FCC ID: PD9WCF2011BM

Exhibit 2

Engineering Reports (Test Reports)

a) Maximum Peak Output Power 15.247(b)(3)(4)
b) Spurious Emissions 15.247(c), Restricted Bands, Bandedge
c) Peak Power Spectral Density 15.247(d)

Assessment of Compliance

of

Direct Sequence Spread Spectrum System

In Accordance with

FCC Part 15.247, Direct Sequence Spread Spectrum System: Maximum Peak Output Power, Spurious Emissions, Restricted Bands, Band Edge & Peak Power Spectral Density

PRO/Wireless 2011B LAN CF Card
WCF2011BM

Intel Corporation

APREL Project No.: ITLB-PRO/Wireless 2011 LAN CF-3983

51 Spectrum Way Nepean ON K2R 1E6
Tel: (613) 820-2730 Fax: (613) 820-4161
email: info@aprel.com

Engineering Report

Subject: **Assessment of Compliance in accordance with the FCC Part 15.247, Direct Sequence Spread Spectrum System: Maximum Peak Output Power, Spurious Emissions, Restricted Bands, Band Edge & Peak Power Spectral Density**

FCC ID: **PD9WCF2011BM**

Equipment: **PRO/Wireless 2011B LAN CF Card**

Model: **WCF2011BM**

Client: **Intel Corporation**
2300 Corporate Centre Drive
Thousand Oaks, CA 91320.

Project #: ITLB-PRO/Wireless 2011 LAN CF-3983

Prepared By: **APREL Laboratories,**
Regulatory Compliance Division
51 Spectrum Way
Nepean, Ontario
K2R 1E6

Approved by: _____ Date: Feb. 28, 2003
Jay Sarkar,
Technical Director, Standards & Certification

Submitted by: _____ Date: Feb. 28, 2003
Jay Sarkar,
Technical Director, Standards & Certification

Released by: _____ Date: Feb. 28/03
Dr. J.J. Wojcik, P.Eng.

Table of Contents

Engineering Summary	4
Introduction	5
Product Information	6
FCC Submission Information	7
Sections: Description of Tests	
a. Maximum Peak Output RF Power	9
b. Radiated Spurious Emissions & Restricted Bands	14
c. Peak Power Spectral Density (Transmitter)	46

Test Equipment List: See Appendix A

FCC ID: **PD9WCF2011BM**
Applicant: Intel.
Equipment: **PRO/Wireless 2011B LAN CF Card**
Models: **WCF2011BM**
Standard: FCC Rules and Regulations Parts 15.247, 15.205, 15.209

ENGINEERING SUMMARY

This report contains the measurement results of the engineering evaluation performed on an **Intel PRO/Wireless 2011B LAN CF Card, henceforth referred to as the Device Under Investigation (DUI).** The measurements were carried out in accordance with the FCC Rules and Regulations Parts 15.247, 15.205 and 15.209. The product was evaluated when it was set at the maximum power**.**

The DUI was evaluated for Class II Permissive Change.

The Intel **PRO/Wireless 2011B LAN CF Card** is a Direct Sequence Spread Spectrum System. The unit was set to operate in continuous mode.

The DUI is equipped with permanently attached (non-detachable) antennas, as such, measurements for the Restricted Bands were performed as radiated, with appropriate correction factor applied. All other measurements were performed as conducted measurements after an additional connector was attached to the circuit at the antenna feeding point.

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

Compliance Summary

Test Description	Page No.	Compliance Summary Pass/Fail
Maximum Peak Output RF Power (conducted) Ref Paragraph FCC Part 15.247 (b)	9	Pass
Spurious Emissions, restricted bands & Band Edge (conducted) Ref Paragraph FCC Part 15.247 (c)	14	Pass
Peak Power Spectral Density (conducted) Ref Paragraph FCC Part 15.247 (d)	46	Pass

INTRODUCTION

General

This report describes the results of the Compliance test under FCC Part 15.247, 15.205, 15.209 conducted on an Intel **PRO/Wireless 2011B LAN CF Card**, **model no. WCF2011BM.**

Measurement Facility

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

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

APREL is accredited by Standard Council of Canada. APREL is also accredited by Industry Canada and recognised by the Federal Communications Commissions (FCC).

Standard

The evaluation and analysis were conducted in accordance with FCC Rules and Regulations Parts 15.247, 15.205.

Report: This report was written by Jay Sarkar, Technical Director, Standards and Certification.

Test Equipment

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

Environmental Conditions

- Temperature:	15 °C ± 2
- Relative Humidity:	30 – 50 %
- Air Pressure:	101 kPa ± 3

Product Information

Equipment Description

The Device Under Investigation (DUI) is the Intel **PRO/Wireless 2011B LAN CF Card** Direct Sequence Spread Spectrum System.

This is an application for Class II Permissive Change.

Equipment:	Intel PRO/Wireless 2011B LAN CF Card
Model:	WCF2011BM
Frequency Range:	2412 MHz – 2462 MHz
Channels:	11
Channel Separation:	5 MHz
Spread Spectrum Method:	Direct Sequence
Max RF Power Output:	20.3 dBm (107 mW)
Antenna Gain:	2.0 dBi
Antenna Type:	PCB Chip, Model Trilogy CF
Ports/Connector(s):	N/A

FCC SUBMISSION INFORMATION

FCC ID:	**PD9WCF2011BM**
Equipment, (Type):	**PRO/Wireless 2011B LAN CF Card (Direct Sequence Spread Spectrum System)**
Model:	**WCF2011BM**
For:	Class II Permissive Change
Complies to:	FCC Rules Part 15.247, 15.205, 15.209
Applicant:	**Intel Corporation** **2300 Corporate Center Drive** **Thousand Oaks, CA 91320**
Evaluated by:	**APREL Laboratories** 51 Spectrum Way Nepean, Ontario Canada K2R 1E6

Test Description

And

Measurement Results

PRO/Wireless 2011B LAN CF Card

WCF2011BM

Intel

Test: Maximum Peak Output RF Power

Ref.: **FCC Part 15.247(b)(3)&(4)**

Criteria: The maximum peak output power shall not exceed 1 watt (30 dBm). If directional transmitting antennas with a gain of more than 6 dB are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dB.

Condition: Conducted Test.

Procedure: The maximum peak output power was measured by conducted method. The DUI was configured to operate at maximum power and the antenna port was connected to the power meter via cable and a suitable attenuator. Tests were done for Low (2412MHz), medium (2437MHz) and high (2462MHz) channels. Results are shown in table a1.

Equipment: See Appendix A.

Test Set-up: See Figure No. a1.

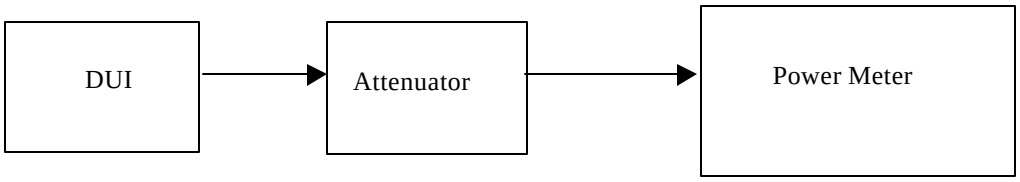


Figure a1**: Test set-up for the Conducted Power Measurement**

Table a1.
Maximum Peak Output RF Power: Conducted

FREQ (MHz)	Channel	Measured Power (dBm)	Attenu. (dB)	Output Power (dBm)	Output Power (mW)	Limit (dBm)	Margin (dB)	Pass/Fail
2412	Low	0.0	20.3	20.3	107.2	30.0	9.7	Pass
2437	Medium	-0.5	20.3	19.8	95.5	30.0	10.2	Pass
2462	High	-0.5	20.3	19.8	95.5	30.0	10.2	Pass

Test performed by: Yinghi Chen **Date:** Feb. 2003

Conclusion: Pass. Since the gain of the built-in antenna specified by manufacturer (G_{ant} = 2.0 dBi) does not exceed 6.0 dBi there was no need to reduce the output power.

Pictures of Test Setup

Intel – 2011B LAN CF Card
Maximum Peak Output RF Power Measurement (Conducted)

Test: Spurious Emissions & Restricted Bands

Ref.: FCC Part 15.247 (c), 15.205

Criteria: 1) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required.

2) **Restricted Bands**: In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Condition: Radiated Test

Set-up: See Figure b1

Equipment: See Appendix A

Methodology: 1) RF Antenna Conducted Test: The DUI was configured to operate at maximum power and the antenna port was connected to the spectrum analyser via an attenuator.
Set the spectrum analyser as following: RBW = 100KHz, VBW = 300KHz, scan up through 10^{th} harmonic. Record harmonics/spurs.

2) Tests for Restricted Bands: The preliminary radiated emission measurement was performed according to the description of ANSI C63.4 – 1992 Sec.8.3.1.1 in a semi anechoic shielded room in order to determine the characteristic frequencies of the radiation and record all frequencies that fall into the restricted bands.

Based on this information, measurements were performed in the open area test site at these characteristic frequencies. APREL Open Area Test Site is calibrated to ANSI C63.4-1992 and is filed with FCC. The test site is characteristically flat, free of reflecting structures. All reflecting objects, including test personnel, lie outside the perimeter of the ellipse (defined in

ANSI C63.4-1992) or below the ground plane level. The horizontal and vertical site attenuation measurements are within ± 4 dB of the theoretical site attenuation of an ideal site. The DUI was placed on a turntable positioned 3 meters away from the receiving antenna, which in turn was connected to the spectrum analyzer. The DUI was operated in a manner that produced the highest emissions.

For each frequency, the received signal was maximized by appropriate positioning of the turntable and the height of the receiving antenna. The height of the antenna was adjusted between 1 m and 4 m in height above the ground plane. The turntable was rotated 360° from a remote control to maximize the emissions. The process was repeated for both horizontal and vertical polarization. All cables were arranged for maximum emission.

Radiated RF emission levels measured were identified as having been emitted by the DUI. Measurements were performed using the spectrum analyzer employing a CISPR quasi-peak detector function and 120 kHz bandwidth on frequencies from 30 MHz to 960 MHz, and for frequencies above 960 MHz employing an average detector function and 1 MHz resolution bandwidth. All measurements were performed at discrete frequencies.

In addition, peak measurements were performed to ensure that the peak levels did not exceed 20dB of the average limit. All out of band emissions, if fall into the restricted band must not exceed the limits in the following table per FCC §15.209, Radiated Emission limits, general requirements.

Table b1: Restricted Bands per §15.205

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
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
6.215 - 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 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285	3600 - 4400	Above 38.6
13.36 - 13.41	322 - 335.4		

Table b2: Radiated Emission Limits per §15.209

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)	**(meters)**
0.009 – 0.490	$2400/F_{(kHz)}$	$20 \cdot \log_{10}(2400/F_{kHz})$	300
0.490 – 1.705	$24000/F_{(kHz)}$	$20 \cdot \log_{10}(24000/F_{kHz})$	30
1.705 – 30.00	30	29.5	30
30.0 – 88.0	100	40.0	3
88.0 – 216.0	150	43.5	3
216 - 960	200	46.0	3
Above 960	500	54.0	3

Note: The emissions from an intentional radiator, which fall in the restricted bands as shown in table b1, shall not exceed the field strength levels specified in table b2.

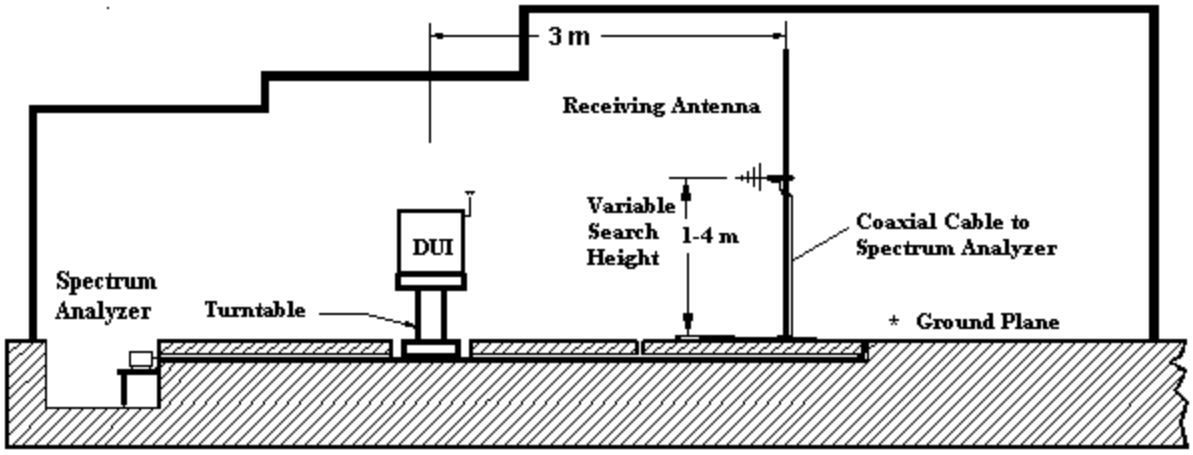


Figure b1.a Test set up for the Field Strength of Spurious Radiation Measurement in OATS (Not to scale)

Fig. b1.b APREL's OATS (Open Area Test Site)

Test Results: Test data is tabulated in Tables b3 and b4

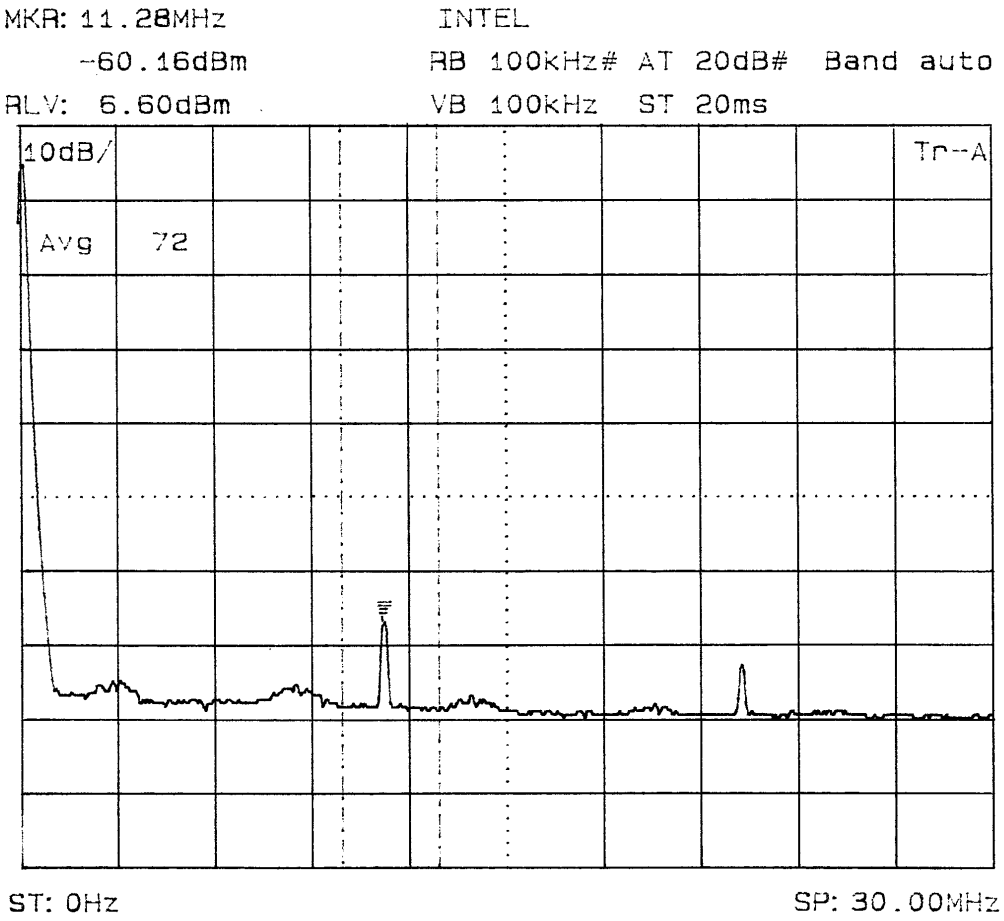
Table b3.a

RF Antenna Port Emissions: Conducted

Channel: 2412MHz

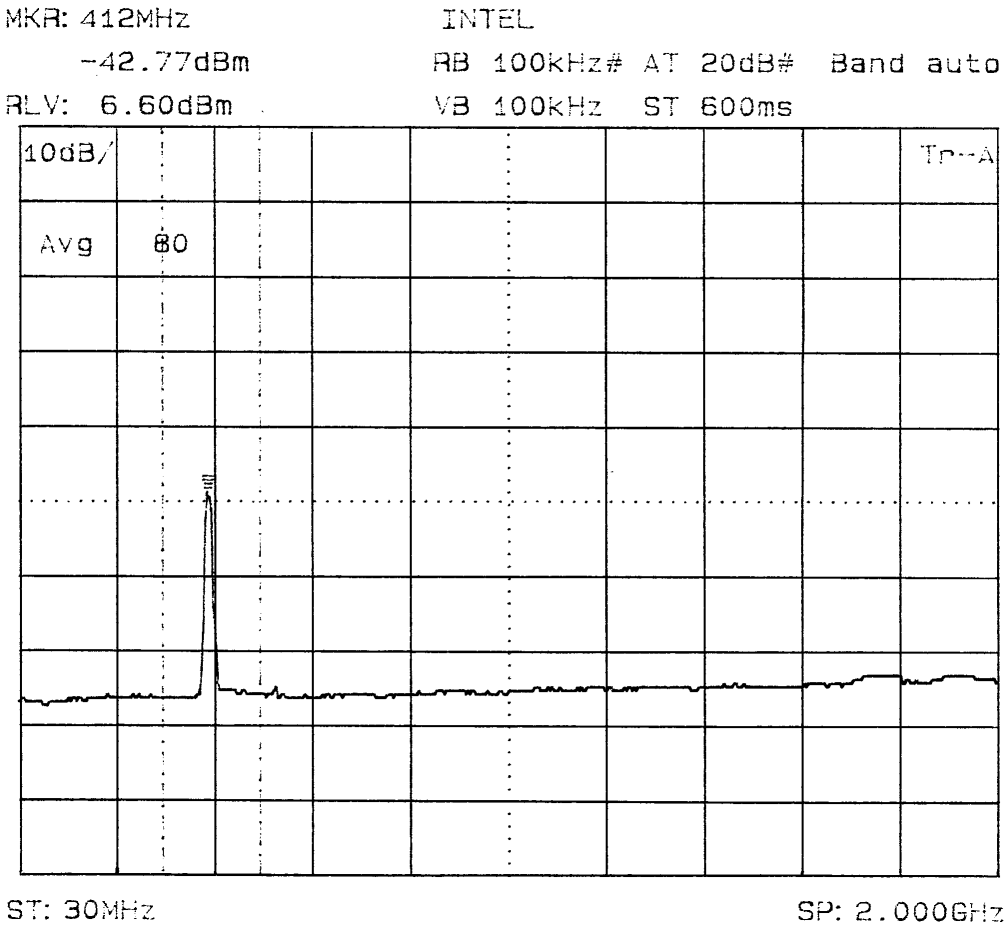
Frequency (MHz)	Reading (dBìV)	Cable Loss (dB)	Emissions (dBm)	Limit (dBm)	Margin (dB)
2412	6.8	0.9	7.7	-12.3	-
4824	-56.2	1.4	-54.8	-12.3	42.5
7236	-58.8	1.8	-57.0	-12.3	44.7
9648	-60.1	1.9	-58.2	-12.3	45.9
12060	-63.7	2.7	-61.0	-12.3	48.7
14472	-65.3	2.9	-62.4	-12.3	50.1
2437	6.2	0.9	7.1	-12.3	-
4874	-60.6	1.4	-59.2	-12.3	46.9
7311	-60.8	1.8	-59.0	-12.3	46.7
9748	-64.4	2.0	-62.4	-12.3	50.1
12185	-64.5	2.5	-62.0	-12.3	49.7
14622	-64.8	3.1	-61.7	-12.3	49.4
2462	6.6	0.9	7.5	-12.3	-
4924	-63.5	1.4	-62.1	-12.3	49.8
7386	-63.0	1.8	-61.2	-12.3	48.9
9848	-65.2	2.0	-63.2	-12.3	50.9
12310	-66.1	3.0	-63.1	-12.3	50.8
14722	-66.4	3.5	-62.9	-12.3	50.6
Spurious em.					
11.28	-60.0	0.0	-60.0	-12.3	47.7
22.32	-65.3	0.1	-65.2	-12.3	52.9
412.00	-42.8	0.3	-42.5	-12.3	30.2
2090	-58.5	0.8	-57.7	-12.3	45.4
2354	-51.8	0.9	-50.9	-12.3	38.6
4150	-56.6	1.2	-55.4	-12.3	43.1

Plot 1



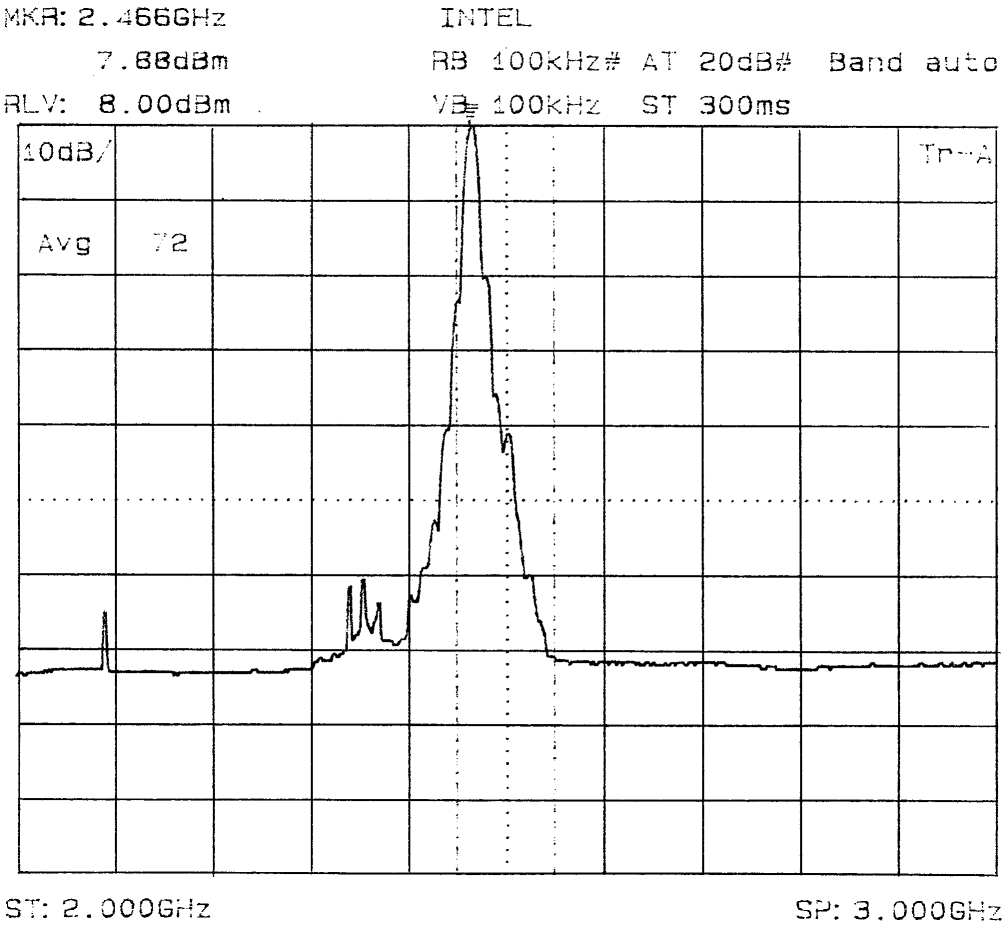
Spurious Emissions at Atenna Port
Frequency Range: 9 kHz – 30 MHz

Plot 2



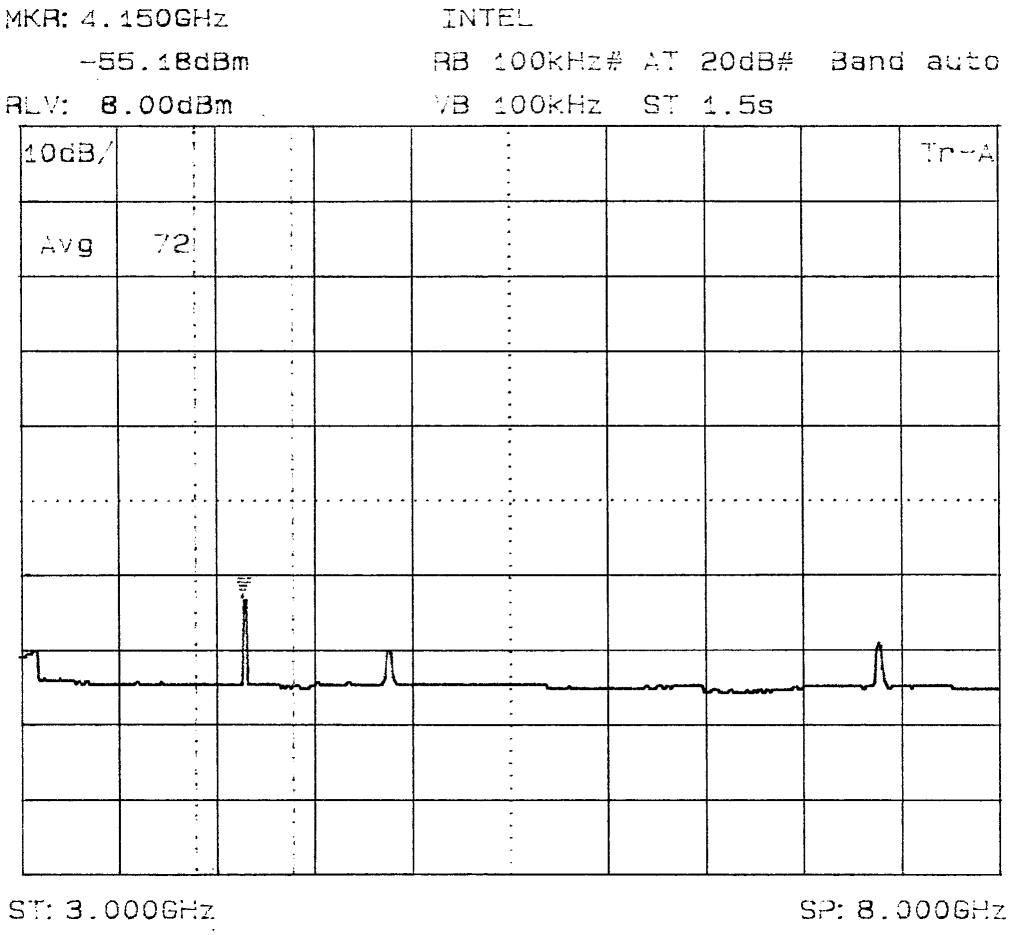
Spurious Emissions at Atenna Port
Frequency Range: 30 MHz – 2 GHz

Plot 3



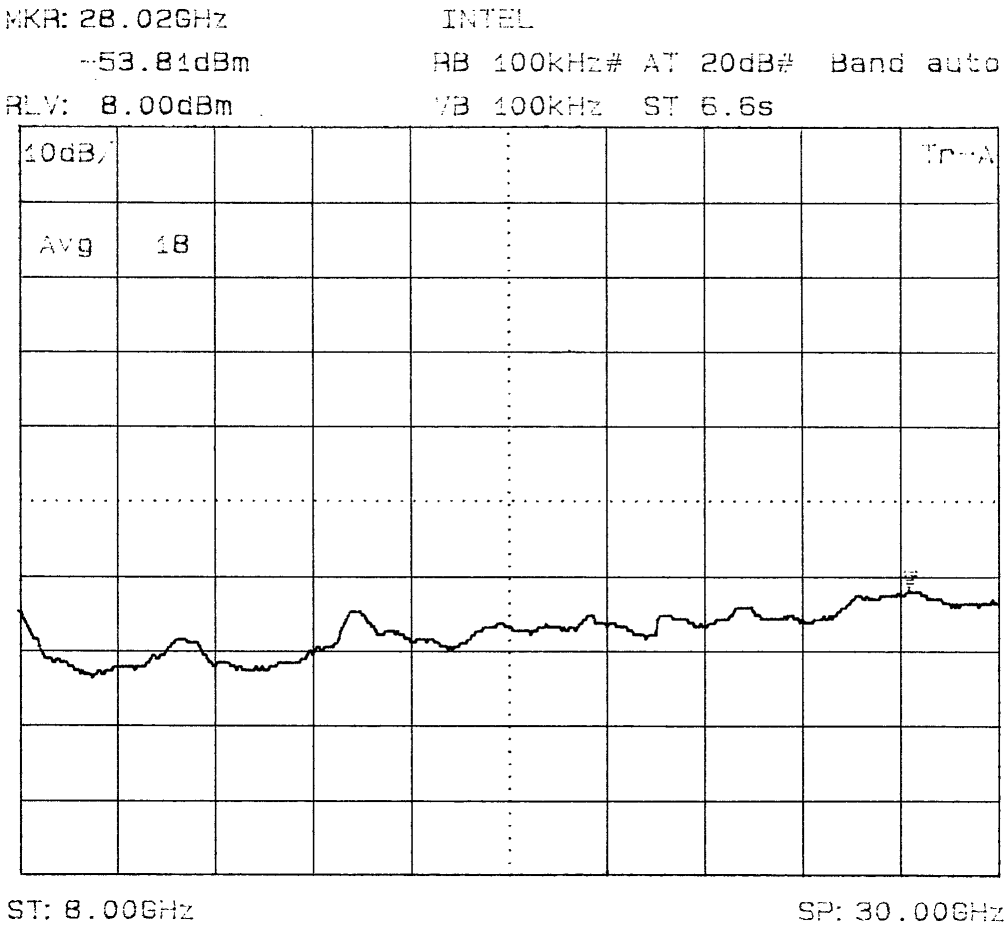
Spurious Emissions at Atenna Port
Frequency Range: 2 GHz – 3 GHz
Modulated fundamental signal – frequency: 2462 MHz

Plot 4



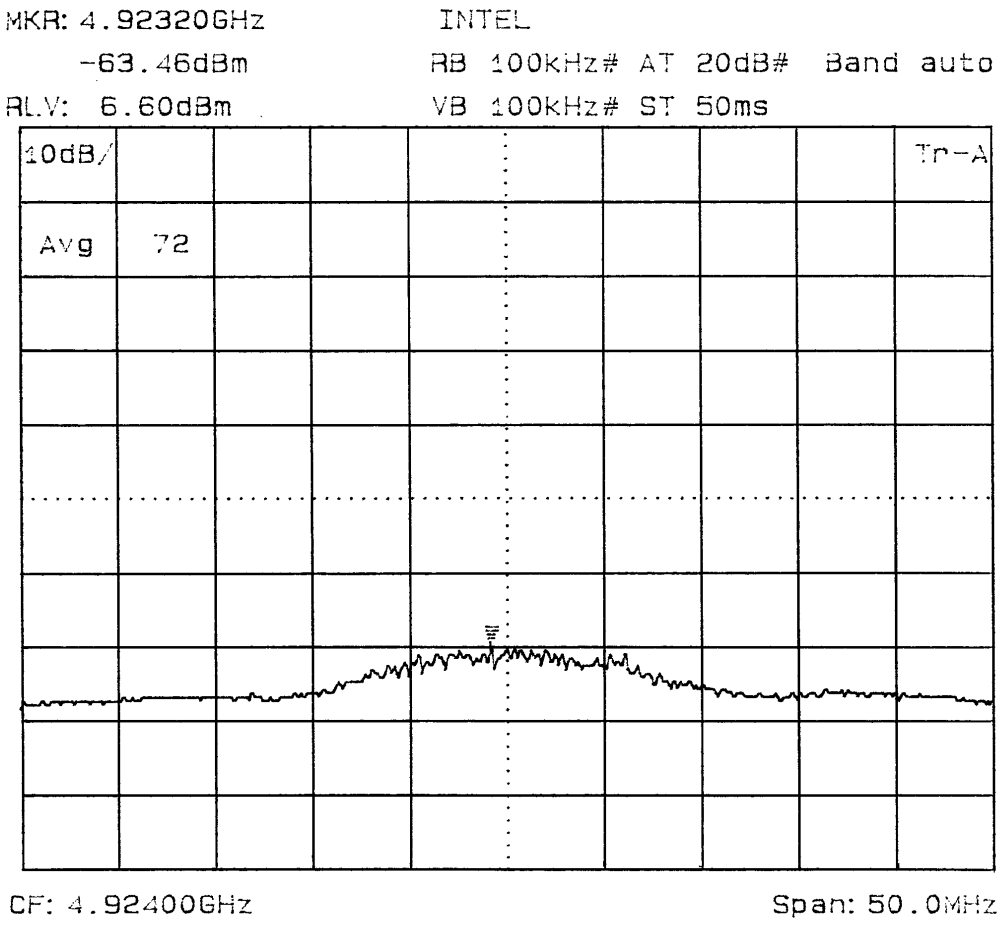
Spurious Emissions at Atenna Port
Frequency Range: 3 GHz – 8 GHz

Plot 5



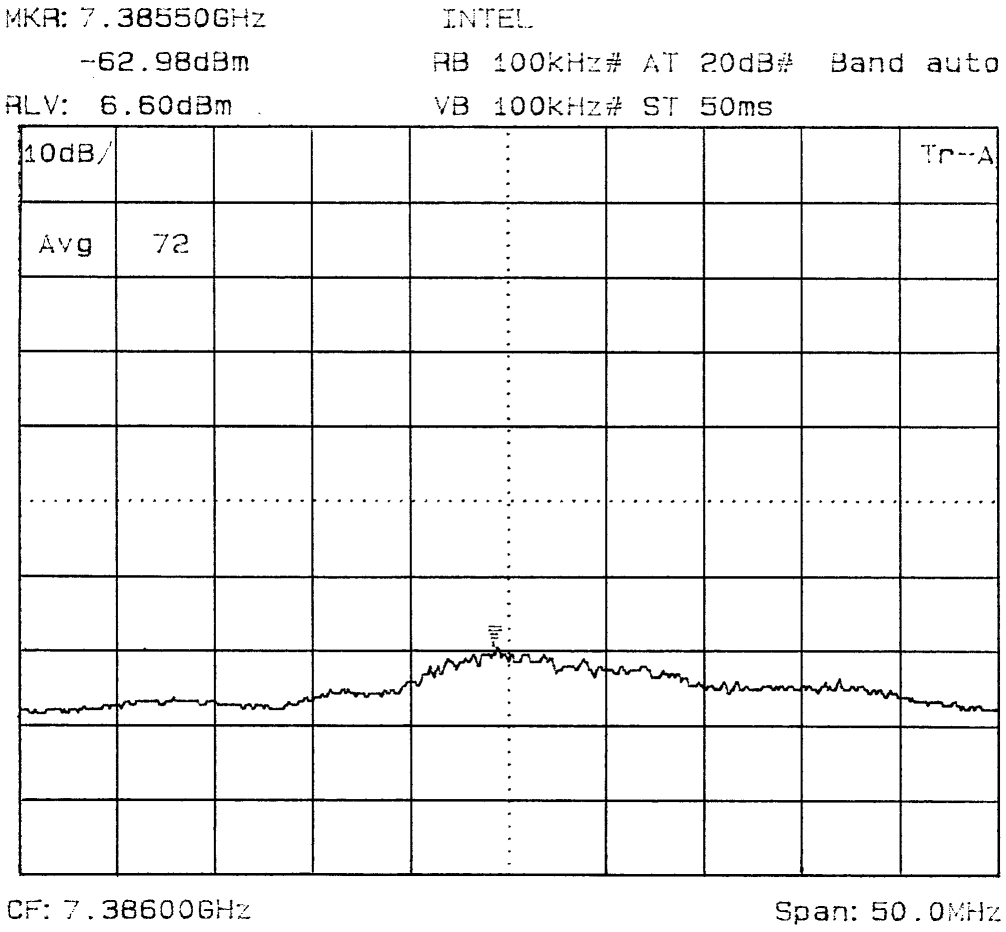
Spurious Emissions at Atenna Port
Frequency Range: 8 GHz – 30 GHz

Plot 6



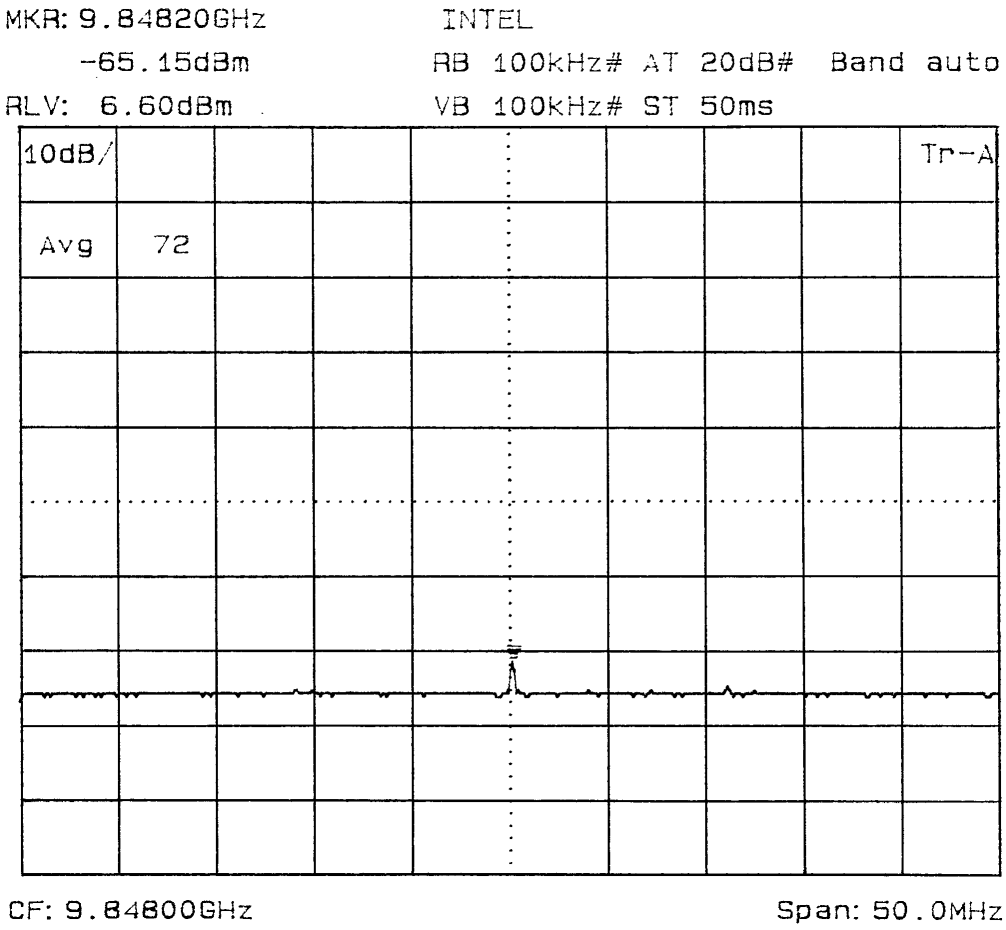
Spurious Emissions at Atenna Port
Frequency: 4.924 GHz

Plot 7



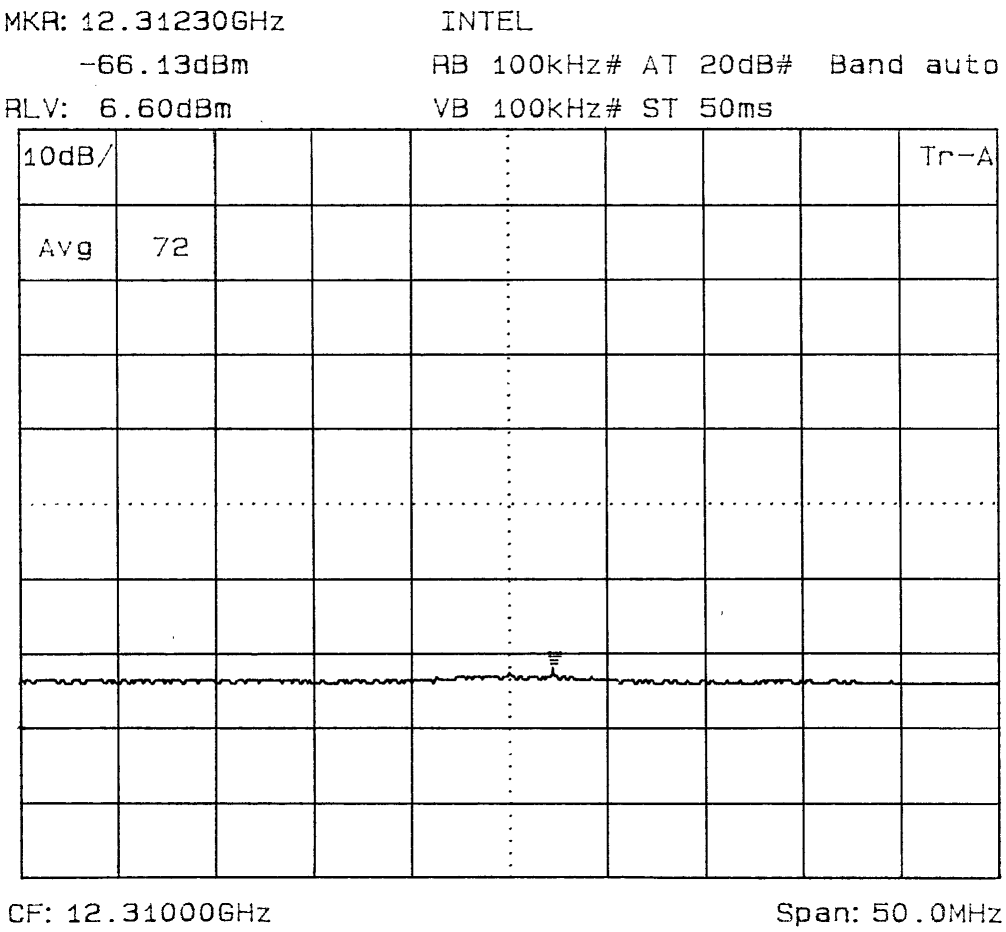
Spurious Emissions at Atenna Port
Frequency: 7.386 GHz

Plot 8



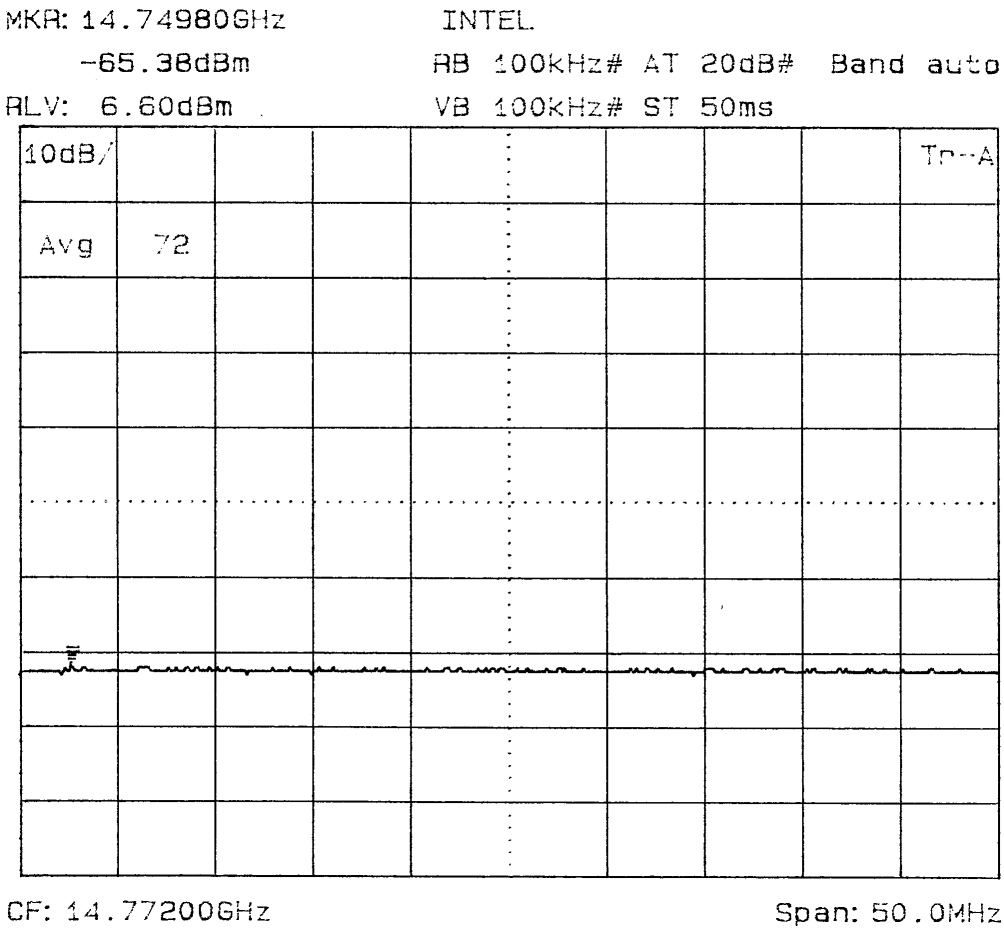
Spurious Emissions at Atenna Port
Frequency: 9.848 GHz

Plot 9



Spurious Emissions at Atenna Port
Frequency: 12.310 GHz

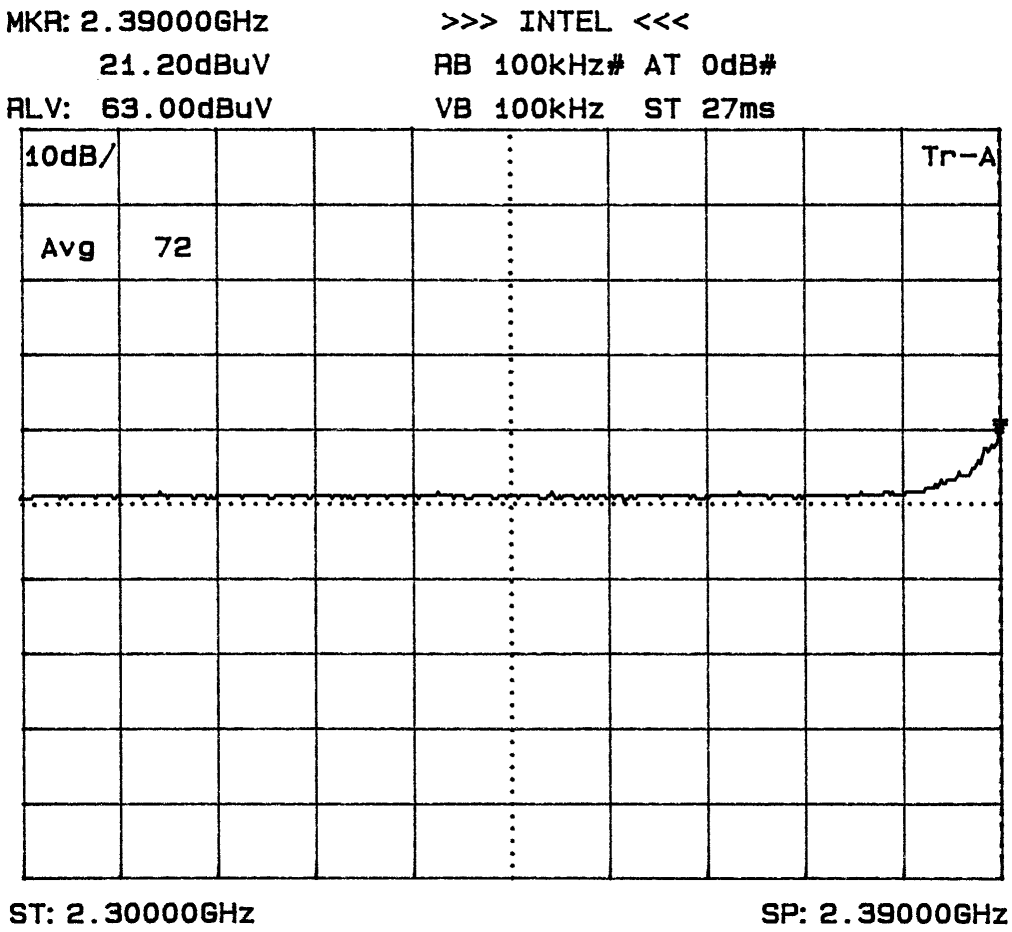
Plot 10



Spurious Emissions at Atenna Port
Frequency: 14.772 GHz

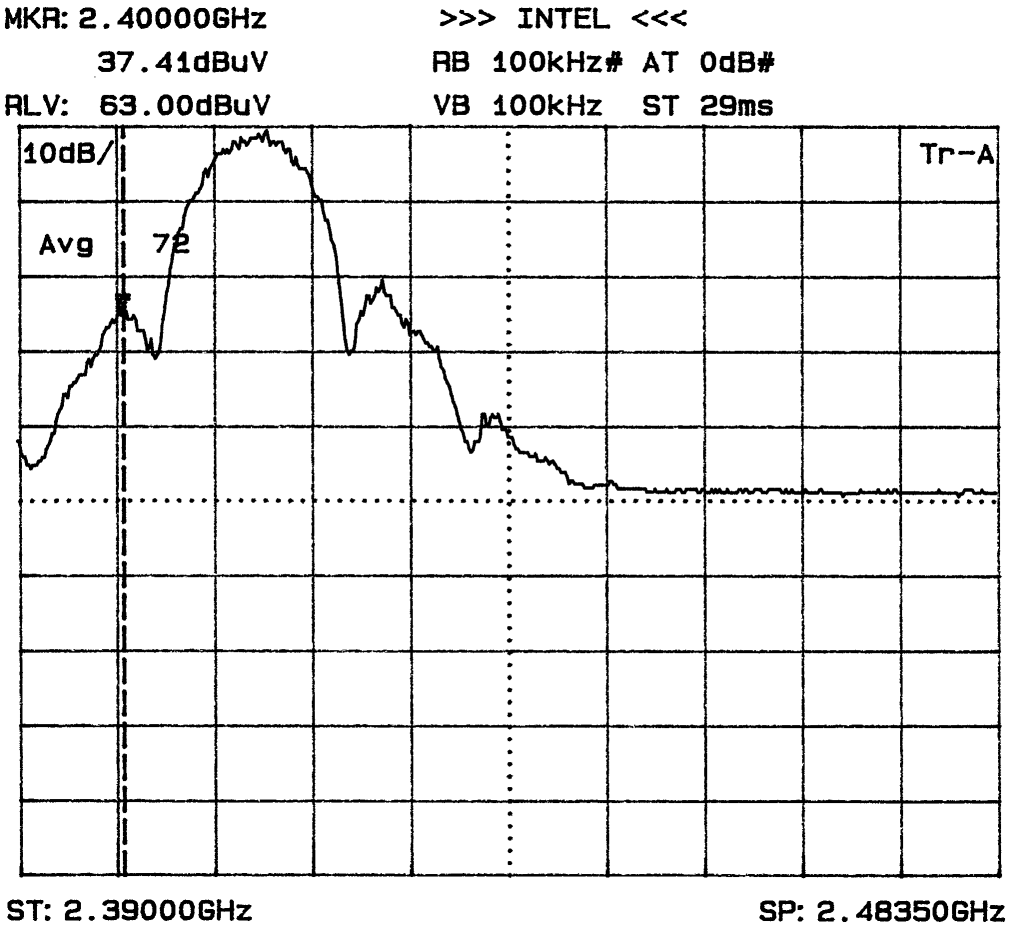
Band Edge Testing

Plot 11



Band Edge
Low Channel (f_{TX} = 2412 MHz)
Highest E-field @ 3m: **E = V + AF + Cable Loss**
E = 21.2 dBmV + 28.5 dB + 3.1 dB
E = 52.8 dBmV/m
Limit = 54.0 dBmV/m
Margin = 1.2 dB

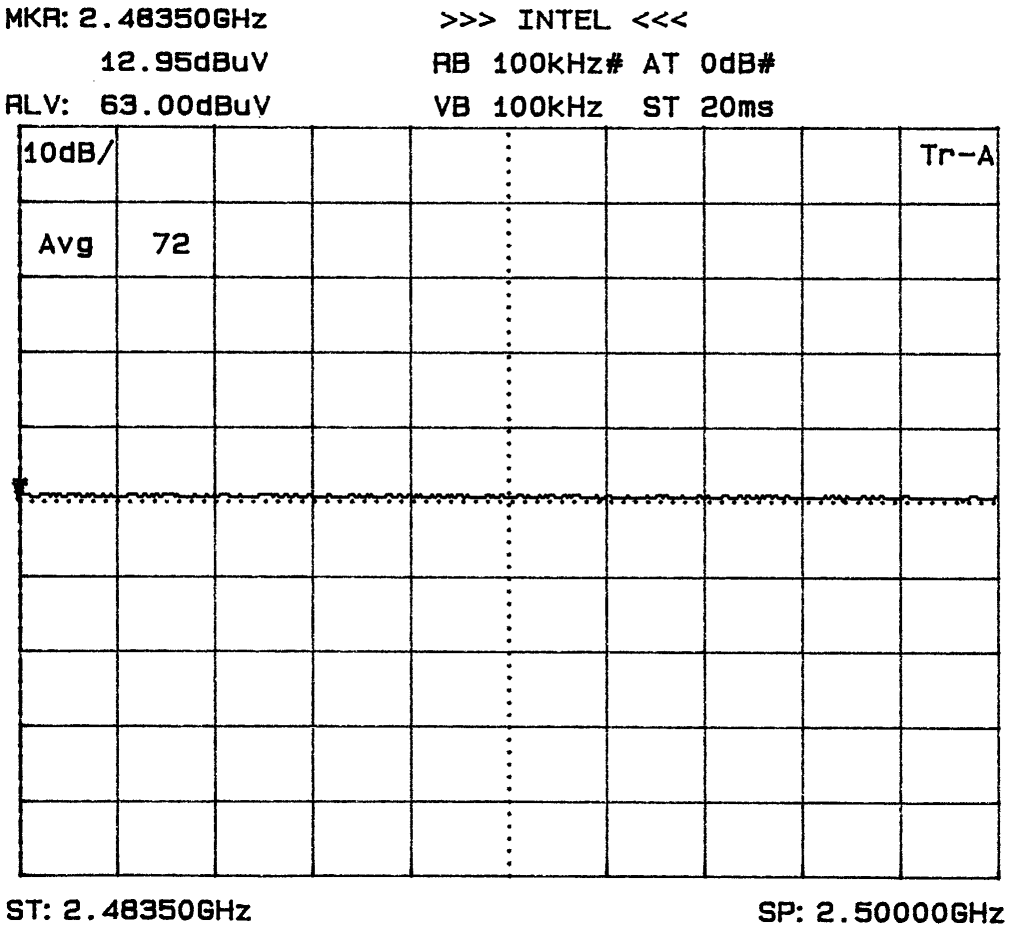
Plot 12



Band Edge
Low Channel (f_{TX} = 2412 MHz)

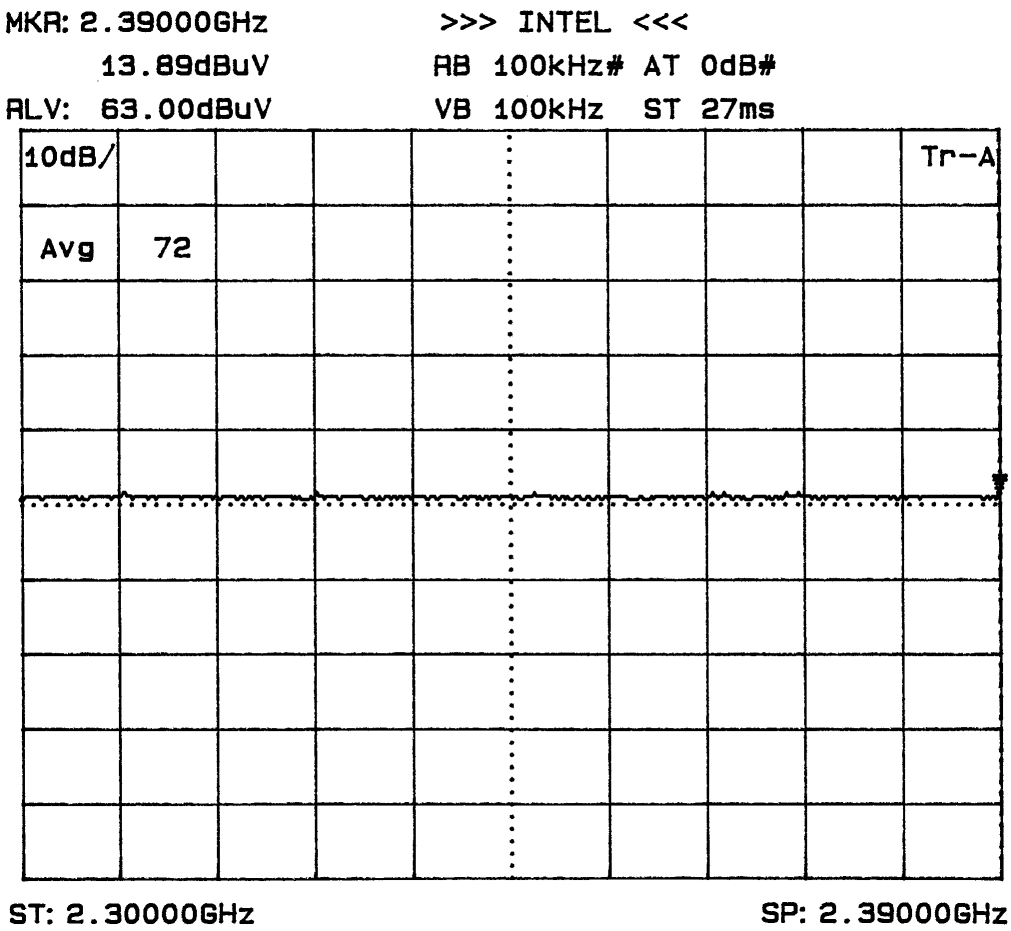
The highest transmitted level:	**63.0 dBmV**
Level measured on band edge:	**37.4 dBmV**
Signal reduction:	**- 25.6 dBc**
Requirement:	**-20.0 dBc**
Margin:	**5.6 dB**

Plot 13



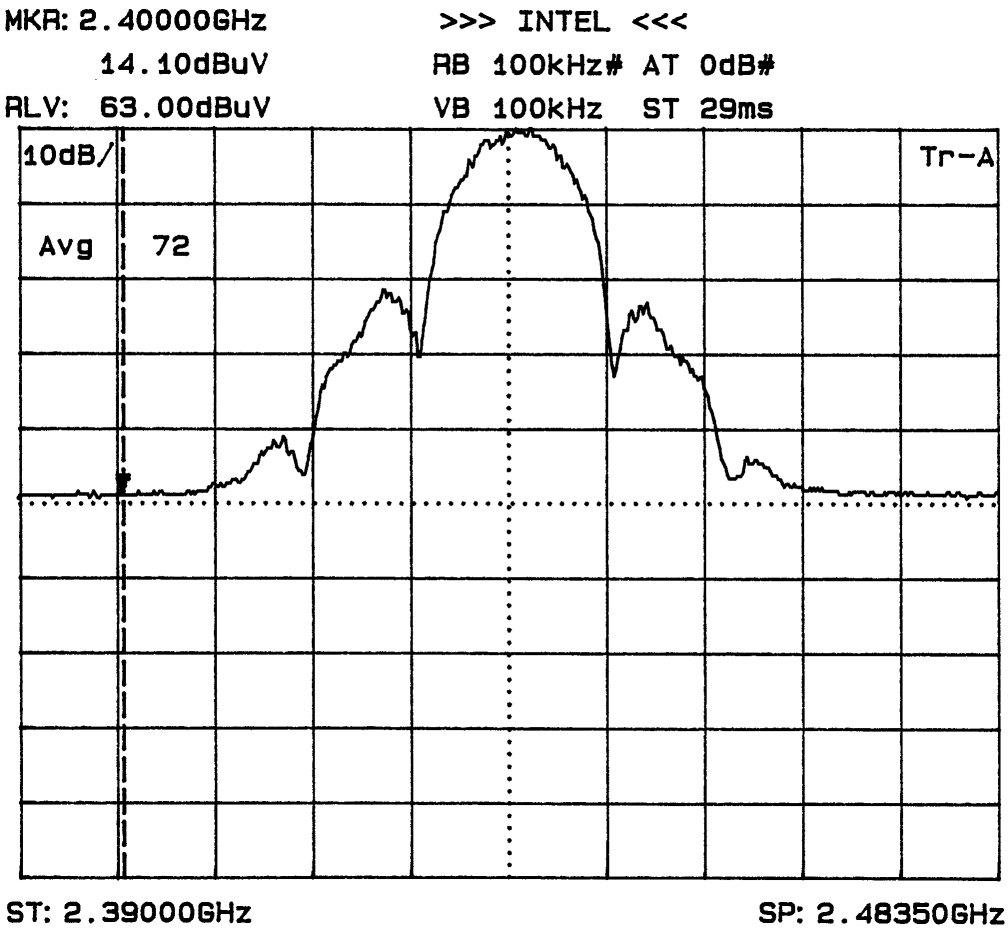
Band Edge
Low Channel (f_{TX} = 2412 MHz)
Highest E-field @ 3m: **E = V + AF + Cable Loss**
E = 13.0 dBmV + 28.5 dB + 3.1 dB (noise floor)
E = 44.6 dBmV/m
Limit = 54.0 dBmV/m
Margin = 9.4 dB

Plot 14



Band Edge
Medium Channel (f_{TX} = 2437 MHz)
Highest E-field @ 3m: **E = V + AF + Cable Loss**
E = 13.9 dBmV + 28.5 dB + 3.1 dB (noise floor)
E = 45.5 dBmV/m
Limit = 54.0 dBmV/m
Margin = 8.5 dB

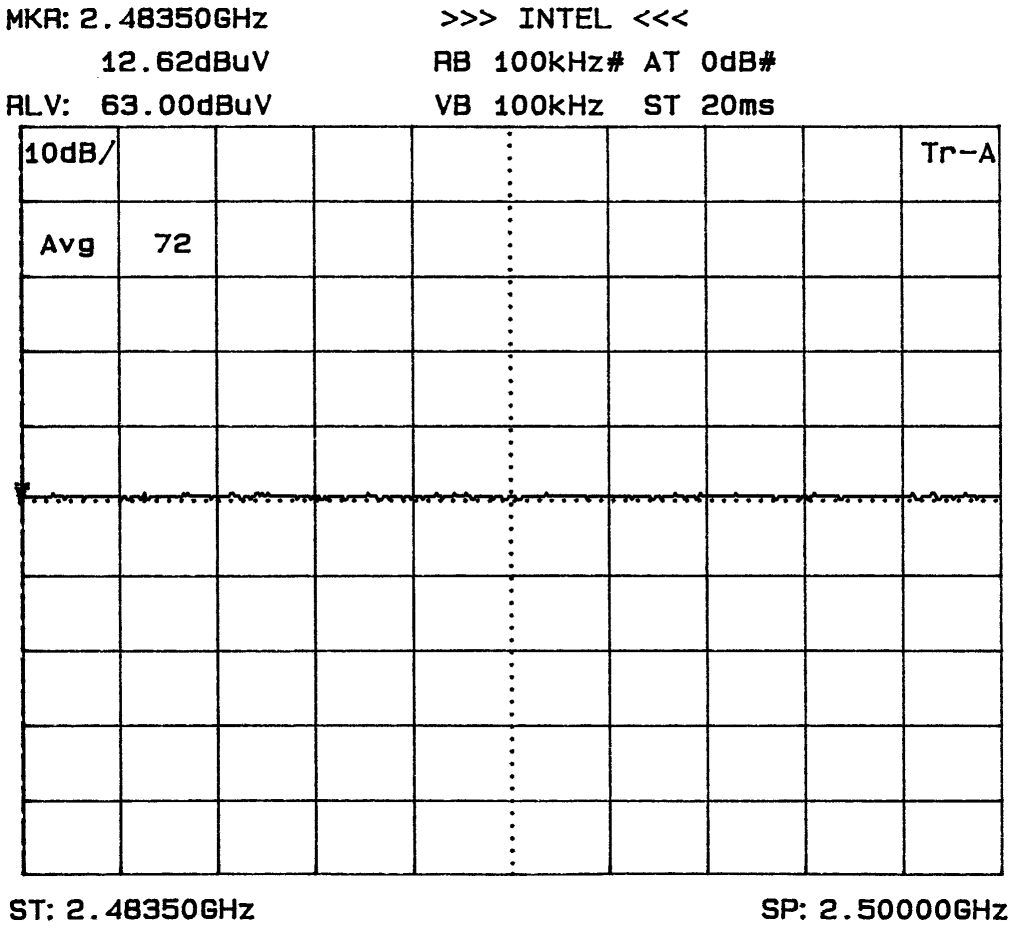
Plot 15



Band Edge
Medium Channel (f_{TX} = 2437 MHz)

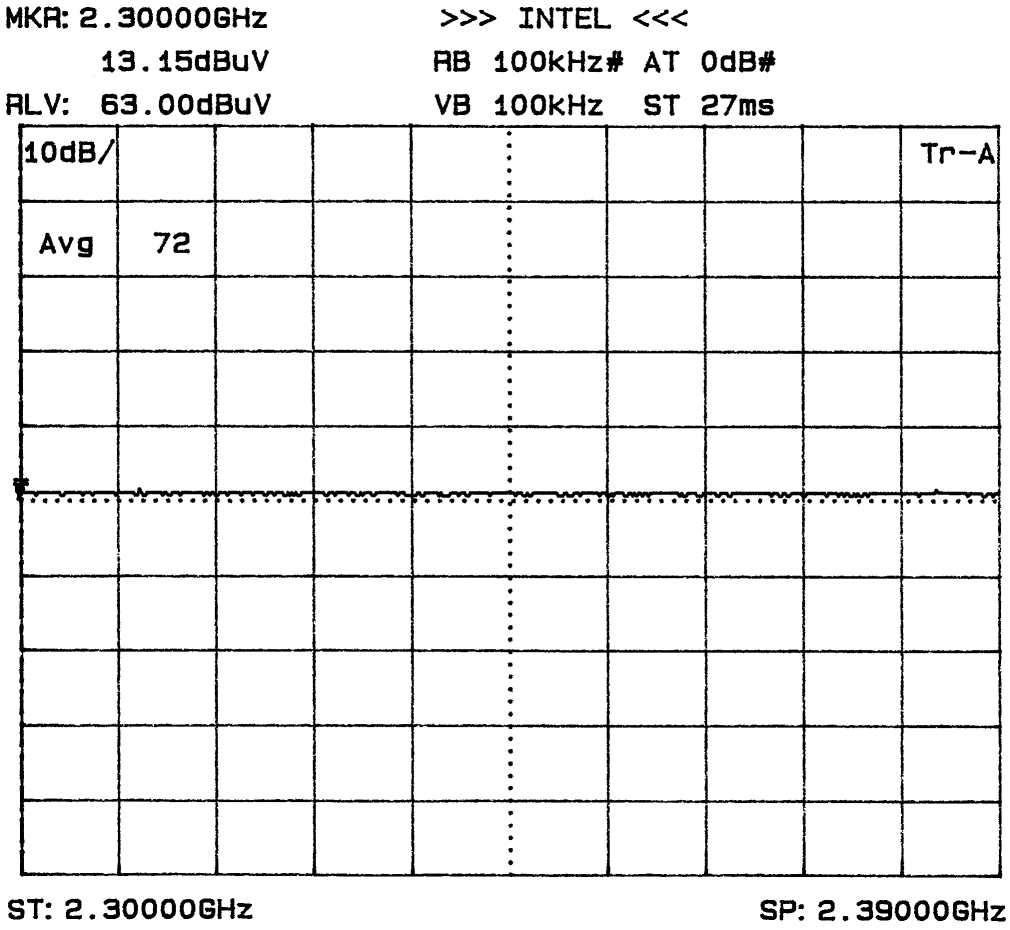
The highest transmitted level:	**63.0 dBmV**
Level measured on band edge:	**14.1 dBmV**
Signal reduction:	**- 48.9 dBc**
Requirement:	**-20.0 dBc**
Margin:	**28.9 dB**

Plot 16



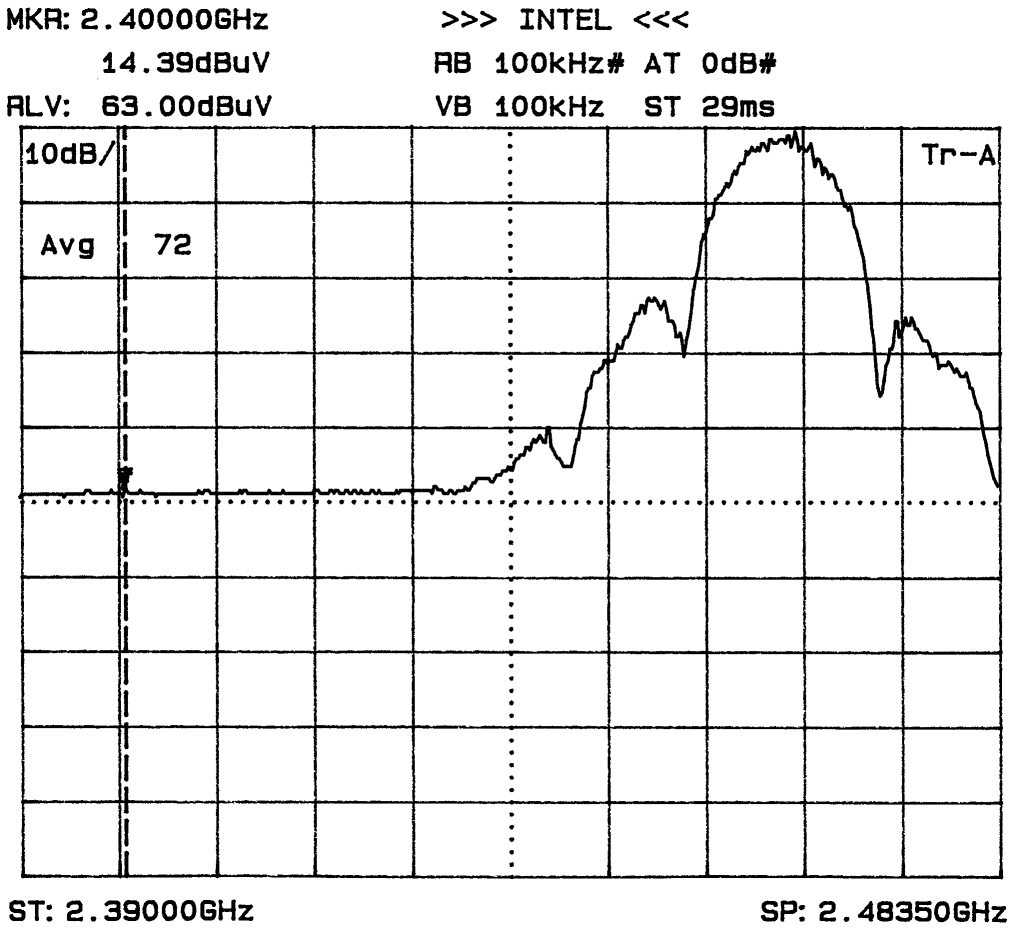
Band Edge
Medium Channel (f_{TX} = 2437 MHz)
Highest E-field @ 3m: **E = V + AF + Cable Loss**
E = 12.6 dBmV + 28.5 dB + 3.1 dB (noise floor)
E = 44.2 dBmV/m
Limit = 54.0 dBmV/m
Margin = 9.8 dB

Plot 17



Band Edge
High Channel (f_{TX} = 2462 MHz)
Highest E-field @ 3m: **E = V + AF + Cable Loss**
E = 13.2 dBmV + 28.5 dB + 3.1 dB (noise floor)
E = 44.8 dBmV/m
Limit = 54.0 dBmV/m
Margin = 9.2 dB

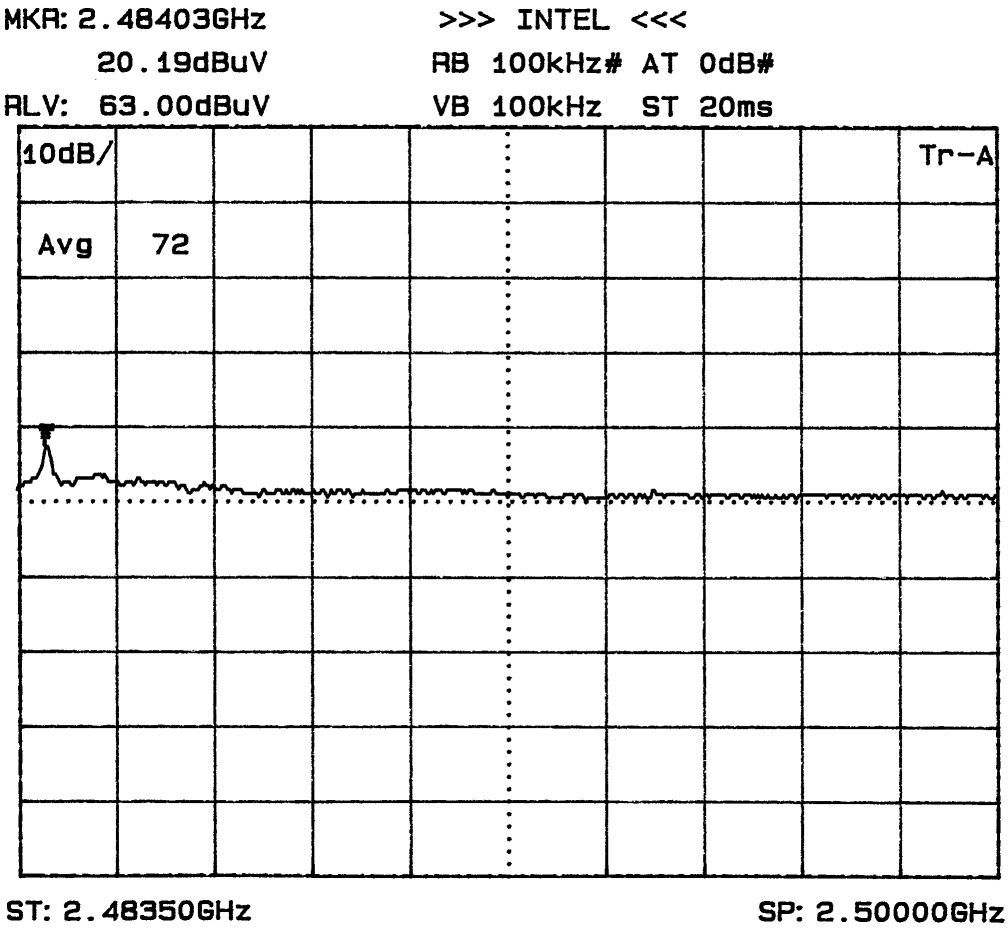
Plot 18



Band Edge
High Channel (f_{TX} = 2462 MHz)

The highest transmitted level:	**63.0 dBmV**
Level measured on lower band edge:	**14.4 dBmV**
Level measured on higher band edge:	**15.4 dBmV**
Signal reduction:	**- 47.6 dBc**
Requirement:	**-20.0 dBc**
Margin:	**27.6 dB**

Plot 19



Band Edge
High Channel (f_{TX} = 2462 MHz)
Highest E-field @ 3m: **E = V + AF + Cable Loss**
E = 20.2 dBmV + 28.5 dB + 3.1 dB (noise floor)
E = 51.8 dBmV/m
Limit = 54.0 dBmV/m
Margin = 2.2 dB

Notes:

1. **There was one significant signal detected in the restricted bands specified in §15.205:**

Frequency (MHz)	Antenna Polarization	Reading (dBmV)	Correction (dB)	Field Strength (dBmV//m)	Limit (dBmV//m)	Margin (dB)
406.74	Vertical	35.4	-4.4	31.0	46.0	15.0
406.74	Horizontal	22.8	-4.4	18.4	46.0	27.6

All other spurious signals with frequencies falling in the restricted bands specified in §15.205 were far below the limits listed in Table b2.

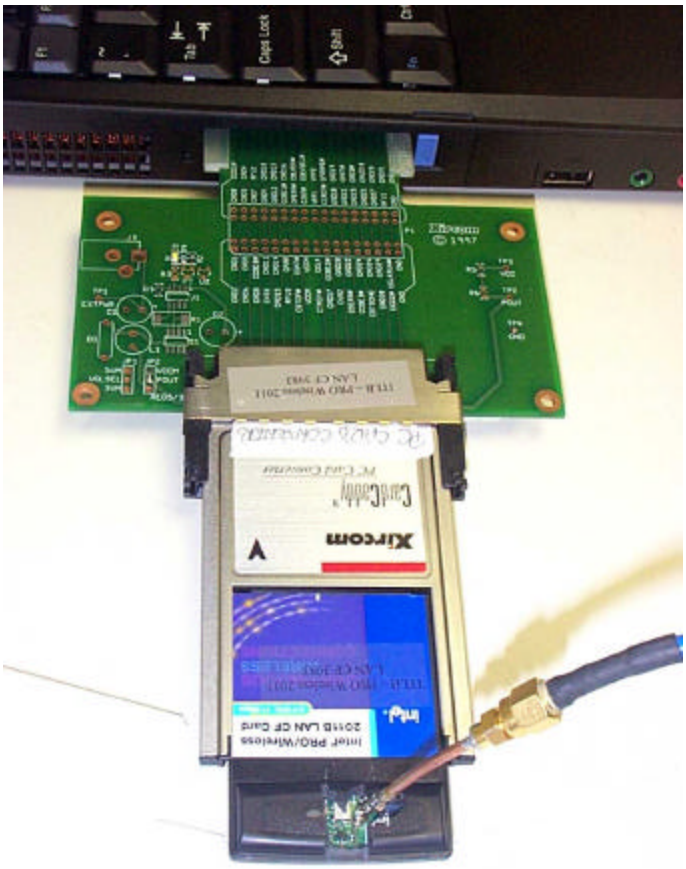
2. **There was no fundamental signals observed within the restricted bands specified in §15.205.**

3. **All harmonics and spurious signals were at least 20 dB below the highest emission level within the authorized band as measured with a 100 kHz Resolution Bandwidth.**

4. **The spectrum was scanned from 9 kHz to 10th harmonic and the worst-case emissions are reported.**

Test performed by: Ki Cha Rowe **Date:** Feb, 2005

Pictures of Test Set-up



Conducted Emissions Measurement
Close View
INTEL 2011B LAN CF Card

Conducted Emissions Measurement

Testing for Radiated Emissions from Transmitter
in Restricted Bands
Close View

Testing for Radiated Emissions from Transmitter
in Restricted Bands
Frequency Range: 30 MHz – 200 MHz

Testing for Radiated Emissions from Transmitter
in Restricted Bands
Frequency Range: 200 MHz – 1 GHz

Testing for Radiated Emissions from Transmitter
in Restricted Bands
Frequency Range: Above 1 GHz

Test: Peak Power Spectral Density (Transmitter)

Ref.: FCC Part 15.247 (d)

Criteria: The power spectral density averaged over any one-second interval shall not be greater than 8.0 dBm in any 3 kHz bandwidth within the pass bands.
For a direct sequence system, it is defined as the peak power spectral density conducted from the intentional radiator to the antenna measured during any time interval of continuous transmission.

Test Set-up: See Figure c1

Condition: Conducted Test

Equipment: See Appendix A

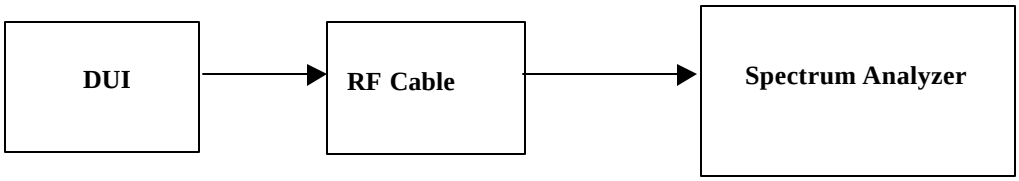


Figure c1

Methodology: The Peak Power Spectral Density of the DUI was measured at the antenna port conducted from the transmitter using a spectrum analyzer.

The test was repeated with two different sets of settings on the spectrum analyzer - wide and narrow span. Results obtained from the measurements are presented in the report (Graphs c1 to c6 and table c1). Testing was performed with the spectrum analyzer settings as shown below (the peak emission frequency was located through the wide span test and then the span was reduced and the sweep time increased in a manner to maintain calibration and to keep the peak emission in the display after which the reading was taken).

1) Spectrum-Analyzer settings – wide span:

Res. Bandwidth:	3 kHz
Video Bandwidth:	10kHz
Span:	20.0MHz
Ref. Level:	5.0 dBm
Sweep:	6.7 seconds

2) Spectrum-Analyzer settings – narrow span:

Res. Bandwidth:	3 kHz
Video Bandwidth:	10 kHz
Span:	300 KHz
Ref. Level:	5.0 dBm
Sweep:	100 seconds

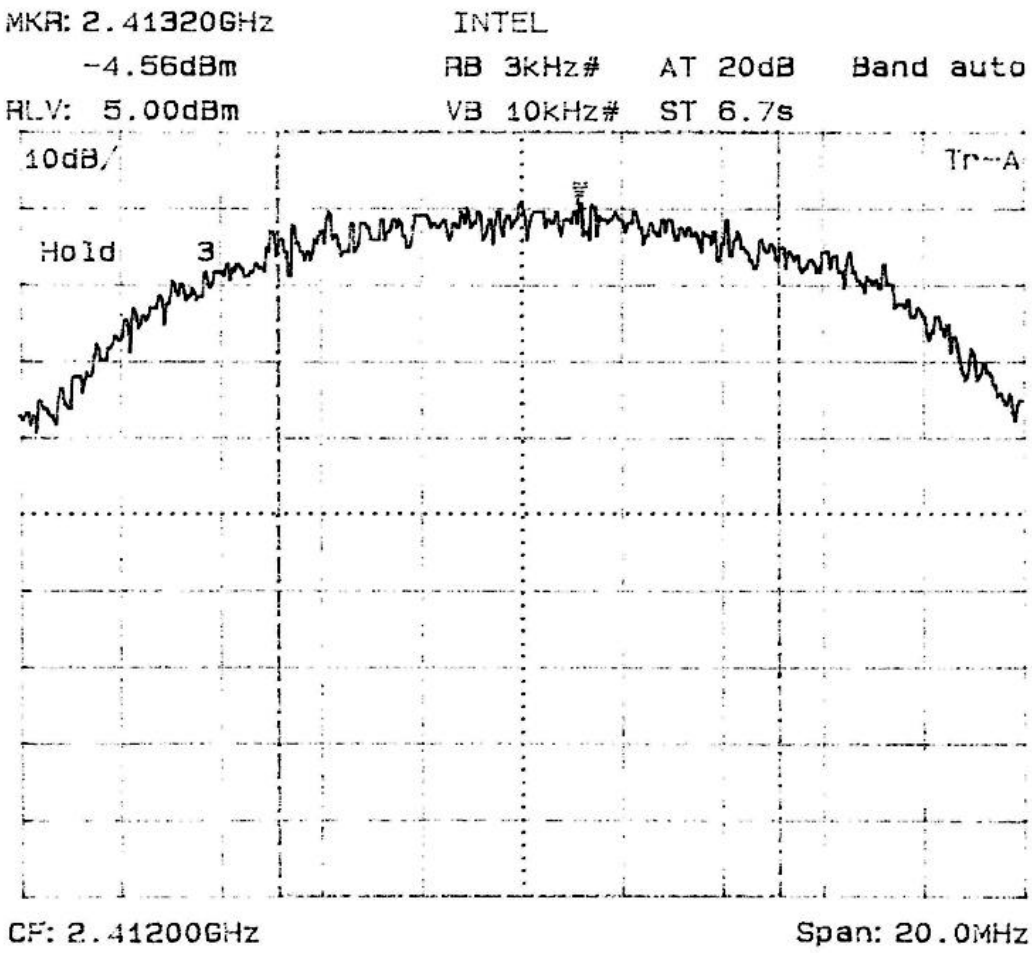
Test Results: See Test Data table c1 and Plots c1 – c6

Table c1 **Power Spectral Density Test Data**

Channel #	Frequency (MHz)	Spectrum Analyser Reading (dBm/3kHz)	Cable Loss (dB)	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)	Pass/Fail
L	2412	-5.04	0.50	-4.54	8.0	12.54	Pass
M	2437	-4.45	0.55	-3.90	8.0	11.90	Pass
H	2462	-4.46	0.53	-3.93	8.0	11.93	Pass

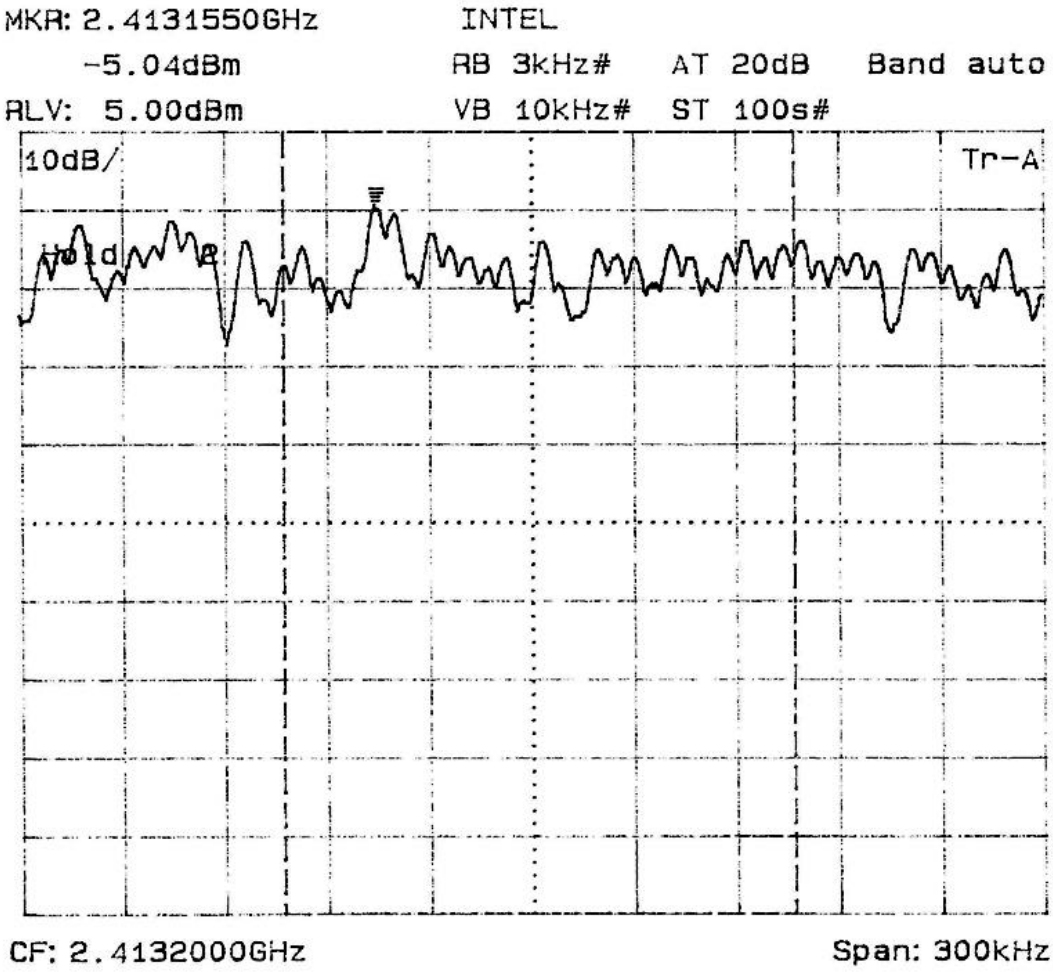
Test performed by: Ka Chan Rowe **Date:** Feb, 2003

Conclusion: Pass.



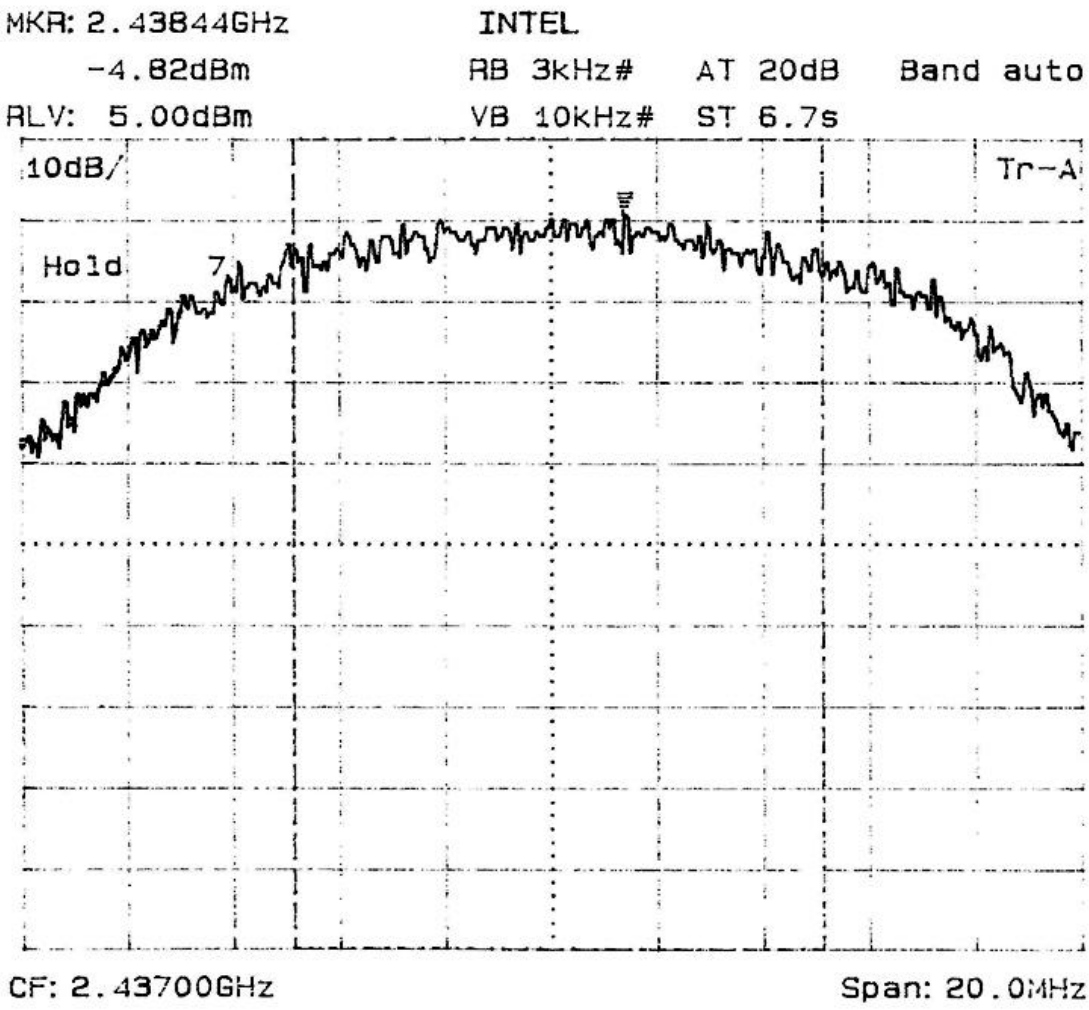
Plot c1

Peak Power Spectral Density
INTEL 2011B LAN CF Card
2412MHz – Wide Span



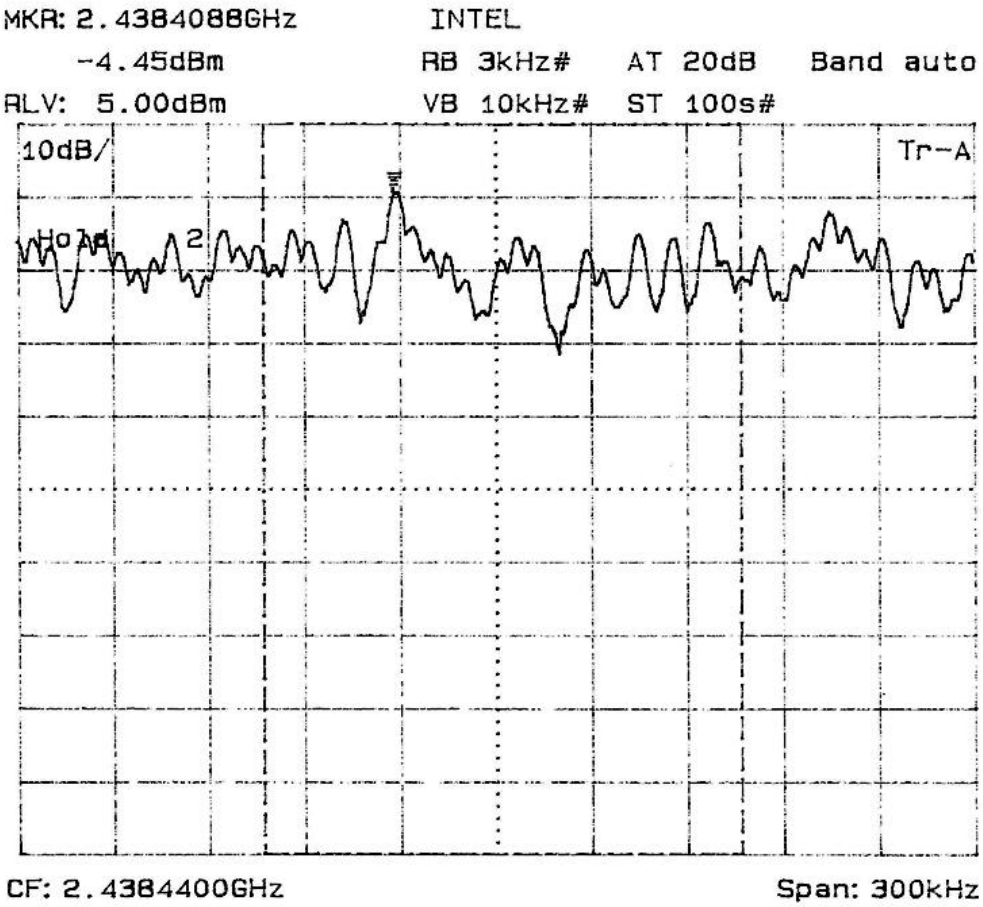
Plot c2

Peak Power Spectral Density
INTEL 2011B LAN CF Card
2412MHz – Narrow Span



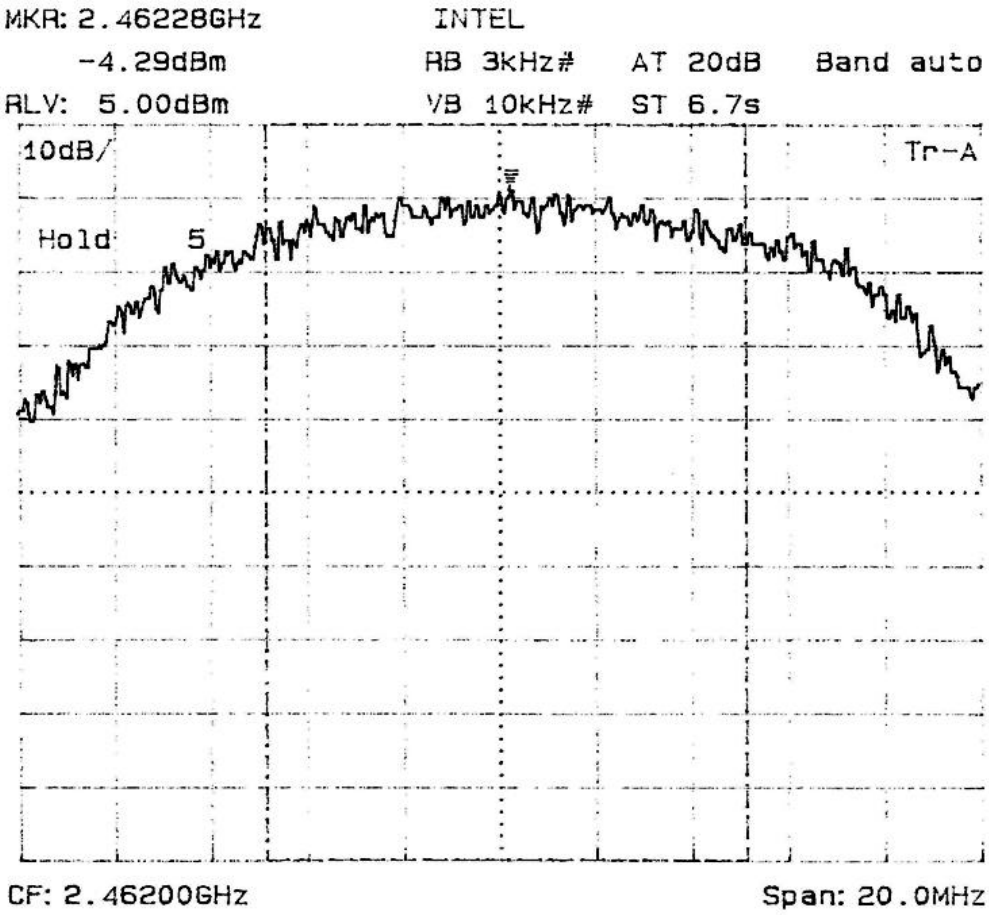
Plot c3

Peak Power Spectral Density
INTEL 2011B LAN CF Card
2437MHz – Wide Span



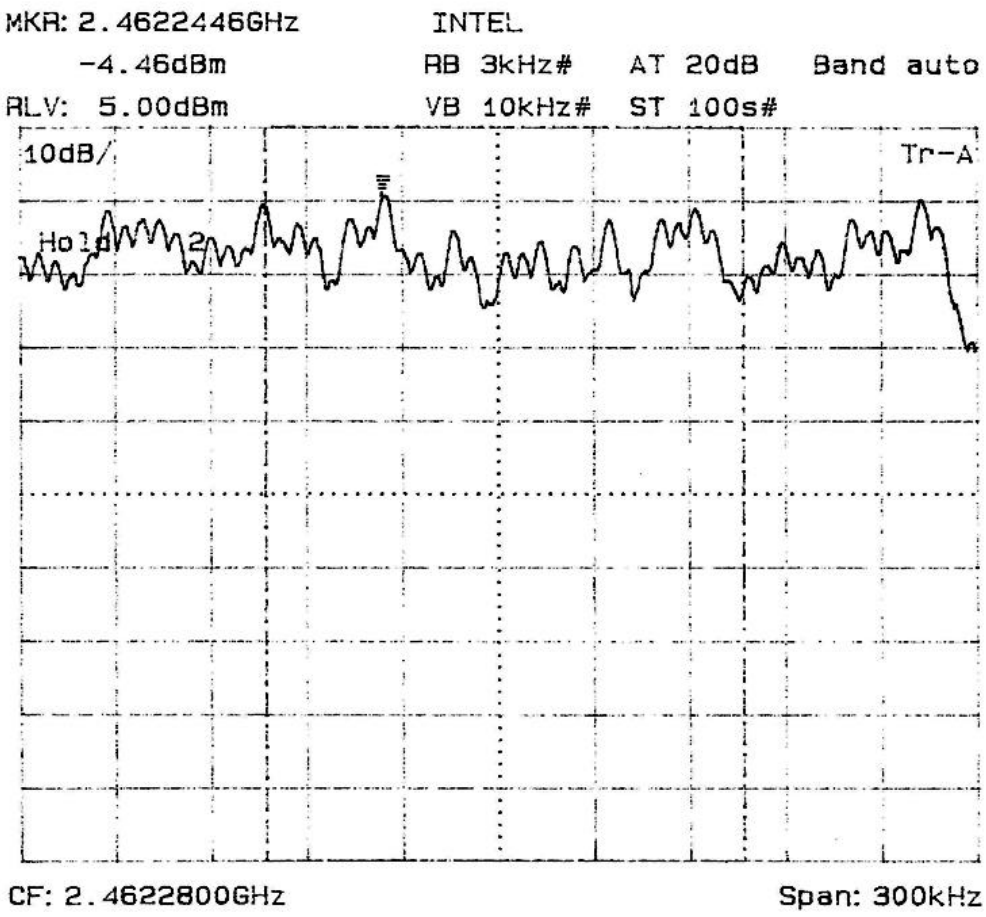
Plot c4

Peak Power Spectral Density
INTEL 2011B LAN CF Card
2437MHz – Narrow Span



Plot c5

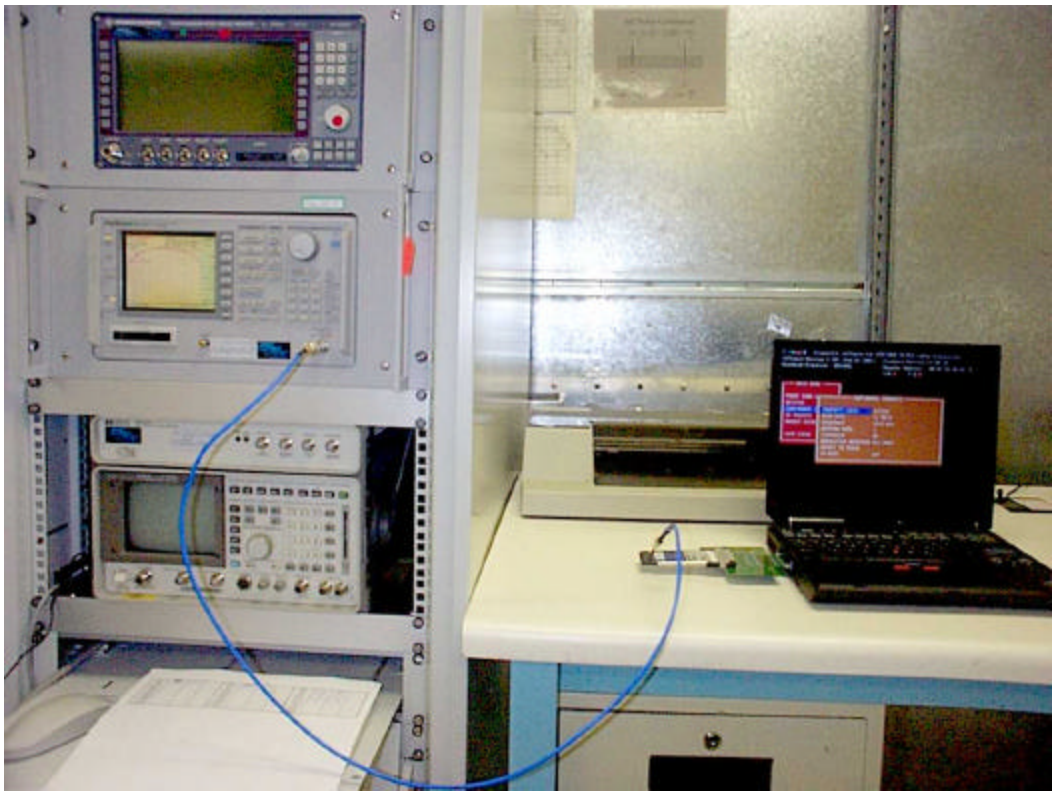
Peak Power Spectral Density
INTEL 2011B LAN CF Card
2462MHz – Wide Span



Plot c6

Peak Power Spectral Density
INTEL 2011B LAN CF Card
2462MHz – Narrow Span

Pictures of the test set-up



Test Set-up of Peak Power Spectral Density (Conducted)

Appendix A

Test Equipment List

List of Equipment

Description	Range	Manufacturer	Model #	APREL Asset #	Cal. Due Date
Spectrum Analyzer	9 kHz - 3 GHz	Anritsu	MS2661C	301330	Sept. 11, 2003
Spectrum Analyzer	9 kHz - 30 GHz	Anritsu	MS2667C	301386	Sept.5, 2003
Attenuator	20 dB	Narda	4774-20	301533	CBT
RF Power Meter	10 MHz - 18 GHz	Gigatronics	8541C	301393	Sept.5, 2003
Biconical Antenna	20 MHz - 200 MHz	Eaton	94455-1	100890	July 18, 2003
Log - Periodic Antenna	200 MHz -1.0 GHz	Eaton	ALP-1	100063	July 31, 2003
Horn Antenna	1 – 18 GHz	APREL Inc.	AA – 118	100553	June 17, 2003
Anechoic Shielded Room	10 kHz - 10 GHz	APREL Inc.	_	301329	N/A
OATS	30 MHz – 1 GHz	APREL Inc.	3 m & 10 m	N/A	N/A
Mast with the Controller	1 m – 4 m	EMCO	1051 – 12	100507	N/A
Turntable with the Controller	0° - 360°	EMCO	1060 – 1.241	100506	N/A