TEST REPORT
FROM
RADIO FREQUENCY
INVESTIGATION LTD.

Test Of: Marconi Selencia Communications Ltd.
H-400-4856 Wireless PTT Switch

To: FCC Part 15.231

Test Report Serial No:
RFI/MPTB1/RP45620JD07A

This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director: 	**Checked By: Tony Henriques** 
Tested By: Elin Danielsen 	**Release Version No: PDF01**
Issue Date: 29 April 2004	**Test Dates: 22 March 2004 to 30 March 2004**

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1. Customer Information

Company Name:	Marconi Selenia Communications Ltd.
Address:	Marconi House New Street Chelmsford Essex CM1 1PL UK
Contact Name:	Keith Starkey

2. Equipment Under Test (EUT)

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

2.1. Identification Of Equipment Under Test (EUT)

Brand Name:	Wireless PTT Switch
Model Name or Number:	H-400-4856
Unique Type Identification:	H400485601
Serial Number:	000528901
FCC ID Number:	RMJPRR0002
Country of Manufacture:	UK
Date of Receipt:	22 March 2004

2.2. Description Of EUT

The equipment under test is a wireless PTT switch operating at 433.92 MHz that forms part of a Personal Radio System which includes a separate 2.4 GHz transceiver and switch pack. Although the switch pack (which is attached to the 2.4 GHz transceiver) has a PTT switch, this is not easily accessible when the transceiver is worn in a pouch. The wireless PTT switch, which is normally strapped to the user's weapon, allows remote operation of the 2.4 GHz transceiver (without the user having to remove his hands from the weapon).

2.3. Modifications Incorporated In EUT

During the course of testing the EUT was not modified.

2.4. Additional Information Related To Testing

Power Supply Requirement:	Internal Battery Supply of 3.6V (nominal)		
Intended Operating Environment:	Commercial, light-industrial		
Equipment Category:	Portable		
Type of Unit:	Transmitter		
Interface Ports:	None		
Transmit Frequency Range	N/A single frequency operation		
Transmit Channels Tested	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	N/A	N/A	433.92
Occupied Bandwidth	40 kHz		
Maximum Average Fieldstrength @ 3 metres	66.4 dBμV/m		

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: 2003 (Section 15.231)
Title:	Code of Federal Regulations, Part 15 (47CFR15) Radio Frequency 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 (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.

DA00-705 (2000)
Title: Filing and Frequency Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

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

During testing, the EUT was powered by an internal battery supply of 3.6V.

5.2. Operating Modes

The EUT was tested in the following operating modes, unless otherwise stated.

Transmit mode

5.3. Configuration And Peripherals

The EUT was tested in the following configuration:

Standalone

6. Summary Of Test Results

Range Of Measurements	Specification Reference	Port Type	Compliancy Status
Transmitter Fundamental Fieldstrength	C.F.R. 47 FCC Part 15: 2003 Section 15.231(b)	Antenna	Complied
Transmitter 20 dB Bandwidth	C.F.R. 47 FCC Part 15: 2003 Section 15.231(c)	Antenna	Complied
Transmitter Timeout	C.F.R. 47 FCC Part 15: 2003 Section 15.231(a)(1)	Antenna	Complied
Transmitter Radiated Spurious Emissions	C.F.R. 47 FCC Part 15: 2003 Section 15.231(b) & 15.209	Antenna	Complied

6.1. 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.

7.1.2. Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 8 for details of measurement uncertainties.

7.2. Transmitter Fundamental Fieldstrength Section 15.231(b)

7.2.1. The EUT was configured as for radiated emissions testing as described in Section 8 of this report.

7.2.2. Tests were performed to identify the maximum fieldstrength of the fundamental frequency.

Result:

Frequency (MHz)	Antenna Polarity	Average Level (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Result
433.959	Vert.	66.4*	80.8	14.4	Complied

**Note: As the EUT employs pulsed operation the average level of the fundamental was found by measuring the peak level of the fundamental and correcting it with the calculated duty cycle correction factor of –21.0 dB using the procedure detailed in ANSI C63.4-2001 Annex I.4 j).*

This was calculated as follows:

Duty cycle = on time/100 milliseconds or period (whichever is the lesser)

On time =8.42 milliseconds (from duty cycle plot)

Duty cycle = 8.42 / 94.99 milliseconds (94.99 milliseconds being the pulse period from duty cycle plot)

Duty cycle = 0.089 or 8.9%

To obtain correction factor in dB i.e. to correct the peak reading to the average value of the fundamental in dB:
20 x log (0.089) = -21.0 dB

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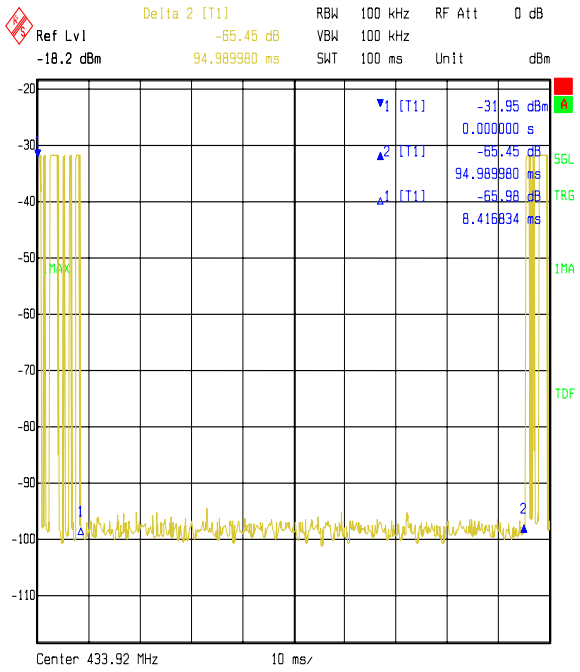
Transmitter Fundamental Fieldstrength Section 15.231(b) - (Continued)

Duty Cycle Plot



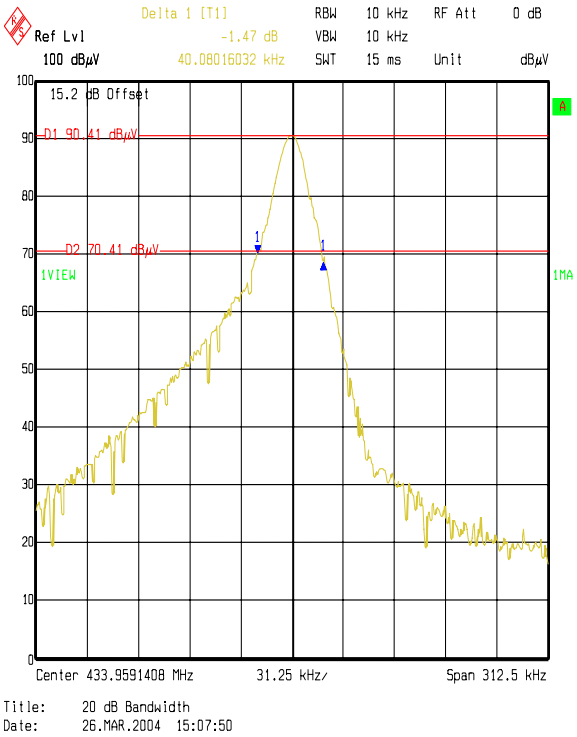
7.3. Transmitter 20 dB Bandwidth: Section 15.231(c)

7.3.1. The EUT was configured as for 20 dB bandwidth measurements as described in Section 8 of this report.

7.3.2. Tests were performed to identify the 20 dB bandwidth.

Transmitter 20 dB Bandwidth (MHz)	Limit (MHz)	Margin (MHz)	Result
0.0408	1.0849*	1.0441	Complied

** Calculated based on a measured fundamental frequency of 433.959 MHz*



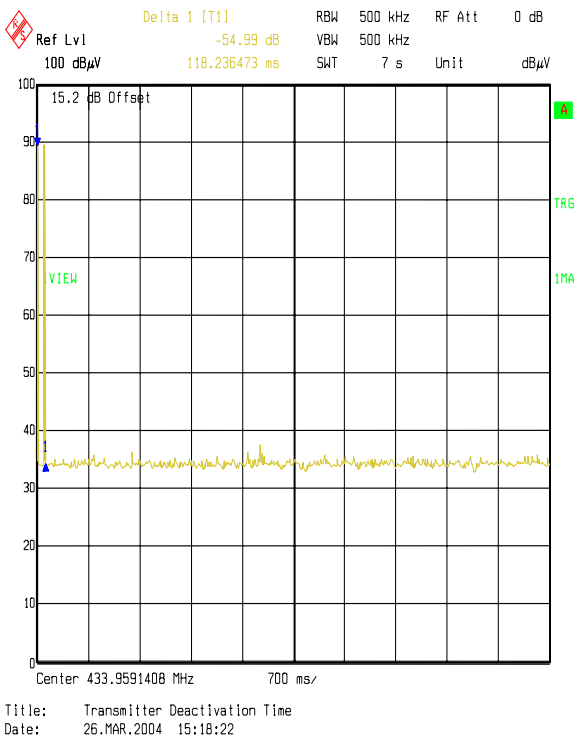
Note: The above plot incorrectly shows a level offset of 15.2 dB, it should have been 12.2 dB. This had the effect of showing the peak fundamental fieldstrength as 90.4 dBµV when it should have been shown as 87.4 dBµV (the actual measured peak fundamental fieldstrength). It is confirmed that the value of the level offset used has no bearing on the measurement and the level recorded for the 20 dB bandwidth is correct.

7.4. Transmitter Timeout: Section 15.231(a)(1)

7.4.1. The EUT was configured as for timeout measurements as described in Section 8 of this report.

7.4.2. Tests were performed to determine the deactivation time of the transmitter.

Deactivation Time (seconds)	Limit (seconds)
0.118	5



7.5. Transmitter Radiated Emissions: Section 15.231(b) & Section 15.209

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

7.5.1.1. The EUT was configured as for radiated emissions testing as described in Section 8 of this report.

7.5.1.2. Tests were performed to identify the maximum radiated spurious emissions levels.

Results:

Frequency (MHz)	Antenna Polarity	Average Level (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Result
867.962	Vert.	24.4*	60.8	36.4	Complied

**Note: As the EUT employs pulsed operation the average level of the fundamental was found by measuring the peak level of the fundamental and correcting it with the calculated duty cycle correction factor of –21.0 dB using the procedure detailed in ANSI C63.4-2001 Annex I.4 j).*

This was calculated as follows:

Duty cycle = on time/100 milliseconds or period (whichever is the lesser)

On time =8.42 milliseconds (from duty cycle plot)

Duty cycle = 8.42 / 94.99 milliseconds (94.99 milliseconds being the pulse period from duty cycle plot)

Duty cycle = 0.089 or 8.9%

To obtain correction factor in dB i.e. to correct the peak reading to the average value of the fundamental in dB:
20 x log (0.089) = -21.0 dB

Transmitter Radiated Emissions (Continued)

7.5.2. Electric Field Strength Measurements: 1.0 to 4.5 GHz

Highest Peak Level:

Frequency (GHz)	Antenna Polarity	Peak Detector level (dBμV)	Antenna factor (dB)	Cable loss (dB)	Actual Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Result
1301.731	Vert.	22.8	20.9	0.8	44.5	74.0	29.5	Complied
3905.548	Vert.	25.5	23.4	1.6	50.5	74.0	23.5	Complied

Highest Average Level:

Frequency (GHz)	Antenna Polarity	Average Detector level (dBμV)	Antenna factor (dB)	Cable loss (dB)	Actual Average Level (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Result
1301.731	Vert.	1.8	20.9	0.8	23.5*	54.0	30.5	Complied
1735.897	Vert.	2.6	21.5	1.0	25.1*	60.8	35.7	Complied
2169.783	Horiz.	1.3	20.7	1.2	23.2*	60.8	37.6	Complied
2603.764	Vert.	-1.7	21.3	1.2	20.8*	60.8	40.0	Complied
3037.865	Vert.	1.3	21.8	1.4	24.5*	60.8	36.3	Complied
3471.470	Vert.	10.0	22.5	1.5	34.0*	60.8	26.8	Complied
3905.548	Vert.	4.5	23.4	1.6	29.5*	54.0	24.5	Complied

**Note: As the EUT employs pulsed operation the average level of the fundamental was found by measuring the peak level of the fundamental and correcting it with the calculated duty cycle correction factor of –21.0 dB using the procedure detailed in ANSI C63.4-2001 Annex I.4 j).*

This was calculated as follows:

Duty cycle = on time/100 milliseconds or period (whichever is the lesser)

On time =8.42 milliseconds (from duty cycle plot)

Duty cycle = 8.42 / 94.99 milliseconds (94.99 milliseconds being the pulse period from duty cycle plot)

Duty cycle = 0.089 or 8.9%

To obtain correction factor in dB i.e. to correct the peak reading to the average value of the fundamental in dB:
20 x log (0.089) = -21.0 dB

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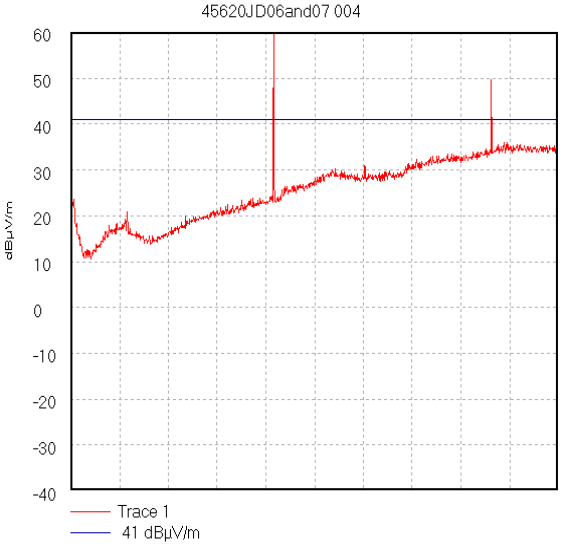
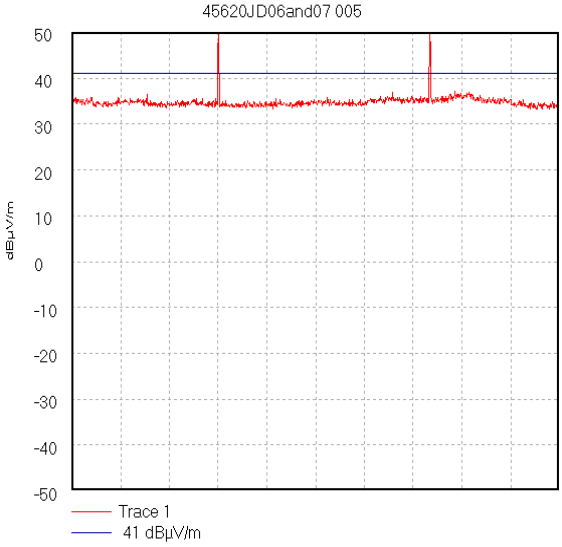
Transmitter Radiated Emissions (Continued)



Start 30.0 MHz; Stop 1.0 GHz
Ref 60 dBµV/m; Ref Offset 0.0 dB; 10 dB/div
RBW 120.0 kHz; VBW 100.0 kHz; Att 0 dB; Swp 2.2 S
Peak 434.167 MHz, 63.98 dBµV/m
Display Line: 41 dBµV/m; ; Limit Test Failed
Transducer Factors: A490
3/22/2004 1:44:29 PM



Start 1.0 GHz; Stop 2.0 GHz
Ref 50 dBµV/m; Ref Offset -9.5 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 1.736 GHz, 51.19 dBµV/m
Display Line: 41 dBµV/m; ; Limit Test Failed
Transducer Factors: A490
3/22/2004 2:23:15 PM

Note: the limit line in the above plots were set to a level approximately 20 dB below the calculated spurious emissions limit of 60.8 dBµV/m (that is applicable for operation outside the restricted bands detailed in Part 15.205).

Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

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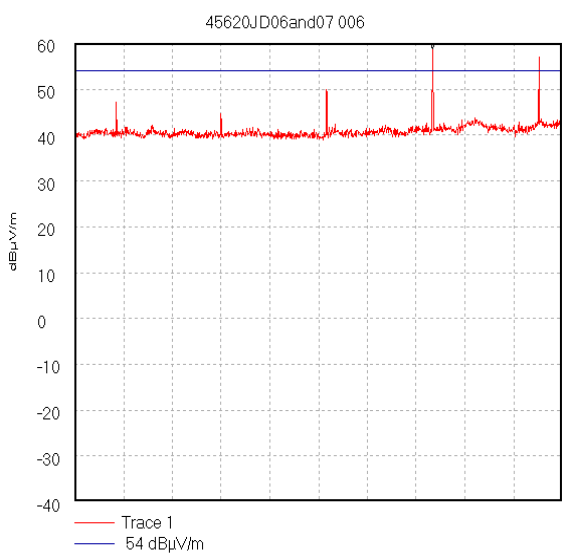
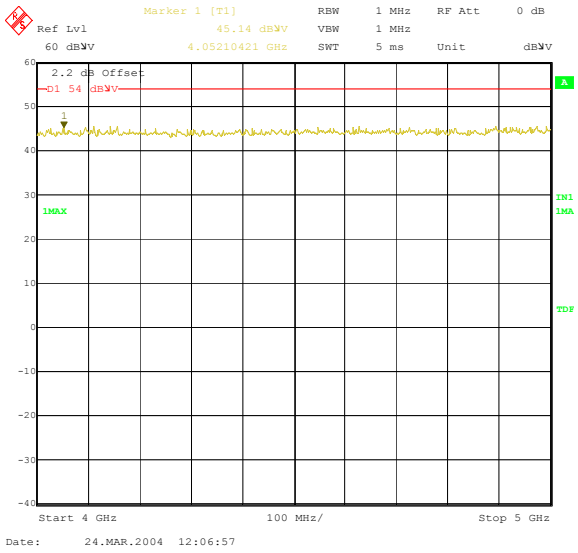
Transmitter Radiated Emissions (Continued)





Start 2.0 GHz; Stop 4.0 GHz
Ref 60 dBµV/m; Ref Offset -9.5 dB; 10 dB/div
RBW 1000.0 kHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS
Peak 3.469 GHz, 58.74 dBµV/m
Display Line: 54 dBµV/m; ; Limit Test Failed
Transducer Factors: A490
3/22/2004 2:49:59 PM

Note: the limit line in the above plots were set to 54 dBµV/m i.e. the average limit applicable for operation inside the restricted bands detailed in Part 15.205.

Note: these plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

8. Measurement Methods

8.1. Radiated Emissions

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

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.

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. Any emission within 20 dB of the limit were then measured on the open area test site, except in cases where the noise floor was within 20 dB of the limit, in these cases the highest point of the noise floor was measured.

In either case the measurement was made at the appropriate distance using a measuring receiver with a Quasi-Peak detector for measurements below 1000 MHz and an Average detector for measurements above 1000 MHz.

For the final measurements the EUT was arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4 – 2001 Clause 5.4.

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

On the open area test site, at each frequency where a signal was to be measured, the trace was maximised by rotating a turntable through 360°. The angle at which the maximum signal was observed was locked out. For frequencies below 1000 MHz the test antenna was varied in height between 1 m and 4 m in order to further maximise the target emission.

For frequencies above 1000 MHz where a horn antenna was used, height searching was performed to locate the optimal height of the horn with respect to the EUT. At this point the horn was locked off and the turntable was again rotated through 360° to maximise the target signal. It should be noted that the received signal from the EUT would diminish very quickly after it exits the beam width of the horn antenna, for this reason it may not be necessary to fully height search with the horns.

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.

Scans were performed to the upper frequency limits as stated in Section 15.33

The final field strength was determined as the indicated level in dBμV plus cable loss and antenna factor.

Radiated Emissions - (Continued)

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

Receiver Function	Initial Scan	Final Measurements Below 1 GHz	Final Measurements Above 1 GHz
Detector Type:	Peak	Quasi-Peak (CISPR)	Peak / Average
Mode:	Max Hold	Not applicable	Max Hold
Bandwidth:	(120 kHz < 1 GHz) (1 MHz > 1 GHz)	120 kHz	1 MHz
Amplitude Range:	100 dB	100 dB	100 dB
Step Size:	Continuous sweep	Not applicable	Not applicable
Sweep Time:	Coupled	Not applicable	Not applicable

Duty Cycle Correction factor procedure

As the EUT employs periodic operation the average level of emission was found by measuring the peak level of the emission and correcting it with the duty cycle correction factor, which was obtained as follows:

The EUT (in its normal operating mode) was switched on, transmitting its pulse train continuously. A spectrum analyzer was set to the transmitter carrier frequency with its Resolution Bandwidth (RBW) set wide enough to encompass all significant spectral components, an RBW of 100 kHz was used. The Video Bandwidth was set to 100 kHz. The frequency span was set to 0 Hz.

The sweep time was set to a to capture the entire pulse train period including the Transmit On Time pulse and to cover a period in excess of the pulse train period to demonstrate whether or not the pulse train exceeded 100 ms. The Transmit On Time pulsewidth and pulse train length were measured and a plot taken. A sweep time of 100 ms was sufficient to demonstrate this. A plot of this was taken.

If the pulse train was less than 100 ms, including blanking intervals, the duty cycle was calculated by averaging the sum of the pulse widths over one complete pulse train. If the pulse train exceeded 100 ms, the duty cycle was calculated by averaging the sum of the pulsewidths over the 100 ms width with the highest average value. The duty cycle is the value of the sum of the pulse widths in one period (or 100 ms), divided by the length of the period (or 100 ms) i.e. Duty cycle = on time/100 milliseconds or period (whichever is the lesser).

To obtain the duty cycle correction factor in dB i.e. to correct the peak reading to the average value of the emission in dB the following formula was used:

Correction factor in dB = 20 x log (Duty cycle in linear terms)

Transmitter 20 dB Bandwidth

The EUT and spectrum analyser was configured as for transmitter radiated emissions measurements.

To determine the occupied bandwidth, a resolution bandwidth of 10 kHz was used, which is greater than 1% of the 20 dB bandwidth. A video bandwidth of a least the same value was used. The analyser was set for a maximum hold scan to capture the profile of the signal. The peak level was then determined and set as the 0 dB reference point. A reference line was drawn 20 dB below this 0 dB reference point. The bandwidth was determined at the points where the 20 dB reference crossed the profile of the emission.

Transmitter Timeout

The EUT and spectrum analyser was configured as for transmitter radiated emissions measurements.

To determine the deactivation time of the transmitter, a spectrum analyzer was set to the transmitter carrier frequency with its Resolution Bandwidth (RBW) set wide enough to encompass all significant spectral components, an RBW of 500 kHz was used. The Video Bandwidth was set to 500 kHz. The frequency span was set to 0 Hz. The sweep time was set to period just in excess of 5 seconds in order to capture the entire Transmit On Time pulse and a period of 5 seconds from the activation of the transmitter. A plot of this was recorded.

9. Measurement Uncertainty

9.1. No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

9.2. The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

9.3. The uncertainty of the result may need to be taken into account when interpreting the measurement results.

9.4. 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. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	**Range**	**Confidence Level (%)**	**Calculated Uncertainty**
Occupied Bandwidth	N/A	95%	+/- 0.12 %
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	+/- 5.26 dB
Radiated Spurious Emissions	1 GHz to 40 GHz	95%	+/- 1.78 dB

9.5. The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

Appendix 1. Test Equipment Used

RFI No.	Instrument	Manufacturer	Type No.	Serial No.
A027	Horn Antenna	Eaton	9188-2	301
A031	Horn Antenna	Eaton	91889-2	557
A249	69 dB Variable Attenuator	Narda	745-69	02329
A253	WG 12 Microwave Horn	Flann Microwave	12240-20	128
A490	Bilog Antenna	Chase	CBL6111A	1590
C178	Cable	Rosenberger	UFA210A-1-1181-70x70	None
M069	Spectrum Analyser / Receiver	Rohde & Schwarz	ESMI	829 808/007 (DU) / 827 063/008 (RU)
M088	Spectrum Analyser / Receiver	Rohde & Schwarz	ESBI	DU:835862/018 RU:835387/006
M1124	Spectrum Analyser	Rohde & Schwarz	ESIB26	100046K
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016
S201	Site 1	RFI	1	
S202	Site 2	RFI	2	S202-15011990

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

Appendix 2. Test Configuration Drawings

This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\45620JD07\EMIRAD	Test configuration for measurement of radiated emissions

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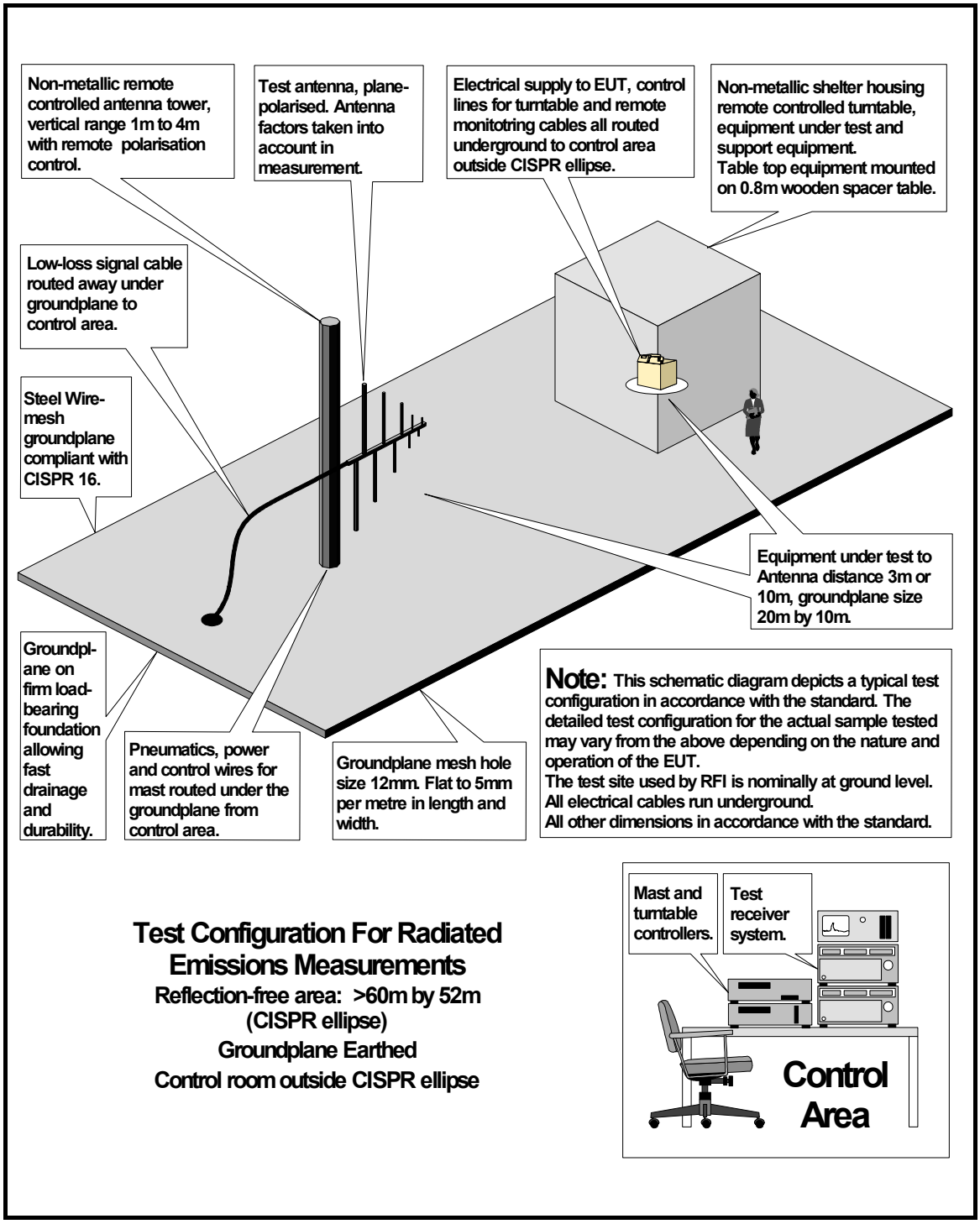
DRG\45620JD07\EMIRAD



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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