TEST REPORT

Tait T854-26 Base Station Transmitter

tested for compliance with the

Code of Federal Regulations (CFR) 47

Part 22 – Public Mobile Services

and

Part 90 –Private Land Mobile Services

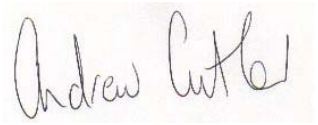
and

Part 15 – Radio Frequency Devices

for

Tait Electronics Ltd

This Test Report is issued with the authority of:



Andrew Cutler - General Manager

Prepared By:

Karen Miller - Office Administrator

EMC Technologies (NZ) Ltd
Telephone: +64 9 360 0862 Fax: +64 9 360 0861
STREET ADDRESS - 47 MacKelvie Street, Grey Lynn, Auckland, New Zealand
E-mail: aucklab@ihug.co.nz
POSTAL ADDRESS - PO Box 68 307, Newton, Auckland, New Zealand
Web Site: www.emctech.com.au

Table of Contents

1. CLIENT INFORMATION

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

2. DESCRIPTION OF TEST SAMPLE

Brand Name	Tait
Model Number	T854-26-7200
Product	Base Station Transmitter
Manufacturer	Tait Electronics Ltd
Country of Origin	New Zealand
Serial Number	13049176
FCC ID	CASTEL0058

The transmitter under test was contained within a base station rack containing the following other modules:

- Tait T800-23-0010 AC power supply. Sn# 13050838
- Tait T855-35-000 Receiver. Sn# 980356.

The base station rack had external controls to allow the following test functions:
- push to talk switch
- narrow and wide band channel selector
- low pass filter input and output ports

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 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
2.1055	Frequency stability	Noted
22.355	Frequency tolerance	Complies
90.213	Frequency stability	Complies
2.1057	Frequency spectrum to be investigated	Noted
15.107	Conducted Emissions	Complies

4. TEST SAMPLE DESCRIPTION

The sample tested is a base station transmitter with the following specifications:

Rated Transmitter Output Power

25 Watts (44.0 dBm)

Transmit frequency

460.000 MHz

Transmitter frequency range

440 – 480 MHz

FCC Bands

Part 90: 421 – 512 MHz

Part 22: 450 – 512 MHz

Emission Types and Necessary Bandwidths

Frequency modulation, analogue speech with narrow and wide band options.

16k0F3E: 25.0 kHz channel spacing with 16 kHz necessary bandwidth

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

Power Supply

115 Vac to the Tait T800-23-0010 power supply.

5. TEST CONDITIONS

Standard Temperature and Humidity

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

Standard Test Power Source

Standard Test Voltage: 115.0 Vac.

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: 132.3 Vac
Low Voltage: 97.7 Vac

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.

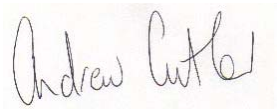
This report does not contain corrections or erasures.

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.

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 and a 50Ω dummy load.

Measurements were carried out when the transmitter was not being modulated.

Measurements were made with the input voltage set to 115 Vac.

RF power output (dBm)			
Frequency	**Channel Spacing**	**Rated**	**Measured**
460.000	Narrow	44.0	43.9
460.000	Wide	44.0	43.9

Limits:
Part 22 contains no transmitter base power limits.

Clause 90.205(g) of Part 90 specifies that in the band 450 – 470 MHz the maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and the required service area.

Result: Complies

Measurement Uncertainty: *±0.5 dB*

Modulation Characteristics

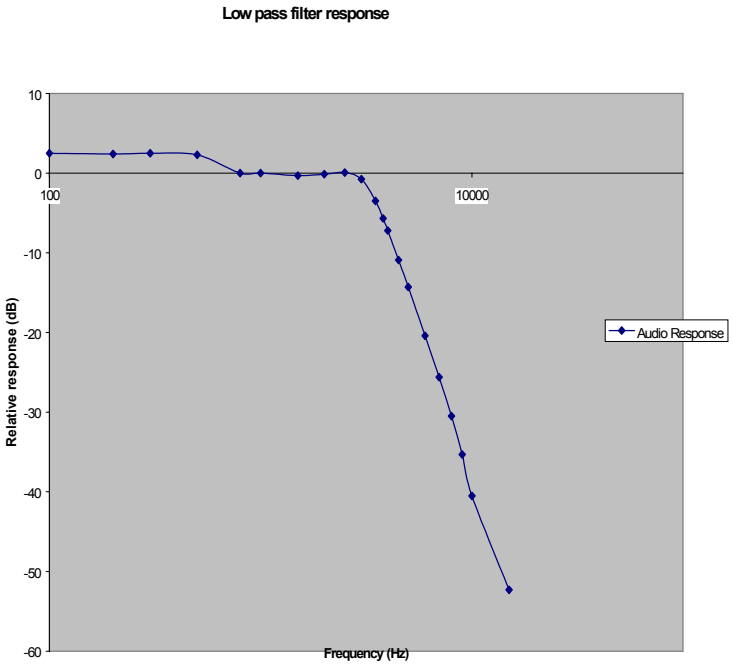
The following graphs are attached:

(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. 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.

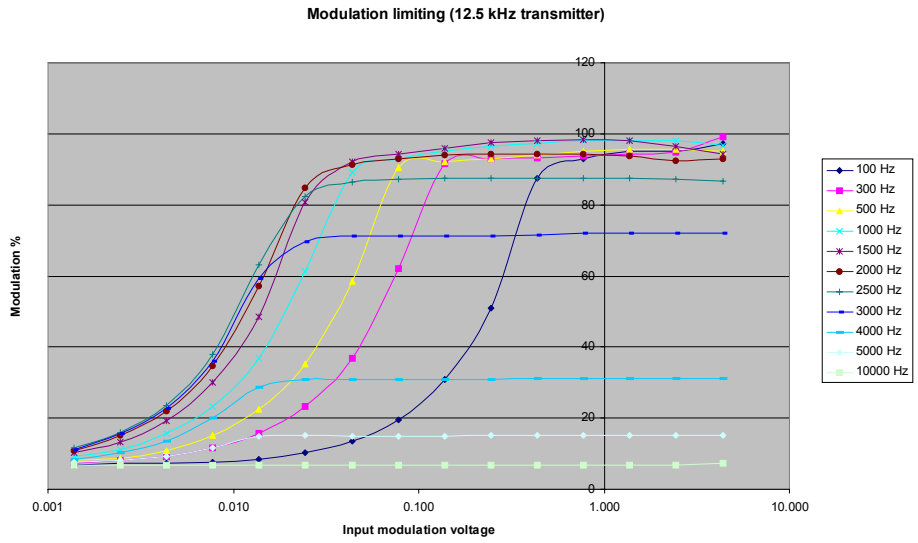


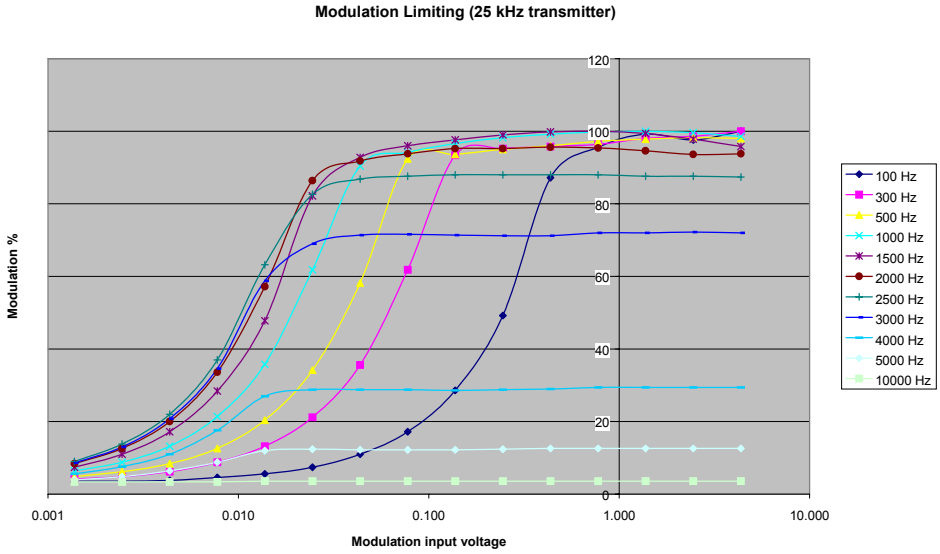
(b) A family of curves showing the percentage of modulation versus the modulation input voltage.

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 5 kHz deviation is 100% for 25 kHz channelling and 2.5 kHz deviation is 100% for 12.5kHz 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. This was found to be at 2200 Hz.

Before occupied bandwidth measurements were made, the 0 dB reference point of the spectrum mask was determined by operating the transmitter with no modulation.

The spectrum mask is defined in:

Part 90.210(b) – Mask B has been applied to the 25 kHz channel option.
Part 90.210(d) – Mask D has been applied to the 12.5 kHz channel option.

Part 90.209(5) defines the authorised bandwidth as 20 kHz or 11.25 kHz where 6.25 kHz channeling is used in the band 421 – 512 MHz.

Part 22.359(a) – Analog modulation

Part 22 has no authorised bandwidth defined.

The necessary bandwidth is taken to be the authorised bandwidth.

Using the formulas contained in Part 2.202:
$B_n = 2 \times D + 2 \times M$
Where D = maximum deviation: 2.5 kHz or 5.0 kHz
Where M = maximum modulation frequency: 3 kHz
$B_n =$ 11.25 kHz or 16 kHz

This is confirmed in the emission designations, 11k0F3E and 16k0F3E as declared by the client.

Part 22 emission mask measurements have been carried out using necessary bandwidths of 11.25 kHz and 16 kHz respectively.

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.

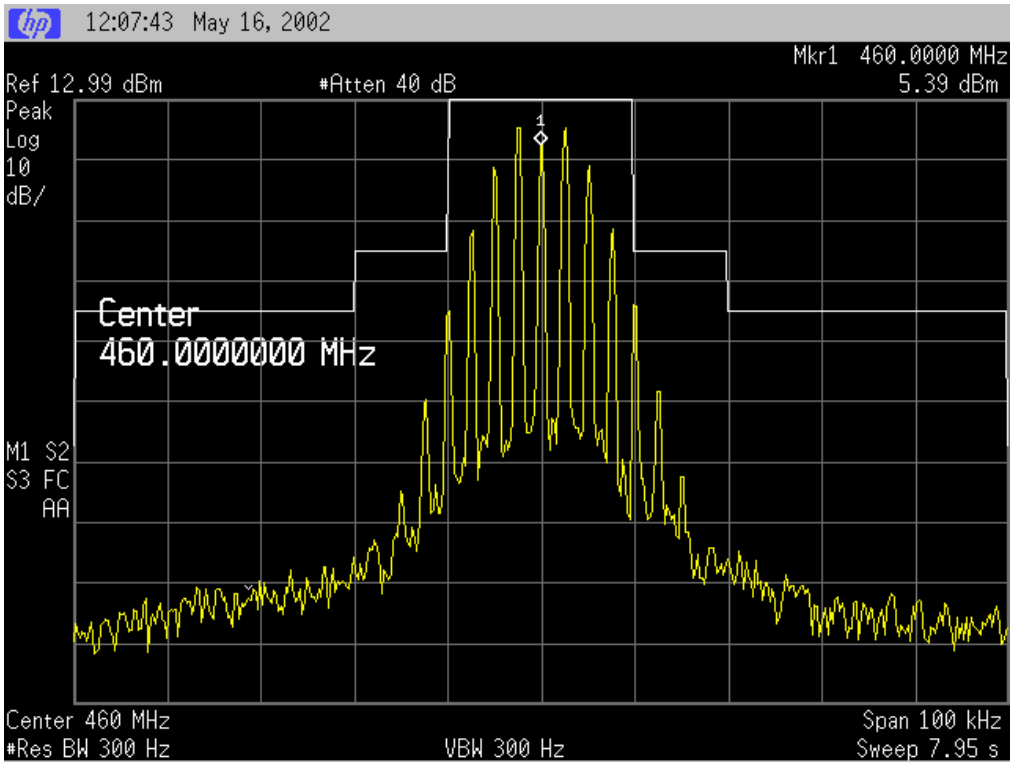
Part 90.207 – Emission types:

Emission type F3E is used by this transmitter.

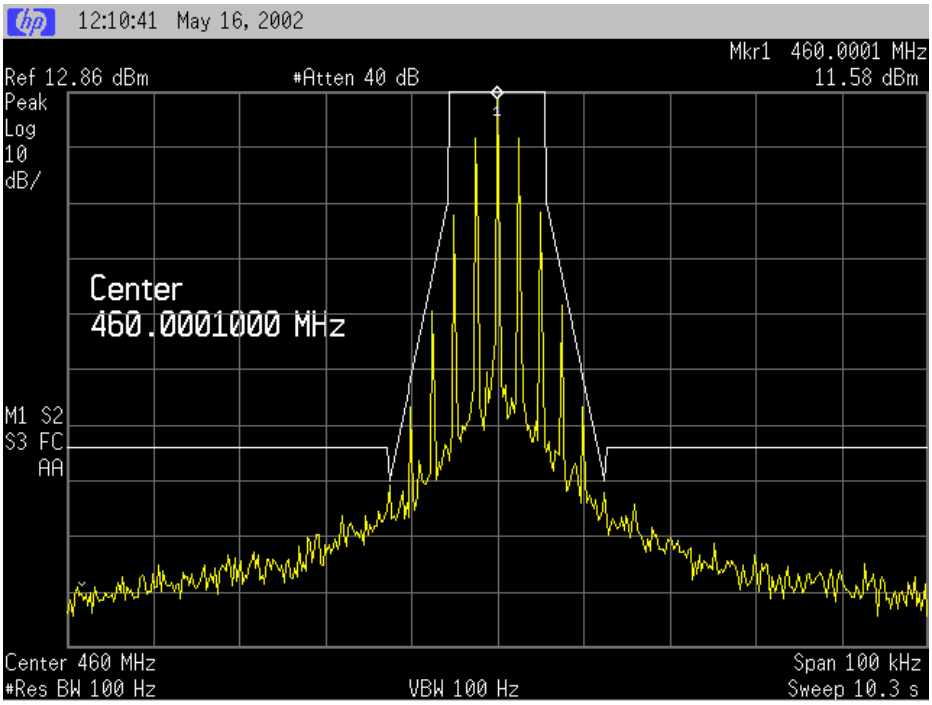
Part 90.209 – Bandwidth limitations:

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

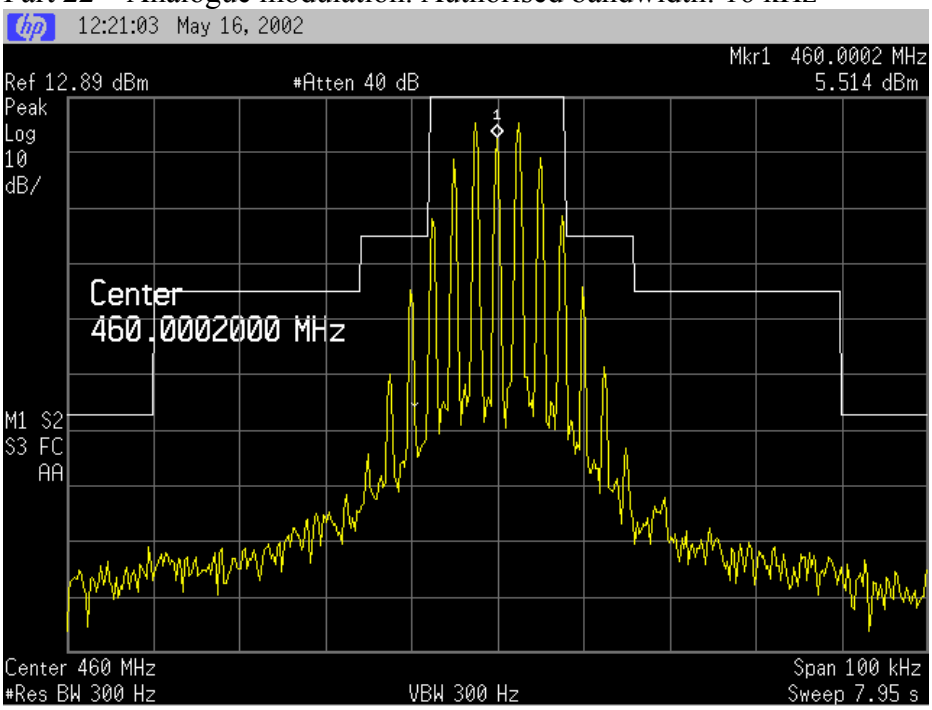
Part 90 – Mask B: Wide band



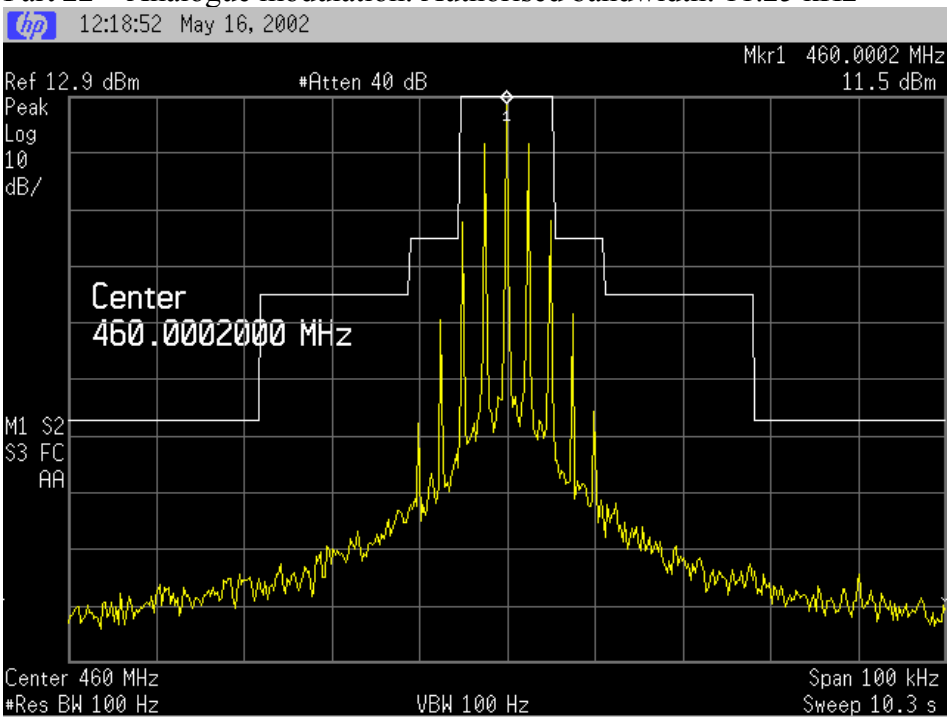
Part 90 – Mask D: Narrow band



Part 22 – Analogue modulation. Authorised bandwidth: 16 kHz



Part 22 – Analogue modulation. Authorised bandwidth: 11.25 kHz



Result: Complies

Spurious emissions at antenna terminals

Frequency: 460.0 MHz

Measured Spurious Emission		
Spurious emission (MHz)	**Emission level – Narrow band (dBm)**	**Emission level – Wide band (dBm)**
449.3	-42.1	-42.7
920.0	-36.3	-36.6
1380.0	-45.4	-47.5
1840.0	-51.8	-52.1
2300.0	-50.5	-51.1
2760.0	-63.5	-64.7
3200.0	-41.7	41.8
3680.0	-43.3	-43.6
4140.0	-36.6	-36.7
4600.0	-33.5	-33.5

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 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 by more than 12.5 kHz from the channel centre frequency all emissions are to be attenuated by at least 50 + 10 log (P) or 70 dB which ever is the lesser attenuation.

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.

The rated power is 25 watts which gives limits of –13 dBm and –20 dBm.

Except for the emissions reported above, no other emissions less than –33 dBm or –40 dBm have been reported.

Result: Complies

Measurement Uncertainty: *±3.3 dB*

Field strength of spurious emissions at antenna terminals

Emission frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Margin (dB)	Polarity
920.000	45.1	-47.0	-20.0	-27.0	Vertical
1380.000	40.2	-43.0	-20.0	-23.0	Horizontal
1840.000	43.7	-45.8	-20.0	-25.8	Horizontal
2300.000	56.1	-29.3	-20.0	-9.3	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 Driving Creek, Orere Point, Auckland. Details of this site have been filed with the Commission, Registration Number: 90838, which was last updated on March 20th, 2002.

The transmitter was tested while in stand by mode and while transmitting continuously into a dummy load while being powered at 115 Vac.

The power level of each emission was 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 gains / losses due to the coax cable and the dipole antenna.

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

The rated power is 25 watts, which gives a limit of –20 dBm.

No measurements were made above the 10th harmonic.

Emissions that are more than 20 dB below the specification limit have not been reported in accordance with Section 2.1057(c).

Result: Complies

***Measurement Uncertainty*:** *±4.1 dB*

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 at 460.0 MHz using the method described in ETS 300-086.

In summary this method calls for the use of an external signal generator tuned to 460.0 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 either 12.5 or 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 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.

The results of these tests are summarised in the tables below.

12.5 kHz:

Measured Transient Deviation		
Period t_1 (ms)	period t_2 (ms)	period t_3 (ms)
10.0	20.0	10.0
Frequency Difference from the Nominal Frequency (kHz)		
nil	nil	6.5 kHz

25.0 kHz:

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	17.5 kHz

Limits

The maximum frequency difference:

Channel Spacing (kHz)	Transmitter Period t_1 (kHz)	Transmitter Period t_2 (kHz)	Transmitter Period t_3 (kHz)
12.5	± 12.5	± 6.25	± 12.5
25.0	± 25.0	± 12.5	± 25.0

Result:Complies

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

12.5 kHz transmitter turn on

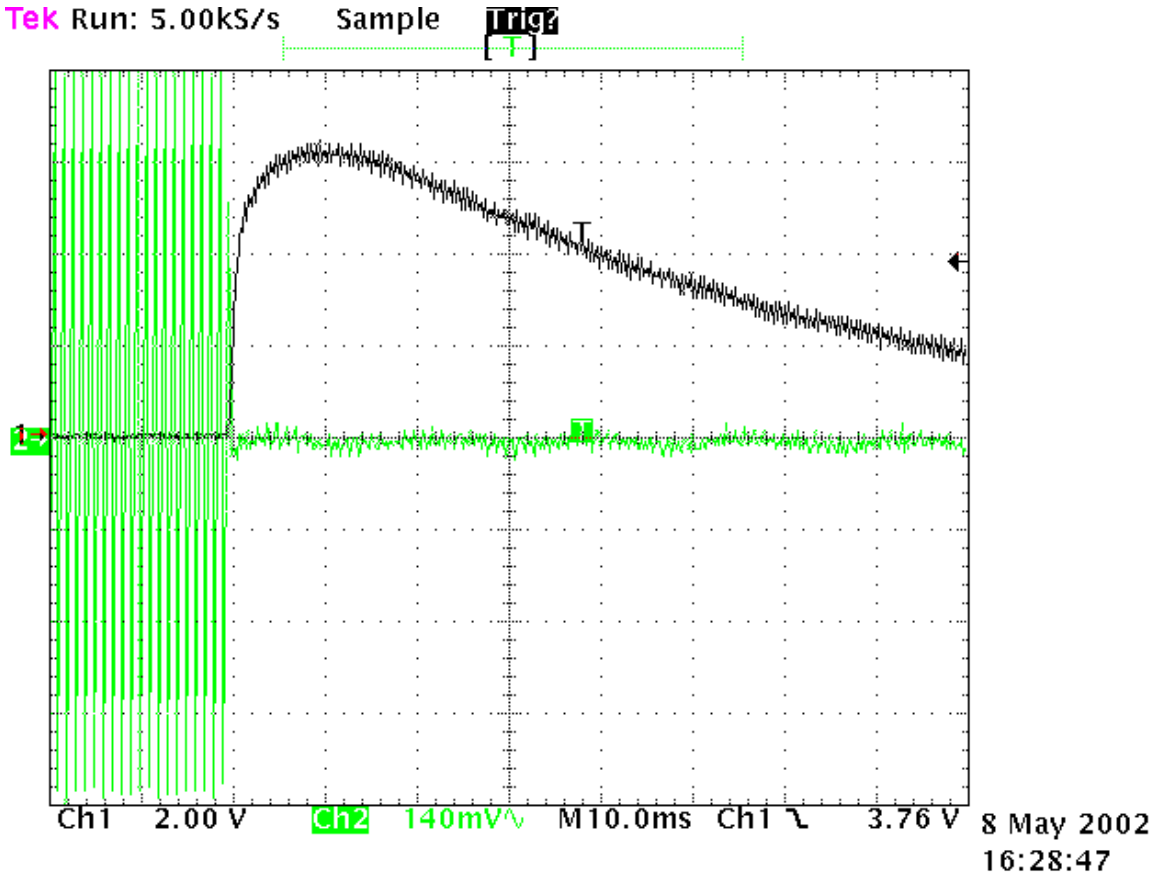
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.
Black trace = transmitter amplitude response.

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 *t*on.

*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 significant transient responses can be observed after *t*on.



12.5 kHz transmitter turn off

Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.
Black trace = transmitter amplitude response.

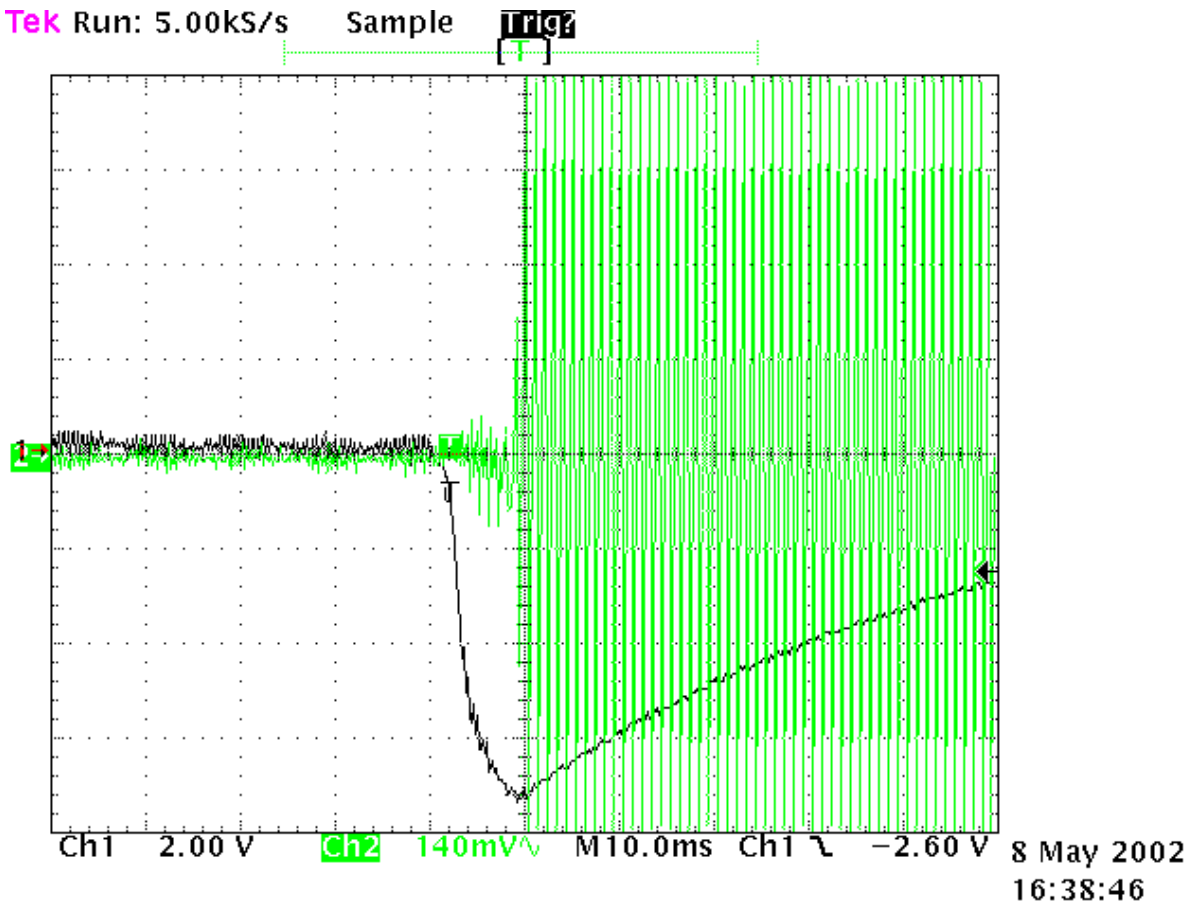
Green trace has been maximised to give full screen indication of a +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

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

This is position *t*off.

*t*3 occurs between 4.0 and 5.0 divisions from the left hand edge.

A transient response can be observed before *t*off.



25 kHz transmitter turn on

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

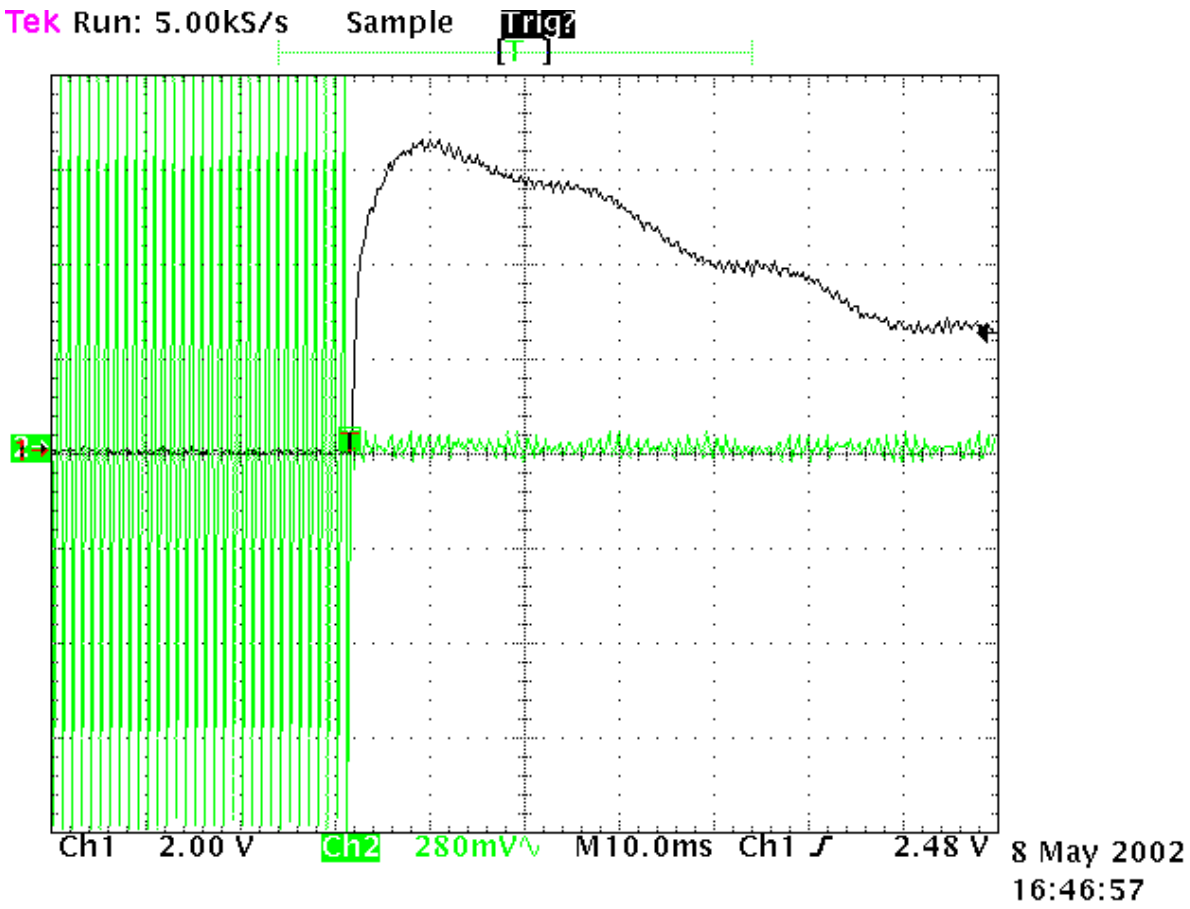
Green trace has been maximised to give full screen indication of a +/- 25 kHz.
Therefore each Y axis division = 6.25 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division.

Triggering has been set to occur 3 divisions from the left hand edge (30 mS).

*t*on occurs 2 divisions from the left of the display (20 mS).

*t*1 occurs between 2 and 2.5 divisions from the left hand edge.
t2 occurs between 2.5 and 5 divisions from the left hand edge.

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



25 kHz transmitter turn off

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

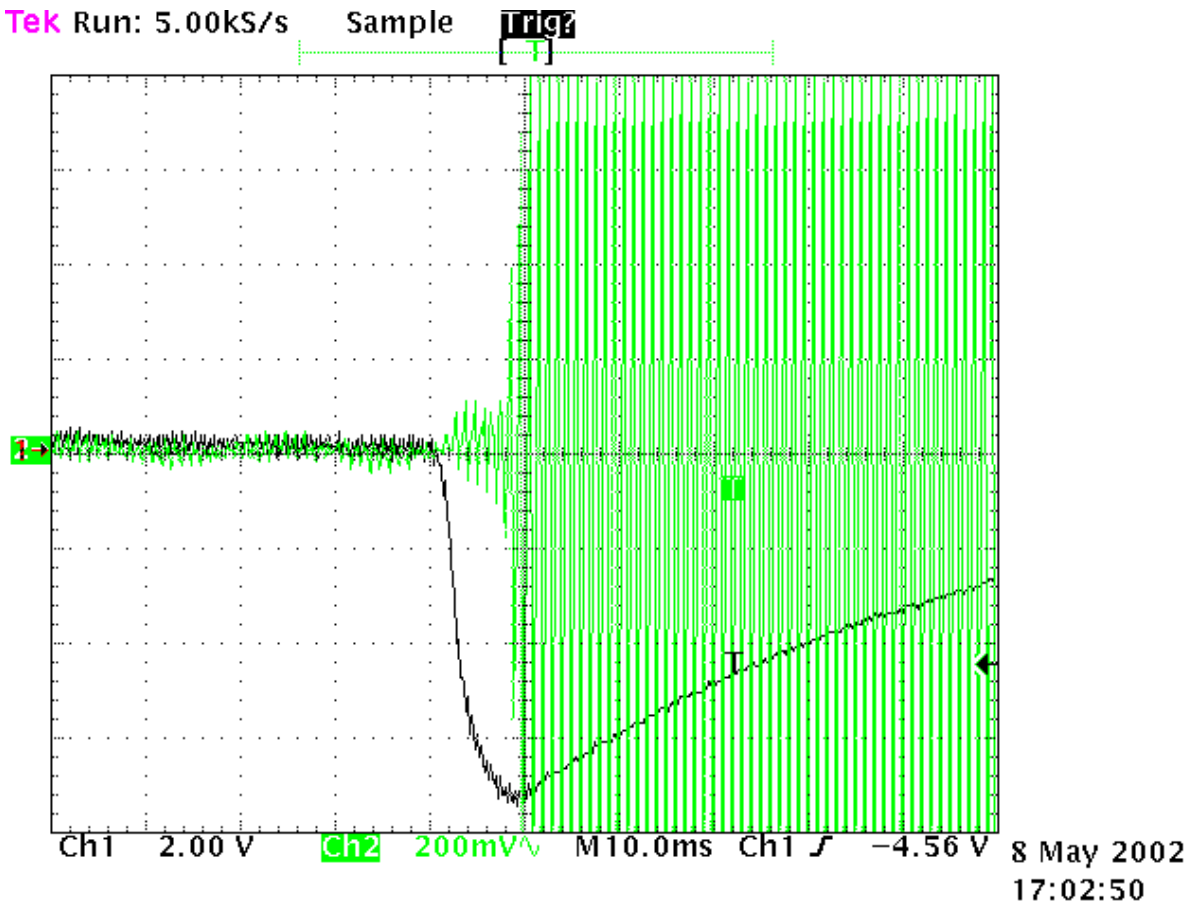
Green trace has been maximised to give full screen indication of a +/- 25 kHz.
Therefore each Y axis division = 6.25 kHz per division.
The X axis has been set to a sweep rate of 10 mS/division

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

This is position *t*off.

*t*3 occurs between 4.5 and 5.0 divisions from the left hand edge.

A transient response can be observed before *t*off.



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 at each temperature were made with the supply varied between 115% and 85% of the nominal supply voltage (115 Vac).

Nominal Frequency: 460.0 MHz

Frequency Error (Hz)			
Voltage Temp.	**97.7 Vac**	**115 Vac**	**132.3 Vac**
+50°C	+119.0	+118.0	+116.0
+40°C	+41.0	+44.0	+45.0
+30°C	-26.0	-25.0	-24.0
+20°C	-2.0	-2.0	-2.0
+10°C	-71.0	-73.0	-73.0
0°C	-150.0	-150.0	-151.0
-10°C	-210.0	-211.0	-213.0
-20°C	-40.0	-39.0	-37.0
-30°C	+219.0	+221.0	+223.0

Limit
Part 22.355 states that base station transmitters operating between 450 – 512 MHz are required to have frequency tolerance of 2.5 ppm.

Part 90.213 states that base station transmitters operating between 421 – 512 MHz are required to have frequency tolerance of 2.5 ppm.

This transmitter operates on 460.0 MHz. 2.5 ppm = 2.5 x 460 = 1150.0 Hz.

Result: Complies

Measurement Uncertainty: ±30 Hz

Conducted emissions testing

Conducted emissions testing was carried out over the frequency range of 450 kHz to 30 MHz.

Testing for conducted emissions was carried out at the laboratory's MacKelvie Street premises in a screened room.

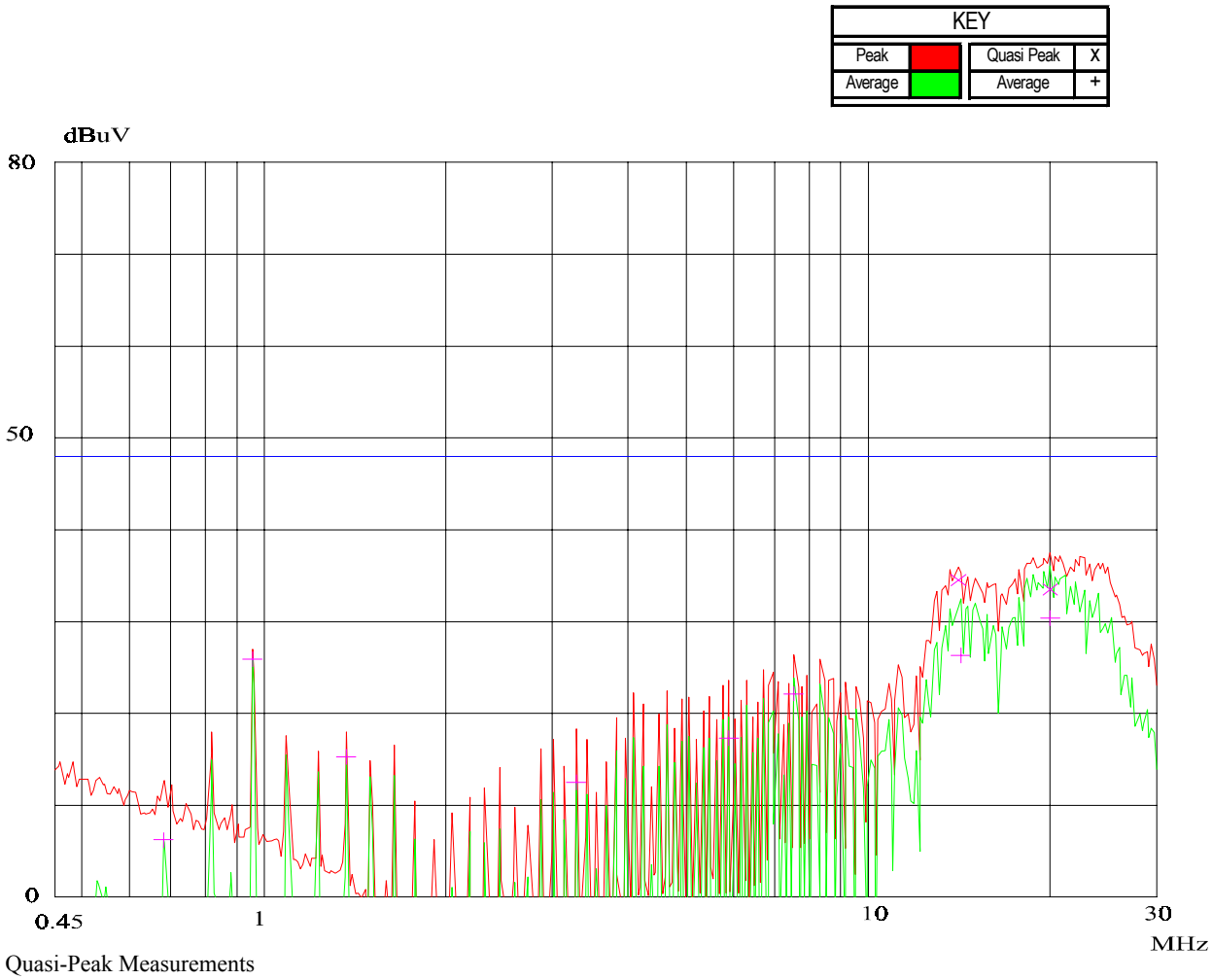
The device was placed 0.8 m away from the closest edge of the artificial mains terminal network on the emissions test table which is 1 m x 1.5 m, and is 0.8 m above the screened room floor which acts as the horizontal ground plane and is 0.6 m away from the screened room wall which acts as the vertical ground plane.

Measurement uncertainty with a confidence interval of 95% is:

- Mains terminal tests (0.45 - 30 MHz) ± 2.2 dB

Conducted Emissions

Comments:	Device tested while powered at 115 Vac while operating in standby mode.



Quasi-Peak Measurements

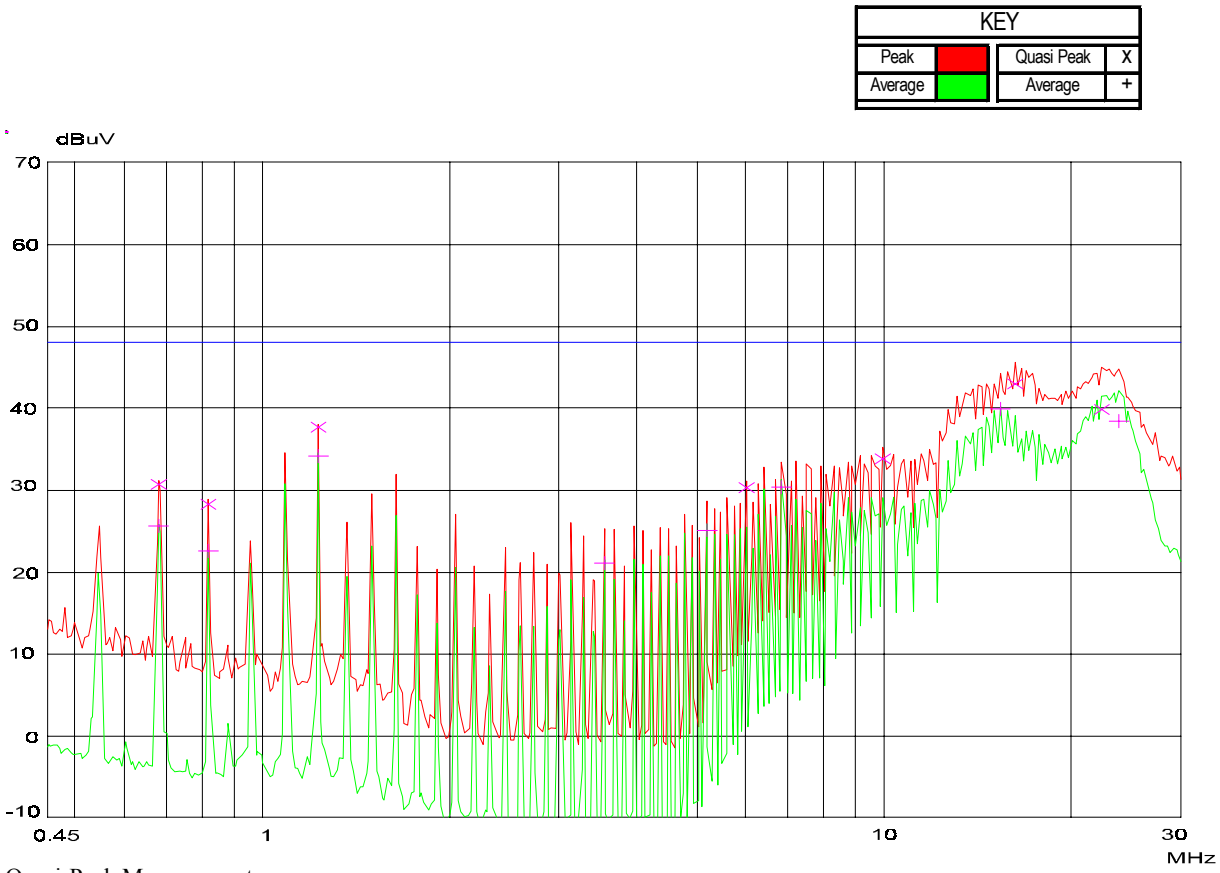
Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Exceed	Phase	Rechecks dBµV
0.6825	6.0	48.0	42.0		N	
0.9575	25.9	48.0	22.1		N	
1.3700	15.2	48.0	32.8		N	
3.2800	12.5	48.0	35.5		L1	
5.8800	17.3	48.0	30.7		N	
7.5200	22.1	48.0	25.9		N	
14.2200	26.3	48.0	21.7		L1	
19.9600	30.3	48.0	17.7		N	

Average Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Exceed	Phase	Rechecks dBµV
14.0800	34.5	48.0	13.4		L1	
19.9600	33.5	48.0	14.4		N	

Conducted Emissions

Comments:	Device tested while powered at 115 Vac while operating in transmit mode.



Quasi-Peak Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Exceed	Phase	Rechecks dBµV
0.6825	25.6	48.0	22.4		N	
0.8200	22.6	48.0	25.4		N	
1.2300	34.2	48.0	13.8		N	
3.5500	21.0	48.0	27.0		N	
5.1900	25.1	48.0	22.9		N	
6.8300	30.4	48.0	17.6		N	
15.4300	39.9	48.0	8.1		N	
23.8900	38.4	48.0	9.6		N	

Average Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Exceed	Phase	Rechecks dBµV
0.6825	30.6	48.0	17.3		L1	
0.8200	28.2	48.0	19.7		N	
1.2300	37.7	48.0	10.3		L1	
6.0100	30.3	48.0	17.6		N	
9.9700	33.8	48.0	14.1		N	
16.2500	42.9	48.0	5.0		N	
22.3900	39.8	48.0	8.1		N	

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
Biconical Antenna	Schwarzbeck	BBA 9106		RFS 3612
Log Periodic Antenna	Schwarzbeck	UHALP 9107		RFS 3702
Horn Antenna	EMCO	3115	9511-4629	E1526
Horn Antenna	Electrometrics	RGA-60	6234	E1494
Coax Cable	Sucolfex	104PA	2545/4PA	-
Artifical Mains Network	Rohde & Schwarz	ESH2-Z5	881362/034	3628
Measurement Receiver	Rohde & Schwarz	ESCS 30	839873/1	
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709
Attenuator 20 dB	Weinschel	49-20-43	GC-104	E1308
Attenuator 10 dB	Hewlett Packard	HP8491A	24838	E1329
Frequency Counter	Hewlett Packard	HP 5342A	1916A01713	E1224
Level generator	Anritsu	MG443B	M61689	E1143
Modulation Analyzer	Hewlett Packard	HP 8901B	2608A00782	E1090
Resistance Thermometer Meter	DSIR	RT200	35	E1409
Oscilloscope	Tektronics	745A	B010643	E1569
Rubidium Oscillator	Ball Efratom	FRS – C	4287	E1053
Selective Level Meter	Anritsu	ML422C	M35386	E1140
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	3776
Variac	General Radio	1592	-	3690
Thermal chamber	Contherm	M180F	86025	E1129

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 March 20th, 2002.

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.

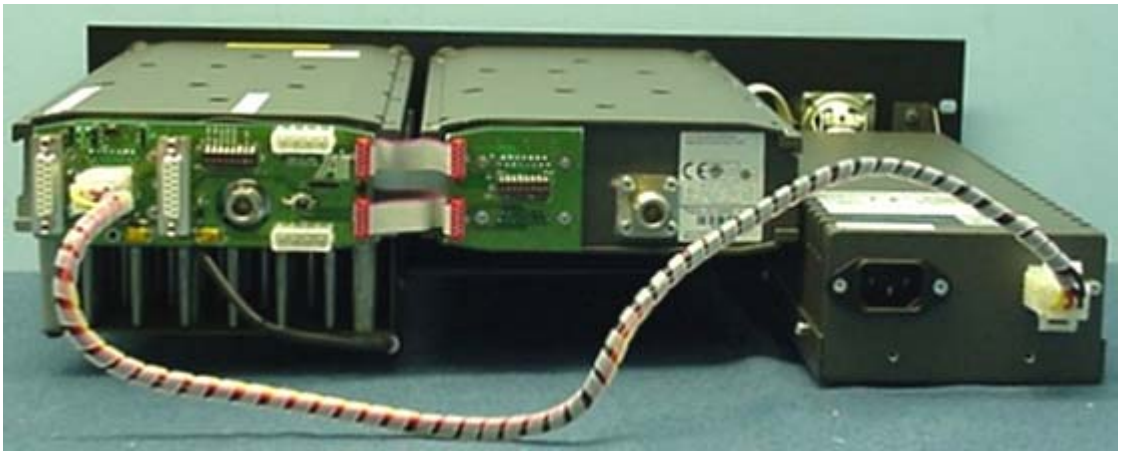
All measurement equipment has been calibrated in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to ISO/IEC 17025.

International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with 25 accreditation bodies in 21 economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

10. PHOTOGRAPH (S)

Overall external view front

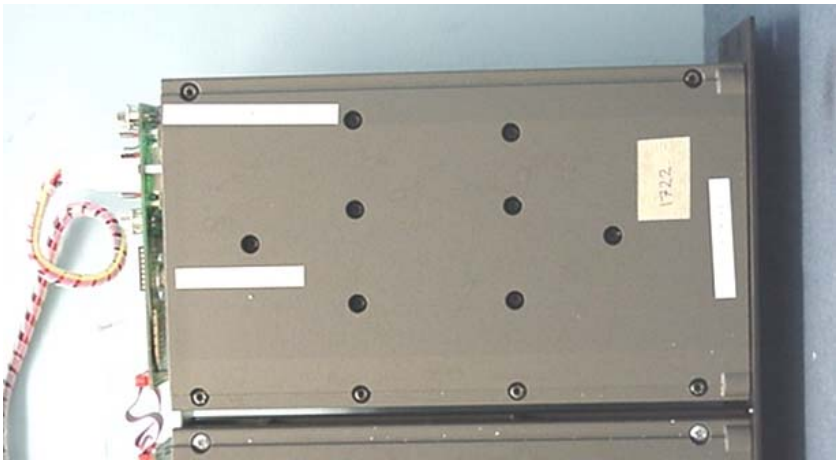
Overall external view rear (Transmitter, Receiver, Power Supply)

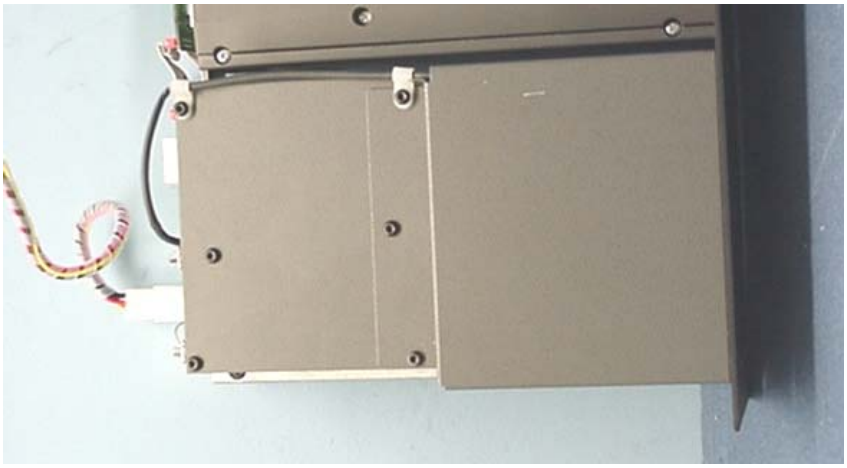


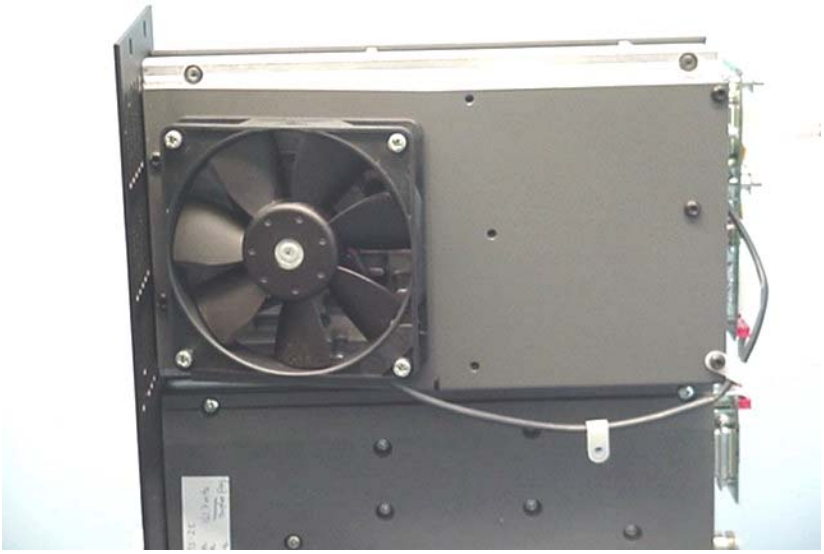
Transmitter label

Power supply label

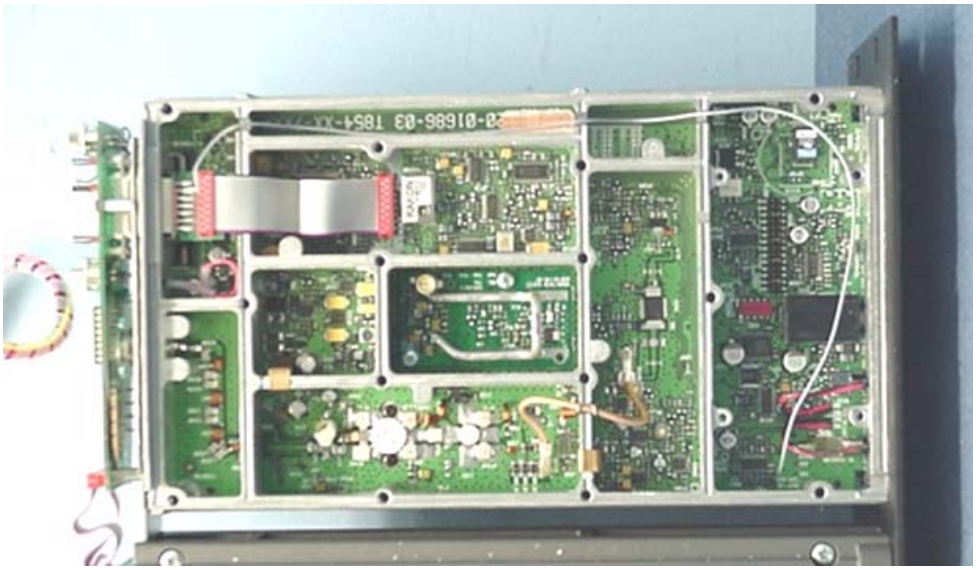
Transmitter external views

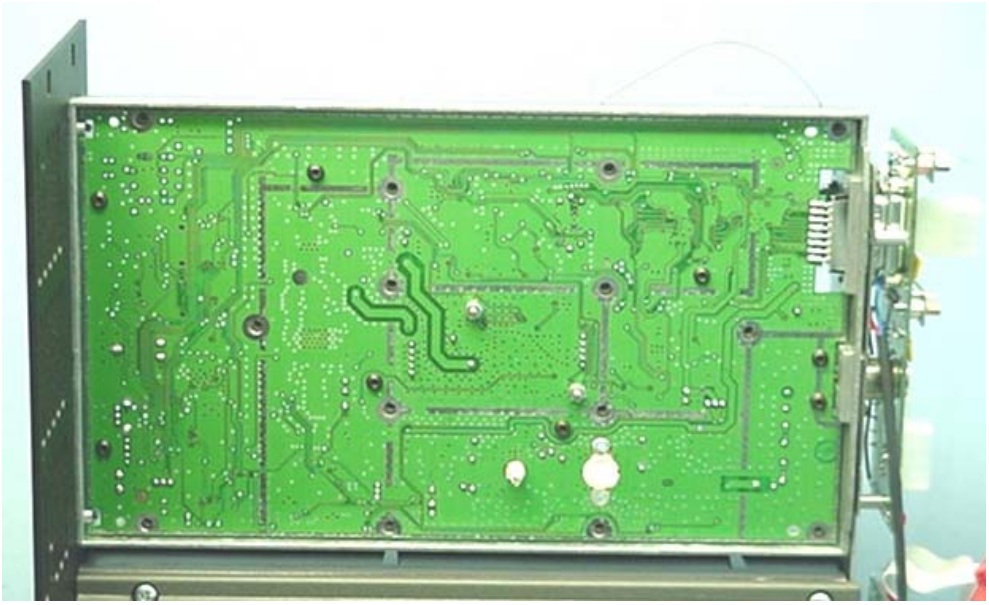




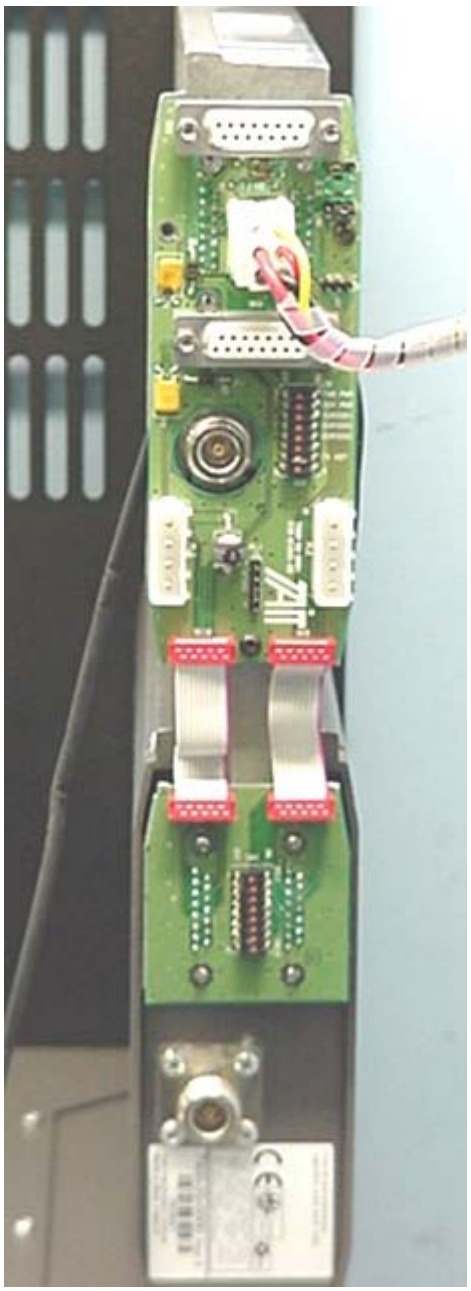


Transmitter internal views

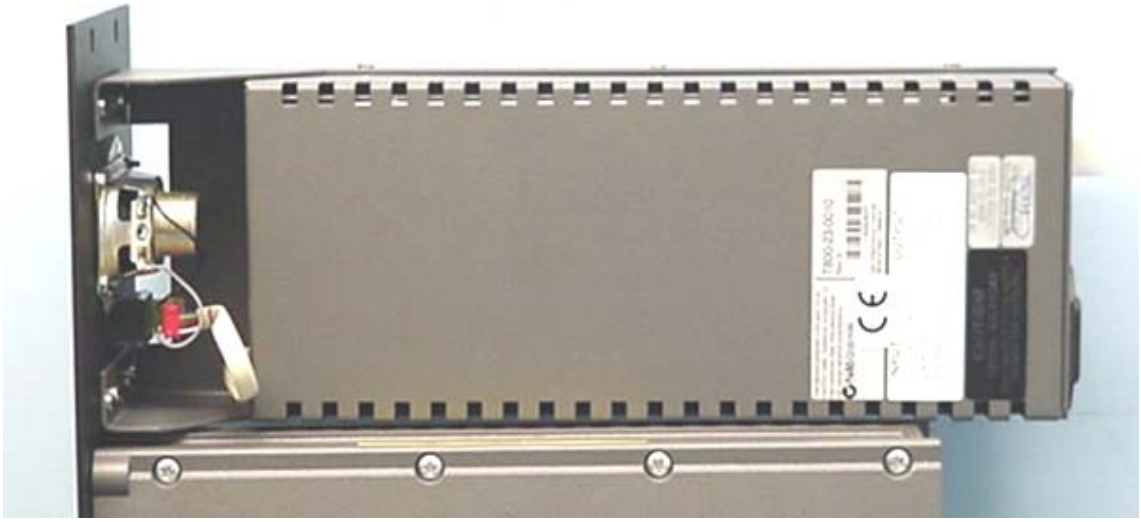




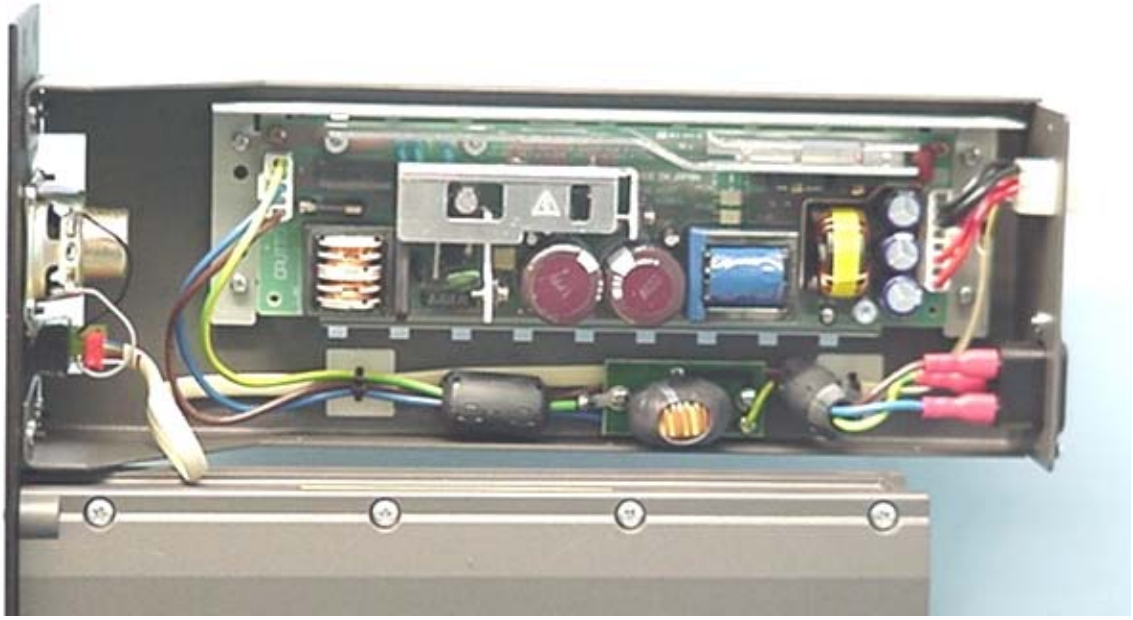
Transmitter rear end view showing the antenna connection (top connector) and the receiver antenna connector (bottom connector next to the CE mark).



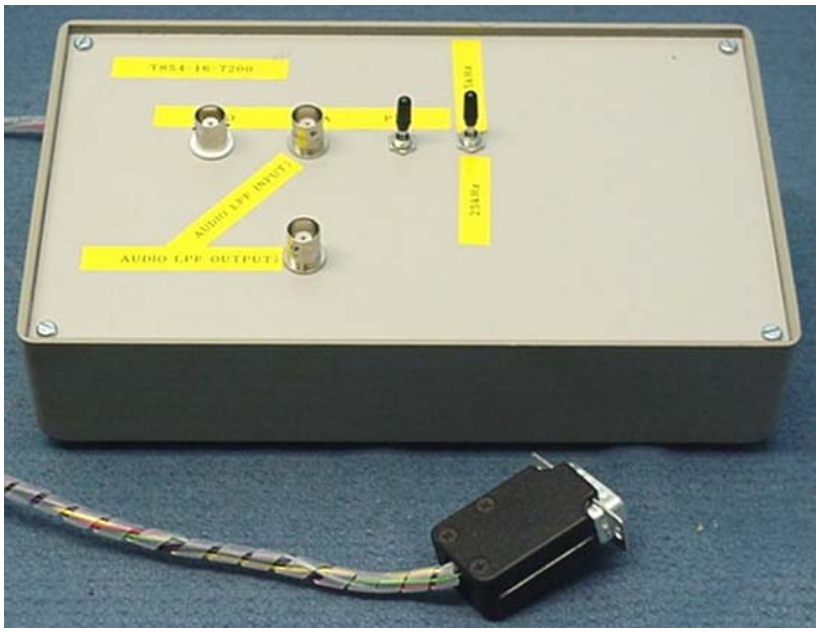
Power supply external views



Power supply internal view



Testing control box



Conducted emissions test set up

Radiated emissions test set up