



EMC Technologies Pty Ltd

ABN 82 057 105 549

57 Assembly Drive

Tullamarine Victoria Australia 3043

Ph: + 613 9335 3333

Fax: + 613 9338 9260

email: melb@emctech.com.au

**EMI TEST REPORT
for
CERTIFICATION to
FCC PART 15 Subpart B (Section 15.121)**

FCC ID: HNL-G3E

Manufacturer: WiNRADiO Communications

Test Sample: WiNRADiO G3 External Radio Receiver (180MHz)

Model Number: G3

Tested for: Robotron Pty Ltd

Report Number: M040535_Cert_G3_Receiver

Issue Date: 25th June 2004

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**NATA Accredited Laboratory
Number: 5292**

**EMI TEST REPORT FOR CERTIFICATION
of
WiNRADiO G3 External Radio Receiver (180MHz)
to
FCC PART 15 Subpart B (Section 15.121)**

EMC Technologies Report No. M040535_Cert_G3_Receiver

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CONTENTS

- 1.0 INTRODUCTION**
- 2.0 GENERAL INFORMATION**
- 3.0 CONDUCTED EMI MEASUREMENTS**
- 4.0 RADIATED EMI MEASUREMENTS**
- 5.0 COMPLIANCE STATEMENT**

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: USER MANUAL



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EMI TEST REPORT FOR CERTIFICATION
to
FCC PART 15 Subpart B (Section 15.121)

Report Number: M040535_Cert_G3_Receiver

Test Sample: WiNRADiO G3 External Radio Receiver (180 MHz)
Model Number: G3
Serial Number: 04E11006

FCC ID: HNL-G3E

Manufacturer: WiNRADiO Communications

Tested for: Robotron Pty Ltd
Address: 15 Stamford Road,
Oakleigh, VIC 3166 Australia
Phone: +61 3 9568 2568
Fax: +61 3 9568 1377
Responsible Party: Milan Hudecek

Equipment Type: Unintentional Radiator (Scanning Receiver)

Test Standards: FCC Part 15 Section 101 Unintentional Radiators
FCC Part 15 Section 121 Scanning Receivers
FCC Part 15 Section 107 Conducted limits
FCC Part 15 Section 109 Radiated limits
ANSI C63.4-1992
OET Bulletin No. 63

Test Dates: 24th May to 17th June 2004



Test Officers:

Chieu Huynh - B.Eng (Hons) Electronics
Janath Gunakesera - BScEng., MTelcomEng, MIEEE
Jorge Lara

Attestation:

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



Authorised Signature:

Chris Zombolas
Technical Director
EMC Technologies Pty Ltd



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EMI TEST REPORT FOR CERTIFICATION
to
FCC PART 15 Subpart B (Section 15.121)
on the
WiNRADiO G3 External Radio Receiver (180MHz)

1. INTRODUCTION

This report details the results of EMI tests and measurements performed on the WiNRADiO G3 External Radio Receiver (180MHz) in accordance with the Federal Communications Commission (FCC) regulations as detailed in Title 47 CFR, Part 15 Subpart B Rules for Unintentional Radiators and Title 47 CFR, Part 15.121 for Scanning Receivers.

The results and technical details of the test sample are detailed in this report. The test sample was found to comply with the conducted and radiated emission requirements of Part 15.107 and Part 15.109 respectively.

1.1 Summary of Results

Part 15.107 Conducted Emissions: Complies Class B limit, margin of > 10 dB

Part 15.109 Radiated Emissions (30 – 1000 MHz):

Config #1: (Tune Frequency - 9 kHz)	Complies Class B limit, margin of 4.3 dB
Config #2: (Tune Frequency - 15 MHz)	Complies Class B limit, margin of 5.7 dB
Config #3: (Tune Frequency - 30 MHz)	Complies Class B limit, margin of 6.9 dB
Config #4: (Tune Frequency - 90 MHz)	Complies Class B limit, margin of 3.7 dB
Config #5: (Tune Frequency - 180 MHz)	Complies Class B limit, margin of 6.3 dB

Part 15.109 Radiated Emissions (>1 GHz): Complies Class B limit, margin of 2.0 dB

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

No modifications were required.



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2. GENERAL INFORMATION

2.1 Product Specifications

Test Sample: WiNRADiO G3 External Radio Receiver (180 MHz)
Tested for: Robotron Pty Ltd
Manufacturer: WiNRADiO Communications
Model Number: G3
Serial Number: 04E11006
FCC ID: HNL-G3E

Equipment Type: Unintentional Radiator (Scanning Receiver)

AC Adaptor Model: AD-1280
Input: 120VAC, 60Hz, 14W
Output: 12VDC, 800mA

2.2 Test Sample Operational Description

(Information supplied by Client)

This is a PC-controlled Software-Defined Receiver, where the incoming frequency (9 kHz to 180 MHz), is first up-converted to 45 MHz IF, and then down-converted to 12 kHz IF, after which it is further processed (demodulated) entirely in software. The demodulator software can run either on the inbuilt DSP, or optionally directly on the PC (after being digitized by the PC sound card).

There is also a separate path for wide FM signals, which are down-converted from 45 MHz to 10.7 MHz, and demodulated conventionally, in hardware.

There are 5 main functional modules:

1. The **RF module** which contains switchable front-end filters, an attenuator and an amplifier
2. The **IF1 module** which contains a mixer and the 45 MHz first IF.
3. The **IF2 module** which contains a 45.012 MHz local oscillator and 12 kHz second IF.
4. The **PLL module** which provides variable frequency 45.009 to 225 MHz used for the first IF mixer.
5. The **USB backplane** which contains the control CPU, USB interface, DSP and master reference oscillator (20 MHz).



2.3 Technical Specifications

Type:	Dual Conversion Superheterodyne
Frequency Range:	0.009 - 180 MHz
Modes:	AM, AMN, AMS, LSB, USB, CW, FM
Tuning Steps:	1 Hz
IF Shift:	3 kHz
Audio Output:	Line Output to Sound Card or 200 mW @ 8 Ω
Antenna:	50 Ω , SMA Connector
Dynamic Range:	90 dB
IP3:	+5 dBm
PCBs:	-----
Power Supply:	+12V-DC
Microprocessor:	PIC16F877, TUSB3200 AND ADSP2185M
Typical Sensitivity:	1 μ V (AM), 0.3 μ V (LSB, USB), 1 μ V (FM)

Oscillator Frequencies:

The master reference crystal oscillator is 20 MHz. From the first reference oscillator, two VCO/PLL oscillators are derived:

First IF: 45.009 to 225 MHz

Second IF: 45.012 MHz

The USB interface uses a 6.000 MHz crystal

The DSP uses a 32.768 MHz oscillator

2.4 Test sample configuration

The EUT was connected to a support Laptop PC via USB cable.

The following cables were connected to the EUT: Receiving Antenna, IF Output/Control and Power.

As supplied by the client, radiated emissions measurement was performed with a ferrite installed on the power cable.

Refer to Appendix B - Test Setup Photographs.

2.5 Test Sample Block Diagram

Refer to Appendix C - Test Sample Block Diagram

2.6 Test Sample Support Equipment

Hewlett Packard Omnibook Laptop.

Model Number: XE3

Serial Number: TW13612410



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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 (A²LA).

2.9 Units of Measurements

2.9.1 Conducted Emissions

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

2.9.2 Radiated Emissions

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



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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.



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3.0 CONDUCTED EMISSION MEASUREMENTS

Testing was performed in accordance with the requirements of FCC Part 15.107

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 μ V to be compared to the limit.
- VRx** = the Voltage in dB μ 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 Measurement

Testing was performed with the EUT tuned to three different frequencies: 9kHz, 90MHz and 180MHz. There were no significant differences in emissions observed.

The worst case conducted EMI complied with the quasi peak and average limits by margins of > 10 dB. The measurement uncertainty was ± 2.0 dB. Refer to Appendix G - Graphs 1 and 2.



4.0 RADIATED EMISSION MEASUREMENTS

Testing was performed in accordance with the requirements of FCC Part 15.109.

4.1 Test Procedure

Radiated emissions 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 Horn antenna was used for measurements between 1 to 2 GHz.

The measurement of emissions between 30 - 1000 MHz was measured at a distance of 10 metres and with the resolution bandwidth of 120 kHz and the video bandwidth of 300 kHz.

The measurement of emissions above 1000 MHz was measured at a distance of 3 metres and with the resolution bandwidth of 1 MHz and the video bandwidth of 1 MHz.

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

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 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 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:

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

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 Plotting of Measurement Data for Radiated Emissions

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 30-1000 MHz and 1 - 2 GHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI *peak* measurements as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the "#" symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with the "#" symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, quasi-peak field strength and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit.

At times, the quasi peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level higher than the peak level.



4.4 Radiated EMI Results

4.4.1 30 – 1000 MHz

Testing was performed with the EUT tuned to five different frequencies: 9kHz, 15MHz, 30MHz, 90MHz and 180MHz. The results of all five configurations were reported.

4.4.1.1 Configuration 1 - Tuned Frequency.: 9 kHz

Frequency MHz	Polarisation	QP Measured dB μ V	QP Limit dB μ V	Δ QP \pm dB
161.51	Vertical	29.2	33.5	- 4.3
162.04	Vertical	28.4	33.5	- 5.1
211.69	Vertical	25.8	33.5	- 7.7
161.94	Horizontal	25.6	33.5	- 7.9
136.88	Vertical	25.5	33.5	- 8.0
198.80	Horizontal	25.2	33.5	- 8.3

Result : The highest radiated emission peak complied with FCC Class B limit by a margin of 4.3 dB at 161.53 MHz. The measurement uncertainty for radiated EMI was ± 3.7 dB. Refer to Appendix G - Graphs 3 and 4.

4.4.1.2 Configuration 2 - Tuned Frequency.: 15 MHz

Frequency MHz	Polarisation	QP Measured dB μ V	QP Limit dB μ V	Δ QP \pm dB
211.59	Vertical	27.8	33.5	- 5.7
647.30	Vertical	30.1	36.0	- 5.9
210.31	Vertical	25.4	33.5	- 8.1
187.03	Vertical	25.0	33.5	- 8.5
215.99	Vertical	24.3	33.5	- 9.2
796.78	Horizontal	26.6	36.0	- 9.5

Result : The highest radiated emission peak complied with FCC Class B limit by a margin of 5.7 dB at 211.59 MHz. The measurement uncertainty for radiated EMI was ± 3.7 dB. Refer to Appendix G - Graphs 5 and 6.

4.4.1.3 Configuration 3 - Tuned Frequency.: 30 MHz

Frequency MHz	Polarisation	QP Measured dB μ V	QP Limit dB μ V	Δ QP \pm dB
161.46	Vertical	26.6	33.5	- 6.9
163.28	Vertical	26.3	33.5	- 7.2
186.40	Vertical	26.1	33.5	- 7.4
211.66	Vertical	25.8	33.5	- 7.8
211.89	Vertical	25.0	33.5	- 8.5
648.17	Vertical	25.5	36.0	- 10.5

Result : The highest radiated emission peak complied with FCC Class B limit by a margin of 6.9 dB at 161.46 MHz. The measurement uncertainty for radiated EMI was ± 3.7 dB. Refer to Appendix G - Graphs 7 and 8.



4.4.1.4 Configuration 4 - Tuned Frequency.: 90 MHz

Frequency MHz	Polarisation	QP Measured dB μ V	QP Limit dB μ V	Δ QP \pm dB
161.80	Vertical	29.8	33.5	- 3.7
135.02	Vertical	29.7	33.5	- 3.8
145.12	Vertical	29.2	33.5	- 4.3
259.95	Vertical	31.0	36.0	- 5.0
211.51	Vertical	27.3	33.5	- 6.2
747.11	Vertical	29.7	36.0	- 6.2

Result : The highest radiated emission peak complied with FCC Class B limit by a margin of 3.7 dB at 161.80 MHz. The measurement uncertainty for radiated EMI was ± 3.7 dB. Refer to Appendix G - Graphs 9 and 10.

4.4.1.5 Configuration 5 - Tuned Frequency.: 180 MHz

Frequency MHz	Polarisation	QP Measured dB μ V	QP Limit dB μ V	Δ QP \pm dB
186.95	Vertical	27.2	33.5	- 6.3
225.00	Horizontal	29.7	36.0	- 6.5
225.00	Vertical	27.9	36.0	- 8.1
211.82	Vertical	25.2	33.5	- 8.3
161.51	Vertical	24.6	33.5	- 8.9
139.58	Vertical	23.2	33.5	- 10.3

Result : The highest radiated emission peak complied with FCC Class B limit by a margin of 6.3 dB at 186.95 MHz. The measurement uncertainty for radiated EMI was ± 3.7 dB. Refer to Appendix G - Graphs 11 and 12.

4.4.2 1 to 2 GHz - Tuned Frequency.: 180 MHz

Frequency MHz	Polarisation	QP Measured dB μ V	QP Limit dB μ V	Δ QP \pm dB
1574.97	Vertical	52.0	54.0	- 2.0
1574.99	Horizontal	48.1	54.0	- 5.9

Result : The highest radiated emission peak complied with FCC Class B limit by a margin of 2.0 dB at 1574.97 MHz. The measurement uncertainty for radiated EMI was ± 4.1 dB. Refer to Appendix G - Graphs 13 and 14.

5.0 COMPLIANCE STATEMENT

The WiNRADiO G3 External Radio Receiver (180 MHz), tested on behalf of Robotron Pty Ltd complied with the requirements of the FCC Part 15 Subpart B Rules for Unintentional Radiators and FCC Part 15.121 Rules for Scanning Receivers.

The compliance margins were as follows:

Part 15.107 Conducted Emissions: Complies Class B limit, margin of > 10 dB

Part 15.109 Radiated Emissions (30 to 1000 MHz):

Config #1: (Tune Frequency - 9 kHz)	Complies Class B limit, margin of 4.3 dB
Config #2: (Tune Frequency - 15 MHz)	Complies Class B limit, margin of 5.7 dB
Config #3: (Tune Frequency - 30 MHz)	Complies Class B limit, margin of 6.9 dB
Config #4: (Tune Frequency - 90 MHz)	Complies Class B limit, margin of 3.7 dB
Config #5: (Tune Frequency - 180 MHz)	Complies Class B limit, margin of 6.3 dB

Part 15.109 Radiated Emissions (>1 GHz): Complies Class B limit, margin of 2.0 dB



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TEST REPORT APPENDICES

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