EMC Technologies Pty Ltd
ABN 82 057 105 549
57 Assembly Drive
Tullamarine Victoria Australia 3043

Ph: + 613 9335 3333
Fax: + 613 9338 9260
email: melb@emctech.com.au

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

FCC ID: **EJE-WB0014**
Industry Canada ID: **337J-WB0014**

Test Sample: LifeBook E Series
Model: E8010 (Emilia2)

Radio Modules: Mini-PCI WLAN (Calexico2 11a+b/g), Model: WM3B2915ABG & Bluetooth, Model UGXZ5-102A

Report Number M040905_Cert_Emilia2_BT_Cal2_11abg

Tested for: Fujitsu Australia Ltd.

Issue Date: 8th October 2004

NATA Accredited Laboratory Number: 5292

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

EMC Technologies Report No. M040905_Cert_Emilia2_BT_Cal2_11abg

Issue Date: 8th October 2004

CONTENTS

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

Report Number:	M040905_Cert_Emilia2_BT_Cal2_11abg
Test Sample:	LifeBook E Series
Model:	E8010 (Emilia2)
Radio Modules:	Mini-PCI WLAN, Model: WM3B2915ABG (Intel Corp.) Bluetooth, Model: UGXZ5-102A (Fujitsu Ltd)
FCC ID:	EJE-WB0014
Industry Canada ID:	337J-WB0014
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
Address:	5 Lakeside Drive, Burwood East, VIC 3151 Australia
Phone:	+613 9845 4300
Fax:	+613 9845 4600
Contact:	Mr Praveen Rao – Senior Compliance Engineer
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:	11th August to 6th October 2004
Test Officers:	**Chieu Huynh** **B.Eng (Hons) Electronics** **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 E8010 (Emilia2) with Mini-PCI Wireless LAN Module (Calexico2 11a+b/g), Model WM3B2915ABG & Bluetooth, Model UGXZ5-102A.

The Calexico2 WLAN supports IEEE 802.11b, IEEE 802.11g and IEEE802.11a (DTS & U-NII) 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 WLAN are reported separately.
Refer to EMC Technologies' test report: M040905_Cert_Emilia2_Cal2_11abg_DTS_BT (DTS) and M040905_Cert_Emilia2_Cal2_11abg_NII_BT (U-NII).

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.

1.1 Summary of Results

1.1.1 Bluetooth - FCC 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, Calexico2 802.11b, 802.11g and 802.11a (DTS) - FCC 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' test report: M040905_Cert_Emilia2_Cal2_11abg_DTS_BT

1.1.3 WLAN, Calexico2 802.11a (U-NII) - FCC 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' test report: M040905_Cert_Emilia2_Cal2_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.

2.0 GENERAL INFORMATION

(Information supplied by the Client)

2.1 Product Details

Test Sample:	LifeBook E series
Codenames:	E8010
Model Name:	Emilia2
LifeBook rating:	80W (19V, 4.22A)
Serial Number:	Pre-production Sample
Manufacturer:	FUJITSU LIMITED
CPU Type and Speed:	Dothan 2.1 GHz Banias 1.7 GHz Celeron-M 1.7 GHz
SDRAM:	1GB
LCD Screen:	14”XGA / 15”XGA / 15”SXGA / 15”UXGA (Mg-Al alloy LCD back cover)
Hard Disk Drive:	20GB
Wired LAN:	BroadCom5705(1000Base) / BroadCom5788(1000Base)
Modem:	MBH7MD33 / MBH7MD35
Wireless LAN (WLAN) Module:	Calexico2 (11abg) WM3B2915ABG
Bluetooth:	ALPS Bluetooth
Bluetooth Model Number:	UGXZ5-102A
Port Replicator Model:	FPCPR48
AC Adapter Model:	SEB100P2-19.0
Alternate Models:	CA01007-092X
Voltage:	19 V
Current Specs:	4.22 A
Watts:	80 W

Radio Modules:	Bluetooth and WLAN (Calexico2 11a+b/g)
Bluetooth Model Number:	UGXZ5-102A
Bluetooth Manufacturer:	Fujitsu Ltd
WLAN Model Number:	WM3B2915ABG
WLAN Manufacturer:	Intel Corporation
Interface Type:	Mini-PCI Wireless LAN Module
FCC ID:	EJE-WB0014
Industry Canada ID:	337J-WB0014
Equipment Type:	Intentional Radiator (Transceiver)

2.2 Technical Specifications

2.2.1 Bluetooth Transmitter Specifications

Transmitter#1: Bluetooth
Model Number: UGXZ5-102A
Manufacturer: Fujitsu Ltd
Network Standard: Bluetooth™ RF Test Specification
Modulation Type: Frequency Hopping Spread Spectrum (FHSS)
Frequency Range: 2.4 –2483.5 GHz
Number of Channels: 79
Carrier Spacing: 1.0 MHz
Antenna Types: Inverted-F Antenna – PN: CP115412-01
Max. Output Power: 12 dBm
Reference Oscillator: 16 MHz (Built-in)
Power Supply: 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

Transmitter #1:	Mini-PCI Wireless LAN Module
Wireless Module:	Calexico2 (11a+b/g)
Model Number:	WM3B2915ABG
Manufacturer:	Intel Corporation
Modulation Type:	Direct Sequence Spread Spectrum (DSSS for 802.11b) Orthogonal Frequency Division Multiplexing (OFDM for 802.11g) Orthogonal Frequency Division Multiplexing (OFDM for 802.11a)
802.11a	BPSK – 6Mbps, 9Mbps QPSK – 12Mbps, 18Mbps 16QAM – 24Mbps, 36Mbps 64QAM – 48Mbps, 54Mbps
802.11g	BPSK – 6Mbps, 9Mbps QPSK – 12Mbps, 18Mbps 16QAM – 24Mbps, 36Mbps 64QAM – 48Mbps, 54Mbps
802.11b	DBPSK – 1Mbps DQPSK – 2Mbps CCK – 5.5Mbps, 11Mbps
Maximum Data Rate:	802.11b = 11Mbps, 802.11g and 802.11a = 54Mbps
Frequency Range:	2.4 –2483.5 GHz for 11b/g 5.15 - 5.35 GHz and 5.725 - 5.850 GHz for 11a
Number of Channels:	11 channels for 11b or 11g 13 channels for 11a
Antenna Types:	Inverted-F Antenna – PN: CP115412-01
Max. Output Power:	802.11b = 15 dBm 802.11g = 14 dBm 802.11a = 10-14 dBm
Power Supply:	3.3 VDC from PCI bus
Chipset Used:	82533MDE and 82533RGE

Frequency allocation for 802.11b/g:

Channel Number	Frequency (MHz)	EUT Power level setting dBm	
		802.11b	802.11g
1	2412	15	14
2	2417	15	14
3	2422	15	14
4	2427	15	14
5	2432	15	14
6	2437	15	14
7	2442	15	14
8	2447	15	14
9	2452	15	14
10	2457	15	14
11	2462	15	14

Frequency allocation for 802.11a:

Channel Number	Frequency (MHz)	Power level setting dBm
*Channels reported in the DTS submission		
149	5745*	14
153	5765	14
157	5785*	14
161	5805	14
165	5825*	14
*Channels reported in the U-NII submission		
36	5180*	10
40	5200	10
44	5220	10
48	5240	10
52	5260*	14
56	5280	14
60	5300	14
64	5320*	14

2.3 Operational Description

The EUT is a LifeBook E Series, Model E8010 (Emilia2) installed with a Mini-PCI Wireless LAN (WLAN) Module (Calexico2 11a+b/g, Model WM3B2915ABG) & Bluetooth, Model UGXZ5-102A.

The WLAN module is an OEM product from Intel Corporation, which is already certified by the manufacturer FCC ID: PD9WM3B2915ABG and IC: 1000M-3B2915.

The ALPS Bluetooth has been previously certified by the manufacturer, Fujitsu Ltd under FCC ID: EJE-WB0002 and IC: 337J-WB0002 for a different host.

The intention of this application is to certify this WLAN and Bluetooth with a Inverted-F Antenna combination in host – LifeBook E Series, Model E8010 (Emilia2)

The measurements reported in this test report are for WLAN (Calexico2 11a+b/g, Model WM3B2915ABG) and Bluetooth (UGXZ5-102A) with Inverted-F Antenna in Host PC, LifeBook E Series, Model E8010 (Emilia2).

2.4 Test Configuration

The Intel WLAN 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 Calexico2 (11a+b/g) WLAN, Model WM3B2915ABG and ALPS Bluetooth device, Model UGXZ5-102A are configured with Inverted-F Antenna – PN: CP115412-01. The installation of the Intel WLAN module, Bluetooth Device and the Antenna in Fujitsu LifeBook E Series, Model E8010 (Emilia2) 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 two antennas: Main antenna is located on the right hand side of the LCD screen and Aux antenna is located on the left hand side of the LCD screen.
WLAN and Bluetooth simultaneous function: WLAN transmit via Main antenna and Bluetooth via Aux antenna
WLAN Only function: Transmit via Main antenna OR Aux antenna
Bluetooth Only function: Transmit via Aux antenna only

Refer to photos in Appendix B3 for Antenna locations.

AC Adapter

The AC adapter SEB100P2-19.0 was used for all the tests. This adapter is also identified as CA01007-092X. The manufacturer has stated that all these adapters are identical electrically and mechanically**.**

2.5 Block Diagram

Refer to Appendix D - Block Diagram

2.6 Support Equipment

External Monitor/s:	
Conducted EMI	Videocom, Model DCM-1588VAE, FCC ID: H79DCM-1588
Radiated EMI	Hewlett Packard 15" Color monitor, Model D2827A, FCC ID: C5F7NFCMC1515X
Printer:	Diconix, Model: 150, FCC ID: E759WG-RBCN150
USB Floppy Drives:	Fujitsu Model: FPCFDD11, P/N CP032173-01 Fujitsu Model: FPCFDD12, P/N CP078720-01 USB OMNI Floppy Drive Model # USB F3501 SN W316000096
Headphones:	Verbatim Multimedia Stereo headset
PS2 Keyboard	Logitech, Model: YBA9, S/N MCT94602411
PS2 Mouse	A4 Tech M/N: SWW-25
LAN Hub:	Kingston SOHO Hub Model: KNE8TP/H (FCC ID: JICKNE8TP-HO)
Modem:	Maestro Companion Series 3
PCMCIA Slot:	6 MB Compact flash card with Adapter, Apacer P/N 88.10200030

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 5th 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
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^2LA).

2.9 Units of Measurements

2.9.1 Conducted Emissions

Measurements are reported in units of dB relative to one microvolt. (dBμV).

2.9.2 Radiated Emissions

Measurements are reported in units of dB relative to one microvolt per metre (dBμV/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)

Conducted Emission Measurements were performed on the LifeBook E Series, Model E8010 (Emilia2) with WLAN module and Bluetooth.

Initial investigations were performed with the WLAN in all configurations (802.11b, 801.11g and 802.11a) 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 dBμV	QP Limit dBμV	ΔQP ±dB	Measured AV Level dBμV	AV Limit dBμV	ΔAV ±dB
0.202	Active	51.5	63.5	-12.0	47.0	53.5	-6.5
0.208	Neutral	52.2	63.3	-11.1	45.3	53.3	-8.0
0.303	Neutral	48.4	60.2	-11.7	40.1	50.2	-10.1
0.621	Active	40.0	56.0	-16.0	31.8	46.0	-14.2
0.311	Active	44.8	59.9	-15.2	35.6	49.9	-14.3
0.619	Neutral	40.0	56.0	-16.0	31.5	46.0	-14.5

The worst case conducted EMI occurred at 0.202 MHz and complied with the quasi peak and average limits by margins of 12.0 dB and 6.5 dB respectively. The measurement uncertainty was ±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 dBµV/m.
V = EMI Receiver Voltage in dBµV. (measured value)
AF = Antenna Factor in dB(m^{-1}). (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 dBµV 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 dBµV/m

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (1000 MHz – 18,000 MHz) ± 4.1 dB
(30 MHz – 1,000 MHz) ± 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 dBμV/m limit at 3 metres has been converted to 64 dBμV/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 report: M040905_Cert_Emilia2_Cal2_11abg_DTS_BT (DTS) and M040905_Cert_Emilia2_Cal2_11abg_NII_BT (U-NII).

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 52.7 dBμV/m peak & 38.6 dBμV/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 66.0 dBμV/m peak & 49.2 dBμV/m average and was > 20 dB below the maximum field strength of the in-band carrier.

2.3.1.1 Bluetooth

Channel 1 - 2402 MHz

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
2402	Transmitter	Fundamental		-	-	
4804	54.0	41.8	Vert/Hort	74.0	54.0	Pass
7206	56.4	52.1	Vert/Hort	-	-	Pass
9608	55.3	42.2	Vert/Hort	-	-	Pass
12010	58.9	46.8	Vert/Hort	74.0	54.0	Pass
14412	60.7	47.2	Vert/Hort	-	-	Pass
16814	62.9	49.3	Vert/Hort	-	-	Pass
19216	65.3	52.5	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
21618	67.4	53.2	Vert/Hort	-	-	Pass
24020	67.8	54.0	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	53.5	41.4	Vert/Hort	74.0	54.0	Pass
7323	56.1	52.0	Vert/Hort	74.0	54.0	Pass
9764	55.3	42.2	Vert/Hort	-	-	Pass
12205	58.9	46.8	Vert/Hort	74.0	54.0	Pass
14646	60.7	47.2	Vert/Hort	-	-	Pass
17087	62.9	49.3	Vert/Hort	-	-	Pass
19528	65.3	52.5	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
21969	67.4	53.2	Vert/Hort	-	-	Pass
24410	67.8	54.0	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	54.3	41.9	Vert/Hort	74.0	54.0	Pass
7440	56.6	52.4	Vert/Hort	74.0	54.0	Pass
9920	55.3	42.2	Vert/Hort	-	-	Pass
12400	58.9	46.8	Vert/Hort	74.0	54.0	Pass
14880	60.7	47.2	Vert/Hort	-	-	Pass
17360	62.9	49.3	Vert/Hort	-	-	Pass
19840	65.3	52.5	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
22320	67.4	53.2	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
24800	67.8	54.0	Vert/Hort	-	-	Pass

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

Result: Harmonics were recorded within the restricted bands of up to 25 GHz and complied with the FCC Class B average limits by a margin of 7.2 dB. Harmonics were below the limit in section 15.209. The measurement uncertainty for radiated emissions in this band was ±4.1 dB.

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

WLAN (configuration 802.11a) - 5260MHz and BT – 2480MHz

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
7728	51.4	40.7	Vert/Hort	74.0	54.0	Pass

Result: Spurious emissions were recorded within the restricted bands of up to 40 GHz and complied with the FCC Class B limits by a margin of 13.3 dB. Harmonics were below the limit in section 15.209 and 15.407. The measurement uncertainty for radiated emissions in this band was ±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, Model E8010 (Emilia2) with WLAN module and Bluetooth.

Initial investigations were performed with the WLAN in both configurations (802.11b, 802.11g and 802.11a) 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 dBμV/m	QP Limit dBμV/m	ΔQP ± dB
234.50	Vertical	34.8	35.5	-0.7
231.38	Vertical	33.6	35.5	-1.9
369.91	Vertical	32.9	35.5	-2.6
203.64	Vertical	29.7	33.0	-3.3
215.40	Vertical	29.2	33.0	-3.8
184.30	Vertical	28.6	33.0	-4.4
198.27	Vertical	28.1	33.0	-4.9
165.82	Vertical	26.7	33.0	-6.4
169.82	Vertical	26.2	33.0	-6.8
162.51	Vertical	24.4	33.0	-8.7

Horizontal Polarity

Frequency MHz	Polarisation	QP Measured dBμV/m	QP Limit dBμV/m	ΔQP ± dB
203.67	Horizontal	29.6	33.0	-3.4
363.41	Horizontal	31.5	35.5	-4.0
234.51	Horizontal	30.2	35.5	-5.3
432.01	Horizontal	29.2	35.5	-6.4
212.48	Horizontal	23.8	33.0	-9.2
198.84	Horizontal	22.9	33.0	-10.1
169.99	Horizontal	22.0	33.0	-11.0
171.07	Horizontal	20.3	33.0	-12.7
801.82	Horizontal	22.6	35.5	-12.9

Result: The highest radiated emission peak occurred at 234.5 MHz (Vertical Polarity) and complied with FCC quasi peak limit by a margin of 0.7 dB. The measurement uncertainty in this band was ± 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 (2412 MHz) and high frequency (2462 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 100 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.

The Peak Output Power (P) was calculated as follows:

P = R + G where R is the recorded peak power
G is the antenna gain in dBi (with EUT cable loss)

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	R dBm	G dBi	P dBm	Limit dBm	P mW	Limit mW
2402.0	10.41	1.06	11.47	30	14.0	1000
2441.0	10.25	1.06	11.31	30	13.5	1000
2480.0	9.93	1.06	10.99	30	12.6	1000

The specification limit is 1W (30 dBm).

Refer to Appendix M for Peak Power plots

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	751	Complies	Appendix J
2441	781	Complies	Appendix J
2480	741	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.

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).

In accordance with this section and also section 2.1091 this device has been defined as a mobile device whereby a distance of 20 cm normally can be maintained between the user and the device.

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 1mW/cm^2.

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

where: Pd = power density (mW/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 this report. (Bluetooth):
Maximum peak output power = 10.41dBm = 11.0 mW
Antenna (Inverted-F) gain (typical) = 1.06 dBi = 1.28 numeric
Prediction distance = 20 cm
Prediction frequency = 2402 MHz
MPE limit for uncontrolled exposure at prediction frequency = 1 mW/cm^2

Therefore, the power density at prediction frequency (Pd) = 0.003mW/cm^2

The result was extracted from section 3.0 of EMC Technologies Report No: M040905_Cert_Emilia2_Cal2_11abg_DTS_BT (WLAN Module):
Maximum peak output power = 19.2dBm = 83.2mW
Antenna (Inverted-F) gain (typical) = -0.41 dBi = 0.91 numeric
Prediction distance = 20 cm
Prediction frequency = 2437 MHz
MPE limit for uncontrolled exposure at prediction frequency = 1 mW/cm^2

Therefore, the power density at prediction frequency (Pd) = 0.02 mW/cm^2

The total power density (TPd) for WLAN and Bluetooth transmitters continuously operated:

TPd = 0.02 (WLAN) + 0.003 (Bluetooth) = 0.023mW/cm^2

Calculations show that this device with described antenna does meet the MPE requirements for portable devices falling below the 20 cm clearance required.

Results: Complies

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 E8010 (Emilia2) with Mini-PCI Wireless LAN Module (Calexico2 11a+b/g, Model WM3B2915ABG) & 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
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**

The results for WLAN are reported separately.
Refer to EMC Technologies' test report: M040905_Cert_Emilia2_Cal2_11abg_DTS_BT (DTS) and M040905_Cert_Emilia2_Cal2_11abg_NII_BT (U-NII).

TEST REPORT APPENDICES

APPENDIX A: MEASUREMENT INSTRUMENT DETAILS
APPENDIX B: REPORT PHOTOGRAPHS
APPENDIX C: FUNCTIONAL DESCRIPTION
APPENDIX D: BLOCK DIAGRAM
APPENDIX E: SCHEMATICS
APPENDIX F: ANTENNA INFORMATION (INVERTED-F ANTENNA)
APPENDIX G: SPECIFICATIONS
APPENDIX H: FCC LABELLING DETAILS
APPENDIX I: GRAPHS of EMI MEASUREMENTS
APPENDIX J: CHANNEL BANDWIDTH PLOTS
APPENDIX K: HARMONICS PLOTS
APPENDIX L: BANDEDGE PLOTS
APPENDIX M: PEAK POWER OUTPUT PLOTS
APPENDIX N BLUETOOTH CHANNEL OCCUPANCY PLOTS
APPENDIX O: USER MANUAL

Attachment 1: RF Exposure Information
Attachment 2: FCC DOC for LifeBook Emilia2 E Series (E8010)