FCC PART 15 SUBPART C

EMI MEASUREMENT AND TEST REPORT

For

FreeWave Technologies Inc.

1880 S. Flatiron Court, Suite F
Boulder CO 80301

FCC ID: KNY-6231812519

2003-08-27

This Report Concerns:	**Equipment Type:**
☒ Class II Permissive Change	RF Transceiver & Antenna

Reviewed By:	Ming Jing
Report No.:	R0308151
Test Date:	2003-08-18
Reviewed By:	Ling Zhang
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1 - GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

The *FreeWave Technologies Inc.'s*, model: *DGRO9RMS*, or the "EUT" as referred to in this report is an RF transceiver & antenna which measures approximately 5.5"L x 2.8"W x 0.6"H. The EUT will operate at the frequency range of 902.24 – 927.82 MHz, with the maximum conducted output power of 0.955 Watt.

The EUT can be installed with 11 antennas respectively. The antenna list is as follows:

Gain	Manufacturer	Manufacturer Model #
0 dB	Maxrad	MUF9000
3 dB	MicroPulse	31717W-D/A
3 dB	Astron Wireless Technologies	V9183
0 dB	Astron Wireless Technologies	PCNLP09V-TF10I
3 dB	Centurion	EXS-902-TN
0 dB	Centurion	CXS-902-TN
0 dB	Astron Wireless Technologies	V9180
5 dB	Comet Antenna	CFC7-71
3 dB	Maxrad	MFB9153
0 dB	AeroAntenna Technologies	AT900-128
0 dB	Benelec	02461G

The 11 antennas are classified as two types, one is the 0 & 3 dB antenna, the other is 5 dB antenna. The CFC7-71 and 31717W-D/A were tested to represent the worst case of the two types of antenna.

** The test data gathered are from typical production samples provided by the manufacturer.*

1.2 Objective

This type approval report is prepared on behalf of. *FreeWave Technologies Inc.* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commissions rules.

The objective of the manufacturer is to demonstrate compliance with FCC rules for Spurious Radiated Emission, for a Permissive Class II application. The difference between the original application and this PC2 is that the antennas installed with the device have been changed. Please see antenna list in section 1.1 and antenna spec in Exhibit B. No changes are made to the EUT itself.

1.3 Related Submittal(s)/Grant(s)

This device was originally granted on 10/31/2002.

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-1992, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz and FCC97114 for Direct Sequence SS.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.5 Test Facility

The Open Area Test site used by BACL to collect radiated and conducted emission measurement data is located in the back parking lot of the building at 230 Commercial Street, Sunnyvale, California, USA.

Test site at BACL has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-1992.

The Federal Communications Commission and Voluntary Control Council for Interference has the reports on file and is listed under FCC file 31040/SIT 1300F2 and VCCI Registration No.: C-1298 and R-1234. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The scope of the accreditation covers the FCC Method – 47 CFR Part – Digital Devices, CISPER 22: 1997: Electromagnetic Interference – Limits and Methods of Measurement of Information Technology Equipment test methods.

1.6 Test Equipment List

Manufacturer	Description	Model	Serial Number	Cal. Due Date
HP	Spectrum Analyzer	8568B	2517A01610	2003-10-30
HP	Amplifier	8447E	2944A07030	2004-06-28
HP	Quasi-Peak Adapter	85650A	2521A00718	2004-03-08
Com-Power	Biconical Antenna	AB-100	14012	2003-09-05
Com-Power	Log Periodic Antenna	AL-100	16005	2004-08-23
Com-Power	Log Periodic Antenna	AB-900	15049	2004-05-01
Agilent	Spectrum Analyzer (9KHz – 40GHz)	8564E	3943A01781	2004-08-01
Agilent	Spectrum Analyzer (9KHz – 50GHz)	8565EC	3946A00131	2004-05-03
HP	Amplifier (1-26.5GHz)	8449B	3147A00400	2004-03-14
A.H.System	Horn Antenna (700MHz-18GHz)	SAS-200/571	261	2004-05-31

*** Statement of Traceability: Bay Area Compliance Laboratory Corp.** certifies that all calibration has been performed using suitable standards traceable to the NIST.

1.7 Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	FCC ID
Dell	Notebook PC	PP05	N/A	DOC

1.8 External I/O Cabling List and Details

Cable Description	Length (M)	Port/From	To
Shield Cable	1.0	EUT	RS232 Port/Laptop PC
Shield RF Cable	1.0	RF Port/EUT	Antenna
Power Cable	0.5	EUT	DC Power Supply

2 - SYSTEM TEST CONFIGURATION

2.1 Justification

The host system was configured for testing in a typical fashion (as normally used by a typical user).

The EUT was tested in the normal (native) operating mode to represent *worst*-case results during the final qualification test.

2.2 EUT Exercise Software

The EUT exercise program used during radiated and conducted testing was designed to exercise the system components in a manner similar to a typical use. The test software, provided by the customer, is started the Windows terminal program under the Windows 98/2000/ME/XP operating system.

Once loaded, set the Tx channel to low, mid and high for testing.

2.3 Special Accessories

As shown in section 2.7, all interface cables used for compliance testing are shielded. The notebook and the peripherals featured shielded metal connectors.

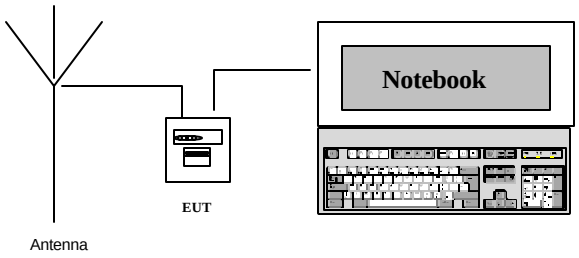
2.4 Schematics / Block Diagram

Please refer to Appendix A.

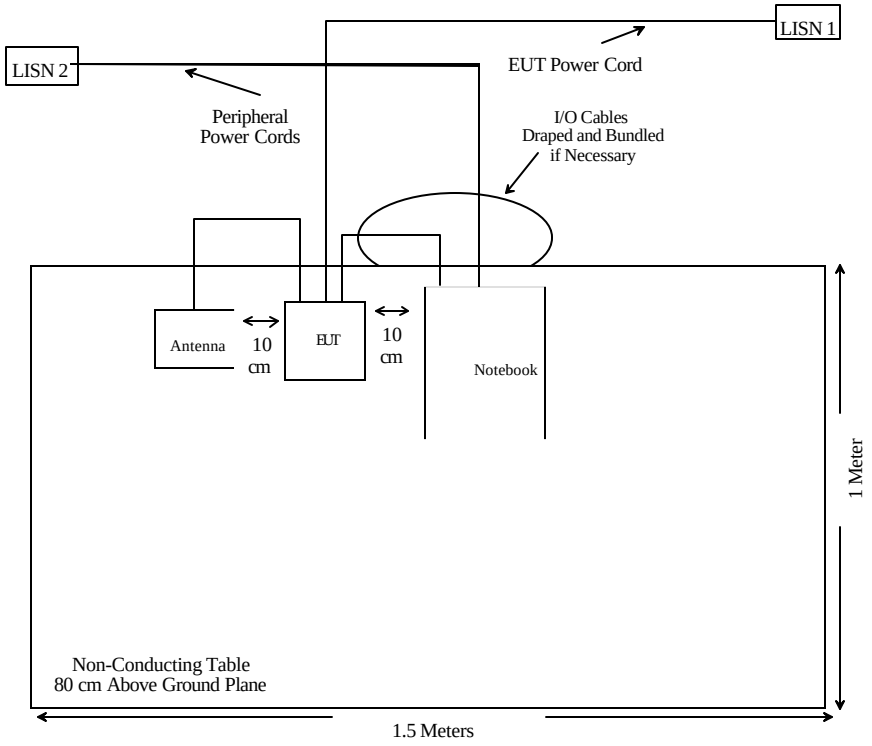
2.5 Equipment Modifications

No modifications were made by BACL to ensure the EUT to comply with the applicable limits and requirements.

2.6 Configuration of Test System



2.7 Test Setup Block Diagram



3 - SUMMARY OF TEST RESULTS

FCC RULES	DESCRIPTION OF TEST	RESULT	REFERENCE
§15.203	Antenna Requirement	Compliant	Section 4
§15.209 (a)	Radiated Emission	Compliant	Section 5

4 - ANTENNA REQUIREMENT

4.1 Standard Applicable

For intentional device, according to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

And according to § 15.247 (1), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2 Antenna Connected Construction

The directional gains of antennas used for transmitting are 0 dBi, 3dBi and 5dBi, and the antennas require professional installations.

5 - SPURIOUS RADIATED EMISSION

5.1 Measurement Uncertainty

All measurements involve certain levels of uncertainties. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of a radiation emissions measurement at BACL is ±4.0 dB.

5.2 EUT Setup

The radiated emission tests were performed in the open area 3-meter test site, using the setup in accordance with the ANSI C63.4-1992. The specification used was the FCC 15 Subpart C limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

The host PC system was connected with 120Vac/60Hz power source.

5.3 Spectrum Analyzer Setup

According to FCC Rules, 47 CFR §15.33 (a) (1), the system was tested to 25GHz.

During the radiated emission test, the spectrum analyzer was set with the following configurations:

Frequency Range	***RBW***	***Video B/W***
Below 30MHz	10kHz	10kHz
30 – 1000MHz	100kHz	100kHz
Above 1000MHz	1MHz	1MHz

5.4 Test Procedure

For the radiated emissions test, the Host PC system power cord was connected to the AC floor outlet since the power supply used in the EUT did not provide an accessory power outlet.

Maximizing procedure was performed on the six (6) highest emissions to ensure EUT compliance is with all installation combinations. All data was recorded in the peak detection mode. Quasi-peak readings was performed only when an emission was found to be marginal (within -4 dBµV of specification limits), and are distinguished with a "**Qp**" in the data table.

5.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dBµV means the emission is 7dBµV below the maximum limit for Subpart C. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Subpart C Limit

5.6 Test Equipment

Manufacturer	Model No.	Serial No.	Calibration Due Date
HP	8564E	Spectrum Analyzer	2003-12-06

5.7 Summary of Test Results

According to the data in section 10.8, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.207 and 15.247, and had the worst margin of:

EUT & CFC7-71 Antenna (5dB):

-2.2 dB at **943.25 MHz** in the **Vertical** polarization, Low Channel

-1.8 dB at **946.17 MHz** in the **Vertical** polarization, Middle Channel

-1.6 dB at **948.03 MHz** in the **Vertical** polarization, High Channel

-1.1 dB at **311.74 MHz** in the **Vertical** polarization, Unintentional Emission

EUT & 31717W-D/A Antenna (3dB):

-2.0 dB at **943.25 MHz** in the **Vertical** polarization, Low Channel

-1.7 dB at **946.17 MHz** in the **Vertical** polarization, Middle Channel

-1.5 dB at **948.05 MHz** in the **Vertical** polarization, High Channel

-0.8 dB at **311.74 MHz** in the **Vertical** polarization, Unintentional Emission

5.8.1 Final test data, 1 – 25 GHz, EUT & CFC7-71 Antenna (5dB)

Indicated			Table	Antenna		Correction Factor			Corrected Amplitude	FCC 15 Subpart C	
Frequency MHz	Ampl. dBµV/m	Comments	Angle Degree	Height Meter	Polar H/V	Antenna dBµV/m	Cable DB	Amp. DB	Corr. Ampl. dBµV/m	Limit dBµV/m	Margin dB
Low Channel											
902.71	120.4	FUND	0	1.5	v	24.8	3.0	25.0	123.2		
902.71	114.1	FUND	0	1.2	h	24.8	3.0	25.0	116.9		
943.25	40.7	Peak	70	1.8	v	24.4	3.7	25.0	43.8	46	-2.2
943.25	39.8	Peak	110	1.5	h	24.4	3.7	25.0	42.9	46	-3.1
1805.42	37.3	Avg.	60	1.8	v	25.3	2.6	30.0	35.2	54	-18.8
1805.42	36.9	Avg.	180	1.5	h	25.3	2.6	30.0	34.8	54	-19.2
2708.13	31.5	Avg.	110	1.5	v	29.0	3.7	30.0	34.2	54	-19.8
2708.13	31.1	Avg.	230	1.5	h	29.0	3.7	30.0	33.8	54	-20.2
1805.42	55.2	Peak	60	1.8	v	25.3	2.6	30.0	53.1	74	-20.9
1805.42	54.9	Peak	180	1.5	h	25.3	2.6	30.0	52.8	74	-21.2
2708.13	48.7	Peak	110	1.5	v	29.0	3.7	30.0	51.4	74	-22.6
2708.13	48.3	Peak	230	1.5	h	29.0	3.7	30.0	51.0	74	-23.0
Middle Channel											
914.92	120.6	FUND	0	1.5	v	24.6	4.2	25.0	124.4		
914.92	114.3	FUND	0	1.2	h	24.6	4.2	25.0	118.1		
946.17	41.1	Peak	90	1.5	v	24.4	3.7	25.0	44.2	46	-1.8
946.17	40.2	Peak	120	1.5	h	24.4	3.7	25.0	43.3	46	-2.7
1829.84	37.5	Avg.	90	1.5	v	25.3	2.6	30.0	35.4	54	-18.6
1829.84	37.2	Avg.	310	1.5	h	25.3	2.6	30.0	35.1	54	-18.9
2744.76	31.7	Avg.	150	1.2	v	29.0	3.7	30.0	34.4	54	-19.6
2744.76	31.3	Avg.	210	1.5	h	29.0	3.7	30.0	34.0	54	-20.0
1829.84	55.4	Peak	90	1.8	v	25.3	2.6	30.0	53.3	74	-20.7
1829.84	55.1	Peak	310	1.5	h	25.3	2.6	30.0	53.0	74	-21.0
2744.76	49.1	Peak	150	1.2	v	29.0	3.7	30.0	51.8	74	-22.2
2744.76	48.6	Peak	210	1.5	h	29.0	3.7	30.0	51.3	74	-22.7
High Channel											
927.59	120.9	FUND.	0	1.5	v	24.7	4.4	25.0	125.0		
927.59	114.5	FUND.	0	1.5	h	24.7	4.4	25.0	118.6		
948.03	41.3	Peak	110	1.5	v	24.4	3.7	25.0	44.4	46	-1.6
948.03	40.4	Peak	160	1.5	h	24.4	3.7	25.0	43.5	46	-2.5
1855.18	37.7	Avg.	120	1.5	v	25.3	2.6	30.0	35.6	54	-18.4
1855.18	37.4	Avg.	330	1.2	h	25.3	2.6	30.0	35.3	54	-18.7
2782.77	31.8	Avg.	180	1.5	v	29.0	3.7	30.0	34.5	54	-19.5
2782.77	31.5	Avg.	230	1.5	h	29.0	3.7	30.0	34.2	54	-19.8
1855.18	55.6	Peak	120	1.5	v	25.3	2.6	30.0	53.5	74	-20.5
1855.18	55.3	Peak	330	1.2	h	25.3	2.6	30.0	53.2	74	-20.8
2782.77	49.3	Peak	180	1.5	v	29.0	3.7	30.0	52.0	74	-22.0
2782.77	48.9	Peak	230	1.5	h	29.0	3.7	30.0	51.6	74	-22.4

Indicated			Table	Antenna		Correction Factor			FCC 15 Subpart B	
Frequency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin
MHz	dBµV/m	Degree	Meter	H/V	dBµV/m	dBµV/m	dB	dBµV/m	dBµV/m	dB
311.74	50.3	45	1.5	v	15.9	3.7	25.0	44.9	46	-1.1
307.22	49.8	270	1.5	v	15.1	4.6	25.0	44.5	46	-1.5
407.61	49.8	270	1.8	v	16.5	2.9	25.0	44.2	46	-1.8
114.20	52.1	180	1.5	v	11.7	1.3	25.0	40.1	43.5	-3.4
299.75	47.6	225	1.8	h	14.9	5.1	25.0	42.6	46	-3.4
230.48	52.9	270	1.5	v	12.0	1.2	25.0	41.1	46	-4.9
898.62	37.5	45	1.5	h	24.8	2.7	25.0	40.0	46	-6.0
245.76	38.9	60	1.5	v	12.6	2.3	25.0	28.8	46	-17.2

5.8.2 Final test data, 1 – 25 GHz, EUT & 31717W-D/A Antenna (3dB)

Indicated			Table	Antenna		Correction Factor			Corrected Amplitude	FCC 15 Subpart C	
Frequency MHz	Ampl. dBµV/m	Comments	Angle Degree	Height Meter	Polar H/V	Antenna dBµV/m	Cable DB	Amp. DB	Corr. Ampl. dBµV/m	Limit dBµV/m	Margin dB
Low Channel											
902.71	121.0	FUND	0	1.5	v	24.8	3.0	25.0	123.8		
902.71	120.8	FUND	0	1.5	h	24.8	3.0	25.0	123.6		
943.25	40.9	Peak	70	1.8	v	24.4	3.7	25.0	44.0	46	-2.0
943.25	40.1	Peak	110	1.5	h	24.4	3.7	25.0	43.2	46	-2.8
1805.42	37.5	Avg.	60	1.8	v	25.3	2.6	30.0	35.4	54	-18.6
1805.42	37.3	Avg.	180	1.8	h	25.3	2.6	30.0	35.2	54	-18.8
2708.13	31.7	Avg.	110	1.5	v	29.0	3.7	30.0	34.4	54	-19.6
2708.13	31.3	Avg.	230	1.5	h	29.0	3.7	30.0	34.0	54	-20.0
1805.42	55.4	Peak	60	1.8	v	25.3	2.6	30.0	53.3	74	-20.7
1805.42	55.1	Peak	180	1.8	h	25.3	2.6	30.0	53.0	74	-21.0
2708.13	49.1	Peak	110	1.5	v	29.0	3.7	30.0	51.8	74	-22.2
2708.13	48.6	Peak	230	1.5	h	29.0	3.7	30.0	51.3	74	-22.7
Middle Channel											
914.92	121.1	FUND	0	2.0	v	24.6	4.2	25.0	124.9		
914.92	121.0	FUND	0	1.8	h	24.6	4.2	25.0	124.8		
946.17	41.2	Peak	90	1.8	v	24.4	3.7	25.0	44.3	46	-1.7
946.17	40.3	Peak	120	1.8	h	24.4	3.7	25.0	43.4	46	-2.6
1829.84	37.7	Avg.	90	1.8	v	25.3	2.6	30.0	35.6	54	-18.4
1829.84	37.5	Avg.	310	1.5	h	25.3	2.6	30.0	35.4	54	-18.6
2744.76	31.9	Avg.	150	1.5	v	29.0	3.7	30.0	34.6	54	-19.4
2744.76	31.5	Avg.	210	1.5	h	29.0	3.7	30.0	34.2	54	-19.8
1829.84	55.6	Peak	90	1.8	v	25.3	2.6	30.0	53.5	74	-20.5
1829.84	55.3	Peak	310	1.5	h	25.3	2.6	30.0	53.2	74	-20.8
2744.76	49.3	Peak	150	1.5	v	29.0	3.7	30.0	52.0	74	-22.0
2744.76	48.8	Peak	210	1.5	h	29.0	3.7	30.0	51.5	74	-22.5
High Channel											
927.59	121.3	FUND.	0	1.5	v	24.7	4.4	25.0	125.4		
927.59	121.1	FUND.	0	1.5	h	24.7	4.4	25.0	125.2		
948.03	41.4	Peak	110	1.8	v	24.4	3.7	25.0	44.5	46	-1.5
948.03	40.5	Peak	160	1.8	h	24.4	3.7	25.0	43.6	46	-2.4
1855.18	38.1	Avg.	120	1.5	v	25.3	2.6	30.0	36.0	54	-18.0
1855.18	37.8	Avg.	330	1.8	h	25.3	2.6	30.0	35.7	54	-18.3
2782.77	32.3	Avg.	180	1.5	v	29.0	3.7	30.0	35.0	54	-19.0
2782.77	31.9	Avg.	230	1.5	h	29.0	3.7	30.0	34.6	54	-19.4
1855.18	55.8	Peak	120	1.5	v	25.3	2.6	30.0	53.7	74	-20.3
1855.18	55.6	Peak	330	1.8	h	25.3	2.6	30.0	53.5	74	-20.5
2782.77	49.6	Peak	180	1.5	v	29.0	3.7	30.0	52.3	74	-21.7
2782.77	49.2	Peak	230	1.5	h	29.0	3.7	30.0	51.9	74	-22.1

Indicated			Table	Antenna		Correction Factor			FCC 15 Subpart B	
Frequency	Ampl.	Direction	Height	Polar	Antenna	Cable Loss	Amp.	Corr. Ampl.	Limit	Margin
MHz	dBµV/m	Degree	Meter	H/V	dBµV/m	dBµV/m	dB	dBµV/m	dBµV/m	dB
311.74	50.6	45	1.5	v	15.9	3.7	25.0	45.2	46	-0.8
307.22	50.1	270	1.5	v	15.1	4.6	25.0	44.8	46	-1.2
407.61	49.9	270	1.8	v	16.5	2.9	25.0	44.3	46	-1.7
114.20	52.4	180	1.5	v	11.7	1.3	25.0	40.4	43.5	-3.1
299.75	47.9	225	1.8	h	14.9	5.1	25.0	42.9	46	-3.1
230.48	53.1	270	1.5	v	12.0	1.2	25.0	41.3	46	-4.7
898.62	38.1	45	1.5	h	24.8	2.7	25.0	40.6	46	-5.4
245.76	39.4	60	1.5	v	12.6	2.3	25.0	29.3	46	-16.7

Note:

AVG = average
Fund = fundamental