FCC Part 15

EMI TEST REPORT

of

E.U.T.: **Bluetooth Audio Gateway**

Trade Name: Windigo Systems

Model Number: PBTAG02C2-XX
(X=A~Z, 0~9 or Blank)

Prepared for

Windigo Systems

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TEST REPORT CERTIFICATION

Applicant:	Windigo Systems
Manufacturer:	Wearnes Electronics (M) Sdn Bhd
EUT Description:	Bluetooth Audio Gateway
Model No.:	PBTAG02C2-XX (X=A~Z, 0~9 or Blank)
Serial No.:	N/A
Tested Power Supply:	120Vac, 60Hz
Date of Final Test:	Oct. 15, 2003

Measurement Procedures and Standards Used :

FCC Rules and Regulations Part 15 Subpart B & C (2002)

I HEREBY CERTIFY THAT: The data shown in this report were made in accordance with the procedures given in ANSI C63.4, and the energy emitted by the device was founded to be within the limits applicable. I assume full responsibility for accuracy and completeness of these data.

Note: 1. The result of the testing report relate only to the item tested.

2. The testing report shall not be reproduced expect in full, without the written approval of IETC

Report Issued: 2003/11/18

Test Engineer: Posen Huang 2003/11/18
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Checked: Jeff Chuang 2003/11/18
Jeff Chuang

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1 General Information

1.1 Description of Equipment Under Test

Equipment Under Test	:	Bluetooth Audio Gateway
Model Number	:	PBTAG02C2-XX (X=A~Z, 0~9 or Blank)
Serial Number	:	N/A
Type of Sample Tested	:	☒Proto-type ☐Pre-Production ☐Mass Production
Applicant	:	**Windigo Systems** 2210 O' Toole Ave Suite 200, San Jose, CA 95131, U.S.A.
Manufacturer	:	**Wearnes Electronics (M) Sdn Bhd** 99, Jalan Parit Masjid, 82000 Pontian, Johor, Malaysia.
Power Adapter	:	Manufacturer: BALANCE ELECTRONICS, M/N: GPSA-0750150 Input: 100-240Vac, 50-60Hz, 0.5A Output: 7Vdc, 0.6A Power cable: ☒Non-shielded ☒Detachable, 1.8m
Date of Receipt of Sample		Aug. 18, 2003
Date of Test		Aug. 18 ~ Oct. 15, 2003
Description of E.U.T.		1. The EUT is Bluetooth Audio Gateway. 2. Windigo Bluetooth Audio Gateway is battery power wireless communication device used to transfer both control command and voice between headset and audio gateway device, which is Bluetooth specification V1.1 compliant, and a single chip RF transceiver from Cambridge Silicon Radio is used. Single 16MHz crystal is used for both generating the timing for Bluetooth communication and internal micro-controller. PCB antenna is built in. The maximum antenna Gain is 2.5dBi.This Bluetooth audio gateway is major used with cellular phone as hands-free kit, but also can be used with computer, notebook, PDA and other computing and communication devices. 3. EUT Ports: ① Audio Out Port * 1. ② Power Port * 1. 4. The PBTAG02C2-1 is representative selected in the test and included in this report.

1.2 Supporting System Detail (For Radiation Emission Measurement)

- IBM Note Book

Model Number	:	2655-GT1
Serial Number	:	78-LRZR4
EMC Approved	:	FCC DoC, CE, VCCI, 檢磁 3902I050
Manufacturer	:	IBM
Adapter	:	IBM AA21070, 檢磁 3892A299 Input: 100-240Vac, 1.2~0.5A, 50/60Hz Non-shielded, Detachable, 1.5m Output: 16Vdc, 4.5A Non-shielded, Un-detachable, 1.8m

- Bluetooth Earphone

Model Number	:	PBTHSTF2C2-ELC
Serial Number	:	N/A
EMC Approved	:	QQFPBTHSTX2C2XXX
Manufacturer	:	Windigo

1.3 Test Methodology

For Bluetooth Audio Gateway, both conducted and radiated emissions were performed according to the procedures illustrated in ANSI C63.4 (1992) and Other required measurements were illustrated in separate sections of this test report for details.

1.4 Bluetooth Approvals

For Bluetooth Earphone meeting the Bluetooth Specifications in the 2.4GHz band as of February 2001 operating in the USA.

1.5 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the roof top of Building at No.5-2, Lin 1, Tin-Fu Tsun, Lin-Kou Hsiang, Taipei County, Taiwan, R.O.C.

This site has been fully described in a report submitted to your office, and accepted in a letter dated Oct 28,2002.

2 PROVISIONS APPLICABLE

2.1 Definition

Unintentional radiator:
A device that intentionally generates and radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction.

Class A Digital Device:
A digital device which is marketed for use in commercial or business environment; exclusive of a device which is market for use by the general public, or which is intended to be used in the home.

Class B Digital Device :
A digital device which is marketed for use in a residential environment notwithstanding use in a commercial, business of industrial environment. Example of such devices that are marketed for the
general public.

Note : A manufacturer may also qualify a device intended to be marketed in a commercial, business, or industrial environment as a Class B digital device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B Digital Device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B Digital Device, Regardless of its intended use.

Intentional radiator:
A device that intentionally generates and emits radio frequency energy by radiation or induction.

2.2 Requirement for Compliance

(1) Conducted Emission Requirement

For intentional device, according to §15.207(a) Line Conducted Emission Limits is same as above table.

For unintentional device, according to CISPR Line Conducted Emission Limits class B is as following:

Frequency (MHz)	Quasi Peak (dB μV)	Average (dB μV)
0.15 - 0.5	66-56	56-46
0.5 - 5.0	56	46
5.0 - 30.0	60	50

For intentional device, according to CISPR Line Conducted Emission Limits is same as above table.

(2) Radiated Emission Requirement

For unintentional device, according to §15.109(a), except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency (MHz)	Distance Meters (m)	Radiated (dB μV/m)	Radiated (μV/m)
30 - 88	3	40.0	100
88 - 216	3	43.5	150
216 - 960	3	46.0	200
Above 960	3	54.0	500

For intentional device, according to §15.209(a), the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the above table.

For unintentional device, according to CISPR Line Conducted Emission Limits class B is as following:

Frequency (MHz)	Distance Meters (m)	Radiated (dB μV/m)
30 to 230	10	30
230 to 1000	10	37

(3) Hopping Channel Separation and 20 dB Bandwidth

According to 15.247(a)(1), frequency hopping system shall have , hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

(4) Dwell Time on each channel

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any frequency shall not be greater than 0.4 second within a period of 0.4 seconds multiplied by the number of hopping channels employed.

(5) Maximum Output Power Requirement

According to 15.247(b)(1) For frequency hopping systems operating in the 2400-2483.5MHz band employing at least 75 hopping channels and all frequency hopping systems in the 5725MHz-5850MHz band: 1 Watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(6) 100 kHz Bandwidth of Frequency Band Edges Requirement

According to 15.247(c), if any 100 kHz bandwidth outside these frequency bands, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in § 15.209(a), whichever results in the lesser attenuation.

2.3 Restricted Bands of Operation

Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42-16.423	399.9-410	4.5-5.25
0.495 - 0.505 **	16.69475 - 16.69525	608-614	5.35-5.46
2.1735 - 2.1905	16.80425 - 16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475 - 156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3360-4400	Above 38.6
13.36-13.41			

** : Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz

2.4 Labeling Requirement

The device shall bear the following statement in a conspicuous location on the device :

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions : (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.5 User Information

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual.

The Federal Communications Commission Radio Frequency Interference Statement includes the following paragraph.

This equipment has been tested and found to comply with the limits for a Class B Digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-- Consult the dealer or an experienced radio / TV technician for help.

3 SYSTEM TEST CONFIGURATION

3.1 Justification

For both radiated and conducted emissions below 1 GHz, the system was configured for testing in a typical fashion as a customer would normally use it. The peripherals other than EUT were connected in normally standing by situation. Measurement was performed under the condition that a computer program was exercised to simulate data communication of EUT, and the transmission rate was set to maximum allowed by EUT. Three highest emissions were verified with varying placement of the transmitting antenna connected to EUT to maximize the emission from EUT.

For conducted emissions, only measured on TX / RX and charge mode operation, for the digital circuits portion also function normally whenever TX or RX is operated. For radiated emissions, whichever RF channel is operated, the digital circuits function identically. As the reason, measurement of radiated emissions from digital circuits is only performed with channel 40 by transmitting mode.

During the preliminary test, the worse case are TX / RX and charge mode, and data presented in this test report just shows the worse case.

4 Power Line Conducted Emission Measurement

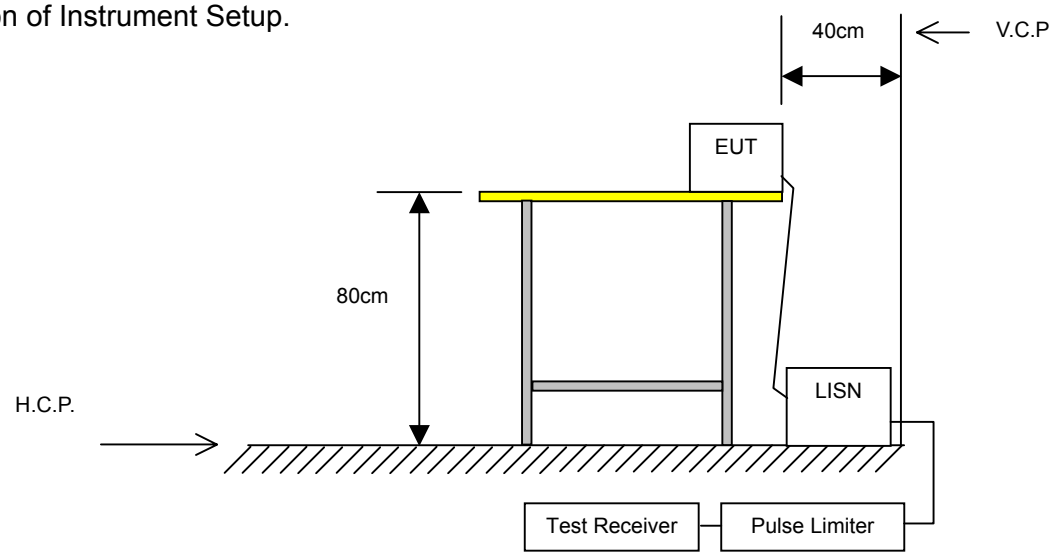
4.1 Instrument

Instrument	Manufacturer	Model	Serial No.	Last Calibration
EMI Test Receiver	Rohde & Schwarz	ESCS 30	100127	2003/08/30
L.I.S.N.	Schwarzbeck	NNLK8121	8121417	2003/07/26
L.I.S.N.	Rohde & Schwarz	ESH3-Z5	829996/016	2003/06/11
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	830836/026	2003/07/15
RF Cable	IETC	CBL04	N/A	2003/10/14

Note: All instrument upon which need to be calibrated are within calibration period of 1 year.

4.2 Block Diagram of Test Configuration

Configuration of Instrument Setup.



4.3 Conducted Limit (Power Line)

Frequency (MHz)	☐ Class A		☒ Class B	
	Q.P. (Quasi-Peak)	A.V. (Average)	Q.P. (Quasi-Peak)	A.V. (Average)
0.15 ~ 0.50	79 dBμ V	66 dBμ V	66 to 56 dBμ V	56 to 46 dBμ V
0.50 ~ 5.0	73 dBμ V	60 dBμ V	56 dBμ V	46 dBμ V
5.0 ~ 30	73 dBμ V	60 dBμ V	60 dBμ V	50 dBμ V

Note: The emission requirement only applies to telecommunication ports as specified in EN 55022[7]. The provisional relaxation 10dB.Will be review no later than 3 years After the date of withdrawal based on the results and interface cases seen in the period. Wherever possible it is recommended to comply with the limits without the provisional relaxation.

4.4 Measurement Procedure

1. The EUT was placed on a non-conductive table whose total height equaled 80cm and vertical conducting plane located 40cm to the rear of the EUT.
2. The EUT was connected to the main power through Line Impedance Stabilization Networks (LISN). This setup provided a 50ohm / 50μH coupling impedance for the measuring equipment. The auxiliary equipment was also connected to the main power through a LISN that provided a 50ohm/50μH coupling impedance with 50ohm termination. (Refer to the block diagram of the test setup and photographs.)
3. The conducted disturbance was measured between the phase lead and the reference ground, and between the neutral lead and reference ground. The initial testing identified the frequency that has the highest disturbance relative to the limit while operating the EUT in typical modes of operation and cable positions in a test setup representative of typical system configuration.
4. The identification of the frequency of highest disturbance with respect to the limit was found by investigating disturbances at a number of significant frequencies. The probable frequency of maximum disturbance had been found and that the associated cable and EUT configuration and mode of operation had been identified.

4.5 Measuring Instrument

1. Set the EMI test receiver frequency range from 150 KHz to 30 MHz.
2. Set the EMI test receiver bandwidth at 9kHz.
3. Set the EMI test receiver detector as Quasi-Peak (Q.P.) and Average (AV).

4.6 Test Step of EUT

1. Setup the EUT and peripheral as shown in section 4.2.
2. Turn on the power of all equipment.
3. Turn on EUT and press pause power key for 3 sec.
4. Turn on earphone and press pause power key for 3 sec. Then the communication between bluetooth earphone and EUT started to link.
5. Measured the Line phase and record value.
6. Changed into Neutral phase then measure and record value.

Power Line Conducted Test Data

Date of Tested : Sep. 18, 2003 Power Line : Line
Temperature : 26°C Humidity : 42%
Tested Mode : Charge Mode

Frequency (MHz)	Factor (dB)	Meter Reading (dBuV)		Emission Level (dBuV)		Limits (dBuV)		Margin (dB)	
		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
0.201	0.20	44.66	41.74	44.86	41.94	64.55	54.55	-19.69	-12.61
0.267	0.20	39.31	39.67	39.51	39.87	62.65	52.65	-23.14	-12.78
0.334	0.20	33.39	33.21	33.59	33.41	60.75	50.75	-27.16	-17.34
0.396	0.18	32.04	31.63	32.22	31.81	58.97	48.97	-26.75	-17.16
0.463	0.16	33.90	31.84	34.06	32.00	57.07	47.07	-23.01	-15.07
0.595	0.20	33.04	31.48	33.24	31.68	56.00	46.00	-22.76	-14.32

Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.
3. Please refer to appendix 1.

Power Line Conducted Test Data

Date of Tested : Sep. 18, 2003 Power Line : Neutral
Temperature : 26°C Humidity : 42%
Tested Mode : Charge Mode

Frequency (MHz)	Factor (dB)	Meter Reading (dBuV)		Emission Level (dBuV)		Limits (dBuV)		Margin (dB)	
		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
0.201	0.20	44.88	43.96	45.08	44.16	64.55	54.55	-19.47	-10.39
0.267	0.20	35.91	36.14	36.11	36.34	62.65	52.65	-26.54	-16.31
0.396	0.18	32.44	30.76	32.62	30.94	58.97	48.97	-26.35	-18.03
0.466	0.16	34.94	32.11	35.10	32.27	56.96	46.96	-21.86	-14.69
0.533	0.19	31.63	28.80	31.82	28.99	56.00	46.00	-24.18	-17.01
0.599	0.20	36.59	33.07	36.79	33.27	56.00	46.00	-19.21	-12.73

Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.
3. Please refer to appendix 1.

Power Line Conducted Test Data

Date of Tested : Oct. 15, 2003 Power Line : Line
Temperature : 26°C Humidity : 42%
Tested Mode : TX/RX Mode

Frequency (MHz)	Factor (dB)	Meter Reading (dBuV)		Emission Level (dBuV)		Limits (dBuV)		Margin (dB)	
		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
0.201	0.20	44.66	41.74	44.86	41.94	63.57	53.57	-18.71	-11.63
0.267	0.20	39.31	39.67	39.51	39.87	61.21	51.21	-21.70	-11.34
0.334	0.20	33.39	33.21	33.59	33.41	59.35	49.35	-25.76	-15.94
0.396	0.18	32.04	31.63	32.22	31.81	57.94	47.94	-25.72	-16.13
0.463	0.16	33.90	31.84	34.06	32.00	56.64	46.64	-22.58	-14.64
0.595	0.20	33.04	31.48	33.24	31.68	56.00	46.00	-22.76	-14.32

Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.
3. Please refer to appendix 1.

Power Line Conducted Test Data

Date of Tested : Oct. 15, 2003 Power Line : Neutral
Temperature : 26°C Humidity : 42%
Tested Mode : TX/RX Mode

Frequency (MHz)	Factor (dB)	Meter Reading (dBuV)		Emission Level (dBuV)		Limits (dBuV)		Margin (dB)	
		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
0.201	0.20	44.88	43.96	45.08	44.16	63.57	53.57	-18.49	-9.41
0.267	0.20	35.91	36.14	36.11	36.34	61.21	51.21	-25.10	-14.87
0.396	0.18	32.44	30.76	32.62	30.94	57.94	47.94	-25.32	-17.00
0.466	0.16	34.94	32.11	35.10	32.27	56.58	46.58	-21.48	-14.31
0.533	0.19	31.63	28.80	31.82	28.99	56.00	46.00	-24.18	-17.01
0.599	0.20	36.59	33.07	36.79	33.27	56.00	46.00	-19.21	-12.73

Remark:
1. All readings are Quasi-Peak and Average values.
2. Factor = Insertion Loss + Cable Loss.
3. Please refer to appendix 1.

5 RADIATED EMISSION MEASUREMENT

5.1 Instrument

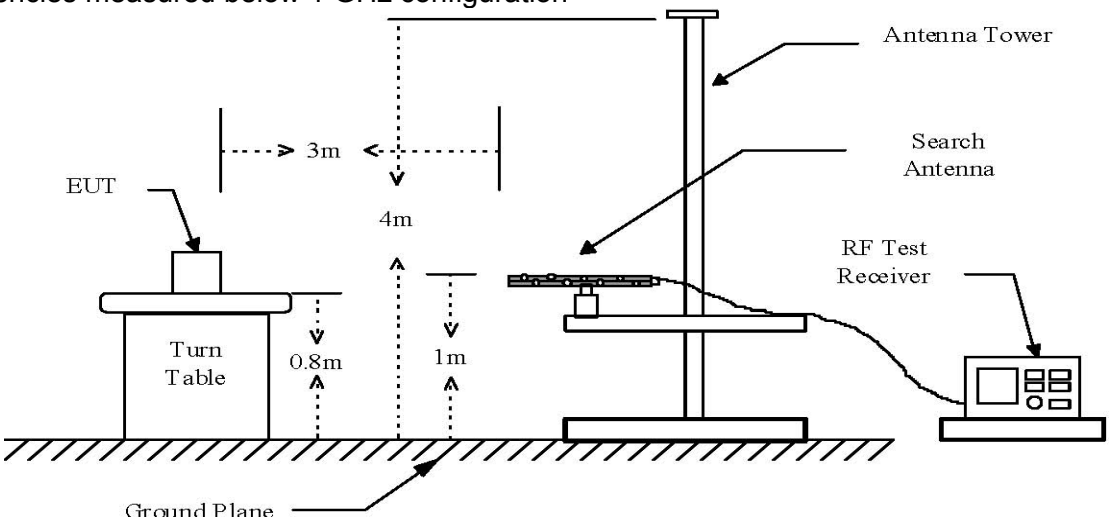
☒OATS 1

Instrument	Manufacturer	Model	Serial No.	Last Calibration
EMI Test Receiver	Rohde & Schwarz	ESI 07	830154/002	2003/07/24
Antenna	Schaffner	CBL6112B	2610	2003/02/25
Pre-Amplifier	Schaffner	CPA9231A	3351	2003/09/30
RF Cable	IETC	CBL01	N/A	2003/09/15
HORN Antenna	COM-POWER	AH-118	10081	2003/04/19
RF Preamplifier	Agilent Technologies	8449B	3008A01434	2003/04/24
Cable	Insulated Wire Incorporated	NPS-2251-7880-NPR	CBL06	2003/05/05

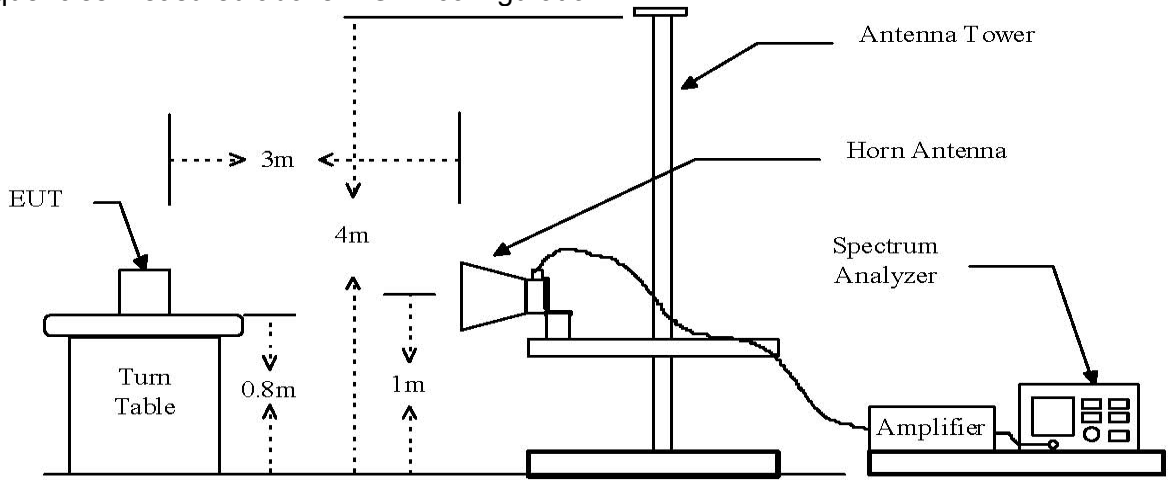
Note: All instrument upon which need to be calibrated are within calibration period of 1 year.

5.2 Block Diagram of Test Configuration

Frequencies measured below 1 GHz configuration



Frequencies measured above 1 GHz configuration



5.3 Applicable Standard

For unintentional radiator, the radiated emission shall comply with §15.109(a).

For intentional radiators, according to §15.247 (a), operation under this provision is limited to frequency hopping and direct sequence spread spectrum, and the out band emission shall be comply with §15.247 (c)

5.4 Measurement Procedure

1. Setup the configuration per figure 5 and 6 for frequencies measured below and above 1 GHz respectively.
2. For emission frequencies measured below 1 GHz, a pre-scan is performed in a shielded chamber to determine the accurate frequencies of higher emissions will be checked on a open test site. As the same purpose, for emission frequencies measured above 1 GHz, a pre-scan also be performed with a 1 meter measuring distance before final test.
3. For emission frequencies measured below and above 1 GHz, set the spectrum analyzer on a 100 kHz and 1 MHz resolution bandwidth respectively for each frequency measured in step 2.
4. The search antenna is to be raised and lowered over a range from 1 to 4 meters in horizontally polarized orientation. Position the highness when the highest value is indicated on spectrum

   analyzer, then change the orientation of EUT on test table over a range from 0◦ to 360◦ with a speed as slow as possible, and keep the azimuth that highest emission is indicated on the spectrum analyzer. Vary the antenna position again and record the highest value as a final reading. A RF test receiver is also used to confirm emissions measured.

   Note : A band pass filter was used to avoid pre-amplifier saturated when measure TX operation mode in frequency band above 1 GHz.

5. Repeat step 4 until all frequencies need to be measured were complete.
6. Repeat step 5 with search antenna in vertical polarized orientations.
7. Check the three frequencies of highest emission with varying the placement of cables associated with EUT to obtain the worse case and record the result.

5.5 Measuring Instrument

Measuring instrument setup in measured frequency band when specified detector function is used:

Frequency Band (MHz)	Instrument	Function	Resolution bandwidth	Video Bandwidth
0.01 to 30	RF Test Receiver	Quasi-Peak	9 kHz	N/A
	Spectrum Analyzer	Peak	100 kHz	100 kHz
30 to 1000	RF Test Receiver	Quasi-Peak	120 kHz	N/A
	Spectrum Analyzer	Peak	100 kHz	100 kHz
Above 1000	Spectrum Analyzer	Peak	1 MHz	1 MHz
	Spectrum Analyzer	Average	1 MHz	300 Hz

5.6 Test Step of EUT

1. Setup the EUT and peripheral as shown in section 5.2.
2. Inserted EUT with test module, connected with Notebook PC.
3. Turn on the power of all equipment.
4. Executed “bluetest” program from Notebook PC and selected channels (low, middle, high).
5. Measured the horizontal polarization and record the value.
6. Changed into vertical polarization measure and record the value.

5.7 Radiated Emission Data

Results for the radiated measurements below 30MHz according §15.33

Frequency	Measured Values	Remarks
10KHz-30MHz	No emission found, caused by the EUT	This is valid for all the test channels

Radiated Emission Measurement Data

Date of Tested :	Oct. 1, 2003	Polarization :	Horizontal
Temperature :	28°C	Humidity :	63%
Tested Mode :	Charge Mode	Distance :	10m

Frequency (MHz)	Factor (dB)	Meter Reading (dBuV)	Emission Level dB(uV/m)	Limits dB(uV/m)	Margin (dB)
73.521 *	-21.39	38.37	16.98	30.00	-13.02
85.287 *	-20.59	38.72	18.13	30.00	-11.87
111.503 *	-15.32	36.86	21.54	30.00	-8.46
143.030 *	-16.62	37.82	21.20	30.00	-8.80
193.547 *	-18.22	37.00	18.78	30.00	-11.22
213.226 *	-18.42	35.65	17.23	30.00	-12.77

Remark:
1. " * " Mark means readings are Peak Values.
2. " ** " Mark means readings are Quasi-Peak values.
3. Factor = Antenna Factor + Cable Loss – Pre-amplifier.

Radiated Emission Measurement Data

Date of Tested :	Oct. 1, 2003	Polarization :	Vertical
Temperature :	28°C	Humidity :	63%
Tested Mode :	Charge Mode	Distance :	10m

Frequency (MHz)	Factor (dB)	Meter Reading (dBuV)	Emission Level dB(uV/m)	Limits dB(uV/m)	Margin (dB)
53.987 **	-20.47	46.30	25.83	30.00	-4.17
73.978 *	-21.34	42.41	21.07	30.00	-8.93
110.950 *	-15.34	37.07	21.73	30.00	-8.27
167.320 *	-18.26	38.79	20.53	30.00	-9.47
197.925 *	-18.01	37.77	19.76	30.00	-10.24
204.810 *	-18.16	38.58	20.42	30.00	-9.58

Remark:
1. " * " Mark means readings are Peak Values.
2. " ** " Mark means readings are Quasi-Peak values.
3. Factor = Antenna Factor + Cable Loss – Pre-amplifier.

Radiated Emission Measurement Data

Date of Tested :	Sep. 30, 2003	Polarization :	Horizontal
Temperature :	28°C	Humidity :	63%
Tested Mode :	TX/RX Mode	Distance :	3m

Frequency (MHz)	Factor (dB)	Meter Reading (dBuV)	Emission Level dB(uV/m)	Limits dB(uV/m)	Margin (dB)
231.750 *	17.20	12.02	29.22	46.00	-16.78
299.540 *	16.37	13.89	30.26	46.00	-15.74
498.780 *	22.13	17.45	39.58	46.00	-6.42
596.560 *	18.84	18.92	37.76	46.00	-8.24
648.890 *	19.43	19.23	38.66	46.00	-7.34
730.350 *	19.17	20.38	39.55	46.00	-6.45

Remark:
1. " * " Mark means readings are Peak Values.
2. " ** " Mark means readings are Quasi-Peak values.
3. Factor = Antenna Factor + Cable Loss – Pre-amplifier.

Radiated Emission Measurement Data

Date of Tested :	Sep. 30, 2003	Polarization :	Vertical
Temperature :	28°C	Humidity :	63%
Tested Mode :	TX/RX Mode	Distance :	3m

Frequency (MHz)	Factor (dB)	Meter Reading (dBuV)	Emission Level dB(uV/m)	Limits dB(uV/m)	Margin (dB)
133.150 *	-20.82	54.30	33.48	43.50	-10.02
299.980 *	-16.20	48.60	32.40	46.00	-13.60
498.650 *	-9.01	44.30	35.29	46.00	-10.71
598.980 *	-6.63	45.00	38.37	46.00	-7.63
778.850 *	-3.98	43.20	39.22	46.00	-6.78
895.420 *	-2.65	40.50	37.85	46.00	-8.15

Remark:
1. " * " Mark means readings are Peak Values.
2. " ** " Mark means readings are Quasi-Peak values.
3. Factor = Antenna Factor + Cable Loss – Pre-amplifier.

Radio Frequency Measurement Results

Date of Tested	:	Sep. 18, 2003	Polarization	:	Vertical / Horizontal
Temperature	:	27°C	Humidity	:	49%
Fundamental Wave Frequency	:	2402MHz	Distance	:	3m
Tested Mode	:	TX/RX Mode (Channel 00)			

Frequency	Read Value (dBuV)		Corrected Factor	Max. Results (dBuv/m)		Limit (dBuV/m)		Tolerance (dB)	Altitude	Angle
(MHz)	QP	AV	(dB)	QP	AV	Peak	AV	(dBuV/m)	(m)	(degre
4804.000	---	---	4.10	---	---	74.00	54.00	---	---	---
7206.000	---	---	10.10	---	---	74.00	54.00	---	---	---
9608.000	---	---	12.50	---	---	74.00	54.00	---	---	---
12010.000	---	---	14.90	---	---	74.00	54.00	---	---	---
14412.000	---	---	23.10	---	---	74.00	54.00	---	---	---
16814.000	---	---	20.20	---	---	74.00	54.00	---	---	---
19216.000	---	---	14.70	---	---	74.00	54.00	---	---	---
21618.000	---	---	14.64	---	---	74.00	54.00	---	---	---
24020.000	---	---	16.20	---	---	74.00	54.00	---	---	---

Note :

1. *Item of margin shown in above table refer to average limit.*
2. *It is considered that the results of average comply with average limit when measuring data with a peak function detector meet the average limit. Mark "***" means that Peak result is meet average limit.*
3. *Remark "---" means that the emissions level is too low to be measured.*
4. *Item "Margin" referred to Average limit while there is only peak result.*
5. *The expanded uncertainty of the radiated emission tests is 3.53 dB.*

Radio Frequency Measurement Results

Date of Tested	:	Sep. 18, 2003	Polarization	:	Vertical / Horizontal
Temperature	:	27°C	Humidity	:	49%
Fundamental Wave Frequency	:	2440MHz	Distance	:	3m
Tested Mode	:	TX/RX Mode (Channel 40)			

Frequency	Read Value (dBuV)		Corrected Factor	Max. Results (dBuv/m)		Limit (dBuV/m)		Tolerance (dB)	Altitude	Angle
(MHz)	QP	AV	(dB)	QP	AV	Peak	AV	(dBuV/m)	(m)	(degre
4880.000	---	---	4.30	---	---	74.00	54.00	---	---	---
7320.000	---	---	10.30	---	---	74.00	54.00	---	---	---
9760.000	---	---	13.30	---	---	74.00	54.00	---	---	---
12200.000	---	---	16.40	---	---	74.00	54.00	---	---	---
14640.000	---	---	22.90	---	---	74.00	54.00	---	---	---
17080.000	---	---	22.40	---	---	74.00	54.00	---	---	---
19520.000	---	---	14.70	---	---	74.00	54.00	---	---	---
21960.000	---	---	14.64	---	---	74.00	54.00	---	---	---
24400.000	---	---	16.20	---	---	74.00	54.00	---	---	---

Note :

1. *Item of margin shown in above table refer to average limit.*
2. *It is considered that the results of average comply with average limit when measuring data with a peak function detector meet the average limit. Mark "***" means that Peak result is meet average limit.*
3. *Remark "---" means that the emissions level is too low to be measured.*
4. *Item "Margin" referred to Average limit while there is only peak result.*
5. *The expanded uncertainty of the radiated emission tests is 3.53 dB.*

Radio Frequency Measurement Results

Date of Tested	:	Sep. 18, 2003	Polarization	:	Vertical / Horizontal
Temperature	:	27°C	Humidity	:	49%
Fundamental Wave Frequency	:	2480MHz	Distance	:	3m
Tested Mode	:	TX/RX Mode (Channel 78)			

Frequency	Read Value (dBuV)		Corrected Factor	Max. Results (dBuv/m)		Limit (dBuV/m)		Tolerance (dB)	Altitude	Angle
(MHz)	QP	AV	(dB)	QP	AV	Peak	AV	(dBuV/m)	(m)	(degre
4960.000	---	---	4.50	---	---	74.00	54.00	---	---	---
7440.000	---	---	10.40	---	---	74.00	54.00	---	---	---
9920.000	---	---	14.50	---	---	74.00	54.00	---	---	---
12400.000	---	---	16.80	---	---	74.00	54.00	---	---	---
14880.000	---	---	20.70	---	---	74.00	54.00	---	---	---
17360.000	---	---	24.80	---	---	74.00	54.00	---	---	---
19840.000	---	---	14.70	---	---	74.00	54.00	---	---	---
22320.000	---	---	14.64	---	---	74.00	54.00	---	---	---
24800.000	---	---	16.20	---	---	74.00	54.00	---	---	---

Note :

1. *Item of margin shown in above table refer to average limit.*
2. *It is considered that the results of average comply with average limit when measuring data with a peak function detector meet the average limit. Mark "***" means that Peak result is meet average limit.*
3. *Remark "---" means that the emissions level is too low to be measured.*
4. *Item "Margin" referred to Average limit while there is only peak result.*
5. *The expanded uncertainty of the radiated emission tests is 3.53 dB.*

5.8 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor, High Pass Filter Loss(if used) and Cable Loss, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation calculation is as follows:

Result = Reading + Corrected Factor

where Corrected Factor = Antenna FACTOR + Cable Loss + High Pass Filter Loss - Amplifier Gain

6 ANTENNA REQUIREMENT

6.1 Standard Applicable

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to §15.247 (b), if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.2 Antenna Construction and Directional Gain

This device uses PCB antenna. Please see photo of EUT (**Page 54**).
The max antenna gain is **2.5** dBi.

7 HOPPING CHANNEL BANDWIDTH MEASUREMENT

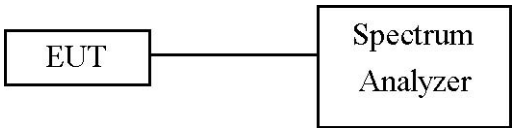
7.1 Standard Applicable

According to 15.247(a)(1), frequency hopping system shall have , hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

7.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 5 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

Figure 4: Emission bandwidth measurement configuration.



7.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Next Calibration
Spectrum Analyzer	Rohde & Schwarz	FSP -30	March/10/2004

7.4 Measurement Data

Test Date: Aug. 18, 2003 Temperature: 23 ℃ Humidity: 61 %

A. Channel 00: 20 dB Emission Bandwidth is 552 kHz
B. Channel 40: 20 dB Emission Bandwidth is 555 kHz
C. Channel 78: 20 dB Emission Bandwidth is 555 kHz

Note : 1. Please see appendix 2 for Plotted Data

2. The expanded uncertainty of the emission bandwidth tests is 1500Hz.

8 MAXIMUM OUTPUT POWER MEASUREMENT

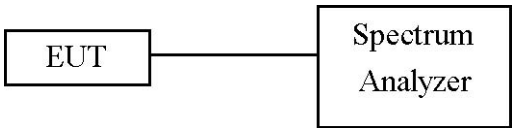
8.1 Standard Applicable

According to15.247(b)(1)For frequency hopping systems operating in the 2400-2483.5MHz band employing at least 75 hopping channels and all frequency hopping systems in the 5725MHz-5850MHz band: 1 Watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 5 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 3 MHz and VBW to 3 MHz.
4. Measure the highest amplitude appearing on spectral display and record the level to calculate result data.
5. Repeat above procedures until all frequencies measured were complete.

Figure 5: Output power and measurement configuration.



8.2 Measurement Equipment

Equipment	Manufacturer	Model No.	Next Calibration
Spectrum Analyzer	Rohde & Schwarz	FSP -30	March/10/2004

.

8.3 Measurement Data

Test Date: Aug. 18, 2003 Temperature: 23 ℃ Humidity: 61 %

A. Channel 00: Output Peak Power is –0.43 dBm or 0.929mW
B. Channel 40: Output Peak Power is –0.03 dBm or 0.993mW
C. Channel 78: Output Peak Power is –0.32 dBm or 0.478mW

Note : 1. The expanded uncertainty of the output power tests is 2dB.

9 100 kHz BANDWIDTH OF BAND EDGES MEASUREMENT

9.1 Standard Applicable

According to 15.247(c), if any 100 kHz bandwidth outside these frequency bands, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in § 15.209(a), whichever results in the lesser attenuation.

9.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 5 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

9.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Next Calibration
Spectrum Analyzer	Rohde & Schwarz	FSP -30	March/10/2004

9.4 Measurement Data

Test Date: Aug. 18, 2003 Temperature: 23 ℃ Humidity: 61 %

A. Lower Band Edge: maximum value is –44.23 dBm that is attenuated more than 20 dB
B. Upper Band Edge: maximum value is –46.28 dBm that is attenuated more than 20 dB

Note : 1. Please see appendix 3 for Plotted Data

2. The expanded uncertainty of the 100 khz bandwidth of band edges tests is 2dB.

10 HOPPING CHANNEL SEPARATION

10.1 Standard Applicable

According to 15.247(a)(1), frequency hopping system shall have, hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

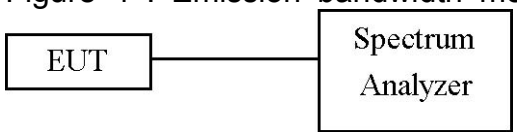
10.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument.

Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.

3. By using the MaxHold function record the separation of two adjacent channels.
4. Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

Figure 4 : Emission bandwidth measurement configuration.



10.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Next Calibration
Spectrum Analyzer	Rohde & Schwarz	FSP -30	March/10/2004

10.4 Measurement Data

Test Date: Aug. 18, 2003 Temperature: 23 ℃ Humidity: 61 %

A. Channel 00: Adjacent Hopping Channel Separation is 996.0kHz
B. Channel 40: Adjacent Hopping Channel Separation is 996.0kHz
C. Channel 78: Adjacent Hopping Channel Separation is 1000.0kHz

Note : 1. Please see appendix 4 for Plotted Data

2. The expanded uncertainty of the hopping channel separation tests is 2dB.

11 NUMBER OF HOPPING FREQUENCY USED

11.1 Standard Applicable

According to 15.247(b)(1), for frequency hopping system operating in the 2400-2483.5 MHz bands shall use at least 75 hopping frequencies

11.2 Measurement Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
4. Set the SA on View mode and then plot the result on SA screen.
5. Repeat above procedures until all frequencies measured were complete.

11.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Next Calibration
Spectrum Analyzer	Rohde & Schwarz	FSP -30	March/10/2004

11.4 Measurement Data

Test Date: Aug. 18, 2003 Temperature: 23 ℃ Humidity: 61 %

There are **79 hopping** frequencies in a hopping sequence.

Note : 1. Please see appendix 5 for Plotted Data
2. The expanded uncertainty of umber of hopping frequency used tests is 2dB.

12 DWELL TIME ON EACH CHANNEL

12.1 Standard Applicable

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any frequency shall not be greater than 0.4 second within a period of 0.4 seconds multiplied by the number of hopping channels employed .

12.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
5. Repeat above procedures until all frequencies measured were complete.

12.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Next Calibration
Spectrum Analyzer	Rohde & Schwarz	FSP -30	March/10/2004

12.4 Bluetooth operation modes

A. DH1 Mode
B. DH5 Mode

12.5 Measurement Data

Test Date: Aug. 18, 2003 Temperature: 23 ℃ Humidity: 61 %

The operation mode during testing is connection state ACL Link.

Test Mode: DH1
The period is 0.4 * 79(channels) = 31.6 sec
31.6 * 10 (hoping/sec)= 316 (please see page 48)
per one period of ON Time is 0.42 msec (please see page 48)
Test Result: DH1

Channel 00:	the dwell time is 0.42ms× 316＝132.72ms
Channel 40:	the dwell time is 0.42ms× 316＝132.72 ms
Channel 78:	the dwell time is 0.42ms× 316＝132.72ms

Test Mode: DH5
The period is 0.4(Sec) * 79(channels) = 31.6 sec
31.6 * 4 (hoping/sec)= 125.6 (hops)
per one period of ON Time is 2.1 msec
Test Result: DH5

Channel 00:	the dwell time is 2.1 ms× 125.6＝263.76 ms
Channel 40:	the dwell time is 2.1 ms× 125.6＝263.76 ms
Channel 78:	the dwell time is 2.1 ms× 125.6＝263.76 ms

The maximum time of occupancy for a particular channel are 132.72msec (DH1) and 263.76 msec (DH5) that is less than the 400 msec allowed by the rules; therefore, it meets the requirements of this section.

Note : 1. Please see appendix 6 for Plotted Data
2. The expanded uncertainty of dwell time on each channel tests is 2dB.

13 HOPPING SEQUENCE TEST

79 hopping sequence in data mode:

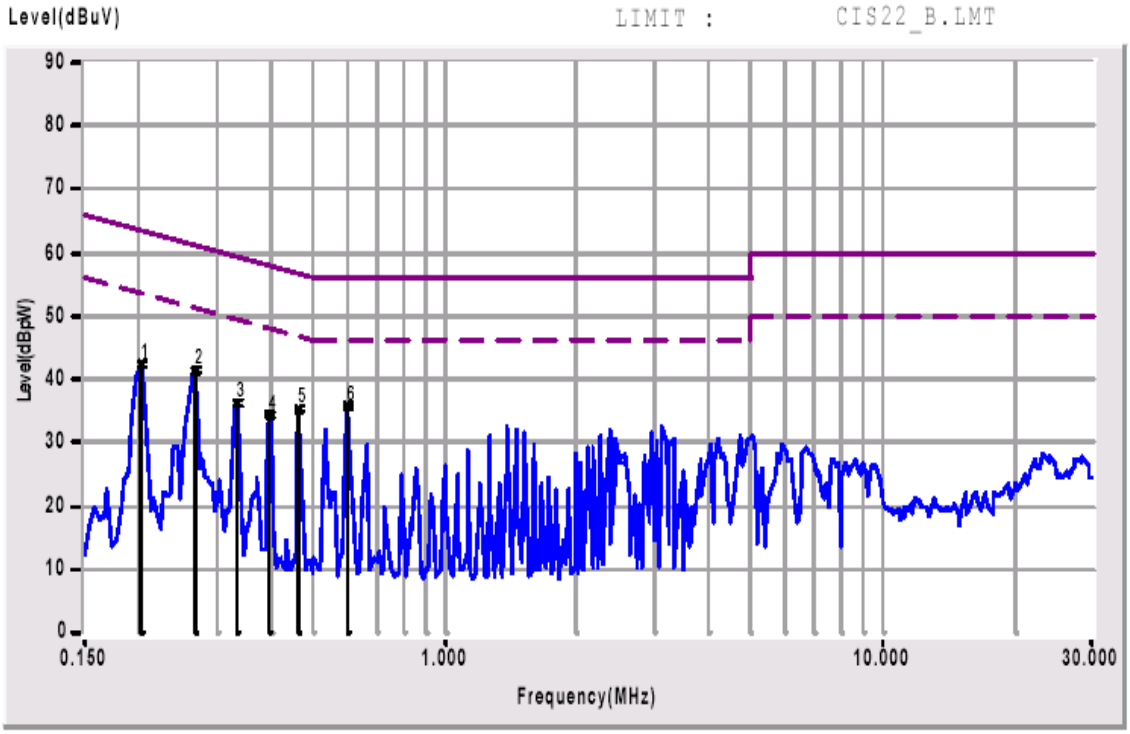
40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67, 56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59, 72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75, 09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06, 01, 51, 03, 55, 05, 04

14 Receiver input bandwidth

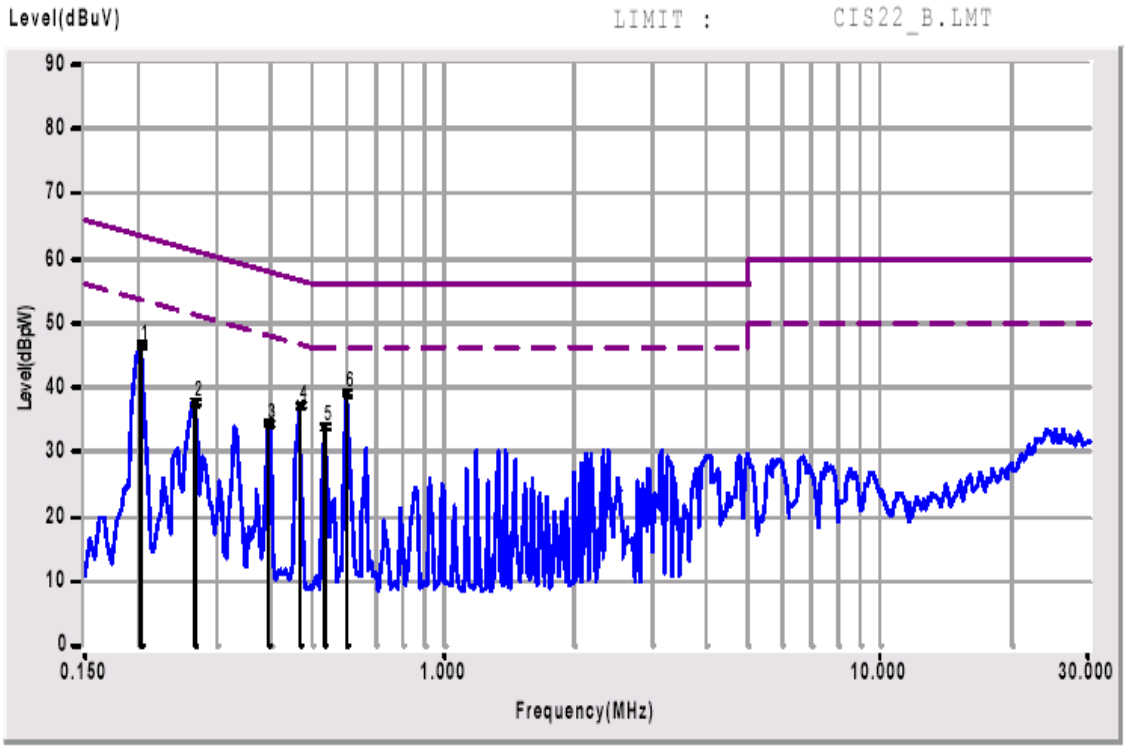
The receiver input bandwidth is in the data mode: **1MHz**

Appendix 1: Power Line Conducted Emission Measurement

A1.1 Mode 1: Charge Mode

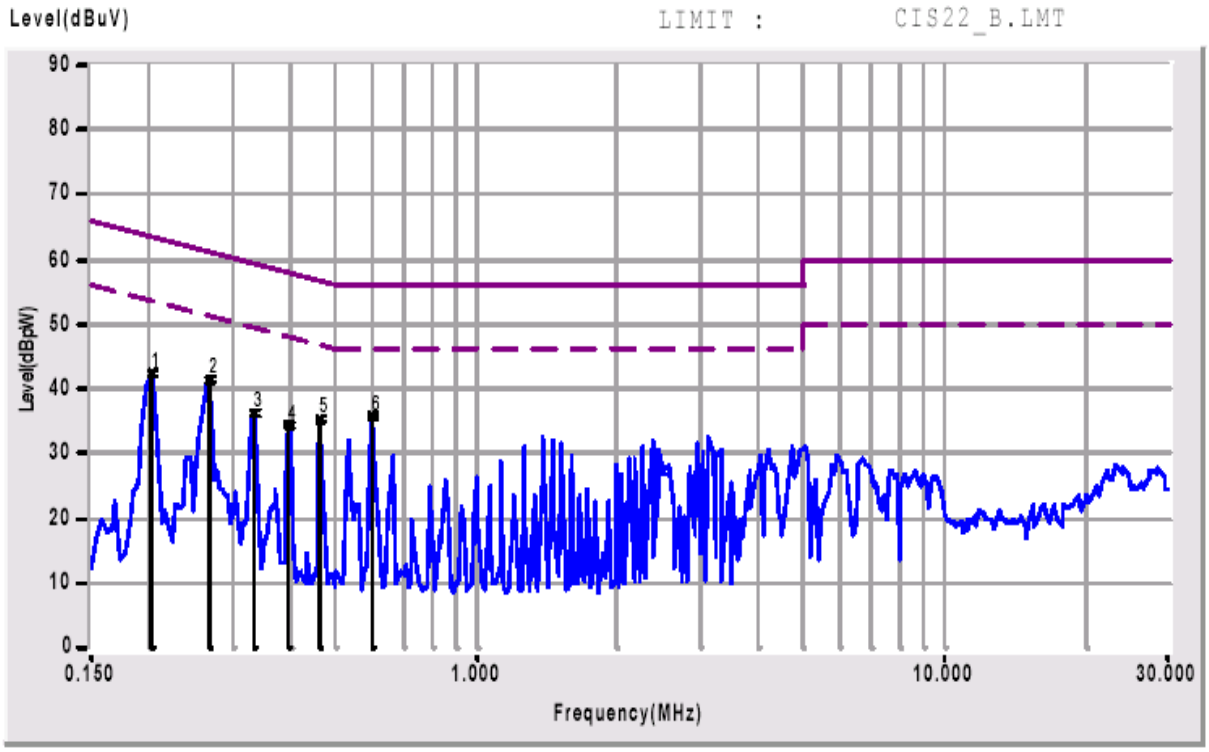


Line



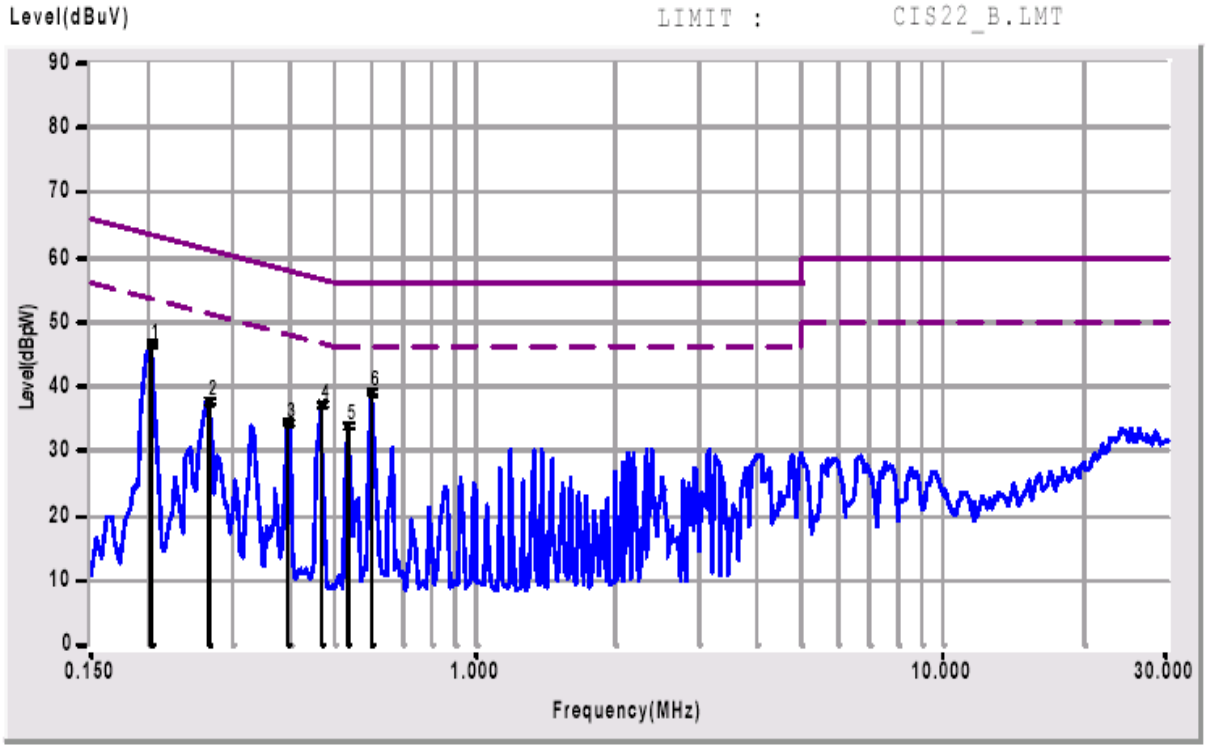
Neutral

A1.2 Mode 2: TX/RX Mode



COMMENT: TX/RX

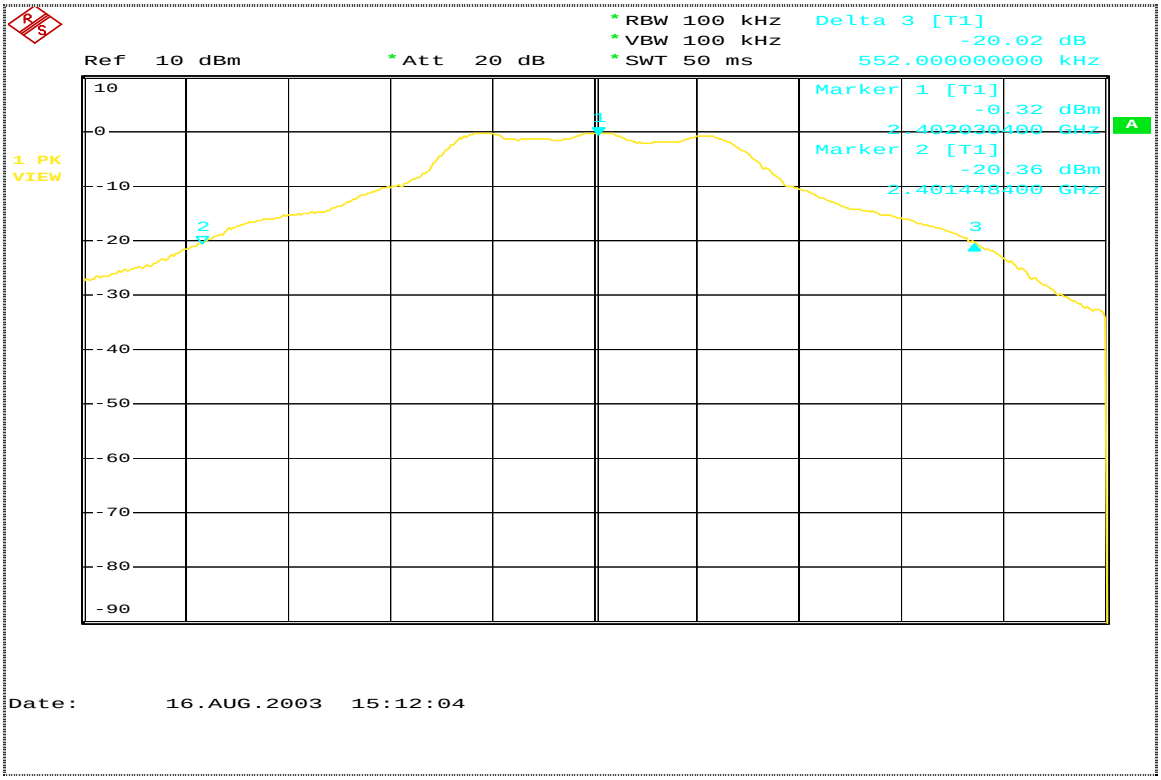
Line



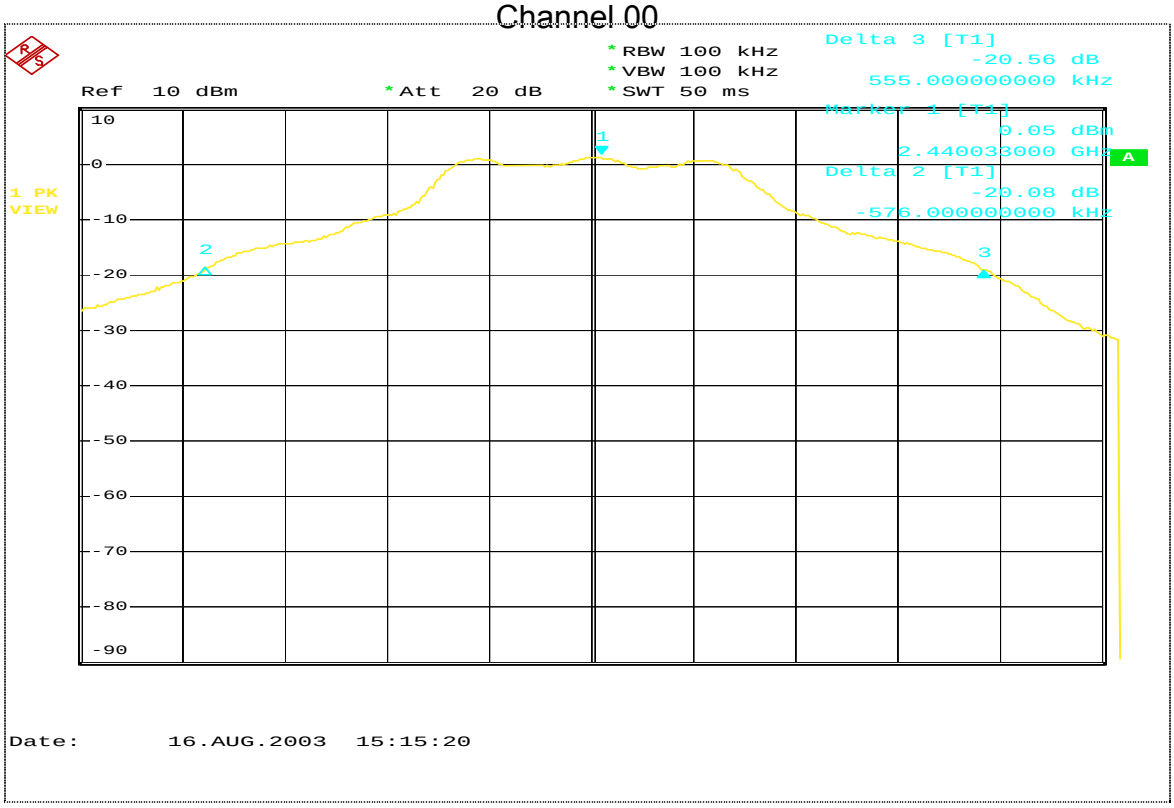
COMMENT: TX/RX

Neutral

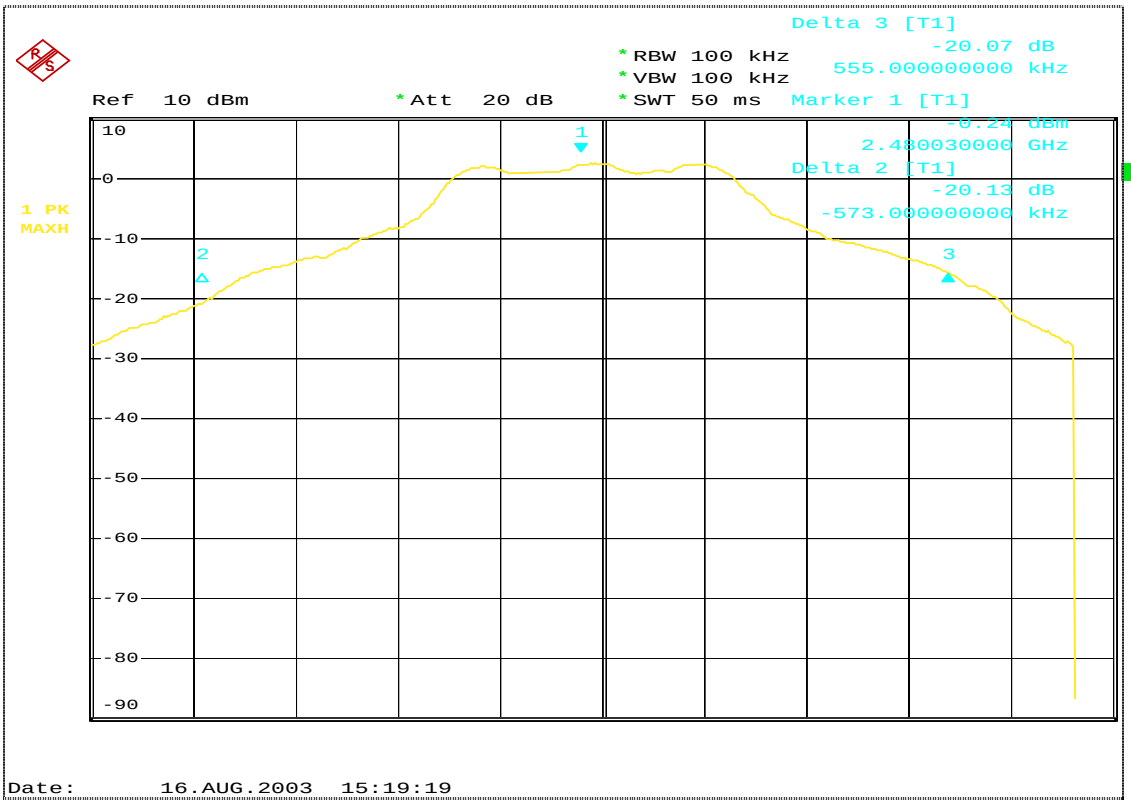
Appendix 2: Ploted Datas of HOPPING CHANNEL BANDWIDTH



Channel 00

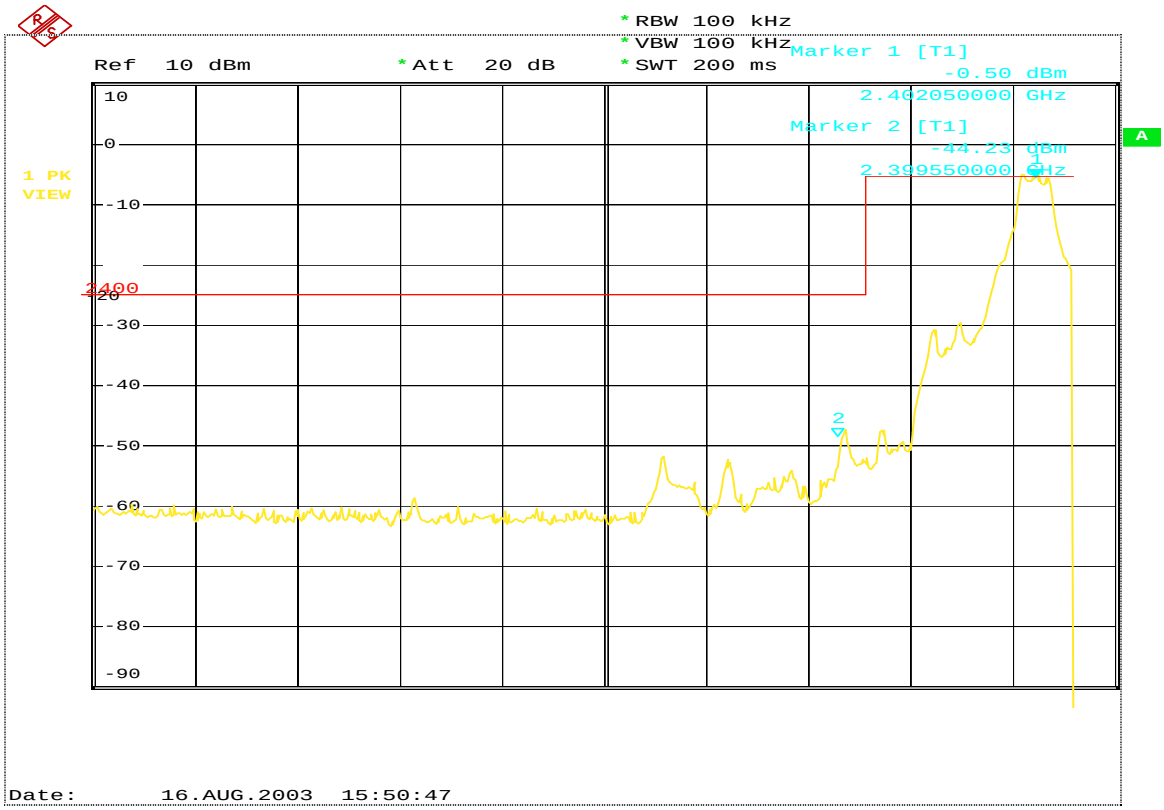


Channel 40

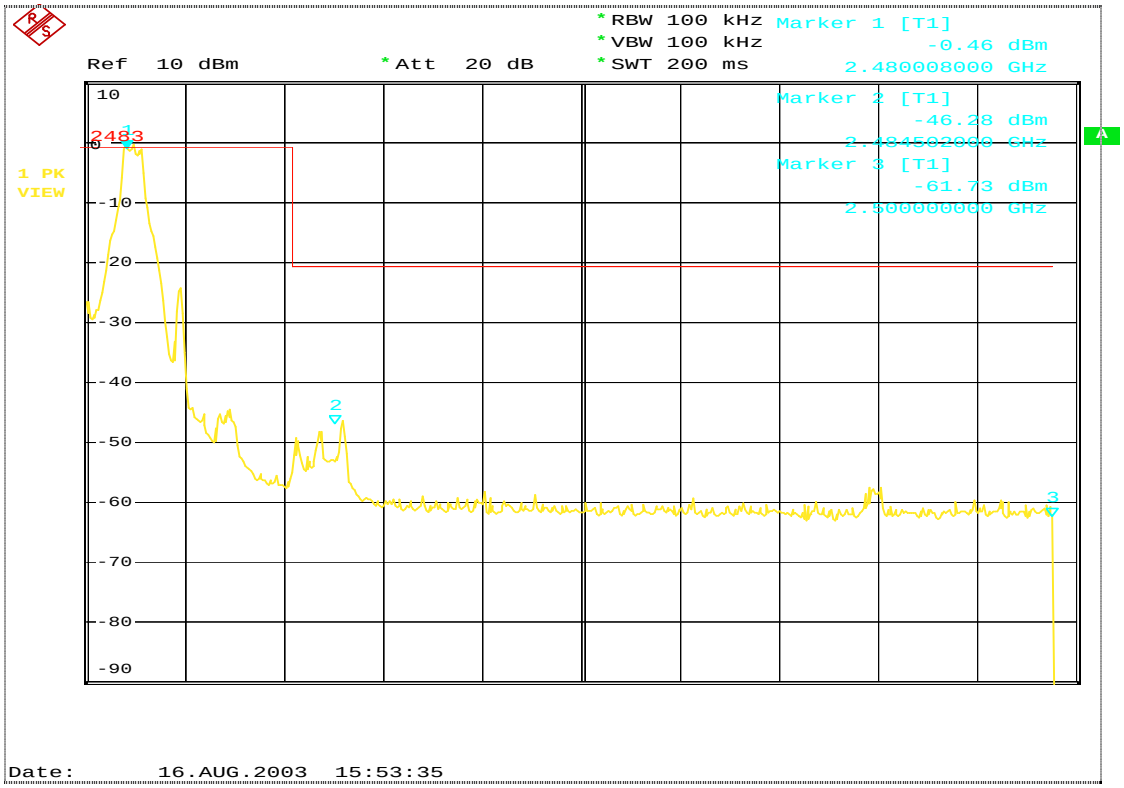

Delta 3 [T1]
-20.07 dB
555.000000000 kHz
*RBW 100 kHz
*VBW 100 kHz
Ref 10 dBm
*Att 20 dB
*SWT 50 ms
Marker 1 [T1]
-0.24 dBm
2.480030000 GHz
Delta 2 [T1]
-20.13 dB
-573.000000000 kHz
1 PK
MAXH
A
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Date: 16.AUG.2003 15:19:19

Channel 78

Appendix 3: 100 kHz BANDWIDTH OF BAND EDGES MEASUREMENT

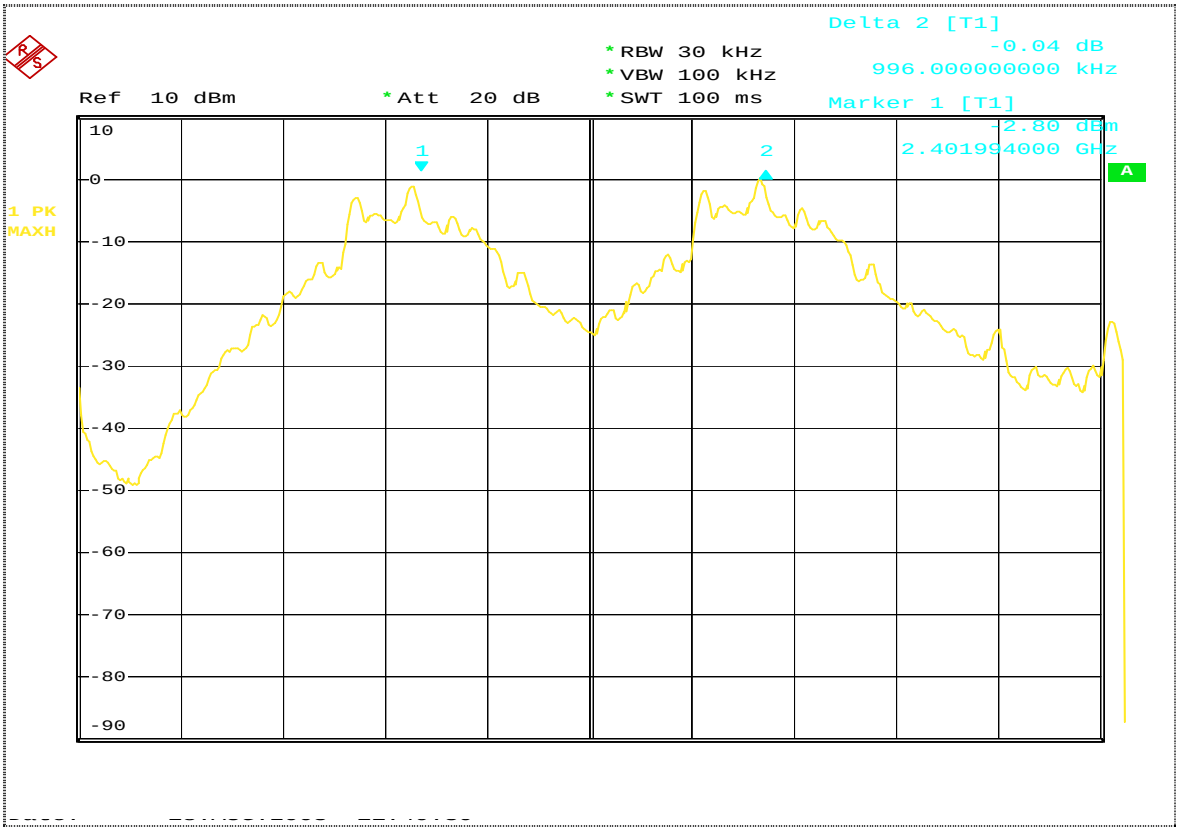


Channel 00

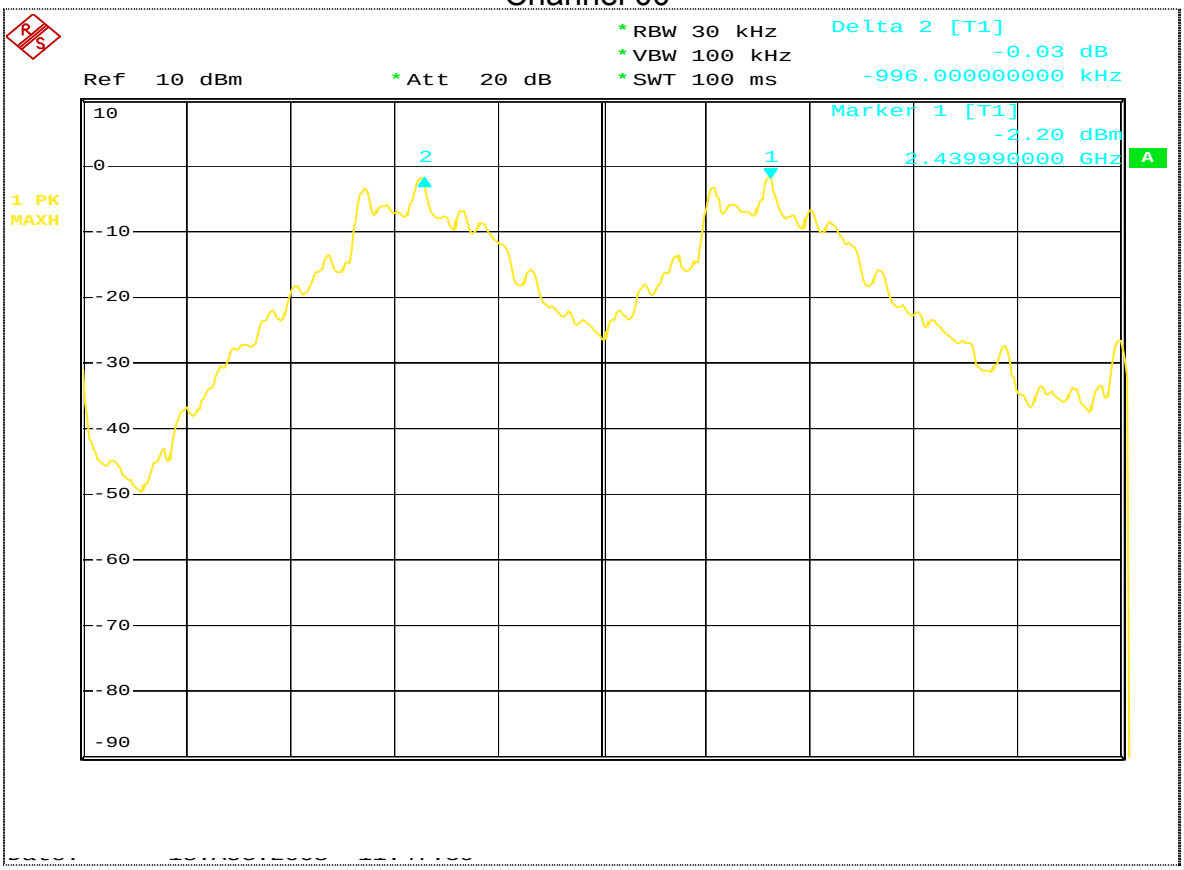


Channel 78

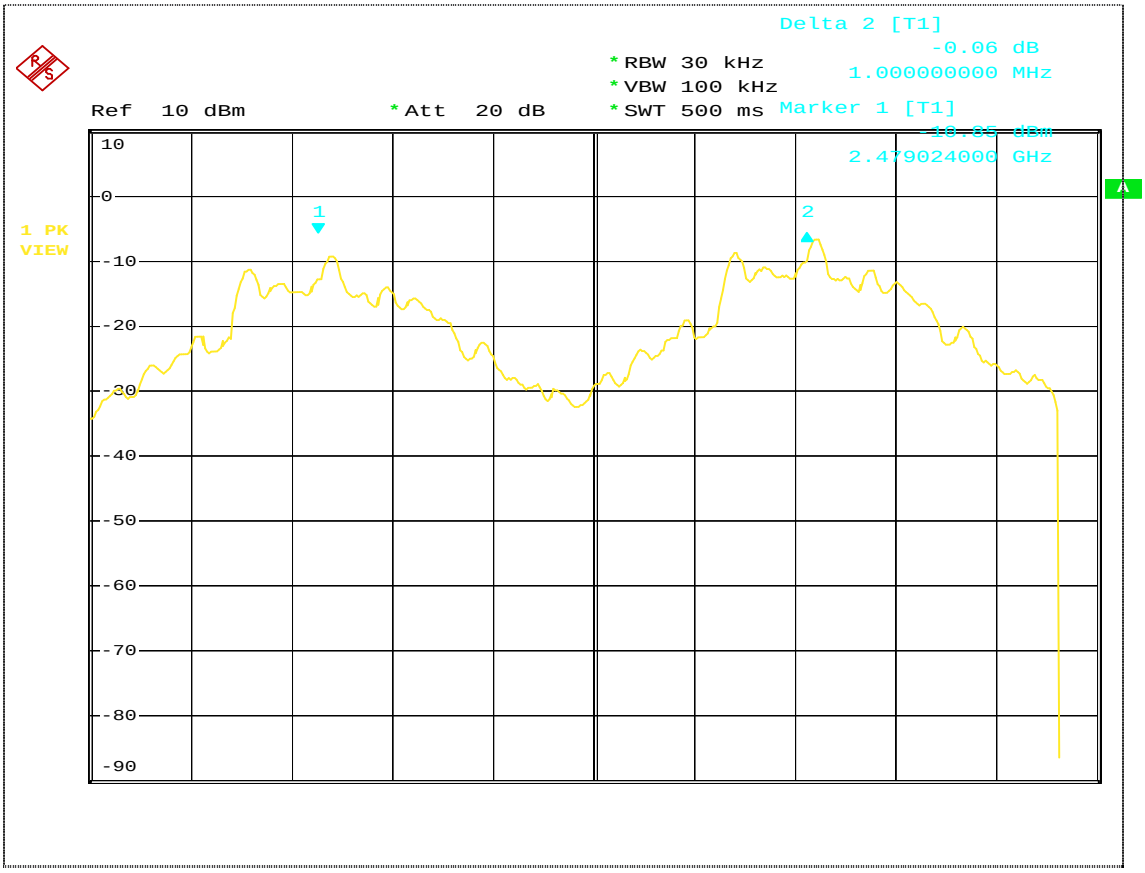
Appendix 4: HOPPING CHANNEL SEPARATION



Channel 00

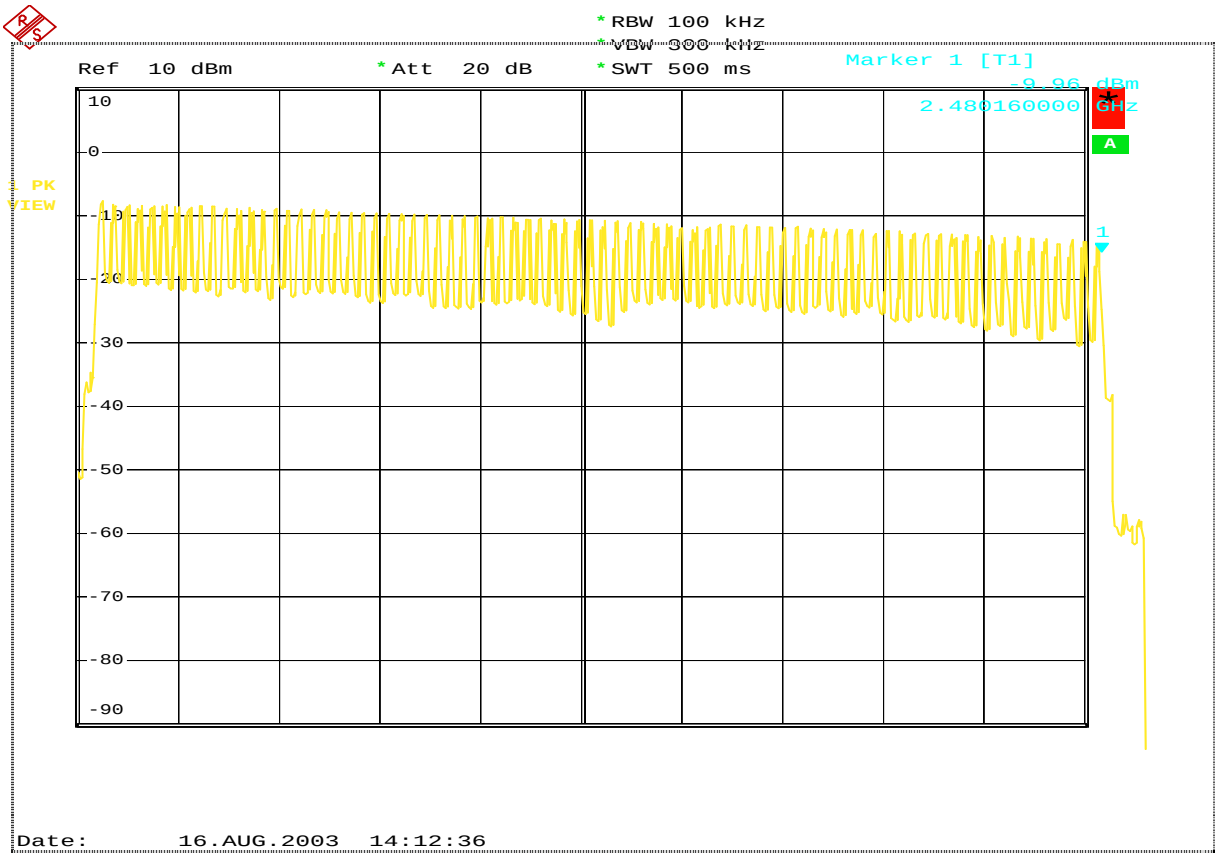


Channel 40

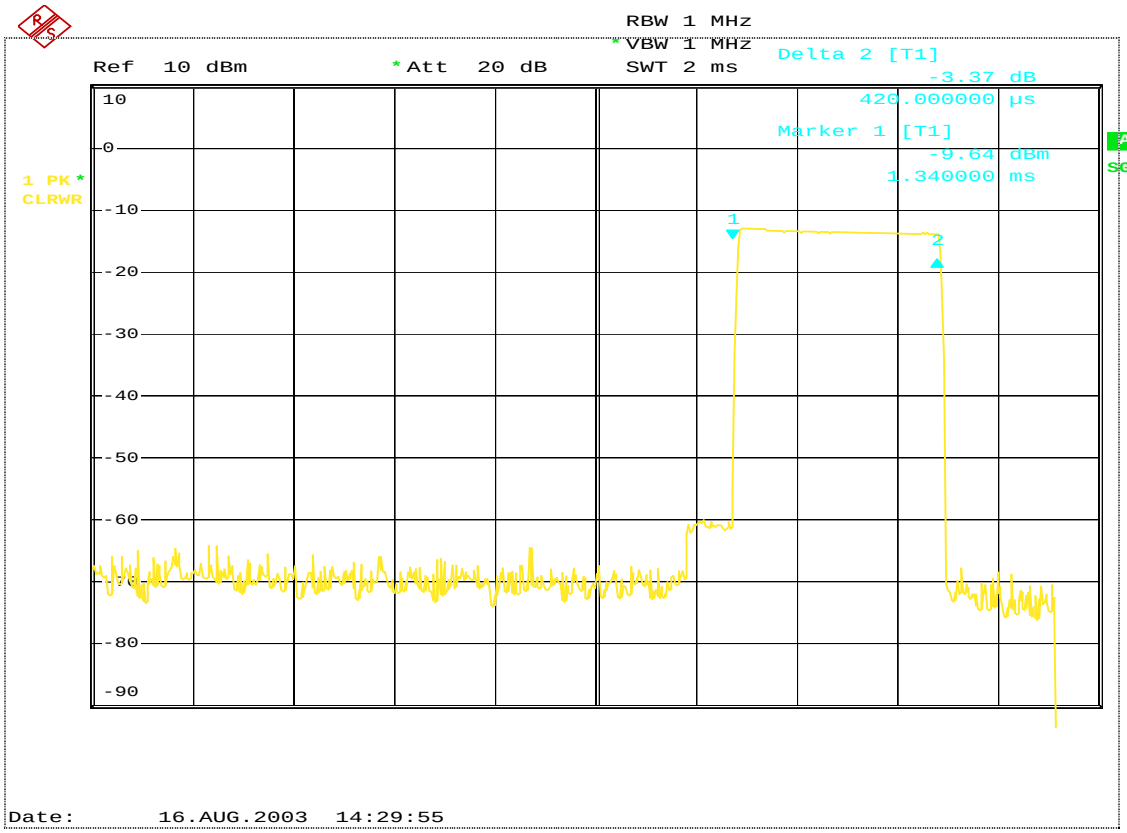

Delta 2 [T1]
-0.06 dB
1.000000000 MHz
RBW 30 kHz
VBW 100 kHz
SWT 500 ms
Marker 1 [T1]
-18.05 dBm
2.479024000 GHz
Ref 10 dBm
Att 20 dB
1 PK
VIEW
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
2
A

Channel 78

Appendix 5: NUMBER OF HOPPING FREQUENCY USED



Appendix 6: DWELL TIME ON EACH CHANNEL



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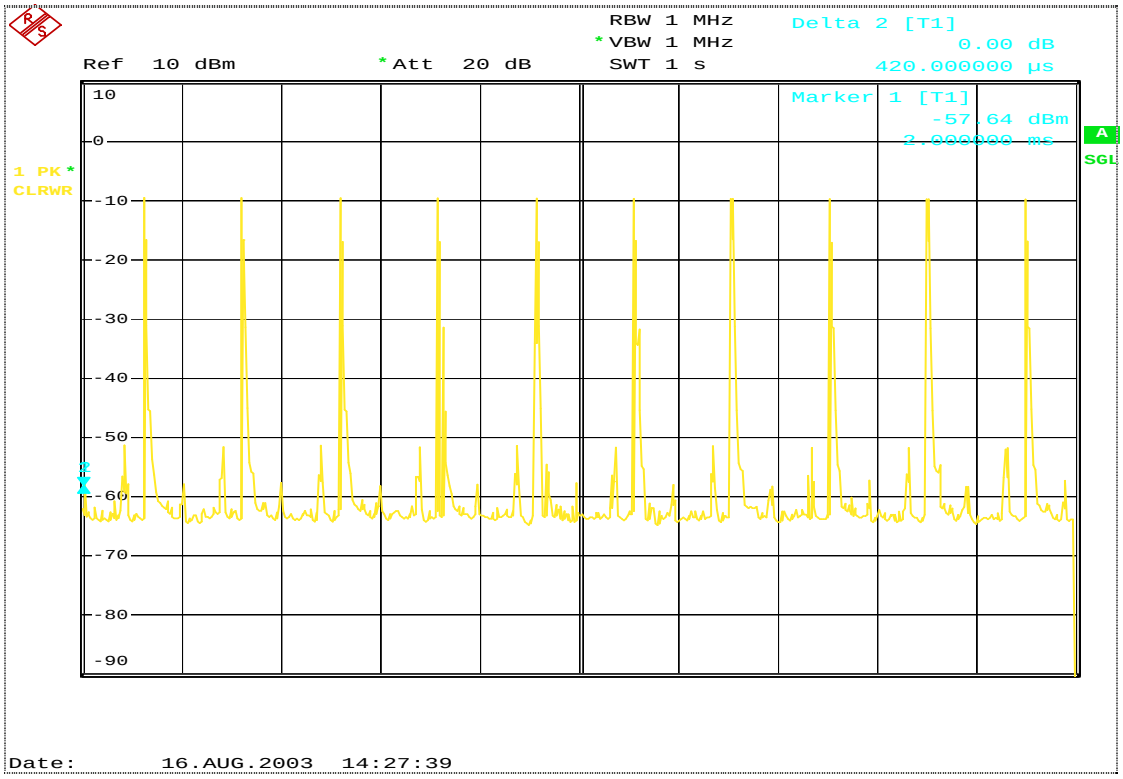


Channel 00 / 40 / 78

15 Photographs of Measurement

15.1 Power Line Conducted Emission Measurement

Front View

Rear View

15.2 Radiated Emission Measurement

Front View

Rear View

16 Photographs of EUT

Front View of Appearance (PBTAG02C2-1)

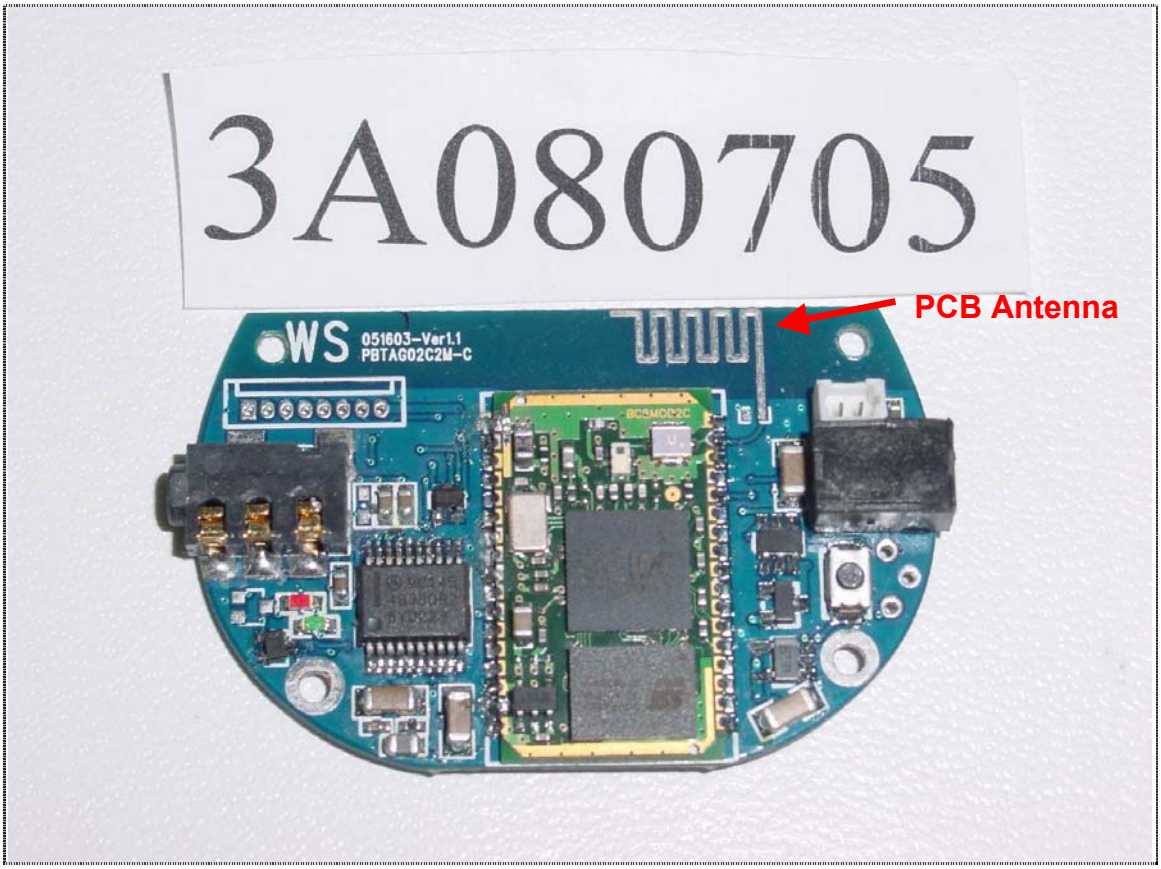
Rear View of Appearance (PBTAG02C2-1)

I/O Port of EUT (PBTAG02C2-1)

I/O Port of EUT (PBTAG02C2-1)

Front View of EUT (PBTAG02C2-2)

Inside View of EUT



Component Side View of Main Board

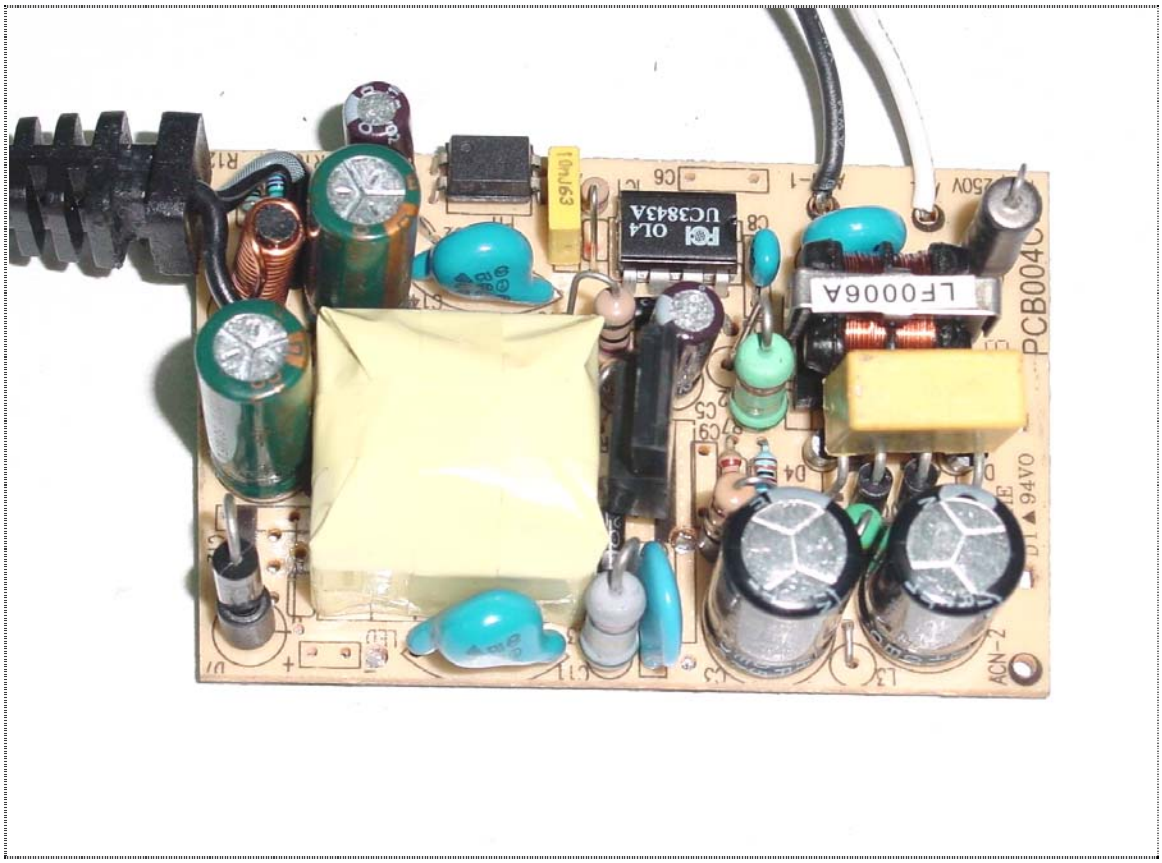
Solder Side View of Main Board

Front View of Power Adapter

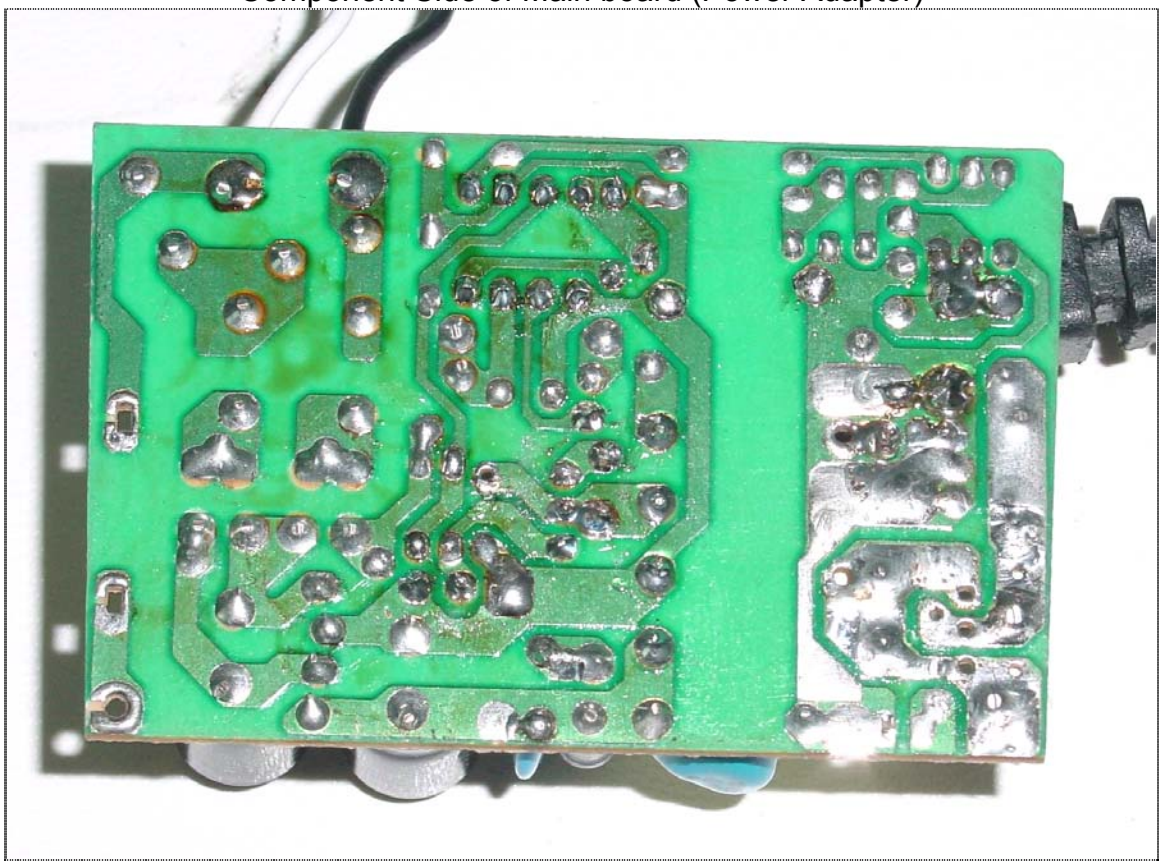
Rear View of Power Adapter

Label of Power Adapter

Inside View of Power Adapter



Component Side of Main board (Power Adapter)



Solder Side of Main board (Power Adapter)