Lab Code: 200167-0

FCC PART 15.247

MEASUREMENT AND TEST REPORT

For

Dust Networks, Inc.

30695 Huntwood Ave.
Hayward, CA 94544

FCC ID: SJC-M2135

This Report Concerns:	Equipment Type:
☒ Original Report	2.4GHz Mote Frequency Hopping System Module

Test Engineer:	Dan Coronia
Report Number:	R0611013-247
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Reviewed By:	VP of Engineering: Hans Mellberg
Prepared By: (12)	Bay Area Compliance Laboratories Corp. (BACL) 1274 Anvilwood Avenue Sunnyvale, CA 94089 Tel: (408) 732-9162 Fax: (408) 732 9164

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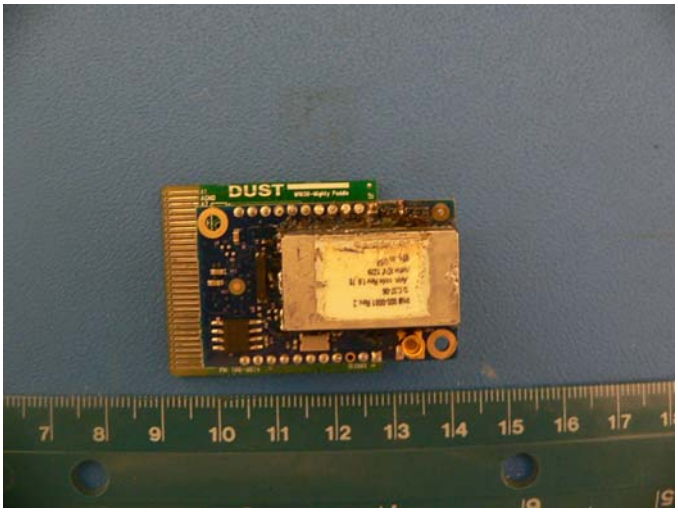
GENERAL INFORMATION

Product Description for Equipment Under Test (EUT)

This measurement and test report has been compiled by Bay Area Compliance Laboratories on behalf of *Dust Networks, Inc.* and their product, FCC ID: SJC-M2135, or the "EUT" as referred to in this report. The EUT is a 2.4GHz Mote, Model # M2135, Frequency Hopping System Module which is designed to act like a network interface card and features standard serial connection in order to make it compatible with many possible mobile devices. It is designed for use in battery powered or line-powered wireless devices and utilizes Time-Synchronized Mesh Protocol is channel hopping device via direct-sequence spread spectrum (DSSS). The EUT operates at the frequency range of 2.4000GHz – 2.4835GHz, with the maximum conducted output power of 38mW.

** The test data gathered are from a production sample, P/N: 800-0081 Rev2, provided by the manufacturer.*

EUT Photo



Please see Exhibit C for additional photos

Mechanical Description

The *Dust Networks, Inc.* product, model: *M2135*, or the "EUT" as referred to in this report, is a *2.4 GHz Mote, Frequency Hopping System module*, which measures approximately 39.9 mmL x 24.4 mmW x 12.65 mmH.*

**The test data gathered are from a production sample, P/N: 800-0081 Rev2, provided by the manufacturer.*

Objective

This modular transmitter approval report is prepared on behalf of *Dust Networks, Inc.* in accordance with Part 2, Subpart J, Part 15, Subparts A, B and C.

Related Submittal(s)/Grant(s)

No Related Submittals

Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-2003.

Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the values range from ±2.0 dB for Conducted Emissions tests and ±4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL.

Detailed instrumentation measurement uncertainties can be found in BACL report QAP-018.

Test Facility

The three Semi-Anechoic Chambers (two 5 m and one 10 m) utilized by BACL to collect radiated and conducted emission measurement are located within their Headquarters at 1274 Anvilwood Avenue, Sunnyvale, California, USA.

The test site at BACL has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2003.

The Federal Communications Commission and Voluntary Control Council for Interference has the reports on file and is listed under FCC file 31040/SIT 1300F2 and VCCI Registration No.: C-1298 and R-1234. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The current scope of accreditations can be found at http://ts.nist.gov/ts/htdocs/210/214/scopes/2001670.htm

SYSTEM TEST CONFIGURATION

Justification

The EUT was configured for testing according to ANSI C63.4-2003.

The EUT was tested in the normal (native) operating mode to represent *worst*-case results during the final qualification test.

Special Accessories

As shown in following test block diagram, all interface cables used for compliance testing are shielded.

Schematics / Block Diagram

Please refer to Appendix A.

Equipment Modifications

No modifications were made to the EUT.

Local Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
DELL	Laptop	D600	Cn-0g5152-48643-46l-1133

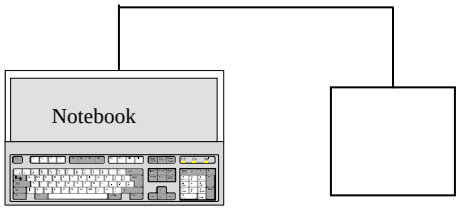
External I/O Cabling List and Details

Cable Description	Length (M)	Port/From	To
Serial Cable	1.0	Laptop Serial Port	EUT Serial Port

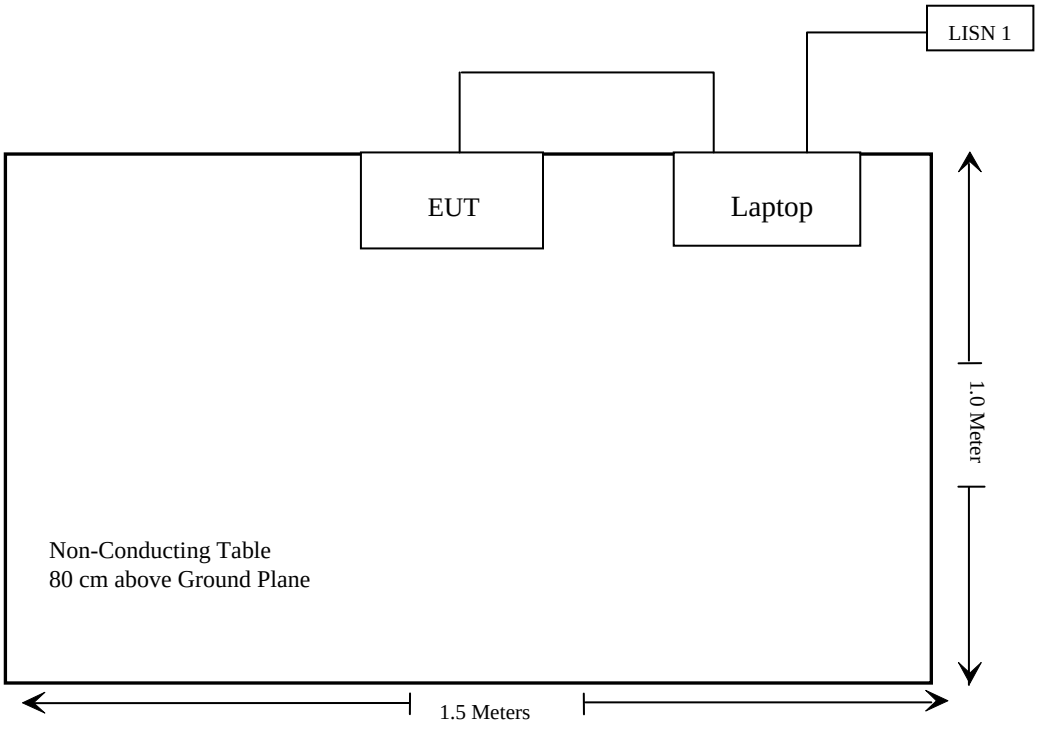
Power Supply Information

Manufacturer	Description	Model	Serial Number
DVE	AC Adaptor	DSA-0151A-05 A	N/A

Configuration of Test System



Test Setup Block Diagram



SUMMARY OF TEST RESULTS FOR FCC PART 15.247

FCC RULES	DESCRIPTION OF TEST	RESULT
§ 15.247 (b)(4) § 2.1091	RF Safety Requirements	Compliant
§15.203	Antenna Requirement	Compliant
§ 15.205	Restricted Bands	Compliant
§15.207 (a)	Conducted Emission	N/A
§15.209	Radiated Emission	Compliant
§15.247 (a) (1)	Hopping Channel Separation	Compliant
§15.247 (a) (1)	Channel Bandwidth	Compliant
§15.247 (a) (1) (iii)	Number of Hopping Frequencies Used	Compliant
§15.247 (a) (1) (iii)	Dwell Time of Each Frequency within a period of 0.4 seconds multiplied by the number of hopping channels employed	Compliant
§15.247 (b) (1)	Maximum Peak Output Power	Compliant
§ 2.1051	Spurious Emission at Antenna Port	Compliant
§ 15.247 (d)	100 kHz Bandwidth of Frequency Band Edge	Compliant

§ 15.247 (e)(i) and § 2.1091 - RF EXPOSURE

According to §15.247(e)(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

MPE Prediction

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$S = PG/4\pi R^2$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Base:

Maximum peak output power at antenna input terminal: 15.79 (dBm)
Maximum peak output power at antenna input terminal: 38 (mW)
Prediction distance: 20 (cm)
Predication frequency: 2478.5 (MHz)
Antenna Gain (typical): 2 (dBi)
Maximum antenna gain: 1.58 (numeric)
Power density at predication frequency at 20 cm: 0.0119(mW/cm^2)
MPE limit for uncontrolled exposure at prediction frequency: 1.0 (mW/cm^2)

Test Result

The predicted power density level at 20 cm is 0.0119 mW/cm^2. This is below the uncontrolled exposure limit of 1 mW/cm^2 at 2478.5 MHz. The EUT is used at least 20cm away from user's body. It is determined as mobile equipment.

ANTENNA REQUIREMENT

Applicable Standard

As per FCC §15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

As per FCC §15.247 (b) (4)

Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Result

The antenna requirement is **compliant** as the EUT does not have an integral antenna and final measurement will be required of the OEM. The antenna port is standard a MMCX-compatible male connector and designed to be plugged into the OEM provided antenna. Product will require retesting by OEM when integrated in their product to ensure continued compliance. Testing was performed with an antenna designed to represent worst-case results with a maximum gain of 2 dBi.

Antenna Specifications

A MMCX-compatible male connector is provided on board for the antenna connection. The antenna must meet specifications in Table 8.

Table 8 Antenna Specifications

Parameter	Value
Frequency range	2.4–2.4835 GHz
Impedance	50 Ω
Gain	+2 dBi maximum
Pattern	Omni-directional
Maximum VSWR	3:1
Connector	MMCX*
* The M2135-1 can accommodate the following RF mating connectors: • MMCX straight connector such as Johnson 135-3402-001, or equivalent • MMCX right angle connector such as Tyco 1408149-1, or equivalent	

When the mote is placed inside an enclosure, the antenna should be mounted such that the radiating portion of the antenna protrudes from the enclosure, and connected using a MMCX connector on a coaxial cable. For optimum performance, allow the antenna to be positioned vertically when installed.

§15.207 – CONDUCTED EMISSIONS

Applicable Standard

According to FCC §15.207 (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of emission (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 Result: NA, the EUT does not connect to the public utility and is designed to use battery or be line-powered (DC).

§15.205 & §15.209 - RADIATED EMISSIONS

Applicable Standard:

FCC §15.205 Restricted bands of operation

(a) Except as shown in 15.205 paragraphs (d), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	MHz	GHz	GHz
0.090 – 0.110	8.291 – 8.294	16.69475 – 16.69525	156.7 – 156.9	1435 – 1626.5	3.332 – 3.339	10.6 – 12.7
0.495 – 0.505	8.362 – 8.366	25.5 – 25.67	162.0125 –167.17	1645.5 – 1646.5	3.3458 – 3.358	13.25 – 13.4
2.1735 – 2.1905	8.37625 – 8.38675	37.5 – 38.25	167.72 – 173.2	1660 – 1710	3.600 – 4.400	14.47 – 14.5
4.125 – 4.128	8.41425 – 8.41475	73 – 74.6	240 – 285	1718.8 – 1722.2	4.5 – 5.15	15.35 – 16.2
4.17725 – 4.17775	12.29 – 12.293	74.8 – 75.2	322 – 335.4	2200 – 2300	5.35 – 5.46	17.7 – 21.4
4.20725 – 4.20775	12.51975 – 12.52025	108 – 121.94	399.9 – 410	2310 – 2390	7.25 – 7.75	22.01 – 23.12
6.215 – 6.218	12.57675 – 12.57725	123 – 138	608 – 614	2483.5 – 2500	8.025 – 8.5	23.6 – 24.0
6.26775 – 6.26825	13.36 – 13.41	149.9 – 150.05	960 – 1240	2690 – 2900	9.0 – 9.2	31.2 – 31.8
6.31175 – 6.31225	16.42 – 16.423	156.52475 – 156.52525	1300 – 1427	3260 – 3267	9.3 – 9.5	36.43 – 36.5
						Above 38.6

(b) Except as provided in 15.205 paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e), regardless of the field strength limits specified elsewhere in this Subpart, the provisions of this Section apply to emissions from any intentional radiator.

☒ **Compliant** ☐ **N/A**

Applicable Standard: FCC §15.209 Radiated emission limits, general requirements.

(a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency	Field Strength	Measurement Distance
(MHz)	**(microvolts/meter)**	**(meters)**
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

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

(b) In the emission table above, the tighter limit applies at the band edges.

☒ **Compliant** ☐ **N/A**

Test Setup

The radiated emissions tests were performed in the 3-meter semi-anechoic test chamber, using the setup in accordance with ANSI C63.4-2003. The specification used was the FCC 15 Subpart C limits.

Spectrum Analyzer Setup

According to FCC Rules, 47 CFR §15.33 (a) (1), the system was tested to 25GHz.

During the radiated emission test, the spectrum analyzer was set with the following configurations:

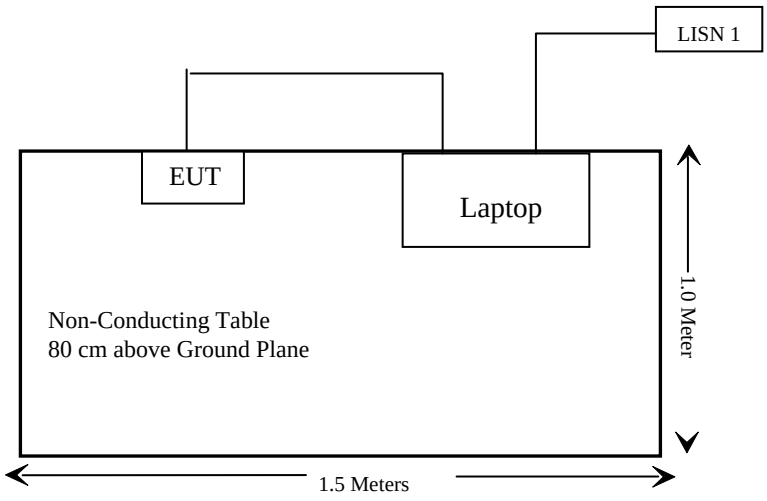
Frequency Range	***RBW***	***Video B/W***
Below 30MHz	10KHz	10KHz
30 – 1000MHz	100KHz	100KHz
Above 1000MHz	1MHz	1MHz

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
HP	Analyzer, Spectrum	8565EC	3946A00131	2006-01-11
Sonoma Instrument	Amplifier Broadband (10 KHz - 2500 MHz)	317	260407	2006-03-20
HP	Amiplifier, Pre	8449B	3147A00400	2006-08-21
A.R.A	Antenna, Horn, DRG	DRG-118/A	1132	2006-08-17
Sunol Science	Antenna	JB3	A020106-3/S006628	2006-02-14

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Test Setup Block Diagram



Environmental Conditions

Temperature:	25°C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

**The testing was performed by Dan Coronia on 2006-11-07.*

Test Procedure

Maximizing procedure was performed on the six (6) highest emissions to ensure EUT compliance is with all installation combinations.

All data was recorded in the peak detection mode. Quasi-peak readings was performed only when an emission was found to be marginal (within -4 dB of specification limits), and are distinguished with a "**Qp**" in the data table.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. - Class B Limit

Summary of Test Results

According to the recorded data in following tables, the EUT test data are within the measurement uncertainty of ±4.0dB, and had the worst margin of:

-5.9 dB at **4810 MHz** in the **Vertical** polarization, **Low** Channel, 3 meters

-5.6 dB at **4880.00 MHz** in the **Vertical** polarization, **Middle** Channel, 3 meters

-8.6 dB at **4950.00 MHz** in the **Vertical** polarization, **High** Channel, 3 meters

3 Meters Radiated Emission Test Data

Low Channel

Frequency MHz	Reading dBuV/m	Direction Degree	Height Meter	Polar. H / V	Antenna Factor dB/m	Cable loss dB	Amplifier dB	Correction Reading dBuV/m	15.247 Limit (dBuV/m)	15.247 Margin	Comments
2405.00	101.2	161	1.3	V	28.7	2.7	35.8	96.7			Fund/Peak
2405.00	100.5	319	1.5	H	28.7	2.7	35.8	96.0			Fund/Peak
2405.00	105.1	40	1.5	V	28.7	2.7	35.8	100.6			Ave
2405.00	109.8	300	1.5	H	28.7	2.7	35.8	105.3			Ave
4810.00	46.6	211	1.5	V	32.5	3.8	34.8	48.1	54	-5.9	Ave
7215.00	41.6	218	1.6	H	36.7	4.7	34.9	48.1	54	-5.9	Ave
4810.00	44.2	66	1.3	H	32.5	3.8	34.8	45.7	54	-8.3	Ave
9620.00	38.3	220	1.5	V	38.1	5.5	36.9	45.0	54	-9.0	Ave
9620.00	36.9	220	1.4	H	38.1	5.5	36.9	43.6	54	-10.4	Ave
7215.00	33.5	209	1.4	V	36.7	4.7	34.9	40.0	54	-14.0	Ave
4810.00	60.3	211	1.5	V	32.5	3.8	34.8	61.8	74	-12.2	Peak
7215.00	53.6	257	1.4	V	36.7	4.7	34.9	60.1	74	-13.9	Peak
4810.00	53.5	371	1.4	H	32.5	3.8	34.8	55.0	74	-19.0	Peak
7215.00	47.3	147	1.4	H	36.7	4.7	34.9	53.8	74	-20.2	Peak
9620.00	46.2	220	1.4	H	38.1	5.5	36.9	52.9	74	-21.1	Peak
9620.00	45.5	177	1.5	V	38.1	5.5	36.9	52.2	74	-21.8	Peak

Middle Channel

Frequency MHz	Reading dBuV/m	Direction Degree	Height Meter	Polar. H / V	Antenna Factor dB/m	Cable loss dB	Amplifier dB	Correction Reading dBuV/m	15.247 Limit (dBuV/m)	15.247 Margin	Comments
2440.00	102.3	225	1.3	V	28.7	2.7	35.8	97.8			Fund/Peak
2440.00	101.5	270	1.5	H	28.7	2.7	35.8	97.0			Fund/Peak
2440.00	105.5	225	1.3	V	28.7	2.7	35.8	101.0			Ave
2440.00	110.7	270	1.5	H	28.7	2.7	35.8	106.2			Ave
4880.00	46.8	200	1.3	V	32.5	3.9	34.8	48.4	54	-5.6	Ave
4880.00	45.8	220	1.4	H	32.5	3.9	34.8	47.4	54	-6.6	Ave
7320.00	40.5	70	1.4	H	36.7	4.8	35.1	46.9	54	-7.1	Ave
9760.00	39.5	220	1.4	H	38.1	5.5	36.7	46.5	54	-7.5	Ave
4880.00	64.7	161	1.7	V	32.5	3.9	34.8	66.3	74	-7.7	Peak
9760.00	38.7	200	1.6	V	38.1	5.5	36.7	45.7	54	-8.3	Ave
7320.00	56.3	356	1.3	V	36.7	4.8	35.1	62.7	74	-11.3	Peak
7320.00	34.6	356	1.3	V	36.7	4.8	35.1	41.0	54	-13.0	Ave
7320.00	54.0	249	1.6	H	36.7	4.8	35.1	60.4	74	-13.6	Peak
9760.00	49.5	115	2.0	H	38.1	5.5	36.7	56.5	74	-17.5	Peak
4880.00	53.0	307	1.5	H	32.5	3.9	34.8	54.6	74	-19.4	Peak
9760.00	47.0	291	1.6	V	38.1	5.5	36.7	54.0	74	-20.0	Peak

High Channel

Frequency	Reading	Direction	Height	Polar.	Antenna Factor	Cable loss	Amplifier	Correction Reading	15.247	15.247	
MHz	dBuV/m	Degree	Meter	H / V	dB/m	dB	dB	dBuV/m	Limit (dBuV/m)	Margin	Comments
2475.00	101.3	115	2.1	V	28.7	2.7	35.8	96.9			Fund/Peak
2475.00	100.1	180	1.3	H	28.7	2.7	35.8	95.6			Fund/Peak
2475.00	100.3	120	1.5	V	28.7	2.7	35.8	95.8			Ave
2475.00	100.0	145	1.3	H	28.7	2.7	35.8	95.5			Ave
4950.00	44.0	169	1.7	V	32.5	3.9	35.0	45.4	54	-8.6	Ave
9900.00	36.7	256	1.7	H	38.1	5.6	36.4	44.0	54	-10.0	Ave
4950.00	62.5	186	1.6	V	32.5	3.9	35.0	63.9	74	-10.1	Peak
9900.00	35.8	198	1.5	V	38.1	5.6	36.4	43.1	54	-10.9	Ave
7425.00	36.5	184	1.8	V	36.7	4.8	35.6	42.3	54	-11.7	Ave
7425.00	34.5	123	1.7	H	36.7	4.8	35.6	40.3	54	-13.7	Ave
7425.00	52.7	137	1.4	V	36.7	4.8	35.6	58.5	74	-15.5	Peak
4950.00	35.7	141	2.0	H	32.5	3.9	35.0	37.1	54	-16.9	Ave
9900.00	48.8	154	1.5	V	38.1	5.6	36.4	56.1	74	-17.9	Peak
9900.00	47.0	206	1.5	H	38.1	5.6	36.4	54.3	74	-19.7	Peak
7425.00	46.7	220	1.6	H	36.7	4.8	35.6	52.5	74	-21.5	Peak
4950.00	50.2	126	1.7	H	32.5	3.9	35.0	51.6	74	-22.4	Peak

Note:

FUND: Fundamental
AVE: Average

§15.247 (a) (1) - HOPPING CHANNEL SEPARATION

Applicable Standard

According to §15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Measurement Procedure

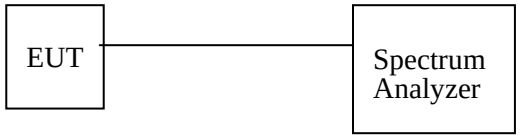
1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Position the EUT on a bench without connection to measurement instrument Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the Max-Hold function record the separation of two adjacent channels.
4. Measure the frequency difference of these two adjacent channels by SA MARK function, and then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

Test Equipment

Manufacturer	Description	Model Number	Serial Number	Calibration Date
HP	Analyzer, Spectrum	8565EC	3946A00131	2006-01-11

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Test Setup Diagram



Environmental Conditions

Temperature:	25°C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

**The testing was performed by Dan Coronia on 2006-11-07*

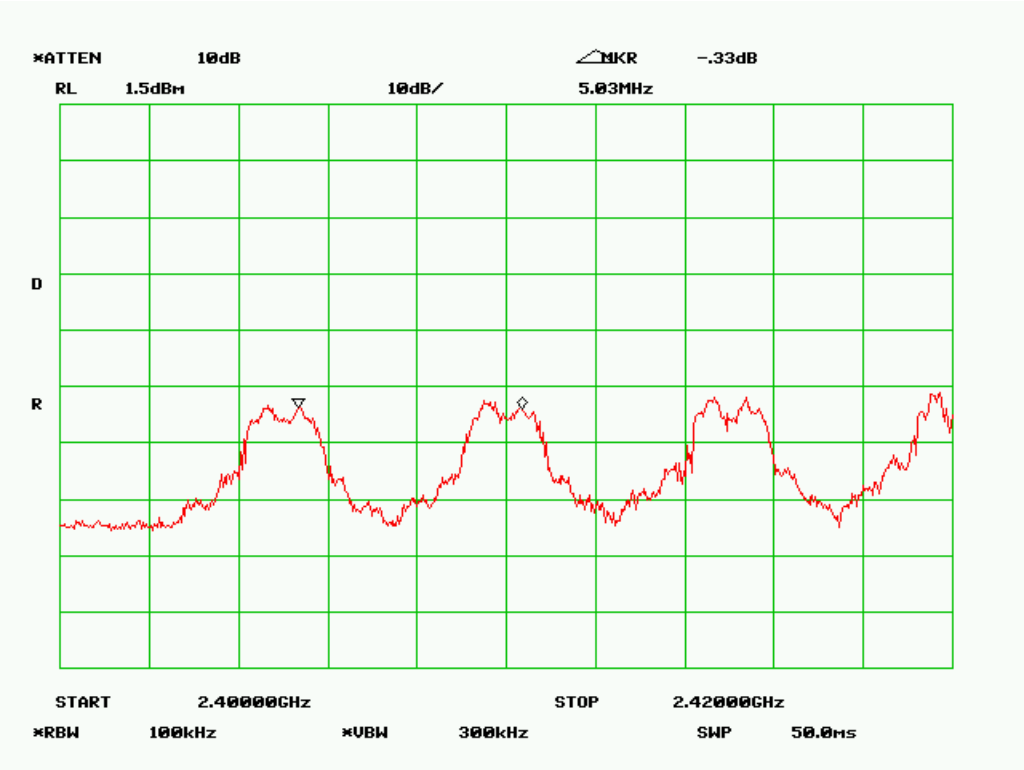
Measurement Results

Channel	Frequency (MHz)	Channel Separation (MHz)	Limit > MHz
Low	2405.0	5.03	1.73
Mid	2440.0	5.00	1.78
High	2475.0	5.17	1.90

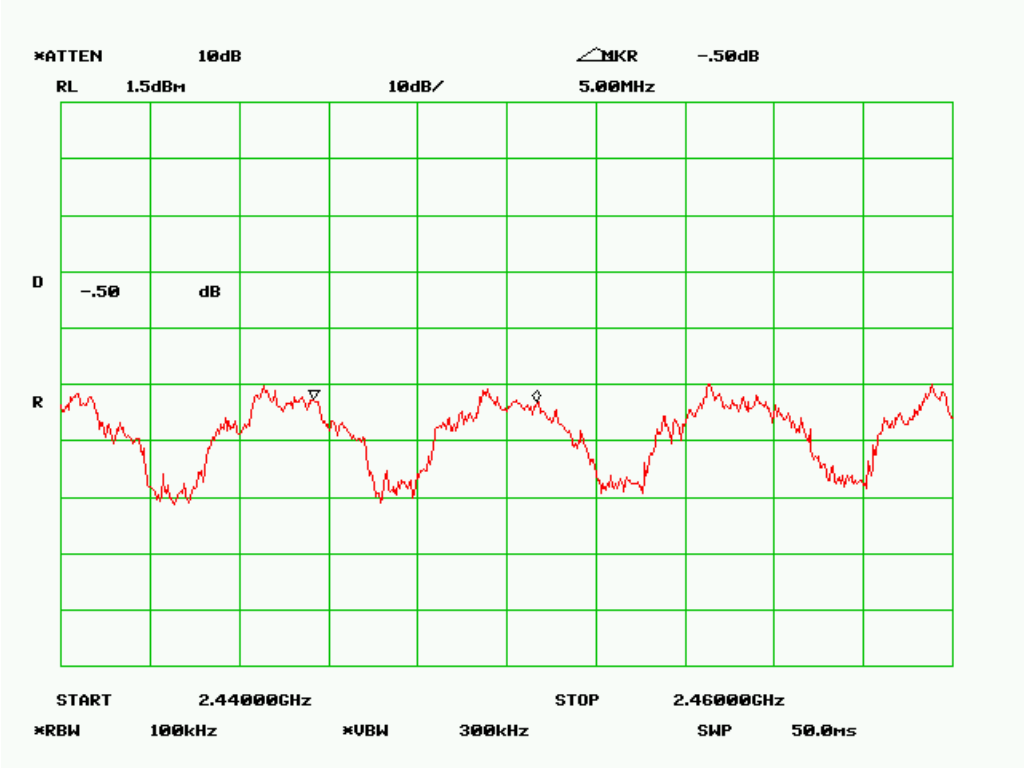
Note: The test was conducted at both hopping enable and disable mode, only the worst test data were presented.

Plots of Hopping Channel Separation

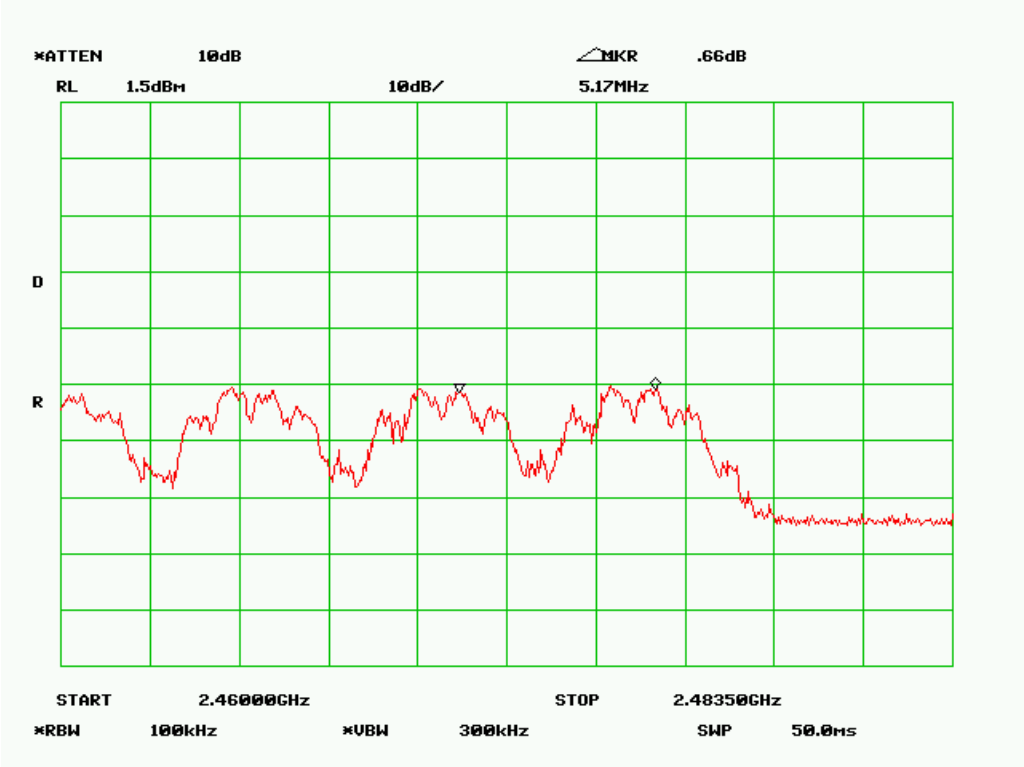
Low Channel



Middle Channel



High Channel



§15.247 (a) (1) - HOPPING CHANNEL BANDWIDTH

Applicable Standard

According to §15.247(a)(l), the maximum 20 dB bandwidth of the hopping channel shall be presented.

Measurement Procedure

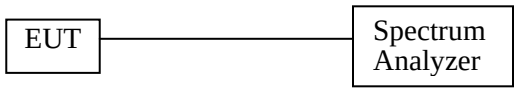
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

Test Equipment

Manufacturer	Description	Model Number	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2006-03-06

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Test Setup Diagram



Environmental Conditions

Temperature:	25°C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

**The testing was performed by Dan Coronia on 2006-11-07.*

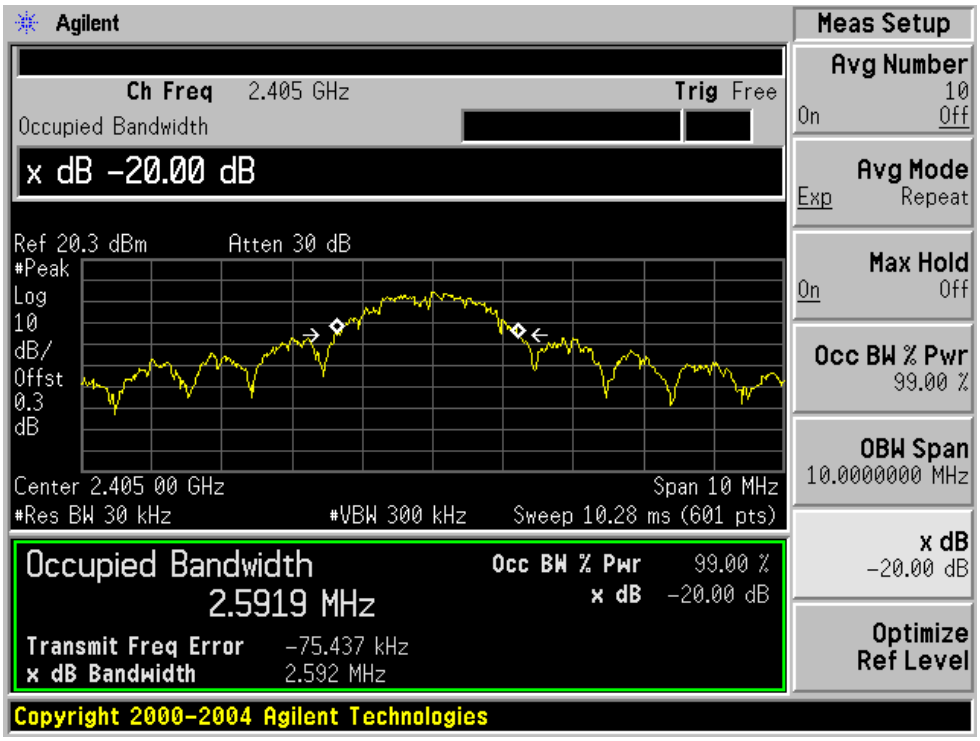
Measurement Result

Channel	Frequency MHz	20 dB Channel Bandwidth (kHz)
Low	2405	2592
Mid	2440	2676
High	2475	2857

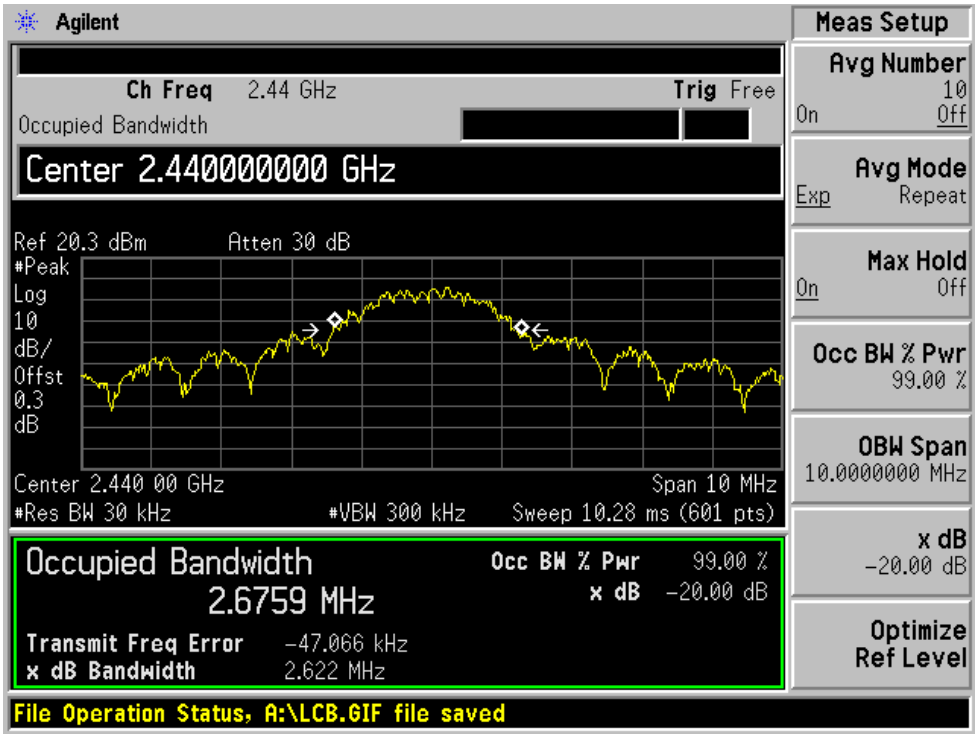
Please refer to the following plots for specific test data

Plot of Channel Bandwidth

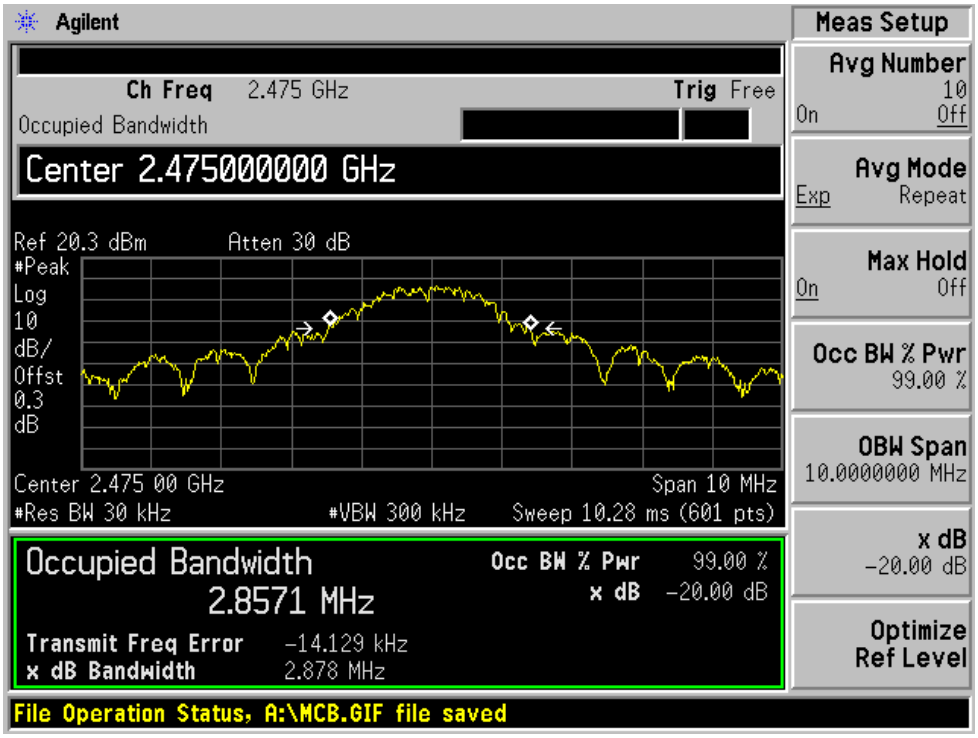
Low Channel



Middle Channel



High Channel



§15.247 (a) (1) (iii) - NUMBER OF HOPPING FREQUENCY USED

Applicable Standard

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

Measurement Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Enable hopping mode. Position the EUT on the bench without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set the SA on Max-Hold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
4. Set the SA on View mode and then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

Test Equipment

Manufacturer	Description	Model Number	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2006-03-06

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Test Setup Block Diagram

Environmental Conditions

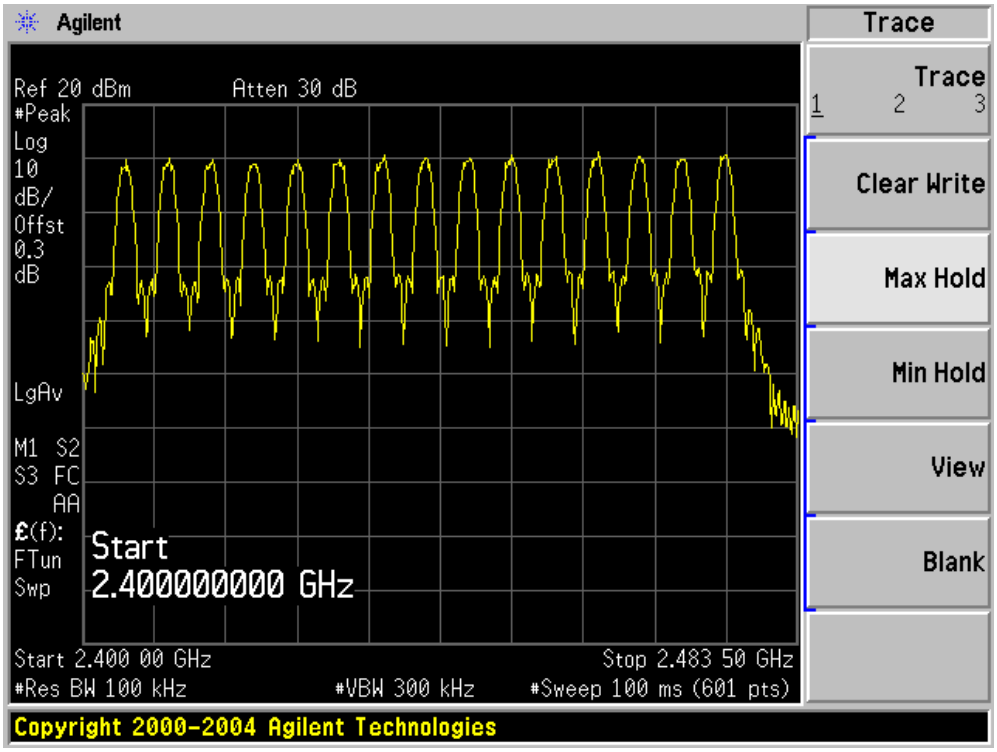
Temperature:	25°C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

**The testing was performed by Dan Coronia on 2006-11-07.*

Measurement Results

Measurement	Limit (≥ 15)	Result
15	15	Compliant

Number of Hopping Frequencies Used Plot



§15.247 9 (a) (1) (iii) - DWELL TIME

Applicable Standard

According to §15.247 (a)(1)(iii), the average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Measurement Procedure

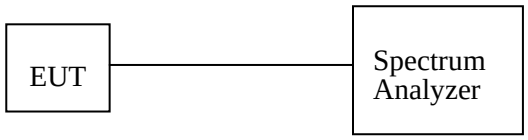
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Enable hopping mode. Position the EUT was set without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
5. Repeat above procedures until all frequencies measured were complete.

Test Equipment

Manufacturer	Description	Model Number	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2006-03-06

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Test Setup Diagram



Environmental Conditions

Temperature:	25°C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

**The testing was performed by Dan Coronia on 2006-11-07*

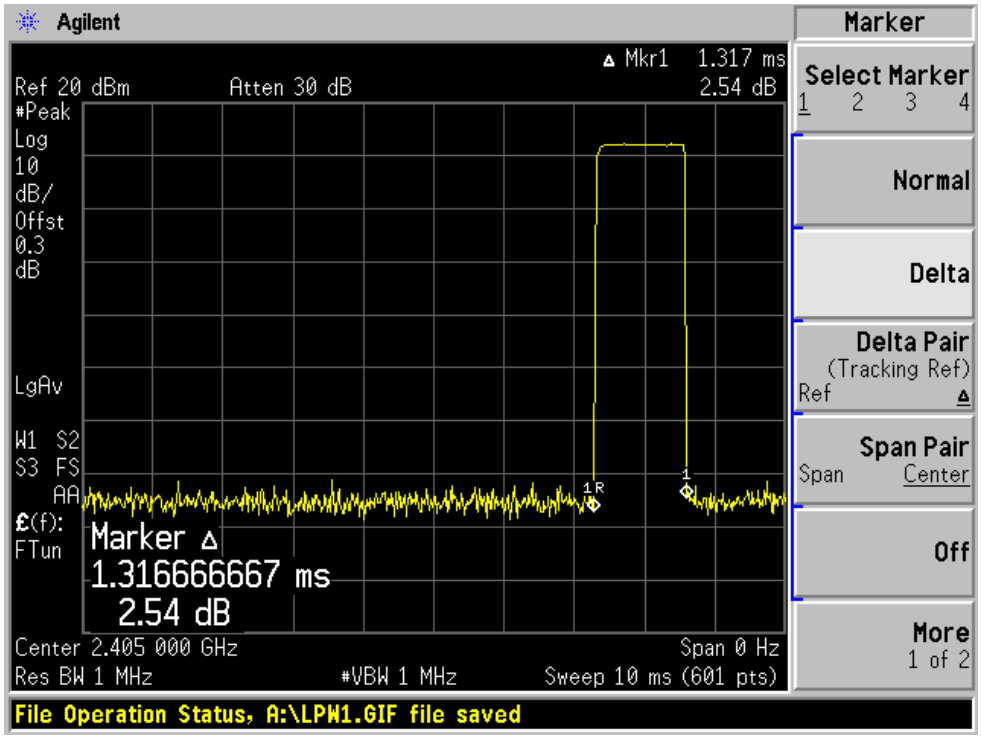
Measurement Results

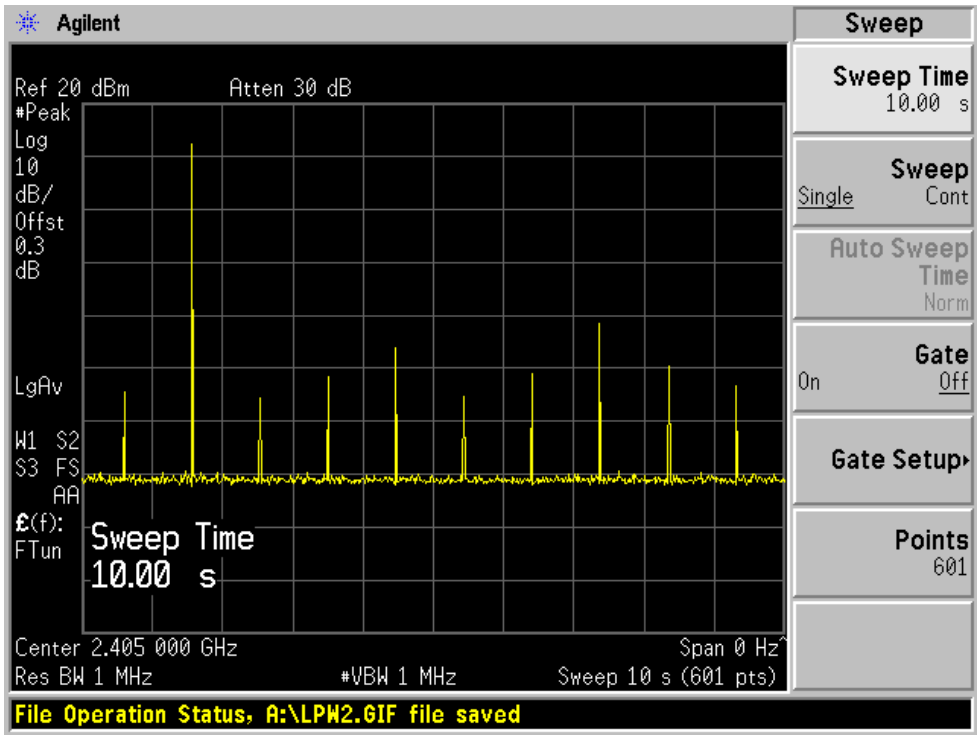
Channel	Frequency (MHz)	Pulse Width (ms)	Pulse Quantity	Dwell Time (s)	Limit (s)
Low	2405	1.317	1	0.001	0.4
Mid	2440	1.283	1	0.001	0.4
High	2475	1.233	1	0.001	0.4

Plots of Dwell Time

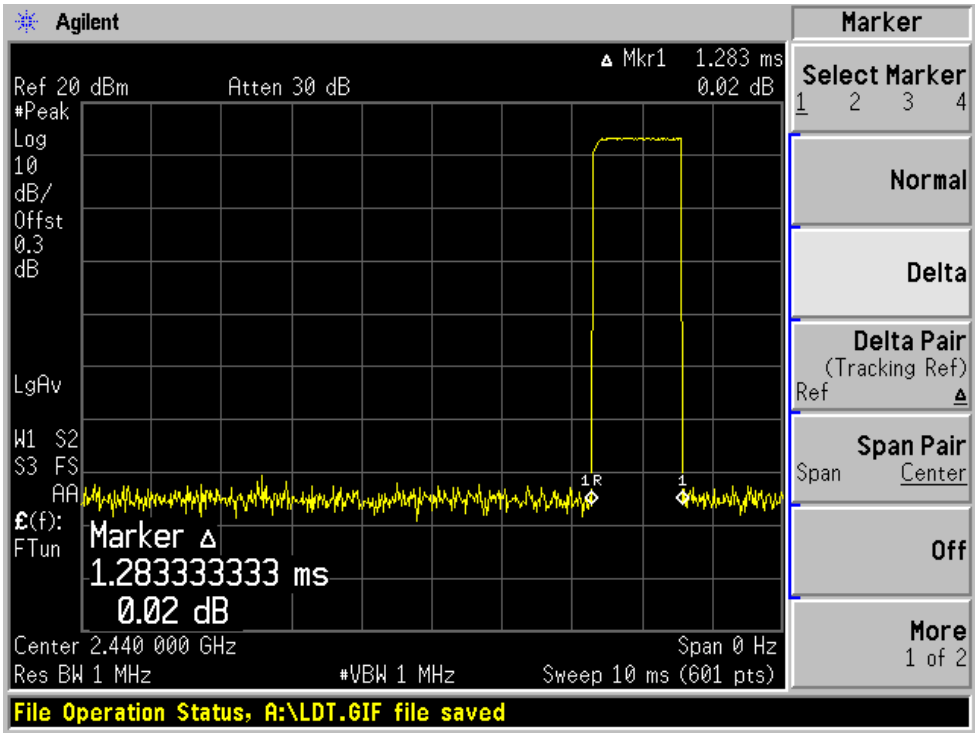
Please refer the following plots.

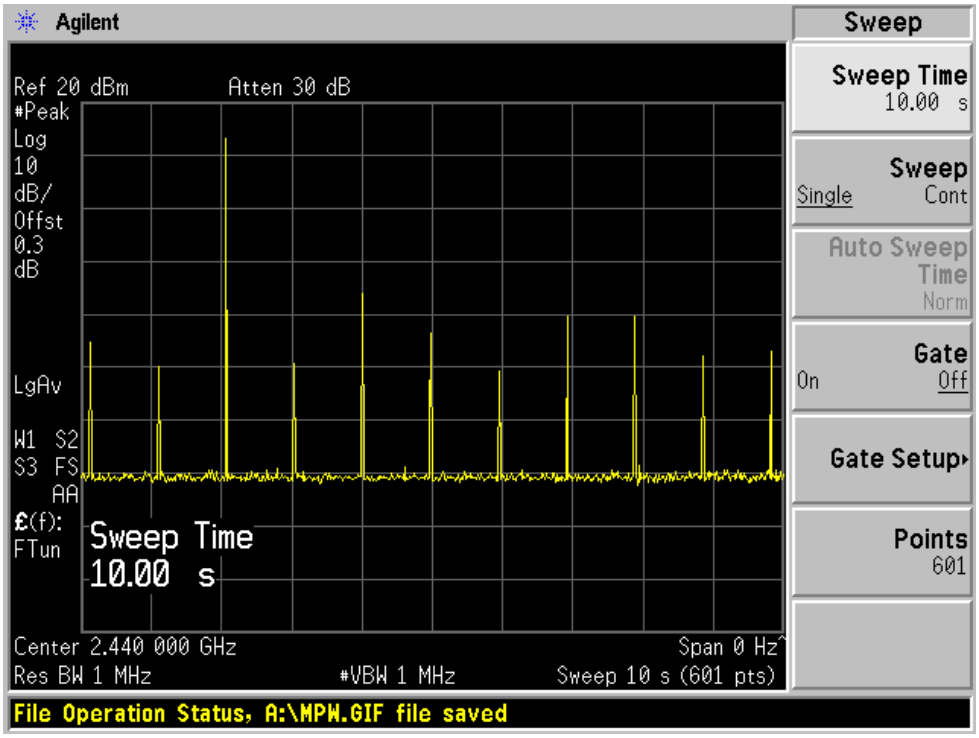
Low Channel


Agilent
Marker
Mkr1 1.317 ms
2.54 dB
Ref 20 dBm
Atten 30 dB
#Peak
Log
10
dB/
Offst
0.3
dB
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Marker Δ
1.316666667 ms
2.54 dB
Center 2.405 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 1 MHz
Sweep 10 ms (601 pts)
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2
File Operation Status, A:\LPW1.GIF file saved

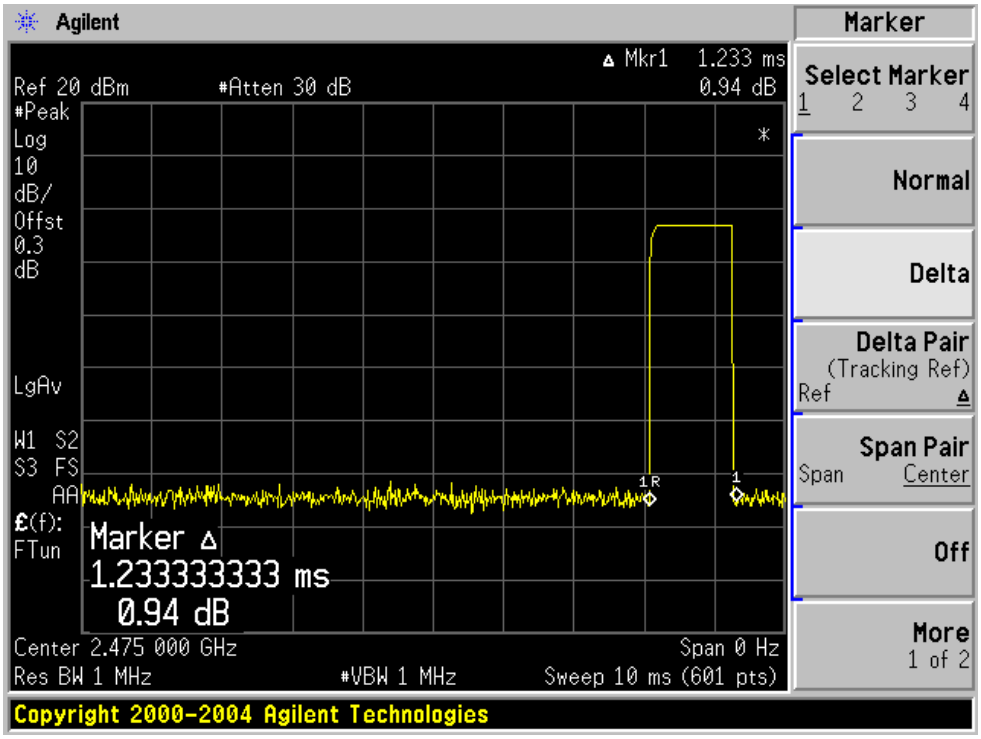

Agilent
Sweep
Ref 20 dBm
Atten 30 dB
#Peak
Log
10
dB/
Offst
0.3
dB
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Sweep Time
10.00 s
Center 2.405 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 1 MHz
Sweep 10 s (601 pts)
Sweep Time
10.00 s
Sweep
Single Cont
Auto Sweep Time
Norm
Gate
On Off
Gate Setup
Points
601
File Operation Status, A:\LPW2.GIF file saved

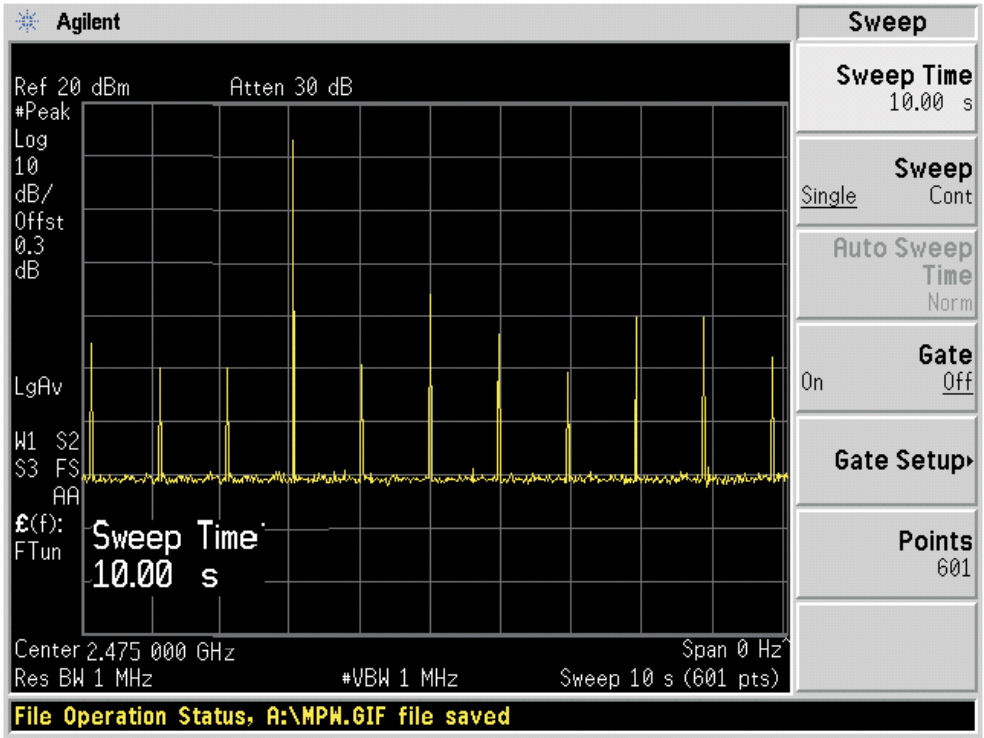
Mid Channel


Agilent
Marker
Mkr1 1.283 ms
0.02 dB
Ref 20 dBm
Atten 30 dB
#Peak
Log
10
dB/
Offst
0.3
dB
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Marker Δ
1.283333333 ms
0.02 dB
Center 2.440 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 1 MHz
Sweep 10 ms (601 pts)
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2
File Operation Status, A:\LDT.GIF file saved


Agilent
Sweep
Ref 20 dBm
Atten 30 dB
#Peak
Log
10
dB/
Offst
0.3
dB
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Sweep Time
10.00 s
Center 2.440 000 GHz
Span 0 Hz
Res BW 1 MHz
#VBW 1 MHz
Sweep 10 s (601 pts)
Sweep Time
10.00 s
Sweep
Single Cont
Auto Sweep Time
Norm
Gate
On Off
Gate Setup
Points
601
File Operation Status, A:\MPW.GIF file saved

High Channel





§15.247 (b) (1) - MAXIMUM PEAK OUTPUT POWER

Standard Applicable

According to §15.247(b) (1), for frequency hopping systems in the 2400-2483.5MHz band employing at least 75 hopping channels, and all direct sequence systems, the maximum peak output power of the transmitter shall not exceed 1 Watt. For all other frequency hopping system in the 2400 – 2483.5 MHz band, the maximum peak output power of the transmitter shall not exceed 0.125 Watt.

Measurement Procedure

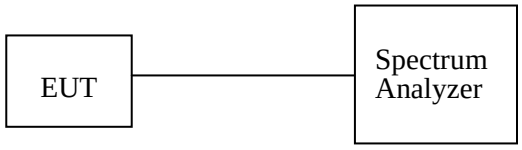
1. Place the EUT on the turntable and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

Test Equipment

Manufacturer	Description	Model Number	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2006-03-06

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Test Setup Block Diagram



Environmental Conditions

Temperature:	25°C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

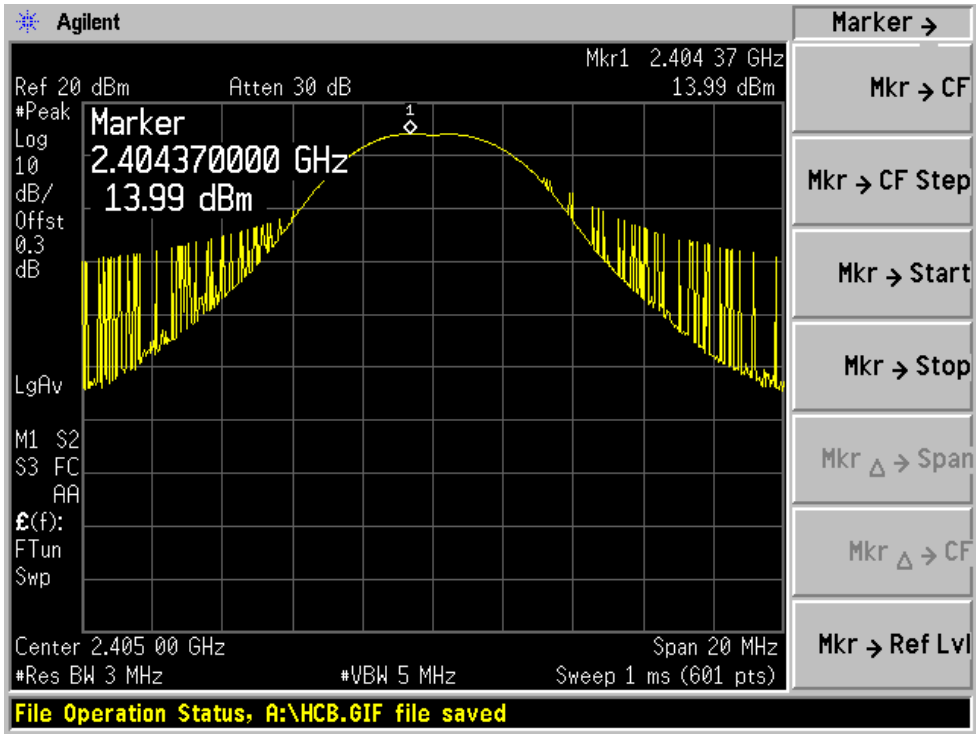
**The testing was performed by Dan Coronia on 2006-11-07.*

Measurement Result

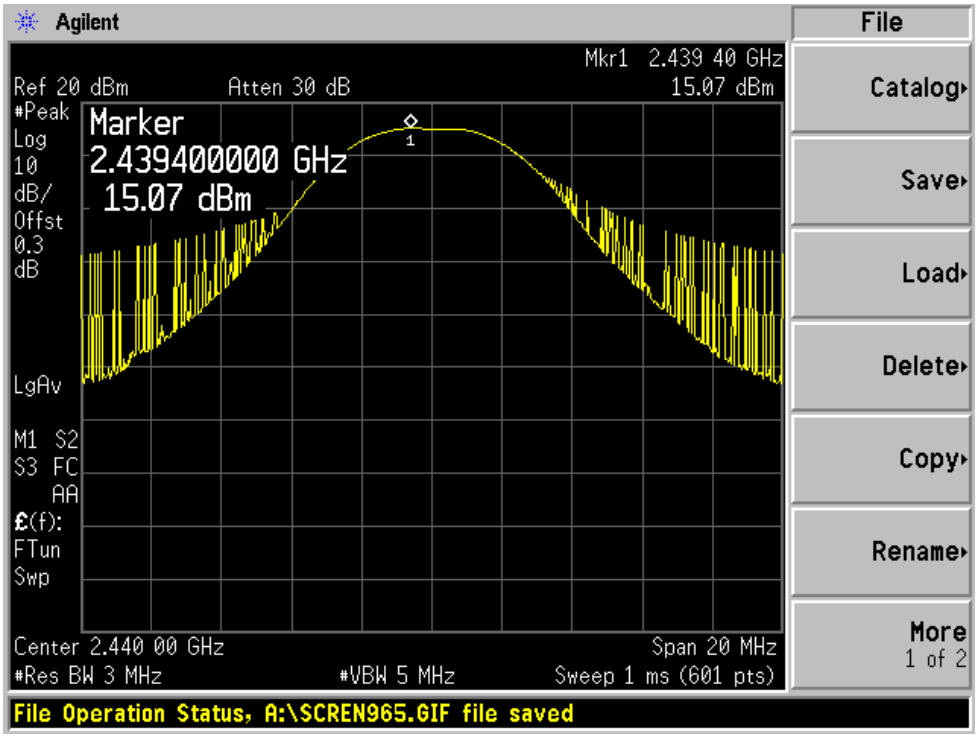
Channel	Frequency (MHz)	Max Peak Output Power		Limit (mW)	Result
		(dBm)	(mW)		
Low	2405	13.99	25	125	pass
Mid	2440	15.07	32	125	pass
High	2475	15.79	38	125	pass

Plots of Maximum Peak Output Power

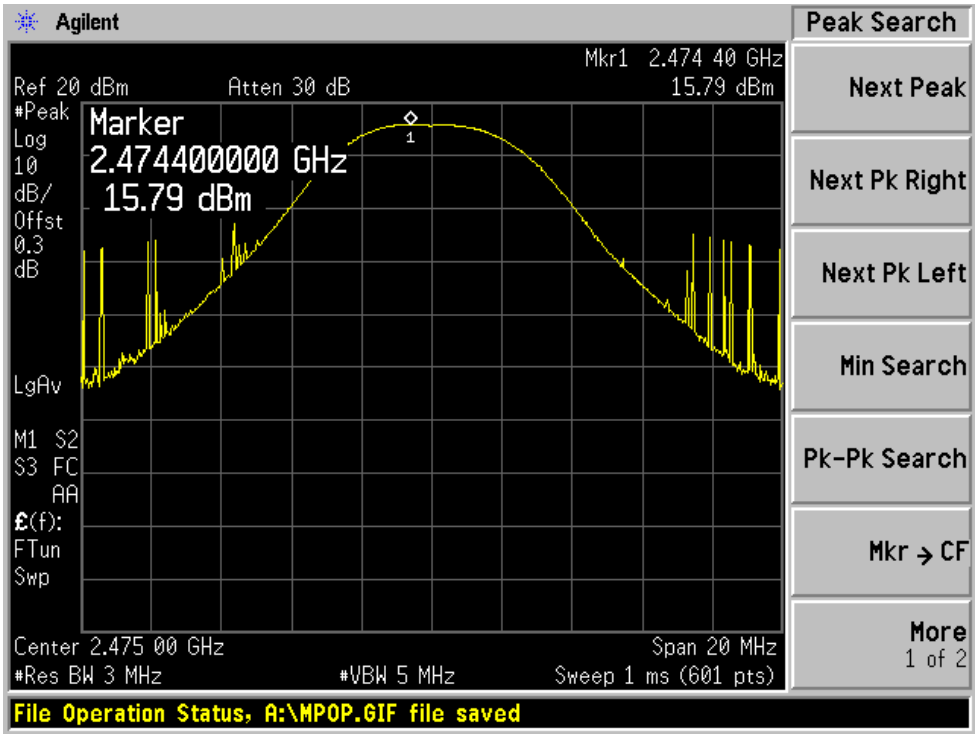
Low Channel



Middle Channel



High Channel



§ 2.1051 - SPURIOUS EMISSION AT ANTENNA PORT

Applicable Standard

According to §15.209 (f) and §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit.

Measurement Procedure

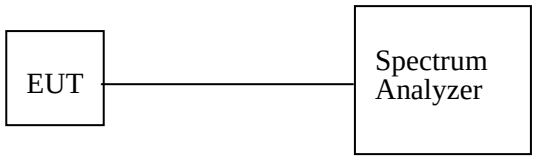
1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Enable hopping mode. Position the EUT on a bench without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set the SA on Max-Hold Mode, and then keep the EUT in transmitting mode. Record all the signals from each channel until each one has been recorded.
4. Set the SA on View mode and then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

Test Equipment

Manufacturer	Description	Model Number	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2006-03-06

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Test Setup Diagram



Environmental Conditions

Temperature:	25°C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

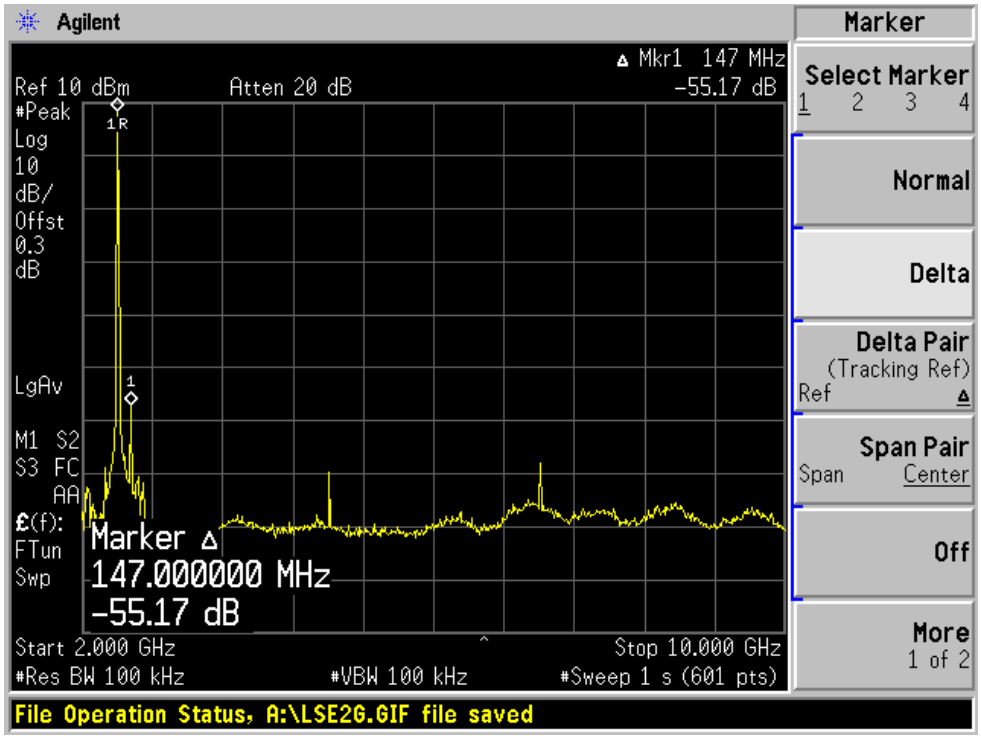
**The testing was performed by Dan Coronia 2006-11-07.*

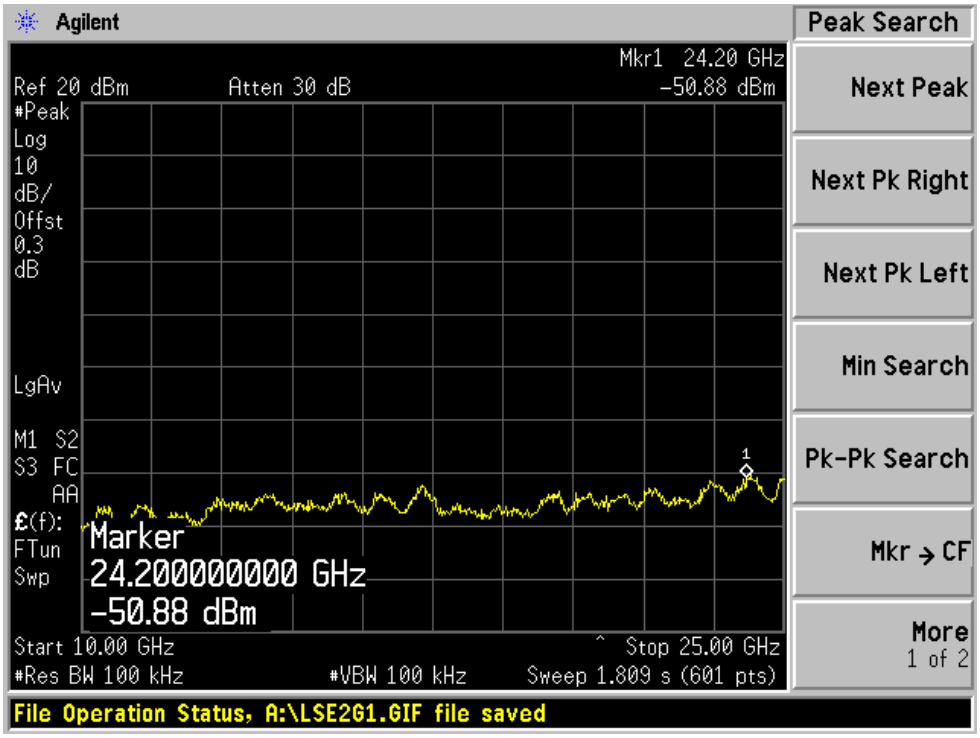
Measurement Results

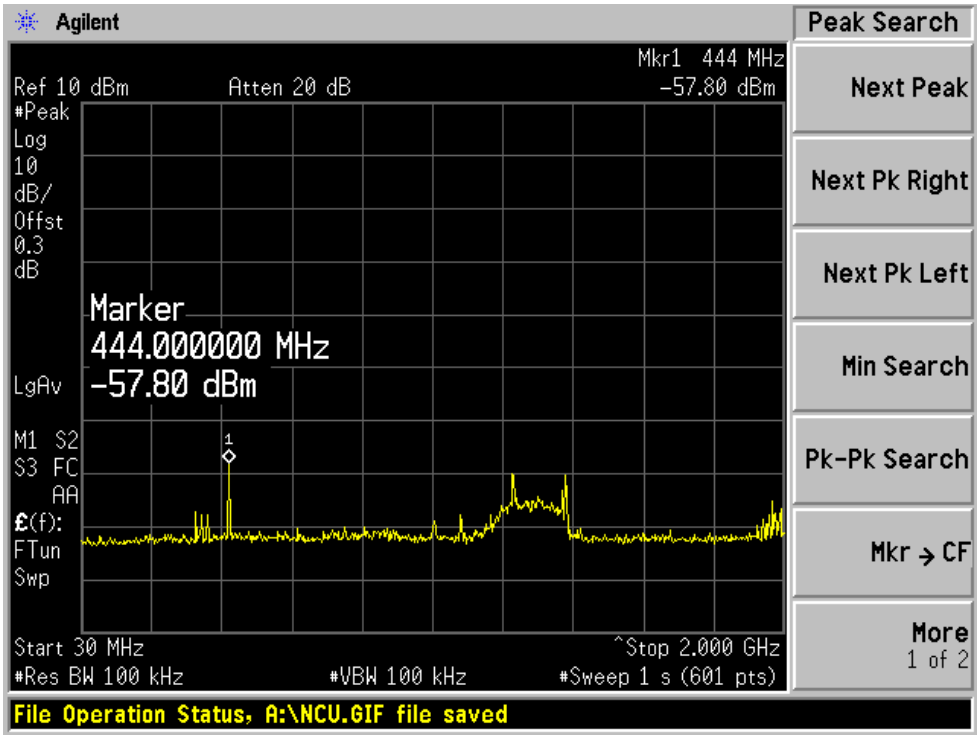
Please refer to the following plots.

Note: The test was conducted at both hopping enable and disable mode, only the worst test data were presented.

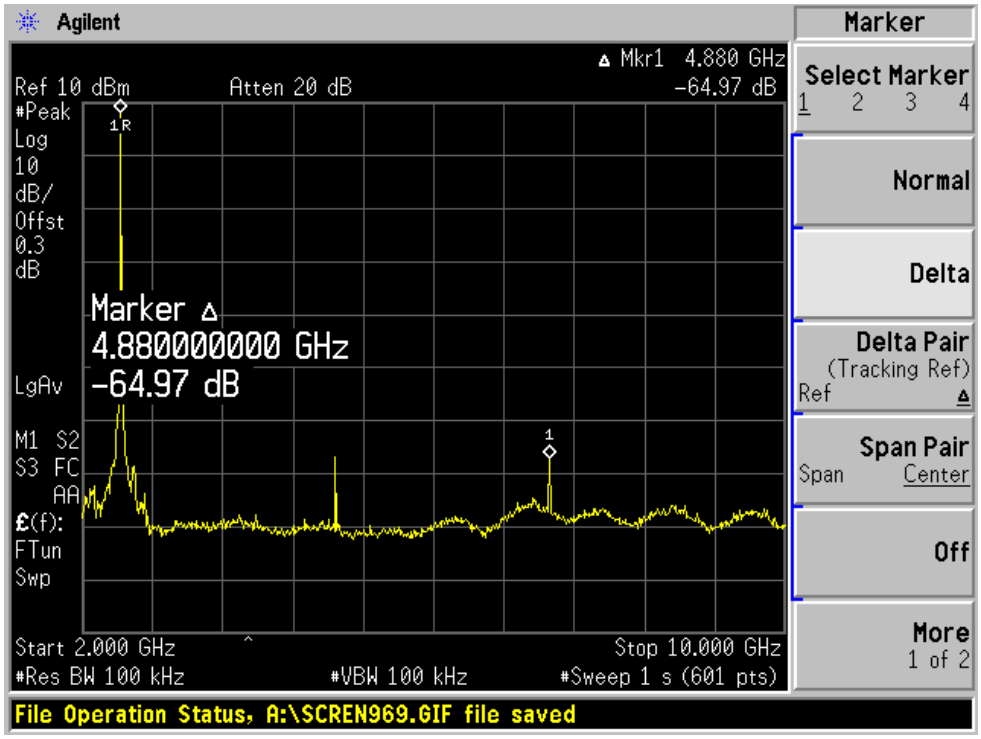
Low Channel

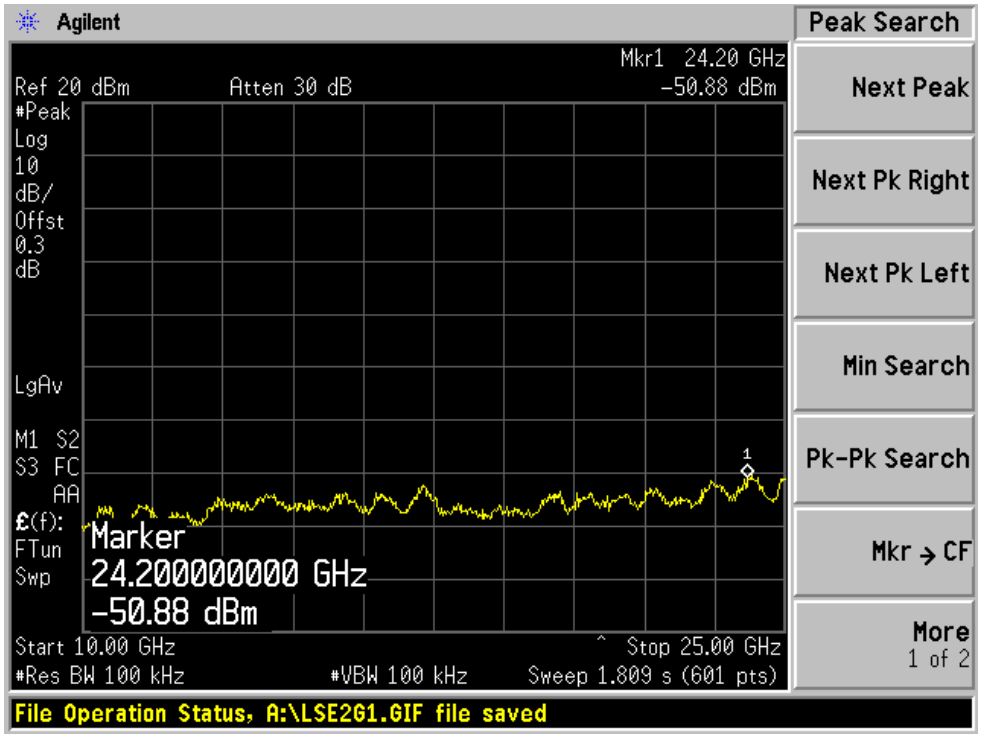


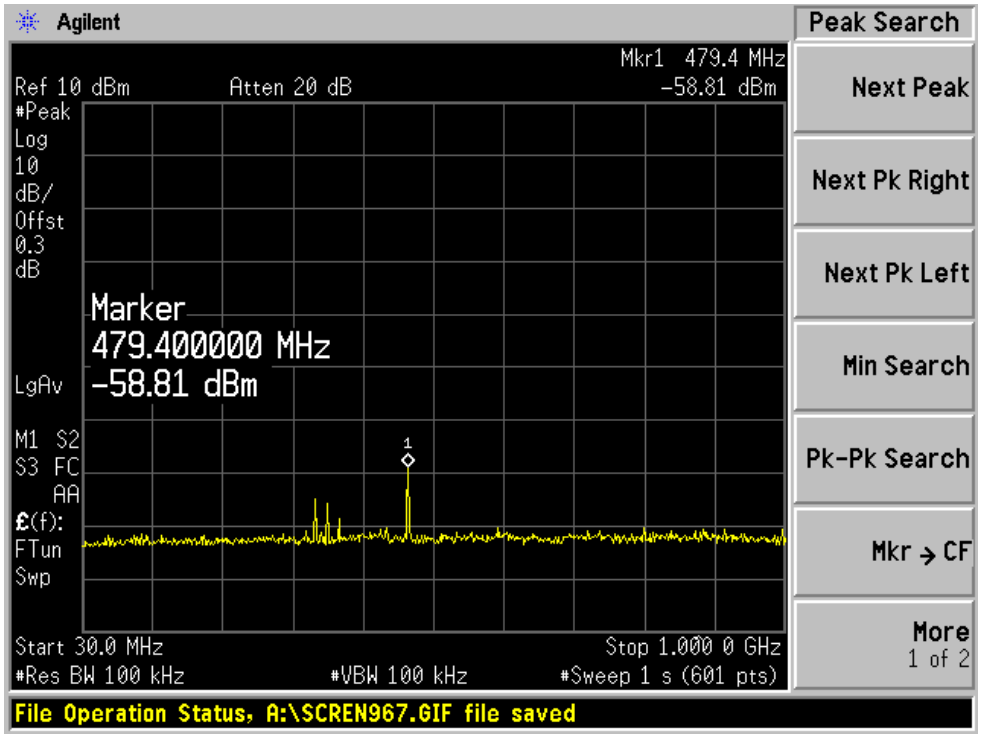

Agilent
Peak Search
Mkr1 24.20 GHz
Ref 20 dBm
Atten 30 dB
-50.88 dBm
#Peak
Log
10
dB/
Offst
0.3
dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Marker
24.200000000 GHz
-50.88 dBm
Start 10.00 GHz
Stop 25.00 GHz
#Res BW 100 kHz
#VBW 100 kHz
Sweep 1.809 s (601 pts)
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
File Operation Status, A:\LSE2G1.GIF file saved


Agilent
Peak Search
Mkr1 444 MHz
Ref 10 dBm
Atten 20 dB
-57.80 dBm
#Peak
Log
10
dB/
Offst
0.3
dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Marker
444.000000 MHz
-57.80 dBm
Start 30 MHz
Stop 2.000 GHz
#Res BW 100 kHz
#VBW 100 kHz
#Sweep 1 s (601 pts)
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
File Operation Status, A:\NCU.GIF file saved

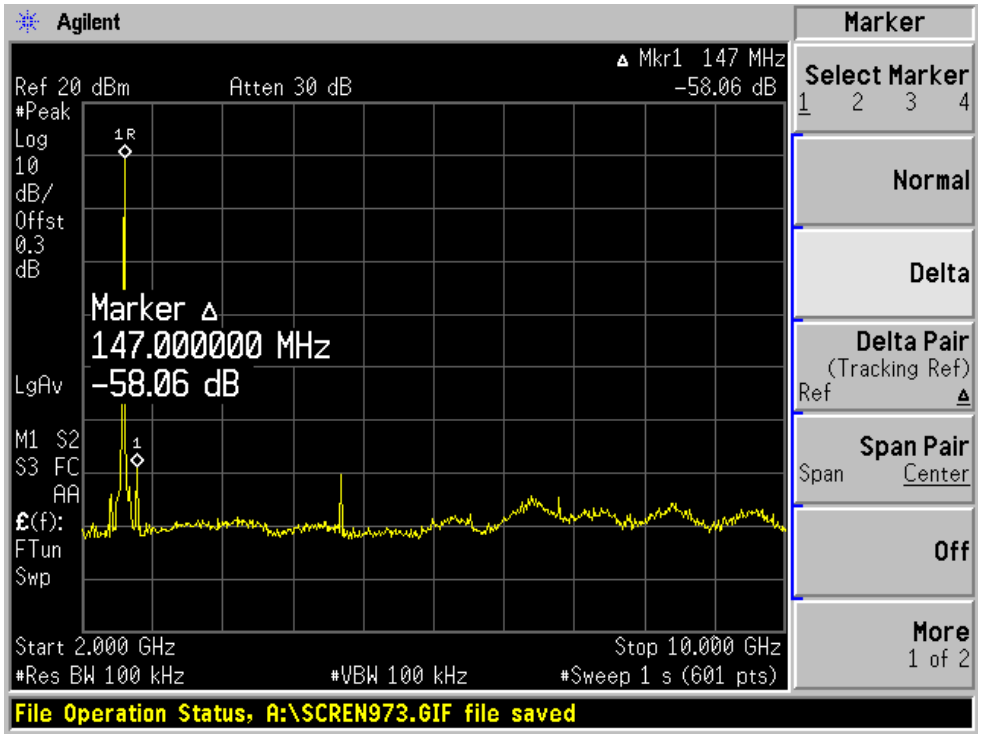
Mid Channel

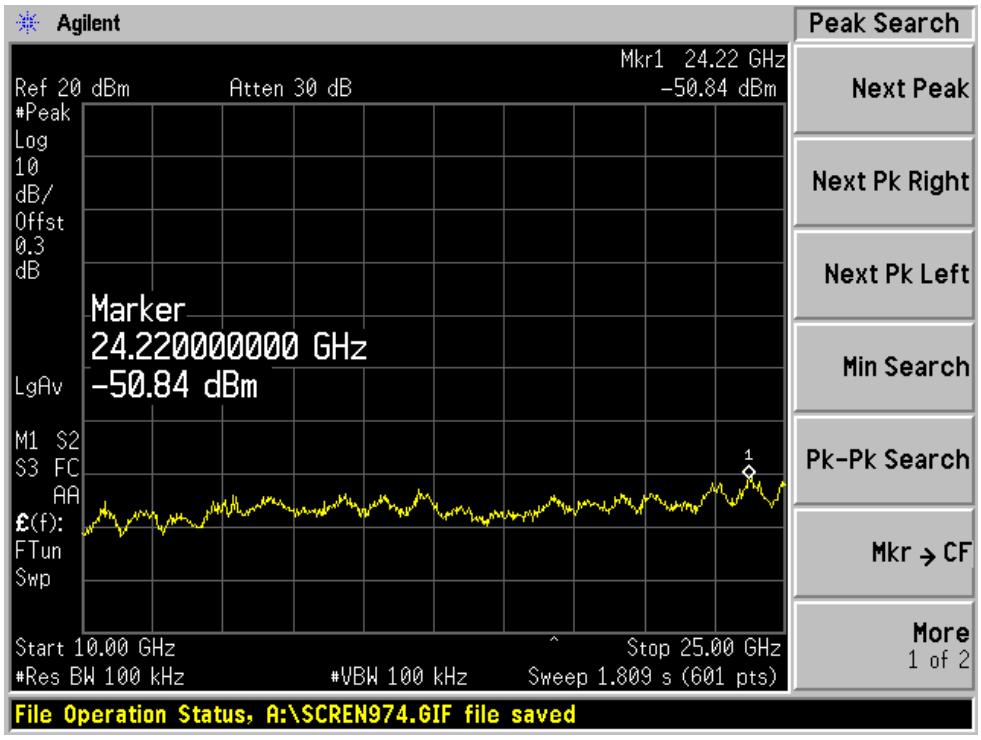

Agilent
Marker
Ref 10 dBm
Atten 20 dB
Mkr1 4.880 GHz
-64.97 dB
#Peak
Log
10
dB/
Offst
0.3
dB
Marker Δ
4.880000000 GHz
-64.97 dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Start 2.000 GHz
#Res BW 100 kHz
#VBW 100 kHz
Stop 10.000 GHz
#Sweep 1 s (601 pts)
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2
File Operation Status, A:\SCREN969.GIF file saved

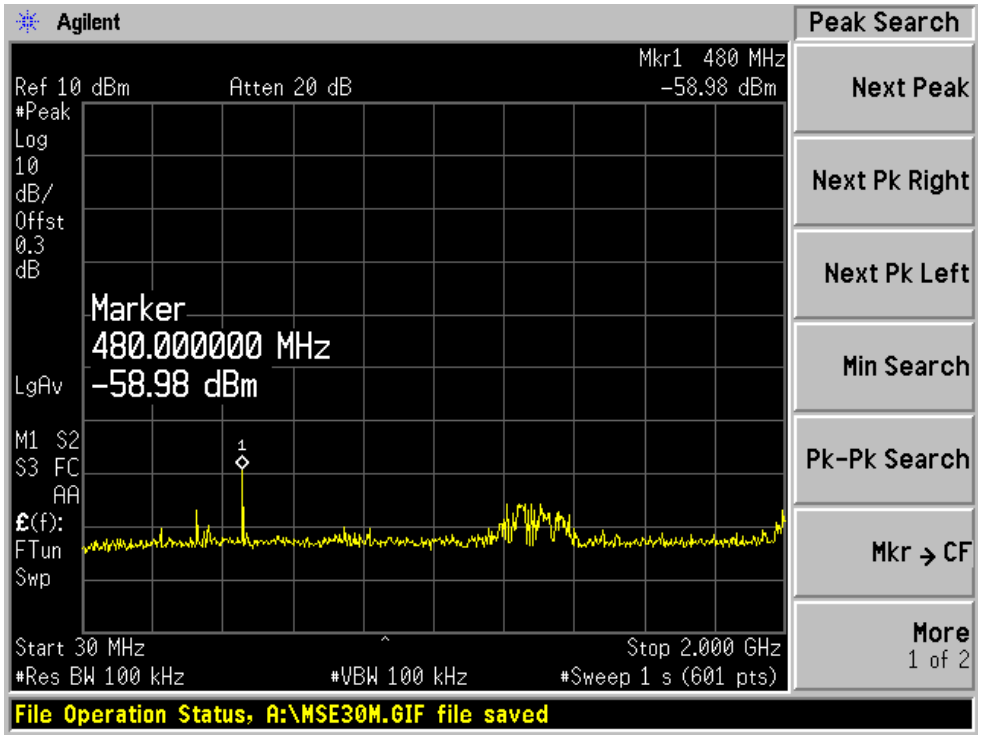

Agilent
Peak Search
Ref 20 dBm
Atten 30 dB
Mkr1 24.20 GHz
-50.88 dBm
#Peak
Log
10
dB/
Offst
0.3
dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Marker
24.200000000 GHz
-50.88 dBm
Start 10.00 GHz
#Res BW 100 kHz
#VBW 100 kHz
Stop 25.00 GHz
Sweep 1.809 s (601 pts)
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
File Operation Status, A:\LSE2G1.GIF file saved



High Channel




Agilent
Peak Search
Mkr1 24.22 GHz
Ref 20 dBm
Atten 30 dB
-50.84 dBm
#Peak
Log
10
dB/
Offst
0.3
dB
Next Peak
Next Pk Right
Next Pk Left
Min Search
Marker
24.220000000 GHz
-50.84 dBm
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 10.00 GHz
Stop 25.00 GHz
#Res BW 100 kHz
#VBW 100 kHz
Sweep 1.809 s (601 pts)
File Operation Status, A:\SCREN974.GIF file saved


Agilent
Peak Search
Mkr1 480 MHz
Ref 10 dBm
Atten 20 dB
-58.98 dBm
#Peak
Log
10
dB/
Offst
0.3
dB
Next Peak
Next Pk Right
Next Pk Left
Min Search
Marker
480.000000 MHz
-58.98 dBm
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Pk-Pk Search
Mkr → CF
More
1 of 2
Start 30 MHz
Stop 2.000 GHz
#Res BW 100 kHz
#VBW 100 kHz
#Sweep 1 s (601 pts)
File Operation Status, A:\MSE30M.GIF file saved

§15.247 (d) - 100 KHZ BANDWIDTH OF BAND EDGES

Standard Applicable

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in §15.209(a) is not required.

Measurement Procedure

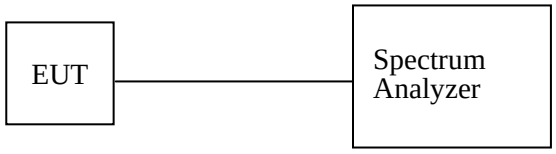
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Enable hopping mode. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Equipment

Manufacturer	Description	Model Number	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2006-03-06

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

Test Setup Diagram



Environmental Conditions

Temperature:	25°C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

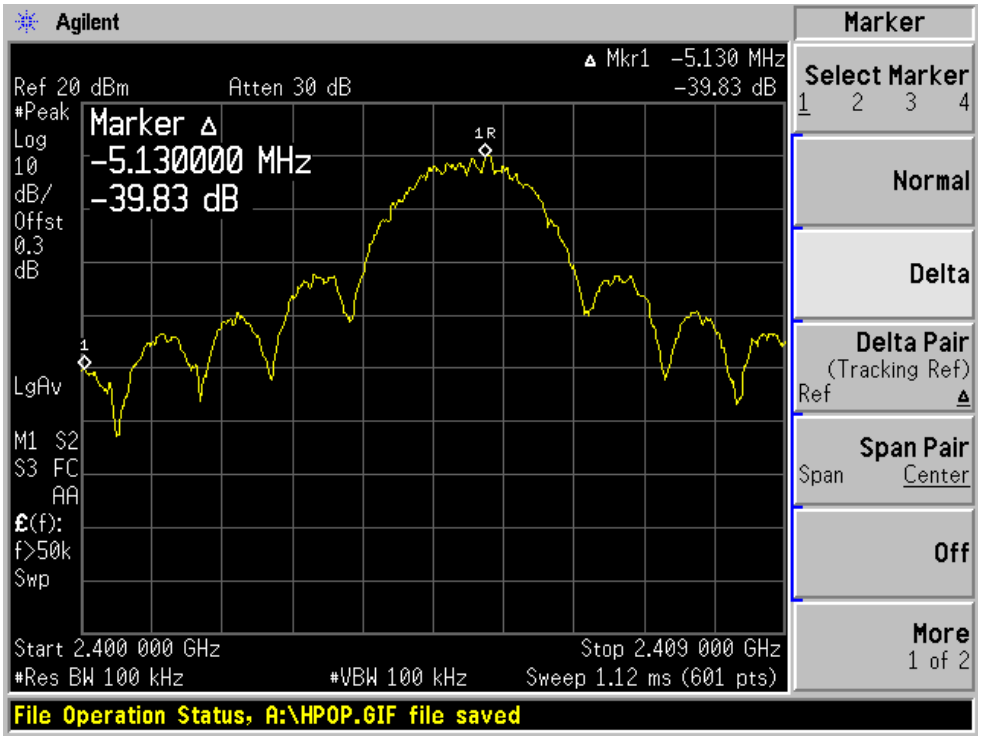
**The testing was performed by Dan Coronia 2006-11-07.*

Plots of 100 kHz Bandwidth of Band Edge

Please refer the following plots.

Note: The test was conducted at both hopping enabled and disabled mode, only the worst case test data are presented.

Low Channel



High Channel

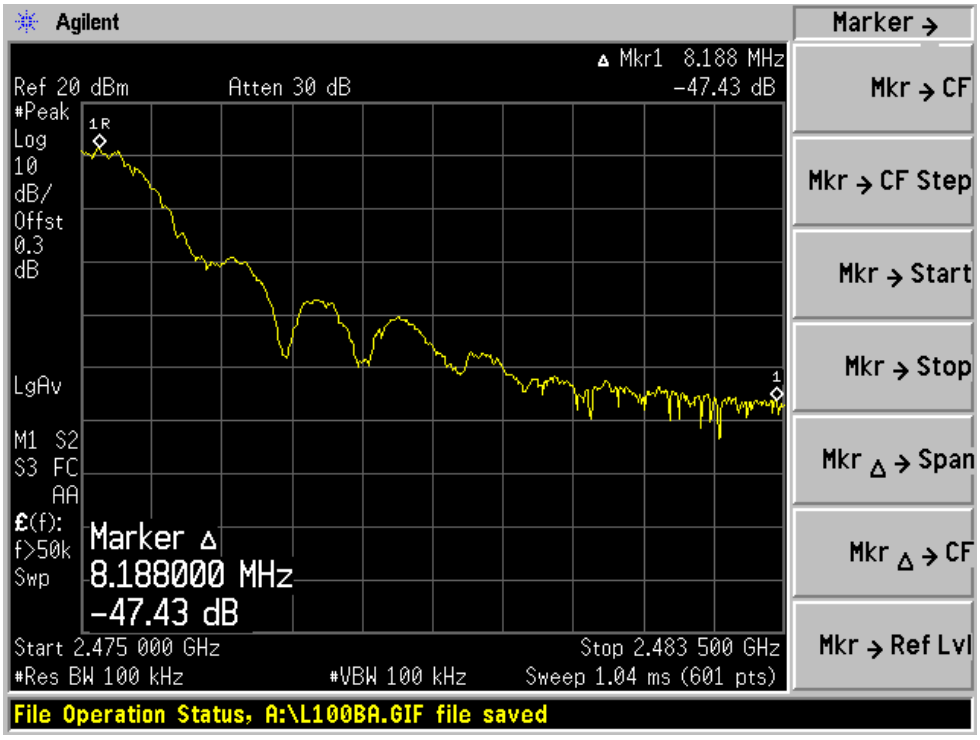
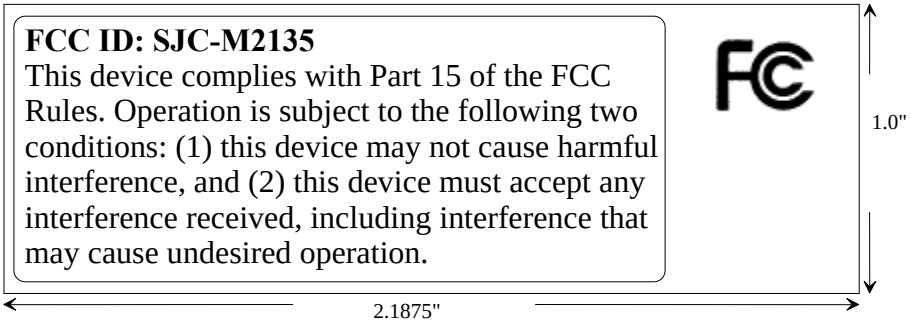


EXHIBIT A - FCC ID LABEL INFORMATION

FCC ID Label

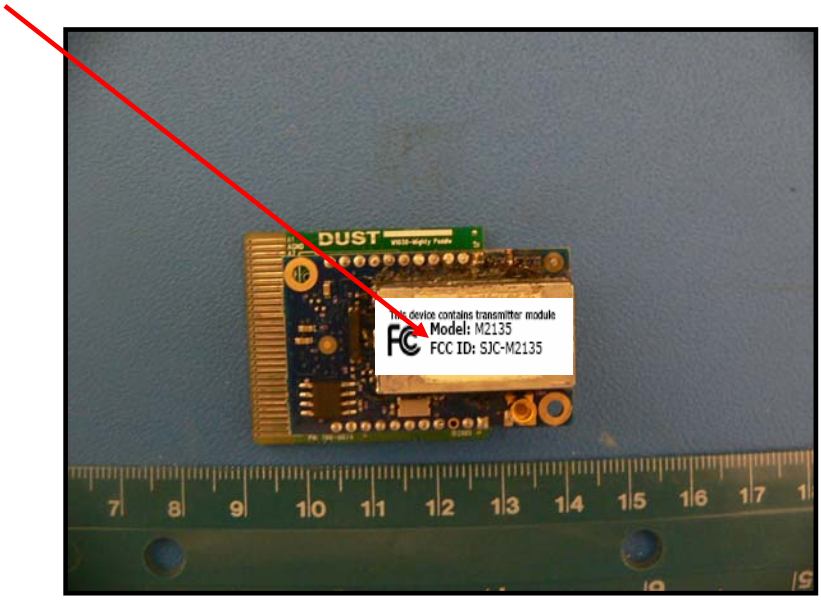
The FCC labels should contain FCC statement in FCC 15.19 paragraph (3). A sample of the statement is presented hereinafter as reference.

Also, as per FCC §15.19 a(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified above is required to be affixed only to the main control unit. If the EUT is integrated within another device then a label affixed to the host shall also state, "Contains FCC ID: **SJC-M2135**"



Proposed Label Location on EUT

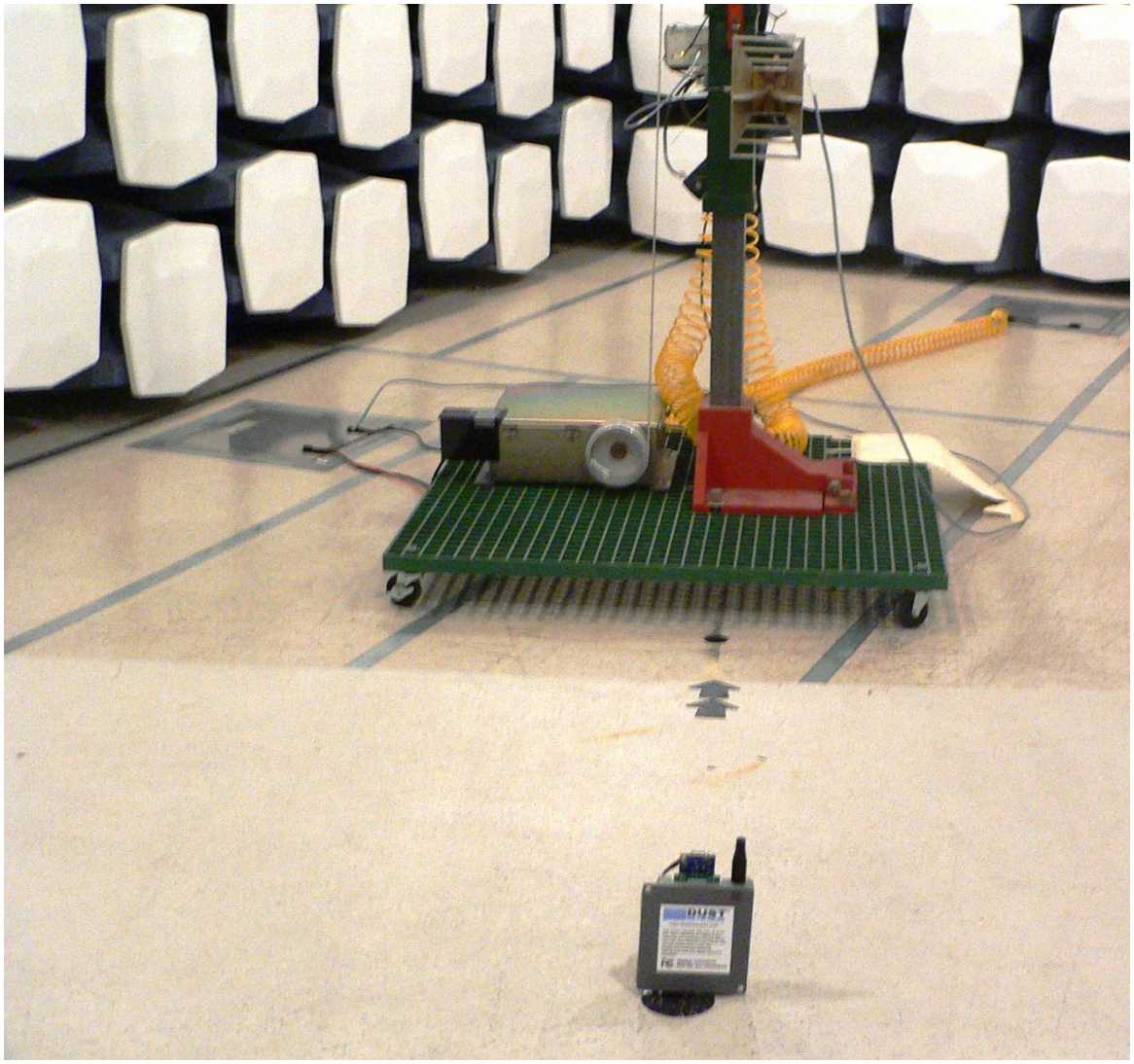
Back View of EUT / Proposed FCC ID Location



As per FCC §15.19 (b) (4), the label shall not be a stick-on, paper label. The label on these products shall be permanently affixed to the product and shall be readily visible to the purchaser at the time of purchase, as described in Section 2.925(d) of this chapter. "Permanently affixed" means that the label is etched, engraved, stamped, silk-screened, indelibly printed, or otherwise permanently marked on a permanently attached part of the equipment or on a nameplate of metal, plastic, or other material fastened to the equipment by welding, riveting, or a permanent adhesive. The label must be designed to last the expected lifetime of the equipment in the environment in which the equipment may be operated and must not be readily detachable.

EXHIBIT B - TEST SETUP PHOTOGRAPHS

EUT - Radiated Emissions Front View



EUT - Radiated Emissions Rear View

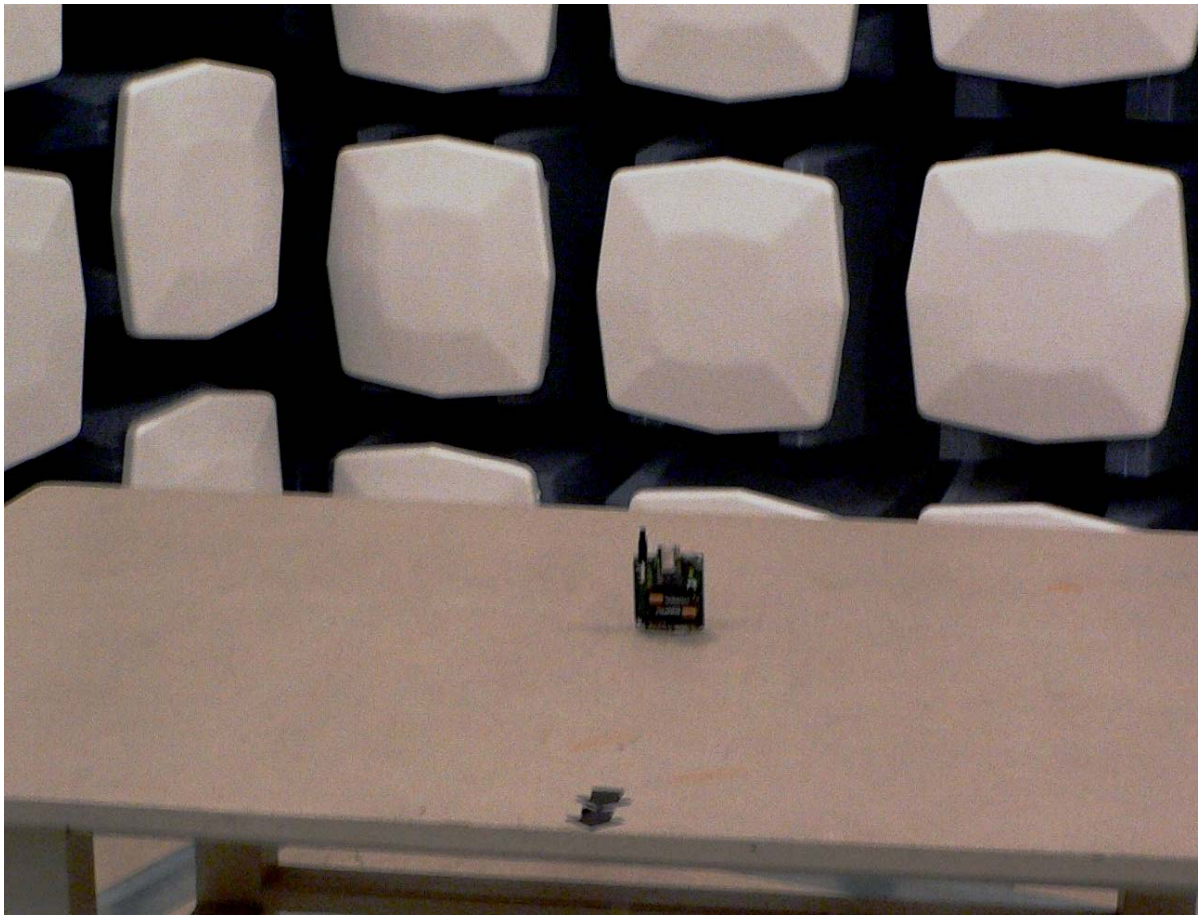
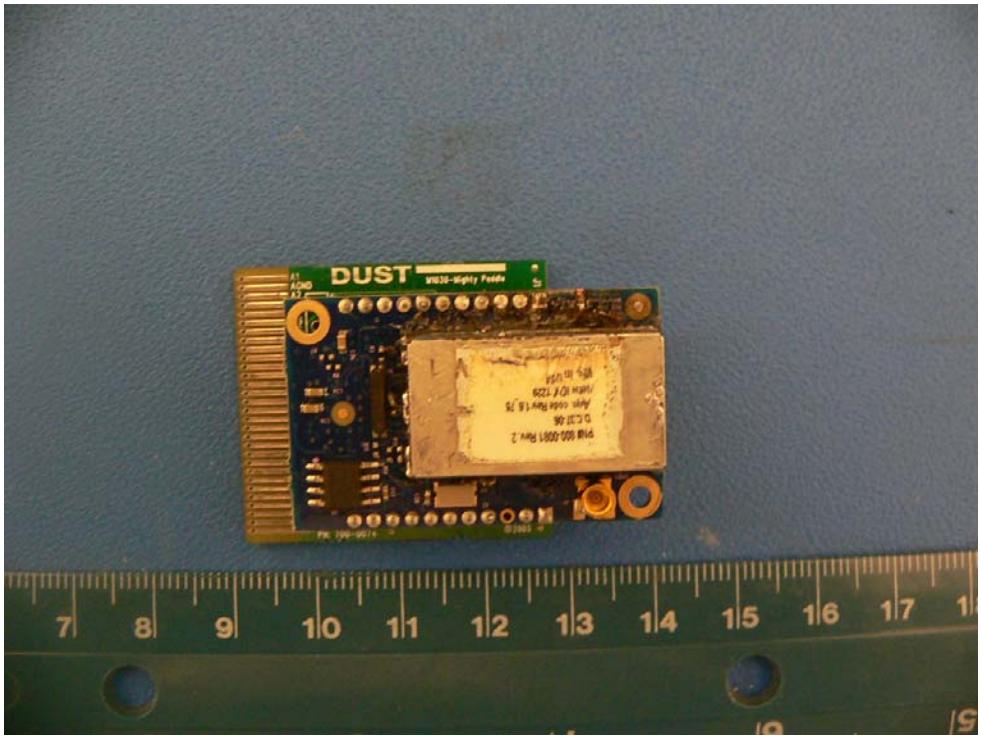
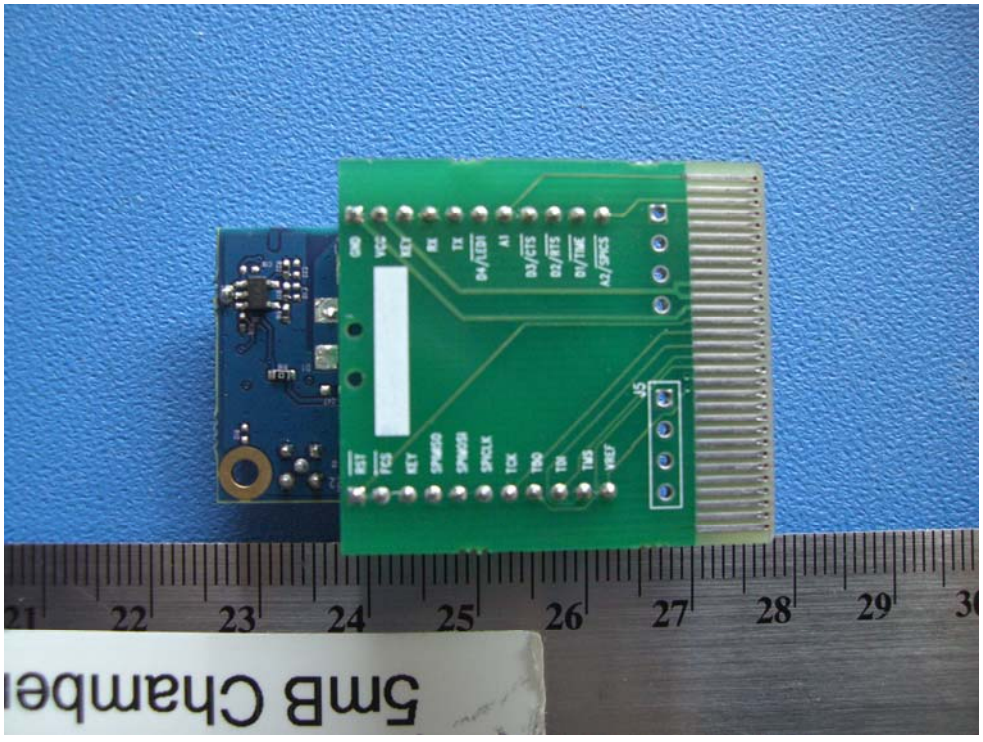


EXHIBIT C - EUT PHOTOGRAPHS

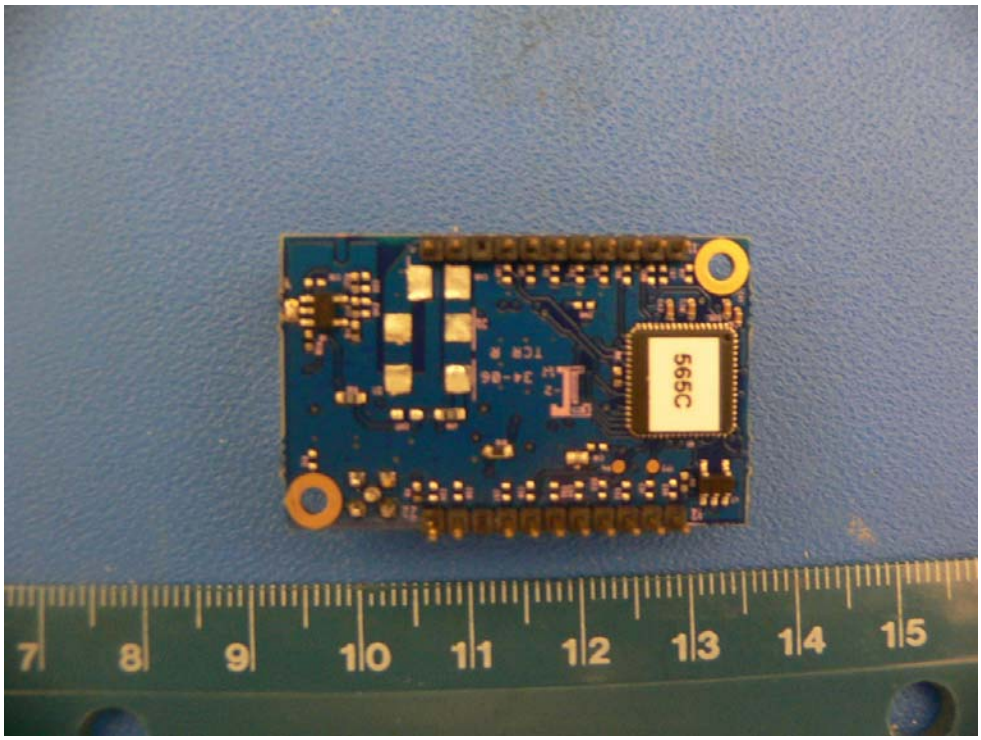
EUT & Adaptor Board – Front View



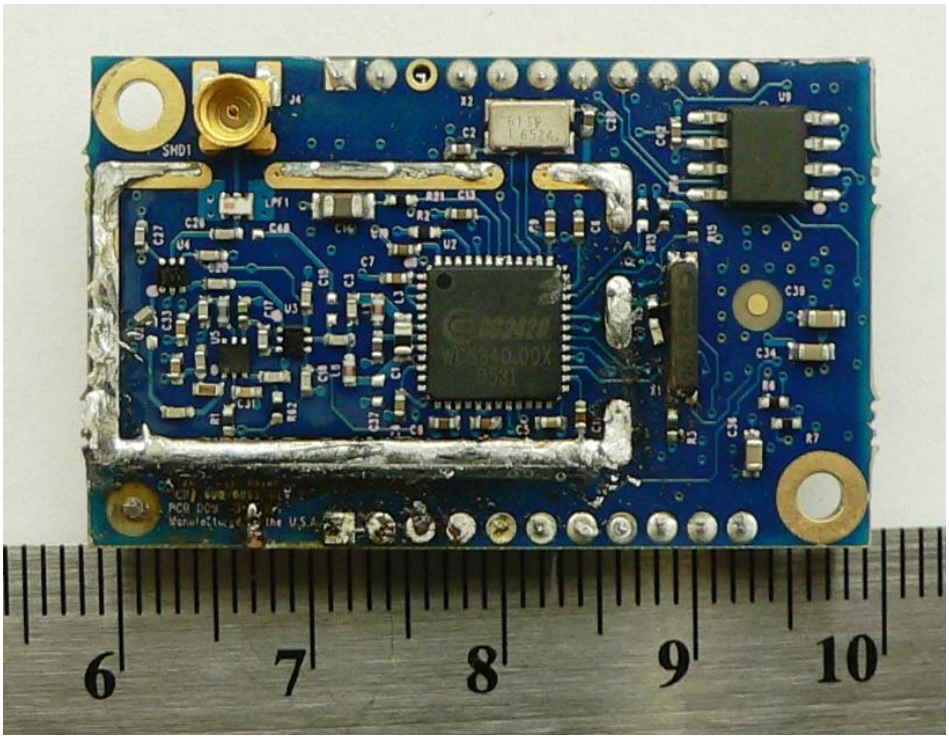
EUT & Adaptor Board – Back View



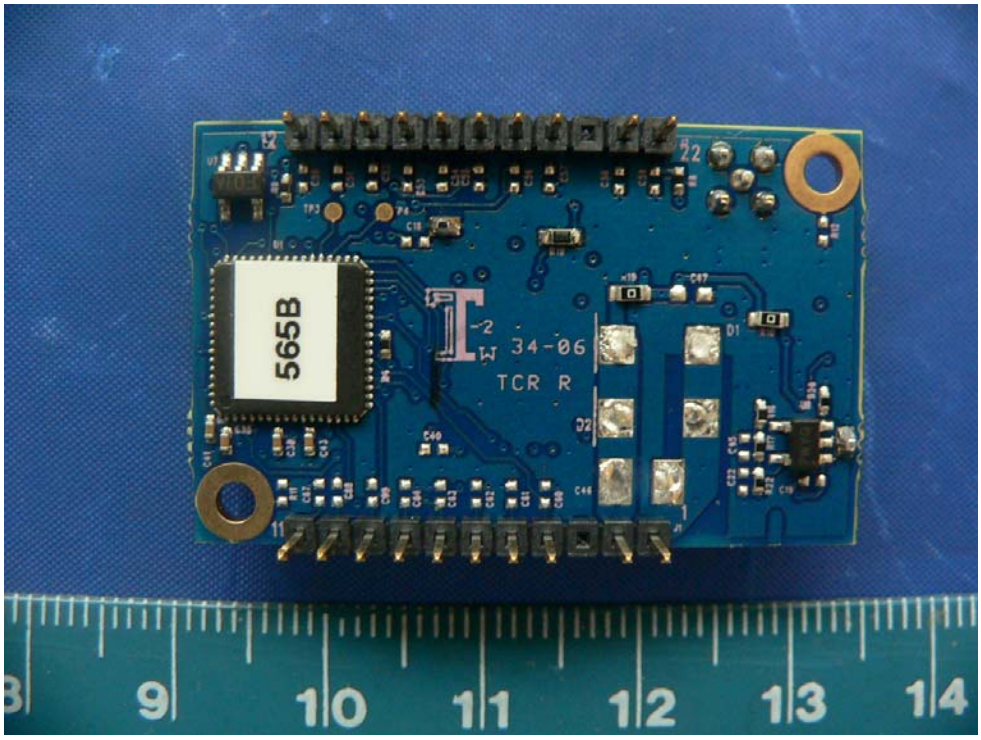
EUT with Shield on – Component Side View



EUT with Shield off – Component Side View

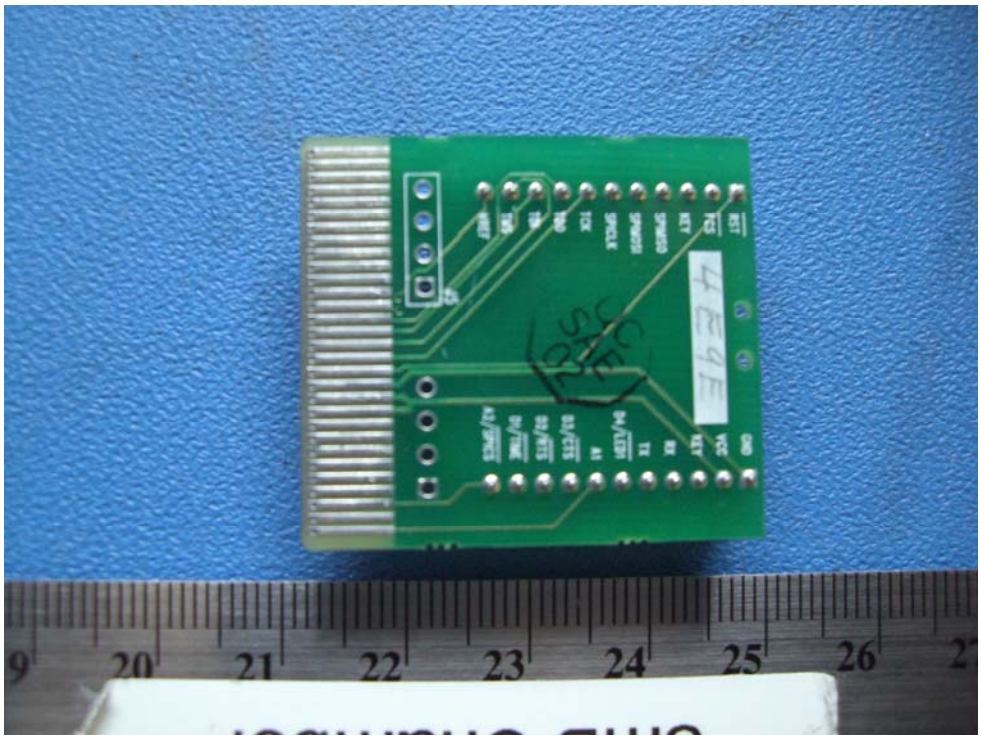


EUT – Solder Side View



Adaptor Board – Component Side View

Adaptor Board – Solder Side View



APPENDIX A - SCHEMATICS / BLOCK DIAGRAM

APPENDIX B - TECHNICAL SPECIFICATIONS

APPENDIX C - USERS MANUAL