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**EMI TEST REPORT FOR CERTIFICATION  
to  
FCC PART 15 Subpart C (Section 15.247) & RSS-210**

**FCC ID:** EJE-WB0015

**Industry Canada ID:** 337J-WB0015

**Test Sample:** LifeBook E Series

**Model:** E8020D (Eton)

**Radio Modules:** Bluetooth, Model: UGXZ5-102A &  
Mini-PCI WLAN (Atheros 11a+b/g), Model: WLL4030

**Report Number** M041106\_Cert\_Eton\_BT\_Atheros\_11abg

**Tested for:** Fujitsu Australia Ltd.

**Issue Date:** 30<sup>th</sup> November 2004

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**Number: 5292**

**EMI TEST REPORT FOR CERTIFICATION**  
**to**  
**FCC PART 15 Subpart C (Section 15.247) & RSS-210**  
**EMC Technologies Report No. M041106\_Cert\_Eton\_BT\_Atheros\_11abg**  
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**to**  
**FCC PART 15 Subpart C (Section 15.247) & RSS-210**

**Report Number:** M041106\_Cert\_Eton\_BT\_Atheros\_11abg

**Test Sample:** LifeBook E Series  
**Model:** E8020D (Eton)

**Radio Modules:** Bluetooth, Model: UGXZ5-102A (Fujitsu Ltd)  
Mini-PCI WLAN, Model: WLL4030 (Askey Computer Corp.)

**FCC ID:** EJE-WB0015  
**Industry Canada ID:** 337J-WB0015  
**Equipment Type:** Intentional Radiator (Transceiver)

**Manufacturer (LifeBook):** Fujitsu Ltd  
**Address:** 1405, Ohamaru, Inagi-shi, Tokyo 206-8503, Japan  
**Contact:** Mr. Hirotaka Yakame

**Tested for:** Fujitsu Australia Ltd

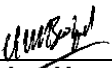
**Test Standards:** FCC Part 15, Subpart C – Intentional Radiators  
FCC Part 15.247, 2400 – 2483.5 MHz Operation Band  
ANSI C63.4 – 2003  
OET Bulletin No. 65

RSS-210 Issue 5 Low Power Licence-Exempt RadioCommunication Devices: 6.2.2 (o) 2400 – 2483.5 MHz Spread Spectrum

RSS-102 Issue 1 (Provisional), Evaluation Procedure for Mobile and Portable Radio Transmitters with respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields

**Test Dates:** 10<sup>th</sup> to 25<sup>th</sup> November 2004

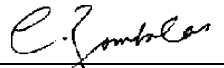
**Test Officers:**

  
\_\_\_\_\_  
**Chieu Huynh** **B.Eng (Hons) Electronics**  
**Adam Chowanetz**  
**Jorge Lara**

**Attestation:**

*I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*

**Authorised Signatory:**

  
\_\_\_\_\_  
**Chris Zombolas**  
**Technical Director**  
**EMC Technologies Pty Ltd**



**EMI TEST REPORT FOR CERTIFICATION**  
**to**  
**FCC PART 15 Subpart C (Section 15.247) & RSS-210**

## 1.0 INTRODUCTION

EMI testing was performed on test sample LifeBook E Series, Model: E8020D (Eton) with Mini-PCI Wireless LAN Module (Atheros 11a+b/g), Model WLL4030 & Bluetooth, Model UGXZ5-102A.

The Atheros WLAN supports IEEE 802.11a, IEEE 802.11b and IEEE 802.11g configurations. Tests were performed in all three configurations and also on the Bluetooth.

The results for the Bluetooth are reported in this test report.

The results for the Atheros module are reported separately.

Refer to EMC Technologies' test reports: M041106\_Cert\_Eton\_Atheros\_11abg\_DTS\_BT and M041106\_Cert\_Eton\_Atheros\_11abg\_NII\_BT.

Test results and procedures were performed in accordance with the following Federal Communications Commission (FCC) standards/regulations:

47 CFR, Part 15, Subpart C:	Rules for intentional radiators (particularly section 15.247)
Section 15.203:	Antenna requirements
Section 15.205:	Restricted bands of operation
Section 15.207:	Conducted Emission Limits
Section 15.209:	Radiated Emission Limits (General requirements)
Section 15.247:	Operation in the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5850 MHz

The test sample **complied** with the requirements of 47 CFR, Part 15 Subpart C - Section 15.247.

The test sample also complied with the Industry Canada RSS-210 issue 5 (Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)) clause 6.2.2(o) and the RF exposure requirements of RSS-102.



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## 1.1 Summary of Results

### 1.1.1 Bluetooth - FCC PART 15 Subpart C (Section 15.247)

FCC Part 15, Subpart C Clauses	Industry Canada RSS-210 Clauses	Test Performed	Result
15.203	5.5	Antenna Requirement	Not Applicable
15.205	6.3	Operation in Restricted Band	Complies
15.207	6.6	Conducted Emissions	Complies
15.209	6.3	Radiated Emissions	Complies
15.247 (a)(1)&(3)	6.2.2(o)(ii)	Channel Occupancy/Bandwidth	Complies
15.247 (b)(1)	6.2.2(o)(b)	Peak Output Power	Complies
15.247 (b)(5)		Radio Frequency Hazard	Complies
15.247 (c)	6.2.2(o)(e1)	Out of Band Emissions	Complies

### 1.1.2 WLAN, Atheros 802.11b/g - FCC PART 15 Subpart C (Section 15.247)

FCC Part 15, Subpart C Clauses	Industry Canada RSS-210 Clauses	Test Performed	Result
15.203	5.5	Antenna Requirement	Not Applicable
15.205	6.3	Operation in Restricted Band	Complies
15.207	6.6	Conducted Emissions	Complies
15.209	6.3	Radiated Emissions	Complies
15.247 (a)(2)	6.2.2(o)(iv)	Channel Bandwidth	Complies
15.247 (b)(3)	6.2.2(o)(b)	Peak Output Power	Complies
15.247 (b)(5)		Radio Frequency Hazard	Complies
15.247 (c)	6.2.2(o)(e1)	Out of Band Emissions	Complies
15.247 (d)	6.2.2(o)(iv)	Peak Power Spectral Density	Complies

Refer to EMC Technologies Report No: M041106\_Cert\_Eton\_Atheros\_11abg\_DTS\_BT

### 1.1.3 WLAN, Atheros 802.11a - FCC PART 15 Subpart E (Section 15.407)

FCC Part 15, Subpart E Clauses	Industry Canada RSS-210 Clauses	Test Performed	Result
15.203	5.5	Antenna Requirement	Not Applicable
15.205	6.3	Operation in Restricted Band	Complies
15.207	6.6	Conducted Emissions	Complies
15.209	6.3	Radiated Emissions	Complies
15.407 (a)(4)	6.2.2(q1)	Peak Transmit Power	Complies
15.407 (a)(5)	6.2.2(q1)	Peak Power Spectral Density	Complies
15.407 (a)(6)		Peak Excursion	Complies
15.407 (b)	6.2.2(q1)	Undesirable Emission	Complies
15.407 (f)		Radio Frequency Hazard	Complies
15.407 (g)	6.4	Frequency Stability	Complies

Refer to EMC Technologies Report No: M041106\_Cert\_Eton\_Atheros\_11abg\_NII\_BT

The measurement procedure used was in accordance with ANSI C63.4-2003 and OET Bulletin No. 65. The instrumentation conformed to the requirements of ANSI C63.2-1996.

## 1.2 Modifications by EMC Technologies

No modifications were required.



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## 2.0 GENERAL INFORMATION

(Information supplied by the Client)

### 2.1 Product Details

<b>Test Sample (Host PC):</b>	LifeBook E Series
<b>Model Number:</b>	E8020D
<b>Code Name:</b>	Eton
<b>Serial Number:</b>	Pre-production Sample
<b>Manufacturer:</b>	Fujitsu Ltd
<b>CPU Type and Speed:</b>	Dothan 2.13 GHz Celeron-M 1.7 GHz
<b>SDRAM:</b>	1.0 GB
<b>LCD Screen:</b>	15"XGA / 15"SXGA / 15"UXGA
<b>Hard Disk Drive:</b>	40 GB
<b>Wired LAN:</b>	Broadcom BCM5751M 10 Base-T/100 Base-TX/1000 Base-T)
<b>Modem:</b>	MBH7MD33 / MBH7MD35
<b>Wireless LAN Module:</b>	Atheros 11a+b/g (WLL4030)
<b>Bluetooth:</b>	ALPS Bluetooth
<b>Bluetooth Model Number:</b>	UGXZ5-102A
<b>Port Replicator Model:</b>	FPCPR48
<b>AC Adapter Model:</b>	SEB100P2-19.0
<b>Alternate Models:</b>	CA01007-092x
<b>Voltage:</b>	19 V
<b>Current Specs:</b>	4.22 A
<b>Watts:</b>	80 W
<b>Radio Modules:</b>	Bluetooth and WLAN (Atheros 11a+b/g)
<b>Bluetooth Model Number:</b>	UGXZ5-102A
<b>Bluetooth Manufacturer:</b>	Fujitsu Ltd
<b>WLAN Model Number:</b>	WLL4030
<b>WLAN Manufacturer:</b>	Askey Computer Corp.
<b>Interface Type:</b>	Mini-PCI Wireless LAN Module
<b>FCC ID:</b>	EJE-WB0015
<b>Industry Canada ID:</b>	337J-WB0015
<b>Equipment Type:</b>	Intentional Radiator (Transceiver)



## 2.2 Technical Specifications

### 2.2.1 Bluetooth Transmitter Specifications

<b>Transmitter:</b>	Bluetooth
<b>Model Number:</b>	UGXZ5-102A
<b>Manufacturer:</b>	Fujitsu Ltd
<b>Network Standard:</b>	Bluetooth™ RF Test Specification
<b>Modulation Type:</b>	Frequency Hopping Spread Spectrum (FHSS)
<b>Frequency Range:</b>	2402 MHz to 2480 MHz
<b>Number of Channels:</b>	79
<b>Carrier Spacing:</b>	1.0 MHz
<b>Antenna Types:</b>	Monopole Ceramic Antenna, Model Number: YCE-5250 Located on the right hinge of LCD screen
<b>Antenna gain:</b>	0.6 dBi
<b>Max. Output Power:</b>	12 dBm
<b>Reference Oscillator:</b>	16 MHz (Built-in)
<b>Power Supply:</b>	3.3 VDC from host.

#### Frequency allocation:

Channel Number	Frequency (MHz)
1	2402
2	2403
3	2404
.	.
.	.
.	.
39	2440
40	2441
41	2442
.	.
.	.
.	.
77	2478
78	2479
79	2480



**2.2.2 WLAN Transmitter Specifications**

<b>Transmitter:</b>	Mini-PCI Wireless LAN Module
<b>Wireless Module:</b>	Atheros
<b>Model Number:</b>	WLL4030 (11a+b/g module)
<b>Manufacturer:</b>	Askey Computer Corp.
<b>Modulation Type:</b>	Direct Sequence Spread Spectrum (DSSS for 802.11b) Orthogonal Frequency Division Multiplexing (OFDM for 802.11g) Orthogonal Frequency Division Multiplexing (OFDM for 802.11a)
<b>802.11a</b>	BPSK – 6Mbps, 9Mbps QPSK – 12Mbps, 18Mbps 16QAM – 24Mbps, 36Mbps 64QAM – 48Mbps, 54Mbps
<b>802.11g</b>	BPSK – 6Mbps, 9Mbps QPSK – 12Mbps, 18Mbps 16QAM – 24Mbps, 36Mbps 64QAM – 48Mbps, 54Mbps
<b>802.11b</b>	DBPSK – 1Mbps DQPSK – 2Mbps CCK – 5.5Mbps, 11Mbps
<b>Maximum Data Rate:</b>	802.11b = 11Mbps, 802.11g and 802.11a = 54Mbps
<b>Frequency Range:</b>	2.4 – 2483.5 GHz for 11b/g 5.15 - 5.35 GHz and 5.725 - 5.825 GHz for 11a
<b>Number of Channels:</b>	11 maximum (for 11b/11g) 12 maximum (for 11a) *Passive Scan only
<b>Antenna Types:</b>	2 x Inverted-F Antenna – PN: CP115412-01 Located on top edge of LCD screen
<b>Antenna gain:</b>	802.11b/g = 1.06 dBi 802.11a (5.15 – 5.35 GHz) = -2.0 dBi 802.11a (5.725 – 5.825 GHz) = -1.18 dBi
<b>Max. Output Power:</b>	802.11b = 15 dBm 802.11g = 14.5 dBm 802.11a Band 1 (5.15 to 5.25 GHz) = 13.5 dBm 802.11a Band 2 (5.25 to 5.35 GHz) = 14 dBm 802.11a Band 3 (5.725 to 5.825 GHz) = 14.5 dBm
<b>Power Supply:</b>	3.3 VDC from PCI bus
<b>Chipset Used:</b>	Atheros AR5212, AR5112
<b>Turbo Mode:</b>	For 802.11g & 802.11a only
<b>Data rate (Turbo):</b>	12 Mbps to 108 Mbps





**Frequency allocation for 802.11b/g:**

Channel Number	Frequency (MHz)	Turbo mode Frequency (MHz) FOR 802.11g ONLY
1	2412	--
2	2417	--
3	2422	--
4	2427	--
5	2432	--
6	2437	2437
7	2442	--
8	2447	--
9	2452	--
10	2457	--
11	2462	--

**Frequency allocation for 802.11a:**

Channel Number	Frequency (MHz)	Turbo mode Frequency (MHz)
36	5180	5210
40	5200	--
44	5220	--
48	5240	5250
52	5260	--
56	5280	5290
60	5300	
64	5320	
149	5745	
153	5765	5760
157	5785	--
161	5805	5800



## 2.3 Operational Description

The EUT is a LifeBook E Series, Model: E8020D (Eton) installed with a Mini-PCI Wireless LAN (WLAN) Module (Atheros 11a+b/g, Model WLL4030) & Bluetooth, Model UGXZ5-102A.

The WLAN module is an OEM product from Askey Computer Corp., which is already certified by the manufacturer FCC ID: H8NWLL4030 and IC: 1353A-WLL4030. The same WLAN radio module and Bluetooth combination has been previously certified by Fujitsu under FCC ID: EJE-WB0009 and IC: 337J-WB0009 in a different host.

The intention of this application is to re-certify this WLAN and Bluetooth with a different antenna combination in host – LifeBook E Series, Model: E8020D (Eton).

## 2.4 Test Configuration

The Askey software and the BlueSuiteCasira software were used to set-up the WLAN module and Bluetooth devices respectively to continuously transmit during the tests. The LCD screen was observed for the transmitter status shown for the respective software.

### Antenna

The Atheros (11a+b/g) WLAN, Model WLL4030, is configured with Inverted-F Antenna – PN: CP115412-01 and ALPS Bluetooth device, Model UGXZ5-102A is configured with Monopole Ceramic Antenna - model Number: YCE-5250. The installation of the OEM WLAN module, Bluetooth Device and the Antenna in Fujitsu LifeBook E Series, Model: E8020D (Eton) is in a controlled environment. The installation is performed during the production/assembly process at the Fujitsu factory.

Refer to Appendix F – Antenna Information.

There are three antennas: WLAN antennas are located on the right hand side and left hand side on the top edge of the LCD screen. Bluetooth antenna is located on the right hand side hinge of the LCD screen.

Refer to photos in Appendix B3 for Bluetooth Antenna locations.

### AC Adapter

The AC adapter SEB100P2-19.0 was used for all the tests. This adapter is also identified as CA01007-092x. Details of the AC adapters are supplied in section 2.1 of this report.

## 2.5 Block Diagram

Refer to Appendix D - Block Diagram



## 2.6 Support Equipment

### External Monitor/s:

Conducted EMI

Viewmaster, P/N CA64 150DL, S/N CN7610276

Radiated EMI

Hewlett Packard 15" Color monitor, Model D2827A,

FCC ID: C5F7NFCMC1515X

### Printer:

HP Deskjet 930C, Serial: MY11H180DP

### USB Floppy Drive/s:

Fujitsu Model: FPCFDD11, P/N CP032173-01

Fujitsu Model: FPCFDD12, P/N CP078720-01

USB OMNI Floppy Drive Model # USB F3501 SN W316000096

### PS2 Mouse

A4 Tech M/N: SWW-25

### Modem:

Maestro Companion Series 3

### LAN Hub:

Kingston SOHO Hub Model: KNE8TP/H (FCC ID: JICKNE8TP-HO)

### Headphones:

Verbatim Multimedia Stereo headset

### PCMCIA Slot:

6 MB Compact flash card with Adapter, Apacer P/N 88.10200030

### Memory Card:

Secure Digital- 32 MB

## 2.7 Test Procedure

Emissions measurements were performed in accordance with the procedures of ANSI C63.4-2003. Radiated emissions tests were performed at a distance of 3 and 10 metres from the EUT. OET Bulletin 65 dated June 2001 was used for reference.

## 2.8 Test Facility

### 2.8.1 General

Radiated Emission measurements were performed at EMC Technologies open area test site (OATS) situated at Lerderderg Gorge, near the township of Bacchus Marsh in Victoria, Australia. Conducted emission measurements were performed at EMC Technologies' laboratory in Tullamarine, Victoria Australia.

The above sites have been fully described in a report submitted to the FCC office, and accepted in a letter dated June 14, 2002, **FCC Registration Number 90560**.

EMC Technologies open area test site (OATS) has also been accepted by Industry Canada for the performance of radiated measurements in accordance with RSS 212, Issue 1 (Provisional).

**Industry Canada File Number, IC 4161**, (Registration Date - November 5<sup>th</sup> 2001).

### 2.8.2 NATA Accreditation

EMC Technologies is accredited in Australia to test to the following standards by the National Association of Testing Authorities (NATA).

***"FCC Part 15 unintentional and intentional emitters in the frequency range 9kHz to 18 GHz excluding TV receivers (15.117 and 15.119), TV interface devices (15.115), cable ready consumer electronic equipment (15.118), cable locating equipment (15.213) and unlicensed national information infrastructure devices (Sub part E)."***

The current full scope of accreditation can be found on the NATA website: [www.nata.asn.au](http://www.nata.asn.au)  
It also includes a large number of emission, immunity, SAR, EMR and Safety standards.

NATA is the Australian national laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Laboratory (NML) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A<sup>2</sup>LA).



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## 2.9 Units of Measurements

### 2.9.1 Conducted Emissions

Measurements are reported in units of dB relative to one microvolt. (dB $\mu$ V).

### 2.9.2 Radiated Emissions

Measurements are reported in units of dB relative to one microvolt per metre (dB $\mu$ V/m).

## 2.10 Test Equipment Calibration

All measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Laboratory (NML). All equipment calibration is traceable to Australia national standards at the National Measurements Laboratory. The reference antenna calibration was performed by NML and the working antennas (biconical and log-periodic) calibrated by the NATA approved procedures. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A

## 2.11 Ambients at OATS

The Open Area Test Site (OATS) is an area of low background ambient signals. No significant broadband ambients are present however commercial radio and TV signals exceed the limit in the FM radio, VHF and UHF television bands. Radiated prescan measurements were performed in the shielded enclosure to check for possible radiated emissions at the frequencies where the OATS ambient signals exceeded the test limit.



## RESULTS

### Bluetooth Module, Model UGXZ5-102A

#### 1.0 CONDUCTED EMISSION MEASUREMENTS

Testing was performed in accordance with the requirements of FCC Part 15.207

##### 1.1 Test Procedure

The arrangement specified in ANSI C63.4-2003 was adhered to for the conducted EMI measurements. The EUT was placed in the RF screened enclosure and a CISPR EMI Receiver as defined in ANSI C63.2-1996 was used to perform the measurements.

The EMI Receiver was operated under program control using the Max-Hold function and automatic frequency scanning, measurement and data logging techniques. The specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all short duration peaks were captured.

##### 1.2 Peak Maximising Procedure

The various operating modes of the system were investigated. For each of the sub-ranges, the EMI receiver was set to continuous scan with the Peak detector set to Max-Hold mode. The Quasi-Peak detector and the Average detector were then invoked to measure the actual Quasi-Peak and Average level of the most significant peaks, which were detected.

##### 1.3 Calculation of Voltage Levels

The voltage levels were automatically measured in software and compared to the test limit. The method of calculation was as follows:

$$VEMI = VRx + LBPF$$

Where:

- VEMI** = the Measured EMI voltage in dBμV to be compared to the limit.
- VRx** = the Voltage in dBμV read directly at the EMI receiver.
- LBPF** = the insertion loss in dB of the cables and the Limiter and Pass Filter.

##### 1.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were then concatenated to form a single graph of (peak) amplitude versus frequency. This was performed for both Active and Neutral lines and the composite graph were subsequently plotted. A list of the highest relevant peaks and the respective Quasi-Peak and Average values were also plotted on the graph.



## 1.5 Results of Conducted Emission Measurements (AC Mains Ports)

Measurements were performed on the LifeBook E Series (Eton), with WLAN module and Bluetooth.

Initial investigations were performed with the WLAN in both configurations (802.11b and 802.11g) and all modulation types: (BPSK, QPSK, 16QAM, 64QAM, DBPSK, DQPSK and CCK). No significant differences in emissions were observed. Final testing was performed while the WLAN transmitter continuously operated with configuration 802.11g on the high (Channel 11, 2462 MHz) frequency channel with the modulation rate of 6 Mbps (BPSK) and the Bluetooth transmitter continuously operated on the low (Channel 1, 2402 MHz) frequency channel.

The reported frequencies in the tables below are mainly concerned with the Host PC emissions and not directly related to the WLAN & Bluetooth emissions.

Frequency MHz	Line	Measured QP Level dB $\mu$ V	QP Limit dB $\mu$ V	$\Delta$ QP $\pm$ dB	Measured AV Level dB $\mu$ V	AV Limit dB $\mu$ V	$\Delta$ AV $\pm$ dB
0.377	Active	45.9	58.3	-12.5	41.8	48.3	-6.5
0.382	Neutral	45.3	58.2	-12.9	40.9	48.2	-7.3
0.478	Neutral	44.6	56.4	-11.8	38.5	46.4	-7.9
0.203	Active	54.3	63.5	-9.2	45.5	53.5	-8.0
0.204	Neutral	53.9	63.4	-9.6	45.4	53.4	-8.0
0.487	Active	44.5	56.2	-11.7	31.8	46.2	-14.4
0.290	Active	46.2	60.5	-14.3	33.7	50.5	-16.8
3.643	Neutral	36.5	56.0	-19.5	24.3	46.0	-21.7
3.668	Active	36.2	56.0	-19.8	23.7	46.0	-22.3

The worst case conducted EMI occurred at 0.377 MHz and complied with the quasi peak and average limits by margins of 12.5 dB and 6.5 dB respectively. The measurement uncertainty was  $\pm 2.0$  dB. Refer to Appendix I (graphs 1 & 2) for plots of the conducted EMI measurements.

**Result:** Complies



## 2.0 SPURIOUS EMISSION MEASUREMENTS

### 2.1 Test Procedure

Testing was performed in accordance with the requirements of FCC Part 15.247(c).

Radiated emission measurements were performed to the limits as per section 15.209. The measurements were made at the open area test site.

The EUT was set up on the table top (placed on turntable) of total height 80 cm above the ground plane, and operated as described in section 2 of this report. The EMI Receiver was operated under software control via the PC Controller through the IEEE.488 Interface Bus Card Adaptor. The test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. A calibrated Biconical antenna was used for measurements between 30 MHz to 232 MHz and a calibrated Logperiodic antenna used for measurements between 230 MHz to 1000 MHz. Calibrated EMCO 3115 and EMCO 3116 Horn antennas were used for measurements between 1 to 25 GHz.

The measurement of emissions between 30 - 1000 MHz was measured with the resolution bandwidth of 120 kHz and the video bandwidth of 300 kHz.

The measurement of emissions above 1000 MHz, appearing in the restricted bands, was made using an average detector with a bandwidth of 1.0 MHz.

The EUT was slowly rotated with the Peak Detector set to Max-Hold. This was performed for two antenna heights. When an emission was located, it was positively identified and its maximum level found by rotating the automated turntable, and by varying the antenna height. Each significant peak was investigated with the Quasi-Peak/Average Detectors. The software for cable losses automatically corrected the measurement data for each frequency range, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical antenna polarisations.

### 2.2 Calculation of field strength

The field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

**E = V + AF - G + L** Where:

**E** = Radiated Field Strength in dB $\mu$ V/m.

**V** = EMI Receiver Voltage in dB $\mu$ V. (measured value)

**AF** = Antenna Factor in dB(m<sup>-1</sup>). (stored as a data array)

**G** = Preamplifier Gain in dB. (stored as a data array)

**L** = Cable insertion loss in dB. (stored as a data array of Insertion Loss versus frequency)

#### • Example Field Strength Calculation

Assuming a receiver reading of 34.0 dB $\mu$ V is obtained at 90 MHz, the Antenna Factor at that frequency is 9.2 dB. The cable loss is 1.9 dB while the preamplifier gain is 20 dB. The resulting Field Strength is therefore as follows:

$$34.0 + 9.2 + 1.9 - 20 = 25.1 \text{ dB}\mu\text{V/m}$$

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (1000 MHz – 18,000 MHz)  $\pm$  4.1 dB
- (30 MHz – 1,000 MHz)  $\pm$  3.7 dB



## 2.3 Radiated Emissions (Spurious and Harmonics)

### 2.3.1 Frequency Band: 1 – 25 GHz

All measurements above 1 GHz were initially made over a distance of 3 metres. This was decreased to 1.0 metre as the emission levels from the device were very low.

The 54 dB $\mu$ V/m limit at 3 metres has been converted to 64 dB $\mu$ V/m at 1 metre using a factor of 20 dB per decade where emissions were located in the restricted bands.

Testing was performed while both the Bluetooth transmitter and WLAN transmitter continuously operated. Harmonics related to the Bluetooth transmitter are reported below. For harmonics related to the WLAN transmitter, Refer to EMC Technologies' test reports: M041106\_Cert\_Eton\_Atheros\_11abg\_DTS\_BT and M041106\_Cert\_Eton\_Atheros\_11abg\_NII\_BT.

Measurements for the WLAN were made on a low (channel 1, 2402 MHz), middle (channel 40, 2441 MHz) and high (Channel 79, 2480 MHz) frequency channel.

The field strength at 2483.5 MHz when the EUT was operating at its highest channel (2480 MHz), was 49.6 dB $\mu$ V/m peak & 35.3 dB $\mu$ V/m average and was > 20 dB below the maximum field strength of the in-band carrier.

The field strength at 2400 MHz when the EUT was operating at its lowest channel (2402 MHz), was 56.4 dB $\mu$ V/m peak & 42.7 dB $\mu$ V/m average and was > 20 dB below the maximum field strength of the in-band carrier.

#### Channel 1 - 2402 MHz

Frequency MHz	Level dB $\mu$ V/m		Antenna Polarization	Peak Limit dB $\mu$ V/m	Average Limit dB $\mu$ V/m	Result
	Peak Detector	Average Detector				
2402	Transmitter	Fundamental		-	-	
4804	53.7	40.8	Vert/Hort	74.0	54.0	Pass
7206	53.4	41.1	Vert/Hort	-	-	Pass
9608	55.9	42.4	Vert/Hort	-	-	Pass
12010	57.0	43.8	Vert/Hort	74.0	54.0	Pass
14412	60.3	46.7	Vert/Hort	-	-	Pass
16814	63.9	49.3	Vert/Hort	-	-	Pass
19216	65.0	51.5	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
21618	66.4	53.2	Vert/Hort	-	-	Pass
24020	67.8	54.7	Vert/Hort	-	-	Pass

\*Measurement was performed at 1 metre distance and the limits were corrected accordingly.





**Channel 40 - 2441 MHz**

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
2441	Transmitter	Fundamental		-	-	
4882	53.7	40.8	Vert/Hort	74.0	54.0	Pass
7323	53.4	41.1	Vert/Hort	74.0	54.0	Pass
9764	55.9	42.4	Vert/Hort	-	-	Pass
12205	57.0	43.8	Vert/Hort	74.0	54.0	Pass
14646	60.3	46.7	Vert/Hort	-	-	Pass
17087	63.9	49.3	Vert/Hort	-	-	Pass
19528	65.0	51.5	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
21969	66.4	53.2	Vert/Hort	-	-	Pass
24410	67.8	54.7	Vert/Hort	-	-	Pass

\*Measurement was performed at 1 metre distance and the limits were corrected accordingly.

**Channel 79 - 2480 MHz**

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
2480	Transmitter	Fundamental		-	-	
4960	53.7	40.8	Vert/Hort	74.0	54.0	Pass
7440	53.4	41.1	Vert/Hort	74.0	54.0	Pass
9920	55.9	42.4	Vert/Hort	-	-	Pass
12400	57.0	43.8	Vert/Hort	74.0	54.0	Pass
14880	60.3	46.7	Vert/Hort	-	-	Pass
17360	63.9	49.3	Vert/Hort	-	-	Pass
19840	65.0	51.5	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
22320	66.4	53.2	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
24800	67.8	54.7	Vert/Hort	-	-	Pass

\*Measurement was performed at 1 metre distance and the limits were corrected accordingly.

**Result:** No harmonics were recorded within the restricted bands of up to 25 GHz. Harmonics were confirmed low with both RBW and VBW reduced. Harmonics were complied with the FCC limits in section 15.209. The measurement uncertainty for radiated emissions in this band was  $\pm 4.1$  dB.

**2.3.2 Spurious Emissions Generated When Both (WLAN and BT) Transmitters Transmitting**

**Result:** No spurious were recorded within the restricted bands of up to 40 GHz. Harmonics were below the limit in section 15.209 and 15.407. The measurement uncertainty for radiated emissions in this band was  $\pm 4.1$  dB.



**2.3.2 Frequency Band: 30 - 1000 MHz**

Testing was performed at a distance of 10 metres.

Measurements were performed on the LifeBook E Series (Eton), with WLAN module and Bluetooth.

Initial investigations were performed with the WLAN in both configurations (802.11b and 802.11g) and all modulation types: (BPSK, QPSK, 16QAM, 64QAM, DBPSK, DQPSK and CCK). No significant differences in emissions were observed. Final testing was performed while the WLAN transmitter continuously operated with configuration 802.11g on the high (Channel 11, 2462 MHz) frequency channel with the modulation rate of 6 Mbps (BPSK) and the Bluetooth transmitter continuously operated on the low (Channel 1, 2402 MHz) frequency channel.

The reported frequencies in the tables below are mainly concerned with the Host PC emissions and not directly related to the WLAN & Bluetooth emissions.

**Vertical Polarity**

Frequency MHz	Polarisation	QP Measured dB $\mu$ V/m	QP Limit dB $\mu$ V/m	$\Delta$ QP $\pm$ dB
233.41	Vertical	35.0	35.5	-0.5
249.75	Vertical	32.1	35.5	-3.4
214.26	Vertical	27.1	33.0	-5.9
207.77	Vertical	26.9	33.0	-6.1
371.63	Vertical	28.8	35.5	-6.8
122.90	Vertical	23.8	33.0	-9.2
325.44	Vertical	25.6	35.5	-9.9
142.87	Vertical	22.3	33.0	-10.7
124.47	Vertical	22.0	33.0	-11.0
678.76	Vertical	23.1	35.5	-12.5
200.02	Vertical	20.5	33.0	-12.5
184.35	Vertical	19.4	33.0	-13.6
120.80	Vertical	19.2	33.0	-13.8

**Horizontal Polarity**

Frequency MHz	Polarisation	QP Measured dB $\mu$ V/m	QP Limit dB $\mu$ V/m	$\Delta$ QP $\pm$ dB
207.77	Horizontal	29.4	33.0	-3.6
214.26	Horizontal	26.3	33.0	-6.8
272.69	Horizontal	26.7	35.5	-8.8
240.23	Horizontal	24.9	35.5	-10.6
279.18	Horizontal	24.7	35.5	-10.8
232.26	Horizontal	24.1	35.5	-11.4
408.00	Horizontal	23.7	35.5	-11.8
122.90	Horizontal	19.4	33.0	-13.6
120.77	Horizontal	18.2	33.0	-14.8
795.02	Horizontal	20.5	35.5	-15.0
119.25	Horizontal	18.0	33.0	-15.0
597.26	Horizontal	18.2	35.5	-17.3

**Result:** The highest radiated emission peak occurred at 233.41 MHz (Vertical Polarity) and complied with FCC quasi peak limit by a margin of 0.5 dB. The measurement uncertainty in this band was  $\pm 3.7$  dB. Refer to tables above for results.



**2.3.3 RF Conducted Measurements at the antenna terminal**

In the 100 kHz bandwidth within the operating band, the highest emissions (spurious/harmonics) level that is produced by the intentional radiator shall be at least 20 dB below.

Measurements for the WLAN were made on a low (channel 1, 2402 MHz), middle (channel 40, 2441 MHz) and high (Channel 79, 2480 MHz) frequency channel.

The transmitter output was connected to the spectrum analyser in peak hold mode.

The resolution bandwidth of 100 kHz and the video bandwidth of 300 kHz were utilised.

Refer to Appendix K for Harmonics plots

**Result:** Complies.

**2.3.4 Band Edge Measurements**

In the 100 kHz bandwidth within the operating band, the highest emissions (spurious/harmonics) level that is produced by the intentional radiator shall be at least 20 dB below.

Testing was performed while the WLAN transmitter continuously transmitted on a low (2402 MHz) and high frequency (2480 MHz) channel.

The transmitter output was connected to the spectrum analyser in peak hold mode.

The resolution bandwidth of 100 kHz and the video bandwidth of 300 kHz were utilised.

Refer to Appendix L for Band Edge plots

**NB:** D1 line indicates the highest level of the transmitter

D2 line indicates 20 dB limit below D1.

**Result:** Complies.



### 3.0 PEAK OUTPUT POWER - Section 15.247 (b)(1) & (3)

Testing was performed in accordance with the requirements of FCC Part 15.247(b)(3).

Measurements were performed while the Bluetooth transmitter continuously transmitted.

The transmitter output was connected to the spectrum analyser in peak hold mode.

The resolution bandwidth of 1 MHz and the video bandwidth of 3 MHz were utilised.

Testing was performed while the transmitter continuously transmitted on a low (channel 1, 2402 MHz), middle (channel 40, 2441 MHz) and high (Channel 79, 2480 MHz) frequency channel.

Variation by +/- 15% of the supply voltage, in accordance with section 15.31(e), to the computer power supply power did not cause any variations to the RF output power.

Frequency MHz	P dBm	Limit dBm	P mW	Limit mW	Power Plots
2402	10.4	30	11.0	1000	Appendix M
2441	10.2	30	10.5	1000	Appendix M
2480	9.8	30	9.6	1000	Appendix M

**Result:** Complies.



#### 4.0 CHANNEL BANDWIDTH & CHANNEL OCCUPANCY

Testing was carried out in accordance with the requirements of FCC Part 15.247(a)(1)(i)&(iii)

The EUT was a Frequency Hopping Spread Spectrum transmitter and operated as described in section 2 of this report.

##### 4.1 Channel Bandwidth

In the band 2400 - 2483.5 MHz the hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

The transmitter output was connected to the spectrum analyser in peak hold mode.

A resolution bandwidth of 30 kHz and the video bandwidth of 100 kHz were utilised.

Testing was performed while the transmitter continuously transmitted on a low (channel 1, 2402 MHz), middle (channel 40, 2441 MHz) and high (Channel 79, 2480 MHz) frequency channel.

Frequency MHz	Bandwidth kHz	Result	20 dB Bandwidth Plots
2402	739	Complies	Appendix J
2441	745	Complies	Appendix J
2480	733	Complies	Appendix J

##### 4.2 Channel Occupancy

79 channels were observed operating between 2400 – 2483.5 MHz. Refer to Appendix N for number of channel plot.

The channel separation of 1 MHz was recorded. Refer to Appendix N for number of channel separation plot.

The device was observed to have a dwell time of 410.8 uS. This measurement was made on a channel using a spectrum analyser with a 0 Hz span and a sweep time of 5 mS. Refer to Appendix N for dwell time plot.

The specification allows for a dwell time not exceeding 0.4 seconds.

The maximum period is 79 channels x 0.4 seconds = 31.6 seconds

During the test the transmitter was observed to activate on average 315 times in 31.6 seconds.

The transmitter therefore occupies in one channel for 315 x 410.8uS = 0.129 seconds

**Result:** Complies.



## 5.0 RADIO FREQUENCY EXPOSURE (HAZARD) INFORMATION

Testing was performed in accordance with the requirements of FCC Part 15.247(b)(5)

Spread spectrum transmitters operating in the 2400 - 2483.5 MHz band are required to be operated in a manner that ensures that the public is not exposed to RF energy levels in accordance with CFR 47, Section 1.1307(b)(1).

The WLAN is a mobile device. The antennas are located on the top edge of LCD screen (2 antennas left and right) projected distance of greater than 20cm from user.

The Bluetooth is a portable device. The antenna is located on the right hinge of the LCD screen projected distance of greater than 2.5cm from the bottom of the laptop.

The separation distance between the WLAN and BT antennas is greater than 20cm. Therefore, they are not co-located transmitters.

MPE calculation for Bluetooth is not applicable and SAR is not required as the power for BT is below the low threshold.

The MPE calculation shown below is for the WLAN mobile device for a separation distance of greater than 20cm.

In accordance with Section 1.1310, the Maximum Permissible Exposure (MPE) limit for the General Population/Uncontrolled Exposure of 1.0 has been applied, i.e  $1\text{mW}/\text{cm}^2$ .

Friis transmission formula:  $P_d = (P \cdot G) / (4 \cdot \pi \cdot r^2)$

where:  $P_d$  = power density ( $\text{mW}/\text{cm}^2$ )

$P$  = power input to the antenna (mW)

$G$  = antenna gain (numeric)

$r$  = distance to the center of radiation of the antenna (cm)

**The result was extracted from section 3.0 of EMC Technologies Report No: M041106\_Cert\_Eton\_Atheros\_11abg\_DTS\_BT (WLAN Module)**

Maximum peak output power = 19.9dBm = 97.8mW

Antenna (Inverted F) gain (typical) = 1.06 dBi = 1.28 numeric

Prediction distance = 20 cm

Prediction frequency = 2437 MHz

MPE limit for uncontrolled exposure at prediction frequency =  $1\text{mW}/\text{cm}^2$

The power density calculated =  $0.025\text{mW}/\text{cm}^2$

**Results:** Calculations show that the Radio devices with described antennas complied with Maximum Permissible Exposure (MPE) limit for the General Population/Uncontrolled Exposure



## 6.0 ANTENNA REQUIREMENT

Testing to the requirements of FCC Part 15.203 was not applicable as this intentional radiator was designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

## 7.0 COMPLIANCE STATEMENT

The LifeBook E Series, Model: E8020D (Eton) with Mini-PCI Wireless LAN Module (Atheros 11a+b/g), Model WLL4030 & Bluetooth, Model UGXZ5-102A, tested on behalf of Fujitsu Australia Ltd, **comply** with the requirements of 47 CFR, Part 15 Subpart C - Rules for Radio Frequency Devices (intentional radiators), Section 15.247 -Operation in the frequency band 2400 - 2483.5 MHz.

The test sample also complies with the Industry Canada RSS-210 issue 5 (Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)) clause 6.2.2(o) 2400 – 2483.5 MHz Spread Spectrum requirements and the RF exposure requirements of RSS-102.

**Results were as follows:**

### Bluetooth

FCC Part 15, Subpart C Clauses	Industry Canada RSS-210 Clauses	Test Performed	Result
<b>15.203</b>	5.5	Antenna Requirement	<b>Not Applicable</b>
<b>15.205</b>	6.3	Operation in Restricted Band	<b>Complies</b>
<b>15.207</b>	6.6	Conducted Emissions	<b>Complies</b>
<b>15.209</b>	6.3	Radiated Emissions	<b>Complies</b>
<b>15.247 (a)(1)&amp;(3)</b>	6.2.2(o)(ii)	Channel Occupancy/Bandwidth	<b>Complies</b>
<b>15.247 (b)(1)</b>	6.2.2(o)(b)	Peak Output Power	<b>Complies</b>
<b>15.247 (b)(5)</b>		Radio Frequency Hazard	<b>Complies</b>
<b>15.247 (c)</b>	6.2.2(o)(e1)	Out of Band Emissions	<b>Complies</b>

**The results for the Atheros module are reported separately.**

Refer to EMC Technologies' test report: M041106\_Cert\_Eton\_Atheros\_11abg\_DTS\_BT and M041106\_Cert\_Eton\_Atheros\_11abg\_NII\_BT.



## TEST REPORT APPENDICES

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**Attachment 1: RF Exposure Information**

**Attachment 2: FCC DOC for LifeBook E Series (Eton)**



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