

TEST REPORT FROM RADIO FREQUENCY INVESTIGATION LTD.

Test Of: Sony Corporation
RC-S445C Smart Card Reader

To: FCC Part 15 Subpart C
Clause 15.225: 1998

Test Report Serial No:
RFI\EMCB1\RP40219B

This Test Report Is Issued Under The Authority Of Brian Watson Technical Director: 	Checked By: 
Tested By: 	Release Version No: PDF01
Issue Date: 20 December 1999	Test Date: 2 December to 6 December 1999

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RADIO FREQUENCY INVESTIGATION LTD.

EMC Department

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1. Client Information

Company Name:	Sony Corporation
Address:	6-7-35 Kitashinagawa Shinagawaku Tokyo 141-0001-Japan
Contact Name:	Mr Toshimichi Okita

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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:	Sony
Model Name or Number:	RC-S445C
Unique Type Identification:	None Stated by Client
Serial Number:	00000016
Country of Manufacture:	Japan
FCC ID Number:	Awaiting Certification
Date of Receipt:	2 December 1999

2.2. Description Of EUT

The equipment under test is a smart card reader.

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 + 12 V
Intended Operating Environment:	Residential and Commercial
Weight:	0.5 kg
Dimensions:	190 mm (L) x 125 mm (W) x 50 mm (H)
Interface Ports:	None

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2.5. Support Equipment

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

Description:	Smart Card (Support Tag)
Brand Name:	None Stated by Client
Model Name or Number:	None Stated by Client
Serial Number:	None Stated by Client
FCC ID Number:	None Stated by Client
Cable Length And Type:	No Direct Connection
Connected to Port:	Not applicable

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3. Test Specification, Methods And Procedures

3.1. Test Specification

Reference:	FCC Part 15 Subpart C Clause 15.225: 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 (1993)

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.

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4. Deviations From The Test Specification

None.

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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 + 12 V.

5.2. Operating Modes

The EUT was tested in the following operating mode:

Continuously transmitting with tag present in field.

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:

With tag positioned in close proximity of the EUT.

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.

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6. Summary Of Test Results

6.1. Summary Of Test Results

Range Of Measurements	Specification Reference	Compliance Status
Electric Field Strength of Fundamental Emission	FCC Part 15 Subpart C Clause 15.225 (a): 1998	Complied
Electric Field Strength of Spurious Emissions	FCC Part 15 Subpart C Clause 15.225 (b): 1998	Complied
Frequency Tolerance	FCC Part 15 Subpart C Clause 15.225 (c): 1998	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.

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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.

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7.2. Test Results For Radiated Emissions

7.2.1. Electric Field Strength Measurement of Fundamental Frequency

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

7.2.1.2. Measurements were performed in to the limits specified in FCC Part 15.225(a). For fundamental frequencies between 13.553 and 13.567 MHz, any emissions appearing in this frequency band must not exceed 10,000 $\mu\text{V/m}$ at 30 meters (80dB $\mu\text{V/m}$ at 30 meters).

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):

Frequency (MHz)	Ant. Pol.	Q-P Level (dB $\mu\text{V/m}$)	Q-P Limit (dB $\mu\text{V/m}$)	Margin (dB)	Result
13.560	90°	65.9	120.0	55.9	Complied

Note: Due to high levels of ambient signal, final radiated emission measurements were performed with the measurement antenna at a test distance of 3m. The limit was calculated using the square of an inverse linear distance extrapolation factor (40dB/decade). i.e. $40 \log (d1/d2)$.

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

7.2.2.1. The client has stated that the highest clock frequency for the EUT was 13.56 MHz. Therefore tests were performed up to 1000 MHz.

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

7.2.2.3. Measurements were performed in to the limits specified in FCC Part 15.209.

7.2.2.4. 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):

Frequency (MHz)	Ant. Pol.	Q-P Level (dB _m V/m)	Q_P Limit (dB _m V/m)	Margin (dB)	Result
54.240	Vert.	21.2	40.0	18.8	Complied
81.630	Vert.	25.8	40.0	14.2	Complied
94.920	Vert.	41.2	43.5	2.3	Complied
149.161	Horiz.	26.0	43.5	17.5	Complied
162.720	Vert.	43.1	43.5	0.3	Complied
176.280	Vert.	24.8	43.5	18.7	Complied
216.961	Horiz.	36.9	46.0	9.1	Complied
382.264	Horiz.	27.9	46.0	18.1	Complied
596.642	Vert.	42.6	46.0	3.4	Complied
650.883	Vert.	43.3	46.0	2.7	Complied

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7.3. Frequency Stability Measurements

7.3.1. Measurements were performed to determine the frequency stability of the fundamental emission from the EUT, when subjected to variation of ambient temperature and variation of supply voltage.

7.3.1. Variation of Ambient Temperature

7.3.1.1. The ambient temperature was varied from -20°C to +50°C in 10°C steps. During the test the fundamental frequency of the EUT shall be maintained within $\pm 0.01\%$ of the operating frequency.

7.3.1.2. The client has stated that the operating frequency of the EUT is 13.56 MHz. The following frequency limits shall not be exceeded throughout the test.

Lower Limit	13.558644 MHz
Upper Limit	13.561356 MHz

Results:

Temperature (°C)	Measured Frequency (MHz)	Margin (MHz)	Result
-20	13.561	0.000356	Complied
-10	13.561	0.000356	Complied
0	13.561	0.000356	Complied
+10	13.561	0.000356	Complied
+20	13.561	0.000356	Complied
+30	13.561	0.000356	Complied
+40	13.561	0.000356	Complied
+50	13.561	0.000356	Complied

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7.3.2. Variation of Supply Voltage

7.3.2.1. The supply voltage was varied between 85% and 115% of the rated supply voltage for the EUT. During the test the fundamental frequency of the EUT shall be maintained within $\pm 0.01\%$ of the operating frequency.

7.3.2.2. The client has stated that the operating frequency of the EUT is 13.56 MHz. The following frequency limits shall not be exceeded throughout the test.

Lower Limit	13.558644 MHz
Upper Limit	13.561356 MHz

Results:

% of Rated Supply	Supply Voltage to EUT (V)	Measured Frequency (MHz)	Margin (MHz)	Result
Nominal	12.0	13.561	0.000356	Complied
-15 %	10.2	13.561	0.000356	Complied
+15 %	13.8	13.561	0.000356	Complied

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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	150 kHz to 30 MHz	95%	+/- 2.6 dB
Radiated Emissions	30 MHz to 1000 MHz	95%	+/- 4.9 dB
Frequency Tolerance	13.561 MHz	95%	±0.8 ppm

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).

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Appendix 1. Test Equipment Used

Instrument	Manufacturer	Model	RFI No.
Loop Antenna	R & S	HFH2-Z2	A007
Receiver / Spectrum Analysyer System	R & S	ESBI	M090
Bilog Antenna	Chase	CBL6111A	A490
OATS Positioning Controller	R & S	HCC	A276
OATS Antenna Mast	R & S	HCM	A277
Spectrum Monitor	R & S	EZM	M003
Receiver	R & S	ESVP	M023
Bilog Antenna	Chase	CBL6112B	A1037
3 dB Attenuator	Suhner	6803.17.B	A392
Portable Analyser	HP	8594A	M053
Power Supply Unit	Farnell	PDD3502A	S009
DVM	Fluke	77	M105
Environmental Chamber	Prolan	PV427H75F 30HV	E007

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

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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.

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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)
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

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

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A2.2. Frequency Stability:

A.2.2.1. Tests were performed to determine the frequency stability of the EUT under varied ambient temperatures, and varied supply voltages.

A.2.2.2. For ambient temperature tests the EUT was placed in an environmental test chamber in close proximity to a measuring antenna which in turn was connected to a measuring analyser. The EUT was fitted with fully charged or new batteries. The EUT remained switched off.

A.2.2.3. The test chamber was set to acclimatise to -20°C, for a minimum of 30 minutes. The EUT was then switched on and the fundamental frequency was noted. The EUT was then switched off.

A.2.2.4. The test chamber was set to the next temperature setting and step A.2.2.3. was repeated.

A.2.2.5. For supply variation tests, the EUT was operated in an ambient environment of 20°C. The battery was replaced with a suitable power supply unit (PSU), and voltage monitored with a calibrated digital volt meter (DVM). The EUT was switched off.

A.2.2.6. The supply was adjusted to the first setting, and the EUT was switched on and the fundamental frequency was noted. The EUT was then switched off.

A.2.2.7. The supply voltage was set to the next setting and step A.2.2.6. was repeated.

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Appendix 3. Test Configuration Drawings

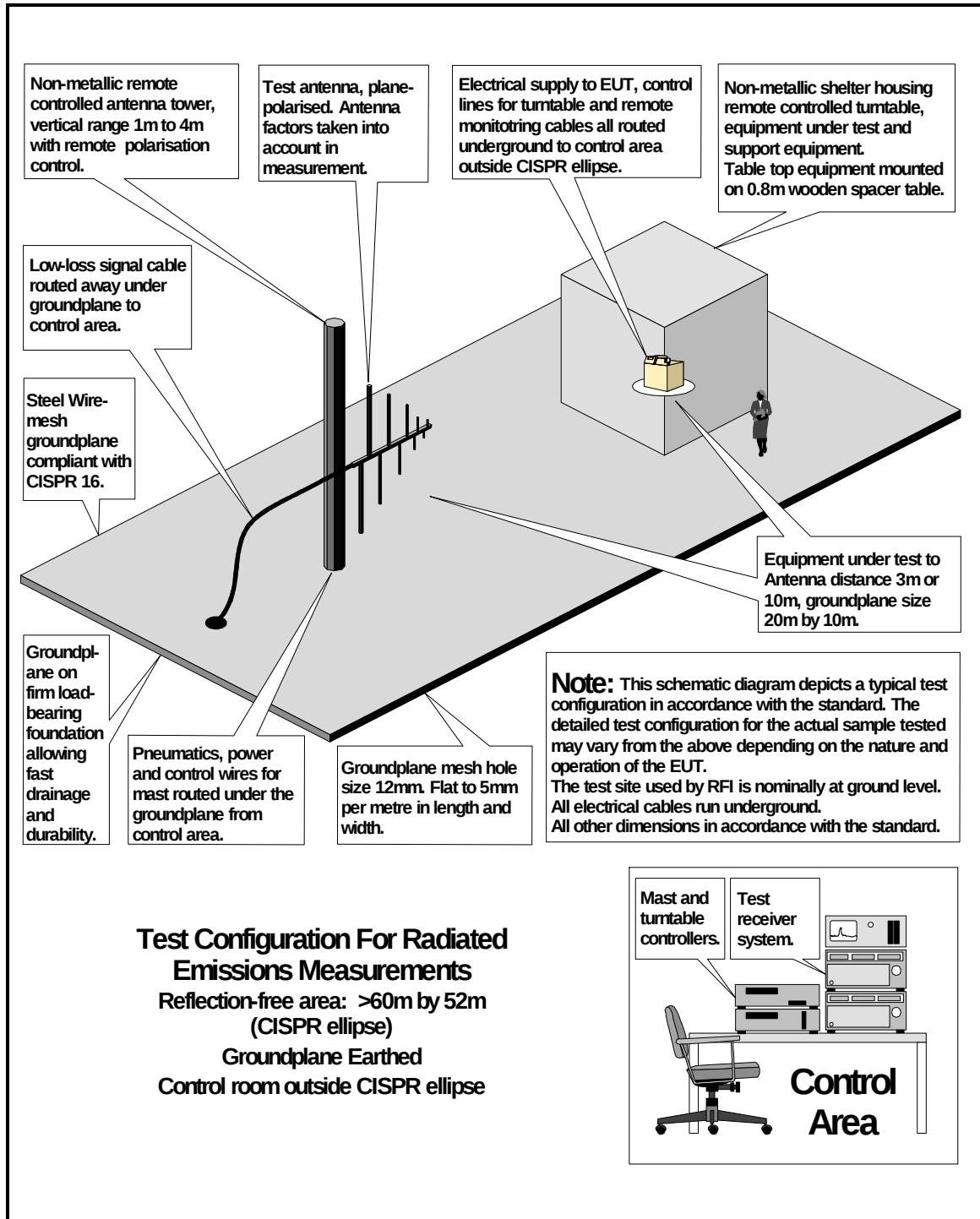
This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\40219JD05\EMIRAD	Test configuration for measurement of radiated emissions
DRG\40219JD05\001	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test

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DRG\40219JD05\001

Configuration of EUT and Support Equipment

Tag

EUT

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Appendix 4. Graphical Test Results

This appendix contains the following graphs:

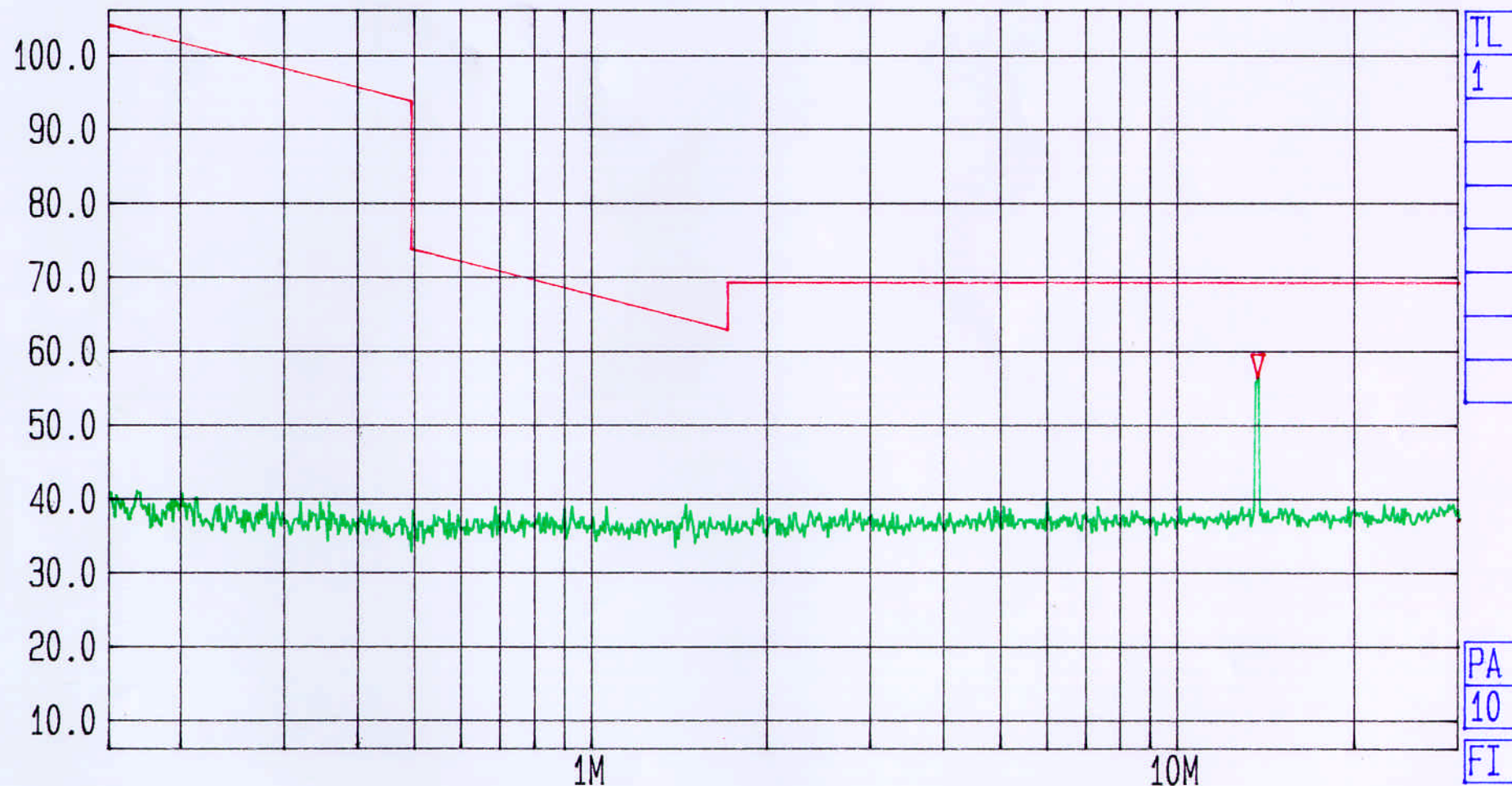
Graph Reference Number	Title
GPH\40219JD05\001	Scan of Radiated Electric Field 150 kHz to 30 MHz
GPH\40219JD05\002	Scan of Radiated Electric Field 30 MHz to 1000 MHz

These pages are not included in the total number of pages for this report.



Date 02.Dec.'99 Time 11:35:11
Ref.Lvl 106.00 dB*
Marker 56.46 dB*
13.63 MHz

Res.Bw 10 kHz [imp]
TG.Lvl off
CF.Stp 2.985 MHz
Vid.Bw 10 kHz
RF.Att 20 dB
Unit [dBμV/m]



Start
150 kHz

Span
29.85 MHz

Center
2.12132 MHz

Sweep
1.58 s

Stop
30 MHz

Radiated. Tested By RFI For Sony
FCC Part 15.225 (limit 15.209)

EUT: RC-S445C
Tag Present

FCC Part 15 Sub C: 1998
GPH: 40219/05/05/001

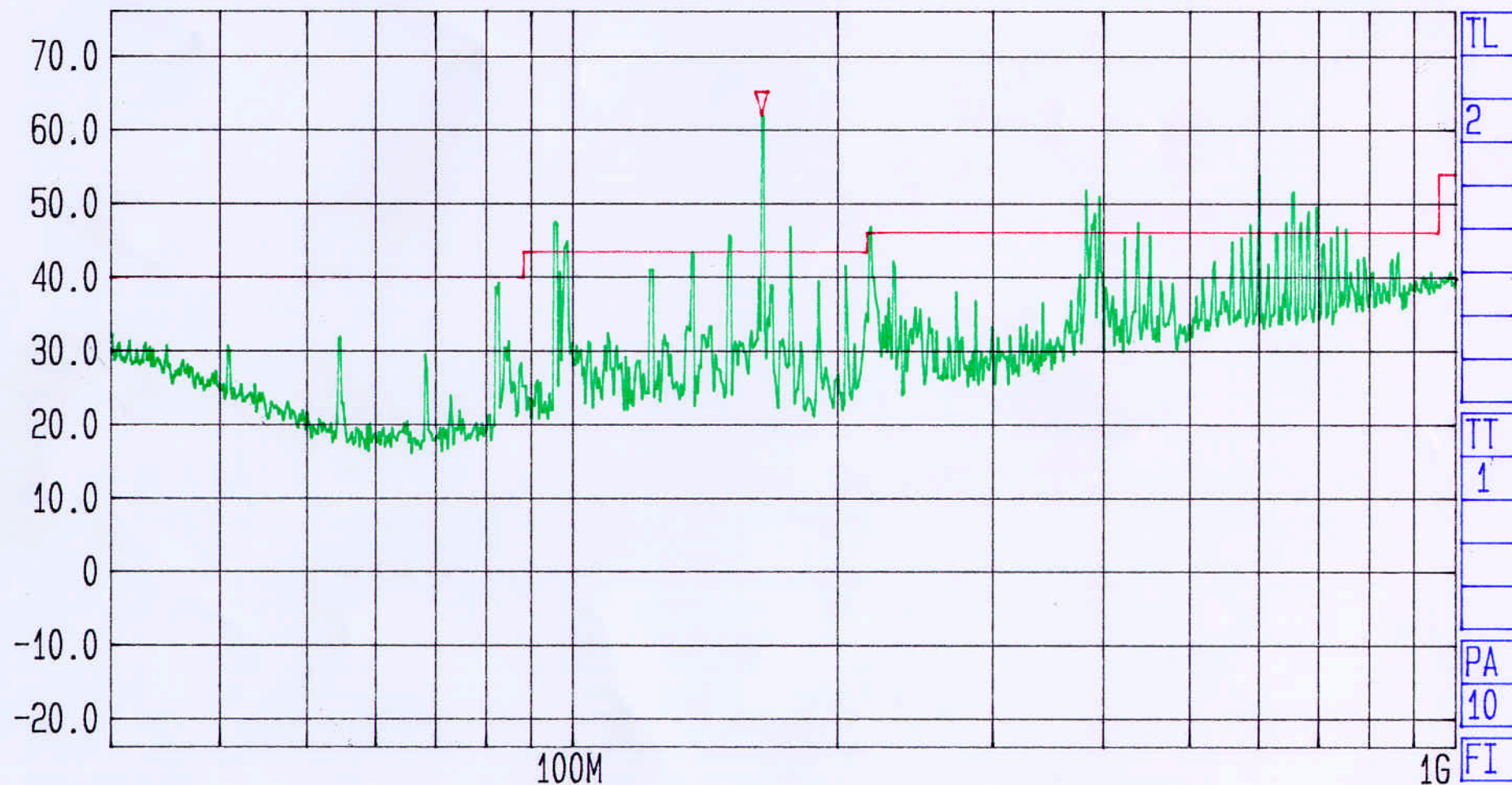


Date 02.Dec.'99 Time 14:25:45

Ref.Lvl 76.00 dB*
Marker 61.91 dB*
163.3 MHz

Res.Bw 120 kHz [imp]
TG.Lvl off
CF.Stp 97.000 MHz

Vid.Bw 100 kHz
RF.Att 0 dB
Unit [dBμV/m]



Start
30 MHz

Span
970 MHz

Center
173.2 MHz

Sweep
380 ms

Stop
1 GHz

Radiated. Tested By RFI For Sony
FCC Part 15.225 (limit 15.209)

EUT: RC-S445C
Tag Present

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GPH: 40219/05/05/002

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Appendix 5. Photographs of EUT

This appendix contains the following photographs:

Photo Reference Number	Title
PHT\40219\001	View of equipment under test.
PHT\40219\002	View of equipment under test.

These pages are not included in the total number of pages for this report.

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PHT\40219\001 View of equipment under test.



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PHT\40219\002 View of equipment under test.

