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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 written 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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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-D-2010.

2. RESULT SUMMARY

The results of testing carried out in September 2016 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 Complies
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 Harry Courtice

5. TEST SAMPLE DESCRIPTION

Brand Name ELPRO
Model Number E2-950
Product UHF Transceiver
Manufacturer ELPRO Technologies Pty Ltd
Manufactured in Australia
Serial Number 06160380
FCC ID O9P-E2-950



The device tested is a module transmitter that is intended for use in the FCC licensed bands that has previously been certified to FCC parts 90 and 101 between 932.5 - 952.0 MHz.

Class 2 permissive change testing was carried out in order to extend the frequency range of the Limited Modular Certification to 928 – 954 MHz

The device tested had the following specifications:

Rated Transmitter Output Power

5.0 Watts (37.0 dBm)

Transmitter Frequency Operating Range

928.0 - 954.0 MHz

FCC Band(s): Part 101:

928.0 - 929.0 MHz
932.5 - 935.0 MHz
941.0 - 941.5 MHz
941.5 - 944.0 MHz
952.0 - 954.0 MHz

Channel Spacing:

25.0 kHz

Emission Designators / Modes of operation:

16k0F1D – Data at a rate of 19200 bps using 4FSK and a symbol rate of 9600.

Test frequencies

928.100 MHz, 953.900 MHz

Power Supply

DC voltage supply between 9 - 30 Vdc

Standard Temperature and Humidity

Temperature: +15°C to +30° maintained.
Relative Humidity: 20% to 75% observed.

Standard Test Power Source

Standard Test Voltage: 24.0 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 in Hz was measured as detailed below after a period of 1 minute while transmitting on 928.100 MHz and 953.900 MHz.

Operating Frequency: 928.100 MHz

Temperature	Voltage 9.0 Vdc	Voltage 24.0 Vdc	Voltage 30.0 Vdc
+50°C	-106	-163	-175
+40°C	+52	-45	+59
+30°C	+28	+52	+55
+20°C	-13	+150	-8
+10°C	+190	+258	+319
0°C	+88	+89	+82
-10°C	+86	+113	+120
-20°C	+26	-44	-44
-30°C	+116	+11	+24

Operating Frequency: 953.900 MHz

Temperature	Voltage 9.0 Vdc	Voltage 24.0 Vdc	Voltage 30.0 Vdc
+50°C	-33	-25	+51
+40°C	-207	-180	-250
+30°C	+25	+65	+66
+20°C	+19	+78	+78
+10°C	+360	+289	+267
0°C	+101	+120	+115
-10°C	+105	+122	+177
-20°C	+26	+51	+52
-30°C	+96	+101	+88

Limit:

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

Frequency (MHz)	Frequency Tolerance (%)
928.0 to 929.0	0.00015
932.5 to 935.0	0.00025
941.0 to 941.5	0.00015
941.5 to 944.0	0.00025
952.0 – 960.0	0.00015

The transmitter was tested on 928.100 MHz and 953.900 MHz.

1.5 ppm for 928.100 MHz is 1392 Hz

When tested on 928.1 MHz the worst case frequency error was observed to be:

$258 \text{ Hz} / 928.1 \text{ MHz} = 0.27 \text{ ppm}$

1.5 ppm for 953.900 MHz is 1430 Hz

When tested on 953.9 MHz a worst case frequency error was observed to be:

$360 \text{ Hz} / 953.9 \text{ MHz} = 0.37 \text{ ppm}$

Result: Complies.

Measurement Uncertainty: $\pm 30 \text{ Hz}$.



Part 101.109 - Bandwidth:

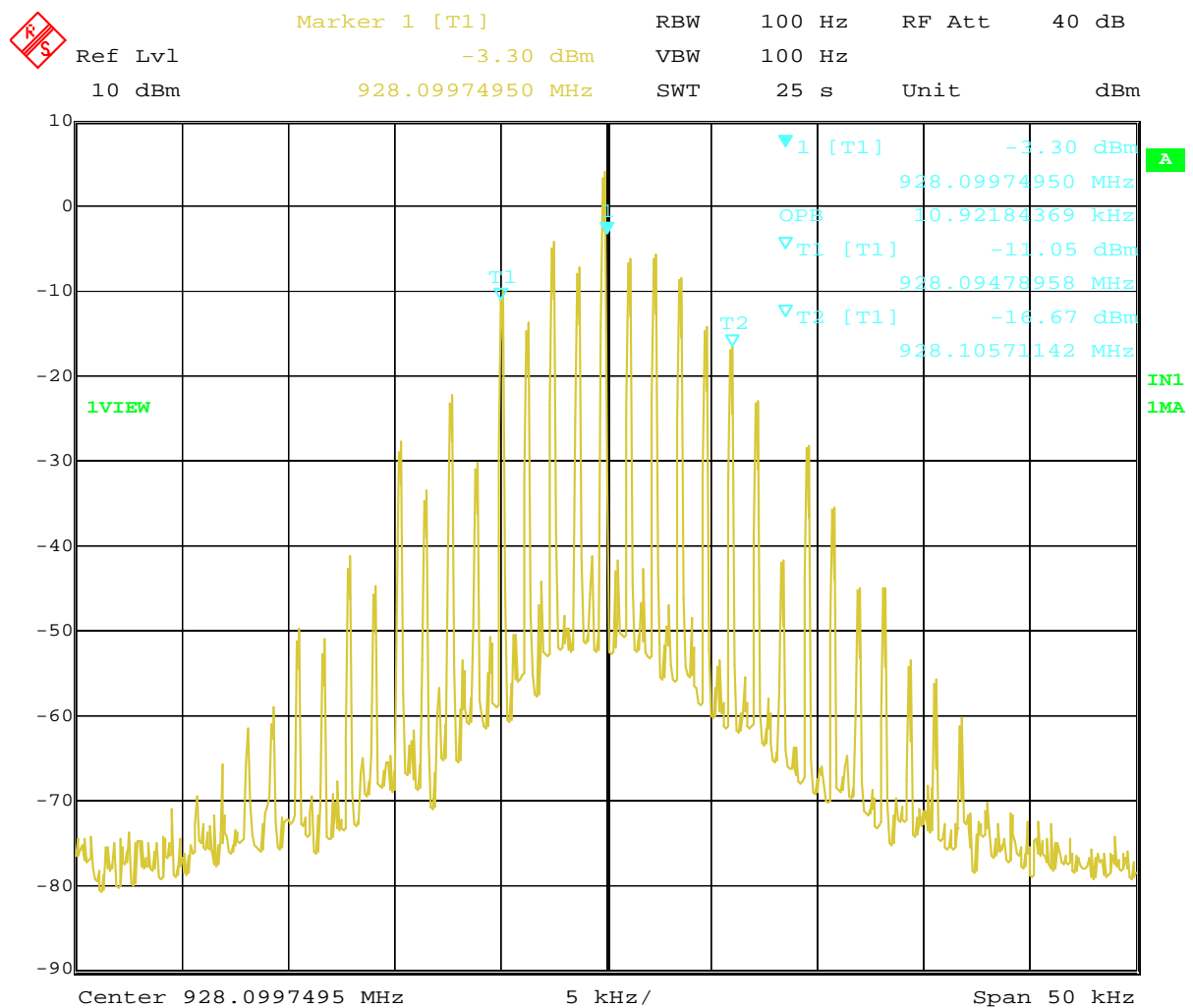
This transmitter uses Frequency Shift Keying (FSK) for data transmission at 19200 bps using 4FSK.

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

Measurements have been made using spectrum analyser with the occupied bandwidth function activated.

Nominal Frequency: 928.100 MHz


Emission	Channel (kHz)	Measured (kHz)	Authorised Bandwidth (kHz)
F1D	25.0	10.9218	20.0

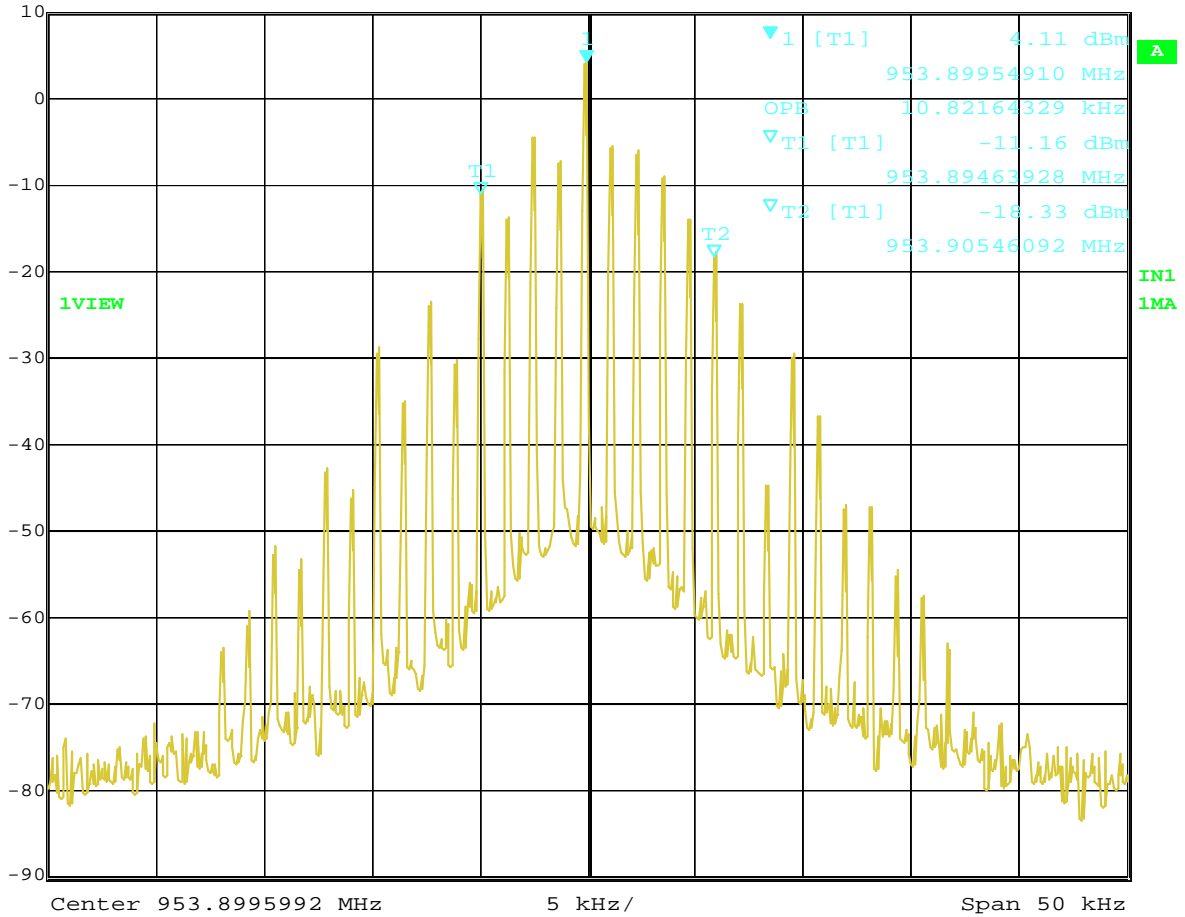


Date: 1.JAN.1997 01:20:09

Nominal Frequency: 953.900 MHz

Emission	Channel (kHz)	Measured (kHz)	Authorised Bandwidth (kHz)
F1D	25.0	10.8216	20.0


 Marker 1 [T1] RBW 100 Hz RF Att 40 dB
 Ref Lvl 4.11 dBm VBW 100 Hz
 10 dBm 953.89954910 MHz SWT 25 s Unit dBm



Date: 1.JAN.1997 01:22:58

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;

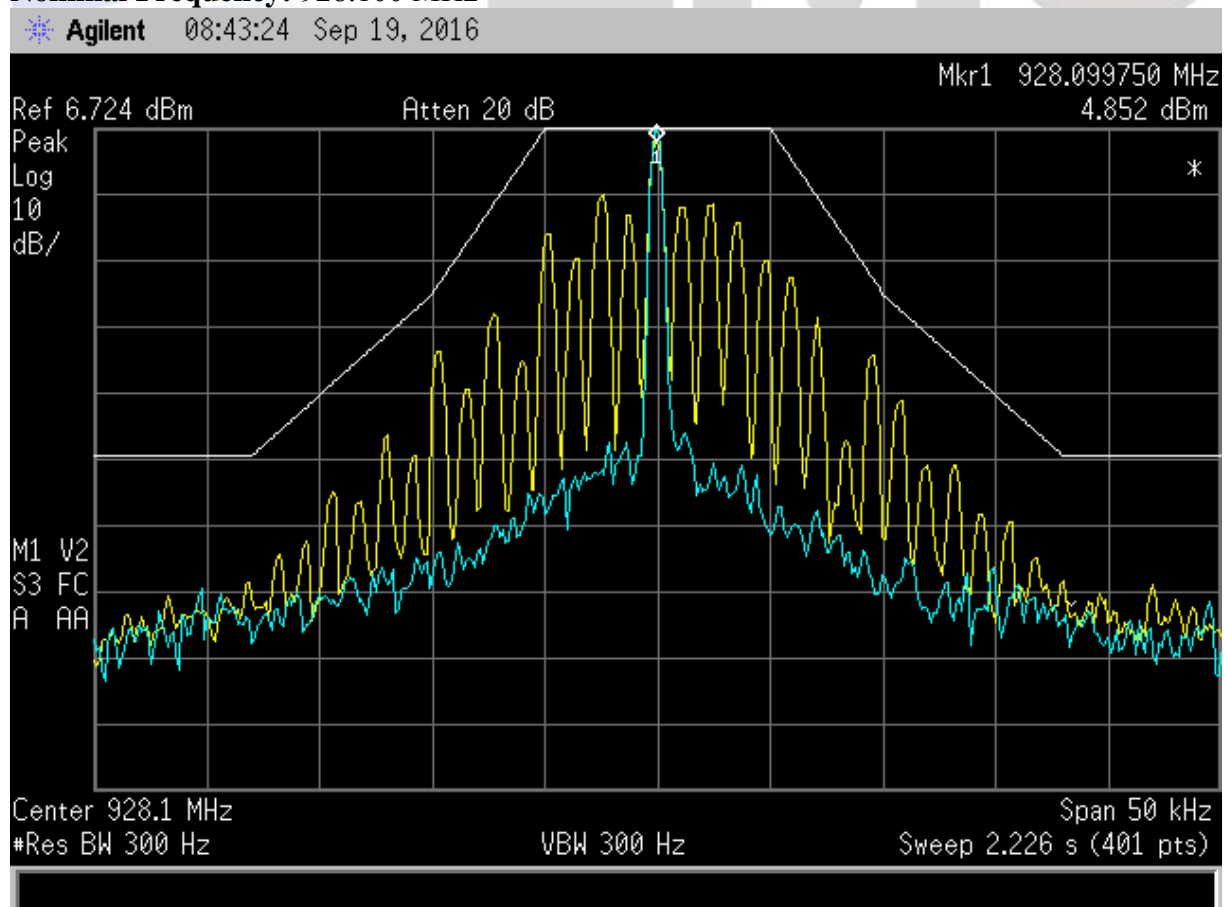
(ii) On any frequency removed from the centre of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz up to and including 250 percent of the authorized bandwidth: At least $116 \log_{10}(f_d/6.1)$ decibels or 50 plus $10 \log_{10}(P)$ or 70 decibels, whichever is the 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.

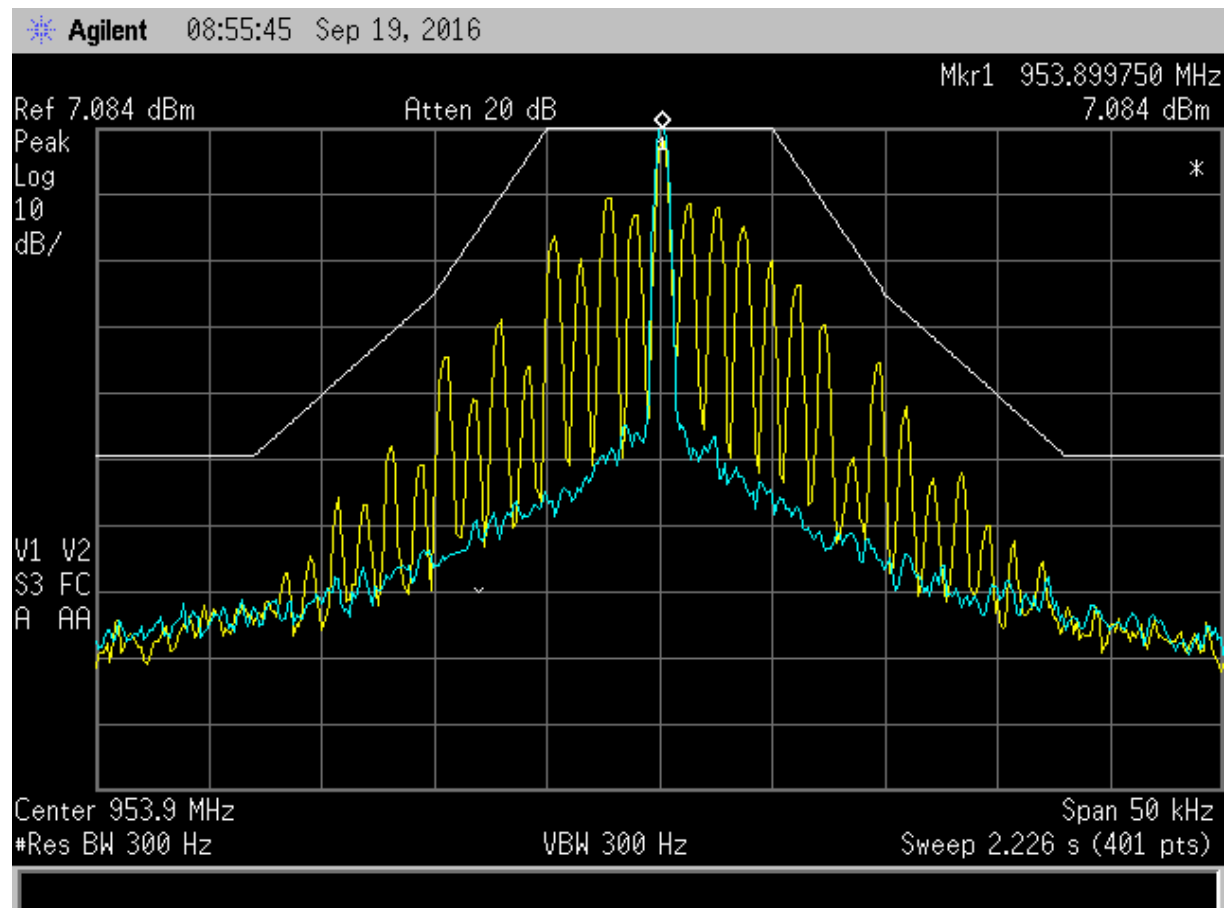
Measurements have been made when the transmitter was operating with a data rate of 19200 bps using 4FSK.

The spectrum analyser reference level was set when the transmitter was configured to transmit an un-modulated carrier with is shown as the blue trace.

Nominal Frequency: 928.100 MHz



Nominal Frequency: 953.900 MHz



Result: Complies

Technologies

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 being modulated with a data rate of 19600 bps using 4FSK and also using an un-modulated carrier with the worst case result being recorded below.

Testing was carried out at maximum rated power output of 5 watts (37 dBm).

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
928.100	9.0	37.0	36.7
	24.0	37.0	36.7
	30.0	37.0	36.7
953.900	9.0	37.0	37.0
	24.0	37.0	37.0
	30.0	37.0	37.0

Limits:

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

Result: Complies.

Measurement Uncertainty: ± 0.5 dB.

EMC
Technologies

Part 2.1051 -Transmitter spurious emissions at the antenna terminals

Measurements were carried out when the transmitter was being modulated with a data rate of 19600 bps using 4FSK and also using an un-modulated carrier with the worst case result being recorded below.

Frequency: 928.100 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
1856.200	-48.1	-20.0
2784.300	-39.6	-20.0
3712.400	-35.1	-20.0
4640.500	-55.0*	-20.0
5568.600	-48.2	-20.0
6496.700	-51.4	-20.0
7424.800	-55.0*	-20.0
8352.900	-55.0*	-20.0
9281.000	-55.0*	-20.0

Frequency: 953.900 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
1907.800	-49.3	-20.0
2861.700	-42.7	-20.0
3815.600	-35.2	-20.0
4769.500	-55.0*	-20.0
5723.400	-48.5	-20.0
6677.300	-50.2	-20.0
7631.200	-55.0*	-20.0
8585.100	-55.0*	-20.0
9539.000	-55.0*	-20.0

* Noise floor measurement

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: 928.100 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Antenna	Margin (dB)	Result
1856.2000	54.0	-43.4	-20.0	Vertical	23.4	Pass
	46.4	-51.0	-20.0	Horizontal	31.0	Pass
2784.3000	57.8	-39.6	-20.0	Vertical	19.6	Pass
	52.2	-45.2	-20.0	Horizontal	25.2	Pass
3712.4000	57.8	-39.6	-20.0	Vertical	19.6	Pass
	56.7	-40.7	-20.0	Horizontal	20.7	Pass
4640.5000	47.0*	-50.4	-20.0	Vertical	30.4	Pass
	47.0*	-50.4	-20.0	Horizontal	30.4	Pass
5568.6000	52.2	-45.2	-20.0	Vertical	25.2	Pass
	52.1	-45.3	-20.0	Horizontal	25.3	Pass
6496.7000	51.2	-46.2	-20.0	Vertical	26.2	Pass
	50.0*	-47.4	-20.0	Horizontal	27.4	Pass
7424.8000	50.0*	-47.4	-20.0	Vertical	27.4	Pass
	50.0*	-47.4	-20.0	Horizontal	27.4	Pass
8352.9000	50.0*	-47.4	-20.0	Vertical	27.4	Pass
	50.0*	-47.4	-20.0	Horizontal	27.4	Pass
9281.0000	50.0*	-47.4	-20.0	Vertical	27.4	Pass
	50.0*	-47.4	-20.0	Horizontal	27.4	Pass

Frequency: 953.900 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Antenna	Margin (dB)	Result
1907.8000	54.3	-43.1	-20.0	Vertical	23.1	Pass
	48.1	-49.3	-20.0	Horizontal	29.3	Pass
2861.7000	58.0	-39.4	-20.0	Vertical	19.4	Pass
	54.1	-43.3	-20.0	Horizontal	23.3	Pass
3815.6000	56.8	-40.6	-20.0	Vertical	20.6	Pass
	54.8	-42.6	-20.0	Horizontal	22.6	Pass
4769.5000	47.0*	-50.4	-20.0	Vertical	30.4	Pass
	47.0*	-50.4	-20.0	Horizontal	30.4	Pass
5723.4000	54.1	-43.3	-20.0	Vertical	23.3	Pass
	50.7	-46.7	-20.0	Horizontal	26.7	Pass
6677.3000	50.0*	-47.4	-20.0	Vertical	27.4	Pass
	50.0*	-47.4	-20.0	Horizontal	27.4	Pass
7631.2000	50.0*	-47.4	-20.0	Vertical	27.4	Pass
	50.0*	-47.4	-20.0	Horizontal	27.4	Pass
8585.1000	50.0*	-47.4	-20.0	Vertical	27.4	Pass
	50.0*	-47.4	-20.0	Horizontal	27.4	Pass
9539.0000	50.0*	-47.4	-20.0	Vertical	27.4	Pass
	50.0*	-47.4	-20.0	Horizontal	27.4	Pass

* Noise floor measurement

Measurements were carried out when the transmitter was being modulated with a data rate of 19600 bps using 4FSK and also using an un-modulated carrier with the worst case result being recorded.

Only harmonic spurious emissions were detected from the transmitter.

The 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:

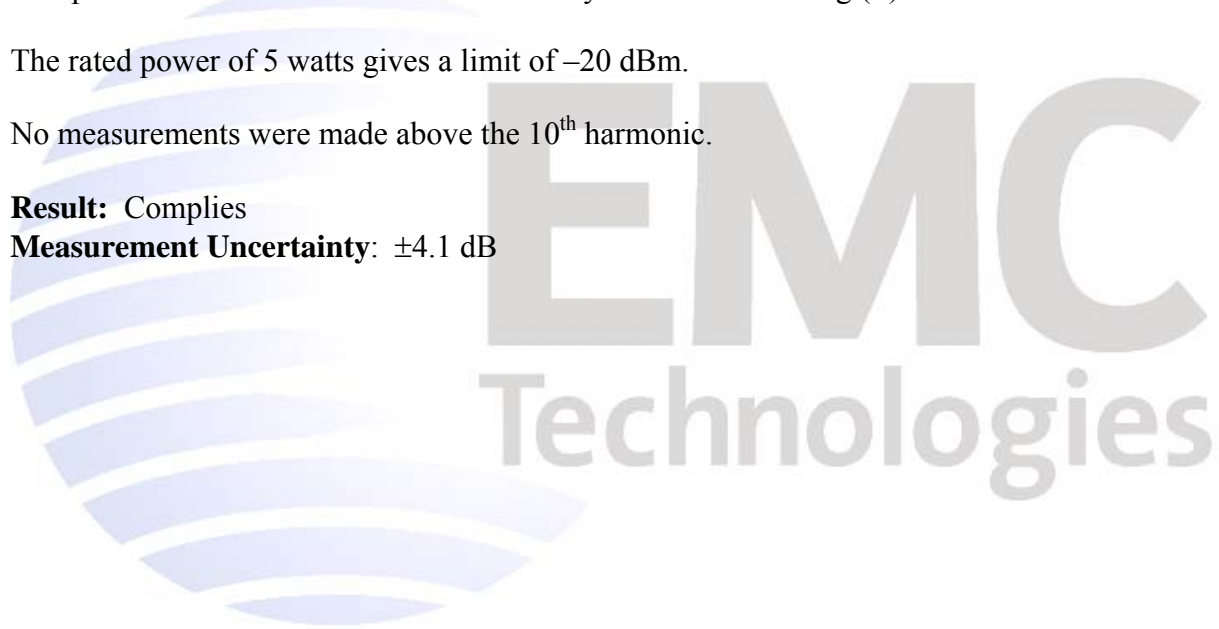
All spurious emissions are to be attenuated by at least $50 + 10 \log (P)$.

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 Section 1.1310 and Section 2.1091 certification of this transmitter is sought using the General Public / Uncontrolled exposure limits as detailed in OST/OET Bulletin Number 65 as the transmitter could be used in a base station / fixed environment using a power output of 5 watts.

In accordance with Section 1.1310 the following Maximum Permissible Exposure (MPE) power density limits have been applied:

- General Population /Uncontrolled exposure = $0.619 \text{ mW/cm}^2 (f/1500 = 928 \text{ MHz}/1500)$

As Part 101 certification is being sought for a number of bands between 928 - 954 MHz this assessment has been carried out at 928 MHz which will give a worst case assessment.

$$\text{MPE} = E^2/3770 = 0.619 \text{ mW/cm}^2$$

Therefore:

$$E = \sqrt{0.619 * 3770}$$

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

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:

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

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

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

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

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

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
Biconical Antenna	Schwarzbeck	BBA 9106	-	3612	03Feb 2018	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	04 June 2017	3 years
Log Periodic Antenna	Schwarzbeck	VUSLP 9111	9111-228	3785	17 Dec 2017	3 years
Power Attenuator	JFW	50FH-030-100	-	-	N/a	N/a
Receiver	Rohde & Schwarz	ESIB-40	100171	4003	16 April 2017	1 year
Thermal chamber	Contherm	M180F	86025	E1129	01 Dec 2016	6 months
Thermometer	DSIR	RT200	035	E1049	01 Dec 2016	6 months
Turntable	EMCO	1080-1-2.1	9109-1578	3709	N/a	N/a
VHF Balun	Schwarzbeck	VHA9103	-	3603	03 Feb 2018	3 years

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.

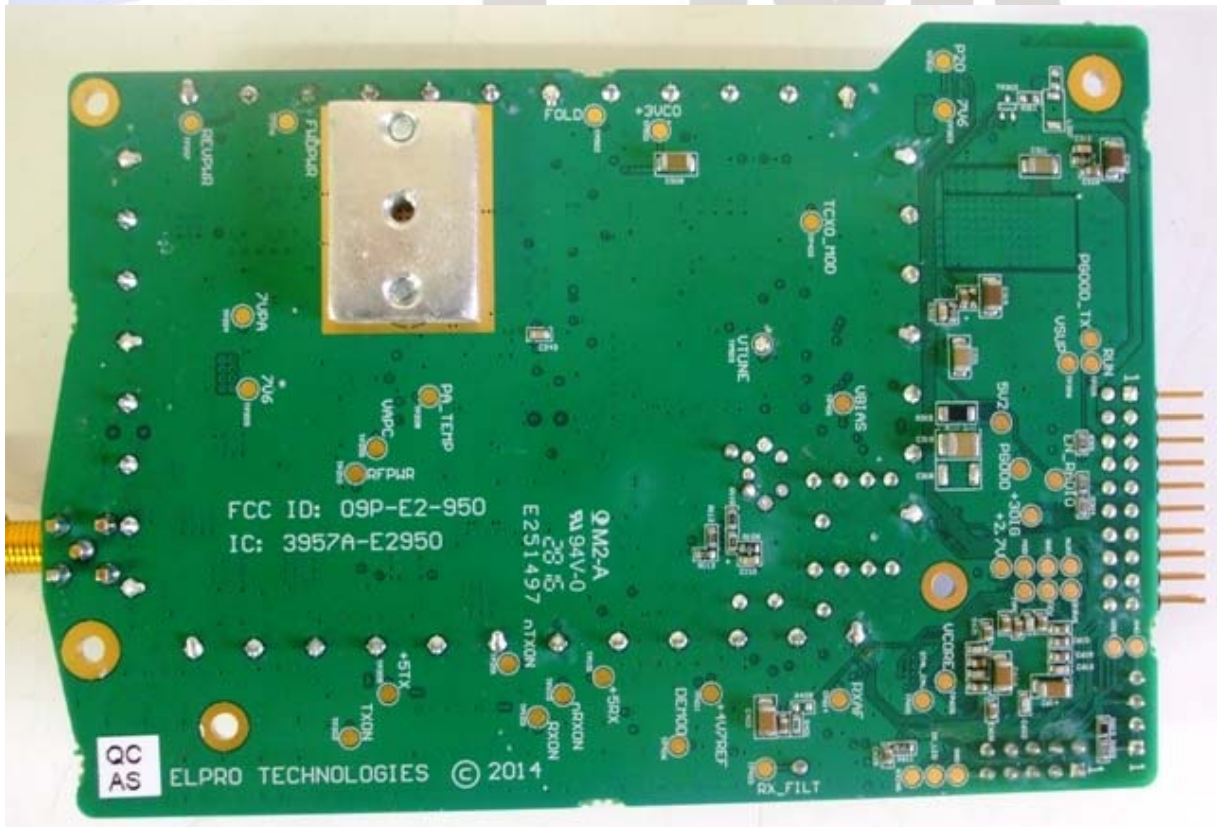
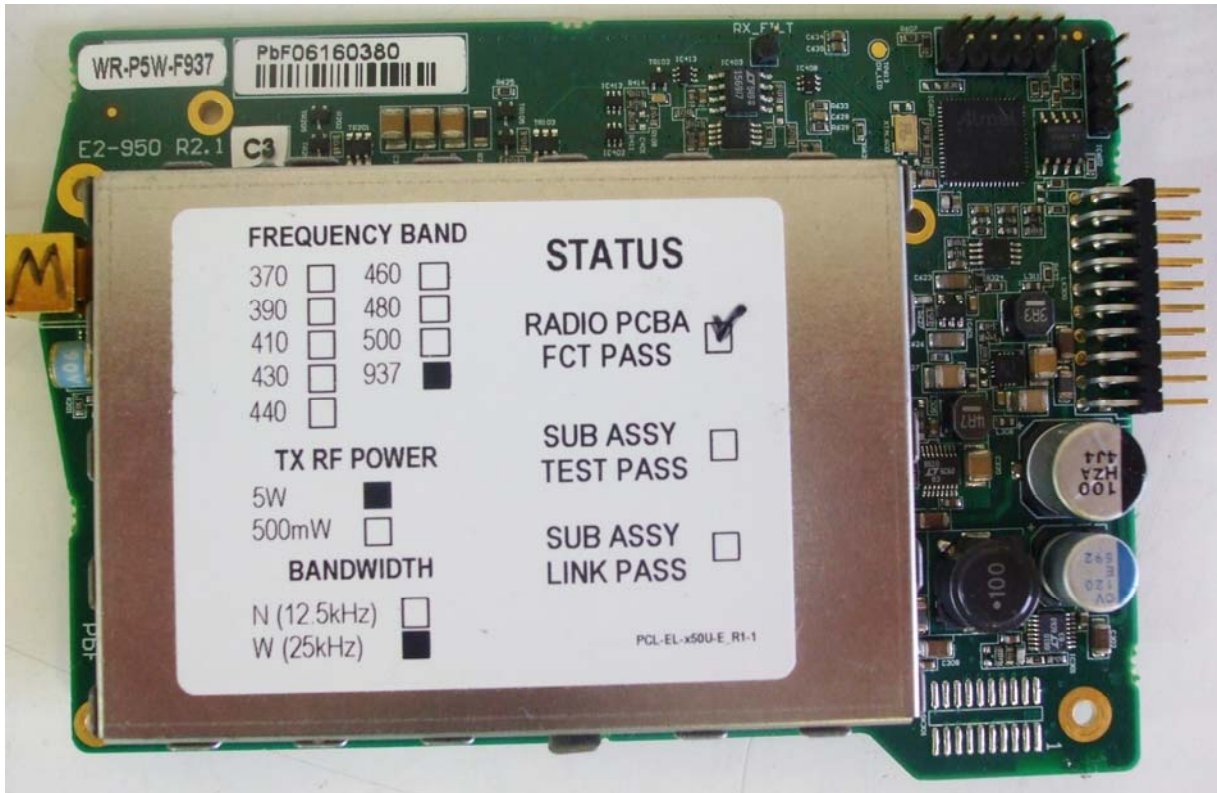
All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

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.

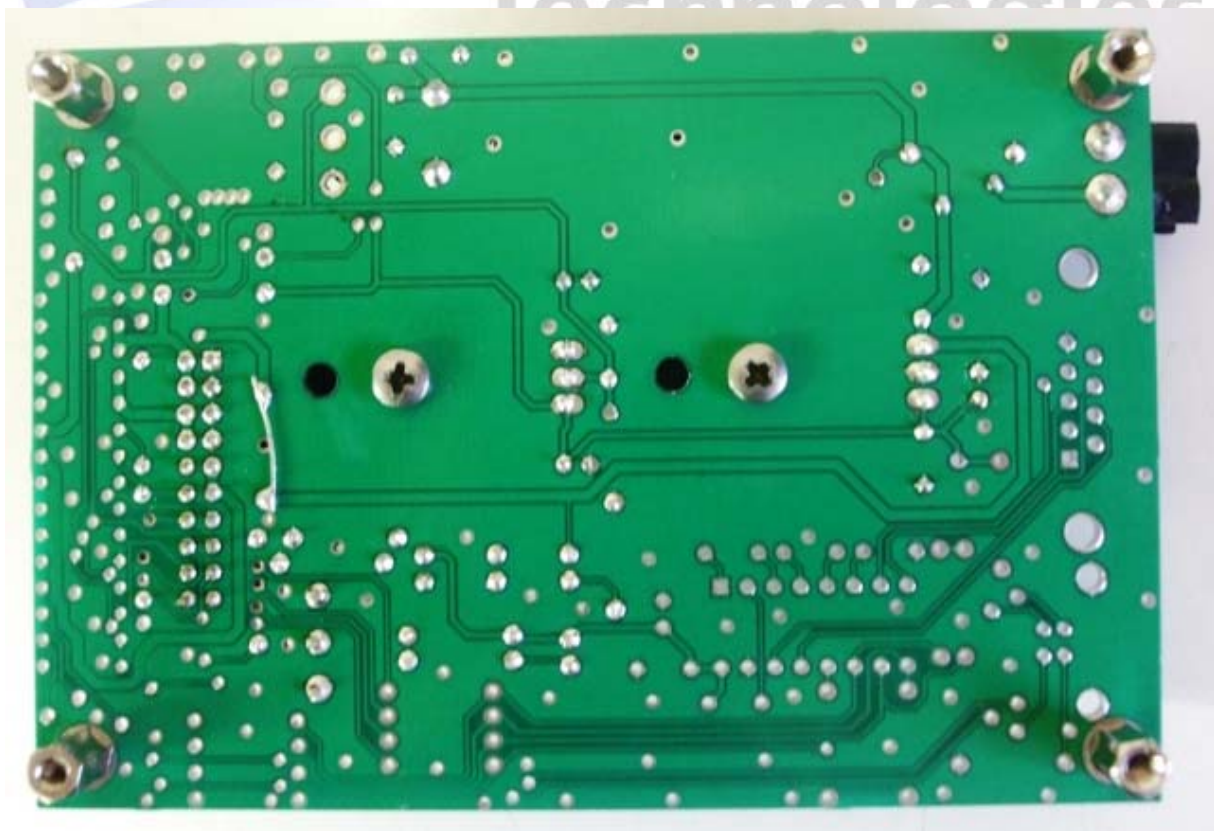
9. PHOTOGRAPHS

Module external and internal photos





Internal photos of the exercise unit



Radiated emissions test setup

