

FCC ID: QRM-WEX-10-EXT

Exhibit 2b

Engineering Report on

Radiated Spurious Emissions (2.1053)



Assessment of Compliance

for

Measurement of Field Strength of Spurious Radiation in accordance
with the FCC Rules & Regulations Part 2.1053 and 22

WaveCell Neptune CDPD Modem
Neptune WEX-10 CDPD Modem
WaveCell International Corp.



January 2003

APREL Project No.: WAMB-NEPTUNE-WEX10-3957

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Engineering Report

Subject: Measurement of Field Strength of Spurious
Radiation in accordance with the
FCC Rules & Regulations Part 2.1053 and 22

FCC ID: QRM-WEX-10-EXT

Equipment: WaveCell Neptune CDPD Modem

Model: Neptune Wex-10 CDPD Modem

Client: WaveCell International Corp.
111 Redpath Dr.
Ottawa, Ontario, K2G 6K4
CANADA

Project #: WAMB-NEPTUNE WEX10-3957

Prepared By: APREL Laboratories,
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51 Spectrum Way
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Approved by: J. Sarkar Date: Jan 16, 2003
Jay Sarkar,
Technical Director, Standards & Certification

Submitted by: J. Sarkar Date: Jan 16, 2003
Jay Sarkar,
Technical Director, Standards & Certification

Released by: J. Wojcik Date: Jan 16/03.
Dr. J.J. Wojcik, P.Eng.



FCC ID: QRM-WEX-10-EXT
Applicant: WaveCell International Corp.
Equipment: WaveCell Neptune CDPD Modem
Model: **Neptune Wex-10 CDPD Modem**
Standard: FCC Rules and Regulations Part 2.1053 and 22.917(e)

ENGINEERING SUMMARY

This report contains the results of Field Strength of Spurious Radiation measurement performed on a WaveCell, for model **Neptune Wex-10 CDPD Wireless Modem** with a **Smarteq wireless AB Minimag Dual Band 800/1900 MHz - 0 dBd antenna**. The measurement was carried out in accordance with the FCC Rules and Regulations Part 2.1053 and 22.917(e) using 1) Direct Method and 2) Substitution Method, both as radiated.

Neptune Wex-10 CDPD Mode was tested at high, middle and low channel frequencies.

Test Configuration: The test was performed with the antenna connected to the modem by 2.6 m long RG174 cable provided with and permanently attached to the antenna. The antenna was mounted on a ground plane that was placed on the table with the modem positioned under the ground plane, simulating the same conditions when the antenna is mounted on the car roof or a flat ground plane at least 10 cm away from any uneven surface.

The results presented in this report relate only to the sample tested.

Table one
Summary of the Results

Test Description	Page No.	Test Set-up Figure No.	Pass/Fail
Field Strength of Spurious Radiation Ref. Paragraph 2.1053 and 90	8	1	Passed

INTRODUCTION

General

This report describes the results of the Field Strength of Spurious Radiation measurement conducted on a WaveCell , model **Neptune Wex-10 CDPD Modem**

Test Facility

The tests were performed for WaveCell International Corp. by APREL Laboratories at APREL's EMI facility located in Nepean, Ontario, Canada. The laboratory operates an (3m and 10m) Open Area Test Site (OATS). The measurement facility is calibrated in accordance with ANSI C63.4-1992.

A description of the measurement facility in accordance with the radiated and AC line conducted test site criteria per ANSI C63.4-1992 is on file with the Federal Communications Commission and is in compliance with the requirements of Section 2.948 of the Commissions rules and regulations. **APREL's registration number is 90416.**

APREL is accredited by Standard Council of Canada. APREL is also accredited by Industry Canada.

Standard

The evaluation and analysis were conducted in accordance with FCC Rules and Regulations Parts 2.1053 and the appropriate limits.

Personnel: The equipment was tested by Roman Kuleba, RF-EMC Engineer. The methodology developed and the report was written by Jayanta (Jay) K. Sarkar, Technical Director, Standards and Certification.

Test Equipment

The test equipment used during the evaluation is listed in Appendix A with calibration due dates.

Environmental Conditions

Measurements were conducted in open area test site. Temperature: $20^{\circ}\text{C} \pm 2$,
Relative Humidity: 30 - 50 % , Air Pressure: $101 \text{ kPa} \pm 3$.

FCC SUBMISSION INFORMATION

FCC ID: **QRM-WEX-10-EXT**

Equipment type: **WaveCell Neptune CDPD Modem**

Model: **Neptune Wex-10 CDPD Modem**

For: Certification

Applicant: **WaveCell International Corp.**
111 Redpath Dr.
Ottawa, Ontario, K2G 6K4
CANADA

Manufacturer: **WaveCell International Corp.**
111 Redpath Dr.
Ottawa, Ontario, K2G 6K4
CANADA

Evaluated by: **APREL Laboratories**
51 Spectrum Way
Nepean, Ontario
Canada K2R 1E6

MANUFACTURER'S DATA

FCC ID: QRM-WEX-10-EXT

Equipment Type: WaveCell Neptune CDPD Modem

Model: Neptune Wex-10 CDPD Modem

Reference: FCC Rules and Regulations Parts 2 and Part 22

Manufacturer: WaveCell International Corp.

Development Stage of Unit: Production

GENERAL SPECIFICATIONS

1. Frequency Range: 824-849 MHz (Transmitter)
2. Measured ERP: 0.458 W (26.61 dBm)
3. Emission Designators Per 47 CFR § 2.201 and §2.202 28K8FXW
4. Antenna Impedance: 50 Ohms

Measurement: Field Strength of Spurious Emissions

DUI: WaveCell Neptune CDPD Wireless Modem

Frequency Band: 824-849 MHz

Ref: FCC Parts 2.1046 and 22.917 (e)

Criteria: Emission :
The permitted maximum level of spurious emission is $43 + 10 \log (P)$ dB below the unmodulated carrier power of the transmitter (P). This was calculated to be 84.6 dBμV/m at 3 meters.

Set-up: See Figure 1.a

Equipment: See Appendix A.

Procedure: **A. Direct Method as Radiated (See Section B for Substitution Method).**

The final measurements were taken at APREL Laboratory's open area test site (OATS) measurement facility. This open area test site is calibrated to ANSI C63.4 document and a description of the measurement facility is on file with the Federal Communications Commission and is in compliance with the requirements of Section 2.948 of the Commissions rules and regulations.
(FCC Registration No.:90416).

The **DUI** was configured to operate at maximum power with appropriate modulation. Special software was employed in order that the transmitter was processing data in a normal manner.

Prior to final measurement in the OATS, preliminary radiated spurious emissions were scanned in a shielded enclosure at a distance of 1 m using biconical, log-periodic and horn antennas in order to determine the characteristic frequencies of the field strength of spurious emissions. Based on this information, measurements were performed in the OATS at these characteristic frequencies using calibrated antennas

All field strength measurements were made with a spectrum analyser and the appropriate calibrated antenna for the frequency range from 9 kHz up to 10th harmonics of the transmit frequency (see equipment list for the calibrated antenna used).

Test configuration: **DUI** was tested as a stand-alone unit.

The **DUI** was placed on a turntable positioned 3 meters away from the calibrated receiving antenna, which in turn was connected to the spectrum analyzer. For each identified frequency, the received signal was maximised by the positioning of the turntable and the height of the antenna. The process was repeated for both horizontal and vertical polarisation.

Information submitted includes the relative radiated power of each spurious emissions with reference to the calculated 84.6 dBμV/m limit per 22.917(e), assuming all emissions are radiated from half-wave dipole antenna.

Measurements given in the spurious emissions test result tables contain: analyzer reading, correction factor, and final reading. The final field strength level are derived from the analyzer measurement and the correction factor (antenna factor and cable loss) as shown in the following example:

Sample Calculation

A. Spectrum analyzer reading

at 1672.98 MHz a spurious level of 25.8 dBμV @ 3 meters is measured.

B. Correction factor (antenna factor and cable loss)

Cable loss: 2.5 dB

Antenna Factor: 27.3 dB

Total Correction Factor: $2.5 + 27.3 = 29.8$ dB/m

C. Final reading (Field Strength of spurious emission):

$C = A + B$

$C = 25.8 \text{ dB}\mu\text{V} + 29.8 \text{ dB}$

$C = 55.6 \text{ dB}\mu\text{V/m @ 3 meters}$

D. The criteria level.

The field intensity, which would be produced by the transmitter carrier operating into a half-wave dipole antenna (gain of 1.64), at a distance of 3 m, was calculated using the following formula:

$$\text{Field Strength of unmodulated carrier (dB}\mu\text{V/m)} = 10 \log_{10} (\text{PtG}/4\pi r^2) + 146 \text{ dB}$$

Pt is transmitter carrier power, unmodulated

G is gain, 1.64

R is distance, 3 meters

Criteria (reference) level at 3 meters from 0.427 Watt (ERP) into half-wave dipole antenna is 84.6 dB μ V/m.

E = Margin (spurious emission below the reference level)

$$E = D - C$$

$$E = 84.6 \text{ dB}\mu\text{V/m} - 55.6 \text{ dB}\mu\text{V/m}$$

$$E = 29.0 \text{ dB}\mu\text{V/m}$$

Results: **Passed** . **See Table 1**

B: Substitution Method (Radiated)

The DUI was also tested for spurious radiated emissions using the substitution method with a procedure similar to that used in the ERP measurement and described in the ERP measurement portion of the Test Report.

A set of three reference dipoles, a horn antenna and a signal generator to duplicate the signal were used. Signals radiated from the DUI on the fundamental frequency as well as second and third harmonic were evaluated by comparing to the signals transmitted from the reference dipoles. For testing the higher frequencies, fourth to 8th harmonics, a calibrated horn antenna with known gain was used as a replacement source of radiation thus substituting the Neptune WEX-10 CDPD Modem. The duplicated reading (taken in dBm) was then referenced to the dipole.

Criteria: The criteria level using substitution method was calculated to be –13 dBm in the frequency band 824-849 MHz.

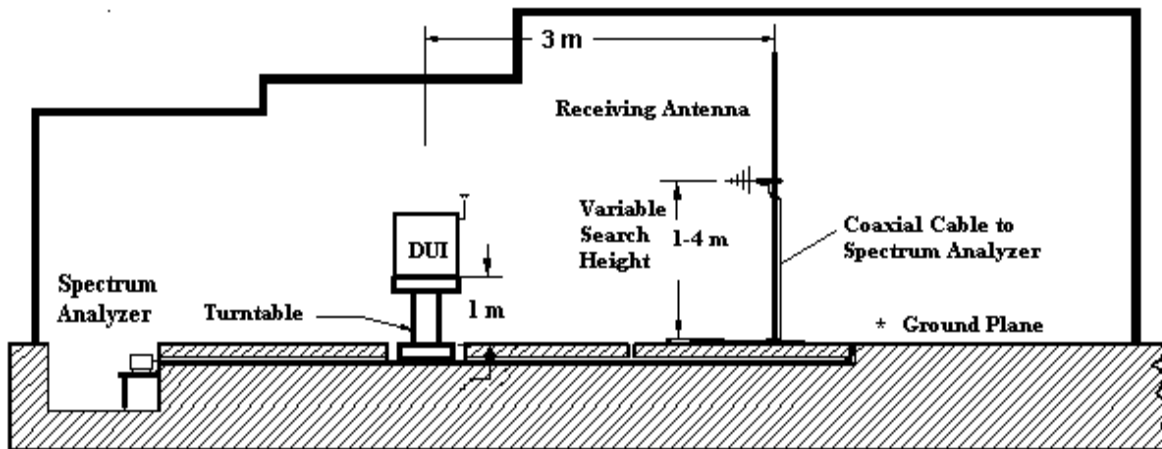
This level was obtained by using the following expression:

$$\text{Criteria}_{\text{Limit (dBm)}} = \text{ERP}_{\text{Carrier (dBm)}} - [45 + 10 \cdot \log_{10} \text{ERP}_{\text{(W)}}]$$

Example:

$$\text{Criteria}_{\text{Limit(dBm)}} = 31.9 \text{ dBm} - [45 + 10 \cdot \log_{10}(1.556 \text{ W})]$$
$$\text{Criteria}_{\text{Limit(dBm)}} = 31.9 \text{ dBm} - (45 + 1.9) \text{ dB} = -13.0 \text{ dBm}$$

Results: **Passed** . **See Tables 2 to 7 for direct method**
 See Tables 8 to 13 for substitution method



**Figure 1.a Test set up for the Field Strength of Spurious Radiation Measurement in OATS
(Not to scale)**



Fig. 1.b APREL's OATS (Open Area Test Site)

MEASUREMENT DATA

Table 2
WaveCell Neptune Wex-10 CDPD Modem
Field Strength of Spurious Emissions
Fundamental frequency: 824.04 MHz, Ch.: Low
Direct Method
Antenna Polarisation: Vertical

Harmonic No.	Frequency (MHz)	Measured Level (dB μ V) A	Correction Factor (dB/m) B	Field Strength (dB μ V/m) C	Criteria Level (dB μ V/m) D	Margin (dB) E
Fundamental	824.04	96.02	25.53	121.55	-	-
1	1648.08	18.00	29.67	47.67	84.60	36.93
2	2472.12	16.00 noise floor	31.93	47.93	84.60	36.67
3	3296.16	15.20 noise floor	34.78	49.98	84.60	34.62
4	4120.20	14.40 noise floor	37.96	52.36	84.60	32.24

$$C=A+B, E=D-C$$

Table 3
Antenna Polarisation: Horizontal

Harmonic No.	Frequency (MHz)	Measured Level (dB μ V) A	Correction Factor (dB/m) B	Field Strength (dB μ V/m) C	Criteria Level (dB μ V/m) D	Margin (dB) E
Fundamental	824.04	85.57	25.53	111.10	-	-
1	1648.08	12.50	29.67	42.17	84.60	42.43
2	2472.12	13.90	31.93	45.83	84.60	38.77
3	3296.16	15.50	34.78	50.28	84.60	34.32
4	4120.20	12.40 noise floor	37.96	50.36	84.60	34.24

$$C=A+B, E=D-C$$

MEASUREMENT DATA

Table 4
WaveCell Neptune Wex-10 CDPD Modem
Field Strength of Spurious Emissions
Fundamental frequency: 836.49 MHz, Ch.: Medium
Direct Method
Antenna Polarisation: Vertical

Harmonic No.	Frequency (MHz)	Measured Level (dB μ V) A	Correction Factor (dB/m) B	Field Strength (dB μ V/m) C	Criteria Level (dB μ V/m) D	Margin (dB) E
Fundamental	836.49	97.30	26.63	123.93	-	-
1	1672.98	25.80	29.81	55.61	84.60	28.99
2	2509.47	16.20	32.03	48.23	84.60	36.37
3	3345.96	15.00	34.95	49.95	84.60	34.65
4	4182.45	14.10	37.87	51.97	84.60	32.63

$$C=A+B, E=D-C$$

Table 5
Antenna Polarisation: Horizontal

Harmonic No.	Frequency (MHz)	Measured Level (dB μ V) A	Correction Factor (dB/m) B	Field Strength (dB μ V/m) C	Criteria Level (dB μ V/m) D	Margin (dB) E
Fundamental	836.49	84.00	26.63	110.63	-	-
1	1672.98	12.20	29.81	42.01	84.60	42.59
2	2509.47	11.50 noise floor	32.03	43.53	84.60	41.07
3	3345.96	14.20 noise floor	34.95	49.15	84.60	35.45
4	4182.45	12.30 noise floor	37.87	50.17	84.60	34.43

$$C=A+B, E=D-C$$

MEASUREMENT DATA

Table 6
Field Strength of Spurious Emissions
Fundamental frequency: 848.97 MHz, Ch.: High
Direct Method
Antenna Polarization: Vertical

Harmonic No.	Frequency (MHz)	Measured Level (dB μ V) A	Correction Factor (dB/m) B	Field Strength (dB μ V/m) C	Criteria Level (dB μ V/m) D	Margin (dB) E
Fundamental	848.97	96.60	25.73	122.33	-	-
1	1697.94	23.10	29.94	53.04	84.60	31.56
2	2546.91	15.50 noise floor	32.16	47.66	84.60	36.94
3	3395.88	15.20 noise floor	35.13	50.33	84.60	34.27
4	4244.85	14.00 noise floor	37.77	51.77	84.60	32.83

$$C=A+B, E=D-C$$

Table 7
Antenna Polarization: Horizontal

Harmonic No.	Frequency (MHz)	Measured Level (dB μ V) A	Correction Factor (dB/m) B	Field Strength (dB μ V/m) C	Criteria Level (dB μ V/m) D	Margin (dB) E
Fundamental	848.97	84.30	25.73	110.03	-	-
1	1697.94	11.00 noise floor	29.94	40.94	84.60	43.66
2	2546.91	13.00	32.16	45.16	84.60	39.44
3	3395.88	13.30 noise floor	35.13	48.43	84.60	36.17
4	4244.85	12.30 noise floor	37.77	50.07	84.60	34.53

$$C=A+B, E=D-C$$

MEASUREMENT DATA

Table 8
WaveCell Neptune WEX-10 CDPD Modem
Field Strength of Spurious Emissions
Fundamental frequency: 824.04 MHz, Ch. Low
Substitution Method as Radiated
Antenna Polarisation: Vertical

Harmonic No.	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Margin (dB)
Fundamenta l	824.04	26.00	-	-
1	1648.08	-49.72	-13.00	36.72
2	2472.12	-49.85 noise floor	-13.00	36.85
3	3296.16	-48.40 noise floor	-13.00	35.40
4	4120.20	-47.22 noise floor	-13.00	34.22

$$C=A+B, E=D-C$$

Table 9
Antenna Polarisation: Horizontal

Harmonic No.	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Margin (dB)
Fundamenta l	824.04	13.71	-	-
1	1648.08	-55.21	-13.00	42.21
2	2472.12	-51.85 noise floor	-13.00	38.85
3	3296.16	-48.00 noise floor	-13.00	35.00
4	4120.20	-49.12 noise floor	-13.00	36.12

$$C=A+B, E=D-C$$

MEASUREMENT DATA

Table 10
WaveCell Neptune WEX-10 CDPD Modem
Field Strength of Spurious Emissions
Fundamental frequency: 836.49 MHz, Ch. Medium
Substitution Method as Radiated
Antenna Polarisation: Vertical

Harmonic No.	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Margin (dB)
Fundamenta I	836.49	25.60	-	-
1	1672.98	-41.78	-13.00	28.78
2	2509.47	-49.67 noise floor	-13.00	36.67
3	3345.96	-48.63 noise floor	-13.00	35.63
4	4182.45	-47.41 noise floor	-13.00	34.41

$$C=A+B, E=D-C$$

Table 11
Antenna Polarisation: Horizontal

Harmonic No.	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Margin (dB)
Fundamenta I	836.49	13.24	-	-
1	1672.98	-55.47	-13.00	42.47
2	2509.47	-54.45 noise floor	-13.00	41.45
3	3345.96	-49.53 noise floor	-13.00	36.53
4	4182.45	-49.31 noise floor	-13.00	36.31

$$C=A+B, E=D-C$$

MEASUREMENT DATA

Table 12
WaveCell Neptune WEX-10 CDPD Modem
Field Strength of Spurious Emissions
Fundamental frequency: 848.97 MHz, Ch. High
Substitution Method as Radiated
Antenna Polarisation: Vertical

Harmonic No.	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Margin (dB)
Fundamenta l	848.97	26.60	-	-
1	1697.94	-44.35	-13.00	31.35
2	2546.91	-50.33 noise floor	-13.00	37.33
3	3395.88	-48.15 noise floor	-13.00	35.15
4	4244.85	-47.41 noise floor	-13.00	34.41

$$C=A+B, E=D-C$$

Table 13
Antenna Polarisation: Horizontal

Harmonic No.	Frequency (MHz)	ERP (dBm)	Limit (dBm)	Margin (dB)
Fundamenta l	848.97	12.64	-	-
1	1697.94	-56.51	-13.00	43.51
2	2546.91	-52.83 noise floor	-13.00	39.83
3	3395.88	-50.10	-13.00	37.10
4	4244.85	-49.21 noise floor	-13.00	36.21

$$C=A+B, E=D-C$$

Test performed by: Kulcha Poonan Date: January 2003

APPENDIX A

List of Test Equipment

Table 14
Radiated Spurious Emissions
List of Equipment

Description	Range	Manufacturer	Model #	APREL Asset #	Cal. Due Date
Spectrum Analyzer	9 kHz - 3 GHz	Anritsu	MS2661C	301330	Sept. 11, 2003
Spectrum Analyzer	9 kHz - 30 GHz	Anritsu	MS2667C	301386	September 5, 2003
RF Signal Generator	10 MHz – 26.5 GHz	Hewlett Packard	HP 8340 B	100955	October 5, 2003
Low Noise Antenna Pre-amplifier	30-1000 MHz	APREL Inc.	LNA-1	301415	August 27, 2003
Attenuator	20 dB	NARDA	9779-20	301533	August 15, 2003
High Pass Filter	3 GHz	--	KPMC 03570	301560	August 15, 2003
RF Power Meter	10 MHz - 18 GHz	Hewlett Packard	438A	301417	September 5, 2003
RF Power Sensor	10 MHz - 18 GHz	Hewlett Packard	8481A	100999	September 5, 2003
Biconical Antenna	20 MHz - 200 MHz	Eaton	94455-1	100890	July 18, 2003
Log - Periodic Antenna	200 MHz -1.0 GHz	Eaton	ALP-1	100063	July 31, 2003
Horn Antenna	1 – 18 GHz	APREL Inc.	AA – 118	100400	June 17, 2003
Anechoic Shielded Room	10 kHz - 10 GHz	APREL Inc.	–	301329	N/A
Reference Half -wave Dipole Antenna	815.00 MHz	APREL Inc.	–	301482	July 3, 2003
Reference Half -wave Dipole Antenna	1630.00 MHz	APREL Inc.	–	301549	July 3, 2003
Reference Half -wave Dipole Antenna	2500.00 MHz	APREL Inc.	–	301550	July 3, 2003
OATS	30 MHz – 1 GHz	APREL Inc.	3 m & 10 m	N/A	FCC: April 4, 2003 IC: Sept. 18, 2005
Mast with the Controller	1 m – 4 m	EMCO	1051 – 12	100507	N/A
Turntable with the Controller	0° - 360°	EMCO	1060 – 1.241	100506	N/A

APPENDIX B

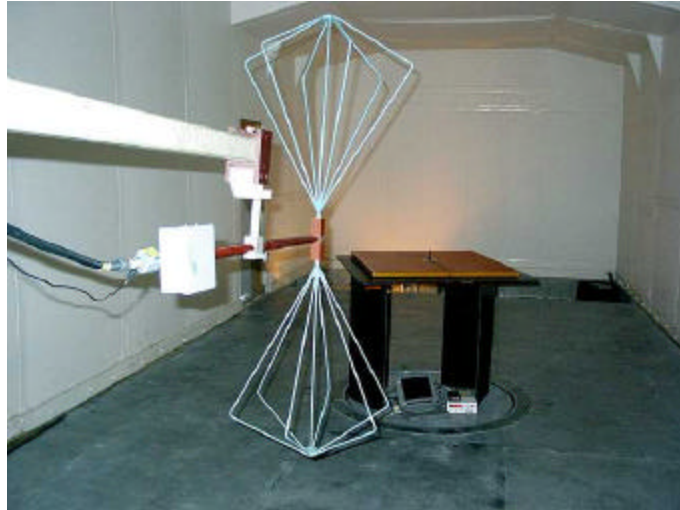
PHOTOGRAPHS



WaveCell Neptune WEX-10 CDPD Modem



**WaveCell Neptune WEX-10 CDPD Modem
Testing for Spurious Emissions from Transmitter
Close View**



**WaveCell Neptune WEX-10 CDPD Modem
Testing for Spurious Emissions from Transmitter
Frequency Range: 30 MHz – 200 MHz**



**WaveCell Neptune WEX-10 CDPD Modem
Testing for Spurious Emissions from Transmitter
Frequency Range: 200 MHz – 1 GHz**



**WaveCell Neptune WEX-10 CDPD Modem
tested for Spurious Emissions from Transmitter
Frequency Range: 1 GHz – 18 GHz**