-2.EMI (314) Date: 10-20-2014



Freq	RD	RD	C.F	Result	Result	Limit	Limit	Margin	Margin
MHz	QP	AV	dB	QP	AV	QP	AV	QP	AV
	dBuV	dBuV		dBuV	dBuV	dBuV	dBuV	dB	dB
0.153	41.25	21.85	9.61	50.85	31.45	65.84	55.84	14.98	24.38
0.517	20.04	11.94	9.59	29.63	21.53	56.00	46.00	26.37	24.47
2.371	16.06	10.76	9.69	25.75	20.45	56.00	46.00	30.25	25.55
13.195	18.34	12.54	9.78	28.12	22.32	60.00	50.00	31.88	27.68
17.849	19.77	14.17	9.90	29.67	24.07	60.00	50.00	30.33	25.93
27.707	12.14	5.44	9.99	22.13	15.43	60.00	50.00	37.87	34.57

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	Signal Analyzer (9kHz~30GHz)	FSV-30	100757	R&S	1 year	2014-01-16
2	Signal Generator (~3.2GHz)	8648C	3623A02597	HP	1 year	2014-03-25
3	SYNTHESIZED CW GENERATOR	83711B	US34490456	HP	1 year	2014-03-25
4	Attenuator (3dB)	8491A	37822	HP	1 year	2014-09-16
5	Attenuator (10dB)	8491A	63196	HP	1 year	2014-09-16
6	Test Receiver (~30MHz)	ESHS10	828404/009	R&S	1 year	2014-03-25
7	EMI Test Receiver (~7GHz)	ESCI7	100722	R&S	1 year	2014-09-15
8	RF Amplifier (~1.3GHz)	8447D OPT 010	2944A07684	HP	1 year	2014-09-16
9	RF Amplifier (1~26.5GHz)	8449B	3008A02126	HP	1 year	2014-03-25
10	Horn Antenna (1~18GHz)	3115	00114105	ETS	2 year	2013-05-13
11	DRG Horn (Small)	3116B	81109	ETS-Lindgren	2 year	2014-02-26
12	DRG Horn (Small)	3116B	133350	ETS-Lindgren	2 year	2014-02-26
13	TRILOG Antenna	VULB 9160	9160-3237	SCHWARZBECK	2 year	2013-05-14
14	Temp.Humidity Data Logger	SK-L200TH II A	00801	SATO	1 year	2014-04-03
15	Splitter (SMA)	ZFSC-2-2500	SF617800326	Mini-Circuits	-	-
16	Power Divider	11636A	06243	HP	1 year	2014-09-16
17	DC Power Supply	6674A	3637A01657	Agilent	-	-
18	Frequency Counter	5342A	2826A12411	HP	1 year	2014-03-25
19	Power Meter	EPM-441A	GB32481702	HP	1 year	2014-03-25
20	Power Sensor	8481A	3318A99464	HP	1 year	2014-01-17
21	Audio Analyzer	8903B	3729A18901	HP	1 year	2014-09-15
22	Modulation Analyzer	8901B	3749A05878	HP	1 year	2014-09-15
23	TEMP & HUMIDITY Chamber	YJ-500	LTAS06041	JinYoung Tech	1 year	2014-09-16
24	Stop Watch	HS-3	812Q08R	CASIO	2 year	2014-04-03
25	LISN	KNW-407	8-1430-1	Kyoritsu	1 year	2014-09-15
26	Two-Lime V-Network	ESH3-Z5	893045/017	R&S	1 year	2014-03-26
27	UNIVERSAL RADIO COMMUNICATION TESTER	CMU200	106243	R&S	1 year	2014-07-11
28	Highpass Filter	WHKX1.5/15G-10SS	74	Wainwright Instruments	-	-
29	Highpass Filter	WHKX3.0/18G-10SS	118	Wainwright Instruments	-	-
30	Active Loop Antenna	FMZB1519	1519-031	SCHWARZBECK	1 year	2014-01-07
31	OSP120 BASE UNIT	OSP120	101230	R&S	1 year	2014-08-20
32	Signal Generator(100kHz~40GHz)	SMB100A03	177621	R&S	1 year	2014-08-20
33	Signal Analyzer (10Hz~40GHz)	FSV40	101367	R&S	1 year	2014-08-20