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TEST REPORT

Aprisa SR 135 – 175 MHz
Point to Multi-Point Digital Radio

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

4RF Limited

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. COMPLIANCE STATEMENT

The **Aprisa SR 135 – 175 MHz Point to Multi Point Digital Radio** complies with the limits defined in 47 CFR Part 90 and 47 CFR Part 2 when tested in-accordance with the test methods described in 47 CFR Part 2 and ANSI C63.4, 2002.

2. RESULT SUMMARY

The results of testing carried out between 19th and 21st February 2014 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
2.1055 90.213	Frequency stability Frequency stability	Noted Complies
90.214	Transient frequency behaviour	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 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.

This test report is to show compliance to a Class II permissive change to add 6.25 kHz channel spacing to this radio.

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 4RF Limited

Address 26 Glover Street
Ngauranga
Wellington

Country New Zealand

Contact Mr Paul Young

5. TEST SAMPLE DESCRIPTION

Brand Name Aprisa SR

Model Number SR N100-030

Product Point to Multi Point Digital Radio

Manufacturer 4RF Limited

Manufactured in New Zealand

Designed in New Zealand

Serial Numbers R1110000529

FCC ID UIPSR135M130

This report covers the following model variants,

Frequency band (MHz)	Channel spacing (kHz)	Antenna option	Model number
135-175	6.25	Single	SR N100-030
135-175	6.25	Dual	SR N100-031

Product overview
The 4RF Aprisa SR is a point to multi point digital radio providing secure narrowband wireless data connectivity for SCADA, infrastructure and telemetry applications.

The radios carry a combination of serial packet data and Ethernet data between the base station, repeater stations and remote stations.

The Aprisa SR is configurable as a point to multi point base station, a remote station or a repeater station.

The sample tested has the following specifications:

Rated Transmitter Output Power

5.0 Watts (37.0 dBm)

Transmitter FCC frequency range

Part 90: 150- 174 MHz

Test frequencies

Chl	Frequency (MHz)	Power (Watts)	Spacing (kHz)
1	150.075	5.0	6.25
2	160.075	5.0	6.25
3	173.975	5.0	6.25

Emission Designators / Modes of operation

3k70F1D – digital data

Power Supply

The equipment is powered using an external DC supply.

Standard Temperature and Humidity

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

Standard Test Power Source

Nominal Voltage: 13.8 V dc.
Standard Test Voltage: 13.8 V dc.

Extreme Temperature

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

Extreme Test Voltages

High Voltage: 30.0 Vdc
Low Voltage: 10.0 Vdc

6. TEST RESULTS

Certification required

This device has previously been certified as FCC ID: UIPSR135M130 using 25 kHz and 12.5 kHz channel spacings.

The equipment has now been modified to allow 6.25 kHz channel spacing operations.

Certification is therefore requested for this mode of operation using the Class 2 permissive change process.

The following Part 90.203(j) sections have been refered to

4) Applications for part 90 certification of transmitters designed to operate on frequencies in the 150.8–162.0125 MHz, 173.2–173.4 MHz, and/or 421–512 MHz bands, received on or after January 1, 2011,

(ii) 12.5 kHz for multi-bandwidth mode equipment with a maximum channel bandwidth of 12.5 kHz if it is capable of operating on channels of 6.25 kHz or less;

(iii) 25 kHz for multi-bandwidth mode equipment with a maximum channel bandwidth of 25 kHz if it is capable of operating on channels of 6.25 kHz or less; and

(iv) Up to 25 kHz if the equipment meets the efficiency standard of paragraph (j)(5) of this section.

(5), Applications for part 90 certification of transmitters designed to operate on frequencies in the 150.8–162.0125 MHz, 173.2–173.4 MHz, and/or 421–512 MHz bands, after January 1, 2011, must include a certification that the equipment meets a spectrum efficiency standard of one voice channel per 6.25 kHz of channel bandwidth.

Additionally, if the equipment is capable of transmitting data, has transmitter output power greater than 500 mW, and has a channel bandwidth of more than 6.25 kHz, the equipment must be capable of supporting a minimum data rate of 4800 bits per second 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 Ω dummy load.

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

Testing was carried out at maximum rated power output of 5 watts (37 dBm).

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
160.075	13.8	37.0	36.6
160.075	30.0	37.0	36.6
160.075	10.0	37.0	36.6

Limits:

90.205 Power and antenna height limits,

(s) The output power shall not exceed by more than 20 percent either the output power shown in the Radio Equipment List [available in accordance with § 90.203(a)(1)] for transmitters included in this list or when not so listed, the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

Result: Complies.
Measurement Uncertainty: ± 0.5 dB

Part 90.207 – Emission types:

The following emission types are used:

- F1D: 4 level FSK (Frequency Shift Keying) sending data

Part 90.209 – Bandwidth limitations:

The authorised bandwidth is taken to be the necessary bandwidth. Measurement has been used to determine as in cases not covered by paragraph (c) (1), (2), or (3) of section 90.209

Measurements have been made to verify the declared bandwidth.

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

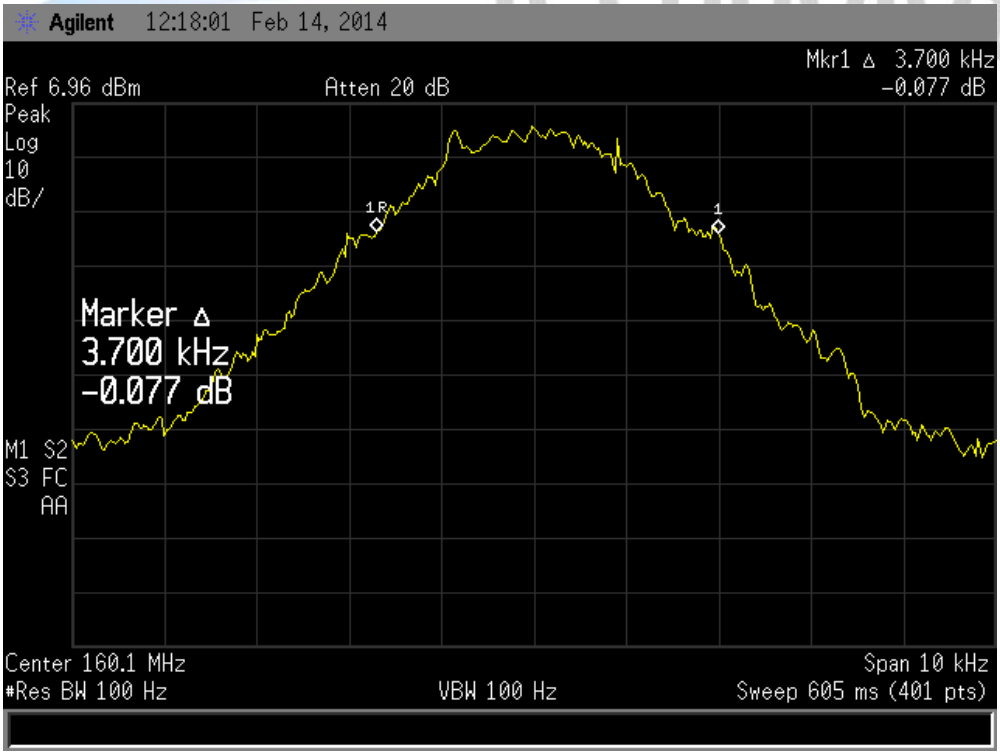
Measurements have been made of each modulation type using a spectrum analyser operating in peak hold mode and a 30 dB attenuator.

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 (kHz)	Measured (kHz)	Authorised Bandwidth (kHz)
F1D	6.25	3.700	7.5



Result: Complies.

Spectrum Masks

Equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E. Mask E has been applied as the transmitter has an audio low pass filter.

The transmitter can operate in the band 150-174 MHz using an authorised bandwidth of 7.5 kHz and channel spacing of 6.25 kHz.

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

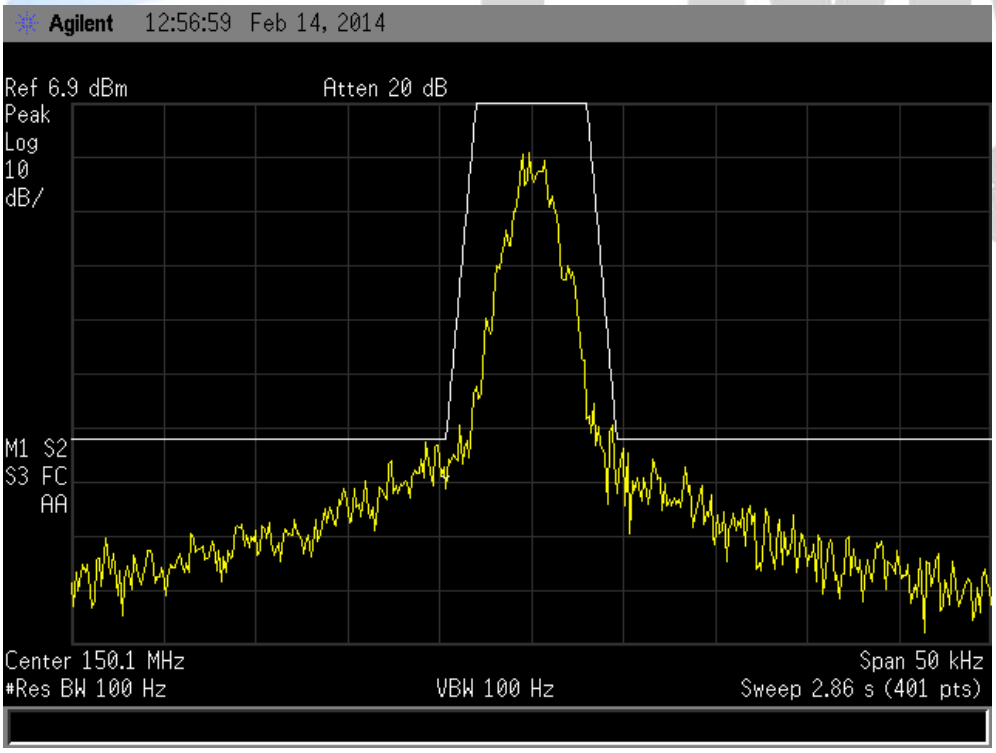
Initially power measurements are made using a resolution bandwidth of 120 kHz.

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

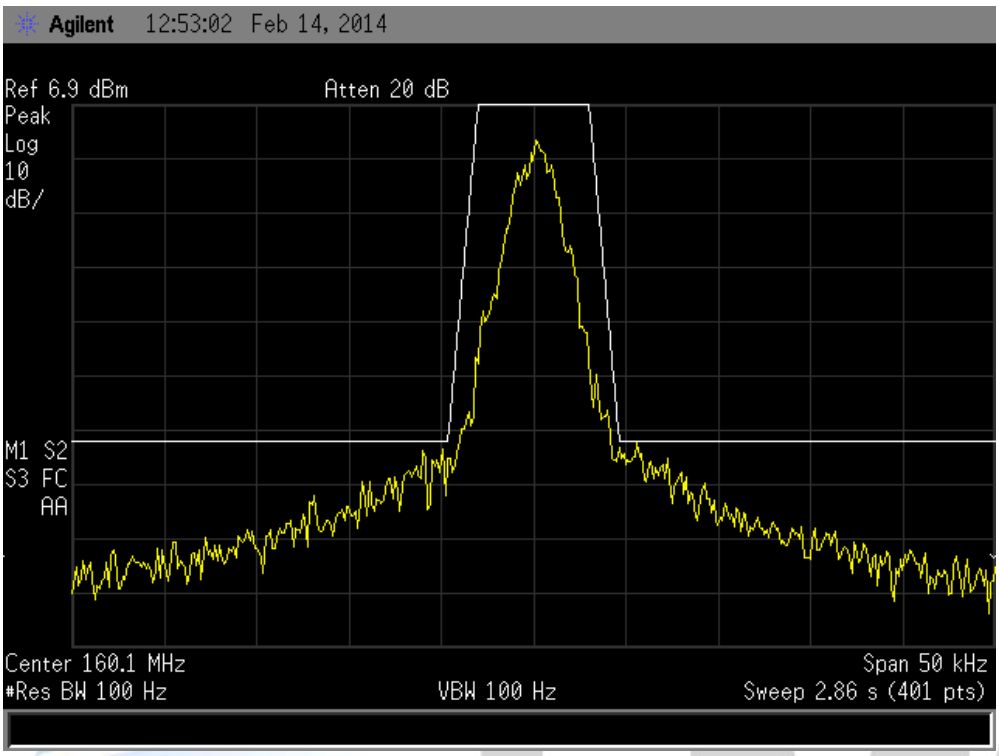
The resolution bandwidth is then changed to 100 Hz and the reference level minus 23 dB (99%) absolute bandwidth points determined.

Measurements were made with the spectrum analyser operating in peak hold centred on the allocated frequency.

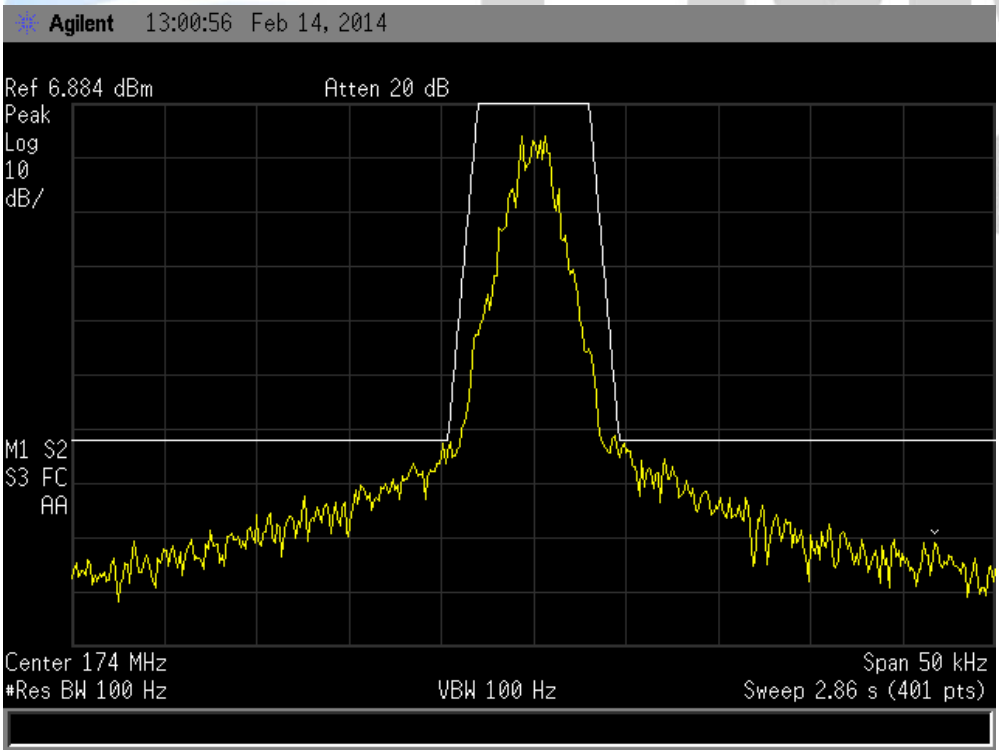
F1D 6.25 kHz Mask E, 150.075 MHz



F1D 6.25 kHz Mask E, 160.075 MHz



F1D 6.25 kHz Mask E, 173.975 MHz



Result: Complies.

Transmitter spurious emissions at the antenna terminals

Frequency: 150.075 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
300.150	-66.0	-20.0
450.225	-67.1	-20.0
600.300	<-80.0	-20.0
750.375	<-80.0	-20.0
900.450	<-80.0	-20.0
1050.525	<-80.0	-20.0
1200.600	<-80.0	-20.0
1350.675	<-80.0	-20.0
1500.750	<-80.0	-20.0

Frequency: 160.075 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
320.150	-66.2	-20.0
480.225	-65.0	-20.0
640.300	<-80.0	-20.0
800.375	<-80.0	-20.0
960.450	<-80.0	-20.0
1120.525	<-80.0	-20.0
1280.600	<-80.0	-20.0
1440.675	<-80.0	-20.0
1600.750	<-80.0	-20.0

Frequency: 173.975 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
347.950	-66.3	-20.0
521.925	-68.0	-20.0
695.900	<-80.0	-20.0
869.875	<-80.0	-20.0
1043.850	<-80.0	-20.0
1217.825	<-80.0	-20.0
1391.800	<-80.0	-20.0
1565.775	<-80.0	-20.0
1739.750	<-80.0	-20.0

Limit:

Applied mask E, on any frequency removed from the centre of the authorised bandwidth by a displacement frequency of more than 4.6 kHz shall be attenuated by at least 55 + 10 log (P) or 65.0 dB whichever is the lesser attenuation.

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

A rated power of 5.0 watts gives a limit of –20 dBm.

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

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: 160.075 MHz

Frequency Error (Hz)

Temperature (°C)	Voltage (10.0 Vdc)	Voltage (13.8 Vdc)	Voltage (30.0 Vdc)
+50	-21.0	-10.0	-17.0
+40	-15.0	-13.0	-14.0
+30	-8.0	-5.0	-12.0
+20	+4.0	+3.0	+3.0
+10	+11.0	+9.0	+15.0
0	+10.0	+8.0	+17.0
-10	-13.0	-13.0	-11.0
-20	-45.0	-27.0	-33.0
-30	-50.0	-46.0	-41.0

Limit:

Part 90.213 states in the 150-174 MHz band, fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

This transmitter was tested on 160.075 MHz.

1.0 ppm = 161.0 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 with an output level 0.1 % (-30 dB) of the level from the transmitter with a 1 kHz tone with a frequency deviation of 6.25 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 (kHz)	**Transient Period t_1**	**Frequency Period t_2**	**Deviation (kHz) Period t_3**
6.25	Nil	Nil	Nil

Limits:

Time Interval	**Period (**ms)	**6.25 kHz Deviation (kHz)**
t_1	5	± 6.25
t_2	20	± 3.125
t_3	5	± 6.25

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

6.25 kHz transmitter turn on

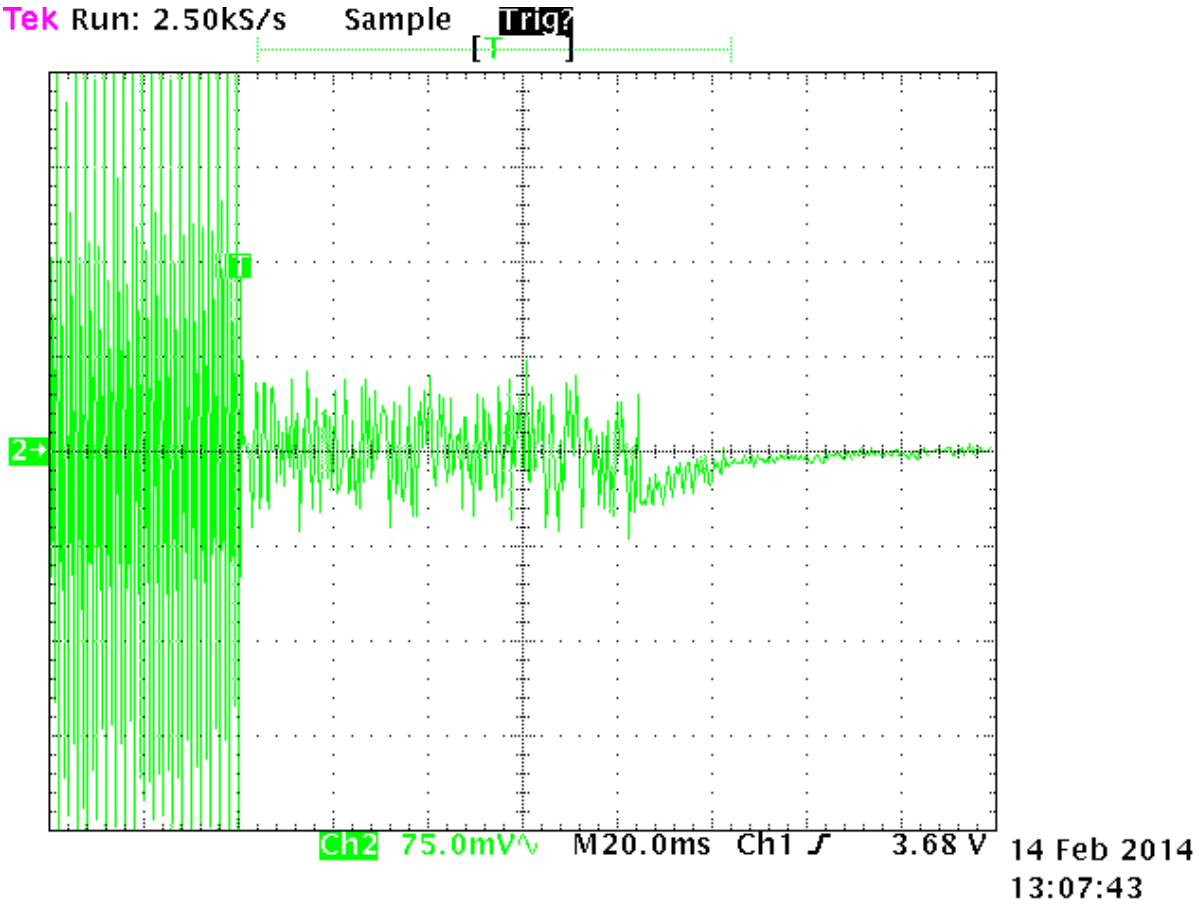
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz and any transient.

Green trace has been maximised to give full screen indication of a ±6.25 kHz.
Therefore each Y axis division = 1.5625 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 response can be observed during *t*1 and *t*2. The *ton* ramp time for the transmitter can be observed for 100 ms period.



6.25 kHz transmitter turn off

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

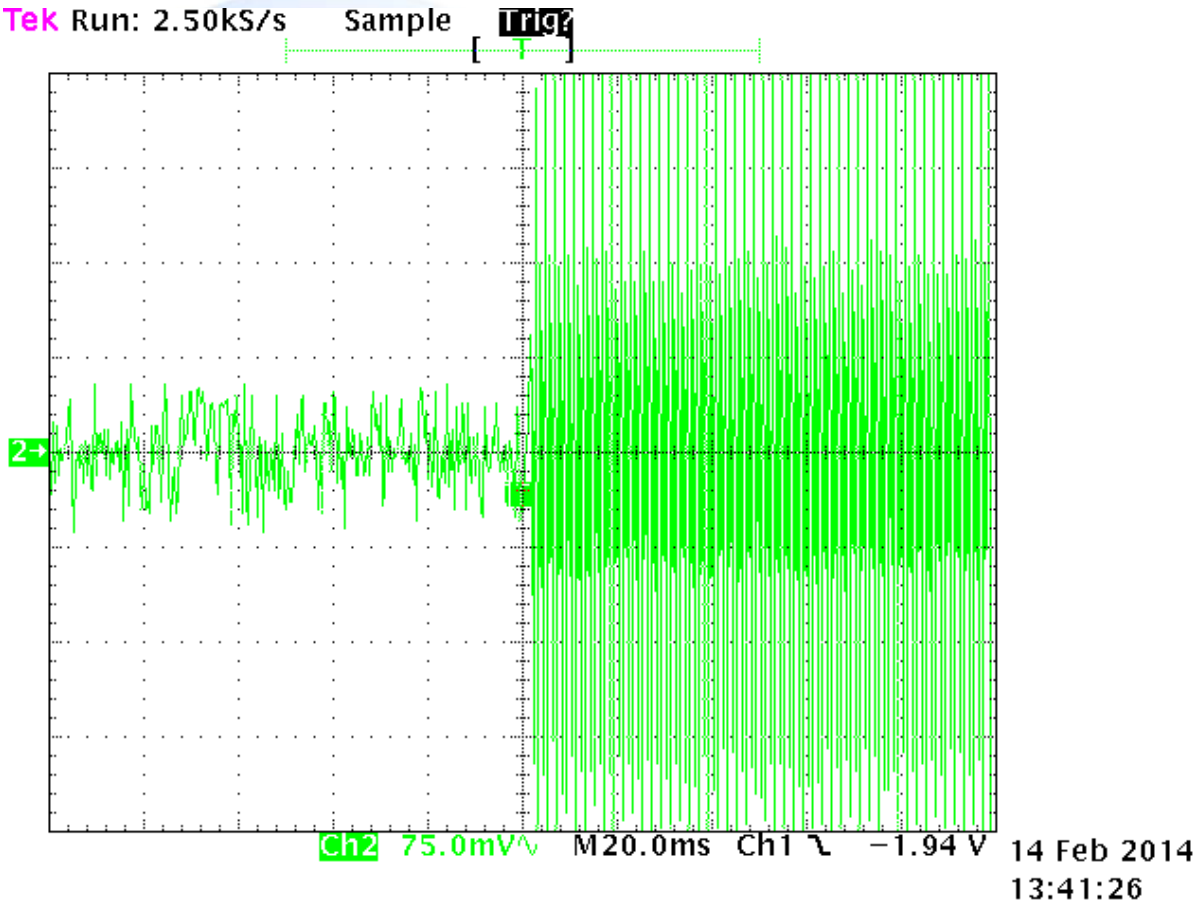
Green trace has been maximised to give full screen indication of a ± 6.25 kHz.
Therefore each Y axis division = 1.5625 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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

This is position *t*off.

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

No transient response can be observed before *t*off. The *toff* ramp time for the transmitter can be observed for 100 ms period.



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 Exposure limits.

Minimum safe distances have been calculated below at 160.075 MHz.

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

- General Public / Uncontrolled exposure limit will be 0.2 mW/cm^2 or 27.5 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 (P) = 5 watts.

Transmitter is operated using an antenna with a gain (G) of up to 20 (+13 dBi).

The client has declared a duty cycle (DC) of 100% (1)

General Public / Uncontrolled

d = √ (30 * P * G*DC) / E

d = √ (30 * 5 * 20 * 1) / 32.5

d = 1.68 metres or 168 cm

Result: Complies if the above safe distance is defined in the user manual for this equipment.

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal Due	Internval
Aerial Controller	EMCO	1090	9112-1062	3710	N/a	N/a
Aerial Mast	EMCO	1070-1	9203-1661	3708	N/a	N/a
Turntable	EMCO	1080-1-2.1	9109-1578	3709	N/a	N/a
VHF Balun	Schwarzbeck	VHA9103	-	3603	12/01/2015	1 year
Biconical Antenna	Schwarzbeck	BBA 9106	-	3612	12/01/2015	1 year
Log Periodic	Schwarzbeck	VUSLP 91111	9111-228	3785	12/01/2015	1 year
Horn Antenna	Electrometrics	RGA-60	6234	E1494	04/07/2014	1 year
Measuring receiver	Rohde & Schwarz	ESIB-40	100171	EMC4003	29/01/2015	1 year
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552	15/01/2015	1 year
Oscilloscope	Tektronics	745A	B010643	E1569	15/01/2015	1 year
Power Attenuator	Weinschel	49-20-43	GC104	E1308	N/a	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a	N/a
Signal Generator	Rohde & Schwarz	SMHU	838923/028	E1493	22/01/2015	1 year
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	RFS 3776	26/02/2014	1 year
Thermal chamber	Contherm	M180F	86025	E1129	01/06/2014	1 year
Thermometer	DSIR	RT200	035	E1049	01/06/2014	1 year

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 July 2013.

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 various accreditation bodies in a number of 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 Photos: