

**YOUNG DESIGN, INC.
FCC INFORMATION**

RF Measurement Report

Prepared by:

National Certification Laboratory

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In Support of:

FCC APPLICATION FOR CERTIFICATION

For:

**Young Design, Inc.
8000 Lee Highway
Arlington, VA 22042**

Model: Ethernet Transmitter Antenna

FCCID: NM5-ETH-ANT-LR

Demonstration of Compliance with FCC Rules Part 15.247

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July 22, 2002

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NCL PROJ.# YOUNG-0654

1.0 General Information:

This report has been prepared on behalf of **Young Design, Inc.**, to support the attached Application for a Certification of a Part 15 Spread Spectrum Transmitter. The Equipment Under Test (EUT) was the **Model: Ethernet Transmitter Antenna**. The EUT configuration consisted of a single unit containing a PCMCIA WLAN card, LAN adapter, RF amplifier, 18 dBi flat panel antenna, and Network interface cable . The test results reported in this document relate only to the item that was tested.

Radio-Noise Emissions tests were performed according to *FCC Public Notice 54797, titled "Guidance on Measurement for Direct Sequence SST"*. The measuring equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.1 Summary:

The Young Design, Inc., **Ethernet Transmitter Antenna**, complies with the FCC limits (15.247) for a Direct Sequence SST. Tests were performed on radio channels 1, 6, and 11. These are referred to in the report as the low, mid and high channels respectively.

1.2 Test Methodology:

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

1.3 Test Facility:

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of National Certification Laboratory 8370 Court Avenue, Suite B-1, Ellicott City, Maryland 21043. This site has been fully described in a report dated May 26, 1993, submitted to and approved by the Federal Communications Commission to perform AC line conducted and radiated emissions testing.

2.0 Description of Equipment Under Test (EUT):

The **Lucent Agere WaveLAN Card** is currently certified with FCCID: **IMRWLPCE24H**. Young Design, Inc. has not modified this product in any manner except for the addition of a high gain antenna in which the card is built into the antenna housing.

The EUT features:

Direct Sequence Spread Spectrum Modulation

24 dBm Peak RF Output to Antenna

2412 to 2462 MHz Frequency Range

10 MHz, 6 dB Emission Bandwidth

11 Available Channels

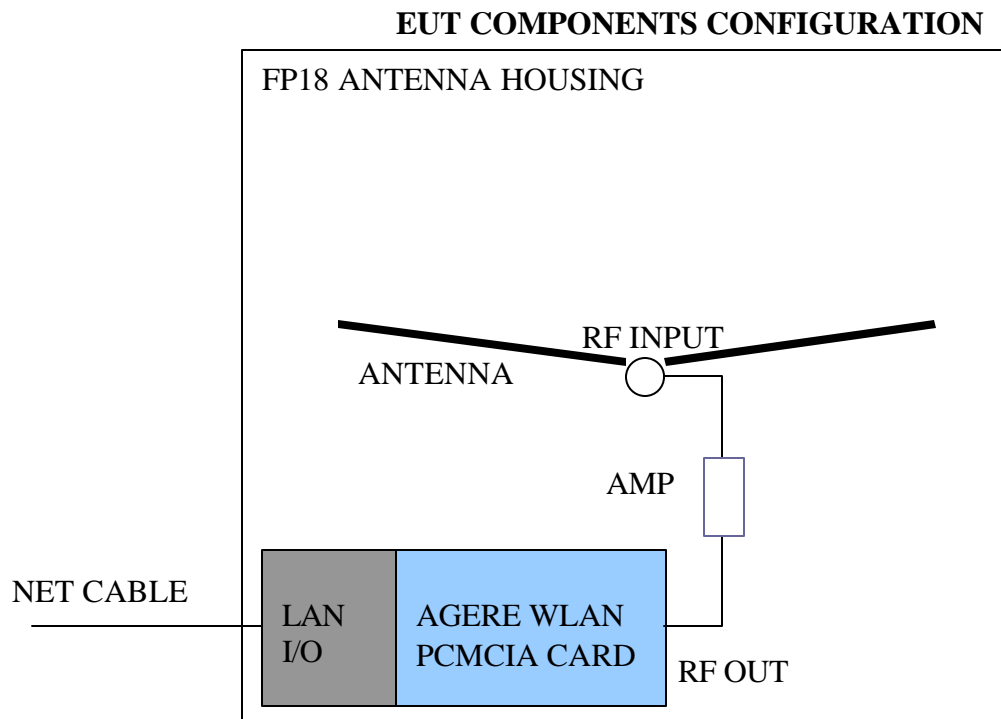
5 MHz Channel Separation

11 Mbps Data Rate (Radio Link)

2.1 EMI Countermeasure:

The following modifications were made to the EUT, by the project engineer to assure compliance to specifications:

None.



The LAN interface and WLAN card are contained inside the antenna housing.

3.0 Test Program:

This report contains measurement charts and data as evidence for the following tests performed:

1. (15.247b) Peak RF output power.
2. (15.247a) 6 dB Emission Bandwidth.
3. (15.247c) RF Antenna Conducted output of harmonics and spurious out-of-band emissions.
4. (15.247c) Field Strength of harmonics and spurious out-of-band emissions.
5. (15.207) AC Power Line Conducted emissions.
6. (15.247c) Band Edge emissions.
7. (15.247d) Power Spectral Density.

4.0 Test Configuration for Antenna Terminal Conducted:

RF power output measurements were taken with a Peak RF power meter at the RF amplifier antenna connector. RF antenna conducted output tests such as Bandwidth, Spurious/Harmonics, and Power Spectral Density were taken with the RF amplifier antenna connector feeding directly into the spectrum analyzer. The analyzer's internal attenuator was adjusted to prevent overloading of the front end. All four data bit-rates were checked to determine if variations in Power, Bandwidth, Bandedge, and Power Spectral Density levels were measured. The worse-case data rate was 11 Mbps, thus charts and tables given in this report, reflect this mode.

4.1 Peak Power Test Results:

Limit: 1 watt (30 dBm)

Condition: Transmitter is set to a single 11 Mbps modulated channel at full power.
Measurements taken at RF amplifier antenna connector.

Readings from Peak Power Meter:

WLAN Card @ 2412 MHz:	23.8 dBm
WLAN Card @ 2437 MHz:	24.0 dBm
WLAN Card @ 2462 MHz:	23.7 dBm

4.2 6 dB Emission Bandwidth Test Results:

Minimum 6 dB BW: 0.500 MHz
RBW Setting on S.A.: 100 kHz

Condition: Transmitter is set to a single 11 Mbps modulated channel at full power.
Measurements taken at WLAN card antenna connector.

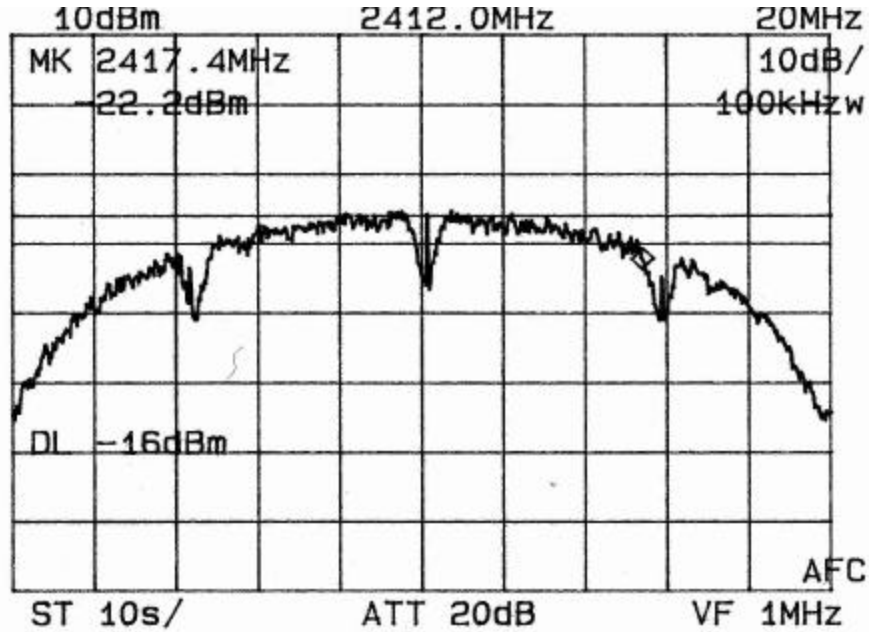
Readings from Spectrum Analyzer:

WLAN Card @ 2412 MHz:	10.5 MHz
WLAN Card @ 2437 MHz:	10.8 MHz
WLAN Card @ 2462 MHz:	10.7 MHz

SEE FOLLOWING THREE (3) PLOTS OF MODULATED CARRIER

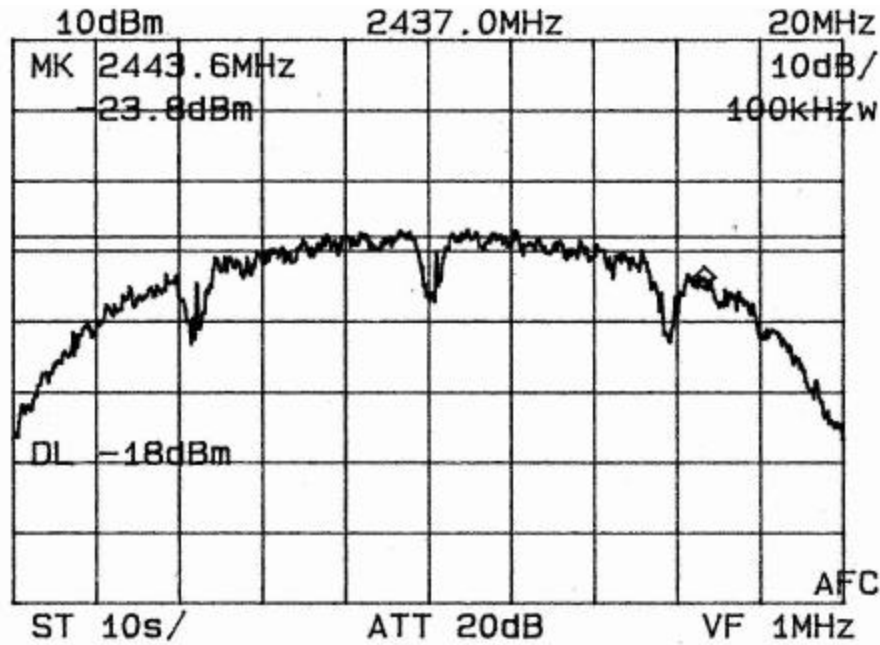
4.2.1 6 dB Bandwidth Emissions (100 kHz Res. BW) Low Channel Bandwidth
Plot:

6 dB EMISSION BANDWIDTH – MODULATED CARRIER
Low Channel



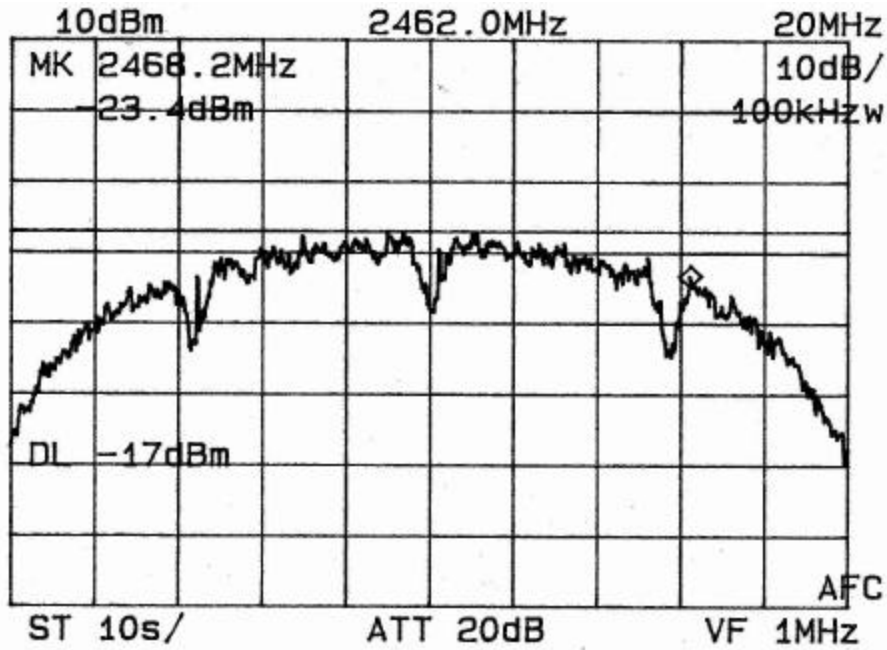
4.2.2 6 dB Bandwidth Emissions (100 kHz Res. BW) Mid Channel Bandwidth Plot:

6 dB EMISSION BANDWIDTH – MODULATED CARRIER
 Mid Channel



4.2.3 6 dB Bandwidth Emissions (100 kHz Res. BW) High Channel Bandwidth Plot:

6 dB EMISSION BANDWIDTH – MODULATED CARRIER
High Channel



4.3 RF Antenna Conducted Spurious/Harmonics Emissions:

Limit: 20 dB below Carrier Level Measured with 100 kHz RBW
RBW Setting on S.A.: 100 kHz

Condition: Transmitter is set to a single 11 Mbps modulated channel at full power.
Measurements taken at WLAN card antenna connector.

Three separate measurements are performed to show harmonic and spurious emissions generated with the transmitter tuned to low, middle, and high parts of the spectral range.

SEE FOLLOWING THREE (3) DATA TABLES

4.3.1 FCC Part 15.247(c) Conducted Spurious, 2412 MHz Frequency Of Carrier:

Frequency of Carrier = 2412 MHz

Limit = 20 dBc

Condition: Transmitter is set to a single modulated channel.

TEST RESULTS

LIMIT: -20 dB FROM PEAK CARRIER

<u>Component</u>	<u>Frequency (MHz)</u>	<u>Result (dBc)</u>
Harmonic	4824.00	-65.0
Harmonic	7236.00	-66.0
Harmonic	9648.00	-71.0
Harmonic	12060.00	-72.0
Harmonic	14472.00	-73.0
Harmonic	16884.00	-75.0
Harmonic	19296.00	-75.0
Harmonic	21708.00	-75.0
Harmonic	24120.00	-75.0

4.3.2 FCC Part 15.247(c) Conducted Spurious, 2437 MHz Frequency of Carrier:

Frequency of Carrier = 2437 MHz

Limit = 20 dBc

Condition: Transmitter is set to a single modulated channel.

TEST RESULTS

LIMIT: -20 dB FROM PEAK CARRIER

<u>Component</u>	<u>Frequency (MHz)</u>	<u>Result (dBc)</u>
Harmonic	4874.00	-63.0
Harmonic	7311.00	-64.0
Harmonic	9748.00	-68.0
Harmonic	12185.00	-72.0
Harmonic	14622.00	-74.0
Harmonic	17059.00	-74.0
Harmonic	19496.00	-75.0
Harmonic	21933.00	-75.0
Harmonic	24370.00	-75.0

4.3.3 FCC Part 15.247(c) Conducted Spurious, 2462 MHz Frequency of Carrier:

Frequency of Carrier = 2462 MHz

Limit = 20 dBc

Condition: Transmitter is set to a single modulated channel.

TEST RESULTS

LIMIT: -20 dB FROM PEAK CARRIER

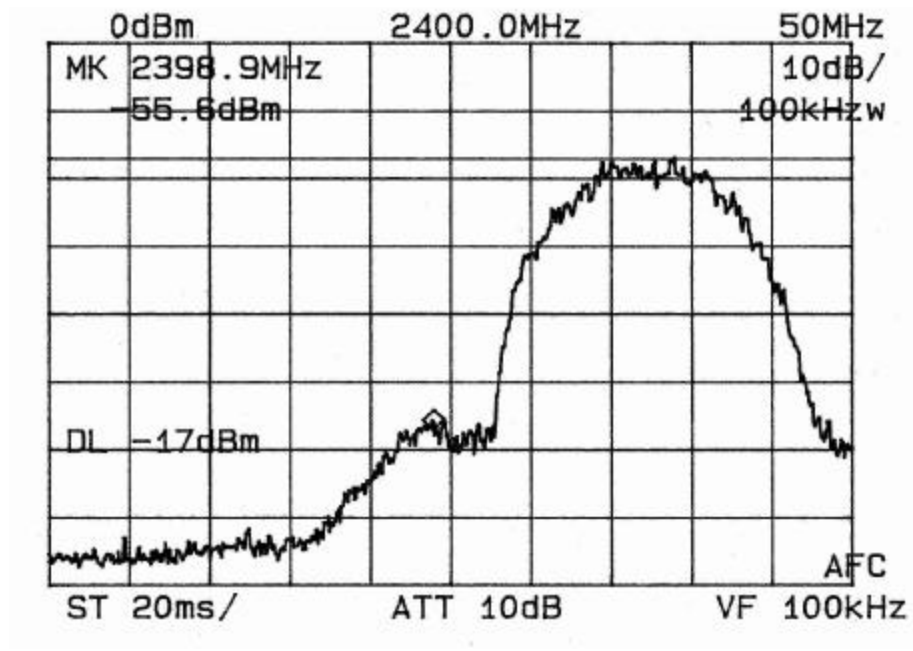
<u>Component</u>	<u>Frequency (MHz)</u>	<u>Result (dBc)</u>
Harmonic	4924.00	-65.0
Harmonic	7386.00	-66.0
Harmonic	9848.00	-69.0
Harmonic	12310.00	-71.0
Harmonic	14772.00	-71.0
Harmonic	17234.00	-73.0
Harmonic	19696.00	-74.0
Harmonic	22158.00	-75.0
Harmonic	24620.00	-75.0

4.4 Conducted Bandedge Emissions Test Results:

4.4.1 Low Channel Conducted Bandedge Emissions Plot:

CONDUCTED BAND EDGE EMISSIONS – MODULATED CARRIER (100 kHz RES. BW)

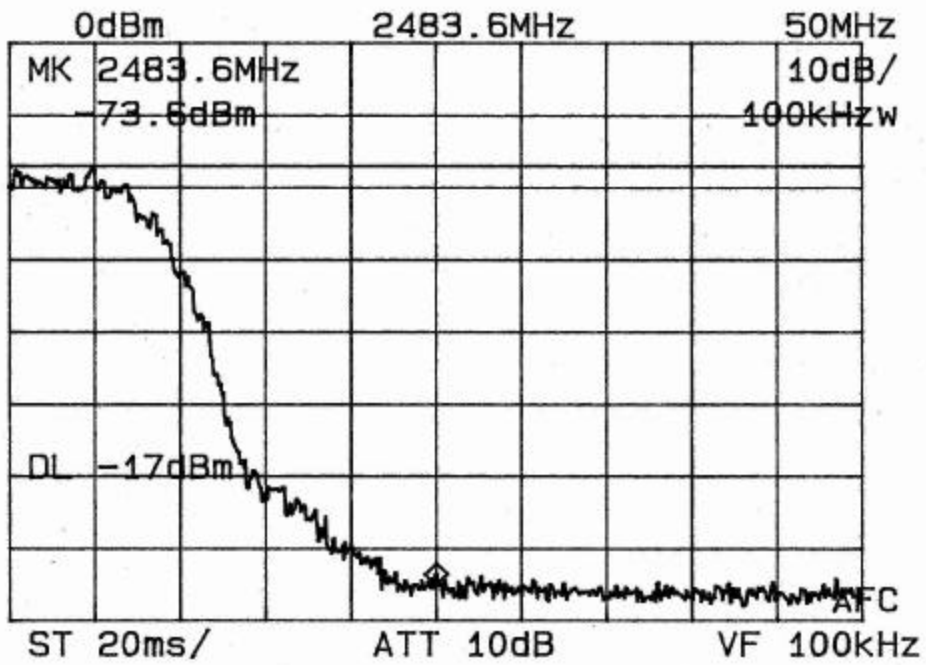
LOW CHANNEL



4.4.2 High Channel Conducted Bandedge Emissions Plot:

CONDUCTED BAND EDGE EMISSIONS – MODULATED CARRIER (100 kHz RES. BW)

HIGH CHANNEL



4.5 Power Spectral Density:

Limit: 8 dBm
Resolution Bandwidth: 3 kHz
Average Time Interval: 1 second/3 kHz

Actual Time Interval used for testing: 1.5 seconds/3 kHz

Condition: Transmitter is set to a single 11 Mbps modulated channel at full power.
Measurements taken at WLAN card antenna connector.

Note: 30 dB front-end attenuator on analyzer

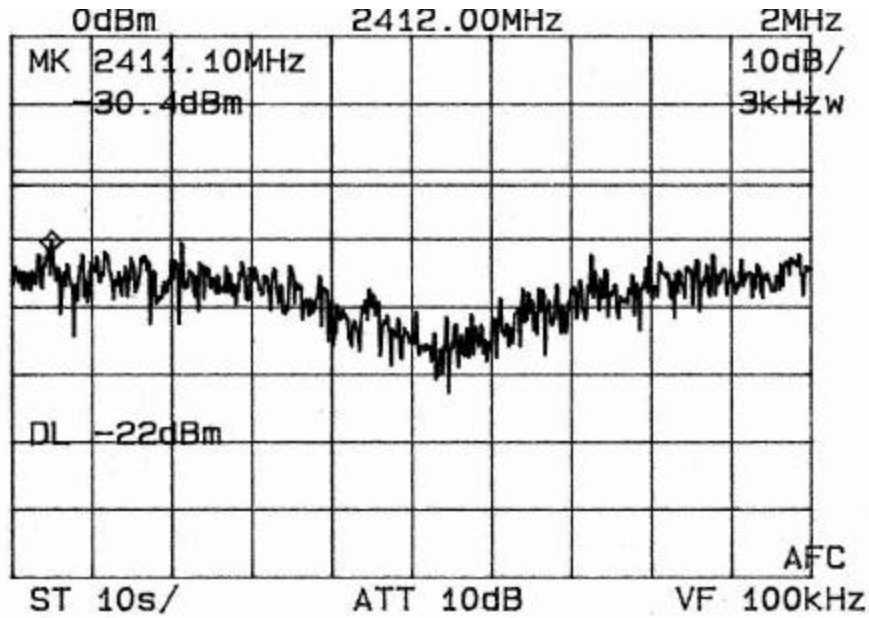
Readings from spectrum analyzer:

WLAN Card @ 2412 MHz: **-0.4 dBm**

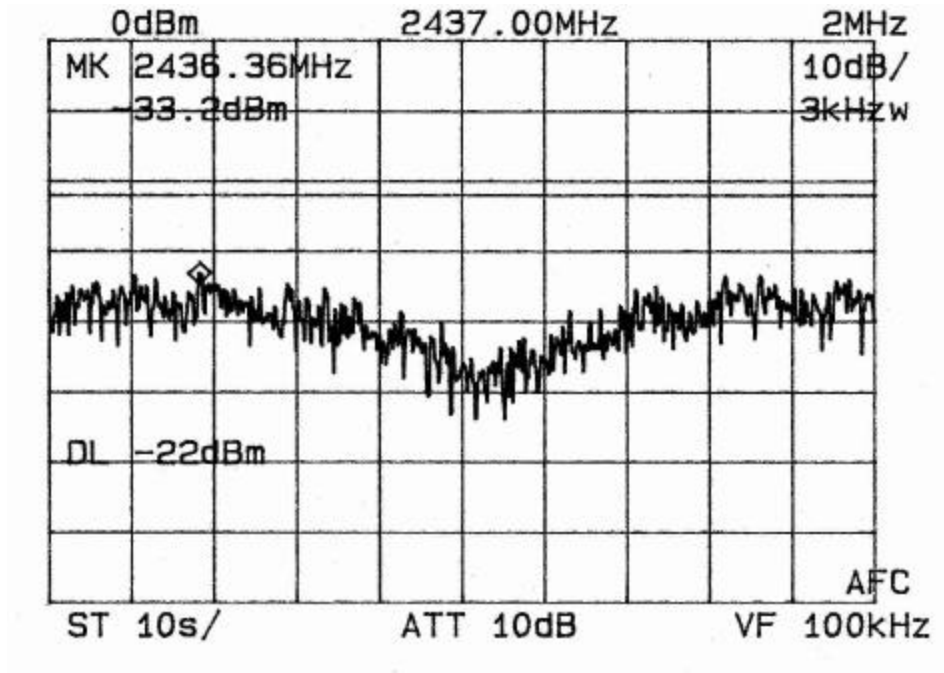
WLAN Card @ 2437 MHz: **-3.2 dBm**

WLAN Card @ 2462 MHz: **-2.4 dBm**

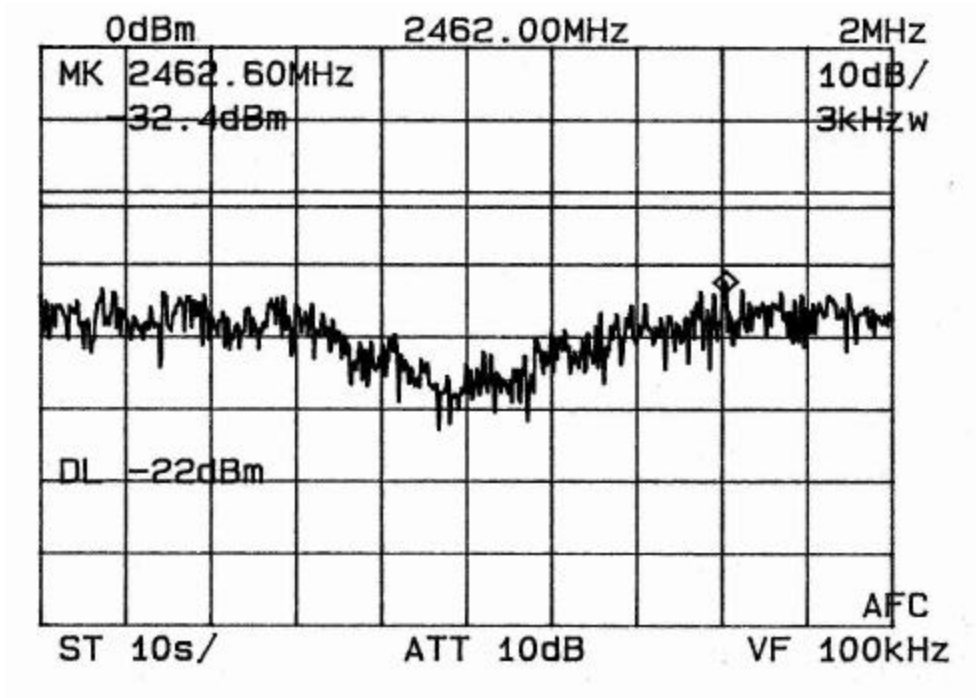
4.5.1 Power Spectral Density Low Channel Plot:



4.5.1 Power Spectral Density Mid Channel Plot:



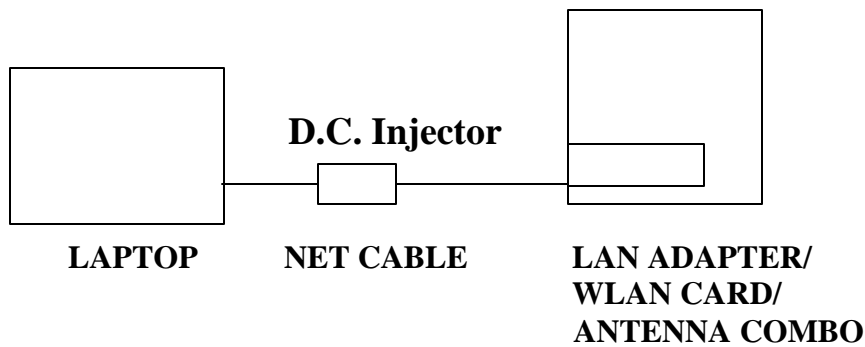
4.5.3 Power Spectral Density High Channel Plot:



5.0 Test Configuration for Conducted and Radiated Emissions:

The EUT was set up on the center of the test table, in a manner which follows the general guidelines of ANSI C63.4, Section 6 **“General Operating Conditions and Configurations”**.

This is described below:



6.0 A.C. Conducted Emissions Scheme:

The EUT is placed on an 80 cm high 1 X 1.5 m non-conductive table. Power to the RF amplifier is provided through a Solar Corporation 50 Ω / 50 uH Line Impedance Stabilization Network bonded to a 2.2 X 2 meter horizontal ground plane, and a 2.2 X 2 meter vertical ground plane. The LISN has its AC input supplied from a filtered AC power source. A separate LISN provides AC power to the peripheral equipment. I/O cables are moved about to obtain maximum emissions.

The 50 Ω output of the LISN is connected to the input of the spectrum analyzer and emissions in the frequency range of 450 kHz to 30 MHz are searched. The detector function is set to Quasi-Peak and the resolution bandwidth is set at 9 kHz, with all post detector filtering no less than 10 times the resolution bandwidth for final measurements. All emissions within 20 dB of the limit are recorded in the data tables.

6.1 AC Conducted Emissions Data Table

FCC CLASS "B" CONDUCTED EMISSIONS DATA

CLIENT: YOUNG DESIGN
EUT: Ethernet Antenna

MODE: TRANSMIT

LINE 1-Neutral: Quasi-Peak Level **Date:** 07/18/2002

FREQUENCY MHz	SPEC. Ana. dBuV	Calc. Volt. uV	FCC LIMIT uV	MARGIN dB	CONDITION
1.150	36.00	63.10	250.00	11.96	PASS
7.170	35.00	56.23	250.00	12.96	PASS
15.100	38.00	79.43	250.00	9.96	PASS
18.900	31.00	35.48	250.00	16.96	PASS

LINE 2-Phase: Quasi-Peak Level

FREQUENCY MHz	SPEC. Anal dBuV	Calc. Volt. uV	FCC LIMIT uV	MARGIN dB	CONDITION
1.120	36.00	63.10	250.00	11.96	PASS
7.230	34.00	50.12	250.00	13.96	PASS
15.100	35.00	56.23	250.00	12.96	PASS
18.800	33.00	44.67	250.00	14.96	PASS

TEST ENGINEER:



Brian Haghtalab

7.0 Radiated Emissions Scheme:

The EUT is placed on an 80 cm high 1 X 1.5 meter non-conductive motorized turntable for radiated testing on the 3 meter open area test site. The emissions from the EUT are measured continuously at every azimuth by rotating the turntable. Guided horn and log periodic broadband antennas are mounted on an antenna mast to determine the height of the maximum emissions. The heights of the antennas are varied between 1 and 4 meters. Both the horizontal and vertical field components are measured.

The RF spectrum is searched from 30 MHz to 24 GHz.

The output from the antenna is connected to the input of the preamplifier. The pre-amp out is connected to the spectrum analyzer. The detector function is set to PEAK. The resolution bandwidth of the spectrum analyzer is set at 120 kHz for the frequency range of 30-1000 MHz, and 1 MHz for the frequency range of 1-9 GHz. A 10Hz video BW setting is used to average readings above 1 GHz when applicable. All emissions within 20 dB of the limit are recorded in the data tables.

To convert the spectrum analyzer reading into a quantified E-field level to allow comparison with the FCC limits, it is necessary to account for various calibration factors. These factors include cable loss (CL) and antenna factors (AF). The AF/CL in dB/m is algebraically added to the Spectrum Analyzer Voltage in dBμV/m. This level is then compared to the FCC limit.

EXAMPLE

Spectrum Analyzer Voltage:	VdBmV
Composite Factor:	AF/CL dB/m
Electric Field:	E dBmV/m = V dBmV + AF/CL dB/m
Linear Conversion:	E mV/m = Antilog (E dBmV/m /20)

7.1 Low Channel Radiated Emissions Data Table

FCC RADIATED EMISSIONS DATA

CLIENT: YOUNG DESIGN
 EUT:
 ANTENNA: 18 dBi FLAT PANEL
 FREQ.: 2412 MHZ
 POWER: 250 mW

3 METER TEST

Detector - PEAK

DATE: 07/18/2002

FREQUENCY MHz	POLARITY		SPEC A dBuV	AF/CL dB/m	AMP Gain dB	Average Factor dB	Peak E-Field dbuV/m	Avg. Limit dBuV/m	MARGIN dB	CONDITION
	H	V								
4,824.00		V	33.00	35.00	25.00	0.00	43.00	54.00	11.00	PASS
12,060.00		V	29.00	40.00	25.00	0.00	44.00	54.00	10.00	PASS
14,472.00	H		22.00	43.00	25.00	0.00	40.00	54.00	14.00	PASS
19,296.00		V	23.00	36.00	25.00	0.00	34.00	54.00	20.00	PASS

TEST ENGINEER:

Brian Haghtalab

7.2 Mid Channel Radiated Emissions Data Table

FCC RADIATED EMISSIONS DATA

CLIENT: YOUNG DESIGN
EUT:
ANTENNA: 18 dBi FLAT PANEL
FREQ.: 2437 MHZ
POWER: 250 mW

3 METER TEST

Detector - PEAK

DATE: 07/18/2002

FREQUENCY MHz	POLARITY		SPEC A dBuV	AF/CL dB/m	AMP Gain dB	Average Factor dB	Peak E-Field dbuV/m	Avg. Limit dBuV/m	MARGIN dB	CONDITION
	H	V								
4,874.00	H		31.00	35.00	25.00	0.00	41.00	54.00	13.00	PASS
7,311.00		V	32.00	37.00	25.00	0.00	44.00	54.00	10.00	PASS
12,185.00		V	27.00	40.00	25.00	0.00	42.00	54.00	12.00	PASS
19,496.00	H		24.00	36.00	25.00	0.00	35.00	54.00	19.00	PASS

TEST ENGINEER:

Brian Haghtalab

7.3 High Channel Radiated Emissions Data Table

FCC RADIATED EMISSIONS DATA

CLIENT: YOUNG DESIGN
 EUT:
 ANTENNA: 18 dBi Flat Panel
 FREQ.: 2462 MHZ
 POWER: 250 mW

3 METER TEST

Detector - PEAK

DATE: 07/18/2002

FREQUENCY MHz	POLARITY		SPEC A dBuV	AF/CL dB/m	AMP Gain dB	Average Factor dB	Peak E-Field dbuV/m	Avg. Limit dBuV/m	MARGIN dB	CONDITION
	H	V								
4,924.00		V	32.00	35.00	25.00	0.00	42.00	54.00	12.00	PASS
7,386.00		V	29.00	37.00	25.00	0.00	41.00	54.00	13.00	PASS
12,310.00		V	28.00	40.00	25.00	0.00	43.00	54.00	11.00	PASS
19,696.00	H		21.00	36.00	25.00	0.00	32.00	54.00	22.00	PASS
22,158.00	H		22.00	37.00	25.00	0.00	34.00	54.00	20.00	PASS

TEST ENGINEER:

Brian Haghtalab

7.4 2483.5 MHz, High Channel Bandedge Radiated Emissions Data Table

FCC BANDEDGE - RADIATED EMISSIONS DATA

CLIENT: YOUNG DESIGN
EUT:
ANTENNA: 18 dBi FLAT
FREQ.: 2483.5 MHZ
POWER: 250 mW

3 METER TEST PEAK DETECT DATE: 07/18/2002

FREQUENCY MHz	POLARITY		SPEC A dBuV	AF/CL dB/m	AMP Gain dB	Average Factor dB	PEAK E-Field dbuV/m	PEAK Limit dBuV/m	MARGIN dB	CONDITION
	H	V								
2,483.50	H		19.00	34.00	25.00	0.00	28.00	74.00	46.00	PASS
2,483.50		V	18.00	34.00	25.00	0.00	27.00	74.00	47.00	PASS

TEST ENGINEER:

Brian Haghtalab

3 METER TEST AVERAGE DETECT DATE: 07/18/2002

FREQUENCY MHz	POLARITY		SPEC A dBuV	AF/CL dB/m	AMP Gain dB	Average Factor dB	AVRG E-Field dbuV/m	AVRG Limit dBuV/m	MARGIN dB	CONDITION
	H	V								
2,483.50	H		16.00	34.00	25.00	0.00	25.00	54.00	29.00	PASS
2,483.50		V	16.00	34.00	25.00	0.00	25.00	54.00	29.00	PASS

7.5 2390 MHz, Low Channel Bandedge Radiated Emissions Data Table

FCC BANDEDGE - RADIATED EMISSIONS DATA

CLIENT: YOUNG DESIGN
EUT:
ANTENNA: 18 dBi FLAT PANEL
FREQ.: 2390 MHz
POWER: 250 mW

3 METER TEST PEAK DETECT DATE: 07/18/2002

FREQUENCY MHz	POLARITY		SPEC A dBuV	AF/CL dB/m	AMP Gain dB	Average Factor dB	PEAK E-Field dbuV/m	PEAK Limit dBuV/m	MARGIN dB	CONDITION
	H	V								
2,390.00	H		19.00	34.00	25.00	0.00	28.00	74.00	46.00	PASS
2,390.00		V	18.00	34.00	25.00	0.00	27.00	74.00	47.00	PASS

TEST ENGINEER:

Brian Haghtalab

3 METER TEST AVERAGE DETECT DATE: 07/18/2002

FREQUENCY MHz	POLARITY		SPEC A dBuV	AF/CL dB/m	AMP Gain dB	Average Factor dB	AVRG E-Field dbuV/m	AVRG Limit dBuV/m	MARGIN dB	CONDITION
	H	V								
2,390.00	H		17.00	34.00	25.00	0.00	26.00	54.00	28.00	PASS
2,390.00		V	16.00	34.00	25.00	0.00	25.00	54.00	29.00	PASS

8.0 RF Exposure Statement:

Notice in Installation Manual:

FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment when installed as directed. This equipment should be installed and operated with fix-mounted antennas that are installed with a minimum of 2 meters of separation distance between the antenna and all persons' body during normal operation.

RF Exposure Calculations:

The following information provides the **minimum** separation distance for the highest gain antenna provided with the **LANNet Transmitter Antenna**, as calculated from **FCC OET 65 Appendix B, Table 1B** Guidelines for General Population/Uncontrolled Exposure. This calculation is based on the highest EIRP possible from the system, considering maximum power and antenna gain, and considering a 1.0 mW/cm² uncontrolled exposure limit. The Friss formula used was:

$$S = (P_o * G) / (4 * \pi * r^2) \quad \text{or} \quad r = \sqrt{(P_o * G) / (4 * \pi * S)}$$

Where S = 1.0 mW/cm² for 2400 MHz

Where P_o = 250 mW (Peak RF)

Where G = Isotropic antenna gain (numeric)

Where r = Minimum Safe Distance from antenna (cm)

For: 18 dBi Flat Panel Antenna - YDI model r = 35 cm

Note: The minimum MPE distance has been calculated for the maximum allowed Power Density (S) limit of 1.0 mW/cm² in the Frequency range 1500-100,000 MHz for uncontrolled environments (Ref. 2).

Reference:

1. FCC Part 15, sub-clause 15.247 (b) (4)
2. FCC OET Bulletin 65, Edition 97-01
3. FCC Supplement C to OET Bulletin 65, edition 97-01

TABLE 1 – EUT ACCESSORIES

FCC ID#: NM5-ETH-ANT-LR

FCC certified system consists of:

- LAN Adapter PCB
- Lucent Agere WLAN card with the FCC ID#: IMRWLPCE24H
- Outdoor Antenna – Model FP18 Flat Panel – 18 dBi gain
- Network Cable
- RF Amplifier

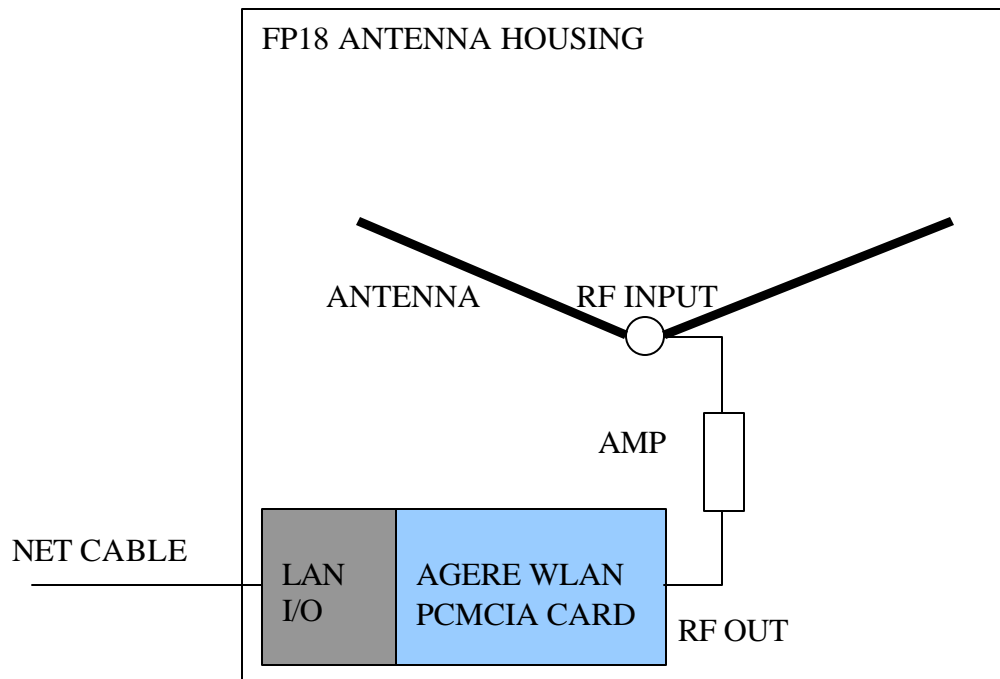


TABLE 2
SUPPORT EQUIPMENT

MANUFACTURER	FCC ID #	SERIAL #
Host PC: Panasonic Model CF35 Pen. Laptop		

**TABLE 3
 MEASUREMENT EQUIPMENT USED**

The following equipment is used to perform measurements:

EQUIPMENT	SERIAL #
HP 434A RF Peak Power Meter	1362016
EMCO Model 3110 Biconical Antenna	1619
Antenna Research MWH-1825B Horn Antenna	1005
EMCO Model 3115 Ridged Horn Antenna	3007
HP 8348A Pre-Amplifier	197-2564A
Solar 8012-50-R-24-BNC LISN	924867
Bird 8306-300-N-30dB Attenuator	29198391515
HP 14IT w/8555A Spectrum Analyzer	6-95-1124
Advanet Model R41131D Spectrum Analyzer	54378A
4 Meter Antenna Mast	
Motorized Turntable	
Heliac FSJ1-50A ¼" Superflex Coax Cable	