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TEST REPORT

SIMOCO Pulse Air
DMR Tier III SCADA Modem

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

Simoco Wireless Solutions Pty Ltd

This Test Report is issued with the authority of:

Andrew Cutler- General Manager

IANZ ACCREDITED LABORATORY

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

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1. COMPLIANCE STATEMENT

The **SIMOCO Pulse Air DMR Tier III SCADA Modem** 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 / TIA-603-D-2010.

2. RESULT SUMMARY

The results of testing carried out between the 5th and the 19th of September 2019 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
2.1049 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	Not tested
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 Wireless Solutions Pty Ltd
Address	1270 Ferntree Gully Rd, Scoresby, Victoria 3179
Country	Australia
Contact	Mr Barend Gildenhuys

5. TEST SAMPLE DESCRIPTION

Brand Name	Simoco
Make	Pulse
Model Number	AIR
Product	Digital Transceiver
Manufacturer	Simoco Wireless Solutions
Serial Number	5PDTU154802RH
FCC ID	STZAIR600TU

Product Overview:

Product is a DMR Tier III SCADA modem that interfaces to a SCADA RTU via an RS232 port (DB9F) running a DNP3 protocol.

SCADA messages received via DNP3 over RS232 are fragmented into DMR Tier III Short Data Messages and transmitted over a DMR Tier III network where they are reassembled at the DMR Tier III Infrastructure SCADA Gateway before being forwarded onto the SCADA Master.

SCADA messages originating from the SCADA Master are fragmented, transmitted and reassembled in exactly the same way.

For type approval testing purposes, Simoco has supplied the following accessories:

- A programming cable and Field Personality Programmer (FPP) software that can be used to program and/or change the unit's ID, DMR Tier III channels etc.; and
- Type approval software applications (RTU Type Approval Control) that can be used to force the unit to transmit and/or monitor receive information.
- The FPP and RTU Type Approval Control application are installed on a laptop.

The sample tested has the following specifications

Rated Transmitter Output Power

5.0 Watts (+37 dBm) burst which is a DMR 50% TDMA

Transmitter Certification Range

Part 90: 406.1 - 480.0 MHz

Test frequencies

Frequency (MHz)	Power (Watts)	Emission
406.900	5.0	FXD/FXE
429.500	5.0	FXD/FXE
453.700	5.0	FXD/FXE
478.700	5.0	FXD/FXE

Transmitter Type

This equipment has been classed as fixed / mobile

Emission designators

7K60FXE – Speech
7K60FXD – DMR data

Channel Spacing

Equipment designed to operate using 12.5 kHz channel spacing.

Transmitter Duty Cycle

Intermittent 1:4 (25%)

General Test Conditions

Standard Temperature and Humidity

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

Standard Test Power Source

Standard Test Voltage:	13.0 Vdc

Extreme Temperature

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

Extreme Test Voltages

High Voltage:	15.0 Vdc
Low Voltage:	11.0 Vdc

6. TEST RESULTS

Certification required

Part 90.203(j)

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;

(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 power output.

Maximum transmitter power (CW) - Rated 5 W (+37.0 dBm)

Frequency (MHz)	Voltage (Vdc)	Carrier Power (dBm) +22˚ C	+55˚ C	-30˚ C
406.900	11.0	36.1	36.1	36.6
	13.0	36.2	36.1	36.6
	15.0	36.2	36.1	36.6
429.500	11.0	36.3	36.2	36.6
	13.0	36.3	36.2	36.7
	15.0	36.3	36.2	36.7
453.700	11.0	36.3	36.3	36.7
	13.0	36.3	36.3	36.7
	15.0	36.3	36.3	36.7
478.700	11.0	36.1	36.1	36.6
	13.0	36.1	36.1	36.6
	15.0	36.1	36.1	36.6

Limits:

Part 90 does not specify the transmitter output power

Result: Complies.
Measurement Uncertainty: ± 0.5 dB

Emission types and bandwidth limitations:

The authorised bandwidth for the 400.0-480.0 MHz band is 11.25 kHz when a 12.5 kHz channel bandwidth is used.

The following emission types are used:

- FXE: 4FSK digital modulation is used for digital telephony using a channel bandwidth of 12.5 kHz. The client has declared a necessary bandwidth of 7.6 kHz

- FXD: 4FSK digital modulation is used for data transmissions using a channel bandwidth of 12.5 kHz. The client has declared a necessary bandwidth of 7.6 kHz

An emission designator of 7K60FXD has been declared by the client for 12.5 kHz channels.

The occupied bandwidth is calculated using a maximum deviation of 2600 Hz and a symbol rate of 1200 Hz.

$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 2600 Hz
Where M = symbol rate: 1200 Hz
$B_n =$ 7600 Hz or 7.6 kHz

Measurements have been made to verify this declared bandwidth using the modulation types and data rates that this radio can support at each test frequency.

Measurements were made using a spectrum analyser that was operating in occupied bandwidth mode with the 99% power points being determined automatically.

The analyser was set up with a resolution bandwidth of 100 Hz and a video bandwidth of 200 Hz while operating in peak hold mode.

Attached to the input of the spectrum analyser was an external 30 dB attenuator.

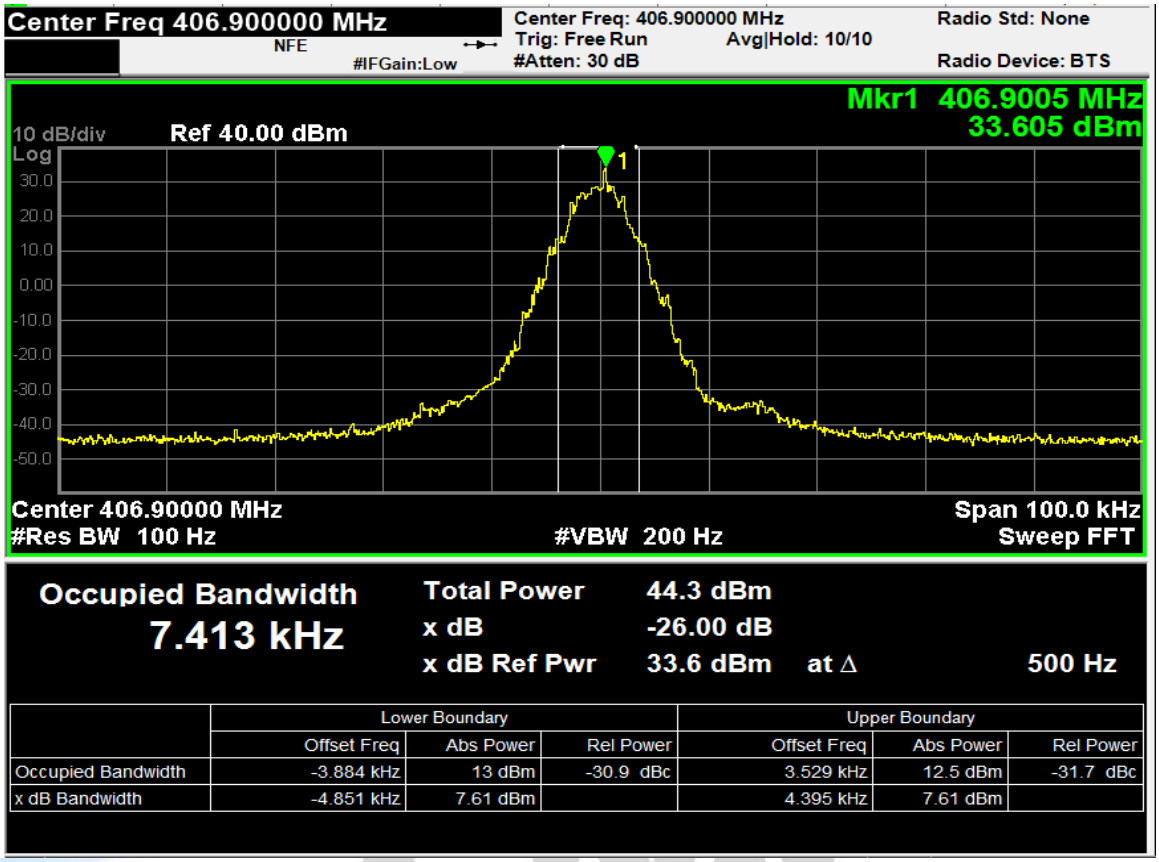
The transmitter was internally modulated.

Modulation type: FXD / FXE

Emission	Frequency (MHz)	Measured (kHz)	Designated (kHz)	Plot No
7K60FXD/FXE	406.9	7.413	7.600	Plot-1
	429.5	7.050		Plot-2
	453.7	7.155		Plot-3
	478.7	7.183		Plot-4

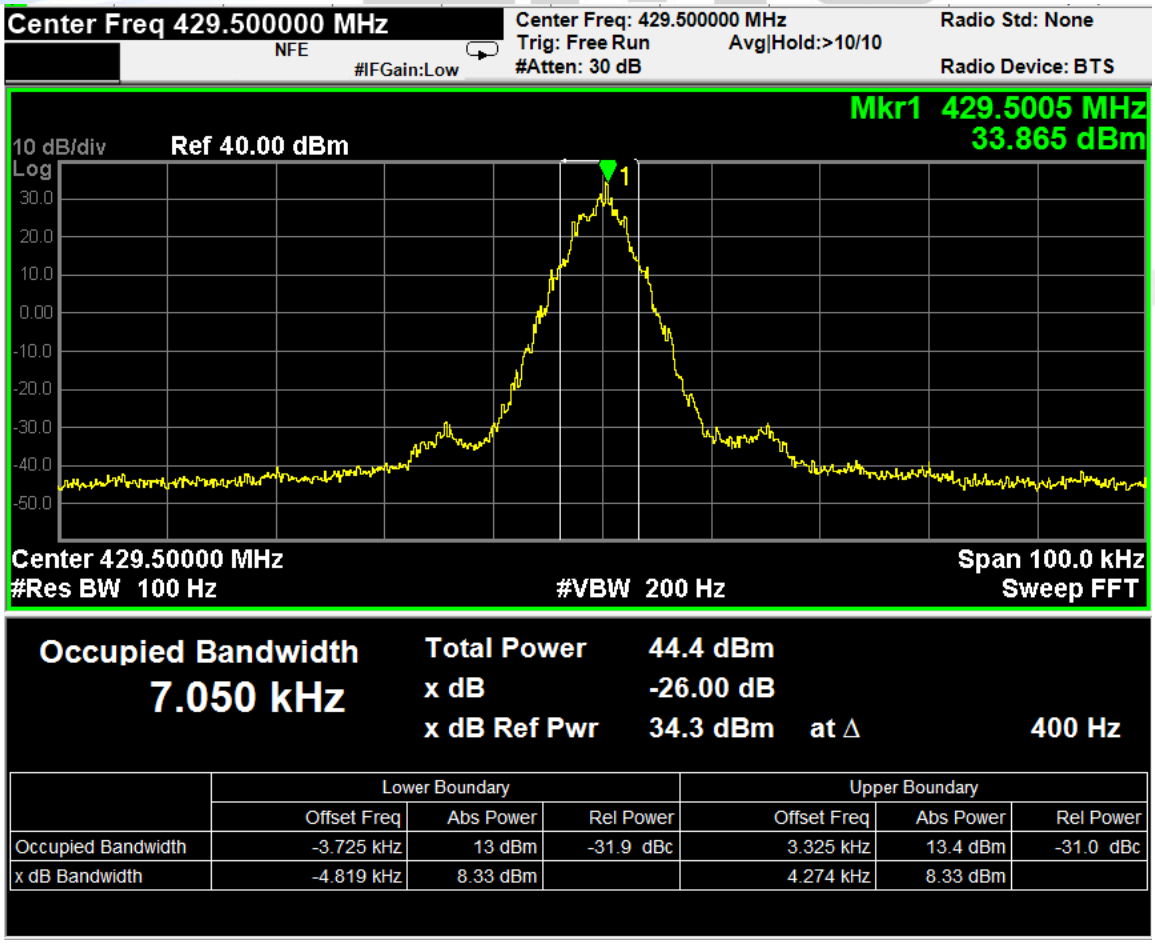
Result: Complies

Plot 1: OCW- 406.9 MHz



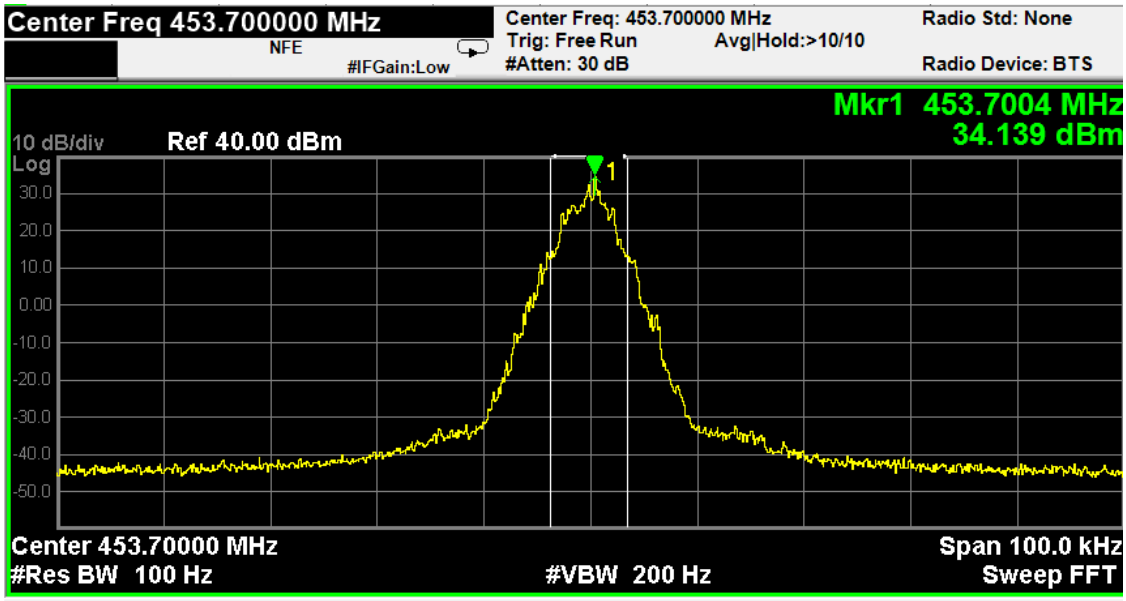
	Lower Boundary			Upper Boundary		
	Offset Freq	Abs Power	Rel Power	Offset Freq	Abs Power	Rel Power
Occupied Bandwidth	-3.884 kHz	13 dBm	-30.9 dBc	3.529 kHz	12.5 dBm	-31.7 dBc
x dB Bandwidth	-4.851 kHz	7.61 dBm		4.395 kHz	7.61 dBm	

Plot 2: OBW- 429.5 MHz



	Lower Boundary			Upper Boundary		
	Offset Freq	Abs Power	Rel Power	Offset Freq	Abs Power	Rel Power
Occupied Bandwidth	-3.725 kHz	13 dBm	-31.9 dBc	3.325 kHz	13.4 dBm	-31.0 dBc
x dB Bandwidth	-4.819 kHz	8.33 dBm		4.274 kHz	8.33 dBm	

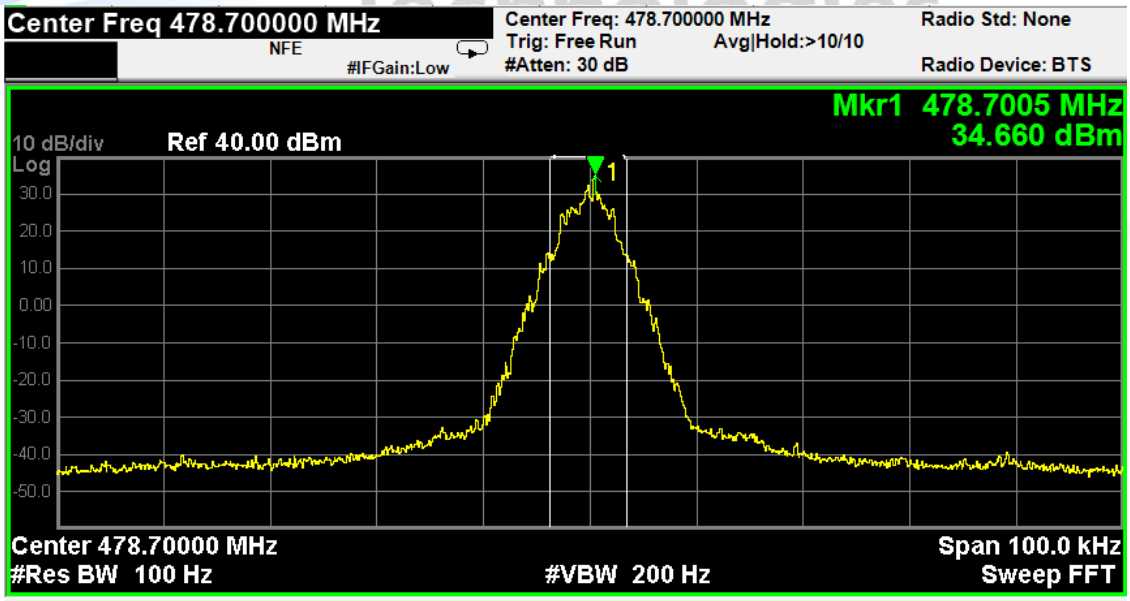
Plot 3: OBW- 453.7 MHz



Occupied Bandwidth	**Total Power**	44.8 dBm	
7.155 kHz	x dB	-26.00 dB	
	x dB Ref Pwr	34.5 dBm	at Δ 500 Hz

	Lower Boundary			Upper Boundary		
	Offset Freq	Abs Power	Rel Power	Offset Freq	Abs Power	Rel Power
Occupied Bandwidth	-3.721 kHz	13 dBm	-32.2 dBc	3.434 kHz	13.3 dBm	-31.6 dBc
x dB Bandwidth	-4.812 kHz	8.48 dBm		4.370 kHz	8.48 dBm	

Plot 4: OBW- 478.7 MHz



Occupied Bandwidth	**Total Power**	44.9 dBm	
7.183 kHz	x dB	-26.00 dB	
	x dB Ref Pwr	34.7 dBm	at Δ 500 Hz

	Lower Boundary			Upper Boundary		
	Offset Freq	Abs Power	Rel Power	Offset Freq	Abs Power	Rel Power
Occupied Bandwidth	-3.757 kHz	12 dBm	-32.8 dBc	3.426 kHz	13.5 dBm	-31.4 dBc
x dB Bandwidth	-4.773 kHz	8.66 dBm		4.367 kHz	8.66 dBm	

Spectrum Masks

The spectrum masks are defined in:

Section 90.210(d) – Mask D have been applied as the transmitter can operate in the band 406.0 MHz–512.000 MHz using an authorised bandwidth of 12.5 kHz respectively as per Section 90.209(b)(5).

The reference level for the following emission mask measurements has been determined using an un-modulated carrier which is shown in the FXD / FXE mask measurements.

The yellow trace is the un-modulated carrier and the blue trace is the emission spectrum that was observed.

All measurements have been made when a 30 dB attenuator is placed between the transmitter and the spectrum analyser.

A correction file to account for the path loss from Transmitter to the spectrum analyser was included in the measurements.

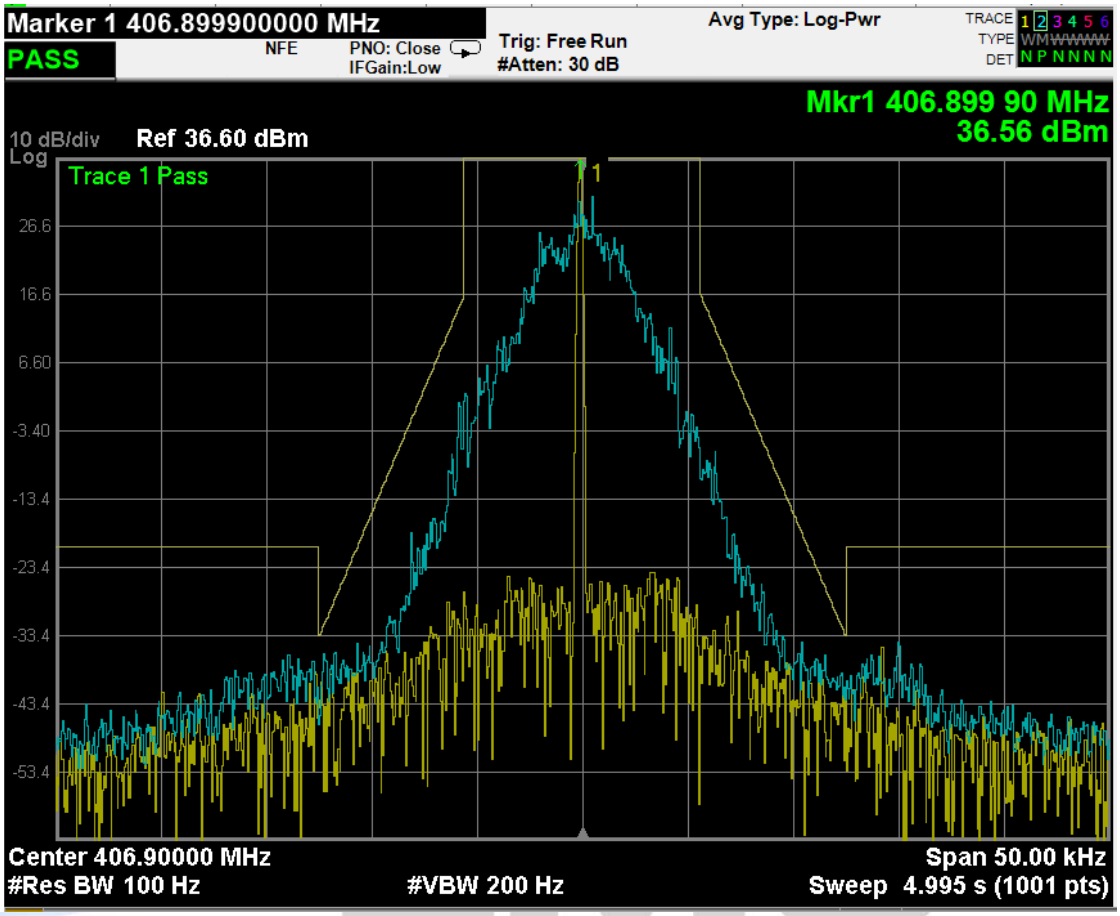
The Reference level was set equal to the power level of the unmodulated carrier.

Measurements were made in peak hold with the transmitter operating on 406.900 MHz, 429.500 MHz, 453.700 MHz and 478.700 MHz.

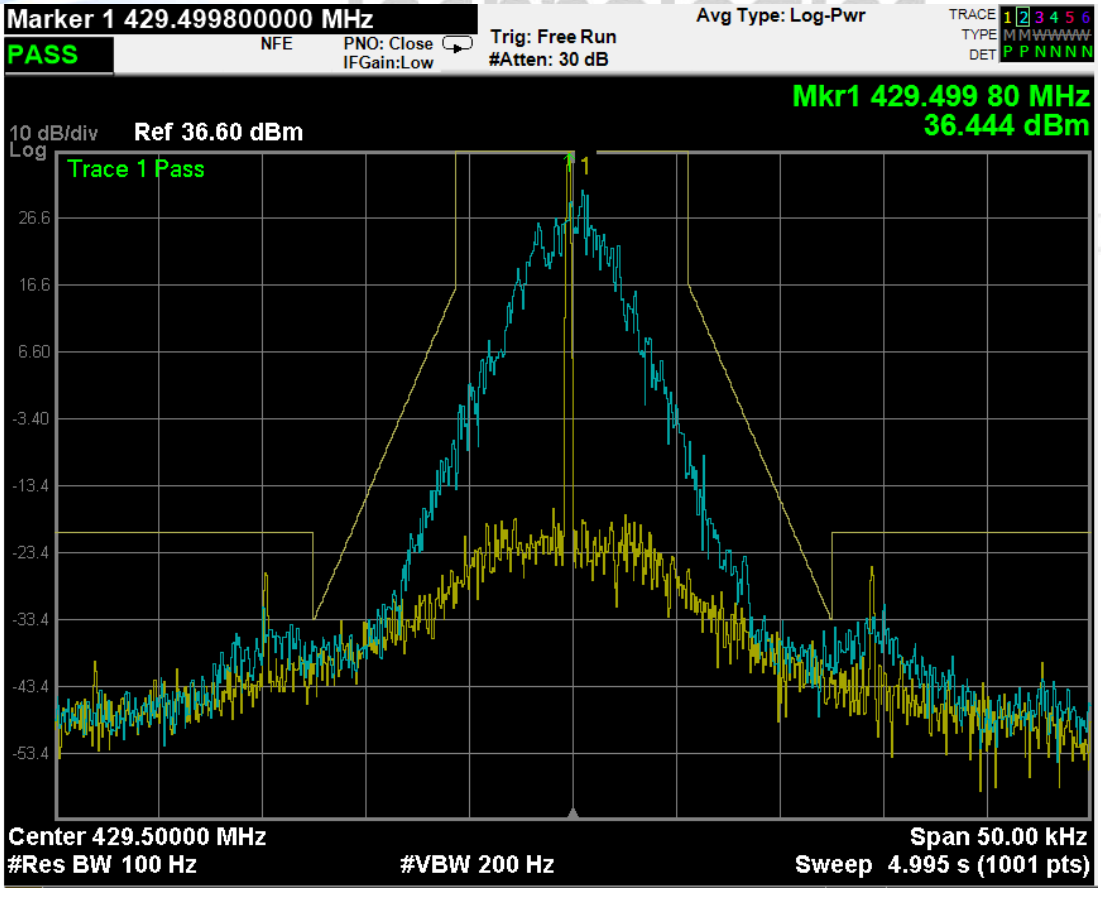
The transmitter was modulated using modulation sources internal to the transmitter as supplied by the client.

Result: Complies.

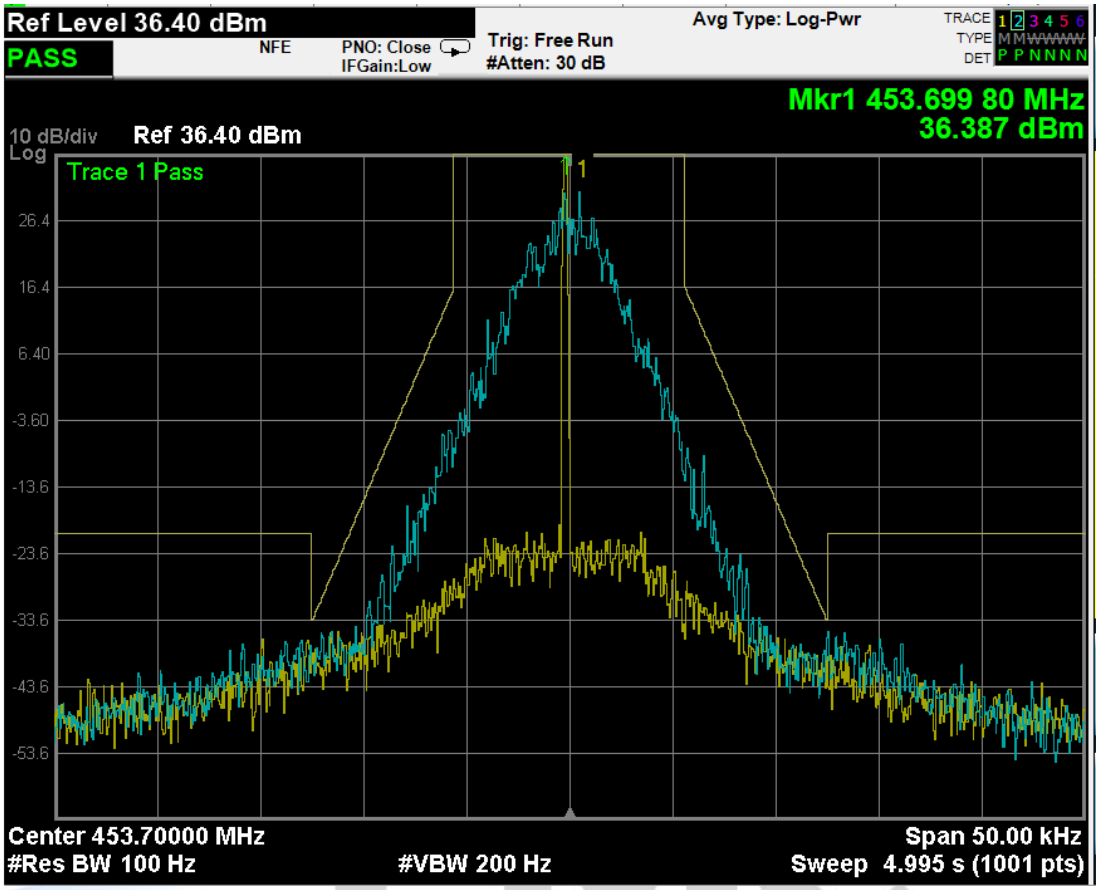
Plot 5: Emission mask D-406.9 MHz



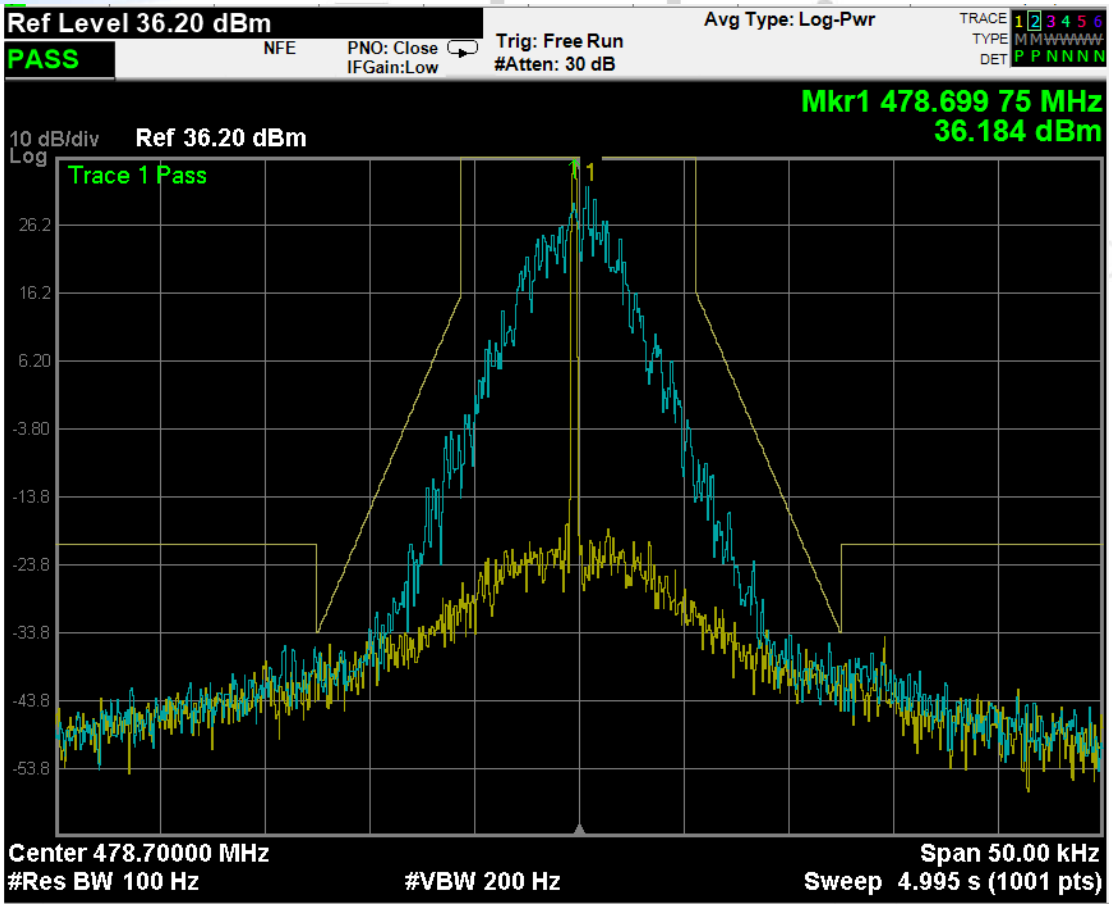
Plot 6: Emission Mask D- 429.5 MHz



Plot 7: Emission Mask D- 453.7 MHz



Plot 8: Emission Mask D- 478.7 MHz



Transmitter spurious emissions at the antenna terminals

All measurements have been made when a 30 dB attenuator is placed between the transmitter and the spectrum analyser.

A correction file to account for the path loss from the device under test to the spectrum analyser was included in the measurements.

The measurement was made with an un-modulated carrier output.

Frequency: 406.900 MHz

Frequency (MHz)	Emission level (dBm)	Limit (dBm)
813.8	-39.8	-20.0
1220.7	-38.9	-20.0
1627.6	<-40.0	-20.0
2034.5	<-40.0	-20.0
2441.4	<-40.0	-20.0
2848.3	<-40.0	-20.0
3255.2	<-40.0	-20.0
3662.1	<-40.0	-20.0

Frequency: 429.500 MHz

Frequency (MHz)	Emission level (dBm)	Limit (dBm)
859.0	-39.4	-20.0
1288.5	-41.0	-20.0
1718.0	<-40.0	-20.0
2147.5	<-40.0	-20.0
2577.0	<-40.0	-20.0
3006.5	<-40.0	-20.0
3436.0	<-40.0	-20.0
3865.5	<-40.0	-20.0

Frequency: 453.700 MHz

Frequency (MHz)	Emission level (dBm)	Limit (dBm)
907.4	-38.5	-20.0
1361.1	-36.9	-20.0
1814.8	<-40.0	-20.0
2268.5	<-40.0	-20.0
2722.2	<-40.0	-20.0
3175.9	<-40.0	-20.0
3629.6	<-40.0	-20.0
4083.3	<-40.0	-20.0

Frequency: 478.700 MHz

Frequency (MHz)	Emission level (dBm)	Limit (dBm)
957.4	-37.8	-20.0
1436.1	-34.5	-20.0
1914.8	<-40.0	-20.0
2393.5	<-40.0	-20.0
2872.2	<-40.0	-20.0
3350.9	<-40.0	-20.0
3829.6	<-40.0	-20.0
4308.3	<-40.0	-20.0

Limit:

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

The spurious emission limit defined by Mask D has been applied as this transmitter can operate using channel spacing of 12.5 kHz.

Part 2.1051 states that emissions greater than 20 dB below the limit need not be specified.

Part 2.1057 states that the spectrum should be investigated up to the 10th harmonic if the transmitter operates below 10 GHz.

A rated power of 5.0 watts gives a limit of –20.0 dBm.

No measurements were made above the 10th harmonic.

Result: Complies.
Measurement Uncertainty: ± 3.3 dB

Field strength of the transmitter spurious emissions

The device was powered using a 12 Vdc lead acid battery.

Attached to the transceiver were the following cables / devices:

- A 1.2 metre long serial cable that was terminated with a laptop computer that was running a Client supplied control programme.

- A resistive dummy load that was attached to the antenna port.

Transmitter testing was carried out when the device was transmitting continuously on 406.900 MHz, 429.500 MHz, 453.700 MHz and 478.700 MHz.

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.

Testing was carried out with an un-modulated carrier and with digital modulation applied.

Testing with an un-modulated carrier gave worst case results which have been recorded below.

Limit:

All spurious emissions are to be attenuated by at least 50 + 10 log (P).

The rated power of 5 watts gives a limit of –20 dBm.

No measurements were made above the 10th harmonic

Result: Complies.

Measurement Uncertainty: ± 4.1 dB

Transmitter spurious emissions results:

Nominal Frequency: 406.900 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
813.8000	51.0	-46.4	-20.0	Vertical	26.4	Pass
	55.6	-41.8	-20.0	Horizontal	21.8	Pass
1220.7000	62.3	-35.1	-20.0	Vertical	15.1	Pass
	65.9	-31.5	-20.0	Horizontal	11.5	Pass
1627.6000	59.9	-37.5	-20.0	Vertical	17.5	Pass
	58.8	-38.6	-20.0	Horizontal	18.6	Pass
2034.5000	56.0	-41.4	-20.0	Vertical	21.4	Pass
	54.0	-43.4	-20.0	Horizontal	23.4	Pass
2441.4000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
2848.3000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3255.2000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3662.1000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
4069.0000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass

* Noise floor measurement.

Nominal Frequency: 429.500 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
859.0000	66.8	-30.6	-20.0	Vertical	10.6	Pass
	70.6	-26.8	-20.0	Horizontal	6.8	Pass
1288.5000	56.6	-40.8	-20.0	Vertical	20.8	Pass
	55.6	-41.8	-20.0	Horizontal	21.8	Pass
1718.0000	62.4	-35.0	-20.0	Vertical	15.0	Pass
	60.0	-37.4	-20.0	Horizontal	17.4	Pass
2147.5000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
2577.0000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3006.5000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3436.0000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3865.5000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
4295.0000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass

* Noise floor measurement.

(Cont…) Transmitter spurious emissions results:

Nominal Frequency: 453.700 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
907.4000	70.6	-26.8	-20.0	Vertical	6.8	Pass
	70.1	-27.3	-20.0	Horizontal	7.3	Pass
1361.1000	62.4	-35.0	-20.0	Vertical	15.0	Pass
	62.9	-34.5	-20.0	Horizontal	14.5	Pass
1814.8000	62.4	-35.0	-20.0	Vertical	15.0	Pass
	59.3	-38.1	-20.0	Horizontal	18.1	Pass
2268.5000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
2722.2000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3175.9000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3629.6000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
4083.3000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
4537.0000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass

* Noise floor measurement.

Nominal Frequency: 478.700 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
957.4000	53.6	-43.8	-20.0	Vertical	23.8	Pass
	50.1	-47.3	-20.0	Horizontal	27.3	Pass
1436.1000	69.1	-28.3	-20.0	Vertical	8.3	Pass
	69.6	-27.8	-20.0	Horizontal	7.8	Pass
1914.8000	61.9	-35.5	-20.0	Vertical	15.5	Pass
	62.8	-34.6	-20.0	Horizontal	14.6	Pass
2393.5000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
2872.2000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3350.9000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
3829.6000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
4308.3000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass
4787.0000	<50.0*	-	-20.0	Vertical	-	Pass
	<50.0*	-	-20.0	Horizontal	-	Pass

* Noise floor measurement.

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: 406.900 MHz

Temperature (°C)	11.0 Vdc (Hz)	13.0 Vdc (Hz)	15.0 Vdc (Hz)
+50	-220	-230	-230
+40	-180	-170	-160
+30	-130	-140	-140
+20	-130	-140	-130
+10	-90	-130	-90
0	-140	-140	-100
-10	-160	-150	-210
-20	-200	-190	-190
-30	-140	-140	-200

Frequency: 429.500 MHz

Temperature (°C)	11.0 Vdc (Hz)	13.0 Vdc (Hz)	15.0 Vdc (Hz)
+50	-230	-230	-230
+40	-190	-180	-160
+30	-140	-140	-140
+20	-140	-140	-140
+10	-80	-110	-100
0	-160	-140	-110
-10	-160	-170	-200
-20	-220	-200	-180
-30	-160	-160	-200

Frequency: 453.700 MHz

Temperature (°C)	11.0 Vdc (Hz)	13.0 Vdc (Hz)	15.0 Vdc (Hz)
+50	-260	-260	-270
+40	-190	-180	-180
+30	-150	-150	-150
+20	-140	-150	-150
+10	-100	-110	-110
0	-180	-140	-130
-10	-170	-200	-220
-20	-240	-210	-210
-30	-160	-180	-200

Frequency: 478.700 MHz

Temperature (°C)	11.0 Vdc (Hz)	13.0 Vdc (Hz)	15.0 Vdc (Hz)
+50	-270	-270	-280
+40	-200	-190	-190
+30	-150	-160	-160
+20	-150	-150	-150
+10	-100	-110	-120
0	-210	-150	-140
-10	-160	-220	-220
-20	-240	-220	-220
-30	-150	-200	-190

Limits:

Part 90.213 states that fixed station transmitters operating between 421.000-512.000 MHz with 12.5 kHz channelling are required to have a frequency tolerance of 1.5 ppm.

A worst case error of 0.58 ppm (280 Hz / 478.700 MHz) was observed.

Result: Complies.
Measurement Uncertainty: ± 30 Hz

Transient frequency behaviour

Measurements were carried out using the method described in TIA-603.

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
12.5	Nil	Nil	Nil

Limits:

Time Interval	Period (ms)	6.25 kHz Deviation (kHz)	12.5 kHz Deviation (kHz)	25 kHz Deviation (kHz)
t_1	10	± 6.25	± 12.5	± 25.0
t_2	25	± 3.125	± 6.25	± 12.5
t_3	10	± 6.25	± 12.5	± 25.0

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

12.5 kHz Transmitter

Transmitter turn on

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

Green trace has been maximised to give full screen indication of +/- 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.

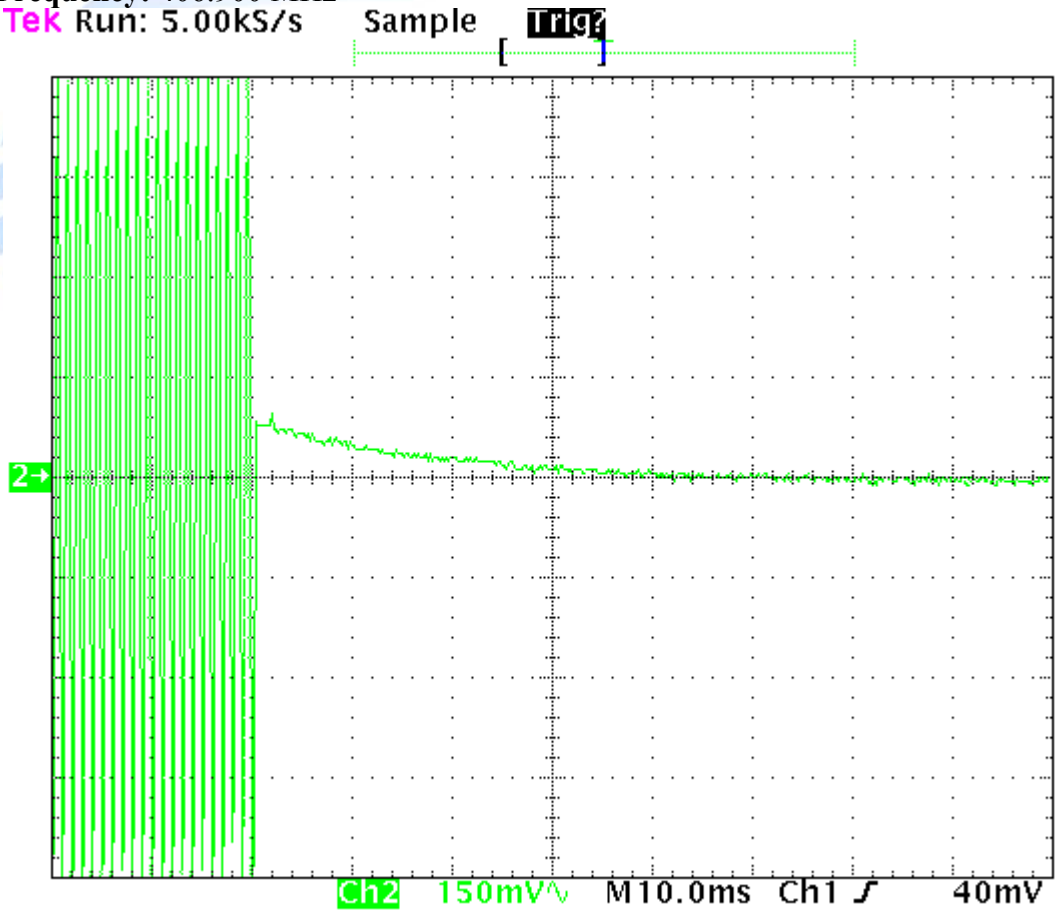
Triggering has been set to occur 2 divisions from the left hand edge (20 ms).

*t*on occurs at 20 ms.

*t*1 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 was observed during *t*1 and t2.

Frequency: 406.900 MHz



Transmitter turn off

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

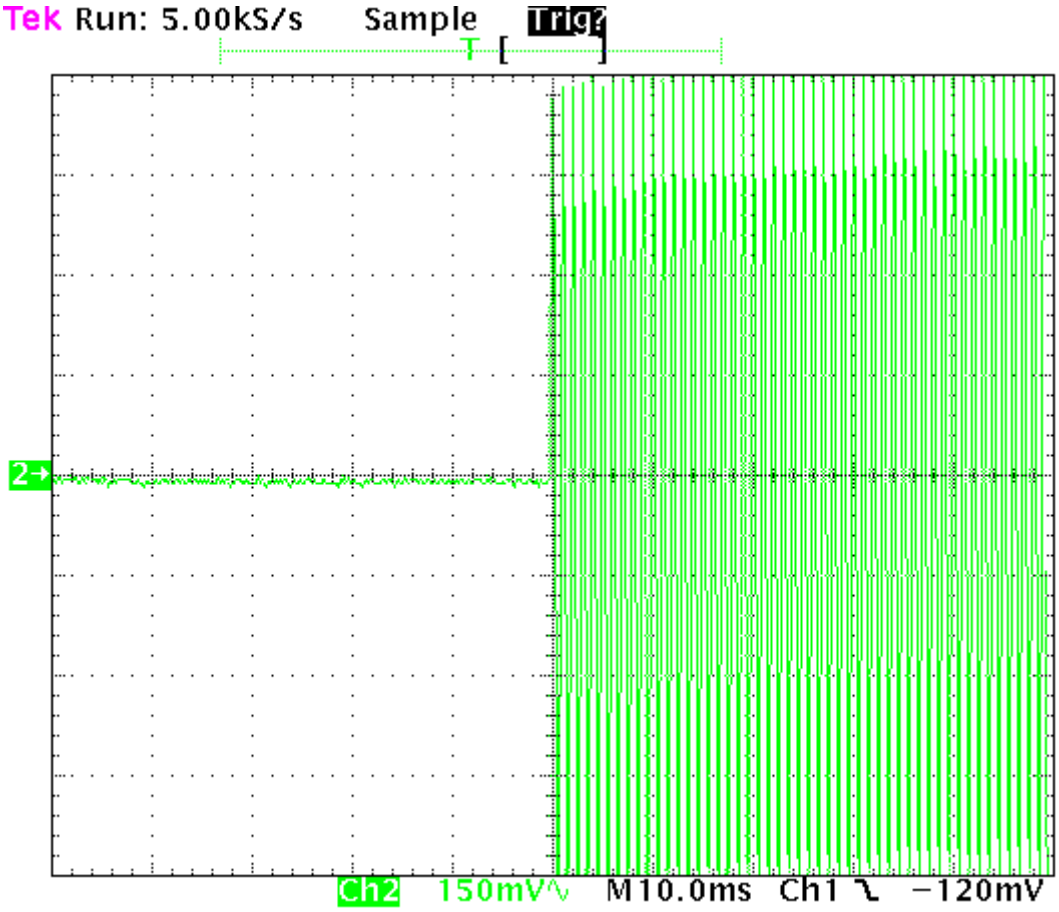
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division

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 was observed before *t*off.

Frequency: 406.900 MHz



Exposure of humans to RF fields

As per FCC KDB 447498 D01 and Section 2.1091 radio frequency transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels.

Calculations have been made using the General Public/Uncontrolled Exposure limits that are defined in Section 1.1310.

Minimum safe distances have been calculated below.

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

Limits for General Population / Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S) (mW/ cm²)**	**Averaging Time |E|²,|H|² or S (minutes)**
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30
Note 1: f = frequency in MHz ; *Plane-wave equivalent power density Note 2: For the applicable limit, see FCC 1.1310				

- General Population / Uncontrolled exposure is (f/1500) mW/cm^2

As this radio can operate over the range of 406.9 to 480.0 MHz the lowest frequency of operation which will give the worst case result, would be 406.9 MHz.

The power density at 406.900 MHz comes out to be 0.271 mW/cm^2.

For Uncontrolled Environment

Power Density = 0.271 $mW/cm^2 = E^2/3770$

$E = \sqrt{0.271*3770}$

E = 31.9 V/m

The rated maximum transmitter power = 5 watts (+37 dBm).

A duty cycle (DC) of 50% (0.5) has been applied as the device uses source based 50% TDMA which relates to the carrier duty cycle.

The client has declared that this transmitter can be operated using a non-directional antenna with a gain of 0 dBd or a directional antenna with a gain of up to 6 dBd.

Calculations of the safe distance for these types of antenna are detailed as below.

The minimum distance from the antenna at which the MPE is met is calculated from the following

Field strength in V/m (E),
Transmit power in watts (P)
Transmit antenna gain (G)
Transmitter duty cycle (DC)
Separation distance in metres (D)

The calculation is as follows:

$D = \sqrt{\ } (30 * P * G*DC) / E$

A sample calculation for the safe distance would be:

$D = \sqrt{\ } (30 * P * G*DC) / E$
$D = \sqrt{\ } (30 * 32.73 * 0.5) / 31.9$
D = 0.69 metres or 69 cm

Antenna Gain (dBd)	Max Gain (dBi)	Tx Power (dBm)	EIRP (dBm)	EIRP (Watts)	E Limit (V/m)	Safe Distance (metres)
0.0	2.15	37.0	39.15	8.22	31.9	0.34
6.0	8.15	37.0	45.15	32.73	31.9	0.69

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

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Last Cal	Cal Due	Interval
Aerial Controller	EMCO	1090	9112-1062	N/a	N/a	N/a
Aerial Mast	EMCO	1070-1	9203-1661	N/a	N/a	N/a
Biconical Antenna	Schwarzbeck	BBA 9106	-	28/09/2017	28/09/2020	3 years
Horn Antenna	EMCO	3115	9511-4629	08/08/2017	08/08/2020	3 years
Log Periodic Antenna	Schwarzbeck	VUSLP 91111	9111-112	24/09/2017	24/09/2020	3 years
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	08/05/2018	08/05/2021	3 years
Power Attenuator	JFW	50FH-030-100	-	N/a	N/a	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	N/a	N/a	N/a
Receiver	Rohde & Schwarz	ESIB-40	100295	12/09/18	11/09/20	2 years
Selective Level Meter	Anritsu	ML422C	M35386	22/05/2018	22/05/2020	2 years
Signal Generator	Rohde & Schwarz	SMHU	838923/028	21/05/2019	20/05/2021	2 years
Spectrum Analyzer	Keysight	N9038A	MY57290153	11/01/2019	11/01/2020	1 year
Thermal chamber	Contherm	M180F	86025	N/a	N/a	N/a
Thermometer	DSIR	RT200	35	10/10/2016	10/10/2021	5 years
Turntable	EMCO	1080-1-2.1	9109-1578	N/a	N/a	N/a
VHF Balun	Schwarzbeck	VHA9103	-	N/a	N/a	N/a

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

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies NZ Ltd designation as a FCC Accredited Laboratory by International Accreditation New Zealand, designation number: NZ0002 under the APEC TEL MRA.

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

Label

Label on product

External Views: Face showing connectors

Top Face

Rear Face

End on view

Rear Face

Radiated Emissions Test Setup