EMC Technologies (NZ) Ltd

Test Report No **10831 FCC**
Report date: 1st September 2001

TEST REPORT

Tait T2030-K27 Mobile Transceiver

tested for compliance with the

Code of Federal Regulations (CFR) 47

Part 22 – Public Mobile Services

and

Part 90 –Private Land Mobile Services

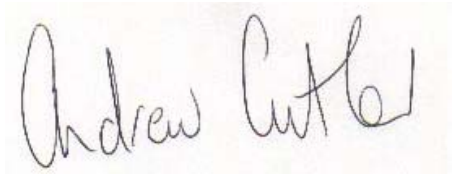
and

Part 15 – Radio Frequency Devices

for

Tait Electronics Ltd

This Test Report is issued with the authority of:



Andrew Cutler - General Manager

Prepared By:

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1. CLIENT INFORMATION

Company Name	Tait Electronics Ltd
Address	558 Wairakei Road Burnside
City	Christchurch
Country	New Zealand
Contact	Linda Grose

2. DESCRIPTION OF TEST SAMPLE

Brand Name	Tait
Model Number	T2030-K27
Product	Mobile Transceiver
Manufacturer	Tait Electronics Ltd
Country of Origin	New Zealand
Serial Number	17085682
FCC ID	CASTEL0057

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 15, Part 22 and Part 90.

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(a)	Low pass filter response	Complies
2.1047(b)	Modulation limiting characteristics	Complies
90.211(a)	Modulation characteristics	Complies
2.1049	Occupied bandwidth	Noted
2.202	Bandwidths	Noted
22.357	Emission types	Complies
22.359(a)	Emission masks	Complies
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
2.1057	Frequency spectrum to be investigated	Noted
15.109	Radiated emission limits	Complies
15.111	Antenna power conducted limits for receivers	Complies
2.1055	Frequency stability	Noted
22.355	Frequency tolerance	Complies
90.213	Frequency stability	Complies

4. TEST SAMPLE DESCRIPTION

The sample tested is a mobile transceiver with the following specifications:

Rated Transmitter Output Power

High power: 15 Watts (41.8 dBm)
Low power: 5 Watts (37.0 dBm)

Test frequency

Transmit: 898.100 MHz Receive: 938.100 MHz

Frequency Range

Transmit: 896 – 941 MHz Receive: 935 – 941MHz

FCC Frequency Bands

Transmit: 896 – 901 MHz Receive: 935 – 940 MHz

Emission Types and Necessary Bandwidths

Frequency Modulation, analogue speech with narrow band option

11k0F3E: 12.5 kHz channel spacing with 11kHz necessary bandwidth

Power Supply

External DC power supply.

Typically a lead acid battery with a nominal voltage of 13.8 Vdc.

5. TEST CONDITIONS

Standard Temperature and Humidity

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

Standard Test Power Source

External 13.8 Vdc power supply.

Standard Test Voltage: 13.8 Vdc

Extreme Temperature

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

Tests carried out in 10° intervals over this range

Extreme Test Voltages

High Voltage: 15.9 Vdc (115%)
Low Voltage: 11.7 Vdc (85%)

6. ATTESTATION

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

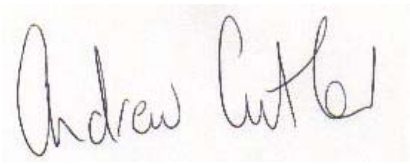
The test sample was selected by the client.

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. TEST RESULTS

RF power ouput

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.

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

RF power output (Watts)			
Temp.	**Level**	**Rated**	**Measured**
+25°C	High	15.0	15.0
+25°C	Low	5.0	4.1

Limits:
Part 22 contains no transmitter base power limits.

Part 90 contains no transmitter base power limits.

Section 90.205(i) specifies that the transmitter must meet the power and height limitations contained within section 90.635. The limitations contained in this section relate to base station transmitter and therefore do not apply to this transmitter.

Result: Complies

Measurement Uncertainty: *±0.5 dB*

Modulation Characteristics

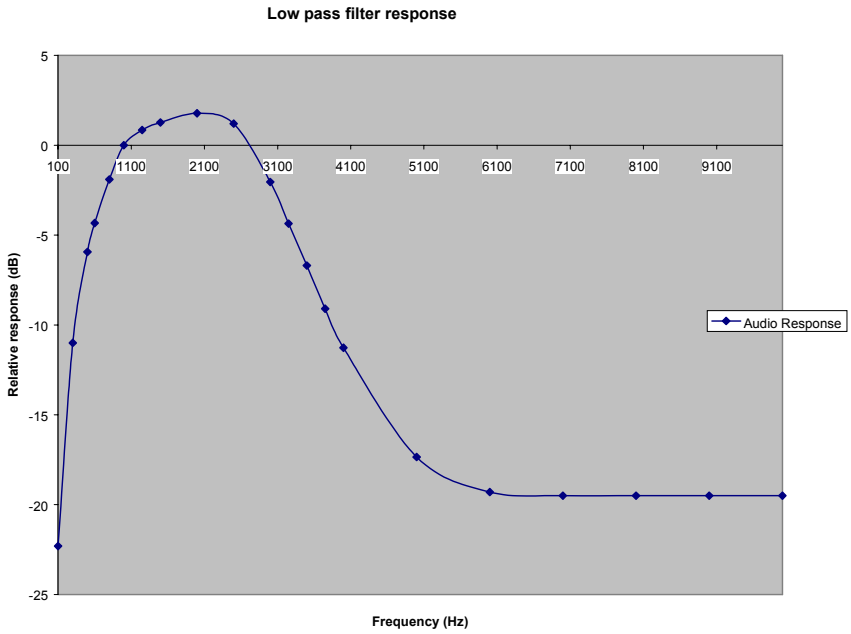
The following graphs are attached:

(a) 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.

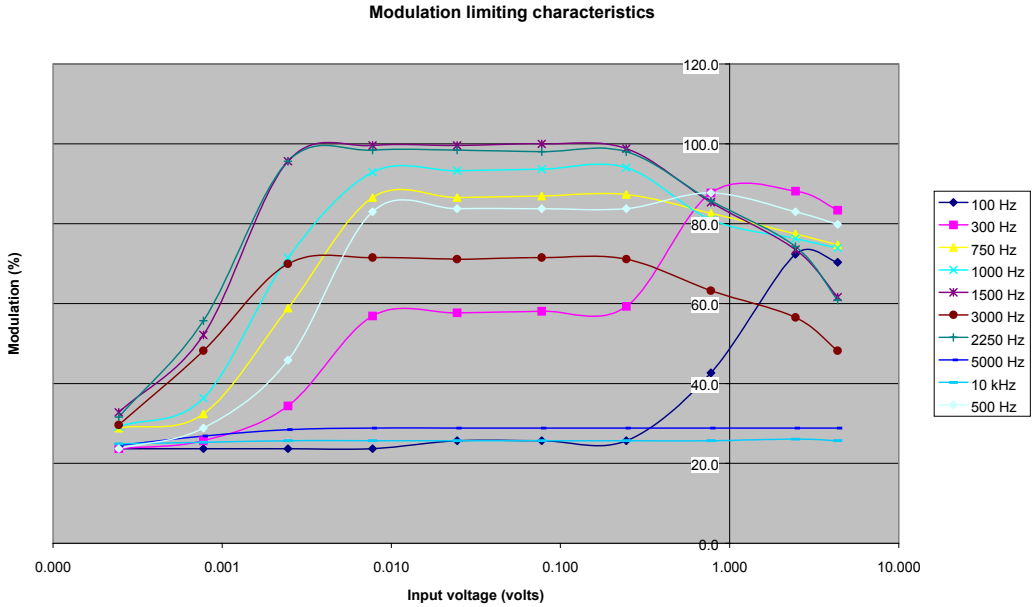


(b) A family of curves showing the percentage of modulation versus the modulation input voltage.

These measurements were carried out with modulating frequencies from 100 Hz to 10 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 channeling.



Limit

Part 22 provides no limits for these measurements.

Part 90.211 – Modulation requirements states the transmitter must meet the emission requirements of 90.210. Refer to the Occupied Bandwidth measurements in this report.

Result: Complies

Measurement Uncertainty: ±1%.

Occupied Bandwidth

Measurements were carried out with a 2500 Hz modulating frequency applied at a level 16 dB higher than the level required to achieve 50% modulation (2.5 kHz deviation) at the frequency of maximum response. The worst case frequency response was found to be at 2500 Hz.

Before occupied bandwidth measurements were made, the 0 dB reference point of the spectrum mask was determined by using a resolution bandwidth of 30 kHz.

The spectrum mask is defined in:
Section 22.359(a) – Analog modulation
Section 90.210(b) – Mask I has been applied

Part 22 has no authorised bandwidths defined. The authorised bandwidth is therefore the necessary bandwidth.

Using the formulas contained in Part 2.202:
$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 2.5 kHz
Where M = maximum modulation frequency: 3 kHz
$B_n =$ 11 kHz

This is confirmed in the emission designation, 11k0F3E as declared by the client.

Section 90.209(b)(5) defines the authorised bandwidth as 13.6 kHz where 12.5 kHz channelling is used in the band 896 – 901 / 935 – 941 MHz.

Emission mask testing has been carried out with as follows:
- Part 22 where the authorised bandwidth = necessary bandwidth = 11 kHz.
- Part 90 where Mask I has been applied.

The following clauses are also covered by these tests:

Part 22.357 - Emission types:
The transmitter uses analogue speech, which complies with the appropriate emission mask.

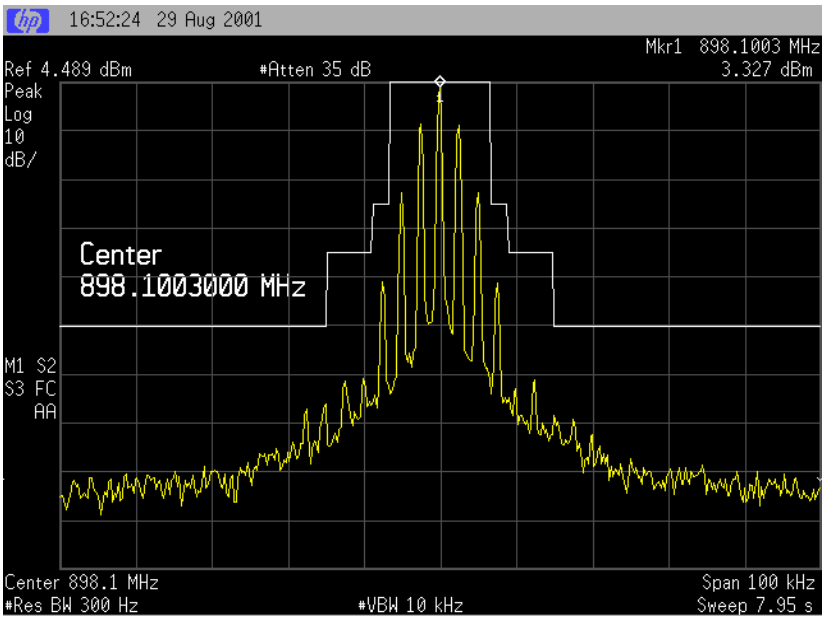
Part 90.207 – Emission types:

F3E is used by this transmitter.

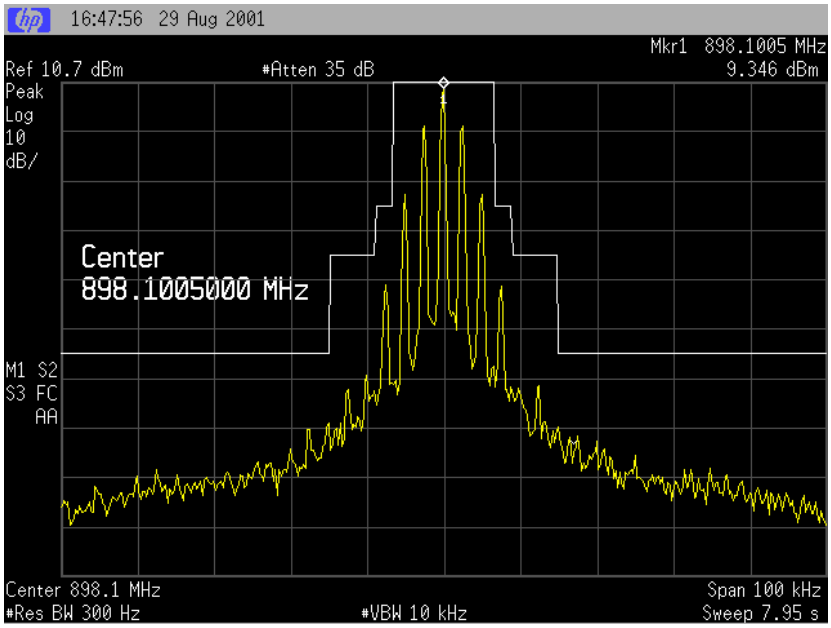
Part 90.209 – Bandwidth limitations:
Bandwidth has been calculated using the formula contained in Part 2.202 as described for the Part 22 requirements above.

Two plots have been provided. One plot is for high power operation and the other plot is for low power operation.

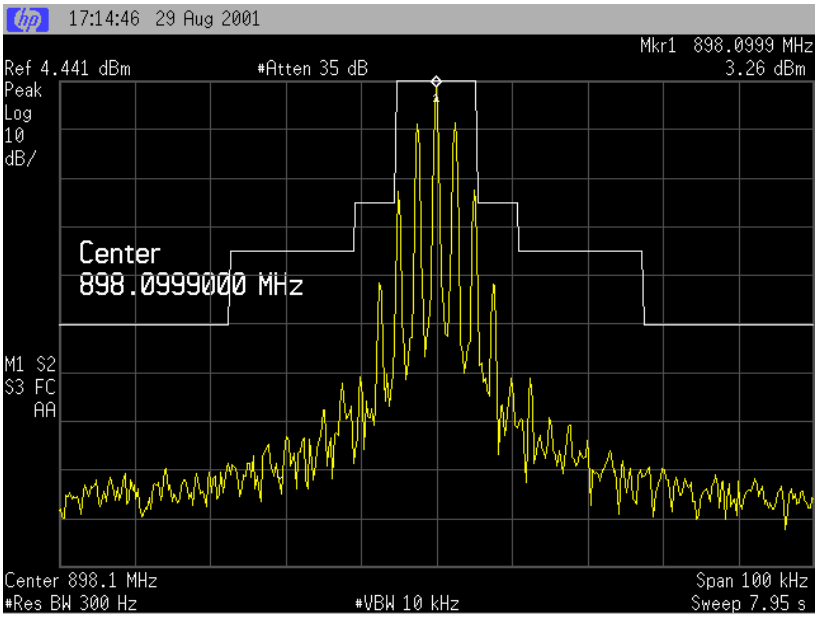
Part 90 - Low power (Mask I)



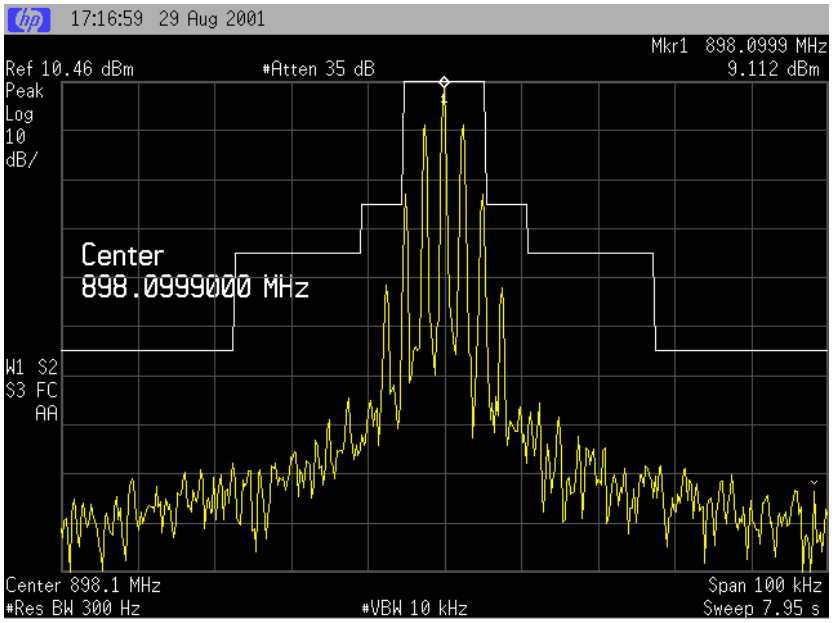
Part 90 - High power (Mask I)



Part 22 - Low power (11 kHz authorised bandwidth)



Part 22 - High power (11 kHz authorised bandwidth)



Result: Complies

Surious emissions at antenna terminals

Frequency: 898.1 MHz

Measured Spurious Emission		
Spurious emission (MHz)	**Emission level – High power (dBm)**	**Emission level – Low power (dBm)**
887.400	-46.4	-56.7
1796.200	-41.6	-44.1
2694.300	-43.6	-50.4
3592.400	-44.6	-50.1
4490.500	-	-
5388.600	-	-
6289.700	-51.9	-56.7
7184.000	-	-
8082.900	-	-
8981.000	-	-

Limit
Part 22.359(a) Analogue Modulation, (3) on any frequency removed by more than 250% all emissions are to be attenuated by at least 43 + 10 log (P) dB or 80 dB which ever is the lesser attenuation.

Part 90.210(b) Mask I, (3) on any frequency removed by more than 15 kHz from the carrier frequency, all emissions are to be attenuated by at least 43 + 10 log (P) or 70 dB whichever is less.

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.

Rated powers are 15 watts and 5 watts gives a limit of –13 dBm.

No measurements less than –40 dBm have been reported. except those reported above.

No measurements were made above the 10th harmonic.

Result: Complies

Measurement Uncertainty: *±3.3 dB*

Field strength of spurious emissions at antenna terminals

Frequency: 898.100 MHz

Transmitter Harmonics:

Emission Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Worst Case Margin (dB)	Worst Case Antenna Polarity
1796.200	57.1	-34.7	-13.0	21.7	Vertical
2694.300	65.4	-30.9	-13.0	17.9	Vertical
3592.400	48.1	-34.6	-13.0	21.6	Vertical
4490.500	-	-	-13.0	-	Vert/Hort
5388.600	-	-	-13.0	-	Vert/Hort
6286.700	-	-	-13.0	-	Vert/Hort
7184.800	-	-	-13.0	-	Vert/Hort
8082.900	-	-	-13.0	-	Vert/Hort
8981.000	-	-	-13.0	-	Vert/Hort

Other significant emissions detected:

Emission Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Worst Case Margin (dB)	Worst Case Antenna Polarity
74.593	41.6	-53.6	-13.0	40.6	Vertical
76.611	41.4	-54.0	-13.0	41.0	Vertical
78.625	38.5	-57.0	-13.0	44.0	Vertical

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 tested operating on high power with a 50 Ω dummy load attached to the output while being powered using a 13.8 Vdc battery.

Testing was carried out using the substitution method. The power level of each emission was then determined by replacing the transmitter with an 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 / gains due to the coax cable and the antenna.

Limit
Part 22.359(a) Analogue Modulation, (3) on any frequency removed by more than 250% all emissions are to be attenuated by at least 43 + 10 log (P) dB.

Part 90.210(b) Mask I, (3) on any frequency removed by more than 15 kHz from the carrier frequency, all emissions are to be attenuated by at least 43 + 10 log (P) or 70 dB whichever is less.

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.

Rated powers are 15 watts and 5 watts gives a limit of –13 dBm.

Result: Complies

Measurement Uncertainty: *±4.1 dB*

Field strength of receiver spurious emissions

Receive frequency: 938.100 MHz

IF Frequencies: 61.9 MHz, 10.7 MHz and 0.455 MHz

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

Receiver Local Oscillator:

Frequency (MHz)	Level Vertical (dBuV/m)	Level Horizontal (dBuV/m)	Limit (dBuV/m)	Worst Case Margin (dB)	Worst Case Antenna Polarity
876.200	39.2	41.2	46.0	4.8	Horizontal
1752.400	48.5	42.0	54.0	5.5	Vertical
2628.600	41.6	40.5	54.0	12.4	Vertical
3504.800	-	-	54.0	-	Vert/Hort
4381.000	-	-	54.0	-	Vert/Hort
5257.200	-	-	54.0	-	Vert/Hort
6133.400	-	-	54.0	-	Vert/Hort
7009.600	-	-	54.0	-	Vert/Hort
7885.800	-	-	54.0	-	Vert/Hort
8762.000	-	-	54.0	-	Vert/Hort

Other emissions observed (transmitter in standby):

Frequency (MHz)	Level Vertical (dBuV/m)	Level Horizontal (dBuV/m)	Limit (dBuV/m)	Worst Case Margin (dB)	Worst Case Antenna Polarity
38.398	31.8		40.0	8.2	Vertical
42.335	22.8		40.0	17.2	Vertical
46.370	23.3		40.0	16.7	Vertical
49.155	20.2		40.0	19.8	Vertical
58.460	20.0		40.0	20.0	Vertical
60.480	32.0		40.0	8.0	Vertical
62.495	28.4		40.0	11.6	Vertical
64.510	24.1		40.0	15.9	Vertical
68.548	30.1		40.0	9.9	Vertical
70.563	32.9	26.3	40.0	7.1	Vertical
72.578	37.8	31.4	40.0	2.2	Vertical
74.593	39.0	35.0	40.0	1.0	Vertical
76.611	37.4	32.5	40.0	2.6	Vertical
78.625	37.2	32.3	40.0	2.8	Vertical

Frequency (MHz)	Level Vertical (dBuV/m)	Level Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Polarity
80.642	23.8		40.0	16.2	Vertical
84.673	29.5	29.2	40.0	10.5	Vertical
86.688	25.0		40.0	15.0	Vertical
88.703	34.0		43.5	9.5	Vertical
90.720	24.5		43.5	19.0	Vertical
92.738	25.2		43.5	18.3	Vertical
94.752	26.9		43.5	16.6	Vertical
98.783	26.8		43.5	16.7	Vertical
100.798	30.7		43.5	12.8	Vertical
102.810	21.5		43.5	22.0	Vertical
106.851	23.1		43.5	20.4	Vertical
241.927	25.0		46.0	21.0	Vertical
249.994	25.0		46.0	21.0	Vertical
278.216	28.5	29.5	46.0	16.5	Horizontal
282.251	29.7	31.3	46.0	14.7	Horizontal
286.281	27.7		46.0	18.3	Vertical
294.346	27.2		46.0	18.8	Vertical
300.339	28.0		46.0	18.0	Vertical
304.420	27.2		46.0	18.8	Vertical
342.736	27.4		46.0	18.6	Vertical

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.

Testing carried out with a 800 MHz dipole antenna attached to the transceiver. The transceiver was powered using a 13.8 Vdc battery.

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

30 – 88 MHz: 100 uV/m = 40 dBuV/m
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

Result: Complies

Measurement Uncertainty: *±4.1 dB*

Antenna power conduction limits for receivers

Receive frequency: 938.1 MHz

IF Frequencies: 61.9 MHz, 10.7 MHz and 0.455 MHz

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

Spurious emission measurements were made at the antenna terminals using a spectrum analyser.

Frequency (MHz)	Level (dBm)	Limit (dBm)
No significant emissions detected 30 – 10000 MHz	Nil	-57.0

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. The transmitter was then turned on and the frequency error measured after a period of 1 minute.

Measurements were made with the supply varied between 115% and 85% of the nominal supply voltage (13.8 Vdc).

Nominal Frequency: 898.1 MHz

Frequency Error (Hz)			
Voltage Temp.	**11.7 Vdc**	**13.8 Vdc**	**15.9 Vdc**
+50°C	-804.0	-805.0	-804.0
+40°C	-699.0	-702.0	-704.0
+30°C	-504.0	-500.0	-503.0
+20°C	-237.0	-237.0	-236.0
+10°C	-5.0	-8.0	-10.0
0°C	+530.0	+524.0	+522.0
-10°C	+579.0	+574.0	+570.0
-20°C	+350.0	+350.0	+351.0
-30°C	+114.0	+109.0	+105.0

Limit
Part 22 gives no frequency tolerance for mobiles operating between 896 – 901 MHz.

Part 90.213 states that mobile stations operating in the band 896 – 901 MHz shall have a frequency stability that does not exceed 1.5 ppm.

This transmitter operates on 898.1 MHz.

1.5 ppm = 1.5 x 898.1 = 1347 Hz

Result: Complies.

Measurement Uncertainty: ±30 Hz

8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset
Aerial Controller	EMCO	1090	9112-1062	RFS 3710
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708
Attenuator	Hewlett Packard	8491A	24838	E1329
Attenuator	Wienschel	49-20-43	GC104	E1308
Audio Analyzer	Hewlett Packard	HP 8903B	2216A01713	E1146
Biconical Antenna	Schwarzbeck	BBA 9106		RFS 3612
Coax Cable	Sucoflex	104PA	2736/4PA	
DC Power Supply	Hewlett Packard	HP6032A	2743A-02859	E1069
Frequency Counter	Hewlett Packard	HP 5342A	1916A01835	E1224
Horn Antenna	Electrometrics	RGA-60	6234	E1494
Horn Antenna	EMCO	3115	9511-4629	E1526
Level generator	Anritsu	MG443B	M61689	E1143
Log Periodic Antenna	Schwarzbeck	UHALP 9107		RFS 3702
Measurement Receiver	Rohde & Schwarz	ESCS 30	839873/1	
Modulation Analyzer	Hewlett Packard	HP 8901B	2608A00782	E1090
Resistance Thermometer Meter	DSIR	RT200	35	E1409
RF Power Meter	Hewlett Packard	HP 436A	2512A22439	E1198
Rubidium Oscillator	Ball Efratom	FRS – C	4287	E1053
Signal Generator	Rohde and Schwarz	SMP-04	1035 5005.04	E1560
Spectrum Analyser	Hewlett Packard	E7405A	US 39150142	RFS 3776
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	3776
Thermal chamber	Contherm	M180F	86025	E1129
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709

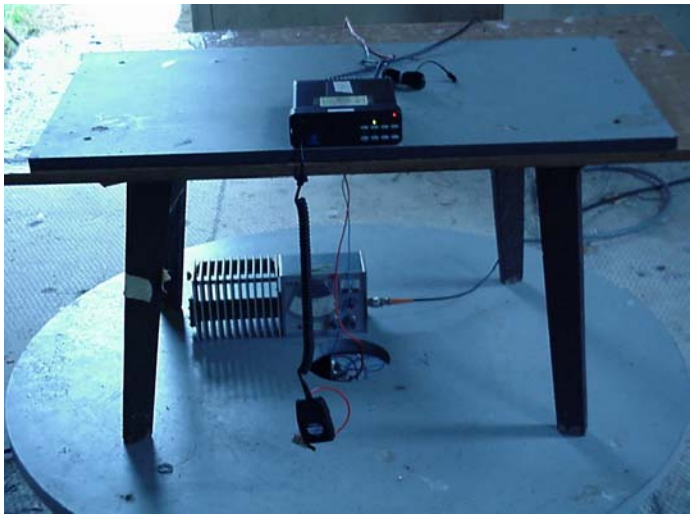
9. ACCREDITATIONS

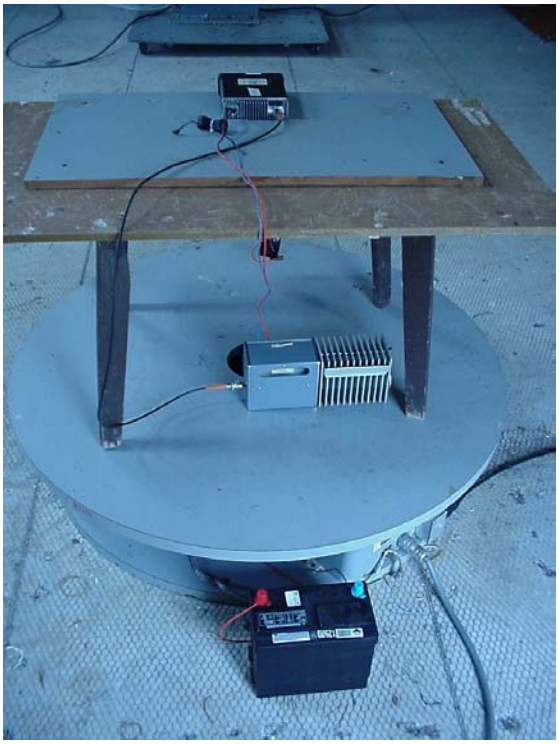
Testing was carried out in accordance with EMC Technologies NZ Ltd registration with the Federal Communications Commission as a listed facility, Registration Number: 90838, which was updated on February 11th, 2000.

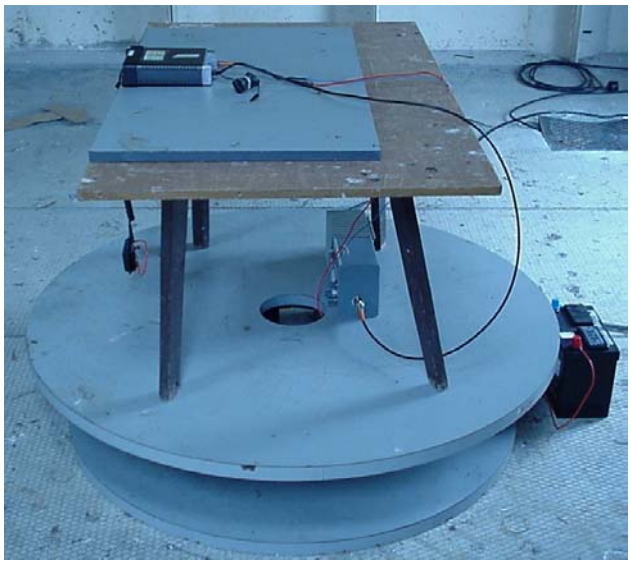
All measurement equipment has been calibrated in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to the New Zealand Code of Laboratory Management Practice incorporating ISO Guide 25: 1990 and ISO 9002: 1994.

10. PHOTOGRAPH (S)

Radiated emission test set up for the transmitter.







Radiated emissions test set up for the receiver.