



**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 15.247 & RSS-210**

**FCC ID:** EJE-WL0001  
**Industry Canada ID:** IC: 337J-WL0001  
**Wireless Module:** Calexico  
**Model Number:** WM3B2100-Mace  
**Tested for:** Fujitsu Australia Ltd

**Issue Date:** 4<sup>th</sup> August 2003

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**NATA Accredited Laboratory  
Number: 5292**

**EMI TEST REPORT FOR CERTIFICATION  
to  
FCC Part 15.247 & RSS-210**

**EMC Technologies Report No. M030725\_Certification\_Mace\_Calexico**

**Issue Date: 4<sup>th</sup> August 2003**

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# EMI TEST REPORT FOR CERTIFICATION to FCC PART 15.247 & RSS-210

**Report Number:** M030725\_Certification\_Mace\_Calexico  
**Test Sample:** Mini-PCI Wireless LAN Module  
**Model Number:** WM3B2100-Mace  
**Manufacturer:** Intel Corporation

**Manufacturer (Host PC):** Fujitsu Limited  
**Address:** 1405 Ohamaru, Inagi-shi, Tokyo 206-8503, Japan  
**Contact:** Kanbe Katsuhito


**FCC ID:** EJE-WL0001  
**Industry Canada ID:** IC:337J-WL0001

**Tested for:** Fujitsu Australia Ltd  
**Address:** 5 Lakeside Drive,  
 Burwood East, VIC 3151 Australia  
**Phone:** +613 9845 4300  
**Fax:** +613 9845 4600  
**Responsible Party:** Mr Praveen Rao - Senior Compliance Engineer

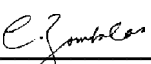
**Equipment Type:** Intentional Radiator (Transmitter)

**Test Standards:** FCC Part 15, Subpart C - Intentional Radiators  
 FCC Part 15.247 2400 - 2483.5 MHz Operation Band  
 FCC Part 15.205 Operation in Restricted Bands  
 FCC Part 15.207 Conducted Emissions  
 FCC Part 15.209 Radiated Emissions  
 ANSI C63.4-1992  
 OET Bulletin No. 63  
  
 RSS-210 Issue 5 Low Power Licence-Exempt  
 RadioCommunication Devices 6.2.2 (o) 2400 – 2483.5 MHz  
 Spread Spectrum 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:** 15<sup>th</sup> July – 5<sup>th</sup> August 2003

**Test Officer:**   
**Chieu Huynh B. Eng (Hons) Electronics**  
**Janath Gunasekera BscEng., MtelcomEng, MIEEE**

**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 Signature:**   
**Chris Zombolas**  
**Technical Director**  
**EMC Technologies Pty Ltd**



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## EMI TEST REPORT FOR CERTIFICATION to FCC PART 15.247 & RSS-210

### 1. INTRODUCTION

This report details the results of EMI tests and measurements performed on the Mini-PCI Wireless LAN Module (Calexico), Model WM3B2100-Mace in accordance with the Federal Communications Commission (FCC) regulations as detailed in Title 47 CFR, Part 15 Subpart C Rules for intentional radiators, particularly Section 15.247 (Operation in the frequency band 2400 - 2483.5 MHz).

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 C - Radio Frequency Devices (intentional radiators), Section 15.247.

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

### 1.1 Summary of Results

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

\*Refer to EMC Technologies' report M030726\_Mace\_Calexico SAR Report

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.



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## 2. GENERAL INFORMATION

(Information supplied by the Client)

### 2.1 Product Details

**Test Sample:** Mini-PCI Wireless LAN Module (Transceiver)  
**Wireless Module:** Calexico  
**Model Number:** WM3B2100-Mace  
**Interface Type:** Mini-PCI Module  
**FCC ID:** EJE-WL0001  
**Industry Canada ID:** IC:337J-WL0001  
**Equipment Type:** Intentional Radiator (Transceiver)

### 2.2 Test Sample Operational Description

The EUT is a Mini-PCI Wireless LAN (WLAN) Module (Calexico WM3B2100) for Fujitsu Notebook PCs (LifeBooks). The Calexico module is an OEM product from Intel Corp., which has been FCC certified under modular approval (FCC ID: PD9WM3B2100) (Report Number: INTEL-021001F)

This Calexico module was re-certified under modular certification FCC ID: QK3-WB0001 and IC: 337H-WB0001. Applied by EMC Technologies and FCC certification granted by Curtis-Straus LLC, (refer Grant dated 27<sup>th</sup> May 2003 & Industry Canada Grant, dated 18<sup>th</sup> June 2003).

The intention of this application is to certify the Calexico WLAN module for LifeBook T series – model T3010 (Mace). The Mace is a notebook/Pentablet.

The highest CPU speed, Pentium-M 1.4 GHz model was chosen for the tests and all other Mace models which are identical to the tested model except with lower CPU speed shall be declared compliant based on this test report.

Refer to Appendix B, Test Sample Photographs for details of WLAN and Antenna locations.

### 2.3 Technical Specifications

**Wireless Module:** Calexico  
**Model Number:** WM3B2100-Mace  
**Manufacturer:** Intel Corporation  
**Interface Type:** Mini-PCI Module  
**Network Standards:** IEEE 802.11b  
**Modulation Type:** Direct Sequence Spread Spectrum (DSSS)  
**Maximum Data Rate:** 11Mbps max  
**Frequency Range:** 2400 MHz to 2483.5 MHz (Operational range 2402 to 2462 MHz)  
**Number of Channels:** 14 maximum (Only 11 channels operative in North America)  
**Antenna Type:** Monopole Dielectric Antenna  
**Output Power:** 16 dBm typical  
**Power Supply:** 3.3 VDC from PCI bus.

#### EUT Host Details:

**Test Sample:** LIFEBOOK T Series  
**Model Name:** T3010  
**Codename:** Mace  
**Serial Number:** Not Supplied  
**CPU Speed:** Pentium-M 1.4 GHz  
**Manufacturer:** Fujitsu Ltd.  
**SDRAM:** 256MB  
**LCD Screen:** 12.1"XGA  
**Hard Disk Drive:** 60 GB



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**LAN:** Realtech 10/100 Base-T (on Board)  
**Modem:** MBH7MD33 and MBH7MD35  
**Wireless LAN Module:** Calexico with Monopole Dielectric Antenna  
**Port Replicator Model:** FPCPR39 or FPCPR39AP

**AC Adapter:** Tests performed with CA01007-0850 adapter

AC Adapter Model Number	Alternate Model Number	Adapter Spec		
		Volts	Amps	Watts
SEB80N2-16.0	CA01007-0850	16	3.75	60
UJ88	CA01007-0870			

## 2.4 Test sample configuration

The INTEL Calexico utility software was used to set-up the WLAN module to continuously transmit during the tests. The notebook LCD screen was observed for the transmitter status shown by the Calexico software.

### AC Adapter

The AC adapter CA01007-0850 was used for all the tests. This adapter is also identified as CA01007-0870, SEB80N2-16.0 & UJ88. The manufacturer has stated that all these adapters are identical electrically and mechanically.

Refer to Appendix B - Test Setup Photographs.

## 2.5 Test Sample Block Diagram

Refer to Appendix C.

## 2.6 Test Sample Support Equipment

### External Monitor/s:

Conducted EMI IPEX, Model: H566, FCC ID: GKR567  
 Radiated EMI Hewlett Packard 15" Color monitor, Model D2827A,  
 FCC ID: C5F7NFCMC1515X

### USB Floppy Drives:

Fujitsu Model: FPCFDD11, P/N CP032173-01  
 Fujitsu Model: FPCFDD12, P/N CP078720-01

### Headphones:

Verbatim Multimedia Stereo headset

### USB Mouse:

Microsoft Intellimouse, P/N X05-48976, S/N 3220403

### USB Keyboard:

Logitech Model: Y-BA9, S/N MCT94602411

### LAN Hub:

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

### PCMCIA Slot:

8 MB flash card, Kingmax ATA008M

### AC Adaptor:

CA01007-0850

## 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**.



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EMC Technologies open area test site (OATS) has also been accepted by Industry Canada for the performance of radiated measurements in accordance with RSS 212, Issue 1 (Provisional). **Industry Canada File Number, IC 4161**, (Registration Date - November 5<sup>th</sup> 2001).

## 2.8.2 NATA Accreditation

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

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

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

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

## 2.9 Units of Measurements

### 2.9.1 Conducted Emissions

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

### 2.9.2 Radiated Emissions

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

## 2.10 Test Equipment Calibration

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

## 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.



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### 3.0 CONDUCTED EMISSION MEASUREMENTS

Testing was carried out in accordance with the requirements of FCC Part 15.207

#### 3.1 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.

#### 3.2 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.

#### 3.3 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 dB $\mu$ V to be compared to the limit.

**VRx** = the Voltage in dB $\mu$ V read directly at the EMI receiver.

**LBPF** = the insertion loss in dB of the cables and the Limiter and Pass Filter.

#### 3.4 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.

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

Frequency MHz	Line	Measured QP Level dB $\mu$ V	QP Limit dB $\mu$ V	$\Delta$ QP $\pm$ dB	Measured AV Level dB $\mu$ V	AV Limit dB $\mu$ V	$\Delta$ AV $\pm$ dB
0.620	Neutral	44.1	56.0	-11.9	39.4	46.0	-6.6
23.26	Neutral	49.1	60.0	-10.9	42.6	50.0	-7.4
23.18	Active	49.3	60.0	-10.7	42.4	50.0	-7.6
0.554	Neutral	42.3	56.0	-13.7	36.0	46.0	-10.0

The worst case conducted EMI occurred at 0.620 MHz and complied with the quasi peak and average limits by margins of 11.9 dB and 6.6 dB respectively. The measurement uncertainty was  $\pm 2.0$  dB. Refer to Appendix G for plots of the conducted EMI measurements.





## 4.0 RADIATED EMISSION MEASUREMENTS

### 4.1 Test Procedure

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 and HP8449B preamplifier were used for measurements between 1 to 25 GHz.

Testing was performed at a distance of 10 metres for the frequency ranges 30 to 1000 MHz and 3 metres for the frequency range 1 to 25 GHz.

The EUT was slowly rotated with the Peak Detector set to Max-Hold. This was performed for two antenna heights. Each significant peak was then investigated and maximised with the Quasi-Peak detector. 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.

### 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 $\mu$ V/m.
- V** = EMI Receiver Voltage in dB $\mu$ V. (measured value)
- AF** = Antenna Factor in dB(m<sup>-1</sup>). (stored as a data array)
- G** = Preamplifier Gain in dB. (stored as a data array)
- L** = Cable insertion loss in dB. (stored as a data array of Insertion Loss versus frequency)

#### • Example Field Strength Calculation

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

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



### 4.3 Section: 15.247 (c) Out of Band Emissions (Spurious and Harmonics)

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

As the transmitter has no external connections measurements were made at the open area test site. Testing was carried while transmitter continuously on a low, middle and high frequency channel.

The device was placed on the test table, being 0.8 m above the ground plane, with the front display facing the test antenna.

Measurements were made using a resolution bandwidth of 100 kHz where an emission fell outside of a restricted band. When an emission fell within a restricted band an average detector with a resolution bandwidth of 1 MHz was utilised.

All measurements were initially made over a distance of 3 metres which was decreased to 1.0 metres as the emission levels from the device were very low. All measurements have been made in absolute field strength uV/m which has been converted to dBuV/m.

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

In the unrestricted bands measurements were made to determine if the field strength of the emissions observed were more than 20 dB down on the fundamental.

Radiated emission measurements are required to be carried out with the limits as per section 15.209 applied.

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, that appear in the restricted bands, was made using an average detector with a bandwidth of 1.0 MHz.

When an emission is located, it is positively identified and its maximum level is found by rotating the automated turntable, and by varying the antenna height.

The emission is measured in both vertical and horizontal antenna polarisations.

The emission level is determined in field strength by taking the following into consideration:

$$\text{Level (dB}\mu\text{V/m)} = \text{Receiver Reading (dB}\mu\text{V)} + \text{Antenna Factor (dB)} + \text{Coax Loss (dB)} - \text{Pre Amp (dB)}$$

Measurement uncertainty with a confidence interval of 95% is:

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

#### 4.3.1 Frequency Band: 1 – 25 GHz

All recorded emissions complied with the FCC Class B average limit by a margin of greater than 10 dB. No harmonics were recorded within the restricted bands of up to 25 GHz. Harmonics were below the limit in section 15.209. The measurement uncertainty for radiated emissions in this band was  $\pm 4.1$  dB.

The field strength at 2483.5 MHz when the EUT is operating at its highest channel (2462 MHz), is <38 dBuV/m (noise floor) and is > 20 dB below the maximum field strength of the in-band carrier.



Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
2412	101.9	-	Vert	-	-	Pass
4824	45.1	32.9	Vert/Hort	74.0	54.0	Pass
7236	48.9	36.6	Vert/Hort	-	-	Pass
9648	52.9	38.9	Vert/Hort	-	-	Pass
12060	55.2	41.2	Vert/Hort	74.0	54.0	Pass
14472	58.5	44.5	Vert/Hort	74.0	54.0	Pass
16884	61.9	46.9	Vert/Hort	-	-	Pass
19296	64.3	50.1	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
21708	66.6	53.9	Vert/Hort	-	-	Pass
24120	67.8	55.5	Vert/Hort	-	-	Pass

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
2437	102.1	-	Vert	-	-	Pass
4874	45.2	32.9	Vert/Hort	74.0	54.0	Pass
7311	48.9	36.8	Vert/Hort	74.0	54.0	Pass
9748	52.7	39.2	Vert/Hort	-	-	Pass
12185	55.5	41.5	Vert/Hort	74.0	54.0	Pass
14622	58.1	44.7	Vert/Hort	-	-	Pass
17059	62.2	46.8	Vert/Hort	-	-	Pass
19496	64.4	50.3	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
21933	66.5	53.7	Vert/Hort	-	-	Pass
24370	68.1	55.9	Vert/Hort	-	-	Pass

Frequency MHz	Level dBuV/m		Antenna Polarization	Peak Limit dBuV/m	Average Limit dBuV/m	Result
	Peak Detector	Average Detector				
2462	101.7	-	Vert	-	-	Pass
4924	45.1	32.7	Vert/Hort	74.0	54.0	Pass
7386	49.4	37.1	Vert/Hort	74.0	54.0	Pass
9848	53.3	39.3	Vert/Hort	-	-	Pass
12310	55.4	41.9	Vert/Hort	74.0	54.0	Pass
14772	58.8	44.7	Vert/Hort	-	-	Pass
17234	62.3	47.7	Vert/Hort	-	-	Pass
19696	64.9	51.3	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
22158	66.8	53.8	Vert/Hort	84.0* (1m)	64.0* (1m)	Pass
24620	68.5	55.4	Vert/Hort	-	-	Pass

\*Measurement was performed at 1 metre distance and the limits were corrected accordingly.  
No further emissions detected.

**Result:** Complies



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

The highest radiated emission peak occurred at 441.07 MHz (Horizontal polarity) and complied with FCC quasi peak limit by a margin of 1.8 dB. The measurement uncertainty in this band was  $\pm 3.7$  dB.

Refer to tables below for results.

**Vertical Polarity**

Frequency MHz	Polarisation	QP Measured dB $\mu$ V/m	QP Limit dB $\mu$ V/m	$\Delta$ QP $\pm$ dB
441.38	Vertical	29.8	36.0	-6.2
86.01	Vertical	23.7	30.0	-6.3
192.07	Vertical	27.0	33.5	-6.5
625.26	Vertical	29.0	36.0	-7.0
709.21	Vertical	29.0	36.0	-7.0
439.97	Vertical	28.9	36.0	-7.1
359.20	Vertical	28.6	36.0	-7.4
210.51	Vertical	23.7	33.5	-9.8
207.38	Vertical	22.4	33.5	-11.1
258.69	Vertical	22.7	36.0	-13.3
169.07	Vertical	18.3	33.5	-15.2

**Horizontal Polarity**

Frequency MHz	Polarisation	QP Measured dB $\mu$ V/m	QP Limit dB $\mu$ V/m	$\Delta$ QP $\pm$ dB
441.07	Horizontal	34.2	36.0	-1.8
623.10	Horizontal	34.1	36.0	-1.9
627.00	Horizontal	34.0	36.0	-2.0
444.23	Horizontal	34.0	36.0	-2.0
437.32	Horizontal	33.7	36.0	-2.3
707.95	Horizontal	29.6	36.0	-6.4
634.05	Horizontal	28.9	36.0	-7.1
575.76	Horizontal	28.2	36.0	-7.8
359.03	Horizontal	26.9	36.0	-9.1
643.59	Horizontal	26.5	36.0	-9.5
184.30	Horizontal	18.4	33.5	-15.1

**Result:** Complies.



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#### 4.4 Channel Bandwidth

Testing was carried out in accordance with the requirements of FCC Part 15.247(a)(2). The EUT was a Direct Sequence Spread Spectrum transmitter using digital modulation techniques and operated as described in section 2 of this report.

In the band 2400 - 2483.5 MHz the minimum 6 dB bandwidth was at least 500 kHz. The 6 dB bandwidth was measured at 2412, 2437 and 2462 MHz which equated to low, middle and top frequencies using a spectrum analyser in peak hold mode and a horn antenna. A resolution bandwidth of 300 kHz was utilised.

The 6 dB bandwidth for these 3 frequencies was determined to be:

Frequency MHz	Bandwidth MHz	Result
2412.0	11.2	Complies
2437.0	11.5	Complies
2462.0	11.5	Complies

**Result:** Complies.

Refer to Appendix H for Channel Bandwidth plots.



#### 4.5 Section 15.247 (b)(1) & (3) - Peak Output Power

Testing was carried out in accordance with the requirements of FCC Part 15.247(b)(3). The device was placed on the test table, being 80 cm above the ground plane, with the computer screen display facing the test antenna located 3 metre away.

Measurements were made with the spectrum analyser operating in peak hold mode with a resolution bandwidth of 3 MHz. The power envelope of the device was determined with the antenna using vertical and horizontal polarisations. The power envelope was maximised by rotating the device using a turntable and by height scanning between 1 – 4 metres using the automated antenna tower.

As the bandwidth of the emission exceeded the resolution bandwidth of the spectrum analyser power measurements were made in 3 MHz steps across the frequency band occupied by the emission that were then summed using a spreadsheet.

Each of these emissions were recorded in dBuV and were then converted to dBm and subsequently into an absolute power level (mW). Each of these individual power levels was then summed to give a total envelope power for the emission. The total envelope power in mW was then converted to dBm.

The radiated power was then determined by adding factors for the cable losses, antenna gains, path loss and the preamplifier gain.

Measurements were made on a low, middle and high frequency channel

##### Example calculation - Low Channel – 2412 MHz

Freq MHz	Level dBuV	Level dBm	Level uW	Total Power mW	Total Power dBm	Ant Gain dB	Coax Loss dB	Preamp Gain dB	Path Loss dB	Power dBm	Power mW
2403	99.44	-7.6	175								
2406	98.83	-8.2	152								
2409	99.85	-7.2	193								
2412	99.32	-7.7	171	1.06	0.26	9.8	9.5	35	49.6	14.6	29.0
2415	99.24	-7.8	167								
2418	98.5	-8.5	141								
2421	94.59	-12.4	57								

The specification limit is 30 dBm (1.0W).

Variation by +/- 15% of the supply voltage, in accordance with section 15.31(e), to the computer power supply power did not vary the output power. This device has no external antenna port with the antenna being located internally.

Frequency MHz	Level mW	Limit mW	Result
2412.0	37.6	1000	Complies
2437.0	38.6	1000	Complies
2462.0	33.7	1000	Complies

The specification limit is 1W (30 dBm).

**Result:** Complies.



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#### 4.6 Radio Frequency Exposure (Hazard) Information

Testing was carried out 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 portable device whereby a distance of 20 cm cannot normally 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  $1\text{mW/cm}^2$ .

The maximum distance from the antenna at which the MPE is met or exceeded has been calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain and separation distance in metres:

$$\begin{aligned} E, \text{ V/m} &= (\sqrt{30 * P * G}) / d \\ \text{Power density, mW/m}^2 &= E^2 / 3770 \\ E \text{ for MPE:} &= \sqrt{E^2 / 3770} \\ E &= \sqrt{1 * 3770} \\ E &= 61.4 \text{ V/m} \end{aligned}$$

The max Antenna (Monopole Dielectric) gain = 1.0 dBi

##### Conducted Power

Conducted power of the device was measured after temporary modification of antenna connector inside the device's TX RX compartment. Measurements were conducted with a calibrated Power Meter. The results of this measurement are listed below.

##### Frequency and Output Power

Frequency MHz	Modulation	Maximum Conducted Output Power Measured
2437	DSSS	15.20 dBm (33.1mW)

The total power (P\*G) measured at the Antenna of WLAN Module (Calexico, WLL3010-Mace):

The maximum transmitter power measured (DSSS) = 15.20 dBm or 33.1 milliwatts.

$$\begin{aligned} d &= \sqrt{(30 * P * G) / E} \\ &= \sqrt{(30 * 0.033) / 61.4} \\ &= 0.016 \text{ metres or } 1.6 \text{ cm} \end{aligned}$$

##### Radiated Power

The result was extracted from section 4.5 of this report.

##### Frequency and Output Power

Frequency MHz	Modulation	Maximum Conducted Output Power Measured
2437	DSSS	15.9 dBm (38.6mW)

The total power (P\*G) measured at the Antenna of WLAN Module (Calexico, WLL3010-Mace):

The maximum transmitter power measured (DSSS) = 15.9 dBm or 38.6 milliwatts.

$$\begin{aligned} d &= \sqrt{(30 * P * G) / E} \\ &= \sqrt{(30 * 0.039) / 61.4} \\ &= 0.018 \text{ metres or } 1.8 \text{ cm} \end{aligned}$$

**Conclusion:** Complies.



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Calculations show that this device with described antenna does not meet the MPE requirements for portable devices falling below the 20 cm clearance required, however the SAR value of 1.05 mW/g complies with the FCC human exposure requirements of 47 CFR 2.1093 (d). Refer to EMC Technologies' report - M030726\_Mace\_Calexico SAR Report for details of SAR compliance.

#### 4.7 Section 15.247(d) - Peak Power Spectral Density

Testing was carried out in accordance with the requirements of FCC Part 15.247(d). The device was placed on the test table, being 80 cm above the ground plane, with the computer screen display facing the test antenna located 3 metres away.

Measurements were made with the spectrum analyser operating in peak hold mode with a resolution bandwidth of 3 kHz.

The maximum peak power spectral density was determined with the antenna using vertical and horizontal polarisations and when the device was rotated by using a turntable and it was height scanned between 1 – 4 metres using an automated antenna tower.

The peak power spectral density was then determined by adding factors for the cable losses, antenna gains, path loss and the preamplifier gain.

Measurements were made on a low, middle and high frequency channel.

##### Example Calculation

Freq MHz	Level dBuV	Level dBm	Ant Gain dB	Coax Loss dB	Preamp Gain dB	Path Loss dB	Power dBm	Antenna Polarisation
2408.23	76.15	-30.9	9.8	10.7	35	49.6	-15.4	Vertical
2407.94	73.45	-33.6	9.8	10.7	35	49.6	-18.1	Horizontal

The specification limit is 8 dBm in any 3 kHz band during a continuous transmission.

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.

This device has no external antenna port with the antenna being located internally.

Frequency MHz	Level dBm	Limit dBm	Result
2412.0	-8.2	8.0	Complies
2437.0	-8.1	8.0	Complies
2462.0	-8.5	8.0	Complies

The specification limit is 8 dBm in any 3 kHz band during a continuous transmission.

**Result:** Complies.





## 5.0 COMPLIANCE STATEMENT

The Mini-PCI Wireless LAN Module (Calexico), Model WM3B2100-Mace, tested on behalf of Fujitsu Australia Ltd, **complies** 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.

It also complies with the requirements of Industry Canada RSS-210 Issue 5 section 6.2.2 (o).

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

\*Refer to EMC Technologies' report M030726\_Mace\_Calexico SAR Report



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**APPENDIX A****MEASUREMENT INSTRUMENTATION DETAILS**

<b>EQUIPMENT TYPE</b>	<b>MAKE/MODEL SERIAL NUMBER</b>	<b>LAST CAL. DD/MM/YY</b>	<b>DUE DATE DD/MM/YY</b>	<b>CAL. INTERVAL</b>
<b>EMI RECEIVER</b>	HP 8546A Sn.3549A00290 EMI Receiver	13/01/03	13/03/04	1 YEAR *2
<b>EMI RECEIVER</b>	HP 8574B System Components	12/02/03	12/02/04	1 YEAR *2
<b>SPECTRUM ANALYSER</b>	HP8593EM Sn. 3146A-01297 9 kHz –26 GHz	13/06/03	13/06/04	1 YEAR *2
<b>ANTENNAS</b>	EMCO 93110B BICONICAL 20 - 300 MHz Sn. 9804-3092	07/08/02	07/08/03	1 YEAR *3
	EMCO 93146A LOG PERIODIC 200 -1000MHz Sn. 5033	11/07/03	11/07/04	1 YEAR *3
	EMCO 3115 DOUBLE RIDGED HORN 1 - 18 GHz Sn: 8908-3282	29/01/03	29/01/04	1 YEAR *3
	EMCO 3116 Double Ridged Guide Horn 18 – 40 GHz Sn 2276	22/08/02	22/08/04	2 YEARS *1
<b>PREAMPLIFIER</b>	HP 8449B PREAMPLIFIER 1 - 26.5 GHz (30 dB Gain) Sn: 3008A01113	02/07/03	02/07/04	1 YEAR *3
<b>LISN</b>	EMCO 3825/2 50ohm / 50 microH 0.009 – 30MHz Sn.9607-2567	10/02/03	10/02/04	1 YEAR *3

Note \*1. National Measurements Laboratory calibration.

Note \*2. NATA calibration by Agilent Technologies (Aust) Pty Ltd

Note \*3. In-house calibration. Refer to Quality Manual.

**TEST SITES**

<b>Shielded Room Test Laboratory</b>	<b>Melbourne</b> 11m x 8m x 4m Chamber-semi-anechoic 8.8m x 5.8m x 3.1m Test Chamber 3.4m x 6.1m x 2.5m Test Chamber 3.4m x 7.3m x 7.5m Test Chamber	Feb 03 N/A N/A N/A	Feb 04 N/A N/A N/A	1 Year *1 N/A N/A N/A
<b>Open Area Test Site</b>	<b>Melbourne</b> 3/10 Metre site. 1-4 metre antenna mast. 1.2 metre/400 kg Turntable. (Situated at Lerderderg Gorge, near Bacchus Marsh, Victoria)	21/01/03	21/01/04	1 Year *1

Note \*1. In-house calibration. Refer to Quality Manual.



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## **TEST REPORT APPENDICES**

**(Submitted as attachments)**

**APPENDIX A: MEASUREMENT INSTRUMENT DETAILS**

**APPENDIX B: TEST SAMPLE PHOTOGRAPHS**

**APPENDIX C: BLOCK DIAGRAM**

**APPENDIX D: FCC ID LABELLING**

**APPENDIX E: TEST SAMPLE SCHEMATICS**

**APPENDIX F: PCB LAYOUTS**

**APPENDIX G: GRAPHS of EMI MEASUREMENTS**

**APPENDIX H: CHANNEL BANDWIDTH PLOTS**

**APPENDIX I: ANTENNA INFORMATION (MONOPOLE DIELECTRIC ANTENNA)**

**APPENDIX J: USER MANUAL (SUPPLIED TO ALL END USERS)**

**APPENDIX K: EUT THEORY OF OPERATION**

**APPENDIX L: EUT HOST SPECIFICATIONS**

**APPENDIX M: EUT HOST USER MANUAL**

