Emission Test Report
Standard: FCC Part 15 Subpart C / IC RSS-210
Class II Permissive change

Document Number : FCC 19-0259-0

Model Number: WM3B2100
measured with **IBM ThinkPad T40 Series, 15 inch model**

FCC ID: ANO20020201CLK
IC: 349E- WM3B2100

February 25, 2004

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MEASUREMENT / TECHNICAL REPORT – Part 15 Subpart C
(Intentional Radiator)

Model: WM3B2100 (IEEE802.11b Wireless LAN Adapter)
with
IBM ThinkPad T40 Series
(Machine Type: 2373, 2374, 2375, 2376, 2378, 2379)

FCC ID : ANO20020201CLK

February 25, 2004

This report concerns: (check one) Original Grant _____ Class I change _____ Class II change ✓ Equipment type: Wireless LAN device
This report shall not be reproduced except in full, without the written permission of this test lab.
The measurement results contained in this report relate only to the item which was tested.
Measurement procedure used is ANSI C63.4-2000 unless otherwise specified. Other test procedure: _____
The FCC has issued provisional acceptance of this test laboratory for Declaration of Conformity testing per letter dated 1997.
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A. General Information

APPLICANT	: IBM Japan, Ltd.
TEST SITE	: IBM Japan, Ltd., Yamato Semi-anechoic chamber #1
TEST SITE ADDRESS	: 1623 – 14 Shimotsuruma, Yamato-shi, Kanagawa 242-8502 Japan Tel: +81-46-215-4779, Fax: +81-46-273-7420
REGULATION	: FCC Part 15 Subpart C Industry Canada RSS-210 (Issue No.5)
MODEL NUMBER (Advertising Name)	: WM3B2100 (Intel PRO/Wireless LAN 2100 3B Mini PCI Adapter)
FCC ID IC Certification Number	: ANO20020201CLK : 349E-WM3B2100
SERIAL NUMBER	: 0004234572F6
PYSICAL CONDITION	: Preproduction
KIND OF EQUIPMENT	: DTS: IEEE802.11b Wireless LAN Mini-PCI card
TESTED DATE	: February 12 and 13, 2004

A.1 Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.4-2000.
Radiated testing was performed at an antenna to EUT distance of 3 meters.

A.2 Test Facility / NVLAP Accreditation

The semi-anechoic chamber #1 used to correct the data are located in Yamato Laboratory, IBM Japan.

- This facility has been fully described in a report dated September 1998, submitted to the FCC office, and accepted in a letter, dated Nov. 2,1998(31040/SIT).
- IBM Yamato EMC Engineering is recognized under the National Voluntary Laboratory Accreditation Program for satisfactory compliance with Criteria established in Title 15, Part 285 Code of Federal Regulations.(NVLAP Lab code: 200198-0)
- Theses facilities are accepted by **Industry Canada** as number **4221** for chamber #1 (expiry date January 25, 2005), and as number **IC 4221-1** for chamber #2 (expiry date February 16, 2007).

A.3 EUT details

Table A EUT details

Model and S/N	**FCC ID** **IC Certification Number**	**Description**
WM3B2100 (s/n 0004234572F6)	FCC ID: ANO20020201CLK IC:349E-WM3B2100	**Applying modular transmitter** Built_in type IEEE802.11b Wireless LAN Mini-PCI card without antenna
ThinkPad T40 Series M/T : 2373-PUU(15inch) (s/n ZZ-22134)	N/A	Host equipment IBM Notebook PC with built-in antenna CPU: Intel® Pentium® M Processor 735
P/N 02K6746	N/A	Universal AC adapter 72W, Unshielded power cord

B. Summary of Test Results

Table-B presents the list of the measurement items for DTS (Digital Transmissions System) devices under FCC Part 15 Subpart C and Industry Canada RSS-210.
The section numbers of upper portion are showing FCC number, and the other (lower) ones are for IC.

Table-B List of the measurements

Section(s)	Test Items : Transmit mode (TX):		Condition	Result
15.247(a)(2) **6.2.2(o)**	Bandwidth at 6 dB below	FCC requirement RSS-210 Issue5: Amendment	Conducted	Pass
– **5.9.1**	Occupied BW (Bandwidth at 20 dB below)	IC requirement		Pass
15.247(c) **6.2.2(o)(e1)**	Out of Band Emissions	The radiated emission in any 100kHz of outband shall be at least 20dB below the highest inband spectral density.		Pass
15.247(b)(3) **6.2.2(o)(b)**	Transmitter peak output power	Shall not exceed 1.0 W.		Pass
15.247(d) **6.2.2(o)(b)**	Transmitter power spectral Density	Shall not be greater than 8 dBm in any 3kHz band.		Pass
15.207 **6.2.2(o)(e3)** **/ 6.6**	AC Wireline Conducted Emissions 150kHz – 30MHz	Class B: Freq.(MHz) QP(dBμV) Ave.(dBμV) 0.15 - 0.5 66 - 56 56 - 46 0.5 - 5 56 46 5 - 30 60 50		Pass
15.205 / 209 **6.2.1** **/6.2.2(o)(e3)** **/6.3**	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Shall not exceed the limits specified in FCC 15.209 or RSS-210 Table3.	Radiated (30MHz-1GHz)	Pass
			Radiated (1– 25GHz)	Pass

	Test Items : Receive mode (RX):			
15.207 **6.2.2(o)(e3)** **/ 7.4**	AC Wireline Conducted Emissions 150kHz – 30MHz	Class B: Freq.(MHz) QP(dBμV) Ave.(dBμV) 0.15 - 0.5 66 - 56 56 - 46 0.5 - 5 56 46 5 - 30 60 50	Conducted	Pass
15.205 / 209 **6.2.1** **/6.2.2(o)(e3)** **/7.3**	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Shall not exceed the limits specified in FCC 15.209 or RSS-210 Table3.	Radiated (30MHz -1GHz)	Pass
			Radiated (1– 25GHz)	Pass

	Other requirements		Result
15.247(b)(4)(i) **–**	Antenna gain	Peak gain of the device : 1.24 dBi	N/A
– **5.2**	Supply Voltage	Main power source: Universal AC adapter 72W Mini-PCI PC bus to applying card : DC 3.3V ± 0.3V	N/A
15.203 **6.2.2(o)(e2)**	Unique antenna connector	The device employs a unique electronic connector so called **BIOS Lock**. Refer to “Confidential_BIOS-Lock” exhibit.	complies

C. Operation Mode of EUT

All tests were performed using the “CRTU Program”, Version 1.1.5. Three kinds of modulation are used for transmission with appropriate bit rates:

Table C-1 Transmit mode (TX)

Operation Frequency [GHz]	Rated output power (conducted) [dBm]		Test performed
	Bit rate 1/2Mbps	Bit rate 5.5/11Mbps	
2.412 (Ch. 1)	+17	+17	X
2.417 (Ch. 2)	+17	+17	
2.422 (Ch. 3)	+17	+17	
2.427 (Ch. 4)	+17	+17	
2.432 (Ch. 5)	+17	+17	
2.437 (Ch. 6)	+17	+17	X
2.442 (Ch. 7)	+17	+17	
2.447 (Ch. 8)	+17	+17	
2.452 (Ch. 9)	+17	+17	
2.457 (Ch. 10)	+17	+17	
2.462 (Ch. 11)	+17	+17	X

Table C-2 Receive mode (RX)

Operation Frequency [GHz]	Test performed
2.412 (Ch. 1)	
2.417 (Ch. 2)	
2.422 (Ch. 3)	
2.427 (Ch. 4)	
2.432 (Ch. 5)	
2.437 (Ch. 6)	X
2.442 (Ch. 7)	
2.447 (Ch. 8)	
2.452 (Ch. 9)	
2.457 (Ch. 10)	
2.462 (Ch. 11)	

Note) The Tx tests were performed with the main (left) antenna, since the auxiliary (right) antenna is used for receiving only.

Table-C-3 Peak Antenna Gains of EUT

	Left Antenna gain	Right Antenna gain **(receiving only)**
2.4GHz band	1.24 dBi (peak)	0.38 dBi (peak)

D. Test Instruments

Table-D List of Measuring Instruments

Description	**Model**	**Serial Number**	**Calibration Date**	**Calibration Interval**
Computer	IBM 6868-30J	97-901X3	N/A	N/A
Computer	IBM 6589-13J	97-15613	N/A	N/A
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2601A02634	09/09/03	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	3019A05156	08/14/03	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2841A04254	08/25/03	1 year
Spectrum Analyzer Display	HP 85662A	2542A12308	09/09/03	1 year
Spectrum Analyzer Display	HP 85662A	3026A19366	08/14/03	1 year
Spectrum Analyzer Display	HP 85662A	2816A16831	08/25/03	1 year
Quasi-Peak Adapter	HP 85650A	2043A00062	09/09/03	1 year
Quasi-Peak Adapter	HP 85650A	2811A01433	08/14/03	1 year
Quasi-Peak Adapter	HP 85650A	2811A01156	08/25/03	1 year
Amplifier (100KHz - 1.3GHz)				
- for 30-200MHz	HP 8447D	2805A02919	04/14/03	1 year
- for 200-1000MHz	HP 8447D	2727A05190	04/14/03	1 year
Amplifier (1GHz - 18GHz)	HP 8449B	3008A00582	06/11/03	1 year
Amplifier (18 – 25GHz)	Agilent 83051A	3950M00193	01/24/04	1 year
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003	05/01/03	1 year
Receiver (9kHz-30MHz)	R&S ESH3	891806/012	10/17/03	1 year
Receiver (20MHz-1.3GHz)	R&S ESVP	892111/030	03/17/03	1 year
Biconical Antenna (30-200MHz)	EMCO 3108	2536	04/23/03	1 year
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	2849	04/23/03	1 year
Horn Antenna (1- 18GHz)	EMCO 3115	9903-5774	07/17/03	1 year
Horn Antenna (3.95- 5.85GHz)	EMCO 3160-5	1099	07/17/03	1 year
Horn Antenna (5.85- 8.20GHz)	EMCO 3160-6	9712-1044	07/17/03	1 year
Horn Antenna (18- 26.5GHz)	EMCO 3160-9	0004-1202	07/17/03	1 year
LISN	EMCO 3810/2NM	00022007	05/20/03	1 year
Power Meter	HP 437B	3043U03437	11/19/03	1 year
Power Sensor	HP 8481A	US41030582	11/19/03	1 year
Switch/control unit	HP 3488A	2719A17226	N/A	N/A
		2719A17228	N/A	N/A
Plotter	HP 7550A	2631A33619	N/A	N/A
Coaxial cables (1 – 18GHz):	Length:			
- Horn Ant <=> RF Amp.	6 m	- EM206SCO	03/27/03	1 year
- RF Amp.<=>Spectrum Analyzer	16m	- GEM0101	03/27/03	1 year
Coaxial cables (18 – 25GHz):				
- Horn Ant <=> RF Amp.	3m	- SF102-20167	03/27/03	1 year
- RF Amp.<=>Spectrum Analyzer	1m	- SF102-21105	03/27/03	1 year
N-Coax cables:				
- Bi-coni Ant <=> 10m Cable	9 m	- EM103L01	04/14/03	1 year
- 10m Cable <=> Shield Panel	10 m	- EM103L02	04/14/03	1 year
- Shield Panel <=> RF Amp	7 m	- EM103L03	04/14/03	1 year

- RF Amp <=> Power Splitter	0.5m	- EM103L04	04/14/03	1 year
- Log-peri Ant <=> 10m Cable	9 m	- EM103H01	04/14/03	1 year
- 10m Cable <=> Shield Panel	10 m	- EM103H02	04/14/03	1 year
- Shield Panel <=> RF Amp	7 m	- EM103H03	04/14/03	1 year
- RF Amp <=> Power Splitter	0.5m	- EM103H04	04/14/03	1 year
Coax cables:				
- Lisn-L <=> SW/Con.unit (SW100)	4 m	- EMIC-L	04/14/03	1 year
- Lisn-N <=> SW/Con.unit (SW101)	4 m	- EMIC-N	04/14/03	1 year
- SW/Con.unit <=> RCVR (Input)	1 m	- EMIC-R	04/14/03	1 year
- SW/Con.unit<=> Spe Ana.(Signal In)	1 m	- EMIC-S	04/14/03	1 year
- Power Splitter <=> SW/Con.unit (SW110)	1 m	- EM103L05	04/14/03	1 year
- Power Splitter <=> SW/Con.unit (SW300)	1 m	- EM103L06	04/14/03	1 year
- Power Splitter <=> SW/Con.unit (SW100)	1 m	- EM103H05	04/14/03	1 year
- Power Splitter <=> SW/Con.unit (SW301)	1 m	- EM103H06	04/14/03	1 year
- SW/Con.unit <=> Receiver (Input)	2 m	- EM1RCV	04/14/03	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz	2 m	- EM1SPL	04/14/03	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	2 m	- EM1SPH	04/14/03	1 year

Notes.

- The above equipment calibration is traceable to National standards.
- HP: Hewlett Packard, R&S: Rohde & Schwarz

E. Measurement Uncertainty

Uncertainties of the both, the Yamato EMI radiated test facilities (EMI chambers, #1 and #2) and the Yamato EMI conducted test facility are derived with the NIS 81 " Treatment of uncertainty in EMC measurements" 1994.

Estimated site uncertainty values are as follows.

EMI chamber #1 : 4.39dB
EMI chamber #2 : 4.40dB
EMI conducted measurement system : 2.4dB

Detail should be referred to "Treatment of Uncertainty, Calculations and Policy" report, document number TCR 10-0015.

F. Temperature and Humidity

The temperature is controlled within range of 17˚ to 28˚.
The relative humidity is controlled within range of 40% to 70%.

G. Related Submittal(s)/Grant(s)/Notes

The host unit with full peripheral devices including the applying modular as an unintentional radiator is classified as a Digital Device under the FCC Part 15 Subpart B or the Industry Canada Class B Emission Compliance (ICES-003), and subject to DoC.

1. Bandwidth at 6 dB below

[FCC 15.247(a)(2)]

1.1 Test Procedure

The bandwidth at 6 dB down from the highest inband spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT was operating in transmission mode at the appropriate center frequency.
The spectrum analyzer was set to :
RBW=100kHz, VBW=100kHz*1, Span=30MHz, Mode= Peak detector,
Sweep=suitable duration based on the EUT specification
*1: To be adjusted accordingly based on the spectrum stability

1.2 Test Instruments and Measurement Setup

Table 1-1 : 6 dB Bandwidth Test Instruments

Description	**Model**	**Serial Number**
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003
Coax cables: - Spectrum Analyzer <=> EUT	Length: Loss: 110 cm 1.3 dB	

Notes: - R&S: Rohde & Schwarz

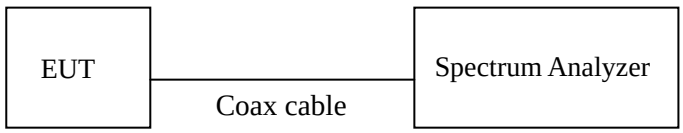


Figure 1: Measurement setup for 6dB bandwidth test

1.3 Measurement Results

Test Date: February 12, 2004

Table 1-2-1. 6dB bandwidth, TX mode 1Mbps

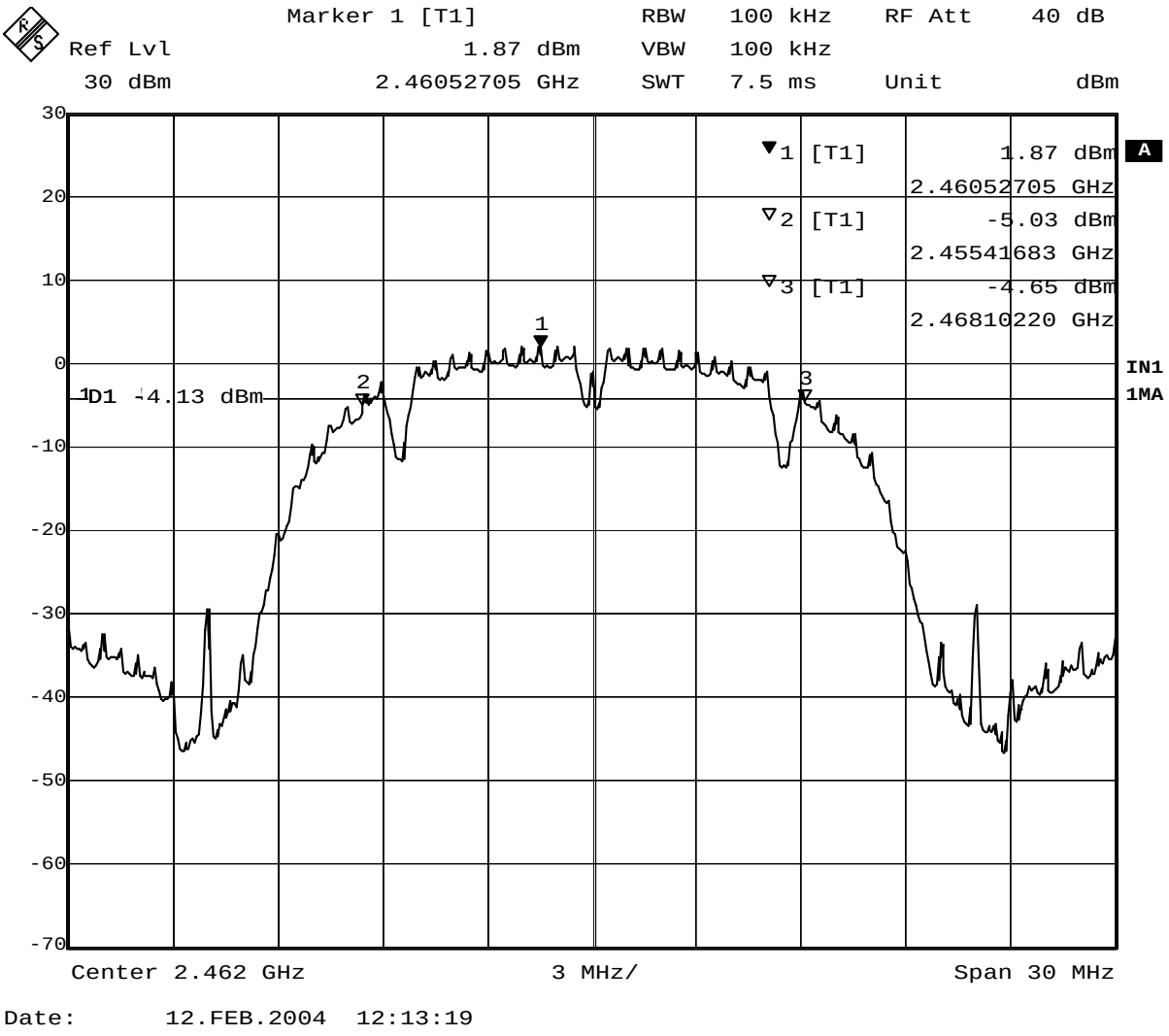
Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
2412 (ch. 1)	omitted	2405.42	2418.10	12.68	> 0.5
2437 (ch. 6)	omitted	2430.42	2443.10	12.68	
2462 (ch. 11)	Plot 1-1	2455.42	2468.10	12.68	

Table 1-2-2. 6dB bandwidth, TX mode 11Mbps

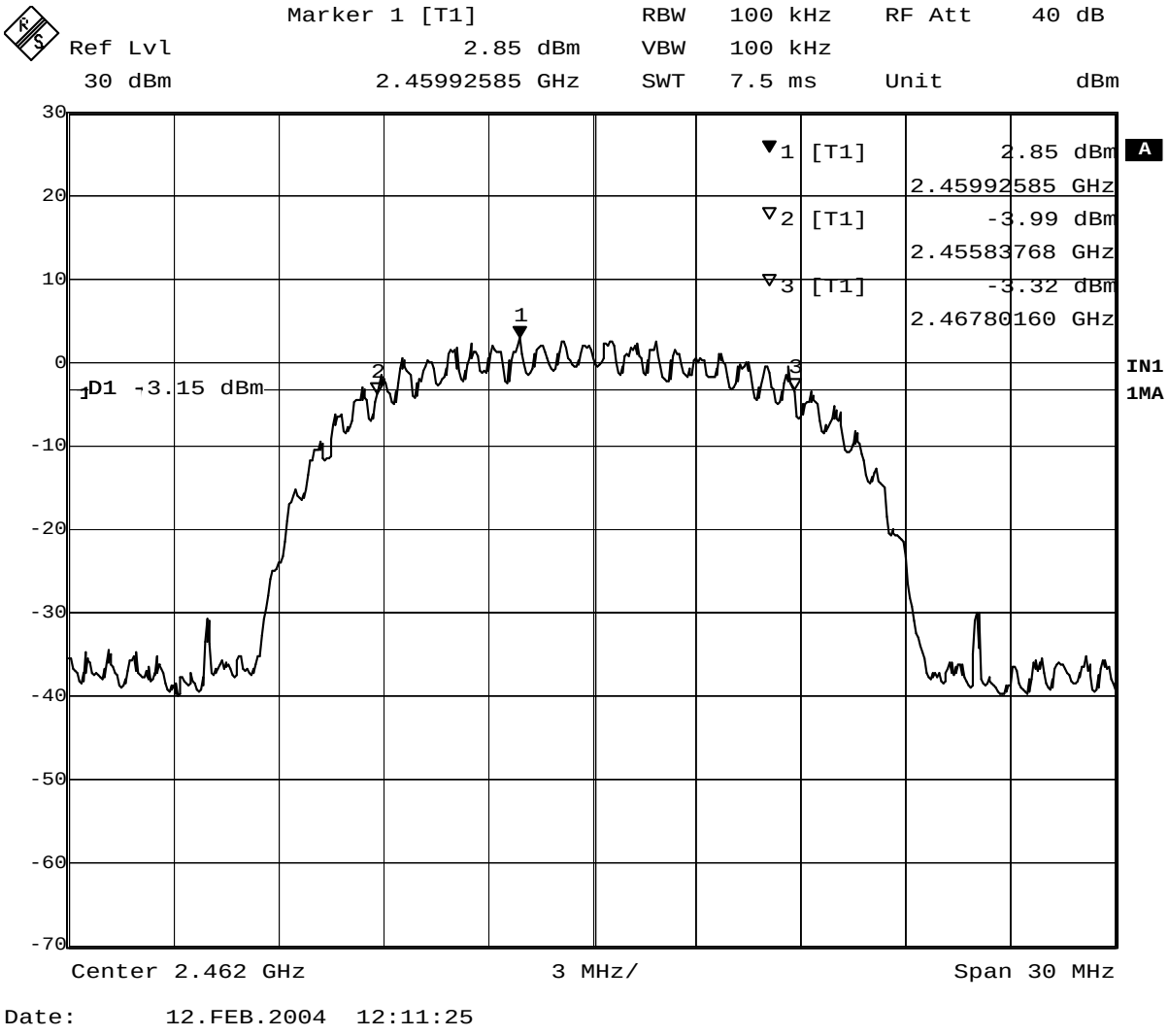
Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
2412 (ch. 1)	omitted	2405.84	2417.86	12.02	> 0.5
2437 (ch. 6)	omitted	2430.84	2442.86	12.02	
2462 (ch. 11)	Plot 1-2	2455.84	2467.80	11.96	

1.4 Trace Data of 6dB bandwidth

The plots are comparatively worse measurement cases in the previous Table 1-2-1 and Table 1-2-2.



Plot 1-1. 6dB BW at 2462MHz (1Mbps)



Plot 1-2. 6dB BW at 2462MHz (11Mbps)

2. Occupied Bandwidth (20 dB Bandwidth)

[RSS-210 5.9.1]

2.1 Test Procedure

The bandwidth at 20 dB down from the highest inband spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT was operating in transmission mode at the appropriate center frequency.

The spectrum analyzer was set to:

RBW=100kHz, VBW=100kHz[*1], Span=50MHz, Mode= Peak detector,

Sweep= suitable duration based on the EUT specification

*1: To be adjusted accordingly based on the spectrum stability

2.2 Test Instruments and Measurement Setup

Same as the Chapter 1 (Table 1-1 & Figure 1).

2.3 Measurement Results

note) The transmission speed rate for the measurement was determined based on the results of previous 6 dB bandwidth measurement. The worse case (i.e. Tx 11Mb/s mode) was selected representatively.

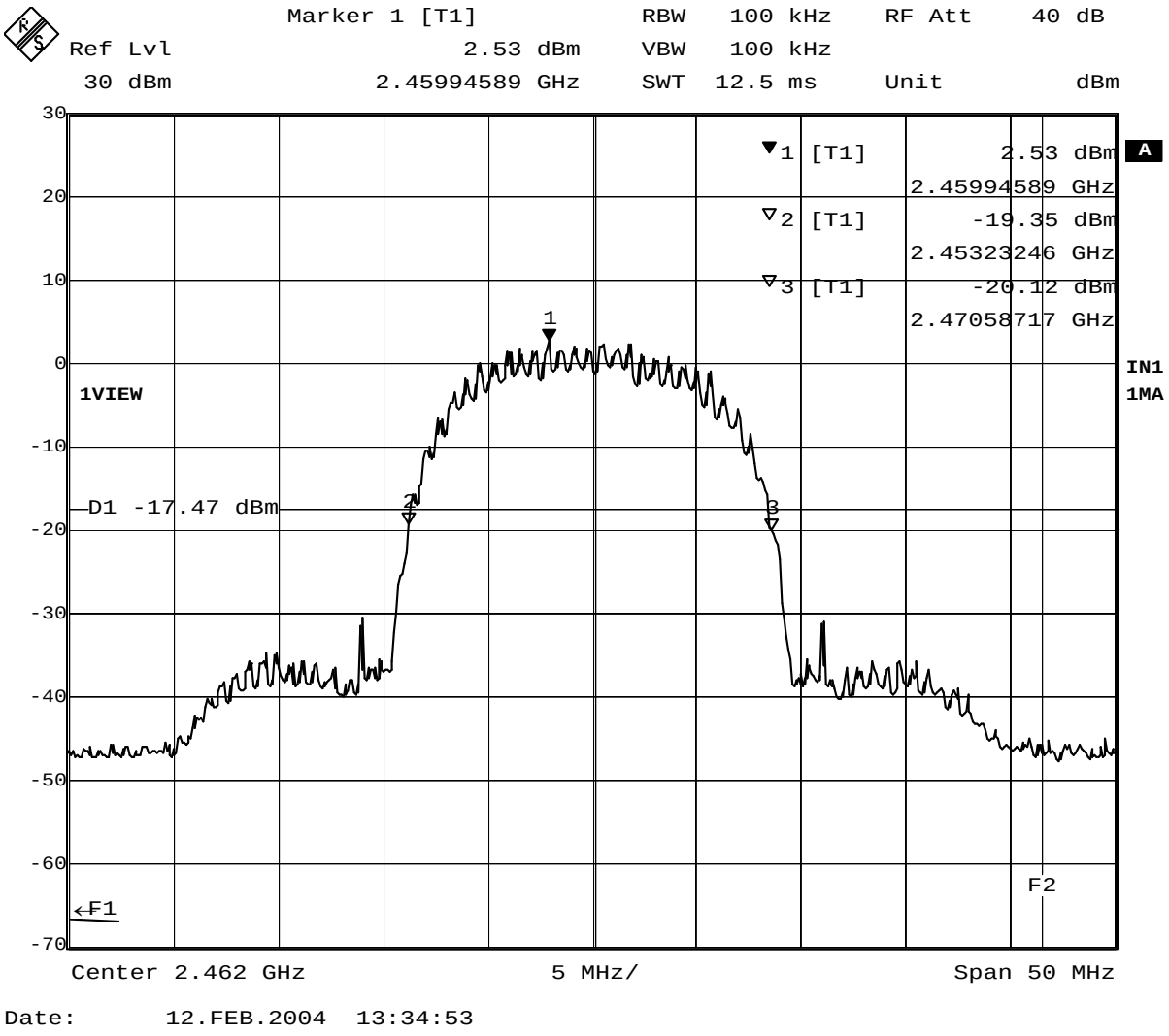
Test Date: February 12, 2003

Table 2-2-1. Occupied bandwidth, TX 11Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
2412 (ch. 1)	omitted	2403.35	2420.59	17.24
2437 (ch. 6)	omitted	2428.33	2445.54	17.21
2462 (ch. 11)	Plot 2-1	2453.23	2470.59	17.36

2.4 Trace Data of Occupied Bandwidth

The plot is comparatively worse measurement case in the previous Table 2-2-1.



Plot 2-1. 20dB BW at 2462MHz (11Mbps)

3. Conducted Peak Output Power

[FCC 15.247(b)(3), RSS-210 6.2.2(o)(b)]

3.1 Test Procedure

- A transmitter antenna terminal of EUT is connected to the input of a RF power sensor.
- Measurement is made while EUT is operating in transmission mode at the appropriate center frequency.

Table 3-1 : Peak Output Power Test Instruments

Description	**Model**	**Serial Number**
Power Meter	HP 437B	3043U03437
Power Sensor	HP 8481A	US41030582
Coax cables: - Power Sensor <=> EUT	Length: Loss: 20 cm 0.7dB	

Notes: - HP: Hewlett Packard

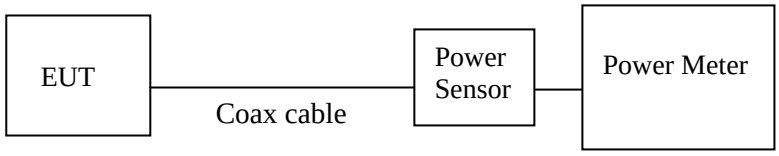


Figure 3: Measurement setup for RF output power

3.2 Measurement Results

Test Date: February 12, 2003

Table 3-2. Peak Output Power, TX mode 1Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	16.10	0.7	16.8	0.0479	30.0	13.2
2437 (ch. 6)	16.35	0.7	17.1	0.0513	30.0	12.9
2462 (ch. 11)	16.21	0.7	16.9	0.0490	30.0	13.1

Table 3-3. Peak Output Power, TX mode 11Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	16.18	0.7	16.9	0.0490	30.0	13.1
2437 (ch. 6)	16.53	0.7	17.2	0.0525	30.0	12.8
2462 (ch. 11)	16.27	0.7	17.0	0.0501	30.0	13.0

4. Out of Band Emissions (Conducted Spurious)

[FCC 15.247(c), RSS-210 6.2.2(o)(e1)]

4.1 Test Procedure

The outband emissions in any 100kHz bandwidth was measured with a spectrum analyzer connected to the antenna terminal, while EUT was operating in transmission mode at the appropriate center frequency.
The spectrum analyzer was set to:
RBW = 100kHz, VBW = 100kHz[*1], Scanning frequency range = 30MHz~2Ghz, 2GHz~3GHz, and 3GHz~26.5GHz, Mode= Peak detector, Sweep = suitable duration based on the EUT specification
*1: To be adjusted accordingly based on the spectrum stability

4.2 Test Instruments and Measurement Setup

Same as the Chapter 1 (Table 1-1 & Figure 1).

4.3 Measurement Results

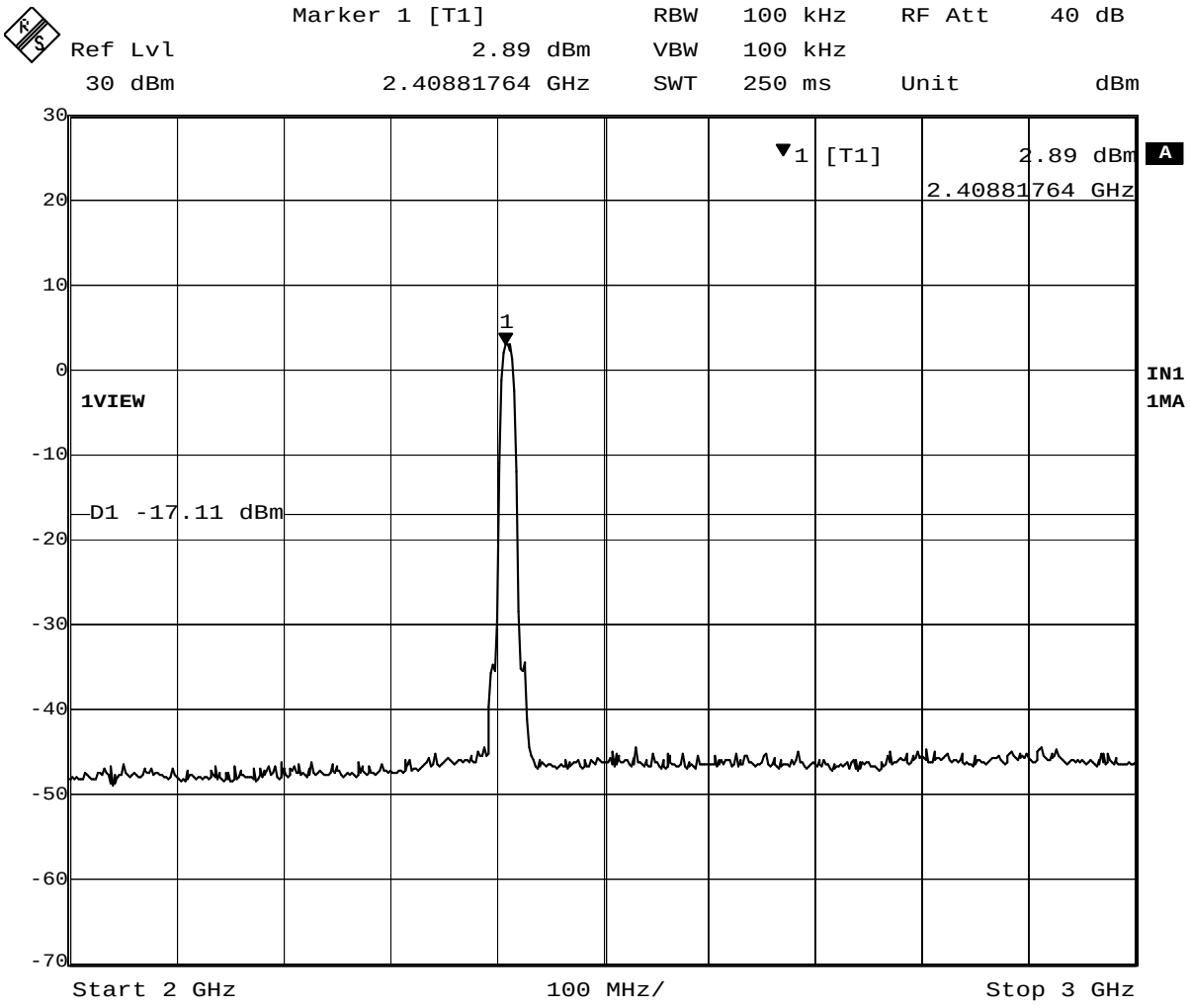
All conducted emission in any 100kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest inband spectral density.

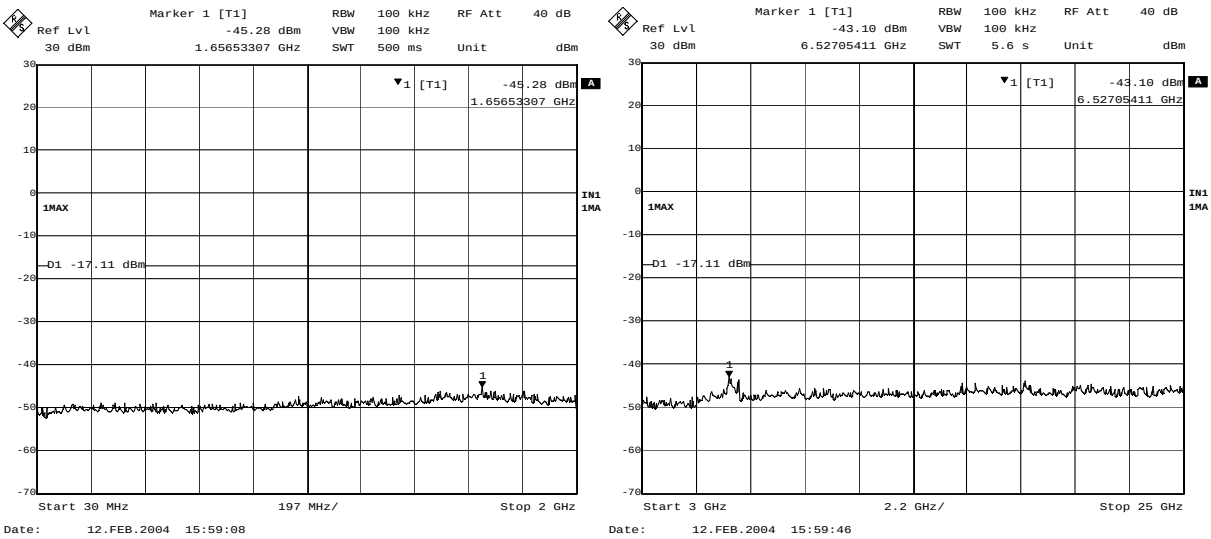
The measurement was performed with the worse cases that tend to have higher conducted peak power, based on the results of previous Chapter 3 “Conducted Peak Output Power” measurement. (i.e. Tx 11Mb/s mode)

Test Date: February 12, 2004 : See the following plots.

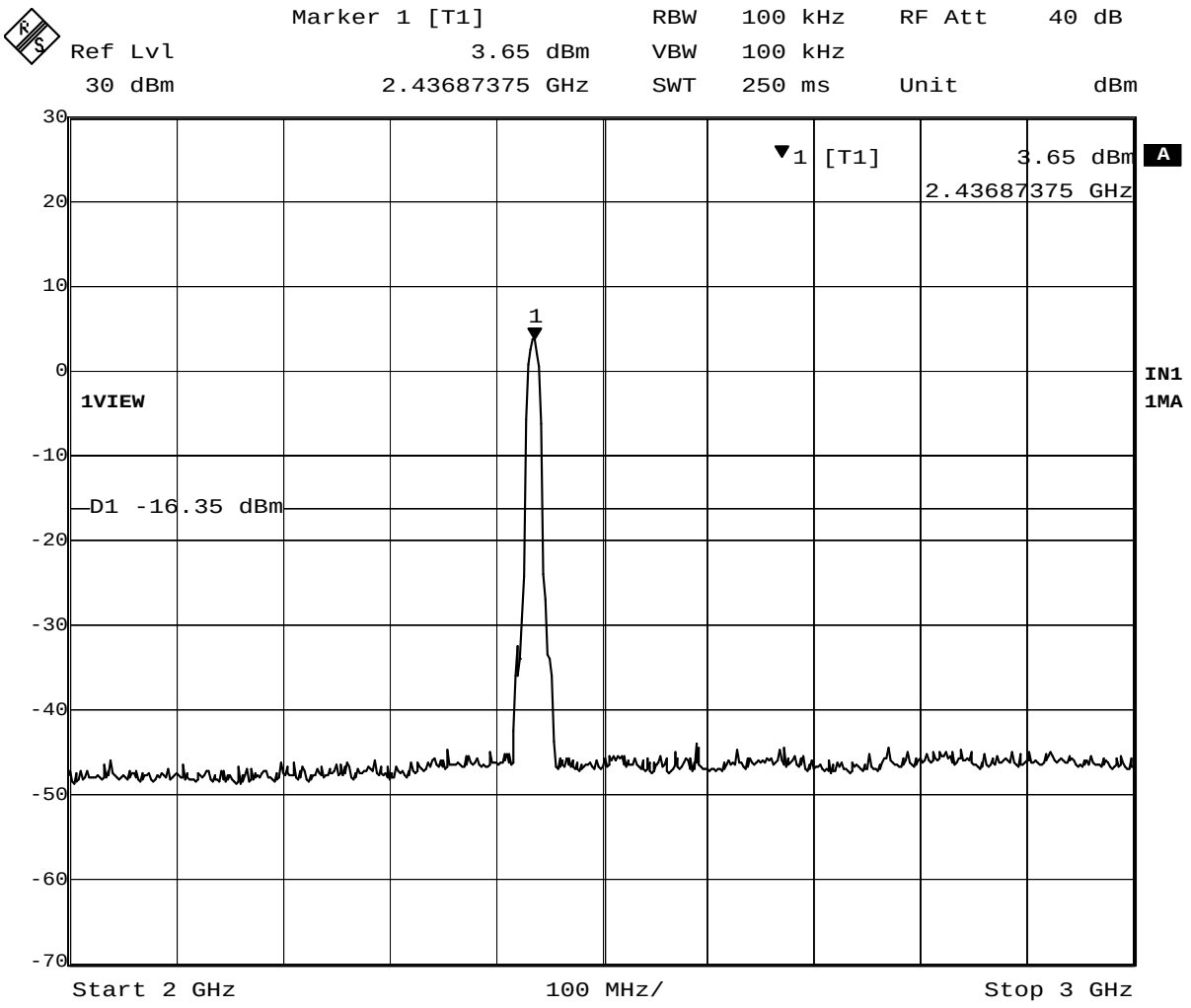
Transmission Frequency (MHz)		Trace number
2412 (ch. 1)	11Mbps	Plot 4-1
2437 (ch. 6)		Plot 4-2
2462 (ch. 11)		Plot 4-3

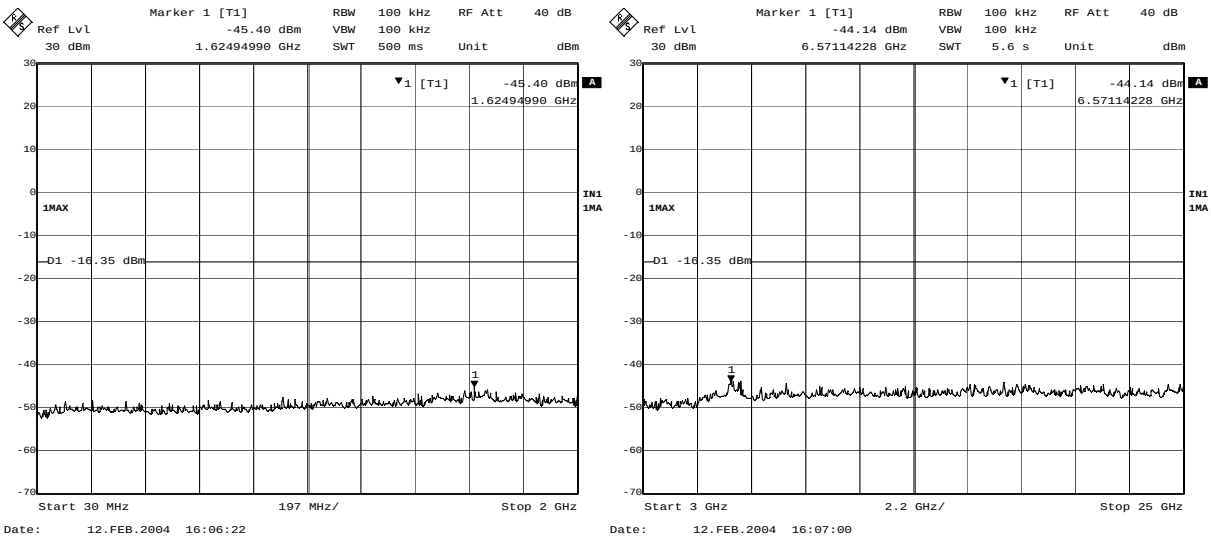
4.4 Trace Data of Out of Band Emissions



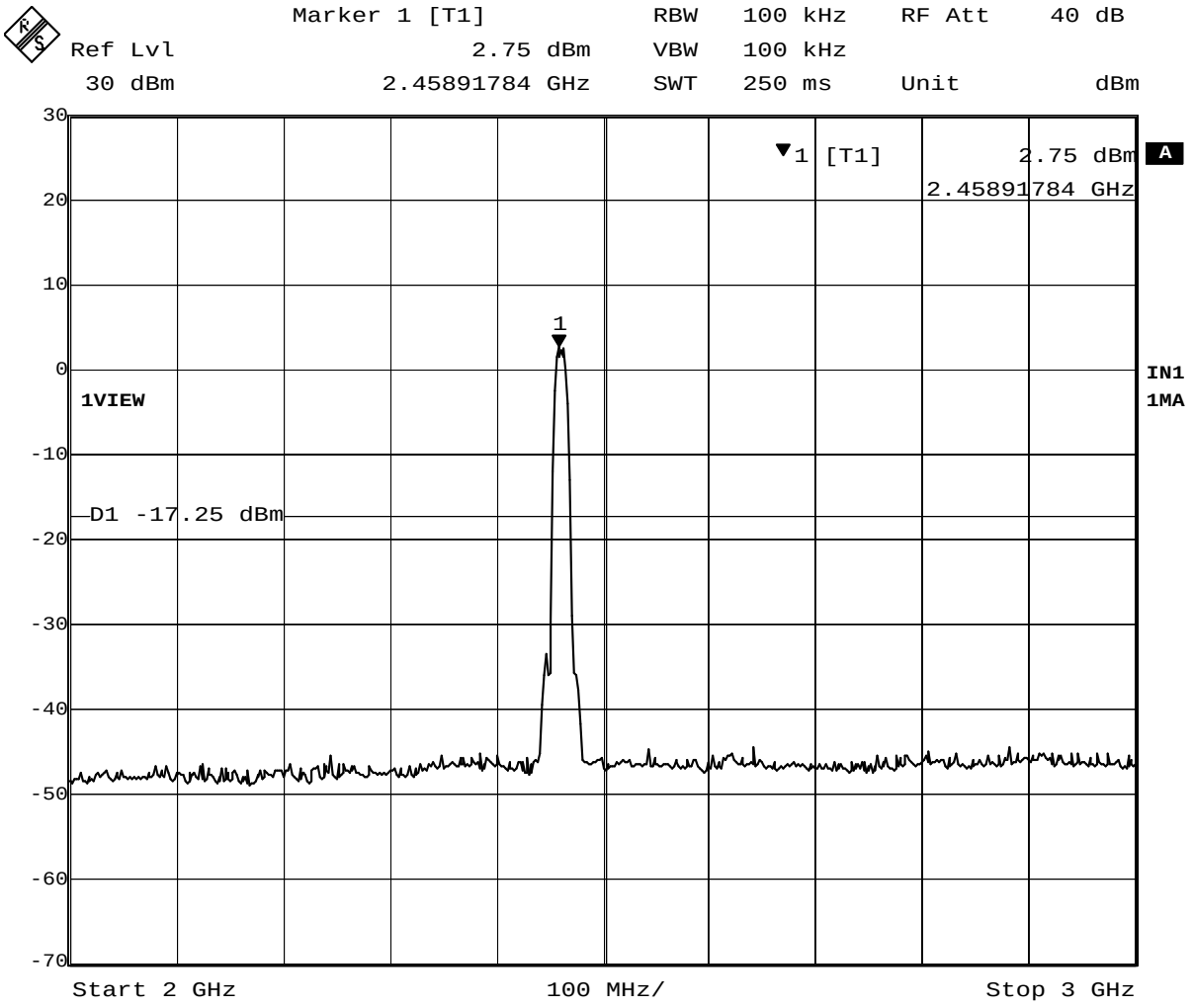


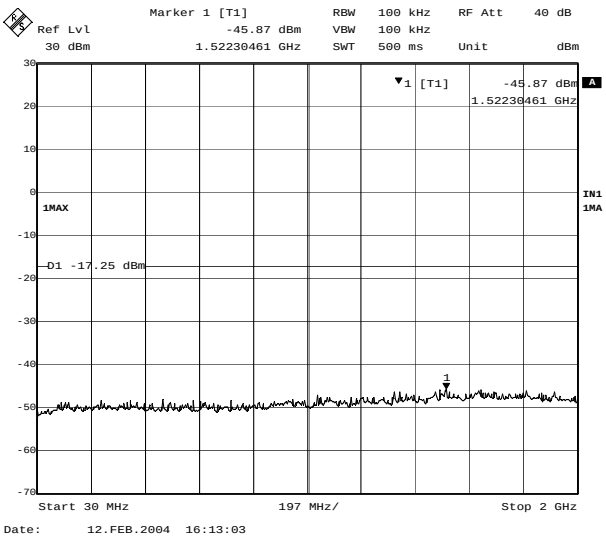
Plot 4-1. Conducted Spurious (11Mbps, ch.1)

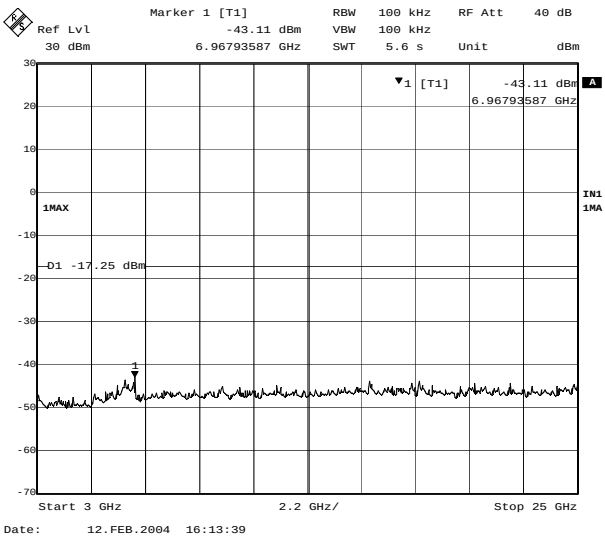




Plot 4-2. Conducted Spurious (11Mbps, ch. 6)







Plot 4-3. Conducted Spurious (11Mbps, ch. 11)

5. Peak Power Spectral Density

[FCC 15.247(d), RSS-210 6.2.2(o)(b)]

5.1 Test Procedure

The power spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT was operating in transmission mode at the appropriate center frequency.

The pre-scanning was performed with the spectrum analyzer to search and locate the center frequency at the peak emission of each transmission mode.
Then, the spectral analyzer was set to the emission peak found in the pre-scan and the peak power spectral density was measured with:

RBW = 3 kHz, VBW = 3 kHz, Span = 300 kHz, Sweep = 100 seconds, Mode= Peak detector

5.2 Test Instruments and Measurement Setup

Same as the Chapter 1 (Table 1-1 & Figure 1).

5.3 Measurement Results

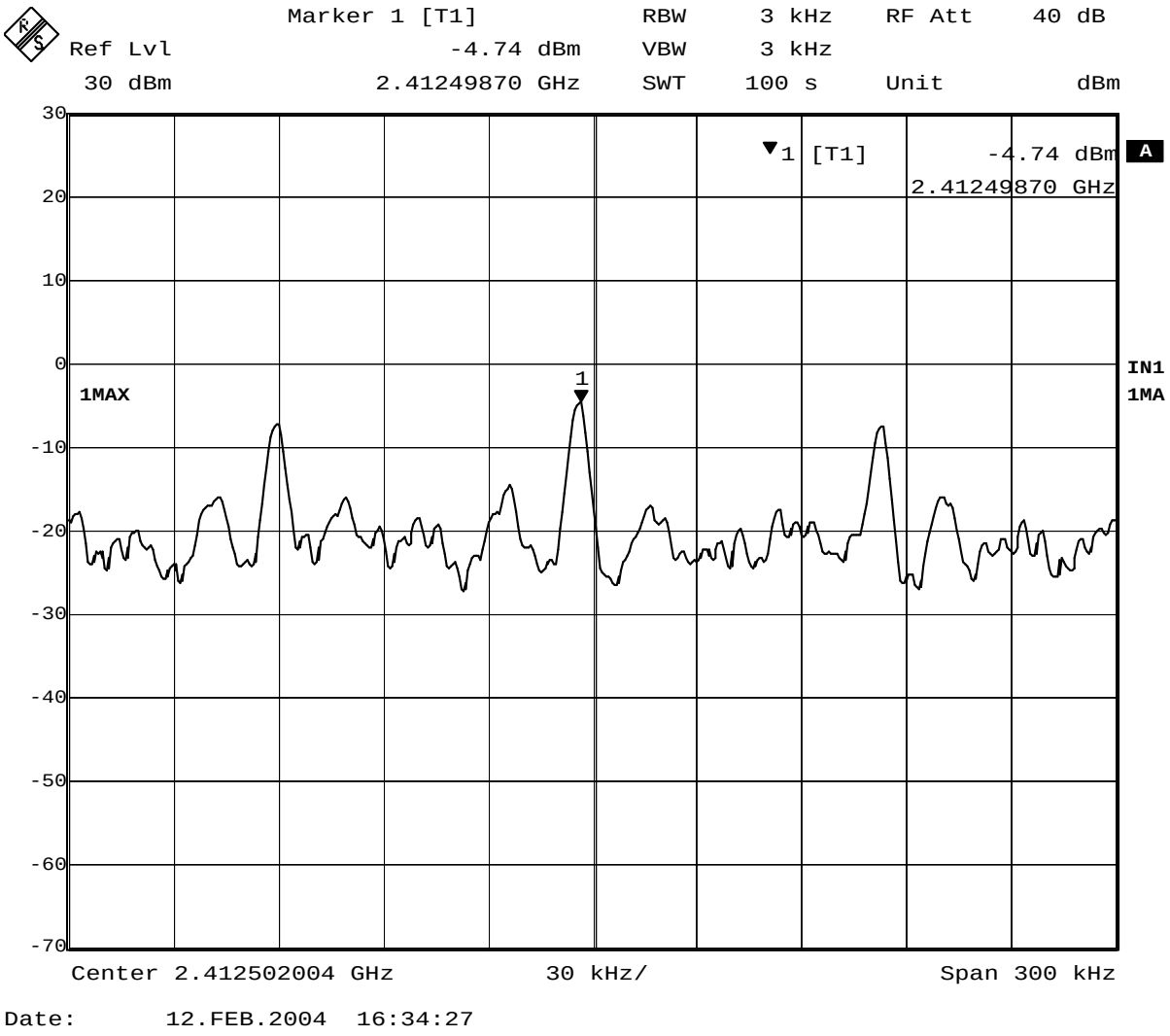
The measurement was performed with the worse cases that tend to have higher conducted peak power, based on the results of previous Chapter 3 “Conducted Peak Output Power” measurement. (i.e. Tx 11Mb/s mode)

Test Date: February 12, 2004

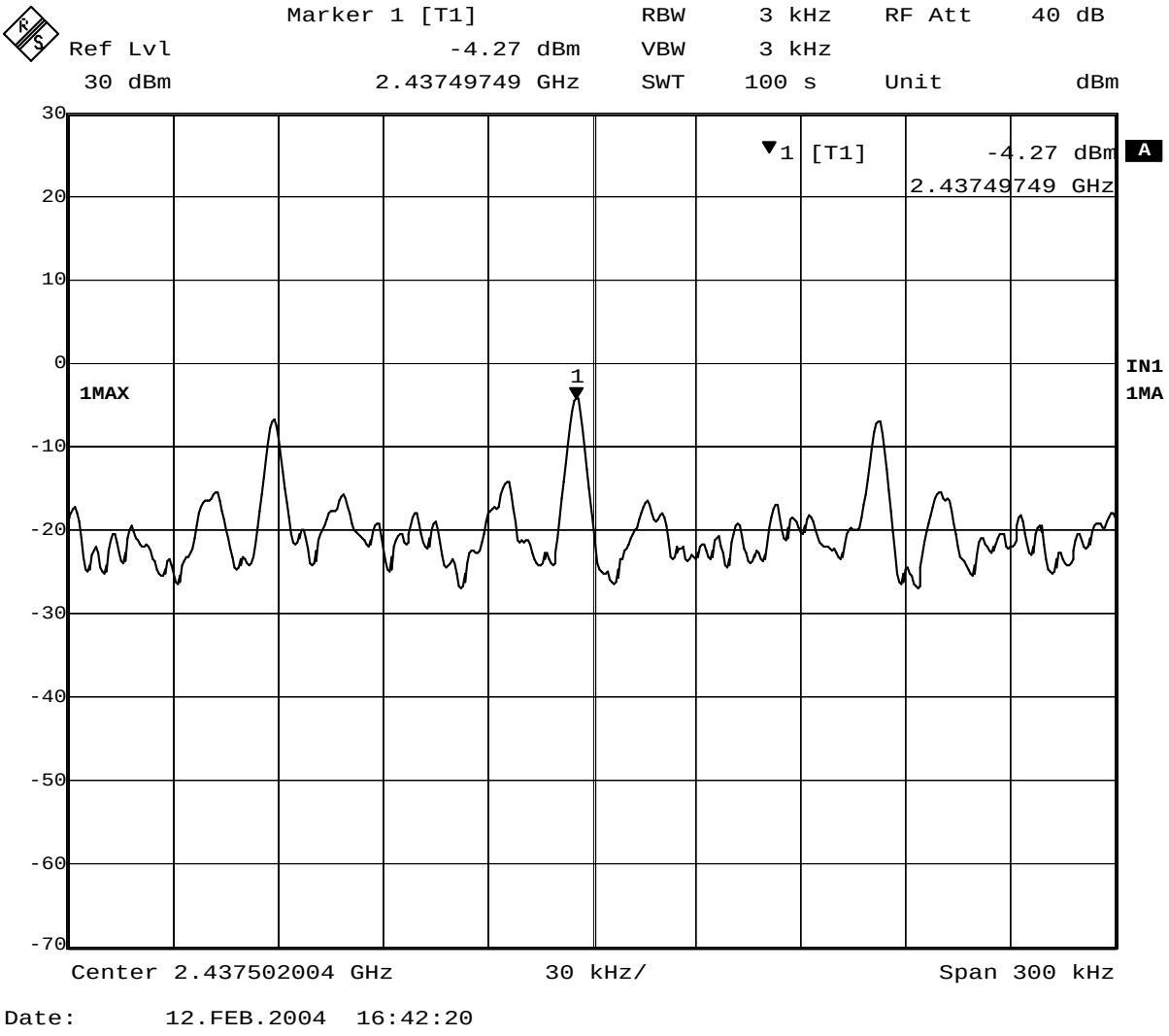
Table 5-1. Peak Power Spectrum Density, TX mode

	Ch No.	Frequency (MHz)	**Analyzer Reading** (dBm)	Trace number	Cable loss (dB)	**Result** (dBm)	Limit (dBm)	Margin (dB)
11Mbps	1	2412.50	-4.74	Plot 5-1	1.3	- 3.4	8.0	11.4
	6	2437.50	-4.27	Plot 5-2	1.3	- 3.0	8.0	11.0
	11	2461.98	-4.87	Plot 5-3	1.3	- 3.6	8.0	11.6

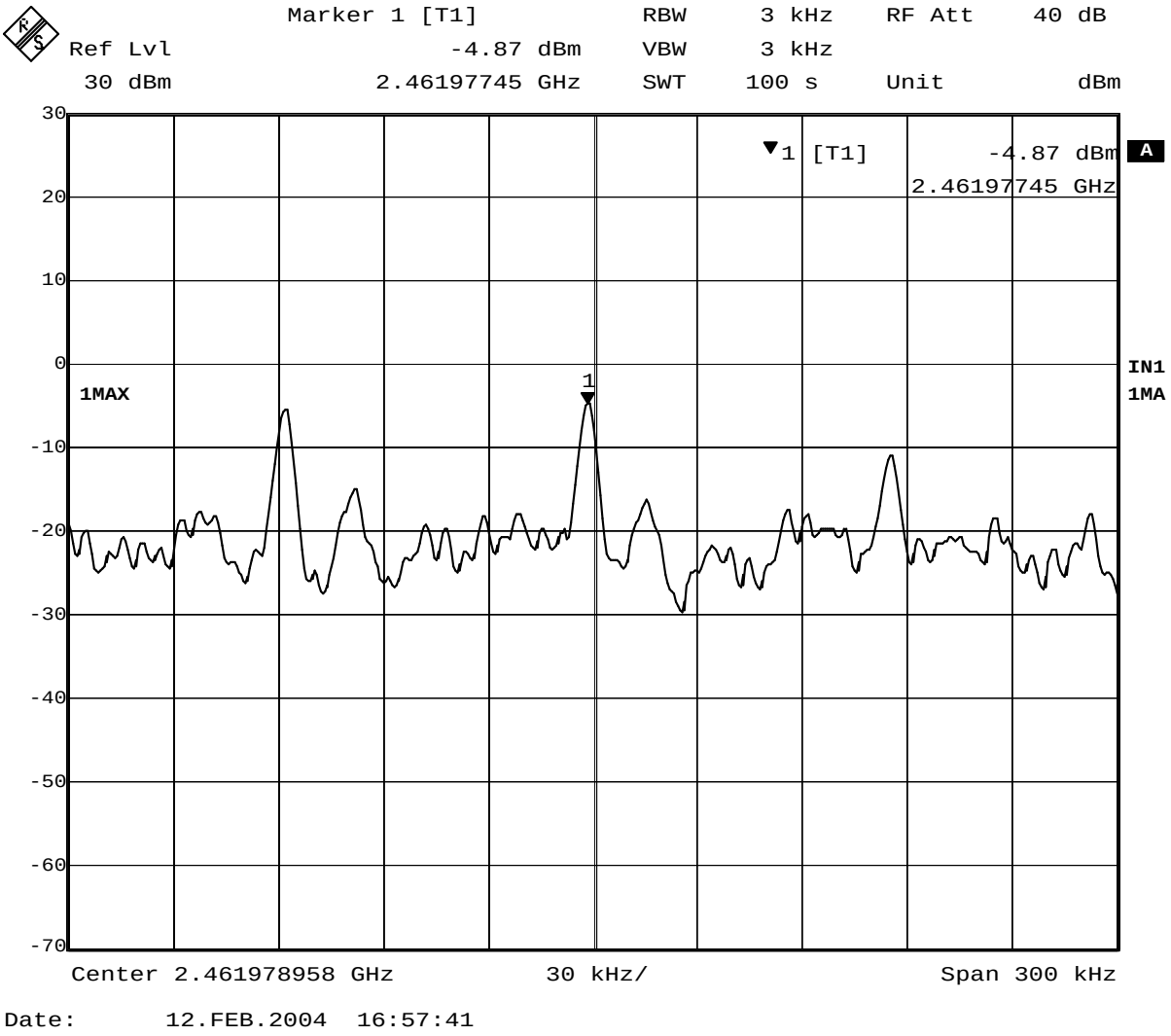
5.4 Trace Data of Peak Power Spectral Density



Plot 5-1. Peak Power Spectral Density of 2412MHz (11Mbps)



Plot 5-2. Peak Power Spectral Density of 2437MHz (11Mbps)



Plot 5-3. Peak Power Spectral Density of 2462MHz (11Mbps)

6. AC WIRELINE CONDUCTED EMISSIONS (150KHz – 30MHz)

[FCC 15.207, RSS-210 6.6 / 7.4]

6.1 Test Procedure

The conducted emissions are measured in the IBM shielded room with a spectrum analyzer in peak hold. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9KHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

6.2 Test Instruments and Measurement Setup

Table 6-1. Conducted Emission Test Instrumentation

Description	**Model**	**Serial Number**
Computer	IBM 6589-13J	97-15613
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2841A04254
Spectrum Analyzer Display	HP 85662A	2816A16831
Quasi-Peak Adapter	HP 85650A	2811A01156
Receiver (9kHz-30MHz)	R&S ESH3	891806/012
LISN	EMCO 3810/2NM	00022007
Switch/control unit	HP 3488A	2719A17228
Plotter	HP 7550A	2631A33619
Coax cables: - Lisn-L <=> SW/Con.unit (SW100) - Lisn-N <=> SW/Con.unit (SW101) - SW/Con.unit <=> RCVR (Input) - SW/Con.unit<=> Spe Ana.(Signal In)	Length: 4 m 4 m 1 m 1 m	 - EMIC-L - EMIC-N - EMIC-R - EMIC-S

Notes: - HP: Hewlett Packard, R&S: Rohde & Schwarz

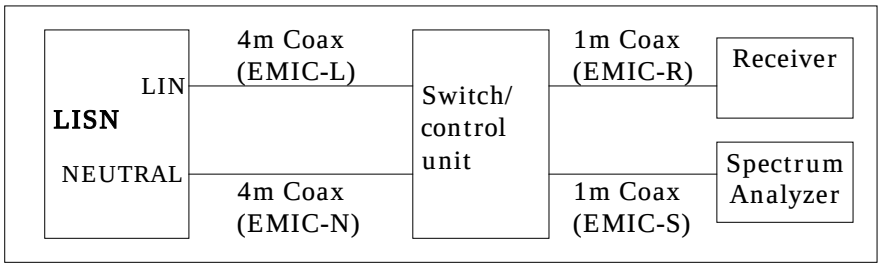


Figure 6. Cables for Conducted Emission Test

6.3 Powerline Voltage Calculation

The powerline voltage is calculated by adding insertion losses of LISN, Cable, Switch control unit and Pulse limiter to the measured reading. All factors are included in the reported data.

PV = R + CORR

where:

PV = Powerline Voltage (dBμV)
R = Measured Receiver Input Amplitude (dBμV)
CORR = Correction Factor (dB) = LL+CL+SWL+PLL
LL = Insertion loss of LISN (dB)
CL = Insertion loss of Cable (dB)
SWL = Insertion loss of Switch control unit (dB)
PLL = Insertion loss of Pulse Limiter (dB)

Given a Receiver input reading of 50.0 dBμV, LISN loss of 0.6 dB, Cable loss of 0.1dB, Switch control unit loss of 0.1dB and Pulse limiter loss of 0.2dB. The Powerline Voltage of the measured emission is:

CORR = 0.6 + 0.1 + 0.1 + 0.2 = 1.0 (dB)
PV = 50.0 + 1.0 = 51.0 (dBμV)

6.4 Measurement Results

The EUT was found to comply to the limits of FCC Part 15 Subpart C and RSS-210 with a margin of 11.6dB. The 6 highest emissions relative to the limits are reported.

Test Date: February 13, 2004

Table 6-2-1. Ch.1 (2412MHz) **TX** mode 11Mbps

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.1984	42.2	0.5	42.7	30.9	0.5	31.4	63.7	53.7	Line
0.2630	38.3	0.6	38.9	26.6	0.6	27.2	61.3	51.3	Line
0.3400	34.2	0.6	34.8	23.2	0.6	23.8	59.2	49.2	Line
0.5288	38.8	0.6	39.4	33.8	0.6	34.4	56.0	46.0	Neutral
0.5451	39.3	0.6	39.9	26.8	0.6	27.4	56.0	46.0	Line
0.6105	34.8	0.6	35.4	22.1	0.6	22.7	56.0	46.0	Line

Table 6-2-2. Ch.6 (2437MHz) **TX** mode 11Mbps

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.1935	40.4	0.5	40.9	31.0	0.5	31.5	63.9	53.9	Line
0.2651	36.4	0.6	37.0	27.0	0.6	27.6	61.3	51.3	Line
0.3406	33.6	0.6	34.2	22.6	0.6	23.2	59.2	49.2	Line
0.4705	28.5	0.6	29.1	20.1	0.6	20.7	56.5	46.5	Neutral
0.5441	40.1	0.6	40.7	27.4	0.6	28.0	56.0	46.0	Line
0.6105	33.7	0.6	34.3	23.1	0.6	23.7	56.0	46.0	Neutral

Table 6-2-3. Ch.11 (2462MHz) **TX** mode 11Mbps

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2599	36.2	0.6	36.8	23.7	0.6	24.3	61.4	51.4	Line
0.3383	34.2	0.6	34.8	23.9	0.6	24.5	59.2	49.2	Line
0.3943	30.2	0.6	30.8	23.4	0.6	24.0	58.0	48.0	Neutral
0.5321	40.2	0.6	40.8	29.9	0.6	30.5	56.0	46.0	Line
0.5411	41.1	0.6	41.7	31.0	0.6	31.6	56.0	46.0	Line
0.5907	33.8	0.6	34.4	26.7	0.6	27.3	56.0	46.0	Neutral

Table 6-2-4. Ch. 6 (2437MHz) **RX** mode

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2651	36.3	0.6	36.9	27.3	0.6	27.9	61.3	51.3	Line
0.3395	33.8	0.6	34.4	23.2	0.6	23.8	59.2	49.2	Line
0.4762	30.8	0.6	31.4	19.5	0.6	20.1	56.4	46.4	Neutral
0.5429	41.2	0.6	41.8	30.1	0.6	30.7	56.0	46.0	Line
0.6097	33.0	0.6	33.6	22.5	0.6	23.1	56.0	46.0	Neutral
0.7243	28.4	0.6	29.0	22.6	0.6	23.2	56.0	46.0	Line

7. RESTRICTED BANDS RADIATIONS (30MHz – 1GHz)

[FCC 15.205 / 209, RSS-210 6.3 / 7.3]

7.1 Test Procedure

Preliminary radiated emissions are measured in the semi-anechoic chamber at a 3 meter distance on every azimuth in both horizontal and vertical polarity. The antennas are also scanned in height. The emissions are recorded with a spectrum analyzer in peak hold mode. The identified emissions are further maximized by a cable manipulation. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120kHz. The highest emissions relative to the limit are listed.

7.2 Test Instruments and Measurement Setup

Table 7-1 Radiated Emission Test Instrumentation

Description	**Model**	**Serial Number**
Computer	IBM 6868-30J	97-901X3
Spectrum Analyzer (100Hz-1.5GHz) for 30-200MHz	HP 85680B	2601A02634
Spectrum Analyzer Display for 30-200MHz	HP 85662A	2542A12308
Quasi-Peak Adapter for 30-200MHz	HP 85650A	2043A00062
Spectrum Analyzer (100Hz-1.5GHz) for 200-1000MHz	HP 85680B	3019A05156
Spectrum Analyzer Display for 200-1000MHz	HP 85662A	3026A19366
Quasi-Peak Adapter for 200-1000MHz	HP 85650A	2811A01433
Amplifier (100KHz-1.3GHz) - for 30-200MHz - for 200-1000MHz	 HP 8447D HP 8447D	 2805A02919 2727A05190
Biconical Antenna (30-200MHz)	EMCO 3108	2536
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	2849
Receiver (20MHz-1.3GHz)	R&S ESVP	892111/030
Switch/control unit	HP 3488A	2719A17226
N-Coax cables: - Bi-coni Ant <=> 10m Cable - 10m Cable <=> Shield Panel - Shield Panel <=> RF Amp - RF Amp <=> Power Splitter - Log-peri Ant <=> 10m Cable - 10m Cable <=> Shield Panel - Shield Panel <=> RF Amp - RF Amp <=> Power Splitter	Length: 9 m 10 m 7 m 0.5m 9 m 10 m 7 m 0.5m	 - EM103L01 - EM103L02 - EM103L03 - EM103L04 - EM103H01 - EM103H02 - EM103H03 - EM103H04
Coax cables: - Power Splitter <=> SW/Con.unit (SW110) - Power Splitter <=> SW/Con.unit (SW300) - Power Splitter <=> SW/Con.unit (SW100) - Power Splitter <=> SW/Con.unit (SW301) - SW/Con.unit <=> Receiver (Input) - SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz - SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	 1 m 1 m 1 m 1 m 2 m 2 m 2 m	 - EM103L05 - EM103L06 - EM103H05 - EM103H06 - EM1RCV - EM1SPL - EM1SPH

Notes:
- HP: Hewlett Packard, R&S: Rohde & Schwarz

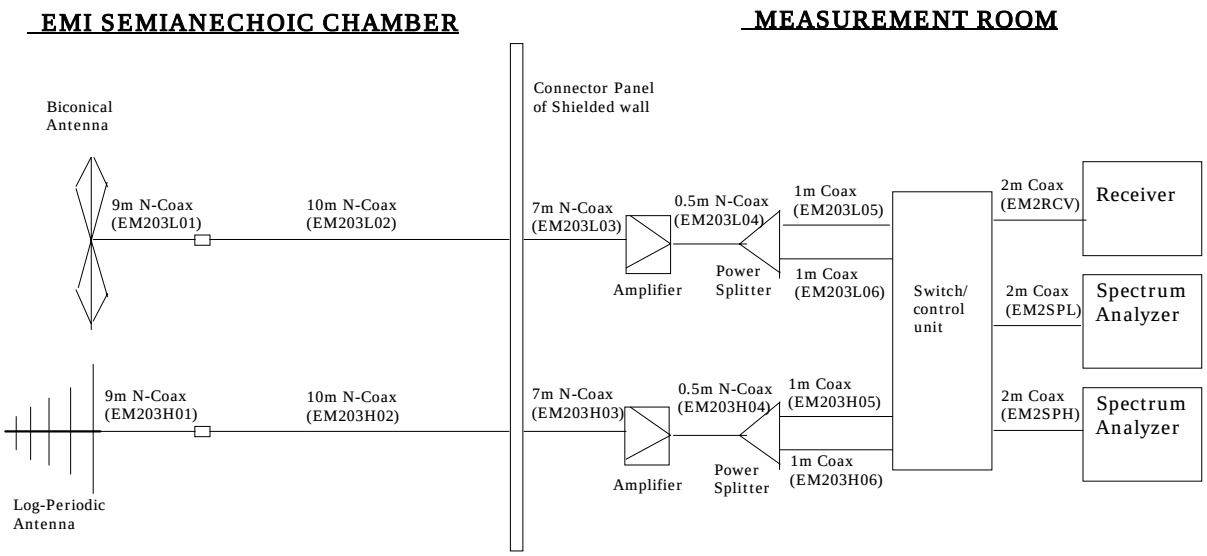


Figure 7 Cables for Radiated Emission Test

7.3 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver. All factors are included in the reported data.

FS = R + AF + CORR

where:

FS	=	Field Strength
R	=	Measured Receiver Input Amplitude
AF	=	Antenna Factor
CORR	=	Correction Factor = CL - AG
CL	=	Cable Loss
AG	=	Amplifier Gain

For example:
Given a Receiver input reading of 51.5dBμV; Antenna Factor of 8.5dB/m; Cable Loss of 1.3dB; and an Amplifier Gain of 26dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 = 35.3dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level(dBμV/m) = 20 $\times$ Log(Level(μV/m))

40dBμV/m = 100μV/m
48dBμV/m = 250μV/m

7.4 Measurement Results

The EUT was found to comply to the limits of FCC Part 15 Subpart C and RSS-210 with a margin of 8.6 dB at 30MHz - 1000MHz band.
The 6 highest emissions relative to the limits are reported.

Test Date: February 13, 2004

Table 7-2-1. Ch.1 (2412MHz) **TX** mode 11Mbps

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
143.181	V	34.1	12.2	-16.6	29.7	43.5	30.5	150
175.963	H	37.1	12.6	-16.0	33.7	43.5	48.4	150
200.453	H	35.9	11.4	-12.6	34.7	43.5	54.3	150
464.882	V	28.4	16.8	-13.8	31.4	46.0	37.2	200
570.173	V	28.4	18.3	-13.1	33.6	46.0	47.9	200
701.541	V	25.8	21.0	-11.6	35.2	46.0	57.5	200

Table 7-2-2. Ch.6 (2437MHz) **TX** mode 11Mbps

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
143.181	V	34.3	12.2	-16.6	29.9	43.5	31.3	150
173.874	H	38.4	12.6	-16.1	34.9	43.5	55.6	150
200.453	H	35.4	11.4	-12.6	34.2	43.5	51.3	150
300.661	H	29.9	14.2	-14.1	30.0	46.0	31.6	200
465.827	V	30.7	16.8	-13.7	33.8	46.0	49.0	200
570.267	V	27.2	18.3	-13.1	32.4	46.0	41.7	200

Table 7-2-3. Ch.11 (2462MHz) **TX** mode 11Mbps

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
143.181	V	34.6	12.2	-16.6	30.2	43.5	32.4	150
177.000	H	35.5	12.7	-16.1	32.1	43.5	40.3	150
200.453	H	36.1	11.4	-12.6	34.9	43.5	55.6	150
464.892	V	29.7	16.8	-13.8	32.7	46.0	43.2	200
568.861	V	26.1	18.3	-12.9	31.5	46.0	37.6	200
701.541	V	26.2	21.0	-11.6	35.6	46.0	60.3	200

Table 7-2-4. Ch.6 (2437MHz) **RX** mode

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
143.181	V	34.7	12.2	-16.6	30.3	43.5	32.7	150
173.516	H	36.2	12.6	-16.1	32.7	43.5	43.2	150
200.453	H	35.2	11.4	-12.6	34.0	43.5	50.1	150
351.997	V	32.8	14.4	-13.6	33.6	46.0	47.9	200
463.934	V	31.1	16.8	-13.9	34.0	46.0	50.1	200
701.540	V	26.1	21.0	-11.6	35.5	46.0	59.6	200

8. RESTRICTED BANDS RADIATIONS (1GHz – 25GHz)

[FCC 15.205 / 209, RSS-210 6.3 / 7.3]

8.1 Test Procedure

Radiated emissions were measured in the frequency range with 1 GHz to 25GHz in transmitting mode and 1 GHz to 12.5GHz in receiving mode. All tests were performed in the semi-anechoic chamber at a 3-meter distance (except for the frequency range with 18 GHz to 25 GHz where test distance was reduced to 1 meter) on both horizontal and vertical polarities. The antenna was also scanned in height. The emissions are recorded with a spectrum analyzer in peak hold mode. The identified emissions are further maximized as a function of cable manipulation, azimuth, and antenna height. The emissions closest to the limits are measured in the peak mode with the tuned spectrum analyzer using resolution bandwidth of 1MHz / video bandwidth of 1MHz, and the average setting mode with the tuned spectrum analyzer using resolution bandwidth of 1MHz / video bandwidth of 100Hz or 10Hz. The highest emissions relative to the limit are listed.

8.2 Test Instruments and Measurement Setup

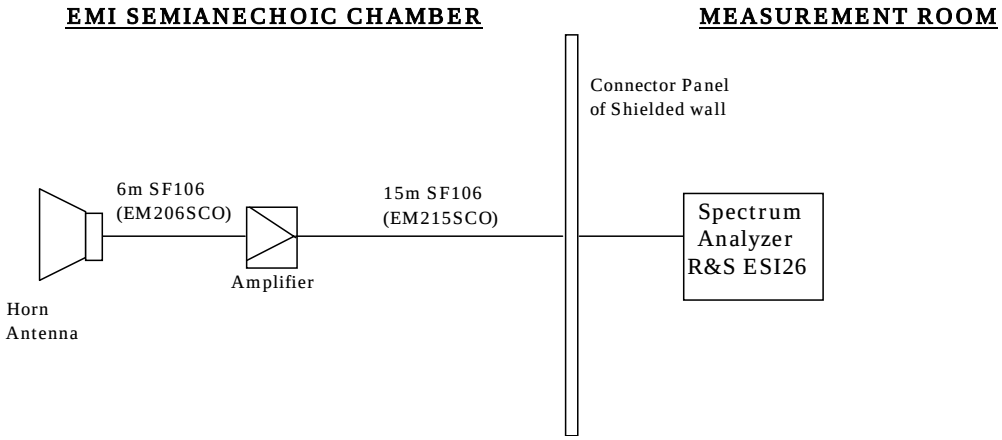


Figure 8-1. Cables for Radiated Emission Test (1 – 18 GHz)

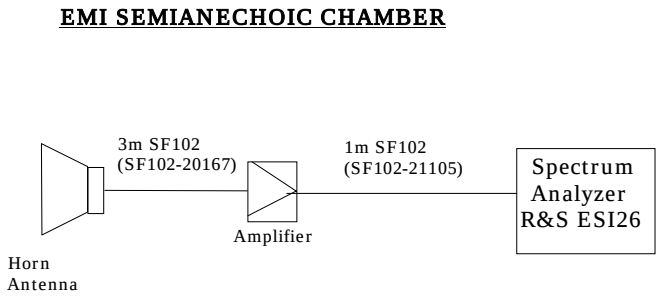


Figure 8-2. Cables for Radiated Emission Test (18 - 25GHz)

Table 8 Radiated Emission Test Instrumentation (1GHz – 25GHz)

Description	**Model**	**Serial Number**
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003
Amplifier (1 – 18GHz)	HP 8449B	3008A00582
Amplifier (18 – 25GHz)	Agilent 83051A	3950M00193
Horn Antenna (1 - 18GHz)	EMCO 3115	9903-5774
Horn Antenna (3.95 – 5.85GHz)	EMCO 3160-5	1099
Horn Antenna (5.85 – 8.2GHz)	EMCO 3160-6	9712-1044
Horn Antenna (18 - 25GHz)	EMCO 3160-9	0004-1202
Coaxial cables: - Horn Ant <=> RF Amp. (1-18GHz) - RF Amp.<=>Spectrum Analyzer (1-18GHz) - Horn Ant <=> RF Amp. (18-25GHz) - RF Amp.<=>Spectrum Analyzer (18-25GHz)	Length: 6 m 16 m 3m 1m	 - EM206SCO - GEM0101 - SF102-20167 - SF102-21105

Notes: - HP: Hewlett Packard, R&S: Rohde & Schwarz

8.3 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO

where:

FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL-AG
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor

For example:
Given a Spectrum Analyzer input reading of 51.5 dBμV; Antenna Factor of 8.5 dB/m; Cable Loss of 1.3 dB; Falloff Factor of 0 dB; and an Amplifier Gain of 26 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 – 26 – 0.0 = 35.6 dBμV/m

Conversions between dBμV/m (or dBμV) and μV/m (or μV) are done as :

Level(dBμV/m) = 20 × Log (Level(μV/m))
40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

8.4 Measurement Results

The EUT was found to comply to the limits of FCC Part 15 Subpart C and RSS-210 with a margin of 7.5dB. The measurement was done for the frequency range of 1 GHz to 25 GHz in TX mode and 1 GHz to 12.5GHz in RX mode.

Test Date: February 12 and 13, 2004

Table 8-1. Ch.1 (2412MHz) **TX** mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.411	H	114.2	104.2	28.3	-29.6	0.0	112.9	OB*	102.9	OB*
Adjacent RB										
2.386	H	59.0	46.8	28.2	-29.6	0.0	57.6	74.0	45.4	54.0
2.390	H	57.9	47.9	28.2	-29.6	0.0	56.5	74.0	46.5	54.0
1.015	V	49.0	-	24.3	-32.2	0.0	41.1	74.0	-	54.0
1.102	V	50.1	-	24.4	-31.9	0.0	42.6	74.0	-	54.0
1.194	V	49.3	-	25.2	-31.6	0.0	42.9	74.0	-	54.0
2.351	H	52.0	-	28.1	-29.6	0.0	50.5	74.0	-	54.0
2.361	H	52.4	-	28.1	-29.6	0.0	50.9	74.0	-	54.0
2.373	H	52.5	-	28.2	-29.6	0.0	51.1	74.0	-	54.0
4.826	H	40.9	-	27.1	-27.2	0.0	40.8	74.0	-	54.0

*Note: OB means “operation band” (2400-2483.5MHz); in this case limit is 1W (measured conducted with power meter)

Table 8-2. Ch.6 (2437MHz) **TX** mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.436	H	114.6	104.9	28.4	-29.6	0.0	113.4	OB*	103.7	OB*
Adjacent RB										
2.384	H	53.9	-	28.2	-29.6	0.0	52.5	74.0	-	54.0
2.390	H	53.3	-	28.2	-29.6	0.0	51.9	74.0	-	54.0
2.484	H	50.0	-	28.4	-29.6	0.0	48.8	74.0	-	54.0
1.013	V	48.2	-	24.3	-32.2	0.0	40.3	74.0	-	54.0
1.102	V	49.0	-	24.4	-31.9	0.0	41.5	74.0	-	54.0
1.198	V	50.4	-	25.2	-31.6	0.0	44.0	74.0	-	54.0
2.354	H	52.0	-	28.1	-29.6	0.0	50.5	74.0	-	54.0
2.373	H	53.0	-	28.2	-29.6	0.0	51.6	74.0	-	54.0
2.376	H	52.8	-	28.2	-29.6	0.0	51.4	74.0	-	54.0
4.868	V	40.5	-	27.0	-27.0	0.0	40.5	74.0	-	54.0
7.314	H	40.1	-	29.9	-24.9	0.0	45.1	74.0	-	54.0

*Note: OB means “operation band” (2400-2483.5MHz); in this case limit is 1W (measured conducted with power meter).

Table 8-3. Ch.11 (2462MHz) **TX** mode 11Mbps

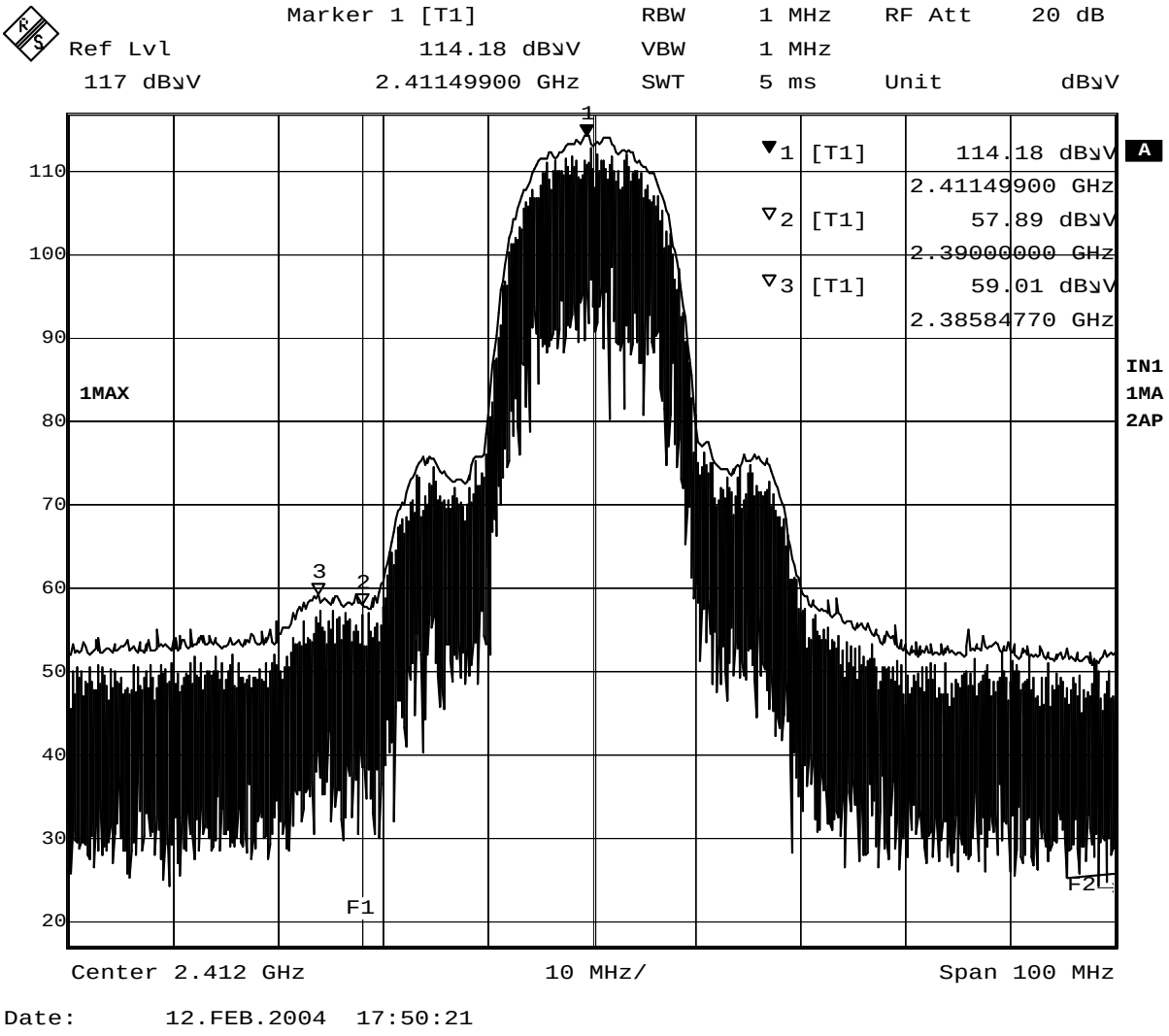
Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.461	H	113.6	103.8	28.4	-29.6	0.0	112.4	OB*	102.6	OB*
Adjacent RB										
2.484	H	56.1	45.2	28.4	-29.6	0.0	54.9	74.0	44.0	54.0
1.013	V	48.8	-	24.3	-32.2	0.0	40.9	74.0	-	54.0
1.102	V	50.0	-	24.4	-31.9	0.0	42.5	74.0	-	54.0
1.196	V	51.9	-	25.2	-31.6	0.0	45.5	74.0	-	54.0
2.361	H	52.1	-	28.1	-29.6	0.0	50.6	74.0	-	54.0
2.375	H	53.2	-	28.2	-29.6	0.0	51.8	74.0	-	54.0
2.384	H	53.3	-	28.2	-29.6	0.0	51.9	74.0	-	54.0
4.928	V	38.7	-	27.0	-27.0	0.0	38.7	74.0	-	54.0
7.389	H	38.0	-	29.8	-24.9	0.0	42.9	74.0	-	54.0

*Note: OB means “operation band” (2400-2483.5MHz); in this case limit is 1W (measured conducted with power meter).

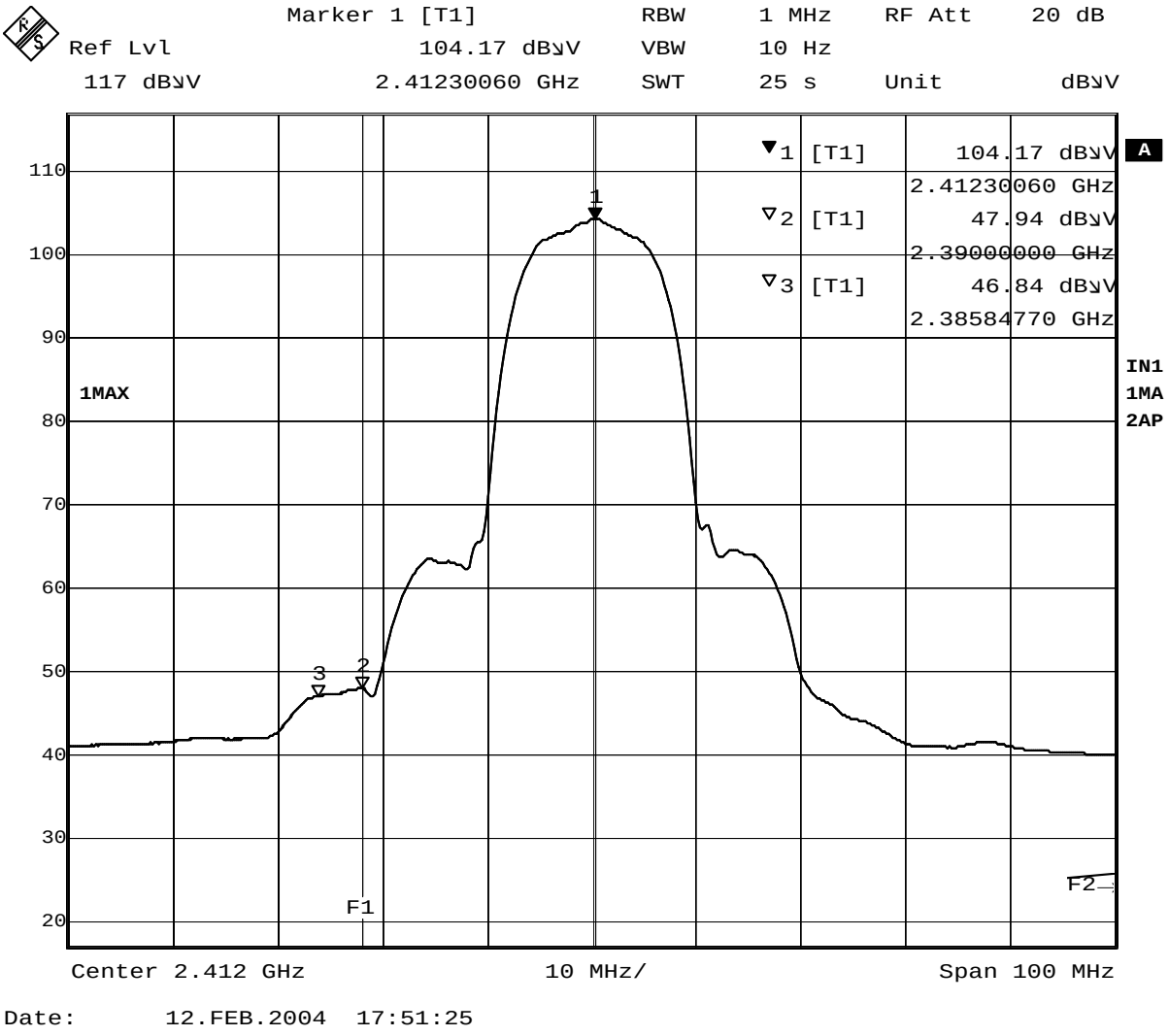
Table 8-4. Ch.6 (2437MHz) **RX** mode

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
1.013	V	48.6	-	24.3	-32.2	0.0	40.7	74.0	-	54.0
1.102	V	49.5	-	24.4	-31.9	0.0	42.0	74.0	-	54.0
1.198	V	51.1	-	25.2	-31.6	0.0	44.7	74.0	-	54.0

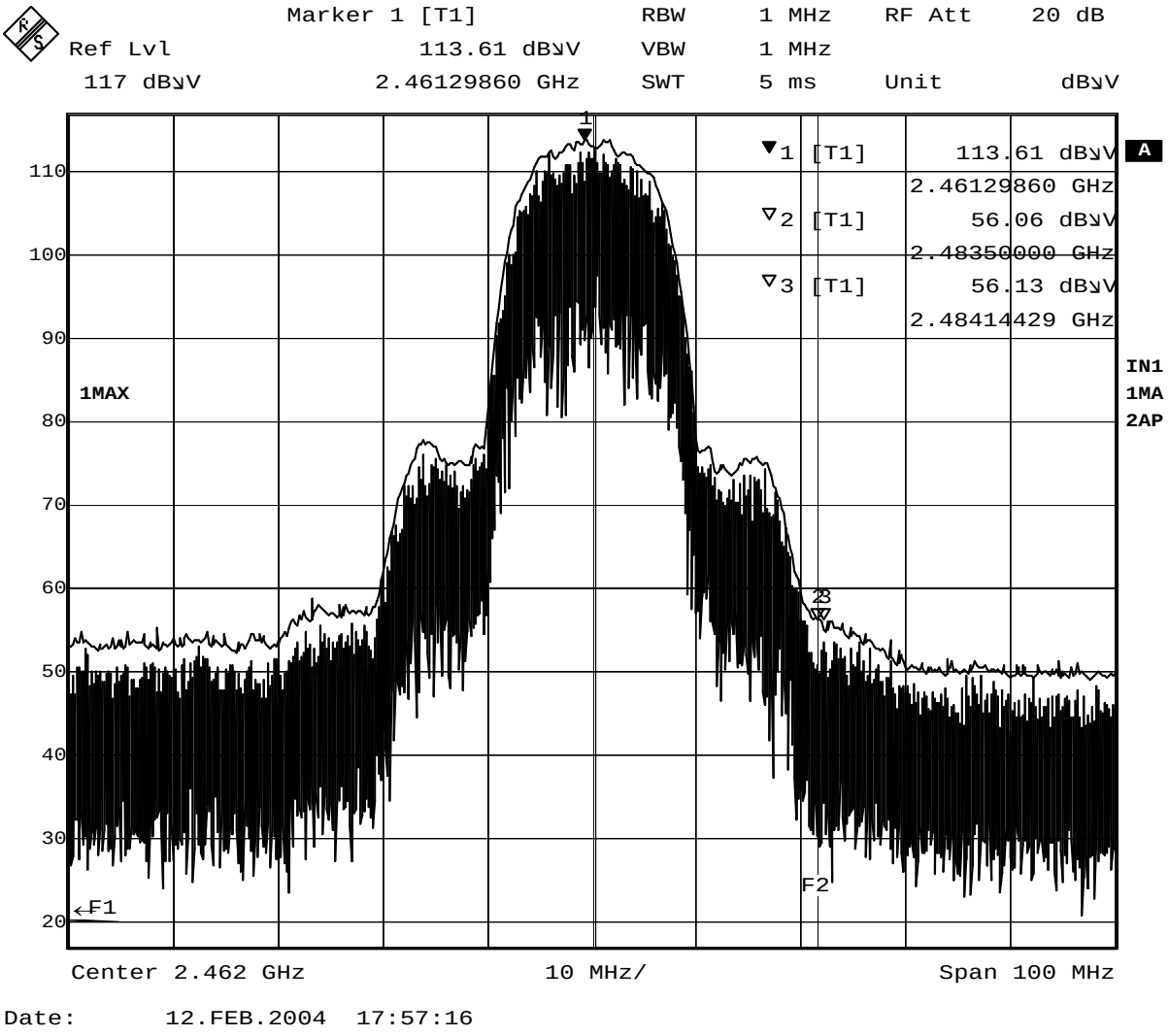
8.5 Measurement plots of adjacent restricted band



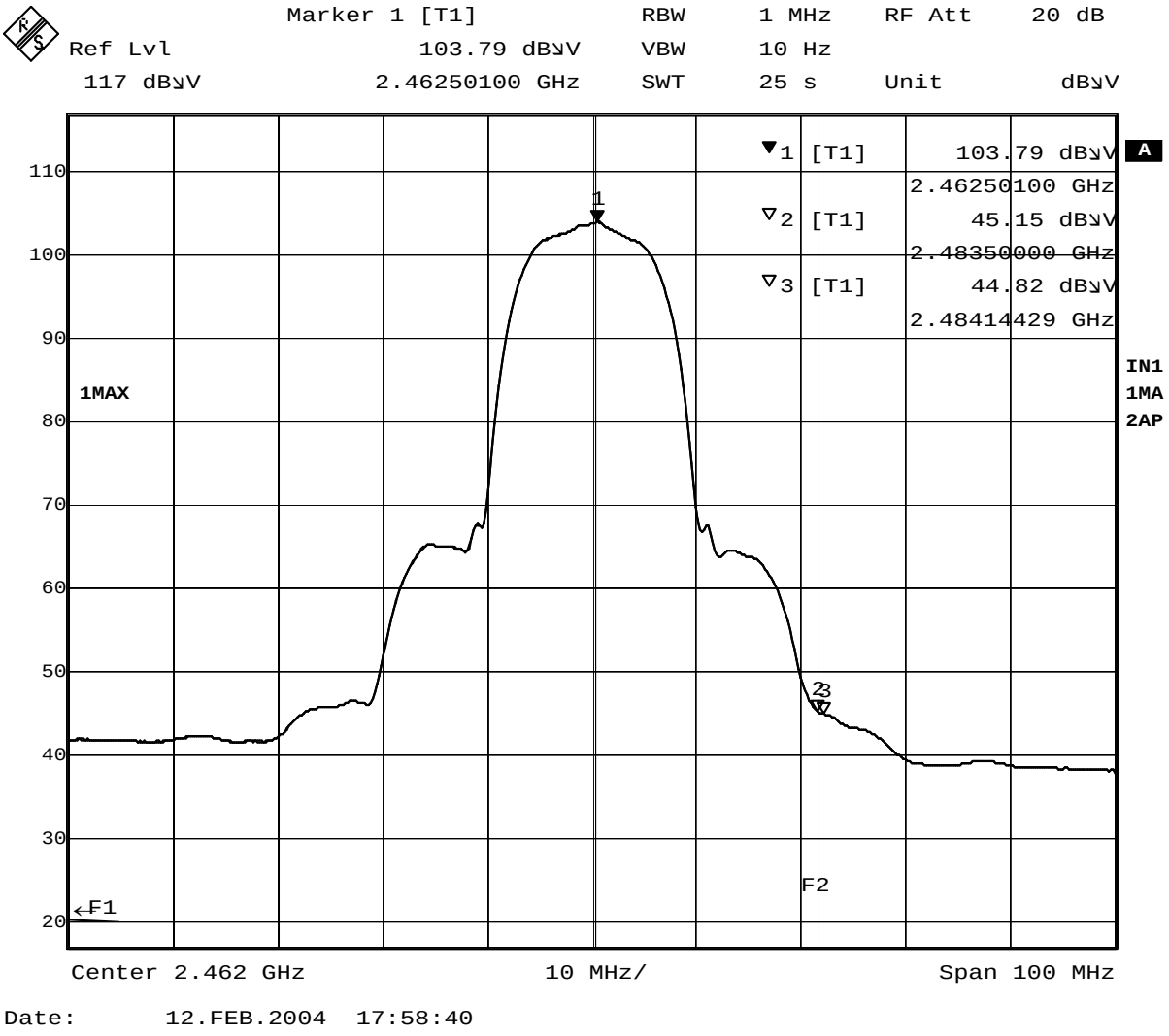
Plot 8-1 Ch.1 2412MHz TX, 11Mbps (Peak)



Plot 8-2 Ch.1 2412MHz TX, 11Mbps (Average)



Plot 8-3 Ch.11 2462MHz TX, 11Mbps (Peak)



Plot 8-4 Ch.11 2462MHz TX, 11Mbps (Average)