20 August 2001

TEST REPORT

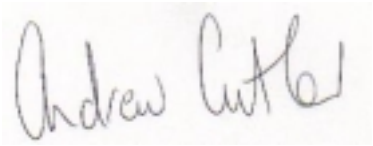
Exicom EX7100 Digital Transceiver

Tested for compliance with the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

This Test Report is issued with the authority of:



Andrew Cutler - General Manager

Prepared By:

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1. CLIENT INFORMATION

Company Name	Exicom Technologies (1996) Ltd
Address	Private Bag 50912 Porirua
City	Wellington
Country	New Zealand
Contact	Mr Peter Scragg

2. DESCRIPTION OF TEST SAMPLE

Brand Name	Exicom
Model Number	EX7100
Product	Digital Transceiver
Manufacturer	Exicom Technologies (1996) Ltd
Country of Origin	New Zealand
Serial Number	388263

Device was tested communicating with a second EX7100 transceiver sn# 388264

3. SUMMARY OF TEST RESULTS

Testing was carried out in accordance with the test methods defined in 47 CFR Part 2. Listed below are the relevant Part 2 test methods and the limits defined in Part 90 and Part 15.

CLAUSE	TEST PERFORMED	RESULT
2.1041	Measurement procedures	Noted
2.1046	RF power output	Noted
90.205	Power and antenna height limits	Complies
2.1047	Modulation Characteristics	
2.1047(d)	Other types of equipment	Complies
90.211(a)	Modulation characteristics	Complies
2.1049	Occupied bandwidth	Noted
90.207	Types of emissions	Complies
90.209	Bandwidth limitations	Complies
90.210	Emission masks	Complies
2.1051	Spurious emissions at the transmitter antenna terminals	Complies
2.1053	Field strength of transmitter spurious radiation	Complies
15.109	Receiver radiated emissions	Complies
15.111	Antenna power conduction limits for receivers	Complies
2.1055	Frequency stability	Noted
90.213	Frequency stability	Complies
2.1057	Frequency spectrum to be investigated	Noted
15.33	Frequency range of unintentional radiators	Noted

4. TEST SAMPLE DESCRIPTION

The sample tested is a UHF digital transmitter capable of sending 6 telephone channels over a standard 25 kHz channel audio bandwidth with the following specifications:

Rated Transmitter Output Power

10 Watts Peak Envelope Power (40.0 dBm)

Test frequencies

156.0250 MHz Transmit 151.0250 MHz Receive

Channel spacing

25.0 kHz

Band of operation

150.0 – 174.0 MHz

Emission Types and Necessary Bandwidths

18k4D1WET

6 audio channel digital transceiver, using 16QAM modulation.

Authorised bandwidth

20.0 kHz

Power Supply

48.0 Vdc from an external DC power supply (eg lead acid battery).

5. TEST CONDITIONS

Standard Temperature and Humidity

Temperature: +25°C ± 4° maintained.
Relative Humidity: 60% ± 10% observed.

Extreme Temperature

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

Tests carried out in 10° intervals over this range.

6. ATTESTATION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification with the following conditions:

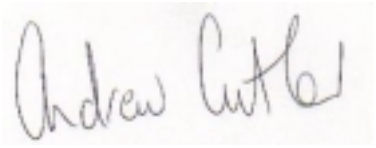
The test sample was selected by the client.

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. Each unit manufactured, imported, or marketed, as defined in the Commission's regulations, will conform to the sample(s) tested with the variations statistical basis. 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. TRANSMITTER TEST RESULTS

RF power output

Measurements were carried out at the RF output terminals of the transmitter using a 30 dB power attenuator, a power splitter with an attenuation of 3.5 dB and a spectrum analyser using a resolution bandwidth wider than the occupied bandwidth of the transmitter operating in peak hold.

A resolution bandwidth of 30 kHz has been used.

Transmitter tested with a 64 kB/s data transfer established with a second EX7100 Digital Transceiver.

Measurements were made with the input voltage set to 48.0 Vdc.

RF power output (dBm)			
Frequency	**Channel Spacing**	**Rated**	**Measured**
162.0250	25 kHz	40.0	40.0

Limits:
Part 90 contains no transmitter base power limits.

Section 90.205(d) defines that maximum allowable station ERP which is dependent upon the station's antenna HAAT and required service area.

Result: Complies

Measurement Uncertainty: *±0.5 dB*

Modulation Characteristics

This transmitter does not use frequency modulation but Digital Modulation with the emission designation 18k4D1Wet.

The transmitter has 6 audio inputs with each path containing a low pass filter.

Audio processing is carried out using an AMD Am79C02 Dual Subscriber Line Audio Processing Circuit (DSLAC) Device that contains the low pass filters.

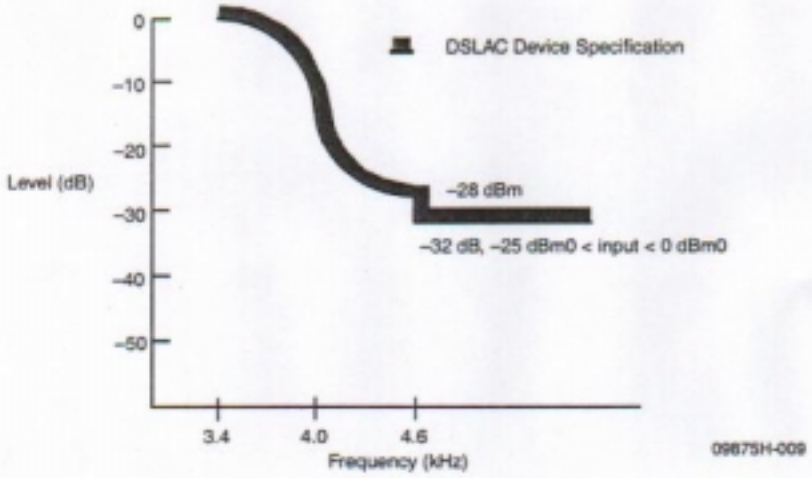
The manufacturer's specification for these filters is attached.

Testing of the transmitter has been carried out in accordance with section 90.210, which shows that the emissions from this digital transmitter meet the requirements for Mask B.

Discrimination against Out-of-Band Input Signals

When an out-of-band sine wave signal with frequency f and level A is applied to the analog input, there may be frequency components below 4 kHz at the digital output, caused by the out-of-band signal. These components are at least the specified dB level below the level of a signal at the same output originating from a 1014 Hz sine wave signal with a level of A dBm0 also applied to the analog input. The minimum specifications are shown in Figure 5.

Frequency of Out-of-Band Signal	Amplitude of Out-of-Band Signal	Level below A
16.6 Hz < f < 45 Hz	–25 dBm0 < A ≤ 0 dBm0	18 dB
45 Hz < f < 65 Hz	–25 dBm0 < A ≤ 0 dBm0	25 dB
65 Hz < f < 100 Hz	–25 dBm0 < A ≤ 0 dBm0	10 dB
3400 Hz < f < 4600 Hz	–25 dBm0 < A ≤ 0 dBm0	see Figure 5
4600 Hz < f < 100 kHz	–25 dBm0 < A ≤ 0 dBm0	32 dB



Note:
The attenuation of the waveform below amplitude A between 3400 Hz and 4600 Hz is given by the formula:

$$\text{Attenuation (dB)} = 14 - 14 \sin \frac{\pi(4000 - f)}{1200}$$

Figure 5. Discrimination against Out-of-Band Signals

Occupied Bandwidth

The spectrum mask is defined in:

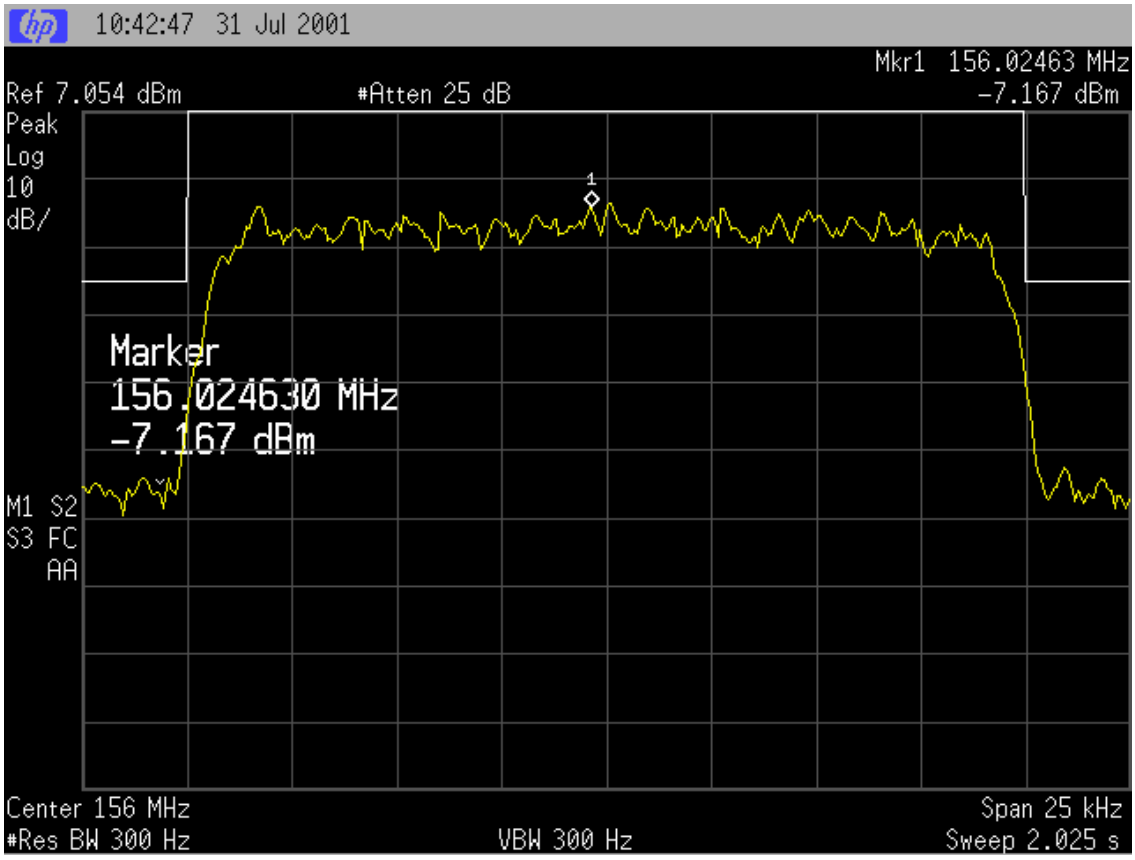
Section 90.210(b) – Mask B has been applied as the transmitter can operate in the band 150 – 174 MHz.

Section 90.209(b)(5) defines the authorised bandwidth as 20 kHz where 25 kHz channeling is used.

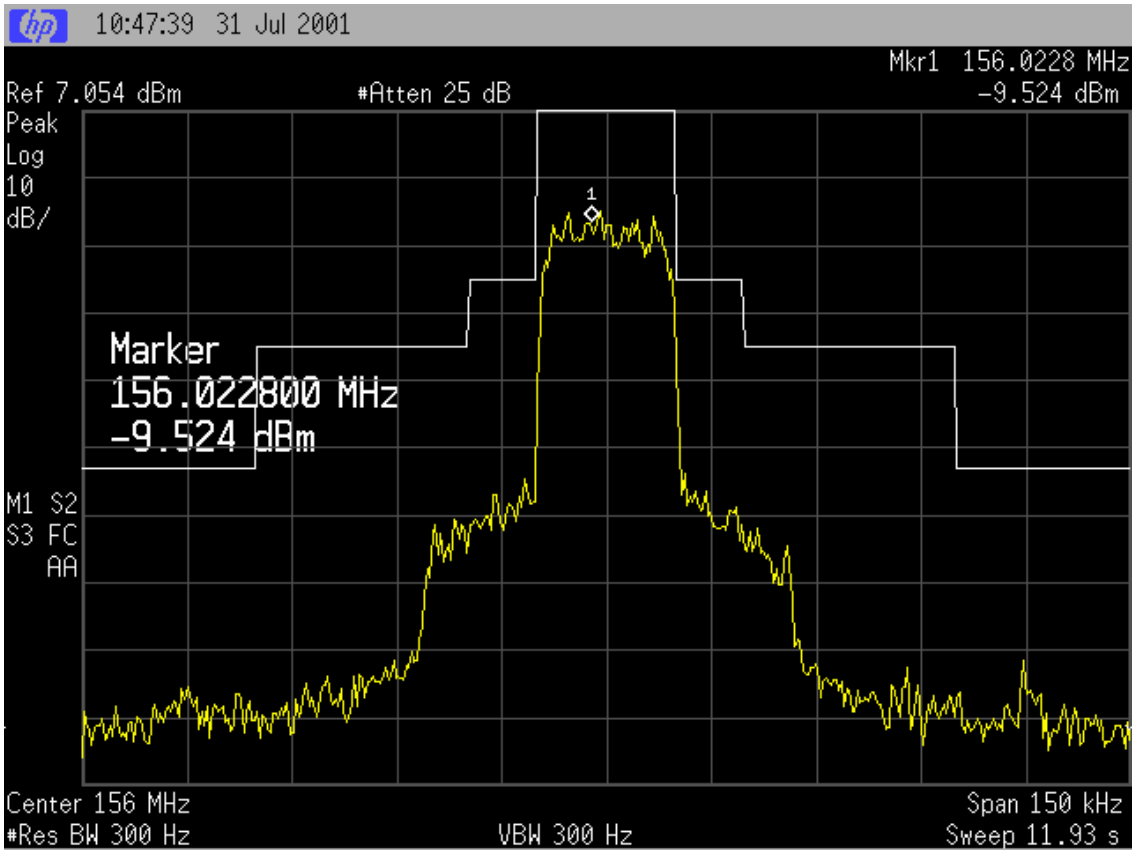
The reference level for all emission mask measurements has been determined using a resolution bandwidth of 30 kHz.

Emission mask plots have been made using a resolution bandwidth of 300 Hz.

Plot 2: Mask B with a 64 kB/s data transfer established with a second EX7100 Digital Transceiver with a span of 25 kHz.



Plot 3: Mask B with a 64 kB/s data transfer established with a second EX7100 Digital Transceiver with a span of 150 kHz.



Result: Complies

Transmitter spurious emissions at the antenna terminals

Frequency: 156.025 MHz

Measured Spurious Emission	
Spurious emission (MHz)	**Emission level (dBm)**
312.050	-43.4
468.075	-47.9
624.100	Less than –35.0
780.125	Less than –35.0
936.150	Less than –35.0
1092.175	Less than –35.0
1248.200	Less than –35.0
1404.225	Less than –35.0
1560.250	Less than –35.0

Limit
Part 90.210(b) Mask B, (3) on any frequency removed by more than 250% all emissions are to be attenuated by at least 43 + 10 log (P).

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.

Rated power is 10 watts . 43 + 10 log (P) gives a limit of –13 dBm.

No measurements less that –35 dBm have been reported except those reported.

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

Result: Complies

Measurement Uncertainty: *±3.3 dB*

Field strength of transmitter spurious emissions at the antenna terminals

Frequency: 156.0250 MHz

Transmit Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Margin (dB)	Polarity
Tx harmonics					
312.050	20.0	-77.4	-13.0	-64.6	Horizontal
468.075	-	-	-13.0	-	Vert/Hort
624.100	24.7	-72.7	-13.0	-59.7	Vertical
780.125	-	-	-13.0	-	Vert/Hort
936.150	-	-	-13.0	-	Vert/Hort
1092.175	-	-	-13.0	-	Vert/Hort
1248.200	-	-	-13.0	-	Vert/Hort
1404.225	-	-	-13.0	-	Vert/Hort
1560.250	-	-	-13.0	-	Vert/Hort
Other Emissions					
30.200	30.8	-66.6	-13.0	-53.6	Vertical
47.000	32.0	-65.4	-13.0	-52.4	Vertical
49.000	32.6	-64.8	-13.0	-51.8	Vertical
67.000	27.3	-70.1	-13.0	-57.1	Vertical
72.500	34.3	-63.1	-13.0	-50.1	Vertical
93.800	33.7	-63.7	-13.0	-50.7	Vertical
104.447	25.0	-72.4	-13.0	-59.4	Vertical
112.100	15.5	-81.9	-13.0	-68.9	Vertical
121.850	37.0	-60.4	-13.0	-47.4	Vertical
129.625	35.3	-62.1	-13.0	-49.1	Vertical
130.550	27.3	-70.1	-13.0	-57.1	Vertical
134.905	23.8	-73.6	-13.0	-60.6	Vertical
139.260	42.4	-55.0	-13.0	-42.0	Vertical
156.670	33.5	-63.9	-13.0	-50.9	Vertical
174.078	37.3	-60.1	-13.0	-47.1	Vertical
191.486	34.0	-63.4	-13.0	-50.4	Vertical
208.894	40.1	-57.3	-13.0	-44.3	Vertical
226.302	40.0	-57.4	-13.0	-44.4	Vertical
243.710	38.5	-58.9	-13.0	-45.9	Vertical
261.118	33.5	-63.9	-13.0	-50.9	Vertical
278.520	23.1	-74.3	-13.0	-61.3	Vertical
295.934	30.0	-67.4	-13.0	-54.4	Vertical
261.320	27.5	-69.9	-13.0	-56.9	Vertical

Transmit Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Margin (dB)	Polarity
313.339	29.4	-68.0	-13.0	-55.0	Vertical
330.740	23.1	-74.3	-13.0	-61.3	Vertical
348.149	20.0	-77.4	-13.0	-64.4	Vertical
435.197	28.6	-68.8	-13.0	-55.8	Horizontal
452.602	33.4	-64.0	-13.0	-51.0	Horizontal
470.006	35.5	-61.9	-13.0	-48.9	Horizontal
487.411	34.6	-62.8	-13.0	-49.8	Horizontal
504.817	25.1	-72.3	-13.0	-59.3	Vertical
539.637	34.9	-62.5	-13.0	-49.5	Horizontal
574.451	32.1	-65.3	-13.0	-52.3	Horizontal
609.269	28.7	-68.7	-13.0	-55.7	Horizontal

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 Dakota Lane, Ardmore Aerodrome, Auckland. Details of this site have been filed with the Commission, Registration Number: 90838, which was last updated on February 11, 2000.

The transmitter was tested while transferring data at a rate of 64 kb/s from a 2nd EX7100 which, was located 30 metres away.

Attached to the output of the 2nd transmitter was a 90 dB power attenuator.

The transmitter was tested transmitting and receiving continuously (100% duty cycle).

Field strength measurements have been carried out and converted to transmitted power measurements using the formula:

$$\text{Field strength (V/m)} = \sqrt{(1.64 \times 30 \times P)} / D$$

Where:
P is the eirp transmitted power
1.64 is a the gain of a dipole antenna when compared to an isotropic antenna
D is D is the distance in metres. In this case 3 metres

Limit
Part 90.210(b) Mask B, (3) on any frequency removed by more than 250% all emissions are to be attenuated by at least 43 + 10 log (P).

The rated power is 10 watts which gives a limit of –13 dBm .

No measurements were made above the 10th harmonic.

Result: Complies

Measurement Uncertainty: *±4.1 dB*

Field strength of receiver spurious emissions

Receive frequency: 151.025 MHz

IF Frequency: 21.4 MHz

Tests carried out in accordance with Part 15, Section 15.109.

Transmit Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Polarity
172.425	-	43.5	-	Vert/Hort
344.850	-	46.0	-	Vert/Hort
517.275	-	46.0	-	Vert/Hort
689.700	-	46.0	-	Vert/Hort
862.125	-	46.0	-	Vert/Hort
1034.550	-	54.0	-	Vert/Hort
1206.975	-	54.0	-	Vert/Hort
1379.400	-	54.0	-	Vert/Hort
1551.825	-	54.0	-	Vert/Hort
1724.250	-	54.0	-	Vert/Hort

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 si located at Dakota Lane, Ardmore Aerodrome, Auckland. Details of this site have been filed with the Commission, Registration Number: 90838, which was last updated on February 11, 2000.

The receiver was tested while the systems were transferring data at a rate of 64 kb/s from a 2nd EX7100 which was located 30 metres away.

This transceiver operates with a 100% duty cycle meaning that the receiver operates continuously along with the transmitter.

Limit
Part 15 section 15.109(a). The following limits have been applied:

88 – 216 MHz: 150 uV/m = 43.5 dBuV/m
216 – 960 MHz: 200 uV/m = 46.0 dBuV/m
above 960 MHz: 500 uV/m = 54.0 dBuV/m

No measurements were made above the 6th harmonic.

Result: Complies

Measurement Uncertainty: *±4.1 dB*

Antenna power conduction limits for receivers.

Receive frequency: 151.025 MHz

IF Frequency: 21.4 MHz

Tests carried out in accordance with Part 15, Section 15.111.

As the transceiver has no dedicated antenna, spurious emission measurements were made at the antenna terminals using a spectrum analyser.

Measured Spurious Signals		
Spurious signal (MHz)	**Level at the receiver input (dBm)**	**Description**
172.425	Less than –100	LO
344.850	Less than –100	2LO
517.275	Less than –100	3LO
689.700	Less than –100	4LO
862.125	Less than –100	5LO
1034.550	Less than –100	6LO
1206.975	Less than –100	7LO
1379.400	Less than –100	8LO
1551.825	Less than –100	9LO
1724.250	Less than –100	10LO

All other emissions detected were less than –100 dBm.

Limit
The spurious emission power should not exceed 2 nW (-57 dBm).

Result: Complies

***Measurement Uncertainty*:** *±3.3 dB*

Frequency Stability

Frequency stability measurements were made over the range - 30 °C to + 50°C in + 10°C increments.

At each temperature the transmitter was given a period of 30 minutes to stabilise.

Measurements were made with the supply varied between 115% and 85% of the nominal supply voltage (48 Vdc).

Nominal Frequency: 156.025 MHz

Frequency Error (Hz)			
Voltage Temp.	**40.8 Vdc**	**48.0 Vdc**	**55.2 Vdc**
+50°C	+107.0	+108.0	+107.0
+40°C	+110.0	+110.0	+111.0
+30°C	+117.0	+117.0	+117.0
+20°C	+123.0	+123.0	+123.0
+10°C	+101.0	+101.0	+100.0
0°C	+103.0	+103.0	+103.0
-10°C	+103.0	+103.0	+102.0
-20°C	+65.0	+65.0	+65.0
-30°C	+12.0	+14.0	+14.0

Limit
Part 90.213 states that the frequency stability requirements for fixed and base transmitters operating between 150 – 174 MHz is 5 ppm.

This transmitter operates on 156.025 MHz.
5 ppm = 5 x 156.025 = 780 Hz.

Result: Complies.

Measurement Uncertainty: ±30 Hz

Transient frequency behaviour

Transient frequency behaviour measurements are applicable to wide band transmitters operating in the frequency band 150 – 174 MHz as required by section 90.214.

Measurements were carried out at 156.025 MHz using the method described in ETS 300-086.

While these measurements are not strictly applicable, as this transmitter operates with a 100% duty cycle, measurements have been made to show the affect of the transmitter being powered on and off.

In summary this method calls for the use of an external signal generator tuned to 156.025 MHz with a output level 0.1 % (-30 dB) of the level from the transmitter with a 1 kHz tone with a frequency deviation of 25.0 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 and a picture on the oscilloscope.

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.

Measured Transient Deviation		
Period t_1 (ms)	period t_2 (ms)	period t_3 (ms)
10.0	25.0	10.0
Frequency Difference from the Nominal Frequency (kHz)		
Nil	Nil	Nil

Result: Complies

***Measurement Uncertainty*:** *Frequency difference ±1.6 kHz*
Time period ±1 ms

Transmitter turn on:

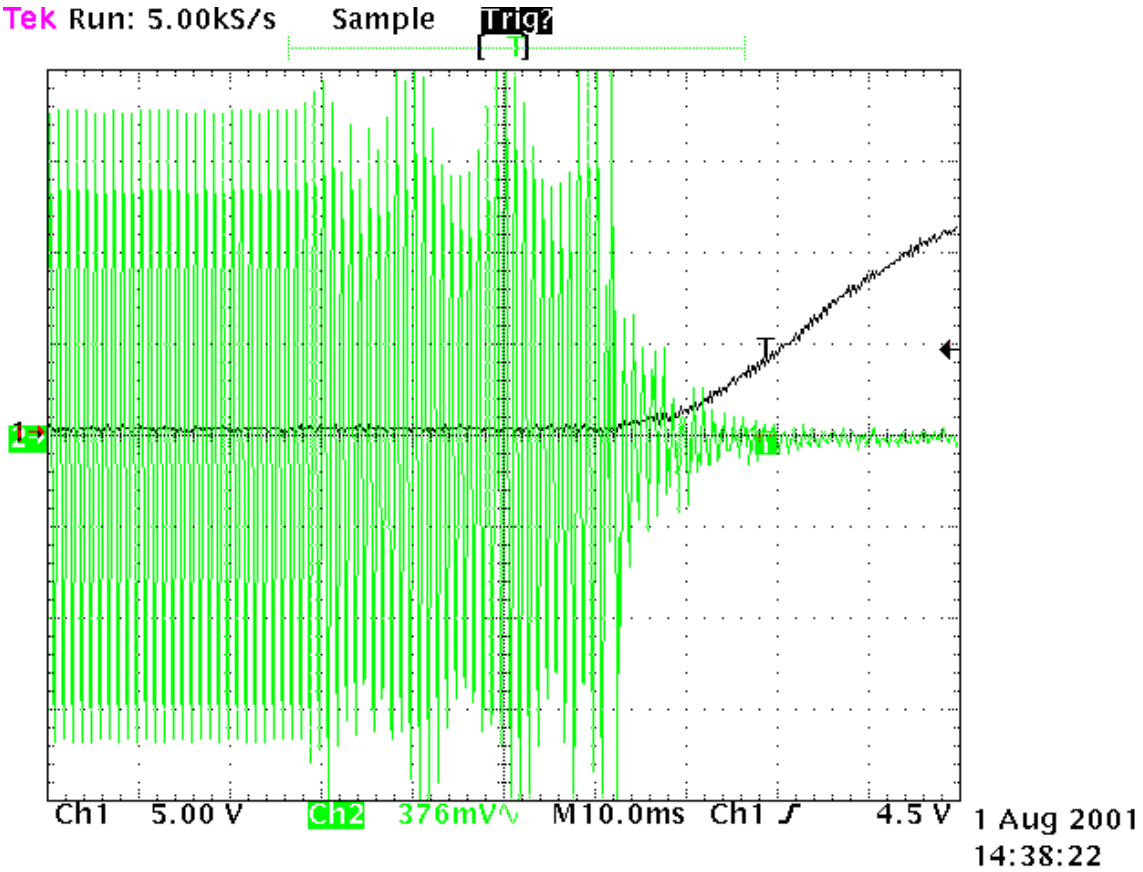
Green Trace = 1 kHz tone with FM deviation of 25 kHz.
Black trace = transmitter amplitude response.

Green trace has been maximised to give full screen indication of a +/- 25 kHz.
Therefore each Y axis division = 6.25 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

Triggering has been set to occur 8 divisions from the left hand edge (80 mS).
This is position *t*on where the 1 kHz tone is observed to be completely extinguished.

*t*1 occurs between 8 and 9 divisions from the left hand edge.
t2 occurs between 9 and 10 divisions from the left hand edge. *t2* actually extends to 11.5 divisions which is not shown in this plot but was observed.

No transient response can be observed after *t*on.



Transmitter turn off:

Green Trace = 1 kHz tone with FM deviation of 25 kHz.
Black trace = transmitter amplitude response.

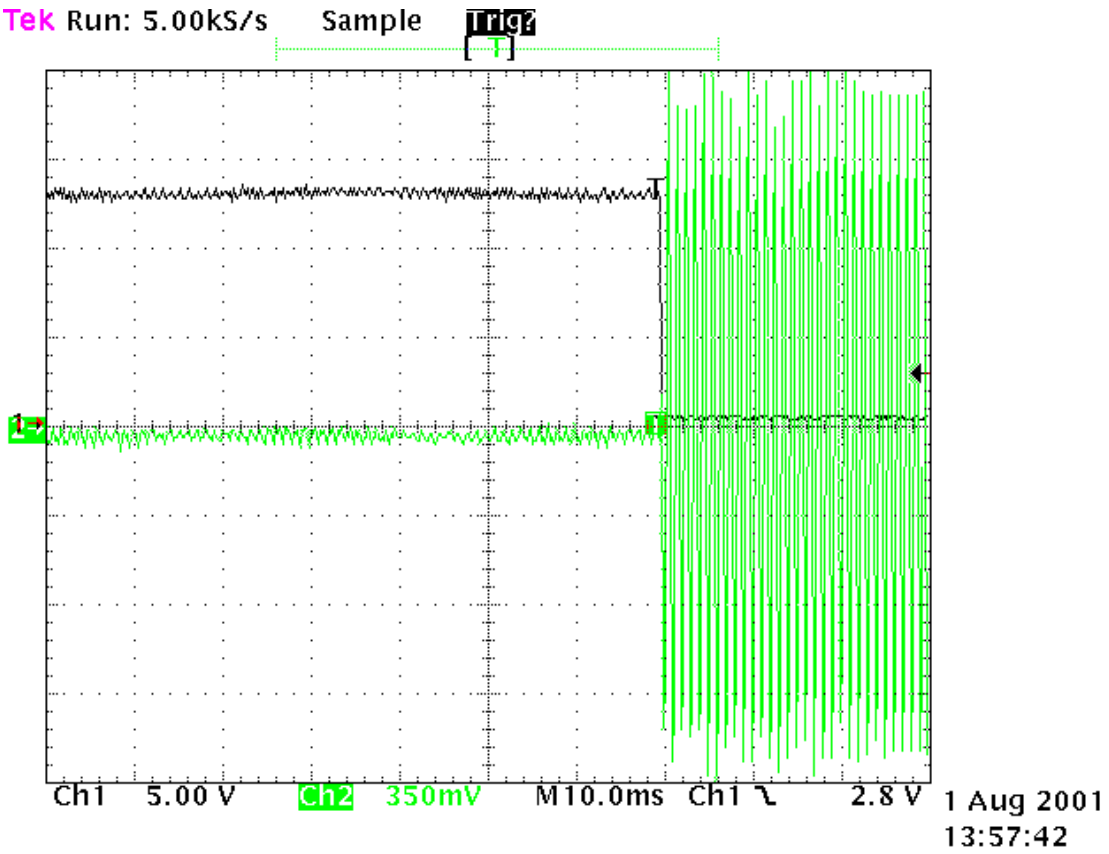
Green trace has been maximised to give full screen indication of a +/- 25 kHz.
Therefore each Y axis division = 6.25 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

The display of the 1 kHz signal rising has been positioned 7 divisions from the left hand edge (70 mS).

This is position *t*off.

*t*3 occurs between 6 and 7 divisions from the left hand edge..

No transient response can be observed before *t*off.



8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset
Power Supply	Hewlett Packard	HP6032A	2743A-02859	E1069
Frequency Counter	Hewlett Packard	HP 5342A	1916A01835	E1224
Resistance Thermometer Meter	DSIR	RT200	35	E1409
Rubidium Oscillator	Ball Efratom	FRS – C	4287	E1053
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	3776
Attenuator	Hewlett Packard	HP8491A	2216A01713	E1329
Power Attenuator	Weinschel	49-20-43	GC104	E1308
Notch Filter	TelonicAltair	TTR 190-3EE	60501-2	E1184
Modulation Analyser	Rohde and Schwarz	FMA	837807/020	E1552
Storage Oscilloscope	Tektronics	745A	B010643	E1569
Thermal chamber	Contherm	M180F	-	E1129
Signal Generator	Rohde and Schwarz	SMHU 58	838923/028	E 1493
Aerial Controller	EMCO	1090	9112-1062	RFS 3710
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612
Log Periodic Antenna	Schwarzbeck	UHALP 9107	-	RFS 3702
Horn Antenna	EMCO	3115	9511-4629	E1526
Measurement Receiver	Rohde & Schwarz	ESCS 30	847124/020	E1595

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 updated on February 11th, 2000.

All measurement equipment has been calibrated in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to the New Zealand Code of Laboratory Management Practice incorporating ISO Guide 25: 1990 and ISO 9002: 1994.