

Nemko Test Report: 2L0523RUS1

Applicant: Sychip, Inc
2805 North Dallas Parkway
Suite 400
Plano, TX 75093

**Equipment Under Test:
(E.U.T.)** WLAN 6060 BGAEVK

In Accordance With: **FCC Part 15, Subpart C, 15.247**
Direct Sequence Spread Spectrum Transmitters

Tested By: Nemko Dallas Inc.
802 N. Kealy
Lewisville, Texas 75057-3136

Authorized By:



Tom Tidwell, RF Group Manager

Date: 10/29/02

Total Number of Pages: 44

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Section 1. Summary of Test Results

Manufacturer: Sychip, Inc.

Model No.: WLAN 6060 BGAEVK

Serial No.: None

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.247 for Direct Sequence Spread Spectrum devices. Radiated tests were conducted in accordance with ANSI C63.4-1992. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.

- | | | | |
|-------------------------------------|----------------------------|-------------------------------------|---------------------|
| <input checked="" type="checkbox"/> | New Submission | <input type="checkbox"/> | Production Unit |
| <input type="checkbox"/> | Class II Permissive Change | <input checked="" type="checkbox"/> | Pre-Production Unit |

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.

See " Summary of Test Data".



NVLAP LAB CODE: 100426-0

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Summary Of Test Data

NAME OF TEST	PARA. NO.	SPEC.	RESULT
Powerline Conducted Emissions	15.207(a)	48 dB μ V	Complies
Minimum 6 dB Bandwidth	15.247(a)(2)	>500 kHz	Complies
Maximum Peak Power Output	15.247(b)(1)	<1 Watt	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	-20 dBc/100kHz	Complies
Spurious Emissions (Restricted Bands)	15.247(c)	< 74 dBuV/m Peak < 54 dBuV/m Avg	Complies
Peak Power Spectral Density	15.247(d)	+8 dBm/3kHz	Complies

Footnotes:

Section 2. Equipment Under Test (E.U.T.)

General Equipment Information

Frequency Band: 902 – 928 MHz
 2400 – 2483.5 MHz
 5725 – 5850 MHz

Tuning Range: 2412 – 2462 MHz

Channel Spacing: 5 MHz

User Frequency Adjustment: Software controlled

Description of EUT

WLAN6060 EVK from SyChip Inc provides a platform for testing SyChip WLAN embedded modules (WLAN6060BB for BGA version and WLAN6060EB for 60-pin connector version).

System Diagram

Refer to separate exhibit.

Section 3. Powerline Conducted Emissions

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY: David Light	DATE: 10/28/2002

Test Results: Complies.

Measurement Data: See attached plots.

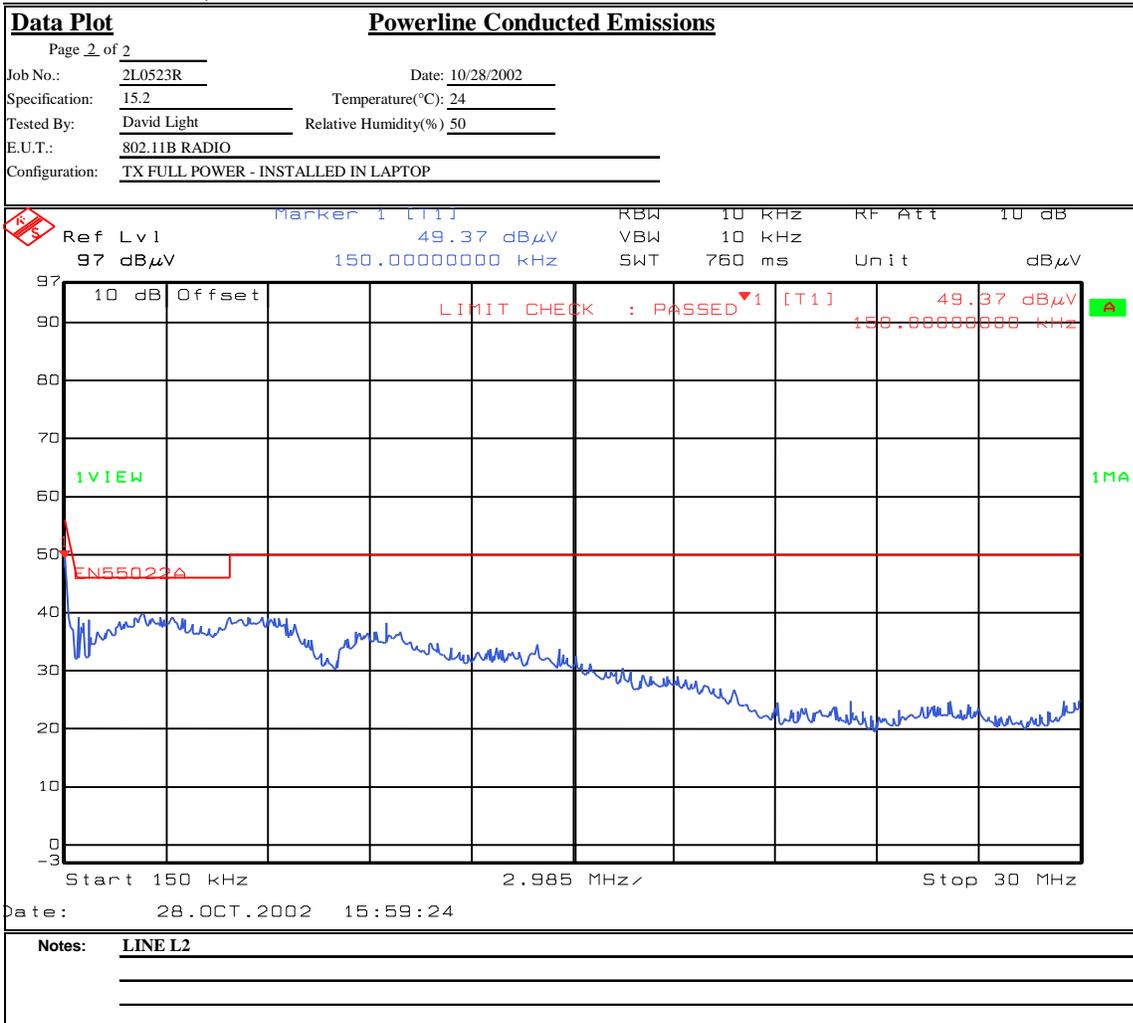
Measurement Uncertainty: +/- 1.7 dB

Test Data – Powerline Conducted Emissions



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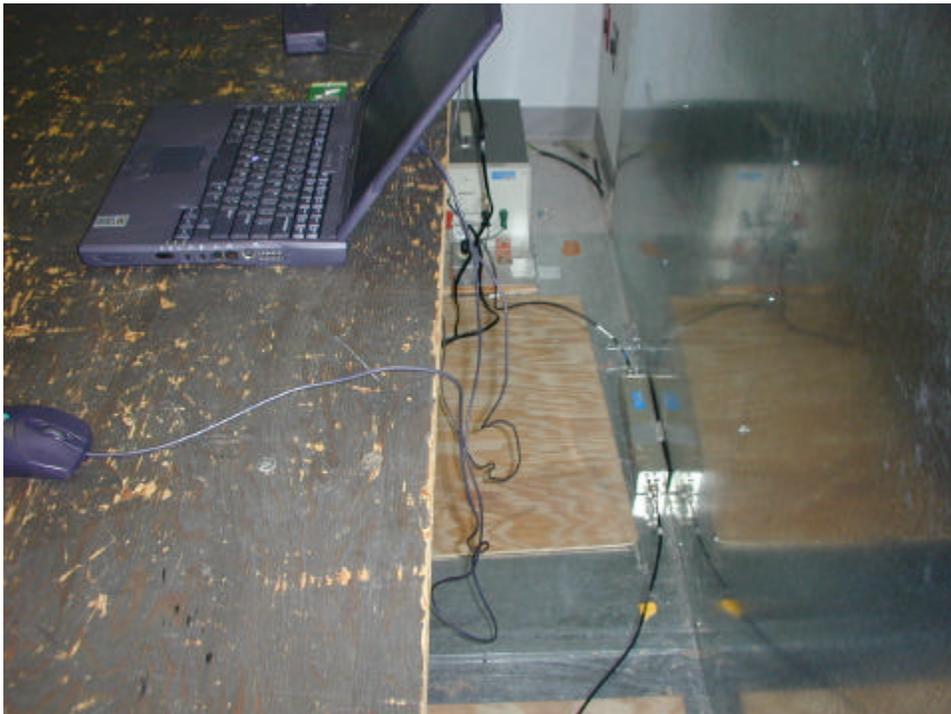


Photos – Powerline Conducted Emissions

Front



Side



Section 4. Minimum 6 dB Bandwidth

NAME OF TEST: Minimum 6 dB Bandwidth	PARA. NO.: 15.247(a)(2)
TESTED BY: David Light	DATE:10/28/2002

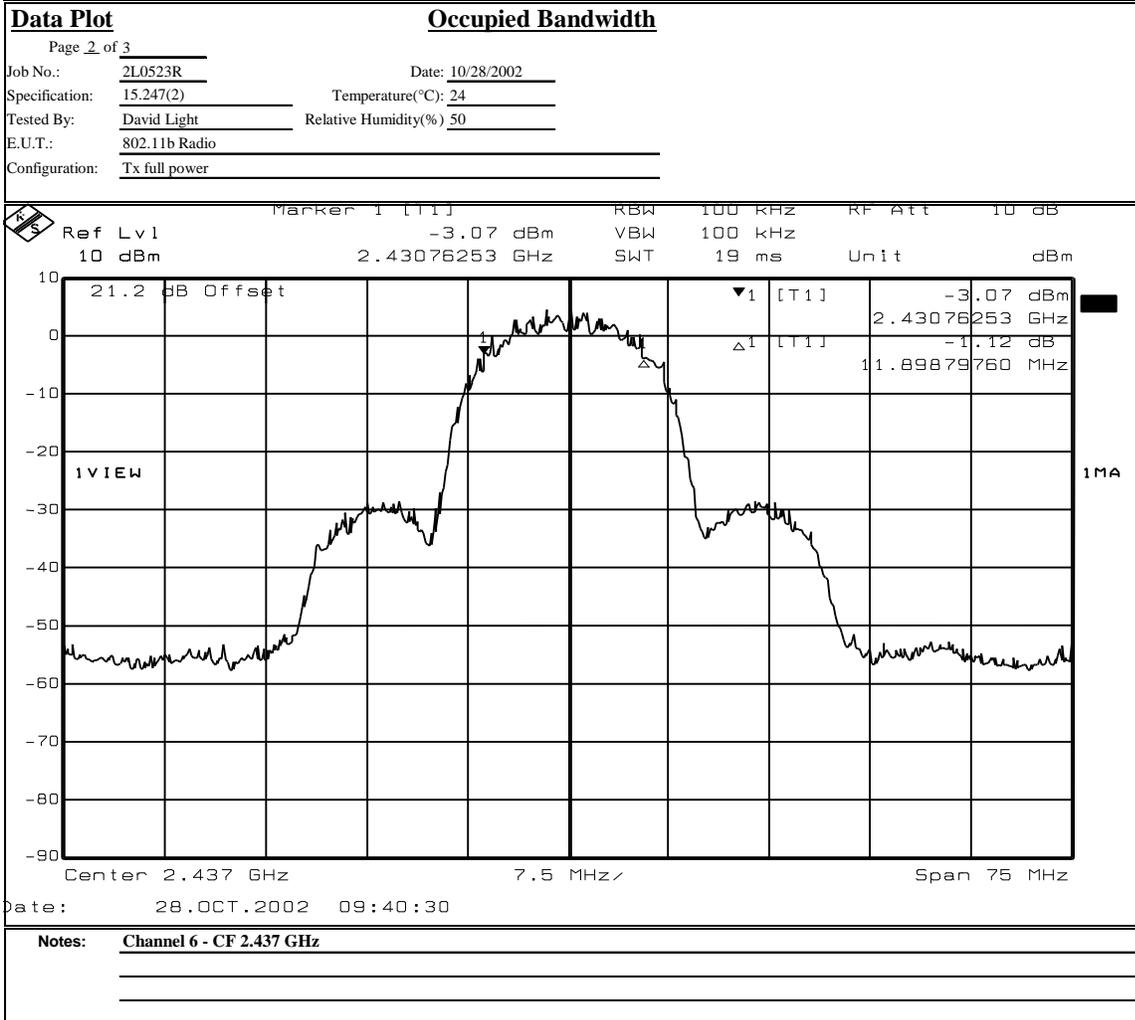
Test Results: Complies.

Measurement Data: See 6 dB BW plot
Measured 6 dB bandwidth: 12.3 MHz
Channel Separation: 5 MHz



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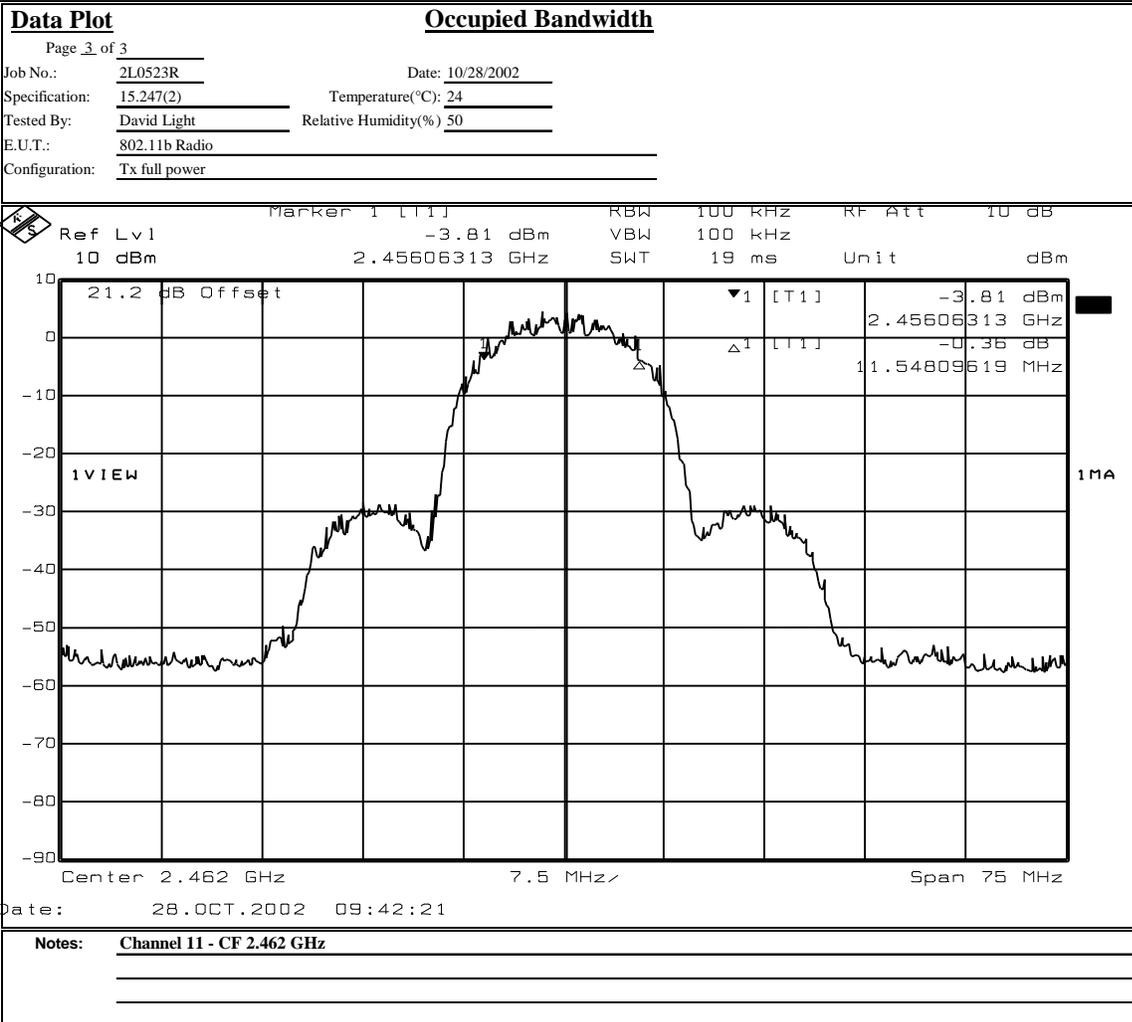
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Section 5. Maximum Peak Output Power

NAME OF TEST: Maximum Peak Output power	PARA. NO.: 15.247(b)(1)
TESTED BY: David Light	DATE: 10/28/2002

Test Results: Complies.

Measurement Data:

Antennas: 2.45 GHz Chip Antennal

Center Frequency (GHz)	Conducted Power (dBm)	Conducted Power (mW)	Gain (dBi)	E.I.R.P. (dBm)
2.412 (Vnom)	16	40	3	19
2.437 (Vnom)	16	40	3	19
2.462 (Vnom)	16	40	3	19
2.412 (Vmin)	15.3	33.9	3	18.3
2.437 (Vmin)	15.3	33.9	3	18.3
2.462 (Vmin)	15.3	33.9	3	18.3
2.412 (Vmax)	16.9	49	3	19.9
2.437 (Vmax)	16.9	49	3	19.9
2.462 (Vmax)	16.9	49	3	19.9

Equipment Used: 1029-1030

Measurement Uncertainty: +/- 0.7 dB

Temperature: 24 °C

Relative Humidity: 50 %

Section 6. RF Exposure

NAME OF TEST: RF Exposure	PARA. NO.: 15.247(b)(4)
TESTED BY: David Light	DATE:10/28/2002

Test Results: Complies.

Measurement Data: Complies



Prediction of MPE limit at a given distance

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

$$S = \frac{PG}{4\pi R^2}$$

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

Maximum peak output power at antenna input terminal: 16.90 (dBm)
 Maximum peak output power at antenna input terminal: 48.97788 (mW)
 Antenna gain(typical): 3 (dBi)
 Maximum antenna gain: 1.995262 (numeric)
 Prediction distance: 5 (cm)
 Prediction frequency: 2400 (MHz)
 MPE limit for uncontrolled exposure at prediction frequency: 1 (mW/cm²)

Power density at prediction frequency: **0.311064** (mW/cm²)

Section 7. Spurious Emissions (conducted)

NAME OF TEST: Spurious Emissions (conducted)	PARA. NO.: 15.247(c)
TESTED BY: David Light	DATE:10/28/2002

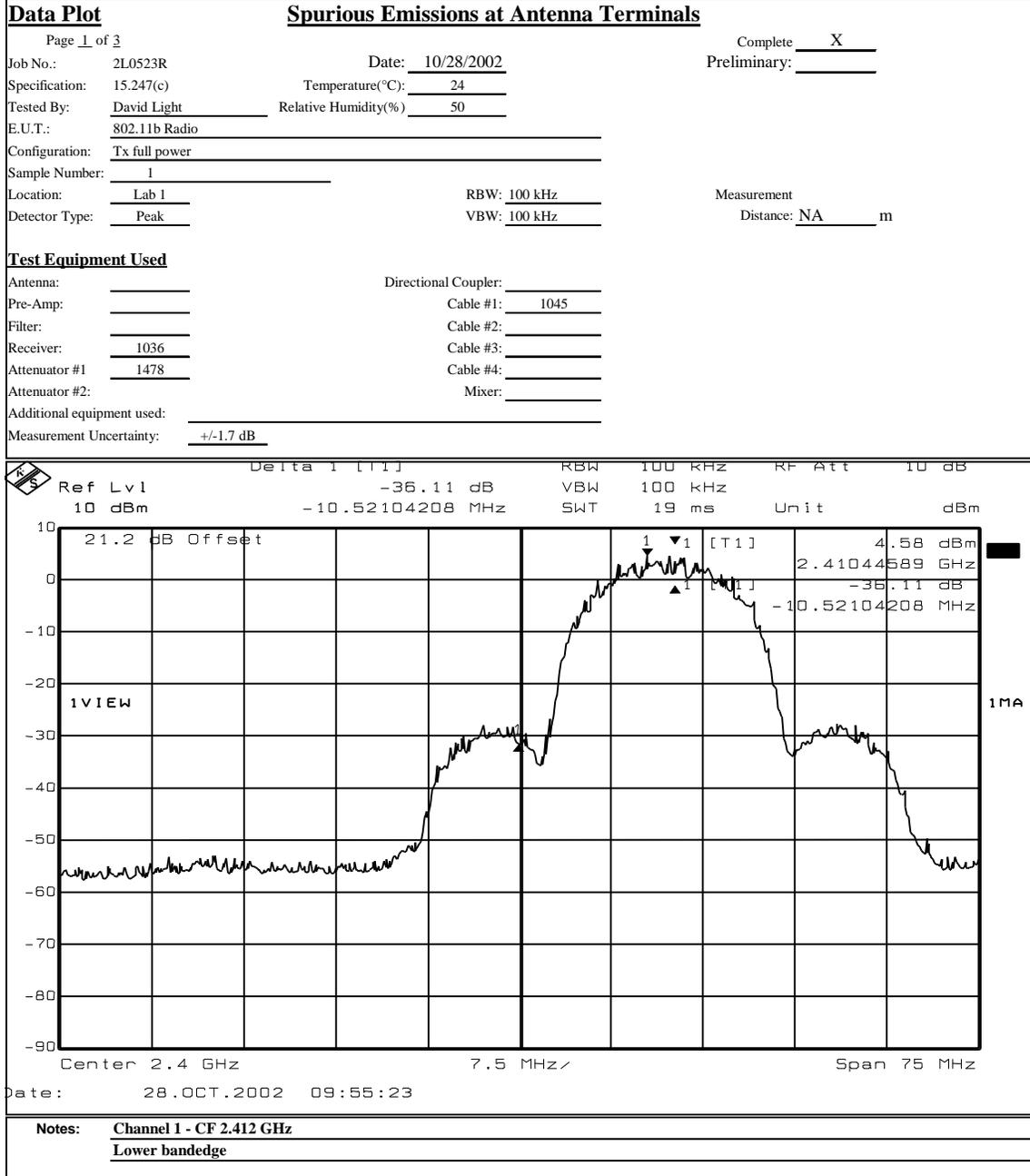
Test Results: Complies.

Measurement Data: See attached plots.



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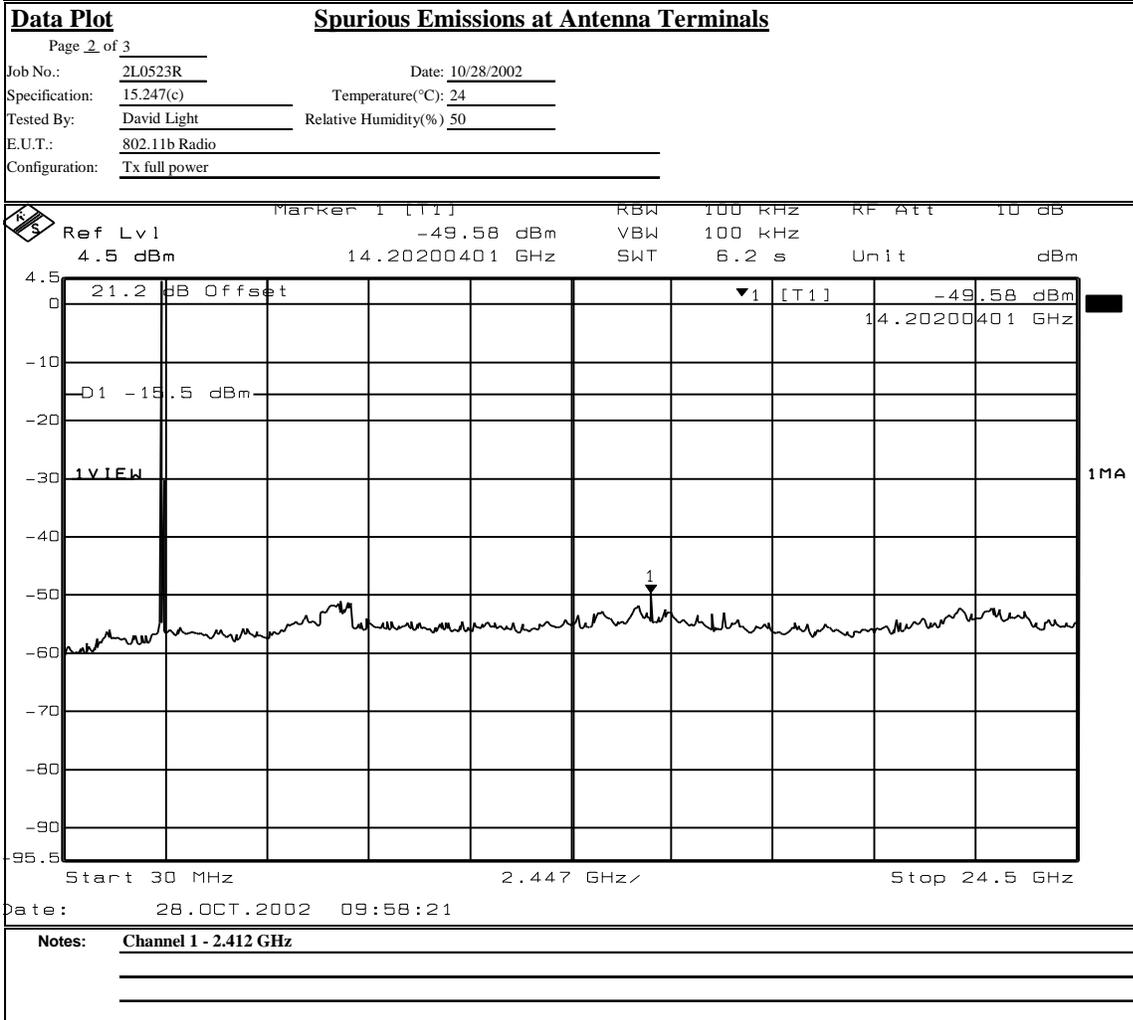
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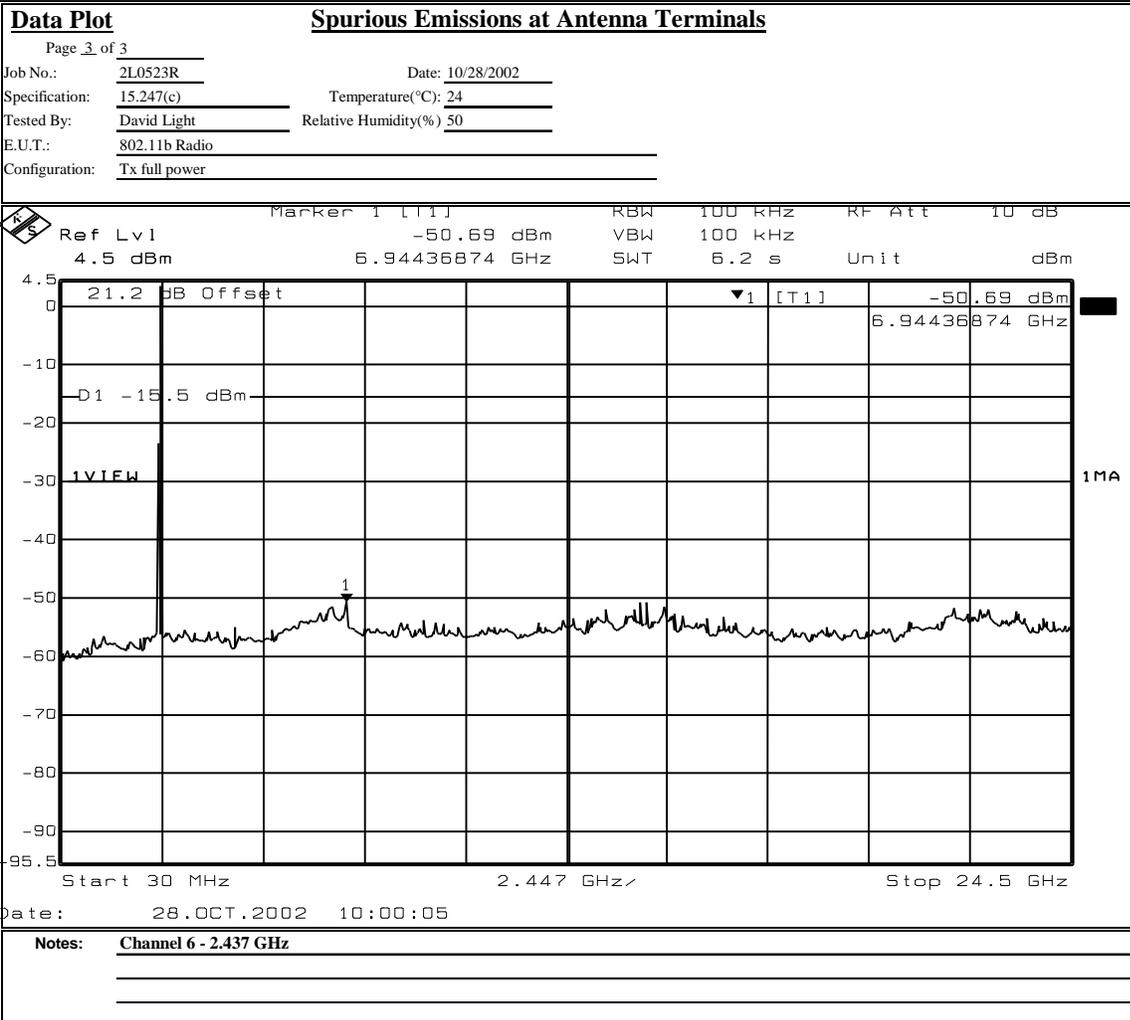
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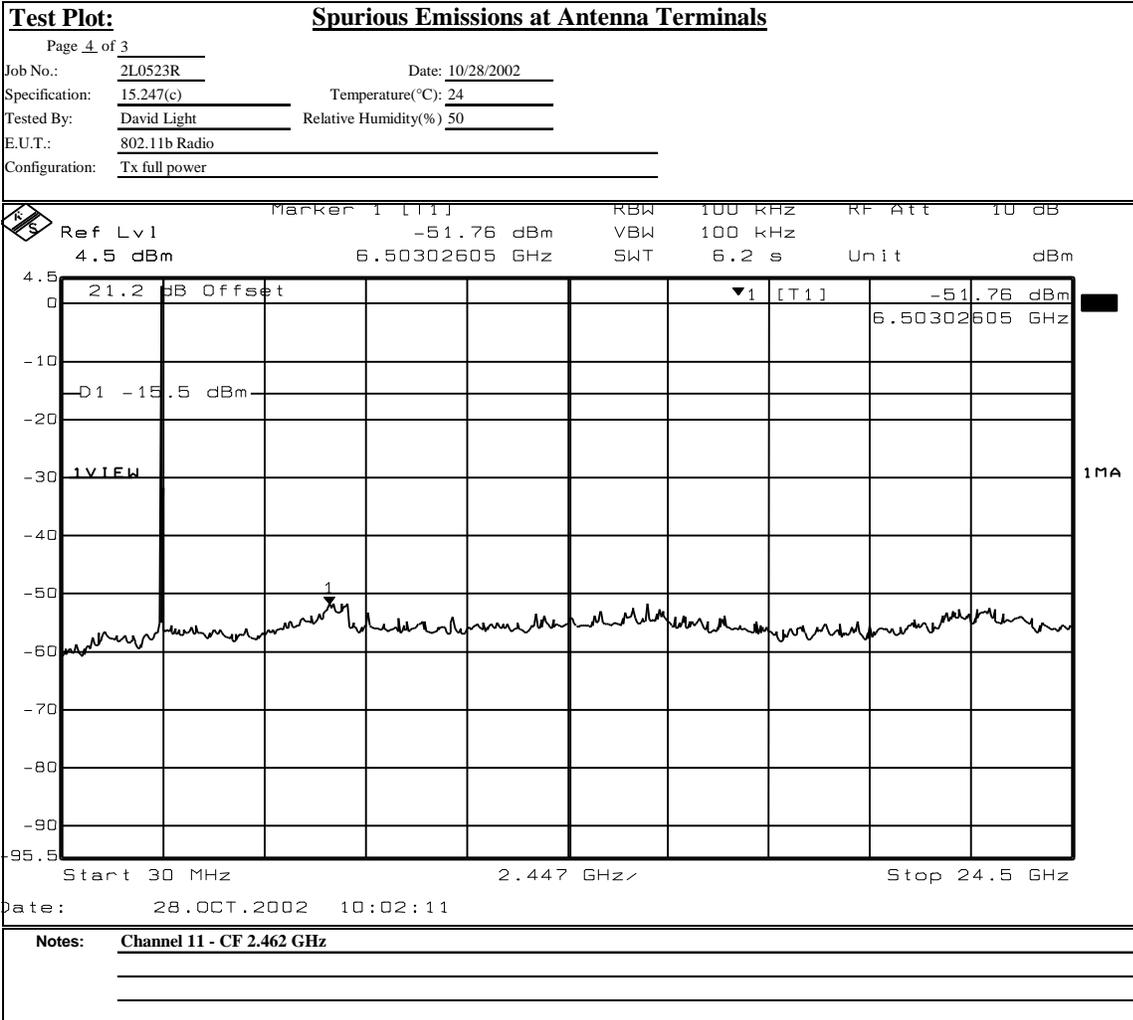
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Section 8. Spurious Emissions (radiated)

NAME OF TEST: Radiated Spurious Emissions	PARA. NO.: 15.247 (c)
TESTED BY: David Light	DATE:10/28/2002

Test Results: Complies.

Measurement Data: See attached table.

EQUIPMENT: **WLAN 6060 BGAEVK**

PROJECT NO.: **2L0523RUS1**



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Radiated Emissions

Page 1 of 2
 Job No.: 2L0523R Date: 10/28/02
 Specification: 15.247 Temperature(°C): 24
 Tested By: David Light Relative Humidity(%) 50
 E.U.T.: 802.11b Radio
 Configuration: Tabletop in laptop host
 Sample Number: _____
 Location: AC 3 RBW: 1 MHz
 Detector Type: Peak VBW: 1 MHz

Test Equipment Used

Antenna: 993 Directional Coupler: #N/A
 Pre-Amp: 1016 Cable #1: 1484
 Filter: 1482 Cable #2: 1485
 Receiver: 1464 Cable #3: #N/A
 Attenuator #1: #N/A Cable #4: #N/A
 Attenuator #2: #N/A Mixer: #N/A

Note: If PEAK measurement met the AVERAGE limit, then an AVERAGE measurement was not made
 Measurement Uncertainty: +/-3.7 dB

Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Comment
								Channel 11 - CF 2.437
2.4835	32.3	29.0	3.1	0.0	64.4	74	-9.6	H - PEAK
2.4835	33.8	29.0	3.1	22.2	43.7	54	-10.3	H - AVERAGE
4.924	44.2	33.5	4.3	29.7	52.3	54	-1.7	H - PEAK
7.386	43.2	35.9	5.2	34.1	50.2	54	-3.8	H - PEAK
12.31	44.5	40.0	7.3	32.8	59.0	74	-15.0	H - PEAK
12.31	32.7	40.0	7.3	32.8	47.2	54	-6.8	H - AVERAGE
2.4835	24.3	29.0	3.1	0.0	56.4	74	-17.6	V - PEAK
2.4835	34	29.0	3.1	22.2	43.9	54	-10.1	V - AVERAGE
4.9240	45.3	33.5	4.3	29.7	53.4	54	-0.6	V - PEAK
7.386	42.2	35.9	5.2	34.1	49.2	54	-4.8	V - PEAK
12.31	44	40.0	7.3	32.8	58.5	74	-15.5	V - PEAK
12.31	32.3	40.0	7.3	32.8	46.8	54	-7.2	V - AVERAGE

Notes: **Peak measurements are 1 MHz RBW/1 MHz VBW**
Average measurements 1 MHz RBW/10 Hz VBW



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Radiated Spurious Emissions								
Page <u>1</u> of		Continuation Page						
Job No.:		Date: 10/28/02						
Specification: CFR 47, Part 15		Temperature(°F): <u>72</u>						
Tested By: #N/A		Relative Humidity(%) <u>50</u>						
E.U.T.:		802.11b Radio						
Configuration:		Tabletop in laptop host						
Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Comment
								Channel 1
4.824	46	33.2	4.2	30.1	53.3	54	-0.7	V - PEAK
7.236	42.8	35.8	5.1	34	49.7	54	-4.3	V - PEAK
12.06	44	39.7	7.3	33.4	57.6	74	-16.4	V - PEAK
12.060	32.0	39.7	7.3	33.4	45.6	54	-8.4	V - AVERAGE
4.824	44.8	33.2	4.2	30.1	52.1	54	-1.9	H - PEAK
7.236	41.5	35.8	5.1	34	48.4	54	-5.6	H - PEAK
12.06	43.5	39.7	7.3	33.4	57.1	74	-16.9	H - PEAK
12.060	32.2	39.7	7.3	33.4	45.8	54	-8.2	H - AVERAGE
								Channel 6
4.874	43.3	33.2	4.2	30.1	50.6	54	-3.4	H - PEAK
7.311	42.5	35.8	5.1	34	49.4	54	-4.6	H - PEAK
12.185	43.5	39.7	7.3	33.4	57.1	74	-16.9	H - PEAK
12.185	32.2	39.7	7.3	33.4	45.8	54	-8.2	H - AVERAGE
4.874	45.8	33.2	4.2	30.1	53.1	54	-0.9	V - PEAK
7.311	42.2	35.8	5.1	34	49.1	54	-4.9	V - PEAK
12.185	43.3	39.7	7.3	33.4	56.9	74	-17.1	V - PEAK
12.185	32	39.7	7.3	33.4	45.6	54	-8.4	V - AVERAGE
Notes:	Searched spectrum to the 10th harmonic of carrier frequency							
	All emissions within 20 dB of the spec limit were reported							

Radiated Photographs (Worst Case Configuration)



EQUIPMENT: WLAN 6060 BGAEVK

PROJECT NO.: 2L0523RUS1

Section 9. Peak Power Spectral Density

NAME OF TEST: Peak Power Spectral Density	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE:10/28/2002

Test Results: Complies.

Measurement Data: See attached plots.

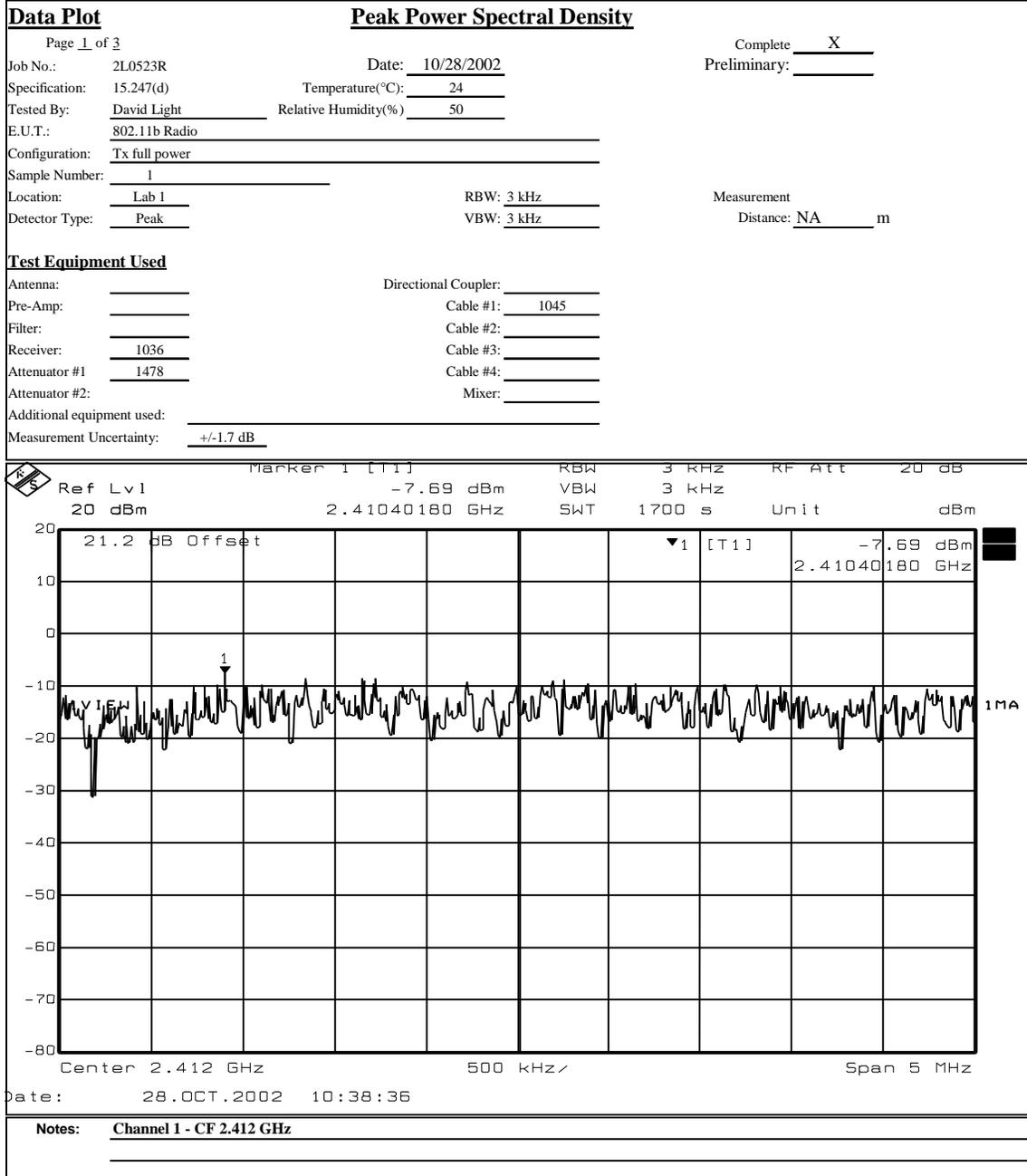
EQUIPMENT: **WLAN 6060 BGAEVK**

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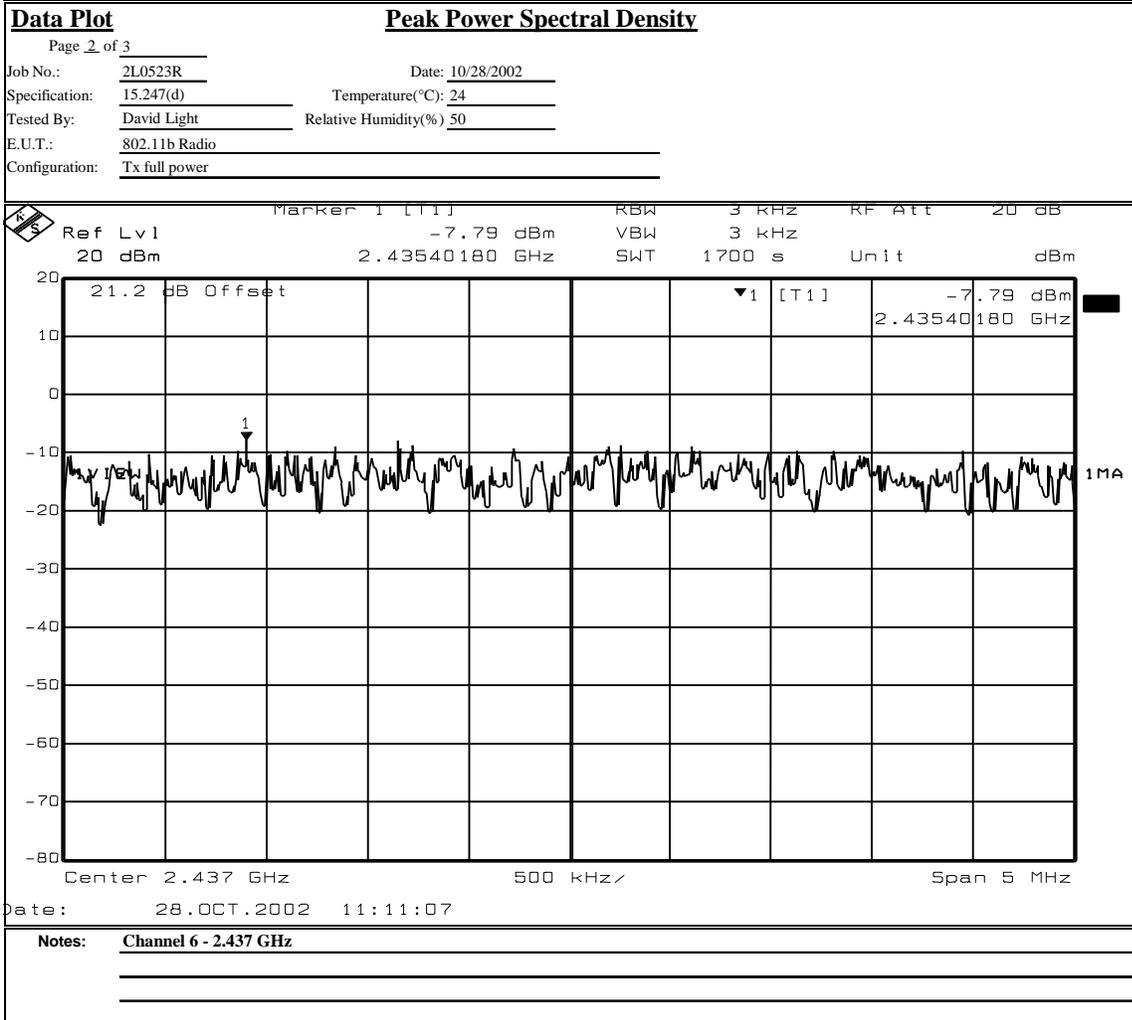
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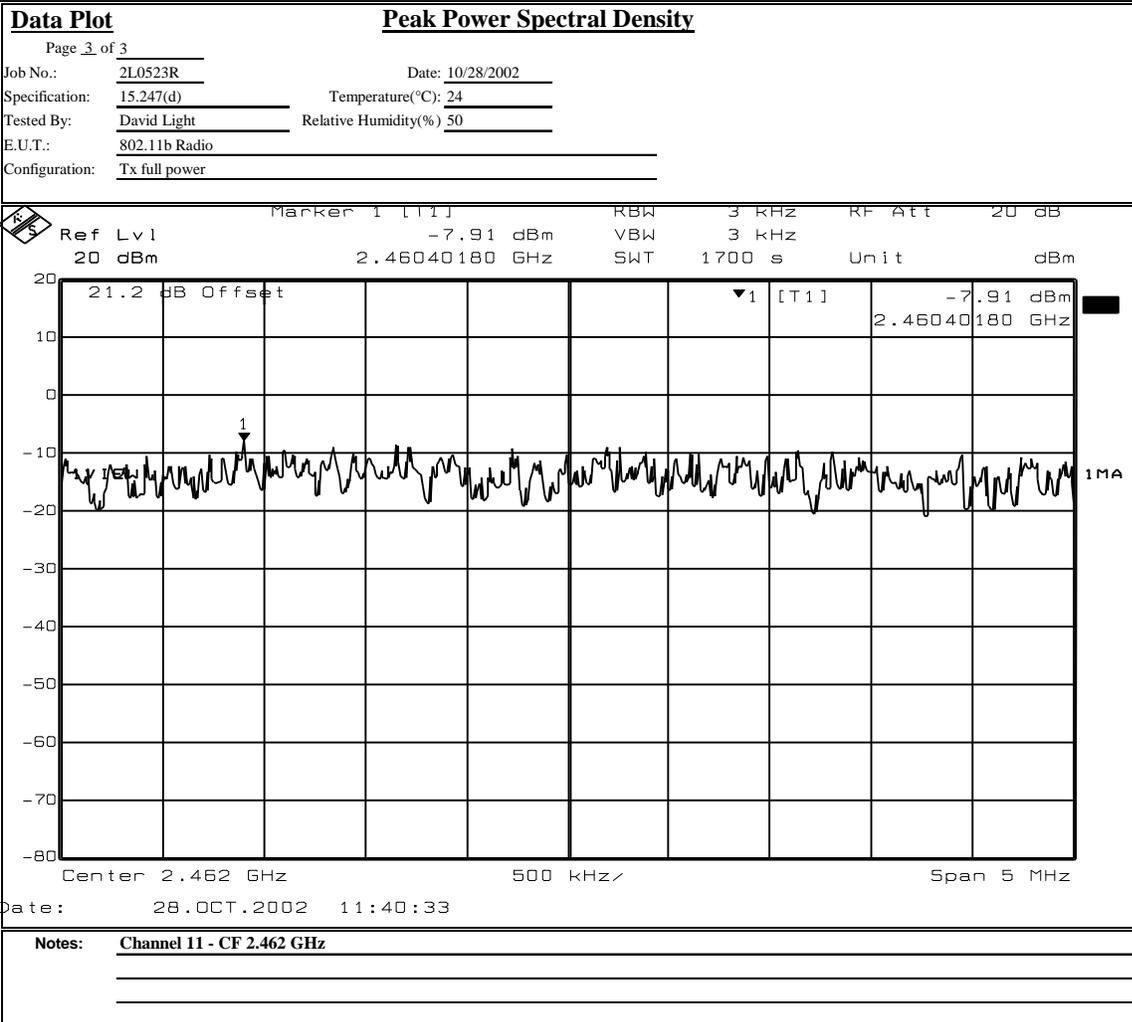
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EQUIPMENT: WLAN 6060 BGAEVK

PROJECT NO.: 2L0523RUS1

Section 10. Test Equipment List

ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due Date
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	01/02/01	01/02/03
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	07/15/02	07/15/03
1482	Band Pass Filter	K & L 11SH10-4000/T12000-0/0	2	Cal B4 Use	NA
1484	Cable 2.0-18.0 Ghz	Storm PR90-010-072	N/A	07/15/02	07/15/03
1485	Cable 2.0-18.0 Ghz	Storm PR90-010-216	N/A	07/15/02	07/15/03
993	Horn antenna	A.H. Systems SAS-200/571	XXX	01/08/02	01/08/03
674	LIMITER	HP 11947A	3107A02200	11/04/01	11/04/02
1547	CABLE .6m	KTL RG223	N/A	08/06/02	08/06/03
1030	PEAK POWER SENSOR	HP 84811A	2539A03573	08/13/02	08/13/03
1029	PEAK POWER METER	HP 8900D	3303U0012	08/13/02	08/13/03
1045	CABLE 2m	Astrolab Inc. 32027-2-29094-72TC	N/A	CBU	NA
1988	CABLE, 6.8m	KTL RG223	N/A	10/01/02	10/01/03
1478	20db Attenuator DC 18 Ghz	MCL Inc. BW-S20W6	NONE	CBU	NA
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	12/18/01	12/18/03
1555	Filter high pass 5KHz	Solar Electronics 7930-5.0	933125	06/06/02	06/06/03
1258	LISN .15mhz-30mhz	EMCO 0	1305	07/09/02	07/09/03

ANNEX A - TEST DETAILS

EQUIPMENT: [WLAN 6060 BGAEVK](#)

PROJECT NO.: [2L0523RUS1](#)

NAME OF TEST: Powerline Conducted Emissions

PARA. NO.: 15.207(a)

Minimum Standard:

The R.F. that is conducted back onto the AC power line on any frequency within the band 0.45 to 30 MHz shall not exceed 250 μ V (48 dB μ V) across 50 ohms.

Nemko Dallas

FCC PART 15, SUBPART C
DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: [WLAN 6060 BGAEVK](#)

PROJECT NO.: [2L0523RUS1](#)

NAME OF TEST: Minimum 6 dB bandwidth

PARA. NO.: 15.247(a)(2)

Minimum Standard: The minimum 6 dB bandwidth shall be at least 500 kHz

EQUIPMENT: WLAN 6060 BGAEVKPROJECT NO.: 2L0523RUS1

NAME OF TEST: Maximum Peak Output Power

PARA. NO.: 15.247(b)(1)

Minimum Standard: The maximum peak output power shall not exceed 1 watt.

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.

Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point to point operation may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceed 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operation may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Direct Measurement Method For Detachable Antennas:

If the antenna is detachable, a peak power meter is used to measure the power output with the transmitter operating into a 50 ohm load. The dBi gain of the antenna(s) employed shall be reported.

Calculation Of EIRP For Integral Antenna:

If the antenna is not detachable from the circuit then the Peak Power Output is derived from the peak radiated field strength of the fundamental emission by using the plane wave relation $GP/4\pi R^2 = E^2/120\pi$ and proceeding as follows:

$$P = \frac{E^2 R^2}{30G} = \frac{E^2 3^2}{30G}$$

where,

P = the equivalent isotropic radiated power in watts

E = the maximum measured field strength in V/m

R = the measurement range (3 meters)

G = the numeric gain of the transmit antenna in relation to an isotropic radiator

The RBW of the spectrum analyzer shall be set to a value greater than the measured 6 dB occupied bandwidth of the E.U.T.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

EQUIPMENT: [WLAN 6060 BGAEVK](#)

PROJECT NO.: [2L0523RUS1](#)

NAME OF TEST: RF Exposure	PARA. NO.: 15.247(b)(4)
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Minimum Standard:

Systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines stipulated in 1.1307(b)(1) of CFR 47.

NAME OF TEST: Spurious Emissions(conducted)	PARA. NO.: 15.247(c)
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Minimum Standard:

In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits. Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength (mV/m @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM IS SEARCHED TO THE 10th HARMONIC OF THE HIGHEST FREQUENCY GENERATED IN THE EUT.

Method Of Measurement:

30 MHz - 10th harmonic plot

RBW: 100 kHz

VBW: 300 kHz

Sweep: Auto

Display line: -20 dBc

Lower Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 902 MHz, 2400 MHz, or 5725 MHz

Marker: Peak of fundamental emission

Marker Δ: Peak of highest spurious level below center frequency.

Upper Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 928 MHz, 2483.5 MHz, or 5850 MHz

Marker: Peak of fundamental emission

Marker Δ: Peak of highest spurious level above center frequency.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

EQUIPMENT: WLAN 6060 BGAEVK

PROJECT NO.: 2L0523RUS1

NAME OF TEST: Radiated Spurious Emissions	PARA. NO.: 15.247(c)
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Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits:

Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength (mV/m @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC

15.205 Restricted Bands

MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
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
6.125-6.218	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	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41	1718		

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Transmitter Power Density	PARA. NO.: 15.247(d)
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Minimum Standard: The transmitted power density averaged over any 1 second interval shall not be greater than +8 dBm in any 3 kHz bandwidth.

Method Of Measurement: The spectrum analyzer is set as follows:

- RBW: 3 kHz
- VBW: >3 kHz
- Span: => measured 6 dB bandwidth
- Sweep: Span(kHz)/3 (i.e. for a span of 1.5 MHz the sweep rate is 1500/3 = 500 sec.
- LOG dB/div.: 2 dB

Note: For devices with spectrum line spacing ≤ 3 kHz, the RBW of the analyzer is reduced until the spectral lines are resolved. The measurement data is normalized to 3 kHz by summing the power of all the individual spectral lines within a 3 kHz band in linear power units.

For Devices With Integral Antenna:

For devices with non-detachable antennas, the received field strength is peaked and the spectrum analyzer is set as above. The peak emission level is then measured and converted to a field strength by adding the appropriate antenna factor and cable loss. This field strength is then converted to an equivalent isotropic radiated power using the same method as described for Peak Power output.

Number of channels tested:

Tuning Range	Number Of Channels Tested	Channel Location In Band
1 MHz or Less	1	Middle
1 to 10 MHz	2	Top And Bottom
More Than 10 MHz	3	Top, Middle, Bottom

NAME OF TEST: Processing Gain

PARA. NO.: 15.247(e)

Minimum Standard: The processing gain shall be at least 10 dB.

Method Of Measurement: The CW jamming margin method was used to determine the processing gain. A CW signal generator is stepped across the passband of the receiver in 50 kHz increments. At each point the signal generator level required to obtain the recommended bit error rate is recorded. The jammer to signal ratio (J/S) is then calculated. The worst 20% of the J/S points is discarded. The lowest remaining J/S ratio is used to calculate the processing gain.

Calculation Of Processing Gain:

The processing gain was determined by measuring the jamming margin of the E.U.T. and using the following formula:

$$\text{Jamming Margin} = G_p - (S/N)_{\text{out}} - L_{\text{sys}}$$

For a receiver using non-coherent detection the value $(S/N)_{\text{out}}$ is calculated using the formula:

$P_e = (1/2)\text{EXP}\{-E/2N_o\}$ where P_e is the probability of error (minimum Bit Error Rate required for proper operation).

E/N_o is $(S/N)_{\text{out}}$

for example, for a bit error rate of 10^{-4} a S/N ratio of 12.3 dB is required.

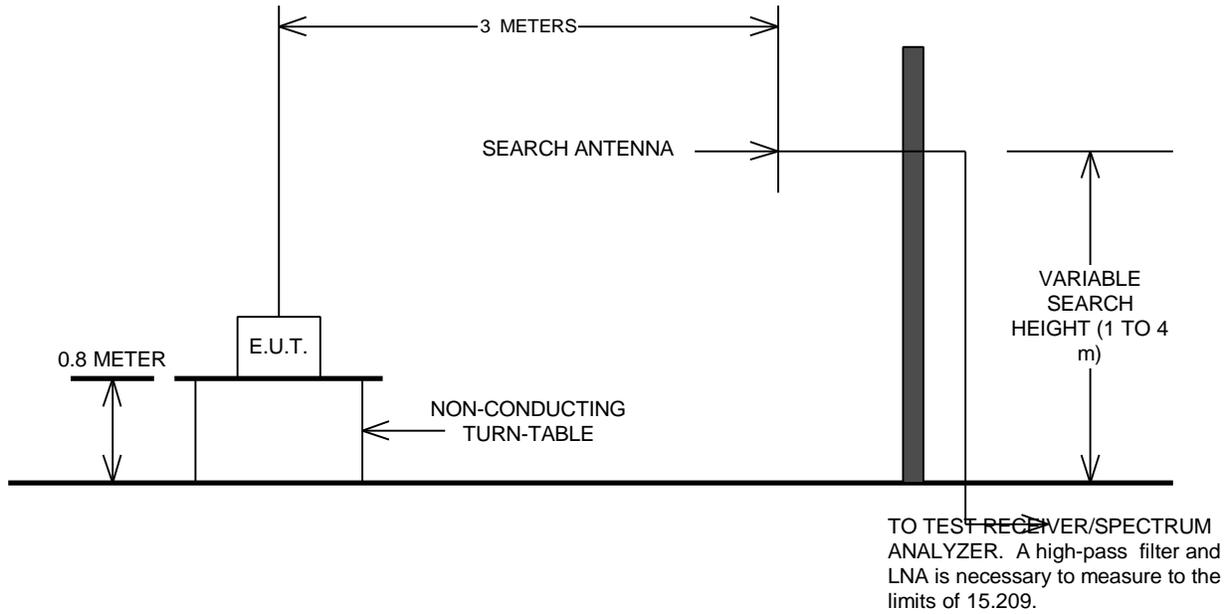
L_{sys} (system losses) is assumed to be 2 dB.

Therefore $G_p = M_j + (S/N)_{\text{out}} + L_{\text{sys}}$

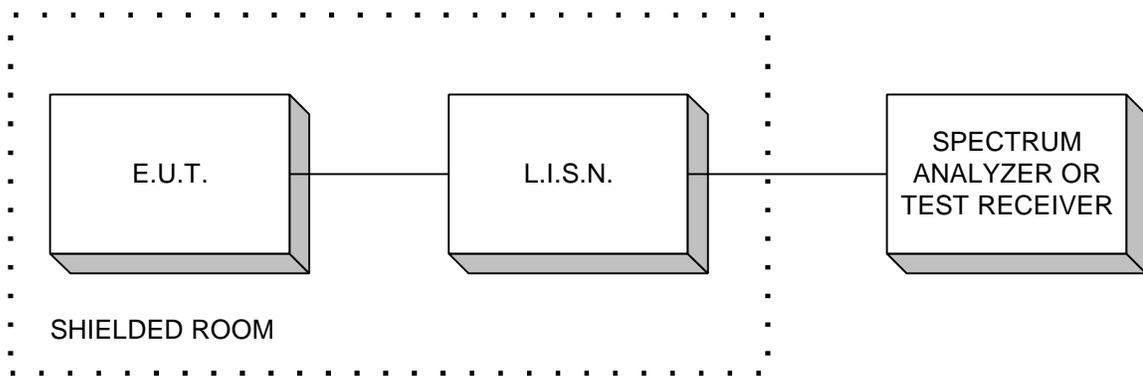
Measurement performed at a channel in the center of the operating band of the EUT.

ANNEX B - TEST DIAGRAMS

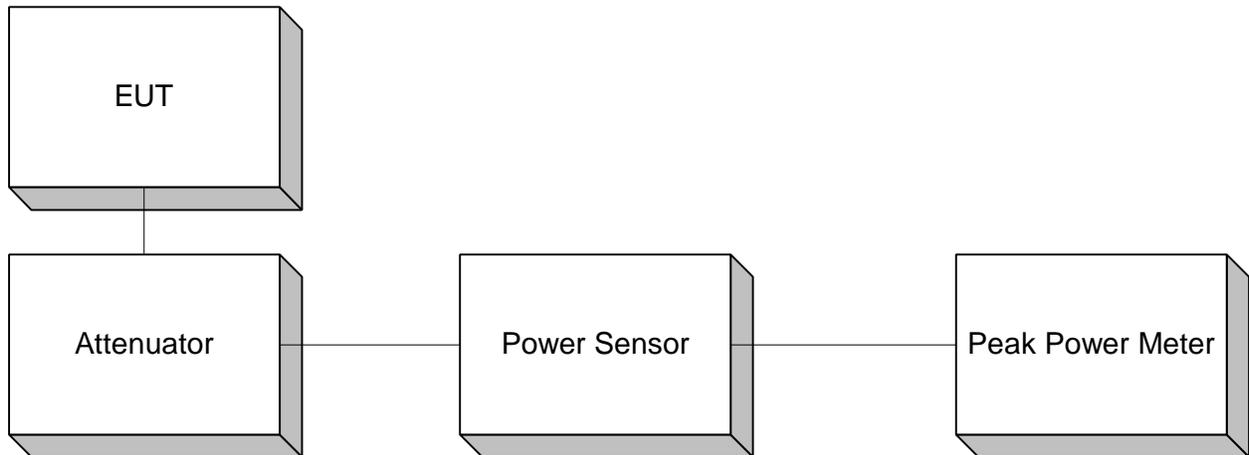
Test Site For Radiated Emissions



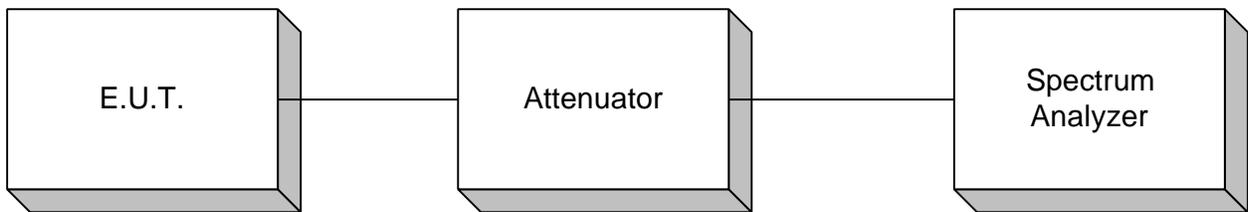
Conducted Emissions



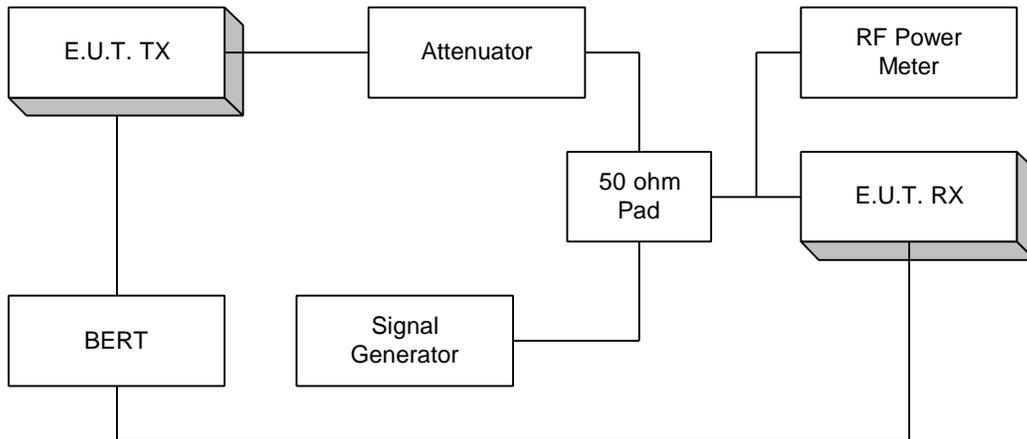
Peak Power At Antenna Terminals



**Minimum 6 dB Bandwidth
Peak Power Spectral Density
Spurious Emissions (conducted)**



Processing Gain



NOTE: This is a typical setup. The setup may vary slightly since many devices have BER test functions built into the device.