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TEST REPORT

Simoco SDM600 UW UHF Mobile Transceiver

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

Simoco Australasia 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

Table of Contents

1.	COMPLIANCE STATEMENT	3
2.	RESULT SUMMARY	3
3.	INTRODUCTION	4
4.	CLIENT INFORMATION	4
5.	TEST SAMPLE DESCRIPTION	4
6.	ATTESTATION	6
7.	TEST RESULTS	7
8.	TEST EQUIPMENT USED	26
9.	ACCREDITATIONS	26
10.	PHOTOGRAPHS	27

1. COMPLIANCE STATEMENT

The **Simoco SDM600 UW 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. RESULT SUMMARY

The results of testing carried out between 21st August and 6th September 2013 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	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	SDM600 UW
Product	UHF Mobile Transceiver
Manufacturer	Simoco
Manufactured in	Taiwan
Designed in	Australia
Serial Number	36MUW1332300PN
FCC ID	STZDM600UW

The test sample has sockets for a transmit antenna and an accessory (Handset (PTT TX & RX Audio)) interface.

The sample tested has the following specifications:

Rated Transmitter Output Power

25.0 Watts (44.0 dBm).

Transmitter FCC Frequency Bands

Part 90: 421- 512 MHz

Test frequencies

Chl	Frequency MHz	Power Watts	Spacing kHz
2	440.175	25	12.5
3	476.175	25	12.5
4	511.975	25	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

Lead acid rechargeable battery DC voltage supply typically 13.8 Vdc.

Standard Temperature and Humidity

Temperature: +15°C to + 30°C 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. 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.

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.

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)
440.175	13.8	44.0	44.0
476.175	13.8	44.0	44.0
511.975	13.8	44.0	44.0

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
440.175	10.8	44.0	43.2
440.175	15.6	44.0	44.1

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.

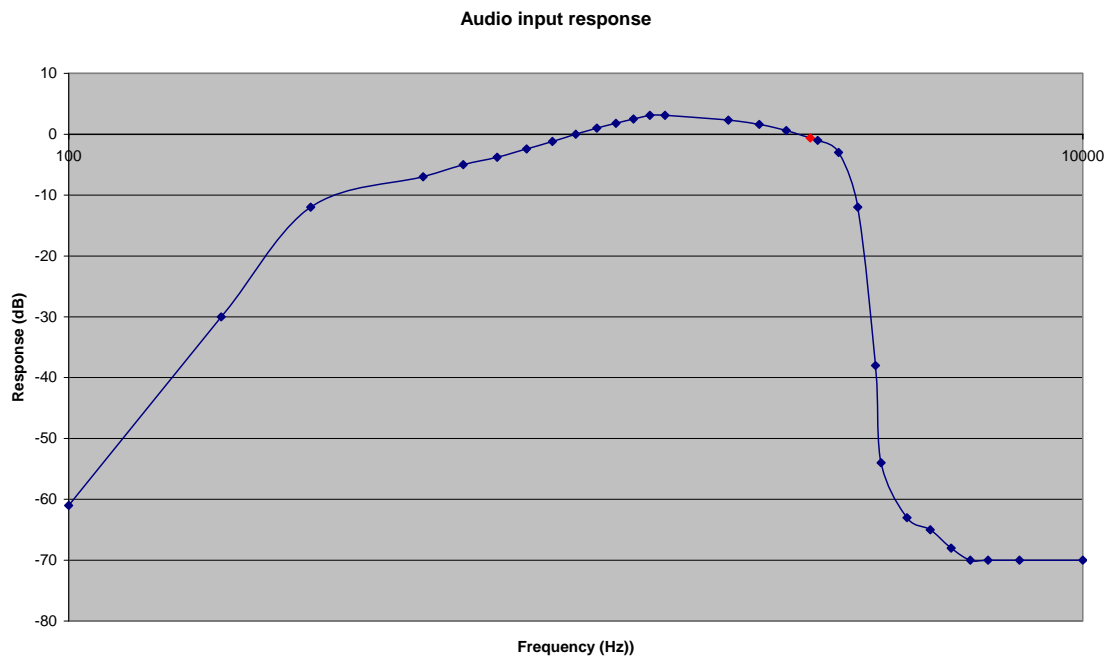
At 1 kHz an audio signal was applied which was used as a 0 dB response reference.

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 1500 Hz.

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

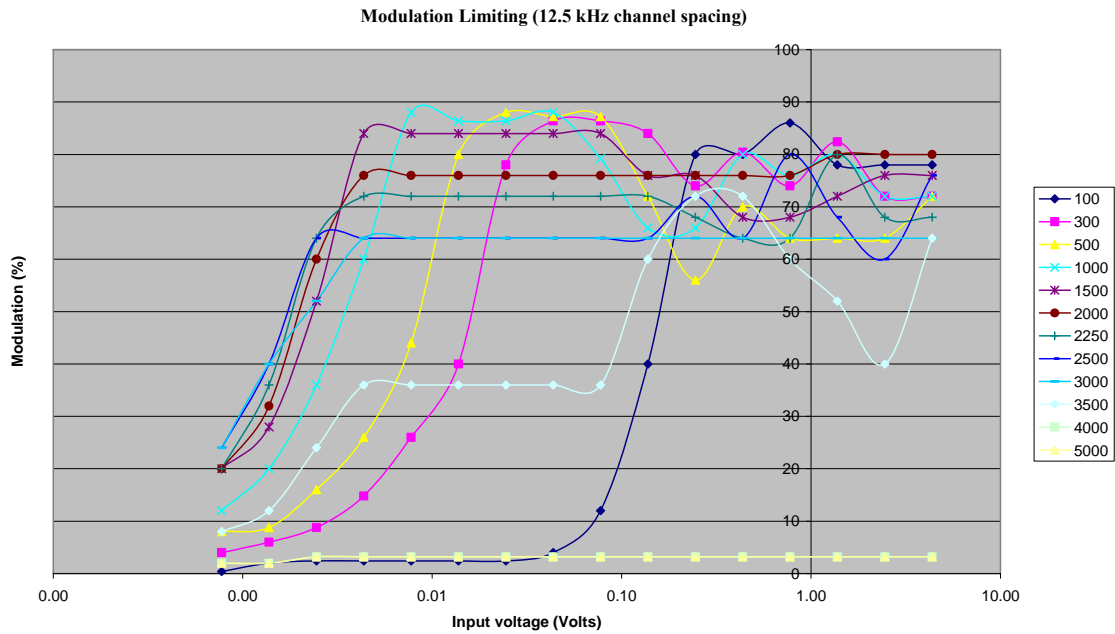


- (a) A family of curves showing the percentage of modulation versus the modulation input voltage.

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.



(b) 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: $\pm 1\%$.

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

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

Measurements show the following

$$B_n = 2 \times 2250 \text{ Hz} + 2 \times 2900 \text{ Hz}$$

$$B_n = \underline{10.3 \text{ kHz}}$$

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.

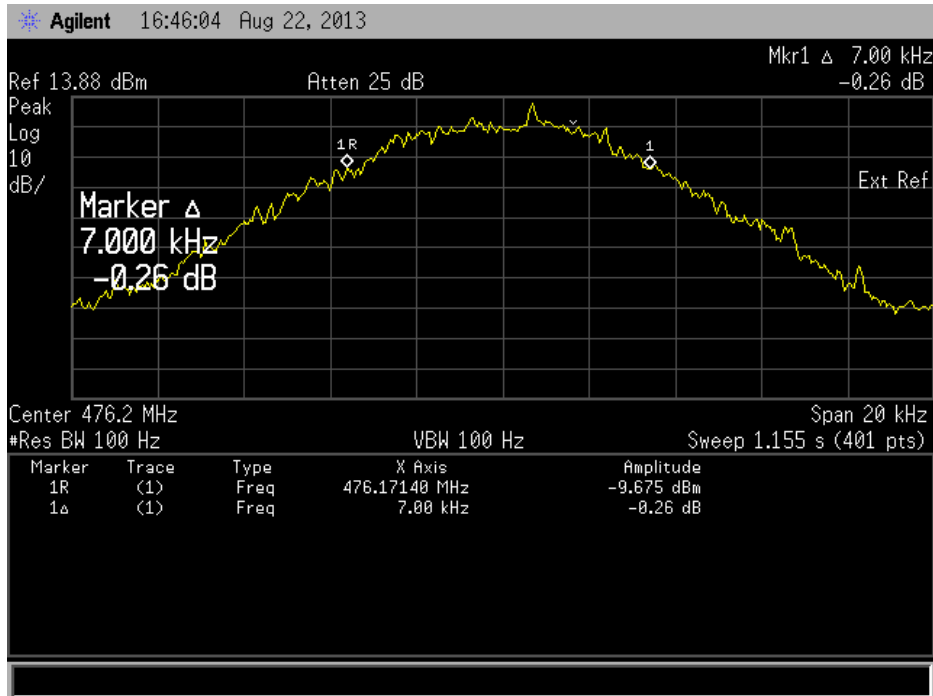
Initially power measurements are made using a resolution bandwidth of 120 kHz.

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	7.0 kHz	7.6 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 30dB attenuator is placed between the transmitter and the spectrum analyser.

Measurements were made in peak hold with the transmitter operating on 440.075 MHz.

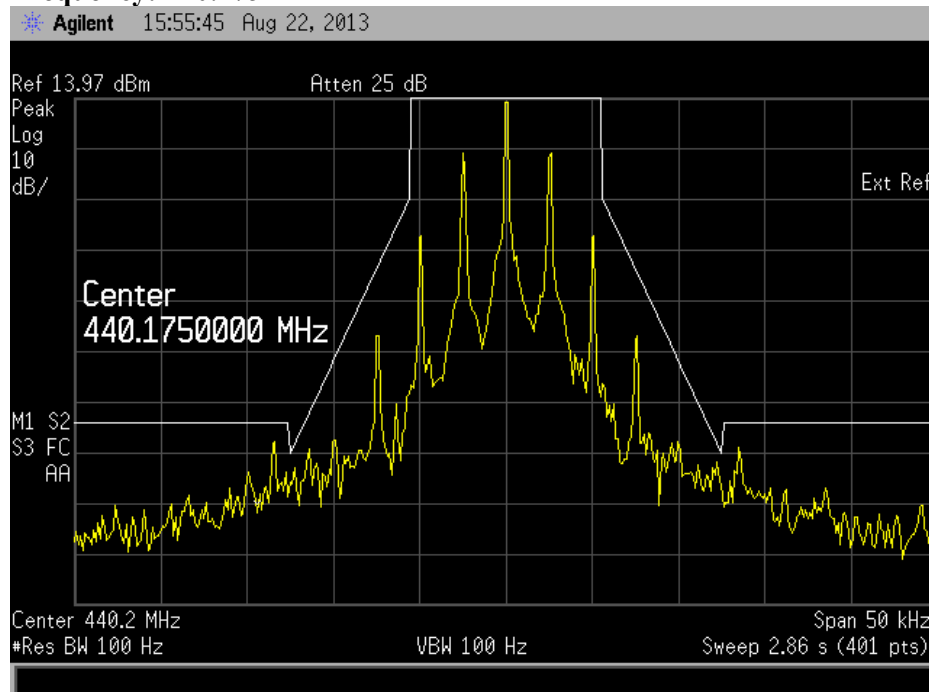
When operating in F3E mode a 2500 Hz tone, which was found to be the frequency of maximum response, that was applied at a level 16 dB higher than that required to achieve 50% modulation.

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

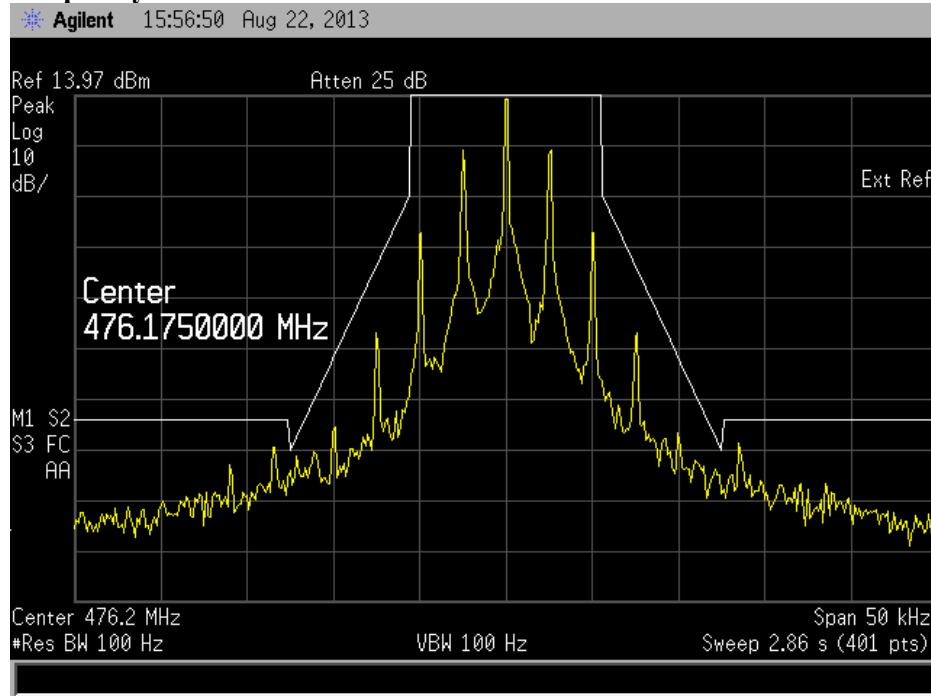
Result: Complies.

F3E 12.5 kHz

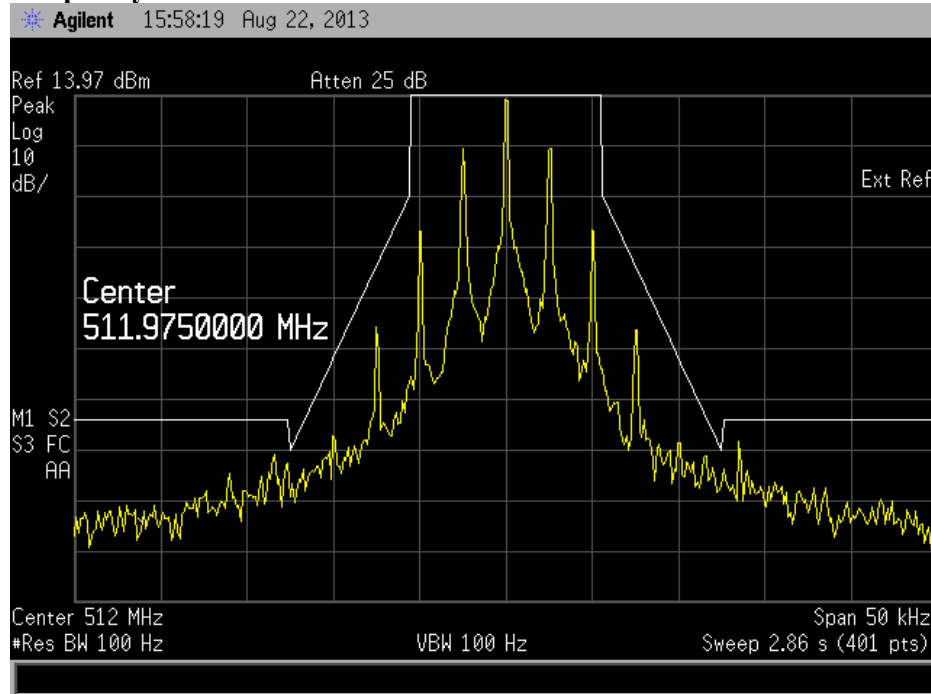
Frequency: 440.175 MHz



Frequency: 476.175 MHz

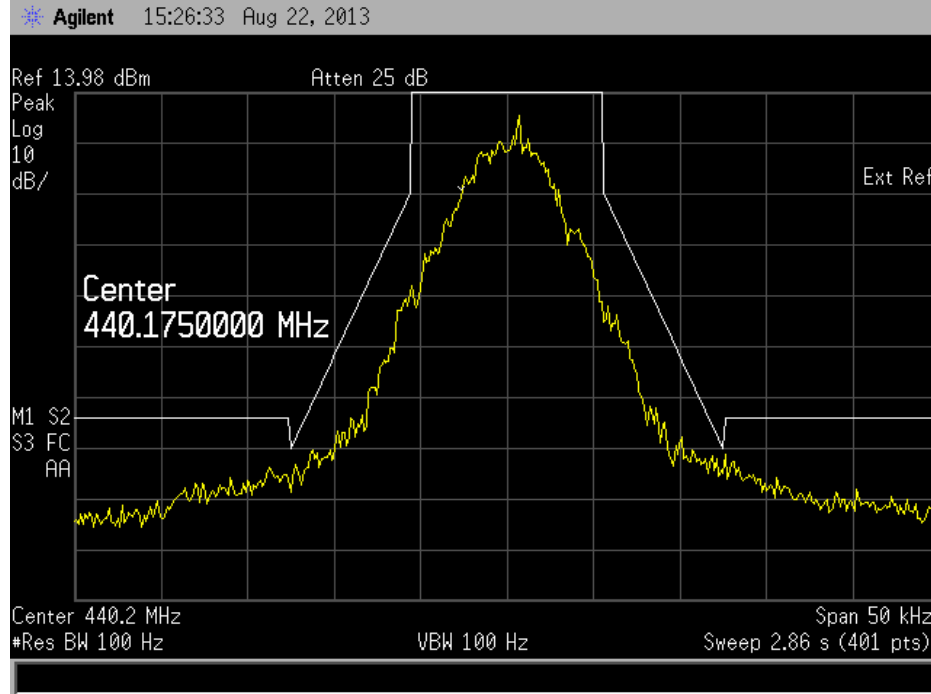


Frequency: 511.975 MHz

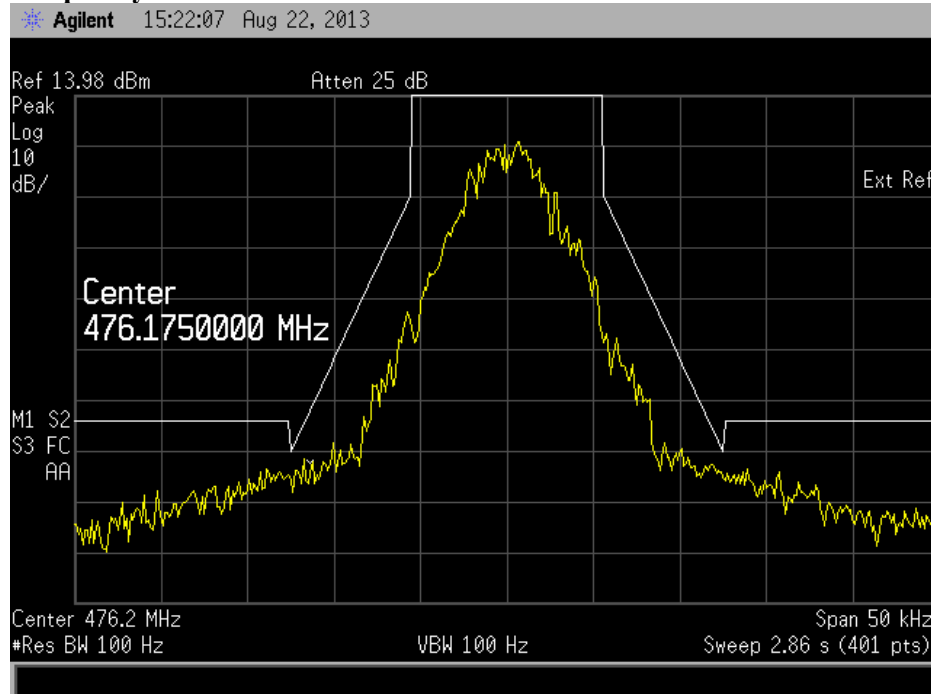


FXE / FXD 12.5 kHz

Frequency: 440.175 MHz

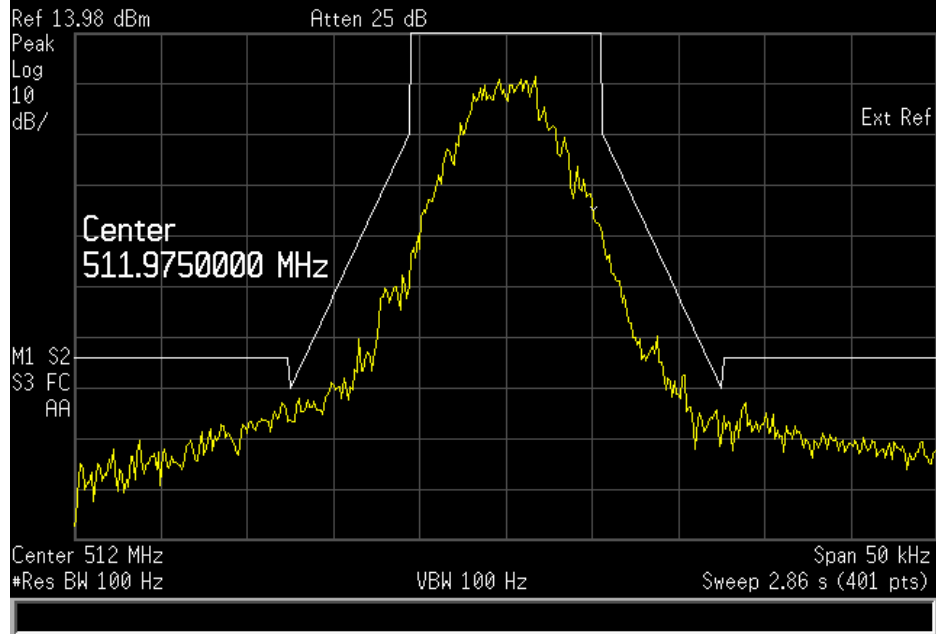


Frequency: 476.175 MHz



Frequency: 511.975

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Transmitter spurious emissions at the antenna terminals

Frequency: 440.175 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
880.350	-62.4	-20.0
1320.525	<-65.0	-20.0
1760.700	<-65.0	-20.0
2200.875	<-65.0	-20.0
2641.050	<-65.0	-20.0
3081.225	<-65.0	-20.0
3521.400	<-65.0	-20.0
3961.575	<-65.0	-20.0
4401.750	<-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 spacings 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)
880.350	38.0	-59.4	-20.0	Vertical	39.4
	38.9	-58.5	-20.0	Horizontal	38.5
1320.525	57.5	-39.9	-20.0	Vertical	19.9
	56.2	-41.2	-20.0	Horizontal	21.2
1760.700	58.1	-39.3	-20.0	Vertical	19.3
	58.8	-38.6	-20.0	Horizontal	18.6
2200.875	65.3	-32.1	-20.0	Vertical	12.1
	65.0	-32.4	-20.0	Horizontal	12.4
2641.050	67.0	-30.4	-20.0	Vertical	10.4
	66.7	-30.7	-20.0	Horizontal	10.7
3081.225	54.8	-42.6	-20.0	Vertical	22.6
	53.5	-43.9	-20.0	Horizontal	23.9
3521.400	56.8	-40.6	-20.0	Vertical	20.6
	56.8	-40.6	-20.0	Horizontal	20.6
3961.575	58.0	-39.4	-20.0	Vertical	19.4
	58.0	-39.4	-20.0	Horizontal	19.4
4401.750	62.0	-35.4	-20.0	Vertical	15.4
	60.0	-37.4	-20.0	Horizontal	17.4

Frequency: 476.175 MHz

Frequency (MHz)	Level (dB μ V/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
952.350	49.5	-47.9	-20.0	Vertical	27.9
	40.2	-57.2	-20.0	Horizontal	37.2
1428.525	58.1	-39.3	-20.0	Vertical	19.3
	56.9	-40.5	-20.0	Horizontal	20.5
1904.700	62.5	-34.9	-20.0	Vertical	14.9
	61.2	-36.2	-20.0	Horizontal	16.2
2380.875	65.0	-32.4	-20.0	Vertical	12.4
	65.4	-32.0	-20.0	Horizontal	12.0
2857.050	54.1	-43.3	-20.0	Vertical	23.3
	54.1	-43.3	-20.0	Horizontal	23.3
3333.225	54.3	-43.1	-20.0	Vertical	23.1
	54.0	-43.4	-20.0	Horizontal	23.4
3809.400	57.1	-40.3	-20.0	Vertical	20.3
	57.2	-40.2	-20.0	Horizontal	20.2
4285.575	58.8	-38.6	-20.0	Vertical	18.6
	58.7	-38.7	-20.0	Horizontal	18.7
4761.750	60.5	-36.9	-20.0	Vertical	16.9
	60.5	-36.9	-20.0	Horizontal	16.9

Frequency: 511.975 MHz

Frequency (MHz)	Level (dBμV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
1023.950	54.4	-43.0	-20.0	Vertical	23.0
	53.8	-43.6	-20.0	Horizontal	23.6
1535.925	59.2	-38.2	-20.0	Vertical	18.2
	58.2	-39.2	-20.0	Horizontal	19.2
2047.900	63.8	-33.6	-20.0	Vertical	13.6
	63.7	-33.7	-20.0	Horizontal	13.7
2559.875	67.1	-30.3	-20.0	Vertical	10.3
	67.3	-30.1	-20.0	Horizontal	10.1
3071.850	55.0	-42.4	-20.0	Vertical	22.4
	54.0	-43.4	-20.0	Horizontal	23.4
3583.825	60.1	-37.3	-20.0	Vertical	17.3
	57.5	-39.9	-20.0	Horizontal	19.9
4095.800	58.5	-38.9	-20.0	Vertical	18.9
	58.5	-38.9	-20.0	Horizontal	18.9
4607.775	60.1	-37.3	-20.0	Vertical	17.3
	60.1	-37.3	-20.0	Horizontal	17.3
5119.750	61.0	-36.4	-20.0	Vertical	16.4
	61.0	-36.4	-20.0	Horizontal	16.4

The transmitter was tested while transmitting continuously while attached to a dummy load.

The level recorded is the signal generator output level in dBm less any gains / losses due to the coax cable and the dipole antenna.

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.

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.

Frequency: 440.175 MHz

Temperature	Voltage 10.8 Vdc	Voltage 13.8 Vdc	Voltage 15.6 Vdc
+50°C	-62.0	-61.0	-58.0
+40°C	-74.0	-75.0	-77.0
+30°C	-97.0	-98.0	-99.0
+20°C	-115.0	-114.0	-118.0
+10°C	-87.0	-87.0	-86.0
0°C	-80.0	-80.0	-80.0
-10°C	-138.0	-138.0	-138.0
-20°C	-39.0	-39.0	-40.0
-30°C	-50.0	-50.0	-49.0

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.

The Part 90 frequency stability requirement has been applied to this transmitter.

This transmitter was tested on 440.175 MHz. $2.5 \text{ ppm} = 2.5 \times 440 = 1100 \text{ Hz}$.

Result: Complies.

Measurement Uncertainty: $\pm 30 \text{ Hz}$.

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	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.

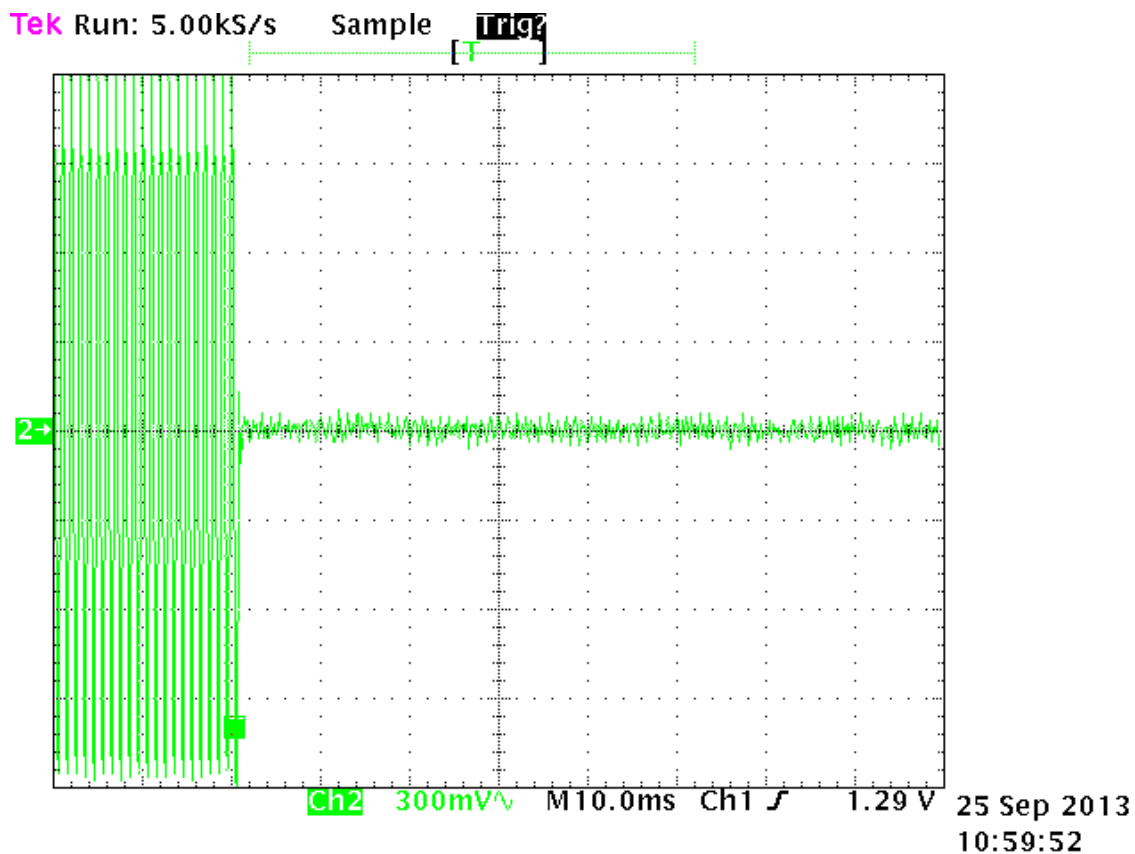
The X axis has been set to a sweep rate of 10 ms/division.

Triggering has been set to occur 2 divisions from the left hand edge (20 ms). This is position ton.

t1 occurs between 2.0 and 3.0 divisions from the left-hand edge.

t2 occurs between 3.0 and 5.5 divisions from the left-hand edge.

No transient response can be observed during t1 or t2



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.

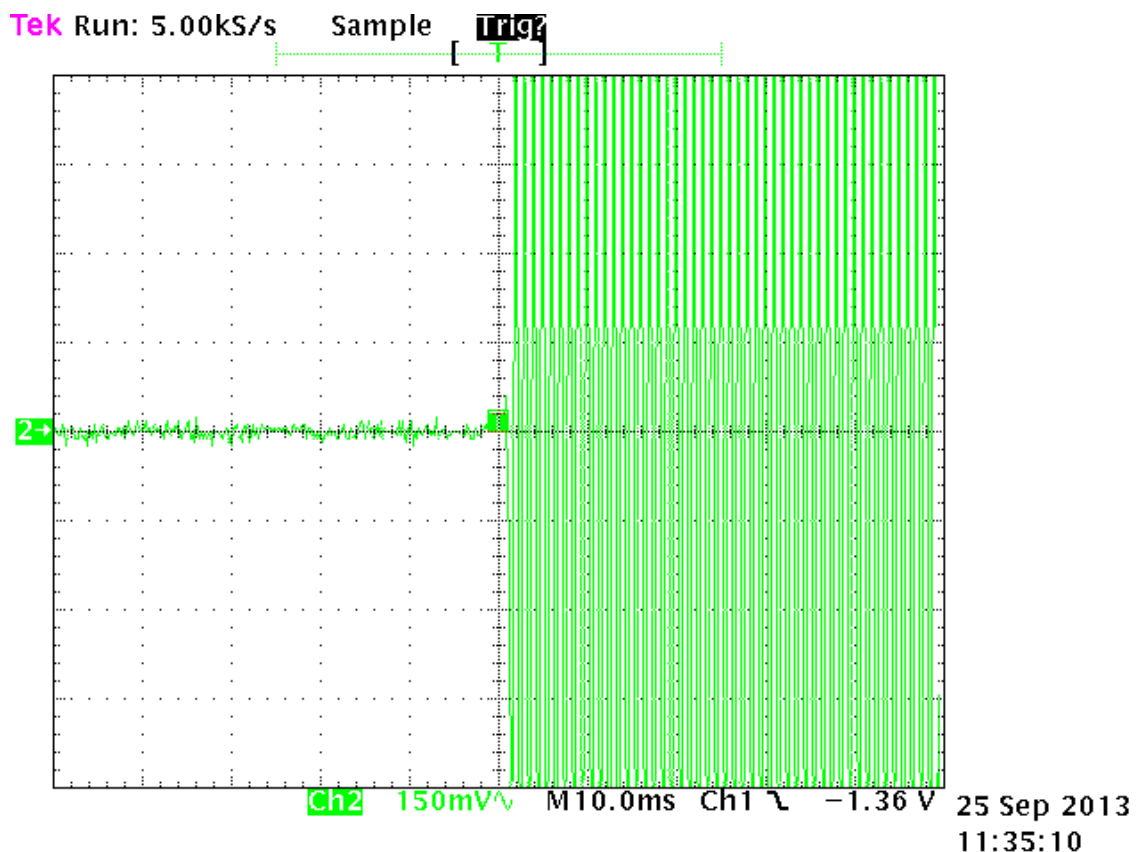
The X axis has been set to a sweep rate of 10 ms/division.

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 before *t*off.



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.

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

- Occupational / Controlled Exposure limit will be 1.47 mW/cm²
(f/300 = 440 MHz/300)

- General Population / Uncontrolled exposure limit will be 0.293 mW/cm²
(f/1500 = 440 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

$$E = 1.47 \text{ W/cm}^2 = E^2/3770$$

$$E = \sqrt{1.47 * 3770}$$

$$E = 74.4 \text{ V/m}$$

Uncontrolled

$$E = 0.293 \text{ W/cm}^2 = E^2/3770$$

$$E = \sqrt{0.293 * 3770}$$

$$E = 33.2 \text{ V/m}$$

The rated maximum transmitter power = 25 watts.

Typically the transmitter would be 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

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

$$d = \sqrt{30 * 25 * 1.64 * 0.5} / 74.4$$

$$d = 0.333 \text{ metres or } 33.3 \text{ cm}$$

Uncontrolled

$$d = \sqrt{30 * 25 * 1.64 * 0.5} / 33.2$$

$$d = 0.747 \text{ metres or } 74.7 \text{ cm}$$

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	3710	N/a
Aerial Mast	EMCO	1070-1	9203-1661	3708	N/a
Turntable	EMCO	1080-1-2.1	9109-1578	3709	N/a
VHF Balun	Schwarzbeck	VHA9103	-	3603	12/01/2015
Biconical Antenna	Schwarzbeck	BBA9106	-	3612	12/01/2015
Log Periodic	Schwarzbeck	VUSLP91111	9111-228	3785	12/01/2015
Horn Antenna	Electrometrics	RGA-60	6234	E1494	04/07/2014
Measuring receiver	Rohde & Schwarz	ESIB-40	100171	EMC4003	20/10/2013
Level generator	Anritsu	MG443B	M61689	E1143	10/07/2014
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552	15/01/2015
Modulation Analyzer	Hewlett Packard	8901B	2608A00782	E1090	10/07/2014
Oscilloscope	Tektronics	745A	B010643	E1569	15/01/2015
Power Attenuator	Weinschel	49-20-43	GC104	E1308	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a
Selective Level Meter	Anritsu	ML422C	M35386	E1140	03/07/2015
Signal Generator	Rohde & Schwarz	SMHU	838923/028	E1493	22/01/2015
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	RFS 3776	26/02/2015
Thermal chamber	Contherm	M180F	86025	E1129	01/06/2015
Thermometer	DSIR	RT200	035	E1049	01/06/2015

9. ACCREDITATIONS

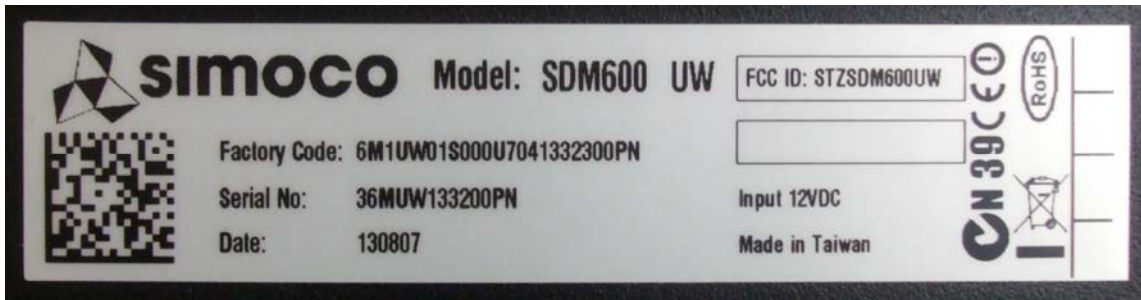
Testing was carried out in accordance with EMC Technologies NZ Ltd registration with the Federal Communications Commission as a listed facility, Registration Number: 90838, which was last updated in July 2013.

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 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.

10. PHOTOGRAPHS



MAR630CH Controller



MAR610CM Controller



Radiated emissions Setup

