

Nemko Test Report: 4L0375RUS1rev2

Applicant: Hitachi America

Equipment Under Test: μ-Chip Reader
(E.U.T.)

In Accordance With: **FCC Part 15, Subpart C, 15.247**
Frequency Hopping Transmitters

Tested By: Nemko Dallas Inc.
802 N. Kealy
Lewisville, Texas 75057-3136

Authorized By: Tom Tidwell, Frontline Group Manager

Date: 11/11/04

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Section 1. Summary of Test Results

Manufacturer: Hitachi America

Model No.: MRA201SL

Serial No.: 3

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 Frequency Hopping Spread Spectrum devices. Radiated tests were conducted in accordance with ANSI C63.4-2001. 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



Class II Permissive Change



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. NONE****NVLAP LAB CODE: 100426-0**

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Summary Of Test Data

NAME OF TEST	PARA. NO.	SPEC.	RESULT
Powerline Conducted Emissions	15.207(a)	0.15 -0 .5 MHz 66 to 56 dB μ V Peak 0.15 – 0.5 MHz 56 to 46 dB μ V Avg. 0.5 – 5.0 MHz 56 dB μ V Peak, 46 dB μ V Avg. 5.0 – 30.0 MHz 60 dB μ V Peak, 50 dB μ V Avg.	Complies
Channel Separation	15.247(a)(1)	Greater of 25 kHz or 20 dB Bandwidth	Complies
Time of Occupancy	15.247(a)(1)(ii)	\leq 0.4 sec in 30 sec	Complies
20 dB Occupied Bandwidth	15.247(a)(1)	\leq 1 MHz	Complies
Peak Power Output	15.247(b)	1 Watt	Complies
Spurious Emissions (Conducted))	15.247(c)	-20 dBc	NA
Spurious Emissions (Radiated)	15.247(c)	Table 15.209(a)	Complies

Footnotes:

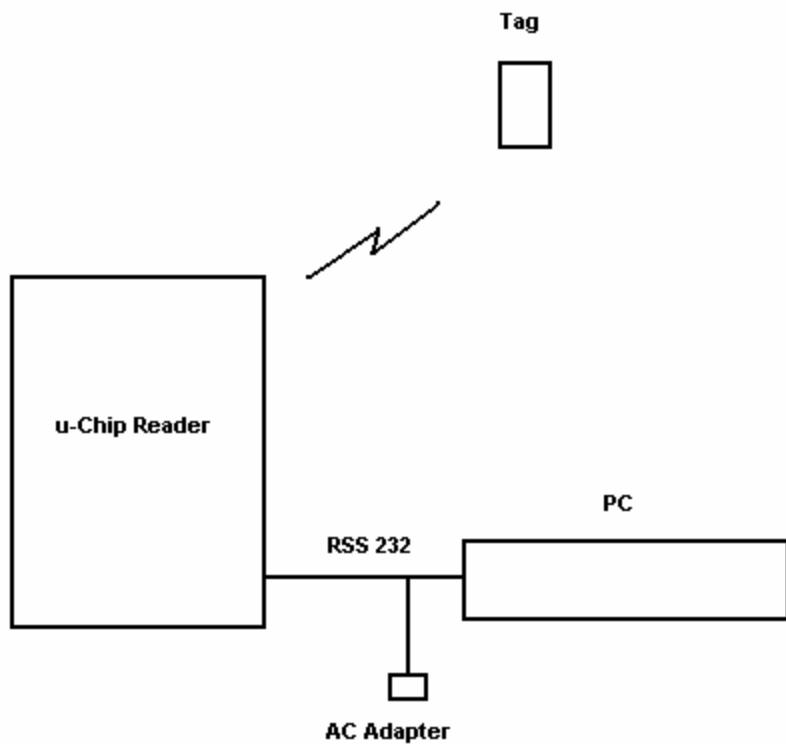
The antenna is permanently attached.

Section 2. Equipment Under Test (E.U.T.)**General Equipment Information****Frequency Band:** 2401 to 2475 MHz**Number of Channels:** 75**Channel Spacing:** 1 MHz**User Frequency Adjustment:** Software controlled

Theory of Operation

The MRA201SL μ -chip reader is an evaluation reader that allows customers considering developing a system using our smallest RFID IC, the " μ -chip," to verify its features and capabilities.

System Diagram



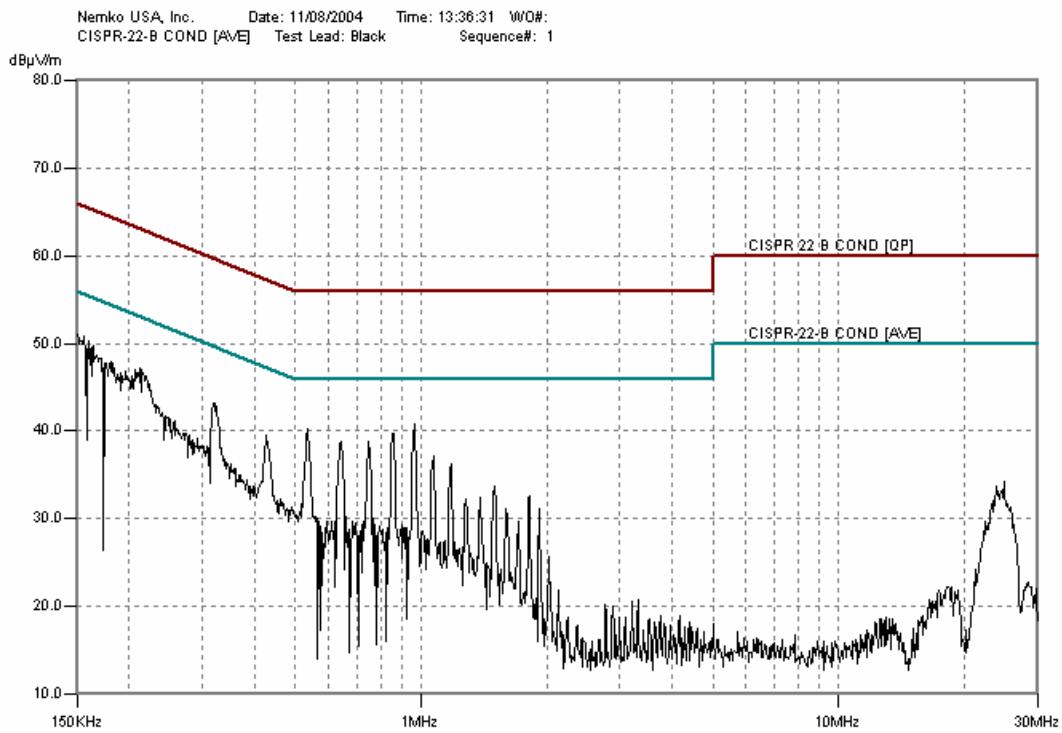
Section 3. Powerline Conducted Emissions

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY: David Light	DATE: 11/8/04

Test Results: Complies.**Measurement Data:** See attached plots.**Equipment Used:** 545-1533-1267-704**Measurement Uncertainty:** +/- 1.7 dB**Temperature:** 25 °C**Relative Humidity:** 50 %

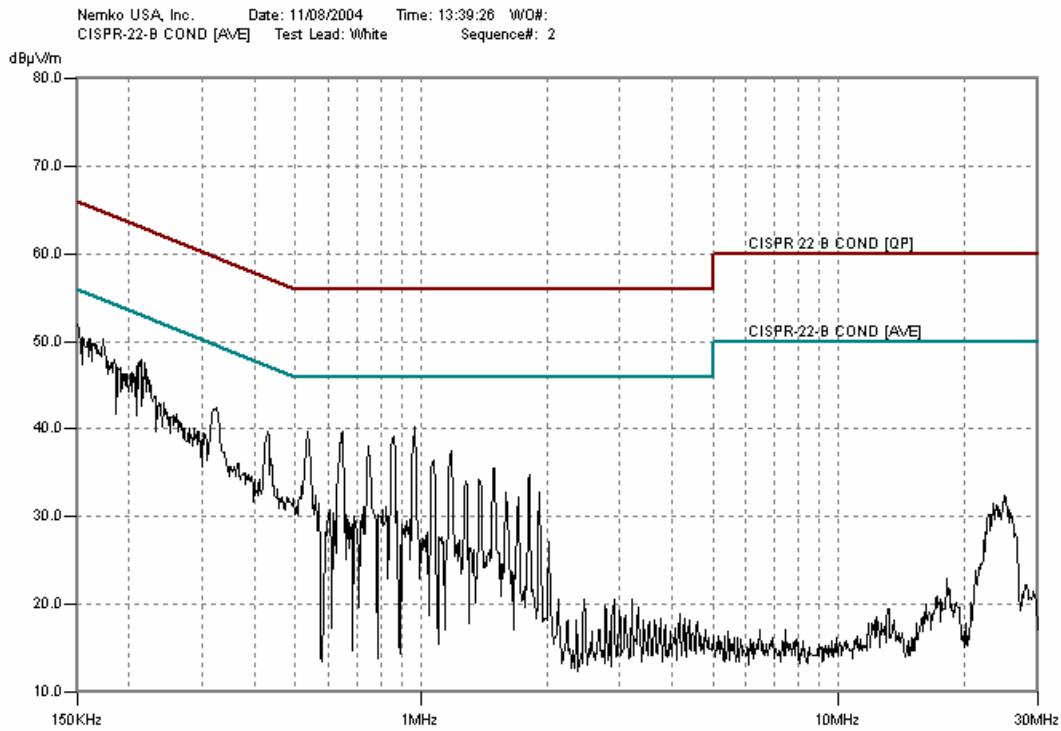
Data – Powerline Conducted Emissions

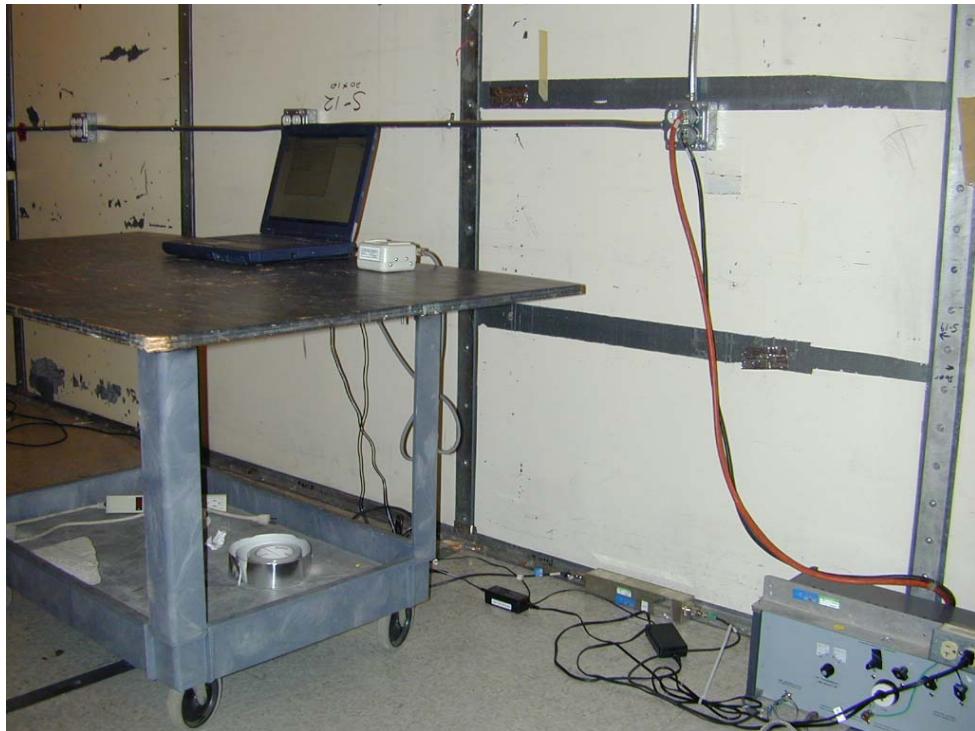
Hot Wire



Data – Powerline Conducted Emissions

Neutral Wire



Test Setup Photos

Section 4. Channel Separation

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 11/8/04

Test Results: Complies.**Measurement Data:** See 20 dB BW plot
Measured 20 dB bandwidth:
Channel Separation:**Measurement Uncertainty:** +/- 1.7 dB**Temperature:** °C**Relative Humidity:** %

Test Data – Channel Separation



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Data Plot		Channel Separation	
Page 1 of 4			
Job No.:	4L0375	Date:	_____
Specification:	15.247	Temperature(°C):	_____
Tested By:	David Light	Relative Humidity(%):	_____
E.U.T.:	U-Chip Reader	_____	
Configuration:	TX - Lying on sie (Worst case emission)		
Sample Number:	1	_____	
Location:	AC 3	RBW:	Refer to plots
Detector Type:	Peak	VBW:	Refer to plots
Test Equipment Used		Measurement	
Antenna:	802	Directional Coupler:	_____
Pre-Amp:	_____	Cable #1:	1045
Filter:	_____	Cable #2:	_____
Receiver:	1464	Cable #3:	_____
Attenuator #1	_____	Cable #4:	_____
Attenuator #2:	_____	Mixer:	_____
Additional equipment used:			
Measurement Uncertainty: +/-1.7 dB			
Notes:	Channel separation 1 MHz		

Test Data – Hopping Channels

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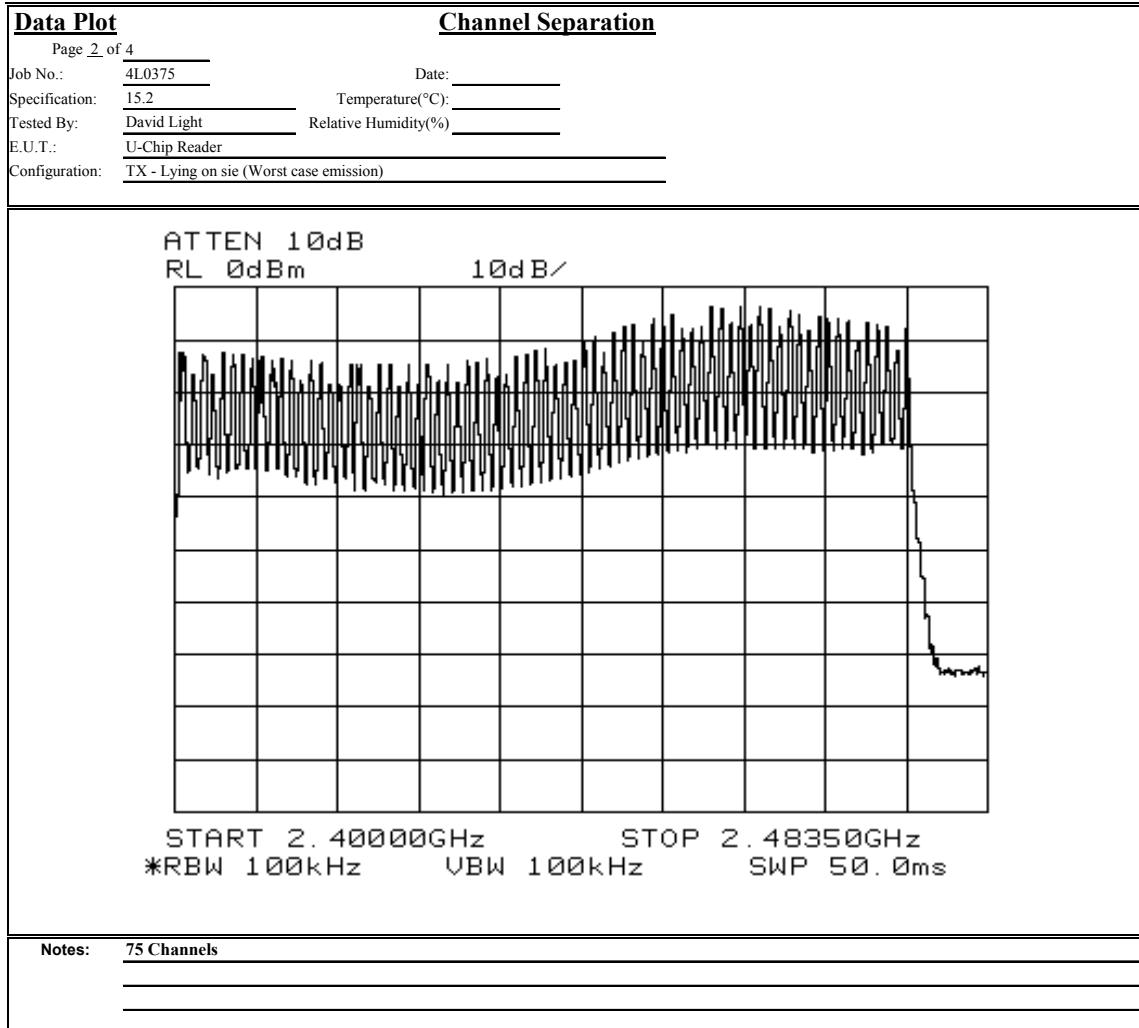
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Section 5. Time of Occupancy

NAME OF TEST: Time of Occupancy	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 11/8/04

Test Results: Complies.**Measurement Data:**
Maximum Dwell Time On Any Channel: 23.66 mS per hop
14 hops in 30 seconds
0.34 seconds within 30 seconds

Test Data – Time of Occupancy



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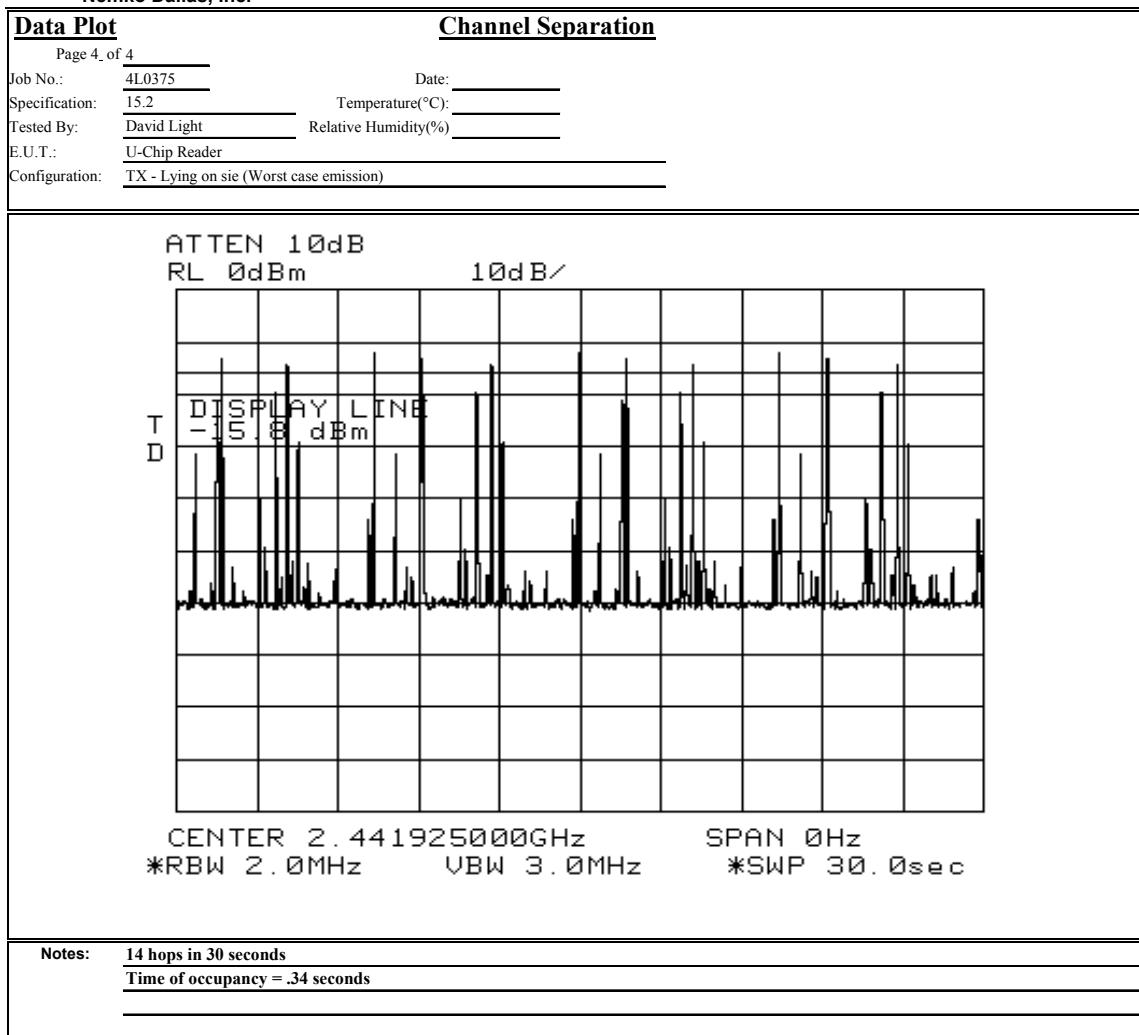
Data Plot		Channel Separation	
Page 3 of 4			
Job No.:	4L0375	Date:	
Specification:	15.2	Temperature(°C):	
Tested By:	David Light	Relative Humidity(%):	
E.U.T.:	U-Chip Reader		
Configuration:	TX - Lying on sie (Worst case emission)		
Notes:	23.66 mS per hop		
<hr/> <hr/> <hr/>			

Test Data – Time of Occupancy



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Section 6. Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(1)(i)
TESTED BY: David Light	DATE: 11/8/04

Test Results: Complies.**Measurement Data:** See attached plots.

Test Data – Occupied Bandwidth



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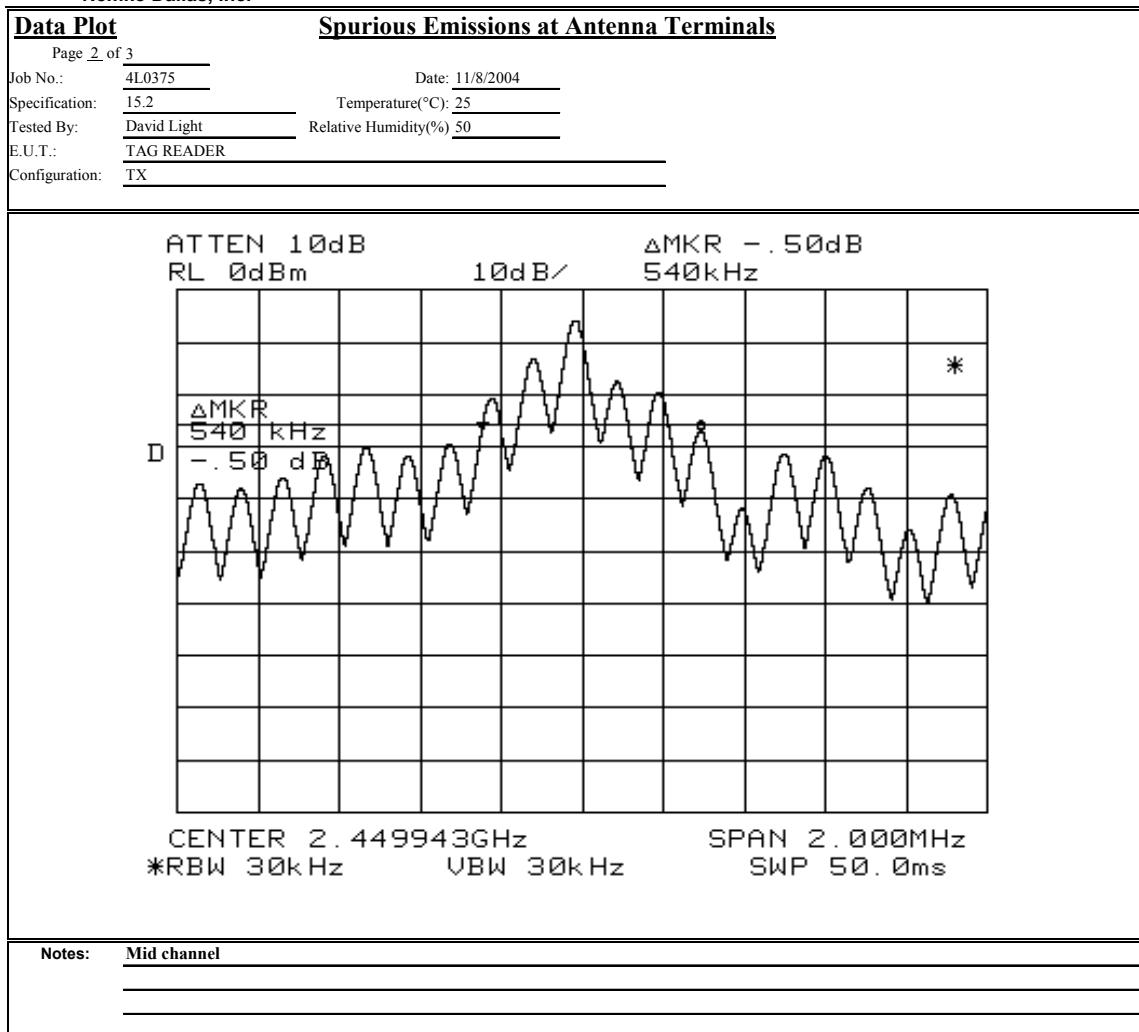
Data Plot		Spurious Emissions at Antenna Terminals	
Page 1 of 3			
Job No.:	4L0375	Date:	11/8/2004
Specification:	15.247	Temperature(°C):	25
Tested By:	David Light	Relative Humidity(%):	50
E.U.T.:	TAG READER		
Configuration:	TX		
Sample Number:	1		
Location:	Lab 2	RBW:	Refer to plots
Detector Type:	Peak	VBW:	Refer to plots
Test Equipment Used		Measurement	
Antenna:	802	Directional Coupler:	
Pre-Amp:		Cable #1:	#N/A
Filter:		Cable #2:	
Receiver:	1036	Cable #3:	
Attenuator #1		Cable #4:	
Attenuator #2:		Mixer:	
Additional equipment used:			
Measurement Uncertainty: +/-1.7 dB			
Notes:	Lowest channel		

Test Data – Occupied Bandwidth



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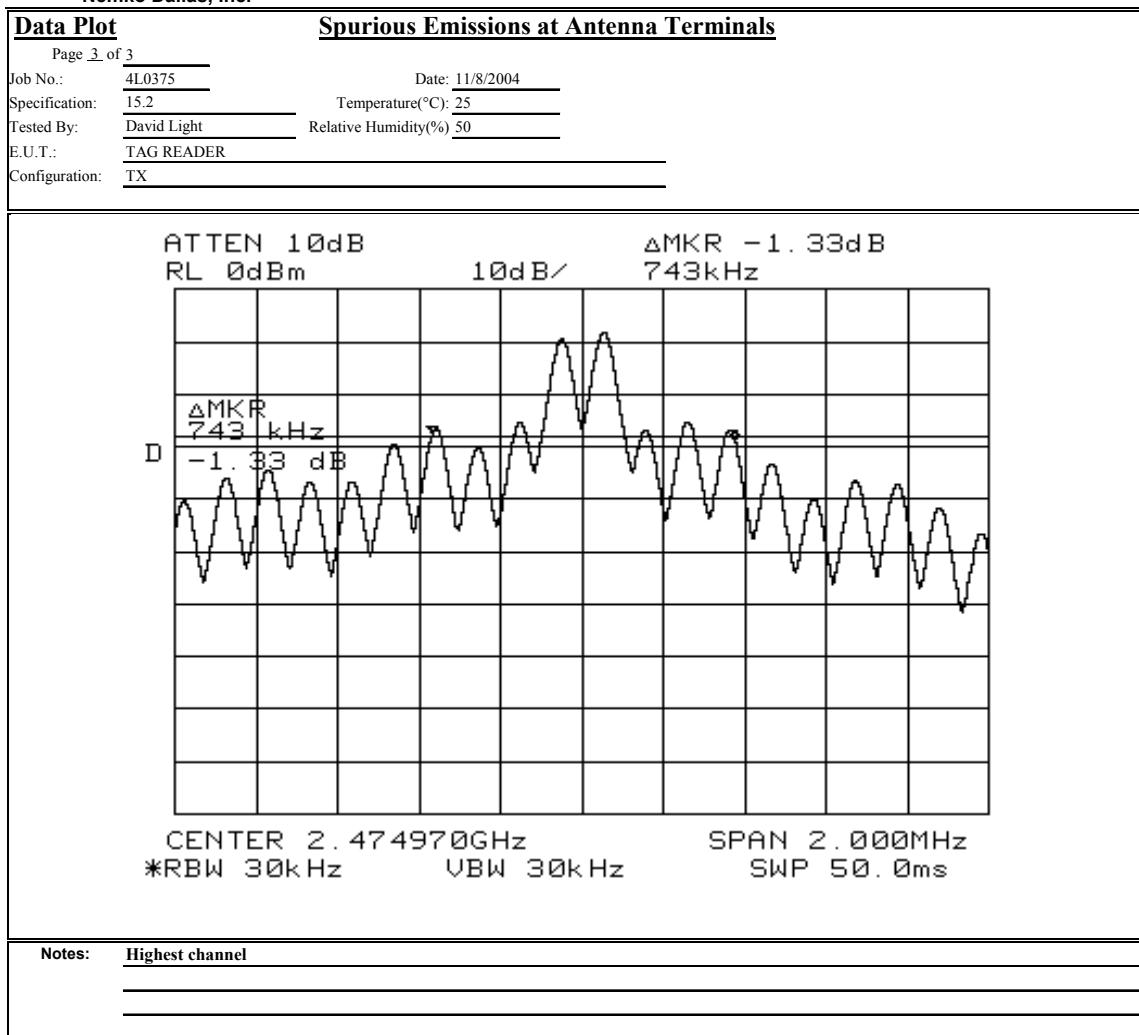


Test Data – Occupied Bandwidth



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Section 7. Peak Power Output

NAME OF TEST: Peak Power Output	PARA. NO.: 15.247 (b)
TESTED BY: David Light	DATE: 11/8/04

Test Results: Complies.**Measurement Data:** See attached data.Detachable antenna? Yes No

If yes, state the type of non-standard connector used:

Max EIRP measure = 530.88mW

Antenna Gain = 6dBi

Conducted power = 133mW

Calculation:

Conducted Power = EIRP - dBi = 27.24996dBm - 6dBi = 21.24996dBm = 133.0509mW

Test Data – E.I.R.P.



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Field Strength of Spurious Emissions										
Page <u>1</u> of <u>1</u>		Date: 11/8/04		Complete <input checked="" type="checkbox"/>		Preliminary <input type="checkbox"/>				
Job No.:	4L0375	Specification:	15.247	Temperature(°C):	25	Measurement		Distance:	3 m	
Tested By:	David Light	Relative Humidity(%):	50	RBW:	1 MHz					
E.U.T.:	TAG READER				VBW:	1 MHz				
Configuration:	TX - LYING ON SIDE (WORST CASE EMISSION)									
Sample No.:	1									
Location:	AC 3									
Detector Type:	Peak									
Test Equipment Used										
Antenna:	1304	Directional Coupler:								
Pre-Amp:		Cable #1:	1484							
Filter:		Cable #2:	1485							
Receiver:	1464	Cable #3:								
Attenuator #1:		Cable #4:								
Attenuator #2:		Mixer:								
Additional equipment used:										
Measurement Uncertainty:	+/-1.7 dB									
Frequency (MHz)	Meter Reading (dBm)	Correction Factor (dB)		Pre-Amp Gain (dB)	Substitution Antenna Gain (dBi)		EIRP (dBm)	EIRP (mW)	Polarity	Comments
2400.96	-15.8	34.1		0	9.0		27.3	530.88	V	
2400.96	-22.0	36.7		0	6.9		21.5	142.232879	H	
2450	-17.5	34.1		0	9.0		25.6	358.921935	V	
2450	-24.3	36.7		0	6.9		19.2	83.752928	H	
2475	-18.0	34.1		0	9.0		25.1	319.89	V	
2475	-26.2	36.7		0	6.9		17.3	54.075432	H	
Notes: Power was varied +/- 15% with no effect on output power The device was tested on 3 axis'										

Section 8. Spurious Emissions

NAME OF TEST: Spurious Emissions	PARA. NO.: 15.247(c)
TESTED BY: David Light	DATE: 11/8/04

Test Results: Complies.

Measurement Data: See attached data.

Note: No emissions were detected above the noise floor. Radiated upper and lower band edge data is provided to demonstrate compliance.

The device was tested at 2401, 2450 and 2475 MHz.

The spectrum was searched from 30 MHz to the 10 harmonic of the carrier.

Test Data – Lower Band Edge



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Data Plot		Spurious Emissions at Antenna Terminals			
Page 1 of 1					
Job No.:	4L0375	Date:	11/8/2004	Complete <input checked="" type="checkbox"/>	
Specification:	15.247	Temperature(°C):	25	Preliminary <input type="checkbox"/>	
Tested By:	David Light	Relative Humidity(%):	50		
E.U.T.:	TAG READER				
Configuration:	TX				
Sample Number:	1				
Location:	AC 3	RBW:	100 kHz	Measurement	
Detector Type:	Peak	VBW:	100 kHz	Distance: 3 m	
Test Equipment Used					
Antenna:	1304	Directional Coupler:			
Pre-Amp:		Cable #1:	1484		
Filter:		Cable #2:	1485		
Receiver:	1464	Cable #3:			
Attenuator #1		Cable #4:			
Attenuator #2:		Mixer:			
Additional equipment used:					
Measurement Uncertainty: +/-1.7 dB					
<p style="text-align: center;">*ATTEN 0 dB RL -10.0 dBm 10 dB/ ΔMKR -27.83 dB </p>					
<p style="text-align: center;">*RBW 100kHz VBW 100kHz SWP 50.0ms</p>					
Notes:	Lowest channel				

Test Data – Upper Band Edge**Nemko Dallas, Inc.****Dallas Headquarters:**

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Radiated Spurious Emissions								
Page <u>3</u> of <u>3</u>		Continuation Page						
Job No.:	4L0375	Date: 11/8/2004						
Specification:	15.247	Temperature(°C): 25						
Tested By:	#N/A	Relative Humidity(%) 50						
E.U.T.:	RFID READER							
Configuration:	TX							
Frequency (MHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Comment
								2475 MHz
2483.50	32.2	28.2	3.1	0	63.5	74	-10.5	Peak - V
2483.50	20	28.2	3.1	0	51.3	54	-2.7	Average - V
2483.50	32.2	28.2	3.1	0	63.5	74	-10.5	Peak - H
2483.50	20	28.2	3.1	0	51.3	54	-2.7	Average - H
Notes:	-12.2 dB Duty cycle correction included in average readings.							

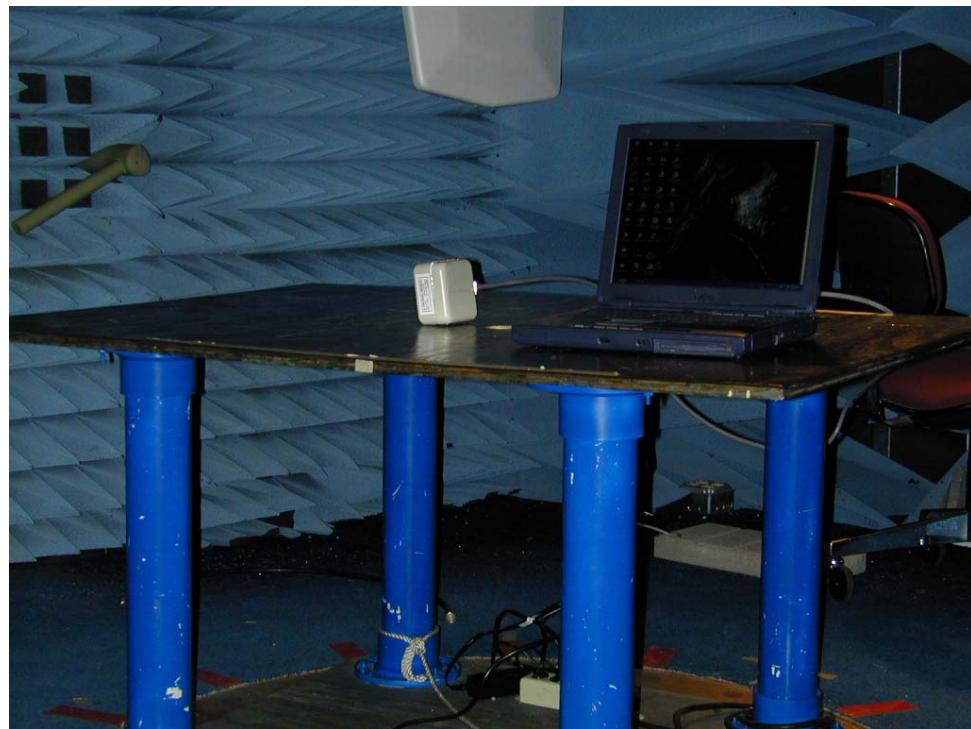
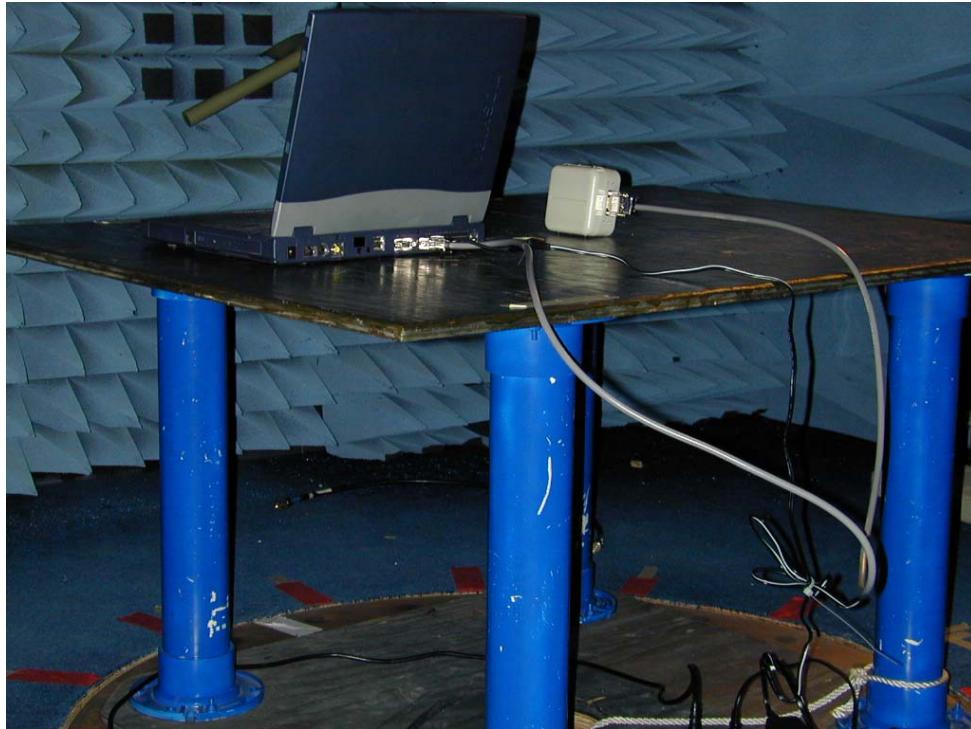
Setup:

30 MHz-1 GHz 100 kHz RBW/100 kHz VBW

>1 GHz 1 MHz RBW, 1 MHz VBW Peak

> 1 GHz 1 MHz RBW/1 MHz VBW Average +Duty Cycle Correction

Test Setup Photos



Section 9. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	07/30/04	07/31/06
1484	Cable 2.0-18.0 Ghz	Storm PR90-010-072	N/A	08/26/04	08/26/05
1485	Cable 2.0-18.0 Ghz	Storm PR90-010-216	N/A	08/02/04	08/02/05
1304	HORN ANTENNA	ELECTRO METRICS RGA-60	6151	09/22/03	09/22/05
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	06/06/04	06/06/05
802	Near Field Probe Set	EMCO 7405	103	N/A	N/A
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	03/22/04	03/23/06
1045	CABLE 2m	Astrolab Inc. 32027-2-29094-72TC	N/A	08/26/04	08/26/05
759	ANTENNA, LOG PERIODIC	A.H. SYSTEMS SAS-200/510	556	07/23/04	07/23/05
1479	Bi Conical Antenna 20-330 Mhz	A. H. Systems SAS-200/540	496	07/02/03	07/01/04
1983	CABLE	KTL Site A OATS	N/A	03/11/04	03/11/05
791	PREAMP, 25dB	ICC LNA25	398	10/27/03	10/26/04
545	LISN	Schwarz Beck 8120	8120350	09/17/04	09/17/05
704	FILTER, HIGH PASS, 5 KHz	SOLAR 7930-5.0	933126	02/05/04	02/04/05
1267	CABLE, 14.8m	KTL RG223	N/A	07/27/04	07/27/05

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FCC PART 15, SUBPART C

FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: *μ-Chip Reader*

Test Report No.: 4L0375RUS1rev1

ANNEX A - TEST DETAILS

Nemko Dallas

FCC PART 15, SUBPART C

FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: *μ-Chip Reader*

Test Report No.: 4L0375RUS1rev1

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 μ V (48 dB μ V) across 50 ohms.

Nemko Dallas

FCC PART 15, SUBPART C

FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: *μ-Chip Reader*

Test Report No.: 4L0375RUS1rev1

NAME OF TEST: Channel Separation

PARA. NO.: 15.247(a)(1)

Minimum Standard: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

NAME OF TEST: Pseudorandom Hopping Algorithm

PARA. NO.: 15.247(a)(1)

Minimum Standard:

The system shall hop to channel frequencies that are selected from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their transmitters and shall shift frequencies in synchronization with the transmitted signals.

NAME OF TEST: Time of Occupancy

PARA. NO.: 15.247(a)(1)(ii)

Minimum Standard:

Frequency Band (MHz)	20 dB Bandwidth	No. of Hopping Channels	Average Time of Occupancy
902 - 928	<250 kHz	50	=<0.4 sec. in 20 sec.
902 - 928	=>250 kHz	25	=<0.4 sec. in 10 sec.
2400 - 2483.5	-----	75	=<0.4 sec. in 30 sec.
5725 - 5850	-----	75	=<0.4 sec. in 30 sec.

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: 1 MHz

VBW: = RBW

Span: 0 Hz

LOG dB/div.: 10 dB

Sweep: Sufficient to see one hop time sequence.

Trigger: Video

The occupancy time of one hop is measured as above. The average time of occupancy is calculated over the appropriate period of time from above table (10, 20, or 30 seconds).

Avg. time of occupancy = (period from table/duration of one hop)/no. of channels multiplied by the duration of one hop.

For instance:

If a 2.4 GHz system has a measured hop duration time of 1 msec. and uses 75 channels, then the average time of occupancy would be:

$(30 \text{ sec.} / .001 \text{ sec.}) / 75 \text{ chan.} = 400 \times 1 \text{ msec.} = 400 \text{ msec. or } 0.4 \text{ sec. in } 30 \text{ sec.}$

NAME OF TEST: Occupied Bandwidth

PARA. NO.: 15.247(a)(2)

Minimum Standard:

Frequency Band (MHz)	Maximum 20 dB Bandwidth
902 - 928	500 kHz
2400 – 2483.5	1 MHz
5725 – 5850	1 MHz

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: At least 1% of span/div.

VBW: >RBW

Span: Sufficient to display 20 dB bandwidth

LOG dB/div.: 10 dB

Sweep: Auto

Number of channels tested:

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

NAME OF TEST: Peak Power Output

PARA. NO.: 15.247(b)

Minimum Standard:

Frequency Band (MHz)	No. of Hopping Channels	Maximum Peak Power Output at Antenna Port
902 - 928	at least 50	1 watt
902 – 928	25 - 49	0.25 watts
2400 – 2483.5	75	1 watt
5725 – 5850	75	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 $GP/4\pi R^2 = E^2/120\pi$ 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

The RBW of the spectrum analyzer shall be set to a value greater than the measured 20 dB occupied bandwidth of the E.U.T.

Number of channels tested:

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

NAME OF TEST: Spurious Emissions at Antenna Terminals 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 WAS SEARCHED TO THE 10th HARMONIC**Method Of Measurement:**30 MHz - 10th harmonic plot

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.

Number of channels tested:

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

NAME OF TEST: Radiated Spurious Emissions

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 (μ V/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		

Number of channels tested:

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

Nemko Dallas

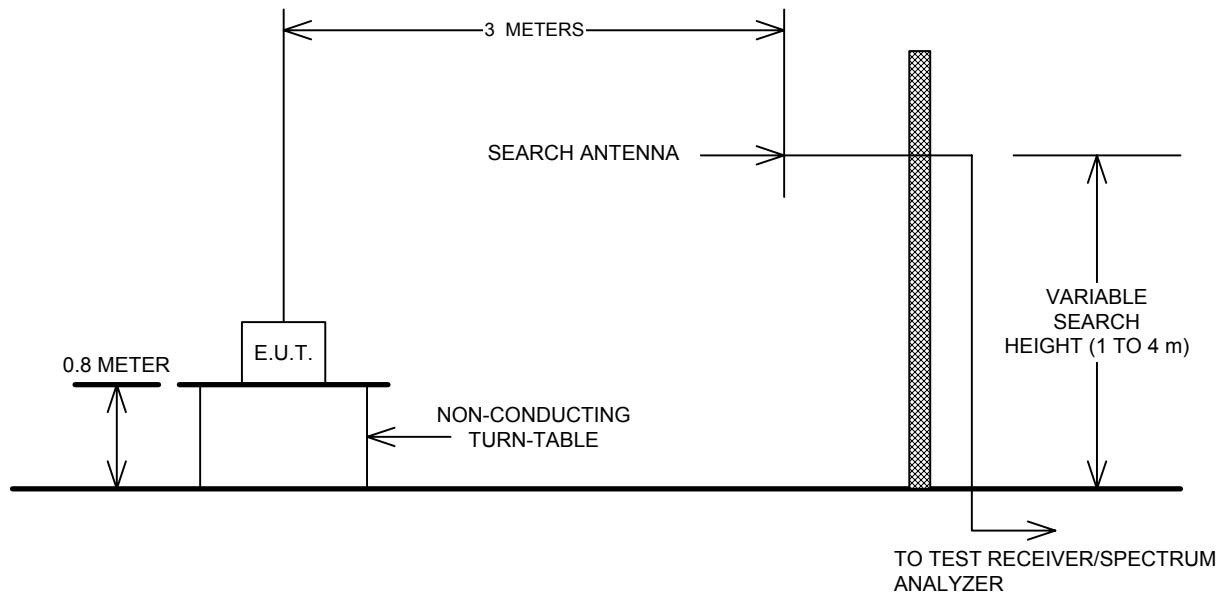
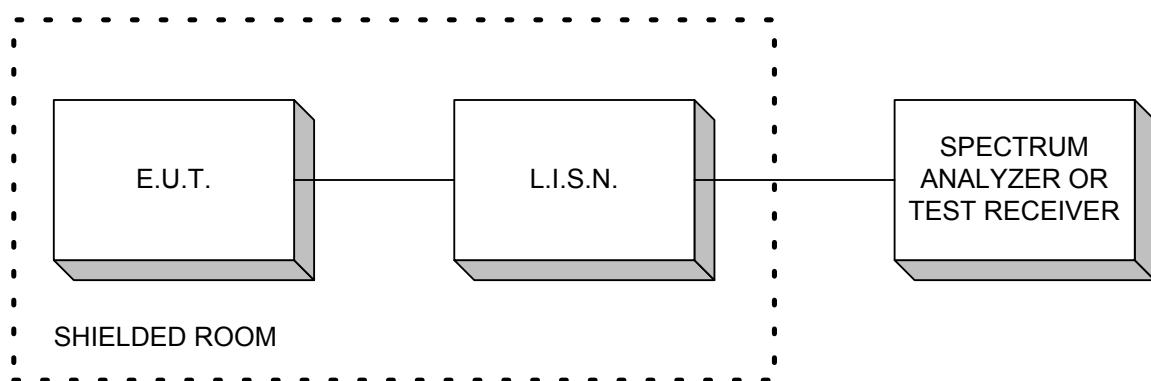
FCC PART 15, SUBPART C

FREQUENCY HOPPING SPREAD SPECTRUM TRANSMITTER

EQUIPMENT: *μ-Chip Reader*

Test Report No.: 4L0375RUS1rev1

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions**Conducted Emissions**

Peak Power At Antenna Terminals

