APPLICATION FOR FCC CERTIFICATION

LOW POWER TRANSCEIVER AND AMPLIFIER UNIT

Frequency Hoping Spread Spectrum (FHSS) Transceiver

Breezecom Ltd.
Atidim Technological Park, Bldg. #1
Tel Aviv 61131, Israel

MODEL: BreezeNet Pro.11 and AMP2440
FCC ID: LKTEAP-10AMP

March 12, 1999

This report concerns (check one): Original Grant: X **Class II Change:** **Equipment Type**: **Transceiver and Amplifier Unit**
Deferred grant requested per 47 CFR 0.457 (d) (1) (ii)? Yes: No: X **If yes, defer until:** _____ ***Date*** **Company name agrees to notify the Commission by: _____(date) of the intended date of announcement of the product so that the grant can be issued on that date.**
Transition Rules Request per 15.37? Yes: No: X **If no, assumed Part 15, subpart B for unintentional radiators - the new 47 CFR [10-1-90 Edition] provision..**

REPORT PREPARED BY:

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Rhein Tech Laboratories, Inc.

Document Number: 990069
Reference: QRTL98-154

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1.0 GENERAL INFORMATION

The following Application for FCC Certification of a low power transmitter is prepared on behalf of **BreezeCOM Ltd.** in accordance with Part 15.247 of the Federal Communications Commissions rules and regulations. The Equipment Under Test (EUT) was the BreezeCOM Ltd. FHSS 2.4GHz-2.48GHz Transceiver and Amplifier Model numbers **BreeezeNet PRO.11** and AMP 2440: The FCC ID for the device is LKTEAP-10AMP. The EUT configuration consisted of a transceiver unit, an amplifier, a DC power injector, four Uni-directional antennas, and three Omni-directional antennas, one twelve volt AC-DC power supply, and one AC-DC power supply including 20 and 50 feet low loss cables. The test results reported in this document relate only to the item that was tested.

All measurements contained in this Application were conducted in accordance with ANSI C63.4 Methods of Measurement of Radio Noise Emissions, 1992. The instrumentation utilized for the measurements conforms to the ANSI C63.4 standard for EMI and Field Strength Instrumentation. Some accessories are used to increase sensitivity and prevent overloading of the measuring instrument. These are explained in the appendix of this report. Calibration checks are performed regularly on the instruments, and all accessories including the high pass filter, preamplifier and cables.

All radiated and conducted emissions measurement were performed manually at Rhein Tech, Incorporated. The radiated emissions measurements required by the rules were performed on the three meter, open field, test range maintained by Rhein Tech Laboratories, Inc., 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. Complete description and site attenuation measurement data have been placed on file with the Federal Communications Commission. The power line conducted emission measurements were performed in a shielded enclosure also located at the Herndon, Virginia facility. Rhein Tech, Labs, Inc. is on the FCC accepted lab list as a Facility available to do measurement work for others on a contract basis.

1.1 RELATED SUBMITTAL(S)/GRANT(S)

This is an application for certification of a previouly certified devices, but with an external RF amplifier and a variety of outdoor antennas. The FCC Class A Verification report for the EUT as a digital interface device is on file with Rhein Tech Laboratories, Inc.

1.2 TEST SYSTEM DETAILS

The FCC Identifiers for all equipment, plus descriptions of all cables used in the tested system (including inserted cards, which have grants) are:

TABLE 1: TEST SYSTEM DETAILS

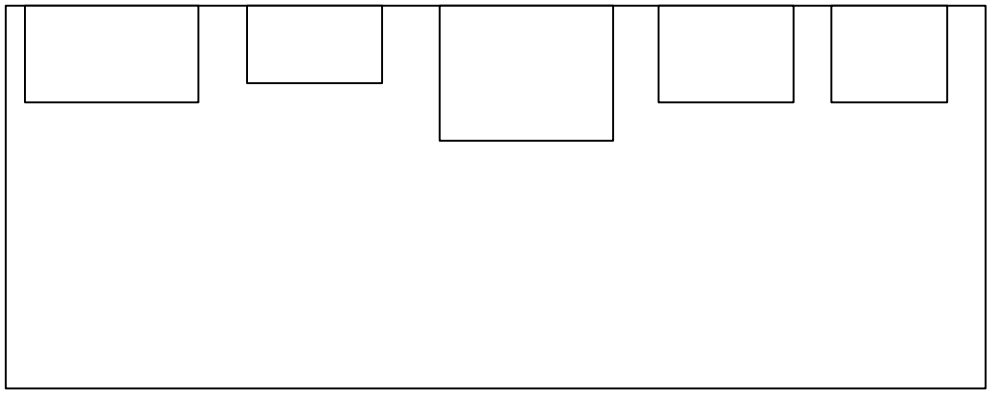
External Components

PART	MANUFACTURER	MODEL	SERIAL NUMBER	FCC ID	CABLE DESCRIPTION	RTL BAR CODE
RADIO (EUT)	BREEZECOM	AP10D PRO.11	S2057765	LKTE-AP-10-CEPT-RLAN-NL	SHIELDED I/O UNSHIELDED POWER WITH FERRITE	010184
RADIO POWER SUPPLY (EUT)	ITE	UPO-1211050	59452414	DOC	UNSHIELDED POWER, FERRITE RADIO END	010183
DC POWER INJECTOR (EUT)	BREEZECOM	N/A	N/A	N/A	SHIELDED I/O, UNSHIELDED POWER	010182
INJECTOR POWER SUPPLY (EUT)	PHIHONG	PSA15W-120	M851005-5-1A5	DOC	UNSHIELDED POWER	010181
BAND PASS FILTER (EUT)	BREEZECOM	F-12053	9611	N/A	SHIELDED I/O	010269
AMPLIFIER (EUT)	YDI	AMP2440 400mW	2.4GHz AMPLIFIER	SAMPLE	SHIELDED I/O	010320
AMPLIFIER (EUT)	YDI	AMP2440 250 mW	2.4GHz AMPLIFER	SAMPLE	SHIELDED I/O	010319
UNI-24 ANTENNA (EUT)	BREEZECOM WIRELESS COMM.	T2400	027810	N/A	SHIELDED I/O	010174
UNI-21 ANTENNA (EUT)	YDI	PT2421	N/A	N/A	SHIELDED I/O	099994
UNI-18 ANTENNA (EUT)	BREEZECOM WIRELESS COMM.	872918	N/A	N/A	SHIELDED I/O	099991
UNI 16 ANTENNA (EUT)	BREEZECOM WIRELESS COM.	QD2415	001764	N/A	SHIELDED I/O	010178
UNI-13 ANTENNA (EUT)	BREEZECOM WIRELESS COMM.	872913	N/A	N/A	SHIELDED I/O	099992
OMNI-12 ANTENNA (EUT)	YDI	A-2412	N/A	N/A	SHIELDED I/O	010208
OMNI-8 ANTENNA (EUT)	MAXRAD	MFB24008	N/A	N/A	SHIELDED I/O	010176
OMNI-6 ANTENNA (EUT)	BREEZECOM WIRELESS COMM.	872108	N/A	N/A	SHIELDED I/O	099993
OMNI DIRECTIONAL ANTENNA BRACKET (EUT)	BREEZECOM	N/A	N/A	SAMPLE	N/A	010451
AMPLIFIER BRACKET (EUT)	BREEZECOM	N/A	N/A	SAMPLE	N/A	010452
UNI GRID ANTENNA BRACKET (EUT)	BREEZECOM	N/A	N/A	SAMPLE	N/A	010453
UNI PATCH ANTENNA BRACKET (EUT)	BREEZECOM	N/A	N/A	SAMPLE	N/A	010454
COMPUTER	METROBOOK	METROBOOKDT	N8XG817901982	DOC	SHIELDED I/O, UNSHIELDED POWER	009251
30' COAX LOW LOSS CABLE	N/A	N/A	N/A	N/A	SHIELDED	
50' COAX LOW LOSS CABLE	N/A	N/A	N/A	N/A	SHIELDED	
4" COAX CABLE	N/A	RG58/U	N/A	N/A	SHIELDED	
EXTERNAL FILTER	RLC ELECTRONICS	F-12053	9611	N/A	N/A	010269

There were two versions of the amplifiers used, a 250mW version and a 500mW version. The output power of these amplifiers is factory set so that they do not exceed 250mW or 500mW

respectively. The 250mW and 500mW versions are exactly the same. An internal potentiometer is used to set the output power.

1.3 CONFIGURATION OF TESTED SYSTEM



1.4 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 3 meters. Emissions above 1 GHz were video averaged.

1.5 TEST FACILITY

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc. 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report dated March 3, 1994, submitted to and approved by the Federal Communication Commission to perform AC line conducted and radiated emissions testing (ANSI C63.4 1992).

2.0 SYSTEM TEST CONFIGURATION

2.1 GENERAL PROCEDURES

To complete the test configuration required by the FCC, the transceiver was powered with the supplied AC/DC adapter. Conducted emission was performed on the AC adapter powering the Transceiver as well as the AC power supply providing power to the DC power injector. The DC power injector supplies power to the amplifier. There was no change in the conducted emission profile when the EUT's channels 2, 41, and 80 were enabled in conjunction with all the various antenna configuration presented in this report. The worst case configuration is presented in this report. The EUT was also tested in all three orthogonal planes in order to determine worst case radiated emission. Three channels were investigated: lower channel, middle channel, and upper channel. All channels were properly investigated and the appropriate worst case results are presented in this report. For conducted emission the emission profile was investigated and tested for all three channels, all three modulating modes (8FSK, 4FSK, 2 FSK), and the four antenna configurations. The results were the same for all channels and antenna configuration. Worst case final conducted emission data is presented for both the DC power injector and the transceiver unit in the data tables. For antenna conducted spurious noise and radiated noise all three modulating modes were investigated, it was determined that the worst-case emission profiles occurred when the EUT was enabled in the 8FSK-modulating mode.

2.2 EUT EXERCISE SOFTWARE

The EUT was enabled to continuously transmit data in the 8FSK-modulating mode that produced the worst case profiles for most of the individual tests. Except for specific tests i.e. occupied bandwidth measurement, that requires enabling the 2FSK and 4FSK modulating modes in-order to determine the worst case profile. This data was verified by a receiving unit during testing. The carrier was also checked to verify that the information was being transmitted.

2.3 SPECIAL ACCESSORIES

N/A

2.4 PROFESSIONAL INSTALLATION IN SUPPORT OF SECTION 15.203 (USE OF STANDARD N TYPE CONNECTOR)

March 26, 1999

Professional Installation for Model BreezeNET PRO.11/AMP1440 System

Intended use

All BreezeCOM devices are used to provide high speed data connections to remote networks. The BreezeNET PRO.11/AMP2440 System is not intended nor is it marketed for home use. It is designed for use by commercial businesses only.

Installation

The installation of the Model BreezeNET PRO.11/AMP2440 System will be controlled. BreezeCOM will ensure that the professional doing the installation is made aware of the requirements so that the final installation complies with FCC rules. Specifically the installer must ensure that the ERP of the transmitting antenna does not exceed the requirements of paragraph 15.247(b).

It will be explicitly explained to the professional installer that they will install a 250mW or 500mW version of the amplifier based on the antenna to be used in the installation. (See attached chart). The output power of the BreezeNET PRO.11/AMP2440 System is limited to 250mW or 500mW, regardless of the loss of cable between the DC injector and the amplifier any length or type of 50 ohm coax transmission can be used.

Since BreezeNET PRO.11/AMP2440 System are shipped labeled as "BreezeNET PRO.11/AMP2440-250 System" for a 250mW output and a "BreezeNET PRO.11/AMP2440-500 System" for a 500mW maximum output, the installer will be aware of the output power of the system. Further, all installations of the Model BreezeNET PRO.11/AMP2440 System will require topographic analysis, site survey and link budget calculation. Therefore, the system will require a BreezeCOMed trained professional to do the installation.

This ensures compliance with the maximum transmitter ERP allowed with the antenna provided as a system.

The following statement is in the BreezeNET user's guide (section 5.5.1) and is also supplied as a separate sheet with each device sold:

"Professional Installers Only :
Detached antennas, whether installed indoors or out, should be installed ONLY by experienced antenna installation professionals who are familiar with local building and safety codes and, wherever applicable, are licensed by the appropriate government regulatory authorities. Failure to do so may void the BreezeNET product warranty and may expose the end user to legal and financial liabilities."

"Regulations regarding maximum antenna gains vary from country to country. It is the responsibility of the end user to operate within the limits of these regulations and to ensure that the professional installer is aware of these regulations, as well. "

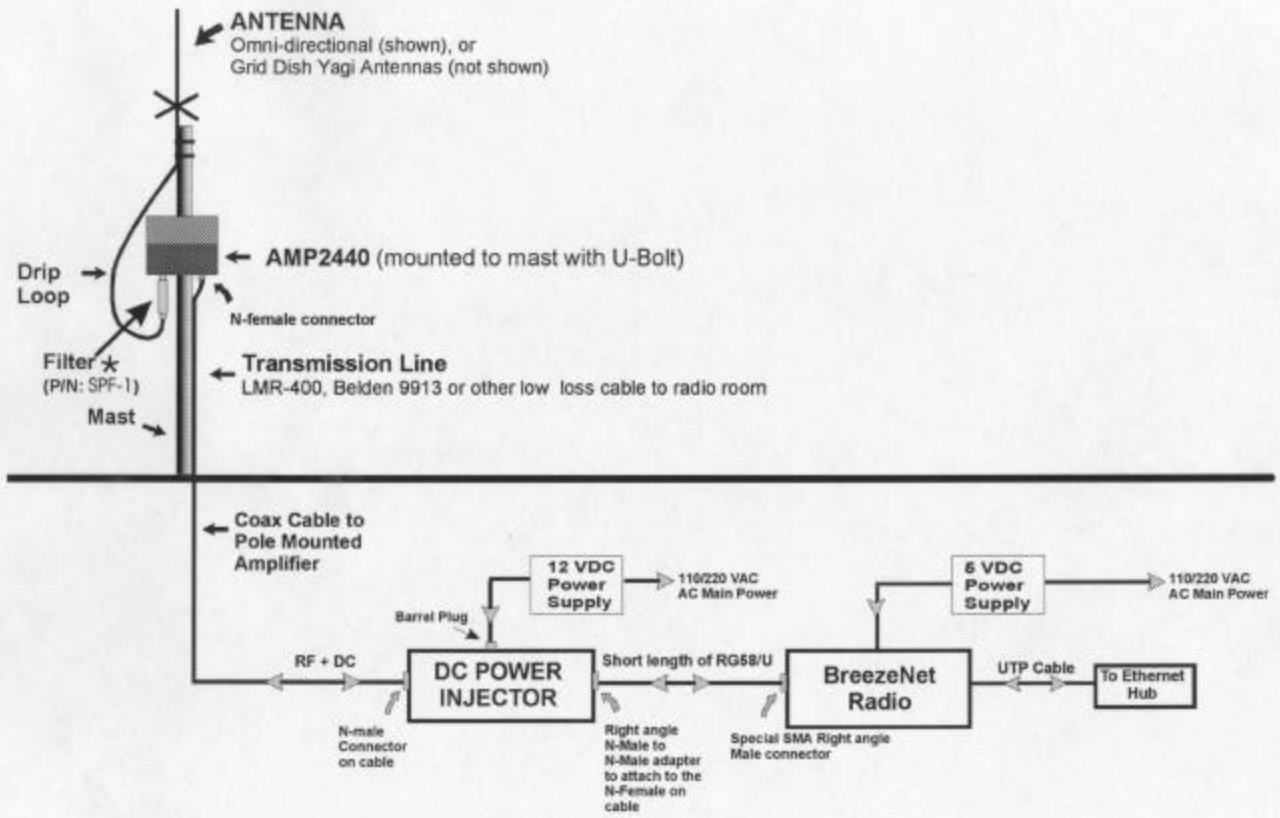
Marketing and sales channels

BreezeCOM DOES NOT sell direct to end users. BreezeNET PRO.11/AMP2440 System will be sold only to BreezeCOM's Authorized Resellers. Those authorized resellers are technically trained by BreezeCOM's Engineers periodically and must follow the rules set by BreezeCOM. The BreezeNET/AMP2440 system is designed for Long Range (10-25 miles) applications and it involves a complicated mandatory site survey, roof top mast installation, high gain antennas, accurate antenna alignment, etc. Those activities can be done ONLY by professional installers that are familiar with the FCC regulations. BreezeCOM do not play in the consumer business at all. We have no resellers in this market and we do not advertise in consumers based publications or attend consumer oriented trade shows. The system will be advertised in technical trade shows and magazines.

Conclusion

BreezeCOM requires professional installation for the Model BreezeNET PRO.11/AMP2440 System in-order to provide the highest reliable system possible. We therefore fully support the mandate for professional installation of our complete system.

BREEZECOM AMPLIFIER INSTALLATION DETAILS



★ Filter is required in the United States when the 24dB grid dish antenna is used in order to comply with FCC emission requirements.

Drawings\amp2440\amp inst breezecom.cdr

2.5 EUT CHANNEL UTILIZATION TEST

The EUT channel utilization was checked per section 15.247(a)(1)(ii) of the Commission's Rules and Regulations. The Spectrum analyzer was set as follows: RBW = 100 kHz, VBW = 300 kHz, sweet time = 10 ms, and the Spectrum analyzers Max hold mode enabled. The EUT was investigated between 2.4 GHz and 2.48 GHz. The 500mW configuration was the only configuration used for this measurement since the results are frequency/time base dependent and not amplitude dependent. The 250-mwatt EUT configuration was investigated and found to produces the same result as the 500mW configuration. The EUT channel utilization plots can be found in section 4 of this report.

2.5.1 EUT Average Time of Channel Occupancy and Dwell Time

The EUT average occupancy time and dwell time was checked per Sec 15.247(a)(1)(ii) for compliance. The customer provided a theoretical sequence analysis that can be found in Appendix A from which the parameters were used to check the EUT. The selected channel frequency for dwell time and measurement was 2.405 GHz, and selecting 8FSK modulating mode. The EUT was found to be in compliance. See plots in section 4.

2.5.2 Channel Occupancy

The EUT uses 79 hopping channels with each channel 1 MHz wide selected from a pseudo randomly ordered list. On the average, each channel is used equally. The number of frequency hopping channels was verified by counting the number of channel frequency within 2.4GHz - 2.483 GHz frequency band. See plot in section 4.

2.5.3 Hopping Dwell Time

The EUT hopping dwell time as provided by the manufacturer is 30 msec of which 88.65% is used for transmission (26.6 msec) and the rest is guard time. The dwell time was verified to be 31.8 msec (see dwell time plot). The rest of the time 31.8 msec X 88.65% = 28.2 msec is used for guard time.
The total transmission time at 79 hopping frequencies per the manufacturers specification is 0.03 X 79 = 2.37 sec. Each frequency used within 30sec period is 30÷2.37 = 12.7 times. The average time of occupancy on any frequency within 30-sec period is 0.03 X 12.7 = 0.38 sec (less than 0.4 sec). The number of hopping frequency was verified at 12 (see plots). The average occupancy time 0.34-sec was determined by multiplying the verified dwell time at 31.8 msec and the verified number of hopping frequency 12. The dwell time and the average occupancy time were measured by setting the Spectrum analyzer to 0 span, RSW/VID = 10 kHz, 30 sec sweep time for average occupancy time and sweep time 200msec for dwell time. See plots in section 4

2.6 OCCUPIED BANDWIDTH

The minimum 20dB bandwidth per FCC 15.247(a)(1)(ii) was measured using a 50-ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 300 kHz. With the EUT transmitting antenna removed, the antenna port was connected directly to the spectrum analyzer. The EUT was operated in continuos transmitting mode with the hopping function disable. The measurements were performed at three channels low, middle, and high. These channels correspond to LO = 2.402 GHz, Middle = 2.441 GHz, and High = 2.480 GHz with three the types of available modulations 2 FSK (1Mbits/sec), 4FSK (2 Mbits/sec), 8FSK (3 Mbits/sec). See section 4 for 20dB bandwidth plots. The occupied bandwidth measurements were performed on 2 configuration of the EUT; namely 250-mwatt and 500-mwatt for the four different antenna configurations. The 250-mwatt version was thoroughly measured. The 500-mwatt configuration was investigated and the maximum and minimum occupied bandwidths for the worst case channels recorded. The minimum 20 dB occupied bandwidth for each channel on each EUT configuration was found less than one MHz.

2.6.1 20dB Occupied Bandwidth 250mW

Frequency GHz	Modulation	20 dB Occupied bandwidth (kHz)
2.402	2FSk	254
2.402	4FSK	704
2.402	8FSK	834
2.441	2FSk	250
2.441	4FSK	710
2.441	8FSK	814
2.480	2FSk	250
2.480	4FSK	698
2.480	8FSK	768

2.6.2 20dB Occupied Bandwidth 500mW

Frequency GHz	Modulation	20 dB Occupied bandwidth (kHz)
2.401	2FSk	774
2.401	8FSK	254
2.480	2FSk	258
2.408	8FSK	704

2.7 POWER OUTPUT

The power output per FCC 15.247(b) for a FHSS device must be no more than 1 watt. The power was measured on both EUT configurations using an RF power meter from Bird model number 43. The EUT was configured for the maximum modulation rate at 8FSK. The Peak power was measured at three frequencies 2.401 GHz, 2.440 GHz, and 2.480 GHz. The EUT was configured based on the diagram below. The output power was measured with the 30' low loss 3/8" coaxial cable that will be shipped with the system. See the drawing below. It contains the output powers for the various configurations to be certified. The Radio Power column is the power measured at the end of the 30' cable, i.e., the power into the amplifier.

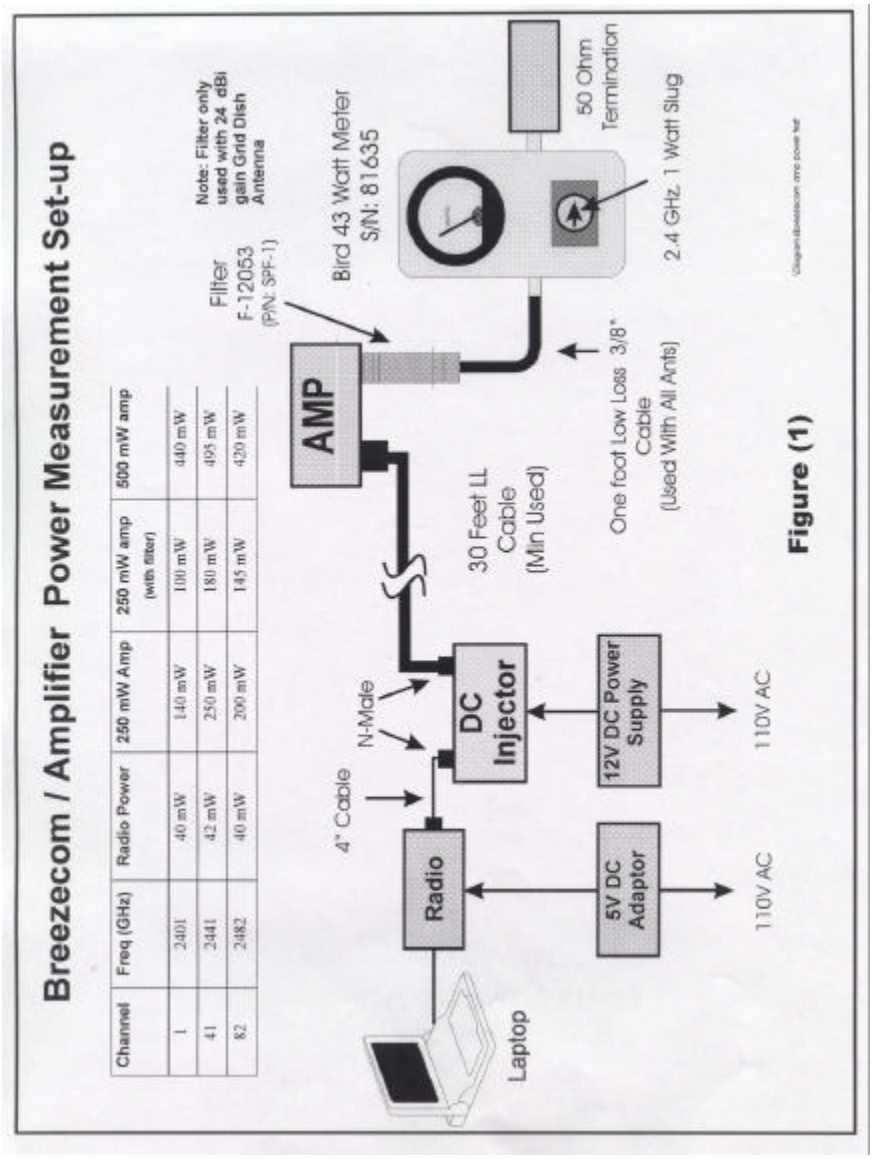


FIGURE 1: AMPLIFIER POWER MEASUREMENT SET-UP

2.7.1 EUT Output Power Level Table

		Radio Power	30 feet Low Loss 8 coax cable		
Channel	Frequency (GHz)	Transceiver Unit (dBm)	250mW Version + filter (dBm)	500mW Version (dBm)	250mW Version (dBm)
2	2.403	16.0	20.0	26.4	21.5
41	2.440	16.2	22.6	26.9	24.0
80	2.480	16.0	21.6	26.2	23.0

Note: The 30' low loss coaxial cable represents the worst case (lightest possible output power) condition. This is the minimum cable length that will be shipped with the system.

2.7.2 Permissible Output Power calculations

The output power on the EUT was corrected per section 15.257 (b) (3) ii for antennas with greater than 6 dBi isotropic gain. The EUT output power was reduced for the four antenna configurations. The two tables below list the power reduction for the output power levels recorded in the table above.

Uni-directional antennas vs EUT power out put setting						
Antenna Type	Gain (dBi)	Gain – 6dBi (dBi)	Reduction from 30 dBm	Max Power to Antenna (dBm)	EUT setting (mW)	Output setting per channel with the 30' low loss coax cable
UNI-24	24	18	6.0	24.0	250	22.6, @ Ch. 41
UNI 21	21	15	5.0	25.0	250	24.0, @ Ch. 41
UNI 18	18	12	4.0	26.0	250	24.0, @ Ch. 41
UNI-16	16	10	3.33	26.7	250	24.0, @ Ch. 41
UNI-13	13	7	2.33	27.7	500	26.9, @ Ch. 41

Omni-directional antennas vs EUT power out put setting							
Antenna Type	Gain (dBi)	Gain +6dBi (dBi)	limit +6dBi (dBm)	Reduction from 30 dBm	Max Power to Antenna (dBm)	EUT setting (mW)	Output setting per channel with the 30' low loss coaxial cable
OMNI-12	12.0	42.0	36	6.0	24.0	250	24.0, @ Ch. 41
OMNI-8	8	38.0	36	2.0	28.0	500	26.9, @ Ch. 41
OMNI-6	6	36.0	36	0	30.0	500	26.9, @ Ch. 41

2.8 ANTENNA CONDUCTED SPURIOUS EMISSIONS

Antenna spurious emission per FCC 15.247(c) was measured from the EUT antenna port using a 50 ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 300 kHz. The modulated carriers were identified at 2.401GHz, 2,440GHz, and 2.48GHz. All harmonics or spurs found within 20 dB of the carrier level, and from 30 MHz to the carrier 10^{th} harmonic. See antenna conducted spurious noise plots.

2.9 RADIATED SPURIOUS EMISSIONS

Radiated spurious emissions apply to harmonics and spurious emissions that fall in the restricted bands and outside the restricted band. The restricted band is listed in Section 15.205. The out of restricted band radiated spurious must meet the peak output power level of each channel less 20 dB. The restricted bands must meet the maximum permitted average field strength listed in Section 15.209. The EUT spurious radiation in the non-restricted bands are less than 20dB of the peak output power. A Filter part# F-12053 was used in conjunction with UNI-24 Antenna only.

Please, refer to section 5.0 for data test results.

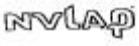
2.10 CONFORMANCE STATEMENT

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this attached test record. No modifications were made during testing to the equipment in order to achieve compliance with these standards.

Furthermore, there was no deviation from, additions to or exclusions from the ANSI C63.4 test methodology.

Signature: _____ Date: March 22, 1999

Typed/Printed Name: Desmond Fraser Position: President
(NVLAP Signatory)


Accredited by the National Voluntary Accreditation Program for the specific scope of accreditation under Lab Code 20061-0.

Note: This report may not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

3.0 Field Strength Calculation, and Radiated Test Methodology

3.1 CONDUCTED MEASUREMENT

The power line conducted emission measurements were performed in a Series 81 type shielded enclosure manufactured by Rayproof. The EUT was assembled on a wooden table 80 centimeters high. Power was fed to the EUT through a 50 ohm / 50 microhenry Line Impedance Stabilization Network (EUT LISN). The EUT LISN was fed power through an A.C. filter box on the outside of the shielded enclosure. The filter box and EUT LISN housing are bonded to the ground plane of the shielded enclosure. A second LISN, the peripheral LISN, provides isolation for the EUT test peripherals. This peripheral LISN was also fed A.C. power. A metal power-outlet box, which is bonded to the ground plane and electrically connected to the peripheral LISN, powers the EUT host peripherals.

The spectrum analyzer was connected to the A.C. line through an isolation transformer. The 50-ohm output of the EUT LISN was connected to the spectrum analyzer input through a Solar 400 kHz high-pass filter. The filter is used to prevent overload of the spectrum analyzer from noise below 400 kHz. Conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable). The analyzer's 6dB bandwidth was set to 9 kHz. Video filters less than 10 times the resolution bandwidth was not used. Average measurements are performed in linear mode using a 10 kHz resolution bandwidth, a 1 Hz video bandwidth, and by increasing the sweep time in order to obtain a calibrated measurement. The emission spectrum was scanned from 450 kHz to 30 MHz. The highest emission amplitudes relative to the appropriate limit were measured and have been recorded in this report.

3.1.1 Conducted Worst Case Profile Rationale

Conducted emission was measured on the AC/DC adaptor providing power to the transceiver unit and the DC Power Injector. Channels 2, 41 and 80 were investigated in conjuction with the Uni-24, Uni-21, Uni-18, Uni-13, and the Omni-12, Omni-8, and Omni-6 directional antennas. The conducted emission profile did not change based on the type of antenna used. The other channels 2 and 80 were investigated and found to be in compliance. The worst case conducted data is presented in this report for the transceiver and power injector units at channel 41.

3.2 FIELD STRENGTH CALCULATION

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

$$FI(dBuV/m) = SAR(dBuV) + SCF(dB/m)$$

FI = Field Intensity
SAR = Spectrum Analyzer Reading
SCF = Site Correction Factor

The Site Correction Factor (SCF) used in the above equation is determined empirically, and is expressed in the following equation:

$$SCF(dB/m) = - PG(dB) + AF(dB/m) + CL(dB)$$

SCF = Site Correction Factor
PG = Pre-amplifier Gain
AF = Antenna Factor
CL = Cable Loss

The field intensity in microvolts per meter can then be determined according to the following equation:

$$FI(uV/m) = 10^{FI(dBuV/m)/20}$$

For example, assume a signal at a frequency of 125 MHz has a received level measured as 49.3 dBuV. The total Site Correction Factor (antenna factor plus cable loss minus preamplifier gain) for 125 MHz is
-11.5 dB/m. The actual radiated field strength is calculated as follows:

$$49.3 \text{ dBuV} - 11.5 \text{ dB/m} = 37.8 \text{ dBuV/m}$$

$$10^{37.8/20} = 10^{1.89} = 77.6 \text{ uV/m}$$

3.3 RADIATED MEASUREMENT

Before final measurements of radiated emissions were made on the open-field three/ten meter range, the EUT was scanned indoors at one meter and three meter distances if necessary in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process was repeated during final radiated emissions measurements on the open-field range, at each frequency, in order to insure that maximum emission amplitudes were attained.

Final radiated emissions measurements were made on the three-meter, open-field test site. The EUT was placed on a nonconductive turntable approximately 0.8 meters above the ground plane. The spectrum was examined from 9 kHz to 10GHz MHz (10^{th} harmonic of carrier frequency) using a Hewlett Packard 8566B spectrum analyzer, a Hewlett Packard 85650A quasi-peak adapter, HP11790 mixers, and EMCO log periodic, EMCO horn antennas and biconical antenna. In order to gain sensitivity, a cougar preamplifier (from 30 to 2GHZ), and an HP preamplifier (from 1GHz to 26.5 GHz) was connected in series between the antenna and the input of the spectrum analyzer.

At each frequency, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters in order to determine the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarizations. The spectrum analyzer's 6 dB resolution bandwidth was set to 120 kHz for measurements below 1GHz, and 1MHz for measurements above 1GHz. The analyzer was operated in peak detection mode below 1GHz and in the peak mode with 10Hz video averaging above 1 GHz. No video filter less than 10 times the resolution bandwidth was used when measuring below 1GHz. The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

3.3.1 Radiated Worst Case Profile Rationale

Radiated emission profile was investigated and measured with the transceiver unit set at channel 2, 41, and 80 using the following: Uni-24, Uni-21, Uni-18, Uni-13, Omni-12, Omni-8, and Omni-6 directional antennas. All antennas and amplifier versions namely 250 and 500 mW were thoroughly investigated from 9kHz to the 10^{th} harmonic fundamental within and out of the restricted band. The worst case radiated data is presented in section 5.0 of this report.

Note: Rhein Tech Laboratories, Inc. has implemented procedures to minimize errors that occur from test instruments, calibration, procedures, and test setups. Test instrument and calibration errors are documented from the manufacturer or calibration lab. Other errors have been defined and calculated within the Rhein Tech quality manual, section 6.1. Rhein Tech implements the following procedures to minimize errors that may occur: yearly as daily calibration methods, technician training, and emphasis to employees on avoiding error.

4.0 CONDUCTED EMISSION DATA

TABLE 2: CONDUCTED EMISSIONS: (Transceiver and 250mW Amp Unit)

Neutral Side (L1)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC Limit (dBuV)	FCC Margin (dB)
0.496	Av	46.9	0.5	45.4	48.0	-2.6
0.550	Av	46.7	0.5	45.2	48.0	-2.8
0.818	Qp	45.1	0.6	45.7	48.0	-2.3
0.820	Av	46.0	0.6	45.6	48.0	-2.4
1.648	Av	44.5	0.9	45.4	48.0	-2.6
1.810	Av	41.4	0.9	42.3	48.0	-5.7
3.080	Av	44.7	1.2	45.9	48.0	-2.1
3.240	Av	44.7	1.2	45.9	48.0	-2.1

Hot Side (L2)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC Limit (dBuV)	FCC Margin (dB)
0.490	Pk	46.7	0.4	45.1	48.0	-2.9
0.490	Qp	46.6	0.4	46.0	48.0	-2.0
0.490	Av	44.0	0.4	44.4	48.0	-3.6
3.215	Av	45.4	1.1	45.5	48.0	-2.5
3.322	Av	46.7	1.2	45.9	48.0	-2.1
3.366	Qp	46.0	1.2	45.2	48.0	-2.8
3.370	Av	45.8	1.2	46.0	48.0	-2.0
3.413	Qp	45.7	1.2	45.9	48.0	-2.1
3.418	Av	45.4	1.2	45.6	48.0	-2.4
15.578	Pk	34.2	2.8	37.0	48.0	-11.0

(1)Pk = Peak; QP = Quasi-Peak; Av = Average

Uni-24 Antenna at Channel 41

TEST PERSONNEL:

Signature**:** _____ **D**ate**:** 3/12/1999

Typed/Printed Name: Daniel Baltzell

TABLE 3: CONDUCTED EMISSIONS: (DC Power Injector and 250mW Amp Unit)

Neutral Side (L1)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC Limit (dBuV)	FCC Margin (dBuV)
0.617	Pk	42.2	0.4	42.6	48.0	-5.4
1.084	Pk	42.9	0.5	43.4	48.0	-4.6
1.531	Pk	42.3	0.8	43.1	48.0	-4.9
1.997	Pk	42.9	1.0	43.9	48.0	-4.1
2.153	Pk	42.5	1.0	43.5	48.0	-4.5
13.951	Pk	38.6	2.4	41.0	48.0	-7.0
19.873	Pk	41.2	2.9	44.1	48.0	-3.9
27.650	Pk	41.8	4.1	45.9	48.0	-2.1

Hot Side (L2)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC Limit (dBuV)	FCC Margin (dBuV)
0.613	Pk	43.6	0.4	44.0	48.0	-4.0
1.069	Pk	42.1	0.5	42.6	48.0	-5.4
1.528	Pk	42.3	0.7	43.0	48.0	-5.0
2.442	Pk	41.8	1.0	42.8	48.0	-5.2
14.378	Pk	38.5	2.3	40.8	48.0	-7.2
20.219	Pk	41.5	2.8	44.3	48.0	-3.7
27.351	Pk	40.1	3.4	43.5	48.0	-4.5

(1)Pk = Peak; QP = Quasi-Peak; Av = Average

Uni-24 Antenna at Channel 41

TEST PERSONNEL:

Signature**:** _____ **D**ate**:** 2/3/1999

Typed/Printed Name: Daniel Baltzell

5.0 RADIATED EMISSION DATA

TABLE 4: RADIATED EMISSIONS: UNI-24 AND 250mW AMP AND F-12053 FILTER

(Temperature: 33F Degree, Humidity: 45%)

EMISSION FREQUENCY (MHz)	RX ANTENNA POLARITY (H/V)	TX ANTENNA POLARITY (H/V)	ANALYZER READING (dBuV)	SITE CORRECTION FACTOR (dB/m)	AVERAGE FACTOR (dB)	EMISSION LEVEL (dBuV/m)	FCC LIMIT (dBuV/m)	FCC MARGIN (dBuV/m)
1367.054	V	H	46.6	2.2	-11.5	37.3	54.0	-16.7
1377.665	V	H	48.5	2.5	-11.5	39.5	54.0	-14.5
1461.824	V	H	60.0	3.2	-11.5	51.7	54.0	-2.3
1472.423	V	H	59.8	3.2	-11.5	57.5	54.0	-2.5
1537.763	V	H	48.6	4.4	-11.5	41.5	54.0	-12.5
1926.315	V	H	48.9	9.7	-11.5	47.1	98.8	-51.7
2353.960	H	V	44.1	-1.3	-11.5	31.3	54.0	-22.7
2365.178	H	V	51.4	-1.2	-11.5	38.7	54.0	-15.3
2370.004	H	V	47.8	-1.2	-11.5	35.1	54.0	-18.9
2377.980	H	V	52.4	-1.2	-11.5	39.7	54.0	-14.3
2386.045	H	V	60.5	-1.2	-11.5	47.8	54.0	-6.2
2389.989	H	V	50.4	-1.2	-11.5	37.7	54.0	-16.3
2498.100	H	V	34.1	1.6	-11.5	24.2	54.0	-29.8
2842.050	H	V	42.9	2.2	-11.5	33.6	54.0	-20.4
3923.990	H	V	56.5	6.7	-11.5	51.7	54.0	-2.3
4803.960	H	H	56.8	-3.6	-11.5	41.7	54.0	-12.3
7206.030	H	V	85.4	-0.4	-11.5	69.9	98.8	-28.9
12009.880	H	V	51.0	5.0	-11.5	44.5	54.0	-9.5

Channel 2

1342.663	V	H	50.0	1.7	-11.5	40.2	54.0	-13.8
1353.352	V	H	50.9	1.8	-11.5	41.2	54.0	-12.8
1576.910	V	H	49.5	4.5	-11.5	42.5	54.0	-11.5
1669.419	V	H	54.5	5.2	-11.5	48.2	54.0	-5.8
2361.010	H	H	37.7	-1.3	-11.5	24.9	54.0	-29.1
2369.180	H	H	40.3	-1.2	-11.5	27.6	54.0	-26.4
4002.050	H	V	60.3	-4.3	-11.5	44.5	54.0	-9.5
4881.990	V	V	66.4	-3.5	-11.5	51.4	54.0	-2.6
7322.910	V	V	63.8	-0.8	-11.5	51.5	54.0	-2.5
12204.81	H	H	53.0	4.7	-11.5	46.2	54.0	-7.8

Channel 41

1381.656	V	H	50.5	2.7	-11.5	41.7	54.0	-12.3
1550.204	V	H	58.2	4.7	-11.5	51.4	54.0	-2.6
1617.610	V	H	45.5	4.5	-11.5	38.5	54.0	-15.5
2319.990	H	V	53.9	-1.4	-11.5	41.0	54.0	-13.0
2360.090	H	V	47.0	-1.3	-11.5	34.2	54.0	-19.8
2368.060	H	V	41.2	-1.2	-11.5	28.5	54.0	-25.5
2384.010	H	V	38.3	-1.2	-11.5	25.6	54.0	-28.4
2488.057	H	V	47.9	-1.0	-11.5	35.4	54.0	-18.6
2491.950	H	V	52.0	1.6	-11.5	42.1	54.0	-11.9
2495.981	H	V	60.4	1.6	-11.5	50.5	54.0	-3.5
4080.010	H	V	50.0	-4.2	-11.5	34.3	54.0	-19.7
4959.990	H	V	66.3	-3.5	-11.5	51.3	54.0	-2.7
7439.890	V	H	49.6	-0.9	-11.5	36.2	54.0	-17.8
12399.990	H	V	49.3	8.2	-11.5	46.0	54.0	-8.0

Channel 80

All readings are quasi-peak, unless stated otherwise. See Appendix B for Radiated Test Methodology.

TEST PERSONNEL:

Signature: _____ **D**ate: 2/1/1999

Typed/Printed Name: Daniel Baltzell

TABLE 5: RADIATED EMISSIONS: (OMNI-12.0 AND 250 mW AMP)

EMISSION FREQUENCY (MHz)	RX ANTENNA POLARITY (H/V)	ANALYZER READING (dBuV)	SITE CORRECTION FACTOR (dB/m)	AVERAGE FACTOR (dB)	EMISSION LEVEL (dBuV/m)	FCC LIMIT (dBuV/m)	FCC MARGIN (dBuV/m)
4001.90	H	60.5	-4.3	-11.5	44.7	54.0	-9.3
4881.95	H	62.0	-3.6	-11.5	46.9	54.0	-7.1
7323.02	H	54.6	-0.8	-11.5	42.3	54.0	-11.7
12204.86	H	38.0	4.7	-11.5	31.2	54.0	-22.8

Channel 41

TABLE 6: RADIATED EMISSIONS: (OMNI-8 AND 500 mW AMP)

EMISSION FREQUENCY (MHz)	RX ANTENNA POLARITY (H/V)	ANALYZER READING (dBuV)	SITE CORRECTION FACTOR (dB/m)	AVERAGE FACTOR (dB)	EMISSION LEVEL (dBuV/m)	FCC LIMIT (dBuV/m)	FCC MARGIN (dBuV/m)
2664.91	H	54.4	2.3	-11.5	45.2	54.0	-8.8
2680.93	H	53.1	2.3	-11.5	43.9	54.0	-10.1
2696.92	H	46.1	2.3	-11.5	36.9	54.0	-17.1
2344.92	V	48.8	-1.2	-11.5	36.1	54.0	-17.9
2880.9	H	54.9	2.2	-11.5	45.6	54.0	-8.4
4001.92	H	64.9	-4.3	-11.5	49.1	54.0	-4.9
4881.93	H	55.7	-3.6	-11.5	40.6	54.0	-13.4
7323.0	H	58.3	-0.8	-11.5	46.0	54.0	-8.0

Channel 41

TABLE 7: RADIATED EMISSIONS: (UNI-16 AND 500 mW AMP)

EMISSION FREQUENCY (MHz)	RX ANTENNA POLARITY (H/V)	TX ANTENNA POLARITY (H/V)	ANALYZER READING (dBuV)	SITE CORRECTION FACTOR (dB/m)	AVERAGE FACTOR (dB)	EMISSION LEVEL (dBuV/m)	FCC LIMIT (dBuV/m)	FCC MARGIN (dBuV/m)
2344.9	V	H	44.5	-1.2	-11.5	31.8	54.0	-16.6
2483.5	H	V	61.3	1.6	-11.5	51.4	54.0	-2.6
2880.93	V	V	51.3	2.2	-11.5	42.0	54.0	-12.0
4001.96	H	V	62.3	-4.3	-11.5	46.5	54.0	-7.5
4881.91	V	V	56.1	-3.6	-11.5	41.0	54.0	-13.0
7322.99	H	H	59.4	-0.8	-11.5	47.1	54.0	-6.9

Channel 41

All readings are quasi-peak, unless stated otherwise. See Appendix B for Radiated Test Methodology.

TEST PERSONNEL:

Signature**:** _____ **D**ate**:** 2/2/1999

Typed/Printed Name: Daniel Baltzell

APPENDIX D: EMISSIONS EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CAL. LAB
AMPLIFIER	HEWLETT PACKARD	11975A	2304A00348	TEST EQUITY
AMPLIFIER (S/A 1)	RHEIN TECH	PR-1040	00001	RTL
AMPLIFIER (S/A 2)	RHEIN TECH	RTL2	900723	RTL
AMPLIFIER (S/A 3)	RHEIN TECH	8447F	2944A03783	RTL
AMPLIFIER (S/A 4)	RHEIN TECH	8447D	2727A05397	RTL
BICONICAL/LOG ANTENNA 1	ANTENNA RESEARCH	LPB-2520	1037	LIBERTY LABS
BICONICAL/LOG ANTENNA 2	ANTENNA RESEARCH	LPB-2520	1036	LIBERTY LABS
FIELD SITE SOURCE	EMCO	4610	9604-1313	RTL
FILTER (ROOM 1)	SOLAR	8130	947305	RTL
FILTER (ROOM 2)	SOLAR	8130	947306	RTL
HARMONIC MIXER 1	HEWLETT PACKARD	11970K	2332A00563	TELOGY
HARMONIC MIXER 2	HEWLETT PACKARD	11970A	2332A01199	TELOGY
HORN ANTENNA 1	EMCO	3160-10	9606-1033	EMCO
HORN ANTENNA 2	EMCO	3160-9	9605-1051	EMCO
HORN ANTENNA 3	EMCO	3160-7	9605-1054	EMCO
HORN ANTENNA 4	EMCO	3160-8	9605-1044	EMCO
HORN ANTENNA 5	EMCO	3160-03	9508-1024	EMCO
LISN (ROOM 1/L1)	SOLAR	7225-1	900727	ACUCAL
LISN (ROOM 1/L2)	SOLAR	7225-1	900726	ACUCAL
LISN (ROOM 2/L1)	SOLAR	7225-1	900078	ACUCAL
LISN (ROOM 2/L2)	SOLAR	7225-1	900077	ACUCAL
PRE-AMPLIFIER	HEWLETT PACKARD	8449B OPT	3008A00505	TELOGY
QUASI-PEAK ADAPTER (S/A 1)	HEWLETT PACKARD	85650A	3145A01599	ACUCAL
QUASI-PEAK ADAPTER (S/A 2)	HEWLETT PACKARD	85650A	2811A01276	ACUCAL
QUASI-PEAK ADAPTER (S/A 3)	HEWLETT PACKARD	85650A	2521A00473	ACUCAL
QUASI-PEAK ADAPTER (S/A 4)	HEWLETT PACKARD	85650A	2521A01032	ACUCAL
RF PRESELECTOR (S/A 1)	HEWLETT PACKARD	85685A	3146A01309	ACUCAL
SIGNAL GENERATOR (HP)	HEWLETT PACKARD	8660C	1947A02956	ACUCAL
SIGNAL GENERATOR (WAVETEK)	WAVETEK	3510B	4952044	ACUCAL
SPECTRUM ANALYZER 1	HEWLETT PACKARD	8566B	3138A07771	ACUCAL
SPECTRUM ANALYZER 2	HEWLETT PACKARD	8567A	2841A00614	ACUCAL
SPECTRUM ANALYZER 4	HEWLETT PACKARD	8567A	2727A00535	ACUCAL
TUNABLE DIPOLE	EMCO	3121	274	LIBERTY LABS
ANTENNA	ATM	WR08	08443-6	ATM
MIXER	OLESON	M08HW	F80814-1	OLESON
MIXER	OLESON	M05HW	G80814-1	OLESON
DIPLEXER	OLESON	M05HW	G80814-1	OLESON
MIXER	HEWLETT PACKARD	11970U	2332A01110	ACUCAL
MIXER	HEWLETT PACKARD	11970V	2521A00512	TELOGY
MIXER	HEWLETT PACKARD	11970W	2521A00710	TELOGY
ANTENNA	ATM	WR15	15-443-6	ATM
ANTENNA	ATM	WR10	10-443-6	ATM
ANTENNA	ATM	WR05	05-443-6	ATM
SWEEP GENERATOR	HEWLETT PACKARD	83752A	3610A00866	HEWLETT PACKARD