



Nemko Test Report: 5L0075RUS1

Applicant: Ecological Networking Systems, LTD
607 N. 2nd Street
Heber Springs, AR 72543

**Equipment Under Test:
(E.U.T.)** R53 Eagle

In Accordance With: **FCC Part 15, Subpart C, 15.247**
Spread Spectrum Transmitters

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

Authorized By: 
Tom Tidwell, Frontline Group Manager

Date: 21 July, 2005

Table of Contents

Section 1.	Summary of Test Results.....	3
Section 2.	Equipment Under Test (E.U.T.)	5
Section 3.	Channel Separation.....	7
Section 4.	Time of Occupancy	9
Section 5.	Occupied Bandwidth	12
Section 6.	Peak Power Output	18
Section 7.	Peak Power Spectral Density	19
Section 8.	Spurious Emissions (Radiated).....	22
Section 9.	Test Equipment List	35
ANNEX A -	TEST DETAILS.....	36
ANNEX B -	TEST DIAGRAMS	46

Section 1. Summary of Test Results

Manufacturer: Ecological Networking Systems, LTD

Model No.: R53 Eagle

Serial No.: 0006003,0006019, 0006021, 0006025, 0006029 and 0006045

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 C63.4-2003. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.

- | | | | |
|-------------------------------------|----------------------------|-------------------------------------|---------------------|
| <input checked="" type="checkbox"/> | New Submission | <input type="checkbox"/> | Production Unit |
| <input type="checkbox"/> | Class II Permissive Change | <input checked="" type="checkbox"/> | 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
See " Summary of Test Data".



NVLAP LAB CODE: 100426-0

Nemko Dallas Inc. authorizes the above named company to reproduce this report provided it is reproduced in its entirety and for use by the company's employees only.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Nemko Dallas Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report applies only to the items tested.

Summary Of Test Data

NAME OF TEST	PARA. NO.	SPEC.	RESULT
Powerline Conducted Emissions	15.207(a)		NA
Channel Separation	15.247(a)(1)	Greater of 25 kHz or 20 dB Bandwidth	Complies
Pseudorandom Hopping Algorithm	15.247(a)(1)		Complies
Time of Occupancy	15.247(a)(1)(ii)	≤ 0.4 sec in 30 sec	Complies
Occupied Bandwidth	15.247(a)(1)	≤ 1 MHz	Complies
Peak Power Output	15.247(b)	1 Watt	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	-20 dBc	NA
Spurious Emissions (Radiated)	15.247(c)	Table 15.209(a)	Complies

Footnotes:

- 1) The EUT is battery powered.
- 2) The EUT has an integral antenna.

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

General Equipment Information

Frequency Band: 902 – 928 MHz
 2400 – 2483.5 MHz

Test Voltage: 3.6 Vdc

Number of Hopping Channels: 50

Number of DTS Channels: 3

Channel Spacing: 150 kHz

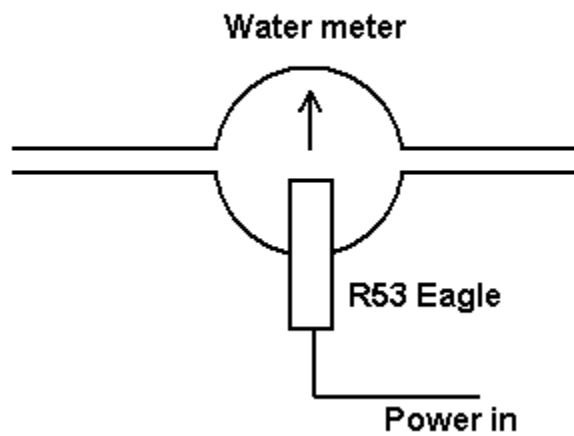
20 dB Bandwidth: 130 kHz

User Frequency Adjustment: Software controlled

Description of EUT

Water meter monitoring device. The transmitter has both frequency hopping and direct sequence spread spectrum channels. The circuit, including the antenna is potted.

System Diagram



Equipment: R53 Eagle

Section 3. Channel Separation

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 2/24/05

Test Results: Complies.

Measurement Data: See 20 dB BW plot
Measured 20 dB bandwidth: 130 kHz
Channel Separation: 150 kHz

Equipment Used: 1036-802

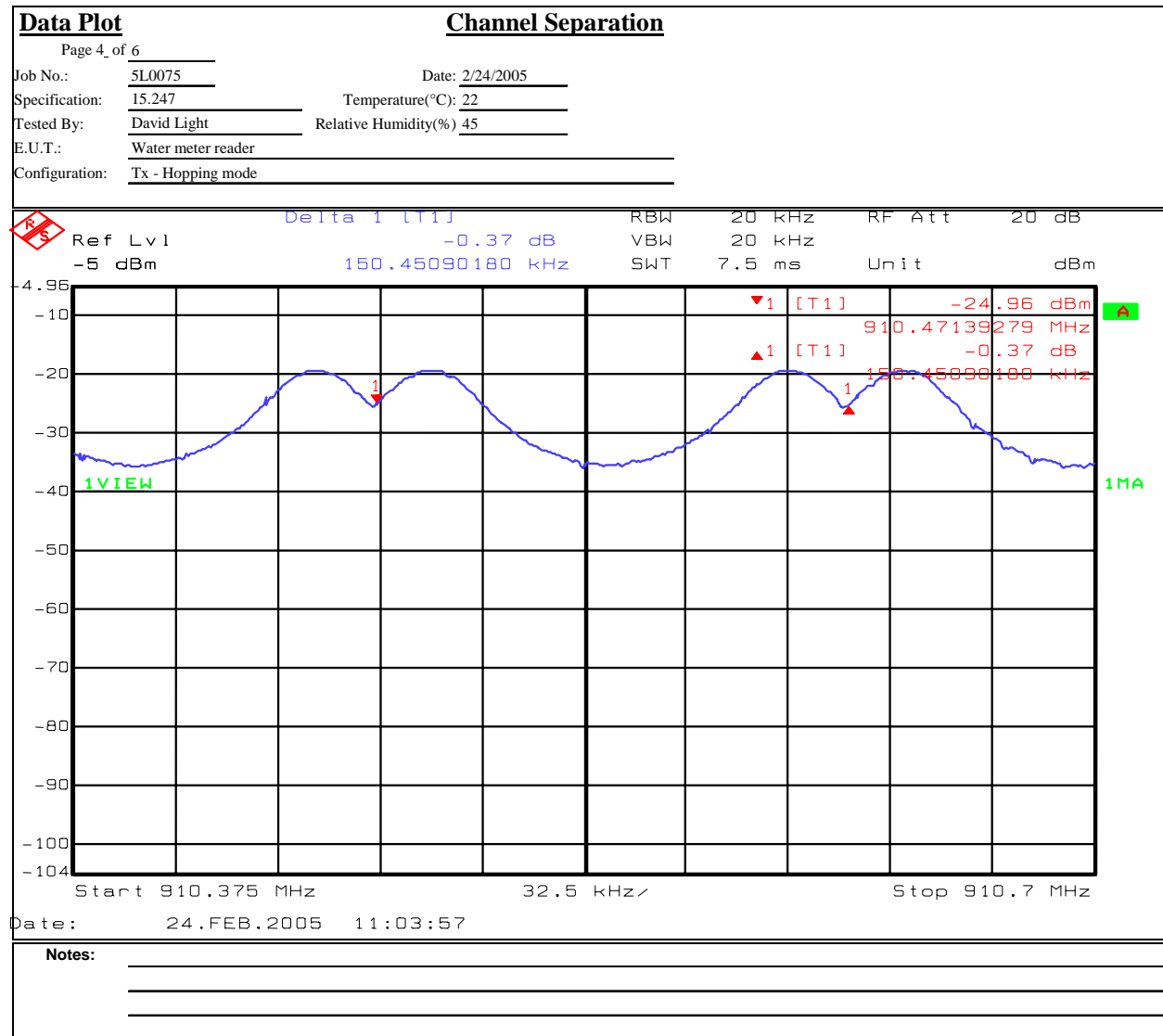
Measurement Uncertainty: +/- 0.7 dB

Temperature: 22 °C

Relative Humidity: 45 %

Equipment: R53 Eagle

Test Data – Channel Separation



Equipment: R53 Eagle

Section 4. Time of Occupancy

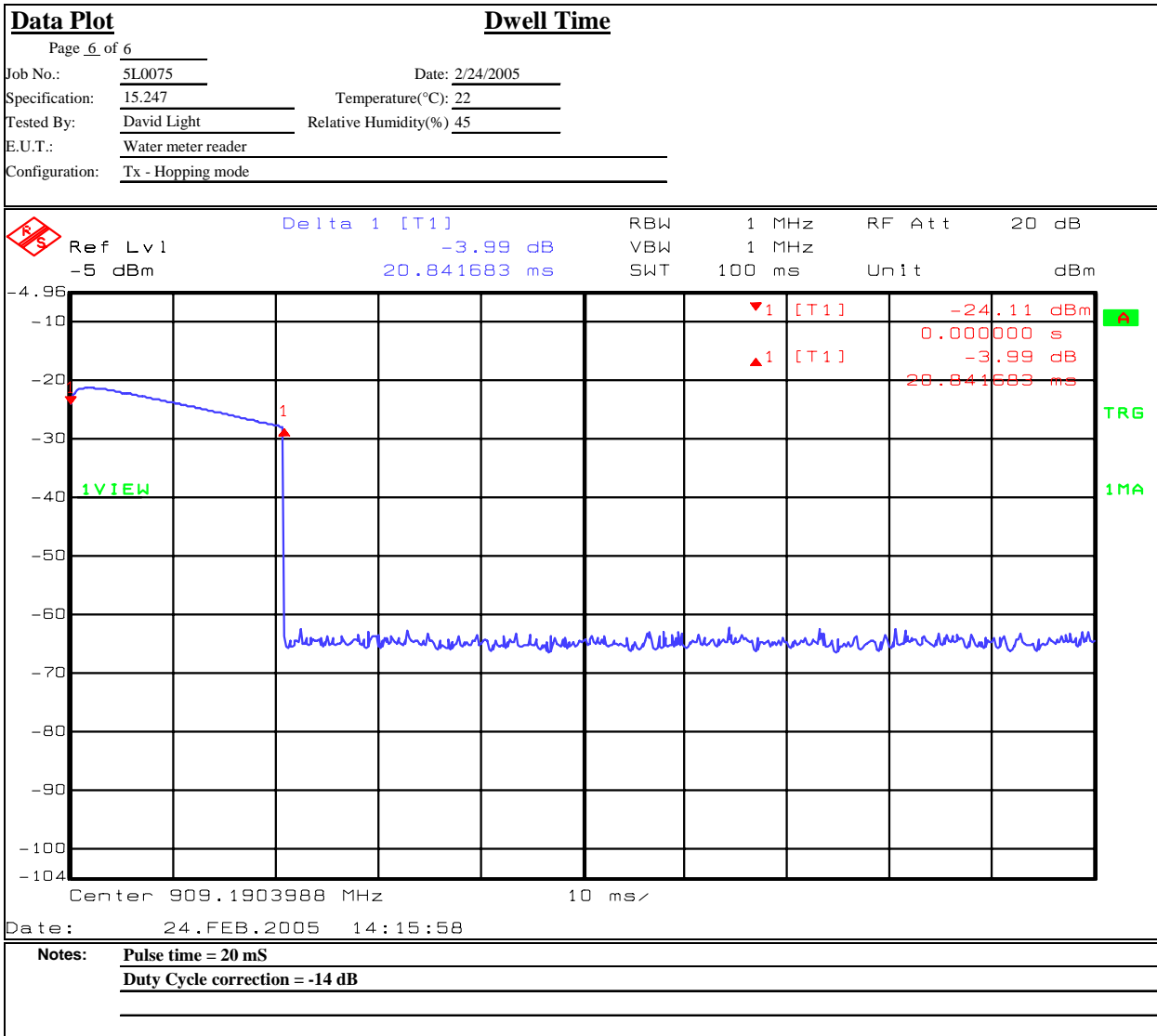
NAME OF TEST: Time of Occupancy	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE:2/24/05

Test Results: Complies.

Measurement Data: Maximum Dwell Time On Any Channel: 0.06 seconds/20 seconds

Equipment: R53 Eagle

Test Data – Time of Occupancy



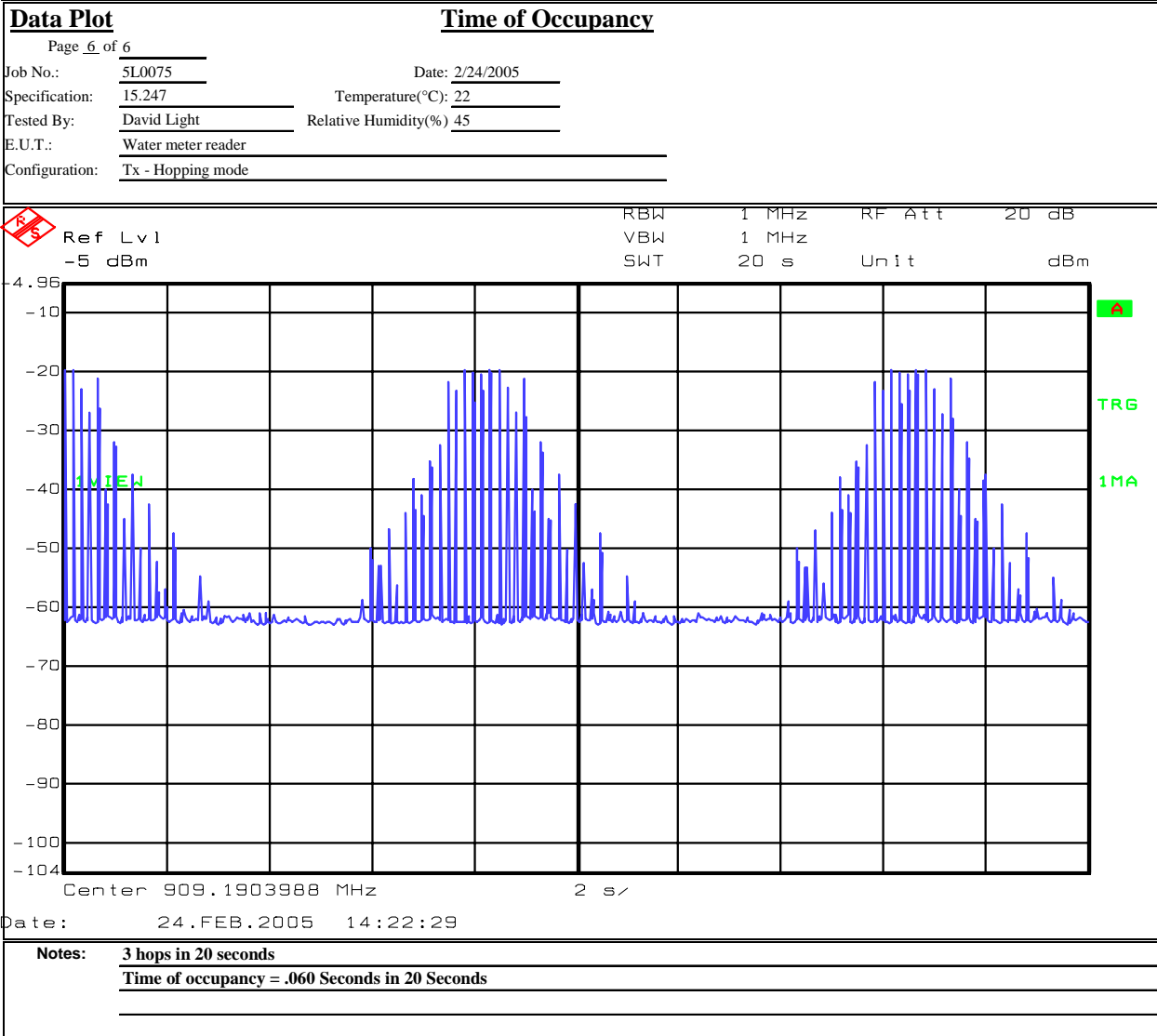
Test Data – Time of Occupancy



Dallas Headquarters:

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

Nemko Dallas, Inc.



Equipment: R53 Eagle

Section 5. Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(1)(i)
TESTED BY: David Light	DATE: 3/23/05

Test Results: Complies.

Measurement Data: See attached plots.

Equipment Used: 1036-802

Measurement Uncertainty: +/- 0.7 dB

Temperature: 22 °C

Relative Humidity: 45 %

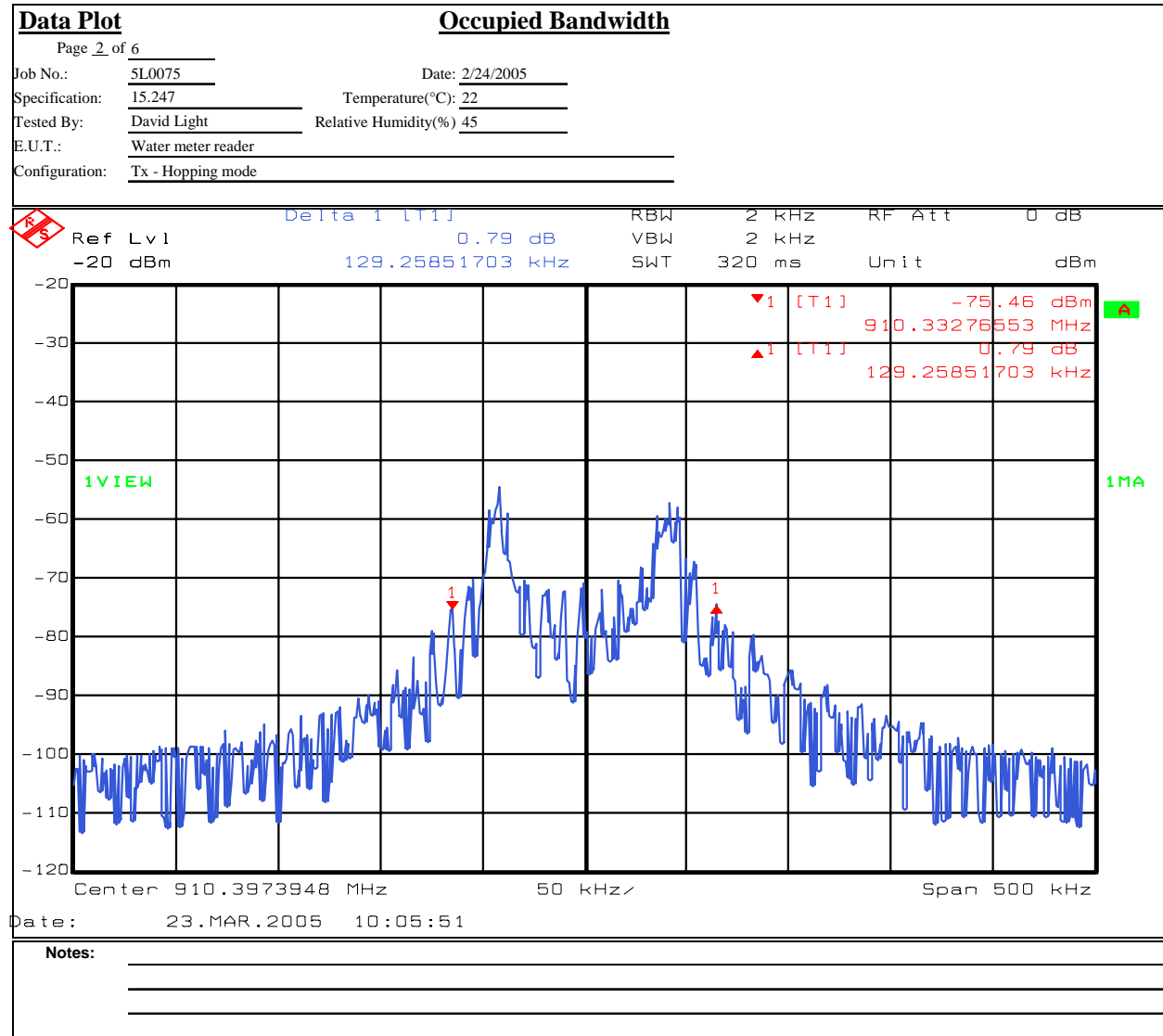
Equipment: R53 Eagle

Test Data – Occupied Bandwidth

Data Plot		Occupied Bandwidth		Complete <u> X </u>																						
Page <u> 1 </u> of <u> 6 </u>		Date: <u> 2/24/2005 </u>		Preliminary: <u> </u>																						
Job No.: <u> 5L0075 </u>	Specification: <u> 15.247 </u>	Temperature(°C): <u> 22 </u>																								
Tested By: <u> David Light </u>	Relative Humidity(%): <u> 45 </u>																									
E.U.T.: <u> Water meter reader </u>																										
Configuration: <u> Tx - Hopping mode </u>																										
Sample Number: <u> 4 </u>																										
Location: <u> Lab 1 </u>	RBW: <u> Refer to plots </u>																									
Detector Type: <u> Peak </u>	VBW: <u> Refer to plots </u>																									
Test Equipment Used																										
Antenna: <u> 802 </u>	Directional Coupler: <u> </u>																									
Pre-Amp: <u> </u>	Cable #1: <u> </u>																									
Filter: <u> </u>	Cable #2: <u> </u>																									
Receiver: <u> 1036 </u>	Cable #3: <u> </u>																									
Attenuator #1: <u> </u>	Cable #4: <u> </u>																									
Attenuator #2: <u> </u>	Mixer: <u> </u>																									
Additional equipment used: <u> </u>																										
Measurement Uncertainty: <u> +/-1.7 dB </u>																										
<table border="1" style="width: 100%; border-collapse: collapse; font-size: small;"> <tr> <td style="width: 15%; text-align: center;">Ref</td> <td style="width: 15%; text-align: center;">Lvl</td> <td style="width: 35%; text-align: center;">Marker 1 [T1]</td> <td style="width: 10%; text-align: center;">RBW</td> <td style="width: 10%; text-align: center;">2 kHz</td> <td style="width: 10%; text-align: center;">RF Att</td> <td style="width: 10%; text-align: center;">0 dB</td> </tr> <tr> <td style="text-align: center;">-20 dBm</td> <td></td> <td style="text-align: center;">-82.90 dBm</td> <td style="text-align: center;">VBW</td> <td style="text-align: center;">2 kHz</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td style="text-align: center;">905.67074148 MHz</td> <td style="text-align: center;">SWT</td> <td style="text-align: center;">320 ms</td> <td style="text-align: center;">Unit</td> <td style="text-align: center;">dBm</td> </tr> </table>						Ref	Lvl	Marker 1 [T1]	RBW	2 kHz	RF Att	0 dB	-20 dBm		-82.90 dBm	VBW	2 kHz					905.67074148 MHz	SWT	320 ms	Unit	dBm
Ref	Lvl	Marker 1 [T1]	RBW	2 kHz	RF Att	0 dB																				
-20 dBm		-82.90 dBm	VBW	2 kHz																						
		905.67074148 MHz	SWT	320 ms	Unit	dBm																				
<p style="text-align: center;">Center 905.7373747 MHz 50 kHz Span 500 kHz</p> <p>Date: <u> 23.MAR.2005 </u> <u> 10:03:43 </u></p>																										
<p>Notes:</p> <hr/> <hr/> <hr/>																										

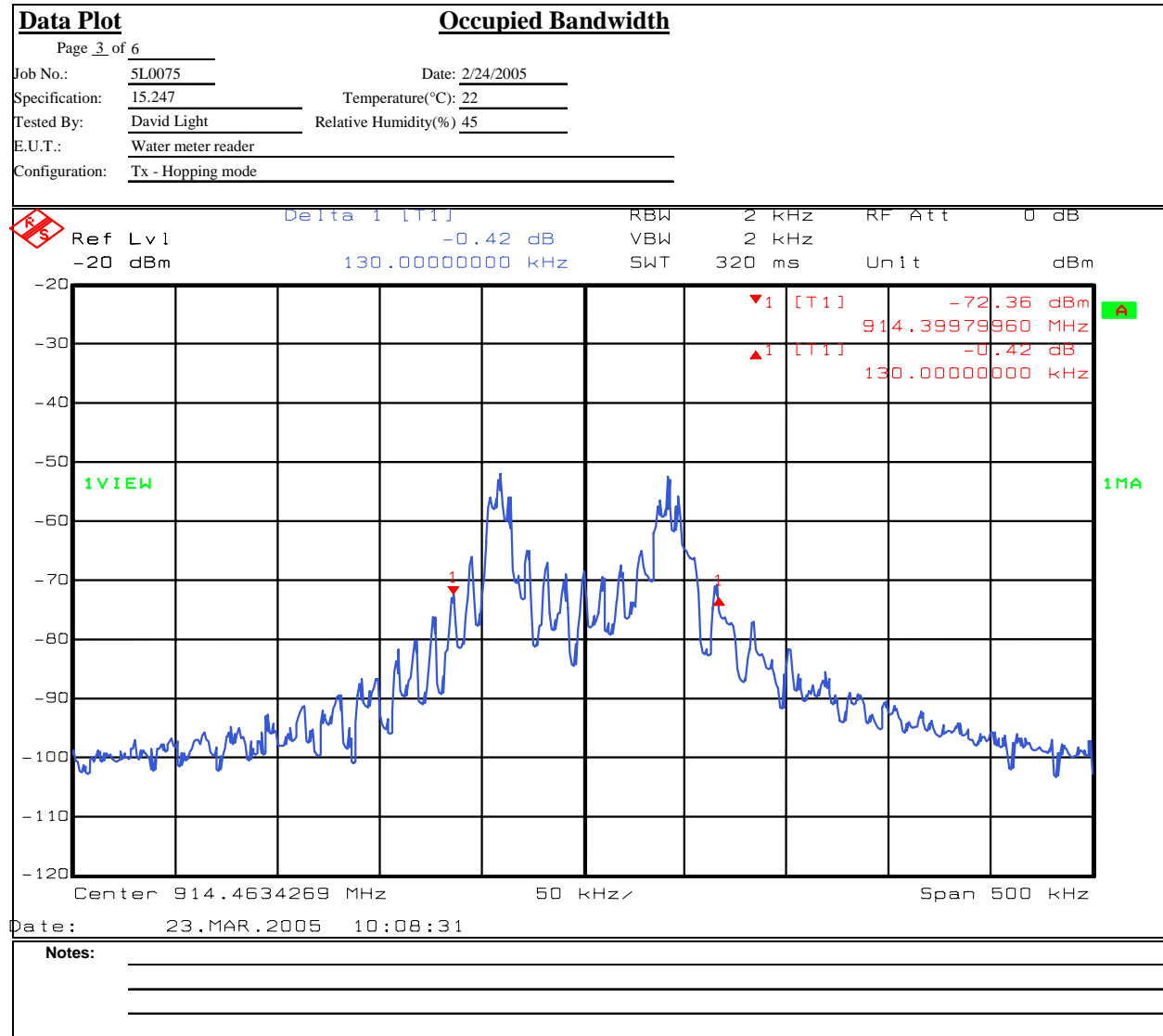
Lowest hopping channel

Test Data – Occupied Bandwidth



Mid Hopping channel

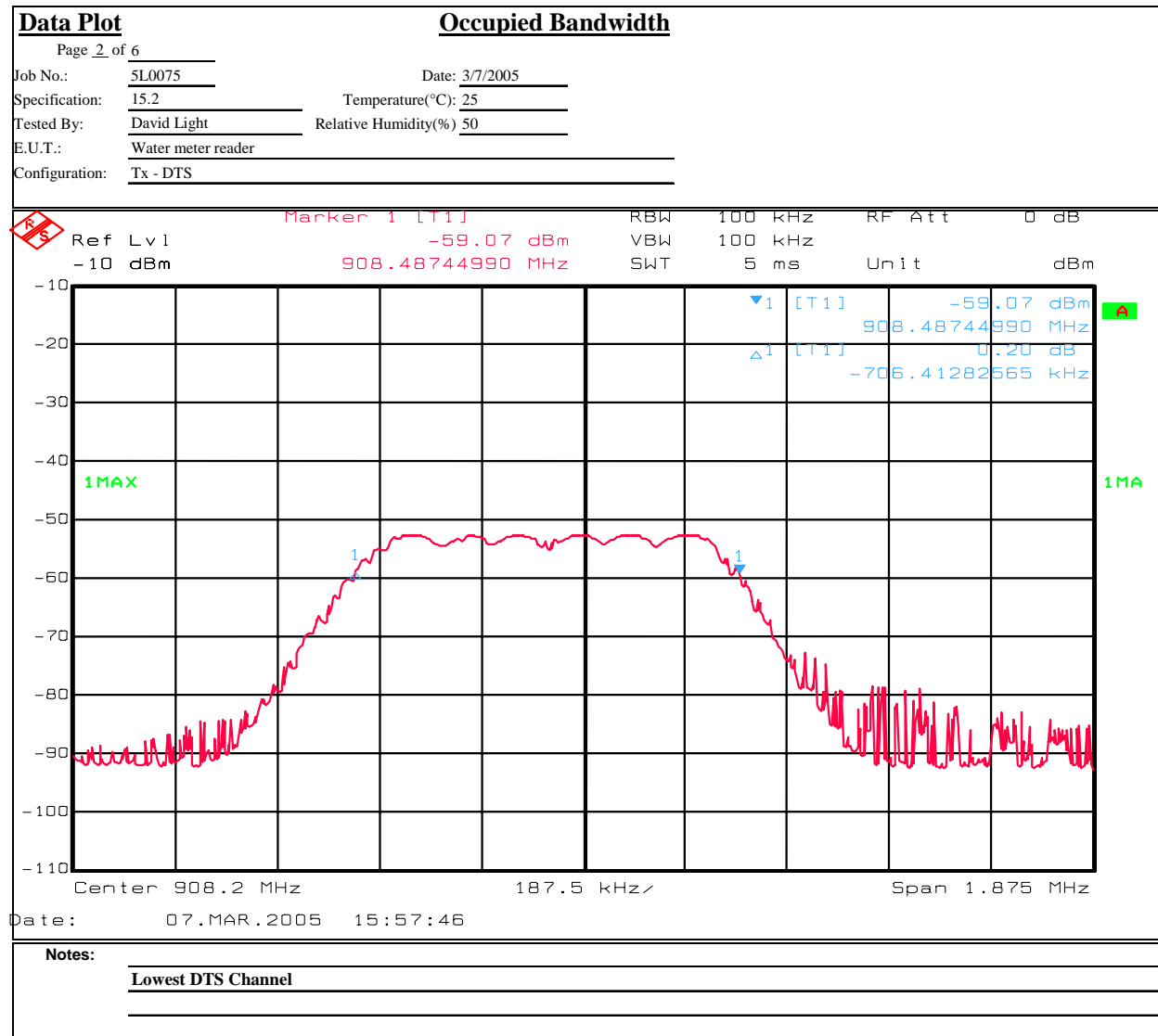
Test Data – Occupied Bandwidth



High hopping channel

Equipment: R53 Eagle

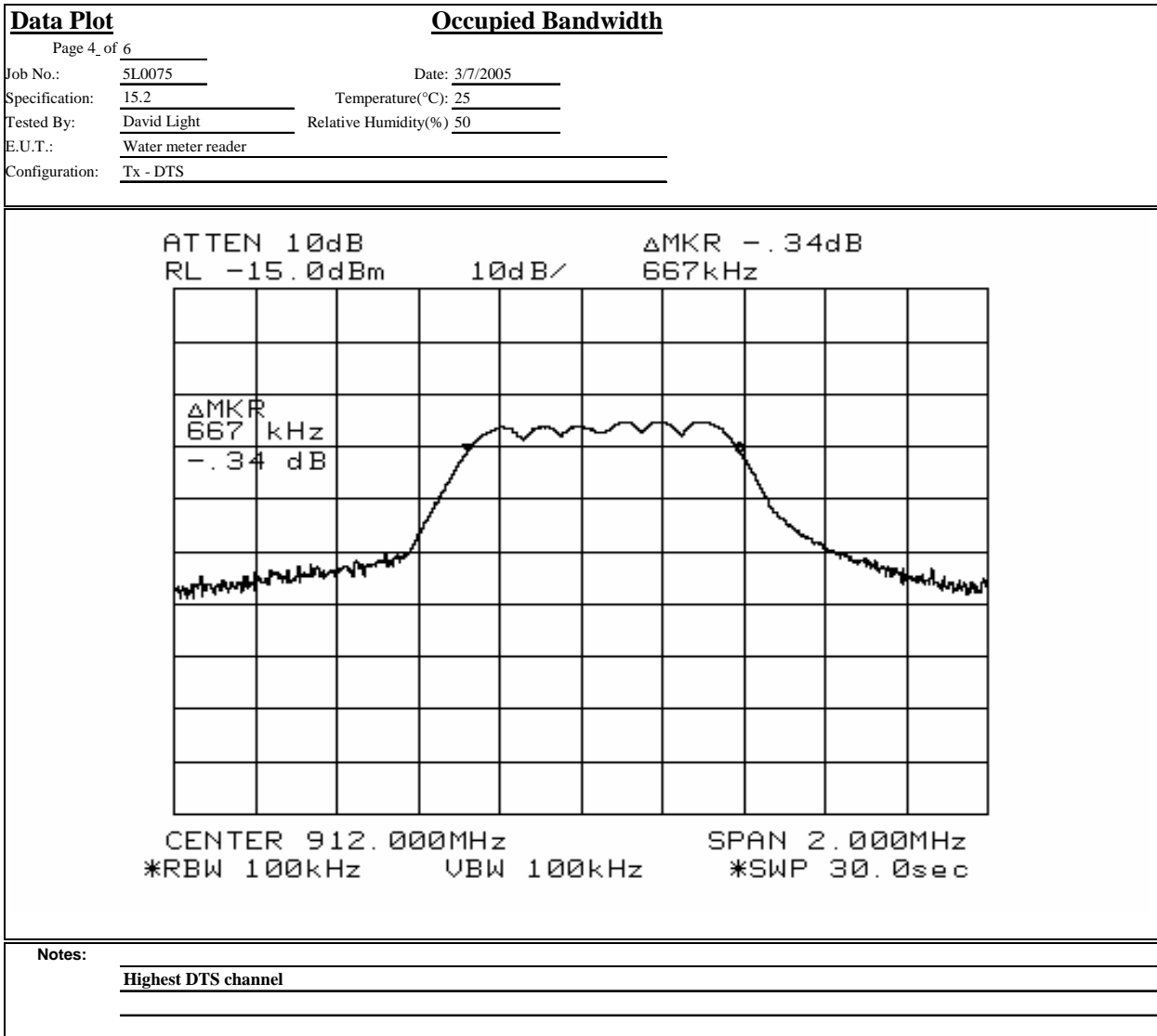
Test Data – Occupied Bandwidth



Low DTS channel

Equipment: R53 Eagle

Test Data – Occupied Bandwidth



High DTS channel

Section 6. Peak Power Output

NAME OF TEST: Peak Power Output	PARA. NO.: 15.247 (b)
TESTED BY: David Light	DATE: 2/24/05

Test Results: Complies.

Measurement Data: See attached plots.
 Detachable antenna? Yes No
 If yes, state the type of non-standard connector used:

Frequency (MHz)	Mode	Peak EIRP (dBm)	Peak EIRP (mW)	Peak Conducted Power (mW)
905.8	FHSS	11.6	14.6	14.6
910.45	FHSS	12	16	16
914.5	FHSS	3.4	2.2	2.2
908.2	DTS	-9	0.1	0.1
912.1	DTS	3.1	2	2

Note: The device was tested with fully charged battery supply. The measurement was made using the substitution method as specified in TIA/EIA-603-1992, Section 2.2.12

Equipment Used: 1304-1484-1485-1036

Analyzer Settings: 1 MHz RBW / 1 MHz VBW

Measurement Uncertainty: +/- 0.7 dB

Temperature: 22 °C

Relative Humidity: 45 %

Equipment: R53 Eagle

Section 7. Peak Power Spectral Density

NAME OF TEST: Peak Power Spectral Density	PARA. NO.: 15.247 (e)
TESTED BY: David Light	DATE: 2/24/05

Test Results: Complies.

Equipment Used: 1304-1484-1485-1036

Analyzer Settings: 3 kHz RBW / 3 kHz VBW

Measurement Uncertainty: +/- 0.7 dB

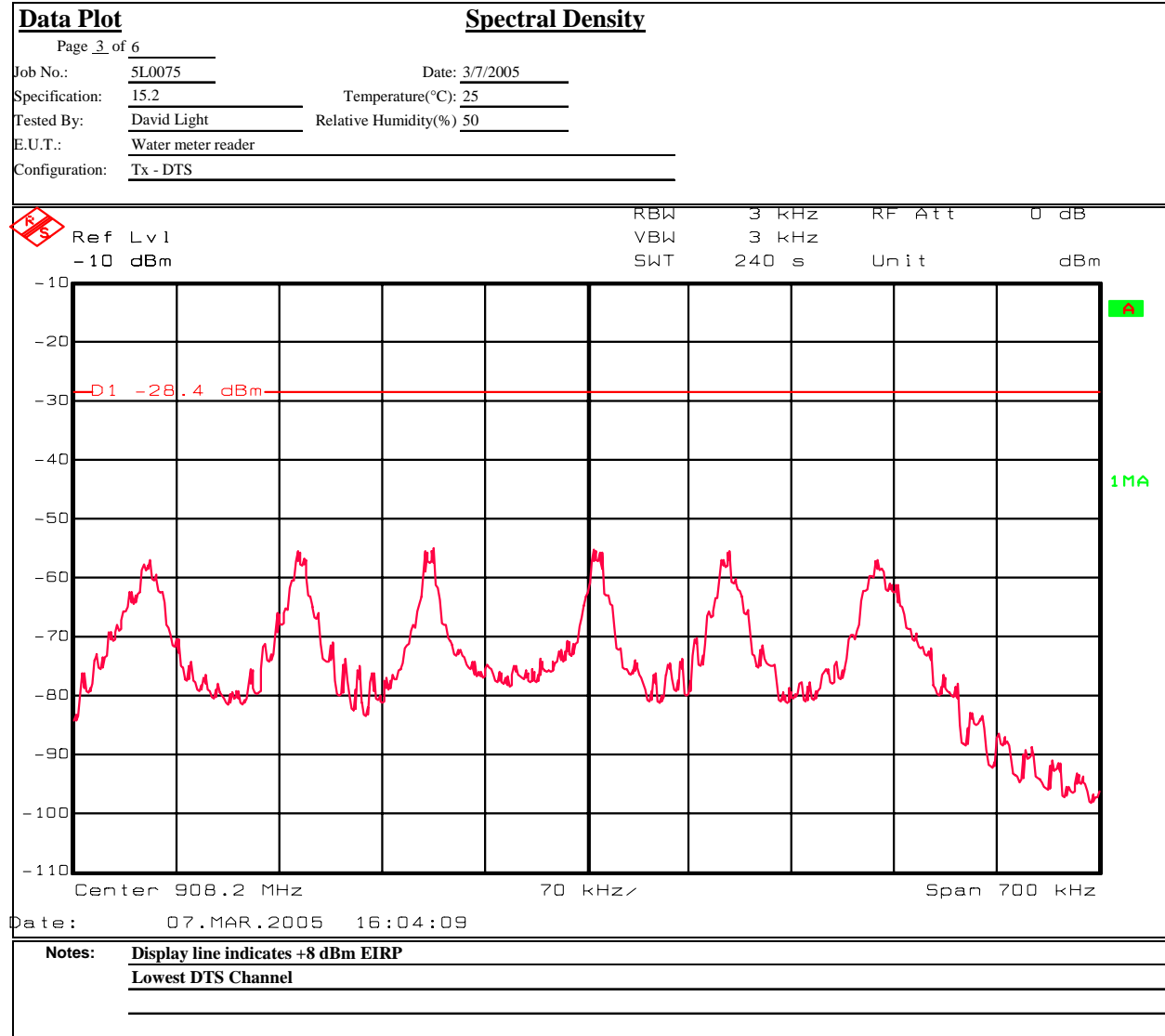
Temperature: 22 °C

Relative Humidity: 45 %

Note: This measurement was made using the signal substitution method for making EIRP measurements as specified in TIA/EIA-603-1992, Section 2.2.12

Equipment: R53 Eagle

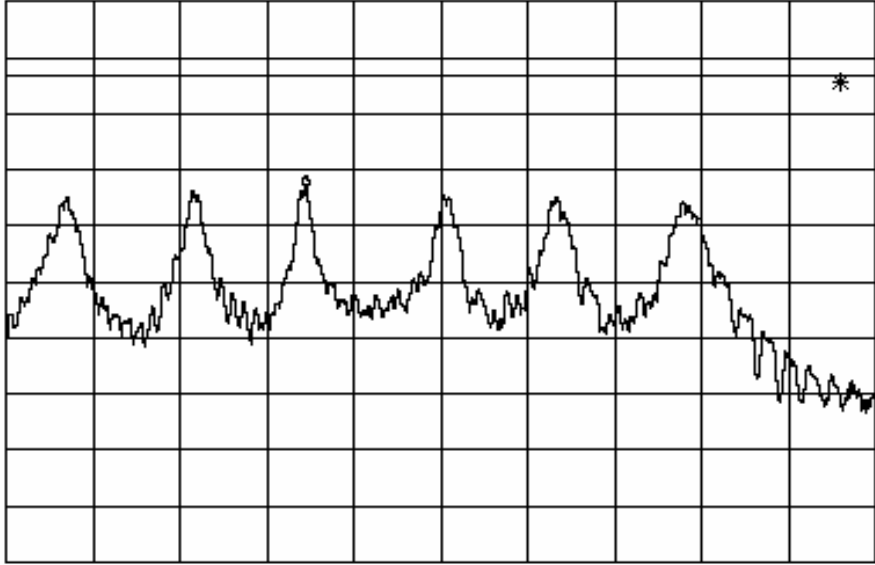
Test Data – Spectral Density



Lowest DTS Channel

Equipment: R53 Eagle

Test Data – Spectral Density

<u>Data Plot</u>	<u>Spectral Density</u>
Page 6 of 6	
Job No.: 5L0075	Date: 3/7/2005
Specification: 15.2	Temperature(°C): 25
Tested By: David Light	Relative Humidity(%) 50
E.U.T.: Water meter reader	
Configuration: Tx - DTS	
<div style="display: flex; justify-content: space-between; margin-bottom: 5px;"> ATTEN 10dB MKR -48.17dBm </div> <div style="display: flex; justify-content: space-between; margin-bottom: 5px;"> RL -15.0dBm 10dB/ 911.9915MHz </div>  <div style="display: flex; justify-content: space-between; margin-top: 5px;"> CENTER 912.1000MHz SPAN 700.0kHz </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> *RBW 3.0kHz VBW 3.0kHz *SWP 240sec </div>	
Notes: <u>Display line indicates +8 dBm EIRP</u> <u>Highest DTS channel</u>	

Highest DTS Channel

Equipment: R53 Eagle

Section 8. Spurious Emissions (Radiated)

NAME OF TEST: Spurious Emissions (Radiated)	PARA. NO.: 15.247(c)
TESTED BY: David Light	DATE: 3/7/05

Test Results: Complies.

Measurement Data: See attached table.

Duty Cycle Calculation:

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

$20 \log (20\text{mS}/100 \text{ mS}) = -14 \text{ dB}$

Equipment Used: 1484-1485-1036-1464-1016-1481-760-759-791-1983

Measurement Uncertainty: +/- 0.7 dB

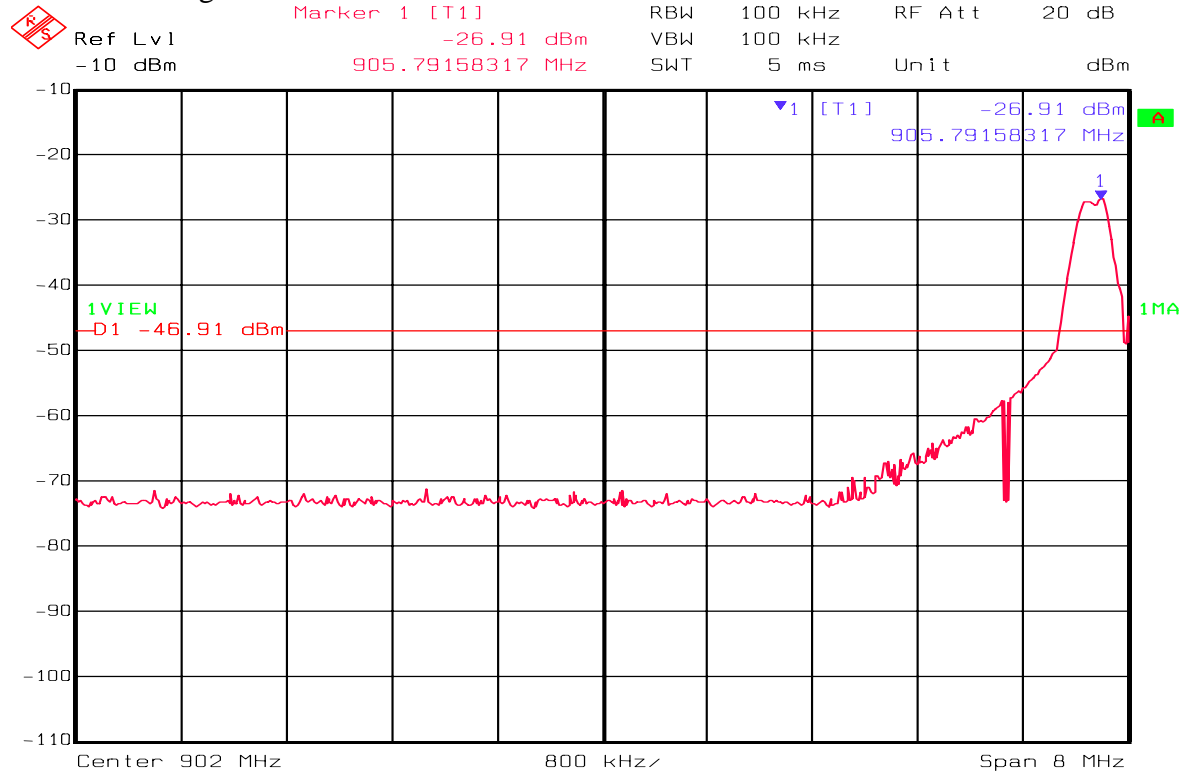
Temperature: 22 °C

Relative Humidity: 45 %

Equipment: R53 Eagle

Test Data - Radiated Emissions

Lower Bandedge - FHSS



Date: 07.MAR.2005 11:57:35

Test Data - Radiated Emissions

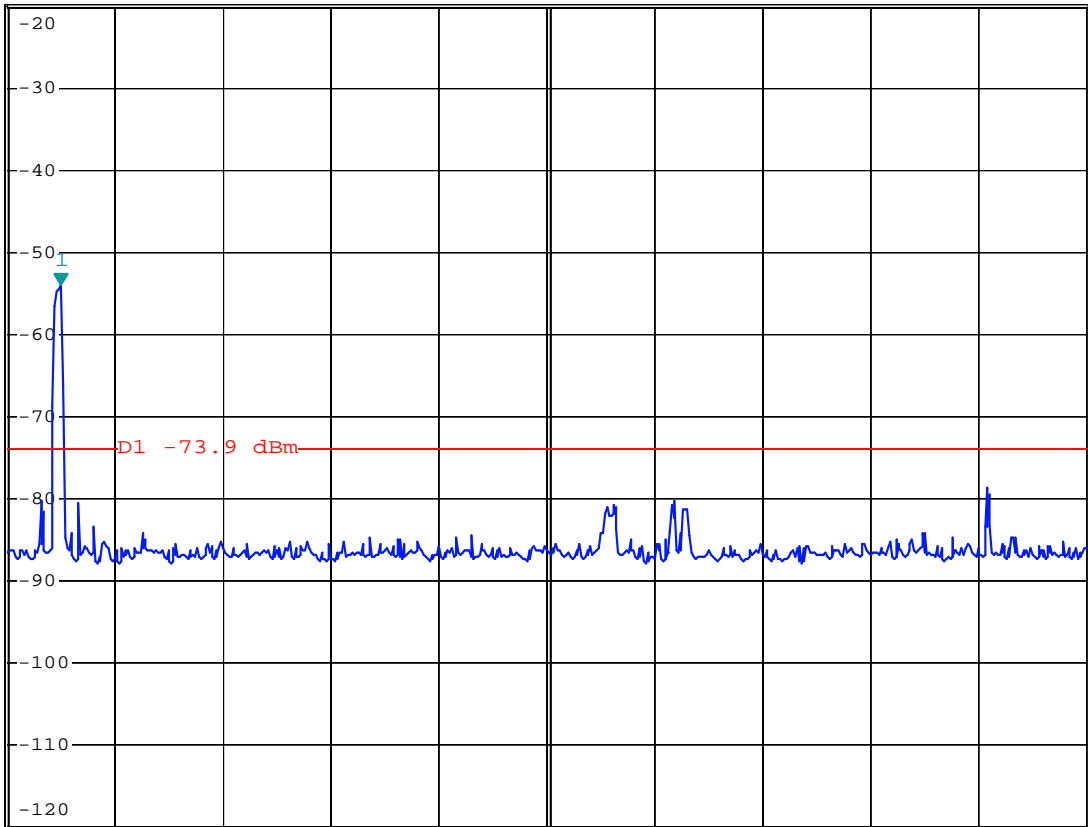
Upper Bandedge - FHSS



DISPLAY LINE 1
-73.9 dBm
Ref -20 dBm Att 10 dB

*RBW 100 kHz Marker 1 [T1]
*VBW 100 kHz -53.89 dBm
SWT 10 ms 914.50000000 MHz

1 PK
VIEW

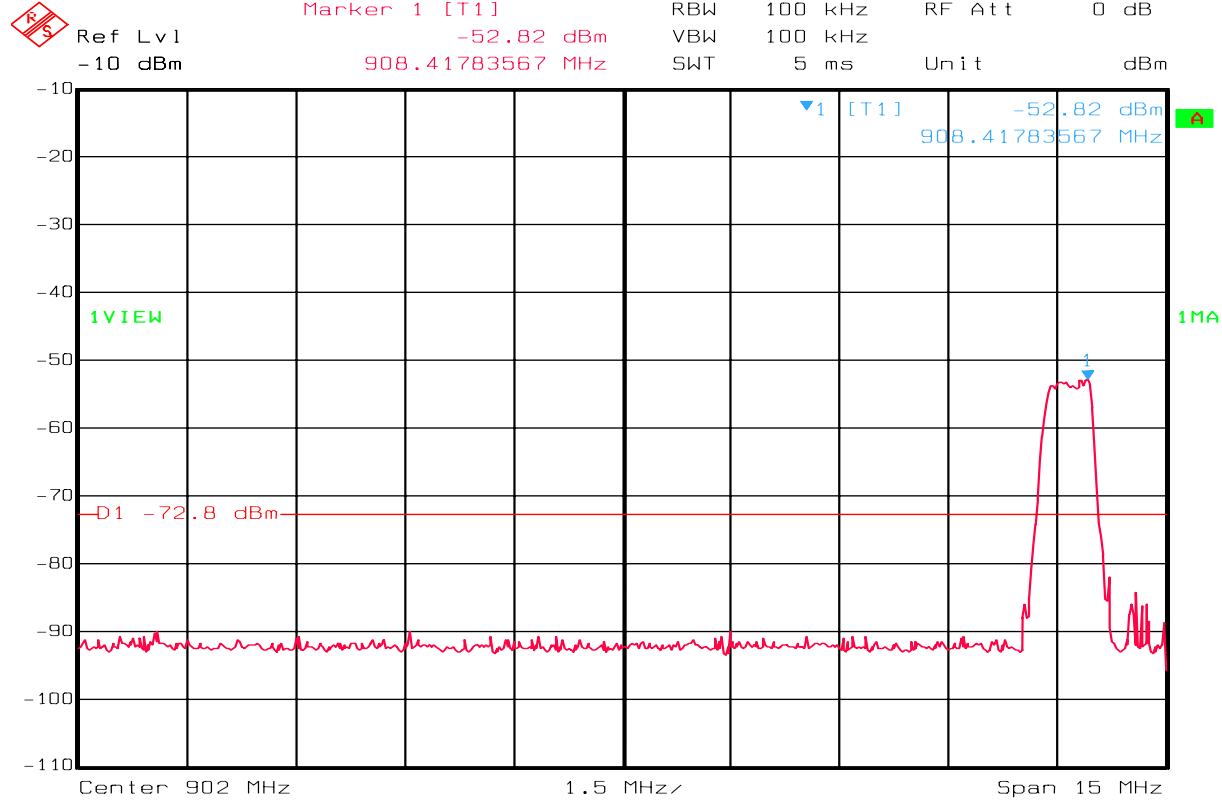


Center 928 MHz 3 MHz/ Span 30 MHz

Date: 24.MAR.2005 12:24:57

Test Data - Radiated Emissions

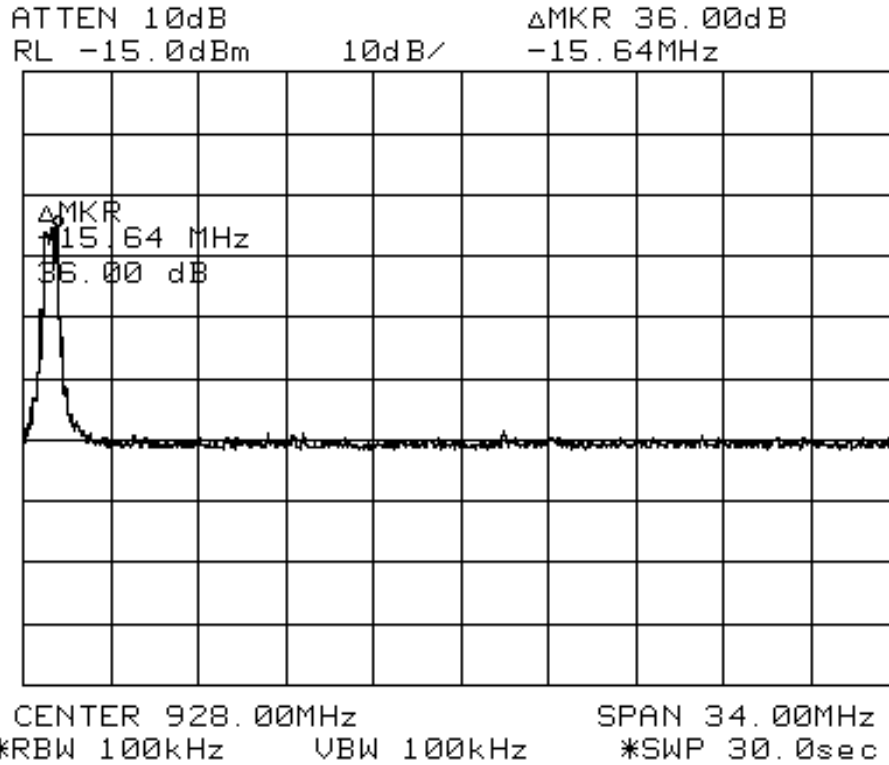
Lower Bandedge - DTS



Date: 07.MAR.2005 15:54:19

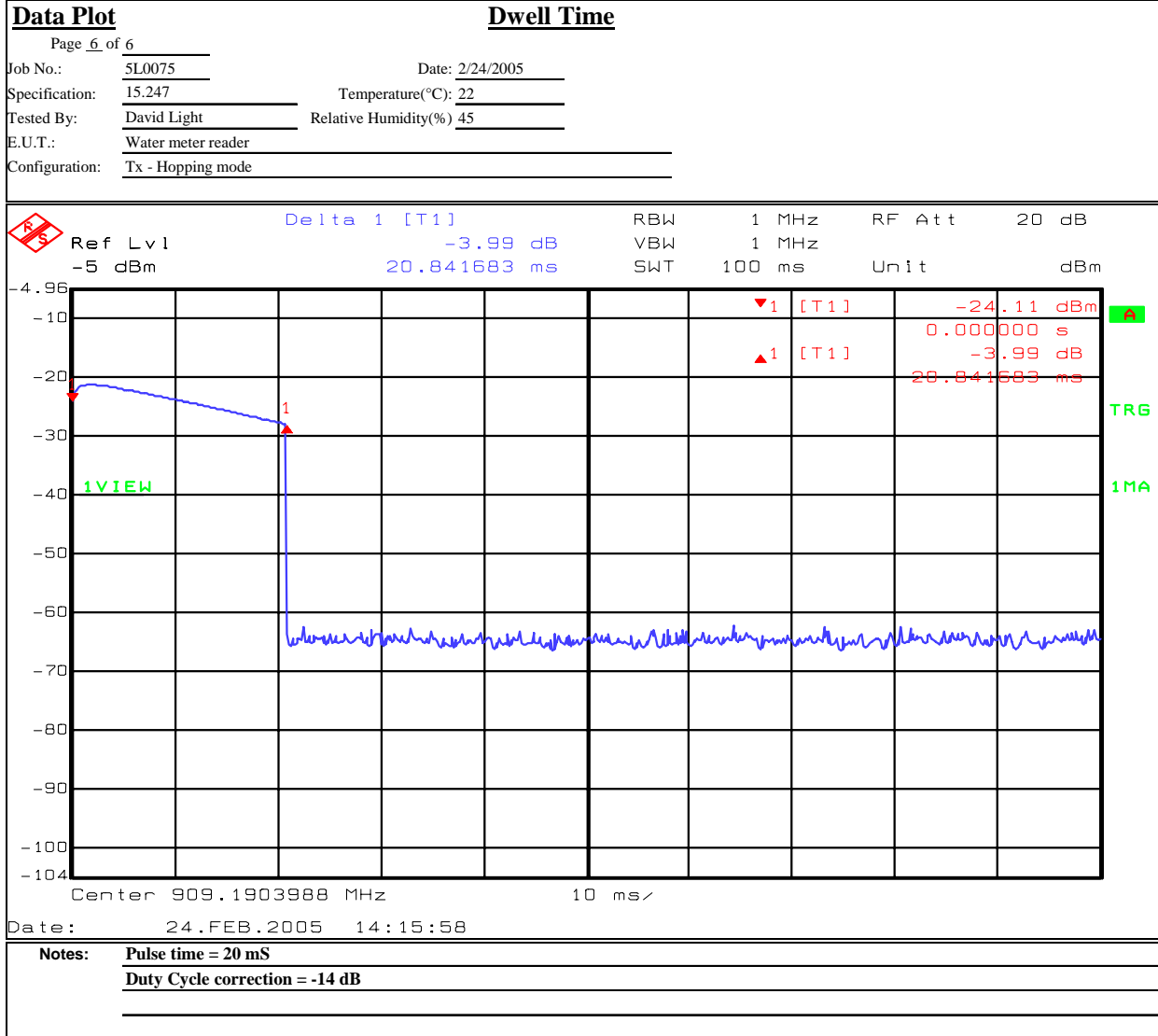
Test Data - Radiated Emissions

Upper Bandedge - DTS



Test Data - Radiated Emissions

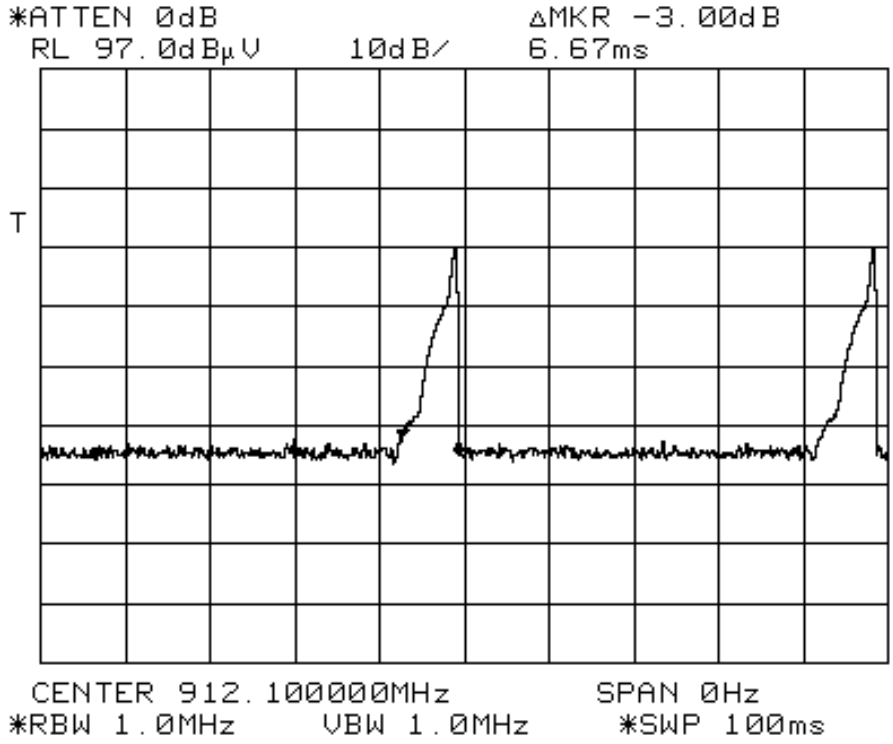
Duty Cycle - FHSS



(20/100)_{log}20=-14 dB correction

Test Data - Radiated Emissions

Duty Cycle - DTS



$(13.34/100)_{\log 20} = -17.5$ dB correction.

Test Data - Radiated Emissions

Restricted Bands – FHSS – Low Channel

<u>Radiated Emissions</u>	
Page <u>1</u> of <u>1</u>	
Job No.: 5L0075	Date: 3/7/2005
Specification: 15.247/15.205	Temperature(°C): <u>20</u>
Tested By: David Light	Relative Humidity(%) <u>50</u>
E.U.T.: 900 MHz Hybrid	
Configuration: Upright per typical installation	
Sample Number: <u>1</u>	
Location: <u>AC 3</u>	RBW: <u>1 MHz</u>
Detector Type: <u>Peak</u>	VBW: <u>1 MHz</u>
	-14 dB Correction for AVG measurements
<u>Test Equipment Used</u>	
Antenna: <u>1304</u>	Directional Coupler: <u>#N/A</u>
Pre-Amp: <u>1016</u>	Cable #1: <u>1484</u>
Filter: <u>1481</u>	Cable #2: <u>1485</u>
Receiver: <u>1036</u>	Cable #3: <u>#N/A</u>
Attenuator #1: <u>#N/A</u>	Cable #4: <u>#N/A</u>
Attenuator #2: <u>#N/A</u>	Mixer: <u>#N/A</u>
Measurement Uncertainty: +/- 3.6 dB	

Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Peak Limit (dBuV/m)	Average Limit (dBuV/m)	Detector / Polarity
2.717	63.4	28.2	3.7	32.7	62.6	74		Peak/Vertical
2.717	49.4	28.2	3.7	32.7	48.6		54	Average/Vertical
3.623	46.3	30.3	3.7	32.7	47.6		54	Peak/Vertical
4.529	45.8	32.2	4.1	31.5	50.6		54	Peak/Vertical
5.435	43.0	33.6	4.7	31.9	49.4		54	Peak/Vertical
6.341	44.0	34.9	5.3	31.1	53.1		54	Peak/Vertical
7.264	40.0	36.3	5.3	32.2	49.4		54	Peak/Vertical
8.152	40.0	36.7	5.7	33.2	49.2		54	Peak/Vertical
9.058	40.0	37.8	5.7	34.5	49.0		54	Peak/Vertical
2.717	59.4	28.2	3.7	32.7	58.6	74		Peak/Horizontal
2.717	45.4	28.2	3.7	32.7	44.6		54	Average/Horizontal
3.623	50.0	30.3	3.7	32.7	51.3		54	Peak/Horizontal
4.529	48.6	30.3	3.7	32.7	49.9		54	Peak/Horizontal
5.435	45.7	32.2	4.1	31.5	50.5		54	Peak/Horizontal
6.341	43.8	33.6	4.7	31.9	50.2		54	Peak/Horizontal
7.264	43.6	34.9	5.3	31.1	52.7		54	Peak/Horizontal
8.152	40.0	36.3	5.3	32.2	49.4		54	Peak/Horizontal
9.058	41.0	36.7	5.7	33.2	50.2		54	Peak/Horizontal

Notes: The spectrum was searched from 30 MHz to 10 GHz.

Test Data - Radiated Emissions

Restricted Bands – FHSS – Mid Channel

Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Peak Limit (dBuV/m)	Average Limit (dBuV/m)	Detector / Polarity
2.731	60.6	28.2	3.7	32.7	59.8	74		Peak/Vertical
2.731	46.6	28.2	3.7	32.7	45.8		54	Average/Vertical
3.642	48.0	30.3	3.7	32.7	49.3		54	Peak/Vertical
4.552	46.0	32.2	4.1	31.5	50.8		54	Peak/Vertical
5.463	40.0	33.6	4.7	31.9	46.4		54	Peak/Vertical
6.373	43.0	34.9	5.3	31.1	52.1		54	Peak/Vertical
7.284	37.0	36.3	5.3	32.2	46.4		54	Peak/Vertical
8.194	40.0	36.7	5.7	33.2	49.2		54	Peak/Vertical
9.105	40.0	37.8	5.7	34.5	49.0		54	Peak/Vertical
2.731	65.0	28.2	3.7	32.7	64.2	74		Peak/Horizontal
2.731	51.0	28.2	3.7	32.7	50.2		54	Average/Horizontal
3.642	53.4	30.3	3.7	32.7	54.7	74		Peak/Horizontal
3.642	39.4	30.3	3.7	32.7	40.7		54	Average/Horizontal
4.552	52.0	30.3	3.7	32.7	53.3		54	Peak/Horizontal
5.463	46.4	32.2	4.1	31.5	51.2		54	Peak/Horizontal
6.373	43.0	33.6	4.7	31.9	49.4		54	Peak/Horizontal
7.284	38.0	34.9	5.3	31.1	47.1		54	Peak/Horizontal
8.194	40.0	36.3	5.3	32.2	49.4		54	Peak/Horizontal
9.105	40.0	36.7	5.7	33.2	49.2		54	Peak/Horizontal
Notes:	The spectrum was searched from 30 MHz to 10 GHz.							

Test Data - Radiated Emissions

Restricted Bands – FHSS – High Channel

Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Peak Limit (dBuV/m)	Average Limit (dBuV/m)	Detector / Polarity
2.744	59.0	28.2	3.7	32.7	58.2	74		Peak/Vertical
2.744	45.0	28.2	3.7	32.7	44.2		54	Average/Vertical
3.658	51.6	30.3	3.7	32.7	52.9		54	Peak/Vertical
4.573	49.6	32.2	4.1	31.5	54.4	74		Peak/Vertical
4.573	35.6	32.2	4.1	31.5	40.4		54	Average/Vertical
5.487	42.0	33.6	4.7	31.9	48.4		54	Peak/Vertical
6.402	40.0	34.9	5.3	31.1	49.1		54	Peak/Vertical
7.316	39.0	36.3	5.3	32.2	48.4		54	Peak/Vertical
8.231	40.0	36.7	5.7	33.2	49.2		54	Peak/Vertical
9.145	40.0	37.8	5.7	34.5	49.0		54	Peak/Vertical
2.744	64.0	28.2	3.7	32.7	63.2	74		Peak/Horizontal
2.744	50.0	28.2	3.7	32.7	49.2		54	Average/Horizontal
3.658	55.0	30.3	3.7	32.7	56.3	74		Peak/Horizontal
3.658	41.0	30.3	3.7	32.7	42.3		54	Average/Horizontal
4.573	53.5	30.3	3.7	32.7	54.8	74		Peak/Horizontal
4.573	39.5	30.3	3.7	32.7	40.8		54	Average/Horizontal
5.487	48.0	32.2	4.1	31.5	52.8		54	Peak/Horizontal
6.402	43.0	33.6	4.7	31.9	49.4		54	Peak/Horizontal
7.316	43.0	34.9	5.3	31.1	52.1		54	Peak/Horizontal
8.231	40.0	36.3	5.3	32.2	49.4		54	Peak/Horizontal
9.145	40.0	36.7	5.7	33.2	49.2		54	Peak/Horizontal
Notes:	The spectrum was searched from 30 MHz to 10 GHz.							

Test Data - Radiated Emissions

Restricted Bands – DTS Low Channel

Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Peak Limit (dBuV/m)	Average Limit (dBuV/m)	Detector / Polarity
2.725	52.5	28.2	3.7	32.7	51.7		54	Peak/Vertical
3.633	42.0	30.3	3.7	32.7	43.3		54	Peak/Vertical
4.541	47.0	32.2	4.1	31.5	51.8		54	Peak/Vertical
5.449	41.0	33.6	4.7	31.9	47.4		54	Peak/Vertical
6.357	40.0	34.9	5.3	31.1	49.1		54	Peak/Vertical
7.266	40.6	36.3	5.3	32.2	50.0		54	Peak/Vertical
8.174	41.3	36.7	5.7	33.2	50.5		54	Peak/Vertical
9.082	42.0	37.8	5.7	34.5	51.0		54	Peak/Vertical
2.725	56.0	28.2	3.7	32.7	55.2	74		Peak/Horizontal
2.725	38.5	28.2	3.7	32.7	37.7		54	Average/Horizontal
3.633	48.0	30.3	3.7	32.7	49.3		54	Peak/Horizontal
4.541	47.0	32.2	4.1	31.5	51.8		54	Peak/Horizontal
5.449	42.0	33.6	4.7	31.9	48.4		54	Peak/Horizontal
6.357	40.0	34.9	5.3	31.1	49.1		54	Peak/Horizontal
7.266	40.0	36.3	5.3	32.2	49.4		54	Peak/Horizontal
8.174	40.0	36.7	5.7	33.2	49.2		54	Peak/Horizontal
9.082	41.0	37.8	5.7	34.5	50.0		54	Peak/Horizontal
Notes:	The spectrum was searched from 30 MHz to 10 GHz.							

Test Data - Radiated Emissions

Restricted Bands – DTS – High Channel

Frequency (GHz)	Meter Reading (dBuV)	Antenna Factor (dB)	Cable Loss (dB)	Pre-Amp Gain (dB)	Corrected Reading (dBuV/m)	Peak Limit (dBuV/m)	Average Limit (dBuV/m)	Detector / Polarity
2.736	64.0	28.2	3.7	32.7	63.2	74		Peak/Vertical
2.736	46.5	28.2	3.7	32.7	45.7		54	Average/Vertical
3.648	49.0	30.3	3.7	32.7	50.3		54	Peak/Vertical
4.561	53.0	32.2	4.1	31.5	57.8	74		Peak/Vertical
4.561	35.5	32.2	4.1	31.5	40.3		54	Average/Vertical
5.473	40.0	33.6	4.7	31.9	46.4		54	Peak/Vertical
6.385	41.0	34.9	5.3	31.1	50.1		54	Peak/Vertical
7.299	40.0	36.3	5.3	32.2	49.4		54	Peak/Vertical
8.209	41.0	36.7	5.7	33.2	50.2		54	Peak/Vertical
9.121	40.5	37.8	5.7	34.5	49.5		54	Peak/Vertical
2.736	59.0	28.2	3.7	32.7	58.2	74		Peak/Horizontal
2.736	41.5	28.2	3.7	32.7	40.7		54	Average/Horizontal
3.648	51.8	30.3	3.7	32.7	53.1	74		Peak/Horizontal
4.561	51.3	30.3	3.7	32.7	52.6	74		Peak/Horizontal
4.561	33.8	30.3	3.7	32.7	35.1		54	Average/Horizontal
5.473	42.0	32.2	4.1	31.5	46.8		54	Peak/Horizontal
6.385	41.0	33.6	4.7	31.9	47.4		54	Peak/Horizontal
7.299	42.0	34.9	5.3	31.1	51.1		54	Peak/Horizontal
8.209	41.0	36.3	5.3	32.2	50.4		54	Peak/Horizontal
9.121	42.0	36.7	5.7	33.2	51.2		54	Peak/Horizontal
Notes:	The spectrum was searched from 30 MHz to 10 GHz.							

Equipment: R53 Eagle

Radiated Photographs)



Section 9. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
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
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	01/14/05	01/15/07
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	03/22/04	03/23/06
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	11/12/04	11/12/05
1304	HORN ANTENNA	ELECTRO METRICS RGA-60	6151	09/22/03	09/22/05
759	ANTENNA, LOG PERIODIC	A.H. SYSTEMS SAS-200/510	556	07/23/04	07/23/05
760	Antenna biconical	Electro Metrics MFC-25	477	06/22/04	06/22/05
791	PREAMP, 25dB	ICC LNA25	398	11/12/04	11/12/05
1983	CABLE	KTL Site A OATS	N/A	03/11/05	03/11/06
802	Near Field Probe Set	EMCO 7405	103	N/A	N/A
1481	Microwave Highpass Filter	K & L 3DH1-2000/T8000-0/0	4	Cal B4 Use	N/A

ANNEX A - TEST DETAILS

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 FHSS	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: Occupied Bandwidth DTS

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

Minimum Standard: Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW: 100 kHz.

VBW: 100 kHz

Span: Sufficient to display 6 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 ($\mu\text{V/m}$ @ 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

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 (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

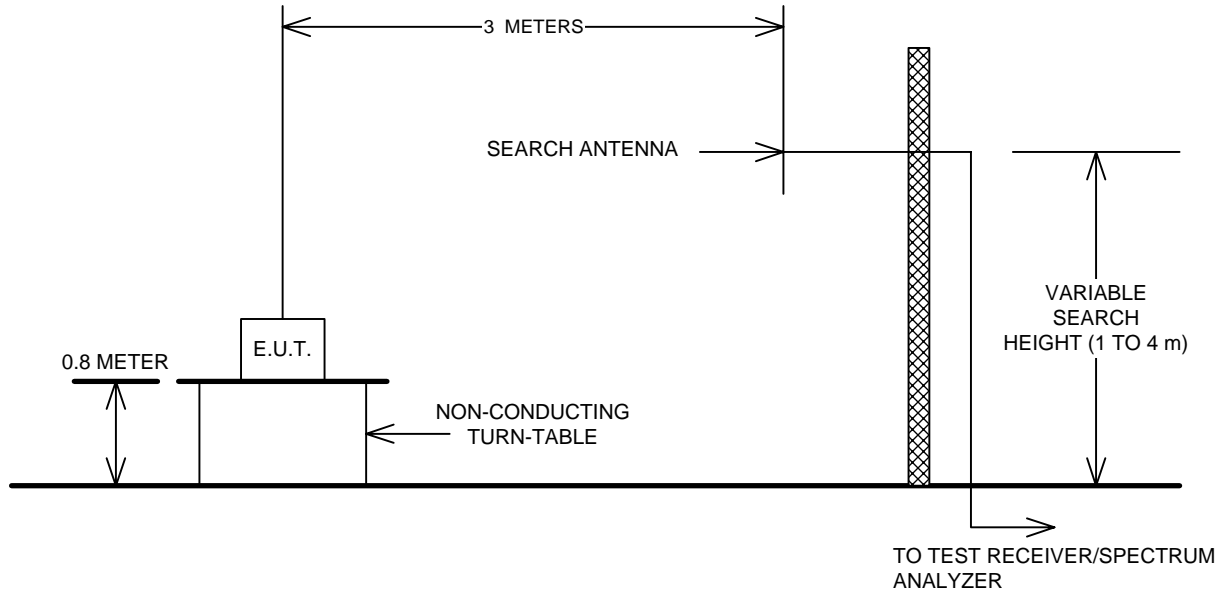
MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.125-6.218	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		

Number of channels tested:

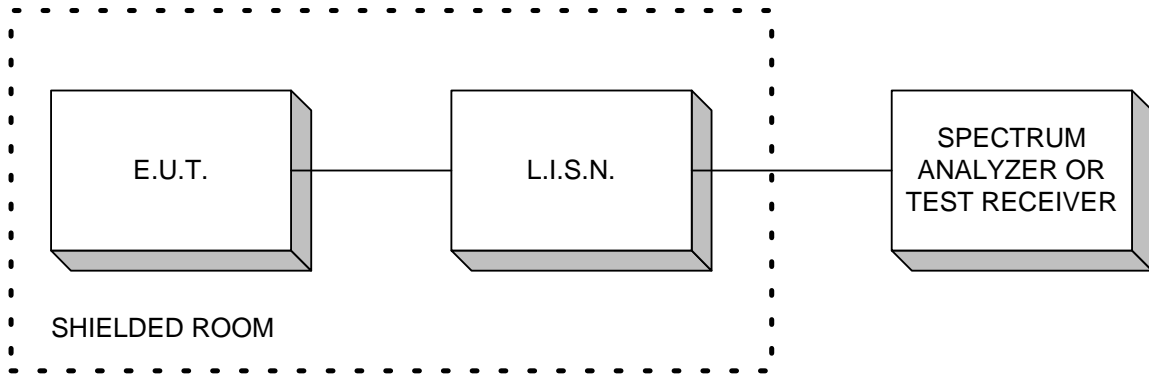
Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions



Conducted Emissions



Peak Power At Antenna Terminals

