

15.247 Certification  
FCC ID: EV9WNIP2458R

EMI TEST REPORT

On

WAVENET IP 2458 REMOTE

Prepared for

Wireless Inc.  
19 Davis Drive  
Belmont CA 94002  
Tel : (650) 595-3300  
Fax: (650) 595-4907

Prepared by

Electronic Compliance Laboratories Inc.  
1249 Birchwood Dr.  
Sunnyvale, CA 94089  
Tel : (408) 747-1490  
Fax: (408) 747-1495

Test Report Number: A810007  
Date of Test: September 21 and 22, 1998

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## 1.0 TEST FACILITY

Name: Electronic Compliance Laboratories

Location: 1249 Birchwood Dr.  
Sunnyvale, CA 94089

Site Filing: A site description is on file at the Federal Communications  
Commission  
P.O. Box 429  
Columbia, MD 21045

NVLAP LAB CODE: 200089

Types of Sites: Open Field Radiated and Indoor Screen Room (Line  
Conducted). All sites are constructed and calibrated to  
meet ANSI C63.4-1994 requirements.

## 2.0 TEST EQUIPMENT

Description	Manufacturer	Model	SN
Spectrum Analyzer	HP	8564E	3741A00986
EMI Receiver	HP	8546A	3325A00137
Spectrum Analyzer	HP	8563A	3137A01183
Preamp	HP	8447F	3113A05849
Preamp	HP	8449B	3008A00527
LISN	EM	ANS-25/2	2532
Biconical Antenna	EM	EM 6912	414
Log Periodic Ant	EM	EM 6950	311
Double Ridge Horn	EM	EM 6961	6231
Filter BP 1.2-45 GHz	FSY	HM 1160-1155	
Filter BP 4-10 GHz	FSW	HM 2950-1565 001	
Filter BP 10-18 GHz	FSW	HP 8601-7SS 001	

## 3.0 EUT

WAVENET IP 2458 REMOTE  
M/N: WaveNet IP 2458  
S/N: 001  
FCC ID: EV9WNIP2458R

## 4.0 SUPPORT EQUIPMENT

Laptop Toshiba T1900S S/N 11453067  
Laptop Power Supply  
Power Supply for EUT 110V 60 Hz to 24VAC

## 5.0 EQUIPMENT CONFIGURATION

All of the equipment and cables were placed in worst case positions to maximize emissions.

Interconnecting cables were of the type and length specified in the individual equipment requirements.

Grounding was in accordance with the manufacturer requirements and conditions for intended use.

## 6.0 SUMMARY OF TESTS

The WAVENET IP 2458 REMOTE is a Wireless Point to Multipoint data communications System with a low power frequency hopping spread spectrum (FHSS) radio system transmitting in the 5725-5850 MHz band and receiving in the 2400-2483 MHz band. Tests were performed with two different pairs of antennas. Test firmware resident in the EUT and was used to do the test.

### 6.1 15.247(a)(1) FREQUENCY HOPPING SYSTEMS

WAVENET IP 2458 REMOTE uses 79 channels, each 1 MHz wide. The system hops over one of 26 pseudorandom sequences. On average, each channel is used equally. Please refer to "WaveNet IP System Description attached to this submission for more details.

#### 6.1.1 15.247(a)(1)(ii) CHANNEL UTILIZATION

A spectrum analyzer plots labeled "Channel UTILIZATION". The total number of channels is 79. The channels used have nominal center frequencies of 5770 through 5848 MHz. Three spectrum analyzer MAX HOLD plots labeled "BANDWIDTH" show the 20 dB bandwidth of the hopping channel to be < 1 MHz (1 / 1 / .995 MHz) at the low/midband/high frequencies of 5770/5809/5848 GHz. **Test Plots are shown in Appendix A.**

Zero span spectrum analyzer plot labeled "DWEELL TIME" shows Worst case transmission time in a given slot : 300 msec elapsed time, <100 %. Please refer to "WaveNet IP System description attached to this submission for more details.

Maximum allowed: 400 msec.

**Test Data in Appendix A.**

6.1.2 **15.247(b) MAXIMUM PEAK OUTPUT POWER**

The three spectrum analyzer plots labeled " POWER OUT" show the maximum power of the hopping channel to be 24.8 dBm or 304 mW. The EUT was made to transmit uninterrupted random data on each of the low/mid/high channels. **Test Plots are shown in Appendix A.**

The output was taken from an N connector, through 3 feet of RG 142 cable, to Spectrum Analyzer set on Max Hold with no additional attenuation.

Power = 23.33 dBm (peak reading) +1.5dB cable loss = +24.83 dBm / 304 mW EIRP

Limit: +30 dBm / 1 W maximum power

Radiowaves SP1-2/5 dual band, 23.3 dBi @ 5-8 GHz, 1' Parabolic Directional Antenna

EIRP = +24.83 (peak power) +23.3 (peak gain) =48.1 dBm/ 65 W

Radiowaves SP2-2/5 dual band, 28.3 dBi @ 5.8 GHz, 2' Parabolic Directional Antenna

EIRP = +24.83 (peak power) +28.3 (peak gain) =53.1 dBm/ 205 W

Note: Transient spikes that appear on Power Out plots are due to the hopping of the frequency synthesizer. The test software used does not key-off the transmitter when it hops. For this test, the transmitter was continuously hopping to the same channel, and transient occurred each time the synthesizer was reloaded.

In actual operation the frequency transients do not occur as the transmitter is turned back on after the synthesizer has had time to stabilize on the new channel frequency.

#### 6.1.3 15.247(c) OUT OF BAND EMISSIONS

The spectrum analyzer plots titled "" OUT OF BAND - BAND EDGES" shows the output spectrum of the EUT while hopping one of the pseudorandom sequences and continuously transmitting packetized data. The analyzer was placed in MAX HOLD mode, and individual sweeps were recorded continually for 10 minutes with the same spectrum analyzer connection as was used for peak output power. The resultant plot shows that the EUT emissions remain inside the 5725 - 5850 MHz band when measured in  $\geq 100$  kHz bandwidth during operation.

The spectrum analyzer plots labeled "OUT OF BAND  $<30$  MHz- 6GHz", " OUT OF BAND 6 GHz - 13 GHz", and "OUT OF BAND 13 GHz – 26.5 GHz" "OUT OF BAND 26.5 GHz -31 GHz "OUT OF BAND 31 GHz – 40 GHz" show that emissions measured in  $\geq 100$  kHz bandwidth are more than 20 dB below the highest level of the desired power outside of the 5725 - 5850 MHz band. **Test Plots are shown in Appendix A.**

#### 6.1.4 15.203 ANTENNA REQUIREMENT

The unit requires professional installation and is therefore exempt from the requirements of 15.203. This product has a standard N type Antenna connector to provide a coupling to the intentional radiator. See the WaveNet IP 2458 System description for justification of professional installation.

#### 6.1.5 15.205 RESTRICTED BAND RADIATION LIMITS

The EUT was placed on a wooden table resting on a turntable. The wooden table was approximately 1 meter above the groundplane of the 3 meter test site. The search antenna was moved in to 1 meter when necessary to improve the noise floor, and the appropriate range factor was applied. While the EUT was transmitting uninterrupted random data on each of the low/mid/high channels and with the spectrum analyzer on MAX HOLD, the turntable was rotated, and the search antenna raised and lowered in an attempt to maximize the received radiated emission level. **Test results are attached in Appendix B** in tabular form showing that no spurious signals were detected above the 74 dBuV/m peak/54dBuV/m average limits. Peak measurements were made with a RBW and VBW = 1Mhz. Average measurements were made with a RBW = 1 MHz and a VBW = 10 Hz.

#### 6.1.6 15.207 AC LINE CONDUCTED EMISSIONS

The RF line conducted levels for emissions in the 0.45 - 30 MHz band must not exceed 250  $\mu$ V when measured with a LISN. Attached graphs and tabular data show that emissions are below the 250  $\mu$ V (48 dB $\mu$ V) maximum allowed level. **Test Data is in Appendix C.**

#### 6.1.7 15.209 RADIATED EMISSIONS

with

The attached table shows that the Class A radiated limits from 30 - 1000 MHz are not exceeded by the EUT. The EUT was operating normally a combination of transmission and reception and hopping one of the 26 pseudorandom sequences during this test. The EUT was placed near one edge of a wooden table resting on a turntable. The wooden table was approximately 1 meter above the groundplane of the 3 meter test site. The search antennas were located at 3 meters. Measurements were made in accordance with ANSI C63.4-1994. **Test Data is in Appendix D.**

Electronic Compliance Laboratories

\_\_\_\_\_  
Chris Byleckie  
Technical Director

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Date

**APPENDIX A**  
**SPREAD SPECTRUM PLOTS**



**The Plots For This Report Are In A Separate File**

**APPENDIX B**  
**RESTRICTED BAND DATA**

<b>EUT:</b> WAVENET IP 2458 5.8Ghz				<b>CUSTOMER NAME:</b> WIRELESS					
<b>RULE PART:</b> 15.247				<b>WORK ORDER:</b> 8092101					
				<b>FILE:</b> 8092101C					
<b>ANTENNA:</b> HORN				<b>ATTN dB</b> 0					
<b>POLARIZATION:</b> HORIZONTAL				<b>DUTY dB</b> 0					
<b>MODULATION TYPE:</b>				<b>HP IL dB</b> 0					
<b>TESTED BY:</b> SHAWN				<b>DIST dB:</b> 0					
<b>COMMENT:</b> 2' DUAL BAND PARABOLIC ANTENNA									
FREQ.	READING		A.F.	Cbl	FLTR	AMP	TOTAL,	LIMIT	DELTA
MHz	dB(uV)	NF or Av	dB	dB	dB	dB	dB(uV/m)	dB(uV/m)	dB
5770									
11540.00	42.60	Pk	39.4	-13.6	-0.5	34.3	61.8	74.0	-12.3
11540.00	24.00	Avg	39.4	-13.6	-0.5	34.3	43.2	54.0	-10.9
17310.00	42.00	Pk	41.9	-16.9	-0.5	34.3	67.0	74.0	-7.0
17310.00	21.30	Avg	41.9	-16.9	-0.5	34.3	46.3	54.0	-7.7
5809									
11618.00	43.20	Pk	39.4	-13.6	-0.5	34.3	62.4	74.0	-11.7
11618.00	25.10	Avg	39.4	-13.6	-0.5	34.3	44.3	54.0	-9.8
17427.00	41.30	Pk	41.9	-16.9	-0.5	34.3	66.3	74.0	-7.7
17427.00	22.00	Avg	41.9	-16.9	-0.5	34.3	47.0	54.0	-7.0
5848									
11696.00	43.40	Pk	39.4	-13.6	-0.5	34.3	62.6	74.0	-11.5
11696.00	24.00	Avg	39.4	-13.6	-0.5	34.3	43.2	54.0	-10.9
17544.00	41.00	Pk	45.3	-17.0	-0.5	34.3	69.5	74.0	-4.5
17544.00	21.50	Avg	45.3	-17.0	-0.5	34.3	50.0	54.0	-4.0

<b>EUT:</b> WAVENET IP 2458 5.8Ghz				<b>CUSTOMER NAME:</b> WIRELESS					
<b>RULE PART:</b> 15.247				<b>WORK ORDER:</b> 8092101					
				<b>FILE:</b> 8092101D					
<b>ANTENNA:</b> HORN				<b>ATTN dB</b> 0					
<b>POLARIZATION:</b> HORIZONTAL				<b>DUTY dB</b> 0					
<b>MODULATION TYPE:</b>				<b>HP IL dB</b> 0					
<b>TESTED BY:</b> SHAWN				<b>DIST dB:</b> 0					
<b>COMMENT:</b> 1' DUAL BAND PARABOLIC ANTENNA									
FREQ.	READING		A.F.	Cbl	FLTR	AMP	TOTAL,	LIMIT	DELTA
MHz	dB(uV)	NF or Av	dB	dB	dB	dB	dB(uV/m)	dB(uV/m)	dB
5770									
11540.00	40.00	Pk	39.4	-13.6	-0.5	34.3	59.2	74.0	-14.9
11540.00	21.00	Avg	39.4	-13.6	-0.5	34.3	40.2	54.0	-13.9
17310.00	38.60	Pk	41.9	-16.9	-0.5	34.3	63.6	74.0	-10.4
17310.00	19.60	Avg	41.9	-16.9	-0.5	34.3	44.6	54.0	-9.4
5809									
11618.00	40.10	Pk	39.4	-13.6	-0.5	34.3	59.3	74.0	-14.8
11618.00	21.10	Avg	39.4	-13.6	-0.5	34.3	40.3	54.0	-13.8
17427.00	40.10	Pk	41.9	-16.9	-0.5	34.3	65.1	74.0	-8.9
17427.00	19.80	Avg	41.9	-16.9	-0.5	34.3	44.8	54.0	-9.2
5848									
11696.00	40.30	Pk	39.4	-13.6	-0.5	34.3	59.5	74.0	-14.6
11696.00	21.20	Avg	39.4	-13.6	-0.5	34.3	40.4	54.0	-13.7
17544.00	39.60	Pk	45.3	-17.0	-0.5	34.3	68.1	74.0	-5.9
17544.00	20.00	Avg	45.3	-17.0	-0.5	34.3	48.5	54.0	-5.5

**APPENDIX C**  
**15.207**  
**CONDUCTED EMISSIONS**

Electronic Compliance Laboratories, Inc.  
1249 Birchwood Ave.  
Sunnyvale, CA  
Conducted Emissions  
Frequency range: 450KHz-30MHz

Government Agency and Limit: FCC Class A

QP = Quasi-Peak    Note: Ignore peak readings when Quasi-Peak reading exists  
PK = Peak

Customer:                      WIRELESS                      Operator:                      SHAWN  
Date:                            10-16-1998                      Time:                            12:00:00  
Temperature Range:    72                      Deg F                      Percent Humidity: 45  
E.U.T.:                          WAVENET IP 2458 5.8Ghz UNIT  
Serial Number:              PROTO  
Support Devices:  
Serial Number:  
FCC ID:  
Exercise Program:  
Modifications:              None  
Report File Name:          F:\TESTDATA\8092101C.F

TEST FREQ =====	TEST dBuV =====	CLASS A LIMIT =====	VERSUS A LIMIT =====	CONDUCTOR =====	TYPE =====
0.599	22.6	60.0	-37.4	LINE	PK
2.890	20.6	69.5	-48.9	LINE	PK
4.879	17.1	69.5	-52.4	LINE	PK
10.640	25.0	69.5	-44.5	LINE	PK
16.330	25.2	69.5	-44.3	LINE	PK
29.560	14.8	69.5	-54.7	LINE	PK
0.890	27.7	60.0	-32.3	NEUTRAL	PK
4.510	24.0	69.5	-45.5	NEUTRAL	PK
10.280	29.2	69.5	-40.3	NEUTRAL	PK
16.190	27.8	69.5	-41.8	NEUTRAL	PK
29.110	14.1	69.5	-55.4	NEUTRAL	PK







**APPENDIX D**  
**15.209**  
**RADIATED EMISSIONS**

Electronic Compliance Laboratories, Inc.  
 1249 Birchwood Ave.  
 Sunnyvale, CA  
 Radiated Emissions  
 Frequency range: 30MHz-1000MHz  
 10 Meter Open Site  
 Site Calibrated: June 1997

Government Agency and Limit: FCC Class A  
 -----

QP = Quasi-Peak    Note: Ignore peak readings when Quasi-Peak reading exists  
 PK = Peak

Customer:                    WIRELESS                    Operator:                    SHAWN  
 Date:                        09-21-1998                    Time:                        16:02:22  
 Temperature Range:        78                        Deg F                    Percent Humidity: 50  
 E.U.T.:                      WAVENET IP 2458 5.8Ghz UNIT  
 Serial Number:              PROTO  
 Support Devices:  
 Serial Number:  
 FCC ID:  
 Exercise Program:  
 Modifications:              None  
 Report File Name:          F:\TESTDATA\8092101C.RF

Antenna Type:                BICONICAL

TEST FREQ	TEST dBuV	ACTUAL dBuV/m	CLASS A LIMIT	VERSUS A LIMIT	TABLE DEGREES	ANTENNA HEIGHT	POLAR- IZATION	DETECTOR Type
=====	=====	=====	=====	=====	=====	=====	=====	=====
40.013	36.0	24.8	39.0	-14.2	90	2.0	V	PK
132.675	38.6	29.0	43.5	-14.5	180	2.0	V	PK
132.663	38.8	29.2	43.5	-14.3	180	2.5	H	PK
40.020	35.0	23.8	39.0	-15.2	180	2.5	H	PK

NOTE: NO OTHER EMISSIONS TO 1 Ghz

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**APPENDIX E**  
**SET-UP PHOTOS**



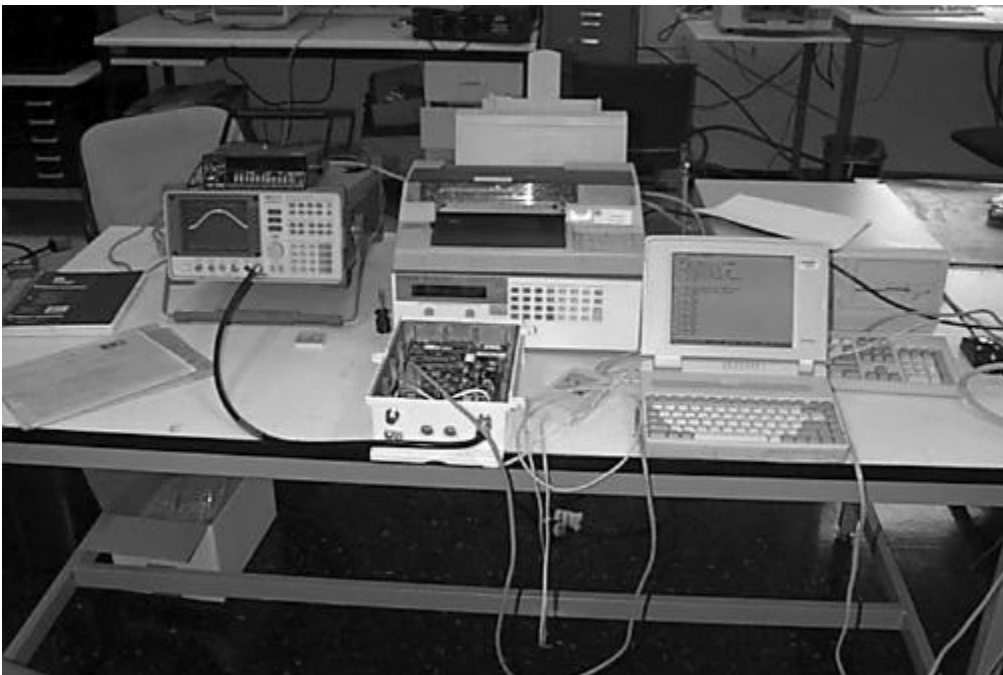
**FCC 15.209 Class B  
Radiated Emissions**



**FCC 15.205 Restricted Band**



**FCC 15.205 Restricted Band**



**FCC 15.247 Conducted RF**