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

FCC ID: PPD-AR5B91-F
Industry Canada ID: 4101A-AR5B91F

Radio Module: AR5B91 Atheros 1x2 Half Mini-PCI WLAN

Host NoteBook: LifeBook T Series
Model: T4310

Report Number: M090738_Cert_AR5B91_C2PC

Issue Date: 14th August 2009

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Report No. M090738_Cert_AR5B91_C2PC

Radio Module: AR5B91 Atheros 1x2 Half Mini-PCI WLAN
Manufacturer: Atheros Communications Inc

FCC ID: PPD-AR5B91-F
Industry Canada ID: 4101A-AR5B91F
Equipment Type: Intentional Radiator (Transceiver)

Host NoteBook: T4310 LifeBook
Manufacturer: Fujitsu Ltd - Mobile Computing Division
Address: 1-1 Kamikodanaka 4-Chome, Nakahara-Ku, Kawasaki, Japan
Contact: Mr. Tsuyoshi Uchihara

Test Standards: FCC Part 15 – Radio Frequency Devices (July 2008)
FCC Part 15 Subpart C - Intentional Radiators
Section 15.247: 2400 – 2483.5 MHz & 5725 – 5850 MHz Operation Bands
ANSI C63.4 – 2003

RSS-210 Issue 7 Low Power Licence-Exempt RadioCommunication
Devices Annex 8: 2400–2483.5 MHz & 5725–5850 MHz Operation Bands

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 to 13th August 2009

Senior Test Engineer:



Chieu Huynh - B.Eng (Hons) Electronics

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:

Chieu Huynh
Senior EMC Engineer
EMC Technologies Pty Ltd



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1.0 INTRODUCTION

EMI testing was performed on the Atheros Half Mini-PCI Wireless LAN Module (HB91 802.11b/g/n 1x2), Model: AR5B91 installed in Fujitsu notebook PC, Model: T4310.

The HB91 1x2 WLAN transmitter installed in the T4310 notebook is an Atheros Half Mini-PCI Wireless LAN Module (HB91 802.11b/g/n 1x2), Model: AR5B91. This module was originally certified by Atheros Communications as a modular approval under FCC ID: PPD-AR5B91-F (Canada ID: 4104A-AR5B91F) and under C2PC application for this Bluetooth module installed in Fujitsu notebook T4310

The other transmitter installed in the T4310 notebook is BSMAN3 CSR Bluetooth Module. This Bluetooth module was originally certified by CSR as a modular approval under FCC ID: PIWBSMAN (Canada ID: 5255A-BSMAN) and under C2PC application for this Bluetooth module installed in Fujitsu notebook T4310

The intention of this Class II Permissive Change application is to enable the certified AR5B91 Atheros module to be co-located with BSMAN3 CSR Bluetooth module in host system Fujitsu LifeBook T Series, Model: T4310. Independent antennas are used for each of the Radio modules and simultaneous transmission is possible. The transmitter modules are installed in a controlled environment at the Fujitsu notebook production/assembly factory.

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 7 - Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Annex 8 and the RF exposure requirements of RSS-102.

The measurement procedure used was in accordance with ANSI C63.4-2003. The instrumentation conformed to the requirements of ANSI C63.2-1996.



1.1 Summary of Results

FCC Subpart C, Section 15.247

FCC Part 15 Subpart C Clauses	Industry Canada RSS-210 Issue 7 and RSS-Gen Clauses	Test Performed	Results
15.203	RSS-Gen (7.1.4)	Antenna Requirement	Complies
15.205	2.2 (Table 1)	Operation in Restricted Band	Complies
15.207	RSS-Gen (7.2.2)	Conducted Emissions	Note 1
15.209	RSS-Gen (6)	Radiated Emissions	Complies
15.247 (a)(2)	A8.1 (b) (d)	Channel Bandwidth	Note 2
15.247 (b)(3)	A8.4	Peak Output Power	Note 2
15.247 (c)	RSS-Gen (7.1.4)	Antenna Gain > 6 dBi	Not Applicable. Antenna gain < 6 dBi
15.247 (d)	A8.5	Out of Band Emissions	Complies
15.247 (e)	A8.2 (b)	Peak Power Spectral Density	Note 2
15.247 (f)	A8.3	Hybrid Systems (Note 3)	Not Applicable. EUT does not employ a hybrid system
15.247 (g)	A8.1	Frequency Hopping	Not Applicable. EUT does not employ frequency hopping
15.247 (h)	A8.1	Frequency Hopping	Not Applicable. EUT does not employ frequency hopping
15.247 (i)	RSS-Gen (5.5)	Radio Frequency Hazard	Complies

Note 1: Refer to Attachment 2, FCC DOC for LifeBook T Series

Note 2: Refer to original approval under FCC ID: PPD-AR5B91 (Canada ID: 4104A-AR5B91)

Note 3: Hybrid systems are those that employ a combination of both frequency hopping and digital modulations technique.

1.2 Modifications by EMC Technologies

No modifications were required.



2.0 GENERAL INFORMATION

(Information supplied by the Client)

2.1 EUT (WLAN) Details

Transmitter:	Half Mini-Card Wireless LAN Module
Wireless Module:	HB91 (11b/g/n) 1x2
Model Number:	AR5B91
Manufacturer:	Atheros Communication Inc,
Modulation Type:	Direct Sequence Spread Spectrum (DSSS for 802.11b) Orthogonal Frequency Division Multiplexing (OFDM for 802.11g/n)
2.4 GHz (802.11b/g/n):	CCK, DQPSK, DBPSK, BPSK, QPSK, 16QAM and 64QAM
Maximum Data Rate:	802.11b = 11Mbps 802.11g = 54Mbps 802.11n = 300 Mbps
Frequency Ranges:	2.412 –2.462 GHz for 11b/g/n
Number of Channels:	11 channels for 11b/g/n with 20 MHz bandwidth 7 channels for 11n with 40 MHz bandwidth
Antenna Types:	Nissei Inverted F (1 st , 2 nd) Locations: Left Top edge of LCD screen(1 st), Right lower edge of LCD screen(2 nd)
Antenna gain:	Max antenna gain is less than 6 dBi. Refer antenna data provided separately
Power Supply:	3.3 VDC from PCI Express bus

Channels and Output Powers:

Modes	Channels	Frequency MHz	Average Output Power (dBm)
802.11b	1	2412	16
	6	2437	
	11	2462	
802.11g	1	2412	14.0
	6	2437	15.0
	11	2462	14.0
802.11n 20 MHz	1	2412	13.5
	6	2437	15.0
	11	2462	13.5
802.11n 40 MHz	3	2422	13.0
	6	2437	13.5
	9	2452	12.0



2.2 Host (Notebook PC) Details

Host:	LifeBook T series
Model Name:	T4310
Serial Number:	Pre-production Sample
Manufacturer:	FUJITSU LIMITED
CPU Type and Speed:	Core2 Duo T9600 2.8GHz
LCD:	12.1" WXGA
Wired LAN:	Broadcom BCM57780 : 10 Base-T/100 Base-TX/1000Base-T
Modem:	None
Port Replicator Model:	FPCPR94
AC Adapter Model:	80W: SEE100P2-19.0 (Sanken), ADP-80NB A(Delta)
Voltage:	19 V
Current Specs:	4.22A
Watts:	80W

2.3 Test Configuration

The Atheros WLAN test software "ART" was used to transmit continuously during the tests.

Conducted tests were performed at the WLAN Antenna ports.

Radiated tests were performed for measuring the harmonics and spurious from the transmitters.

2.4 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 1 and 3 metres from the EUT.

2.5 Test Facility

2.5.1 General

EMC Technologies Pty Ltd is listed by the FCC as a test laboratory able to perform compliance testing for the public. EMC Technologies is listed as an FCC part 47CFR2.948 test lab and may perform the testing required under Parts 15 and 18 – **FCC Registration Number 90560**

EMC Technologies Pty Ltd has also been accredited as a Conformity Assessment Body (CAB) by Australian Communications and Media Authority (ACMA) under the APECTEL MRA and is designated to perform compliance testing on equipment subject to Declaration of Conformity (DoC) and Certification under Parts 15 & 18 of the FCC Commission's rules – **Registration Number 494713 & Designation number AU0001.**

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 OATS number - IC 3569B-1.**

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 measurements at an antenna ports were performed at EMC Technologies' laboratory in Keilor Park, Victoria Australia.



2.5.2 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 emissions, 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 Institute (NMI) 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 (A²LA).

2.6 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 Institute (NMI). All equipment calibration is traceable to Australia national standards at the National Measurements Institute. The reference antenna calibration was performed by NMI and the working antennas (biconical and log-periodic) calibrated by the EMC Technologies. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A

2.7 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.



FCC 15.247 (DTS) RESULTS

3.0 CONDUCTED EMISSION MEASUREMENTS

Testing was performed by Fujitsu General EMC Laboratory, JAPAN accredited by NVLAP (Lab Code: 200373-0).

4.0 RADIATED SPURIOUS EMISSION MEASUREMENTS

4.1 Test Procedure

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

Radiated emission measurements were performed to the limits as per section 15.209 and 15.247. The measurements were made at the open area test site. All measurements above 1 GHz were made over a distance of 3 and 1 metres.

Calibrated EMCO 3115, EMCO 3116 and ETS standard gain horn antennas were used for measurements between 1 to 25 GHz.

The measurement of emissions above 1000 MHz was measured using a following setting:

Peak measurements setting: RBW = VBW = 1 MHz

Average measurements setting: RBW = 1 MHz and VBW = 10 Hz

The receiver bandwidth was set to 6 dB.

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 Peak/Average Detectors. The measurement data for each frequency range was corrected for cable losses, antenna factors and preamplifier gain. This process was performed for both horizontal and vertical antenna polarisations.

4.2 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 μ V/m.

V = EMI Receiver Voltage in dB μ V. (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 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 μ 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:

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



4.3 Radiated Emissions (Spurious and Harmonics)

This transmitter module was originally tested and certified by the manufacturer as a stand-alone module outside a laptop (host) with higher gain antennas. Refer to manufacturer's original test report (Attachment 3) for full results showing compliance with the spurious and harmonics limits. However, to ensure the transmitter module install in T4310 LifeBook is still in compliance, verification tests were performed at the worst case (frequencies with higher average output power) or selected frequencies for harmonics and spurious emissions.

4.3.1 Frequency Band: 1 – 25 GHz

The 74 dB μ V/m @ 3m and 54 dB μ V/m @ 3m limits are applied for emissions fall in the restricted bands. The limits for emission outside the restricted band are 20 dB below the fundamental field strength.

4.3.1.1 Configuration 802.11b

Initial investigations were performed with all data rates: (1 Mbps to 11 Mbps). Final testing was performed while the transmitter continuously operated with the data rate of 1 Mbps.

Harmonics were measured for channels where the average output power was highest.

Channel 6 - 2437 MHz

Frequency MHz	Peak Detector dBuV/m	Average Detector dBuV/m	Peak Limit dBuV/m	Average Limit dBuV/m	Result
2437	102.4	97.8	Transmitter Fundamental Level		
4874	50.7	43.5	74.0	54.0	Complied
3249.4	46.1	34.9	82.4	77.8	Complied

Channel 11 - 2462 MHz

Frequency MHz	Peak Detector dBuV/m	Average Detector dBuV/m	Peak Limit dBuV/m	Average Limit dBuV/m	Result
2462	102.7	97.9	Transmitter Fundamental Level		
Harmonics and spurious are similar to channel 6 (2437 MHz)					
2483.5	53.1	41.9	74.0	54.0	Complied

Result: Harmonic and spurious emissions were recorded up to 25 GHz. Other harmonics were confirmed low with both RBW and VBW reduced. The worst case emissions complied with the FCC limits of sections 15.209 and 15.247 by a margin of 10.5 dB.

4.3.1.2 Configuration 802.11g and 802.11n

Harmonics were measured for channels where the average output power was highest.

Initial investigations were performed with all data rates: (6 Mbps to 54 Mbps and MCS0 to MCS7). Final testing was performed while the transmitter continuously operated in the worst case condition.

Channel 6 - 2437 MHz, Tx BW = 20 MHz

Modes	Data Rates	Frequency MHz	Peak Detector dBuV/m	Average Detector dBuV/m	Peak Limit dBuV/m	Average Limit dBuV/m	Result	
802.11g	6 Mbps	2437	104.5	93.8	Transmitter Fundamental Level			
		Harmonics are low						
		3249.4	43.0	31.1	84.5	73.8	Complied	
802.11n	MCS0	2437	101.9	89.6	Transmitter Fundamental Level			
		3249.4	42.7	30.8	81.9	69.6	Complied	

Channel 6 - 2437 MHz, Tx BW = 40 MHz

Modes	Data Rates	Frequency MHz	Peak Detector dBuV/m	Average Detector dBuV/m	Peak Limit dBuV/m	Average Limit dBuV/m	Result
802.11n	MCS0	2437	99.2	88.5	Transmitter Fundamental Level		
		Harmonics and spurious are low					

Result: Spurious emissions were recorded up to 25 GHz. Harmonics were confirmed low with both RBW and VBW reduced. The worst case emissions complied with the FCC limits of sections 15.209 and 15.247 by a margin of greater than 10 dB.

4.3.2 Frequency Band: 30 - 1000 MHz

Testing was performed by Fujitsu General EMC Laboratory, JAPAN accredited by NVLAP (Lab Code: 200373-0).

4.3.3 RF Conducted Measurements at the Antenna Terminal (including Band Edge)

Refer to original approval under FCC ID: PPD-AR5B91 (Canada ID: 4104A-AR5B91) certified by Atheros.

Testing was performed by Compliance Certification Services (CCS) CA, USA accredited by NVLAP (Lab Code: 200065-0).

5.0 PEAK OUTPUT POWER - Section 15.247 (b)(3)

Refer to original approval under FCC ID: PPD-AR5B91 (Canada ID: 4104A-AR5B91) certified by Atheros.

Testing was performed by Compliance Certification Services (CCS) CA, USA accredited by NVLAP (Lab Code: 200065-0).

6.0 CHANNEL BANDWIDTH

Refer to original approval under FCC ID: PPD-AR5B91 (Canada ID: 4104A-AR5B91) certified by Atheros.

Testing was performed by Compliance Certification Services (CCS) CA, USA accredited by NVLAP (Lab Code: 200065-0).

7.0 PEAK POWER SPECTRAL DENSITY

Refer to original approval under FCC ID: PPD-AR5B91 (Canada ID: 4104A-AR5B91) certified by Atheros.

Testing was performed by Compliance Certification Services (CCS) CA, USA accredited by NVLAP (Lab Code: 200065-0).

8.0 RADIO FREQUENCY EXPOSURE (HAZARD) INFORMATION

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

Spread spectrum transmitters operating in the 2400 - 2483.5 MHz and 5725 – 5850 MHz 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 2.1093 this device has been defined as a portable device.

SAR testing was performed in accordance with OET Bulletin 65 and reported under EMC Technologies reports M090735_Cert_AR5B91_SAR_2.4 (2.4 GHz). SAR values of 0.378 mW/g was measured which complied with the FCC human exposure requirements of 47 CFR 2.1093(d).

9.0 ANTENNA REQUIREMENT

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 Atheros Half Mini-PCI Wireless LAN Module (HB91 802.11b/g/n 1x2), Model: AR5B91 installed in Fujitsu notebook PC, Model: T4310, **complied** 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 complied with the Industry Canada RSS-210 issue 7 - Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Annex 8 and the RF exposure requirements of RSS-102.

Results were as follows:

FCC Subpart C, Section 15.247

FCC Part 15 Subpart C Clauses	Industry Canada RSS-210 Issue 7 and RSS-Gen Clauses	Test Performed	Results
15.203	RSS-Gen (7.1.4)	Antenna Requirement	Complies
15.205	2.2 (Table 1)	Operation in Restricted Band	Complies
15.207	RSS-Gen (7.2.2)	Conducted Emissions	Note 1
15.209	RSS-Gen (6)	Radiated Emissions	Complies
15.247 (a)(2)	A8.1 (b) (d)	Channel Bandwidth	Note 2
15.247 (b)(3)	A8.4	Peak Output Power	Note 2
15.247 (c)	RSS-Gen (7.1.4)	Antenna Gain > 6 dBi	Not Applicable. Antenna gain < 6 dBi
15.247 (d)	A8.5	Out of Band Emissions	Complies
15.247 (e)	A8.2 (b)	Peak Power Spectral Density	Note 2
15.247 (f)	A8.3	Hybrid Systems (Note 3)	Not Applicable. EUT does not employ a hybrid system
15.247 (g)	A8.1	Frequency Hopping	Not Applicable. EUT does not employ frequency hopping
15.247 (h)	A8.1	Frequency Hopping	Not Applicable. EUT does not employ frequency hopping
15.247 (i)	RSS-Gen (5.5)	Radio Frequency Hazard	Complies

Note 1: Refer to Attachment 2, FCC DOC for LifeBook T Series

Note 2: Refer to original approval under FCC ID: PPD-AR5B91 (Canada ID: 4104A-AR5B91)

Note 3: Hybrid systems are those that employ a combination of both frequency hopping and digital modulations technique.



11.0 MEASUREMENT UNCERTAINTIES

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

Conducted Emissions:	9 kHz to 30 MHz	±3.2 dB
Radiated Emissions:	30 MHz to 300 MHz	±5.1 dB
	300 MHz to 1000 MHz	±4.7 dB
	1 GHz to 18 GHz	±4.6 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

12.0 TEST REPORT APPENDICES

APPENDIX A: MEASUREMENT INSTRUMENT DETAILS

APPENDIX B: PHOTOGRAPHS

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Accreditation No. 5292