EMC Technologies (NZ) Ltd

Test Report No **00903.1**
Report date: 6 November 2000

TEST REPORT

Elpro 905U Radio Telemetry Module

tested for compliance with the

Code of Federal Regulations (CFR) 47

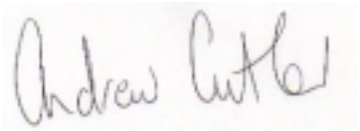
Part 15 – Radio Frequency Devices, Subpart C – Intentional Radiators

Section 15.247 – Operation in the band 902 – 928 MHz

for

ELPRO Technologies PTY Ltd

This Test Report is issued with the authority of:



Andrew Cutler - General Manager

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

Table of Contents

1. CLIENT INFORMATION

Company Name	ELPRO Technologies Pty Ltd
Address	9/12 Billabong Street Stafford
State	Queensland 4053
Country	Australia
Contact	John White

2. DESCRIPTION OF TEST SAMPLE

Brand Name	ELPRO
Model Number	905U-1
Product	Radio Telemetry Module
Manufacturer	ELPRO Technologies Pty Ltd
Country of Origin	Australia
Serial Number	0008998
FCC ID	O9PELPS01

3 SUMMARY OF TEST RESULTS

Testing was carried out in accordance with the test methods defined in 47 CFR Part 15 and in particular Sections, 15.205, 15.207, 15.209 and 15.247.

CLAUSE	TEST PERFORMED	RESULT
15.205	operation in restricted bands	Complies
15.207	conducted emissions	Complies
15.209	radiated emissions	Complies
15.247:		
(a)(1)(i)	channel occupancy / bandwidth	Complies
(b)(2)	peak output power	Complies
(b)(4)	radio frequency hazard	Complies
(c)	out of band emissions	Complies

4. ARTICLES SUBMITTED

1 x ELPRO 905U-1 Radio Telemetry Module, Sn# 0008998 consisted of the following items:

- 902 – 928 MHz frequency hopping spread spectrum transceiver
- Digital and analogue input / output control device
- Radio Shack CAT 273-1776 120 Vac / 12 Vdc AC Adaptor
- Whip antenna

The Radio Telemetry Module has no external user controls.

Testing was carried out using software control which allowed the following changes to be made:

- Frequency hopping in two bands: 902 – 915 MHz and 915 – 928 MHz.
- Frequency hopping using 4 different pseudo random sequences.
- Changes in modulation: None, 115.2 kbps (bit reversals at 115200 bits per second), 57.6 kbps, 19.2 kbps.
- Single frequency operation.

5. TEST SAMPLE DESCRIPTION

The sample tested is a frequency hopping spread spectrum transceiver, which also included a digital and analogue input / output device, with the following specifications:

Rated Transmitter Output Power

1 watt

Test frequencies

902 – 915 MHz
50 frequencies in a pseudo random sequence with a frequency spacing of 250 kHz beginning at 902.375 MHz.

915 – 928 MHz
50 frequencies in a pseudo random sequence with a frequency spacing of 250 kHz beginning at 915.125 MHz.

Frequency Range

902.0 – 928.0 MHz

Modulation Type

The following modulation type was utilised:
- Frequency Hopping Spread Spectrum.
- 115.2 kbps (bit reversals at 115200 bits per second).

Power Supply

Radio Shack CAT 273-1776 120 Vac / 12 Vdc AC Adaptor

External Ports

The Radio Telemetry Module has the following ports:
- antenna port which has a reverse SMA connector (unique connector)
- four digital input ports
- four digital output ports
- two analogue input ports
- two analogue output ports
- RS 232 port
- RS 485 port

Related family models

The 905U-1 Radio Telemetry Module is a member of the 905U product family where the same radio modem is utilised in a number of similar products where the principle difference is the arrangement of input and output ports.

The client requests that certification be granted to the following family members:

- 905U-1: This is the unit that has been tested which has
  - radio modem,
  - 4 digital inputs,
  - 4 digital outputs,
  - 2 analogue inputs
  - 2 analogue outputs

- 905U-2 has:
  - radio modem,
  - 6 analogue inputs
  - 1 digital output

- 905U-3 has:
  - radio modem,
  - 8 digital outputs,
  - 8 analogue outputs
  - no inputs.

- 905U-4 has:
  - radio modem,
  - 20 digital inputs
  - 16 digital outputs

All units contain the same radio modem, power supply and micoprocessor.

The only difference is the input and output configurations.

Circuit diagrams are attached for each individual model.

6. ATTESTATION

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

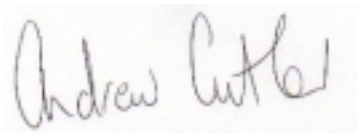
The test sample was selected by the client.

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

Section 15.205 – Restricted bands of operation

Refer to measurements made with reference to Section 15.247 (c)

Section 15.207 – Conducted emissions

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

Testing was carried out at the laboratory's MacKelvie Street screened room.

The device was placed on top of the test table, which is 1m x 1.5m, 80cm above the screened room floor which acts as the horizontal ground plane. In addition the device was positioned 40cm away from the screened room wall which acts as the vertical ground plane. The artificial mains network was bonded to the screened room floor. At all times the device was kept more than 80cm from the artificial mains network.

Measurement uncertainty with a confidence interval of 95% is:

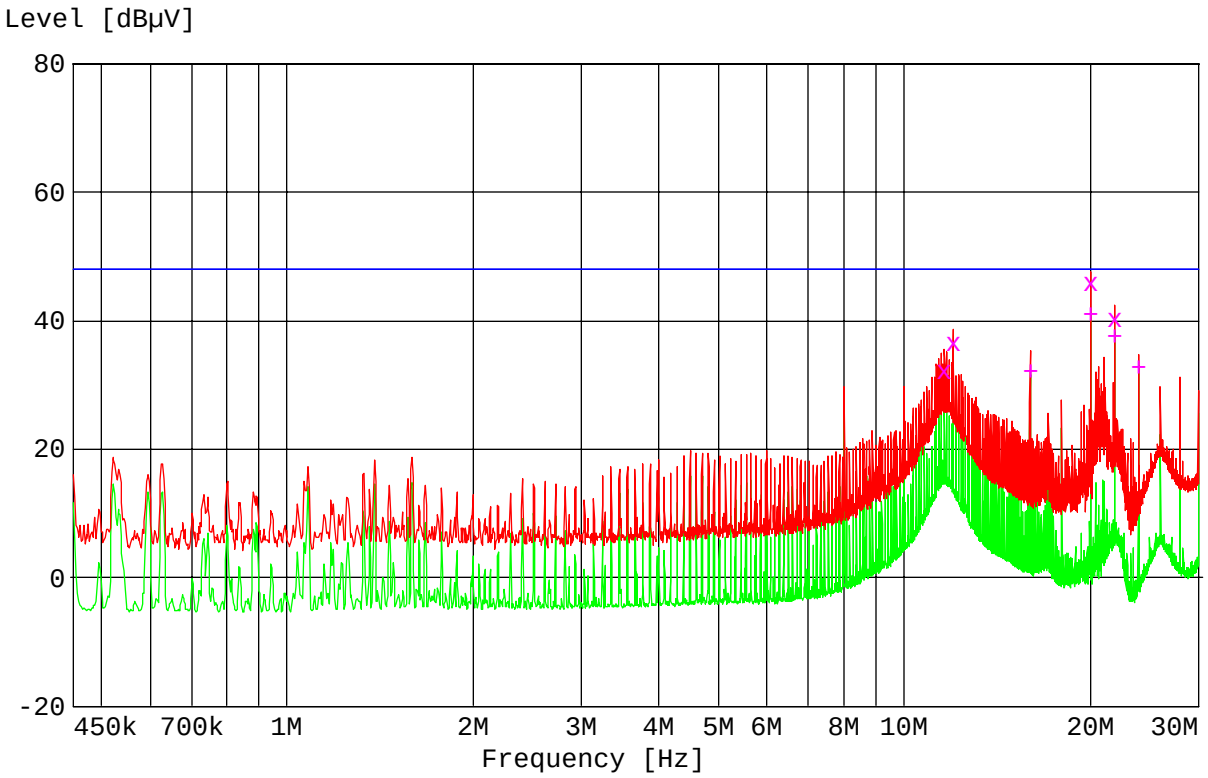
- Mains terminal tests (0.15 - 30 MHz) ± 2.2 dB

Result: Complies with a 1.99 dB margin at 20.000 MHz (Average). Measurement falls within the window of uncertainty for this test method.

Conducted Emissions Results

Comments : Device tested while powered at 110 Vac using a Radioshack AC Adaptor. Device tested while transmitting in frequency hopping mode.

KEY			
Peak		Quasi Peak	X
Average		Average	+



Quasi-Peak Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dBµV	Exceed	Phase	Rechecks dBµV
11.615000	32.34	48.00	15.66		N	
12.000000	36.64	48.00	11.36		N	
20.000000	46.01	48.00	1.99		N	
22.000000	40.38	48.00	7.62		N	

Average Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dBµV	Exceed	Phase	Rechecks dBµV
16.000000	32.11	48.00	15.89		N	
20.000000	41.10	48.00	6.90		N	*41.3*
22.000000	37.42	48.00	10.58		N	
24.000000	32.78	48.00	15.22		N	*33.0*

Section 15.209 – Radiated emissions

Radiated emissions testing was carried out over the frequency range of 30.0 to 1000 MHz.

Testing of the device was carried out at the laboratory's open area test site - located at Dakota Lane, Ardmore Aerodrome, Auckland, New Zealand (Note: Site conforms to the requirements of CISPR 16, Part 1, Clause 16, and ANSI C63.4 - 1992.)

Before testing was carried out, a receiver self calibration was undertaken. Additionally, a check of all connecting cables and programmed antenna factors was carried out.

The device was placed on the test table top which was a total of 0.8 m above the test site ground plane.

Measurements of the radiated field were made with the antenna located at a 3 m horizontal distance from the boundary of the device under test.

Testing was carried out in the various modes in which the device operated. Any external cables were orientated for the worst case emissions level.

Testing was carried out by manually scanning between 30 MHz and 1000 MHz in 100 kHz steps while aurally and visually monitoring for emissions.

When an emission is located, it is positively identified and its maximum level is found by rotating the automated turntable, and by varying the antenna height with an automated antenna tower. The emission is measured in both vertical and horizontal antenna polarisations.

During the test, a number of ambient emissions are identified (list of which can be provided upon request).

The emission level is determined in field strength by taking the following into consideration:

Level (dBµV/m) = Receiver Reading (dBµV) + Antenna Factor (dB) + Coax Loss (dB)

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 - 1000 MHz) ± 4.1 dB

Radiated Emissions

Test setup:

Radio modem tested in hopping mode. Device tested while powered by a Radio Shack AC Adaptor at 110 Vac. Tested with a Nearson 119 series whip antenna attached, standing vertically upright. Tested while attached to a laptop computer using a 3 metre length of ribbon data cable 2 core cable attached to the RS 485 port. 1 metre lengths of unscreened cable were attached to Each of the input and outport ports of the device. Device tested standing upright with these cables Being lead vertically downwards from the test table.

Results:

Frequency	Level		Recheck	Limit	Margin	Result	Worst Case
	Vertical	Horizontal					Antenna
MHz	dBuV/m	dBuV/m	dBuV/m	dBuV/m	dBuV		
32.000	24.0			40.0	16.0	Pass	Vertical
40.000	23.1			40.0	16.9	Pass	Vertical
44.000	21.0			40.0	19.0	Pass	Vertical
48.000	23.6			40.0	16.4	Pass	Vertical
52.000	20.0			40.0	20.0	Pass	Vertical
60.000	15.0			40.0	25.0	Pass	Vertical
64.000	23.1	12.0		40.0	16.9	Pass	Vertical
70.000	18.0			40.0	22.0	Pass	Vertical
72.000	22.1	12.0		40.0	17.9	Pass	Vertical
76.000	22.0			40.0	18.0	Pass	Vertical
80.000	20.0			40.0	20.0	Pass	Vertical

Result: Complies with a 16.0 dB margin at 32.000 MHz.

Section 15.247 (a) (1) (i) - Channel occupancy / bandwidth

Measurements were carried out on 3 single frequencies across the operating range of the transceiver with 115.2 kbps modulation being applied.

At each frequency the 20 dB bandwidth was measured using a spectrum analyser.

Plots of these measurements are contained in pages 13, 14 and 15.

The bandwidth was observed to be:

902.88 MHz	141 kHz
915.37 MHz	139 kHz
927.12 MHz	137 kHz

For a bandwidth of less than 250 kHz at least 50 channels should be used. Tests were carried out between 902 – 915 MHz and 915 – 928 MHz which showed that this device uses 50 channels in each of these bands. Plots of these measurements are contained in pages 16 and 17.

Result: Complies

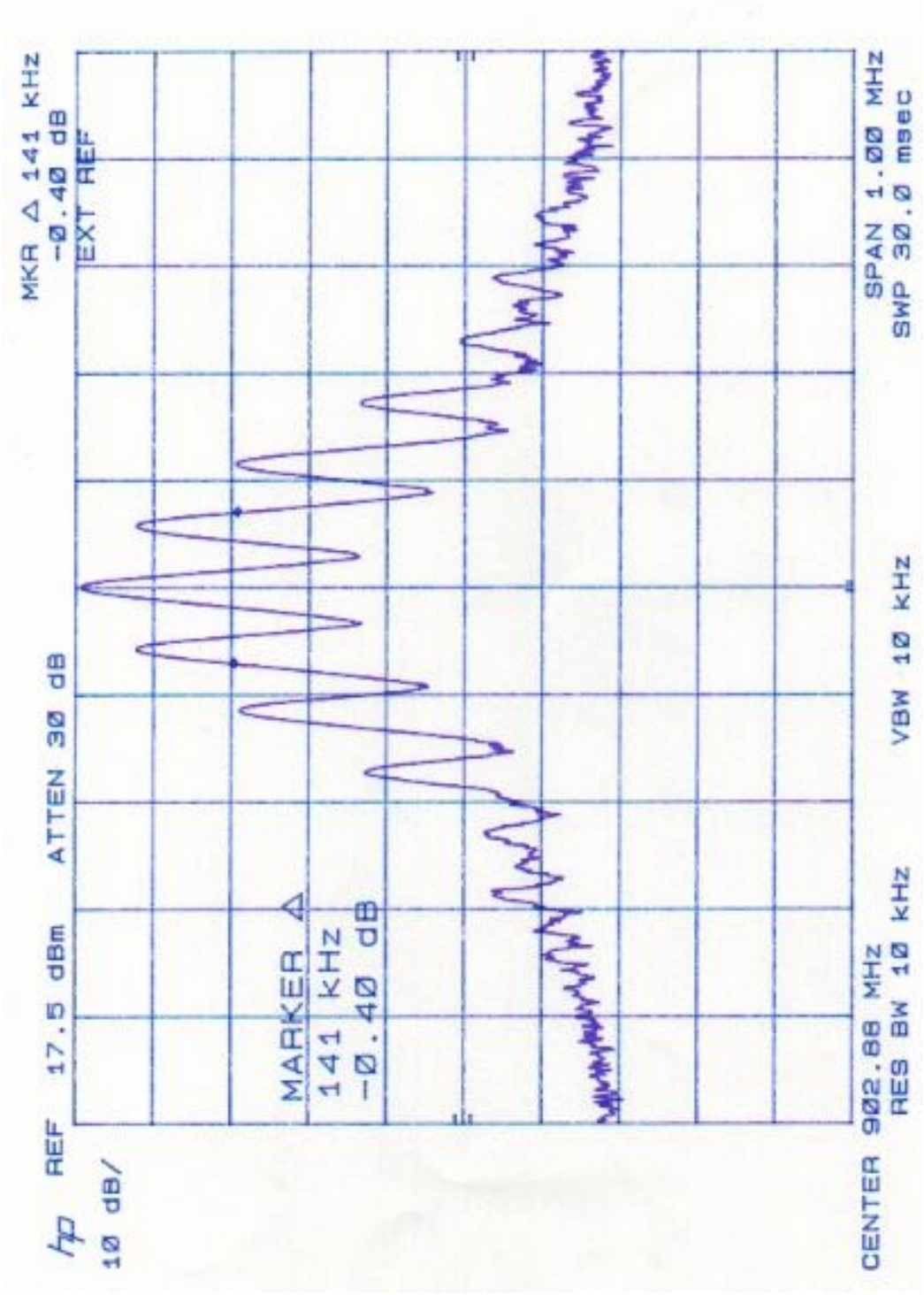
In addition the average time occupancy on any frequency shall not exceed 400 milliseconds in any 20 second period.

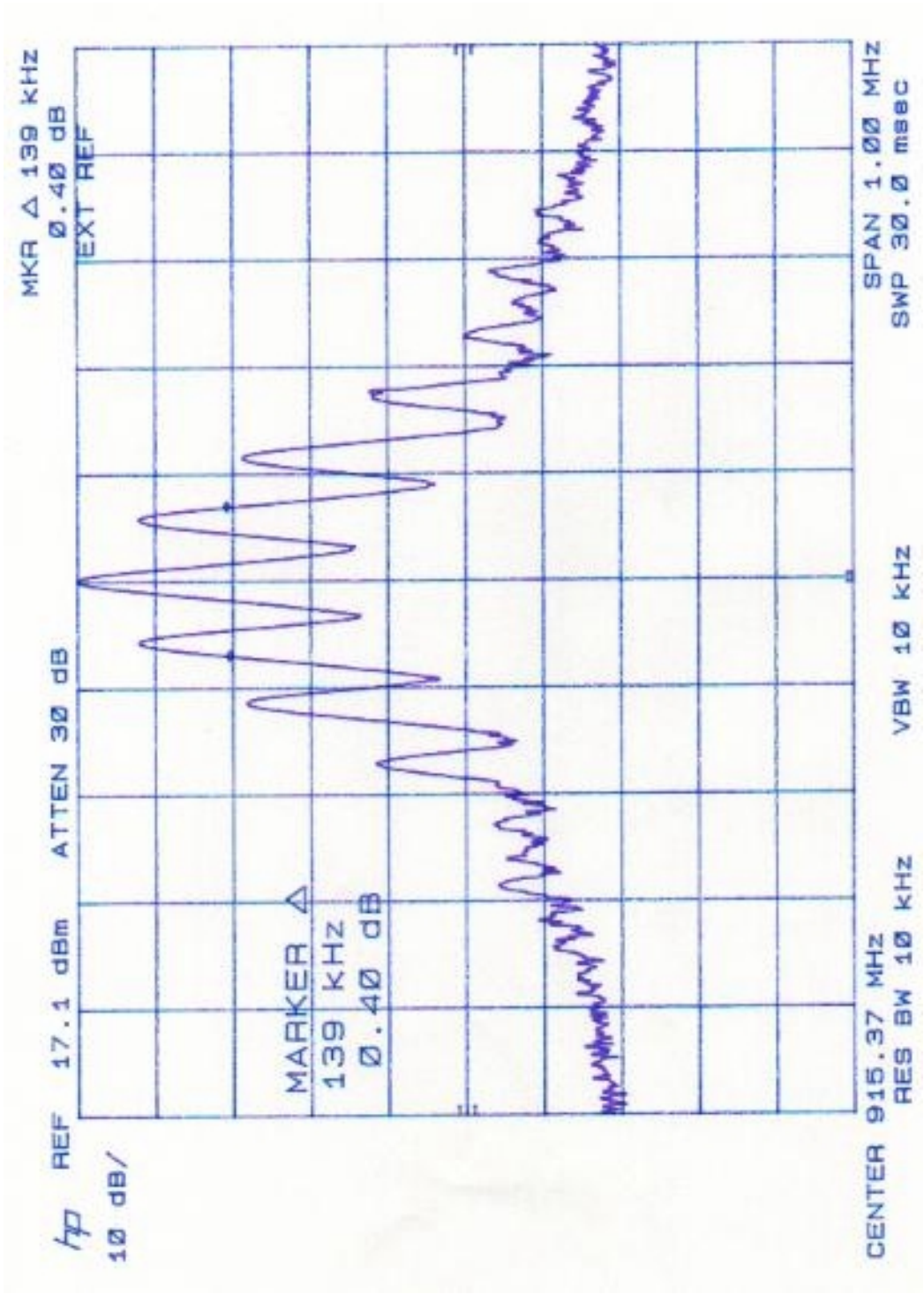
Using a spectrum analyser with a 0 Hz frequency span the "on frequency time" was determined to be 30.5 mS.

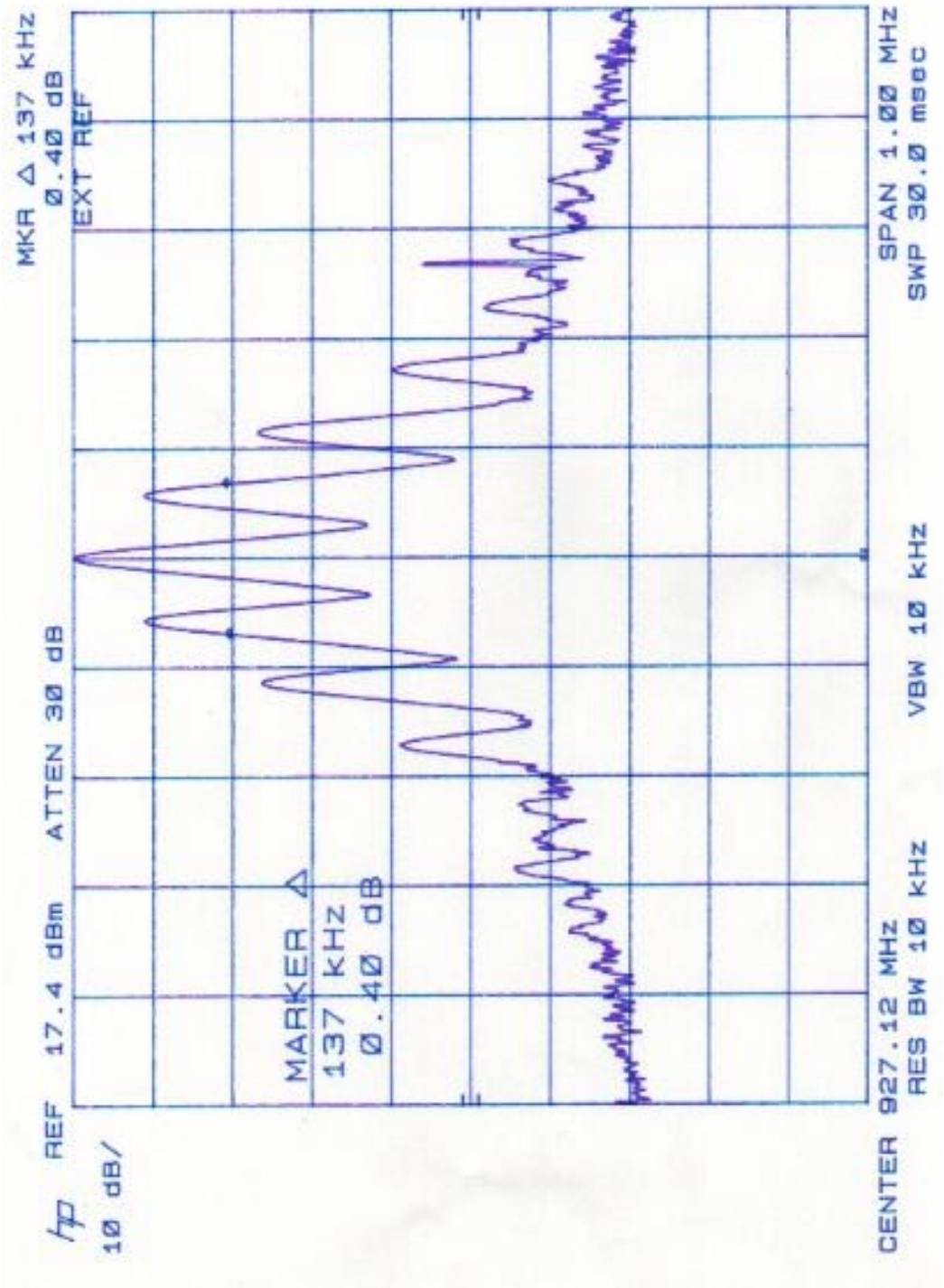
With the spectrum analyser still operating with a 0 Hz frequency span the transmitter was observed to be "on frequency", on average, 13 times in any 20 second period.

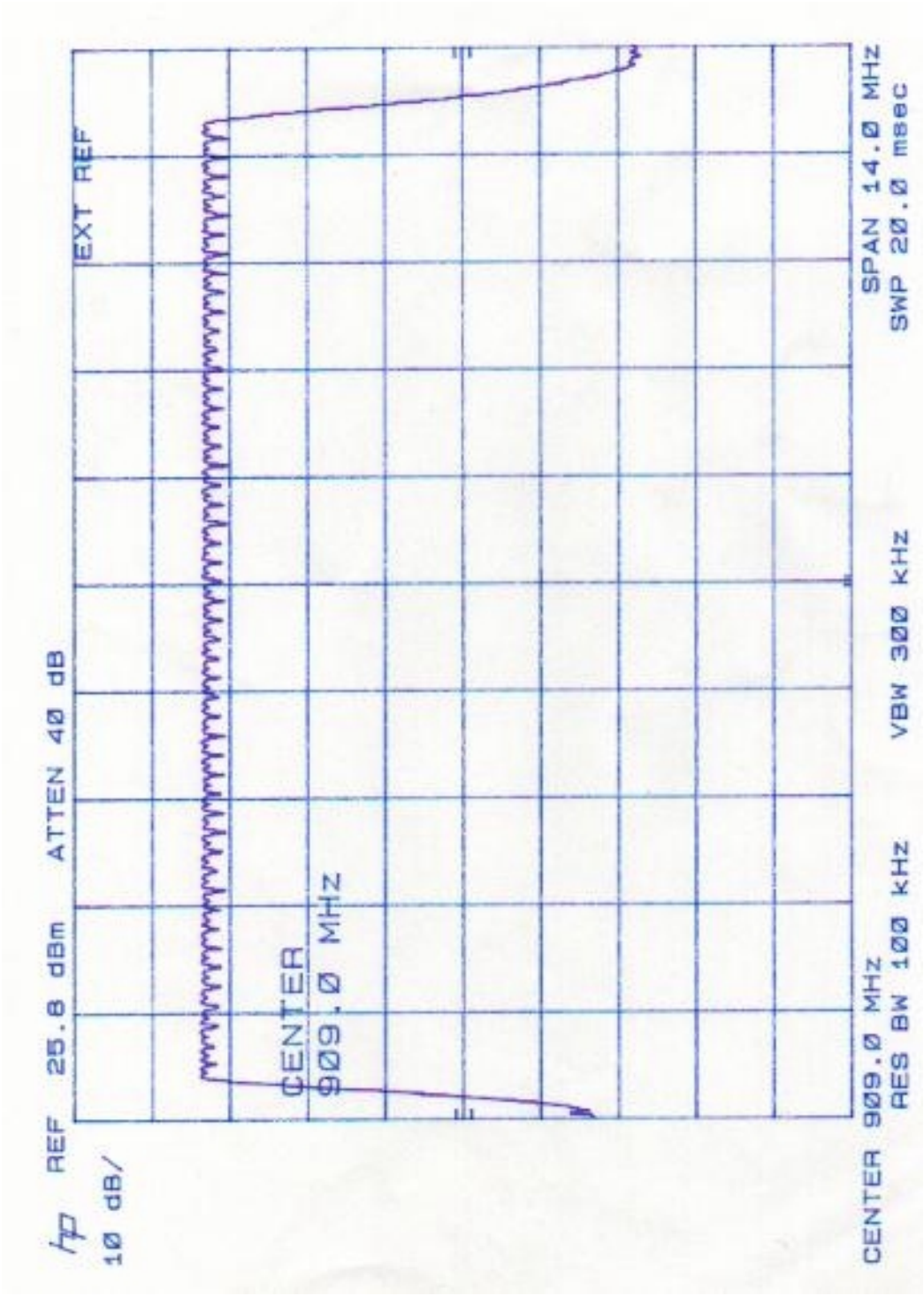
Therefore 30.5 mS x 13 times = 396.5 mS.

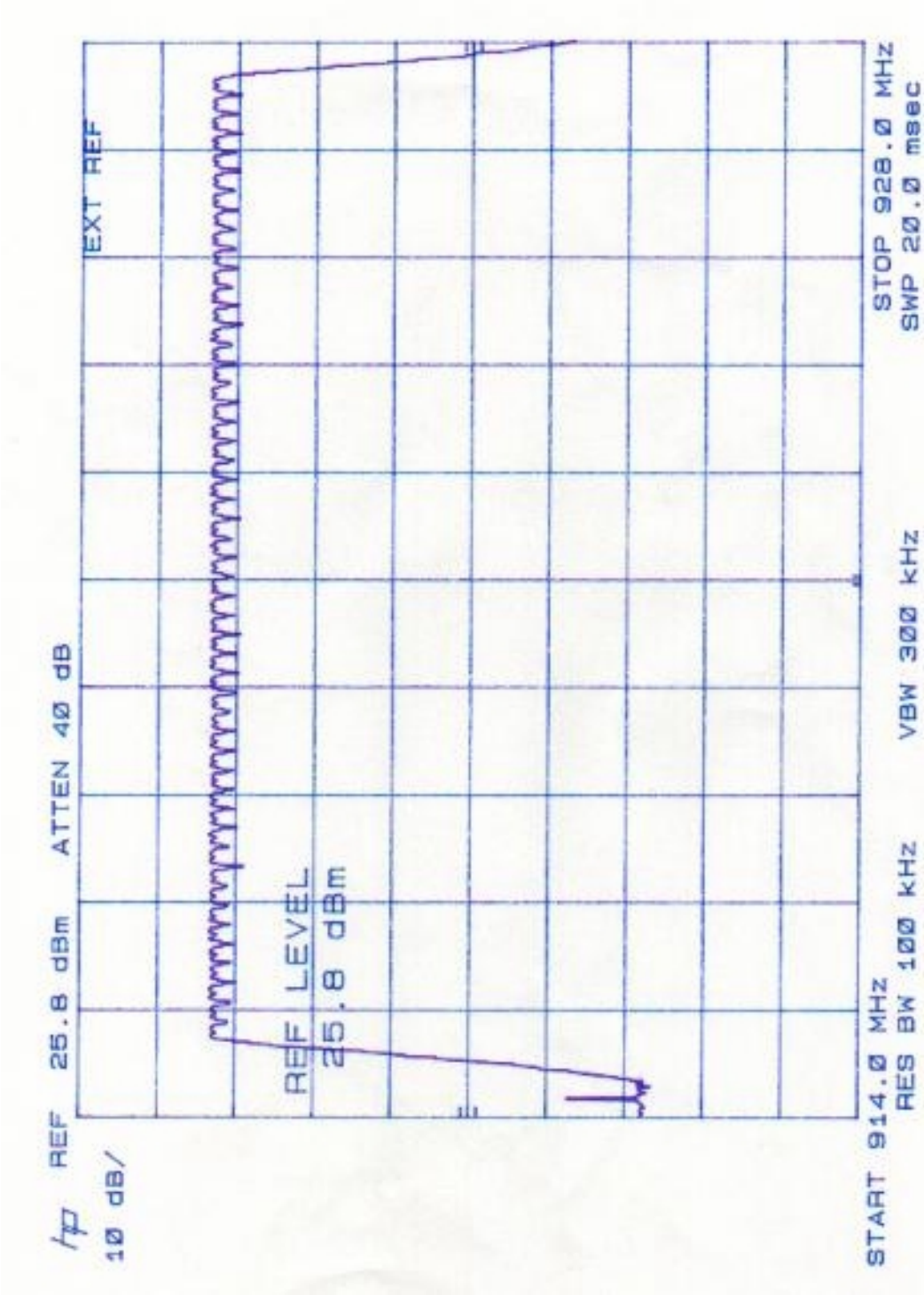
Result: Complies











Section 15.247 (b) (2) – Peak output power

Measurements were carried out at the RF output terminals of the transmitter using a 10 dB power attenuator and a power meter.

Measurements were carried out when the transmitter was not being modulated and while operating on a single frequency.

Measurements were made with the input voltage set to 110 Vac.

RF power output (Watts)			
Frequency (MHz)	**Level**	**Rated**	**Limit**
902.875	0.692	1.000	1.000
915.375	0.660	1.000	1.000
927.125	0.575	1.000	1.000

Limits:
The maximum peak output power for frequency hopping systems operating in the 902 – 928 MHz shall not exceed 1 watt for systems employing at least 50 channels.

Result: Complies

Measurement Uncertainty: *±0.5 dB*

Section 15.247 (b) (4) – Radio Frequency Hazard Information

As per Section 15.247 (b) (4) spread spectrum transmitters operating in the 902 – 928 MHz band are required to be operated in a manner that ensures that the public is not exposed to rf energy levels in accordance with CFR 47, Section 1.1307(b)(1).

In accordance with this section and also Section 2.1091 this device has been defined as a mobile device whereby a distance of 20 cm can normally be maintained between the user and the device.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of f/1500 have been applied.

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

E, V/m = $(\sqrt{}\ (30 * P * G)) / d$

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

E for MPE: $(902/1500) = E^2/3770$

$E = \sqrt{}(902/1500)*3770$

$E = \underline{47.6\ V/m}$

Assuming that the antenna used in the test is an antenna that would typically be used, a gain of 2 dBi (gain = 1.58) has been applied. The maximum transmitter power measured was 0.850 watts.

Therefore:

$d = \sqrt{}\ (30 * P * G) / E$

$= \sqrt{}\ (30 * 0.692 * 1.58\ ) / 47.6$

$= \underline{0.12 \text{ metres or } 12.0 \text{ cm}}$

Calculations show that this device with the described antenna meets the MPE requirement for mobile devices falling below the 20 cm clearance requeired.

Section 15.247 (c) – Out of band emissions

Using a spectrum analyser and an external 10 dB attenuator the power reference level was determined to be +28.4 dBm.

As the transmitter had an external antenna port conducted measurements were carried out.

Frequency: 902.875 MHz

Measured Spurious Emission		
Emission (MHz)	**Emission level (dBm)**	**Limit (dBm)**
1805.750	-21.9	8.4
2708.625	-45.0	8.4
3611.500	-35.9	8.4
4514.375	-40.8	8.4
5417.250	-39.6	8.4
6320.125	-45.0	8.4

No emissions were observed above the 6th harmonic.

Limit
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum transmitter is operating, the rf power produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

Result: Complies

Measurement Uncertainty: *±3.3 dB*

The out of band emissions have been shown to fall within the restricted bands of operation as defined in section 15.205(a) as follows:

- 2708 MHz falls within the band 2655 – 2900 MHz
- 3611 MHz falls within the band 3600 – 4400 MHz
- 4514 MHz falls within the band 4500 – 5150 MHz

Radiated emission measurements are required to be carried out with the limits as per section 15.209 applied.

Test setup:

Radio modem tested while operating on a single frequency with 115.2 kbps modulation applied.
Tested with a Nearson 191 series whip antenna attached, standing vertically upright.
Measurements carried out over a distance of 3 metres.
Measurements made using an average detector with a bandwidth of 1 MHz.
Refer to Section 15.209 – Radiated emissions testing for further test set up information.

Results:

Frequency	Level		Recheck	Limit	Margin	Result	Worst Case
	Vertical	Horizontal					Antenna
MHz	dBuV/m	dBuV/m	dBuV/m	dBuV/m	dBuV		
2722.853	-	-		54.0	-	Pass	Vert/Hort
3630.472	-	-		54.0	-	Pass	Vert/Hort
4538.809	-	-		54.0	-	Pass	Vert/Hort

Result: Complies. No significant emissions detected.

9 TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset
Attenuator 20 dB	Narda	766-20	7807	E1305
RF Power Meter	Hewlett Packard	HP 436A		E1209
Spectrum Analyser	Hewlett Packard	8566B		3771/3772
Spectrum Analyser	Hewlett Packard	E 7405A	US 39150142	3776
Measurement Receiver	Rohde & Schwarz	ESCS 30	839873/1	
Aerial Controller	EMCO	1090	9112-1062	3710
Aerial Mast	EMCO	1070-1	9203-1661	3708
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709
Biconical Antenna	Schwarzbeck	BBA 9106		3612
Log Periodic Antenna	Schwarzbeck	UHALP 9107		3702
Horn Antenna	Electrometrics	RGA-60	6234	E1494

10. 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.

In addition testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (TELARC) Accreditation to the New Zealand Code of Laboratory Management Practice incorporating ISO Guide 25: 1990 and ISO 9002: 1994.

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

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.