EMC Technologies (NZ) Ltd

Test Report No **80523.3a**
Report date: 30 October 2008

TEST REPORT

Salcom 12-62-0000 UHF Base Station Paging Transmitter

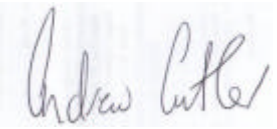
tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

Sea Air and Land Communications (SALCOM) Ltd



This Test Report is issued with the authority of:

_____
Andrew Cutler - General Manager

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

EMC Technologies (NZ) Ltd

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1. STATEMENT OF COMPLIANCE

The **Salcom 12-62-0000 UHF Base Station Paging Transmitter** complies with the limits defined in 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.

2. RESULTS SUMMARY

The results from testing are summarised in the following table:

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

3. INTRODUCTION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification.

- The test sample was selected by the client.
- This report relates only to the sample tested.
- This report contains no 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. This report replaces report 80523.3 to correct several typographical errors.

4. CLIENT INFORMATION

Company Name Sea Air and Land Communications Ltd

Address PO Box 22-621

City Christchurch

Country New Zealand

Contact Mr John Croft

5. DESCRIPTION OF TEST SAMPLE

Brand Name Salcom

Model Number 12-62-0000

Product UHF Base Station Paging Transmitter

Manufacturer Sea Air & Land Communications Ltd (SALCOM)

Country of Origin New Zealand

Serial Number Sample not serialised

FCC ID O871262

6. TEST SAMPLE DESCRIPTION

The sample tested is a UHF Base Station Paging Transmitter that uses POSCAG protocols with the following specifications:

Rated Transmitter Output Power

4.0 watts (36.0 dBm)

Test frequency

451.0000 MHz

Channel spacing

12.5 and 25 kHz

FCC Band of operation

427.500 – 475.000 MHz

Deviation

+/- 4.5 kHz and +/- 2.25 kHz

Emission Types

512 and 1200 baud POCSAG with Carrier FSK and NRZ data.

Emission designations

11k2F1D
16k0F1D

Power Supply

13.8 Vdc nominal from an external DC supply typically a lead acid battery. Declared operating voltage range is 11.5 Vdc to 15.2 Vdc

External Controls

This device has no external controls.

7. TEST CONDITIONS

Standard Temperature and Humidity

Temperature range: +15°C to + 25°C
Relative humidity range: 40% to 70%

Extreme Temperature

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

Tests were carried out at these extremes of temperature.

Standard and Extreme Power Supply

This device is powered using an external dc power supply which would typically be a lead acid battery at 13.8 Vdc.

The declared supply voltage range is 11.5 Vdc to 15.2 Vdc.

Testing has been carried out over this declared range.

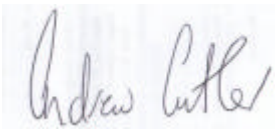
8. ATTESTATION

The **Salcom 12-62-0000 UHF Base Station Paging Transmitter** complies with the Code of Federal Regulations (CFR) 47 Part 90 – Private Land Mobile Services and Part 15 – Radio Frequency Devices.

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

9. TEST RESULTS

Certification required

Certification of this device is sought for transmissions using 12.5 and 25 kHz channel spacing.

12.5 and 25 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 channel per 12.5 kHz of channel bandwidth

Result: Complies.

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 (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
451.000	11.5	36.0	36.1
	13.8	36.0	36.3
	15.2	36.0	36.3

Limit
The power output is required to be within +/- 1 dB of the rated power output

Result: Complies
Measurement Uncertainty: ±0.5 dB

Modulation Characteristics

This transmitter is a POCSAG paging transmitter that is not capable of producing analogue speech modulations.

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

This measurement could not be carried out as the POCSAG modulation is internally generated within the transmitter.

However the client does advise that the transmitter is equipped with an audio low pass filter that is effectively a multipole filter from four RC networks along the modulation path plus the tuned response of the loop filter (250 Hz).

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

This measurement could not be carried out as the POCSAG modulation is internally generated within the transmitter.

However maximum that maximum deviation was measured to be 4.5 and 2.25 kHz respectively when the transmitter was operating continuously in each mode.

Emission types:

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

- F1D: Frequency shift keying for data communications

Bandwidth limitations:

The customer has declared that the authorised bandwidth to be 11.0 kHz for 12.5 kHz channelling and 16 kHz for 25 kHz channelling 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:

For 12.5 kHz channel operations

$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 2.25 kHz.
Where M = maximum modulation frequency: 256 Hz for 512 baud
$B_n \leq$ 5.012 kHz

$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 2.25 kHz.
Where M = maximum modulation frequency: 600 Hz for 1200 baud
$B_n \leq$ 5.700 kHz

For 25 kHz channel operations

$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 4.5 kHz.
Where M = maximum modulation frequency: 256 Hz for 512 baud
$B_n \leq$ 9.512 kHz

$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 4.5 kHz.
Where M = maximum modulation frequency: 600 Hz for 1200 baud
$B_n \leq$ 10.200 kHz

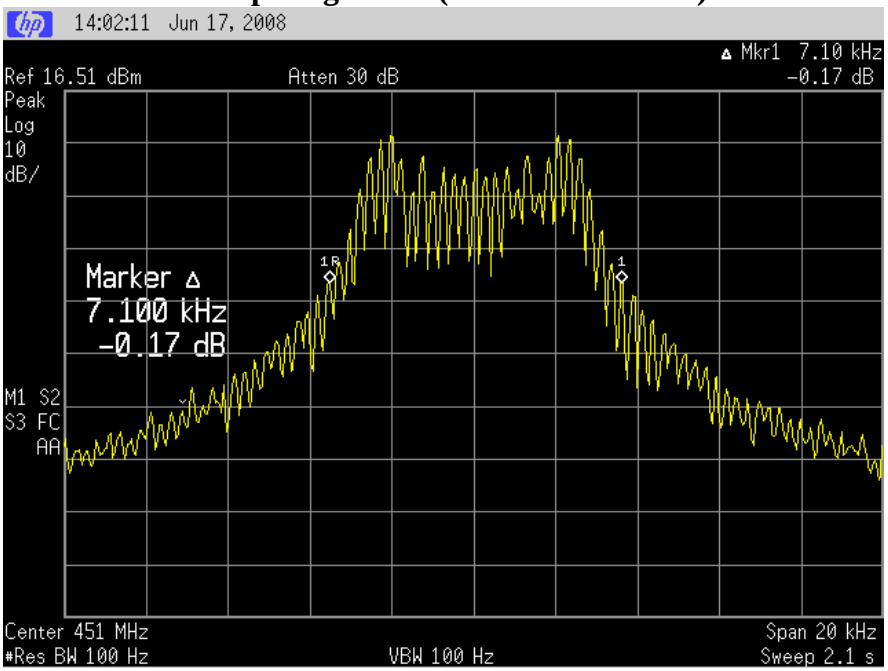
An attempt was then made to confirm these calculations by measurement.

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

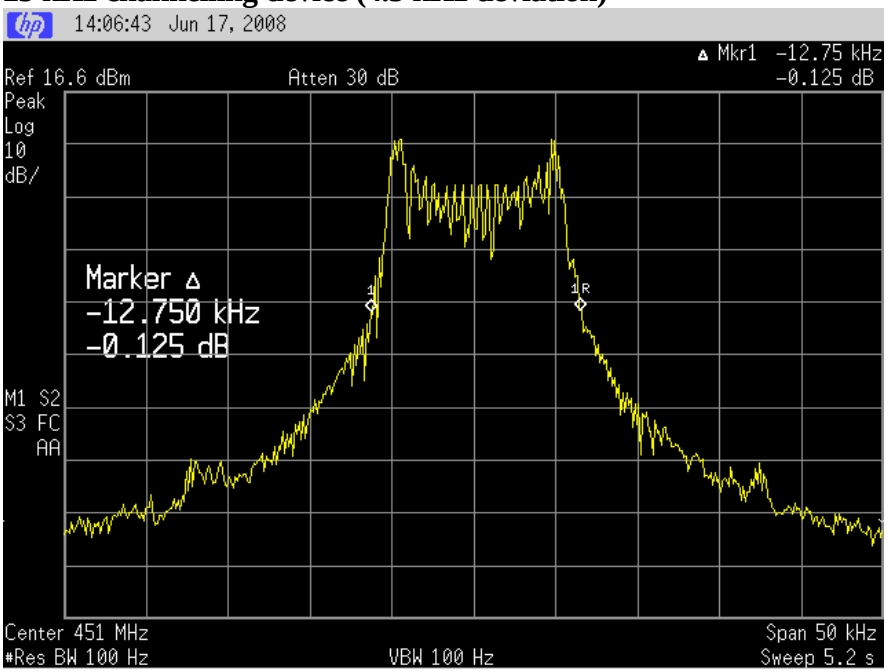
This level is used as a reference level on the spectrum analyser.

The resolution bandwidth is then changed to 100 Hz and the reference level minus 26 dB (99%) absolute bandwidth points determined

12.5 kHz channel spacing device (2.25 kHz deviation)



25 kHz channelling device (4.5 kHz deviation)



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

Result: Complies

Spectrum masks

The spectrum masks are defined in:

Section 90.210(b) – Mask B and Section 90.210(d) – Mask D have been applied as this transmitter can operate in the band 421 to 512 MHz using an authorised bandwidths of 16 kHz and 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.

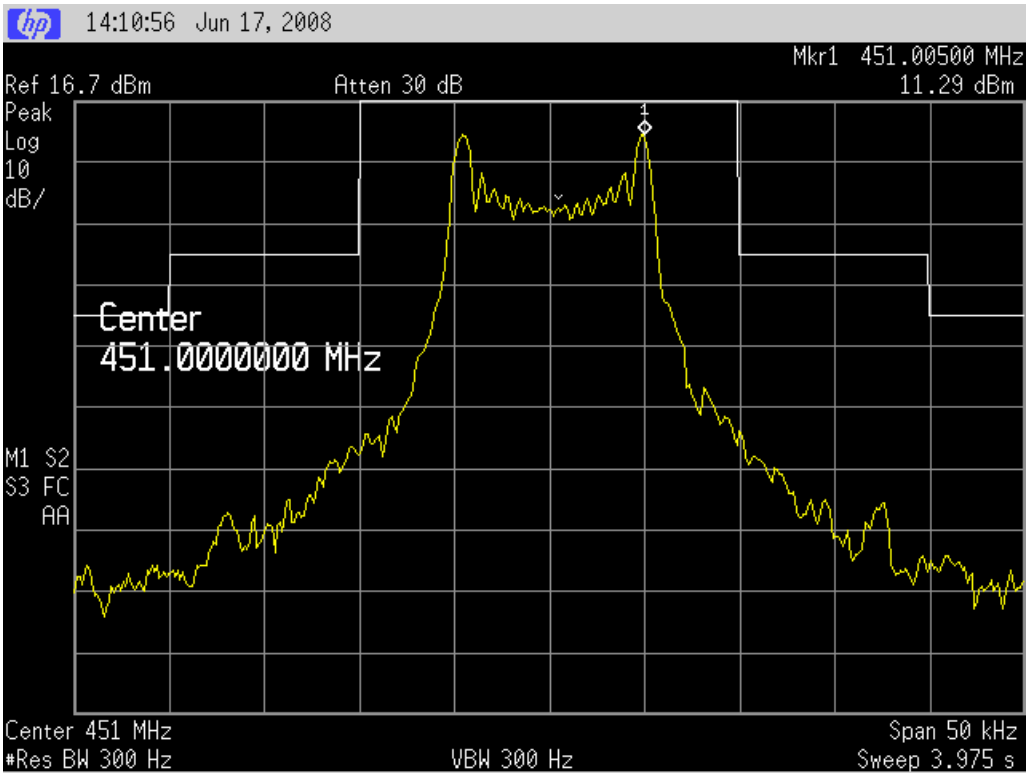
All measurements have been made with a 30 dB attenuator being placed between the transmitter and the spectrum analyser.

Measurements were made in peak hold with the transmitter operating on 451.000 MHz.

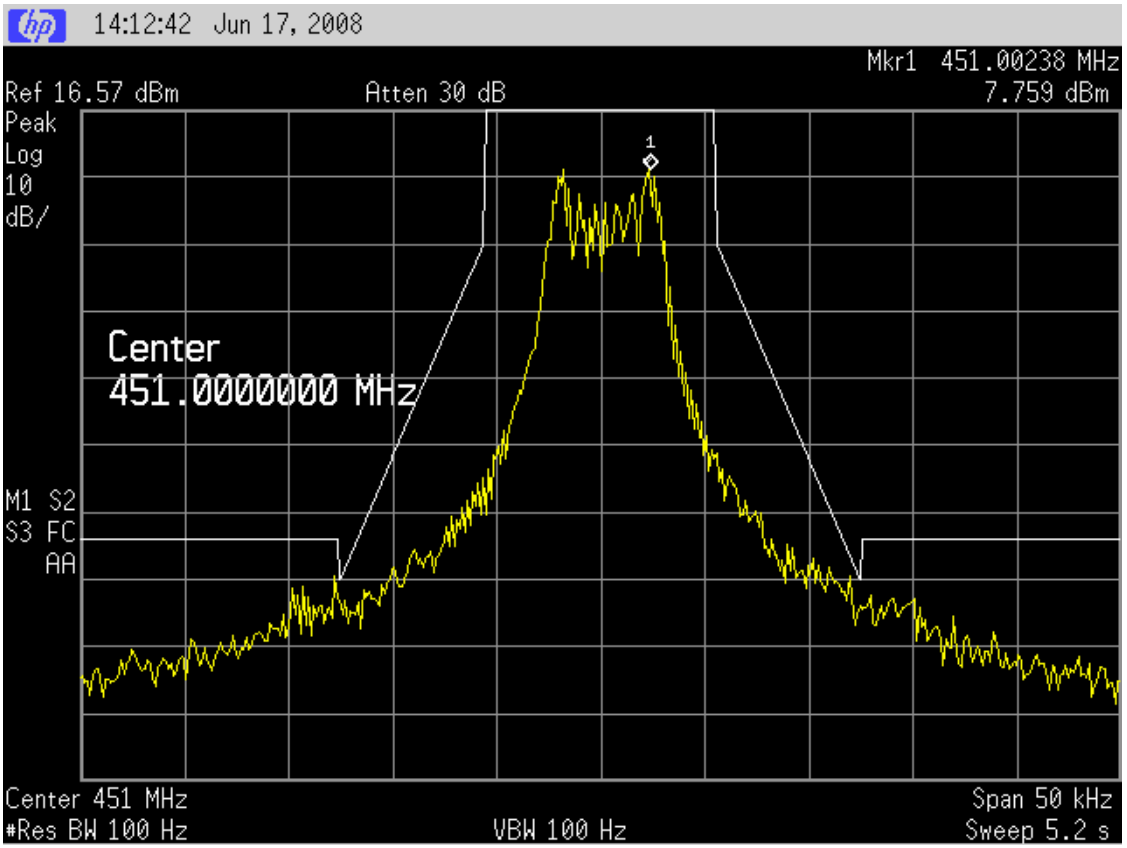
The modulation for this test was supplied internally by the transmitter

Result: Complies

25 kHz



12.5 kHz



Transmitter spurious emissions at the antenna terminals

Frequency: 451.000 MHz

Spurious emission (MHz)	Level (dBm)	Limit (dBm)
902.000	-50.1	-20.0
1353.000	-54.0	-20.0
1804.000	> -67.0	-20.0
2255.000	> -67.0	-20.0
2706.000	> -67.0	-20.0
3157.000	> -67.0	-20.0
3608.000	> -67.0	-20.0
4059.000	> -67.0	-20.0

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 4 watts gives a limit of –20 dBm.

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

Result: Complies
Measurement Uncertainty: ±3.3 dB

Field strength of the transmitter spurious emissions

Frequency: 451.000 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
902.500	55.0	-40.0	-20.0	Vertical	20.0
902.500	50.5	-44.0	-20.0	Horizontal	24.0
1353.500	40.0	-55.0	-20.0	Vertical	35.0
1353.500	36.2	-59.0	-20.0	Horizontal	39.0
1804.500	38.5	-56.0	-20.0	Vertical	36.0
1804.500	38.5	-56.0	-20.0	Horizontal	36.0
2255.500	36.3	-58.0	-20.0	Vertical	38.0
2255.500	36.3	-58.0	-20.0	Horizontal	38.0
2706.500	38.1	-57.0	-20.0	Vertical	37.0
2706.500	38.1	-57.0	-20.0	Horizontal	37.0
3157.500	-	-	-20.0	Vertical	-
3157.500	-	-	-20.0	Horizontal	-
3608.500	-	-	-20.0	Vertical	-
3608.500	-	-	-20.0	Horizontal	-
4059.500	-	-	-20.0	Vertical	-
4059.500	-	-	-20.0	Horizontal	-
4510.500	-	-	-20.0	Vertical	-
4510.500	-	-	-20.0	Horizontal	-

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

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

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

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

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: 451.000 MHz

Temp.	- 15%	13.8 Vdc	+ 15%
+50°C	-33.0	-11.0	7.0
+40°C	-147.0	-154.0	-166.0
+30°C	-142.0	-139.0	-149.0
+20°C	-154.0	-143.0	-151.0
+10°C	-9.0	-2.0	-1.0
0°C	-9.0	+2.0	+7.0
-10°C	+63.0	+79.0	+99.0
-20°C	+305.0	+316.0	+322.0
-30°C	+450.0	+476.0	+513.0

Limit:
Part 90.213 states that in the 421 – 512 MHz band base stations operating with 12.5 kHz channel spacing must have a frequency stability of 2.5 ppm.

This transmitter operates between 427.5 – 470.0 MHz

Worst case = 2.5 ppm = 2.5 x 427.5 MHz = 1068 Hz.

Result: Complies
Measurement Uncertainty: ±30 Hz

Transmitter Transient Performance

Transient frequency behaviour measurements are applicable to wide and narrow band transmitters operating in the frequency band 421 – 512 MHz.

Measurements were carried out at 451.000 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 8.0	-	Less than 6.25
25.0 kHz	Less than 12.5	-	Less than 6.25

Limits:

Time Interval	Period	12.5 kHz Deviation (kHz)	25 kHz Deviation (kHz)
t_1	10 mS	± 12.5	± 25.0
t_2	25 mS	± 6.25	± 12.5
t_3	10 mS	± 12.5	± 25.0

Result: Complies

Measurement Uncertainty: Frequency ±1.6 kHz, Time ±1 ms

12.5 kHz transmitter turn on

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

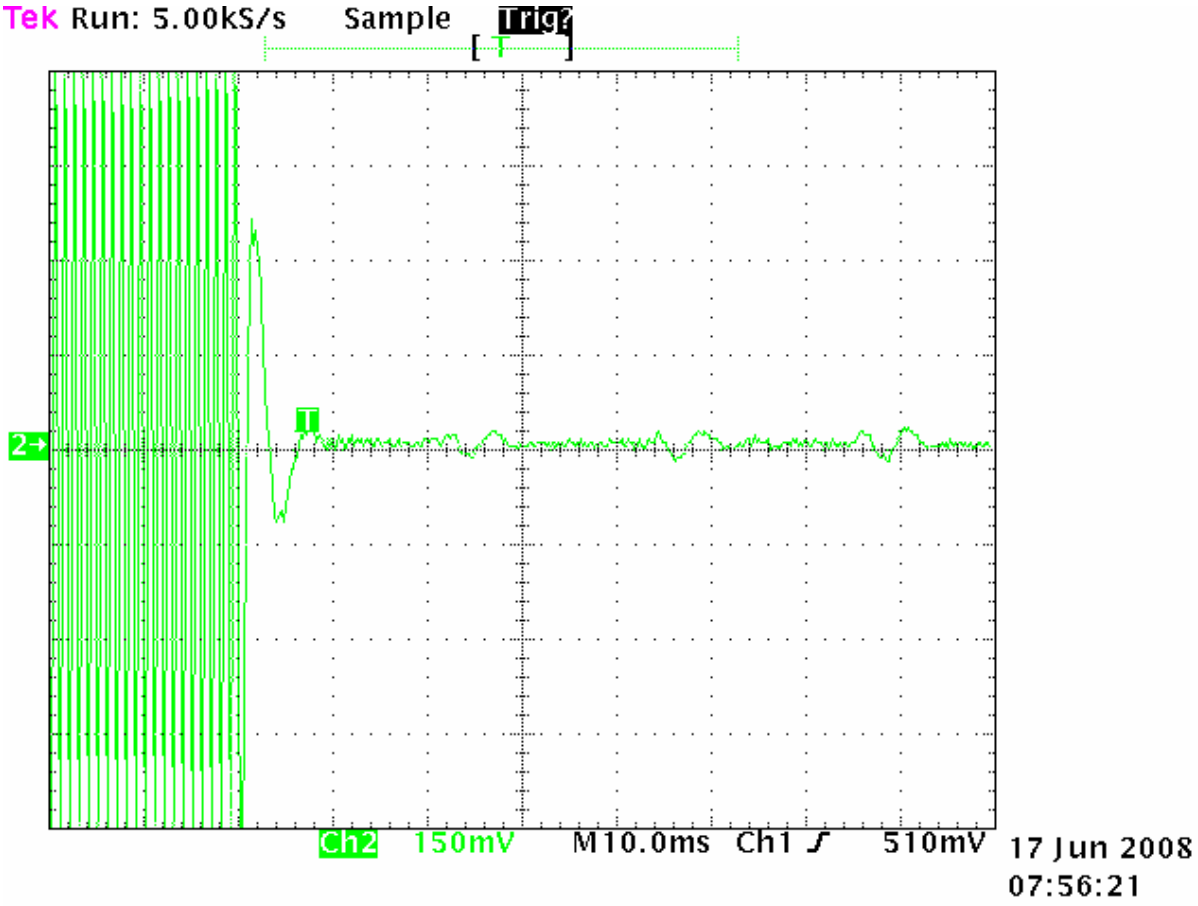
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

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 3.0 divisions from the left hand edge.
t2 occurs between 3.0 and 5.5 divisions from the left hand edge.

A transient response can be observed during *t*1.



12.5 kHz transmitter turn off

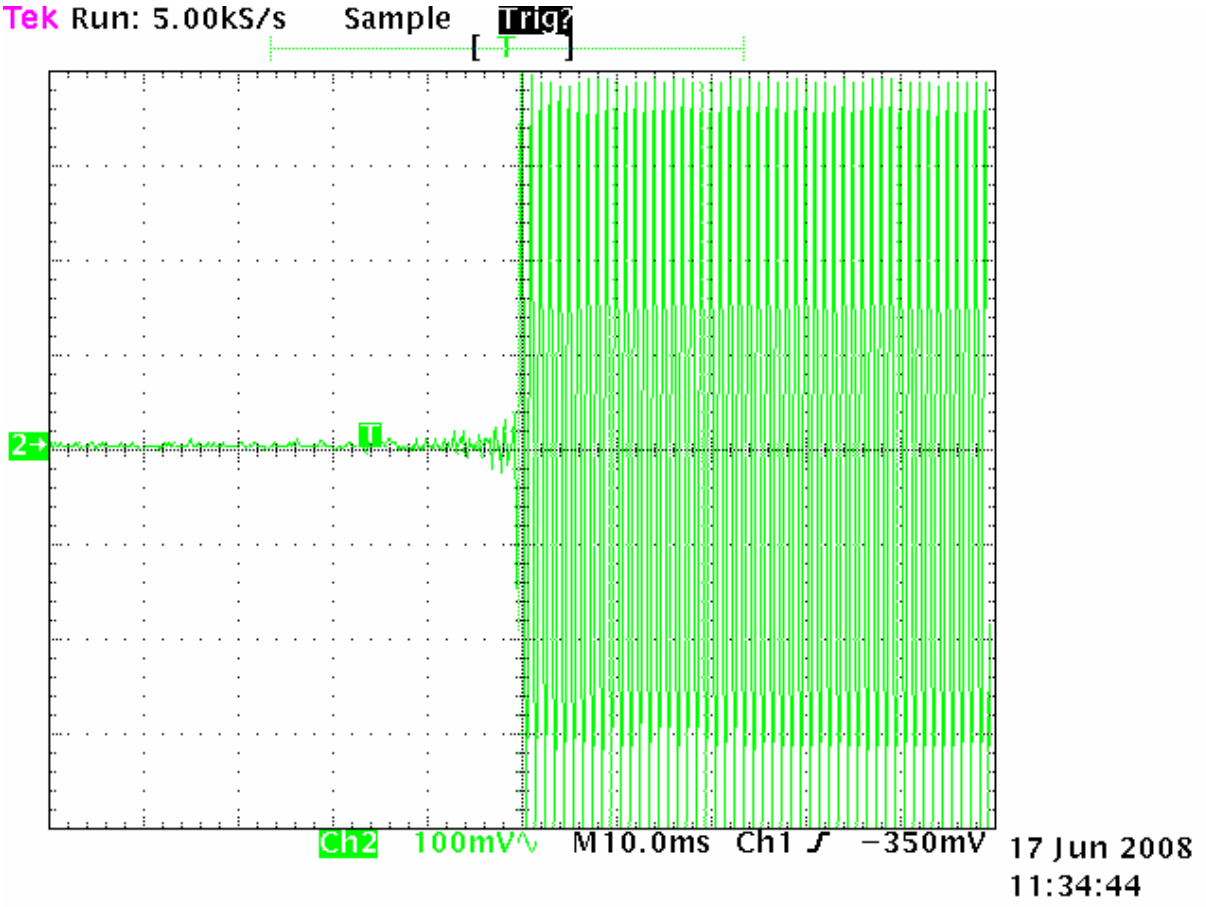
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

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 4.0 and 5.0 divisions from the left hand edge..

No very small transient response can be observed during *t3*.



25.0 kHz transmitter turn on

Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

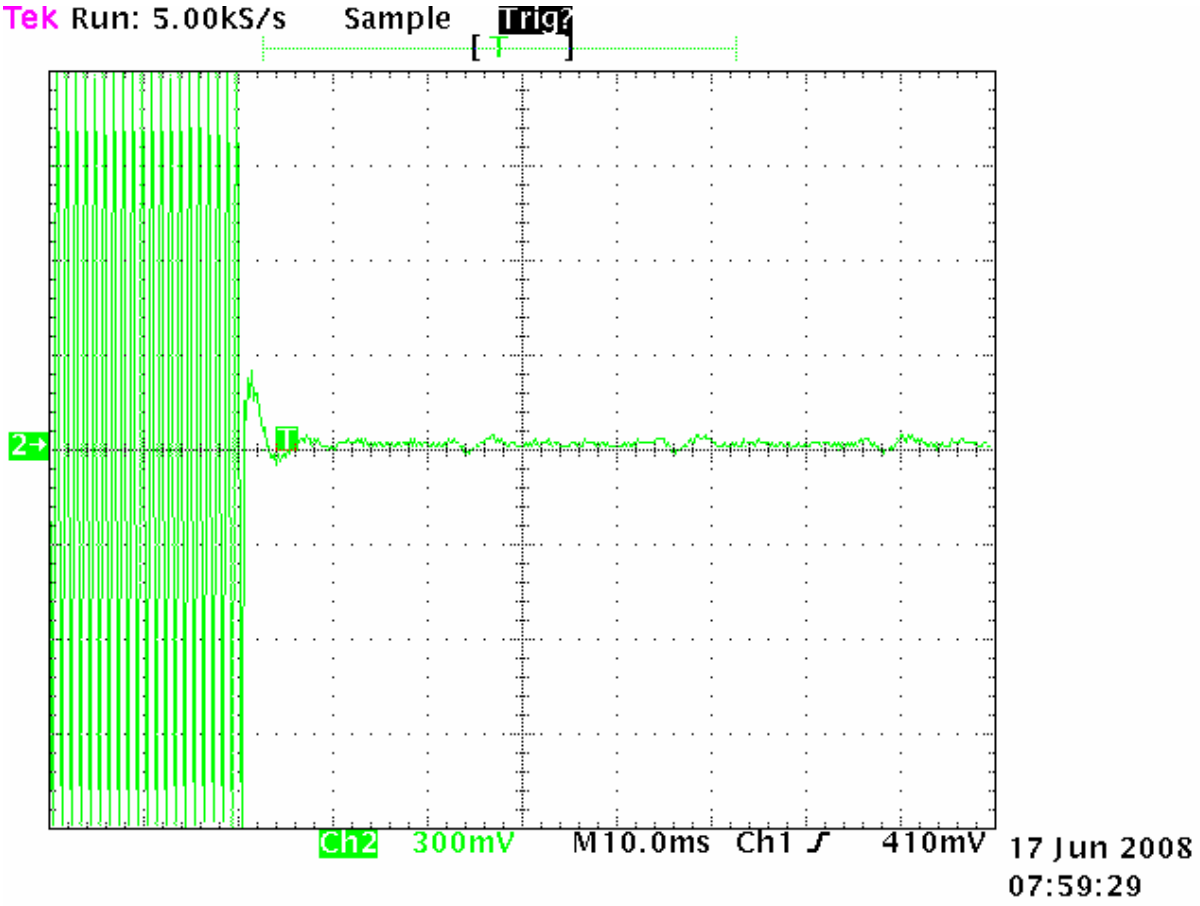
Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
Therefore each Y axis division = 6.25 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

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 3.0 divisions from the left hand edge.
t2 occurs between 3.0 and 5.5 divisions from the left hand edge.

A small transient response can be observed during *t*1.



25.0 kHz transmitter turn off

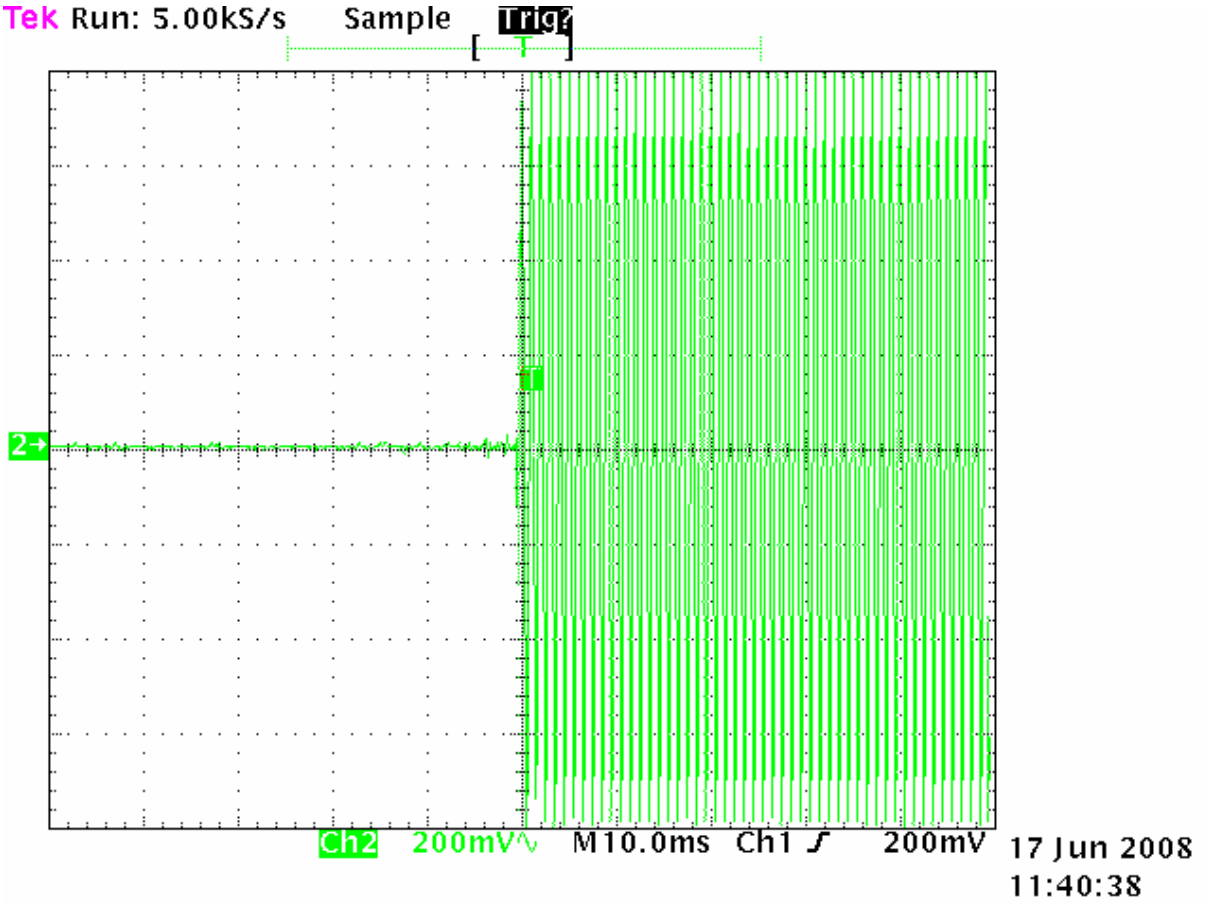
Green Trace = 1 kHz tone with FM deviation of 25.0 kHz.

Green trace has been maximised to give full screen indication of +/- 25.0 kHz.
Therefore each Y axis division = 6.25 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 response can be observed before *t*off.



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 4 watts and is intended to be used a paging base 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: 1.50 mW/cm^2 (f/300 = 451 MHz/300)

General Population / Uncontrolled exposure limit: 0.30 mW/cm^2 (f/1500 = 451 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**
$E = 1.50\ mW/cm^2 = E^2/3770$	$E = 0.30\ mW/cm^2 = E^2/3770$
$E = \sqrt{1.5*3770}$	$E = \sqrt{0.30*3770}$
E = 74.5 V/m	E = 33.6 V/m

The rated maximum transmitter power = 4.0 watts.

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

As a base station the duty cycle would typically be greater than 50% but less than 100%

Controlled / Occupational	**Uncontrolled / General Public**
d = √ (30 * P * G*DC) / E	d = √ (30 * P * G*DC) / E
d = √ (30 * 4 * 1.64 * 1) / 74.5	d = √ (30 * 4 * 1.64 * 1) / 33.6
d = 0.188 metres or 18. 8 cm	d = 0.418 metres or 41.8 cm

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

10. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal Date
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	N/A
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	N/A
Attenuator 10 dB	Hewlett Packard	HP8491A	24838	E1329	12/11/2008
Attenuator 20 dB	Weinschel	49-20-43	GC-104	E1308	12/11/2008
Audio Analyzer	Hewlett Packard	8903A	2216A01713	E1146	13/07/2009
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	31/01/2010
Frequency Counter	Hewlett Packard	HP 5342A	1916A01713	E1224	09/07/2008
Level generator	Anritsu	MG443B	M61689	E1143	02/09/2008
Log Periodic	Schwarzbeck	VUSLP9111	9111-228	3785	31/01/2010
Receiver	Rohde & Schwarz	ESCS 30	847124/020	E1595	30/01/2009
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552	21/07/2008
Modulation Analyzer	Hewlett Packard	8901B	2608A00782	E1090	16/01/2010
Oscilloscope	Tektronics	745A	B010643	1569	09/07/2008
Power Attenuator	Weinschel	49-20-43	GC104	E1308	12/11/2008
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	12/03/2009
RF Power Meter	Hewlett Packard	HP 436A	2512A22439	E1198	19/11/2008
Selective Level Meter	Anritsu	ML422C	M35386	E1140	17/05/2009
Signal Generator	Rohde & Schwarz	SMHU.58	838923/028	E1493	23/07/2009
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	3776	06/03/2009
Thermal chamber	Contherm	M180F	86025	E1129	04/07/2008
Thermometer	DSIR	RT200	035	E1049	04/07/2008
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/A
Horn antenna	Electrometrics	RGA-60	6234	E1494	03/05/2011
Pre Amplifier	Hewlett Packard	8349B	2644A01659	-	12/11/2008

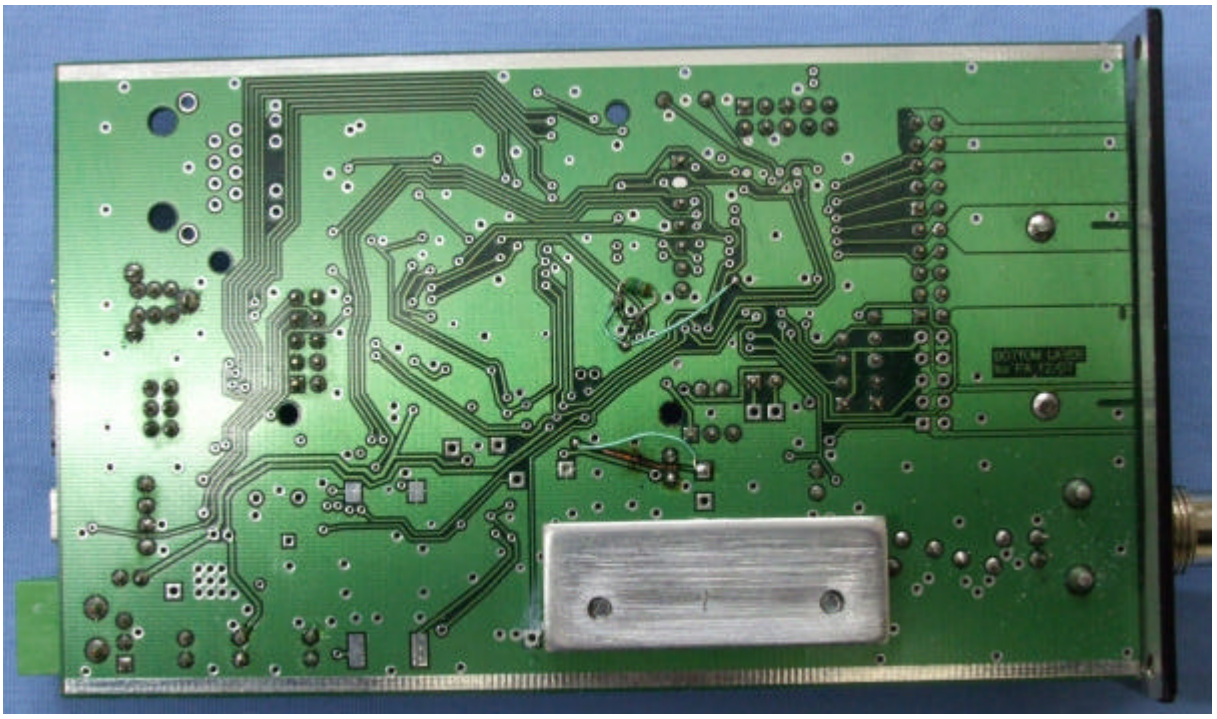
11. ACCREDITATIONS

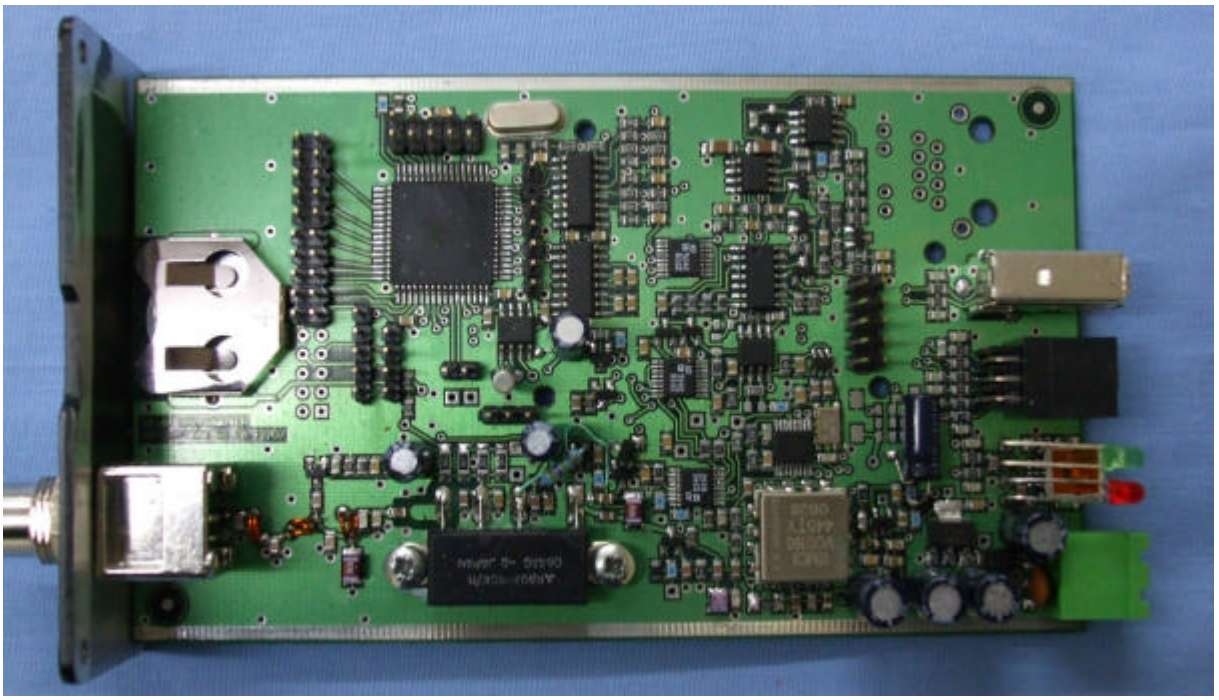
Testing was carried out in accordance with EMC Technologies NZ Ltd registration with the Federal Communications Commission as a listed facility, Registration Number: 90838, which was last updated on January 18th, 2007.

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)





Radiated emissions test set up