TEST REPORT
FROM
RADIO FREQUENCY
INVESTIGATION LTD.

Test Of: Red-M (Communications) Ltd.
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)

To: F.C.C. Part 15 Subpart C: 1998
(Intentional Radiators)
Section 15.247

Test Report Serial No:
RFI/EMCB1/RP41715C

This Test Report Is Issued Under The Authority Of Brian Watson Technical Director: 	**Checked By:** 
Tested By:  **p.p**	**Release Version No: PDF01**
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Test Of: Red-M (Communications) Ltd.
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247

Table of Contents

1. Client Information 4
2. Equipment Under Test (EUT) 5
3. Test Specification, Methods And Procedures 7
4. Deviations From The Test Specification 9
5. Operation Of The EUT During Testing 10
6. Summary Of Test Results 11
7. Measurements, Examinations And Derived Results 12
8. Measurement Uncertainty 26
Appendix 1. Test Equipment Used 27
Appendix 2. Measurement Methods 28
Appendix 3. Test Configuration Drawings 34

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

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1. Client Information

Company Name:	Madge Networks Ltd.
Address:	Red M Division Wrexham Springs Framewood Road Wexham Slough Berks SL3 6PJ United Kingdom.
Contact Name:	Mr C. O'Brien.

2. Equipment Under Test (EUT)

The client has supplied the following information (with the exception of the Date of Receipt):

2.1. Identification Of Equipment Under Test (EUT)

Brand Name:	Red-M
Model Name or Number:	3000AS
Unique Type Identification:	Not applicable
Serial Number:	00028110400A0
Country of Manufacture:	UK
FCC ID Number:	Pending
Date of Receipt:	5 December 2000

Brand Name:	Red-M
Model Name or Number:	Access Server External Aerial (3000-501)
Unique Type Identification:	Not applicable
Serial Number:	1
Country of Manufacture:	UK
FCC ID Number:	Pending
Date of Receipt:	5 December 2000

2.2. Description Of EUT

The 3000AS is a Bluetooth Access Server. It provides connectivity between Bluetooth devices, LAN and WAN. The product has an in-built Bluetooth antenna and the option for the connection of an external antenna.

2.3. Modifications Incorporated In EUT

The EUT has not been modified from what is described by the Model Name and Unique Type Identification stated above.

2.4. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	10/100 Switch
Brand Name:	3COM
Model Name or Number:	3 Com Office Connect Dual Speed Hub 8
Serial Number:	0101/7P1F67471
FCC ID Number:	None stated
Cable Length And Type:	3m, 10/100 Type
Connected to Port:	10/100

3. Test Specification, Methods And Procedures

3.1. Test Specification

Reference:	FCC Part 15 Subpart C: 1998 Section 15.247 (15.207 and 15.209).
Title:	Code of Federal Regulations, Part 15 (47CFR15) Radio Frequency Devices: Digital Devices.
Comments:	A description of the test facility used for this test is on file with, and has been accepted by, the Federal Communications Commission as required by Section 2.948 of Federal Rules.
Purpose of Test:	To determine whether the equipment complied with the requirements of the specification for the purposes of certification.

Reference:	FCC Part 15 Subpart B: 1998.
Title:	Code of Federal Regulations, Part 15 (47CFR15) Radio Frequency Devices: Digital Devices.
Comments:	A description of the test facility used for this test is on file with, and has been accepted by, the Federal Communications Commission as required by Section 2.948 of Federal Rules.
Purpose of Test:	To determine whether the equipment complied with the requirements of the specification for the purposes of certification.

3.2. Methods And Procedures

The methods and procedures used were as detailed in:

ANSI C63.2 (1987)
Title: American National Standard for Instrumentation - Electromagnetic noise and field strength.

ANSI C63.4 (1992)
Title: American National Standard Methods of Measurement of Electromagnetic Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.5 (1988)
Title: American National Standard for the Calibration of antennas used for Radiated Emission measurements in Electromagnetic Interference (EMI) control.

ANSI C63.7 (1988)
Title: American National Standard Guide for Construction of Open Area Test Sites for performing Radiated Emission Measurements.

CISPR 16-1: (1999)
Title: Specification For Radio Disturbance and Immunity Measuring Apparatus and Methods. Part 1: Radio Disturbance and Immunity Measuring Apparatus.

3.3. Definition Of Measurement Equipment

The measurement equipment used complied with the requirements of the standards referenced in the Methods & Procedures section above. Appendix 1 contains a list of the test equipment used.

4. Deviations From The Test Specification

None.

5. Operation Of The EUT During Testing

5.1. Operating Conditions

The EUT was tested in a normal laboratory environment.

During testing, the EUT was powered by a 115 V, 60 Hz AC Mains supply.

5.2. Operating Modes

The EUT was tested in the following operating modes:

During testing the EUT was operated in the following modes:

1: Test Mode: The EUT operated in a test mode with all channels active (transmitting data on pseudo random hopping channels).

2: Enquiry Mode: The EUT operated as intended transmitting and receiving on all pseudo random hopping channels.

3: Receive Mode: The EUT did not transmit on any channels but received on all hopping frequencies.

The reason for choosing these modes was that it was defined by the client as being likely to be the worst case with regards EMC.

5.3. Configuration And Peripherals

The EUT was tested in the following configuration:

During the tests, the EUT was configured as intended with all ports terminated. However due to the operation of the EUT the following tests were performed with the antenna removed, and test equipment connected to the antenna port:

1: Conducted AC Mains Emissions.
2: Conducted Antenna Port Transmit Power
3: Conducted Antenna Port Spurious Emissions (30 to 26000 MHz)
4: Modulation Requirements / Channel Spacing / Timing Requirements

The client has specified that the EUT is equipped with both an internal and an external antenna. The software within the EUT controls which antenna is active at any one time.

The reason for choosing this configuration was that it was defined by the client as being likely to be the worst case with regards EMC.

NB Section 2 of this report contains a full list of support equipment used and Appendix 3 contains a schematic diagram of the test configuration.

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

6. Summary Of Test Results

6.1. Emissions: Transmit Mode

Range Of Measurements	Specification Reference	Compliancy Status
Conducted AC Mains Emissions	C.F.R. 47 FCC Part 15: 1998. Section 15.207	Complied
Conducted Antenna Port Transmit Power	C.F.R. 47 FCC Part 15: 1998. Section 15.247 (b)	Complied
Conducted Antenna Port Spurious Emissions (30 to 26000 MHz)	C.F.R. 47 FCC Part 15: 1998. Section 15.247 (c)	Complied
Modulation Requirements / Channel Spacing / Timing Requirements	C.F.R. 47 FCC Part 15: 1998. Section 15.247 (a)	Complied
Isotropic Effective Radiated Power (EIRP)	C.F.R. 47 FCC Part 15: 1998. Section 15.247 (a3)	Complied
Radiated Electric Field Strength Spurious Emissions (30 to 26000 MHz)	C.F.R. 47 FCC Part 15: 1998. Section 15.247 (c) (15.209)	Complied

6.2. Emissions: Receive Mode

Range Of Measurements	Specification Reference	Compliancy Status
Conducted AC Mains Emissions	C.F.R. 47 FCC Part 15: 1998. Section 15.107	Complied
Radiated Electric Field Strength Spurious Emissions (30 to 26000 MHz)	C.F.R. 47 FCC Part 15: 1998. Section 15.109	Complied

6.3. Location Of Tests

All the measurements described in this report were performed at the premises of Radio Frequency Investigation Ltd, Ewhurst Park, Ramsdell, Basingstoke, Hampshire, RG26 5RQ, England.

7. Measurements, Examinations And Derived Results

7.1. General Comments

7.1.1. This section contains test results only. Details of the test methods and procedures can be found in Appendix 2 of this report.

7.1.2. The measurement uncertainties stated were calculated in accordance with the requirements of NAMAS Document NIS 81 with a confidence level of 95%. Please refer to Section 8 for details of measurement uncertainties.

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

7.2. Test Results For Conducted Emissions: Transmit Mode.

7.2.1. Quasi-Peak Detector Measurements On Live And Neutral Lines

7.2.1.1. Plots of the initial scans can be found in Appendix 4.

7.2.1.2. During the test, the EUT was operated as specified in Section 5.2 of this test report.

7.2.1.3. The following table lists frequencies at which emissions were measured using a Quasi-Peak detector:

Frequency (MHz)	Line	Q-P Level (dBmV)	Q-P Limit (dBmV)	Margin (dB)	Result
7.923	Live	32.12	48.0	15.8	Complied
7.923	Neutral	30.16	48.0	17.8	Complied
10.794	Live	34.86	48.0	13.1	Complied
10.794	Neutral	34.96	48.0	13.0	Complied
16.228	Live	40.35	48.0	7.6	Complied
16.229	Neutral	41.54	48.0	6.4	Complied
18.305	Live	44.59	48.0	3.4	Complied
19.588	Neutral	40.12	48.0	7.8	Complied
19.709	Live	43.19	48.0	4.8	Complied
22.213	Live	43.22	48.0	4.7	Complied
23.129	Neutral	45.93	48.0	2.0	Complied

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

7.3. Tests for Conducted Transmitter Power: Transmit Mode.

7.3.1. Tests were performed to identify the maximum transmit power to FCC Part 15.247(b3).

7.3.2. The client has specified that the antenna port termination where measurements were performed was common for both the internal and external antenna. Therefore tests for spurious emissions was performed once with the antennas removed to allow a direct connection to be made.

7.3.3. The client has specified that the EUT employs frequency hopping with 79 hopping channels. Therefore the maximum transmitter power level under Part 15 of the FCC rules is 1 Watt.

7.3.4. Measurements were performed to identify the channel, which exhibited the highest level of transmitted output. Graphical plots showing the maximum transmitter power can be seen in Appendix 4 (Plot 001) of this test report.

Frequency Range (MHz)	Maximum Transmitter Output Level (dBm)	Maximum Transmitter Output Level (Watts)	Limit (Watts)	Margin	Result
2402 to 2480	7.34	0.00542	1.0	0.99458	Complied

7.3.5. It could be determined from Plot 001 in Appendix 4 that the number of hopping channels employed by the EUT was 79.

7.4. Tests for Antenna Port Spurious Emissions: Transmit Mode.

7.4.1. Spurious emissions tests on the antenna port were performed to Part 15.247(c).

7.4.2. The client has specified that the antenna port termination where measurements were performed was common for both the internal and external antenna. Therefore tests for spurious emissions were performed once with the antennas removed to allow a direct connection to be made.

7.4.3. Section 15.247(c) specifies that all spurious emissions should be attenuated at least 20dB below the level of the highest fundamental level measured between the range of 2400 to 2483.5 MHz.

7.4.4. Scans were performed between 30 and 26000MHz. Initial scans indicated that all spurious emissions were of an amplitude at least 20dB below the reference limit line.

7.4.5. Plots of the initial scans can be found in Appendix 4.

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

7.5. Test Results For Isotropic Effective Radiated Power (EIRP): Transmit Mode.

7.5.1. Tests were performed to determine the EIRP levels of the EUT under normal operating conditions.

7.5.2. Tests were performed with the EUT set to operate on bottom, middle and top channels.

Results:

7.5.3. The following results are for the EUT configured with an internal antenna connected and operating.

Channel	Frequency	Antenna Polarity	Level (dBm)	Level (Watts)
Bottom	2.402	Vert.	2.5	0.00178
		Horiz.	0.2	0.00105
Middle	2.441	Vert.	2.8	0.00191
		Horiz.	1.5	0.00141
Top	2.480	Vert.	0.3	0.00107
		Horiz.	-1.5	0.00071

7.5.4. The following results are for the EUT configured with an external antenna connected and operating.

Channel	Frequency	Antenna Polarity	Level (dBm)	Level (Watts)
Bottom	2.402	Vert.	0.7	0.00117
		Horiz.	1.0	0.00126
Middle	2.441	Vert.	0.0	0.00100
		Horiz.	1.0	0.00126
Top	2.480	Vert.	-2.1	0.00062
		Horiz.	-0.5	0.00089

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

7.6. Test Results For Radiated Emissions: Transmit Mode.

7.6.1. Electric Field Strength Measurements: 30 to 1000 MHz.

7.6.1.1. The following table specifies frequencies, which fall within the restricted bands as specified in section 15.205.

7.6.1.2. Plots of the initial scans can be found in Appendix 4.

7.6.1.3. The following table lists frequencies at which emissions were measured using a Quasi-Peak detector at a test distance of 3m (results incorporate antenna factors and cable losses):

Results:

7.6.1.4. The following results are for the EUT configured with an internal antenna connected and operating.

Frequency (MHz)	Antenna Polarization	Q-P Level (dBmV)	Q-P Limit (dBmV)	Margin (dB)	Result
73.110	Vert.	25.7	40.0	14.3	Complied
112.252	Vert.	29.6	43.5	13.9	Complied
124.999	Vert.	36.5	43.5	7.0	Complied
132.930	Vert.	28.1	43.5	15.4	Complied
149.999	Vert.	35.8	43.5	7.7	Complied
166.630	Vert.	31.2	43.5	12.3	Complied
170.577	Horiz.	25.3	43.5	18.2	Complied
250.013	Horiz.	45.5	46.0	0.5	Complied

7.6.1.5. The following results are for the EUT configured with an external antenna connected and operating.

Frequency (MHz)	Antenna Polarization	Q-P Level (dBmV)	Q-P Limit (dBmV)	Margin (dB)	Result
73.110	Vert.	26.5	40.0	13.5	Complied
112.252	Vert.	32.0	43.5	11.5	Complied
124.999	Vert.	38.4	43.5	5.1	Complied
132.930	Vert.	27.3	43.5	16.2	Complied
149.999	Vert.	37.4	43.5	6.1	Complied
166.630	Vert.	34.8	43.5	8.7	Complied
170.577	Horiz.	30.1	43.5	13.4	Complied
250.013	Horiz.	43.7	46.0	2.3	Complied

7.7. Test Results For Radiated Emissions: Transmit Mode

7.7.1. Electric Field Strength Measurements: 1.0 to 26.0 GHz

7.7.1.1. The following table specifies frequencies, which fall within the restricted bands as specifies in section 15.205.

7.7.1.2. Plots of the initial scans can be found in Appendix 4.

7.7.1.3. The following table lists frequencies at which emissions were measured using an Average and Peak detector at a test distance of 3m (results incorporate antenna factors and cable losses):

Results:

7.7.1.4. The following results are for the EUT configured with an internal antenna connected and operating.

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

7.7.2. Electric Field Strength Measurements

7.7.2.1. The client has stated that the highest clock frequency for the EUT was 2.480 GHz. Therefore tests were performed up to 26 GHz.

7.7.2.2. Plots of the initial scans can be found in Appendix 4.

7.7.2.3. The following tables list frequencies at which emissions were measured using Peak and Average detector functions(results incorporate antenna factors and cable losses):

Highest Average Level:

Frequency (GHz)	Antenna Polarity (H/V)	Average Detector level (dBmV)	Antenna factor (dB)	Cable loss (dB)	Actual Average Level (dBmV/m)	Average Limit (dBmV/m)	Average Margin (dB)	Result
2.3881	Vert.	16.8	20.5	1.1	38.44	54.0	15.56	Complied
2.4864	Vert.	16.4	20.5	1.1	38.01	54.0	15.99	Complied
2.4937	Vert.	16.3	20.5	1.1	37.94	54.0	16.06	Complied
2.3881	Horiz.	16.4	20.5	1.1	38.10	54.0	15.9	Complied
2.4864	Horiz.	16.2	20.5	1.1	37.81	54.0	16.19	Complied
2.4937	Horiz.	16.2	20.5	1.1	37.84	54.0	16.16	Complied
4.8112	Horiz.	17.4	24.8	1.8	44.04	54.0	9.96	Complied
4.8112	Vert.	16.9	24.8	1.8	43.59	54.0	10.41	Complied
4.8188	Horiz.	17.0	24.8	1.8	43.64	54.0	10.36	Complied
4.8188	Vert.	17.0	24.8	1.8	43.61	54.0	10.39	Complied

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

Highest Peak Level:

Frequency (GHz)	Antenna Polarity (H/V)	Average Detector level (dBmV)	Antenna factor (dB)	Cable loss (dB)	Actual Peak Level (dBmV/m)	Peak Limit (dBmV/m)	Peak Margin (dB)	Result
2.3881	Vert.	28.5	20.5	1.1	50.17	74.0	23.83	Complied
2.4864	Vert.	40.8	20.5	1.1	62.47	74.0	11.53	Complied
2.4937	Vert.	38.2	20.5	1.1	59.86	74.0	14.14	Complied
2.3881	Horiz.	30.1	20.5	1.1	51.72	74.0	22.28	Complied
2.4864	Horiz.	34.4	20.5	1.1	55.99	74.0	18.01	Complied
2.4937	Horiz.	31.9	20.5	1.1	53.51	74.0	20.49	Complied
4.8112	Horiz.	35.9	24.8	1.8	62.56	74.0	11.44	Complied
4.8112	Vert.	28.4	24.8	1.8	55.09	74.0	18.91	Complied
4.8188	Horiz.	29.0	24.8	1.8	55.61	74.0	18.39	Complied
4.8188	Vert.	28.4	24.8	1.8	55.19	74.0	18.81	Complied

7.7.2.4. The following results are for the EUT configured with an external antenna connected and operating (results incorporate antenna factors and cable losses):

Highest Average Level:

Frequency (GHz)	Antenna Polarity (H/V)	Average Detector level (dBmV)	Antenna factor (dB)	Cable loss (dB)	Actual Average Level (dBmV/m)	Average Limit (dBmV/m)	Average Margin (dB)	Result
2.3320	Horiz.	16.1	20.5	1.1	37.78	54.0	16.22	Complied
2.3320	Vert.	16.2	20.5	1.1	37.81	54.0	16.19	Complied
2.3663	Horiz.	16.4	20.5	1.1	38.05	54.0	15.95	Complied
2.3663	Vert.	16.5	20.5	1.1	38.15	54.0	15.85	Complied
2.3806	Horiz.	16.3	20.5	1.1	37.90	54.0	16.10	Complied
2.3806	Vert.	16.3	20.5	1.1	37.98	54.0	16.02	Complied
2.3871	Horiz.	16.2	20.5	1.1	37.88	54.0	16.12	Complied
2.3871	Vert.	16.4	20.5	1.1	38.03	54.0	15.97	Complied
2.4894	Horiz.	15.9	20.5	1.2	37.56	54.0	16.44	Complied
2.4894	Vert.	16.0	20.5	1.2	37.66	54.0	16.34	Complied
2.4963	Horiz.	16.0	20.5	1.2	37.61	54.0	16.39	Complied
2.4963	Vert.	16.4	20.5	1.2	38.03	54.0	15.97	Complied

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

Highest Peak Level:

Frequency (GHz)	Antenna Polarity (H/V)	Average Detector level (dBmV)	Antenna factor (dB)	Cable loss (dB)	Actual Peak Level (dBmV/m)	Peak Limit (dBmV/m)	Peak Margin (dB)	Result
2.3320	Horiz.	29.6	20.5	1.1	51.22	74.0	22.78	Complied
2.3320	Vert.	29.1	20.5	1.1	50.75	74.0	23.25	Complied
2.3663	Horiz.	30.6	20.5	1.1	52.27	74.0	21.73	Complied
2.3663	Vert.	33.0	20.5	1.1	54.68	74.0	19.32	Complied
2.3806	Horiz.	34.3	20.5	1.1	55.93	74.0	18.07	Complied
2.3806	Vert.	37.1	20.5	1.1	58.72	74.0	15.28	Complied
2.3871	Horiz.	36.4	20.5	1.1	58.02	74.0	15.98	Complied
2.3871	Vert.	38.9	20.5	1.1	60.58	74.0	13.42	Complied
2.4894	Horiz.	36.6	20.5	1.1	58.25	74.0	15.75	Complied
2.4894	Vert.	39.8	20.5	1.1	61.46	74.0	12.54	Complied
2.4963	Horiz.	36.2	20.5	1.1	57.83	74.0	16.17	Complied
2.4963	Vert.	37.3	20.5	1.1	58.96	74.0	15.04	Complied

7.8. Tests for Occupied Bandwidth, Channel Separation and Time Occupancy.

7.8.1. Tests were performed to identify the Occupied Bandwidth, Channel Separation and Time Occupancy to FCC Part 15.247.

Occupied Bandwidth and Channel Separation:

7.8.2. Section 15.247 (a1) specifies that the channels should be separated by at least 25kHz or the 20dB bandwidth of the channel, and section 15.247 (a1ii) specifies that the maximum bandwidth of the channel should be 1MHz.

Results:

7.8.3. A graphical plot of the characteristics of two adjacent channels was performed. The following results were noted:

Occupied Bandwidth: 821kHz. (Refer to Appendix 4 Plot 003)

Channel Spacing: 998.9kHz. (Refer to Appendix 4 Plot 002)

Time Occupancy:

7.8.4. The time occupancy of the system was tested on a single carrier. The test was carried out 3 times to gain a maximum occupancy time for the given carrier. The maximum packet length was measured to be 2.866ms and can be seen in Appendix 4 (Plot 033). The maximum time the carrier was used in a 30 second period was measured as 0.138 seconds and can be seen in Appendix 4(Plot 035).

Channel Number	Test Number	Time Occupancy	Plot Number	Limit	Result
Middle	1	0.106	034	0.4	Complied
Middle	2	0.138	035	0.4	Complied
Middle	3	0.121	036	0.4	Complied

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

7.9. Radiated Emissions: Receive Mode

7.9.1. Electric Field Strength Measurements (Frequency Range: 30 to 1000 MHz)

7.9.1.1. The following table indicates measured results with the EUT operated in receive mode to the limits specified in Part 15.109.

7.9.1.2. Plots of the initial scans can be found in Appendix 4.

7.9.1.3. The following table lists frequencies at which emissions were measured using a Quasi-Peak detector at a test distance of 10m (results incorporate antenna factors and cable losses):

Frequency (MHz)	Antenna Polarization	Q-P Level (dBmV)	Q-P Limit (dBmV)	Margin (dB)	Result
43.829	Vert.	28.6	29.5	0.8	Complied
61.660	Vert.	29.3	29.5	0.1	Complied
84.895	Vert.	27.4	29.5	2.1	Complied
125.007	Horiz.	26.2	33.0	6.8	Complied
142.693	Vert.	23.4	33.0	9.6	Complied
375.024	Vert.	30.1	35.5	5.4	Complied
528.075	Horiz.	35.2	35.5	0.2	Complied
594.085	Vert.	31.8	35.5	3.7	Complied

7.10. Radiated Emissions: Receive Mode

7.10.1. Electric Field Strength Measurements (Frequency Range: 1.0 to 26.0 GHz)

7.10.1.1. The following table indicates measured results with the EUT operated in receive mode to the limits specified in Part 15.109.

7.10.1.2. Plots of the initial scans can be found in Appendix 4.

7.10.1.3. The following table lists frequencies at which emissions were measured using an Average and Peak detector at a test distance of 3m (results incorporate antenna factors and cable losses):

Frequency (GHz)	Antenna Polarity (H/V)	Average Detector level (dBmV)	Antenna factor (dB)	Cable loss (dB)	Actual Average Level (dBmV/m)	Average Limit (dBmV/m)	Average Margin (dB)	Result
1.0344	Vert.	20.04	22.2	6.2	48.44	54.0	5.56	Complied
1.0344	Horiz.	21.97	22.2	6.2	50.37	54.0	3.63	Complied
1.0722	Vert.	21.29	22.5	6.4	50.19	54.0	3.81	Complied
1.0722	Horiz.	22.07	22.5	6.4	50.97	54.0	3.03	Complied
1.1522	Vert.	20.14	22.0	6.61	48.75	54.0	5.24	Complied
1.1522	Horiz.	21.36	22.0	6.61	49.97	54.0	4.03	Complied
1.1966	Vert.	20.42	21.5	6.73	48.65	54.0	5.35	Complied
1.1966	Horiz.	22.03	21.5	6.73	50.26	54.0	3.74	Complied
1.2277	Vert.	20.68	21.6	6.8	49.08	54.0	4.92	Complied
1.2277	Horiz.	22.43	21.6	6.8	50.83	54.0	3.17	Complied
1.2888	Vert.	20.88	21.9	7.01	49.79	54.0	4.21	Complied
1.2888	Horiz.	21.18	21.9	7.01	50.09	54.0	3.91	Complied
1.3422	Vert.	20.83	22.3	7.16	50.29	54.0	3.71	Complied
1.3422	Horiz.	21.44	22.3	7.16	50.90	54.0	3.1	Complied

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

Electric Field Strength Measurements (Frequency Range: 1.0 to 26.0 GHz) (continued)

Frequency (GHz)	Antenna Polarity (H/V)	Peak Detector level (dBmV)	Antenna factor (dB)	Cable loss (dB)	Actual Peak Level (dBmV/m)	Peak Limit (dBmV/m)	Peak Margin (dB)	Result
1.0344	Vert.	30.30	22.2	6.2	58.7	74.0	15.3	Complied
1.0344	Horiz.	30.63	22.2	6.2	59.03	74.0	14.97	Complied
1.0722	Vert.	29.62	22.5	6.4	58.52	74.0	15.48	Complied
1.0722	Horiz.	30.58	22.5	6.4	59.48	74.0	14.52	Complied
1.1522	Vert.	29.51	22.0	6.61	58.12	74.0	15.88	Complied
1.1522	Horiz.	29.95	22.0	6.61	58.56	74.0	15.44	Complied
1.1966	Vert.	29.51	21.5	6.73	57.74	74.0	16.26	Complied
1.1966	Horiz.	30.53	21.5	6.73	58.76	74.0	15.24	Complied
1.2277	Vert.	30.17	21.6	6.8	58.57	74.0	15.43	Complied
1.2277	Horiz.	29.79	21.6	6.8	58.19	74.0	15.81	Complied
1.2888	Vert.	31.52	21.9	7.01	60.43	74.0	13.57	Complied
1.2888	Horiz.	30.07	21.9	7.01	58.98	74.0	15.02	Complied
1.3422	Vert.	29.41	22.3	7.16	58.87	74.0	15.13	Complied
1.3422	Horiz.	29.84	22.3	7.16	59.3	74.0	14.7	Complied

8. Measurement Uncertainty

8.1. Company Policy, as based on the NAMAS Accreditation Standard, M10, paragraph 12.11 (o), states that Test Reports shall include estimated uncertainty of the calibration or test result (this information need only appear in test reports and test certificates where it is relevant to the validity or application of the test result, where a client's instructions so require or where uncertainty affects compliance to a specification or limit).

8.2. The global uncertainties have been calculated in accordance with NAMAS NIS 81 (Edition 1, May 1994) as follows:

Measurement Type	Range	Confidence Level	Calculated Uncertainty
Conducted Emissions	0.15 MHz to 30 MHz	95%	+/- 3.25 dB
Radiated Electric Field Strength Emissions	30 MHz to 1000 MHz @ 10 m	95%	+/- 5.1 dB
Radiated Electric Field Strength Emissions	1 to 18 GHz	95%	+/- 4.18 dB

8.3. Measurement uncertainties have been applied in accordance with NAMAS document NIS 81 (edition 1, May 1994), and in the absence of any specification criteria, guidance, or code of practice, compliance has been judged on the basis of shared risk.

8.4. In the case of emissions tests, the measured value of the disturbance from the product sample shall be compared directly with the limits. If the measured value is equal to or less than the limit the product is deemed to pass the test.

8.5. In the case of immunity tests, the equipment is deemed to pass the test if it fulfils the stated performance criteria at the required or a higher severity level. The measurement uncertainty has been taken into account in the calibration procedures stated in the relevant basic standard.

8.6. The methods used to calculate the above uncertainties are in line with those used for calibration laboratories contained in NAMAS document NIS 3003 Edition 8 “The Expression of Uncertainty and Confidence in Measurement” May 1995, which align with international recommendations “Guide to the Expression of Uncertainty in Measurement” ISOIEC/OIML/BIPM (Prepared by ISO/TAG 4: January 1993).

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

Appendix 1. Test Equipment Used

Instrument	Manufacturer	Model	RFI No.
2 to 4 GHz Eaton Horn Antenna	Eaton	91889-2	A031
1 to 2 GHz Eaton Horn Antenna	Eaton	9188-2	A027
ESH3-Z5	Rohde & Schwarz	ESH3-Z5	A1069
1 to 18 GHz Double ridge guide	EMCO	3115	A1071
WG 18 Microwave Horn	Flann Microwave	18240-20	A256
Bilog Antenna	Chase	CBL6111	A259
OATS Positioning Controller	Rohde & Schwarz	HCC	A276
3 dB attenuator (9)	Suhner	6803.17.B	A392
WG 14 horn	Flann	14240-20	A427
WG 18 horn	Flann	18240-20	A430
Cable	Andrews	None	C342
Cable	Rosenberger	RG142XX-001-RFIB	C455
Cable	Rosenberger	RG142XX-002-RFIB	C456
Cable	Rosenberger	UFA210A-1-1182-704704	C459
N-Type Coaxial Cable	Rosenberger	UFA210A-1-3937-504504	C468
C565-N-3	Rosenberger	UFA 210A-1-1181-70x70	C565
ESMI Spectrum Analyser / Receiver	Rohde & Schwarz	ESMI	M069
Receiver / Spectrum Analyser System	Rohde & Schwarz	ESBI	M090
Temperature/Humidity Meter	RS Components	212-146	M114
Turntable Controller	R.H.Electrical Services	RH351	M173
Thermo/hygro meter	RS Components Ltd	RS212-124	M210
Site 2	RFI	2	S202
Site 9	RFI	9	S209

NB In accordance with NAMAS requirements, all the measurement equipment is on a calibration schedule.

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

Appendix 2. Measurement Methods

A2.1. AC Mains Conducted Emissions

A2.1.1. AC mains conducted emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

A2.1.2. The test was performed in a shielded enclosure with the equipment arranged as detailed in the standard on a wooden bench using the floor of the screened enclosure as the ground reference plane and with the EUT powered via a 60 Hz AC mains supply.

A2.1.3. Initial measurements in the form of swept scans covering the entire measurement band were performed in order to identify frequencies on which the EUT was generating interference. In order to minimise the time taken for these swept measurements, a Peak detector was used in conjunction with the appropriate detector IF measuring bandwidths (see table below). Repetitive scans were performed to allow for emissions with low repetition rates, and the duty cycle of the EUT. The test configuration was the same for the initial scans as for the final measurements.

A2.1.4. Following the initial scans, a graph was produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. A tolerance line was set 6 dB below the specification limit and levels above the tolerance line were re-tested (at individual frequencies) using the appropriate detector function.

A2.1.5. The test equipment settings for conducted emissions measurements were as follows:

Receiver Function	**Initial Scan**	**Final Measurements**
Detector Type:	Peak	Quasi-Peak (CISPR)*
Mode:	Max Hold	Not applicable
Bandwidth:	10 kHz	9 kHz
Amplitude Range:	60 dB	20 dB
Measurement Time:	Not applicable	> 1 s
Observation Time:	Not applicable	> 15 s
Step Size:	Continuous sweep	Not applicable
Sweep Time:	Coupled	Not applicable

* In some instances an Average detector function may also have been used.

A2.2. Radiated Field Strength Emissions

A2.2.1. Radiated emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

A2.2.2. Initial measurements covering the entire measurement band in the form of swept scans in a shielded enclosure were performed in order to identify frequencies on which the EUT was generating interference. This determined the frequencies on which the EUT should be re-measured in full on the open area test site. In order to minimise the time taken for the swept measurements, a Peak detector was used in conjunction with the appropriate detector IF measuring bandwidth (see table below). Repetitive scans were performed to allow for emissions with low repetition rates, and for the duty cycle of the EUT. The test configuration was the same for the initial scans as for the final measurements.

A2.2.3. The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. Following the initial scans, graphs were produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. A tolerance line was set 6 dB below the specification limit and levels above the tolerance line were re-tested on the open area test site, at the appropriate distance, using a measuring receiver with a Quasi-Peak (below 1000 MHz), Average and Peak (above 1000 MHz) detector, where applicable.

A2.2.4. For the main (final) measurements the EUT was arranged on a non-conducting table on an open area test site, as detailed in the specification.

A2.2.5. All measurements on the open area test site were performed using broadband antennas.

A2.2.6. On the open area test site, at each frequency where a signal was found, the levels were maximised by initially rotating the turntable through 360°. For frequencies below 1000 MHz, the antenna was varied in height between 1 m and 4 m. For frequencies above 1000 MHz, the antenna was fixed at a height of 1.5m. At this point, any signals found to be between the limit and a level 6 dB below it were further maximised by changing the configuration of the EUT, e.g. re-routing cables to peripherals and moving peripherals with respect to the EUT.

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

A2.2.7. The test equipment settings for radiated emissions measurements were as follows:

Receiver Function	**Initial Scan Below 1000 MHz**	**Final Measurements Below 1000 MHz**
Detector Type:	Peak	Quasi-Peak (CISPR)
Mode:	Max Hold	Not applicable
Bandwidth:	100 kHz	120 kHz
Amplitude Range:	60 dB	20 dB
Measurement Time:	Not applicable	> 1 s
Observation Time:	Not applicable	> 15 s
Step Size:	Continuous sweep	Not applicable
Sweep Time:	Coupled	Not applicable

Receiver Function	**Initial Scan Above 1000 MHz**	**Final Measurements Above 1000 MHz**
Detector Type:	Peak	Peak/Average
Mode:	Max Hold	Not applicable
Bandwidth:	1 MHz	1 MHz
Amplitude Range:	60 dB	20 dB (typical)
Measurement Time:	Not applicable	> 1 s
Observation Time:	Not applicable	> 15 s
Step Size:	Continuous sweep	Not applicable
Sweep Time:	Coupled	Not applicable

A2.3. Conducted Antenna Port Emissions

A2.3.1. Conducted Antenna Port Emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

A2.3.2. Prior to testing being performed a suitable RF attenuator and cable were calibrated for the required frequency range. For each measurement range performed, the calibrated level of the attenuator and cable were entered as an offset into the spectrum analyser to compensate for the measurement setup.

A2.3.3. Initial measurements covering the entire measurement band in the form of swept scans were performed in order to identify frequencies on which the EUT was generating interference. This determined the frequencies on which measurements were performed. In order to minimise the time taken for the swept measurements, a Peak detector was used in conjunction with the appropriate detector IF measuring bandwidth (see table below). Repetitive scans were performed to allow for emissions with low repetition rates, and for the duty cycle of the EUT. The test configuration was the same for the initial scans as for the final measurements.

A2.3.4. Due to the design of the EUT, conducted antenna port measurements were common for both the internal and external antenna connection.

A2.3.5. To determine the transmitter output power, the EUT was operated as intended with the spectrum analyser operated in a maximum hold mode over the full operating frequency range of the EUT to identify the highest emission within the band.

A2.3.6. To determine spurious emissions levels, the EUT was operated as intended with the spectrum analyser operated in a maximum hold mode over selected frequency ranges between 30 MHz and 26 GHz. A reference limit line of 20dB below the maximum output of the transmitter was noted. Levels within 20dB of this limit line were then recorded.

A2.4. Occupied Bandwidth / Channel Separation

A2.4.1. The EUT and spectrum analyser was configured as for conducted antenna port measurements.

A2.4.2. To determine the bandwidth and separation of each transmission channel the analyser was configured to measure two adjacent channels.

A2.4.3. To determine the occupied bandwidth, a resolution bandwidth of 100kHz was used with a video bandwidth of a least the same value. The analyser was set for a maximum hold scan to capture the profile of the signal. The peak level was then determined, and a reference line was drawn 20dB below the peak level. The bandwidth was determined at the points where the 20dB reference crossed the profile of the emission.

A2.4.4. For channel separation, the analyser was configured with a resolution bandwidth and video bandwidth of at least 1% of the span set on the analyser. A setting of 10kHz was used. The EUT was operated as intended and the analyser set to a maximum hold mode scan to capture the profile of the signals. The peak points on the two adjacent channels were noted and the separation between them recorded. The channel separation was then determined as greater of 25kHz or the 20dB bandwidth.

A2.5. Channel Time Occupancy

A2.5.1. The EUT and spectrum analyser was configured as for conducted antenna port measurements.

A2.5.2. To determine the maximum packet length on any given channel, the analyser was configured in the time domain and the EUT was configured to operate as intended.

A2.5.3. To determine the average occupancy time on any given channel the analyser was configured in the time domain and a 30 second sweep carried out. This was repeated 3 times to give an average occupancy time. The number of times the channel is used in any 30 second period multiplied by the maximum packet length will give the total time on the given channel.

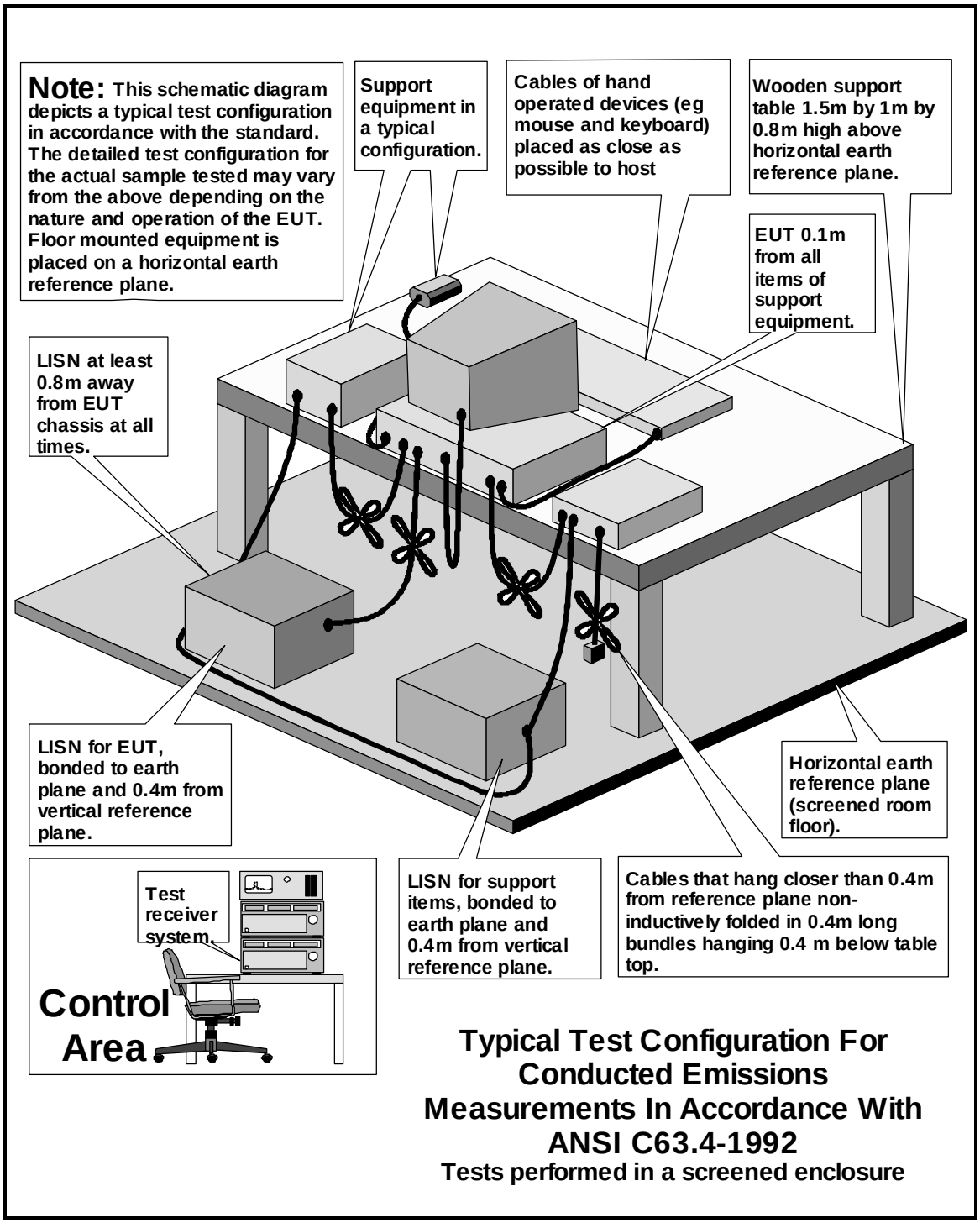
Appendix 3. Test Configuration Drawings

This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\41715ETF04\EMICON	Test configuration for measurement of conducted emissions
DRG\41715ETF04\EMIRAD	Test configuration for measurement of radiated emissions
DRG\41715ETF04\001	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test
DRG\41715ETF04\002	Conducted RF Antenna Port Configuration

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

DRG\41715ETF04\EMICON

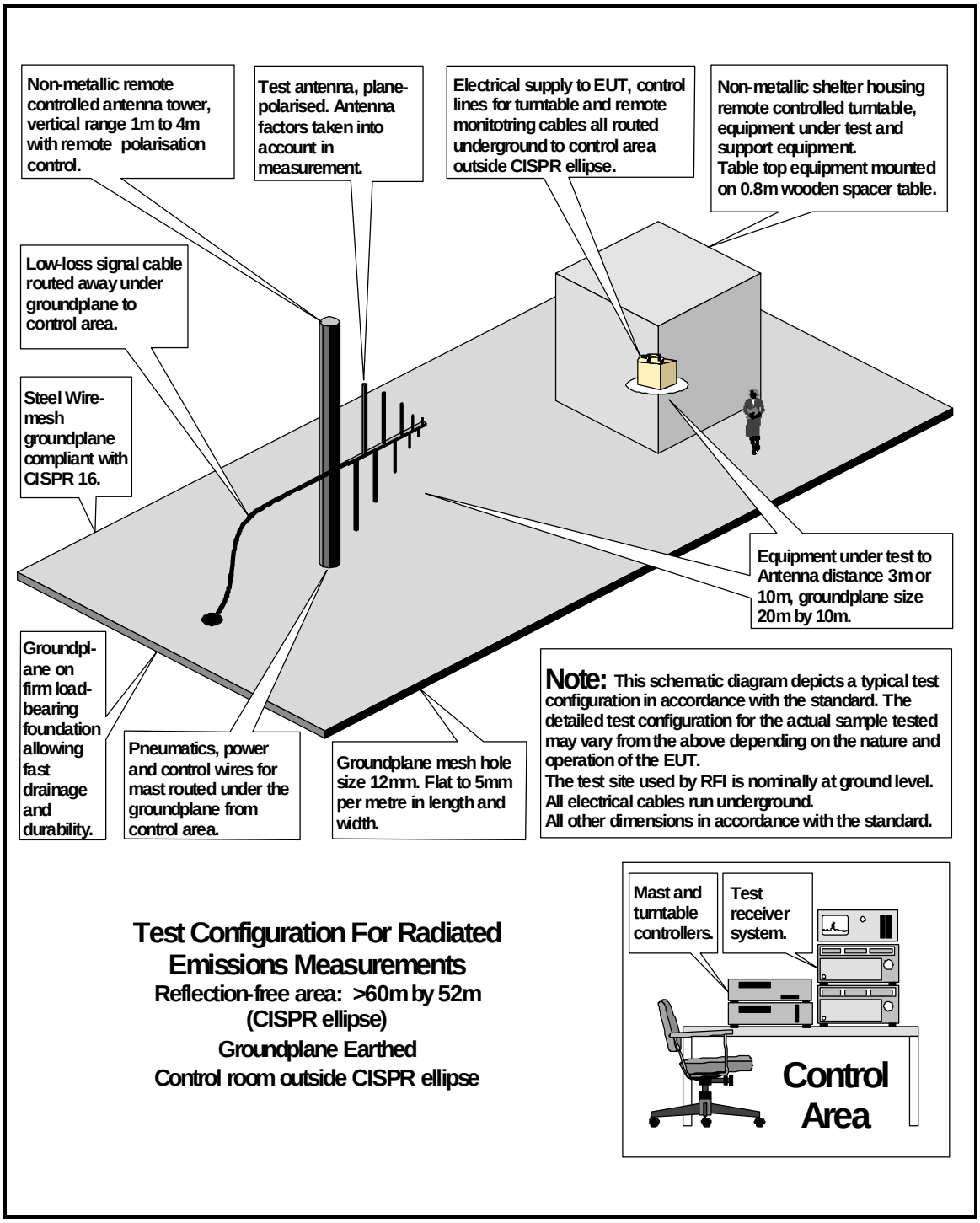


Typical Test Configuration For Conducted Emissions Measurements In Accordance With ANSI C63.4-1992
Tests performed in a screened enclosure

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)

To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

DRG\41715ETF04\EMIRAD



Test Configuration For Radiated Emissions Measurements
Reflection-free area: >60m by 52m (CISPR ellipse)
Groundplane Earthed
Control room outside CISPR ellipse

Test Of: **Red-M (Communications) Ltd.**
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: **F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247**

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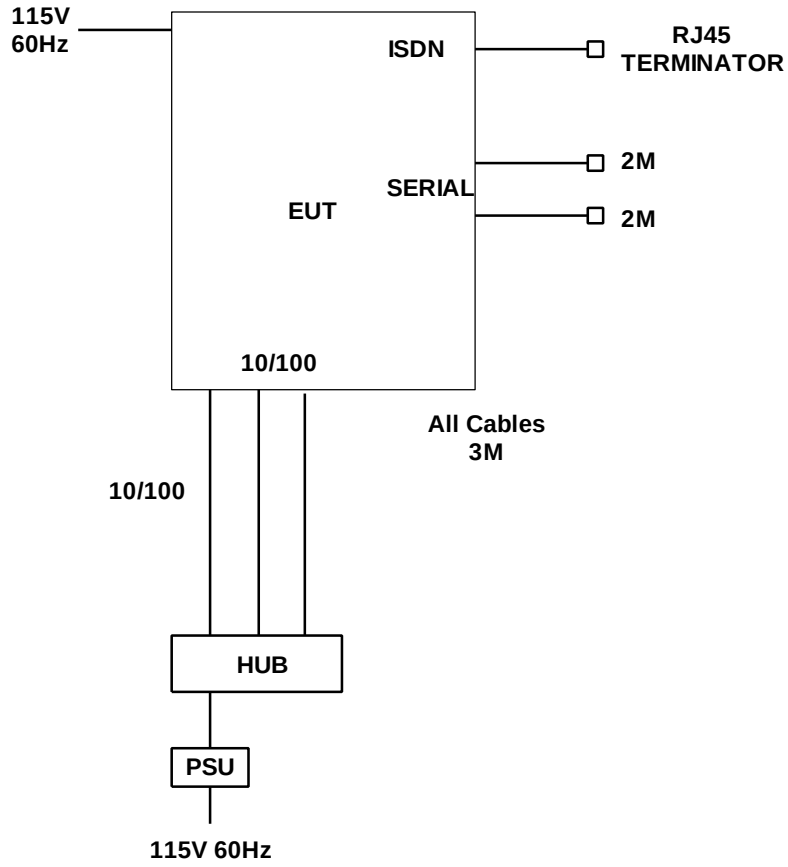
Configuration of EUT and Support Equipment



Test Of: Red-M (Communications) Ltd.
3000AS Wireless Internet Server
with Access Server External Aerial (3000-501)
To: F.C.C. Part 15: 1998 Subpart C (Intentional Radiators). Section 15.247

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Conducted RF Antenna Port Configuration