TEST REPORT
FROM
RADIO FREQUENCY
INVESTIGATION LTD.

Test Of: i2R Ltd.
OEM 400 13.56 MHz Module

To: FCC Part 15 Subpart C: 2000
(Intentional Radiators)
Section 15.225

Test Report Serial No:
RFI/EMCB2/RP43135A

Supersedes Test Report Serial No:
RFI/EMCB1/RP43135A

This Test Report Is Issued Under The Authority Of Richard Jacklin, Operations Director: **pp**	**Checked By:** **pp**
Tested By:	**Release Version No:** **PDF01**
Issue Date: 20 March 2002	**Test Date: 27 February 2002 to 05 March 2002**

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Test Of: **i2R Ltd.**
OEM 400 13.56 MHz Module
To: **FCC Part 15 Subpart C: 2000**
(Intentional Radiators) Section 15.209

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Test Report Serial No: RFI/MPTB2/RP43135A supersedes Test Report Serial No: RFI/MPTB1/RP43135A

1. Client Information

Company Name:	i2R Ltd
Address:	Unit 10 Loughborough Tech Centre Epinal Way Loughborough Leicestershire LE11 3GE
Contact Name:	Mr R Brown

2. Equipment Under Test (EUT)

The client has supplied the following information (with the exception of the Date of Receipt):

2.1. Identification Of Equipment Under Test (EUT)

Brand Name:	i2R Ltd
Model Name or Number:	OEM 400
Unique Type Identification:	None stated by client
Serial Number:	X14000295
Country of Manufacture:	UK
FCC ID Number:	Not Stated by Client
Date of Receipt:	07 February 2002

2.2. Description Of EUT

The EUT is a RFID Tag Reader Module.

2.3. Modifications Incorporated In EUT

The EUT has not been modified from the Model Number stated above.

2.4. Support Equipment

The following equipment was used to support the EUT during testing.

Description:	Printer
Brand Name:	SATO
Model Name or Number:	CL412e
Serial Number:	10170115
FCC ID Number:	Not applicable
Cable Length And Type:	Not Applicable
Connected to Port:	EUT Connected Internally

Description:	Extension Lead (Signal/Power)
Brand Name:	I2R Ltd
Model Name or Number:	None Stated by Client
Serial Number:	None Stated by Client
FCC ID Number:	Not applicable
Cable Length And Type:	1m Multicore Shielded
Connected to Port:	Signal/Power

Description:	Extension Lead (Antenna)
Brand Name:	I2R Ltd
Model Name or Number:	None Stated by Client
Serial Number:	None Stated by Client
FCC ID Number:	Not applicable
Cable Length And Type:	1m Coaxial
Connected to Port:	Antenna

3. Test Specification, Methods And Procedures

3.1. Test Specification

Reference:	FCC Part 15 Subpart C: 2000 (Intentional Radiators). Section 15.225.
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 verification.

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.

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 as follows:

Conducted and Radiated Emissions: The printer was powered from a 115V 60Hz AC Mains Supply which in turn provided an internal 5V DC supply to power the EUT.

Frequency Error: The EUT was supplied by an external PSU which enable the DC Supply to be varied.

5.2. Operating Modes

The EUT was tested in the following operating modes:

Read Mode with Tag present.

5.3. Configuration And Peripherals

The EUT was tested in the following configuration:

Conducted Emissions: The EUT was configured internally to the support printer as in normal operation.

Radiated Emissions: The EUT was configured externally to the support printer (for test purposes only) with the correct connections (with the addition of both extension leads) made between the EUT and the printer.

Frequency Error: The EUT was configured remotely of the support printer. The power being supplied via a separate DC PSU. All other connections (with the addition of both extension leads) were correctly made between the EUT and the printer.

NB Section 2 of this report contains a full list of support equipment used and Appendix 3 contains schematic diagrams of the test configuration.

6. Summary Of Test Results

6.1. Radiated Emissions

Range Of Measurements	Specification Reference	Compliancy Status
Conducted Emissions	C.F.R. 47 FCC Part 15.207: 2000	Complied
Radiated Field Strength Emissions - 9 kHz to 1 GHz	C.F.R. 47 FCC Part 15.225: 2000 (Section 15.209)	Complied
Frequency Stability (Voltage Variation)	C.F.R. 47 FCC Part 15.225: 2000	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.

7.2. Conducted Emissions

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

7.2.1.1. The following table lists frequencies at which emissions were measured using a Quasi-Peak detector:

Frequency (MHz)	Line	Q-P Level (dBmV)	Q-P Limit (dBmV)	Margin (dB)	Result
0.509	Neutral	38.21	48.00	9.79	Complied
0.511	Live	37.93	48.00	10.07	Complied
0.947	Live	42.55	48.00	5.45	Complied
0.949	Neutral	42.65	48.00	5.35	Complied
7.349	Neutral	39.17	48.00	8.83	Complied
7.351	Live	38.94	48.00	9.06	Complied
13.560	Neutral	47.50	48.00	0.50	Complied
13.561	Live	46.89	48.00	1.11	Complied
13.829	Live	44.83	48.00	3.17	Complied

7.3. Radiated Emissions

7.3.1. Radiated Magnetic Field: 9 kHz to 30 MHz

7.3.1.1. The client has stated that the transmitter frequency for the EUT was 13.56 MHz.

7.3.1.2. The following table lists frequencies at which emissions were measured using a Quasi-Peak detector at a test distance of 10m:

Frequency (MHz)	Q-P Level at 10m (dBmV/m)	Adjusted Q-P Level at 30m (dBmV/m)	Q-P Limit at 30m (dBmV/m)	Margin (dB)	Result
13.560	56.2	37.1	80.0	42.9	Complied

Note: The level has been adjusted from the measured 10m distance to the specified 30m distance using the square of an inverse linear extrapolation factor (40dB/decade) as specified in section 15.31(f(2)).

7.3.2. Radiated Electric Field: 30 to 1000 MHz

7.3.2.1. The following table lists the measurement of the fundamental emission in the worse case antenna polarisation, using an Quasi-Peak detector function at a test distance of 3m (results incorporate antenna factors and cable losses):

Frequency (MHz)	Ant. Pol.	Q-P Level (dBmV/m)	Q-P Limit (dBmV/m)	Margin (dB)	Result
40.687	Vert.	36.2	40.0	3.8	Complied
45.262	Vert.	30.2	40.0	9.8	Complied
54.245	Vert.	35.8	40.0	4.2	Complied
58.978	Vert.	39.3	40.0	0.7	Complied
78.625	Vert.	33.9	40.0	6.1	Complied
81.360	Vert.	33.4	40.0	6.6	Complied
94.909	Vert.	42.3	43.5	1.2	Complied
196.595	Vert.	36.8	43.5	6.7	Complied

7.4. Frequency Stability Measurements

7.4.1. 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.

7.4.2. The applicant has stated that the nominal supply voltage is 5 volts, with a lower end point voltage of 4.75 volts and an upper end point voltage of 5.75 volts. Extreme measurements were performed at these three voltages as specify in FCC Part 15.225.

7.4.3. 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 stay within the authorised frequency block.

7.4.4. The authorised frequency block is:

Lower Block Edge	13.553 MHz
Upper Block Edge	13.567 MHz

The limit is defined as the distance between the declared carrier and the band edge of the authorised frequency block. The limit is specified in parts per million.

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Frequency Stability Measurements: (continued)

Results:

Temp (°C)	Input Voltage (Volts)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (ppm)	Result
-20	4.75	13.560375	375	0.0028	0.01	0.0072	Complied
	5.0	13.560375	375	0.0028	0.01	0.0072	Complied
	5.75	13.560375	376	0.0028	0.01	0.0072	Complied
-10	4.75	13.560627	627	0.0046	0.01	0.0054	Complied
	5.0	13.560627	627	0.0046	0.01	0.0054	Complied
	5.75	13.560689	689	0.0051	0.01	0.0049	Complied
0	4.75	13.560438	438	0.0032	0.01	0.0068	Complied
	5.0	13.560438	438	0.0032	0.01	0.0068	Complied
	5.75	13.560501	501	0.0037	0.01	0.0063	Complied
10	4.75	13.560407	407	0.0030	0.01	0.0070	Complied
	5.0	13.560407	407	0.0030	0.01	0.0070	Complied
	5.75	13.560375	375	0.0028	0.01	0.0072	Complied
20	4.75	13.560282	282	0.0021	0.01	0.0079	Complied
	5.0	13.560344	344	0.0025	0.01	0.0075	Complied
	5.75	13.560282	282	0.0021	0.01	0.0079	Complied
30	4.75	13.560251	251	0.0019	0.01	0.0081	Complied
	5.0	13.560251	251	0.0019	0.01	0.0081	Complied
	5.75	13.560250	250	0.0014	0.01	0.0086	Complied
40	4.75	13.560188	188	0.0014	0.01	0.0086	Complied
	5.0	13.560188	188	0.0014	0.01	0.0086	Complied
	5.75	13.560188	188	0.0014	0.01	0.0086	Complied
50	4.75	13.560125	125	0.0009	0.01	0.0091	Complied
	5.0	13.560125	125	0.0009	0.01	0.0091	Complied
	5.75	13.560063	63	0.0005	0.01	0.0091	Complied

7.5. Transmitter Radiated Measurements: (Emissions at Band Edges): Section

7.5.1.The EUT and spectrum analyser was configured as for radiated emission measurements

7.5.2. The client has stated that the transmitter frequency for the EUT was 13.56 MHz.

7.5.3. The following table lists frequencies at which emissions were measured using a Quasi-Peak detector at a test distance of 10m:

Results:

Frequency Band: 13.553 MHz to 13.567 MHz

Frequency (MHz)	Q-P Level at 10m (dBμV/m)	Adjusted Q-P Level at 30m (dBμV/m)	Q-P Limit at 30m (dBμV/m)	Margin (dB)	Result
13.553	42.7	23.6	29.5	5.9	Complied
13.567	44.4	25.3	29.5	4.2	Complied

Note: The level has been adjusted from the measured 10m distance to the specified 30m distance using the square of an inverse linear extrapolation factor (40dB/decade) as specified in section 15.31(f(2)).

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 measured (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 at 3.0 metres	30 MHz to 1 GHz	95%	+/- 5.26 dB
Radiated Magnetic Field	9 kHz to 30 MHz	95 %	+/- 3.53 dB
Frequency Stability	Not applicable	95%	+/- 4.2 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.

Appendix 1. Test Equipment Used

RFI No.	Instrument	Manufacturer	Type No.	Serial No.
A004	Single phase LISN	Rohde & Schwarz	ESH3-Z5	890 604/027
A007	HFH2-Z2 Loop Antenna	Rohde & Schwarz	HFH2-Z2	880 458/020
A259	Bilog Antenna	Chase	CBL6111	1513
A392	3 dB attenuator (9)	Suhner	6803.17.B	None
A490	Bilog Antenna	Chase	CBL6111A	1590
C339	Cable	Rosenberger	UFA 210A-1-1181-70x70	1926
C341	Cable	Andrews	None	None
C468	N-Type Coaxial Cable	Rosenberger	UFA210A-1-3937-504504	98L0440
C573	C573-N-N-2	Rosenberger	UFA210A-1-788-50x50	97E0936
E013	PCN Environmental Chamber	Sanyo	ATMOS chamber	None
M023	ESVP Receiver	Rohde & Schwarz	ESVP	872 991/027
M032	ESH3 Receiver	Rohde & Schwarz	ESH3	892 327/005
M088	Receiver / Spectrum Analyser System	Rohde & Schwarz	ESBI	DU:835862/018 RU:835387/006
M1008	9kHz - 26.5GHz Spectrum Analyser	Hewlett Packard	8563E	3551A04412
M105	Fluke 77 DVM	Fluke	77	963580770
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016
S009	D.C. PSU	Farnell	PDD3502A	174
S022	Single D.C. PSU	INSTEK	PS-3030	9570530

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

Appendix 2. Measurement Methods

A2.1 FCC Part 15: AC Mains Conducted Emissions

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.

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 During the swept measurements (and also during subsequent final measurements on single frequencies) 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.

A2.1.5 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.

A2.1.6 The test equipment settings for conducted emissions measurements were as follows:

Receiver Function	**Initial Scan**	**Final Measurements**
Detector Type:	Peak	Quasi-Peak (CISPR)/Average
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

*Where measurements were made below 150 kHz a 200 Hz bandwidth was used.

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 and an average 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. For final measurements on the open area test site, for frequencies between 30 MHz and 1000 MHz where a signal was found, the level 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.

A2.1.7. For final measurements on the open area test site, for frequencies between 9 kHz and 30 MHz where a signal was found, the levels were maximised by initially rotating the turntable through 360° and then varying the antenna angle through 360°. With the antenna set to a fixed height of 1.5 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.

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)
Mode:	Max Hold	Not applicable
Bandwidth:	200 Hz: (9 kHz to 150 kHz) 10 kHz: (150 kHz to 30 MHz)	200 Hz: (9 kHz to 150 kHz) 9 kHz: (150 kHz to 30 MHz)
Amplitude Range:	60 dB	20 dB (typical)
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) or Average
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

A2.3 Frequency Stability

A2.3.1 Measurements were performed to determine the frequency stability against the specified limits.

A2.3.2 An environmental test chamber was used to perform the resting required.

A2.3.3 The EUT was situated inside the environmental test chamber and at the required temperature, starting from the lowest level the EUT was allowed to settle prior to switching on.

A2.3.4 The EUT was switched on and the relevant frequency was recorded.

A2.3.5 Frequency measurements were then made at over extremes of declared voltage.

A2.3.6 The EUT was then switched off for a minimum of 30 minutes and the environmental chamber was set to the next temperature in the temperature in the range of -20°C to 50°C.

A2.3.7 FCC Part 15.225 states that the frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorised frequency block. As such, the frequency difference from declared was measured in parts per million (ppm) with the difference between this and the authorised band edge being reported also in (ppm)

Appendix 3. Test Configuration Drawings

This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\43135JD04\EMICON	Test configuration for measurement of conducted emissions
DRG\43135JD04\EMIRAD	Test configuration for measurement of radiated emissions
DRG\43135JD04\001	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test
DRG\43135JD04\002	Schematic diagram of the EUT, support equipment and interconnecting cables used for the test

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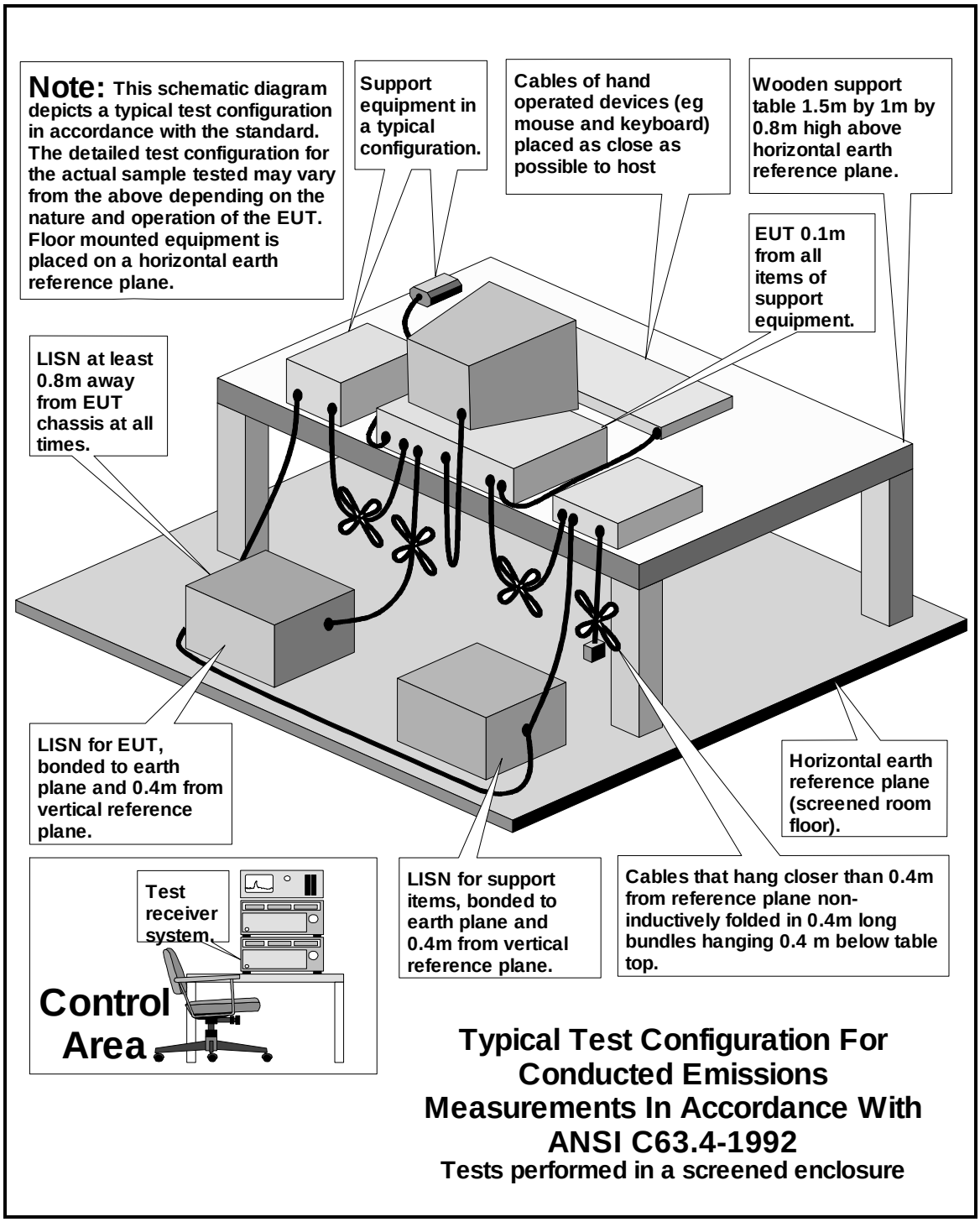
DRG\43135JD04\EMICON



Typical Test Configuration For Conducted Emissions Measurements In Accordance With ANSI C63.4-1992
Tests performed in a screened enclosure

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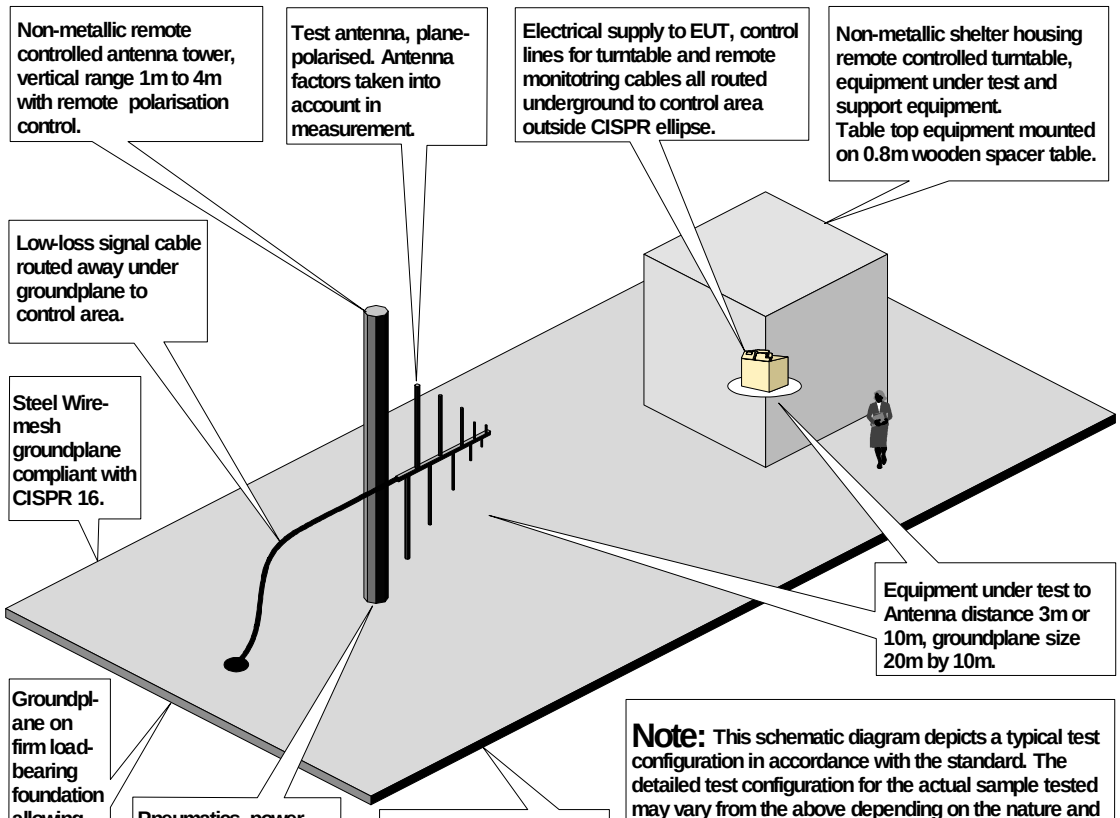
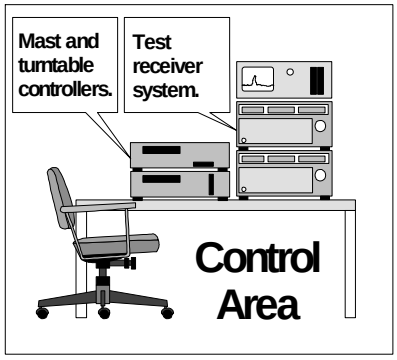
DRG\43135JD04\EMIRAD



Note: This schematic diagram depicts a typical test configuration in accordance with the standard. The detailed test configuration for the actual sample tested may vary from the above depending on the nature and operation of the EUT.
The test site used by RFI is nominally at ground level.
All electrical cables run underground.
All other dimensions in accordance with the standard.

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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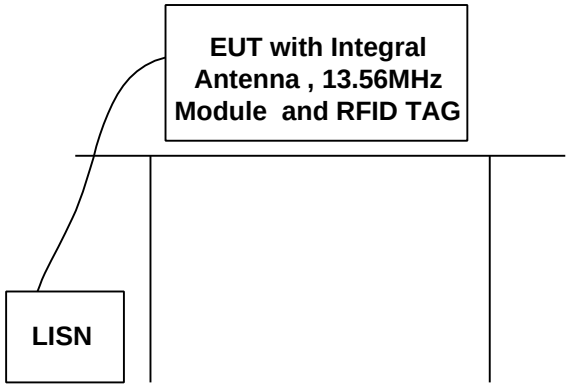
DRG\43135JD04\001

Configuration of EUT and Local Support Equipment for Conducted Emission



Configuration of Remote Support Equipment

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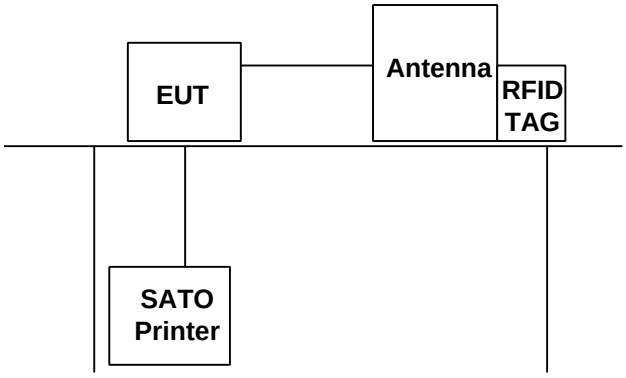
DRG\43135JD04\002

Configuration of EUT and Local Support Equipment for Radiated Emission



Configuration of Remote Support Equipment

Appendix 4. Photographs of EUT

This appendix contains the following photographs:

Photo Reference Number	Title
PHT/43135JD04/001	Front view of conducted emissions set-up
PHT/43135JD04/002	Rear view of conducted emissions set-up
PHT/43135JD04/001	Front view of radiated emissions set-up
PHT/43135JD04/002	Rear view of radiated emissions set-up
PHT/43135JD04/003	Top view of EUT
PHT/43135JD04/004	Bottom view of EUT

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

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PHT/43135JD04/001 Front view of conducted emissions set-up

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PHT/43135JD04/002 Rear view of conducted emissions set-up

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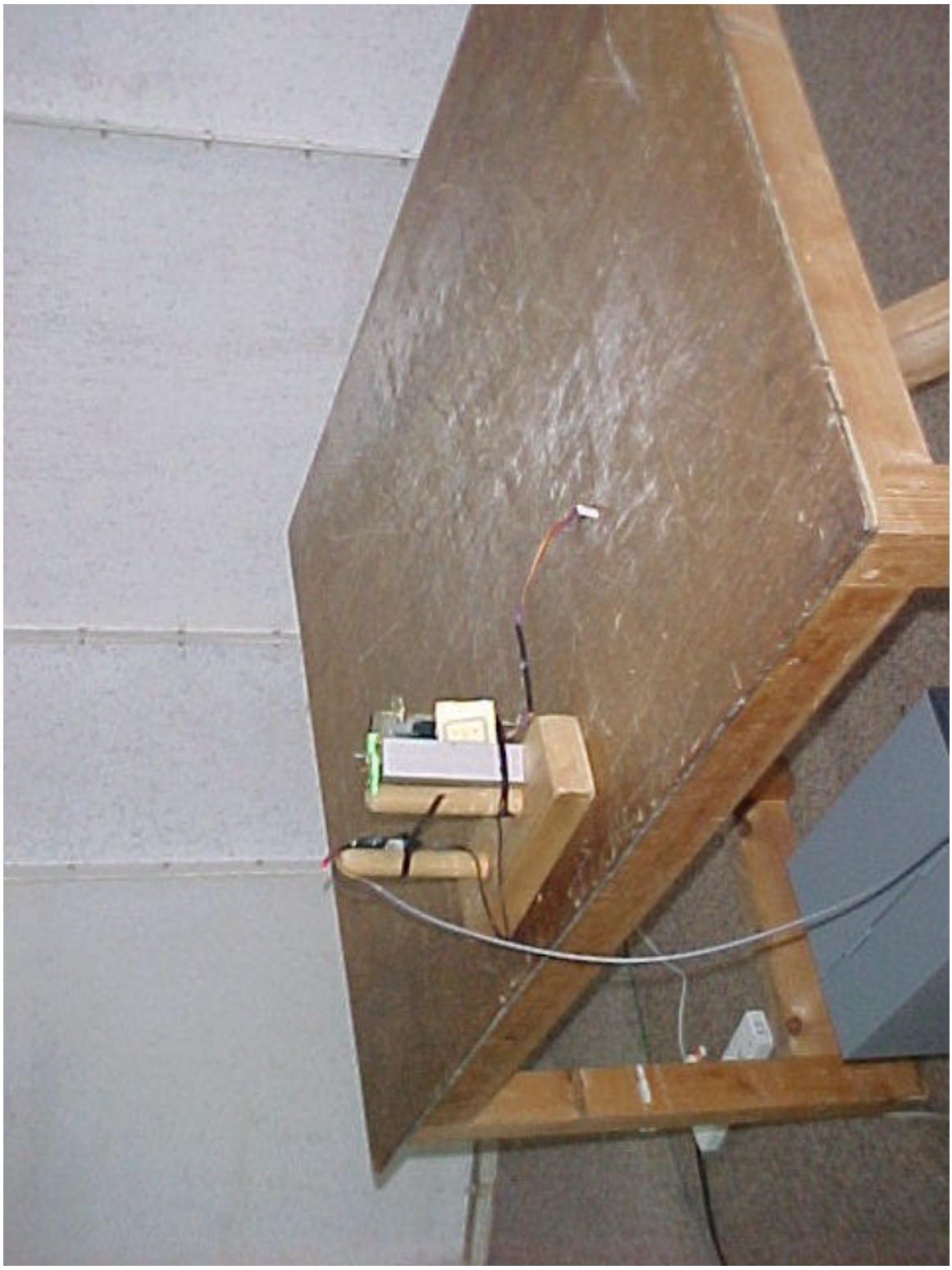
PHT/43135JD04/003 Front view of radiated emissions set-up

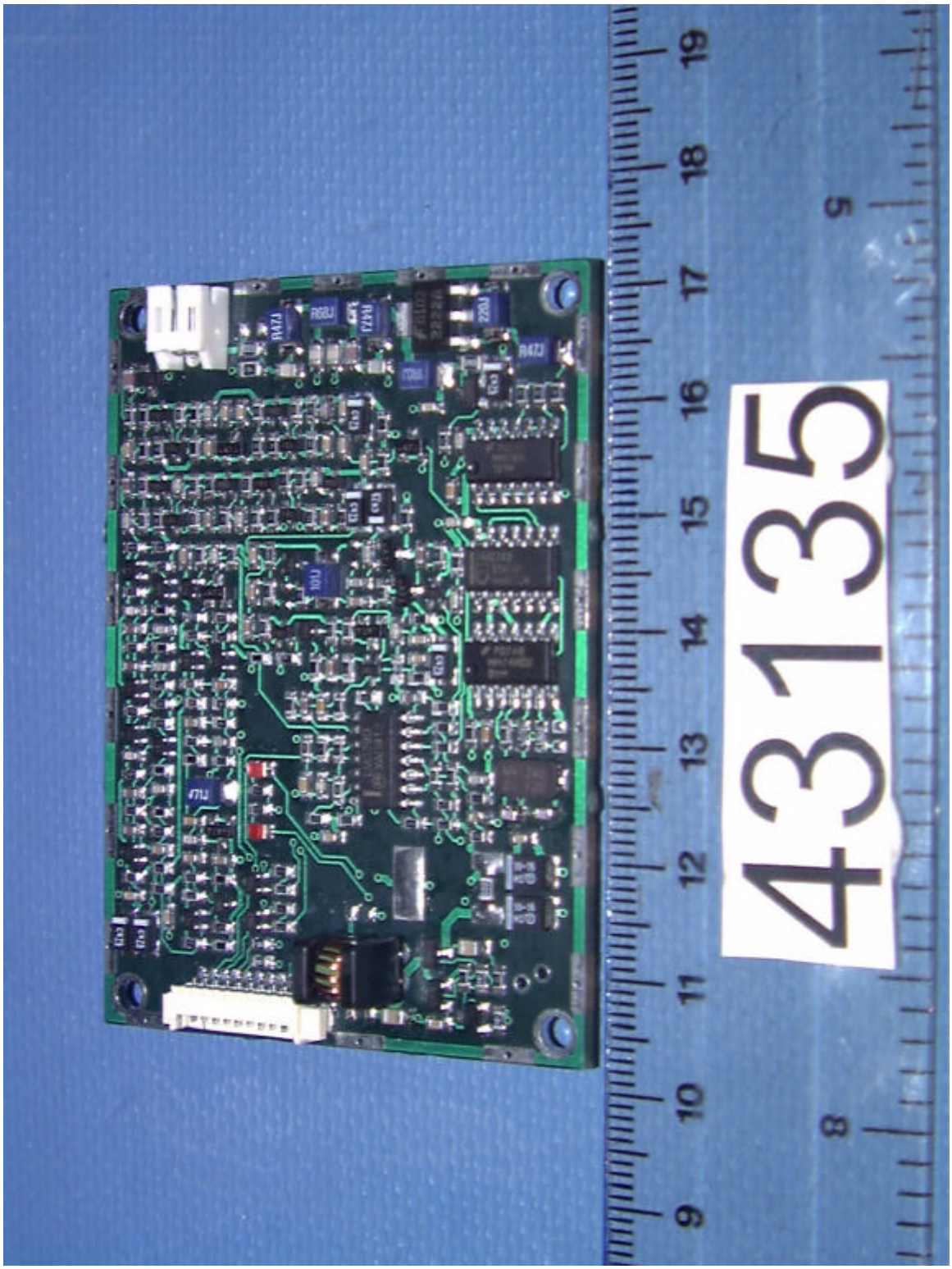


Test Of: **i2R Ltd.**
OEM 400 13.56 MHz Module
To: **FCC Part 15 Subpart C: 2000**
(Intentional Radiators) Section 15.209

PHT/43135JD04/004 Rear view of radiated emissions set-up

Test Of: **i2R Ltd.**
OEM 400 13.56 MHz Module
To: **FCC Part 15 Subpart C: 2000**
(Intentional Radiators) Section 15.209

PHT/43135JD04/005 Top view of EUT



Test Of: **i2R Ltd.**
OEM 400 13.56 MHz Module
To: **FCC Part 15 Subpart C: 2000**
(Intentional Radiators) Section 15.209

PHT/43135JD04/006 Bottom view of EUT