



Radio Test Report

Zinwave Ltd

UNlremote

302-1107

47 CFR Part 90.219 Effective Date 1st October 2014

↳ 47CFR part 2J

Test Date: 28th October 2015 to 9th November 2015

Report Number: 11-8405-3-15 Issue 01

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Certificate of Test 8405-3

The equipment noted below has been partially tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of 47CFR part 90. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	UNlremote
Model Number:	302-1107
Unique Serial Number:	310400000021
Manufacturer:	Zinwave Ltd Harston Mill, Royston Road Harston, Cambridge CB22 7GG
Proposed FCC/IC ID	UPO302-1107
Full measurement results are detailed in Report Number:	11-8405-3-15 Issue 01
Test Standards:	47 CFR Part 90.219(e)3 Effective Date 1st October 2014 ↳ 47CFR part 2J

NOTE:

The above list is incomplete as only partial tests conducted at request of the manufacturer. For details refer to section 3 of this report.

DEVIATIONS:

The following tests have not been performed at the request of Zinwave Ltd:- Spurious emissions at antenna terminals, RF Power Output, Frequency stability, Modulation characteristics, Occupied bandwidth, Band edge / spectrum mask additional emissions limitations

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

Date Of Test: 28th October 2015 to 9th November 2015

Test Engineer:

Approved By:
Technical Director

Customer
Representative:

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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Zinwave Ltd Harston Mill Royston Road Harston Cambridge CB22 7GG	
Manufacturer of EUT	Zinwave Ltd	
Full name of EUT	UNlremote	
Model Number of EUT	302-1107	
Serial Number of EUT	310400000021	
Date Received	28th October 2015	
Date of Test:	28th October 2015 to 9th November 2015	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	6th January 2016	
Visual Description	Metal enclosure with a fibre port and DC jack port on one end and two N-type antenna ports on the other.	
Main Function	Distributed Antenna system	
Information Specification	Height	268 mm
	Width	220 mm
	Depth	50 mm
	Weight	1 kg
	Voltage	100-240 V AC 50/60 Hz
	Current	1 A
EUT Supplied PSU	Manufacturer	XP Power
	Model number	AEB36US09
	Serial number	36090-0000651
	Input voltage	100-240 V AC
	Input current	1 A
	Output	9 V DC, 3 A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Fixed - wall mounted
Choice of model(s) for type tests	Production unit
Antenna details	8 dBi
Antenna port	External N-type Transmit port and External N-type receive port
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2180 MHz (highest supported radio service)
Lowest Signal generated in EUT	150 MHz (lowest supported radio service)
TX Parameters	
Alignment range – transmitter	150 - 2700 MHz
EUT Declared Modulation Parameters	Any, EUT reproduces signal including modulation that is applied to its fibre optic port from the host system it is connected too
EUT Declared Power level	+20dBm max
EUT Declared Signal Bandwidths	CW to 10MHz, EUT reproduces signal including bandwidth that is applied to its fibre optic port from the host system it is connected too
EUT Declared Channel Spacing's	Any, EUT reproduces signal including modulation that is applied to its fibre optic port from the host system it is connected too
EUT Declared Duty Cycle	Any, EUT reproduces signal including Duty cycle that is applied to its fibre optic port from the host system it is connected too
Unmodulated carrier available?	Yes, If a CW signal is applied via the host system
Declared frequency stability	No Frequency translation declared by applicant, EUT is reliant on Host system
RX Parameters	
Alignment range – receiver	150 - 2700 MHz
EUT Declared RX Signal Bandwidth	CW to 10 MHz, EUT receives signal including bandwidth that is applied to its Receive port and translates it to a fibre optic signal to pass to the host system it is connected too

2.3 Functional description

The UNlremote is used with the Zinwave Unihub to provide cellular and private radio services within buildings, sports arenas and similar areas. The system is wideband in nature operating in the 150 – 2700MHz frequency band and can support a wide range of radio services depending on the system connected to the service module of the UNihub.

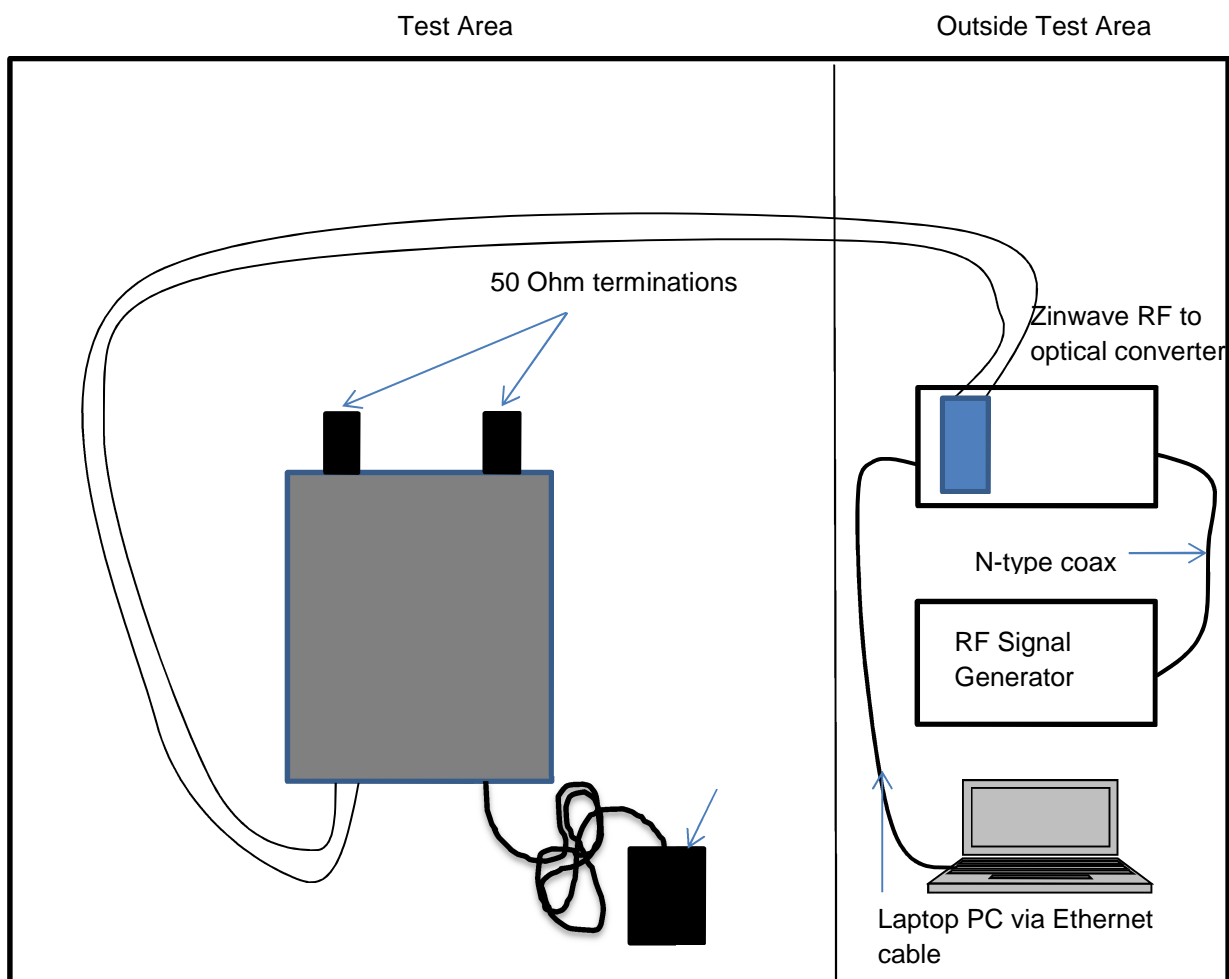
2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	EUT repeating constant signal at 136.0125MHz without modulation	Yes
Mode 2	EUT repeating constant signal at 150MHz without modulation	Yes
Mode 3	EUT repeating constant signal at 173.9875MHz without modulation	Yes
Mode 4	EUT repeating constant signal at 406.1125MHz without modulation	Yes
Mode 5	EUT repeating constant signal at 430MHz without modulation	Yes
Mode 6	EUT repeating constant signal at 453.9875MHz without modulation	Yes
Mode 7	EUT repeating constant signal at 456.0125MHz without modulation	Yes
Mode 8	EUT repeating constant signal at 480MHz without modulation	Yes
Mode 9	EUT repeating constant signal at 511.9875MHz without modulation	Yes
Mode 10	EUT repeating constant signal at 698.0125MHz without modulation	Yes
Mode 11	EUT repeating constant signal at 750MHz without modulation	Yes
Mode 12	EUT repeating constant signal at 823.9875MHz without modulation	Yes
Mode 13	EUT repeating constant signal at 851.0125MHz without modulation	Yes
Mode 14	EUT repeating constant signal at 855MHz without modulation	Yes
Mode 15	EUT repeating constant signal at 868.9875MHz without modulation	Yes
Mode 16	EUT repeating constant signal at 173.9375MHz + 173.9625MHz without modulation	Yes
Mode 17	EUT repeating constant signal at 453.2685MHz + 453.2935MHz without modulation	Yes
Mode 18	EUT repeating constant signal at 469.544MHz + 469.569MHz without modulation	Yes
Mode 19	EUT repeating constant signal at 809.4321MHz + 809.4571MHz without modulation	Yes
Mode 20	EUT repeating constant signal at 851.1555MHz + 851.1805MHz without modulation	Yes
Mode 21	EUT repeating constant signal at 866.5MHz with AWGN Modulation	Yes
Mode 22	EUT repeating constant signal at 866.5MHz with LTE Modulation	Yes
Mode 23	EUT repeating constant signal at 935.0125MHz without modulation	Yes
Mode 24	EUT repeating constant signal at 937.5MHz without modulation	Yes
Mode 25	EUT repeating constant signal at 939.9875MHz without modulation	Yes
Mode 26	EUT repeating constant signal at 935.1242 + 935.0992 MHz without modulation	Yes

Note: This report only pertains to the operation of the equipment to 47CFR parts 90 for details of testing to other rule parts please see RN reports:

11-8405-1-15 Issue 01 (Parts 22E, 22H, 24E)
11-8405-2-15 Issue 01 (Part 27)
11-8405-4-15 Issue 01 (Part 74H)

2.5 Emissions configuration



The unit was powered from the dedicated AC/DC adapter supplied with the unit. No conducted tests were required by the client. For radiated emissions testing both the TX and RX ports were populated with 50 ohm loads. The fibre port was connected back to a Zinwave Unihub which in turn was connected to one or two (combined) signal generator outputs when required. The signal generators were set as required to produce signals on the channels under test with the required bandwidths and modulation schemes. The unit was configured at +20 dBm maximum output power using the provided laptop and software which was used for all tests. Please refer to section 2.4 of this report for a list of test modes used. All transmit modes were 100% continuous. As the EUT can operate as a single channel enhancer and a multi-channel enhancer tests have been performed for both requirements.

Please refer to Zinwave test plan: SC_ZIN_TP10_A, for further information on test set-up, Channels/frequencies used for test and EUT bandwidths and modulation schemes.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Fibre	Fibre optic	Yes
DC Jack	2 core DC from AC/DC supply brick	Yes
TX port	N-Type, terminated into 50ohms	Yes
RX port	N-Type, terminated into 50ohms	Yes
Ethernet	RJ45 connector to cat 5 cable	No

3 Summary of test results

The UNlremote, 302-1107 was tested for compliance to the following standard(s) :

47 CFR Part 90.219(e)3 Effective Date 1st October 2014
↳ 47CFR part 2J

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. Spurious emissions at antenna terminals	47CFR part 2J Part 2.1051	NOT TESTED ¹
2. RF Power Output	47CFR part 2J Part 2.1046	NOT TESTED ¹
3. Frequency stability	47CFR part 2J Part 2.1055	NOT TESTED ¹
4. Occupied bandwidth	47CFR part 2J Part 2.1049	NOT TESTED ¹
5. Spurious Emissions, signal boosters	47CFR part 2J Part 2.1053, 47CFR part 90 Part 90.219(e)3	PASSED ²
6. Modulation characteristics	47CFR part 2J Part 2.1047	NOT TESTED ¹

¹ Not tested at request of applicant

² Spectrum investigated started at a frequency of 30 MHz up to a frequency of 10 GHz based on 10 times the highest channel of 939.9875 MHz.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47CFR part 90	2014	Part 90 – PRIVATE LAND MOBILE RADIO SERVICES
4.1.2	47CFR part 2J	2014	Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations
4.1.3	KDB 971168 D01 v02r02	2014	Measurement Guidance for Certification of Licensed Digital Transmitters
4.1.4	KDB 935210 D02 v03	2015	Signal boosters basic certification requirements
4.1.5	ITU-R SM.329-12	2012	Unwanted emissions in the spurious domain
4.1.6	TIA-603-D	2010	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards, Telecommunications Industry Association, June, 2010.

4.2 Deviations

The following tests have not been performed at the request of Zinwave Ltd:-
Spurious emissions at antenna terminals : Not tested at request of applicant,
RF Power Output : Not tested at request of applicant,
Frequency stability : Not tested at request of applicant,
Modulation characteristics : Not tested at request of applicant,
Occupied bandwidth : Not tested at request of applicant,

5 Tests, methods and results

5.1 Spurious emissions at antenna terminals

NOT TESTED: Not tested at request of applicant.

5.2 RF Power Output

NOT TESTED: Not tested at request of applicant.

5.3 Frequency stability

NOT TESTED: Not tested at request of applicant.

5.4 Occupied bandwidth

NOT TESTED: Not tested at request of applicant.

5.5 Spurious Emissions, Signal boosters

5.5.1 Test methods

Test Requirements:	47CFR part 2J Part 2.1053 [Reference 4.1.2 of this report], 47CFR part 90 Part 90.219(e)3 [Reference 4.1.1 of this report]
Test Methods:	KDB 971168 D01 v02r02 [Reference 4.1.3 of this report], TIA-603-D [Reference 4.1.6 of this report]
Limits:	47CFR part 90 Part 90.219(e)3 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was tested in an ALSE and ambient conditions were monitored. The EUT was examined in its declared normal use position. All test modes specified in section 2.4 were tested. As the EUT can operate as a single channel enhancer and a multi-channel enhancer, tests have been performed to satisfy both requirements.

5.5.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. Peak field strength from the EUT was maximised by rotating it 360 degrees.

30MHz - 1GHz.

The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Substitution method was performed using tuned dipoles / a calibrated bi-conical antenna. Measurement distance of 3metres was used.

1GHz – 10GHz.

The measuring antenna was used in both Horizontal and Vertical polarisations. Substitution method was performed using standard gain horn antennas. Measurement distances used were: 1 – 6 GHz at 3metres, 6 – 10 GHz at 1.2metres.

The EUT was tested in Site B.

5.5.4 Test equipment

E005, E268, E327, E410, E411, E412, E428, E533, E624, TMS78, TMS79, TMS82, E469

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	18-20°C
Humidity of test environment	50-60%
Pressure of test environment	101.5kPa

Setup Table

Band	136-174 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW single signal
Low channel	136.0125 MHz
Mid channel	150 MHz
High channel	173.9875 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	406.1-454 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW single signal
Low channel	406.1125 MHz
Mid channel	430 MHz
High channel	453.9875 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	456-512 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW single signal
Low channel	456.1125 MHz
Mid channel	480 MHz
High channel	511.9875 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	698-824 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW single signal
Low channel	698.0125 MHz
Mid channel	750 MHz
High channel	823.9875 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	851-869 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW single signal
Low channel	851.0125 MHz
Mid channel	855 MHz
High channel	868.9875 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	136-174 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW two signal
Channels	173.9375 + 173.9625 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	406.1-454 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW two signal
Channels	453.2685 + 453.2935 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	456-512 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW two signal
Channels	469.544 + 469.569 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	698-824 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW two signal
Channels	809.4321 + 809.4571 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	851-869 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW two signal
Channels	851.1555 + 851.1805 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	851-869 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	AWGN single signal
Channels	866.5 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	851-869 MHz
Power Level	20 dBm
Channel Spacing	5 MHz
Mod Scheme	LTE single signal
Channels	866.5 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	935-940 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW single signal
Channels	935.0125 MHz
Channels	937.5 MHz
Channels	939.9875 MHz

No signals observed within 20dB of emissions limits.

Setup Table

Band	935-940 MHz
Power Level	20 dBm
Channel Spacing	25 kHz
Mod Scheme	CW two signal
Channels	935.1242 + 935.0992MHz

No signals observed within 20dB of emissions limits.

No spurious emissions were found within 20 dB of limits for any of the stated test modes in 2.4.

LIMITS:

Part 90.219(e)3, -13dBm

Spurious emissions from a signal booster must not exceed -13 dBm within any 100 kHz measurement bandwidth.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
30MHz - 1GHz ± 3.9 dB, 1 – 18 GHz ± 3.5 dB, 18 – 26.5 GHz ± 3.9 dB

5.6 Modulation characteristics

NOT TESTED: Not tested at request of applicant.

6 Plots/Graphical results

As substitution method is employed for radiated emissions, no plots are required.

7 Explanatory Notes

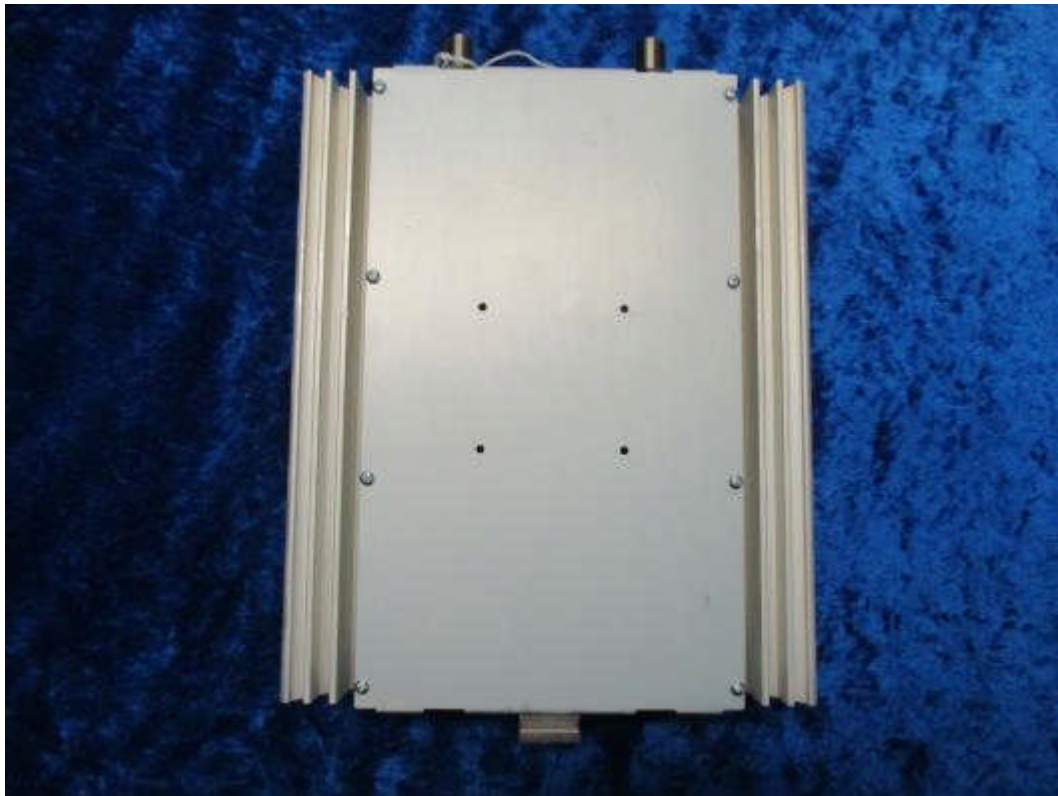
None.

8 Photographs

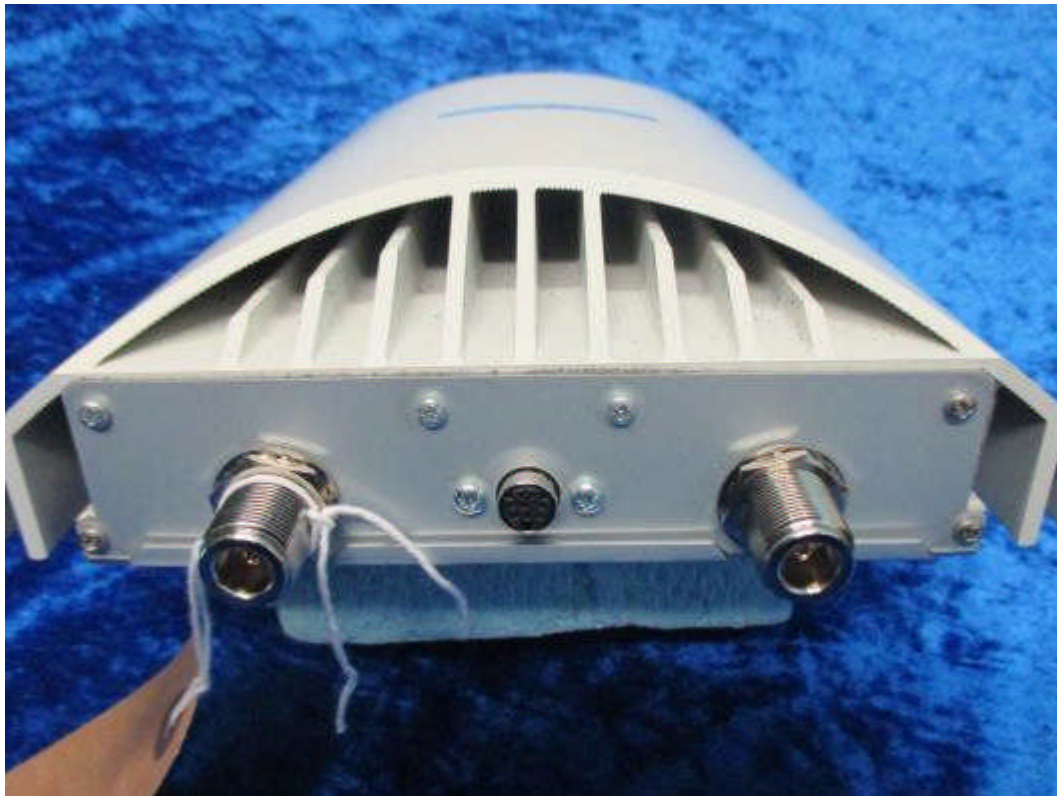
8.1 EUT Front View



8.2 EUT Reverse Angle



8.3 EUT Antenna Ports



8.4 EUT Display & Controls

None.

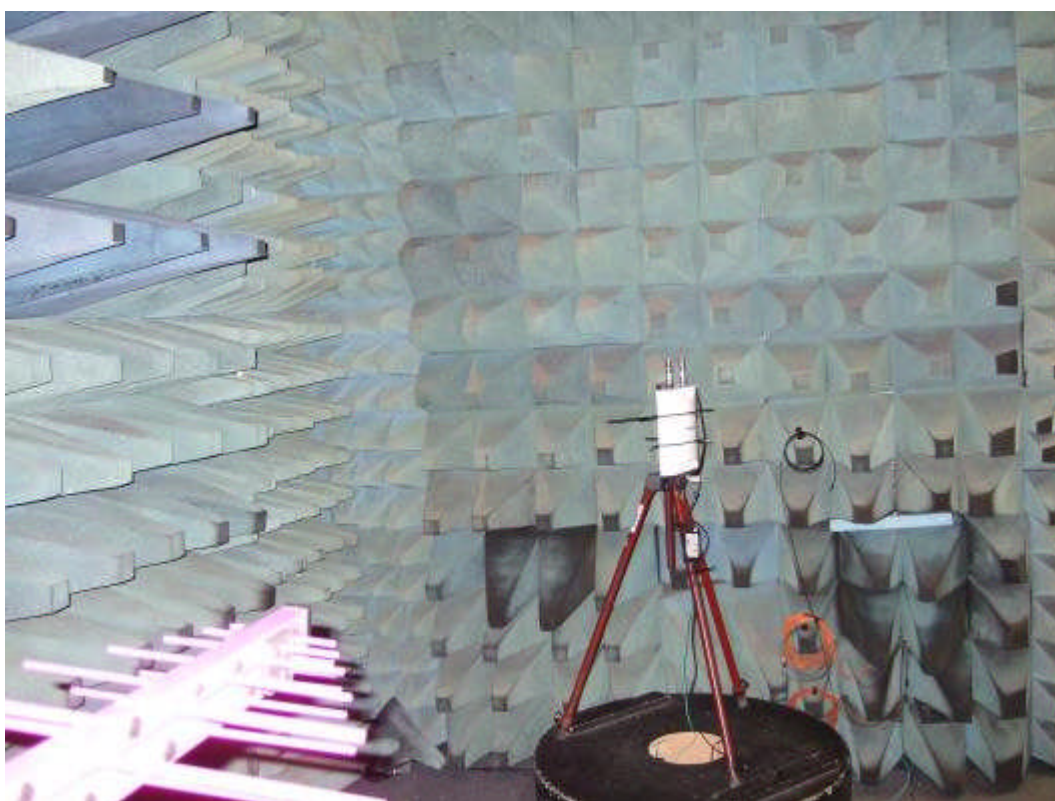
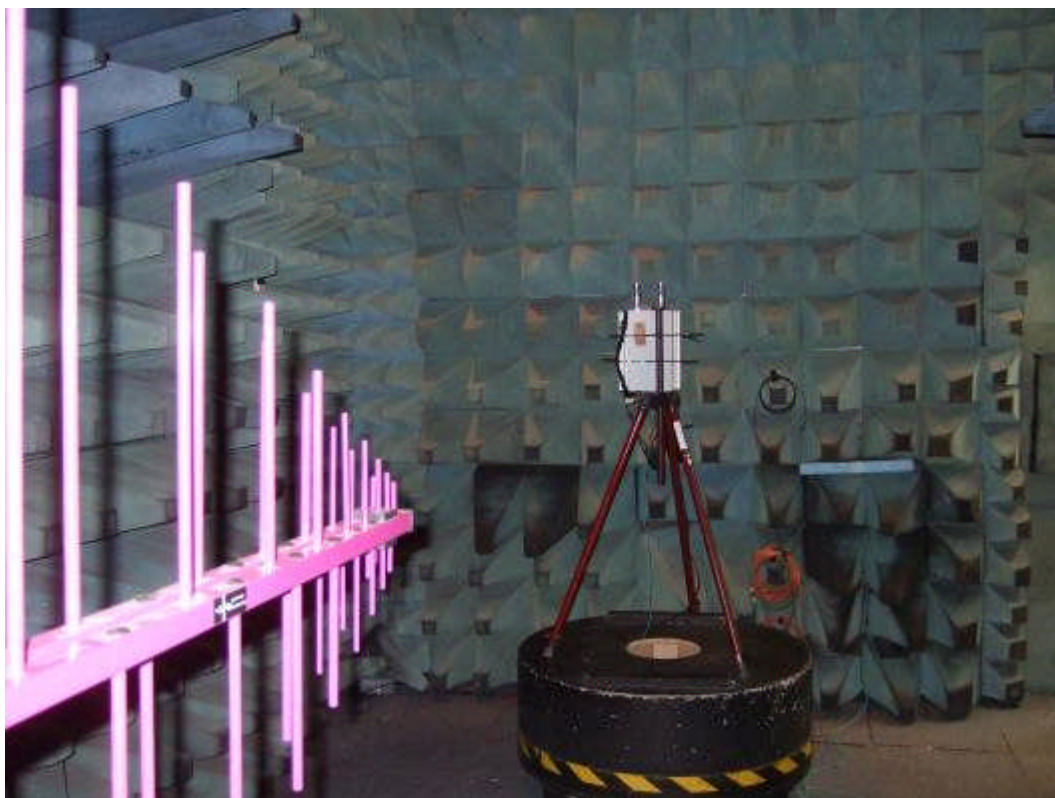
8.5 EUT Internal photos

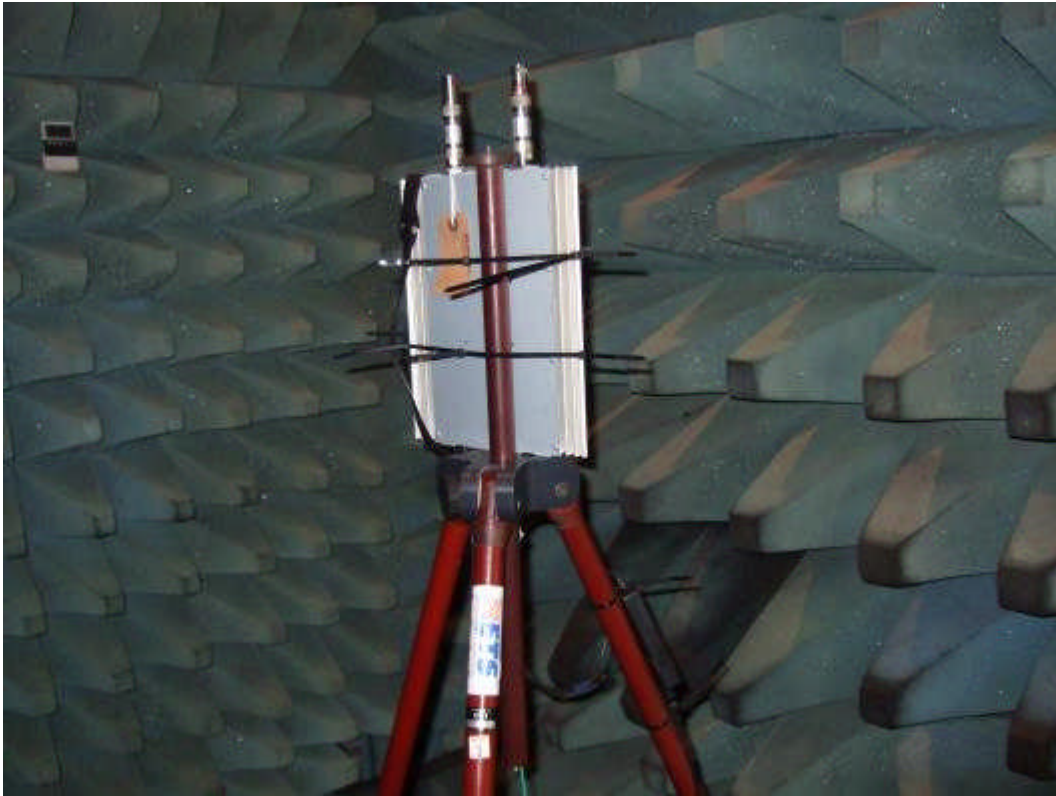
No photos taken.

8.6 EUT ID Label

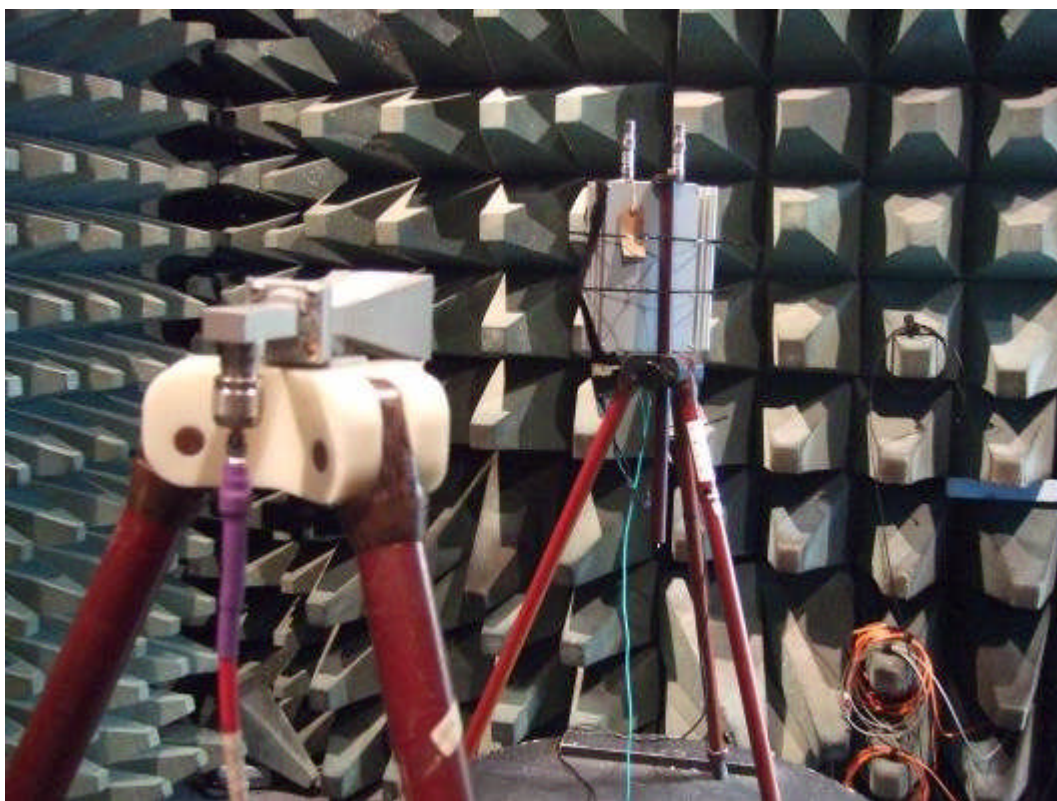
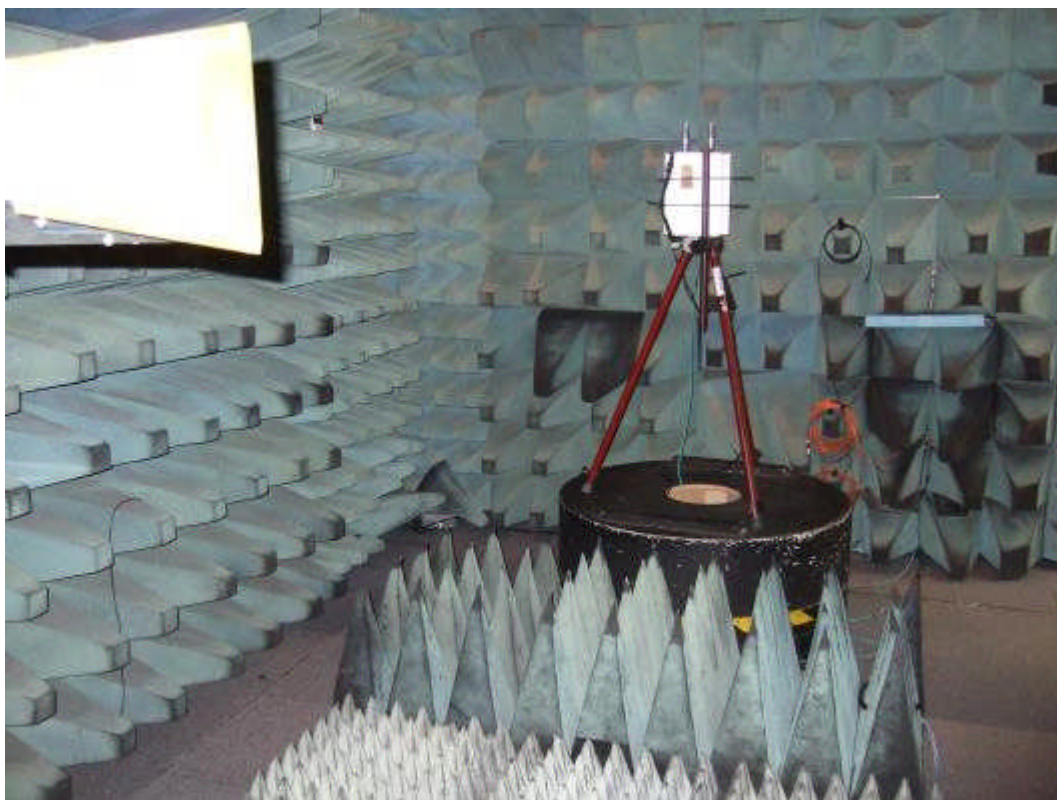
No EUT label supplied.

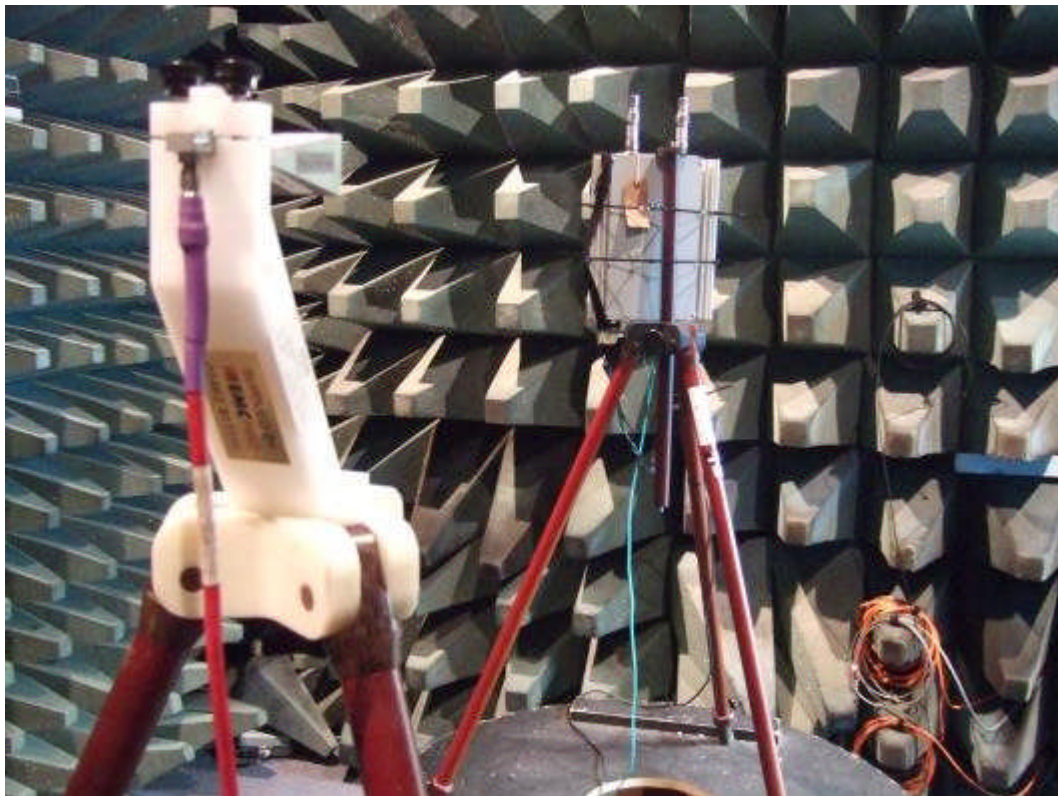
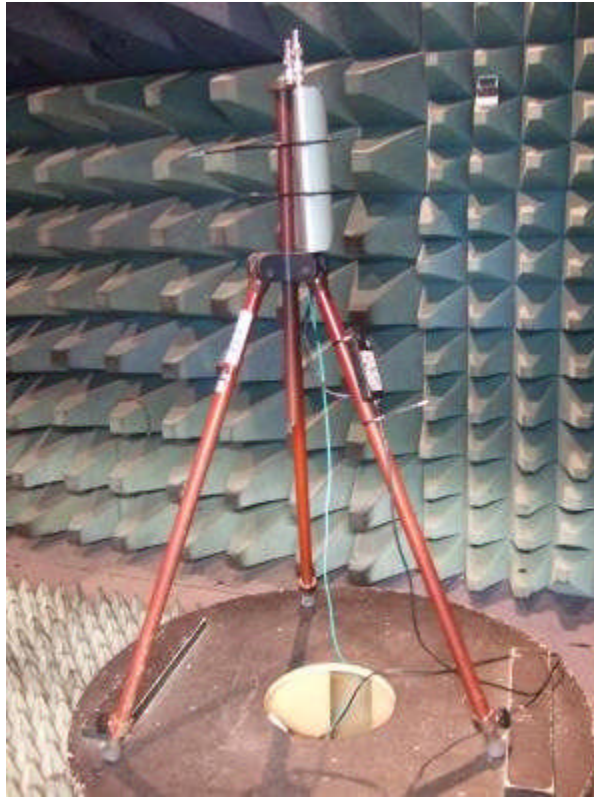
8.7 30 - 1000MHz Spurious emissions test set-up





8.8 Above 1GHz Spurious emissions test set-up





8.9 Radiated emission diagram

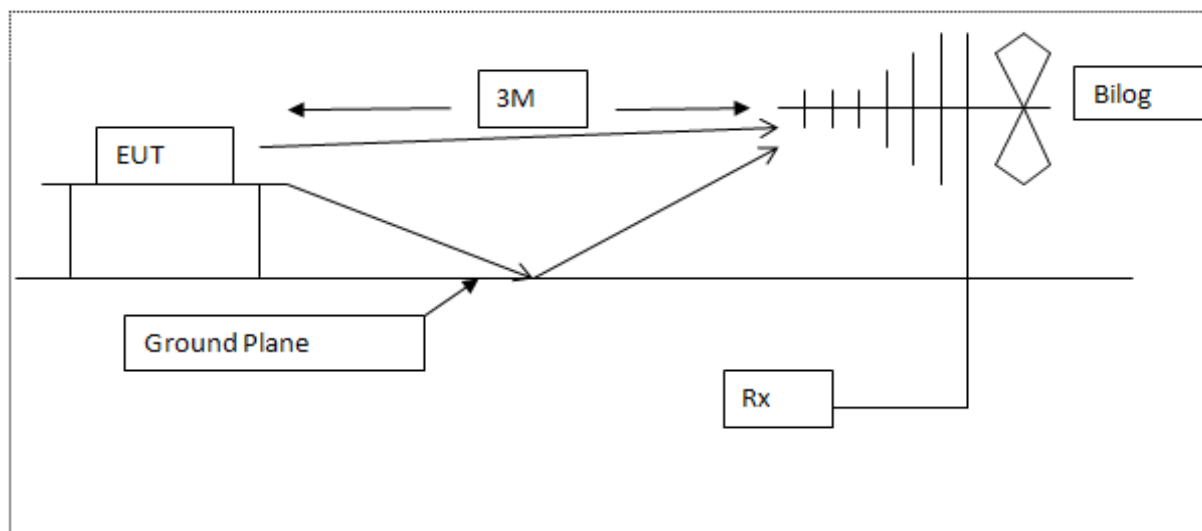


Diagram of the radiated emissions test setup 30 - 1000 MHz

9 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E005	HP8447F	Pre-Amplifier	Hewlett Packard	07-Jan-2015	12 months
E268	BHA 9118	1-18 GHz Horn Antenna	Schaffner	08-Apr-2015	24 months
E327	CBL6141A	Bi-log Antenna	Schaffner	09-May-2014	24 months
E410	N5181A	3 GHz MXG Signal Generator	Agilent Technologies	30-Apr-2015	36 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	29-Apr-2015	12 months
E412	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	29-Apr-2015	24 months
E428	HF906	1-18 GHz Horn Antenna	Rohde & Schwarz	28-Jan-2014	24 months
E533	N5182A	6 GHz MXG Signal Generator	Agilent Technologies	26-Feb-2013	36 months
E624	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	07-Oct-2015	24 months
TMS78	3160-08	Std Gain Horn Antenna 12.4-18 GHz	ETS Systems	05-Jun-2015	12 months
TMS79	3160-09	Std Gain Horn Antenna 18-26.5 GHz	ETS Systems	05-Jun-2015	12 months
TMS82	8449B	Pre Amplifier 1 - 26 GHz	Agilent	*17-Dec-2015	12 months

* Equipment was within calibration dates for tests and has been re-calibrated since date of tests.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	E6510	Laptop +PSU	Dell	-
2	302-1001	Optical to RF converter Box	Zinwave	3.703E+11
3	E4433B	Signal Generator	Agilent	-
4	SMBV100A	Signal Generator	Rhode & Schwarz	-
5	ZAPD-2	Combiner/splitter	Mini Circuits	15542

10.2 RN Electronics supplied equipment

No RN Electronics Ltd supplied equipment was used.

11 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

11.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 Description of test sites

Site A	Radio / Calibration Laboratory and anechoic chamber
Site B	Semi-anechoic chamber
Site B1	Control Room for Site B
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions) VCCI Registration No. C-2823
Site G	Screened Room (Control Room for Site H)
Site H	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 293246 IC Registration No. 5612A-2
Site J	Screened Room
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-anechoic chamber (indoor OATS) FCC Registration No. 293246
Site Q	Fully-anechoic chamber
Site OATS 3m and 10m Open Area Test Site	FCC Registration No. 293246 IC Registration No. 5612A-1 VCCI Registration No. R-2580
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

13 Abbreviations and units

%	Percent	LBT	Listen Before Talk
µA/m	microAmps per metre	LO	Local Oscillator
µV	microVolts	mA	milliAmps
µW	microWatts	max	maximum
AC	Alternating Current	kPa	Kilopascal
ALSE	Absorber Lined Screened Enclosure	Mbit/s	MegaBits per second
AM	Amplitude Modulation	MHz	MegaHertz
Amb	Ambient	mic	Microphone
ATPC	Automatic Transmit Power Control	min	minimum
BER	Bit Error Rate	mm	milliMetres
°C	Degrees Celsius	ms	milliSeconds
C/I	Carrier / Interferer	mW	milliWatts
CEPT	European Conference of Postal and Telecommunications Administrations	NA	Not Applicable
COFDM	Coherent OFDM	nom	Nominal
CS	Channel Spacing	nW	nanoWatt
CW	Continuous Wave	OATS	Open Area Test Site
dB	decibels	OFDM	Orthogonal Frequency Division Multiplexing
dBµA/m	decibels relative to 1µA/m	ppm	Parts per million
dBµV	decibels relative to 1µV	PRBS	Pseudo Random Bit Sequence
dBc	decibels relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	decibels relative to 1mW	QPSK	Quadrature Phase Shift Keying
DC	Direct Current	R&TTE	Radio and Telecommunication Terminal Equipment
DTA	Digital Transmission Analyser	Ref	Reference
EIRP	Equivalent Isotropic Radiated Power	RF	Radio Frequency
ERP	Effective Radiated Power	RFC	Remote Frequency Control
EU	European Union	RSL	Received Signal Level
EUT	Equipment Under Test	RTP	Room Temperature and Pressure
FM	Frequency Modulation	RTPC	Remote Transmit Power Control
FSK	Frequency Shift Keying	Rx	Receiver
g	Grams	s	Seconds
GHz	GigaHertz	SINAD	Signal to Noise And Distortion
Hz	Hertz	Tx	Transmitter
IF	Intermediate Frequency	V	Volts
kHz	kiloHertz		