

EMC TEST REPORT


Report No. : EME-031034
Model No. : ZyAIR B-122
Issued Date : Sep. 15, 2003

Applicant : ZyXEL Communications Corporation
No. 6, Innovation Rd II, Science-Based Industrial Park,
Hsin-Chu, Taiwan

Test By : Intertek Testing Services Taiwan Ltd.
No. 11, Lane 275, Ko-Nan 1 Street, Chia-Tung Li,
Shiang-Shan District, Hsinchu City, Taiwan


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Project Engineer



Jerry Liu

Reviewed By



Elton Chen

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Summary of Tests**CardBus 11Mbps Wireless LAN Card-Model: ZyAIR B-122
FCC ID: I88B122**

Test	Reference	Results
Minimum 6dB Bandwidth test	15.247(a)(2)	Complies
Maximum Output Power test	15.247(b)	Complies
Radiated Spurious Emission test	15.205, 15.209	Complies
Power Spectrum Density test	15.247(d)	Complies
Power Line Conducted Emission test	15.207	Complies

1. General information

1.1 Identification of the EUT

Applicant	: ZyXEL Communications Corporation
Product	: CardBus 11Mbps Wireless LAN Card
Model No.	: ZyAIR B-122
FCC ID.	: I88B122
Frequency Range	: 2412~2462MHz
Channel Number	: 11channels
Frequency of Each Channel	: 2412MHz, 2417MHz, 2422MHz, 2427MHz, 2432MHz, 2437MHz, 2442MHz, 2447MHz, 2452MHz, 2457MHz, 2462MHz
Type of Modulation	: CCK (11Mbps, 5.5Mbps), DQPSK (2Mbps), DBPSK (1Mbps)
Rated Power	: 3.3Vdc
Power Cord	: N/A
Sample Received	: Sep. 8, 2003
Test Date(s)	: Sep. 8, 2003 ~ Sep. 10, 2003

A FCC DoC report has been generated for the client.

1.2 Additional information about the EUT

The ZyAIR B-122 is an 802.11b wireless LAN Cardbus for notebooks. It can maximize user's notebook seamless roaming between home, office & coffee shop. Users can work anywhere within the coverage area and enjoy the convenience and mobility. It also provides a high quality utility which allows users easy to configure and maintain wireless network activities.

For more detail features, please refer to user's Manual.

1.3 Antenna description

The EUT uses a permanently connected antenna.

Antenna Gain : 2.5 dBi

Antenna Type : Ceramic

Connector Type : N/A

1.4 Peripherals equipment

Peripherals	Manufacturer	Product No.	Serial No.	FCC ID
Notebook	TOSHIBA	PS240T-00UHT	92043590J	FCC DoC Approved
Printer	HP	C2642A	TH86K1N2ZB	FCC DoC Approved
Modem	Dynalink	V1456VQE	00V230A00051 494	ARSCM560S
Access Point	Z-COM	XI-1450	AF16001-00242	FCC DoC Approved

2. Test specifications

2.1 Test standard

The EUT was performed according to the procedures in FCC Part 15 Subpart C Section § 15.205 、 §15.207 、 §15.209 、 §15.247 and ANSI C63.4/1992.

The test of radiated measurements according to FCC Part15 Section 15.33(a) had been conducted and the field strength of this frequency band were all meet limit requirement, thus we evaluate the EUT pass the specified test.

2.2 Operation mode

During conducted emission test, the EUT was operated in normal mode, communicating with AP, while were in other tests, it worked in the status of continuously transmitting.

After verifying the maximum output power, we found the maximum output power was occurred at 11Mbps data rate. The final test was executed under this condition and recorded in this report individually.

2.3 Test equipment

Equipment	Brand	Frequency range	Model No.	Series No.	Last Cal.Date
EMI Test Receiver	Rohde & Schwarz	9kHz~2.75GHz	ESCS 30	825788/014	Feb. 18, 2003
EMI Test Receiver	Rohde & Schwarz	20Hz~26.5GHz	ESMI	825428/005	June 10, 2003
Spectrum Analyzer	Rohde & Schwarz	9kHz~30GHz	FSP 30	100137	July 10, 2003
Spectrum Analyzer	Rohde & Schwarz	20Hz~40GHz	FSEK 30	100186	Oct. 9, 2002
Horn Antenna	EMCO	1GHz~18GHz	3115	9906-5890	Sep. 19, 2002
Horn Antenna	SCHWARZBECK	14GHz~40GHz	BBHA 9170	159	June 21, 2003
Bilog Antenna	SCHWARZBECK	25MHz~1.7GHz	VULB 9160	3133	Feb. 21, 2003
Turn Table	HDGmbH	N/A	DS 420S	420/669/01	N/A
Antenna Tower	HDGmbH	N/A	MA 240	240/573	N/A
Microwave Amplifier	Agilent	2GHz~26.5GHz	8348A	3111A00567	Dec. 20, 2002
Crystal Detector	Agilent	10MHz~18GHz	8472B	MY42240243	N/A
Signal Generator	Rohde & Schwarz	20MHz~27GHz	SMR27	100036	Aug. 15, 2003
Two Channel Digital Storage Oscilloscope	Tektronix	N/A	TDS1012	C031679	Aug. 16, 2003

Note:

1. The calibration interval of the above instruments is 12 months.

3. Minimum 6dB Bandwidth test

3.1 Operating environment

Temperature: 22 °C
Relative Humidity: 52 %
Atmospheric Pressure 1023 hPa

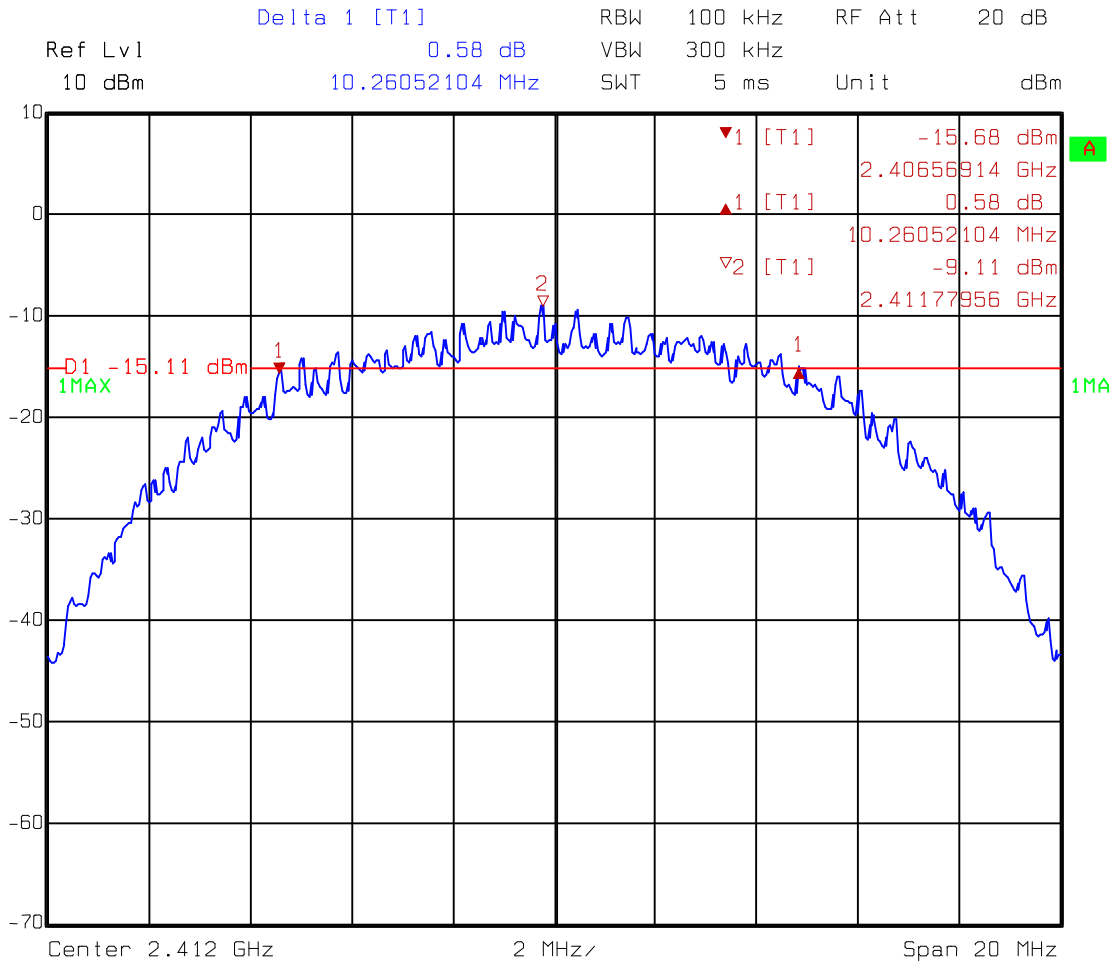
3.2 Test setup & procedure

The minimum 6dB bandwidth per FCC §15.247(a)(2) was measured using a 50 ohm spectrum analyzer with the resolutions bandwidth set at 100kHz, the video bandwidth set at 300kHz, and the SPAN>>RBW. The test was performed at 3 channels (lowest, middle and highest channel). The minimum 6-dB modulation bandwidth is in the following Table.

3.3 Measured data of Minimum 6dB Bandwidth test results

Channel	Frequency (MHz)	Bandwidth (MHz)	Limit
Low	2412	10.26052	> 500kHz
Middle	2437	10.34068	> 500kHz
High	2462	10.30060	> 500kHz

Please see the plot below.



Comment A: 6dB bandwidth at low channel (EC365)
Date: 24.SEP.2003 16:43:33

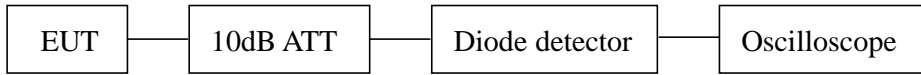
4. Maximum Output Power test

4.1 Operating environment

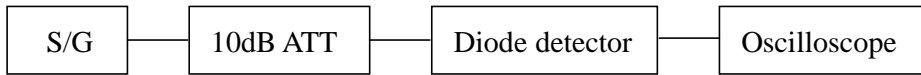
Temperature: 22 °C
 Relative Humidity: 52 %
 Atmospheric Pressure 1023 hPa

4.2 Test setup & procedure

A:



B:



1. The output of the transmitter via a 10 dB attenuator and coupled to a diode detector.
2. The output of the diode detector connected to the vertical channel of an oscilloscope. The observed trace of the oscilloscope shall be recorded as “A”.
3. The transmitter replaced by a signal generator. The output frequency of the signal made equal to the center of the frequency range occupied by the transmitter and unmodulated.
4. The output of the signal generator raised to reach the peak of trace “A” named X.
5. The signal generator output level X (dBm) is the transmitter peak output power.

4.3 Measured data of Maximum Output Power test results

Channel	Frequency (MHz)	Reading (dBm)	Output Power		Limit (dBm)
			(dBm)	(mW)	
Lowest	2412	14.93	14.93	31.117	30
Middle	2437	15.13	15.13	32.584	30
Highest	2462	15.33	15.33	34.119	30

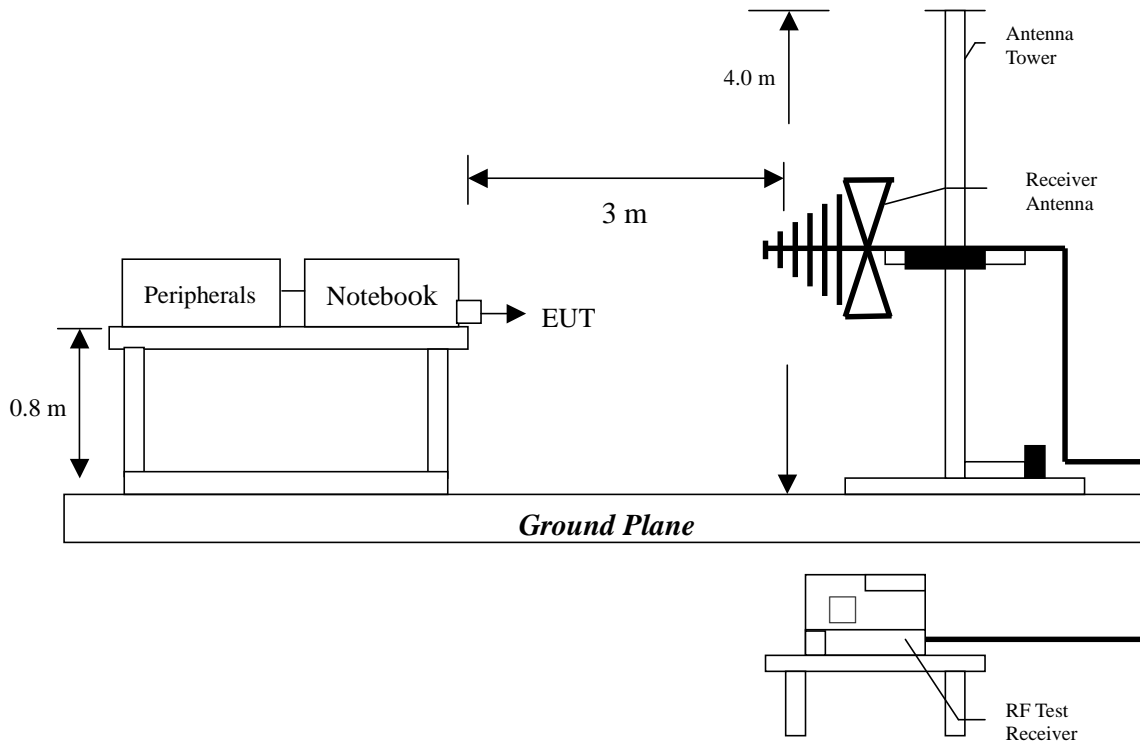
5. Radiated Emission test

5.1 Operating environment

Temperature:	23	°C	(10-40°C)
Relative Humidity:	58	%	(10-90%)
Atmospheric Pressure	1023	hPa	(860-1060hPa)

5.2 Test setup & procedure

The Diagram below shows the test setup, which is utilized to make these measurements.



Radiated emissions were investigated cover the frequency range from 30MHz to 1000MHz using a receiver RBW of 120kHz record QP reading, and the frequency over 1GHz using a spectrum analyzer RBW of 1MHz and 10Hz VBW record Average reading. (15.209 paragraph), the Peak reading (1MHz RBW/VBW) recorded also on the report.

The EUT for testing is arranged on a wooden turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meters and down to 1 meter.

The measurement for radiated emission will be done at the distance of three meters unless the signal level is too low to measure at that distance. In the case of the reading under noise floor, a pre-amplifier is used and/or the test is conducted at a closer distance. And then all readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

The EUT configuration please refer to the “Spurious set-up photo.pdf”.

5.3 Emission limits

The spurious Emission shall test through the 10th harmonic. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

Frequency (MHz)	Limits (dB μ V/m@3m)
30-88	40
88-216	43.5
216-960	46
Above 960	54

Remark:

1. In the above table, the tighter limit applies at the band edges.
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

Uncertainty was calculated in accordance with NAMAS NIS 81.

Expanded uncertainty (k=2) of radiated emission measurement is ± 4.98 dB.

Expanded uncertainty (k=2) of conducted emission measurement is ± 2.02 dB.

5.4 Radiated spurious emission test data

5.4.1 Measurement results: frequencies equal to or less than 1 GHz

EUT : ZyAIR B-122
Worst Case Condition : Tx at low channel

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Correction Factor (dB/m)	Reading (dBuV)	Corrected Level (dBuV)	Limit @ 3 m (dBuV)	Margin (dB)	Antenna high (cm)	Turn Table angle (degree)
265.08000	QP	V	13.38	13.20	26.58	46.00	-19.42	118	65.00
366.47000	QP	V	15.81	18.38	34.19	46.00	-11.81	109	157.00
399.82000	QP	V	16.40	12.56	28.96	46.00	-17.04	110	159.00
433.16000	QP	V	17.37	10.45	27.82	46.00	-18.18	100	232.00
498.25000	QP	V	18.61	15.97	34.58	46.00	-11.42	201	26.00
598.81000	QP	V	20.62	8.22	28.84	46.00	-17.16	100	66.00
265.08000	QP	H	13.38	26.33	39.71	46.00	-6.29	100	105.00
299.58000	QP	H	14.07	23.73	37.80	46.00	-8.20	186	134.00
331.36000	QP	H	14.99	22.95	37.94	46.00	-8.06	100	152.00
364.46000	QP	H	15.81	22.80	38.61	46.00	-7.39	103	148.00
399.80000	QP	H	16.40	19.88	36.28	46.00	-9.72	259	149.00
498.27000	QP	H	18.61	20.61	39.22	46.00	-6.78	100	31.00

Remark:

1. Corrected Level = Reading Level + Correction Factor
2. Correction Factor = Antenna Factor + Cable Loss

5.4.2 Measurement results: frequency above 1GHz

The radiated spurious emissions at

Frequency(MHz)	Margin	Frequency(MHz)	Margin
9647.92	-3.47	1162.63	-4.05
1162.66	-3.68	1162.63	-4.63
9747.9	-4.3		

are less than uncertainty. This is within the stated measurement uncertainty, this may affect compliance determined in other test arrangements.

EUT : ZyAIR B-122
Test Condition : Tx at low channel

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamp (dB)	Correction Factor (dB/m)	Reading (dBuV)	Corrected Level (dBuV)	Limit @ 3 m (dBuV)	Margin (dB)	Antenna high (cm)	Turn Table angle (degree)
1162.61	PK	V	0	27.042	30.288	57.33	74	-16.67	132.00	28.00
1162.61	AV	V	0	27.042	14.268	41.31	54	-12.69	132.00	28.00
7235.80	PK	V	34.17	39.966	49.354	55.15	74	-18.85	146.00	307.00
7235.80	AV	V	34.17	39.966	32.194	37.99	54	-16.01	146.00	307.00
9647.92	PK	V	35.753	43.384	52.6585	60.29	74	-13.71	170.00	256.00
9647.92	AV	V	35.753	43.384	42.8985	50.53	54	-3.47	170.00	256.00
1162.61	PK	H	0	27.042	26.858	53.9	74	-20.1	120.00	339.00
1162.61	AV	H	0	27.042	19.798	46.84	54	-7.16	120.00	339.00
9647.89	PK	H	35.753	43.384	46.6485	54.28	74	-19.72	137.00	150.00
9647.89	AV	H	35.753	43.384	36.1985	43.83	54	-10.17	137.00	150.00

Remark:

1. Corrected Level = Reading Level + Correction Factor – Preamp
2. Correction Factor = Antenna Factor + Cable Loss
3. The frequency measured ranges from 1GHz to 25GHz. The data value listed above which is higher than the noise floor, the others please refer to noise floor level.

For PK:

1GHz-3GHz: 50dBuV
3GHz-14GHz: 54dBuV
14GHz-26.5GHz: 60dBuV

For AV:

1GHz-3GHz: 41.5dBuV
3GHz-14GHz: 46dBuV
14GHz-26.5GHz: 46.5dBuV

EUT : ZyAIR B-122
Test Condition : Tx at middle channel

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamp (dB)	Correction Factor (dB/m)	Reading (dBuV)	Corrected Level (dBuV)	Limit @ 3 m (dBuV)	Margin (dB)	Antenna high (cm)	Turn Table angle (degree)
1162.66	PK	V	0	27.042	30.108	57.15	74	-16.85	103.00	335.00
1162.66	AV	V	0	27.042	23.278	50.32	54	-3.68	103.00	335.00
9747.9	PK	V	35.753	43.384	51.4585	59.09	74	-14.91	168.00	255.00
9747.9	AV	V	35.753	43.384	42.0685	49.7	54	-4.3	168.00	255.00
1162.65	PK	H	0	27.042	26.778	53.82	74	-20.18	119.00	196.00
1162.65	AV	H	0	27.042	17.538	44.58	54	-9.42	119.00	196.00

Remark:

1. Corrected Level = Reading Level + Correction Factor – Preamp
2. Correction Factor = Antenna Factor + Cable Loss
3. The frequency measured ranges from 1GHz to 25GHz. The data value listed above which is higher than the noise floor, the others please refer to noise floor level.

For PK:

1GHz-3GHz: 50dBuV
3GHz-14GHz: 54dBuV
14GHz-26.5GHz: 60dBuV

For AV:

1GHz-3GHz: 41.5dBuV
3GHz-14GHz: 46dBuV
14GHz-26.5GHz: 46.5dBuV

EUT : ZyAIR B-122
Test Condition : Tx at high channel

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamp (dB)	Correction Factor (dB/m)	Reading (dBuV)	Corrected Level (dBuV)	Limit @ 3 m (dBuV)	Margin (dB)	Antenna high (cm)	Turn Table angle (degree)
1162.63	PK	V	0	27.042	28.608	55.65	74	-18.35	178.00	27.00
1162.63	AV	V	0	27.042	22.908	49.95	54	-4.05	178.00	27.00
7387.1	PK	V	34.17	39.966	50.194	55.99	74	-18.01	178.00	280.00
7387.1	AV	V	34.17	39.966	32.704	38.5	54	-15.5	178.00	280.00
9847.95	PK	V	35.753	43.384	51.4485	59.08	74	-14.92	135.00	253.00
9847.95	AV	V	35.753	43.384	40.7085	48.34	54	-5.66	135.00	253.00
1162.63	PK	H	0	27.042	27.818	54.86	74	-19.14	178.00	230.00
1162.63	AV	H	0	27.042	22.328	49.37	54	-4.63	178.00	230.00

Remark:

1. Corrected Level = Reading Level + Correction Factor – Preamp
2. Correction Factor = Antenna Factor + Cable Loss
3. The frequency measured ranges from 1GHz to 25GHz. The data value listed above which is higher than the noise floor, the others please refer to noise floor level.

For PK:

1GHz-3GHz: 50dBuV
3GHz-14GHz: 54dBuV
14GHz-26.5GHz: 60dBuV

For AV:

1GHz-3GHz: 41.5dBuV
3GHz-14GHz: 46dBuV
14GHz-26.5GHz: 46.5dBuV

6. Power Spectrum Density test

6.1 Operating environment

Temperature: 23 °C
Relative Humidity: 58 %
Atmospheric Pressure 1023 hPa

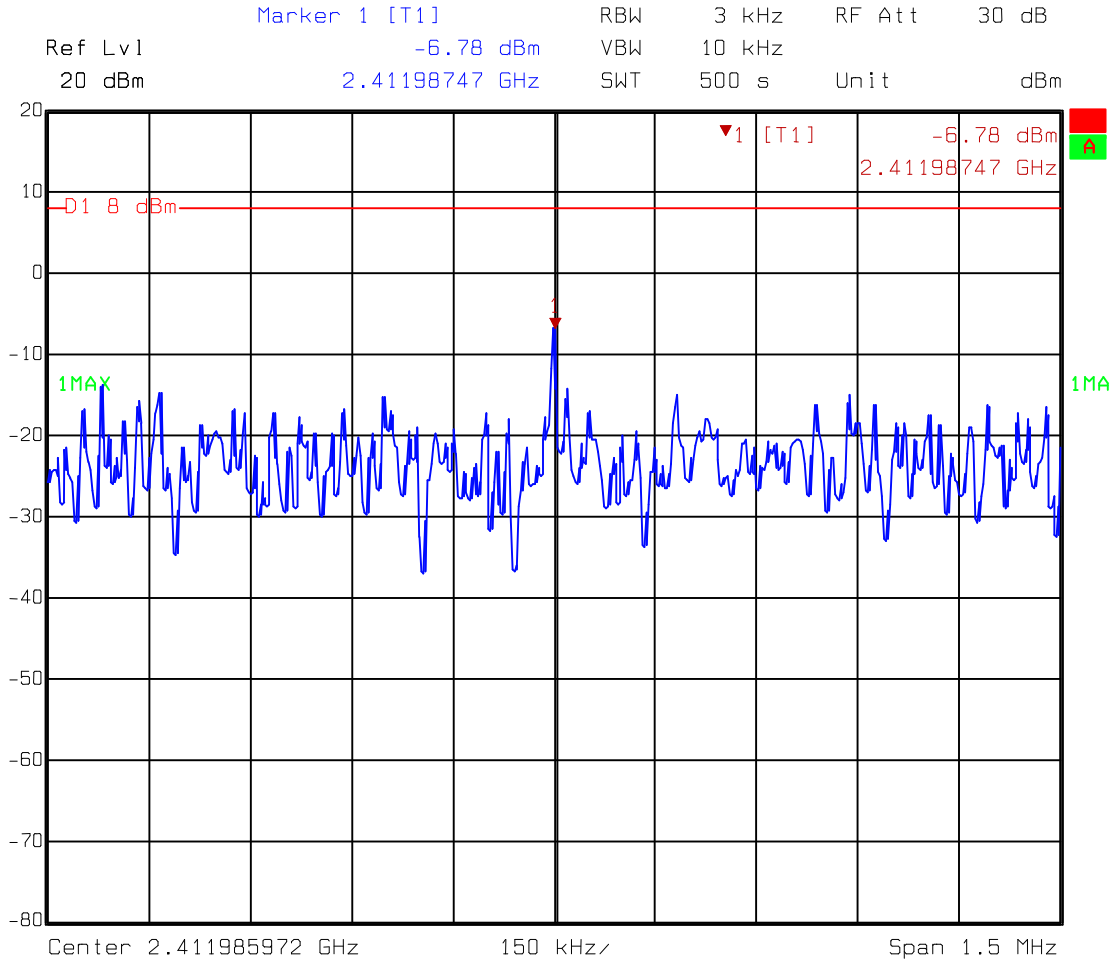
6.2 Test setup & procedure

The power spectrum density per FCC §15.247(d) was measured from the antenna port of the EUT using a 50ohm spectrum analyzer with the resolution bandwidth set at 3kHz, the video bandwidth set at 10kHz, a span of 1.5 MHz, and the sweep time set at 500 seconds. Power Density was read directly and cable loss (2.13dB) correction was added to the reading to obtain power at the EUT antenna terminals. The test was performed at 3 channels (lowest, middle and highest channel). The Power Spectral Density measured result is in the following table.

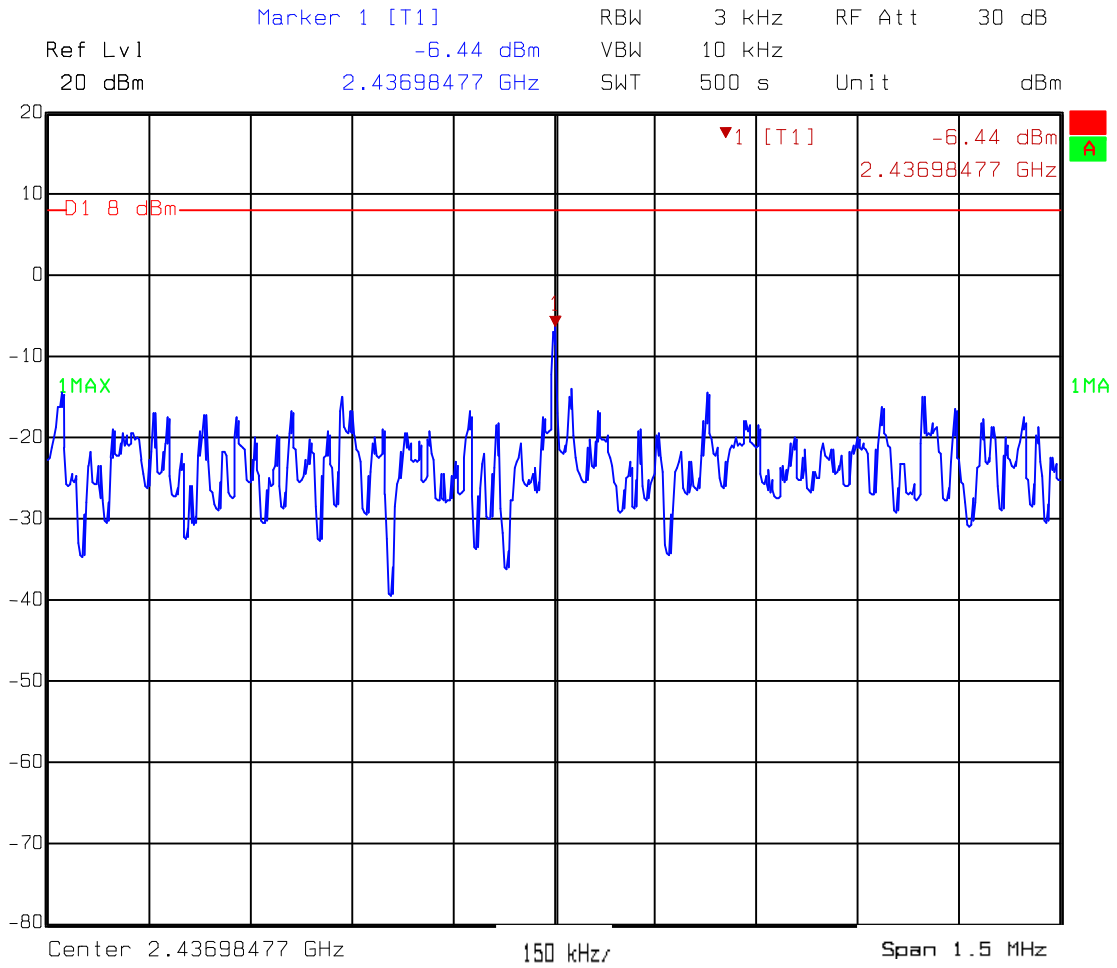
6.3 Measured data of Power Spectrum Density test results

Channel	Frequency (MHz)	Measured level (dBm)	Limit (dBm)
Low	2411.98747	-4.65	8
Middle	2436.98477	-4.31	8
High	2461.98647	-5.10	8

Please see the plot below.

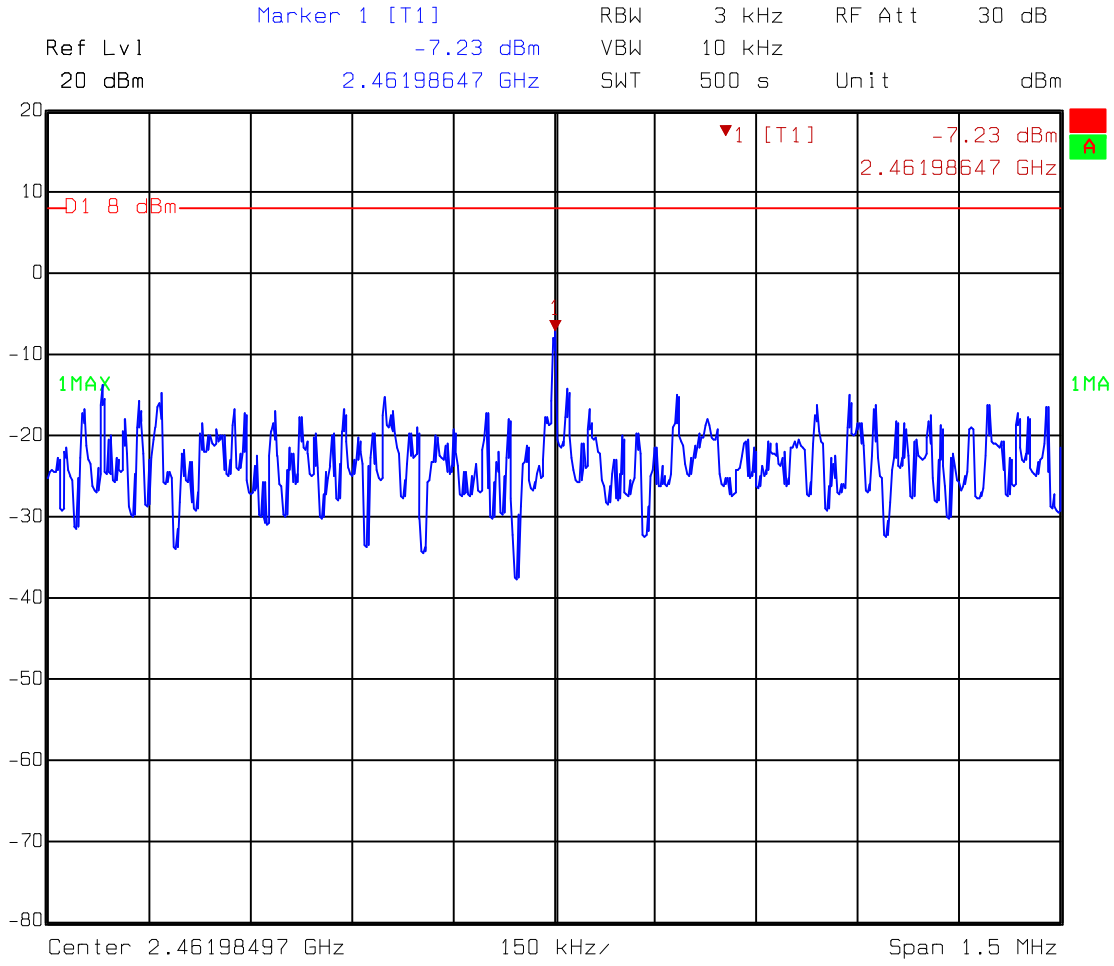


Comment A: Power spectrum density at low channel
 CL=2.13dB
 Date: 10.SEP.2003 15:22:58



Comment A: Power spectrum density at middle channel
CL=2.13dB

Date: 10.SEP.2003 15:24:32



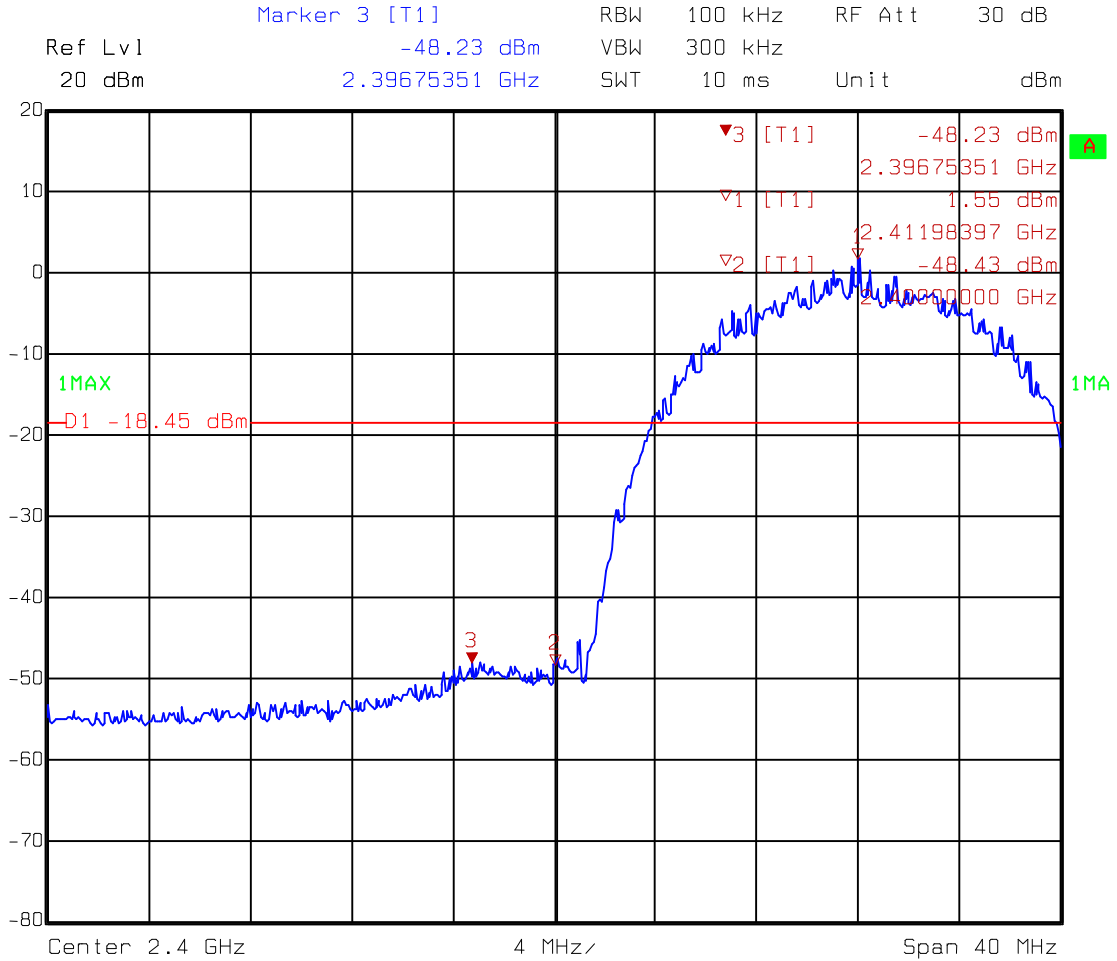
Comment A: Power spectrum density at high channel
 CL=2.13dB
 Date: 10.SEP.2003 15:18:42

7. Emission on the band edge §FCC 15.247(C)

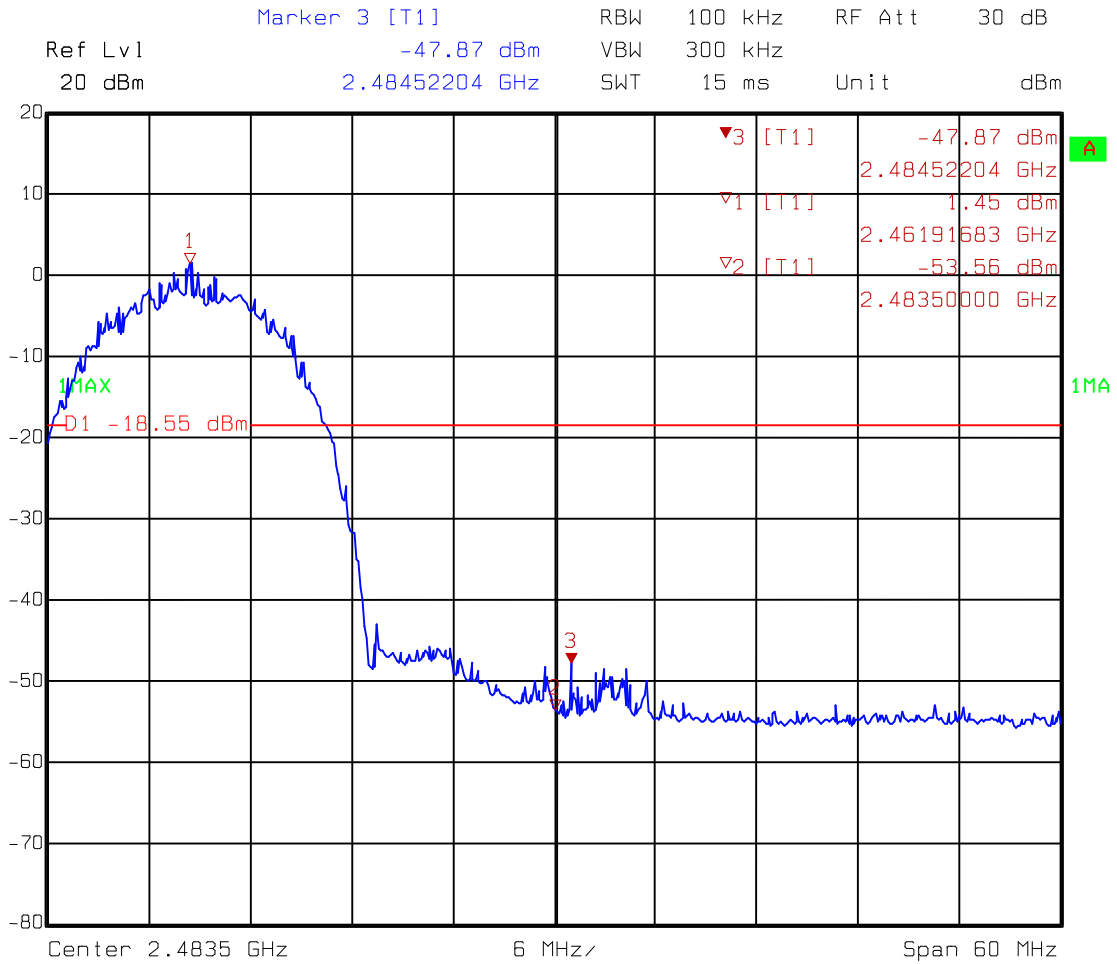
In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

Please see the plot below.

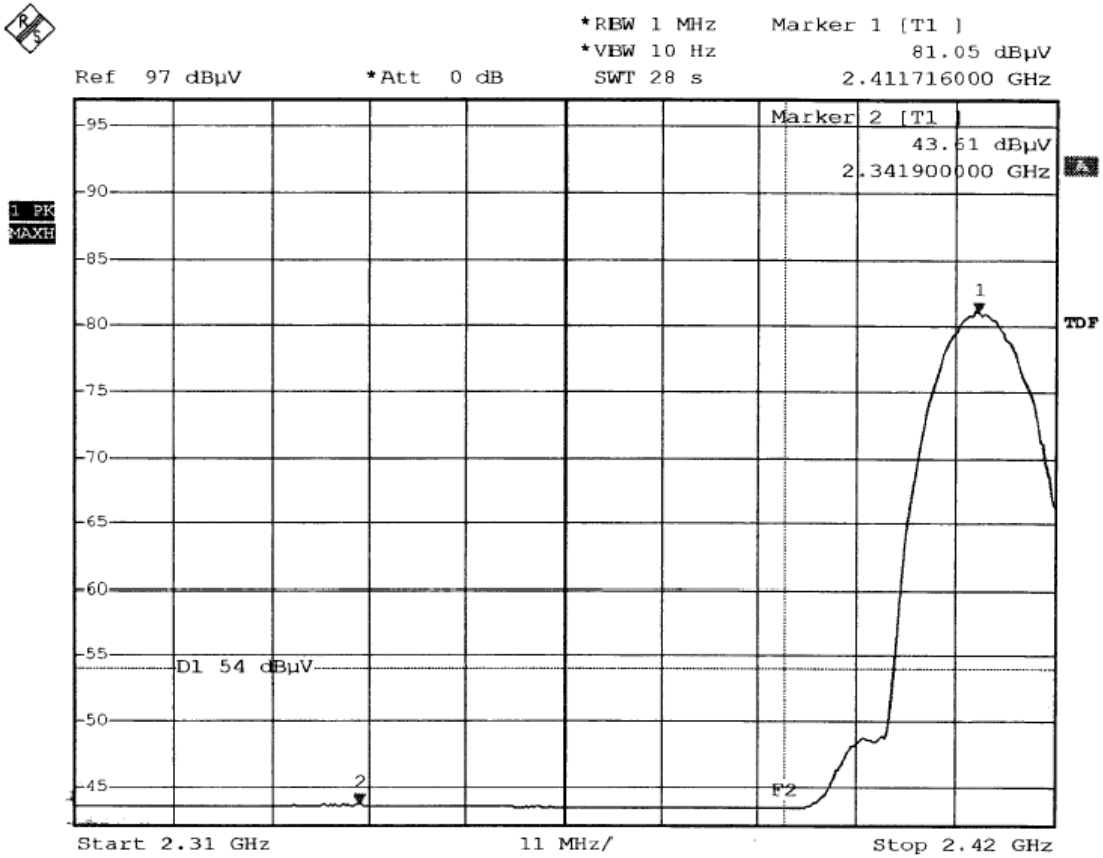
7.1 Band-edge (Conducted method)



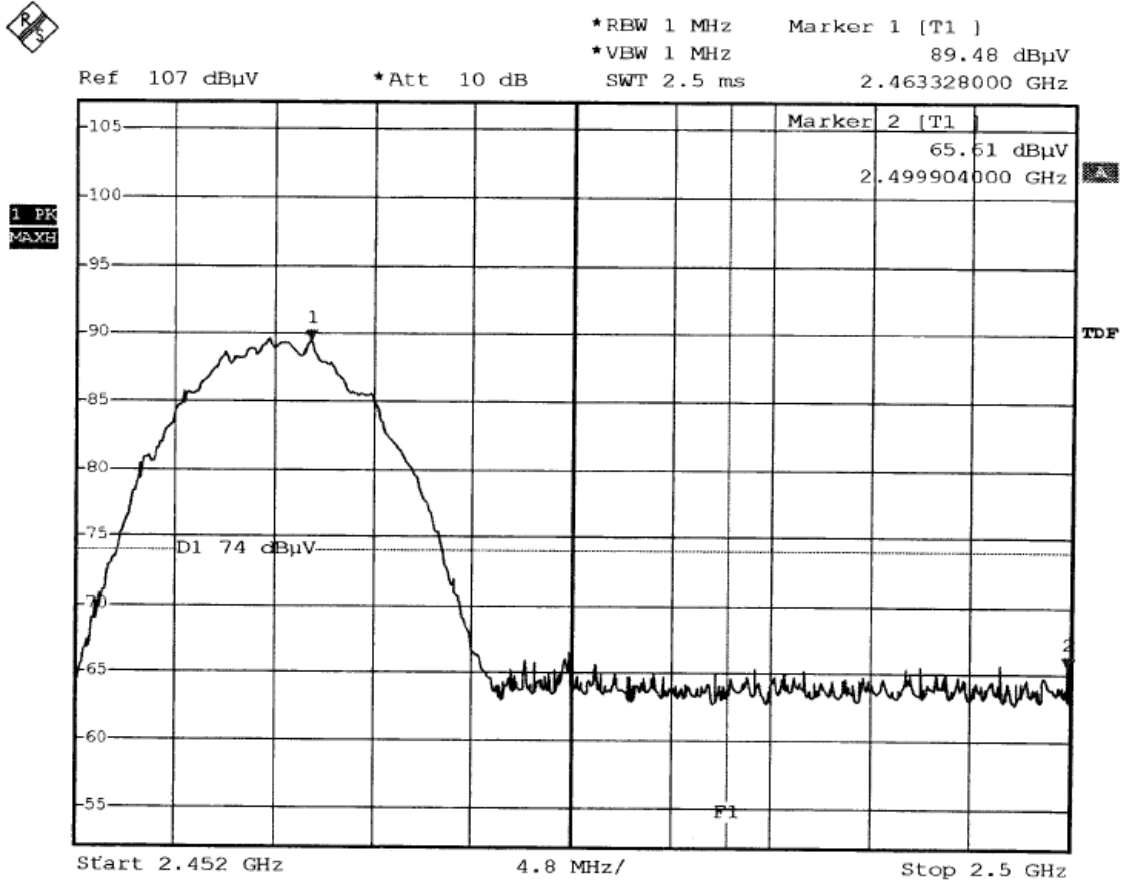
Comment A: Band-edge at low channel
Date: 10.SEP.2003 16:06:59



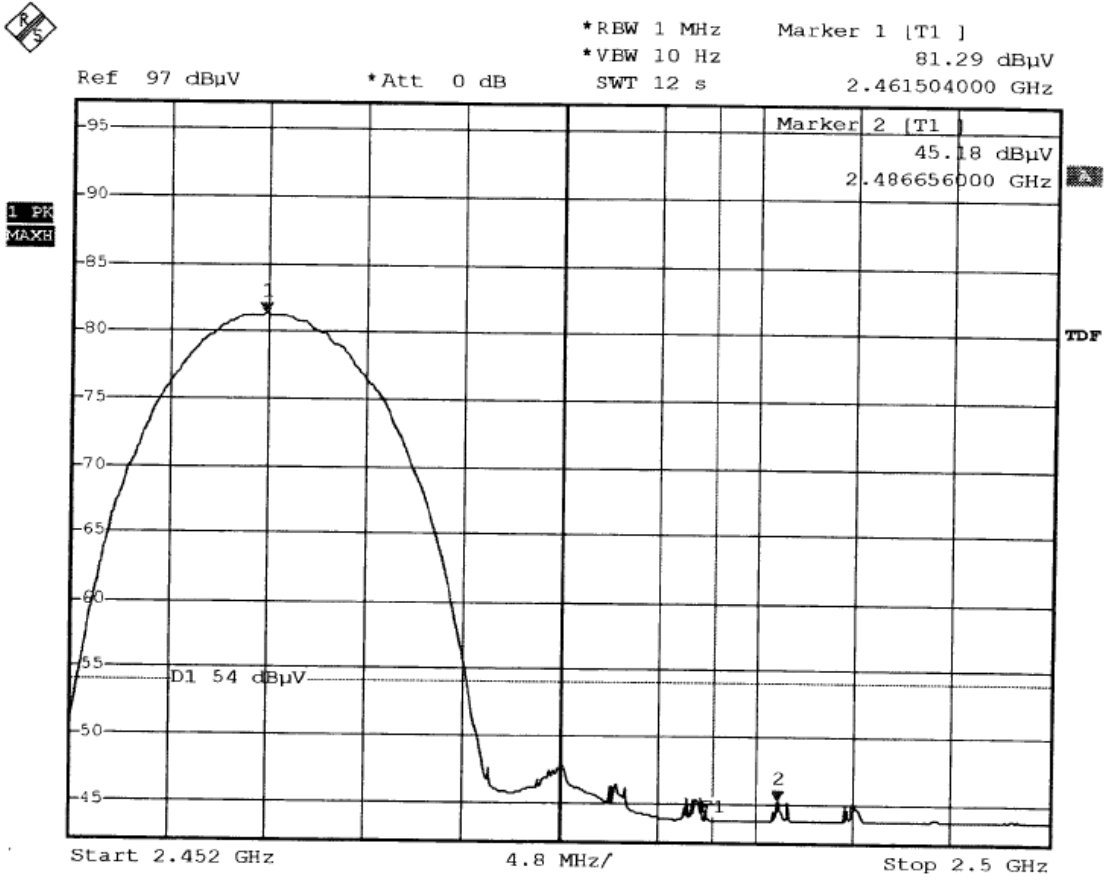
Comment A: Band-edge at high channel
 Date: 10.SEP.2003 15:54:41



Comment A: Band-edge test at low channel EN B
 Average detector F2=2390MHz



Comment A: Band-edge test at high channel B
 Peak detector F1=2483.5MHz



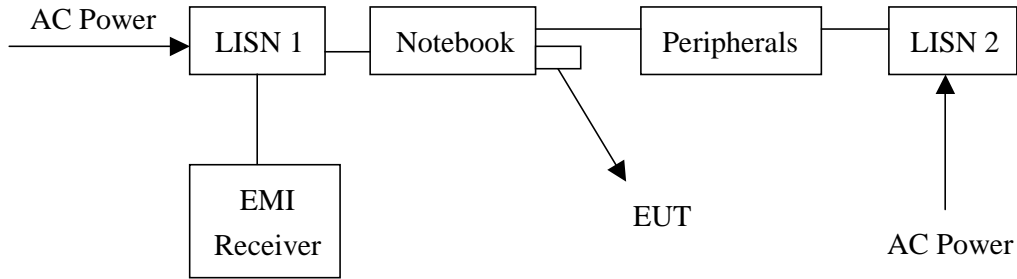
Comment A: Band-edge test at high channel N B
 Average detector F1=2483.5MHz

8. Power Line Conducted Emission test §FCC 15.207

8.1 Operating environment

Temperature:	24	°C	(10-40°C)
Relative Humidity:	58	%	(10-90%)
Atmospheric Pressure	1023	hPa	(860-1061hPa)

8.2 Test setup & procedure



The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50 ohm/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4/1992 on conducted measurement. The AC power conducted emissions was invested over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9kHz. (15.207 paragraph)

The EUT configuration please refer to the “Conducted set-up photo.pdf”.

Emission Limit

Freq. (MHz)	Conducted Limit (dBuV)	
	Q.P.	Ave.
0.15~0.50	66 – 56*	56 – 46*
0.50~5.00	56	46
5.00~30.0	60	50

*Decreases with the logarithm of the frequency.

8.3 Power Line Conducted Emission test data

(1) Line

EUT : ZyAIR B-122
Test Condition : Normal operating

Freq. (MHz)	Reading (dB μ V) QP	Limit (dB μ V) QP	Reading (dB μ V) AV	Limit (dB μ V) AV	Margin (dB)	
					QP	AV
0.15000	51.1	66.00	27.3	56.00	-14.90	-28.70
0.22200	37.8	62.75	17.6	52.75	-24.95	-35.15
0.32600	28.0	59.55	16.5	49.55	-31.55	-33.05
21.23800	27.3	60.00	20.2	50.00	-32.70	-29.80
22.98200	25.5	60.00	18.9	50.00	-34.50	-31.10
25.04600	24.0	60.00	17.3	50.00	-36.00	-32.70

(2) Neutral

EUT : ZyAIR B-122
Test Condition : Normal operating

Freq. (MHz)	Reading (dB μ V) QP	Limit (dB μ V) QP	Reading (dB μ V) AV	Limit (dB μ V) AV	Margin (dB)	
					QP	AV
0.15000	50.9	66.00	26.4	56.00	-15.10	-29.60
0.26200	44.8	61.37	26.6	51.37	-16.57	-24.77
0.37400	45.1	58.41	26.4	48.41	-13.31	-22.01
0.51800	36.3	56.00	20.4	46.00	-19.70	-25.60
0.65400	31.6	56.00	17.0	46.00	-24.40	-29.00
0.93400	31.5	56.00	15.5	46.00	-24.50	-30.50

Remark:

1. The reading value included cable loss and LISN factor.
2. Uncertainty was calculated in accordance with NAMAS NIS 81.
Expanded uncertainty (k=2) of conducted emission measurement is ± 2.6 dB.

Please see the plot below.

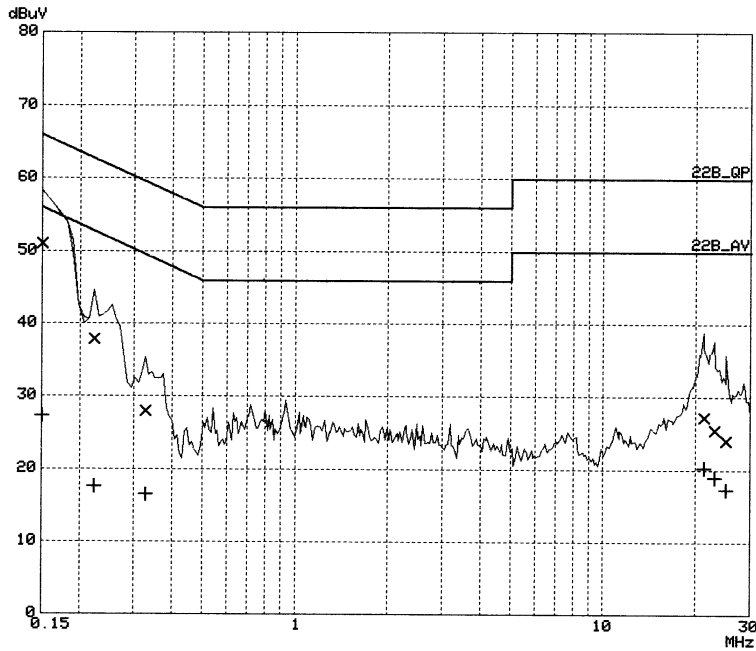
Intertek Testing Services

RF VOLTAGE
 EUT: B-122
 Manuf: ZyXEL
 Op Cond: LISN-L
 Operator: Jerry
 Test Spec: FCC P15 classB
 Comment: EMI RCV:EC346 LISN:EC320
 120V 60Hz 24°C 50%RH Normal Operating
 Date: 08. Sep 03 09:56

Scan Settings (1 Range)

Frequencies			Receiver Settings			
Start	Stop	Step	IF BW	Detector	M-Time	Atten Preamp
150k	30M	8k	9k	PK	20ms	AUTO LN OFF

Final Measurement: x QP / + AV
 Meas Time: 1 s



Intertek Testing Services

RF VOLTAGE
 EUT: B-122
 Manuf: ZyXEL
 Op Cond: LISN-N
 Operator: Jerry
 Test Spec: FCC P15 classB
 Comment: EMI RCV:EC346 LISN:EC320
 120V 60Hz 24°C 50%RH Normal Operating
 Date: 08. Sep 03 09:46

Scan Settings (1 Range)

----- Frequencies -----			----- Receiver Settings -----			
Start	Stop	Step	IF BW	Detector	M-Time	Atten Preamp
150k	30M	8k	9k	PK	20ms AUTO LN	OFF

Final Measurement: x QP / + AV
 Meas Time: 1 s

