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TEST REPORT FROM RADIO FREQUENCY INVESTIGATION LTD.

Test Of: Radiodetection Ltd
Dual Frequency Sonde
ND2099-DF-1

To: FCC Part 15 Subpart C: 1998
(Intentional Radiators)
Clause 15.209

Test Report Serial No:
RFI/EMCB1/RP41080A

This Test Report Is Issued Under The Authority Of Brian Watson, Operations Director:	
Tested By:	**Checked By:** .....
Report Copy No: 01	
Issue Date: 26 June 2000	**Test Date: 21 June 2000**

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Dual Frequency Sonde
ND2099-DF-1

To: FCC Part 15: 1998 Subpart C Section 15.225

Table of Contents

1. Client Information

Company Name:	Radiodetection Ltd
Address:	Western Drive Bristol BS14 0AZ
Contact Name:	Dr. R Lee

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:	Radiodetection Ltd
Model Name or Number:	Dual Frequency Sonde
Unique Type Identification:	ND2099-DF-1
Serial Number:	B7 10879
Country of Manufacture:	England
FCC ID Number:	K68ND2099A
Date of Receipt:	21 June 2000

2.2. Description Of EUT

The EUT is small battery powered unit that is placed in a drill head. It emits an induction field at 33 kHz (and 8 kHz). This induction field contains encoded data related to the EUT (and hence the drill head) such as roll and inclination position. This information is received by other equipment and used to assist operators in a drilling operation.

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. Additional Information Related To Testing

Power Supply Requirement:	Internal battery supply of 3 Volts
Intended Operating Environment:	Light Industry
Weight:	0.8 kg
Dimensions:	380 mm x 32 mm diameter
Interface Ports:	None.

2.5. Support Equipment

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

Description:	Test Jig
Brand Name:	Radiodetection
Model Name or Number:	T362
Serial Number:	Not applicable
FCC ID Number:	Not applicable
Cable Length And Type:	Not applicable
Connected to Port:	Not applicable

Description:	DrillTrack Outstation
Brand Name:	Radiodetection
Model Name or Number:	65/ND1661-USA
Serial Number:	SH20681USA
FCC ID Number:	Not applicable
Cable Length And Type:	Not applicable
Connected to Port:	Not applicable

3. Test Specification, Methods And Procedures

3.1. Test Specification

Reference:	FCC Part 15 Subpart C: 1998 (Intentional Radiators). Section 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 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 (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 Internal battery supply of 3 Volts supply.

5.2. Operating Modes

The EUT was tested in the following operating mode: Operating at an fundamental frequency of 33 kHz at full power whilst being rotated about its long axis, as in normal operation.

The reason for choosing this mode 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: The EUT was placed on the test jig throughout testing. The Drilltrack Outstation was used to set the EUT to operate at 33 kHz prior to testing. The Drilltrack outstation was then removed from the test set-up. During the test, the EUT was rotated about its long axis by the test jig.

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.

6. Summary Of Test Results

6.1. Summary Of Test Results

Range Of Measurements	Specification Reference	Compliancy Status
Electric Field Strength Emissions	FCC Part 15: 1998 Subpart C Clause 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 NAMAS Document NIS 81 with a confidence level of 95%. Please refer to Section 8 for details of measurement uncertainties.

7.2. Test Results For Radiated Emissions

7.2.1. Electric Field Strength Measurements

7.2.1.1. The client has stated that the fundamental frequency of the EUT is 33 kHz, and the highest clock frequency generated within the EUT is 4.608 MHz. Therefore tests were performed up to 30 MHz.

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

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

Frequency (MHz)	Ant. Pol.	Av. Level (dBμV/m)	Av. Limit (dBμV/m)	Margin (dB)	Result
0.0327	Face On	54.8	122.8	68.0	Complied
0.0327	90°	62.7	122.8	60.1	Complied
0.0660	Face On	24.3	117.1	92.8	Complied
0.0660	90°	25.7	117.1	91.4	Complied

7.2.1.4. 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)	Ant. Pol.	Q-P Level (dBμV/m)	Q-P Limit (dBμV/m)	Margin (dB)	Result
0.0990	Face On	31.9	111.4	79.5	Complied
0.0990	90°	36.9	111.4	74.5	Complied

Section 15.209 or C.F.R. 47 specifies radiated emission limits between 9 and 490 kHz at a test distance of 300 metres. The above tables demonstrate levels when performed at a test distance of 10m. Within section 15.31 of C.F.R. 47 measurements below 30 MHz may be performed at a test distance closer than specified by the standard, and in this instance the square of the inverse linear distance extrapolation factor (40dB/decade) was used.

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
Radiated Emissions	10KHz to 30MHz	95%	+/- 2.6 %

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" ISO/IEC/OIML/BIPM (Prepared by ISO/TAG 4: January 1993).

Appendix 1. Test Equipment Used

Instrument	Manufacturer	Model Number	RFI No.
10 kHz to 30 MHz H-Field Antenna	Rohde & Schwarz	HFH2-Z2	A007
HFH2-Z2 Metal Tripod	Rohde & Schwarz	HFU-Z	A008
Cable	Andrews	None	C342
Cable	Rosenberger	UFA210A-1-1181-70x70	C347
Cable	Rosenberger	UFA210A-1-0590-50x50	C353
Cable	Rosenberger	UFA210A-1-1182-704704	C459
N-Type Coaxial Cable	Rosenberger	UFA210A-1-3937-504504	C468
Spectrum Monitor	Rohde & Schwarz	EZM	M003
ESH3 Receiver	Rohde & Schwarz	ESH3	M032
Receiver / Spectrum Analyser System	Rohde & Schwarz	ESBI	M090
Thermometer/Barometer/Hydrometer	Oregan Scientific	BA-116	M172
Thermo/hygrometer	RS Components	RS212-124	M210
Plotter	Hewlett Packard	7440A	P502
Site 1	RFI	1	S201
Site 9	RFI	9	S209

NB In accordance with NAMAS 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.

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°. The antenna was configured 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.

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

Receiver Function	Initial Scan (Below 30 MHz)	Final Measurements (Below 30 MHz)
Detector Type:	Peak	Quasi-Peak (CISPR) or Average
Mode:	Max Hold	Not applicable
Bandwidth:	9 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

Appendix 3. Test Configuration Drawings

This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\41080ETF01\EMIRAD	Test configuration for measurement of radiated emissions
DRG\41080ETF01\001	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test

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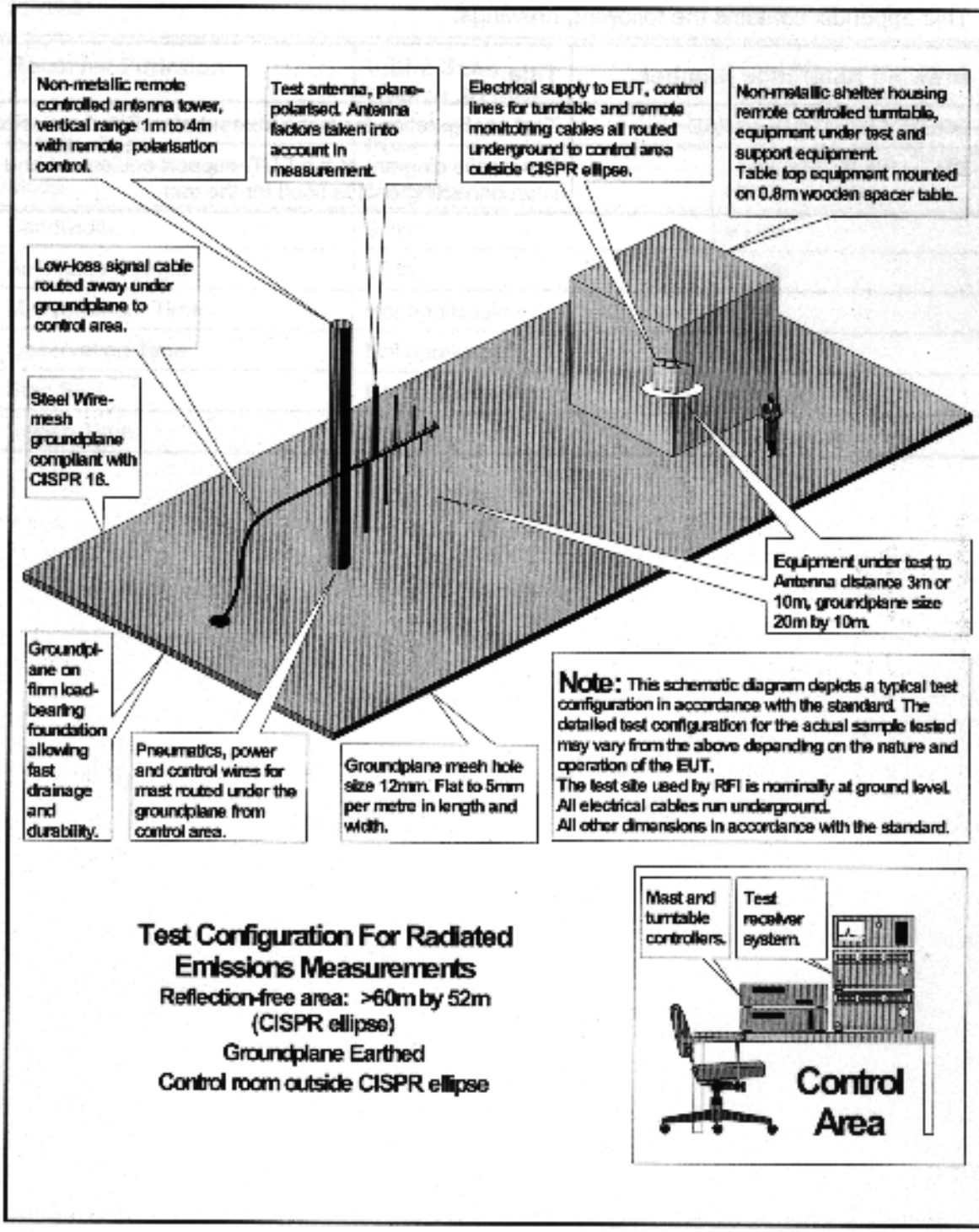
DRG\41080ETF01\EMIRAD



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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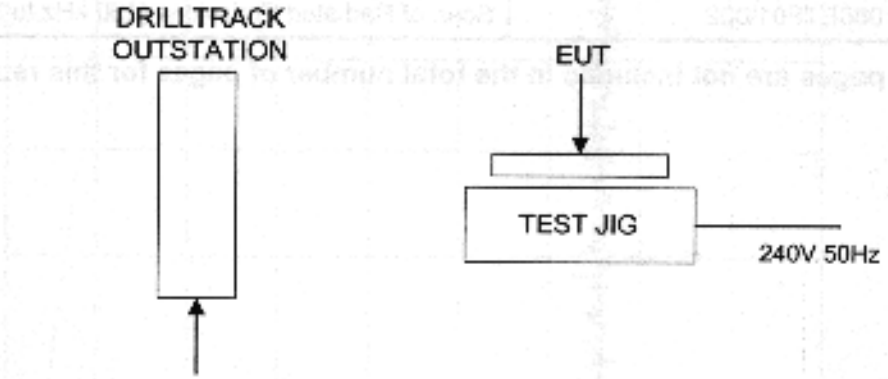
DRG\41080ETF01\001

Configuration of EUT and Support Equipment



SUPPORT EQUIPMENT USED
DURING SET-UP ONLY AND
THEN REMOVED

Appendix 4. Graphical Test Results

This appendix contains the following graphs:

Graph Reference Number	Title
GPH\41080ETF01\001	Scan of Radiated Emissions (9 kHz to 150 kHz)
GPH\41080ETF01\002	Scan of Radiated Emissions (150 kHz to 30 MHz)

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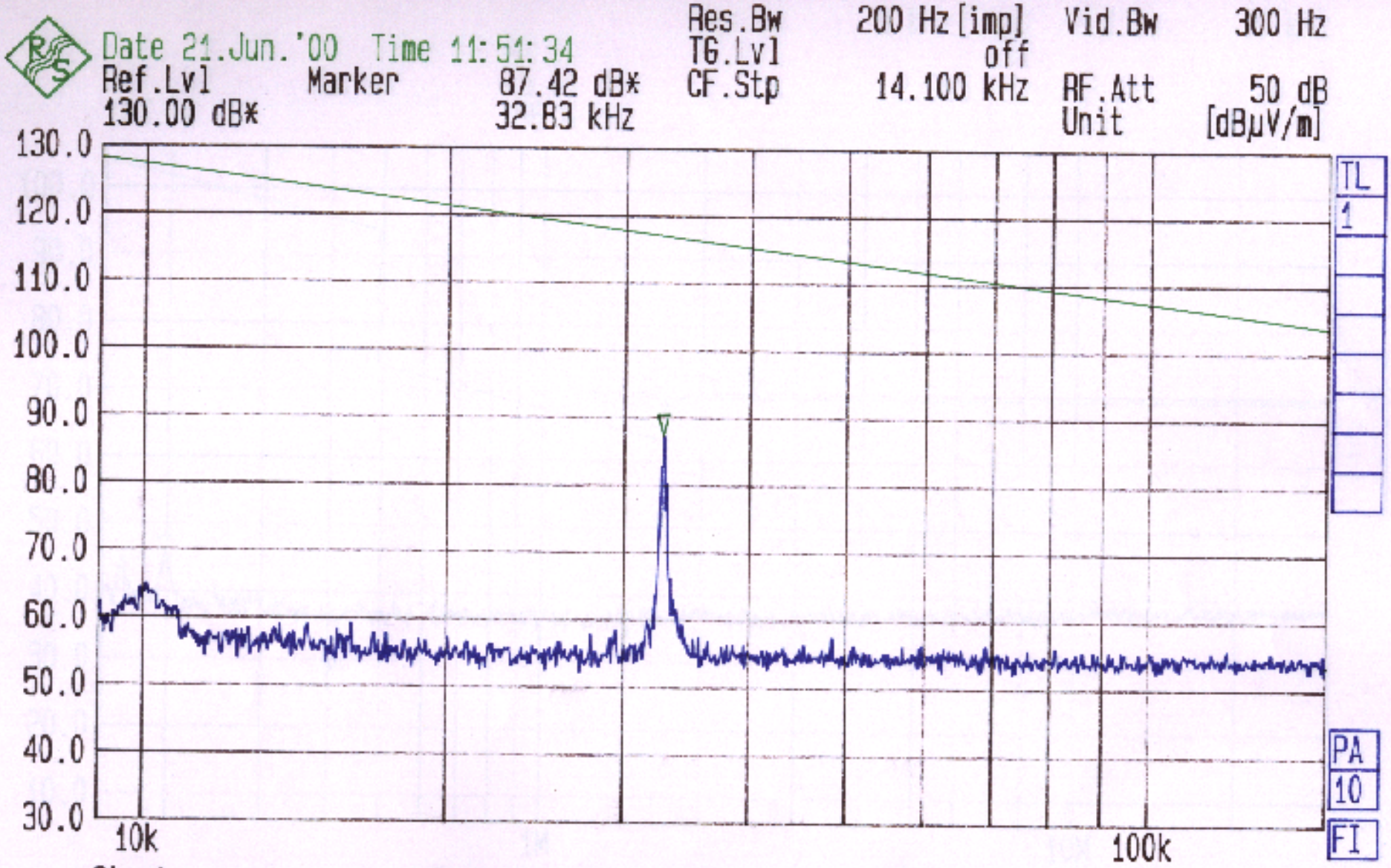
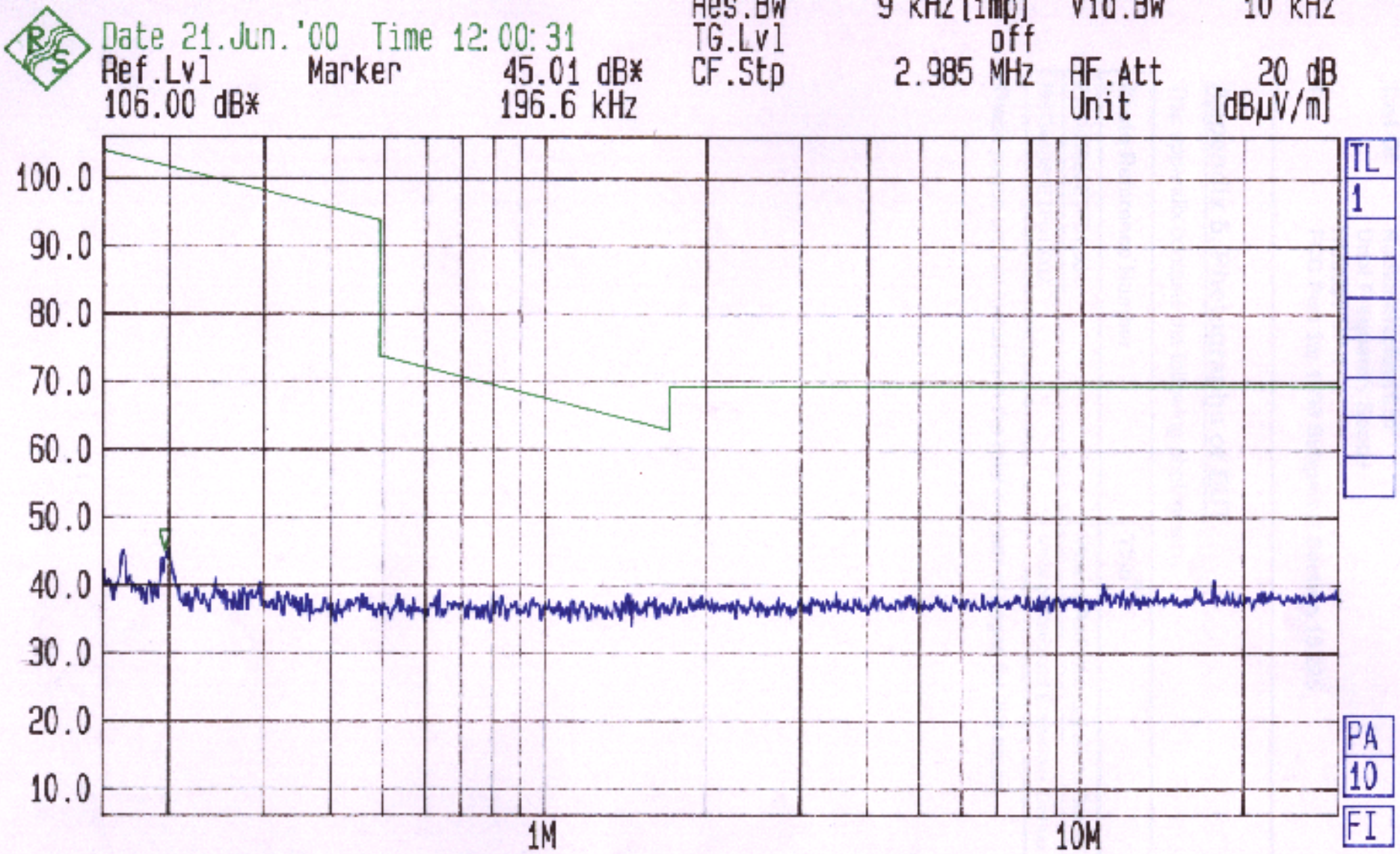


Radiated. Tested by RFI for Radiodetection. EUT: Dual Frequency Sonde. FCC Pt 15: 98
Limit: 15.209 @ 3m. Tx at 33kHz. GPH/41080/JD02/001



Radiated. Tested by RFI for Radiodetection. EUT: Dual Frequency Sonde. FCC Pt 15:98
Limit: 15.209 @ 3m. Tx at 33kHz. GPH/41080/JD02/002

Appendix 5. Photographs of EUT

This appendix contains the following photographs

Photo Reference Number	Title
PHT\41080ETF01\001	View of Radiated Emissions Set-up
PHT\41080ETF01\002	View of Radiated Emissions Set-up

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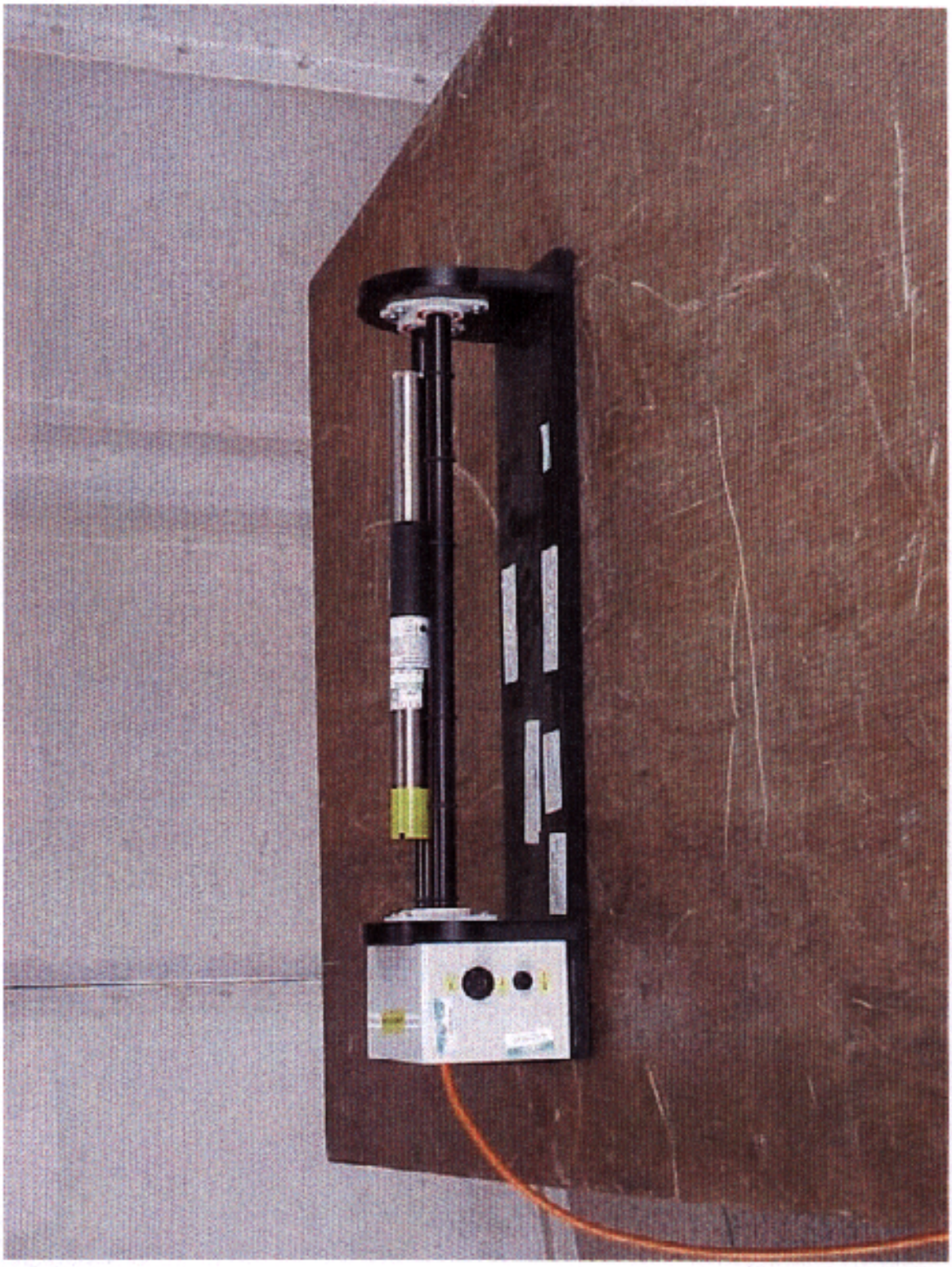
PHT\41080ETF01\001 View of Radiated Emissions Set-up



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PHT\41080ETF01\002 View of Radiated Emissions Set-up