LTA
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radio pulse

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 r eport even partly without the allowance of the te st 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

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.

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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

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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

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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 ≥ 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

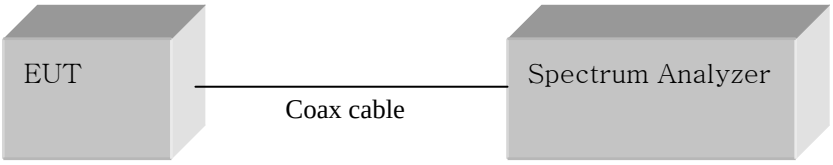
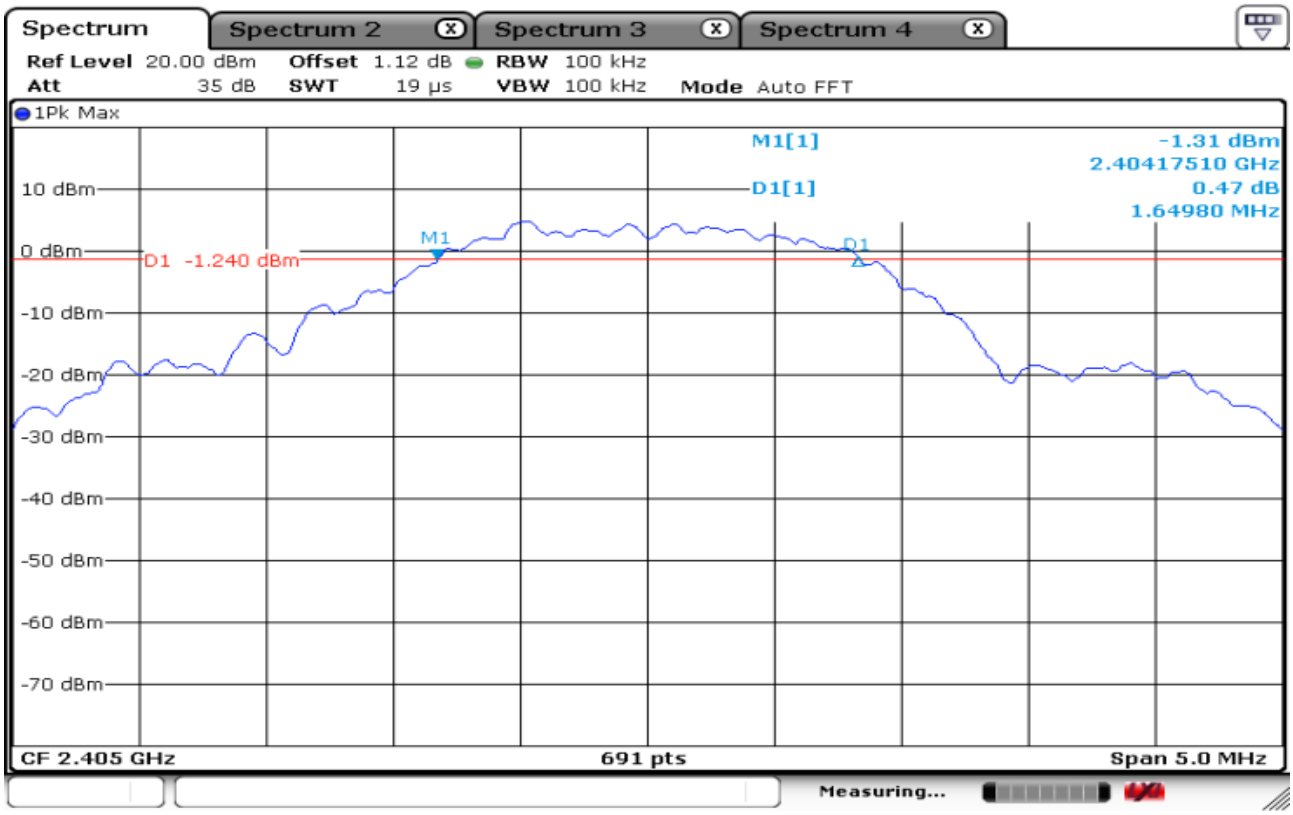
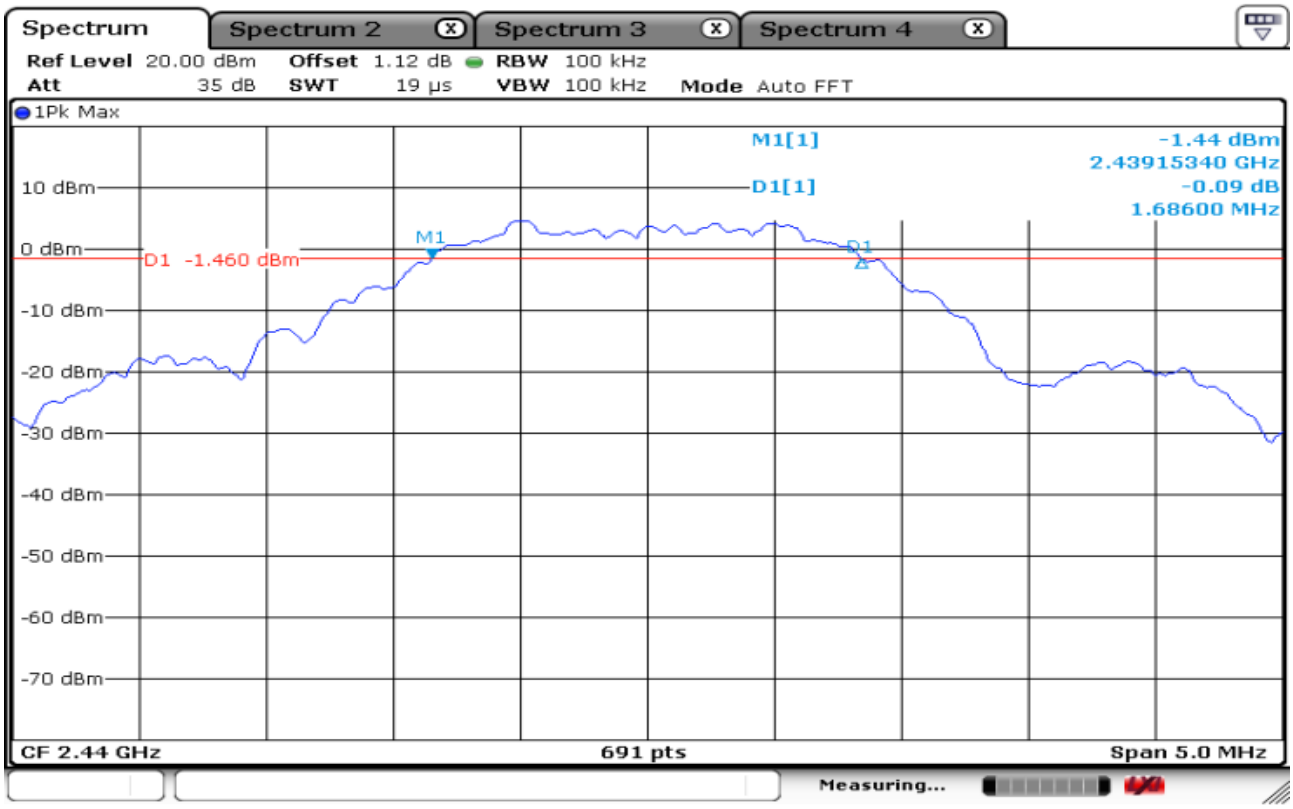


Figure 1: Measurement setup for the carrier frequency separation

Low Channel



Mid Channel



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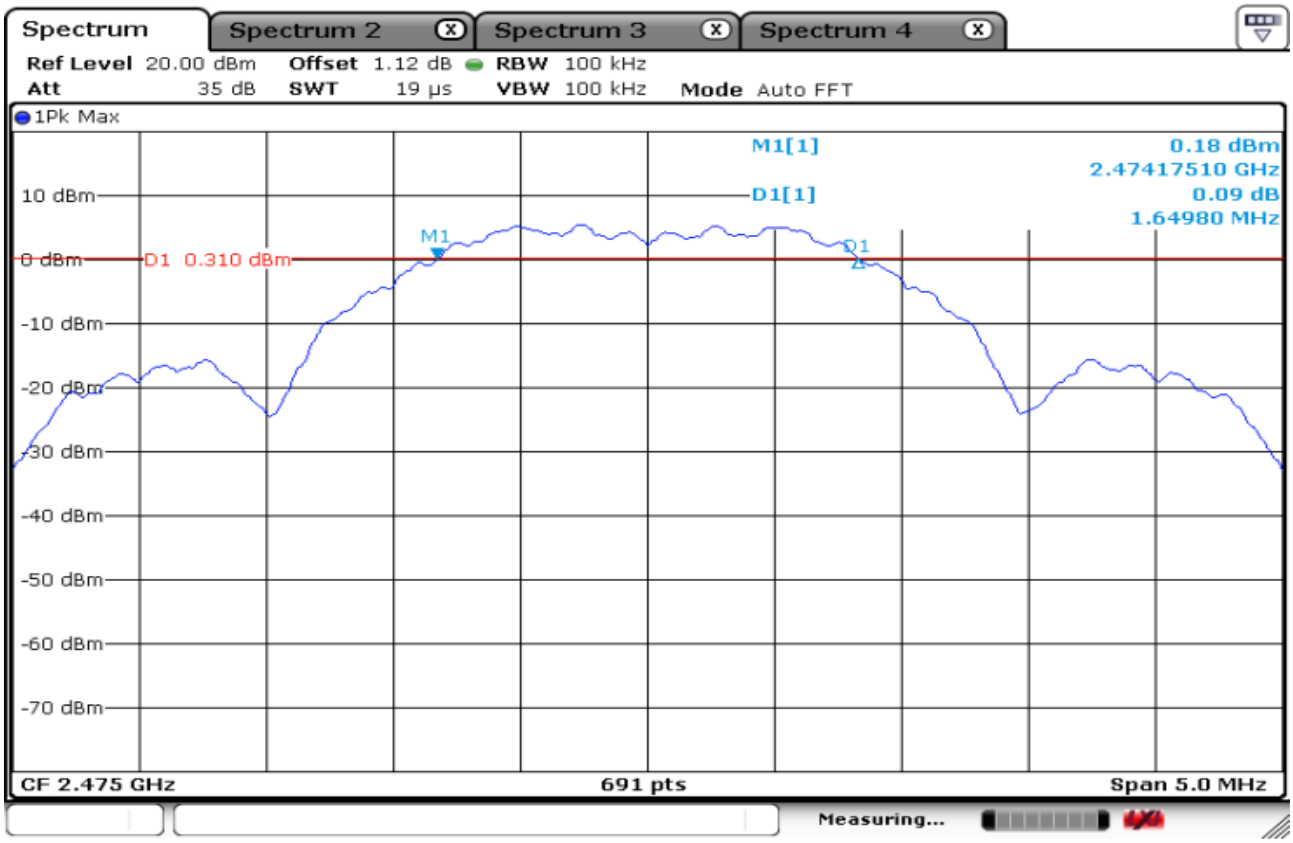
High Channel



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	**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.

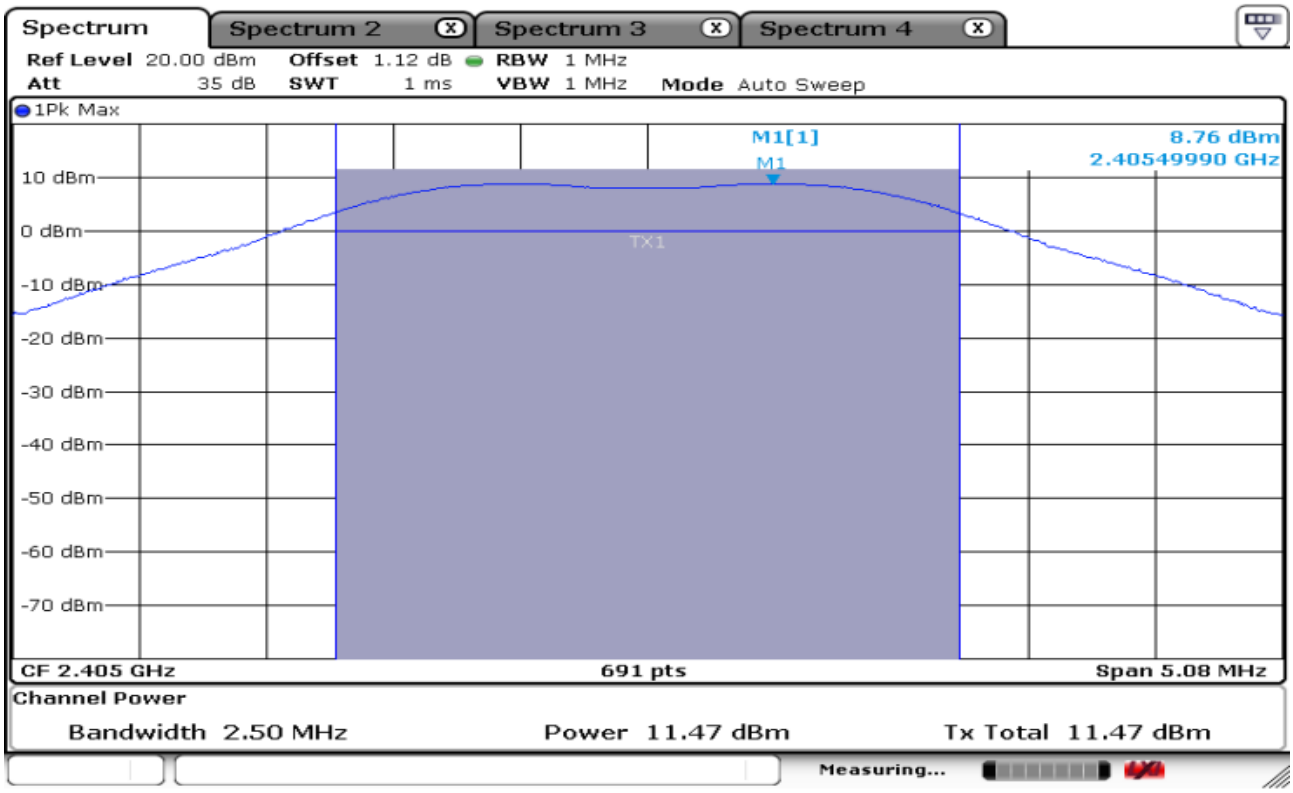
Minimum Standard:

Peak output power	< 1W

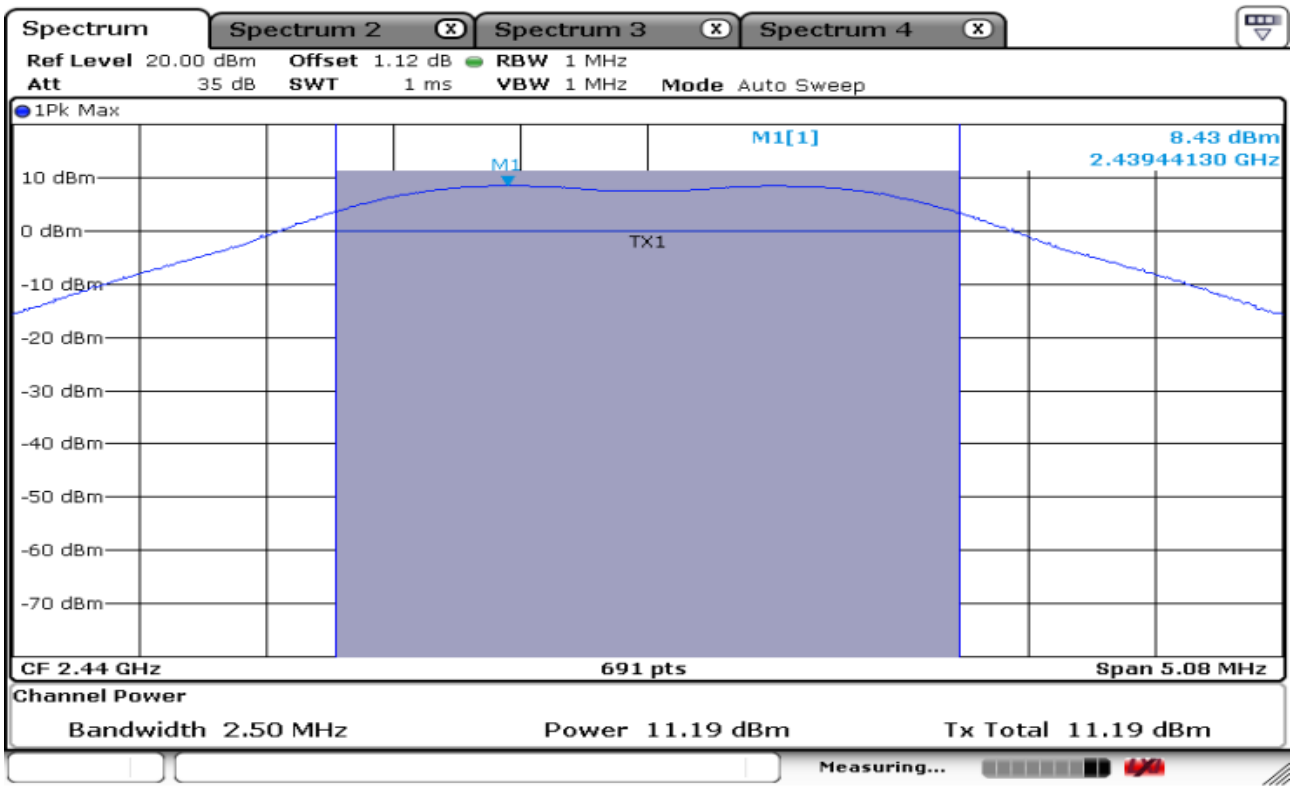
Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

Low Channel



Mid Channel



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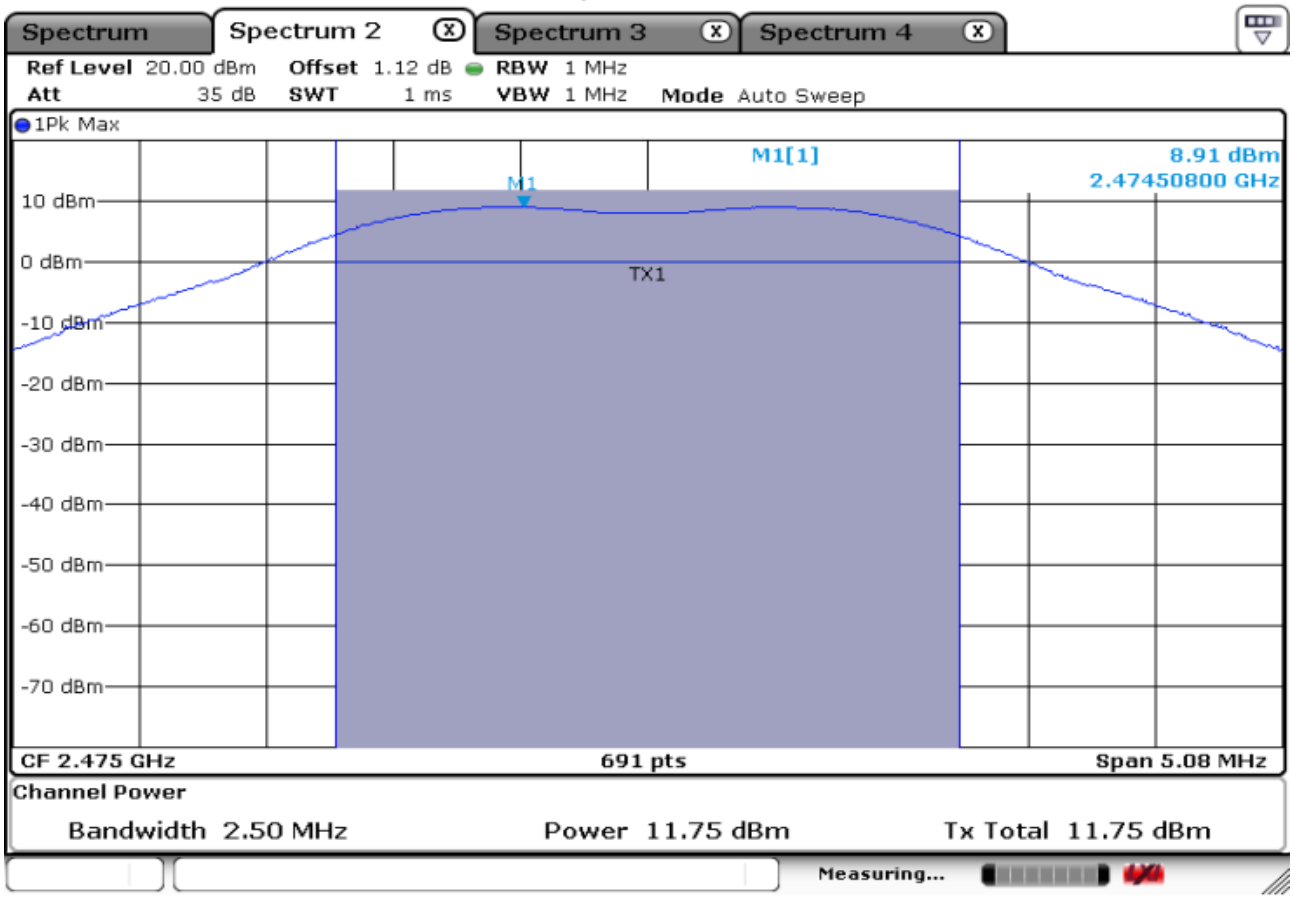
High Channel



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

Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

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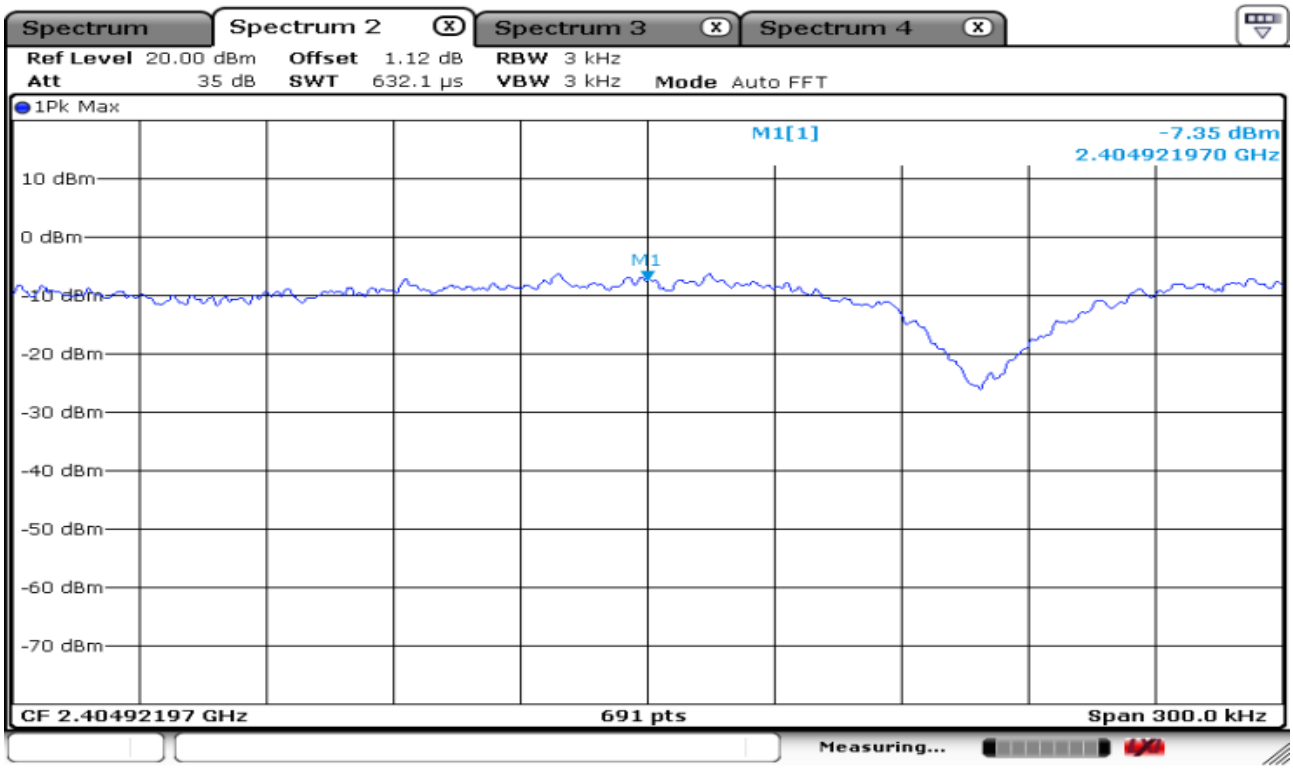
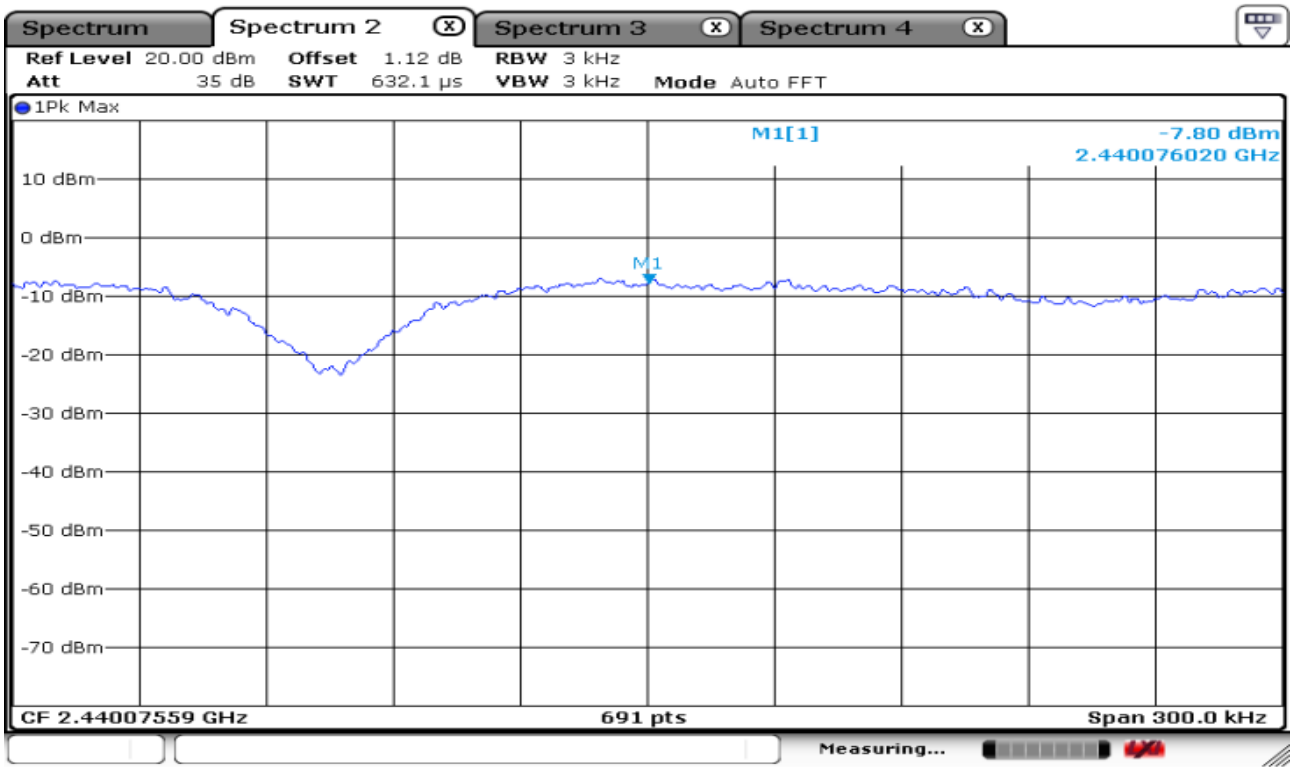
Power Density Measurement

Low Channel



Mid Channel



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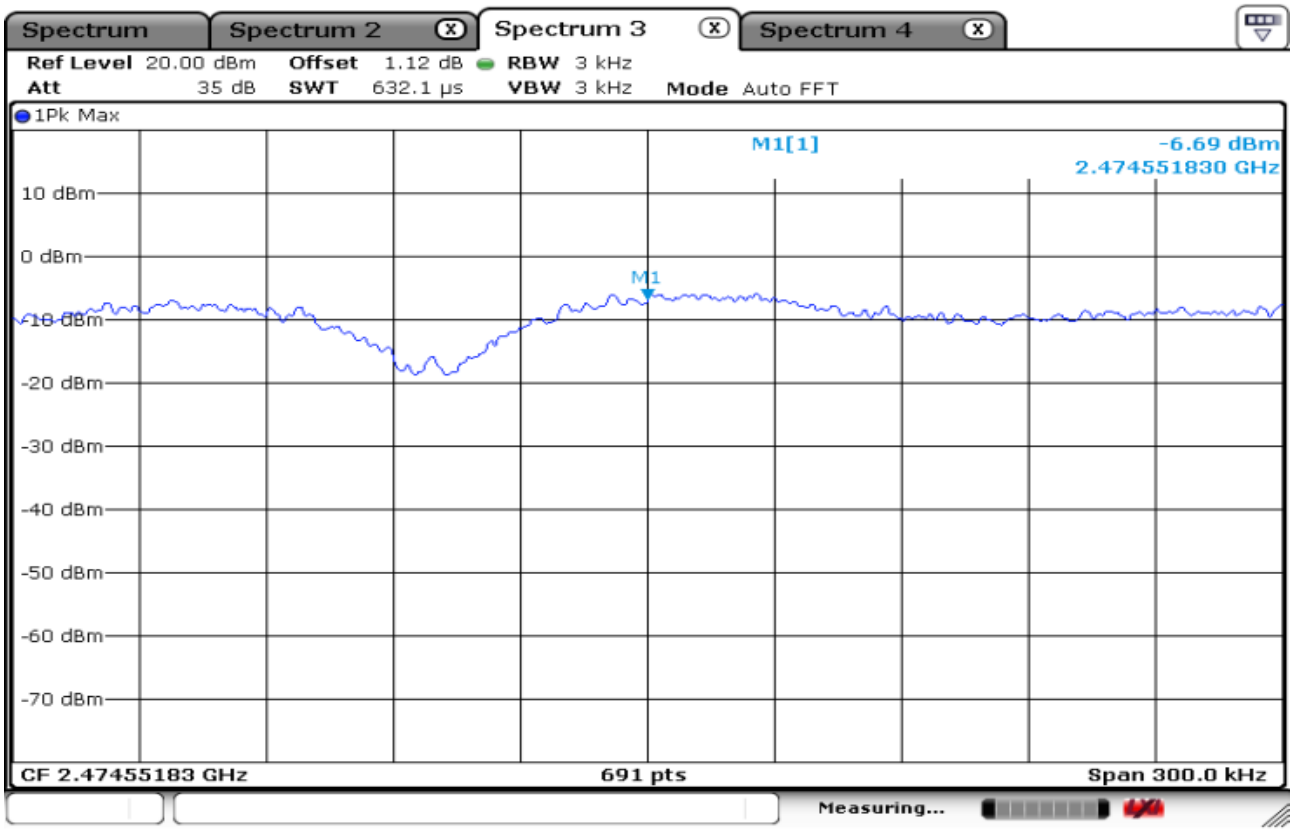
High Channel



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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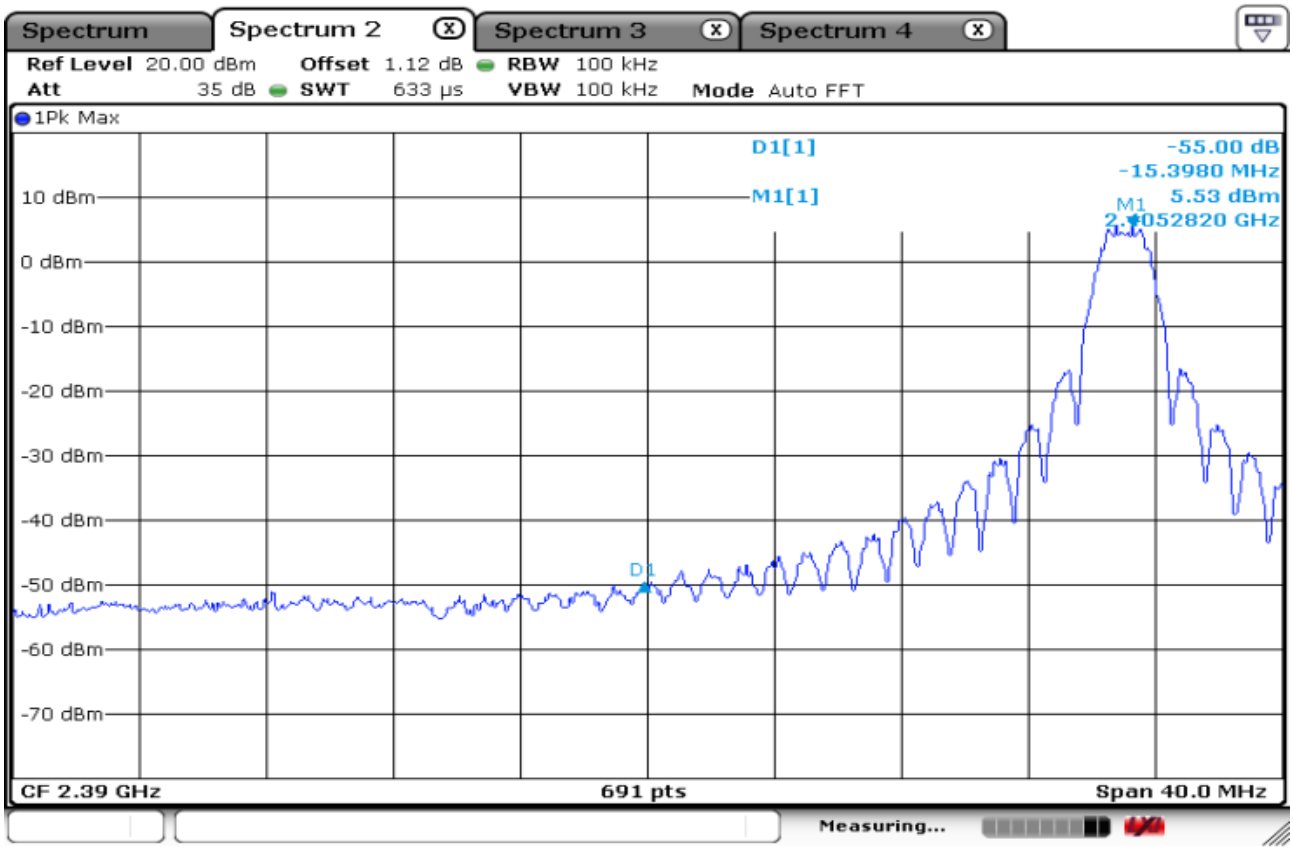
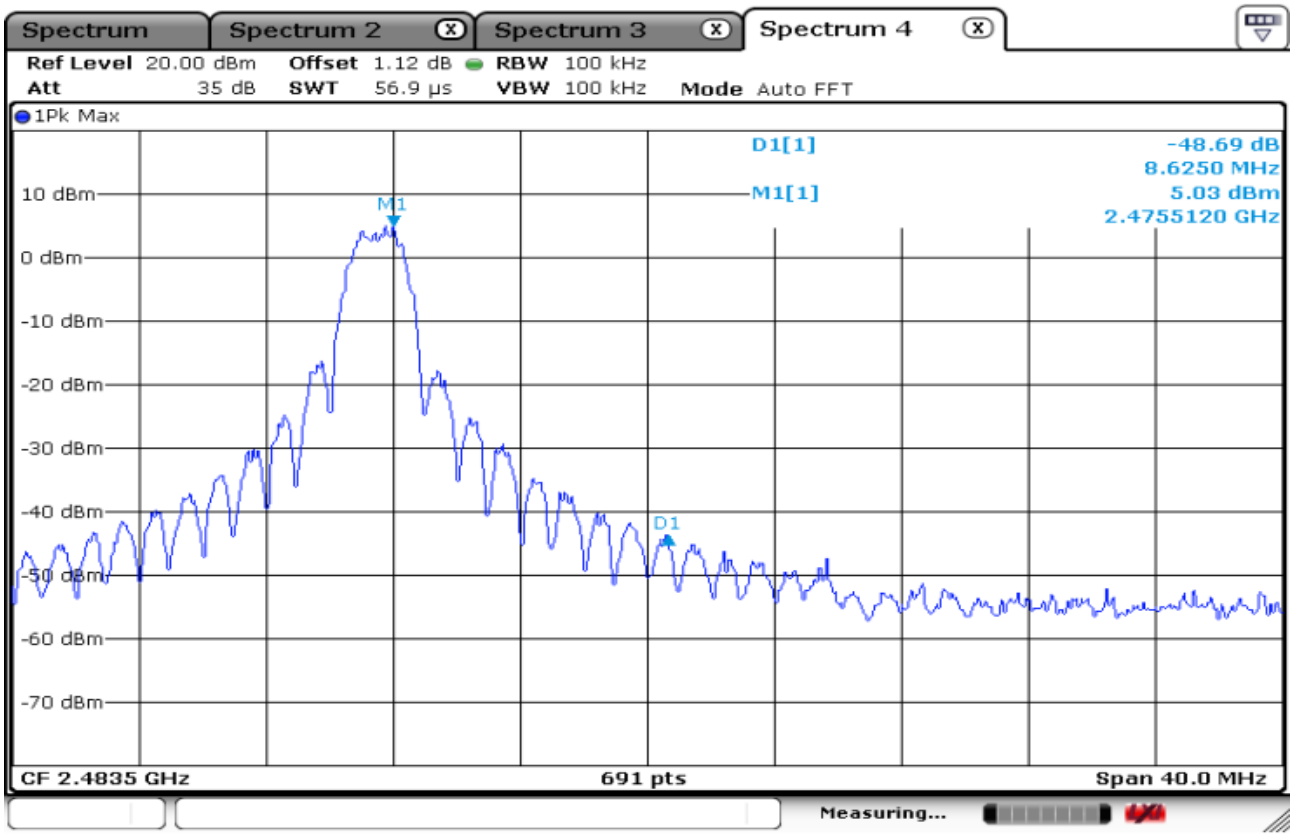
Band–edge


Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 20.00 dBm Offset 1.12 dB RBW 100 kHz
Att 35 dB SWT 633 µs VBW 100 kHz Mode Auto FFT
1Pk Max
D1[1]
-55.00 dB
-15.3980 MHz
M1[1]
5.53 dBm
M1
2.4052820 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1
CF 2.39 GHz
691 pts
Span 40.0 MHz
Measuring...


Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 20.00 dBm Offset 1.12 dB RBW 100 kHz
Att 35 dB SWT 56.9 µs VBW 100 kHz Mode Auto FFT
1Pk Max
D1[1]
-48.69 dB
8.6250 MHz
M1[1]
5.03 dBm
2.4755120 GHz
M1
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1
CF 2.4835 GHz
691 pts
Span 40.0 MHz
Measuring...

Radiated 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 + Cable Loss	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] 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] AV	Reading [dBuV/m] Peak	Pol.	Correction Factor Antenna	Correction Factor Amp. Gain + Cable Loss	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] 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 orth ogonal positions and the w orst-case data w as pre sented

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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.

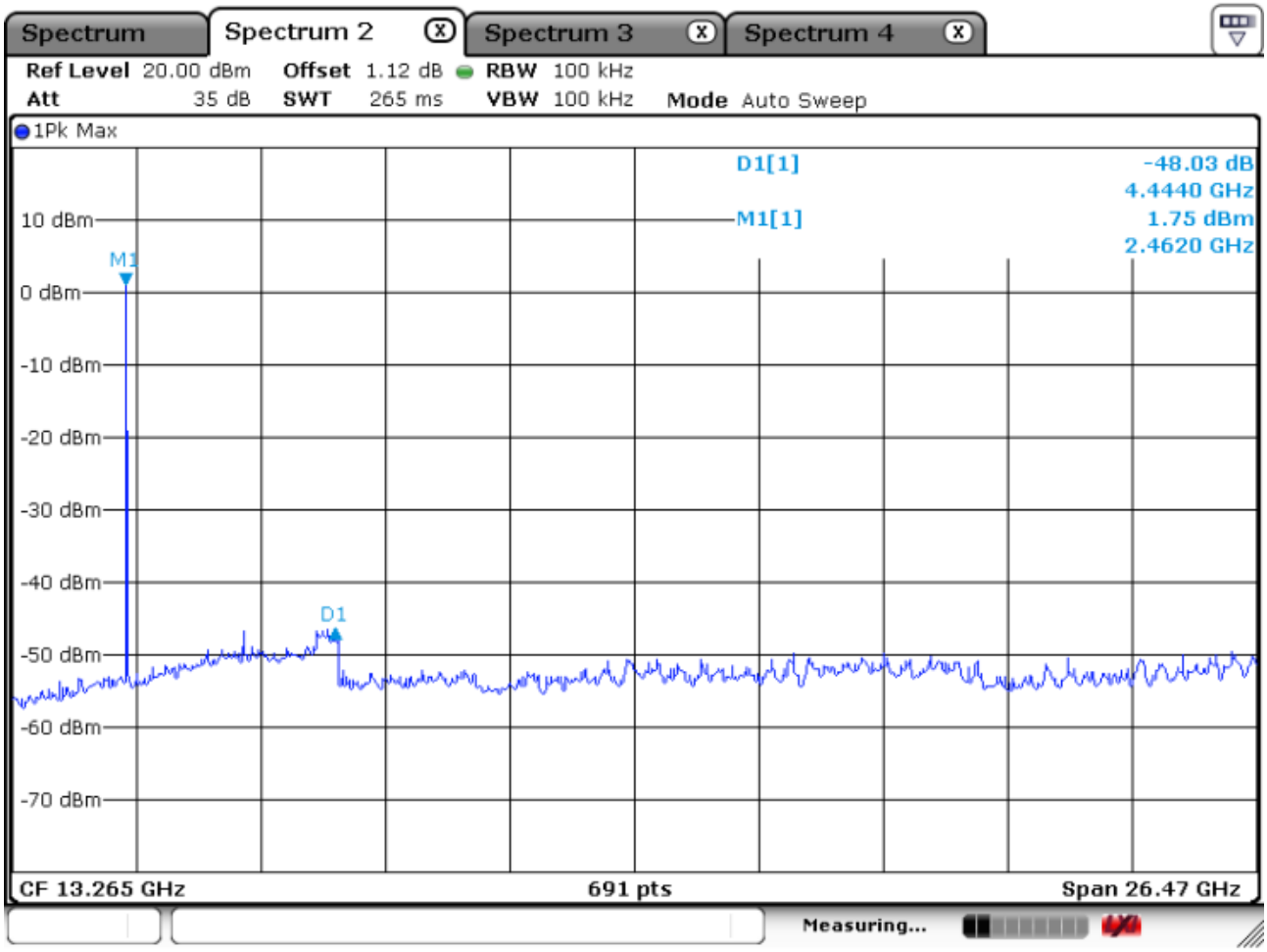
Minimum Standard:	> 20 dBc

Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

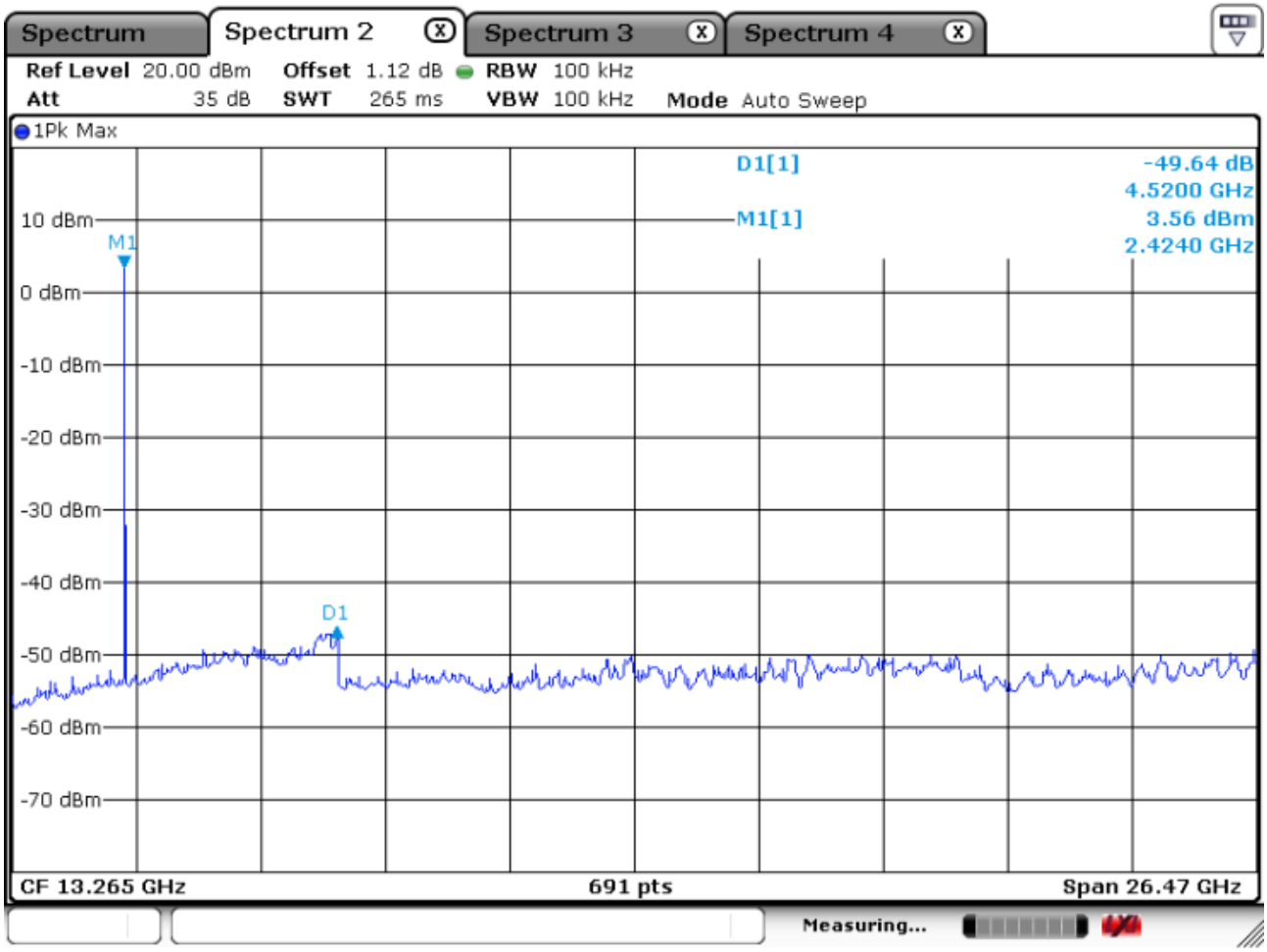
Unwanted Emission – Low channel

Frequency Range = 30 MHz ~ 26.5 GHz



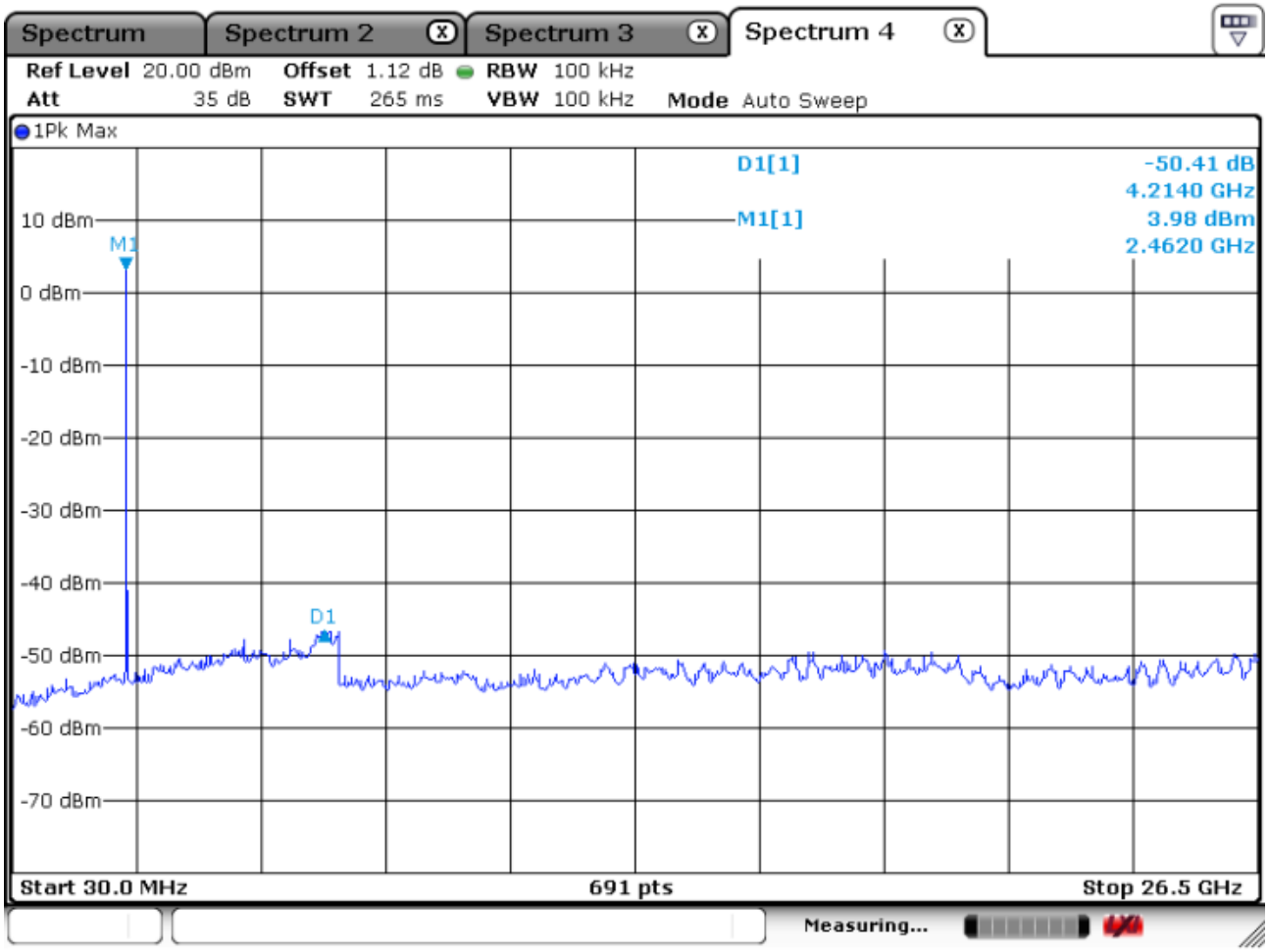
Unwanted Emission – Middle channel

Frequency Range = 30 MHz ~ 26.5 GHz



Unwanted Emission – High channel

Frequency Range = 30 MHz ~ 26.5 GHz



3.2.6 Field Strength of Harmon ics

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
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.

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Measurement Data :

Frequency [MHz]	Reading [dBuV/m] AV	Reading [dBuV/m] Peak	Pol.	Correction Factor Antenna	Correction Factor Amp.Gain+Cable	Limits [dBuV/m] AV	Limits [dBuV/m] Peak	Result [dBuV/m] AV	Result [dBuV/m] Peak	Margin [dB] AV	Margin [dB] Peak
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**	**Reading [dBuV/m] Peak**	**Pol.**	**Correction Factor Antenna**	**Correction Factor Amp.Gain+Cable**	**Limits [dBuV/m] AV**	**Limits [dBuV/m] Peak**	**Result [dBuV/m] AV**	**Result [dBuV/m] Peak**	**Margin [dB] AV**	**Margin [dB] Peak**
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**	**Reading [dBuV/m] Peak**	**Pol.**	**Correction Factor Antenna**	**Correction Factor Amp.Gain+Cable**	**Limits [dBuV/m] AV**	**Limits [dBuV/m] Peak**	**Result [dBuV/m] AV**	**Result [dBuV/m] Peak**	**Margin [dB] AV**	**Margin [dB] Peak**
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.

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Radiated Emissions – Zigbee

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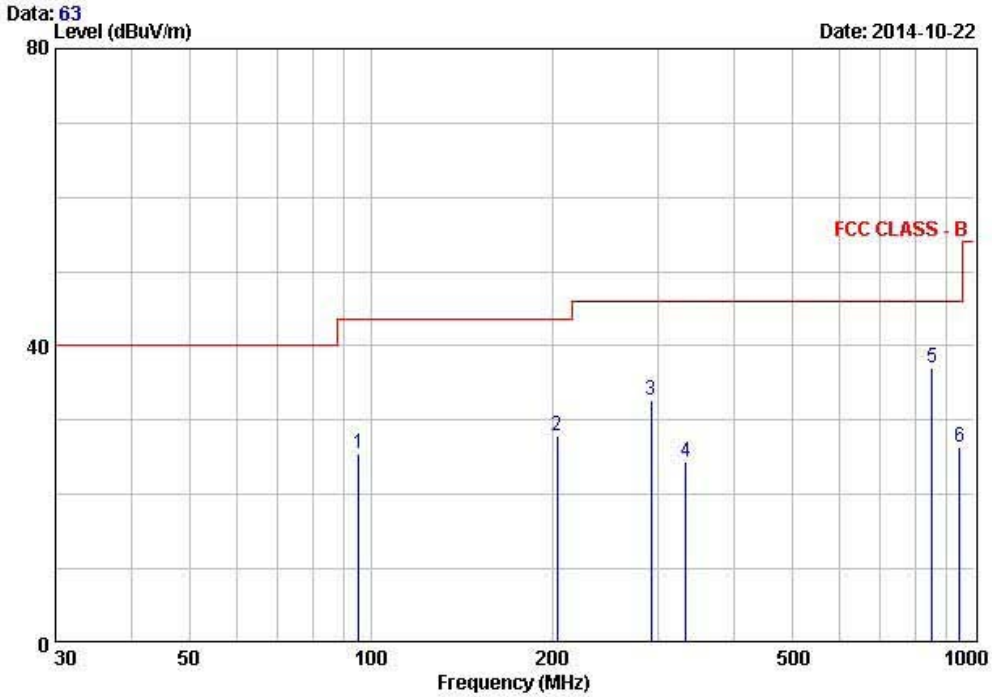
EUT/Model No.: LM2471-EM TEST MODE: zig bee mode

Temp Humi : 22 / 43 Tested by: SIN S U



	Freq MHz	Reading dBuV/m	C.F dB/m	Result dBuV/m	Limit QP dBuV/m	Margin dB	Height cm	Angle deg	Polarity
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

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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

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AC Conducted Emissions – Zigbee – Line

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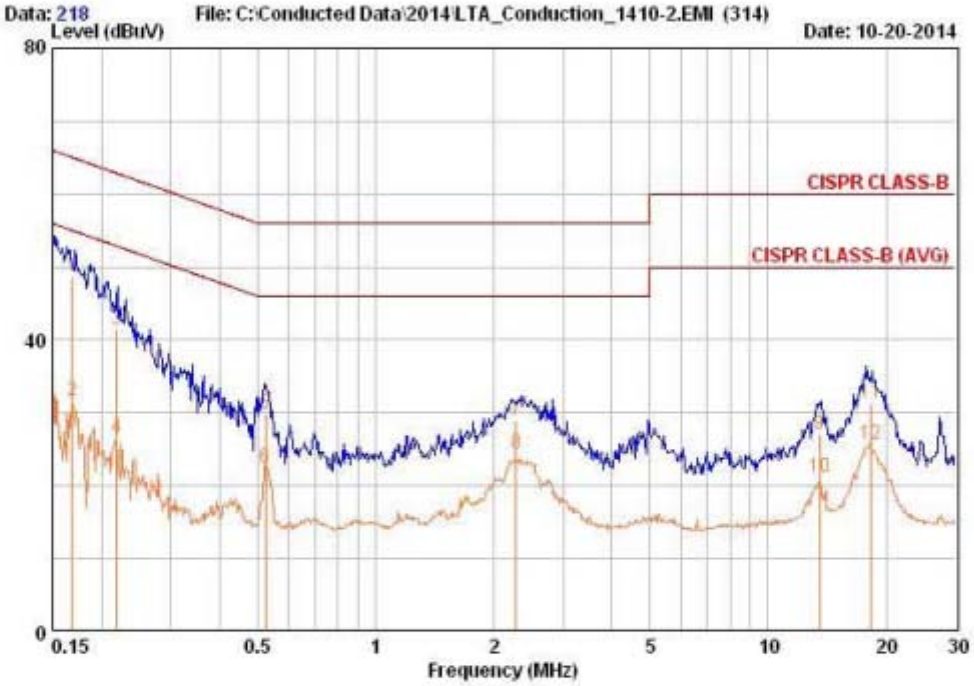
449-822 Korea
Tel :+82-31-3236008,9
Fax :+82-31-3236010

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



Freq MHz	RD QP dBuV	RD AV dBuV	C.F dB	Result QP dBuV	Result AV dBuV	Limit QP dBuV	Limit AV dBuV	Margin QP dB	Margin AV 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

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AC Conducted Emissions – Zigbee – Neutral

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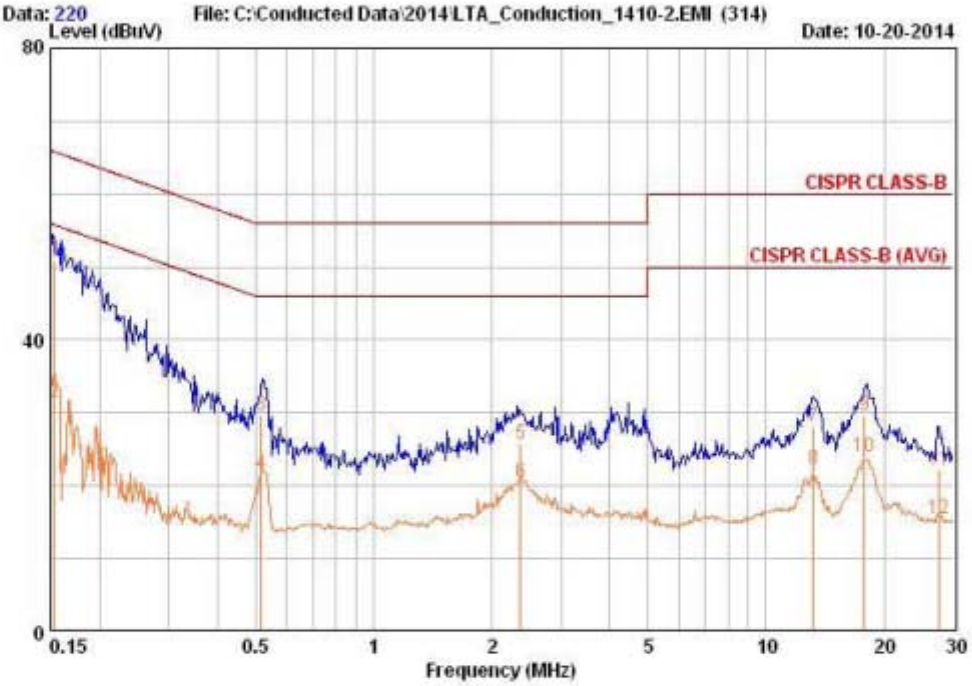
EUT / Model No.	: LM2471-EM	Phase	: NEUTRAL
Test Mode	: zig bee mode	Test Power	: 120 / 60
Temp./Humi.	: 26 / 47	Test Engineer	: SIN S U



Freq MHz	RD QP dBuV	RD AV dBuV	C.F dB	Result QP dBuV	Result AV dBuV	Limit QP dBuV	Limit AV dBuV	Margin QP dB	Margin AV 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

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APPENDIX

TEST EQUIPMENT USED FOR TESTS

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	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

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