EMC Technologies (NZ) Ltd
PO Box 68-307
Newton, Auckland
Phone 09 360 0862
Fax 09 360 0861
E-Mail Address: aucklab@ihug.co.nz
Web Site: www.emctech.com.au

TEST REPORT

RFI-148 250 EC
VHF Paging Transmitter

Tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

STI Engineering Pty Ltd

This Test Report is issued with the authority of:

Andrew Cutler - General Manager

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

Table of Contents

1. STATEMENT OF COMPLIANCE

The **RFI-148 250 EC VHF Paging Transmitter** complies with 47 CFR Part 90 and 47 CFR Part 2 when tested in-accordance with 47 CFR Part 2.

2. RESULTS SUMMARY

The results of testing carried out between the 30th November and the 15th December 2012 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
2.1047 2.1047(a) 2.1047(b) 90.211(a)	Modulation Characteristics Low pass filter response Modulation limiting characteristics Modulation characteristics	Noted Noted 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	Complies
2.1055 90.213	Frequency stability Frequency stability	Noted Complies
90.214	Transient frequency behaviour	Complies
1.1310	Radio frequency exposure limits	Complies

3. INTRODUCTION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification.

The client selected the test sample.

This report relates only to the sample tested.

This report contains no 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.

4. CLIENT INFORMATION

Company Name	STI Engineering Pty Ltd
Address	22 Boulder Rd, Malaga, WA, 6090
Country	Australia
Contact	Mr Lahiru Raffel

5. DESCRIPTION OF TEST SAMPLE

Brand Name	RF Innovations
Model Number	RFI-148 250 EC
Product	VHF Paging Transmitter
Manufacturer	RF Innovations Pty Ltd
Manufactured in	Australia
Designed in	Australia
Serial Numbers	C08042200018
FCC ID	P5MRFI148

The sample tested has the following specifications:

Rated Transmitter Output Power

250.0 Watts (54.0 dBm)

Transmitter FCC frequency range

150 MHz Pager Only
150-174 MHz band

Test frequencies

Chl	Frequency MHz	Power Watts	Spacing kHz
1	150.500	250.0	12.5

FCC Bands

Part 90: 150-174 MHz

Emission Designators

11k0F1D - Data transmission

Modes of operation

FLEX: 1600/2, 3200/2, 3200/4, 6400/4
POCSAG 512, 1200, 2400
ERMES

Power Supply

DC voltage supply typically 24.0 Vdc

Standard Temperature and Humidity

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

Standard Test Power Source

Standard Test Voltage: 24.0 Vdc.
High Voltage: 28.8 Vdc
Low Voltage: 20.4 Vdc

Extreme Temperature

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

6. ATTESTATION

The **RFI-148 250 EC VHF Paging Transmitter** complies with the Code of Federal Regulations 47 CFR Part 90- Private Land Mobile.

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.

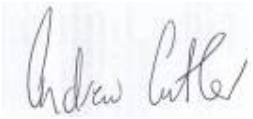
This report does not contain corrections or erasures.

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.

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. TEST RESULTS

Certification required

Certification of this device is sought for transmissions using 12.5 kHz channel spacing.

12.5 kHz channel bandwidth certification is sought for this transmitter under section 90.203(j) (3) as:

- certification has been sought after January 1, 2011.

- the equipment meets the spectrum efficiency standard of one voice channel per 12.5 kHz of channel bandwidth

- the equipment can operate with a data rate greater than 4.8 kbps 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 of 250 Watts (54.0 dBm).

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
150.500	24.0	54.0	53.0

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
150.500	20.4	54.0	52.6
150.500	28.8	54.0	53.1

Limits:
Clause 90.205(h) of Part 90 specifies that in the band 150 – 174 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

Part 90.207 – Emission types:

Frequency shift keying is used with this transmitter with the following paging protocols being used:

POCSAG: 512 baud
1200 baud
2400 baud

FLEX: 1600 – 2 level FSK with a data rate of 1600 bps
3200 – 2 level FSK with a data rate of 3200 bps
3200 – 4 level FSK with a data rate of 3200 bps
6400 – 4 level FSK with a data rate of 6400 bps

ERMES: 4 level FSK with a data rate of 6250 bps

An emission designator of F1D: Data transmission has been applied

Part 90.209 – Bandwidth limitations:

Measurements have been made to verify the declared bandwidths.

The occupied bandwidth has been measured and compared against the occupied bandwidth declared by the client.

The transmitter was modulated using a Pseudorandom Binary Sequence (PRBS).

Measurements have been made of each modulation type using a spectrum analyser operating in peak hold mode and a 40 dB attenuator.

Initially power measurements are made using a resolution bandwidth of 120 kHz.

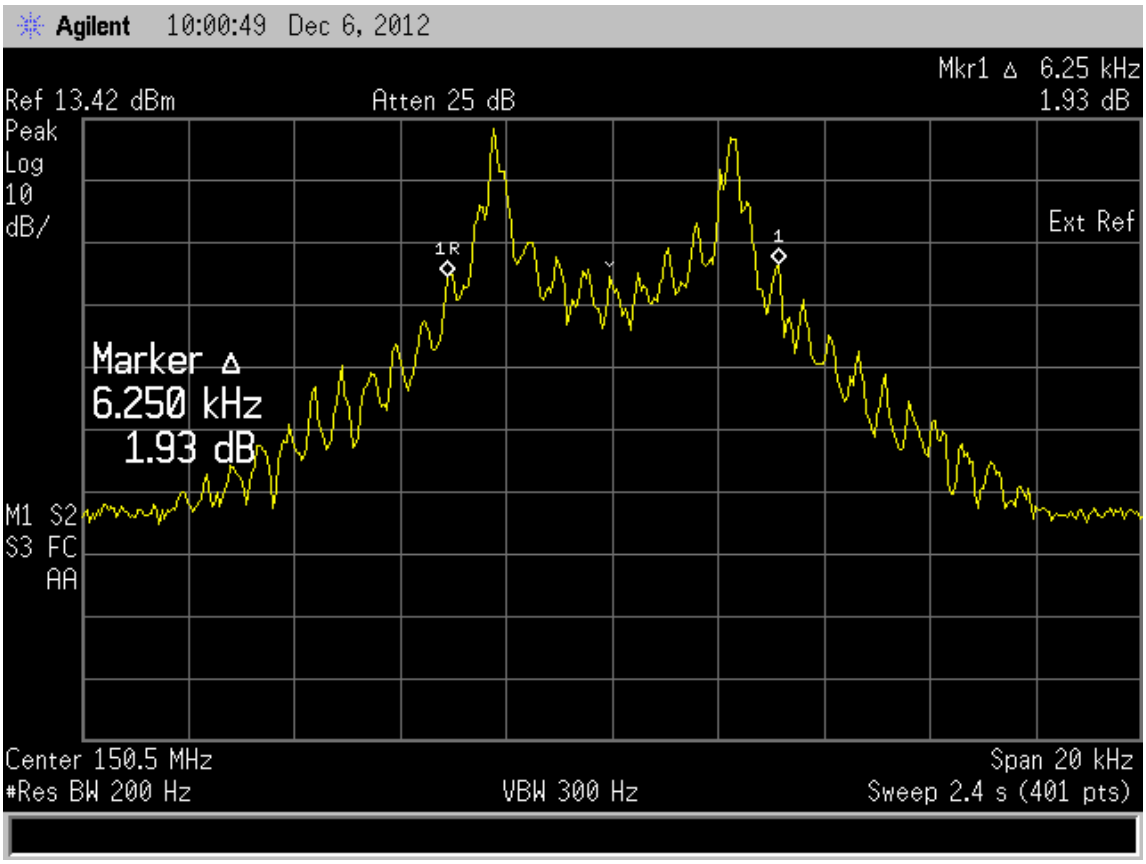
This level is used as a reference level on the spectrum analyser.

The resolution bandwidth is then changed to 100 Hz and the reference level minus 23 dB (99%) absolute bandwidth points determined.

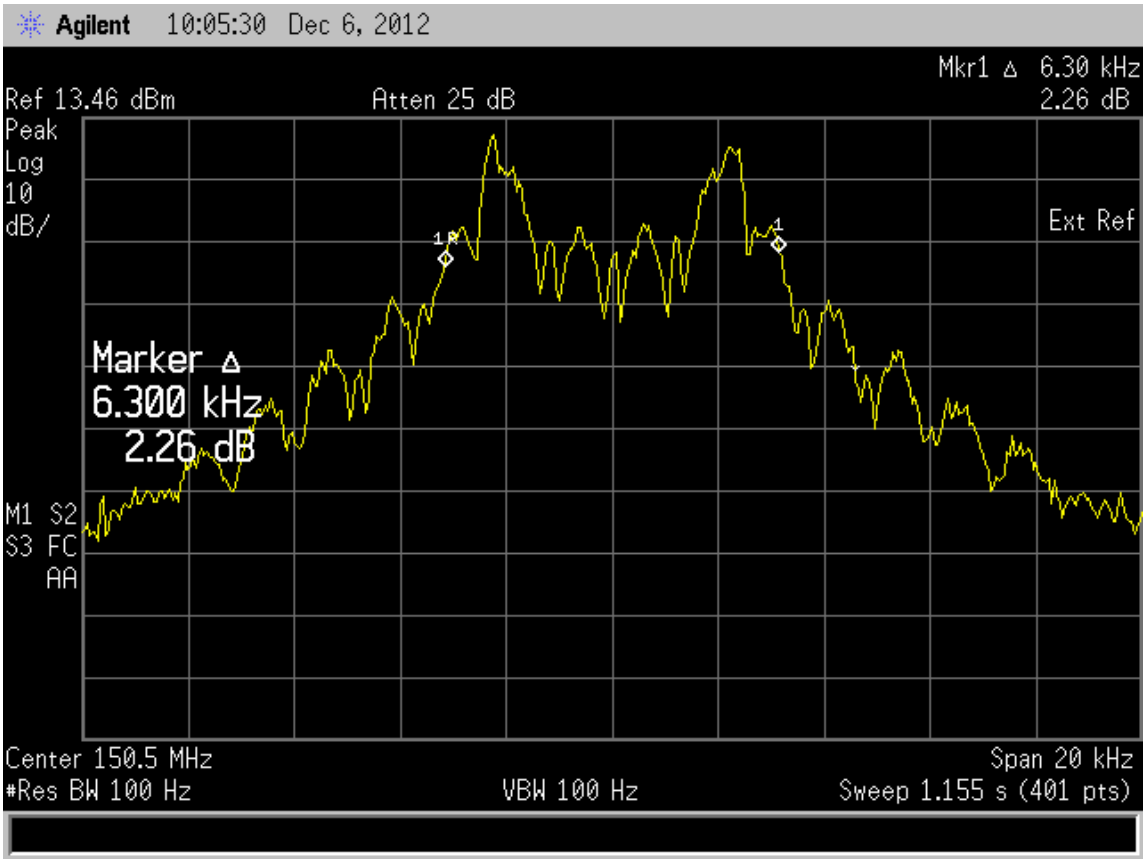
Emission	Measured	Designated
POCSAG 512	6.250 kHz	11.25 kHz
POCSAG 1200	6.300 kHz	11.25 kHz
POCSAG 2400	7.450 kHz	11.25 kHz
FLEX-2 1600	6.900 kHz	11.25 kHz
FLEX-2 3200	7.300 kHz	11.25 kHz
FLEX-4 3200	7.000 kHz	11.25 kHz
FLEX-4 6400	7.800 kHz	11.25 kHz
ERMES	7.550 kHz	11.25 kHz

Result: Complies

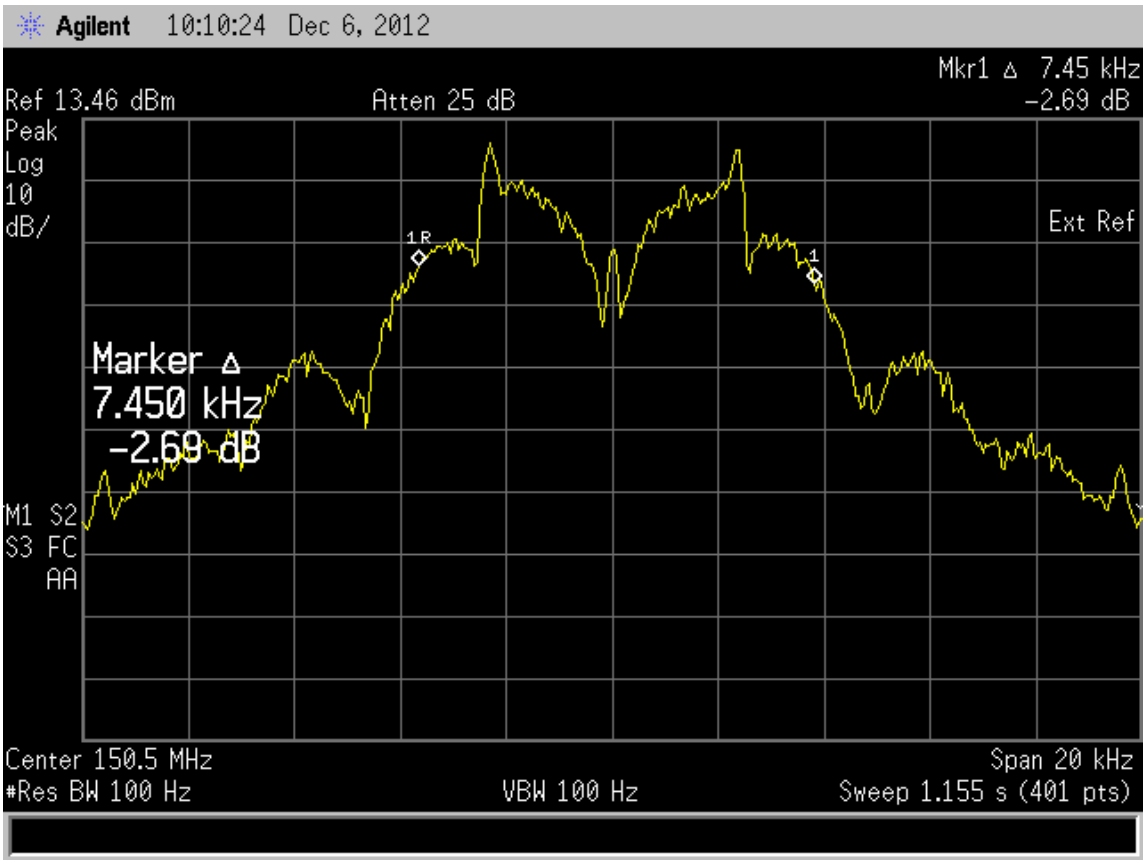
POCSAG 512



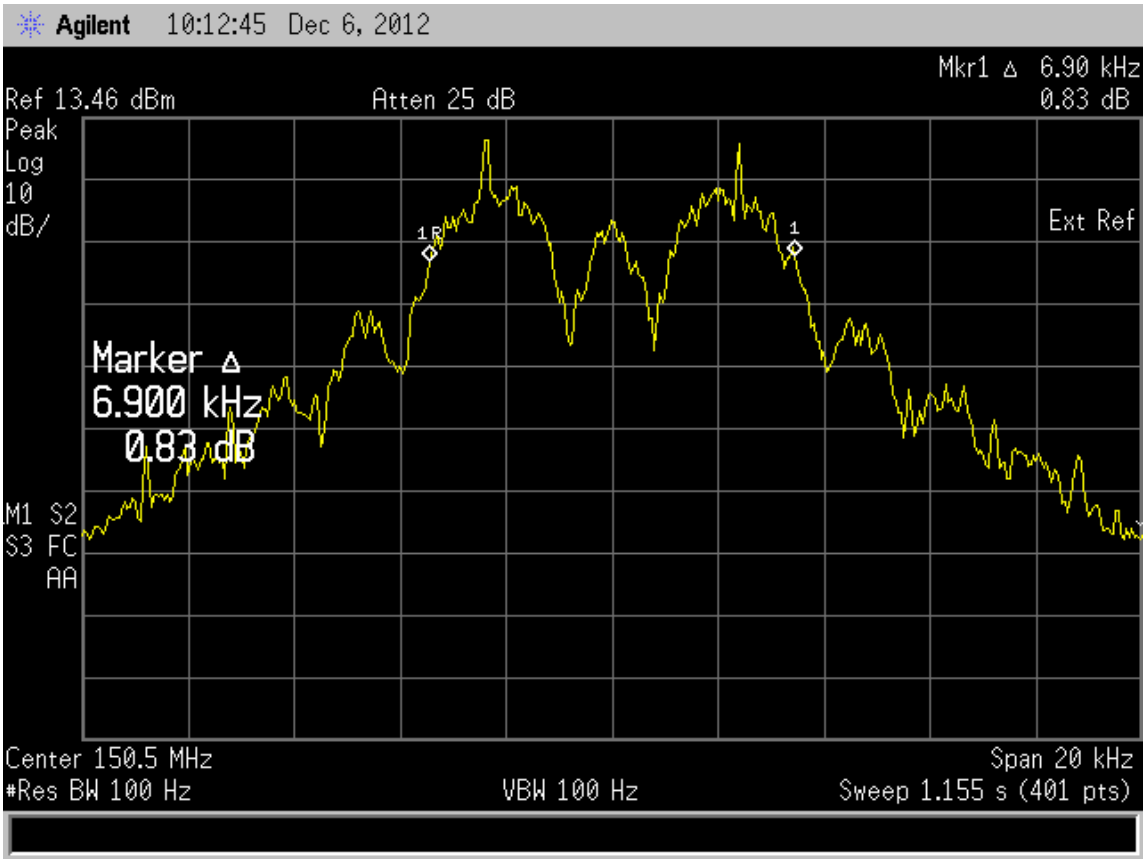
POCSAG 1200



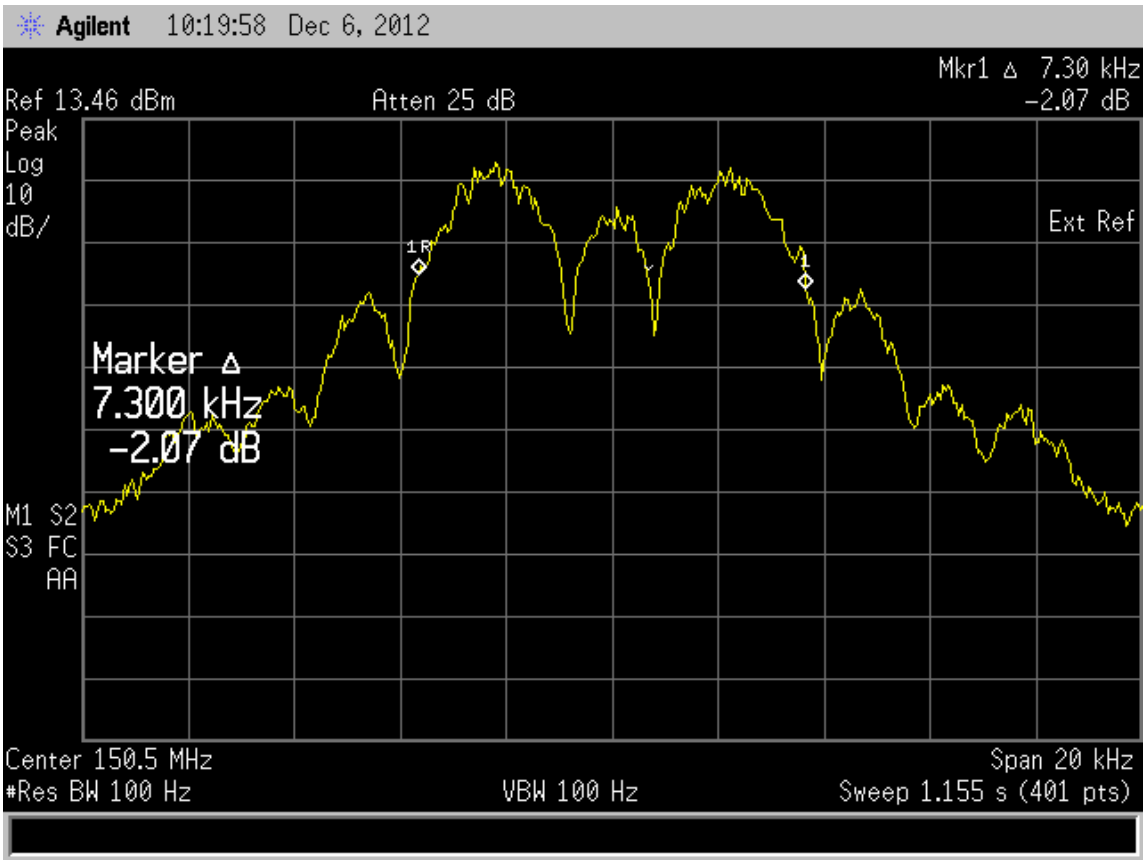
POCSAG 2400



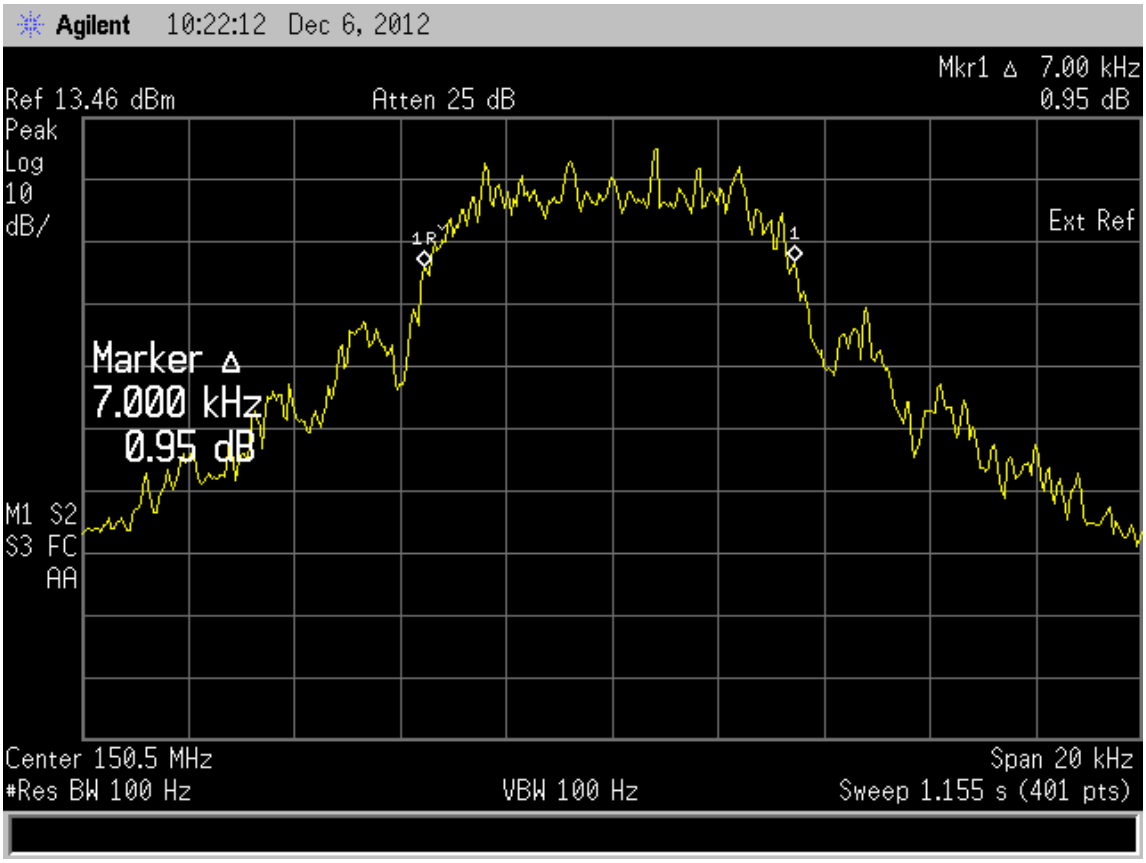
FLEX-2 1600



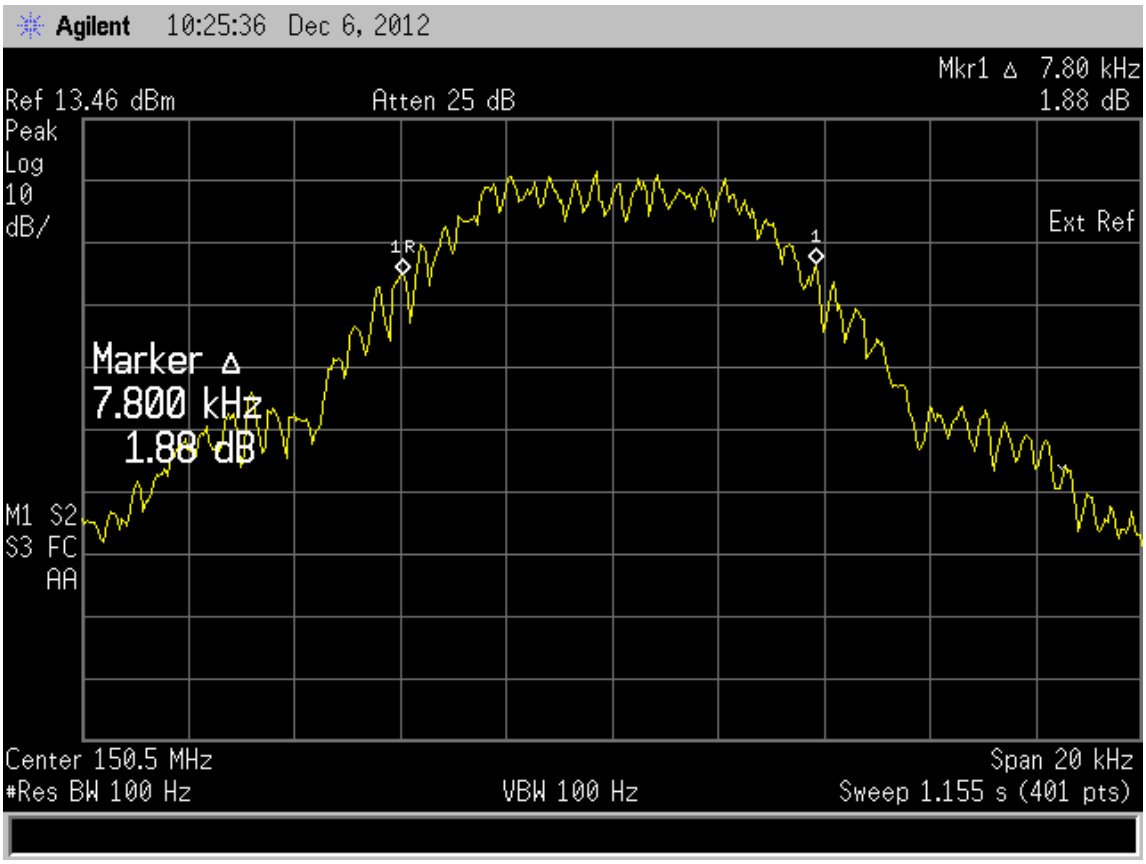
FLEX-2 3200



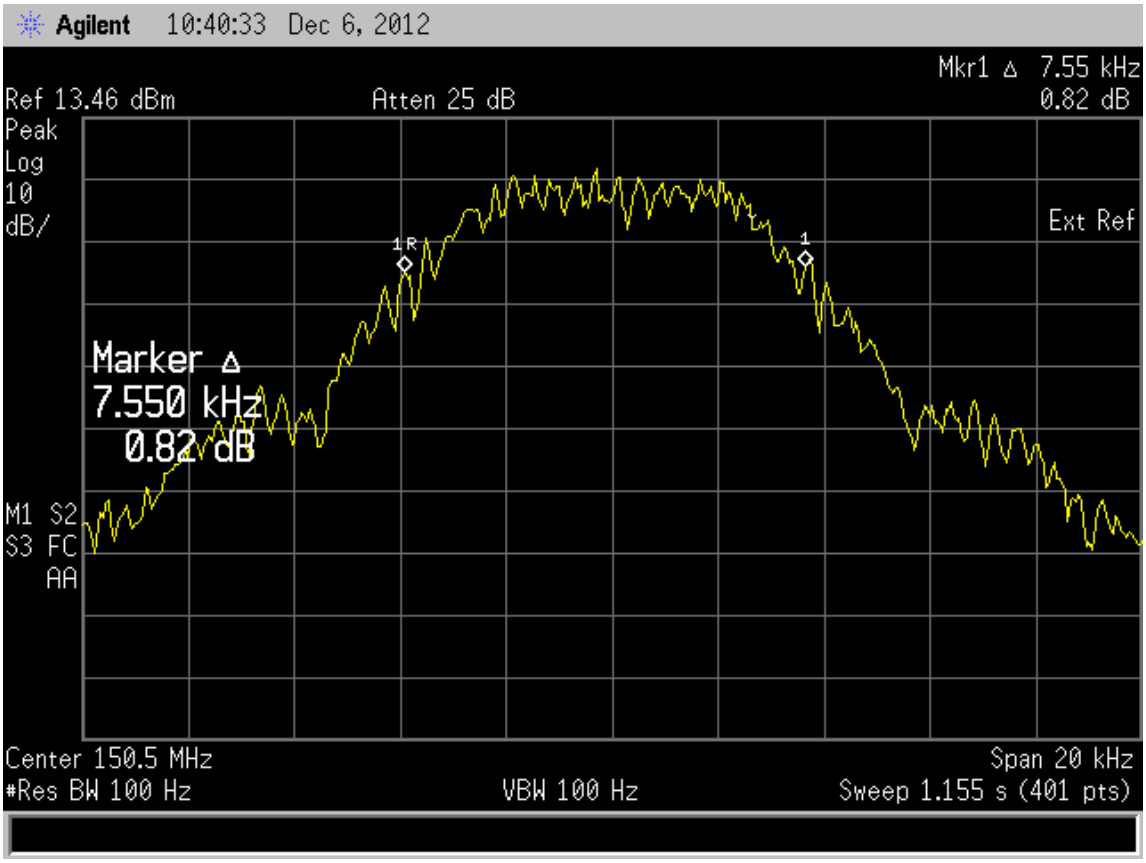
FLEX-4 3200



FLEX-4 6400



ERMES



Spectrum Masks

The spectrum masks are defined in:

Section 90.210(d) – Mask D has been applied as the transmitter can operate in the band 150 – 174 MHz band, using an authorised bandwidth of 12.5 kHz as per Section 90.209(b)(5).

The reference level for the following emission mask measurements has been determined using a resolution bandwidth of 120 kHz with the transmitter modulated.

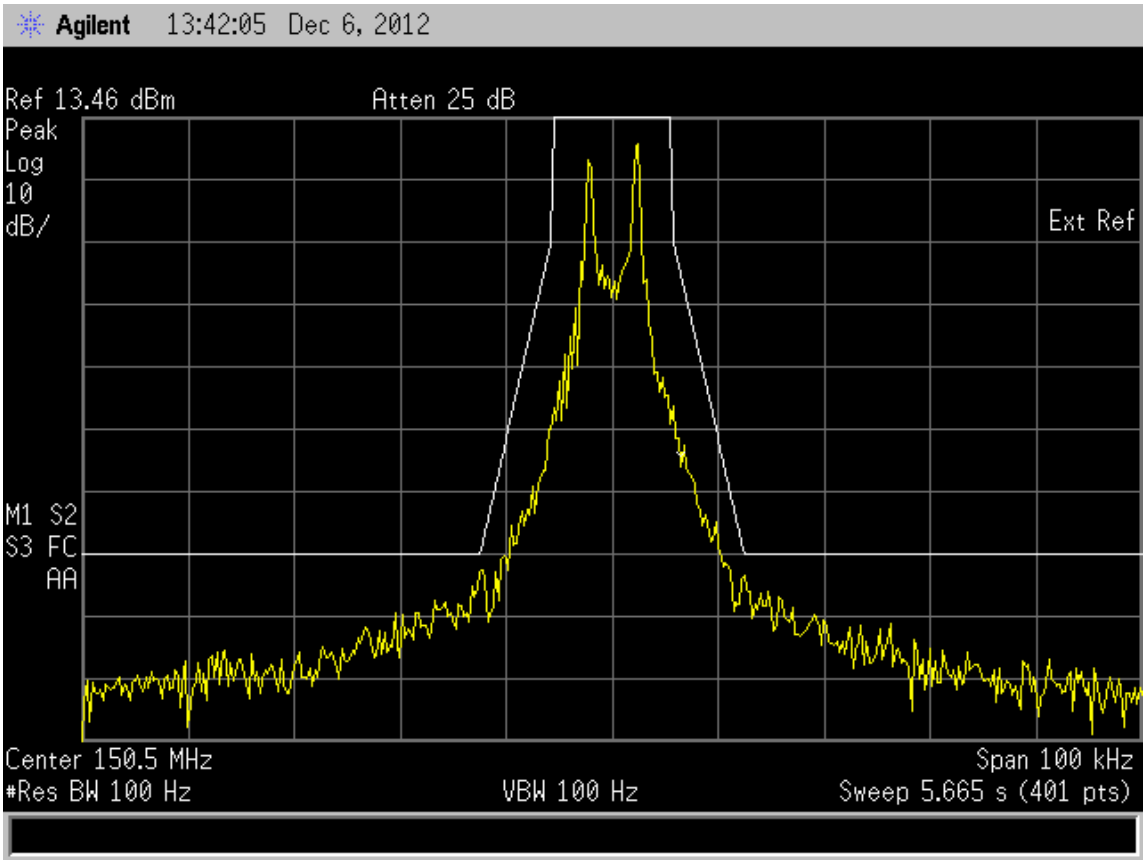
All measurements have been made with a 40 dB attenuator placed between the transmitter and the spectrum analyser.

Measurements were made in peak hold with the transmitter operating on 150.500 MHz

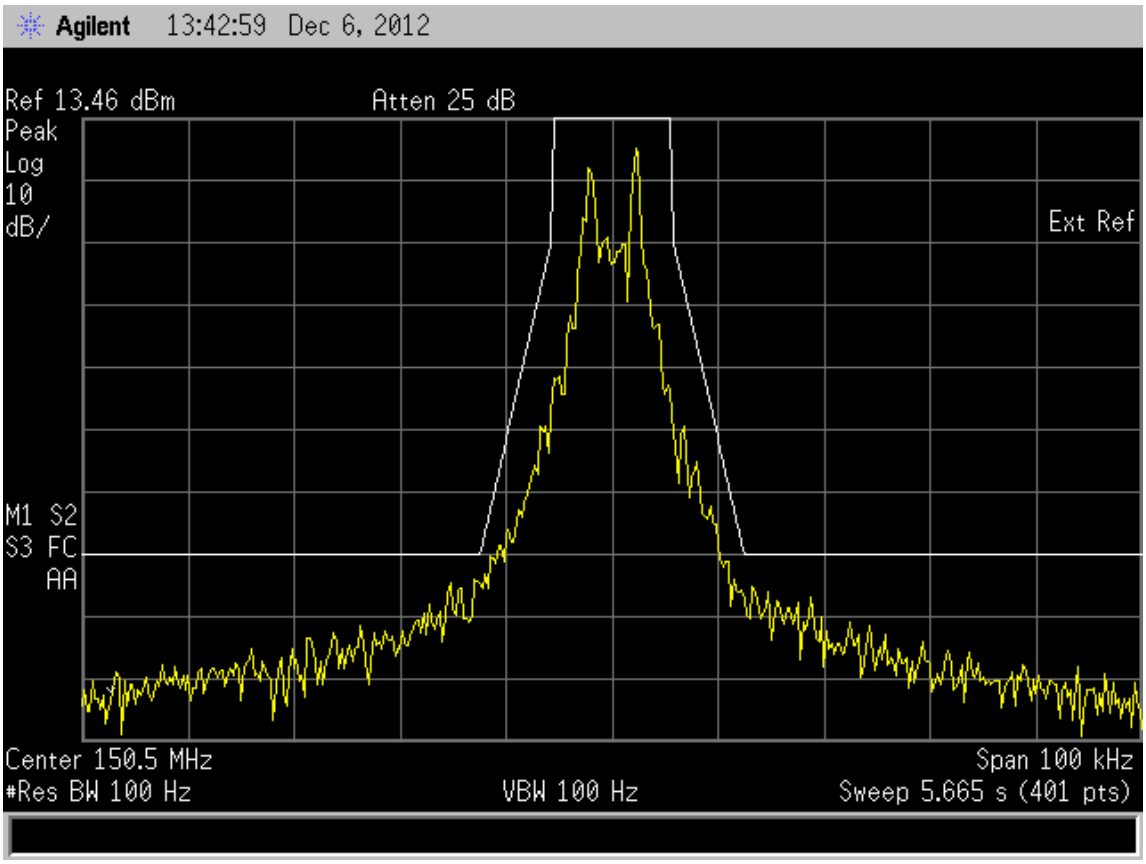
For the F1D mode the transmitter was modulated using a Pseudorandom Binary Sequence (PRBS) modulation sources that was internal to the transmitter.

Result: Complies

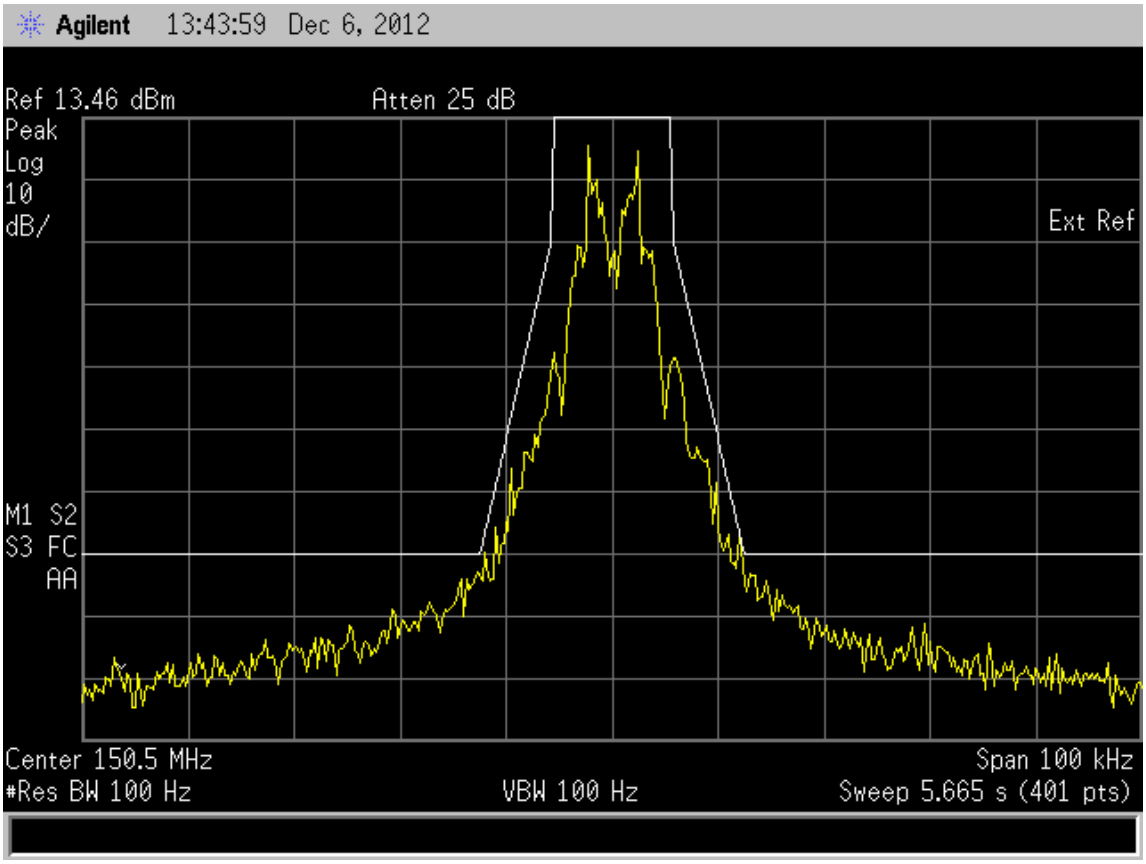
POCSAG 512



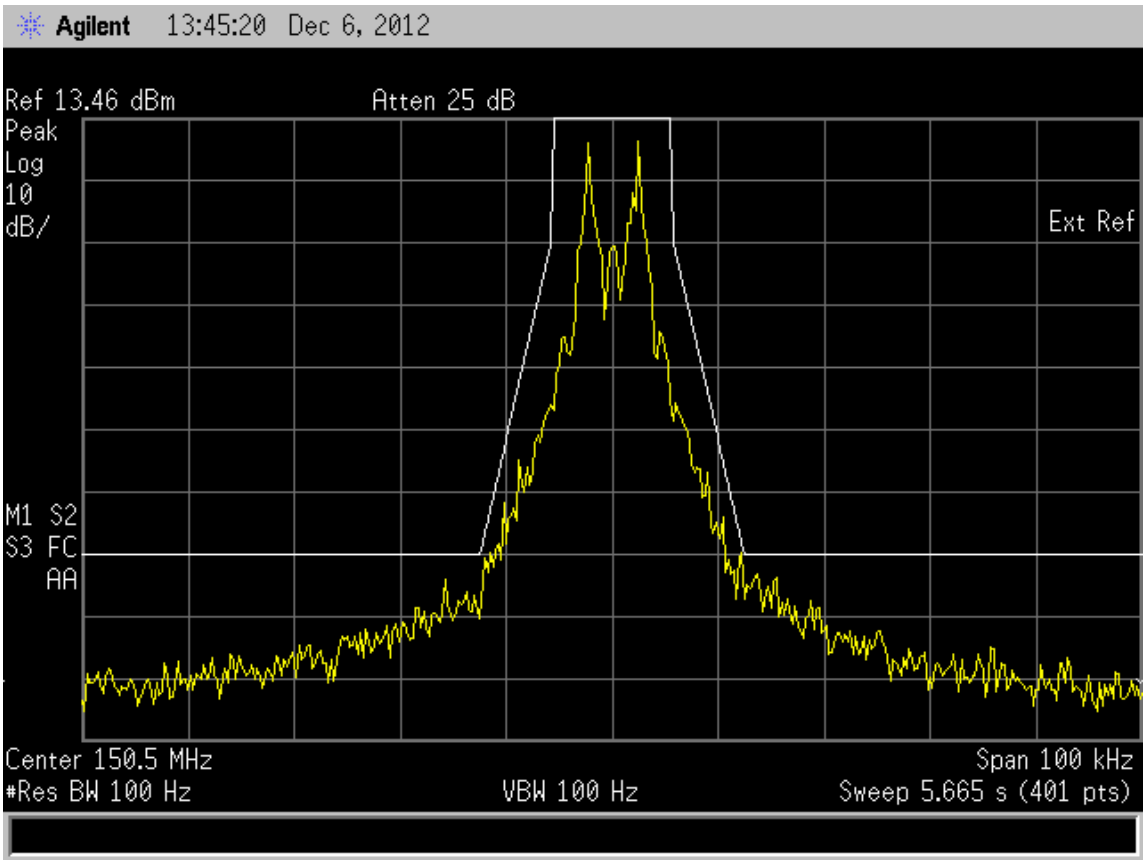
POCSAG 1200



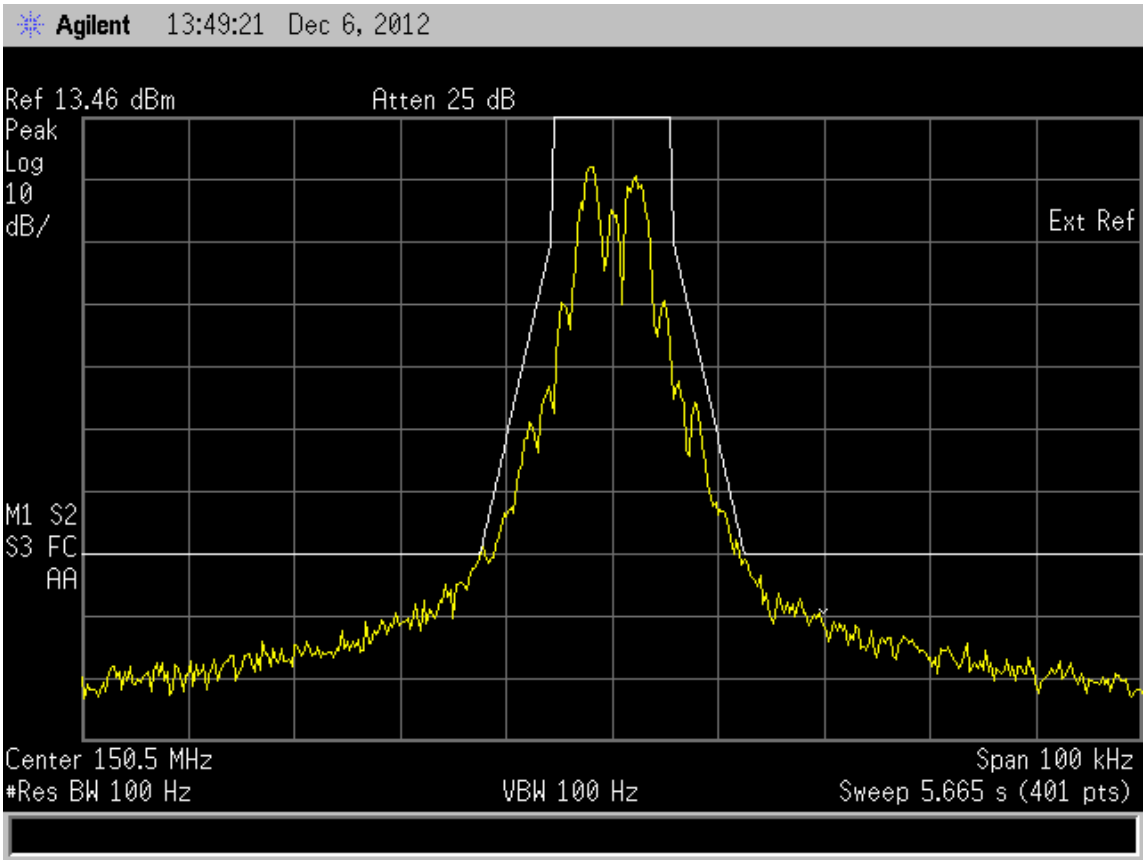
POCSAG 2400



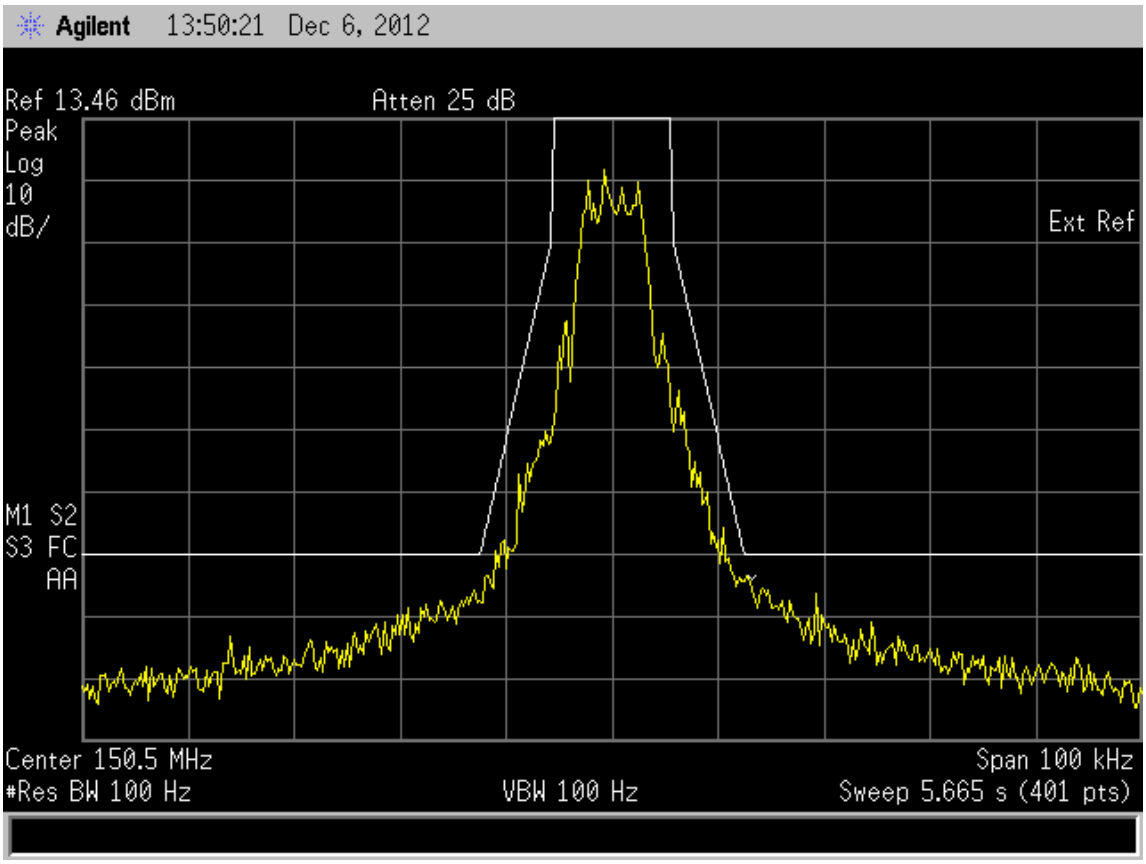
FLEX-2 1600



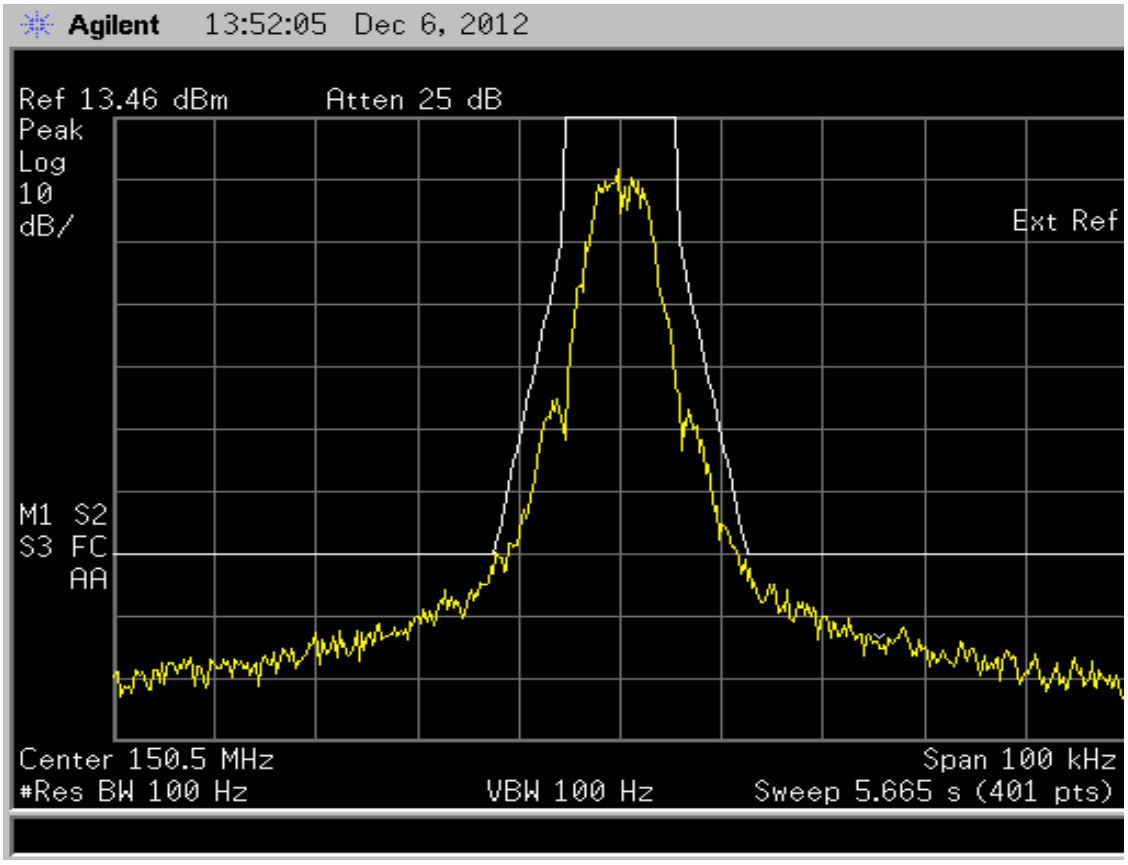
FLEX-2 3200



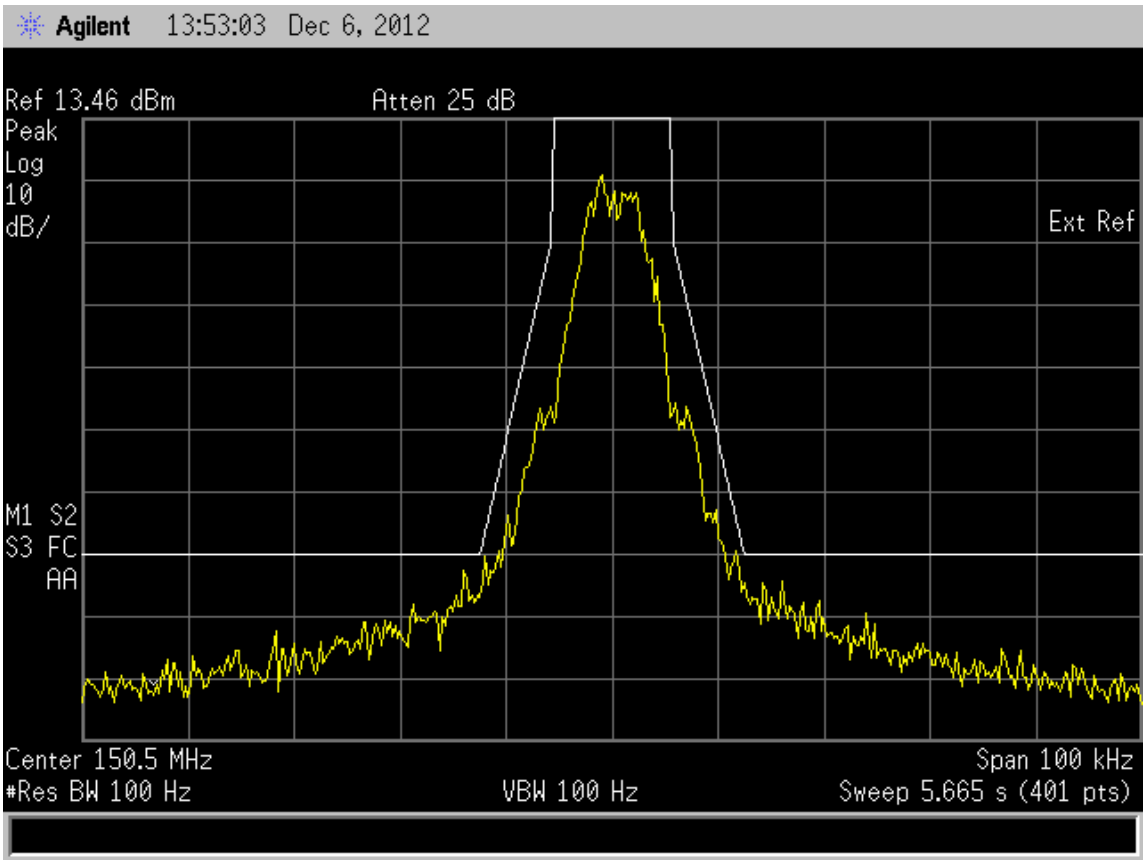
FLEX-4 3200



FLEX-4 6400



ERMES



Transmitter spurious emissions at the antenna terminals

Frequency: 150.500 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
300.100	-43.6	-16.0
451.500	-36.0	-16.0
602.000	-65.3	-16.0
752.500	-58.0	-16.0
903.000	-46.3	-16.0
1053.500	Less than -70 dBm	-16.0
1204.000	-48.6	-16.0
1354.500	Less than -70 dBm	-16.0
1505.000	Less than -70 dBm	-16.0

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: at least 50 + 10 log (P) dB or 70 dB, whichever 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.

A rated power of 250.0 watts (54.0 dBm) gives a limit of –16.0 dBm (-70 dBc).

Some emissions less that –40 dBm have been reported for completeness.

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

Result: Complies
Measurement Uncertainty: ±3.3 dB

Field strength of the transmitter spurious emissions

Frequency: 150.175 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
301.0000	68.2	-29.2	-16.0	Vertical	13.2	Pass
301.0000	78.2	-19.2	-16.0	Horizontal	3.2	Pass
451.5000	58.0	-39.4	-16.0	Vertical	23.4	Pass
451.5000	58.4	-39.0	-16.0	Horizontal	23.0	Pass
602.0000	63.0	-34.4	-16.0	Vertical	18.4	Pass
602.0000	57.2	-40.2	-16.0	Horizontal	24.2	Pass
752.5000	45.2	-52.2	-16.0	Vertical	36.2	Pass
752.5000	47.2	-50.2	-16.0	Horizontal	34.2	Pass
903.0000	65.5	-31.9	-16.0	Vertical	15.9	Pass
903.0000	70.1	-27.3	-16.0	Horizontal	11.3	Pass
1053.5000	43.0	-54.4	-16.0	Vertical	38.4	Pass
1053.5000	46.6	-50.8	-16.0	Horizontal	34.8	Pass
1204.0000	66.1	-31.3	-16.0	Vertical	15.3	Pass
1204.0000	75.1	-22.3	-16.0	Horizontal	6.3	Pass
1354.5000	50.0	-47.4	-16.0	Vertical	31.4	Pass
1354.5000	44.8	-52.6	-16.0	Horizontal	36.6	Pass
1505.0000	50.8	-46.6	-16.0	Vertical	30.6	Pass
1505.0000	67.0	-30.4	-16.0	Horizontal	14.4	Pass

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.

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 in January 2011

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) or -70 dB whichever is the lesser attenuation.

The rated power of 250 watts (54.0 dBm) gives a limit of –16 dBm (-70 dBc).

No measurements were made above the 10th harmonic.

Result: Complies
Measurement Uncertainty: ±4.1 dB

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.

Measurements were made with the supply decreased and increased 15% from nominal battery voltage supply.

Frequency: 162.175 MHz

Temperature	Voltage (20.4 Vdc)	Voltage (24.0 Vdc)	Voltage (28.8 Vdc)
+50°C	+43.0	+43.0	+43.0
+40°C	-60.0	-60.0	-60.0
+30°C	-43.0	-43.0	-42.0
+20°C	-51.0	-50.0	-50.0
+10°C	-8.0	-7.0	-7.0
0°C	-46.0	-45.0	-45.0
-10°C	+75.0	+76.0	+76.0
-20°C	+150.0	+151.0	+151.0
-30°C	+129.0	+129.0	+129.0

Limit:
Part 90.213 states that base station transmitters operating between 150 – 174 MHz with 12.5 kHz channelling are required to have a frequency tolerance of 2.5 ppm.

This transmitter was tested on 150.5 MHz

2.5 ppm = 2.5 x 150.500 = 376.25 Hz.

Result: Complies
Measurement Uncertainty: ±30 Hz

Transient frequency behaviour

Transient frequency behaviour measurements are applicable to wide band and narrow band transmitters operating in the frequency band 150-174 MHz.

Measurements were carried out using the method described in TIA-603 and EN 300-086.

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.

Results:

Spacing	Period t_1 (kHz)	Period t_2 (kHz)	Period t_3 (kHz)
12.5 kHz	Less than 6.25	Less than 3.125	Less than 3.125

Limits:

Time Interval	Period	12.5 kHz Deviation (kHz)
t_1	5 ms	± 12.5
t_2	20 ms	± 6.25
t_3	5 ms	± 12.5

The frequency difference from the nominal frequency of the transmitter shall not exceed the following values of channel separation for the transient period duration described above and below:

(a) One channel separation during the period t_1 and t_3.
(b) Half channel separation during the period t_2.

The frequency difference after the end of t_2 and before the start of t_3, shall be within the limit of frequency error.

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.

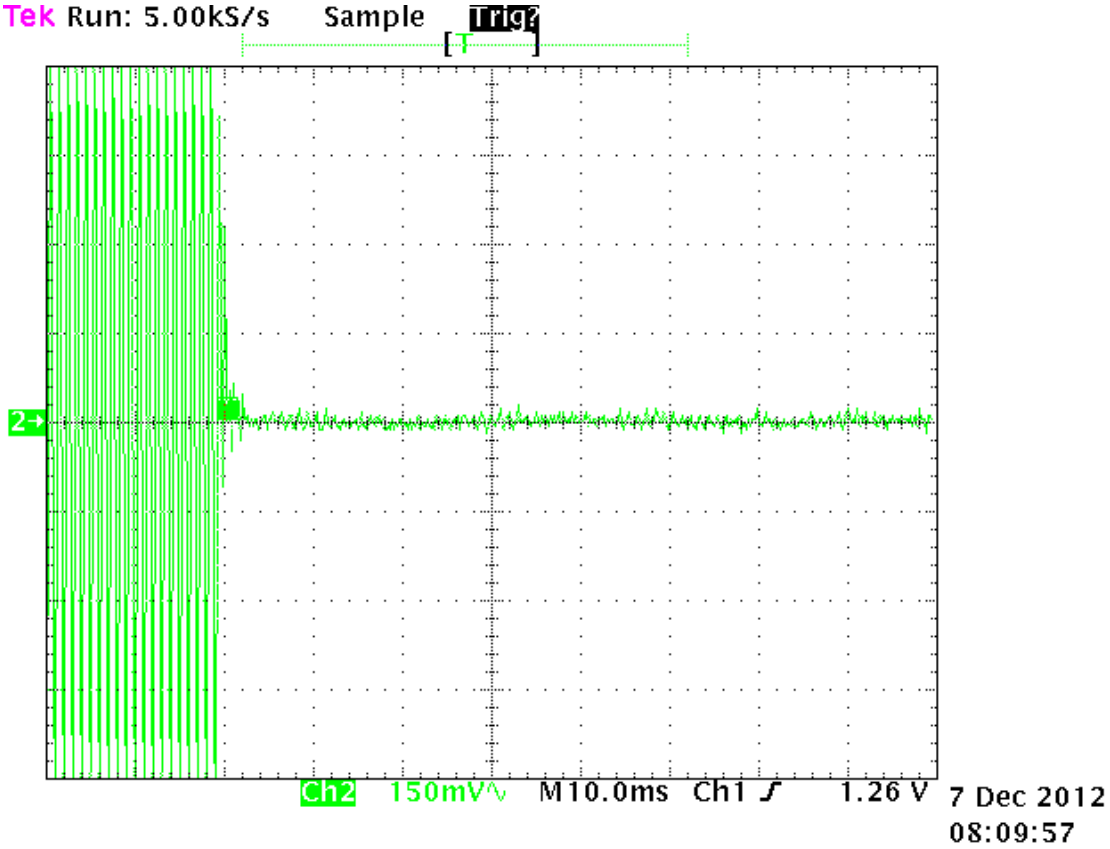
Green trace has been maximised to give full screen indication of +/- 12.5 kHz.
Therefore each Y axis division = 3.125 kHz per division.
The X axis has been set to a sweep rate of 10 ms/division.

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 2.5 divisions from the left hand edge.
*t*2 occurs between 2.5 and 4.5 divisions from the left hand edge.

A small transient response can be observed during *t*1 and *t*2



12.5 kHz transmitter turn off

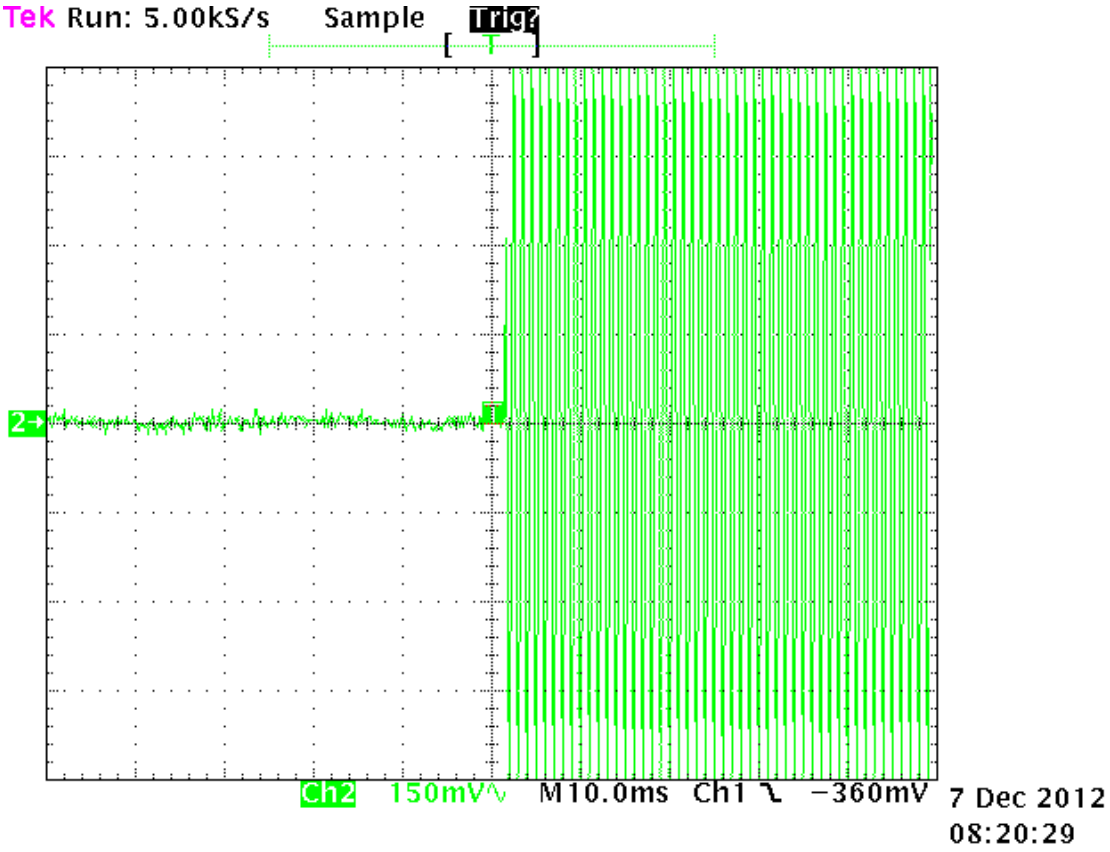
Green Trace = 1 kHz tone with FM deviation of 12.5 kHz.

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 4.5 and 5.0 divisions from the left hand edge..

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



Exposure of humans to RF fields

As per Section 1.1310 mobile transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels in accordance with OST/OET Bulletin Number 65.

Calculations have been made using the General Public/Uncontrolled Exposure limits.

Minimum safe distances have been calculated below.

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

- Occupational / Controlled Exposure limit will be 10 mW/m^2 or 60 V/m

- General Population / Uncontrolled exposure limit will be 2 mW/m^2 or 28 V/m

The minimum distance from the antenna at which the MPE is met is calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain, transmitter duty cycle and separation distance in metres:

E, V/m = (√ (30 * P * G)) / d

The rated maximum transmitter power = 250 watts.

Transmitter is typically operated using a quarter wave whip antenna with a typical gain of 2.14 dB (1.64).

A duty cycle of 100% has been assumed for the transmitter.

Controlled	**Uncontrolled**
d = √ (30 * P * G*DC) / E	
d = √ (30 * 250 * 1.64) / 60	d = √ (30 * 250 * 1.64) / 28
d = 1.85 metres	d = 3.96 metres

Result: Complies if the safe distances defined for each environment are applied.

8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal Due
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	N/a
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	N/a
Audio Analyzer	Hewlett Packard	8903A	2216A01713	E1146	09/07/2014
Biconical Antenna	Schwarzbeck	BBA 9106	9594	RFS 3680	12/01/2015
Level generator	Anritsu	MG443B	M61689	E1143	10/02/2013
Log Periodic	Schwarzbeck	VUSLP9111	9111-228	RFS 3785	12/01/2015
Receiver	Rohde & Schwarz	ESIB 40	100171	EMC4003	20/10/2013
Modulation Analyzer	Rohde & Schwarz	FMA	837807/020	E1552	31/12/2012
Modulation Analyzer	Hewlett Packard	8901B	2608A00782	E1090	10/07/2014
Oscilloscope	Tektronics	745A	B010643	E1569	31/12/2012
Power Attenuator	Weinschel	49-20-43	GC104	E1308	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a
RF Power Meter	Hewlett Packard	HP 436A	2512A22439	E1198	09/07/2014
Selective Level Meter	Anritsu	ML422C	M35386	E1140	21/10/2013
Signal Generator	Rohde & Schwarz	SMHU.58	838923/028	E1493	31/12/2012
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	RFS 3776	31/12/2012
Thermal chamber	Contherm	M180F	86025	E1129	N/a
Thermometer	DSIR	RT200	035	E1409	27/03/2013
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/a

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 last updated in January 2011.

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.

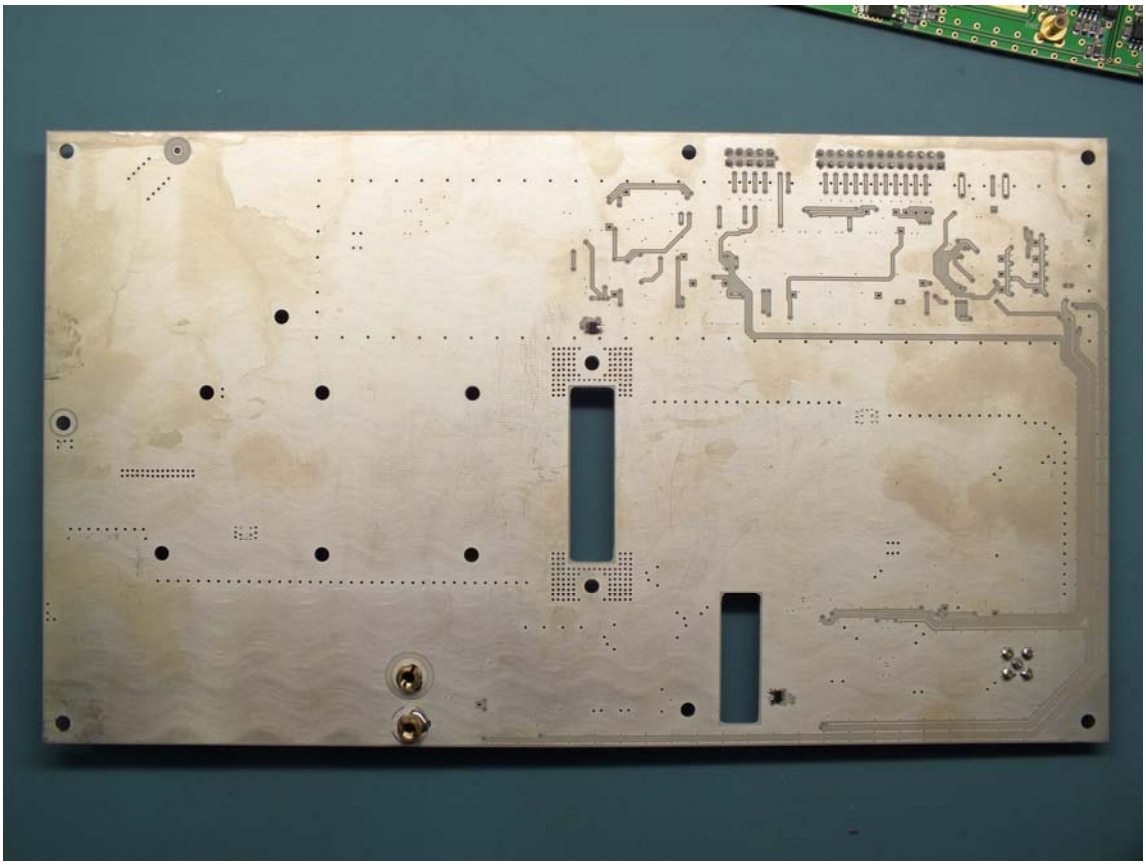
All measurement equipment has been calibrated in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to ISO/IEC 17025.

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

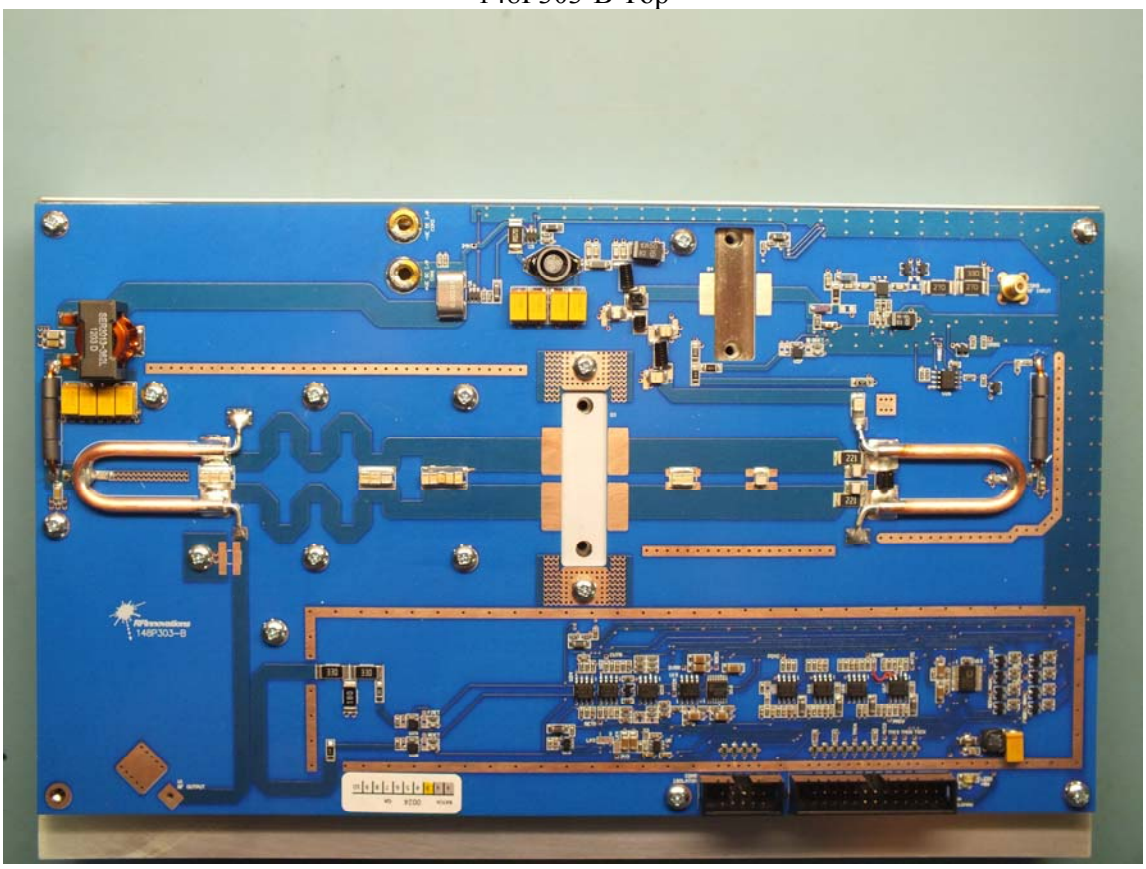
10. PHOTOGRAPH (S)

External Views:

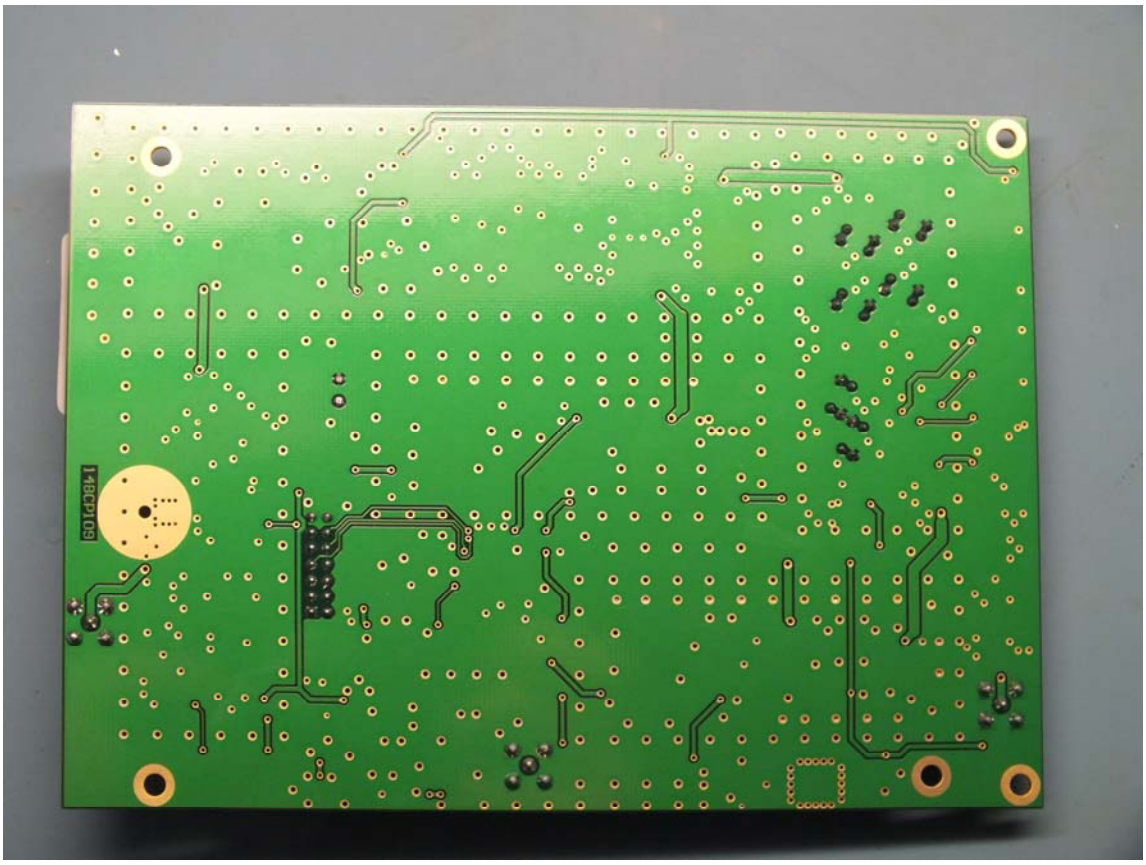
Internal Views:
148P303-B Bottom



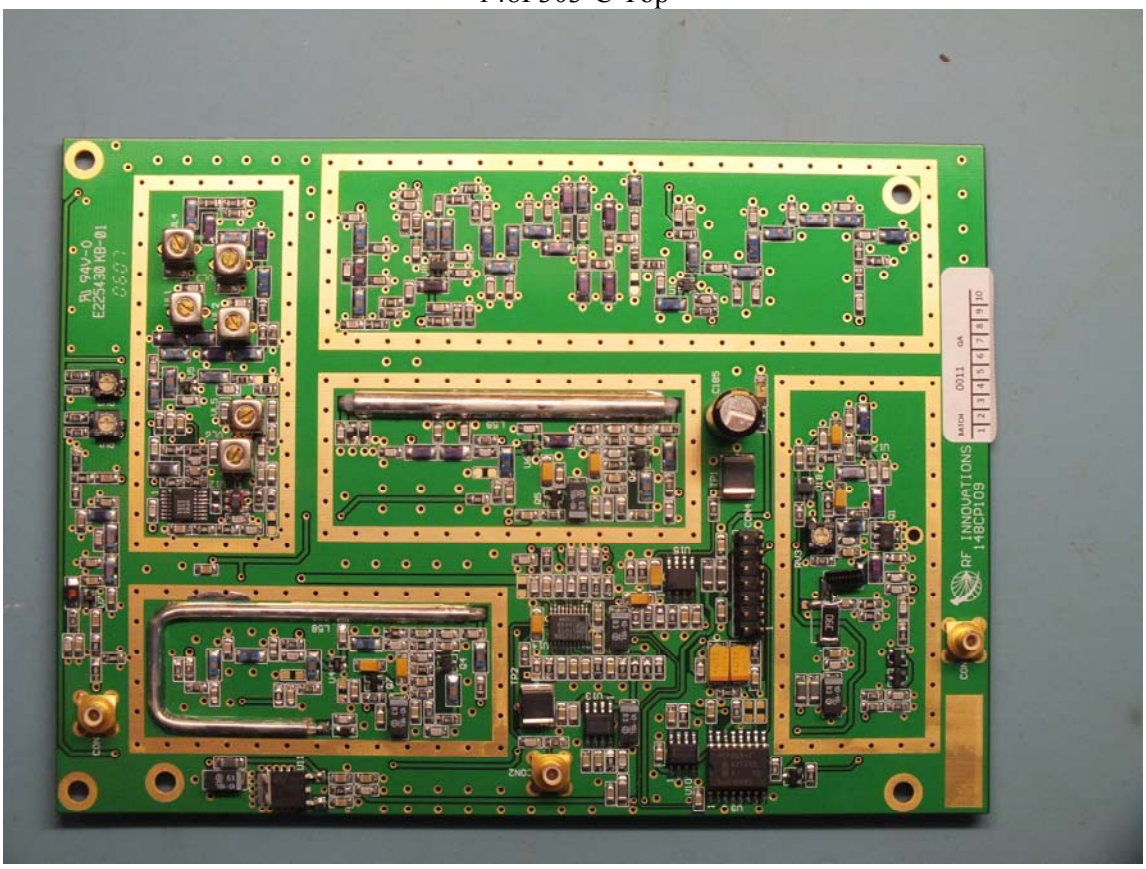
148P303-B Top



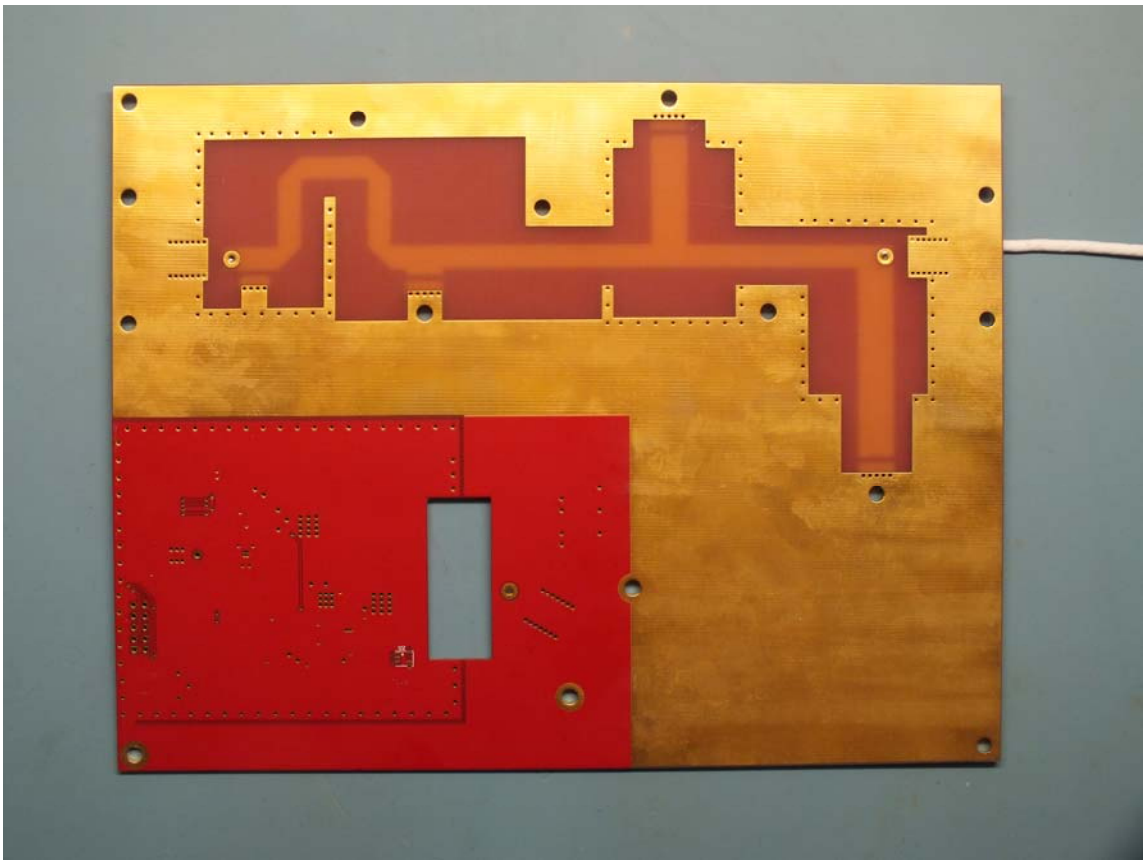
148P303-C Bottom



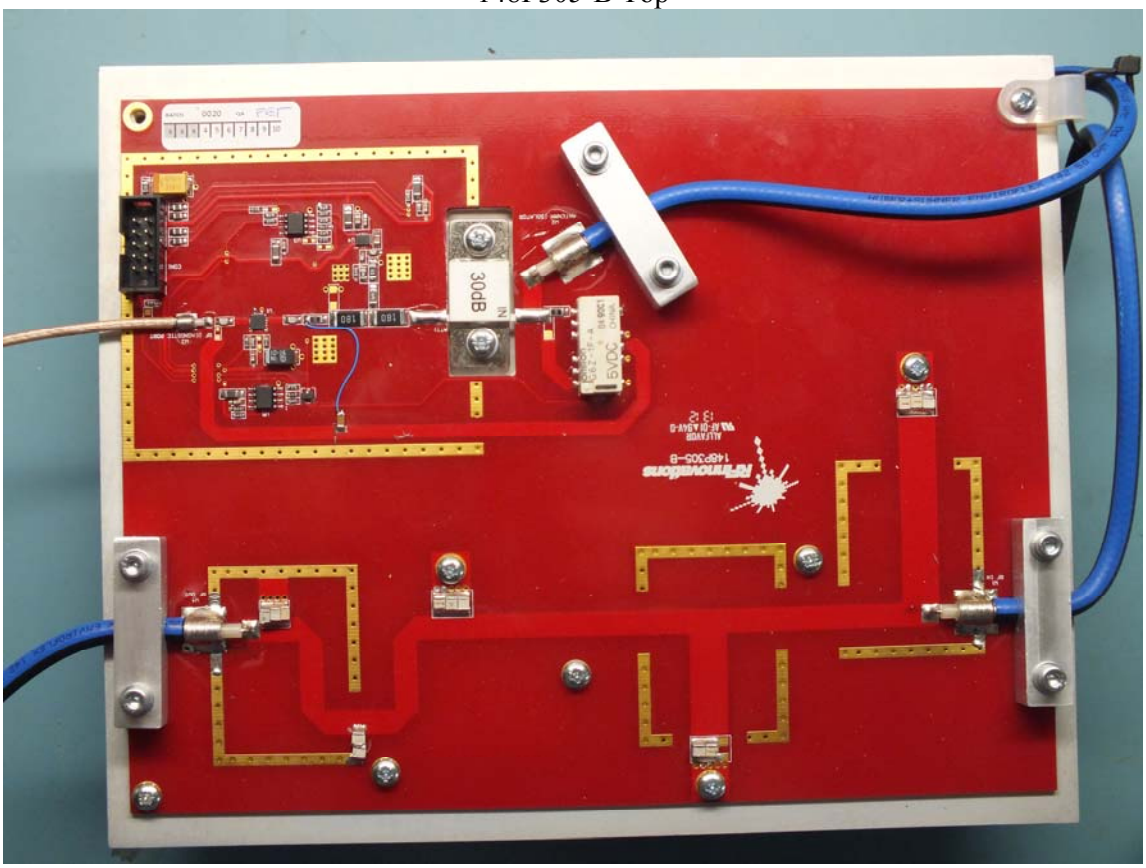
148P303-C Top



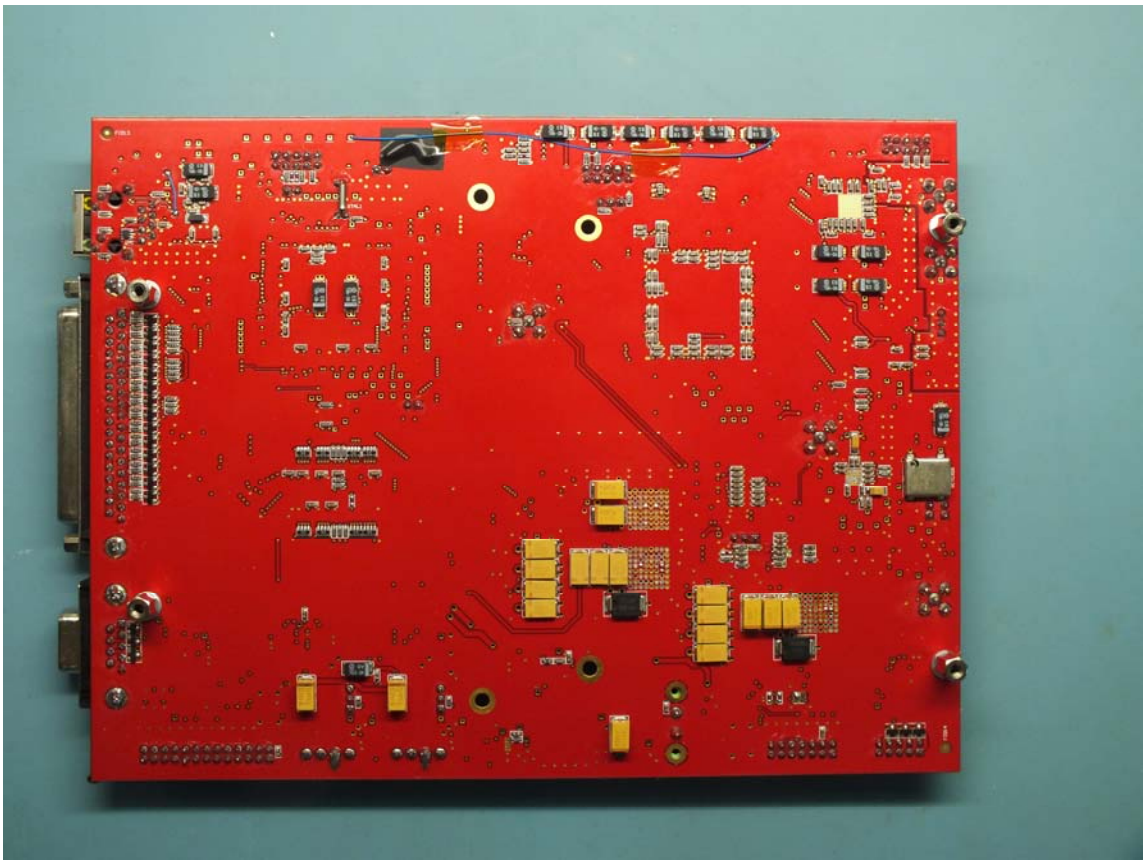
148P305-B Bottom



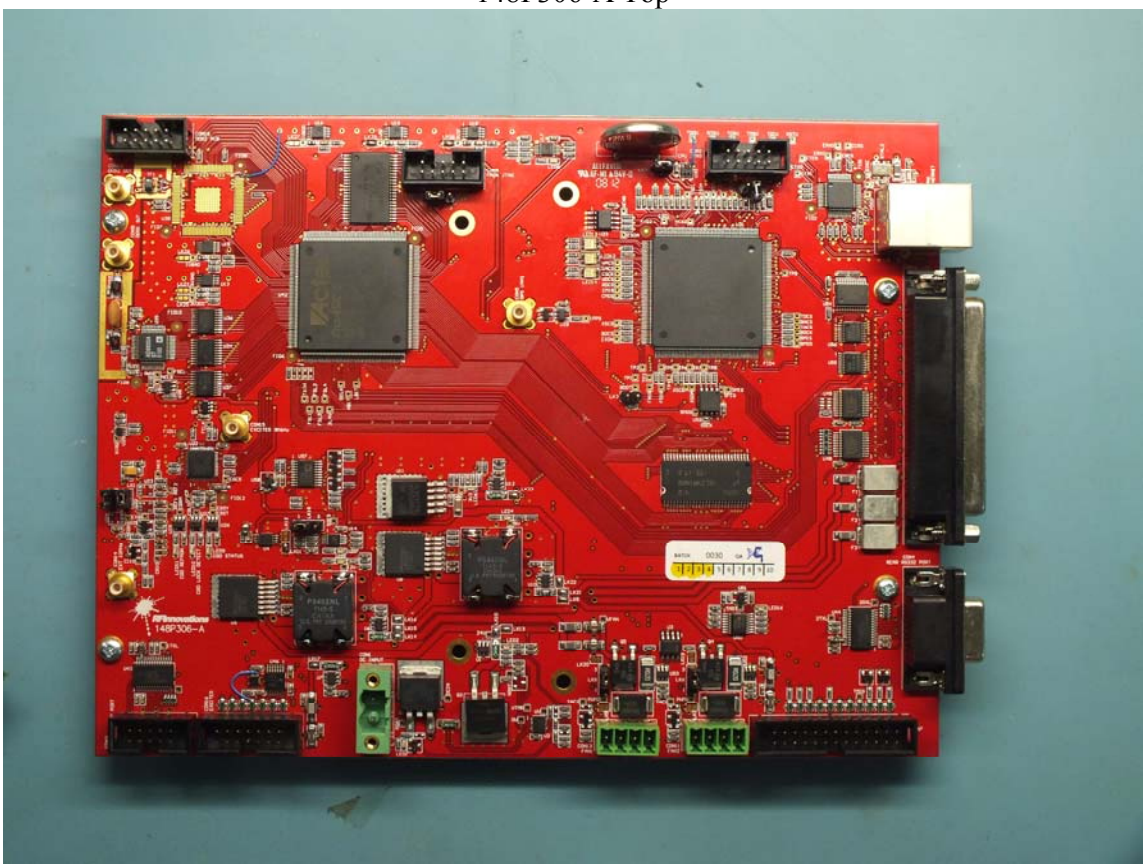
148P305-B Top



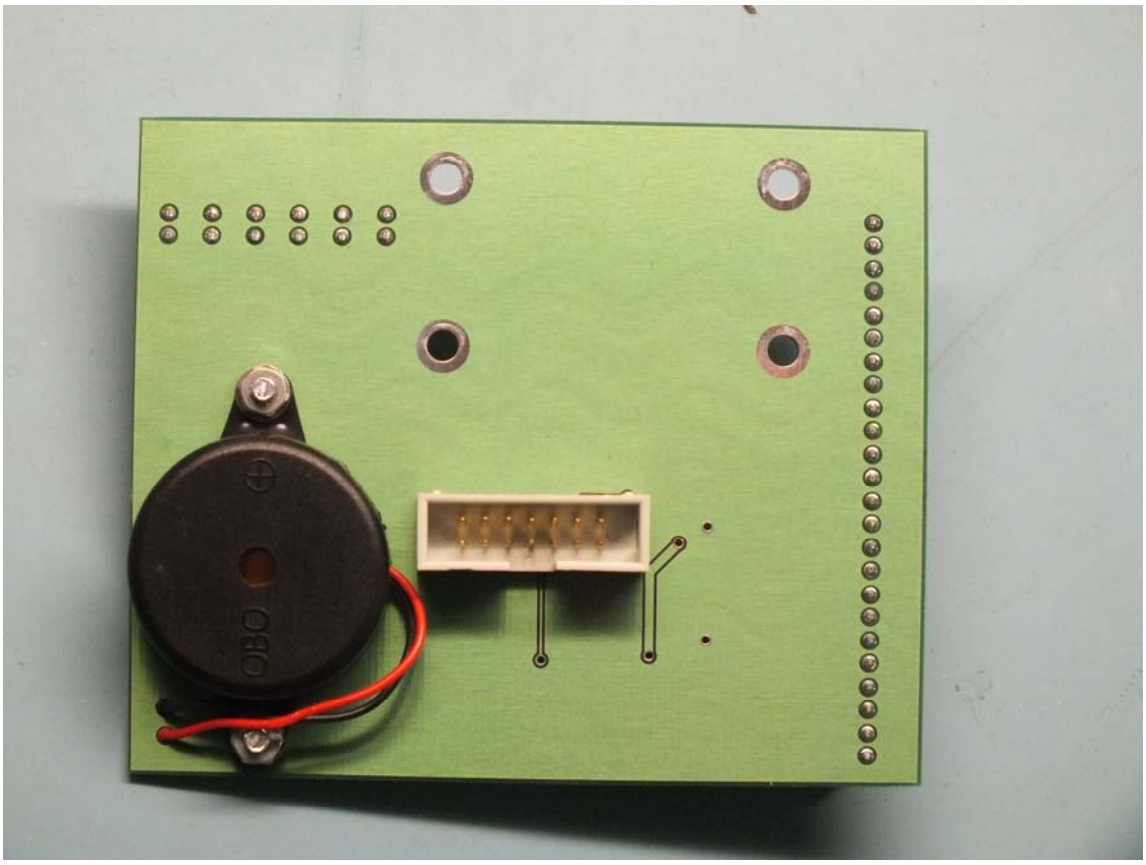
148P306-A Bottom



148P306-A Top



150B104 Bottom



150BP104 Top

O.A.T.S. Radiated emissions setup