

TEST REPORT For FCC

Test Report No. : 2010070009
Date of Issue : July 01, 2010
FCC ID : QJCH318B
Model/Type No. : H318B
Kind of Product : Braille Sense OnHand
Applicant : HIMS Co., Ltd.
Applicant Address : KT Daejeon Satellite Center, 139-9, Gajung-dong, Yuseong-gu, Daejeon, KOREA, 305-350
Manufacturer : HIMS Co., Ltd.
Manufacturer Address : KT Daejeon Satellite Center, 139-9, Gajung-dong, Yuseong-gu, Daejeon, KOREA, 305-350
Contact Person : Kim Sung Man / Researcher
Telephone : +82-42-864-4460
Received Date : June 18, 2010
Test period : Start : June 18, 2010 End : July 01, 2010
Test Results : ☒ In Compliance ☐ Not in Compliance

The test results presented in this report relate only to the object tested.

Tested by

Y. T. Lee

Lee Young-taek
Test Engineer
Date: July 01, 2010

Reviewed by

Y. J. Park

Young-Joon, Park
Technical Manager
Date: July 01, 2010

REPORT REVISION HISTORY

Date	Revision	Page No
July 01, 2010	Issued (2010070009)	All

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1.0 General Product Description

Equipment model name : H318B

Serial number : Prototype

EUT condition : Pre-production, not damaged

Antenna type : Chip antenna Gain -1.0 dBi

Frequency Range : 2412Mhz ~ 2462MHz (DSSS/OFDM)

RF output power : 8.70 dBm Peak Conducted (802.11b)
: 8.55 dBm Peak Conducted (802.11g)

Number of channels : 11 (DSSS/OFDM)

Type of Modulation : CCK, DQPSK, DBPSK for DSSS
: 64QAM, 16QAM, QPSK, BPSK for OFDM

Transfer Rate : 11/5.5/2/1 Mbps for 802.11b
: 54/48/36/24/18/12/9/6 Mbps for 802.11g

Power Source : Lithium Ion Rechargeable Battery(DC 3.7 V)

1.1 Tested Frequency

	LOW	MID	HIGH
Frequency (MHz) For 802.11b	2412	2437	2462
Frequency (MHz) For 802.11g	2412	2437	2462

1.2 Model Differences

Not applicable

1.3 Device Modifications

The following modifications were necessary for compliance:

Not applicable

1.4 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.	FCC ID or DoC

1.5 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

1.6 Test Facility

The measurement facility is located at 386-1, Ho-dong, Cheoin-gu, Yongin-si, Gyeonggi-do, 449-100, Korea. The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

1.7 Laboratory Accreditations and Listings

Country	Agency	Scope of Accreditation	Logo
USA	FCC	3 & 10 meter Open Area Test Sites and one conducted site to perform FCC Part 15/18 measurements.	 805871
JAPAN	VCCI	10 meter Open Area Test Site and one conducted site.	 R-948, C-986
KOREA	KCC	EMI (10 meter Open Area Test Site and two conducted sites) EMS (ESD, RS, EFT/Burst, Surge, CS, Magnetic, Dips and interruptions)	 No. 51, KR0025
International	KOLAS	EMC	

2.0 Summary of tests

FCC Part Section(s)	Parameter	Limit	Test Condition	Status (note 1)
15.247(a)	6 dB Bandwidth	> 500 kHz	Conducted	C
15.247(b)	Transmitter Output Power	< 1 Watt		C
15.247(d)	Conducted Spurious emission	> 20 dBc		C
15.247(d)	Band Edge	> 20 dBc		C
15.247(d)	Transmitter Power Spectral Density	< 8 dBm @ 3 kHz		C
				C
15.209	Field Strength of Harmonics	< 54 dBuV (at 3 m)	Radiated	C
15.207	AC Conducted Emissions	EN 55022	Line Conducted	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.

The sample was tested according to the following specification:
- FCC Part 15.247, ANSI C63.4-2003

2.1 Technical Characteristic Test

2.1.1 6dB 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 = 40 MHz

VBW = 100 kHz (VBW ≥ RBW)

Sweep = auto

Trace = max hold

Detector function = peak

Measurement Data:

Mode	Frequency (MHz)	Channel No.	Test Results	
			Measured Bandwidth (MHz)	Result
802.11b	2412	1	10.00	Complies
	2437	6	10.00	Complies
	2462	11	10.00	Complies
802.11g	2412	1	16.48	Complies
	2437	6	16.48	Complies
	2462	11	16.48	Complies

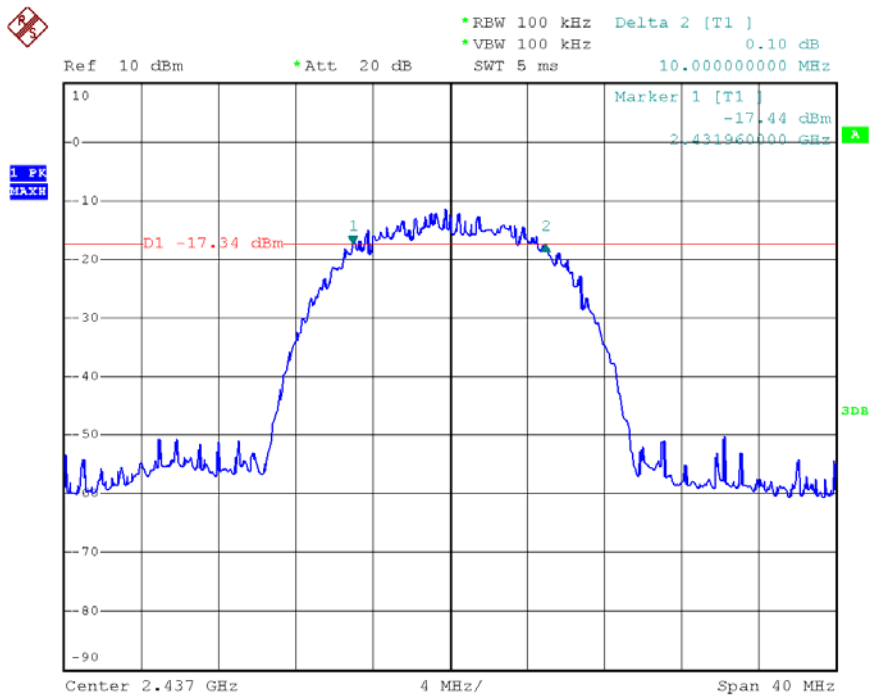
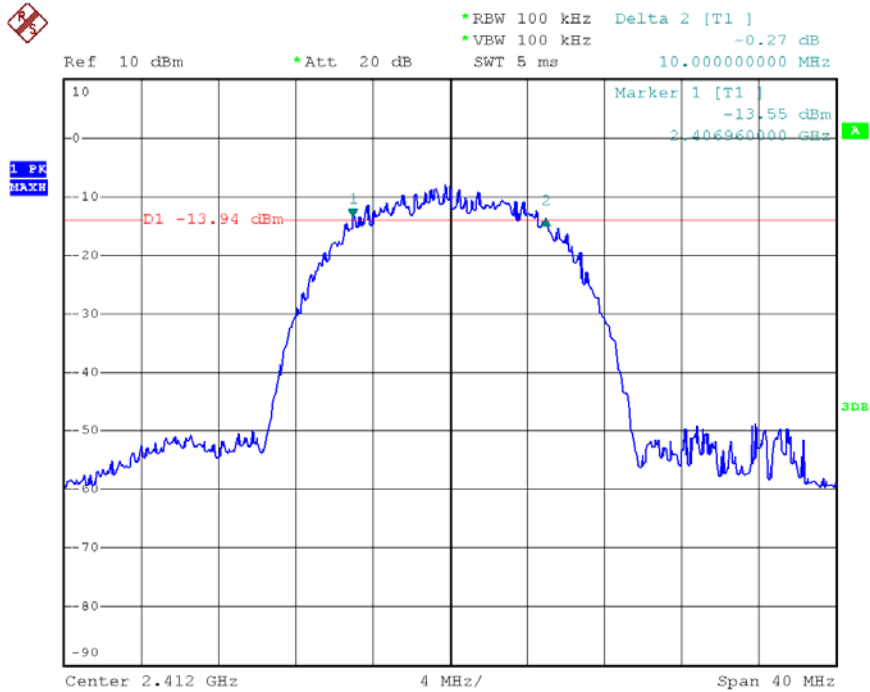
- See next pages for actual measured spectrum plots.

Minimum Standard:

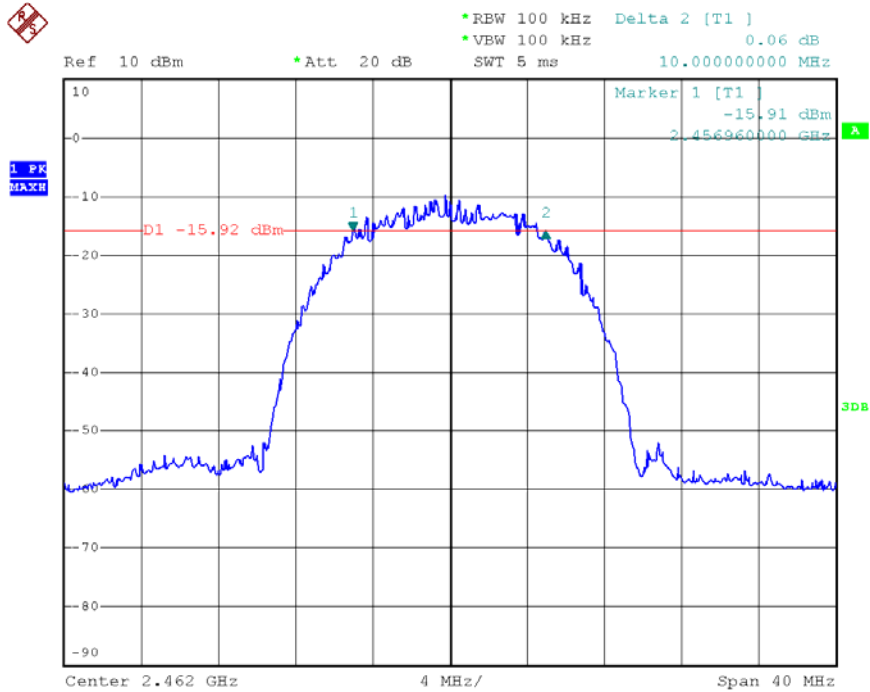
6 dB Bandwidth > 500kHz

See next pages for actual measured spectrum plots.

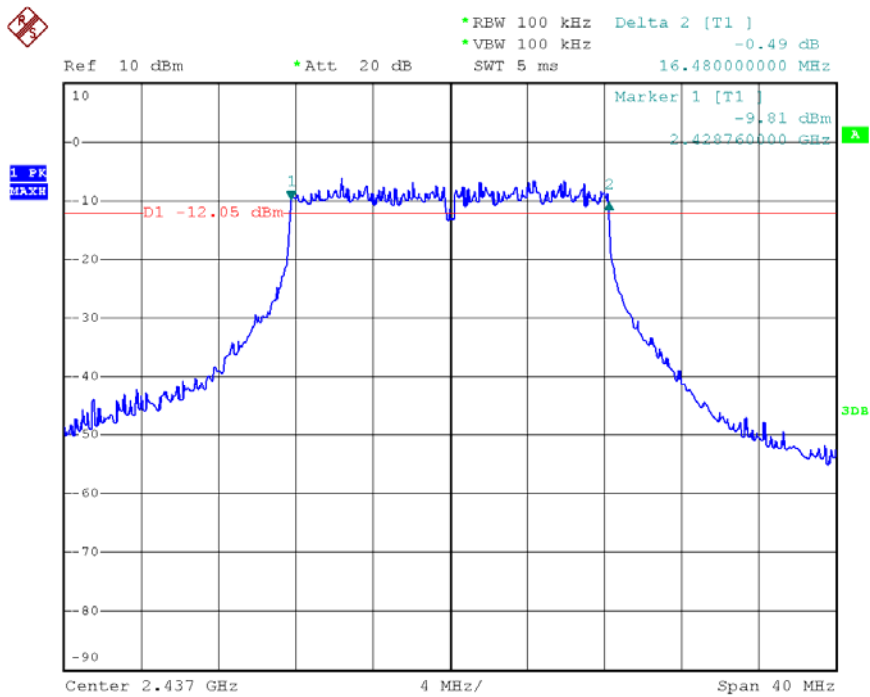
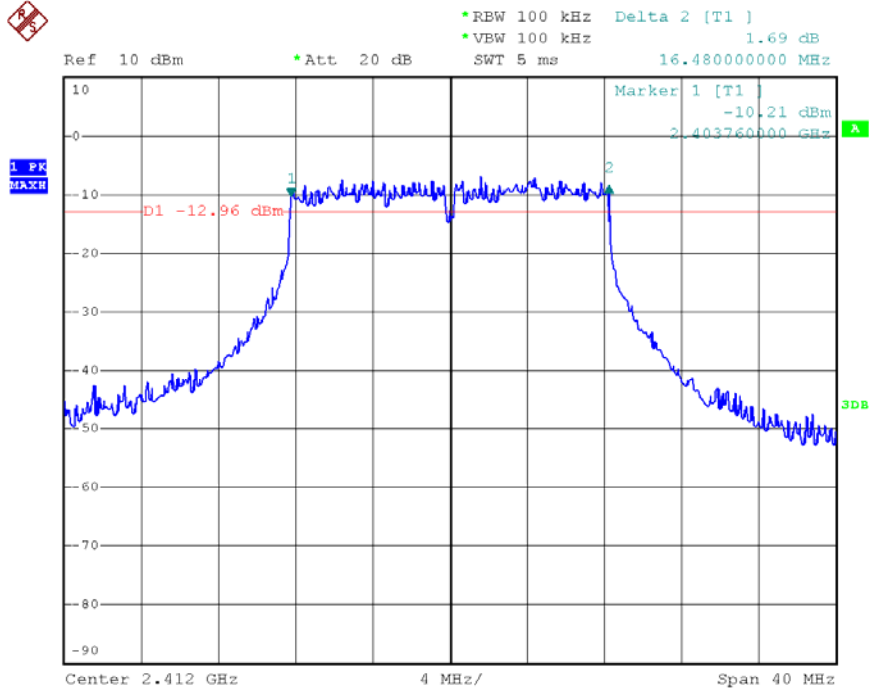
802.11b



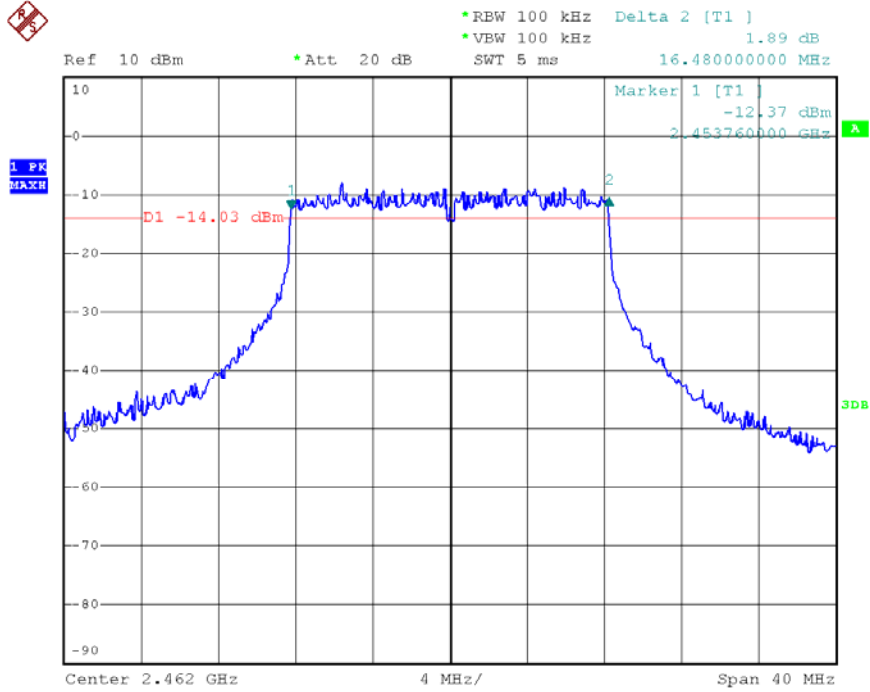
802.11b



802.11g



802.11g



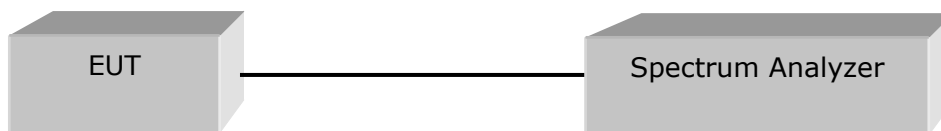
2.1.2 Maximum peak Conducted Output Power

Test Location

RF Test Room

Test Procedures

The transmitter output is connected to a spectrum analyzer and the analyzer's internal channel power integration function is used to integrate the power over a bandwidth greater than or equal to the 99% bandwidth.



Limit

< 1 W

Test Results

802.11b mode

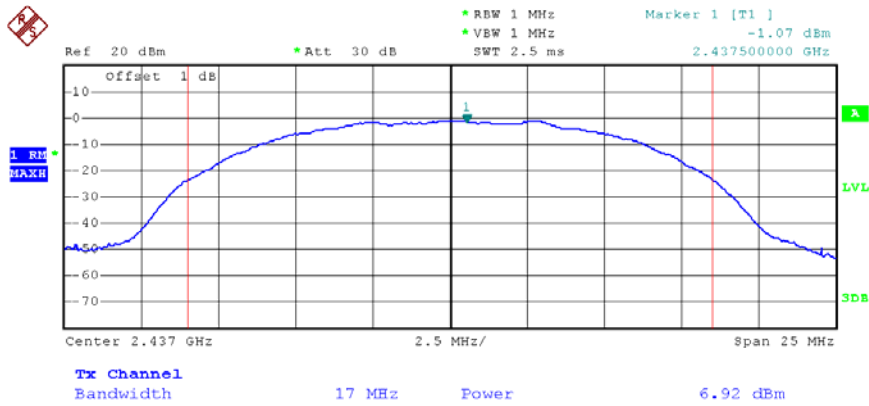
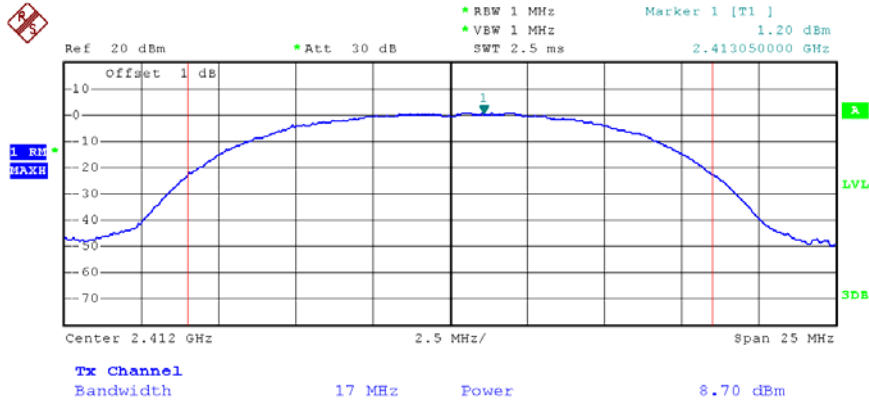
Frequency (MHz)	Channel No.	Peak output power(dBm)	Limit	Result
2412	Low	8.70	30dBm	Complies
2437	Middle	6.92	30dBm	Complies
2462	High	5.29	30dBm	Complies

802.11g mode

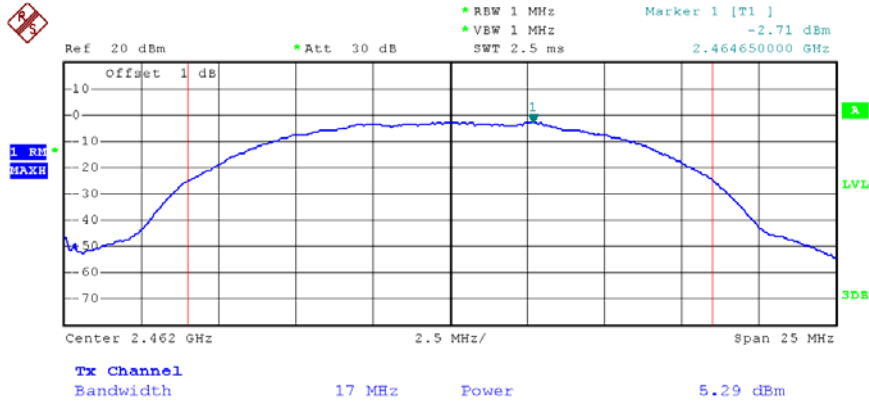
Frequency (MHz)	Channel No.	Peak output power(dBm)	Peak output power(mW)	Result
2412	Low	8.55	30dBm	Complies
2437	Middle	7.82	30dBm	Complies
2462	High	6.29	30dBm	Complies

See next pages for actual measured spectrum plots.

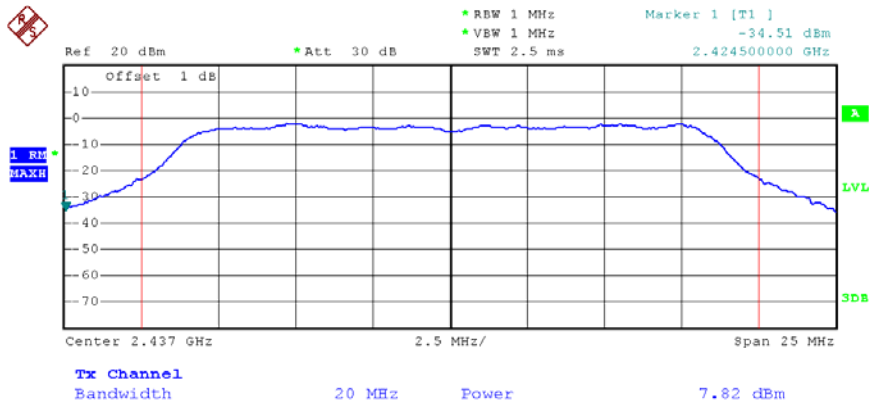
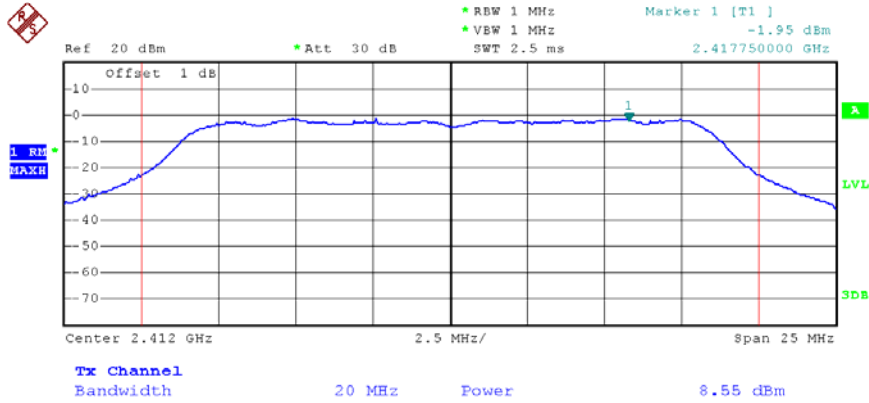
Peak Conducted Output Power – 802.11b



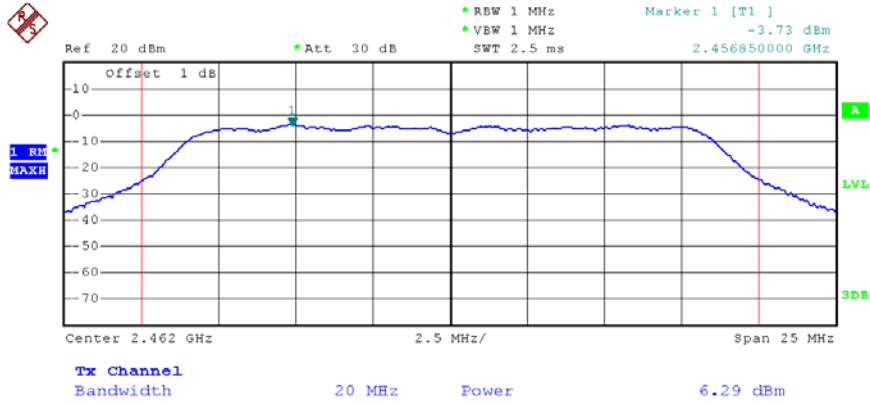
Peak Conducted Output Power – 802.11b



Peak Conducted Output Power – 802.11g



Peak Conducted Output Power – 802.11g



2.1.3 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

VBW = (VBW ≥ RBW)

Sweep = 100KHz(Span/3KHz)

Span = 300 KHz

Detector function = peak

Trace = max hold

Measurement Data:

Mode	Frequency (MHz)	Ch.	Test Results	
			dBm	Result
802.11b	2412	1	-19.32	Complies
	2437	6	-22.75	Complies
	2462	11	-23.32	Complies
802.11g	2412	1	-19.16	Complies
	2437	6	-23.60	Complies
	2462	11	-21.64	Complies

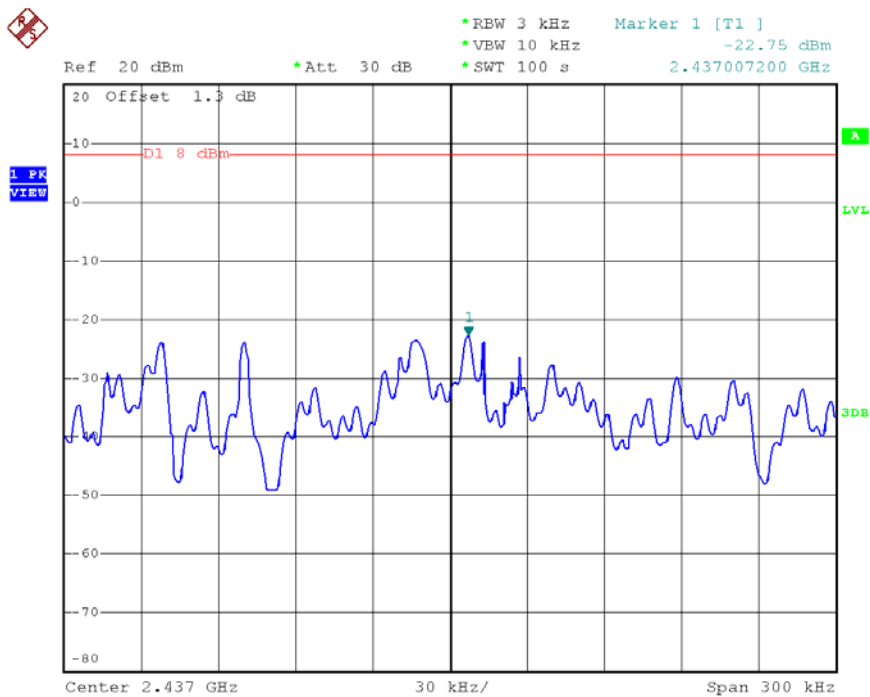
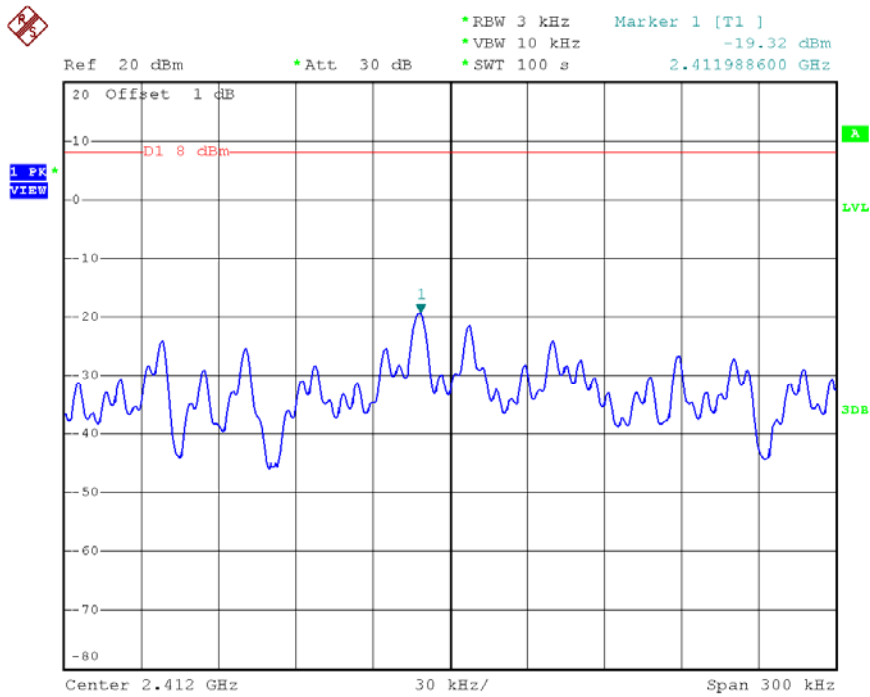
- See next pages for actual measured spectrum plots.

Minimum Standard:

Power Spectral Density	< 8dBm @ 3kHz BW
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See next pages for actual measured spectrum plots.

802.11b Power Density Measurement

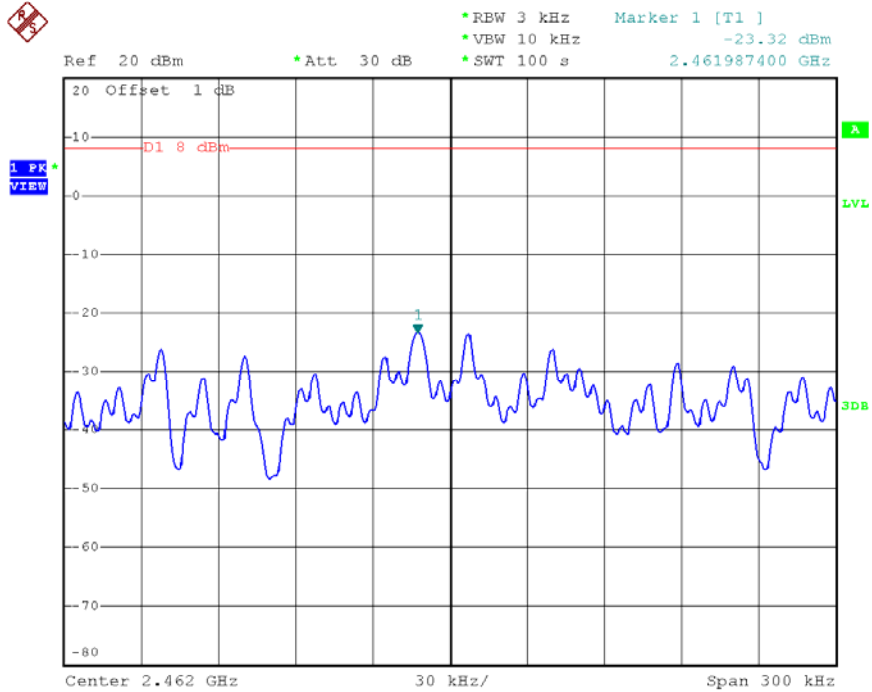




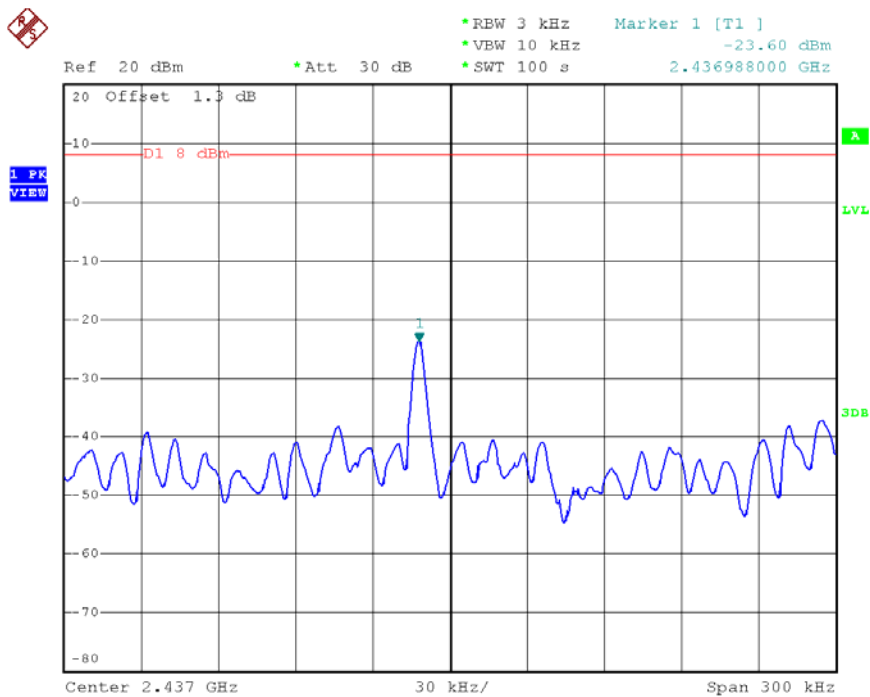
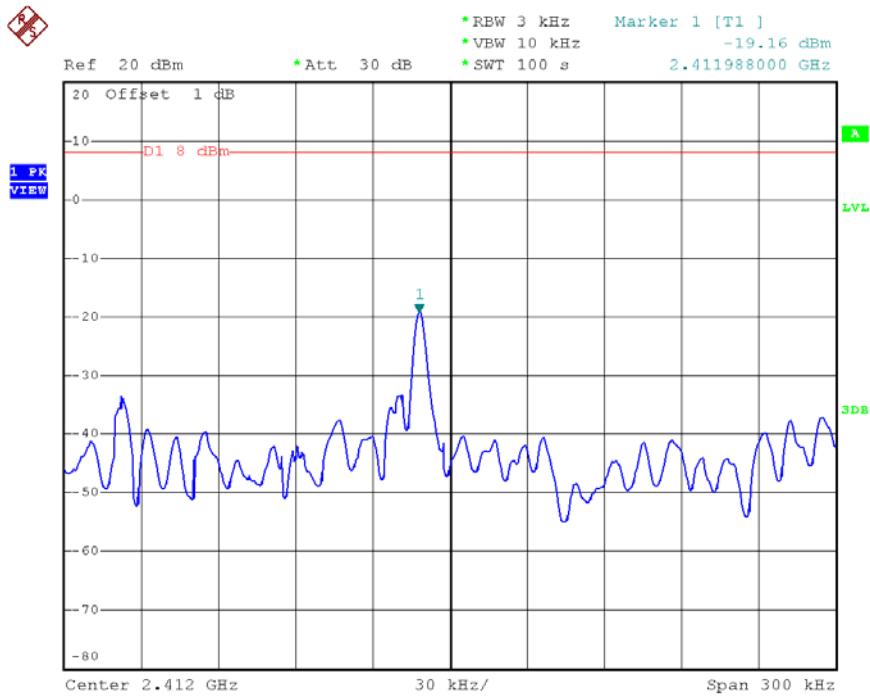
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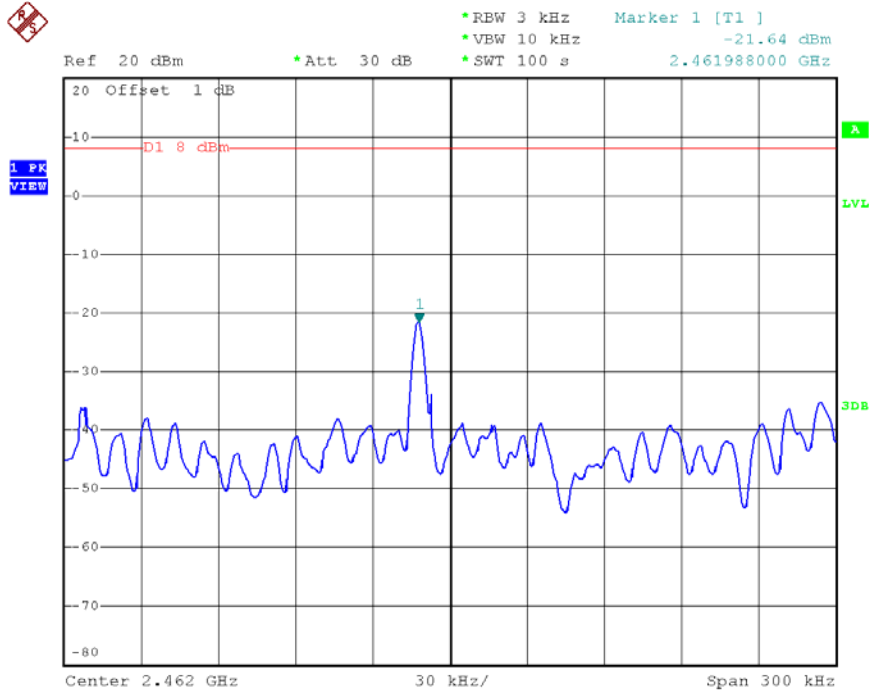
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802.11g Power Density Measurement





2.1.4 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 = 40 MHz

Detector function = peak

Trace = max hold

Sweep = auto

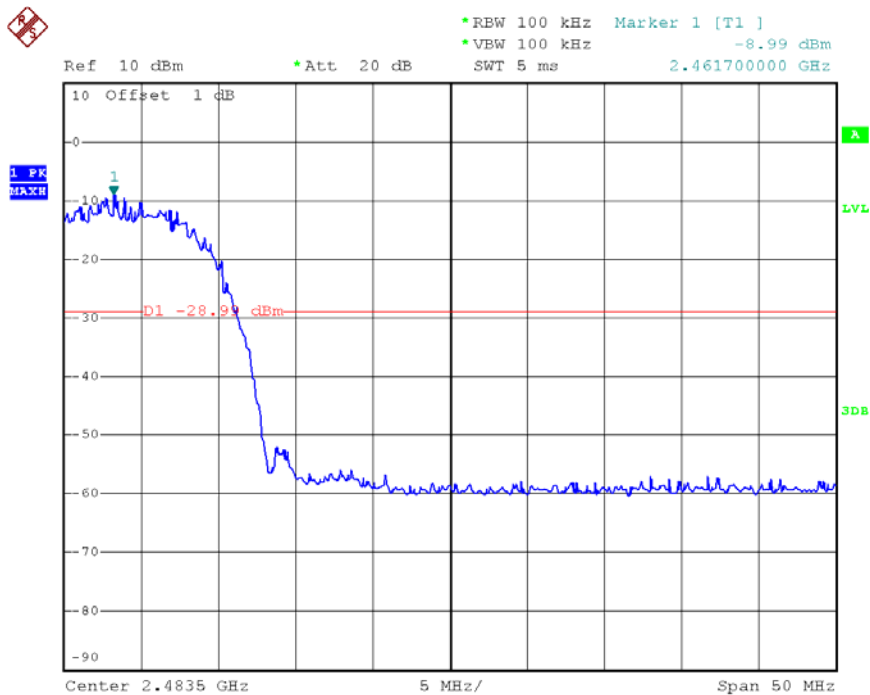
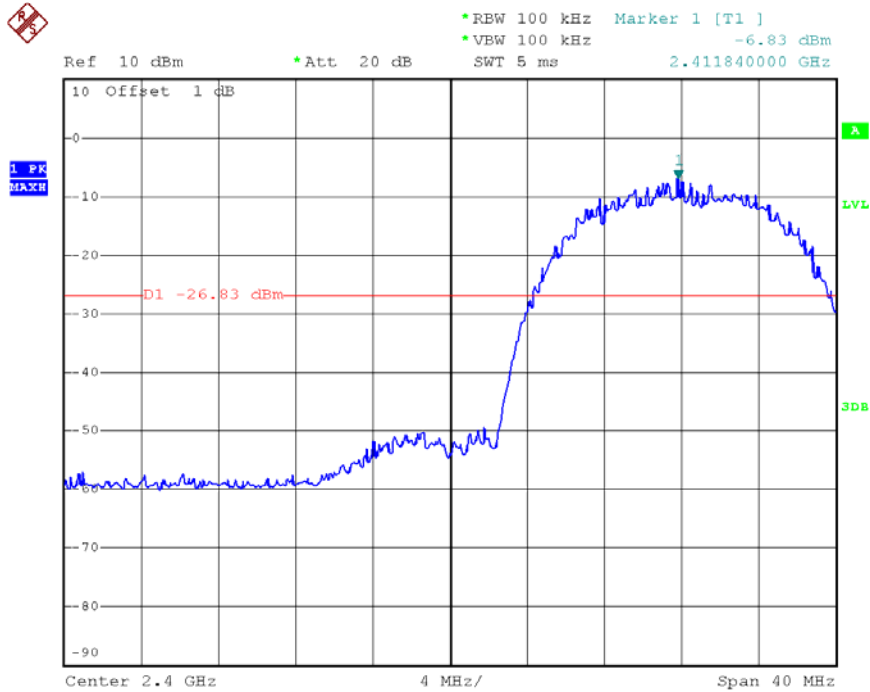
Measurement Data: Complies

- 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.

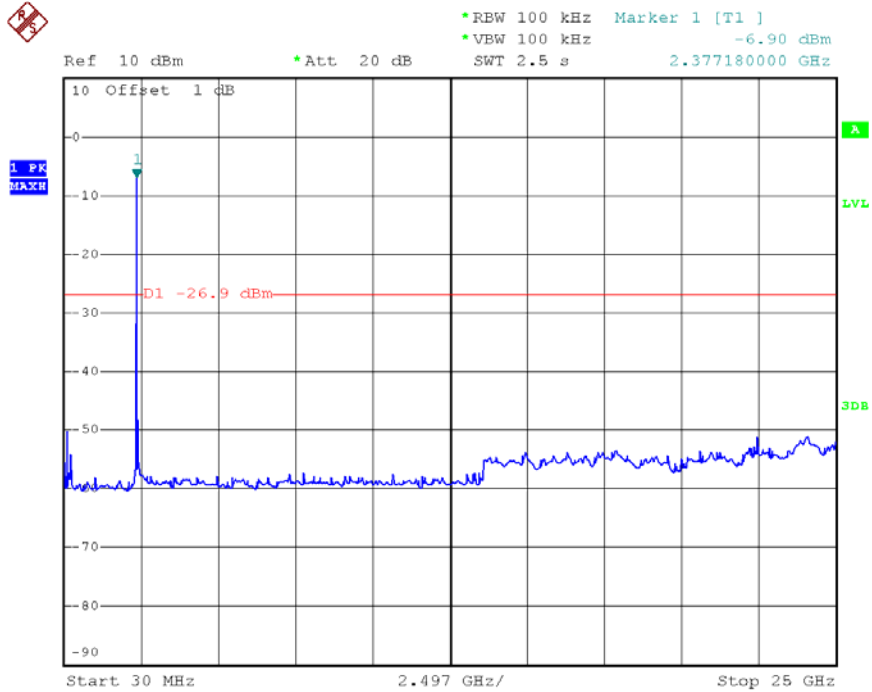
Minimum Standard:	> 20 dBc
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See next pages for actual measured spectrum plots.

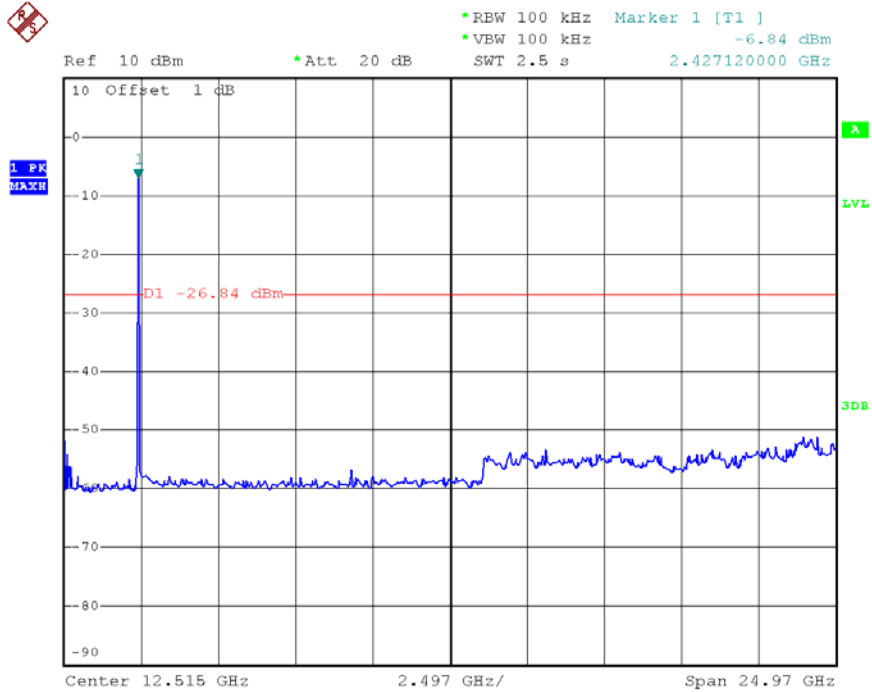
802.11b Band-edge Measurements



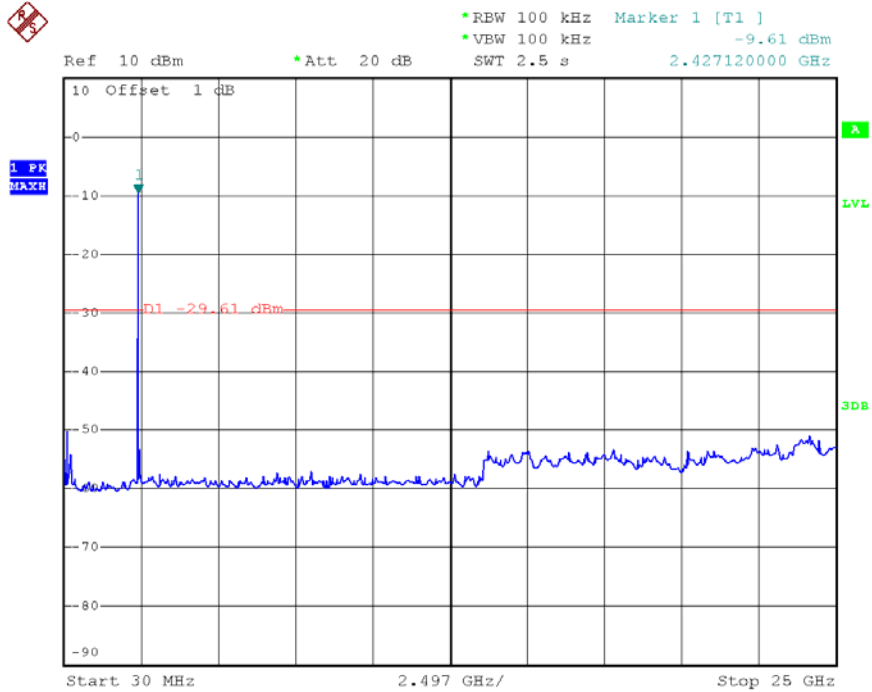
Band – edge (at 20 dB blow) – Low channel(802.11b)
Frequency Range = 30 MHz ~ 10th harmonic



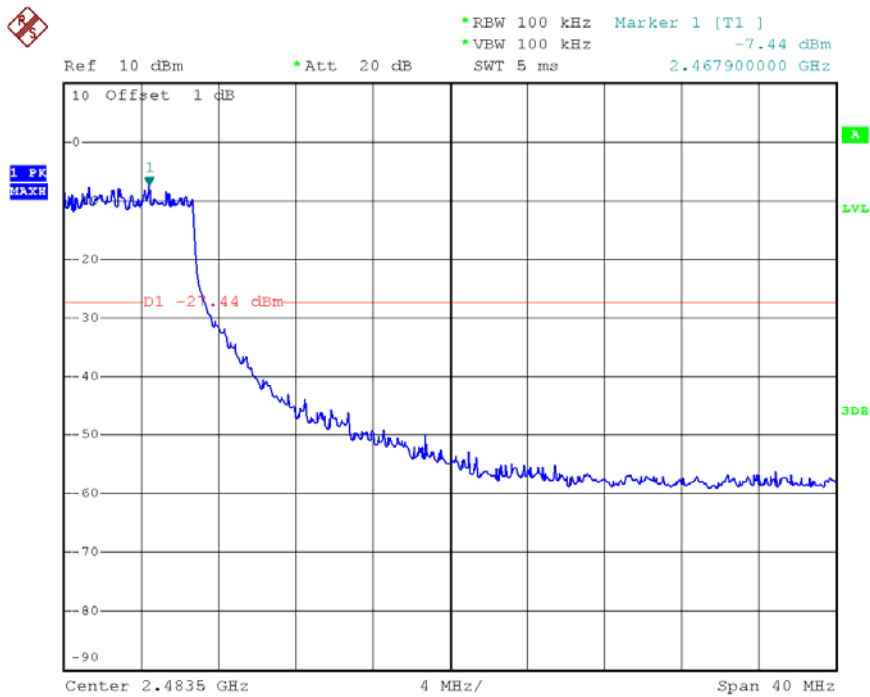
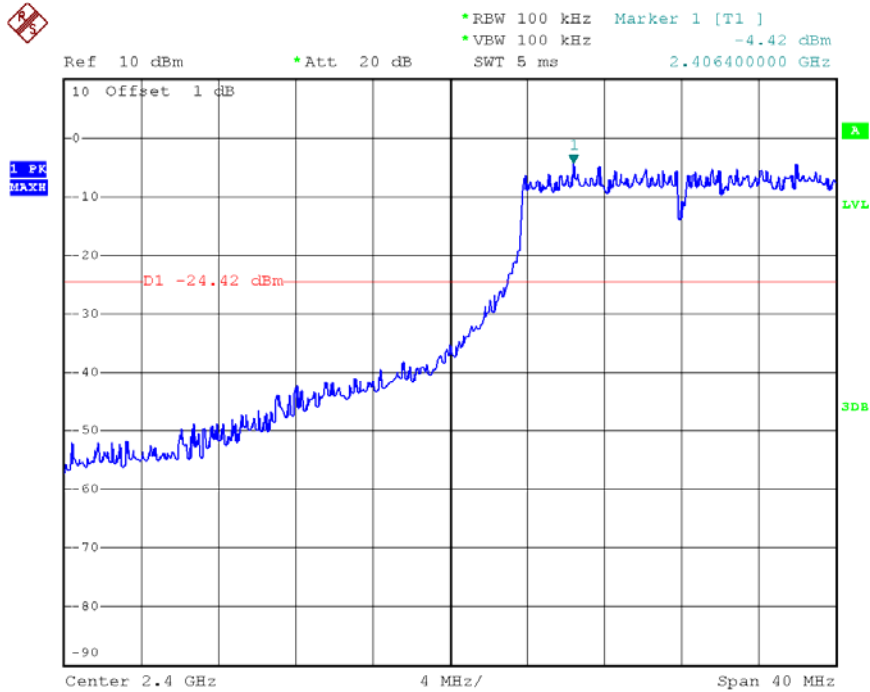
Band – edge (at 20 dB blow) – Mid channel(802.11b)
Frequency Range = 30 MHz ~ 10th harmonic



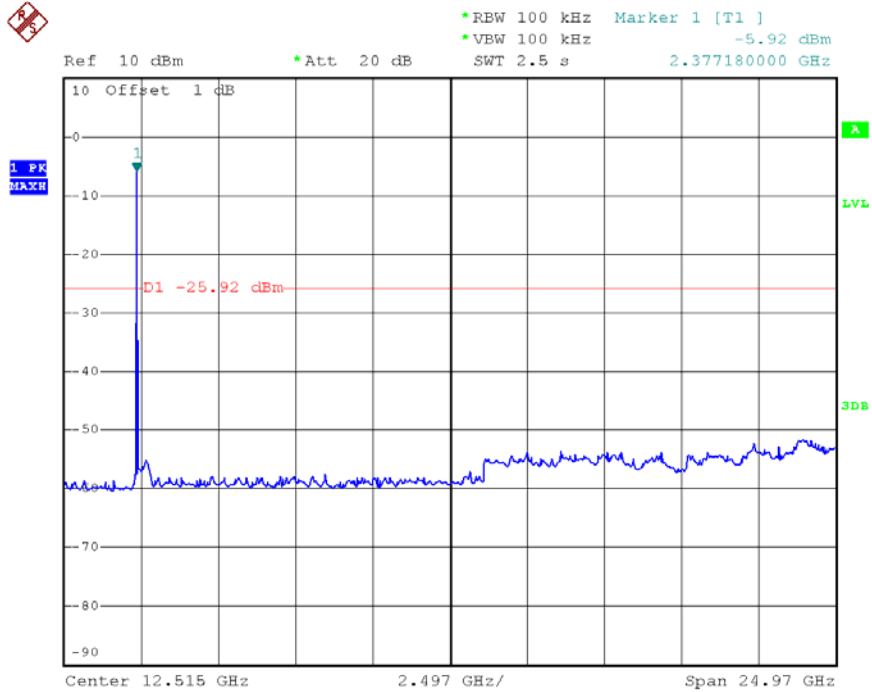
Band – edge (at 20 dB blow) – High channel(802.11b)
Frequency Range = 30 MHz ~ 10th harmonic



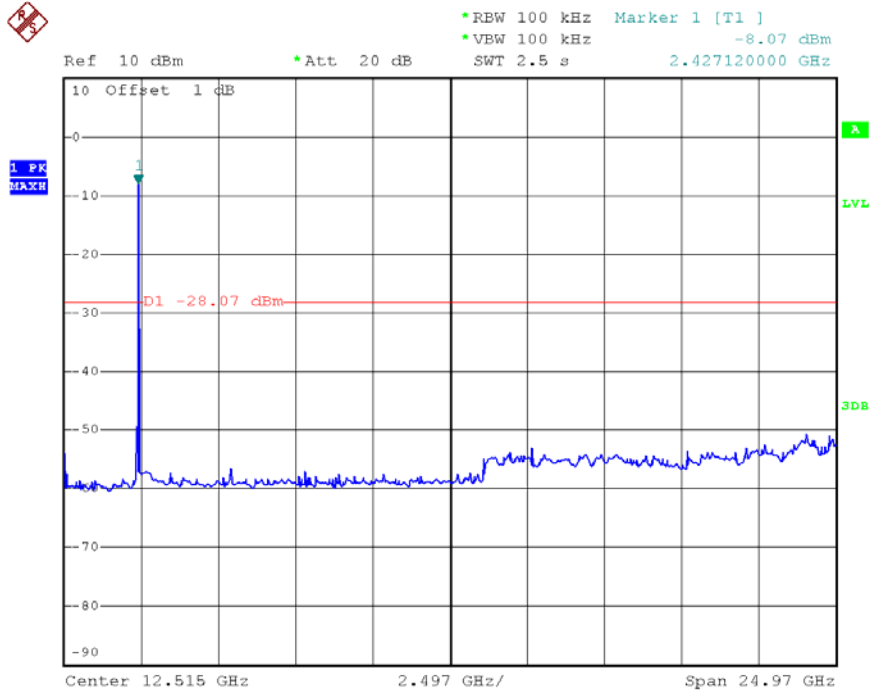
802.11g Band-edge Measurements



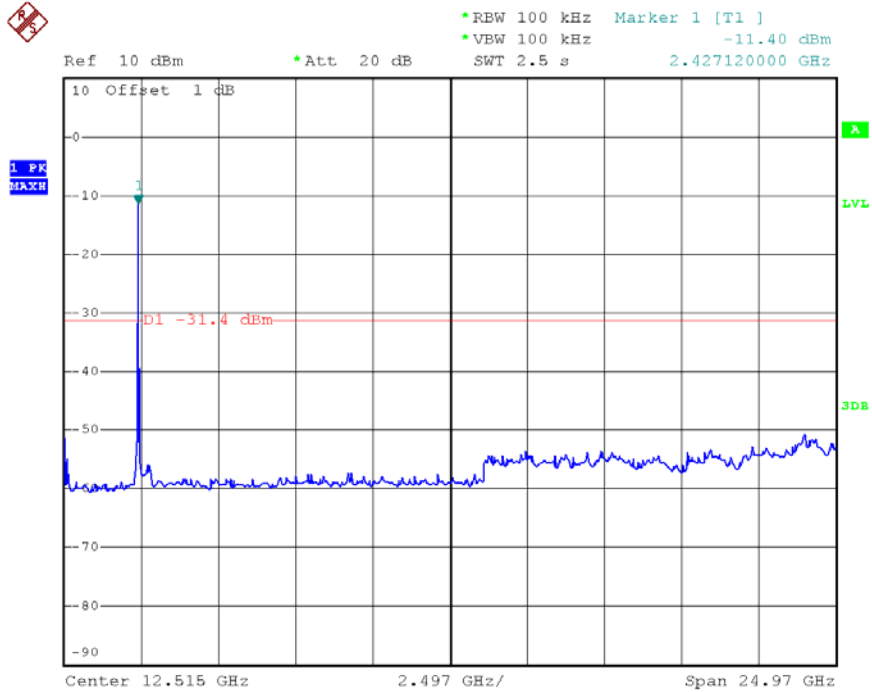
Band – edge (at 20 dB blow) – Low channel(802.11g)
Frequency Range = 30 MHz ~ 10th harmonic



Band – edge (at 20 dB blow) – Mid channel(802.11g)
Frequency Range = 30 MHz ~ 10th harmonic



Band – edge (at 20 dB blow) – High channel(802.11g)
Frequency Range = 30 MHz ~ 10th harmonic



2.1.5 Field Strength of Emissions

Test Location

☒ Testing was performed at a test distance of 3 meter Open Area Test Site

Test Procedures

The height of the measuring antenna was varied between 1 to 4 m and the table was rotated a full revolution in order to obtain maximum values of the electric field intensity. The measurement was made in both the vertical and horizontal polarization, and the maximum value is presented in the report.

The spectrum analyzer is set to:

Center frequency = the worst channel

Frequency Range = 30 MHz ~ 10th harmonic

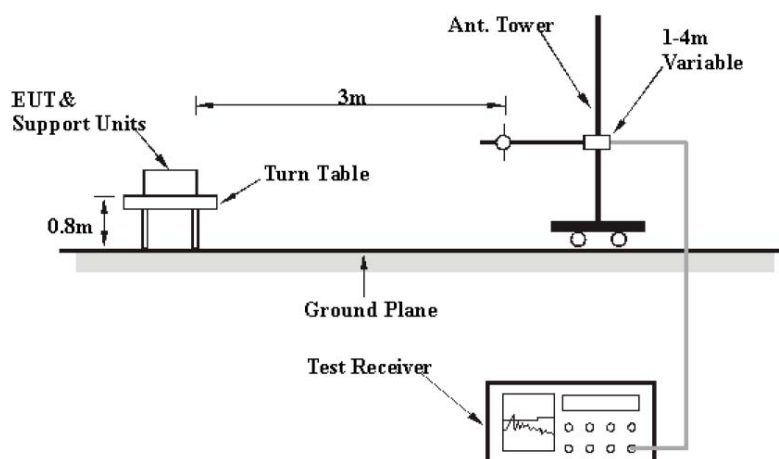
RBW = 120 kHz (30 MHz ~ 1 GHz) VBW ≥ RBW

= 1 MHz (1 GHz ~ 10th harmonic)

Span = 100 MHz

Detector function = Quasi-peak

Trace = max hold



Limit

- 15.209(a)

Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m
30-88	100**	40
88-216	150**	43.5
216-960	200**	46
Above 960	500	54

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

Test Results

EUT	Braille Sense OnHand	Measurement Detail	
Model	H318B	Frequency Range	Below 1000MHz
Mode	802.11b(Worst Case)	Detector function	Quasi-Peak

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
728.61	42.8	3.2	Quasi-peak

Test Data

Frequency [MHz]	Reading [dBuV / m]	Pol.	Height [m]	Correction Factor			Limits [dBuV / m]	Result [dBuV / m]	Margin [dB]
				Antenna	Cable	Amp. Gain			
104.03	56.8	V	1.0	9.9	0.9	31.5	43.5	36.1	7.4
229.10	57.0	H	2.1	9.0	1.8	31.3	46.0	36.5	9.5
526.53	53.7	H	1.8	16.2	3.6	31.4	46.0	42.1	3.9
566.98	53.3	H	2.0	16.8	3.8	31.3	46.0	42.6	3.4
728.61	51.0	H	2.3	19.0	4.1	31.3	46.0	42.8	3.2
847.95	48.9	V	1.0	20.1	4.6	30.9	46.0	42.7	3.3

H : Horizontal, V : Vertical

Result = Reading + Antenna + Cable - Amp.Gain

Remark

The field strength of spurious emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.

Test Results

EUT	Braille Sense OnHand	Measurement Detail	
Model	H318B	Frequency Range	1-25GHz
Channel	Channel 1	Detector function	Peak

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

We have tested two mode (Battery, DC in). The worst mode (DC in) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
4824.00	50.1	3.9	Average

Test Data – 802.11b

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor			Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
					Antenna	Amp. Gain	Cable						
4824.00	40.9	60.0	V	1.2	32.7	34.9	11.4	54.0	74.0	50.1	69.2	3.9	4.8
7236.00	29.3	46.3	V	1.0	37.7	34.8	14.3	54.0	74.0	46.5	63.5	7.5	10.6

Test Data – 802.11g

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor			Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
					Antenna	Amp. Gain	Cable						
4824.00	39.4	53.1	V	1.3	32.7	34.9	11.4	54.0	74.0	48.6	62.3	5.4	11.7
7236.00	32.9	45.9	V	1.4	37.7	34.8	14.3	54.0	74.0	50.1	63.1	3.9	10.9

Restricted band edge test data

Measured frequency range : 2310-2390 MHz, 2483.5-2500 MHz

802.11b

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor			Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
					Antenna	Amp. Gain	Cable						
2378.40	37.2	47.1	H	1.0	28.2	35.3	7.4	54.0	74.0	37.5	47.4	16.5	26.6
2346.50	45.3	55.4	V	1.1	28.2	35.3	7.4	54.0	74.0	45.6	55.7	8.4	18.3

802.11g

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor			Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
					Antenna	Amp. Gain	Cable						
2378.40	36.2	45.5	H	1.0	28.2	35.3	7.4	54.0	74.0	36.5	45.8	17.5	28.2
2346.80	44.3	54.5	V	1.2	28.2	35.3	7.4	54.0	74.0	44.6	54.8	9.4	19.2

Test Results

EUT	Braille Sense OnHand	Measurement Detail	
Model	H318B	Frequency Range	1-25GHz
Channel	Channel 6	Detector function	Peak

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.
We have tested two mode (Battery, DC in). The worst mode (DC in) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
4874.00	49.4	4.6	Average

Test Data – 802.11b

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor			Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
					Antenna	Amp. Gain	Cable						
4874.00	40.2	54.7	V	1.2	32.7	34.9	11.4	54.0	74.0	49.4	63.9	4.6	10.1
7311.00	24.4	38.0	V	1.0	37.7	34.8	14.3	54.0	74.0	41.6	55.2	12.4	18.8

Test Data – 802.11g

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor			Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
					Antenna	Amp. Gain	Cable						
4874.00	37.6	51.0	V	1.1	32.7	34.9	11.4	54.0	74.0	46.8	60.2	7.2	13.8
7311.00	30.1	43.9	V	1.0	37.7	34.8	14.3	54.0	74.0	47.3	61.1	6.7	12.9

Test Results

EUT	Braille Sense OnHand	Measurement Detail	
Model	H318B	Frequency Range	1-25GHz
Channel	Channel 11	Detector function	Peak

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.
We have tested two mode (Battery, DC in). The worst mode (DC in) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
4924.00	44.6	9.4	Average

Test Data – 802.11b

Frequency [MHz]	Reading [dBuV/m] AV / Peak	Pol.	Height [m]	Correction Factor			Limits [dBuV/m] AV / Peak	Result [dBuV/m] AV / Peak	Margin [dB] AV / Peak
				Antenna	Amp. Gain	Cable			
4924.00	33.4 45.3	V	1.1	32.7	34.9	11.4	54.0 74.0	42.6 54.5	11.4 19.5

Test Data – 802.11g

Frequency [MHz]	Reading [dBuV/m] AV / Peak	Pol.	Height [m]	Correction Factor			Limits [dBuV/m] AV / Peak	Result [dBuV/m] AV / Peak	Margin [dB] AV / Peak
				Antenna	Amp. Gain	Cable			
4924.00	35.4 48.6	V	1.3	32.7	34.9	11.4	54.0 74.0	44.6 57.8	9.4 16.2
7386.00	25.1 38.6	V	1.5	37.7	34.8	14.3	54.0 74.0	42.3 55.8	11.7 18.2

Restricted band edge test data

Measured frequency range : 2310-2390 MHz, 2483.5-2500 MHz

802.11b

Frequency [MHz]	Reading [dBuV / m] AV / Peak	Pol.	Height [m]	Correction Factor			Limits [dBuV / m] AV / Peak	Result [dBuV / m] AV / Peak	Margin [dB] AV / Peak
				Antenna	Amp. Gain	Cable			
No emission were detected at a level greater than 20dB below limit.									

802.11g

Frequency [MHz]	Reading [dBuV / m] AV / Peak	Pol.	Height [m]	Correction Factor			Limits [dBuV / m] AV / Peak	Result [dBuV / m] AV / Peak	Margin [dB] AV / Peak
				Antenna	Amp. Gain	Cable			
No emission were detected at a level greater than 20dB below limit.									

2.1.6 AC Conducted Emissions

Test Location

Shielded Room

Frequency Range of Measurement

150 kHz to 30 MHz

Instrument Settings

IF Band Width: 9 kHz

Test Procedures

The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m.

Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit

- 15.207(a)

Frequency (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.

Test Results

The requirements are:

☒ Complies

802.11b(Worst Case)

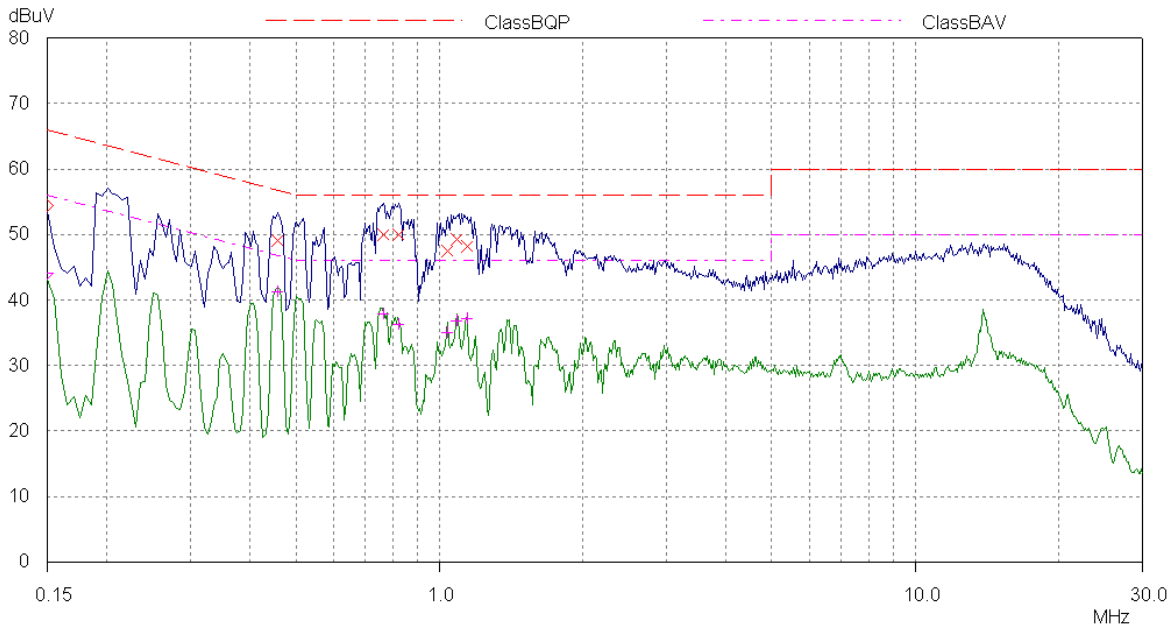
Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
0.45	41.2	5.7	Average

Test Data – 802.11b(Worst Case)

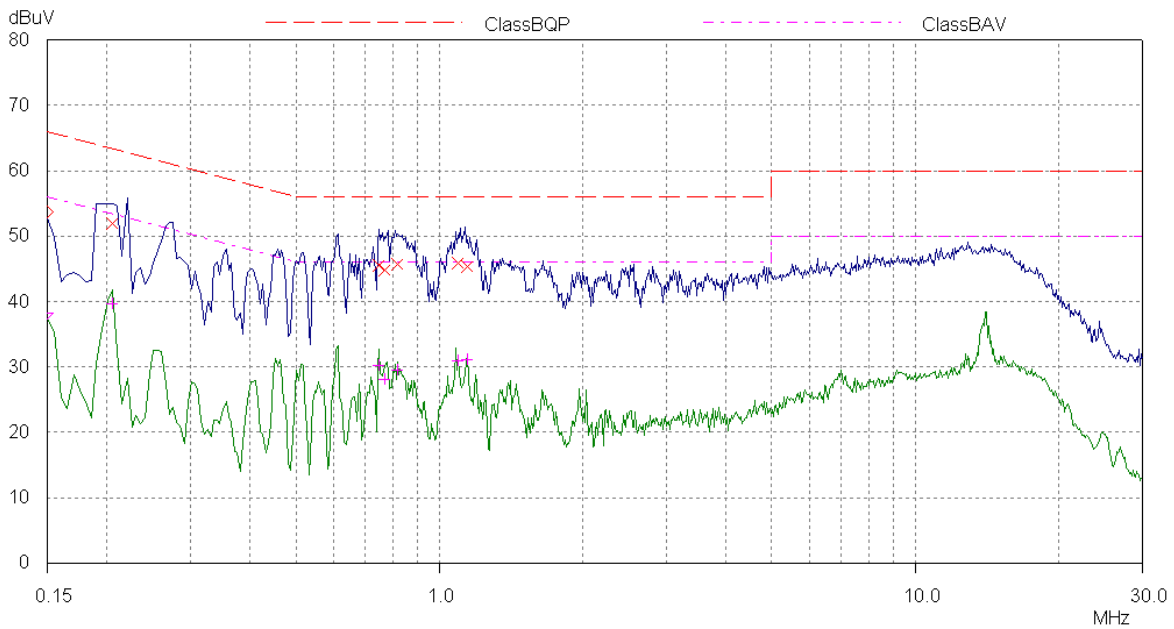
Frequency	Correction		Line	Quasi-peak				Average			
	Factor			Limit	Reading	Result	Margin	Limit	Reading	Result	Margin
	LISN	Cable									
[MHz]											
0.45	10.1	0.1	H	56.9	38.8	49.0	7.9	46.9	31.0	41.2	5.7
0.76	10.0	0.1	H	56.0	39.9	50.0	6.0	46.0	27.8	37.9	8.1
0.82	9.9	0.1	H	56.0	39.9	49.9	6.1	46.0	26.3	36.3	9.7
1.03	9.9	0.1	H	56.0	37.5	47.5	8.5	46.0	25.1	35.1	10.9
1.08	9.9	0.1	H	56.0	39.2	49.2	6.8	46.0	26.8	36.8	9.2
1.14	9.9	0.1	H	56.0	38.2	48.2	7.8	46.0	27.1	37.1	8.9

H : HOT, N : NEUTRAL

[HOT]



[NEUTRAL]





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APPENDIX A – Test Equipment Used For Tests

	Name of Equipment	Manufacturer	Model No.	Serial No.	Due Date
1	Signal Analyzer	Agilent	N9020A	MY48011598	2010-10-30
2	Spectrum Analyzer	Rohde & Schwarz	FSP-30	100994	2010-10-30
3	EMI Test Receiver	Rohde & Schwarz	ESVS30	826638/008	2010-08-10
4	ULTRA Broadband Antenna	Rohde & Schwarz	HL562	361324/014	2011-11-18
5	LOOP ANTENNA	EMCO	6502	9107-2652	2010-10-13
6	System Power Supply	HP	6032A	3440A-10521	2010-07-07
7	EPM Series Power Meter	HP	E4418A	GB38272734	2010-10-30
8	Power Sensor	HP	8487A	3318A03524	2010-07-09
9	Audio Analyzer	HP	8903B	2747A03432	2010-11-03
10	ESG-D Series Signal Generator	Agilent	E4432B	US40054094	2010-10-30
11	SYNTHESIZED SWEEPER	HP	8341B	2819A01563	2010-10-30
12	Modulation Analyzer	HP	8901B	3438A05228	2010-11-06
13	Attenuator	HP	8494A	3308A33351	2010-11-02
14	Temp&Humi Chamber	Kunpoong	KP-1000	2002KP050041	2011-01-25
15	DC POWER SUPPLY	Agilent	E3632A	MY40011638	2010-10-30
16	EMC Analyzer	Agilent	E7405A	MY45110859	2011-01-25
17	Horn Antenna	ETS-Lindgren	3115	00078894	2010-12-18
18	Horn Antenna	ETS-Lindgren	3115	00078895	2010-12-18
19	Dipole Antenna	SCHWARZBECK	VHA 9103	VHA91032557	2010-11-27
20	Dipole Antenna	SCHWARZBECK	UHA 9105	UHA91052417	2010-11-27
21	OPT H64 AMPLIFIER	HP	8447F	3113A06814	2011-03-31
22	PREAMPLIFIER	Agilent	8449B	3008A02307	2010-10-30
23	Radio Communication Tester	Rohde & Schwarz	CMU200	106765	2011-02-23
24	Band Reject Filter	Wainwright Instruments	WRCG824	-	2011-04-01
25	Band Reject Filter	Wainwright Instruments	WRCG1750	-	2011-04-01
26	Field Strength Meter	Rohde & Schwarz	ESHS30	862024/001	2011-03-08
27	LISN	Rohde & Schwarz	ESH3-Z5	100207	2010-12-15
28	LISN	EMCO	3825/2	9206-1971	2010-12-16
29	DC POWER SUPPLY	Agilent	E3632A	MY40011638	2010-10-30

APPENDIX B – MPE CALCULATION

* * MPE Calculations * *

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the user. The MPE calculation for this exposure is shown below.

$EIRP = P + G$ $EIRP = 8.70 \text{ dBm}$	Where, P = Power input to the antenna (mW) G = Power gain of the antenna (dBi)
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The numeric gain(G) of the antenna with a gain specified in dB is determined by:

$$G = \text{Log}^{-1} (\text{dB antenna gain} / 10)$$

$$G = \text{Log}^{-1} (-1 / 10)$$

$$G = 0.79$$

Power density at the specific separation:

$S = PG / (4R^2 \pi)$ $S = (7.41 * 0.79) / (4 * 20^2 * \pi)$ $S = 0.001 \text{ mW/cm}^2$	Where, S = Maximum power density (mW/cm^2) P = Power input to the antenna (mW) G = Numeric power gain of the antenna R = Distance to the center of the radiation of the antenna (20cm = limit for MPE)
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The Maximum permissible exposure (MPE) for the general population is 1 mW/cm^2 .
The power density at 20cm does not exceed the 1 mW/cm^2 limit.

Estimated safe separation:

$R = \sqrt{PG / 4\pi}$ $R = \sqrt{(7.41 * 0.79 / 4\pi)}$ $R = 0.68 \text{ cm}$	Where, P = Power input to the antenna (mW) G = Numeric power gain of the antenna R = Distance to the center of the radiation of the antenna (20cm = limit for MPE)
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