

23 August 2001

TEST REPORT

Salcom 11-78 / 11-75 UHF POCSAG Paging Transmitter

Tested for compliance with the

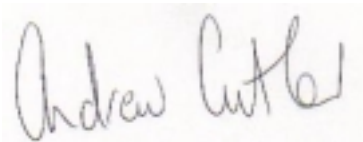
Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

Sea Air & Land Communications Ltd

This Test Report is issued with the authority of:



Andrew Cutler - General Manager

Prepared By:



Karen Miller - Office Administrator



EMC Technologies (NZ) Ltd

Test Report No 10813.1

Report date: 21 August 2001

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1. CLIENT INFORMATION

Company Name	Sea Air & Land Communications Ltd
Address	PO Box 22-621
City	Christchurch
Country	New Zealand
Contact	Mr John Croft

2. DESCRIPTION OF TEST SAMPLE

Brand Name	Salcom
Model Number	11-78
Product	UHF POCSAG Paging Transmitter
Manufacturer	Sea Air & Land Communications Ltd
Country of Origin	New Zealand
Serial Number	11-78-00023

The model tested, 11-78, is identical to model number 11-75.

The differences between these two models is:

- input circuitry
- slew limiter
- data generator

The 11-75 generates its own data train whereas the 11-78, the unit tested, accepts a data train on its input.

In both units the data train passes to the modulator via the microprocessor so the integrity of the data shape is maintained and controlled.

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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.

<u>CLAUSE</u>	<u>TEST PERFORMED</u>	<u>RESULT</u>
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
2.1055	Frequency stability	Noted
90.213	Frequency stability	Complies
2.1057	Frequency spectrum to be investigated	Noted

4. TEST SAMPLE DESCRIPTION

The sample tested is a UHF POCSAG Paging Transmitter with the following specifications:

Rated transmitter output power

4 Watts Nominal (36.0 dBm)

Nominal test frequency

460.050 MHz Transmit

Channel spacing

12.5 kHz

Band of operation

450.0 – 470.0 MHz

Emission type

F1D

Authorised bandwidth

11.25 kHz

Power supply

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

Power supply extreme voltages

85% = 11.7 Vdc

115% = 15.9 Vdc

Modulation modes / ranges

Transmitter is designed to operate using either:

512 baud POCSAG

1200 baud POCSAG

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:

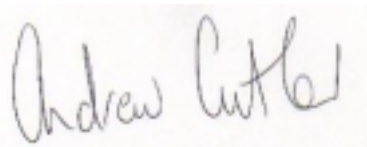
The test sample was selected by the client.

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 6.9 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.

Measurements were made with the input voltage set to 13.8 Vdc.

RF power output (dBm)			
Frequency	Channel Spacing	Rated	Measured
460.0500	12.5 kHz	36.0	35.8

Limits:

Part 90 contains no transmitter base power limits.

Section 90.205(g) 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 is a UHF POCSAG Paging transmitter.

The transmitter can operate in the 450 – 470 MHz paging bands using an authorised bandwidth of 11.25 kHz where the channel spacing is 12.5 kHz.

The modulation used is Carrier Frequency Shift Keying with Non Return Zero data.

The emission designation for this transmitter will therefore be 11K2F1D.

With reference to Masks B and D it can be seen that necessary bandwidth will equal the authorised bandwidth.

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The necessary bandwidth B_n will equal:

$$B_n = 2M + 2DK$$

$M = 600$ as advised by the client and as set on the function generator

$D = 2.5$ kHz as advised by the client and as observed during testing

$K = 2$ as advised by the client.

$$B_n = 2 \times 600 + 2 \times 2.5 \times 2$$

$$B_n = 11.2 \text{ kHz.}$$

In accordance with Section 2.1047(b) measurements were made at 512 baud (256 Hz) and 1200 baud (600 Hz), which are the only baud rates that this transmitter is designed for, for a range of modulation voltages.

100% modulation is 2.5 kHz.

	512 baud (256 Hz)	1200 baud (600 Hz)
Mod Volts	Dev kHz (%)	Dev kHz (%)
8.0	0.2 (8%)	0.2 (8%)
9.0	2.46 (98%)	2.41 (96%)
10.0	2.46 (98%)	2.42 (97%)
15.0	2.47 (99%)	2.42 (97%)
20.0	2.47 (99%)	2.42 (97%)

A family of curves has not been provided as the table above shows that the modulation percentage does not vary over the working input voltage range.

Result: Complies

Occupied Bandwidth

Section 90.210(b) – Mask B has been applied as the transmitter can operate in the band 450 MHz Paging band using an audio low pass filter. Additional measurements have been made with Mask D applied as the transmitter can operate in bands with 12.5 kHz steps.

Section 90.209(b)(5) defines the authorised bandwidth as 11.25 kHz where 12.5 kHz channeling is used between 421 – 512 MHz.

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

Emission mask plot has been made using a resolution bandwidth of 300 Hz.

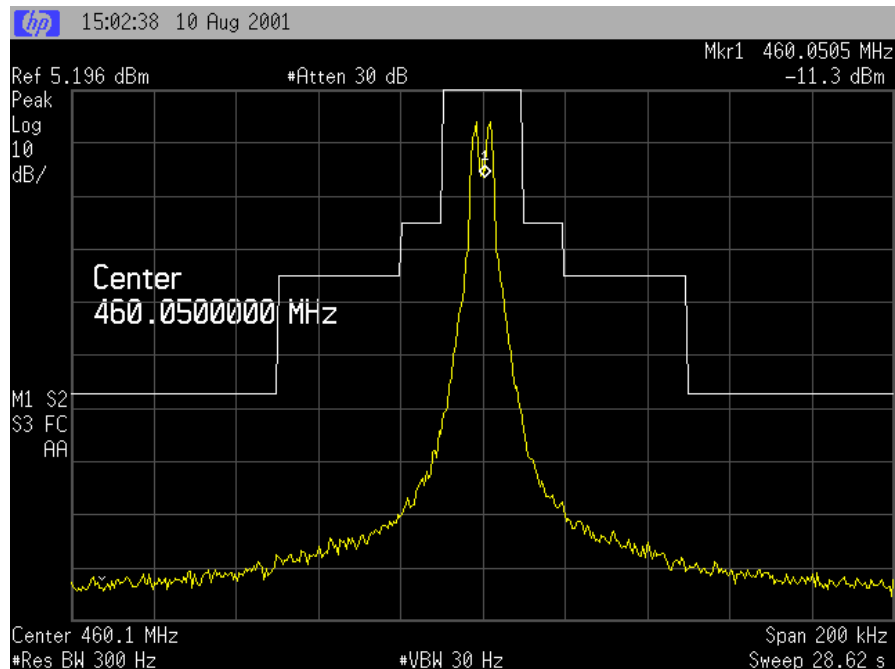
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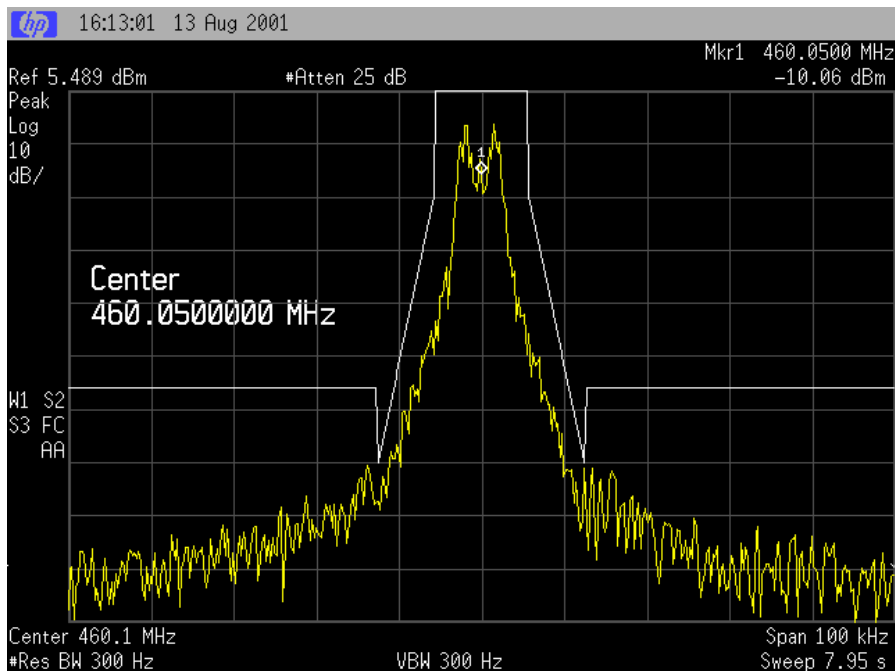
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Initial testing was carried out using a 256 Hz and a 600 Hz square wave at 10 volts peak to peak. 600 Hz modulation was used as this gave the worst case spectral output.

Mask B applied:



Mask D applied:



Result: Complies

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Spurious emissions at the transmitter antenna terminals

Frequency: 460.050 MHz

Measured Spurious Emission	
Spurious emission (MHz)	Emission level (dBm)
920.100	-45.1
1380.150	-45.4
1840.200	-50.4
2300.250	-57.3
2760.300	-73.0
3220.350	-43.0
3680.400	-40.0
4140.450	-72.4
4600.500	-61.3

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

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.

The rated power is 4 watts which gives limits of -13 dBm and -20 dBm.

No measurements were made above the 10th harmonic.

Result: Complies

Measurement Uncertainty: ± 3.3 dB

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Field strength of transmitter spurious emissions at the antenna terminals

Frequency: 460.050 MHz

Transmitter Harmonics

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Margin (dB)	Polarity
920.1000	69.9	-25.3	-20.0	-5.3	Horizontal
1380.1525	58.4	-36.8	-20.0	-16.8	Vertical
1840.2025	51.1	-44.1	-20.0	-24.1	Horizontal
2300.2525	62.5	-32.7	-20.0	-12.7	Horizontal
2760.3000	11.5	-83.7	-20.0	-63.7	Vertical
3220.3500	-	-	-20.0	-	Vert/Hort
3680.4000	-	-	-20.0	-	Vert/Hort
4140.4500	-	-	-20.0	-	Vert/Hort
4600.5000	-	-	-20.0	-	Vert/Hort

Other emissions observed while the transmitter was transmitting

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Margin (dB)	Polarity
188.0425	22.3	-72.9	-20.0	-52.9	Vertical
221.2250	28.3	-66.9	-20.0	-46.9	Vertical
309.7150	21.8	-73.4	-20.0	-53.4	Vertical
315.2475	24.0	-71.2	-20.0	-51.2	Vertical
320.7775	31.2	-64.0	-20.0	-44.0	Vertical
326.3075	33.6	-61.6	-20.0	-41.6	Vertical
331.8425	38.9	-56.3	-20.0	-36.3	Vertical
337.3725	37.1	-58.1	-20.0	-38.1	Vertical
342.9025	40.2	-55.0	-20.0	-35.0	Vertical
348.4325	40.7	-54.5	-20.0	-34.5	Vertical
353.9625	43.0	-52.2	-20.0	-32.2	Vertical
359.4925	38.6	-56.6	-20.0	-36.6	Vertical
365.0225	39.3	-55.9	-20.0	-35.9	Vertical
370.5525	36.0	-59.2	-20.0	-39.2	Vertical
376.0875	33.5	-61.7	-20.0	-41.7	Vertical
381.6175	33.5	-61.7	-20.0	-41.7	Horizontal
387.1475	35.7	-59.5	-20.0	-39.5	Horizontal
392.6775	34.1	-61.1	-20.0	-41.1	Horizontal
398.2075	31.5	-63.7	-20.0	-43.7	Vertical
403.7375	33.4	-61.8	-20.0	-41.8	Vertical
409.2675	30.0	-65.2	-20.0	-45.2	Vertical
420.3325	28.2	-67.0	-20.0	-47.0	Vertical
425.8650	24.1	-71.1	-20.0	-51.1	Vertical
431.3925	20.9	-74.3	-20.0	-54.3	Horizontal
436.9225	20.5	-74.7	-20.0	-54.7	Horizontal

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Other emissions observed while the transmitter was in stand by mode.

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Margin (dB)	Polarity
33.1800	24.0	-71.2	-20.0	-51.2	Vertical
96.5000	27.2	-68.0	-20.0	-48.0	Vertical
188.0400	31.1	-64.1	-20.0	-44.1	Vertical
221.2300	25.0	-70.2	-20.0	-50.2	Vertical
298.6600	26.7	-68.5	-20.0	-48.5	Vertical
304.1900	21.9	-73.3	-20.0	-53.3	Vertical
309.7200	31.4	-63.8	-20.0	-43.8	Vertical
315.2500	30.6	-64.6	-20.0	-44.6	Vertical
320.7800	38.8	-56.4	-20.0	-36.4	Vertical
326.3100	36.0	-59.2	-20.0	-39.2	Vertical
331.8400	39.5	-55.7	-20.0	-35.7	Vertical
337.3700	35.4	-59.8	-20.0	-39.8	Vertical
342.9000	37.9	-57.3	-20.0	-37.3	Vertical
348.4300	36.7	-58.5	-20.0	-38.5	Vertical
353.9625	41.3	-53.9	-20.0	-33.9	Vertical
359.4950	38.7	-56.5	-20.0	-36.5	Vertical
365.0250	41.2	-54.0	-20.0	-34.0	Vertical
370.5550	37.6	-57.6	-20.0	-37.6	Vertical
376.0857	37.9	-57.3	-20.0	-37.3	Vertical
381.6150	33.4	-61.8	-20.0	-41.8	Horizontal
387.1510	35.6	-59.6	-20.0	-39.6	Vertical
392.6750	33.4	-61.8	-20.0	-41.8	Vertical
398.2050	32.2	-63.0	-20.0	-43.0	Vertical
403.7450	22.5	-72.7	-20.0	-52.7	Vertical
409.2658	26.3	-68.9	-20.0	-48.9	Vertical
420.3362	25.7	-69.5	-20.0	-49.5	Vertical
425.8650	22.6	-72.6	-20.0	-52.6	Vertical

The device was tested on an open area test site at a distance of 3 metres with the device positioned 1.5 metres above the ground plane.

Testing was conducted while the transmitter was being modulated by a 600 Hz square wave at 10 V peak to peak which simulated a 1200 baud pocsag signal.

Attached to the device was a 460 MHz whip antenna.

The device was powered using a 13.8 Vdc gel cell battery.

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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.

Field strength measurements were carried out and recorded. The power level of each emission was then determined by replacing the transmitter with a dipole antenna that was connected to a signal generator.

The signal generator output level was increased until the same field strength level was observed at each emission frequency.

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

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

The rated power is 4 watts, which gives limits of -13 dBm and -20 dBm.

A worst case limit of -20 dBm has been applied.

No measurements were made above the 10th harmonic.

For completeness the power level of all emissions has been determined.

Result: Complies

Measurement Uncertainty: ± 4.1 dB

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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 (13.8 Vdc).

Nominal Frequency: 460.050 MHz

Frequency Error (Hz)			
Voltage Temp.	11.7 Vdc	13.8 Vdc	15.9 Vdc
+50°C	-427.0	-423.0	-423.0
+40°C	-383.0	-385.0	-378.0
+30°C	-248.0	-237.0	-252.0
+20°C	-406.0	-409.0	-411.0
+10°C	+87.0	+178.0	+2.0
0°C	+409.0	+449.0	+448.0
-10°C	+530.0	+523.0	+512.0
-20°C	+591.0	+596.0	+592.0
-30°C	+519.0	+522.0	+531.0

Limit

Part 90.213 states a number of frequency stability requirements for fixed and base transmitters operating between 421 – 512 is 2.5 ppm.

This transmitter operates on 460.050 MHz.

$2.5 \text{ ppm} = 2.5 \times 460.025 = 1150 \text{ Hz}$.

Result: Complies.

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

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Transient frequency behaviour

Transient frequency behaviour measurements are applicable to wide band transmitters operating in the frequency band 412 – 512 MHz as required by section 90.214.

Measurements were carried out at 460.050 MHz with no modulation applied using the method described in ETS 300-086.

In summary this method calls for the use of an external signal generator tuned to 420.0 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 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 and a picture on the oscilloscope.

The result of the change in the ration 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)		
8 kHz	3 kHz	Nil

Result: Complies

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

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Transmitter turn on:

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

Black trace = transmitter amplitude response.

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).

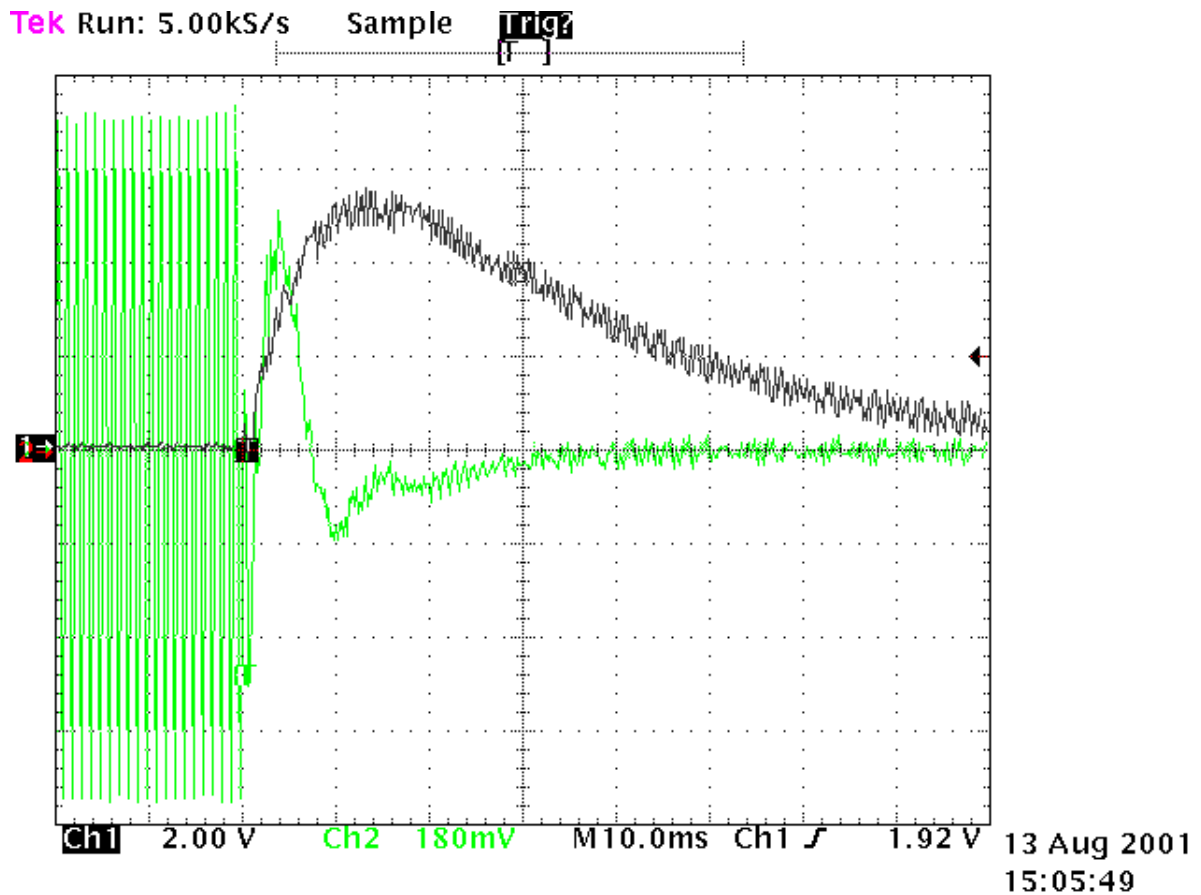
This is position *ton*.

A transient response is indicated by the green trace after *ton*.

t1 occurs between 2 and 3 divisions from the left hand edge.

t2 occurs between 3 and 5.5 divisions from the left hand edge.

Transients have been observed in the periods *t1* and *t2*.



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Transmitter turn off:

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

Black trace = transmitter amplitude response.

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.

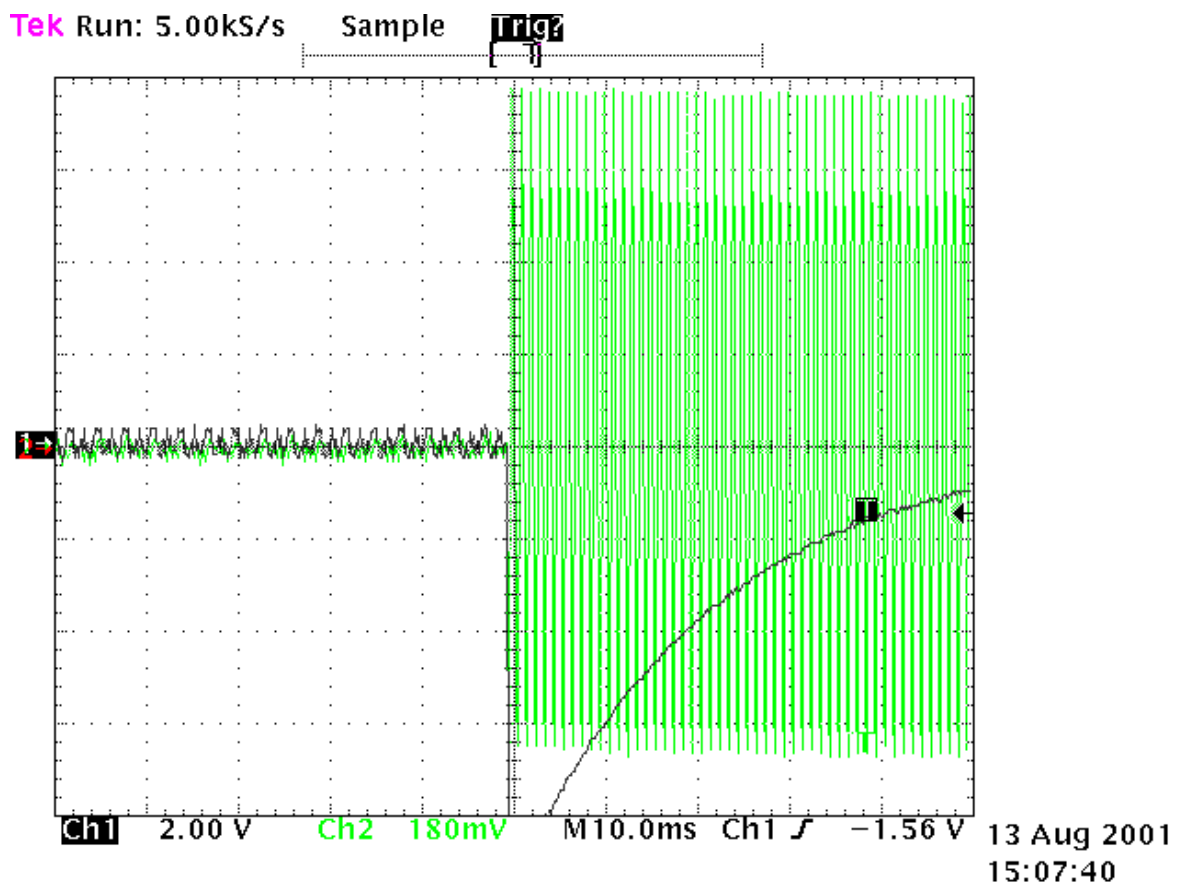
The display of the 1 kHz signal rising has been positioned 5 divisions from the left hand edge (50 mS).

This is position *toff*.

t3 occurs between 4.0 and 5.0 divisions from the left hand edge.

A transient response is indicated by the green trace before *toff*.

No transient response can be observed before *toff*.



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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
Thermal chamber	Contherm	M180F	-	E1129
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.