Nemko Test Report:	1L0617RUS1rev3
Applicant:	Navini Networks 2240 Campbell Creek Blvd. Suite 110 Richardson, TX 75082
Equipment Under Test: (E.U.T.)	RipWave 2.4 GHz BTS, Release 1
FCC ID:	PL6-ISM-BTS-R1
In Accordance With:	FCC Part 15, Subpart C, 15.247 Direct Sequence Spread Spectrum Transmitters
Tested By:	Nemko Dallas Inc. 802 N. Kealy Lewisville, Texas 75057-3136
Authorized By:	David the
	David Light, Wireless Group Supervisor
Date:	26 June 2002
Total Number of Pages:	28

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EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

Section 1. Summary of Test Results

Manufacturer: Navini Networks

Model No.: RipWave 2.4 GHz BTS, Release 1

Serial No.: Sample #01

General: All measurements are traceable to national standards.

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.247 for Direct Sequence Spread Spectrum devices. Radiated tests were conducted is accordance with ANSI C63.4-1992. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.

	New Submission		Production Unit
\boxtimes	Class II Permissive Change	\square	Pre-Production Unit

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.

See "Summary of Test Data".

NVLAP LAB CODE: 100426-0

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EQUIPMENT: RipWave 2.4 GHz BTS

PROJECT NO .:

1L0617RUS1rev3

Summary Of Test Data

NAME OF TEST	PARA. NO.	Limit	RESULT
Powerline Conducted Emissions	15.207(a)	48 dBµV	1
Minimum 6 dB Bandwidth	15.247(a)(2)	>500 kHz	Complies
Maximum Peak Power Output	15.247(b)(1)	<1 Watt	Complies
Spurious Emissions	15.247(a)	$20 dP_0/100 kH_z$	Complies
(Antenna Conducted)	13.247(0)	-20 uDC/100k112	Complies
Spurious Emissions (Restricted	15.247(c)	< 74 dBuV/m Peak	Complies
Bands)	13.247(0)	< 54 dBuV/m Avg	complies
Peak Power Spectral Density	15.247(d)	+8 dBm/3kHz	Complies
Processing Gain			2

Footnotes:

¹The equipment under test does not connect to the AC power mains network.

²It is Navini's understanding that measurements to determine the minimum processing gain will not be required subsequent to the Commission's adoption of the Second Report and Order in ET Docket No. 99231.

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

Section 2. Equipment Under Test (E.U.T.)

General Equipment Information

Frequency Band in which TX operates:	902 – 928 MHz
	🔀 2400 – 2483.5 MHz
	5725 – 5850 MHz
Frequency Range of Operation:	2.403 GHz – 2.4775 GHz
User Frequency Adjustment:	Software adjustable by service provider

Changes Made for Permissive Change Filing

The manufacturer is now offering an 8 dBi antenna array with this transmitter.

EQUIPMENT: RipWave 2.4 GHz BTS PROJECT NO.: 1L0617RUS1rev3

Description of Operation and Approval Notes

The EUT is part of a high speed wireless LAN system. Then transmitter uses Direct Sequence Spread Spectrum techniques.

The antenna for this product is mounted on a fixed outdoor structure. The antenna consists of multiple radiating elements fed by multiple tranmitters. The antenna system uses beam-forming techniques to optimize the efficiency and coverage of the system.

The following points were agreed between the manufacturer and the FCC for the approval of this equipment under 15.247 rules.

- 1. The individual transmitters in the system will be subject to the technical requirements set forth in Section 15.247;
- 2. Section 15.31 will not apply;
- 3. The system will be considered "point to point" under Section 15.247(b)(3)(i) and (iii);
- 4. Total antenna gain per transmitter will be computed as the sum of (a) the actual gain of the antenna used, and (b) the beam-forming gain (18dBi) of the system determined by the formula 20log10 N, where N is the number of transmitters in the array; and
- 5. The peak output power for each transmitter will be reduced per Section 15.247(b)(3)(i) based on the total antenna gain, however, a "phase coherence loss" correction factor of 2dB for the 8 transmitter array will be subtracted from this reduction.

Example:

In accordance with the foregoing, the peak output power of each transmitter in the Navini beamforming array will be reduced as follows for the 12 dBi antenna system:

Total antenna gain $(12 + 18)$	30dB
Free gain per 15.247(b)(3)	- 6dB
Gain subject to power reduction	24dB
Power reduction per 15.247(b)(3)(i)	8dB
Correction for coherence loss	-2dB

Total reduction in transmitter power 6dB

This agreement is summarized in correspondence submitted with the application for equipment approval.

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

System Diagram



EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

Section 3. Maximum Peak Output Power

NAME OF TEST: Maximum Peak Output power	PARA. NO.: 15.247(b)(1)
TESTED BY: T. Tidwell	DATE: 4/26/02

Test Results: Complies.

Measurement Data:

Equipment Used: 1016, 1046

Gain (dBi)	Power @ Antenna Port	E.I.R.P. (dBm)			
8	25.3	33.3			
Note-The device was tested at +/- 15% variation with no effect on output power.					

Measurement Uncertainty: +/- 0.7 dB

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

Section 4. RF Exposure

NAME OF TEST: RF Exposure

PARA. NO.: 15.247(b)(4)

TESTED BY: D. Light

DATE: 6/11/2002

Test Results: Complies.

Measurement Data: See next page



EQUIPMENT: RipWave 2.4 GHz BTS PROJECT NO.: 1L0617RUS1rev3

Section 5. Spurious Emissions (radiated)

NAME OF TEST: Restricted Bands

PARA. NO.: 15.247 (c)

TESTED BY: D. Light

DATE: 6/10/2002

Test Results: Complies.

Measurement Data: See attached table.

Duty Cycle Calculation:

Duty Cycle correction factor(dB) = $20 \log (rf_{ON} \text{ in ms}/100 \text{ ms})$

 $20\log(50mS/100mS) = -6 dB$

Measurement Uncertainty: +/- 0.7 dB

Note: During testing, the input to each antenna was verified to be +25.3 dBm at each channel tested.

EQUIPMENT: RipWave 2.4 GHz BTS

PROJECT NO .:

1L0617RUS1rev3

Nem) R	Enc.		{ 0		Dallas Headquarters: 802 N. Kealy Lewisville, TX 75057 Tel: (972) 436-9600 Fax: (972) 436-2667			
				Radia	ted Emissions		()))		
Page <u>1</u> of	<u>2</u>								
Job No.:	1L0617R			Date:	6/19/02				
Specification:	15.205		Temp	perature(°C):	22	-			
Tested By:	David Light		Relative I	Humidity(%)	40				
E.U.T.:			2.4	GHz BTS					
Configuration:	All transmit	ters active, all	antennas a	ictive, 25.3 d	Bm output per	transmitter,8 dl	B1 Maxrad a	antenna	
Sample Number:				-	DDW.	1 MII-			
Detector Type:	Peak	•			VBW-	1 MHz			
Detector Type.	1 Cak				VDW.	1 IVIIIZ			
			<u> Test Equip</u>	oment Used					
Antenna:	1304			Direc	tional Coupler:	#N/A			
Pre-Amp:	1016				Cable #1:	1484			
Filter:	1482				Cable #2:	1485			
Receiver:	1464				Cable #3:	#N/A			
Attenuator #1	#N/A				Cable #4:	#N/A			
Attenuator #2:	#N/A				Mixer:	#N/A			
Measurement Uncertainty:	+/7 dB								
Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Comment	
								Tx at 2.4775 GHz	
								Highest channel	
2.4835	41	28.2	3.1	0.0	72.3	74	-1.7	Peak-Vertical-Bandedge	
2.4835	17	28.2	3.1	0.0	48.3	54	-5.7	Average-Vertical-Bandedge	
4.955	41.5	33.8	4.3	29.6	50.0	54	-4.0	Peak - Vertical - NF	
7.4325	42.7	36.2	5.3	34.1	50.1	54	-3.9	Peak - Vertical - NF	
12.3875	42	39.9	7.3	32.7	56.5	74	-17.5	Peak - Vertical - NF	
12.3875	33.5	39.9	7.3	32.7	48.0	54	-6.0	Average - Vertical - NF	
2.4835	41.2	28.2	3.1	0.0	72.5	74	-1.5	Peak-Horizontal-BE	
2.4835	15.8	28.2	3.1	0.0	47.1	54	-6.9	Average-Horizontal-BE	
4.955	41.5	35.8	4.5	29.6	50.0	54	-4.0	Peak - Horizontal - NF	
12 2975	42.7	30.2	5.5 7.2	34.1 22.7	56.5	54 74	-3.9	Peak - Horizontal - NF	
12.3875	42	39.9	7.3	32.7	30.3 48.0	74 54	-17.5	Average Horizontal NE	
12.30/3	55.5	39.7	1.5	54.1	40.0	54	-0.0	Ty at 2 4425 CH7	
		Mid Channel							
4,8850	43 7	33.8	43	29.6	52.2	54	-1.8	Peak - Vertical - NF	
7,3725	43	36.2	5.3	34.1	50.4	54	-3.6	Peak - Vertical - NF	
4.8850	43.7	33.8	4.3	29.6	52.2	54	-1.8	Peak - Horizontal - NF	
7.3725	43	36.2	5.3	34.1	50.4	54	-3.6	Peak - Horizontal - NF	
						-			
								1	
Notes:	Peak read	ings 1 MHz	RBW / 1	MHz VBW	/ - Average r	eadings 1 MI	z RBW /	10 Hz VBW	
	Average r	eadings incl	ude -6 dE	correction	for TDD mo	dulation			

EQUIPMENT: RipWave 2.4 GHz BTS

PROJECT NO .:

1L0617RUS1rev3



Dallas Headquarters: 802 N. Kealy Lewisville, TX 75057 Tel: (972) 436-9600 Fax: (972) 436-2667

				Radiated S	purious Emiss	<u>sions</u>		
Page <u>1</u> of	<u>2</u>			Continu	ation Page			
Job No.:	1L0617R		Date: 6/19/02					
Specification:	15.205		Tem	perature(°F):	24			
Tested By:	#N/A		Relative l	Humidity(%)	40	_		
E.U.T.:	2.4 GHz BT	S						
Configuration:	All transmit	ters active, all	antennas a	active, 25.3 d	Bm output per	transmitter,8 dI	Bi Maxrad a	intenna
Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Comment
								Tx at 2.4025 GHz
								Lowest channel
4.805	42.8	33.8	4.3	29.6	51.3	54	-2.7	Peak - Vertical - NF
12.0125	44.3	39.9	7.3	32.7	58.8	74	-15.2	Peak - Vertical - NF
12.0125	28.8	39.9	7.3	32.7	43.3	54	-10.7	Average - Vertical - NF
4.805	42.8	33.8	4.3	29.6	51.3	54	-2.7	Peak - Horizontal - NF
12.0125	44.3	39.9	7.3	32.7	58.8	74	-15.2	Peak - Horizontal - NF
12.0125	28.8	39.9	7.3	32.7	43.3	54	-10.7	Average - Horizontal - NF
Notes:	Peak read	ings 1 MHz	RBW / 1	MHz VBW	/ - Average r	eadings 1 MI	Iz RBW /	10 Hz VBW
	Average r	Average readings include -6 dB correction for TDD modulation						

EQUIPMENT: RipWave 2.4 GHz BTS

PROJECT NO .:

1L0617RUS1rev3

Radiated Photographs (Wo

(Worst Case Configuration) 8 dBi Array



EQUIPMENT: RipWave 2.4 GHz BTS

PROJECT NO.: 1

1L0617RUS1rev3

Radiated Photographs (Worst Case Configuration)



EQUIPMENT:RipWave 2.4 GHz BTSPROJECT

PROJECT NO.: 1L0617RUS1rev3

Section 6. Test Equipment List

Nemko ID	Description	Manufacturer	Serial Number	Calibration
		Model Number		Date
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ	830844/006	12/18/01
		FSEK30		
1304	HORN ANTENNA	ELECTRO METRICS	6151	07/30/01
		RGA-60		
1464	Spectrum analyzer	Hewlett Packard	3551A04428	01/02/02
		8563E		
1625	CABLE, 18 ft	BLE, 18 ft MEGAPHASE		10/23/01
		10311 1GVT4		
1046	Flex cable 1m	Astrolab Inc.	N/A	01/18/02
		32022-2-29094K-1M		
1482	Band Pass Filter	K & L	2	Cal B4 Use
		11SH10-4000/T12000-0/0		
1016	Pre-Amp	HEWLETT PACKARD	2749A00159	05/30/01
		8449A		

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

ANNEX A - TEST DETAILS

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

NAME OF TEST: Powerline Conducted Emissions PARA. NO.: 15.207(a)

Minimum Standard:The R.F. that is conducted back onto the AC power line on any
frequency within the band 0.45 to 30 MHz shall not exceed $250\mu V$
(48 dB μV) across 50 ohms.

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

NAME OF TEST: Minimum 6 dB bandwidth PARA. NO.: 15.247(a)(2)

Minimum Standard: The minimum 6 dB bandwidth shall be at least 500 kHz

EQUIPMENT: RipWave 2.4 GHz BTS PROJECT NO.: 1L0617RUS1rev3

NAME OF TEST: Maximum Peak Output Power	PARA. NO.: 15.247(b)(1)
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Minimum Standard:	The maximum peak output power shall not exceed 1 watt.	
	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.	
	Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point to point operation may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceed 6 dBi.	
	Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operation may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.	

Direct Measurement Method For Detachable Antennas:

If the antenna is detachable, a peak power meter is used to measure the power output with the transmitter operating into a 50 ohm load. The dBi gain of the antenna(s) employed shall be reported.

Calculation Of EIRP For Integral Antenna:

If the antenna is not detachable from the circuit then the Peak Power Output is derived from the peak radiated field strength of the fundamental emission by using the plane wave relation GP/4 π R² = E²/120 π and proceeding as follows:

$$P = \frac{E^2 R^2}{30G} = \frac{E^2 3^2}{30G}$$

where,

P = the equivalent isotropic radiated power in watts

E = the maximum measured field strength in V/m

R = the measurement range (3 meters)

G = the numeric gain of the transmit antenna in relation to an isotropic radiator

Nemko Dallas

FCC PART 15, SUBPART C DIRECT SEQUENCE SPREAD SPECTRUM TRANSMITTER

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

The RBW of the spectrum analyzer shall be set to a value greater than the measured 6 dB occupied bandwidth of the E.U.T.

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

NAME OF TEST, DE E-magnetic DADA NO. 15 $247(h)(4)$		
NAME OF TEST: KF Exposure PARA. NO.: 15.24/(b)(4)	NAME OF TEST: RF Exposure	PARA. NO.: 15.247(b)(4)

Minimum Standard: Systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines stipulated in 1.1307(b)(1) of CFR 47.

EQUIPMENT: RipWave 2.4 GHz BTS

PROJECT NO.: 1L061

1L0617RUS1rev3

NAME OF TEST: Spurious Emissions(conducted) PARA. NO.: 15.247(c)

Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits. Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength (µV/m @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM IS SEARCHED TO THE 10th HARMONIC OF THE HIGHEST FREQUENCY GENERATED IN THE EUT.

Method Of Measurement:

<u>30 MHz - 10th harmonic plot</u> RBW: 100 kHz VBW: 300 kHz Sweep: Auto Display line: -20 dBc

Lower Band Edge

RBW: At least 1% of span/div. VBW: >RBW Span: As necessary to display any spurious at band edge. Sweep: Auto Center Frequency: 902 MHz, 2400 MHz, or 5725 MHz Marker: Peak of fundamental emission Marker Δ: Peak of highest spurious level below center frequency.

Upper Band Edge

RBW: At least 1% of span/div. VBW: >RBW Span: As necessary to display any spurious at band edge. Sweep: Auto Center Frequency: 928 MHz, 2483.5 MHz, or 5850 MHz Marker: Peak of fundamental emission Marker Δ: Peak of highest spurious level above center frequency.

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

EQUIPMENT: RipWave 2.4 GHz BTS PROJECT N

PROJECT NO.: 1L0617RUS1rev3

NAME OF TEST: Radiated Spurious Emissions	PARA. NO.: 15.247(c)
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Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits:

Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength (µV/m @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC

15.205 Restricted Bands				
MHz	MHz	MHz	GHz	
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25	
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46	
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75	
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5	
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2	
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5	
6.125-6.218	74.8-75.2	1660-1710	10.6-12.7	
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4	
6.31175-6.31225	123-138	2200-2300	14.47-14.5	
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2	
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4	
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12	
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0	
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8	
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5	
12.57675-12.57725	322-335.4	3600-4400	Above 38.6	
13.36-13.41	1718			

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

EC	UIPMENT:	RipWave 2.4 GHz BTS	PROJECT NO.:	1L0617RUS1rev3
-	On million.		I ROJECT TO::	

NAME OF TEST: Transmitter Power Density		PARA. NO.: 15.247(d)
Minimum Standard:	The transmitted power density aver interval shall not be greater than +8	raged over any 1 second 3 dBm in any 3 kHz bandwidth.
Method Of Measurement:	The spectrum analyzer is set as follows:	
	RBW: 3 kHz VBW: >3 kHz Span: => measured 6 dB bandwidt Sweep: Span(kHz)/3 (i.e. for a spa 1500/3 = 500 sec. LOG dB/div.: 2 dB	th n of 1.5 MHz the sweep rate is
Note:	For devices with spectrum line spa analyzer is reduced until the spectrum measurement data is normalized to of all the individual spectral lines we power units.	cing =< 3 kHz, the RBW of the al lines are resolved. The 3 kHz by summing the power vithin a 3 kHz band in linear

For Devices With Integral Antenna:

For devices with non-detachable antennas, the received field strength is peaked and the spectrum analyzer is set as above. The peak emission level is then measured and converted to a field strength by adding the appropriate antenna factor and cable loss. This field strength is then converted to an equivalent isotropic radiated power using the same method as described for Peak Power output.

Tuning Range	Number Of Channels Tested	Channel Location In Band
1 MHz or Less	1	Middle
1 to 10 MHz	2	Top And Bottom
More Than 10 MHz	3	Top, Middle, Bottom

EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

ANNEX B - TEST DIAGRAMS

EOUIPMENT:	RipWave 2.4 GHz BTS	PROJECT NO.:	1L0617RUS1rev3
DQUILINE		1100201100	12001/1000110/0

Test Site For Radiated Emissions



TO TEST RECEIVER/SPECTRUM ANALYZER. A high-pass filter and LNA is necessary to measure to the limits of 15.209.

Conducted Emissions



EQUIPMENT:RipWave 2.4 GHz BTSPROJECT NO.:1L0617RUS1rev3

Peak Power At Antenna Terminals



Minimum 6 dB Bandwidth Peak Power Spectral Density Spurious Emissions (conducted)

