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TEST REPORT

Simoco SDB680 TU UHF Base Station Transceiver (400 - 480 MHz)

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

Simoco Australasia Pty Ltd

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

This Test Report is issued with the authority of:

Andrew Cutler- General Manager

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1. COMPLIANCE STATEMENT

The **Simoco SDB680 TU (400-480 MHz) UHF Base Station 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, ANSI C63.4, 2002 and ANSI/ TIA-603-C.

2. RESULT SUMMARY

The results of testing, carried out between 18st August and 30th August 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) 90.211(a)	Modulation Characteristics Low pass filter response Modulation limiting characteristics Modulation characteristics	Noted Noted Noted Complies
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
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.

All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

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	Simoco Australasia 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	SDB680 TU
Product	UHF Base Station Transceiver (400-480 MHz)
Manufacturer	Simoco
Manufactured in	Taiwan
Designed in	Australia
Serial Number	6BTU1430010T
FCC ID	U89SDB680TU01

The sample tested has the following specifications:

Rated Transmitter Output Power

50.0 Watts (47.0 dBm)

Transmitter FCC Frequency Bands

Part 90: 406.1 - 480 MHz

Test frequencies

Frequency MHz	Power Watts	Spacing kHz
406.100	40.0	12.5
440.075	50.0	12.5
479.075	50.0	12.5

Emission Designators / Modes of operation

11k2F3E – Analogue speech
7k60FXE – DMR 4FSK 9600 bps TDMA digital speech and data
7k60FXD – DMR 4FSK 9600 bps TDMA digital data

Power Supply

DC voltage supply typically 14.0 Vdc

Standard Temperature and Humidity

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

Standard Test Power Source

Standard Test Voltage: 14.0 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 12.5 kHz channel spacing.

12.5 kHz channel bandwidth certification is sought for this transmitter under section 90.203(j)(4) and (5) as:

- certification has been sought after January 1, 2011.

- the equipment meets the spectrum efficiency standard of one voice channel per 12.5 kHz of channel bandwidth

- the equipment can operate with a data rate greater than 4.8 kbps per 6.25 kHz of channel bandwidth

Result: Complies.

RF power output

Measurements were carried out at the RF output terminals of the transmitter using a 30 dB power attenuator and a 50 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)
406.100	14.0	47.0	46.5
440.075	10.8	47.0	44.8
440.075	14.0	47.0	46.1
440.075	15.6	47.0	46.3
479.075	14.0	47.0	46.2

Limits:

Part 90 does not specify the transmitter output power

Result: Complies
Measurement Uncertainty: ±0.5 dB

Modulation Characteristics

This transmitter is capable of producing analogue speech and digital speech modulations.

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.

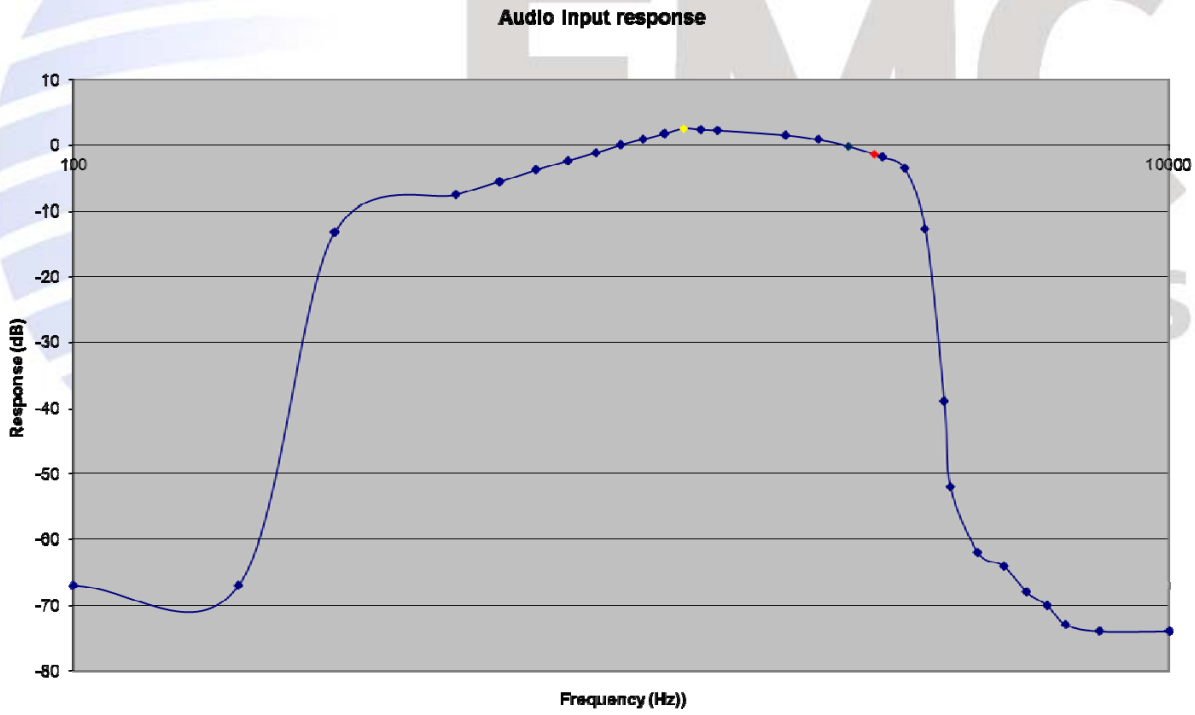
At 1 kHz an audio signal was applied which was used as a 0 dB response reference.

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 1300 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.

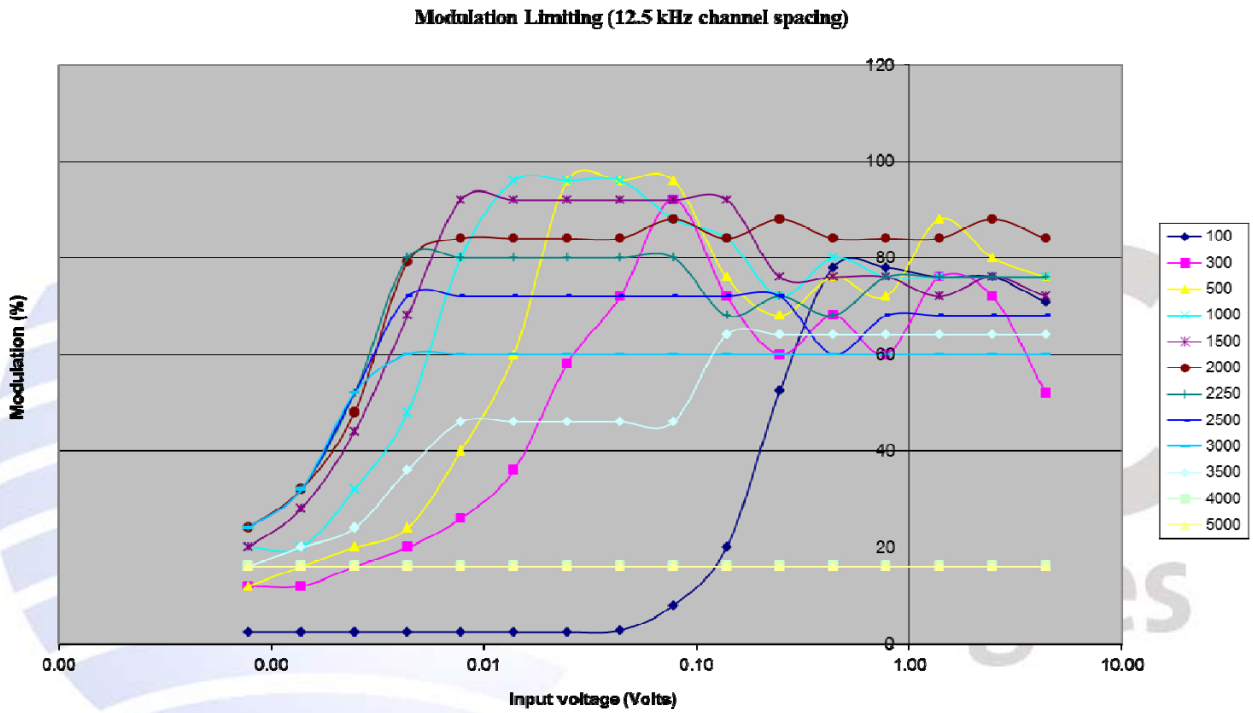


(a) A family of curves showing the percentage of modulation versus the modulation input voltage.

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.

The following other modulation types are used with this transmitter.

- 4FSK 9600 bps TDMA digital speech and data.

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: ±1%.

Part 90.207 – Emission types:

The following emission types are used:

- F3E: Frequency modulation with analogue speech.
- FXE: 4FSK 9600 bps TDMA for the transmission of data and speech
- FXD: 4FSK 9600 bps TDMA for the transmission of data digital data

Part 90.209 – Bandwidth limitations:

The authorised bandwidth is taken to be the necessary bandwidth.

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

$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 2.5 kHz
Where M = maximum modulation frequency: 3 kHz
$B_n =$ 11 kHz

Measurements show the following
$B_n = 2 \times 2400$ Hz + 2 x 2600 Hz
$B_n =$ 10.0 kHz

This is confirmed in the emission designation 11k2F3E

For Digital Modulation 4FSK an emission designator of 7k60FXE has been declared by the client.

Measurements have also been made to verify this 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.

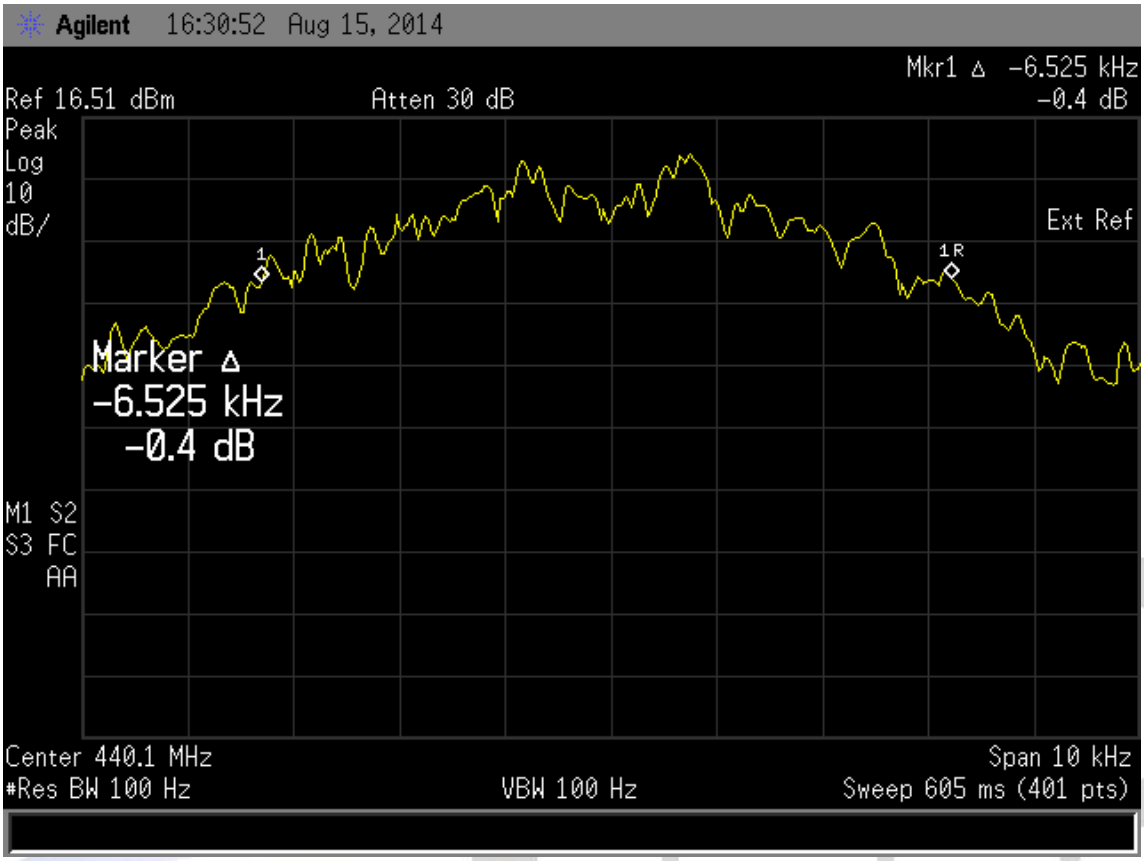
Initially power measurements are made using a resolution bandwidth of 120 kHz.

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

FXE / FXD – 12.5 KHz spacing

Emission	Channel	Measured	Designated
FXE / FXD	12.5 kHz	6.525 kHz	7.600 kHz



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 421 - 512 MHz using an authorised bandwidth of 12.5 kHz as per Section 90.209(b)(5).

The reference level for the following emission mask measurements has been determined using a resolution bandwidth of 120 kHz with the transmitter modulated.

All measurements have been made with a -30 dB 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 440.075 MHz.

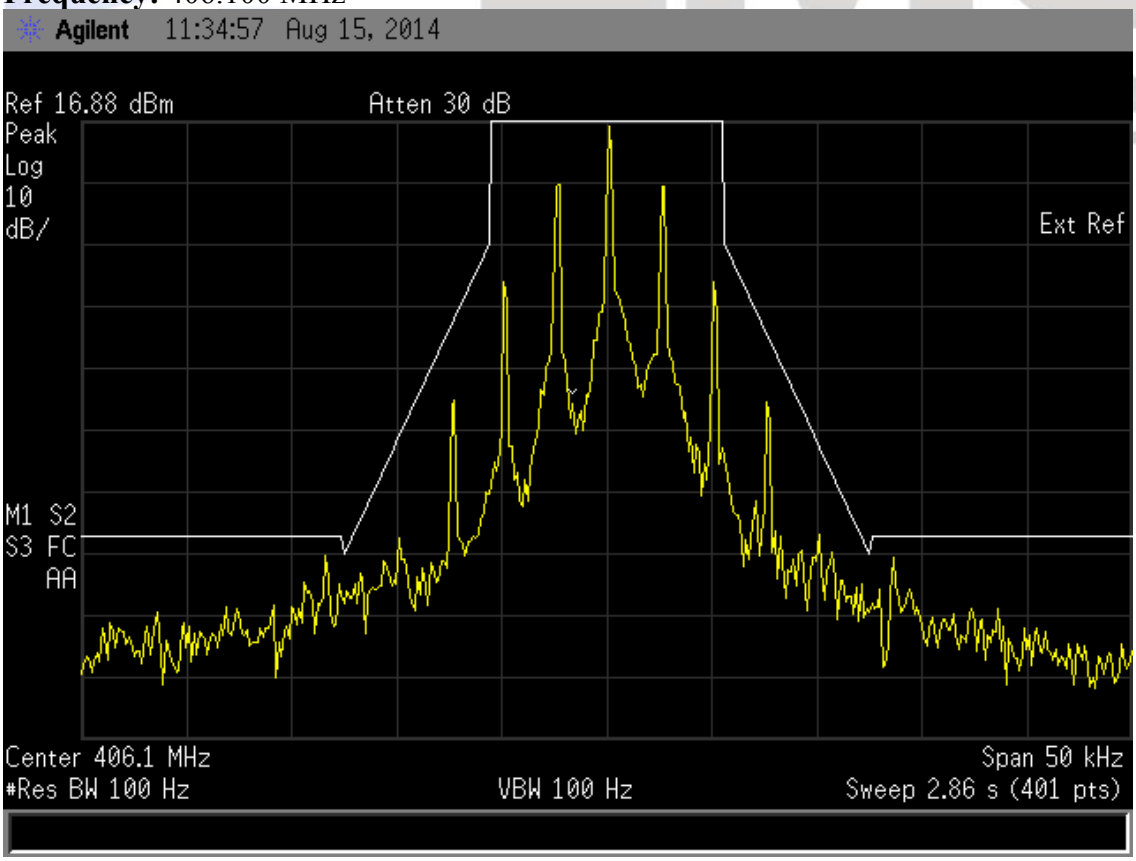
When operating in F3E mode a 2500 Hz tone, which was found to be the frequency of maximum response, that was applied at a level 16 dB higher than that required to achieve 50% modulation.

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

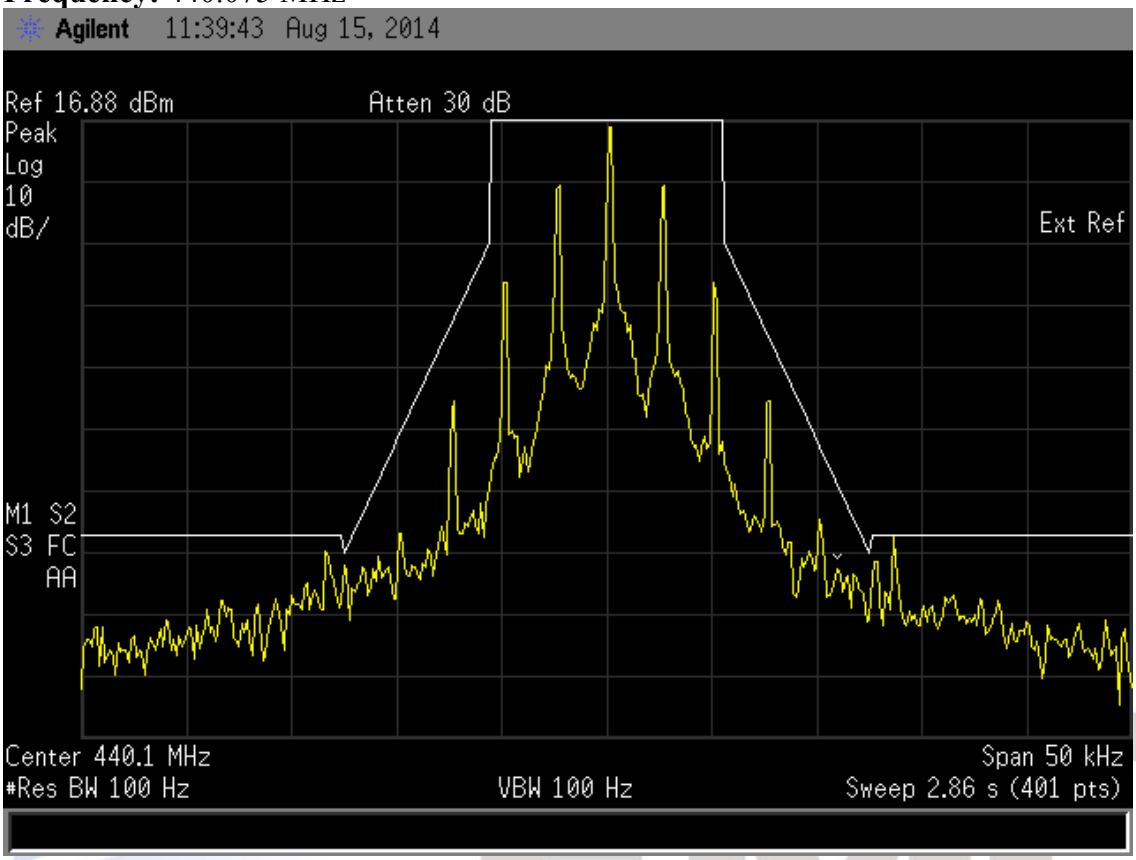
Result: Complies

F3E 12.5 kHz

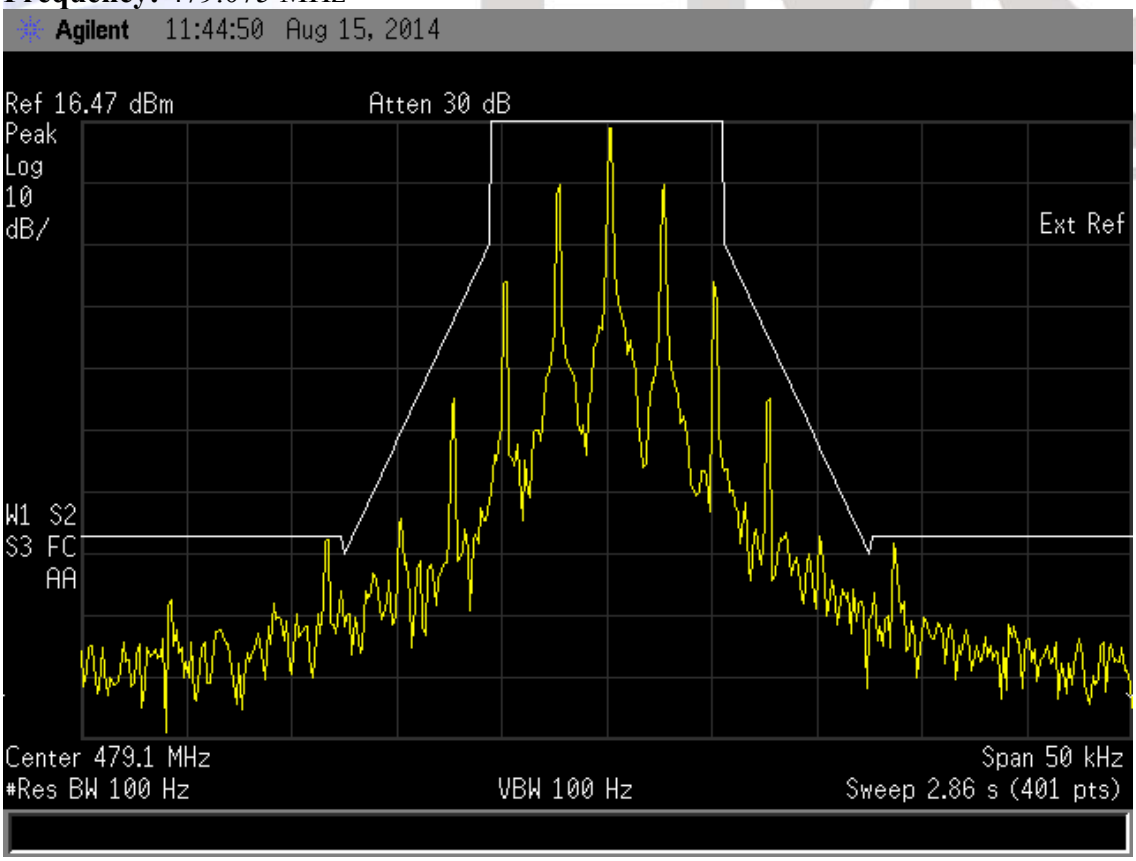
Frequency: 406.100 MHz



Frequency: 440.075 MHz

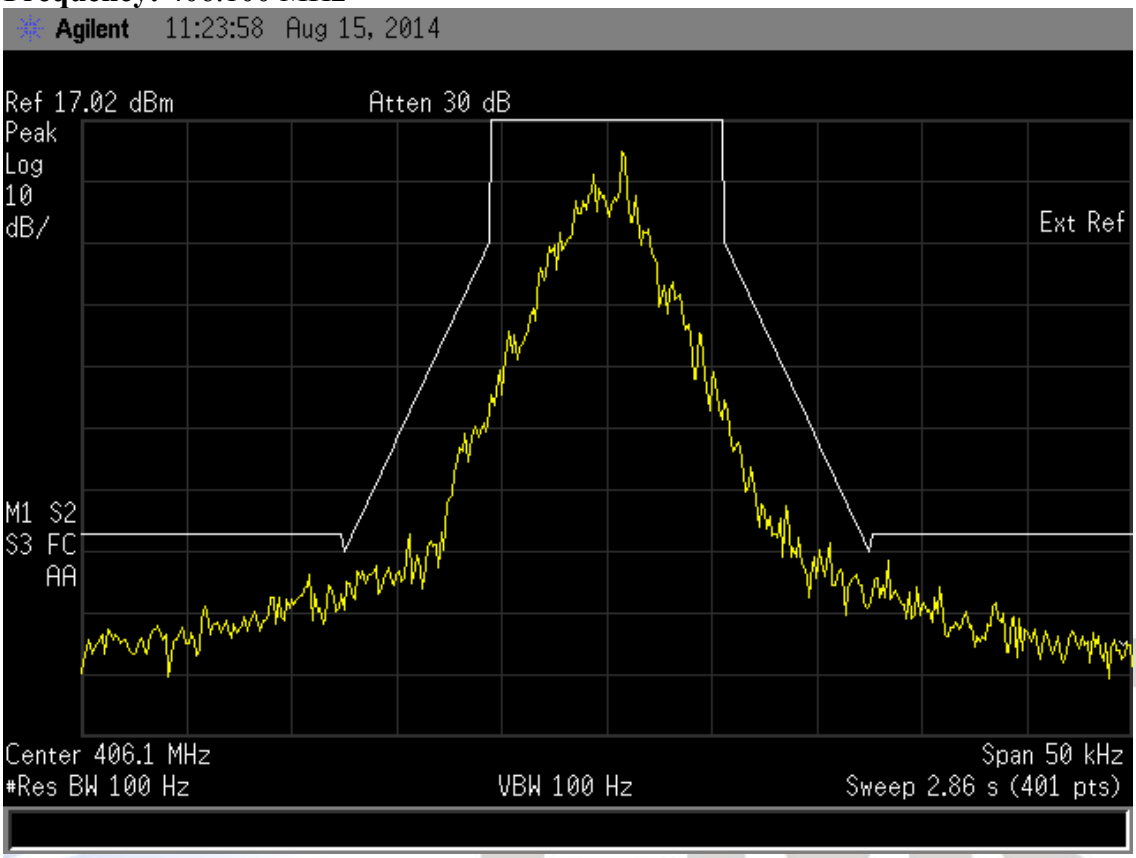


Frequency: 479.075 MHz

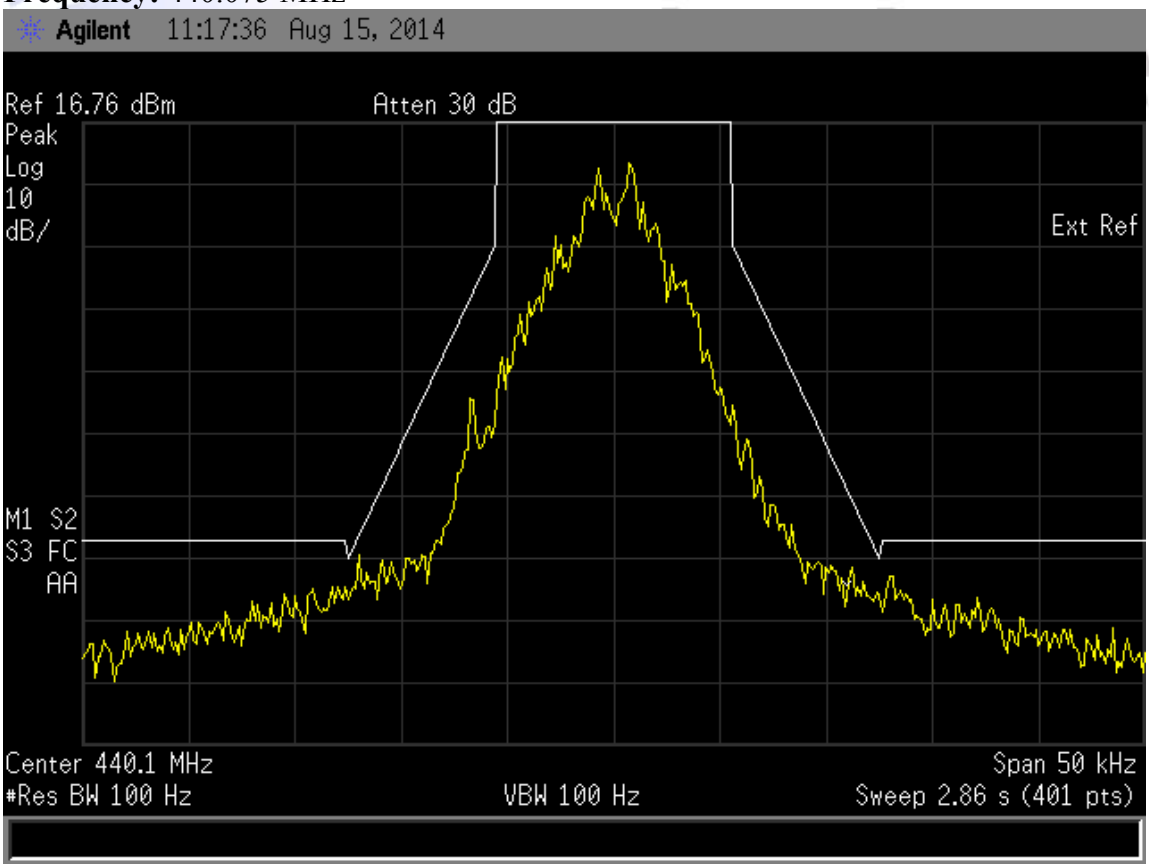


FXE / FXD 12.5 kHz

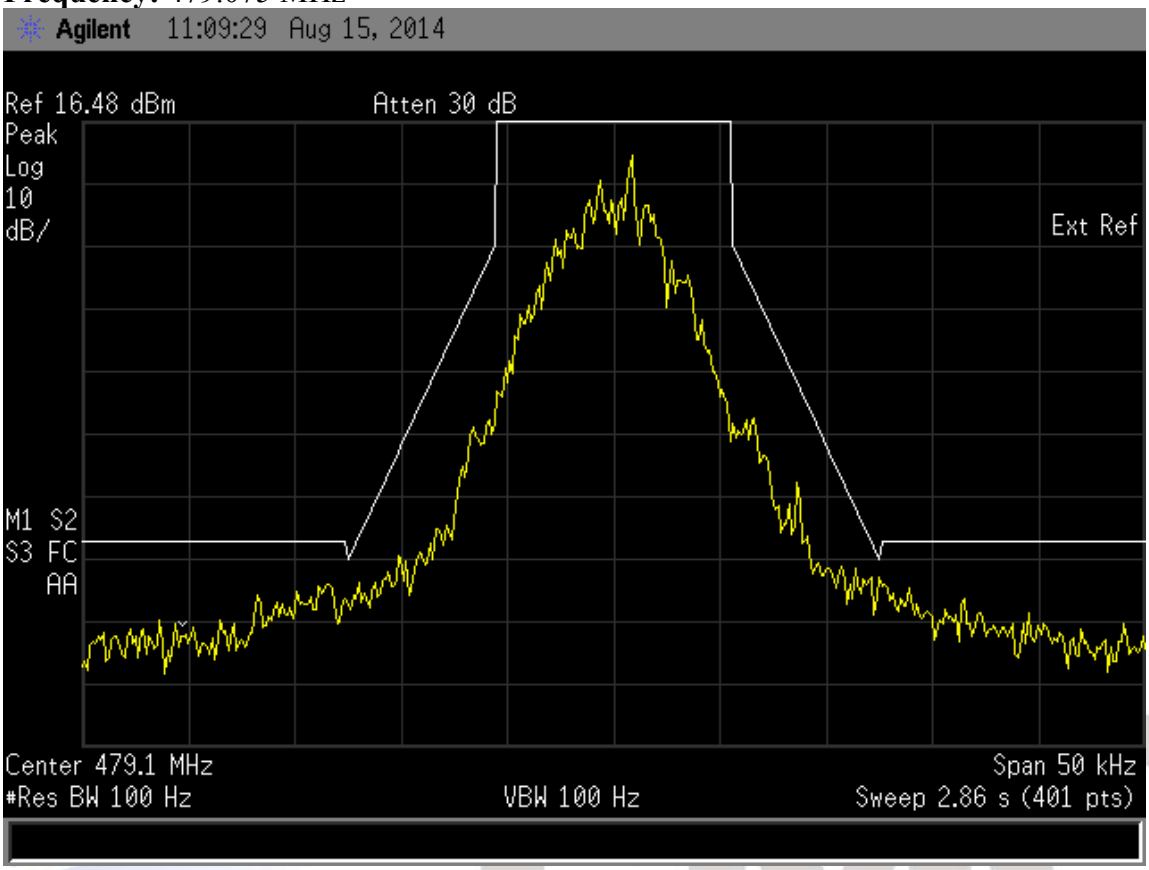
Frequency: 406.100 MHz



Frequency: 440.075 MHz



Frequency: 479.075 MHz



Transmitter spurious emissions at the antenna terminals

Frequency: 440.075 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
800.150	-58.7	-20.0
1320.225	<-65.0	-20.0
1760.300	<-65.0	-20.0
2200.375	<-65.0	-20.0
2640.450	<-65.0	-20.0
3080.525	<-65.0	-20.0
3520.600	<-65.0	-20.0
3960.675	<-65.0	-20.0
4400.750	<-65.0	-20.0

No other emissions were observed

Limit:
Part 90.210(d) Mask D, (3) on any frequency removed from the centre of the authorised bandwidth by a displacement frequency of more than 12.5 kHz shall be attenuated by at least 50 + 10 log (P) or 70 dB whichever is the lesser attenuation.

The spurious emission limit defined by Mask D has been applied as this transmitter can operate using channel 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^{th} harmonic if the transmitter operates below 10 GHz.

A rated power of 50.0 watts gives a limit of –20.0 dBm.

No measurements were made above the 10^{th} harmonic.

Result: Complies
Measurement Uncertainty: ±3.3 dB

Field strength of the transmitter spurious emissions

Frequency: 406.100 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
812.200	38.2	-59.2	-20.0	Vertical	39.2
812.200	33.3	-64.1	-20.0	Horizontal	44.1
1218.300	48.0	-49.4	-20.0	Vertical	29.4
1218.300	48.1	-49.3	-20.0	Horizontal	29.3
1624.400	50.2	-47.2	-20.0	Vertical	27.2
1624.400	50.0	-47.4	-20.0	Horizontal	27.4
2030.500	52.2	-45.2	-20.0	Vertical	25.2
2030.500	52.0	-45.4	-20.0	Horizontal	25.4
2436.600	59.8	-37.6	-20.0	Vertical	17.6
2436.600	56.1	-41.3	-20.0	Horizontal	21.3
2842.700	55.0	-42.4	-20.0	Vertical	22.4
2842.700	55.8	-41.6	-20.0	Horizontal	21.6
3248.800	56.8	-40.6	-20.0	Vertical	20.6
3248.800	56.8	-40.6	-20.0	Horizontal	20.6
3654.900	58.0	-39.4	-20.0	Vertical	19.4
3654.900	58.0	-39.4	-20.0	Horizontal	19.4
4061.000	62.0	-35.4	-20.0	Vertical	15.4
4061.000	60.0	-37.4	-20.0	Horizontal	17.4

Frequency: 440.075 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
880.150	35.0	-62.4	-20.0	Vertical	42.4
880.150	33.0	-64.4	-20.0	Horizontal	44.4
1320.225	49.0	-48.4	-20.0	Vertical	28.4
1320.225	48.5	-48.9	-20.0	Horizontal	28.9
1760.300	48.7	-48.7	-20.0	Vertical	28.7
1760.300	48.0	-49.4	-20.0	Horizontal	29.4
2200.375	54.3	-43.1	-20.0	Vertical	23.1
2200.375	53.5	-43.9	-20.0	Horizontal	23.9
2640.450	57.6	-39.8	-20.0	Vertical	19.8
2640.450	57.6	-39.8	-20.0	Horizontal	19.8
3080.525	55.0	-42.4	-20.0	Vertical	22.4
3080.525	54.6	-42.8	-20.0	Horizontal	22.8
3520.600	57.0	-40.4	-20.0	Vertical	20.4
3520.600	57.2	-40.2	-20.0	Horizontal	20.2
3960.675	58.8	-38.6	-20.0	Vertical	18.6
3960.975	58.7	-38.7	-20.0	Horizontal	18.7
4400.750	61.0	-36.4	-20.0	Vertical	16.4
4400.750	61.0	-36.4	-20.0	Horizontal	16.4

Frequency: 479.075 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
958.150	32.0	-65.4	-20.0	Vertical	45.4
958.150	32.5	-64.9	-20.0	Horizontal	44.9
1437.225	48.3	-49.1	-20.0	Vertical	29.1
1437.225	49.0	-48.4	-20.0	Horizontal	28.4
1916.300	51.4	-46.0	-20.0	Vertical	26.0
1916.300	51.9	-45.5	-20.0	Horizontal	25.5
2395.375	56.2	-41.2	-20.0	Vertical	21.2
2395.375	55.8	-41.6	-20.0	Horizontal	21.6
2874.450	55.8	-41.6	-20.0	Vertical	21.6
2874.450	55.5	-41.9	-20.0	Horizontal	21.9
3353.525	54.5	-42.9	-20.0	Vertical	22.9
3353.525	54.6	-42.8	-20.0	Horizontal	22.8
3832.600	57.4	-40.0	-20.0	Vertical	20.0
3832.600	57.4	-40.0	-20.0	Horizontal	20.0
4311.675	60.8	-36.6	-20.0	Vertical	16.6
4311.675	59.5	-37.9	-20.0	Horizontal	17.9
4790.750	61.2	-36.2	-20.0	Vertical	16.2
4790.075	61.2	-36.2	-20.0	Horizontal	16.2

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.

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 50 watts gives a limit of –20 dBm.

No measurements were made above the 10^{th} 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.

Frequency: 440.075 MHz

Temperature	Voltage 10.8 Vdc	Voltage 14.0 Vdc	Voltage 15.6 Vdc
+50°C	+31.0	+28.0	+21.0
+40°C	+34.0	+84.0	+32.0
+30°C	+43.0	+18.0	+9.0
+20°C	+79.0	+80.0	+78.0
+10°C	+83.0	+128.0	+101.0
0°C	+80.0	+77.0	+117.0
-10°C	+107.0	+148.0	+133.0
-20°C	+110.0	+151.0	+159.0
-30°C	+155.0	+209.0	+164.0

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 440.075 MHz. 2.5 ppm = 2.5 x 440 = 1100 Hz.

The worst case stability was observed to be +209.0 Hz or 0.475 ppm

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 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 440.075 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	12.5	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

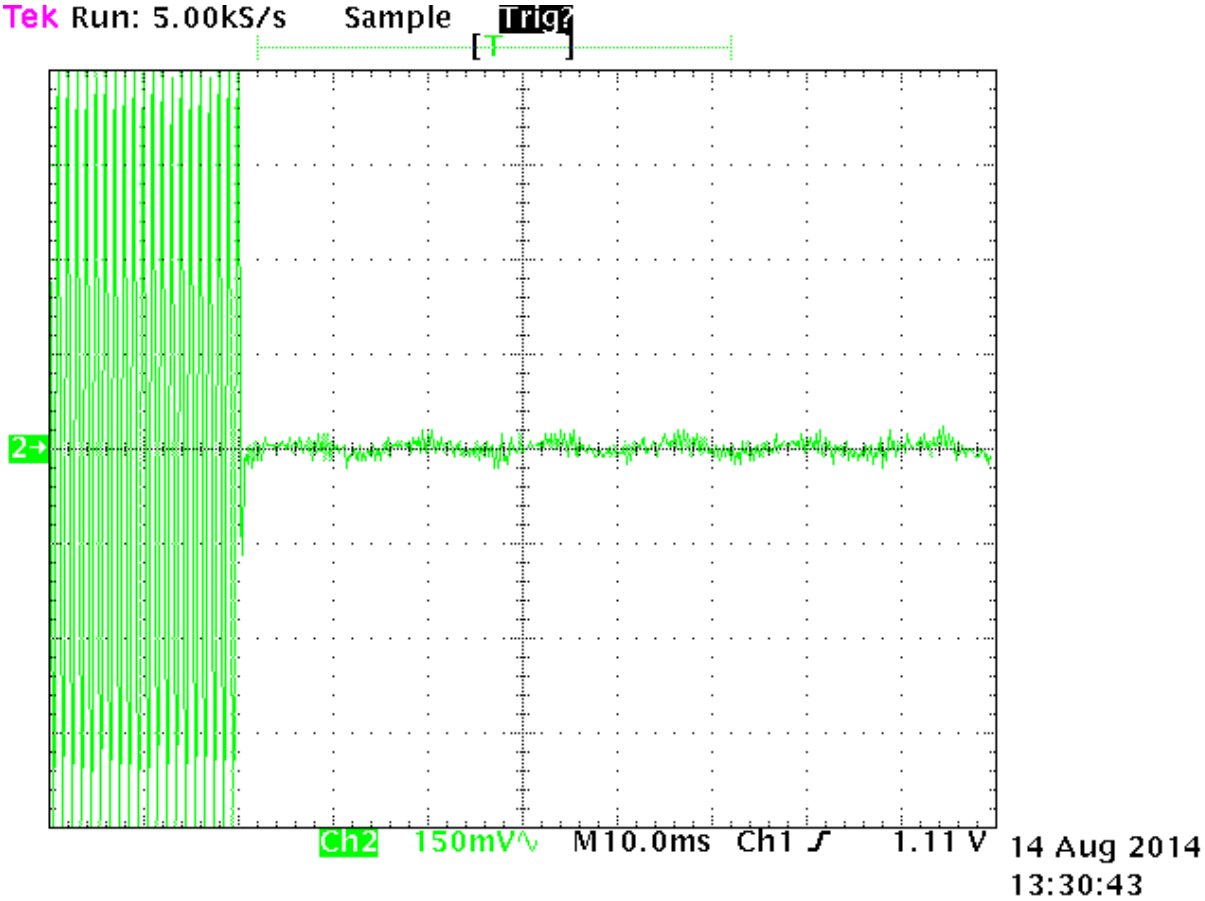
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz and any transient.

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.

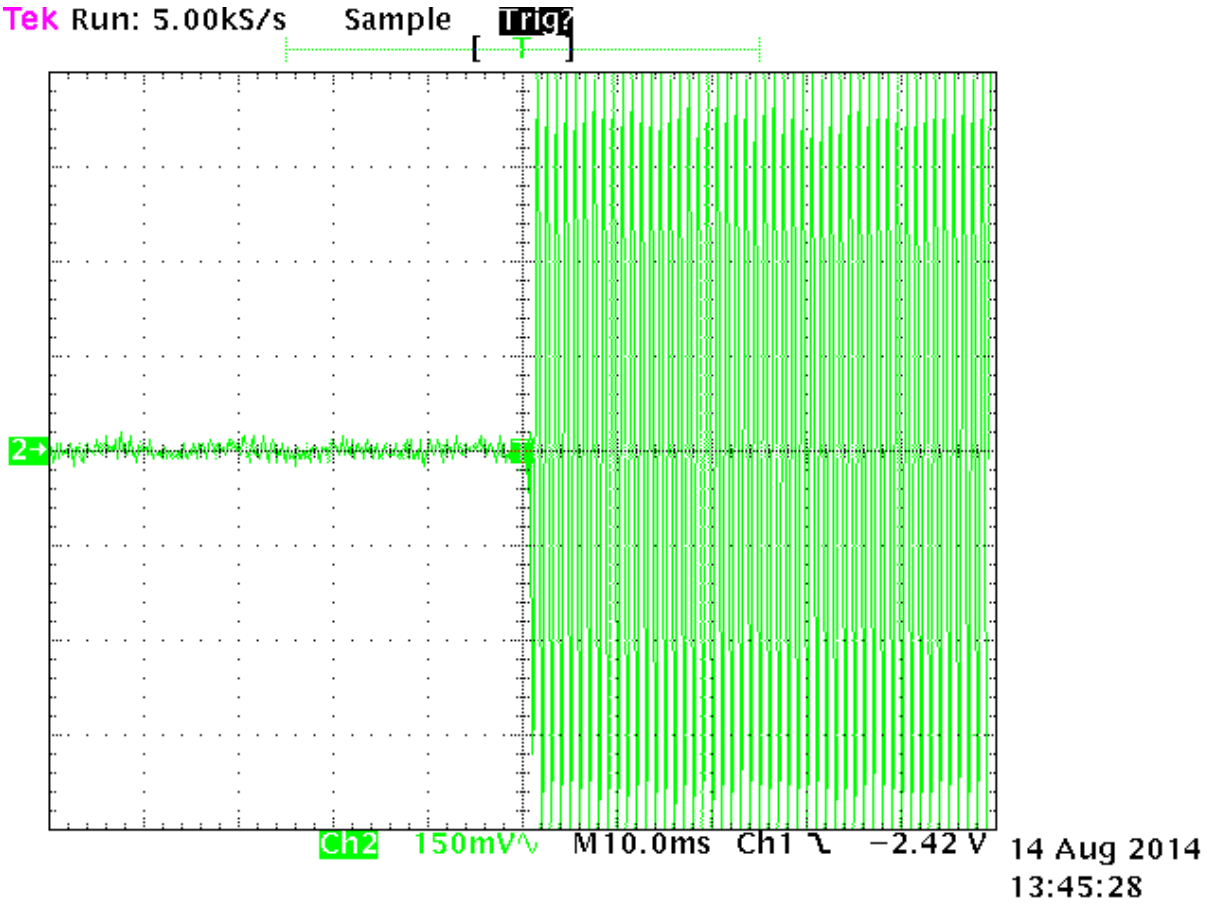
Green trace has been maximised to give full screen indication of a ± 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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

This is position *t*off.

*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.

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

- General Population / Uncontrolled exposure limit will be 0.28 mW/m^2
(f/1500 = 421 MHz/1500)

As this radio can operate over the range of 400 - 480 MHz the lowest frequency of operation in the USA, which will give the worst case result, would be 421 MHz.

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)) / d

Uncontrolled

$E = 0.28\ W/m^2 = E^2/3770$
E= √ 0.28*3770
E = 32.5 V/m

The rated maximum transmitter power = 50 watts.

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

A duty cycle of 100% as the transmitter is a base station could possibly be operated for long periods of time.

Uncontrolled
d = √ (30 * P * G*DC) / E
d = √ (30 *50 * 1.64 * 1.0) / 32.5
d = 1.52 metres or 152.0 cm

Result: Complies if the safe distances defined for this environment is applied.

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal Due	Interval
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	3 years
Biconical Antenna	Schwarzbeck	BBA 9106	-	3612	12/01/2015	3 years
Log Periodic Antenna	Schwarzbeck	VUSLP 91111	9111-228	3785	12/01/2015	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	04/06/2017	3 years
Receiver	Rohde & Schwarz	ESIB-40	100171	4003	29/01/2015	1 year
Level generator	Anritsu	MG443B	M61689	E1143	15/01/2015	2 years
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552	15/01/2015	2 years
Modulation Analyzer	Hewlett Packard	8901B	2608A00782	E1090	15/01/2015	2 years
Oscilloscope	Tektronics	745A	B010643	E1569	15/01/2015	2 years
Power Attenuator	JFW	50FH-030-100	-	-	N/a	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a	N/a
Selective Level Meter	Anritsu	ML422C	M35386	E1140	03/07/2015	2 years
Signal Generator	Rohde & Schwarz	SMHU	838923/028	E1493	22/01/2015	2 years
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	3776	26/02/2015	1 year
Thermal chamber	Contherm	M180F	86025	E1129	01/06/2015	N/a
Thermometer	DSIR	RT200	035	E1049	01/06/2015	N/a

At the time of testing all test equipment was within calibration.

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies Ltd registration with the Federal Communications Commission as a listed facility, registration number: 90838, which was updated in June 2014.

All testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025.

All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/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

Test Set Up Photos