FCC PART 15.247

EMI MEASUREMENT AND TEST REPORT

For

Dust Networks, Inc.

30695 Huntwood Ave.
Hayward, CA 94544

FCC ID: SJC-D2120

This Report Concerns:	**Equipment Type:**
☒ Original Report	2.4GHz Hopping System

Test Engineer:	Snell Leong
Report No.:	R0504211
Report Date:	2005-05-04
Reviewed By:	Daniel Deng
Prepared By:	Bay Area Compliance Laboratory Corporation (BACL) 230 Commercial Street Sunnyvale, CA 94085 Tel: (408) 732-9162 Fax: (408) 732 9164

TABLE OF CONTENTS

GENERAL INFORMATION

Product Description for Equipment Under Test (EUT)

The *Dust Networks, Inc.* product, FCC ID: *SJC-D2120,* or the "EUT" as referred to in this report is a 2.4 GHz Hybrid System, which measures approximately 120mmL x 105mm W x 31mm H. The EUT operates at the frequency range of 2405 – 2480MHz, with the maximum conducted output power of 0.69mW.

** The test data gathered are from a production sample, S/N: 192, provided by the manufacturer.*

Objective

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

Related Submittal(s)/Grant(s)

No Related Submittals

Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-2003& TIA/EIA-603.

Test Facility

The Open Area Test site used by BACL to collect radiated and conducted emission measurement data is located in the back parking lot of the building at 230 Commercial Street, Sunnyvale, California, USA.

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	FCC ID
Compaq	Laptop	Presario 2100	CNF43403FB	None

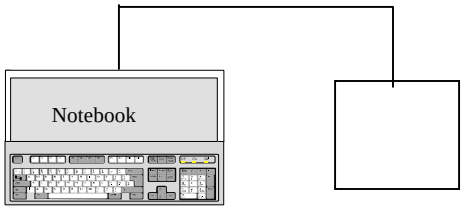
External I/O Cabling List and Details

Cable Description	Length (M)	Port/From	To
Serial Cable	1.5	Laptop Serial Port	EUT Serial Port

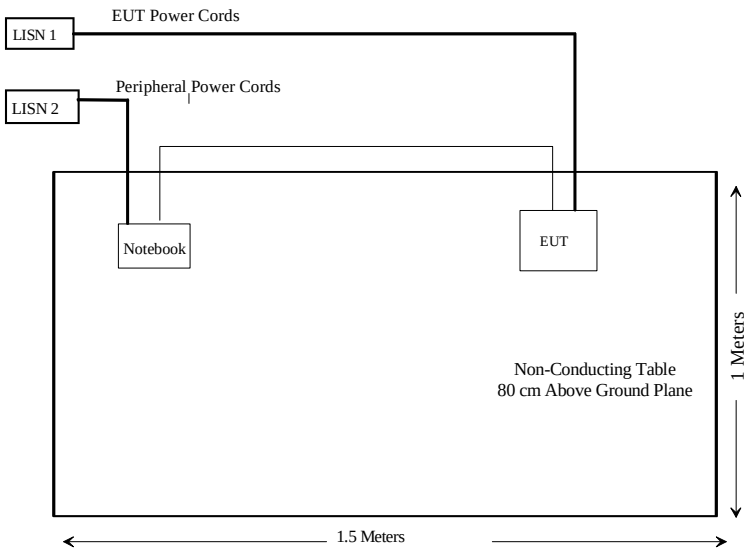
Power Supply Information

Manufacturer	Description	Model	Serial Number	FCC ID
DVE	AC Adaptor	DSA-0151A-05 A	N/A	None

Configuration of Test System



Test Setup Block Diagram



SUMMARY OF TEST RESULTS FOR FCC PART 15

FCC RULES	DESCRIPTION OF TEST	RESULT
§15.203	Antenna Requirement	Compliant
§ 15.205	Restricted Bands	Compliant
§15.207 (a)	Conducted Emission	Compliant
§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(a)(2)	6 dB Bandwidth	Compliant
§15.247 (b) (1)	Maximum Peak Output Power	Compliant
§ 15.247 (b)(4) § 2.1093	RF Safety Requirements	Compliant
§ 15.247 (d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	Peak Power Spectral Density	Compliant
§ 2.1051	Spurious Emission at Antenna Port	Compliant

*: Test data are within measurement uncertainty.

ANTENNA REQUIREMENT

According to § 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.

And according to § 15.247 (4)(i), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The gain of antenna used for transmitting is 2 dBi by default, and the antenna connector is designed with permanent attachment and no consideration of replacement. Please see EUT photo for details.

§15.207(a) - CONDUCTED EMISSION

Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are receiver, cable loss, and LISN.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of any conducted emissions measurement at BACL is $\pm$2.4 dB.

Test Setup

The measurement was performed at shield room, using the same setup per ANSI C63.4 – 2003 measurement procedure. The specification used was FCC Class B limits.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The EUT was connected with LISN-1.

Receiver Setup

The receiver was set to investigate the frequency from 150 kHz to 30MHz.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Cal. Date
Rohde & Schwarz	Receiver, EMI Test	ESCS30	100176	9/15/2004
Rohde & Schwarz	LISN, Artificial Mains	ESH2-Z5	871884/039	8/16/2004

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

Test Procedure

During the conducted emission test, the power cord of the host system was connected to the mains outlet of the LISN-1.

Maximizing procedure were performed on the six (6) highest emissions of the EUT.

All data was recorded in the peak detection mode, quasi-peak and average. Qusi-Peak readings are distinguished with an “QP”. Average readings are distinguished with an “Ave”.

Environmental Conditions

Temperature:	20° C
Relative Humidity:	61%
ATM Pressure:	1022 mbar

**The testing was performed by Snell Leong on 2005-04-21.*

Summary of Test Results

According to the recorded data in following table, the EUT complied with the FCC Conducted limit for a Class B device, with the *worst* margin reading of:

-4.4 dB at **0.250 MHz** in the **Line** conductor

Conducted Emissions Test Data

LINE CONDUCTED EMISSIONS				FCC CLASS B	
Frequency MHz	Amplitude dBµV	Detector Qp/Ave/Peak	Phase Line/Neutral	Limit dBµV	Margin dB
0.250	47.4	Ave	Line	51.76	-4.4
0.250	44.7	Ave	Neutral	51.76	-7.1
0.380	39.6	Ave	Line	48.28	-8.7
0.250	51.2	QP	Line	61.76	-10.6
0.250	49.1	QP	Neutral	61.76	-12.7
0.380	34.6	Ave	Neutral	48.28	-13.7
0.380	41.0	QP	Line	58.28	-17.3
0.770	26.5	Ave	Line	46.00	-19.5
0.770	35.6	QP	Line	56.00	-20.4
0.770	25.5	Ave	Neutral	46.00	-20.5
0.380	37.7	QP	Neutral	58.28	-20.6
0.770	31.5	QP	Neutral	56.00	-24.5

Plot of Conducted Emissions Test Data

Plot(s) of Conducted Emissions Test Data is presented in the following page as reference.

Bay Area Compliance Laboratory Corp
Class B

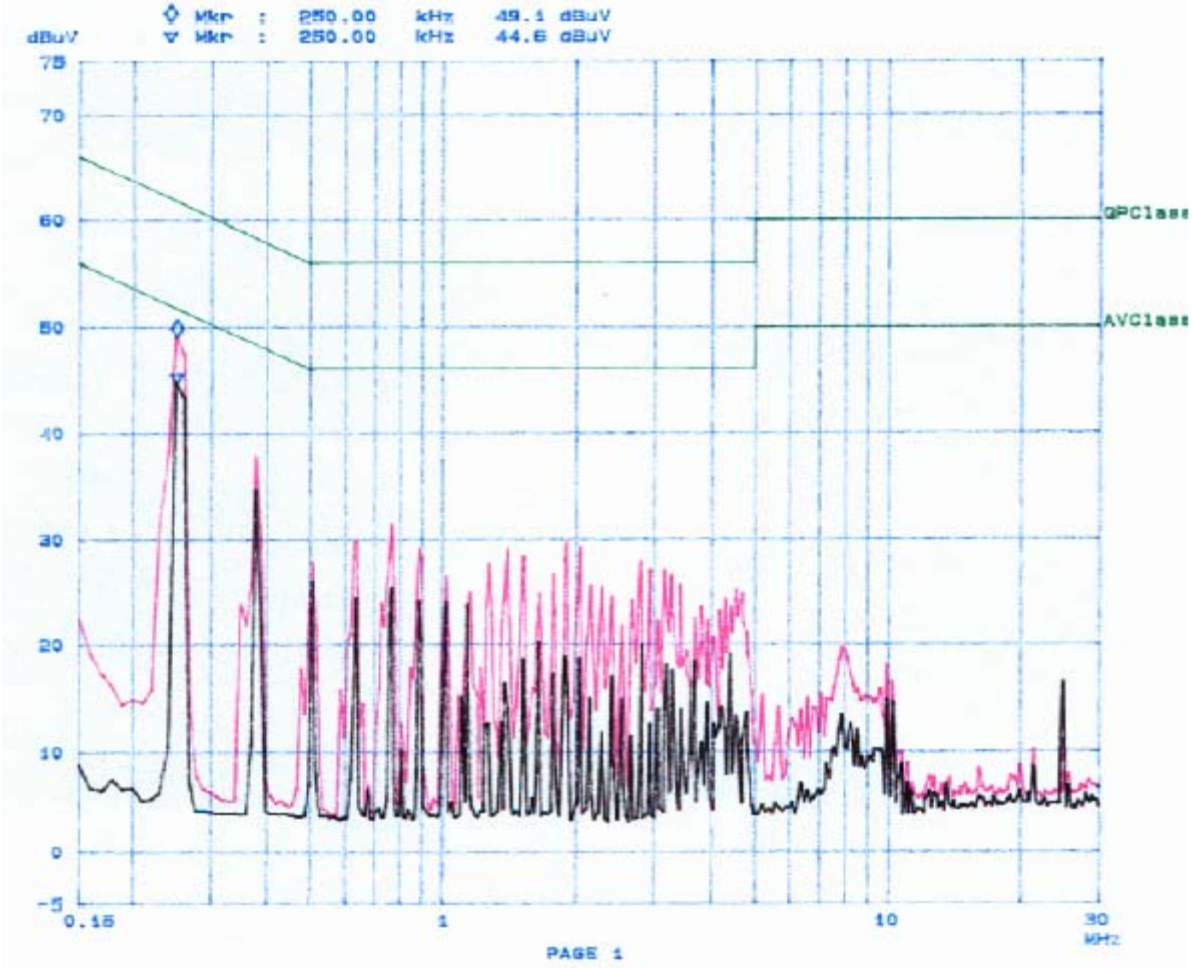
21. Apr 05 16:28

21/April/05
Sneel

EUT: DUST SMARTMESH MANAGER
Manuf: DUST NETWORK
Op Cond: Normal
Operator: SNELL
Comment: N

Scan Settings (3 Ranges)

Frequencies			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp
150k	1M	10k	9k	QP+AV	20ms	15dBLN	OFF
1M	5M	10k	9k	QP+AV	1ms	15dBLN	OFF
5M	30M	100k	9k	QP+AV	1ms	15dBLN	OFF



Bay Area Compliance Laboratory Corp
Class B

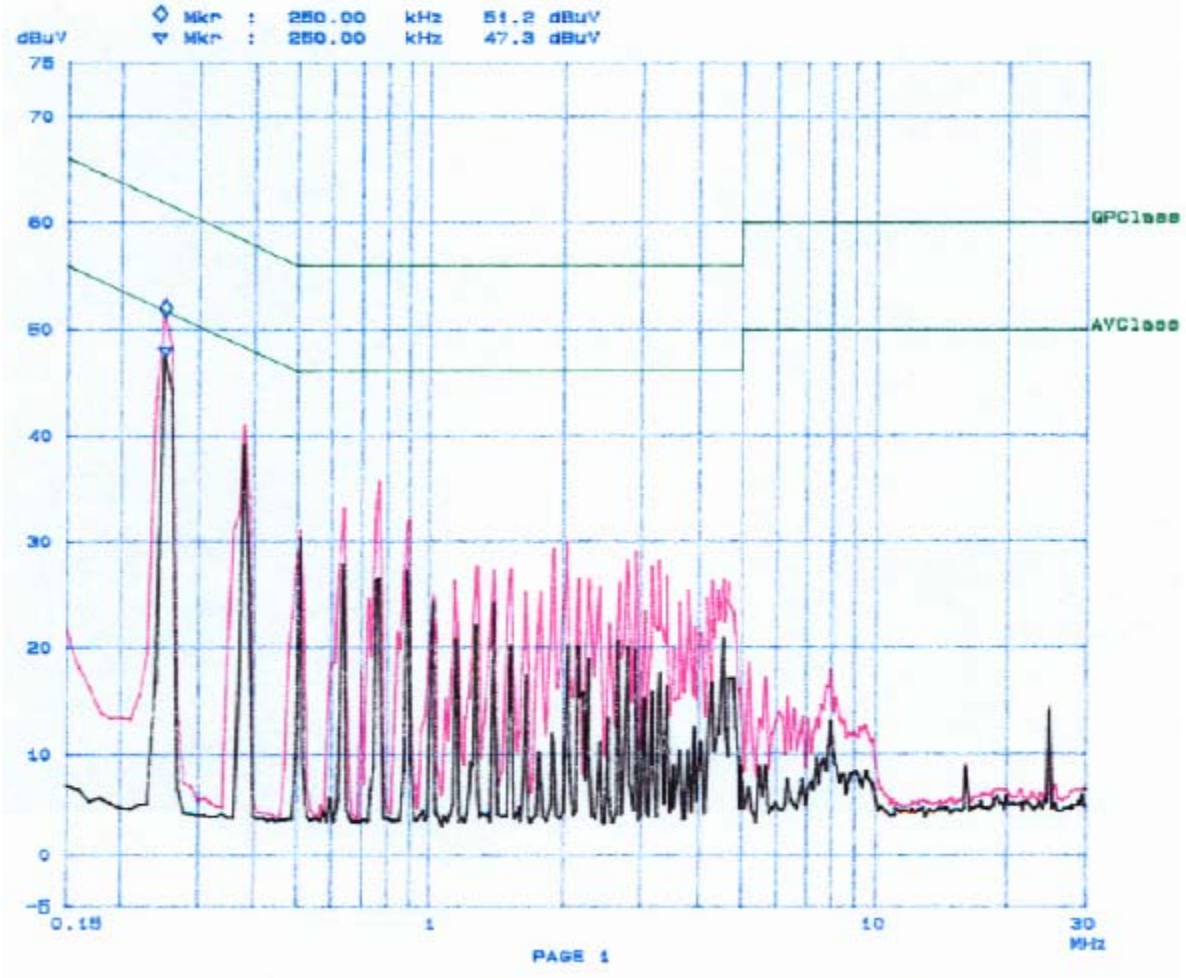
21. Apr 05 16:53

21/April/05
Snell

EUT: DUST SMARTMESH MANAGER
Manuf: DUST NETWORK
Op Cond: Normal
Operator: SNELL
Comment: L

Scan Settings (3 Ranges)

Frequencies			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp
150k	1M	10k	9k	QP+AV	20ms	15dBLN	OFF
1M	5M	10k	9k	QP+AV	1ms	15dBLN	OFF
5M	30M	100k	9k	QP+AV	1ms	15dBLN	OFF



§15.205 & §15.209 - RADIATED EMISSION

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 best estimate of the uncertainty of a radiation emissions measurement at BACL is $\pm$4.0 dB.

Test Setup

The radiated emission tests were performed in the open area 3-meter test site, using the setup in accordance with ANSI C63.4-2003. The specification used was the FCC 15 Subpart C limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The EUT was connected with 120Vac/60Hz power source.

The device was tested with both hopping mode enabled and disabled.

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	Cal. Date
EMCO	Antenna, Biconical	3110B	9603-2315	12/14/2004
HP	Amplifier, Pre	8447D	2944A10198	8/20/2004
Agilent	Analyzer, Spectrum	E4446A	US44300386	11/10/2004
EMCO	Antenna, Log-Periodic	3148	4-1155	12/14/2004
HP	Amiplifier, Pre	8449B	3147A00400	03/14/2004
Wisewave	Antenna, Horn, Std	ARH-2823-02	10555-02	12/13/2004
Sunol Science	Antenna	JB1	A03105-3	02/11/2005

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

Environmental Conditions

Temperature:	23° C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

**The testing was performed by Snell Leong on 2005-04-25.*

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 table, the EUT test data are within the measurement uncertainty of ±4.0dB, and had the worst margin of:

-16.1 dB at **1045.10 MHz** in the **Vertical** polarization, Low Channel, 3 meters

-15.9 dB at **4880.00 MHz** in the **Vertical** polarization, Middle Channel, 3 meters

-17.0 dB at **1045.10 MHz** in the **Vertical** polarization, High Channel, 3 meters

-1.3 dB at **298.57 MHz** in the **Horizontal** polarization, Unintentional Emission, 3 meters

3 Meters Radiated Emission Test Data

Indicated			Antenna	Antenna		Correction Factor			FCC 15.247		
Freqency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin	Comments
MHz	dBμV/m	Degree	Meter	H/V	dB	dB	dB	dBμV/m	dBμV/m	dB	
Low Channel											
2405.0000				v	28.1	2.0	35.8	-5.7			Fund/Peak
2405.0000				h	28.1	2.0	35.8	-5.7			Fund/Peak
2405.0000				v	28.1	2.0	35.8	-5.7			Ave
2405.0000				h	28.1	2.0	35.8	-5.7			Ave
1045.1000	48.9	270	2.4	v	24.5	1.3	36.8	37.9	54	-16.1	Ave
4810.0000	36.6	270	2.4	v	32.5	3.1	34.8	37.4	54	-16.6	Ave
7215.0000	30.1	180	2.3	h	36.3	4.3	34.7	36.0	54	-18.0	Ave
7215.0000	30.0	270	2.4	v	36.3	4.3	34.7	35.9	54	-18.1	Ave
4810.0000	34.3	180	2.2	h	32.5	3.1	34.8	35.1	54	-18.9	Ave
1045.1000	41.4	180	2.2	h	24.5	1.3	36.8	30.4	54	-23.6	Ave
7215.0000	42.0	270	2.4	v	36.3	4.3	34.7	47.9	74	-26.1	Peak
7215.0000	41.4	180	2.3	h	36.3	4.3	34.7	47.4	74	-26.7	Peak
4810.0000	46.0	270	2.4	v	32.5	3.1	34.8	46.8	74	-27.2	Peak
1045.1000	55.0	270	2.4	v	24.5	1.3	36.8	44.0	74	-30.0	Peak
4810.0000	43.0	180	2.2	h	32.5	3.1	34.8	43.8	74	-30.2	Peak
1045.1000	50.9	180	2.2	h	24.5	1.3	36.8	39.9	74	-34.1	Peak
Middle Channel											
2440.0000				v	28.1	2.0	35.8	-5.7			Fund/Peak
2440.0000				h	28.1	2.0	35.8	-5.7			Fund/Peak
2440.0000				v	28.1	2.0	35.8	-5.7			Ave
2440.0000				h	28.1	2.0	35.8	-5.7			Ave
4880.0000	37.3	270	2.4	v	32.5	3.1	34.8	38.1	54	-15.9	Ave
7320.0000	30.4	270	2.4	v	36.3	4.3	34.7	36.3	54	-17.7	Ave
7320.0000	30.2	180	2.3	h	36.3	4.3	34.7	36.1	54	-17.9	Ave
4880.0000	30.9	180	2.2	h	32.5	3.1	34.8	31.7	54	-22.3	Ave
1045.0000	41.2	180	2.2	h	24.5	1.3	36.8	30.2	54	-23.8	Ave
1045.0000	37.9	270	2.4	v	24.5	1.3	36.8	26.9	54	-27.1	Ave
7320.0000	40.9	270	2.4	v	36.3	4.3	34.7	46.8	74	-27.2	Peak
4880.0000	45.6	270	2.4	v	32.5	3.1	34.8	46.4	74	-27.6	Peak
4880.0000	45.0	180	2.2	h	32.5	3.1	34.8	45.8	74	-28.2	Peak
7320.0000	39.7	180	2.3	h	36.3	4.3	34.7	45.7	74	-28.3	Peak
1045.0000	53.2	180	2.2	h	24.5	1.3	36.8	42.2	74	-31.8	Peak
1045.0000	49.8	270	2.4	v	24.5	1.3	36.8	38.8	74	-35.2	Peak

Indicated			Antenna	Antenna		Correction Factor			FCC 15.247		
Freqency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin	Comments
MHz	dBμV/m	Degree	Meter	H/V	dB	dB	dB	dBμV/m	dBμV/m	dB	
High Channel											
2480.0000				v	28.1	2.0	35.8	-5.7			Fund/Peak
2480.0000				h	28.1	2.0	35.8	-5.7			Fund/Peak
2480.0000				v	28.1	2.0	35.8	-5.7			Ave
2480.0000				h	28.1	2.0	35.8	-5.7			Ave
1045.1000	48.0	270	2.4	v	24.5	1.3	36.8	37.0	54	-17.0	Ave
7440.0000	30.7	270	2.4	v	36.3	4.3	34.7	36.7	54	-17.3	Ave
7440.0000	30.7	180	2.3	h	36.3	4.3	34.7	36.6	54	-17.4	Ave
4960.0000	30.9	270	2.4	v	32.5	3.1	34.8	31.7	54	-22.3	Ave
4960.0000	29.6	180	2.2	h	32.5	3.1	34.8	30.4	54	-23.6	Ave
7440.0000	43.6	270	2.4	v	36.3	4.3	34.7	49.5	74	-24.5	Peak
1045.1000	40.1	180	2.2	h	24.5	1.3	36.8	29.1	54	-24.9	Ave
7440.0000	43.0	180	2.3	h	36.3	4.3	34.7	48.9	74	-25.1	Peak
4960.0000	46.7	270	2.4	v	32.5	3.1	34.8	47.5	74	-26.5	Peak
1045.1000	55.7	270	2.4	v	24.5	1.3	36.8	44.7	74	-29.3	Peak
4960.0000	42.3	180	2.2	h	32.5	3.1	34.8	43.1	74	-30.9	Peak
1045.1000	49.9	180	2.2	h	24.5	1.3	36.8	38.9	74	-35.1	Peak

Note:

FUND: Fundemental
AVE: Average

Unintentional Emission

Indicated			Antenna	Antenna		Correction Factor			FCC 15.209	
Frequency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin
MHz	dBμV/m	Degree	Meter	H/V	dB	dB	dB	dBμV/m	dBμV/m	dB
298.57	56.52	0	2.0	H	13.7	2.3	27.8	44.7	46	-1.3
180.00	51.79	180	1.5	V	13.2	2.0	28.3	38.7	43.5	-4.8
160.00	51.99	180	1.5	V	12.9	1.8	28.4	38.3	43.5	-5.2
298.57	52.22	180	2.6	V	13.7	2.3	27.8	40.4	46	-5.6
160.00	50.86	180	1.5	V	12.9	1.8	28.4	37.1	43.5	-6.4
180.00	49.96	180	1.5	V	13.2	2.0	28.3	36.8	43.5	-6.7
895.78	39.61	180	1.5	H	23.7	3.8	28.4	38.7	46	-7.3
895.78	39.50	180	1.5	V	23.7	3.8	28.4	38.6	46	-7.4
911.62	34.96	180	1.5	V	23.2	3.9	28.4	33.7	46	-12.3
911.62	33.20	180	1.5	H	23.2	3.9	28.4	32.0	46	-14.0

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

Standard Applicable

According to §15.247(a)(1), frequency hopping system 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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies.

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 No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2004-11-10

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

Environmental Conditions

Temperature:	23° C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

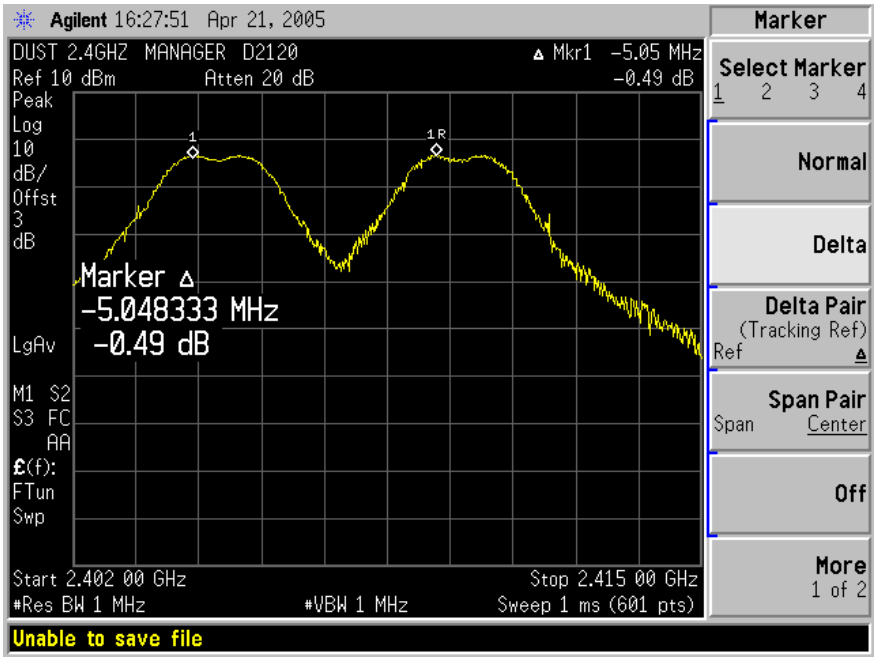
**The testing was performed by Snell Leong on 2005-04-25.*

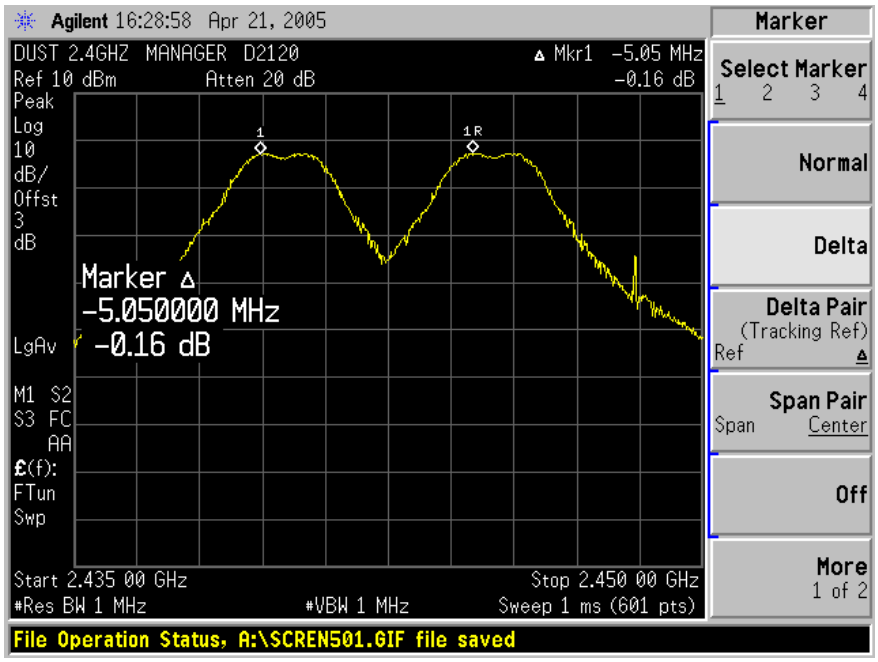
Measurement Results

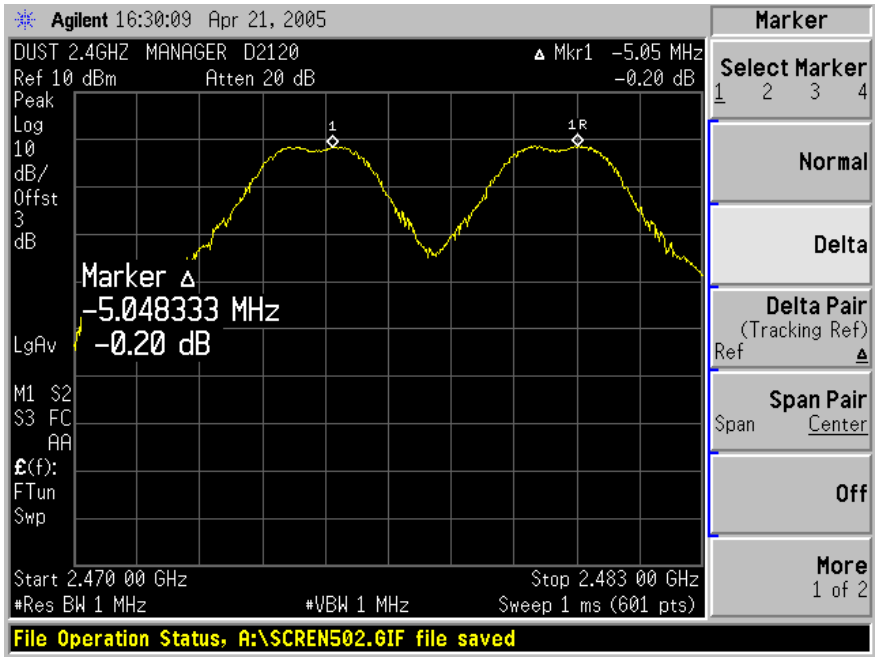
Channel	Frequency MHz	Channel Separation (KHz)
Low	2405	5005
Mid	2440	5005
High	2480	5005

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

Plots of Hopping Channel Separation






Agilent 16:30:09 Apr 21, 2005
DUST 2.4GHZ MANAGER D2120
Ref 10 dBm
Atten 20 dB
Mkr1 -5.05 MHz
-0.20 dB
Peak
Log
10
dB/
Offst
3
dB
Marker Δ
-5.048333 MHz
-0.20 dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Start 2.470 00 GHz
#Res BW 1 MHz
#VBW 1 MHz
Stop 2.483 00 GHz
Sweep 1 ms (601 pts)
Marker
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:\SCREN502.GIF file saved

§15.247 (a) (1) - CHANNEL BANDWIDTH

Standard Applicable

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 No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2004-11-10

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

Environmental Conditions

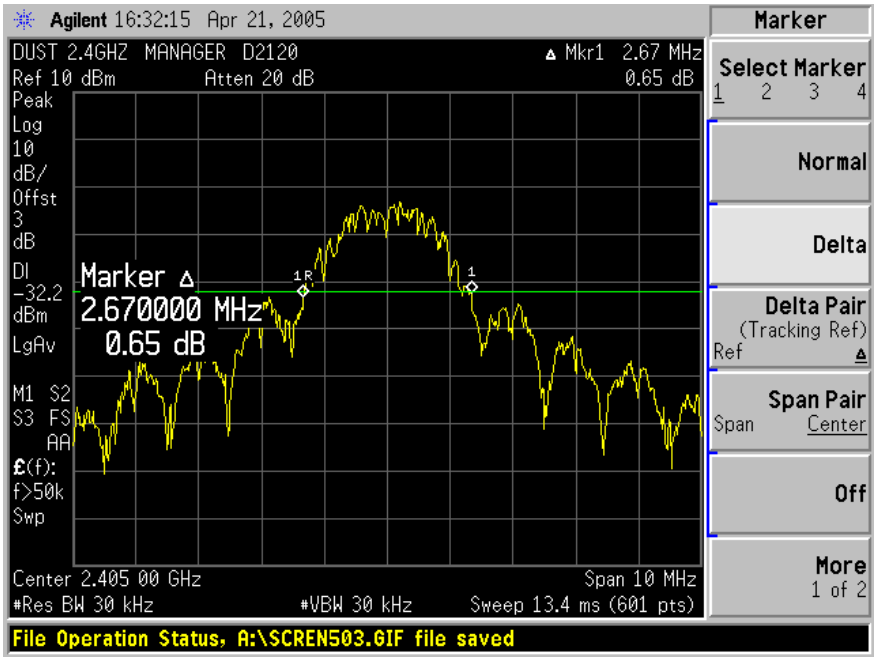
Temperature:	23° C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

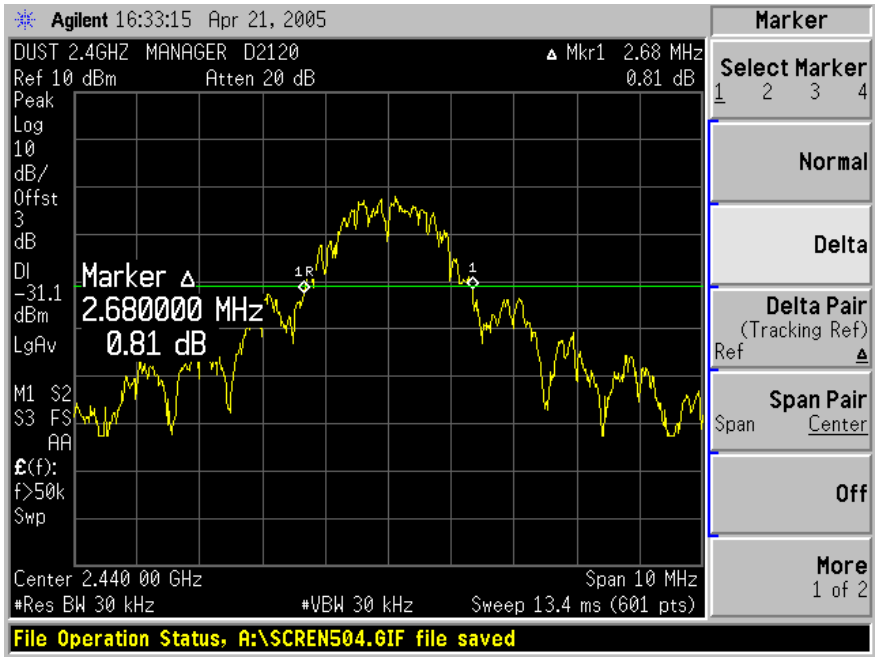
**The testing was performed by Snell Leong on 2005-04-25.*

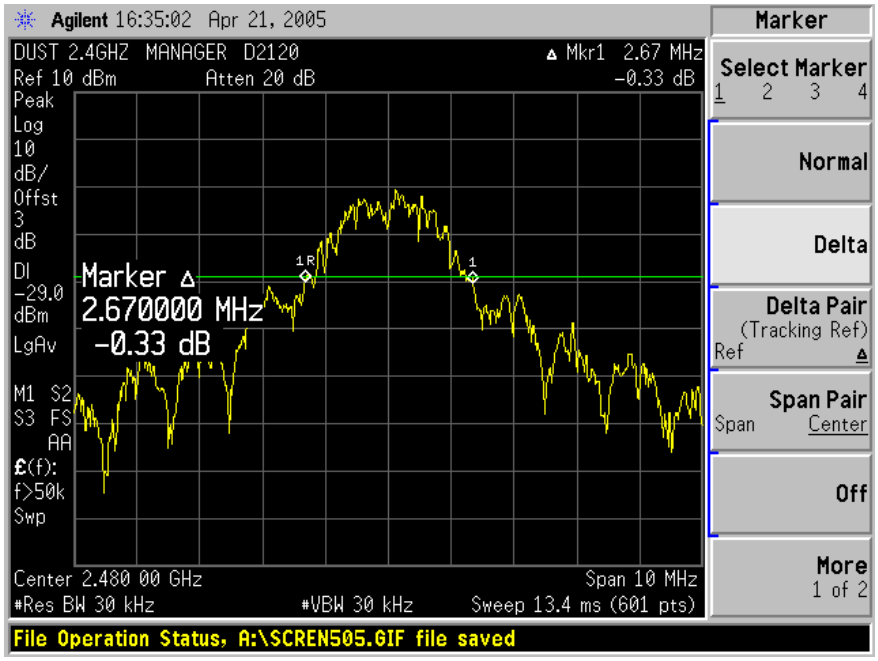
Measurement Result

Channel	Frequency MHz	Channel Bandwidth (KHz)
Low	2405	2670
Mid	2440	2680
High	2480	2670

Plot of Channel Bandwidth






Agilent 16:35:02 Apr 21, 2005
DUST 2.4GHZ MANAGER D2120
Ref 10 dBm
Atten 20 dB
Mkr1 2.67 MHz
-0.33 dB
Peak
Log
10
dB/
Offst
3
dB
Marker
2.670000 MHz
-0.33 dB
Center 2.480 00 GHz
#Res BW 30 kHz
#VBW 30 kHz
Span 10 MHz
Sweep 13.4 ms (601 pts)
Marker
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:\SCREN505.GIF file saved

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

Standard Applicable

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 No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2004-11-10

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

Environmental Conditions

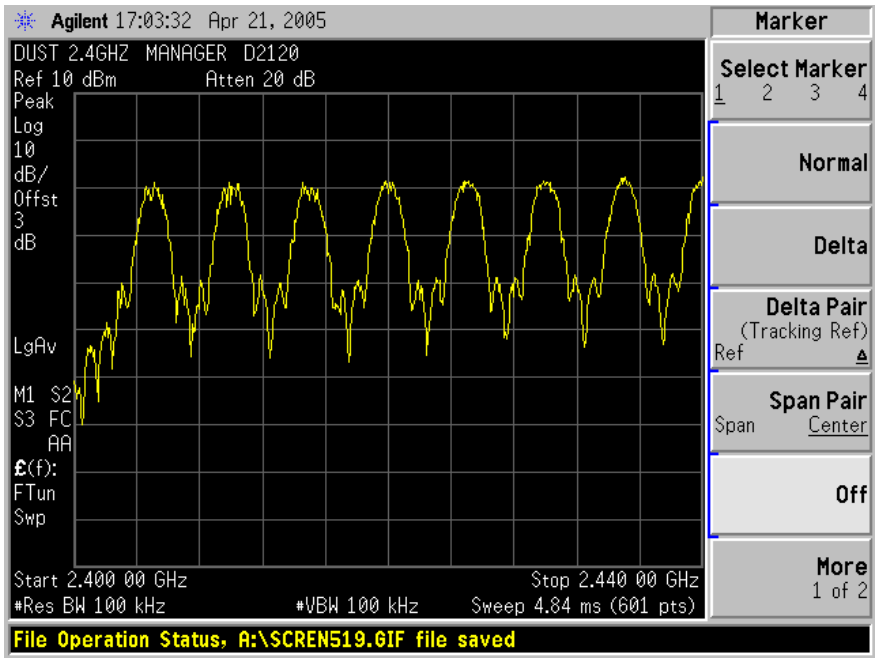
Temperature:	23° C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

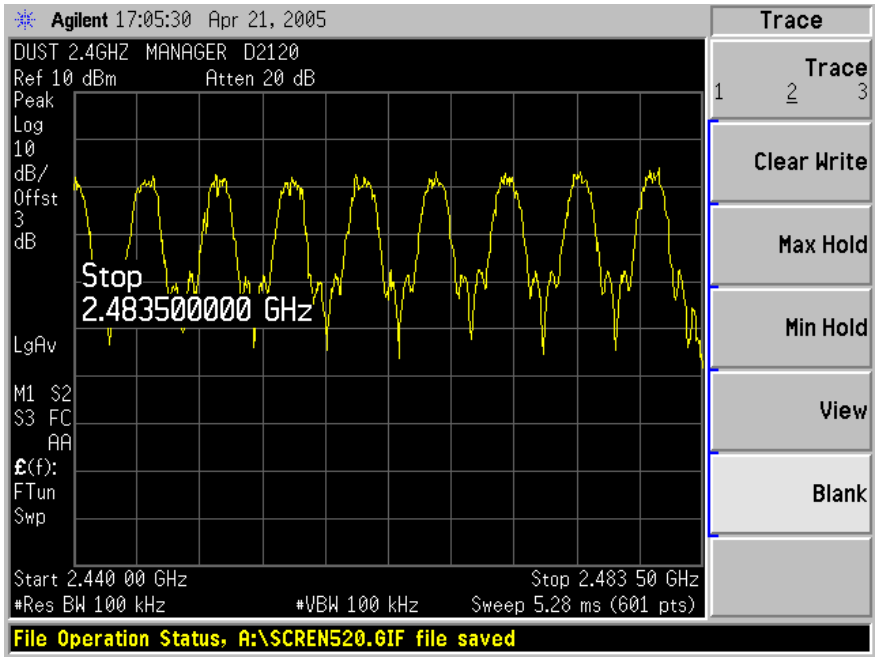
**The testing was performed by Snell Leong on 2005-04-25.*

Measurement Results

Measurement	Standard	Result
16	15	Compliant

Plots of Number of Hopping Frequency





§15.247 9 (a) (1) (iii) - DWELL TIME

Standard Applicable

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 No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2004-11-10

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

Environmental Conditions

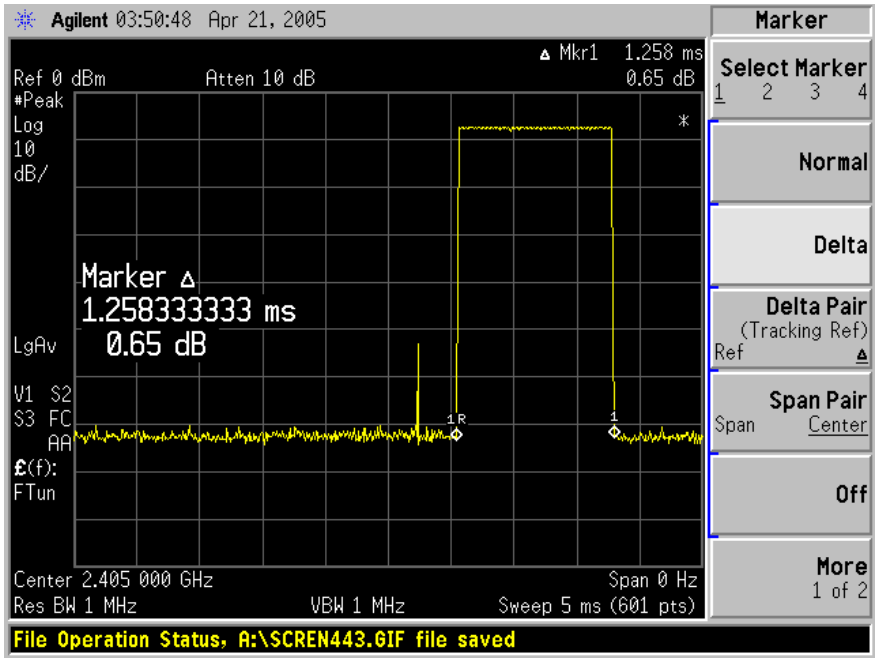
Temperature:	23° C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

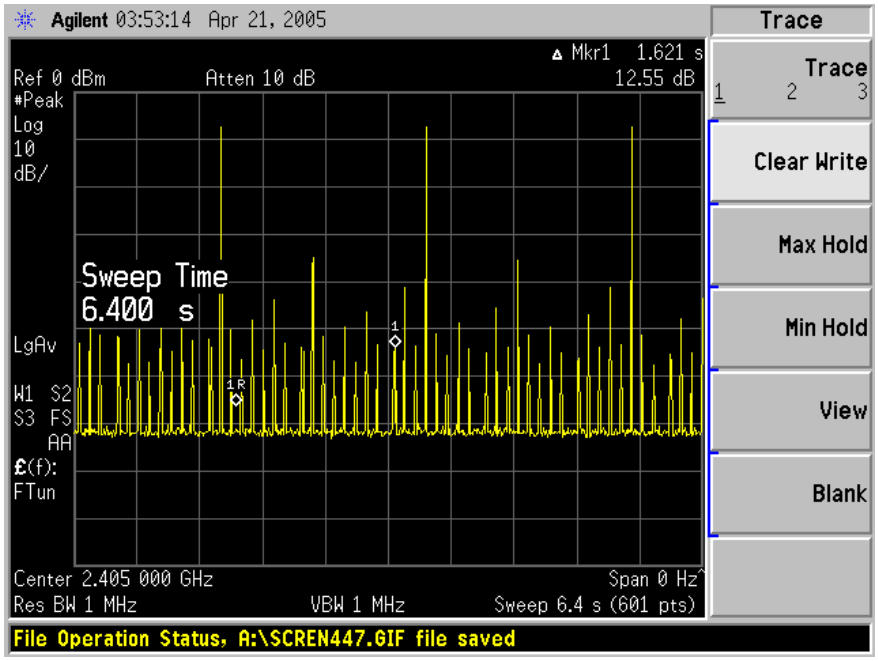
**The testing was performed by Snell Leong on 2005-04-25.*

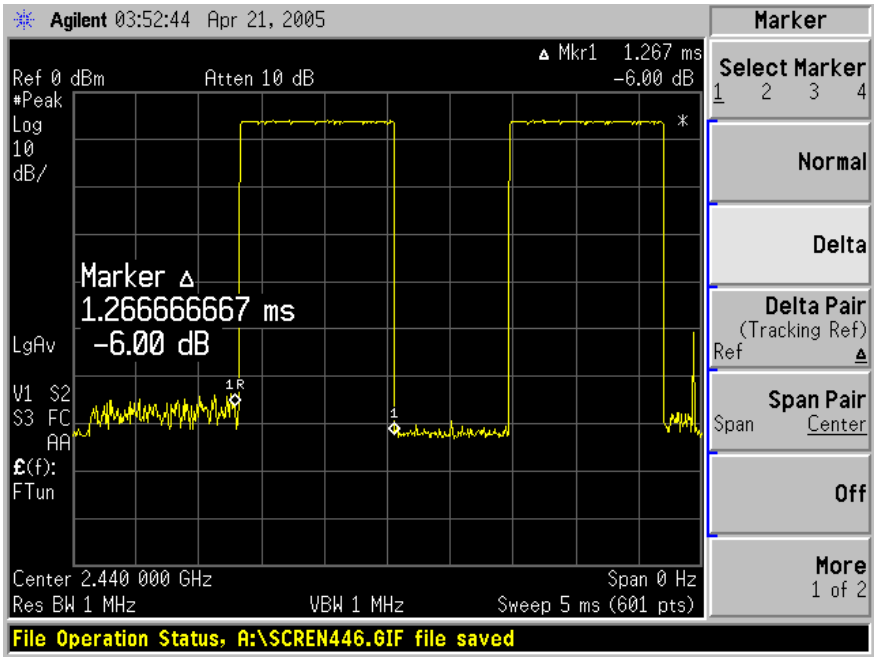
Measurement Results

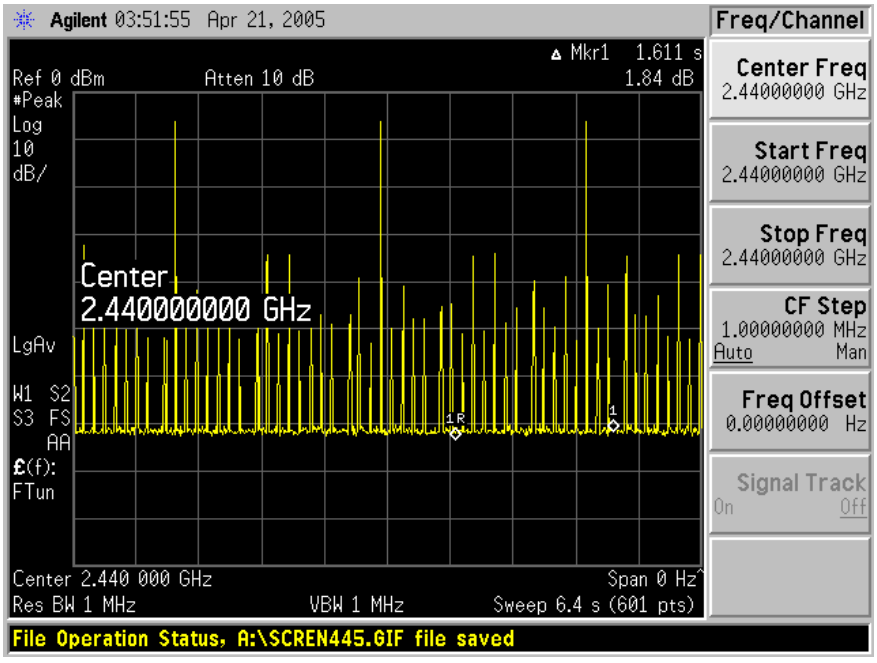
Channel	Frequency MHz	Pulse Wide uSec	Occupied time per 6.4 Sec	Dwell Time Sec	Limit Sec
Low	2405	1258	3	0.004	0.4
Mid	2440	1267	3	0.004	0.4
High	2480	1242	3	0.004	0.4

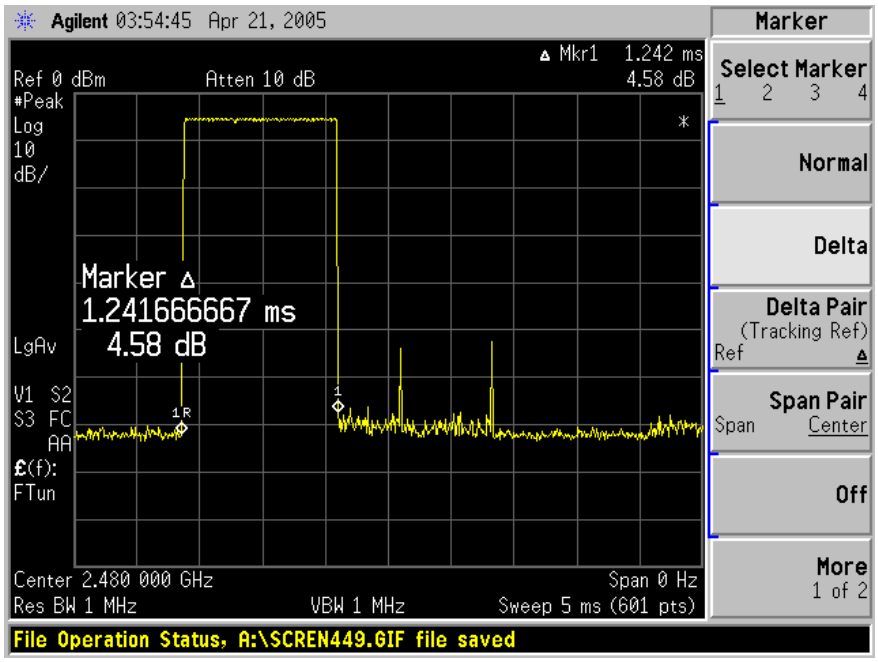
Plots of Dwell Time
Please refer the following plots.

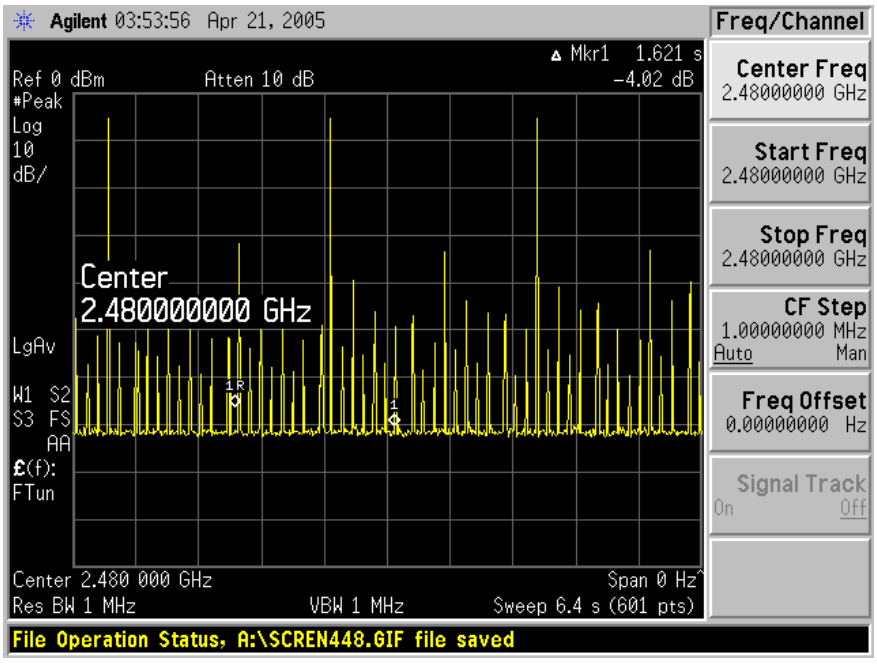

Agilent 03:50:48 Apr 21, 2005
Marker
Mkr1 1.258 ms
Ref 0 dBm
Atten 10 dB
0.65 dB
#Peak
Log
10
dB/
Marker Δ
1.258333333 ms
0.65 dB
LgAv
V1 S2
S3 FC
AA
£(f):
FTun
Center 2.405 000 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 5 ms (601 pts)
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2
File Operation Status, A:\SCREN443.GIF file saved


Agilent 03:53:14 Apr 21, 2005
Trace
Mkr1 1.621 s
Ref 0 dBm
Atten 10 dB
12.55 dB
#Peak
Log
10
dB/
Sweep Time
6.400 s
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Center 2.405 000 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 6.4 s (601 pts)
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
File Operation Status, A:\SCREN447.GIF file saved


Agilent 03:52:44 Apr 21, 2005
Marker
Mkr1 1.267 ms
Ref 0 dBm
Atten 10 dB
-6.00 dB
#Peak
Log
10
dB/
Marker Δ
1.266666667 ms
-6.00 dB
LgAv
V1 S2
S3 FC
AA
£(f):
FTun
Center 2.440 000 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 5 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:\SCREN446.GIF file saved


Agilent 03:51:55 Apr 21, 2005
Freq/Channel
Mkr1 1.611 s
Ref 0 dBm
Atten 10 dB
1.84 dB
#Peak
Log
10
dB/
Center
2.440000000 GHz
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Center 2.440 000 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 6.4 s (601 pts)
Center Freq
2.44000000 GHz
Start Freq
2.44000000 GHz
Stop Freq
2.44000000 GHz
CF Step
1.00000000 MHz
Auto Man
Freq Offset
0.00000000 Hz
Signal Track
On Off
File Operation Status, A:\SCREN445.GIF file saved


Agilent 03:54:45 Apr 21, 2005
Marker
Mkr1 1.242 ms
4.58 dB
Ref 0 dBm
Atten 10 dB
#Peak
Log
10
dB/
Marker Δ
1.241666667 ms
4.58 dB
LgAv
V1 S2
S3 FC
AA
£(f):
FTun
Center 2.480 000 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 5 ms (601 pts)
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Δ
Span Pair
Span Center
Off
More
1 of 2
File Operation Status, A:\SCREN449.GIF file saved


Agilent 03:53:56 Apr 21, 2005
Freq/Channel
Mkr1 1.621 s
-4.02 dB
Ref 0 dBm
Atten 10 dB
#Peak
Log
10
dB/
Center
2.480000000 GHz
LgAv
W1 S2
S3 FS
AA
£(f):
FTun
Center 2.480 000 GHz
Span 0 Hz
Res BW 1 MHz
VBW 1 MHz
Sweep 6.4 s (601 pts)
Center Freq
2.48000000 GHz
Start Freq
2.48000000 GHz
Stop Freq
2.48000000 GHz
CF Step
1.00000000 MHz
Auto Man
Freq Offset
0.00000000 Hz
Signal Track
On Off
File Operation Status, A:\SCREN448.GIF file saved

§15.247(a)(2)– 6 DB BANDWIDTH

Standard Applicable

According to §15.247(a)(2), for direct sequence systems, the minimum 6dB bandwidth shall be at least 500 kHz.

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 6 dB from the reference level. Record the frequency difference as the emission bandwidth. (6 dB bandwidth for DTS)
4. Same as (3) except 26 dB. (26dB bandwidth for UNII)
5. Repeat above procedures until all frequencies measured were complete.

Equipment Lists

Manufacturer	Model No.	Description	Calibration Date
HP	8565EC	Spectrum Analyzer	2005-01-22

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

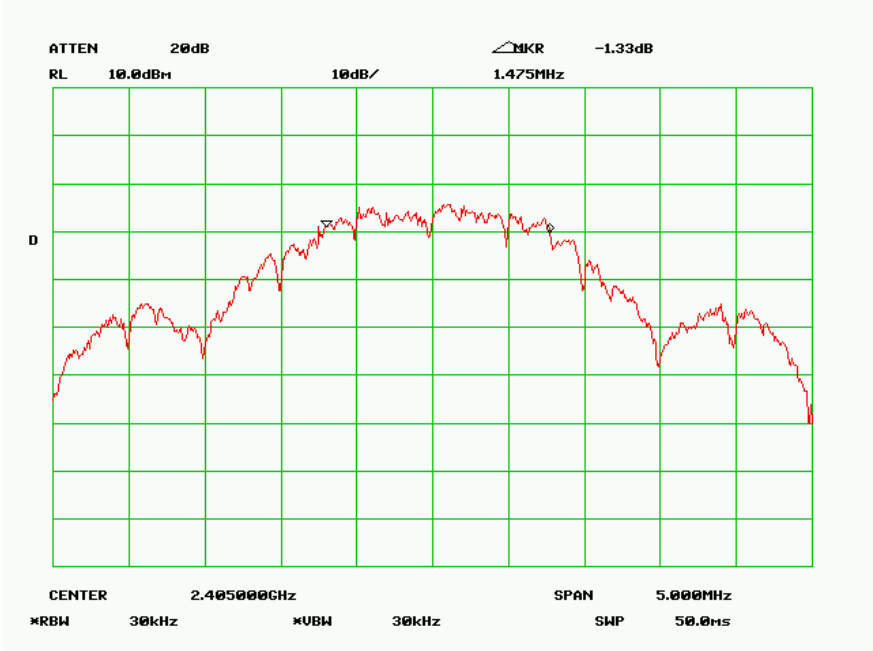
Environmental Conditions

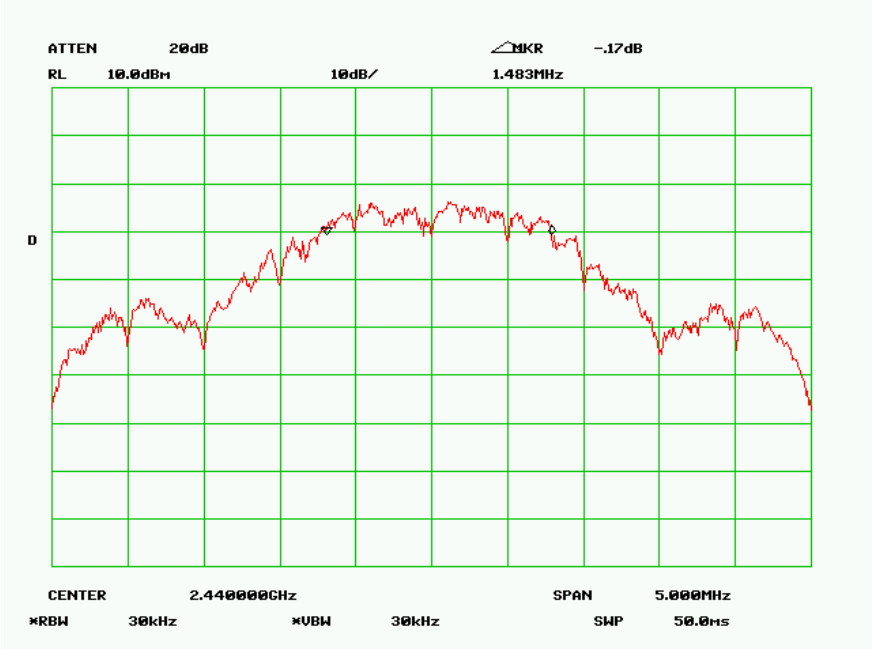
Temperature:	23° C
Relative Humidity:	65%
ATM Pressure:	1025 mbar

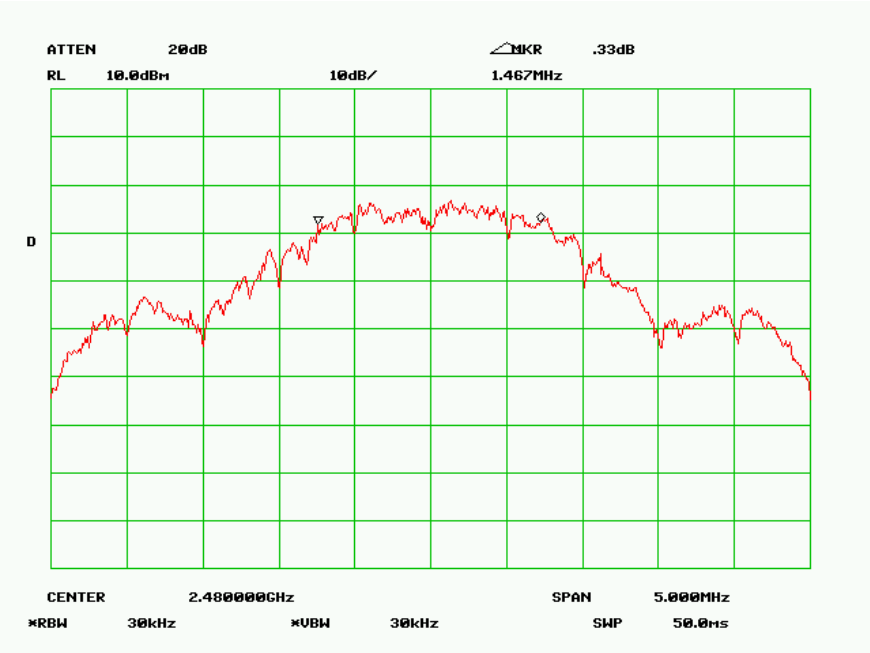
The testing was performed by Snell Leong on 2005-05-29.

Measurement Result

Channel	Frequency MHz	6dB BW MHz	Limit KHz
Low	2405	1.475	>500
Mid	2440	1.483	>500
High	2480	1.467	>500


ATTEN 20dB
MKR -1.33dB
RL 10.0dBm
10dB/
1.475MHz
D
CENTER 2.405000GHz
SPAN 5.000MHz
*RBW 30kHz
*VBW 30kHz
SWP 50.0ms


ATTEN 20dB
MKR -.17dB
RL 10.0dBm
10dB/
1.483MHz
D
CENTER 2.440000GHz
SPAN 5.000MHz
*RBW 30kHz
*VBW 30kHz
SWP 50.0ms


ATTEN 20dB
MKR .33dB
RL 10.0dBm
10dB/
1.467MHz
D
CENTER 2.480000GHz
SPAN 5.000MHz
*RBW 30kHz
*VBW 30kHz
SWP 50.0ms

§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 No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2004-11-10

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

Environmental Conditions

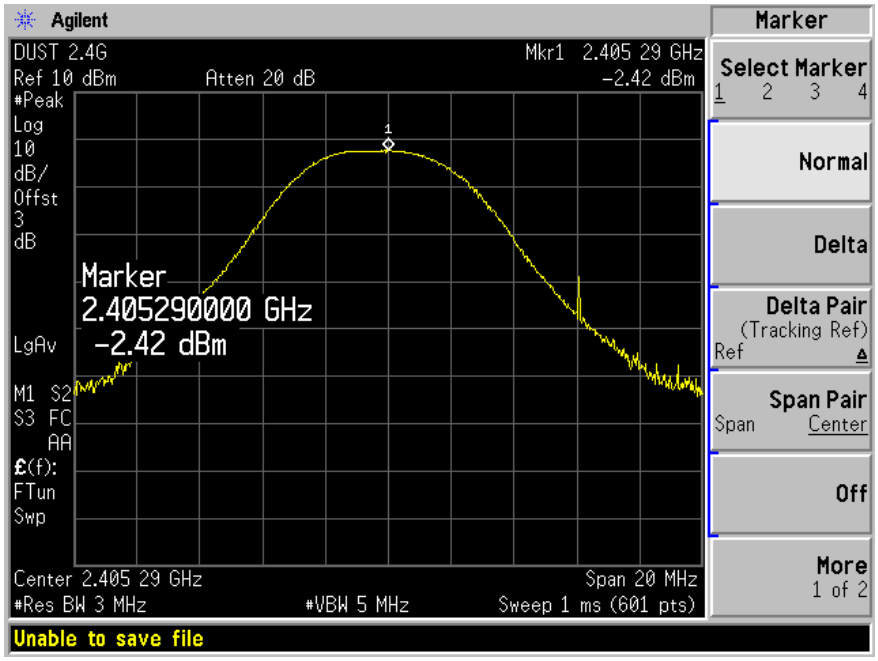
Temperature:	23° C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

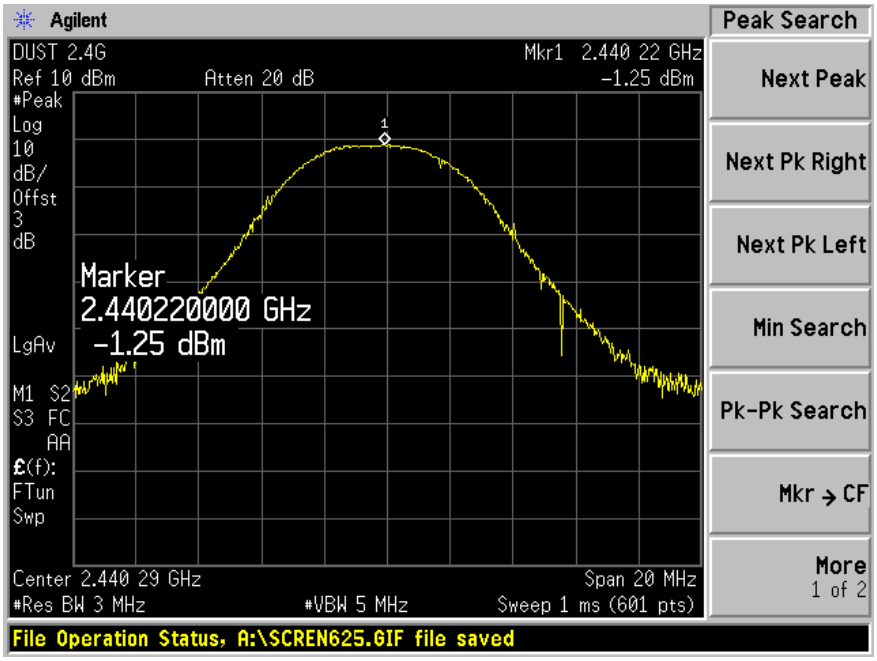
**The testing was performed by Snell Leong on 2005-04-25.*

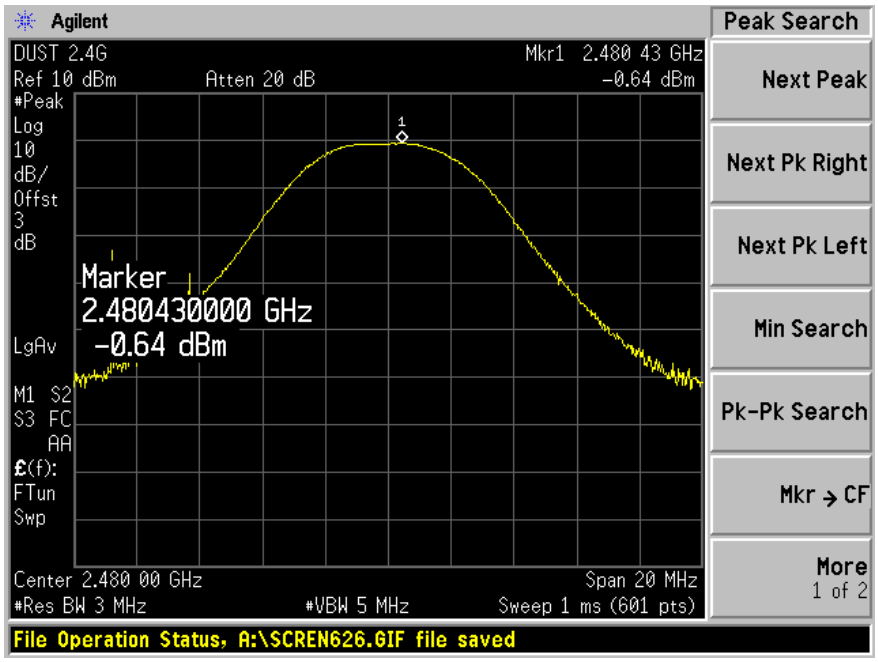
Measurement Result

Channel	Frequency	Max Peak Output Power		Limit	Result
	MHz	(dBm)	(m Watt)	(m Watt)	
Low	2405	-2.42	0.57	125	pass
Mid	2440	-1.25	0.75	125	pass
High	2480	-0.64	0.86	125	pass

Plots of Maximum Peak Output Power


Agilent
DUST 2.4G
Ref 10 dBm
Atten 20 dB
Mkr1 2.405 29 GHz
-2.42 dBm
#Peak
Log
10
dB/
Offst
3
dB
Marker
2.405290000 GHz
-2.42 dBm
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Center 2.405 29 GHz
#Res BW 3 MHz
#VBW 5 MHz
Span 20 MHz
Sweep 1 ms (601 pts)
Unable to save file
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2


Agilent
DUST 2.4G
Ref 10 dBm
Atten 20 dB
Mkr1 2.440 22 GHz
-1.25 dBm
#Peak
Log
10
dB/
Offst
3
dB
Marker
2.440220000 GHz
-1.25 dBm
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Center 2.440 29 GHz
#Res BW 3 MHz
#VBW 5 MHz
Span 20 MHz
Sweep 1 ms (601 pts)
File Operation Status, A:\SCREN625.GIF file saved
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2


Agilent
DUST 2.4G
Mkr1 2.480 43 GHz
Ref 10 dBm
Atten 20 dB
-0.64 dBm
#Peak
Log
10
dB/
Offst
3
dB
Marker
2.480430000 GHz
-0.64 dBm
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
Center 2.480 00 GHz
Span 20 MHz
#Res BW 3 MHz
#VBW 5 MHz
Sweep 1 ms (601 pts)
File Operation Status, A:\SCREN626.GIF file saved
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2

§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 No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2004-11-10

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

Environmental Conditions

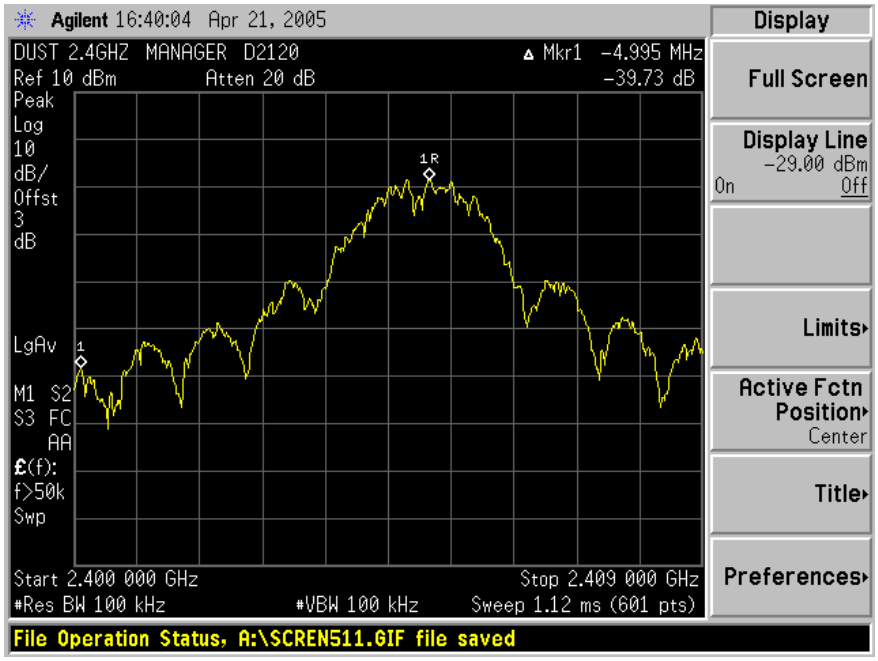
Temperature:	23° C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

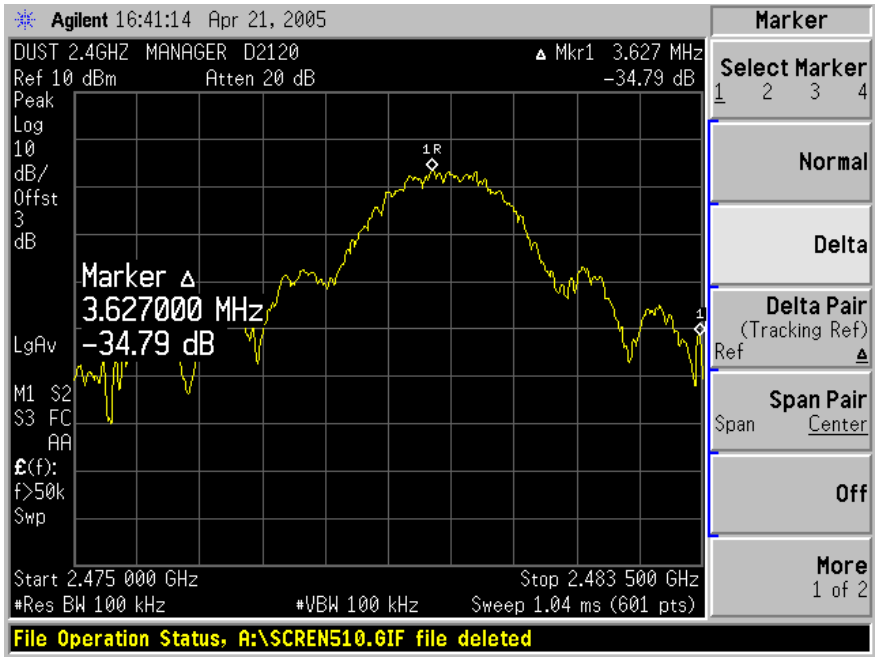
**The testing was performed by Snell Leong on 2005-04-25.*

Plots of 100kHz Bandwidth of Band Edge

Please refer the following plots.

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


Agilent 16:40:04 Apr 21, 2005
DUST 2.4GHZ MANAGER D2120
Ref 10 dBm
Atten 20 dB
Mkr1 -4.995 MHz
-39.73 dB
Peak
Log
10
dB/
Offst
3
dB
1R
LgAv
M1 S2
S3 FC
AA
£(f):
f>50k
Swp
Start 2.400 000 GHz
#Res BW 100 kHz
#VBW 100 kHz
Stop 2.409 000 GHz
Sweep 1.12 ms (601 pts)
File Operation Status, A:\SCREN511.GIF file saved
Display
Full Screen
Display Line
-29.00 dBm
On Off
Limits
Active Fctn
Position
Center
Title
Preferences


Agilent 16:41:14 Apr 21, 2005
DUST 2.4GHZ MANAGER D2120
Ref 10 dBm
Atten 20 dB
Mkr1 3.627 MHz
-34.79 dB
Peak
Log
10
dB/
Offst
3
dB
1R
Marker Δ
3.627000 MHz
-34.79 dB
LgAv
M1 S2
S3 FC
AA
£(f):
f>50k
Swp
Start 2.475 000 GHz
#Res BW 100 kHz
#VBW 100 kHz
Stop 2.483 500 GHz
Sweep 1.04 ms (601 pts)
File Operation Status, A:\SCREN510.GIF file deleted
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref
Span Pair
Span Center
Off
More
1 of 2

§15.247(e) - POWER SPECTRAL DENSITY

Standard Applicable

According to §15.247 (e), for direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

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 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 1.5MHz span mode. And then, set RBW and VBW of spectrum analyzer to proper value. (DTS)
4. Adjust the center frequency of SA on any frequency be measured and set SA to 50MHz span mode. And then, set RBW and VBW of spectrum analyzer to proper value. (UNII)
5. Repeat above procedures until all frequencies measured were complete.

Equipment Lists

Manufacturer	Model No.	Description	Calibration Date
HP	8565EC	Spectrum Analyzer	2005-01-22

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

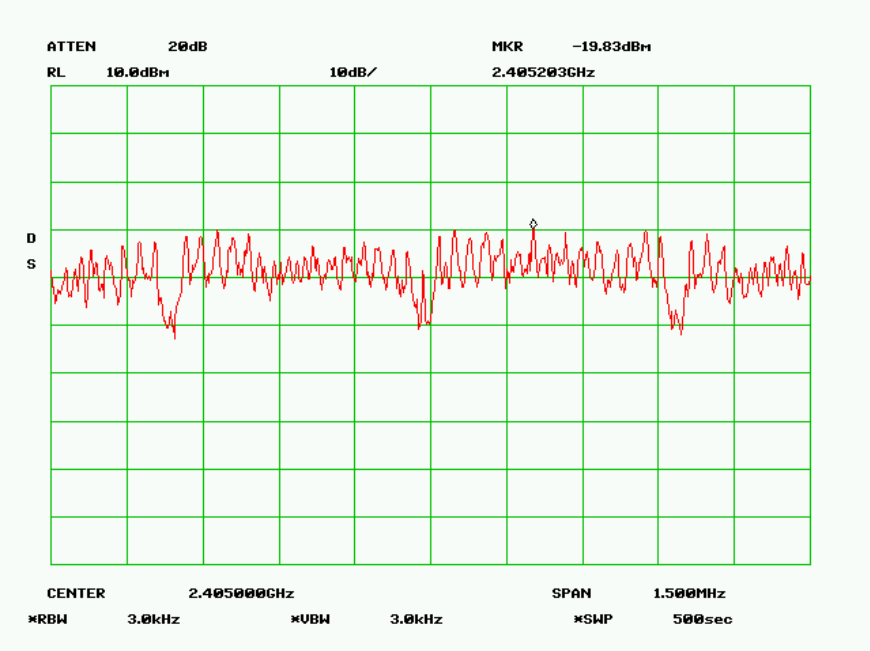
Environmental Conditions

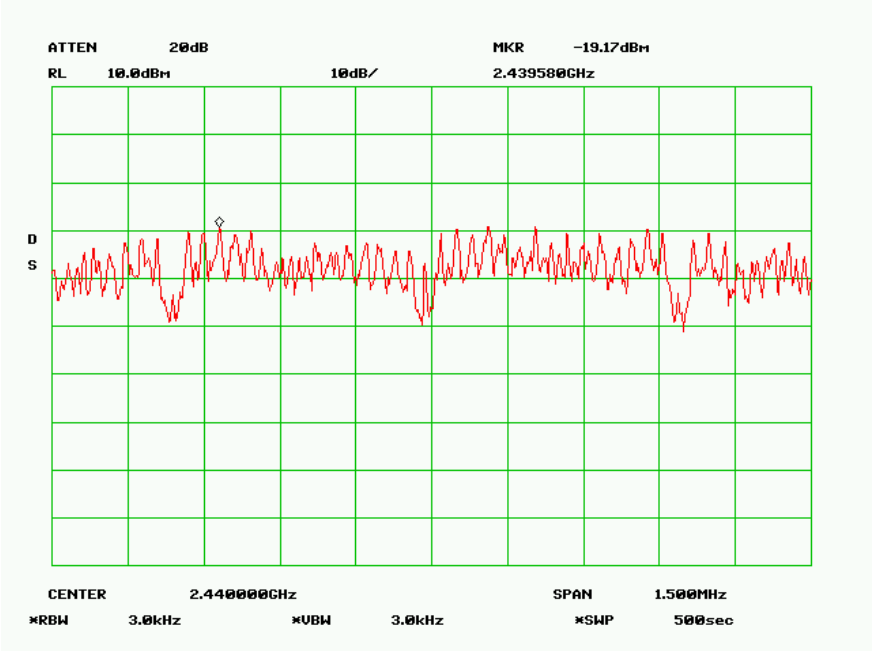
Temperature:	23° C
Relative Humidity:	65%
ATM Pressure:	1025 mbar

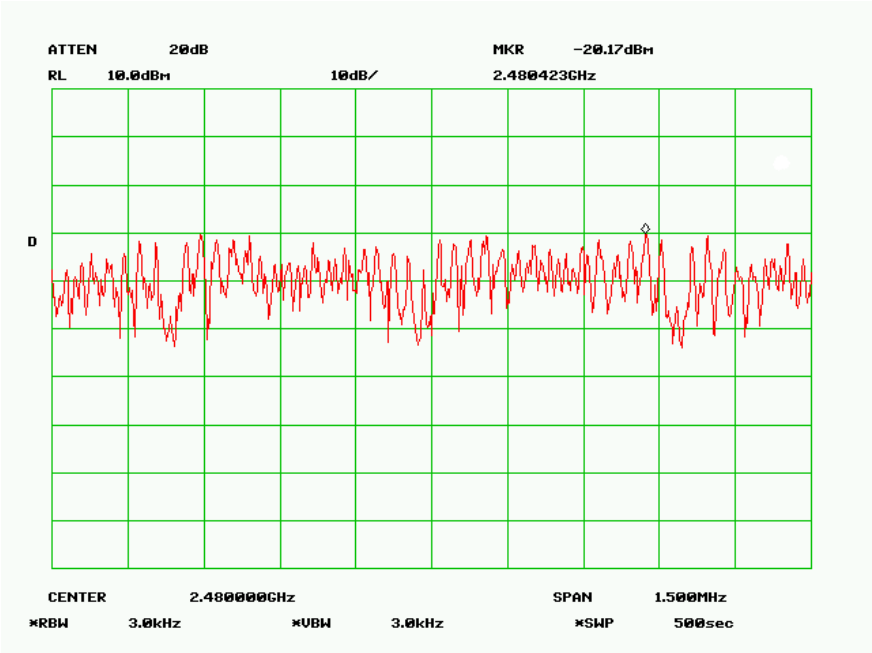
The testing was performed by Snell Leong on 2005-05-29.

Measurement Results

Channel	Frequency MHz	PSD dBm	Limit dBm
Low	2405	-19.83	8
Mid	2440	-19.17	8
High	2480	-20.17	8


ATTEN 20dB
MKR -19.83dBm
RL 10.0dBm
10dB/
2.405203GHz
D
S
CENTER 2.405000GHz
SPAN 1.500MHz
*RBW 3.0kHz
*VBW 3.0kHz
*SWP 500sec


ATTEN 20dB
MKR -19.17dBm
RL 10.0dBm
10dB/
2.439580GHz
D
S
CENTER 2.440000GHz
SPAN 1.500MHz
*RBW 3.0kHz
*VBW 3.0kHz
*SWP 500sec


ATTEN 20dB
MKR -20.17dBm
RL 10.0dBm
10dB/
2.480423GHz
D
CENTER 2.480000GHz
SPAN 1.500MHz
*RBW 3.0kHz
*VBW 3.0kHz
*SWP 500sec

§ 2.1051 - SPURIOUS EMISSION AT ANTENNA PORT

Standard Applicable

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 No.	Serial No.	Calibration Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2004-11-10

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

Environmental Conditions

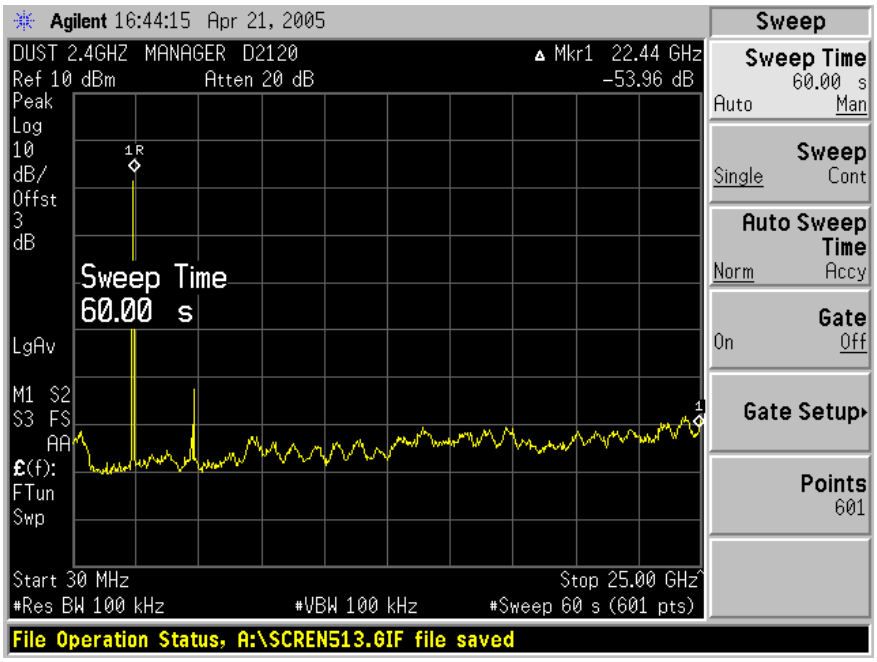
Temperature:	23° C
Relative Humidity:	63%
ATM Pressure:	1025 mbar

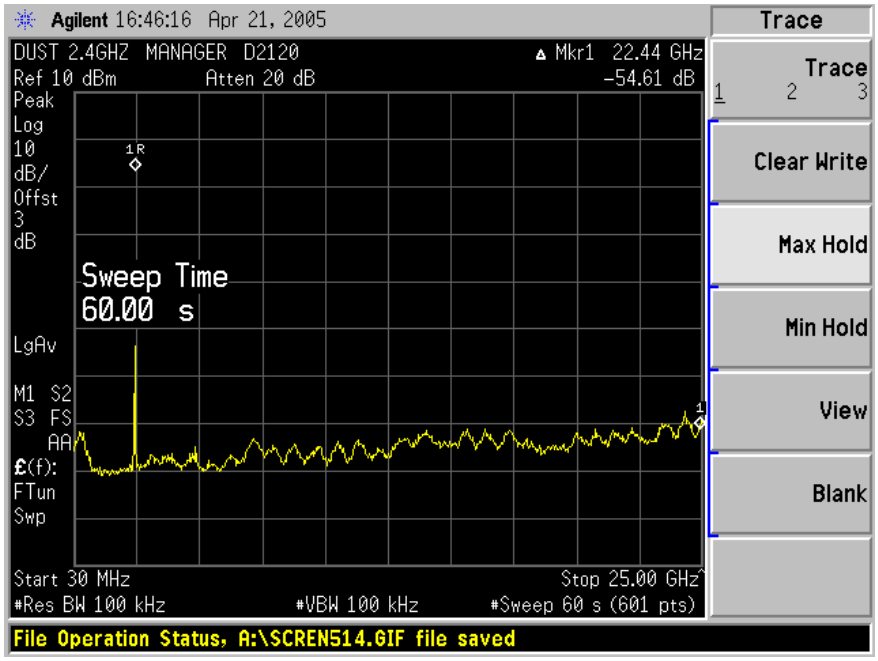
**The testing was performed by Snell Leong on 2005-04-25.*

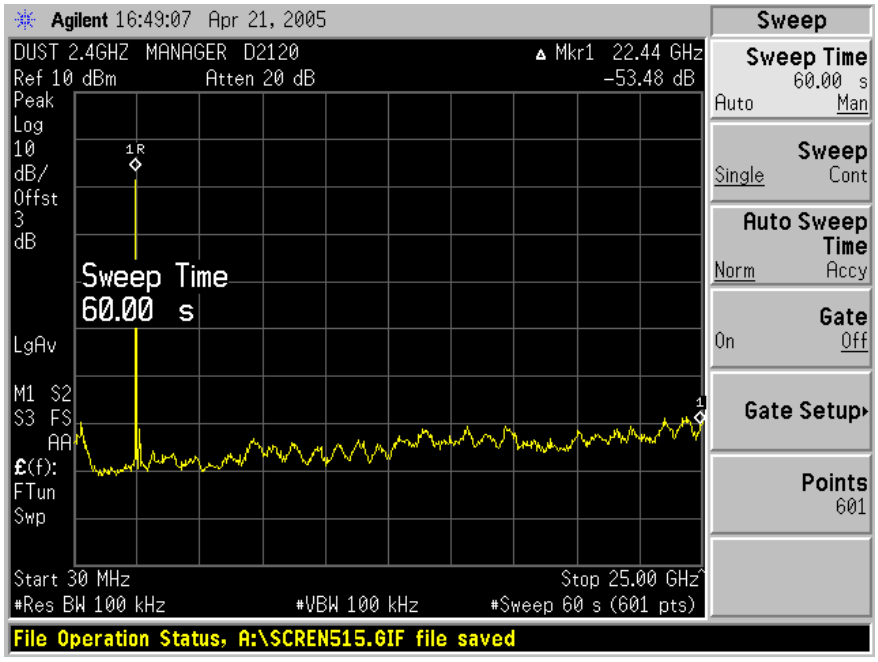
Measurement Results

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.


Agilent 16:44:15 Apr 21, 2005
DUST 2.4GHZ MANAGER D2120
Ref 10 dBm
Atten 20 dB
Mkr1 22.44 GHz
-53.96 dB
Peak
Log
10
dB/
Offst
3
dB
1R
Sweep Time
60.00 s
LgAv
M1 S2
S3 FS
AA
£(f):
FTun
Swp
Start 30 MHz
#Res BW 100 kHz
#VBW 100 kHz
Stop 25.00 GHz
#Sweep 60 s (601 pts)
File Operation Status, A:\SCREN513.GIF file saved
Sweep
Sweep Time
60.00 s
Auto Man
Sweep
Single Cont
Auto Sweep Time
Norm Accy
Gate
On Off
Gate Setup
Points
601


Agilent 16:46:16 Apr 21, 2005
DUST 2.4GHZ MANAGER D2120
Ref 10 dBm
Atten 20 dB
Mkr1 22.44 GHz
-54.61 dB
Peak
Log
10
dB/
Offst
3
dB
1R
Sweep Time
60.00 s
LgAv
M1 S2
S3 FS
AA
£(f):
FTun
Swp
Start 30 MHz
#Res BW 100 kHz
#VBW 100 kHz
Stop 25.00 GHz
#Sweep 60 s (601 pts)
File Operation Status, A:\SCREN514.GIF file saved
Trace
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank


Agilent 16:49:07 Apr 21, 2005
DUST 2.4GHZ MANAGER D2120
Mkr1 22.44 GHz
Ref 10 dBm
Atten 20 dB
-53.48 dB
Peak
Log
10
dB/
Offst
3
dB
1R
Sweep Time
60.00 s
LgAv
M1 S2
S3 FS
AA
£(f):
FTun
Swp
Start 30 MHz
Stop 25.00 GHz
#Res BW 100 kHz
#VBW 100 kHz
#Sweep 60 s (601 pts)
Sweep
Sweep Time
60.00 s
Auto Man
Sweep
Single Cont
Auto Sweep Time
Norm Accy
Gate
On Off
Gate Setup
Points
601
File Operation Status, A:\SCREN515.GIF file saved