

Emission Test Report

Standard: FCC Part 15 Subpart C / IC RSS-210

Document Number : FCC 19-0180-0

Product: IBM ThinkPad T30 Series
Included IBM ThinkPad 802.11b Wireless Lan Mini-PCI Adapter

FCC ID: ANOCORN1TASULIV
IC : xxxxxx-CORN1LIV

January 29, 2002

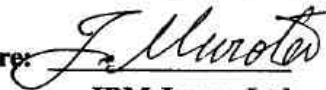
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Annex A

Summary of test results

Equipment model : ThinkPad T30 SeriesTest report page
or reference

Transmitter tested to RSS-210 section <u>6.2.2(o)</u>		
Field strength _____ $\mu\text{V/m}$ at a distance of _____ metres		
or		
RF power <u>0.0380</u> watts		<u>19</u>
Peak – to – average ratio _____ dB or G CISPR		
Test conditions : G Radiated (sections 11 & 13)		
G At antenna (section 10)		
G DC input power (section 12)		
Transmitter frequency <u>center freq. 2412MHz + 5MHz $\times$ N (N=0 to 10ch)</u>		<u>5</u>
Designation of Emission (see section 5.9.2) <u>17M0G1D</u>		
Occupied Bandwidth (measured) <u>66.90MHz (16.96MHz/ch)</u>		<u>12</u>
Frequency tuning range : Min. _____ Max. _____		
Frequency stability _____		
Transmitter spurious (worst case)		
Field strength <u>150</u> $\mu\text{V/m}$ (QP 43.5 dB $\mu\text{V/m}$) at a distance of <u>3</u> metres		<u>30</u>
Frequency <u>729MHz (Vertical)</u>	<u>Non restricted band is excluded.</u>	
Momentary operation? G Yes G <u>No</u>		
Holdover time after manual release : _____ seconds		
or		
Duration of transmission after automatic activation : _____ seconds		
Transmitter/receiver AC wireline conducted emissions (worst case)		
Transmitter : RF level <u>30.2</u> microvolts, frequency <u>23.0MHz</u>		<u>25</u>
Receiver : RF level <u>18.6</u> microvolts, frequency <u>22.0MHz</u>		<u>26</u>
Receiver spurious (worst case)		
Field strength <u>100</u> $\mu\text{V/m}$ (QP 40.0 dB $\mu\text{V/m}$) at a distance of <u>3</u> metres		<u>31</u>
RF power _____ nanowatts		
Frequency <u>729MHz (Vertical)</u>		

Attestation :

The radio device identified in this application has been subject to all the applicable test conditions specified in RSS-210 and all of the requirements of the Standard have been met.

except as noted, _____ pages attached.

EMC Engineer
Title

Takeshi Asano
Name (print)


Signature

January/29/ 2002
Date

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A. GENERAL INFORMATION

APPLICANT : IBM Japan Ltd.

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REGULATION : FCC Part 15 Subpart C
Industry Canada RSS-210 (Issue No.4)

MODEL NUMBER : 2366-52U (ThinkPad T30)

FCC ID : ANOCORN1TASULIV

SERIAL NUMBER : ZZ-00163

PHYSICAL CONDITION : Preproduction

KIND OF EQUIPMENT : Personal computer with a built-in Wireless LAN card

TESTED DATE : January 17, 18, 21, 23 and 24, 2002

TEST SITE : IBM Yamato semi-anechoic chamber #2

A.1 Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.4-1992. Radiated testing was performed at an antenna to EUT distance of 3 meters.

A.2 Test Facility / NVLAP Accreditation

The semi-anechoic chamber #2 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).
- This facility is accepted by **Industry Canada** in a letter dated March 19, 2001 as number **IC 349E**.
- 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)

A.3 EUT details

Table A EUT details

Model and S/N	FCC ID	Description	Cable Description
ThinkPad T30 M/T 2366-52U (s/n ZZ-00163)	ANOCORN1TASULIV	IBM Notebook PC CPU: Intel® Mobile Pentium® 4 1.7GHz	
P/N 02K6665	N/A	Universal AC adapter 72W	Unshielded power cord

B. SUMMARY OF TEST RESULTS

Table-B presents the list of the measurement items for Spread Spectrum, Direct Sequence 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		Condition	Result
	Transmit mode (TX):			
15.247(a)(2) 5.9.1	Bandwidth at 6 dB below		Conducted	Pass
15.247(c) 5.9.1 6.2.2 (o) (e1)	Occupied BW (or Band-edge) Out of Band Emissions (Bandwidth at 20 dB below)	The radiated emission in any 100kHz of outband shall be at least 20dB below the highest inband spectral density.	Conducted	Pass
15.247(b) 6.2.2 (o) (b)	Transmitter output power	Shall not exceed 1.0 W.	Conducted	Pass
15.247(d) 6.2.2 (o) (b)	Transmitter power spectral Density	Shall not be greater than 8 dBm in any 3kHz band.	Conducted	Pass
15.247(e) 6.2.2 (o) (b)	Processing gain	10 dB	Conducted	Pass*
15.207 6.6	AC Wireline Conducted Emissions 450kHz – 30MHz	Class B: 250μV	Conducted	Pass
15.205 / 209 6.2.1 / 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
	Receive mode (RX):			
15.207 7.4	AC Wireline Conducted Emissions 450kHz – 30MHz	Class B: 250μV	Conducted	Pass
15.209 7.3	General Field Strength Limits (Radiated Emission Limits)	Shall not exceed the limits specified in RSS-210.	Radiated (30MHz -1GHz)	Pass
			Radiated (1– 25GHz)	Pass

* See “Processing Gain Report” by ActionTec

C. OPERATION MODE OF EUT

All tests were performed using the “PRISM Test Utility Program”, Version 3.0.24. 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 2Mbps	Bit rate 5.5Mbps	Bit rate 11Mbps	
2.412 (Ch. 1)	+15	+15	+15	X
2.417 (Ch. 2)	+15	+15	+15	
2.422 (Ch. 3)	+15	+15	+15	
2.427 (Ch. 4)	+15	+15	+15	
2.432 (Ch. 5)	+15	+15	+15	
2.437 (Ch. 6)	+15	+15	+15	X
2.442 (Ch. 7)	+15	+15	+15	
2.447 (Ch. 8)	+15	+15	+15	
2.452 (Ch. 9)	+15	+15	+15	
2.457 (Ch. 10)	+15	+15	+15	
2.462 (Ch. 11)	+15	+15	+15	X

* Full testing with bit rate 11Mbps only

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)	

D. TEST INSTRUMENTS

Table-D List of Measuring Instruments

Description	Model	Serial Number	Calibration Date	Calibration Interval
Computer	IBM 5551-L	#4	N/A	N/A
Computer	IBM 6589-13J	97-15613	N/A	N/A
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2841A04242	10/18/01	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	3019A05155	02/07/01	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	3019A05156	04/02/01	1 year
Spectrum Analyzer Display	HP 85662A	2816A16827	10/18/01	1 year
Spectrum Analyzer Display	HP 85662A	3026A19353	02/07/01	1 year
Spectrum Analyzer Display	HP 85662A	3026A19366	04/02/01	1 year
Quasi-Peak Adapter	HP 85650A	2811A01126	10/18/01	1 year
Quasi-Peak Adapter	HP 85650A	3033A01449	02/07/01	1 year
Quasi-Peak Adapter	HP 85650A	2811A01433	04/02/01	1 year
Amplifier (100KHz - 1.3GHz)				
- for 30-200MHz	HP 8447D	2805A02919	04/16/01	1 year
- for 200-1000MHz	HP 8447D	2944A03506	04/16/01	1 year
Amplifier (1GHz - 26.5GHz)	HP 8449B	3008A00582	05/23/01	1 year
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003	07/04/01	1 year
Receiver (9kHz-30MHz)	R&S ESH3	891806/012	09/01/01	1 year
Receiver (20MHz-1.3GHz)	R&S ESVP	893202/018	01/29/01	1 year
Biconical Antenna (30-200MHz)	EMCO 3108	2241	05/11/01	1 year
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	1584	05/10/01	1 year
Horn Antenna (1- 18GHz)	EMCO 3115	9903-5774	04/23/01	1 year
Horn Antenna (3.95- 5.85GHz)	EMCO 3160-5	1099	04/26/01	1 year
Horn Antenna (5.85- 8.20GHz)	EMCO 3160-6	9712-1044	04/26/01	1 year
Horn Antenna (18- 26.5GHz)	EMCO 3160-9	0004-1202	05/01/01	1 year
LISN	EMCO 3825/2	1426	09/01/01	1 year
Power Meter	HP 436A	2604A24192	09/06/01	1 year
Power Sensor	HP 8482A	2607A10987	09/07/01	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
SF106 cables:	Length:			
- Horn Ant <=> RF Amp.	6 m	- EM206SCO	08/07/01	1 year
- RF Amp.<=>Spectrum Analyzer	15m	- EM215SCO	08/07/01	1 year
N-Coax cables:				
- Bi-coni Ant <=> 10m Cable	9 m	- EM203L01	04/16/01	1 year
- 10m Cable <=> Shield Panel	10 m	- EM203L02	04/16/01	1 year
- Shield Panel <=> RF Amp	7 m	- EM203L03	04/16/01	1 year
- RF Amp <=> Power Splitter	0.5m	- EM203L04	04/16/01	1 year
- Log-peri Ant <=> 10m Cable	9 m	- EM203H01	04/16/01	1 year

- 10m Cable <=> Shield Panel	10 m	- EM203H02	04/16/01	1 year
- Shield Panel <=> RF Amp	7 m	- EM203H03	04/16/01	1 year
- RF Amp <=> Power Splitter	0.5m	- EM203H04	04/16/01	1 year
Coax cables:				
- Lisn-L <=> SW/Con.unit (SW100)	4 m	- EMIC-L	04/16/01	1 year
- Lisn-N <=> SW/Con.unit (SW101)	4 m	- EMIC-N	04/16/01	1 year
- SW/Con.unit <=> RCVR (Input)	1 m	- EMIC-R	04/16/01	1 year
- SW/Con.unit<=> Spe Ana.(Signal In)	1 m	- EMIC-S	04/16/01	1 year
- Power Splitter <=> SW/Con.unit (SW110)	1 m	- EM203L05	04/16/01	1 year
- Power Splitter <=> SW/Con.unit (SW300)	1 m	- EM203L06	04/16/01	1 year
- Power Splitter <=> SW/Con.unit (SW100)	1 m	- EM203H05	04/16/01	1 year
- Power Splitter <=> SW/Con.unit (SW301)	1 m	- EM203H06	04/16/01	1 year
- SW/Con.unit <=> Receiver (Input)	2 m	- EM2RCV	04/16/01	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz	2 m	- EM2SPL	04/16/01	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	2 m	- EM2SPH	04/16/01	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 : 4.17dB

EMI chamber #2 : 4.18dB

EMI conducted measurement system : 2.4dB

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

1. Bandwidth at 6 dB below

1.1 Test Procedure

The bandwidth at 6 dB down from the highest inband spectral density is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency.

The spectrum analyzer is set to :

RBW=100kHz, VBW=100kHz*1, Span=30MHz, 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: 120 cm Loss: 1.7 dB	

Notes: - R&S: Rohde & Schwarz

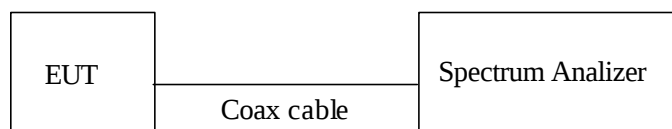


Figure 1: Measurement setup for 6dB bandwidth test

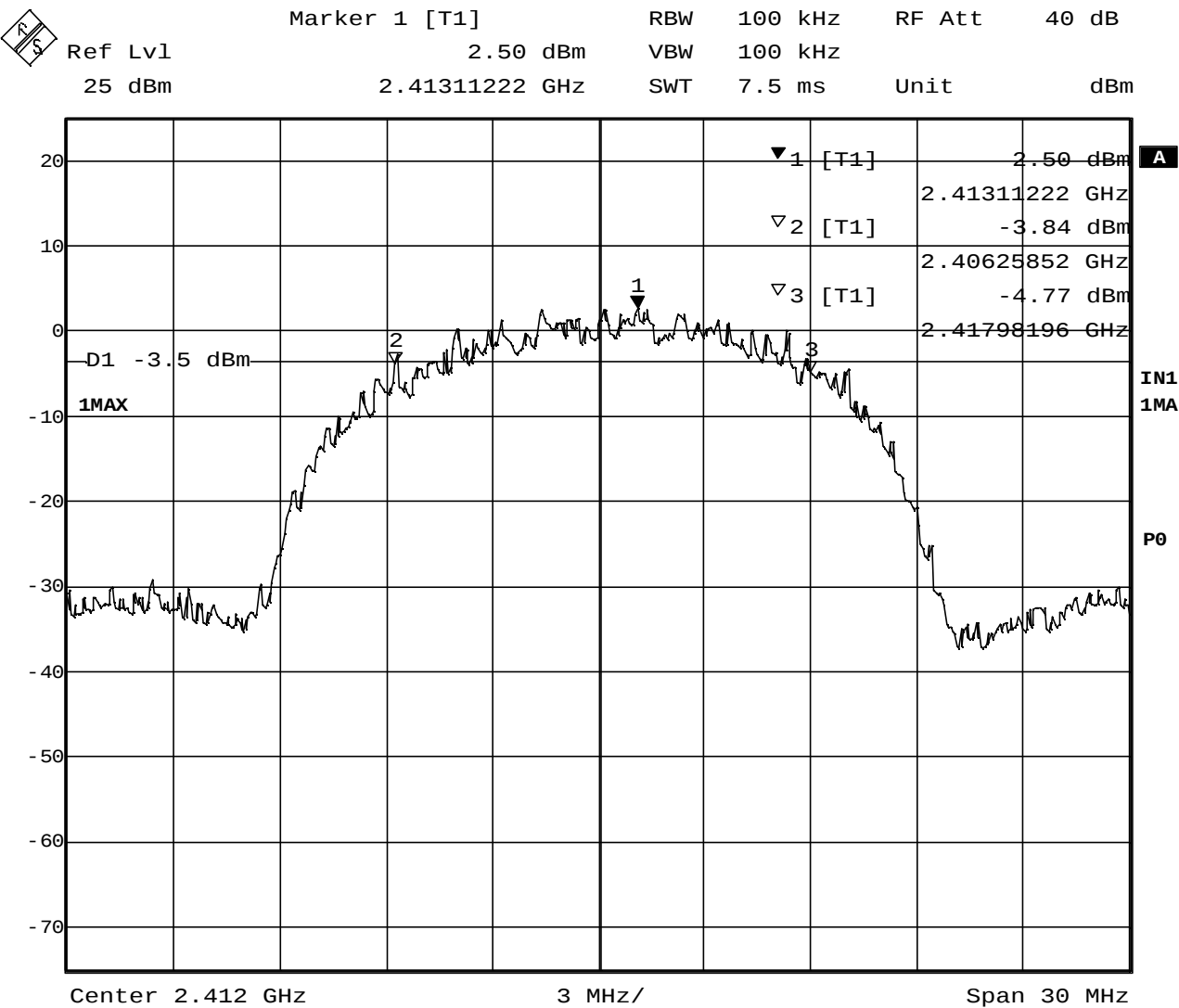
1.3 Measurement Results

Test Date: January 24, 2002

Table 1-2. EUT: M/T 2366-52U, s/n ZZ-00163 , TX mode 11Mbps

Center Frequency (MHz)	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)
2412 (ch. 1)	2406.26	2417.98	11.72
2437 (ch. 6)	2431.26	2442.98	11.72
2462 (ch. 11)	2456.26	2467.86	11.60

1.4 Trace Data



Date: 24 . JAN . 2002 07 : 52 : 35





2. Occupied Bandwidth / Band-edge (at 20 dB below), and Out of Band Emissions

2.1 Test Procedure

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

The spectrum analyzer is set to:

RBW=100kHz, VBW=100kHz*1, Span=30MHz, 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 of Occupied Bandwidth / Band-edge

Test Date: January 24, 2002

Table 2-1. EUT: M/T 2366-52U, s/n ZZ-00163 , TX mode 11Mbps

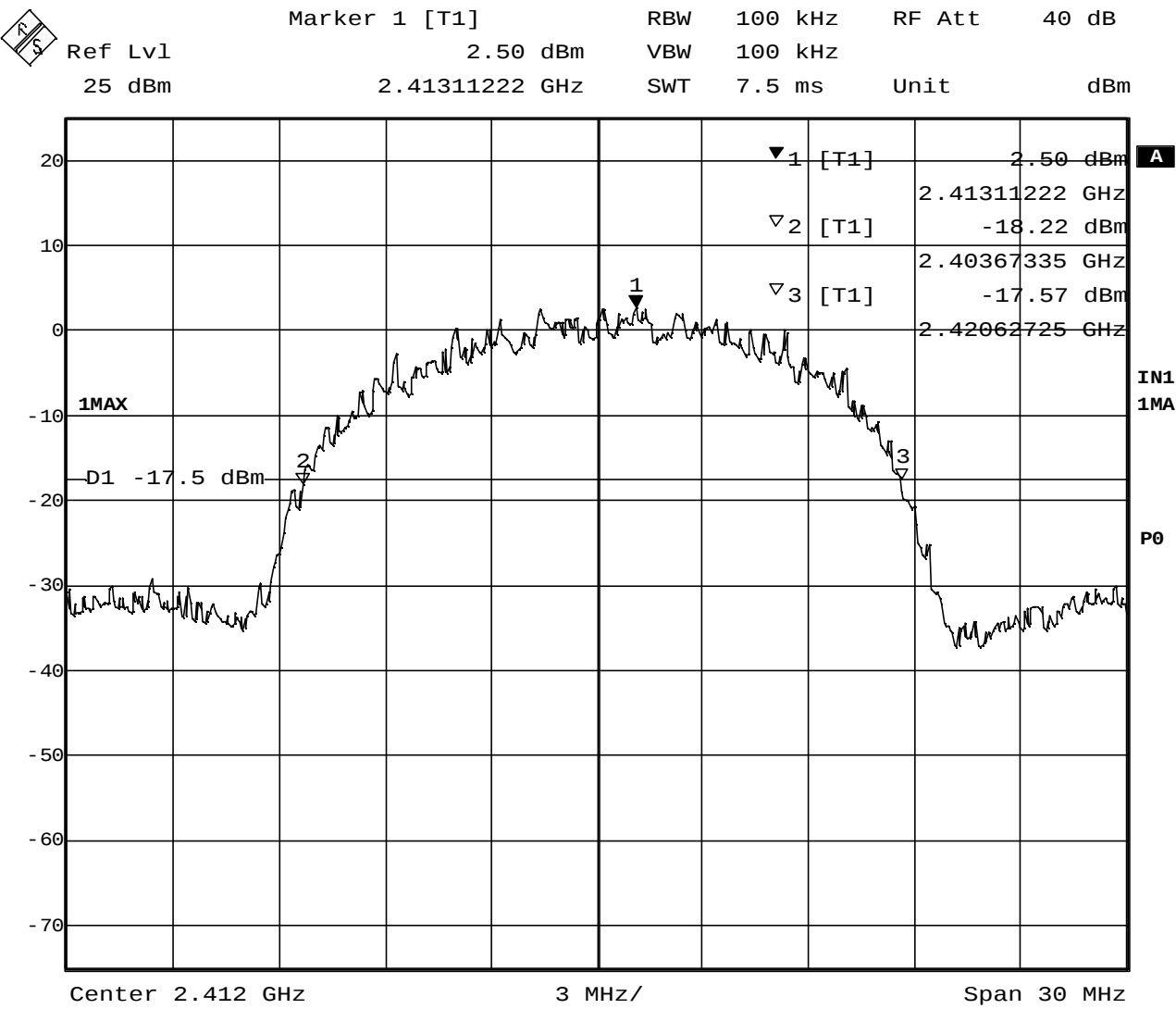
Center Frequency (MHz)	Lower Frequency (MHz)	Upper Frequency (MHz)	Bandwidth at 20 dB below (MHz)	Margin to Lower limit (MHz)	Margin to Upper limit (MHz)
2412 (ch. 1)	2403.67	2420.63	16.96	3.67	
2437 (ch. 6)	2428.67	2445.63	16.96		
2462 (ch. 11)	2453.67	2470.57	16.90		12.93

2.4 Measurement Results of Out of Band Emissions

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

Test Date: January 24, 2002

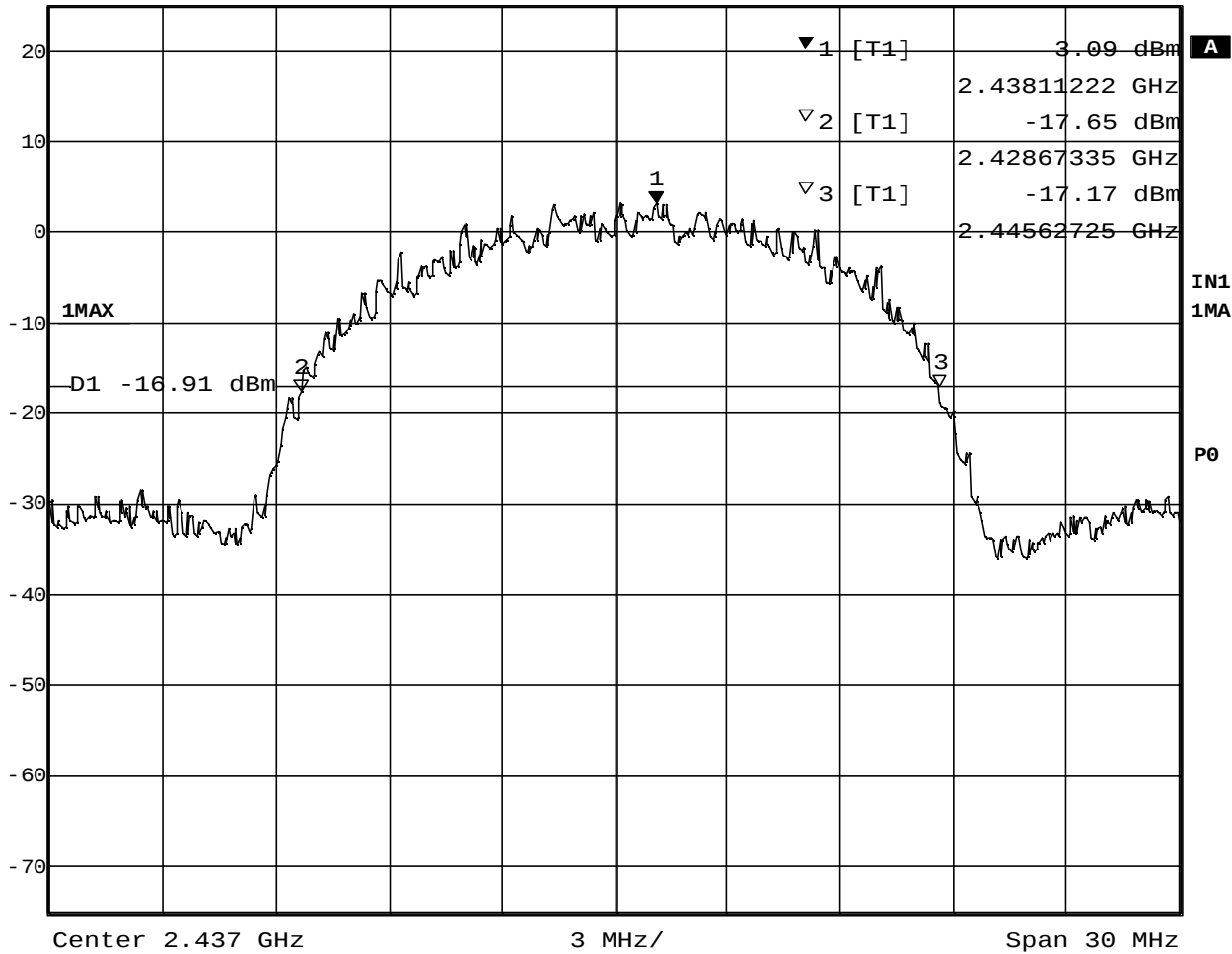
2.5 Trace Data of Band-edge



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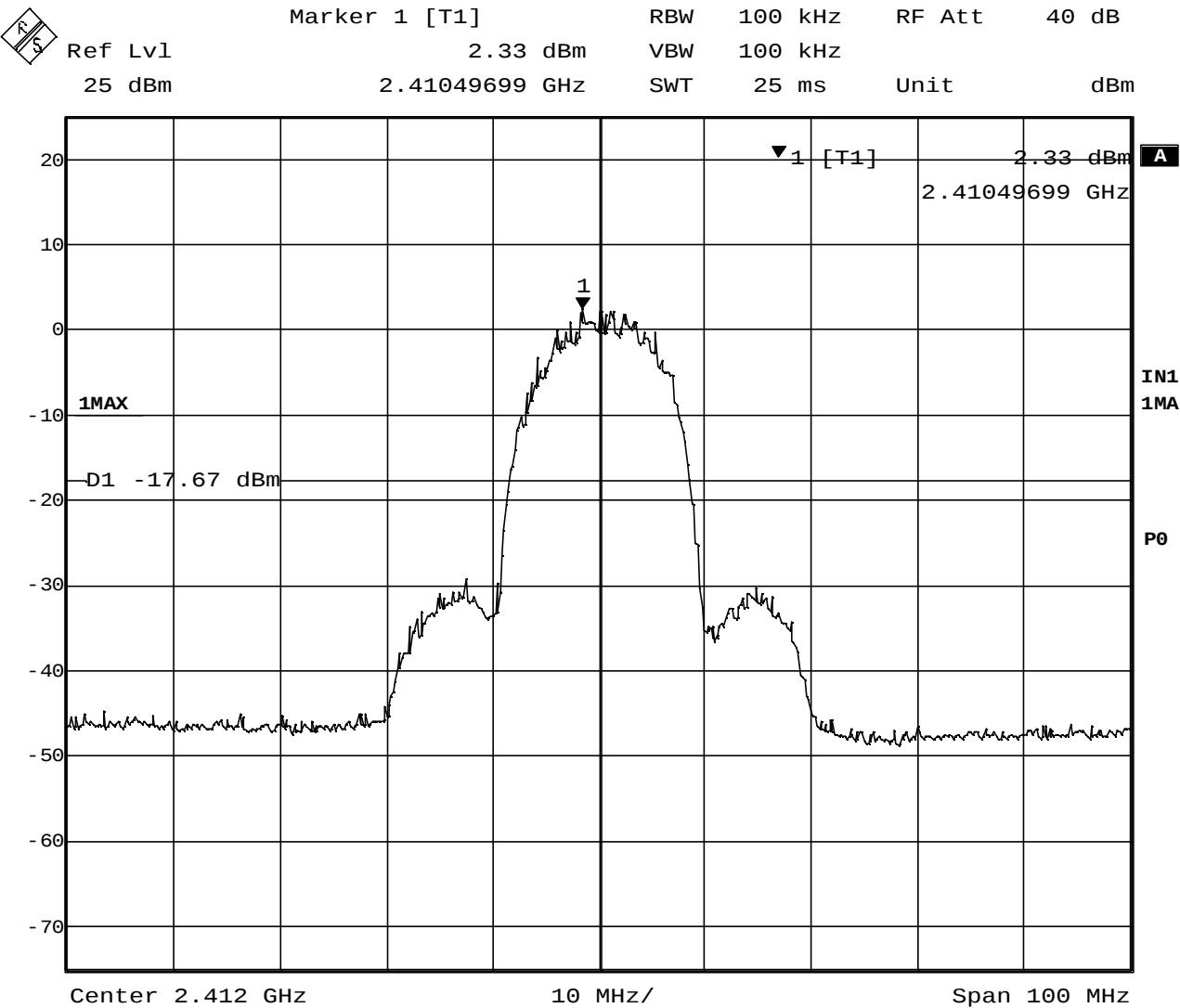
Ref Lvl	Marker 1 [T1]	RBW	100 kHz	RF Att	40 dB
25 dBm	3.09 dBm	VBW	100 kHz		
	2.43811222 GHz	SWT	7.5 ms	Unit	dBm



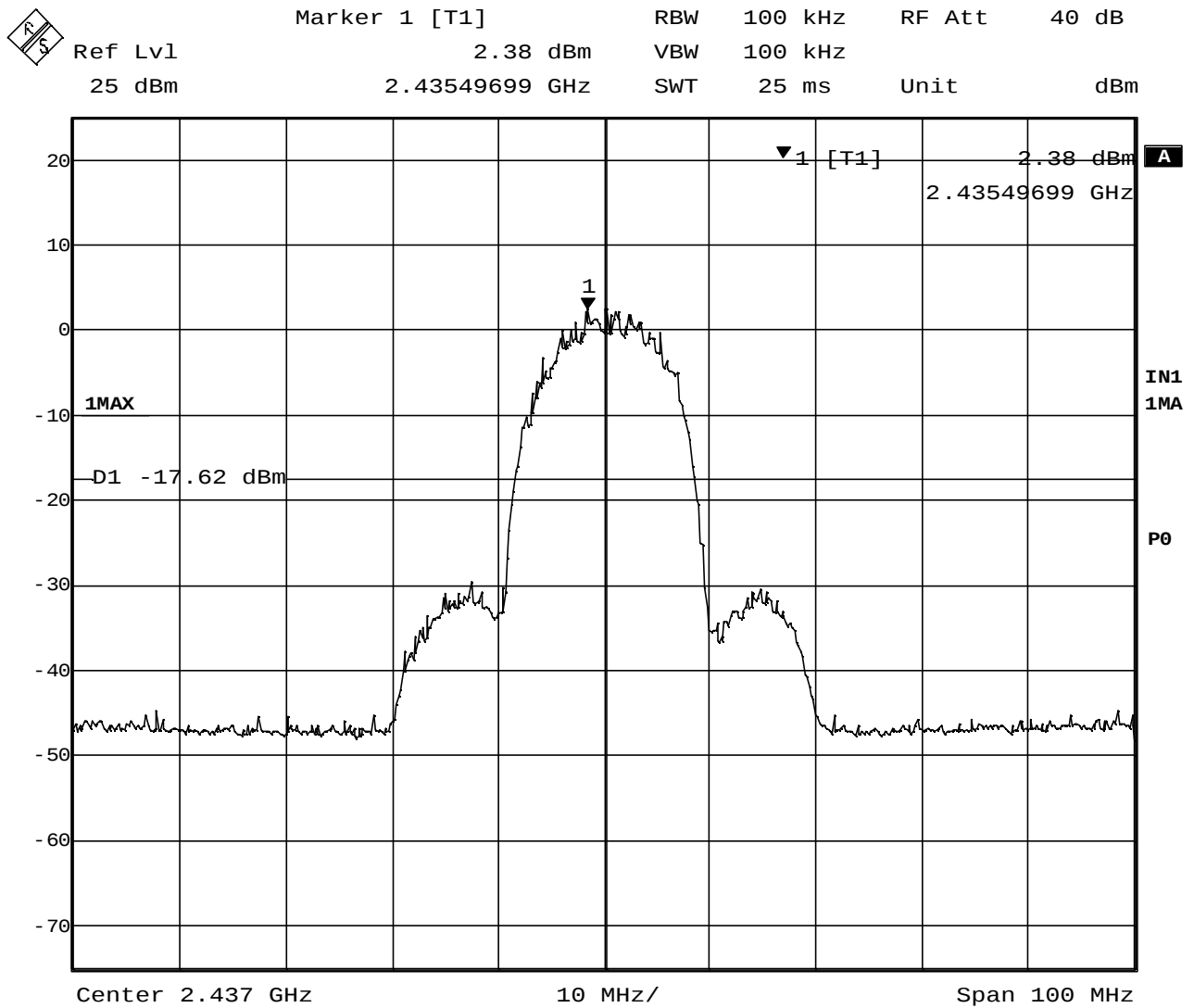
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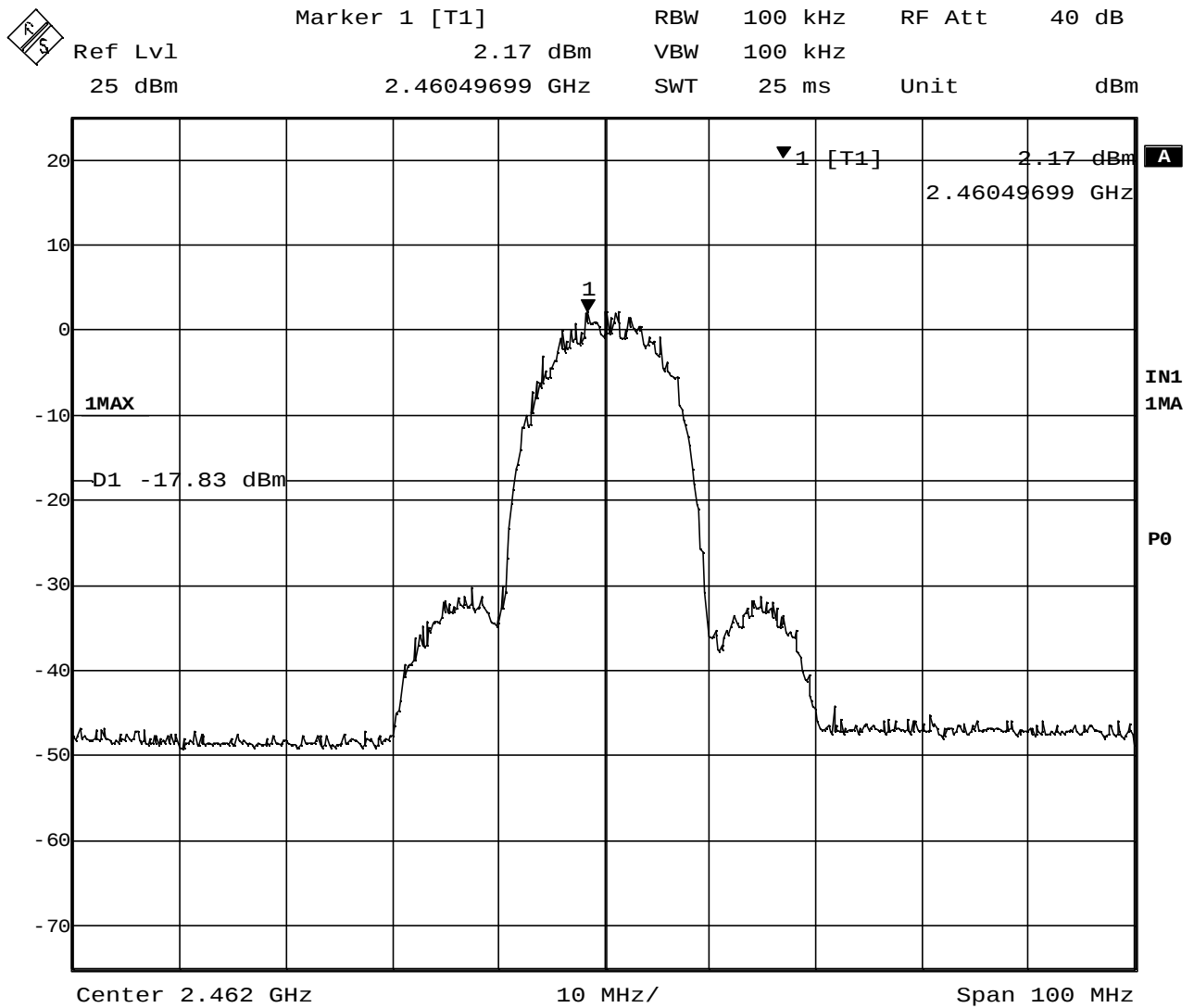


2.6 Trace Data of Out of Band Emissions



Date: 24.JAN.2002 08:13:02





Date: 24 . JAN . 2002 08:20:17

3. Transmitter Output Power

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 : 6 dB Bandwidth Test Instruments

Description	Model	Serial Number
Power Meter	HP 436A	2604A24192
Power Sensor	HP 8482A	2607A10987
Coax cables: - Power Sensor <=> EUT	Length: 30 cm Loss: 1.1dB	

Notes: - HP: Hewlett Packard

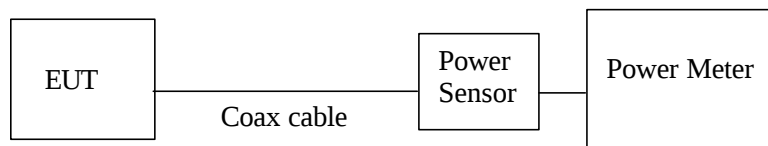


Figure 3: Measurement setup for RF output power

3.2 Measurement Results

Test Date: January 17, 2002

Table 3-2. EUT: M/T 2366-52U, s/n ZZ-00163, TX mode 11Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	14.7	1.1	15.8	0.0380	30.0	14.2
2437 (ch. 6)	14.5	1.1	15.6	0.0363	30.0	14.4
2462 (ch. 11)	14.0	1.1	15.1	0.0324	30.0	14.9

Table 3-3. EUT: M/T 2366-52U, s/n ZZ-00163, TX mode 2Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	14.6	1.1	15.7	0.0372	30.0	14.3
2437 (ch. 6)	14.4	1.1	15.5	0.0355	30.0	14.5
2462 (ch. 11)	14.0	1.1	15.1	0.0324	30.0	14.9

4. Transmitter Power Spectral Density

4.1 Test Procedure

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

The spectrum analyzer is set to:

RBW= 3kHz, VBW=100kHz, Span=10MHz, Sweep = 2.8 seconds

4.2 Test Instruments and Measurement Setup

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

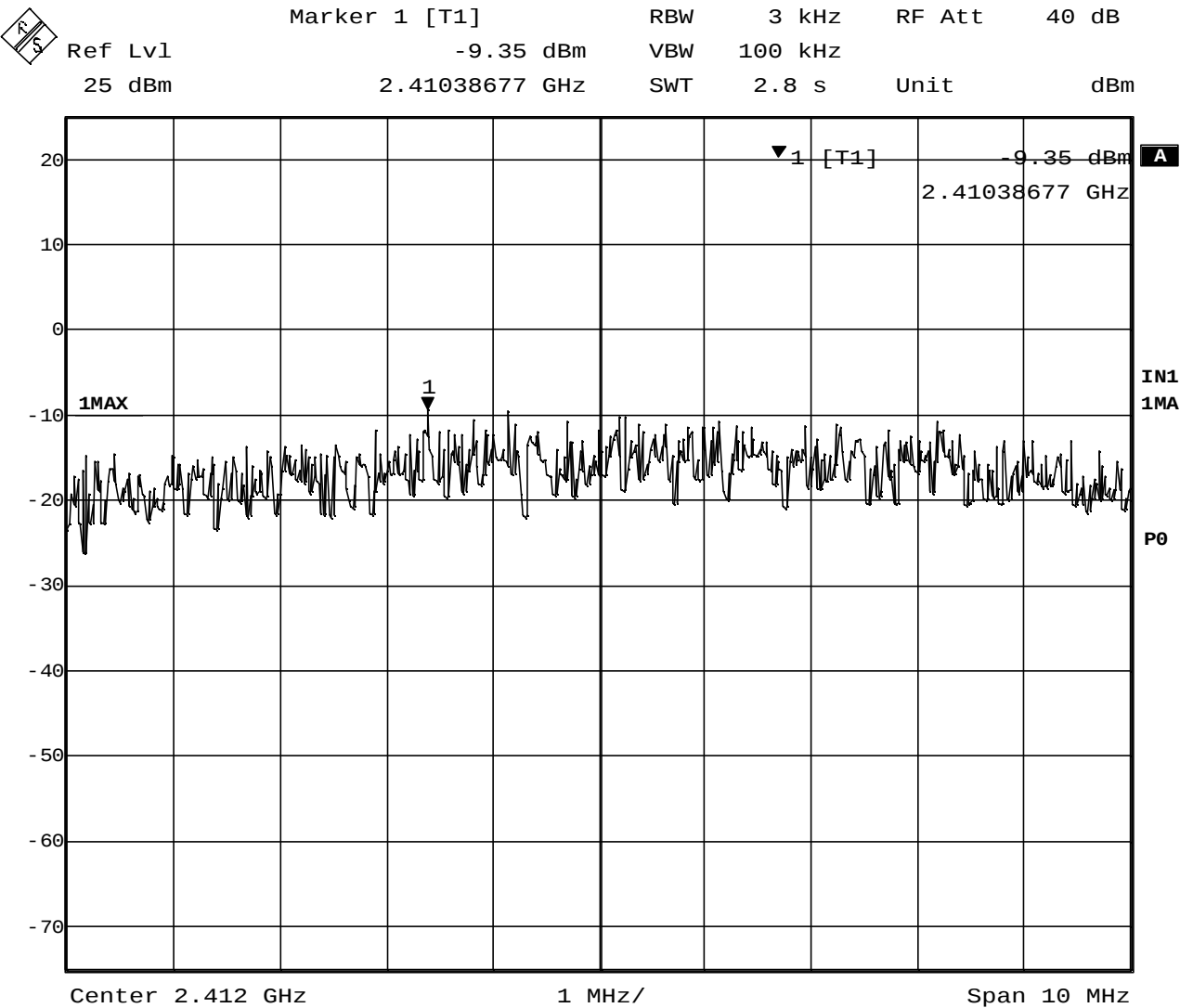
4.3 Measurement Results

Test Date: January 24, 2002

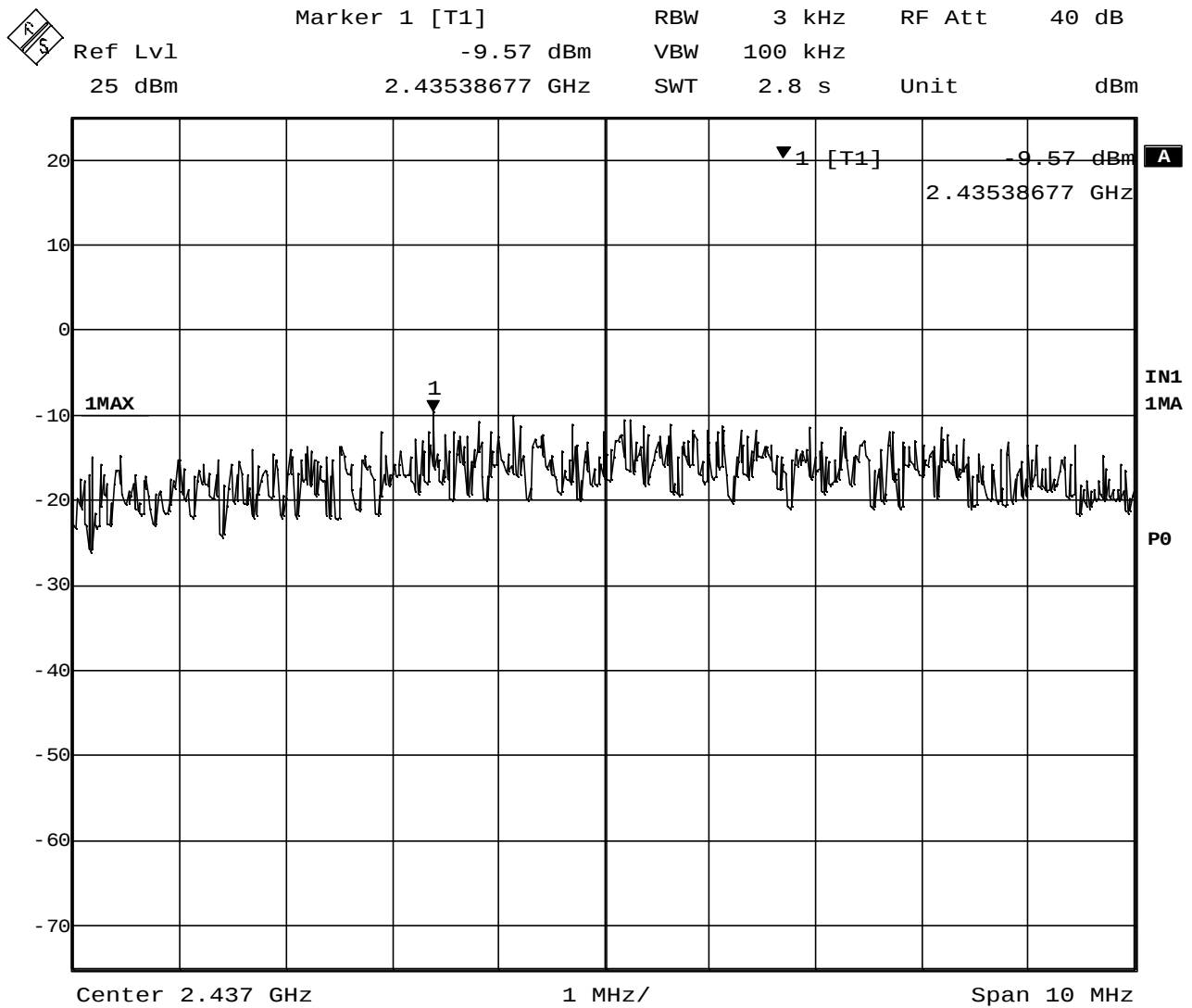
Table 4-1. EUT: M/T 2366-52U, s/n ZZ-00163 , TX mode 11Mbps

Ch No.	Frequency (MHz)	Spectrum Analyzer Reading (dBm)	Cable loss (dB)	Result (dBm)	Limit (dBm)	Margin (dB)
1	2410.39	-9.4	1.7	-7.7	8.0	15.7
6	2435.39	-9.6	1.7	-7.9	8.0	15.9
11	2460.39	-10.0	1.7	-8.3	8.0	16.3

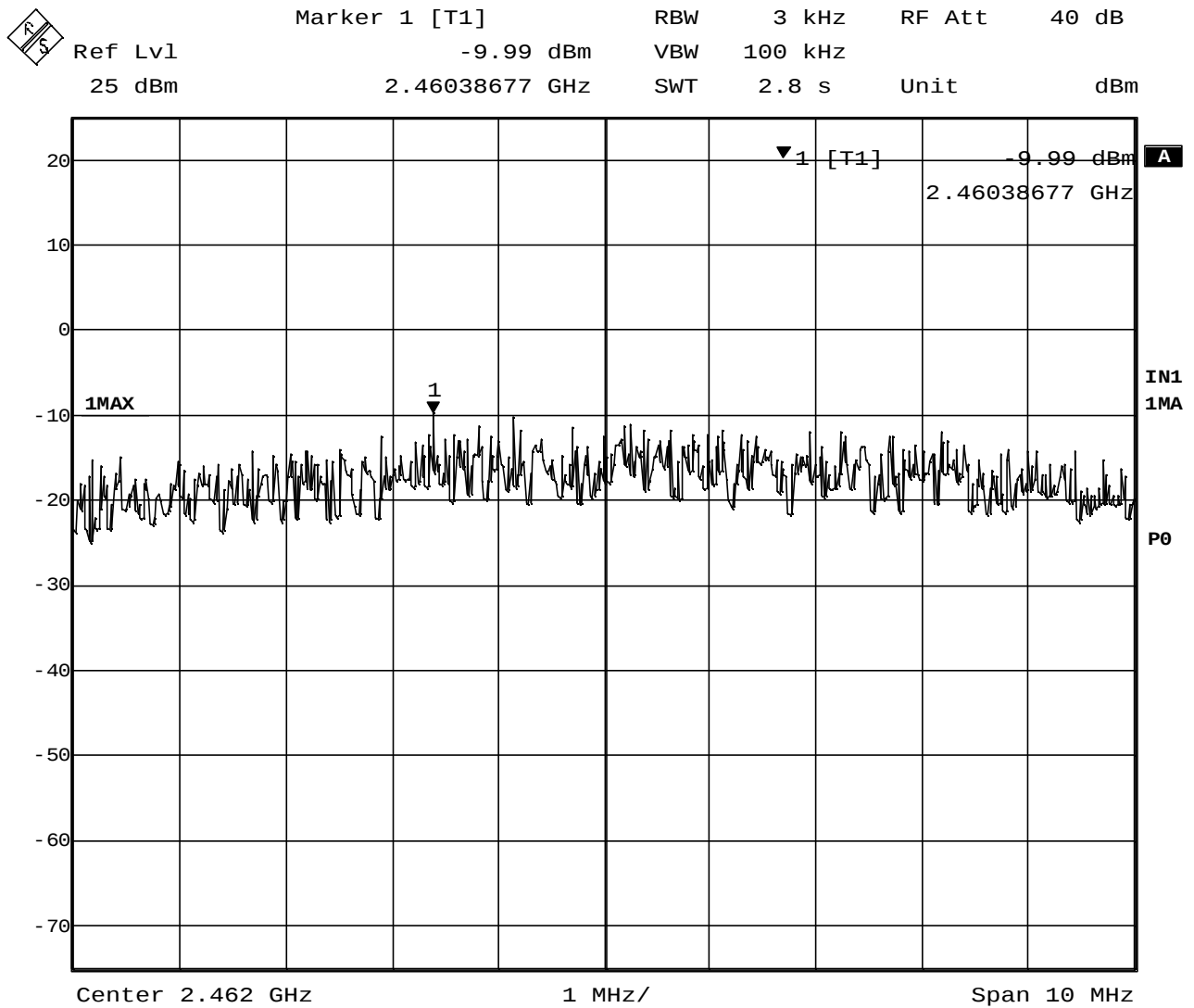
4.4 Trace Data



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Date: 24 . JAN . 2002 14:52:41

5. AC WIRELINE CONDUCTED EMISSIONS (450KHz – 30MHz)

5.1 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.

5.2 Test Instruments and Measurement Setup

Table 5-1. Conducted Emission Test Instrumentation

Description	Model	Serial Number
Computer	IBM 6589-13J	97-15613
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2841A04242
Spectrum Analyzer Display	HP 85662A	2816A16827
Quasi-Peak Adapter	HP 85650A	2811A01126
Receiver (9kHz-30MHz)	R&S ESH3	891806/012
LISN	EMCO 3825/2	1426
Switch/control unit	HP 3488A	2719A17228
Plotter	HP 7550A	2631A33619
Coax cables: - Lisc-L <=> SW/Con.unit (SW100) - Lisc-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

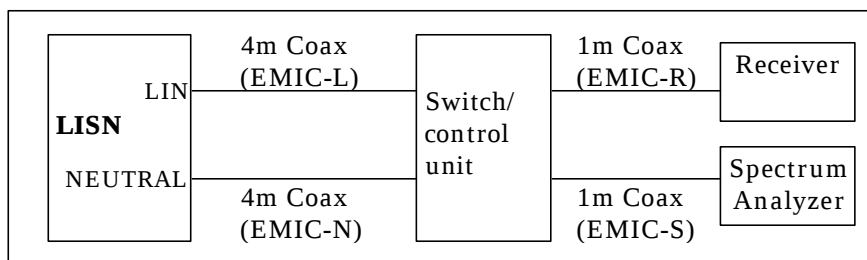


Figure 5. Cables for Conducted Emission Test

5.3 Measurement Results

The EUT was found to comply to the limits of FCC Part 15 Subpart C and RSS-210 with a margin of 17.4 dB. The 6 highest emissions relative to the limits are reported.

Test Date: January 23, 2002

1) EUT in transmission mode

Table 5-2-1. EUT: M/T 2366-52U, s/n ZZ-00163, Ch.1(2412MHz) TX mode 11Mbps

Frequency (MHz)	QP Voltage (dB μ V)	QP Limit (dB μ V)	QP Voltage (μ V)	QP Limit (μ V)	Phase
0.4607	26.4	48	20.9	250	NEUTRAL
0.5890	27.4	48	23.4	250	LINE
0.7222	23.6	48	15.1	250	LINE
9.1626	27.8	48	24.5	250	LINE
10.4301	28.3	48	26.0	250	LINE
26.5455	26.9	48	22.1	250	NEUTRAL

Table 5-2-2. EUT: M/T 2366-52U, s/n ZZ-00163 , Ch.6(2437MHz) TX mode 11Mbps

Frequency (MHz)	QP Voltage (dB μ V)	QP Limit (dB μ V)	QP Voltage (μ V)	QP Limit (μ V)	Phase
0.5075	21.9	48	12.4	250	LINE
0.5906	21.1	48	11.4	250	LINE
4.4145	19.7	48	9.7	250	NEUTRAL
8.0869	24.1	48	16.0	250	LINE
9.6795	23.8	48	15.5	250	LINE
22.9958	29.6	48	30.2	250	NEUTRAL

Table 5-2-3. EUT: M/T 2366-52U, s/n ZZ-00163, Ch.11(2462MHz) TX mode 11Mbps

Frequency (MHz)	QP Voltage (dB μ V)	QP Limit (dB μ V)	QP Voltage (μ V)	QP Limit (μ V)	Phase
0.5867	21.0	48	11.2	250	NEUTRAL
5.6682	22.3	48	13.0	250	NEUTRAL
8.0227	23.1	48	14.3	250	LINE
9.1699	23.2	48	14.5	250	LINE
15.492	22.8	48	13.8	250	LINE
23.8657	23.8	48	15.5	250	LINE

2) EUT in receiving mode

Table 5-2-4. EUT: M/T 2366-52U, s/n ZZ-00163, RX mode

Frequency (MHz)	QP Voltage (dB μ V)	QP Limit (dB μ V)	QP Voltage (μ V)	QP Limit (μ V)	Phase
0.5099	23.8	48	15.5	250	LINE
0.5911	22.6	48	13.5	250	LINE
0.8494	20.0	48	10.0	250	LINE
7.8996	24.7	48	17.2	250	LINE
16.1866	23.2	48	14.5	250	LINE
21.9684	25.4	48	18.6	250	LINE

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

6.1 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.

6.2 Test Instruments and Measurement Setup

Table 6-1 Radiated Emission Test Instrumentation

Description	Model	Serial Number
Computer	IBM 5551-L	#4
Spectrum Analyzer (100Hz-1.5GHz) for 30-200MHz	HP 85680B	3019A05155
Spectrum Analyzer Display for 30-200MHz	HP 85662A	3026A19353
Quasi-Peak Adapter for 30-200MHz	HP 85650A	3033A01449
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	HP 8447D	2805A02919
- for 200-1000MHz	HP 8447D	2944A03506
Biconical Antenna (30-200MHz)	EMCO 3108	2241
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	1584
Receiver (20MHz-1.3GHz)	R&S ESVP	893202/018
Switch/control unit	HP 3488A	2719A17226
N-Coax cables:	Length:	
- Bi-coni Ant <=> 10m Cable	9 m	- EM203L01
- 10m Cable <=> Shield Panel	10 m	- EM203L02
- Shield Panel <=> RF Amp	7 m	- EM203L03
- RF Amp <=> Power Splitter	0.5m	- EM203L04
- Log-peri Ant <=> 10m Cable	9 m	- EM203H01
- 10m Cable <=> Shield Panel	10 m	- EM203H02
- Shield Panel <=> RF Amp	7 m	- EM203H03
- RF Amp <=> Power Splitter	0.5m	- EM203H04
Coax cables:		
- Power Splitter <=> SW/Con.unit (SW110)	1 m	- EM203L05
- Power Splitter <=> SW/Con.unit (SW300)	1 m	- EM203L06
- Power Splitter <=> SW/Con.unit (SW100)	1 m	- EM203H05
- Power Splitter <=> SW/Con.unit (SW301)	1 m	- EM203H06
- SW/Con.unit <=> Receiver (Input)	2 m	- EM2RCV

- SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz	2 m	- EM2SPL
- SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	2 m	- EM2SPH

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

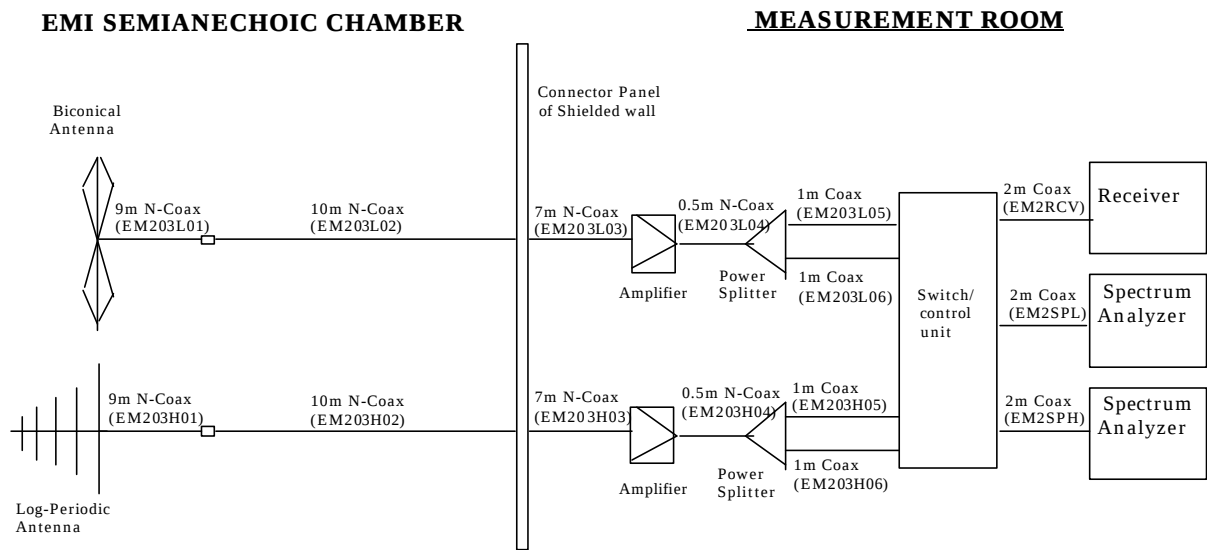


Figure 6 Cables for Radiated Emission Test

6.3 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 51.5dB μ V; 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:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 = 35.3\text{dB}\mu\text{V/m}$$

Conversion between dB μ V/m (or dB μ V) and μ V/m (or μ V) are done as:

$$\text{Level(dB}\mu\text{V/m)} = 20 \times \text{Log(Level}(\mu\text{V/m))}$$

$$40\text{dB}\mu\text{V/m} = 100\mu\text{V/m}$$

$$48\text{dB}\mu\text{V/m} = 250\mu\text{V/m}$$

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 2.5 dB at 30MHz - 1000MHz band.

The 6 highest emissions relative to the limits are reported.

Test Date: January 17, 2002

1) EUT in transmission mode

Table 6-2-1. EUT: M/T 2366-52U, s/n ZZ-00163, Ch.1(2412MHz) TX mode 11Mbps

Frequency (MHz)	Polarity (H/V)	Measured (dB μ V)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dB μ V/m)	Limit (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
191.312	H	35.6	13.4	-17.8	31.2	43.5	36.3	150
364.515	V	38.2	14.2	-14.4	38.0	46.0	79.4	200
439.995	V	36.0	15.8	-14.2	37.6	46.0	75.9	200
729.030	V	36.3	20.6	-13.7	43.2	46.0	144.5	200
902.214	V	21.0	22.7	-11.7	32.0	46.0	39.8	200
959.953	V	23.6	23.2	-11.5	35.3	46.0	58.2	200

Table 6-2-2. EUT: M/T 2366-52U, s/n ZZ-00163, Ch.6(2437MHz) TX mode 11Mbps

Frequency (MHz)	Polarity (H/V)	Measured (dB μ V)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dB μ V/m)	Limit (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
169.487	H	32.7	12.9	-18.1	27.5	43.5	23.7	150
189.063	H	37.0	13.4	-17.8	32.6	43.5	42.7	150
364.515	V	36.4	14.2	-14.4	36.2	46.0	64.6	200
439.996	V	35.8	15.8	-14.2	37.4	46.0	74.1	200
729.030	V	36.6	20.6	-13.7	43.5	46.0	149.6	200
904.486	V	17.4	22.7	-11.8	28.3	46.0	26.0	200

Table 6-2-3. EUT: M/T 2366-52U, s/n ZZ-00163, Ch.11(2462MHz) TX mode 11Mbps

Frequency (MHz)	Polarity (H/V)	Measured (dB μ V)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dB μ V/m)	Limit (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
183.654	H	37.6	13.1	-17.8	32.9	43.5	44.2	150
194.969	H	38.6	13.5	-17.8	34.3	43.5	51.9	150
364.515	V	36.6	14.2	-14.4	36.4	46.0	66.1	200
439.995	V	36.4	15.8	-14.2	38.0	46.0	79.4	200
729.029	V	34.0	20.6	-13.7	40.9	46.0	110.9	200
959.954	V	24.4	23.2	-11.5	36.1	46.0	63.8	200

2) EUT in receiving mode

Table 6-2-4. EUT: M/T 2366-52U, s/n ZZ-00163, RX mode

Frequency (MHz)	Polarity (H/V)	Measured (dB μ V)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dB μ V/m)	Limit (dB μ V/m)	Field Strength (μ V/m)	Limit (μ V/m)
133.252	V	33.9	12.1	-18.7	27.3	43.5	23.2	150
193.835	H	37.7	13.5	-17.8	33.4	43.5	46.8	150
364.515	V	38.8	14.2	-14.4	38.6	46.0	85.1	200
395.996	V	35.6	15.1	-14.4	36.3	46.0	65.3	200
439.996	V	35.5	15.8	-14.2	37.1	46.0	71.6	200
729.030	V	33.1	20.6	-13.7	40.0	46.0	100.0	200

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

7.1 Test Procedure

Radiated emissions were measured in the frequency range with 1 GHz to 25GHz in transmitting mode and 1 GHz to 12.5 GHz 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 a bandwidth of 1MHz and the average setting mode with the tuned spectrum analyzer using resolution bandwidth of 1MHz / video bandwidth of 1kHz. The highest emissions relative to the limit are listed.

7.2 Test Instruments and Measurement Setup

Table 7 Radiated Emission Test Instrumentation (1GHz – 25GHz)

Description	Model	Serial Number
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003
Amplifier (1-26.5GHz)	HP 8449B	3008A00582
Horn Antenna (1- 18GHz)	EMCO 3115	9903-5774
Horn Antenna (3.95 – 5.85GHz)	EMCO 3160-5	1099
Horn Antenna (5.85 – 8.20GHz)	EMCO 3160-6	9712-1044
Horn Antenna (18- 26.5GHz)	EMCO 3160-9	0004-1202
SF106 cables: - Horn Ant <=> RF Amp. - RF Amp.<=>Spectrum Analyzer	Length: 6 m 15 m	- EM206SCO - EM215SCO

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

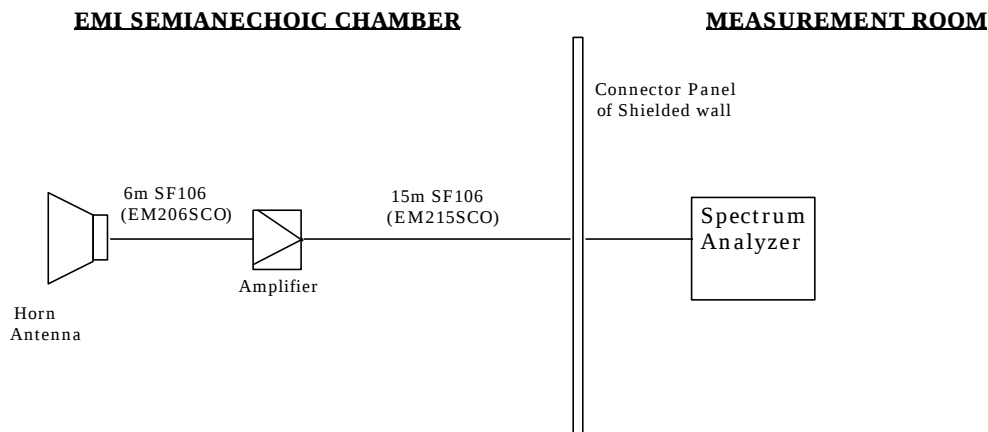


Figure 7 Cables for Radiated Emission Test

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. 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 dB μ V; 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:

$$FS = 51.5 + 8.5 + 1.3 - 26 - 0.0 = 35.6 \text{ dB}\mu\text{V/m}$$

Conversions between dB μ V/m (or dB μ V) and μ V/m (or μ V) are done as :

$$\text{Level(dB}\mu\text{V/m)} = 20 \times \text{Log (Level}(\mu\text{V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100 \mu\text{V/m}$$

$$48 \text{ dB}\mu\text{V/m} = 250 \mu\text{V/m}$$

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 3.2 dB. 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: January 18 and 21, 2002

1) EUT in transmission mode

Table 7-2-1. EUT: M/T 2366-52U, s/n ZZ-00163, Ch.1(2412MHz) TX mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dB μ V) (<i>peak</i>)	Measured (dB μ V) (<i>average</i>)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dB μ V/m) (<i>peak</i>)	FCC Limit (dB μ V/m) (<i>peak</i>)	Field Strength (dB μ V/m) (<i>average</i>)	FCC Limit (dB μ V/m) (<i>average</i>)
1.092	V	48.9	-	24.3	-31.3	0.0	41.9	74.0	-	54.0
1.132	V	48.8	-	24.4	-31.3	0.0	41.9	74.0	-	54.0
1.441	V	47.4	-	25.2	-30.6	0.0	42.0	74.0	-	54.0
1.459	V	49.8	-	25.2	-30.6	0.0	44.4	74.0	-	54.0
2.037	V	60.1	58.7	27.5	-29.5	0.0	58.1	NRB*	56.7	NRB*
2.271	V	50.1	-	28	-28.7	0.0	49.4	74.0	-	54.0
2.281	V	50.5	-	28	-28.7	0.0	49.8	74.0	-	54.0
2.302	V	50.0	-	28	-28.7	0.0	49.3	74.0	-	54.0
2.387	H	52.6	-	28.2	-28.5	0.0	52.3	74.0	-	54.0
2.398	H	76.4	66.6	28.2	-28.4	0.0	76.2	NRB*	66.4	NRB*
2.413	H	109.9	100.8	28.2	-28.4	0.0	109.7	OB*	100.6	OB*
4.074	V	46.5	-	27.4	-24.3	0.0	49.6	74.0	-	54.0
6.113	V	37.4	-	29.8	-23.0	0.0	44.2	74.0	-	54.0
7.238	V	38.1	-	30	-24.6	0.0	43.5	74.0	-	54.0

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

Table 7-2-2. EUT: M/T 2366-52U, s/n ZZ-00163, Ch.6(2437MHz) TX mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dB μ V) (<i>peak</i>)	Measured (dB μ V) (<i>average</i>)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dB μ V/m) (<i>peak</i>)	FCC Limit (dB μ V/m) (<i>peak</i>)	Field Strength (dB μ V/m) (<i>average</i>)	FCC Limit (dB μ V/m) (<i>average</i>)
1.092	V	49.0	-	24.3	-31.3	0.0	42.0	74.0	-	54.0
1.132	V	49.8	-	24.4	-31.3	0.0	42.9	74.0	-	54.0
1.441	V	46.4	-	25.2	-30.6	0.0	41.0	74.0	-	54.0
1.459	V	48.7	-	25.2	-30.6	0.0	43.3	74.0	-	54.0
2.063	H	62.1	61.2	27.5	-29.4	0.0	60.2	NRB*	59.3	NRB*
2.296	H	50.6	-	28	-28.7	0.0	49.9	74.0	-	54.0
2.306	H	52.9	-	28	-28.7	0.0	52.2	74.0	-	54.0
2.327	H	49.6	-	28	-28.7	0.0	48.9	74.0	-	54.0
2.370	H	50.3	-	28.1	-28.6	0.0	49.8	74.0	-	54.0
2.438	H	109.5	101.3	28.3	-28.4	0.0	109.4	OB*	101.2	OB*
4.124	V	45.9	-	27.4	-24.3	0.0	49.0	74.0	-	54.0
6.188	V	39.0	-	29.9	-23.1	0.0	45.8	74.0	-	54.0
7.311	V	37.7	-	29.9	-24.8	0.0	42.8	74.0	-	54.0

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

Table 7-2-3. EUT: M/T 2366-52U, s/n ZZ-00163, Ch.11(2462MHz) TX mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dB μ V) (<i>peak</i>)	Measured (dB μ V) (<i>average</i>)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dB μ V/m) (<i>peak</i>)	FCC Limit (dB μ V/m) (<i>peak</i>)	Field Strength (dB μ V/m) (<i>average</i>)	FCC Limit (dB μ V/m) (<i>average</i>)
1.092	V	49.8	-	24.3	-31.3	0.0	42.8	74.0	-7.0	54.0
1.132	V	49.1	-	24.4	-31.3	0.0	42.2	74.0	-	54.0
1.459	V	49.4	-	25.2	-30.6	0.0	44.0	74.0	-	54.0
1.713	V	49.2	-	26.2	-30.1	0.0	45.3	74.0	-	54.0
2.088	V	62.3	61.1	27.6	-29.3	0.0	60.6	NRB*	59.4	NRB*
2.307	V	51.7	-	28	-28.7	0.0	51.0	74.0	-	54.0
2.321	V	55.6	49.6	28	-28.7	0.0	54.9	74.0	48.9	54.0
2.330	V	55.1	51.3	28.1	-28.6	0.0	54.6	74.0	50.8	54.0
2.463	V	108.6	100.4	28.3	-28.3	0.0	108.6	OB*	100.4	OB*
2.484	V	54.5	43.5	28.4	-28.2	0.0	54.7	74.0	43.7	54.0
4.174	V	47.0	-	27.4	-24.2	0.0	50.2	74.0	-	54.0
6.264	V	40.6	-	29.9	-23.2	0.0	47.3	74.0	-	54.0
7.388	V	37.5	-	29.8	-25.0	0.0	42.3	74.0	-	54.0

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

2) EUT in receiving mode

Table 7-2-4. EUT: M/T 2366-52U, s/n ZZ-00163, RX mode

Frequency (GHz)	Polarity (H/V)	Measured (dB μ V) <i>(peak)</i>	Measured (dB μ V) <i>(average)</i>	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dB μ V/m) <i>(peak)</i>	FCC Limit (dB μ V/m) <i>(peak)</i>	Field Strength (dB μ V/m) <i>(average)</i>	FCC Limit (dB μ V/m) <i>(average)</i>
1.092	V	49.1	-	24.3	-31.5	0.0	41.9	74.0	-	54.0
1.132	V	49.5	-	24.4	-31.2	0.0	42.7	74.0	-	54.0
1.152	V	47.6	-	24.5	-31.2	0.0	40.9	74.0	-	54.0
1.459	V	48.6	-	25.2	-30.9	0.0	42.9	74.0	-	54.0
2.063	V	48.8	-	27.5	-29.4	0.0	46.9	74.0	-	54.0
4.124	V	43.8	-	27.4	-24.3	0.0	46.9	74.0	-	54.0
6.188	V	38.4	-	29.9	-23.1	0.0	45.2	74.0	-	54.0