



Dates of Tests: July 13 ~ July 20, 2009

Test Report S/N: LR500190907G

Test Site : LTA CO., LTD

## CERTIFICATION OF COMPLIANCE

FCC ID.

**RUSSMT100**

APPLICANT

**HandyWave Co., Ltd.**

<b>Equipment Class</b>	:	<b>Part 15 Spread Spectrum Transmitter (DSS)</b>
<b>Manufacturing Description</b>	:	<b>Digital Wireless Microphone</b>
<b>Manufacturer</b>	:	<b>HandyWave Co., Ltd.</b>
<b>Model name</b>	:	<b>SMT-100</b>
<b>Test Device Serial No.:</b>	:	<b>Identical prototype</b>
<b>Rule Part(s)</b>	:	<b>FCC Part 15.247 Subpart C; ANSI C-63.4-2003</b>
<b>Frequency Range</b>	:	<b>2402 ~ 2480MHz</b>
<b>RF power</b>	:	<b>Max 6.18dBm - Conducted</b>
<b>Data of issue</b>	:	<b>July 20, 2009</b>

This test report is issued under the authority of:



Dong -Min JUNG, Technical Manager

The test was supervised by:



Kyung-Taek 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. This report must not be used by the applicant to claim product endorsement by any agency.



NVLAP LAB Code.: 200723-0

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## 1. General information's

### 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](mailto: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	2009-09-30	ECT accredited Lab.
RRL	KOREA	KR0049	2011-06-20	EMC accredited Lab.
FCC	U.S.A	610755	2011-04-22	FCC filing
VCCI	JAPAN	R2133, C2307	2011-06-21	VCCI registration
IC	CANADA	IC5799	2010-05-03	IC filing

## 2. Information's about test item

### 2-1 Client & Manufacturer

Company name : HandyWave Co., Ltd.  
 Address : 202-4 Yatap-dong, Bundang-gu, Seongnam City, Gyunggi Province,  
 463-070, Korea  
 Tel / Fax : TEL No : +82-31-709-8900 / FAX No : +82-31-708-9455

### 2-2 Equipment Under Test (EUT)

Trade name : Digital Wireless Microphone  
 FCC ID : RUSSMT100  
 Model name : SMT-100  
 Serial number : Identical prototype  
 Date of receipt : July 10, 2009  
 EUT condition : Pre-production, not damaged  
 Antenna type : Chip antenna with Max. 5.02dBi gain  
 Frequency Range : 2402 ~ 2480MHz  
 RF output power : Max 6.18dBm – Conducted  
 Number of channels : 79  
 Channel spacing : 1MHz  
 Channel Access Protocol : Frequency Hopping Spread Spectrum (FHSS)  
 Type of Modulation : GFSK  
 Power Source for Batt. : Battery Pack: 3.7V (Li-Ion Polymer RECHARGEABLE BATTERY)  
 Power Source : 5Vdc from PC

### 2-3 Tested frequency

	LOW	MID	HIGH
Frequency (MHz)	2402	2441	2480

### 2-4 Ancillary Equipment

Equipment	Model No.	Serial No.	Manufacturer
NOTEBOOK	SP28-M150	393B93AY200589R	Samsung
MOUSE	M-UV69a	HCA45301156	Logitech

### 3. Test Report

#### 3.1 Summary of tests

FCC Part Section(s)	Parameter	Limit	Test Condition	Status (note 1)
15.247(a)	Carrier Frequency Separation	> 25 kHz	Conducted	C
15.247(a)	Number of Hopping Frequencies	> 15 hops		C
15.247(a)	20 dB Bandwidth 99% Bandwidth	> 1.5 MHz		C
15.247	Dwell Time	< 0.4 seconds		C
15.247(b)	Transmitter Output Power	< 250 mWatt		C
15.247(d)	Conducted Spurious emission	> 20 dBc		C
15.247(d)	Band Edge	> 20 dBc		C
15.249 / 15.209	Field Strength of Harmonics	< 54 dBuV (at 3m)	Radiated	C
15.109	Field Strength	-		C
15.207 / 15.107	AC Conducted Emissions	EN 55022	Line 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 **HandyWave Co., Ltd.** FCC ID: **RUSSMT100** unit complies with the requirement of §15.203. The antenna is connected to inside of EUT. And type is Chip antenna.

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 Carrier Frequency Separation

#### Procedure:

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

After the trace being stable, the reading value between the peaks of the adjacent channels using the marker-delta function was recorded as the measurement results.

The spectrum analyzer is set to:

Span = 3 MHz (wide enough to capture the peaks of two adjacent channels)

RBW = 10 kHz (1% of the span or more)      Sweep = auto

VBW = 10 kHz      Detector function = peak

Trace = max hold

#### Measurement Data:

Test Results	
Carrier Frequency Separation (MHz)	Result
0.9986	Complies

- See next pages for actual measured spectrum plots.

#### Minimum Standard:

The EUT shall have hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of 20dB bandwidth of the hopping channel, whichever is greater.

#### Measurement Setup

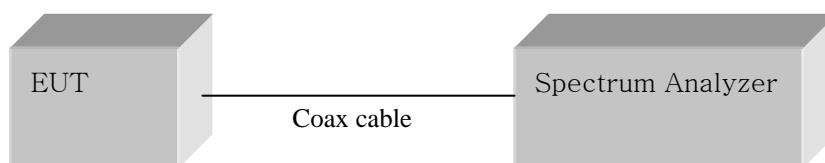
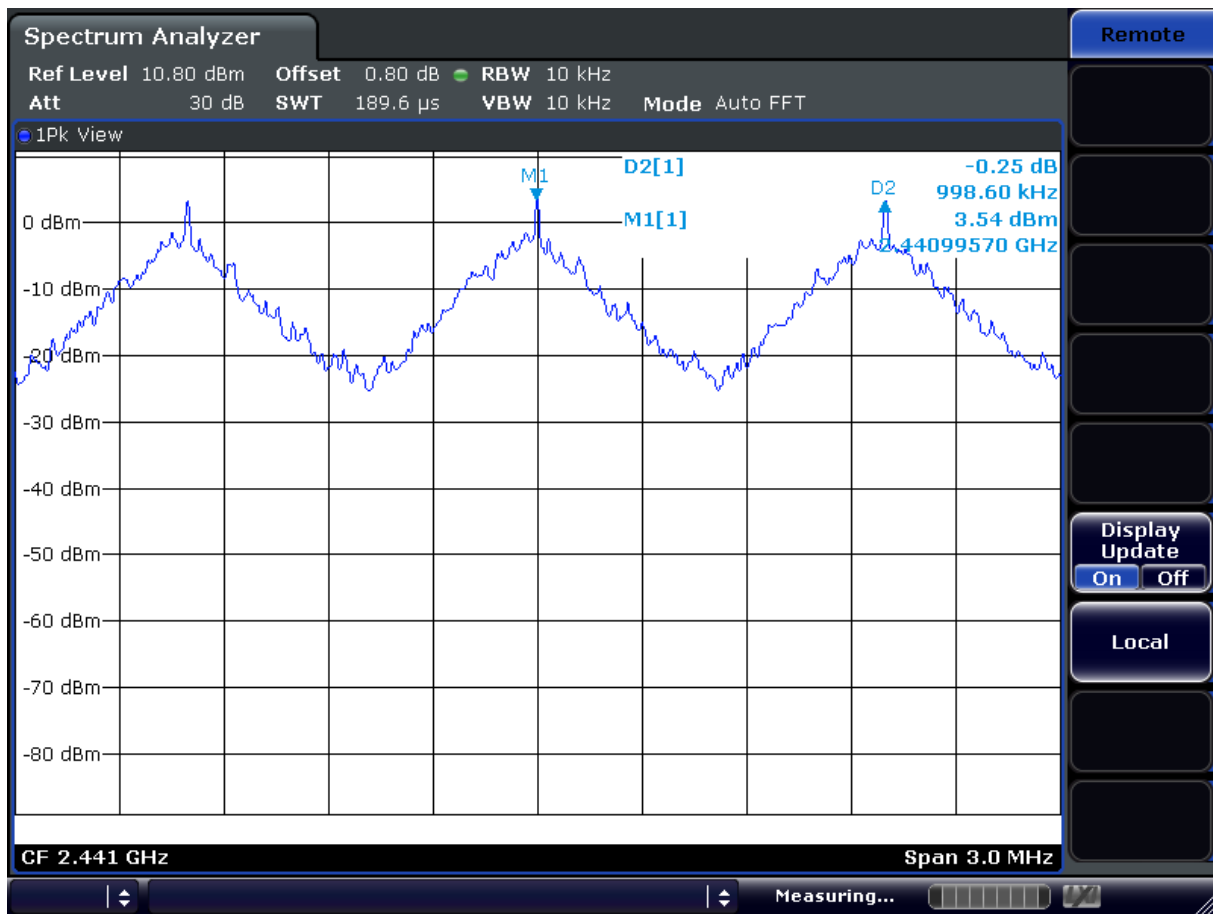


Figure 1: Measurement setup for the carrier frequency separation

### Carrier Frequency Separation



### 3.2.2 Number of Hopping Frequencies

#### Procedure:

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

To get higher resolution, four frequency ranges within the 2400 ~ 2483.5 MHz FH band were examined.

#### The spectrum analyzer is set to:

Frequency range	1: Start = 2400.0MHz, Stop = 2441.5 MHz
	2: Start = 2441.5MHz, Stop = 2483.5 MHz
RBW = 100 kHz (1% of the span or more)	Sweep = auto
VBW = 100 kHz (VBW ≥ RBW)	Detector function = peak
Trace = max hold	Span > 40MHz

#### Measurement Data: Complies

<b>Total number of Hopping Channels</b>	79
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- See next pages for actual measured spectrum plots.

#### Minimum Standard:

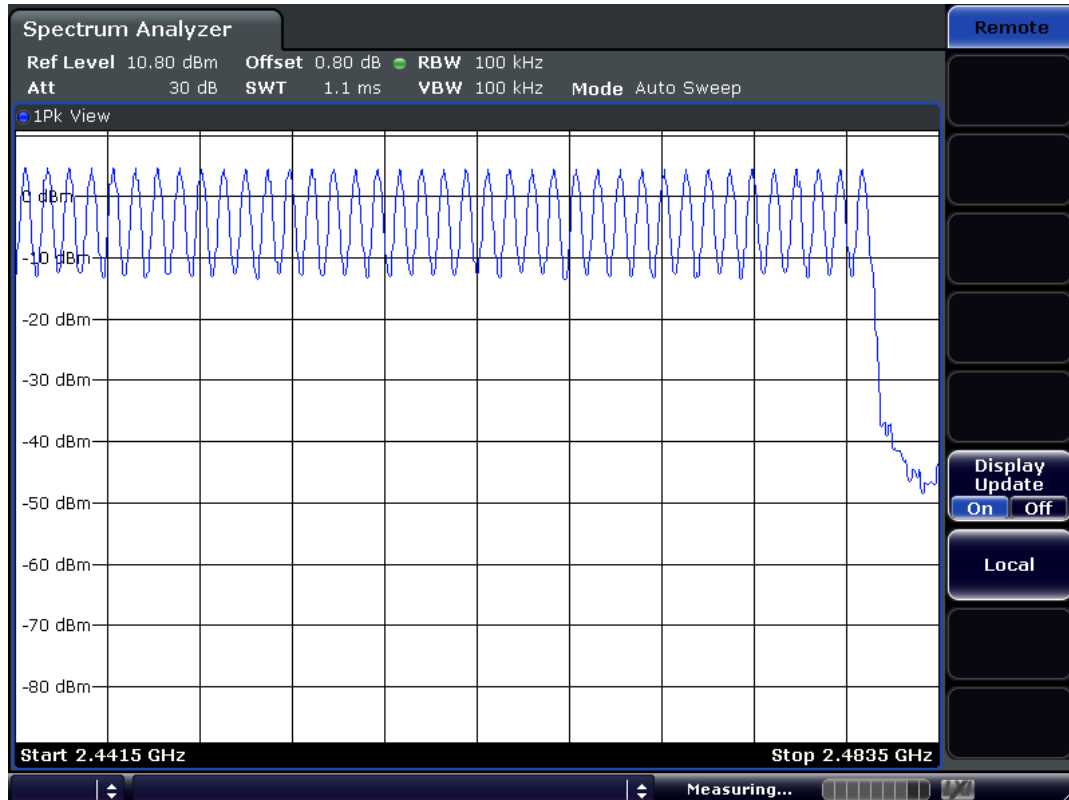
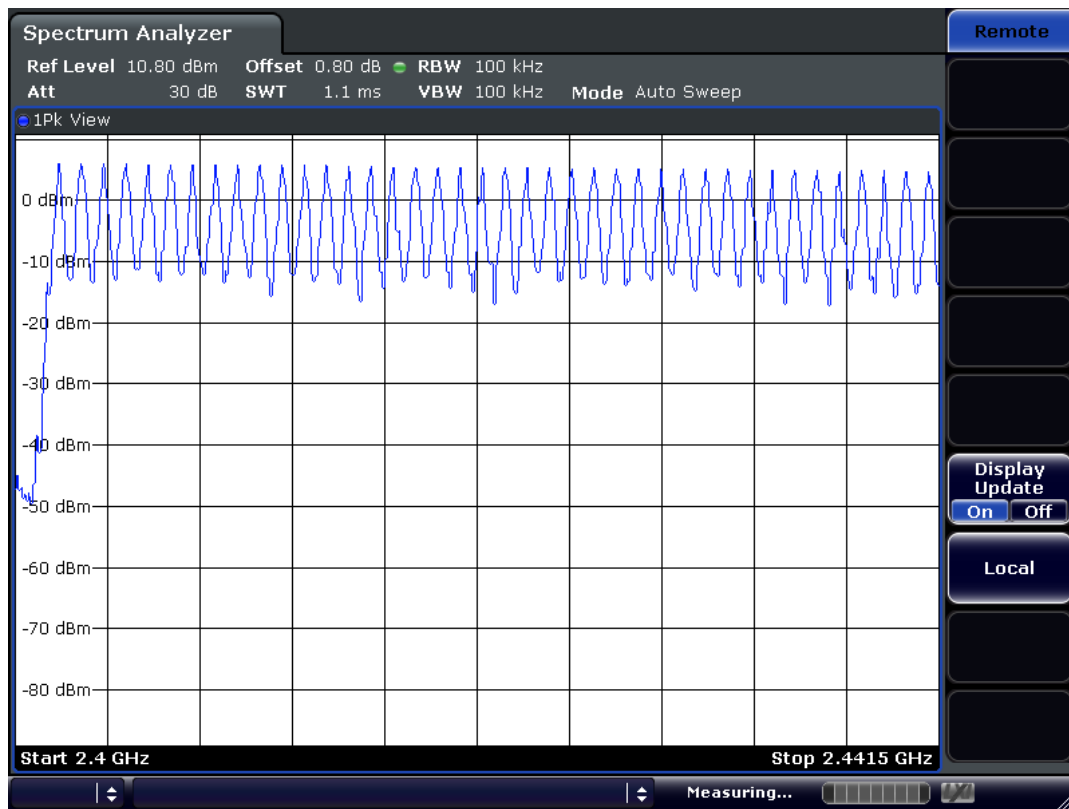
At least 15 hops

#### Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)



### Number of Hopping Frequencies



### 3.2.3 20 dB Bandwidth

#### Procedure:

The bandwidth at 20 dB below the highest inband spectral density was 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, Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20dB 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 20 dB bandwidth of the emission.

#### The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

Span = 3 MHz (approximately 2 or 3 times of the 20 dB bandwidth)

RBW = 30 kHz

Sweep = auto

VBW = 30 kHz (VBW  $\geq$  RBW)

Detector function = peak

Trace = max hold

dB/Div = 5dB

#### Measurement Data

Frequency (MHz)	Channel No.	Test Results(MHz)	
		20dB Bandwidth	99% Bandwidth
2402	0	0.847	0.886
2441	39	0.795	0.881
2480	78	0.803	0.864

- See next pages for actual measured spectrum plots.

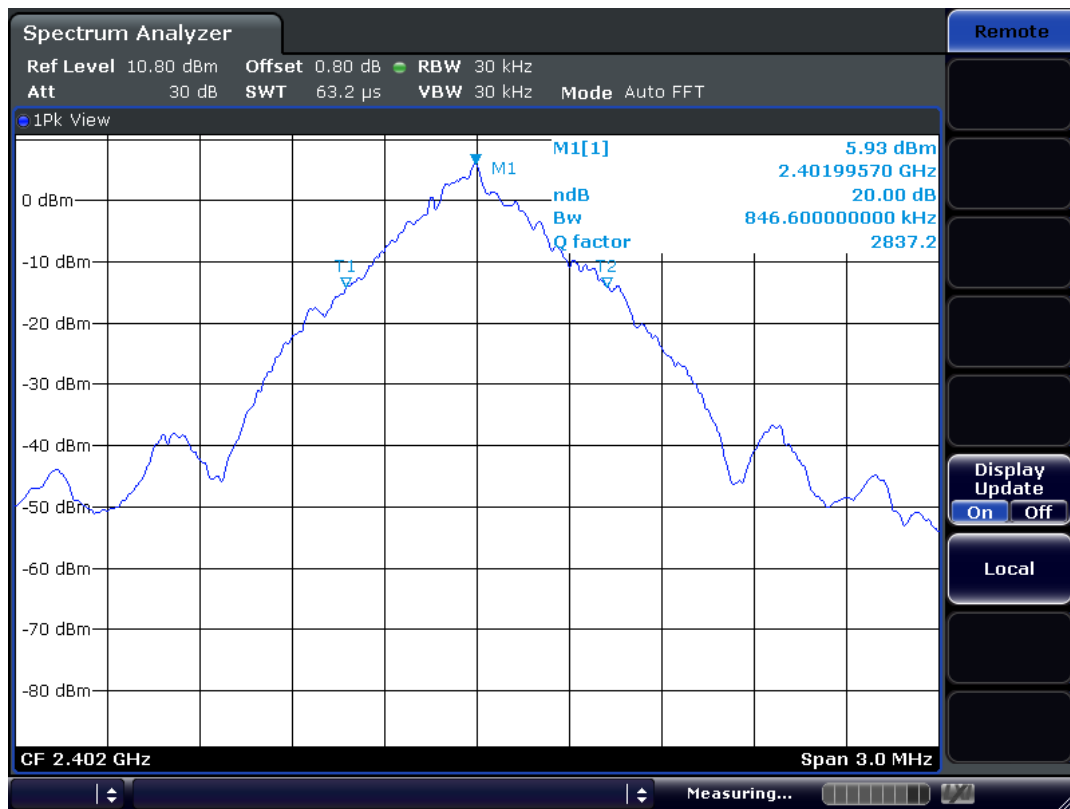
#### Minimum Standard:

N/A

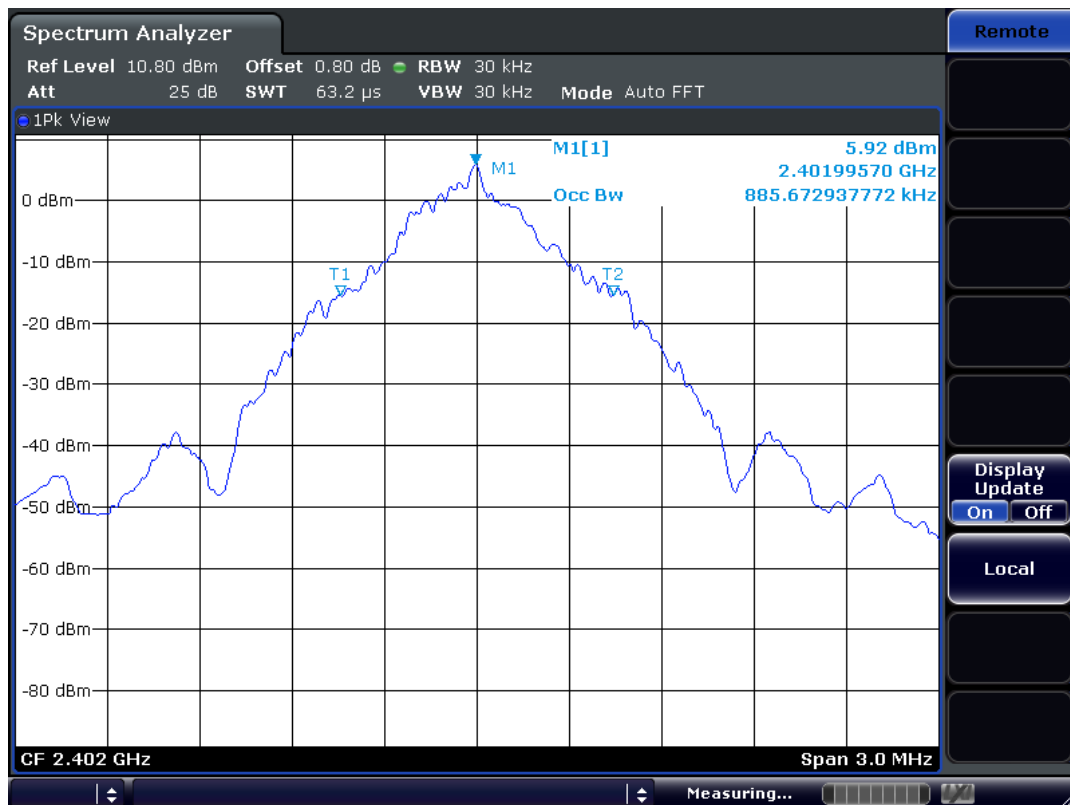
#### Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

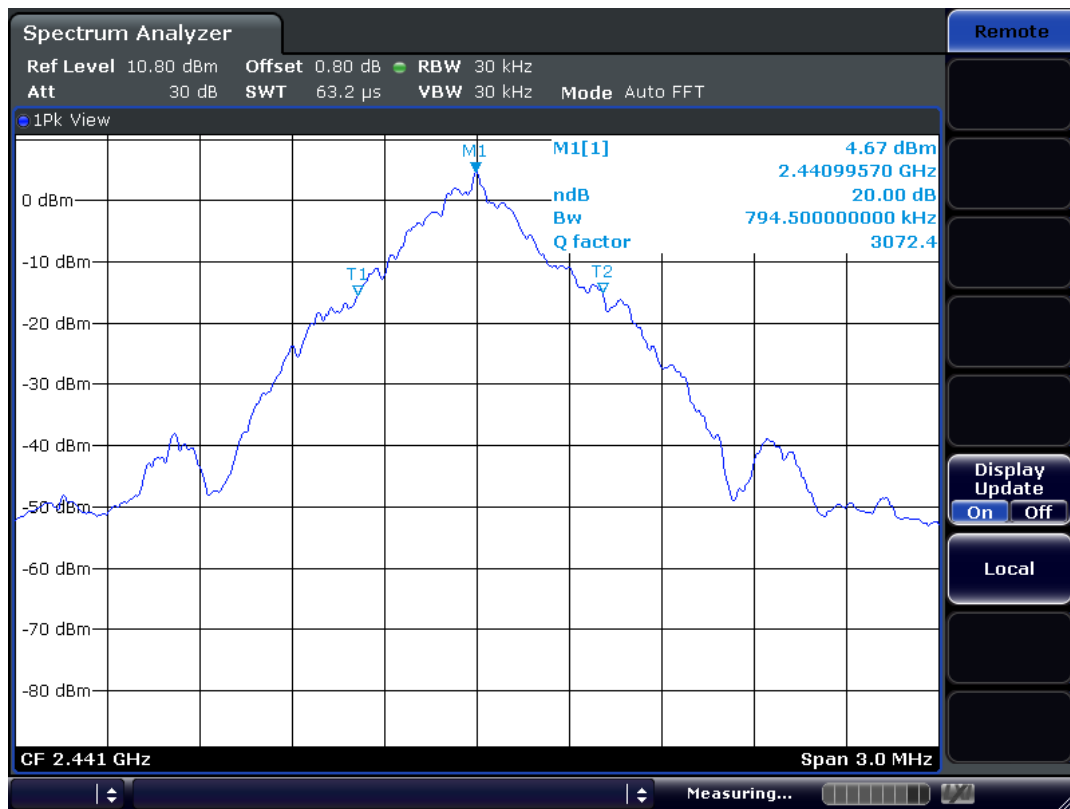
### Channel 1 of 20 dB Bandwidth



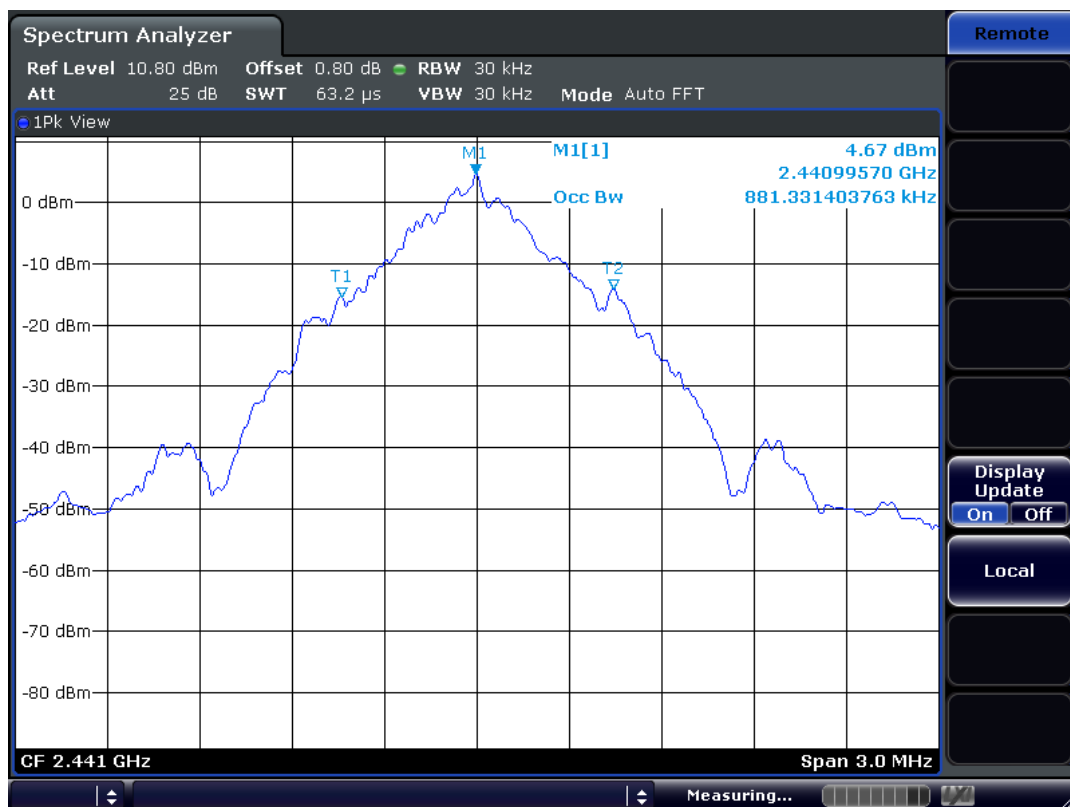
### 99% Bandwidth



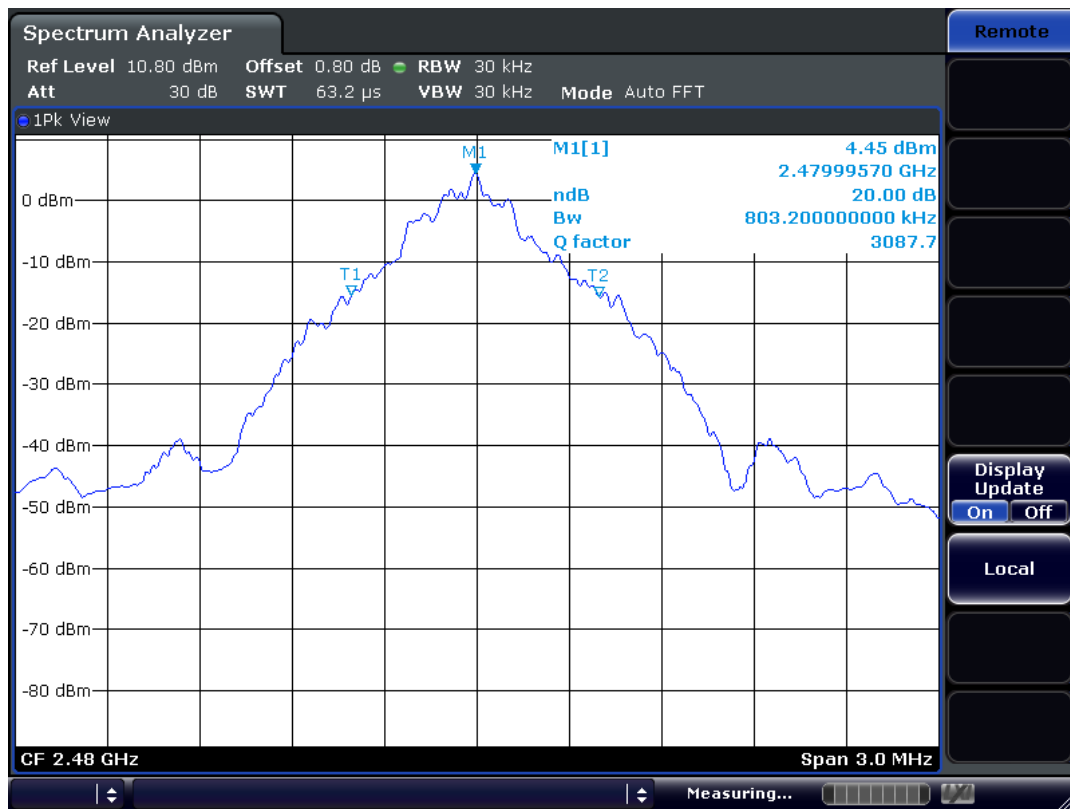
### Channel 2 of 20 dB Bandwidth



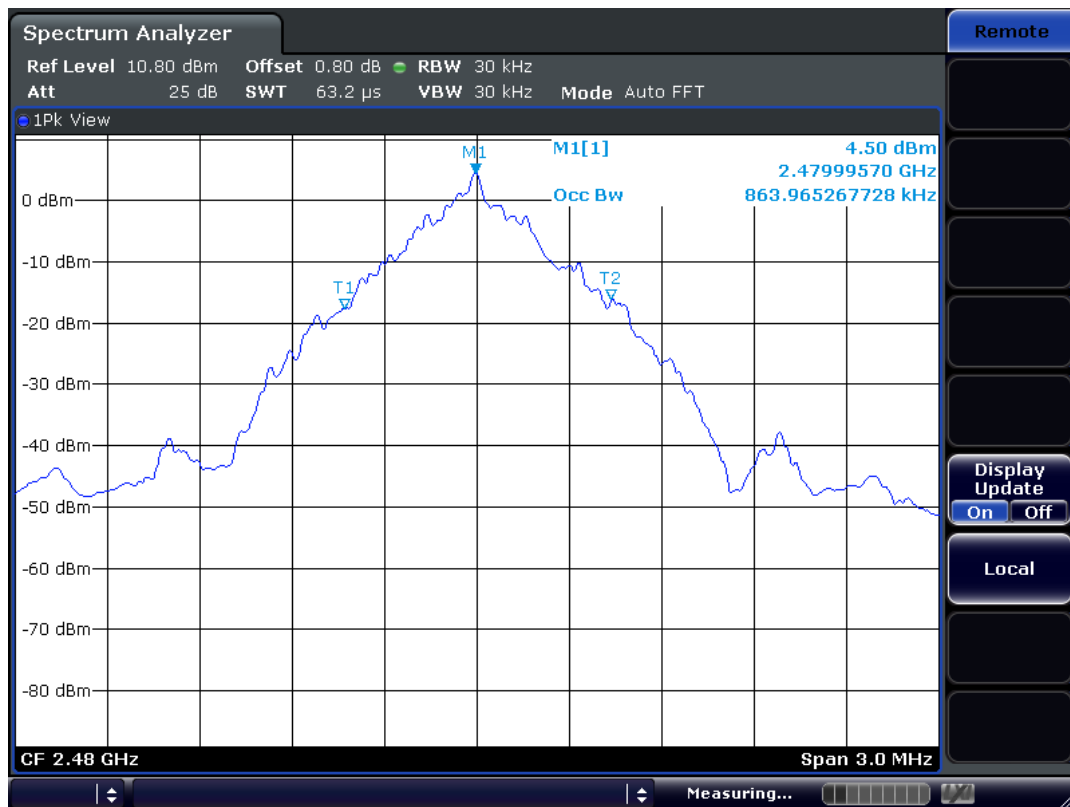
### 99% Bandwidth



### Channel 3 of 20 dB Bandwidth



### 99% Bandwidth



### 3.2.4 Time of Occupancy (Dwell Time)

#### Procedure:

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:

Center frequency = 2441 MHz

Span = zero

RBW = 1 MHz

VBW = 1 MHz (VBW  $\geq$  RBW)

Trace = max hold

Detector function = peak

#### Measurement Data:

Number of transmission in a 31.6 ( 79*0.4)	Length of Transmission Time (msec)	Result (msec)	Limit (msec)
73 times	0.214	15.622	400

- See next pages for actual measured spectrum plots.
- dwell time = {(number of hopping per second / number of slot ) x duration time per channel} x 0.4 ms

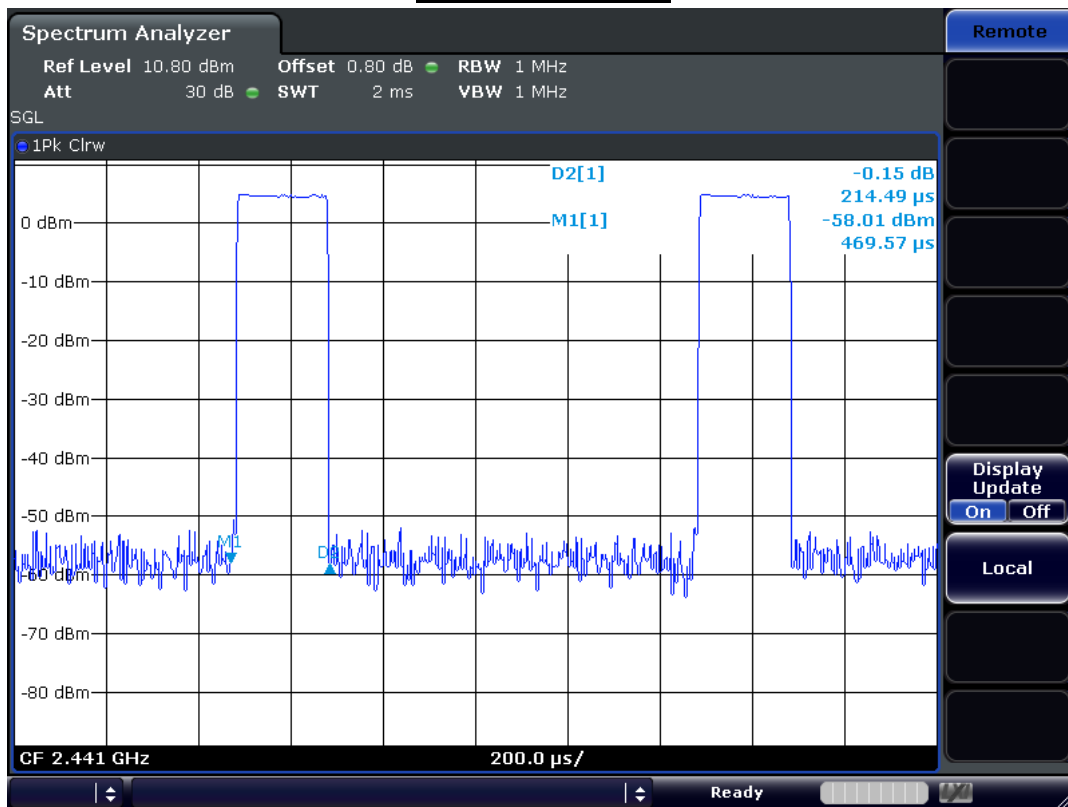
#### Minimum Standard:

0.4 seconds within a 30 second period per any frequency

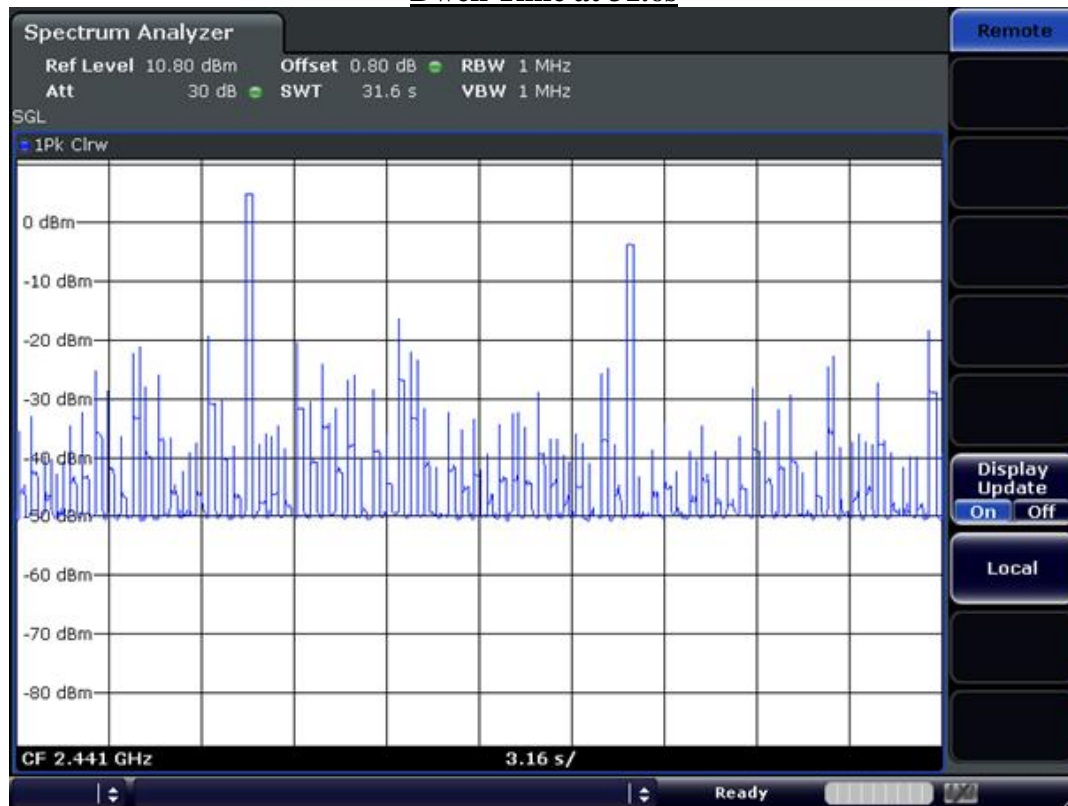
#### Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

### Dwell Time at 2ms



### Dwell Time at 31.6s



### 3.2.5 Transmitter Output Power

#### Procedure:

The peak output power was 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, Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power.

#### The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

Span = 20 MHz (approximately 5 times of the 20 dB bandwidth)

RBW = 3 MHz (greater than the 20dB bandwidth of the emission being measured)

VBW = 3 MHz (VBW  $\geq$  RBW)

Detector function = peak

Trace = max hold

Sweep = auto

#### Measurement Data

Frequency (MHz)	Ch.	Test Results		
		dBm	mW	Result
2402	0	<b>6.18</b>	<b>4.15</b>	Complies
2441	39	<b>4.92</b>	<b>3.10</b>	Complies
2480	78	<b>4.77</b>	<b>3.00</b>	Complies

- See next pages for actual measured spectrum plots.

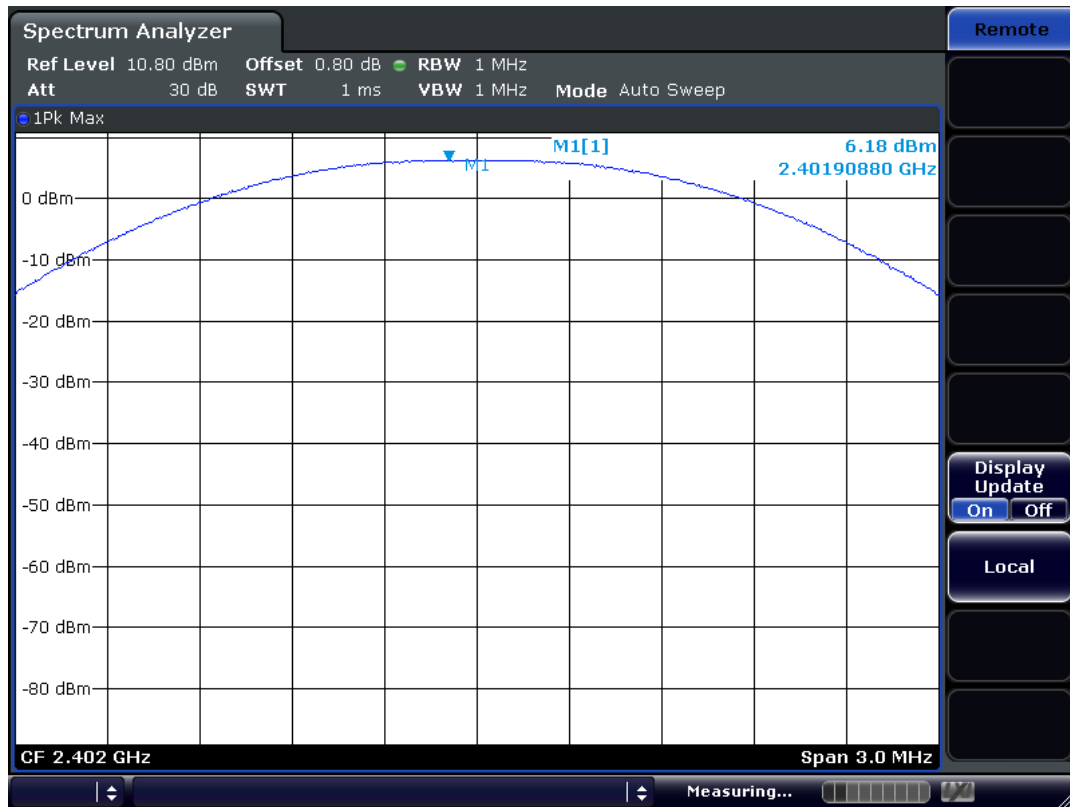
<b>Minimum Standard:</b>	< 250 mW
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#### Measurement Setup

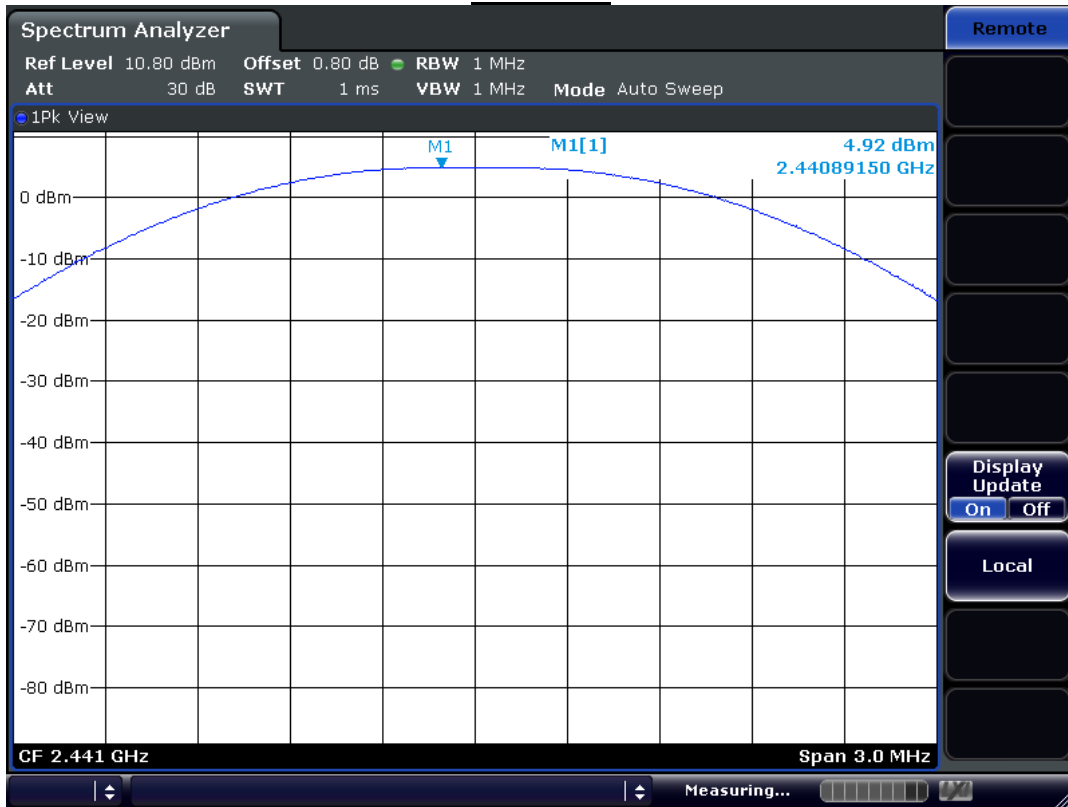
Same as the Chapter 3.2.1 (Figure 1)



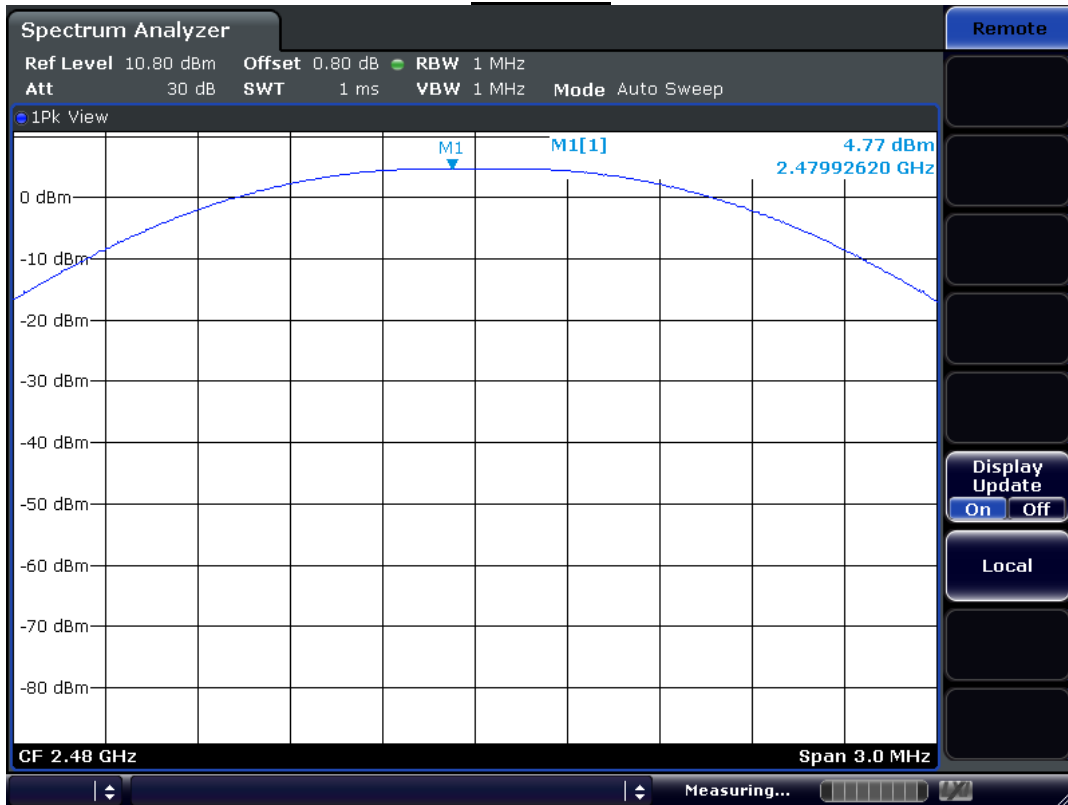
### Channel 1



### Channel 2



### Channel 3



### 3.2.6 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 had its hopping function disabled at the highest, middle and the lowest available channels.

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 = 10 MHz

Detector function = peak

Trace = max hold

Sweep = auto

#### 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.

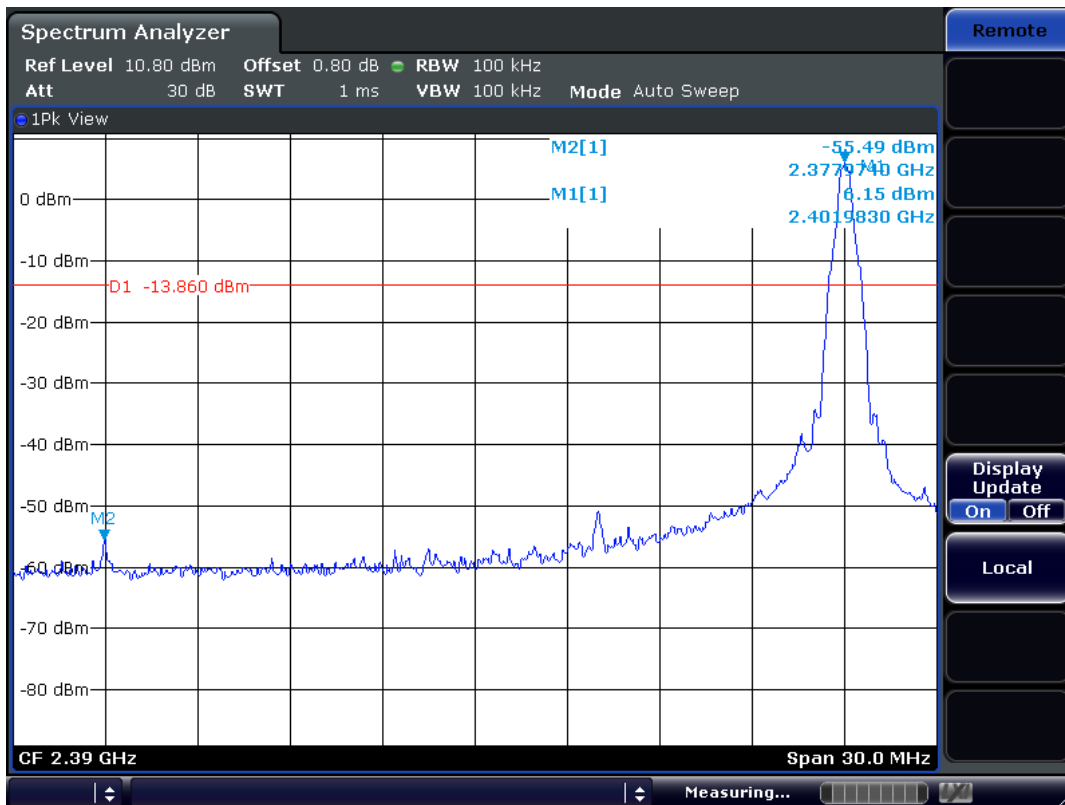
<b>Minimum Standard:</b>	> 20 dBc
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#### Measurement Setup

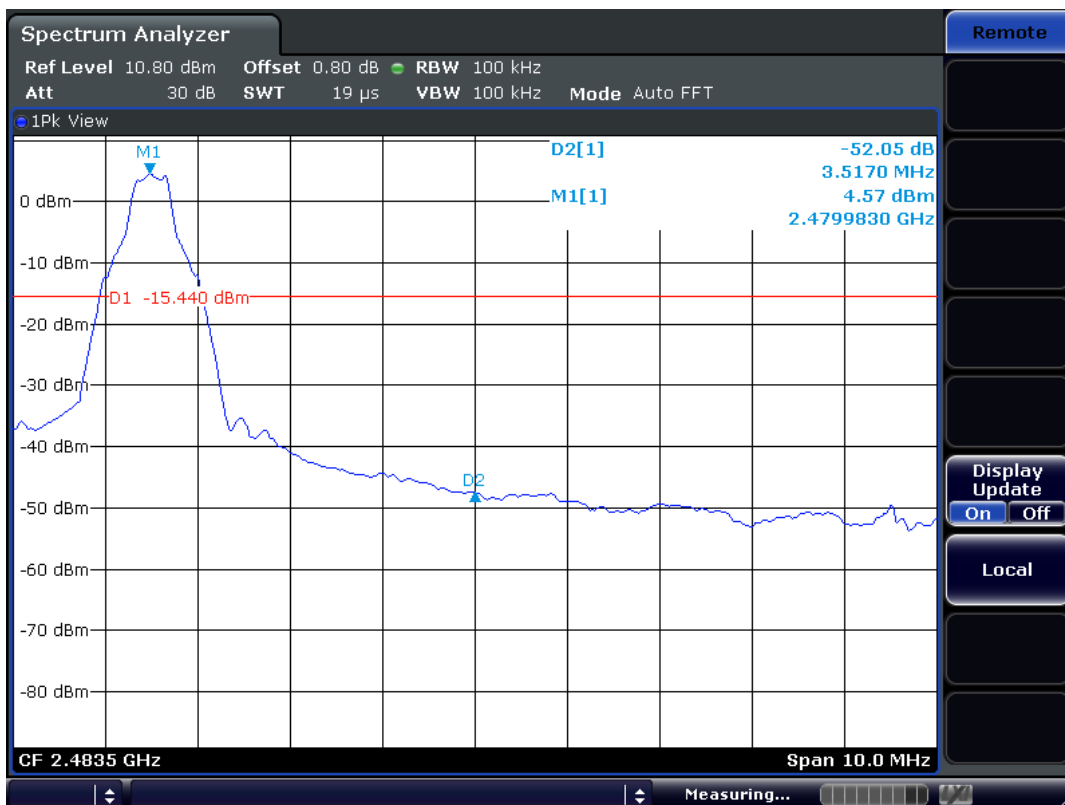
Same as the Chapter 3.2.1 (Figure 1)

### Band – edge of Basic Mode

#### Lower edge



#### Upper edge



**Band-edges in the restricted band 2483.5 ~ 2500 MHz measurement****- Document DA 00-705 Marker Delta Method**

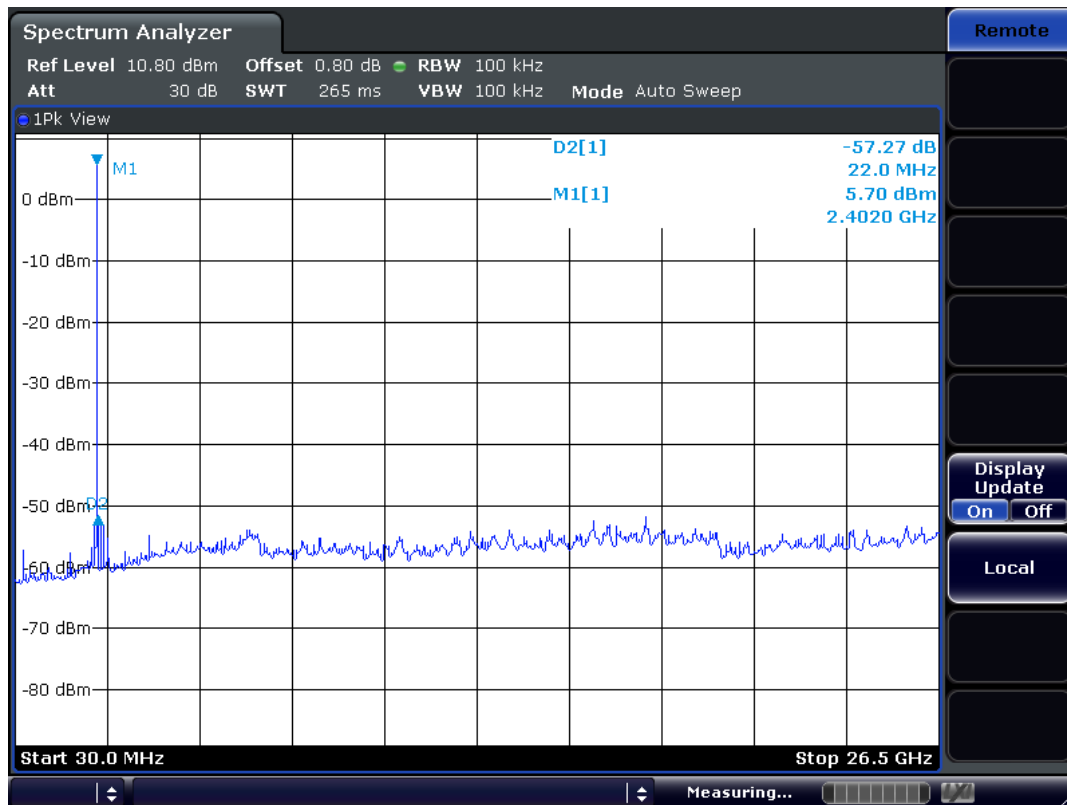
Frequency (MHz)	Detect mode	Pol.	Reading (dBuV/m)	T.F (dB)	Step 1 Data	delta	Step 3 Data	Limit
2483.5	PK	V	109.97	1.1	111.07	52.05	59.02	74
	AV	V	65.64	1.1	66.74	52.05	14.69	54

Note) Step 1 = Reading + T.F

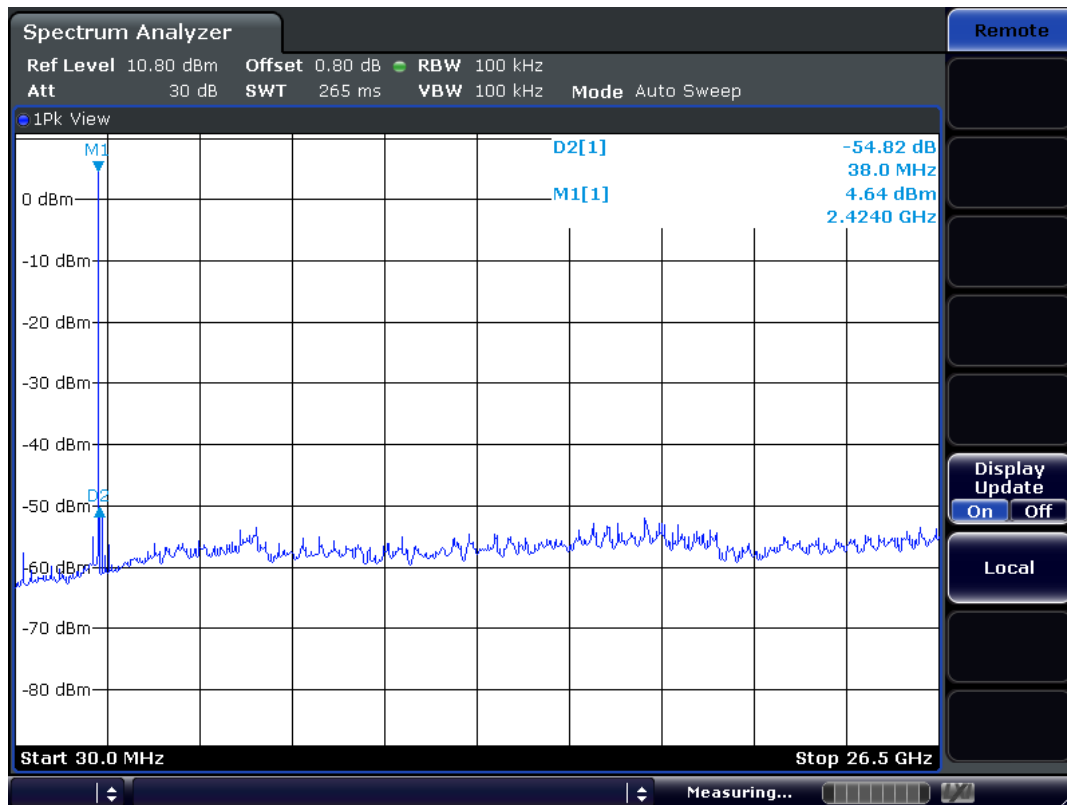
(T.F = Ant.F + Cable loss – PreAmp Gain)

Step 3 = Step 1 – Delta Value

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

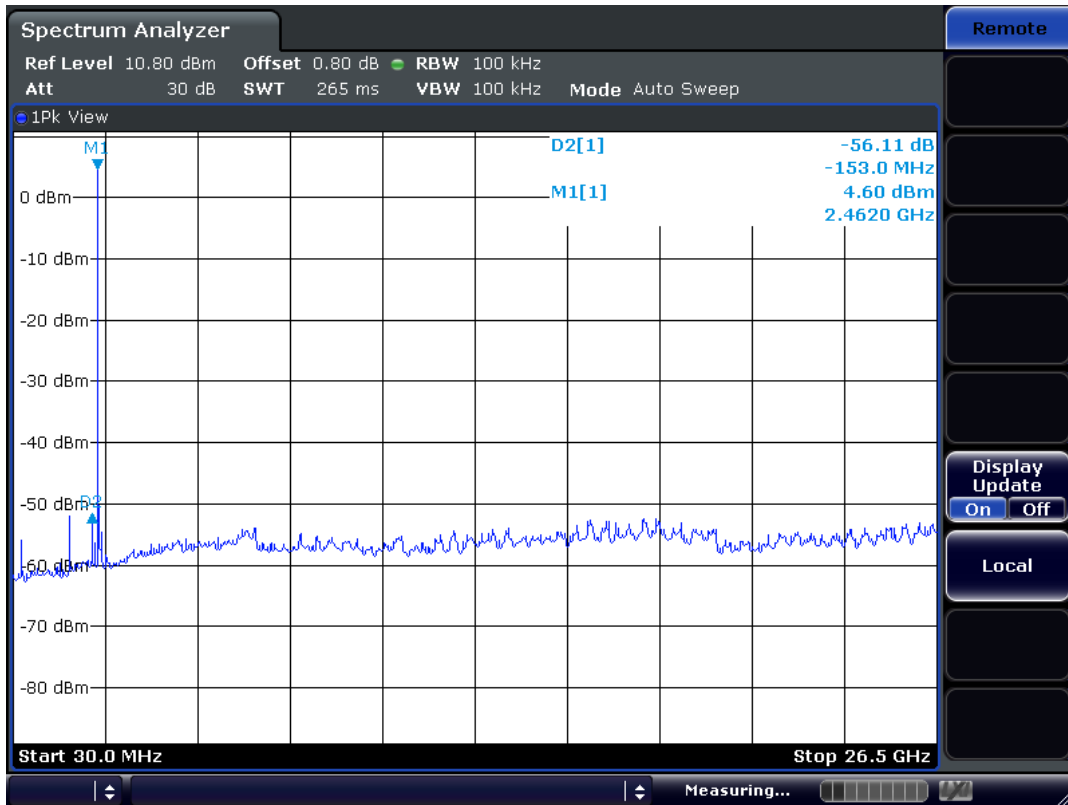


**Unwanted Emission – Middle channel**  
**Frequency Range = 30 MHz ~ 26.5 GHz**





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



### 3.2.7 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 ~ 10<sup>th</sup> harmonic.

RBW = 100 kHz ( 30MHz ~ 1 GHz)

= 1 MHz ( 1 GHz ~ 10<sup>th</sup> harmonic )

Span = 100 MHz

Trace = max hold

Peak:VBW  $\geq$  RBW

Average:VBW=10Hz

Detector function = Peak and Average

Sweep = auto

#### Measurement Data: **Complies**

- Refer to the next page.
- No other emissions were detected at a level greater than 10dB below limit.

#### 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:****1. PEAK data**

Low channel		Mid channel		High channel	
Frequency (MHz)	Level (dBuV/m)	Frequency (MHz)	Level (dBuV/m)	Frequency (MHz)	Level (dBuV/m)
-	-	-	-	-	-
No emissions were detected at a level greater than 20dB below limit.					
-	-	-	-	-	-
<b>Measurement uncertainty</b>		$\pm 6$ dB			

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

**2. AVERAGE data**

Low channel		Mid channel		High channel	
Frequency (MHz)	Level (dBuV/m)	Frequency (MHz)	Level (dBuV/m)	Frequency (MHz)	Level (dBuV/m)
-	-	-	-	-	-
No emissions were detected at a level greater than 20dB below limit.					
-	-	-	-	-	-
<b>Measurement uncertainty</b>		$\pm 6$ dB			

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

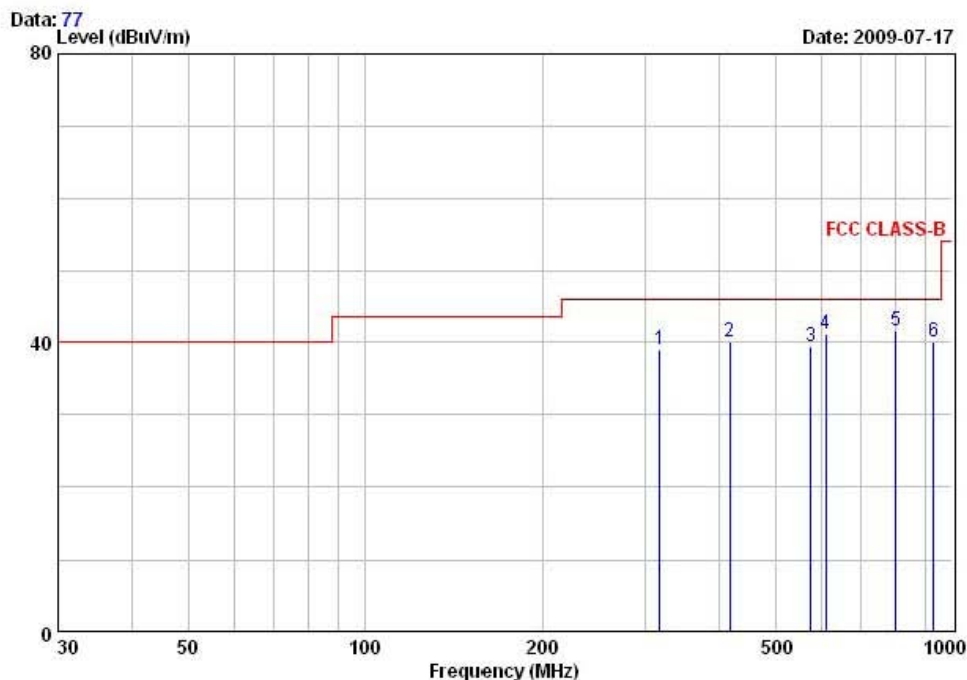
**Radiated Emissions – Wireless + Charging Mode**



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EUT/Model No.: SMT-100 TEST MODE: Wireless + Charging mode

Temp Humi : 27 / 64 Tested by: B.S.KIM



Freq	Reading	C.F	Result	Limit	Margin	Height	Angle	Polarity
MHz	dBuV/m	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	316.94	48.37	-9.31	39.06	46.00	6.94	400	21 HORIZONTAL
2	417.58	47.33	-7.12	40.21	46.00	5.79	400	283 HORIZONTAL
3	573.64	42.78	-3.36	39.42	46.00	6.58	400	100 HORIZONTAL
4	609.06	43.54	-2.25	41.29	46.00	4.71	400	44 HORIZONTAL
5	801.60	40.13	1.51	41.64	46.00	4.36	150	320 VERTICAL
6	929.27	36.12	4.08	40.20	46.00	5.80	400	180 HORIZONTAL

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

### 3.2.8 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 10dB below limit.

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

Frequency Range (MHz)	Conducted Limit (dBuV)	
	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

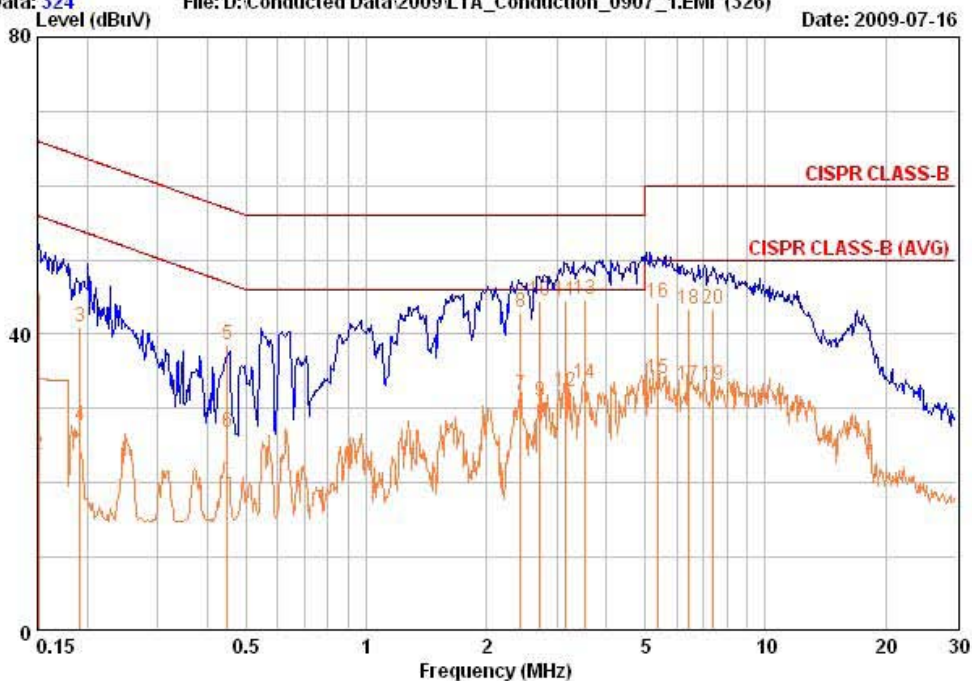
**AC Conducted Emissions – Wireless + Charging – Line**



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Tel +82-31-323-6008  
Fax:+82-31-323-6010

EUT / Model No. : SMT-100 Phase : LINE  
 Test Mode : Wireless + Charging mode Test Power : 120 / 60  
 Temp./Humid. : 25 / 52 Test Engineer : b.s.kim

Data: 324 File: D:\Conducted Data\2009\LTA\_Conduction\_0907\_1.EMI (326) Date: 2009-07-16



Freq MHz	RD	RD	C.F	Result	Result	Limit	Limit	Margin	Margin
	QP	AV		QP	AV	QP	AV		
	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dBuV	dB	dB
0.151	35.70	14.10	9.75	45.45	23.85	65.94	55.94	20.49	32.09
0.192	31.39	17.99	9.61	41.00	27.60	63.95	53.95	22.95	26.35
0.448	28.95	17.05	9.67	38.62	26.72	56.91	46.91	18.29	20.19
2.431	33.06	21.96	9.84	42.90	31.80	56.00	46.00	13.10	14.20
2.728	34.65	21.15	9.86	44.51	31.01	56.00	46.00	11.49	14.99
3.146	34.54	22.44	9.92	44.46	32.36	56.00	46.00	11.54	13.64
3.537	34.74	23.34	9.93	44.67	33.27	56.00	46.00	11.33	12.73
5.389	34.35	23.95	9.98	44.33	33.93	60.00	50.00	15.67	16.07
6.420	33.45	23.15	9.95	43.40	33.10	60.00	50.00	16.60	16.90
7.413	33.26	23.16	10.01	43.27	33.17	60.00	50.00	16.73	16.83

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

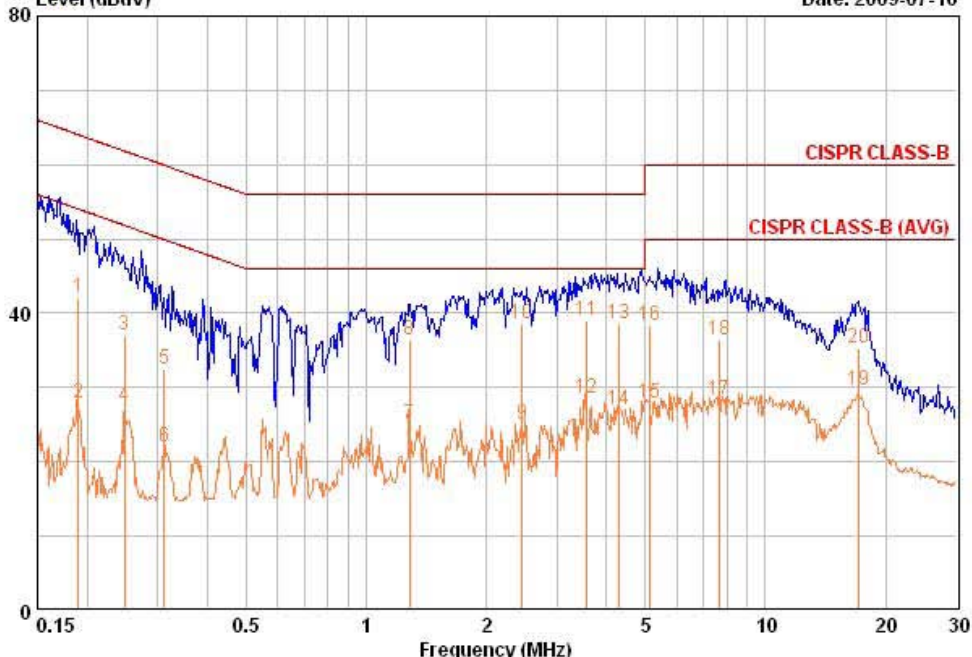
**AC Conducted Emissions – Wireless + Charging – Neutral**



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Tel +82-31-323-6008  
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EUT / Model No. : SMT-100 Phase : NEUTRAL  
 Test Mode : Wireless + Charging mode Test Power : 120 / 60  
 Temp./Humid. : 25 / 53 Test Engineer : b.s.kim

Data: 326 File: D:\Conducted Data\2009\LTA\_Conduction\_0907\_1.EMI (326) Date: 2009-07-16



Freq	RD	RD	C.F	Result	Result	Limit	Limit	Margin	Margin
MHz	QP	AV	dB	QP	AV	QP	AV	QP	AV
0.190	32.39	18.19	9.68	42.07	27.87	64.04	54.04	21.96	26.16
0.248	27.38	17.68	9.69	37.06	27.36	61.82	51.82	24.76	24.46
0.312	22.87	12.37	9.64	32.51	22.01	59.92	49.92	27.40	27.90
1.281	26.65	15.15	9.82	36.47	24.97	56.00	46.00	19.53	21.03
2.460	28.66	15.16	9.86	38.52	25.02	56.00	46.00	17.48	20.98
3.549	29.14	18.64	9.92	39.06	28.56	56.00	46.00	16.94	17.44
4.296	28.64	17.14	9.91	38.55	27.05	56.00	46.00	17.45	18.95
5.111	28.35	18.05	9.95	38.30	28.00	60.00	50.00	21.70	22.00
7.686	26.37	18.27	9.99	36.36	28.26	60.00	50.00	23.64	21.74
17.108	25.01	19.21	10.38	35.39	29.59	60.00	50.00	24.61	20.41

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

## APPENDIX

### TEST EQUIPMENT USED FOR TESTS



	Description	Model No.	Serial No.	Manufacturer	Next Cal. Date
1	Spectrum Analyzer	FSV-30	100757	R&S	Feb-10
2	Spectrum Analyzer	8563E	3425A02505	HP	Apr-10
3	Spectrum Analyzer	8594E	3710A04074	HP	Oct-09
4	Signal Generator	8648C	3623A02597	HP	Apr-10
5	Signal Generator	83711B	US34490456	HP	Apr-10
6	Attenuator (3dB)	8491A	37822	HP	Oct-09
7	Attenuator (10dB)	8491A	63196	HP	Oct-09
8	Attenuator (30dB)	8498A	1801A06689	HP	Oct-09
9	EMI Test Receiver	ESVD	843748/001	R&S	Apr-10
10	Horn Antenna(18 ~ 40GHz)	SAS-574	154	Schwarzbeck	Nov-10
11	Horn Antenna(18 ~ 40GHz)	SAS-574	155	Schwarzbeck	Nov-10
12	RF Amplifier	8447D	2949A02670	HP	Oct-10
13	RF Amplifier	8449B	3008A02126	HP	Apr-10
14	Test Receiver	ESHS10	828404/009	R&S	Apr-10
15	TRILOG Antenna	VULB 9160	9160-3212	SCHWARZBECK	Apr-11
16	Log.-Per. Antenna	VULP 9118	9118 A 401	SCHWARZBECK	Apr-11
17	Biconical Antenna	BBA 9106	VHA 9103-2315	SCHWARZBECK	Apr-11
18	Horn Antenna	3115	00055005	ETS LINDGREN	Mar-11
19	Horn Antenna	BBHA 9120D	9120D122	SCHWARZBECK	Dec-11
20	Dipole Antenna	VHA9103	2116	SCHWARZBECK	Nov-09
21	Dipole Antenna	VHA9103	2117	SCHWARZBECK	Nov-09
22	Dipole Antenna	VHA9105	2261	SCHWARZBECK	Nov-09
23	Dipole Antenna	VHA9105	2262	SCHWARZBECK	Nov-09
24	Hygro-Thermograph	THB-36	0041557-01	ISUZU	Apr-10
25	Splitter (SMA)	ZFSC-2-2500	SF617800326	Mini-Circuits	-
26	RF Switch	MP59B	6200414971	ANRITSU	-
27	Power Divider	11636A	6243	HP	Oct-09
28	DC Power Supply	6622A	3448A03079	HP	Oct-09
29	Frequency Counter	5342A	2826A12411	HP	Apr-10
30	Power Meter	EPM-441A	GB32481702	HP	Apr-10
31	Power Sensor	8481A	2702A64048	HP	Apr-10
32	Audio Analyzer	8903B	3729A18901	HP	Oct-09
33	Modulation Analyzer	8901B	3749A05878	HP	Oct-09
34	TEMP & HUMIDITY Chamber	YJ-500	LTAS06041	JinYoung Tech	Oct-09
35	LOOP-ANTENNA	FMZB 1516	151602/94	SCHWARZBECK	Mar-11
36	Stop Watch	HS-3	601Q09R	CASIO	Apr-10
37	LISN	ENV216	100408	R&S	Oct-09