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

Document Number : FCC 19-0274-0

Model Number: AR5BMB-44

measured with **IBM ThinkPad X30 Series**
and **IBM ThinkPad X40 Series**

FCC ID: ANO20040600BTL
IC: 349E-AR5BMB44

August 9, 2004

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

Model: AR5BMB-44 (802.11a/b/g Wireless LAN Adapter)
with
IBM ThinkPad X30 Series
(Machine Type: 2672, 2673, 2884, 2885, 2890, 2891)
and
IBM ThinkPad X40 Series
(Machine Type: 2369, 2370, 2371, 2372, 2382, 2386)

FCC ID : ANO20040600BTL

August 9, 2004

This report concerns: (check one) Original Grant _____ Class I change _____ Class II change ✓ Equipment type: Wireless LAN device
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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 #1
TEST SITE ADDRESS	: 1623 – 14 Shimotsuruma, Yamato-shi, Kanagawa 242-8502 Japan Tel: +81-46-215-4779, Fax: +81-46-273-7420
REGULATION	: FCC Part 15 Subpart C Industry Canada RSS-210 (Issue No.5)
MODEL NUMBER (Advertising Name)	: AR5BMB-44 (IBM 11a/b/g Wireless LAN Mini PCI Adapter II)
FCC ID IC Certification Number	: ANO20040600BTL : 349E-AR5BMB44
SERIAL NUMBER	: 00S0SIT004
PYSICAL CONDITION	: Preproduction
KIND OF EQUIPMENT	: Personal computer with a IEEE802.11a, 11b & 11g Wireless LAN Mini-PCI Combo Card (Composite application)
TESTED DATE	: June 25, 28, 29, 30, July 1, 2, 5, 6, 9 and 28, 2004

A.1 Test Methodology

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

A.2 Test Facility / NVLAP Accreditation

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

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

A.3 EUT details

Table A EUT details

Model and S/N	**FCC ID** **IC Certification Number**	**Description**
AR5BMB-44 (s/n 00S0SIT004)	FCC ID: ANO20040600BTL IC: 349E-AR5BMB44	**Applying modular transmitter** Built_in type IEEE802.11a/b/g Wireless LAN Mini-PCI card without antenna
ThinkPad X30 Series M/T 2672-UPx (s/n zz-04049)	N/A	Host equipment IBM Notebook PC with built_in antenna CPU: Intel® Pentium® M Processor, 1.7GHz
ThinkPad X40 Series M/T : 2371-SD1 (s/n SIT#15023)		IBM Notebook PC with built-in antenna CPU: Intel® Pentium M Processor, 1.4 GHz
P/N 02K6810	N/A	Universal AC adapter 56W, Unshielded power cord

Prepared by T. Asano

B. Summary of Test Results

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

Table-B List of the measurements

Section(s)	Test Items : Transmit mode (TX):		Condition	Result
15.247(a)(2) **6.2.2(o)** *1	Bandwidth at 6 dB below	At least 500kHz. (*1: RSS-210 Issue5: Amendment)	Conducted	Pass
15.215(c) **5.9.1**	Occupied BW (Bandwidth at 20 dB below)	20 dB bandwidth of the emission to be within the allocation band.		Pass
15.247(c) **6.2.2(o)(e1)**	Out of Band Emissions	The radiated emission in any 100kHz of outband shall be at least 20dB below the highest inband spectral density.		Pass
15.247(b)(3) **6.2.2(o)(b)**	Conducted Peak Transmit Output Power	Shall not exceed 1.0 W.		Pass
15.247(d) **6.2.2(o)(b)**	Transmitter power spectral Density	Shall not be greater than 8 dBm in any 3kHz band.		Pass
15.207 **6.2.2(o)(e3)** **/ 6.6**	AC Wireline Conducted Emissions 150kHz – 30MHz	Class B: Freq.(MHz) QP(dBμV) Ave.(dBμV) 0.15 - 0.5 66 - 56 56 - 46 0.5 - 5 56 46 5 - 30 60 50		Pass
15.205 / 209 **6.2.1** **/6.2.2(o)(e3)** **/6.3**	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Shall not exceed the limits specified in FCC 15.209 or RSS-210 Table3.	Radiated (30MHz-1GHz)	Pass
			Radiated (1– 25GHz)	Pass

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

	Other requirements		Result
15.247(b)(4)(i) **–**	Antenna gain	Peak gain of the device : 1.67 dBi in 2.4GHz band, and 2.04dBi in 5.8GHz band	N/A
– **5.2**	Supply Voltage	Main power source: Universal AC adapter 56W Mini-PCI PC bus to applying card : DC 3.3V ± 0.3V	N/A
15.203 **6.2.2(o)(e2)**	Unique antenna connector	The device employs an unique electronic connector so called **Electronic Handshake.** Refer to “Confidential_e-Handshake” exhibit.	complies

C. Operation Mode of EUT

1. All tests were performed using the "Atheros Radio Test" program. This tool supports the continuous transmission mode for the testing purpose.
2. The following frequencies were chosen for the measurements of each 2.4GHz or 5.8GHz band.
   - 2412MHz (lowest), 2437MHz(middle), and 2462MHz (highest) for 2.4GHz band
   - 5745MHz (lowest), 5785MHz(middle), and 5825MHz (highest) for 5.8GHz band
3. As for the RF receiving test, the middle channels (2437MHz or 5785MHz) were selected representatively.

Table-C Transmission mode of EUT (The measurement plots are shown in shading.)
Note) The table shows the specification of **average** power for the applying device in 'dBm'.

Operation Frequency [GHz]	Designed average output power (conducted) [dBm]										
	IEEE802.11b			**IEEE802.11g**							
	1/2M bps	5.5M bps	11M bps	6M bps	9M bps	12M bps	18M bps	24M bps	36M bps	48M bps	54M bps
2.412 (Ch. 1)	17	17	17	14	14	14	14	14	14	14	14
2.417 (Ch. 2)	18	18	18	17	17	17	17	17	17	15	14
2.422 (Ch. 3)	18	18	18	18	18	18	18	18	17	15	14
2.427 (Ch. 4)	18	18	18	18	18	18	18	18	17	15	14
2.432 (Ch. 5)	18	18	18	18	18	18	18	18	17	15	14
2.437 (Ch. 6)	18	18	18	18	18	18	18	18	17	15	14
2.442 (Ch. 7)	18	18	18	18	18	18	18	18	17	15	14
2.447 (Ch. 8)	18	18	18	18	18	18	18	18	17	15	14
2.452 (Ch. 9)	18	18	18	18	18	18	18	18	17	15	14
2.457 (Ch. 10)	18	18	18	17	17	17	17	17	17	15	14
2.462 (Ch. 11)	17	17	17	14	14	14	14	14	14	14	14
				IEEE802.11a							
5.745 (Ch.149)	N/A			16	16	16	16	16	15	14	11
5.765 (Ch.153)				16	16	16	16	16	15	14	11
5.785 (Ch.157)				16	16	16	16	16	15	14	11
5.805 (Ch.161)				16	16	16	16	16	15	14	11
5.825 (Ch.165)				16	16	16	16	16	15	14	11

D. Justification

The host PCs (IBM ThinkPad X30 Series and X40 Series) are designed with the same conceptual hardware configuration of compact size laptop PC.

- The shading columns in the previous Table C show the transmission modes performed full testing.
- The antenna ports of each host device marked in shading in the Table-D below were used for EUT which have comparatively higher antenna gains and worse measurement results in each host PC series (X30 or X40). Then, the worst case data were selected for this test report among the two PC systems.
  The actual highest emissions taken in this report in the Chapter 6 through 8 were found at 11Mbps for 2.4GHz DSSS and 6Mbps for both 2.4GHz/5.8GHz OFDM on the auxiliary antenna of ThinkPad X40 Series.
  Refer to the Chapter 8.5 concerning the evaluation of the worst emission case.

Table-D Peak Antenna Gains of EUT

		2.4GHz band	5.8GHz band
ThinkPad X30 Series	Main Antenna gain	0.62 dBi (peak)	0.32 dBi (peak)
	Auxiliary Antenna gain	1.28 dBi (peak)	-0.87 dBi (peak)
ThinkPad X40 Series	Main Antenna gain	0.39 dBi (peak)	1.74 dBi (peak)
	Auxiliary Antenna gain	1.67 dBi (peak)	2.04 dBi (peak)

E. Test Instruments

Table-E List of Measuring Instruments

Description	Model	Serial Number	Calibration Date	Calibration Interval
Computer	IBM 6868-30J	97-901X3	N/A	N/A
Computer	IBM 6589-13J	97-15613	N/A	N/A
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2601A02634	09/09/03	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	3019A05156	08/14/03	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2841A04254	08/25/03	1 year
Spectrum Analyzer Display	HP 85662A	2542A12308	09/09/03	1 year
Spectrum Analyzer Display	HP 85662A	3026A19366	08/14/03	1 year
Spectrum Analyzer Display	HP 85662A	2816A16831	08/25/03	1 year
Quasi-Peak Adapter	HP 85650A	2043A00062	09/09/03	1 year
Quasi-Peak Adapter	HP 85650A	2811A01433	08/14/03	1 year
Quasi-Peak Adapter	HP 85650A	2811A01156	08/25/03	1 year
Amplifier (100KHz - 1.3GHz)				
- for 30-200MHz	MITEQ AM-3A	898433	04/23/04	1 year
- for 200-1000MHz	MITEQ AM-3A	898432	04/23/04	1 year
Amplifier (1GHz - 18GHz)	HP 8449B	3008A00582	06/01/04	1 year
Amplifier (18 – 40GHz)	Agilent 83051A	3950M00193	01/27/04	1 year
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003	05/10/04	1 year
Spectrum Analyzer	HP 8563E	3416A02248	08/21/03	1 year
Harmonic Mixer	Agilent 11970A	011269-001	07/19/03	1 year
Receiver (9kHz-30MHz)	R&S ESH3	891806/012	10/17/03	1 year
Receiver (20MHz-1.3GHz)	R&S ESVP	893202/018	02/10/04	1 year
Biconical Antenna (30-200MHz)	EMCO 3108	2536	04/23/04	1 year
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	2849	04/23/04	1 year
Horn Antenna (1- 18GHz)	EMCO 3115	9903-5774	07/17/03	1 year
Horn Antenna (3.95- 5.85GHz)	EMCO 3160-5	1099	07/17/03	1 year
Horn Antenna (5.85- 8.20GHz)	EMCO 3160-6	9712-1044	07/17/03	1 year
Horn Antenna (8.20- 12.4GHz)	EMCO 3160-7	1156	07/17/03	1 year
Horn Antenna (12.4- 18GHz)	EMCO 3160-8	1143	07/17/03	1 year
Horn Antenna (18- 26.5GHz)	EMCO 3160-9	0004-1202	07/17/03	1 year
Horn Antenna (26.5- 40GHz)	EMCO 3160-10	1175	07/17/03	1 year
LISN	EMCO 3810/2NM	00022007	06/15/04	1 year
Switch/control unit	HP 3488A	2719A17226	N/A	N/A
		2719A17228	N/A	N/A
Plotter	HP 7550A	2631A33619	N/A	N/A
Coaxial cables (1 – 18GHz):	Length:			
- Horn Ant <=> RF Amp.	6 m	- EM206SCO	03/25/04	1 year
- RF Amp.<=>Spectrum Analyzer(<12GHz)	16m	- GEM0101	03/25/04	1 year
- RF Amp.<=>Spectrum Analyzer(>12GHz)	3m	- SF102-20166	04/08/04	1 year
Coaxial cables (18 – 40GHz):				
- Horn Ant <=> RF Amp.	3m	- SF102-20167	04/08/04	1 year
- RF Amp.<=>Spectrum Analyzer	1m	- SF102-21105	04/08/04	1 year

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N-Coax cables:				
- Bi-coni Ant <=> 10m Cable	9 m	- EM103L01	04/23/04	1 year
- 10m Cable <=> Shield Panel	10 m	- EM103L02	04/23/04	1 year
- Shield Panel <=> RF Amp	7 m	- EM103L03	04/23/04	1 year
- RF Amp <=> Power Splitter	0.5m	- EM103L04	04/23/04	1 year
- Log-peri Ant <=> 10m Cable	9 m	- EM103H01	04/23/04	1 year
- 10m Cable <=> Shield Panel	10 m	- EM103H02	04/23/04	1 year
- Shield Panel <=> RF Amp	7 m	- EM103H03	04/23/04	1 year
- RF Amp <=> Power Splitter	0.5m	- EM103H04	04/23/04	1 year
Coax cables:				
- Lisn-L <=> SW/Con.unit (SW100)	4 m	- EMIC-L	04/23/04	1 year
- Lisn-N <=> SW/Con.unit (SW101)	4 m	- EMIC-N	04/23/04	1 year
- SW/Con.unit <=> RCVR (Input)	1 m	- EMIC-R	04/23/04	1 year
- SW/Con.unit<=> Spe Ana.(Signal In)	1 m	- EMIC-S	04/23/04	1 year
- Power Splitter <=> SW/Con.unit (SW110)	1 m	- EM103L05	04/23/04	1 year
- Power Splitter <=> SW/Con.unit (SW300)	1 m	- EM103L06	04/23/04	1 year
- Power Splitter <=> SW/Con.unit (SW100)	1 m	- EM103H05	04/23/04	1 year
- Power Splitter <=> SW/Con.unit (SW301)	1 m	- EM103H06	04/23/04	1 year
- SW/Con.unit <=> Receiver (Input)	2 m	- EM1RCV	04/23/04	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz	2 m	- EM1SPL	04/23/04	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	2 m	- EM1SPH	04/23/04	1 year

Notes.

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

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

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

1. Bandwidth at 6 dB below

[FCC 15.247(a)(2), RSS-210 6.2.2(o)/ Issue 5: Amendment]

1.1 Test Procedure

The bandwidth at 6 dB down from the highest inband spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT was operating in transmission mode at the appropriate center frequency.
The spectrum analyzer was set to :
RBW=100kHz, VBW=100kHz[*1], Span=30MHz, 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 : 2.4GHz 1.3 dB 5.8GHz 2.3 dB	

Notes: - R&S: Rohde & Schwarz

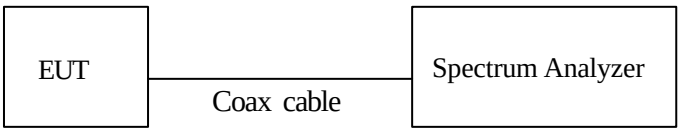

Figure 1: Measurement setup for 6dB bandwidth test

1.3 Measurement Results

Test Date: June 25, 2004

1.3.1 2.4GHz band DSSS mode

Table 1-2-1. 6dB bandwidth, 2.4GHz band DSSS mode, TX mode 1Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
2412 (ch. 1)	omitted	2405.90	2418.10	12.20	> 0.5
2437 (ch. 6)	omitted	2430.96	2443.10	12.14	
2462 (ch. 11)	omitted	2455.42	2468.10	12.68	

Table 1-2-2. 6dB bandwidth, 2.4GHz band DSSS mode, TX mode 11Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
2412 (ch. 1)	omitted	2406.08	2417.92	11.84	> 0.5
2437 (ch. 6)	Plot 1-1	2430.84	2442.62	11.78	
2462 (ch. 11)	omitted	2455.66	2467.62	11.96	

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1.3.2 2.4GHz band OFDM mode

Table 1-2-3. 6dB bandwidth, 2.4GHz band OFDM mode, TX mode 6Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
2412 (ch. 1)	omitted	2403.79	2420.27	16.48	> 0.5
2437 (ch. 6)	omitted	2428.79	2445.27	16.48	
2462 (ch. 11)	Plot 1-2	2453.73	2470.03	16.30	

Table 1-2-4. 6dB bandwidth, 2.4GHz band OFDM mode, TX mode 18Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
2412 (ch. 1)	omitted	2403.73	2420.33	16.60	> 0.5
2437 (ch. 6)	omitted	2428.73	2445.33	16.60	
2462 (ch. 11)	omitted	2453.73	2470.21	16.48	

Table 1-2-5. 6dB bandwidth, 2.4GHz band OFDM mode, TX mode 54Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
2412 (ch. 1)	omitted	2403.73	2420.33	16.60	> 0.5
2437 (ch. 6)	omitted	2428.73	2445.33	16.60	
2462 (ch. 11)	omitted	2453.67	2470.27	16.60	

1.3.3 5.8GHz band OFDM mode

Table 1-2-6. 6dB bandwidth, 5.8GHz band OFDM mode, TX mode 6Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
5745 (ch. 149)	omitted	5736.73	5753.27	16.54	> 0.5
5785 (ch. 157)	Plot 1-3	5776.73	5793.27	16.54	
5825 (ch. 165)	omitted	5816.67	5833.27	16.60	

Table 1-2-7. 6dB bandwidth, 5.8GHz band OFDM mode, TX mode 18Mbps

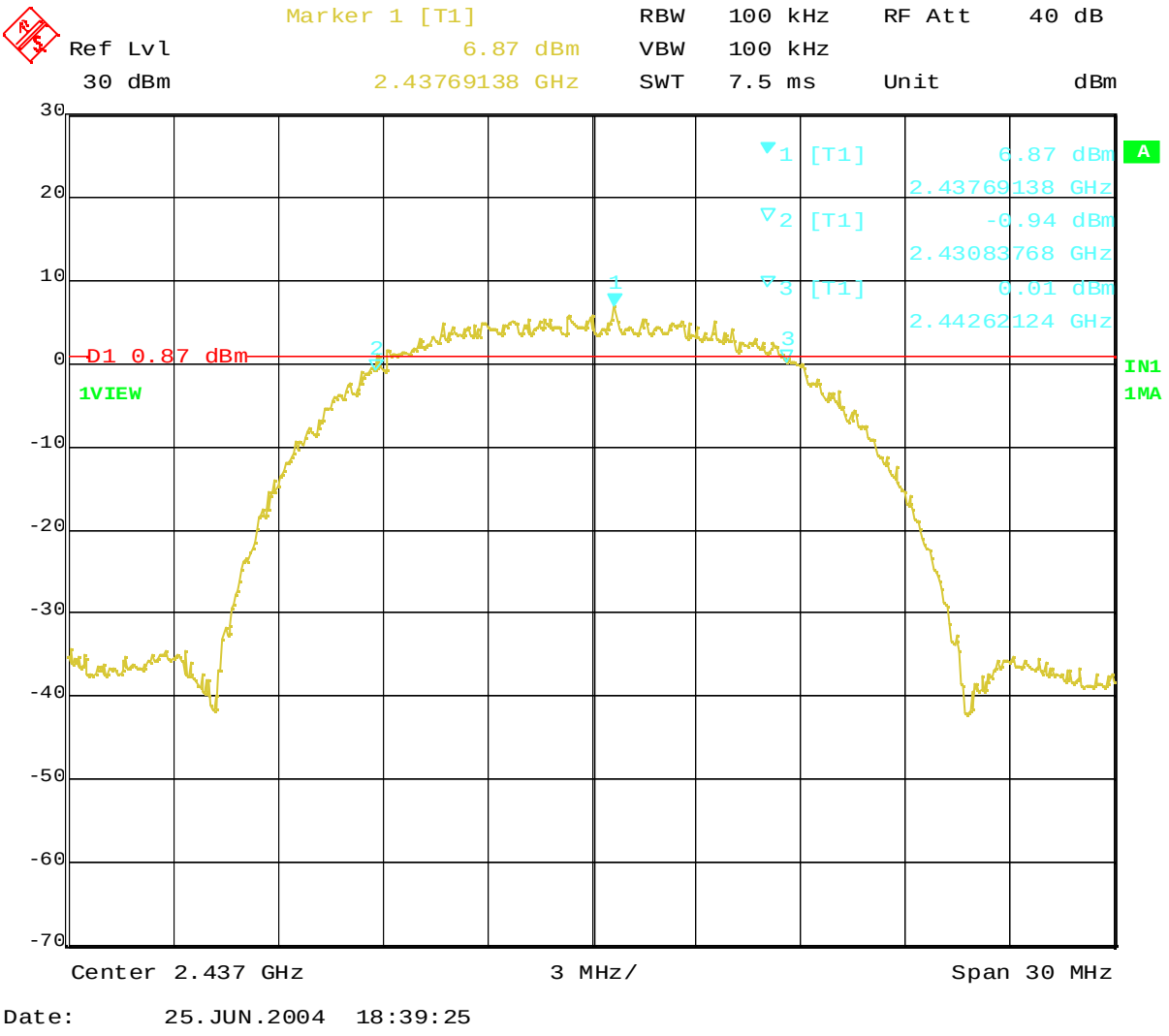
Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
5745 (ch. 149)	omitted	5736.67	5753.27	16.60	> 0.5
5785 (ch. 157)	omitted	5776.67	5793.27	16.60	
5825 (ch. 165)	omitted	5816.67	5833.27	16.60	

Table 1-2-8. 6dB bandwidth, 5.8GHz band OFDM mode, TX mode 54Mbps

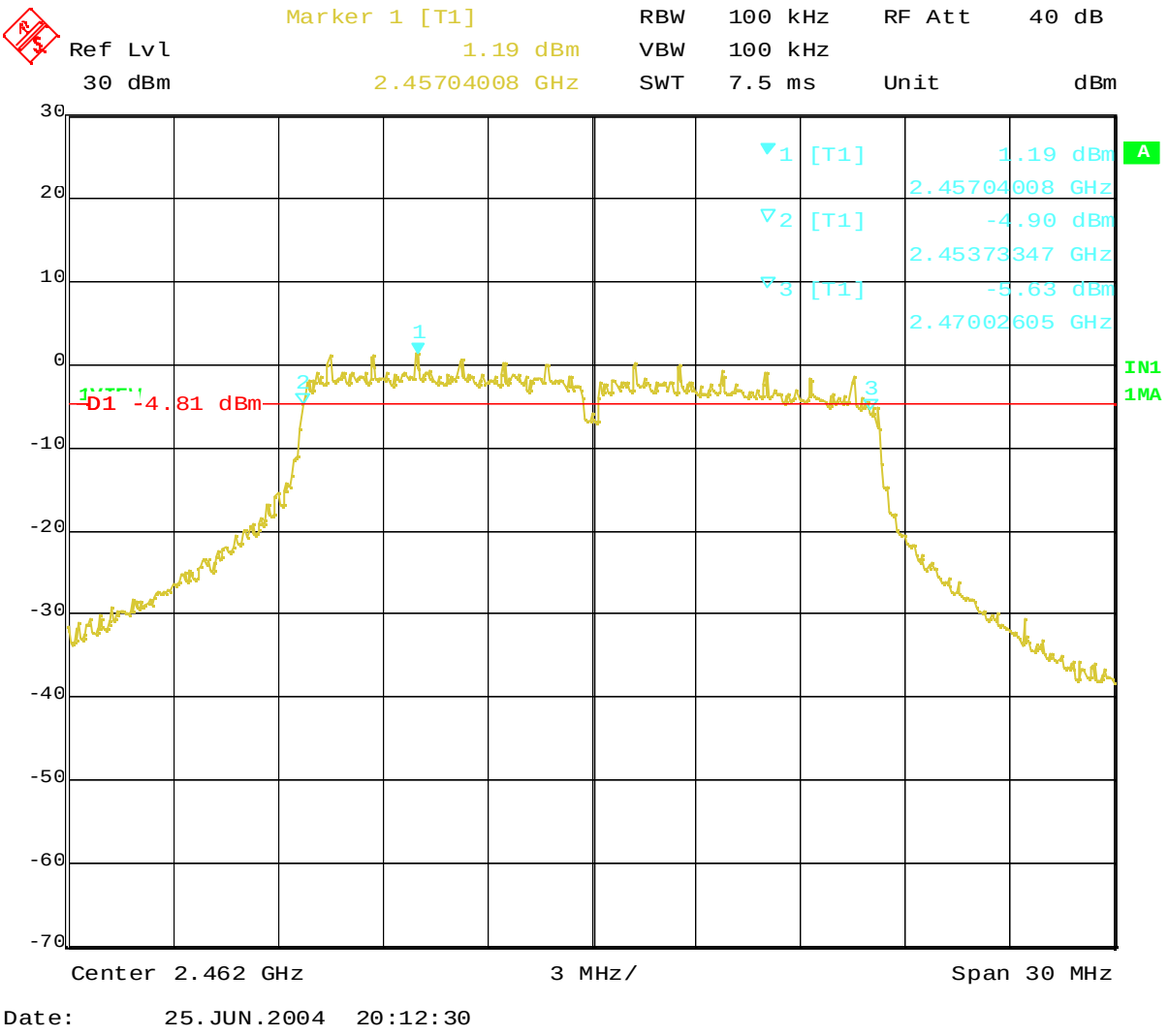
Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	Limit (MHz)
5745 (ch. 149)	omitted	5736.67	5753.33	16.66	> 0.5
5785 (ch. 157)	omitted	5776.67	5793.33	16.66	
5825 (ch. 165)	omitted	5816.67	5833.33	16.66	

1.4 Trace Data of 6dB bandwidth

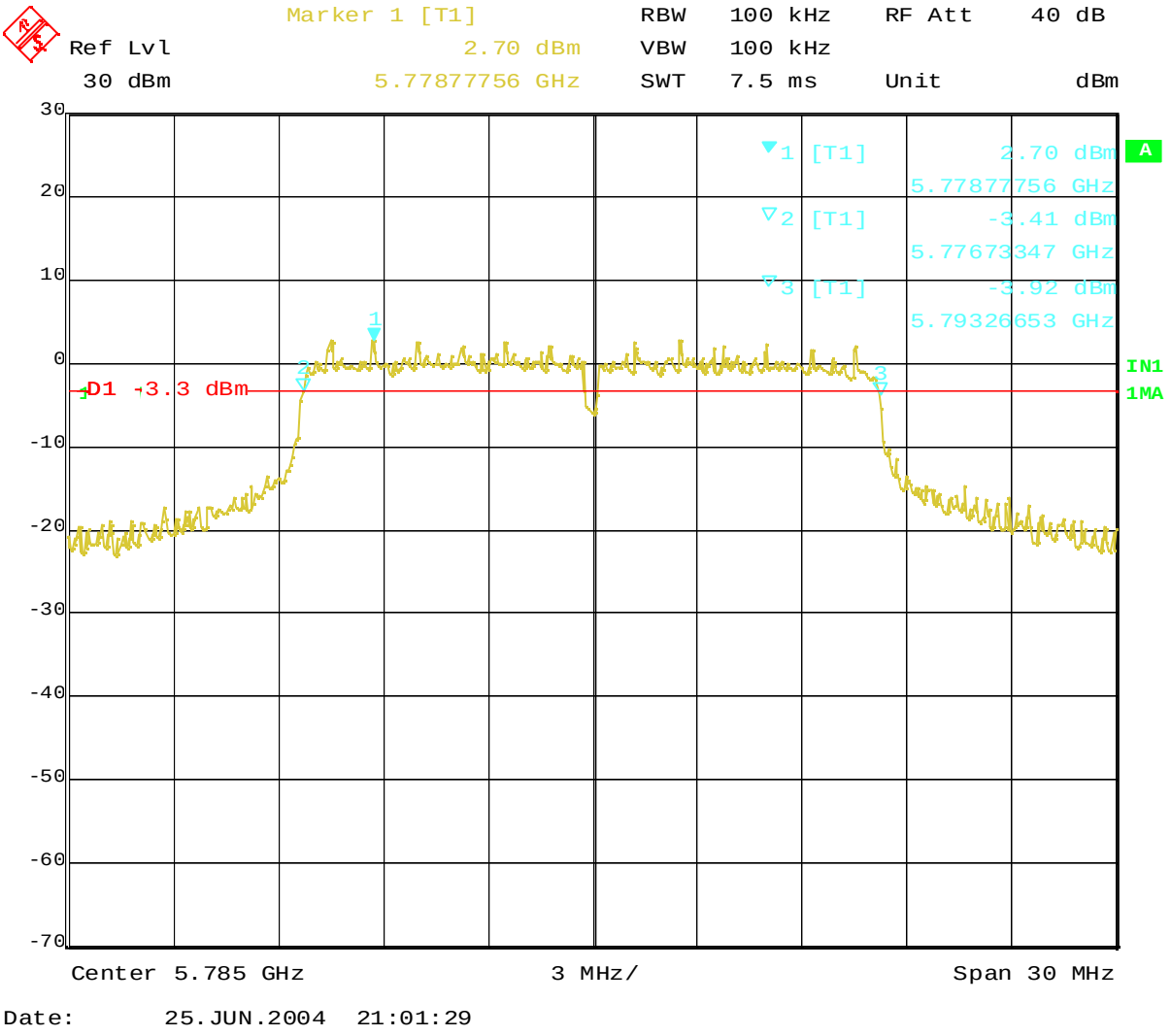
The plots are comparatively worse measurement cases of each transmission mode in the previous Table 1-2-1 through Table 1-2-8.



Plot 1-1. 6dB BW at 2437MHz (DSSS, 11Mbps)



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



Plot 1-3. 6dB BW at 5785MHz (OFDM, 6Mbps)

2. Occupied Bandwidth (20 dB Bandwidth)

[FCC 15.215(c), RSS-210 5.9.1]

2.1 Test Procedure

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

The spectrum analyzer was set to:

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

Test Date: June 25, 2004

2.3.1 2.4GHz band DSSS mode

Table 2-1. Occupied bandwidth, 2.4GHz band DSSS mode, TX 1Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
2412 (ch. 1)	omitted	2403.35	2421.19	17.84
2437 (ch. 6)	omitted	2427.93	2445.64	17.71
2462 (ch. 11)	omitted	2452.93	2470.69	17.76

Table 2-2. Occupied bandwidth, 2.4GHz band DSSS mode, TX 11Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
2412 (ch. 1)	Plot 2-1	2403.15	2420.89	17.74
2437 (ch. 6)	omitted	2428.03	2445.84	17.81
2462 (ch. 11)	omitted	2453.03	2470.69	17.66

2.3.2 2.4GHz band OFDM mode

Table 2-3. Occupied bandwidth, 2.4GHz band OFDM mode, TX 6Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
2412 (ch. 1)	Plot 2-2	2402.63	2421.37	18.74
2437 (ch. 6)	omitted	2427.43	2446.27	18.84
2462 (ch. 11)	omitted	2452.63	2470.92	18.29

Table 2-4. Occupied bandwidth, 2.4GHz band OFDM mode, TX 18Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
2412 (ch. 1)	omitted	2402.93	2421.07	18.14
2437 (ch. 6)	omitted	2427.83	2446.17	18.34
2462 (ch. 11)	omitted	2452.63	2470.72	18.09

Table 2-5. Occupied bandwidth, 2.4GHz band OFDM mode, TX 54Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
2412 (ch. 1)	omitted	2402.93	2421.17	18.24
2437 (ch. 6)	omitted	2427.73	2446.27	18.54
2462 (ch. 11)	omitted	2452.83	2470.92	18.09

2.3.3 5.8GHz band OFDM mode

Table 2-6. Occupied bandwidth, 5.8GHz band OFDM mode, TX 6Mbps

Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
5745 (ch. 149)	Plot 2-3	5735.43	5755.27	19.84
5785 (ch. 157)	omitted	5774.83	5795.67	20.84
5825 (ch. 165)	omitted	5815.13	5834.87	19.74

Table 2-7. Occupied bandwidth, 5.8GHz band OFDM mode, TX 18Mbps

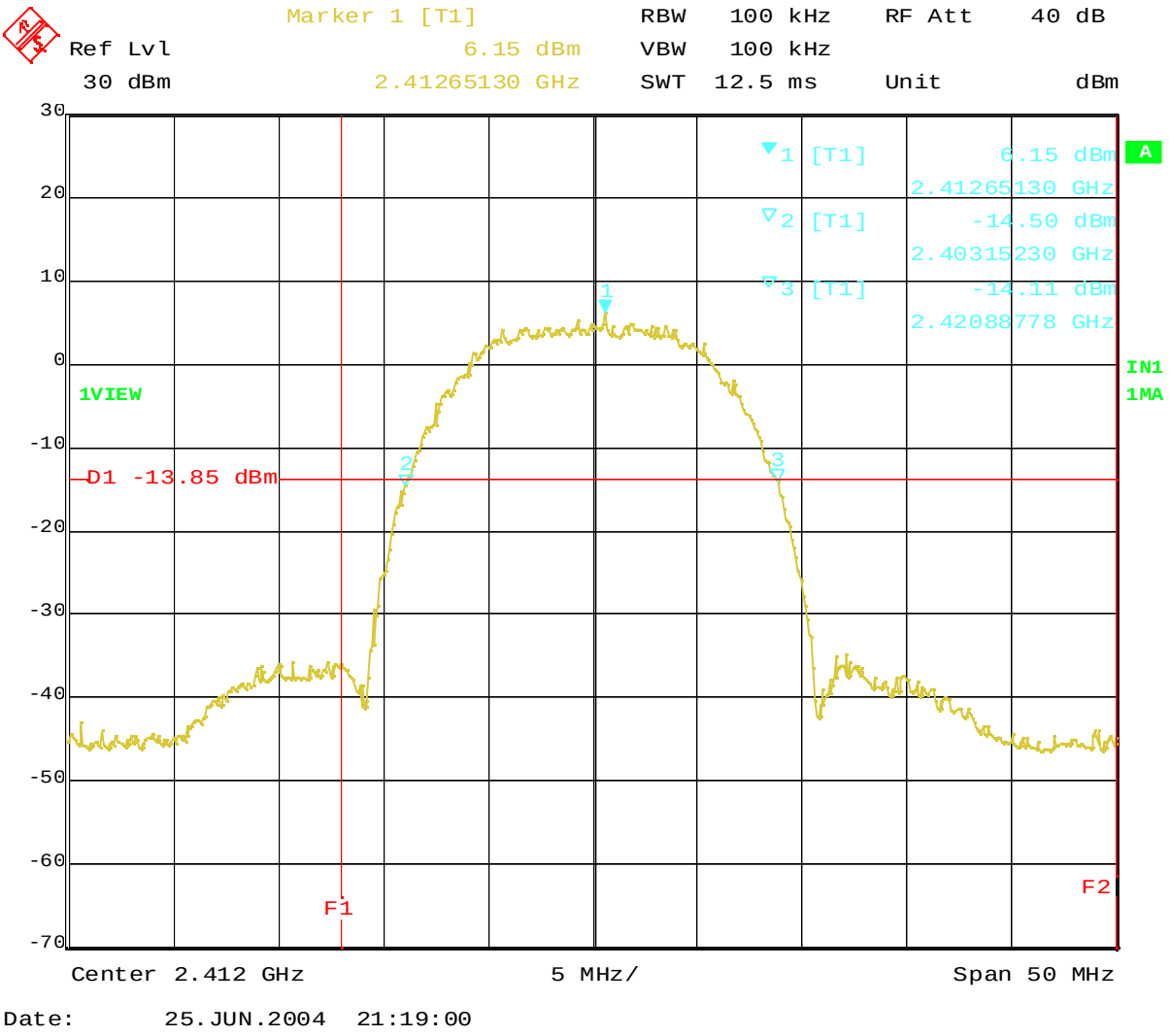
Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
5745 (ch. 149)	omitted	5735.23	5754.57	19.34
5785 (ch. 157)	omitted	5774.83	5795.37	20.54
5825 (ch. 165)	omitted	5814.53	5834.37	19.84

Table 2-8. Occupied bandwidth, 5.8GHz band OFDM mode, TX 54Mbps

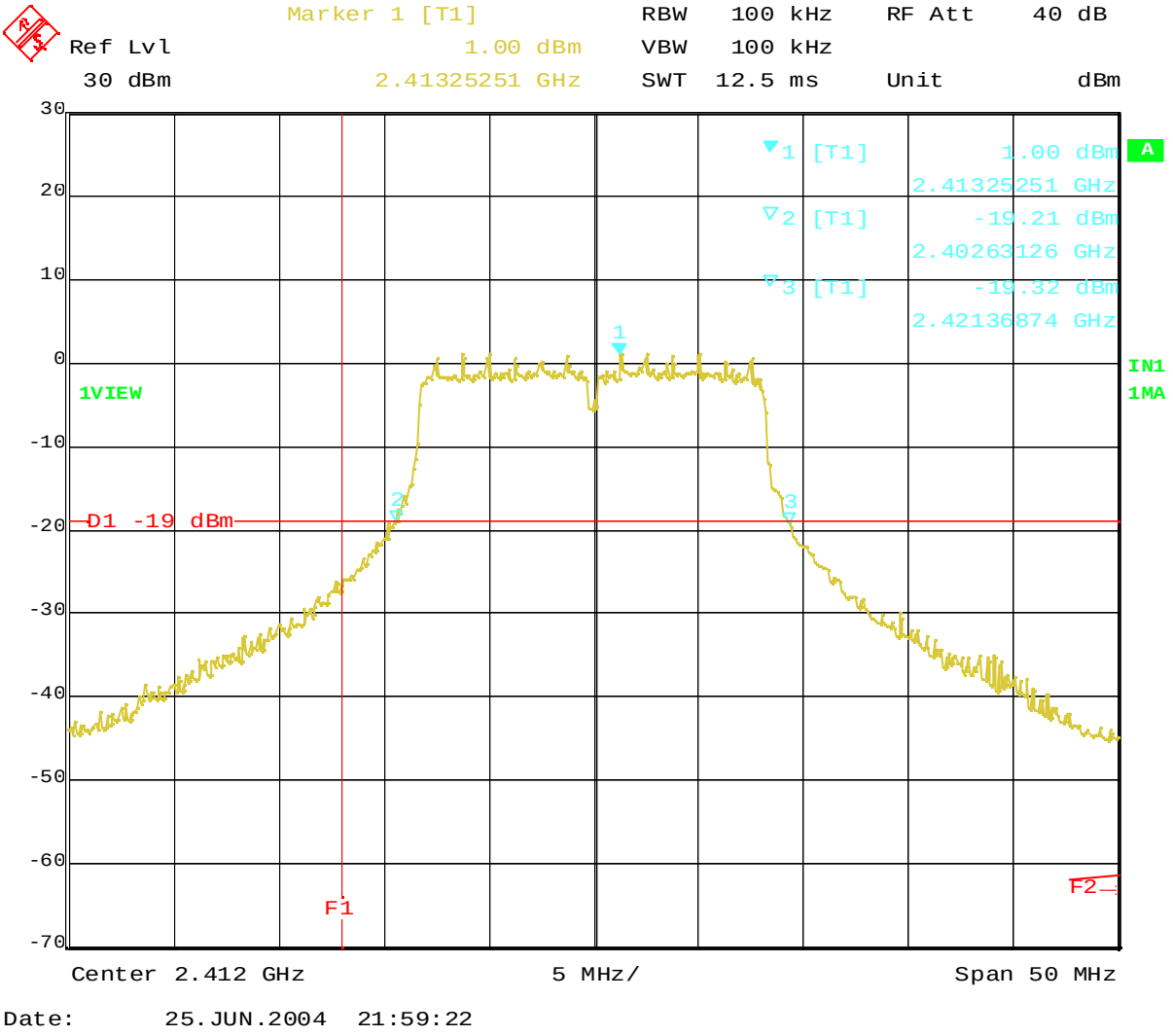
Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 20 dB below (MHz)
5745 (ch. 149)	omitted	5735.63	5754.27	18.64
5785 (ch. 157)	omitted	5775.53	5794.27	18.74
5825 (ch. 165)	omitted	5815.63	5834.47	18.84

2.4 Trace Data of Occupied Bandwidth

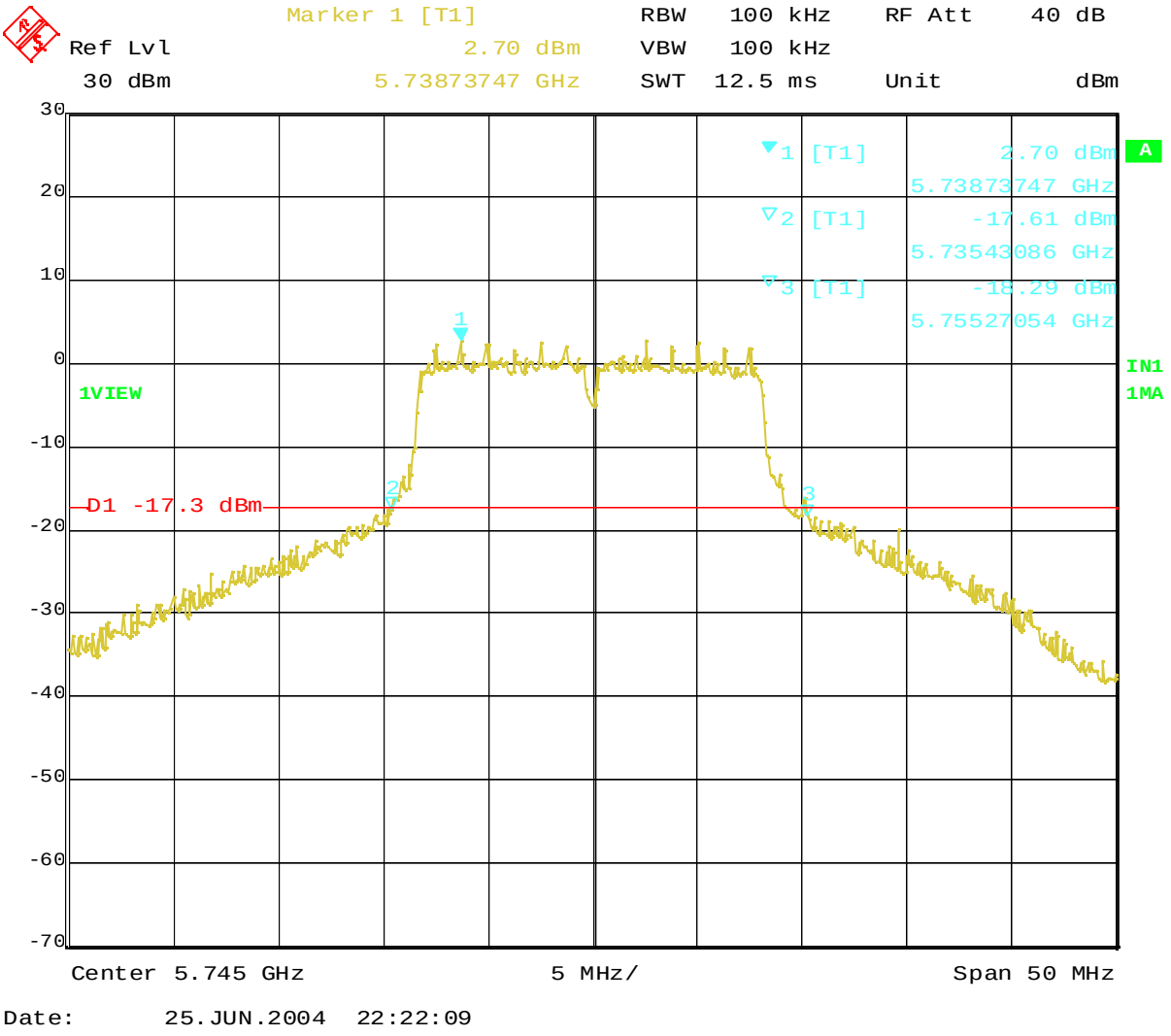
The plots are comparatively worse measurement cases of each transmission mode at the bandedge channels (i.e. ch.1 or ch.11) in the previous Table 2-1 through Table 2-8.



Plot 2-1. 20dB BW at 2412MHz (DSSS, 11Mbps)



Plot 2-2. 20dB BW at 2412MHz (OFDM, 6Mbps)



Plot 2-3. 20dB BW at 5745MHz (OFDM, 6Mbps)

3. Conducted Peak Transmit Output Power

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

3.1 Test Procedure

The spectrum analyzer was connected to the antenna terminal, while EUT was operating in continuous transmission mode at the appropriate center frequencies.

The spectrum analyzer was set to :
RBW=1MHz, VBW=RBW or more, Mode=Peak detection, Trigger=free run,
Span=50MHz encompassing the entire 26 dB emission bandwidth of the transmission signal

The band power measurement function was used to measure the peak power of each transmission mode. The analyzer computed the peak power by integrating the spectrum across the 26 dB emission bandwidth.

3.2 Test Instruments and Measurement Setup

The test instruments and setup configuration are the same as the Table 1-1 and Figure 1.

3.3 Measurement Results

Test Date: July 28, 2004

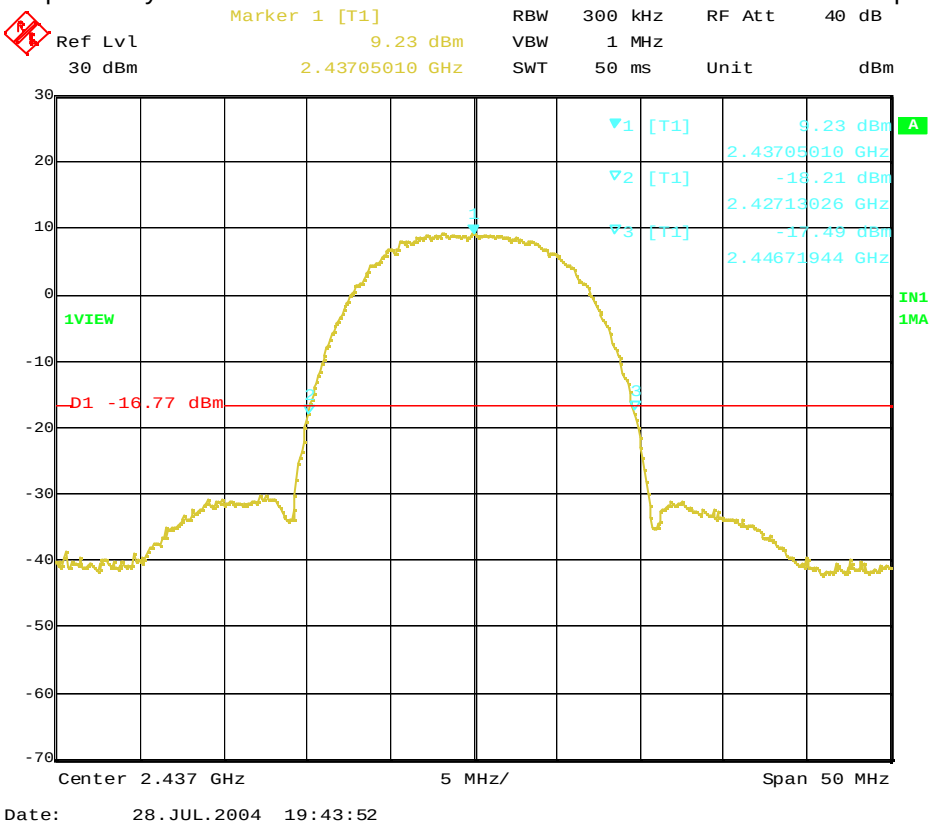
Table 3-1. Conducted peak output power measurement results

Measured Frequency (MHz)	Tx mode (Mb/s)	Analyzer reading (dBm)	Trace number	Cable Loss (dB)	**Results** (dBm)	Limit FCC (dBm)	Limit IC (dBm)	Margin to limit (dBm)
2412 (DSSS)	1	17.85	omitted	1.3	**19.15 (82.2 mW)**	30	30	10.85
	11	20.97	omitted		**22.27 (168.7 mW)**			7.73
2437 (DSSS)	1	18.27	omitted	1.3	**19.57 (90.6 mW)**			10.43
	11	21.71	Plot 3-1a		**23.01 (200.0 mW)**			6.99
2462 (DSSS)	1	17.33	omitted	1.3	**18.63 (72.9 mW)**			11.37
	11	20.35	omitted		**21.65 (146.2 mW)**			8.35
2412 (OFDM)	6	20.28	omitted	1.3	**21.58 (143.9 mW)**			8.42
	18	20.23	omitted		**21.53 (142.2 mW)**			8.47
	54	20.25	omitted		**21.55 (142.9 mW)**			8.45
2437 (OFDM)	6	23.38	Plot 3-2a	1.3	**24.68 (293.8 mW)**			5.32
	18	23.23	omitted		**24.53 (283.8 mW)**			5.47
	54	20.34	omitted		**21.64 (145.9 mW)**			8.36
2462 (OFDM)	6	19.81	omitted	1.3	**21.11 (129.1 mW)**			8.89
	18	19.72	omitted		**21.02 (126.5 mW)**			8.98
	54	19.79	omitted		**21.09 (128.5 mW)**			8.91
5745 (OFDM)	6	21.84	omitted	2.3	**24.14 (259.4 mW)**			5.86
	18	21.74	omitted		**24.04 (253.5 mW)**			5.96
	54	17.89	omitted		**20.19 (104.5 mW)**			9.81
5785 (OFDM)	6	22.34	Plot 3-3a	2.3	**24.64 (291.1 mW)**			5.36
	18	22.29	omitted		**24.59 (287.7 mW)**			5.41
	54	17.99	omitted		**20.29 (106.9 mW)**			9.71
5825 (OFDM)	6	22.05	omitted	2.3	**24.35 (272.3 mW)**			5.65
	18	21.98	omitted		**24.28 (267.9 mW)**			5.72
	54	17.62	omitted		**19.92 (98.2 mW)**			10.08

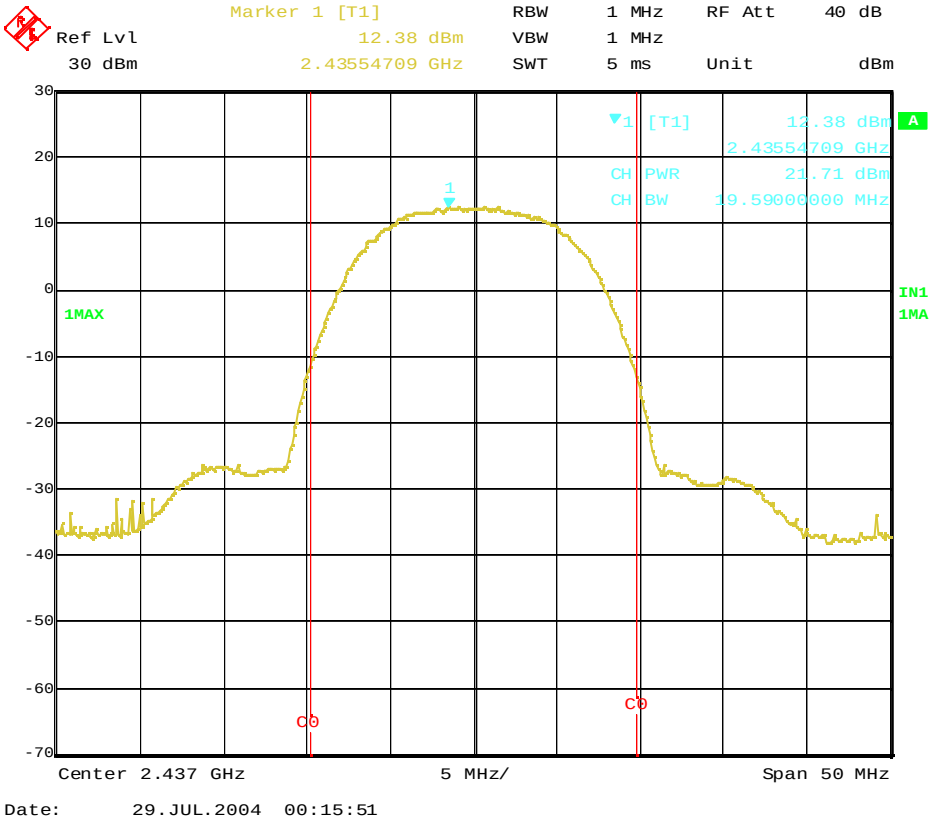
Prepared by T. Asano

3.4 Trace Data of Conducted Peak Output Power

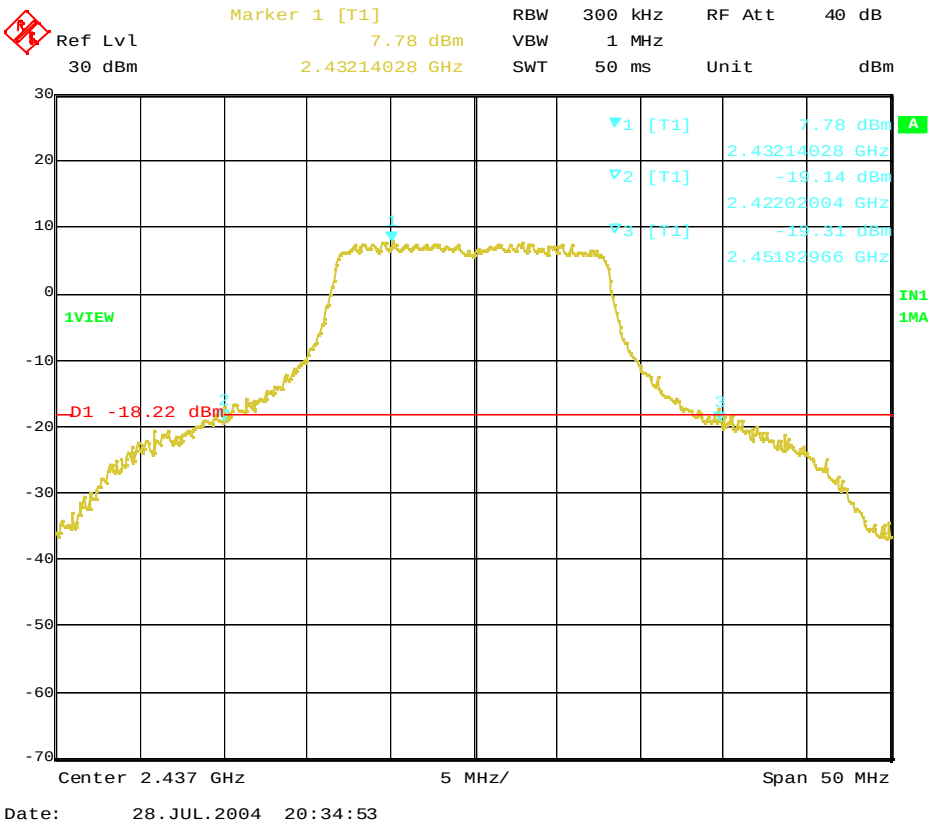
The plots are comparatively worse measurement cases of each transmission mode in the previous Table 3-1.



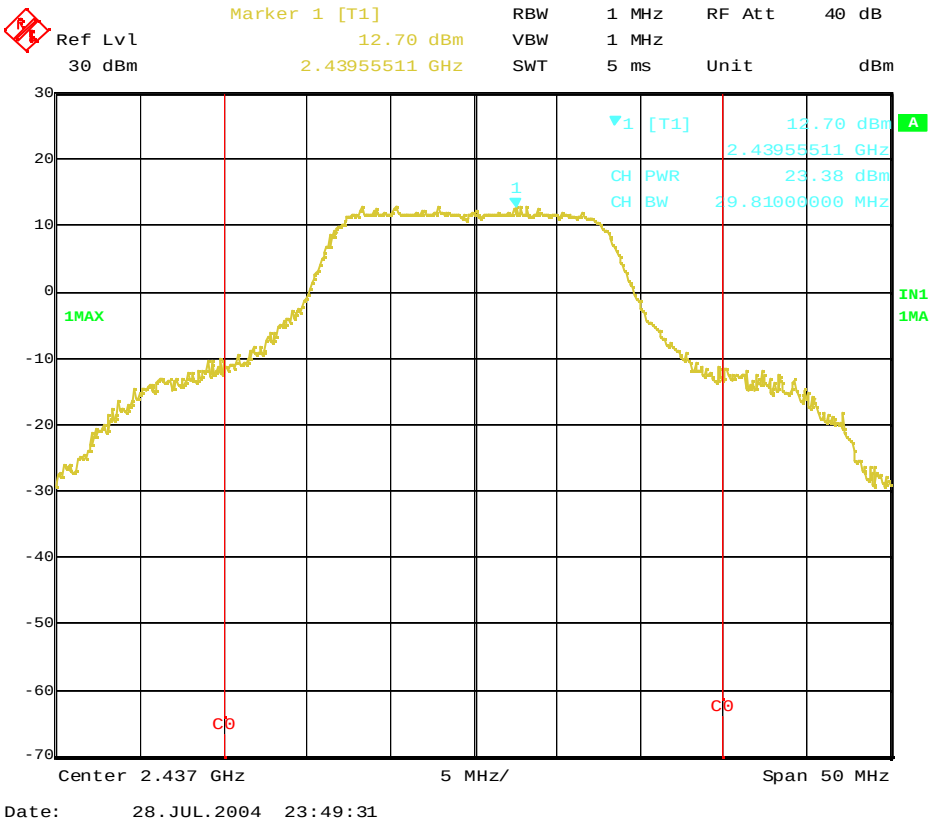
Plot 3-1a. 26dB Bandwidth of 2437MHz (DSSS, 11Mbps)



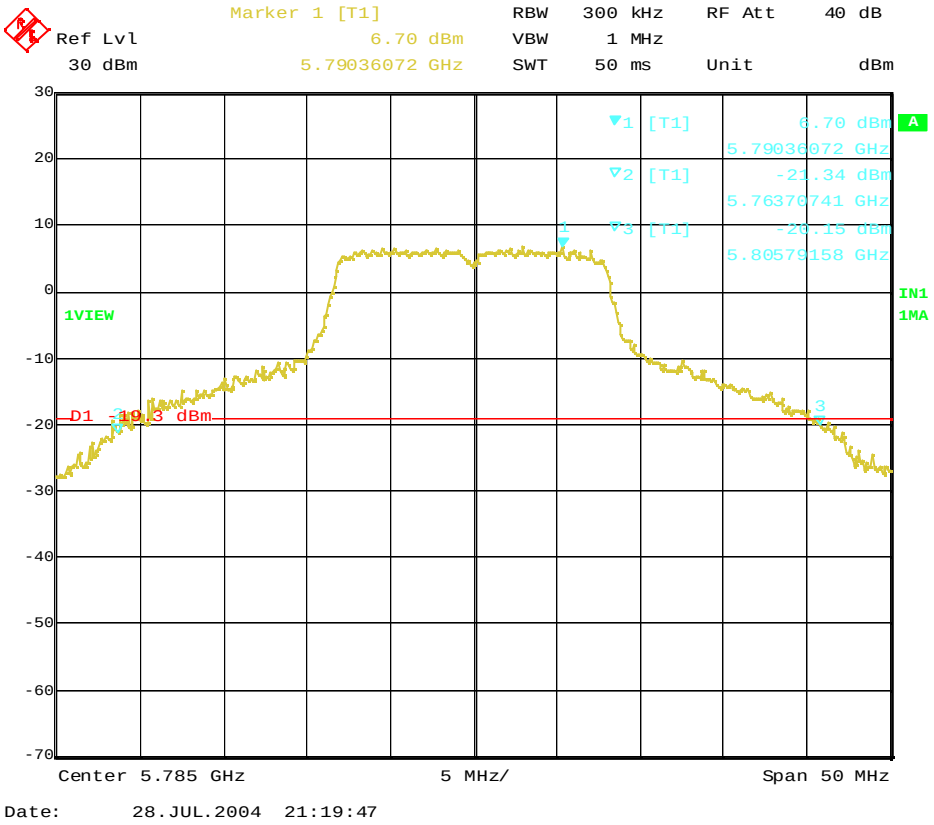
Plot 3-1b. Conducted Peak Output Power of 2437MHz (DSSS, 11Mbps)



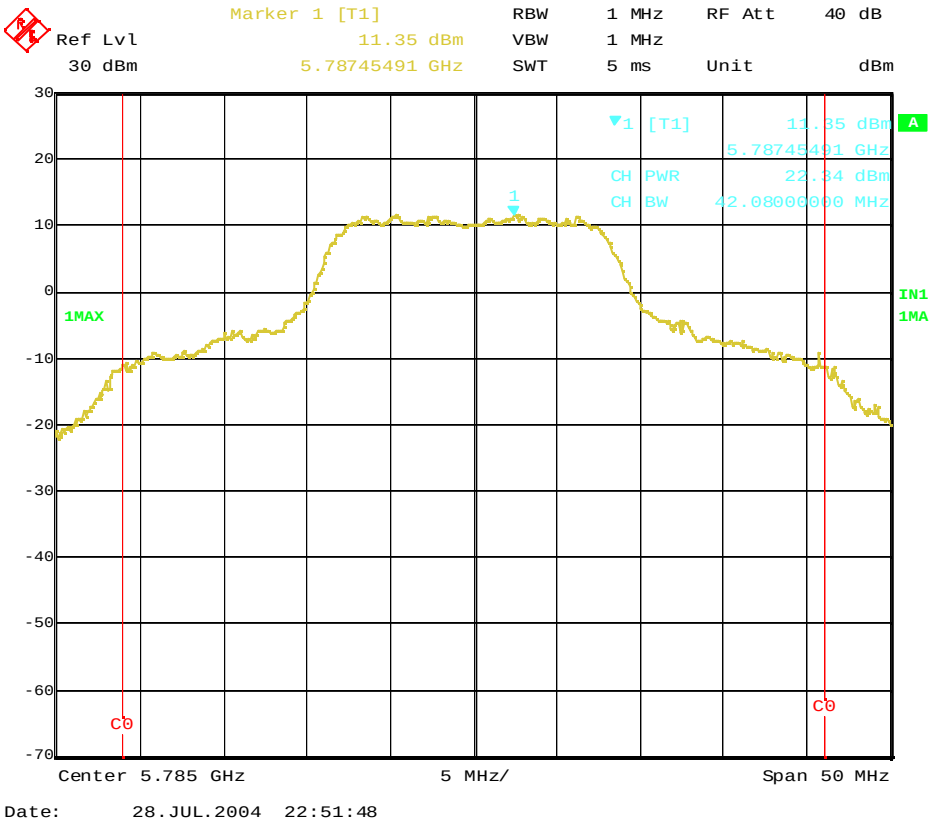
Plot 3-2a. 26dB Bandwidth of 2437MHz (OFDM, 6Mbps)



Plot 3-2b. Conducted Peak Output Power of 2437MHz (OFDM, 6Mbps)



Plot 3-3a. 26dB Bandwidth of 5785MHz (OFDM, 6Mbps)



Plot 3-3b. Conducted Peak Output Power of 5785MHz (OFDM, 6Mbps)

4. Out of Band Emissions (Conducted Spurious)
[FCC 15.247(c), RSS-210 6.2.2(o)(e1)]

4.1 Test Procedure

The outband emissions in any 100kHz bandwidth was measured with a spectrum analyzer connected to the antenna terminal, while EUT was operating in transmission mode at the appropriate center frequency. The spectrum analyzer was set to:

2.4GHz: RBW = 100kHz, VBW = 100kHz[*1], Scanning frequency range = 30MHz~2GHz, 2GHz~3GHz, and 3GHz~25GHz, Sweep = suitable duration based on the EUT specification

5.8GHz: RBW = 100kHz, VBW = 100kHz[*1], Scanning frequency range = 30MHz~5GHz, 5GHz~6GHz, 6GHz~26.5GHz and 26.5GHz~40GHz, Sweep = suitable duration based on the EUT specification

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

4.2 Test Instruments and Measurement Setup

4.2.1 Below 26.5GHz

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

4.2.2 Above 26.5GHz

Table 4-1 Conducted Spurious Test Instrumentation

Description	**Model**	**Serial Number**
Spectrum Analyzer	HP 8563E	3416A02248
Harmonic Mixer (26.5 – 40GHz)	Agilent 11970A	011269-001
Coaxial cables: - EUT <=> Mixer (26.5-40GHz) - Mixer <=>Spectrum Analyzer (26.5-40GHz)	Length: Cable loss: 1m 2.9dB (at 40GHz) 1m 2.9dB (at 40GHz)	 - SF102-21108 - SF102-21105

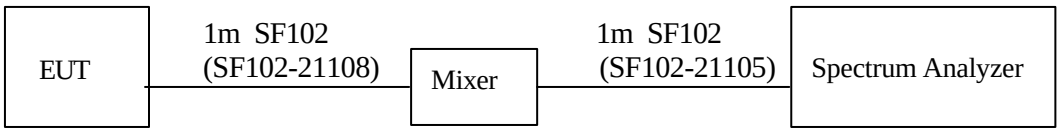


Figure 4: Measurement setup for Conducted Spurious test

4.3 Measurement Results

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

The measurement was performed with the worse cases of each transmission mode, that tend to have higher conducted peak power, based on the results of previous Chapter 3, “Conducted Peak Output Power” measurement.

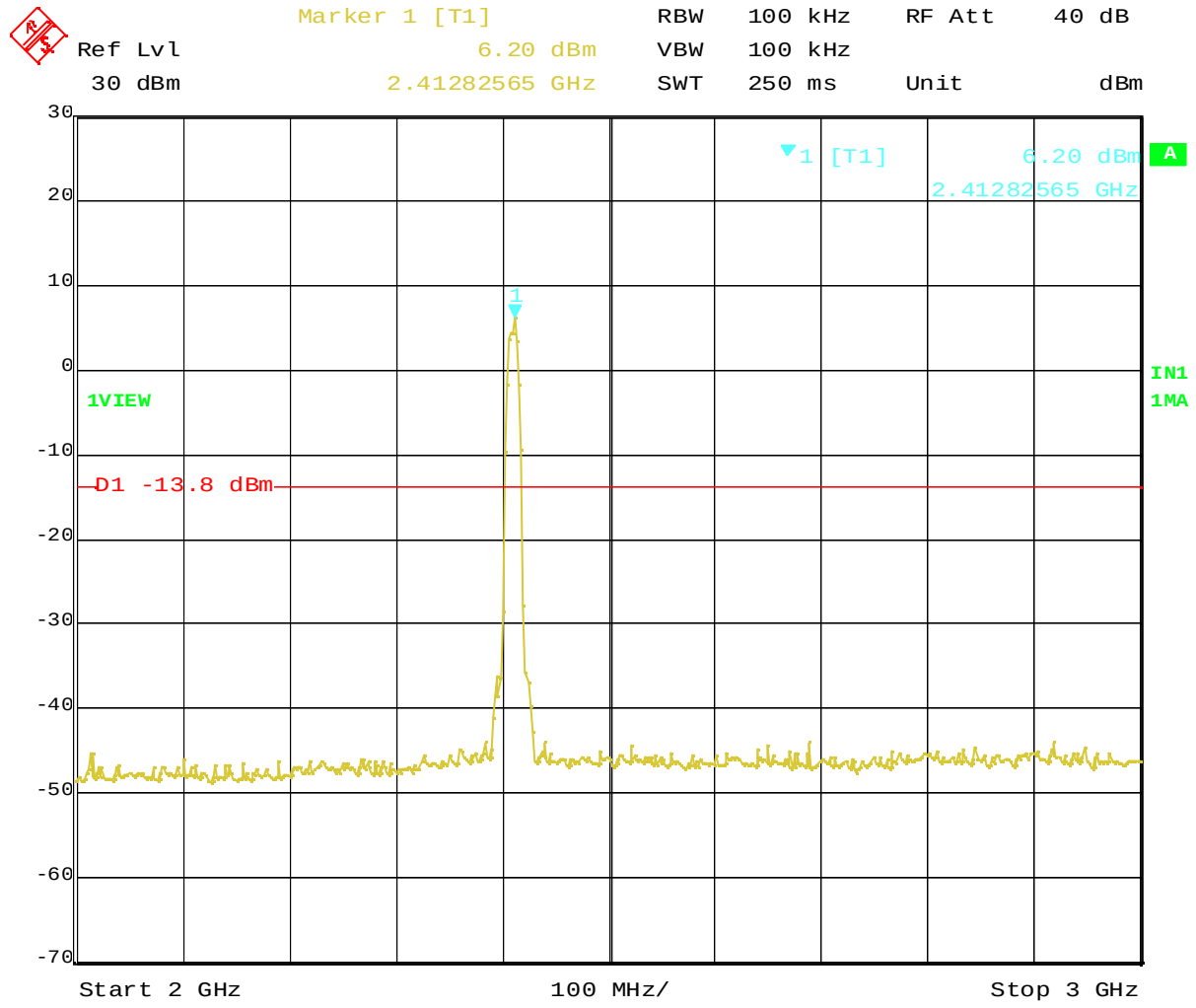
Prepared by T. Asano

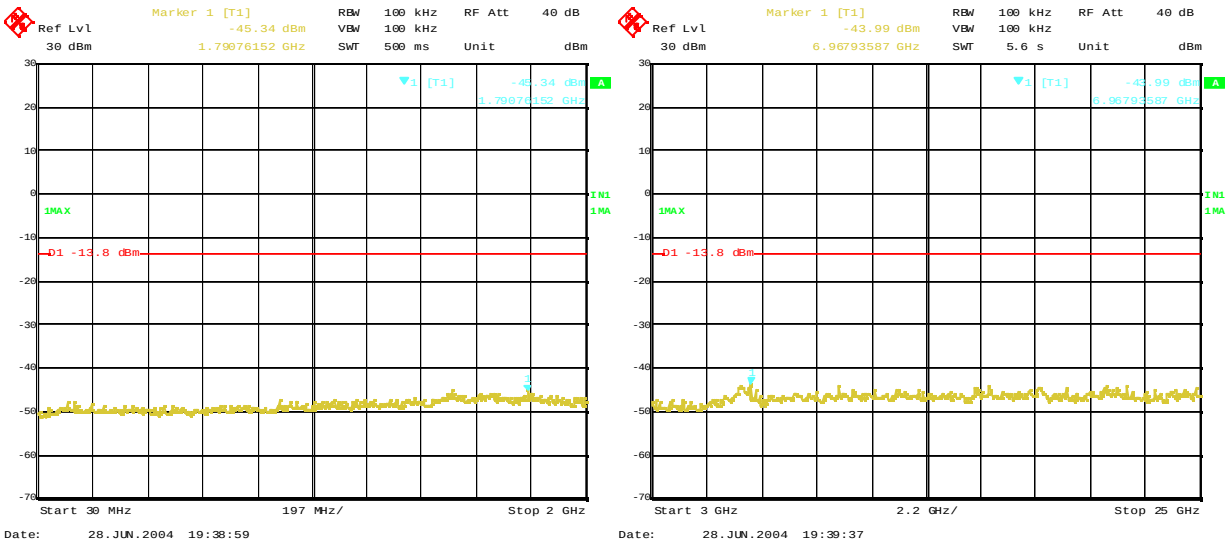
Test Date: June 28, 2004 : See the following plots.

Center Frequency (MHz)		Tx Rate (worst case)	Trace number *1
2412 (ch. 1)	DSSS	11Mbps	Plot 4-1
2437 (ch. 6)		11Mbps	Plot 4-2
2462 (ch. 11)		11Mbps	Plot 4-3
2412 (ch. 1)	OFDM	6Mbps	Plot 4-4
2437 (ch. 6)		6Mbps	Plot 4-5
2462 (ch. 11)		6Mbps	Plot 4-6
5745 (ch. 149)	OFDM	6Mbps	Plot 4-7
5785 (ch. 157)		6Mbps	Plot 4-8
5825 (ch. 165)		6Mbps	Plot 4-9

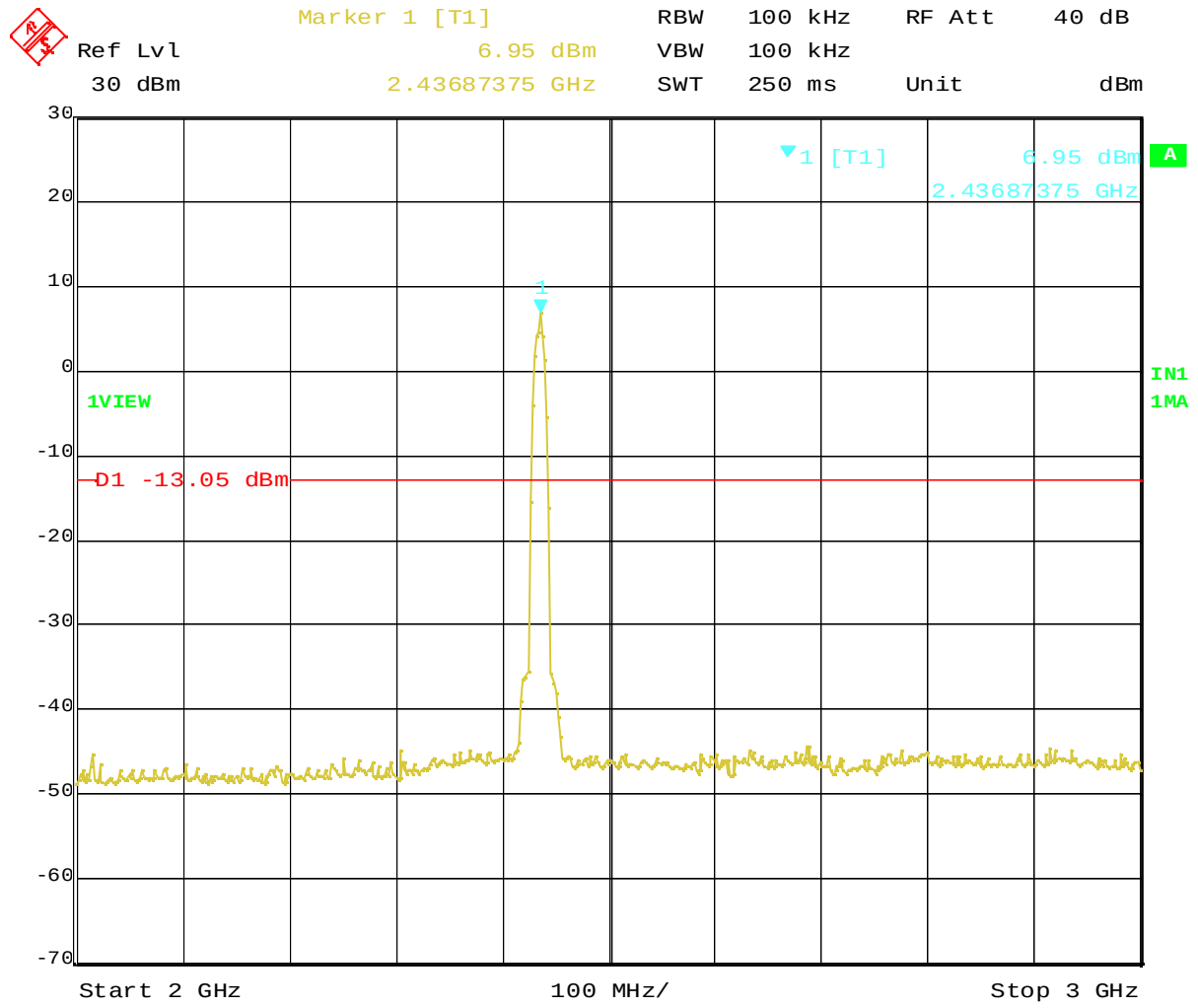
*1 : Each submittal plot includes the highest conducted spurious in the 10^{th} harmonics frequency range of each worst case in measured Tx modes.

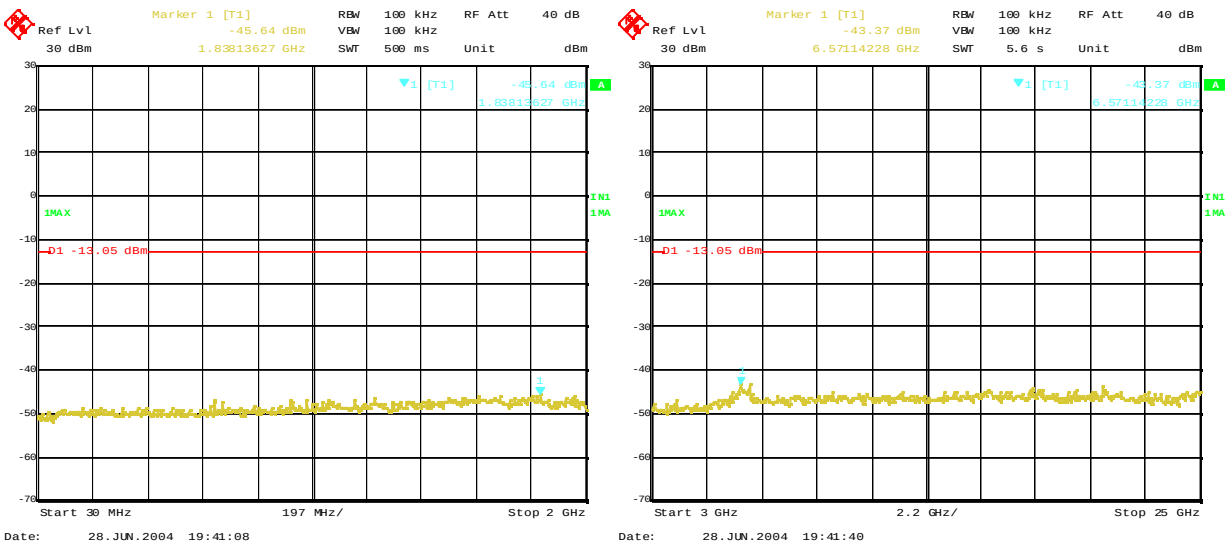
4.4 Trace Data of Out of Band Emissions



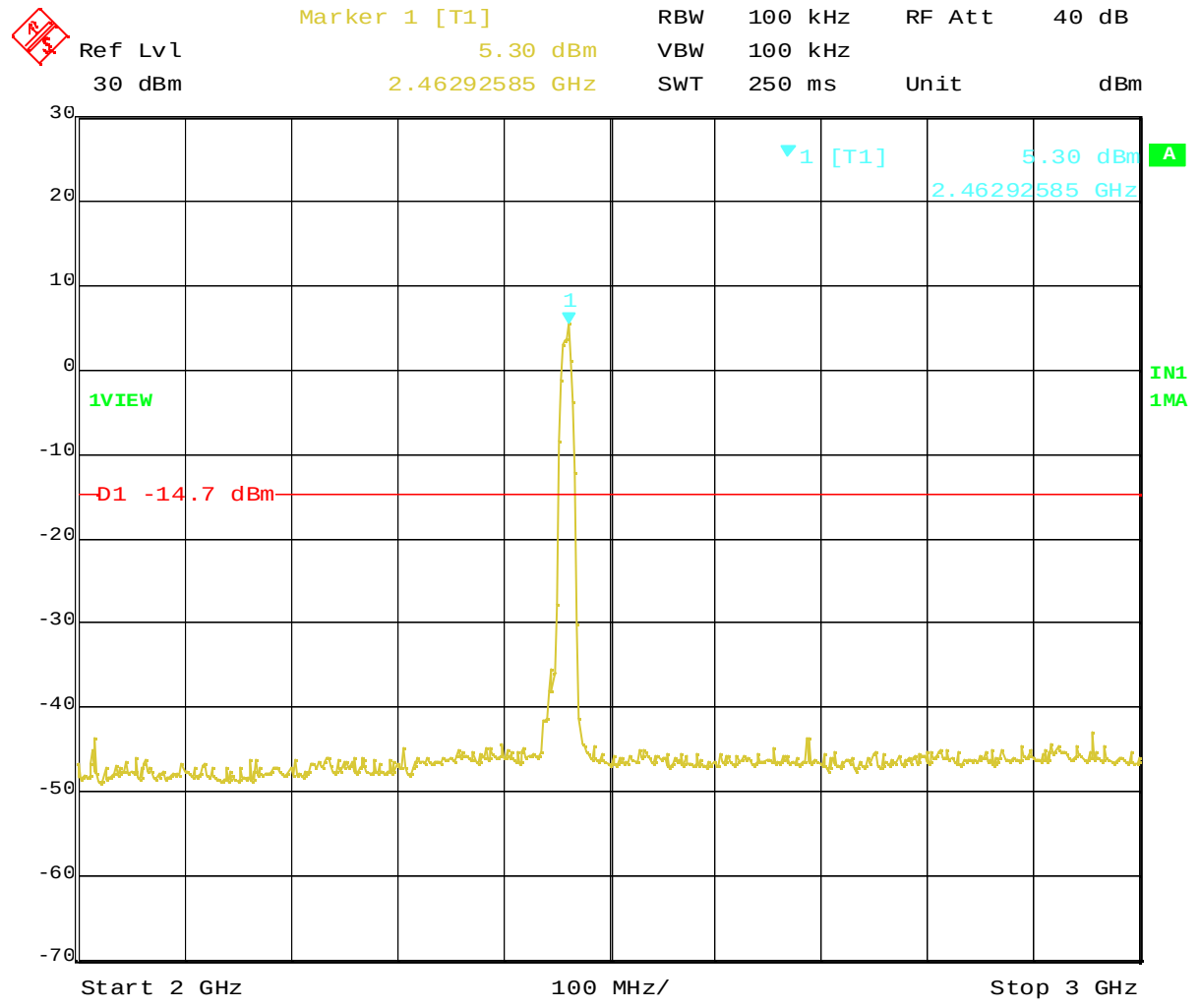


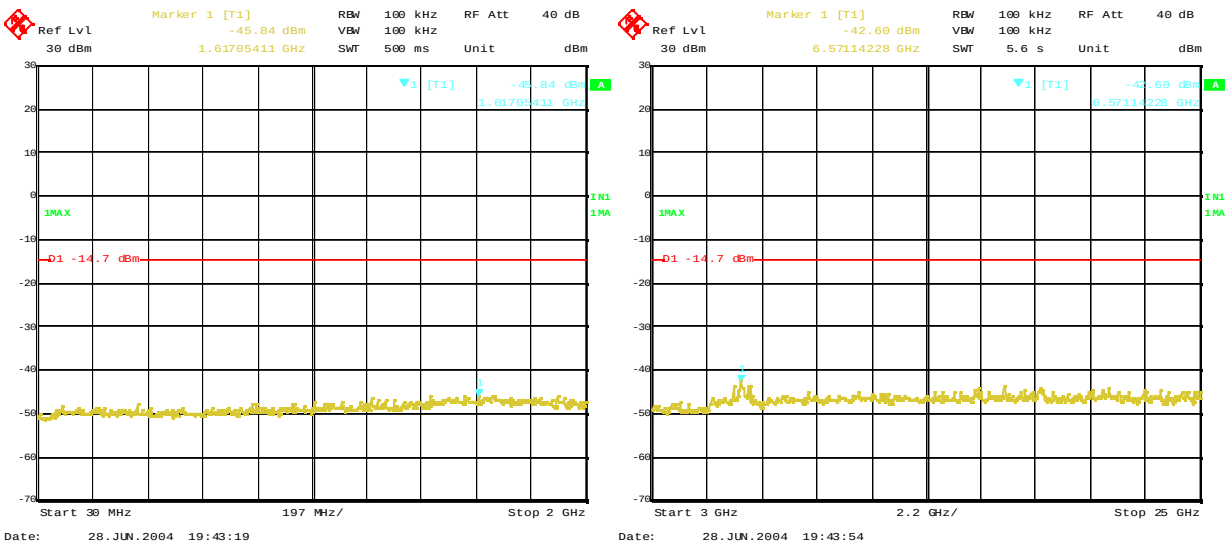
Plot 4-1. Out of band emissions around 2412MHz (DSSS, 11Mbps)



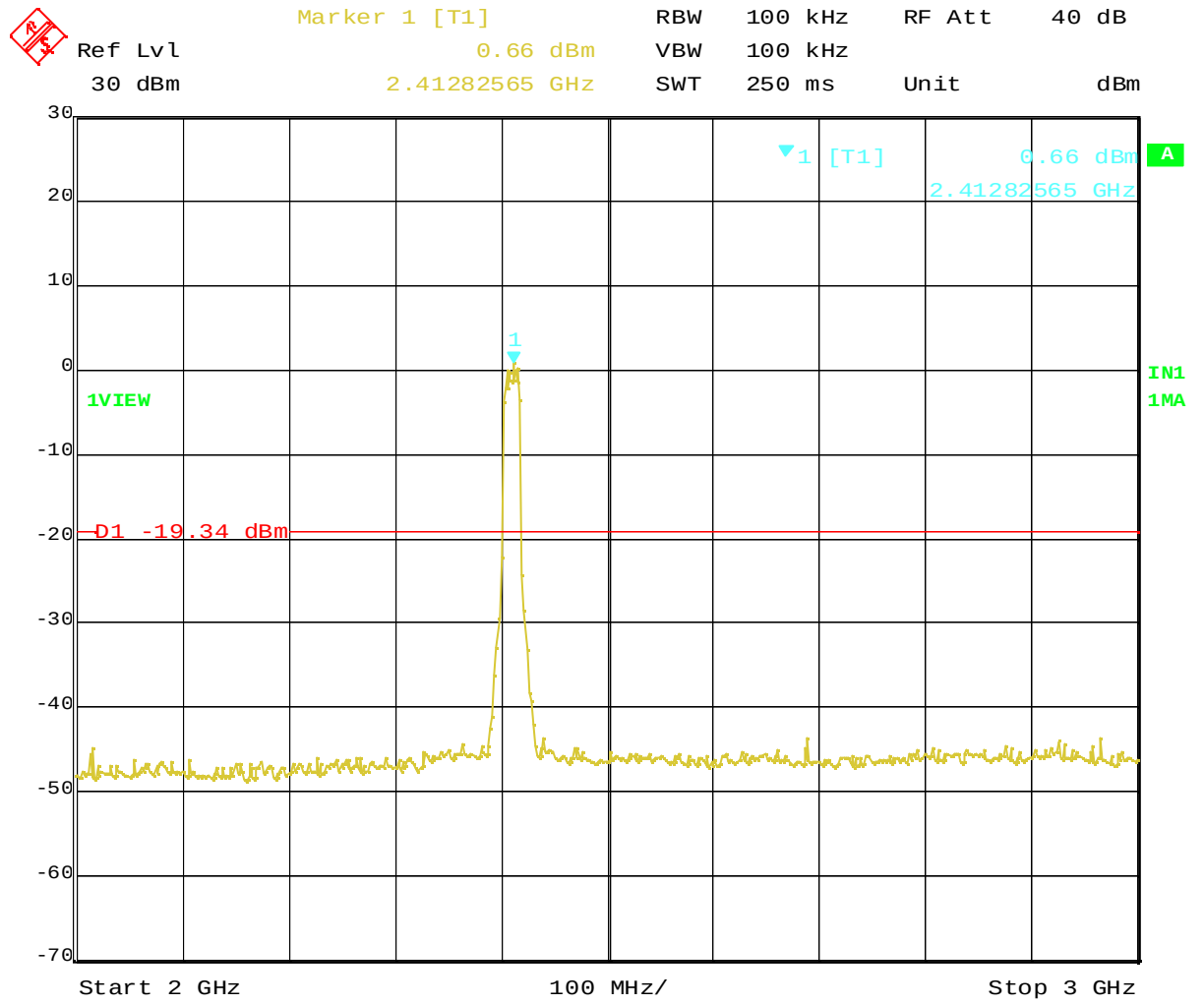


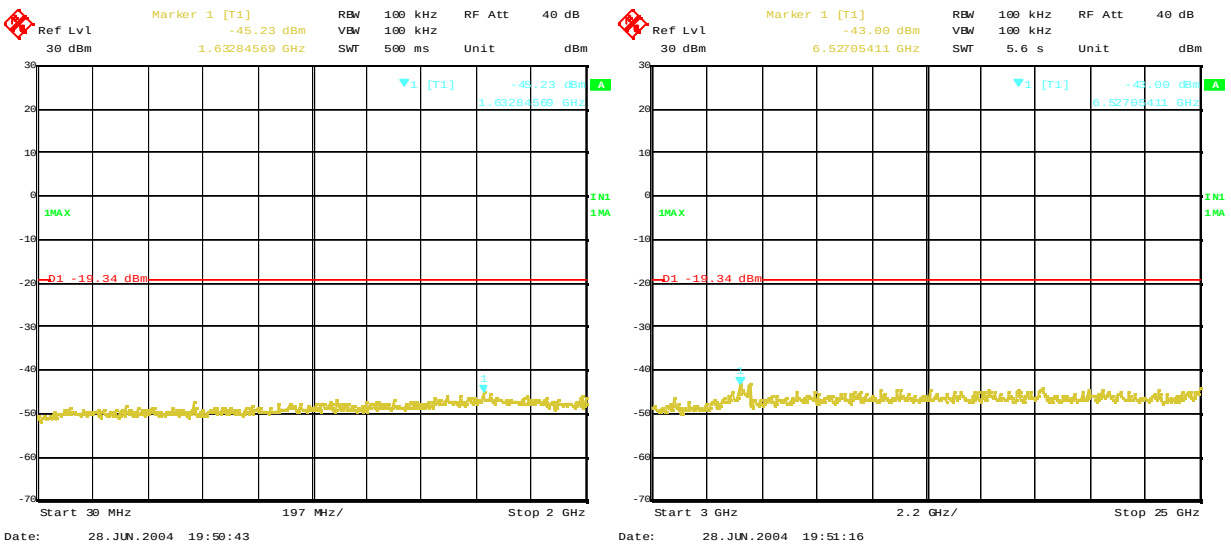
Plot 4-2. Out of band emissions around 2437MHz (DSSS, 11Mbps)



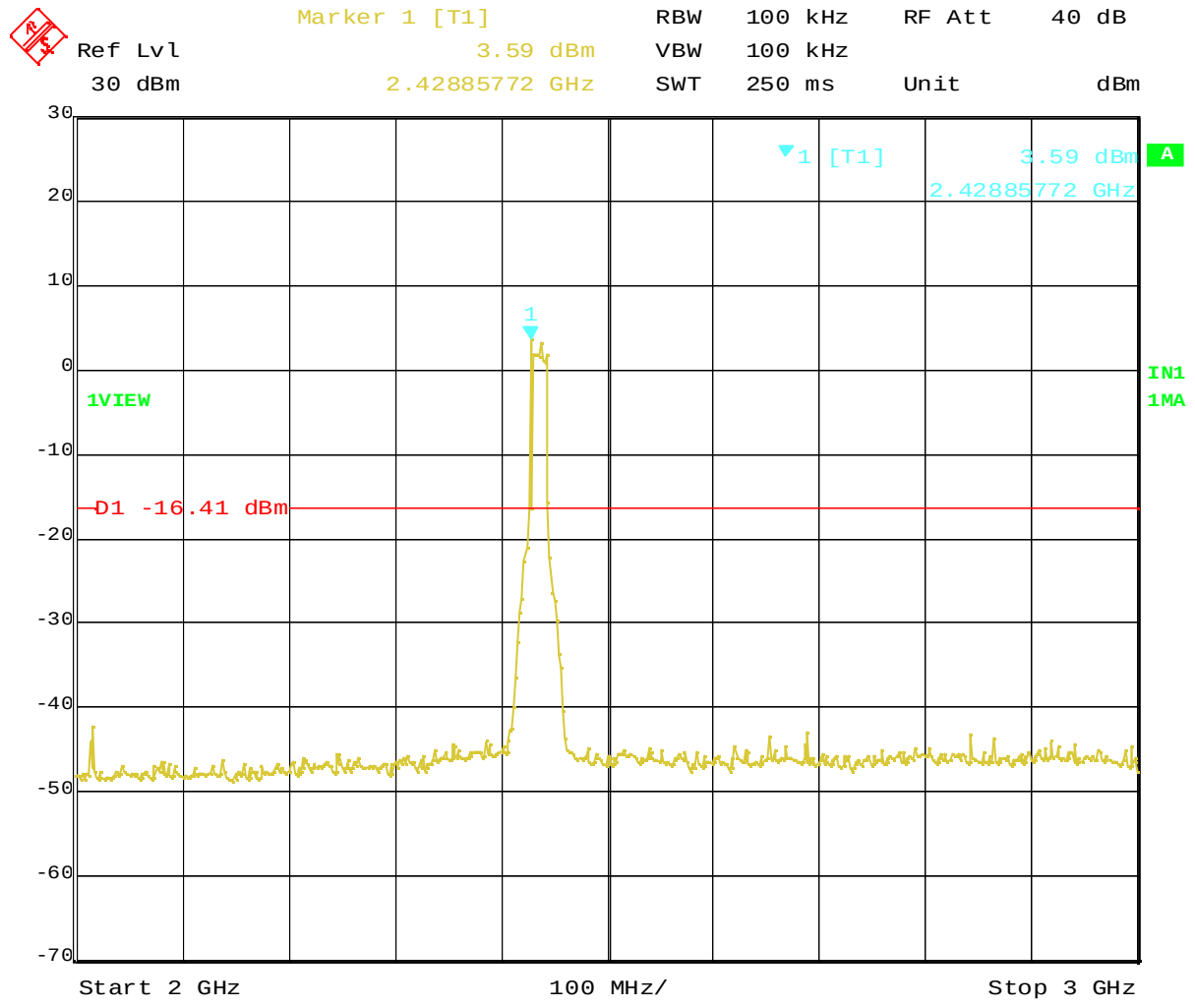


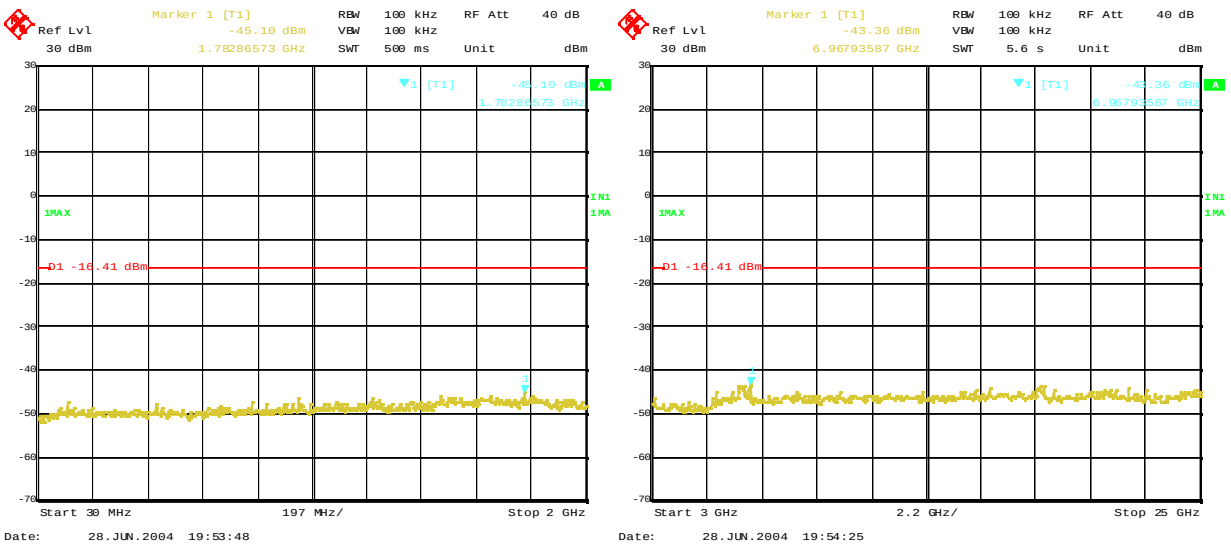
Plot 4-3. Out of band emissions around 2462MHz (DSSS, 11Mbps)



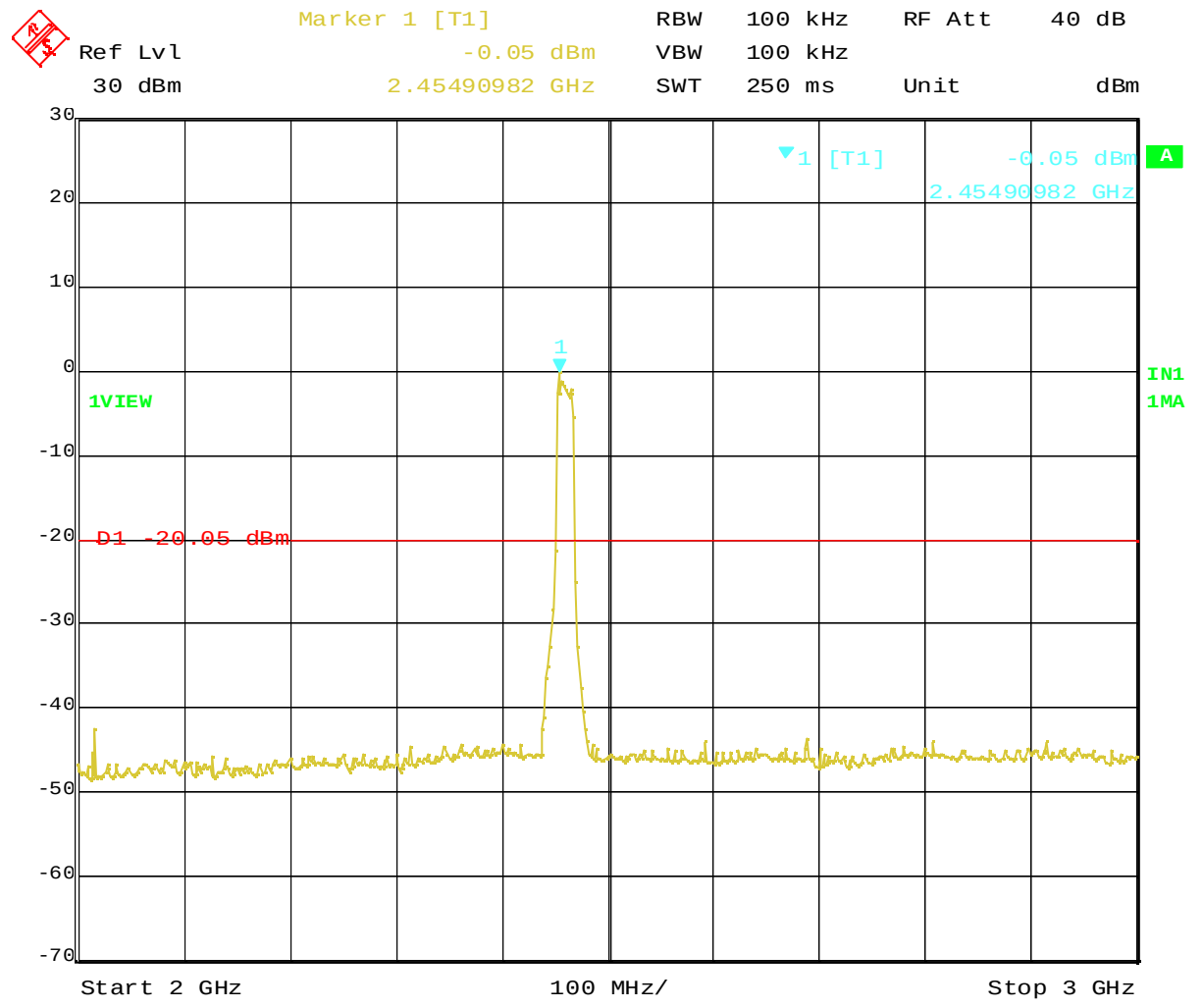


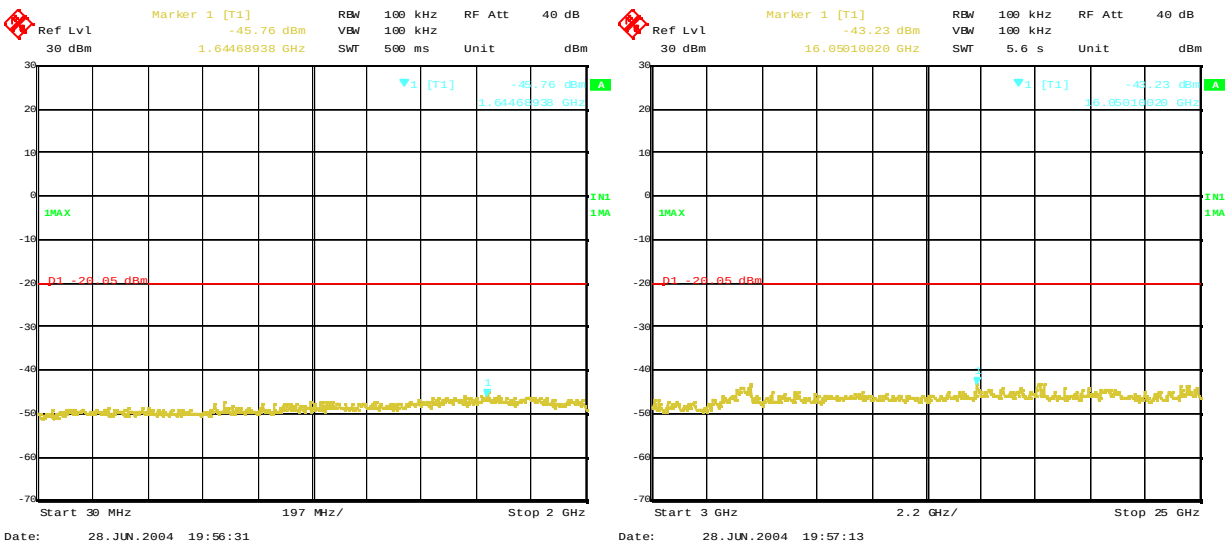
Plot 4-4. Out of band emissions around 2412MHz (OFDM, 6Mbps)



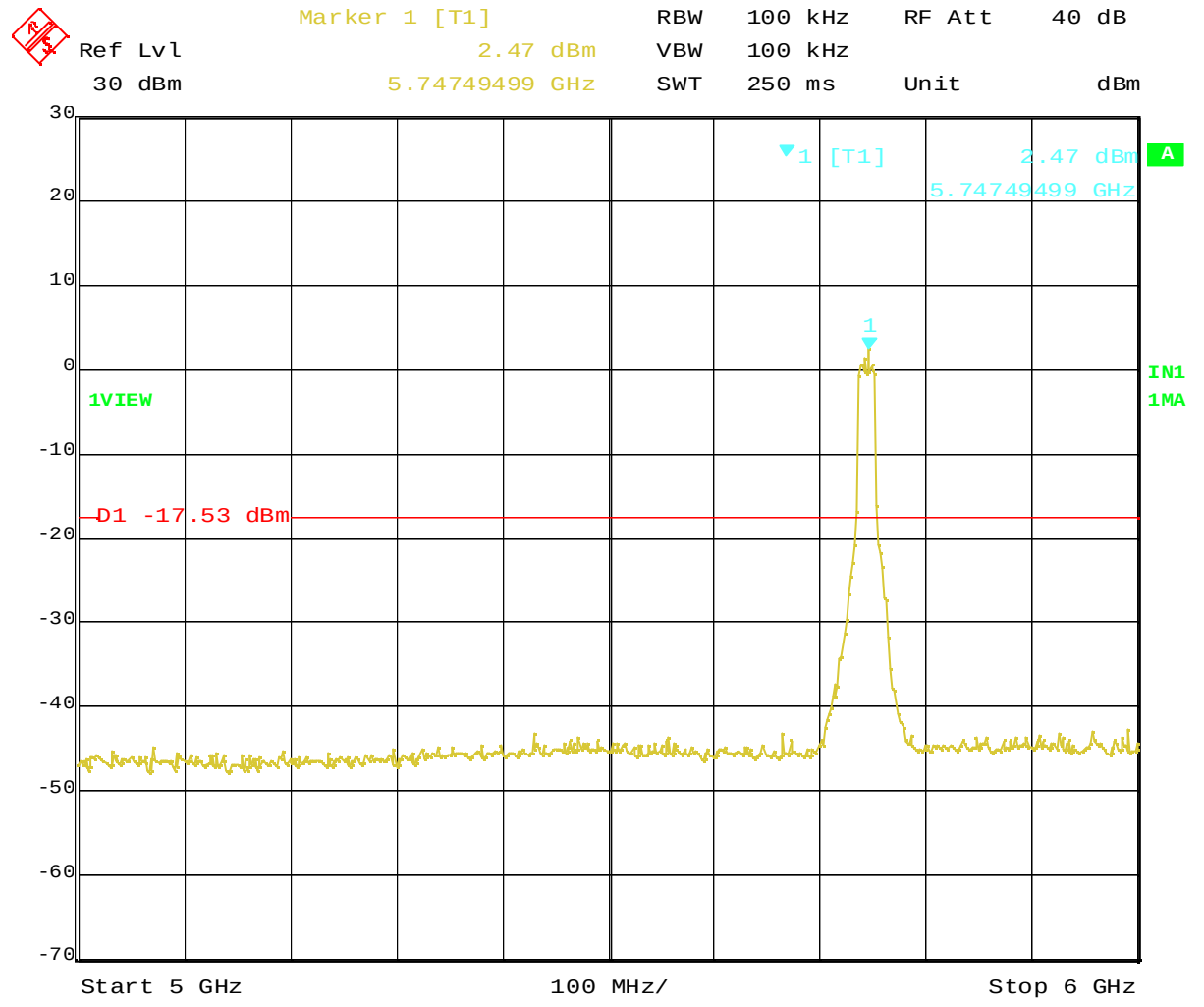


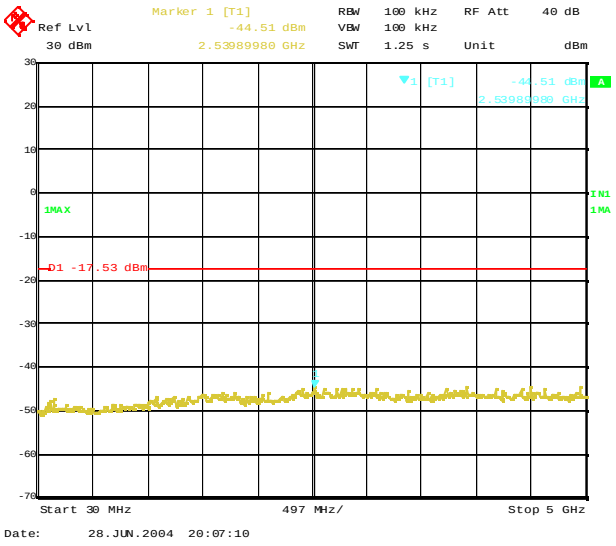
Plot 4-5. Out of band emissions around 2437MHz (OFDM, 6Mbps)

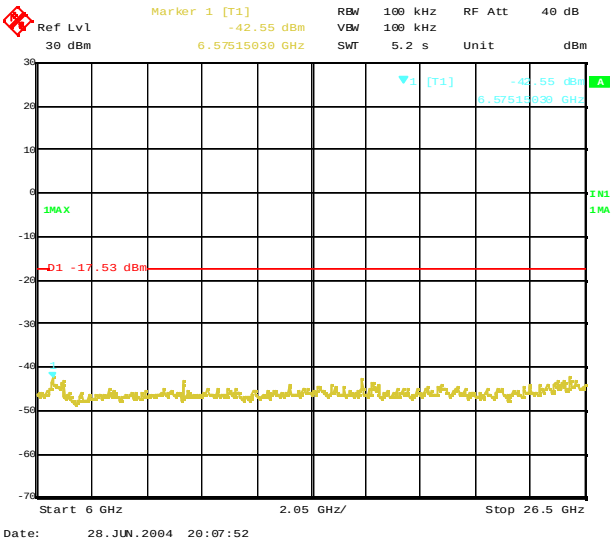




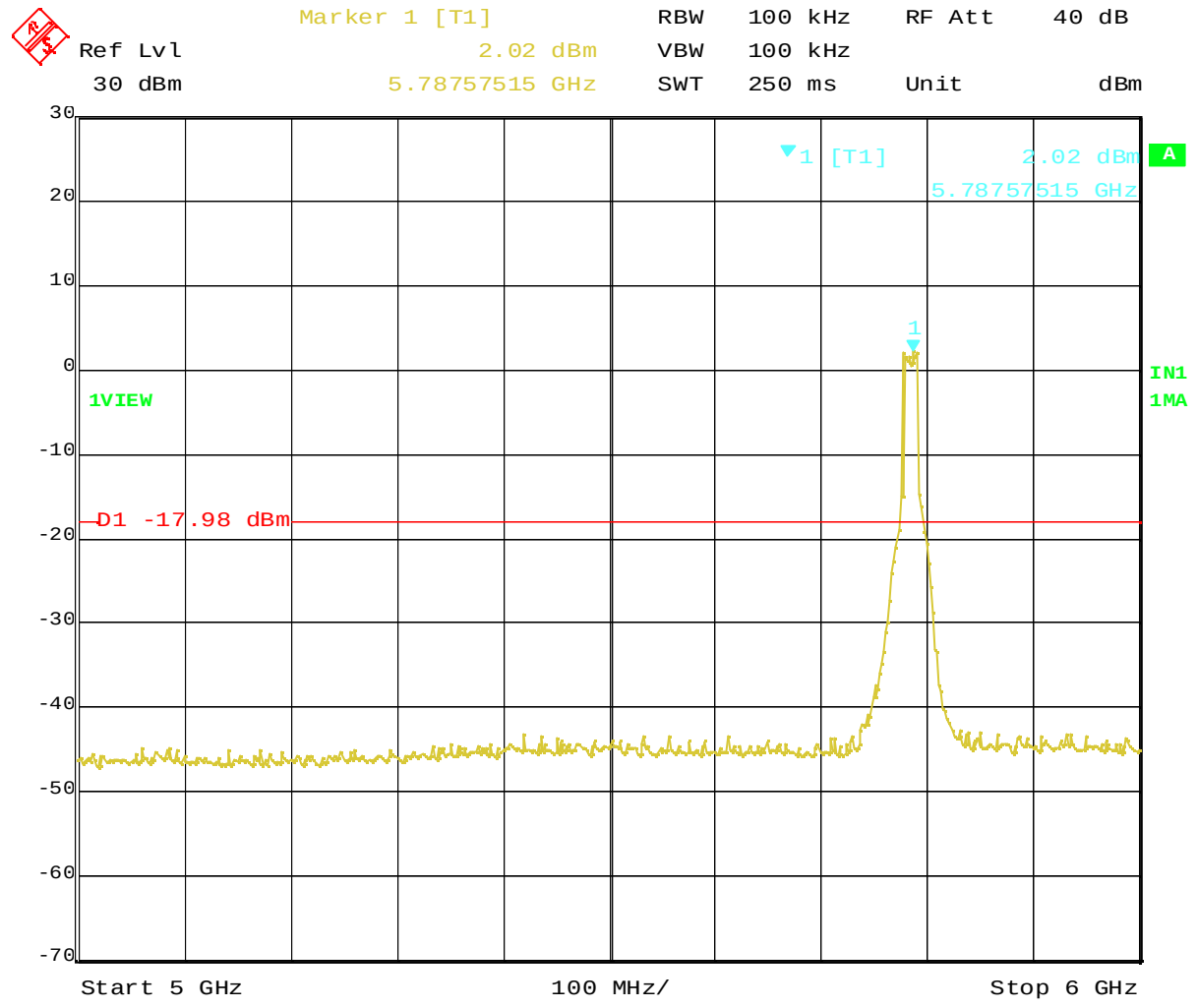
Plot 4-6. Out of band emissions around 2462MHz (OFDM, 6Mbps)

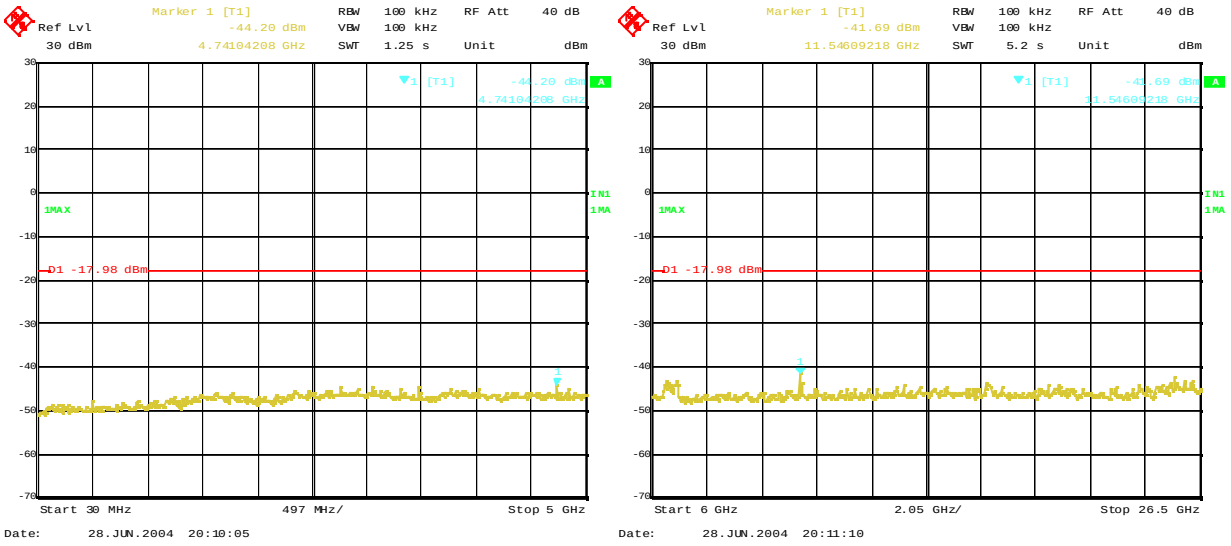




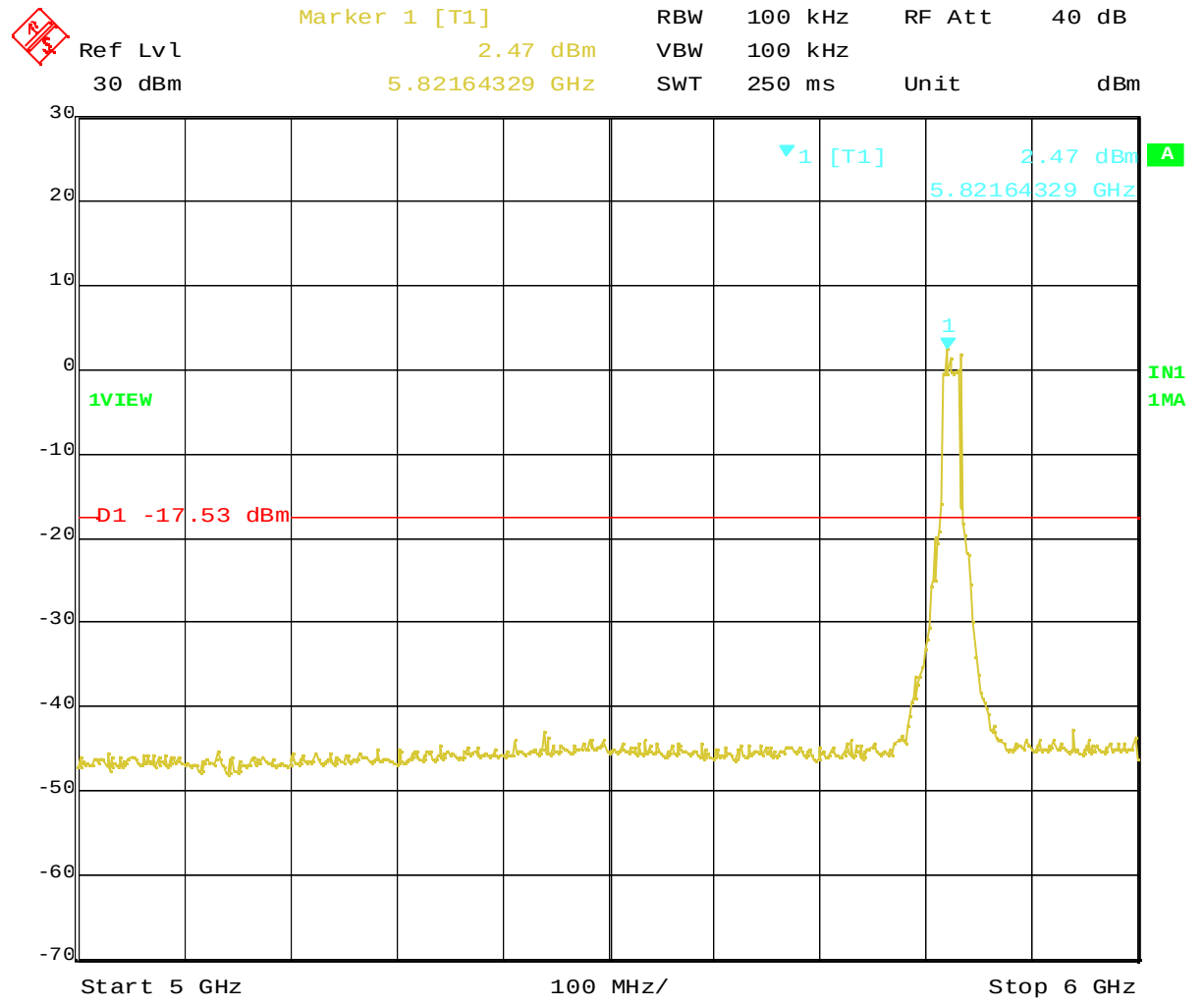


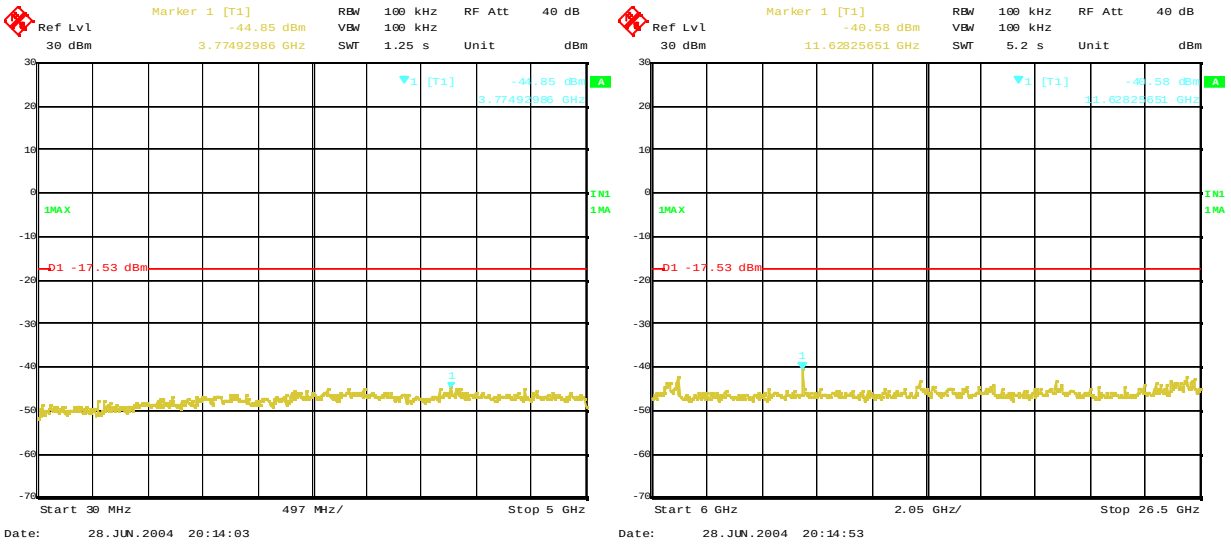
Plot 4-7. Out of band emissions around 5745MHz (OFDM, 6Mbps)





Plot 4-8. Out of band emissions around 5785MHz (OFDM, 6Mbps)





Plot 4-9. Out of band emissions around 5825MHz (OFDM, 6Mbps)

5. Peak Power Spectral Density

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

5.1 Test Procedure

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

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

RBW = 3 kHz, VBW = 3 kHz, Span = 300 kHz, Sweep = 100 seconds

5.2 Test Instruments and Measurement Setup

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

5.3 Measurement Results

The measurement was performed with the worse cases of each transmission mode, that tend to have higher conducted peak power, based on the results of previous Chapter 3, "Conducted Peak Output Power" measurement.

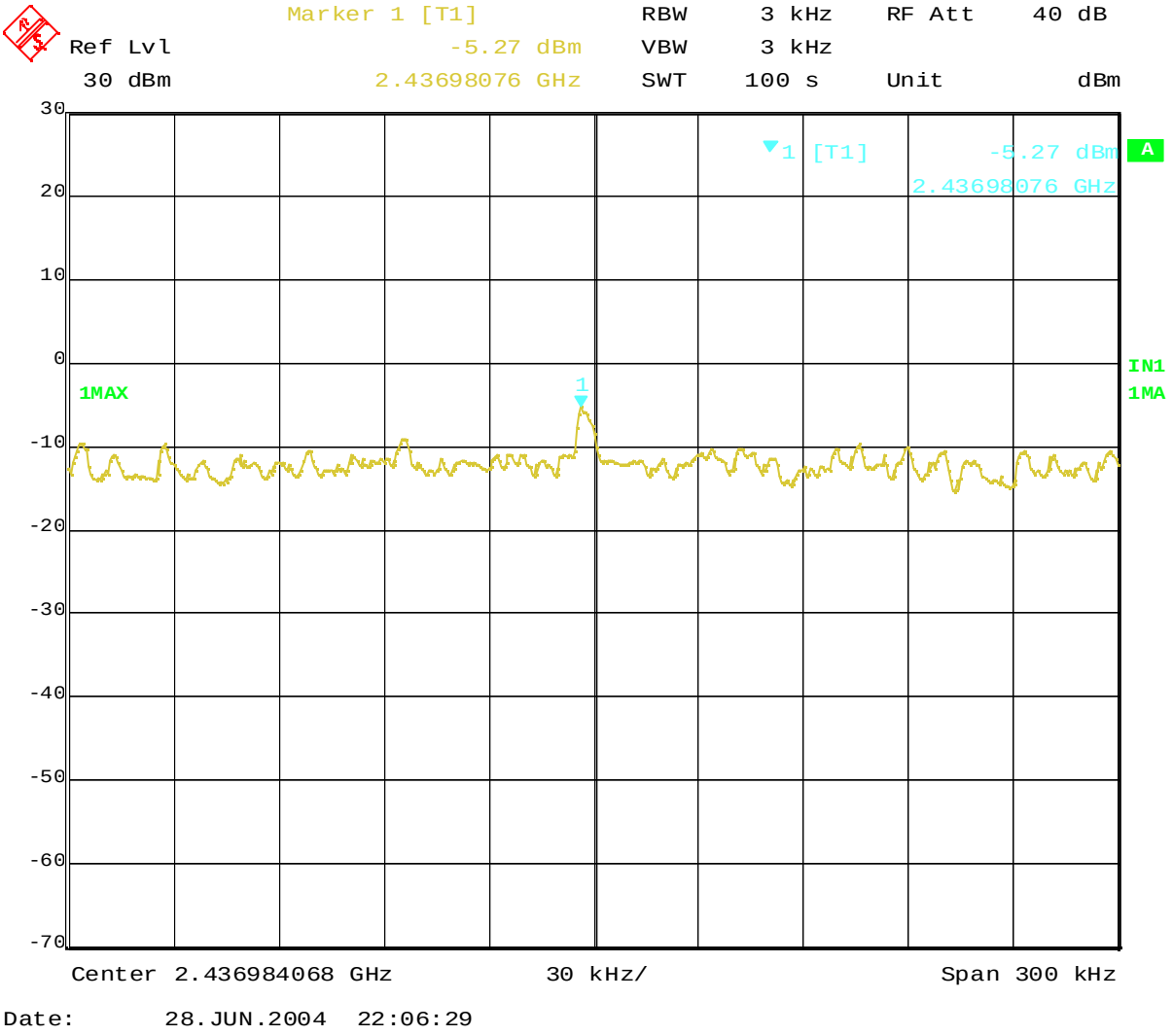
Test Date: June 28, 2004

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

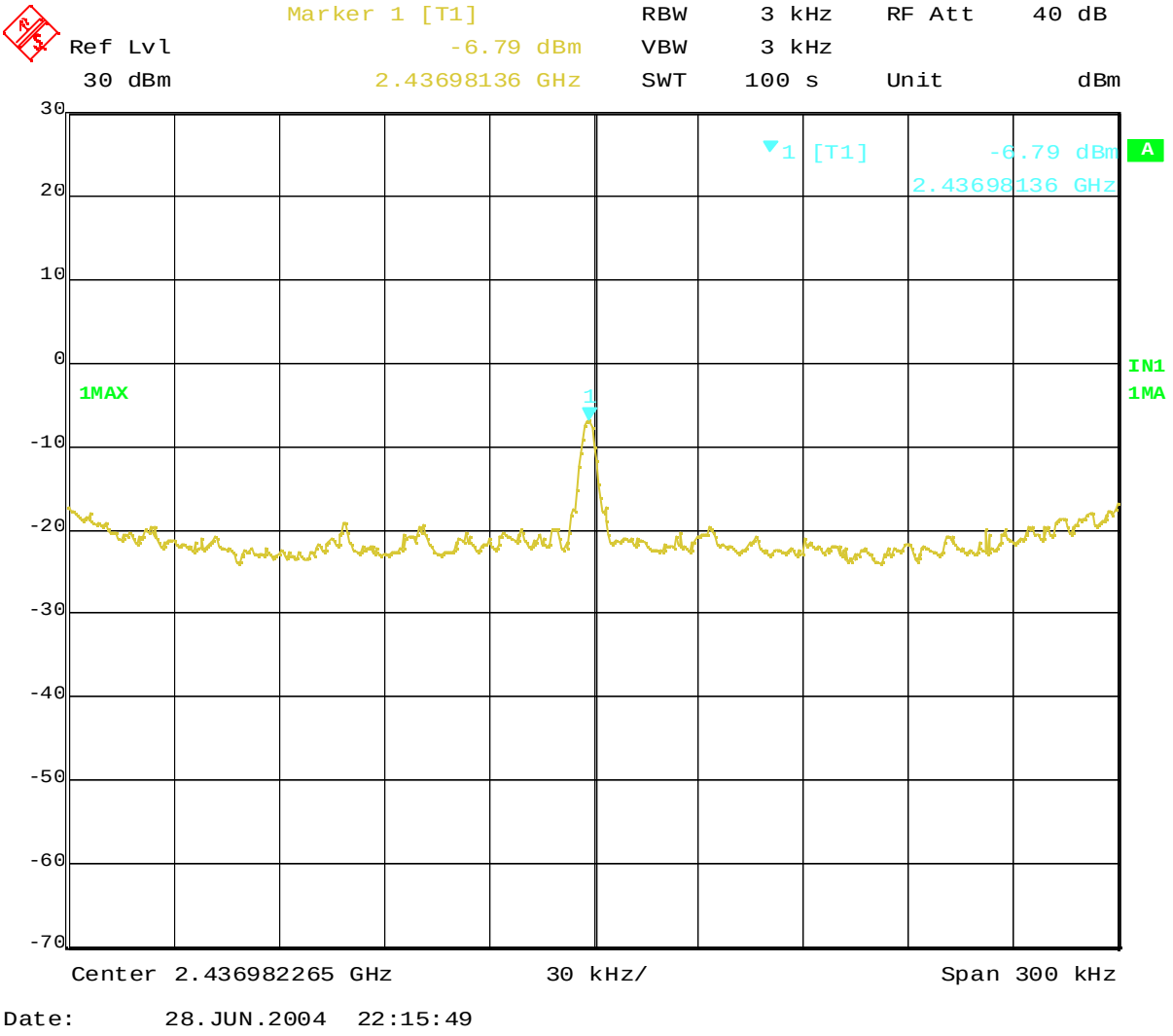
		Ch No.	Frequency (MHz)	**Analyzer Reading** (dBm)	Trace number	Cable loss (dB)	**Result** (dBm)	Limit (dBm)	Margin (dB)
DSSS	2.4GHz 11Mbps	1	2411.98	-6.11	omitted	1.3	- 4.8	8.0	12.8
		6	2436.98	-5.27	Plot 5-1	1.3	- 4.0	8.0	12.0
		11	2461.98	-6.15	omitted	1.3	- 4.9	8.0	12.9
OFDM	2.4GHz 6Mbps	1	2411.98	-10.87	omitted	1.3	- 9.6	8.0	17.6
		6	2436.98	-6.79	Plot 5-2	1.3	- 5.5	8.0	13.5
		11	2461.98	-10.23	omitted	1.3	- 8.9	8.0	16.9
	5.8GHz 6Mbps	149	5745.59	-11.04	Plot 5-3	2.3	- 8.7	8.0	16.7
		157	5785.55	-11.05	omitted	2.3	- 8.8	8.0	16.8
		165	5825.58	-11.39	omitted	2.3	- 9.1	8.0	17.1

5.4 Trace Data of Peak Power Spectral Density

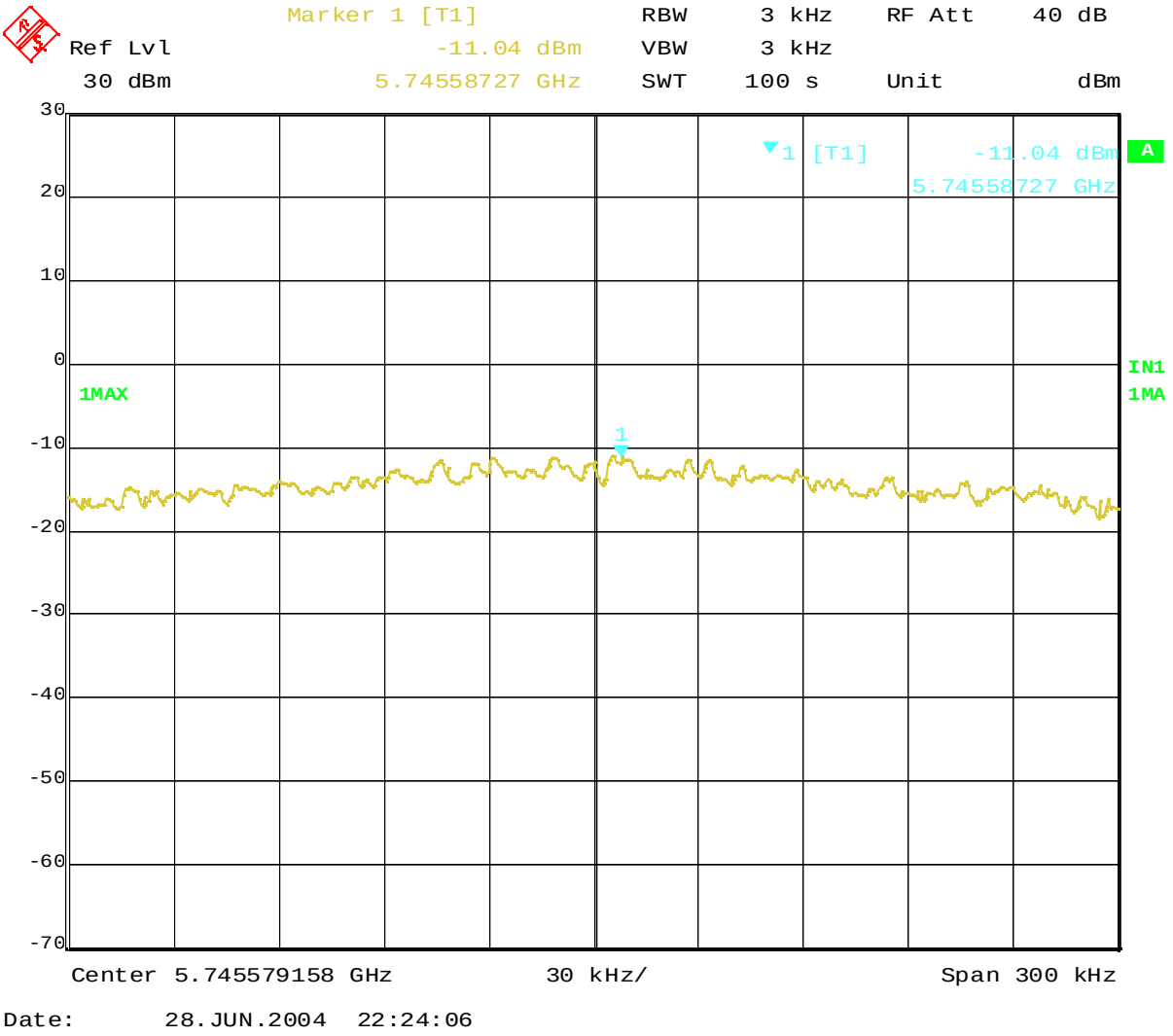
The plots are comparatively worse measurement cases of each transmission mode in the previous Table 5-1.



Plot 5-1. Peak Power Spectral Density of 2437MHz (DSSS, 11Mbps)



Plot 5-2. Peak Power Spectral Density of 2437MHz (OFDM, 6Mbps)



Plot 5-3. Peak Power Spectral Density of 5745MHz (OFDM, 6Mbps)

6. AC Wireline Conducted Emissions (150KHz – 30MHz)
[FCC 15.207, RSS-210 6.6 / 7.4]

6.1 Test Procedure

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

6.2 Test Instruments and Measurement Setup

Table 6-1. Conducted Emission Test Instrumentation

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

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

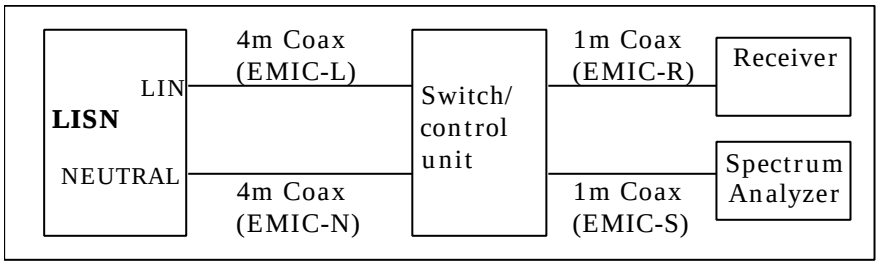


Figure 6. Cables for Conducted Emission Test

6.3 Powerline Voltage Calculation

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

PV = R + CORR

where:

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

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

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

6.4 Measurement Results

The EUT was found to comply to the limits of FCC Part 15 Subpart C and RSS-210 with a margin of 12.2dB. The 6 highest emissions relative to the limits are reported.

Test Date: July 9, 2004

6.3.1 EUT in 2.4GHz DSSS transmission mode (ThinkPad X40 Series)

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

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2023	49.1	0.5	49.6	40.8	0.5	41.3	63.5	53.5	Neutral
0.2672	39.3	0.6	39.9	32.1	0.6	32.7	61.2	51.2	Line
0.3367	32.4	0.6	33.0	26.1	0.6	26.7	59.3	49.3	Neutral
0.4694	33.1	0.6	33.7	29.5	0.6	30.1	56.5	46.5	Neutral
0.5413	27.7	0.6	28.3	22.4	0.6	23.0	56.0	46.0	Neutral
0.6062	23.8	0.6	24.4	20.7	0.6	21.3	56.0	46.0	Neutral

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

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2008	47.9	0.5	48.4	39.7	0.5	40.2	63.6	53.6	Neutral
0.2649	35.1	0.6	35.7	28.1	0.6	28.7	61.3	51.3	Neutral
0.3379	31.2	0.6	31.8	25.0	0.6	25.6	59.3	49.3	Neutral
0.5355	26.0	0.6	26.6	21.9	0.6	22.5	56.0	46.0	Neutral
0.6061	23.9	0.6	24.5	20.7	0.6	21.3	56.0	46.0	Neutral
3.5036	24.2	0.7	24.9	20.8	0.7	21.5	56.0	46.0	Neutral

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

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2015	47.1	0.5	47.6	39.2	0.5	39.7	63.5	53.5	Neutral
0.2699	38.0	0.6	38.6	31.0	0.6	31.6	61.1	51.1	Line
0.4678	31.2	0.6	31.8	28.1	0.6	28.7	56.6	46.6	Neutral
0.5400	27.9	0.6	28.5	23.8	0.6	24.4	56.0	46.0	Neutral
0.6068	23.7	0.6	24.3	20.4	0.6	21.0	56.0	46.0	Neutral
1.8162	24.0	0.7	24.7	21.1	0.7	21.8	56.0	46.0	Neutral

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

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.1999	46.4	0.5	46.9	39.2	0.5	39.7	63.6	53.6	Neutral
0.2710	37.9	0.6	38.5	29.9	0.6	30.5	61.1	51.1	Line
0.4034	30.1	0.6	30.7	26.6	0.6	27.2	57.8	47.8	Neutral
0.5410	28.3	0.6	28.9	26.4	0.6	27.0	56.0	46.0	Neutral
1.8221	25.1	0.7	25.8	23.5	0.7	24.2	56.0	46.0	Neutral
3.4430	25.1	0.7	25.8	23.2	0.7	23.9	56.0	46.0	Neutral

6.3.2 EUT in 2.4GHz OFDM transmission mode (ThinkPad X40 Series)

Table 6-2-5. Ch.1 (2412MHz) **TX** mode 6Mbps

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2042	45.5	0.5	46.0	37.5	0.5	38.0	63.4	53.4	Neutral
0.2648	34.0	0.6	34.6	27.1	0.6	27.7	61.3	51.3	Neutral
0.3355	31.2	0.6	31.8	24.7	0.6	25.3	59.3	49.3	Neutral
0.4701	33.5	0.6	34.1	30.3	0.6	30.9	56.5	46.5	Neutral
0.5375	28.1	0.6	28.7	24.2	0.6	24.8	56.0	46.0	Line
2.9613	25.7	0.7	26.4	21.8	0.7	22.5	56.0	46.0	Neutral

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

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2045	45.2	0.5	45.7	37.0	0.5	37.5	63.4	53.4	Neutral
0.2714	37.3	0.6	37.9	30.2	0.6	30.8	61.1	51.1	Line
0.3371	31.1	0.6	31.7	24.8	0.6	25.4	59.3	49.3	Neutral
0.4718	33.0	0.6	33.6	29.7	0.6	30.3	56.5	46.5	Neutral
0.5364	27.7	0.6	28.3	23.7	0.6	24.3	56.0	46.0	Line
1.8197	23.9	0.7	24.6	20.8	0.7	21.5	56.0	46.0	Neutral

Table 6-2-7. Ch.11 (2462MHz) **TX** mode 6Mbps

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2045	45.3	0.5	45.8	37.1	0.5	37.6	63.4	53.4	Neutral
0.2672	36.8	0.6	37.4	30.7	0.6	31.3	61.2	51.2	Neutral
0.3334	29.8	0.6	30.4	23.3	0.6	23.9	59.4	49.4	Neutral
0.4691	33.0	0.6	33.6	29.7	0.6	30.3	56.5	46.5	Neutral
0.5385	28.1	0.6	28.7	24.2	0.6	24.8	56.0	46.0	Line
1.8872	23.3	0.7	24.0	20.6	0.7	21.3	56.0	46.0	Line

Table 6-2-8. Ch.6 (2437MHz) **RX** mode

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2014	47.3	0.5	47.8	39.6	0.5	40.1	63.6	53.6	Neutral
0.2712	37.3	0.6	37.9	29.3	0.6	29.9	61.1	51.1	Line
0.4047	30.5	0.6	31.1	27.1	0.6	27.7	57.8	47.8	Neutral
0.4725	28.0	0.6	28.6	25.0	0.6	25.6	56.5	46.5	Line
0.5368	27.1	0.6	27.7	24.8	0.6	25.4	56.0	46.0	Neutral
1.8232	25.0	0.7	25.7	23.5	0.7	24.2	56.0	46.0	Neutral

6.3.3 EUT in 5.8GHz OFDM transmission mode (ThinkPad X30 Series)

Table 6-2-9. Ch.1 (5745MHz) **TX** mode 6Mbps

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2036	44.9	0.5	45.4	37.1	0.5	37.6	63.5	53.5	Neutral
0.2646	32.3	0.6	32.9	25.9	0.6	26.5	61.3	51.3	Neutral
0.3358	31.3	0.6	31.9	24.4	0.6	25.0	59.3	49.3	Line
0.4691	32.0	0.6	32.6	29.1	0.6	29.7	56.5	46.5	Neutral
0.5367	28.3	0.6	28.9	25.1	0.6	25.7	56.0	46.0	Line
0.6047	24.2	0.6	24.8	21.3	0.6	21.9	56.0	46.0	Neutral

Table 6-2-10. Ch.6 (5785MHz) **TX** mode 6Mbps

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2037	45.7	0.5	46.2	37.5	0.5	38.0	63.5	53.5	Neutral
0.2688	37.8	0.6	38.4	30.6	0.6	31.2	61.2	51.2	Line
0.3364	31.6	0.6	32.2	24.7	0.6	25.3	59.3	49.3	Line
0.4726	32.2	0.6	32.8	28.8	0.6	29.4	56.5	46.5	Neutral
0.5403	28.2	0.6	28.8	24.5	0.6	25.1	56.0	46.0	Neutral
1.5471	23.8	0.6	24.4	21.5	0.6	22.1	56.0	46.0	Neutral

Table 6-2-11. Ch.11 (5825MHz) **TX** mode 6Mbps

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2013	46.5	0.5	47.0	39.1	0.5	39.6	63.6	53.6	Neutral
0.2684	37.6	0.6	38.2	30.7	0.6	31.3	61.2	51.2	Line
0.3372	31.7	0.6	32.3	24.7	0.6	25.3	59.3	49.3	Line
0.4699	32.8	0.6	33.4	29.1	0.6	29.7	56.5	46.5	Neutral
0.5393	28.4	0.6	29.0	25.2	0.6	25.8	56.0	46.0	Neutral
2.9611	24.8	0.7	25.5	20.2	0.7	20.9	56.0	46.0	Neutral

Table 6-2-12. Ch.6 (5875MHz) **RX** mode

Frequency (MHz)	QP			AV			CISPR22 QP Limit (dBμV)	CISPR22 AV Limit (dBμV)	Phase
	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)	Measured Reading (dBμV)	Corr. Factor (dB)	Powerline Voltage (dBμV)			
0.2041	46.4	0.5	46.9	38.2	0.5	38.7	63.4	53.4	Line
0.2755	38.5	0.6	39.1	31.4	0.6	32.0	60.9	50.9	Line
0.3413	35.5	0.6	36.1	30.5	0.6	31.1	59.2	49.2	Neutral
0.4805	30.1	0.6	30.7	26.2	0.6	26.8	56.3	46.3	Neutral
0.5494	26.1	0.6	26.7	24.0	0.6	24.6	56.0	46.0	Neutral
1.8491	25.8	0.7	26.5	23.7	0.7	24.4	56.0	46.0	Neutral

7. Restricted Bands Radiation (30MHz – 1GHz)

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

7.1 Test Procedure

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

7.2 Test Instruments and Measurement Setup

Table 7-1 Radiated Emission Test Instrumentation

Description	**Model**	**Serial Number**
Computer	IBM 6868-30J	97-901X3
Spectrum Analyzer (100Hz-1.5GHz) for 30-200MHz	HP 85680B	2601A02634
Spectrum Analyzer Display for 30-200MHz	HP 85662A	2542A12308
Quasi-Peak Adapter for 30-200MHz	HP 85650A	2043A00062
Spectrum Analyzer (100Hz-1.5GHz) for 200-1000MHz	HP 85680B	3019A05156
Spectrum Analyzer Display for 200-1000MHz	HP 85662A	3026A19366
Quasi-Peak Adapter for 200-1000MHz	HP 85650A	2811A01433
Amplifier (100KHz-1.3GHz) - for 30-200MHz - for 200-1000MHz	 MITEQ AM-3A MITEQ AM-3A	 898433 898432
Biconical Antenna (30-200MHz)	EMCO 3108	2536
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	2849
Receiver (20MHz-1.3GHz)	R&S ESVP	893202/018
Switch/control unit	HP 3488A	2719A17226
N-Coax cables: - Bi-coni Ant <=> 10m Cable - 10m Cable <=> Shield Panel - Shield Panel <=> RF Amp - RF Amp <=> Power Splitter - Log-peri Ant <=> 10m Cable - 10m Cable <=> Shield Panel - Shield Panel <=> RF Amp - RF Amp <=> Power Splitter	Length: 9 m 10 m 7 m 0.5m 9 m 10 m 7 m 0.5m	 - EM103L01 - EM103L02 - EM103L03 - EM103L04 - EM103H01 - EM103H02 - EM103H03 - EM103H04
Coax cables: - Power Splitter <=> SW/Con.unit (SW110) - Power Splitter <=> SW/Con.unit (SW300) - Power Splitter <=> SW/Con.unit (SW100) - Power Splitter <=> SW/Con.unit (SW301) - SW/Con.unit <=> Receiver (Input) - SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz - SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	 1 m 1 m 1 m 1 m 2 m 2 m 2 m	 - EM103L05 - EM103L06 - EM103H05 - EM103H06 - EM1RCV - EM1SPL - EM1SPH

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

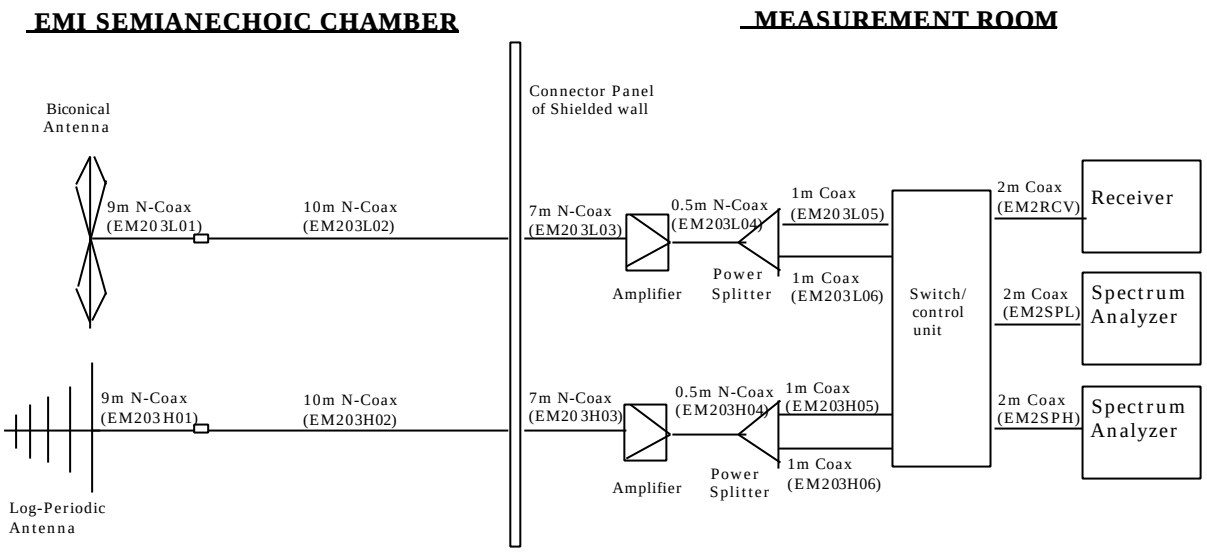


Figure 7 Cables for Radiated Emission Test

7.3 Field Strength Calculation

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

FS = R + AF + CORR

where:

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

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

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

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

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

40dBμV/m = 100μV/m
48dBμV/m = 250μV/m

7.4 Measurement Results

The EUT was found to comply to the limits of FCC Part 15 Subpart C and RSS-210 with a margin of 3.3dB at 30MHz - 1000MHz band.
The 6 highest emissions relative to the limits are reported.

Test Date: July 5 and 6, 2004

7.4.1 EUT in 2.4GHz DSSS transmission mode (ThinkPad X40 Series)

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

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
199.682	V	33.7	13.8	-26.6	20.9	43.5	11.1	150
224.933	H	42.3	10.5	-24.9	27.9	46.0	24.8	200
449.866	V	30.3	16.4	-21.8	24.9	46.0	17.6	200
497.542	V	27.9	17.7	-21.1	24.5	46.0	16.8	200
832.249	V	29.1	21.8	-18.0	32.9	46.0	44.2	200
902.237	V	20.7	22.7	-18.1	25.3	46.0	18.4	200

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

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
224.932	H	38.7	10.5	-24.9	24.3	46.0	16.4	200
274.120	H	34.2	12.8	-24.3	22.7	46.0	13.6	200
452.967	V	32.2	16.5	-21.8	26.9	46.0	22.1	200
498.911	V	28.6	17.8	-21.3	25.1	46.0	18.0	200
830.606	V	29.0	21.7	-18.2	32.5	46.0	42.2	200
904.797	H	21.5	22.7	-17.9	26.3	46.0	20.7	200

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

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
224.933	H	42.7	10.5	-24.9	28.3	46.0	26.0	200
452.992	V	31.4	16.5	-21.8	26.1	46.0	20.2	200
499.139	V	28.3	17.8	-21.3	24.8	46.0	17.4	200
664.263	H	23.9	20.4	-19.9	24.4	46.0	16.6	200
828.557	V	28.4	21.6	-18.1	31.9	46.0	39.4	200
905.004	V	24.6	22.7	-17.9	29.4	46.0	29.5	200

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

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
193.754	H	36.9	13.5	-26.7	23.7	43.5	15.3	150
224.921	H	41.9	10.5	-24.9	27.5	46.0	23.7	200
337.230	V	40.2	14.2	-23.3	31.1	46.0	35.9	200
452.397	V	32.1	16.5	-21.9	26.7	46.0	21.6	200
829.198	V	28.7	21.7	-17.7	32.7	46.0	43.2	200
899.684	V	27.1	22.7	-18.0	31.8	46.0	38.9	200

Prepared by T. Asano

7.4.2 EUT in 2.4GHz OFDM transmission mode (ThinkPad X40 Series)

Table 7-2-5. Ch.1 (2412MHz) **TX** mode 6Mbps

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)
224.937	H	43.2	10.5	-24.9	28.8	46.0	27.5	200
275.081	H	34.0	12.8	-24.3	22.5	46.0	13.3	200
424.392	V	28.2	15.7	-22.1	21.8	46.0	12.3	200
452.576	V	32.4	16.5	-21.9	27.0	46.0	22.4	200
832.262	H	29.8	21.8	-18.0	33.6	46.0	47.9	200
904.306	H	22.2	22.7	-17.9	27.0	46.0	22.4	200

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

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)
224.936	H	42.9	10.5	-24.9	28.5	46.0	26.6	200
275.116	H	34.1	12.8	-24.3	22.6	46.0	13.5	200
497.898	V	29.0	17.7	-21.4	25.3	46.0	18.4	200
599.827	V	24.9	18.7	-20.3	23.3	46.0	14.6	200
832.260	V	30.5	21.8	-18.0	34.3	46.0	51.9	200
904.617	V	27.4	22.7	-17.9	32.2	46.0	40.7	200

Table 7-2-7. Ch.11 (2462MHz) **TX** mode 6Mbps

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)
224.936	H	42.9	10.5	-24.9	28.5	46.0	26.6	200
452.446	V	32.0	16.5	-21.9	26.6	46.0	21.4	200
498.675	V	28.3	17.8	-21.3	24.8	46.0	17.4	200
729.212	V	24.7	21.1	-19.6	26.2	46.0	20.4	200
829.513	H	30.6	21.7	-17.7	34.6	46.0	53.7	200
902.845	H	22.8	22.7	-18.1	27.4	46.0	23.4	200

Table 7-2-8. Ch.6 (2437MHz) **RX** mode

Frequency (MHz)	Polarity (H/V)	Measured (dBμV)	Antenna Factor (dB/m)	Corr. Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Field Strength (μV/m)	Limit (μV/m)
224.922	H	42.4	10.5	-24.9	28.0	46.0	25.1	200
339.664	V	39.8	14.3	-23.5	30.6	46.0	33.9	200
453.273	V	32.7	16.5	-21.8	27.4	46.0	23.4	200
539.815	V	30.8	17.9	-20.9	27.8	46.0	24.5	200
829.298	V	27.4	21.7	-17.7	31.4	46.0	37.2	200
902.992	V	25.8	22.7	-18.1	30.4	46.0	33.1	200

7.4.3 EUT in 5.8GHz OFDM transmission mode (ThinkPad X30 Series)

Table 7-2-9. Ch.1 (5745MHz) **TX** mode 6Mbps

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)
84.473	V	47.7	7.9	-28.4	27.2	40.0	22.9	100
200.260	H	45.7	11.4	-25.3	31.8	43.5	38.9	150
224.608	H	47.4	10.5	-24.8	33.1	46.0	45.2	200
322.148	V	42.6	14.3	-23.8	33.1	46.0	45.2	200
454.778	V	45.6	16.5	-21.8	40.3	46.0	103.5	200
666.449	V	35.2	20.5	-20.0	35.7	46.0	61.0	200

Table 7-2-10. Ch.6 (5785MHz) **TX** mode 6Mbps

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)
200.290	H	46.2	11.4	-25.3	32.3	43.5	41.2	150
287.998	H	44.2	13.4	-23.7	33.9	46.0	49.5	200
322.145	V	40.6	14.3	-23.8	31.1	46.0	35.9	200
454.777	V	45.9	16.5	-21.8	40.6	46.0	107.2	200
575.995	V	34.1	18.4	-20.5	32.0	46.0	39.8	200
667.388	H	29.5	20.6	-20.1	30.0	46.0	31.6	200

Table 7-2-11. Ch.11 (5825MHz) **TX** mode 6Mbps

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)
200.294	H	46.2	11.4	-25.3	32.3	43.5	41.2	150
287.997	H	44.6	13.4	-23.7	34.3	46.0	51.9	200
454.777	V	47.1	16.5	-21.8	41.8	46.0	123.0	200
575.995	V	34.4	18.4	-20.5	32.3	46.0	41.2	200
666.984	V	35.5	20.5	-20.0	36.0	46.0	63.1	200
799.164	H	29.1	21.1	-19.1	31.1	46.0	35.9	200

Table 7-2-12. Ch.6 (5875MHz) **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)
191.338	V	41.8	13.3	-26.9	28.2	43.5	25.7	150
287.998	H	45.7	13.4	-23.7	35.4	46.0	58.9	200
324.841	V	41.4	14.2	-23.7	31.9	46.0	39.4	200
389.811	V	35.6	15.0	-22.7	27.9	46.0	24.8	200
454.778	V	48.0	16.5	-21.8	42.7	46.0	136.5	200
665.609	V	28.8	20.5	-20.2	29.1	46.0	28.5	200

8. Restricted Bands Radiatio (1GHz – 40GHz)

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

8.1 Test Procedure

Radiated emissions were measured in the frequency range with 1 GHz to 40GHz in transmitting mode and 1 GHz to 25GHz 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 40 GHz where test distance was reduced to 1 meter) on both horizontal and vertical polarities. The antenna was also scanned in height. The emissions are recorded with a spectrum analyzer in peak hold mode. The identified emissions are further maximized as a function of cable manipulation, azimuth, and antenna height. The emissions closest to the limits are measured in the peak mode with the tuned spectrum analyzer using resolution bandwidth of 1MHz / video bandwidth of 1MHz, and the average setting mode with the tuned spectrum analyzer using resolution bandwidth of 1MHz / video bandwidth of 100Hz or 10Hz. The highest emissions relative to the limit are listed.

8.2 Test Instruments and Measurement Setup

Table 8 Radiated Emission Test Instrumentation (1GHz – 40GHz)

Description	**Model**	**Serial Number**
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003
Spectrum Analyzer	HP 8563E	3416A02248
Harmonic Mixer (26.5 – 40GHz)	Agilent 11970A	011269-001
Amplifier (1 - 18GHz)	HP 8449B	3008A00582
Amplifier (18 – 40GHz)	Agilent 83051A	3950M00193
Horn Antenna (1 - 18GHz)	EMCO 3115	9903-5774
Horn Antenna (3.95 – 5.85GHz)	EMCO 3160-5	1099
Horn Antenna (5.85 – 8.2GHz)	EMCO 3160-6	9712-1044
Horn Antenna (8.2 – 12.4GHz)	EMCO 3160-7	1156
Horn Antenna (12.4 – 18GHz)	EMCO 3160-8	1143
Horn Antenna (18 - 26.5GHz)	EMCO 3160-9	0004-1202
Horn Antenna (26.5 - 40GHz)	EMCO 3160-10	1175
Coaxial cables: - Horn Ant <=> RF Amp. (1-18GHz) - RF Amp.<=>Spectrum Analyzer (1-12.4GHz) - RF Amp.<=>Spectrum Analyzer (12.4-18GHz) - Horn Ant <=> RF Amp. (18-40GHz) - RF Amp.<=>Spectrum Analyzer (18-40GHz)	Length: 6 m 16 m 3m 3m 1m	 - EM206SCO - GEM0101 - SF102-20166 - SF102-20167 - SF102-21105

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

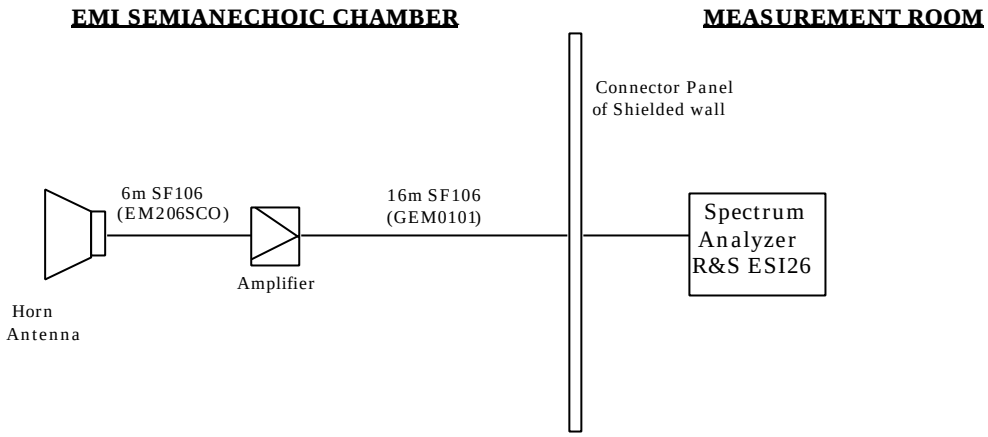


Figure 8-1. Cables for Radiated Emission Test (1 – 12.4 GHz)

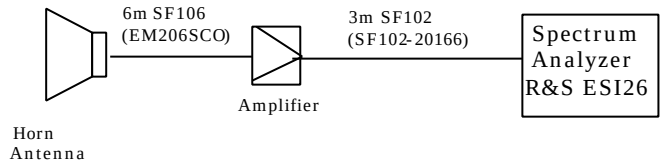


Figure 8-2. Cables for Radiated Emission Test (12.4 - 18GHz)

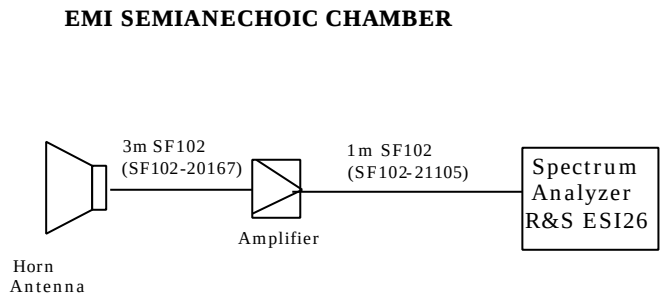


Figure 8-3. Cables for Radiated Emission Test (18 – 26.5GHz)

EMI SEMIANECHOIC CHAMBER

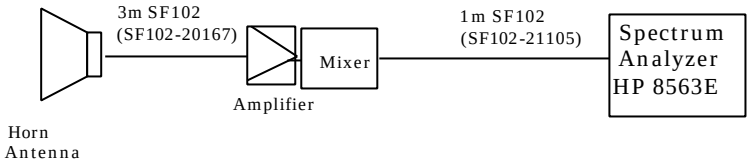


Figure 8-4. Cables for Radiated Emission Test (26.5 - 40GHz)

8.3 Field Strength Calculation

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

FS = R + AF + CORR - FO

where:

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

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

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

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

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

8.4 Measurement Results

The EUT was found to comply to the limits of FCC Part 15 Subpart C and RSS-210 with a margin of 1.9 dB. The measurement was done for the frequency range of 1 GHz to 40 GHz in TX mode and 1 GHz to 25GHz in RX mode.

Test Date: June 29, 30, July 1 and 2, 2004

8.4.1 EUT in 2.4GHz DSSS transmission mode (ThinkPad X40 Series)

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

Table 8-2-1. Ch.1 (2412MHz) **TX** mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.414	H	115.1	106.8	28.3	-29.1	0.0	114.3	OB*	106.0	OB*
Adjacent RB										
2.370	H	64.1	45.2	28.2	-29.2	0.0	63.1	74.0	44.2	54.0
2.387	H	63.3	50.0	28.2	-29.2	0.0	62.3	74.0	49.0	54.0
2.390	H	60.9	49.5	28.2	-29.2	0.0	59.9	74.0	48.5	54.0
1.065	V	48.6	-	24.6	-31.7	0.0	41.5	74.0	-	54.0
1.094	V	48.6	-	24.4	-31.5	0.0	41.5	74.0	-	54.0
1.125	V	48.9	-	24.5	-31.5	0.0	41.9	74.0	-	54.0
1.166	V	52.4	-	24.6	-31.3	0.0	45.7	74.0	-	54.0
2.361	H	53.1	-	28.1	-29.2	0.0	52.0	74.0	-	54.0
4.826	V	61.2	31.6	27.1	-26.6	0.0	61.7	74.0	32.1	54.0

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

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.436	H	114.7	106.2	28.4	-29.2	0.0	113.9	OB*	105.4	OB*
Adjacent RB										
2.385	H	60.7	46.6	28.2	-29.2	0.0	59.7	74.0	45.6	54.0
2.390	H	60.8	46.7	28.2	-29.2	0.0	59.8	74.0	45.7	54.0
2.484	H	51.8	-	28.4	-29.1	0.0	51.1	74.0	-	54.0
1.065	V	49.1	-	24.6	-31.7	0.0	42.0	74.0	-	54.0
1.109	V	48.3	-	24.4	-31.5	0.0	41.2	74.0	-	54.0
1.125	V	48.3	-	24.5	-31.5	0.0	41.3	74.0	-	54.0
1.161	V	51.6	-	24.6	-31.3	0.0	44.9	74.0	-	54.0
2.361	V	52.6	-	28.1	-29.2	0.0	51.5	74.0	-	54.0
2.369	V	51.9	-	28.1	-29.2	0.0	50.8	74.0	-	54.0
2.378	V	52.8	-	28.2	-29.2	0.0	51.8	74.0	-	54.0
2.382	H	54.8	-	28.2	-29.2	0.0	53.8	74.0	-	54.0
4.874	H	61.4	28.3	27.0	-26.6	0.0	61.8	74.0	28.7	54.0
7.310	H	44.2	-	29.9	-24.4	0.0	49.7	74.0	-	54.0

Table 8-2-3. Ch.11 (2462MHz) **TX** mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.460	H	112.4	104.4	28.4	-29.2	0.0	111.6	OB*	103.6	OB*
Adjacent RB										
2.484	H	55.1	42.8	28.4	-29.1	0.0	54.4	74.0	42.1	54.0
2.487	H	55.7	44.0	28.4	-29.1	0.0	55.0	74.0	43.3	54.0
2.488	H	55.9	43.9	28.4	-29.1	0.0	55.2	74.0	43.2	54.0
1.028	V	48.4	-	24.3	-31.9	0.0	40.8	74.0	-	54.0
1.097	V	49.3	-	24.4	-31.5	0.0	42.2	74.0	-	54.0
1.126	V	48.2	-	24.5	-31.5	0.0	41.2	74.0	-	54.0
1.160	V	50.8	-	24.6	-31.3	0.0	44.1	74.0	-	54.0
2.361	V	52.9	-	28.1	-29.2	0.0	51.8	74.0	-	54.0
2.368	H	53.1	-	28.1	-29.2	0.0	52.0	74.0	-	54.0
2.379	H	53.1	-	28.2	-29.2	0.0	52.1	74.0	-	54.0
2.389	H	55.1	41.4	28.2	-29.2	0.0	54.1	74.0	40.4	54.0
4.926	H	55.4	27.5	27.0	-26.4	0.0	56.0	74.0	28.1	54.0
7.384	V	38.7	-	29.8	-24.7	0.0	43.8	74.0	-	54.0

Table 8-2-4. Ch.6 (2437MHz) **RX** mode

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
1.049	V	49.3	-	24.6	-31.8	0.0	42.1	74.0	-	54.0
1.079	V	49.3	-	24.5	-31.5	0.0	42.3	74.0	-	54.0
1.128	V	49.5	-	24.5	-31.5	0.0	42.5	74.0	-	54.0
1.184	V	49.1	-	24.9	-31.3	0.0	42.7	74.0	-	54.0

8.4.2 EUT in 2.4GHz OFDM transmission mode (ThinkPad X40 Series)

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

Table 8-2-5. Ch.1 (2412MHz) **TX** mode 6Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.416	H	112.1	101.3	28.3	-29.1	0.0	111.3	OB*	100.5	OB*
Adjacent RB										
2.387	H	68.1	47.3	28.2	-29.2	0.0	67.1	74.0	46.3	54.0
2.389	H	71.0	51.0	28.2	-29.2	0.0	70.0	74.0	50.0	54.0
2.390	H	72.4	53.1	28.2	-29.2	0.0	71.4	74.0	52.1	54.0
1.129	V	48.8	-	24.5	-31.5	0.0	41.8	74.0	-	54.0
1.150	V	51.3	-	24.6	-31.3	0.0	44.6	74.0	-	54.0
1.160	V	54.2	-	24.6	-31.3	0.0	47.5	74.0	-	54.0
1.327	V	50.5	-	25.6	-31.0	0.0	45.1	74.0	-	54.0
2.361	V	51.6	-	28.1	-29.2	0.0	50.5	74.0	-	54.0
2.375	V	51.3	-	28.2	-29.2	0.0	50.3	74.0	-	54.0
2.384	V	52.9	-	28.2	-29.2	0.0	51.9	74.0	-	54.0
4.824	H	54.5	26.2	27.1	-26.6	0.0	55.0	74.0	26.7	54.0

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

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.432	H	114.2	103.6	28.4	-29.2	0.0	113.4	OB*	102.8	OB*
Adjacent RB										
2.384	H	64.4	46.0	28.2	-29.2	0.0	63.4	74.0	45.0	54.0
2.390	H	60.6	46.4	28.2	-29.2	0.0	59.6	74.0	45.4	54.0
2.484	H	54.1		28.4	-29.1	0.0	53.4	74.0	-	54.0
1.128	V	49.4	-	24.5	-31.5	0.0	42.4	74.0	-	54.0
1.150	V	51.3	-	24.6	-31.3	0.0	44.6	74.0	-	54.0
1.160	V	54.9	-	24.6	-31.3	0.0	48.2	74.0	-	54.0
1.328	V	49.8	-	25.6	-31.0	0.0	44.4	74.0	-	54.0
2.360	V	52.3	-	28.1	-29.2	0.0	51.2	74.0	-	54.0
2.372	V	50.8	-	28.2	-29.2	0.0	49.8	74.0	-	54.0
2.382	V	51.7	-	28.2	-29.2	0.0	50.7	74.0	-	54.0
4.876	H	57.1	28.6	27.0	-26.6	0.0	57.5	74.0	29.0	54.0
7.303	V	47.5	-	29.9	-24.4	0.0	53.0	74.0	-	54.0

Table 8-2-7. Ch.11 (2462MHz) **TX** mode 6Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
2.455	H	110.1	99.8	28.4	-29.2	0.0	109.3	OB*	99.0	OB*
Adjacent RB										
2.484	H	67.1	46.7	28.4	-29.1	0.0	66.4	74.0	46.0	54.0
2.486	H	61.8	43.3	28.4	-29.1	0.0	61.1	74.0	42.6	54.0
1.121	V	49.0	-	24.5	-31.5	0.0	42.0	74.0	-	54.0
1.150	V	48.5	-	24.6	-31.3	0.0	41.8	74.0	-	54.0
1.163	V	53.2	-	24.6	-31.3	0.0	46.5	74.0	-	54.0
1.327	V	49.8	-	25.6	-31.0	0.0	44.4	74.0	-	54.0
2.360	V	52.8	-	28.1	-29.2	0.0	51.7	74.0	-	54.0
2.372	V	51.5	-	28.2	-29.2	0.0	50.5	74.0	-	54.0
2.382	V	54.2	-	28.2	-29.2	0.0	53.2	74.0	-	54.0
2.386	V	54.3	-	28.2	-29.2	0.0	53.3	74.0	-	54.0
4.924	H	47.9	-	27.0	-26.4	0.0	48.5	74.0	-	54.0
7.385	V	38.1	-	29.8	-24.7	0.0	43.2	74.0	-	54.0

Table 8-2-8. Ch.6 (2437MHz) **RX** mode

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
1.032	V	47.3	-	24.6	-31.8	0.0	40.1	74.0	-	54.0
1.150	V	46.2	-	24.6	-31.3	0.0	39.5	74.0	-	54.0
1.161	V	48.8	-	24.6	-31.3	0.0	42.1	74.0	-	54.0
1.328	V	48.4	-	25.6	-31.0	0.0	43.0	74.0	-	54.0

8.4.3 EUT in 5.8GHz OFDM transmission mode (ThinkPad X30 Series)

*Note: OB means “operation band” (5725-5850MHz); in this case limit is 1W (measured conducted with power meter)

Table 8-2-9. Ch.149 (5745MHz) **TX** mode 6Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
5.747	V	102.8	92.7	34.0	-25.6	0.0	111.2	OB*	101.1	OB*
1.009	V	51.1	-	24.1	-31.9	0.0	43.3	74.0	-	54.0
1.066	V	56.8	-	24.6	-31.7	0.0	49.7	74.0	-	54.0
1.122	V	53.3	-	24.4	-31.5	0.0	46.2	74.0	-	54.0
1.198	V	52.4	-	25.2	-31.3	0.0	46.3	74.0	-	54.0
11.491	V	42.7	29.6	33.5	-19.9	0.0	56.3	74.0	43.2	54.0
22.979	V	41.0	-	40.7	-18.4	9.5	53.8	74.0	-	54.0

Table 8-2-10 Ch.157 (5785MHz) **TX** mode 6Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
5.792	V	103.9	93.2	34.0	-25.5	0.0	112.4	OB*	101.7	OB*
1.009	V	51.2	-	24.1	-31.9	0.0	43.4	74.0	-	54.0
1.064	V	56.1	-	24.6	-31.7	0.0	49.0	74.0	-	54.0
1.152	V	51.5	-	24.6	-31.3	0.0	44.8	74.0	-	54.0
1.198	V	52.7	-	25.2	-31.3	0.0	46.6	74.0	-	54.0
11.571	V	43.6	31.9	33.5	-19.7	0.0	57.4	74.0	45.7	54.0

Table 8-2-11 EUT: Ch.165 (5825MHz) **TX** mode 6Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
Inband										
5.826	V	102.8	92.4	34.0	-25.6	0.0	111.2	OB*	100.8	OB*
1.009	V	51.0	-	24.1	-31.9	0.0	43.2	74.0	-	54.0
1.064	V	61.7	37.4	24.6	-31.7	0.0	54.6	74.0	30.3	54.0
1.144	V	54.7	-	24.6	-31.4	0.0	47.9	74.0	-	54.0
1.198	V	53.2	-	25.2	-31.3	0.0	47.1	74.0	-	54.0
11.651	V	46.6	32.7	33.6	-20.0	0.0	60.2	74.0	46.3	54.0

Table 8-2-12 Ch.157 (5785MHz) **RX** mode

Frequency (GHz)	Polarity (H/V)	Measured (dBμV) ***(peak)***	Measured (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	FCC Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	FCC Limit (dBμV/m) ***(average)***
1.009	V	51.2	-	24.1	-31.9	0.0	43.4	74.0	-	54.0
1.064	V	57.3	-	24.6	-31.7	0.0	50.2	74.0	-	54.0
1.152	V	51.1	-	24.6	-31.3	0.0	44.4	74.0	-	54.0
1.198	V	50.0	-	25.2	-31.3	0.0	43.9	74.0	-	54.0

8.5 Measurement plots of adjacent restricted band

8.5.1 List of Measurement Results

The measurement was performed with the worse cases of each transmission mode that tend to have higher peak output power based on the results of previous Chapter 3 "Conducted Peak Output Power" measurement. And each host device with the highest antenna gain was selected for each transmission mode.

Table 8-3-1. Radiated peak emission in 2.4GHz DSSS transmission mode, 11Mbps

Measured host device: IBM ThinkPad **X30** Series, auxiliary antenna
IBM ThinkPad **X40** Series, auxiliary antenna

Host device	Frequency (GHz)	Polarity (H/V)	Reading (dBμV) ***(peak)***	Rading (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	Margin to Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	Margin to Limit (dBμV/m) ***(average)***
X30	2.386	H	61.9	43.3	28.2	-29.2	0.0	60.9	13.1	42.3	11.7
	2.486	H	59.3	42.8	28.4	-29.1	0.0	58.6	15.4	42.1	11.9
X40	2.387	H	63.3	50.0	28.2	-29.2	0.0	62.3	11.7	49.0	**5.0**
	2.487	H	55.7	44.0	28.4	-29.1	0.0	55.0	19.0	43.3	10.7

Table 8-3-2. Radiated peak emission in 2.4GHz OFDM transmission mode, 6Mbps

Measured host device: IBM ThinkPad **X30** Series, auxiliary antenna
IBM ThinkPad **X40** Series, auxiliary antenna

Host device	Frequency (GHz)	Polarity (H/V)	Reading (dBμV) ***(peak)***	Rading (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	Margin to Limit (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***	Margin to Limit (dBμV/m) ***(average)***
X30	2.390	H	66.8	48.1	28.2	-29.2	0.0	65.8	8.2	47.1	6.9
	2.484	H	63.5	43.7	28.4	-29.1	0.0	62.8	11.2	43.0	11.0
X40	2.390	H	72.4	53.1	28.2	-29.2	0.0	71.4	2.6	52.1	**1.9**
	2.484	H	67.1	46.7	28.4	-29.1	0.0	66.4	7.6	46.0	8.0

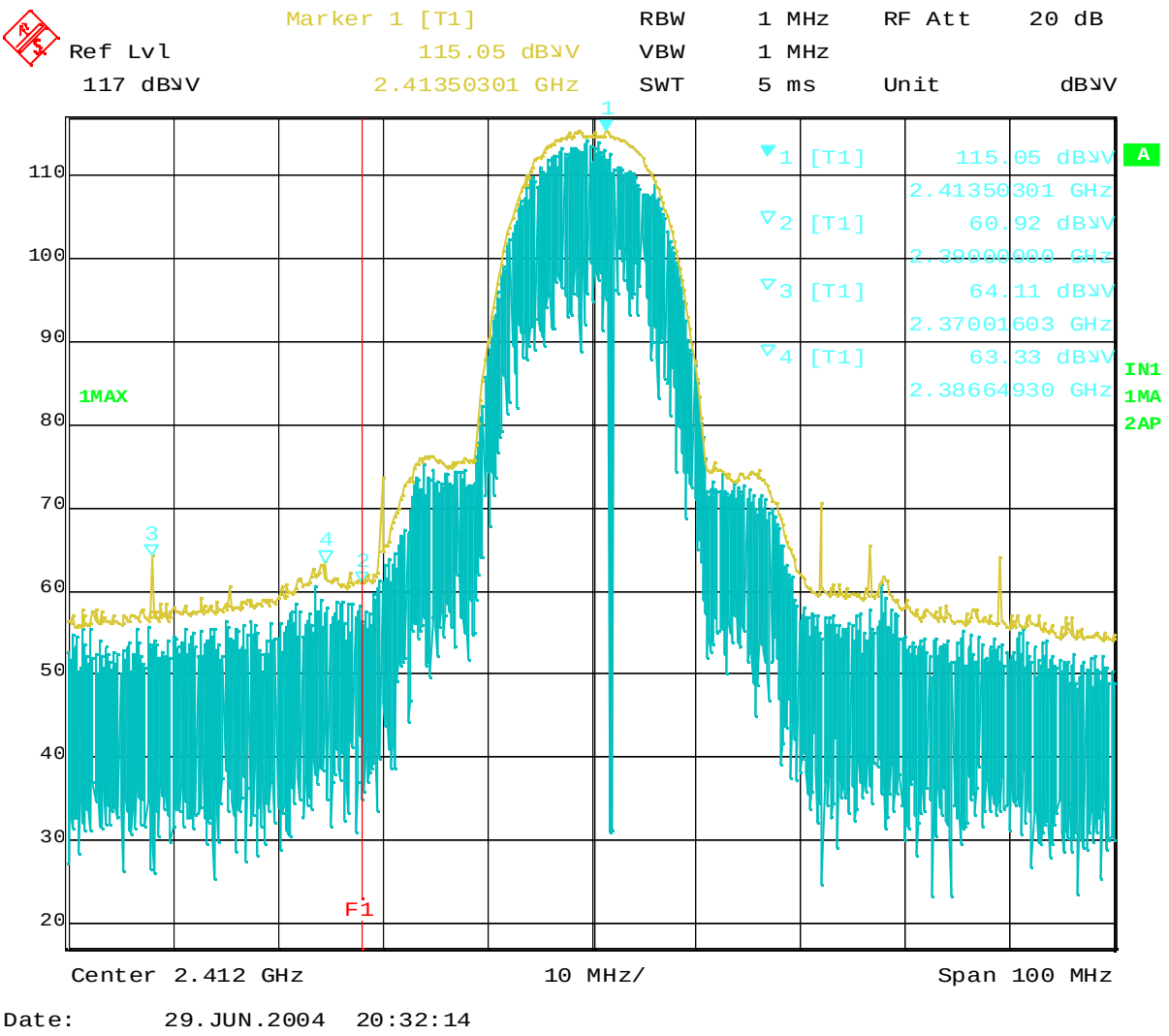
Table 8-3-3. Radiated peak emission in 5.8GHz OFDM transmission mode, 6Mbps
(References only since there is no restricted band near 5.8GHz band.)

Measured host device: IBM ThinkPad **X30** Series, main antenna
IBM ThinkPad **X40** Series, auxiliary antenna

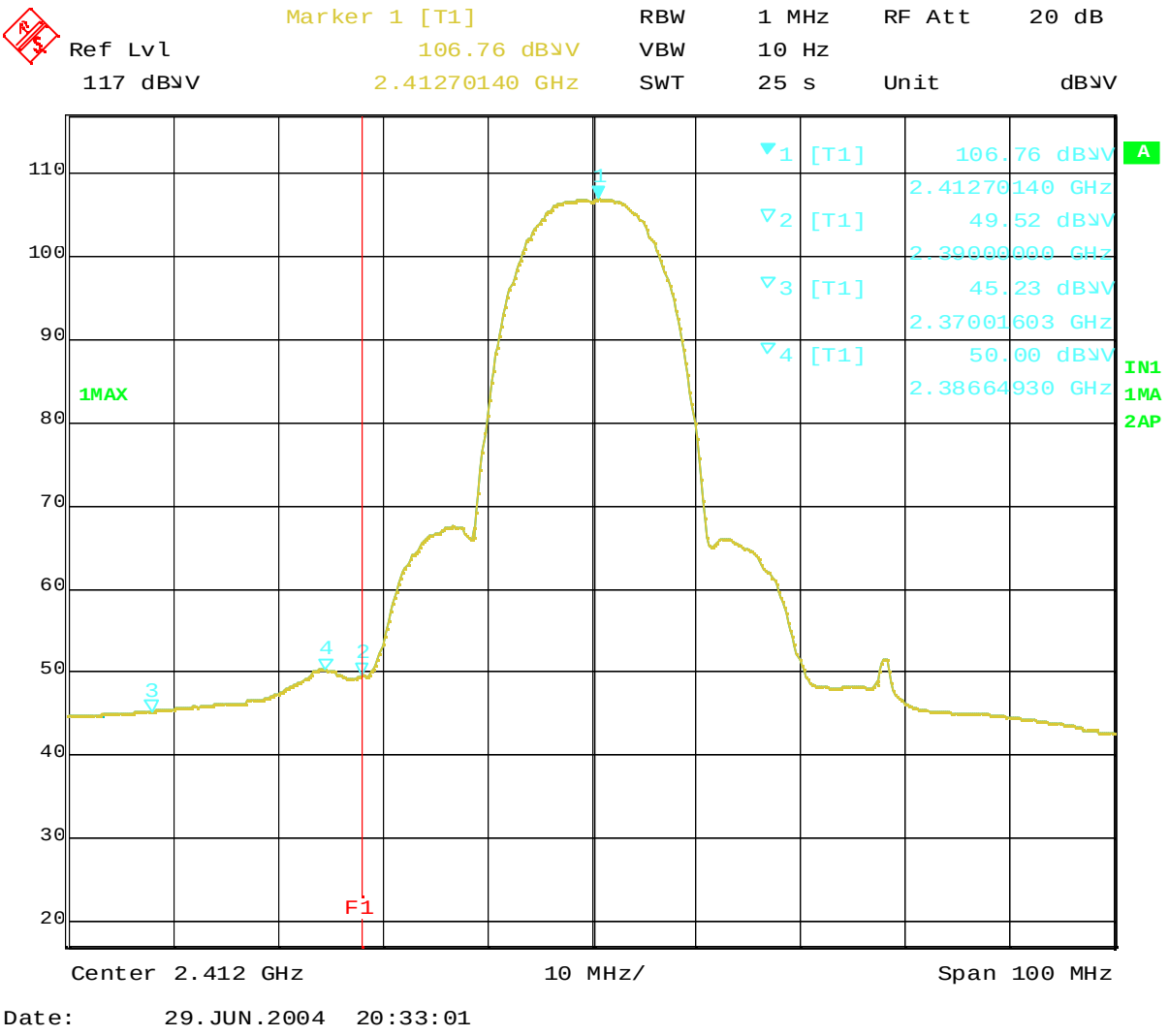
Host device	Frequency (GHz)	Polarity (H/V)	Reading (dBμV) ***(peak)***	Rading (dBμV) ***(average)***	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dBμV/m) ***(peak)***	Field Strength (dBμV/m) ***(average)***
X30	5.785	V	103.9	93.2	34.0	-25.5	0.0	**112.4**	**101.7**
X40	5.745	H	101.3	90.7	34.0	-25.6	0.0	109.7	99.1

8.5.2 Bandedge Measurement Plots

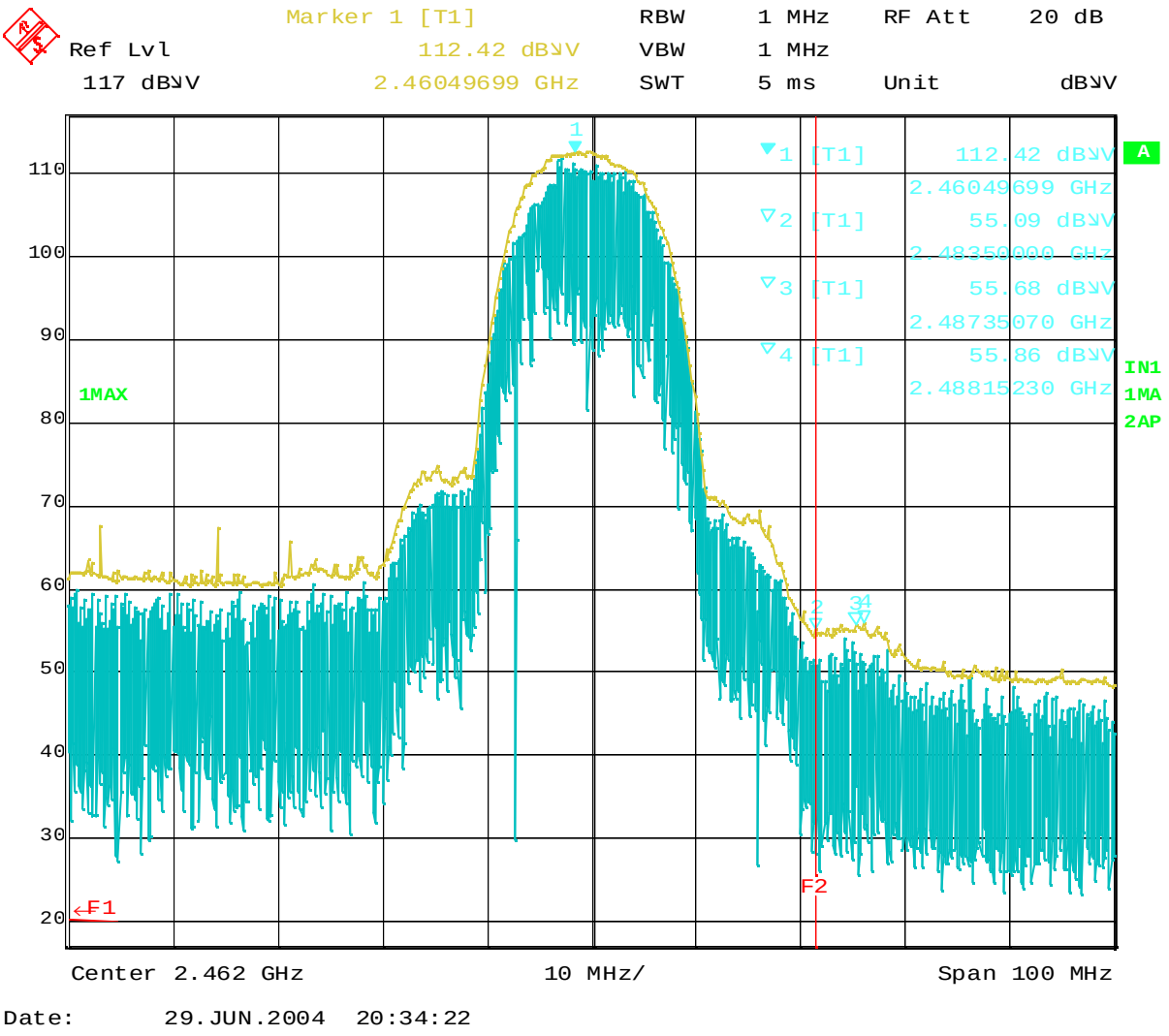
The plots are comparatively worse measurement cases of each transmission mode in the Table 8-3-1 through Table 8-3-3.



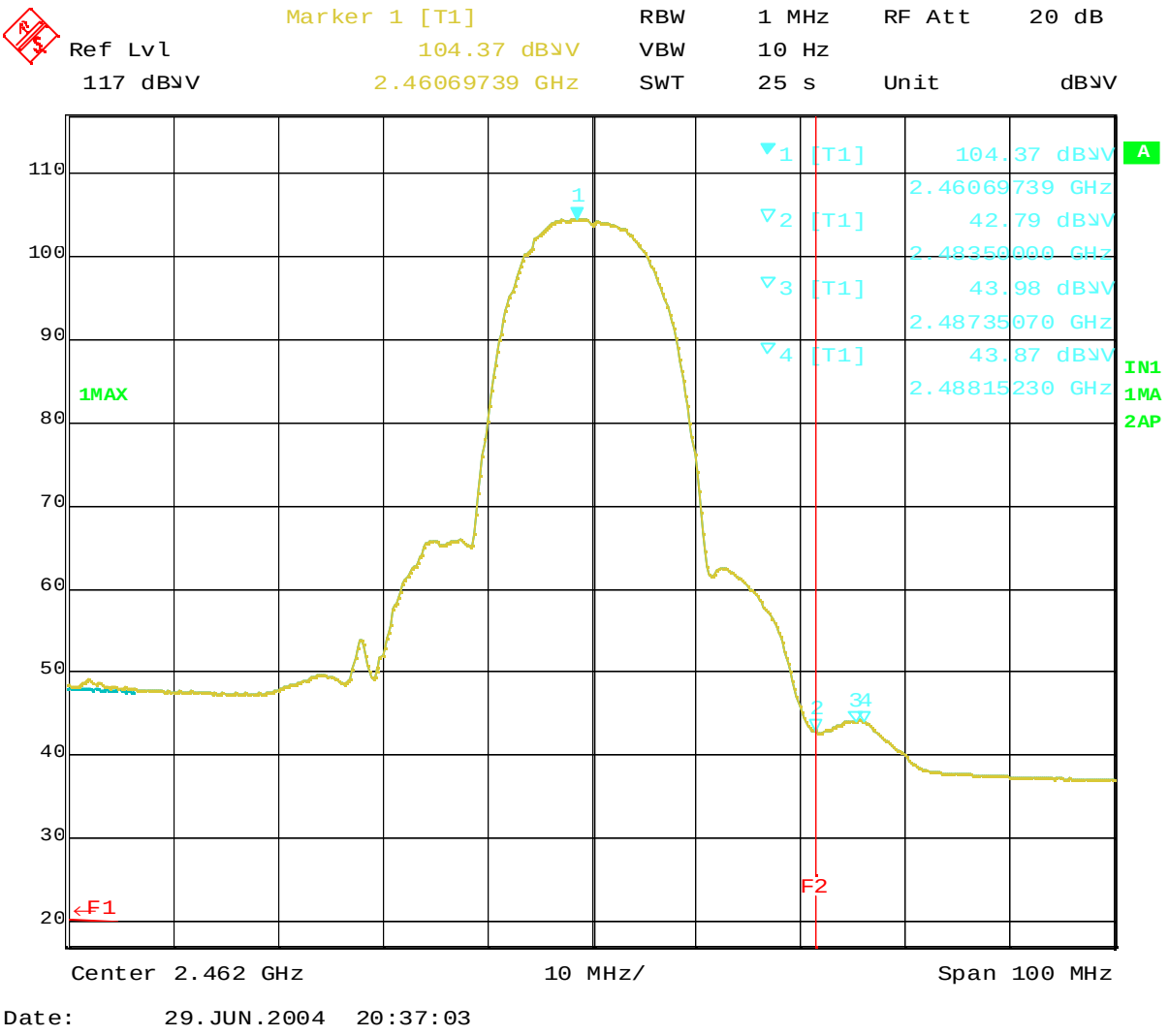
Plot 8-1 Ch.1 2412MHz TX, DSSS 11Mbps (Peak), X40 Series



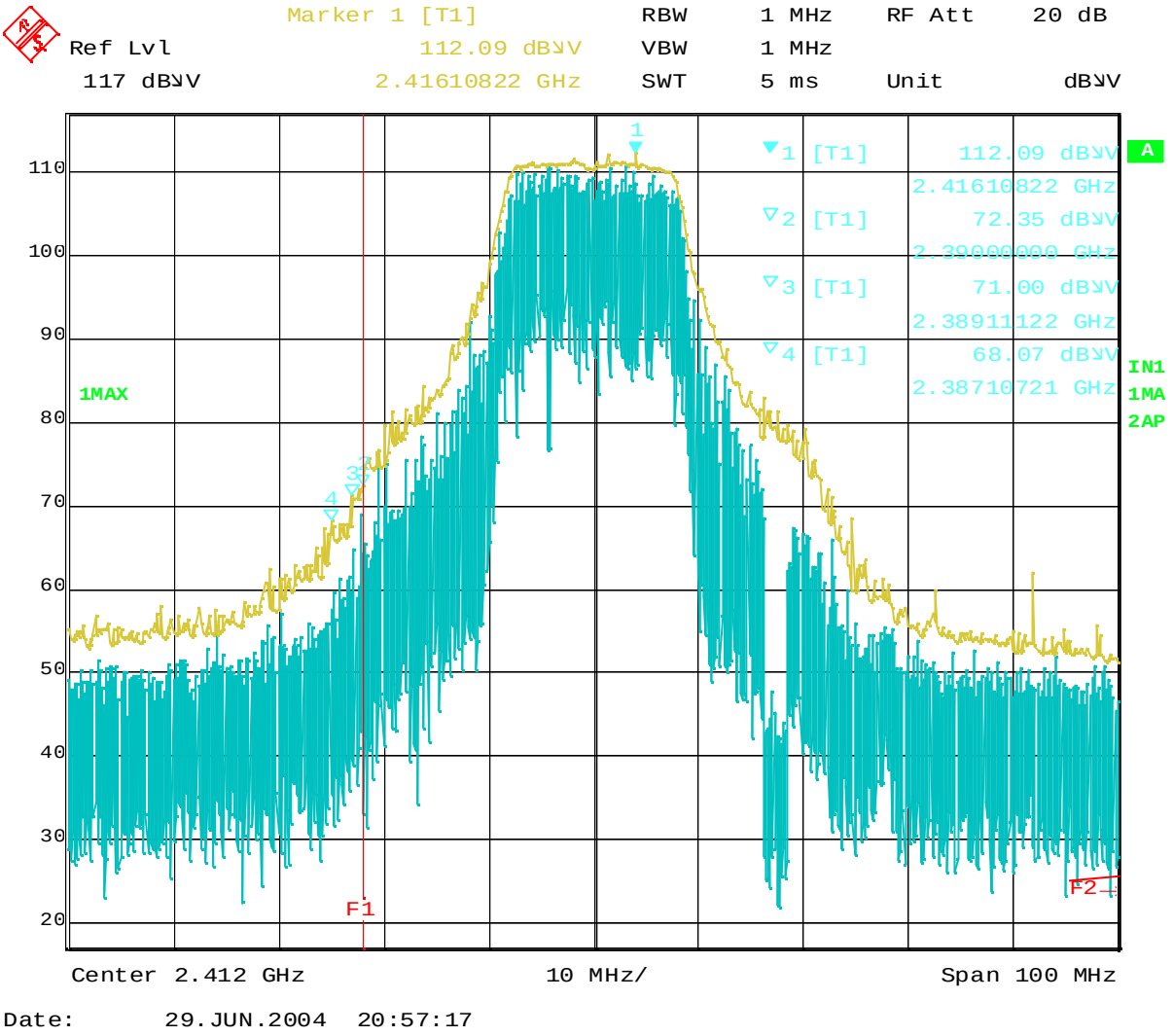
Plot 8-2 Ch.1 2412MHz TX, DSSS 11Mbps (Average), X40 Series



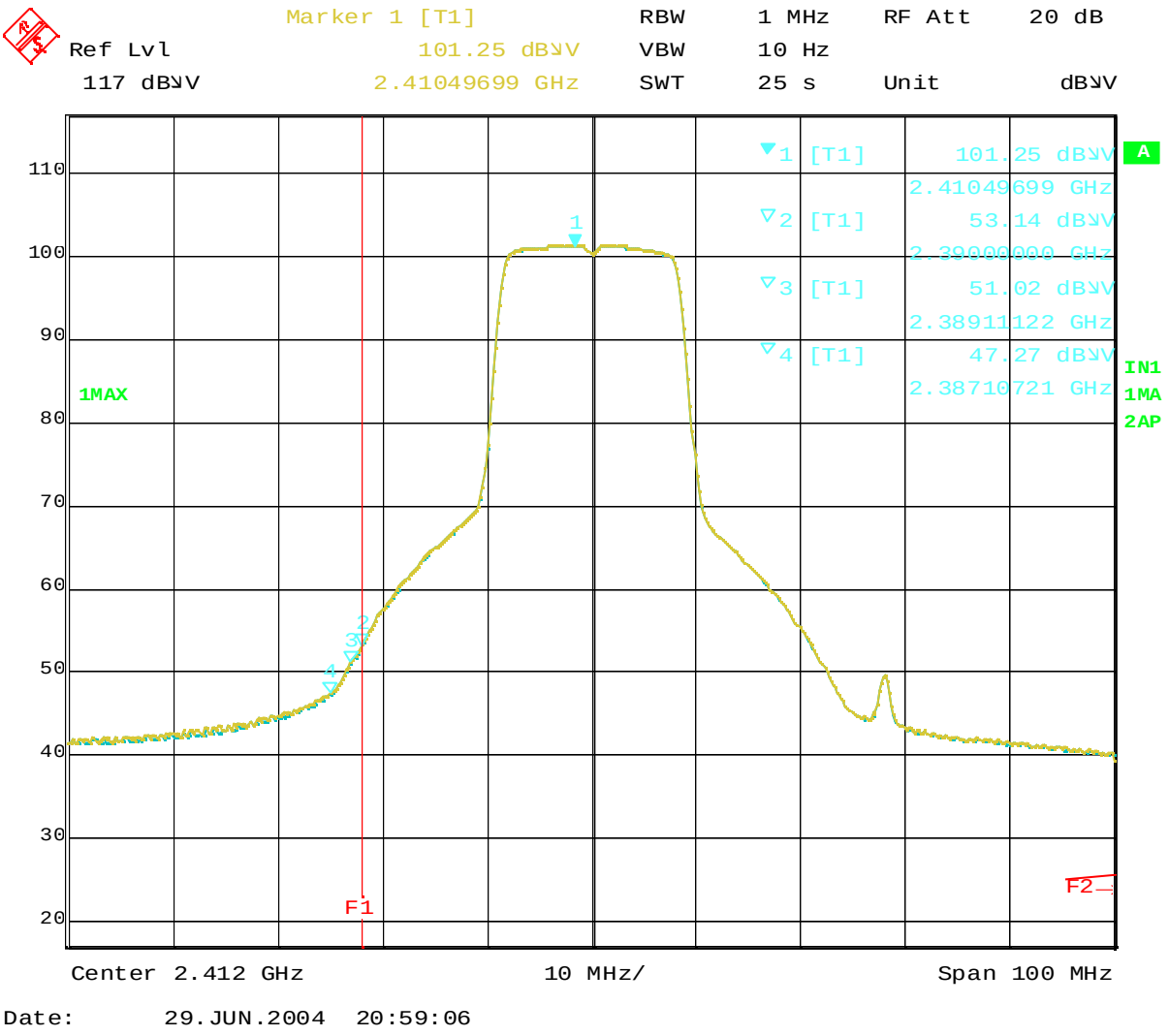
Plot 8-3 Ch.11 2462MHz TX, DSSS 11Mbps (Peak), X40 Series



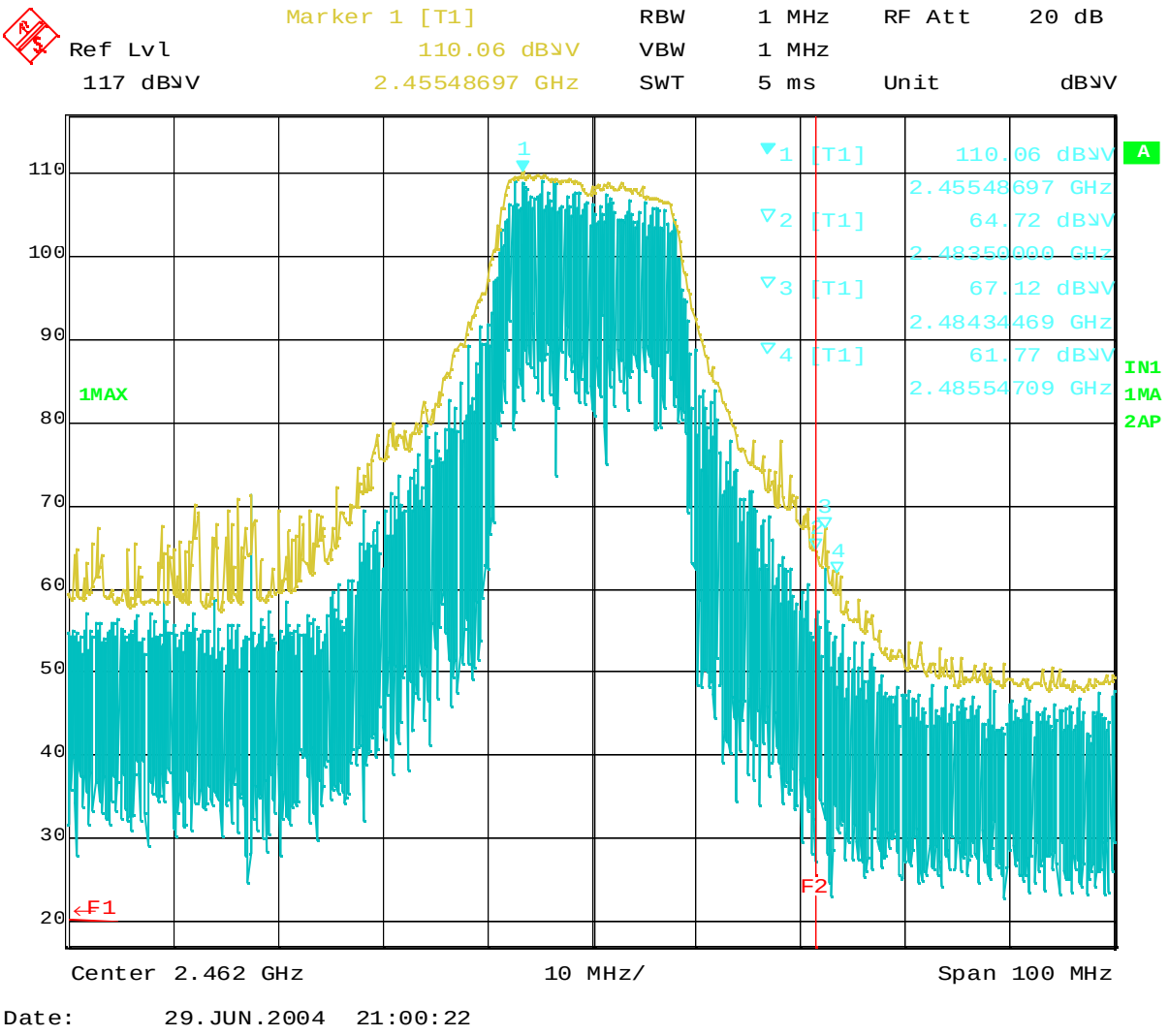
Plot 8-4 Ch.11 2462MHz TX, DSSS 11Mbps (Average), X40 Series



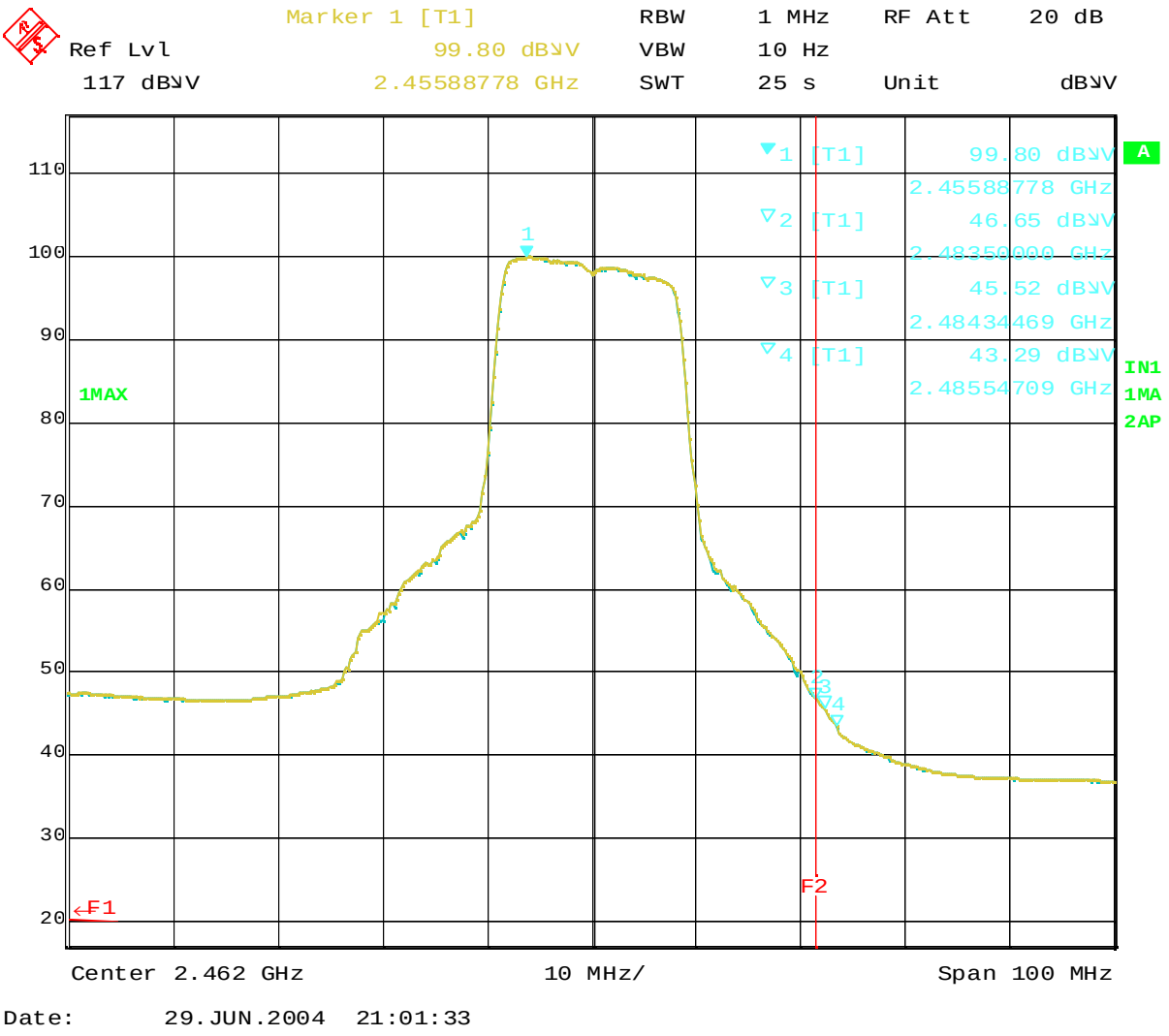
Plot 8-5 Ch.1 2412MHz TX, OFDM 6Mbps (Peak), X40 Series



Plot 8-6 Ch.1 2412MHz TX, OFDM 6Mbps (Average), X40 Series



Plot 8-7 Ch.11 2462MHz TX, OFDM 6Mbps (Peak), X40 Series



Plot 8-8 Ch.11 2462MHz TX, OFDM 6Mbps (Average), X40 Series