



EMC Technologies (NZ) Ltd
PO Box 68-307, Newton
Auckland 1145
New Zealand
Phone 09 360 0862
Fax 09 360 0861
E-Mail Address: aucklab@ihug.co.nz
Web Site: www.emctech.com.au

TEST REPORT

ELPRO E2-950 UHF Module Transceiver

tested to the

Code of Federal Regulations (CFR) 47

Part 101 –Fixed Microwave Services

for

ELPRO Technologies Pty Ltd

This Test Report is issued with the authority of:

A handwritten signature in black ink, appearing to read "Andrew Cutler", is placed over a light blue rectangular background.

Andrew Cutler - General Manager



All tests reported
herein have been
performed in accordance
with the laboratory's
scope of accreditation

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EMC
Technologies

1. COMPLIANCE STATEMENT

The **ELPRO E2-950 UHF Transceiver** complies with the limits defined in 47 CFR Part 101 and 47 CFR Part 2 when tested in-accordance with the test methods described in 47 CFR Part 2 and ANSI / TIA-603-C.

2. RESULT SUMMARY

The results of testing carried out in September and October 2014 are summarised below.

Clause	Description	Result
2.1055 101.107	Frequency stability Frequency tolerance	Noted Complies
2.1049 2.202	Occupied bandwidth Bandwidths	Noted Noted
101.109 101.111	Bandwidth Emission limitations	Complies Complies
2.1046 101.113 (a)	RF power output Power and antenna height limits	Noted Noted
2.1051	Spurious emissions at antenna terminals	Complies
2.1053	Field strength of spurious radiation	Complies

3. ATTESTATION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification with the following conditions:

The client selected the test sample.

The report relates only to the sample tested.

This report does not contain corrections or erasures.

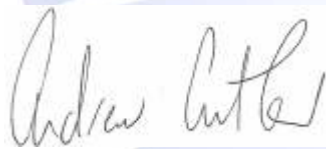
Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

To the best of my knowledge, these tests were performed using measurement procedures that are consistent with industry or Commission standards and demonstrate that the equipment complies with the appropriate standards.

I further certify that the necessary measurements were made by EMC Technologies NZ Ltd, 47 MacKelvie Street, Grey Lynn, Auckland, New Zealand.



Andrew Cutler
General Manager
EMC Technologies NZ Ltd

4. CLIENT INFORMATION

Company Name ELPRO Technologies Pty Ltd
Address 9/12 Billabong Street
City Stafford
State Queensland 4053
Country Australia
Contact Mr Robert Tsien

5. TEST SAMPLE DESCRIPTION

Brand Name ELPRO
Model Number E2-950
Product UHF Transceiver
Manufacturer ELPRO Technologies Pty Ltd
Manufactured in Australia
Serial Number 08140085
FCC ID 09P-E2-950

The device tested is a module transmitter that is intended for use in the FCC licensed bands between 932.5 - 952.0 MHz which would typically be covered by FCC parts 90 and 101.

Testing was carried out in order to gain Limited Modular Certification.

The device tested had the following specifications:

Rated Transmitter Output Power

5.0 Watts (37.0 dBm)

Transmitter Frequency Operating Range

932.5 - 952.0 MHz

FCC Band: Part 101:

932.5 - 935.0 MHz

941.0 - 941.5 MHz

941.5 - 944.0 MHz

Channel Spacing:

25.0 kHz

Emission Designators / Modes of operation:

16k0F1D – Data at a rate of 19200 bps

Test frequency

942.000 MHz

Power Supply

DC voltage supply 9-30 Vdc, typically 13.8 Vdc

Standard Temperature and Humidity

Temperature: +15°C to + 30° maintained.

Relative Humidity: 20% to 75% observed.

Standard Test Power Source

Standard Test Voltage: 13.8 Vdc

Extreme Temperature

High Temperature: + 50°C maintained.

Low Temperature: - 30 °C maintained.

Extreme Test Voltages

Low Voltage: 9.0 Vdc

High Voltage: 30.0 Vdc

6. TEST RESULTS

Part 101.107 - Frequency Tolerance

Frequency tolerance measurements were between - 30 °C and + 50°C in 10°C increments.

At each temperature the transmitter was given a period of 30 minutes to stabilise.

The transmitter was then turned on and the frequency error measured after a period of 1 minute while transmitting on 942.000 MHz.

Frequency Error (Hz)

Temperature	Voltage 9.0 Vdc	Voltage 13.8 Vdc	Voltage 30.0 Vdc
+50°C	-799.0	-801.0	-810.0
+40°C	-685.0	-688.0	-701.0
+30°C	-545.0	-573.0	-588.0
+20°C	-388.0	-415.0	-423.0
+10°C	-104.0	-124.0	-133.0
0°C	-90.0	-95.0	-101.0
-10°C	-138.0	-156.0	-161.0
-20°C	-178.0	-180.0	-185.0
-30°C	+52.0	+43.0	+31.0

Limit:

Part 101.107 states that transmitters operating in the following bands must meet the associate frequency tolerances.

Frequency (MHz)	Frequency Tolerance (%)
932.5 to 935.0	0.00025
941.0 to 941.5	0.00015
941.5 to 944.0	0.00025

The transmitter was tested on 942.000 MHz.

$$1.5 \text{ ppm} = 1.5 \times 942.000 = 1413 \text{ Hz.}$$

The worst case frequency tolerance was observed to be 810 Hz / 942 MHz = 0.86 ppm.

Result: Complies.

Measurement Uncertainty: ± 30 Hz.

Part 101.109 - Bandwidth:

This transmitter uses Frequency Shift Keying (FSK) for data transmission with an emission designation of F1D

The authorised bandwidth is taken to be the necessary bandwidth.

Measurements have been made to verify the declared bandwidth.

The occupied bandwidth has been measured and compared against the occupied bandwidth declared by the client of 16 kHz.

Measurements have been made of each modulation type using a spectrum analyser operating in peak hold mode and a 30 dB attenuator.

Initially power measurements are made using a resolution bandwidth of 120 kHz.

This level is used as a reference level on the spectrum analyser.

The resolution bandwidth is then changed to 100 Hz and the reference level minus 23 dB (99%) absolute bandwidth points determined.

Nominal Frequency: 942.000 MHz

Emission	Channel (kHz)	Measured (kHz)	Authorised Bandwidth (kHz)
F1D	25.0	11.75	20.0

Result: Complies.

Part 101.111 - Emission Limitations

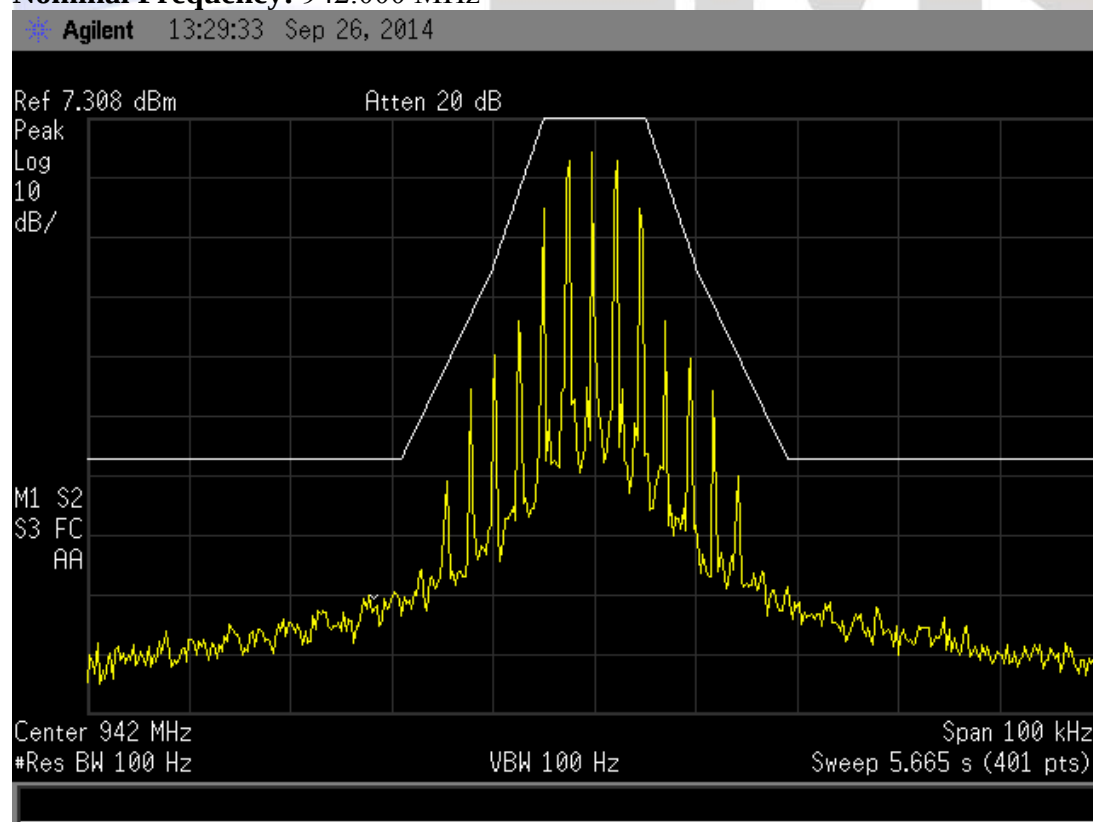
When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a bandwidth greater than 12.5 kHz, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

- (i) On any frequency removed from the centre of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz up to and including 10 kHz: At least $83 \log_{10} (f_d/5)$ decibels;
- (ii) On any frequency removed from the centre of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz up to and including 250 percent of the authorized bandwidth: At least $116 \log_{10} (f_d/6.1)$ decibels or 50 plus $10 \log_{10} (P)$ or 70 decibels, whichever is the lesser attenuation; and
- (iii) On any frequency removed from the centre of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 plus $10 \log_{10} (\text{output power in watts})$ decibels or 80 decibels, whichever is the lesser attenuation.

Measurements have been made whilst modulated with 9.6k symbols/sec modulation.

Initially power measurements are made using a spectrum analyser operating in peak hold mode and a 30 dB attenuator with a resolution bandwidth of 120 kHz. This level is used as a reference level on the spectrum analyser.

Nominal Frequency: 942.000 MHz



Result: Complies

Part 101.113(a) - RF power output

Measurements were carried out at the RF output terminals of the transmitter using a 30 dB power attenuator and a 50 Ω dummy load.

Measurements were carried out when the transmitter was not being modulated.

Testing was carried out at maximum rated power output of 5 watts (37 dBm) and a minimum rated power of 500 mW (27 dBm).

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
942.000	9.0	37.0	36.1
	13.8	37.0	36.1
	30.0	37.0	36.1
942.000	9.0	27.0	26.5
	13.8	27.0	26.5
	30.0	27.0	26.5

Limits:

The output power shall be within +/- 1 dB of the manufacturers rated power.

Result: Complies.

Measurement Uncertainty: ± 0.5 dB.

Part 2.1051 -Transmitter spurious emissions at the antenna terminals

Frequency: 942.000 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
544.300	-51.4	-20.0
931.300	-32.6	-20.0
1884.000	-48.4	-20.0
2825.000	<-70.0	-20.0
3768.000	-38.5	-20.0
4710.000	<-70.0	-20.0
5652.000	<-70.0	-20.0
6594.000	<-70.0	-20.0
7536.000	<-70.0	-20.0
8478.000	<-70.0	-20.0
9420.000	<-70.0	-20.0

Limit

Applied mask, on any frequency removed from the centre of the authorised bandwidth by a displacement frequency of more than 12.5 kHz shall be attenuated by at least $50 + 10 \log (P)$.

A rated power of 5.0 watts (37.0 dBm) gives a limit of -20 dBm.

The spectrum has been investigated up to the 10th harmonic of the transmitter.

Part 2.1051 states that emissions greater than 20 dB below the limit need not be specified.

Part 2.1057 states that the spectrum should be investigated up to the 10th harmonic if the transmitter operates below 10 GHz.

Result: Complies.

Measurement Uncertainty: ± 3.3 dB

Part 2.1053 - Field strength of the transmitter spurious emissions

Frequency: 942.000 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Antenna	Margin (dB)	Result
1884.0000	46.9	-50.5	-20.0	Vertical	30.5	Pass
1884.0000	46.9	-50.5	-20.0	Vertical	30.5	Pass
1884.0000	45.6	-51.8	-20.0	Horizontal	31.8	Pass
2826.0000	48.3	-49.1	-20.0	Vertical	29.1	Pass
2826.0000	48.0	-49.4	-20.0	Horizontal	29.4	Pass
3768.0000	54.2	-43.2	-20.0	Vertical	23.2	Pass
3768.0000	55.2	-42.2	-20.0	Horizontal	22.2	Pass
4710.0000	55.5	-41.9	-20.0	Vertical	21.9	Pass
4710.0000	54.8	-42.6	-20.0	Horizontal	22.6	Pass
5652.0000	57.9	-39.5	-20.0	Vertical	19.5	Pass
5652.0000	58.7	-38.7	-20.0	Horizontal	18.7	Pass
6594.0000	59.0	-38.4	-20.0	Vertical	18.4	Pass
6594.0000	59.0	-38.4	-20.0	Horizontal	18.4	Pass
7536.0000	54.0	-43.4	-20.0	Vertical	23.4	Pass
7536.0000	54.0	-43.4	-20.0	Horizontal	23.4	Pass
8478.0000	55.0	-42.4	-20.0	Vertical	22.4	Pass
8478.0000	55.0	-42.4	-20.0	Horizontal	22.4	Pass
9420.0000	57.0	-40.4	-20.0	Vertical	20.4	Pass
9420.0000	57.0	-40.4	-20.0	Horizontal	20.4	Pass

Device was tested on an open area test site at a distance of 3 metres.

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland. Details of this site have been filed with the Commission, Registration Number: 90838, which was last updated in June 2014

The level recorded is the signal generator output level in dBm less any gains / losses due to the coax cable and the dipole antenna.

Limit:

All spurious emissions are to be attenuated by at least $50 + 10 \log (P)$. The rated power of 5 watts gives a limit of -20 dBm.

No measurements were made above the 10th harmonic.

Result: Complies

Measurement Uncertainty: ± 4.1 dB

Part 1.1310 - Exposure of humans to RF fields

As per FCC KDB 447498 D01 and Section 2.1091 radio frequency transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels.

Calculations have been made using the General Public/Uncontrolled Exposure limits that are defined in Section 1.1310.

Minimum safe distances have been calculated below

- General Population /Uncontrolled exposure = 0.62 mW/cm^2 ($f/1500 = 932.5 \text{ MHz}/1500$)

As Part 101 certification is being sought for a number of bands between 932.5 - 944 MHz band this assessment has been carried out at 932.5 MHz which will give a worst case assessment.

$$\text{Power Density} = E^2/3770 = 0.62 \text{ mW/cm}^2$$

Therefore:

$$E = \sqrt{0.62 \times 3770}$$

$$E = 48.3 \text{ V/m}$$

The minimum distance from the antenna at which the MPE is met is calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain, transmitter duty cycle and separation distance in metres:

$$V/m = (\sqrt{(30 \times P \times G)}) / d$$

The rated maximum transmitter power = 5 watts.

The transmitter would typically be operated using number of antennas.

The highest gain antenna is a yagi antenna with a gain of 11 dBi (12.6).

It has been assumed that the transmitter can be used with a duty cycle of 100%.

Therefore

$$d = \sqrt{(30 \times P \times G \times DC)} / E$$

$$d = \sqrt{(30.0 \times 5.0 \times 12.6 \times 1.0)} / 48.3$$

$$d = 0.90 \text{ metres or } 90 \text{ cm}$$

Result: Transmitter will comply if the safe distance calculated above is applied..

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal Due	Interval
Aerial Controller	EMCO	1090	9112-1062	3710	N/a	N/a
Aerial Mast	EMCO	1070-1	9203-1661	3708	N/a	N/a
Turntable	EMCO	1080-1-2.1	9109-1578	3709	N/a	N/a
VHF Balun	Schwarzbeck	VHA9103	-	3603	12/01/2015	3 years
Biconical Antenna	Schwarzbeck	BBA 9106	-	3612	12/01/2015	3 years
Log Periodic Antenna	Schwarzbeck	VUSLP 91111	9111-228	3785	12/01/2015	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	04/06/2017	3 years
Receiver	Rohde & Schwarz	ESIB-40	100171	EMC4003	29/01/2015	1 year
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a	N/a
Signal Generator	Rohde & Schwarz	SMHU	838923/028	E1493	22/01/2015	2 years
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	RFS 3776	26/02/2015	1 year
Thermal chamber	Contherm	M180F	86025	E1129	01/06/2015	N/a
Thermometer	DSIR	RT200	035	E1049	01/06/2015	N/a

At the time of testing all test equipment was within calibration.

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies Ltd registration with the Federal Communications Commission as a listed facility, registration number: 90838, which was updated in June 2014.

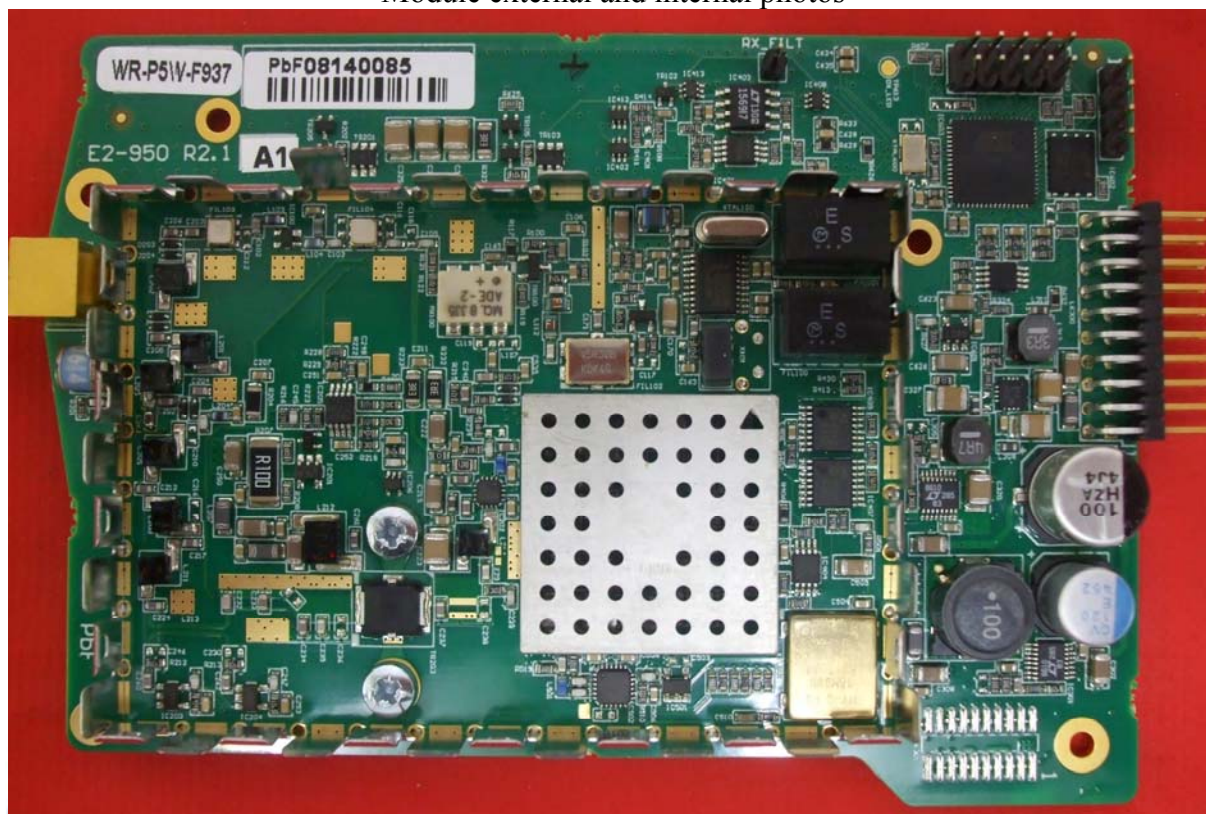
All testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

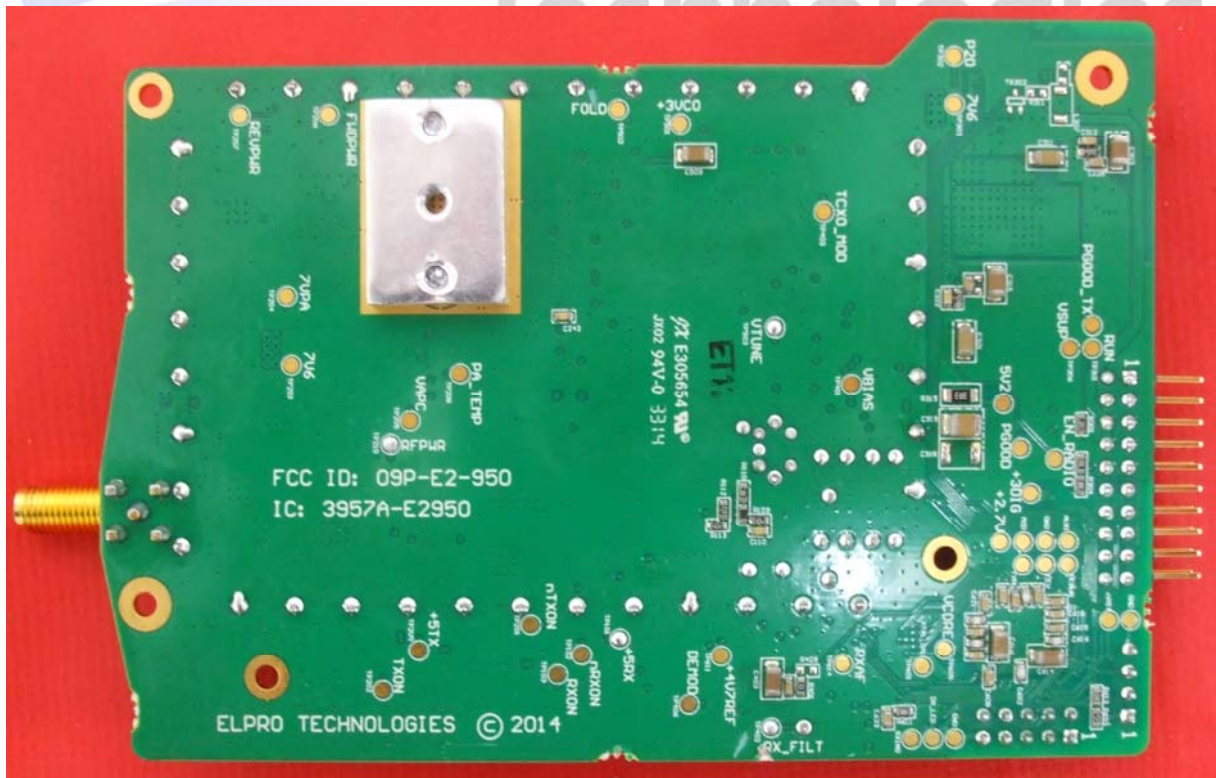
All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

9. PHOTOGRAPHS

Module external and internal photos







Radiated emissions test setup

