FCC 47 CFR PART 15 SUBPART E

TEST REPORT

For

Wireless LAN module built in Notebook PC

Brand Name: Compal; acer

Model Number: CL51

FCC ID: GKRWM3BAB51

Report No: B30811202-RP

Issue Date: September 9, 2003

Prepared for

Compal Electronics Inc.
No. 581, Jui Kuang Rd., Neihu,
Taipei, (114) Taiwan, R.O.C.

Prepared by

Compliance Certification Services Inc.
No. 81-1, Lane 210, Bade Rd. 2, Luchu Hsiang,
Taoyuan Hsien, (338) Taiwan, R.O.C.
TEL: 886-3-324-0332
FAX: 886-3-324-5235

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1. TEST RESULT CERTIFICATION

Applicant:	COMPAL ELECTRONICS, INC. No. 581, Jui Kuang Rd., Neihu, Taipei (114), Taiwan, R.O.C.
Equipment Under Test:	Wireless LAN module built in Notebook PC
Trade Name:	Compal; acer
Model:	CL51
Model Difference:	N/A
Report Number:	B30811202-RP
Date of Test:	August 22 ~ 29, 2003

APPLICABLE STANDARDS	
STANDARD	**TEST RESULT**
FCC Part 15 Subpart E	No non-compliance noted

We hereby certify that:

Compliance Certification Services Inc. tested the above equipment. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.4 (1992) and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits of FCC Rules Part 15.407.

The test results of this report relate only to the tested sample identified in this report.

Approved by:

Jonson Lee
Director of Linkou Laboratory
Compliance Certification Services Inc.

Reviewed by:

Eric Wong
Section Manager
Compliance Certification Services Inc.

2. EUT DESCRIPTION

Product	Wireless LAN module built in Notebook PC
Trade Name	Compal; acer
Model	CL51
Model Discrepancy	N/A
FCC ID	GKRWM3BAB51
Module Trade Name	Intel
Module Model	WM3A2100A
Power Rating	Input: 100-240Vac, 60Hz, 1.6A Output: +18.5 Vdc, 3.5A
Frequency Range	802.11a: 5.15 ~ 5.35GHz 802.11b: 2.4 ~ 2.497GHz
Modulation Technique	802.11a: OFDM 802.11b: DSSS (DBPSK, DQPSK, CCK)
Transmitting Speed	802.11a: 54, 48, 36, 24, 18, 12, 9, 6Mbps 802.11b: 11, 5.5, 2, 1Mbps
Transmit Power	802.11a: 17.32 dBm 802.11b: 16.60 dBm
Number of Channels	802.11a: 8 CH 802.11b: 11 CH
Antenna Designation	Two PIFA anteenas

Operation Frequency

UNLICENSED NATIONAL INFORMATION INFRASTRUCTURE (U-NII)	
CHANNEL	**BASE MODE (MHz)**
1	5180
2	5200
3	5220
4	5240
5	5260
6	5280
7	5300
8	5320

Note: *This submittal(s) (test report) is intended for FCC ID: GKRWM3BAB51 filing to comply with Section 15.407 of the FCC Part 15, Subpart E Rules. The composite system (digital device) is in compliance with Subpart B authorized under a DoC procedure.*

Note: *The 5.2 GHz U-NII band is applicable to this report; another bands of operation (2.4 GHz) is documented in a separate report.*

3. TEST METHODOLOGY

Both conducted and radiated testing was performed according to the procedures in ANSI C63.4 (1992). Radiated testing was performed at an antenna to EUT distance 3 meters.

3.1EUT CONFIGURATION

The EUT configuration for testing is installed for RF field strength measurement to meet the Commissions requirement, and is operated in a manner intended to generate the maximum emission in a continuous normal application.

3.2EUT EXERCISE

The EUT (Wireless LAN module built in Notebook PC) is operated in the engineering mode to fix the Tx frequency for the purposes of measurement.

According to its specifications, the EUT must comply with the requirements of Section 15.407 under the FCC Rules Part 15 Subpart E. The composite system (Digital device) is in compliance with Subpart B authorized under the DoC procedure.

3.3GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is positioned at 0.8 m above the ground plane. According to the requirements in Section 13.1.4.1 of ANSI C63.4-1992, the conducted emission from the EUT is measured in the frequency range between 0.15 MHz and 30MHz, using the CISPR Quasi-Peak detector mode.

Radiated Emissions

The EUT is placed on the turntable, which is 0.8 m above the ground plane. The turntable is then rotated for 360 degrees to determine the proper orientation for the maximum emission level. The EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission level. And, each emission is to be maximized by changing the horizontal and vertical polarization of the receiving antenna. In order to find out the maximum emission level, the relative positions of the EUT was rotated in each of the three orthogonal axes, according to the requirements in Section 13.1.4.1 of ANSI C63.4-1992.

3.4FCC PART 15.205 RESTRICTED BANDS OF OPERATIONS

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

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285	3600 - 4400	([2])
13.36 - 13.41	322 - 335.4		

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

[2] Above 38.6

(b) Except as provided in 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.

3.5DESCRIPTION OF TEST MODES

The EUT has been tested under the operating condition.

Software used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

Test mode: Channel 1 (5180MHz), Channel 4 (5240MHz) and Channel 8 (5320MHz), which give the highest data rate of 54Mbps, are chosen for full testing.

4. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

5. FACILITIES AND ACCREDITATIONS

5.1FACILITIES

All measurement facilities used to collect the measurement data are located at

☒ No. 81-1, Lane 210, Bade Rd. 2, Luchu Hsiang, Taoyuan Hsien, Taiwan, R.O.C.

☐ No. 199, Chunghsen Road, Hsintien City, Taipei Hsien, Taiwan, R.O.C.

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

5.2EQUIPMENT

Radiated emissions are measured with one or more of the following types of linearly polarized antennas: tuned dipole, biconical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers.

Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

5.3LABORATORY ACCREDITATIONS AND LISTING

The test facilities used to perform radiated and conducted emissions tests are accredited by National Voluntary Laboratory Accreditation Program for the specific scope of accreditation under Lab Code: 200600-0 to perform Electromagnetic Interference tests according to FCC PART 15 AND CISPR 22 requirements. No part of this report may be used to claim or imply product endorsement by NVLAP or any agency of the US Government. In addition, the test facilities are listed with Federal Communications Commission (registration no: 93105 and 90471).

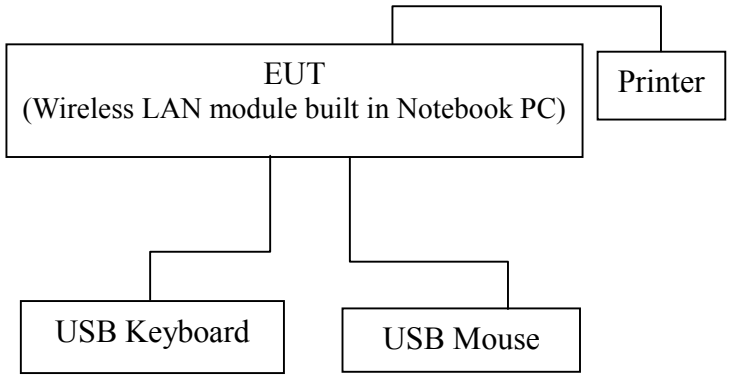
5.4TABLE OF ACCREDITATIONS AND LISTINGS

Country	Agency	Scope of Accreditation	Logo
USA	NVLAP*	EN 55011, EN 55014-1, AS/NZS 1044, CNS 13783-1, EN 55022, CNS 13438, EN 61000-3-2, EN 61000-3-3, ANSI C63.4, FCC OST/MP-5, AS/NZS 3548IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8, IEC 61000-4-11	NVLAP® 200600-0
USA	FCC	3/10 meter Open Area Test Sites to perform FCC Part 15/18 measurements	FC 93105, 90471
Japan	VCCI	4 3/10 meter Open Area Test Sites to perform conducted/radiated measurements	VCCI R-393/1066/725/879 C-402/747/912
Norway	NEMKO	EN 50081-1/2, EN 50082-1/2, IEC 61000-6-1/2, EN 50091-2, EN 50130-4, EN 55011, EN 55013, EN 55014-1/2, EN 55015, EN 55022, EN 55024, EN 61000-3-2/3, EN 61326-1, IEC 61000-4-2/3/4/5/6/8/11, EN 60601-1-2, EN 300 328-2, EN 300 422-2, EN 301 419-1, EN 301 489-01/03/07/08/09/17, EN 301 419-2/3, EN 300 454-2, EN 301 357-2	N ELA 124a ELA 124b ELA 124c
Taiwan	CNLA	EN 300 328-1, EN 300 328-2, EN 300 220-1, EN 300 220-2, EN 300 220-3, 47 CFR FCC Part 15 Subpart C, EN 61000-3-2, EN 61000-3-3, CNS 13439, CNS 13783-1, CNS 14115, CNS 13438, AS/NZS 3548, CNS 13022-1, IEC 1000-4-3/4/5/6/8/11, CNS 13022-2/3	CNLA 0363 ILAC MRA
Taiwan	BSMI	CNS 13438, CNS 13783-1, CNS 13439, CNS 14115	SL2-IS-E-0014 SL2-IN-E-0014 SL2-A1-E-0014 SL2-R1-E-0014 SL2-R2-E-0014 SL2-L1-E-0014
Canada	Industry Canada	RSS212, Issue 1	Canada IC 3991-3 IC 3991-4

** No part of this report may be used to claim or imply product endorsement by NVLAP or any agency of the US Government.*

6. SETUP OF EQUIPMENT UNDER TEST

6.1 SETUP CONFIGURATION OF EUT



6.2SUPPORT EQUIPMENT

Device Type	Brand	Model	FCC ID	Series No.	Data Cable	Power Cord
USB Keyboard	Logitech	M-MM43	FCC DoC	LZE94052771	Shielded, 1.8m	N/A
USB Mouse	Logitech	M-CAA43	FCC DoC	PHB02400489	Shielded, 1.8m	N/A
Printer	HP	3137S01428	FCC DoC	DSI6XU2225	Unshielded, 1.8m	Unshielded, 1.8m

Notes:

1. *All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.*
2. *Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.*

7. FCC PART 15 REQUIREMENTS

7.1. BAND EDGES MEASUREMENT

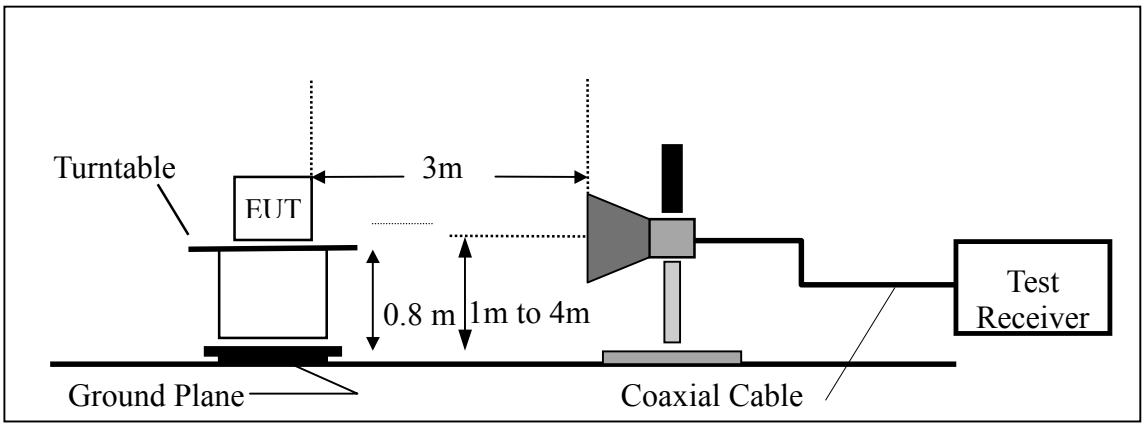
LIMIT

According to §15.247(c), in any 100 KHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in15.209(a).

MEASUREMENT EQUIPMENT USED

EQUIPMENT TYPE	MFR	Model No.	Serial No.	Cal. Due.
Spectrum Analyzer	Agilent	E4446A	US42510252	4/27/2004
Spectrum Analyzer	R&S	FSP30	1093.4495.30	7/22/2004
Low Loss Cable	Huber + Suhner	Sucoflex 104	N/A	N/A
Horn Antenna	EMCO	3115	N/A	2/24/2004

TEST CONFIGURATION



TEST PROCEDURE

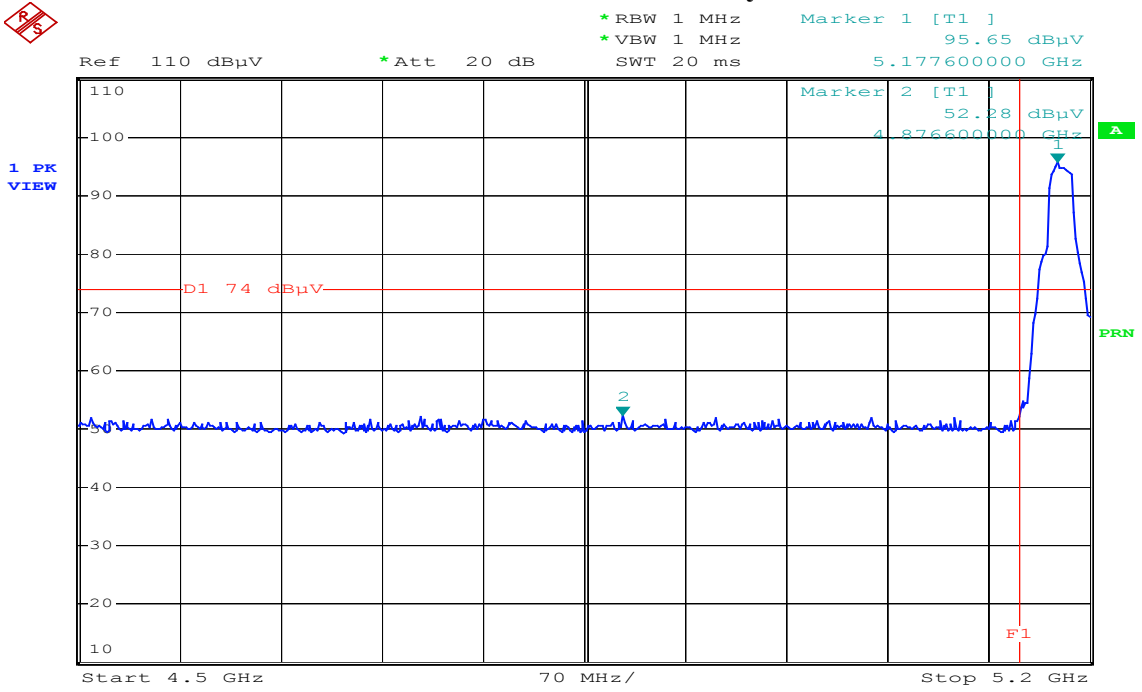
1. The EUT is placed on a turntable, which is 0.8m above the ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission.
4. Set the spectrum analyzer in the following setting in order to capture the lower and upper band-edges of the emission:
   (a) PEAK: RBW=VBW=1MHz / Sweep=AUTO
   (b) AVERAGE: RBW=1MHz / VBW=10Hz / Sweep=AUTO
5. Repeat the procedures until all the PEAK and AVERAGE versus POLARIZATION are measured.

TEST RESULTS

Refer to attach spectrum analyzer data chart.

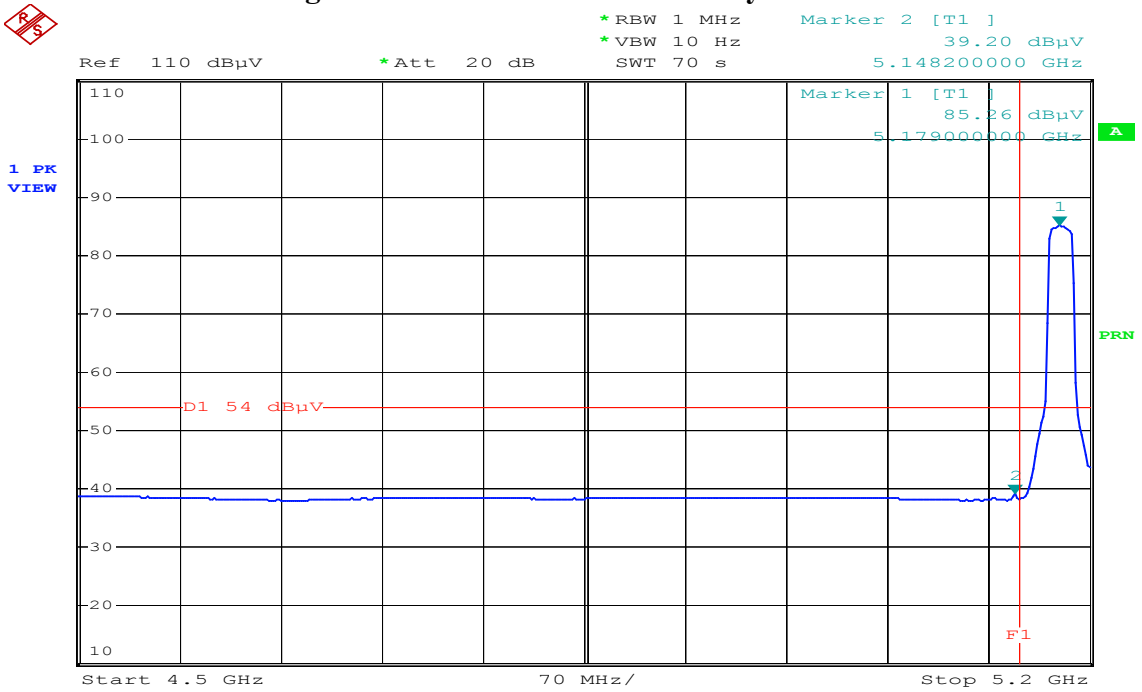
Band Edges Test Data CH-Low

Detector mode: Peak Polarity: Vertical



Date: 25.AUG.2003 08:33:41

Detector mode: Average Polarity: Vertical



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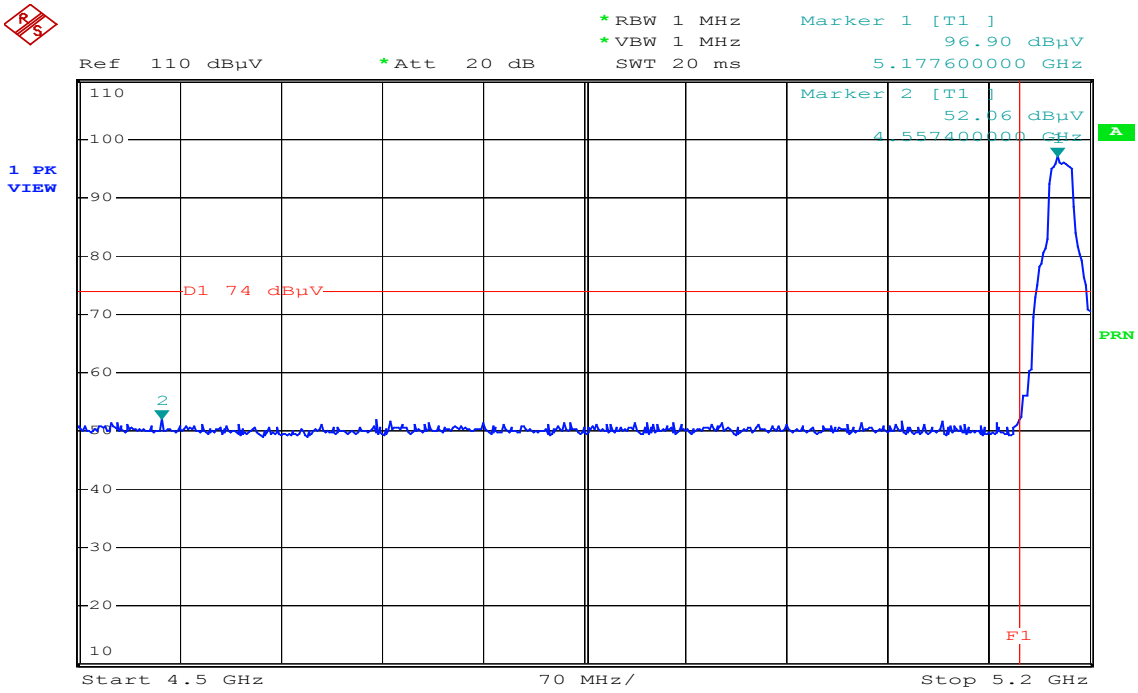
Detector mode: Peak **Polarity: Horizontal**



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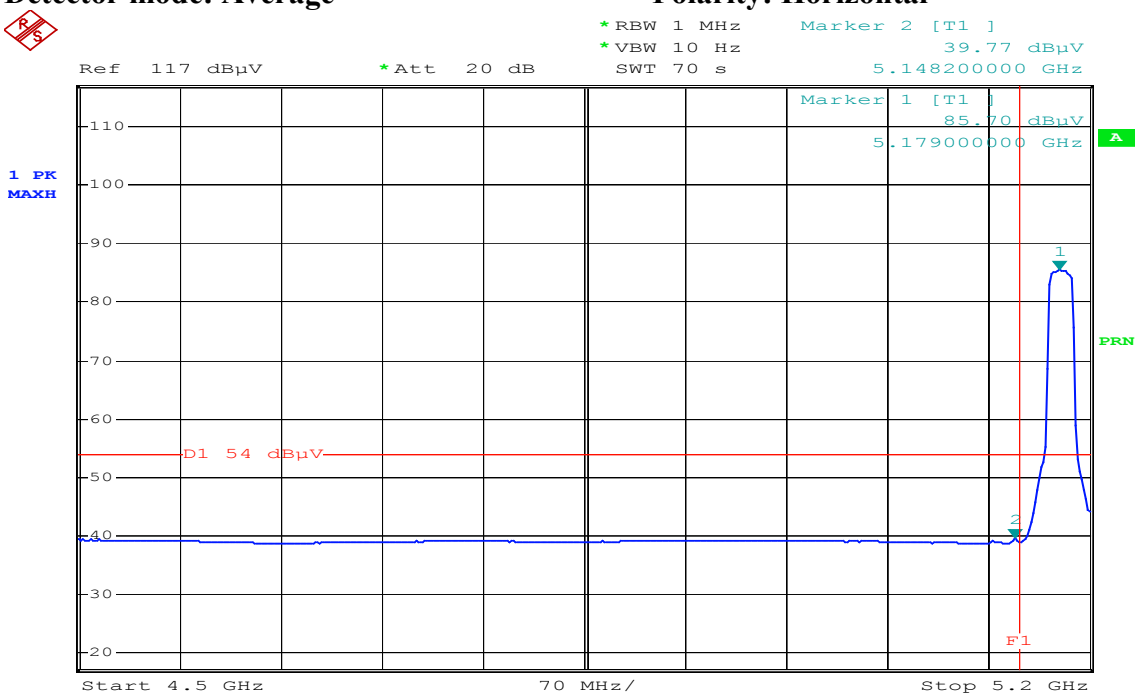
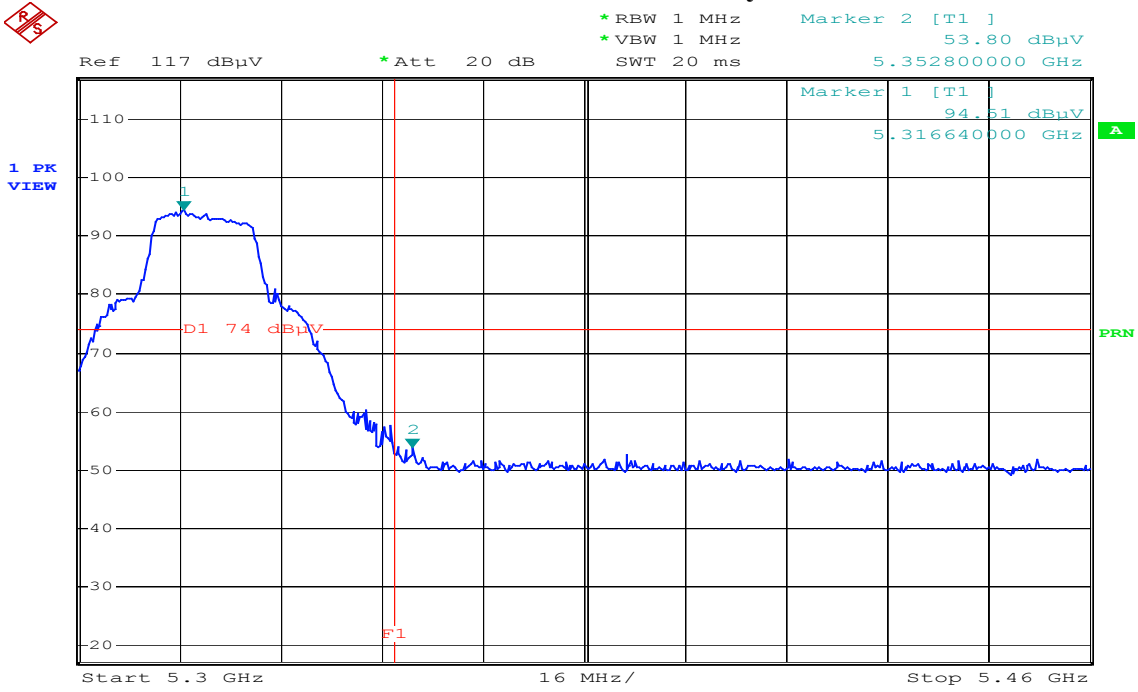
Detector mode: Average **Polarity: Horizontal**



Date: 25.AUG.2003 09:33:16

Band Edges Test Data CH-High

Detector mode: Peak Polarity: Vertical



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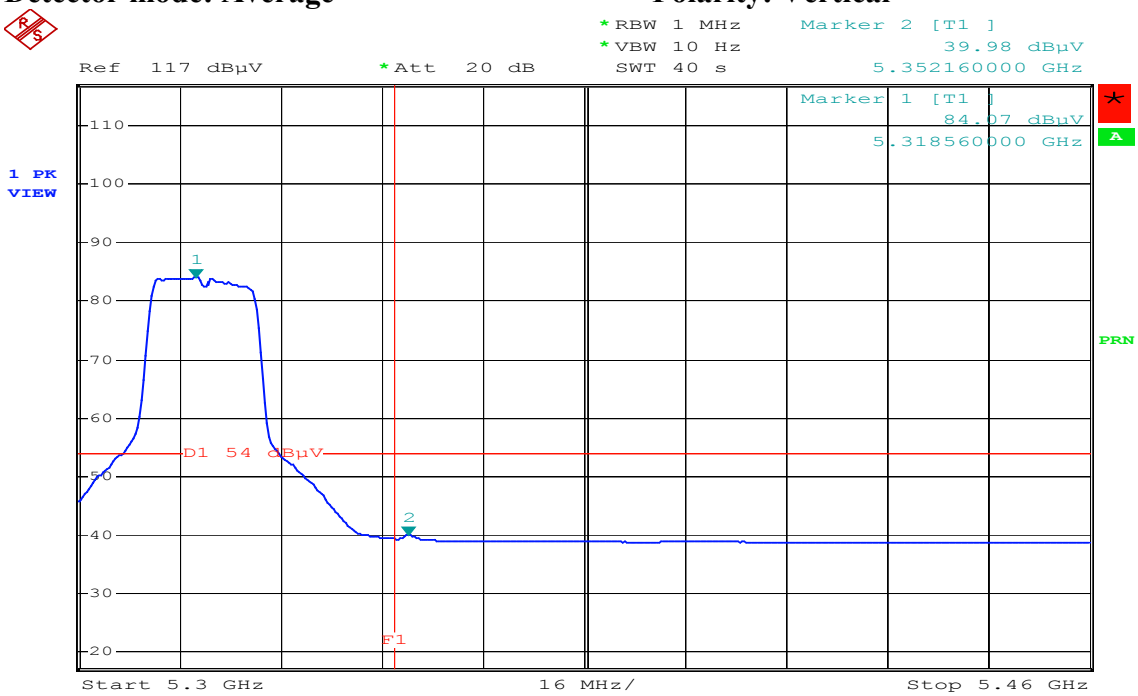
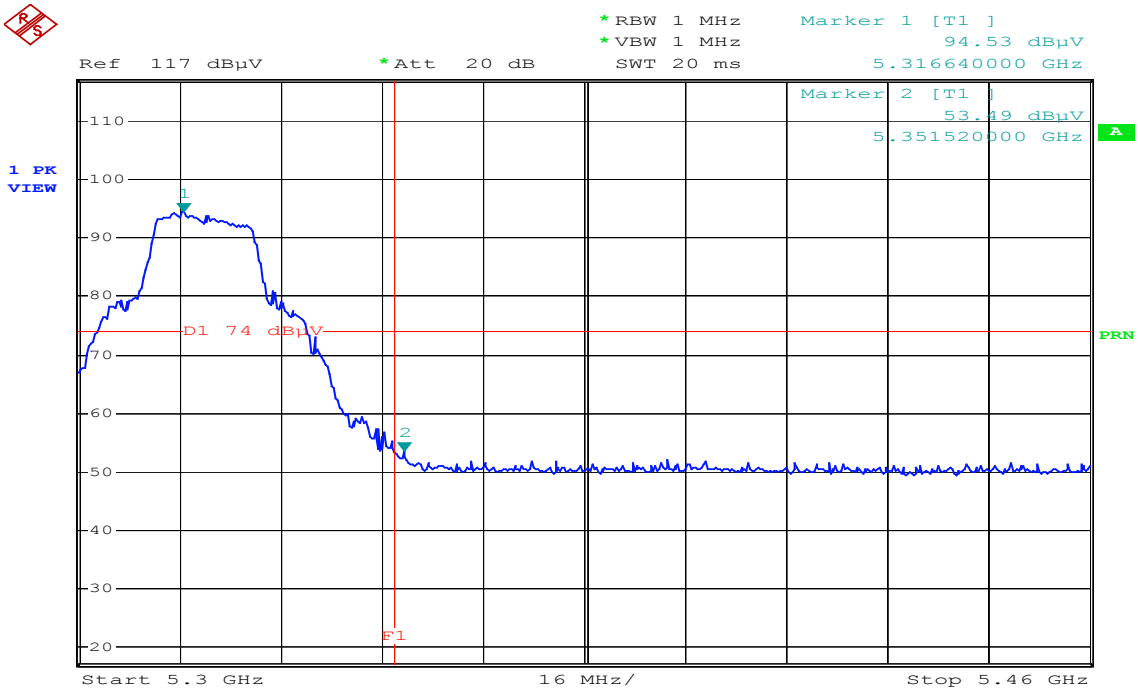
Detector mode: Average Polarity: Vertical



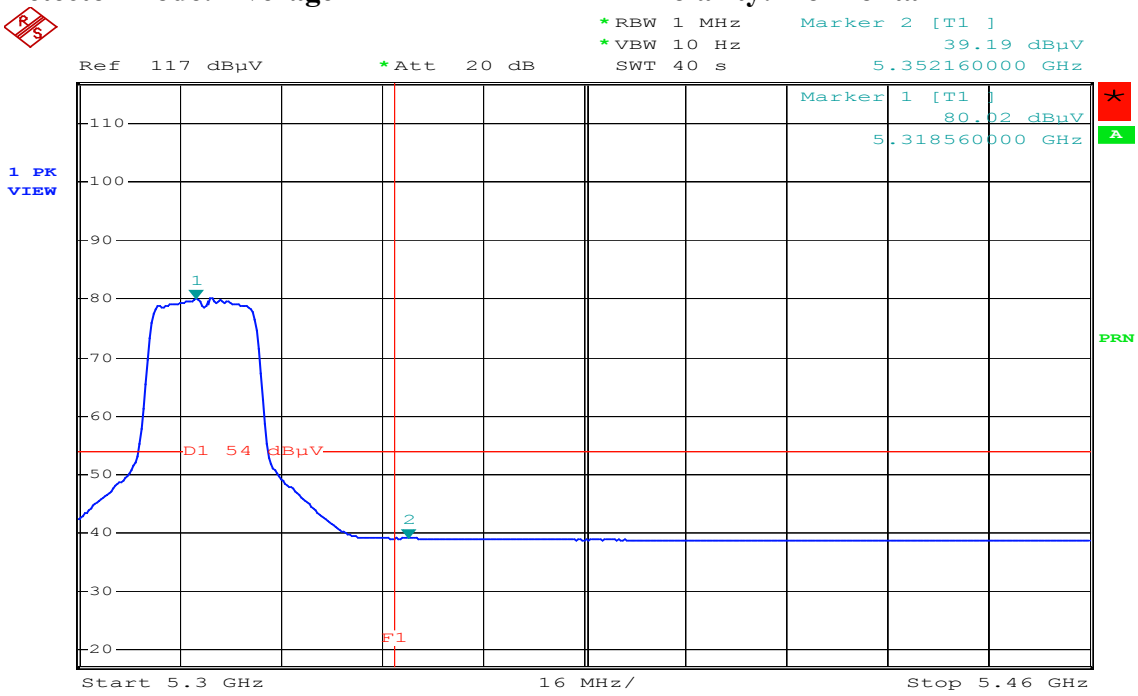
Date: 25.AUG.2003 09:19:08

Detector mode: Peak **Polarity: Horizontal**



Date: 25.AUG.2003 09:24:38

Detector mode: Average **Polarity: Horizontal**



Date: 25.AUG.2003 09:21:45

7.2. POWERLINE CONDUCTED EMISSION (15.207)

LIMIT

For an intentional radiator which 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 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

MEASUREMENT EQUIPMENT USED

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
EMI Test Receiver	R&S	ESCS30	847793/012	12/20/2003
LISN	R&S	ESH2-Z5	843285/010	12/15/2003
LISN	EMCO	3825/2	9003-1628	07/25/2004

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST CONFIGURATION

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.4-1992.
2. The EUT was plug-in the host PC via USB port. The host PC system was placed on the center of the back edge on the test table. The peripherals like modem, monitor printer, K/B, and mouse were placed on the side of the host PC system. The rear of the EUT and peripherals were placed flushed with the rear of the tabletop.
3. The keyboard was placed directly in the front of the monitor, flushed with the front tabletop. The mouse was placed next to the Keyboard, flushed with the back of keyboard.
4. The spacing between the peripherals was 10 centimeters.
5. External I/O cables were draped along the edge of the test table and bundle when necessary.
6. The host PC system was connected with 110Vac/60Hz power source.

The EUT is set to transmit in a continuous mode.

TEST PROCEDURE

1. The EUT was placed on a table, which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

TEST RESULTS

The initial step in collecting conducted data is a spectrum analyzer peak scan of the measurement range. Significant peaks are then marked as shown on the following data page, and these signals are then quasi-peaked.

Operation Mode:	Tx + Rx mode	**Test Date:**	August 21, 2003
Temperature:	25°C	**Tested by:**	Roy Cheng
Humidity:	70 % RH		

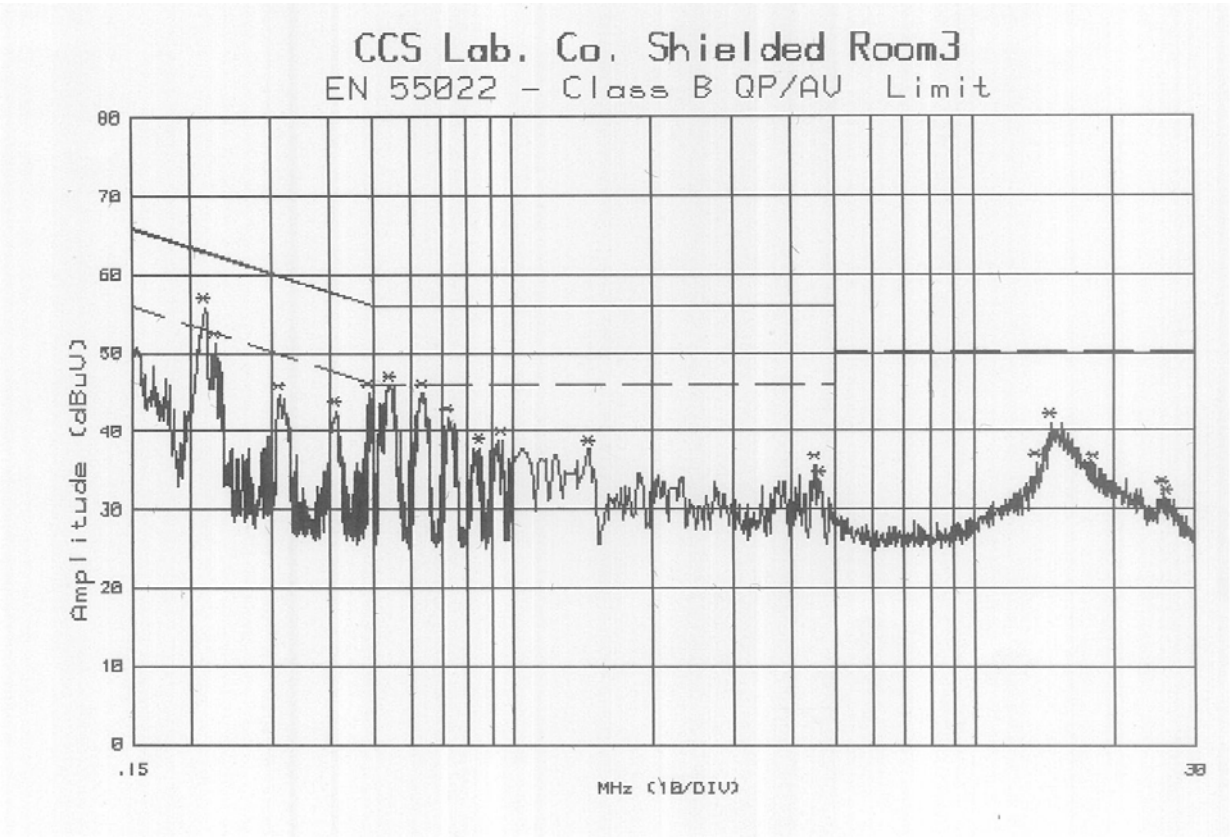
FREQ MHz	Q.P. Raw dBuV	AVG Raw dBuV	Q.P. Limit dBuV	AVG Limit dBuV	Q.P. Margin dB	AVG Margin dB	NOTE
0.215	52.60	41.10	63.01	53.01	-10.41	-11.91	L1
0.220	50.60	---	62.82	52.82	-12.22	---	L1
0.500	43.80	---	56.00	46.00	-12.20	---	L1
0.545	43.80	---	56.00	46.00	-12.20	---	L1
0.639	43.80	---	56.00	46.00	-12.20	---	L1
0.731	42.00	---	56.00	46.00	-14.00	---	L1
0.216	52.90	43.50	62.97	52.97	-10.07	-9.47	L2
0.228	52.10	43.70	62.52	52.52	-10.42	-8.82	L2
0.490	43.50	---	56.17	46.17	-12.67	---	L2
0.545	43.00	---	56.00	46.00	-13.00	---	L2
0.641	43.50	---	56.00	46.00	-12.50	---	L2
0.726	41.60	---	56.00	46.00	-14.40	---	L2

Note:

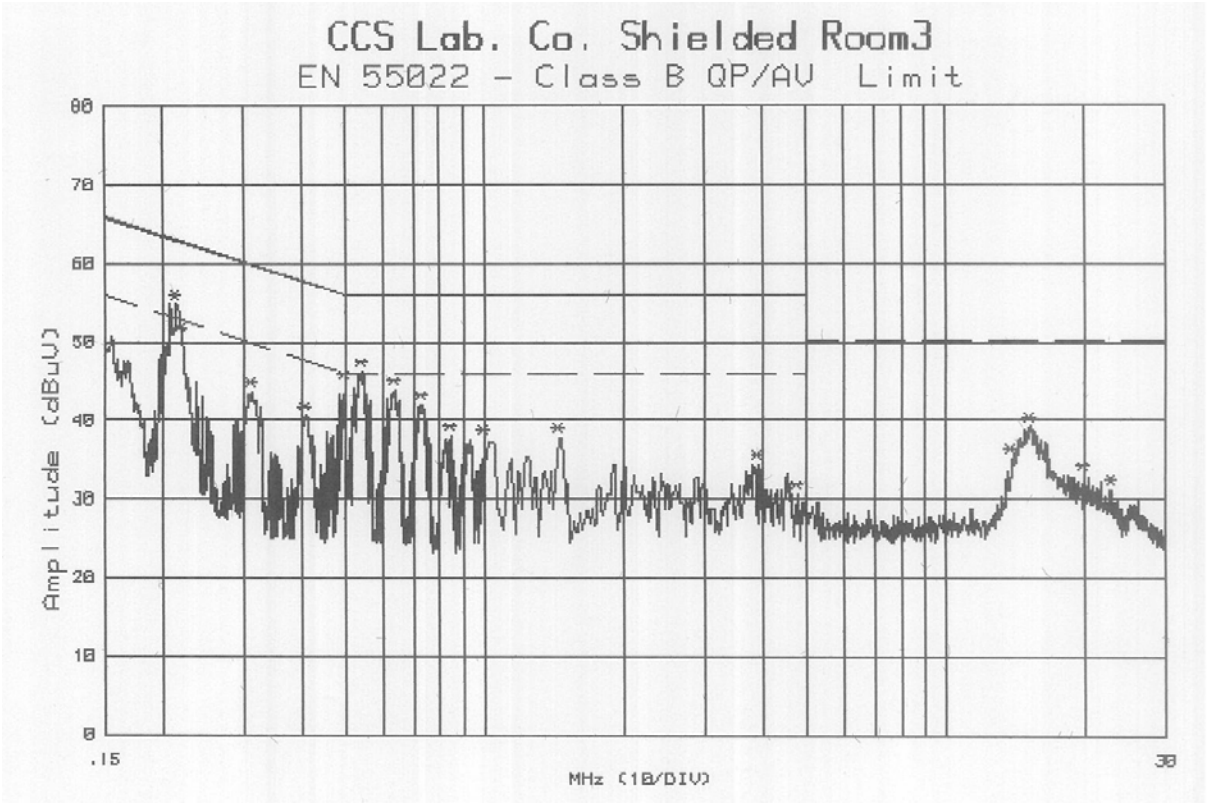
1. *Measuring frequencies from 0.15 MHz to 30MHz.*
2. *The emissions measured in frequency range from 0.15 MHz to 30MHz were made with an instrument using Quasi-peak detector and average detector.*
3. *"---" denotes the emission level was or more than 2dB below the Average limit*
4. *The IF bandwidth of SPA between 0.15MHz to 30MHz was 10kHz; the IF bandwidth of Test Receiver between 0.15MHz to 30MHz was 9kHz;*
5. *L1 = Line One (Live line) / L2 = Line Two (Neutral Line)*

Test Data Plots

Conducted emissions (Line 1)



Conducted emissions (Line 2)



7.3. 26 DB EMISSION BANDWITH (15.403)

LIMIT

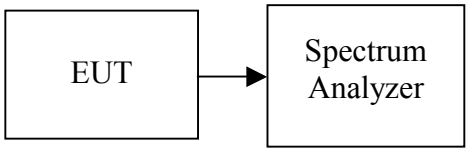
For purposes of this subpart, the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolutions bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

MEASUREMENT EQUIPMENT USED

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	E4446A	US42510252	4/28/2004
Low Loss Cable	Huber + Suhner	Sucoflex 104	N/A	N/A

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST CONFIGURATION



TEST PROCEDURE

1. Place the EUT on the table and set it in the 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.
3. Set the spectrum analyzer as RBW = 1%EBW, VBW = RBW, Span = 50MHz / 100MHz (Turbo Mode), and Sweep = auto.
4. Mark the peak frequency and –26dBc (upper and lower) frequency.
5. Repeat until all the rest channels were investigated.

TEST RESULTS

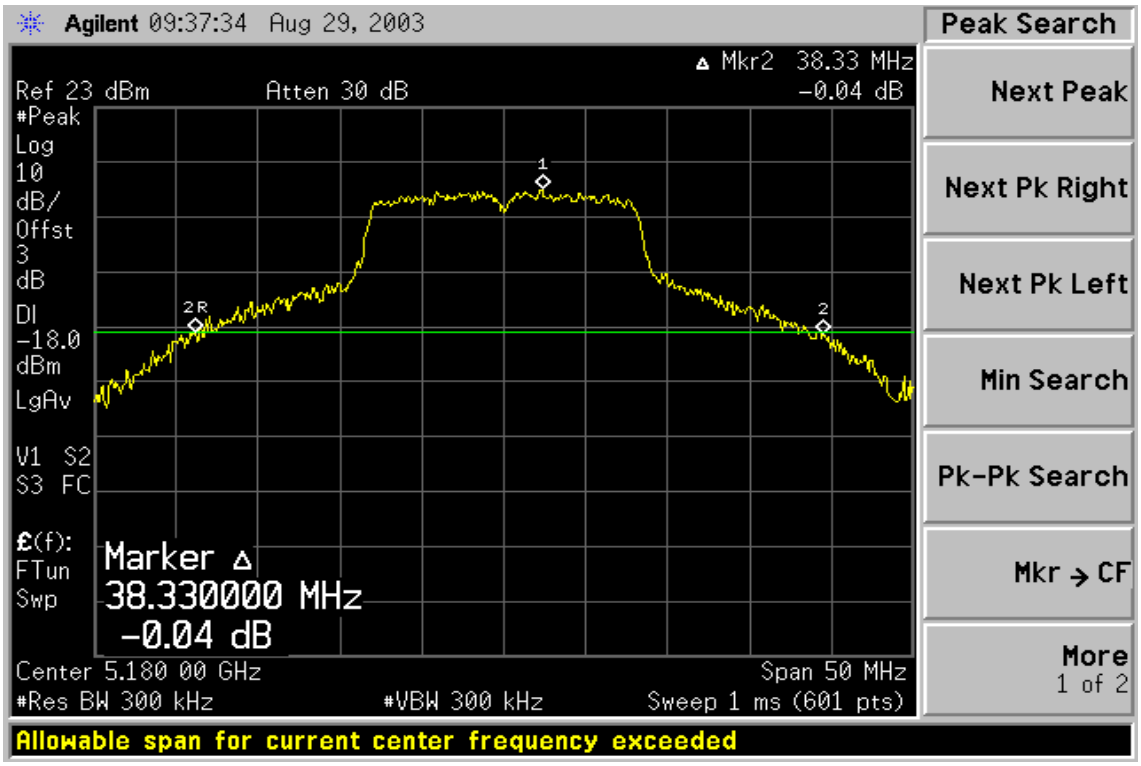
No non-compliance noted

TEST DATA

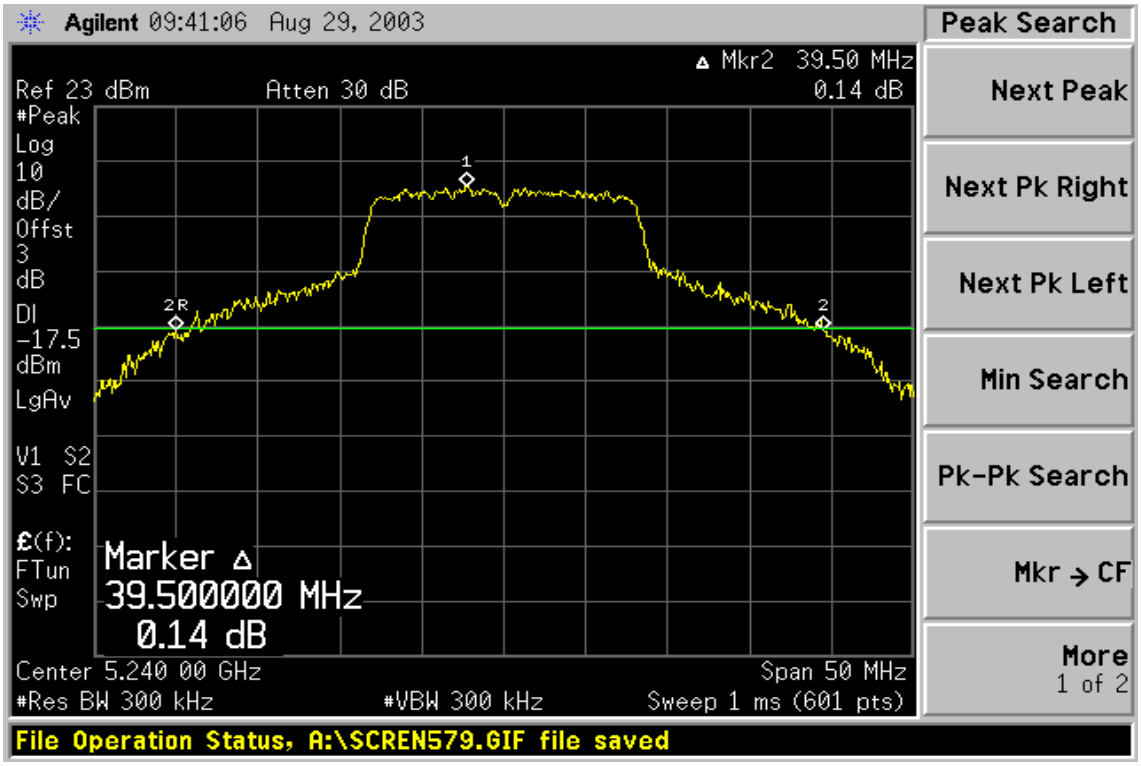
Channel	Frequency (MHz)	Bandwidth (B) (MHz)	10 Log B (dB)
CH Low	5180	38.33	15.84
CH Mid	5240	39.50	15.97
CH High	5320	41.58	16.19

Test Plot

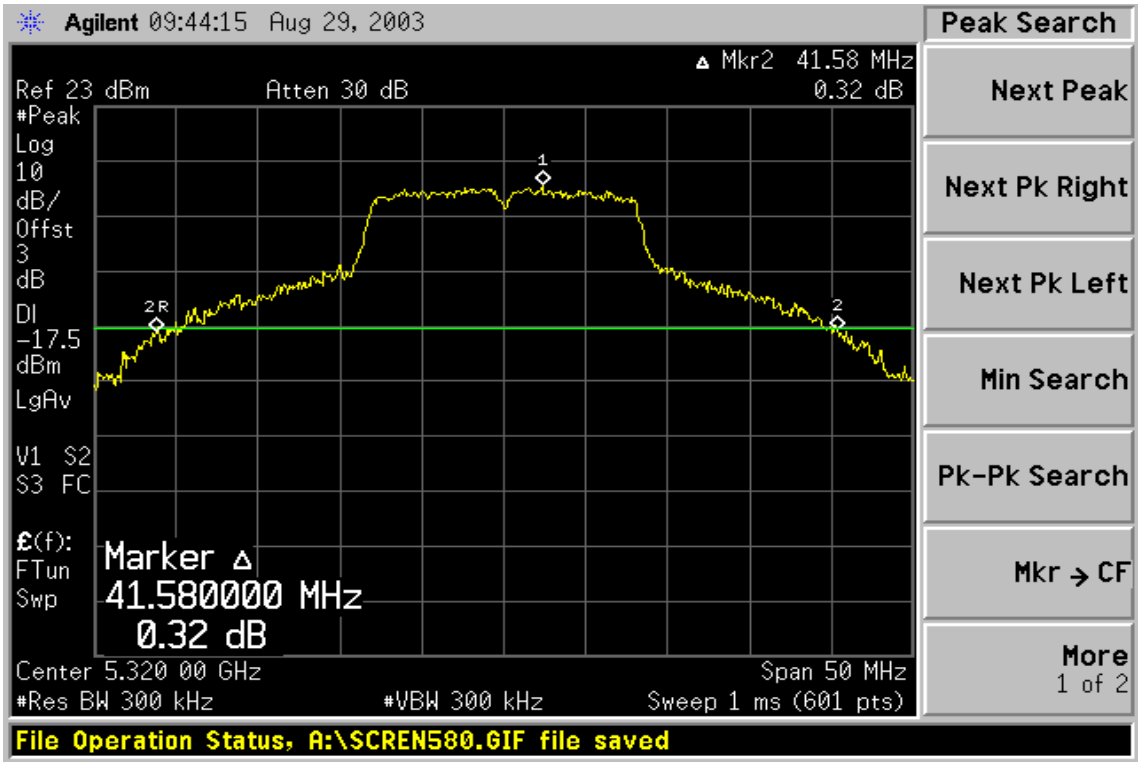
CH Low



CH Mid



CH High


Agilent 09:44:15 Aug 29, 2003
Peak Search
Mkr2 41.58 MHz
0.32 dB
Ref 23 dBm
Atten 30 dB
#Peak
Log
10
dB/
Offst
3
dB
Dl
-17.5
dBm
LgAv
V1 S2
S3 FC
£(f):
FTun
Swp
Marker Δ
41.580000 MHz
0.32 dB
Center 5.320 00 GHz
#Res BW 300 kHz
#VBW 300 kHz
Span 50 MHz
Sweep 1 ms (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:\SCREN580.GIF file saved

7.4. PEAK POWER (15.407)

LIMIT

- For the band 5.15-5.25 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 50mW (17dBm) or 4dBm + 10log B, where B is the 26dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4dBm in any 1 MHz band.
- For the band 5.25-5.35 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 250mW (24dBm) or 11dBm + 10logB, where B is the 26dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 11dBm in any 1 MHz band.
- For the band 5.725-5.825 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 1mW (30dBm) or 17dBm + 10logB, where B is the 26dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 17dBm in any 1 MHz band.

If transmitting antennas of directional gain greater than 6dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi. The peak power shall not exceeded the limit as follows:

Specified Limit of the Peak Power

Channel	Frequency (MHz)	10 Log B (dB)	4 + 10 Log B or 11 + 10 Log B (dBm)	Power Limit (dBm)
CH Low	5180	15.84	19.84	17.00
CH Mid	5240	15.97	19.97	17.00
CH High	5320	16.19	27.19	24.00

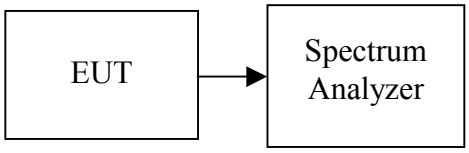
(Note: Maximum antenna gain = 1.06 dBi, therefore there is no reduction due to antenna gain.)

MEASUREMENT EQUIPMENT USED

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	E4446A	US42510252	04/28/2004
Low Loss Cable	Huber + Suhner	Sucoflex 104	N/A	N/A

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST CONFIGURATION



TEST PROCEDURE

Set span to encompass the entire emission bandwidth (EBW) of the signal.

Set RBW = 1 MHz / Set VBW = 3 MHz.

Use sample detector mode if bin width (i.e., span/number of points in spectrum display) < 0.5 RBW. Otherwise use peak detector mode. Use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at full control power for entire sweep of every sweep. If the device transmits continuously, with no off intervals or reduced power intervals, the trigger may be set to "free run".· Trace average 100 traces in power averaging mode. Compute power by integrating the spectrum across the 26 dB EBW of the signal. The integration can be performed using the spectrum analyzer's band power measurement function with band limits set equal to the EBW band edges or by summing power levels in each 1 MHz band in linear power terms. The 1 MHz band power levels to be summed can be obtained by averaging, in linear power terms, power levels in each frequency bin across the 1 MHz.

TEST RESULTS

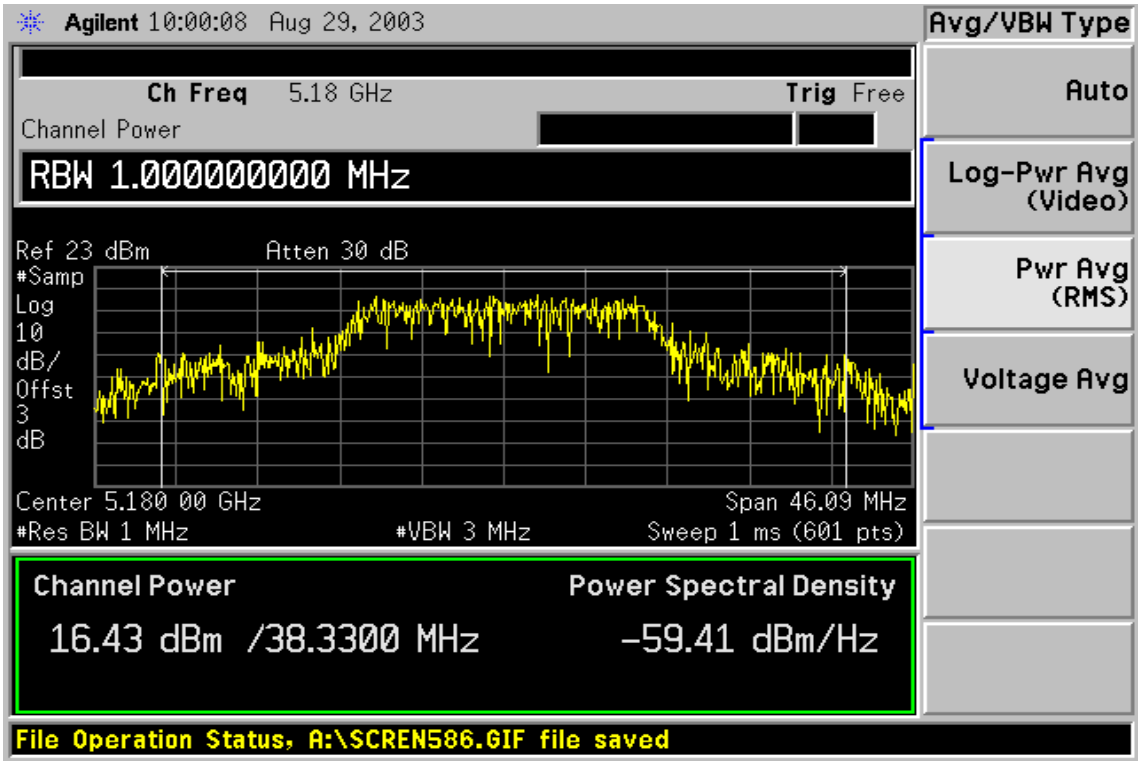
No non-compliance noted

TEST DATA

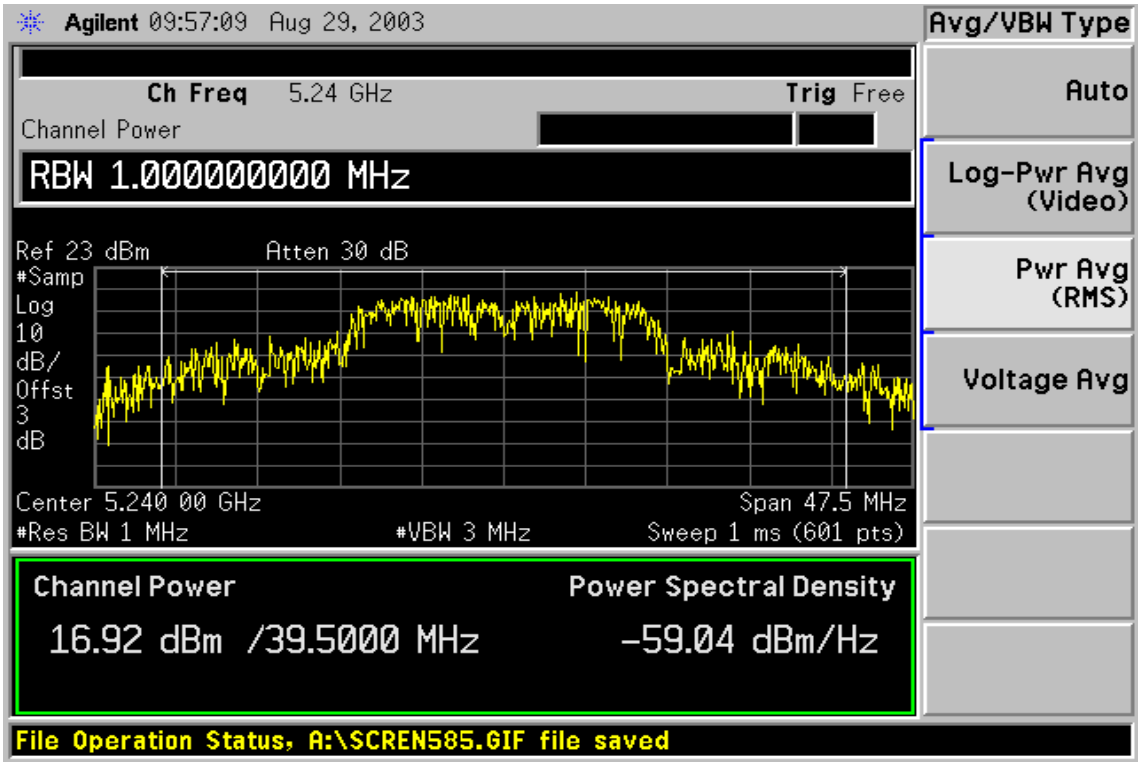
Channel	Frequency (MHz)	Reading (dBm)	Factor (dB)	Output Power (dBm)	Limit (dBm)
Low	5180	13.43	3.00	16.43	17
Mid	5240	13.92	3.00	16.92	17
High	5320	14.32	3.00	17.32	24

Test Plot

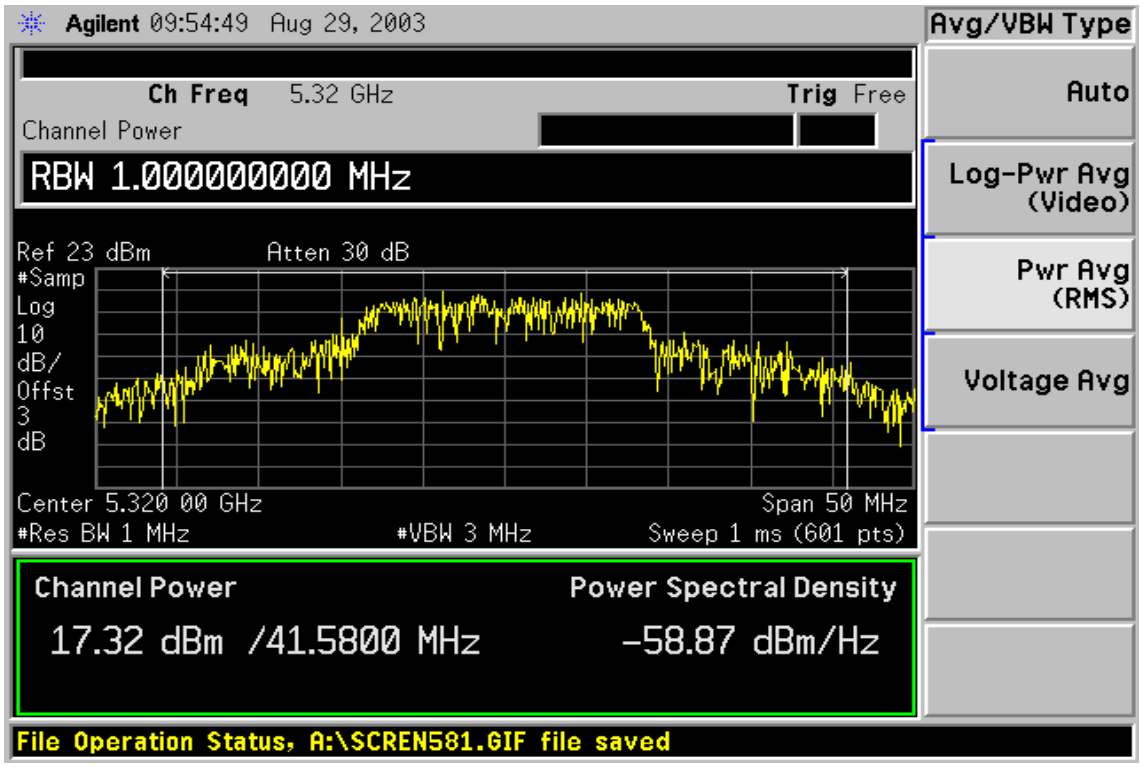
Ch Low



Ch Mid



Ch High


Agilent 09:54:49 Aug 29, 2003
Ch Freq 5.32 GHz
Trig Free
Channel Power
RBW 1.000000000 MHz
Ref 23 dBm
Atten 30 dB
#Samp
Log
10
dB/
Offst
3
dB
Center 5.320 00 GHz
Span 50 MHz
#Res BW 1 MHz
#VBW 3 MHz
Sweep 1 ms (601 pts)
Channel Power
17.32 dBm /41.5800 MHz
Power Spectral Density
-58.87 dBm/Hz
File Operation Status, A:\SCREN581.GIF file saved
Avg/VBW Type
Auto
Log-Pwr Avg (Video)
Pwr Avg (RMS)
Voltage Avg

7.5. PEAK POWER SPECTRAL DENSITY (15.407)

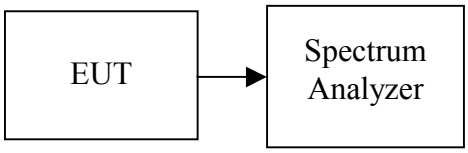
1. For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.
2. The direct sequence operating of the hybrid system, with the frequency hopping operation turned off, shall comply with the power density requirements of paragraph (d) of this section.

MEASUREMENT EQUIPMENT USED

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	E4446A	US42510252	04/28/2004
Low loss Cable	Huber + Suhner	Sucoflex 104	N/A	N/A

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST CONFIGURATION



TEST PROCEDURE

1. Place the EUT on the table 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.
3. Set the spectrum analyzer as RBW = 1MHz, VBW = 3MHz, Span = 50MHz, Sweep=Auto
4. Record the max. reading.
5. Repeat the above procedure until the measurements for all frequencies are completed.

TEST RESULTS

No non-compliance noted

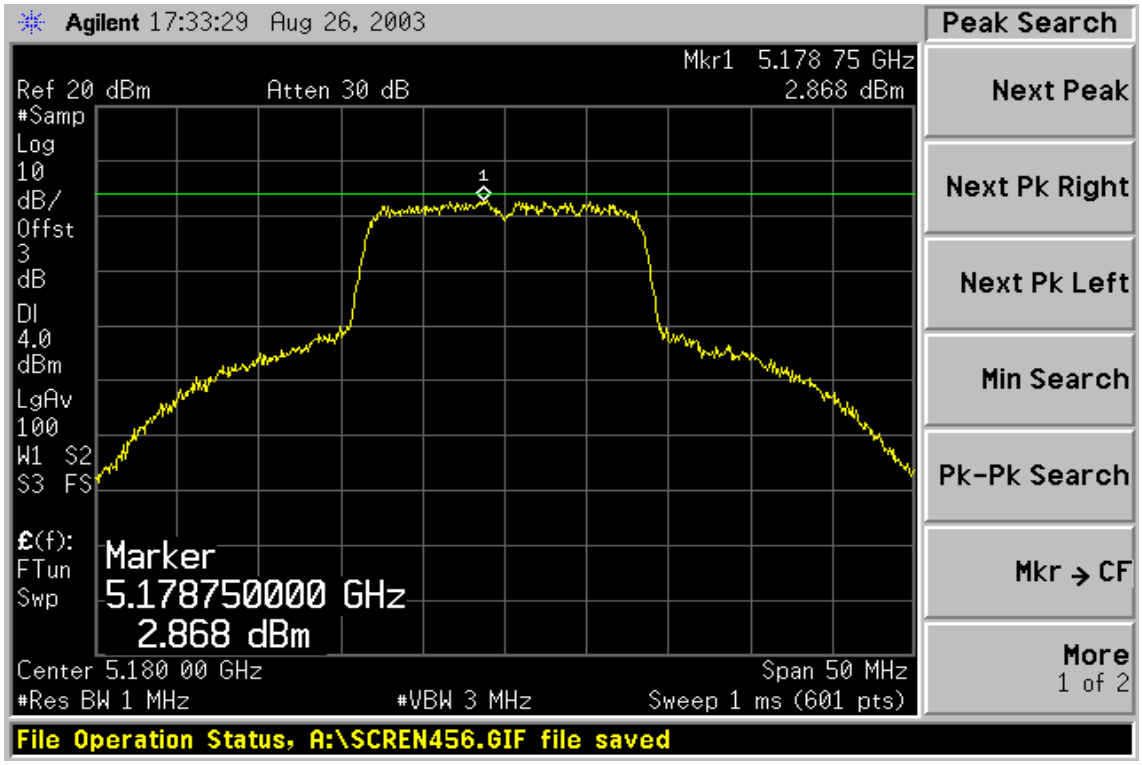
TEST DATA

Channel	Frequency (MHz)	Reading (dBm)	Factor (dB)	PPSD (dBm)	Limit (dBm)	Result
Low	5180	-0.13	3.00	2.87	4.00	PASS
Mid	5240	0.67	3.00	3.67		PASS
High	5320	0.45	3.00	3.45		PASS

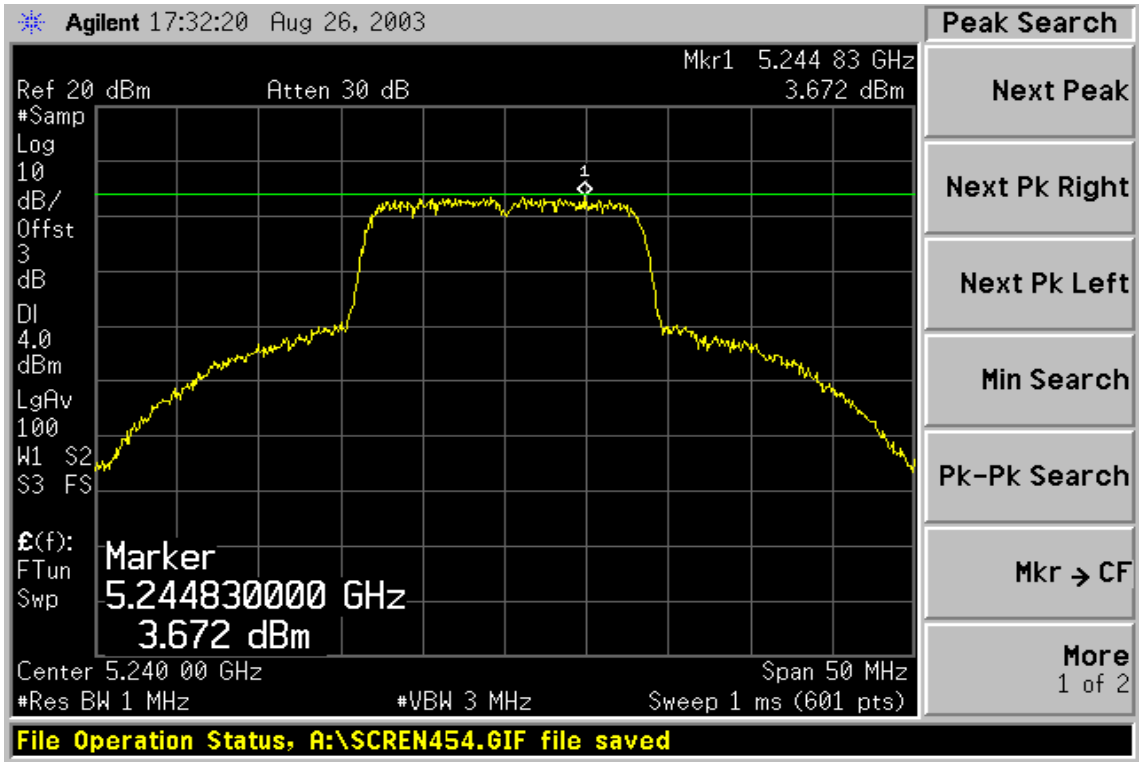
Notes: *The cable loss was offset in the spectrum.*

Test Plot

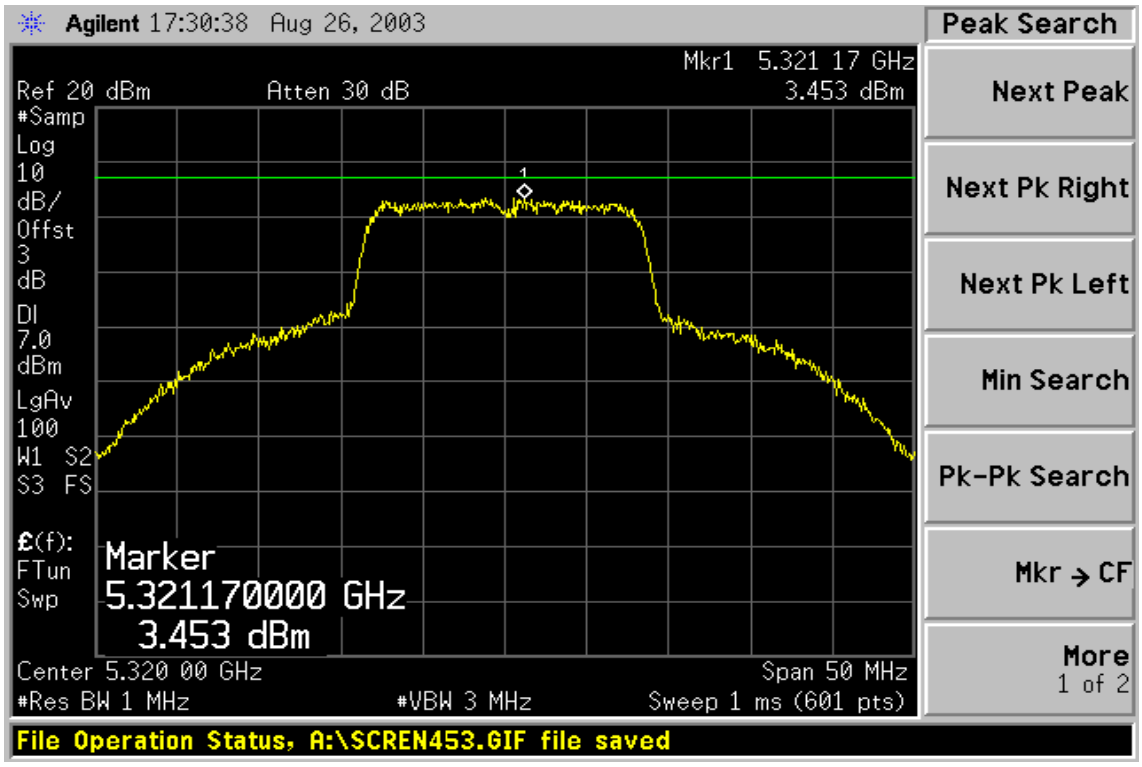
Ch Low



Ch Mid



Ch High


Agilent 17:30:38 Aug 26, 2003
Peak Search
Mkr1 5.321 17 GHz
Ref 20 dBm
Atten 30 dB
3.453 dBm
#Samp
Log
10
dB/
Offst
3
dB
Dl
7.0
dBm
LgAv
100
W1 S2
S3 FS
£(f):
FTun
Swp
Marker
5.321170000 GHz
3.453 dBm
Next Peak
Next Pk Right
Next Pk Left
Min Search
Pk-Pk Search
Mkr → CF
More
1 of 2
Center 5.320 00 GHz
Span 50 MHz
#Res BW 1 MHz
#VBW 3 MHz
Sweep 1 ms (601 pts)
File Operation Status, A:\SCREN453.GIF file saved

7.6. PEAK EXCURSION (15.407)

LIMIT

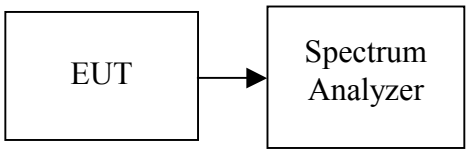
The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

MEASUREMENT EQUIPMENT USED

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	E4446A	US42510252	04/28/2004
Spectrum Analyzer	R&S	FSP30	1093.4495.30	07/22/2004
Low-Loss RF Cable	Huber + Suhner	Sucoflex 104	N/A	N/A

Remark: *Each piece of equipment is scheduled for calibration once a year.*

Test Configuration



TEST PROCEDURE

The test is performed in accordance with <FCC Public Notice: APPENDIX A Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices> – Part 15, Subpart E, August 2002.

1. Place the EUT on the table 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 spectrum.
3. Trace A: Set RBW = 1 MHz, VBW=3 MHz with peak detector and max hold.
4. Trace B: Set RBW = 1 MHz, VBW=3 MHz with peak detector and Video average 100 times.
5. Repeat the above procedure until measurements for all channels were completed.

TEST RESULTS

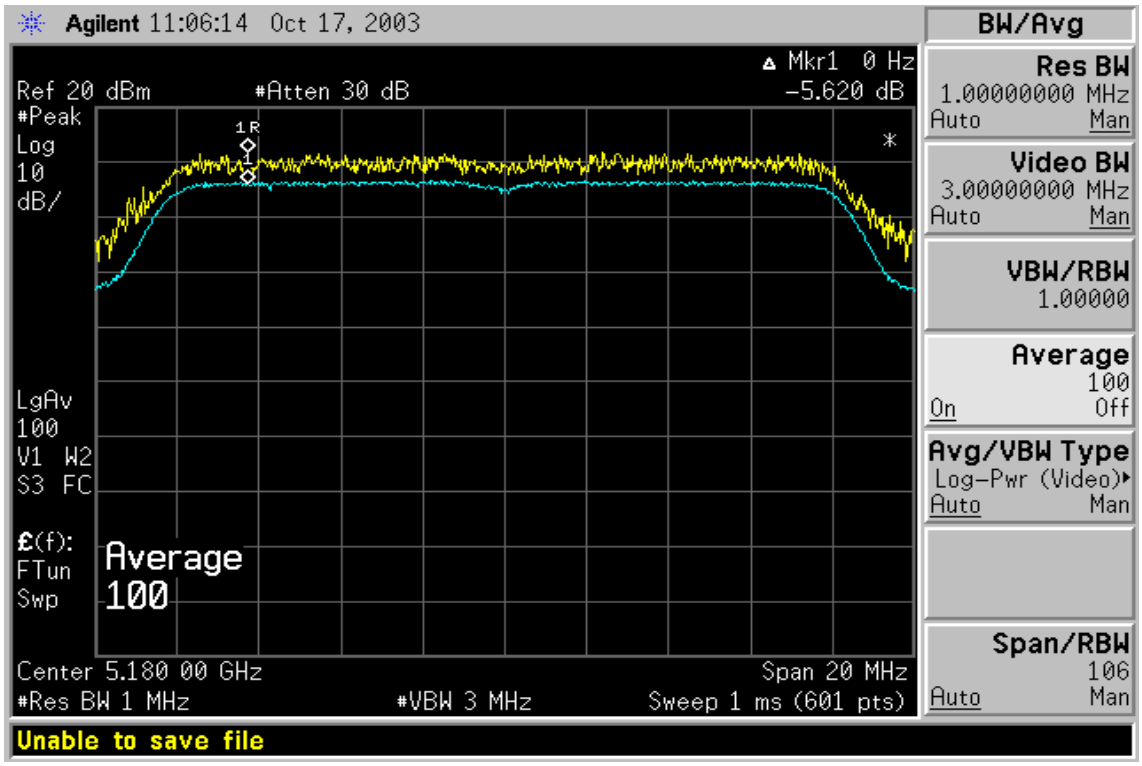
No non-compliance noted

TEST DATA

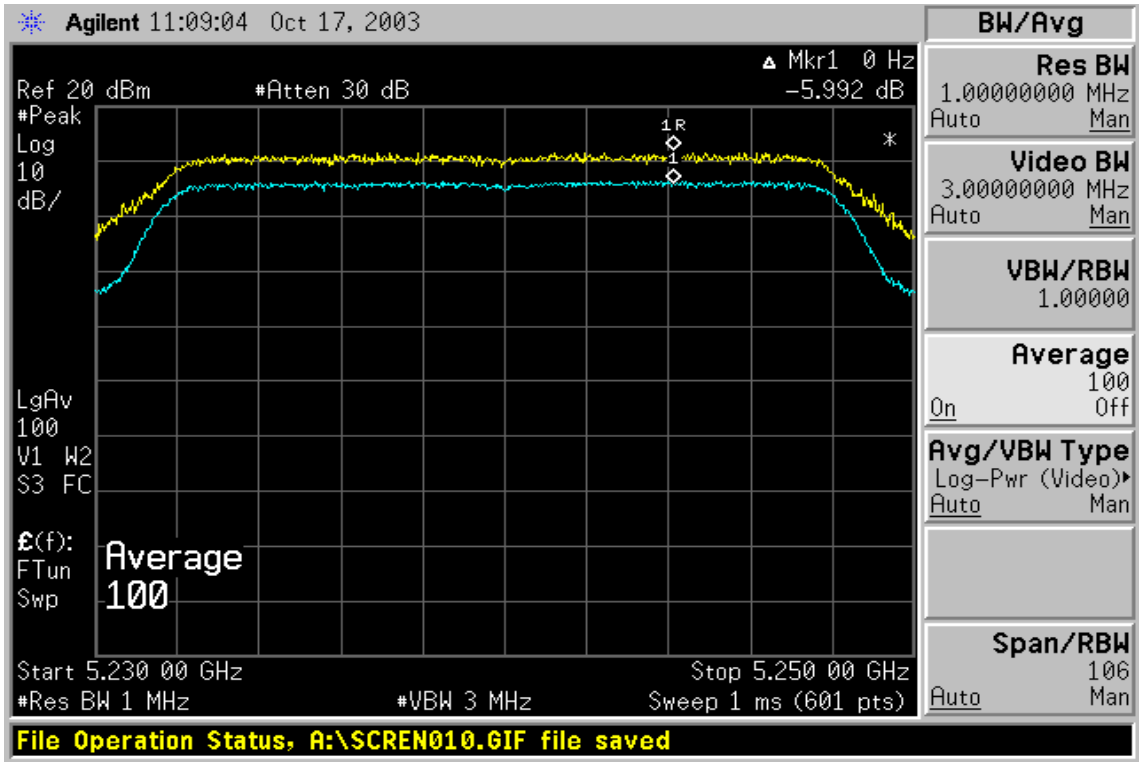
Channel	Frequency (MHz)	Peak Excursion	Limit (dB)	Margin (dB)
Low	5180	5.62	13	-7.38
Mid	5240	5.99	13	-7.01
High	5320	5.55	13	-7.45

Test Plot

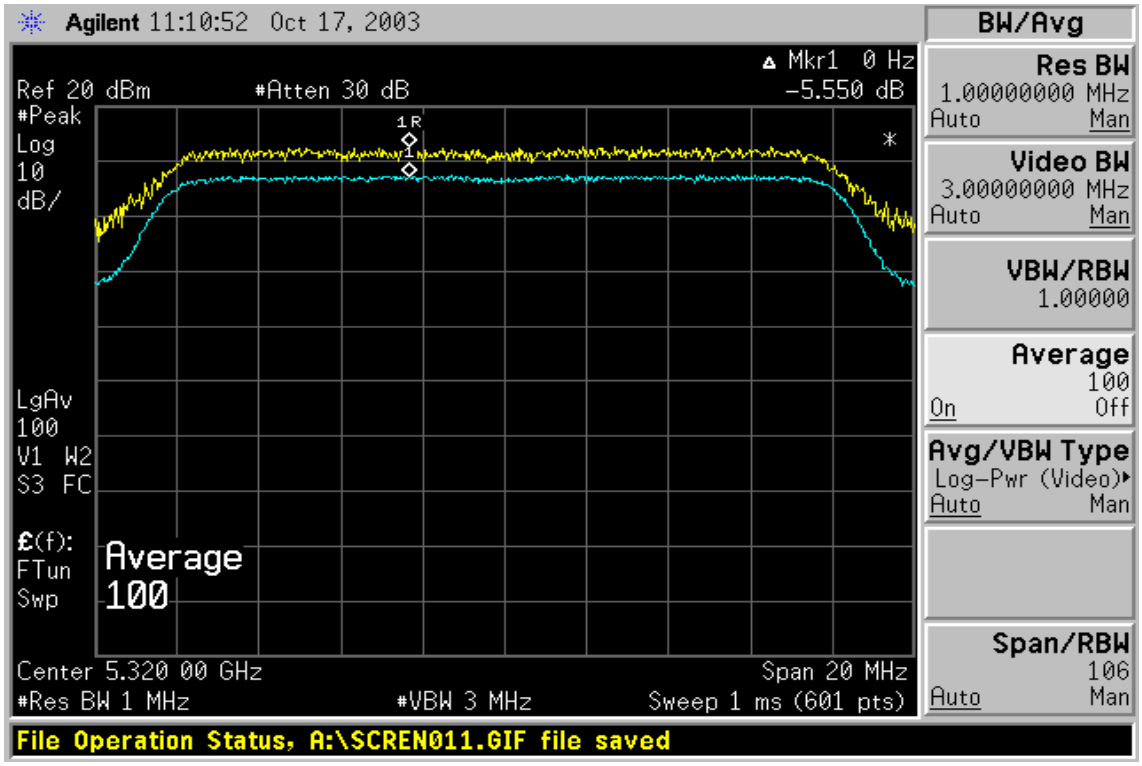
CH Low



CH Mid



CH High


Agilent 11:10:52 Oct 17, 2003
Ref 20 dBm
#Atten 30 dB
Mkr1 0 Hz
-5.550 dB
#Peak
Log
10
dB/
1R
LgAv
100
V1 W2
S3 FC
£(f):
FTun
Swp
Average
100
Center 5.320 00 GHz
Span 20 MHz
#Res BW 1 MHz
#VBW 3 MHz
Sweep 1 ms (601 pts)
BW/Avg
Res BW
1.00000000 MHz
Auto Man
Video BW
3.00000000 MHz
Auto Man
VBW/RBW
1.00000
Average
100
On Off
Avg/VBW Type
Log-Pwr (Video)
Auto Man
Span/RBW
106
Auto Man
File Operation Status, A:\SCREN011.GIF file saved

7.7. CONDUCTED UNDESIRABLE EMISSION (15.407)

LIMIT

Transmitters operating in the 5.15-5.35 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27dBm / MHz. Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.

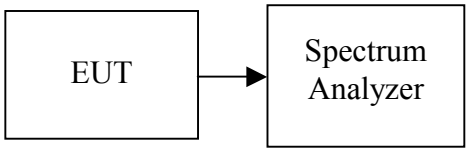
The provisions of §15.205 apply to intentional radiators operating under this section.

MEASUREMENT EQUIPMENT USED

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	E4446A	US42510252	04/28/2004

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST CONFIGURATION



TEST PROCEDURE

Conducted RF measurements of the transmitter output were made to confirm that the EUT antenna port conducted emissions meet the specified limit and to identify any spurious signals that require further investigation or measurements on the radiated emissions site.

The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to 1 MHz. The video bandwidth is set to 1 MHz. Peak detection measurements are compared to the average EIRP limit, adjusted for the maximum antenna gain. If necessary, additional average detection measurements are made.

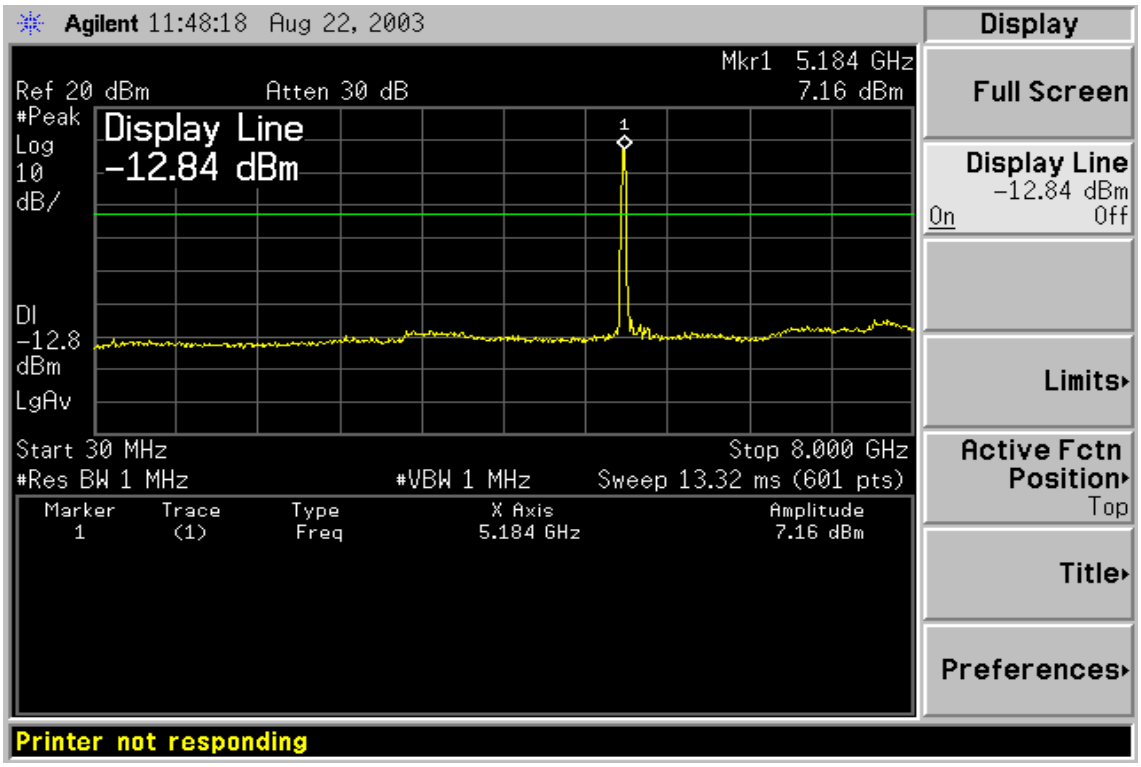
Measurements are made over the 30 MHz to 40 GHz range with the transmitter set to the lowest, middle, and highest channels.

TEST RESULTS

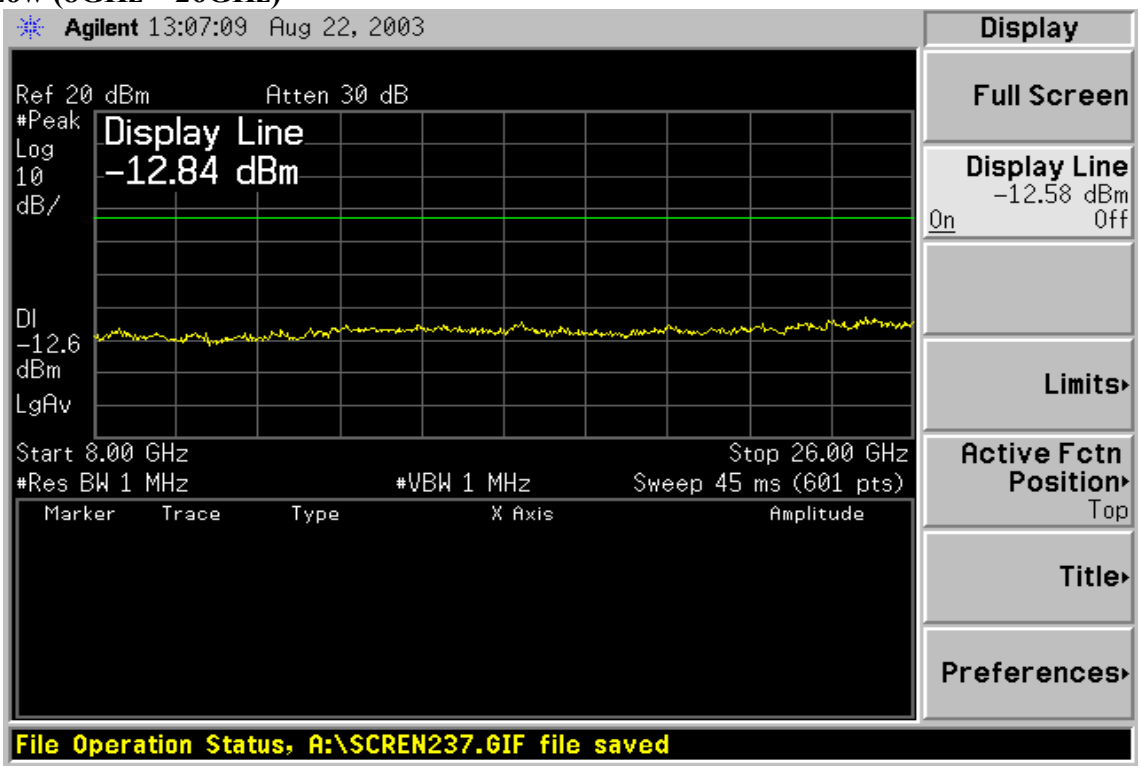
No non-compliance noted

Test Plot

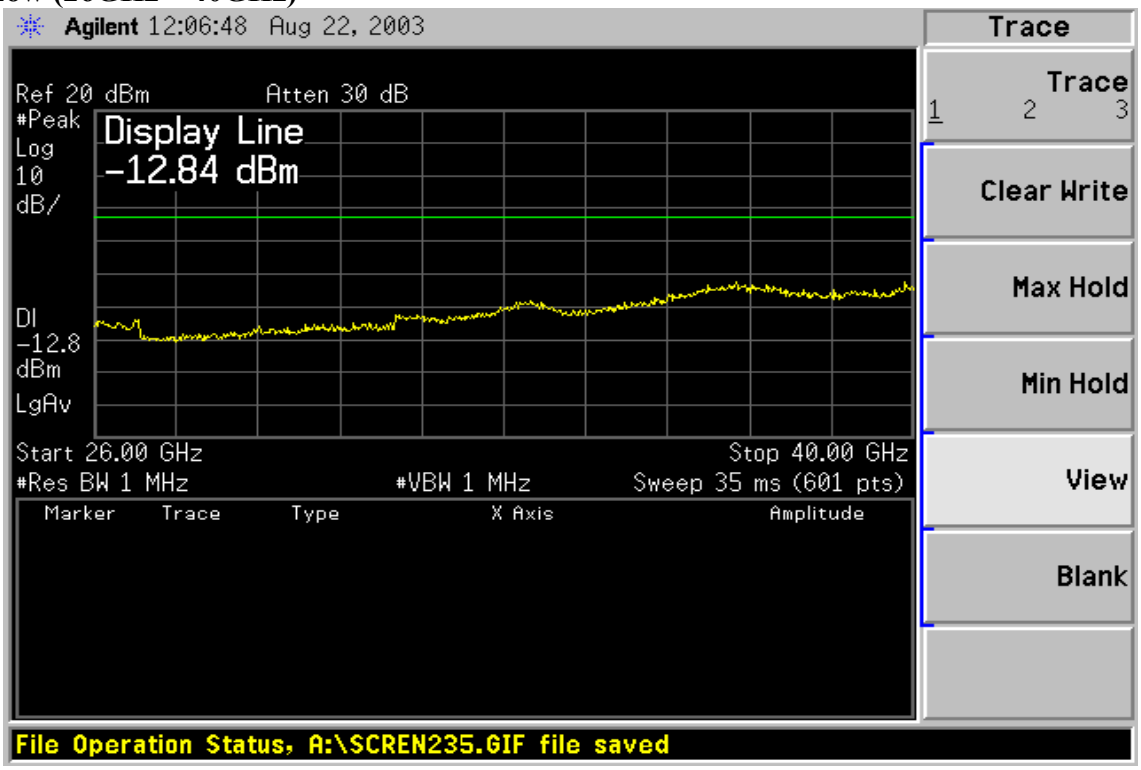
CH Low (30MHz – 8GHz)



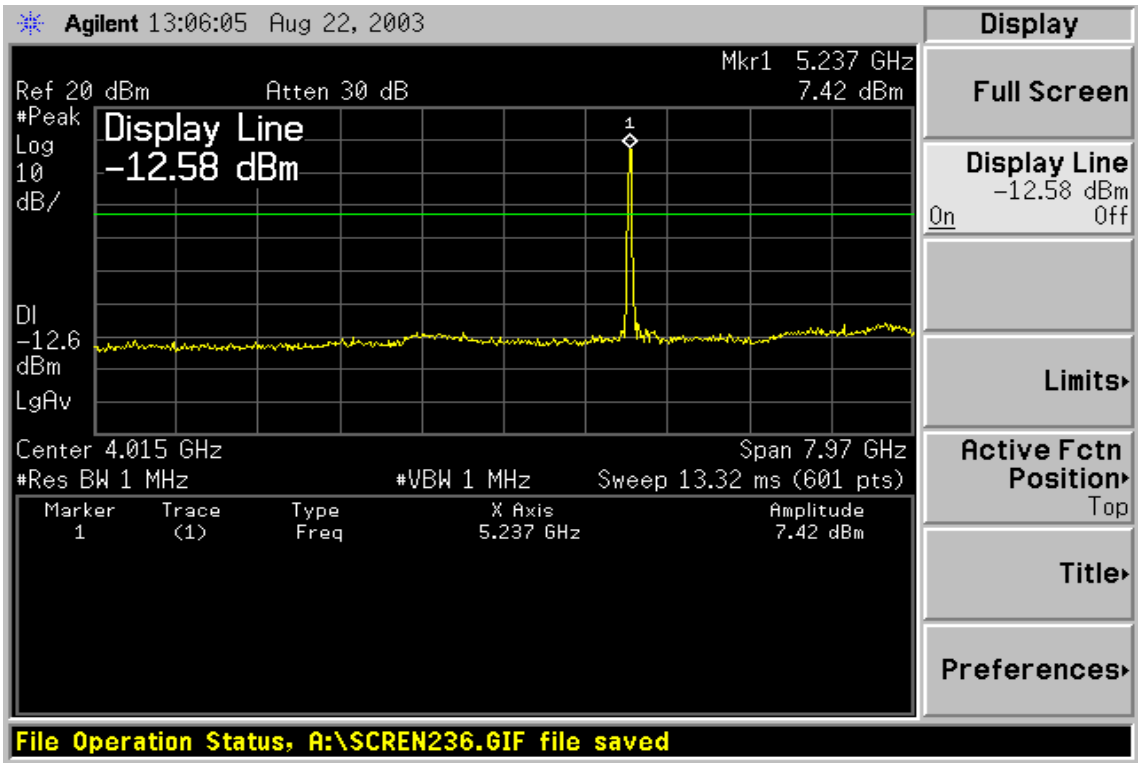
CH Low (8GHz – 26GHz)



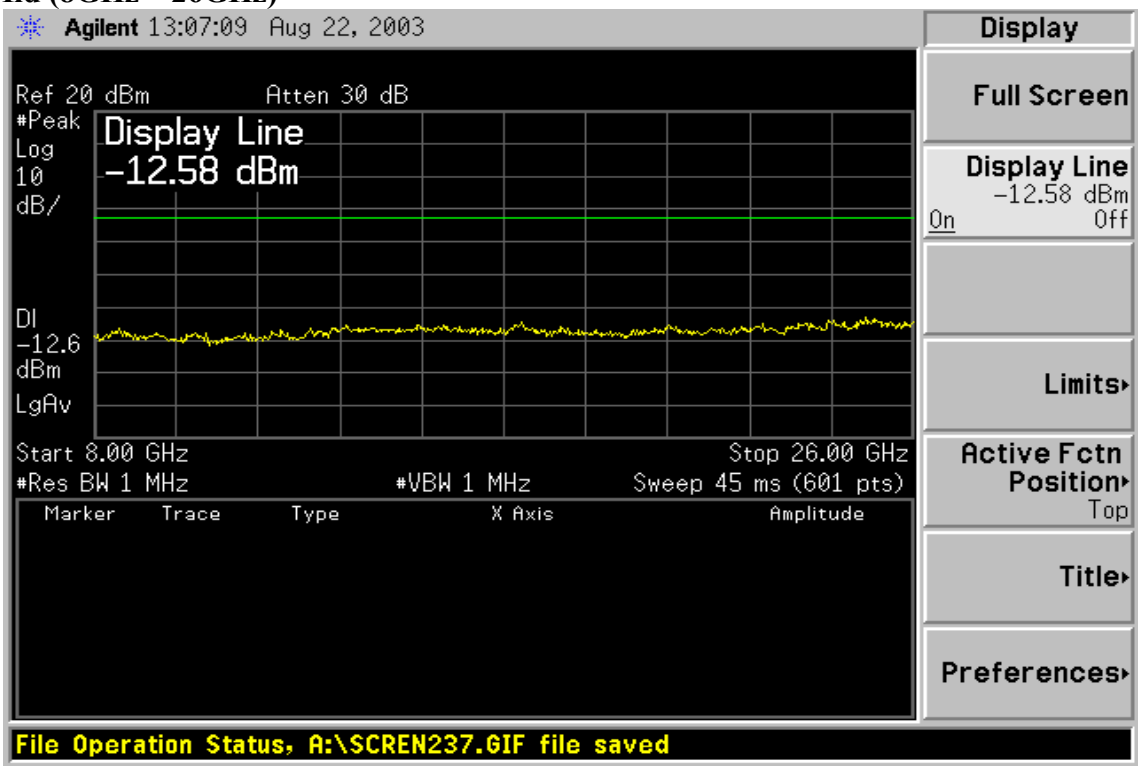
CH Low (26GHz – 40GHz)



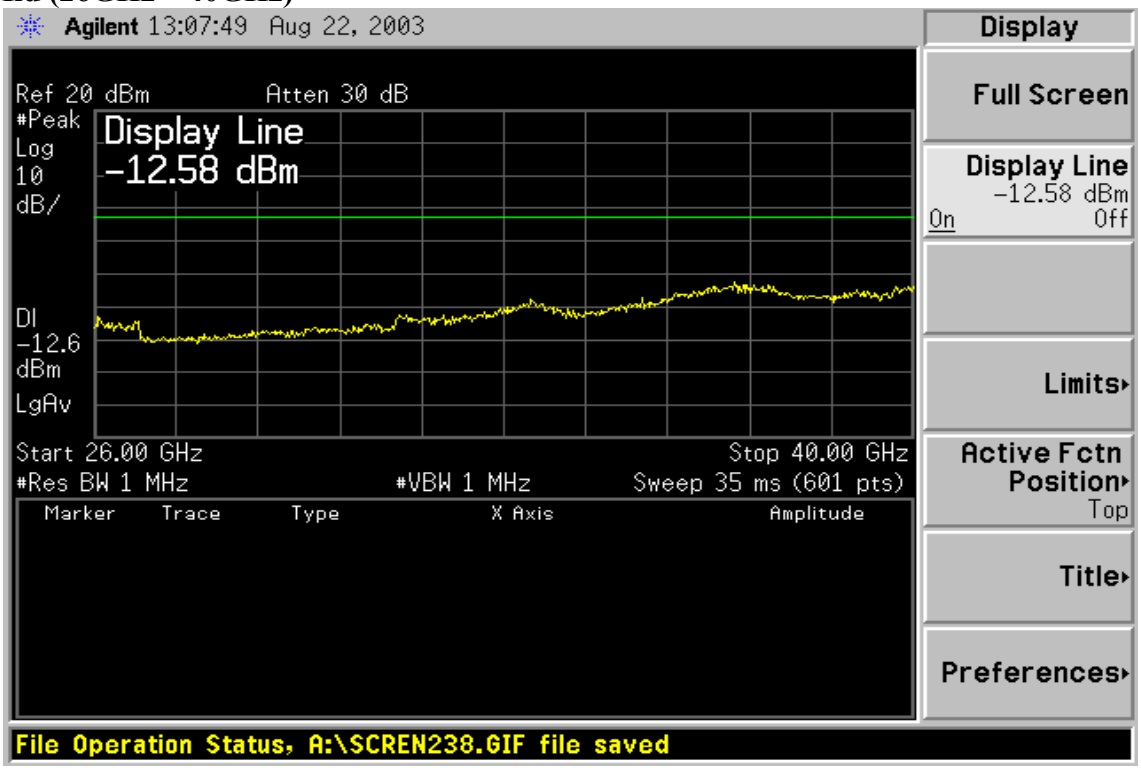
CH Mid (30MHz – 8GHz)



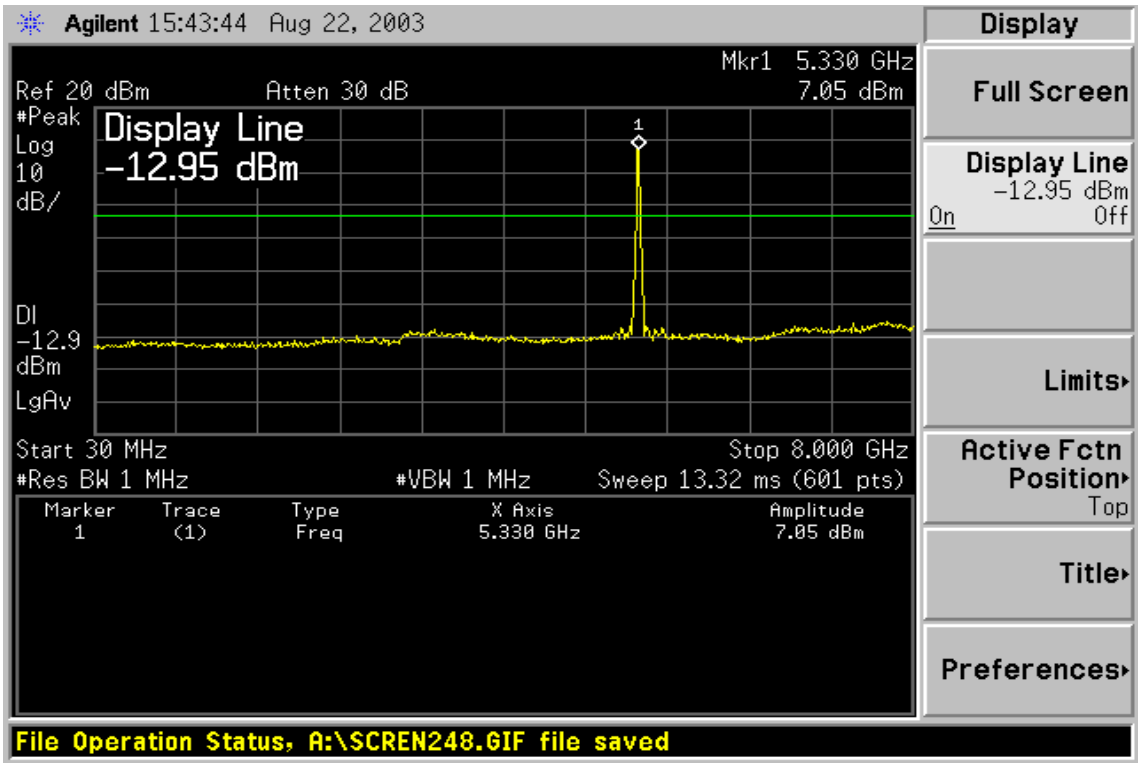
CH Mid (8GHz – 26GHz)



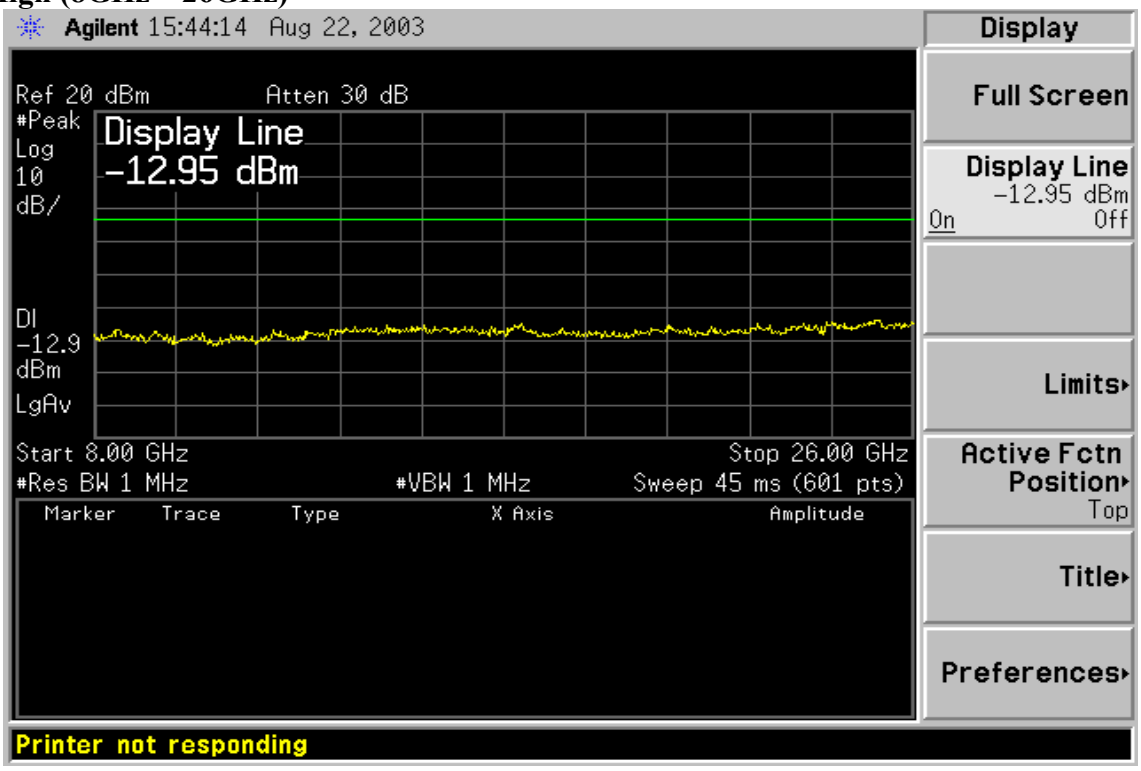
CH Mid (26GHz – 40GHz)



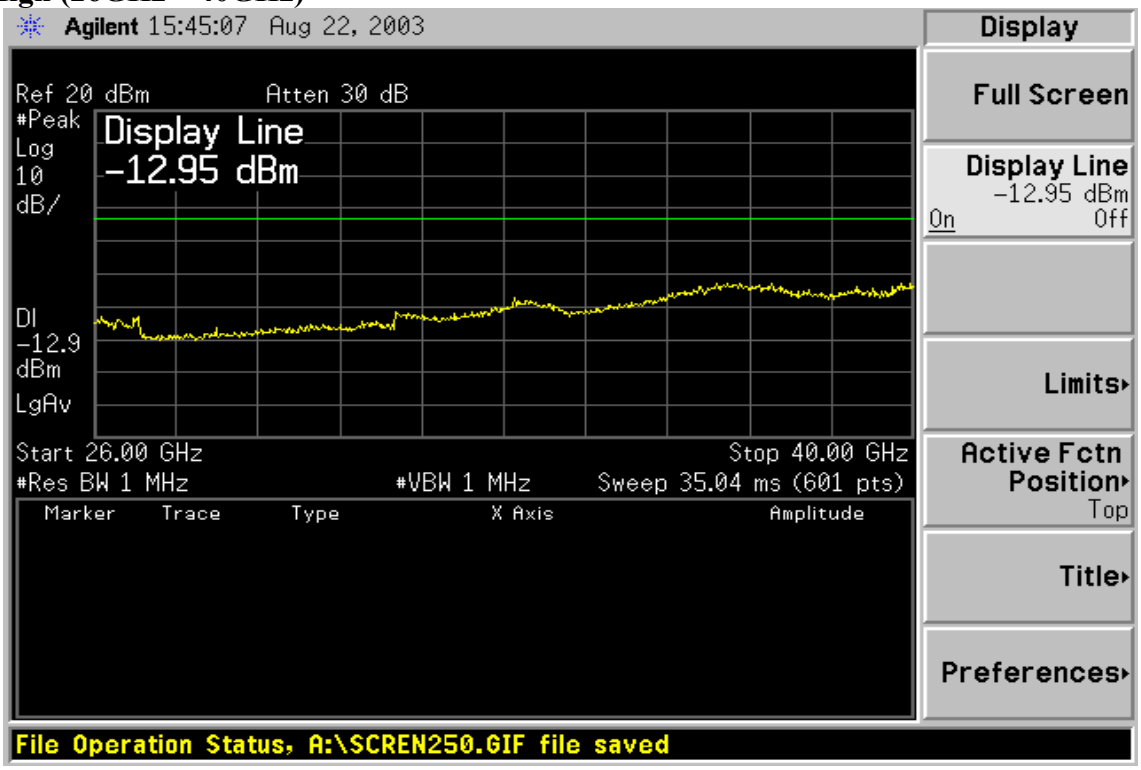
CH High (30MHz – 8GHz)



CH High (8GHz – 26GHz)



CH High (26GHz – 40GHz)



7.8. RADIATED UNDESIRABLE EMISSION (15.407)

LIMIT

For transmitters operating in the 5.15-5.35 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27dBm / MHz. Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.
The provisions of §15.205 apply to intentional radiators operating under this section. The EUT is set to transmit in a continuous mode.

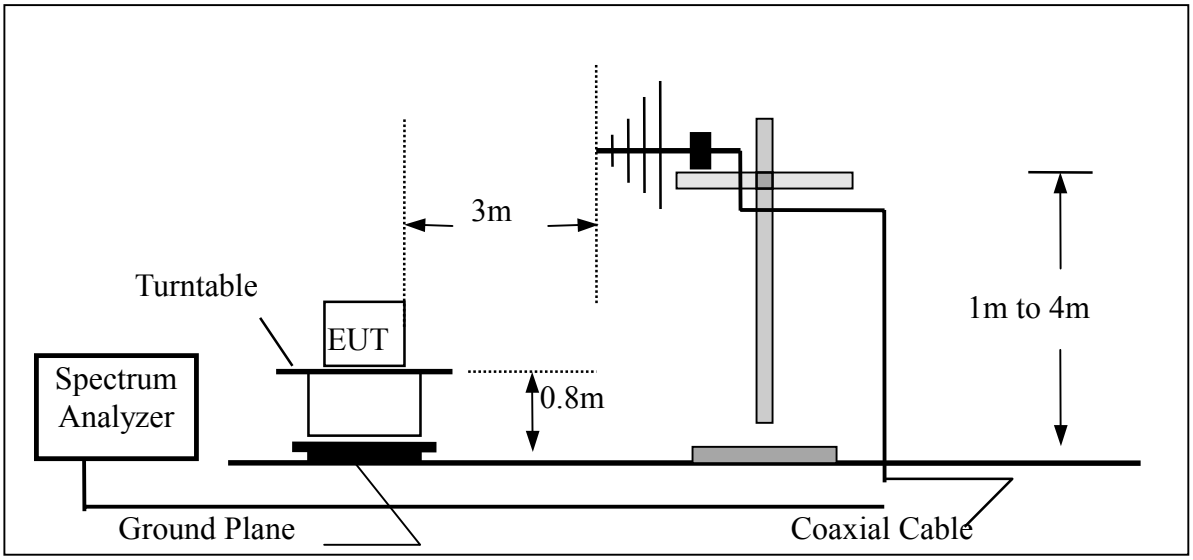
MEASUREMENT EQUIPMENT USED

Open Area Test Site # 3				
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Due**
Spectrum Analyzer	ADVANTEST	R3261A	N/A	03/18/2004
EMI Test Receiver	R&S	ESVS20	838804/004	01/04/2004
Pre-Amplifier	HP	8447D	2944A09173	03/03/2004
Bilog Antenna	SCHWAZBECK	VULB9163	145	07/05/2004
Turn Table	EMCO	2081-1.21	9709-1885	N.C.R
Antenna Tower	EMCO	2075-2	9707-2060	N.C.R
Controller	EMCO	2090	9709-1256	N.C.R
RF Switch	ANRITSU	MP59B	M53867	N.C.R
Site NSA	C&C	N/A	N/A	09/06/2004
Horn antenna	Schwarzbeck	BBHA 9120	D210	02/23/2004
Loop Antenna	EMCO	6502	2356	07/10/2004
Pre-Amplifier	HP	8449B	3008B00965	10/02/2003

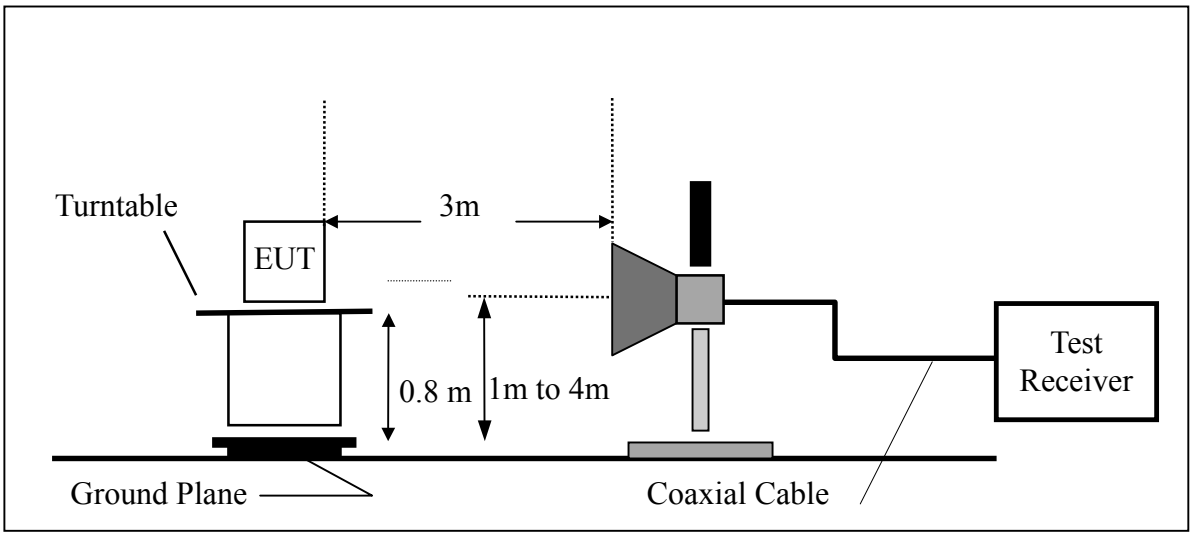
Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST CONFIGURATION

For Frequencies Below 1 GHz



For Frequencies Above 1 GHz



TEST PROCEDURE

1. The EUT is placed on a turntable, which is 0.8m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

Note: *The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 100kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1GHz.*

FACTOR CALCULATION

The Factor is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

F = AF + CL - AG

Where F = Factor
E = Field Strength in Volts / meter
AF = Antenna factor
CL = Cable attenuation factor (cable loss)
AG = Amplifier gain

EIRP Calculation

Given $E = \frac{\sqrt{(30 \times P \times G}}{d}$

Where E = Field strength (Volts/Meter)
P = Power (Watts)
G = Numeric antenna gain
d = Distance (Meter)

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields

$$P \times G = \frac{(d \times E)^2}{30}$$

Re-arranging the terms yields

P (mW) = P (W) / 1000 and
*d (cm) =100 * d (m)*

Converting to the logarithmic form and changing to units of mW and μV/m, using

P (mW) = P (W) / 1000 and E (uV/m) = E (V/m) / 1000000

Yields

$$10\log(P \times G) = 10\log d^2 + 10\log E^2 - 10\log 30 - 10\log 10^9 = 20\log d + 20\log E - 104.77$$

*Where 10 log (P * G) is PG in dBm and 20 log (E) is E in dBuV/m*

Since

*EIRP = P * G*

Then, at a specification distance of 3 meters, the EIRP, in terms of field strength, is

*EIRP (dBm) = P * G (dBm) = E (dBuV/m) – 95.2*

TEST RESULTS

For Frequency Below 1 GHz

Operation Mode: Tx CH Low Mode **Test Date:** August 25, 2003

Temperature: 32°C **Tested by:** Roy Cheng

Humidity: 62 % RH **Polarity:** Ver. / Hor.

Freq. (MHz)	Ant.Pol. H/V	Detector Mode (PK/QP)	Reading (dBuV)	Ant./CL/ Amp. CF(dB)	Actual FS (dBuV/m)	Limit3m (dBuV/m)	Safe Margin (dB)
86.700	V	Peak	17.75	11.24	28.99	40.00	-11.01
145.020	V	Peak	18.28	11.00	29.28	43.50	-14.22
357.400	V	Peak	13.17	18.43	31.60	46.00	-14.40
388.200	V	Peak	15.49	20.09	35.58	46.00	-10.42
400.800	V	Peak	11.28	20.71	31.99	46.00	-14.01
777.400	V	Peak	5.50	26.02	31.52	46.00	-14.48
323.800	H	Peak	13.91	17.32	31.23	46.00	-14.77
388.200	H	Peak	15.76	20.09	35.85	46.00	-10.15
455.400	H	Peak	11.12	20.42	31.54	46.00	-14.46
517.000	H	Peak	15.92	23.11	39.03	46.00	-6.97
650.000	H	Peak	9.71	24.88	34.59	46.00	-11.41
664.000	H	Peak	6.83	25.13	31.96	46.00	-14.04

Notes:

1. *Measuring frequencies from 30 MHz to the 1GHz.*
2. *Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using Peak detector mode.*
3. *Data of measurement within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.*
4. *The IF bandwidth of SPA between 30MHz to 1GHz was 100kHz.*

Operation Mode:	Tx CH Mid Mode	**Test Date:**	August 25, 2003
Temperature:	32°C	**Tested by:**	Roy Cheng
Humidity:	62 % RH	**Polarity:**	Ver. / Hor.

Freq. (MHz)	Ant.Pol. H/V	Detector Mode (PK/QP)	Reading (dBuV)	Ant./CL/ Amp. CF(dB)	Actual FS (dBuV/m)	Limit3m (dBuV/m)	Safe Margin (dB)
195.240	V	Peak	14.91	14.45	29.36	43.50	-14.14
388.200	V	Peak	15.44	20.09	35.53	46.00	-10.47
454.000	V	Peak	12.44	20.36	32.80	46.00	-13.20
517.000	V	Peak	16.11	23.11	39.22	46.00	-6.78
648.600	V	Peak	10.06	24.89	34.95	46.00	-11.05
668.200	V	Peak	6.96	25.20	32.16	46.00	-13.84
152.040	H	Peak	22.68	11.18	33.86	43.50	-9.64
258.960	H	Peak	14.65	16.09	30.74	46.00	-15.26
357.400	H	Peak	12.60	18.43	31.03	46.00	-14.97
389.600	H	Peak	13.79	20.16	33.95	46.00	-12.05
398.000	H	Peak	12.33	20.61	32.94	46.00	-13.06
517.000	H	Peak	7.39	23.11	30.50	46.00	-15.50

Notes:

1. *Measuring frequencies from 30 MHz to the 1GHz.*
2. *Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using Peak detector mode.*
3. *Data of measurement within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.*
4. *The IF bandwidth of SPA between 30MHz to 1GHz was 100kHz.*

Operation Mode:	Tx CH High Mode	**Test Date:**	August 25, 2003
Temperature:	32°C	**Tested by:**	Devin Chang
Humidity:	62 % RH	**Polarity:**	Ver. / Hor.

Freq. (MHz)	Ant.Pol. H/V	Detector Mode (PK/QP)	Reading (dBuV)	Ant./CL/ Amp. CF(dB)	Actual FS (dBuV/m)	Limit3m (dBuV/m)	Safe Margin (dB)
260.040	V	Peak	15.52	16.07	31.59	46.00	-14.41
388.200	V	Peak	15.30	20.09	35.39	46.00	-10.61
454.000	V	Peak	11.82	20.36	32.18	46.00	-13.82
518.400	V	Peak	16.25	23.16	39.41	46.00	-6.59
647.200	V	Peak	10.23	24.91	35.14	46.00	-10.86
668.200	V	Peak	6.36	25.20	31.56	46.00	-14.44
82.380	H	Peak	19.07	10.12	29.19	40.00	-10.81
150.960	H	Peak	25.00	11.15	36.15	43.50	-7.35
381.200	H	Peak	11.77	19.71	31.48	46.00	-14.52
388.200	H	Peak	13.89	20.09	33.98	46.00	-12.02
400.800	H	Peak	11.15	20.71	31.86	46.00	-14.14
665.400	H	Peak	7.38	25.15	32.53	46.00	-13.47

Notes:

1. *Measuring frequencies from 30 MHz to the 1GHz.*
2. *Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using Peak detector mode.*
3. *Data of measurement within this frequency range shown " - " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.*
4. *The IF bandwidth of SPA between 30MHz to 1GHz was 100kHz.*

For Frequency Above 1 GHz

No emissions to be recorded.

(*Since no specific emission noted beyond the background noise floor. Minimum 20dB separation of the field strength applied between the background noise-floor and the applicable limits.)*

7.9. TRANSMISSION IN ABSENCE OF DATA (15.407)

LIMIT

The device shall automatically discontinue transmission in case of either absence of information to transmit or operation failure. These provisions are not intended to preclude the transmission of control or signaling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization a description of how this requirement is met.

TEST RESULTS

No non-compliance noted

Note: *For the details, refer to the theory of the operation.*

7.10. FREQUENCY STABILITY (15.407)

LIMIT

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

Referring to the theory of operation, the crystal used to set the frequency has a temperature coefficient of +/- 20 ppm over the specified rated temperature range. For a transmitter fundamental frequency of 5.35 GHz, this corresponds to +/- 107 kHz.

TEST RESULTS

No non-compliance noted

Note: *An examination of the band-edge plots shows that the emission will stay within the authorized band over the entire temperature range.*

7.11.ANTENNA REQUIREMENT (15.407)

LIMIT

According to FCC Part 15.407(d), any U-NII device that operates in the 5.15-5.25 GHz band shall use a transmitting antenna that is an integral part of the device.

TEST RESULTS

No non-compliance noted

The antenna connector is designed with a unique connector and replacement by the user is not considered. For details, please refer to the EUT photos.

7.12.RADIO FREQUENCY EXPOSURE (15.407)

LIMIT

U-NII devices are subject to the radio frequency radiation exposure requirements specified in §1.1307(b), §2.1091 and §2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

EUT SPECIFICATION

EUT	Wireless LAN module built in Notebook PC
Frequency band (Operating)	☐ WLAN: 2.412GHz ~ 2.462GHz ☒ WLAN: 5.18GHz ~ 5.32GHz / 5.50GHz ~ 5.70GHz ☐ WLAN: 5.745GHz ~ 5825GHz ☐ Others _____
Device category	☐ Portable (<20cm separation) ☒ Mobile (>20cm separation) ☐ Others _____
Exposure classification	☐ Occupational/Controlled exposure *(S = 5mW/cm^2)* ☒ General Population/Uncontrolled exposure *(S=1mW/cm^2)*
Antenna diversity	☐ Single antenna ☒ Multiple antennas ☐ Tx diversity ☐ Rx diversity ☒ Tx/Rx diversity
Max. output power	17.32 dBm (53.95mW)
Antenna gain (Max)	1.06 dBi (Numeric gain: 1.28)
Evaluation applied	☒ MPE Evaluation* ☐ SAR Evaluation ☐ N/A

Note:

1. **The maximum output power is 17.32dBm(53.95mW) at 5320MHz..*
2. *For mobile or fixed location transmitters, no SAR consideration applied. The minimum separation generally be used is at least 20 cm, even if the calculations indicate that the MPE distance would be lesser.*

TEST RESULTS

No non-compliance noted

Calculation

Given $E = \sqrt{\frac{30 \times P \times G}{d}}$ & $S = \frac{E^2}{3770}$

Where *E = Field Strength in Volts / meter*
P = Power in Watts
G=Numeric antenna gain
d=Distance in meters
S=Power Density in milliwatts / square centimeter

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields:

$$d = \sqrt{\frac{30 \times P \times G}{3770 \times S}}$$

Changing to units of mW and cm, using:

P (mW) = P (W) / 1000 and

*d (cm) =100 * d (m)*

Yields

$$d = 100 \times \sqrt{\frac{30 \times (P/1000) \times G}{3770 \times S}} = 0.282 \times \sqrt{\frac{P \times G}{S}}$$

Where *d = distance in cm*
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW / cm^2

Substituting the logarithmic form of power and gain using:

P (mW) = 10 ^ (P (dBm) / 10) and

G (numeric) = 10 ^ (G (dBi) / 10)

Yields

$$d = 0.282 \times \frac{10^{(P+G)/20}}{\sqrt{20}}$$ ***Equation 1***

Where *d = MPE safe distance in cm*
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW / cm^2

Maximum Permissible Exposure

EUT output power = 53.95 mW

Antenna Gain = 1.28

S = 1.0 mW / cm^2 from 1.1310 Table 1

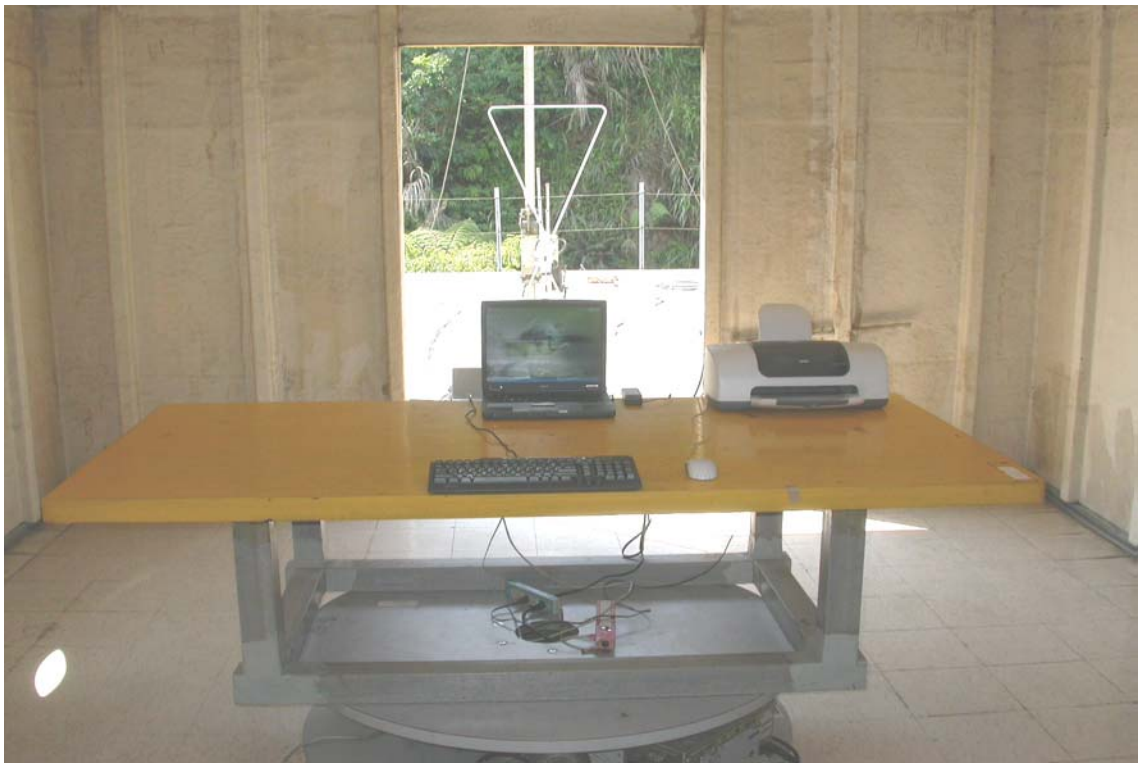
Substituting these parameters into the above Equation 1:

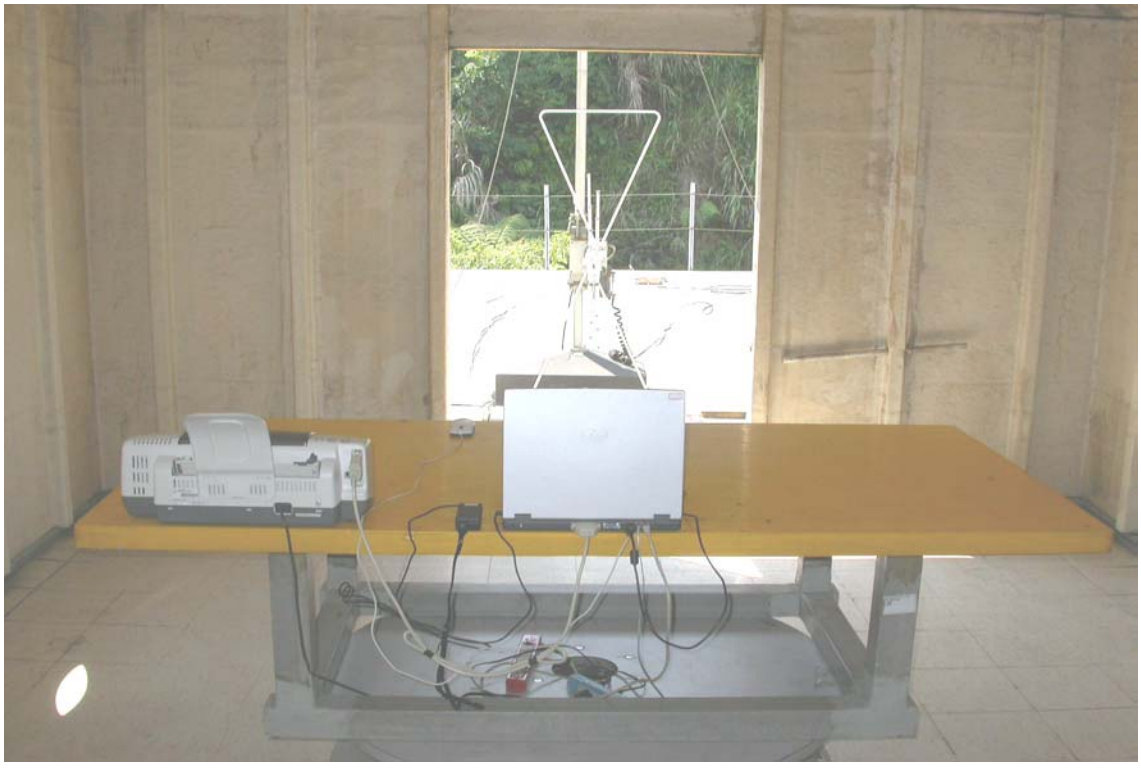
→ *MPE Safe Distance = 2.34 cm*

(For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.)

APPENDIX 1
PHOTOGRPHS OF TEST SETUP

Radiated Emission Set up Photos





Conducted Emission Set Up Photos

APPENDIX 2
EXTERNAL PHOTOGRPHS OF EUT

Front view of EUT

Back view of EUT

Left view of EUT

Right view of EUT

Open view of EUT

Bottom view of EUT

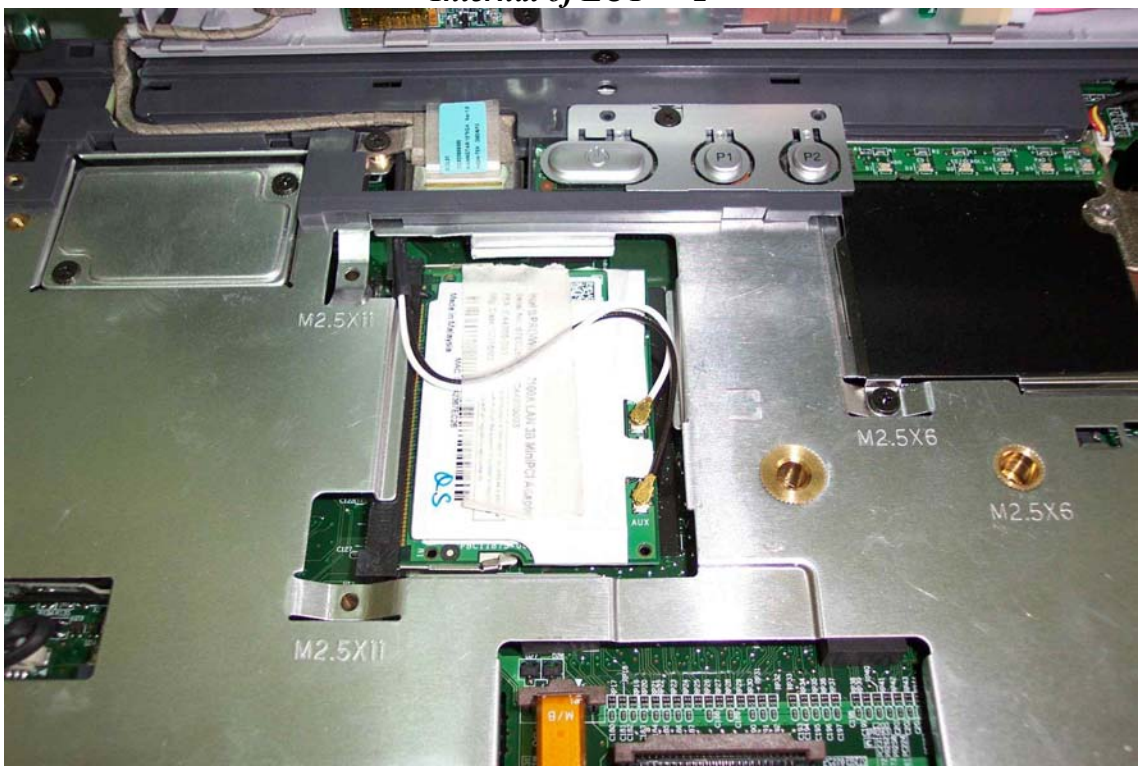
Front view of Power Adapter

Back view of Power Adapter

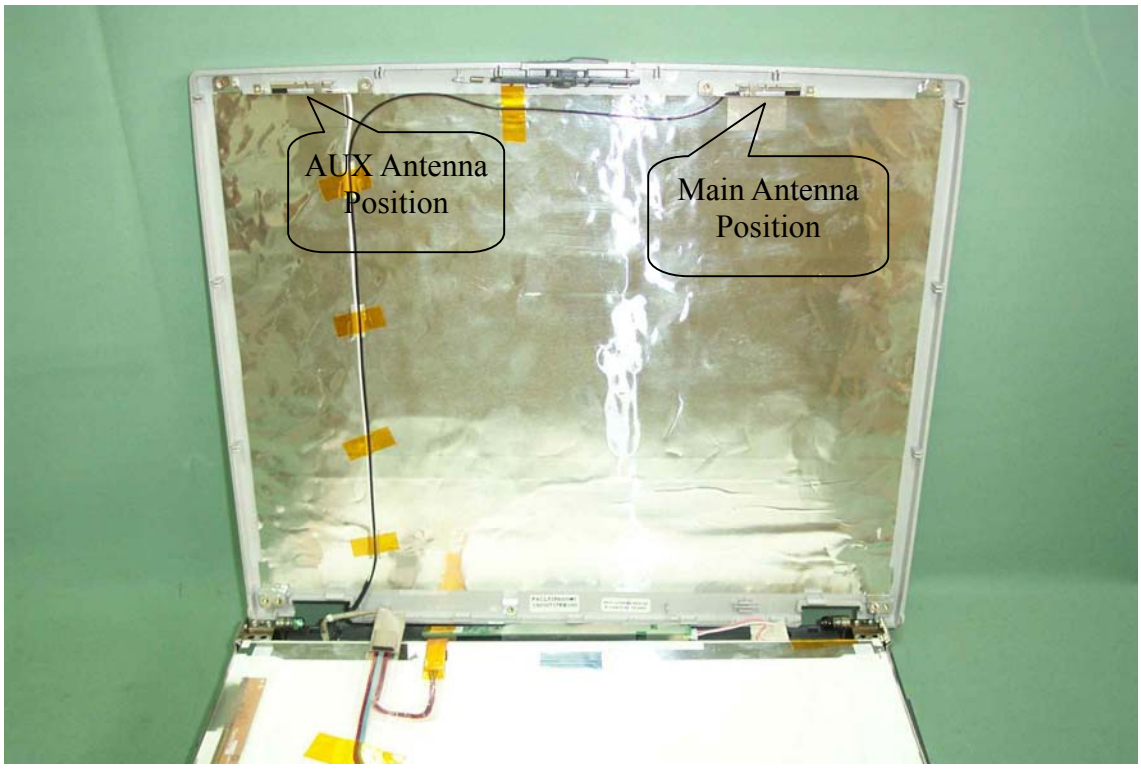
APPENDIX 3
INTERNAL PHOTOGRPHS OF EUT

Internal of EUT --- 1

Internal of EUT --- 2



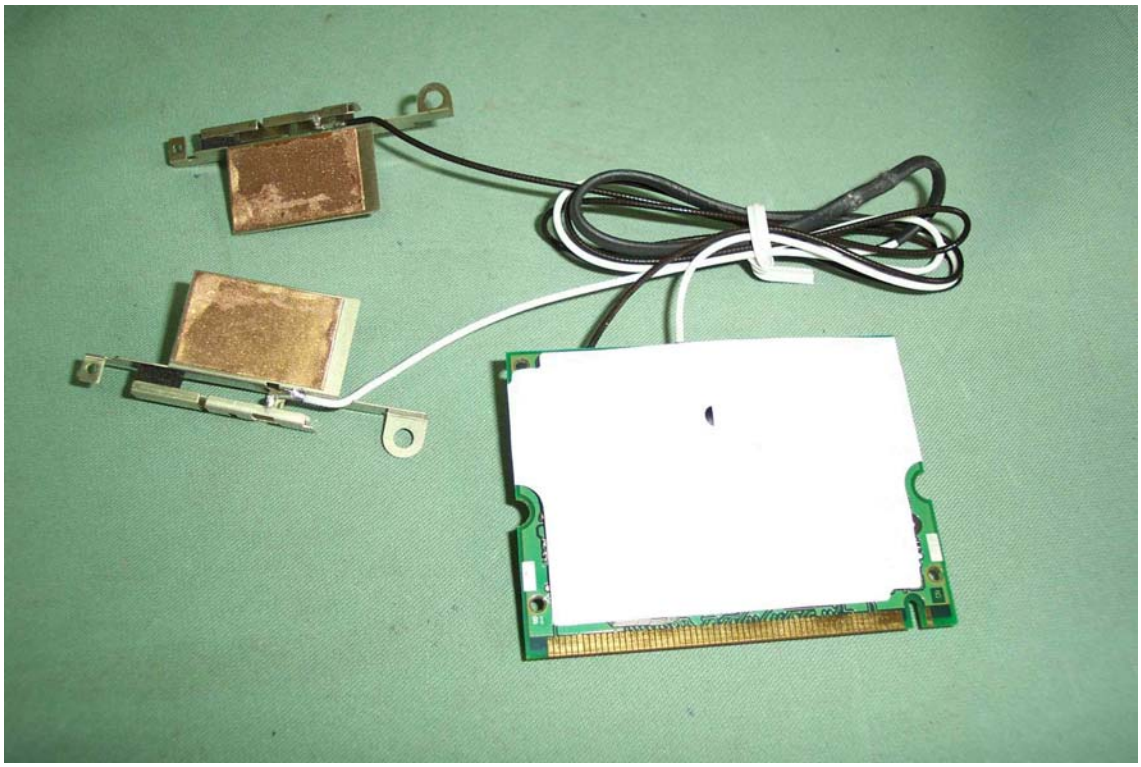
Internal of EUT --- 3



Internal of EUT --- 4

Internal of EUT --- 5

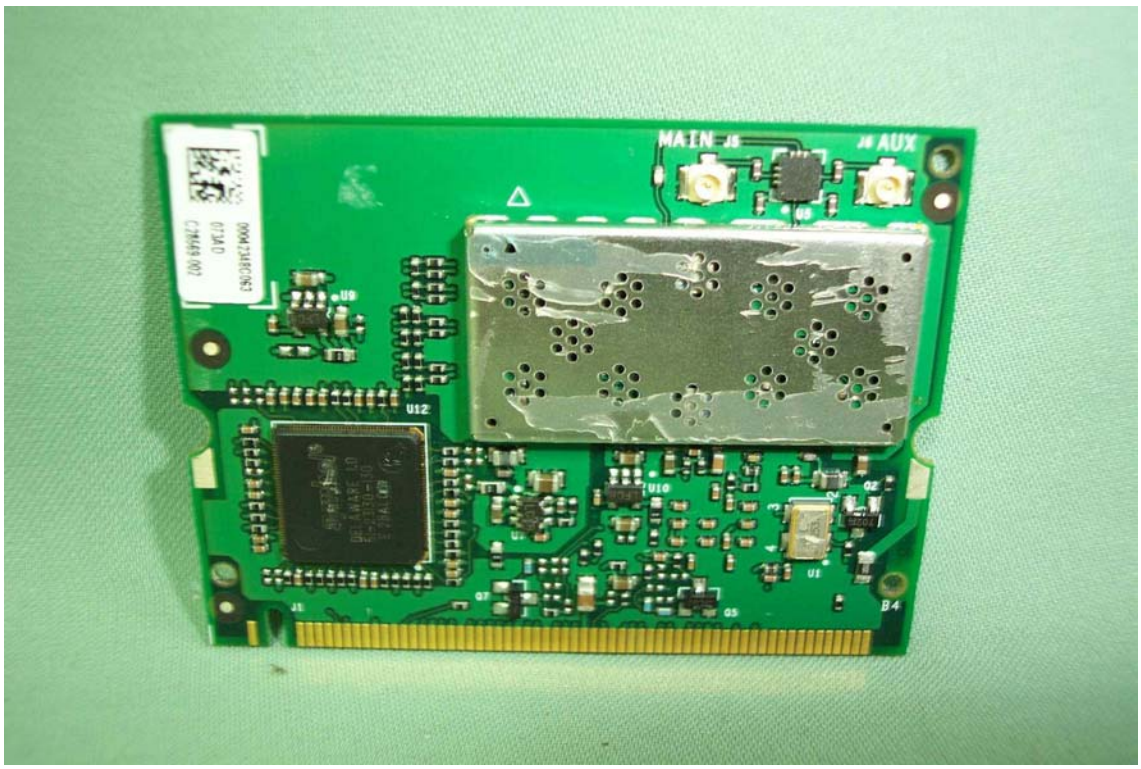
Internal of EUT --- 6



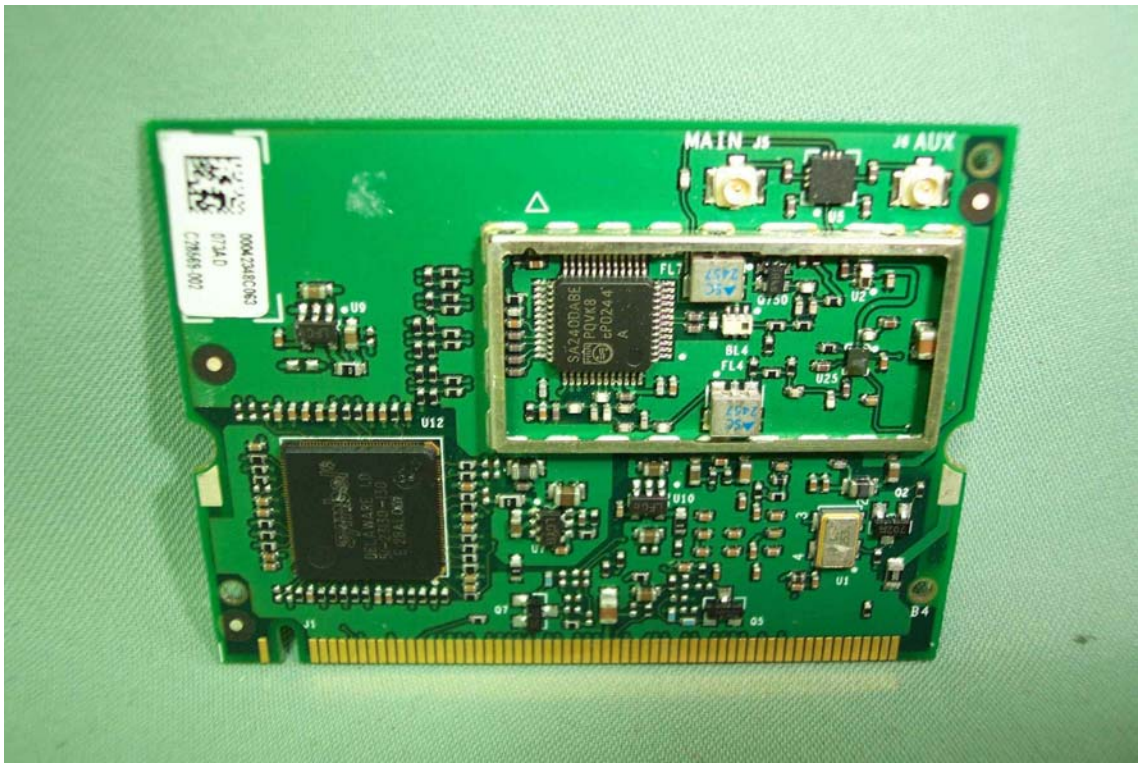
Internal of EUT --- 7

Internal of EUT --- 8

Internal of EUT --- 9



Internal of EUT --- 10



Internal of EUT --- 11