Engineering Analysis of

Transceiver Model LM4511

FCC ID: LOZ102035

To

Federal Communications Commission

Part 1.1310 Radio Frequency Exposure Limits

&

OET 65 Supplement C

10/14/1998

David A. Case N.C.E.
Sr. EMC Engineer
Aironet Wireless Communications
3875 Embassy Parkway, 3rd Floor
Akron, OH 44333
330-664-7396

LOZ102035

I Equipment Under Test

FCC ID:	LOZ102035
Model:	LM4511
Type:	PCMCIA Wireless LAN Adapter
Max Power	0.25 Watts
Duty Cycle	0.5

Antenna	TX Power	EIRP	Install Distance (Recommended)	Min MPE Distance*
20dB Parabolic	+16dBm	+36dBm	30cm	~~>12cm~~
13.5dB Yagi	+20dBm	+33.5dBm	30cm	~~>10cm~~
12dB Omni	+20dBm	+32dBm	30cm	~~>10cm~~

Per OET 65 Supplement C page 23

II Power Density

Ref: Reference Data for Engineers 8th edition p32-7

$$P := \frac{Pt \cdot Gant}{\left(4 \cdot \pi \cdot R^2\right)}$$

P	=	Power Density in $\frac{W}{m^2}$
Pt	=	Power radiated by an isotropic radiator (watts)
Gant	=	Antenna Gain
R	=	distance in measurement from source

Assume R = 0.2 meters (~8 inches)

Justification: Antennas are designed for mast mounted outdoor use and should be located above and away from user for maximum signal integrity, These combinations are not hand held nor is it designed to positioned close to the human body for extended periods during normal use. (per manufacturers specifications)

For worst case duty cycle of 100% will be used.

III Maximum Permissible Exposure

Ref: FCC Rules, CFR 47 1.1310

FCC Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	E Field Strength (V/m)	M Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

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

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

The uncontrolled environment represents the most restrictive limits.

LOZ102035

IV. Summary

In an uncontrolled environment, the maximum permissible exposure from a radio device operating at 2.4 Ghz is 1mW/cm2 average over a 30 minute period.

Based on the calculated power density, the high gain antenna must be mounted at a minimum distance of 10 Centimeters from the user. This antenna focuses it's energy on a narrow path (about 12 degrees) and is designed to be mounted on a mast above the user. By design, this antennas placement in the field would be mast mounted and located usually on a roof or tower, normally out of the near field of the user.

Since the analysis is favorable in the Uncontrolled Environment, it is unnecessary to analyze the device to the less restrictive limits of the Controlled Environment or Partial Body Exposure.

Aironet

Pages 15

09/28/98

Joe Dichoso
FCC

Joe,

Here is the requested information for the Class II Permissive Change of the LOZ102035.

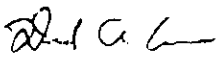
Here are the radio power settings verse the antennas .

TX Power	Antenna Gain	EIRP
+24dBm	1dBi Snap On antenna (Laptop)	25dBm
+24dBm	2.2dBi Dipole (On AP or Bridge)	27.2dBm
+24dBm	5.2dBi Omni (Wall Mount)	29.2dBm
+24dBm	8.5dBi Patch (Wall Mount)	34.5dBm
+20dBm	12.0dBi Omni (Mast mount)	32.0dBm
+20dBm	13.5 Yagi 9Mast Mount)	33.5dBm
+16dBm	+20dBm (Mast Mount)	36dBm

As far as instructions on mounting, systems are sold by are VAR's and Distributors who are responsible for installation. (Most of our VAR's and Distributors go through an in house training class and are given a good review of the FCC rules as well as recommended system set up).

Aironet provides no instructions on installation of high gain antennas other then the product sheet provided by the antenna manufacturer. The only antenna information provided by Aironet is to connect the dipoles that come with the bridges to the product.

Regards



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Email dcase@aironet.com

Case, David

From: oetech@fccsun07w.fcc.gov
Sent: Friday, September 25, 1998 5:25 PM
To: dcase@telxon.com
Subject: FCC ID: LOZ102035 [Correspondance ID: 3681]

With regard to the RF Safety analysis, please provide a list of each approved antenna, show each EIRP and how each will be installed or used in order to verfy the Safety Information that you provided. Provide calculations for any safety distances noted.

731 Confirmation Number: EA91356
jdichoso@fcc.gov
09/25/1998==========
The items indicated above must be submitted before processing can continue on the above referenced application. Failure to provide the requested information within 60 days of 09/25/1998 may result in application dismissal pursuant to Section 2.917(c) and forfeiture of the filing fee pursuant to Section 1.1106.

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430-0053S0

Telex Technical Data

High-Gain WLAN Parabolic Dish Antenna

Models 2440AC

General Description

This antenna is a parabolic dish designed for the band of frequencies from 2400 to 2483 MHz. It is designed to be used as a bridge antenna between two networks or for point-to-point communications. It consists of an aluminum parabolic reflector and feed antenna.

The antenna features a rugged mount. It also offers 20 degree fine adjustment features for both horizontal and vertical planes.

It has a nominal VSWR of 1.5:1 and is less than 1.8:1 over the entire frequency band. The antenna is provided with hardware for mast mounting and is vertically polarized.

Specifications

Electrical:

Frequency Range	2400-2483 MHz
VSWR	Less than 1.8:1, 1.5:1 Nominal
Nominal Impedance	50 ohms
Gain	20 dBi nominal
Polarization	Vertical
Front-to-back Ratio	Greater than 25 db
Half Power Beamwith	12.4°
Maximum Side Lobe Level	-17 dB

Mechanical:

Antenna Size	24 inches
Cable length	15 inches
Cable Type	RG-303/U
Connector	TNC Reverse Polarity
Wind Rating with 1/2 inch ice	110 MPH

Since it is the intent of TELEX COMMUNICATIONS, INC. to continually improve its products, Telex reserves the right to make specification and design changes without notice.

TELEX.

TELEX COMMUNICATIONS, INC.
8601 East Cornhusker Highway, Lincoln, NE 68505
Phone: (402) 467-5321 FAX: (402) 467-3279

TELEX.
TELEX COMMUNICATIONS, INC.
8601 East Cornhusker Highway, Lincoln, NE 68505

ORDER No. 2415AB/AC
High-Gain WLAN Antenna
MODEL HGY-15

INSTRUCTION SHEET

General Description

This antenna is a totally enclosed 16 element Yagi antenna for the 2400 to 2483 MHz frequency band. It is designed to be used as a bridge antenna between two networks, or for point to point communications.

It has a typical VSWR of 1.5:1 and is less than 2:1 over the entire frequency band. The gain is 13.5 dBi and the half-power beamwidth is 30 degrees. This antenna is normally mounted on a 1.25" OD mast and is vertically polarized.

SPECIFICATIONS

Electrical:	
Frequency Range	2400-2483 MHz
VSWR	Less than 2:1, typically 1.5:1
Nominal Impedance	50 ohms
Gain	13.5 dBi (11.3 dBd)
Front-to-Back Ratio	greater than 20 dB
Half-power Beamwidth	30 degrees
Polarization	Vertical
Mechanical:	
Size	18" long
Mounting method	clamps to vertical mast, 1.125" - 1.25" OD
Cable length	36"
Cable Type	RG-58A/U, 50 ohm low-loss, white
Connector	2415AB: Reverse TNC (polarized) 2415AC: Reverse SMA (polarized)

Mounting

Attach the antenna to the mast using the U-bolts, washers, and nuts provided. Minimum recommended height above ground is five (5) feet. If mounted indoors, all antennas should be at the same height. For outside use, heights greater than 20 feet will give greater range. Point the antenna toward the other WLAN antenna. The accuracy of the orientation should be within plus or minus 15 degrees to achieve maximum gain.

This is especially important if the pathlength is over one mile! If you will be using this antenna to connect to several terminals, aim the antenna in the general direction of the group. If the paths are not obstructed or not over 1 mile, this arrangement should work well. If your path is obstructed by buildings, high fences, or hills, mush less performance can be expected. Once you have selected a direction, tighten the U-bolts securely.

Engineering Analysis of

Transceiver Model LM4511

FCC ID: LOZ102035

To

Federal Communications Commission

Part 1.1310 Radio Frequency Exposure Limits

&

OET 65 Supplement C

6/24/98

David A. Case N.C.E.
Sr. EMC Engineer
Aironet Wireless Communications
367 Ghent Rd Suite 300
Fairlawn OH 44334
330-664-7396

I Equipment Under Test

FCC ID:	LOZ102035
Model:	LM4511
Type:	PCMCIA Wireless LAN Adapter
Max Power	0.25 Watts
Duty Cycle	0.5

Max Radio Power for antenna combination

For 21dB Parabolic 0.02 Watts

II Power Density

Ref: Reference Data for Engineers 8th edition p32-7

$$P := \frac{Pt \cdot Gant}{\left(4 \cdot \pi \cdot R^2\right)}$$

P	=	Power Density in $\frac{W}{m^2}$
Pt	=	Power radiated by an isotropic radiator (watts)
Gant	=	Antenna Gain
R	=	distance in measurement from source

Assume R = 0.2 meters (~8 inches)

Justification: Antenna is designed for mast mounting above the user, it is not hand held and it is not positioned close to the human body for extended periods during normal use. (per manufacturers specifications)

For worst case duty cycle of 100% will be used.

Case #1

Pt = Rated Power x Duty cycle x Antenna Gain
= 0.04 x 1.0 x 125.989
= 5.04 Watts
R = 0.205

Therefore at 0.205 m from the EUT P=0.952mW/cm2

$$P := \frac{Pt \cdot Gant}{\left(4 \cdot \pi \cdot R^2\right)}$$

P= 9.563W/m

P= 0.956mW/cm2

III Maximum Permissible Exposure

Ref: FCC Rules, CFR 47 1.1310

FCC Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	E Field Strength (V/m)	M Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

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

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

The uncontrolled environment represents the most restrictive limits.

IV. Summary

In an uncontrolled environment, the maximum permissible exposure from a radio device operating at 2.4 Ghz is 1mW/cm2 average over a 30 minute period.

Based on the calculated power density, the high gain antenna must be mounted at a minimum distance of .21meters from the user. This antenna focuses it's energy on a narrow path (about 12 degrees) and is designed to be mounted on a mast above the user. By design, this antennas placement in the field would keep it out of the near field of the user. The following warning statement will be placed in the user manuals to caution the user on correct and safe use of this antenna.

For High Gain wall mount or mast mount antennas

These antennas are designed to be professionally installed and should be located above and oricnted away from the user. Please contact your professional installer, VAR, or antenna manufacturer for proper installation requirements

---

Since the analysis is favorable in the Uncontrolled Environment, it is unnecessary to analyze the device to the less restrictive limits of the Controlled Environment or Partial Body Exposure.

MFA **M. Flom Associates, Inc. - Global Compliance Center**
3356 North San Marcos Place, Suite 107, Chandler, Arizona 85224-1571
www.goodnet.com/~mflom, (602) 926-3100, FAX: 926-3598

ENGINEERING ANALYSIS

IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Field, 3 kHz to 300 GHz (IEEE C95.1-1991)

and

FCC Rule 1.1310, Radiofrequency Radiation Exposure Limits

for

AIRONET WIRELESS COMMUNICATIONS, INC.
TRANSCEIVER MODEL PC4511
FCC ID: LOZ102035

I. Product Data

Model No.	PC4511
FCC ID:	LOZ102035
Equipment Type:	Direct Sequence Spreadspectrum Transceiver
RF Frequency:	2.4 GHz
Maximum RF Power:	0.25 Watts

II. Power Density

Ref: Reference Data for Radio Engineers, Fifth Ed., p. 25-7

$$P = P_t / 4\pi R^2$$

where

P = Power Density (in W/m^2) at a distance R
P_t = Power radiated by an isotropic radiator (Watts)
= (Transmitter Power)x(Duty Cycle)x(Antenna Gain)
R = Distance of measurement from source (meters)

III. Analysis

Assume:
R = 0.1 meter (4 inches) (This is atypical value, per manufacturer's specifications)
Duty Cycle = 1.0
Antenna Gain = 3.42 (2.2 dBi) <---- X

P_t = (0.25) x (1.0) x (3.42)
= 0.855

$P = P_t / 4\pi R^2$
$= (0.855) / 4\pi(0.1)^2$
$= 6.8\ W/m^2$

P = 0.68 mW/cm^2 (at 0.1 m from the EUT)

M. Flom Associates, Inc. - Global Compliance Center
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www.goodnet.com/~mflom, (602) 926-3100, FAX: 926-3598

SUPPLEMENTARY

ENGINEERING ANALYSIS

of

TRANSCEIVER MODEL PC 4500
FCC ID: LOZ102034

to

FEDERAL COMMUNICATIONS COMMISSION

Part 1.1310, Radiofrequency Radiation Exposure Limits

AND

IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (IEEE C95.1-1991)

DATE OF REPORT: January 21, 1998

AT THE REQUEST OF:

Aironet Wireless Communications, Inc.
367 Ghent Rd., Suite 301
Fairlawn, OH 44334

SUPERVISED BY:

MORTON FLOM, P. Eng.

SUPERVISED BY:
MF:glk

PAGE NO. 1. LOZ102034

I. Equipment Under Test

FCC ID = LOZ102034
MODEL NO = PC 4500
TYPE = Wireless LAN Adapter
FREQUENCY, MHz = 2412 to 2483.5
MAXIMUM POWER, W = 0.25
MAXIMUM DUTY CYCLE = 0.5

II. Power Density

Ref: Reference Data for Radio Engineers, 5th Ed., p25-7

$P = P_t G_{Ant} / (4\pi R^2)$ where

P = Power Density (in W/m^2) at a distance R
P_t = Power radiated by an isotropic radiator (Watts)
G_{Ant} = Antenna Gain
R = Distance of measurement from source (m)

Assume: R = 0.1 m (~4 inches)

Justification: Antenna is wall-mounted; it is not hand -held, and it is not positioned close to the human body for extended period during normal use (per manufacturer's specification).

For the EUT:

CASE I:

P_t = Rated Power x Duty cycle factor x Antenna Gain
= 0.25 x 0.5 x 1.0
= 0.125 Watts

Therefore,

$P = P_t G_{Ant} / (4\pi R^2)$
$= 0.125 / (4\pi(0.1)^2) = 0.995 \text{ W/m}^2$

$= 0.0995 \text{ mW / cm}^2$ (@ 0.1 m from EUT)

CASE II:

P_t = Rated Power x Duty cycle factor x Antenna Gain
= 0.25 x 0.5 x 1.0
= 0.125 Watts

Therefore,

$P = P_t G_{Ant} / (4\pi R^2)$
$= 0.125 / (4\pi(0.2)^2) = 0.995 \text{ W/m}^2$

$= 0.0995 \text{ mW / cm}^2$ (@ 0.2 m from EUT)

III. Maximum Permissible Exposure (MPE)

Ref: FCC Rules, 47 CFR 1.1310

(A) Limits for Occupational/Controlled Exposures

Frequency Range (MHz)	E Field Strength (V/m)	M Field Strength (A/m)	Power Density mW/cm2	Averaging Time (minutes)
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f2)	6
30-300	61.4	0.163	1.0	6
300-1500	---	---	f/300	6
1500-100,000	---	---	5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	E Field Strength (V/m)	M Field Strength (A/m)	Power Density mW/cm2	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f2)	30
30-300	27.5	0.073	0.2	30
300-1500	---	---	f/1500	30
1500-100,000	---	---	1.0	30

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

[illegible] represents the [illegible]

[illegible] uncontrol[illegible], the maximum [illegible] a radio d[illegible]e operating at 2.4 GHz is 1.0 mW/cm[illegible] ave[illegible] [illegible] minute period

7 PAGES

Aironet

09/22/98

Joe Dichoso
FCC

Joe,

Here is the requested information for the Class II Permissive Change of the LOZ102035.

1) The data has a typo . The data point 2390 Mhz listed as an average measurement with a reading of 671uV/m is in reality a peak reading. If you look at the data, you will see it has been transposed. There are 3 readings for 2390 Mhz the first one labeled peak, the second and third average. In reality, the first reading is average, the second is peak, and the third is average (both readings #1 and 3 are the same except for #1 being labeled as peak.
2) We have limited the system to a maximum EIRP of 36dBm (including cable loss), this explains the low power setting of the radio. Currently Aironet products are not being marketed for high power operation (Future filter designs will allow us to offer higher power).
3) I have enclosed a copy of the safety statement from our manual.
4) Attached is a copy of the processing gain – I sent it electronically to Greg.

Regards

David A Case

David A. Case NCE
Senior EMC \ Reliability \ Antenna Engineer
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Email dcasc@aironet.com

Case, David

From: oetech@fccsun07w.fcc.gov
Sent: Tuesday, September 22, 1998 2:23 PM
To: dcase@telxon.com
Subject: FCC ID: LOZ102035 [Correspondance ID: 3553]

1)Page 53 of 74, the radiated test for the 12 dBi OMNI antenna shows an average level of 671uV/m at 2390 MHz. This is in a restricted band and is limited to 500 uV/m. The application should be dismissed. Please correct/explain.

2)The measured output power was about 7 dB below the maximum. It was measured at 17 dB while the device is capable of 24 dBm. Please explain or retest. The problem could be that you used a 1 MHz IF BW, please use a power meter or a RBW and VBW that is greater than the 6 dB bandwidth of the emission. Because of this discrepancy and in order to clarify output powers, please list the output power for each antenna. On the same list, indicate which antennas will be operated Point-to-point and which will be operated point-to-multipoint so that the appropriate EIRP limit can be checked.

3) With regard to the RF safety analysis, please take into account each antenna. Also, take into account the EIRP and how the will be installed or used. i.e. Will they all be mast mounted?

731 Confirmation Number: EA91356
jdichoso@fcc.gov
09/22/1998==========
The items indicated above must be submitted before processing can continue on the above referenced application. Failure to provide the requested information within 60 days of 09/22/1998 may result in application dismissal pursuant to Section 2.917(c) and forfeiture of the filing fee pursuant to Section 1.1106.

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36 dBm EIRP limit

Safety Information

The FCC with it's action in ET Docket 96-8 has adopted a safety standard for human exposure to radiated frequency (RF) electromagnetic energy emitted by FCC certified equipment. The Aironet products meet the uncontrolled environmental limits found in OET-65 and ANSI C95.1, 1991. For proper operation of this radio according to the instructions found in this manual will result in the user exposure to be substantially below the FCC recommended limits.

- Do not touch or move the PC4500 / AP4500 antenna while unit is transmitting or receiving
- Do not hold any component containing the radio such that the antenna is very close or touching , any exposed parts of the body, especially the face or eyes, while transmitting.
- Do not operate a portable transmitter near unshielded blasting caps or in an explosive environment unless it is a type especially qualified for such use
- Do not operate radio or attempt to transmit data unless the antenna is connected , if not, the radio may be damaged.

For Snap on Antenna

Always orient antenna , such that it is at least 5cm (2 inches) away from your body.

For High Gain wall mount or mast mount antennas

These antennas are designed to be professionally installed and should be located at or close to ceiling height oriented away from your body. Please contact your professional installer, VAR, or antenna manufacturer for proper installation requirements

Warning for laptop user

In order to comply with the FCC RF exposure limits, it is recommended that when using a laptop with the snap on antenna, that the antenna should not be positioned closer than 5cm (2inches) from his body or nearby persons for extended periods of time while it is transmitting (or operating). If the antenna is positioned less then 5cm from the user, it is recommended that the user limit his exposure time or engage the power saving features of the PC4500 radio to reduce RF exposure. (see technical reference guide for proper operation of power savings mode).

To: David Case (Aironet Wireless Communications Inc)
From: Joe Dichoso FCC Application Processing Branch
Date: September 22, 1998
FCC ID: LOZ102035

Applicant Name: David Case

Subject: FCC ID: LOZ102035
The items indicated below must be submitted before processing can continue on the above referenced application. Failure to provide the requested information within 60 days may result in application dismissal pursuant to Section 2.917(c) and forfeiture of the filing fee pursuant to Section 1.1106

1) Page 53 of 74, the radiated test for the 12 dBi OMNI antenna shows an average level of 671uV/m at 2390 MHz. This is in a restricted band and is limited to 500 uV/m. The application should be dismissed. Please correct/explain.

2) The measured output power was about 7 dB below the maximum. It was measured at 17 dB while the device is capable of 24 dBm. Please explain or retest. * The problem could be that you used a 1 MHz IF BW, please use a power meter or a RBW and VBW that is greater than the 6 dB bandwidth of the emission. Because of this discrepancy and in order to clarify output powers, please list the output power for each antenna. On the same list, indicate which antennas will be operated Point-to-point and which will be operated point-to-multipoint so that the appropriate EIRP limit can be checked. 36 dBm EIRP

3) With regard to the RF safety analysis, please take into account each antenna. Also, take into account the EIRP and how the will be installed or used. i.e. Will they all be mast mounted?

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Replies to this letter MUST contain the Reference Number: 3553