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EMI TEST REPORT FOR CERTIFICATION to FCC PART 15 Subpart E (Section 15.407) & RSS-210

FCC ID: **EJE-WB0011**
Industry Canada ID: **337J-WB0011**

Test Sample: LifeBook T Series
Model: T4010 (Soriel)

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

Report Number M040821_Cert_Soriel_Cal2_11abg_NII_BT

Tested for: Fujitsu Australia Ltd.

Issue Date: 3rd September 2004

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Radio Modules:	Mini-PCI WLAN, Model: WM3B2915ABG (Intel Corp.) Bluetooth, Model: UGXZ5-102A (Fujitsu Ltd)
FCC ID:	EJE-WB0011
Industry Canada ID:	337J-WB0011
Equipment Type:	Intentional Radiator (Transceiver)
Manufacturer (LifeBook):	Fujitsu Ltd
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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 E – Unlicensed National Information, Infrastructure Devices FCC Part 15.407, General Technical Requirements ANSI C63.4 – 1992 OET Bulletin No. 63 RSS-210 Issue 5 Low Power Licence-Exempt RadioCommunication Devices: 6.2.2 (q1) 5150 - 5350 MHz & 5725-5825 MHz Local Area Network Devices 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 1st September 2004
Test Officers:	**Chieu Huynh** **B.Eng (Hons) Electronics** **Kevin Hansen**
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 E (Section 15.407) & RSS-210

1.0 INTRODUCTION

EMI testing was performed on test sample LifeBook T Series, Model: T4010 (Soriel) 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 configurations IEEE 802.11a (U-NII: 5150 – 5350 MHz) are reported in this test report.

The results for configurations IEEE 802.11b, IEEE 802.11g and IEEE802.11a (DTS: 5725 – 5850 MHz) and Bluetooth are reported separately.
Refer to EMC Technologies' test report: M040821_Cert_Soriel_Cal2_11abg_DTS_BT (802.11b/g and 802.11a: DTS) and M040821_Cert_Soriel_BT_Cal2_11abg (Bluetooth).

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

47 CFR, Part 15, Subpart E:	Unlicensed National Information Infrastructure Devices (U-NII) operating in the 5.15-5.35 GHz and 5.725-5.825 GHz frequency bands
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 15.407:	General Technical Requirements

The results and technical details of the test sample are detailed in this report. The test sample **complies** with the requirements of 47 CFR, Part 15 Subpart E - Section 15.407.

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(q1) requirements and the RF exposure requirements of RSS-102.

1.1 Summary of Results

1.1.1 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 with SAR requirements**
15.407 (g)	6.4	Frequency Stability	**Complies**

*Refer to EMC Technologies' report M040822_Soriel_Calexico2_11abg_SAR_5.2

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 with SAR requirements**
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: M040821_Cert_Soriel_Cal2_11abg_DTS_BT

1.1.3 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 with SAR requirements**
15.247 (c)	6.2.2(o)(e1)	Out of Band Emissions	**Complies**

Refer to EMC Technologies Report No: M040821_Cert_Soriel_BT_Cal2_11abg

**Refer to EMC Technologies' report M040822_Soriel_Calexico2_11abg_SAR_2.4

The measurement procedure used was in accordance with ANSI C63.4-1992 and OET Bulletin No. 96-43. The instrumentation conformed to the requirements of ANSI C63.2-1987.

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 (Host PC):	LifeBook T Series
Model Number:	T4010
Code Name:	Soriel
Serial Number:	Pre-production Sample
Manufacturer:	Fujitsu Ltd
CPU Type and Speed:	Dothan 2.1 GHz
SDRAM:	256MB
LCD Screen:	12.1”XGA / 12.1”SXGA
Hard Disk Drive:	40GB
Wired LAN:	Giga-LAN/10/100Base-T
Modem:	MBH7MD33 / MBH7MD35
Wireless LAN (WLAN) Module:	Calexico2 (11abg) WM3B2915ABG
Bluetooth:	ALPS Bluetooth
Bluetooth Model Number:	UGXZ5-102A
Port Replicator Model:	FPCPR49
AC Adapter Model:	SEB80N2-19.0 / UJ97 / PTW1931N / SEC80N2-19.0 / SEB100P2-19.0
Alternate Models:	CA01007-0930 / CA01007-098x / CP196212-xx / CP214612-xx / CA01007-092x
Voltage:	19 V
Current Specs:	3.16 A / 4.22 A
Watts:	60 W / 80 W
Radio Modules:	WLAN (Calexico2 11a+b/g) and Bluetooth
WLAN Model Number:	WM3B2915ABG
WLAN Manufacturer:	Intel Corporation
Interface Type:	Mini-PCI Wireless LAN Module
Bluetooth Model Number:	UGXZ5-102A
Bluetooth Manufacturer:	Fujitsu Ltd
FCC ID:	EJE-WB0011
Industry Canada ID:	337J-WB0011
Equipment Type:	Intentional Radiator (Transceiver)

2.2 Technical Specifications

2.2.1 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: Monopole Dielectric Antenna
Part Number: DA120D-2454M-FJ01
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 this report		
36	5180*	10
40	5200	10
44	5220	10
48	5240	10
52	5260*	14
56	5280	14
60	5300	14
64	5320*	14

2.2.2 Bluetooth Transmitter Specifications

Transmitter#2: 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: Monopole Dielectric Antenna
Part Number: DA120D-2454M-FJ01
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

2.3 Operational Description

The EUT is a LifeBook T Series, Model: T4010 (Soriel) 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: PD9WM3A2915ABG and IC: 1000M-3A2915.

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 Monopole Dielectric antenna combination in host – LifeBook T Series, Model: T4010 (Soriel).

The measurements reported in this test report are for WLAN (Calexico2 11a+b/g, Model WM3B2915ABG) and Bluetooth (UGXZ5-102A) with Monopole Dielectric Antenna in Host PC, LifeBook T Series, Model: T4010 (Soriel).

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.

Data Transmission is always initiated by software, which is then passed down through the MAC, through the digital and analog baseband, finally to the RF chip. Several special packets (ACKs, CTS, PSPoll, etc) are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which then turns off at the end of the packet. Therefore, the transmitter will be ON only while one of the four mentioned packets is being transmitted.

Antenna

The Calexico2 (11a+b/g) WLAN, Model WM3B2915ABG and ALPS Bluetooth device, Model UGXZ5-102A are configured with Monopole Dielectric Antenna – DA120D-2454M-FJ01. The installation of the Intel WLAN module, Bluetooth Device and the Antenna in Fujitsu LifeBook T Series, Model: T4010 (Soriel) is in a controlled environment. The installation is performed during the production/assembly process at the Fujitsu factory.

Refer to Appendix F – Antenna Information.

AC Adapter

Testing was performed with both AC adapters SEB80N2-19.0 (80W) and PTW1931N (60W). Results for 80W adapter are reported.

The adapters are also identified as UJ97 / SEC80N2-19.0 / SEB100P2-19.0 / CA01007-0930 / CA01007-098x / CP196212-xx / CP214612-xx / 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
USB Mouse:	Microsoft Intellimouse, S/N 00723014, FCC ID: C3KKS9
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 C63.4-1992. Radiated emissions tests were performed at a distance of 3 and 10 metres from the EUT. OET Bulletin 63 dated October 1993 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

WLAN Module – WM3B2915ABG (802.11a (NII) of Calexico2 11a+b/g)

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 C63.4-1992 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 C63.2-1987 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 was 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 T Series, Model T4010 with WLAN module and Bluetooth. Measurements were tested individually with both adapters (PTW1931N and SEB100P2-19.0). Final test results are reported for adapter SEB100P2-19.0 (80W).

Initial investigations were performed with the WLAN in all modulation types: (BPSK, QPSK, 16QAM and 64QAM). No significant differences in emissions were observed. Final testing was performed while the WLAN transmitter continuously operated on the high (Channel 36, 5180 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
0.155	Active	51.8	65.7	-13.9	13.2	55.7	-42.5
0.154	Neutral	51.9	65.8	-13.9	13.2	55.8	-42.6
0.206	Neutral	47.7	63.4	-15.6	32.2	53.4	-21.2
0.200	Active	47.6	63.6	-16.0	19.5	53.6	-34.1
0.273	Neutral	43.6	61.0	-17.4	32.7	51.0	-18.3
7.699	Neutral	42.3	60.0	-17.8	29.5	50.0	-20.5
0.414	Neutral	39.5	57.6	-18.1	31.6	47.6	-16.0
7.633	Active	41.4	60.0	-18.6	26.8	50.0	-23.2
0.621	Neutral	37.1	56.0	-18.9	32.6	46.0	-13.4
0.273	Active	41.4	61.0	-19.6	29.5	51.0	-21.5
0.761	Active	34.4	56.0	-21.6	33.3	46.0	-12.7
4.923	Active	31.9	56.0	-24.1	22.0	46.0	-24.0

The worst case conducted EMI occurred at 0.155 MHz and complied with the quasi peak and average limits by margins of 13.9 dB and 42.5 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 RADIATED EMISSION MEASUREMENTS

2.1 Test Procedure

Testing was performed in accordance with the requirements of FCC Part 15.407(b).

Radiated emission measurements were performed to the limits as per section 15.209 and 15.407. 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 40 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 measurement data for each frequency range was automatically corrected by the software for cable losses, 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 Results - Out of Band Emissions (Spurious and Harmonics)

2.3.1 Frequency Band: 1 – 40 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.

The peak limits for undesirable emission outside of the restricted bands are –27 dBm (68.3 dBuV/m @ 3m).

Measurements were performed on frequency band (5.15 - 5.35 GHz)

Testing was performed while both the WLAN transmitter and Bluetooth transmitter continuously operated. Harmonics related to the WLAN transmitter are reported below. For harmonics related to the Bluetooth transmitter, refer to M040821_Cert_Soriel_BT_Calexico2_11abg.

Initial investigations were performed with four modulation types: (BPSK, QPSK, 16QAM and 64QAM). No significant differences in emissions were observed. Final testing was performed while the transmitter continuously operated with the modulation rate of 54 Mbps (64QAM).

The field strength at 5350 MHz when the EUT was operating at its highest channel (5320 MHz), was 60.5 dBμV/m peak & 44.9 dBμV/m average and was > 20 dB below the maximum field strength of the in-band carrier.

The field strength at 5150 MHz when the EUT was operating at its lowest channel (5180 MHz), was 59.7 dBμV/m peak & 45.1 dBμV/m average and was > 20 dB below the maximum field strength of the in-band carrier.

Channel 36 – 5180 MHz

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
5180	Transmitter	Fundamental				
10360	69.8	55.3	Vert/Hort	68.3	-	Pass
15540	61.6	48.2	Vert/Hort	74.0	54.0	Pass
20720	64.5	49.5	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
25900	68.8	54.2	Vert/Hort	78.3* (1m)	-	Pass
31080	65.3	52.1	Vert/Hort	78.3* (1m)	-	Pass
36260	70.1	55.4	Vert/Hort	78.3* (1m)	-	Pass

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

Channel 52 – 5260 MHz

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
5260	Transmitter	Fundamental				
10520	71.2	55.9	Vert/Hort	68.3	-	Pass
15780	62.0	49.3	Vert/Hort	74.0	54.0	Pass
21040	64.6	49.7	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
26300	68.3	54.4	Vert/Hort	78.3* (1m)	-	Pass
31560	65.8	52.0	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
36820	70.2	55.4	Vert/Hort	78.3* (1m)	-	Pass

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

Channel 64 – 5320 MHz

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
5320	Transmitter	Fundamental				
10640	70.4	55.4	Vert/Hort	74.0	54.0	Pass
15960	61.2	48.8	Vert/Hort	74.0	54.0	Pass
21280	65.7	50.6	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
26600	61.1	46.2	Vert/Hort	78.3* (1m)	-	Pass
31920	66.6	52.5	Vert/Hort	78.3* (1m)	-	Pass
37240	69.8	54.7	Vert/Hort	78.3* (1m)	-	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 40 GHz and complied with the FCC Class B limits by a margin of 4.7 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 T Series, Model T4010 with WLAN module and Bluetooth. Measurements were tested individually with both adapters (PTW1931N and SEB100P2-19.0). Final test results are reported for adapter SEB100P2-19.0 (80W).

Initial investigations were performed with the WLAN in all modulation types: (BPSK, QPSK, 16QAM and 64QAM). No significant differences in emissions were observed. Final testing was performed while the WLAN transmitter continuously operated on the high (Channel 36, 5180 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
85.99	Vertical	26.3	30.0	-3.7
300.12	Vertical	30.8	36.0	-5.2
85.99	Vertical	24.5	30.0	-5.5
77.85	Vertical	23.6	30.0	-6.4
61.43	Vertical	23.3	30.0	-6.7
184.32	Vertical	25.1	33.5	-8.4
49.40	Vertical	20.0	30.0	-10.0
480.00	Vertical	25.9	36.0	-10.2
100.00	Vertical	21.7	33.5	-11.8
144.02	Vertical	21.1	33.5	-12.4
200.00	Vertical	20.6	33.5	-12.9

Horizontal Polarity

Frequency MHz	Polarisation	QP Measured dBμV/m	QP Limit dBμV/m	ΔQP ± dB
82.14	Horizontal	29.1	30.0	-0.9
81.54	Horizontal	28.6	30.0	-1.4
83.05	Horizontal	28.2	30.0	-1.8
86.00	Horizontal	27.7	30.0	-2.3
86.28	Horizontal	25.2	36.0	-4.8
480.01	Horizontal	31.0	36.0	-5.0
399.85	Horizontal	31.0	36.0	-5.0
431.99	Horizontal	30.4	36.0	-5.6
243.40	Horizontal	30.4	36.0	-5.6
600.00	Horizontal	29.6	36.0	-6.4

Result: The highest radiated emission peak occurred at 82.14 MHz (Horizontal Polarity) and complied with FCC quasi peak limit by a margin of 0.9 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.

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

The resolution bandwidth of 300 kHz and the video bandwidth of 1000 kHz were utilised.

Refer to Appendix N for Harmonics plots

Result: Complies.

2.3.4 Band Edge Measurements

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

The resolution bandwidth of 1000 kHz and the video bandwidth of 1000 kHz were utilised.

Testing was performed while transmitter continuously transmitted on a low and high frequency channel of frequency band (5.150 – 5.350 GHz)

Refer to Appendix K for Band Edge plots

NB: D1 indicates the limit line for undesirable emission frequencies outside the operation frequency band.

Result: Complies.

3.0 PEAK OUTPUT POWER - Section 15.407(a)

Testing was performed in accordance with the requirements of FCC Part 15.407(a)(4)

Measurements were performed while the WLAN transmitter continuously transmitted.

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

The resolution bandwidth of 20 MHz and the video bandwidth of 20 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)

Measurements were performed on frequency band (5.150 – 5.350 GHz)

Initial investigations were performed with four modulation types: (BPSK, QPSK, 16QAM and 64QAM). No significant differences in peak transmit power were observed. Final testing was performed while the transmitter continuously operated with the modulation rate of 54 Mbps (64QAM).

Frequency MHz	A dBm	G dBi	P dBm	Limit dBm	P mW	Limit mW
5180	15.49	1.29	16.78	17	47.64	50
5260	17.93	1.29	19.21	24	83.05	250
5320	19.07	1.29	20.36	24	108.64	250

Refer to Appendix O for Peak Power plots

Variation by +/- 15% of the supply voltage, in accordance with Section 15.31(e), to the computer power supply did not vary the output power observed.

Result: Complies.

4.0 CHANNEL BANDWIDTH

Testing was performed in accordance with the requirements of FCC Part 15.407(a)

The 26 dB bandwidth was measured while the transmitter continuously transmitted.

The transmitter output (antenna port) was connected to the spectrum analyser in peak hold mode.

The resolution bandwidth of 300 kHz and the video bandwidth of 1000 kHz were utilised

Measurements were performed on frequency band (5.150 – 5.350 GHz)

Initial investigations were performed with four modulation types: (BPSK, QPSK, 16QAM and 64QAM). No significant differences in bandwidth were observed. Final testing was performed while the transmitter continuously operated with the modulation rate of 54 Mbps (64QAM).

Channel	Frequency MHz	Bandwidth MHz	26 dB Bandwidth Plots
36	5180	22.2	Appendix J
52	5260	22.0	Appendix J
64	5320	22.4	Appendix J

5.0 RADIO FREQUENCY EXPOSURE (HAZARD) INFORMATION

Testing was performed in accordance with the requirements of FCC Part 15.407(f)

Spread spectrum transmitters operating in the 5.150 – 5.350 GHz and 5.725 – 5.825 GHz bands 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.

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. (WLAN Module):
Maximum peak output power = 19.1dBm = 81.3mW
Antenna (Monopole Dielectric) gain (typical) = 1.29 dBi = 1.35 numeric
Prediction distance = 3.15 cm
Prediction frequency = 5320 MHz
MPE limit for uncontrolled exposure at prediction frequency = 1 mW/cm^2

Therefore, the power density at prediction frequency (Pd) = 0.878 mW/cm^2

The result was extracted from section 3.0 of EMC Technologies Report No: M040821_Cert_Soriel_BT_Cal2_11abg (Bluetooth):
Maximum peak output power = 11.63dBm = 14.55mW
Antenna (Monopole Dielectric) gain (typical) = 0.05 dBi = 1.01 numeric
Prediction distance = 3.15 cm
Prediction frequency = 2441 MHz
MPE limit for uncontrolled exposure at prediction frequency = 1 mW/cm^2

Therefore, the power density at prediction frequency (Pd) = 0.118 mW/cm^2

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

TPd = 0.878 (WLAN) + 0.118 (Bluetooth) = 0.996mW/cm^2

Calculations show that this portable device with described antenna must have a minimum of 3.15 cm clearance between the user and the device.

SAR testing was performed in accordance with OET Bulletin 65 and reported under EMC Technologies M040822_Soriel_Calexico2_11abg_SAR_5.2. The highest SAR value was 1.55 mW/g which complies with the FCC human exposure requirements of 47 CFR 2.1093 (d).

Refer to EMC Technologies' report - M040822_Soriel_Calexico2_11abg_SAR_5.2 for details of SAR compliance.

Results: Complies

6.0 PEAK POWER SPECTRAL DENSITY - Section 15.407 (a)

Testing was performed in accordance with the requirements of FCC Part 15.407(a)(5)

The peak power spectral density was measured over an interval of continuous transmission using a calibrated spectrum analyser with the resolution bandwidth of 1 MHz and the video bandwidth of 3 MHz.

The transmitter output was connected to the spectrum analyser with a span setting to capture the entire emission bandwidth of the signal. The peak power spectral density was recorded in dBm.

Measurements were performed on frequency bands (5.150 – 5.350 GHz)

Initial investigations were performed with four modulation types: (BPSK, QPSK, 16QAM and 64QAM). No significant differences in peak power spectral density were observed. Final testing was performed while the transmitter continuously operated with the modulation rate of 54 Mbps (64QAM).

Channel	Frequency MHz	Peak Power Spectral Density (dBm)	Limit (dBm)	Result	Spectral Density plots
36	5180	2.22	4.0	Complies	Appendix L
52	5260	4.72	11.0	Complies	Appendix L
64	5320	3.97	11.0	Complies	Appendix L

Result: Complies.

7.0 PEAK EXCURSION - Section 15.407 (a)

Testing was performed in accordance with the requirements of FCC Part 15.407(a)(6)

The transmitter output was connected to the spectrum analyser with a span setting to capture the entire emission bandwidth of the signal.

The peak power excursion was measured over an interval of continuous transmission using a calibrated spectrum analyser with the resolution bandwidth of 1 MHz and the video bandwidth of 3 MHz for Trace 1 and video bandwidth of 300 kHz for Trace 2. The difference between Trace 1 and Trace 2 was recorded.

Measurements were performed on frequency bands (5.150 – 5.350 GHz)

Initial investigations were performed with four modulation types: (BPSK, QPSK, 16QAM and 64QAM). No significant differences in peak excursion were observed. Final testing was performed while the transmitter continuously operated with the modulation rate of 54 Mbps (64QAM).

Channel	Frequency MHz	Peak Power Excursion (dB)	Limit (dB)	Result	Peak Excursion plots
36	5180	3.02	13.0	Complies	Appendix M
52	5260	2.63	13.0	Complies	Appendix M
64	5320	3.27	13.0	Complies	Appendix M

Result: Complies.

8.0 FREQUENCY STABILITY

Testing was performed in accordance with the requirements of FCC Part 15.407(g)

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

The measurements were made at ambient room temperature and extreme (-20 to +55 ˚C) test conditions.

The AC supply voltage to the computer was varied by ±15%. This was observed to have no effect on the results obtained.

Measurements were performed on frequency bands (5.150 – 5.350 GHz)

Testing was performed while the transmitter continuously operated with the modulation rate of 54 Mbps (64QAM).

Channel	Frequency MHz	Maximum Frequency Deviation kHz	Maximum Deviation %	± 0.02 % Limit kHz	Result
36	5180	451	0.009	1036	Complies
52	5260	446	0.009	1052	Complies
64	5320	539	0.010	1064	Complies

Result: Complies.

9.0 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.

10.0 COMPLIANCE STATEMENT

The LifeBook T Series, Model: T4010 (Soriel) 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 E -Section 15.407 (5.15-5.35 GHz and 5.725-5.825 GHz bands).

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(q1) 5150-5350 MHz and 5725-5825 MHz Local Area Network Devices requirements and the RF exposure requirements of RSS-102.

Results were as follows:

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 with SAR requirements**
15.407 (g)	6.4	Frequency Stability	**Complies**

*Refer to EMC Technologies' report M040822_Soriel_Calexico2_11abg_SAR_5.2

The results for configurations IEEE 802.11b, IEEE 802.11g and IEEE802.11a (DTS: 5725 – 5850 MHz) and Bluetooth are reported separately.
Refer to EMC Technologies' test report: M040821_Cert_Soriel_Cal2_11abg_DTS_BT (802.11b/g and 802.11a: DTS) and M040821_Cert_Soriel_BT_Cal2_11abg (Bluetooth).

TEST REPORT APPENDICES

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APPENDIX C: FUNCTIONAL DESCRIPTION
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Attachment 1: RF Exposure Information
Attachment 2: FCC DOC for LifeBook T Series (Soriel).