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

FCC ID:	ZWD-WITMR11
IC:	9980A-WITMR11
Test Sample:	Wear Indicator (WI) Transmitter
Model Number:	B
Report Number	M101045_Cert
Tested for:	Weir Mineral
Issue Date:	4th November 2011

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Report Number:	M101045_Cert
Test Sample:	Wear Indicator (WI) Transmitter
Model Number:	B
Manufacturer:	Benbro Electronics
FCC ID:	ZWD-WITMR11
IC:	9980A-WITMR11
Equipment Type:	Intentional Radiator
Tested for:	Weir Mineral
Address:	1550 Airport Road, Gallatin, TN 37066 USA
Phone:	+1 615 230 2237
Contact:	Paula Russell
Test Standards:	FCC Part 15 – Radio Frequency Devices FCC Part 15 Subpart C – Intentional Radiators Section 15.247: 2400 – 2483.5 MHz Operation Band ANSI C63.4 – 2009 RSS-210 Issue 8, Licence-Exempt Radio Apparatus Annex 8: 2400 – 2483.5 MHz Operation Band RSS-Gen Issue 3, General Requirements and Information for the Certification of Radiocommunication Equipment
Test Dates:	15th to 26th August 2011
Test Engineer:	**Chieu Huynh**
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** **EMC Technologies Pty Ltd**

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1.0 INTRODUCTION

EMI testing was performed on the Wear Indicator (WI) Transmitter, model number: B.

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 and RSS-Gen.

1.1 Summary of Results

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

FCC Part 15 Subpart C Clauses	Industry Canada RSS-210 Issue 8 and RSS-Gen Clauses	Test Performed	Results
15.203	RSS-Gen (7.1.2)	Antenna Requirement	**Complied**
15.205	RSS-Gen (7.2.2)	Operation in Restricted Band	**Complied**
15.207	RSS-Gen (7.2.4)	Conducted Emissions	**Not Applicable** EUT is battery powered
15.209	RSS-Gen (7.2.5)	Radiated Emissions	**Complied**
15.247 (a)(1)	A8.1 (c)	Channel Bandwidth	**Complied**
15.247 (b)(2)	A8.4 (1)	Peak Output Power	**Complied**
15.247 (c)	RSS-Gen (7.1.2)	Antenna Gain > 6 dBi	**Not Applicable.** Antenna gain < 6 dBi
15.247 (d)	A8.5	Out of Band Emissions	**Complied**
15.247 (e)	A8.2 (b)	Peak Power Spectral Density	**Not Applicable.** EUT is not digital modulated system
15.247 (f)	A8.3	Hybrid Systems (Note 1)	**Not Applicable.** EUT does not employ a hybrid system
15.247 (g)	A8.1	Frequency Hopping	**Complied**
15.247 (h)	A8.1	Frequency Hopping	**Complied**
15.247 (i)	RSS-Gen (5.6)	Radio Frequency Hazard	**Complied**

Note 1: Hybrid systems are those that employ a combination of both frequency hopping and digital modulations technique.

The measurement procedure used was in accordance with ANSI C63.4-2009. The instrumentation conformed to the requirements of ANSI C63.2-1996.

1.2 EUT – Voltage Power Conditions

Testing was performed with the test sample powered from an inbuilt 6V battery.

1.3 Modifications

No modifications were performed.

2.0 GENERAL INFORMATION

(Information supplied by the Client)

2.1 Product Details

Test Sample:	Wear Indicator (WI) Transmitter
Model Number:	B
Manufacturer:	Benbro Electronics
Microcontroller:	Microchip PIC16F688
Crystal frequency:	4 MHz and 30 MHz
RF Operating frequency:	903.24 MHz to 926.76 MHz
RF Output Power:	17dBm
Modulation:	Frequency Hopping
Data Transmission:	2400 baud
Input Supply Voltage:	Inbuilt 6V battery

2.2 Operational Description

Intended for unattended operation in monitoring the wear in mining hoses that are installed on mine sites and in metals and minerals processing plants. Transmitters can be located in the open or within processing plants and may be far from the receiver units.

Operational Description - Refer to Appendix D.

2.3 Test Configuration

WI Transmitter positioned with antenna vertical and connected by 2 m cable to WI Programmer. WI Programmer is set to transmit a test signal once every minute for 30 minutes (starts immediately).

2.4 Test Procedure

Emissions measurements were performed in accordance with the procedures of ANSI C63.4-2009. 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 has also been accepted by Industry Canada for the performance of radiated measurements in accordance with RSS 212, Issue 1 (Provisional) - **Industry Canada number 3569B.**

Measurements 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 (A^2LA).

2.6 Test Equipment Calibration

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, log-periodic and horns) calibrated by the EMC Technologies. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in the Measurement Instrument Details.

3.0 CONDUCTED EMISSION MEASUREMENTS

Conducted emission testing was not applicable as the EUT is battery powered.

4.0 RADIATED 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. All measurements above 1 GHz were made over a distance of 3 and 1 metres.

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 loop antenna was used for measurements between 0.009 MHz to 30 MHz**.** A calibrated Biconical antenna was used for measurements between 30 MHz to 200 MHz and a calibrated Logperiodic antenna used for measurements between 200 MHz to 1000 MHz. Calibrated EMCO 3115 and ETS standard gain horn antennas were used for measurements between 1 to 9.3 GHz.

The Receiver bandwidth was set to 6.0 dB.

The following bandwidth settings were used:
RBW = 1 kHz and VBW = 3 kHz for frequency band 9 kHz – 150 kHz
RBW = 9 kHz and VBW = 30 kHz for frequency band 150 kHz – 30 MHz
RBW = 120 kHz and VBW = 300 kHz for frequency band 30 MHz – 1000 MHz
RBW = 200 Hz and VBW = 10 Hz for frequency bands 9 kHz – 90 kHz and 110 kHz – 490 kHz
Peak measurements above 1 GHz: RBW = VBW = 1 MHz
Average measurements above 1 GHz: RBW = 1 MHz and VBW = 10 Hz

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 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 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

4.3 Transmitter Harmonics and Spurious Emissions

4.3.1 Frequency Band: 1 – 9.3 GHz

Low Frequency - Tx at 903.2 MHz

Frequency MHz	Peak Detector dBuV/m	Average Detector dBuV/m	Peak Limit dBuV/m	Average Limit dBuV/m	Result
903.2	Fundamental, Refer to section 5.0 – Peak Output Power				
1806.5	52.8	49.0	74.0	54.0	Complied
3613.0	49.7	41.6	74.0	54.0	Complied
4516	52.0	44.9	74.0	54.0	Complied
5419.4	55.1	48.6	74.0	54.0	Complied
6322.7	51.5	39.3	74.0	54.0	Complied
7225.9	51.8	39.8	74.0	54.0	Complied
8129.2	52.3	41.0	74.0	54.0	Complied

Middle Frequency - Tx at 917.6 MHz

Frequency MHz	Peak Detector dBuV/m	Average Detector dBuV/m	Peak Limit dBuV/m	Average Limit dBuV/m	Result
917.6	Fundamental, Refer to section 5.0 – Peak Output Power				
1835.2	51.2	42.1	74.0	54.0	Complied
3670.5	50.1	44.3	74.0	54.0	Complied
4588	53.0	45.8	74.0	54.0	Complied
5505.6	55.3	49.7	74.0	54.0	Complied
6423.2	51.1	39.0	74.0	54.0	Complied
7340.8	56.9	41.9	74.0	54.0	Complied
8258.4	55.1	43.1	74.0	54.0	Complied

High Frequency - Tx at 926.76 MHz

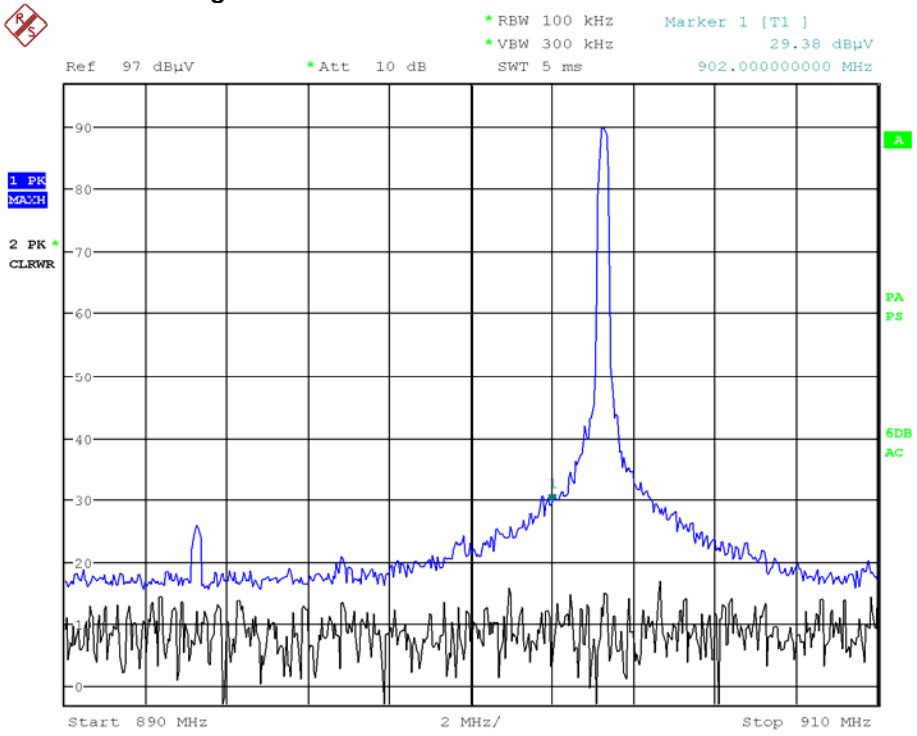
Frequency MHz	Peak Detector dBuV/m	Average Detector dBuV/m	Peak Limit dBuV/m	Average Limit dBuV/m	Result
926.76	Fundamental, Refer to section 5.0 – Peak Output Power				
1853.5	47.2	35.0	74.0	54.0	Complied
3707	50.5	44.1	74.0	54.0	Complied
4633.8	54.4	48.4	74.0	54.0	Complied
5560.5	55.9	50.3	74.0	54.0	Complied
6487.3	50.5	38.0	74.0	54.0	Complied
7414	54.7	44.8	74.0	54.0	Complied
8340.8	53.6	41.8	74.0	54.0	Complied

Results: Harmonic emissions complied with the FCC limits in sections 15.209 and 15.247.

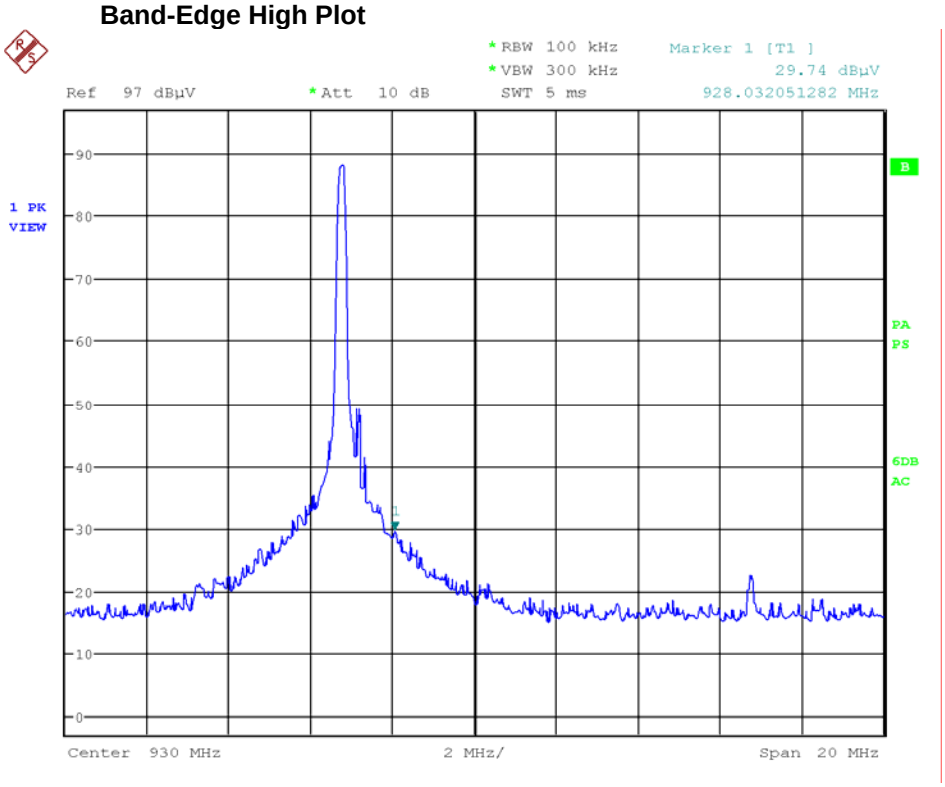
4.3.2 Band Edge Measurements

Band-Edge Low (902 MHz) – Complied, > 50dB below the carrier, Refer to Band-edge low plot
Band-Edge High (928 MHz) – Complied, > 50dB below the carrier, Refer to Band-edge high plot

Band-Edge Low Plot

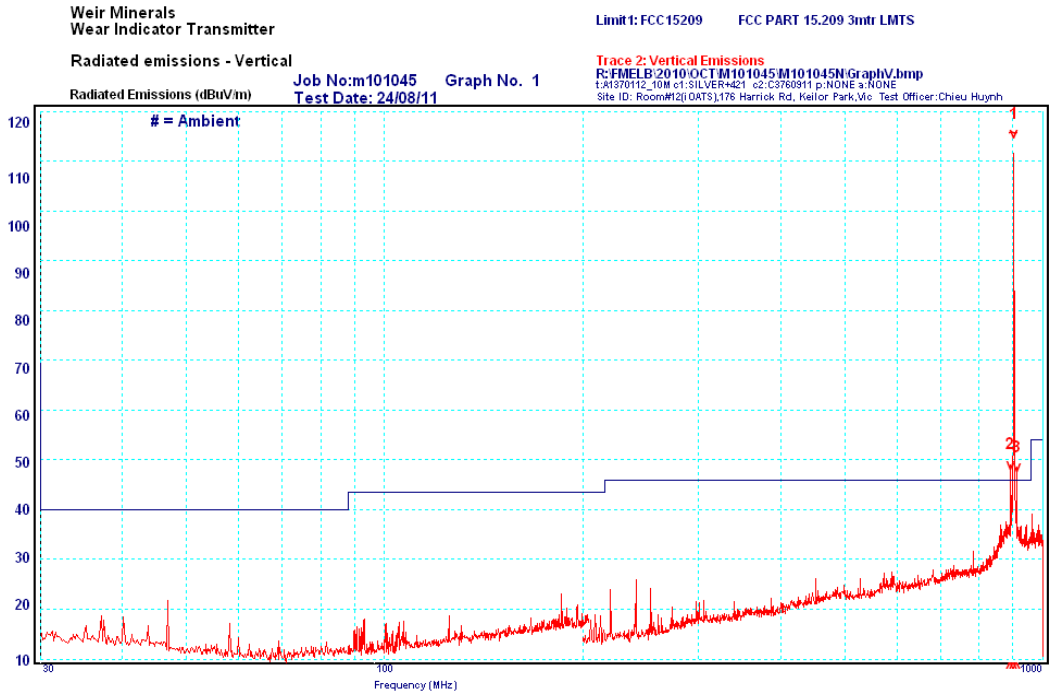


Band-Edge High Plot

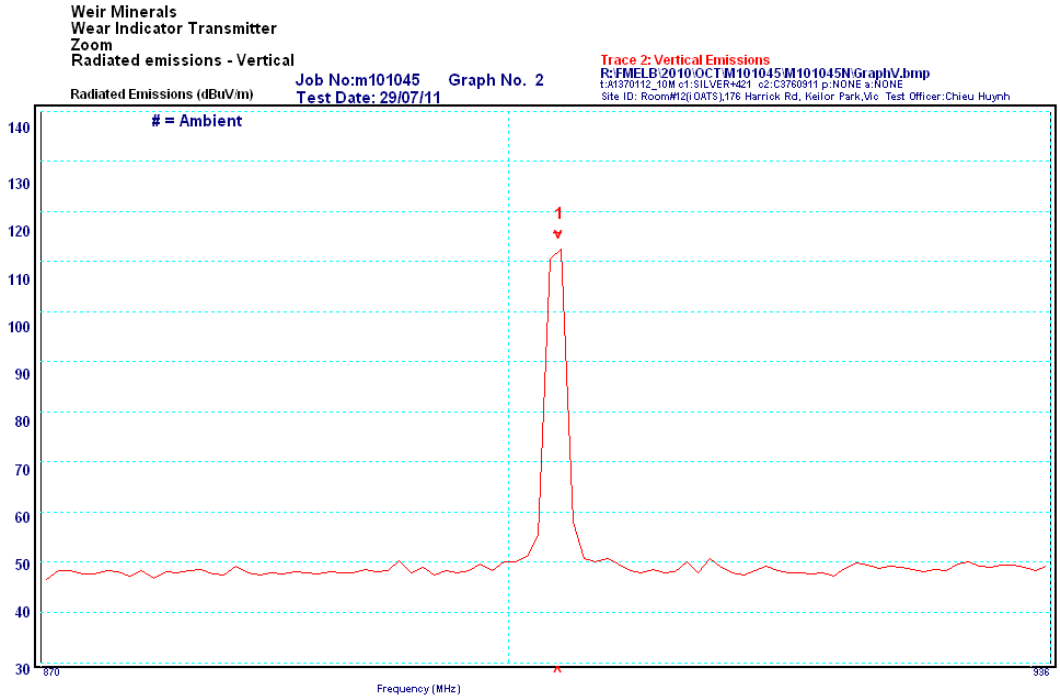


4.3.3 Frequency Band: 9 kHz - 1000 MHz

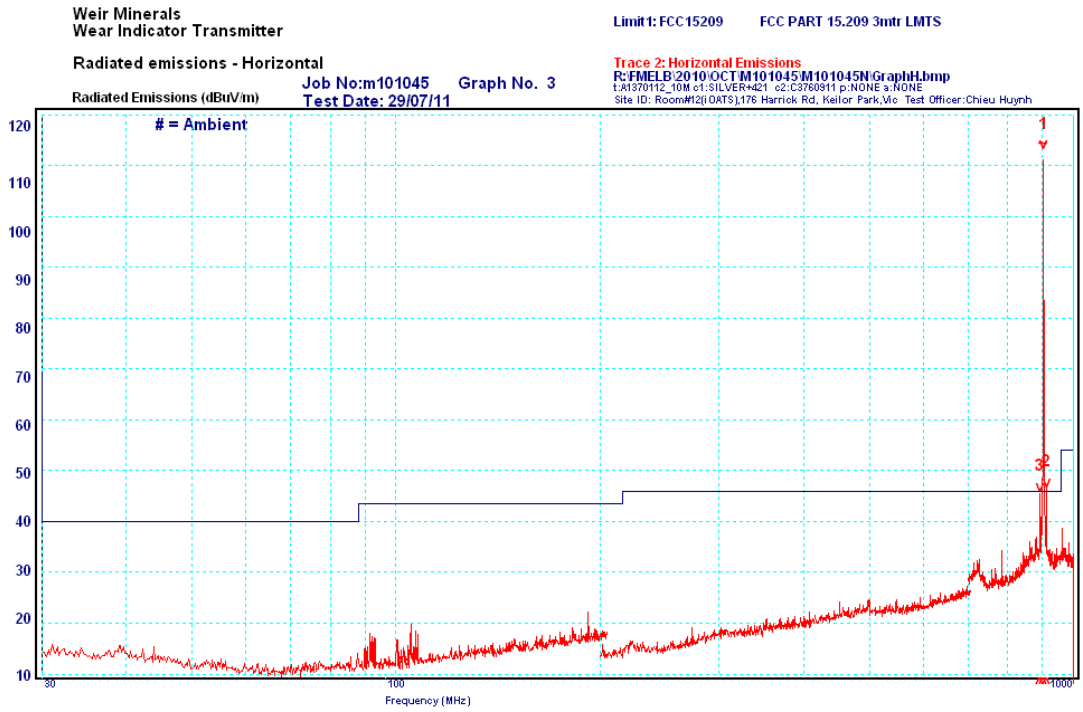
Initial investigations were performed with all three frequencies (low, middle and high). No significant differences in emissions were observed. Final testing was performed while the transmitter continuously operated at 903.2 MHz.



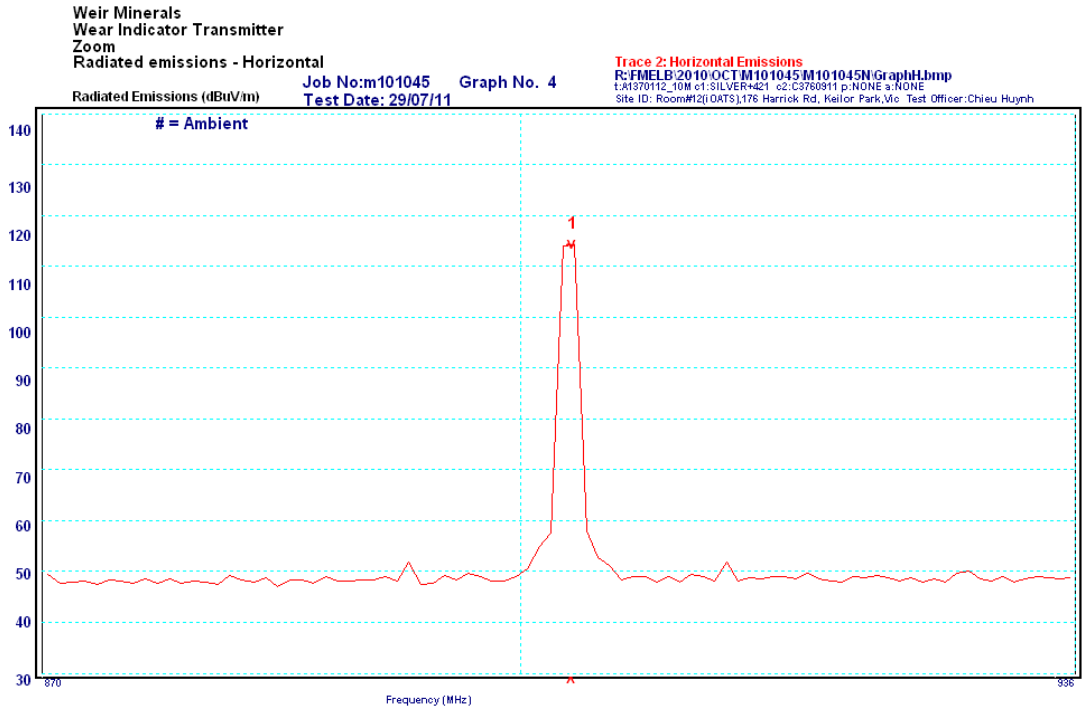
Plot 1 – Vertical: 30 MHz to 1000 MHz



Plot 2 – Vertical: Zoom In



Plot 3 – Horizontal: 30 MHz to 1000 MHz



Plot 4 – Horizontal: Zoom In

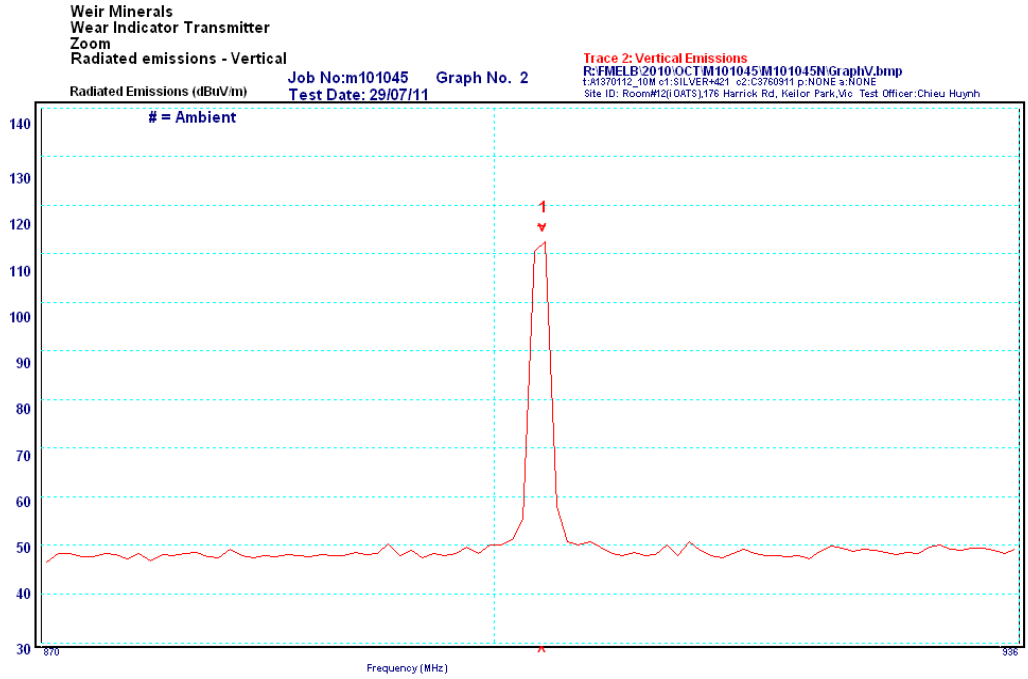
Results: The worst case radiated EMI complied with the FCC limits in sections 15.209 and 15.247 by a margin of >10 dB. Refer to above Plots 1 to 4. No emissions were recorded/measured below 30MHz (9 kHz to 30 MHz).

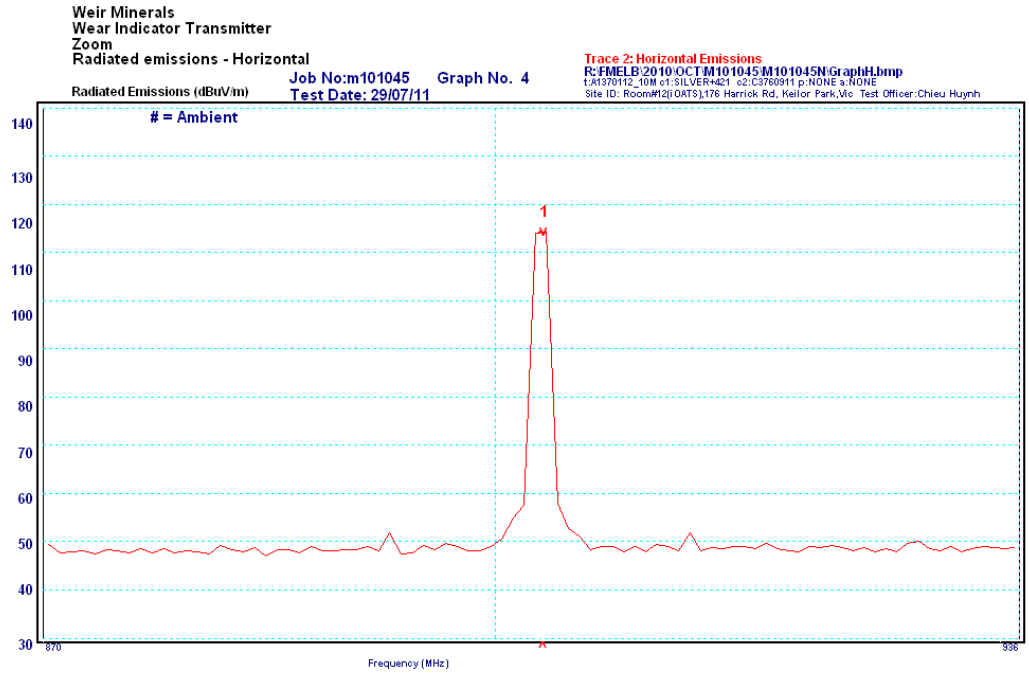
5.0 PEAK OUTPUT POWER

Testing was performed in accordance with the requirements of FCC Part 15.247(b)(2).

Measurements were performed at a distance of 3 metres from the EUT.

Frequency MHz	Field Strength dBuV/m	Limit dBuV/m	Power mW	Limit mW	Result
903.24	115.5	125.2	107	1000	Complied
917.6	116.0	125.2	118	1000	Complied
926.76	115.8	125.2	114	1000	Complied





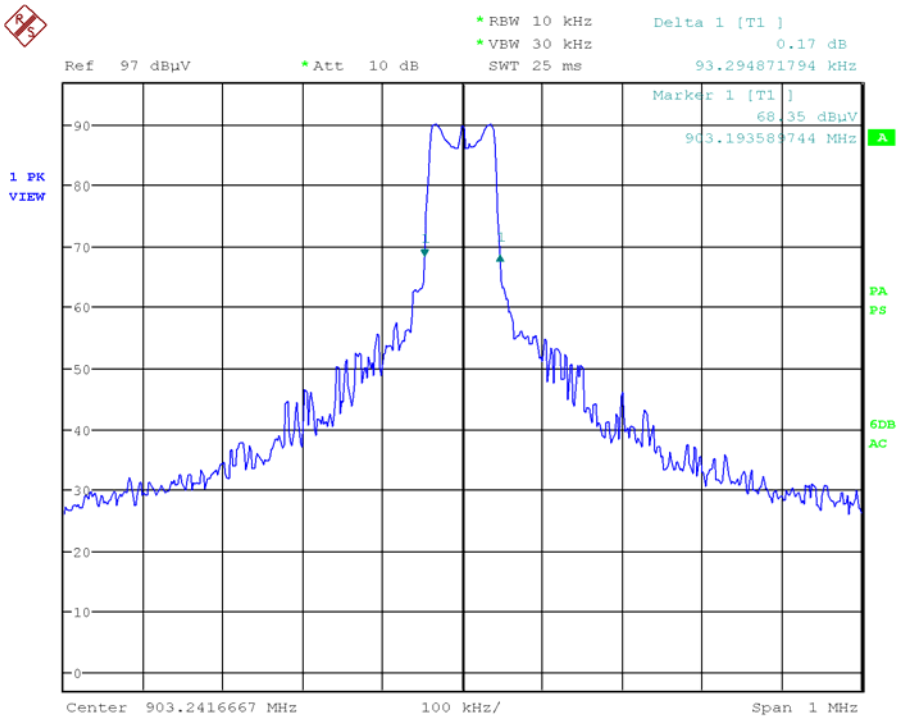
6.0 CHANNEL BANDWIDTH & CHANNEL OCCUPANCY

Testing was carried out in accordance with the requirements of FCC Part 15.247(a)(1)(i)

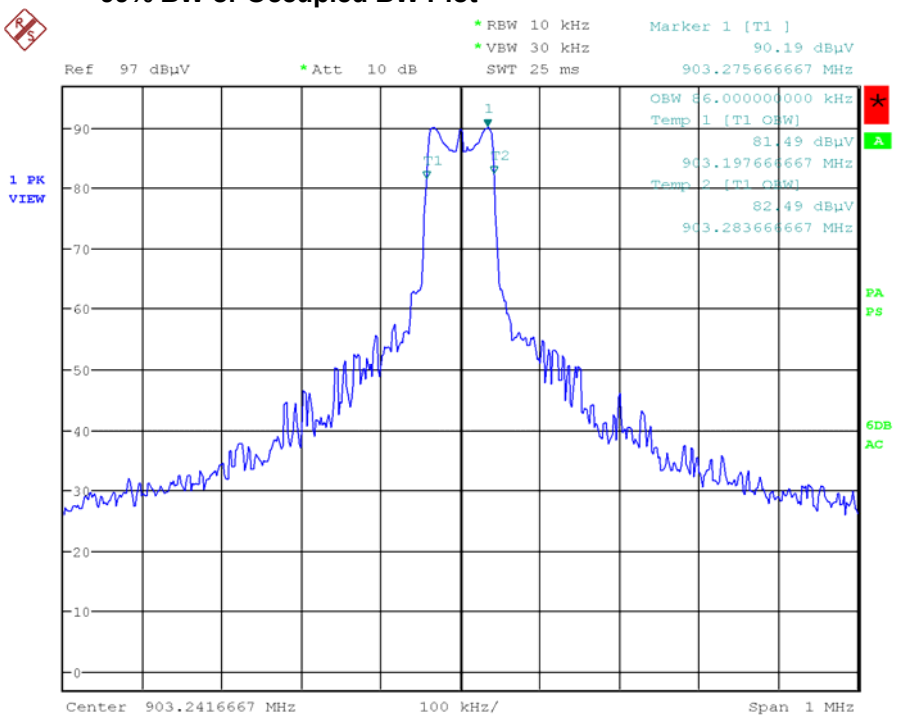
6.1 Channel Bandwidth

The 20dB bandwidth is 93.3 kHz. Therefore, the system should use at least 50 channels. Refer to section 6.2 for channel occupancy.

20dB BW Plot

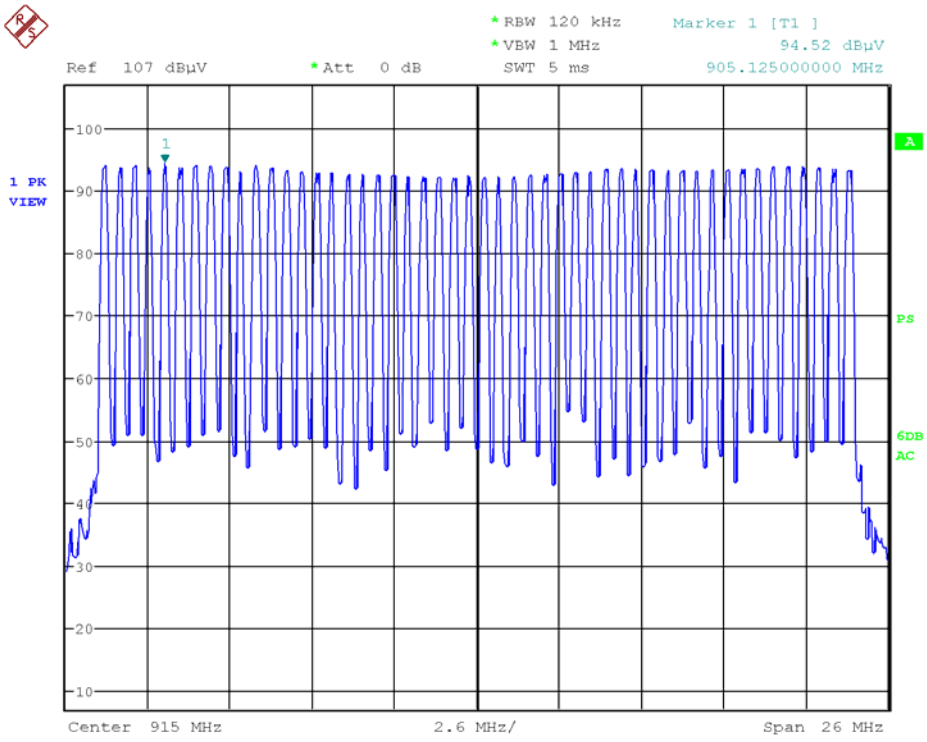


99% BW or Occupied BW Plot

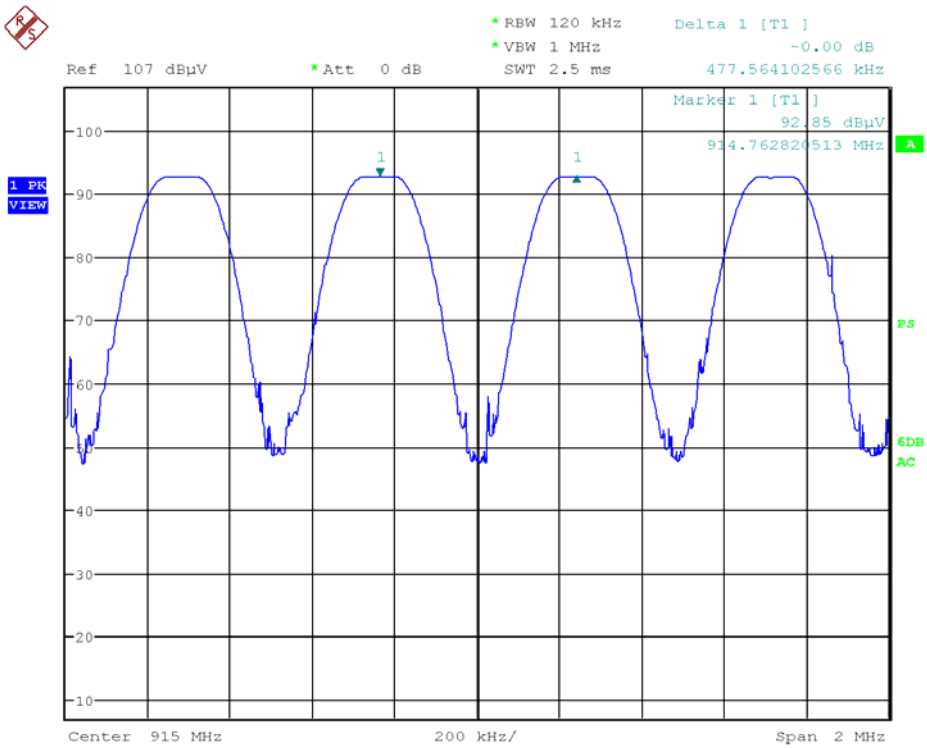


6.2 Channel Occupancy

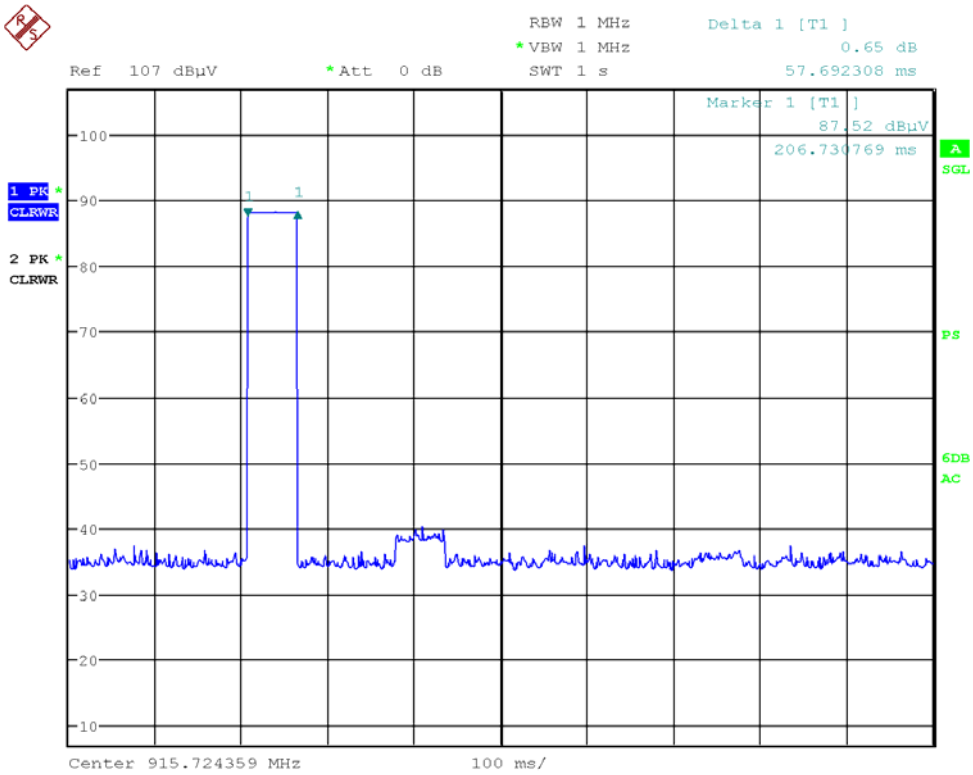
50 channels were observed operating between 902 MHz to 928 MHz. Refer to number of channel plot.



The channel separation of 477 kHz was recorded. Refer to channel separation plot.



The device was observed to have a dwell time of 0.0577 seconds (57.7ms). Refer to dwell time plot.



The specification allows for a dwell time not exceeding 0.4 seconds.

The maximum period is 50 channels x 0.4 seconds = 20 seconds.

During the test the transmitter was observed to activate 3 times in 20 seconds.

The transmitter therefore occupies in one channel for 3 x 0.0577 = 0.173 seconds.

Result: Complied.

7.0 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 902 MHz - 928 MHz band is 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).

The MPE calculation shown below is for the antenna with a minimum separation distance of 20cm.

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)

Prediction frequency = 915 MHz
Maximum peak output power with antenna = 20.72 dBm = 118 mW
Prediction distance = 20 cm
The power density calculated = 0.024 mW/cm^2

Results: Calculations show that the device with described antennas complied with Maximum Permissible Exposure (MPE) limit for the General Population/Uncontrolled Exposure with a separation distance of 20cm.

8.0 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.

9.0 COMPLIANCE STATEMENT

The Wear Indicator (WI) Transmitter, model number: B tested on behalf of Weir Mineral, **complied** with the requirements of 47 CFR, Part 15 Subpart C - Rules for Radio Frequency Devices (intentional radiators), Section 15.247.

The test sample also complied with the Industry Canada RSS-210 and RSS-Gen.

Results were as follows:

FCC Part 15 Subpart C Clauses	Industry Canada RSS-210 Issue 8 and RSS-Gen Clauses	Test Performed	Results
15.203	RSS-Gen (7.1.2)	Antenna Requirement	**Complied**
15.205	RSS-Gen (7.2.2)	Operation in Restricted Band	**Complied**
15.207	RSS-Gen (7.2.4)	Conducted Emissions	**Not Applicable** EUT is battery powered
15.209	RSS-Gen (7.2.5)	Radiated Emissions	**Complied**
15.247 (a)(1)	A8.1 (c)	Channel Bandwidth	**Complied**
15.247 (b)(2)	A8.4 (1)	Peak Output Power	**Complied**
15.247 (c)	RSS-Gen (7.1.2)	Antenna Gain > 6 dBi	**Not Applicable.** Antenna gain < 6 dBi
15.247 (d)	A8.5	Out of Band Emissions	**Complied**
15.247 (e)	A8.2 (b)	Peak Power Spectral Density	**Not Applicable.** EUT is not digital modulated system
15.247 (f)	A8.3	Hybrid Systems (Note 1)	**Not Applicable.** EUT does not employ a hybrid system
15.247 (g)	A8.1	Frequency Hopping	**Complied**
15.247 (h)	A8.1	Frequency Hopping	**Complied**
15.247 (i)	RSS-Gen (5.6)	Radio Frequency Hazard	**Complied**

Note 1: Hybrid systems are those that employ a combination of both frequency hopping and digital modulations technique.

10.0 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:

Radiated Emissions:	9 kHz to 30 MHz	±4.1 dB
	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%.

11.0 MEASUREMENT INSTRUMENT

EQUIPMENT TYPE	MANUFACTURER, MODEL NUMBER and SERIAL NUMBER	CALIBRATION DUE DD/MM/YY
EMI RECEIVER	Rohde & Schwarz, Model ESU40 SN 1302.6005.40, 20 Hz – 40 GHz	08/12/11
	HP 8546A Sn: 3549A00290 (R-009)	11/08/12
ANTENNAS	Narda Standard Gain Horn, M/N: 644	19/11/12
	ETS Standard Gain Horn, M/N: 3160-03	19/11/12
	ETS Standard Gain Horn, M/N: 3160-05	19/11/12
	ETS Standard Gain Horn, M/N: 3160-06	19/11/12
	ETS Standard Gain Horn, M/N: 3160-07	19/11/12
	ETS Standard Gain Horn, M/N: 3160-08	19/11/12
	ETS Standard Gain Horn, M/N: 3160-09	08/02/14
	EMCO 6502 LOOP ANTENNA 9 kHz – 30 MHz Sn: 2021	29/11/11
	EMCO 93110B BICONICAL 20 - 300 MHz Sn. 96122801	02/05/12
	EMCO 93146A LOG PERIODIC 200 -1000MHz Sn. 98035033	17/01/12
	EMCO 3115 DOUBLE RIDGED HORN 1 - 18 GHz Sn: 8908-3282	12/01/12