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TEST REPORT

Eclipse 2, 500 Series, Band B (450-480 MHz) UHF Base Station

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

Part 15 – Radio Frequency Device

for

RF Technology Pty 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

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1. CLIENT INFORMATION

Company Name RF Technology Pty Ltd

Address Unit 46/ 7 Sefton Rd
Thornleigh

State NSW

Country Australia

Contact Mr Guang Lou

2. DESCRIPTION OF TEST SAMPLE

Brand Name Eclipse 2

Model Number 500 Series, Band B

Product Base Station (450-480 MHz)

Manufacturer RF Technologies

Manufactured in Australia

Serial Number 00307

FCC ID -

3. COMPLIANCE STATEMENT AND RESULT SUMMARY

The **Eclipse 2, 500 series, Band B (450-480 MHz) UHF Base station** complies 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.

Clause	Description	Result
90.203	Certification required	Noted
2.1046	RF power output	Noted
90.205	Power and antenna height limits	Complies
2.1047	Modulation Characteristics	Noted
2.1047(a)	Low pass filter response	Noted
2.1047(b)	Modulation limiting characteristics	Noted
90.211(a)	Modulation characteristics	Complies
2.1049	Occupied bandwidth	Noted
2.202	Bandwidths	Noted
22.357	Emission types	Complies
22.359(a)	Emission masks	Complies
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
22.355	Frequency stability	Complies
90.213	Frequency stability	Complies
90.214	Transient frequency behaviour	Complies
15.109	Receiver radiated emissions	Complies
15.111	Receiver local oscillator voltage	Complies

4. TEST SAMPLE DESCRIPTION

The sample tested has the following specifications:

Rated Transmitter Output Power

3.0 Watts (34.7 dBm)

Test frequencies

Chl	Frequency MHz	Power Watts	Spacing kHz	Mode
1	459.075	3.0	12.5	F1E
2	459.075	3.0	12.5	F3E

FCC Bands

Part 90: 421 - 512 MHz

Emission Designators / Modes of operation

8k10F1E – C4FM digital speech

11k2F3E – Analogue speech

Power Supply

AC voltage supply typically 110.0 V ac

5. TEST CONDITIONS

Standard Temperature and Humidity

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

Standard Test Power Source

Standard Test Voltage: 110.0 V ac.

Extreme Temperature

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

Extreme Test Voltages

Low Voltage: 93.5 V ac

High Voltage: 126.5 V ac

6. ATTESTATION

The **Eclipse 2, 500 series, Band B (450-480 MHz) UHF Base station** complies with the Code of Federal Regulations (CFR) 47 Part 90 –Private Land Mobile Services and 47 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.

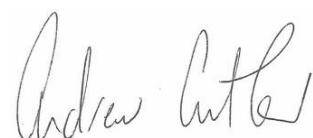
This report has been issued in conjunction with report number 110132.3b to show compliance with the FCC narrowband requirements only.

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

7. TEST RESULTS

Certification required

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

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

- certification has been sought after January 1, 2011.
- the equipment meets the spectrum efficiency standard of one voice channel per 12.5 kHz of channel bandwidth
- the equipment can operate with a data rate greater than 4.8 kbps per 6.25 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 $50\ \Omega$ dummy load.

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

Measurements were made with the input voltage set to 110.0 Vac and when decreased 15% to 95.6 Vac and increased 15% to 126.5 Vac.

Testing was carried out at maximum power output.

Frequency (MHz)	Voltage (Vac)	Rated (dBm)	Measured (dBm)
459.075	110.0	34.7	34.9

Frequency (MHz)	Voltage (Vac)	Rated (dBm)	Measured (dBm)
459.075	126.5	34.7	34.9
459.075	95.6	34.7	34.9

Results are within 1 dB of the manufacturer's rated transmitter output power.

Result: Complies

Measurement Uncertainty: ± 0.5 dB

Modulation Characteristics

This transmitter is capable of producing analogue speech and digital 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.

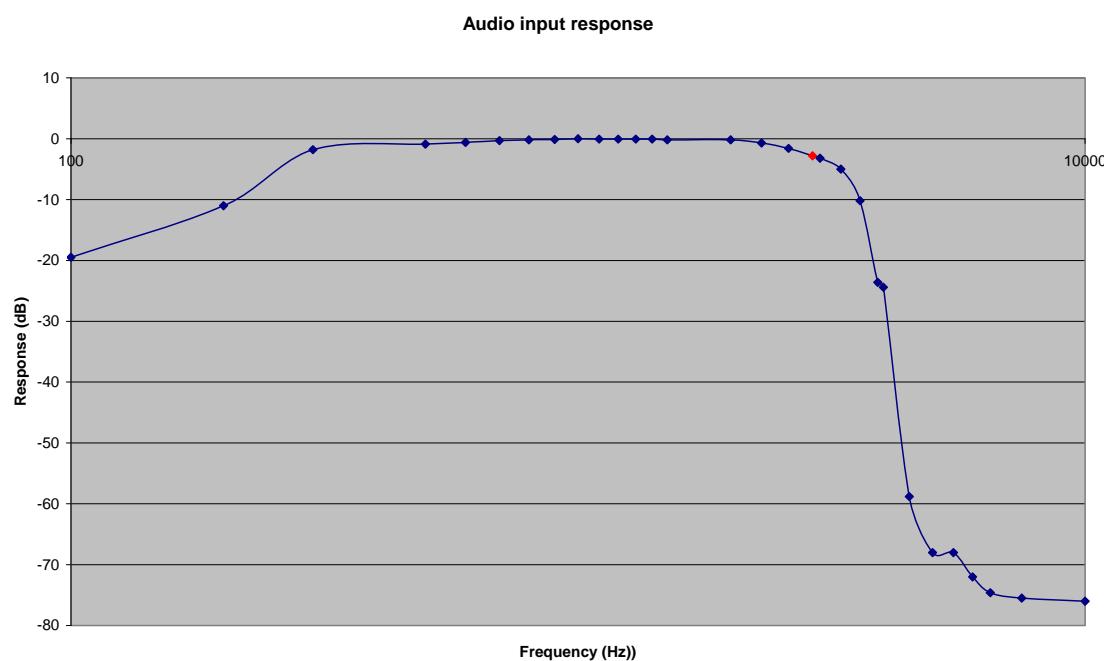
At 1 kHz an audio signal was applied which was used as a 0 dB response reference.

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 peak deviation response was found to be at 900 Hz.

The -3dB roll off from peak deviation occurs at 2900 Hz, and is denoted as a red data series point on the following graph.

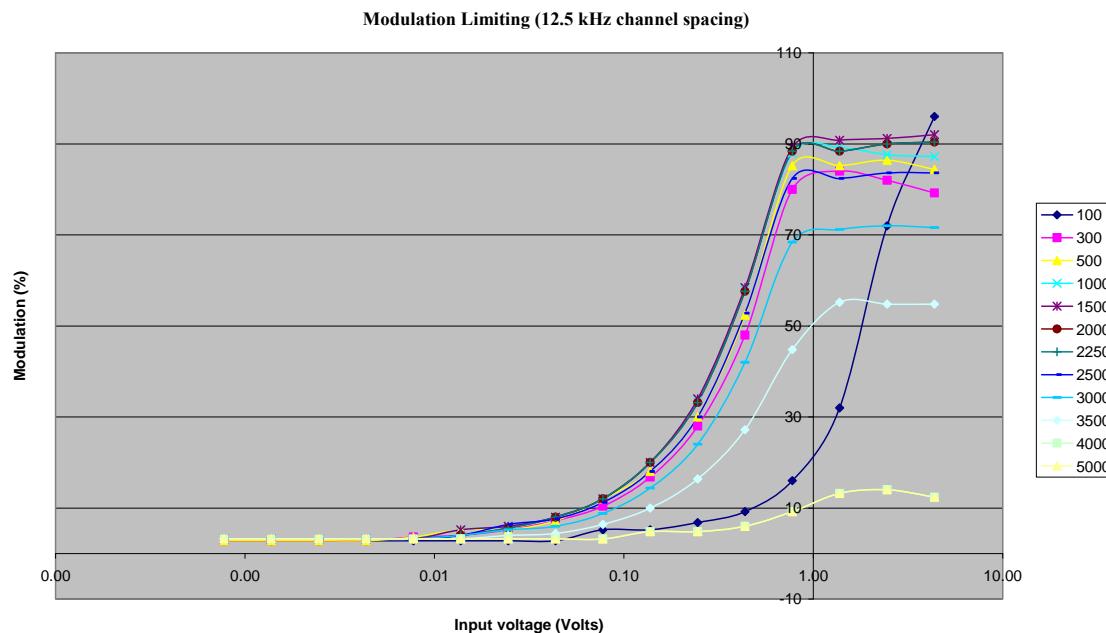


(b) A family of curves showing the percentage of modulation versus the modulation input voltage.

Measurements were made between 100 Hz to 4 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.



(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.

The following other modulation types are used with this transmitter.

C4FM digital modulation is used for digital telephony (F1E).

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: $\pm 1\%$.

Part 90.207 – Emission types:

The following emission types are used:

- F3E: Frequency modulation with analogue speech.
- F1E: Digital telephony using C4FM.

Part 90.209 – Bandwidth limitations:

The authorised bandwidth is taken to be the necessary bandwidth.

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

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

Where D = maximum deviation: 2.5 kHz

Where M = maximum modulation frequency: 3 kHz

$$B_n = \underline{11 \text{ kHz}}$$

Measurements show the following

$$B_n = 2 \times 2300 \text{ Hz} + 2 \times 2900 \text{ Hz}$$

$$B_n = \underline{10.4 \text{ kHz}}$$

This is confirmed in the emission designation 11k0F3E

For F1E according to the APCO 25 information, supplied by the client, C4FM modulation is used and the occupied bandwidth is calculated from the P25 high deviation pattern of 2827 Hz deviation at a 1200 Hz symbol rate.

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

Where D = high deviation pattern: 2827 kHz

Where M = symbol rate: 1200Hz

$$B_n = \underline{8054 \text{ Hz or } 8.1 \text{ kHz}}$$

This is confirmed in the emission designation 8k10F1E

Spectrum Masks

The spectrum masks are defined in:

Section 90.210(d) – Mask D has been applied as the transmitter can operate in the band 421-512 MHz using an authorised bandwidth of 12.5 kHz as per Section 90.209(b)(5).

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 is placed between the transmitter and the spectrum analyser.

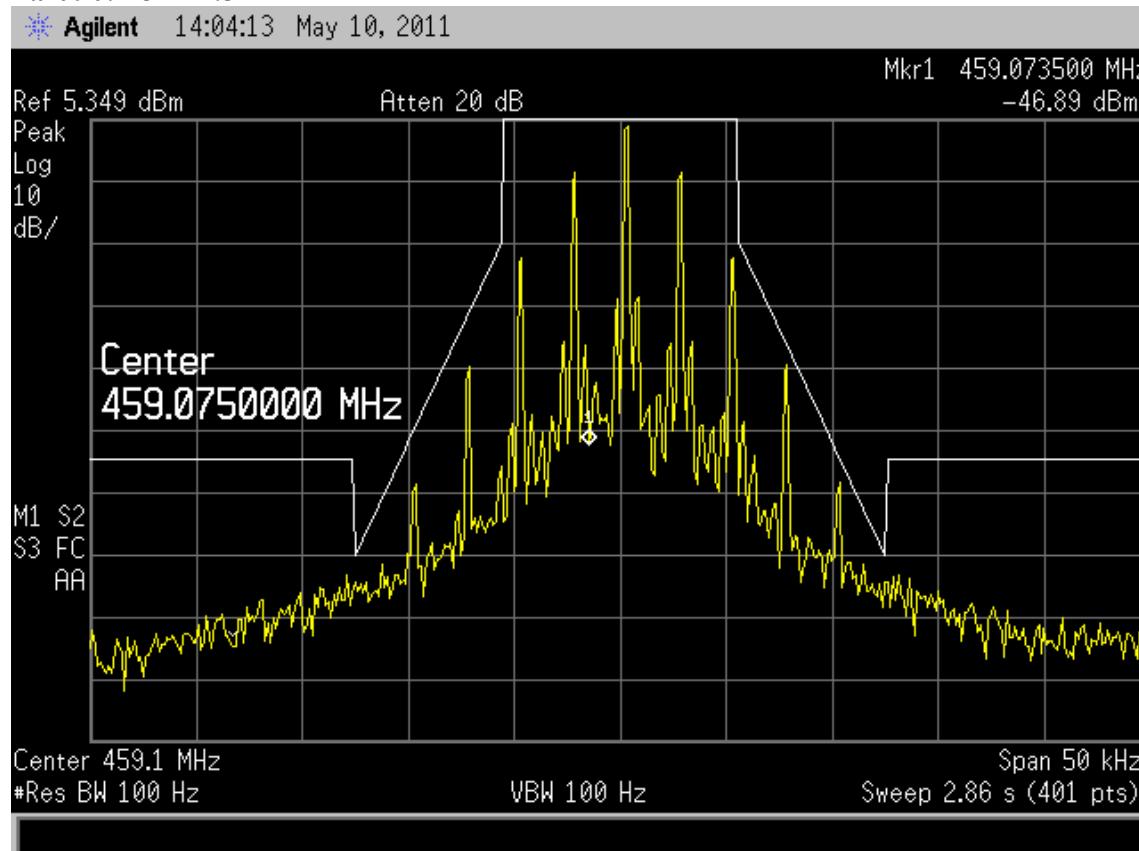
Measurements were made in peak hold with the transmitter operating on 459.075 MHz.

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

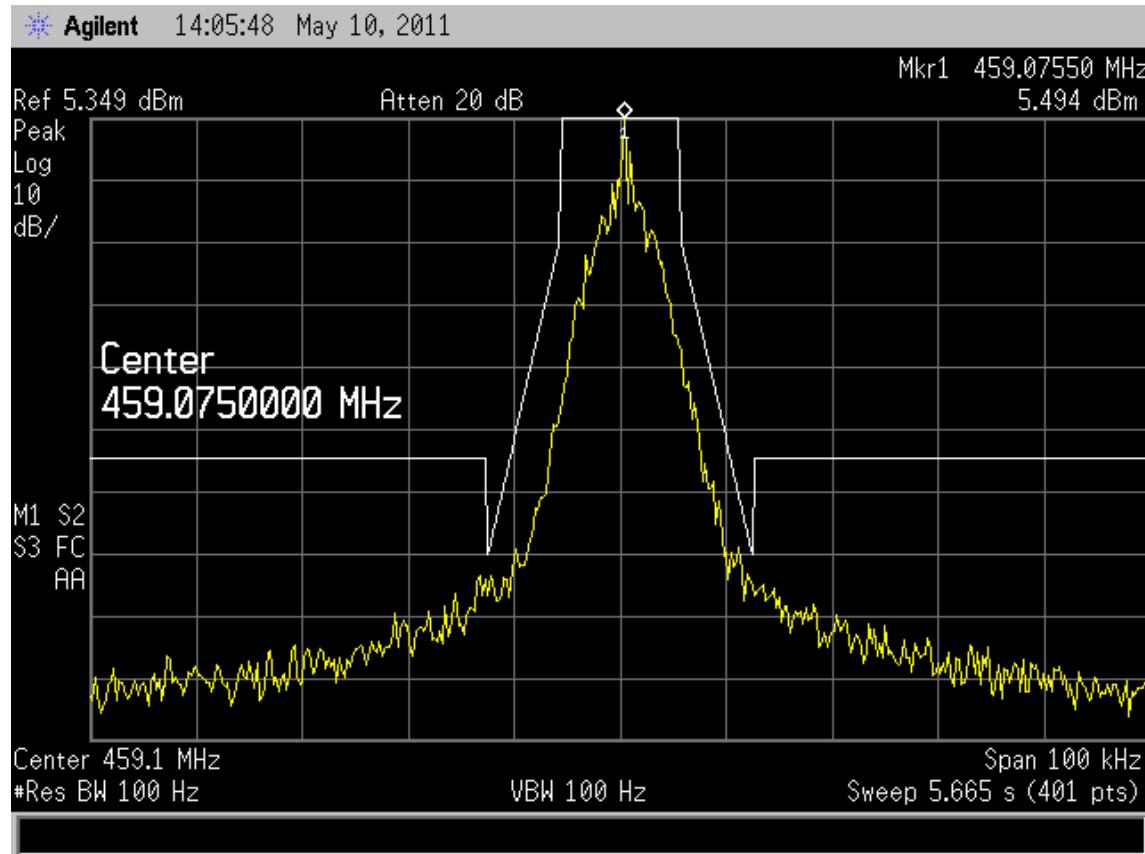
For the F1E mode the transmitter was modulated using modulation sources internal to the transmitter as supplied by the client.

Result: Complies

Part 90: F3E 12.5 kHz



Part 90: F1E 12.5 kHz



Transmitter spurious emissions at the antenna terminals

Frequency: 459.075 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
918.150	-37.2	-20.0
1377.225	-46.0	-20.0
1836.300	-55.4	-20.0
2295.375	-55.0	-20.0
2754.450	-31.6	-20.0
3213.525	-35.0	-20.0
3672.600	-68.0	-20.0
4131.675	-68.3	-20.0
4590.750	-66.6	-20.0

No other emissions observed

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 10th harmonic if the transmitter operates below 10 GHz.

A rated power of 3.0 watts gives a limit of -20.0 dBm.

Some emissions less than -40 dBm have been reported for completeness.

No measurements were made above the 10th harmonic.

Result: Complies

Measurement Uncertainty: ± 3.3 dB

Receiver spurious emissions at antenna terminals

Receive frequency: 459.075 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
504.075	-85.3	-57.0
1512.225	-83.5	-47.0

The receiver has an intermediate frequency of 45 MHz

No other emissions within 30 dB of the limit were observed.

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

Field strength of the transmitter spurious emissions

Frequency: 459.075 MHz

Frequency (MHz)	Level (dB μ V/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
918.1500	49.6	-45.6	-20.0	Vertical	25.6
918.1500	49.2	-46.0	-20.0	Horizontal	26.0
1377.2250	42.2	-53.0	-20.0	Vertical	33.0
1377.2250	55.0	-40.2	-20.0	Horizontal	20.2
1836.3000	41.9	-53.3	-20.0	Vertical	33.3
1836.3000	39.6	-55.6	-20.0	Horizontal	35.6
2295.3750	41.0	-54.2	-20.0	Vertical	34.2
2295.3750	43.0	-52.2	-20.0	Horizontal	32.2
2754.4500	<40	-	-20.0	Vertical	-
2754.4500	<40	-	-20.0	Horizontal	-
3213.5250	<40	-	-20.0	Vertical	-
3213.5250	<40	-	-20.0	Horizontal	-
3672.6000	<40	-	-20.0	Vertical	-
3672.6000	<40	-	-20.0	Horizontal	-
4131.6750	<43	-	-20.0	Vertical	-
4131.6750	<43	-	-20.0	Horizontal	-
4590.7500	<43	-	-20.0	Vertical	-
4590.7500	<43	-	-20.0	Horizontal	-

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

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

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 February 2011

Limit:

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

The rated power of 3.0 watts gives a limit of -20 dBm.

No measurements were made above the 10th harmonic.

Result: Complies

Measurement Uncertainty: ± 4.1 dB

Field strength of the receiver spurious emissions

Frequency: 459.075 MHz

Frequency MHz	Vertical dB μ V/m	Horizontal dB μ V/m	Limit dB μ V/m	Margin dB	Result
504.075	23.5	22.5	43.5	20.0	Pass
300.015	21.1	31.0	43.5	12.5	Pass
320.000	23.0	29.6	43.5	13.9	Pass
325.000	19.0	23.6	46.0	22.4	Pass
371.200	28.0	36.0	46.0	10.0	Pass
396.795	31.0	32.8	46.0	13.2	Pass
402.700	16.0	16.0	46.0	30.0	Pass
422.400	27.0	29.0	46.0	17.0	Pass
601.598	26.5	29.2	46.0	16.8	Pass
726.000	32.2	33.6	46.0	12.4	Pass

The receiver has an intermediate frequency of 45 MHz

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 February 2011

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

Above 1000 MHz an average detector was used with a bandwidth of 1 MHz.

The receiver was tested while receiving continuously while attached to a dummy load.

Limit:

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

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.

Measurements were made with the input voltage set to 110.0 Vac and when decreased 15% to 95.6 Vac and increased 15% to 126.5 Vac.

Testing was carried out at maximum power output.

Frequency: 459.075 MHz

Temperature	Voltage 95.6 Vac	Voltage 110.0 Vac	Voltage 126.5 Vac
+50°C	+3.0	+3.0	+3.0
+40°C	-6.0	-6.0	-6.0
+30°C	-21.0	-21.0	-21.0
+20°C	-9.0	-10.0	-10.0
+10°C	-56.0	-56.0	-56.0
0°C	-153.0	-153.0	-153.0
-10°C	-316.0	-316.0	-316.0
-20°C	-421.0	-421.0	-421.0
-30°C	-462.0	-462.0	-462.0

Limit:

Part 90.213 state that mobile station transmitters operating between 421 – 512 MHz with 12.5 kHz channelling are required to have a frequency tolerance of 2.5 ppm.

This transmitter was tested on 440.0750 MHz. $2.5 \text{ ppm} = 2.5 \times 440 = 1100 \text{ Hz}$.

Result: Complies

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

Transient frequency behaviour

Transient frequency behaviour measurements are applicable to wide band and narrow band transmitters operating in the frequency band 406-512 MHz. Measurements were carried out at 459.075 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 459.075 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.

Channel Spacing	Period t_1 (kHz)	Period t_2 (kHz)	Period t_3 (kHz)
12.5 kHz	nil	nil	nil

Limits:

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

Result: Complies

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

12.5 kHz transmitter turn on

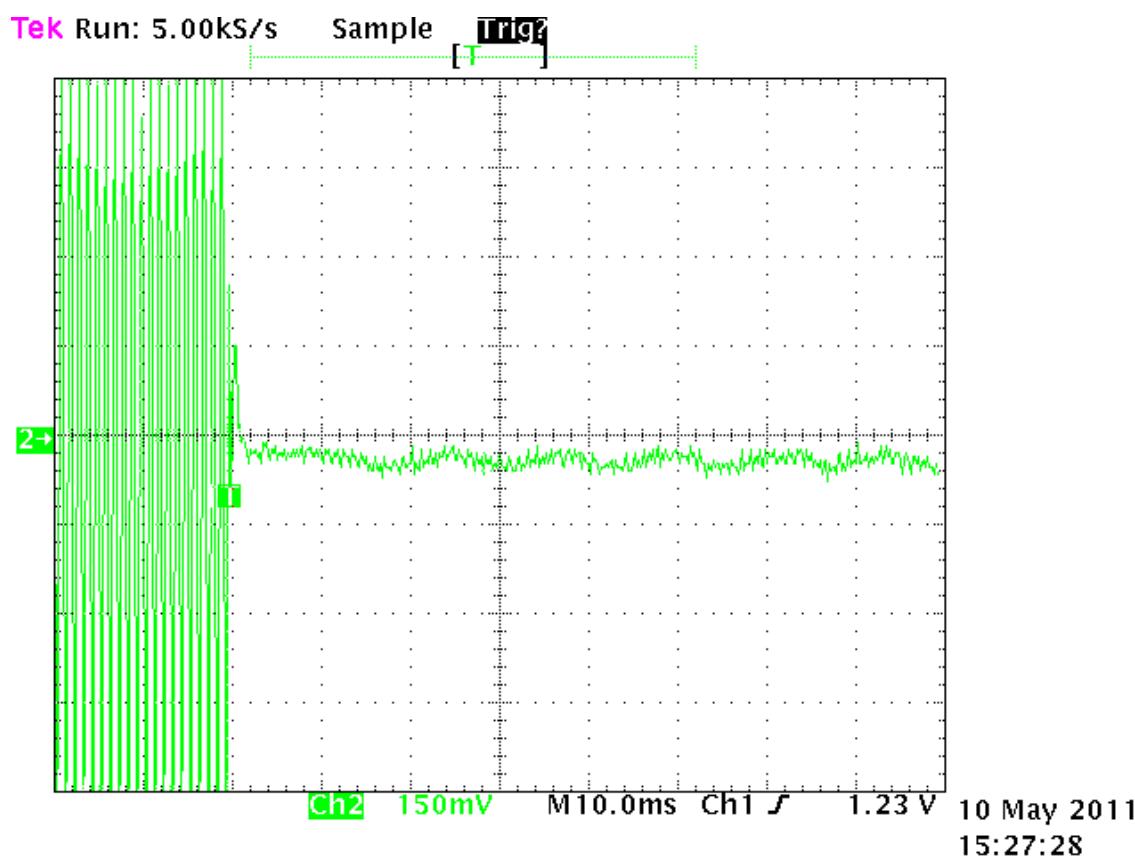
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz and any transient.

Green trace has been maximised to give full screen indication of a ± 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). This is position ton.

t_1 occurs between 2.0 and 3.0 divisions from the left-hand edge.
 t_2 occurs between 3.0 and 5.5 divisions from the left-hand edge.

A transient can be observed just after ton.



12.5 kHz transmitter turn off

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

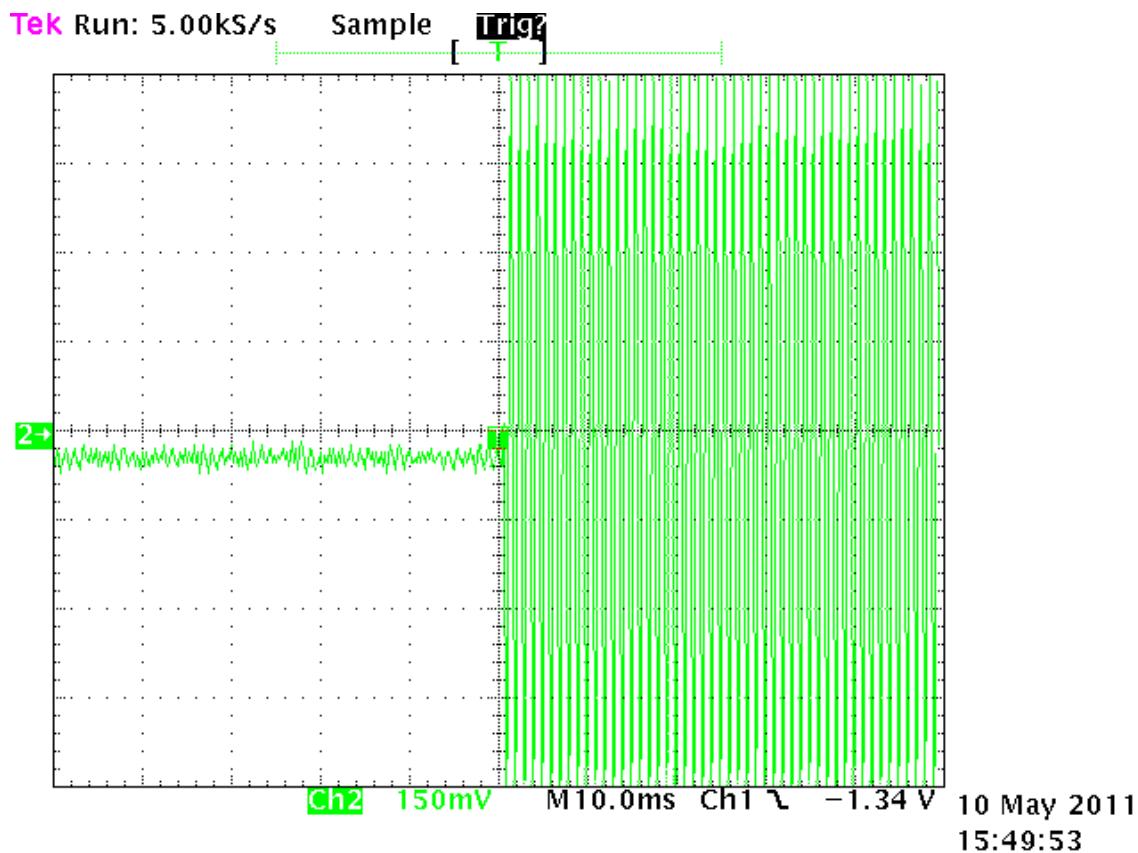
Green trace has been maximised to give full screen indication of a \pm 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

The display of the 1 kHz signal rising has been positioned 5 divisions from the left hand edge (50 mS).

This is position *toff*.

t3 occurs between 4.0 and 5.0 divisions from the left hand edge.

No transient response can be observed just before *toff*.



8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal due
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	N/a
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	N/a
Attenuator 20 dB	Tenuline	8323	1045	E1217	N/a
Audio Analyzer	Hewlett Packard	8903A	2216A01713	E1146	29/09/11
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	17/01/14
Frequency Counter	Hewlett Packard	HP 5342A	1916A01713	E1224	17/12/12
Level generator	Anritsu	MG443B	M61689	E1143	10/11/13
Log Periodic	Schwarzbeck	VUSLP9111	9111-228	3785	03/03/13
Receiver	Rohde & Schwarz	ESIB 40	100171	4003	10/06/11
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552	07/12/12
Modulation Analyzer	Hewlett Packard	8901B	2608A00782	E1090	27/01/12
Oscilloscope	Tektronics	745A	B010643	1569	07/12/12
Power Attenuator	Weinschel	49-20-43	GC104	E1308	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a
RF Power Meter	Hewlett Packard	HP 436A	2512A22439	E1198	29/10/11
Selective Level Meter	Anritsu	ML422C	M35386	E1140	29/09/11
Signal Generator	Rohde & Schwarz	SMHU.58	838923/028	E1493	07/12/12
Spectrum Analyzer	Hewlett Packard	E7405	US39150142	3776	14/12/12
Thermal chamber	Contherm	M180F	86025	E1129	01/06/12
Thermometer	DSIR	RT200	035	E1049	01/06/12
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/a
Horn antenna	EMCO	3115	9511-4629	E1526	21/02/14
Pre Amplifier	Hewlett Packard	8349B	2644A01659	-	N/a

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 February, 2011.

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)

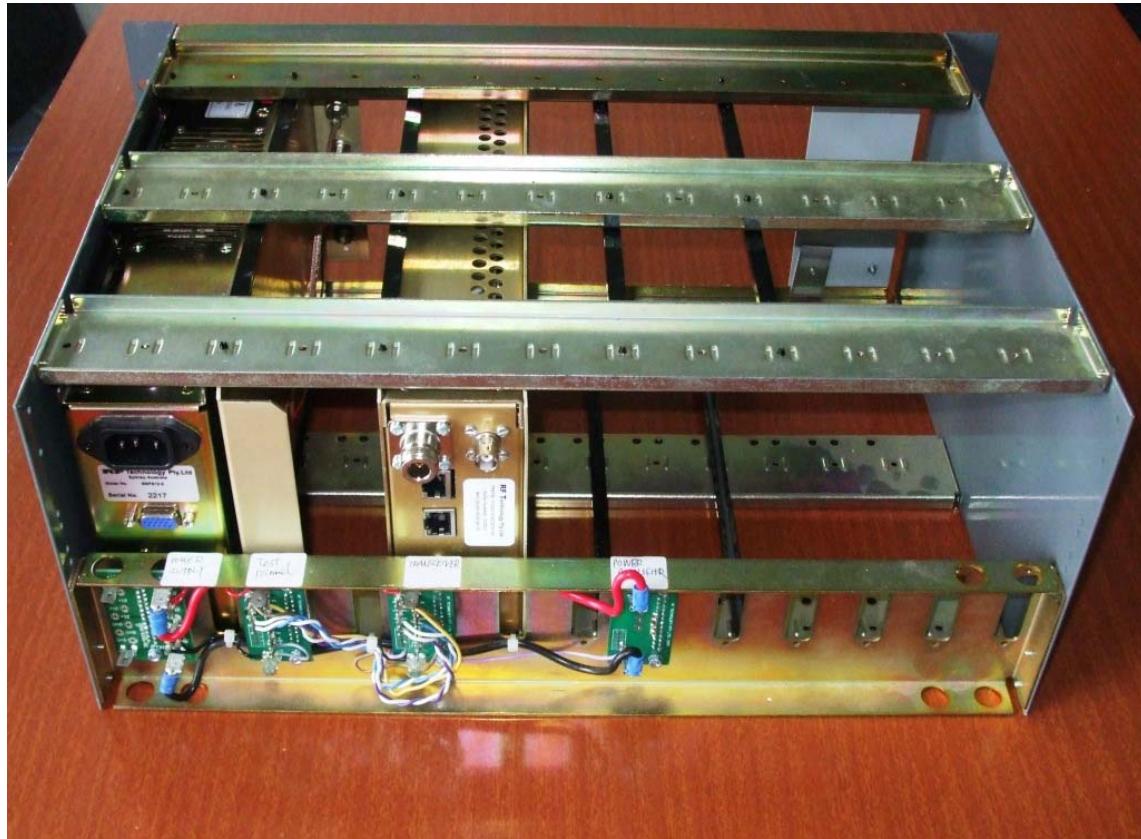
Base station external view



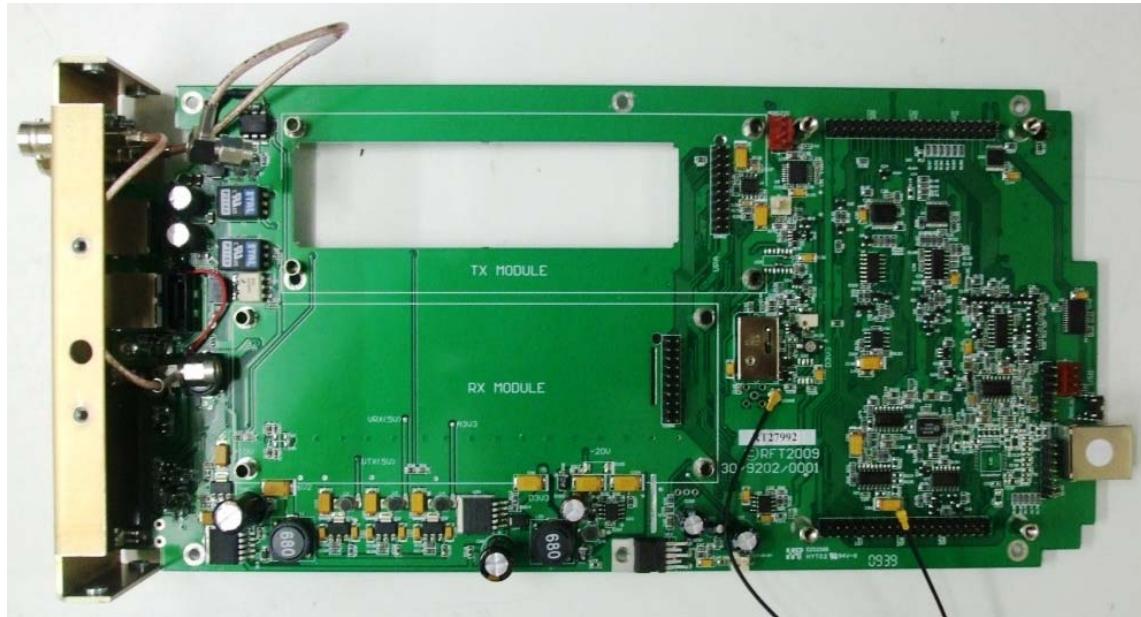
Rack



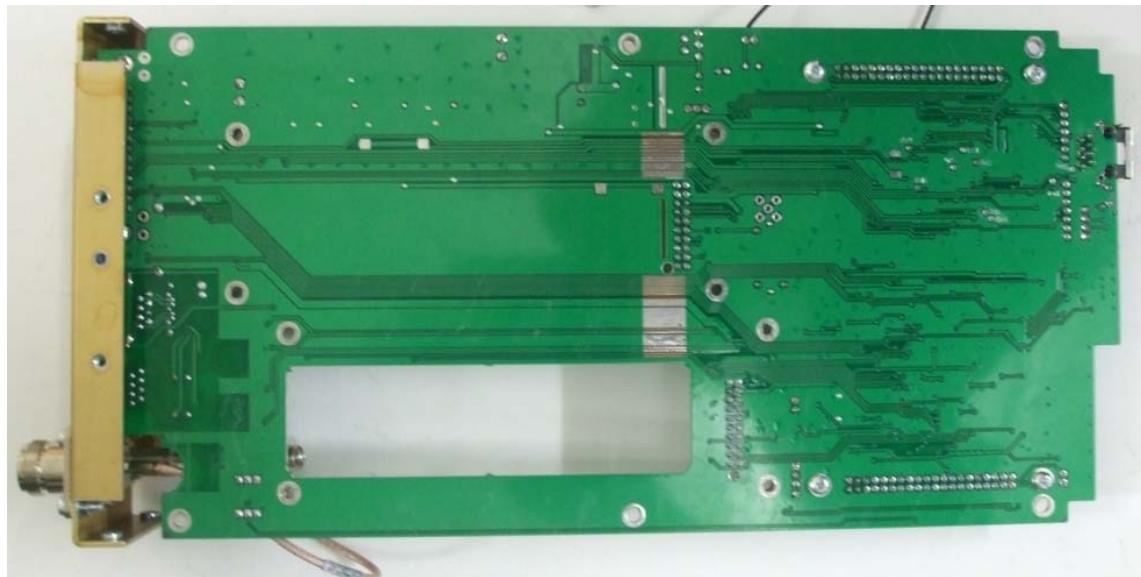
Rack



Main PCB



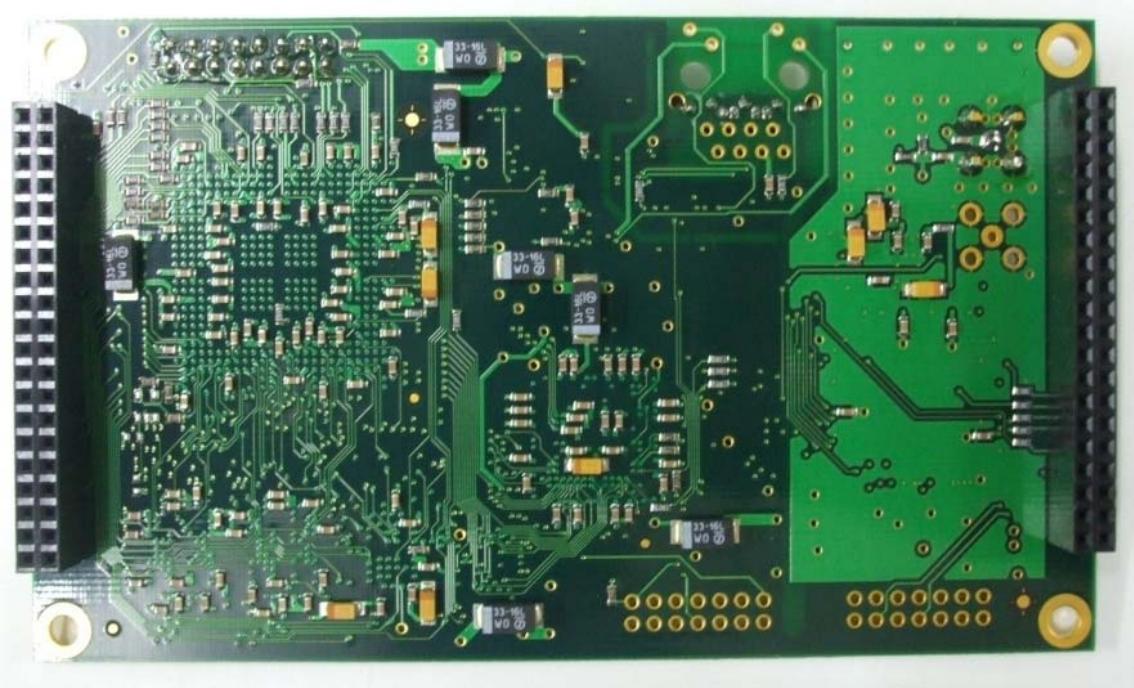
Main PCB



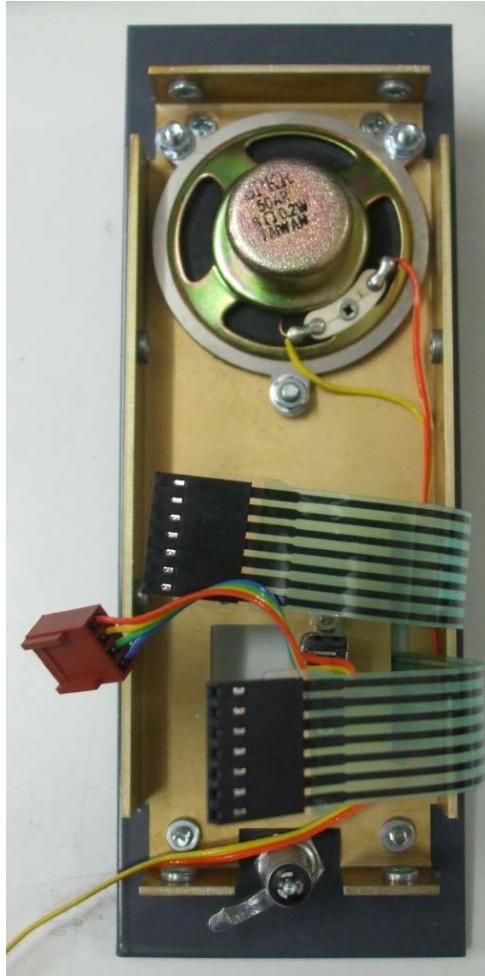
Sub board



Sub board



Front panel



Rx module



Rx module



Tx module



Tx module



Open air test setup

