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TEST REPORT

SIMOCO SRM9000 TU, Series 2, UHF 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 TU, Series 2, UHF 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 16th November and 30th 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

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

5. DESCRIPTION OF TEST SAMPLE

Brand Name	SIMOCO
Model Number	SRM9000 TU
Product	Series 2, UHF Mobile Transceiver
Manufacturer	ComGroup Australia
Manufactured in	Taiwan
Designed in	Australia
Serial Numbers	ERTUX12281235
FCC ID	STZSRMA9000TU

The sample tested has the following specifications:

Rated Transmitter Output Power

25.0 Watts (43.9 dBm)

Transmitter FCC frequency range

406.1- 480 MHz

Test frequencies

Chl	Frequency MHz	Power Watts	Spacing kHz
1	406.175 (F3E)	25.0	12.5
2	440.175 (F3E)	25.0	12.5
3	479.975 (F3E)	25.0	12.5
4	406.175 (P25)	25.0	12.5
5	440.175 (P25)	25.0	12.5
6	479.975 (P25)	25.0	12.5

FCC Bands

Part 90: 406 - 512 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 TU, Series 2, UHF 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.

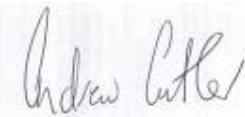
This report does not contain corrections or erasures.

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 Ω 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)
406.175	13.8	43.9	43.6
440.175	13.8	43.9	43.5
479.975	13.8	43.9	43.5

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
406.175	10.8	43.9	43.6
406.175	15.6	43.9	43.5

Limits:

Clause 90.205(h) of Part 90 specifies that in the band 450 – 470 MHz the maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and the required service area.

Clause 90.205(i) of Part 90 specifies that in the band 470- 512 MHz the maximum allowable station effective radiated power (ERP) is specified in Clause 90.307 and 90.309.

Result: Complies

Measurement Uncertainty: ± 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.

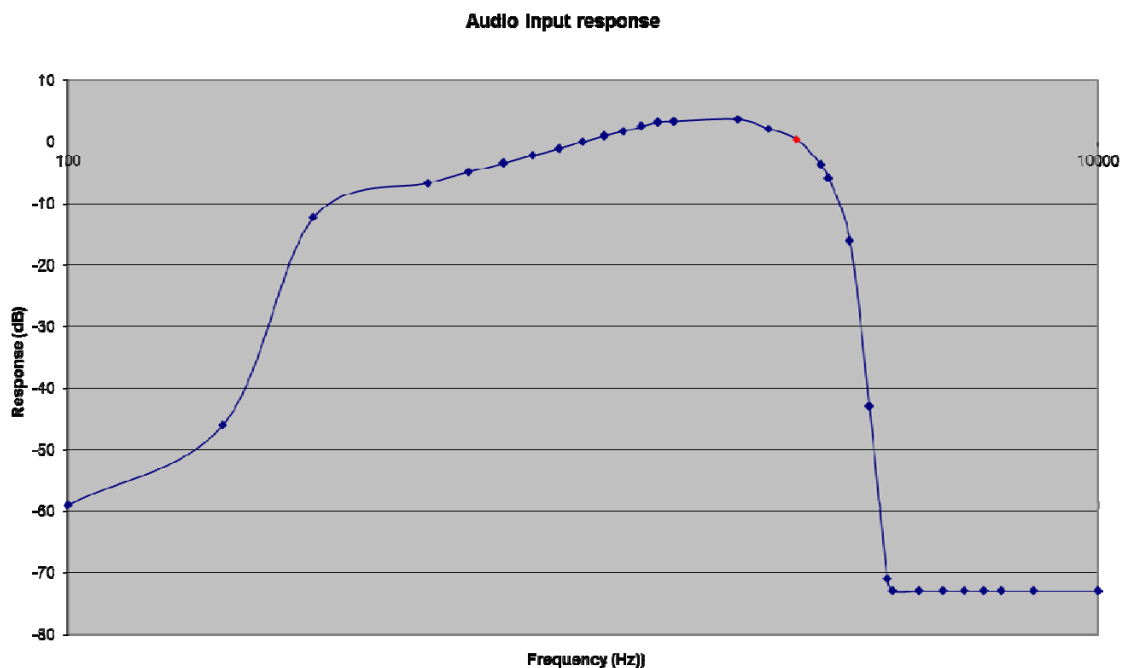
At 1 kHz an audio signal was applied which was used as a 0 dB response reference.

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.

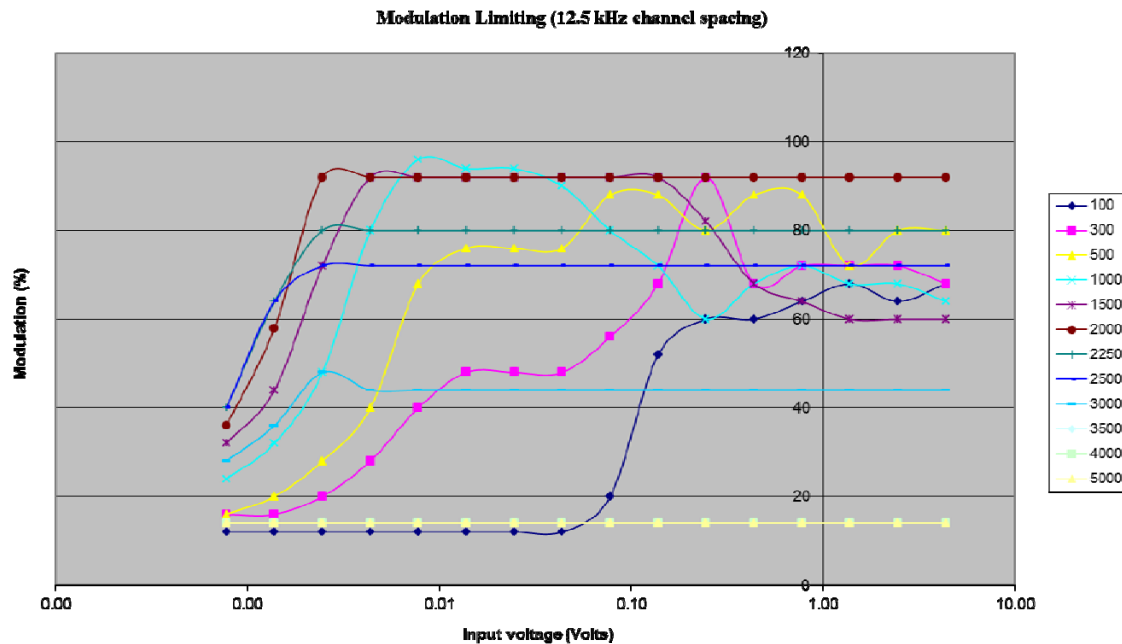


- (b) A family of curves showing the percentage of modulation versus the modulation input voltage.

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 406 – 512 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 calculation 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.

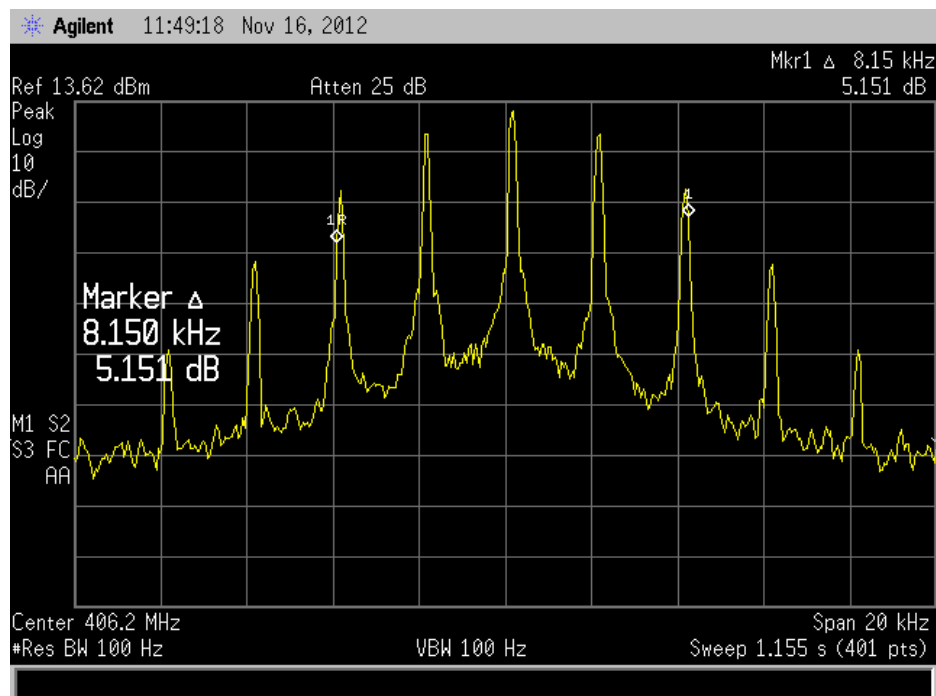
Initially power measurements are made using a resolution bandwidth of 120 kHz.

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

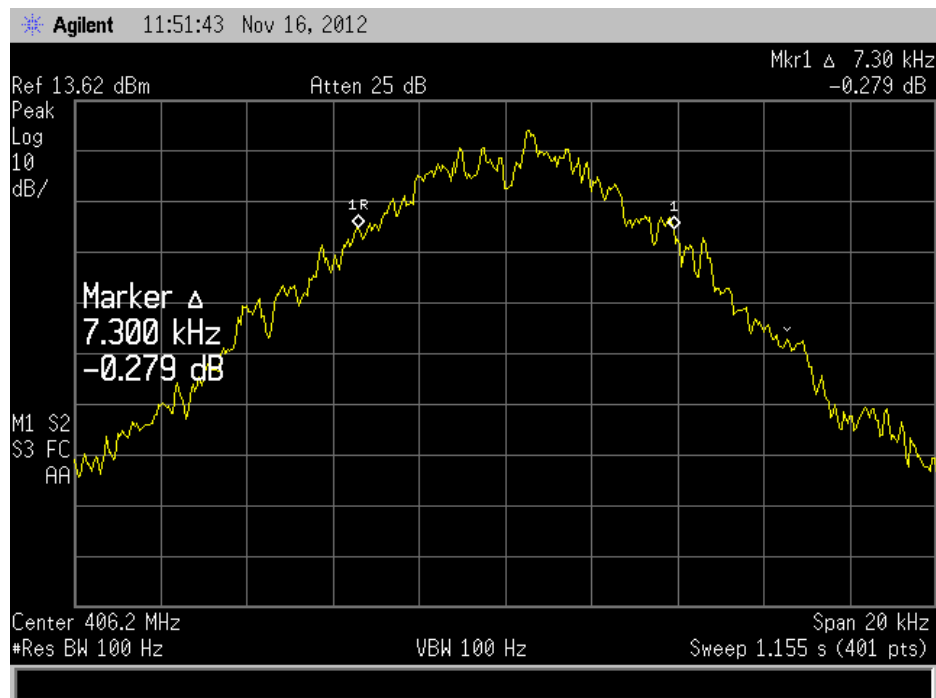
The resolution bandwidth is then changed to 100 Hz and the reference level minus 23 dB (99%) absolute bandwidth points determined.

Emission	Channel	Measured	Designated
F3E	12.5 kHz	8.150 kHz	11.0 kHz
F1E/ F1D	12.5 kHz	7.300 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 406 - 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 placed between the transmitter and the spectrum analyser.

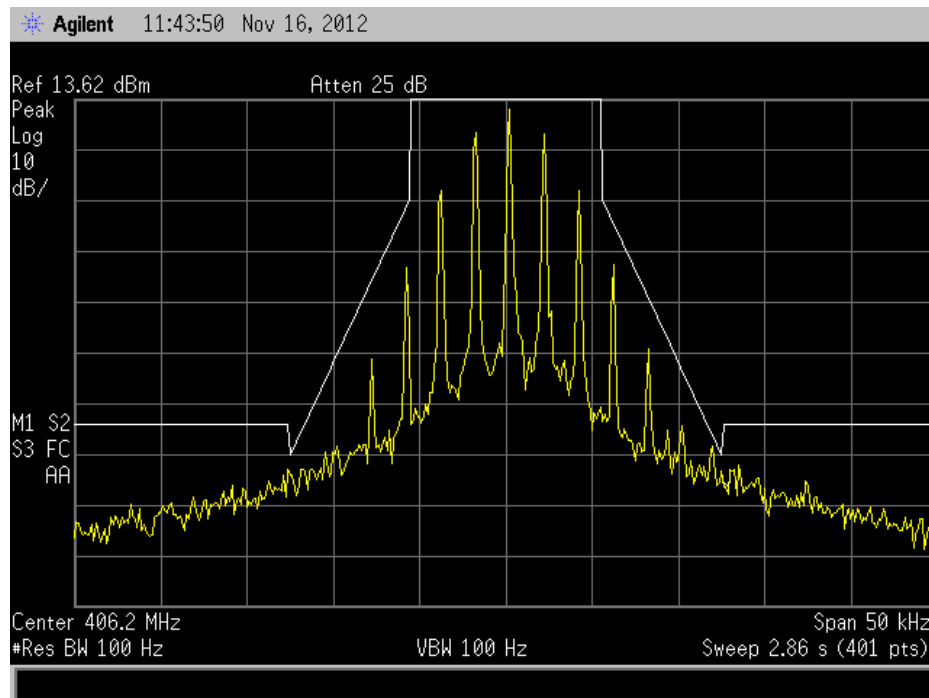
Measurements were made in peak hold with the transmitter operating on 406.175 MHz.

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.

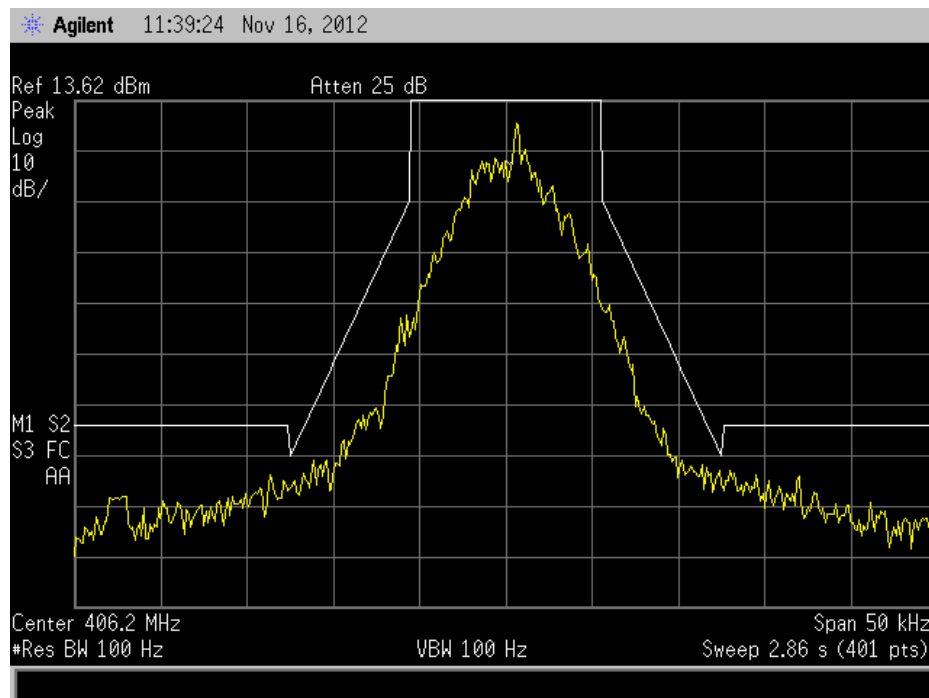
For the F1E and F1D modes the transmitter was modulated uses modulation sources internal to the transmitter as supplied by the client.

Result: Complies

Part 90: F3E 12.5 kHz



Part 90: F1D / F1E 12.5 kHz



Transmitter spurious emissions at the antenna terminals

Frequency: 406.175 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
812.350	-61.0	-20.0
1218.525	<-70.0	-20.0
1624.700	<-70.0	-20.0
2030.875	<-70.0	-20.0
2437.050	<-70.0	-20.0
2843.225	-61.3	-20.0
3249.400	<-70.0	-20.0
3655.575	-65.0	-20.0
4061.750	<-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 10th 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 10th harmonic.

Result: Complies

Measurement Uncertainty: ± 3.3 dB

Field strength of the transmitter spurious emissions

Frequency: 440.175 MHz

Frequency (MHz)	Level (dB μ V/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
880.350	45.0	-52.4	-20.0	Vertical	32.4	Pass
	55.1	-42.3	-20.0	Horizontal	22.3	Pass
1320.525	56.0	-41.4	-20.0	Vertical	21.4	Pass
	56.3	-41.1	-20.0	Horizontal	21.1	Pass
1760.700	59.0	-38.4	-20.0	Vertical	18.4	Pass
	59.4	-38.0	-20.0	Horizontal	18.0	Pass
2200.875	64.0	-33.4	-20.0	Vertical	13.4	Pass
	65.6	-31.8	-20.0	Horizontal	11.8	Pass
2641.050	55.4	-42.0	-20.0	Vertical	22.0	Pass
	54.0	-43.4	-20.0	Horizontal	23.4	Pass
3081.225	57.2	-40.2	-20.0	Vertical	20.2	Pass
	56.3	-41.1	-20.0	Horizontal	21.1	Pass
3521.400	67.8	-29.6	-20.0	Vertical	9.6	Pass
	60.0	-37.4	-20.0	Horizontal	17.4	Pass
3961.575	58.0	-39.4	-20.0	Vertical	19.4	Pass
	58.0	-39.4	-20.0	Horizontal	19.4	Pass
4401.750	60.4	-37.0	-20.0	Vertical	17.0	Pass
	59.0	-38.4	-20.0	Horizontal	18.4	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 10th 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.

Measurements were made with the supply decreased and increased 10% from nominal battery voltage supply.

Frequency: 440.175 MHz

Temperature	Voltage 10.8 Vdc	Voltage 13.8 Vdc	Voltage 15.6 Vdc
+50°C	-184.0	-184.0	-183.0
+40°C	-75.0	-81.0	-84.0
+30°C	-52.0	-50.0	-45.0
+20°C	-19.0	-30.0	-31.0
+10°C	-31.0	-29.0	-28.0
0°C	-53.0	-50.0	-48.0
-10°C	+44.0	+40.0	+38.0
-20°C	+31.0	+35.0	+34.0
-30°C	+57.0	+56.0	+55.0

Limit:

Part 90.213 states 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 440.175 MHz

$$2.5 \text{ ppm} = 2.5 \times 440.175 = 1100 \text{ Hz.}$$

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 421-512 MHz. Measurements were carried out at 406.175 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 406.175 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	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 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.

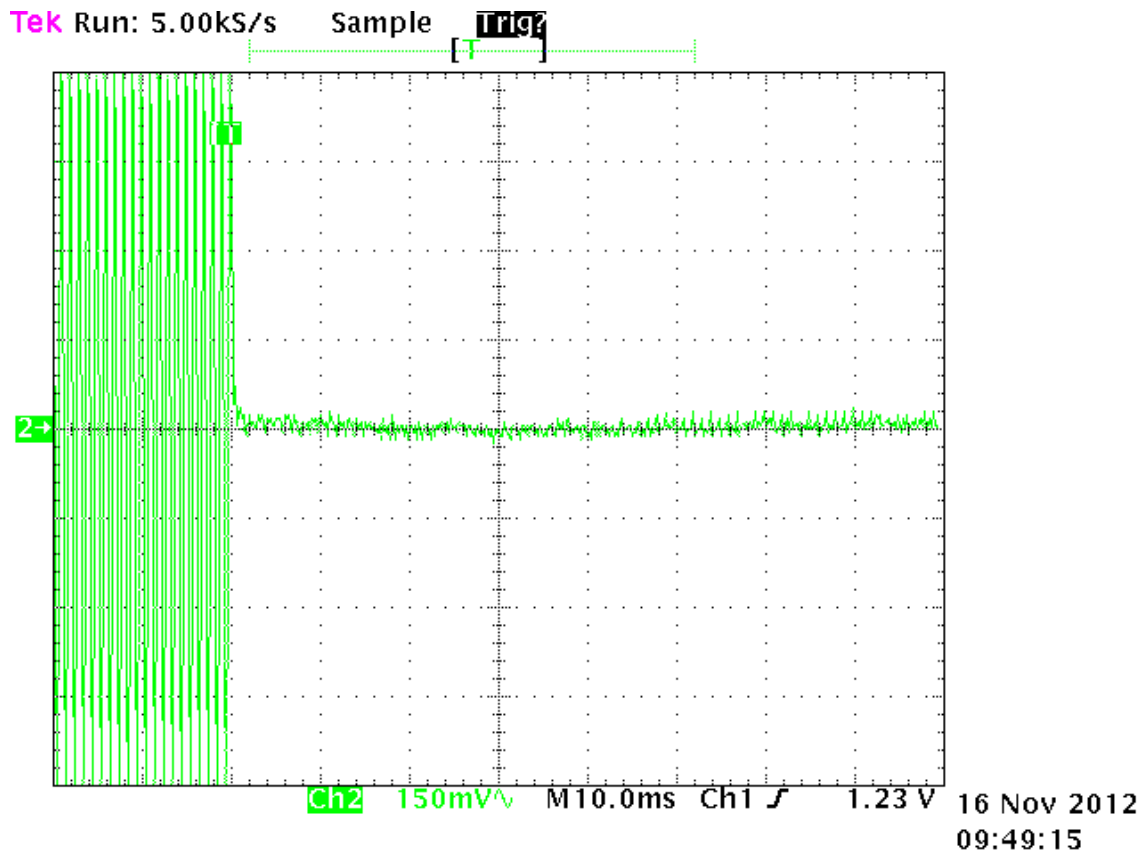
The X axis has been set to a sweep rate of 10 mS/division.

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

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.

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 ± 12.5 kHz.

Therefore each Y axis division = 3.125 kHz per division.

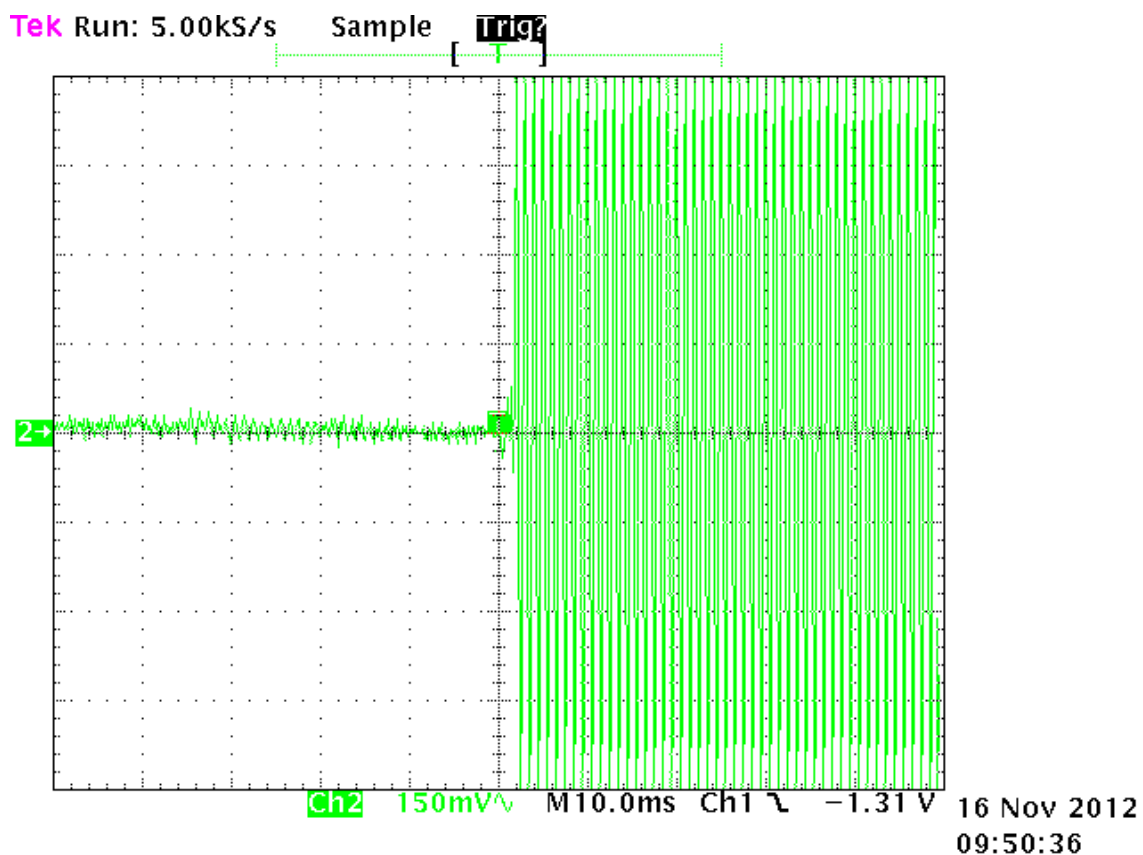
The X axis has been set to a sweep rate of 10 mS/division.

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

This is position *toff*.

t_3 occurs between 4.0 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 1.35 mW/m²
(f/300 = 406 MHz/300)

- General Population / Uncontrolled exposure limit will be 0.270 mW/m²
(f/1500 = 406 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:

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

Controlled

$$E = 1.35 \text{ W/m}^2 = E^2/3770$$

$$E = \sqrt{1.35 * 3770}$$

$$E = 71.3 \text{ V/m}$$

Uncontrolled

$$E = 0.270 \text{ W/m}^2 = E^2/3770$$

$$E = \sqrt{0.270 * 3770}$$

$$E = 31.9 \text{ V/m}$$

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).

The client has declared a duty cycle of 50% as the device operates on a push to talk basis

Controlled

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

$$d = \sqrt{30 * 25 * 1.64 * 0.5} / 71.3$$

$$d = 0.348 \text{ metres or } 34.8 \text{ cm}$$

Uncontrolled

$$d = \sqrt{30 * 25 * 1.64 * 0.5} / 31.9$$

$$d = 0.777 \text{ metres or } 77.7 \text{ cm}$$

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	20/10/13
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



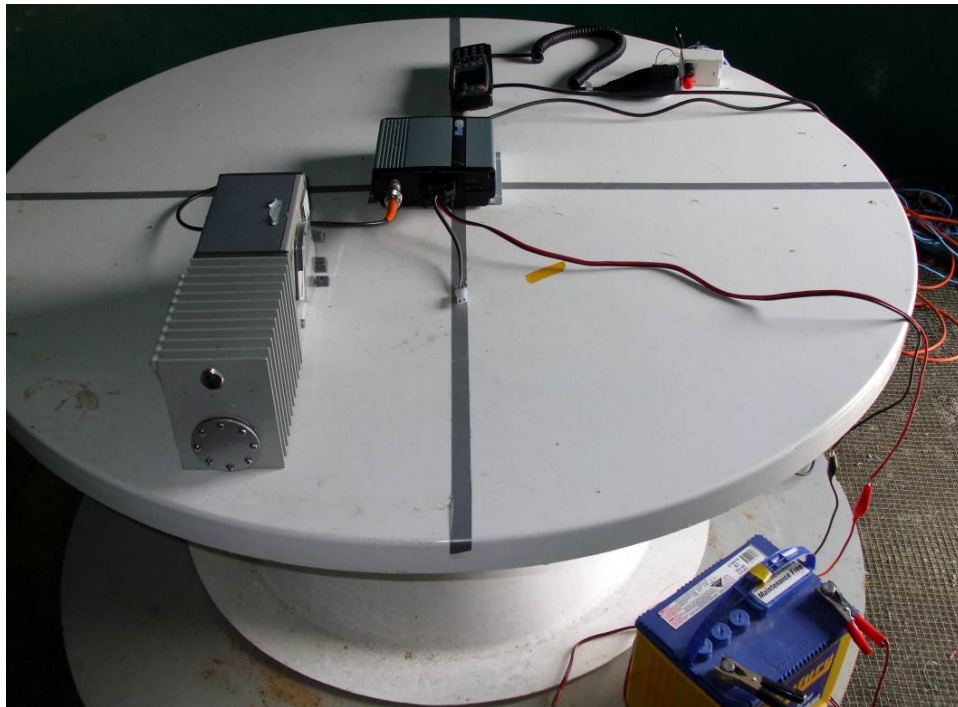
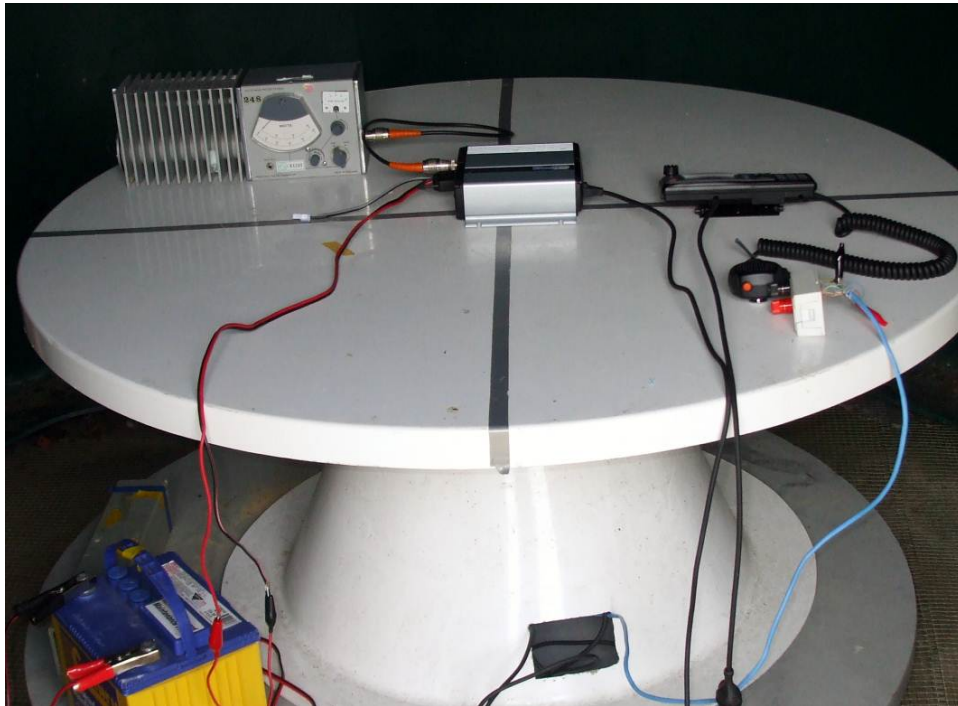
MAR-9022CM control head

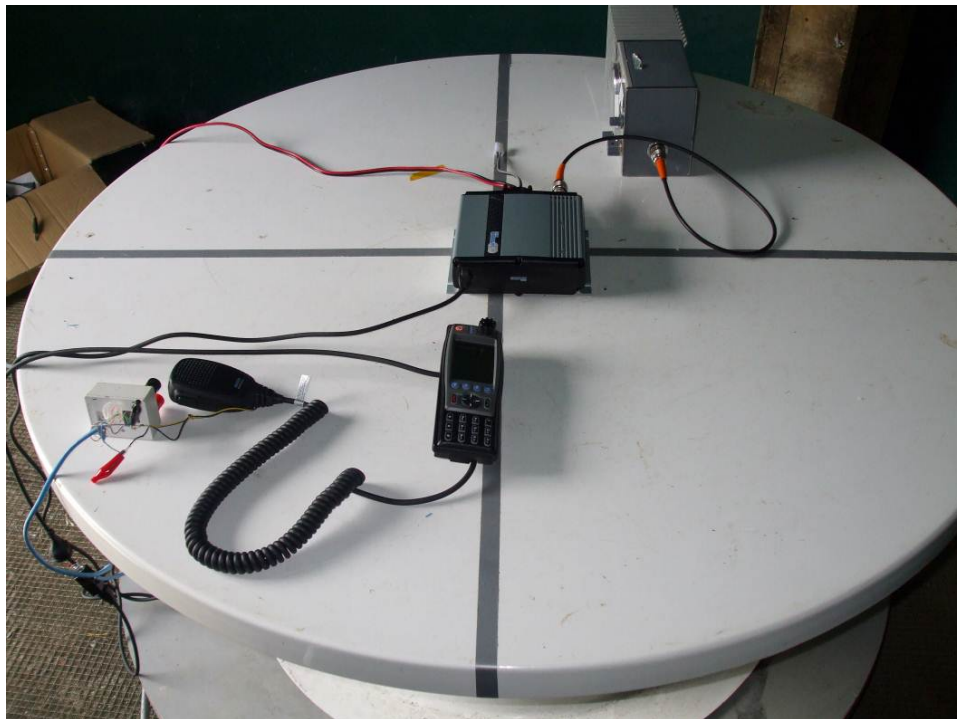
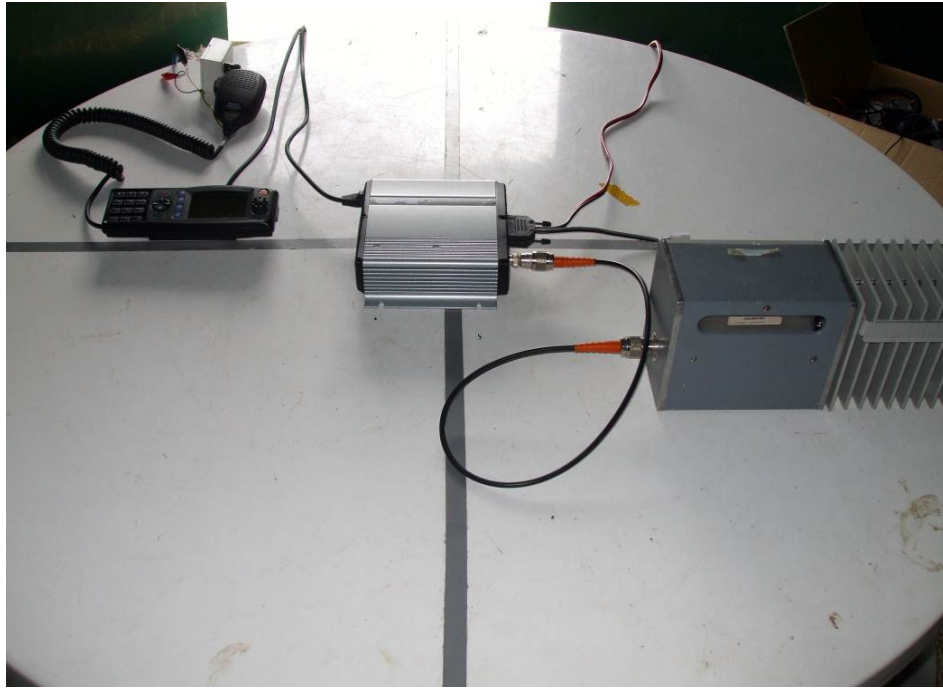


MAR-9020plus control head

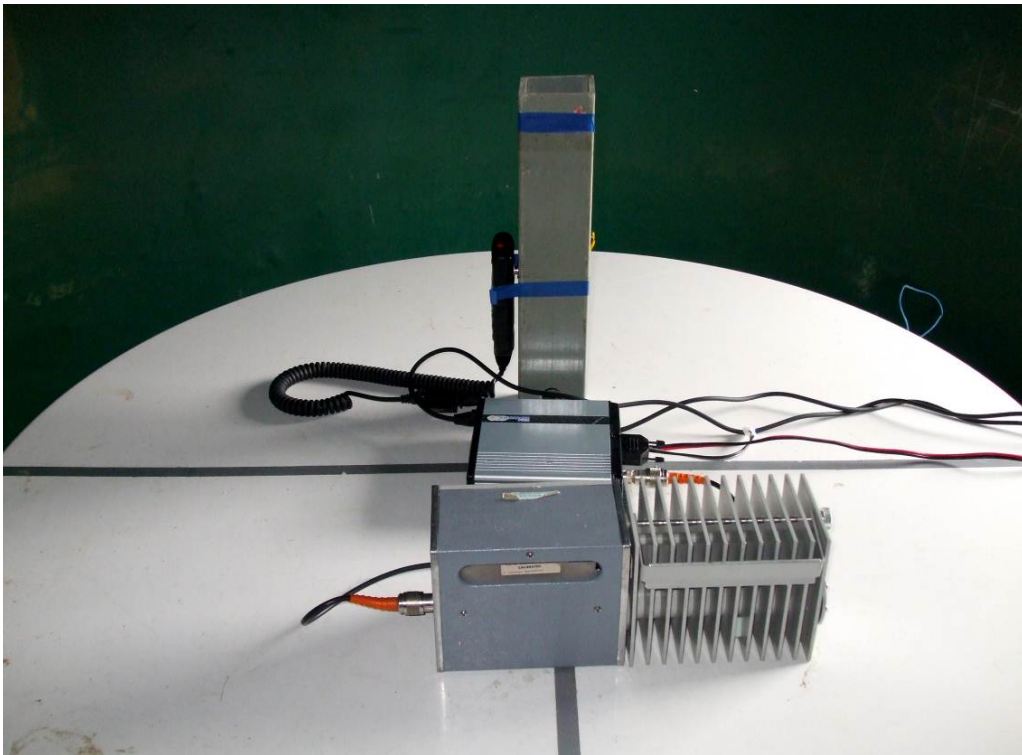
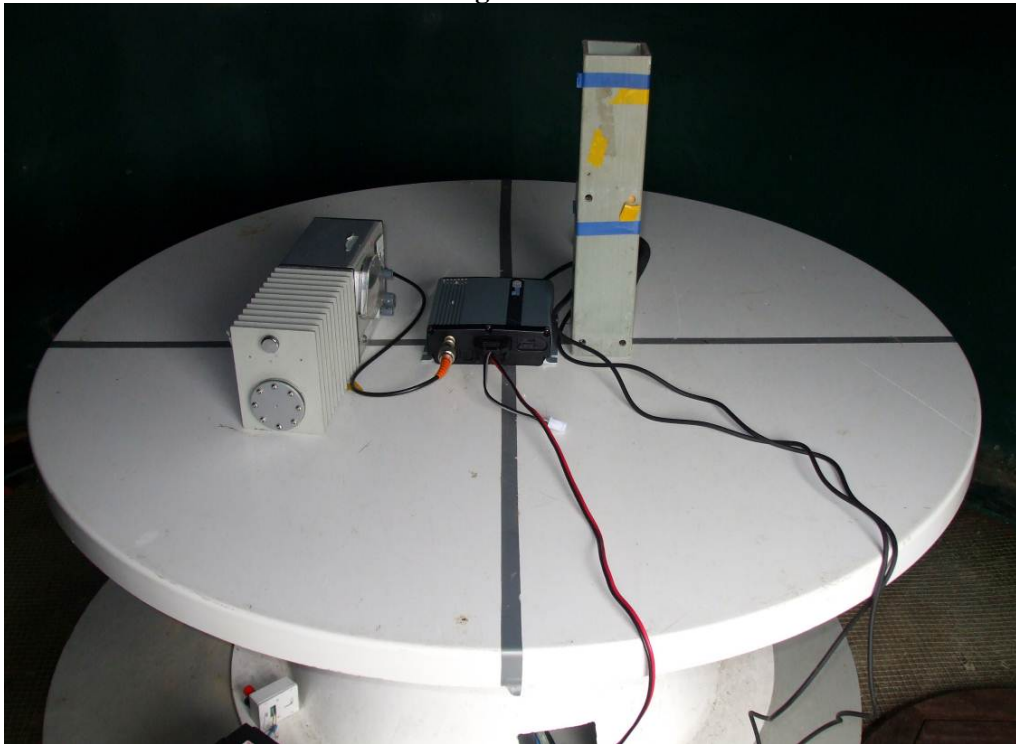


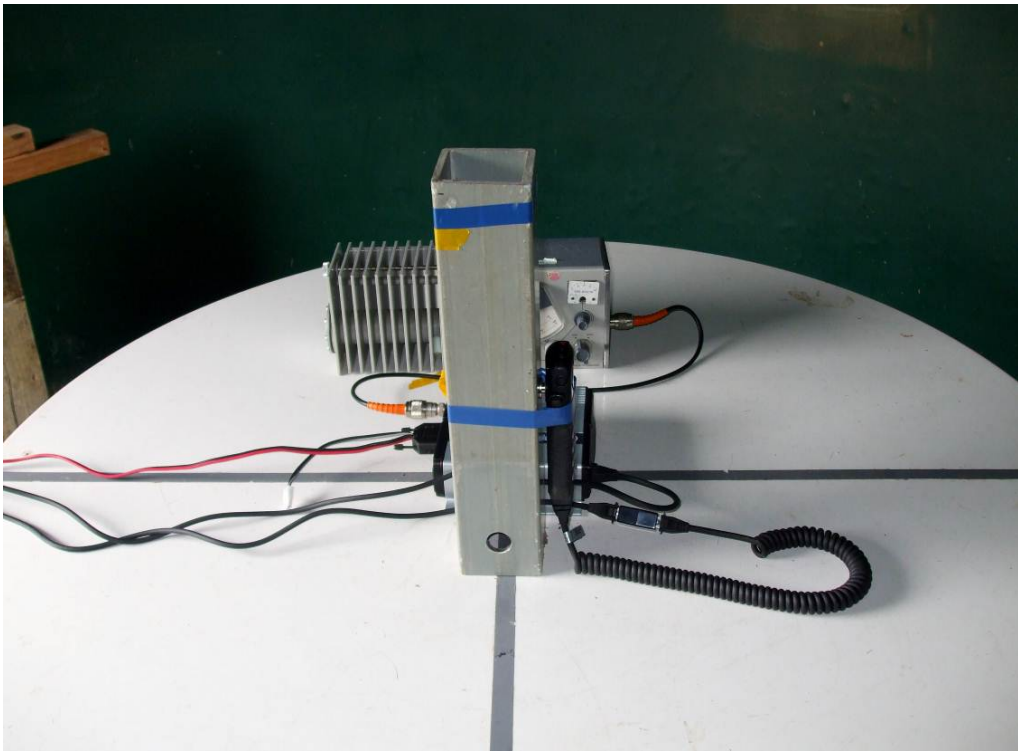
Radiated emissions



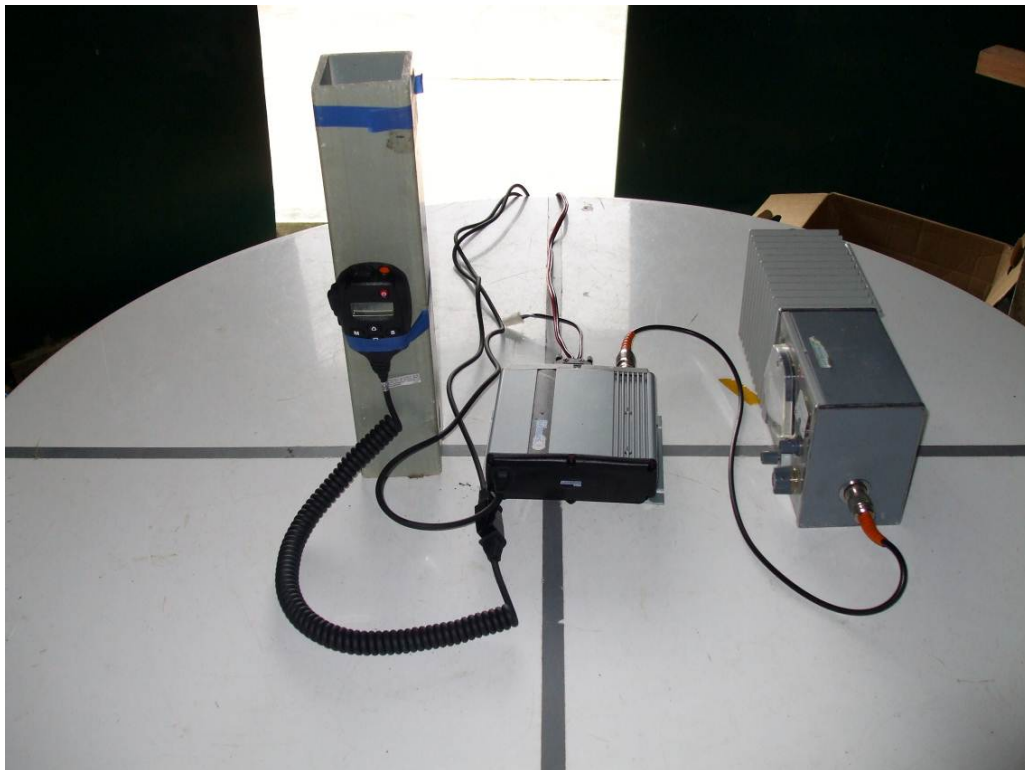
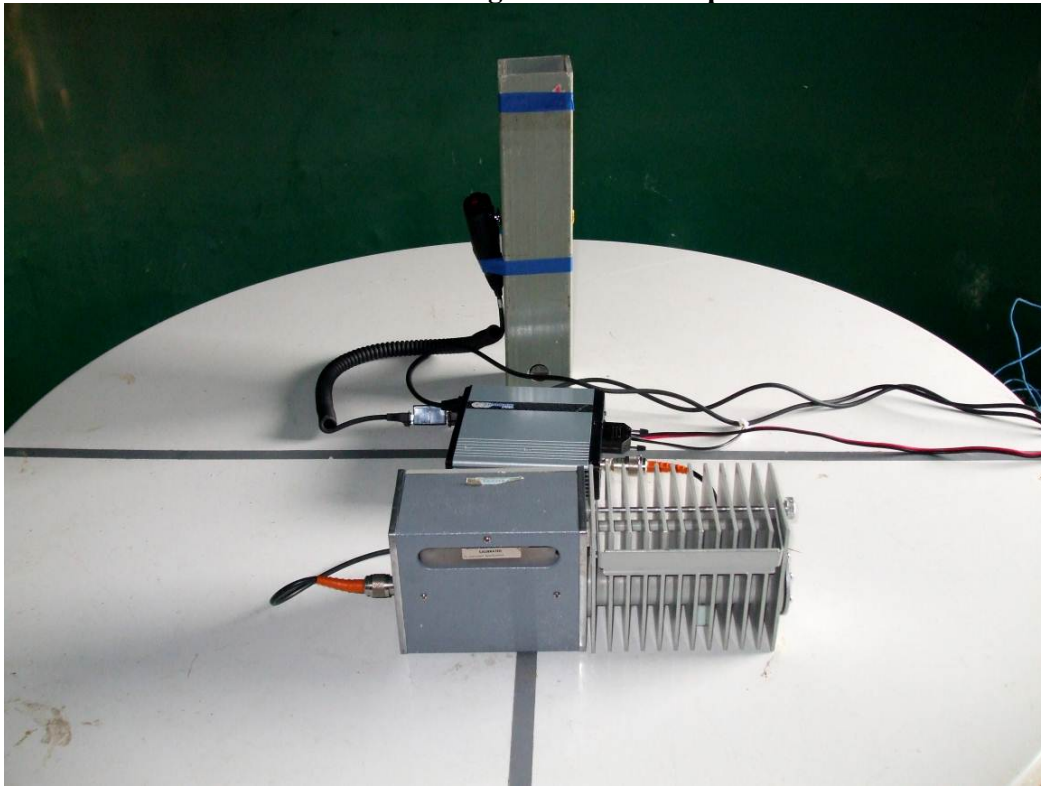


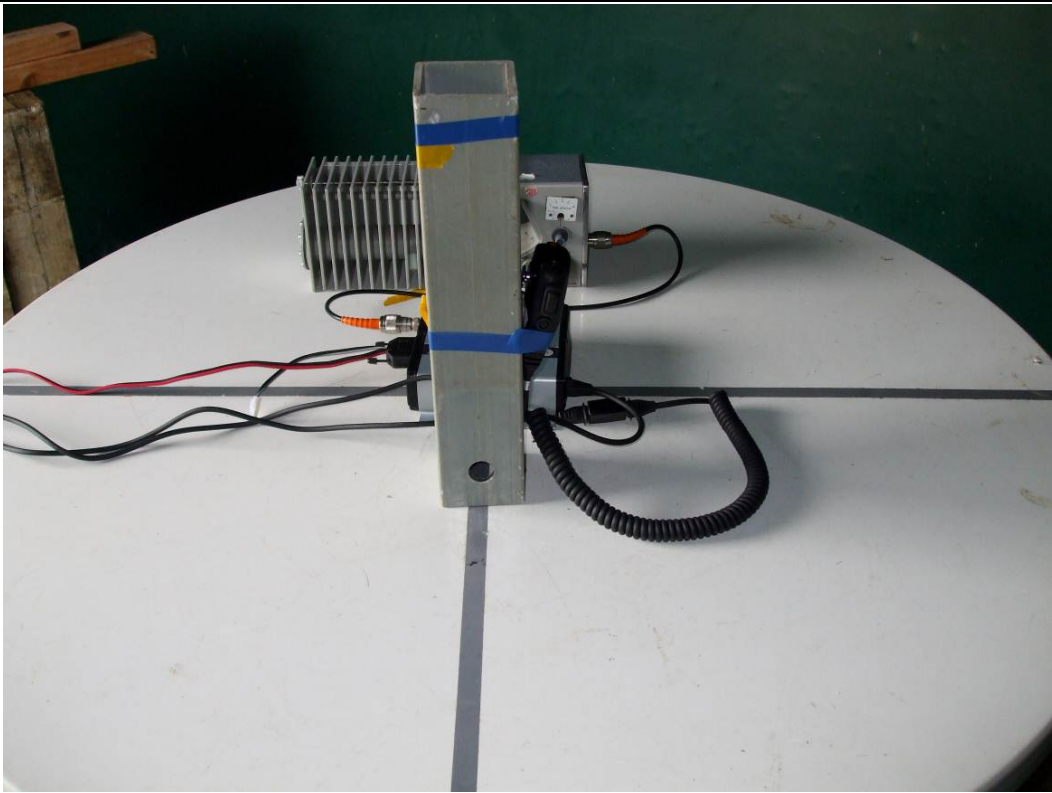
Radiated testing with MAR9022CM





Radiated testing with MAR9020plus





Internal Photos

