

Emission Test Report

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Class II Permissive change

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Product Model: Cisco Aironet Wireless 802.11b
(with IBM ThinkPad R40 Series)

FCC ID: ANOU58H004
IC: 349E-U58H004

December 10, 2002

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

**Cisco Aironet Wireless 802.11b
(with IBM ThinkPad R40 Series)**

FCC ID : ANOU58H004

December 10, 2002

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Equipment type: <u>Wireless LAN device</u>
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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 #2
 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 NAME : Cisco Aironet Wireless 802.11b
 FCC ID : ANOU58H004
 IC Certification Number : 349E-U58H004
 SERIAL NUMBER : 00000001DHF
 PHYSICAL CONDITION : Preproduction
 KIND OF EQUIPMENT : DTS: IEEE802.11b Wireless LAN Mini-PCI card
 TESTED DATE : December 4, 5 and 6, 2002

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

A.3 EUT details

Model and S/N	FCC ID IC Certification Number	Description
Cisco Aironet Wireless 802.11b (s/n 00000001DHF)	FCC ID: ANOU58H004 IC: 349E-U58H004	Applying modular transmitter Built_in type IEEE802.11b Wireless LAN Mini-PCI card without antenna
ThinkPad R40 Series M/T 2681-3NU (s/n FX-0N14F)	N/A	Host equipment IBM Notebook PC with built_in antenna CPU: Intel® Mobile Pentium® 4, 1.6GHz LCD: 14" XGA
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 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
15.207 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 (1G - 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 (1G - 25GHz)	Pass

C. OPERATION MODE OF EUT

All tests were performed using the “Venus MPI 350 Software”. 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)	+20	+20	+20	X
2.417 (Ch. 2)	+20	+20	+20	
2.422 (Ch. 3)	+20	+20	+20	
2.427 (Ch. 4)	+20	+20	+20	
2.432 (Ch. 5)	+20	+20	+20	
2.437 (Ch. 6)	+20	+20	+20	X
2.442 (Ch. 7)	+20	+20	+20	
2.447 (Ch. 8)	+20	+20	+20	
2.452 (Ch. 9)	+20	+20	+20	
2.457 (Ch. 10)	+20	+20	+20	
2.462 (Ch. 11)	+20	+20	+20	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	2732A03651	02/19/02	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	3019A05156	04/04/02	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2601A02634	08/28/02	1 year
Spectrum Analyzer Display	HP 85662A	2648A15255	02/19/02	1 year
Spectrum Analyzer Display	HP 85662A	3026A19366	04/04/02	1 year
Spectrum Analyzer Display	HP 85662A	2542A12308	08/28/02	1 year
Quasi-Peak Adapter	HP 85650A	2521A00968	02/15/02	1 year
Quasi-Peak Adapter	HP 85650A	2811A01433	04/04/02	1 year
Quasi-Peak Adapter	HP 85650A	2043A00062	08/28/02	1 year
Amplifier (100KHz - 1.3GHz) - for 30-200MHz - for 200-1000MHz	HP 8447D HP 8447D	2805A02919 2944A03506	04/15/02 04/15/02	1 year 1 year
Amplifier (1GHz - 26.5GHz)	HP 8449B	3008A00582	06/13/02	1 year
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003	07/18/02	1 year
Receiver (9kHz-30MHz)	R&S ESH3	891806/012	10/07/02	1 year
Receiver (20MHz-1.3GHz)	R&S ESVP	892111/030	02/19/02	1 year
Biconical Antenna (30-200MHz)	EMCO 3108	2400	05/06/02	1 year
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	2150	05/06/02	1 year
Horn Antenna (1- 18GHz)	EMCO 3115	9903-5774	07/18/02	1 year
Horn Antenna (3.95- 5.85GHz)	EMCO 3160-5	1099	04/17/02	1 year
Horn Antenna (5.85- 8.2GHz)	EMCO 3160-6	9712-1044	04/17/02	1 year
Horn Antenna (8.2- 12.4GHz)	EMCO 3160-7	1156	04/17/02	1 year
Horn Antenna (18- 26.5GHz)	EMCO 3160-9	0004-1202	04/17/02	1 year
LISN	EMCO 3825/2	1426	09/01/02	1 year
Power Meter	HP 437B	3043U03437	11/08/02	1 year
Power Sensor	HP 8481A	US41030582	11/08/02	1 year
Switch/control unit	HP 3488A	2719A17226 2719A17228	N/A N/A	N/A N/A
Plotter	HP 7550A	2631A33619	N/A	N/A
SF106 cables: - Horn Ant <=> RF Amp. - RF Amp.<=>Spectrum Analyzer	Length: 6 m 15m	- EM206SCO - EM215SCO	09/05/02 09/05/02	1 year 1 year
N-Coax cables: - Bi-coni Ant <=> 10m Cable - 10m Cable <=> Shield Panel - Shield Panel <=> RF Amp	9 m 10 m 7 m	- EM203L01 - EM203L02 - EM203L03	04/15/02 04/15/02 04/15/02	1 year 1 year 1 year

- RF Amp <=> Power Splitter	0.5m	- EM203L04	04/15/02	1 year
- Log-peri Ant <=> 10m Cable	9 m	- EM203H01	04/15/02	1 year
- 10m Cable <=> Shield Panel	10 m	- EM203H02	04/15/02	1 year
- Shield Panel <=> RF Amp	7 m	- EM203H03	04/15/02	1 year
- RF Amp <=> Power Splitter	0.5m	- EM203H04	04/15/02	1 year
Coax cables:				
- Lisn-L <=> SW/Con.unit (SW100)	4 m	- EMIC-L	04/15/02	1 year
- Lisn-N <=> SW/Con.unit (SW101)	4 m	- EMIC-N	04/15/02	1 year
- SW/Con.unit <=> RCVR (Input)	1 m	- EMIC-R	04/15/02	1 year
- SW/Con.unit<=> Spe Ana.(Signal In)	1 m	- EMIC-S	04/15/02	1 year
- Power Splitter <=> SW/Con.unit (SW110)	1 m	- EM203L05	04/15/02	1 year
- Power Splitter <=> SW/Con.unit (SW300)	1 m	- EM203L06	04/15/02	1 year
- Power Splitter <=> SW/Con.unit (SW100)	1 m	- EM203H05	04/15/02	1 year
- Power Splitter <=> SW/Con.unit (SW301)	1 m	- EM203H06	04/15/02	1 year
- SW/Con.unit <=> Receiver (Input)	2 m	- EM2RCV	04/15/02	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz	2 m	- EM2SPL	04/15/02	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	2 m	- EM2SPH	04/15/02	1 year

Notes.

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

E. JUSTIFICATION

The EUT was investigated for both the left (main, **A0** port) and the right (auxiliary, **A1** port) antennas. The conducted output powers for both antenna ports were almost the same (See Chapter 3 in this report). Thus the worse case data taken in this report represents the measurement results of the right antenna of 14” LCD model, since this combination has the highest gain among the 4 antennas as listed below.

	14" LCD model	15" LCD model
Left Antenna (A0 port) gain	-0.37 dBi (peak)	0.46 dBi (peak)
Right Antenna (A1 port) gain	0.83 dBi (peak)	-1.06 dBi (peak)

F. 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.

G. Temperature and Humidity

The temperature is controlled within range of 17° to 28°.

The relative humidity is controlled within range of 40% to 70%.

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

The host unit with full peripheral devices including the applying modular(s) 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 SDoC.

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: 110 cm Loss: 1.3 dB	

Notes: - R&S: Rohde & Schwarz

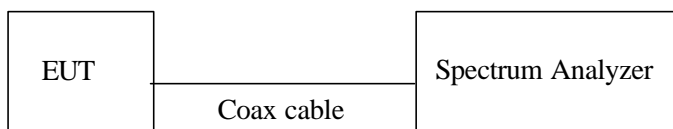


Figure 1: Measurement setup for 6dB bandwidth test

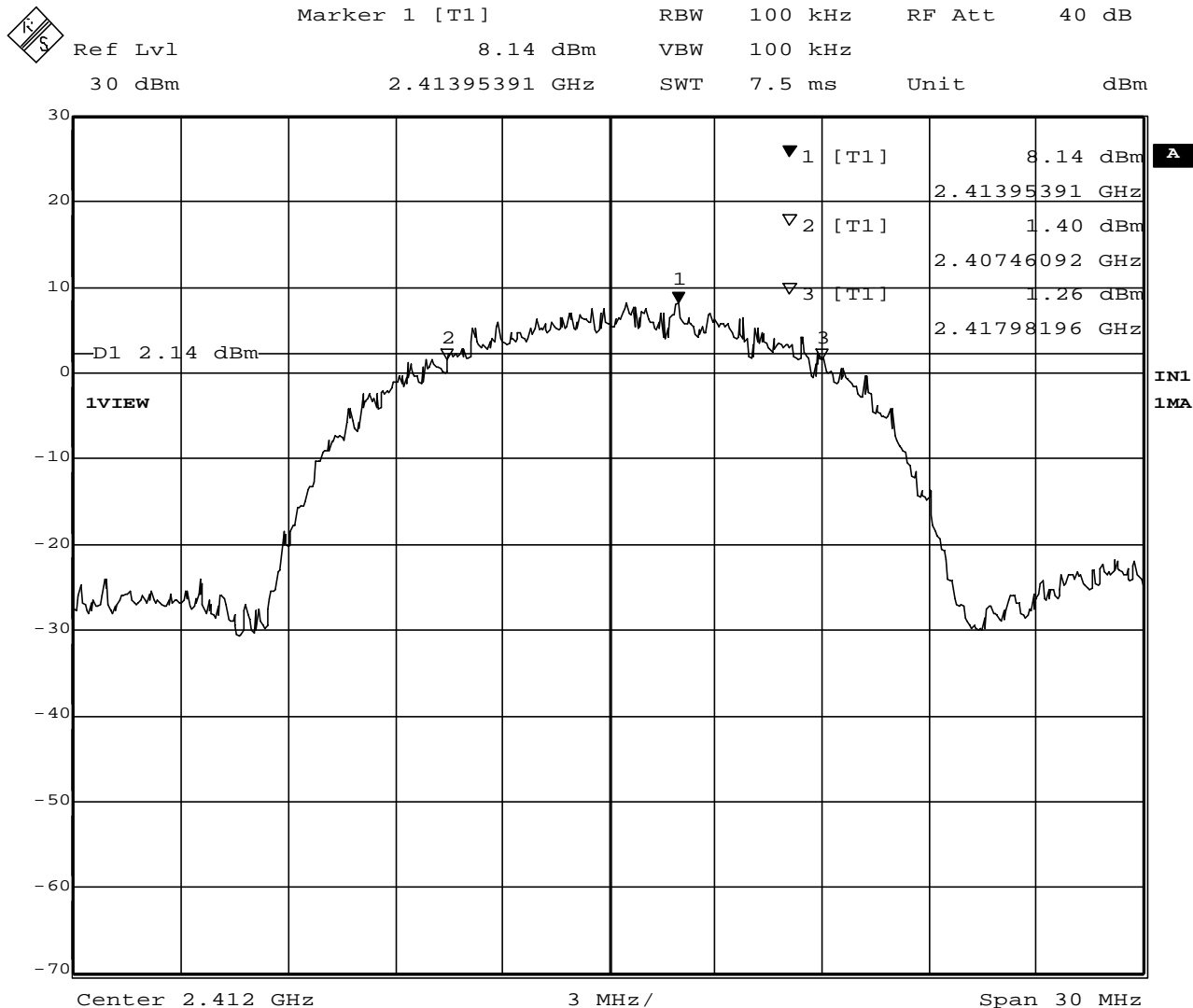
1.3 Measurement Results

Test Date: December 5, 2002

Table 1-2. EUT: M/T 2681-3NU, s/n FX-0N14F, TX mode 11Mbps

Center Frequency (MHz)	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)
2412 (ch. 1)	2407.46	2417.98	10.52
2437 (ch. 6)	2432.46	2442.92	10.46
2462 (ch. 11)	2457.40	2467.92	10.52

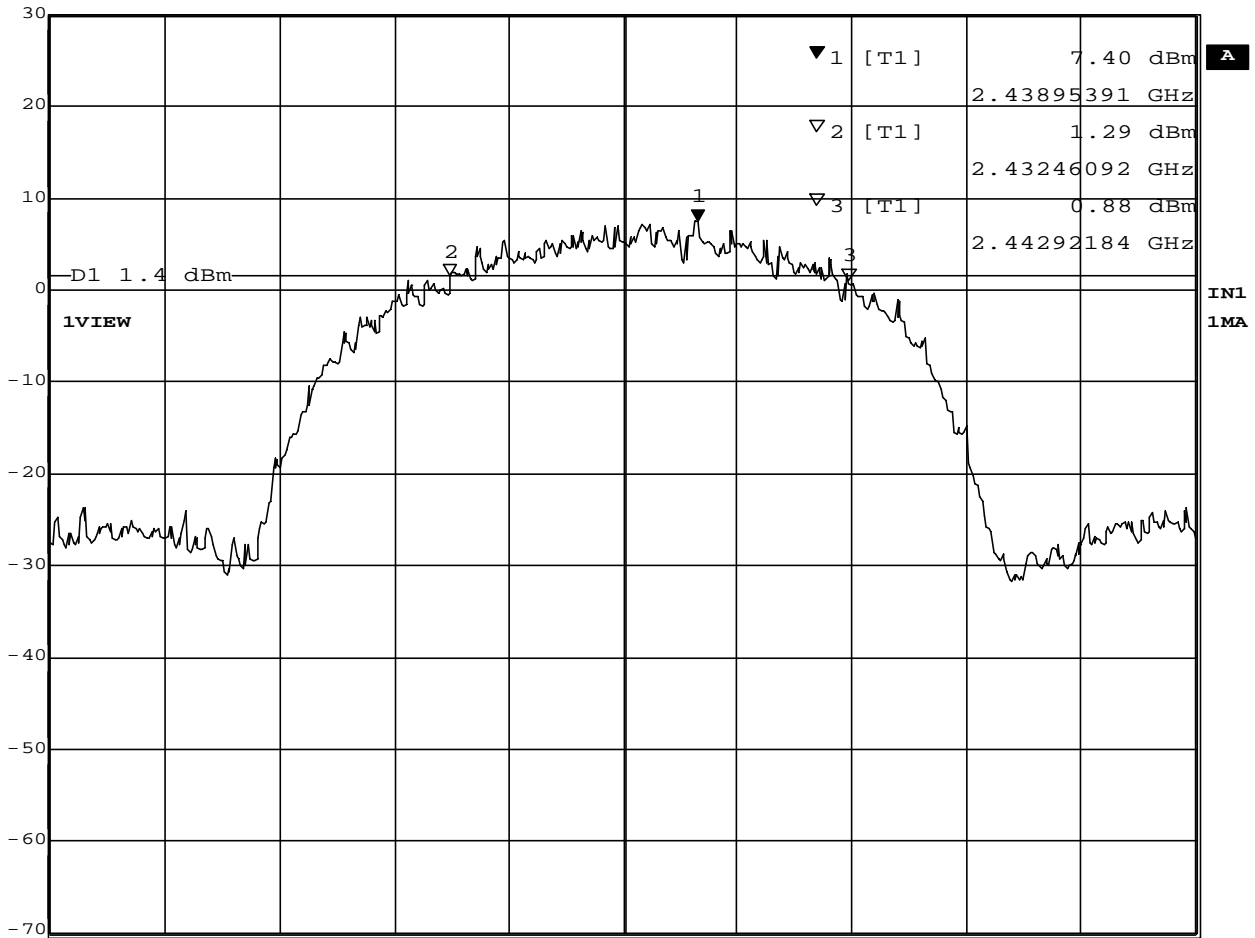
1.4 Trace Data



Date: 5.DEC.2002 17:52:56



Marker 1 [T1] RBW 100 kHz RF Att 40 dB
 Ref Lvl 7.40 dBm VBW 100 kHz
 30 dBm 2.43895391 GHz SWT 7.5 ms Unit dBm

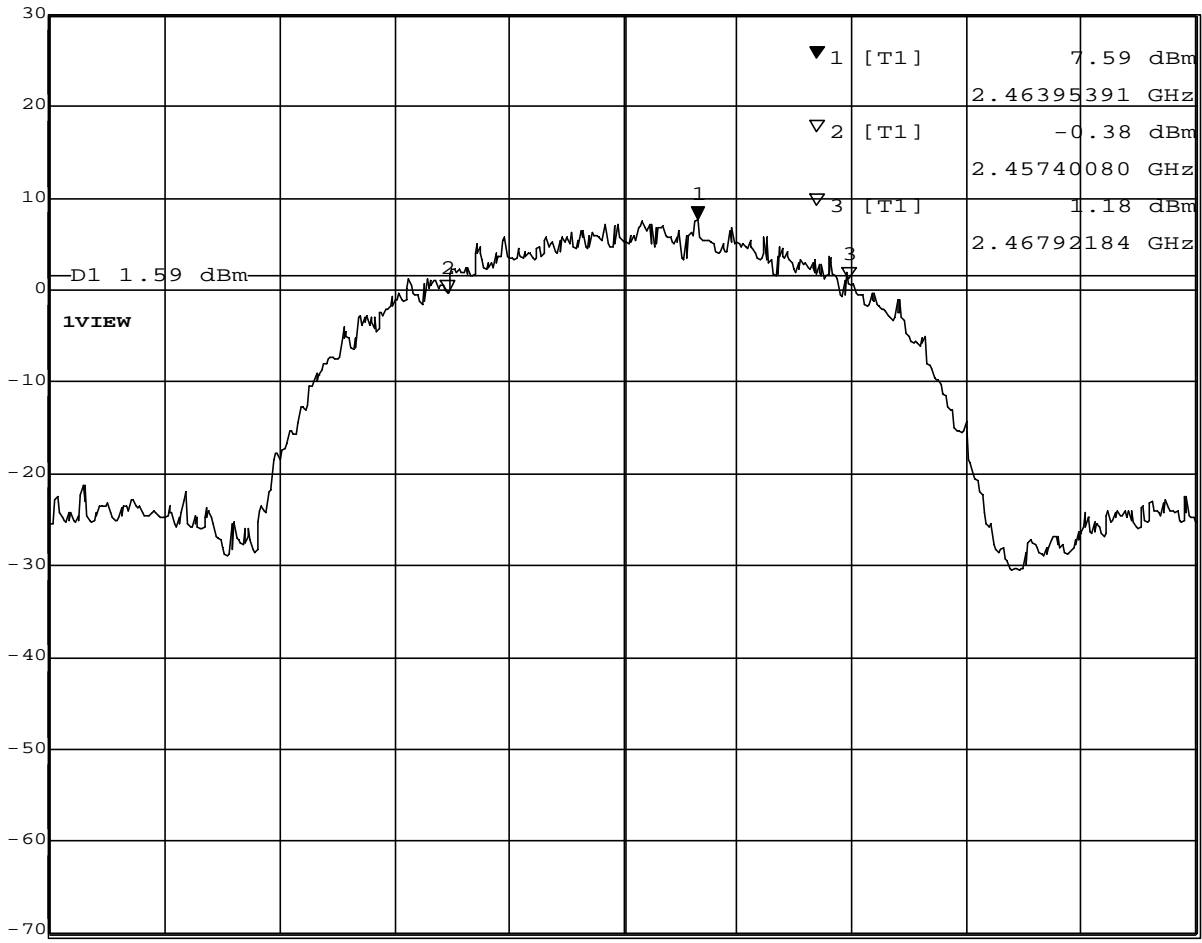


Center 2.437 GHz 3 MHz/ Span 30 MHz

Date: 5.DEC.2002 17:54:38



Marker 1 [T1] RBW 100 kHz RF Att 40 dB
 Ref Lvl 7.59 dBm VBW 100 kHz
 30 dBm 2.46395391 GHz SWT 7.5 ms Unit dBm



Center 2.462 GHz 3 MHz/ Span 30 MHz

Date: 5.DEC.2002 17:56:25

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=50MHz, 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: December 5, 2002

Table 2-1. EUT: M/T 2681-3NU, s/n FX-0N14F, TX mode 11Mbps

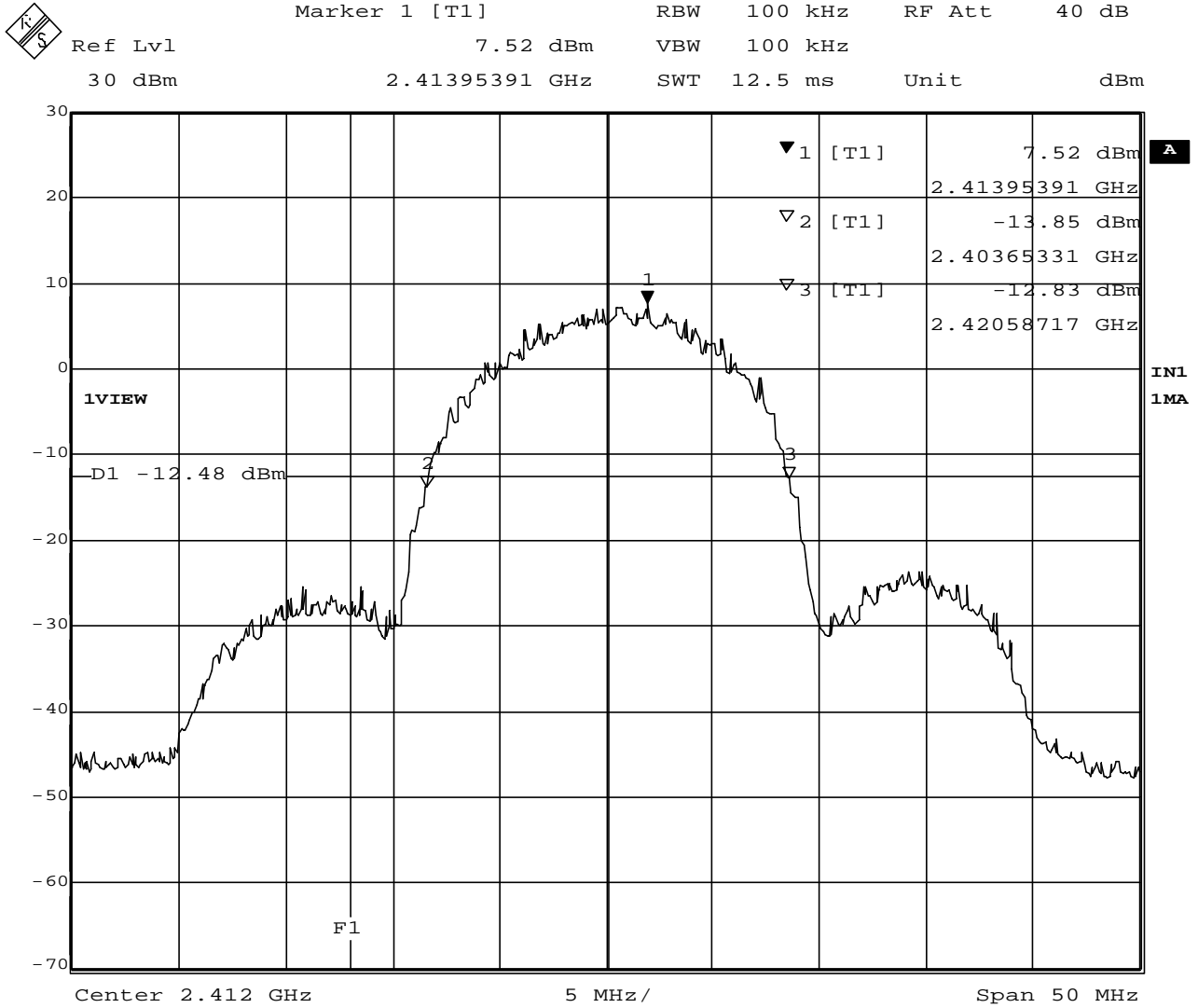
Center Frequency (MHz)	Lower Frequency (MHz)	Upper Frequency (MHz)	Bandwidth at 20 dB below (MHz)	Margin to Lower limit (MHz)	Margin to Upper limit (MHz)
2412 (ch. 1)	2403.65	2420.59	16.94	3.65	
2437 (ch. 6)	2428.63	2445.54	16.91		
2462 (ch. 11)	2453.63	2470.59	16.96		12.91

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: December 5, 2002

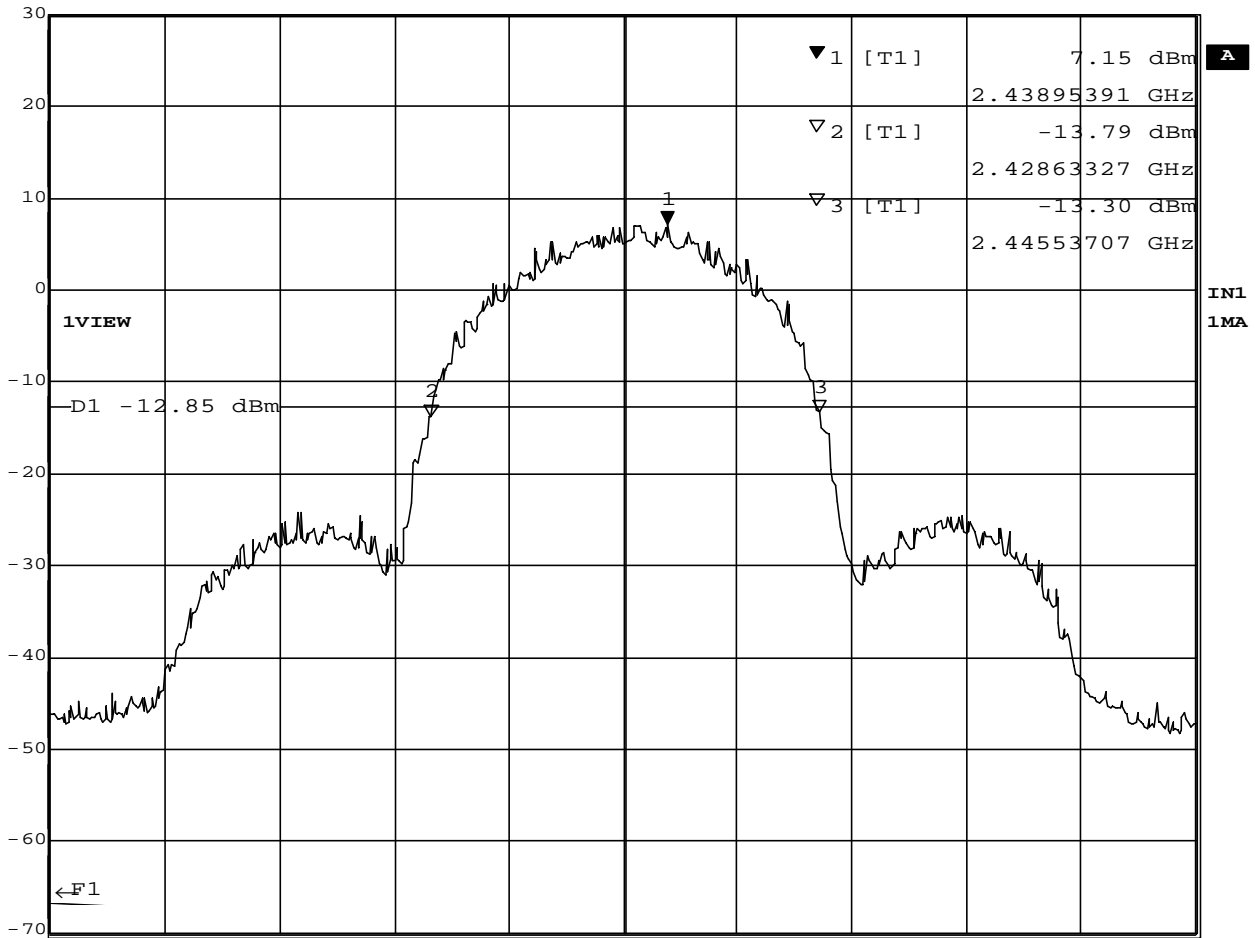
2.5 Trace Data of Band-edge



Date: 5.DEC.2002 17:59:29



Marker 1 [T1] RBW 100 kHz RF Att 40 dB
 Ref Lvl 7.15 dBm VBW 100 kHz
 30 dBm 2.43895391 GHz SWT 12.5 ms Unit dBm

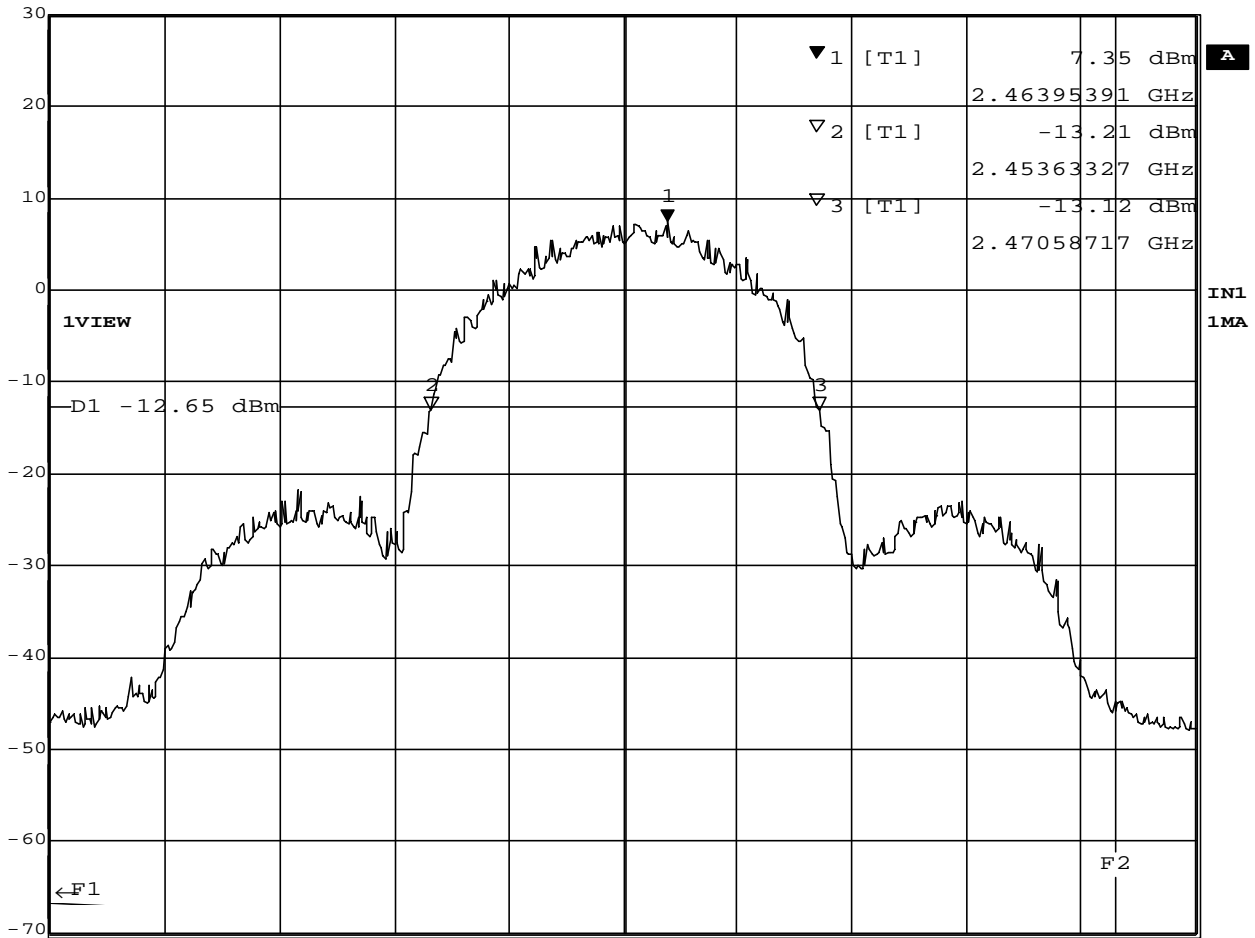


Center 2.437 GHz 5 MHz/ Span 50 MHz

Date: 5.DEC.2002 18:01:12



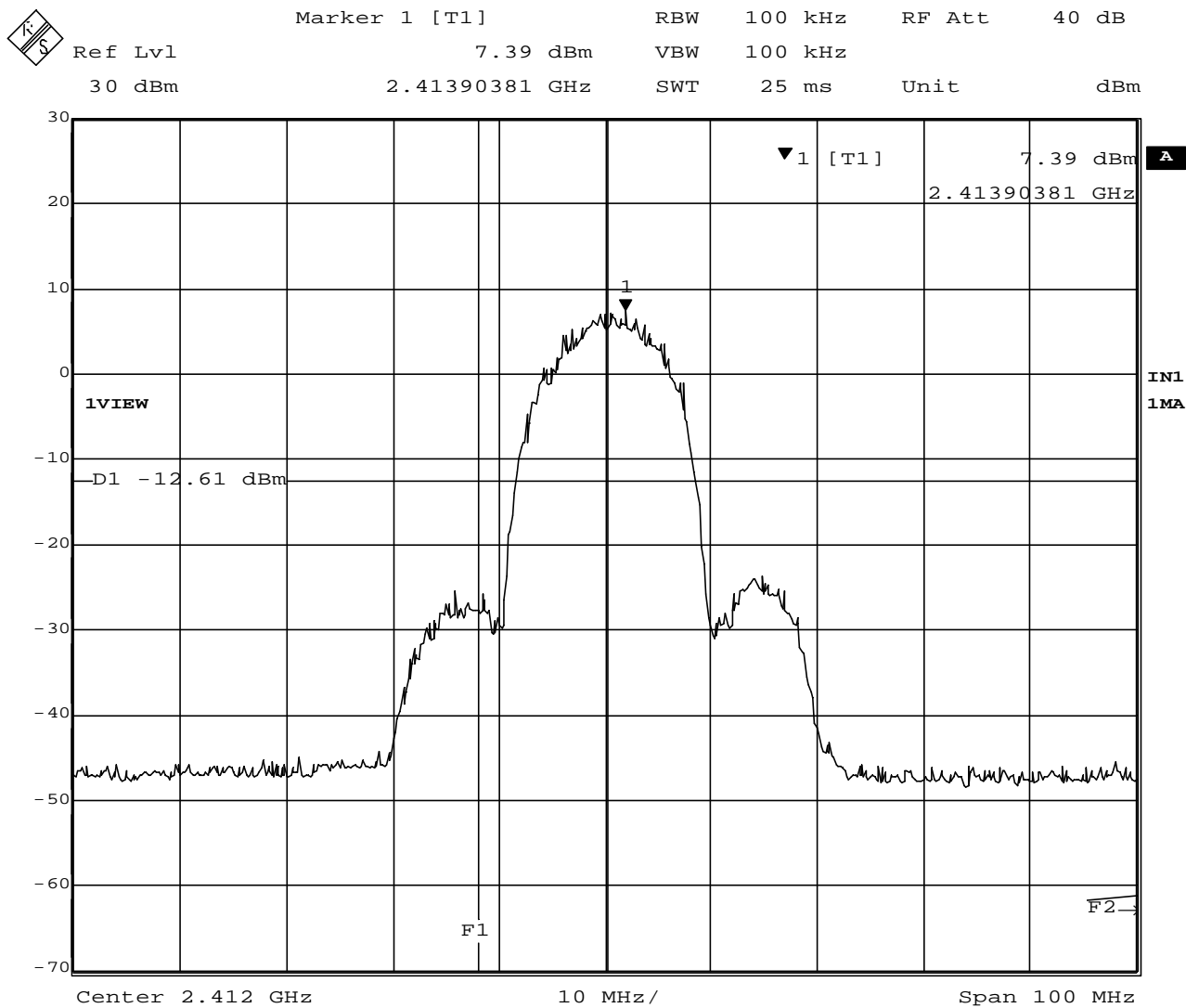
Marker 1 [T1] RBW 100 kHz RF Att 40 dB
 Ref Lvl 7.35 dBm VBW 100 kHz
 30 dBm 2.46395391 GHz SWT 12.5 ms Unit dBm



Center 2.462 GHz 5 MHz/ Span 50 MHz

Date: 5.DEC.2002 18:03:10

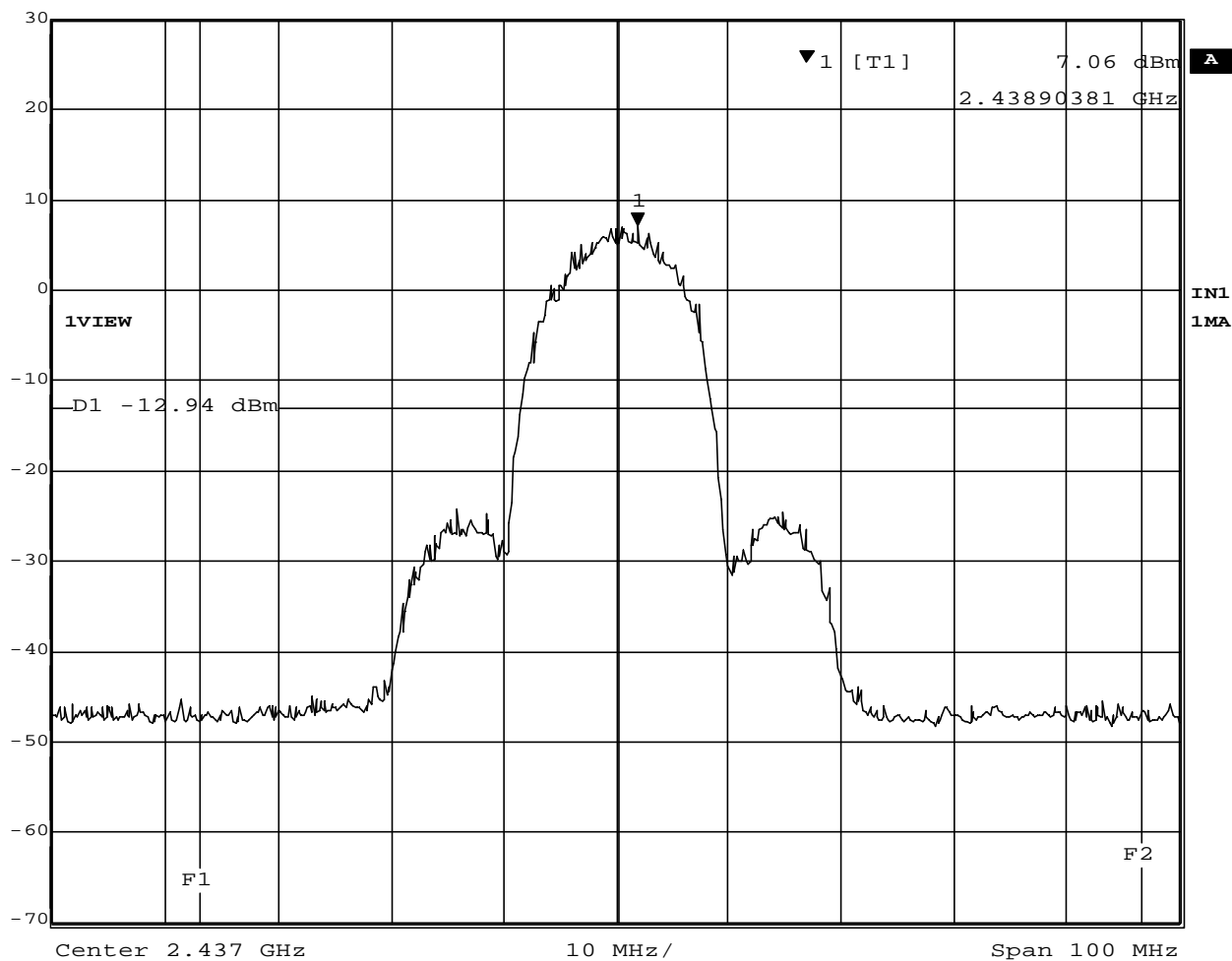
2.6 Trace Data of Out of Band Emissions



Date: 5.DEC.2002 18:05:04



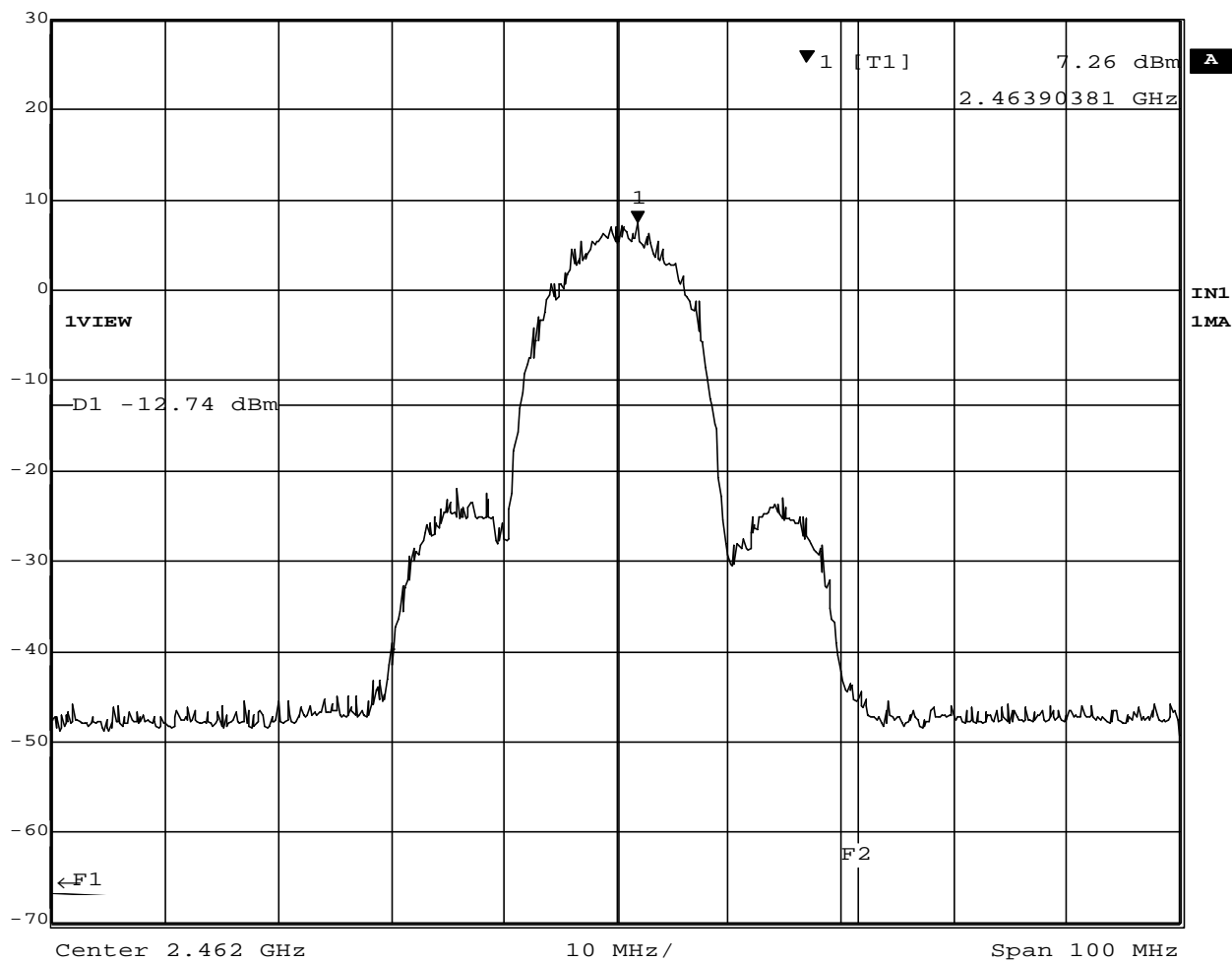
Marker 1 [T1] RBW 100 kHz RF Att 40 dB
 Ref Lvl 7.06 dBm VBW 100 kHz
 30 dBm 2.43890381 GHz SWT 25 ms Unit dBm



Date: 5.DEC.2002 18:06:25



Marker 1 [T1] RBW 100 kHz RF Att 40 dB
 Ref Lvl 7.26 dBm VBW 100 kHz
 30 dBm 2.46390381 GHz SWT 25 ms Unit dBm



Date: 5.DEC.2002 18:07:34

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

Notes: - HP: Hewlett Packard

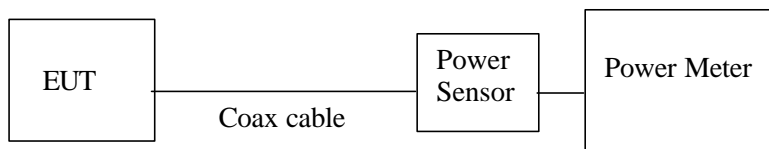


Figure 3: Measurement setup for RF output power

3.2 Measurement Results

Test Date: December 4, 2002

Table 3-2. EUT: M/T 2681-3NU, s/n FX-0N14F, **A0 Main port** (left antenna), TX mode 11Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	19.2	0.7	19.9	0.0977	30.0	10.1
2437 (ch. 6)	19.1	0.7	19.8	0.0955	30.0	10.2
2462 (ch. 11)	19.1	0.7	19.8	0.0955	30.0	10.2

Table 3-3. EUT: M/T 2681-3NU, s/n FX-0N14F, **A0 Main port** (left antenna), TX mode 2Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	18.9	0.7	19.6	0.0912	30.0	10.4
2437 (ch. 6)	18.7	0.7	19.4	0.0871	30.0	10.6
2462 (ch. 11)	19.0	0.7	19.7	0.0933	30.0	10.3

Table 3-3. EUT: M/T 2681-3NU, s/n FX-0N14F, **A1 Auxiliary port** (right antenna), TX mode 11Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	19.2	0.7	19.9	0.0977	30.0	10.1
2437 (ch. 6)	18.9	0.7	19.6	0.0912	30.0	10.4
2462 (ch. 11)	19.1	0.7	19.8	0.0912	30.0	10.2

Table 3-4. EUT: M/T 2681-3NU, s/n FX-0N14F, **A1 Auxiliary port** (right antenna), TX mode 2Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	18.9	0.7	19.6	0.0912	30.0	10.4
2437 (ch. 6)	18.8	0.7	19.5	0.0891	30.0	10.5
2462 (ch. 11)	19.0	0.7	19.7	0.0933	30.0	10.3

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).

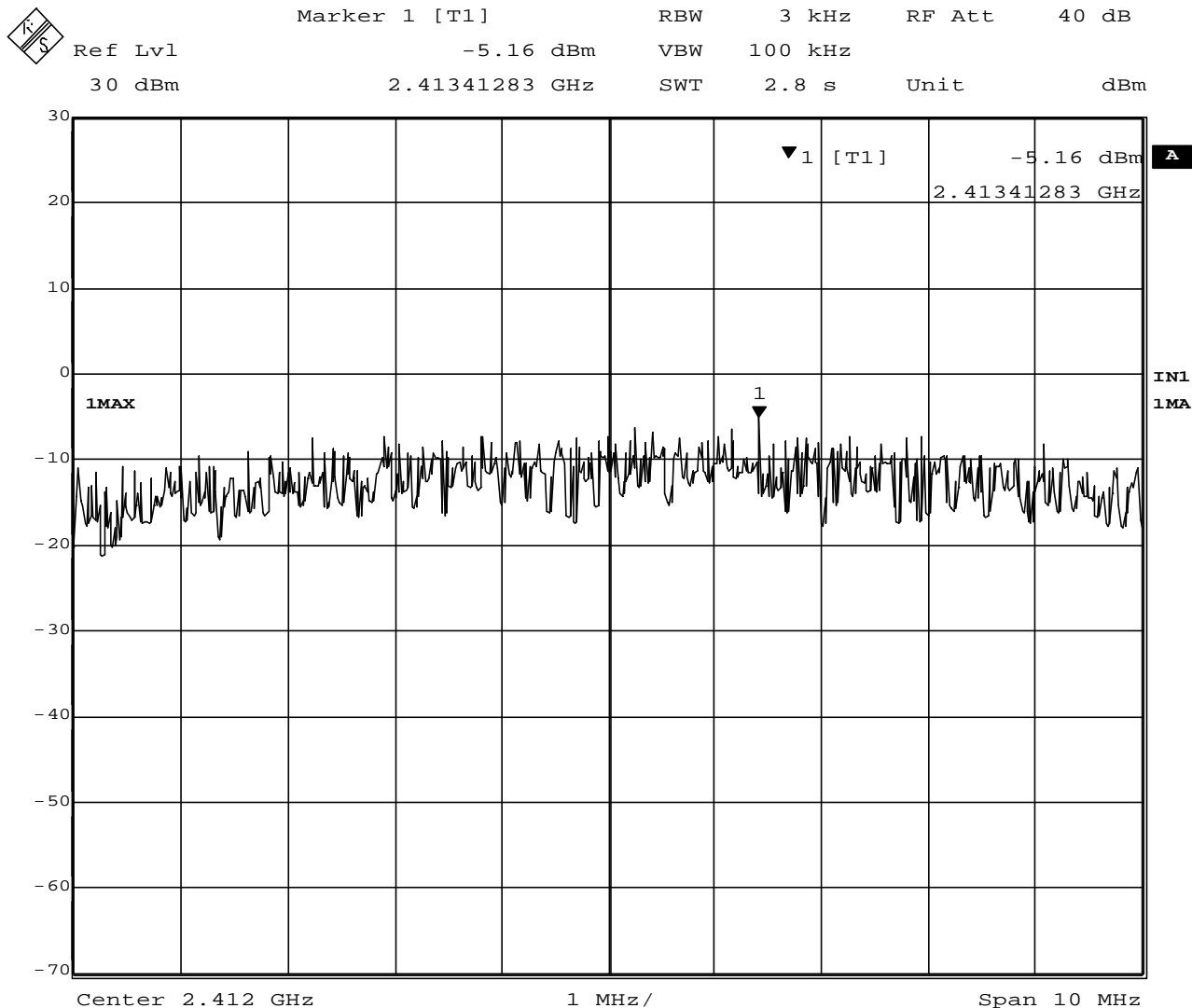
4.3 Measurement Results

Test Date: December 5, 2002

Table 4-1. EUT: M/T 2681-3NU, s/n FX-0N14F, TX mode 11Mbps

Ch No.	Frequency (MHz)	Spectrum Analyzer Reading (dBm)	Cable loss (dB)	Result (dBm)	Limit (dBm)	Margin (dB)
1	2413.41	-5.2	1.3	-3.9	8.0	11.9
6	2438.41	-5.5	1.3	-4.2	8.0	12.2
11	2463.41	-5.2	1.3	-3.9	8.0	11.9

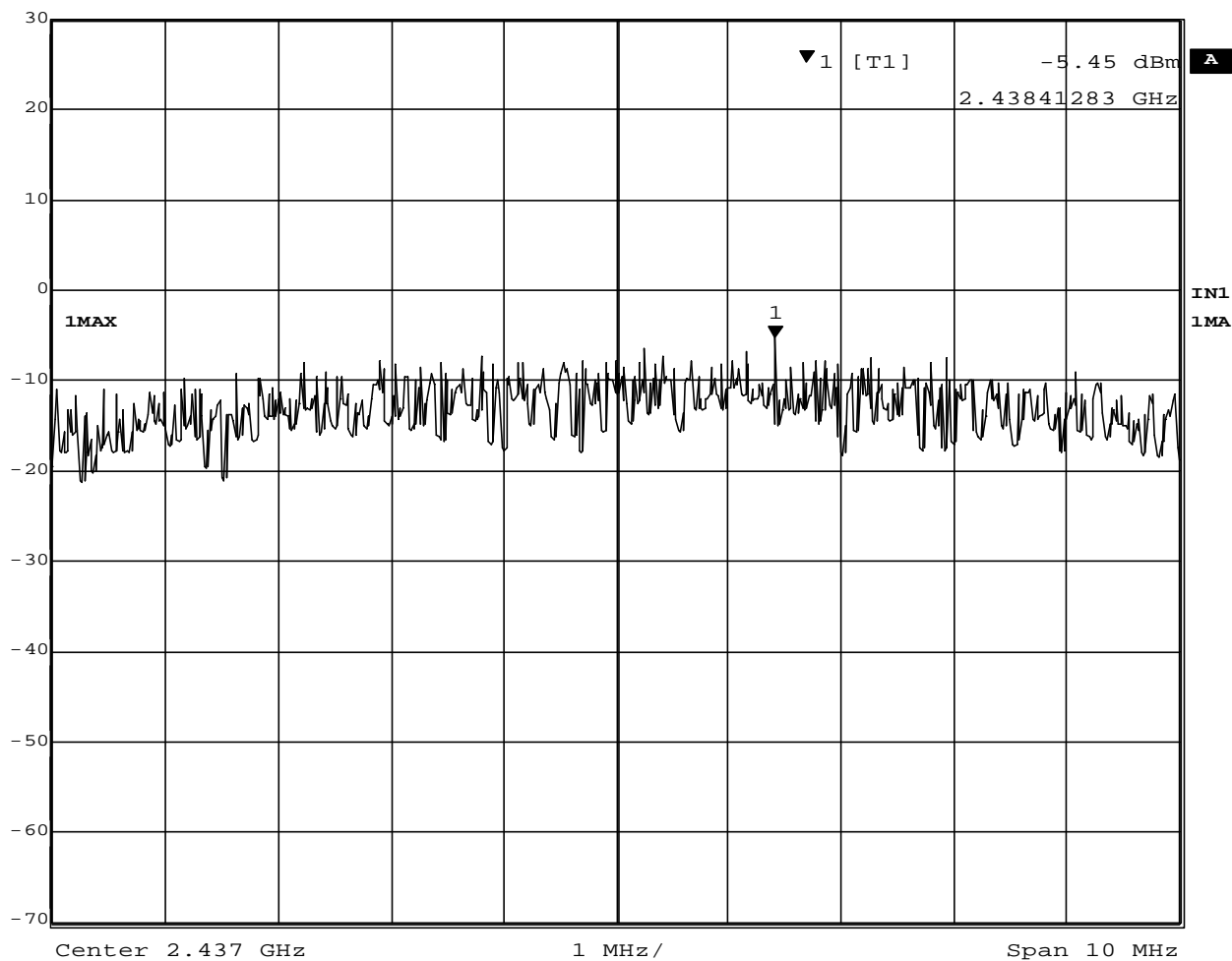
4.4 Trace Data



Date: 5.DEC.2002 18:12:02



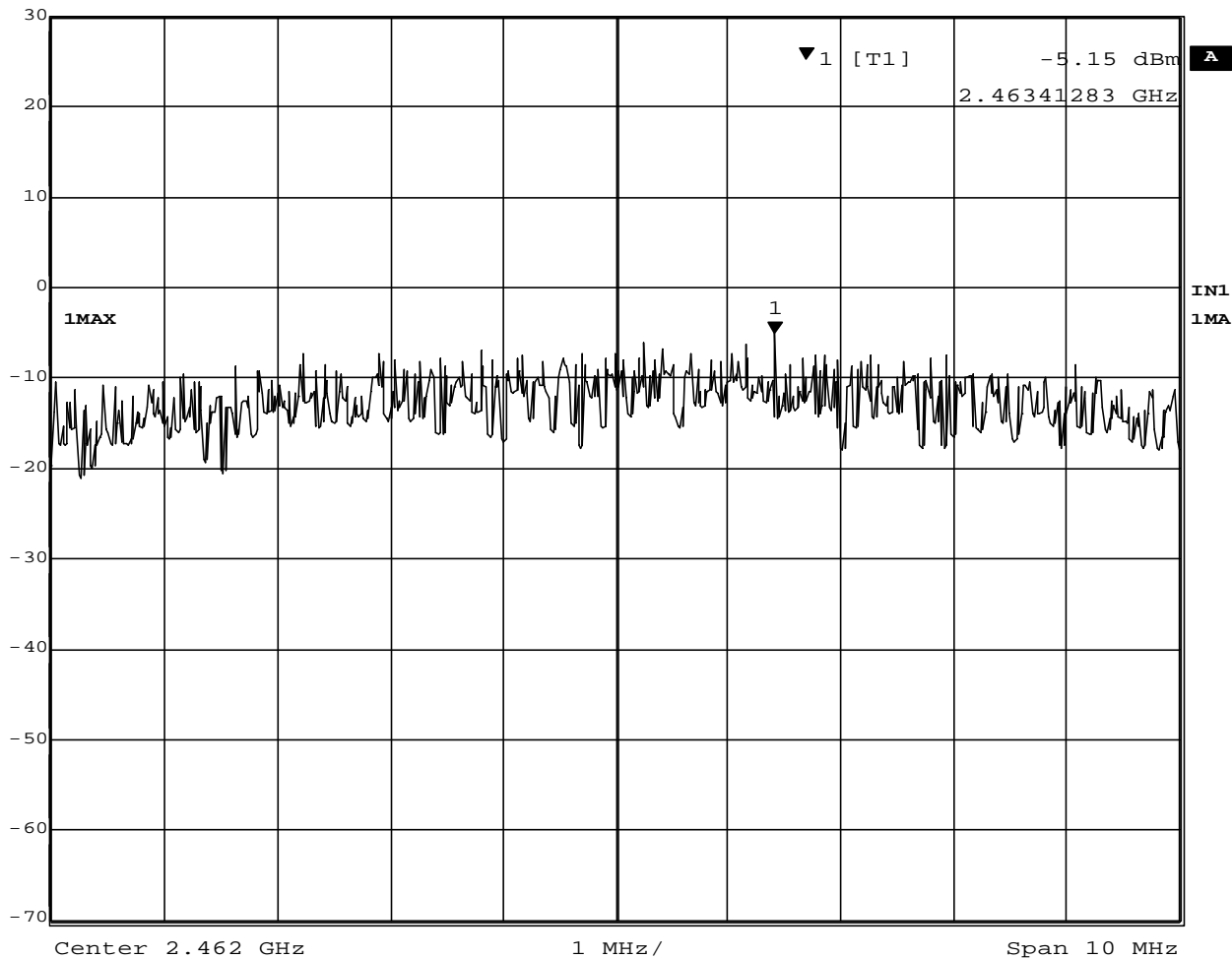
Marker 1 [T1] RBW 3 kHz RF Att 40 dB
Ref Lvl -5.45 dBm VBW 100 kHz
30 dBm 2.43841283 GHz SWT 2.8 s Unit dBm



Date: 5.DEC.2002 18:12:50



Ref Lvl	30 dBm	Marker 1 [T1]	2.46341283 GHz	RBW	3 kHz	RF Att	40 dB
				VBW	100 kHz		
				SWT	2.8 s	Unit	dBm



Date: 5.DEC.2002 18:13:48

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	2601A02634
Spectrum Analyzer Display	HP 85662A	2542A12308
Quasi-Peak Adapter	HP 85650A	2043A00062
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: - Liscn-L <=> SW/Con.unit (SW100) - Liscn-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

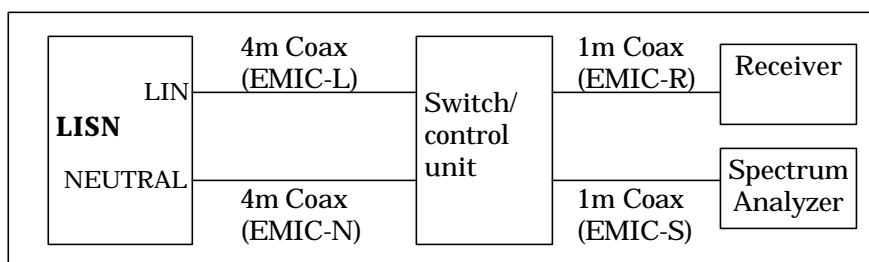


Figure 5. Cables for Conducted Emission Test

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 16.2dB. The 6 highest emissions relative to the limits are reported.

Test Date: December 6, 2002

1) EUT in transmission mode

Table 5-2-1. EUT: M/T 2681-3NU, s/n FX-0N14F, 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
0.4848	27.5	48	23.7	250	NEUTRAL
0.5532	29.6	48	30.2	250	NEUTRAL
0.7656	26.0	48	20.0	250	NEUTRAL
0.9035	26.5	48	21.1	250	NEUTRAL
4.0219	31.7	48	38.5	250	LINE
6.9987	25.5	48	18.8	250	LINE

Table 5-2-2. EUT: M/T 2681-3NU, s/n FX-0N14F, 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
0.4807	25.3	48	18.4	250	NEUTRAL
0.5566	29.5	48	29.9	250	NEUTRAL
0.6245	25.7	48	19.3	250	NEUTRAL
0.6931	27.7	48	24.3	250	NEUTRAL
0.9025	25.9	48	19.7	250	NEUTRAL
4.0099	30.9	48	35.1	250	NEUTRAL

Table 5-2-3. EUT: M/T 2681-3NU, s/n FX-0N14F, 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
0.5544	30.1	48	32.0	250	NEUTRAL
0.6249	25.6	48	19.1	250	NEUTRAL
0.6911	27.8	48	24.5	250	NEUTRAL
0.7635	26.1	48	20.2	250	NEUTRAL
1.0388	25.8	48	19.5	250	NEUTRAL
4.0081	31.8	48	38.9	250	LINE

2) EUT in receiving mode

Table 5-2-4. EUT: M/T 2681-3NU, s/n FX-0N14F, Ch.6(2437MHz) RX mode

Frequency (MHz)	QP Voltage (dB μ V)	QP Limit (dB μ V)	QP Voltage (μ V)	QP Limit (μ V)	Phase
0.4845	31.5	48	37.6	250	NEUTRAL
0.5530	25.8	48	19.5	250	NEUTRAL
0.621	26.9	48	22.1	250	NEUTRAL
0.6916	28.2	48	25.7	250	NEUTRAL
0.8335	27.4	48	23.4	250	NEUTRAL
4.0179	29.0	48	28.2	250	NEUTRAL

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	3019A05156
Spectrum Analyzer Display for 30-200MHz	HP 85662A	3026A19366
Quasi-Peak Adapter for 30-200MHz	HP 85650A	2811A01433
Spectrum Analyzer (100Hz-1.5GHz) for 200-1000MHz	HP 85680B	2732A03651
Spectrum Analyzer Display for 200-1000MHz	HP 85662A	2648A15255
Quasi-Peak Adapter for 200-1000MHz	HP 85650A	2521A00968
Amplifier (100KHz-1.3GHz)		
- for 30-200MHz	HP 8447D	2805A02919
- for 200-1000MHz	HP 8447D	2944A03506
Biconical Antenna (30-200MHz)	EMCO 3108	2400
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	2150
Receiver (20MHz-1.3GHz)	R&S ESVP	892111/030
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

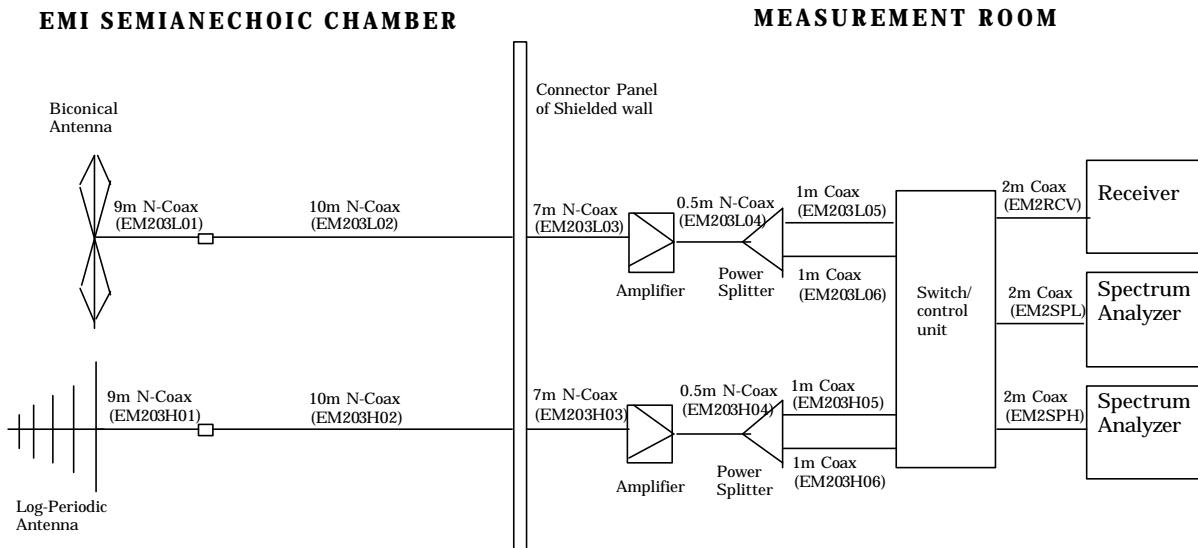


Figure 6 Cables for Radiated Emission Test

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:

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

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

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

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 9.4 dB at 30MHz - 1000MHz band.

The 6 highest emissions relative to the limits are reported.

Test Date: December 4, 2002

1) EUT in transmission mode

Table 6-2-1. EUT: M/T 2681-3NU, s/n FX-0N14F, 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)
165.896	H	38.7	12.4	-24.1	27.0	43.5	22.4	150
232.401	H	36.0	10.7	-16.2	30.5	46.0	33.5	200
432.079	V	32.5	15.8	-15.3	33.0	46.0	44.7	200
498.636	V	33.3	17.6	-15.4	35.5	46.0	59.6	200
563.915	V	29.2	18.2	-15.3	32.1	46.0	40.3	200
728.752	H	24.2	20.7	-14.4	30.5	46.0	33.5	200

Table 6-2-2. EUT: M/T 2681-3NU, s/n FX-0N14F, 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)
232.735	H	35.6	10.7	-16.2	30.1	46.0	32.0	200
364.145	H	31.5	14.4	-15.3	30.6	46.0	33.9	200
432.078	V	32.6	15.8	-15.3	33.1	46.0	45.2	200
498.114	V	33.9	17.6	-15.4	36.1	46.0	63.8	200
563.337	V	29.7	18.2	-15.3	32.6	46.0	42.7	200
728.840	H	23.9	20.7	-14.3	30.3	46.0	32.7	200

Table 6-2-3. EUT: M/T 2681-3NU, s/n FX-0N14F, 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)
232.666	H	35.7	10.7	-16.2	30.2	46.0	32.4	200
432.079	V	32.7	15.8	-15.3	33.2	46.0	45.7	200
499.217	V	34.3	17.6	-15.3	36.6	46.0	67.6	200
563.943	V	29.6	18.2	-15.3	32.5	46.0	42.2	200
630.050	H	23.9	19	-14.5	28.4	46.0	26.3	200
729.863	H	23.8	20.7	-14.3	30.2	46.0	32.4	200

2) EUT in receiving mode

Table 6-2-4. EUT: M/T 2681-3NU, s/n FX-0N14F, 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)
232.733	H	36.1	10.7	-16.2	30.6	46.0	33.9	200
432.079	V	32.4	15.8	-15.3	32.9	46.0	44.2	200
498.899	V	34.2	17.6	-15.4	36.4	46.0	66.1	200
528.097	V	28.1	17.8	-15.3	30.6	46.0	33.9	200
564.285	V	29.1	18.2	-15.3	32.0	46.0	39.8	200
730.239	H	24.3	20.7	-14.3	30.7	46.0	34.3	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 or 100Hz. 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 – 8.2GHz)	EMCO 3160-6	9712-1044
Horn Antenna (8.2 – 12.4GHz)	EMCO 3160-6	1156
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

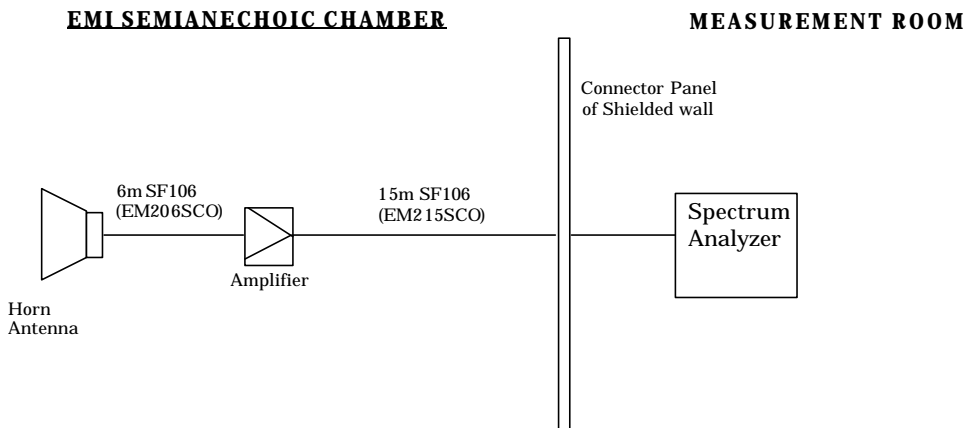


Figure 7 Cables for Radiated Emission Test

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 :

Level(dB μ V/m)	=	$20 \times \text{Log} (\text{Level}(\mu\text{V/m}))$
40 dB μ V/m	=	100 μ V/m
48 dB μ V/m	=	250 μ 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 6.2 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: December 5, 2002

1) EUT in transmission mode

Table 7-2-1. EUT: M/T 2681-3NU, s/n FX-0N14F, 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)
1.008	V	47.3	-	24.1	-32.9	0.0	38.5	74.0	-	54.0
1.065	V	49.6	-	24.6	-32.7	0.0	41.5	74.0	-	54.0
1.104	V	49.0	-	24.4	-32.6	0.0	40.8	74.0	-	54.0
1.196	V	51.1	-	25.2	-32.3	0.0	44.0	74.0	-	54.0
2.390	H	54.7	-	28.2	-30.4	0.0	52.5	74.0	-	54.0
2.413	H	112.5	103.3	28.3	-30.4	0.0	110.4	OB*	101.2	OB*
4.828	H	53.0	-	27.1	-27.2	0.0	52.9	74.0	-	54.0

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

Table 7-2-2. EUT: M/T 2681-3NU, s/n FX-0N14F, 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)
1.008	V	48.1	-	24.1	-32.9	0.0	39.3	74.0	-	54.0
1.065	V	48.1	-	24.6	-32.7	0.0	40.0	74.0	-	54.0
1.104	V	49.0	-	24.4	-32.6	0.0	40.8	74.0	-	54.0
1.196	V	51.5	-	25.2	-32.3	0.0	44.4	74.0	-	54.0
2.390	H	49.7	-	28.2	-30.4	0.0	47.5	74.0	-	54.0
2.438	H	111.8	103.5	28.4	-30.3	0.0	109.9	OB*	101.6	OB*
2.484	V	49.0	-	28.4	-30.2	0.0	47.2	74.0	-	54.0
4.876	H	59.3	47.7	27	-26.9	0.0	59.4	74.0	47.8	54.0
7.314	V	38.4	-	29.8	-25.7	0.0	42.5	74.0	-	54.0

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

Table 7-2-3. EUT: M/T 2681-3NU, s/n FX-0N14F, Ch.11(2462MHz) TX mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) (<i>peak</i>)	Measured (dBμV) (<i>average</i>)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) (<i>peak</i>)	FCC Limit (dBμV/m) (<i>peak</i>)	Field Strength (dBμV/m) (<i>average</i>)	FCC Limit (dBμV/m) (<i>average</i>)
1.008	V	47.8	-	24.1	-32.9	0.0	39.0	74.0	-	54.0
1.065	V	50.9	-	24.6	-32.7	0.0	42.8	74.0	-	54.0
1.104	V	48.8	-	24.4	-32.6	0.0	40.6	74.0	-	54.0
1.196	V	51.0	-	25.2	-32.3	0.0	43.9	74.0	-	54.0
2.386	H	49.0	-	28.2	-30.4	0.0	46.8	74.0	-	54.0
2.464	H	113.3	105.3	28.4	-30.2	0.0	111.5	OB*	103.5	OB*
2.484	V	59.0	48.5	28.4	-30.2	0.0	57.2	74.0	46.7	54.0
4.926	H	54.7	42.2	27	-27.7	0.0	54.0	74.0	41.5	54.0
7.389	V	38.5	-	29.8	-26.2	0.0	42.1	74.0	-	54.0

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

2) EUT in receiving mode

Table 7-2-4. EUT: M/T 2681-3NU, s/n FX-0N14F, Ch.6(2437MHz) RX mode

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) (<i>peak</i>)	Measured (dBμV) (<i>average</i>)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) (<i>peak</i>)	FCC Limit (dBμV/m) (<i>peak</i>)	Field Strength (dBμV/m) (<i>average</i>)	FCC Limit (dBμV/m) (<i>average</i>)
1.008	V	48.5	-	24.1	-32.9	0.0	39.7	74.0	-	54.0
1.065	V	50.2	-	24.6	-32.7	0.0	42.1	74.0	-	54.0
1.104	V	48.6	-	24.4	-32.6	0.0	40.4	74.0	-	54.0
1.196	V	51.4	-	25.2	-32.3	0.0	44.3	74.0	-	54.0
2.064	V	48.1	-	27.4	-30.8	0.0	44.7	74.0	-	54.0