

TEST REPORT FROM RADIO FREQUENCY INVESTIGATION LTD.

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

To: FCC Part 15 Subpart C: 2002

Test Report Serial No:
RFI/MPTB1/RP44655JD01A

This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director: 	Checked By: 
Tested By:  pp	Release Version No: PDF01
Issue Date: 26 June 2003	Test Dates: 1 May 2003

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Operations Department

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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:	P5ROEM176SAC
Date of Receipt:	1 st May 2003

2.2. Description Of EUT

The equipment under test is a dual technology laser barcode scanner & RFID Reader running at 134.2 kHz 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
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

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3. Test Specification, Methods And Procedures

3.1. Test Specification

Reference:	FCC Part 15: 2002 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: 2002 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.

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 modes:

Continuous tag read / write mode and standby 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

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 AC Mains Emissions	Part 15 of CFR 47: 2002, Section 15.207	Operating	Complied
Conducted AC Mains Emissions	Part 15 of CFR 47: 2002, Section 15.107	Standby	Complied
Radiated Spurious Emissions	Part 15 of CFR 47: 2002, Section 15.209	Operating	Complied
Radiated Spurious Emissions	Part 15 of CFR 47: 2002, 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.

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. AC Mains Conducted Emissions – Read/Write Mode**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
0.20324	Live	47.77	63.48	15.71	Complied
1.21718	Neutral	37.49	56.00	18.51	Complied

Frequency (MHz)	Line	Av Level (dB μ V)	Av Limit (dB μ V)	Margin (dB)	Result
0.20324	Live	42.01	53.48	11.47	Complied
1.21718	Neutral	24.82	46.00	21.18	Complied

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7.3. AC Mains Conducted Emissions – Standby Mode

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
0.21657	Neutral	46.22	62.95	16.73	Complied
1.29247	Live	37.36	56.00	18.64	Complied

Frequency (MHz)	Line	Av Level (dB μ V)	Av Limit (dB μ V)	Margin (dB)	Result
0.21657	Neutral	45.03	52.95	7.92	Complied
1.29247	Live	29.41	46.00	16.59	Complied

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7.4. Radiated Emissions – Read/Write Mode

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
134.455	45 deg	-12.8	25.0	37.8	Complied

Note: The limit is specified at a test distance of 300 metres. 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 (40 dB/decade). In this case the measurement was obtained using a peak detector during the pre-scan at a distance of 3 metres 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 metres distance and thereafter the inverse linear distance extrapolation factor was applied to 300 metres.

7.4.2. Field Strength Measurements: 9 kHz to 30 MHz – Read/Write Mode

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 below the reference limit line. Therefore no final measurements were performed.

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7.4.3. Field Strength Measurements: 30 to 1000 MHz – Read/Write Mode

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

7.4.3.2. 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
79.98	Vert.	27.8	40.0	12.2	Complied
239.99	Horiz	34.1	46.0	11.9	Complied

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

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
79.99	Vert.	26.3	40.0	13.7	Complied
239.99	Horiz	31.8	46.0	14.2	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.
A007	HFH2-Z2 Loop Antenna	Rohde & Schwarz	HFH2-Z2	880 458/020
A008	HFH2-Z2 Metal Tripod	Rohde & Schwarz	HFU-Z	None
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002
A157	Matching Pad	RFI Ltd Basingstoke	None	None
A276	OATS Positioning Controller	Rohde & Schwarz	HCC	-
A490	Bilog Antenna	Chase	CBL6111A	1590
A553	Bi-log Antenna	Chase	CBL6111A	1593
A559	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	357881052
C341	Cable	Andrews	None	None
C363	BNC Cable	Rosenberger	RG142	None
C451	Cable	RS	463-552	C451-463-552
C457	Cable	Rosenberger	RG142XX-002-RFIB	C457-10081998
C461	Cable	Rosenberger	UFA210A-1-1182-704704	98H0305
C468	N-Type Coaxial Cable	Rosenberger	UFA210A-1-3937-504504	98L0440
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
M090	Receiver / Spectrum Analyser System	Rohde & Schwarz	ESBI	DU:838494/005 RU:836833/001
M173	Turntable Controller	R.H.Electrical Services	RH351	3510020
S201	Site 1	RFI	1	
S212	Site 12	RFI	12	

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

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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

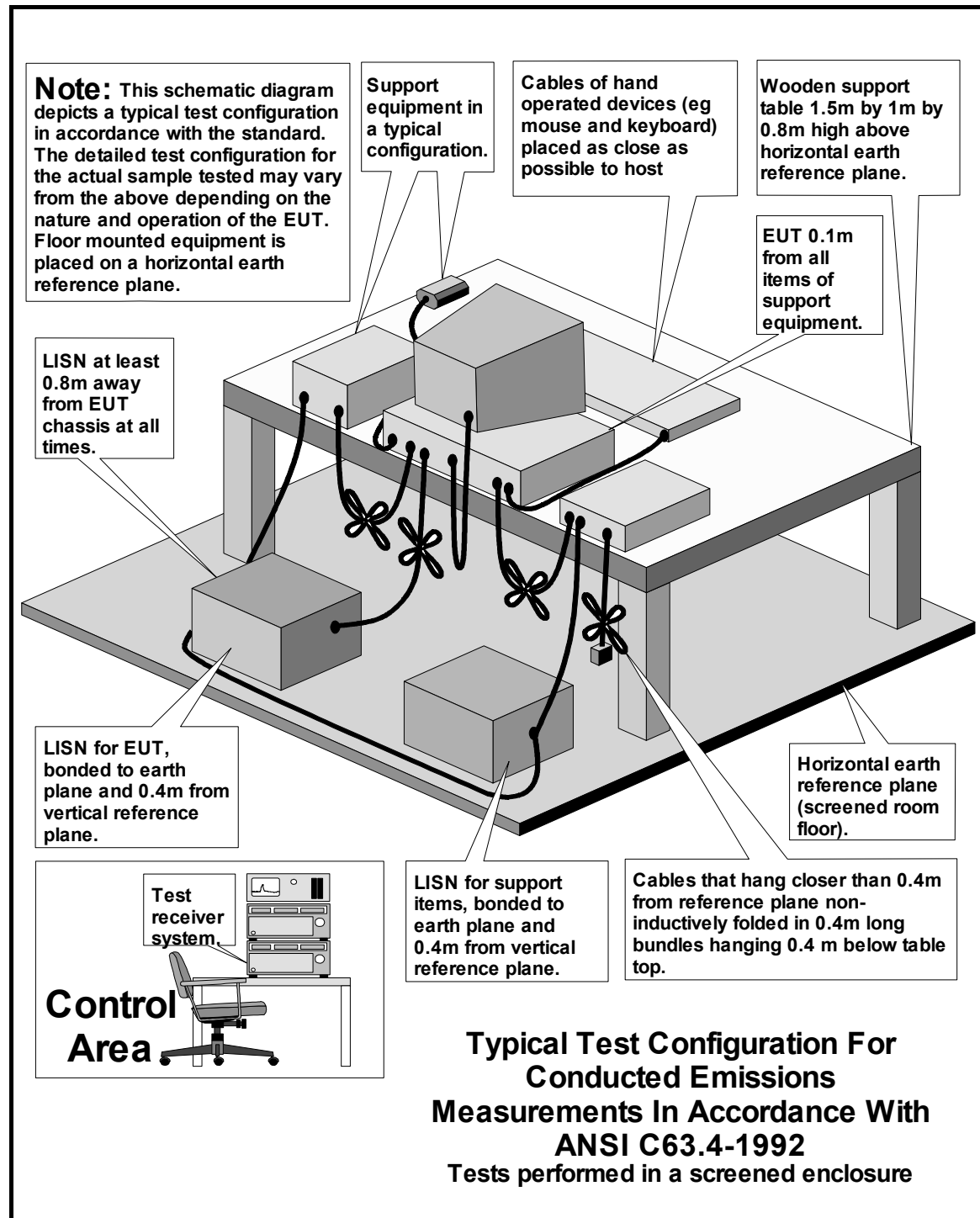
This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\44655JD01\EMICON	Test configuration for measurement of conducted emissions
DRG\44655JD01\EMIRAD	Test configuration for measurement of radiated emissions
DRG\44655JD01\001	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test

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DRG\44655JD01\EMICON

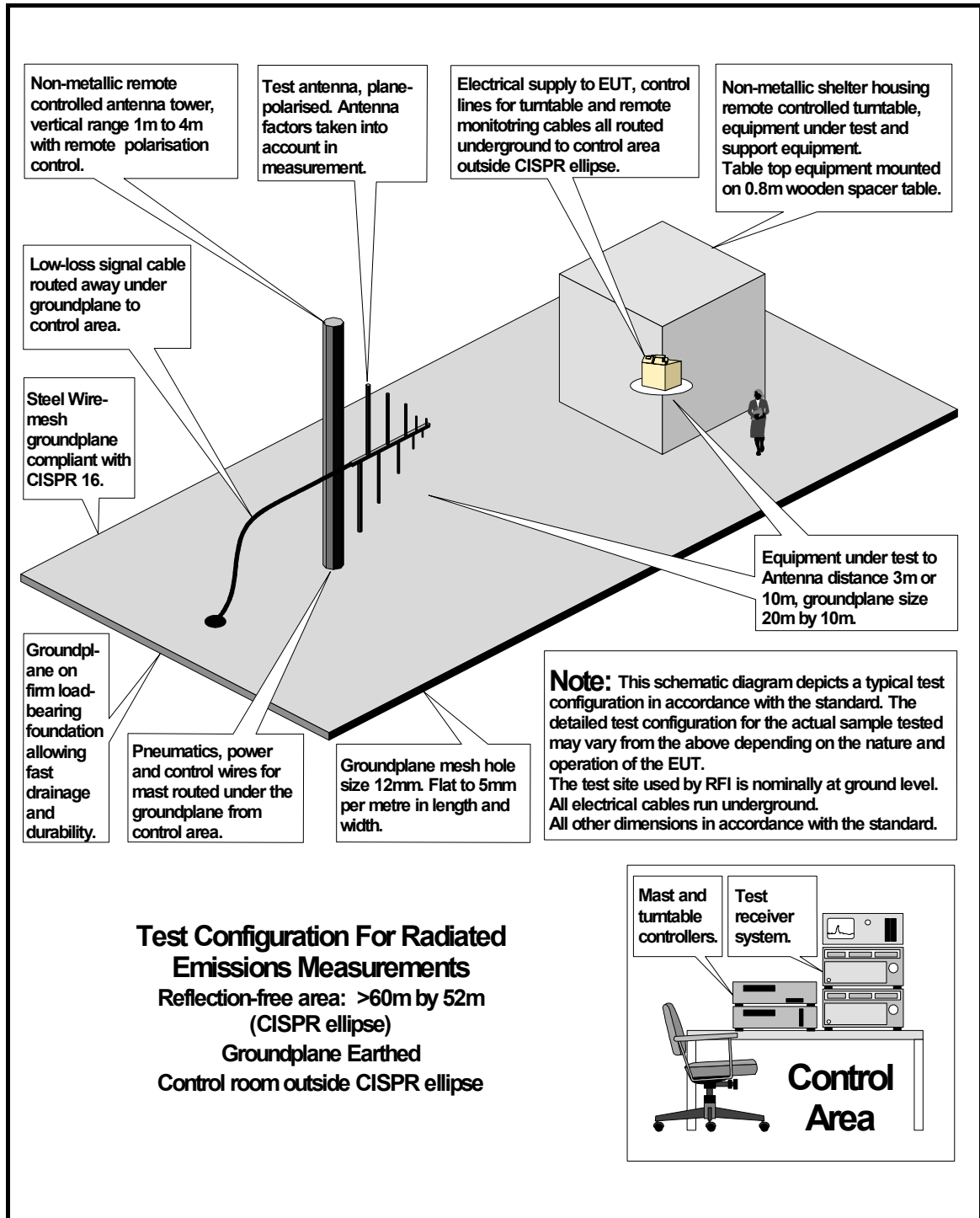


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DRG\44655JD01\EMIRAD



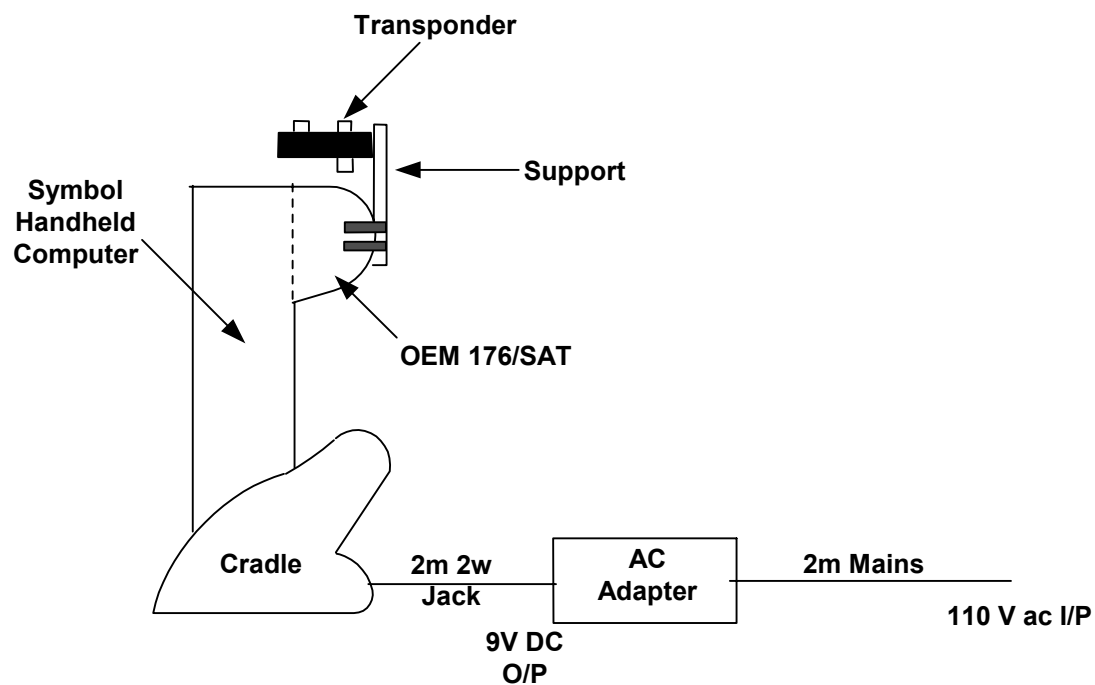
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Configuration of EUT and Local Support Equipment



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Appendix 4. Graphical Test Results

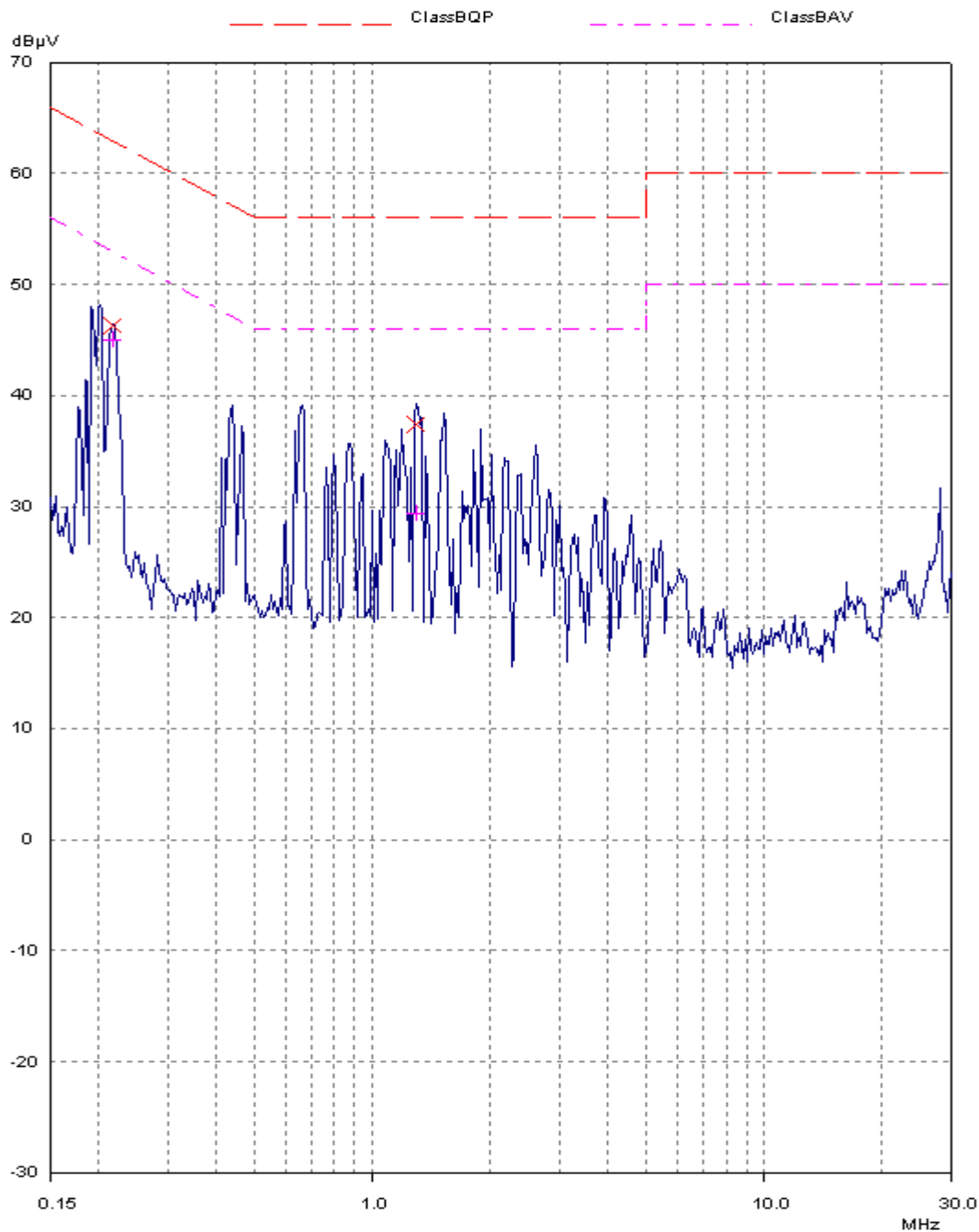
This appendix contains the following graphs:

Graph Reference Number	Title
GPH\44655JD01\001	Scan of AC Mains Conducted Emissions - Standby Mode (150 kHz to 30 MHz)
GPH\44655JD01\002	Scan of AC Mains Conducted Emissions - Read/Write Mode (150 kHz to 30 MHz)
GPH\44655JD01\001a	Scan of Radiated Emissions - Read/Write Mode (9 kHz to 150 kHz)
GPH\44655JD01\002a	Scan of Radiated Emissions - Read/Write Mode (150 kHz to 30 MHz)
GPH\44655JD01\006	Scan of Radiated Emissions - Read/Write Mode (30 MHz to 1000 MHz)
GPH\44655JD01\007	Scan of Radiated Emissions - Standby Mode (30 MHz to 1000 MHz)

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GPH\44655JD01\001
AC Mains Conducted Emissions – Standby Mode

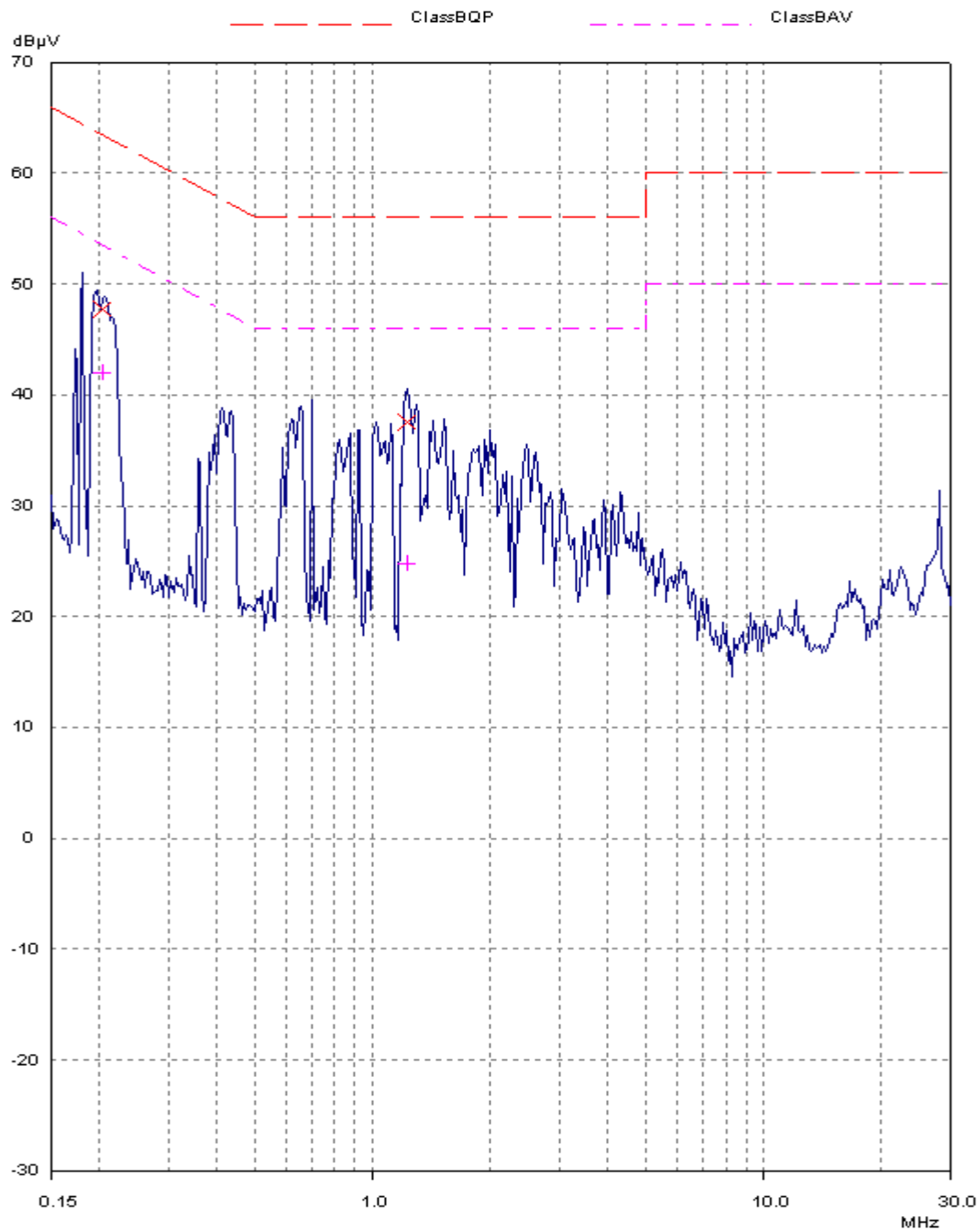


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GPH\44655JD01\002
AC Mains Conducted Emissions – Read/Write Mode



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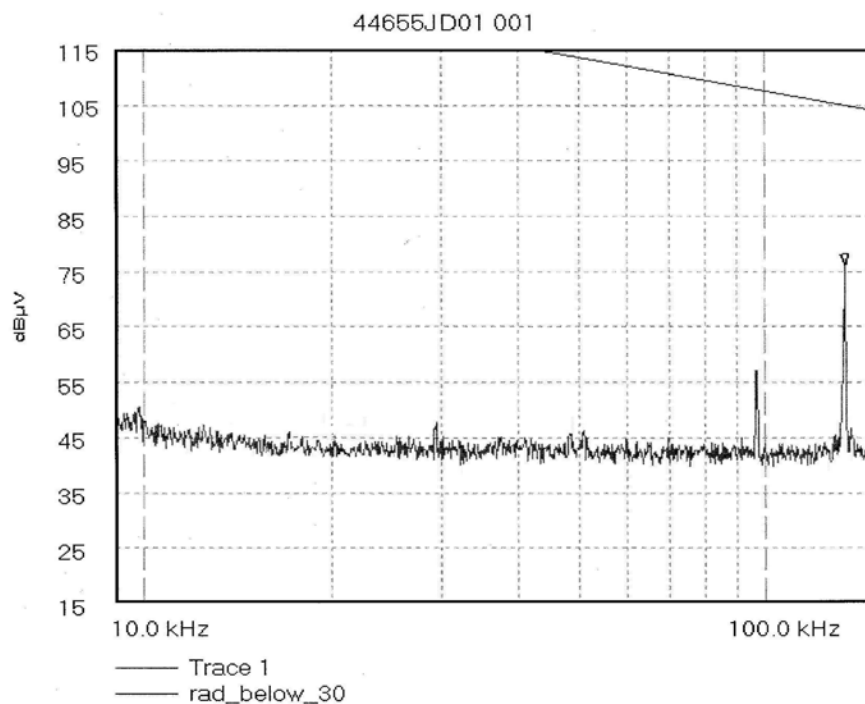
GPH\44655JD01\001a
Radiated Emissions – Read/Write Mode

GPH\44655JD01\001a

Radiated Emissions, FCC Part 15.209 Prescan @3m

Testing for Sirit Technologies Inc. TX Mode - Read/Write

EUT: OEM 176 module fitted inside Symbol PDT 8146 Handheld Computer



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 134.455 kHz, 75.9 dBμV

Limit/Mask: rad_below_30; ; Limit Test Passed

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GPH\44655JD01\002a
Radiated Emissions – Read/Write Mode

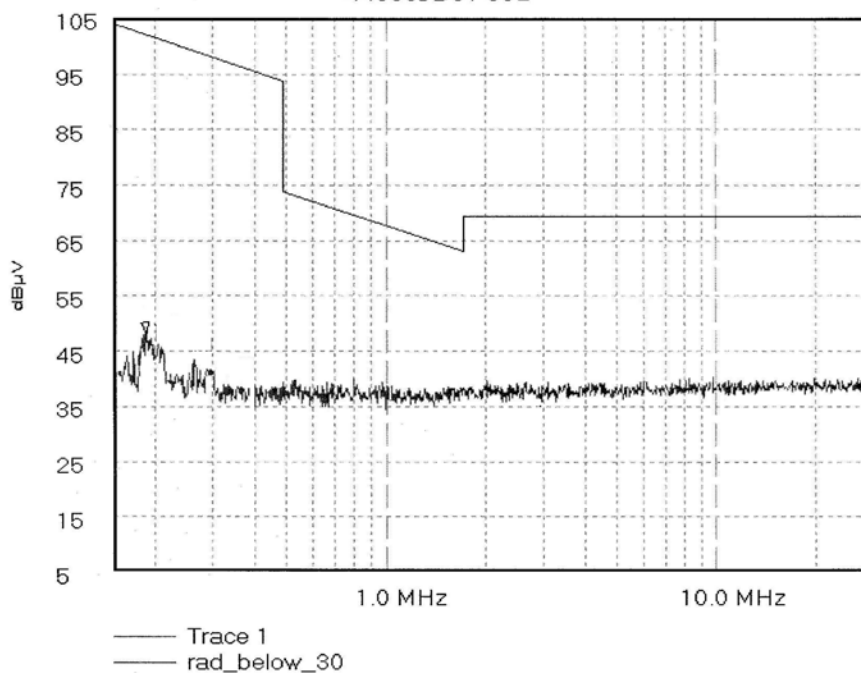
GPH\44655JD01\002a

Radiated Emissions. FCC Part 15.209 Prescan @3m

Testing for Sirit Technologies Inc. TX Mode - Read/Write

EUT: OEM 176 module fitted inside Symbol PDT 8146 Handheld Computer

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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 182.36 kHz, 48.55 dBμV

Limit/Mask: rad_below_30; ; Limit Test Passed

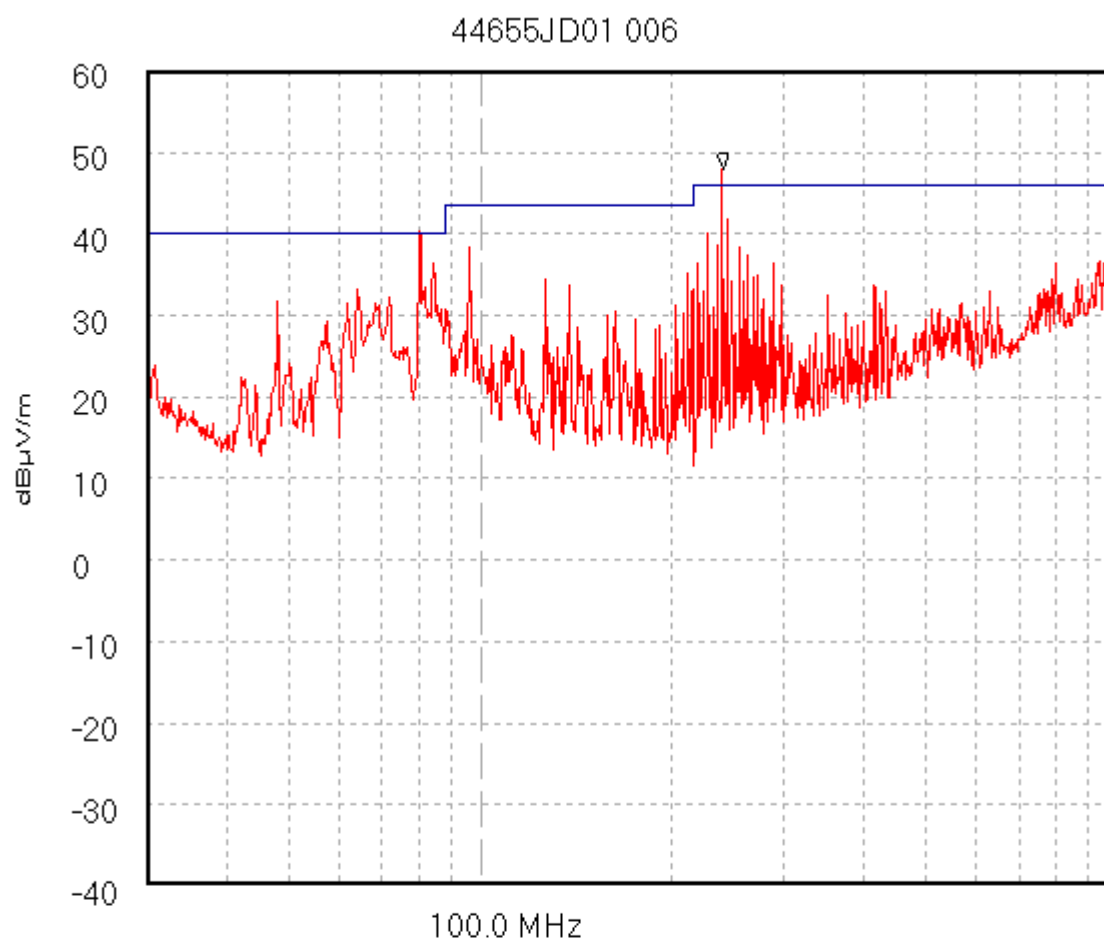
01/05/2003 11:52:27

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GPH\44655JD01\006
Radiated Emissions – Read/Write Mode



Trace 1
rad_30_to_1000

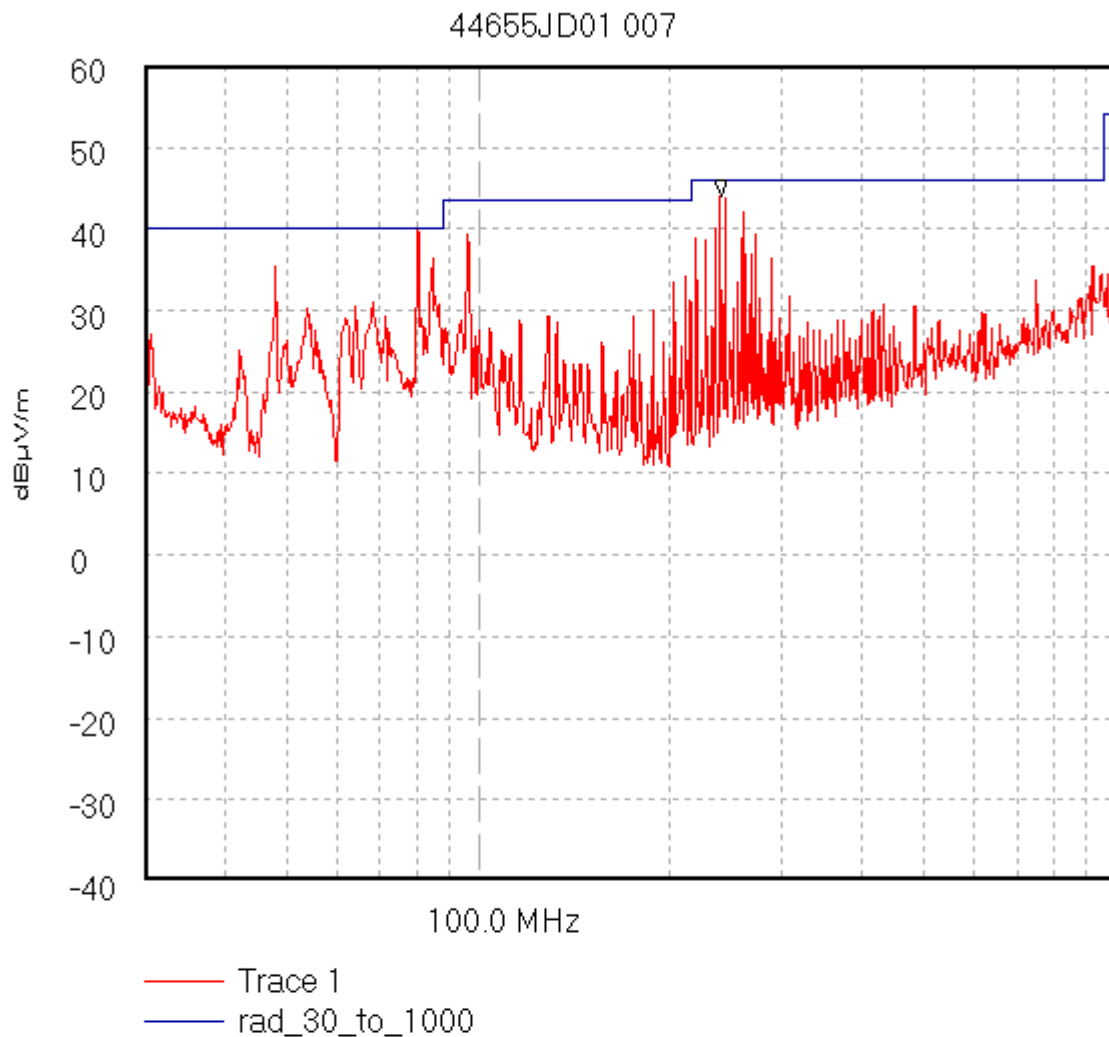
Start 30.0 MHz; Stop 1.0 GHz - Log Scale
Ref 60 dBμV/m; Ref Offset 0.0 dB; 10 dB/div
RBW 120.0 kHz; VBW 100.0 kHz; Att 0 dB; Swp 440.0 mS
Peak 240.268 MHz, 47.92 dBμV/m
Limit/Mask: rad_30_to_1000; ; Limit Test Failed
Transducer Factors: A490
01/05/2003 12:02:21

Test Of: i2r Ltd (Sirit UK).

OEM176/SAT

To: FCC Part 15 Subpart C: 2002

GPH\44655JD01\007
Radiated Emissions – Standby Mode



Start 30.0 MHz; Stop 1.0 GHz - Log Scale

Ref 60 dBµV/m; Ref Offset 0.0 dB; 10 dB/div

RBW 120.0 kHz; VBW 100.0 kHz; Att 0 dB; Swp 380.0 mS

Peak 240.268 MHz, 43.96 dBµV/m

Limit/Mask: rad_30_to_1000; ; Limit Test Passed

Transducer Factors: A490

01/05/2003 12:19:35

RADIO FREQUENCY INVESTIGATION LTD.

Operations Department

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

To: FCC Part 15 Subpart C: 2002

TEST REPORT

S.No. RFI/MPTB1/RP44655JD01A

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Issue Date: 26 June 2003

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