EMC Technologies (NZ) Ltd

Test Report No **80428.1**
Report date: 7 May 2008

TEST REPORT

ELPRO P150H VHF Base Station Transceiver

tested to the

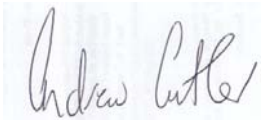
Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

Part 15 – Radio Frequency Devices

for

ELPRO Technologies Pty Ltd



This Test Report is issued with the authority of:

Andrew Cutler - General Manager

EMC Technologies (NZ) Ltd

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1. CLIENT INFORMATION

Company Name	ELPRO Technologies PTY Ltd
Address	Unit 9/12 Billabong Street
City	Stafford
State	Queensland 4053
Country	Australia
Contact	Mr John White

2. DESCRIPTION OF TEST SAMPLE

Brand Name	ELPRO
Model Number	P150H
Product	VHF Base Station Transceiver
Manufacturer	ELPRO Technologies PTY Ltd
Manufactured in	Australia
Serial Number	09071304, 09071305
FCC ID	O9PP150H

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3. COMPLIANCE STATEMENT & RESULT SUMMARY

The **ELPRO P150H VHF Base Station Transceiver** complies with the limits defined in 47 CFR Part 15, 47 CFR Part 90 and 47 CFR Part 2 when tested in-accordance with the test methods described in 47 CFR Part 2 and ANSI C63.4, 2003.

CLAUSE	TEST PERFORMED	RESULT
90.203	Certification required	Complies
2.1046	RF power output	Noted
90.205	Power and antenna height limits	Complies
2.1047	Modulation Characteristics	
2.1047(a)	Low pass filter response	Complies
2.1047(b)	Modulation limiting characteristics	Complies
90.211(a)	Modulation characteristics	Complies
2.1049	Occupied bandwidth	Noted
2.202	Bandwidths	Noted
90.207	Types of emissions	Complies
90.209	Bandwidth limitations	Complies
90.210	Emission masks	Complies
2.1051	Spurious emissions at antenna terminals	Complies
2.1053	Field strength of spurious radiation	Complies
2.1055	Frequency stability	Noted
90.213	Frequency stability	Complies
90.214	Transient frequency behaviour	Complies
15.109	Radiated emission limits	Complies
15.111	Antenna conducted power measurement	Complies

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4. TEST SAMPLE DESCRIPTION

The sample tested has the following specifications:

Rated Transmitter Output Power

5.0 Watts (37.0 dBm)

FCC Transmitter frequency range

150.0 to 174.0 MHz

Test frequency

Frequency MHz	Power Watts	Spacing kHz
174.000	5.0	12.5

FCC Bands

Part 90: 150 to 174 MHz

Emission Designators / Modes of operation

11k2F3E – Analogue speech
8k50F1D – Data communications

Power Supply

DC voltage supply at 12.0 Vdc.

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5. TEST CONDITIONS

Standard Temperature and Humidity

Temperature Range: +18°C to 30°C

Relative Humidity Range: 20% to 75%

Standard Test Power Source

Standard Test Voltage: 12.0 Vdc.

Extreme Temperature

High Temperature: + 50°C maintained.
Low Temperature: - 30 °C maintained.

Extreme Test Voltages

Low Voltage: 10.2 Vdc.
High Voltage: 13.8 Vdc.

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6. ATTESTATION

The **ELPRO P150H VHF Base Station Transceiver** complies with the Code of Federal Regulations (CFR) 47 Part 90 – Private Land Mobile Services and Part 15 – Radio Frequency Devices.

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.

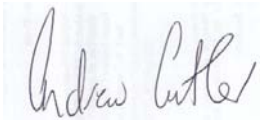
This report does not contain corrections or erasures.

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.

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

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7. TEST RESULTS

Certification required

Certification of this device is sought for analogue speech transmissions using 12.5 kHz channel spacing.

12.5 kHz channel bandwidth certification is sought for this transmitter under section 90.203(j)(3) as:

- certification has been sought after February 14, 1997 and before January 1, 2011.

- the equipment meets the spectrum efficiency standard of one voice channel per 12.5 kHz of channel bandwidth

Result: Complies.

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RF power output

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

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

Measurements were made with the input voltage set to 12.0 Vdc and when varied +/- 15%.

Testing was carried out at maximum power output.

Frequency	Voltage (Vac)	Rated (dBm)	Measured (dBm)
174.000	10.2	37.0	36.9
	12.0	37.0	36.9
	13.8	37.0	37.0

Limits:
Clause 90.205(d) of Part 90 specifies (d) 150-174 MHz. The maximum allowable station ERP is dependent upon the station's antenna HAAT and required service area

Result: Complies
Measurement Uncertainty: ±0.5 dB

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Modulation Characteristics

This transmitter is capable of producing analogue speech modulations.

(a) Frequency response of the audio frequency low pass filter between 100 Hz and 15 kHz.

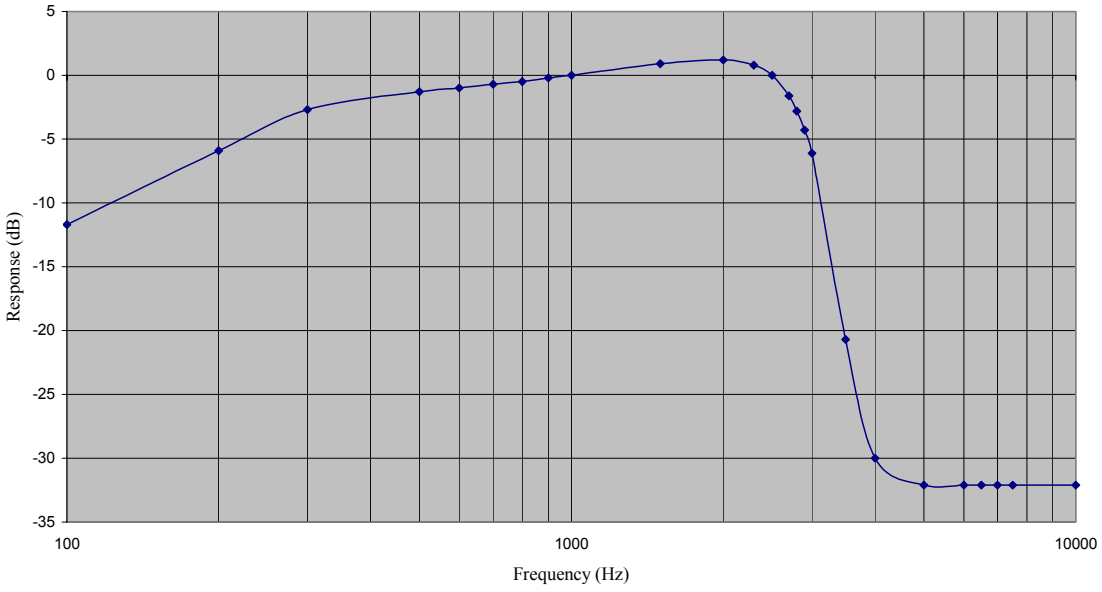
This measurement was carried out using an audio signal generator and an audio modulation analyser.

At 1 kHz an audio signal was applied which was used as a 0 dB response reference.

The frequency of the input signal was then varied and the output response noted. This measurement was carried out from 100 Hz to 5000 Hz as required by Part 2 with further measurements carried out in order to show the full range of this filter.

The -3 dB roll off was measured to be approximately 2.9 kHz with reference the 1 kHz level.

Audio input response



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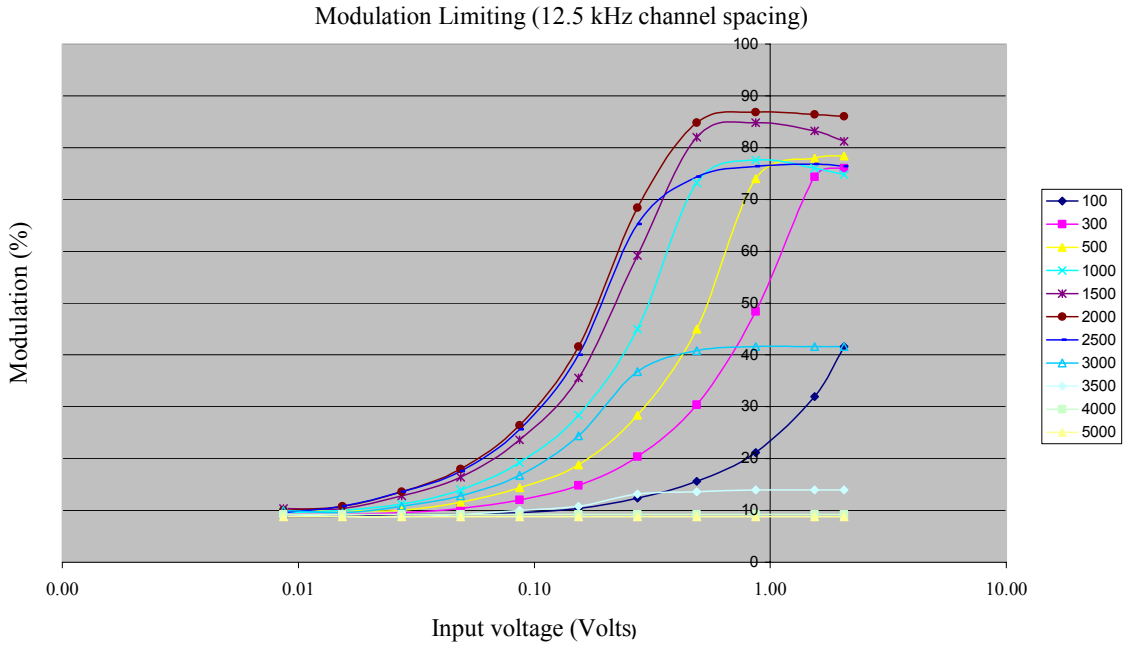
(b) A family of curves showing the percentage of modulation versus the modulation input voltage.

Measurements were made between 100 Hz to 5 kHz.

At each frequency the input voltage was slowly increased with the resulting frequency deviation of the transmitter being recorded.

This deviation was then converted to a modulation percentage where 2.5 kHz deviation is 100% for 12.5 kHz channels.

The maximum 12.5 kHz deviation was 2.17 kHz when a 2 kHz input tone was applied.



(d) A curve or equivalent data that shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

Limit:
Part 90.211 – Modulation requirements states the transmitter must meet the emission requirements of 90.210. Refer to the Occupied Bandwidth measurements in this report.

Result: Complies
Measurement Uncertainty: ±1%.

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Emission types:

The following emission types have been declared by the customer as being used:

- F3E: Frequency modulation with analogue speech
-
- F1D: Frequency shift keying for data communications

Bandwidth limitations:

Analogue Modulation

Using the formulas contained in Part 2.202 the necessary bandwidth calculation for 12.5 kHz channel spacing is:

$B_n = 2 \times D + 2 \times M$

In theory for 12.5 kHz channels
Where D = maximum deviation: 2.5 kHz.
Where M = maximum modulation frequency: 3 kHz.
$B_n =$ 11.00 kHz

When measured
Where D = maximum measured deviation: 2.17 kHz
Where M = low pass filter roll off: 2.9 kHz
$B_n =$ 10.14 kHz

This is confirmed in the emission designations, 11k0F3E as declared by the client.

Result: Complies

Data modulation

The customer has declared that the authorised bandwidth to be 8.5 kHz when using FID.

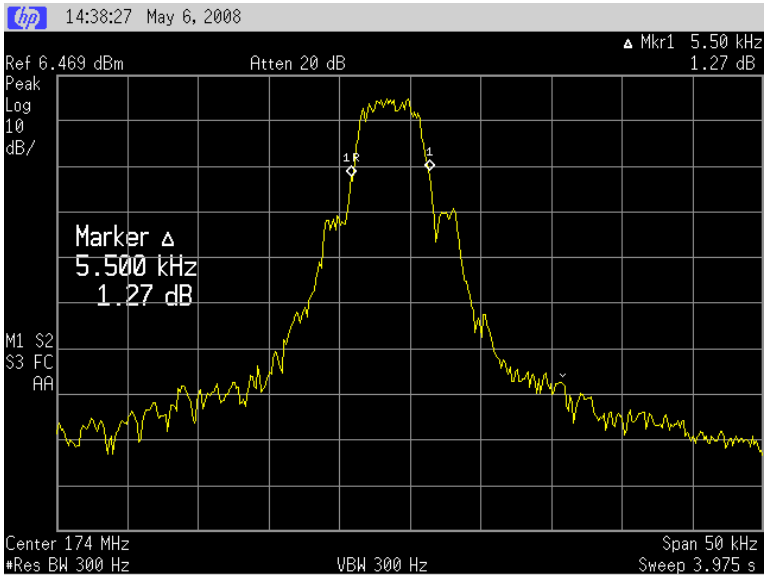
Using the formulas contained in Part 2.202 and information supplied by the client the necessary bandwidth calculation for data transmission is:

$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 1.5 kHz.
Where M = maximum modulation frequency: 2.4 kHz.
$B_n = 7.8$ kHz

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 300 Hz and the reference level minus 23 dB (99%) absolute bandwidth points determined



The declared bandwidth has been confirmed even though it is slightly higher that the calculated and measured necessary bandwidth and therefore allows for measurement uncertainties.

Result: Complies

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Spectrum masks

The spectrum masks are defined in:

Section 90.210(d) – Mask D has been applied as this transmitter can operate in the band 150 to 174 MHz using an authorised bandwidth of 11.25 kHz as per Section 90.209(b)(5) and it has a low pass audio filter installed.

The reference level for the following emission mask measurements has been determined using a resolution bandwidth of 120 kHz with the transmitter modulated.

All measurements have been made with a 30 dB attenuator being placed between the transmitter and the spectrum analyser.

Measurements were made in peak hold with the transmitter operating on 174.000 MHz.

When operating in F3E mode a 2500 Hz tone, which was found to be the frequency of maximum response, was applied at a level 16 dB higher than that required to achieve 50% modulation.

When operating in F1D mode the radio was configured in order that the modulation was internally generated for test purposes.

Result: Complies

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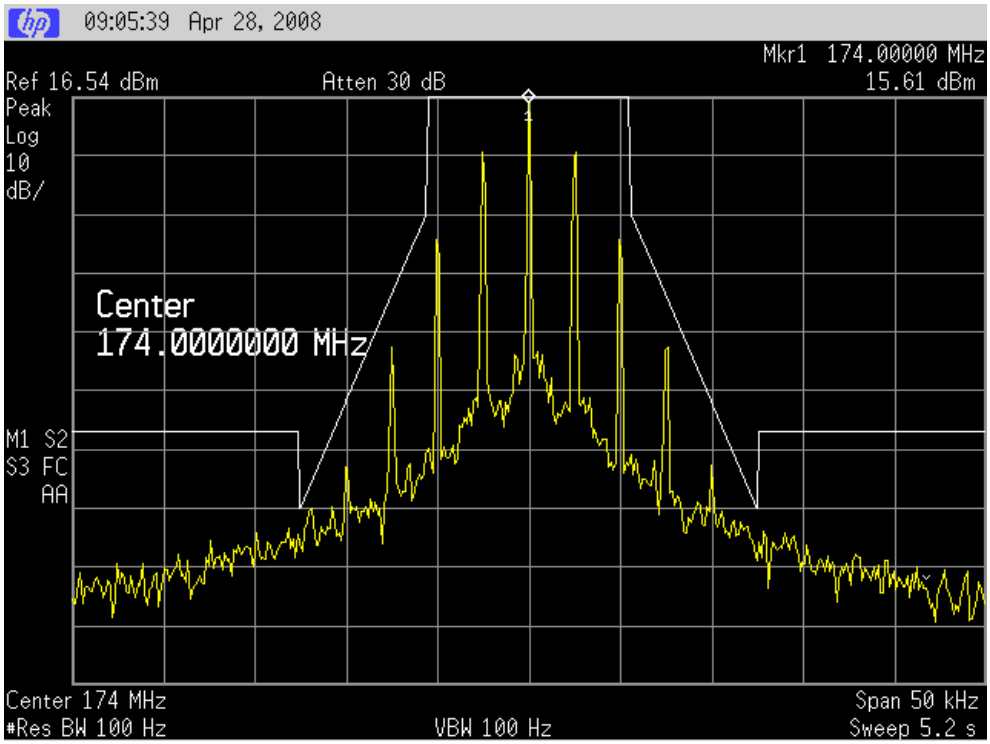
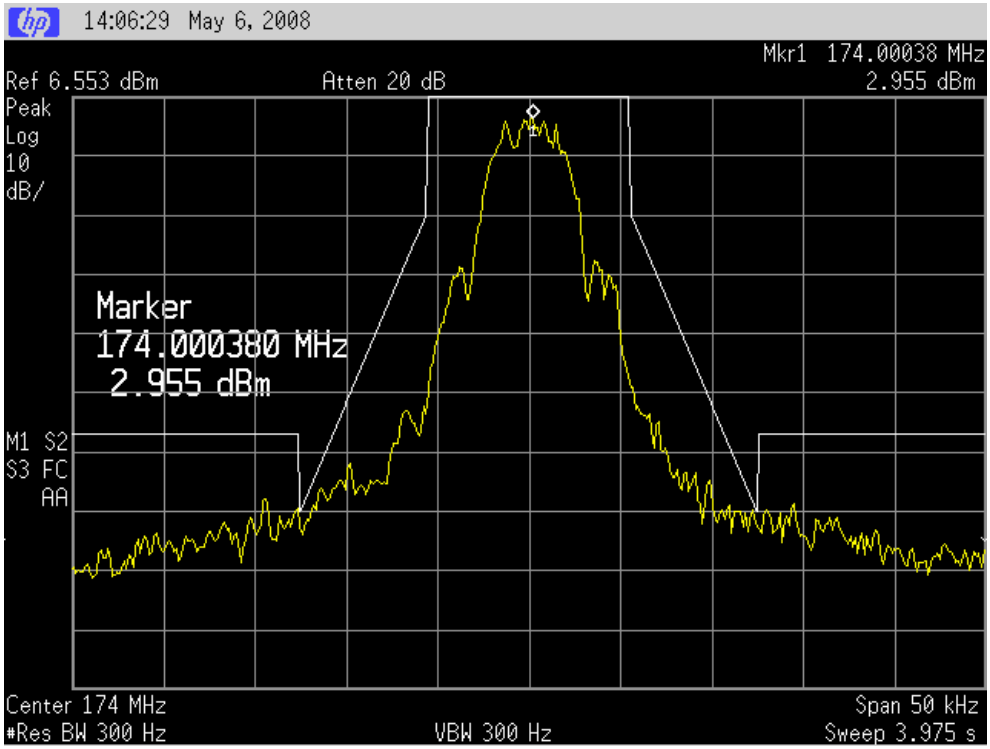
F3E 12.5 kHz



F1D 12.5 kHz



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Transmitter spurious emissions at the antenna terminals

Frequency: 174.000 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
348.000	-45.8	-20.0
522.000	-52.5	-20.0
696.000	-44.1	-20.0

All other emissions observed less than -55.0 dBm.

Limit:
Part 90.210(d) Mask D, (3) 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) or 70 dB whichever is the lesser attenuation.

The spurious emission limit defined by Mask D has been applied as this transmitter can operate using channel spacings of 12.5 kHz.

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 10^{th} harmonic if the transmitter operates below 10 GHz.

Some emissions less that –40 dBm have been reported for completeness.

The rated power of 5 watts gives a limit of –20 dBm.

No measurements were made above the 10^{th} harmonic.

Result: Complies
Measurement Uncertainty: ±3.3 dB

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Receiver spurious emissions at antenna terminals

Receive frequency: 174.000 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
216.000	-77.1	-57.0
438.000	-80.5	-57.0
1533.000	-84.7	-57.0
1752.000	-87.4	-57.0
2628.000	-87.3	-57.0

All other emissions observed less than –90.0 dBm.

The receiver has an intermediate frequency of 45 MHz.

Limit:
In accordance with CFR 47 Part 15, section 15.111 the power of any emission at the antenna terminal should not exceed 2 nW (–57.0 dBm).

Result: Complies
Measurement Uncertainty: ±3.3 dB

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Field strength of the transmitter spurious emissions

Frequency: 174.000 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
348.000	36.7	-58.5	-20.0	Vertical	38.5
348.000	43.6	-51.6	-20.0	Horizontal	31.6
522.000	39.1	-56.1	-20.0	Vertical	36.1
522.000	34.7	-60.5	-20.0	Horizontal	40.5
696.000	45.3	-49.9	-20.0	Vertical	29.9
696.000	43.6	-51.6	-20.0	Horizontal	31.6
870.000	47.2	-48.0	-20.0	Vertical	28.0
870.000	46.4	-48.8	-20.0	Horizontal	28.8
1044.000	36.4	-58.8	-20.0	Vertical	38.8
1044.000	37.9	-57.3	-20.0	Horizontal	37.3
1218.000	32.5	-62.7	-20.0	Vertical	42.7
1218.000	32.0	-63.2	-20.0	Horizontal	43.2
1392.000	37.6	-57.6	-20.0	Vertical	37.6
1392.000	38.0	-57.2	-20.0	Horizontal	37.2
1566.000	37.1	-58.1	-20.0	Vertical	38.1
1566.000	35.8	-59.4	-20.0	Horizontal	39.4
1740.000	-	-	-20.0	Vertical	-
1740.000	-	-	-20.0	Horizontal	-
1914.000	-	-	-20.0	Vertical	-
1914.000	-	-	-20.0	Horizontal	-
2088.000	-	-	-20.0	Vertical	-
2088.000	-	-	-20.0	Horizontal	-

When operating in transmit mode no significant emissions were detected between the harmonic emissions

The transmitter was tested while transmitting continuously while attached to a dummy load

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 on January 18th, 2007

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Testing was carried out using the substitution method where by the power level of each emission was determined by replacing the transmitter with a dipole antenna that was connected to a signal generator.

The signal generator output level was increased until the same field strength level was observed at each emission frequency.

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 W gives a limit of –20 dBm.

No measurements were made above the 10^{th} harmonic.

Result: Complies
Measurement Uncertainty: ±4.1 dB

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Field strength of the receiver spurious emissions

Receive frequency: 174.000 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Polarity	Margin (dB)
219.000	21.0	21.0	43.5	Hoizontal	22.5
438.000	34.8	32.3	46.0	Vertical	11.2
657.000	22.2	25.5	46.0	Hoizontal	20.5
876.000	27.3	27.1	46.0	Vertical	18.7
1095.000	-	-	54.0	Vert/Hort	-
1314.000	35.1	33.0	54.0	Vertical	18.9
1533.000	-	-	54.0	Vert/Hort	-
1752.000	-	-	54.0	Vert/Hort	-
1971.000	-	-	54.0	Vert/Hort	-
2190.000	-	-	54.0	Vert/Hort	-

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

Below 1000 MHz a quasi peak detector was used with a bandwidth of 120 kHz.

Limit: The field strength limits as per CFR 47 Part 15, section 15.109 have been applied.

Result: Complies
Measurement uncertainty +/- 4.1 dB

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Frequency Stability

Frequency stability 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.

The dc supply to the device was varied by +/- 15%.

Nominal Frequency: 174.000 MHz

Temp.	- 15%	12.0 Vdc	+ 15%
+50°C	+80	+77	+80
+40°C	+33	+33	+36
+30°C	+20	+23	+23
+20°C	+20	+21	+23
+10°C	+49	+50	+50
0°C	+70	+71	+71
-10°C	+95	+98	+95
-20°C	+174	+178	+178
-30°C	+306	+312	+302

Limit:

Part 90.213 states that in the 150–174 MHz band base stations operating with 12.5 kHz channel spacing must have a frequency stability of 2.5 ppm.

This transmitter operates between 150 - 174 MHz

Worst case = 2.5 ppm = 2.5 x 150.000 = 375 Hz.

Result: Complies
Measurement Uncertainty: ±30 Hz

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Transmitter Transient Performance

Transient frequency behaviour measurements are applicable to narrow band transmitters operating in the frequency band 150 – 174 MHz.

Measurements were carried out at 174.000 MHz using the method described in TIA-603 and EN 300-086.

In summary this method calls for the use of an external signal generator tuned to 174.000 MHz with a output level 0.1 % (-30 dB) of the level from the transmitter with a 1 kHz tone with a frequency deviation of 12.5 kHz being applied to the input of a modulation analyser along with the output from the transmitter.

The modulation analyser produces an amplitude difference signal and a frequency difference signal, which are applied to the input of a storage oscilloscope.

The unmodulated transmitter is then keyed which produces a trigger pulse that is AC coupled to the oscilloscope that produces a display on the screen.

The result of the change in the ratio of power between the test signal from the signal generator and the transmitter output will produce 2 separate sides on the oscilloscope picture.

One will show the 1000 Hz test modulation and the other will be the frequency difference of the transmitter versus time.

Results:

Spacing	Period t_1 (kHz)	Period t_2 (kHz)	Period t_3 (kHz)
12.5 kHz	Less than 6	Nil	Nil

Limits:

Time Interval	Period (ms)	Deviation (kHz)
T_1	5 ms	± 12.5
T_2	20 ms	± 6.25
T_3	5 ms	± 12.5

Result: Complies

Measurement Uncertainty: Frequency difference ±1.6 kHz
Time period ±1 ms

12.5 kHz transmitter turn on (174.000 MHz)

Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

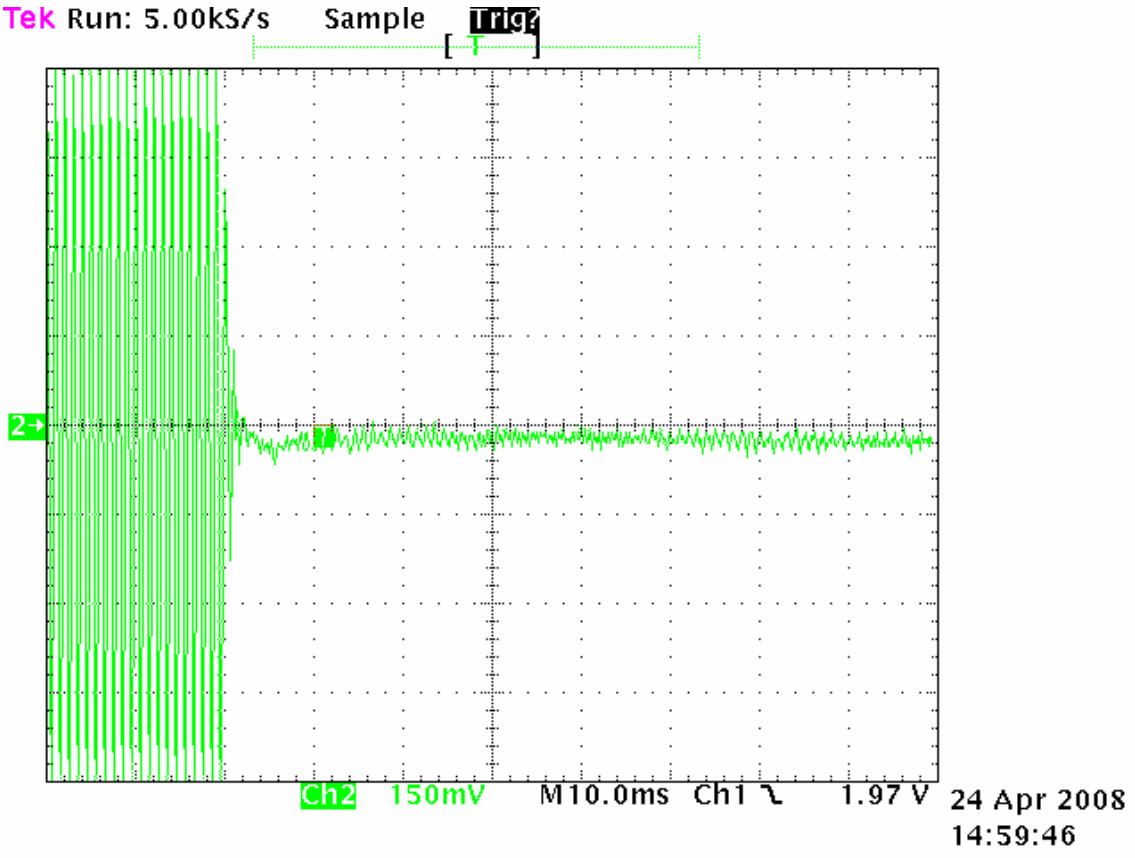
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

Triggering has been set to occur 2 divisions from the left hand edge (20 mS).

*t*on occurs at 20 mS.

*t*1 occurs between 2.0 and 2.5 divisions from the left hand edge.
t2 occurs between 2.5 and 4.5 divisions from the left hand edge.

A small transient can be seen at the start of *t*1 but no transients can be observed during *t*2.



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12.5 kHz transmitter turn off (174.000 MHz)

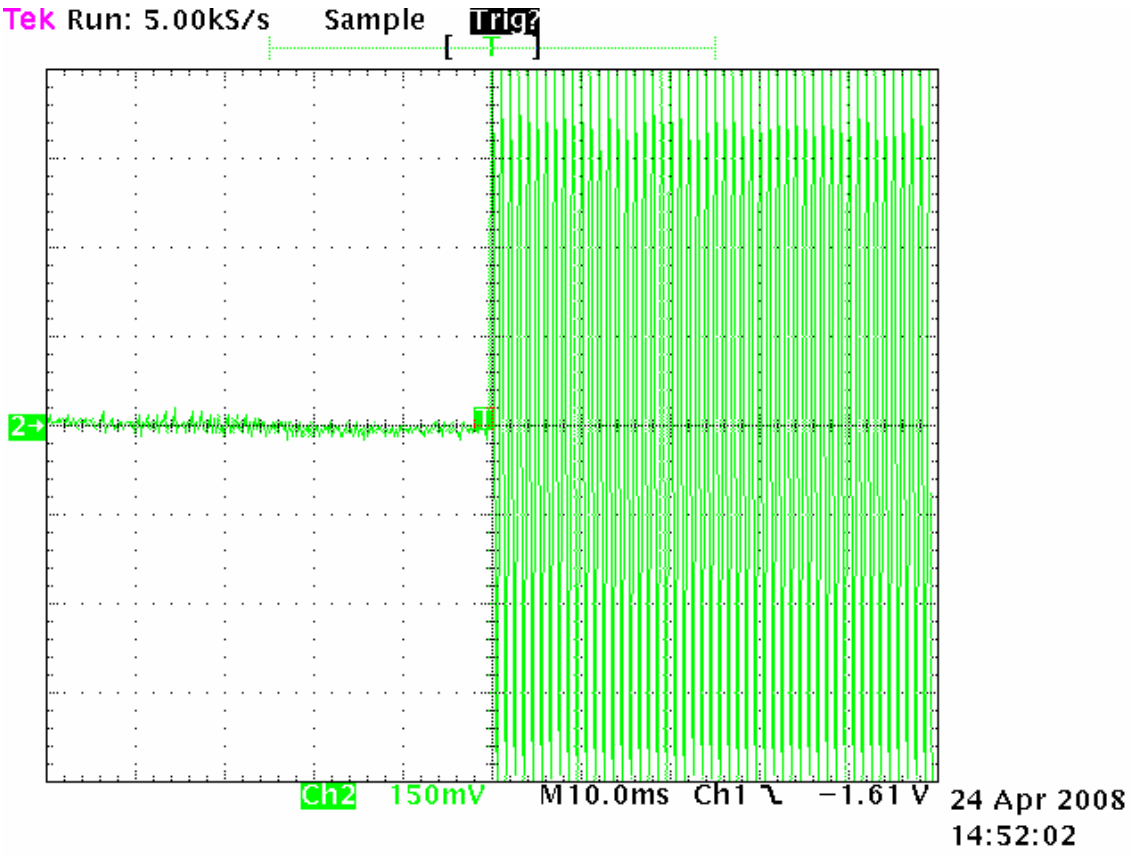
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division

The display of the 1 kHz signal rising has been positioned 5 divisions from the left hand edge (50 mS). This is position *t*off.

*t*3 occurs between 4.5 and 5.0 divisions from the left hand edge..

No transient responses can be observed before *t*off.



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Radio Frequency Hazard Information

As per Section 1.1310 and Section 2.1091 certification of this transmitter is sought using the Controlled / Occupational exposure limits as detailed in OST/OET Bulletin Number 65.

The transmitter has a radiated power of 5 watts and can be used in a mobile station environment for employment related uses.

Calculations have also been made using the General Public/Uncontrolled Exposure limits.

Minimum safe distances have been calculated below.

Power density, $mW/cm^2 = E^2/3770$

Occupational / Controlled Exposure limit: 0.58 mW/cm^2 (f/300 = 174 MHz/300)

General Population / Uncontrolled exposure limit: 0.12 mW/cm^2 (f/1500 = 174 MHz/1500)

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: E, V/m = (√ (30 * P * G)) / d

Controlled / Occupational	**Uncontrolled / General Public**
$E = 0.58\ mW/cm^2 = E^2/3770$	$E = 0.12\ mW/cm^2 = E^2/3770$
$E = \sqrt{0.58*3770}$	$E = \sqrt{0.12*3770}$
$E = 46.8$ V/m	$E = 21.3$ V/m

The rated maximum transmitter power = 5.0 watts.

This transmitter would typically be operated using a quarter wave whip antenna with a gain of 2.15 dBi (1.64).

As a mobile station the duty cycle would typically be 50%

Controlled / Occupational	**Uncontrolled / General Public**
d = √ (30 * P * G*DC) / E	d = √ (30 * P * G*DC) / E
d = √ (30 * 5 * 1.64 * 0.5) / 46.8	d = √ (30 * 5 * 1.64 * 0.5) / 21.3
d = 0.236 metres or 23.6 cm	d = 0.521 metres or 52.1 cm

Result: Complies if the user is advised of the above safe distances in the appropriate documentation.

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8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset
Aerial Controller	EMCO	1090	9112-1062	RFS 3710
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708
Attenuator 10 dB	Hewlett Packard	HP8491A	24838	E1329
Attenuator 20 dB	Weinschel	49-20-43	GC-104	E1308
Audio Analyzer	Hewlett Packard	8903A	2216A01713	E1146
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612
Frequency Counter	Hewlett Packard	HP 5342A	1916A01713	E1224
Level generator	Anritsu	MG443B	M61689	E1143
Log Periodic Antenna	Schwarzbeck	VUSLP9111	9111-228	3785
Measurement Receiver	Rohde & Schwarz	ESCS 30	847124/020	E1595
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552
Modulation Analyzer	Hewlett Packard	8901B	2608A00782	E1090
Oscilloscope	Tektronics	745A	B010643	1569
Power Attenuator	Weinschel	49-20-43	GC104	E1308
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069
RF Power Meter	Hewlett Packard	HP 436A	2512A22439	E1198
Rubidium Oscillator	Ball Efratom	FRS – C	4287	E1053
Selective Level Meter	Anritsu	ML422C	M35386	E1140
Signal Generator	Rohde & Schwarz	SMHU.58	838923/028	E1493
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	3776
Thermal chamber	Contherm	M180F	86025	E1129
Thermometer	DSIR	RT200	035	E1049
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709
Horn antenna	Electrometrics	RGA-60	6234	E1494
Microwave Pre Amplifier	Hewlett Packard	8349B	2644A01659	-

9. ACCREDITATIONS

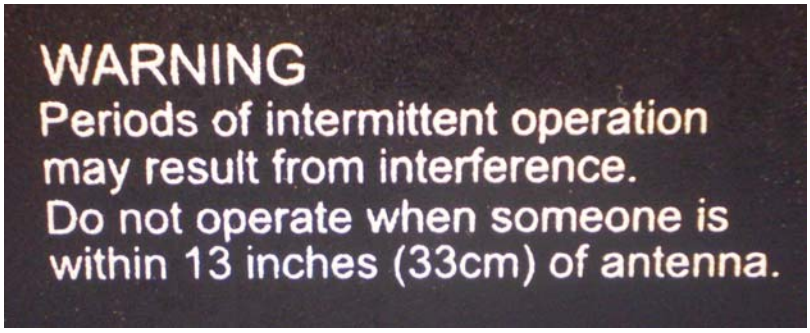
Testing was carried out in accordance with EMC Technologies NZ Ltd registration with the Federal Communications Commission as a listed facility, Registration Number: 90838, which was last updated on January 18th, 2007.

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

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

10. PHOTOGRAPH (S)

External Views



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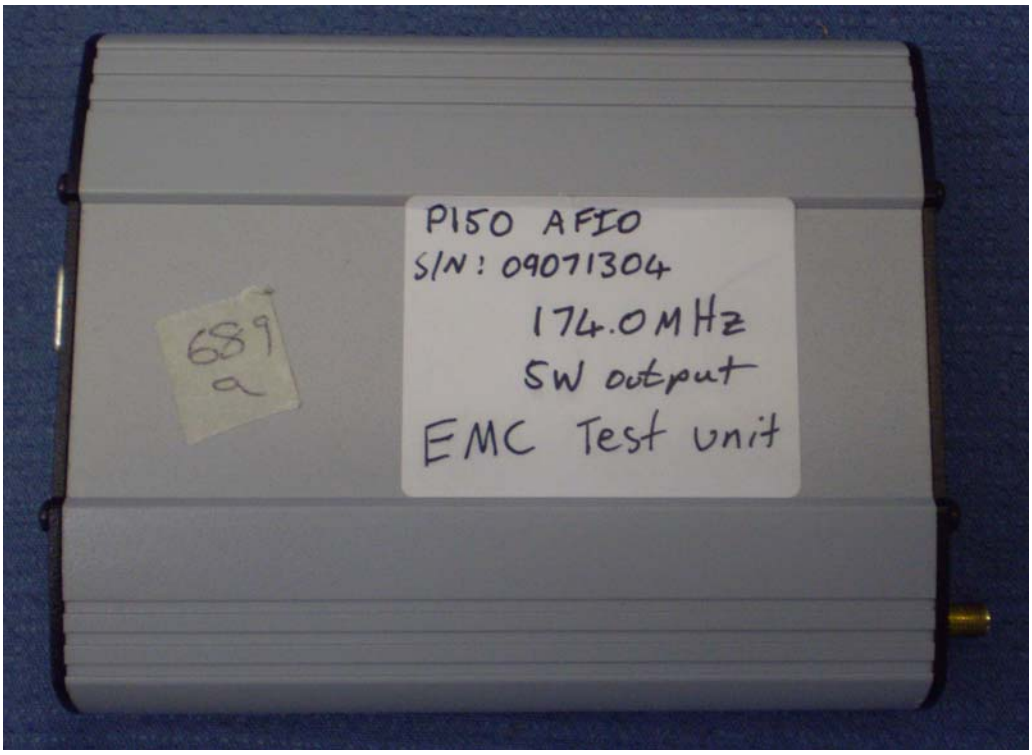

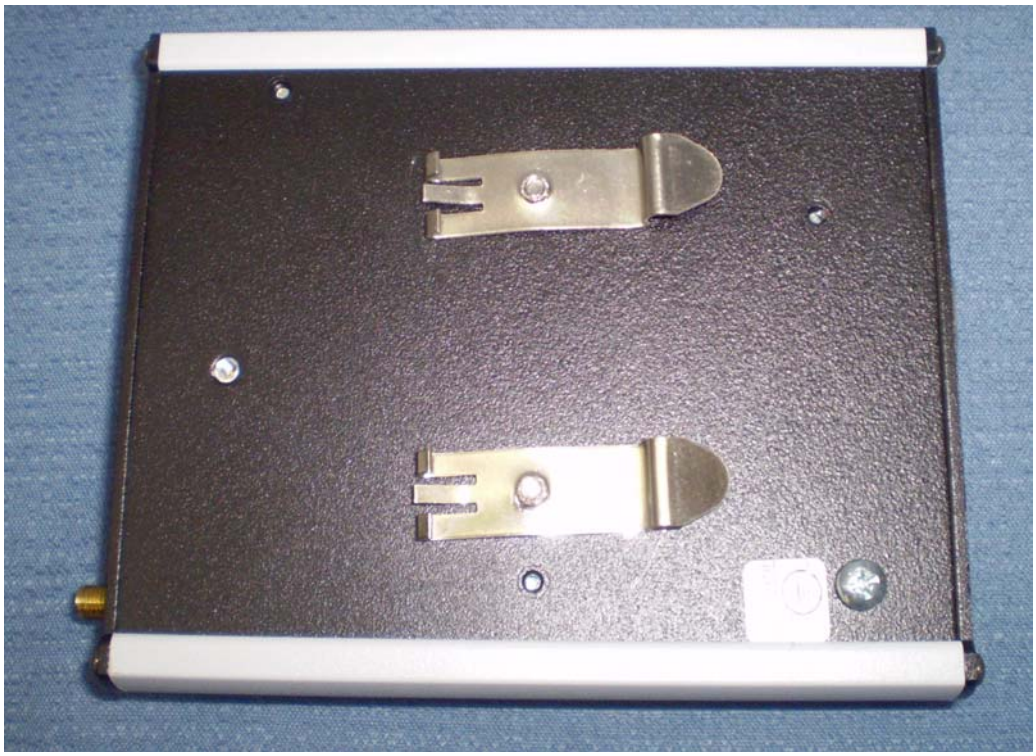

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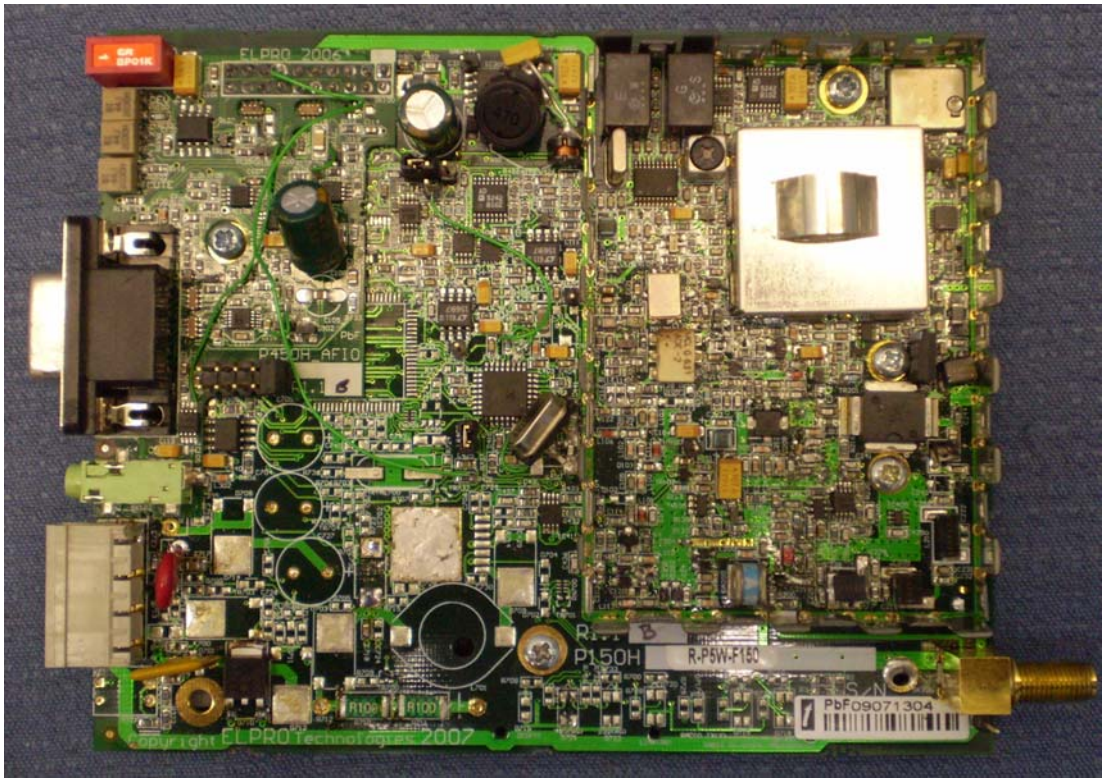
Internal Views



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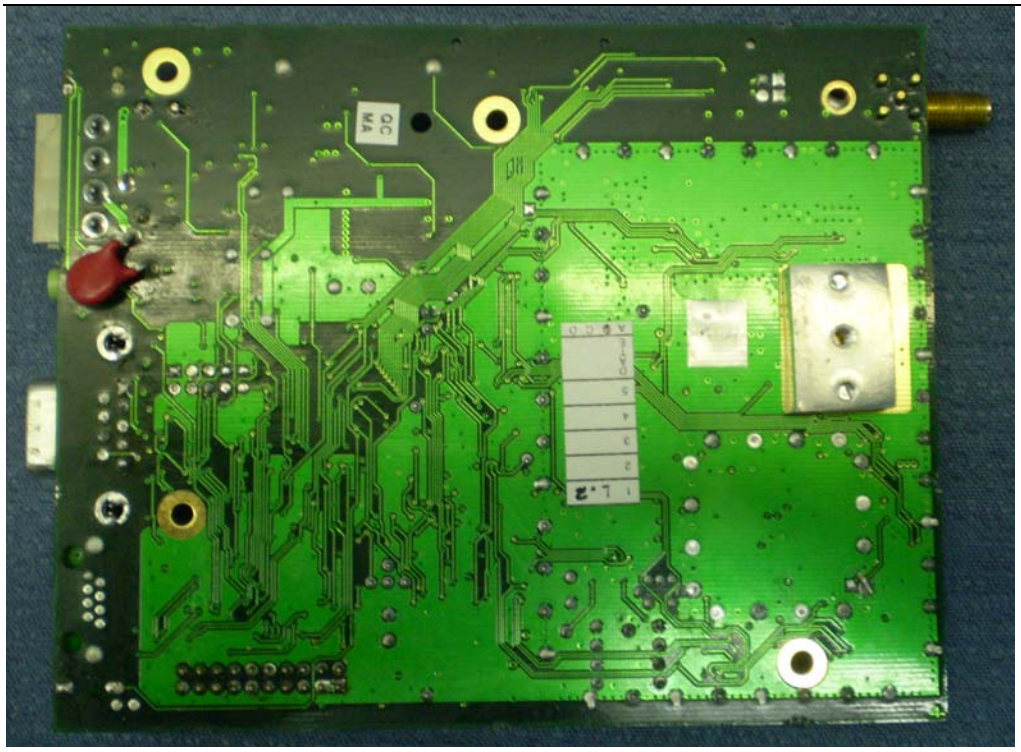

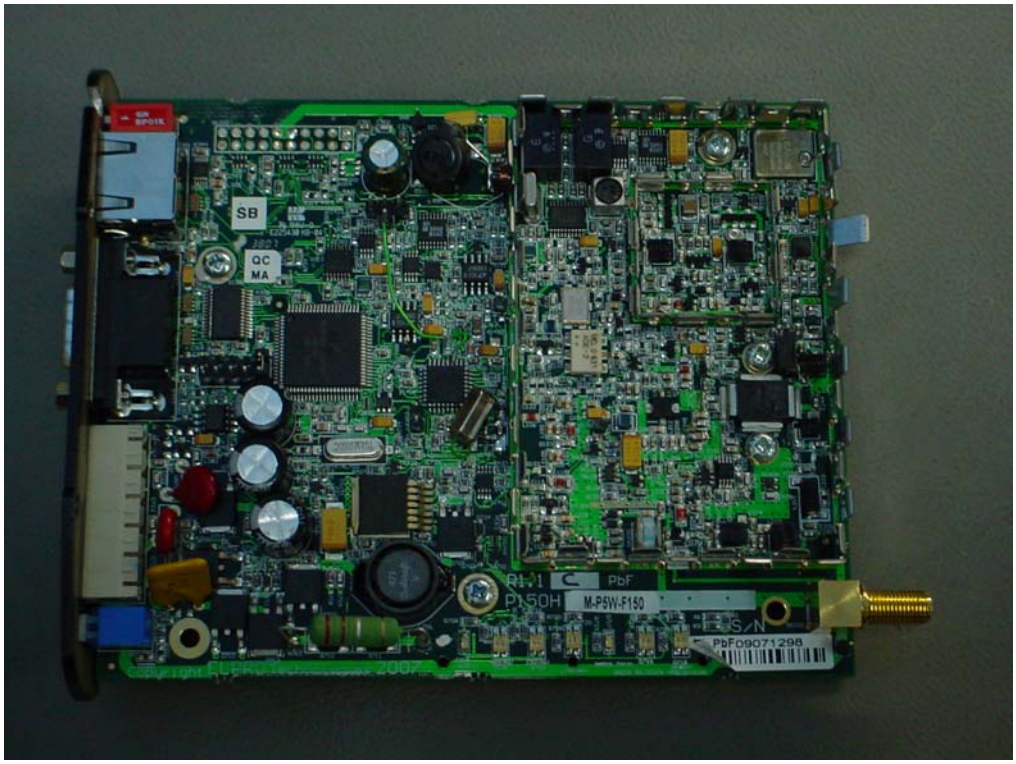

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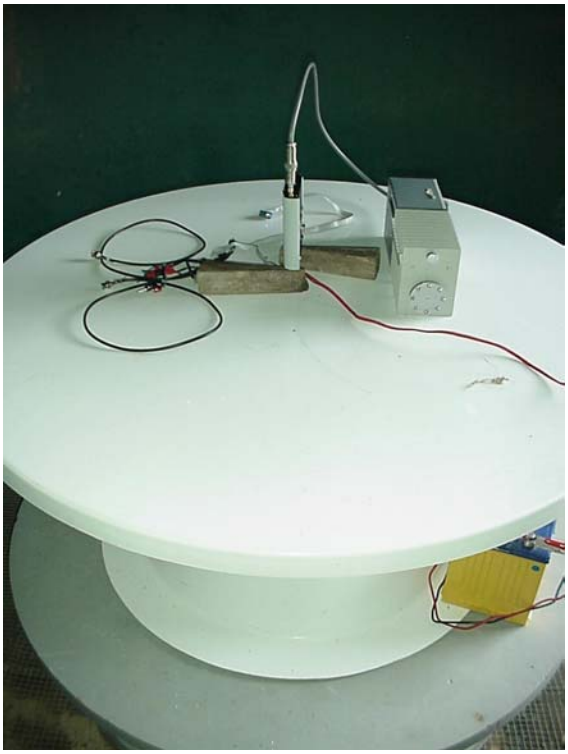
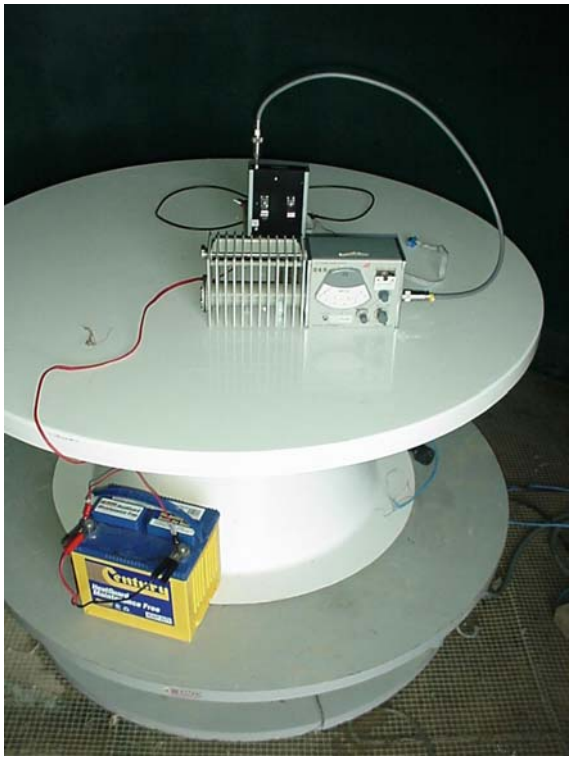
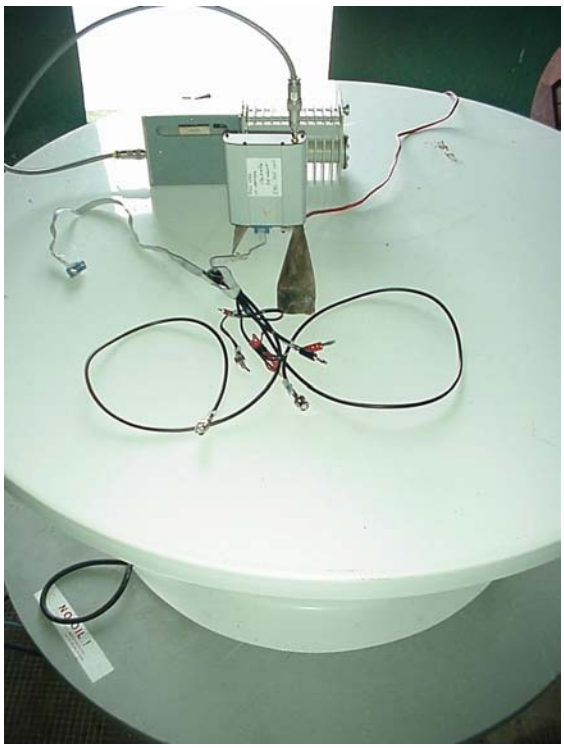
Radiated emissions test set up







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