

Emission Test Report

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

Document Number : FCC 19-0227-0

Product: IBM ThinkPad G40 Series

included IBM Dual-Band 11a/b Wi-Fi® Wireless Mini PCI Adapter

FCC ID: ANO20020306A1L

IC: 349E- PH11107E

February 21, 2003

**Prepared :
EMC Staff Engineer**

Takeshi Asano

Signature: 

IBM Japan, Ltd.

EMC Engineering

LAB-S59

1623-14, Shimotsuruma,

Yamato-shi Kanagawa-ken 242, Japan

Phone: +81-46-215-4779

Fax: +81-46-273-7420

E-Mail: asano@jp.ibm.com

**Reviewed and Checked :
EMC Staff Engineer**

Toshiya Murota

Signature: 

IBM Japan, Ltd.

EMC Engineering

LAB-S59

1623-14, Shimotsuruma,

Yamato-shi Kanagawa-ken 242, Japan

Phone: +81-46-215-6574

Fax: +81-46-273-7420

E-Mail: murota@jp.ibm.com

**Approved :
Manager, EMC Engineering**

Akihisa Sakurai

Signature: 

IBM Japan, Ltd.

EMC Engineering

LAB-S59

1623-14, Shimotsuruma,

Yamato-shi Kanagawa-ken 242, Japan

Phone: +81-46-215-2613

Fax: +81-46-273-7420

E-Mail: akihisa@jp.ibm.com

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

IBM ThinkPad G40 Series
(Machine type : 2387, 2388, 2389)

with

IBM Dual-Band 11a/b Wi-Fi® Wireless Mini PCI Adapter

FCC ID : ANO20020306A1L

February 21, 2003

This report concerns: (check one)

Original Grant ☒

Class I change ☐

Class II change ☐

Equipment type: Wireless LAN device

This report shall not be reproduced except in full, without the written permission of this test lab.

The measurement results contained in this report relate only to the item which was tested.

Measurement procedure used is ANSI C63.4-2000 unless otherwise specified.

Other test procedure: _____

The FCC has issued provisional acceptance of this test laboratory for Declaration of Conformity testing per letter dated 1997.

APPLICANT ANTI-DRUG ABUSE CERTIFICATION:

By checking yes, the applicant certifies that, in the case of an individual applicant, he or she is not subject to a denial of federal benefits, that includes FCC benefits, pursuant to Section 5301 of the Anti-Drug Abuse of 1988, 21 U.S.C. 853(a), or, in the case of a non-individual applicant (e.g. corporation, partnership or other unincorporated association), no party to the application is subject to a denial of federal benefits, that includes FCC benefits, pursuant to that section. For the definition of a "party" for these purposes, see 47 CFR 1.2002(b).

☒ Yes or No

"Report shall not be reproduced except in full, without the written approval of the laboratory" "the report must not be used by the client to claim product endorsement by NVLAP or any agency of the US government"

Prepared by: Takeshi Asano

IBM Japan Corporation, Yamato EMC Engineering

LAB-S59, 1623-14, Shimotsuruma, Yamato-shi Kanagawa-ken 242-8502, Japan

Tel: +81-46-215-4779 Fax: +81-46-273-7420

- Index -

A. GENERAL INFORMATION	3
A.1 TEST METHODOLOGY.....	3
A.2 TEST FACILITY / NVLAP ACCREDITATION.....	3
A.3 EUT DETAILS	3
B. SUMMARY OF TEST RESULTS.....	3
C. OPERATION MODE OF EUT	3
D. JUSTIFICATION.....	3
E. TEST INSTRUMENTS	3
F. MEASUREMENT UNCERTAINTY.....	3
G. TEMPERATURE AND HUMIDITY.....	3
H. RELATED SUBMITTAL(S)/GRANT(S)/NOTES	3
1. BANDWIDTH AT 6 DB BELOW	3
1.1 TEST PROCEDURE.....	3
1.2 TEST INSTRUMENTS AND MEASUREMENT SETUP.....	3
1.3 MEASUREMENT RESULTS	3
1.4 TRACE DATA OF 6DB BANDWIDTH.....	3
2. OCCUPIED BANDWIDTH AT 20 DB BELOW / BANDEDGE, AND OUT OF BAND EMISSIONS.....	3
2.1 TEST PROCEDURE.....	3
2.2 TEST INSTRUMENTS AND MEASUREMENT SETUP.....	3
2.3 MEASUREMENT RESULTS OF OCCUPIED BANDWIDTH/BAND-EDGE.....	3
2.4 MEASUREMENT RESULTS OF OUT OF BAND EMISSIONS	3
2.5 TRACE DATA OF 20DB BANDWIDTH.....	3
2.6 TRACE DATA OF OUT OF BAND EMISSIONS	3
3. CONDUCTED PEAK OUTPUT POWER	3
3.1 TEST PROCEDURE.....	3
3.2 MEASUREMENT RESULTS	3
3.4 TRACE DATA OF CONDUCTED PEAK OUTPUT POWER.....	3
4. PEAK POWER SPECTRAL DENSITY.....	3
4.1 TEST PROCEDURE.....	3
4.2 TEST INSTRUMENTS AND MEASUREMENT SETUP.....	3
4.3 MEASUREMENT RESULTS	3
4.4 TRACE DATA OF PEAK POWER SPECTRAL DENSITY	3
5. AC WIRELINE CONDUCTED EMISSIONS (150KHZ – 30MHZ)	3
5.1 TEST PROCEDURE.....	3
5.2 TEST INSTRUMENTS AND MEASUREMENT SETUP.....	3
5.3 MEASUREMENT RESULTS	3
6. RESTRICTED BANDS RADIATIONS (30MHZ – 1GHZ)	3
6.1 TEST PROCEDURE.....	3
6.2 TEST INSTRUMENTS AND MEASUREMENT SETUP.....	3
6.3 FIELD STRENGTH CALCULATION	3

6.4	MEASUREMENT RESULTS	3
7.	RESTRICTED BANDS RADIATIONS (1GHZ – 40GHZ).....	3
7.1	TEST PROCEDURE.....	3
7.2	TEST INSTRUMENTS AND MEASUREMENT SETUP.....	3
7.3	FIELD STRENGTH CALCULATION	3
7.4	MEASUREMENT RESULTS	3

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 : 2388-2UU (ThinkPad G40 Series)
 FCC ID : ANO20020306A1L
 IC Certification Number : 349E-PH11107E
 SERIAL NUMBER : BA00022
 PHYSICAL CONDITION : Preproduction
 KIND OF EQUIPMENT : Personal computer with a IEEE802.11a & b Wireless LAN
 Mini-PCI Combo Card ([Composite application](#))
 TESTED DATE : January 14, 15, 16, 20, 21, 22, 23, 24 and 27, 2003

A.1 Test Methodology

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

A.2 Test Facility / NVLAP Accreditation

The semi-anechoic chamber #2 used to correct the data are located in Yamato Laboratory, IBM Japan.

- This facility has been fully described in a report dated September 1998, submitted to the FCC office, and accepted in a letter, dated Nov. 2, 1998(31040/SIT).
- IBM Yamato EMC Engineering is recognized under the National Voluntary Laboratory Accreditation Program for satisfactory compliance with Criteria established in Title 15, Part 285 Code of Federal Regulations.(NVLAP Lab code: 200198-0)
- This facility is accepted by **Industry Canada** in a letter dated March 19, 2001 as number **IC 349E** for chamber #2, and January 25, 2002 as number **IC 4221** for chamber #1.

A.3 EUT details

Table-A EUT details

Model and S/N	FCC ID IC Certification Number	Description
IBM Dual-Band 11a/b Wi-Fi® Wireless Mini PCI Adapter (s/n PVT-074F)	IC: 349E-PH11107E	IEEE802.11a & b Wireless LAN Mini-PCI Combo Card without antenna
ThinkPad G40 Series M/T 2388-2UU (s/n BA00022)	FCC ID: ANO20020306A1L	Applying equipment IBM Notebook PC with built_in antenna CPU: Intel® Desktop Pentium® 4, 2.4GHz
P/N 02K7085	N/A	Universal AC adapter 120W, Unshielded power cord

B. Summary of Test Results

Table-B presents the list of the measurement items for DTS (Digital Transmissions System) devices under FCC Part 15 Subpart C and Industry Canada RSS-210.

The section numbers of upper portion are showing FCC number, and the other (lower) ones are for IC.

Table-B List of the measurements

Section(s)	Test Items		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.		Pass
15.247(b) 6.2.2 (o) (b)	Transmitter peak output power	Shall not exceed 1.0 W.		Pass
15.247(d) 6.2.2 (o) (b)	Transmitter power spectral Density	Shall not be greater than 8 dBm in any 3kHz band.		Pass
15.207 6.6	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 / 6.3	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Shall not exceed the limits specified in FCC 15.209 or RSS-210 Table3.	Radiated (30MHz -1GHz)	Pass
			Radiated (1– 25GHz)	Pass

	Receive mode (RX):			
15.207 7.4	AC Wireline Conducted Emissions 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
15.209 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

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. 11Mbps and 24Mbps transmission modes were selected for full testing as the worse case samplings. See “Chapter 3. Conducted Peak Output Power” as to the determination of measurement plots.
4. 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.)

Operation Frequency [GHz]	Rated output power (conducted) [dBm]										
	Bit rate 1/2M bps	5.5M bps	11M bps	6M bps	9M bps	12M bps	18M bps	24M bps	36M bps	18M bps	54M bps
2.412 (Ch. 1)	+17	+17	+17	-	-	-	-	-	-	-	-
2.417 (Ch. 2)	+17	+17	+17	-	-	-	-	-	-	-	-
2.422 (Ch. 3)	+17	+17	+17	-	-	-	-	-	-	-	-
2.427 (Ch. 4)	+17	+17	+17	-	-	-	-	-	-	-	-
2.432 (Ch. 5)	+17	+17	+17	-	-	-	-	-	-	-	-
2.437 (Ch. 6)	+17	+17	+17	-	-	-	-	-	-	-	-
2.442 (Ch. 7)	+17	+17	+17	-	-	-	-	-	-	-	-
2.447 (Ch. 8)	+17	+17	+17	-	-	-	-	-	-	-	-
2.452 (Ch. 9)	+17	+17	+17	-	-	-	-	-	-	-	-
2.457 (Ch. 10)	+17	+17	+17	-	-	-	-	-	-	-	-
2.462 (Ch. 11)	+17	+17	+17	-	-	-	-	-	-	-	-
5.745 (Ch.149)	-	-	-	+16	+16	+16	+16	+16	+15	+12	+10
5.765 (Ch.153)	-	-	-	+16	+16	+16	+16	+16	+15	+12	+10
5.785 (Ch.157)	-	-	-	+16	+16	+16	+16	+16	+15	+12	+10
5.805 (Ch.161)	-	-	-	+16	+16	+16	+16	+16	+15	+12	+10
5.825 (Ch.165)	-	-	-	+16	+16	+16	+16	+16	+15	+12	+10

D. Justification

The EUT was investigated for both the main (left) and the auxiliary (right) antennas. The worse case data taken in this report represents the measurement result of the right antenna that has comparatively higher gain in 2.4GHz band and the left antenna in 5.8GHz band.

The same tendency with the previous application (ANO20020300D3L, ANO20020304T2L, ANO20020302R1L) was found on the worse cases, since the applying transmitter module is the same. i.e. The columns marked in shading of the above table are the worst cases of each Tx mode for all measurement items (conducted power, 6dB BW,...etc.).

Table-D Peak Antenna Gains of EUT

2.4GHz band	Left Antenna gain	-0.25 dBi (peak)
	Right Antenna gain	0.87 dBi (peak)
5.8GHz band	Left Antenna gain	3.15 dBi (peak)
	Right Antenna gain	2.11 dBi (peak)

E. Test Instruments

Table-E 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	2601A02634	08/28/02	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	3019A05155	02/15/02	1 year
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2841A04252	06/17/02	1 year
Spectrum Analyzer Display	HP 85662A	2542A12308	08/28/02	1 year
Spectrum Analyzer Display	HP 85662A	3026A19353	02/15/02	1 year
Spectrum Analyzer Display	HP 85662A	2816A16831	06/17/02	1 year
Quasi-Peak Adapter	HP 85650A	2043A00062	08/28/02	1 year
Quasi-Peak Adapter	HP 85650A	2811A01156	06/17/02	1 year
Quasi-Peak Adapter	HP 85650A	3033A01449	02/15/02	1 year
Amplifier (100KHz - 1.3GHz)				
- for 30-200MHz	HP 8447D	2805A02919	04/15/02	1 year
- for 200-1000MHz	HP 8447D	2944A03506	04/15/02	1 year
Amplifier (1 - 26.5GHz)	HP 8449B	3008A00582	06/13/02	1 year
Amplifier (26.5 - 40GHz)	Agilent 83051A	3950M00193	01/06/03	1 year
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003	07/18/02	1 year
Spectrum Analyzer	HP 8563E	3416A02248	08/14/02	1 year
Harmonic Mixer	Agilent 11970A	011269-001	07/19/02	1 year
Receiver (9kHz-30MHz)	R&S ESH3	891806/012	10/07/02	1 year
Receiver (20MHz-1.3GHz)	R&S ESVP	893202/018	02/06/02	1 year
Biconical Antenna (30-200MHz)	EMCO 3108	2309	05/06/02	1 year
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	1585	05/06/02	1 year
Horn Antenna (1- 18GHz)	EMCO 3115	9903-5774	07/18/02	1 year
Horn Antenna (3.95- 5.85GHz)	EMCO 3160-5	1099	04/17/02	1 year
Horn Antenna (5.85- 8.20GHz)	EMCO 3160-6	9712-1044	04/17/02	1 year
Horn Antenna (8.2- 12.4GHz)	EMCO 3160-7	1156	04/17/02	1 year
Horn Antenna (12.4- 18GHz)	EMCO 3160-8	1143	04/17/02	1 year
Horn Antenna (18- 26.5GHz)	EMCO 3160-9	0004-1202	04/17/02	1 year
Horn Antenna (26.5- 40GHz)	EMCO 3160-10	1175	04/17/02	1 year
LISN	EMCO 3825/2	1426	09/01/02	1 year
Power Meter	HP 437B	3043U03437	11/08/02	1 year
Power Sensor	HP 8481A	US41030582	11/08/02	1 year
Switch/control unit	HP 3488A	2719A17226	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	09/05/02	1 year
- RF Amp.<=>Spectrum Analyzer(<12GHz)	15m	- EM215SCO	09/05/02	1 year
- RF Amp.<=>Spectrum Analyzer(>12GHz)	3 m	- SF102-20166	09/05/02	1 year
Coaxial cables (18 – 40GHz):				
- Horn Ant <=> RF Amp.	3m	- SF102-20167	09/05/02	1 year
- RF Amp.<=>Spectrum Analyzer	1m	- SF102-21105	09/05/02	1 year
N-Coax cables:				
- Bi-coni Ant <=> 10m Cable	9 m	- EM103L01	04/15/02	1 year
- 10m Cable <=> Shield Panel	10 m	- EM103L02	04/15/02	1 year
- Shield Panel <=> RF Amp	7 m	- EM103L03	04/15/02	1 year
- RF Amp <=> Power Splitter	0.5m	- EM103L04	04/15/02	1 year
- Log-peri Ant <=> 10m Cable	9 m	- EM103H01	04/15/02	1 year
- 10m Cable <=> Shield Panel	10 m	- EM103H02	04/15/02	1 year
- Shield Panel <=> RF Amp	7 m	- EM103H03	04/15/02	1 year
- RF Amp <=> Power Splitter	0.5m	- EM103H04	04/15/02	1 year
Coax cables:				
- Lism-L <=> SW/Con.unit (SW100)	4 m	- EMIC-L	04/15/02	1 year
- Lism-N <=> SW/Con.unit (SW101)	4 m	- EMIC-N	04/15/02	1 year
- SW/Con.unit <=> RCVR (Input)	1 m	- EMIC-R	04/15/02	1 year
- SW/Con.unit<=> Spe Ana.(Signal In)	1 m	- EMIC-S	04/15/02	1 year
- Power Splitter <=> SW/Con.unit (SW110)	1 m	- EM103L05	04/15/02	1 year
- Power Splitter <=> SW/Con.unit (SW300)	1 m	- EM103L06	04/15/02	1 year
- Power Splitter <=> SW/Con.unit (SW100)	1 m	- EM103H05	04/15/02	1 year
- Power Splitter <=> SW/Con.unit (SW301)	1 m	- EM103H06	04/15/02	1 year
- SW/Con.unit <=> Receiver (Input)	2 m	- EM1RCV	04/15/02	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz	2 m	- EM1SPL	04/15/02	1 year
- SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	2 m	- EM1SPH	04/15/02	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

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

1. Bandwidth at 6 dB below

1.1 Test Procedure

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

The spectrum analyzer is set to :

RBW=100kHz, VBW=100kHz^{*1}, Span=30MHz, Sweep=suitable duration based on the EUT specification

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

1.2 Test Instruments and Measurement Setup

Table 1-1 : 6 dB Bandwidth Test Instruments

Description	Model	Serial Number
Spectrum Analyzer EMI Test Receiver	R&S ESI26	836119/003
Coax cables: - Spectrum Analyzer <=> EUT	Length: 110 cm Loss: 1.3 dB (for 2.4GHz) 2.3 dB (for 5.8GHz)	

Notes: - R&S: Rohde & Schwarz

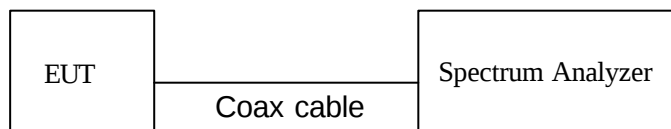


Figure 1: Measurement setup for 6dB bandwidth test

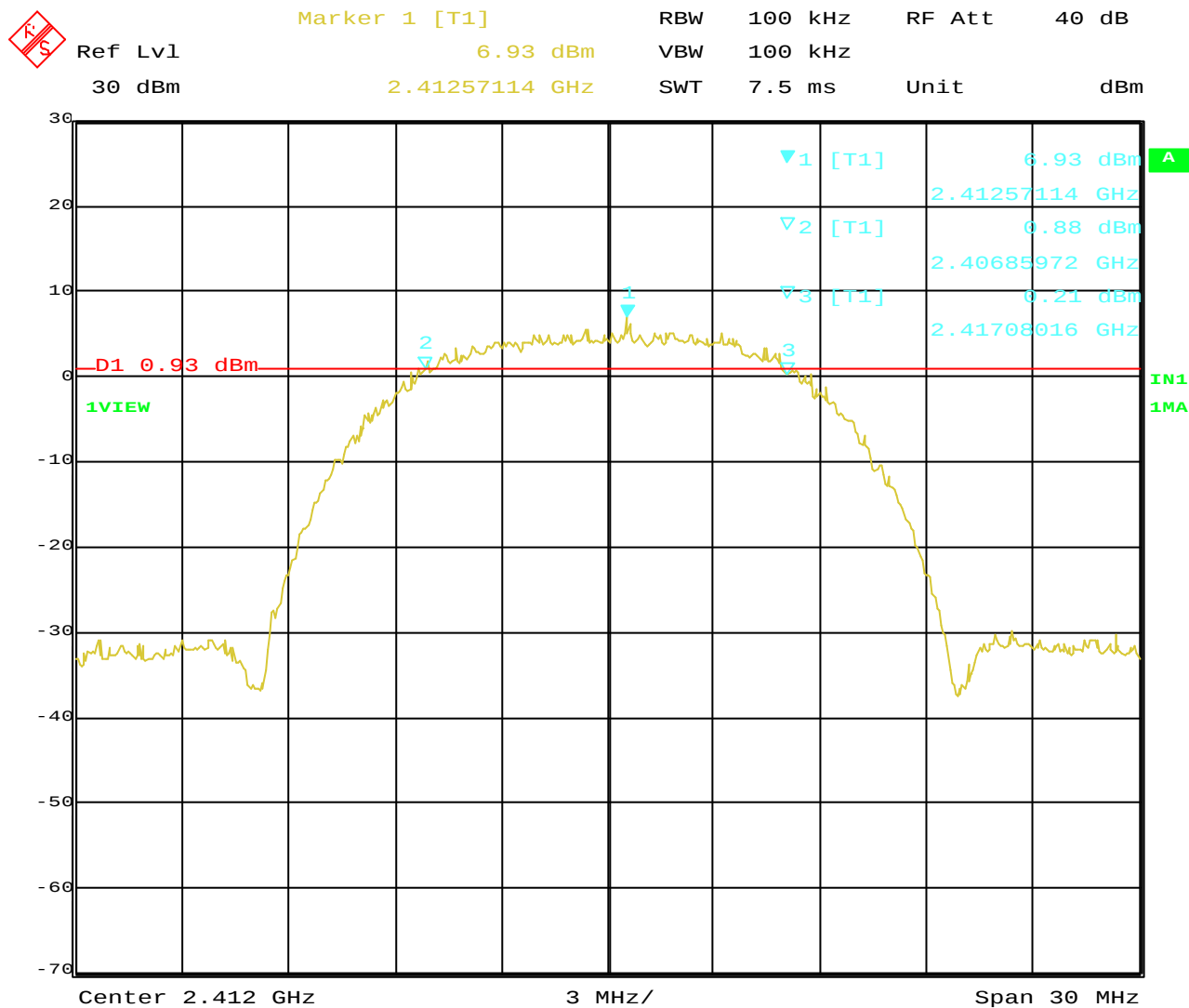
1.3 Measurement Results

Test Date: January 14, 2003

Table 1-2. EUT: M/T 2388-2UU, s/n BA00022 , TX mode

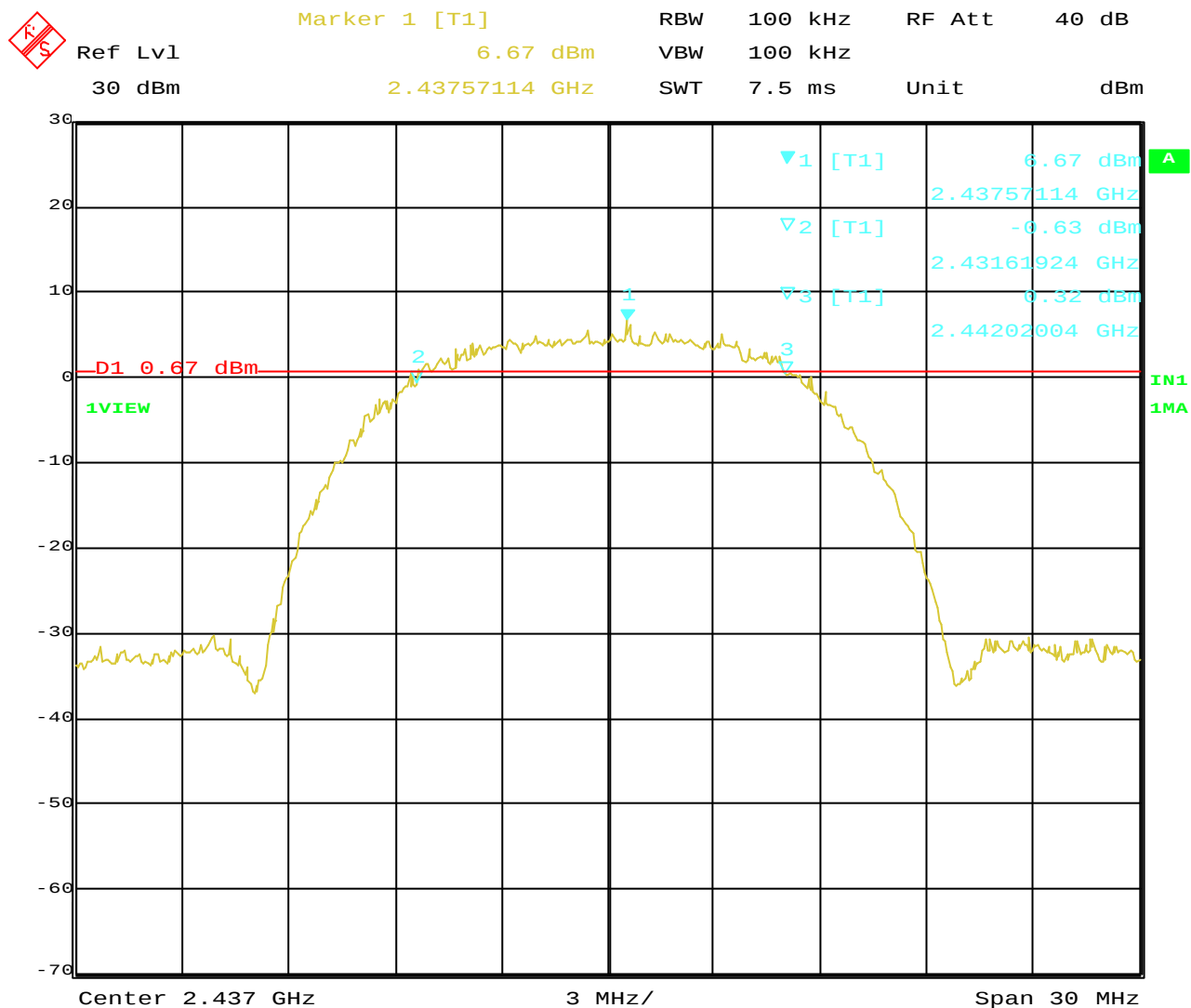
Center Frequency (MHz)	Trace number	Lower frequency (MHz)	Upper frequency (MHz)	Bandwidth at 6 dB below (MHz)	note
2412	Plot 1-1	2406.86	2417.08	10.22	> 500kHz
2437	Plot 1-2	2431.62	2442.02	10.40	
2462	Plot 1-3	2456.62	2467.08	10.46	
5745	Plot 1-4	5736.67	5753.33	16.66	> 500kHz
5785	Plot 1-5	5776.67	5793.33	16.66	
5825	Plot 1-6	5816.67	5833.33	16.66	

1.4 Trace Data of 6dB bandwidth



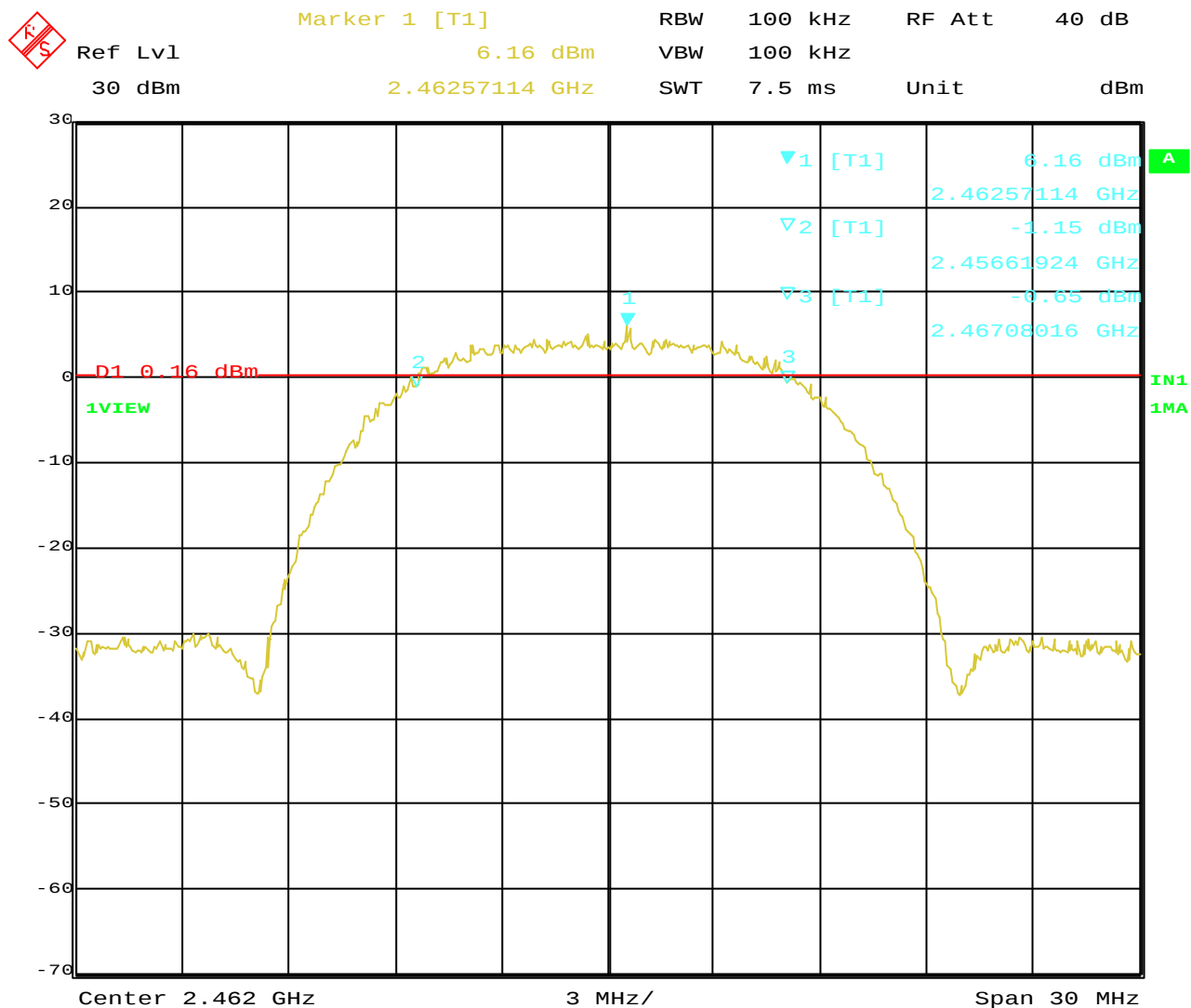
Date: 14.JAN.2003 16:02:59

Plot 1-1. 6dB BW at 2412MHz



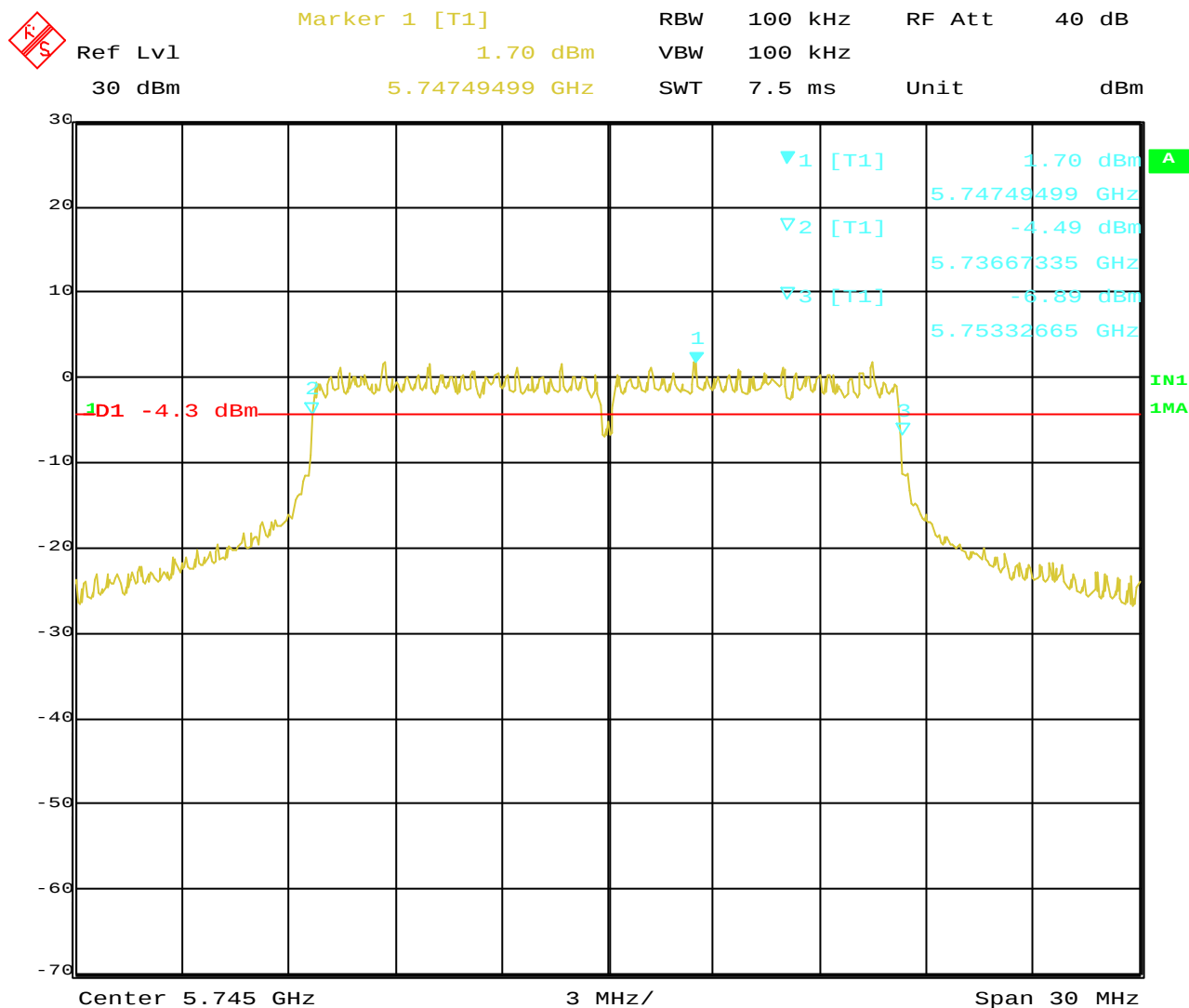
Date: 14.JAN.2003 16:05:59

Plot 1-2. 6dB BW at 2437MHz



Date: 14.JAN.2003 16:08:46

Plot 1-3. 6dB BW at 2462MHz

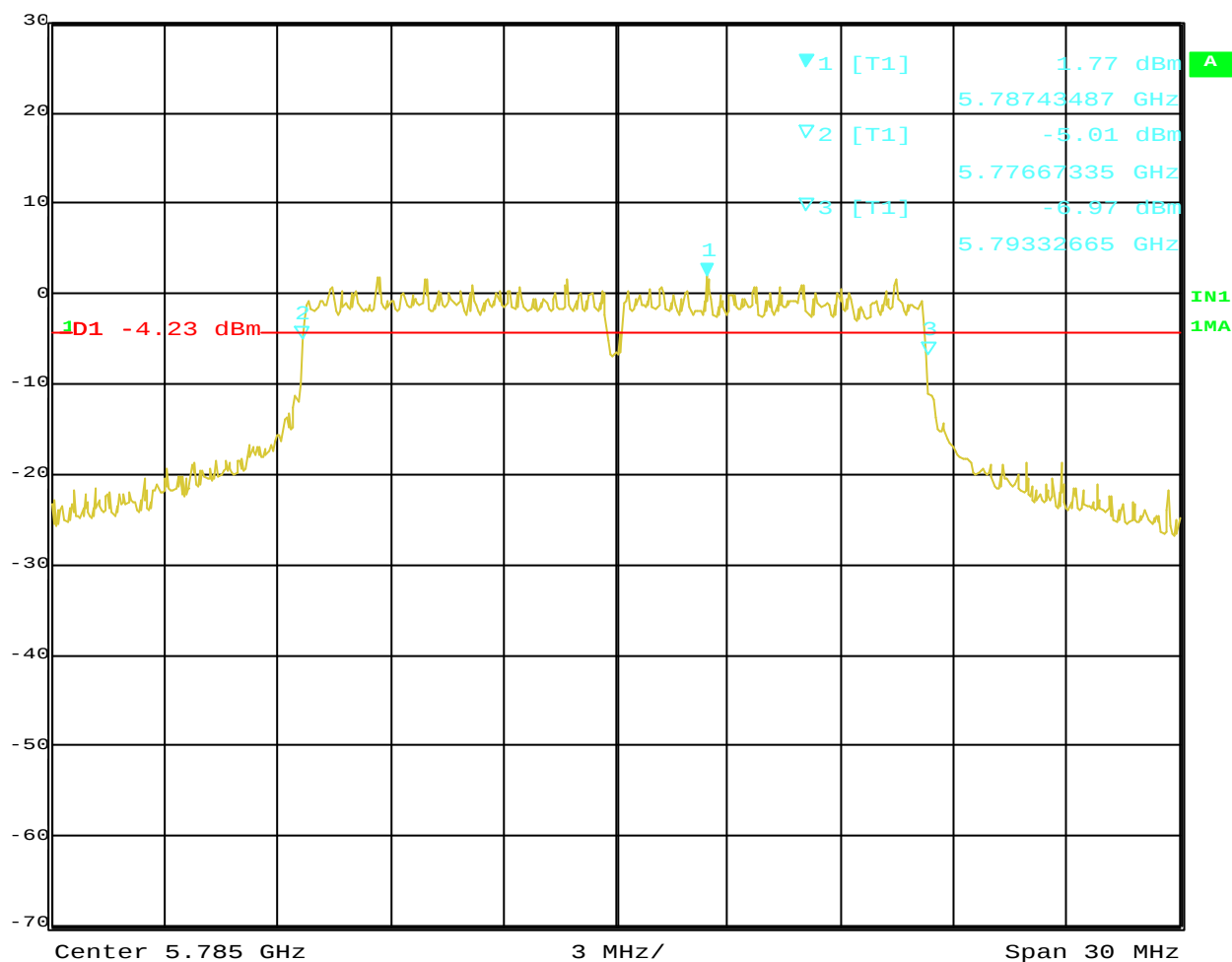


Date: 14.JAN.2003 17:08:51

Plot 1-4. 6dB BW at 5745MHz

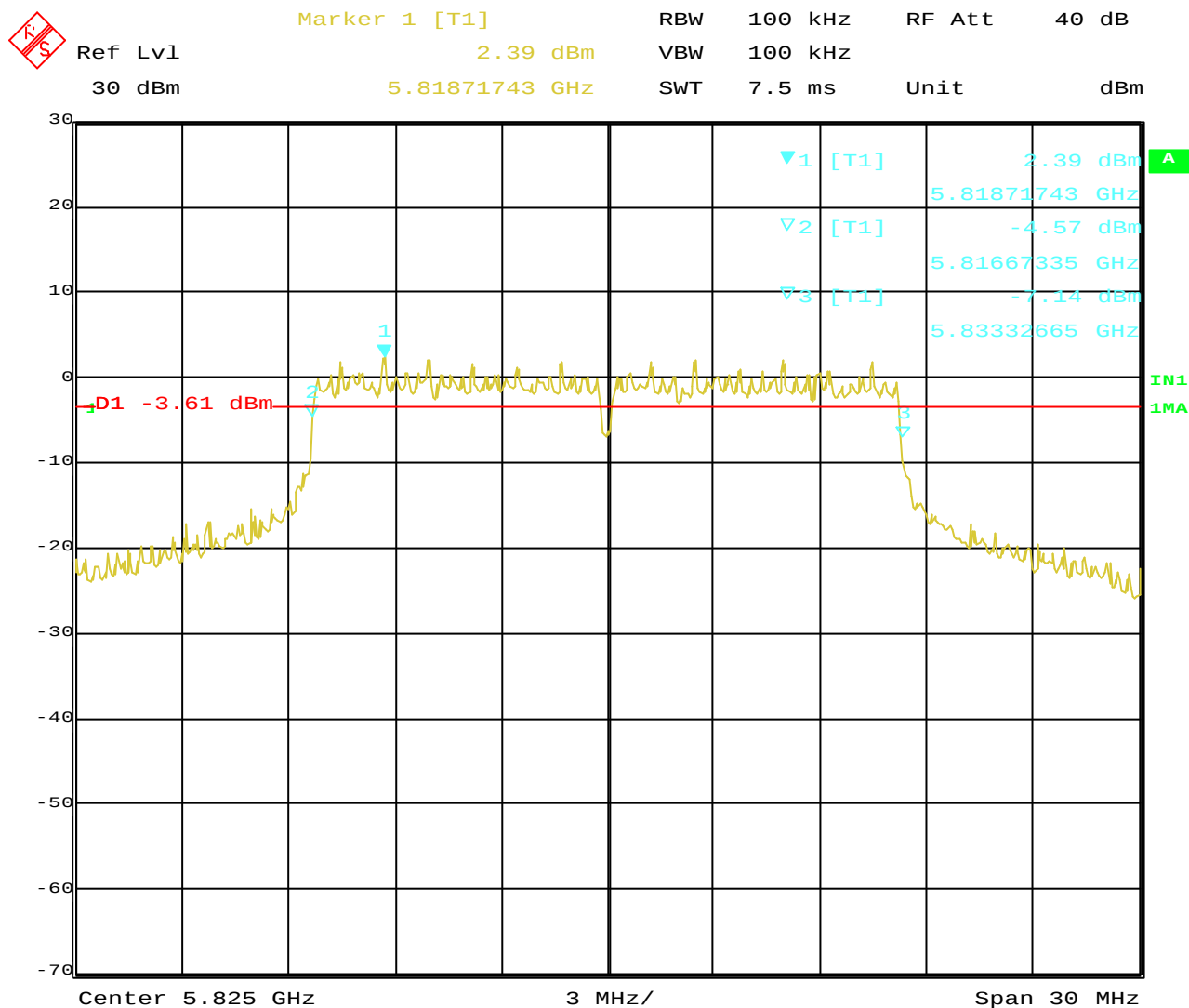


Ref Lvl 30 dBm
Marker 1 [T1] 1.77 dBm
5.78743487 GHz
RBW 100 kHz RF Att 40 dB
VBW 100 kHz
SWT 7.5 ms Unit dBm



Date: 14.JAN.2003 17:11:40

Plot 1-5. 6dB BW at 5785MHz



Date: 14.JAN.2003 17:13:35

Plot 1-6. 6dB BW at 5825MHz

2. Occupied Bandwidth at 20 dB below / Bandedge, and Out of Band Emissions

2.1 Test Procedure

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

The spectrum analyzer is set to:

RBW=100kHz, VBW=100kHz^{*1}, Span=50MHz, Sweep=suitable duration based on the EUT specification

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

2.2 Test Instruments and Measurement Setup

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

2.3 Measurement Results of Occupied Bandwidth/Band-edge

Test Date: January 14, 2003

Table 2-1. EUT: M/T 2388-2UU, s/n BA00022 , TX mode

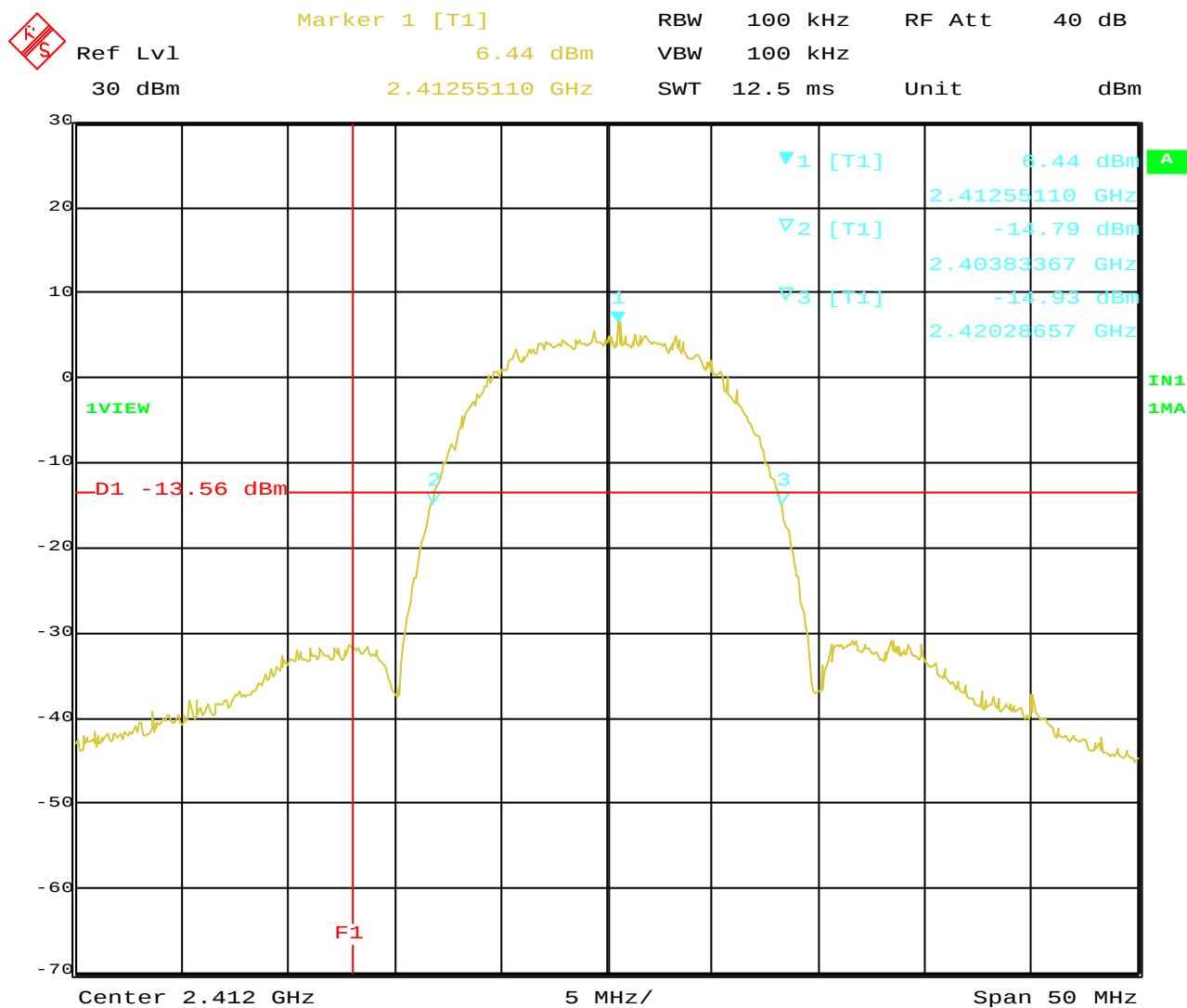
Center Frequency (MHz)	Trace number	Lower Frequency 20dB below (MHz)	Upper Frequency 20dB below (MHz)	Bandwidth at 20dB below (MHz)	Margin to Lower bandedge (MHz)	Margin to Upper bandedge (MHz)
2412	Plot 2-1	2403.83	2420.29	16.46	3.83	
2437	Plot 2-2	2428.93	2445.04	16.11		
2462	Plot 2-3	2453.93	2470.09	16.16		13.41
5745	Plot 2-4	5734.97	5754.43	19.46	9.97	
5785	Plot 2-5	5774.83	5794.27	19.44		
5825	Plot 2-6	5813.63	5835.47	21.84		14.53

2.4 Measurement Results of Out of Band Emissions

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

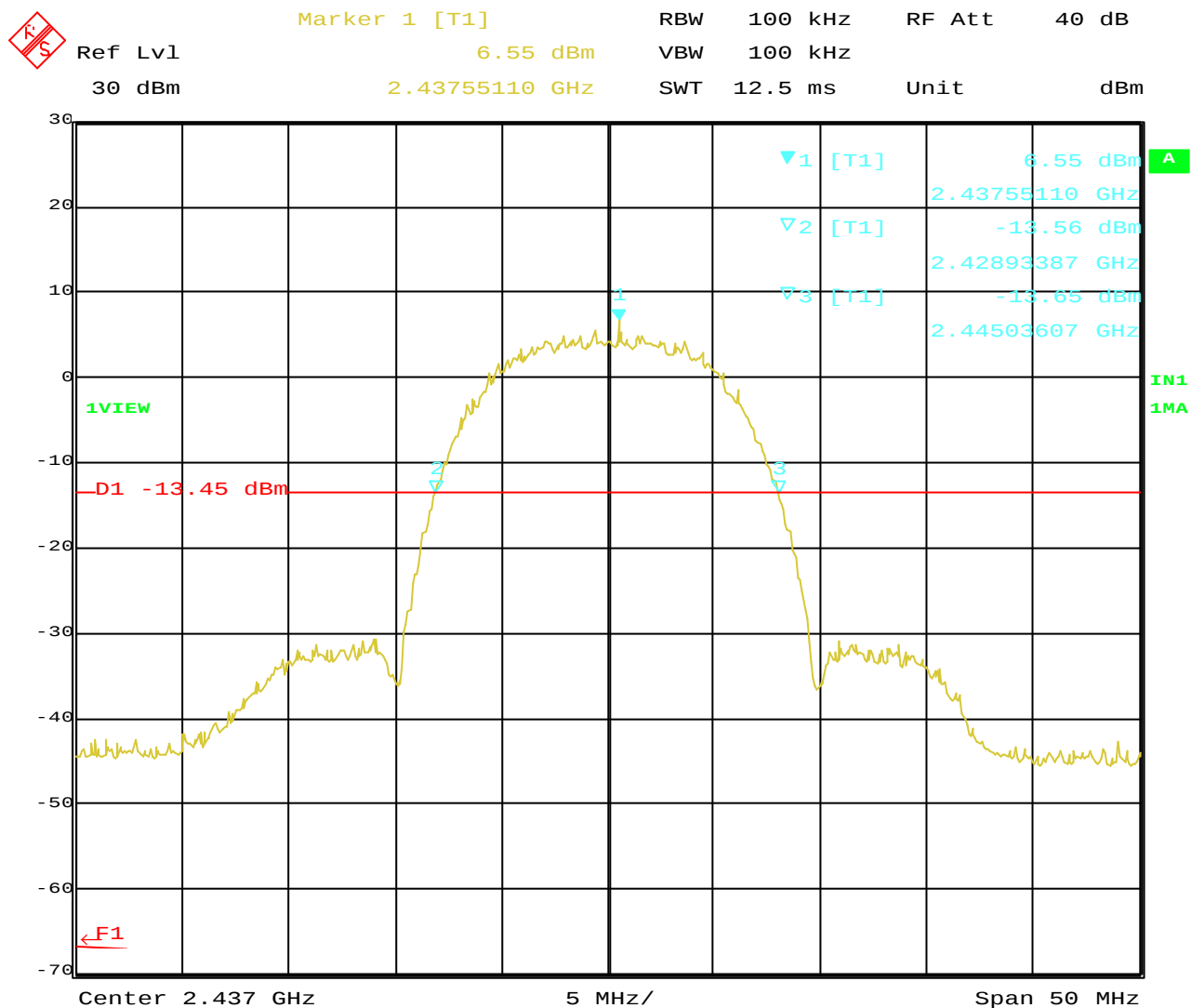
Test Date: January 14, 2003 : See Plot 2-7 to 2-12.

2.5 Trace Data of 20dB bandwidth



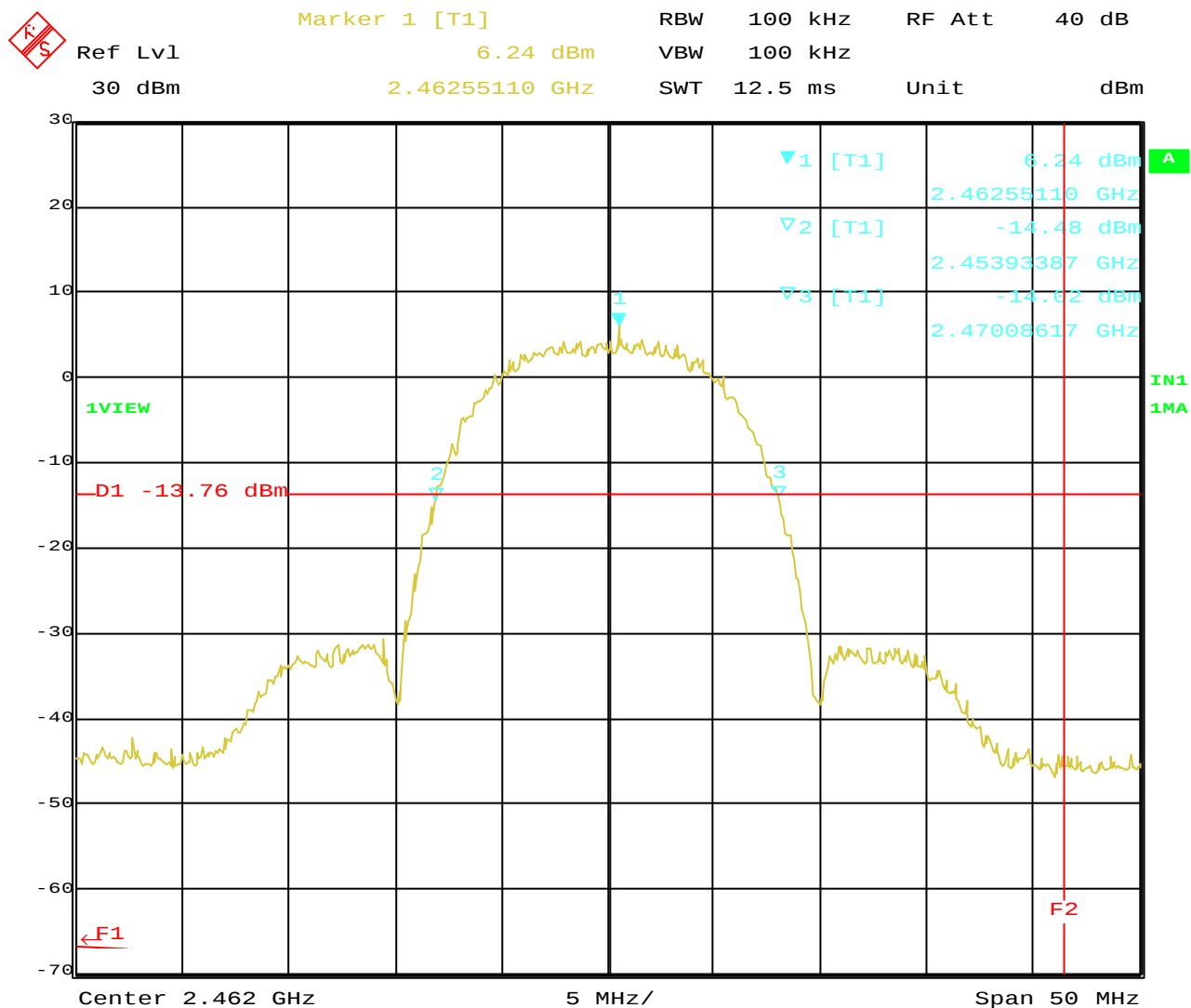
Date: 14.JAN.2003 16:15:51

Plot 2-1. 20dB BW at 2412MHz



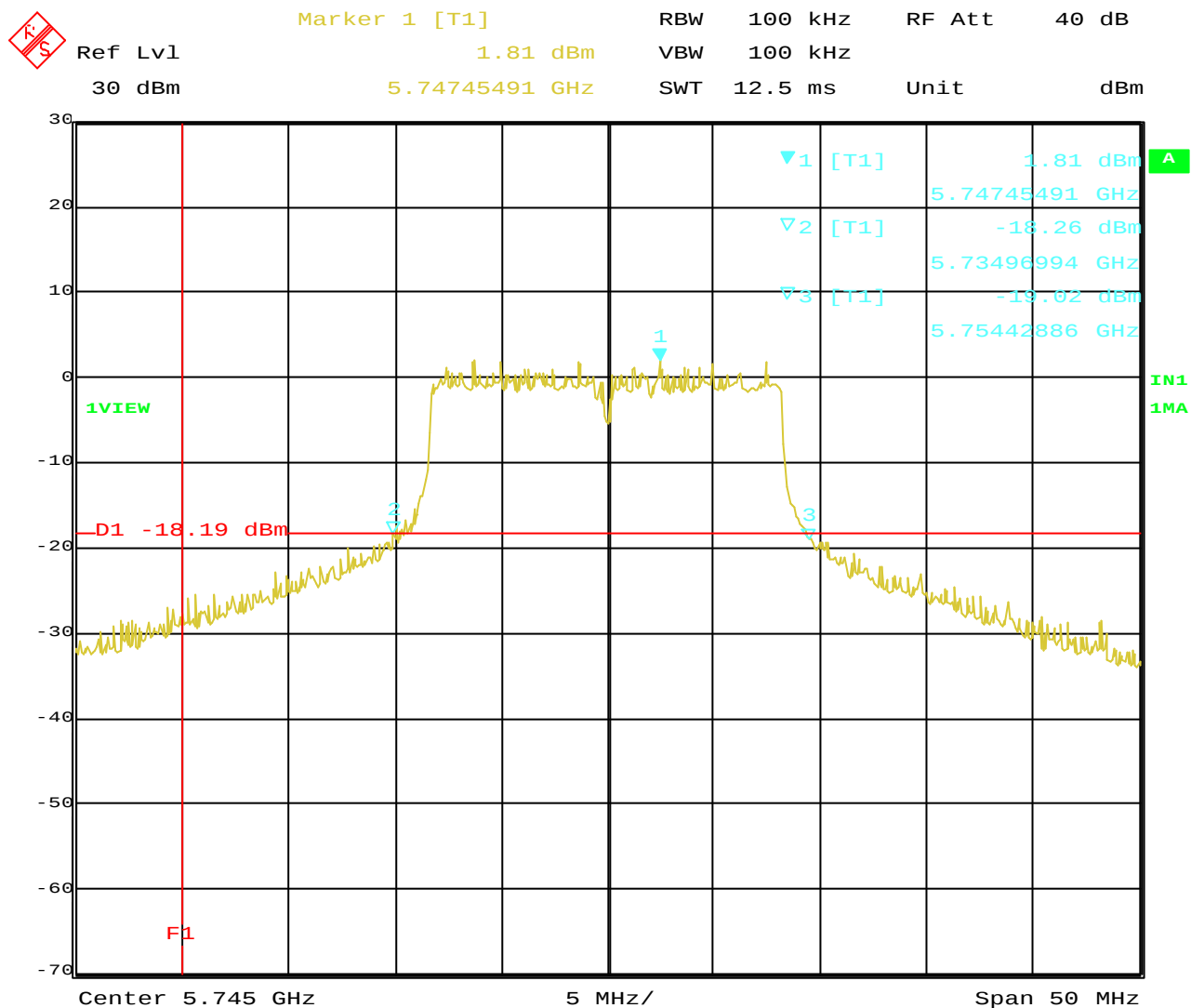
Date: 14.JAN.2003 16:17:28

Plot 2-2. 20dB BW at 2437MHz



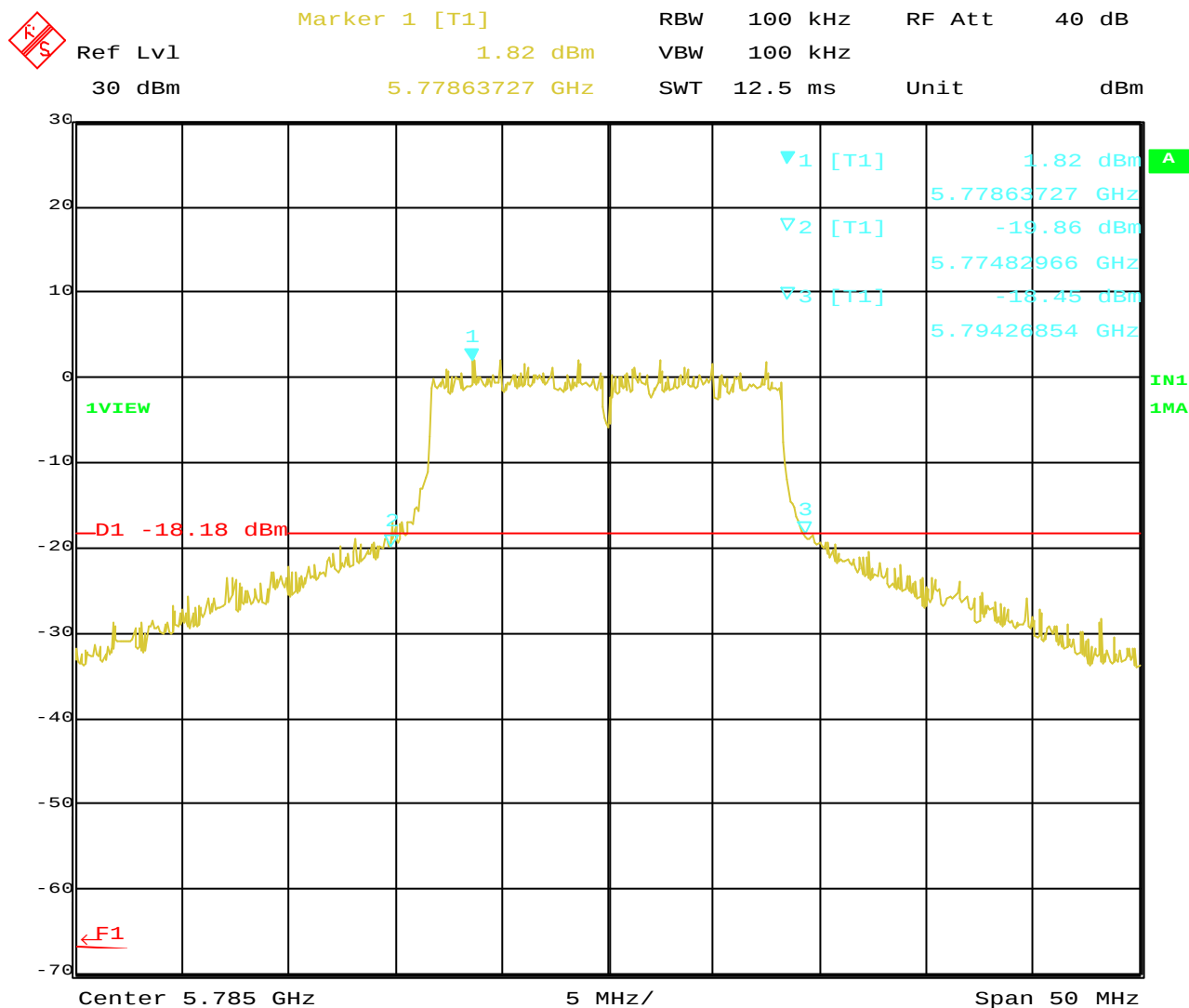
Date: 14.JAN.2003 16:19:10

Plot 2-3. 20dB BW at 2462MHz



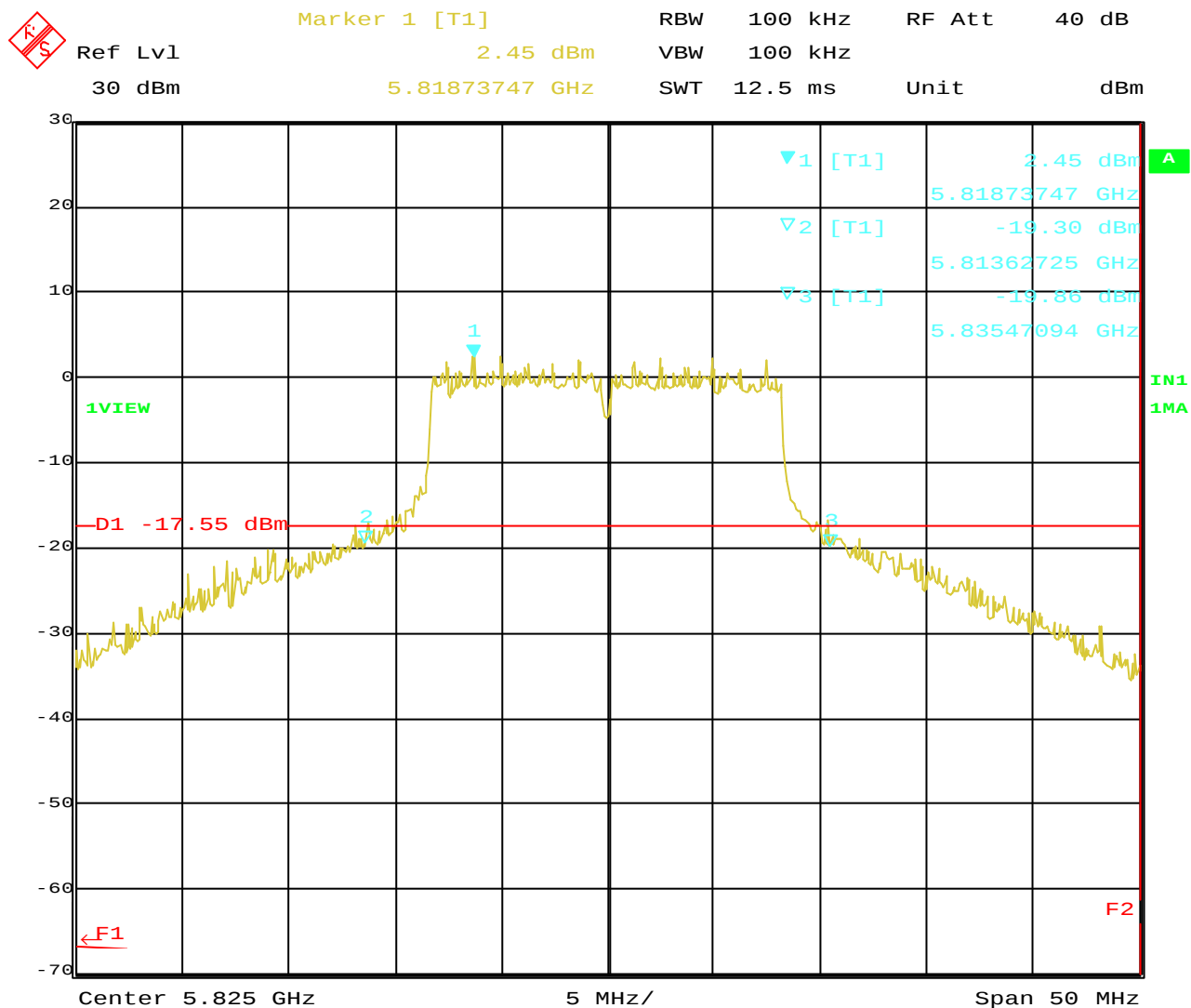
Date: 14.JAN.2003 17:43:58

Plot 2-4. 20dB BW at 5745MHz



Date: 14.JAN.2003 17:45:51

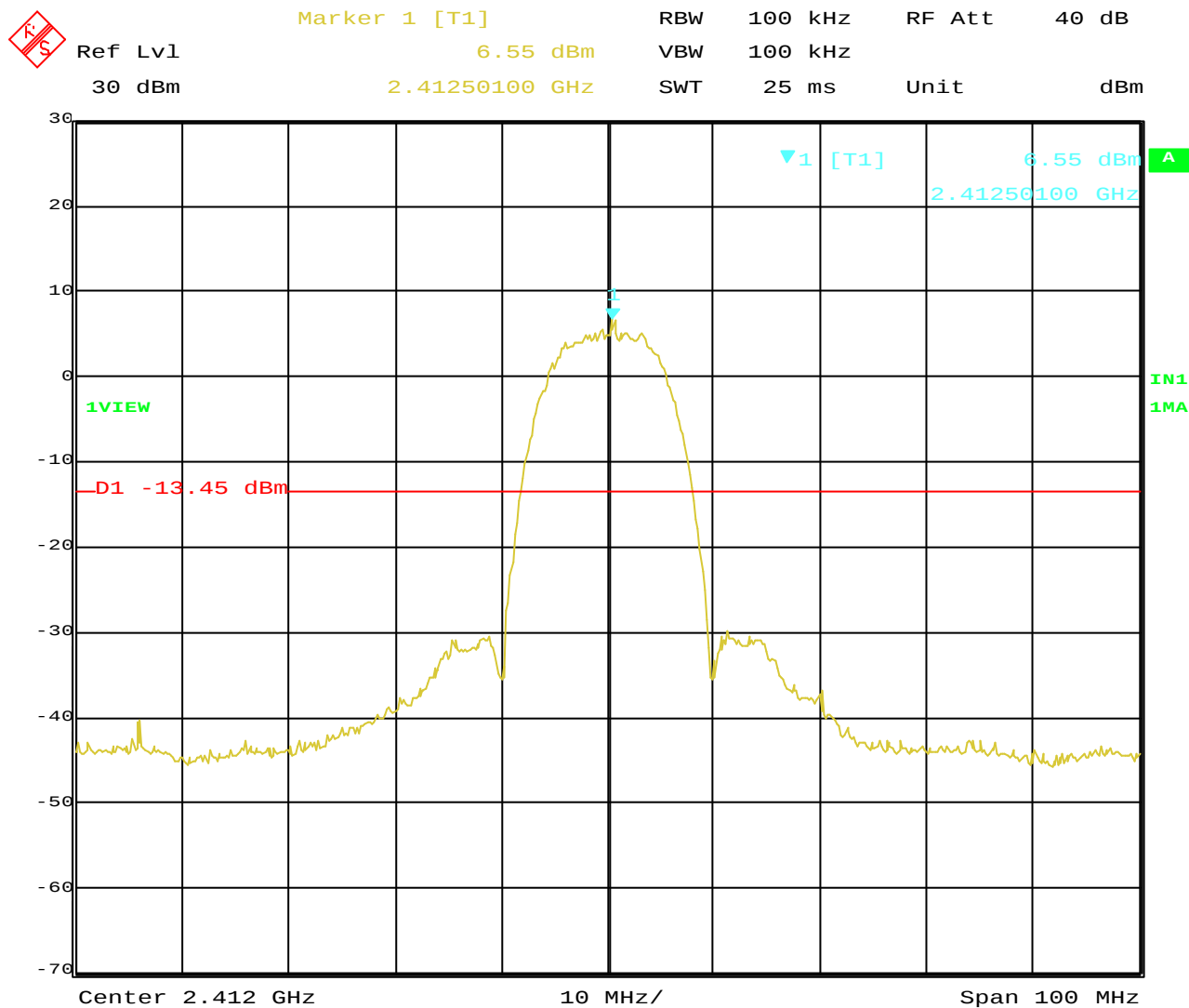
Plot 2-5. 20dB BW at 5785MHz



Date: 14.JAN.2003 17:49:45

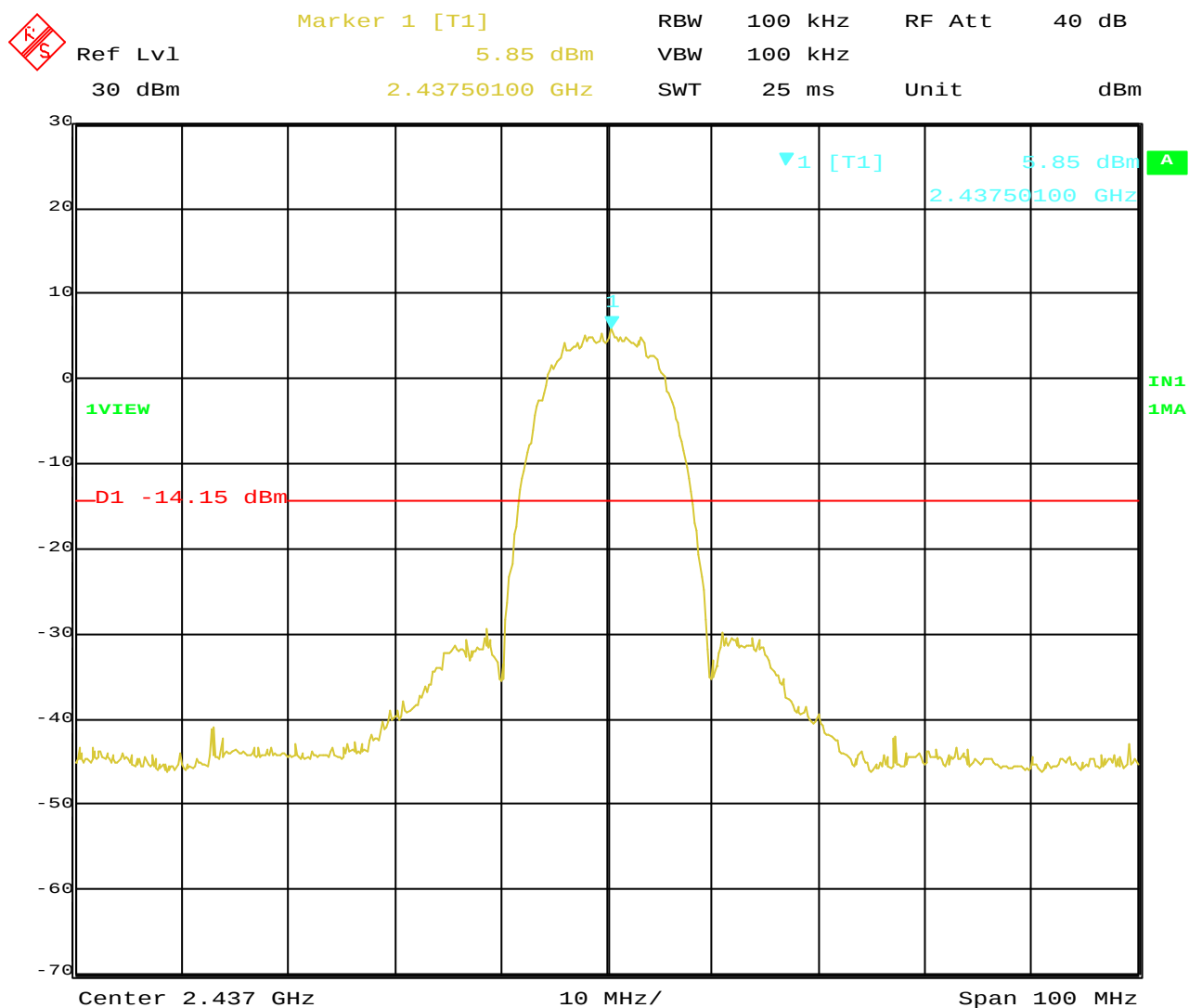
Plot 2-6. 20dB BW at 5825MHz

2.6 Trace Data of Out of Band Emissions



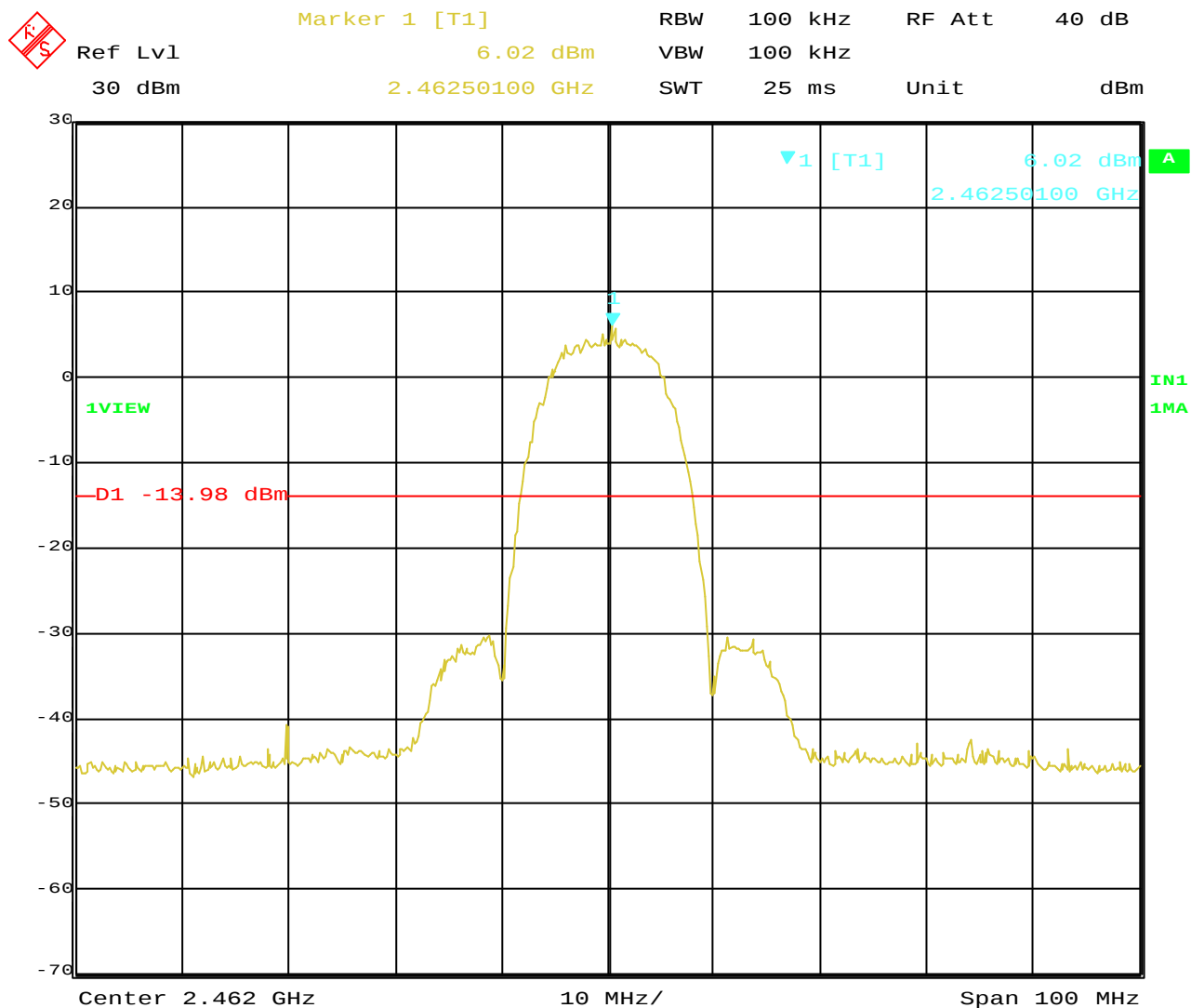
Date: 14.JAN.2003 16:30:17

Plot 2-7. Out of band emissions around 2412MHz



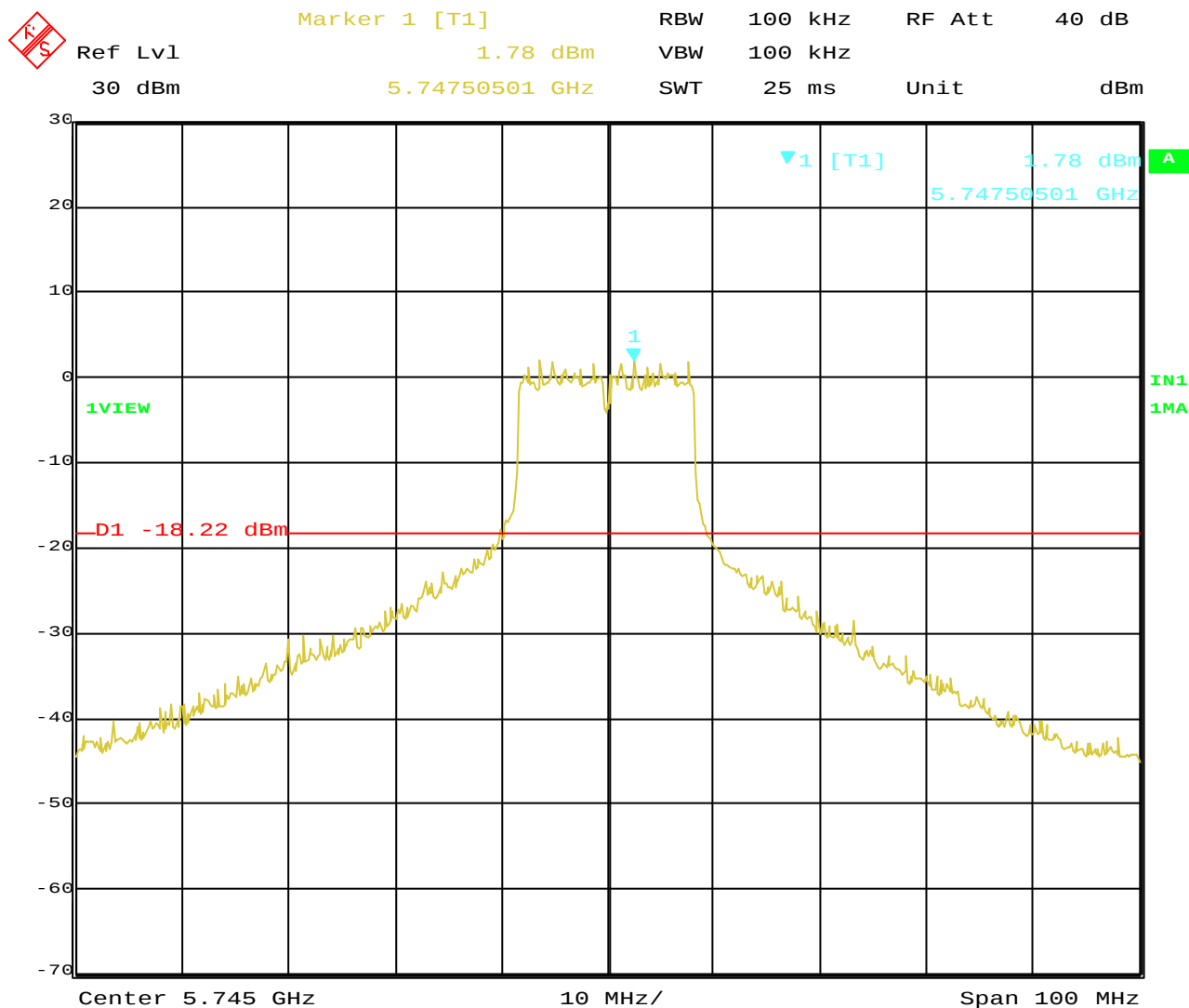
Date: 14.JAN.2003 16:31:47

Plot 2-8. Out of band emissions around 2437MHz



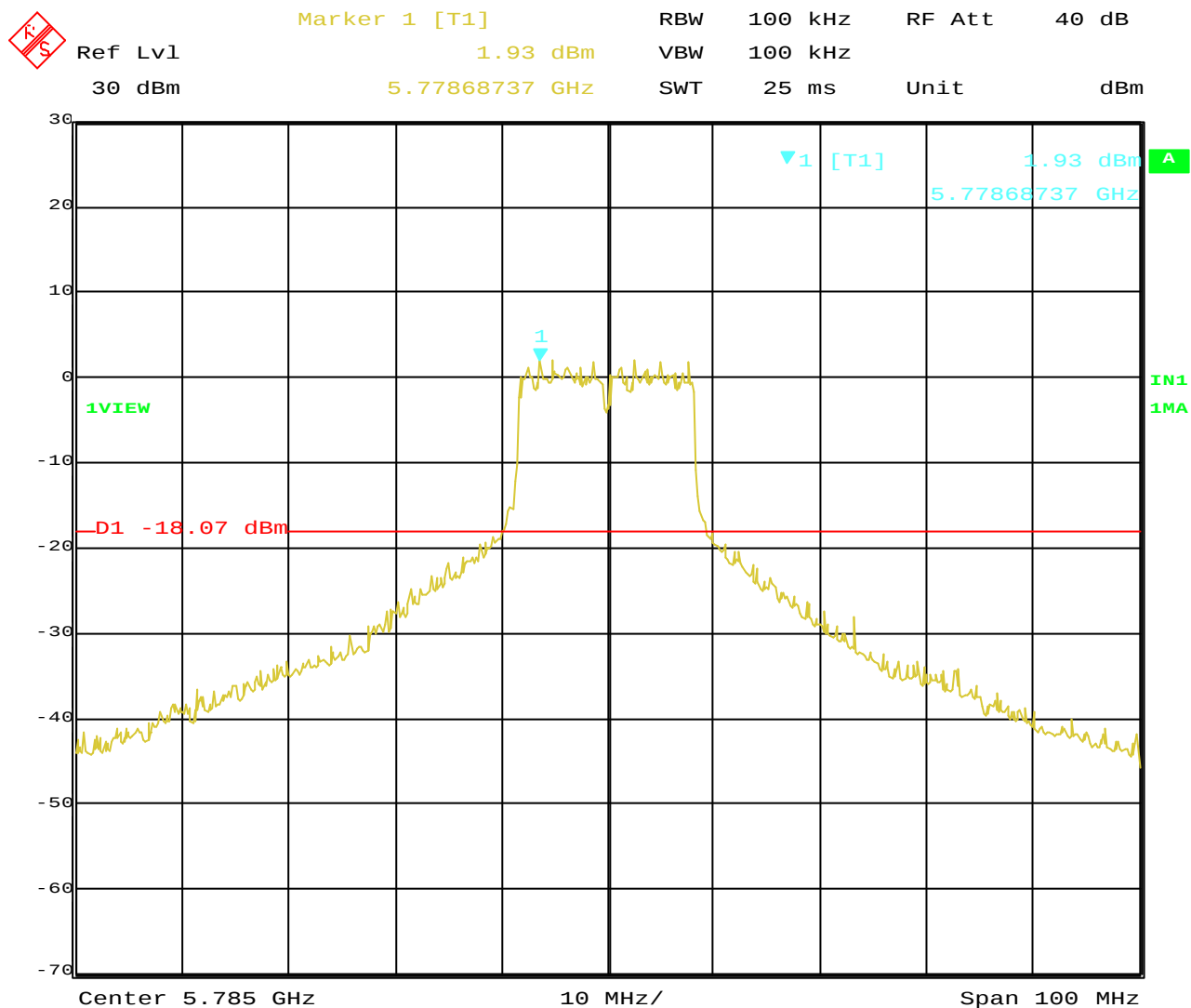
Date: 14.JAN.2003 16:33:12

Plot 2-9. Out of band emissions around 2462MHz



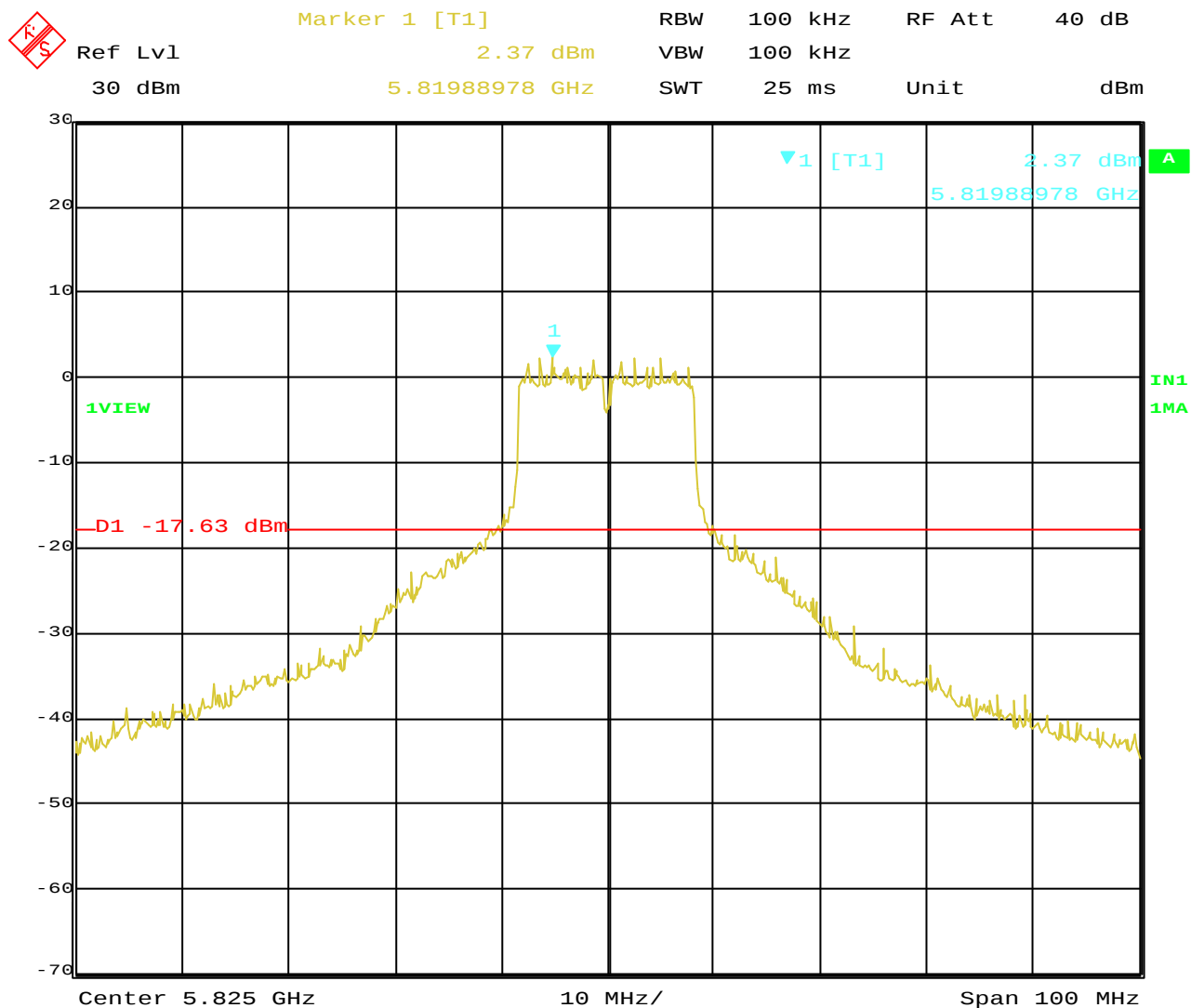
Date: 14.JAN.2003 17:58:48

Plot 2-10. Out of band emissions around 5745MHz



Date: 14.JAN.2003 17:59:50

Plot 2-11. Out of band emissions around 5785MHz



Date: 14.JAN.2003 18:01:09

Plot 2-12. Out of band emissions around 5825MHz

3. Conducted Peak Output Power

The test was performed with two kinds of measurement methods using power meter or spectrum analyzer.

3.1 Test Procedure

3.1.1 Power Meter measurement method

- A transmitter antenna terminal of EUT was connected to the input of a RF power sensor.
- Measurement was performed while EUT was operating in continuous transmission mode at the appropriate center frequencies. i.e. the lowest, middle, and highest frequencies of each 2.4GHz or 5.8GHz band.

Table 3-1 : Test Instruments of power meter method

Description	Model	Serial Number
Power Meter	HP 437B	3043U03437
Power Sensor	HP 8481A	US41030582
Coax cables: - Power Sensor <=> EUT	Length: 20 cm Loss: 0.7dB (for 2.4GHz) 1.3dB (for 5.8GHz)	

Notes: - HP: Hewlett Packard

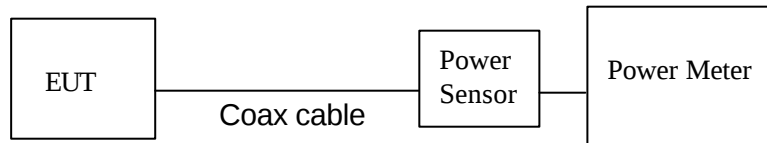


Figure 3-1: Measurement setup of power meter method

3.1.2 Spectrum Analyzer measurement method

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

The spectrum analyzer was set to :

VBW= 30kHz, RBW=1MHz,

Span=30-40MHz encompassing the entire 6 dB emission bandwidth of the transmission signal,
Mode= sample detector, Trigger= free run

The band power measurement function was used to measure the peak power of each transmission mode selected by the step 3.1.1. The analyzer computed the peak power by integrating the spectrum across the 6 dB emission bandwidth given by the previous chapter.

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

3.2 Measurement Results

Test Date: January 14, 2003

Table 3-2-1. Power meter measurement results (EUT: M/T 2388-2UU, s/n BA00022)

Operation Frequency [GHz]	Rated output power (conducted) [dBm]									
	1 / 2M bps	5.5/11M bps	6M bps	9M bps	12M bps	18M bps	24M bps	36M bps	48M bps	54M bps
2.412 (Aux)	16.2	16.3	NA							
Specification	17									
2.437 (Aux)	16.1	16.2	N/A							
Specification	17									
2.462 (Aux)	16.1	16.2	N/A							
Specification	17									
5.745 (Main)	N/A		15.1	-	-	-	15.2	14.0	11.6	9.6
Specification			16					15	12	10
5.785 (Main)	N/A		15.1	-	-	-	15.2	14.3	11.6	9.8
Specification			16					15	12	10
5.825 (Main)	N/A		15.2	-	-	-	15.3	14.2	11.6	9.8
specification			16					15	12	10

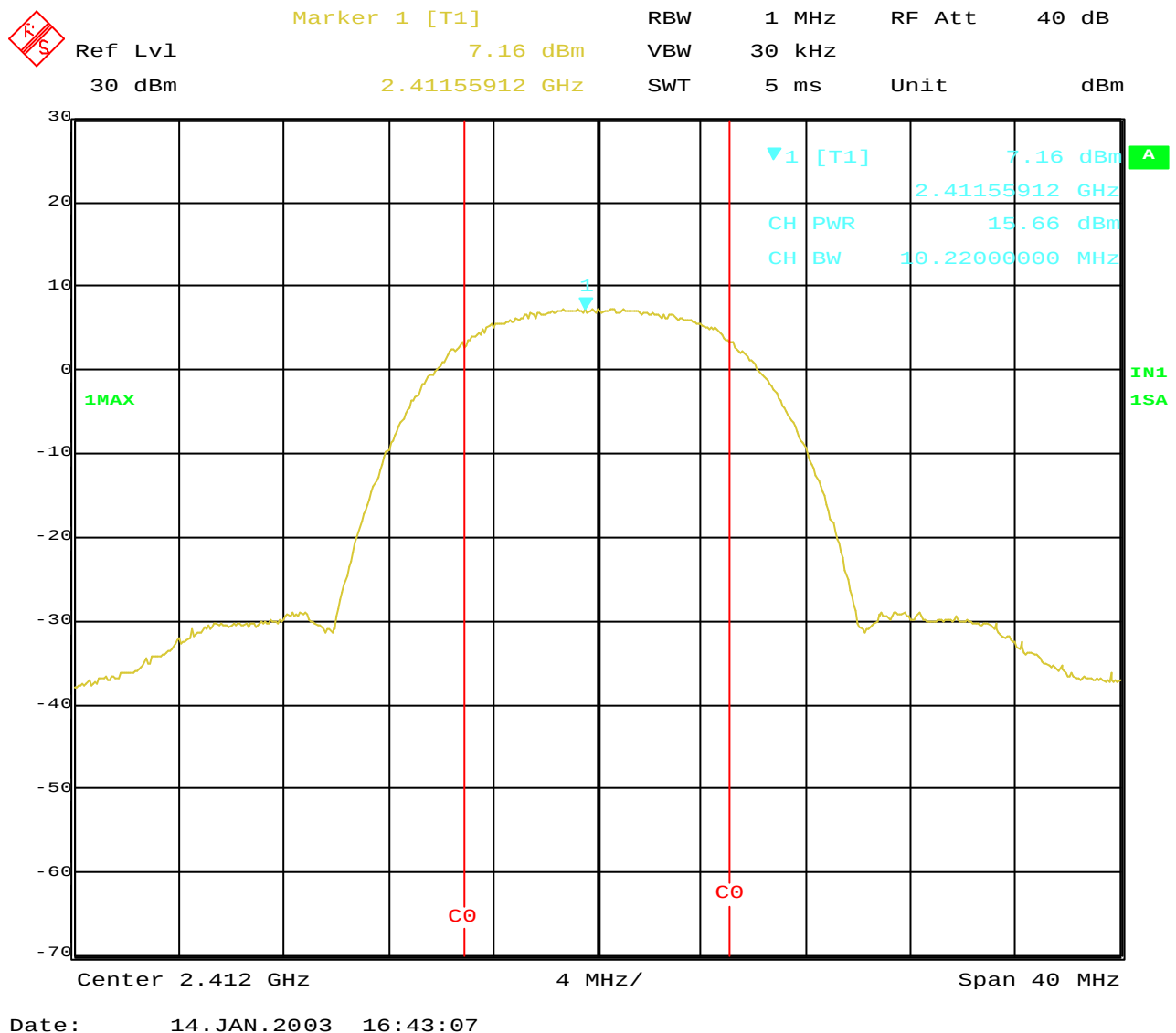
[Calculation table]

Measured Frequency (MHz)	Power Meter Reading (dBm)	Cable Loss (dB)	Results (dBm)	Limit		Peak antenna gain of EUT (dBi)	EIRP (dBm)	IC limit (dBm)
				FCC (dBm)	IC (dBm)			
2412	16.3	0.7	17.0	30	30	-	-	N/A
2437	16.2	0.7	16.9					
2462	16.2	0.7	16.9					
5745	15.2	1.3	16.5			3.15	19.7	36
5785	15.2	1.3	16.5				19.7	
5825	15.3	1.3	16.6				19.8	

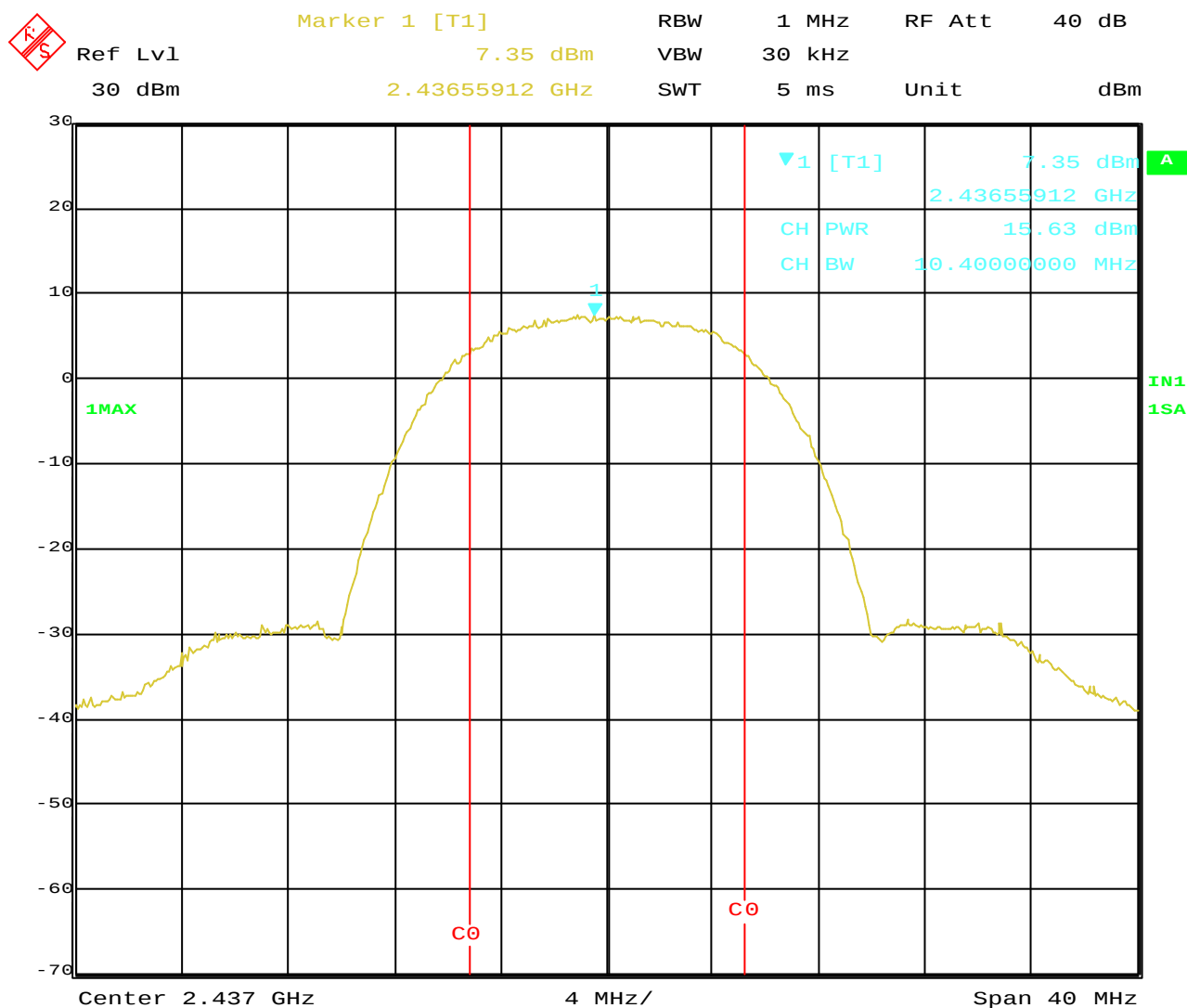
Table 3-2-2. Spectrum analyzer measurement results (EUT: M/T 2388-2UU, s/n BA00022)

Measured Frequency (MHz)	Analyzer reading (dBm)	Trace number	Cable Loss (dB)	Results (dBm)	Limit		Peak antenna gain of EUT (dBi)	EIRP (dBm)	IC limit (dBm)
					FCC (dBm)	IC (dBm)			
2412	15.66	Plot 3-1	1.3	17.0	30	30	-	-	N/A
2437	15.63	Plot 3-2	1.3	16.9					
2462	15.45	Plot 3-3	1.3	16.8					
5745	14.16	Plot 3-4	2.3	16.5			3.15	19.7	36
5785	14.05	Plot 3-5	2.3	16.4				19.6	
5825	14.29	Plot 3-6	2.3	16.6				19.8	

3.4 Trace Data of Conducted Peak Output Power

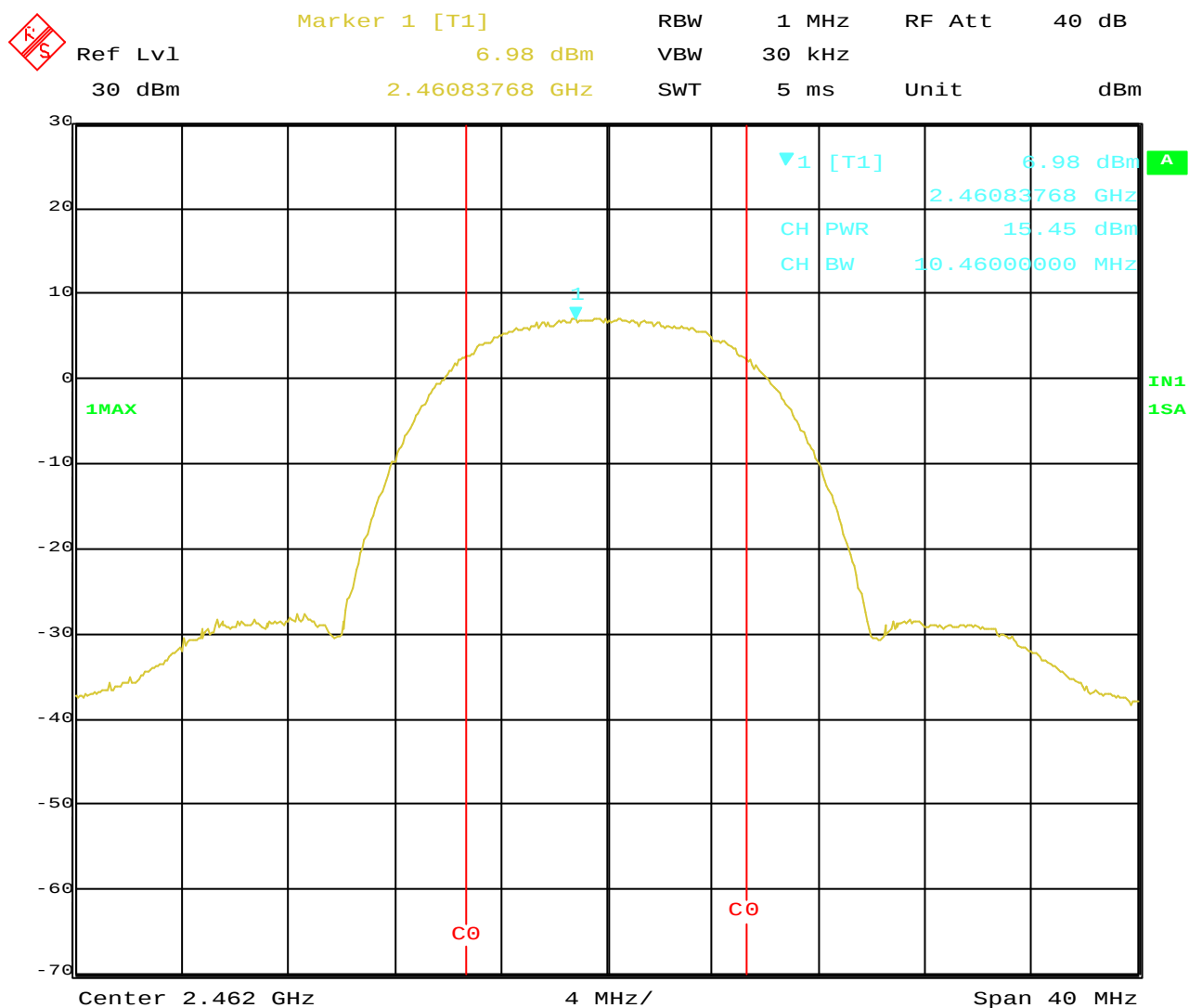


Plot 3-1. Conducted Peak Output Power of 2412MHz



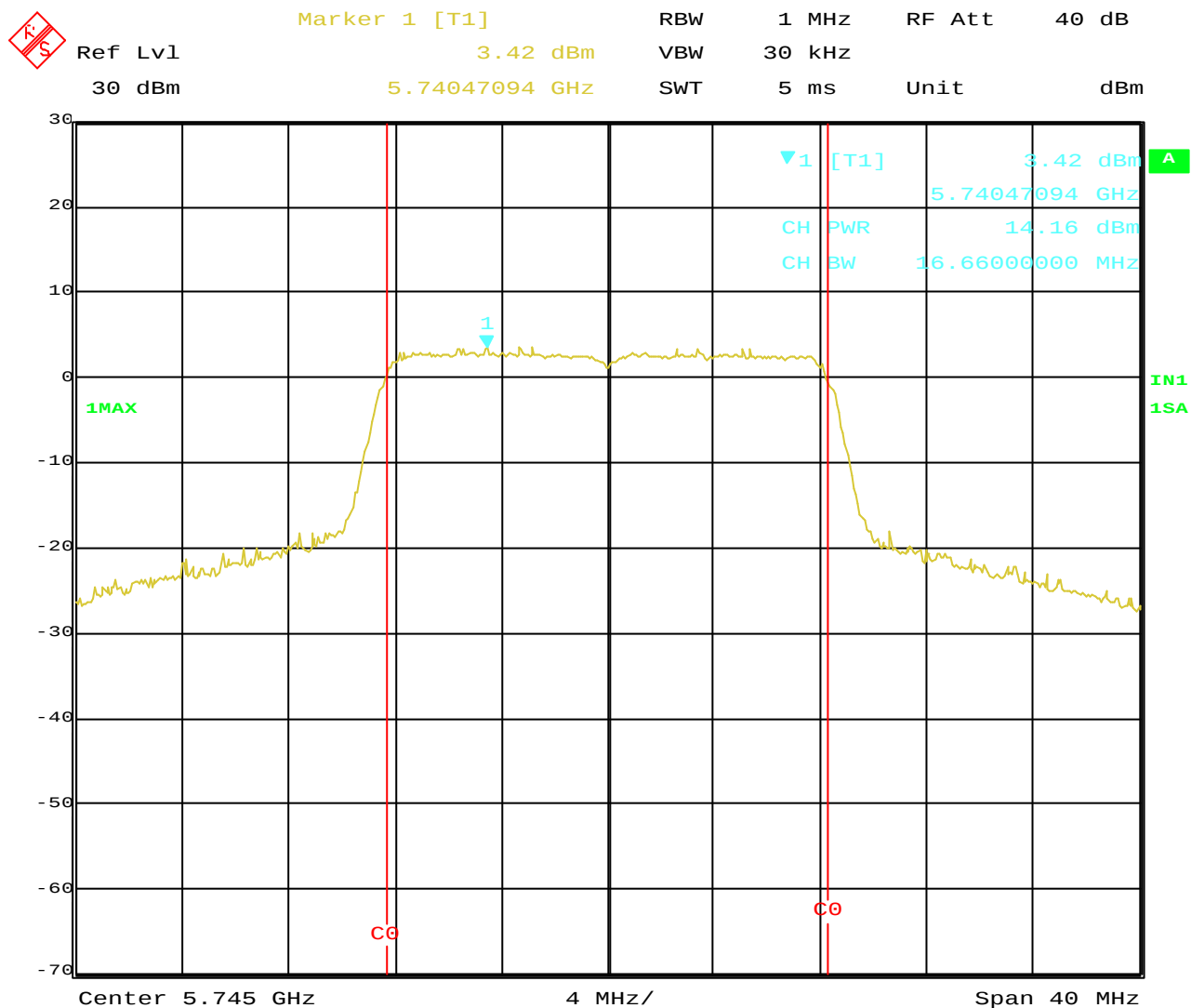
Date: 14.JAN.2003 16:44:46

Plot 3-2. Conducted Peak Output Power of 2437MHz



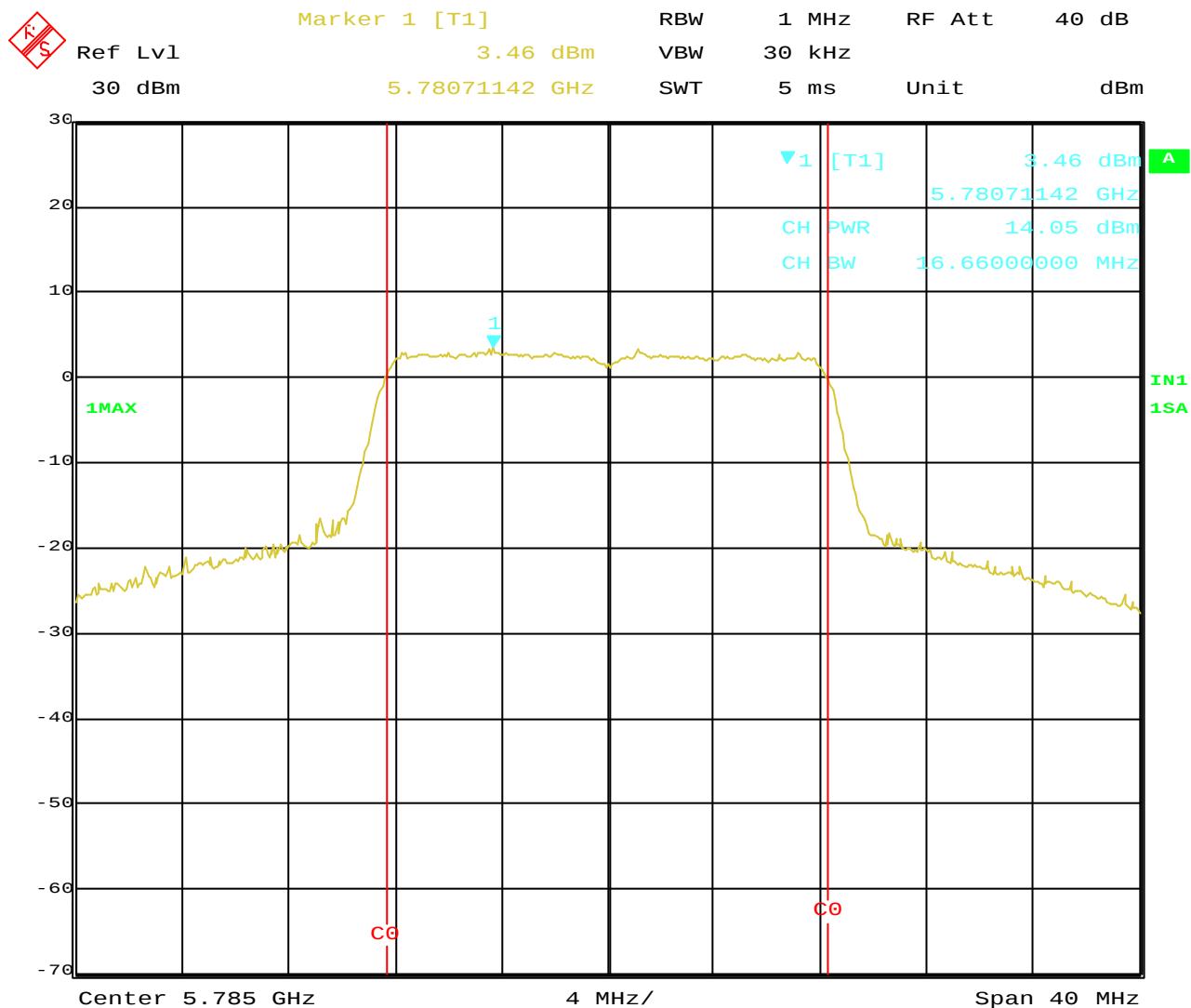
Date: 14.JAN.2003 16:55:56

Plot 3-3. Conducted Peak Output Power of 2462MHz



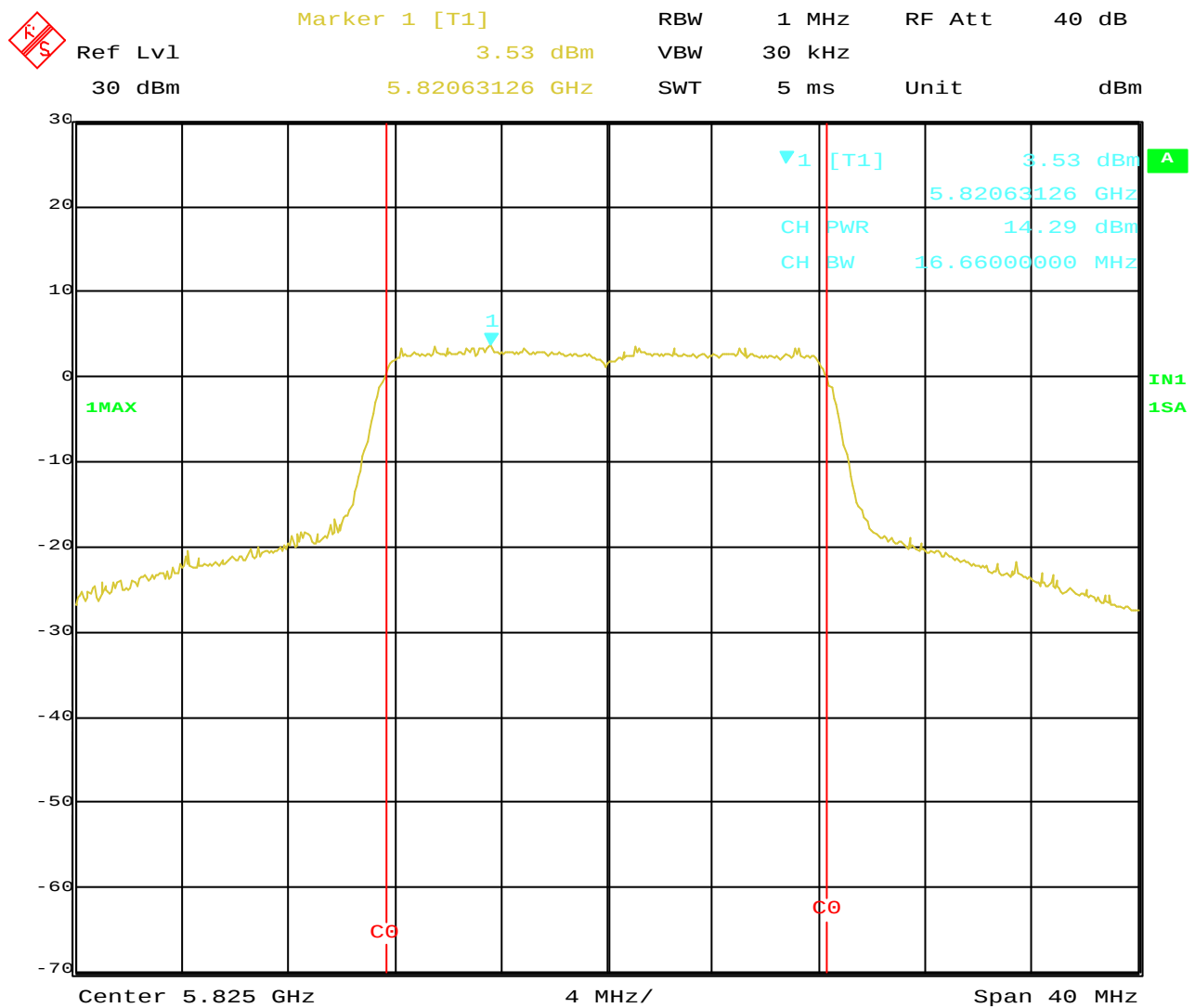
Date: 14.JAN.2003 18:04:40

Plot 3-4. Conducted Peak Output Power of 5745MHz



Date: 14.JAN.2003 18:08:30

Plot 3-5. Conducted Peak Output Power of 5785MHz



Date: 14.JAN.2003 18:11:31

Plot 3-6. Conducted Peak Output Power of 5825MHz

4. Peak 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 frequencies of each 2.4GHz or 5.8GHz band.

The spectrum analyzer is set to:

RBW= 3kHz, VBW=100kHz, Span=10MHz(for 2.4GHz band) or 20MHz(for 5.8GHz band),
Sweep=2.8 seconds

4.2 Test Instruments and Measurement Setup

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

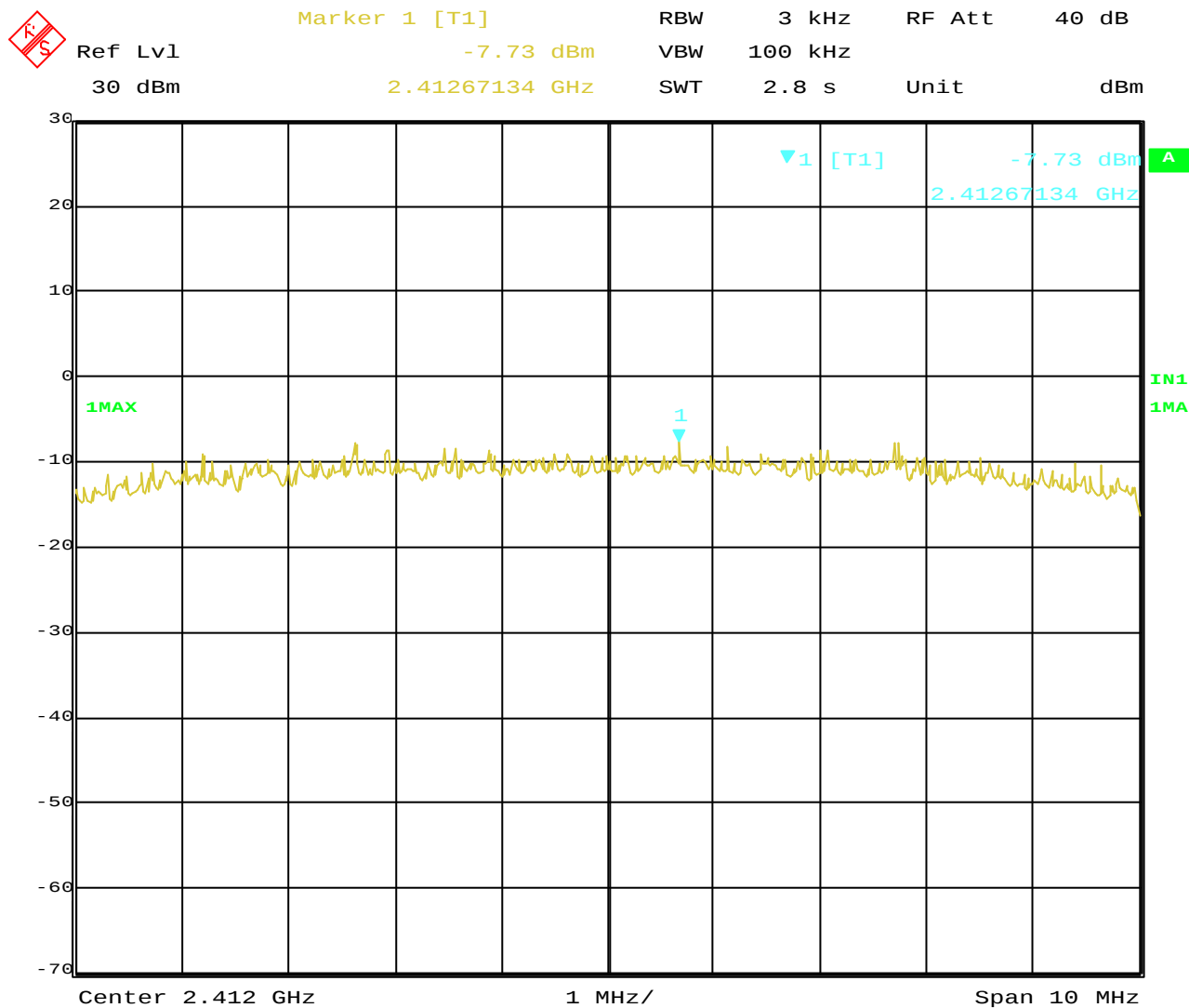
4.3 Measurement Results

Test Date: January 14, 2003

Table 4-1. EUT: M/T 2388-2UU, s/n BA00022 , TX mode

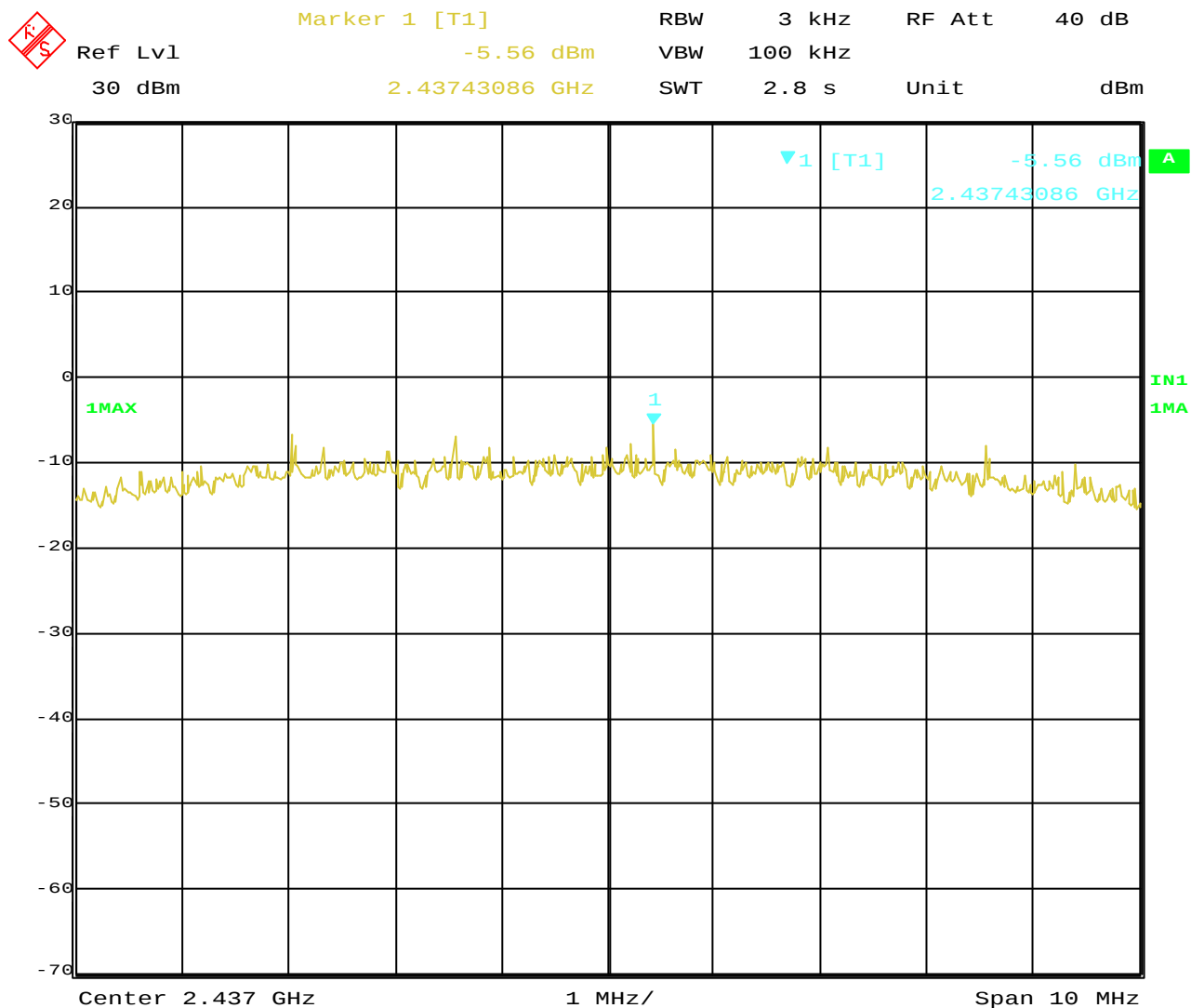
Ch No.	Frequency (MHz)	Analyzer Reading (dBm)	Trace number	Cable loss (dB)	Result (dBm)	Limit (dBm)	Margin (dB)
1	2412.67	-7.73	Plot 4-1	1.3	- 6.4	8.0	14.4
6	2437.43	-5.56	Plot 4-2	1.3	- 4.3	8.0	12.3
11	2461.19	-7.36	Plot 4-3	1.3	- 6.1	8.0	14.1
149	5740.33	-11.45	Plot 4-4	2.3	- 9.2	8.0	17.2
157	5780.57	-10.94	Plot 4-5	2.3	- 8.6	8.0	16.6
165	5820.57	-10.29	Plot 4-6	2.3	- 8.0	8.0	16.0

4.4 Trace Data of Peak Power Spectral Density



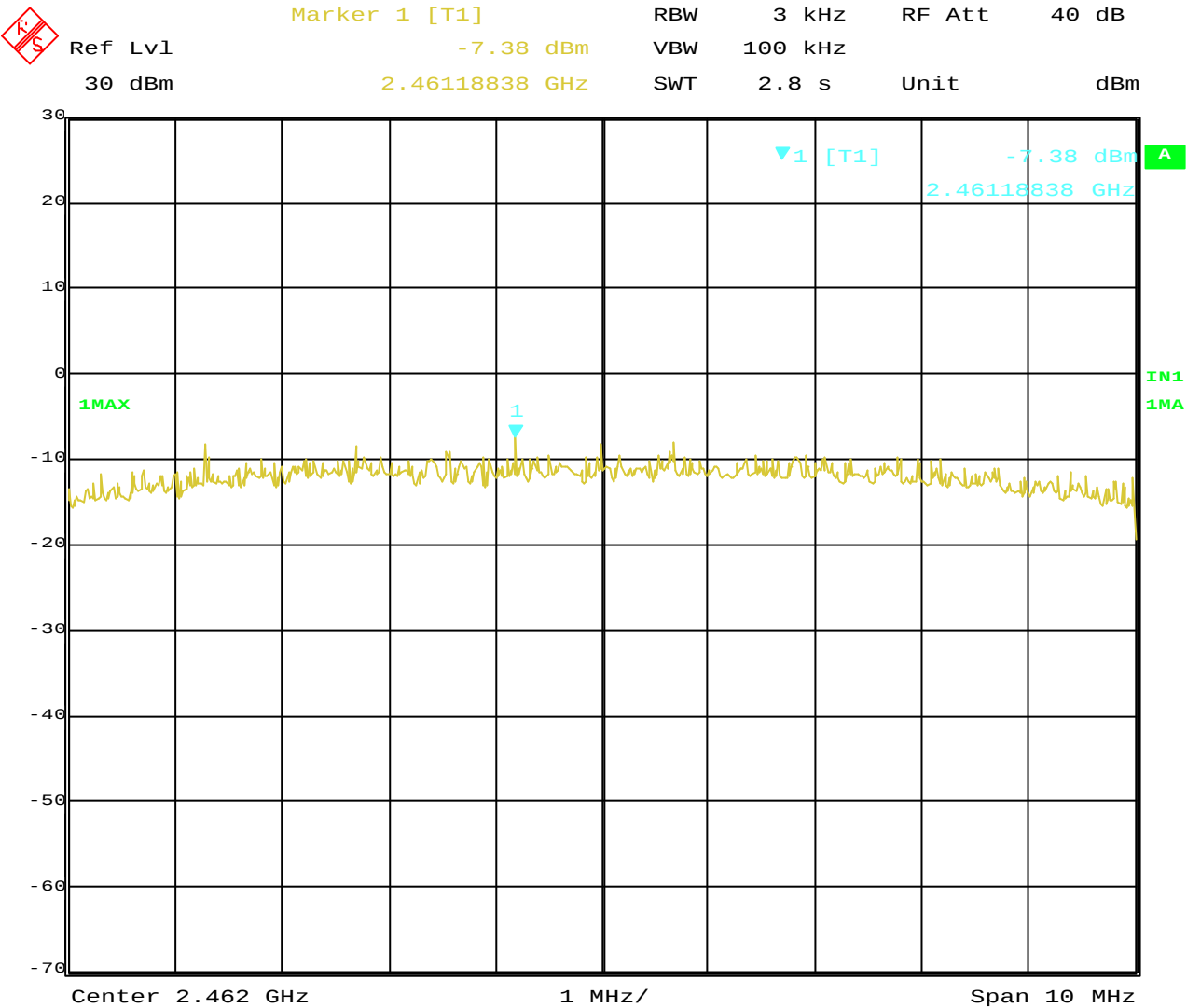
Date: 14.JAN.2003 16:58:17

Plot 4-1. Peak Power Spectral Density of 2412MHz



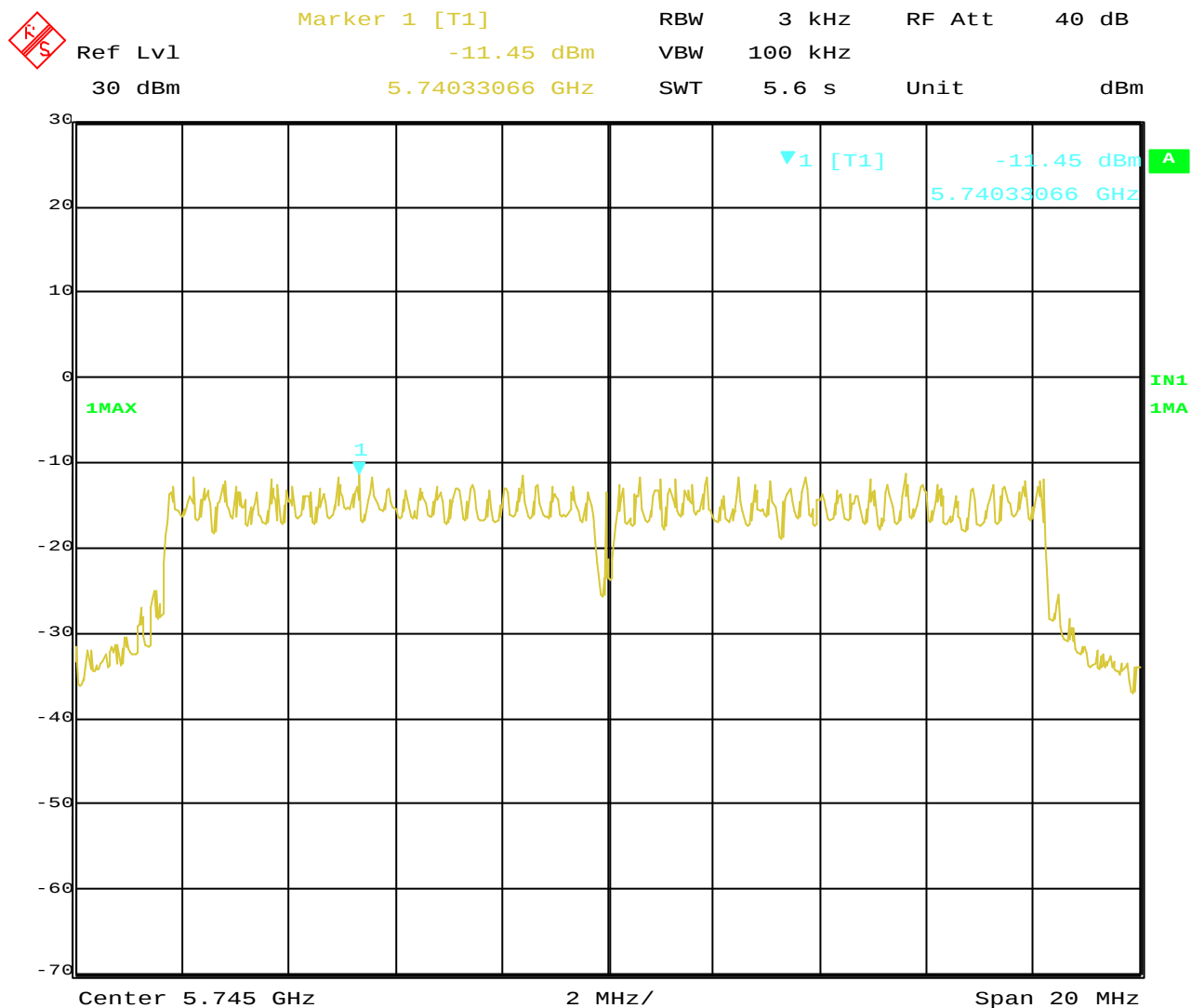
Date: 14.JAN.2003 16:59:14

Plot 4-2. Peak Power Spectral Density of 2437MHz



Date: 14.JAN.2003 17:00:29

Plot 4-3. Peak Power Spectral Density of 2462MHz

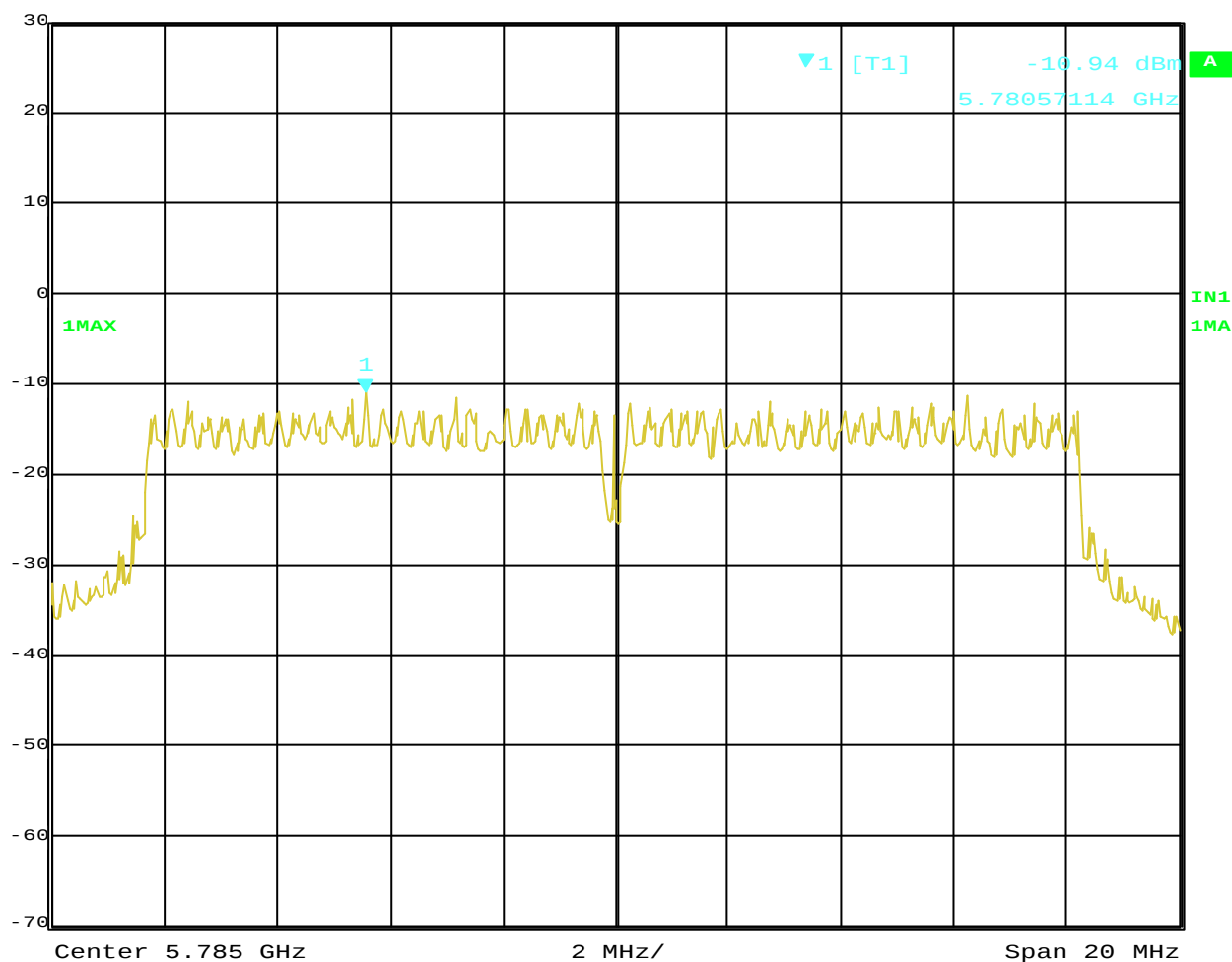


Date: 14.JAN.2003 18:13:04

Plot 4-4. Peak Power Spectral Density of 5745MHz

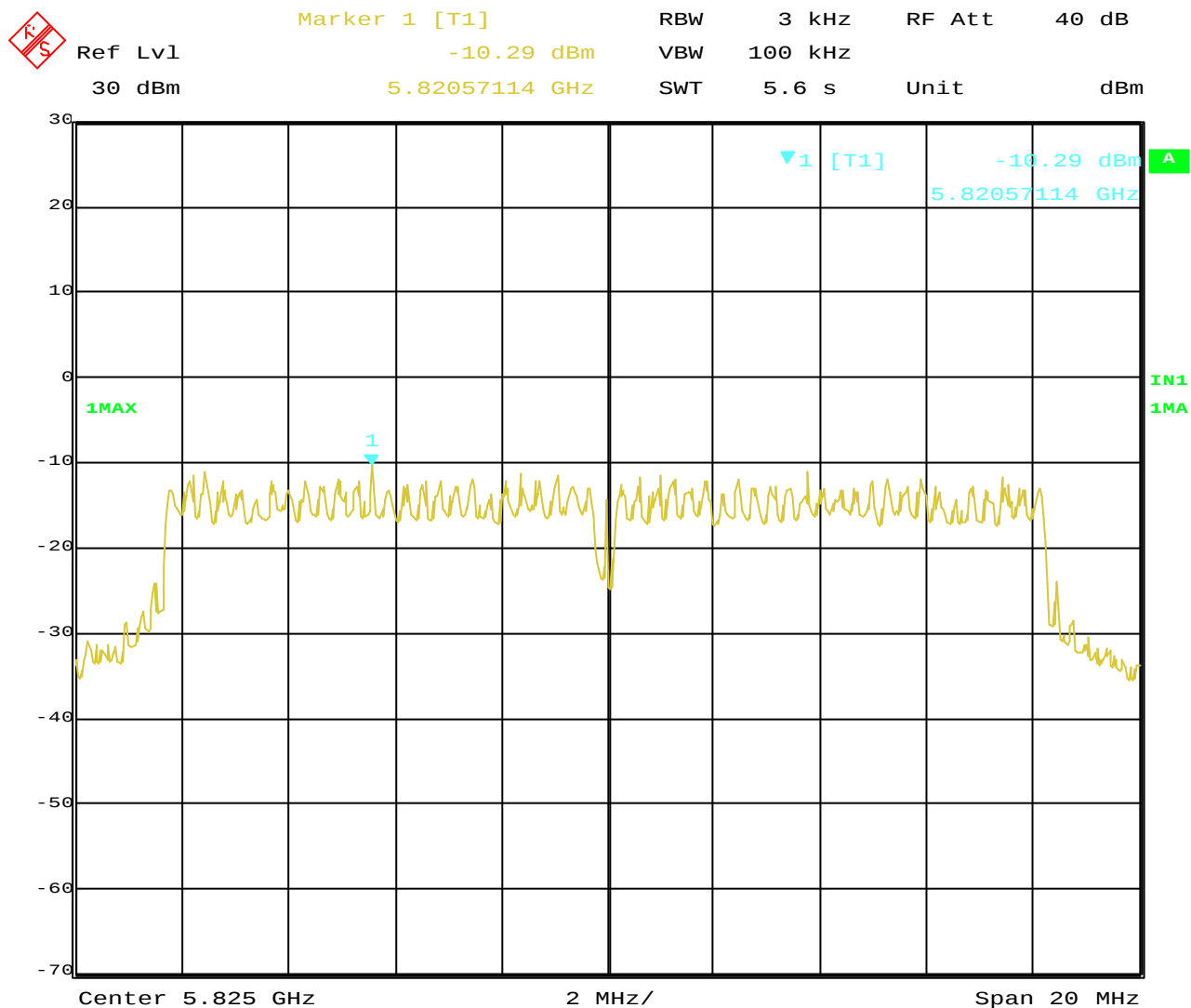


Ref Lvl 30 dBm
Marker 1 [T1] -10.94 dBm
5.78057114 GHz
RBW 3 kHz
VBW 100 kHz
SWT 5.6 s
RF Att 40 dB
Unit dBm



Date: 14.JAN.2003 18:14:06

Plot 4-5. Peak Power Spectral Density of 5785MHz



Date: 14.JAN.2003 18:15:04

Plot 4-6. Peak Power Spectral Density of 5825MHz

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

[FCC 15.207, RSS-210 6.6 / 7.4]

5.1 Test Procedure

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

5.2 Test Instruments and Measurement Setup

Table 5-1. Conducted Emission Test Instrumentation

Description	Model	Serial Number
Computer	IBM 6589-13J	97-15613
Spectrum Analyzer (100Hz-1.5GHz)	HP 85680B	2601A02634
Spectrum Analyzer Display	HP 85662A	2542A12308
Quasi-Peak Adapter	HP 85650A	2043A00062
Receiver (9kHz-30MHz)	R&S ESH3	891806/012
LISN	EMCO 3825/2	1426
Switch/control unit	HP 3488A	2719A17228
Plotter	HP 7550A	2631A33619
Coax cables: - Lisc-L <=> SW/Con.unit (SW100) - Lisc-N <=> SW/Con.unit (SW101) - SW/Con.unit <=> RCVR (Input) - SW/Con.unit<=> Spe Ana.(Signal In)	Length: 4 m 4 m 1 m 1 m	- EMIC-L - EMIC-N - EMIC-R - EMIC-S

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

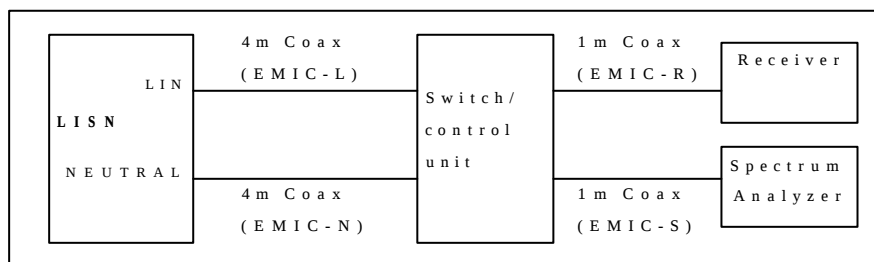


Figure 5. Cables for Conducted Emission Test

5.3 Measurement Results

The EUT was found to comply to the limits of FCC Part 15 Subpart C and RSS-210 with a margin of 7.2 dB. The 6 highest emissions relative to the limits are reported.

Test Date: January 20 and 23, 2003

5.3.1 EUT in 2.4GHz IEEE802.11b transmission mode

Table 5-2-1. EUT: M/T 2388-2UU, s/n BA00022, Ch.1(2412MHz) TX mode 11Mbps

Frequency (MHz)	Phase	QP Voltage (dBμV)	CISPR22 QP Limit (dBμV)	AV Voltage (dBμV)	CISPR22 AV Limit (dBμV)
0.3371	NEUTRAL	36.0	59.3	32.1	49.3
0.4680	NEUTRAL	35.5	56.5	33.8	46.5
0.6031	NEUTRAL	35.1	56.0	33.4	46.0
0.7358	LINE	39.9	56.0	37.8	46.0
0.8067	NEUTRAL	34.9	56.0	33.2	46.0
1.1486	NEUTRAL	31.8	56.0	30.8	46.0

Table 5-2-2. EUT: M/T 2388-2UU, s/n BA00022 , Ch.6(2437MHz) TX mode 11Mbps

Frequency (MHz)	Phase	QP Voltage (dBμV)	CISPR22 QP Limit (dBμV)	AV Voltage (dBμV)	CISPR22 AV Limit (dBμV)
0.4712	NEUTRAL	36.8	56.5	35.0	46.5
0.6101	NEUTRAL	35.5	56.0	33.6	46.0
0.7361	NEUTRAL	39.7	56.0	37.6	46.0
0.8114	NEUTRAL	35.7	56.0	34.0	46.0
0.9437	NEUTRAL	31.8	56.0	31.1	46.0
1.1494	NEUTRAL	32.2	56.0	31.4	46.0

Table 5-2-3. EUT: M/T 2388-2UU, s/n BA00022, Ch.11(2462MHz) TX mode 11Mbps

Frequency (MHz)	Phase	QP Voltage (dBμV)	CISPR22 QP Limit (dBμV)	AV Voltage (dBμV)	CISPR22 AV Limit (dBμV)
0.4720	NEUTRAL	36.8	56.5	34.9	46.5
0.6103	NEUTRAL	35.7	56.0	33.7	46.0
0.7357	LINE	39.9	56.0	37.8	46.0
0.8069	NEUTRAL	32.2	56.0	30.1	46.0
0.9474	NEUTRAL	32.3	56.0	31.6	46.0
1.1478	NEUTRAL	31.7	56.0	30.8	46.0

Table 5-2-4. EUT: M/T 2388-2UU, s/n BA00022, Ch. 6 (2437MHz) RX mode

Frequency (MHz)	Phase	QP Voltage (dBμV)	CISPR22 QP Limit (dBμV)	AV Voltage (dBμV)	CISPR22 AV Limit (dBμV)
0.4648	LINE	37.0	56.6	35.8	46.6
0.6010	LINE	35.2	56.0	33.8	46.0
0.6683	LINE	33.8	56.0	32.1	46.0
0.7341	LINE	39.9	56.0	37.4	46.0
0.8037	LINE	34.6	56.0	33.0	46.0
1.0062	LINE	32.6	56.0	31.9	46.0

5.3.2 EUT in 5.8GHz IEEE802.11a transmission modeTable 5-3-1. EUT: M/T 2388-2UU, s/n BA00022, Ch.149(5745MHz) **TX** mode 24Mbps

Frequency (MHz)	Phase	QP Voltage (dBμ V)	CISPR22 QP Limit (dBμ V)	AV Voltage (dBμ V)	CISPR22 AV Limit (dBμ V)
0.4619	LINE	33.4	56.7	31.2	46.7
0.5998	LINE	31.8	56.0	29.3	46.0
0.6676	LINE	33.6	56.0	31.3	46.0
0.7325	NEUTRAL	40.4	56.0	38.2	46.0
0.8717	LINE	32.7	56.0	31.9	46.0
1.0744	LINE	30.7	56.0	29.8	46.0

Table 5-3-2 EUT: M/T 2388-2UU, s/n BA00022, Ch.157(5785MHz) **TX** mode 24Mbps

Frequency (MHz)	Phase	QP Voltage (dBμ V)	CISPR22 QP Limit (dBμ V)	AV Voltage (dBμ V)	CISPR22 AV Limit (dBμ V)
0.4713	LINE	36.9	56.5	36.1	46.5
0.5390	LINE	33.4	56.0	30.5	46.0
0.6737	LINE	34.9	56.0	32.9	46.0
0.7365	NEUTRAL	40.1	56.0	38.0	46.0
0.8752	LINE	33.1	56.0	32.4	46.0
1.0784	LINE	31.4	56.0	30.5	46.0

Table 5-3-3 EUT: M/T 2388-2UU, s/n BA00022, Ch.165(5825MHz) **TX** mode 24Mbps

Frequency (MHz)	Phase	QP Voltage (dBμ V)	CISPR22 QP Limit (dBμ V)	AV Voltage (dBμ V)	CISPR22 AV Limit (dBμ V)
0.3355	LINE	37.8	59.3	34.9	49.3
0.4697	LINE	36.0	56.5	35.2	46.5
0.5404	LINE	33.6	56.0	30.8	46.0
0.6751	LINE	35.6	56.0	33.1	46.0
0.7337	NEUTRAL	40.7	56.0	38.8	46.0
0.8783	LINE	32.9	56.0	32.3	46.0

Table 5-3-4 EUT: M/T 2388-2UU, s/n BA00022, Ch.157(5785MHz) **RX** mode

Frequency (MHz)	Phase	QP Voltage (dBμ V)	CISPR22 QP Limit (dBμ V)	AV Voltage (dBμ V)	CISPR22 AV Limit (dBμ V)
0.3382	LINE	37.6	59.2	35.2	49.2
0.4720	LINE	37.2	56.5	36.3	46.5
0.6046	LINE	31.5	56.0	28.9	46.0
0.7339	NEUTRAL	40.7	56.0	38.7	46.0
0.8760	LINE	33.0	56.0	32.0	46.0
1.0776	LINE	30.1	56.0	29.0	46.0

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

[FCC 15.205 / 209, RSS-210 6.2.1 / 6.3 / 7.3]

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	2841A04252
Spectrum Analyzer Display for 200-1000MHz	HP 85662A	2816A16831
Quasi-Peak Adapter for 200-1000MHz	HP 85650A	2811A01156
Amplifier (100KHz-1.3GHz)		
- for 30-200MHz	HP 8447D	2805A02919
- for 200-1000MHz	HP 8447D	2944A03506
Biconical Antenna (30-200MHz)	EMCO 3108	2309
Log-Periodic Antenna (200-1000MHz)	EMCO 3146	1585
Receiver (20MHz-1.3GHz)	R&S ESVP	893202/018
Switch/control unit	HP 3488A	2719A17226
N-Coax cables:	Length:	
- Bi-coni Ant <=> 10m Cable	9 m	- EM103L01
- 10m Cable <=> Shield Panel	10 m	- EM103L02
- Shield Panel <=> RF Amp	7 m	- EM103L03
- RF Amp <=> Power Splitter	0.5m	- EM103L04
- Log-peri Ant <=> 10m Cable	9 m	- EM103H01
- 10m Cable <=> Shield Panel	10 m	- EM103H02
- Shield Panel <=> RF Amp	7 m	- EM103H03
- RF Amp <=> Power Splitter	0.5m	- EM103H04
Coax cables:		
- Power Splitter <=> SW/Con.unit (SW110)	1 m	- EM103L05
- Power Splitter <=> SW/Con.unit (SW300)	1 m	- EM103L06
- Power Splitter <=> SW/Con.unit (SW100)	1 m	- EM103H05
- Power Splitter <=> SW/Con.unit (SW301)	1 m	- EM103H06

- SW/Con.unit <=> Receiver (Input)	2 m	- EM1RCV
- SW/Con.unit <=> Spe Ana.(Signal In) for 30- 200MHz	2 m	- EM1SPL
- SW/Con.unit <=> Spe Ana.(Signal In) for 200-1000MHz	2 m	- EM1SPH

Notes:

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

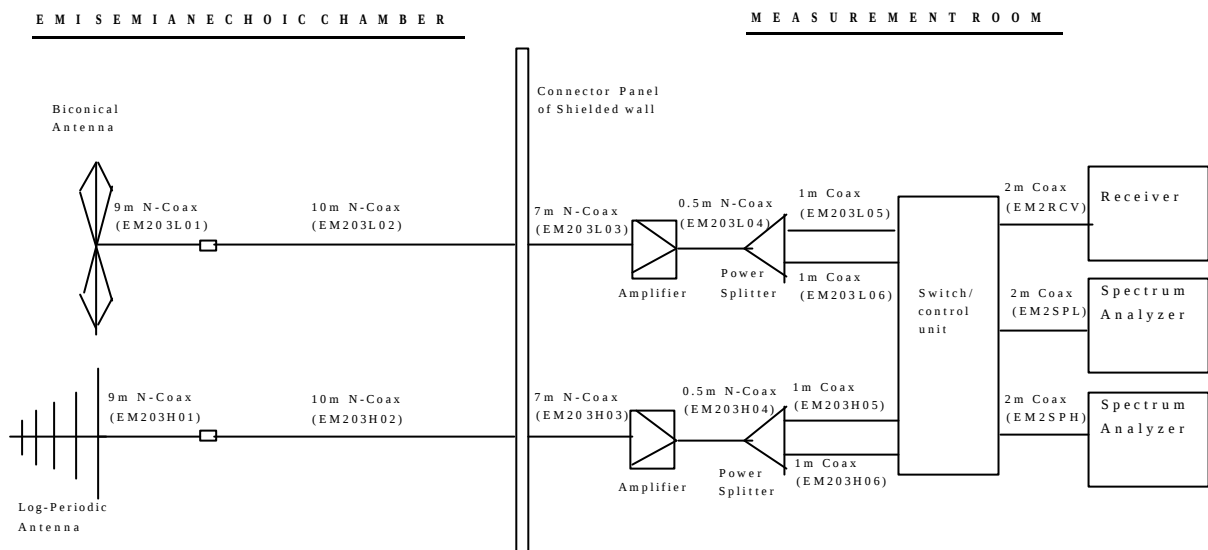


Figure 6 Cables for Radiated Emission Test

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 5.8 dB at 30MHz - 1000MHz band.

The 6 highest emissions relative to the limits are reported.

Test Date: January 21, 2003

6.4.1 EUT in 2.4GHz IEEE802.11b transmission mode

Table 6-2-1. EUT: M/T 2388-2UU, s/n BA00022, 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)
193.562	H	37.8	13.5	-15.9	35.4	43.5	58.9	150
450.543	V	33.7	16.4	-13.7	36.4	46.0	66.1	200
465.376	V	34.8	16.8	-13.8	37.8	46.0	77.6	200
497.061	V	31.9	17.6	-13.4	36.1	46.0	63.8	200
830.423	H	25.6	21.6	-9.7	37.5	46.0	75.0	200
861.314	H	26.5	22.1	-10.3	38.3	46.0	82.2	200

Table 6-2-2. EUT: M/T 2388-2UU, s/n BA00022, 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)
192.905	H	36.9	13.4	-16.0	34.3	43.5	51.9	150
332.334	V	36.4	14.1	-13.9	36.6	46.0	67.6	200
450.543	V	33.9	16.4	-13.7	36.6	46.0	67.6	200
465.067	V	34.5	16.8	-13.8	37.5	46.0	75.0	200
498.584	V	31.6	17.7	-13.4	35.9	46.0	62.4	200
863.466	V	25.0	22.2	-10.3	36.9	46.0	70.0	200

Table 6-2-3. EUT: M/T 2388-2UU, s/n BA00022, 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)
32.000	H	34.9	13.0	-18.8	29.1	40.0	28.5	100
192.859	H	40.2	13.4	-15.9	37.7	43.5	76.7	150
331.917	V	35.5	14.1	-13.9	35.7	46.0	61.0	200
448.200	V	33.6	16.3	-13.7	36.2	46.0	64.6	200
465.668	V	34.7	16.8	-13.7	37.8	46.0	77.6	200
498.338	V	31.6	17.7	-13.4	35.9	46.0	62.4	200

Table 6-2-4. EUT: M/T 2388-2UU, s/n BA00022, Ch.6(2437MHz) **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)
32.000	H	34.8	13.0	-18.8	29.0	40.0	28.2	100
192.918	V	37.5	13.4	-16.0	34.9	43.5	55.6	150
331.626	V	35.2	14.1	-13.9	35.4	46.0	58.9	200
450.543	V	34.0	16.4	-13.7	36.7	46.0	68.4	200
463.946	V	34.2	16.7	-13.9	37.0	46.0	70.8	200
500.046	V	30.8	17.8	-13.3	35.3	46.0	58.2	200

6.4.2 EUT in 5.8GHz IEEE802.11a transmission modeTable 6-3-1. EUT: M/T 2388-2UU, s/n BA00022, Ch.149(5745MHz) **TX** mode 24Mbps

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)
31.998	H	34.4	13.0	-18.8	28.6	40.0	26.9	100
192.025	H	37.0	13.4	-16.0	34.4	43.5	52.5	150
331.775	V	34.6	14.1	-13.9	34.8	46.0	55.0	200
450.542	V	35.1	16.4	-13.7	37.8	46.0	77.6	200
464.722	V	32.9	16.7	-13.8	35.8	46.0	61.7	200
827.199	H	22.5	21.5	-9.6	34.4	46.0	52.5	200

Table 6-3-2 EUT: M/T 2388-2UU, s/n BA00022, Ch.157(5785MHz) **TX** mode 24Mbps

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)
192.025	H	37.1	13.4	-16.0	34.5	43.5	53.1	150
449.134	V	34.1	16.3	-13.8	36.6	46.0	67.6	200
463.535	V	34.2	16.7	-13.9	37.0	46.0	70.8	200
497.230	V	31.1	17.6	-13.4	35.3	46.0	58.2	200
830.423	V	23.3	21.6	-9.7	35.2	46.0	57.5	200
944.909	H	25.9	22.7	-9.3	39.3	46.0	92.3	200

Table 6-3-3 EUT: M/T 2388-2UU, s/n BA00022, Ch.165(5825MHz) **TX** mode 24Mbps

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)
69.248	V	42.9	8.9	-17.8	34.0	40.0	50.1	100
192.026	H	36.9	13.4	-16.0	34.3	43.5	51.9	150
450.543	V	35.5	16.4	-13.7	38.2	46.0	81.3	200
465.304	V	33.1	16.8	-13.8	36.1	46.0	63.8	200
497.152	V	31.3	17.6	-13.4	35.5	46.0	59.6	200
860.277	V	22.6	22.1	-10.3	34.4	46.0	52.5	200

Table 6-3-4 EUT: M/T 2388-2UU, s/n BA00022, Ch.157(5785MHz) **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)
192.308	H	36.9	13.4	-16.0	34.3	43.5	51.9	150
332.686	V	35.7	14.1	-13.9	35.9	46.0	62.4	200
450.543	V	34.6	16.4	-13.7	37.3	46.0	73.3	200
464.277	V	33.6	16.7	-13.8	36.5	46.0	66.8	200
828.719	H	23.5	21.5	-9.7	35.3	46.0	58.2	200
944.910	H	26.7	22.7	-9.3	40.1	46.0	101.2	200

7. RESTRICTED BANDS RADIATIONS (1GHz – 40GHz)

[FCC 15.205 / 209, RSS-210 6.2.1 / 6.3 / 7.3]

7.1 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.

7.2 Test Instruments and Measurement Setup

Table 7 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 - 26.5GHz)	HP 8449B	3008A00582
Amplifier (26.5 – 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	1158
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
Coaxialcables: - 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 15 m 3m 3m 1m	- EM206SCO - EM215SCO - SF102-20166 - SF102-20167 - SF102-21105

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

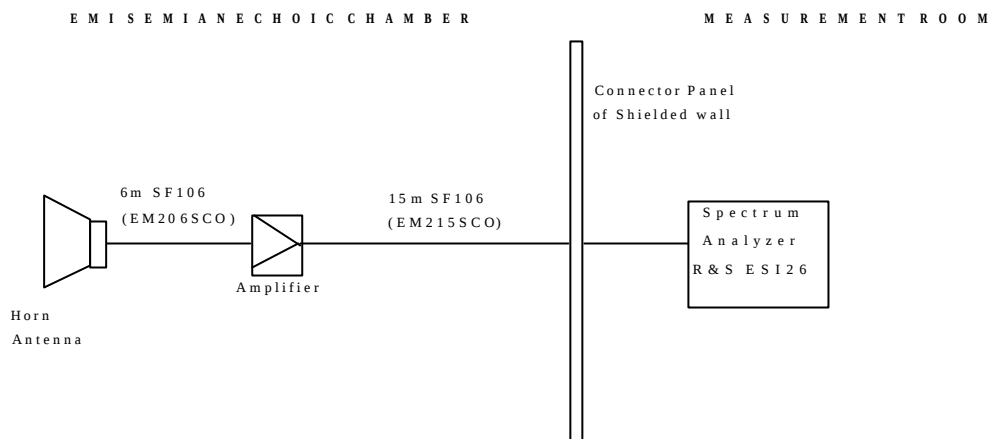


Figure 7-1. Cables for Radiated Emission Test (1 – 12.4 GHz)

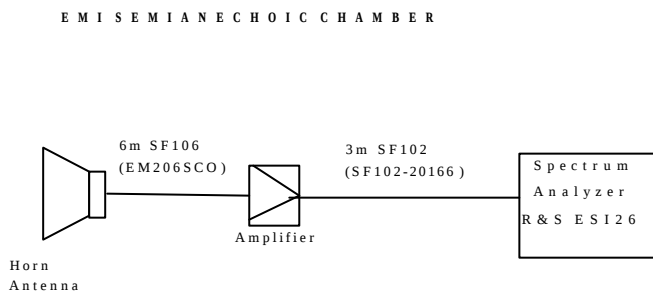


Figure 7-2. Cables for Radiated Emission Test (12.4 - 18GHz)

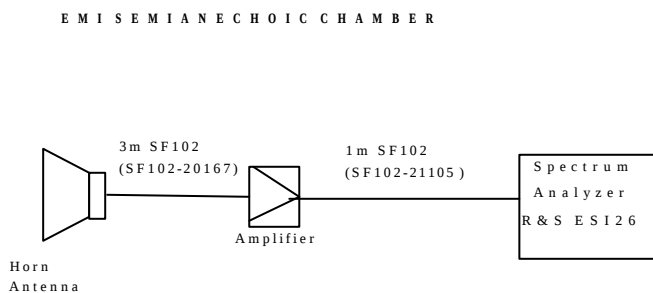


Figure 7-3. Cables for Radiated Emission Test (18 - 26.5GHz)

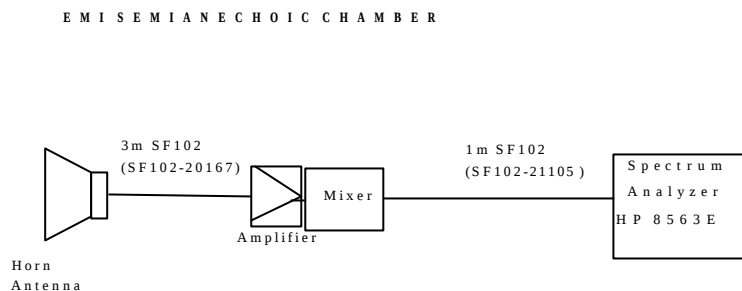


Figure 7-4. Cables for Radiated Emission Test (26.5 - 40GHz)

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 0.9 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: January 15, 16, 22, 24 and 27, 2003

7.4.1 EUT in 2.4GHz IEEE802.11b transmission mode

Table 7-2-1. EUT: M/T 2388-2UU, s/n BA00022, Ch.1(2412MHz) TX mode 11Mbps

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)
1.063	V	55.1	-	24.6	-32.7	0.0	47.0	74.0	-	54.0
1.125	V	50.5	-	24.5	-32.5	0.0	42.5	74.0	-	54.0
1.306	V	48.7	-	25.9	-32.0	0.0	42.6	74.0	-	54.0
1.328	V	53.7	-	25.6	-31.8	0.0	47.5	74.0	-	54.0
2.272	H	59.1	49.9	27.8	-30.5	0.0	56.4	74.0	47.2	54.0
2.368	H	62.2	55.4	28.1	-30.4	0.0	59.9	74.0	53.1	54.0
2.388	H	64.7	54.2	28.2	-30.4	0.0	62.5	74.0	52.0	54.0
2.414	H	113.5	105.4	28.3	-30.4	0.0	111.4	OB*	103.3	OB*
4.826	H	45.6	-	27.1	-27.2	0.0	45.5	74.0	-	54.0
7.235	V	42.4	-	30.0	-26.4	0.0	46.0	74.0	-	54.0

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

Table 7-2-2. EUT: M/T 2388-2UU, s/n BA00022, Ch.6(2437MHz) TX mode 11Mbps

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)
1.063	V	56.1	-	24.6	-32.7	0.0	48.0	74.0	-	54.0
1.125	V	50.6	-	24.5	-32.5	0.0	42.6	74.0	-	54.0
1.306	V	48.2	-	25.9	-32.0	0.0	42.1	74.0	-	54.0
1.328	V	55.7	-	25.6	-31.8	0.0	49.5	74.0	-	54.0
2.272	H	55.6	-	27.8	-30.5	0.0	52.9	74.0	-	54.0
2.368	H	61.8	55.4	28.1	-30.4	0.0	59.5	74.0	53.1	54.0
2.436	H	113.8	105.7	28.4	-30.3	0.0	111.9	OB*	103.8	OB*
2.496	H	58.9	52.2	28.4	-30.2	0.0	57.1	74.0	50.4	54.0
4.876	H	48.9	-	27.0	-26.9	0.0	49.0	74.0	-	54.0
7.312	V	39.5	-	29.9	-25.8	0.0	43.6	74.0	-	54.0

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

Table 7-2-3. EUT: M/T 2388-2UU, s/n BA00022, Ch.11(2462MHz) **TX** mode 11Mbps

Frequency (GHz)	Polarity (H/V)	Measured (dB μ V) (<i>peak</i>)	Measured (dB μ V) (<i>average</i>)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dB μ V/m) (<i>peak</i>)	FCC Limit (dB μ V/m) (<i>peak</i>)	Field Strength (dB μ V/m) (<i>average</i>)	FCC Limit (dB μ V/m) (<i>average</i>)
1.065	V	58.9	-	24.6	-32.7	0.0	50.8	74.0	-	54.0
1.125	V	50.9	-	24.5	-32.5	0.0	42.9	74.0	-	54.0
1.306	V	48.5	-	25.9	-32.0	0.0	42.4	74.0	-	54.0
1.328	V	53.6	-	25.6	-31.8	0.0	47.4	74.0	-	54.0
2.272	H	55.6	-	27.8	-30.5	0.0	52.9	74.0	-	54.0
2.337	H	55.8	-	28.1	-30.3	0.0	53.6	74.0	-	54.0
2.369	H	58.1	52.8	28.1	-30.4	0.0	55.8	74.0	50.5	54.0
2.463	H	113.2	105.4	28.4	-30.2	0.0	111.4	OB*	103.6	OB*
2.484	H	61.2	49.9	28.4	-30.2	0.0	59.4	74.0	48.1	54.0
2.496	H	61.4	52.7	28.4	-30.2	0.0	59.6	74.0	50.9	54.0
4.924	H	45.4	-	27.0	-27.7	0.0	44.7	74.0	-	54.0
7.387	V	41.9	-	29.8	-26.2	0.0	45.5	74.0	-	54.0

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

Table 7-2-4. EUT: M/T 2388-2UU, s/n BA00022, Ch.6(2437MHz) **RX** mode

Frequency (GHz)	Polarity (H/V)	Measured (dB μ V) (<i>peak</i>)	Measured (dB μ V) (<i>average</i>)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dB μ V/m) (<i>peak</i>)	FCC Limit (dB μ V/m) (<i>peak</i>)	Field Strength (dB μ V/m) (<i>average</i>)	FCC Limit (dB μ V/m) (<i>average</i>)
1.065	V	56.1	-	24.6	-32.7	0.0	48.0	74.0	-	54.0
1.125	V	51.0	-	24.5	-32.5	0.0	43.0	74.0	-	54.0
1.306	V	49.9	-	25.9	-32.0	0.0	43.8	74.0	-	54.0
1.328	V	55.3	-	25.6	-31.8	0.0	49.1	74.0	-	54.0

7.4.2 EUT in 5.8GHz IEEE802.11a transmission mode

Table 7-3-1. EUT: M/T 2388-2UU, s/n BA00022, Ch.149(5745MHz) **TX** mode 24Mbps

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>)
1.062	V	52.9	-	24.6	-32.7	0.0	44.8	74.0	-	54.0
1.124	V	51.4	-	24.5	-32.5	0.0	43.4	74.0	-	54.0
1.395	V	51.1	-	25.8	-31.8	0.0	45.1	74.0	-	54.0
1.463	V	54.0	-	25.1	-31.6	0.0	47.5	74.0	-	54.0
5.749	H	102.5	90.9	34.0	-26.6	0.0	109.9	OB*	98.3	OB*
11.489	V	41.0	-	33.5	-21.6	0.0	52.9	74.0	-	54.0

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

Table 7-3-2 EUT: M/T 2388-2UU, s/n BA00022, Ch.157(5785MHz) **TX** mode 24Mbps

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>)
1.062	V	53.4	-	24.6	-32.7	0.0	45.3	74.0	-	54.0
1.124	V	50.6	-	24.5	-32.5	0.0	42.6	74.0	-	54.0
1.395	V	51.5	-	25.8	-31.8	0.0	45.5	74.0	-	54.0
1.461	V	54.1	-	25.1	-31.6	0.0	47.6	74.0	-	54.0
5.790	H	101.5	90.0	34.2	-26.3	0.0	109.4	OB*	97.9	OB*
11.567	V	39.0	-	33.5	-21.7	0.0	50.8	74.0	-	54.0

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

Table 7-3-3 EUT: M/T 2388-2UU, s/n BA00022, Ch.165(5825MHz) **TX** mode 24Mbps

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>)
1.062	V	52.8	-	24.6	-32.7	0.0	44.7	74.0	-	54.0
1.124	V	50.9	-	24.5	-32.5	0.0	42.9	74.0	-	54.0
1.214	V	51.6	-	25.2	-32.2	0.0	44.6	74.0	-	54.0
1.395	V	51.6	-	25.8	-31.8	0.0	45.6	74.0	-	54.0
5.830	H	101.4	89.3	34.0	-26.2	0.0	109.2	OB*	97.1	OB*
11.651	V	40.3	-	33.6	-21.6	0.0	52.3	74.0	-	54.0

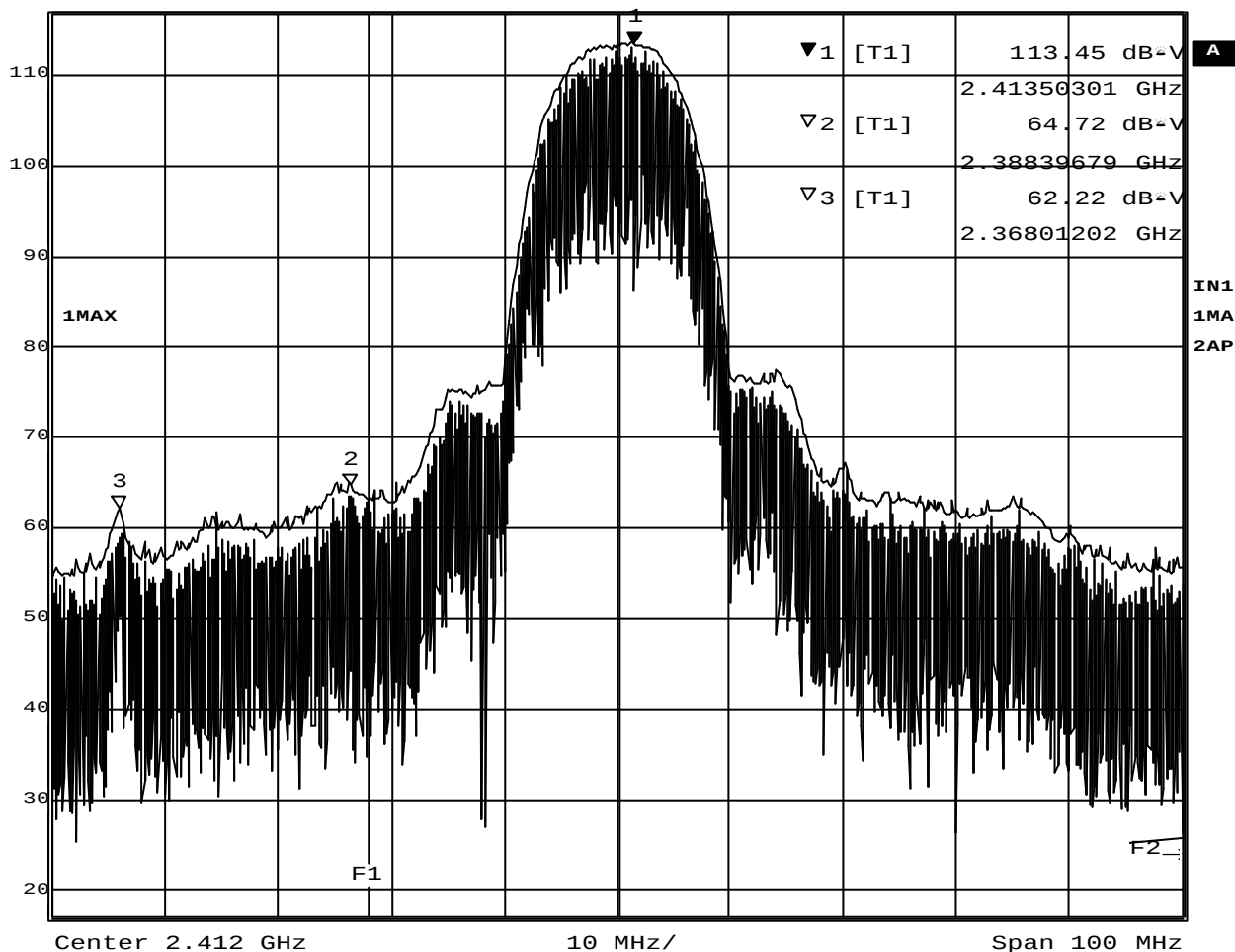
*Note: OB means “operation band” (5725-5850MHz); in this case limit is 1W (measured conducted with power meter)

Table 7-3-4 EUT: M/T 2388-2UU, s/n BA00022, Ch.157(5785MHz) **RX** mode

Frequency (GHz)	Polarity (H/V)	Measured (dB μ V) (<i>peak</i>)	Measured (dB μ V) (<i>average</i>)	Antenna Factor (dB/m)	Corr. Factor (dB)	Falloff Factor (dB)	Field Strength (dB μ V/m) (<i>peak</i>)	FCC Limit (dB μ V/m) (<i>peak</i>)	Field Strength (dB μ V/m) (<i>average</i>)	FCC Limit (dB μ V/m) (<i>average</i>)
1.062	V	53.6	-	24.6	-32.7	0.0	45.5	74.0	-	54.0
1.124	V	51.0	-	24.5	-32.5	0.0	43.0	74.0	-	54.0
1.200	V	53.4	-	25.2	-32.2	0.0	46.4	74.0	-	54.0
1.395	V	51.6	-	25.8	-31.8	0.0	45.6	74.0	-	54.0

Measurement plots for adjacent restricted band

Marker 1 [T1] RBW 1 MHz RF Att 20 dB
Ref Lvl 113.45 dBμV VBW 1 MHz
117 dBμV 2.41350301 GHz SWT 5 ms Unit dBμV

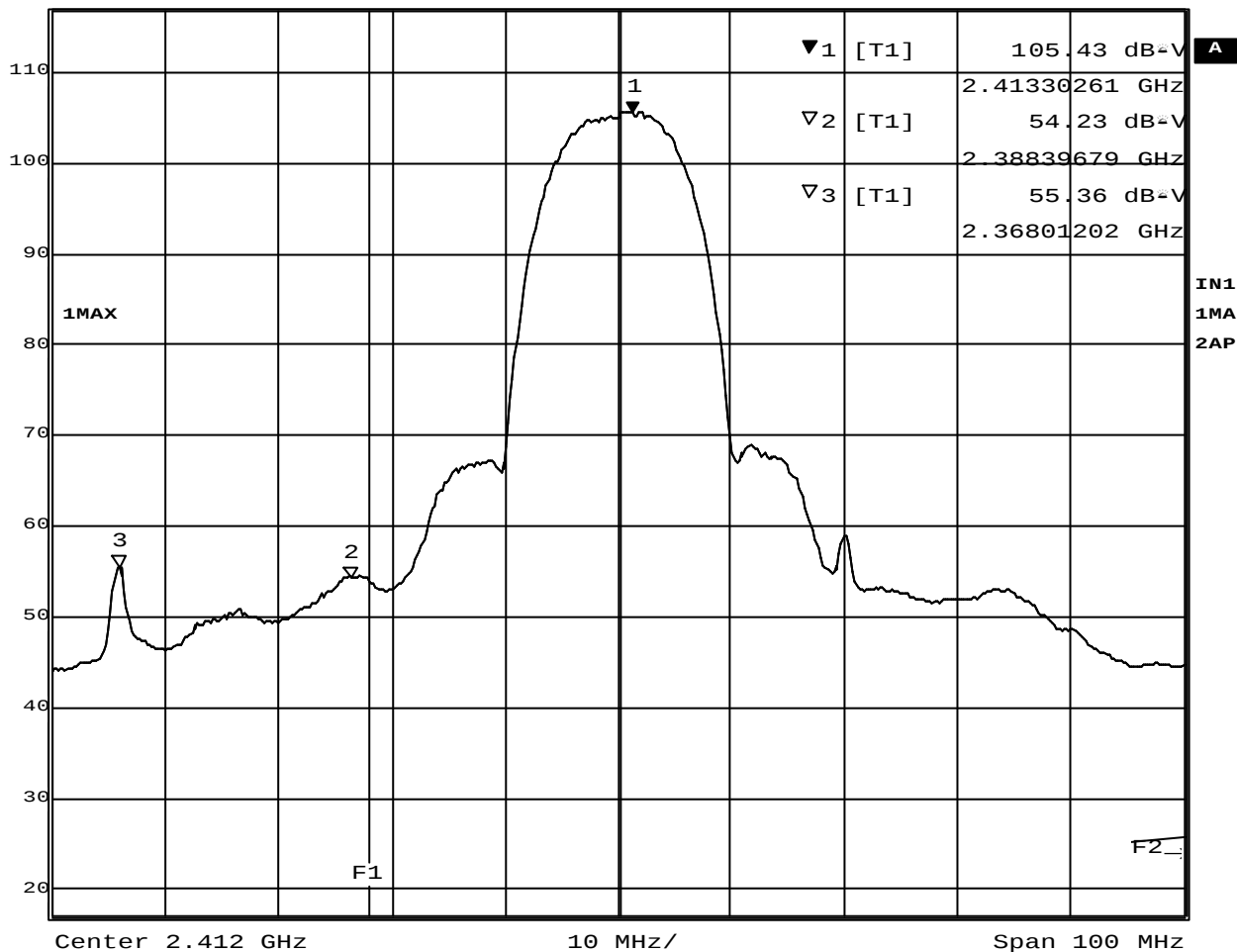


Date: 15.JAN.2003 23:51:10

Plot 7-3-1 Ch.1 2412MHz TX 11Mb/s (Peak)



Ref Lvl 117 dB μ V
Marker 1 [T1] 2.41330261 GHz 105.43 dB μ V
RBW 1 MHz RF Att 20 dB
VBW 10 Hz
SWT 25 s Unit dB μ V

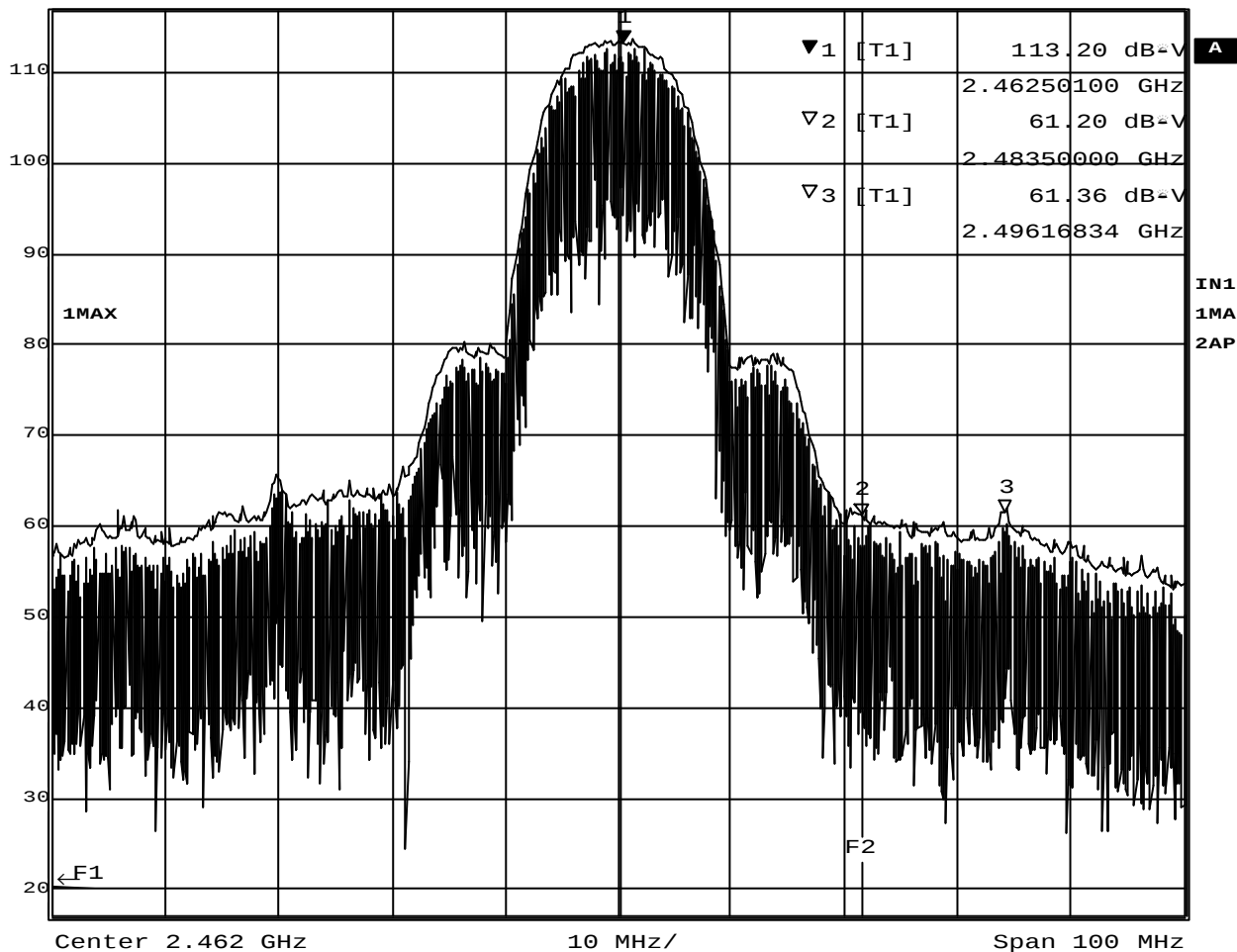


Date: 15.JAN.2003 23:50:38

Plot 7-3-2 Ch.1 2412MHz TX11Mb/s (Average)



Marker 1 [T1] RBW 1 MHz RF Att 20 dB
Ref Lvl 113.20 dBμV VBW 1 MHz
117 dBμV 2.46250100 GHz SWT 5 ms Unit dBμV

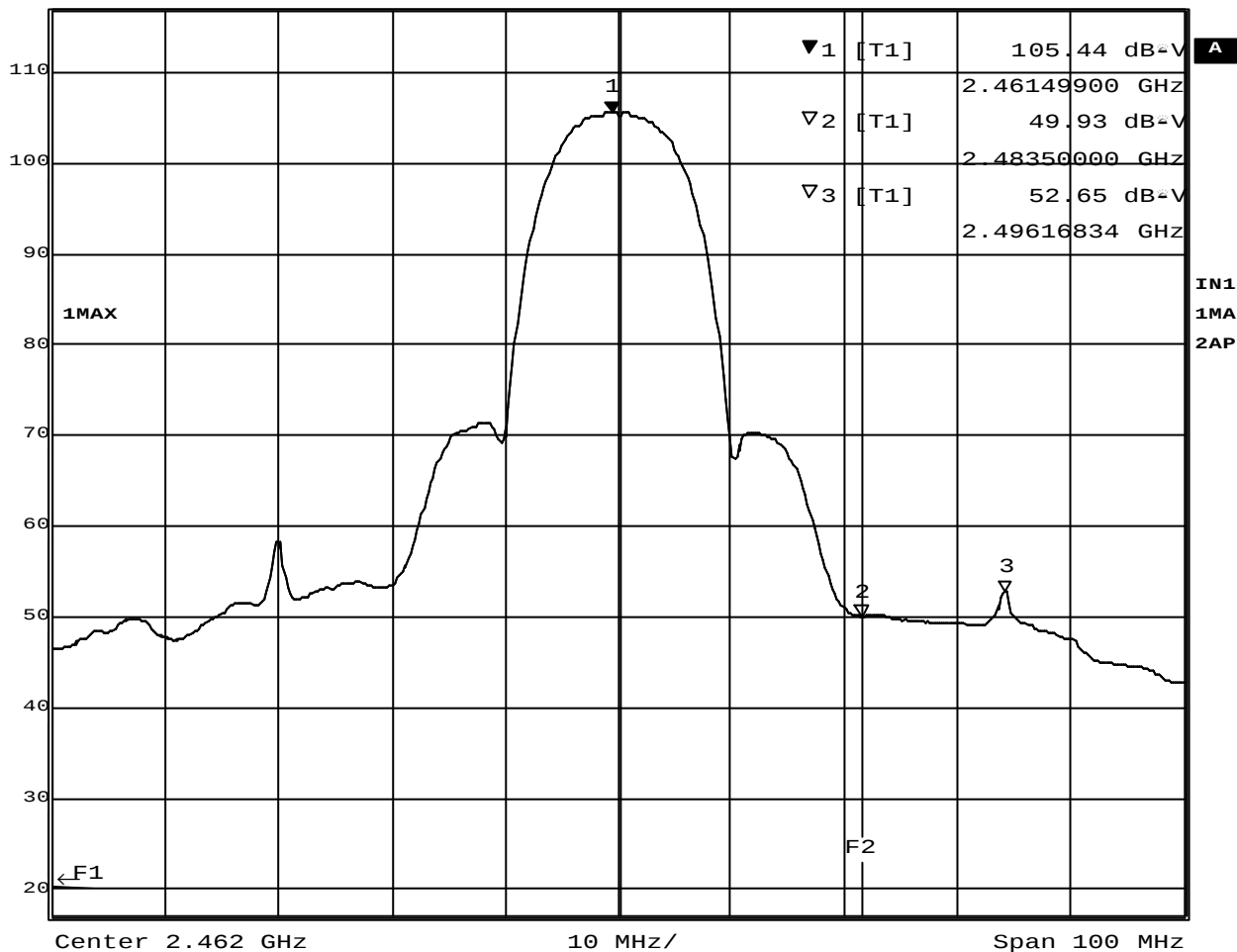


Date: 15.JAN.2003 23:54:45

Plot 7-3-3 Ch.11 2462MHz TX 11Mb/s (Peak)



Marker 1 [T1] RBW 1 MHz RF Att 20 dB
Ref Lvl 105.44 dBμV VBW 10 Hz
117 dBμV 2.46149900 GHz SWT 25 s Unit dBμV



Date: 15.JAN.2003 23:54:18

Plot 7-3-4 Ch.11 2462MHz TX 11Mb/s (Average)