TEST REPORT
FROM
RADIO FREQUENCY
INVESTIGATION LTD.

Test Of: Lo-Q Plc
Q-Bot

To: FCC Part 15 Subpart C: 2000
(Intentional Radiators)
Clause 15.249

Test Report Serial No:
RFI/EMCB1/RP43230A

This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director:	**Checked By:**
Tested By:	**Release Version No: PDF01**
Issue Date: 15 April 2002	**Test Date: 11 March 2002 to 12 March 2002**

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Test Of: **Lo-Q Plc**
Q-Bot
To: **FCC Part 15: 1998 Subpart C Section 15.225**

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1. Client Information

Company Name:	Lo-Q Plc
Address:	Greenlands Henley-on-Thames Oxfordshire RG9 3AL
Contact Name:	Mr C Butler

2. Equipment Under Test (EUT)

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

2.1. Identification Of Equipment Under Test (EUT)

Brand Name:	Lo-Q
Model Name or Number:	Q-Bot
Unique Type Identification:	QB916-003
Serial Number:	None Stated by Client
Country of Manufacture:	UK
FCC ID Number:	Not Applicable
Date of Receipt:	11th March 2002

2.2. Description Of EUT

Virtual queuing system for queue management in theme parks. Consists of a series of IR (Infra Red) and RF (Radio Frequency) Loqators (base stations) linked by an RS485 and fibre optic Ethernet network, all under the control of a PC based site manager program. The RF Loqators from the centre of radio cells, to allow communications with any nearby Q-Bots (hand held units). Communications consists of periodic polls, sent out by RF Loqators, to which and Q-Bots in range will respond with a poll response after a random delay (within a specified window). RF Loqators also transmit download packets addressed to specific Q-Bots, which carry any messages to be displayed on the Q-Bot LCD. IR Loqators are used for short-range communications with Q-Bots for the purposes of booking rides etc.

Loqators are teed off from an RS485 bus via Junction Boxes. The main RS485 bus cable (between junction boxes) is a single 4-pair Cat 5 cable carrying RS485 data, zero volt reference and DC power. The tee links between junction boxes and their associated Loqators are twin 4-pair Cat 5 cables, one carrying the above mentioned signals, and the junction box.

2.3. Modifications Incorporated In EUT

The device has been modified to allow continuos transmit/receive to be selected on top middle and bottom channels.

The transmit mode consists of repeated data bursts of approximately 2 seconds duration, with gaps of approximately 100ms between bursts.

2.4. Additional Information Related To Testing

Power Supply Requirement:	Internal battery supply of 1.2V
Intended Operating Environment:	Portable (All environments)
Weight:	90g
Dimensions:	90 x 70 x 23mm
Interface Ports:	Infra Red

2.5. Support Equipment

No support equipment was used to exercise the EUT during testing:

3. Test Specification, Methods And Procedures

3.1. Test Specification

Reference:	FCC Part 15 Subpart C: 2000 (Intentional Radiators). Section 15.249. (Operation within the band 902 - 928 MHz, 2400 – 2483.5 MHz, 5725 – 5875 MHz, 24.0 – 24.25 GHz).
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 applicable 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 (2001)
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 an internal battery supply of 1.2V.

5.2. Operating Modes

The EUT was tested in the following operating mode:

Continuous transmit and receive at 903, 915 and 927 MHz.

5.3. Configuration And Peripherals

The EUT was tested in the following configuration:

Stand alone.

NB. Appendix 3 contains a schematic diagram of the test configuration.

6. Summary Of Test Results

6.1. Summary Of Test Results

Range Of Measurements	Specification Reference	Compliancy Status
Electric Field Strength of Fundamental Emission	FCC Part 15.249(a): 2000.	Complied
Electric Field Strength of Harmonic Emission	FCC Part 15.249(a): 2000.	Complied
Electric Field Strength of Spurious Emissions	FCC Part 15.249(c): 2000. (Section 15.209)	Complied

6.2. 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 UKAS Document NIS 81 with a confidence level of 95%. Please refer to Section 8 for details of measurement uncertainties.

7.2. Radiated Emissions: Transmit Mode

7.2.1. Electric Field Strength Measurement of Fundamental Frequency

7.2.1.1. Measurements were performed in to the limits specified in FCC Part 15.249(a). For fundamental frequencies between 902 and 928 MHz, any emissions appearing in this frequency band must not exceed 50 mV/m at 3 meters (94dBµV/m at 3 meters).

7.2.1.2. Measurements were performed on bottom, middle and top channels.

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

Bottom Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
902.872	Vert.	90.7	94.0	3.3	Complied

Middle Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
914.286	Vert.	89.9	94.0	4.1	Complied

Top Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
926.845	Vert.	85.9	94.0	8.1	Complied

7.2.2. Electric Field Strength Measurements: (Emissions at Band Edges)

7.2.2.1. The EUT was setup for radiated emissions measurements as stated in this section above.

Results:

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
902.000	Vert.	25.5	46.0	20.5	Complied
928.000	Vert.	30.0	46.0	16.0	Complied

7.2.3. Electric Field Strength Measurements: 30 to 1000 MHz: Transmit Mode

7.2.3.1. The client has stated that the highest clock frequency for the EUT was 927 MHz. Therefore tests were performed up to 10000 MHz.

7.2.3.2. Measurements were performed on bottom, middle and top channels.

7.2.3.3. Measurements were performed in to the limits specified in FCC Part 15.249 (c) (15.209).

Bottom Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
892.72	Vert.	26.2	46.0	19.8	Complied
878.56	Vert.	25.9	46.0	20.1	Complied

Middle Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
890.99	Vert.	42.3	46.0	3.7	Complied
887.07	Vert.	25.8	46.0	20.2	Complied

Top Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
909.9	Vert.	31.0	46.0	15.0	Complied
912.06	Vert.	25.8	46.0	20.2	Complied

7.2.4. Electric Field Strength Measurements: 30 to 1000 MHz: Receive Mode

7.2.4.1. The client has stated that the highest clock frequency for the EUT was 927 MHz. Therefore tests were performed up to 5000 MHz.

7.2.4.2. The EUT was configured in receive mode in bottom, middle and top channels.

7.2.4.3. Measurements were performed in to the limits specified in FCC Part 15.109 Class B.

Bottom Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
892.295	Horiz.	39.2	46.0	6.8	Complied

Middle Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
904.317	Vert.	38.3	46.0	7.7	Complied

Top Channel

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
916.302	Vert.	37.5	46.0	8.5	Complied

7.2.5. Electric Field Strength Measurements: 1 to 10 GHz. Transmit Mode

7.2.5.1. The client has stated that the highest clock frequency for the EUT was 927MHz. Therefore tests were performed up to 10 GHz.

7.2.5.2. Measurements were performed on bottom, middle and top channels.

7.2.5.3. Measurements were performed in to the limits specified in FCC Part 15.249 (a and c) (15.209).

7.2.5.4. The following tables list frequencies at which emissions were measured using Peak and Average detector functions:

Highest Average Level: Bottom Channel

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
1.80575	Vert.	29.7	21.8	0.7	52.2	54	2.8	Complied
2.78091	Vert.	23.8	20.7	0.9	45.4	54	8.6	Complied
3.61189	Vert.	13.6	20.9	1.0	35.5	54	20.5	Complied

Highest Peak Level: Bottom Channel

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
1.80575	Vert	31.1	21.8	0.7	53.6	74	20.4	Complied
2.78091	Vert	27.2	20.7	0.9	48.8	74	25.2	Complied
3.61189	Vert	21.3	20.9	1.0	43.2	74	30.8	Complied

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Results Continued

Highest Average Level: Middle Channel

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
1.82998	Vert	29.2	21.8	0.7	51.7	54	2.3	Complied
2.74499	Vert	24.5	20.7	0.9	46.1	54	7.9	Complied
3.65996	Vert	13.5	20.9	1.0	35.4	54	18.6	Complied

Highest Peak Level: Middle Channel

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
1.82998	Vert	31.2	21.8	0.7	53.7	74	20.3	Complied
2.74499	Vert	27.9	20.7	0.9	49.5	74	24.5	Complied
3.65996	Vert	20.8	20.9	1.0	42.7	74	31.3	Complied

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Results Continued

Highest Average Level: Top Channel

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
1.85397	Vert	22.6	21.9	0.7	45.2	54	8.8	Complied
2.70874	Vert	26.1	20.7	0.9	47.7	54	6.3	Complied
3.70777	Vert	12.5	20.9	1.0	34.4	54	19.6	Complied

Highest Peak Level: Top3.43 Channel

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
1.85397	Vert	27.2	21.9	0.7	49.7	74	24.3	Complied
2.70874	Vert	28.4	20.7	0.9	50.0	74	24.0	Complied
3.70777	Vert	20.7	20.9	1.0	42.6	74	31.4	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 reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
Radiated Emissions	30 MHz to 1000 MHz	95%	± 5.26 dB
Radiated Emissions	1 GHz to 10 GHz	95%	± 4.18 dB

8.3. Measurement uncertainties have been applied in accordance with UKAS 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” ISO/IEC/OIML/BIPM (Prepared by ISO/TAG 4: January 1993).

Appendix 1. Test Equipment Used

RFI No.	Instrument	Maker	Type No.	Serial No.
A1137	3dB Attenuator	Narda	779	04690
A197	Site 2 Controller SC144	Unknown	SC144	150720
A255	WG 16 Microwave Horn	Flann Microwave	16240-20	519
A259	Bilog Antenna	Chase	CBL6111	1513
A276	OATS Positioning Controller	Rohde & Schwarz	HCC	None
A277	OATS Antenna Mast	Rohde & Schwarz	HCM	None
A427	WG 14 horn	Flann	14240-20	150
A428	WG 12 horn	Flann	12240-20	134
C055	Cable	RFI	None	None
C160	Cables	Rosenberger	UFA210A-1-1181-70x70	None
C564	C564-N-2	Rosenberger	UFA 210A-1-0787-70x70	96L0226
M003	Spectrum Monitor	Rohde & Schwarz	EZM	883 580/008
M023	ESVP Receiver	Rohde & Schwarz	ESVP	872 991/027
M028	FSB Spectrum Analyser	Rohde & Schwarz	FSB	860 001/009 (RF), 860 161/007 (Display)
M115	Temperature/ Humidity Meter	RS Components	212-146	None
M173	Turntable Controller	R.H. Electrical Services	RH351	3510020
M174	OATS Turntable	British Turntable Ltd	S36069	None
M210	Thermo/hygro meter	RS Components Ltd	RS212-124	M210-RS212-124
S201	Site 1	RFI	1	

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

Appendix 2. Measurement Methods

A2.1. Radiated Emissions: FCC Part 15

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

A2.1.2. 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.

A2.1.3. 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 receivers with a Quasi-Peak detector (below 1000 MHz), where applicable, for measurements above 1000 MHz average and peak detectors were used.

A2.1.4. 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.

A2.1.5. All measurements on the open area test site were performed using broadband antennas.

A2.1.6. 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° and then varying the antenna height between 1 m and 4 m. 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.

A2.1.7. The test equipment settings for radiated emissions measurements were as follows:

Receiver Function	**Initial Scan (30 to 1000 MHz)**	**Final Measurements (30 to 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 (1 to 10 GHz)**	**Final Measurements (1 to 10 GHz)**
Detector Type:	Peak	Average and Peak
Mode:	Max Hold	Not applicable
Bandwidth:	1 MHz	1 MHz
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

Appendix 3. Test Configuration Drawings

This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\43230JD01\EMIRAD	Test configuration for measurement of radiated emissions
DRG\43230JD01\001	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test

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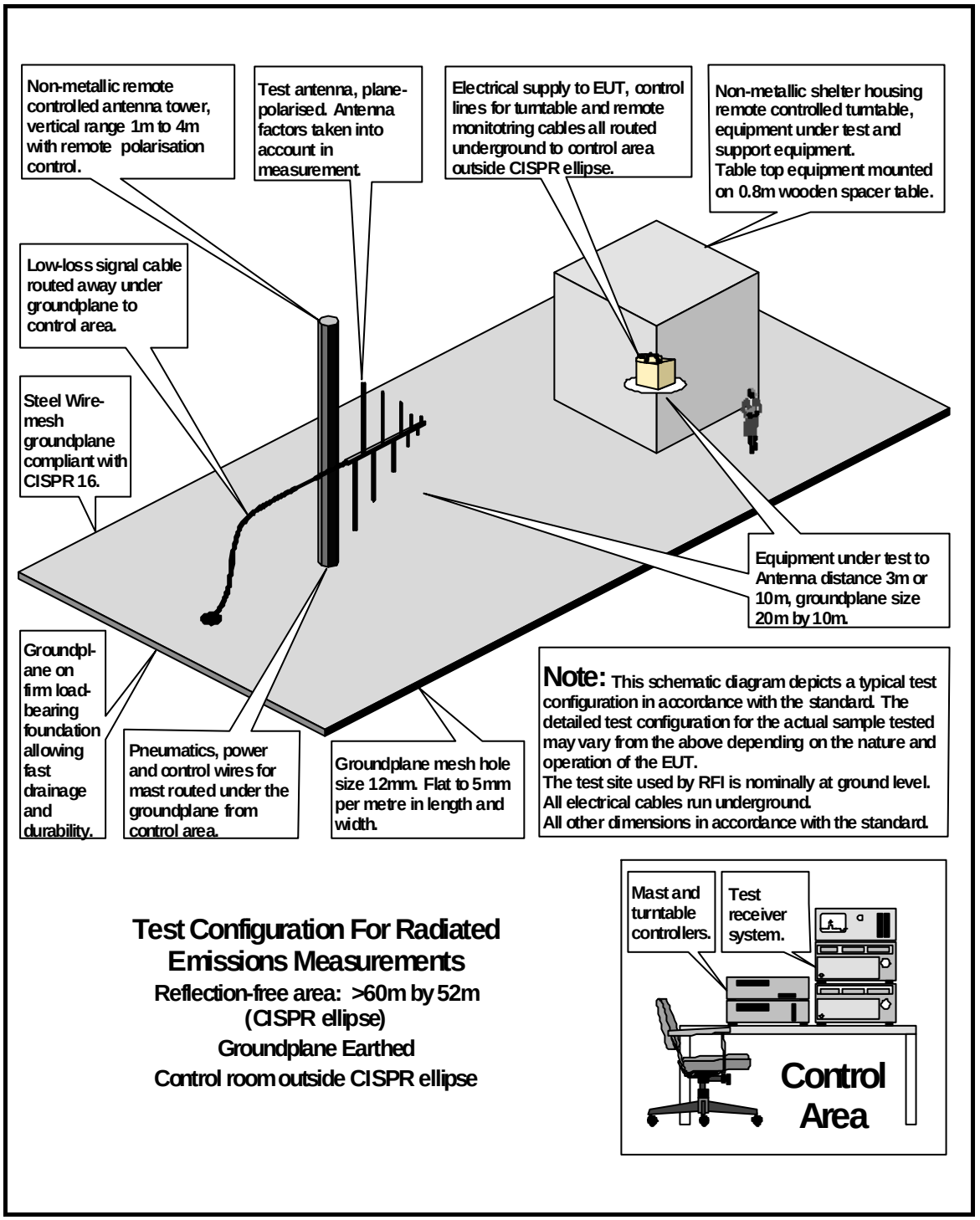

Test Configuration For Radiated Emissions Measurements

Reflection-free area: >60m by 52m (CISPR ellipse)

Groundplane Earthed

Control room outside CISPR ellipse

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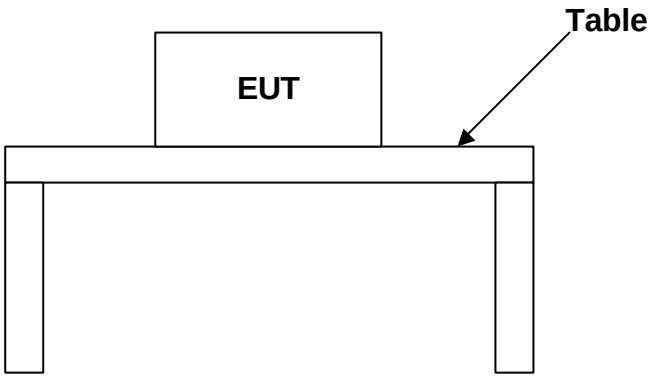
Configuration of EUT and Local Support Equipment



Configuration of Remote Support Equipment

Appendix 4 .Photographs of EUT

This appendix contains the following photographs

Photo Reference Number	Title
PHT\43230JD01\001	Front view of EUT on Site 1
PHT\43230JD01\002	Rear view of EUT on Site 1
PHT\43230JD01\003	Front view of EUT on Site 2
PHT\43230JD01\004	Rear view of EUT on Site 2

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PHT\43230JD01\001 Front view of EUT on Site 1

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PHT\43230JD01\002 Rear view of EUT on Site 1