EMC
TEST REPORT

Report No. : EME-031224
Model No. : ZyAIR B-320
Issued Date : Nov. 11, 2003

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

Test By : Intertek Testing Services Taiwan Ltd.
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Reviewed By

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Summary of Tests

802.11b WLAN PCI-Model: ZyAIR B-320
FCC ID: I88B320

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	: 802.11b WLAN PCI
Model No.	: ZyAIR B-320
FCC ID.	: I88B320
Frequency Range	: 2412MHz ~ 2462MHz
Channel Number	: 11 channels
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	: 5Vdc from PC
Power Cord	: N/A
Sample Received	: Oct. 29, 2003
Test Date(s)	: Oct. 29, 2003 ~ Nov. 7, 2003

A FCC DoC report has been generated for the client.

1.2 Additional information about the EUT

A wireless LAN (WLAN) provides a flexible data communication system that User's can use to access various services (navigating the Internet, email, printer services, etc.) on the wired network without additional expensive network cabling infrastructure. In effect, a wireless LAN environment provides User's the freedom to stay connected to the wired network while moving in the coverage area.

For more detail features, please refer to User's manual as file name "Installation guide.pdf"

1.3 Antenna description

The antenna is affixed to the EUT using a unique connector, which allows for replacement of a broken antenna, but DOES NOT use a standard antenna jack or electrical connector.

Antenna Gain : 5dBi
Antenna Type : Dipole antenna
Connector Type : SMA

1.4 Peripherals equipment

Peripherals	Manufacturer	Product No.	Serial No.	FCC ID
PC	IBM	57V	BN3P0IC	FCC DoC Approved
Key Board	IBM	37L2548	0081621	FCC DoC Approved
Monitor	IBM	6331-0LN	23-NW828	ARSCM560S
Mouse	IBM	10L6145	23-022880	FCC DoC Approved
Printer	HP	C2642A	TH86K1N2ZB	FCC DoC Approved
Modem	Dynalink	V1456VQE	00V230A00051494	FCC DoC Approved
Access Point	SMC	WG 4005-17 2 (A3)	C-G 3030232-1-1-3*1000	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 C63.4/2001.

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 the conduction test, the EUT was operated in normal mode. While in other tests, it works in continuously transmitting status.

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, 2003
Horn Antenna	EMCO	1GHz~18GHz	3115	9906-5890	Sep. 19, 2003
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:	24	℃
Relative Humidity:	56	%
Atmospheric Pressure	1023	hPa

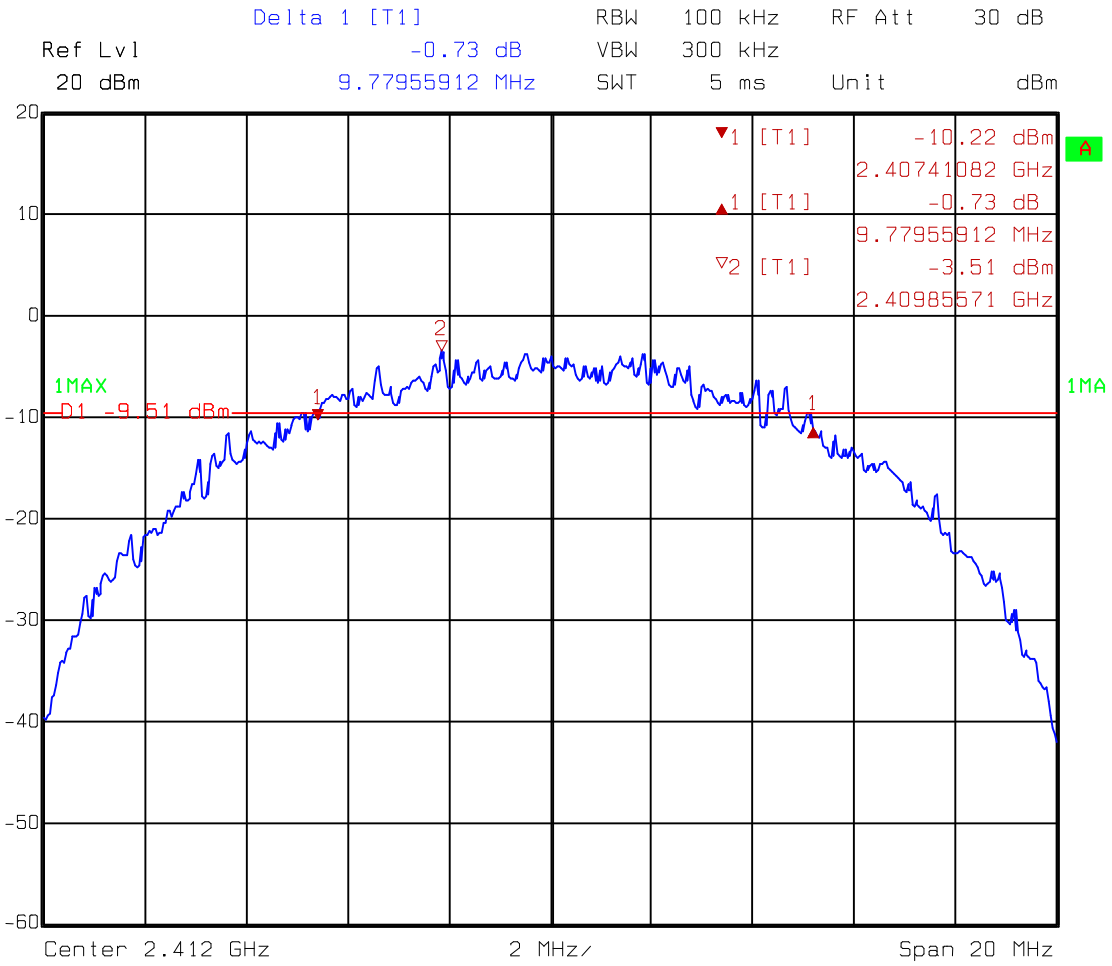
3.2 Test setup & procedure

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.

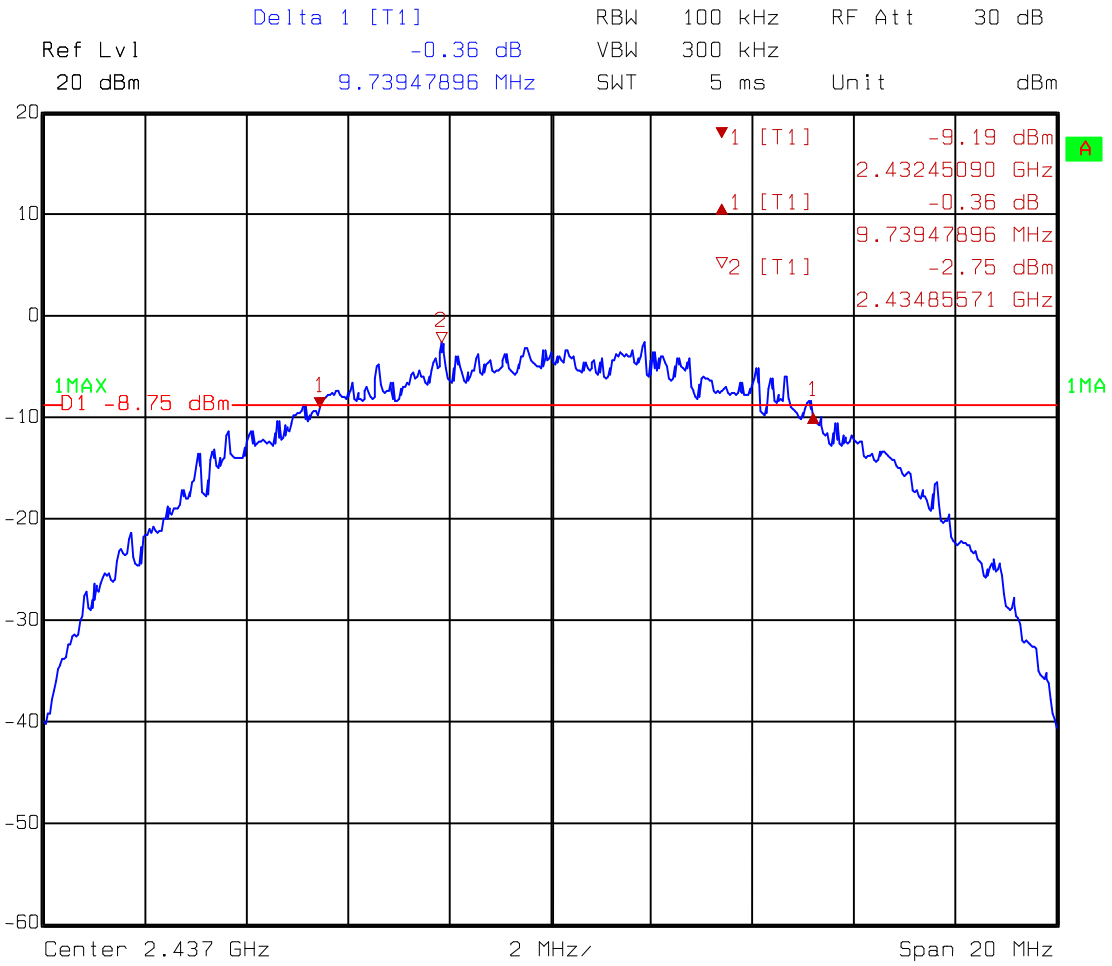
3.3 Measured data of Minimum 6dB Bandwidth test results

Channel	Frequency (MHz)	Bandwidth (MHz)	Limit
Low	2412	9.77956	＞500kHz
Middle	2437	9.73948	＞500kHz
High	2462	10.10020	＞500kHz

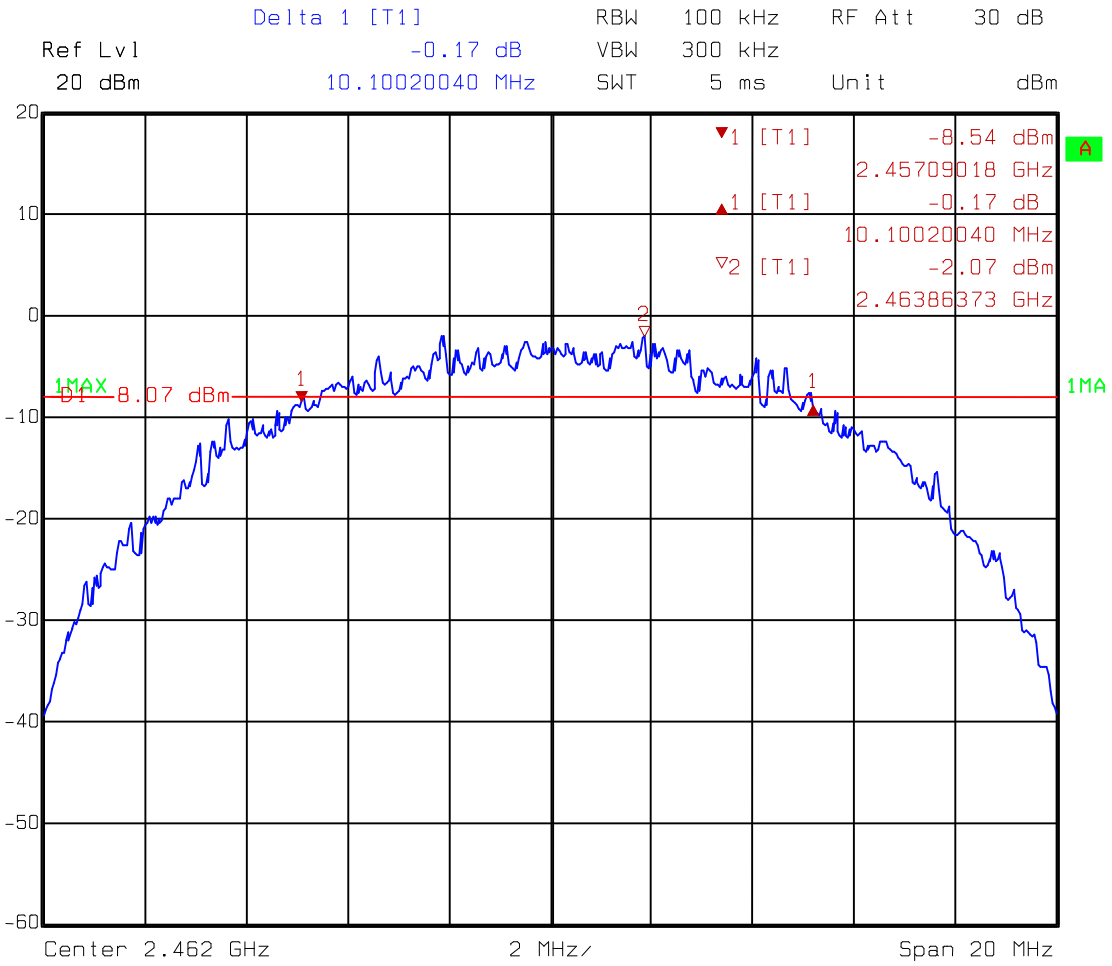
Please see the plot below.



Comment A: 6dB bandwidth at low channel (EC365)
Date: 07.NOV.2003 15:16:56



Comment A: 6dB bandwidth at middle channel (EC365)
Date: 07.NOV.2003 15:21:31



Comment A: 6dB bandwidth at high channel (EC365)
Date: 07.NOV.2003 15:23:39

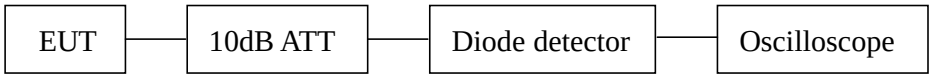
4. Maximum Output Power test

4.1 Operating environment

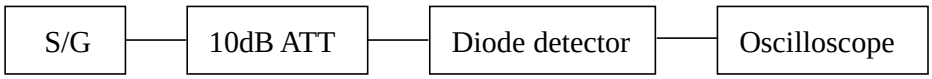
Temperature:	22	℃
Relative Humidity:	60	%
Atmospheric Pressure	1023	hPa

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 and 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	19.63	19.63	91.83	30
Middle	2437	19.93	19.93	98.40	30
Highest	2462	19.83	19.83	96.16	30

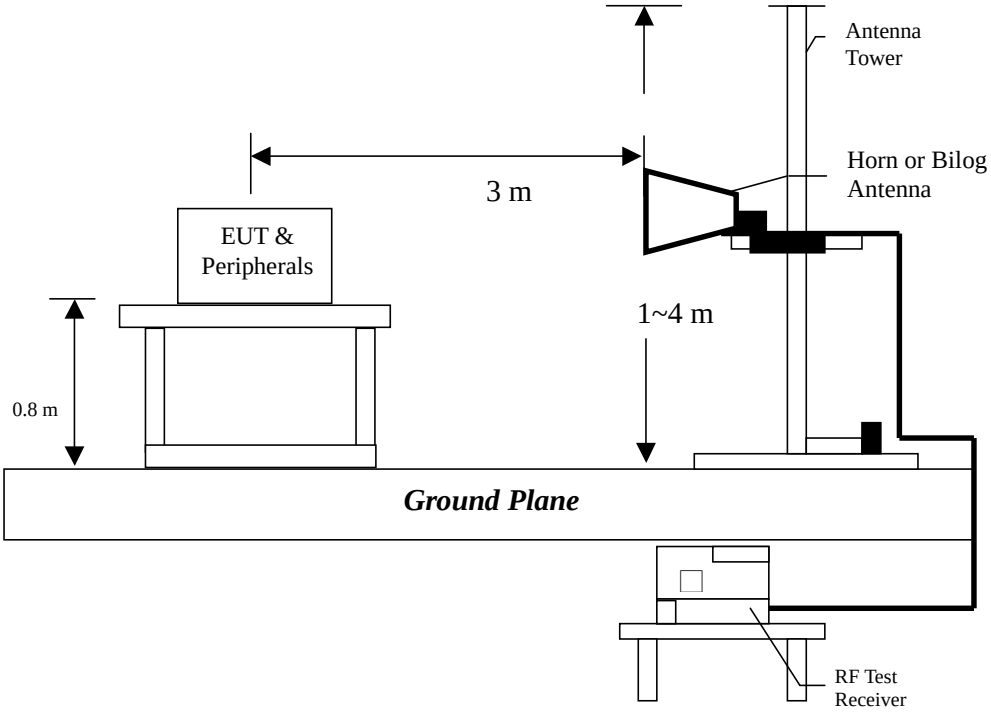
5. Radiated Emission test

5.1 Operating environment

Temperature:	25	℃	(10-40℃)
Relative Humidity:	59	%	(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 invested 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-320
Test 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)
301.49900	QP	V	14.45	20.49	34.94	46.00	-11.06	153	326
502.55500	QP	V	18.58	11.53	30.11	46.00	-15.89	102	4
599.64000	QP	V	20.62	1.88	22.50	46.00	-23.50	137	169
699.57000	QP	V	21.72	9.65	31.37	46.00	-14.63	142	176
804.12000	QP	V	23.89	10.13	34.02	46.00	-11.98	139	194
899.76000	QP	V	24.51	11.81	36.32	46.00	-9.68	156	349
299.87400	QP	H	14.07	18.71	32.78	46.00	-13.22	100	271
502.53300	QP	H	18.58	15.36	33.94	46.00	-12.06	120	151
599.76000	QP	H	20.62	5.46	26.08	46.00	-19.92	100	165
699.64900	QP	H	21.72	17.47	39.19	46.00	-6.81	162	176
799.58000	QP	H	23.49	9.88	33.37	46.00	-12.63	229	170
899.47000	QP	H	24.51	10.76	35.27	46.00	-10.73	117	174

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
9648	-0.87
9648	-1.18
9748	-2.68

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

EUT : ZyAIR B-320
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)
3216	PK	V	32.81	33.642	53.118	53.95	74	-20.05	172	192
3216	AV	V	32.81	33.642	44.718	45.55	54	-8.45	172	192
4824	PK	V	32.265	35.742	54.683	58.16	74	-15.84	135	163
4824	AV	V	32.265	35.742	41.023	44.5	54	-9.5	135	163
7236	PK	V	34.17	39.966	53.244	59.04	74	-14.96	149	197
7236	AV	V	34.17	39.966	41.404	47.2	54	-6.8	149	197
9648	PK	V	35.753	43.384	53.0185	60.65	74	-13.35	141	170
9648	AV	V	35.753	43.384	45.4985	53.13	54	-0.87	141	170
3216	PK	H	32.81	33.642	50.468	51.3	74	-22.7	179	238
3216	AV	H	32.81	33.642	41.378	42.21	54	-11.79	179	238
7236	PK	H	34.17	39.966	50.434	56.23	74	-17.77	103	194
7236	AV	H	34.17	39.966	37.984	43.78	54	-10.22	103	194
9648	PK	H	35.753	43.384	52.2685	59.9	74	-14.1	151	301
9648	AV	H	35.753	43.384	45.1885	52.82	54	-1.18	151	301

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-320
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)
3249	PK	V	32.81	33.642	51.978	52.81	74	-21.19	167	198
3249	AV	V	32.81	33.642	42.988	43.82	54	-10.18	167	198
9748	PK	V	35.753	43.384	50.9185	58.55	74	-15.45	127	191
9748	AV	V	35.753	43.384	41.2585	48.89	54	-5.11	127	191
9748	PK	H	35.753	43.384	51.5385	59.17	74	-14.83	100	214
9748	AV	H	35.753	43.384	43.6885	51.32	54	-2.68	100	214

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-320
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)
9848	PK	H	35.753	43.384	47.3485	54.98	74	-19.02	194	235
9848	AV	H	35.753	43.384	35.5085	43.14	54	-10.86	194	235

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	℃
Relative Humidity:	54	%
Atmospheric Pressure	1023	hPa

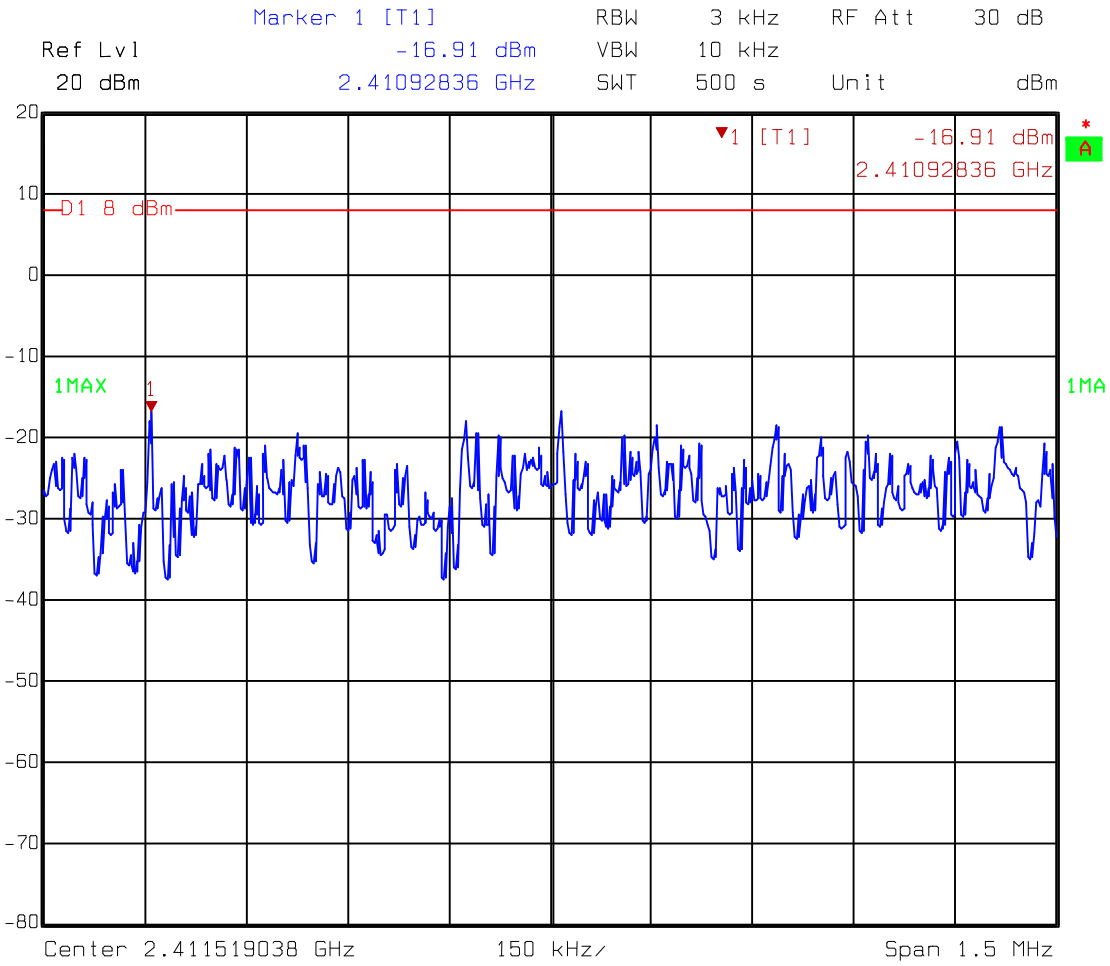
6.2 Test setup & procedure

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.

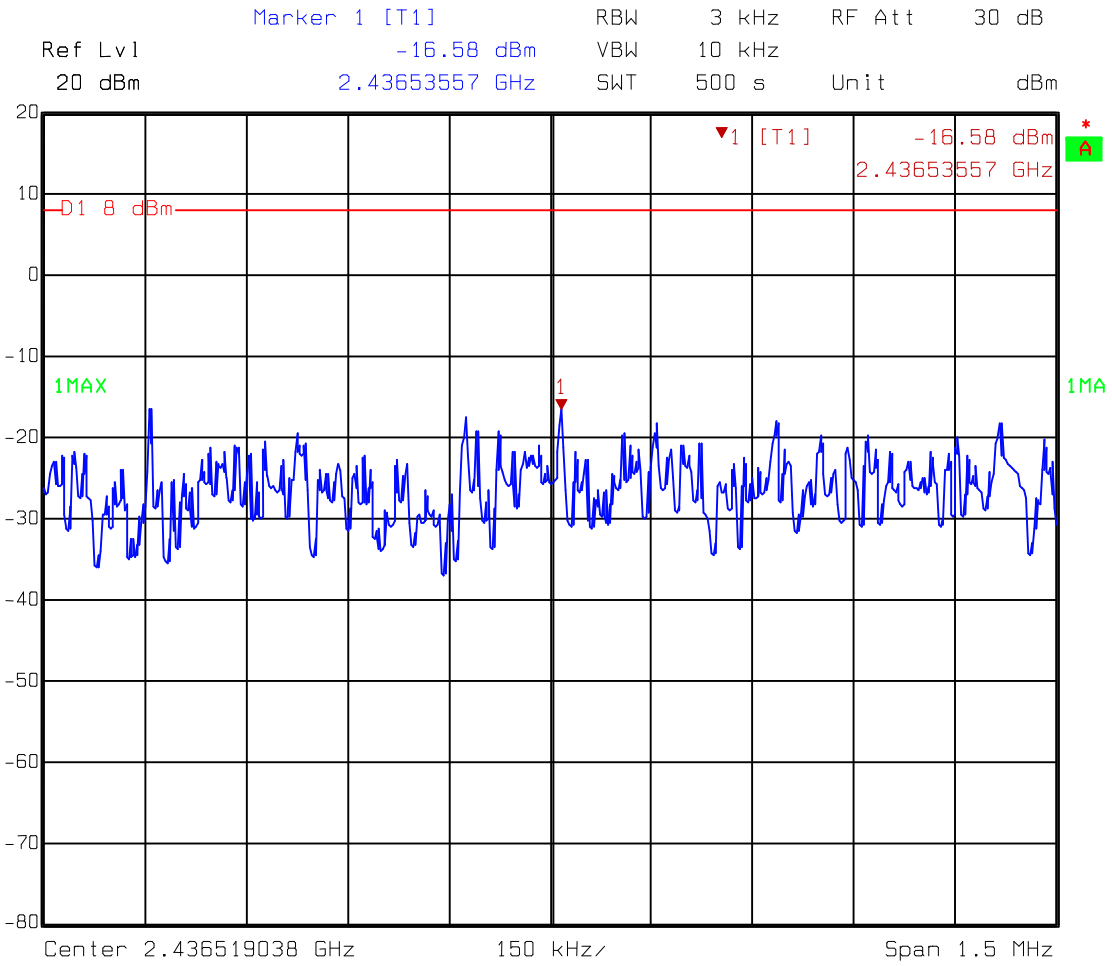
6.3 Measured data of Power Spectrum Density test results

Channel	Frequency (MHz)	Measured level (dBm)	Limit (dBm)
Low	2410.93	-14.78	8
Middle	2436.54	-14.45	8
High	2461.54	-13.71	8

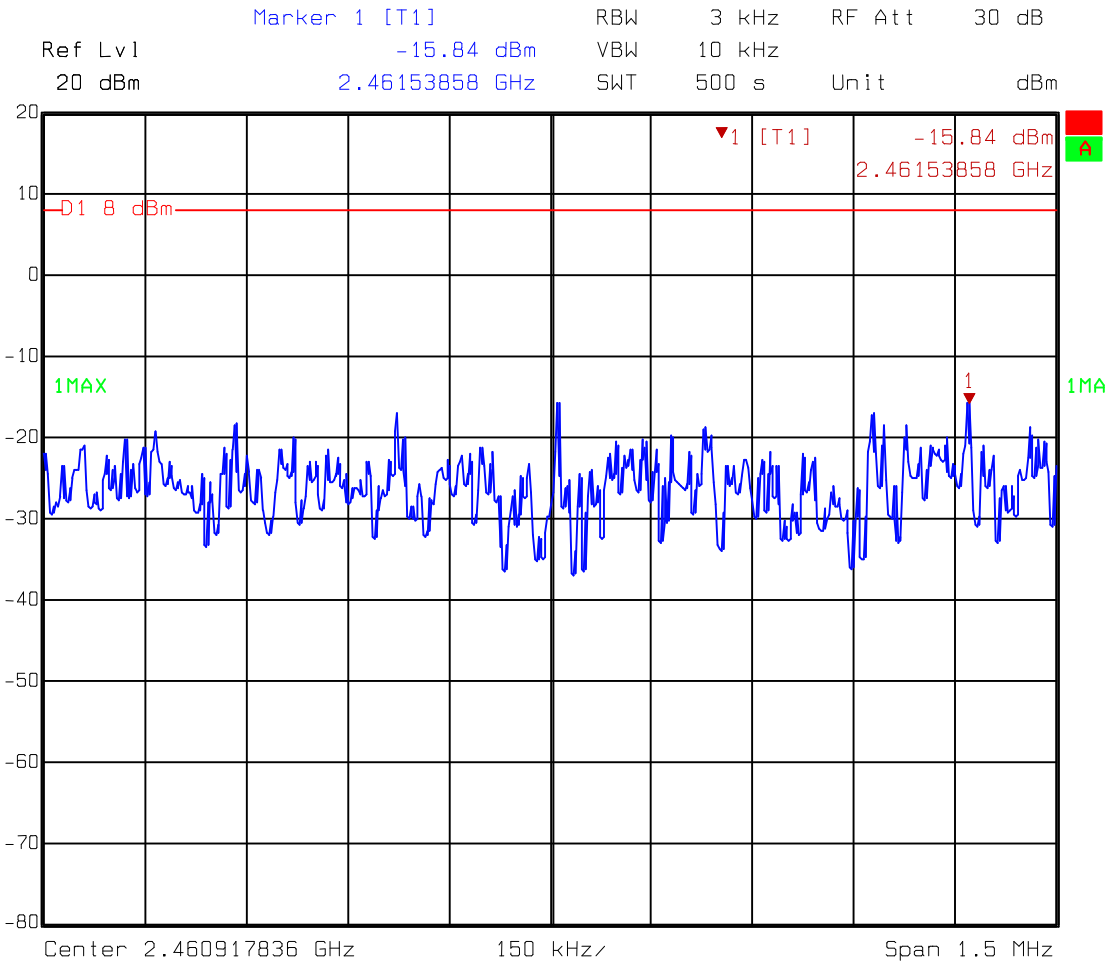
Please see the plot below.



Comment A: Power spectrum density at low channel
CL=2.13dB
Date: 07.NOV.2003 15:31:38



Comment A: Power spectrum density at middle channel
CL=2.13dB
Date: 07.NOV.2003 15:29:09



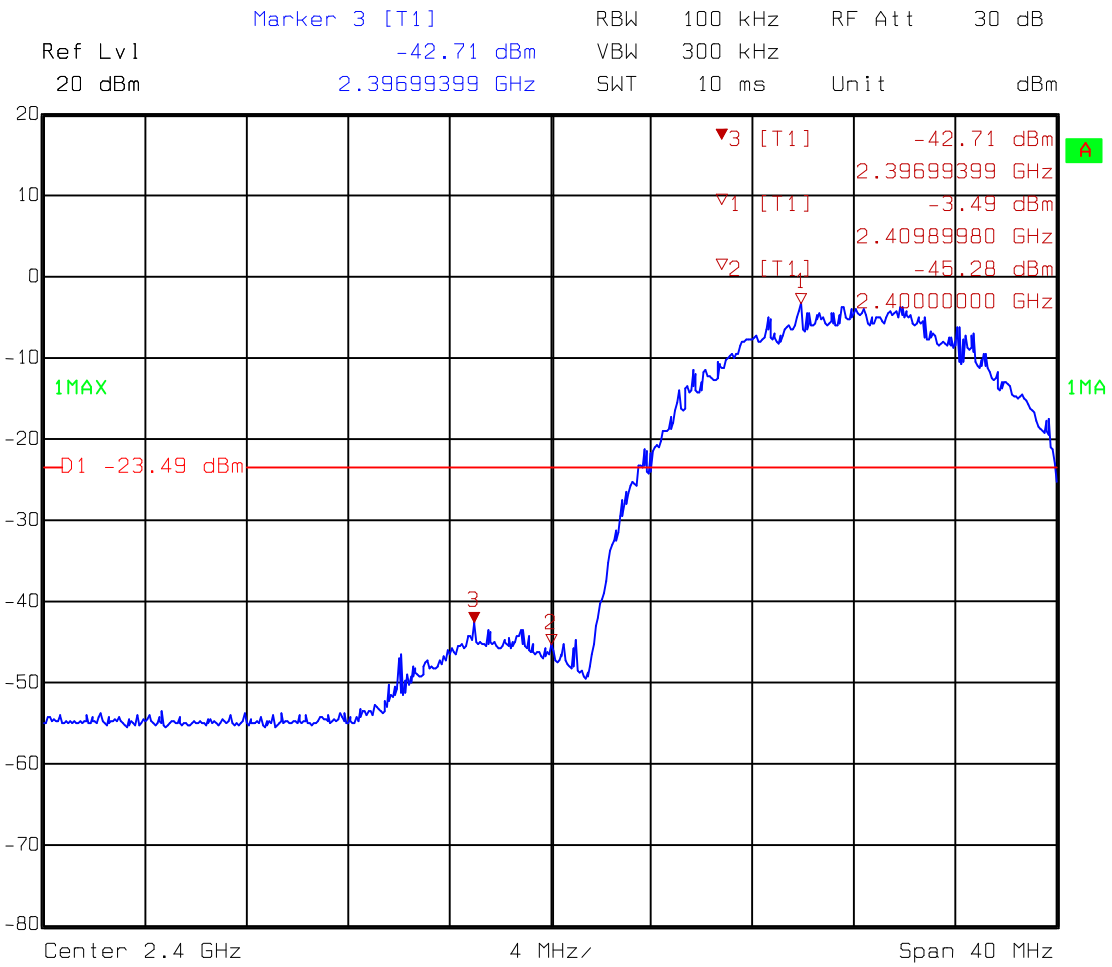
Comment A: Power spectrum density at high channel
CL=2.13dB
Date: 07.NOV.2003 15:26:47

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

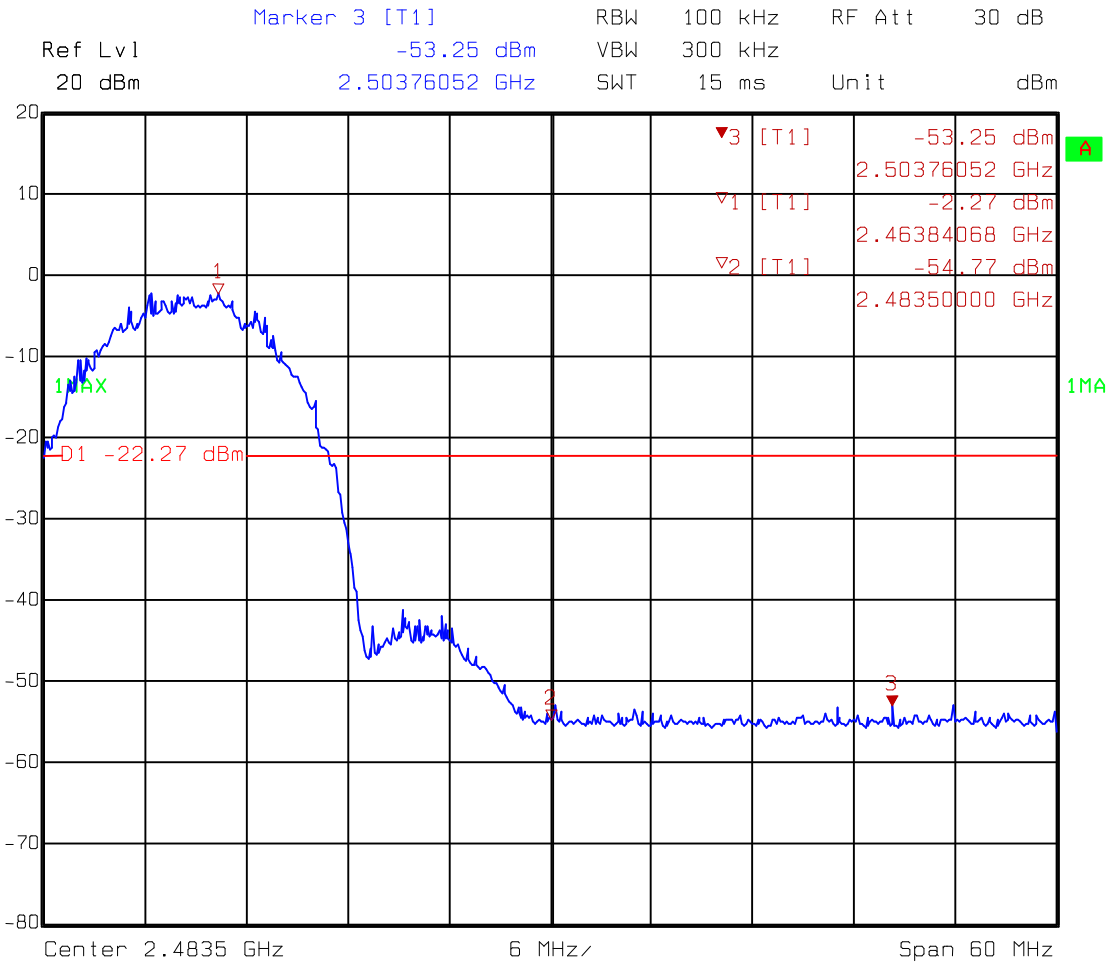
In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the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

Please see the plot below.

7.1 Band-edge (Conducted method)

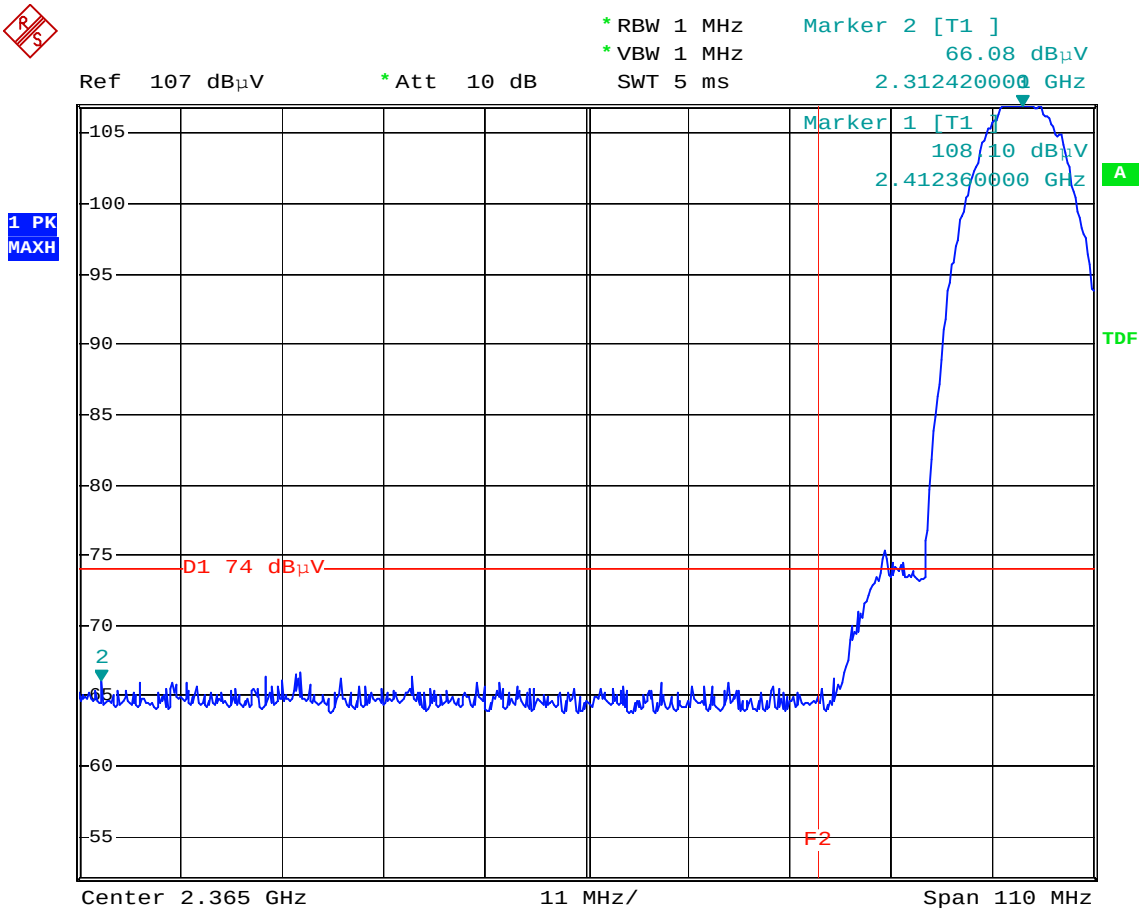


Comment A: Band-edge at low channel
Date: 07.NOV.2003 15:40:56

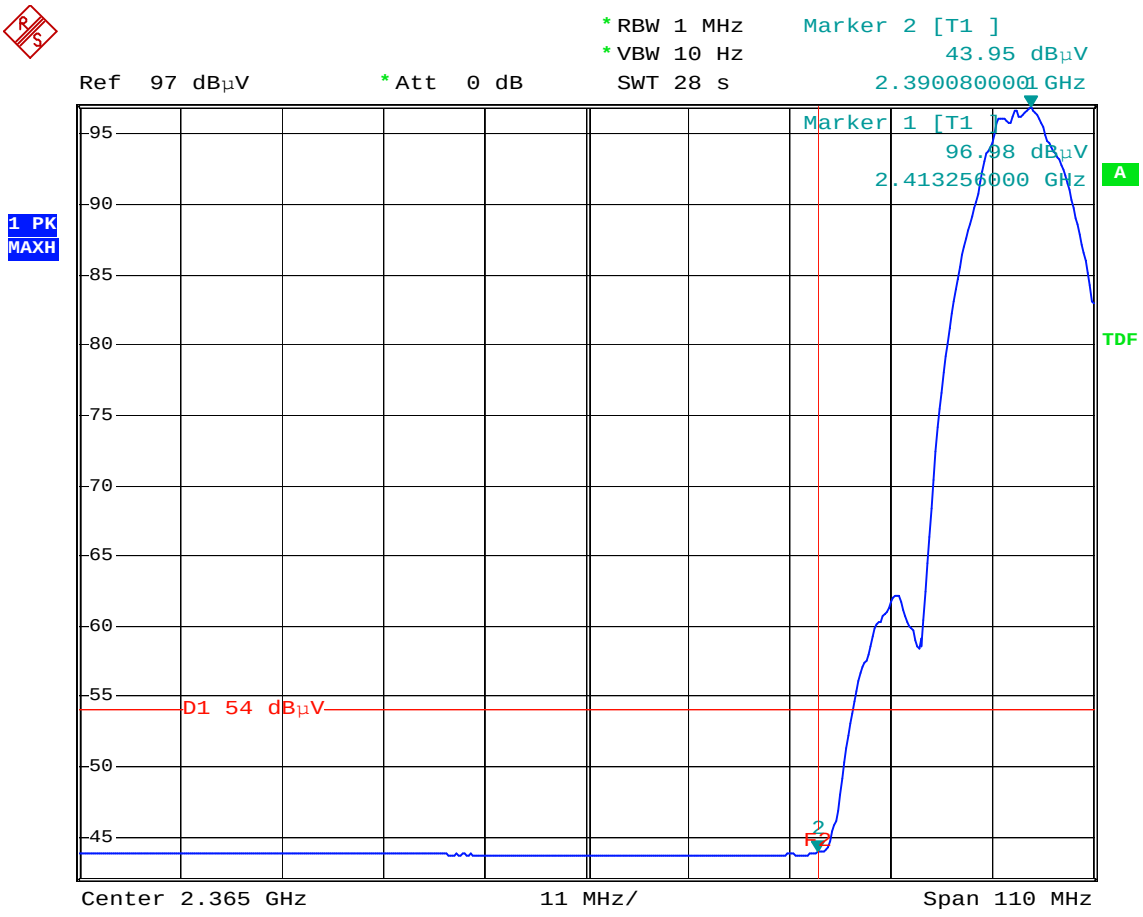


Comment A: Band-edge at high channel
Date: 07.NOV.2003 15:45:37

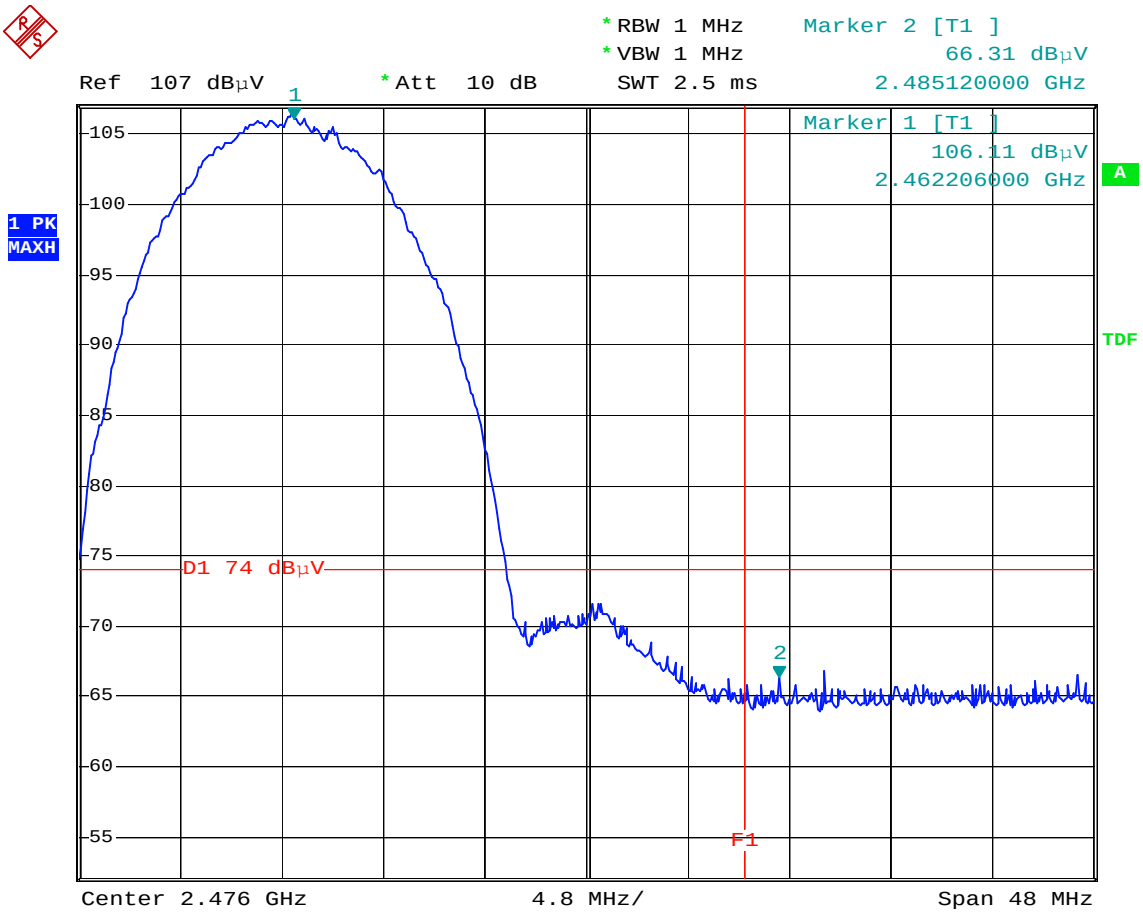
7.2 Band-edge (Radiated method)



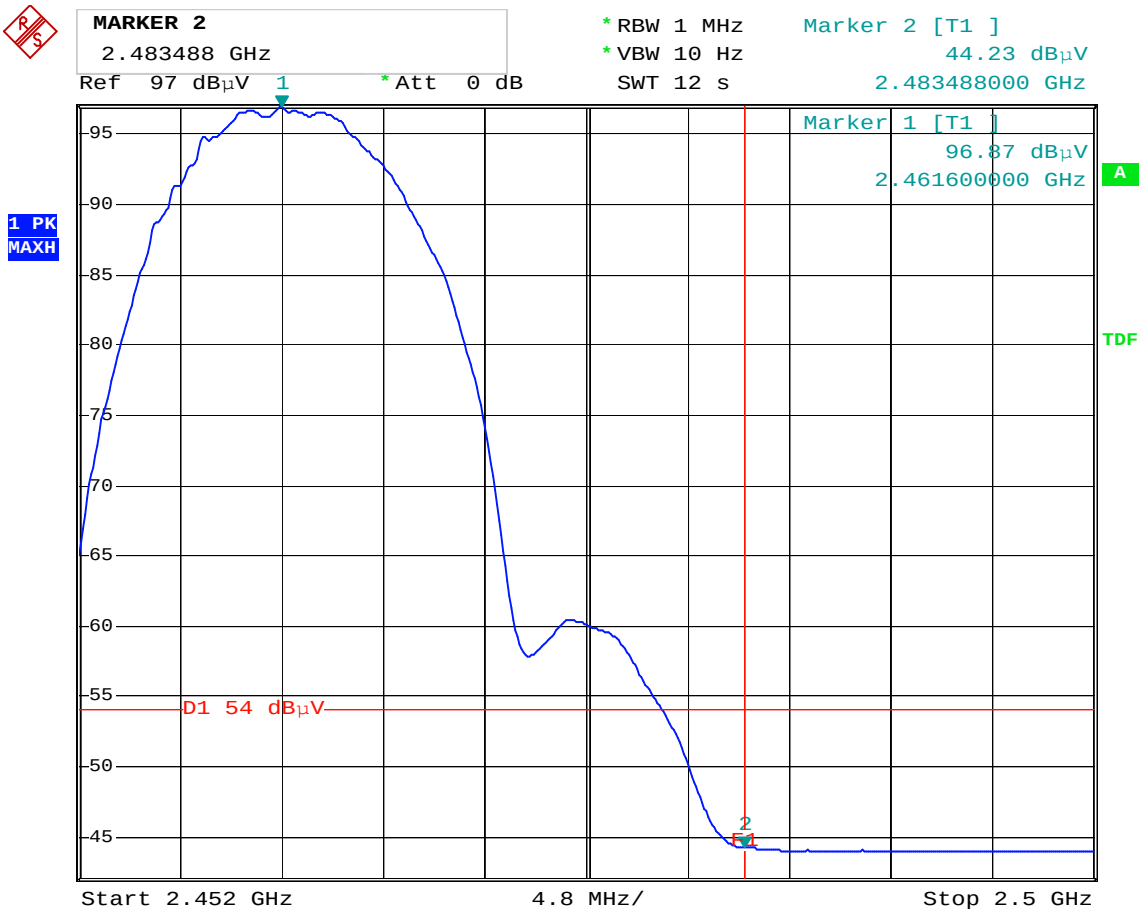
Comment A: Band-edge test at low channelEN B
Peak detector F2=2390MHz
Date: 29.OCT.2003 15:44:57



Comment A: Band-edge test at low channelEN B
Average detector F2=2390MHz
Date: 29.OCT.2003 15:52:22



Comment A: Band-edge test at high channelN B
Peak detector F1=2483.5MHz
Date: 29.OCT.2003 15:56:03



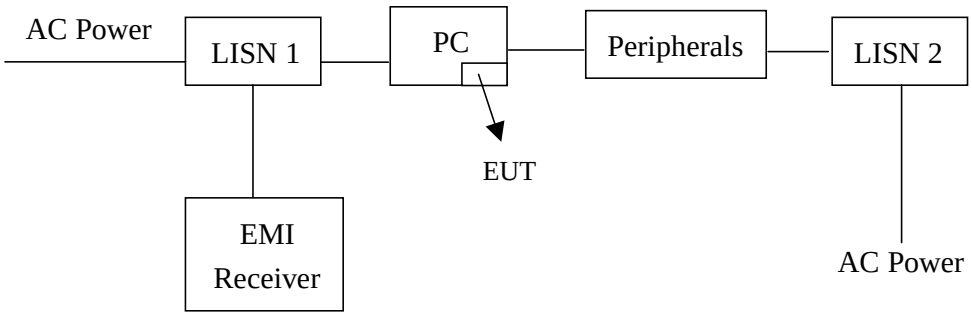
Comment A: Band-edge test at high channelN B
Average detector F1=2483.5MHz
Date: 29.OCT.2003 15:59:47

8. Power Line Conducted Emission test §FCC 15.207

8.1 Operating environment

Temperature:	24	℃	(10-40℃)
Relative Humidity:	56	%	(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”.

Please see the plot below.

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-320

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
0.17400	46.1	64.77	46.2	54.77	-18.67	-8.57
2.91000	34.4	56.00	34.5	46.00	-21.60	-11.50
6.84600	40.4	60.00	35.8	50.00	-19.60	-14.20
15.62200	36.2	60.00	30.9	50.00	-23.80	-19.10
19.54200	34.5	60.00	29.9	50.00	-25.50	-20.10
23.43800	35.3	60.00	29.5	50.00	-24.70	-20.50

(2) Neutral

EUT : ZyAIR B-320

Test Condition : Normal operating

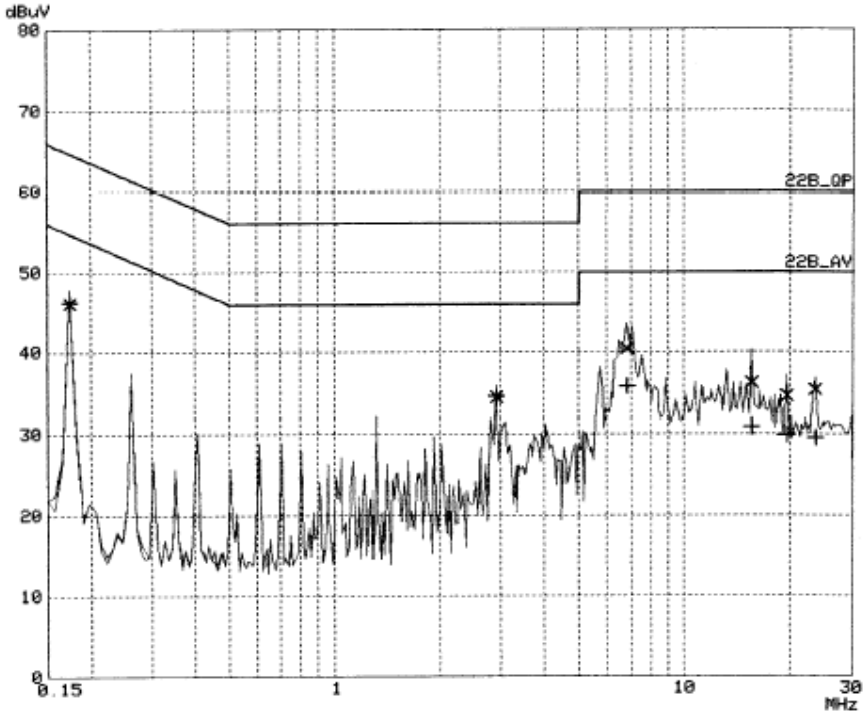
Freq. (MHz)	Reading (dB μ V) QP	Limit (dB μ V) QP	Reading (dB μ V) AV	Limit (dB μ V) AV	Margin (dB)	
					QP	AV
0.17400	41.9	64.77	42.1	54.77	-22.87	-12.67
2.91000	34.2	56.00	34.5	46.00	-21.80	-11.50
6.70200	38.4	60.00	33.5	50.00	-21.60	-16.50
15.63000	35.4	60.00	31.5	50.00	-24.60	-18.50
19.53200	31.6	60.00	27.8	50.00	-28.40	-22.20
23.44600	34.4	60.00	29.5	50.00	-25.60	-20.50

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.

RF Voltage

EUT : ZyAIR B-320
Manufacturer : ZyXEL Communications Corporation
Op Cond : LISN-L
Operator : Jackey
Test Spec. : FCC P15 Class B
Comment : RCV: EC303 LISN: EC320
TEMP: 24℃ R.H.: 56% TEST: 120V 60HZ Normal operating
Date : Oct. 30, 2003 09:53



RF Voltage

EUT : ZyAIR B-320
Manufacturer : ZyXEL Communications Corporation
Op Cond : LISN-N
Operator : Jackey
Test Spec. : FCC P15 Class B
Comment : RCV: EC303 LISN: EC320
TEMP: 24℃ R.H.: 56% TEST: 120V 60HZ Normal operating
Date : Oct. 30, 2003 09:44