

TEST REPORT FROM RADIO FREQUENCY INVESTIGATION LTD.

Test Of: i2r Ltd (Sirit UK).
OEM176/SAT

To: FCC Part 15 Subpart C: 2001

Test Report Serial No:
RFI/MPTB2/RP44300JD01A

Supersedes test Report Serial No:
RFI/MPTB1/RP44300JD01A

This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director: 	Checked By: 
Tested By:  pp	Release Version No: PDF02
Issue Date: 13 March 2003	Test Dates: 18 December 2002 to 19 December 2002

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The results in this report apply only to the sample(s) tested.

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1. Client Information

Company Name:	i2r Ltd (Sirit UK)
Address:	Unit 10 Loughborough Technology Centre Epinal Way Loughborough Leicestershire LE11 3GE
Contact Name:	Mr G Bishop / Mr T Weeks

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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:	Sirit
Model Name or Number:	OEM176/SAT
Unique Type Identification:	None stated by client
Serial Number:	X20000148
Country of Manufacture:	UK
FCC ID Number:	P5ROEM176SAT
Date of Receipt:	18 December 2002

2.2. Description Of EUT

The equipment under test is a dual technology laser barcode scanner & RFID Reader running at 134.2kHz mounted in a handheld computer.

2.3. Modifications Incorporated In EUT

The EUT has not been modified from what is described by the model number stated above.

2.4. Additional Information Related To Testing

Power Supply Requirement:	Internal battery supply of approx. 3.7V internally regulated to +5V
Intended Operating Environment:	Commercial / light Industry
Weight:	Approx. 20 g including antenna
Dimensions:	38 x 25 x 19 mm
Interface Ports:	Serial data and control port internally connected to the Symbol terminal. No external connection.

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2.5. Support Equipment

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

Description:	Handheld Computer in which the EUT is mounted
Brand Name:	Symbol
Model Name or Number:	PDT 8146 – B2A930EU
Serial Number:	None stated by client
FCC ID Number:	None stated by client
Cable Length And Type:	Not applicable
Connected to Port:	Not applicable

Description:	AC power adaptor with cradle
Brand Name:	Symbol
Model Name or Number:	B100
Serial Number:	050017
FCC ID Number:	None stated by client
Cable Length And Type:	2 m Mains Cable
Connected to Port:	100 – 240V AC input
Cable Length And Type:	2 m 2 core
Connected to Port:	9V output

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3. Test Specification, Methods And Procedures

3.1. Test Specification

Reference:	FCC Part 15: 2001 Subpart C, Sections: 15.207 and 15.209.
Title:	Code of Federal Regulations, Part 15 (47CFR) 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.

Reference:	FCC Part 15: 2001 Subpart B, Sections: 15.107 and 15.109
Title:	Code of Federal Regulations, Part 15 (47CFR) 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.

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3.2. Methods And Procedures

The methods and procedures used were as detailed in:

ANSI C63.2 (1996)

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 (1998)

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.

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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 of approx. 3.7V internally regulated to +5V. The supply was derived from the host Symbol handheld computer. This was supported in a cradle and supplied by an AC charger connected to 110V AC mains.

5.2. Operating Modes

The EUT was tested in the following operating mode:

Continuous tag read / write mode

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

5.3. Configuration And Peripherals

The EUT was tested in the following configuration:

Stand alone mounted in the Symbol handheld computer as supplied

The reason for choosing this configuration was that the client defined it as being the only configuration that can be used.

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	Mode of Operation	Compliance Status
Conducted Emissions	Part 15 of CFR 47: 2001, Section 15.207	Operating	Complied
Conducted Emissions	Part 15 of CFR 47: 2001, Section 15.107	Standby	Complied
Radiated Field Strength of Spurious Emissions	Part 15 of CFR 47: 2001, Section 15.209	Operating	Complied
Radiated Field Strength of Spurious Emissions	Part 15 of CFR 47: 2001, Section 15.109	Standby	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. 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.

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7.2. Conducted Emissions – Operating**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. Measurements were performed to the limits specified in FCC Part 15.207.

7.2.1.3. The following tables lists frequencies at which emissions were measured using the Quasi-Peak and average detectors:

Frequency (MHz)	Line	Q-P Level (dB μ V)	Q-P Limit (dB μ V)	Margin (dB)	Result
0.150000	Neutral	43.35	66.00	22.65	Complied
0.162490	Live	47.79	65.34	17.55	Complied
0.347660	Live	36.98	59.02	22.04	Complied
0.694840	Live	33.58	56.00	22.42	Complied
0.858780	Live	35.15	56.00	20.85	Complied
1.044620	Live	37.56	56.00	18.44	Complied
1.465620	Live	36.95	56.00	19.05	Complied
1.951280	Neutral	35.35	56.00	20.65	Complied
16.000009	Live	33.32	60.00	26.68	Complied

Frequency (MHz)	Line	Av Level (dB μ V)	Av Limit (dB μ V)	Margin (dB)	Result
0.150000	Neutral	20.24	56.00	35.76	Complied
0.162490	Live	41.49	55.34	13.85	Complied
0.347660	Live	25.02	49.02	24.00	Complied
0.694840	Live	20.65	46.00	25.35	Complied
0.858780	Live	19.18	46.00	26.82	Complied
1.044620	Live	23.37	46.00	22.63	Complied
1.465620	Live	26.16	46.00	19.84	Complied
1.951280	Neutral	24.26	46.00	21.74	Complied
16.000009	Live	32.89	50.00	17.11	Complied

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7.3. Conducted Emissions – Standby

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

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

7.3.1.2. Measurements were performed to the limits specified in FCC Part 15.107.

7.3.1.3. The following tables lists frequencies at which emissions were measured using the Quasi-Peak and average detectors:

Frequency (MHz)	Line	Q-P Level (dB μ V)	Q-P Limit (dB μ V)	Margin (dB)	Result
0.17939	Live	44.93	64.51	19.58	Complied
0.35866	Live	38.00	58.76	20.76	Complied
1.07296	Live	38.60	56.00	17.40	Complied
1.61321	Neutral	36.95	56.00	19.05	Complied
1.78983	Neutral	36.50	56.00	19.50	Complied
2.34020	Neutral	33.93	56.00	22.07	Complied

Frequency (MHz)	Line	Av Level (dB μ V)	Av Limit (dB μ V)	Margin (dB)	Result
0.17939	Live	43.89	54.51	10.62	Complied
0.35866	Live	36.40	48.76	12.36	Complied
1.07296	Live	34.72	46.00	11.28	Complied
1.61321	Neutral	31.01	46.00	14.99	Complied
1.78983	Neutral	30.35	46.00	15.64	Complied
2.34020	Neutral	21.49	46.00	24.51	Complied

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7.4. Radiated Emissions

7.4.1. Field Strength Measurement of Fundamental Frequency

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

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

7.4.1.3. The following table lists the measurement of the fundamental emission (results incorporate antenna factors and cable losses).

Frequency (kHz)	Ant. Pol.	Peak Level (dB μ V/m)	Av Limit (dB μ V/m)	Margin (dB)	Result
134.454	45 deg	-12.4	25.0	37.4	Complied

Note: The limit is specified at a test distance of 300m. However as specified by section 15.31 (f(2)), measurements may be performed at a closer distance, and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40dB/decade). In this case the measurement was obtained using a peak detector during the pre-scan at a distance of 3 m during which the antenna was orientated for maximum. A known correlation factor between the pre-scan environment and the OATS was used to extrapolate the result to a 10 m distance and thereafter the inverse linear distance extrapolation factor was applied to 300 m. Due to the margin obtained, final measurements on the test site were unnecessary.

7.4.2. Field Strength Measurements: 9 kHz to 30 MHz - Operating

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

7.4.2.2. The test was performed to the limits specified in FCC Part 15.209.

7.4.2.3. Preliminary radiated emission scans were performed with the EUT operating. Emissions recorded by these scans indicated all emissions to be at least 20 dB from the reference limit line. Therefore no final measurements were performed.

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7.4.3. Field Strength Measurements: 30 to 1000 MHz. – Operating

7.4.3.1. The client has stated that the highest clock frequency for the EUT was 16MHz. Therefore tests were performed up to 1000 MHz.

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

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

7.4.3.4. 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 μ V/m)	Q-P Limit (dB μ V/m)	Margin (dB)	Result
44.4862	Vert.	22.6	40.0	17.4	Complied
47.9853	Vert.	21.6	40.0	18.4	Complied
53.4678	Vert.	14.1	40.0	25.9	Complied
80.0016	Vert.	23.9	40.0	16.1	Complied
111.9794	Vert.	21.9	43.5	21.6	Complied
211.9908	Vert.	24.1	43.5	19.4	Complied
307.9978	Vert.	35.6	46.0	10.4	Complied
516.4874	Vert.	25.0	46.0	21.0	Complied
967.9848	Vert.	38.1	54.0	15.9	Complied

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7.4.4. Field Strength Measurements: 30 to 1000 MHz. – Standby

7.4.4.1. The client has stated that the highest clock frequency for the EUT was 16 MHz. Therefore tests were performed up to 1000 MHz.

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

7.4.4.3. Measurements were performed to the limits specified in FCC Part 15.109.

7.4.4.4. 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 μ V/m)	Q-P Limit (dB μ V/m)	Margin (dB)	Result
45.5832	Vert.	18.8	40.0	21.2	Complied
57.5468	Vert.	12.5	40.0	27.5	Complied
307.9722	Horiz.	31.1	46.0	14.9	Complied
967.9848	Vert.	34.8	54.0	11.2	Complied

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8. Measurement Uncertainty

8.1. 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.

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

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

8.4. 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
Conducted Emissions	0.15 MHz to 30 MHz	95%	± 3.25 dB
Radiated Emissions	0.09 MHz to 30 MHz	95%	± 3.53 dB
Radiated Emissions	30 MHz to 1000 MHz	95%	± 5.26 dB

8.5. 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.

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Appendix 1. Test Equipment Used

RFI No.	Instrument	Maker	Type No.	Serial No.
A003	ESH3-Z2 Pulse Limiter	Rohde & Schwarz	ESH3-Z2	357 881/052
A004	ESH3-Z5 LISN	Rohde & Schwarz	ESH3-Z5	890 604/027
A007	HFH2-Z2 Loop Antenna	Rohde & Schwarz	HFH2-Z2	880 458/020
A008	HFH2-Z2 Metal Tripod	Rohde & Schwarz	HFU-Z	None
A259	Bilog Antenna	Chase	CBL6111	1513
A276	OATS Positioning Controller	Rohde & Schwarz	HCC	
A277	OATS Antenna Mast	Rohde & Schwarz	HCM	
A392	3 dB attenuator (9)	Suhner	6803.17.B	None
A490	Bilog Antenna	Chase	CBL6111A	1590
C222	Cable	Rosenberger	UFA210A-1-1181-70x70	None
C362	Cable	Rosenberger	UFA210A-1-1181-70x70	1925
C363	BNC Cable	Rosenberger	RG142	None
C364	BNC Cable	Rosenberger	RG142	None
M003	Spectrum Monitor	Rohde & Schwarz	EZM	883 580/008
M044	ESVP Receiver	Rohde & Schwarz	ESVP	891 845/026
M173	Turntable Controller	R.H.Electrical Services	RH351	3510020
M174	OATS Turntable	British Turntable Ltd	S36069	None
M209	Thermo/hygro meter	RS Components	RS212-124	M209-RS212-124
M210	Thermo/hygro meter	RS Components Ltd	RS212-124	M210-RS212-124
M505	Analyser Display Unit	Rohde & Schwarz	ESAI-D	825316/010
S201	Site 1	RFI	1	
S209	Site 9	RFI	9	

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

Appendix 2. Measurement Methods

A2.1. AC Mains Conducted Emissions: FCC Part 15

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.

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A2.2. Radiated Emissions: FCC Part 15

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

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° 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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A2.2.7. 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

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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Appendix 3. Test Configuration Drawings

This appendix contains the following drawings:

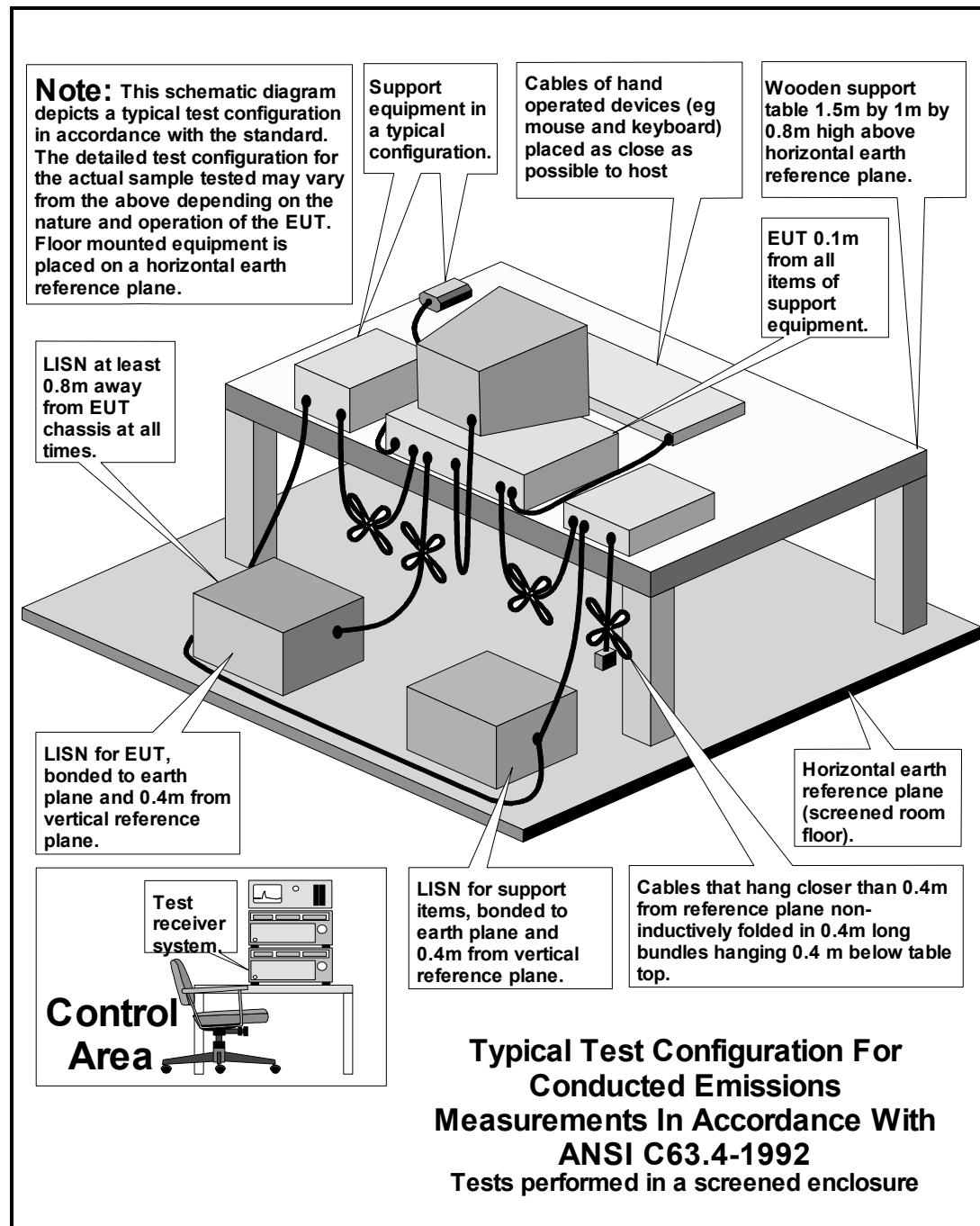
Drawing Reference Number	Title
DRG\44300JD01\EMICON	Test configuration for measurement of conducted emissions
DRG\44300JD01\EMIRAD	Test configuration for measurement of radiated emissions
DRG\44300JD01\001	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test

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DRG\44300JD01\EMICON



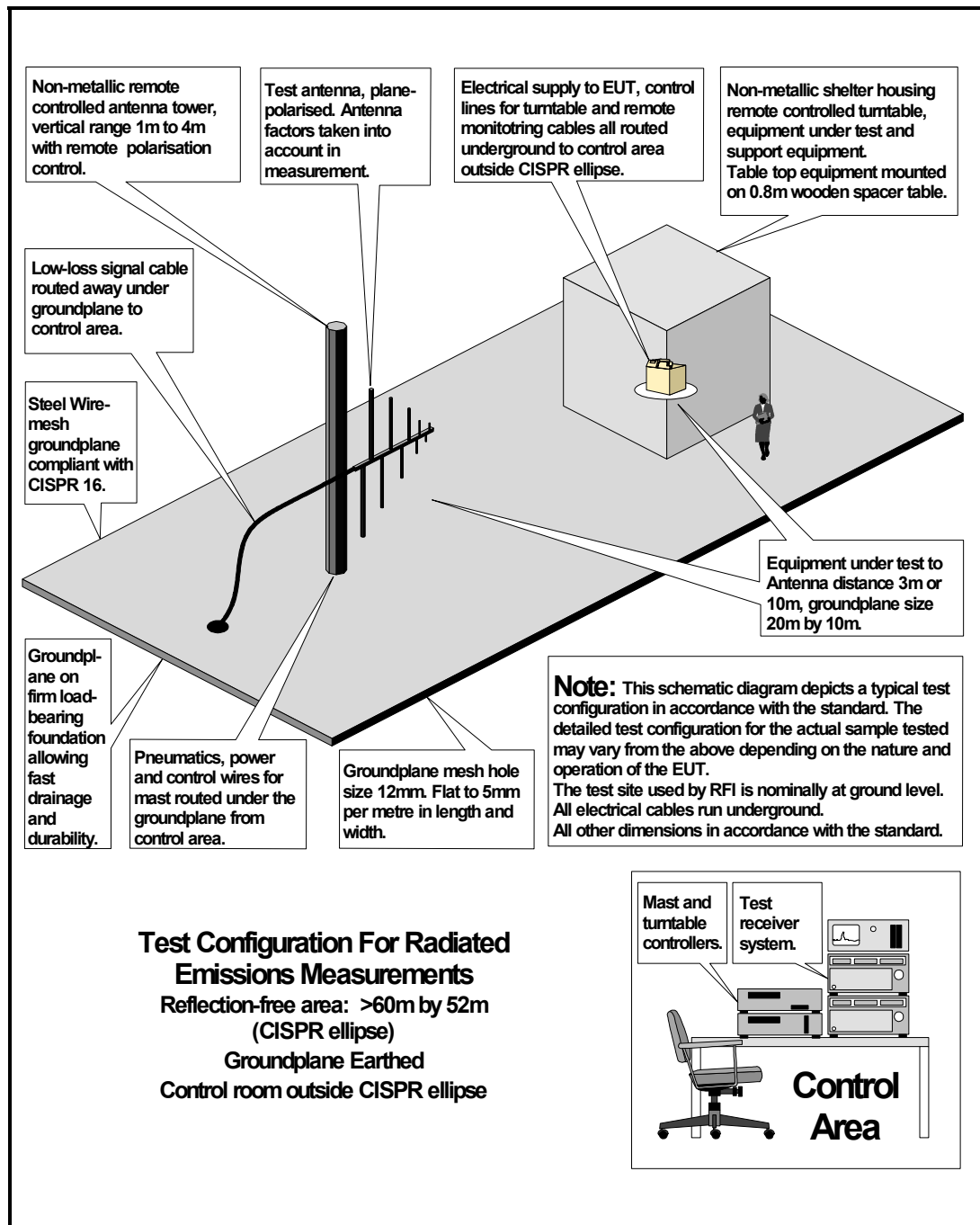
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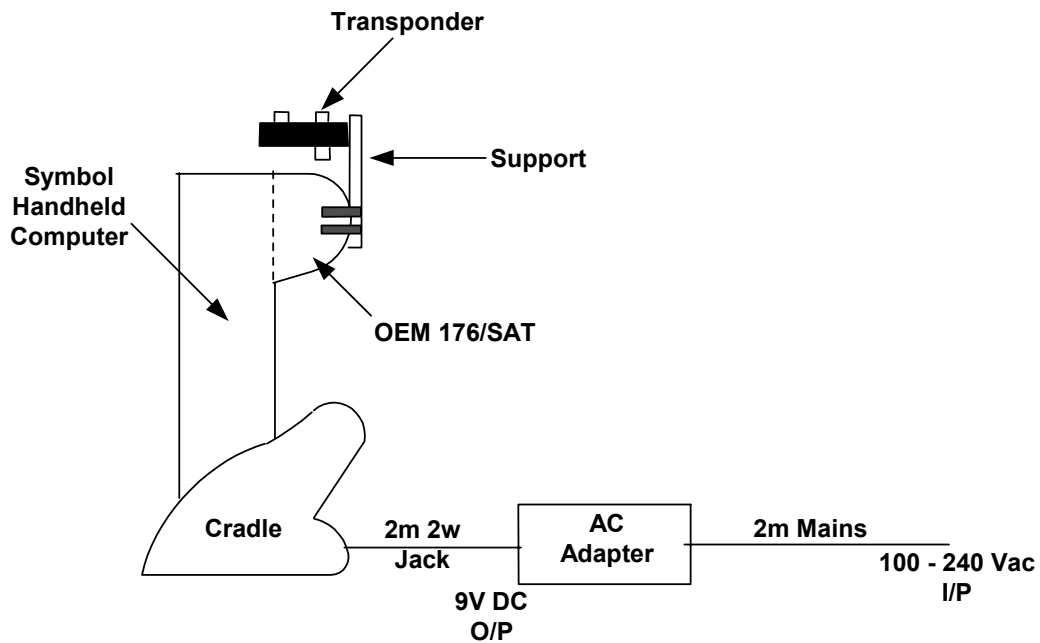
DRG\44300JD01\EMIRAD



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DRG\44300JD01\001

Configuration of EUT and Local Support Equipment



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Appendix 4. Graphical Test Results

This appendix contains the following graphs:

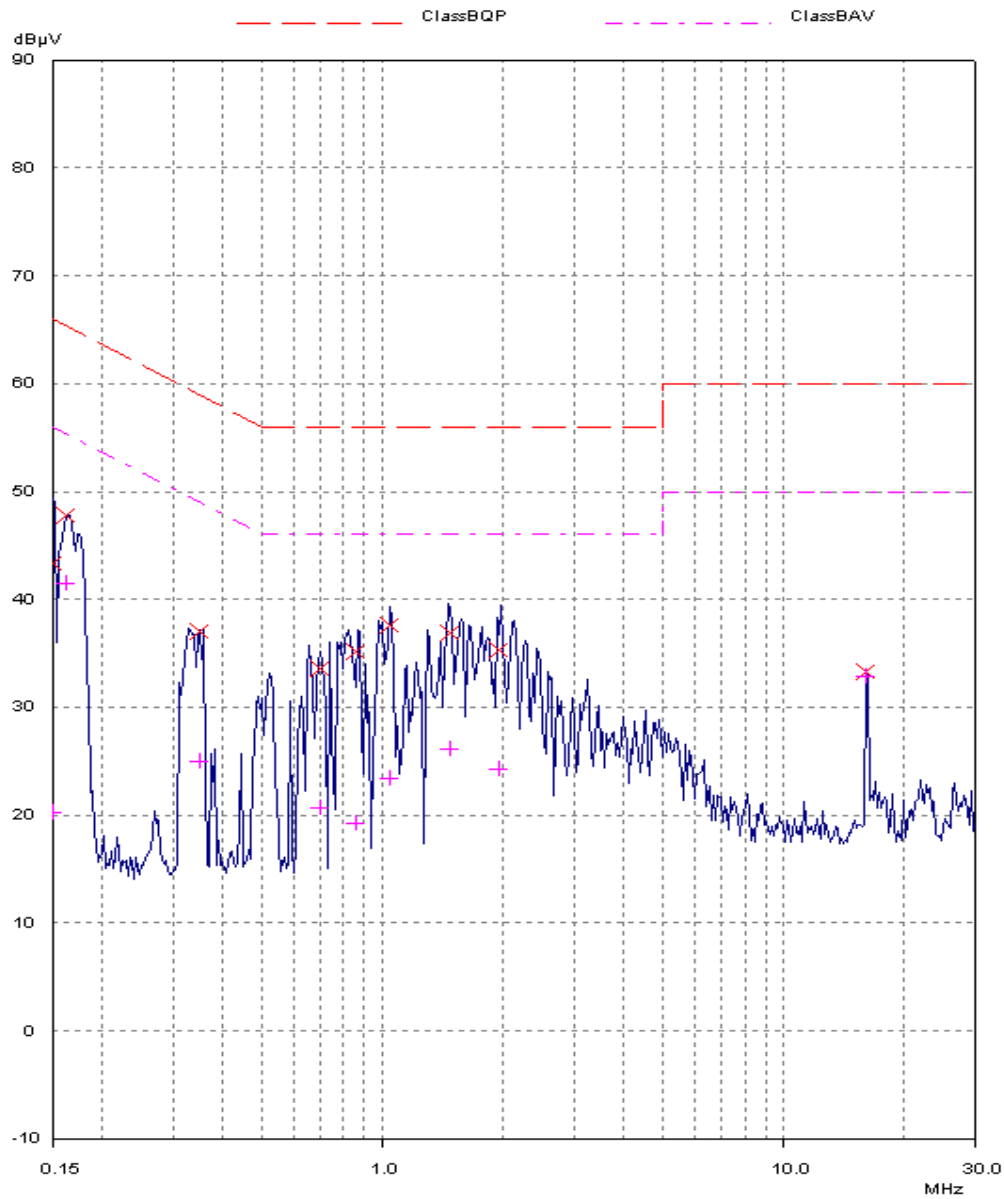
Graph Reference Number	Title
GPH\44300JD01\001a	Scan of Conducted Emissions Operating Mode (0.15 MHz to 30.0 MHz)
GPH\44300JD01\002a	Scan of Conducted Emissions Standby Mode (0.15 MHz to 30.0 MHz)
GPH\44300JD01\001	Scan of Radiated Emissions Operating Mode (10.0 kHz to 150.0 kHz)
GPH\44300JD01\004	Scan of Radiated Emissions Operating Mode (150.0 kHz to 30.0 MHz)
GPH\44300JD01\003a	Scan of Radiated Emissions Operating Mode (30.0 MHz to 1000.0 MHz)
GPH\44300JD01\004a	Scan of Radiated Emissions Standby Mode (30.0 MHz to 1000.0 MHz)

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GPH\44300JD01\001a
Conducted Emissions Operating Mode

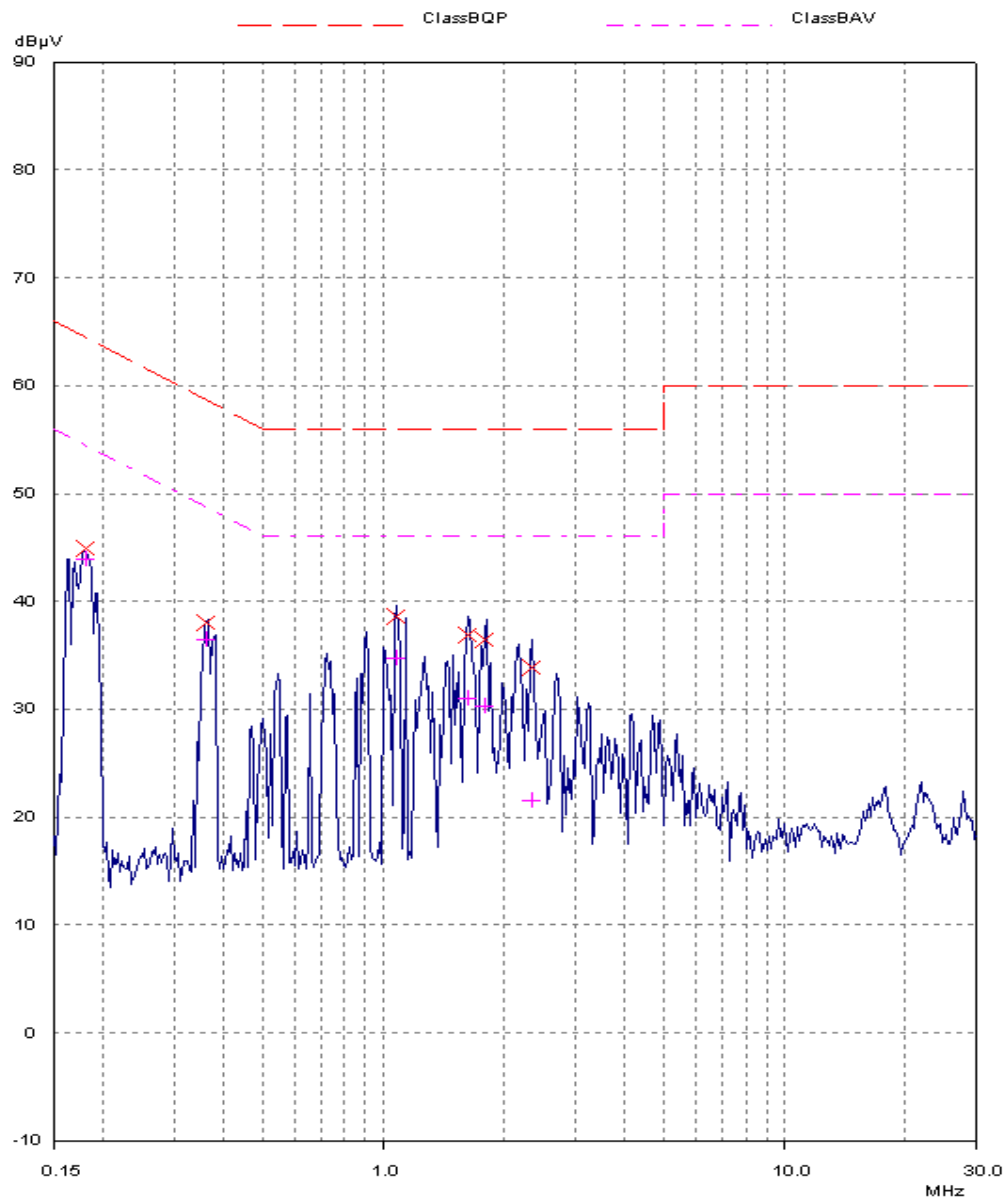


Test Of: i2r Ltd (Sirit UK).

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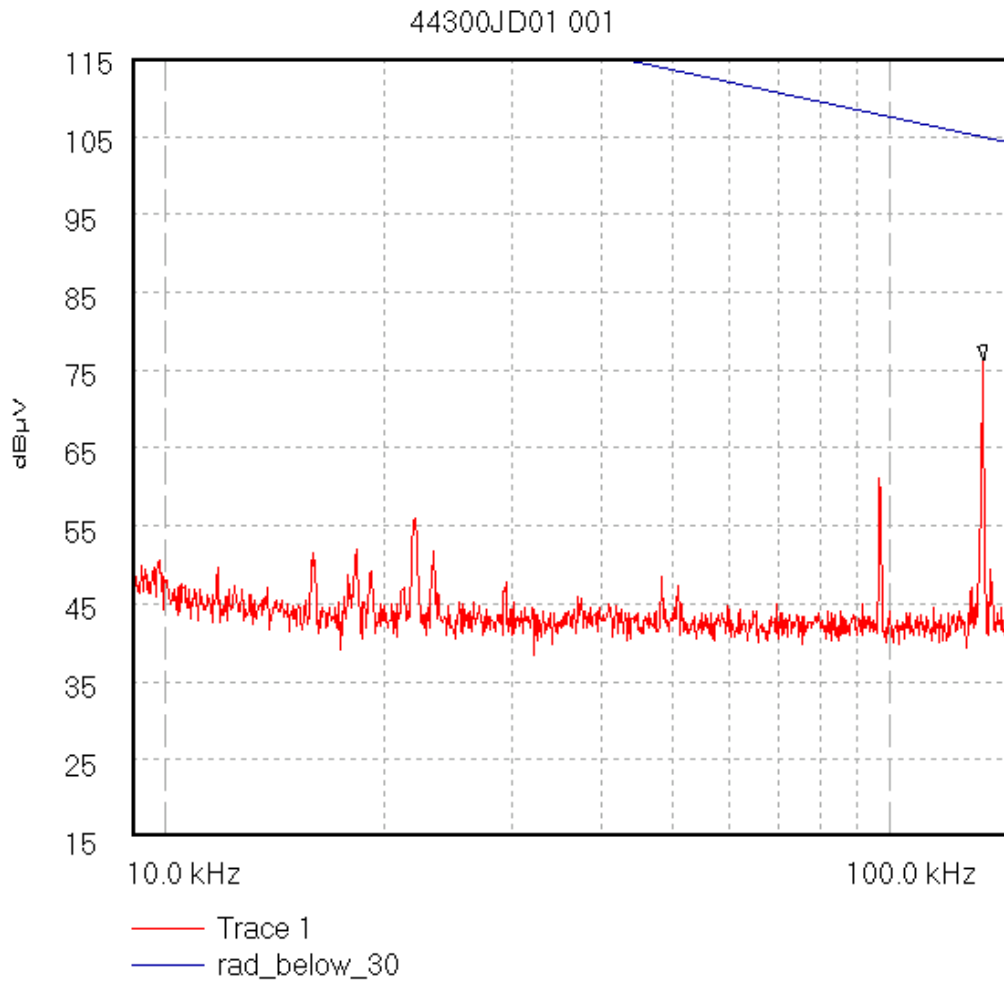
To: FCC Part 15 Subpart C: 2001

GPH\44300JD01\002a
Conducted Emissions Standby Mode



Test Of: i2r Ltd (Sirit UK).
OEM176/SAT
To: FCC Part 15 Subpart C: 2001

GPH\44300JD01\001
Radiated Emissions Operating Mode



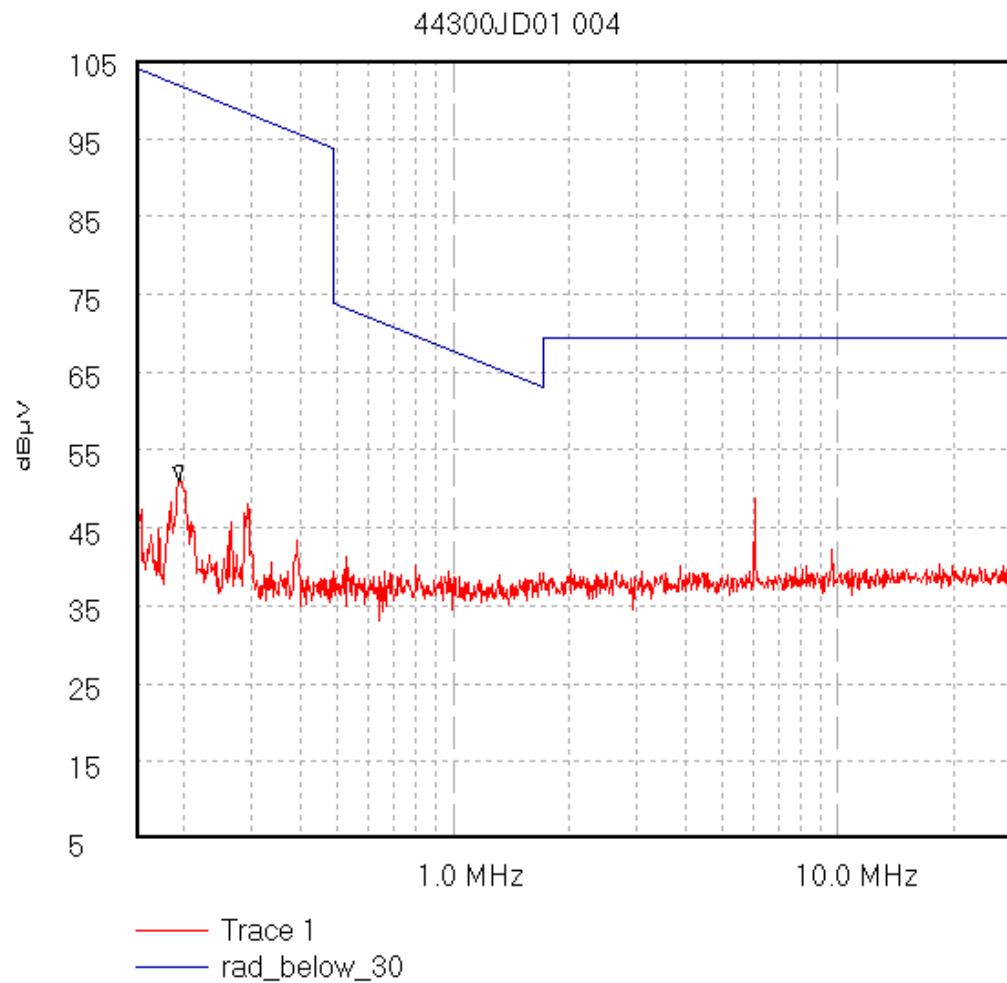
Start 9.0 kHz; Stop 150.0 kHz - Log Scale
Ref 115 dBμV; Ref Offset 0.0 dB; 10 dB/div
RBW 200.0 Hz; VBW 300.0 Hz; Att 40 dB; Swp 18.0 S
Peak 134.454 kHz, 76.18 dBμV
Limit/Mask: rad_below_30; ; Limit Test Passed
18/12/2002 14:55:37

Test Of: i2r Ltd (Sirit UK).

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To: FCC Part 15 Subpart C: 2001

GPH\44300JD01\004
Radiated Emissions Operating Mode



Start 150.0 kHz; Stop 30.0 MHz - Log Scale

Ref 105 dBμV; Ref Offset 0.0 dB; 10 dB/div

RBW 10.0 kHz; VBW 10.0 kHz; Att 20 dB; Swp 60.0 mS

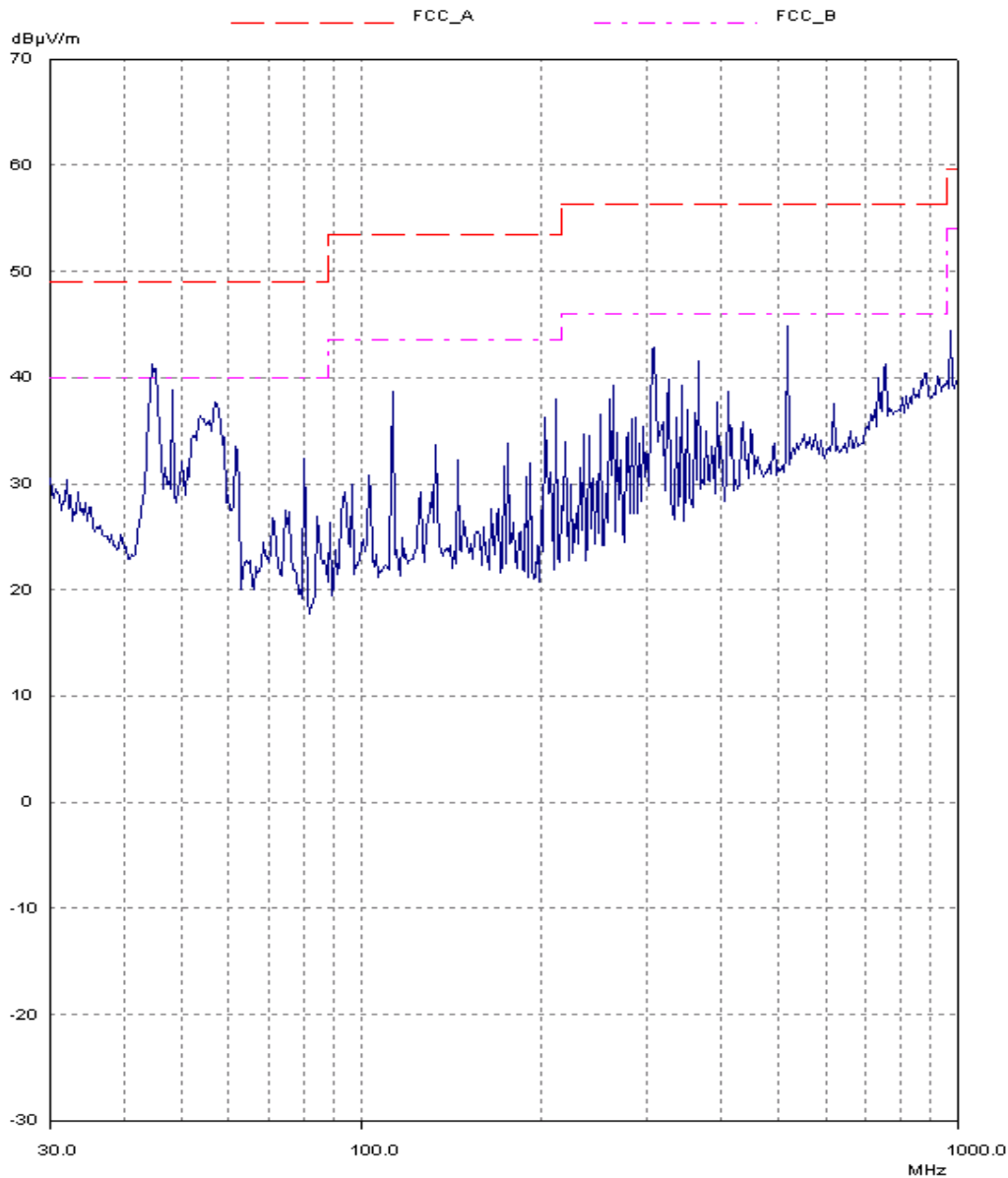
Peak 194.35 kHz, 51.04 dBμV

Limit/Mask: rad_below_30; ; Limit Test Passed

18/12/2002 15:38:12

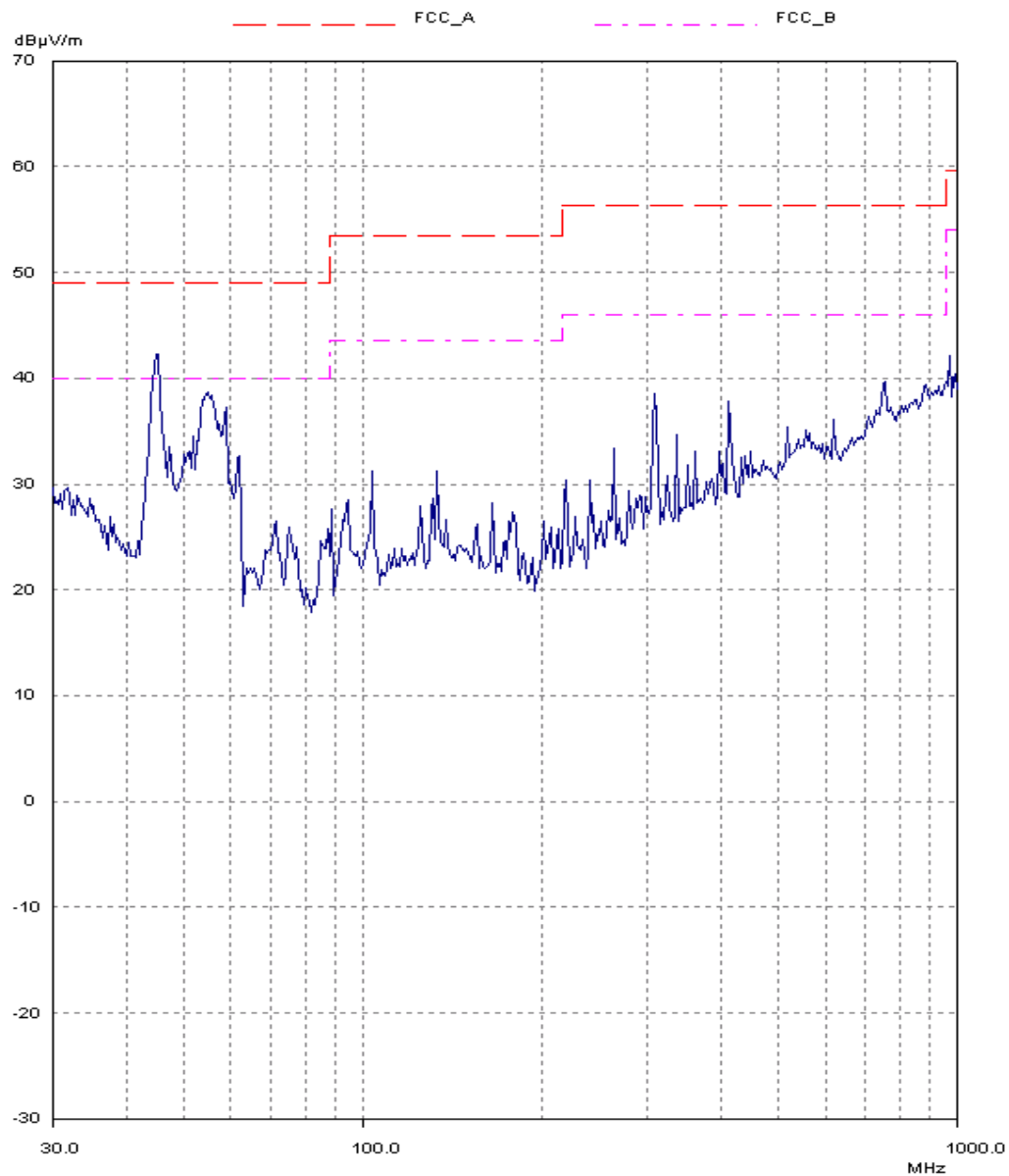
Test Of: i2r Ltd (Sirit UK).
OEM176/SAT
To: FCC Part 15 Subpart C: 2001

GPH\44300JD01\003a
Radiated Emissions Operating Mode



Test Of: i2r Ltd (Sirit UK).
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To: FCC Part 15 Subpart C: 2001

GPH\44300JD01\00a
Radiated Emissions Standby Mode



RADIO FREQUENCY INVESTIGATION LTD.

Operations Department

Test Of: i2r Ltd (Sirit UK).

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To: FCC Part 15 Subpart C: 2001

TEST REPORT

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