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TEST REPORT

SIMOCO SRM9000 KMA
VHF Mobile Transceiver

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

Part 15 – Radio Frequency Devices

for

ComGroup Australia 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

Table of Contents

1. COMPLIANCE STATEMENT

The **Simoco SRM9000 KMA VHF Mobile Transceiver** complies with the limits defined in 47 CFR Part 15, 47 CFR Part 90 and 47 CFR Part 2 when tested in-accordance with the test methods described in 47 CFR Part 2.

2. RESULT SUMMARY

The results of testing, carried out in 25th - 31st July 2012, are summarised below.

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)	Modulation Characteristics Low pass filter response Modulation limiting characteristics	Noted Noted Noted
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
15.109 15.111	Receiver radiated emissions Receiver local oscillator voltage	Complies Complies
1.1310	Radio frequency exposure limits	Complies

3. ATTESTATION

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 contains corrections to Report 120624.1 dated 15th August 2012 correcting poor graph reproduction and typographical errors.

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

4. CLIENT INFORMATION

Company Name	ComGroup Australia Pty Ltd
Address	1270 Ferntree Gully Road Scoresby
State	Victoria, 3179
Country	Australia
Contact	Mr Robert Stowell

5. TEST SAMPLE DESCRIPTION

Brand Name	Simoco
Model Number	SRM9000 KMA
Product	VHF mobile radio
Manufacturer	Simoco
Manufactured in	Taiwan
Designed in	Australia
Serial Number	ERKMA12251234
FCC ID	STZSRM9000KMA

The test sample has sockets for a transmit antenna, external audio and control head.

The radio was tested for emissions using three different control heads as described:

- MAR-9030PLCH in transmit and receive modes
- MAR-9022CM in receive mode
- MAR9020*plus* in receive mode only.

The sample tested has the following specifications:

Rated Transmitter Output Power

25.0 Watts (44.0 dBm)

Transmitter FCC frequency range

Part 90: 220-222 MHz

Test frequencies

Chl	Frequency MHz	Power Watts	Spacing kHz
1	221.075	25.0	10.0
2	221.075	25.0	12.5

Emission Designators / Modes of operation

9k60F3E – Analogue speech
11k2F3E – Analogue speech

Power Supply

Rechargeable 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

Extreme Temperature

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

Extreme Test Voltages

High Voltage: 15.6 Vdc
Low Voltage: 10.8 Vdc

6. TEST RESULTS

Certification required

Certification of this device is sought for transmissions using 10.0 kHz and 12.5 kHz channel spacing.

This channel bandwidth certification is sought for this transmitter under section 90.203(k) as:

The transmitter operates on frequencies in the 220–222 MHz band, certification will be sought for equipment operating on 220–222 MHz band using :-

- Channels 1 through 160 (220.0025 through 220.7975/221.0025 through 221.7975),

- Channels 171 through 180 (220.8525 through 220.8975/221.8525 through 221.8975),

- Channels 186 through 200 (220.9275 through 220.9975/221.9275 through 221.9975),

with channel bandwidths greater than 5 kHz.

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)
221.075	13.8Vdc	44.0	44.5
221.075	15.6 Vdc	44.0	44.5
221.075	10.8 Vdc	44.0	43.1

Result: Complies
Measurement Uncertainty: ±0.5 dB

Modulation Characteristics

This transmitter is capable of producing analogue speech modulation.

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.

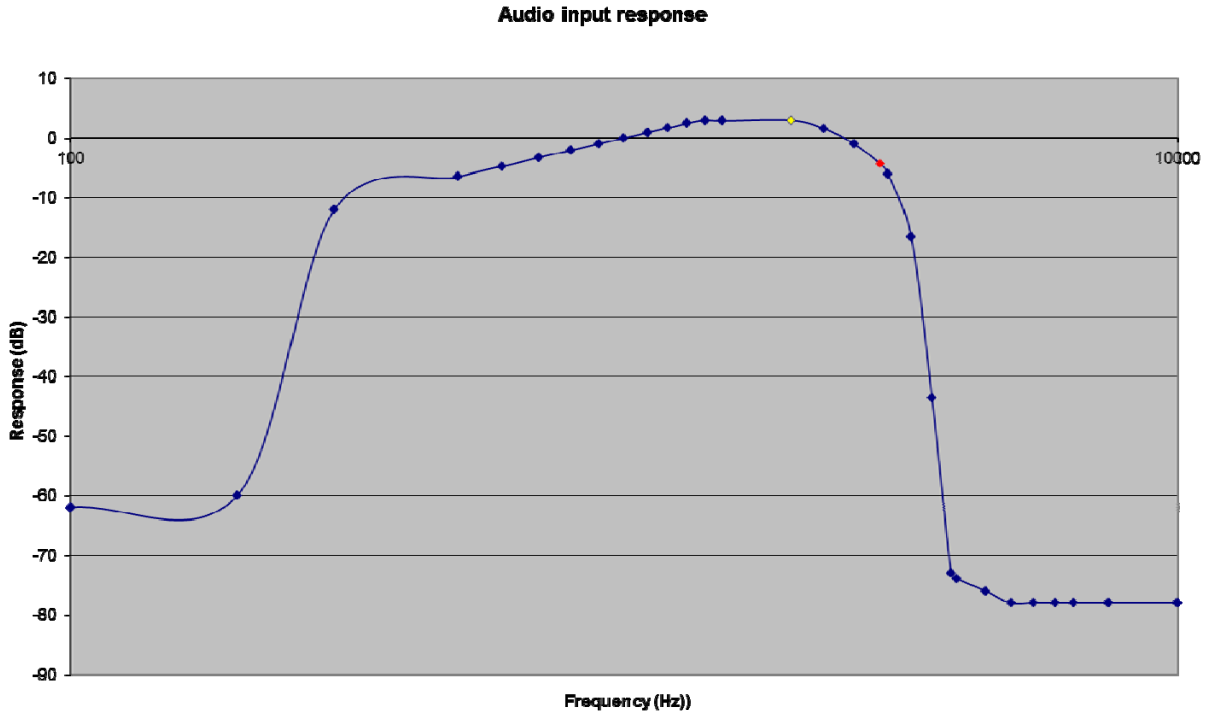
At 1 kHz an audio signal was applied which was used as a 0 dB response reference.

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 denoted as a yellow data point on the following graph.

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

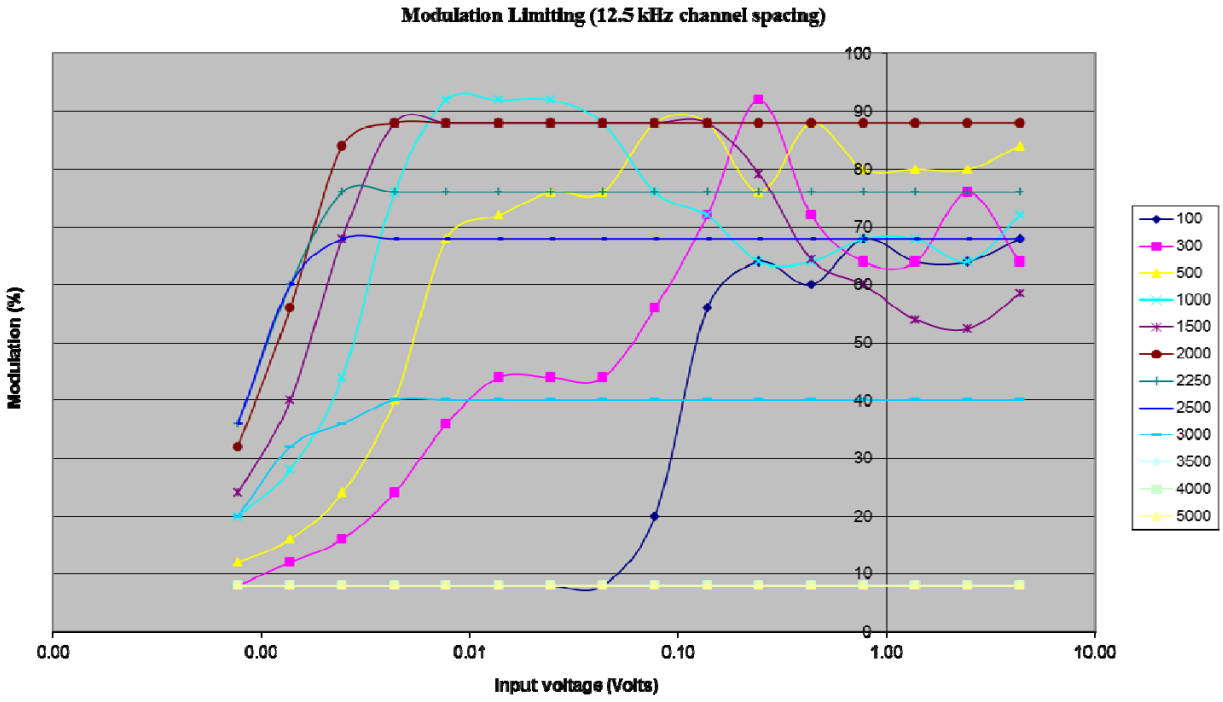


(a) A family of curves showing the percentage of modulation versus the modulation input voltage.

Measurements were made between 100 Hz to 5 kHz.

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

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



(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.

Result: Complies
Measurement Uncertainty: ±1%.

Part 90.207 – Emission types:
The following emission types are used:

- F3E: Frequency modulation with analogue speech.

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 calculations as follows:

Necessary bandwidth calculation for the 10.0 kHz channel step emission is:

Bn = 2 x D + 2 x M
Where D = maximum deviation: 1.8 kHz
Where M = maximum modulation frequency: 3 kHz
Bn = 9.6 kHz

Measurements show the following
Bn = 2 x 1500 Hz + 2 x 2900 Hz
Bn = 8.8 kHz

This is confirmed in the emission designation 9k60F3E

Necessary bandwidth calculation for the 12.5 kHz channel step emission is:

Bn = 2 x D + 2 x M
Where D = maximum deviation: 2.5 kHz
Where M = maximum modulation frequency: 3 kHz
Bn = 11 kHz

Measurements show the following
Bn = 2 x 2000 Hz + 2 x 2900 Hz
Bn = 9.8 kHz

This is confirmed in the emission designation 11k0F3E

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 220-222 MHz using an authorised bandwidth of 9.6 kHz and 11 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.

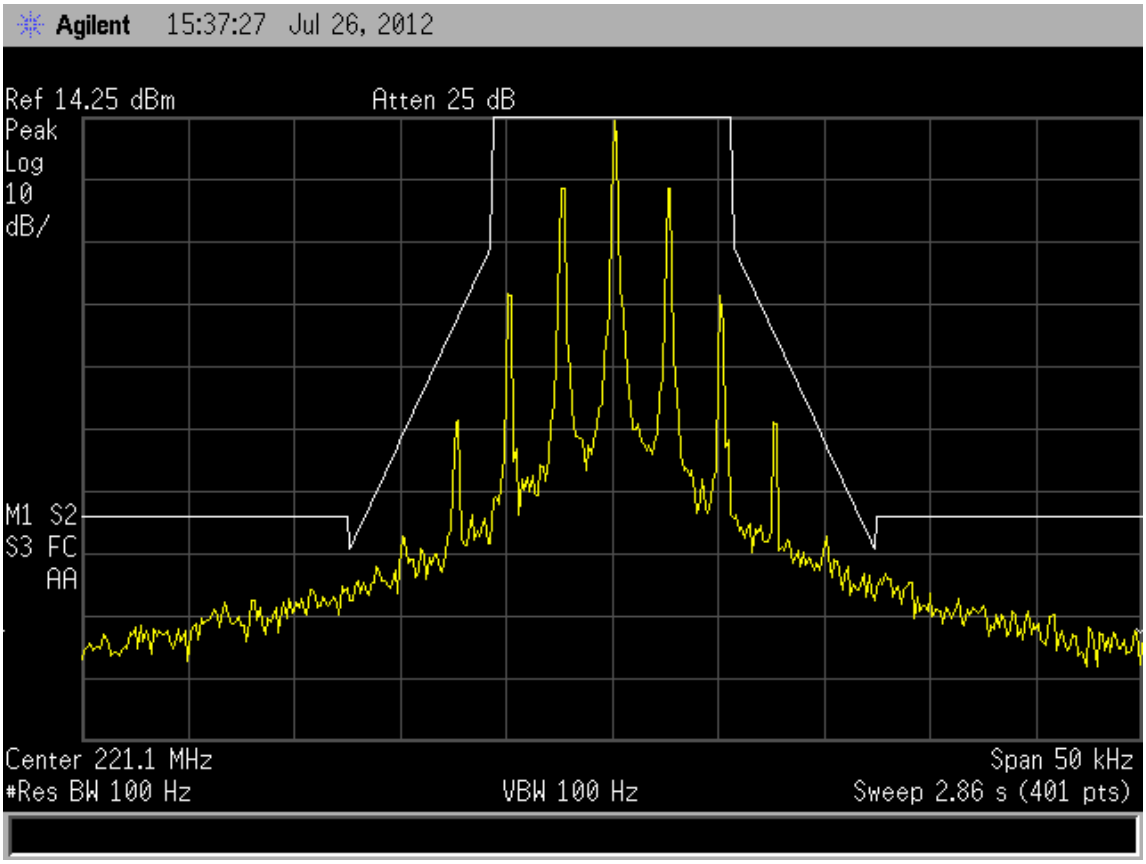
All measurements have been made with a -30 dB correction factor as a 30 dB attenuator is placed between the transmitter and the spectrum analyser.

Measurements were made in peak hold with the transmitter operating on 221.075 MHz

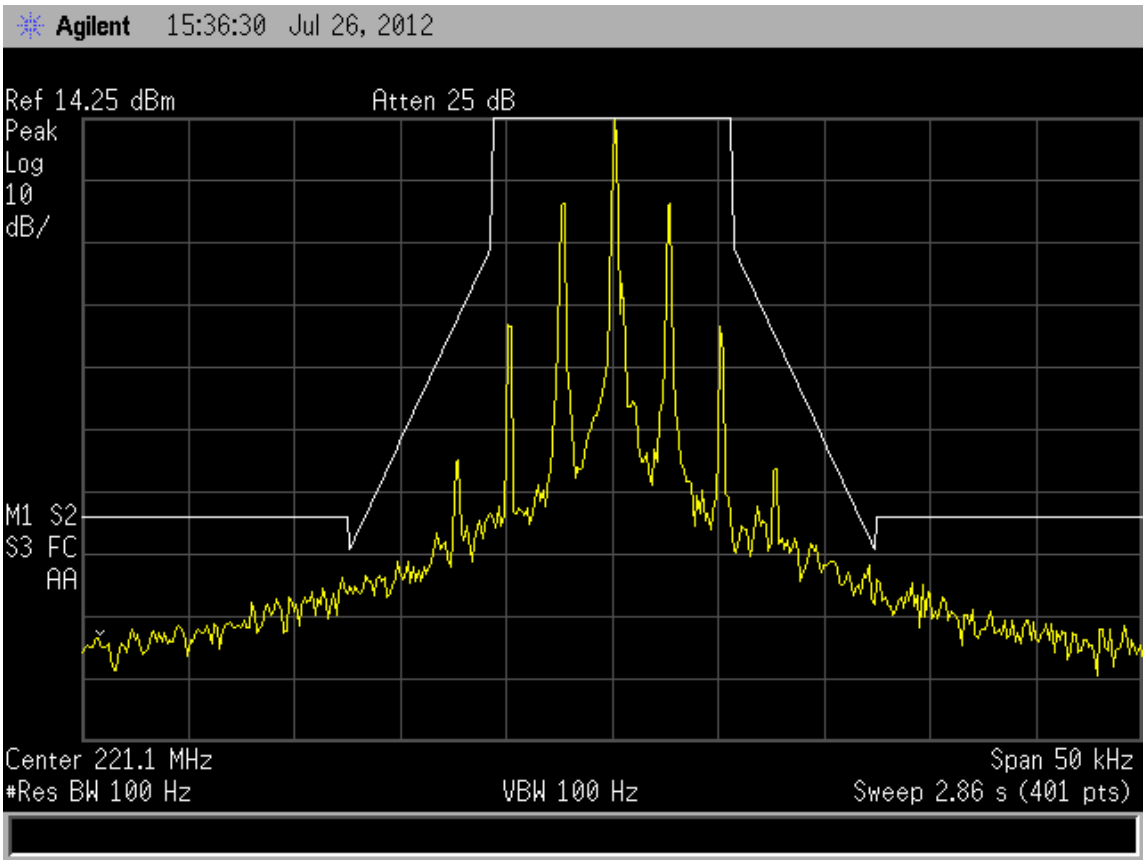
When operating in F3E mode a 2500 Hz tone, which was found to be the frequency of maximum response, that was applied at a level 16 dB higher than that required to achieve 50% modulation.

Result: Complies

F3E 12.5 kHz



F3E 10.0 kHz



Transmitter spurious emissions at the antenna terminals

Frequency: 221.075 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
442.150	-66.4	-20.0
663.225	-46.4	-20.0
884.300	<-60.0	-20.0
1105.375	<-60.0	-20.0
1326.425	<-60.0	-20.0
1547.500	<-60.0	-20.0
1768.575	<-60.0	-20.0
1989.650	<-60.0	-20.0
2210.750	<-60.0	-20.0

No other emissions observed.

Limit:
Mask D, 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 70.0 dB whichever is the lesser attenuation.

The spectrum has been investigated up to the 10th harmonic of the transmitter.

A rated power of 25.0 watts gives a limit of –20 dBm.

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.

Result: Complies
Measurement Uncertainty: ±3.3 dB

Receiver spurious emissions at antenna terminals

Frequency: 221.075 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
266.075	-93.0	-57.0
532.135	<-100 dBm	-57.0
798.225	<-100 dBm	-57.0
1064.300	<-100 dBm	-47.0
1330.375	<-100 dBm	-47.0
1596.450	<-100 dBm	-47.0
1862.525	<-100 dBm	-47.0
2128.600	<-100 dBm	-47.0
2394.675	<-100 dBm	-47.0
2660.750	<-100 dBm	-47.0
2926.825	<-100 dBm	-47.0

The receiver has an intermediate frequency of 45 MHz

No 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: 221.075 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
442.1500	26.4	-71.0	-20.0	Vertical	51.0
442.1500	27.5	-69.9	-20.0	Horizontal	49.9
663.2250	44.5	-52.9	-20.0	Vertical	32.9
663.2250	43.0	-54.4	-20.0	Horizontal	34.4
884.3000	56.0	-41.4	-20.0	Vertical	21.4
884.3000	57.8	-39.6	-20.0	Horizontal	19.6
1105.3750	40.4	-57.0	-20.0	Vertical	37.0
1105.3750	41.5	-55.9	-20.0	Horizontal	35.9
1326.4500	41.0	-56.4	-20.0	Vertical	36.4
1326.4500	39.0	-58.4	-20.0	Horizontal	38.4
1547.525	34.0	-63.4	-20.0	Vertical	43.4
1547.525	33.5	-63.9	-20.0	Horizontal	43.9
1768.600	35.5	-61.9	-20.0	Vertical	41.9
1768.600	34.8	-62.6	-20.0	Horizontal	42.6
1989.675	40.1	-57.3	-20.0	Vertical	37.3
1989.675	42.0	-55.4	-20.0	Horizontal	35.4
2210.750	40.7	-56.7	-20.0	Vertical	36.7
2210.750	43.7	-53.7	-20.0	Horizontal	33.7

The transmitter was tested with the MAR-9030PLCH Control head attached, while transmitting continuously, 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^{th} harmonic.

Result: Complies
Measurement Uncertainty: ±4.1 dB

Field strength of the receiver spurious emissions

Frequency: 221.075 MHz

MAR-9030PLCH Control Head Attached

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Polarity	Margin (dB)
532.150	28.1	46.5	Vertical	18.4
532.150	24.0	46.5	Horizontal	22.5
798.225	24.5	46.5	Horizontal	22.0

MAR-9022CM Control Head Attached

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Polarity	Margin (dB)
46.078	28.5	40.0	Vertical	11.5
49.915	28.9	40.0	Vertical	11.1
65.278	13.8	40.0	Vertical	26.2
76.795	24.5	40.0	Vertical	15.5
76.795	14.6	40.0	Horizontal	25.4
92.155	20.0	43.5	Vertical	23.5
184.310	17.3	43.5	Vertical	26.2
532.150	28.3	46.5	Vertical	18.2
532.150	24.0	46.5	Horizontal	22.5
798.225	24.3	46.5	Horizontal	22.2

MAR-9020plus Control Head Attached

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Polarity	Margin (dB)
46.078	15.0	40.0	Vertical	25
532.150	28.3	46.5	Vertical	18.2
532.150	24.0	46.5	Horizontal	22.5
798.225	24.4	46.5	Horizontal	22.1

The receiver has an intermediate frequency of 45 MHz

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

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

Frequency: 221.075 MHz

Temperature	Voltage 10.8 Vdc	Voltage 13.8 Vdc	Voltage 15.6 Vdc
+50°C	-77.0	-78.0	-78.0
+40°C	-76.0	-80.0	-79.0
+30°C	-73.0	-73.0	-74.0
+20°C	+1.0	+1.0	+2.0
+10°C	+46.0	+45.0	+47.0
0°C	+35.0	+34.0	+35.0
-10°C	+37.0	+36.0	+36.0
-20°C	+60.0	+60.0	+61.0
-30°C	+85.0	+82.0	+86.0

Limit:
Part 90.213 state that mobile station transmitters operating between 220-222 MHz are required to have a frequency tolerance of 1.5 ppm.

This transmitter was tested on 221.075 MHz. 1.5 ppm = 1.5 x 221.075 = 331 Hz.

Result: Complies
Measurement Uncertainty: ±30 Hz

Transient frequency behaviour

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 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	5 mS	± 12.5	± 25.0
t_2	20 mS	± 6.25	± 12.5
t_3	5 mS	± 12.5	± 25.0

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

12.5 kHz transmitter turn on

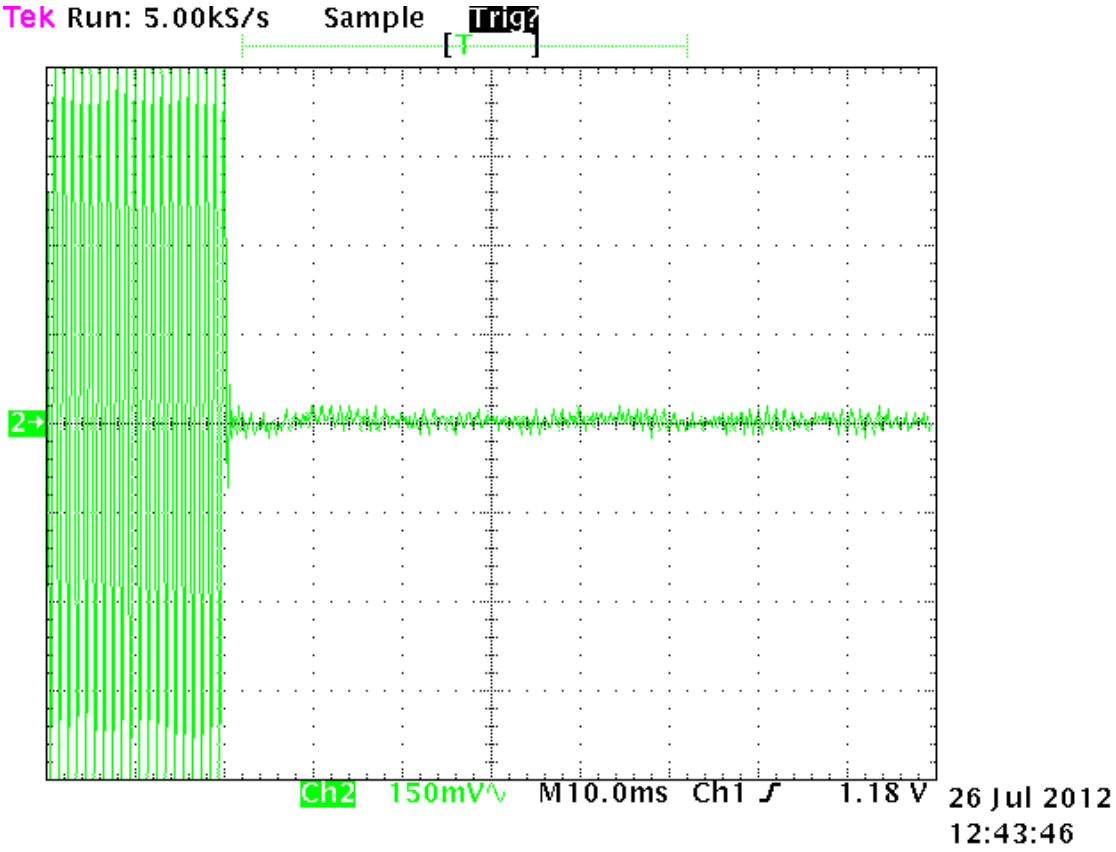
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz and any transient.

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 2.5 divisions from the left-hand edge.
t2 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.

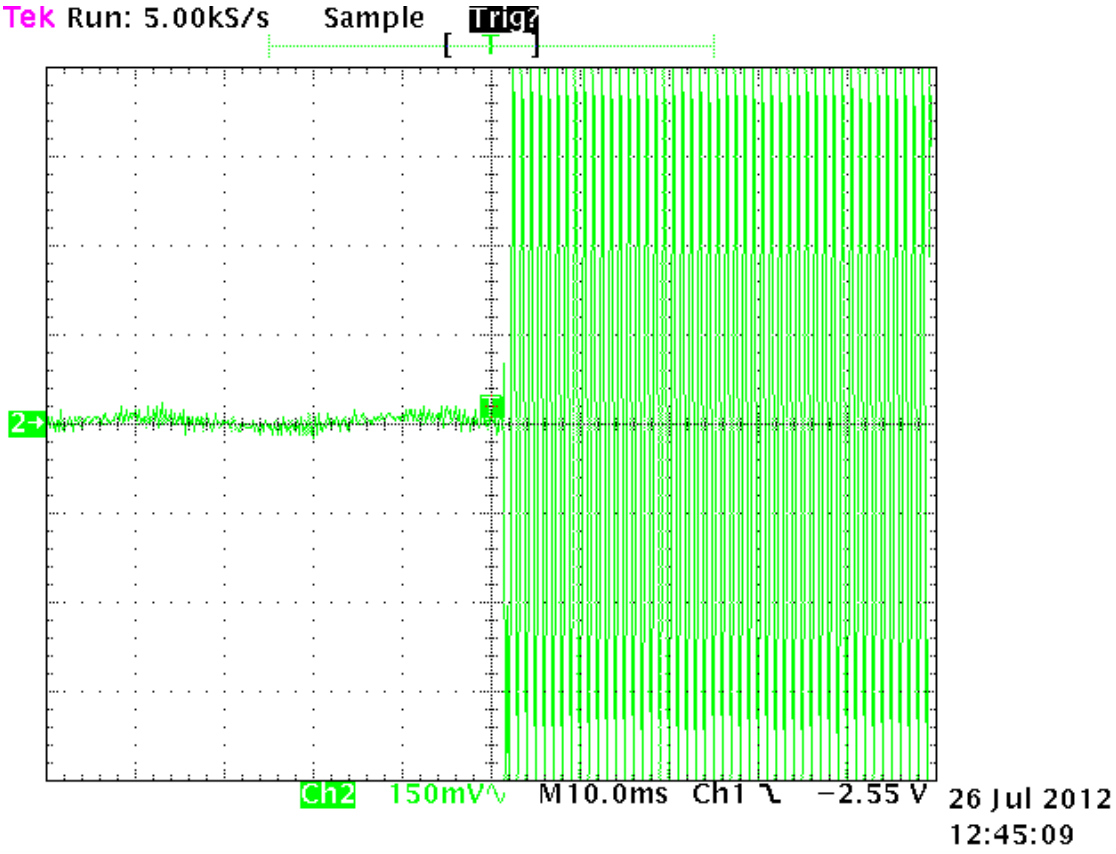
Green trace has been maximised to give full screen indication of a ± 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

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.

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

- Occupational / Controlled Exposure limit will be 10 mW/m^2 or 60 V/m

- General Population / Uncontrolled exposure limit will be 2 mW/m^2 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, V/m = (√ (30 * P * G * DC)) / d

The rated maximum transmitter power = 25 watts.

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

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

Controlled	**Uncontrolled**
d = √ (30 * P * G*DC) / E	
d = √ (30 * 25 * 1.64 * 0.5) / 60	d = √ (30 * 25 * 1.64 * 0.5) / 28
d = 0.41 metres or 41 cm	d = 0.88 metres or 0.88 cm

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

7. 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	ESCS 30	847124/020	E1595	09/02/2013
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	27/09/2012
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/a

8. 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 46 accreditation bodies in 34 economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

9. PHOTOGRAPHS

External views

MAR-9030PLCH Control Head

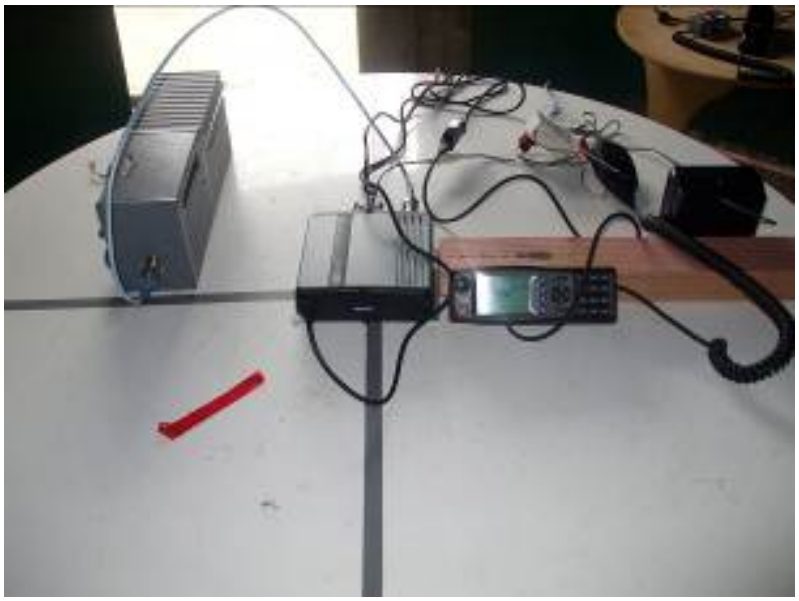
MAR-9022CM Control Head

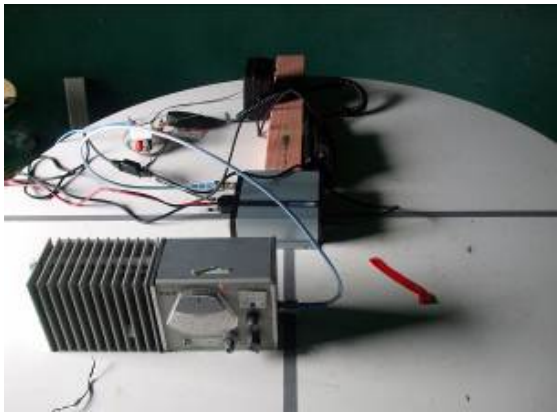
MAR-9020plus Control Head

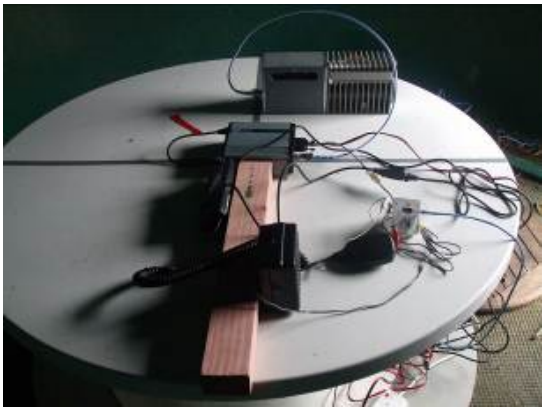
Internal Views

Shields removed

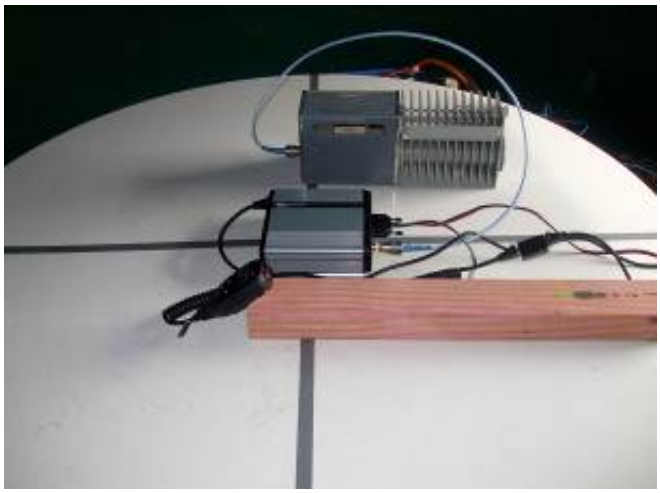
Open Air Test Site Setup: MAR-9030PLCH Control Head Attached

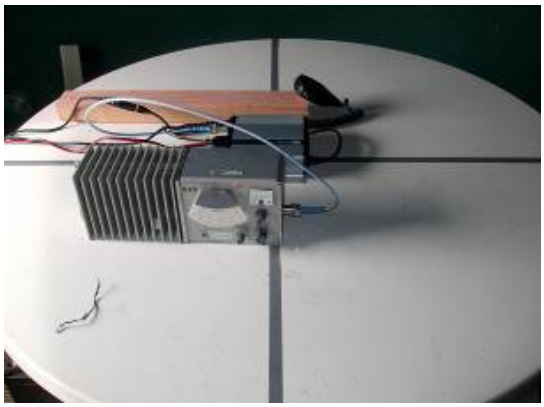






MAR-9022CM Control Head Attached





MAR-9020plus Control Head Attached