TEST REPORT

Your Ref:

Date: 14 Mar 2006

Our Ref: 55S052712/01

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
FCC Parts 15B, C & E : 2006
OF A
VEHICLE MOUNTED MOBILE COMPUTER
[Model : VC5090]
[FCC ID : H9PVC5090]

TEST FACILITY	Telecoms & EMC, Testing Group, PSB Corporation Pte Ltd 1 Science Park Drive, Singapore 118221
FCC REG. NO.	90937 (3m & 10m OATS) 99142 (10m Anechoic Chamber) 871638 (5m Anechoic Chamber) 325572 (10m Anechoic Chamber)
IND. CANADA REG. NO.	IC 4257 (10m Anechoic Chamber)
PREPARED FOR	Mr. Andrew Ho Symbol Technologies, Inc. One Symbol Plaza Holtsville. N.Y. 11742-1300 Tel : +65-6796-9635 Fax : +65-6796-7198
JOB NUMBER	55S052712
TEST PERIOD	26 Nov 2005 – 14 Mar 2006

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LA-2001-0212-A
LA-2001-0213-F
LA-2001-0214-E
LA-2001-0215-B
LA-2001-0216-G
LA-2001-0217-G

The results reported herein have been performed in accordance with the laboratory's terms of accreditation under the Singapore Accreditation Council - Singapore Laboratory Accreditation Scheme. Tests marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our laboratory.

The product was tested in accordance with the customer's specifications.

Test Results Summary (Bluetooth)

Test Standard	Description	Pass / Fail
FCC Part 15: 2006		
15.107(a), 15.207	Conducted Emissions	Pass
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.247(a)(1)	Carrier Frequency Separation	Pass
	Spectrum Bandwidth (20dB Bandwidth Measurement)	Pass
15.247(a)(1)(iii)	Number of Hopping Frequencies	Pass
	Average Frequency Dwell Time	Pass
15.247(b)(1)	Maximum Peak Power	Pass
15.247(d)	RF Conducted Spurious Emissions	Pass
15.247(d)	Band Edge Compliance	Pass
15.247(e)	Peak Power Spectral Density	Pass
1.1310	Maximum Permissible Exposure	Pass
15.35(c)	Duty Cycle Factor Computation	Refer to page 125 for details

Notes

1. Three channels as listed below, which respectively represent the lower, middle and upper channels of the Equipment Under Test (EUT) were chosen and tested. For each channel, the EUT was configured to operate in the test mode.

	Transmit Channel	Frequency (GHz)
Bluetooth	0	2.402
	39	2.441
	78	2.480

2. All the measurements in section 15.247 for Bluetooth module were done based on conducted measurements.

3. The EUT is a Class B device when in non-transmitting state and meets the FCC Part15B Class B requirements.

Modifications

1. No modifications were made.

The product was tested in accordance with the customer's specifications.

Test Results Summary (WLAN 802.11b/g)

Test Standard	Description	Pass / Fail
FCC Part 15: 2006		
15.107(a), 15.207	Conducted Emissions	Pass
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.247(a)(2)	Spectrum Bandwidth (6dB Bandwidth Measurement)	Not Tested *See Note 1
15.247(b)(3)	Maximum Peak Power	Pass
15.247(d)	RF Conducted Spurious Emissions	Not Tested *See Note 1
15.247(d)	Band Edge Compliance	Pass
15.247(e)	Peak Power Spectral Density	Not Tested *See Note 1
1.1310	Maximum Permissible Exposure	Pass
15.35(c)	Duty Cycle Factor Computation	See Note 5

Notes

1. The WLAN module is a FCC certified RF module, which bears the FCC ID: H9P2121160. Only limited tests were conducted which are critical to ensure the compliance of FCC requirements once the module is integrated into the product system. Other RF parameters of the module were not tested, as these RF characteristics remain unchanged upon module integration into the product system.

2. The channels as listed below were tested for both WLAN 802.11b and WLAN 802.11g. For both configurations, the worst case data rate of 11Mbps and 6Mbps were respectively used for WLAN 802.11b and WALN 802.11g.

	Transmit Channel	Frequency (GHz)
WLAN 802.11b/g	Channel 1	2.412
	Channel 6	2.437
	Channel 11	2.462

3. The EUT was tested with external antenna configuration, which was found to be the worst case.

4. All the tests mentioned in the table above were done based on radiated method.

5. The EUT is a Class B device when in non-transmitting state and meets the FCC Part15B Class B requirements.

6. The EUT was tested in continuous transmission mode. As such, duty cycle computation is not required.

Modifications

1. No modifications were made.

Test Results Summary (WLAN 802.11a)

Test Standard	Description	Pass / Fail
FCC Part 15: 2006		
15.107(a), 15.207	Conducted Emissions	Pass
15.109(a), 15.205, 15.209, 15.407(b)	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.407(a)	26dB Bandwidth	Not Tested *See Note 1
15.407(a)	Maximum Output Power	Pass
15.407(a)	Peak Power Spectral Density	Not Tested *See Note 1
15.407(a)	Ratio of Peak Excursion	Not Tested *See Note 1
15.407(b)	Band Edge Compliance	Pass
15.407(g)	Frequency Stability	Not Tested *See Note 1
1.1310	Maximum Permissible Exposure	Pass
15.35(c)	Duty Cycle Factor Computation	See Note 5

Notes

1. The WLAN module is a FCC certified RF module, which bears the FCC ID: H9P2121160. Only limited tests were conducted which are critical to ensure the compliance of FCC requirements once the module is integrated into the product system. Other RF parameters of the module were not tested, as these RF characteristics remain unchanged upon module integration into the product system.

2. The channels as listed below were tested for WLAN 802.11a. The worst case data rate of 6Mbps was used for testing.

	Transmit Channel	Frequency (GHz)
WLAN 802.11a (Lower Band)	Channel 36 Channel 48	5.180 5.240
WLAN 802.11a (Middle Band)	Channel 52 Channel 64	2.260 5.320
WLAN 802.11a (Upper Band)	Channel 149 Channel 157 Channel 161	5.745 5.785 5.805

3. The EUT was tested with external antenna configuration, which was found to be the worst case.

4. All the tests mentioned in the table above were done based on radiated method.

5. The EUT is a Class B device when in non-transmitting state and meets the FCC Part15B Class B requirements.

6. The EUT was tested in continuous transmission mode. As such, duty cycle computation is not required.

Modifications

1. No modifications were made.

The product was tested in accordance with the customer's specifications.

Test Results Summary (WLAN 802.11a - ISM Band)

Test Standard	Description	Pass / Fail
FCC Part 15: 2006		
15.107(a), 15.207	Conducted Emissions	Pass
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.247(a)(2)	Spectrum Bandwidth (6dB Bandwidth Measurement)	Not Tested *See Note 1
15.247(b)(3)	Maximum Peak Power	Pass
15.247(d)	RF Conducted Spurious Emissions	Not Tested *See Note 1
15.247(d)	Band Edge Compliance	Pass
15.247(e)	Peak Power Spectral Density	Not Tested *See Note 1
1.1310	Maximum Permissible Exposure	Pass
15.35(c)	Duty Cycle Factor Computation	See Note 5

Notes

1. The WLAN module is a FCC certified RF module, which bears the FCC ID: H9P2121160. Only limited tests were conducted which are critical to ensure the compliance of FCC requirements once the module is integrated into the product system. Other RF parameters of the module were not tested, as these RF characteristics remain unchanged upon module integration into the product system.

2. The channel as listed below was tested for WLAN 802.11a. The worst case data rate of 6Mbps was used.

	Transmit Channel	Frequency (GHz)
WLAN 802.11a	Channel 165	5.825

3. The EUT was tested with external antenna configuration, which was found to be the worst case.

4. All the tests mentioned in the table above were done based on radiated method.

5. The EUT is a Class B device when in non-transmitting state and meets the FCC Part15B Class B requirements.

6. The EUT was tested in continuous transmission mode. As such, duty cycle computation is not required.

Modifications

1. No modifications were made.

Description	:	The Equipment Under Test (EUT) is a Vehicle Mounted Mobile Computer. The EUT is intended to use on heavy equipment, for example, forklifts. The EUT offers Bluetooth and WLAN 802.11a/b/g connectivity. The WLAN used is a FCC certified module which bears the FCC ID:H9P2121160. For Bluetooth, it a qualified Bluetooh module without FCC certified. The EUT allows the con-current transmission of Bluetoooth and WLAN. For the use of WLAN, the use of internal or external antenna is possible.
Manufacturer	:	ELTECH Electronic Technology (M) Sdn Bhd; E227745 PLO 34, Fasa II, Kawasan Perindustrian Senai, 81400 Senai, Johor, Malaysia
Model Number	:	VC5090
FCC ID	:	H9PVC5090
Serial Number	:	DVT52070200015
Microprocessor	:	Intel PXA270
Operating / Transmitting Frequency	:	Bluetooth 2.400GHz - 2.4835GHz WLAN 802.11b/g 2.400GHz - 2.4835GHz WLAN 802.11a 5.150GHz to 5.250GHz (Lower Band) 5.250GHz to 5.350GHz (Mid Band) 5.725GHz to 5.825GHz (Upper Band) WLAN 802.11a 5.725GHz to 5.850GHz (ISM Band)
Clock / Oscillator Frequency	:	624MHz (Intel PXA270) 105/133MHz SDRAM
Modulation	:	Bluetooth Gaussian Frequency Shift Keying (GFSK) WLAN 802.11b DBPSK, DQPSK and CCK WLAN 802.11a/g BPSK, QPSK, 16QAM and 64QAM
Port / Connectors	:	1 x USB keyboard port 2 x serial ports 1 x headset port 1 x external antenna 1 x external PSU port

Rated Input Power	:	9VDC, 12VDC, 24VDC, 72VDC, 110VAC 60Hz
Accessories	:	Heated keyboard with bracket assembly Scanners and cables Headsets Vehicle motion detector kit
Antennas Used	:	Bluetooth Antenna Ethertronics Integral Antenna (P/N: SD1000013) 802.11a/b/g Antenna Ethertronics Integral Antenna (WLAN1) (P/N: SD1000001) Ethertronics Integral Antenna (WLAN2) (P/N: SD1000012) 802.11a/b/g Antenna Centurion External Antenna (M/N: WTS2450-RPSMA)

Equipment Description (Including Brand Name)	**Model, Serial & FCC ID Number**	**Cable Description** (List Length, Type & Purpose)
Symbol Technologies, Inc. AC/DC Power Supply	M/N: SYM04-1 S/N: M030250973 FCC ID: DoC	1.80m unshielded DC cable 2.8m unshielded AC cable
Symbol Technologies, Inc. Infra-red (IR) Barcode Scanner	M/N: LS3408-ER20005 S/N: M1J36B99K FCC ID: DoC	1.40m standard IR signal cable
Symbol Technologies, Inc. Infra-red (IR) Barcode Scanner	M/N: LS3408-ER20005 S/N: M1J36C03F FCC ID: DoC	1.40m standard IR signal cable
Symbol Technologies, Inc. Keyboard	M/N: 70150006 S/N: Nil FCC ID: DoC	0.50m standard keyboard cable
VXI Microphone with Earpiece	M/N: VR10 S/N: Nil FCC ID: DoC	0.50m standard audio cable
Symbol Technologies, Inc. USB cable	P/N: 25-64396-01 S/N: Nil FCC ID: Nil	1.80m standard USB cable with ferrite loaded
Logitech Mouse	M/N: M-S34 S/N: LZB3916766 FCC ID: DZL211029	1.80m standard mouse cable
HP PC	M/N: U813I S/N: 003916978 FCC ID: DoC	2.30m unshielded AC cable
HP Monitor	M/N: L1506 S/N: CNC5352CNN FCC ID: DoC	2.30m unshielded AC cable
HP Mouse	M/N: M-S34 S/N: LZA64400205 FCC ID: DZL21129	1.80m standard mouse cable
HP Keyboard	M/N: SK-2502 S/N: M9712147020 FCC ID: GYUR41SK	1.80m standard keyboard cable

Unintentional Radiator - Information Technology Equipment (ITE)

FCC Part 15
1. Conducted Emissions **2. Radiated Emissions**
The EUT was exercised by operating in the following conditions thorough the test: - continuous printing of character 'H' to touch screen monitor - continuous activation of keyboard by pressing character 'H' - continuous activation of IR barcode scanners (continuos reading) - continuous activation of audio port

Bluetooth

FCC Part 15
1. Conducted Emissions **2. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)** **3. Spectrum Bandwidth (20dB Bandwidth Measurement)** **4. Maximum Peak Power** **5. RF Conducted Spurious Emissions** **6. Peak Power Spectral Density** **7. Maximum Permissible Exposure** **8. Duty Cycle Factor Computation**
The EUT was exercised by operating in maximum continuous transmission with frequency hopping off, i.e transmitting at lower, middle and upper channels respectively at one time.
FCC Part 15
1. Carrier Frequency Separation **2. Number of Hopping Frequencies** **3. Average Frequency Dwell Time** **4. Band Edge Compliance**
The EUT was exercised by operating in maximum continuous transmission with frequency hopping on.

WLAN 802.11b/g

FCC Part 15
1. Conducted Emissions **2. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)** **3. Maximum Peak Power** **4. Band Edge Compliance** **5. Maximum Permissible Exposure** **6. Duty Cycle Factor Computation**
The EUT was exercised by operating in maximum continuous transmission in test mode, i.e transmitting at lower, middle and upper channels respectively at one time.

WLAN 802.11a

FCC Part 15
1. Conducted Emissions **2. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)** **3. Maximum Output Power** **4. Band Edges of Operating Frequency** **5. Maximum Permissible Exposure** **6. Duty Cycle Factor Computation**
The EUT was exercised by operating in maximum continuous transmission in test mode, i.e transmitting at the following channel at one time: Lower Band Lower channel Upper channel Middle Band Lower channel Upper channel Upper Band Lower channel Middle Channel Upper Channel

WLAN 802.11a (ISM Band)

FCC Part 15
1. Conducted Emissions **2. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)** **3. Maximum Peak Power** **4. Band Edge Compliance** **5. Maximum Permissible Exposure**
The EUT was exercised by operating in maximum continuous transmission in test mode, i.e transmitting at channel 165MHz (5.825GHz).

PART 1

This part (Part 1) details the following test results on ITE:

1. **Conducted Emission Test**
2. **Radiated Emission Test**

FCC Parts 15.107(a) Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (QP)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

FCC Parts 15.107(a) Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz–26.5GHz) – ESMI2	ESMI	829214/006 829550/001	22 Apr 2006
EMCO LISN (for EUT) – LISN9	3825/2	9309-2128	24 Jan 2006
EMCO LISN (for supporting) – LISN6	3825/2	9309-2127	03 May 2006
R&S Pulse Limiter – PL2	ESH3-Z2	100347	15 Apr 2006

FCC Parts 15.107(a) Conducted Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50µH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

FCC Parts 15.107(a) Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10kHz. Both Quasi-peak and Average measurements were made.
5. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz Q-P limit (Class B) = 1000 µV = 60.0 dBµV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBµV
(Calibrated for system losses)

Therefore, Q-P margin = 40.0 - 60.0 = -20.0 i.e. **20.0 dB below Q-P limit**

Conducted Emissions Test Setup (Front View)

Conducted Emissions Test Setup (Rear View)

FCC Parts 15.107(a) Conducted Emission Results

Operating Mode	ITE	Temperature	22°C
Test Input Power	110V 60Hz	Relative Humidity	58%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Tan Swee Seng

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line
0.1590	54.7	-10.8	50.0	-5.5	Neutral
0.2213	42.1	-20.7	36.5	-16.3	Neutral
0.4754	29.6	-26.8	28.9	-17.5	Live
18.9575	36.1	-23.9	31.3	-18.7	Neutral
19.0865	37.4	-22.6	32.8	-17.2	Live
19.3053	37.4	-22.6	33.0	-17.0	Live

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
4. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 9kHz – 30MHz (Average & Quasi-peak) is ±2.4dB.

FCC Parts 15.109(a) Radiated Emission Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m) @ 3m
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
Above 960	54.0*
* Above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

FCC Parts 15.109(a) Radiated Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
HP Preamplifier (100kHz-1.3GHz) – PA2	8447D	2944A08173	01 Apr 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
Schaffner Bilog Antenna – BL9	CBL6143	5045	13 May 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006
EMCO Horn Antenna – H14	3115	0003-6087	19 May 2006
HP Spectrum Analyser (30Hz-40GHz)	8564E	3846A01433	27 Apr 2006
Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Aug 2006

FCC Parts 15.109(a) Radiated Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

FCC Parts 15.109(a) Radiated Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which attitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from 30MHz to 5th harmonics of the EUT fundamental frequency or 40GHz whichever is lower, using the Bi-log antenna for frequencies from 30MHz up to 3GHz, and the Horn antenna above 3GHz.

Sample Calculation Example

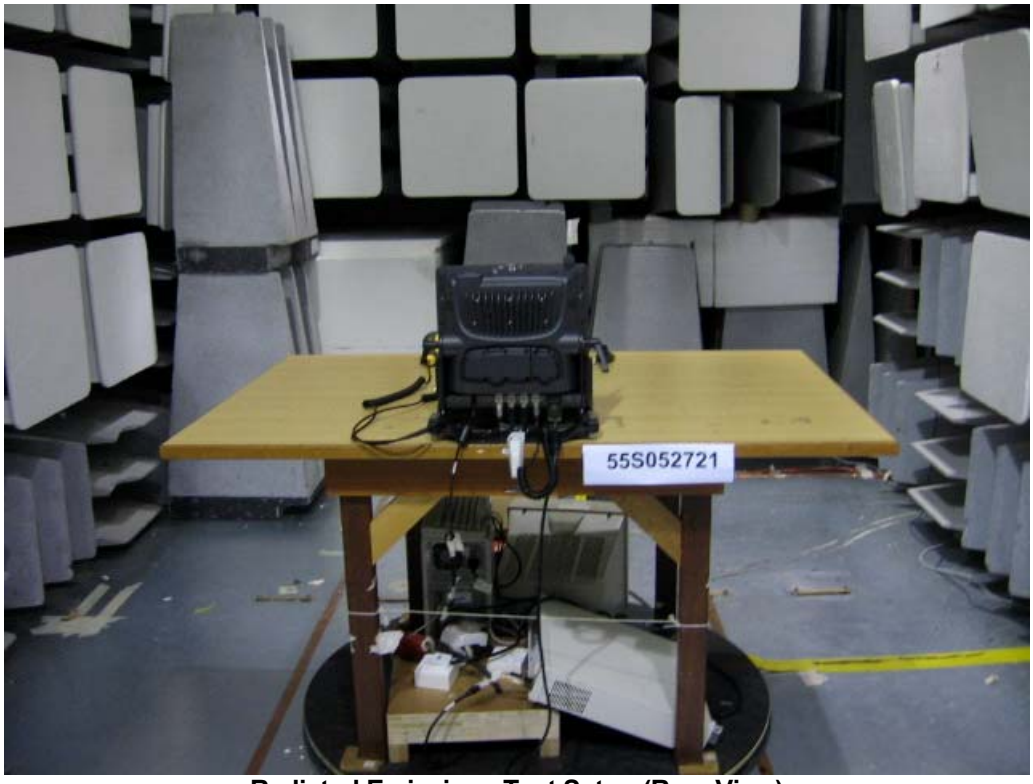
At 300 MHz Q-P limit (Class B) = 200 μV/m = 46.0 dBμV/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 40.0 - 46.0 = -6.0 i.e. **6 dB below Q-P limit**

Radiated Emissions Test Setup (Front View)



Radiated Emissions Test Setup (Rear View)

FCC Parts 15.109(a) Radiated Emission Results

Operating Mode	ITE	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)
233.7213	36.2	-9.8	134	130	H
351.2331	33.4	-12.6	86	100	V
407.3302	37.9	-8.1	102	100	V
521.7911	37.4	-8.6	151	124	V
733.2564	38.3	-7.7	101	100	V
998.0610	39.7	-14.3	113	121	H

Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m) Note 2	Average Margin (dB) Note 3	Azimuth (Degrees)	Height (cm)	Pol (H/V)
1.5003	42.1	--	-11.9	48	1.0	H
--	--	--	--	--	--	--
--	--	--	--	--	--	--
--	--	--	--	--	--	--
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--	--	--	--	--	--	--

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. As the measured peak shows compliance to the average limit, as such no average measurement was required.
3. The average margin indicates the margin of the measured peak value below the average limit.
4. "--" indicates no emissions were found and shows compliance to the limits.
5. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz.
6. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
7. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz

8. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
9. Radiated Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 40GHz (QP only @ 3m & 10m) is ±4.3dB (for EUTs < 0.5m X 0.5m X 0.5m).

PART 2

This part (Part 2) details the following test results on Bluetooth:

1. **Conducted Emission Test**
2. **Radiated Emission Test**
3. **Carrier Frequency Separation Test**
4. **Spectrum Bandwidth (20dB Bandwidth Measurement) Test**
5. **Number of Hopping Frequencies Test**
6. **Average Frequency Dwell Time Test**
7. **Maximum Peak Power Test**
8. **RF Conducted Spurious Emissions Test**
9. **Band Edge Compliance Test**
10. **Peak Power Spectral Density Test**

FCC Parts 15.107(a) and 15.207 Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (QP)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz–26.5GHz) – ESMI2	ESMI	829214/006 829550/001	22 Apr 2006
EMCO LISN (for EUT) – LISN9	3825/2	9309-2128	24 Jan 2006
EMCO LISN (for supporting) – LISN6	3825/2	9309-2127	03 May 2006
R&S Pulse Limiter – PL2	ESH3-Z2	100347	15 Apr 2006

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50µH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10kHz. Both Quasi-peak and Average measurements were made.
6. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz Q-P limit (Class B) = 1000 µV = 60.0 dBµV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBµV
(Calibrated for system losses)

Therefore, Q-P margin = 40.0 - 60.0 = -20.0 i.e. **20.0 dB below Q-P limit**

Conducted Emissions Test Setup (Front View)

Conducted Emissions Test Setup (Rear View)

FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Operating Mode	Bluetooth	Temperature	22°C
Test Input Power	110V 60Hz	Relative Humidity	58%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Tan Swee Seng

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.1575	53.8	-11.8	50.0	-5.6	Neutral	0
0.2223	42.0	-20.7	36.4	-16.3	Neutral	0
0.7281	30.2	-25.8	29.6	-16.4	Live	0
19.2338	36.6	-23.4	32.2	-17.9	Neutral	0
19.4639	34.9	-25.1	30.5	-19.5	Neutral	0
19.6323	34.3	-25.7	29.6	-20.4	Live	0

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
4. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 9kHz – 30MHz (Average & Quasi-peak) is ±2.4dB.

FCC Part 15.205 Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
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	2690	-	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	3600	-	4400	Above 38.6		
13.36	-	13.41									

FCC Parts 15.109(a) and 15.209 Radiated Emission Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m) @ 3m
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
Above 960	54.0*
* Above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
HP Preamplifier (100kHz-1.3GHz) – PA2	8447D	2944A08173	01 Apr 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
Schaffner Bilog Antenna – BL9	CBL6143	5045	13 May 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006
EMCO Horn Antenna – H14	3115	0003-6087	19 May 2006
HP Spectrum Analyser (30Hz-40GHz)	8564E	3846A01433	27 Apr 2006
Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Aug 2006

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which attitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from 30MHz to 10th harmonics of the EUT fundamental frequency or 40GHz whichever is lower, using the Bi-log antenna for frequencies from 30MHz up to 3GHz, and the Horn antenna above 3GHz.

Sample Calculation Example

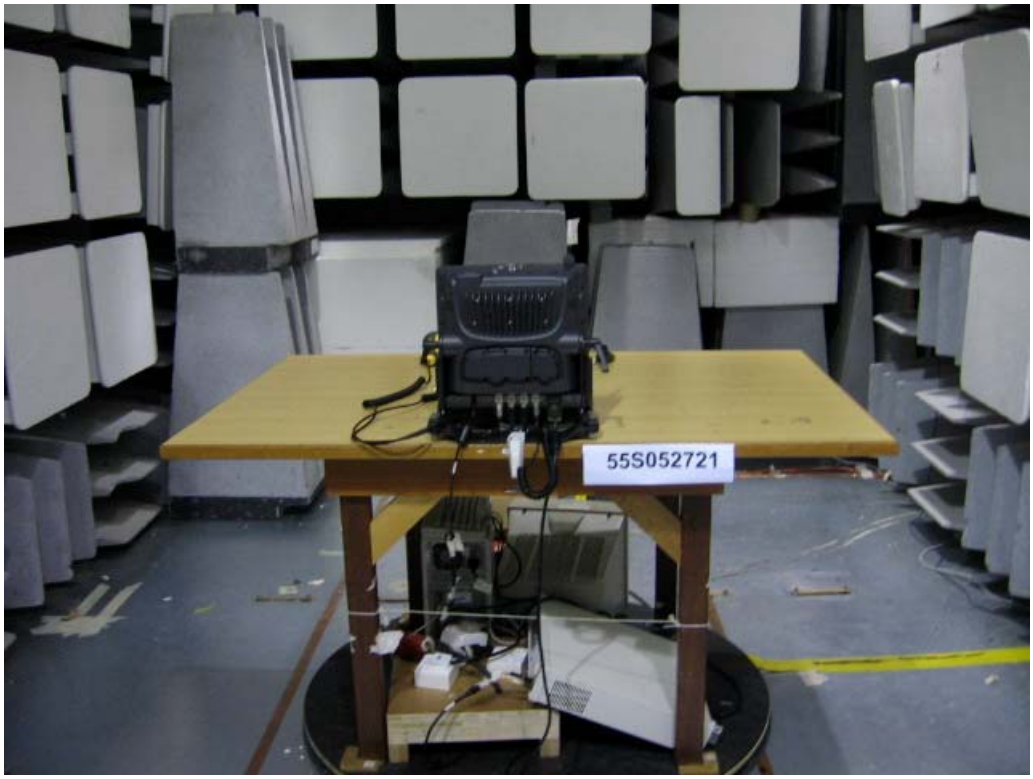
At 300 MHz Q-P limit (Class B) = 200 μV/m = 46.0 dBμV/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 40.0 - 46.0 = -6.0 i.e. **6 dB below Q-P limit**

Radiated Emissions Test Setup (Front View)



Radiated Emissions Test Setup (Rear View)

FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results

Operating Mode	Bluetooth	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)	Channel
50.5001	37.6	-2.4	124	100	V	0
72.1461	35.9	-4.1	28	100	V	0
91.2890	38.8	-4.2	2	101	V	0
151.7011	40.7	-2.8	105	102	H	0
325.3012	36.9	-9.1	214	100	V	0
--	--	--	--	--	--	--

Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m) Note 2	Average Margin (dB) Note 3	Azimuth (Degrees)	Height (cm)	Pol (H/V)	Channel
4.8044	47.7	--	-6.3	45	100	H	0
4.8822	47.8	--	-6.2	50	100	H	39
4.9600	47.6	--	-6.4	66	100	H	78
7.2063	41.1	--	-12.9	43	100	H	0
7.3233	42.1	--	-11.9	49	100	H	39
7.4401	42.5	--	-11.5	61	100	H	78

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. For the measurement below 1GHz, the worst case channel was selected for test.
3. As the measured peak shows compliance to the average limit, as such no average measurement was required.
4. The average margin indicates the margin of the measured peak value below the average limit.
5. "--" indicates no emissions were found and shows compliance to the limits.
6. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz.
7. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
8. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz

9. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
10. The channel in the table refers to the transmit channel of the EUT.
11. Radiated Emissions Measurement Uncertainty
    All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 40GHz (QP only @ 3m & 10m) is ±4.3dB (for EUTs < 0.5m X 0.5m X 0.5m).

FCC Part 15.247(a)(1) Carrier Frequency Separation Limits

The EUT shows compliance to the requirements of this section, which states the adjacent carrier frequencies must be separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, the EUT may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW (21dBm).

FCC Part 15.247(a)(1) Carrier Frequency Separation Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer	8564E	3846A1433	17 Apr 2006

FCC Part 15.247(a)(1) Carrier Frequency Separation Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 100kHz.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(a)(1) Carrier Frequency Separation Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 2.401GHz and 2.404GHz.
3. The spectrum analyser was set to max hold to capture the two adjacent transmitting frequencies within the span. The signal capturing was continuous until no further signals were detected.
4. The carrier frequency separation of the two adjacent transmitting / operating frequency was measured by finding the carrier frequency difference between the two adjacent channels.
5. The steps 2 to 4 were repeated with the following start and stop frequencies settings:
   a. 2.439GHz to 2.442GHz
   b. 2.440GHz to 2.443GHz
   c. 2.478GHz to 2.481GHz

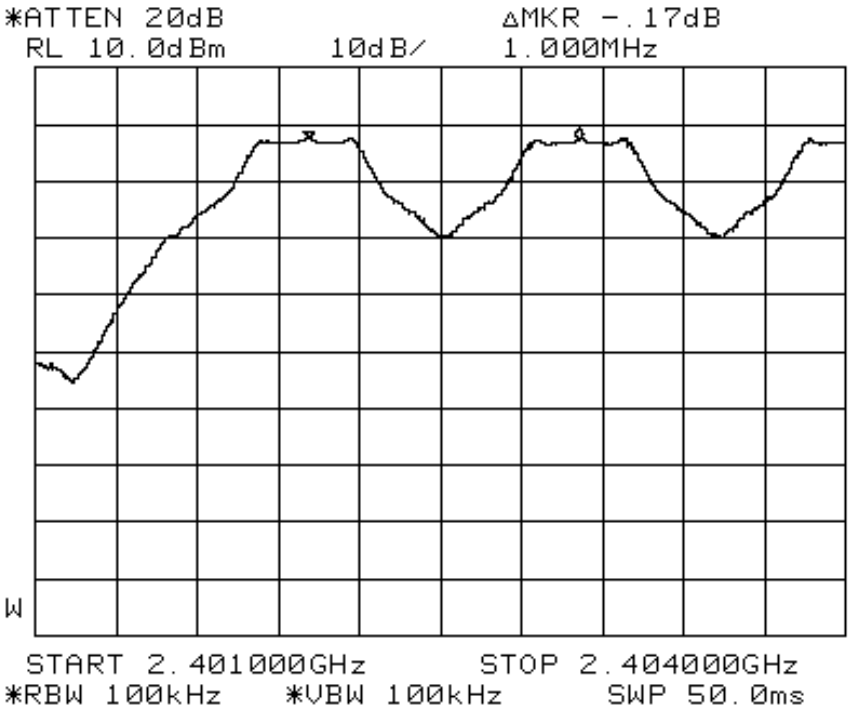
Carrier Frequency Separation Test Setup

FCC Part 15C (15.247(a)(1)) Carrier Frequency Separation Results

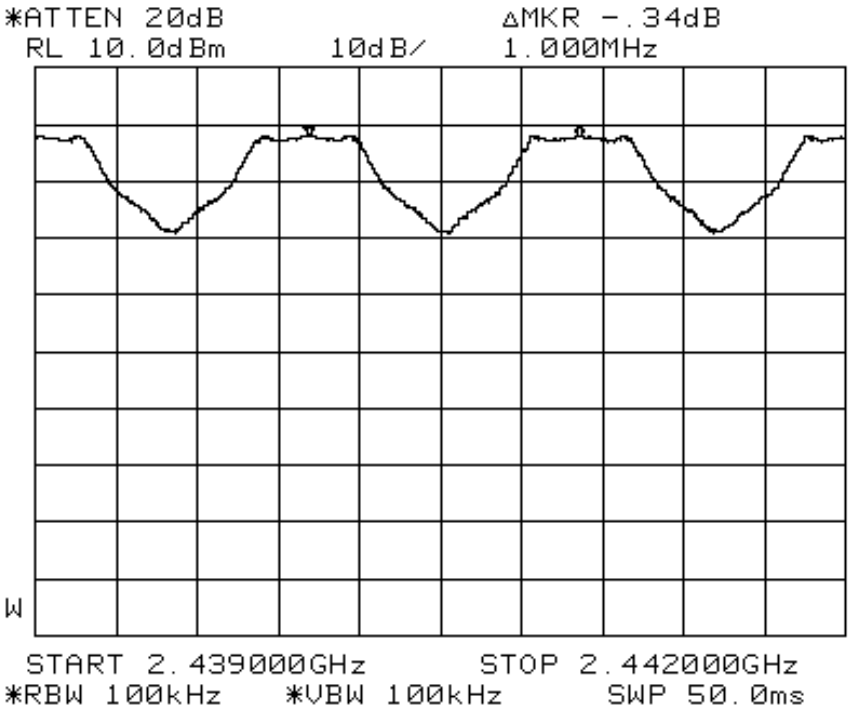
Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Attached Plots	1 - 4	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Adjacent Channels	Channel Separation (MHz)
0 and 1 (2.402GHz and 2.403GHz)	1.000
38 and 39 (2.440GHz and 2.441GHz)	1.000
39 and 40 (2.441GHz and 2.442GHz)	1.000
77 and 78 (2.479GHz and 2.480GHz)	1.000

Carrier Frequency Separation Plots

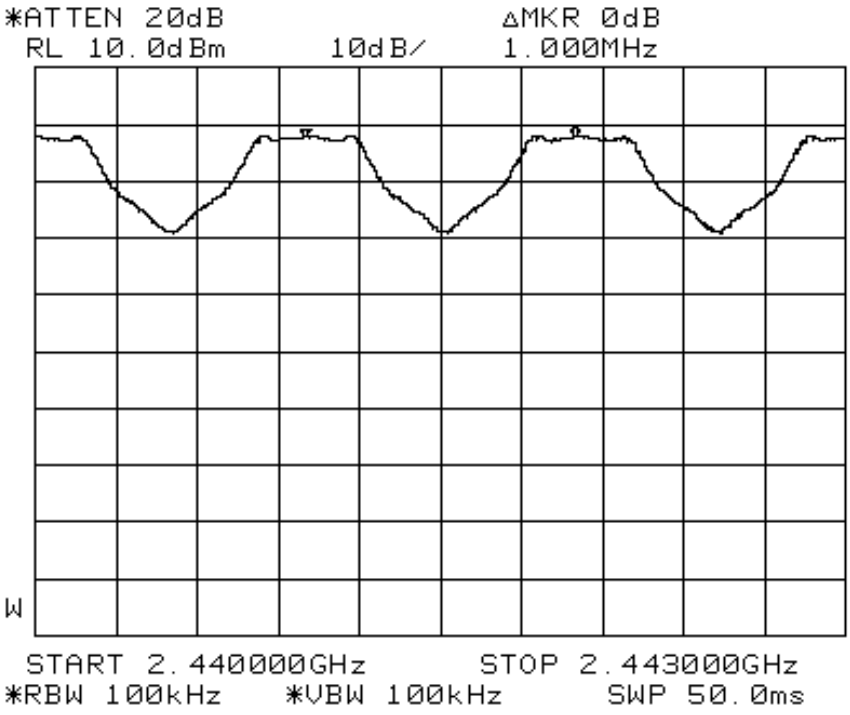


Plot 1 - Channels 0 and 1 Separation

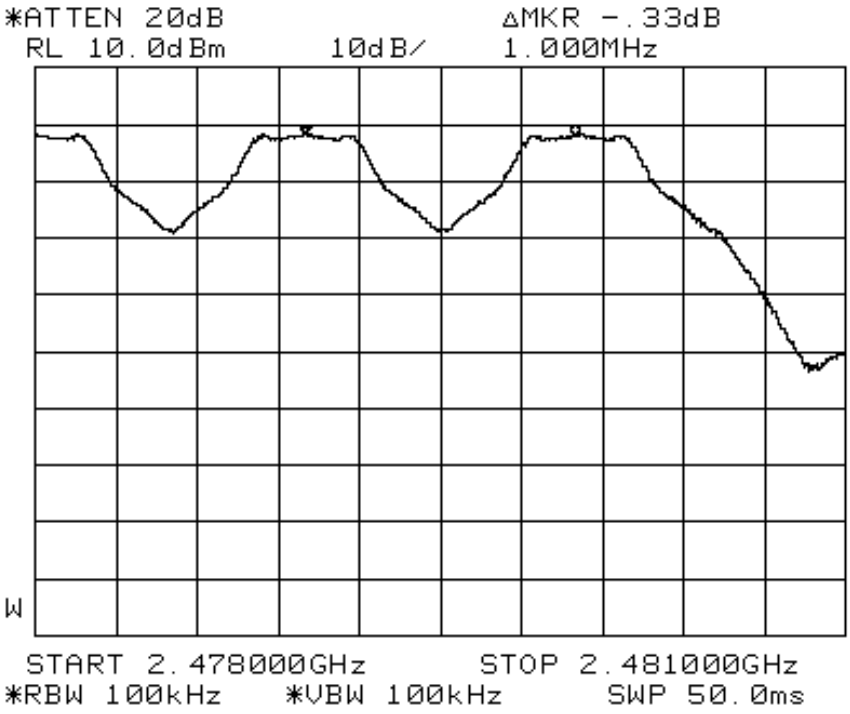


Plot 2 – Channels 38 and 39 Separation

Carrier Frequency Separation Plots



Plot 3 - Channels 39 and 40 Separation



Plot 4 - Channels 77 and 78 Separation

PART 2 - SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST

FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Limits

The EUT shows compliance to the requirements of this section, which states that the 20dB bandwidth of the hopping channel shall be the channel frequency separation by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer	8564E	3846A1433	17 Apr 2006

FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 10kHz and 30kHz.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz).
2. The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span wide enough to capture the 20dB bandwidth of the transmitting frequency.
3. The spectrum analyser was set to max hold to capture the transmitting frequency. The signal capturing was continuous until no further changes were observed.
4. The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser. The frequencies below the 20dB peak frequency at lower (f_L) and upper (f_H) sides of the transmitting frequency were marked and measured by using the marker-delta function of the spectrum analyser.
5. The 20dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies, $| f_H - f_L |$.
6. The steps 2 to 5 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

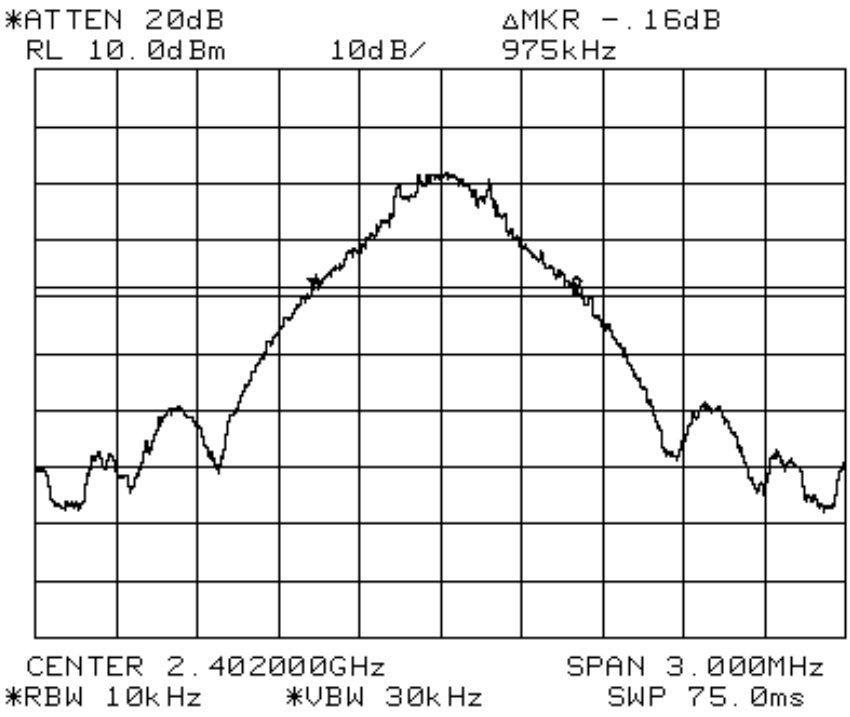
Spectrum Bandwidth (20dB Bandwidth Measurement) Test Setup

FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Results

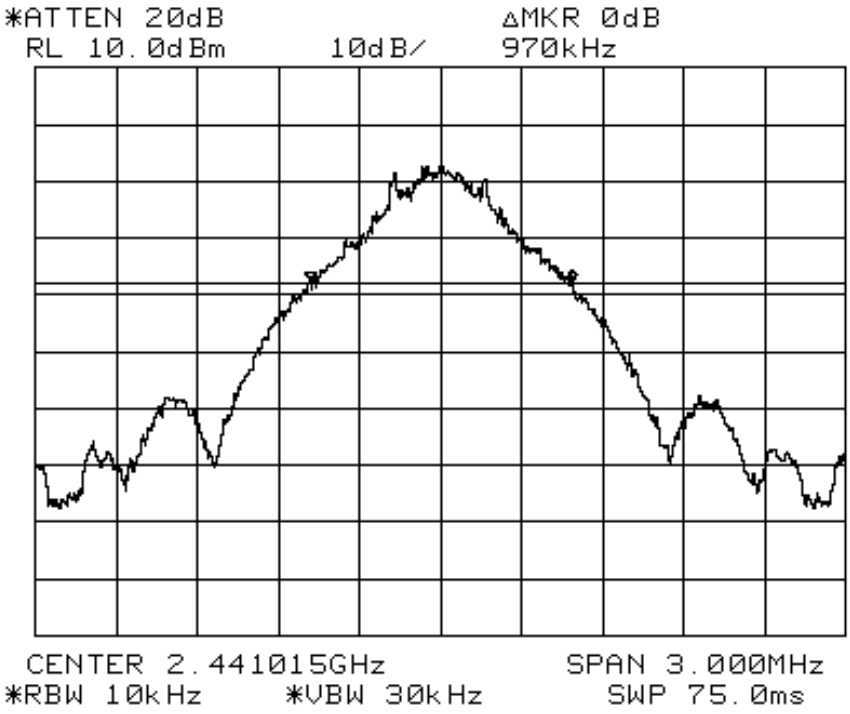
Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Attached Plots	5 - 7	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0	2.402	0.975
39	2.441	0.970
78	2.480	0.995

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots

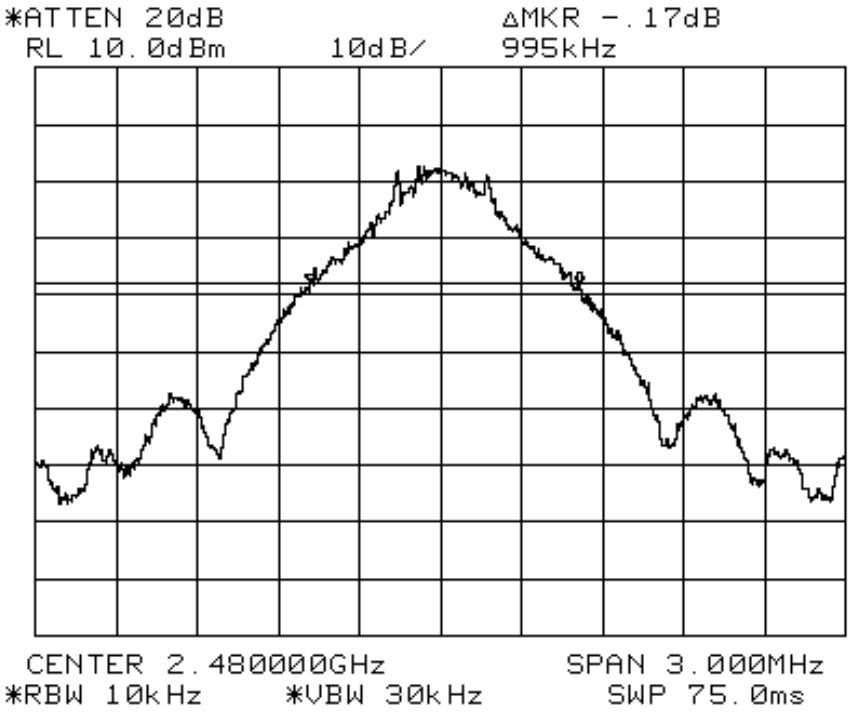


Plot 5 – Channel 0



Plot 6 – Channel 39

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots



Plot 7 – Channel 78

FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Limits

The EUT shows compliance to the requirements of this section, which states the EUT shall use at least 15 channels.

FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer	8564E	3846A1433	17 Apr 2006

FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 300kHz and 1000kHz.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 2.400GHz and 2.421GHz.
3. The spectrum analyser was set to max hold to capture all the transmitting frequencies within the span. The signal capturing was continuous until all the transmitting frequencies were captured and no further signals were detected.
4. The numbers of transmitting frequencies were counted and recorded.
5. The steps 2 to 4 were repeated with the following start and stop frequencies settings:
   a. 2.420GHz to 2.441GHz
   b. 2.440GHz to 2.461GHz
   c. 2.460GHz to 2.4835GHz
6. The total number of hopping frequencies is the sum of the number of the hopping frequencies found for each span.

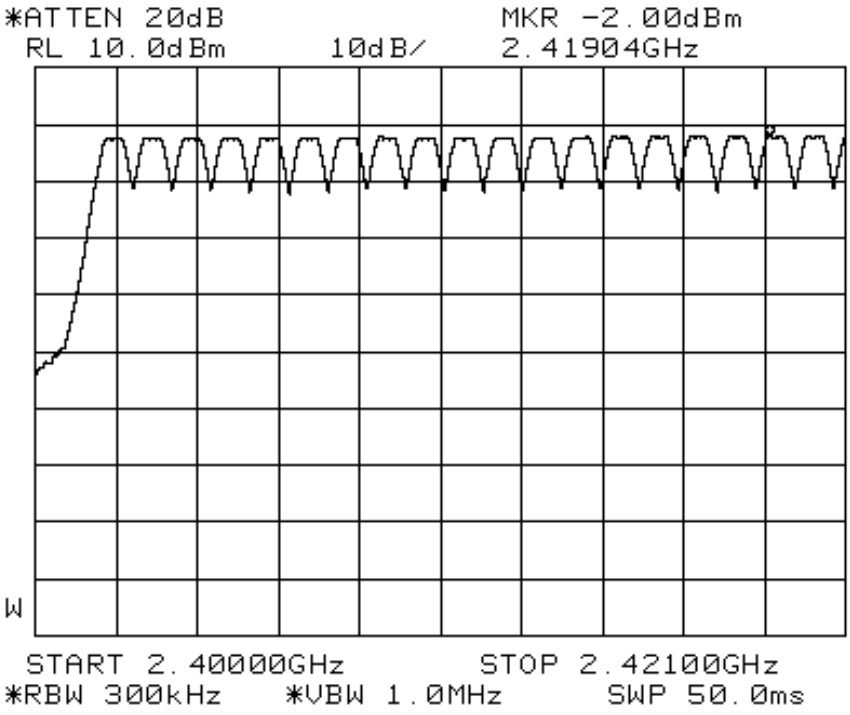
Number of Hopping Frequencies Test Setup

FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Results

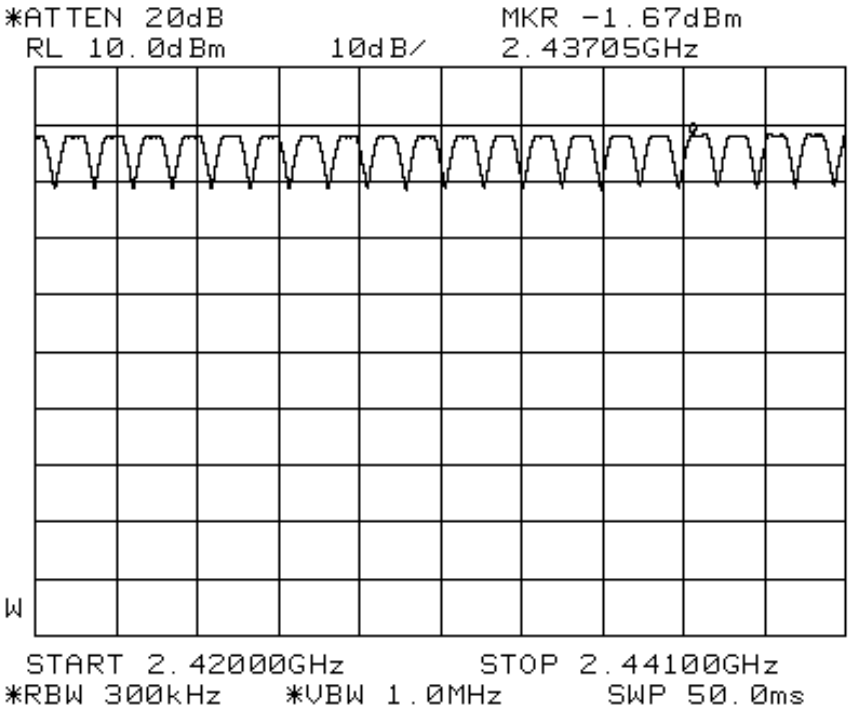
Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Attached Plots	8 - 11	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

The EUT was found to have 79 hopping frequencies. Please refer to the attached plots.

Number Of Hopping Frequencies Plots

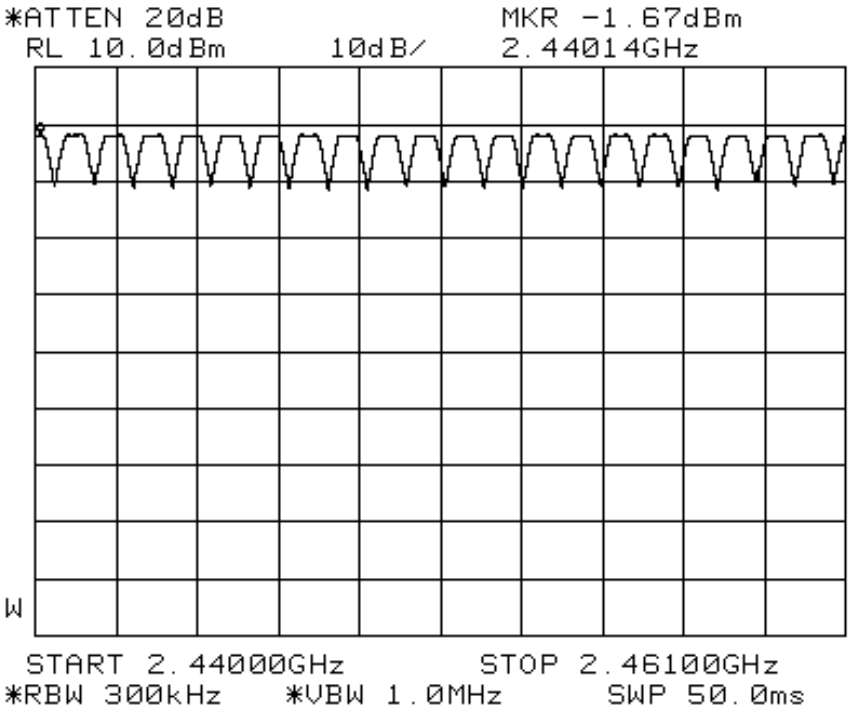


Plot 8 - Channels 0 to 18

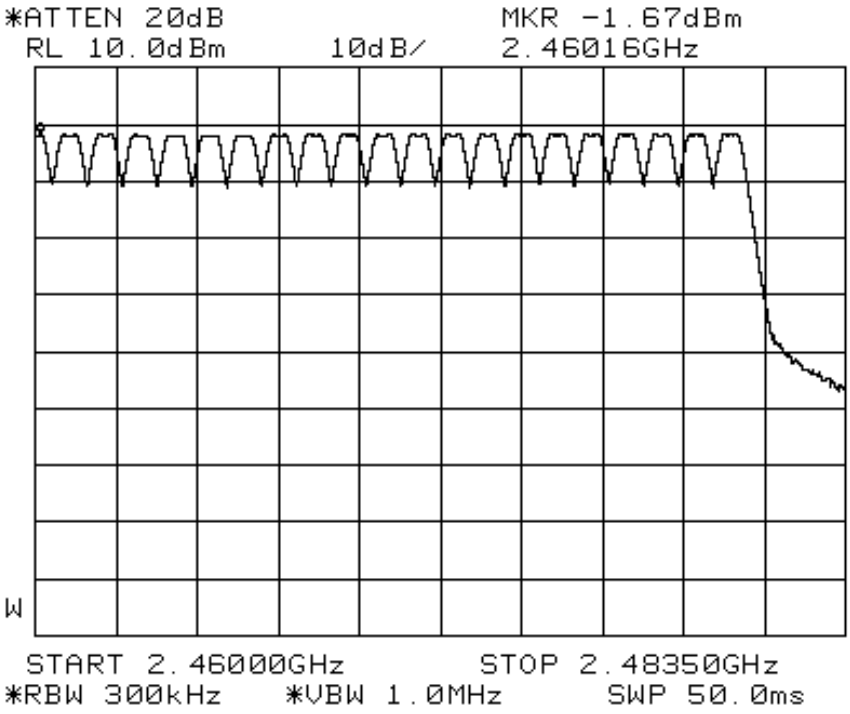


Plot 9 - Channels 19 to 38

Number Of Hopping Frequencies Plots



Plot 10 - Channels 39 to 58



Plot 11 - Channels 59 to 78

FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Time Limits

The EUT shows compliance to the requirements of this section, which states the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Time Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer	8564E	3846A1433	17 Apr 2006

FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 1MHz and 3MHz.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The center frequency of the spectrum analyser was set to 2.402GHz with zero frequency span (spectrum analyser acts as an oscilloscope).
3. The sweep time of the spectrum analyser was adjusted until a stable signal can be seen on the spectrum analyser.
4. The duration (dwell time) of a packet was measured using the marker-delta function of the spectrum analyser. The average dwell time of the transmitting frequency was computed as below:

   Average Frequency Dwell Time = [measured time slot length x hopping rate / number of hopping channels] x [0.4 x number of hopping channels]

   where EUT hopping rate = 1600 hops/s
   Number of EUT hopping channels = 79 channels

5. The steps 2 to 4 were repeated with the center frequency of the spectrum analyser were set to 2.441GHz and 2.480GHz respectively.

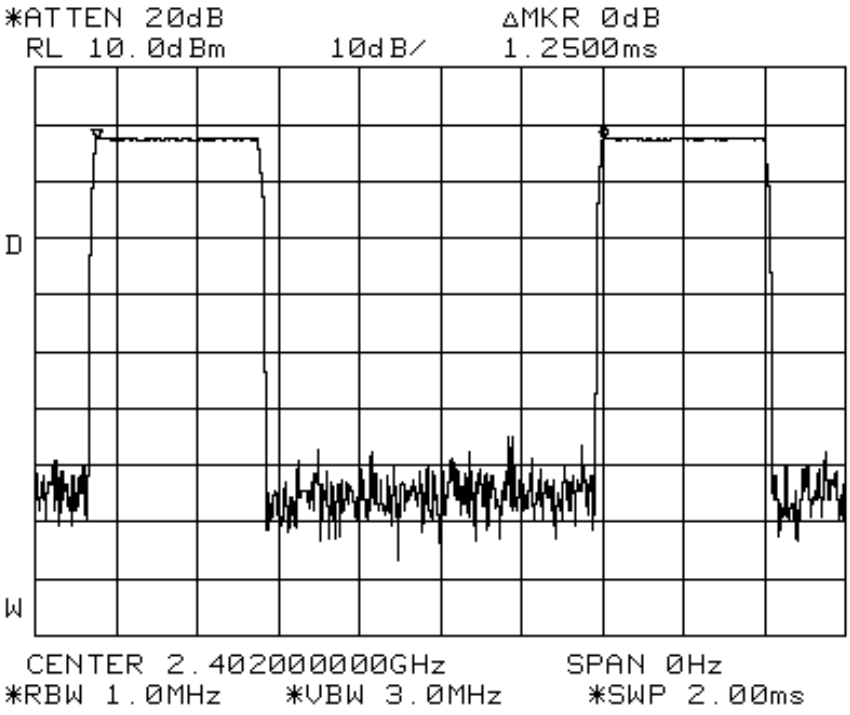
Average Frequency Dwell Time Test Setup

FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Time Results

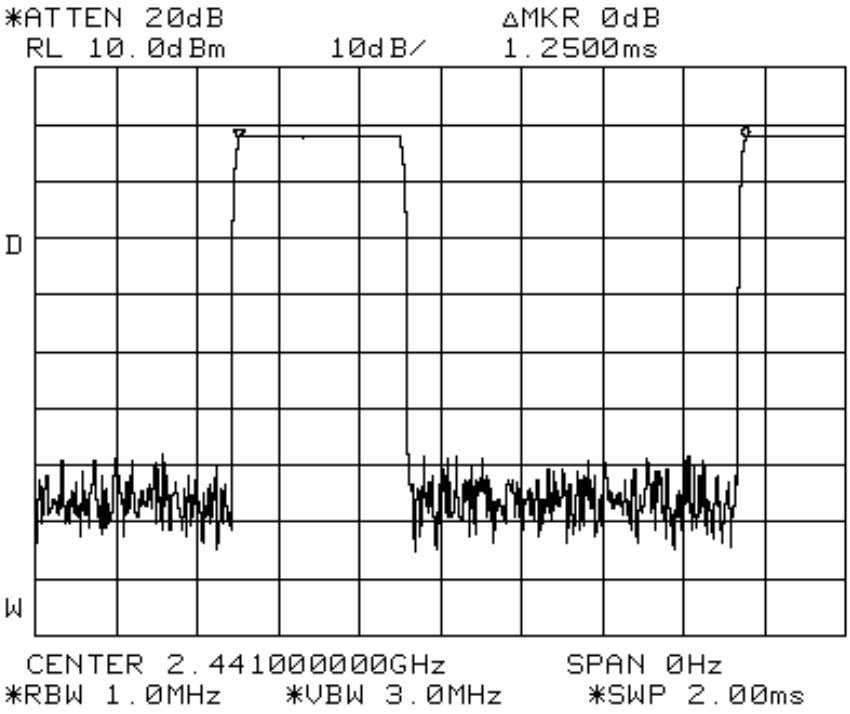
Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Attached Plots	12 - 14	Atmospheric Pressure	1029mbar
Hopping Rate	1600 hops / s	Tested By	Foo Kai Maun
Number of Hopping Channels	79 channels		

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0	2.402	0.625	0.4	0.4
39	2.441	0.625	0.4	0.4
78	2.480	0.625	0.4	0.4

Average Frequency Dwell Time Plots

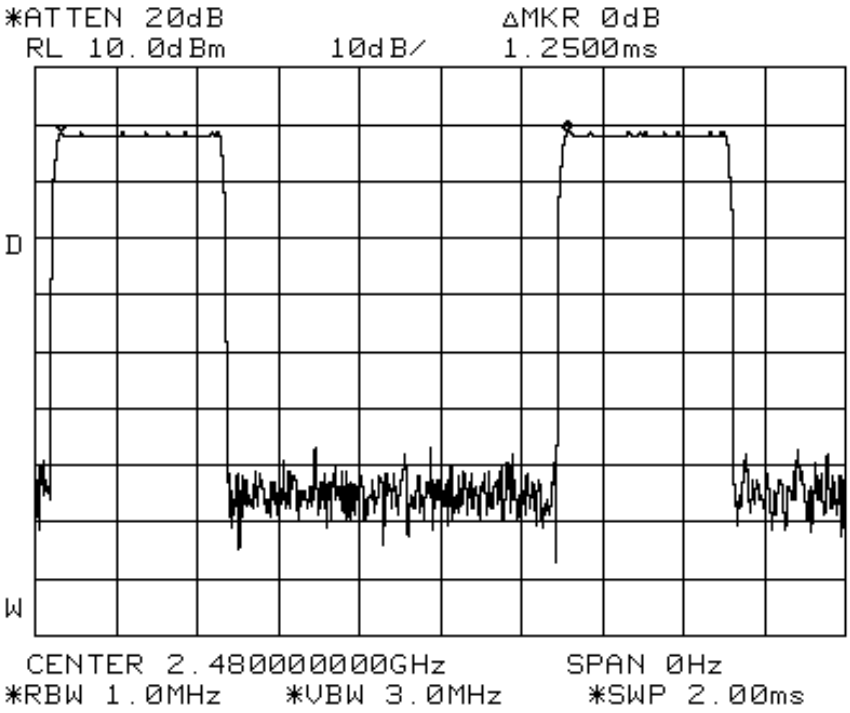


Plot 12 – Channel 0



Plot 13 – Channel 39

Average Frequency Dwell Time Plots



Plot 14 – Channel 78

FCC Part 15.247(b)(1) Maximum Peak Power Limits

The EUT shows compliance to the requirements of this section, which states the EUT employing at least 75 non-overlapping hopping channels shall not exceed 1W (30dBm). For the EUT employs other frequency hopping systems, the peak power shall not greater than 0.125W (21dBm).

FCC Part 15.247(b)(1) Maximum Peak Power Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Universal Radio Communication Tester	CMU 200	837587/068	23 Mar 2006

FCC Part 15.247(b)(1) Maximum Peak Power Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the Universal Radio Communication Tester, which set into power analyser mode via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(b)(1) Maximum Peak Power Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz).
2. The maximum peak power of the transmitting frequency was detected and recorded.
3. The step 2 was repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

Maximum Peak Power Test Setup

FCC Part 15.247(b)(1) Maximum Peak Power Results

Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
		Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
0	2.402	0.0008	1.0
39	2.441	0.0008	1.0
78	2.480	0.0010	1.0

Notes

1. Power analyser of Universal Radio Communication Tester was used for power measurement with peak detection as mode of measurement. The power analyser mode supports a wideband power measurement ranging from 100kHz to 2700MHz.

FCC Part 15.247(d) RF Conducted Spurious Emissions Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

FCC Part 15.247(d) RF Conducted Spurious Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer	8564E	3846A1433	17 Apr 2006

FCC Part 15.247(d) RF Conducted Spurious Emissions Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(d) RF Conducted Spurious Emissions Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz).
2. The start and stop frequencies of the spectrum analyser were set to 30MHz and 10GHz.
3. The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.
4. The steps 2 to 3 were repeated with frequency span was set from 10GHz to 25GHz.
5. The steps 2 to 4 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

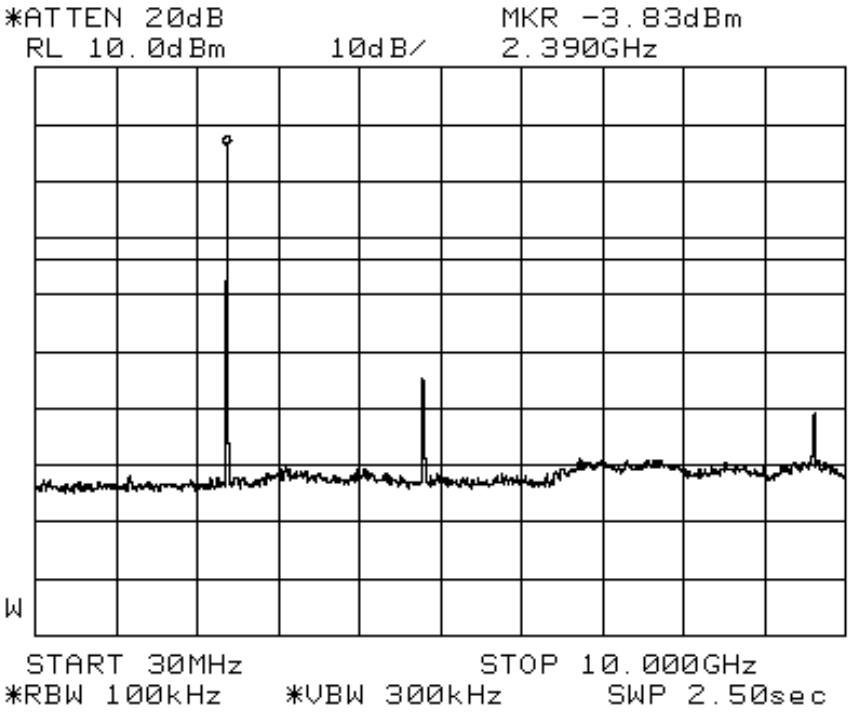
RF Conducted Spurious Emissions Test Setup

FCC Part 15.247(d) RF Conducted Spurious Emissions Results

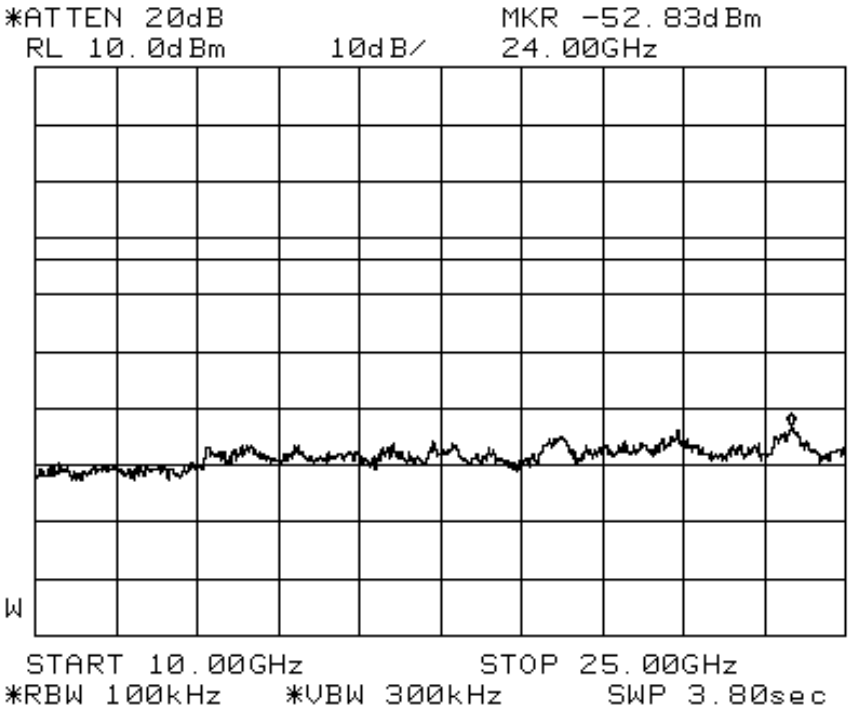
Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Attached Plots	15 - 20	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

All spurious signals found were below the specified limit. Please refer to the attached plots.

RF Conducted Spurious Emissions Plots

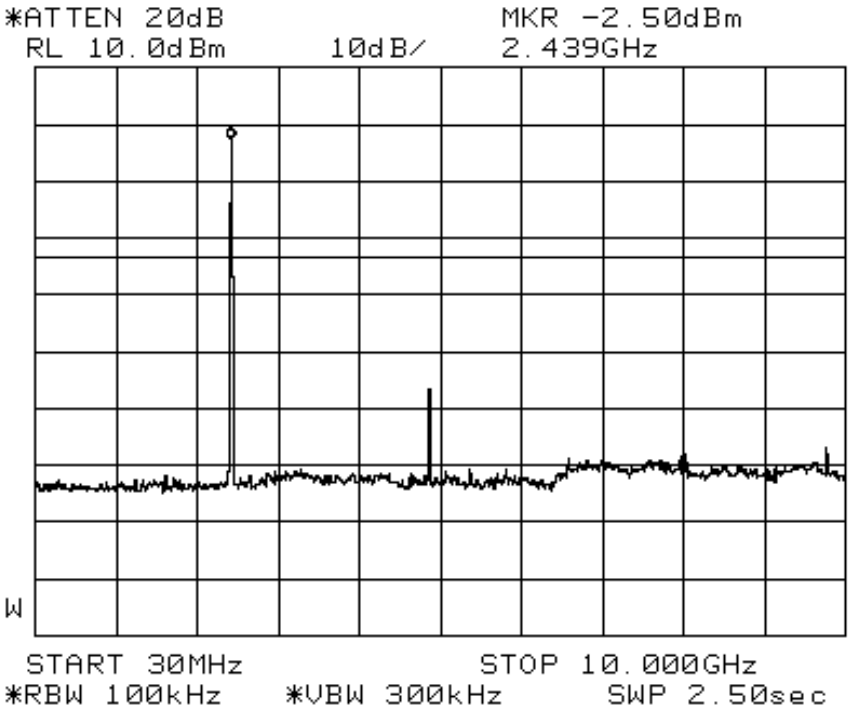


Plot 15 – Channel 0

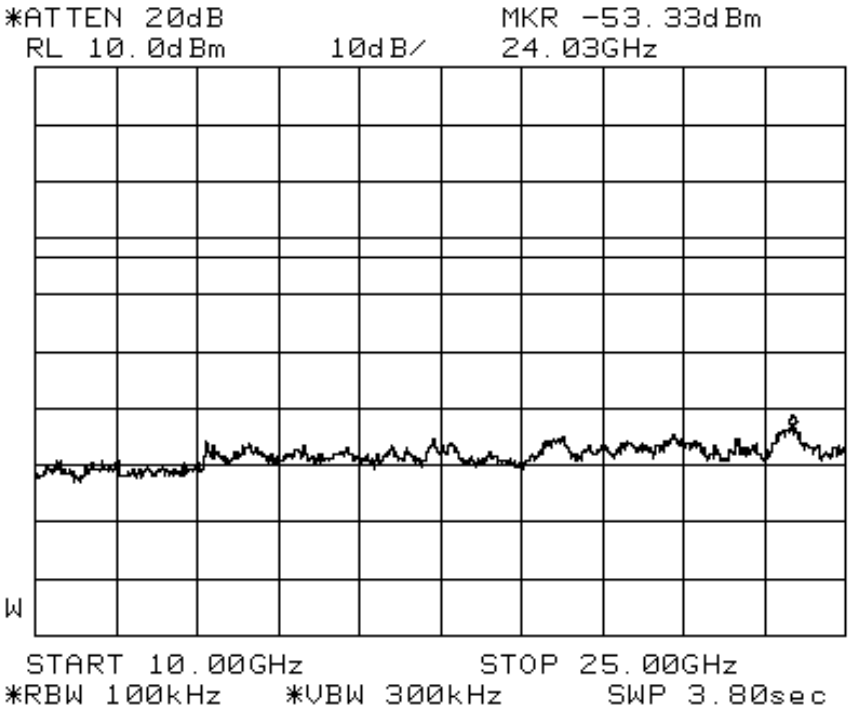


Plot 16 – Channel 0

RF Conducted Spurious Emissions Plots

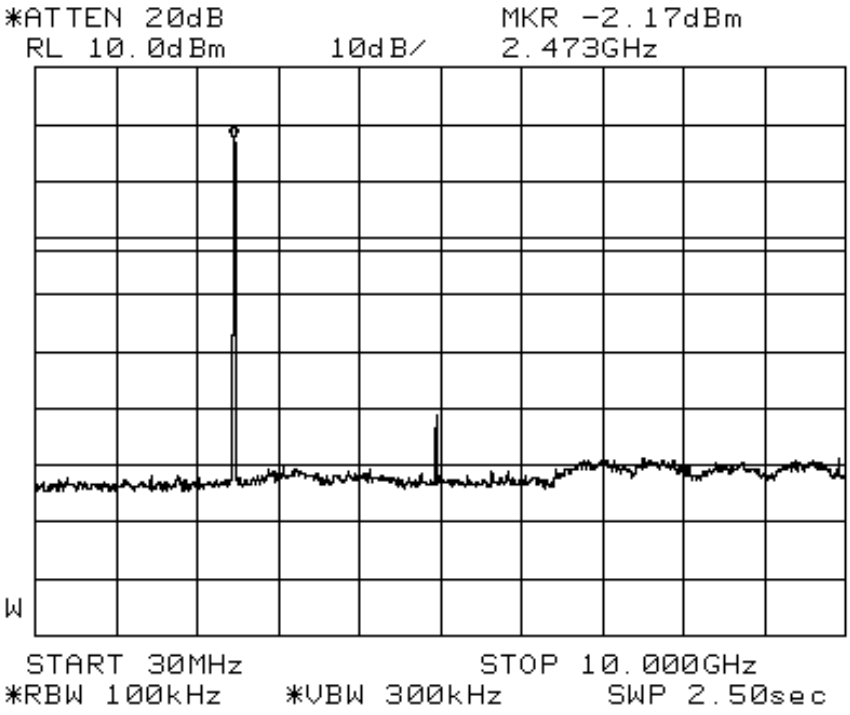


Plot 17 – Channel 39

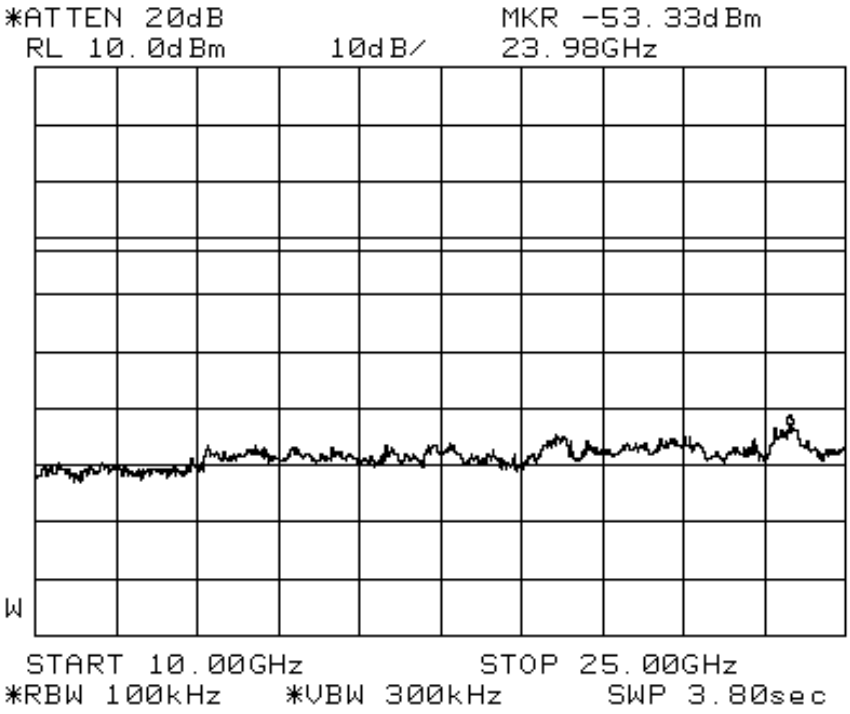


Plot 18 – Channel 39

RF Conducted Spurious Emissions Plots



Plot 19 – Channel 78



Plot 20 – Channel 78

FCC Part 15.247(d) Band Edge Compliance Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

FCC Part 15.247(d) Band Edge Compliance Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer	8564E	3846A1433	17 Apr 2006

FCC Part 15.247(d) Band Edge Compliance Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(d) Band Edge Compliance Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions at the band edge.
3. The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.
4. The steps 2 to 3 were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the transmission band, 2.4835GHz and the any spurious emissions at the band-edge.

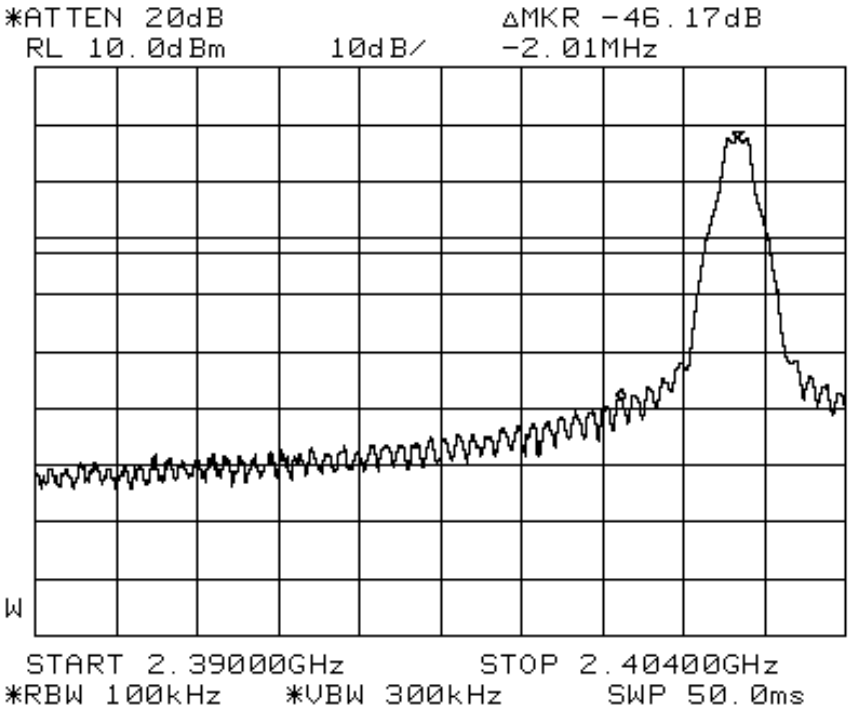
Band Edge Compliance Test Setup

FCC Part 15.247(d) Band Edge Compliance Results

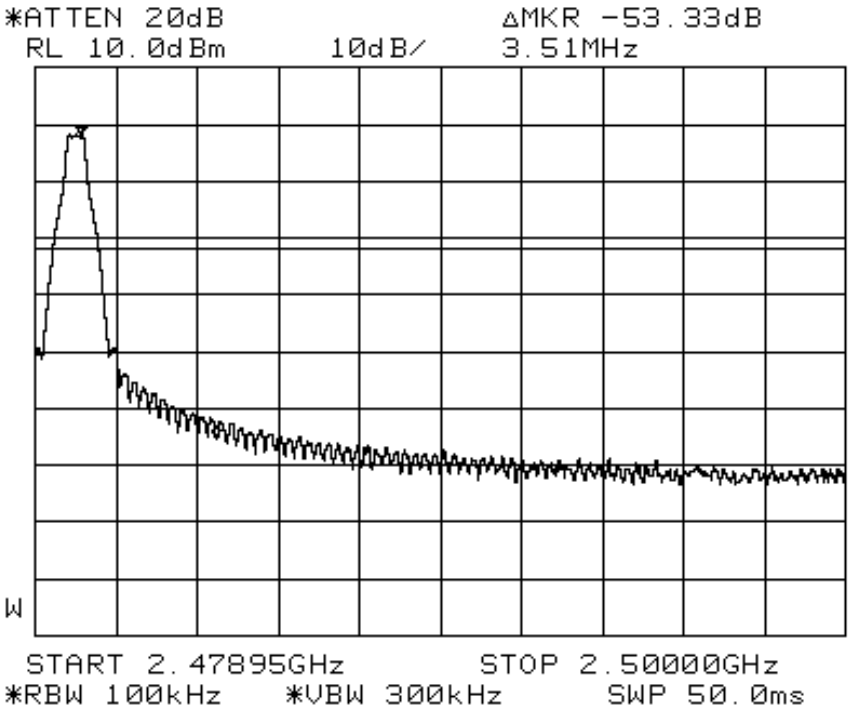
Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Attached Plots	21 - 22	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

No significant signal was found and they were below the specified limit.

Band Edge Compliance Plots



Plot 21 – Lower Band Edge at 2.4800GHz



Plot 22 – Upper Band Edge at 2.4835GHz

FCC Part 15.247(e) Peak Power Spectral Density Limits

The EUT shows compliance to the requirements of this section, which states the peak power spectral density conducted from the intentional radiator (EUT) to the antenna shall not be greater than 8dBm (6.3mW) in any 3kHz band during any time interval of continuous transmission.

FCC Part 15.247(e) Peak Power Spectral Density Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer	8564E	3846A1433	17 Apr 2006

FCC Part 15.247(e) Peak Power Spectral Density Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 3kHz and 10kHz.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(e) Peak Power Spectral Density Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz).
2. The sweep time of the spectrum analyser was set to the value of the ratio of the frequency span divided by the RBW.
3. The peak power density of the transmitting frequency was detected and recorded.
4. The step 3 was repeated with the transmitting frequency was set to Channel 39 (2.441GHz) and Channel 78 (2.480GHz) respectively.

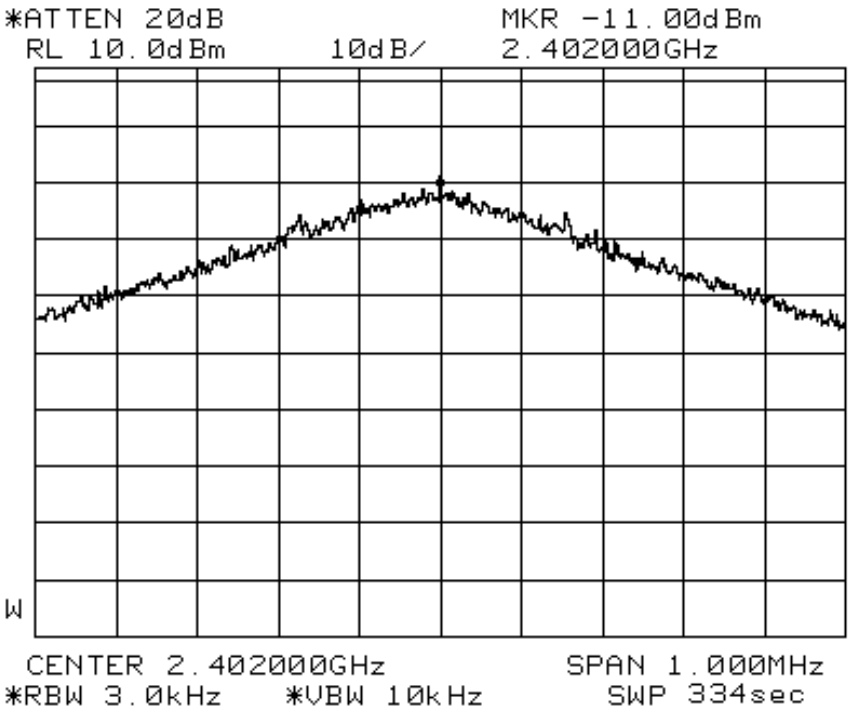
Peak Power Spectral Density Test Setup

FCC Part 15.247(e) Peak Power Spectral Density Results

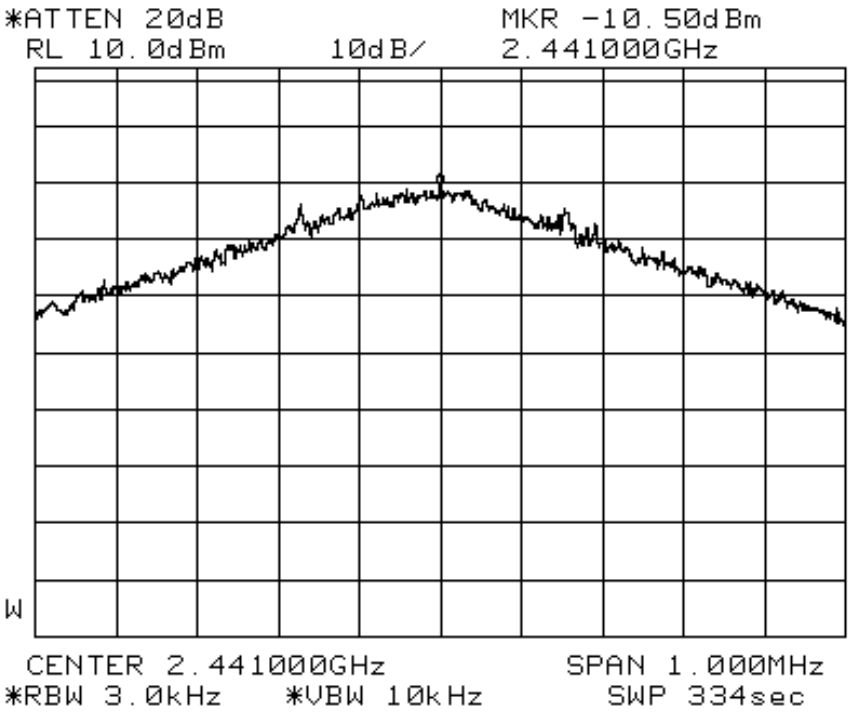
Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Attached Plots	23 - 25	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0	2.402	-11.00	6.3
39	2.441	-10.50	6.3
78	2.480	-10.33	6.3

Peak Power Spectral Density Plots

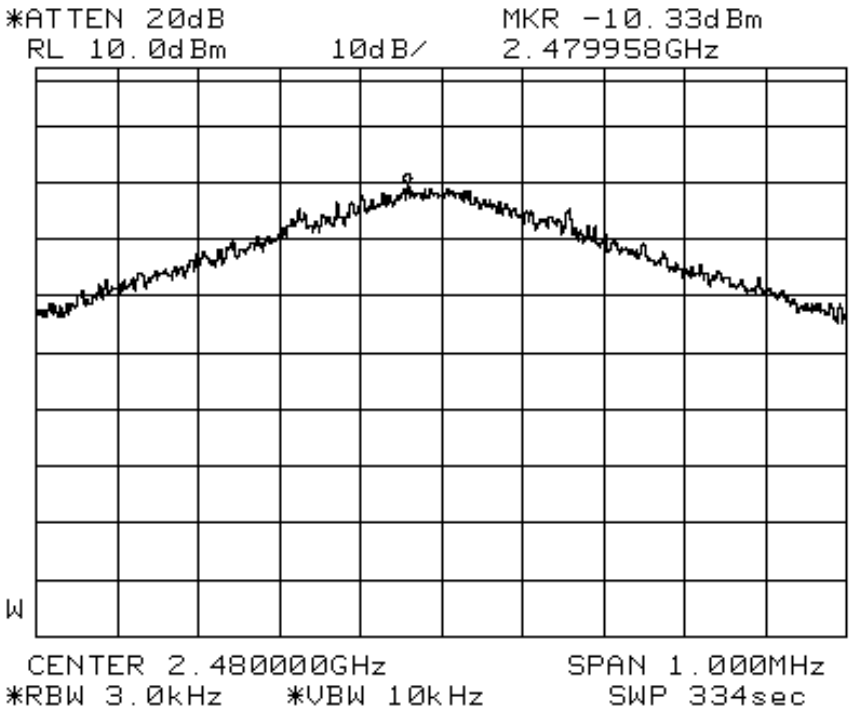


Plot 23 – Channel 0



Plot 24 – Channel 39

Peak Power Spectral Density Plots



Plot 25 – Channel 78

PART 3

This part (Part 3) details the following test results on WLAN 802.11b/g:

1. **Conducted Emission Test**
2. **Radiated Emission Test**
3. **Maximum Peak Power Test**
4. **Band Edge Compliance Test**

FCC Parts 15.107(a) and 15.207 Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (QP)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz–26.5GHz) – ESMI2	ESMI	829214/006 829550/001	22 Apr 2006
EMCO LISN (for EUT) – LISN9	3825/2	9309-2128	24 Jan 2006
EMCO LISN (for supporting) – LISN6	3825/2	9309-2127	03 May 2006
R&S Pulse Limiter – PL2	ESH3-Z2	100347	15 Apr 2006

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50µH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10kHz. Both Quasi-peak and Average measurements were made.
5. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz Q-P limit (Class B) = 1000 µV = 60.0 dBµV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBµV
(Calibrated for system losses)

Therefore, Q-P margin = 40.0 - 60.0 = -20.0 i.e. **20.0 dB below Q-P limit**

Conducted Emissions Test Setup (Front View)

Conducted Emissions Test Setup (Rear View)

FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Operating Mode	WLAN 802.11b	Temperature	22°C
Test Input Power	110V 60Hz	Relative Humidity	58%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Tan Swee Seng

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.1574	53.6	-12.0	50.0	-5.6	Neutral	1
0.2202	42.9	-19.9	35.0	-17.8	Live	1
0.7288	30.3	-25.7	29.7	-16.3	Live	1
0.85616	29.9	-26.1	29.3	-16.7	Live	1
19.2615	37.7	-22.3	32.8	-17.2	Live	1
19.7268	33.7	-26.3	29.0	-21.0	Live	1

Operating Mode	802.11g	Temperature	22°C
Test Input Power	110V 60Hz	Relative Humidity	58%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Tan Swee Seng

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.1591	53.5	-12.0	50.1	-5.4	Neutral	1
0.2209	42.6	-20.2	36.4	-16.4	Neutral	1
0.7292	29.9	-26.1	29.4	-16.6	Neutral	1
13.571	44.8	-15.2	42.2	-7.8	Live	1
19.2075	38.1	-21.9	33.8	-16.2	Live	1
19.4945	36.0	-24.0	31.7	-18.3	Live	1

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
4. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 9kHz – 30MHz (Average & Quasi-peak) is ±2.4dB.

FCC Part 15.205 Restricted Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
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	2690 - 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	3600 - 4400	Above 38.6
13.36 - 13.41			

FCC Parts 15.109(a) and 15.209 Radiated Emission Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m) @ 3m
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
Above 960	54.0*
* Above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
HP Preamplifier (100kHz-1.3GHz) – PA2	8447D	2944A08173	01 Apr 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
Schaffner Bilog Antenna – BL9	CBL6143	5045	13 May 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006
EMCO Horn Antenna – H14	3115	0003-6087	19 May 2006
HP Spectrum Analyser (30Hz-40GHz)	8564E	3846A01433	27 Apr 2006
Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Aug 2006

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Method

4. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which attitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from 30MHz to 10th harmonics of the EUT fundamental frequency or 40GHz whichever is lower, using the Bi-log antenna for frequencies from 30MHz up to 3GHz, and the Horn antenna above 3GHz.

Sample Calculation Example

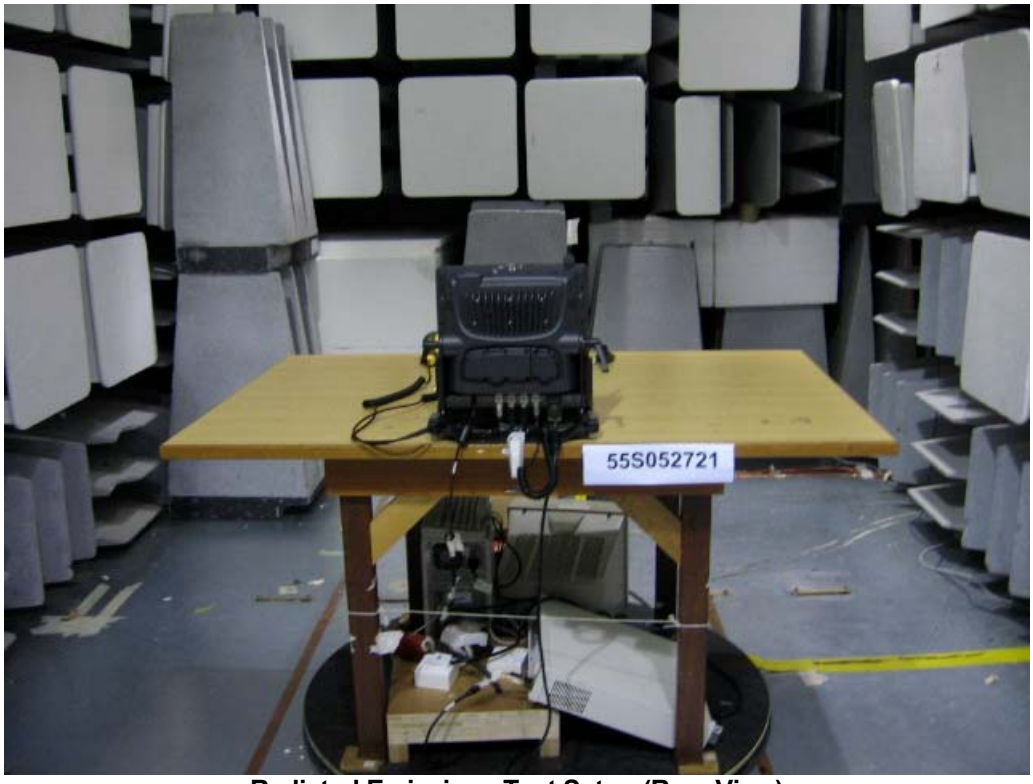
At 300 MHz Q-P limit (Class B) = 200 μV/m = 46.0 dBμV/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 40.0 - 46.0 = -6.0 i.e. **6 dB below Q-P limit**

Radiated Emissions Test Setup (Front View)



Radiated Emissions Test Setup (Rear View)

FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results

Operating Mode	WLAN 802.11b	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)	Channel
61.2010	35.9	-4.0	135	107	V	1
126.7167	31.2	-12.3	359	101	V	1
374.6321	37.3	-8.7	124	100	V	1
511.4213	30.4	-15.6	221	102	H	1
771.8125	37.1	-8.9	200	100	H	1
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Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m) Note 4	Average Margin (dB) Note 5	Azimuth (Degrees)	Height (cm)	Pol (H/V)	Channel
4.8248	46.8	--	-7.2	87	103	H	1
4.8744	45.2	--	-8.8	66	100	H	6
4.9247	46.9	--	-7.1	78	100	H	11
7.2366	40.1	--	-13.9	65	100	H	1
7.3117	39.2	--	-14.8	60	100	H	6
7.3866	38.7	--	-15.3	90	100	H	11
10.1800	46.8	--	-7.2	0	100	V	1

FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results

Operating Mode	WLAN 802.11g	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)	Channel
201.1101	30.4	-13.1	167	100	V	1
235.5901	38.1	-7.9	145	123	V	1
282.6778	35.5	-10.5	317	100	H	1
366.2014	39.4	-6.6	0	101	V	1
934.0643	38.1	-7.9	125	101	H	1
--	--	--	--	--	--	--

Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m) Note 4	Average Margin (dB) Note 5	Azimuth (Degrees)	Height (cm)	Pol (H/V)	Channel
4.8241	45.2	--	-8.8	110	100	H	1
4.8745	45.4	--	-8.6	151	100	H	6
4.9244	47.0	--	-7.0	90	100	H	11
7.2360	39.3	--	-14.7	100	100	H	1
7.3119	38.4	--	-15.6	99	105	H	6
7.3862	39.6	--	-14.1	104	100	H	11
10.6600	43.9	--	-10.1	0	100	V	1

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. For the measurement below 1GHz, the worst case channel was selected for test.
3. The external antenna was used during the measurement as it was found to be the worst case configuration.
4. The transmitting antenna was found to be in the worst case condition when it was orientated in a vertical position.
5. As the measured peak shows compliance to the average limit, as such no average measurement was required.
6. The average margin indicates the margin of the measured peak value below the average limit.
7. "--" indicates no emissions were found and shows compliance to the limits.
8. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz.
9. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.

10. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
    30MHz - 1GHz
    RBW: 120kHz VBW: 1MHz
    >1GHz
    RBW: 1MHz VBW: 1MHz
11. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
12. The channel in the table refers to the transmit channel of the EUT.
13. Radiated Emissions Measurement Uncertainty
    All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 40GHz (QP only @ 3m & 10m) is ±4.3dB (for EUTs < 0.5m X 0.5m X 0.5m).

FCC Part 15.247(b)(3) Maximum Peak Power Limits

The EUT shows compliance to the requirements of this section, which states the maximum peak power of the EUT employing digital modulation shall not exceed 1W (30dBm).

FCC Part 15.247(b)(3) Maximum Peak Power Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
Agilent Synthesized Sweeper – SG10	83620B	3844A01337	24 Jan 2008
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006
EMCO Horn Antenna – H14	3115	0003-6087	19 May 2006

FCC Part 15.247(b)(3) Maximum Peak Power Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF external antenna connector was connected to the EUT.
4. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(b)(3) Maximum Peak Power Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at Channel 1 (2.412GHz) with specified modulation and data rate.
2. The maximum peak power of the transmitting frequency was detected and recorded.
3. The steps 2 to 3 were repeated with the transmitting frequency was set to Channel 6 (2.437GHz) and Channel 11 (2.462GHz) respectively.
4. The EUT was replaced with the substitution antenna with the antenna input was connected to the signal generator via a 10dB attenuator (if possible). The antenna was set to vertical polarization.
5. The signal generator was set to the recorded transmitting frequency in step 2. The output level of the signal generator was adjusted until the test receiver was at least 20dB above the level when the signal generator was switched off.
6. The test antenna was raised and lowered through the specified range of heights (1m – 4m) until the maximum signal level was received on the test receiver.
7. The substitution antenna was rotated until the maximum level was detected on the test receiver.
8. The output level of the signal generator was adjusted until the received signal level at the test receiver was equal to the level recorded in step 2 (A dBm). The signal generator output level was recorded as B (in dBm).
9. The maximum peak power, P (e.i.r.p) was computed as followed:

   P (e.i.r.p) = B – C – D + E

   where C = cable loss between the signal generator and the substitution

   D = attenuation level if attenuator is used

   E = substitution antenna gain
10. The steps 6 to 9 were repeated with the receiving antenna was set to horizontal polarization.
11. Comparison was made on both measured results with vertical and horizontal polarizations. The highest value out of vertical and horizontal polarizations was recorded.
12. The steps 5 to 11 were repeated with the signal generator was set to the middle and upper channel frequencies.

Maximum Peak Power Test Setup

FCC Part 15.247(b)(3) Maximum Peak Power Results

Operating Mode	WLAN 802.11b	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
		Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)	Data Rate
1	2.412	0.0457	1.0	11Mbps
6	2.437	0.0567	1.0	11Mbps
11	2.462	0.0768	1.0	11Mbps

Operating Mode	WLAN 802.11g	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
		Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)	Data Rate
1	2.412	0.0323	1.0	6Mbps
6	2.437	0.0450	1.0	6Mbps
11	2.462	0.0507	1.0	6Mbps

Notes

1. The measurement was done using an external antenna attached to the EUT, which was found to be emitting the highest RF power. The antenna was orientated in a vertical position where the highest emission was detected.

FCC Part 15.247(d) Band Edge Compliance Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

FCC Part 15.247(d) Band Edge Compliance Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006

FCC Part 15.247(d) Band Edge Compliance Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF external antenna connector was connected to the EUT.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz to show compliance of spurious at band edges are at least 20dB below the carriers. For restricted band spurious at band edges, peak and average measurement plots were taken using the following setting:
   a. Peak Plot:
      RBW = VBW = 1MHz
   b. Average Plot
      RBW = 1MHz, VBW = 10Hz
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(d) Band Edge Compliance Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with specified modulation and data rate.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions at the band edge.
3. The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.
4. The steps 2 to 3 were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the transmission band, 2.4835GHz and the any spurious emissions at the band-edge.

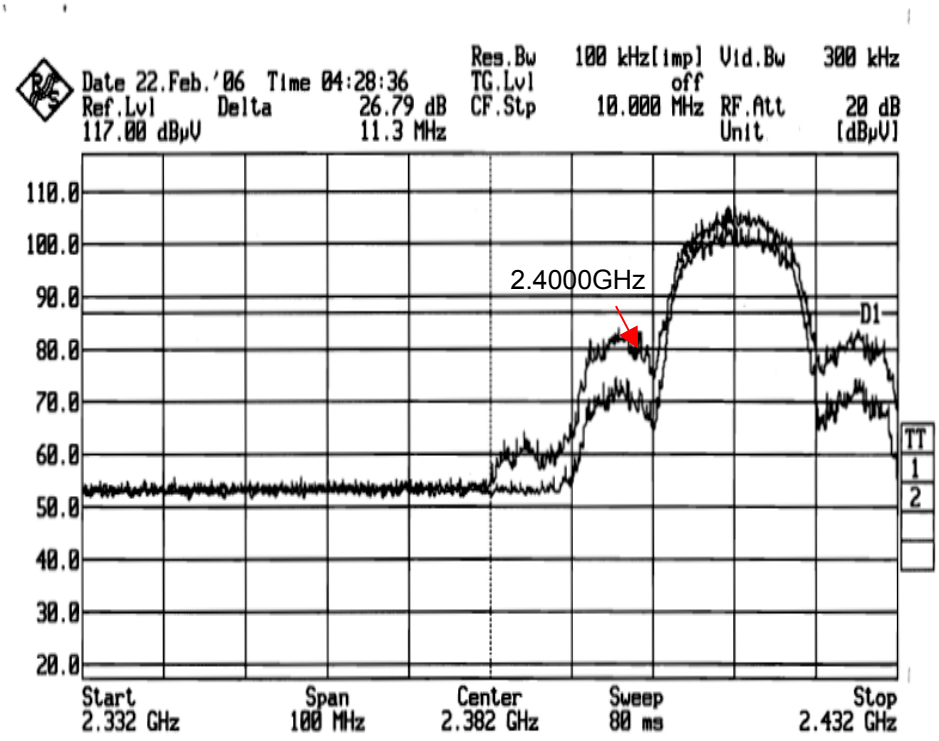
Band Edge Compliance Test Setup

FCC Part 15.247(d) Band Edge Compliance Results

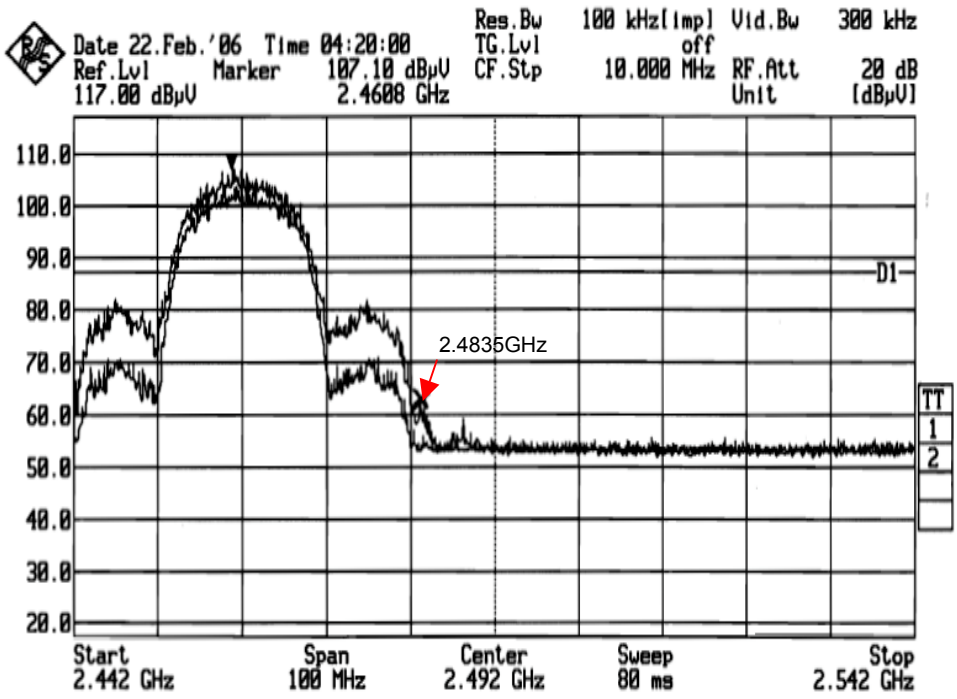
Operating Mode	WLAN 802.11b/g	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Attached Plots	26 - 37	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

No significant signal was found and they were below the specified limit.

Band Edge Compliance Plots (20dB Delta from Carrier at Band Edge) - WLAN 802.11b

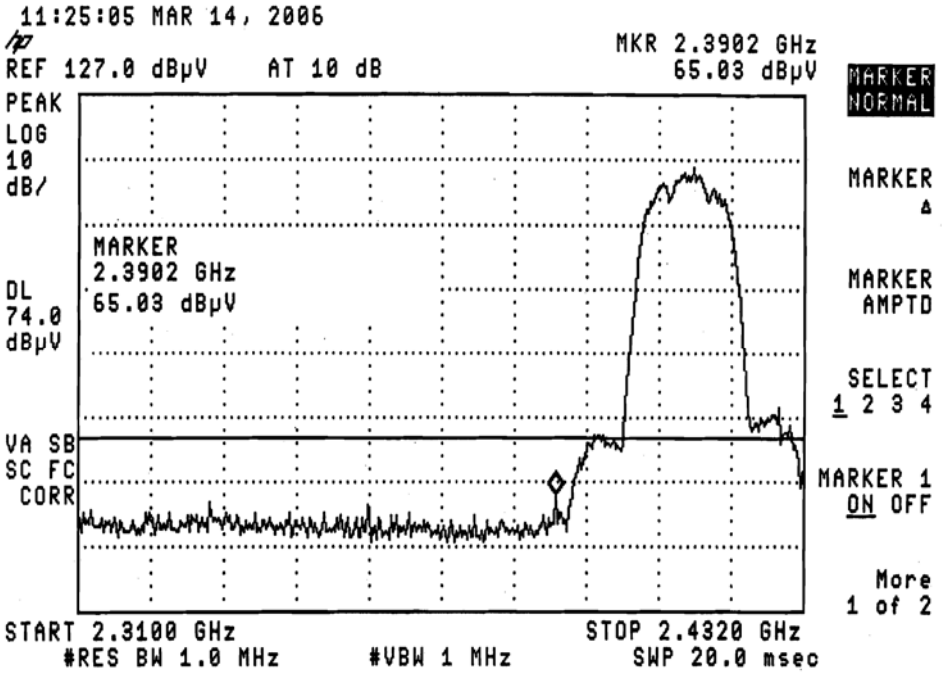


Plot 26 – Lower Band Edge at 2.4000GHz (WLAN 802.11b)

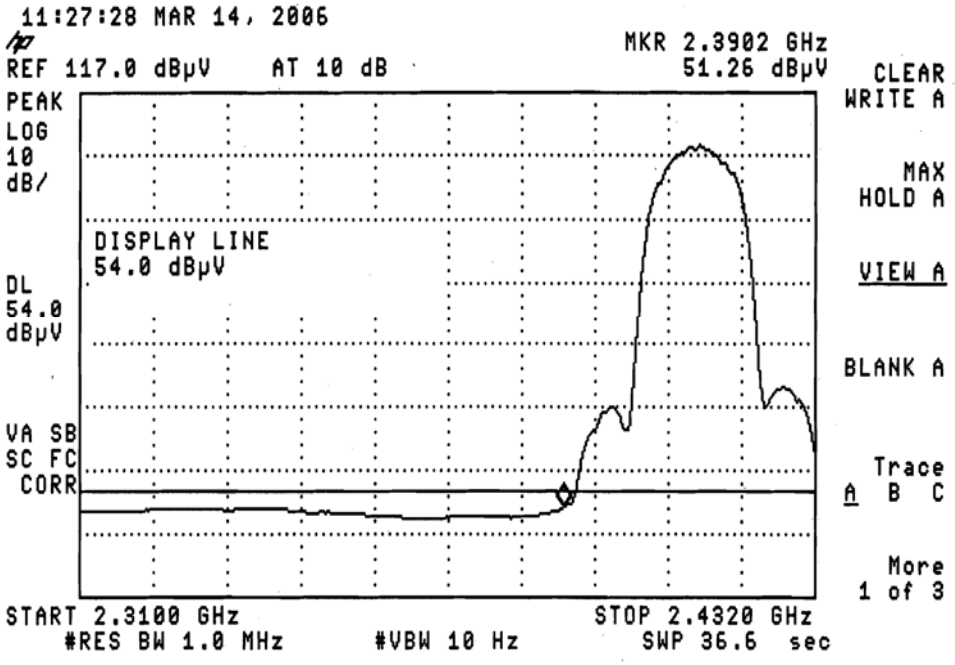


Plot 27 – Upper Band Edge at 2.4835GHz (WLAN 802.11b)

Band Edge Compliance Plots (Restricted Band)- WLAN 802.11b

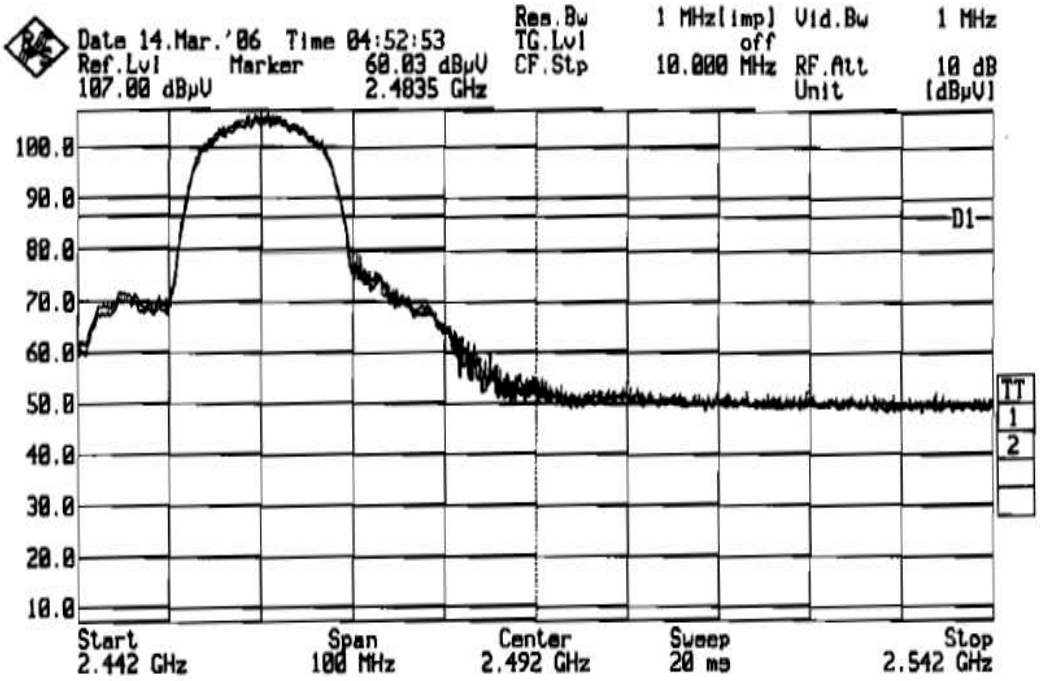


Plot 28 – Peak Plot for Lower Band Edge (WLAN 802.11b)

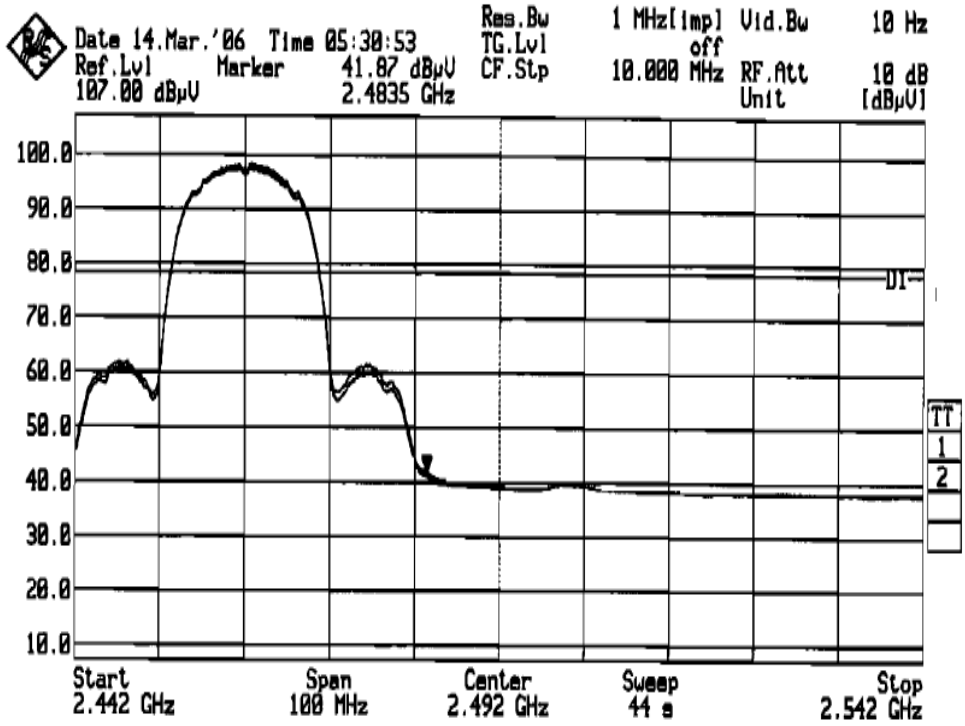


Plot 29 – Average Plot for Lower Band Edge (WLAN 802.11b)

Band Edge Compliance Plots (Restricted Band) - WLAN 802.11b

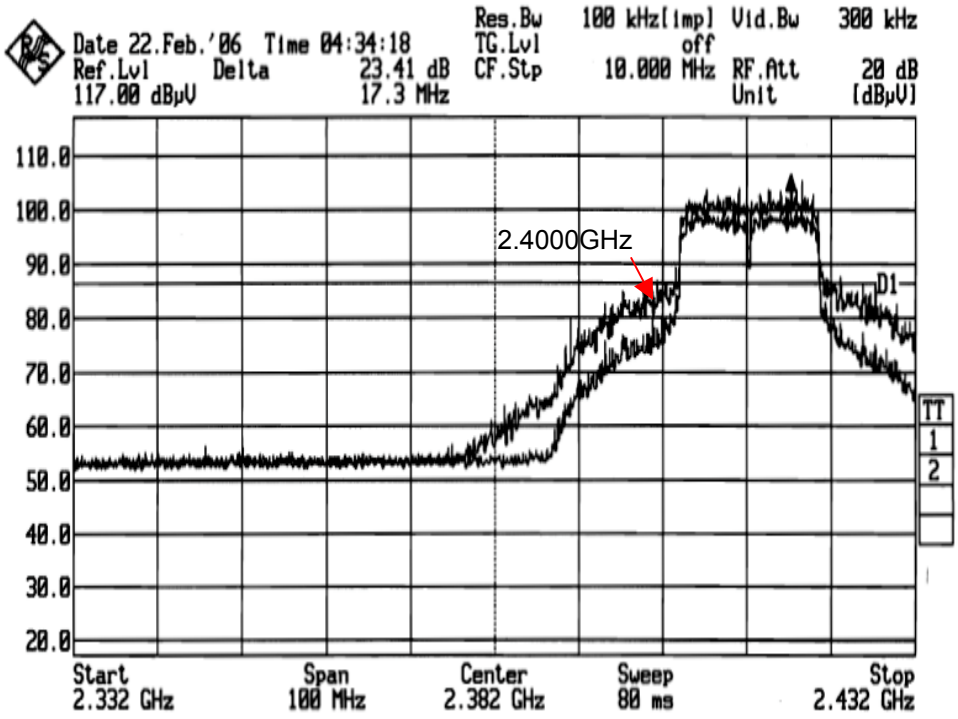


Plot 30 – Peak Plot for Upper Band Edge (WLAN 802.11b)

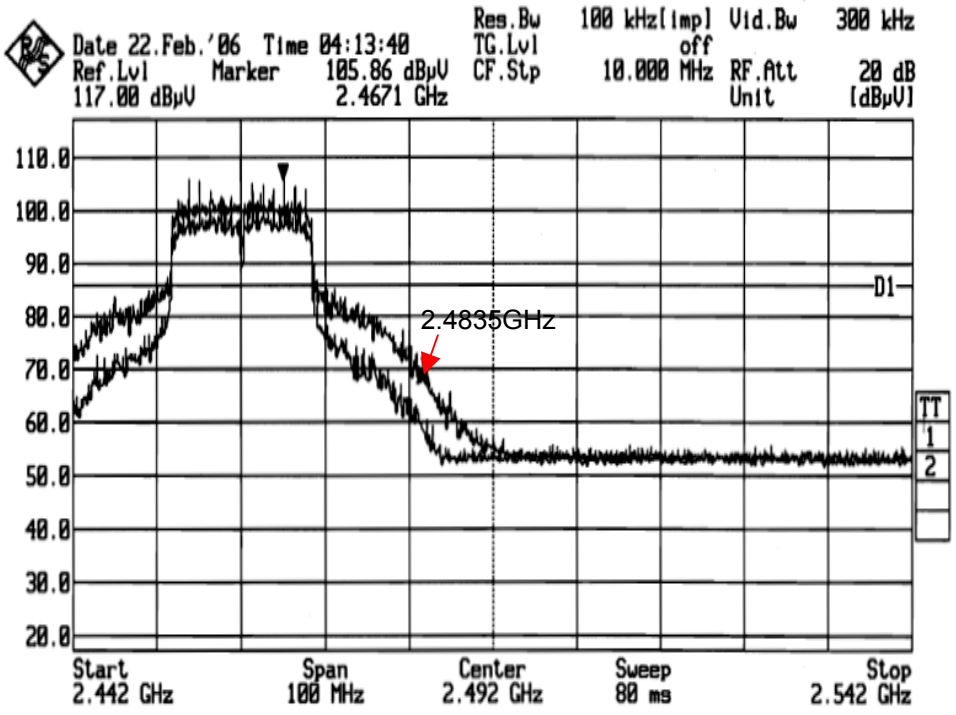


Plot 31 – Average Plot for Upper Band Edge (WLAN 802.11b)

Band Edge Compliance Plots (20dB Delta from Carrier at Band Edge) - WLAN 802.11g

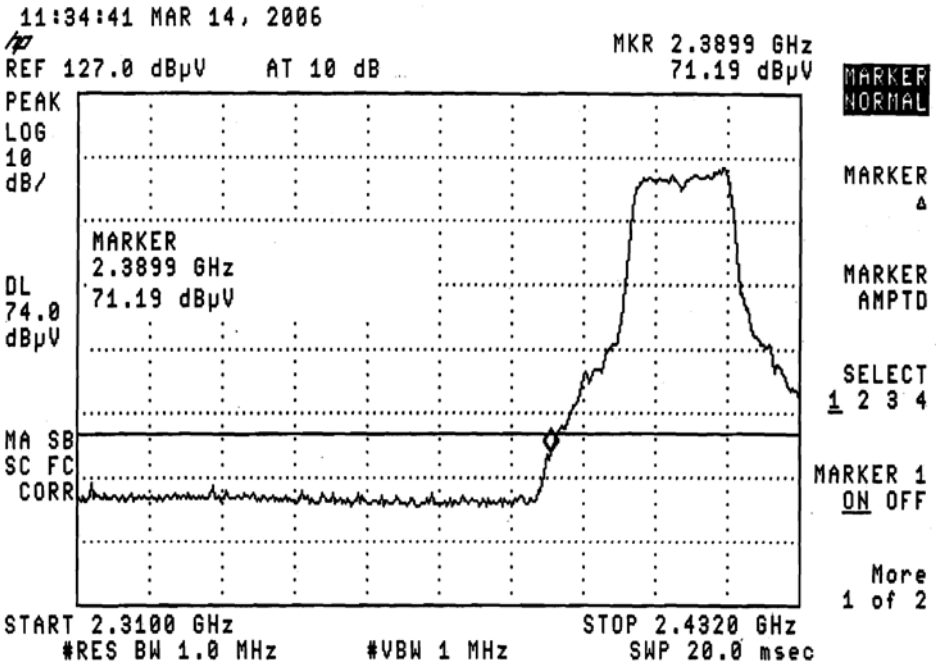


Plot 32 – Lower Band Edge at 2.4000GHz (WLAN 802.11g)

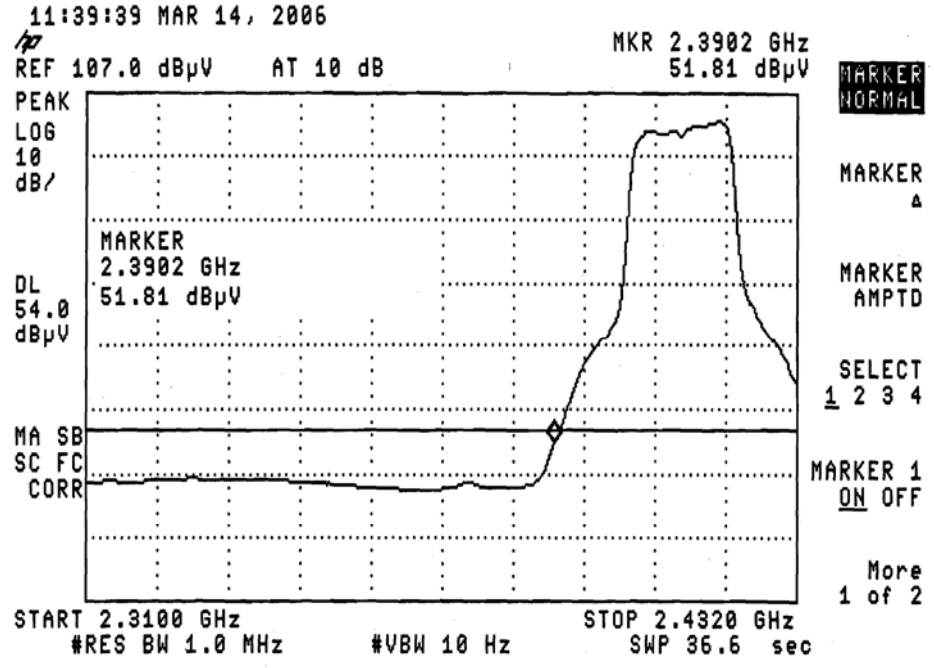


Plot 33 – Upper Band Edge at 2.4835GHz (WLAN 802.11g)

Band Edge Compliance Plots (Restricted Band) - WLAN 802.11g

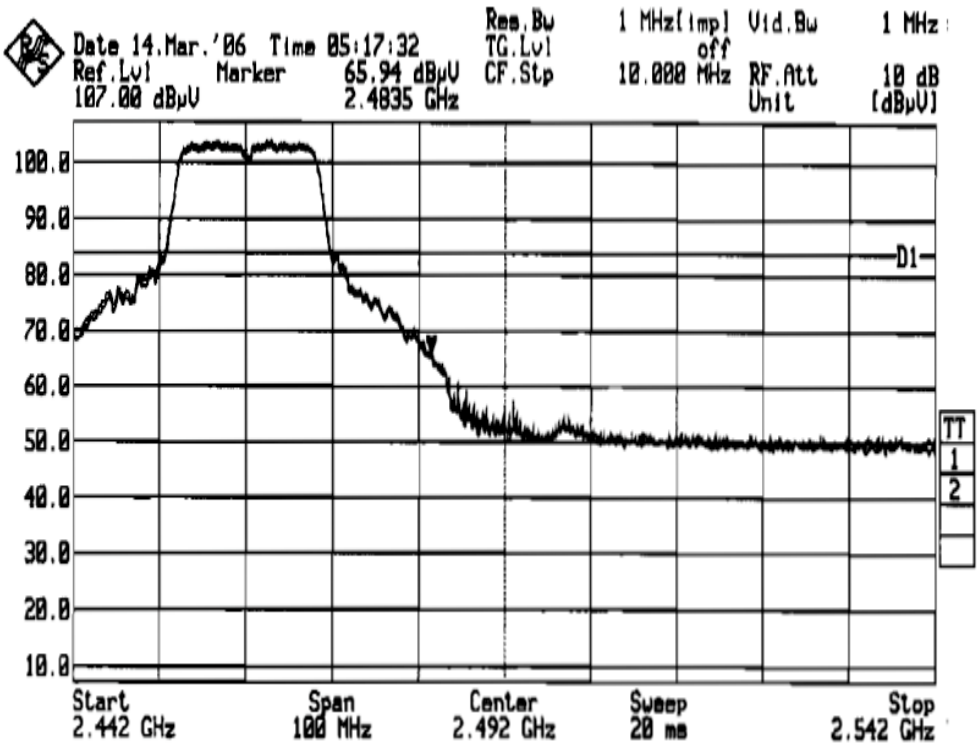


Plot 34 – Peak Plot for Lower Band Edge (WLAN 802.11g)

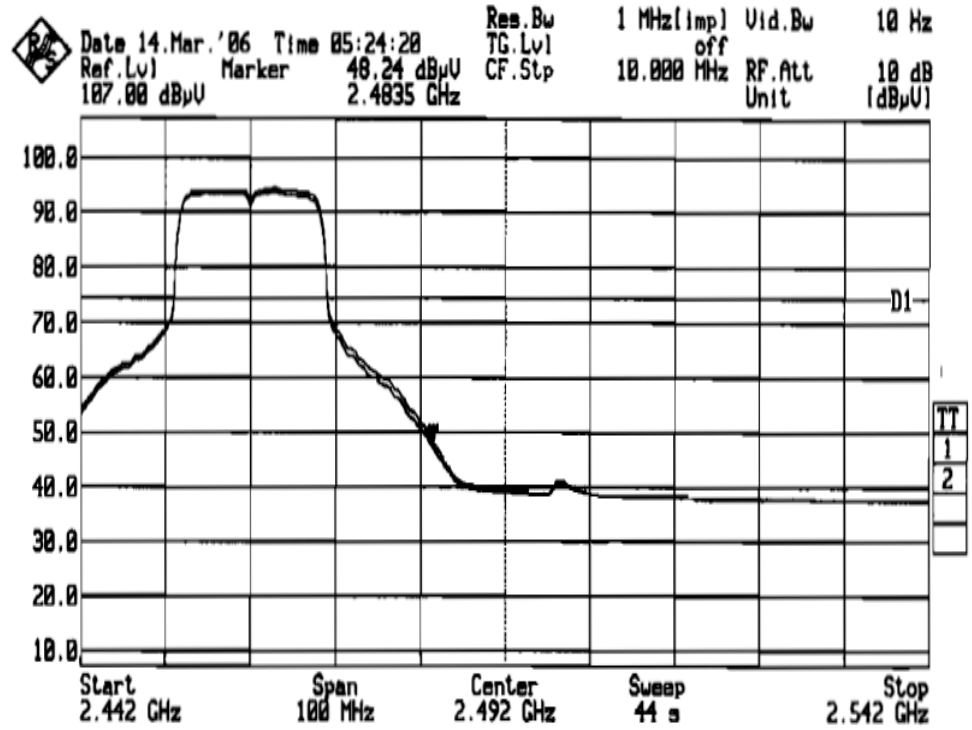


Plot 35 – Average Plot for Lower Band Edge (WLAN 802.11g)

Band Edge Compliance Plots (Restricted Band) - WLAN 802.11g



Plot 36 – Peak Plot for Upper Band Edge (WLAN 802.11g)



Plot 37 – Average Plot for Upper Band Edge (WLAN 802.11g)

PART 4

This part (Part 4) details the following test results on WLAN 802.11a:

1. **Conducted Emission Test**
2. **Radiated Emission Test**
3. **Maximum Peak Power Test**
4. **Band Edge Compliance Test**

FCC Parts 15.107(a) and 15.207 Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (QP)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz–26.5GHz) – ESMI2	ESMI	829214/006 829550/001	22 Apr 2006
EMCO LISN (for EUT) – LISN9	3825/2	9309-2128	24 Jan 2006
EMCO LISN (for supporting) – LISN6	3825/2	9309-2127	03 May 2006
R&S Pulse Limiter – PL2	ESH3-Z2	100347	15 Apr 2006

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50µH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10kHz. Both Quasi-peak and Average measurements were made.
5. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz Q-P limit (Class B) = 1000 µV = 60.0 dBµV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBµV
(Calibrated for system losses)

Therefore, Q-P margin = 40.0 - 60.0 = -20.0 i.e. **20.0 dB below Q-P limit**

Conducted Emissions Test Setup (Front View)

Conducted Emissions Test Setup (Rear View)

FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Operating Mode	WLAN 802.11a (Lower Band)	Temperature	22°C
Test Input Power	110V 60Hz	Relative Humidity	58%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Tan Swee Seng

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.1593	52.9	-12.6	47.1	-8.4	Live	36
0.2235	41.7	-21.0	35.4	-17.3	Neutral	36
0.3459	37.7	-21.4	27.6	-21.5	Neutral	36
13.4845	37.3	-22.7	27.1	-22.9	Neutral	36
19.0935	39.3	-20.7	29.3	-20.7	Live	36
19.7465	37.2	-22.8	27.1	-22.9	Live	36

Operating Mode	WLAN 802.11a (Middle Band)	Temperature	22°C
Test Input Power	110V 60Hz	Relative Humidity	58%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Tan Swee Seng

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.2357	47.8	-14.4	37.8	-14.4	Live	52
0.2847	40.9	-19.8	30.8	-19.9	Neutral	52
0.6025	29.6	-26.4	29.1	-16.9	Neutral	52
0.8560	29.6	-26.4	28.9	-17.1	Neutral	52
19.0935	39.3	-20.7	34.1	-15.9	Live	52
19.1910	38.2	-21.8	27.7	-22.3	Neutral	52

Operating Mode	WLAN 802.11a (Upper Band)	Temperature	22°C
Test Input Power	110V 60Hz	Relative Humidity	58%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Tan Swee Seng

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.2602	43.0	-18.4	32.9	-18.5	Neutral	149
0.3337	36.8	-22.6	26.7	-22.7	Neutral	149
0.5908	31.4	-24.6	25.4	-20.6	Neutral	149
13.5708	45.1	-14.9	41.6	-8.4	Live	149
19.3085	37.3	-22.7	32.8	-17.2	Live	149
19.6708	37.4	-22.6	28.9	-21.1	Live	149

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
4. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 9kHz – 30MHz (Average & Quasi-peak) is ±2.4dB.

FCC Part 15.205 Restricted Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
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	2690 - 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	3600 - 4400	Above 38.6
13.36 - 13.41			

FCC Parts 15.109(a) and 15.209 Radiated Emission Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m) @ 3m
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
Above 960	54.0*
* Above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
HP Preamplifier (100kHz-1.3GHz) – PA2	8447D	2944A08173	01 Apr 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
Schaffner Bilog Antenna – BL9	CBL6143	5045	13 May 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006
EMCO Horn Antenna – H14	3115	0003-6087	19 May 2006
HP Spectrum Analyser (30Hz-40GHz)	8564E	3846A01433	27 Apr 2006
Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Aug 2006

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which attitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from 30MHz to 10th harmonics of the EUT fundamental frequency or 40GHz whichever is lower, using the Bi-log antenna for frequencies from 30MHz up to 3GHz, and the Horn antenna above 3GHz.

Sample Calculation Example

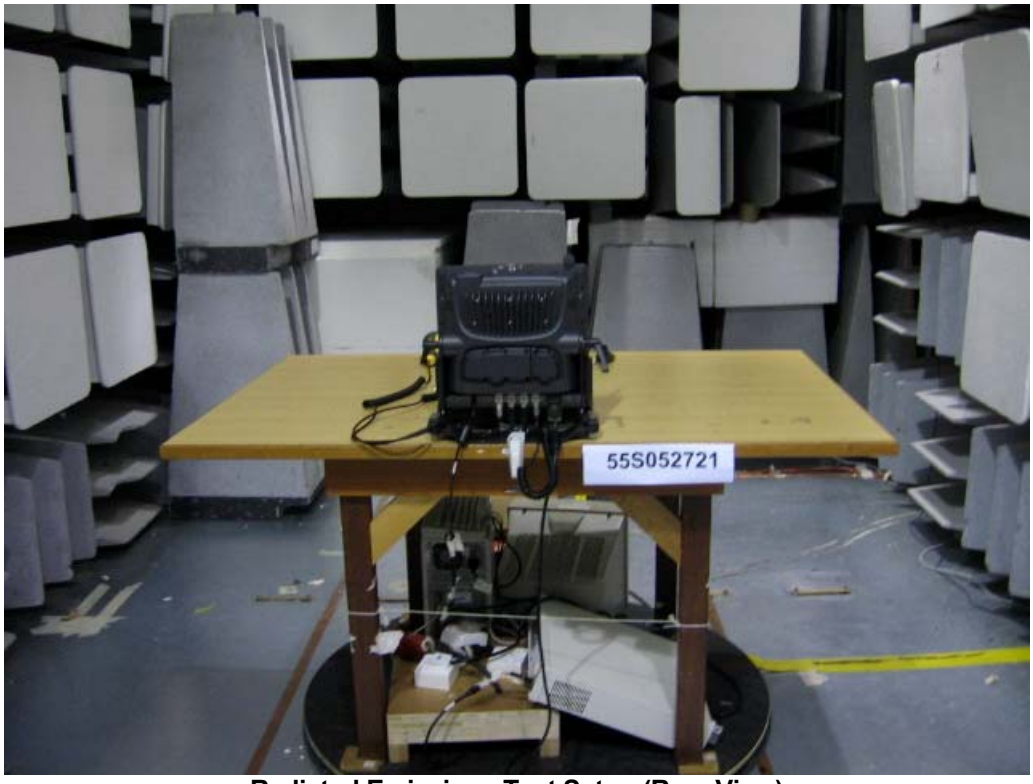
At 300 MHz Q-P limit (Class B) = 200 μV/m = 46.0 dBμV/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 40.0 - 46.0 = -6.0 i.e. **6 dB below Q-P limit**

Radiated Emissions Test Setup (Front View)



Radiated Emissions Test Setup (Rear View)

FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results

Operating Mode	WLAN 802.11a (Lower Band)	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)	Channel
91.4901	37.4	-6.1	0	100	V	36
127.0348	37.5	-6.1	0	100	V	36
281.2211	38.5	-7.5	24	102	V	36
363.4322	39.9	-6.1	55	130	H	36
--	--	--	--	--	--	--
--	--	--	--	--	--	--

Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m) Note 4	Average Margin (dB) Note 5	Azimuth (Degrees)	Height (cm)	Pol (H/V)	Channel
10.3602	48.4	--	-5.6	65	100	H	36
10.4809	48.5	--	-5.5	78	100	H	48
15.5404	44.3	--	-9.7	54	100	H	36
15.7205	43.1	--	-109	90	100	H	48
--	--	--	--	--	--	--	--
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FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results

Operating Mode	WLAN 802.11a (Middle Band)	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)	Channel
162.8901	36.2	-7.4	359	101	V	52
283.1711	40.8	-5.2	301	100	H	52
311.5045	37.1	-8.9	333	110	V	52
823.8912	36.7	-9.3	278	121	V	52
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Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m) Note 4	Average Margin (dB) Note 5	Azimuth (Degrees)	Height (cm)	Pol (H/V)	Channel
10.5203	48.5	--	-5.5	45	100	H	52
10.6401	48.1	--	-5.9	55	100	H	64
15.7806	43.2	--	-10.8	67	100	H	52
15.9602	43.7	--	-10.4	77	100	H	64
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FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results

Operating Mode	WLAN 802.11a (Upper Band)	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)	Channel
151.2311	33.3	-10.2	222	101	V	149
340.4301	35.8	-10.2	143	120	V	149
365.1290	30.1	-15.9	30	121	V	149
933.4581	40.7	-5.4	236	100	H	149
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Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m) Note 4	Average Margin (dB) Note 5	Azimuth (Degrees)	Height (cm)	Pol (H/V)	Channel
11.4903	47.8	--	-6.2	3	100	H	149
11.5702	48.1	--	-5.9	43	100	H	157
11.6101	48.1	--	-5.9	78	100	H	161
17.2350	44.5	--	-9.5	44	100	H	149
17.3551	43.5	--	-10.5	54	100	H	157
17.4150	43.2	--	-10.8	65	100	H	161

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. For the measurement below 1GHz, the worst case channel was selected for test.
3. The external antenna was used during the measurement as it was found to be the worst case configuration.
4. The transmitting antenna was found to be in the worst case condition when it was orientated in a vertical position.
5. As the measured peak shows compliance to the average limit, as such no average measurement was required.
6. The average margin indicates the margin of the measured peak value below the average limit.
7. "--" indicates no emissions were found and shows compliance to the limits.
8. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz.
9. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.

10. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
    30MHz - 1GHz
    RBW: 120kHz VBW: 1MHz
    >1GHz
    RBW: 1MHz VBW: 1MHz
11. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
12. The channel in the table refers to the transmit channel of the EUT.
13. Radiated Emissions Measurement Uncertainty
    All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 40GHz (QP only @ 3m & 10m) is ±4.3dB (for EUTs < 0.5m X 0.5m X 0.5m).

FCC Part 15.407(a) Maximum Output Power Limits

The EUT shows compliance to the requirements of this section, which states:

1. For the band 5.15GHz - 5.25GHz, the maximum output power over the frequency band of operation shall not exceeded the lesser of 50mW or 4dBm + 10logB, where B is the 26dB emission bandwidth in MHz.
2. For the 5.25GHz - 5.35GHz and 5.47GHz - 5.725GHz bands, the maximum output power over the frequency band of operation shall not exceeded the lesser of 250mW or 11dBm + 10logB, where B is the 26dB emission bandwidth in MHz.
3. For the 5.725GHz - 5.825GHz band, the maximum output power over the frequency band of operation shall not exceeded the lesser of 1W or 17dBm + 10logB, where B is the 26dB emission bandwidth in MHz.

FCC Part 15.407(a) Maximum Output Power Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP Spectrum Analyzer (30Hz-40GHz)	8564E	3846A01433	27 Apr 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006
EMCO Horn Antenna – H14	3115	0003-6087	19 May 2006
Agilent Synthesized Sweeper – SG10	83620B	3844A01337	24 Jan 2008

FCC Parts 15.407(a) Maximum Output Power Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 1MHz and 1/T where T is the pulse duration over which transmitter is on at maximum power.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.407(a) Maximum Output Power Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at Channel 36 (5.180GHz) with specified modulation and data rate.
2. The span of the spectrum analyser was set to wide enough to encompass the emission bandwidth of the transmitting signal.
3. The signal capturing was set in max hold mode and last for 60 seconds.
4. The maximum output power was computed by integrating the spectrum across the 26dB entire emission bandwidth (EBW) or apply a bandwidth correction factor of 10log (EBW / 1MHz) to the spectral peak of the emission.
5. Repeat steps 1 to 4 on channels 48 (5.240GHz), 52 (5.260GHz), 64 (5.320GHz), 149 (5.745GHz), 157 (5.785GHz), and 161 (5.805GHz) respectively.

Maximum Output Power Test Setup

FCC Part 15.407(a) Maximum Output Power Results

Operating Mode	WLAN 802.11a	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
		Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)	Data Rate

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)	Data Rate
Lower Band				
36	5.180	0.0011	0.050	6Mbps
48	5.240	0.0007	0.050	6Mbps
Middle Band				
52	5.260	0.0013	0.250	6Mbps
64	5.320	0.0035	0.250	6Mbps
Upper Band				
149	5.745	0.0034	1.000	6Mbps
157	5.785	0.0043	1.000	6Mbps
161	5.805	0.0036	1.000	6Mbps

FCC Part 15.407(b) Band Edge Compliance Limits

The EUT shows compliance to the requirements of this section, which states:

1. For transmitter operating in the 5.15GHz - 5.25GHz band, all emissions outside the 5.15GHz - 5.25GHz band shall not exceed an EIRP of -27dBm/MHz.
2. For transmitter operating in the 5.25GHz - 5.35GHz band, all emissions outside of the 5.15GHz - 5.35GHz band shall not exceed an EIRP of -27dBm/MHz.
3. For transmitter operating in the 5.725GHz - 5.825GHz band, all emissions within the frequency range from the band edge to 10MHz above or below the band edge shall not exceed an EIRP of -17dBm/MHz. For frequencies 10MHz or greater above or below the band edge, emissions shall not exceed an EIRP of -27dBm/MHz.

FCC Part 15.407(b) Band Edge Compliance Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006

FCC Part 15.407(b) Band Edge Compliance Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF external antenna connector was connected to the EUT.
4. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.407(b) Band Edge Compliance Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at Channel 36 (5.180GHz) with specified modulation and data rate.
2. The spurious emission at the band edge of 5.150GHz were captured and recorded.
3. The EUT was replaced with the substitution antenna with the antenna input was connected to the signal generator via a 10dB attenuator (if possible). The antenna was set to vertical polarization.
4. The signal generator was set to the recorded spurious frequency in step 2. The output level of the signal generator was adjusted until the test receiver was at least 20dB above the level when the signal generator was switched off.
5. The test antenna was raised and lowered through the specified range of heights (1m – 4m) until the maximum signal level was received on the test receiver.
6. The substitution antenna was rotated until the maximum level was detected on the test receiver.
7. The output level of the signal generator was adjusted until the received signal level at the test receiver was equal to the level recorded in step 2 (A dBm). The signal generator output level was recorded as B (in dBm).
8. The spurious emission at the band edge, P (e.i.r.p) was computed as followed:

P (e.i.r.p) = B – C – D + E

where C = Cable loss between the signal generator and the substitution

D = Attenuation level if attenuator is used

E = Substitution antenna gain

9. The steps 5 to 8 were repeated with the receiving antenna was set to horizontal polarization.
10. Comparison was made on both measured results with vertical and horizontal polarizations. The highest value out of vertical and horizontal polarizations was recorded.
11. The steps 1 to 10 were repeated with the EUT was set to transmit at Channel 64 to capture band edge spurious emission at band edge 5.35GHz.
12. The steps 1 to 10 were repeated with the EUT was set to transmit at Channels 149 and 161 to capture the spurious emission band edge at 5.725GHz and 5.825GHz respectively.

Band Edge Compliance Test Setup

FCC Part 15.407(b) Band Edge Compliance Results

Operating Mode	WLAN 802.11a	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Attached Plots	38 - 41	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

5.15GHz - 5.35GHz @ 6Mbps (WLAN 802.11a) (See plots 38 - 39 for details)

Spurious (GHz)	Maximum EIRP outside Band edge (dBm)	Limit (dBm)	Margin (dB)
Lower Edge			
<5.15GHz	--	-27	--
Upper Edge			
>5.35GHz	--	-27	--

See plots 36 - 37 for details

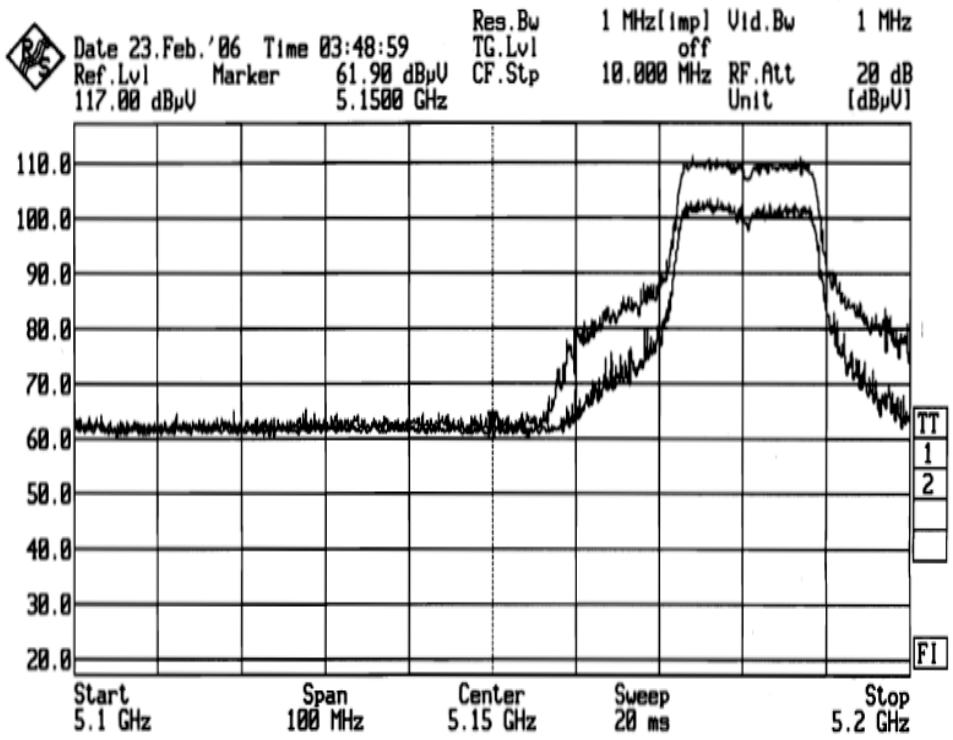
5.725GHz - 5.825GHz @ 6Mbps (WLAN 802.11a) (See plots 40 - 41 for details)

Spurious (GHz)	Maximum EIRP outside Band edge (dBm)	Limit (dBm)	Margin (dB)
Lower Edge			
5.715 - 5.725	--	-17.0	--
< 5.715	--	-27.0	--
Upper Edge			
5.825 - 5.835	--	-17.0	--
>5.835	--	-27.0	--

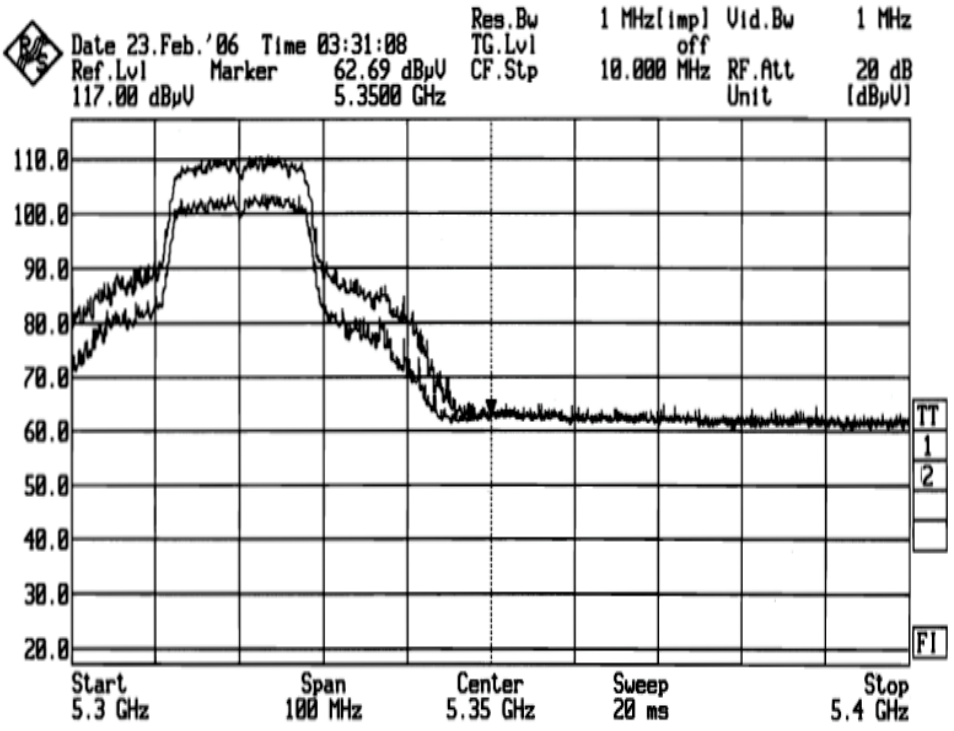
Notes

1. "--" indicates no emissions were found and shows compliance to the limits.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.

Band Edge Compliance Plots - WLAN 802.11a (5.150GHz - 5.350GHz)

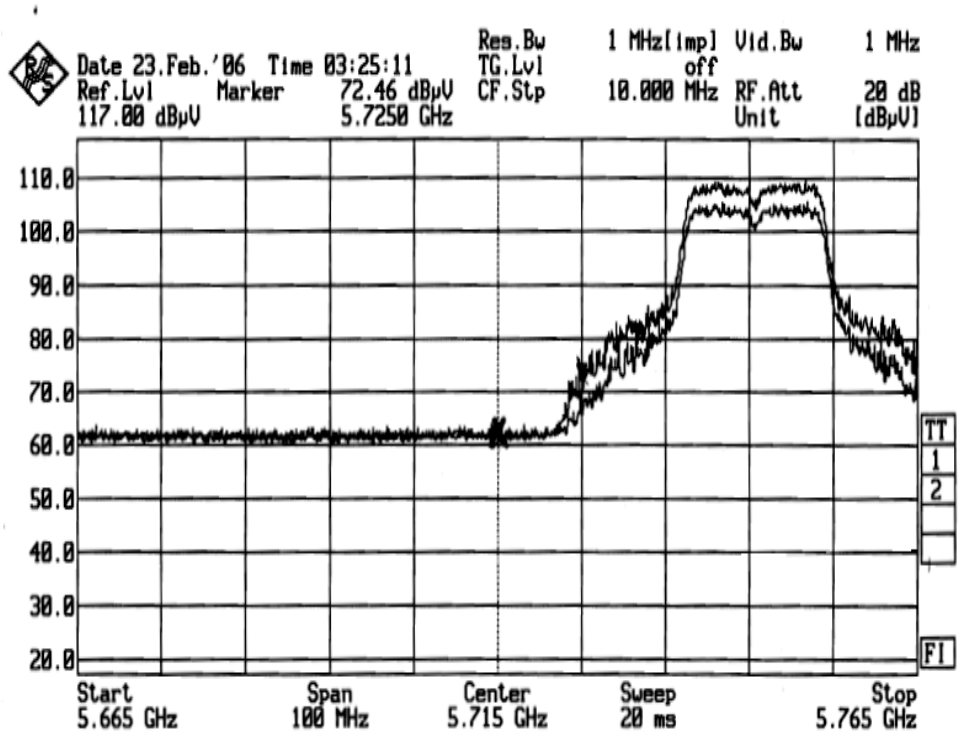


Plot 38 – Lower Band Edge at 5.1500GHz

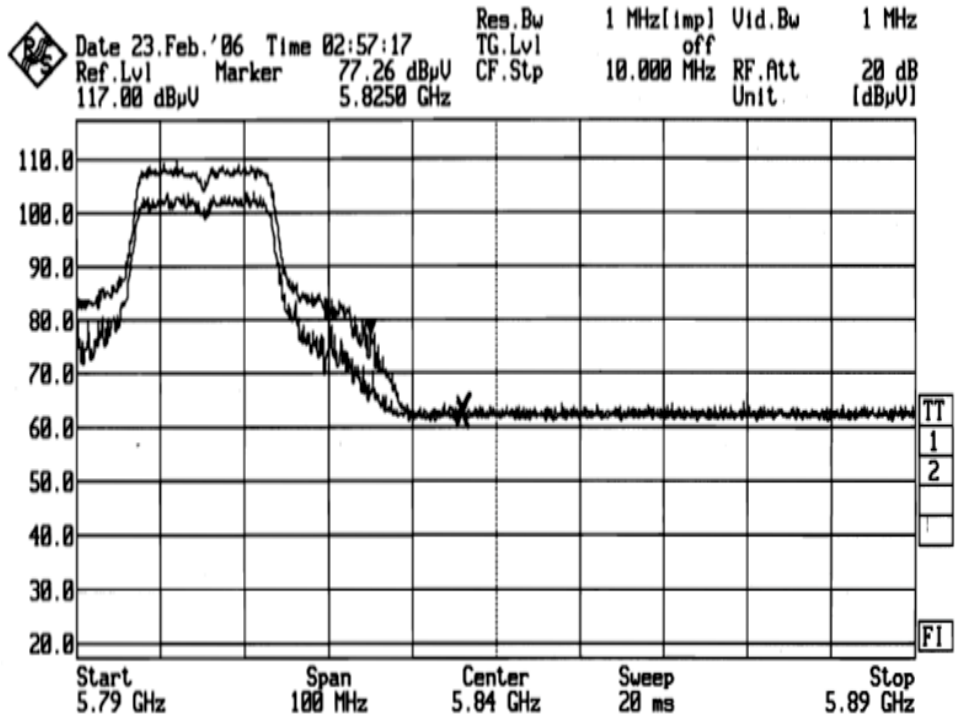


Plot 39 – Upper Band Edge at 5.3500GHz

Band Edge Compliance Plots - WLAN 802.11a (5.725GHz - 5.825GHz)



Plot 40 – Lower Band Edge at 5.7250GHz



Plot 41 – Upper Band Edge at 5.8250GHz

PART 5

This part (Part 5) details the following test results on WLAN 802.11a (ISM Band):

1. **Conducted Emission Test**
2. **Radiated Emission Test**
3. **Maximum Peak Power Test**
4. **Band Edge Compliance Test**

FCC Parts 15.107(a) and 15.207 Conducted Emission Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (QP)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz–26.5GHz) – ESMI2	ESMI	829214/006 829550/001	22 Apr 2006
EMCO LISN (for EUT) – LISN9	3825/2	9309-2128	24 Jan 2006
EMCO LISN (for supporting) – LISN6	3825/2	9309-2127	03 May 2006
R&S Pulse Limiter – PL2	ESH3-Z2	100347	15 Apr 2006

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50µH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
4. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10kHz. Both Quasi-peak and Average measurements were made.
5. Steps 2 to 4 were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz Q-P limit (Class B) = 1000 µV = 60.0 dBµV

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBµV
(Calibrated for system losses)

Therefore, Q-P margin = 40.0 - 60.0 = -20.0 i.e. **20.0 dB below Q-P limit**

Conducted Emissions Test Setup (Front View)

Conducted Emissions Test Setup (Rear View)

FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Operating Mode	WLAN 802.11a (ISM Band)	Temperature	22°C
Test Input Power	110V 60Hz	Relative Humidity	58%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
		Tested By	Tan Swee Seng

Frequency (MHz)	Q-P Value (dBμV)	Q-P Margin (dB)	AV Value (dBμV)	AV Margin (dB)	Line	Channel
0.2847	42.1	-18.6	35.0	-15.7	Neutral	165
0.3459	35.8	-23.3	25.7	-23.4	Neutral	165
0.5908	31.5	-24.5	25.4	-20.6	Live	165
19.1910	39.4	-20.6	32.3	-17.7	Live	165
19.3930	38.2	-21.8	29.8	-20.2	Neutral	165
19.6455	37.1	-22.9	28.9	-21.1	Live	165

Notes

1. All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.
3. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 10kHz VBW: 30kHz
4. Conducted Emissions Measurement Uncertainty
   All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 9kHz – 30MHz (Average & Quasi-peak) is ±2.4dB.

FCC Part 15.205 Restricted Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
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	2690 - 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	3600 - 4400	Above 38.6
13.36 - 13.41			

FCC Parts 15.109(a) and 15.209 Radiated Emission Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m) @ 3m
30 - 88	40.0
88 - 216	43.5
216 - 960	46.0
Above 960	54.0*
* Above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
HP Preamplifier (100kHz-1.3GHz) – PA2	8447D	2944A08173	01 Apr 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
Schaffner Bilog Antenna – BL9	CBL6143	5045	13 May 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006
EMCO Horn Antenna – H14	3115	0003-6087	19 May 2006
HP Spectrum Analyser (30Hz-40GHz)	8564E	3846A01433	27 Apr 2006
Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Aug 2006

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Setup

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

FCC Parts 15.109(a) and 15.209 Radiated Emission Test Method

5. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which attitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point that above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from 30MHz to 10th harmonics of the EUT fundamental frequency or 40GHz whichever is lower, using the Bi-log antenna for frequencies from 30MHz up to 3GHz, and the Horn antenna above 3GHz.

Sample Calculation Example

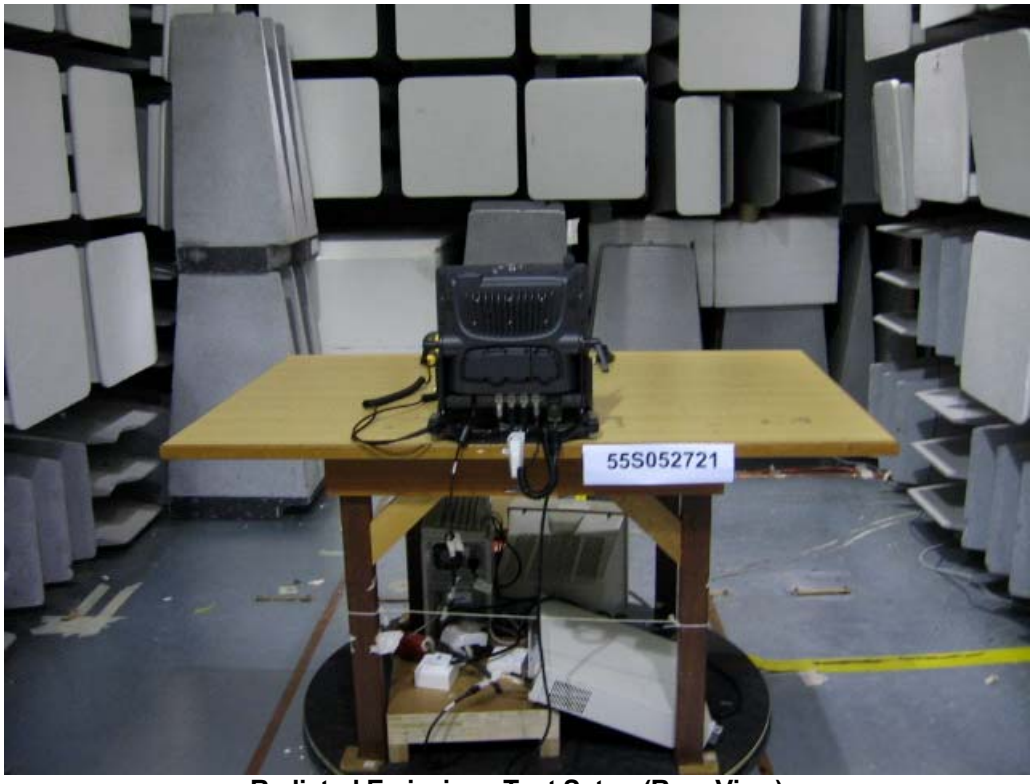
At 300 MHz Q-P limit (Class B) = 200 μV/m = 46.0 dBμV/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m
(Calibrated level including antenna factors & cable losses)

Therefore, Q-P margin = 40.0 - 46.0 = -6.0 i.e. **6 dB below Q-P limit**

Radiated Emissions Test Setup (Front View)



Radiated Emissions Test Setup (Rear View)

FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results

Operating Mode	WLAN 802.11a (ISM Band)	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Test Distance	3m	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBμV/m)	Q-P Margin (dB)	Azimuth (Degrees)	Height (cm)	Polarisation (H/V)	Channel
340.1145	36.9	-9.1	21	120	H	165
383.9763	31.2	-14.8	3	115	H	165
458.3478	29.8	-16.2	255	100	V	165
541.7712	35.9	-10.1	340	100	H	165
601.4219	34.3	-11.7	168	103	V	165
739.9986	38.5	-7.5	171	100	H	165

Spurious Emissions above 1GHz

Frequency (GHz)	Peak Value (dBμV/m)	Average Value (dBμV/m) Note 4	Average Margin (dB) Note 5	Azimuth (Degrees)	Height (cm)	Pol (H/V)	Channel
11.6502	47.5	--	-6.5	87	103	H	165
17.4750	44.3	--	-9.7	66	100	H	165
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--

Notes

1. All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2. For the measurement below 1GHz, the worst case channel was selected for test.
3. The external antenna was used during the measurement as it was found to be the worst case configuration.
4. The transmitting antenna was found to be in the worst case condition when it was orientated in a vertical position.
5. As the measured peak shows compliance to the average limit, as such no average measurement was required.
6. The average margin indicates the margin of the measured peak value below the average limit.
7. "--" indicates no emissions were found and shows compliance to the limits.
8. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz.
9. A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.

10. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
    30MHz - 1GHz
    RBW: 120kHz VBW: 1MHz
    >1GHz
    RBW: 1MHz VBW: 1MHz
11. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
12. The channel in the table refers to the transmit channel of the EUT.
13. Radiated Emissions Measurement Uncertainty
    All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 30MHz – 40GHz (QP only @ 3m & 10m) is ±4.3dB (for EUTs < 0.5m X 0.5m X 0.5m).

FCC Part 15.247(b)(3) Maximum Peak Power Limits

The EUT shows compliance to the requirements of this section, which states the maximum peak power of the EUT employing digital modulation shall not exceed 1W (30dBm).

FCC Part 15.247(b)(3) Maximum Peak Power Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
Agilent Synthesized Sweeper – SG10	83620B	3844A01337	24 Jan 2008
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006
EMCO Horn Antenna – H14	3115	0003-6087	19 May 2006

FCC Part 15.247(b)(3) Maximum Peak Power Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF external antenna connector was connected to the EUT.
4. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(b)(3) Maximum Peak Power Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at Channel 165 (5.825GHz) with specified modulation and data rate.
2. The maximum peak power of the transmitting frequency was detected and recorded.
3. The EUT was replaced with the substitution antenna with the antenna input was connected to the signal generator via a 10dB attenuator (if possible). The antenna was set to vertical polarization.
4. The signal generator was set to the recorded transmitting frequency in step 2. The output level of the signal generator was adjusted until the test receiver was at least 20dB above the level when the signal generator was switched off.
5. The test antenna was raised and lowered through the specified range of heights (1m – 4m) until the maximum signal level was received on the test receiver.
6. The substitution antenna was rotated until the maximum level was detected on the test receiver.
7. The output level of the signal generator was adjusted until the received signal level at the test receiver was equal to the level recorded in step 2 (A dBm). The signal generator output level was recorded as B (in dBm).
8. The maximum peak power, P (e.i.r.p) was computed as followed:

   P (e.i.r.p) = B – C – D + E

   where C = cable loss between the signal generator and the substitution

   D = attenuation level if attenuator is used

   E = substitution antenna gain
9. The steps 5 to 8 were repeated with the receiving antenna was set to horizontal polarization.
10. Comparison was made on both measured results with vertical and horizontal polarizations. The highest value out of vertical and horizontal polarizations was recorded.

Maximum Peak Power Test Setup

FCC Part 15.247(b)(3) Maximum Peak Power Results

Operating Mode	WLAN 802.11a (ISM Band)	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
		Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)	Data Rate
165	5.825	0.0046	1.000	6Mbps

Notes

1. The measurement was done using an external antenna attached to the EUT, which was found to be emitting the highest RF power. The antenna was orientated in a vertical position where the highest emission was detected.

FCC Part 15.247(d) Band Edge Compliance Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

FCC Part 15.247(d) Band Edge Compliance Test Instrumentation

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829214/005 829550/004	04 Oct 2006
MITEQ Preamplifier (0.1-26.5GHz) – PA4	NSP2650-N	604879	07 Nov 2006
EMCO Horn Antenna – H15	3115	0003-6088	19 May 2006

FCC Part 15.247(d) Band Edge Compliance Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF external antenna connector was connected to the EUT.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.
5. All other supporting equipment were powered separately from another filtered mains.

FCC Part 15.247(d) Band Edge Compliance Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with specified modulation and data rate.
2. The frequency span of the spectrum analyser was set to wide enough to capture the band edge of the transmission band, 2.5850GHz and any spurious emissions at the band edge.
3. The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

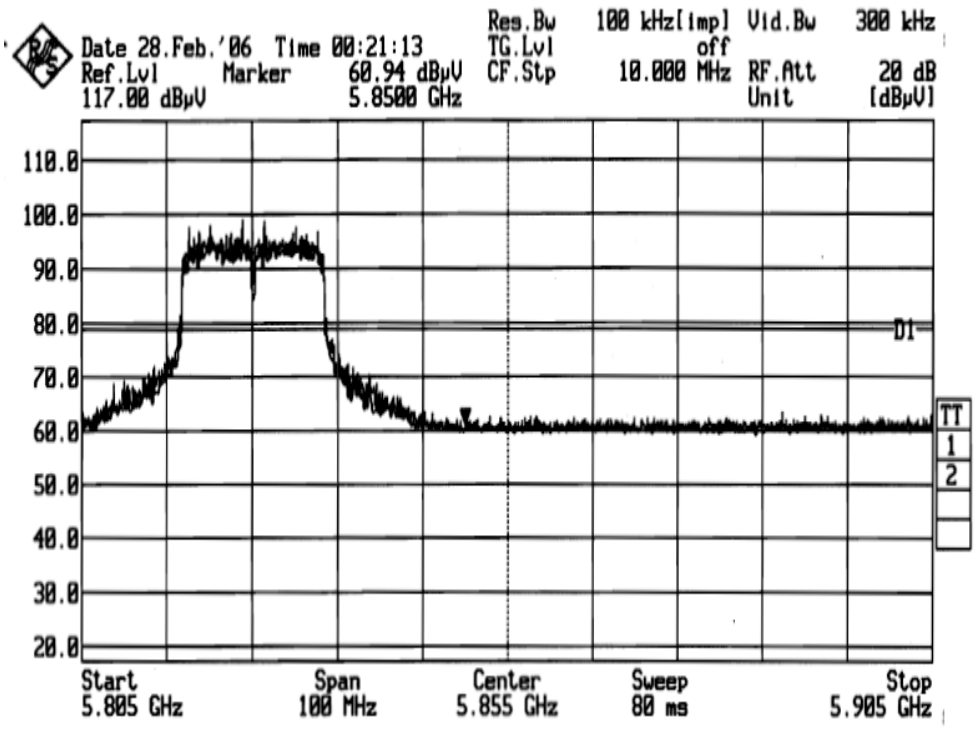
Band Edge Compliance Test Setup

FCC Part 15.247(d) Band Edge Compliance Results

Operating Mode	WLAN 802.11b (ISM Band)	Temperature	23°C
Test Input Power	110V 60Hz	Relative Humidity	55%
Attached Plots	42	Atmospheric Pressure	1030mbar
		Tested By	Thor Wen Lei

No significant signal was found and they were below the specified limit.

Band Edge Compliance Plots - WLAN 802.11a (ISM Band)



Plot 42 – Upper Band Edge at 5.8500GHz @ 6Mbps

PART 6

This part (Part 6) details the following test results on Bluetooth and WLAN 802.11a/b/g:

1. **Maximum Permissible Exposure (MPE) Test**
2. **Duty Cycle Computation**

FCC Part 1.1310 Maximum Permissible Exposure (MPE) Limits

The EUT shows compliance to the requirements of this section, which states the MPE limits for general population / uncontrolled exposure are as shown below:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (min)
0.3 - 1.34	614	1.63	100 Note 2	30
1.34 - 30	824 / f	2.19 / f	180 / f^2 Note 2	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f / 1500	30
1500 - 100000	-	-	1.0	30
Notes				
1. f = frequency in MHz				
2. Plane wave equivalent power density				

FCC Part 1.1310 Maximum Permissible Exposure (MPE) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
PMM 8053 Portable Field Meter	8053	0220J10308	02 Apr 2006
PMM Electric and Magnetic Field Analyzer	EHP-50A	1311L10515	02 Apr 2006

FCC Part 1.1310 Maximum Permissible Exposure (MPE) Test Setup

1. The EUT and supporting equipment were set up as shown on the setup photo.
2. The relevant field probe was positioned at least 20cm away from the EUT and supporting equipment boundary.

FCC Part 1.1310 Maximum Permissible Exposure (MPE) Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was first carried out at one of the positions / sides of the EUT.
3. Power density measurement (mW/cm^2) was made using the field meter set to the required averaging time.
4. Steps 2 and 3 were repeated for the next position and its associate EUT operating mode, until all possible positions and modes were measured.

Sample Calculation Example

At 2400 MHz, limit = 1.0 mW/cm^2

Power density reading obtained directly from field meter = 0.3 mW/cm^2 averaged over the required 30 minutes.

Therefore, margin = 0.3 – 1.0 = -0.7 mW/cm^2 i.e. **0.7 mW/cm^2 below limit**

Maximum Permissible Exposure (MPE) Test Setup

FCC Part 1.1310 Maximum Permissible Exposure (MPE) Results

Operating Mode	Bluetooth	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Test Distance	20cm	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Channel	Channel Frequency (GHz)	Power Density Value (mW/cm^2)	Margin (mW/cm^2)	Averaging Time (min)	Limit (mW/cm^2)
0	2.402	0.0001	-0.9999	30	1.0
39	2.441	0.0001	-0.9999	30	1.0
78	2.480	0.0001	-0.9999	30	1.0

Operating Mode	Bluetooth + WLAN 802.11b	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Test Distance	20cm	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Channel	Channel Frequency (GHz)	Power Density Value (mW/cm^2)	Margin (mW/cm^2)	Averaging Time (min)	Limit (mW/cm^2)
0 (Bluetooh) + 1 (802.11b)	2.402 (Bluetooth) + 2.412 (802.11b)	0.0158	-0.9842	30	1.0
39 (Bluetooh) + 7 (802.11b)	2.441 (Bluetooth) + 2.437 (802.11b)	0.0162	-0.9838	30	1.0
78 (Bluetooh) + 11 (802.11b)	2.480 (Bluetooth) + 2.462 (802.11b)	0.0155	-0.9845	30	1.0

Operating Mode	Bluetooth + WLAN 802.11g	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Test Distance	20cm	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Channel	Channel Frequency (GHz)	Power Density Value (mW/cm^2)	Margin (mW/cm^2)	Averaging Time (min)	Limit (mW/cm^2)
0 (Bluetooh) + 1 (802.11g)	2.402 (Bluetooth) + 2.412 (802.11g)	0.0112	-0.9888	30	1.0
39 (Bluetooh) + 7 (802.11g)	2.441 (Bluetooth) + 2.437 (802.11g)	0.0120	-0.9880	30	1.0
78 (Bluetooh) + 11 (802.11g)	2.480 (Bluetooth) + 2.462 (802.11g)	0.0115	-0.9885	30	1.0

Operating Mode	Bluetooth + WLAN 802.11a	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Test Distance	20cm	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Channel	Channel Frequency (GHz)	Power Density Value (mW/cm^2)	Margin (mW/cm^2)	Averaging Time (min)	Limit (mW/cm^2)
0 (Bluetooh) + 36 (802.11a)	2.402 (Bluetooth) + 5.180 (802.11a)	0.0135	-0.9865	30	1.0
78 (Bluetooh) + 48 (802.11a)	2.480 (Bluetooth) + 5.240 (802.11a)	0.0136	-0.9864	30	1.0
0 (Bluetooh) + 52 (802.11a)	2.402 (Bluetooth) + 5.260 (802.11a)	0.0144	-0.9856	30	1.0
78 (Bluetooh) + 64 (802.11a)	2.480 (Bluetooth) + 5.320 (802.11a)	0.0145	-0.9855	30	1.0
0 (Bluetooh) + 149 (802.11a)	2.402 (Bluetooth) + 5.745 (802.11a)	0.0144	-0.9856	30	1.0
39 (Bluetooh) + 157 (802.11a)	2.441 (Bluetooth) + 5.785 (802.11a)	0.0156	-0.9844	30	1.0
78 (Bluetooh) + 161 (802.11a)	2.480 (Bluetooth) + 5.805 (802.11a)	0.0154	-0.9846	30	1.0

Operating Mode	Bluetooth + WLAN 802.11a (ISM Band)	Temperature	24°C
Test Input Power	110V 60Hz	Relative Humidity	52%
Test Distance	20cm	Atmospheric Pressure	1029mbar
		Tested By	Foo Kai Maun

Channel	Channel Frequency (GHz)	Power Density Value (mW/cm^2)	Margin (mW/cm^2)	Averaging Time (min)	Limit (mW/cm^2)
0 (Bluetooh) + 165 (802.11a)	2.402 (Bluetooth) + 5.825 (802.11a)	0.0143	-0.9857	30	1.0
39 (Bluetooh) + 165 (802.11a)	2.441 (Bluetooth) + 5.825 (802.11a)	0.0144	-0.9856	30	1.0
78 (Bluetooh) + 165 (802.11a)	2.480 (Bluetooth) + 5.825 (802.11a)	0.0139	-0.9861	30	1.0

Notes

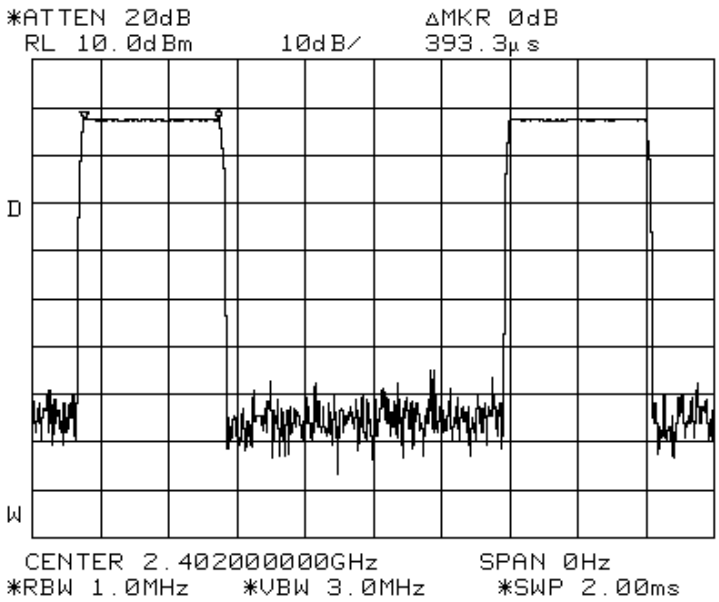
1. All possible modes of operation were investigated. Only the worst case highest radiation levels were measured. Measurements were taken at the required averaging time. All other radiation levels were relatively insignificant.

2 A "-ve" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency.

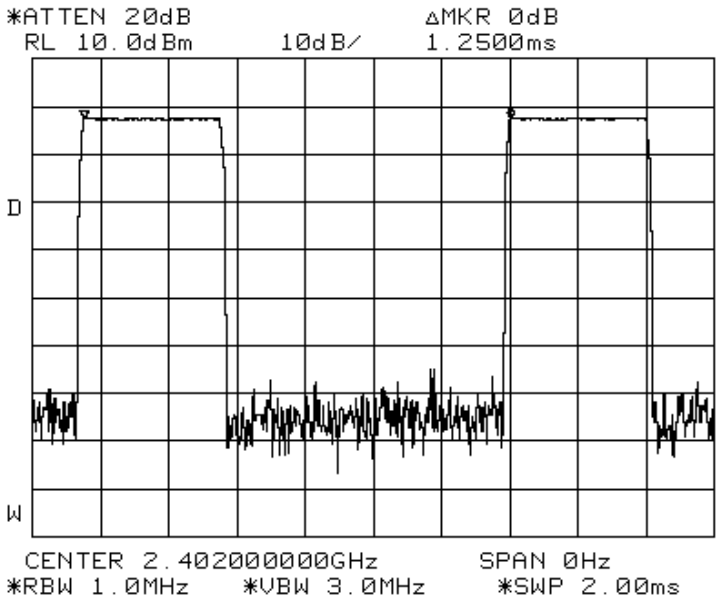
3 Measurement Uncertainty

All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2, in the range 0.1MHz – 3GHz is ±15%.

FCC Part 15.35(c) Duty Cycle Correction Factor - Bluetooth



On Time



Period

Duty Cycle Factor (worst- case) = 20 log [Total On time / Period]
= 20 log [(0.3933 / 1.25)]
= **-10.0dB**

This Report is issued under the following conditions:

1. Results of the testing/calibration in the form of a report will be issued immediately after the service has been completed or terminated.

2. Unless otherwise requested, a report shall contain only technical results. Analysis and interpretation of the results and professional opinion and recommendations expressed thereupon, if required, shall be clearly indicated and additional fee paid for, by the Client.

3. This report applies to the sample of the specific product/equipment given at the time of its testing/calibration. The results are not used to indicate or imply that they are applicable to other similar items. In addition, such results must not be used to indicate or imply that PSB Corporation approves, recommends or endorses the manufacturer, supplier or user of such product/equipment, or that PSB Corporation in any way "guarantees" the later performance of the product/equipment.

4. The sample/s mentioned in this report is/are submitted/supplied/manufactured by the Client. PSB Corporation therefore assumes no responsibility for the accuracy of information on the brand name, model number, origin of manufacture, consignment or any information supplied.

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10. Unless otherwise stated, the tests are carried out in PSB Corporation Pte Ltd, No.1 Science Park Drive Singapore 118221.

May 2005

ANNEX A

EUT PHOTOGRAPHS / DIAGRAMS

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

EUT PHOTOGRAPHS

Front View (With External Antenna Attached)

Rear View (With External Antenna Attached)

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

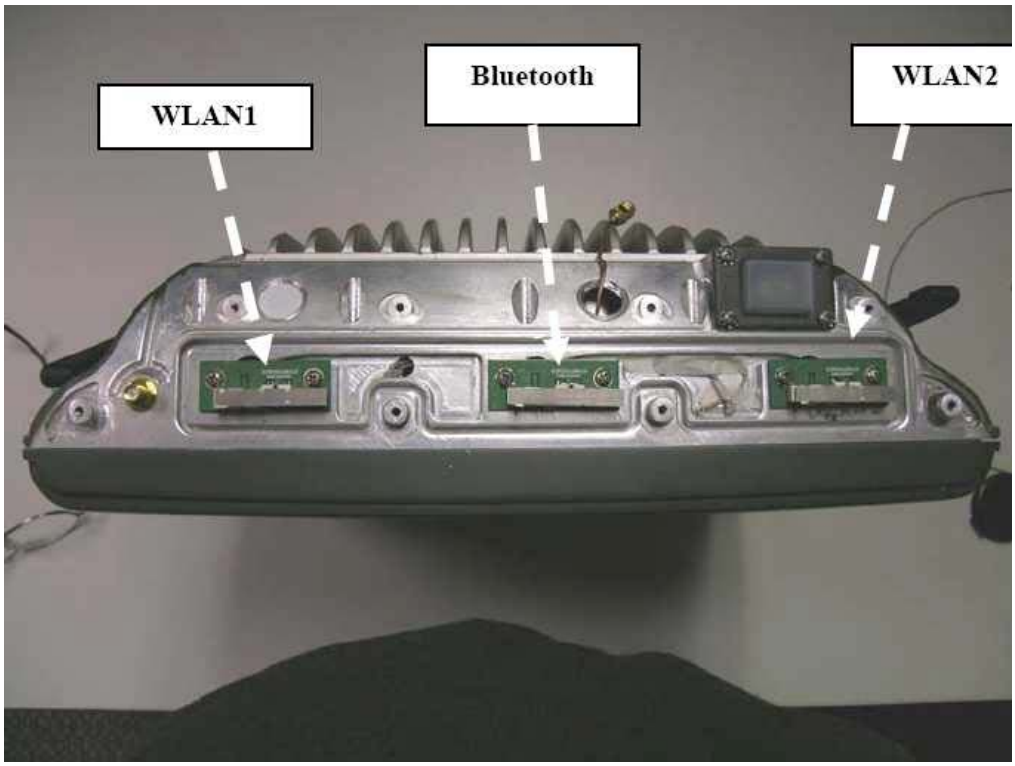
EUT PHOTOGRAPHS

Front View (With External Antenna Removed)

Rear View (With External Antenna Removed)

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

EUT PHOTOGRAPHS



EUT's Internal Antennas

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

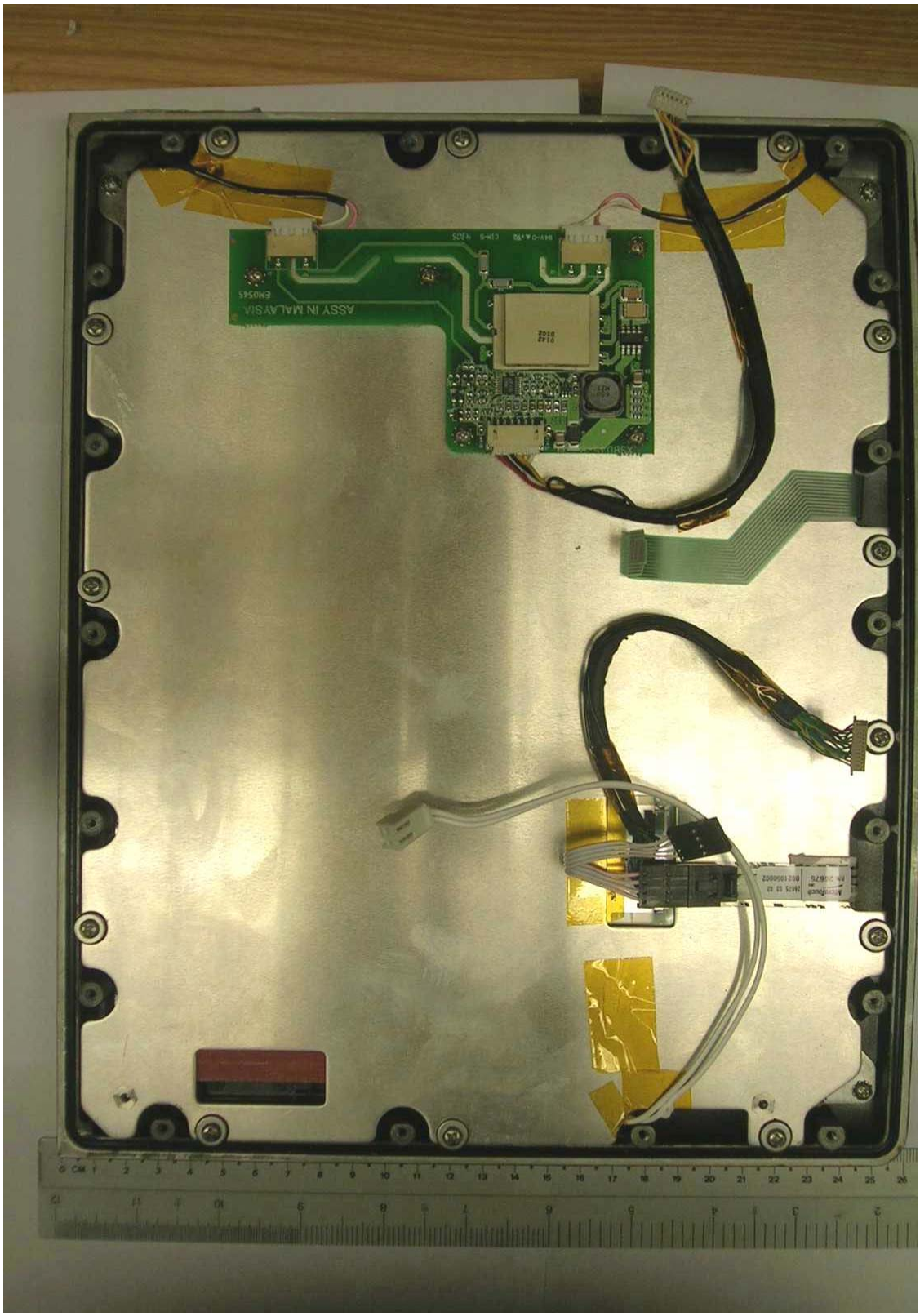
EUT PHOTOGRAPHS

Antenna Port on the EUT

EUT's External Antenna

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

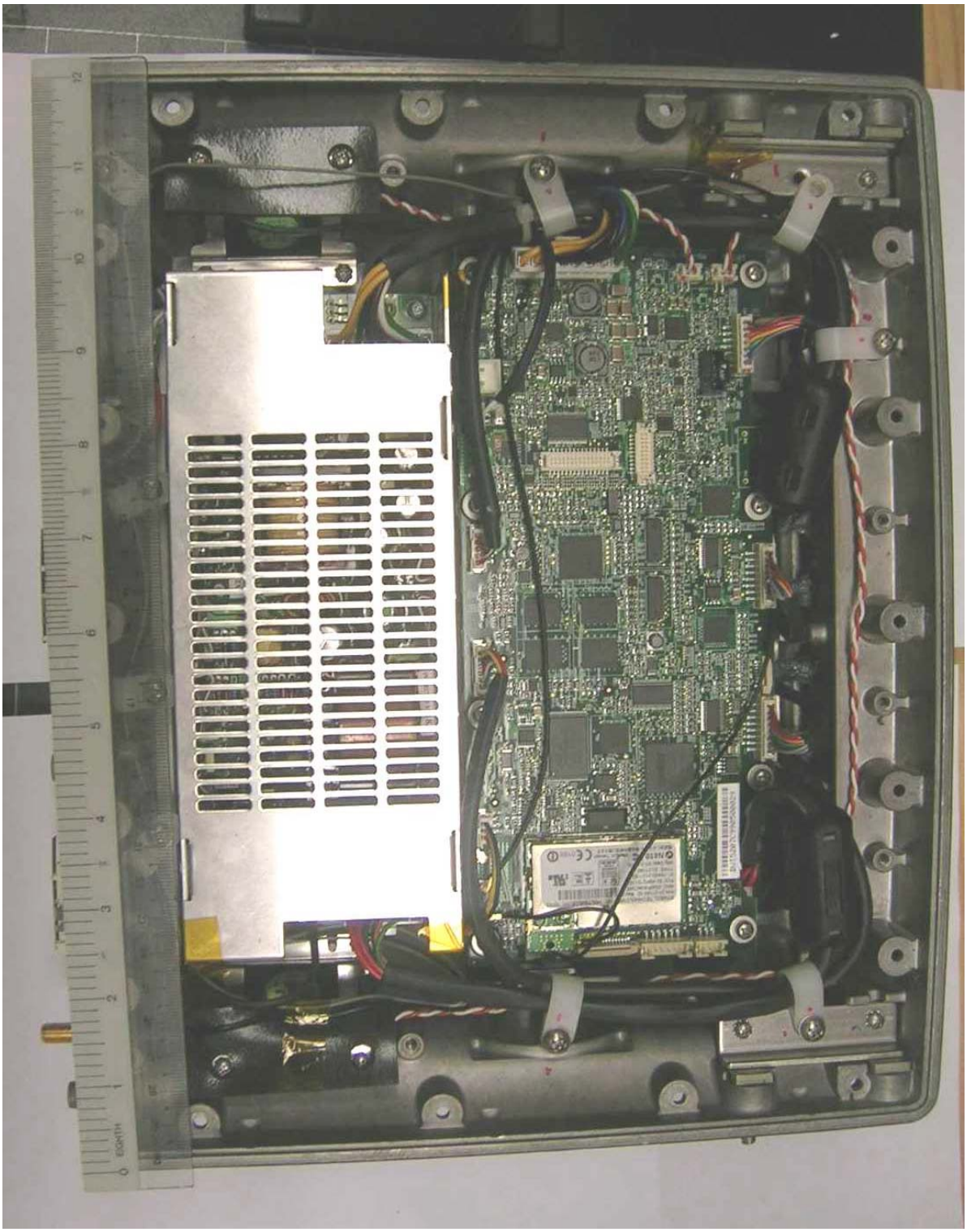
EUT PHOTOGRAPHS



EUT Internal View 1

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

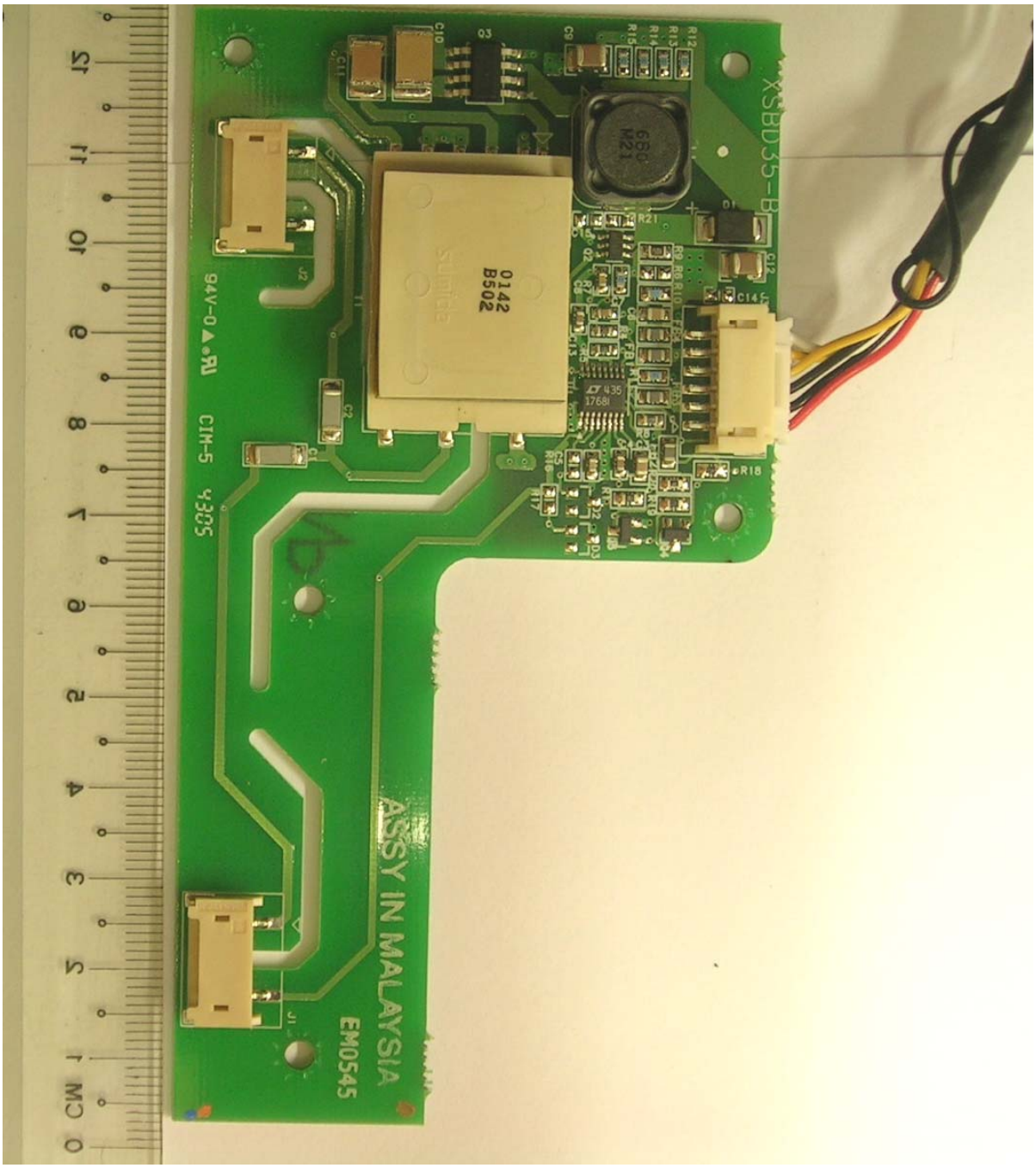
EUT PHOTOGRAPHS



EUT Internal View 2

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

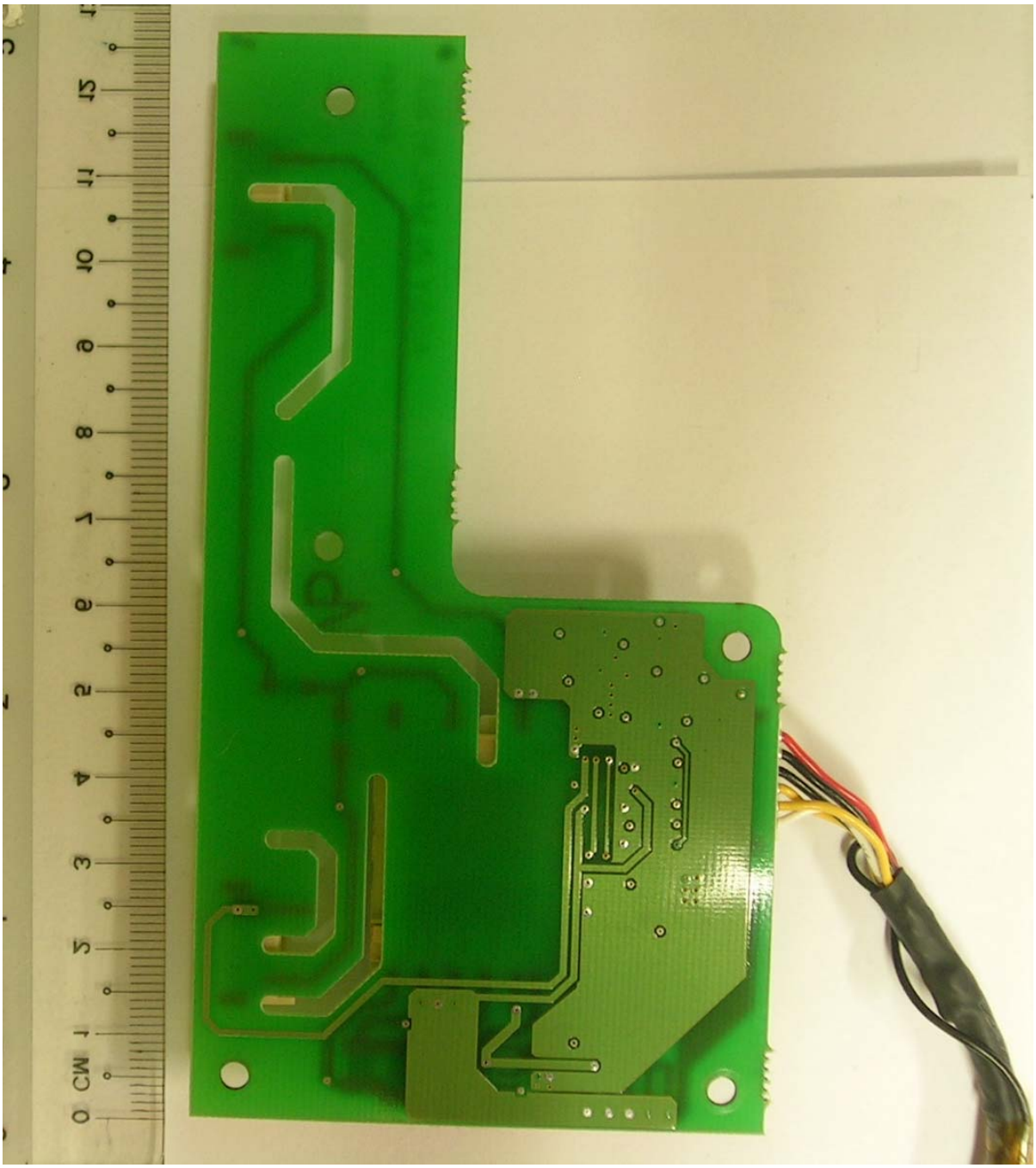
EUT PHOTOGRAPHS



PCB Component Side - LCD Display Board

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

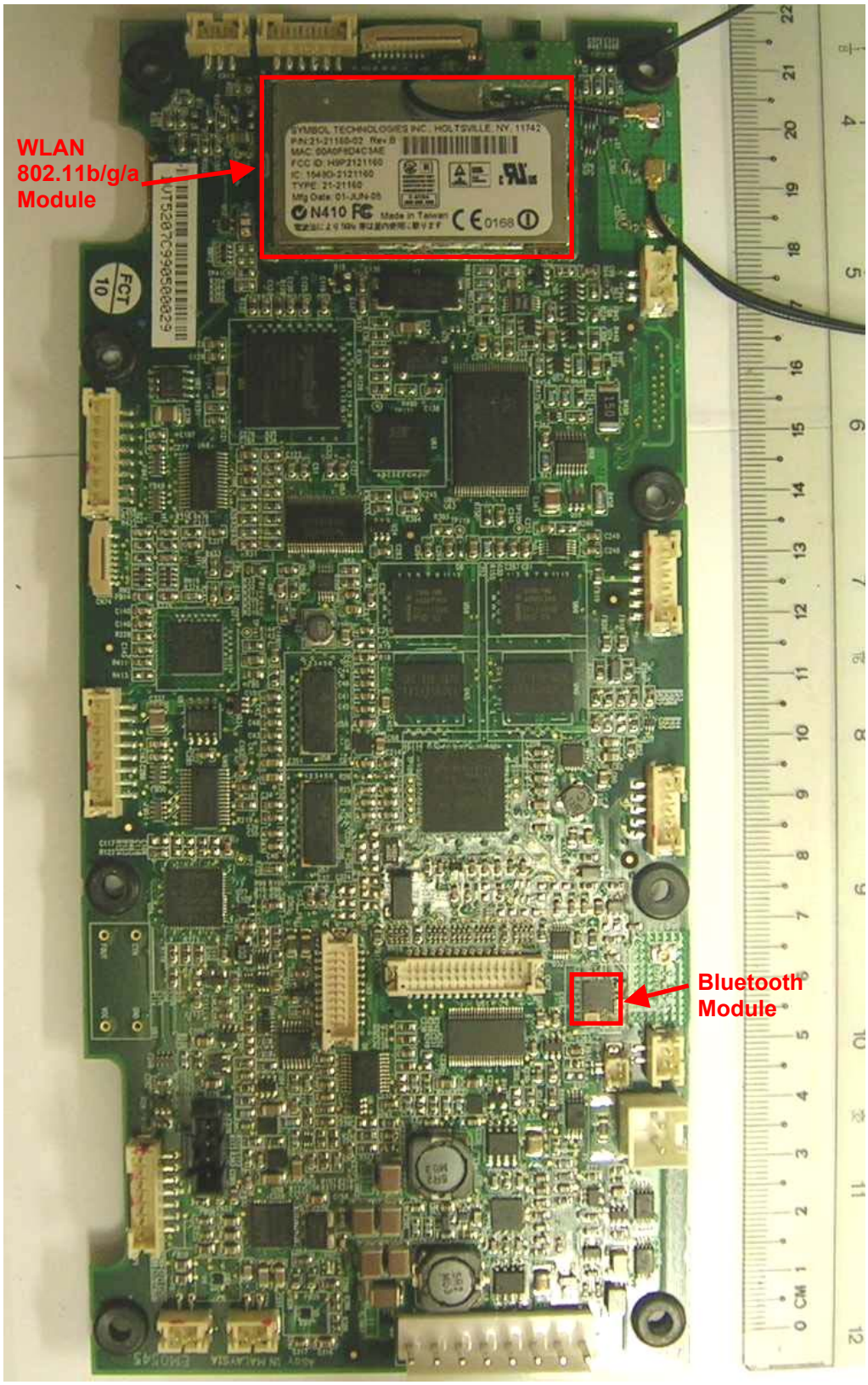
EUT PHOTOGRAPHS



PCB Trace Side - LCD Display Board

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

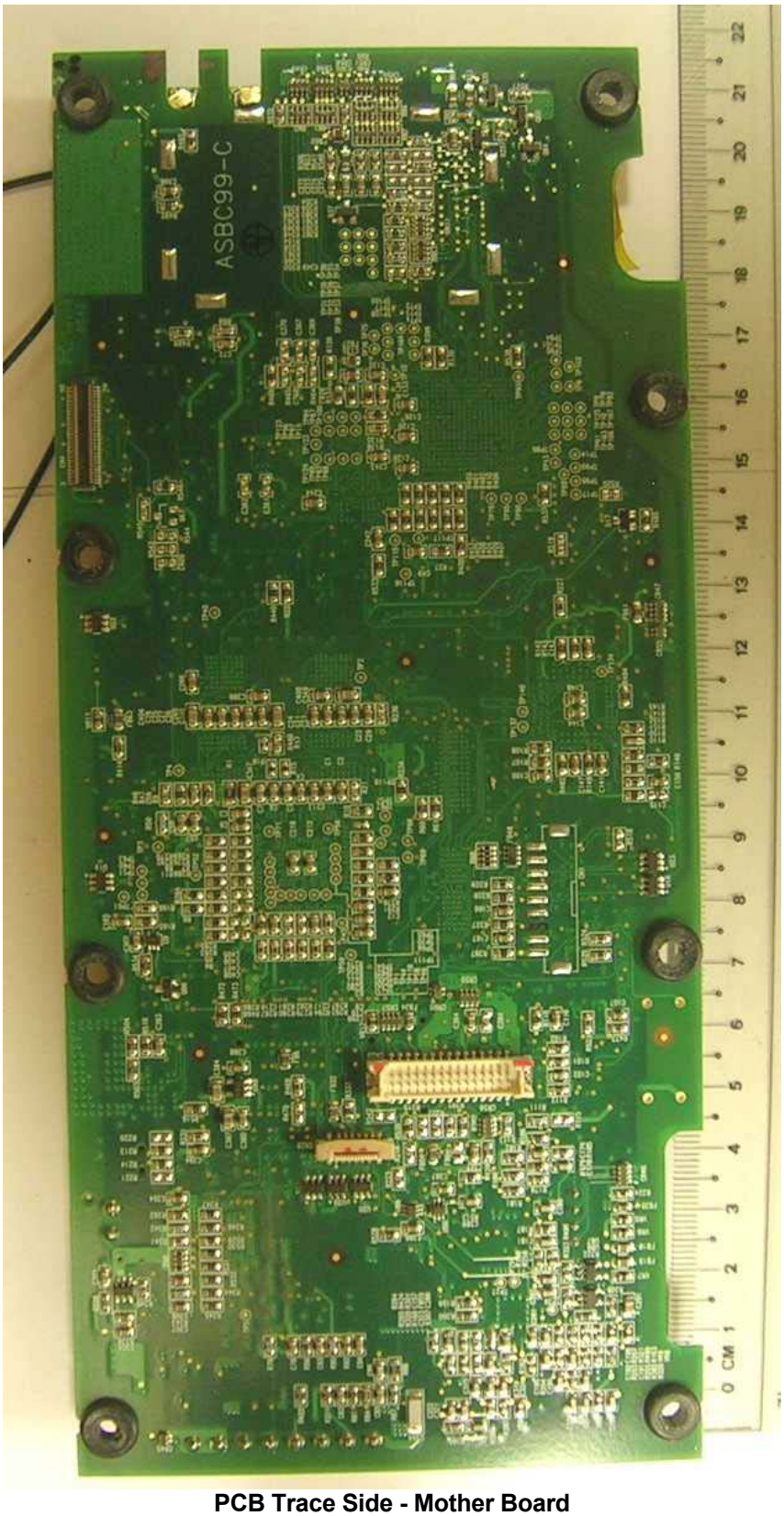
EUT PHOTOGRAPHS



PCB Component Side - Mother Board

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

EUT PHOTOGRAPHS



PCB Trace Side - Mother Board

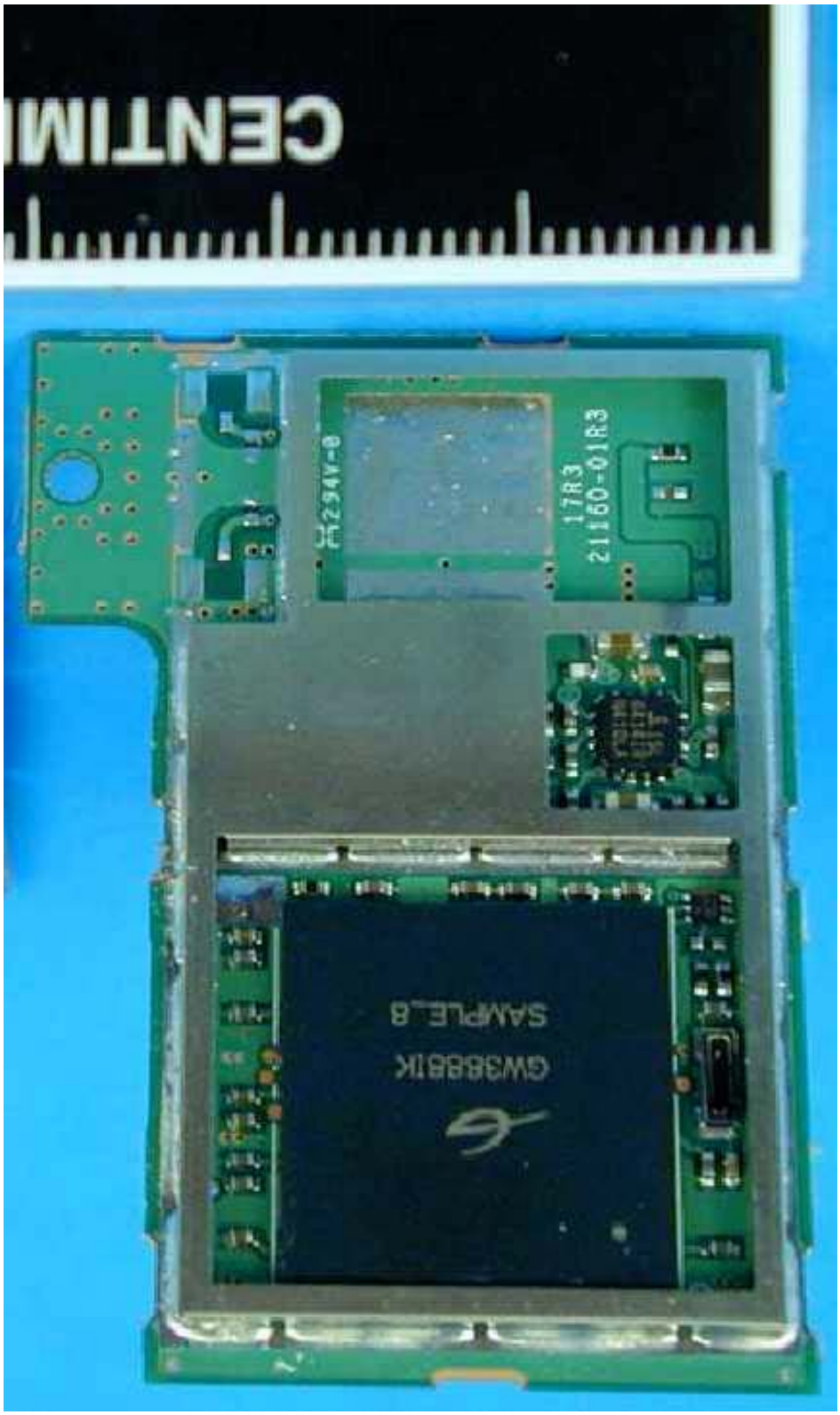
EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

EUT PHOTOGRAPHS

WLAN (802.11a/b/g) Module (With RF Shield)

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

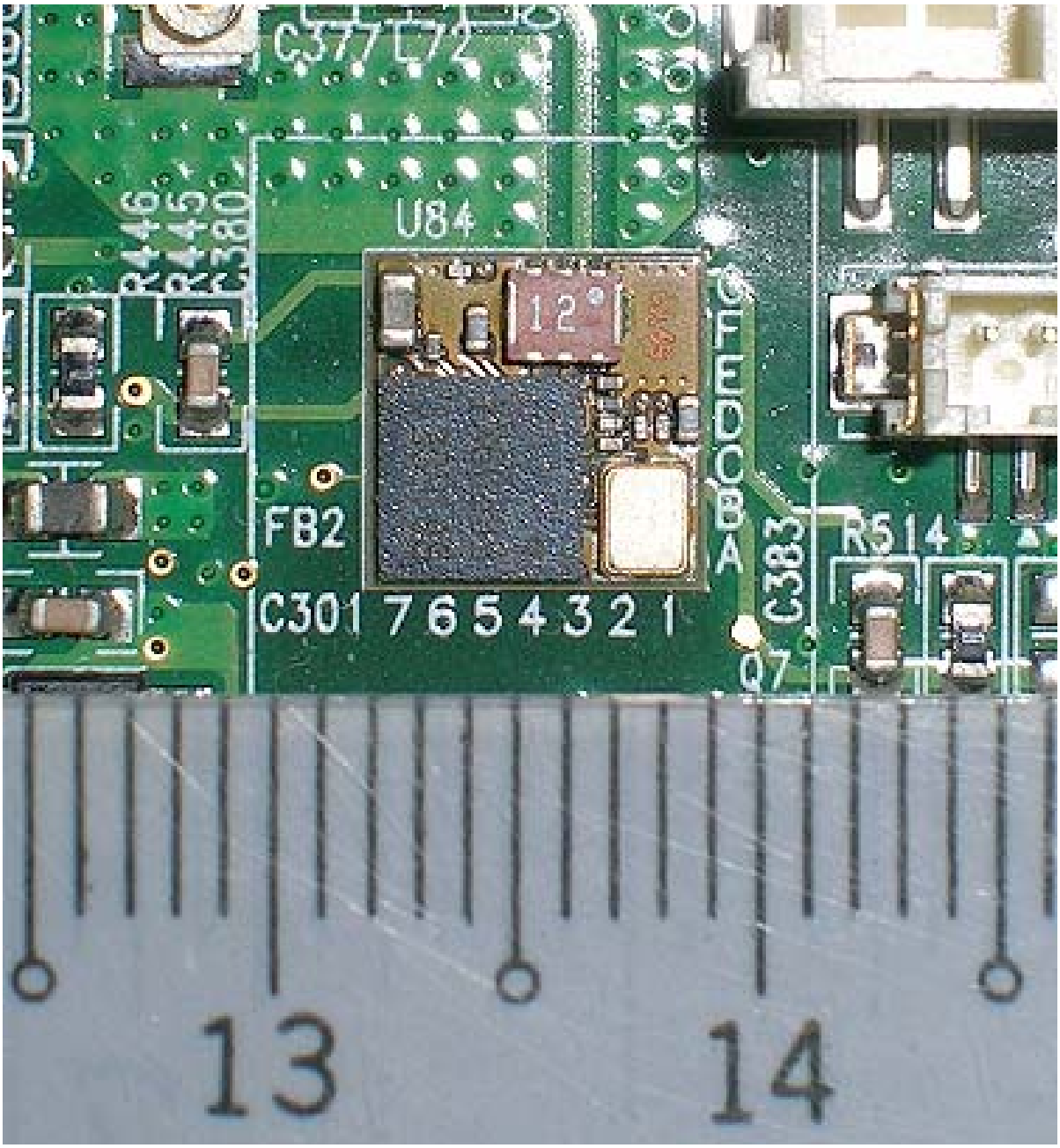
EUT PHOTOGRAPHS



WLAN (802.11a/b/g) Module (With RF Shield Removed)

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

EUT PHOTOGRAPHS



Bluetooth Module

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

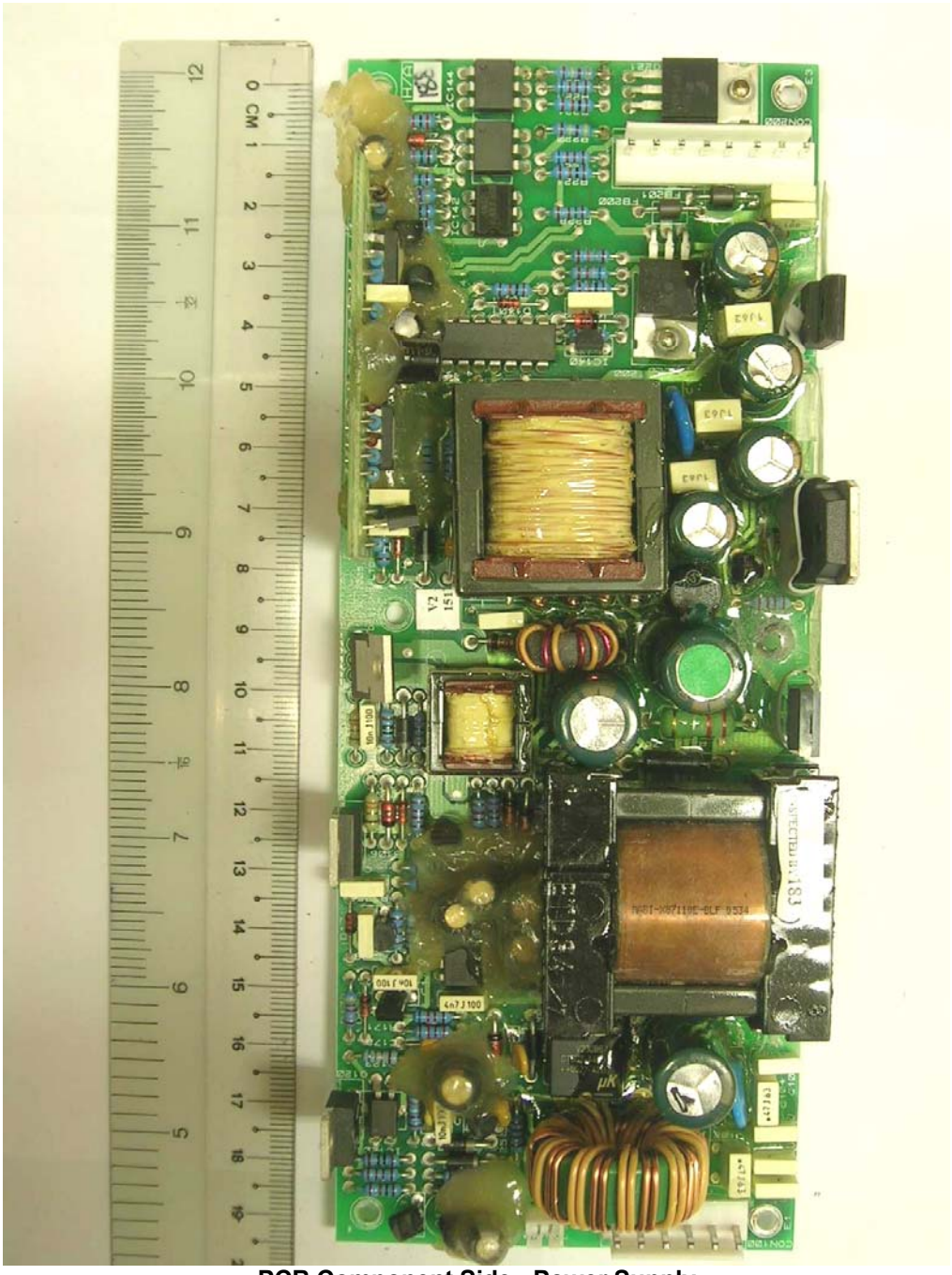
EUT PHOTOGRAPHS

AC/DC Power Supply - View 1

AC/DC Power Supply - View 2

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

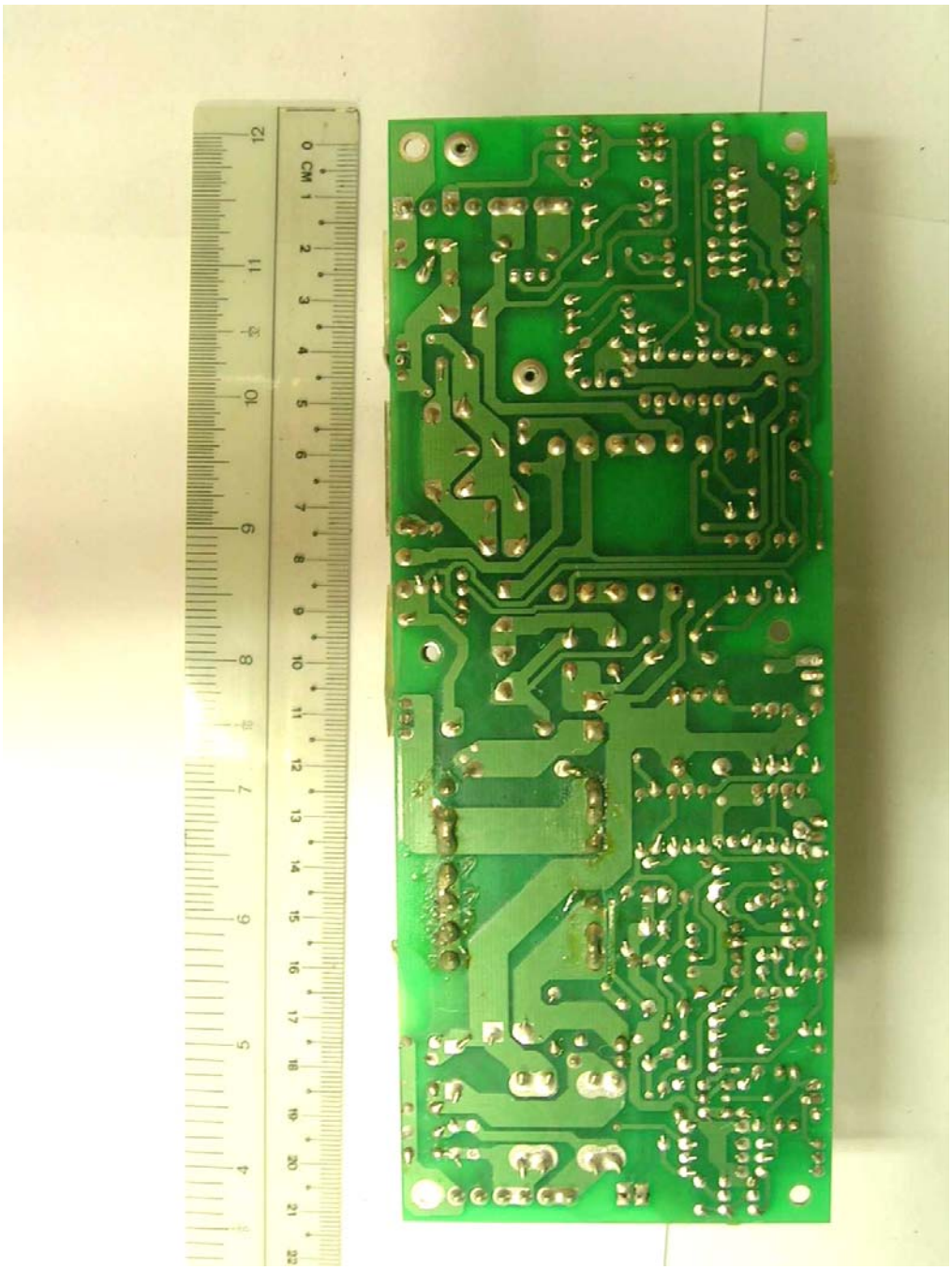
EUT PHOTOGRAPHS



PCB Component Side - Power Supply

EUT PHOTOGRAPHS / DIAGRAMS ANNEX A

EUT PHOTOGRAPHS



PCB Trace Side - Power Supply

ANNEX B

FCC LABEL & POSITION

FCC LABEL & POSITION ANNEX B

Labelling requirements per Section 2.925 & 15.19

The label shown will be permanently affixed at a conspicuous location on the device and be readily visible to the user at the time of purchase.

Sample Label

Physical Location of FCC Label on EUT

ANNEX C

USER MANUAL
TECHNICAL DESCRIPTION
BLOCK & CIRCUIT DIAGRAMS

(Please refer to manufacturer for details)