

Emission Test Report

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

Document Number : FCC 19-0163-0

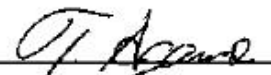
Product: IBM ThinkPad T23
Included IBM ThinkPad 802.11b Wireless Lan Mini-PCI Adapter (P/N 26P8056)

FCC ID: ANOTR4WGA1BAN

April 17, 2001

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A. GENERAL INFORMATION

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

MODEL NUMBER : 2647-4LU (ThinkPad T23)

FCC ID : ANOTR4WGA1BAN

SERIAL NUMBER : ZZ-00064

PHYSICAL CONDITION : Preproduction

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

TESTED DATE : April 5, 6, 9 and 10, 2001

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 T23 M/T 2647-4LU (s/n ZZ-00064)	ANOTR4WGA1BAN	IBM Notebook PC CPU: Intel Mobile Geyserville 1GHz	
P/N 02K6657	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: 250uV	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 RSS-210.	Radiated (30MHz - 1GHz)	Pass
			Radiated (1– 25GHz)	Pass

	Receive mode (RX):			
15.207 7.4	AC Wireline Conducted Emissions 450kHz – 30MHz	Class B: 250uV	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	2732A03651	01/16/01	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	2648A15255	01/16/01	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	2521A00968	01/16/01	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	04/14/00	1 year
- for 200-1000MHz	HP 8447D	2944A03506	04/14/00	1 year
Amplifier (1GHz - 26.5GHz)	HP 8449B	3008A00580	06/02/00	1 year
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003	07/12/00	1 year
Receiver (9kHz-30MHz)	R&S ESH3	891806/012	09/11/00	1 year
Receiver (9kHz-30MHz)	R&S ESH3	892108/003	10/04/00	1 year
Receiver (20MHz-1.3GHz)	R&S ESVP	892111/030	05/19/00	1 year
Biconical Antenna (30-200MHz)	EMCO 3108	2400	06/09/00	1 year
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	2150	06/06/00	1 year
Horn Antenna (1- 18GHz)	EMCO 3115	6121	04/17/00	1 year
Horn Antenna (3.95- 5.85GHz)	EMCO 3160-5	1102	01/23/01	1 year
Horn Antenna (5.85- 8.20GHz)	EMCO 3160-6	1067	01/09/01	1 year
Horn Antenna (18- 26.5GHz)	EMCO 3160-9	1202	04/17/00	1 year
LISN	EMCO 3825/2	1426	09/01/00	1 year
Signal Generator	HP E4432B	GB38450342	09/07/00	1 year
Power Meter	HP 436A	2604A24191	12/12/00	1 year
Power Sensor	HP 8482A	2607A11105	12/13/00	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: - Horn Ant <=> RF Amp.	Length: 6 m	- EM206SCO	08/10/00	1 year

- RF Amp.<=>Spectrum Analyzer	15m	- EM215SCO	08/10/00	1 year
N-Coax cables:				
- Bi-coni Ant <=> 10m Cable	9 m	- EM203L01	04/14/00	1 year
- 10m Cable <=> Shield Panel	10 m	- EM203L02	04/14/00	1 year
- Shield Panel <=> RF Amp	7 m	- EM203L03	04/14/00	1 year
- RF Amp <=> Power Splitter	0.5m	- EM203L04	04/14/00	1 year
- Log-peri Ant <=> 10m Cable	9 m	- EM203H01	04/14/00	1 year
- 10m Cable <=> Shield Panel	10 m	- EM203H02	04/14/00	1 year
- Shield Panel <=> RF Amp	7 m	- EM203H03	04/14/00	1 year
- RF Amp <=> Power Splitter	0.5m	- EM203H04	04/14/00	1 year
Coax cables:				
- Lism-L <=> SW/Con.unit (SW100)	4 m	- EMIC-L	04/14/00	1 year
- Lism-N <=> SW/Con.unit (SW101)	4 m	- EMIC-N	04/14/00	1 year
- SW/Con.unit <=> RCVR (Input)	1 m	- EMIC-R	04/14/00	1 year
- SW/Con.unit<=> Spe Ana.(Signal In)	1 m	- EMIC-S	04/14/00	1 year
- Power Splitter <=> SW/Con.unit (SW110)	1 m	- EM203L05	04/14/00	1 year
- Power Splitter <=> SW/Con.unit (SW300)	1 m	- EM203L06	04/14/00	1 year
- Power Splitter <=> SW/Con.unit (SW100)	1 m	- EM203H05	04/14/00	1 year
- Power Splitter <=> SW/Con.unit (SW301)	1 m	- EM203H06	04/14/00	1 year
- SW/Con.unit <=> Receiver (Input)	2 m	- EM2RCV	04/14/00	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz	2 m	- EM2SPL	04/14/00	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	2 m	- EM2SPH	04/14/00	1 year

Notes.

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

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: 1.9 dB	

Notes: - R&S: Rohde & Schwarz

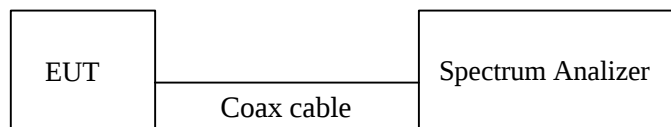


Figure 1: Measurement setup for 6dB bandwidth test

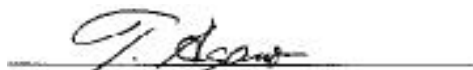
1.3 Measurement Results

Table 1-2. EUT: M/T 2647-4LU, s/n ZZ-00064 , TX mode 11Mbps

Center Frequency (MHz)	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)
2412 (ch. 1)	2407.40	2417.56	10.16
2437 (ch. 6)	2432.40	2442.56	10.16
2462 (ch. 11)	2457.40	2467.56	10.16

Test Personnel:

Tester Signature :

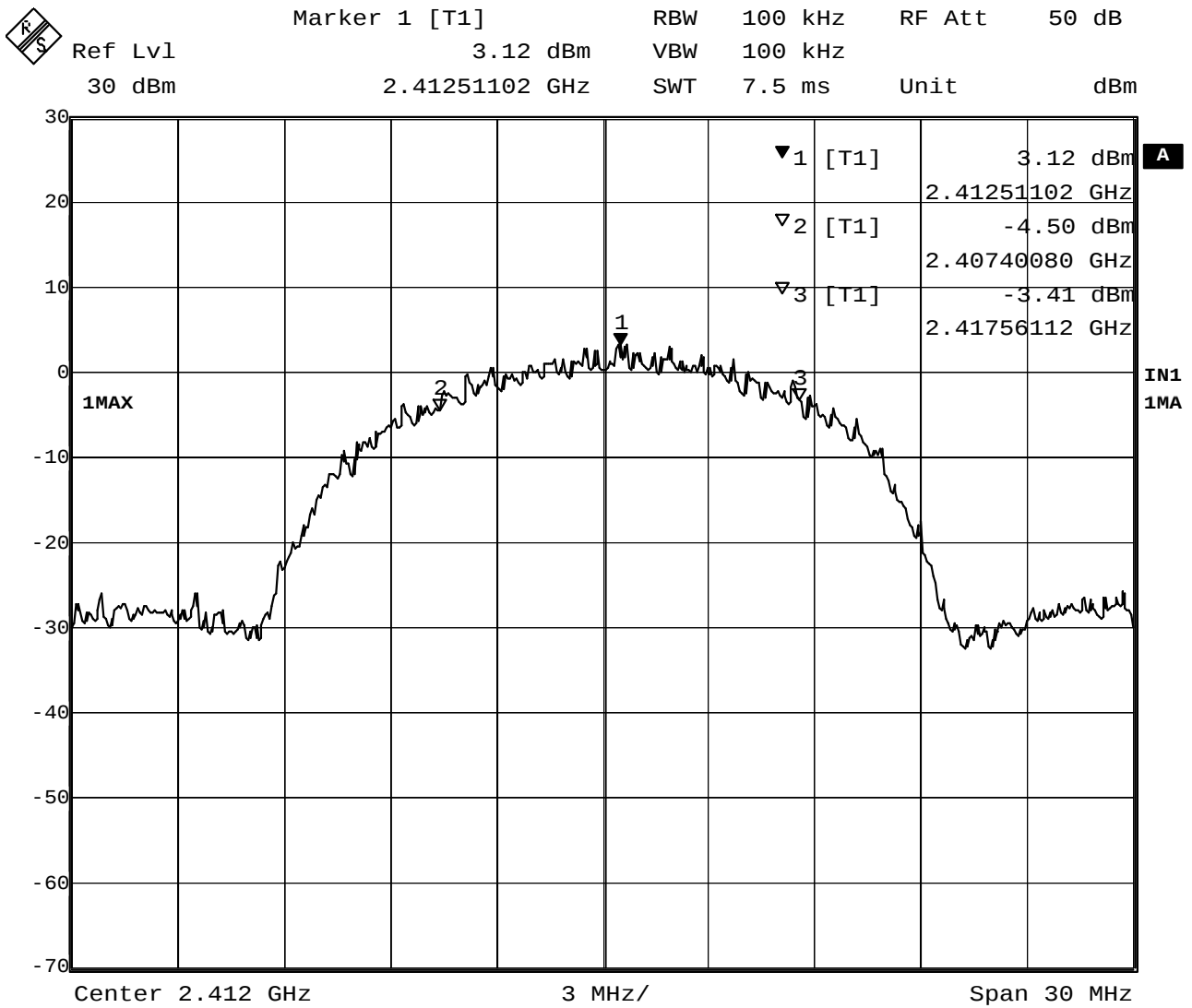


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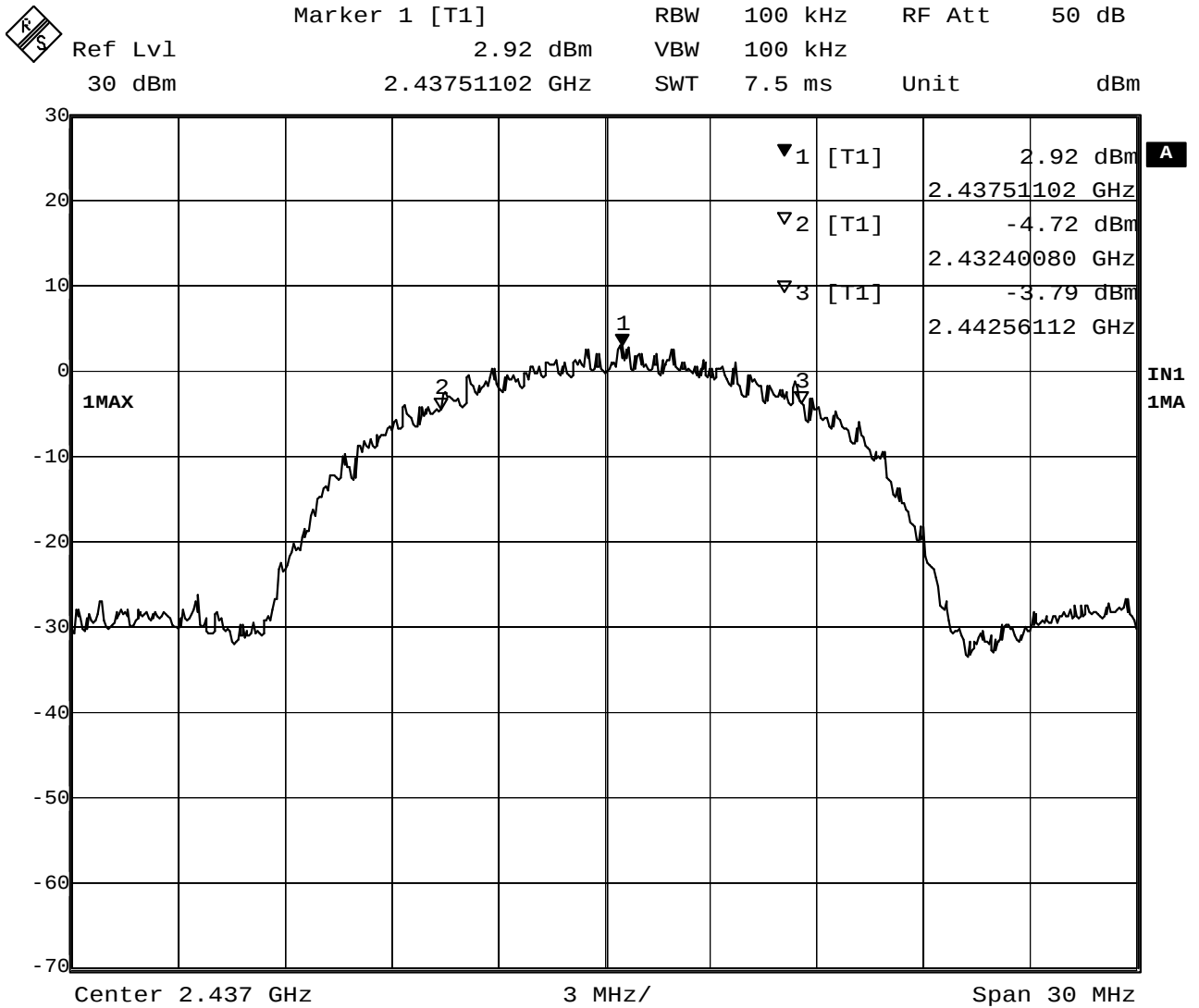
Tester Name : Takeshi Asano

Prepared by T. Asano

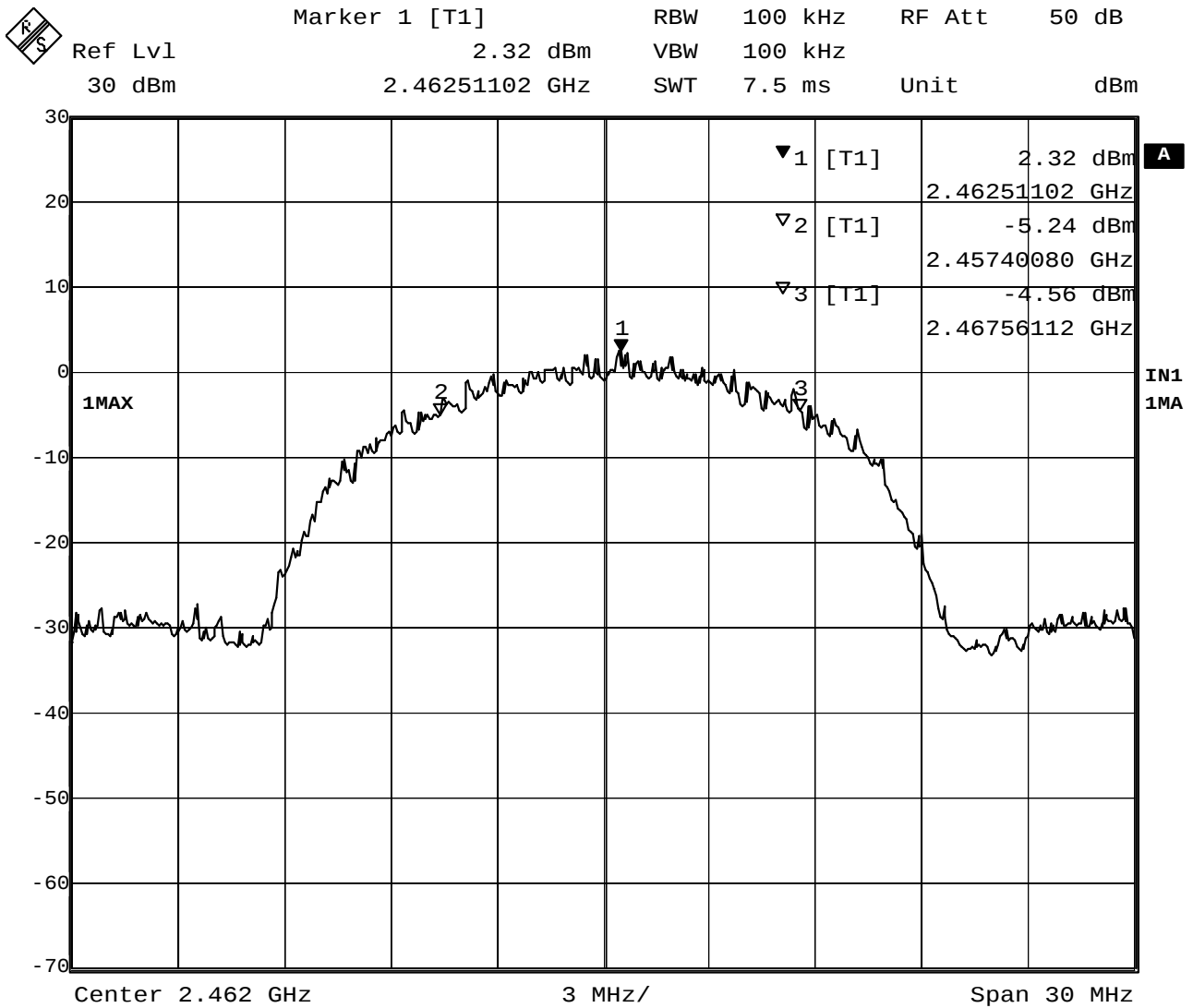
1.4 Trace Data



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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

Table 2-1. EUT: M/T 2647-4LU, s/n ZZ-00064 , 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	2420.69	17.02	3.67	
2437 (ch. 6)	2428.73	2445.69	16.96		
2462 (ch. 11)	2453.67	2470.69	17.02		12.81

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.

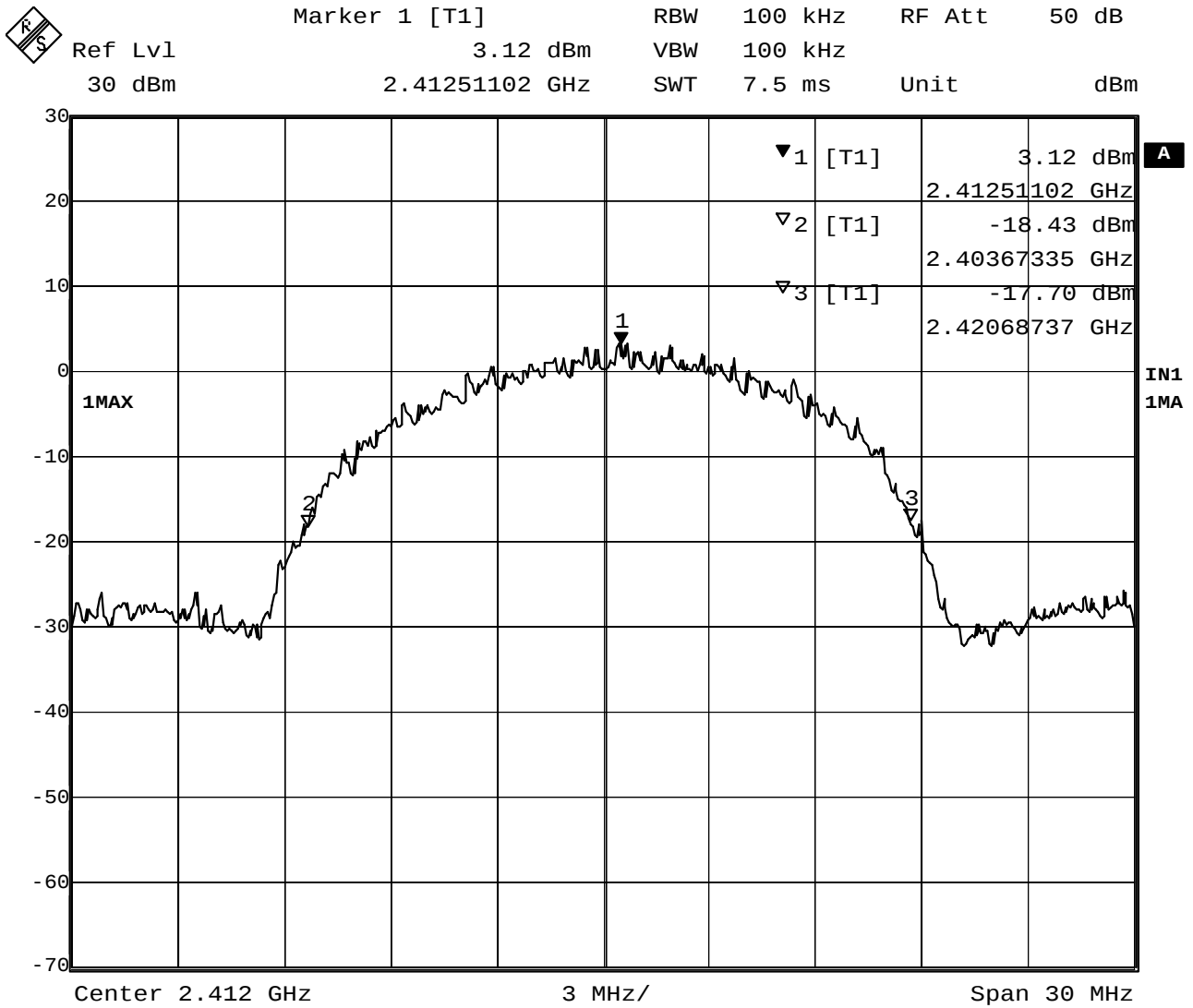
Test Personnel:

Tester Signature : T. Asano Date April 17, 2001

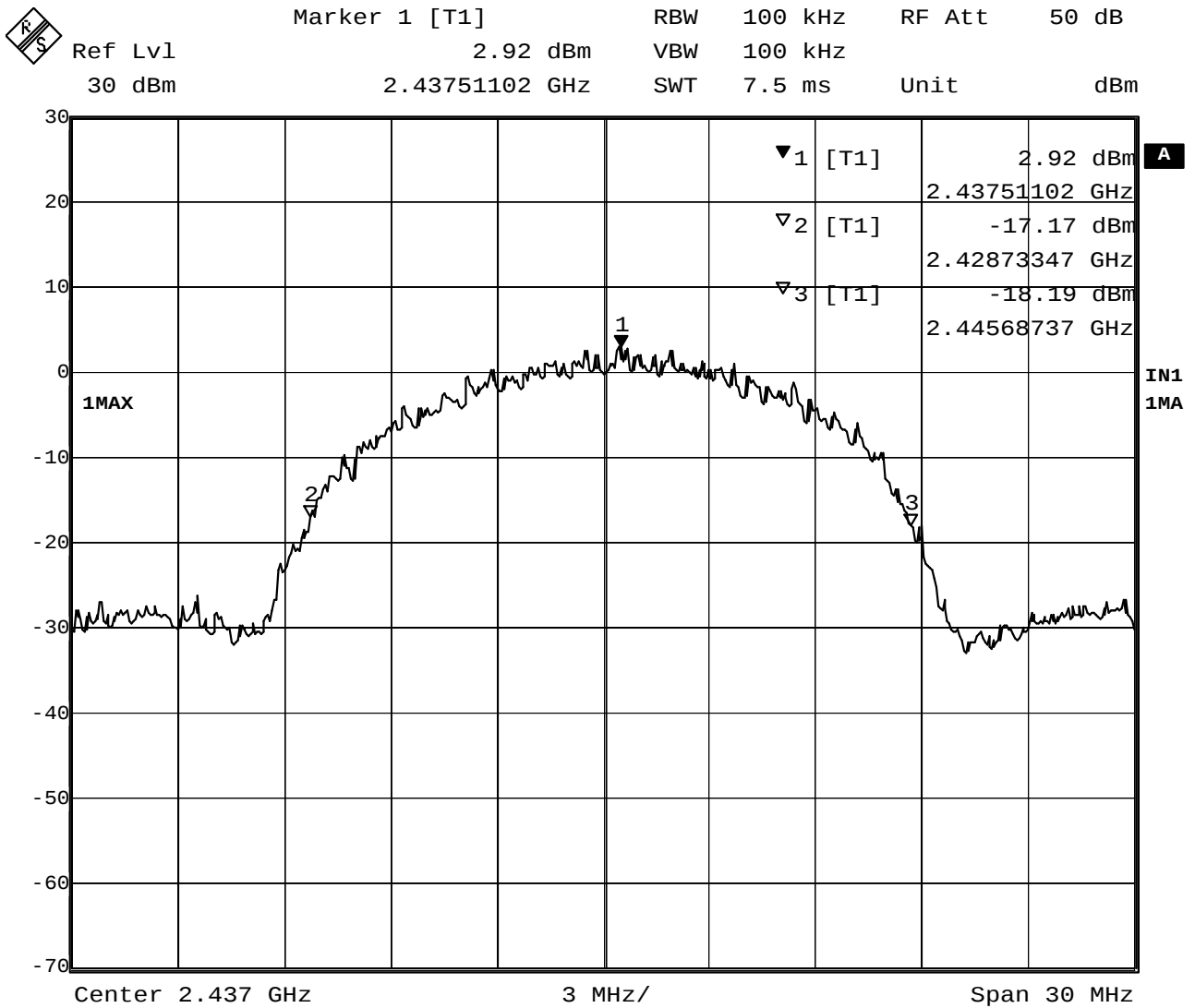
Tester Name : Takeshi Asano

Prepared by T. Asano

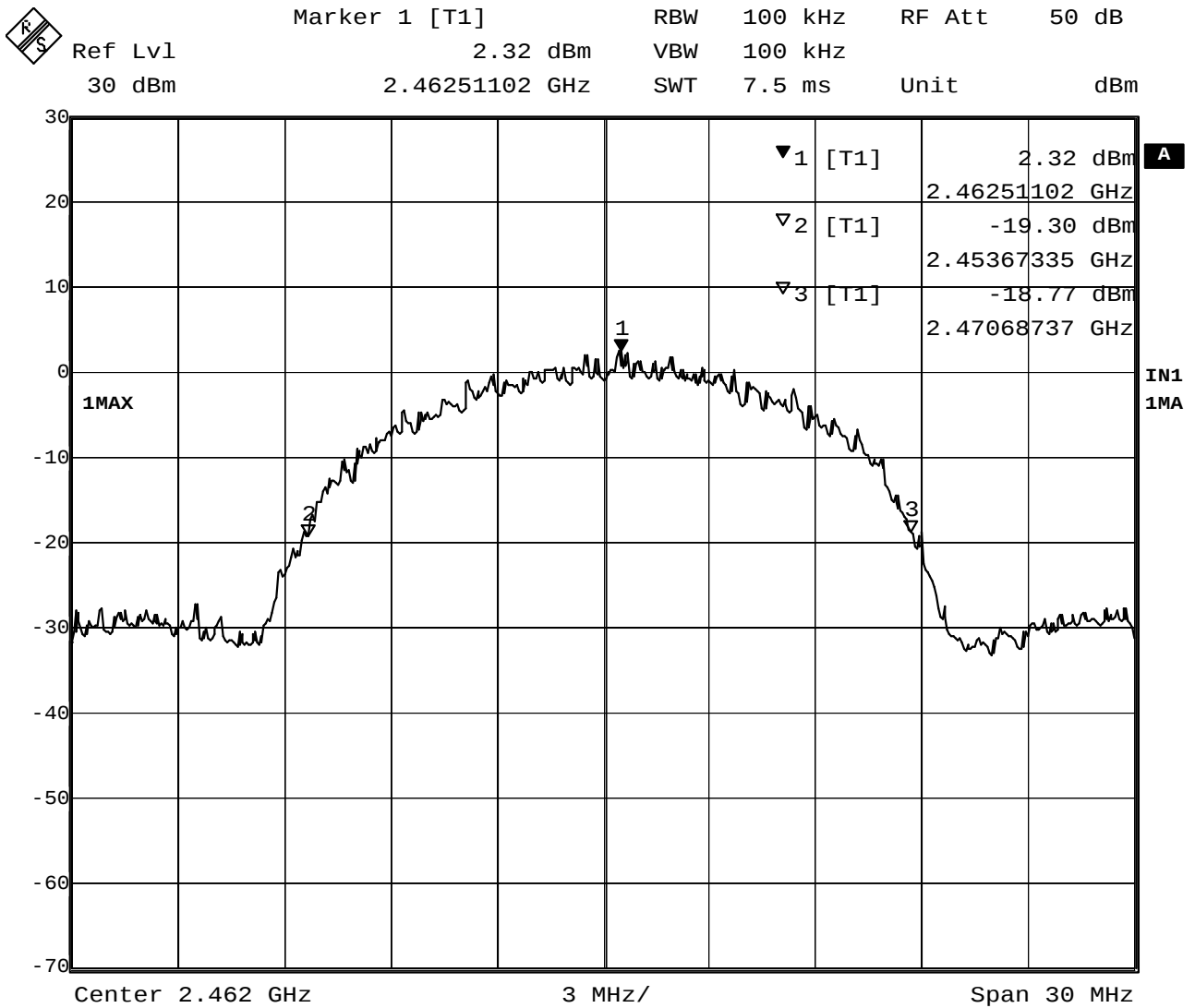
2.5 Trace Data of Band-edge



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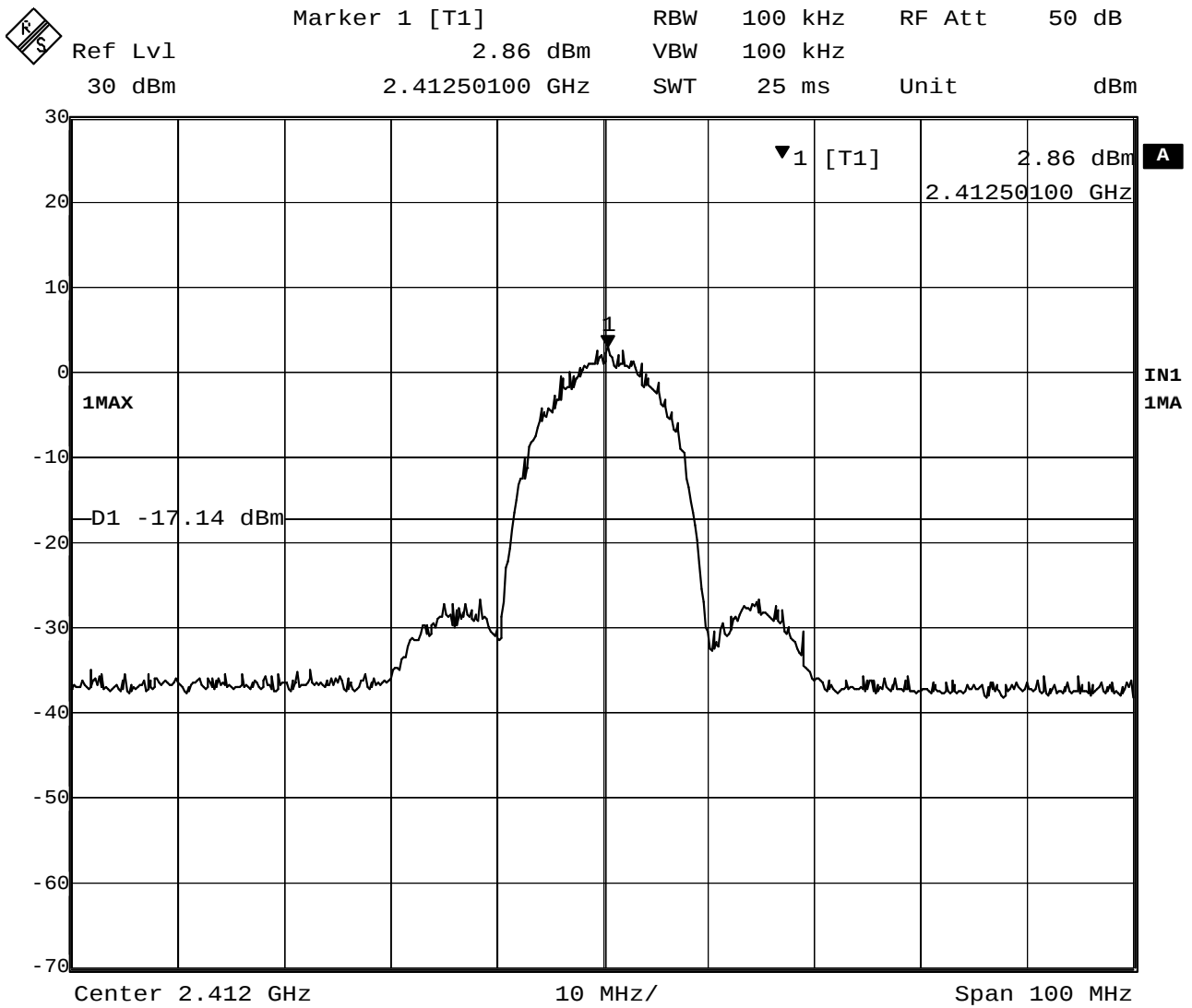


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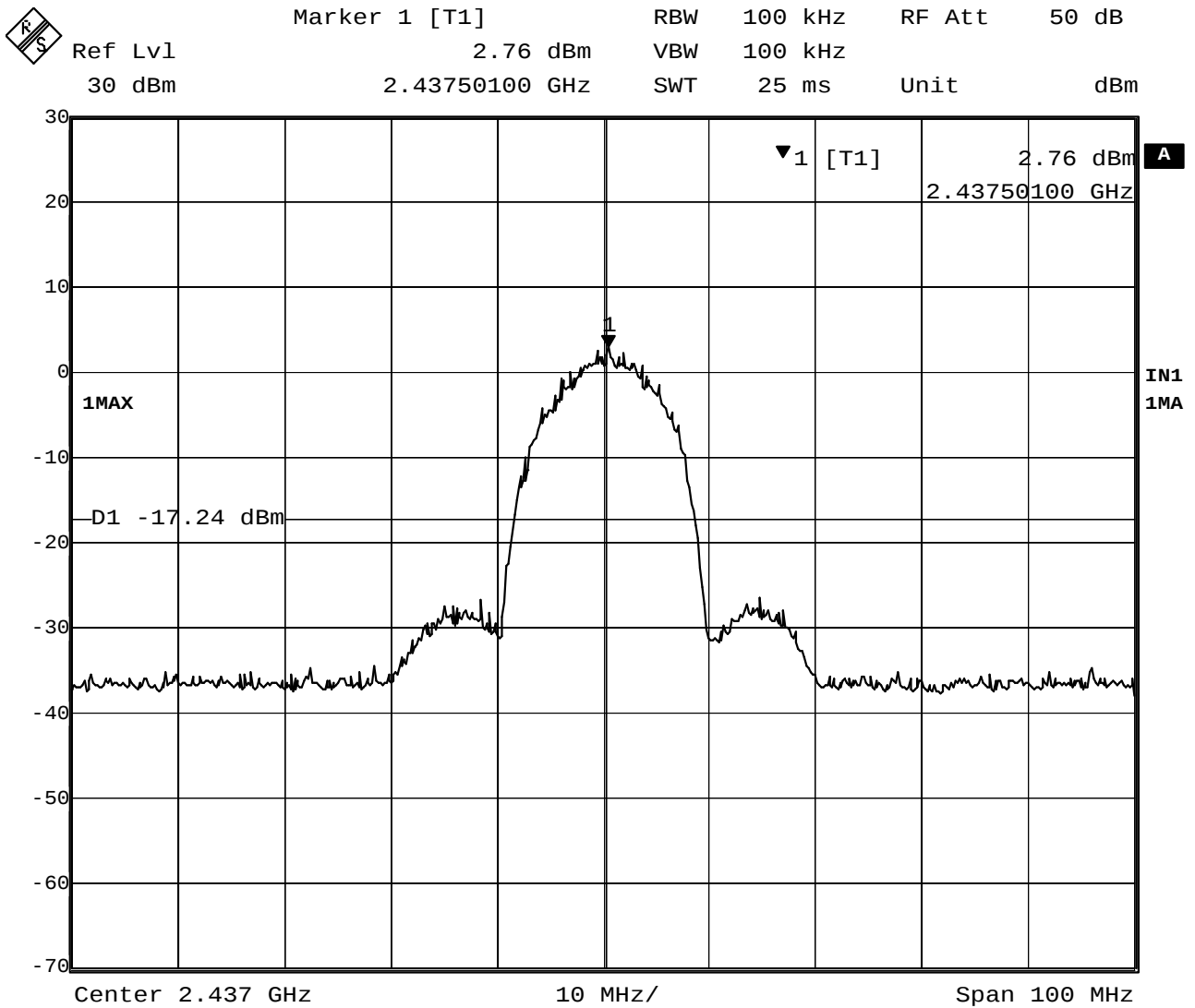


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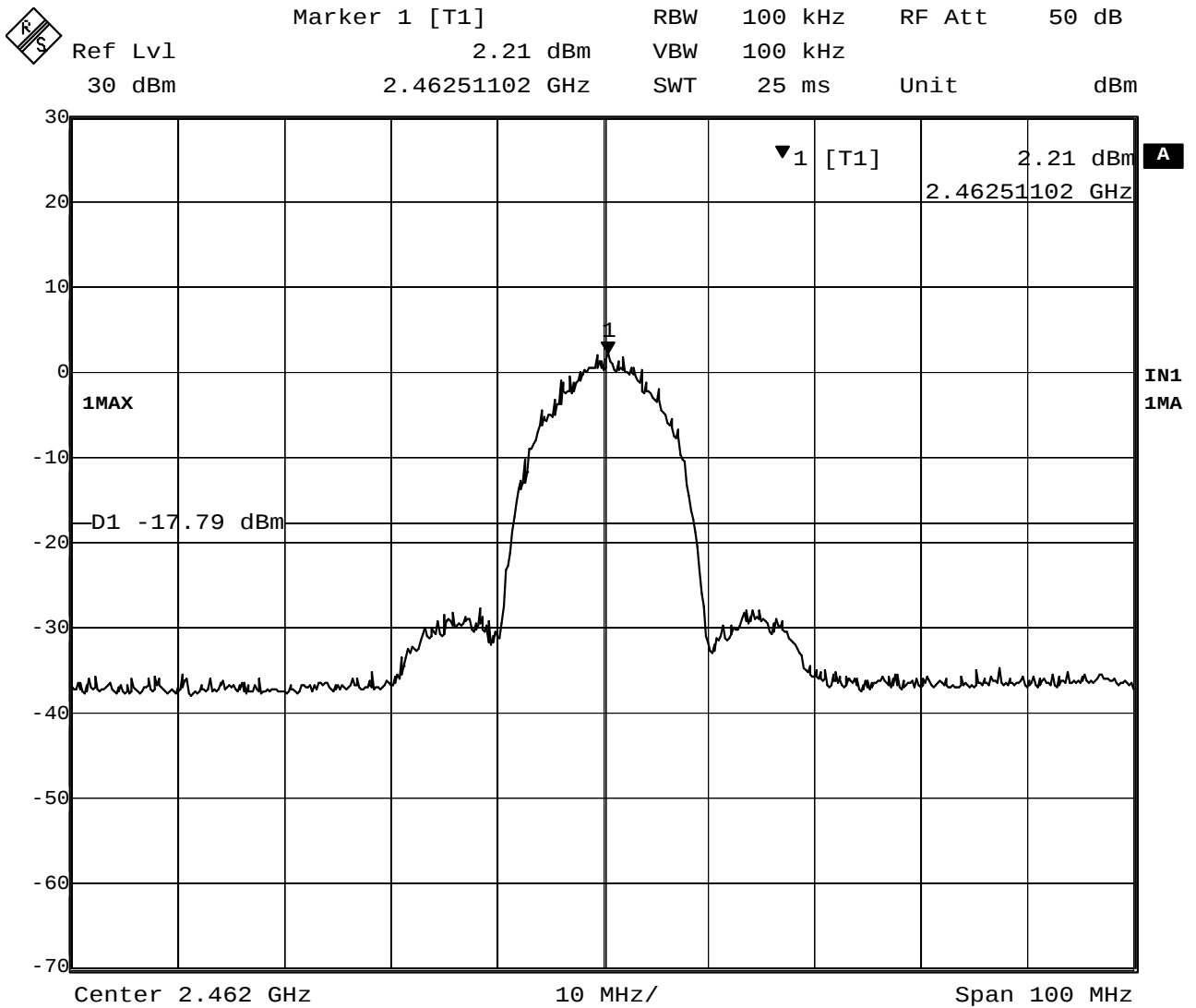
2.6 Trace Data of Out of Band Emissions



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Date: 10.APR.2001 21:03:02



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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	2604A24191
Power Sensor	HP 8482A	2607A11105
Coax cables: - Power Sensor <=> EUT	Length: 30 cm Loss: 1.3 dB	

Notes: - HP: Hewlett Packard

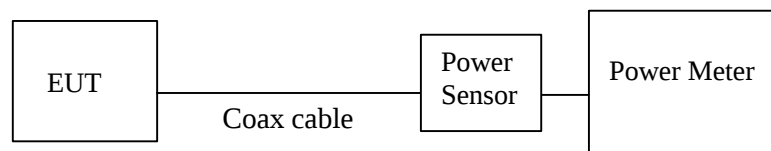


Figure 3: Measurement setup for RF output power

3.2 Measurement Results

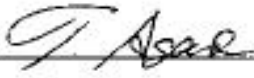
Table 3-2. EUT: M/T 2647-4LU, s/n ZZ-00064, TX mode 11Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	14.2	1.3	15.5	0.0355	30.0	14.5
2437 (ch. 6)	14.1	1.3	15.4	0.0347	30.0	14.6
2462 (ch. 11)	13.6	1.3	14.9	0.0309	30.0	15.1

Table 3-3. EUT: M/T 2647-4LU, s/n ZZ-00064, TX mode 2Mbps

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results		Limit [1W] (dBm)	Margin (dB)
			(dBm)	(W)		
2412 (ch. 1)	14.2	1.3	15.5	0.0355	30.0	14.5
2437 (ch. 6)	14.0	1.3	15.3	0.0339	30.0	14.7
2462 (ch. 11)	13.6	1.3	14.9	0.0309	30.0	15.1

Test Personnel:

Tester Signature :  Date April 17, 2001

Tester Name : Takeshi Asano

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).

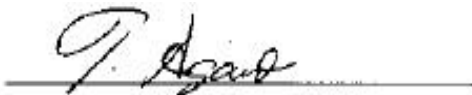
4.3 Measurement Results

Table 4-1. EUT: M/T 2647-4LU, s/n ZZ-00064 , TX mode 11Mbps

Ch No.	Frequency (MHz)	Spectrum Analyzer Reading (dBm)	Cable loss (dB)	Result (dBm)	Limit (dBm)	Margin (dB)
1	2413.41	-9.8	1.9	-7.9	8.0	16.1
6	2438.41	-9.8	1.9	-7.9	8.0	16.1
11	2463.41	-10.6	1.9	-8.7	8.0	16.7

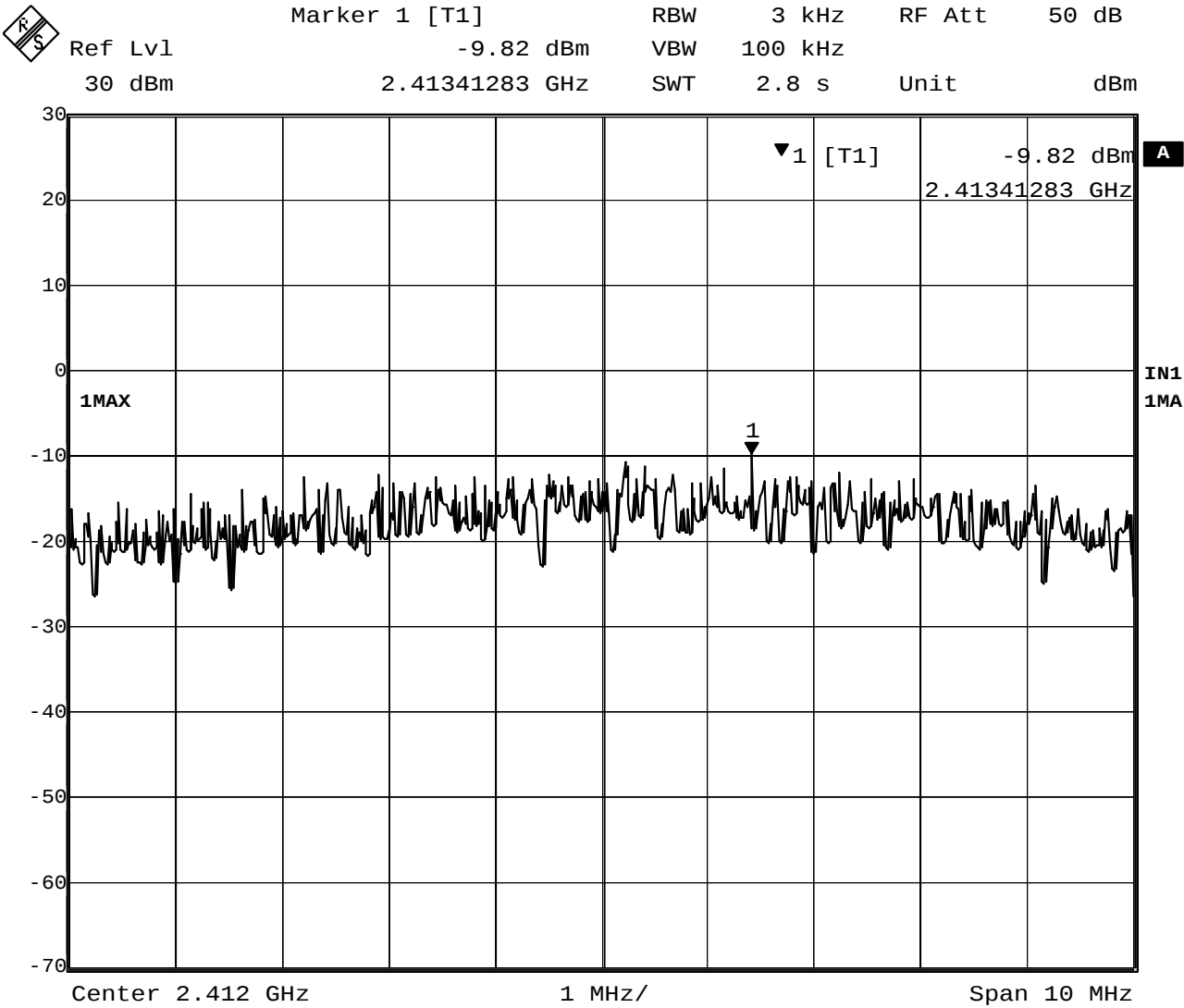
Test Personnel:

Tester Signature :

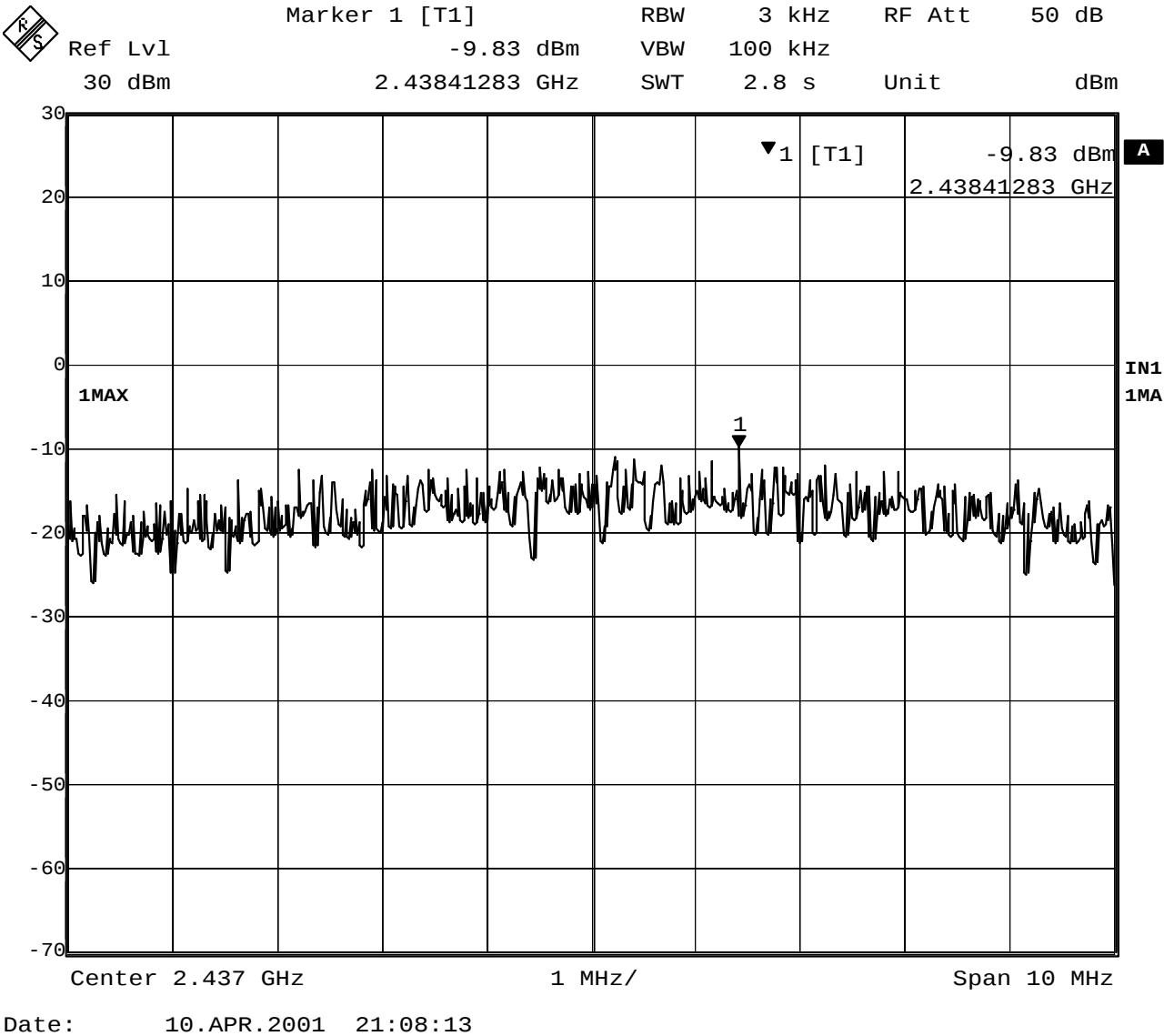
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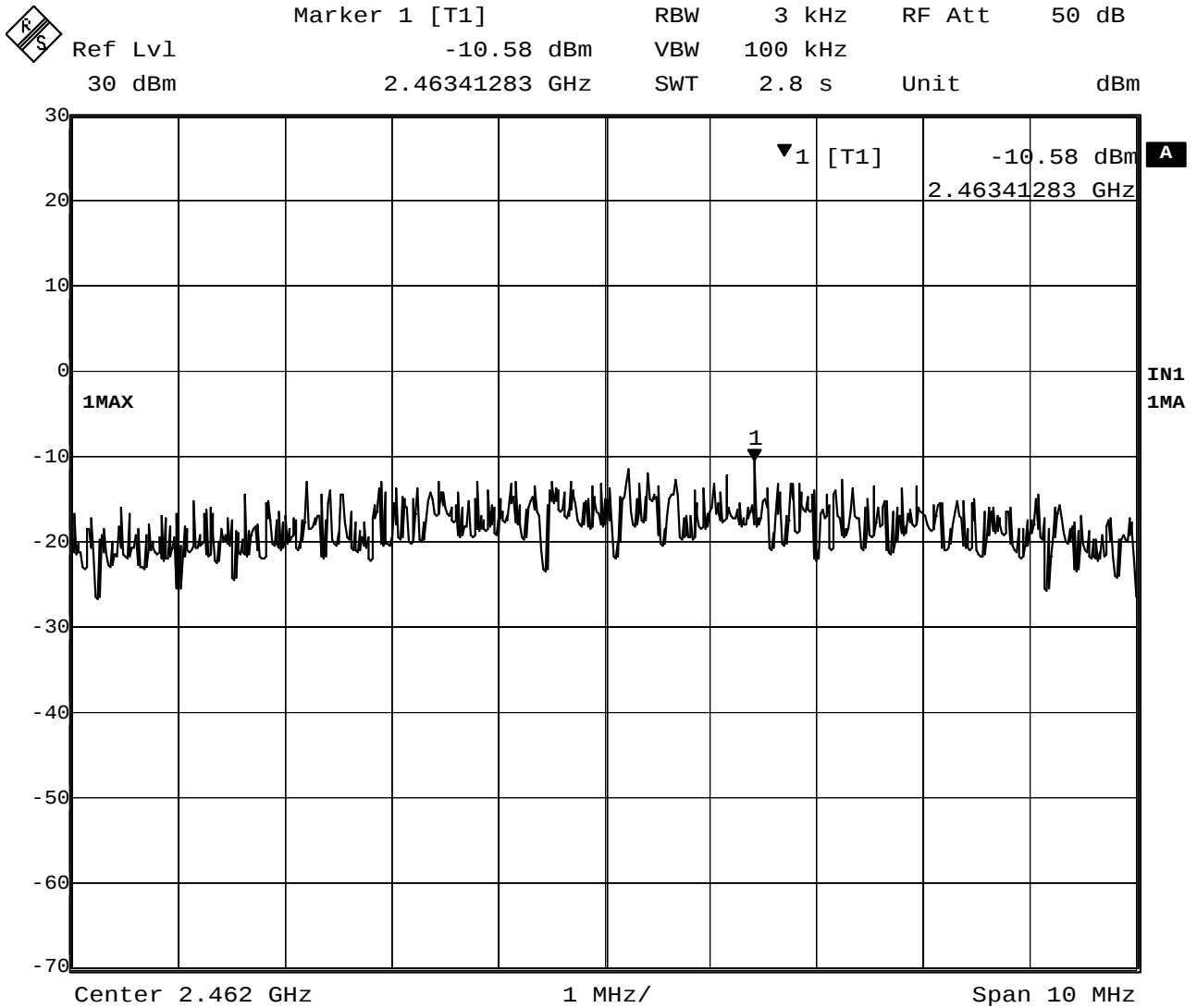
Tester Name : Takeshi Asano

4.4 Trace Data



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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 8568B	2732A03651
Spectrum Analyzer Display	HP 8568B	2648A15255
Quasi-Peak Adapter	HP 85650A	2521A00968
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: - 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

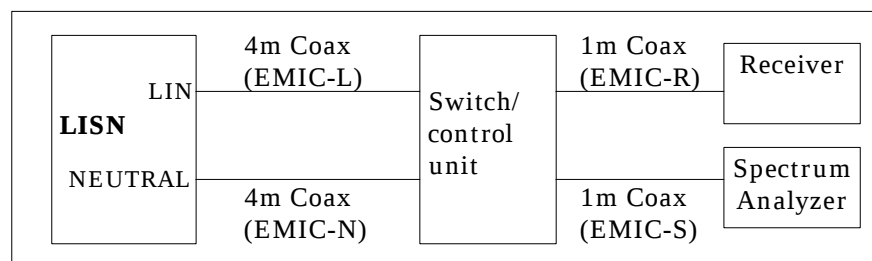


Figure 5. Cables for Conducted Emission Test

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

1) EUT in transmission mode

Table 5-2-1. EUT: M/T 2647-4LU, s/n ZZ-00064, 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
0.4805	27.2	48.0	22.9	250	Line
0.5843	24.5	48.0	16.8	250	Line
0.7423	24.7	48.0	17.2	250	Line
6.6255	21.4	48.0	11.7	250	Line
8.4604	20.1	48.0	10.1	250	Line
9.5999	21.4	48.0	11.7	250	Line

Table 5-2-2. EUT: M/T 2647-4LU, s/n ZZ-00064 , 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
0.4883	28.9	48.0	27.9	250	Line
0.6037	25.8	48.0	19.5	250	Line
0.7430	25.4	48.0	18.6	250	Line
5.3045	17.6	48.0	7.6	250	Line
6.8868	21.2	48.0	11.5	250	Line
8.7429	22.5	48.0	13.3	250	Line

Table 5-2-3. EUT: M/T 2647-4LU, s/n ZZ-00064, 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
0.4833	28.4	48.0	26.3	250	Line
0.5612	26.1	48.0	20.2	250	Line
0.6058	25.4	48.0	18.6	250	Line
0.7407	23.5	48.0	15.0	250	Line
5.5559	19.3	48.0	9.5	250	Line
6.2530	23.2	48.0	14.5	250	Line

2) EUT in receiving mode

Table 5-2-4. EUT: M/T 2647-4LU, s/n ZZ-00064, RX mode

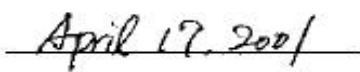
Frequency (MHz)	QP Voltage (dB μ V)	QP Limit (dB μ V)	QP Voltage (μ V)	QP Limit (μ V)	Phase
0.4838	28.6	48.0	26.9	250	Line
0.5631	25.9	48.0	19.7	250	Line
0.8611	25.5	48.0	18.8	250	Line
5.9238	22.4	48.0	13.2	250	Line
8.7233	19.0	48.0	8.9	250	Line
9.3602	19.2	48.0	9.1	250	Line

Test Personnel:

Tester Signature :



Date



Tester Name : Takeshi Asano

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	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

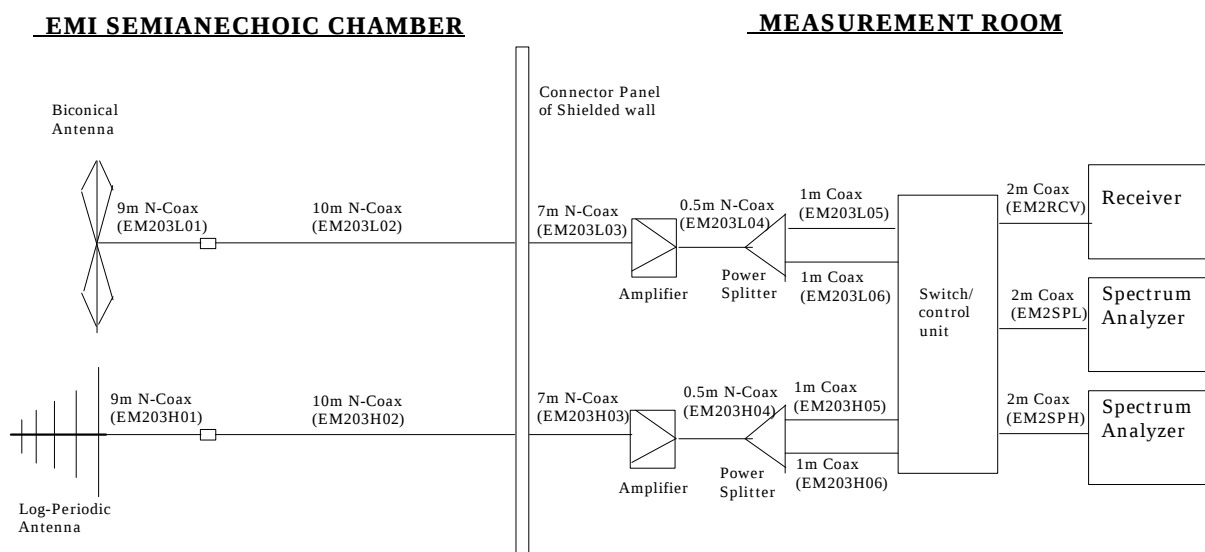


Figure 6 Cables for Radiated Emission Test

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:

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

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

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

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 3.9 dB at 30MHz - 1000MHz band.

The 6 highest emissions relative to the limits are reported.

1) EUT in transmission mode

Table 6-2-1. EUT: M/T 2647-4LU, s/n ZZ-00064, 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)
133.153	H	43.0	11.9	-21.0	33.9	43.5	49.5	150
399.491	V	36.5	15.2	-16.6	35.1	46.0	56.9	200
461.994	V	37.6	16.8	-16.8	37.6	46.0	75.9	200
599.143	V	33.6	18.8	-16.1	36.3	46.0	65.3	200
665.826	V	32.7	20.6	-15.9	37.4	46.0	74.1	200
859.078	V	28.9	22.3	-14.6	36.6	46.0	67.6	200

Table 6-2-2. EUT: M/T 2647-4LU, s/n ZZ-00064, 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)
133.154	H	43.2	11.9	-21.0	34.1	43.5	50.7	150
461.994	V	37.5	16.8	-16.8	37.5	46.0	75.0	200
505.994	V	35.2	17.9	-16.3	36.8	46.0	69.2	200
599.236	V	34.3	18.8	-16.0	37.1	46.0	71.6	200
665.735	H	33.4	20.6	-15.9	38.1	46.0	80.4	200
859.078	V	28.9	22.3	-14.6	36.6	46.0	67.6	200

Table 6-2-3. EUT: M/T 2647-4LU, s/n ZZ-00064, 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)
133.154	H	43.4	11.9	-21.0	34.3	43.5	51.9	150
461.994	V	37.6	16.8	-16.8	37.6	46.0	75.9	200
505.994	V	35.7	17.9	-16.3	37.3	46.0	73.3	200
599.235	V	33.8	18.8	-16.0	36.6	46.0	67.6	200
665.734	H	33.1	20.6	-15.9	37.8	46.0	77.6	200
859.078	V	29.3	22.3	-14.6	37.0	46.0	70.8	200

2) EUT in receiving mode

Table 6-2-4. EUT: M/T 2647-4LU, s/n ZZ-00064, 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)
472.994	V	36.6	17.0	-16.9	36.7	46.0	68.4	200
527.993	V	40.8	17.7	-16.4	42.1	46.0	127.4	200
599.143	V	34.5	18.8	-16.1	37.2	46.0	72.4	200
665.735	H	32.8	20.6	-15.9	37.5	46.0	75.0	200
799.490	V	30.9	21.3	-14.8	37.4	46.0	74.1	200
859.078	V	29.0	22.3	-14.6	36.7	46.0	68.4	200

Test Personnel:

Tester Signature :  Date April 17, 2001

Tester Name : Takeshi Asano

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	3008A00580
Horn Antenna (1- 18GHz)	EMCO 3115	6121
Horn Antenna (3.95 – 5.85GHz)	EMCO 3160-5	1099
Horn Antenna (5.85 – 8.20GHz)	EMCO 3160-6	1044
Horn Antenna (18- 26.5GHz)	EMCO 3160-9	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

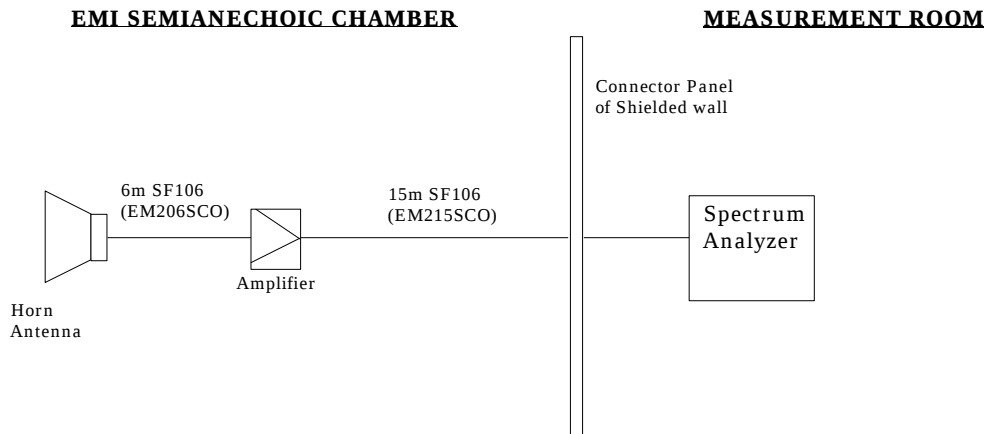


Figure 7 Cables for Radiated Emission Test

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 :

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

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

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

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 2.8 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.

1) EUT in transmission mode

Table 7-2-1. EUT: M/T 2647-4LU, s/n ZZ-00064, 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>)
1.066	V	57.1	-	25.1	-32.5	0.0	49.7	74.0	-	54.0
1.144	V	62.4	55.5	25.1	-32.2	0.0	55.3	74.0	48.4	54.0
1.198	V	64.0	49.8	25.1	-32.1	0.0	57.0	74.0	42.8	54.0
1.289	V	56.1	-	25.1	-32.0	0.0	49.2	74.0	-	54.0
1.731	V	50.7	-	26.3	-31.2	0.0	45.8	74.0	-	54.0
2.039	V	57.5	55.3	27.6	-30.7	0.0	54.4	NRB*	52.2	NRB*
2.387	V	58.3	49.2	28.6	-30.3	0.0	56.6	74.0	47.5	54.0
2.400	H	77.5	69.6	28.6	-30.2	0.0	75.9	NRB*	68.0	NRB*
2.413	H	108.1	100.6	28.7	-30.2	0.0	106.6	OB*	99.1	OB*
4.075	V	50.0	40.2	32.5	-28.6	0.0	53.9	74.0	44.1	54.0
4.824	H	52.5	40.1	33.1	-27.9	0.0	57.7	74.0	45.3	54.0
7.235	H	51.9	40.4	36.6	-26.2	0.0	62.3	NRB*	50.8	NRB*

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

NRB means “non restricted band”: in this case limit is 20dB below maximum in-band-power equivalent to 106.6 dB μ V/m (peak) and 99.1 dB μ V/m (average).

Table 7-2-2. EUT: M/T 2647-4LU, s/n ZZ-00064, 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)
1.064	V	57.0	-	25.1	-32.5	0.0	49.6	74.0	-	54.0
1.146	V	62.0	54.3	25.1	-32.2	0.0	54.9	74.0	47.2	54.0
1.196	V	64.4	47.4	25.1	-32.1	0.0	57.4	74.0	40.4	54.0
1.289	V	56.9	-	25.1	-32.0	0.0	50.0	74.0	-	54.0
2.063	H	58.9	56.9	27.7	-30.7	0.0	55.9	NRB*	53.9	NRB*
2.400	H	49.2	38.5	28.6	-30.2	0.0	47.6	NRB*	36.9	NRB*
2.437	H	108.4	101.0	28.7	-30.2	0.0	106.9	OB*	99.5	OB*
2.484	H	48.3	-	28.8	-30.1	0.0	47.0	74.0	-	54.0
4.125	V	49.3	-	32.4	-28.5	0.0	53.2	74.0	-	54.0
4.874	H	52.4	40.3	33.3	-27.9	0.0	57.8	74.0	45.7	54.0
7.313	H	51.6	40.7	36.7	-26.2	0.0	62.1	74.0	51.2	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”: in this case limit is 20dB below maximum in-band-power equivalent to 106.9 dBμV/m (peak) and 99.5 dBμV/m (average).

Table 7-2-3. EUT: M/T 2647-4LU, s/n ZZ-00064, 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)
1.064	V	57.2	-	25.1	-32.5	0.0	49.8	74.0	-	54.0
1.146	V	61.3	54.4	25.1	-32.2	0.0	54.2	74.0	47.3	54.0
1.196	V	64.6	46.9	25.1	-32.1	0.0	57.6	74.0	39.9	54.0
1.289	V	56.5	-	25.1	-32.0	0.0	49.6	74.0	-	54.0
2.088	H	59.7	58.0	27.7	-30.6	0.0	56.8	NRB*	55.1	NRB*
2.462	H	108.4	100.9	28.8	-30.2	0.0	107.0	OB*	99.5	OB*
2.484	H	60.0	48.9	28.8	-30.1	0.0	58.7	74.0	47.6	54.0
4.176	V	48.6	-	32.4	-28.5	0.0	52.5	74.0	-	54.0
4.924	H	52.4	39.9	33.4	-27.9	0.0	57.9	74.0	45.4	54.0
7.387	H	51.8	40.3	36.9	-26.1	0.0	62.6	74.0	51.1	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”: in this case limit is 20dB below maximum in-band-power equivalent to 107.0 dBμV/m (peak) and 99.5 dBμV/m (average).

2) EUT in receiving mode

Table 7-2-4. EUT: M/T 2647-4LU, s/n ZZ-00064, RX mode

Frequency (GHz)	Polarity (H/V)	Measured (dB μ V) (peak)	Measured (dB μ V) (average)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dB μ V/m) (peak)	FCC Limit (dB μ V/m) (peak)	Field Strength (dB μ V/m) (average)	FCC Limit (dB μ V/m) (average)
1.064	V	57.2	-	25.1	-32.5	0.0	49.8	74.0	-	54.0
1.146	V	61.9	54.7	25.1	-32.2	0.0	54.8	74.0	47.6	54.0
1.198	V	63.9	49.2	25.1	-32.1	0.0	56.9	74.0	42.2	54.0
1.289	V	56.1	-	25.1	-32.0	0.0	49.2	74.0	-	54.0

No other
peak was
detected

Test Personnel:

Tester Signature :



Date



Tester Name : Takeshi Asano