

Nemko Test Report: 2L0466RUS1

Applicant: Navini Networks
2240 Campbell Creek Blvd. Suite # 110
Richardson, TX 75082

**Equipment Under Test:
(E.U.T.)** 2.4 GHz BTS with 17 dBi Panel Antenna

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:



Tom Tidwell, RF Group Manager

Date: 10/9/03

Total Number of Pages: 44

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Section 1. Summary of Test Results

Manufacturer: Navini Networks

Model No.: 2400-BTS with 2400-RFS-P

Serial No.: None

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 in 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

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.

See " Summary of Test Data".



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)	48 dB?V	Complies
Minimum 6 dB Bandwidth	15.247(a)(2)	>500 kHz	Complies
Maximum Peak Power Output	15.247(b)(1)	<1 Watt	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	-20 dBc/100kHz	Complies
Spurious Emissions (Restricted Bands)	15.247(c)	< 74 dBuV/m Peak < 54 dBuV/m Avg	Complies
Peak Power Spectral Density	15.247(d)	+8 dBm/3kHz	Complies

Footnotes:

The MPE prediction is submitted as a separate exhibit.

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

General Equipment Information

Frequency Band:

902 – 928 MHz

2400 – 2483.5 MHz (2.4035 to 2.4775 GHz)

5725 – 5850 MHz

Channel Spacing

250 kHz

User Frequency Adjustment:

Software controlled

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 transmitters. 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 $20\log_{10} N$, 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.

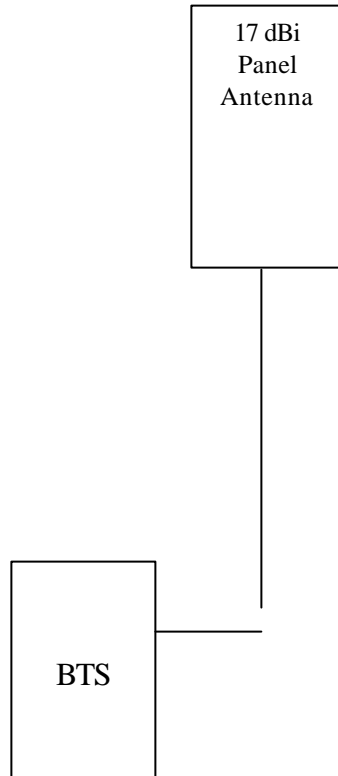
Example:

In accordance with the foregoing, the peak output power of each transmitter in the Navini beam-forming array will be reduced as follows for the 17dBi antenna system:

Total antenna gain(17 + 18)	35dB
Free gain per 15.247(b)(3)	- 6dB
Gain subject to power reduction	29dB
Power reduction per 15.247(b)(3)(i)	9.66dB
Correction for coherence loss	-2dB
Total reduction in transmitter power	7.66dB

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

System Diagram



Section 3. Powerline Conducted Emissions

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY: David Light	DATE: 9/6/2002

Test Results: Complies.

Measurement Data: See attached plots.

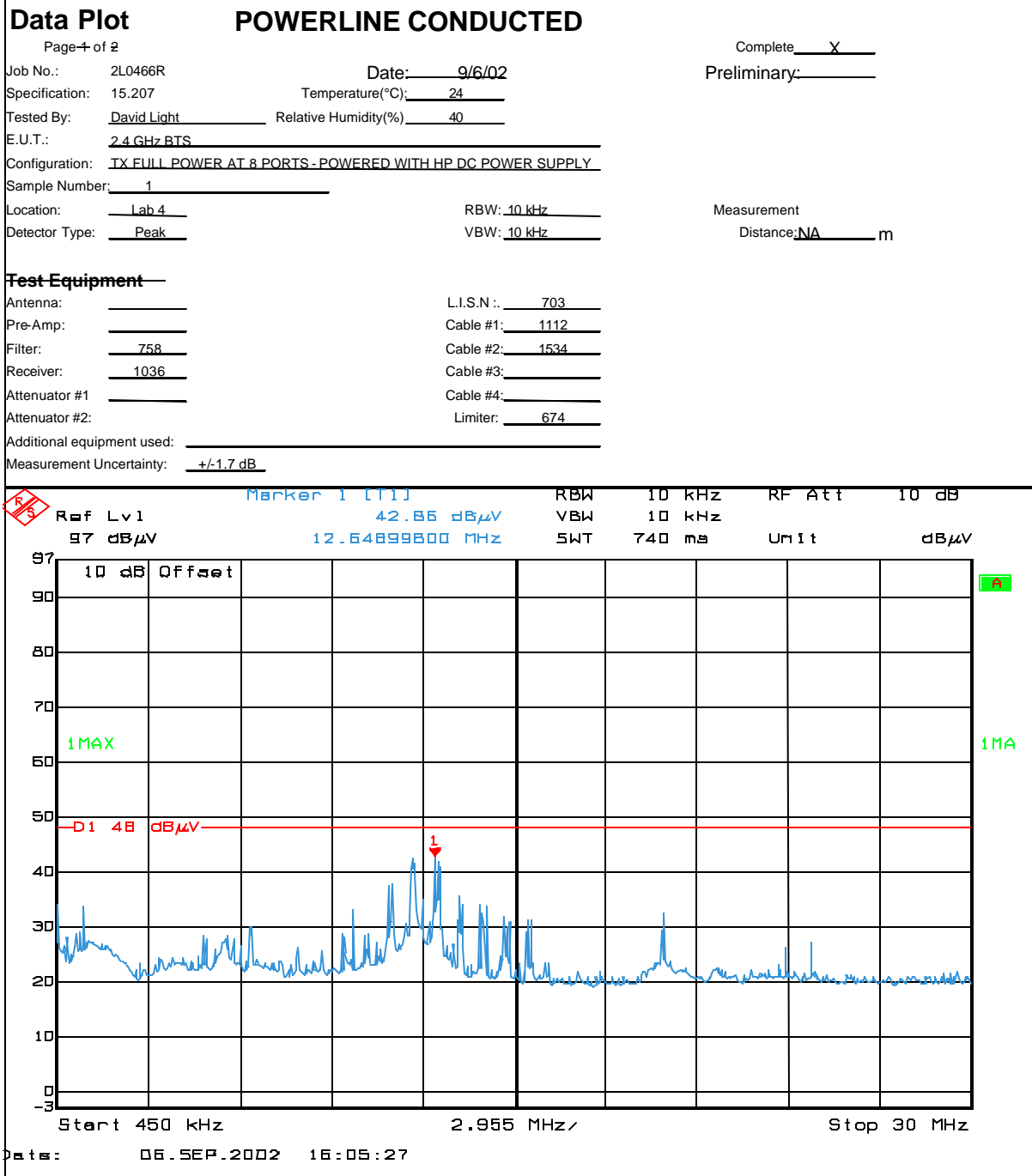
Measurement Uncertainty: +/- 1.7 dB

Test Data – Powerline Conducted Emissions



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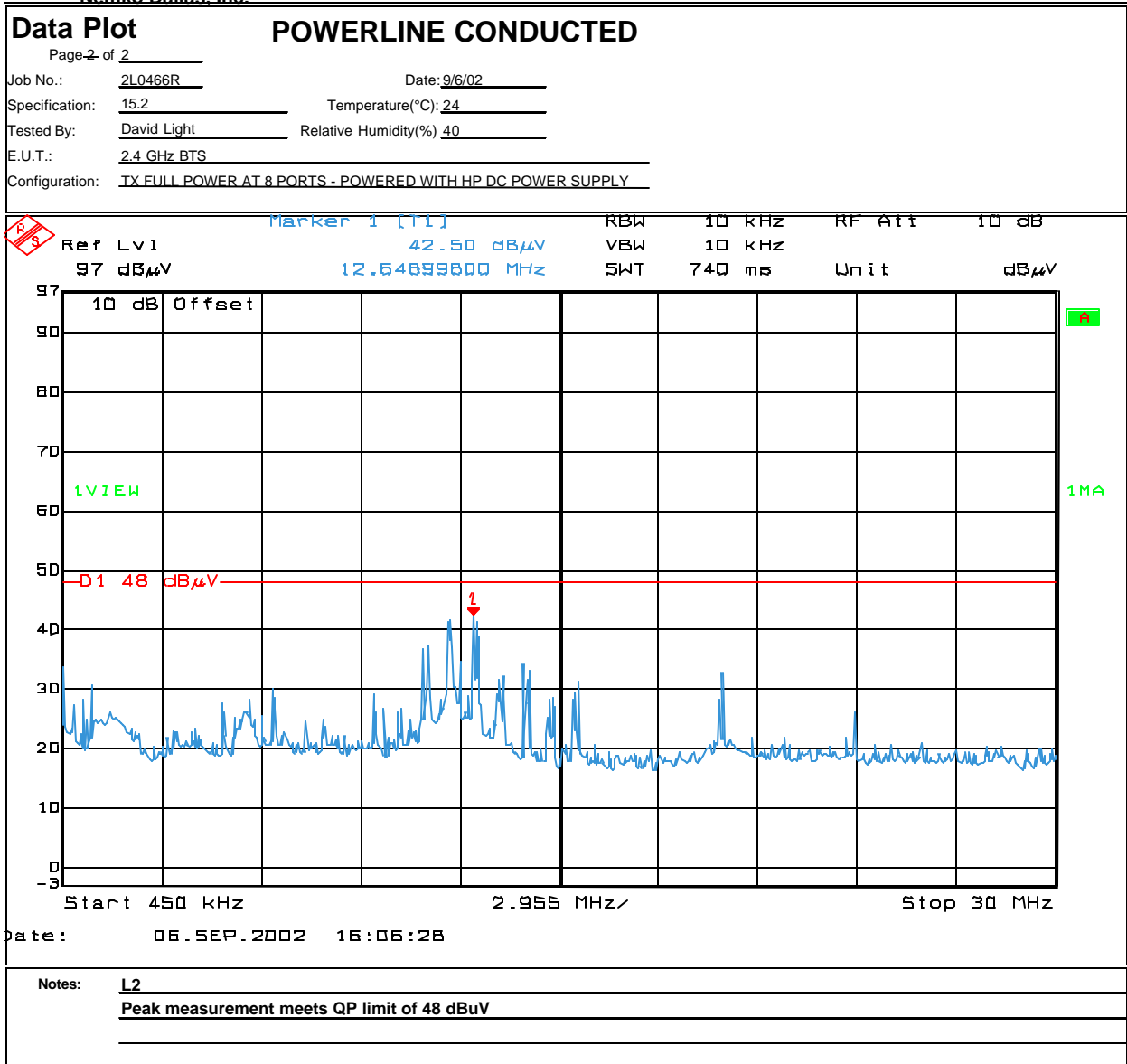


Test Data – Powerline Conducted Emissions



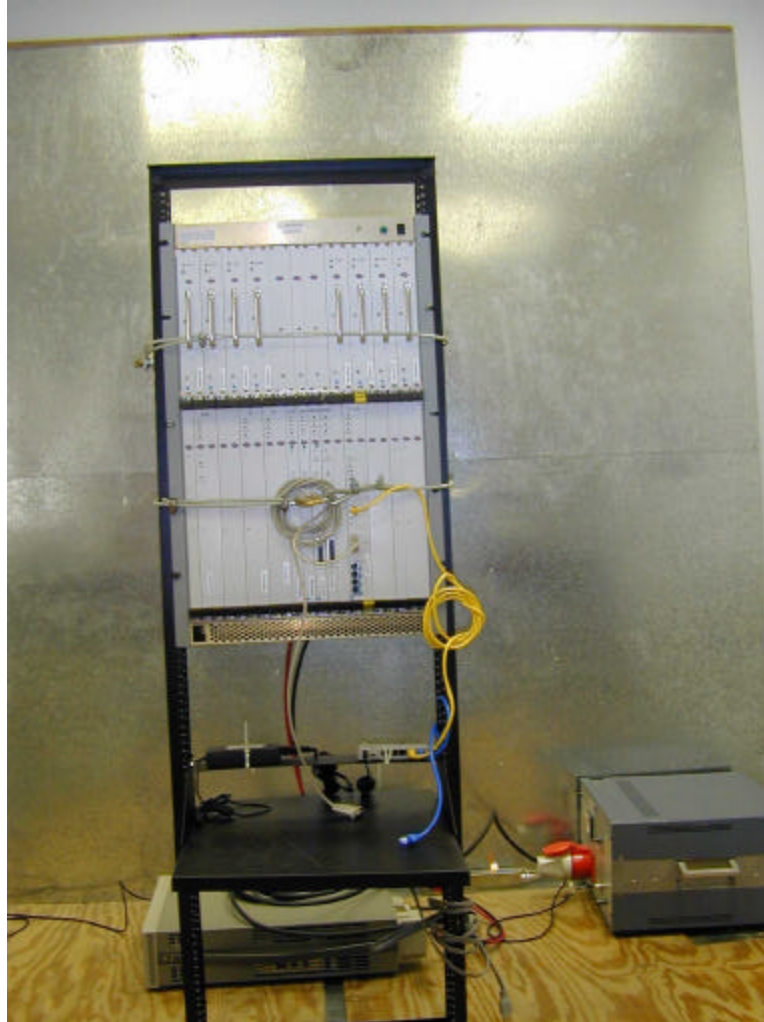
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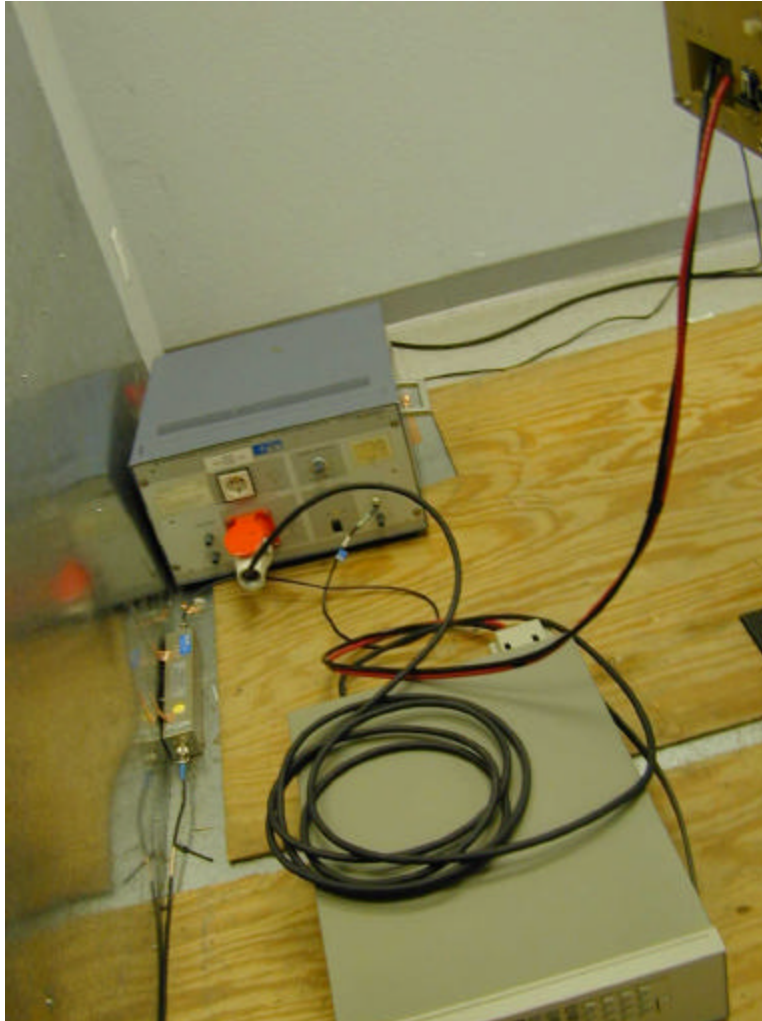


Photos – Powerline Conducted Emissions

Front



Side



Section 4. Minimum 6 dB Bandwidth

NAME OF TEST: Minimum 6 dB Bandwidth	PARA. NO.: 15.247(a)(2)
TESTED BY: David Light	DATE: 9/9/2002

Test Results: Complies.

Measurement Data: See 6 dB BW plot
Measured 6 dB bandwidth: 5 MHz

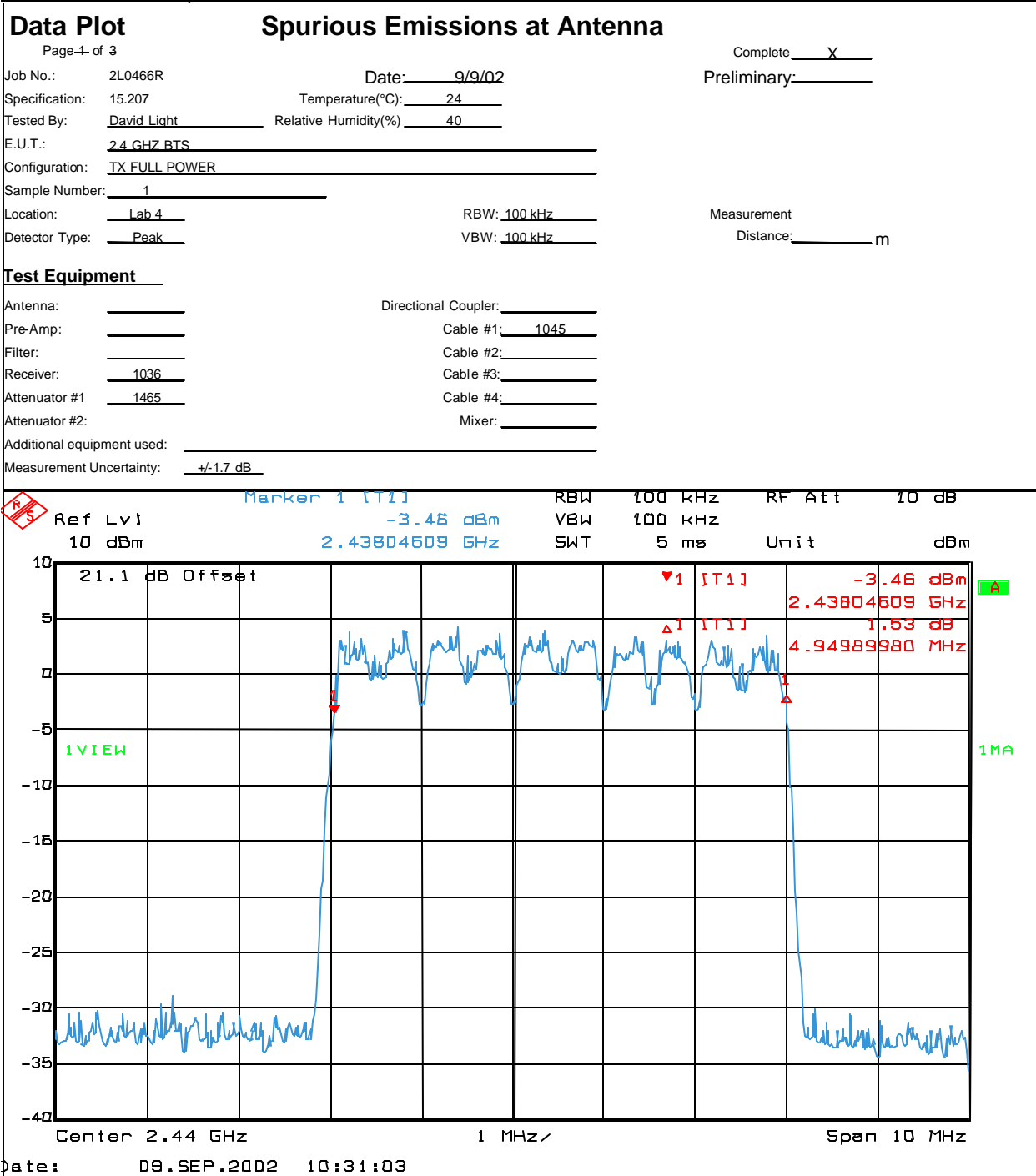
Measurement Uncertainty: +/- 1.7 dB

Plots - 6 dB Bandwidth



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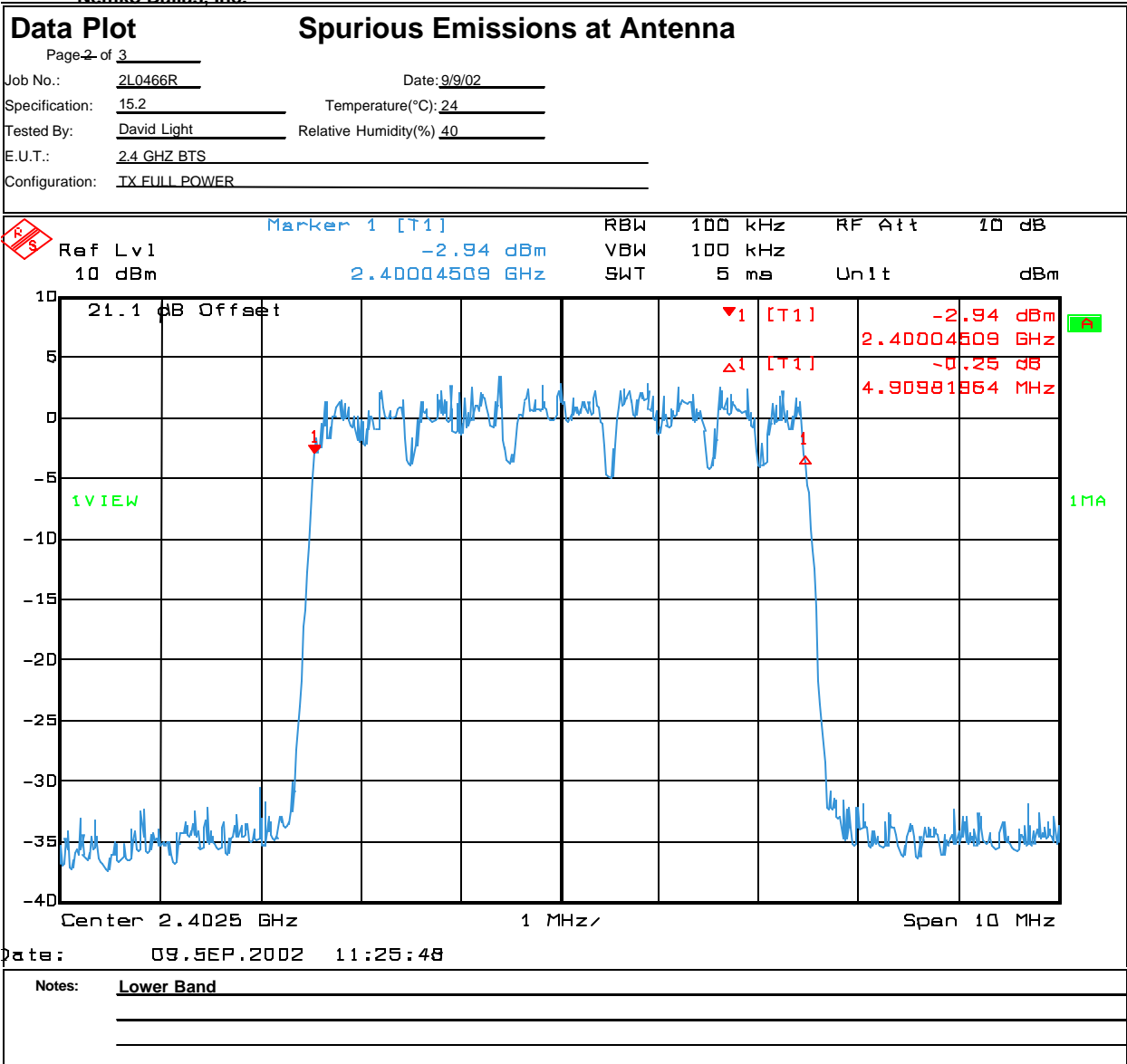


Plots - 6 dB Bandwidth



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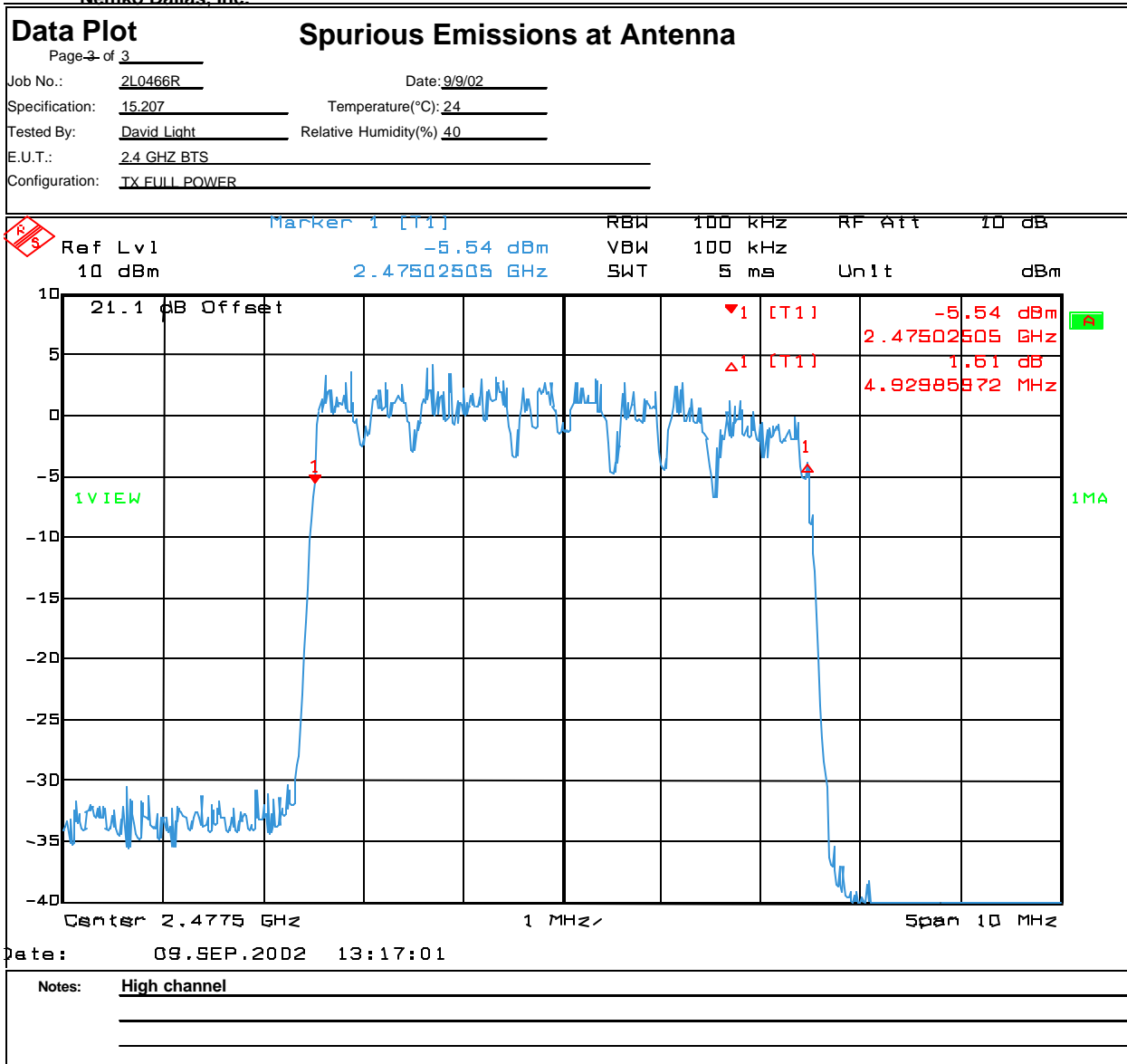
Plots - 6 dB Bandwidth



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Section 5. Maximum Peak Output Power

NAME OF TEST: Maximum Peak Output power	PARA. NO.: 15.247(b)(1)
TESTED BY: David Light	DATE: 9/9/2002

Test Results: Complies.

Measurement Data:

Frequency (MHz)	Antenna Type	Manufacturer	Peak Output Power (dBm)	Gain (dBi)	E.I.R.P. (dBm)
2440.5	Panel	Navini	22.3	17	39.3
2403.5	Panel	Navini	22.3	17	39.3
2477.5	Panel	Navini	22.3	17	39.3

The supply voltage was varied +/- 15% with no effect on output power.

Equipment Used: 1029-1030-1477

Measurement Uncertainty: +/- 0.7 dB

Temperature: 24 °C

Relative Humidity: 40 %

Section 6. RF Exposure

NAME OF TEST: RF Exposure	PARA. NO.: 15.247(b)(4)
TESTED BY:	DATE:

Test Results: Complies.

Note - Refer to separate exhibit.

Section 7. Spurious Emissions (conducted)

NAME OF TEST: Spurious Emissions (conducted)	PARA. NO.: 15.247(c)
TESTED BY: David Light	DATE: 9/9/2002

Test Results: Complies.

Measurement Data: See attached plots.

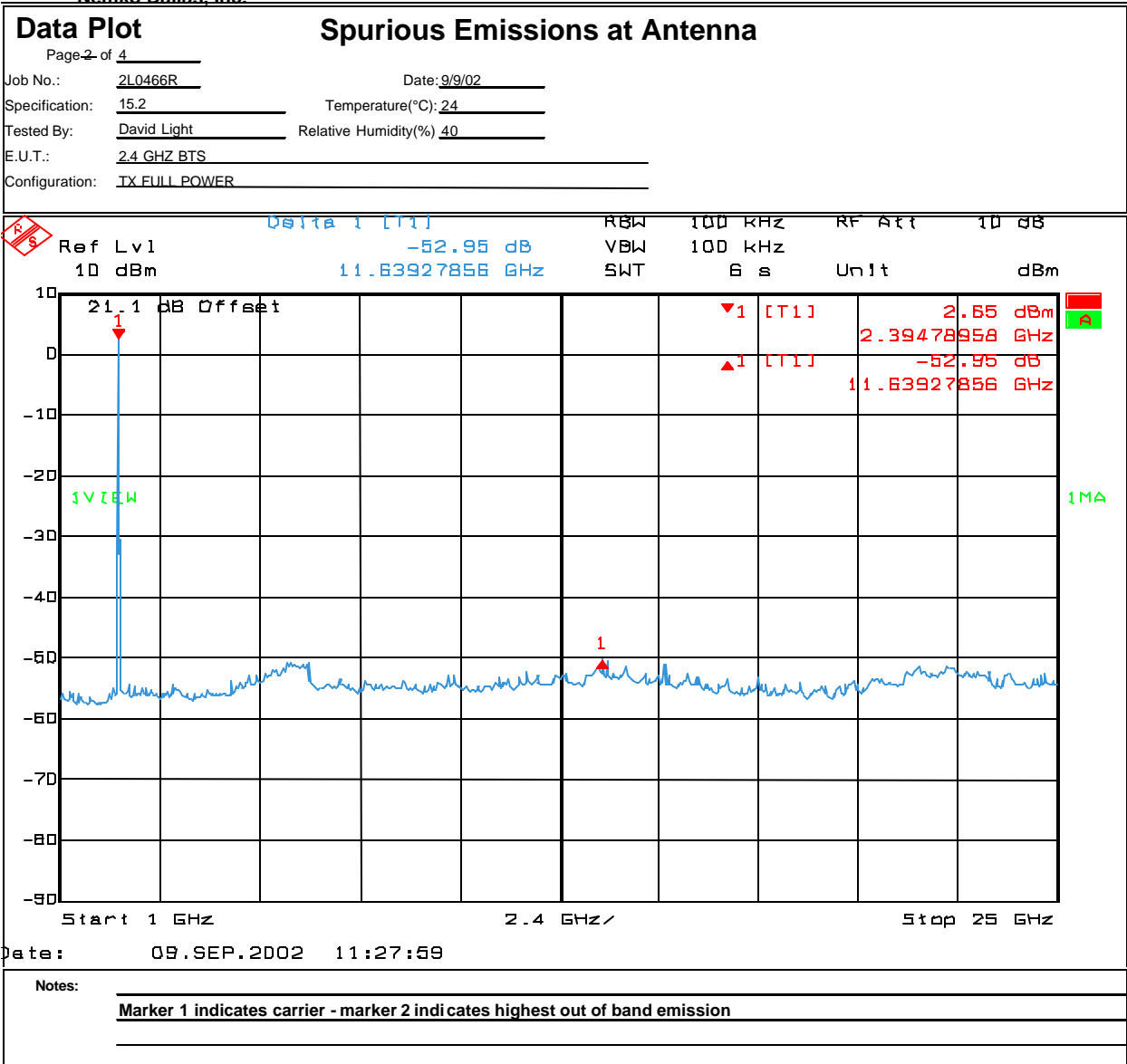
Measurement Uncertainty: +/- 1.7 dB

Test Plots – Spurious Emissions at Antenna Terminals



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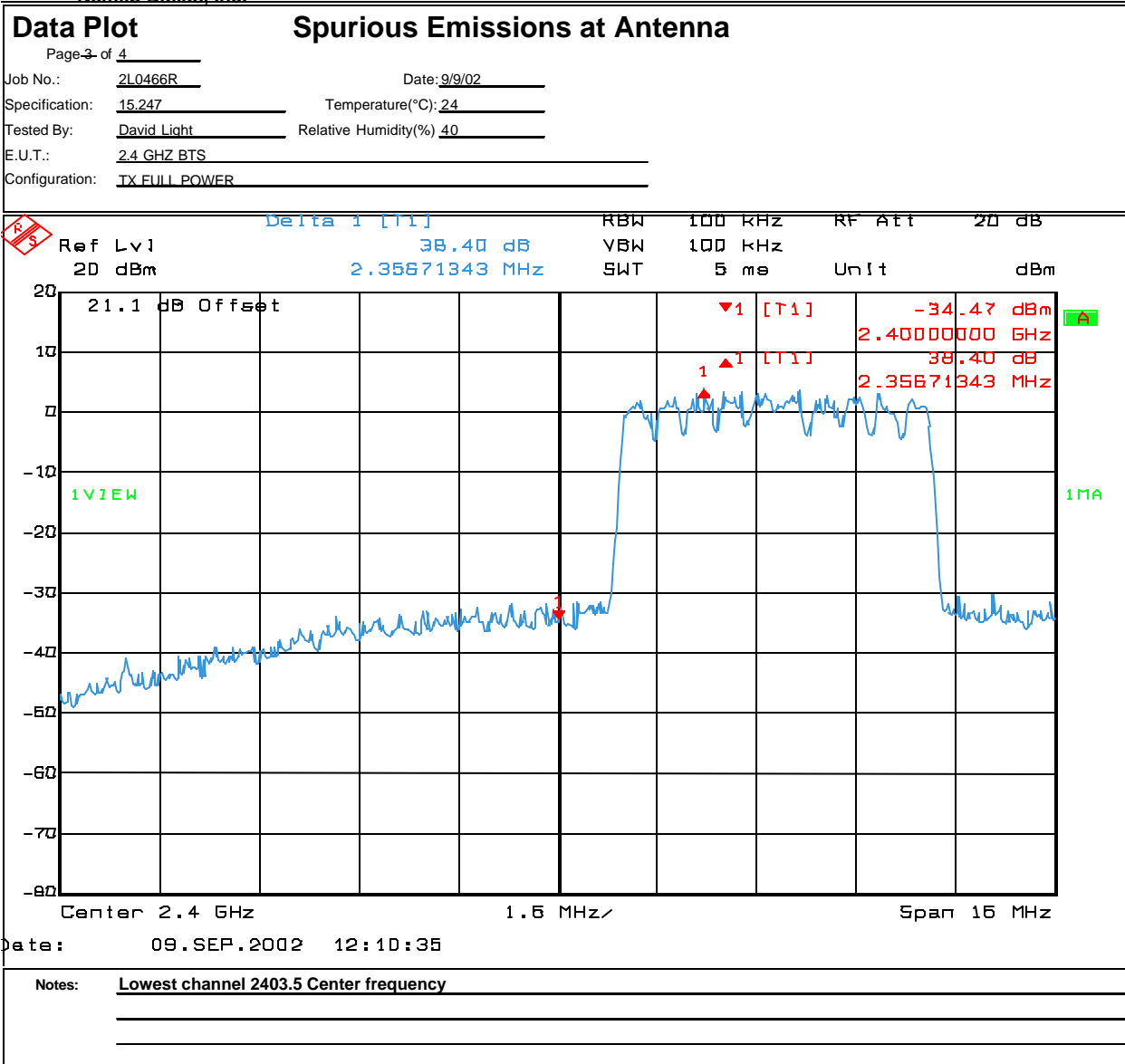
Test Plots – Spurious Emissions at Antenna Terminals



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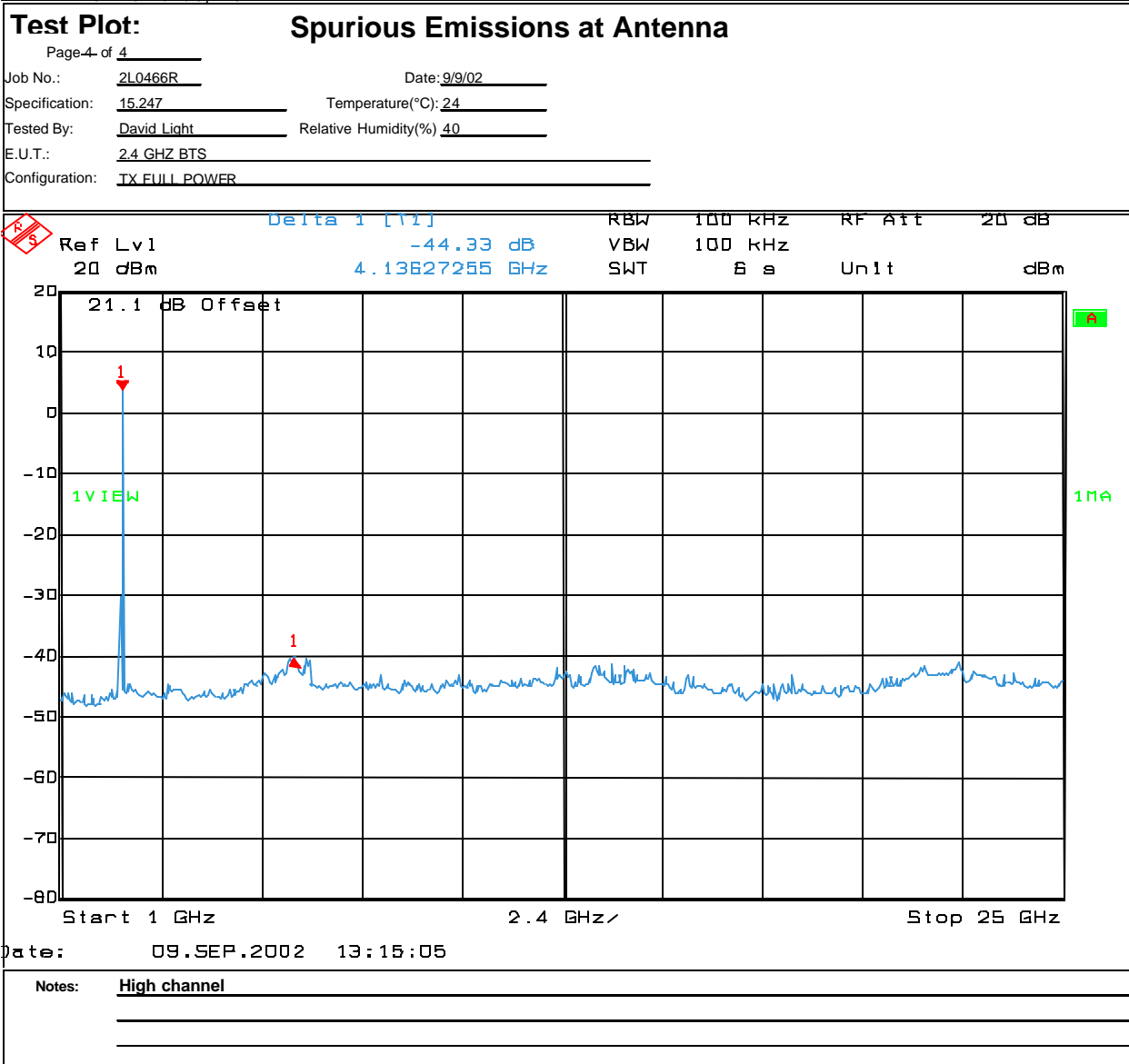
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Section 8. Spurious Emissions (radiated)

NAME OF TEST: Peak Power Output	PARA. NO.: 15.247 (c)
TESTED BY: David Light	DATE: 9/12/2002

Test Results: Complies.

Measurement Data: See attached table.

Duty Cycle Calculation:

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

Measurement Uncertainty: +/- 0.7 dB

Test Data – Radiated Emissions

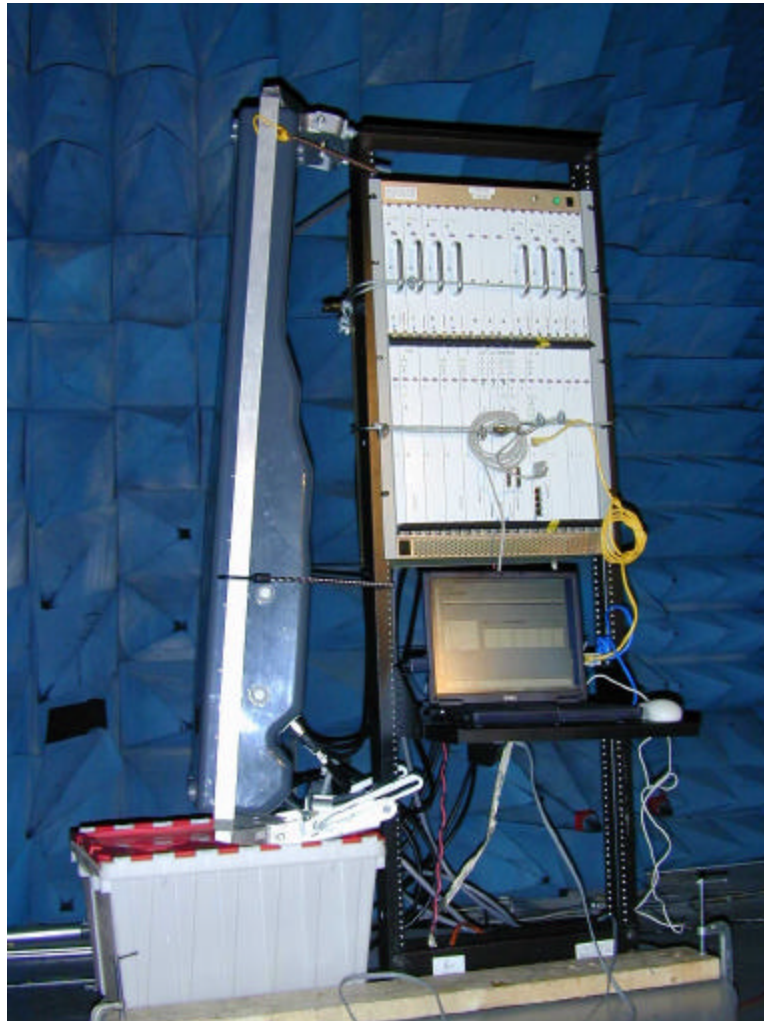


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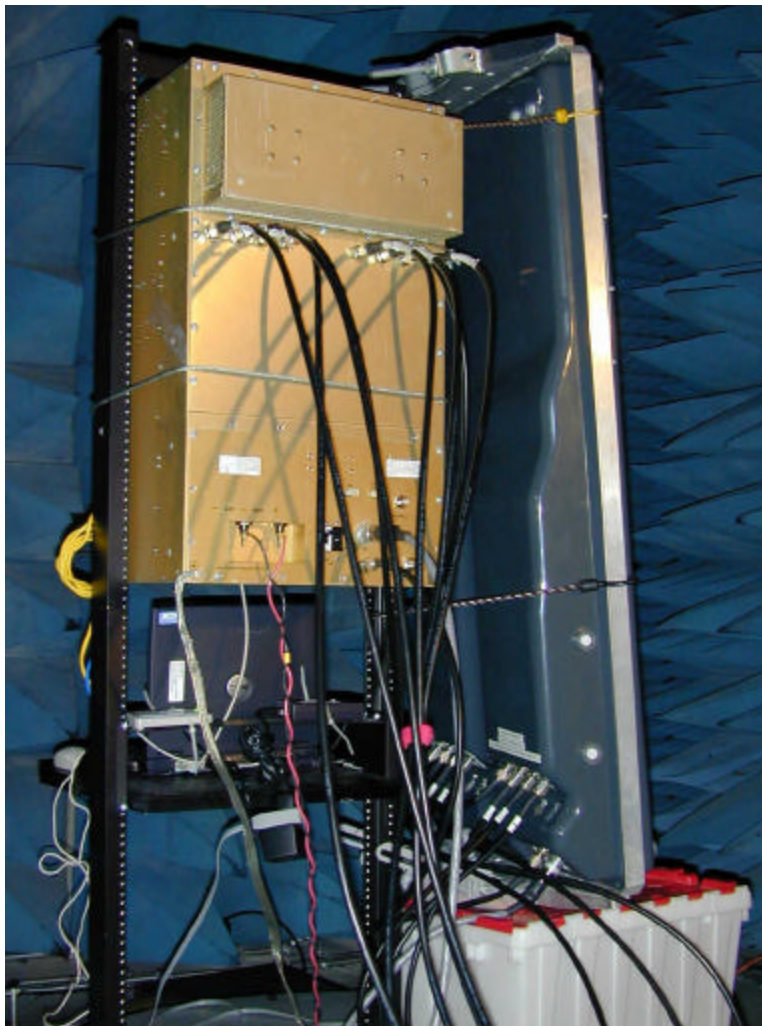
Nemko Dallas.

Radiated Emissions in Restricted Bands of								
Page 4 of 4								
Job No.:	2L0466R		Date: 9/12/02					
Specification:	15.247		Temperature (°C): 24					
Tested	David Light		Relative		40			
E.U.T.:	2.4 GHz							
Configuration:	Tx full power with full antenna array - Panel							
Sample	1							
Location:	AC 1		RBW: 1 MHz for PEAK and					
Detector	See		VBW: 1 MHz PEAK / 10 HZ					
Test Equipment								
Antenna:	1304		Directional		#N/A			
Pre-Amp:	1016		Cable		1484			
Filter:	#N/A		Cable		1485			
Receiver:	1036		Cable		#N/A			
Attenuator	#N/A		Cable		#N/A			
Attenuator	#N/A		Mixer:		#N/A			
Additional equipment	_____							
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
2.4835	25.4	28.2	3.1	0	56.7	74	-17.3	Peak reading-Horizontal
2.4835	17.8	28.2	3.1	0.0	49.1	54	-4.9	Average reading-Horizontal
4.9573	36.2	33.8	4.3	29.6	44.7	54	-9.3	Peak reading-Horizontal
7.4324	35.4	36.2	5.3	34.1	42.8	54	-11.2	Peak reading-Horizontal
12.387	37.3	39.9	7.3	32.7	51.8	54	-2.2	Peak reading-Horizontal
2.4835	28	28.2	3.1	0	59.3	74	-14.7	Peak reading-Vertical
2.4835	19.4	28.2	3.1	0	50.7	54	-3.3	Average reading-Vertical
4.9573	37.4	33.8	4.3	29.6	45.9	54	-8.1	Peak reading-Vertical
7.4324	38.5	36.2	5.3	34.1	45.9	54	-8.1	Peak reading-Vertical
12.3874	37.2	39.9	7.3	32.7	51.7	54	-2.3	Peak reading-Vertical
								Tx at 2.4405 Ghz
4.881	36.5	33.5	4.3	29.9	44.4	54	-9.6	Peak reading-Vertical
7.3215	35	36.1	5.2	34.2	42.1	54	-11.9	Peak reading-Vertical
12.2025	37.4	40.0	7.3	33.0	51.7	54	-2.3	Peak reading-Vertical
4.881	36.8	33.5	4.3	29.9	44.7	54	-9.3	Peak reading-Horizontal
7.3215	35.6	36.1	5.2	34.2	42.7	54	-11.3	Peak reading-Horizontal
12.2025	33.9	40.0	7.3	33.0	48.2	54	-5.8	Peak reading-Horizontal
								Tx at 2.4035 GHz
4.8070	36.8	33.3	4.2	30.1	44.2	54	-9.8	Peak reading-Horizontal
12.0175	37.1	40.0	7.3	33.5	50.9	54	-3.1	Peak reading-Horizontal
4.807	36.6	33.3	4.2	30.1	44.0	54	-10.0	Peak reading-Vertical
12.0175	37.7	40.0	7.3	33.5	51.5	54	-2.5	Peak reading-Vertical

Radiated Photographs (Worst Case Configuration)



Radiated Photographs (Worst Case Configuration)



Section 9. Peak Power Spectral Density

NAME OF TEST: Peak Power Spectral Density	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE: 9/9/2002

Test Results: Complies.

Measurement Data: See attached plots.

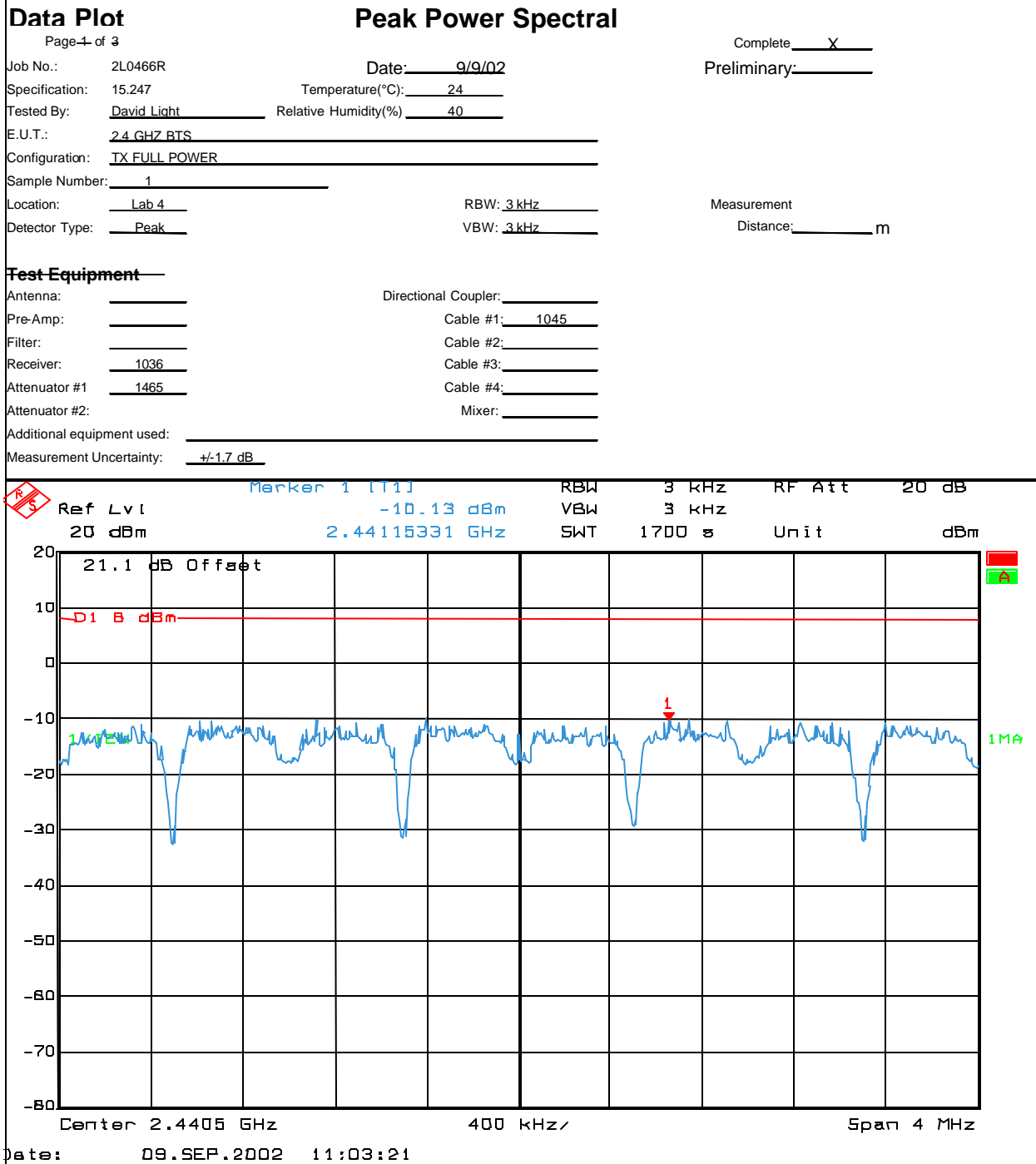
Measurement Uncertainty: +/- 1.7 dB

Test Plots – Spectral Density



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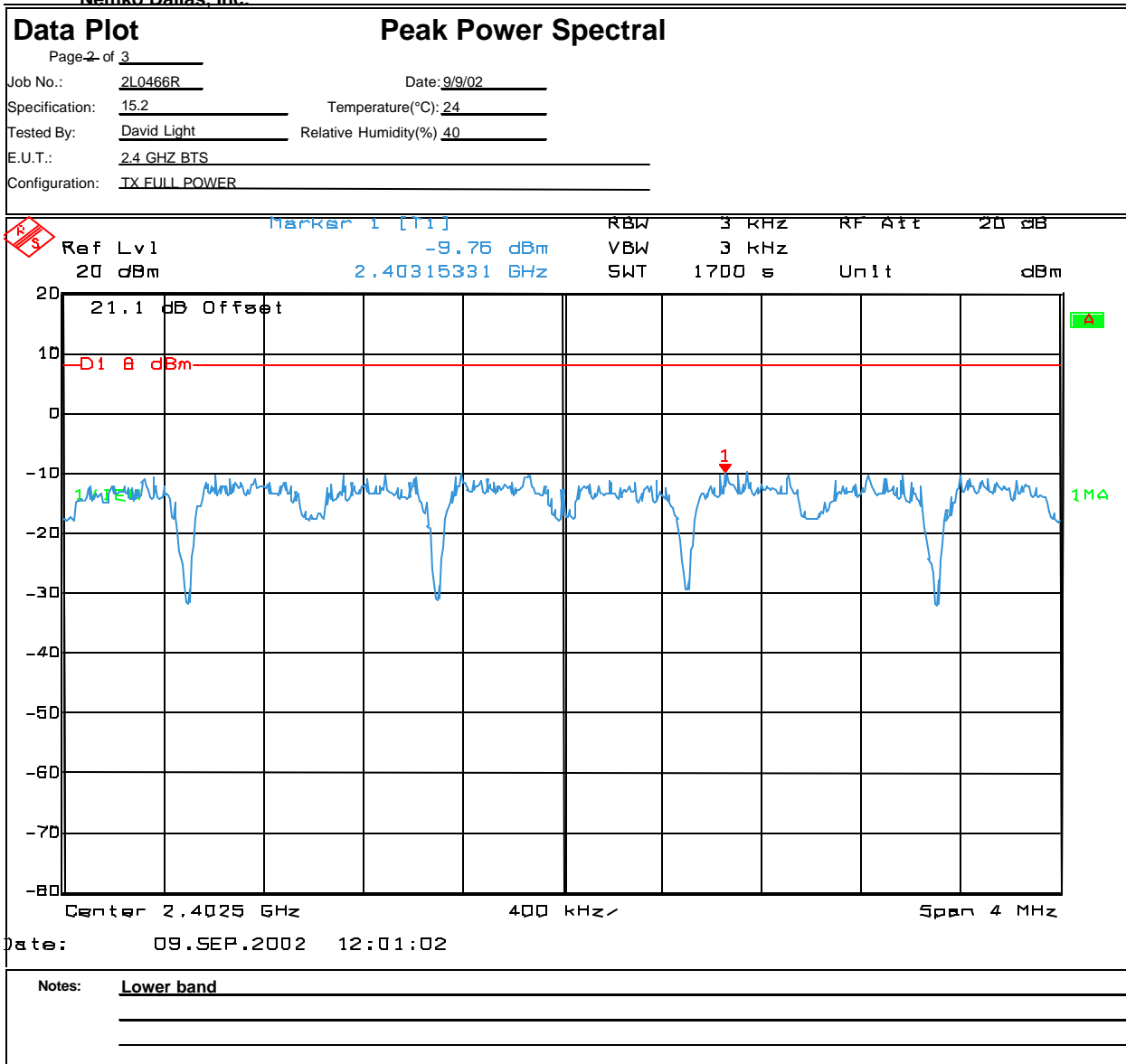


Test Plots – Spectral Density



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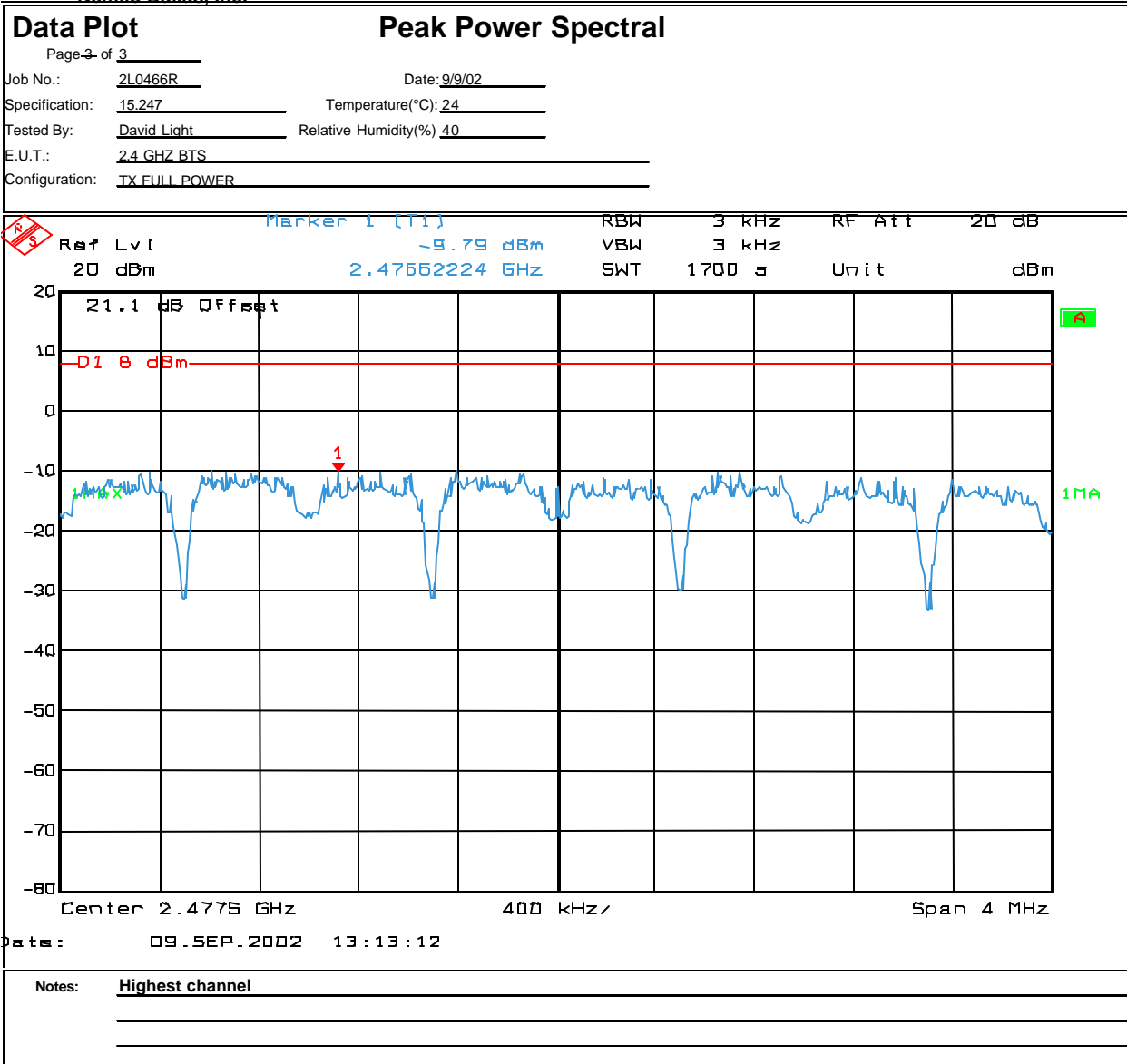
Test Plots – Spectral Density



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Section 10. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	12/18/01	12/19/03
1465	10 db Attenuator DC 8.0 Ghz	Midwest Microwave 292/10db	NONE	CBU	N/A
1045	CABLE 2m	Astrolab Inc. 32027-2-29094-72TC	N/A	CBU	N/A
1304	HORN ANTENNA	ELECTRO METRICS RGA-60	6151	07/30/01	07/31/03
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	07/15/02	07/15/03
1484	Cable 2.0-18.0 Ghz	Storm PR90-010-072	N/A	07/15/02	07/15/03
1485	Cable 2.0-18.0 Ghz	Storm PR90-010-216	N/A	07/15/02	07/15/03
758	HIGH PASS FILTER	SOLAR 7930-5.0	197	07/18/01	07/18/02
703	LISN	Schwarz Beck 8020	8020350	08/09/02	08/09/03
1112	Cable 1.1m	KTL RG223	0	03/05/02	03/05/03
1534	CABLE, 9M	KTL RG223	NA	08/06/02	08/06/03
674	LIMITER	HP 11947A	3107A02200	CBU	N/A

ANNEX A - TEST DETAILS

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.

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

The minimum 6 dB bandwidth shall be at least 500 kHz

NAME OF TEST: Maximum Peak Output Power

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

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 $GP/4\pi R^2 = E^2/120\pi$ 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 6 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: RF Exposure	PARA. NO.: 15.247(b)(4)
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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.

NAME OF TEST: Spurious Emissions(conducted)	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 (? 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 IS SEARCHED TO THE 10th HARMONIC OF THE HIGHEST FREQUENCY GENERATED IN THE EUT.

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 ?: 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 ?: 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 (? 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

NAME OF TEST: Transmitter Power Density	PARA. NO.: 15.247(d)
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Minimum Standard: The transmitted power density averaged over any 1 second interval shall not be greater than +8 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 bandwidth
- Sweep: Span(kHz)/3 (i.e. for a span of 1.5 MHz the sweep rate is 1500/3 = 500 sec.
- LOG dB/div.: 2 dB

Note: For devices with spectrum line spacing ≤ 3 kHz, the RBW of the analyzer is reduced until the spectral lines are resolved. The measurement data is normalized to 3 kHz by summing the power of all the individual spectral lines within a 3 kHz band in linear power units.

For Devices With Integral Antenna:

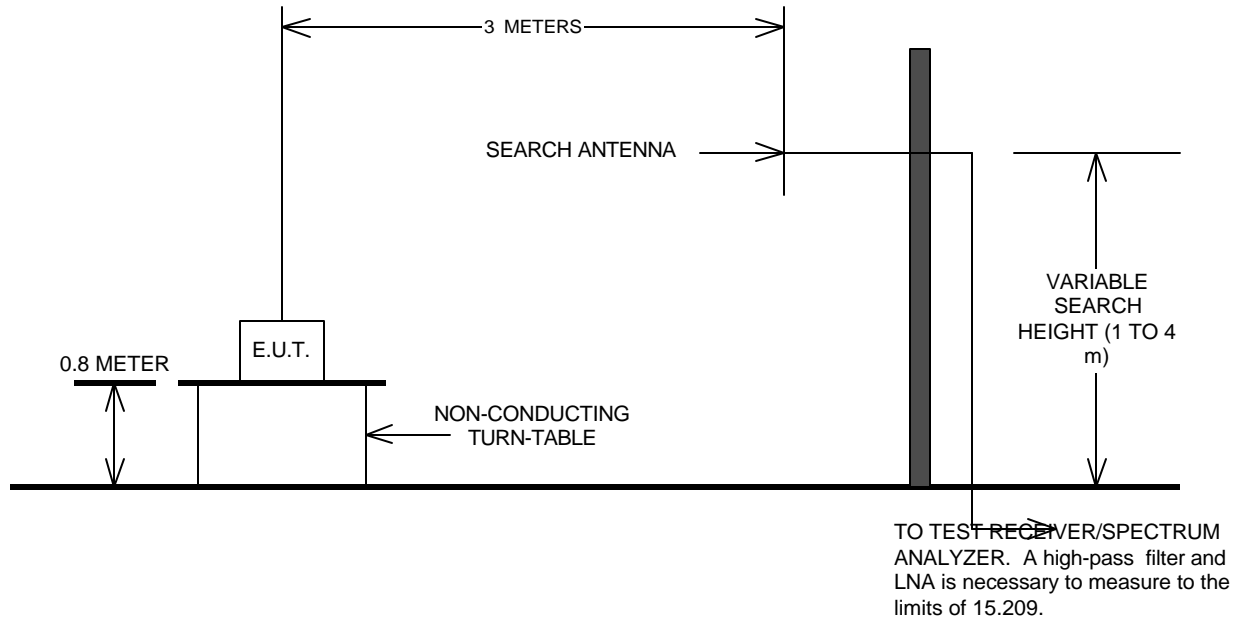
For devices with non-detachable antennas, the received field strength is peaked and the spectrum analyzer is set as above. The peak emission level is then measured and converted to a field strength by adding the appropriate antenna factor and cable loss. This field strength is then converted to an equivalent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

Number of channels tested:

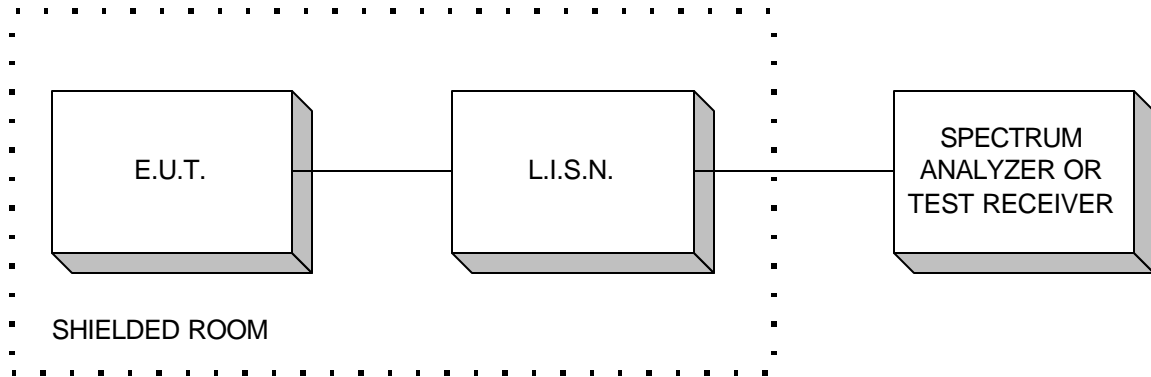
Tuning Range	Number Of Channels Tested	Channel Location In Band
1 MHz or Less	1	Middle
1 to 10 MHz	2	Top And Bottom
More Than 10 MHz	3	Top, Middle, Bottom

ANNEX B - TEST DIAGRAMS

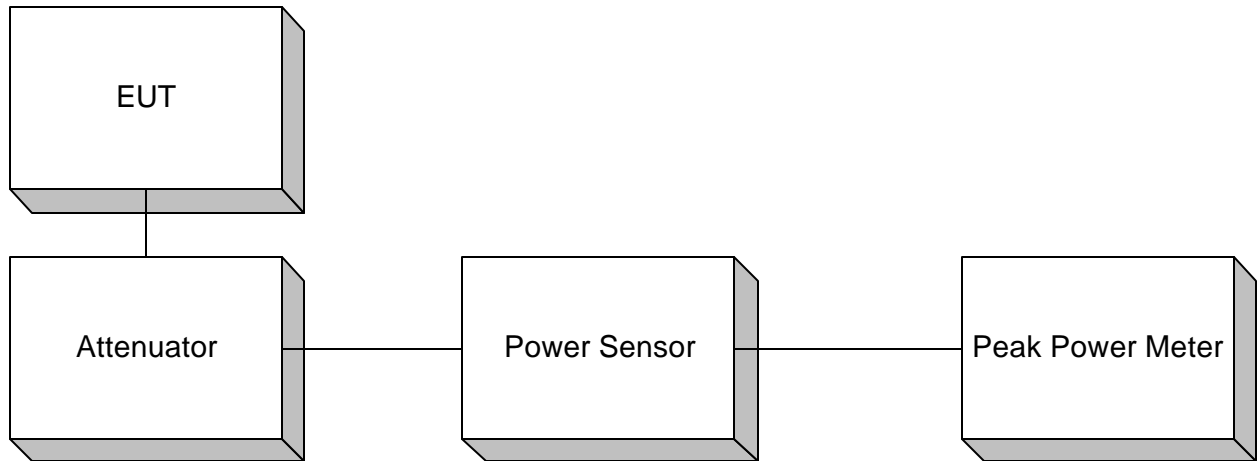
Test Site For Radiated Emissions



Conducted Emissions



Peak Power At Antenna Terminals



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

