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## TEST REPORT

### **SIMOCO SRM9000 AC, Series 2, VHF Mobile Transceiver**

*Tested to the*

**Code of Federal Regulations (CFR) 47**

**Part 90 –Private Land Mobile Services**

*for*

**ComGroup Australia Pty Ltd**

This Test Report is issued with the authority of:

A handwritten signature in black ink, appearing to read "Andrew Cutler".

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. STATEMENT OF COMPLIANCE

The **SIMOCO SRM9000 AC, Series 2, VHF Mobile Transceiver** 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.

## 2. RESULTS SUMMARY

The results of testing carried out between 16<sup>th</sup> November and 30<sup>th</sup> November 2012 are summarised below.

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
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
1.1310	Radio frequency exposure limits	Complies

### 3. INTRODUCTION

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

**The client selected the test sample.**

**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.

### 4. CLIENT INFORMATION

<b>Company Name</b>	ComGroup Australia Pty Ltd
<b>Address</b>	1270 Ferntree Gully Rd, Scoresby, Victoria, 3179
<b>Country</b>	Australia
<b>Contact</b>	Mr Bob Stowell

### 5. DESCRIPTION OF TEST SAMPLE

<b>Brand Name</b>	SIMOCO
<b>Model Number</b>	SRM9000 AC
<b>Product</b>	Series 2, VHF Mobile Transceiver
<b>Manufacturer</b>	ComGroup Australia
<b>Manufactured in</b>	Taiwan
<b>Designed in</b>	Australia
<b>Serial Numbers</b>	ERACX12281234
<b>FCC ID</b>	STZSRMA9000AC

The sample tested has the following specifications:

**Rated Transmitter Output Power**

25.0 Watts (43.9 dBm)

**Transmitter FCC frequency range**

150 - 174 MHz

**Test frequencies**

Chl	Frequency MHz	Power Watts	Spacing kHz
1	150.175 (F3E)	25.0	12.5
2	162.175 (F3E)	25.0	12.5
3	173.975 (F3E)	25.0	12.5
4	150.175 (P25)	25.0	12.5
5	162.175 (P25)	25.0	12.5
6	173.975 (P25)	25.0	12.5

**FCC Bands**

Part 90: 150 - 174 MHz

**Emission Designators / Modes of operation**

11k0F3E – Analogue speech  
8k10F1E – C4FM digital speech  
8k10F1D – C4FM data transmission

**Power Supply**

Lead acid battery DC voltage supply typically 12.0 Vdc

**Standard Temperature and Humidity**

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

**Standard Test Power Source**

Standard Test Voltage: 13.8 Vdc.  
High Voltage: 15.6 Vdc  
Low Voltage: 10.8 Vdc

**Extreme Temperature**

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

## 6. ATTESTATION

The **SIMOCO SRM9000 AC, Series 2, VHF Mobile Transceiver** complies with the Code of Federal Regulations (CFR) 47 Part 90 – Private Land Mobile Services.

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

## 7. TEST RESULTS

### Certification required

Certification of this device is sought for transmissions using 12.5 kHz channel spacing with an authorised bandwidth of 11.25 kHz.

12.5 kHz channel spacing 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
- the equipment can operate with a data rate greater than 4.8 kbps per 6.25 kHz of channel bandwidth
- the equipment meets the requirements of FCC Order 10-119.

**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.

Testing was carried out at maximum power output.

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
150.175	13.8	43.9	43.7
162.175	13.8	43.9	43.7
173.975	13.8	43.9	43.7

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
150.175	10.8	43.9	43.7
150.175	15.6	43.9	43.5

### Limits:

Clause 90.205(h) of Part 90 specifies that in the band 150 – 174 MHz the maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and the required service area.

**Result:** Complies

**Measurement Uncertainty:**  $\pm 0.5$  dB

### Emission types:

The following emission types are used:

- F3E: Frequency modulation with analogue speech.
- F1E: C4FM digital modulation is used for digital telephony
- F1D: C4FM digital modulation is used for data transmissions



## 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.

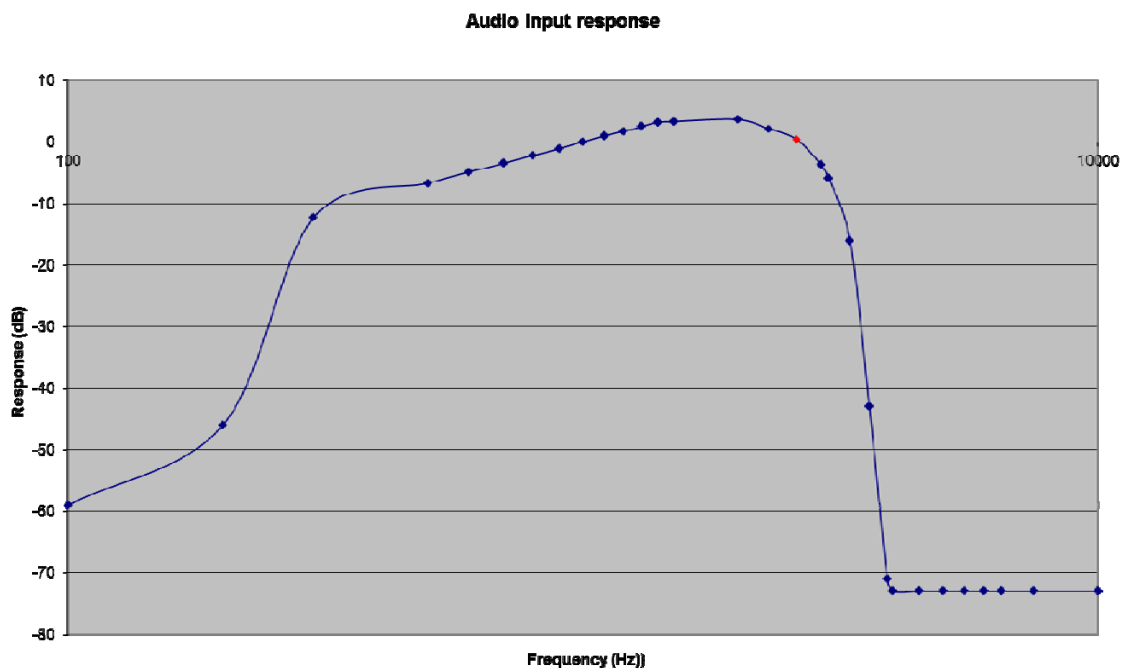
At 1 kHz an audio signal was applied which was used as a 0 dB response reference.

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 2000 Hz.

The -3dB roll off from peak deviation occurs at 2600 Hz, and is denoted as a red data series point on the following graph.

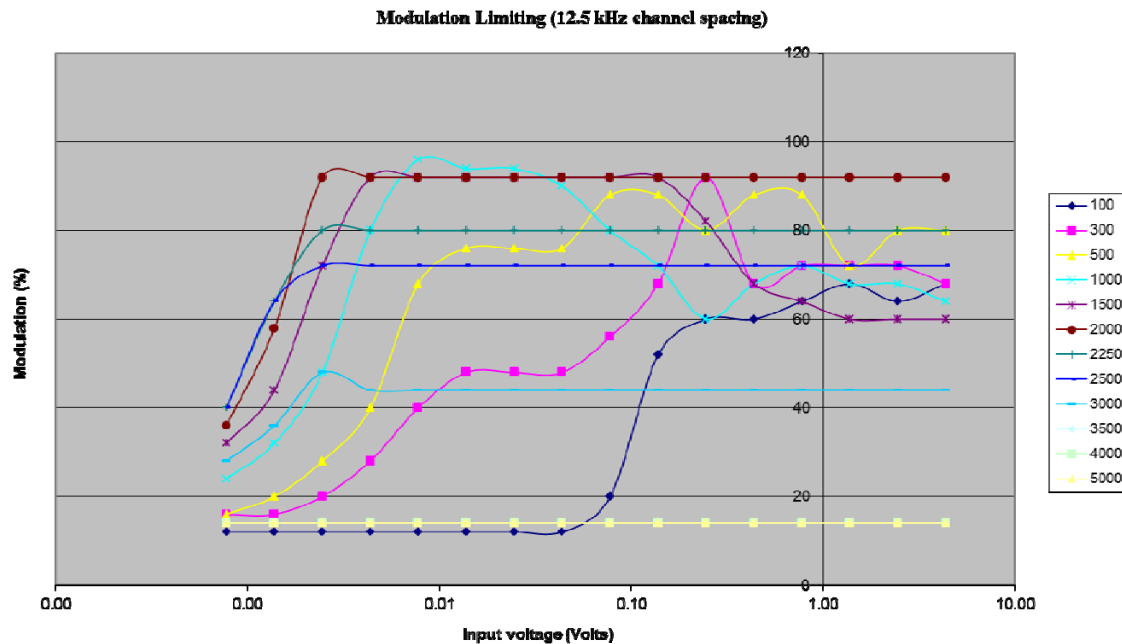


- (b) A family of curves showing the percentage of modulation versus the modulation input voltage.

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).

C4FM digital modulation is used for data transmissions (F1D).

**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:**  $\pm 1\%$ .

**Bandwidth limitations:**

The authorised bandwidth for the 150 – 174 MHz band is 11.25 kHz when 12.5 kHz channel spacing is used.

Using the formulas contained in Part 2.202 the necessary bandwidth calculations will be:

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

Where D = maximum deviation: 2.5 kHz

Where M = maximum modulation frequency: 3 kHz

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

Measurements show the following

$$B_n = 2 \times 2000 \text{ Hz} + 2 \times 2600 \text{ Hz}$$

$$B_n = \underline{9.2 \text{ kHz}}$$

This is confirmed in the emission designation 11k0F3E

For F1E / F1D 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 designations 8k10F1E & 8k10F1D

Measurements have also been made to verify these calculated and declared bandwidths.

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

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

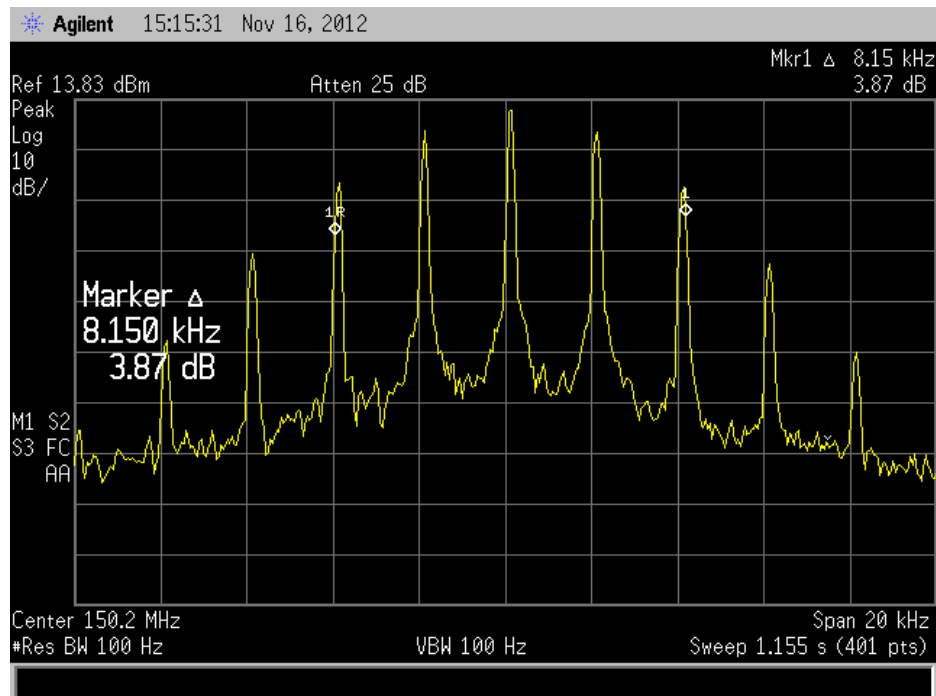
Initially power measurements are made using a resolution bandwidth of 120 kHz.

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

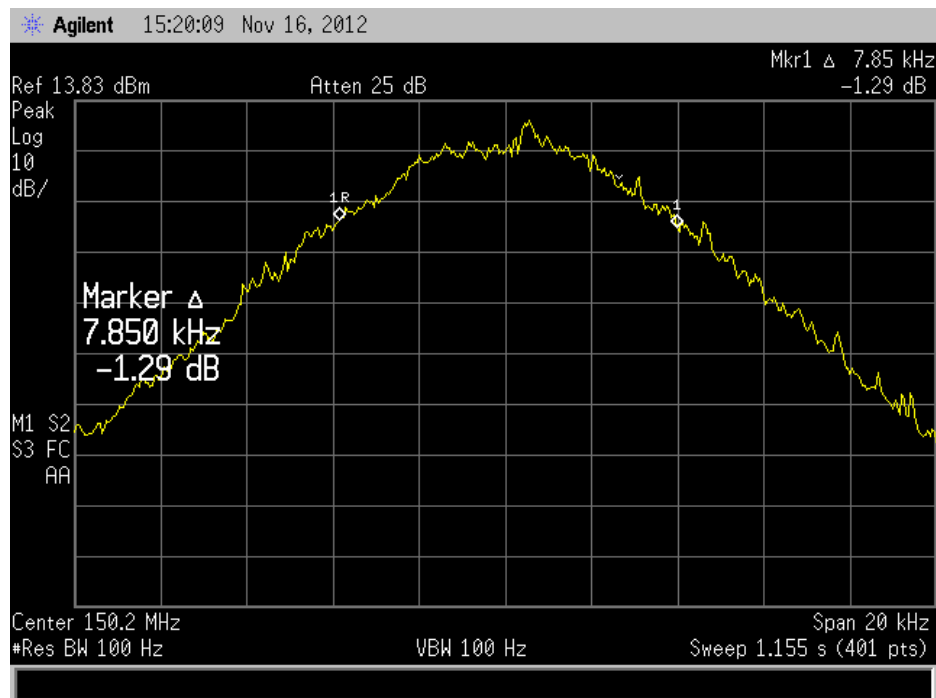
The resolution bandwidth is then changed to 100 Hz and the reference level minus 23 dB (99%) absolute bandwidth points determined.

<b>Emission</b>	<b>Channel</b>	<b>Measured</b>	<b>Designated</b>
F3E	12.5 kHz	8.15 kHz	11.0 kHz
F1E/ F1D	12.5 kHz	7.85 kHz	8.10 kHz

### F3E – 12.5 kHz channel spacing



### F1D / F1E – 12.5 kHz channel spacing



**Result:** Complies

## **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 150 - 174 MHz using an authorised bandwidth of 11.25 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 placed between the transmitter and the spectrum analyser.

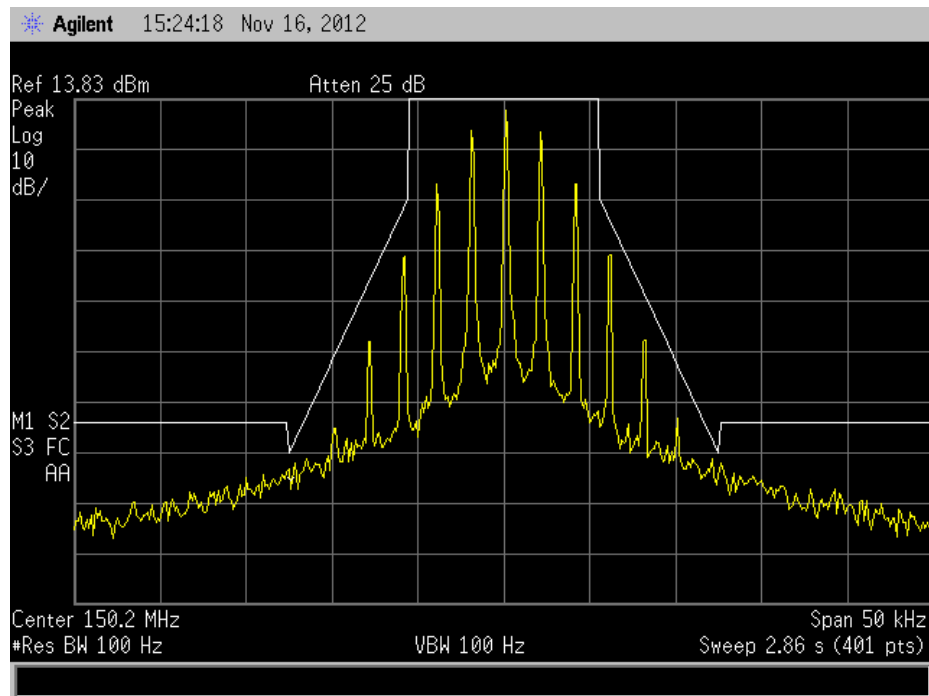
Measurements were made in peak hold with the transmitter operating on 150.175 MHz.

When operating in F3E mode a 2000 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.

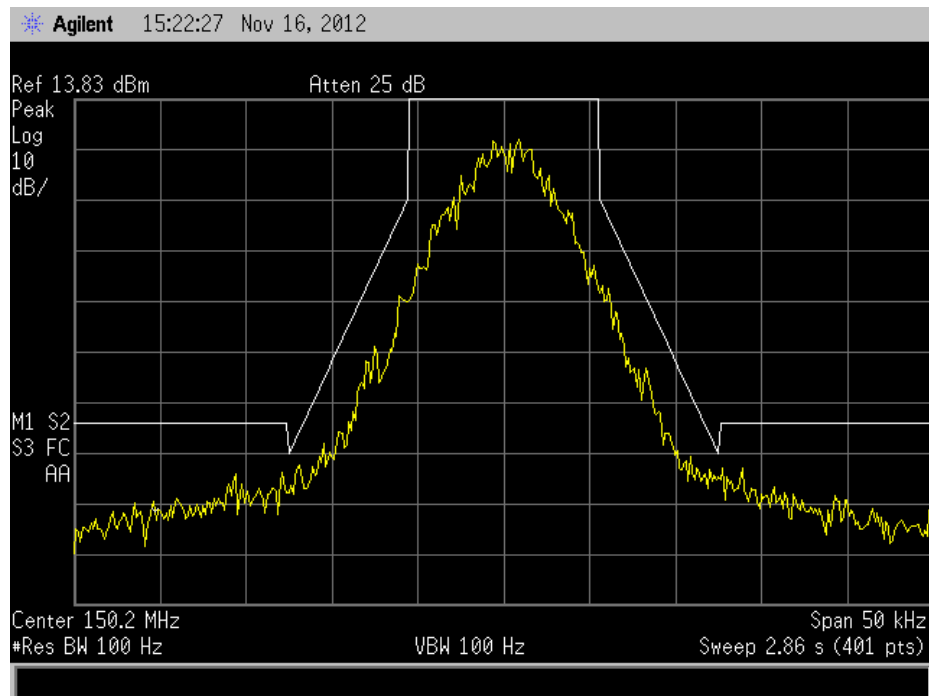
For the F1E and F1D modes the transmitter was modulated uses modulation sources internal to the transmitter as supplied by the client.

**Result:** Complies

### Part 90: F3E 12.5 kHz



### Part 90: F1D / F1E 12.5 kHz



## Transmitter spurious emissions at the antenna terminals

Frequency: 150.175 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
300.350	-55.7	-20.0
450.525	-51.4	-20.0
600.700	-65.6	-20.0
750.875	<-70.0	-20.0
901.050	<-70.0	-20.0
1051.225	<-70.0	-20.0
1201.400	<-70.0	-20.0
1351.575	<-70.0	-20.0
1501.750	<-70.0	-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 spacing 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<sup>th</sup> harmonic if the transmitter operates below 10 GHz.

A rated power of 25.0 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 10<sup>th</sup> harmonic.

**Result:** Complies

**Measurement Uncertainty:**  $\pm 3.3$  dB

## Field strength of the transmitter spurious emissions

Frequency: 150.175 MHz

Frequency (MHz)	Level (dB $\mu$ V/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
324.350	43.0	-54.4	-20.0	Vertical	34.4	Pass
324.350	52.5	-44.9	-20.0	Horizontal	24.9	Pass
486.525	37.8	-59.6	-20.0	Vertical	39.6	Pass
486.525	38.0	-59.4	-20.0	Horizontal	39.4	Pass
648.700	41.0	-56.4	-20.0	Vertical	36.4	Pass
648.700	45.6	-51.8	-20.0	Horizontal	31.8	Pass
810.875	47.2	-50.2	-20.0	Vertical	30.2	Pass
810.875	49.0	-48.4	-20.0	Horizontal	28.4	Pass
973.050	41.0	-56.4	-20.0	Vertical	36.4	Pass
973.050	40.5	-56.9	-20.0	Horizontal	36.9	Pass
1135.225	41.5	-55.9	-20.0	Vertical	35.9	Pass
1135.225	40.5	-56.9	-20.0	Horizontal	36.9	Pass
1297.400	43.0	-54.4	-20.0	Vertical	34.4	Pass
1297.400	42.0	-55.4	-20.0	Horizontal	35.4	Pass
1459.575	43.5	-53.9	-20.0	Vertical	33.9	Pass
1459.575	42.3	-55.1	-20.0	Horizontal	35.1	Pass
1621.750	45.8	-51.6	-20.0	Vertical	31.6	Pass
1621.750	44.0	-53.4	-20.0	Horizontal	33.4	Pass

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 January 2011

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 25 watts gives a limit of  $-20$  dBm.

No measurements were made above the 10<sup>th</sup> harmonic.

**Result:** Complies

**Measurement Uncertainty:**  $\pm 4.1$  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 supply decreased and increased 10% from nominal battery voltage supply.

**Frequency:** 162.175 MHz

Temperature	Voltage 10.8 Vdc	Voltage 13.8 Vdc	Voltage 15.6 Vdc
+50°C	-42.0	-41.0	-41.0
+40°C	-5.0	-12.0	-11.0
+30°C	-1.0	-1.0	+2.0
+20°C	+9.0	+8.0	+8.0
+10°C	+20.0	+20.0	+19.0
0°C	+19.0	+19.0	+19.0
-10°C	+19.0	+18.0	+18.0
-20°C	+16.0	+17.0	+17.0
-30°C	+17.0	+17.0	+18.0

### Limit:

Part 90.213 states that mobile station transmitters operating between 150 – 174 MHz with 12.5 kHz channelling are required to have a frequency tolerance of 5.0 ppm.

This transmitter was tested on 162.175 MHz

$$5 \text{ ppm} = 5 \times 162.175 = 810 \text{ Hz.}$$

**Result:** Complies

**Measurement Uncertainty:** ±30 Hz

## Transient frequency behaviour

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

Measurements were carried out 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 transmitter transmit frequency of 150.175 MHz with an 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	12.5 kHz Deviation (kHz)	25 kHz Deviation (kHz)
$t_1$	5 ms	$\pm 12.5$	$\pm 25.0$
$t_2$	20 ms	$\pm 6.25$	$\pm 12.5$
$t_3$	5 ms	$\pm 12.5$	$\pm 25.0$

**Result:** Complies

**Measurement Uncertainty:** Frequency difference  $\pm 1.6$  kHz, Time period  $\pm 1$  ms

## 12.5 kHz transmitter turn on

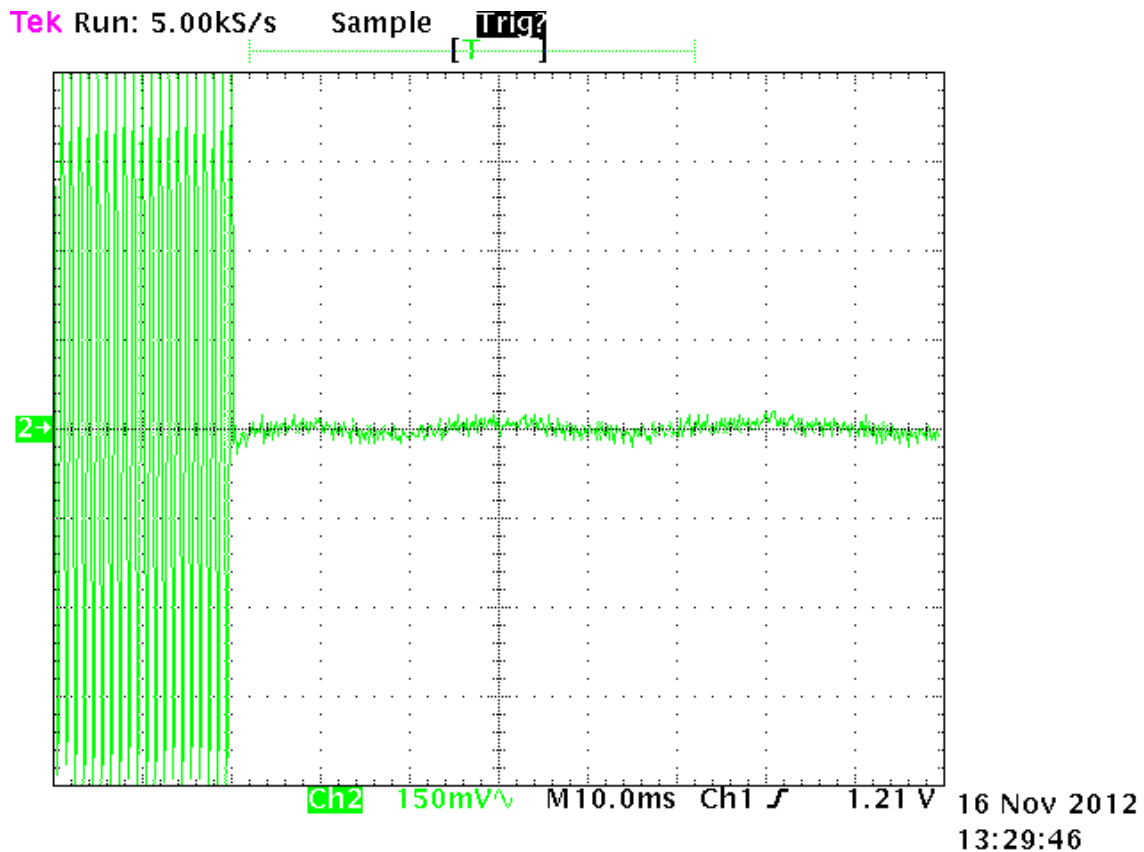
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz and any transient.

Green trace has been maximised to give full screen indication of a  $\pm 12.5$  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.

Triggering has been set to occur 2 divisions from the left hand edge (20 ms). This is position  $t_{on}$ .

$t_1$  occurs between 2.0 and 2.5 divisions from the left-hand edge.  
 $t_2$  occurs between 2.5 and 4.5 divisions from the left-hand edge.

No transient can be observed just after  $t_{on}$ .



## 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.

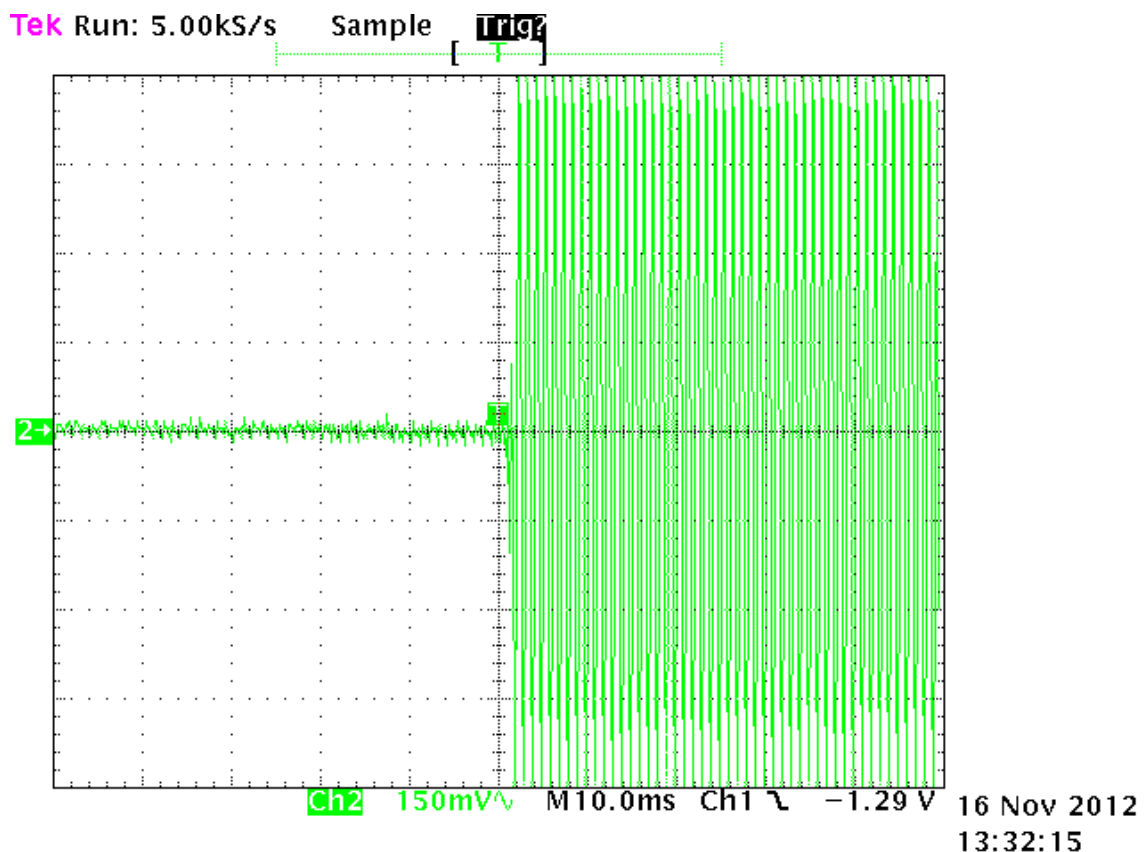
The X axis has been set to a sweep rate of 10 ms/division.

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

This is position *t*off.

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

No transient response can be observed just before toff.



## Exposure of humans to RF fields

As per Section 1.1310 mobile transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels in accordance with OST/OET Bulletin Number 65.

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

Minimum safe distances have been calculated below.

$$\text{Power density, mW/m}^2 = E^2/3770$$

- Occupational / Controlled Exposure limit will be 10 mW/m<sup>2</sup> or 60 V/m
- General Population / Uncontrolled exposure limit will be 2 mW/m<sup>2</sup> or 28 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:

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

The rated maximum transmitter power = 25 watts.

Transmitter is operated using a quarter wave whip antenna with a gain of 2.14 dBi (1.64).

As the transmitter is used on a push to talk basis a duty cycle of 50% has been applied.

### Controlled

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

$$d = \sqrt{30 * 25 * 1.64 * 0.50} / 60$$

$$d = 0.41 \text{ metres or } 41 \text{ cm}$$

### Uncontrolled

$$d = \sqrt{30 * 25 * 1.64 * 0.50} / 28$$

$$d = 0.89 \text{ metres or } 89 \text{ cm}$$

**Result:** Complies if the safe distances defined for each environment are applied.

## 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
Audio Analyzer	Hewlett Packard	8903A	2216A01713	E1146	09/07/2014
Biconical Antenna	Schwarzbeck	BBA 9106	9594	RFS 3680	12/01/2015
Frequency Counter	Hewlett Packard	HP 5342A	1916A01713	E1224	17/12/2012
Level generator	Anritsu	MG443B	M61689	E1143	10/02/2013
Log Periodic	Schwarzbeck	VUSLP9111	9111-228	RFS 3785	12/01/2015
Receiver	Rohde & Schwarz	ESIB 40	100171	EMC4003	20/10/2013
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552	07/12/2012
Modulation Analyzer	Hewlett Packard	8901B	2608A00782	E1090	10/07/2014
Oscilloscope	Tektronics	745A	B010643	E1569	07/12/2012
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	09/07/2014
Selective Level Meter	Anritsu	ML422C	M35386	E1140	21/10/2013
Signal Generator	Rohde & Schwarz	SMHU.58	838923/028	E1493	07/12/2012
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	RFS 3776	14/12/2012
Thermal chamber	Contherm	M180F	86025	E1129	N/a
Thermometer	DSIR	RT200	035	E1409	27/03/2013
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	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 in January 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.

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

## 10. PHOTOGRAPH (S)





**MAR-9030PLCH control head**



**MAR-9022CM control head**



**MAR-9020plus control head**





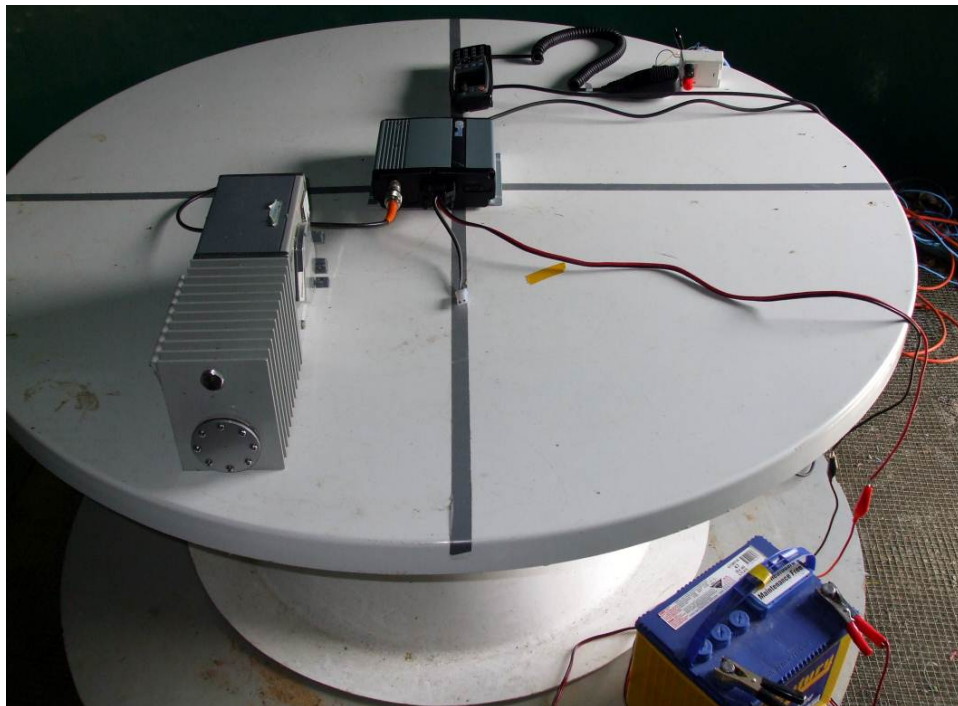
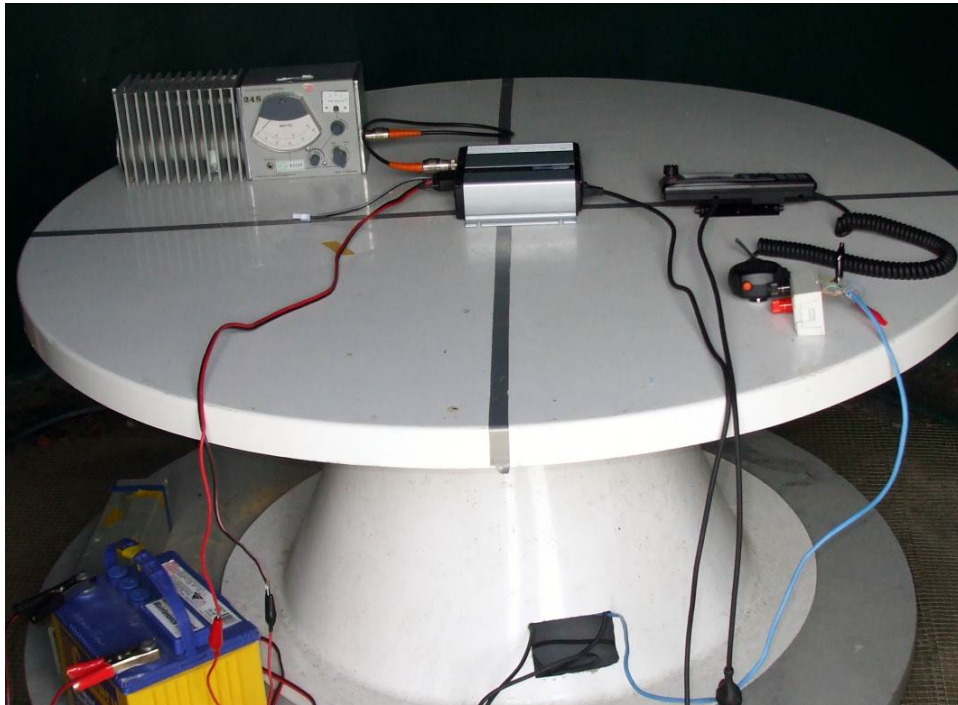
Label

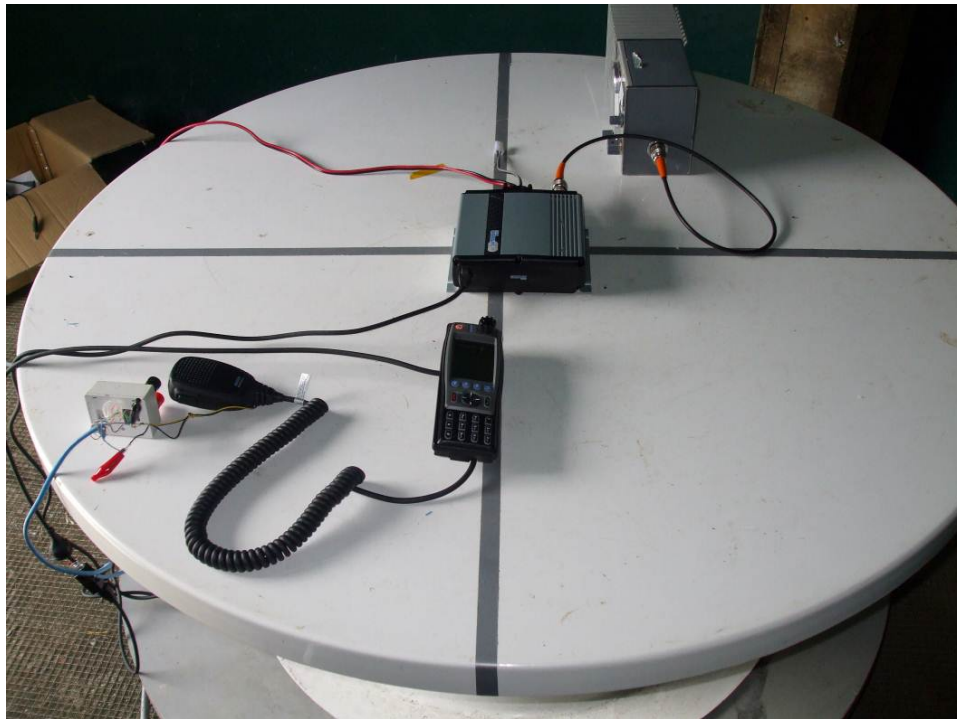
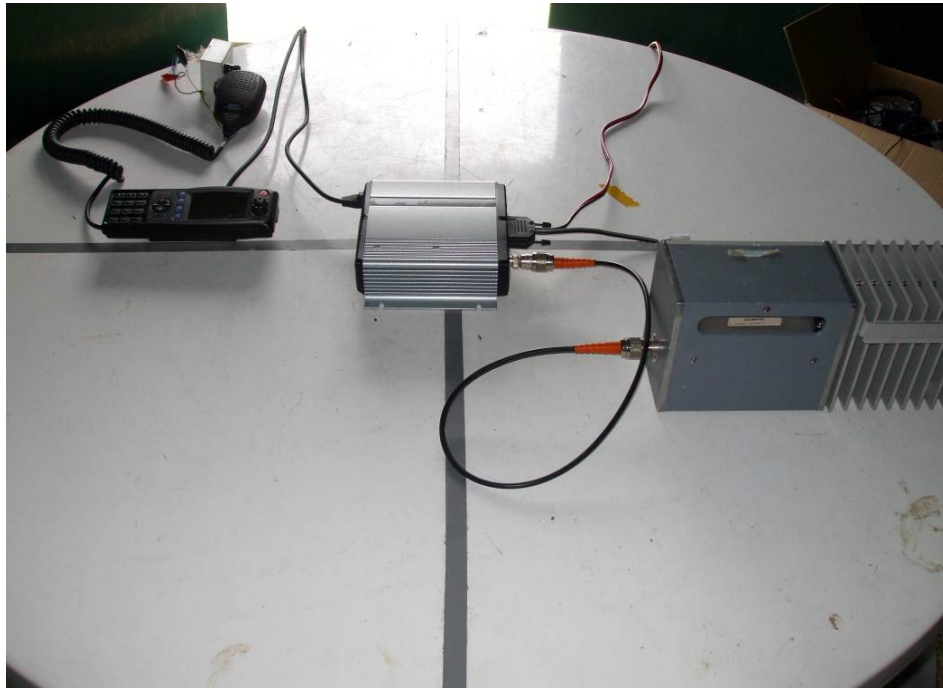


Label on bottom of transceiver



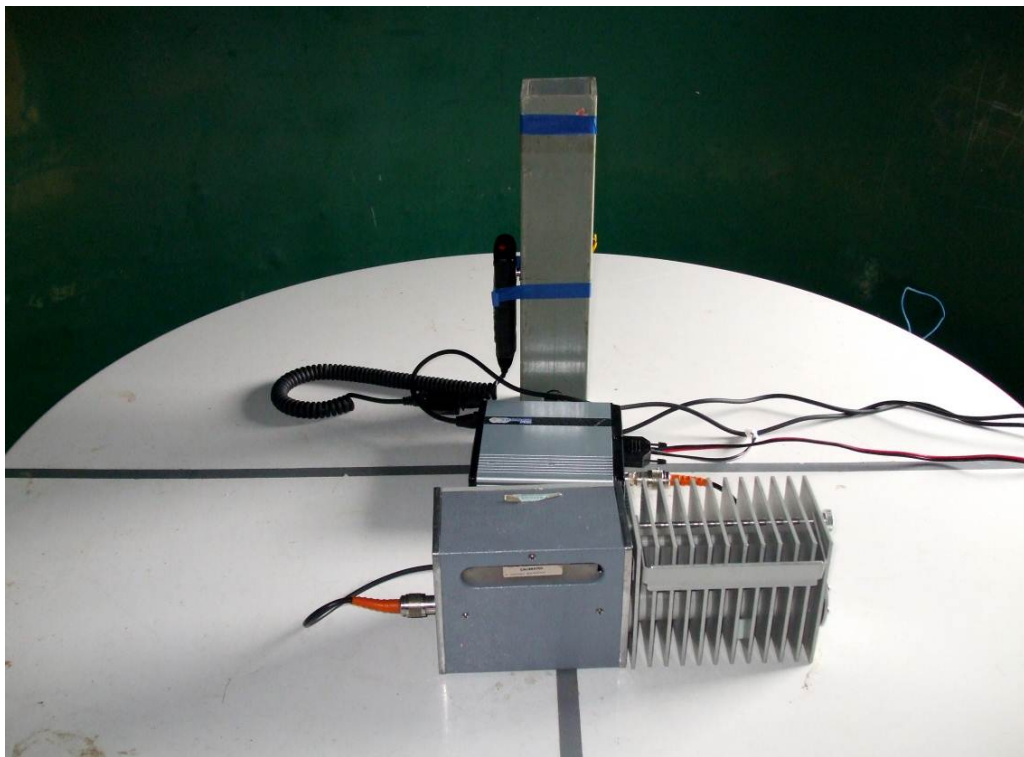
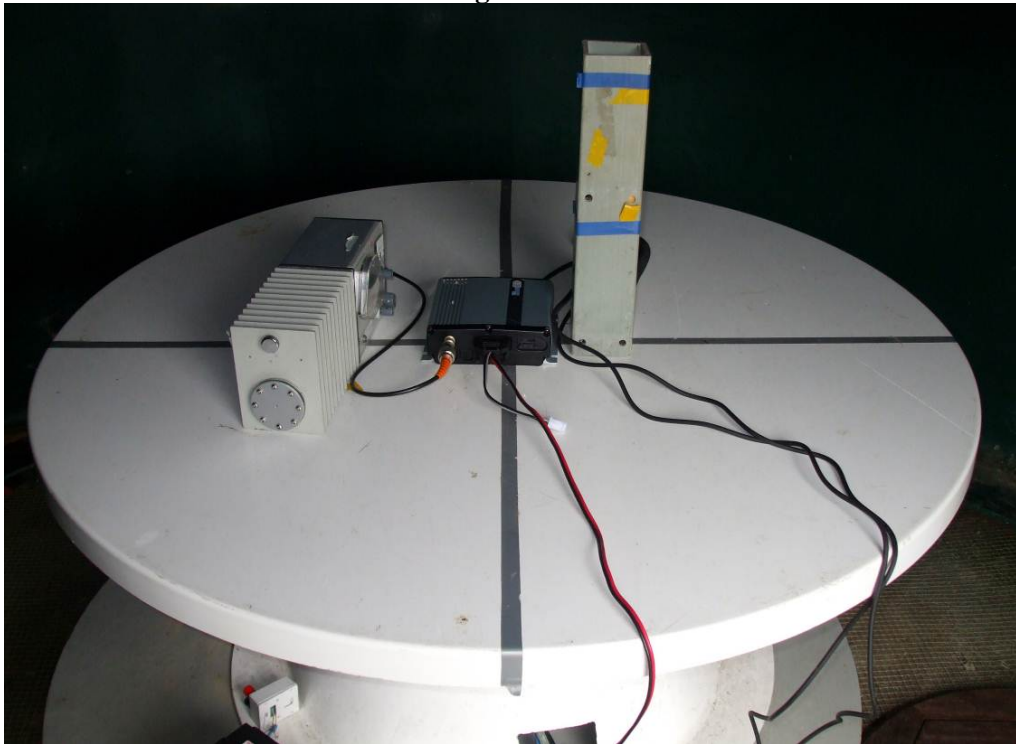
## Radiated emissions

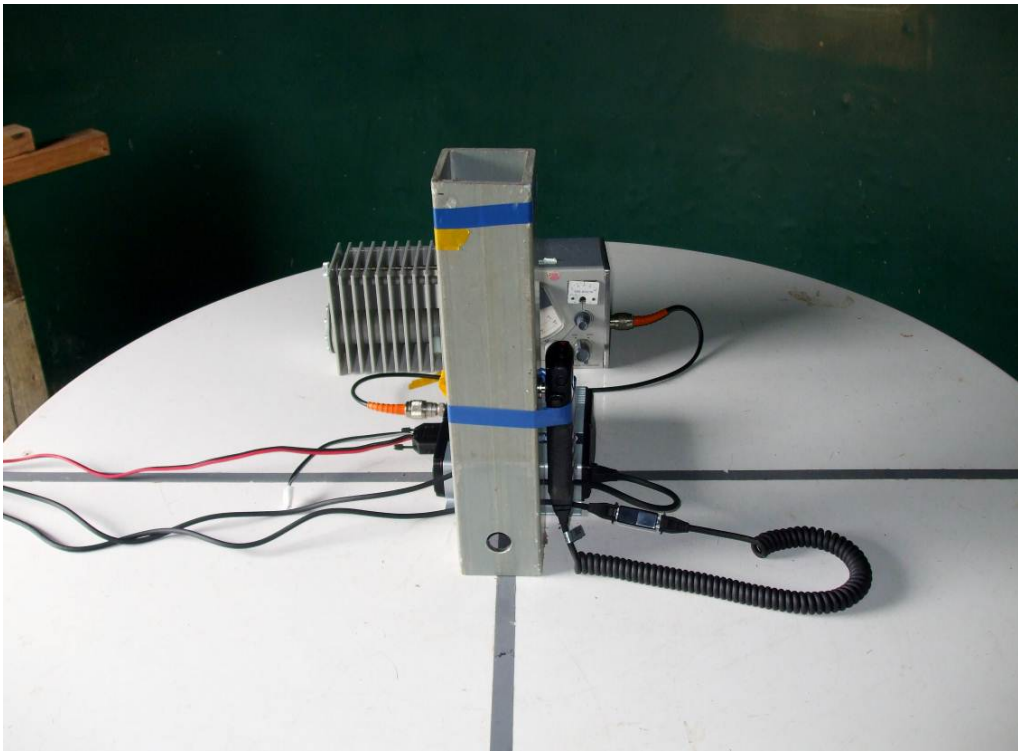




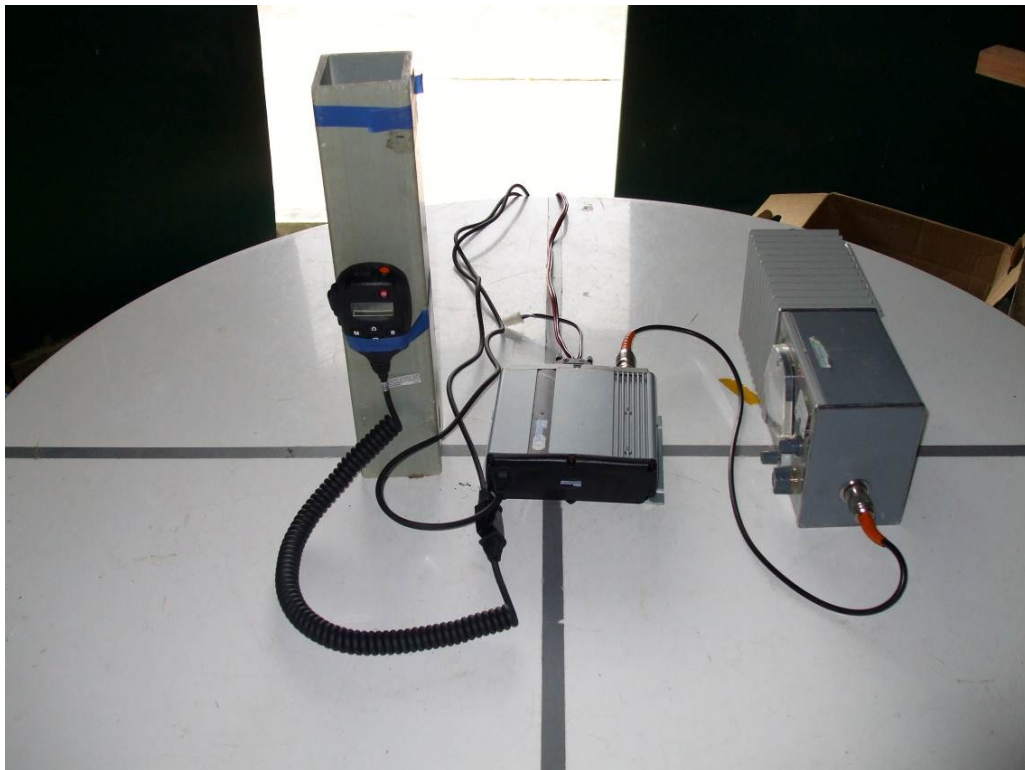
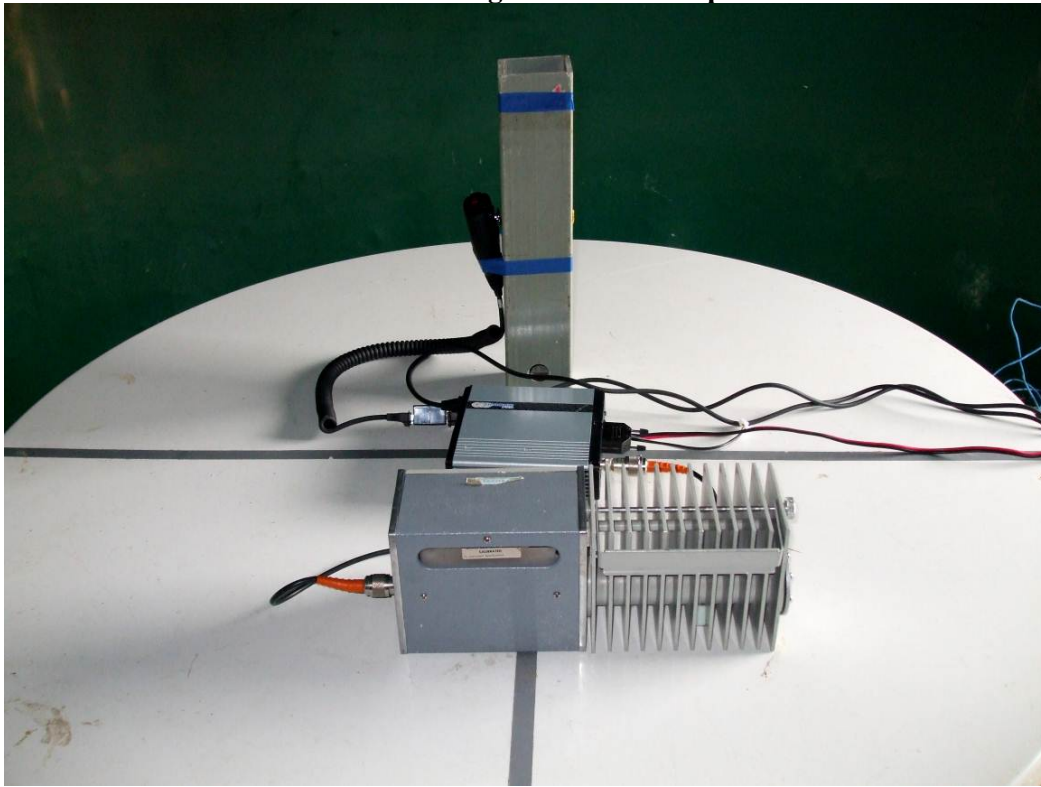


## Radiated testing with MAR9022CM

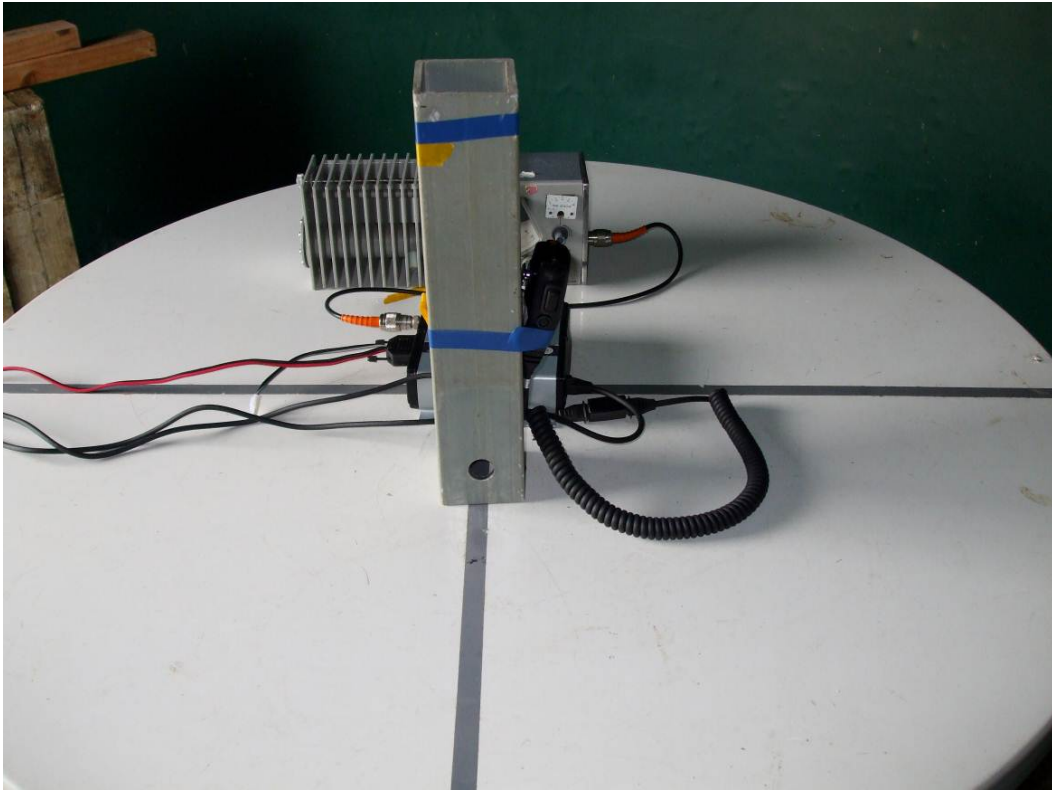




**Radiated testing with MAR9020plus**







## Internal Photos





