



1107  
1107 SI

# EMC Projects Limited

HOLLY GROVE FARM, VERWOOD ROAD, ASHLEY, RINGWOOD, HANTS. BH24 2DB  
TEL: +44 (0) 1425 479979 FAX: +44 (0) 1425 480637  
email:enquiries@emc-projects.co.uk  
website: www.emc-projects.co.uk

U.K. COMPETENT BODY  
NOTIFIED BODY (R&TTE)

AI/9411/93

Commercial In Confidence



## TEST REPORT No: P2843/1 - Issue 1

Customer/Applicant: DENSITRON COMPUTERS LIMITED  
Address: Unit 4,  
Airport Trading Estate  
Biggin Hill  
Kent  
TN16 3BW

Subject: **ELECTROMAGNETIC COMPATIBILITY**

Customer Ref:

Manufacturer: DENSITRON COMPUTERS LIMITED

Product: Personal Computer

Model/Trade Name: Cassius-Multimedia Computer

Serial No/Lot No: 001

Tests Carried Out: FCC CFR 47

NAMAS Accreditation No: 1107

*NAMAS accreditations do not cover opinions and interpretation, and any expressed herein are outside the scope of any NAMAS accreditation. Results of tests not covered by our NAMAS Schedule are marked NNA (Not NAMAS Accredited.)*

**Report Author:** M.C. Wood  
**Title:** (EMC Engineer)

**Checked By:** O.W. Cockram  
**Title:** (General Manager)

Signature

Signature

Date: 18<sup>th</sup> January 2001

Commercial In Confidence

Page 1 of 22

**Report Summary****Report No:** P2843**Test Standard:** CFR 47 Part 15 B (Unintentional Radiators) Sections 15.107 & 15.109**Carried Out At:** EMC Projects Ltd., Ringwood, Hants, BH24 2DB**Equipment Tested:** Personal Computer**Model No:** Cassius-Multimedia Computer**Serial No:** 001**Software Version:** Windows 98 and EMC Test software**Carried Out On:** Conducted and Radiated Emissions**Test Engineer:** M.C.Wood**In Attendance:** N/a**SUMMARY of RESULTS**

The Table below depicts a summary of the tests and test results detailed in this report.

Test	Test Type	Specification & Issue	Result	Pages	Levels/Comments
1	Conducted Emissions	CFR 47 Part 15 B Section 15.107: Unintentional Radiators	Pass	8 to 12	110 V 60 Hz Supply - Class B
2	Radiated Emissions	CFR 47 Part 15 B Section 15.109: Unintentional Radiators	Pass	13 to 20	10 m Open Area Test Site - Class B

**CONTENTS**

Report Summary

**PAGE**

2

<b>1. INTRODUCTION</b>	<b>4</b>
<b>2. Modes of operation</b>	<b>4</b>
<b>3. Test Setup</b>	<b>4</b>
<b>3.1 Conducted Emissions</b>	<b>5</b>
<b>3.2 Radiated Emissions</b>	<b>5</b>
<b>3.3 Figure 1 - Block Diagram of EUT Set-up</b>	<b>6</b>
<b>4. Test equipment</b>	<b>7</b>
<b>5. Ambient Conditions</b>	<b>7</b>
<b>6. Test Procedures</b>	<b>7</b>
<b>7. Tests Carried out</b>	<b>7</b>
<b>8. Test Results</b>	<b>8</b>
<b>8.1 Test 1 - Conducted Emissions 110 V 60 Hz Supply</b>	<b>8</b>
<b>8.1.1 Test Equipment Used</b>	<b>8</b>
<b>8.1.2 Test 1 - Figure 1 - General Test Set-up - Table Top Equipment</b>	<b>9</b>
<b>8.1.3 Test 1 - Figure 2 - Set-up Photographs</b>	<b>10</b>
<b>8.1.4 Test 1 - Figure 3 - 110 V 60 Hz Supply - Live Line</b>	<b>11</b>
<b>8.1.5 Test 1 - Figure 4 - 110 V 60 Hz Supply - Neutral Line</b>	<b>11</b>
<b>8.1.6 Test 1 - Figure 5 - 110 V 60 Hz - Neutral Line CISPR Detector</b>	<b>12</b>
<b>8.2 Test 2 - Radiated Emissions 30 MHz to 7.5 GHz</b>	<b>13</b>
<b>8.2.1 Test 2 - Test Equipment Used</b>	<b>13</b>
<b>8.2.2 Test 2 - Figure 1 - OATS General Test Set-up</b>	<b>14</b>
<b>8.2.3 Test 2 - Figure 2 - General Table Top Layout</b>	<b>14</b>
<b>8.2.4 Test 2 - Figure 3 - Set-up Photograph Screened Room</b>	<b>15</b>
<b>8.2.5 Test 2 - Figure 4 - Set-up Photograph OATS</b>	<b>15</b>
<b>8.2.6 Test 2 - Figure 5 - Screened Room Emission Measurements - Uncorrected</b>	<b>16</b>
<b>8.2.7 Test 2 - Figure 6 - Screened Room Emission Measurements - Antenna corrected</b>	<b>17</b>
<b>8.2.8 Test 2 - Figure 7 - Radiated Emissions 10m OATS</b>	<b>18</b>
<b>8.2.9 Test 2 - Table 1- Radiated Emissions, Data worst case</b>	<b>19</b>
<b>8.2.10 Test 2 - Figure 8 - Set-up Photographs (showing cable configuration)</b>	<b>20</b>
<b>9. conclusions</b>	<b>21</b>
<b>10. annex A - Test Equipment List</b>	<b>22</b>

## 1. INTRODUCTION

This report details the results of the Electromagnetic Compatibility (EMC) tests carried out on a Cassius personal computer (EUT) manufactured by Densitron Limited to CFR 47 Part 15 B Sections 15.107 & 15.109.

The Equipment Under Test (EUT) comprised of the following components:

Main Unit Model No Cassius Serial No 001

EMC Projects Ltd., is an UKAS accredited EMC Test House and is registered with the FCC.

## 2. MODES OF OPERATION

For the duration of the testing the EUT was operated in various modes to ascertain the worst-case emission levels. This was found to be the EMC software mode, which sequentially exercised the following functions: -

1. Printing a row of characters on the printer
2. Displaying a screen of Black H,s on a white background
3. Writing to floppy drive
4. Writing to memory

## 3. TEST SETUP

The EUT was set-up for the individual tests as described below and as shown in the set-up photographs.

A block diagram of the EUT is shown in Figure 1 of this section, detailing cable connections.

The tests were carried out with all cables connected and support equipment (Printer etc) powered up.

### 3.1 Conducted Emissions

The EUT being Table Top Equipment was set up upon a non-metallic table measuring 1.5 x 1.0 m, 800 mm above the conducting ground plane and 400 mm from the vertical conducting surface in Screened Room No 1, as indicated in the test set-up and set-up photographs.

The EUT was powered from a filtered 110 V 60 Hz supply via Line Impedance Stabilizing Networks (LISN's). The LISN's were mounted and bonded to the conducting ground plane 800 mm from the EUT. All unused 50 Ohm connectors of the LISN's were terminated with resistive 50 Ohm terminations.

The excess length of the EUT supply and interconnecting cables were folded back and forth at the center of the cable to produce a bundle 40 cm in length to ensure the overall length did not exceed 1 m.

The EUT ground (safety) connection was connected to the ground at the LISN, through the conductor provided in the supply lead and via a braided earth stud to the screened room floor.

Conducted emissions were recorded on each supply line over the frequency range 450 kHz to 30 MHz with a receiver bandwidth of 10 kHz, and the receiver in Peak, Quasi-Peak and Average detector modes.

### 3.2 Radiated Emissions

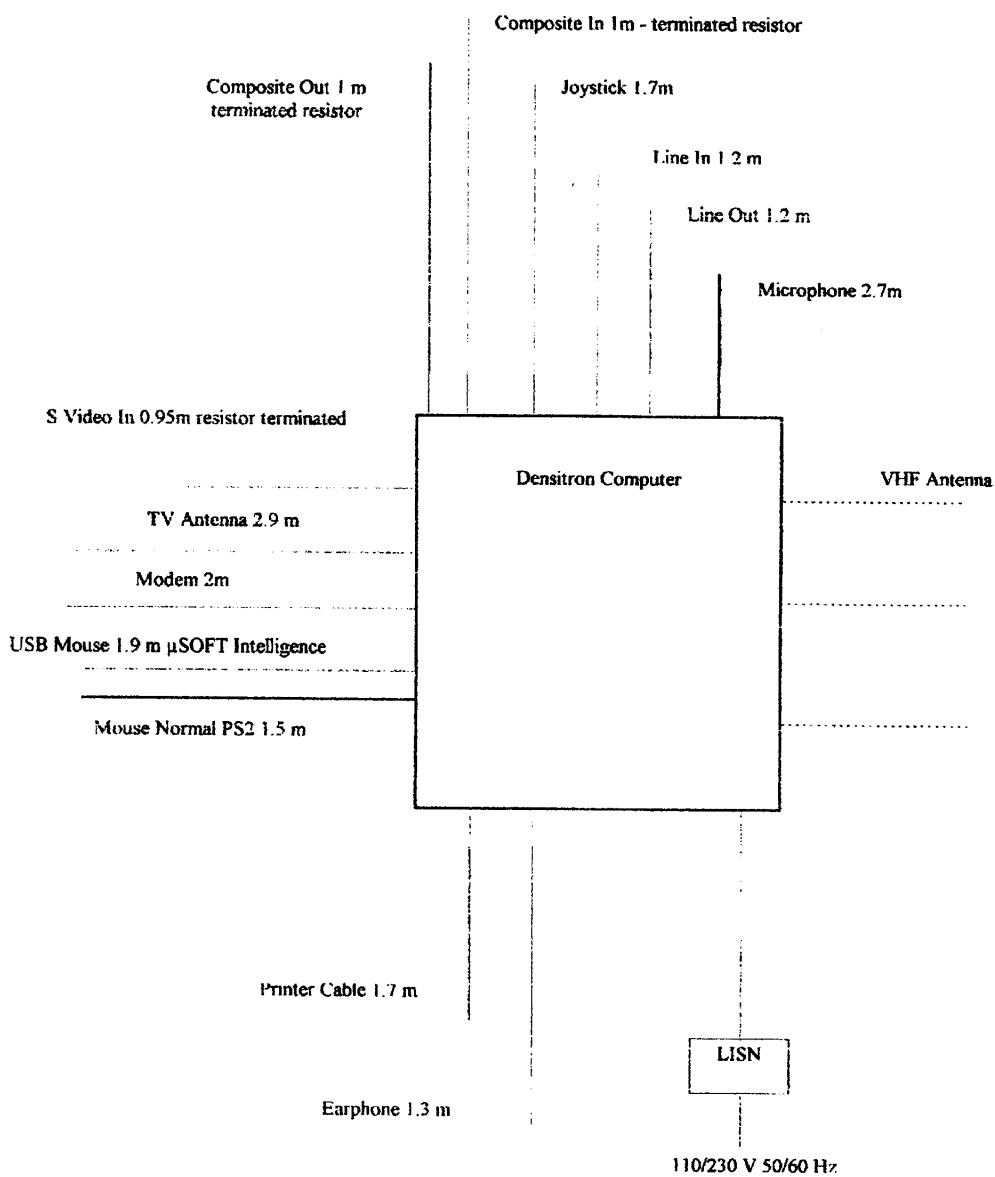
Measurements for radiated emissions were carried out on a 10 m Open Area Test Site (OATS) meeting the requirements of 5.3 of ANSI 63.2:1992.

For preliminary testing radiated emissions were first recorded in an unlined screened room to record the frequencies of emissions and to determine the mode of operation and cable and sub-assembly layout that produced the maximum emission levels.

The EUT was then moved to the OATS and placed on a Turntable 800 mm above the conducting ground plane as previously laid out in the screened room, as indicated in the test set-up and set-up photographs.

Maximum emissions were then recorded, using a receiver bandwidth of 120 kHz and 1 MHz, and the receiver Quasi-Peak detector mode from the EUT by changing the height and polarization of the receive antenna together with rotating the turntable for each frequency detected from the EUT.

### 3.3 Figure 1 - Block Diagram of EUT Set-up



## 4. TEST EQUIPMENT

All test equipment used for the tests was calibrated and its operation verified prior to being used, a full list of which is shown in Annex A.

## 5. AMBIENT CONDITIONS

For the duration of the tests the ambient conditions were recorded and found to fall in the following ranges:

Temperature Recorded: 12 to 15 °C

Humidity Recorded: 50 to 61 %

Atmospheric Pressure: 995 to 120 mBar

## 6. TEST PROCEDURES

Procedures and methods of test employed were in accordance with the requirements of the specifications applied, using accredited in-house test procedures in accordance with ANSI 63.4:1992. For emission testing the ambient conditions were measured and found to be satisfactory.

## 7. TESTS CARRIED OUT

The following tests were deemed to be applicable to the EUT and were carried out as detailed in the test results section.

Test	Test Type	Specification & Issue	Levels Comments
1	Conducted Emissions	CFR 47 Part 15B Section 15.107	110 V 60 Hz Supply - Live Line
2	Conducted Emissions	CFR 47 Part 15 B Section 15.107	110 V 60 Hz Supply - Neutral Line
3	Radiated Emissions	CFR 47 Part 15B Section 15.109	10 m Open Area Test Site

## 8. TEST RESULTS

### 8.1 Test 1 - Conducted Emissions 110 V 60 Hz Supply

The EUT was set up in a screened room as indicated below and powered from a filtered 110 V 60 Hz supply via Line Impedance Stabilization Units (LISN's) as depicted in Figures 1 and 2.

The Test Equipment operation was verified for calibration and operation prior to being used.

Prior to carrying out the tests ambient levels were recorded and found to be greater than 6 dB below the required limits.

The EUT was powered up and allowed to stabilize measurements were taken to ascertain the worst mode of operation. This was found to be when using the EMC test software.

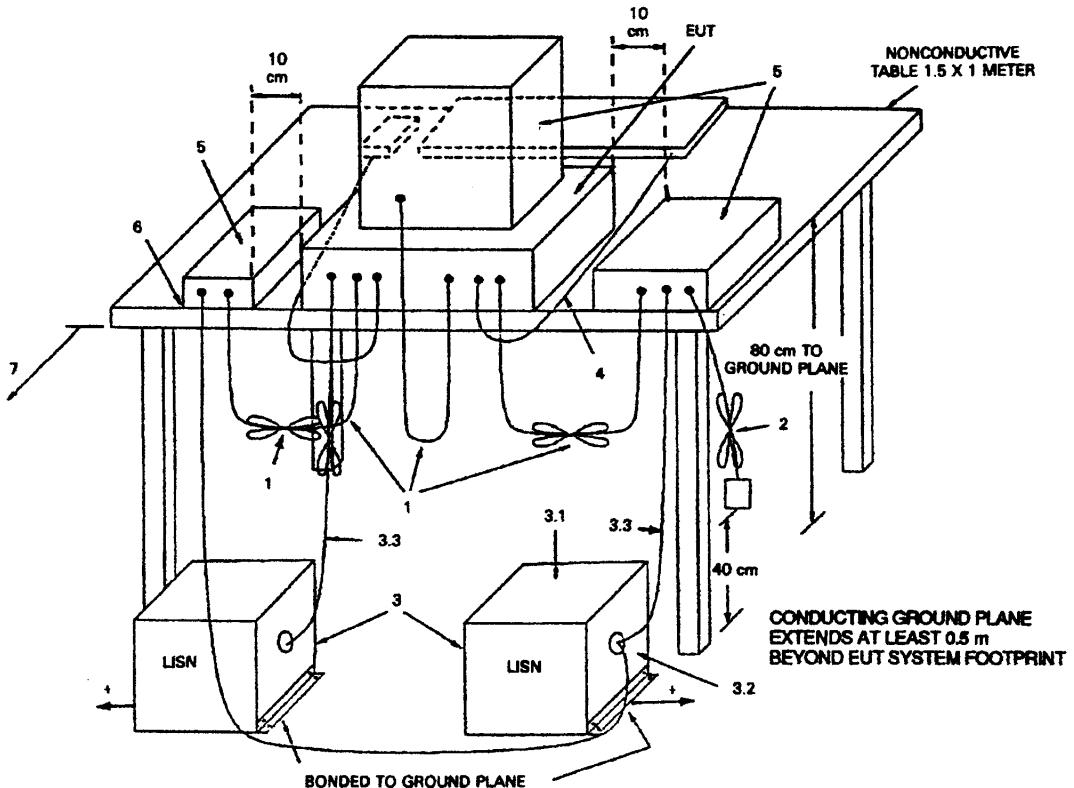
Conducted emissions were recorded on both Live and Neutral supply lines over the frequency range 450 kHz to 30 MHz in accordance with the specification requirements. and are depicted in Figures 3,4 & 5. From these figures it can be seen that the maximum recorded emissions were within the required limits.

#### 8.1.1 Test Equipment Used

The following major items of test equipment were used for the conducted emission tests:

RX1	RX2	RX3	DB20	Room 1	L2/2	L2/1
-----	-----	-----	------	--------	------	------

### 8.1.2 Test 1 - Figure 1 - General Test Set-up - Table Top Equipment

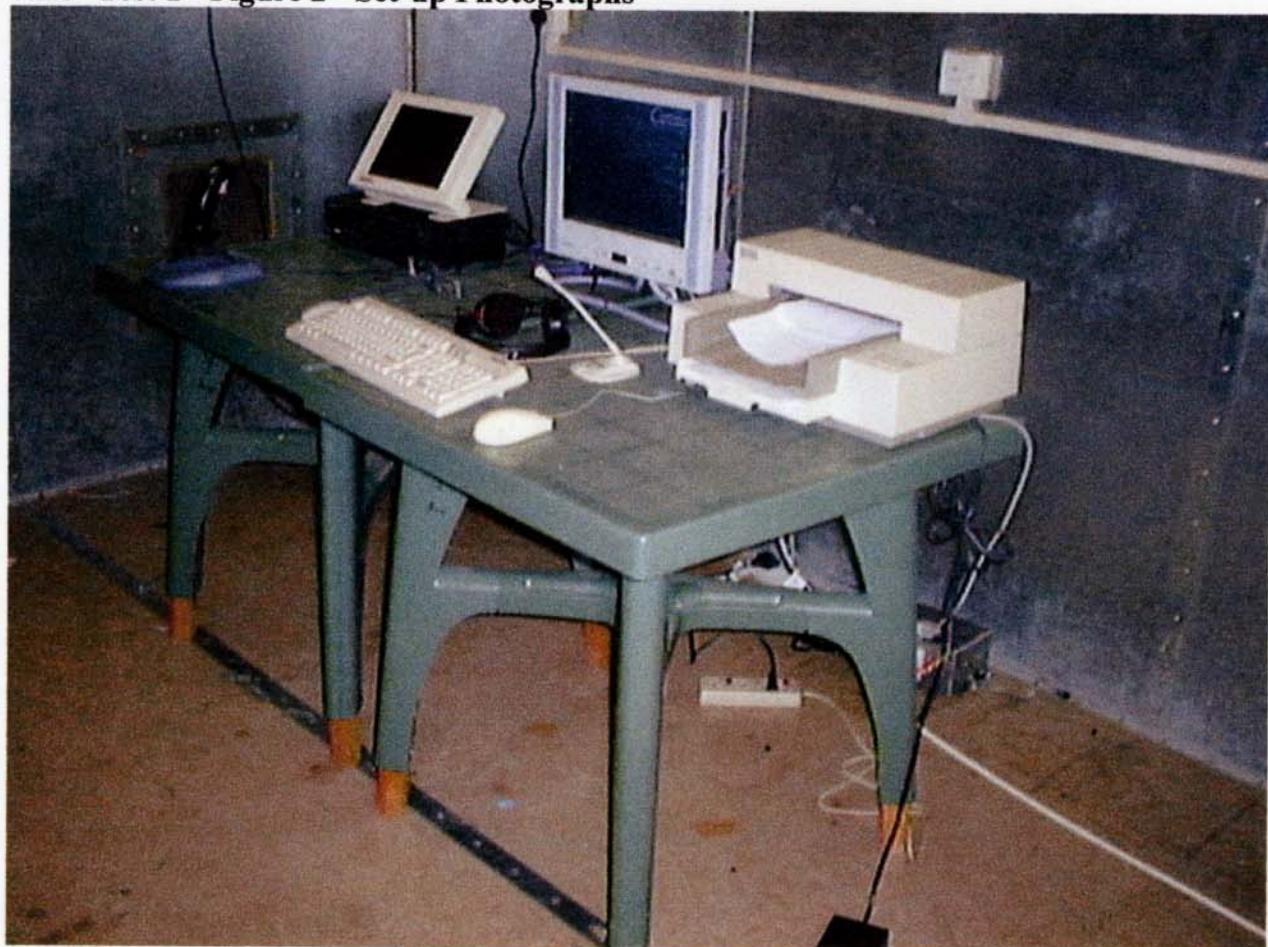


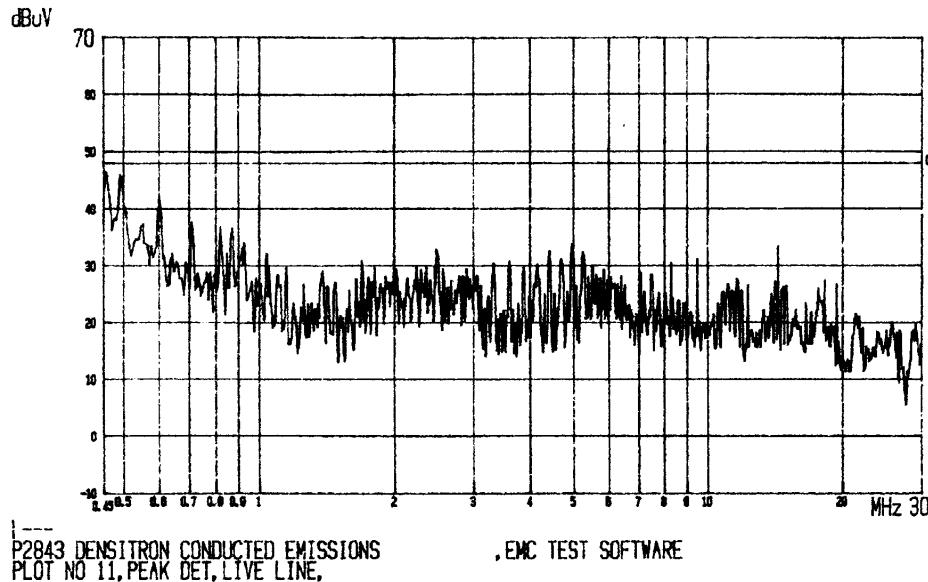
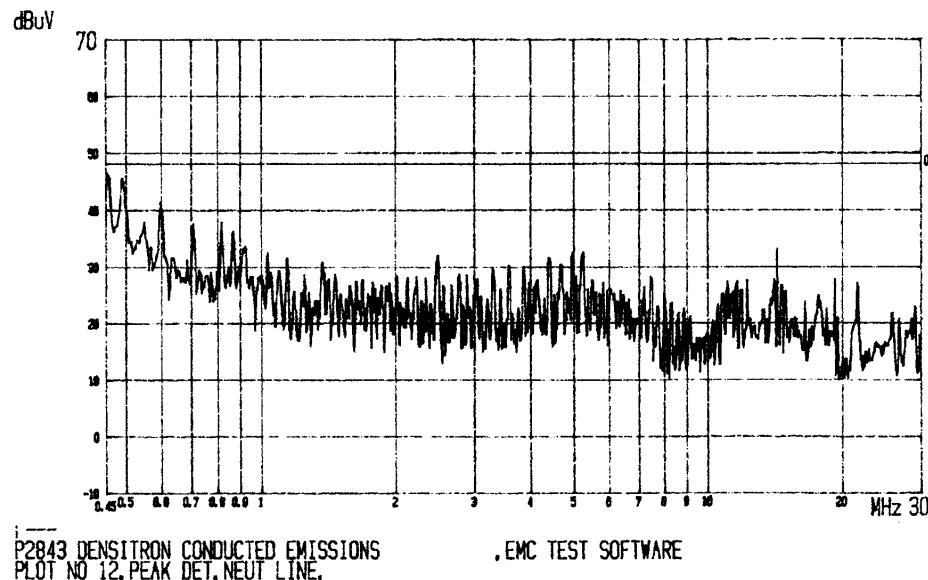
†LISNs may have to be moved to the side to meet 3.3 below.

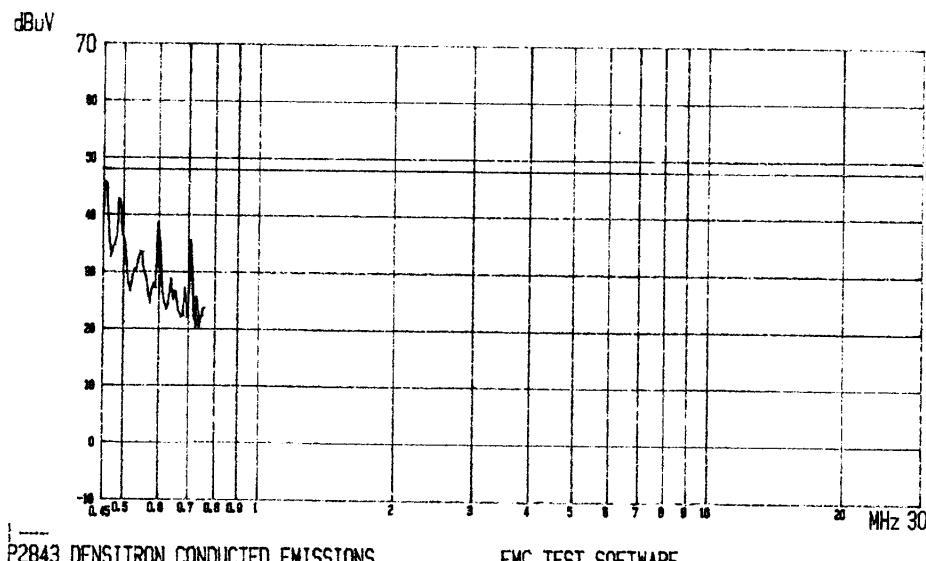
LEGEND:

1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth forming a bundle 30 to 40 cm long, hanging approximately in the middle between ground plane and table.
2. I/O cables that are connected to a peripheral shall be bundled in center. The end of the cable may be terminated if required using correct terminating impedance. The total length shall not exceed 1 m.
3. EUT connected to one LISN. Unused LISN connectors shall be terminated in 50  $\Omega$ . LISN can be placed on top of, or immediately beneath, ground plane.
  - 3.1 All other equipment powered from second LISN.
  - 3.2 Multiple outlet strip can be used for multiple power cords of non-EUT equipment.
  - 3.3 LISN at least 80 cm from nearest part of EUT chassis.
4. Cables of hand-operated devices, such as keyboards, mouses, etc., have to be placed as close as possible to the host.
5. Non-EUT components being tested.
6. Rear of EUT, including peripherals, shall be all aligned and flush with rear of tabletop.
7. Rear of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the floor ground plane (see 5.2).

### 8.1.3 Test 1 - Figure 2 - Set-up Photographs



**8.1.4 Test 1 - Figure 3 - 110 V 60 Hz Supply - Live Line****8.1.5 Test 1 - Figure 4 - 110 V 60 Hz Supply - Neutral Line**

**8.1.6 Test 1 - Figure 5 - 110 V 60 Hz - Neutral Line CISPR Detector**

## 8.2 Test 2 - Radiated Emissions 30 MHz to 7.5 GHz

Radiated emissions over the frequency range 30 MHz to 7.5 GHz were recorded 1 m from the EUT whilst setup in a screened room. During this test checks were carried out to determine the mode of operation, software and cable configuration most likely to produce the maximum emissions as indicated in Figures 3,4 & 8.

The Test Equipment operation was verified for calibration and operation prior to being used.

The EUT was then set-up on a turn table on the 10 m Open Area Test Site (OATS) powered up from a 110 V 60 Hz supply, allowed to stabilize and then operated using the EMC Test Software with the cable configuration found to produce the maximum emissions in the screened room tests, as shown in the set-up photographs.

Radiated emission tests were repeated over the full frequency range, paying particular attention at those frequencies detected in the screened room test (figures 5 & 6). At each frequency detected, the height and polarization of the receive antenna was adjusted and the turntable rotated to record the maximum level on the receiver.

The maximum recorded levels were corrected with antenna factor and cable losses and compared against the specification limits to determine compliance with the standard as shown in Table 1 and Figure 7.

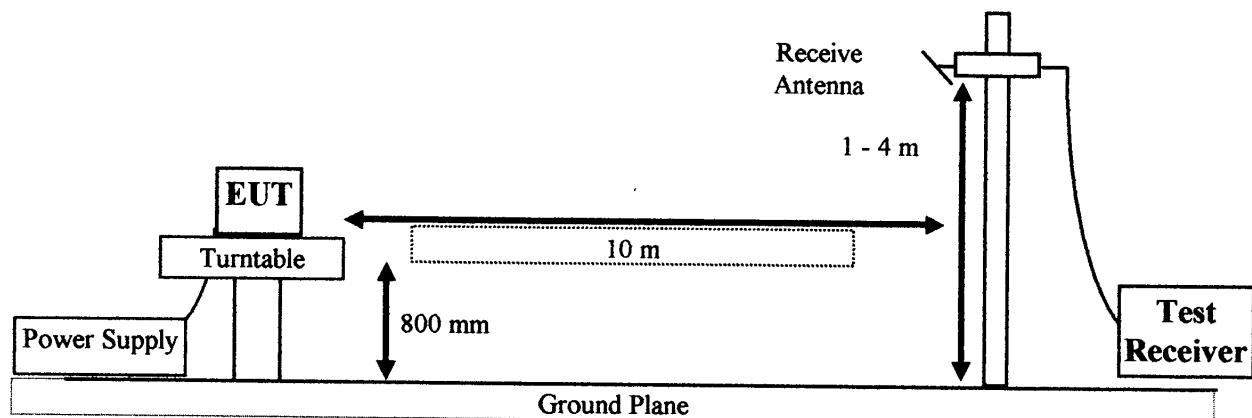
From the Table and Figure it can be seen that the radiated emissions were found to be within the requirements of class B Limits.

### 8.2.1 Test 2 - Test Equipment Used

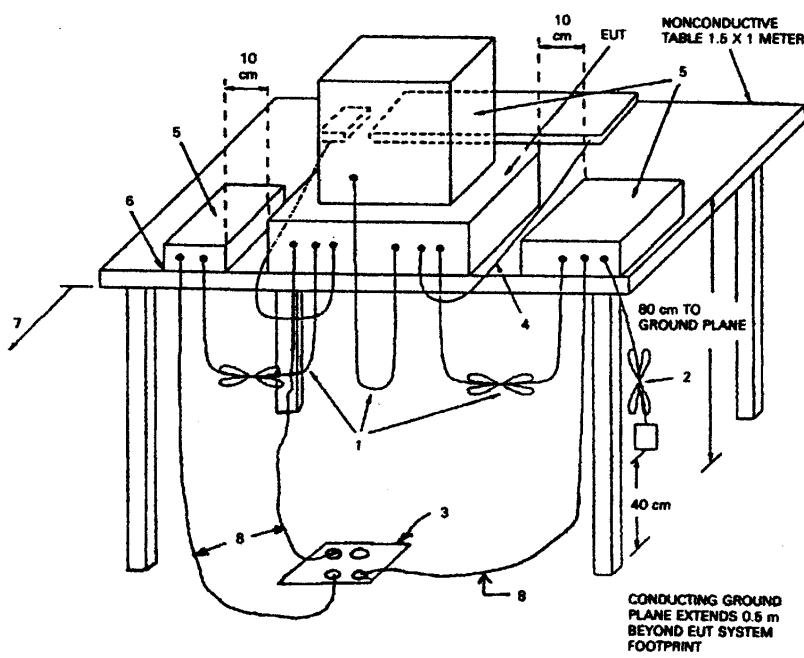
The following major items of test equipment were used for the radiated emission tests:

UHR1	BA3	OATS 2	Room 1	
------	-----	--------	--------	--

## 8.2.2 Test 2 - Figure 1 - OATS General Test Set-up



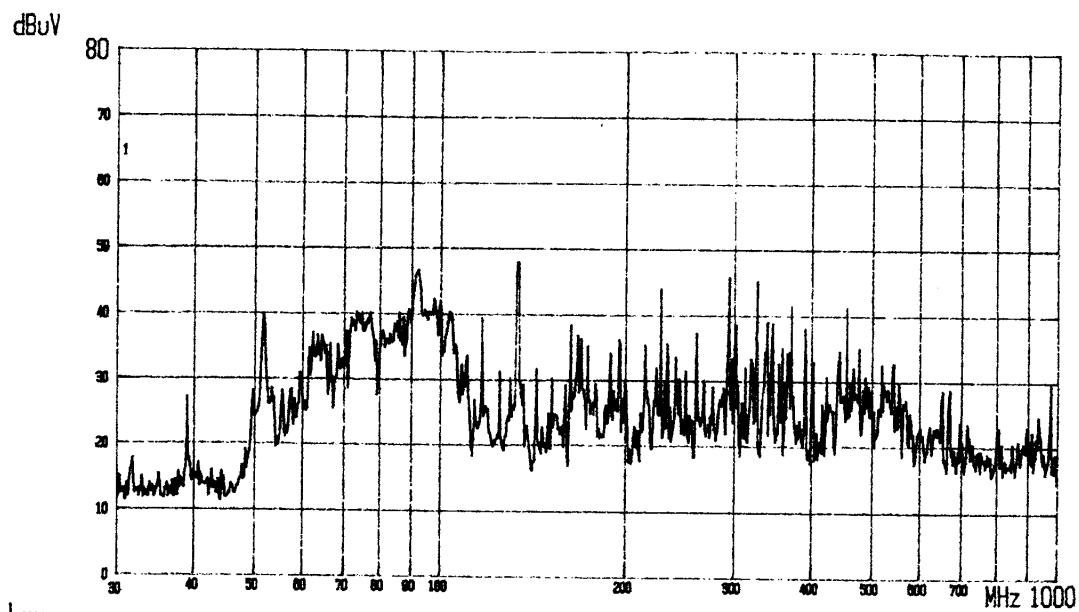
## 8.2.3 Test 2 - Figure 2 - General Table Top Layout



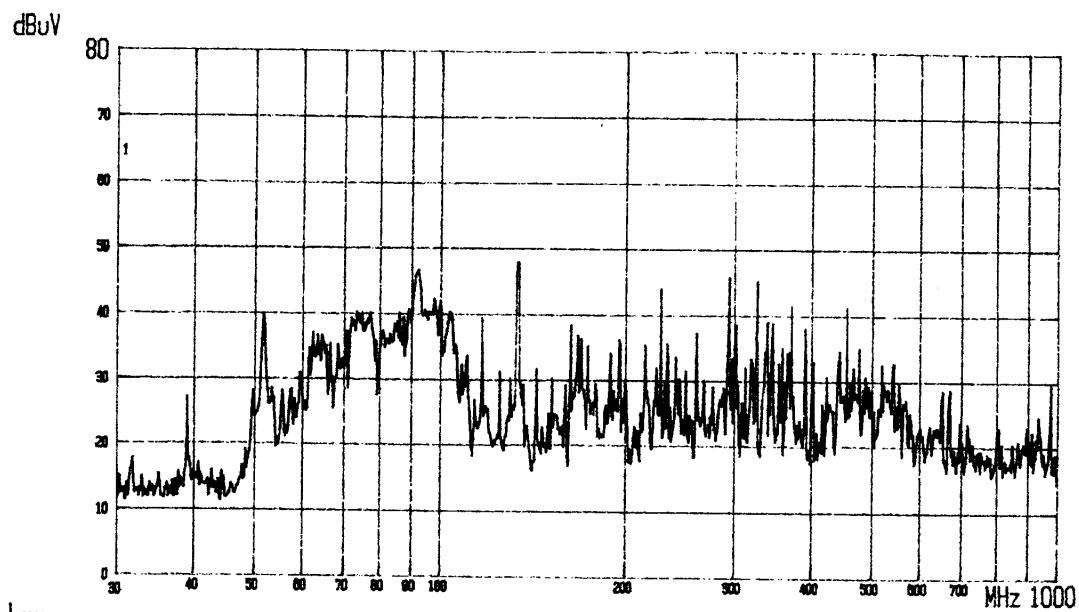
### LEGEND:

1. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth forming a bundle 30 to 40 cm long, hanging approximately in the middle between ground plane and table.
2. I/O cables that are connected to a peripheral shall be bundled in center. The end of the cable may be terminated if required using correct terminating impedance. The total length shall not exceed 1 m.
3. If LISNs are kept in the test setup for radiated emissions, it is preferred that they be installed under the ground plane with the receptacle flush with the ground plane.
4. Cables of hand-operated devices, such as keyboards, mouses, etc., have to be placed as close as possible to the controller.
5. Non-EUT components of EUT system being tested.
6. The rear of all components of the system under test shall be located flush with the rear of the table.
7. No vertical conducting wall used.
8. Power cords drape to the floor and are routed over to receptacle.

**8.2.4 Test 2 - Figure 3 - Set-up Photograph Screened Room****8.2.5 Test 2 - Figure 4 - Set-up Photograph OATS**

**8.2.6 Test 2 - Figure 5 - Screened Room Emission Measurements - Uncorrected**

P2843 DENSITRON RADIATED EMISSIONS, EMC TEST SOFTWARE  
PLOT NO 15, PEAK DET, VERTICAL POLARISATION.

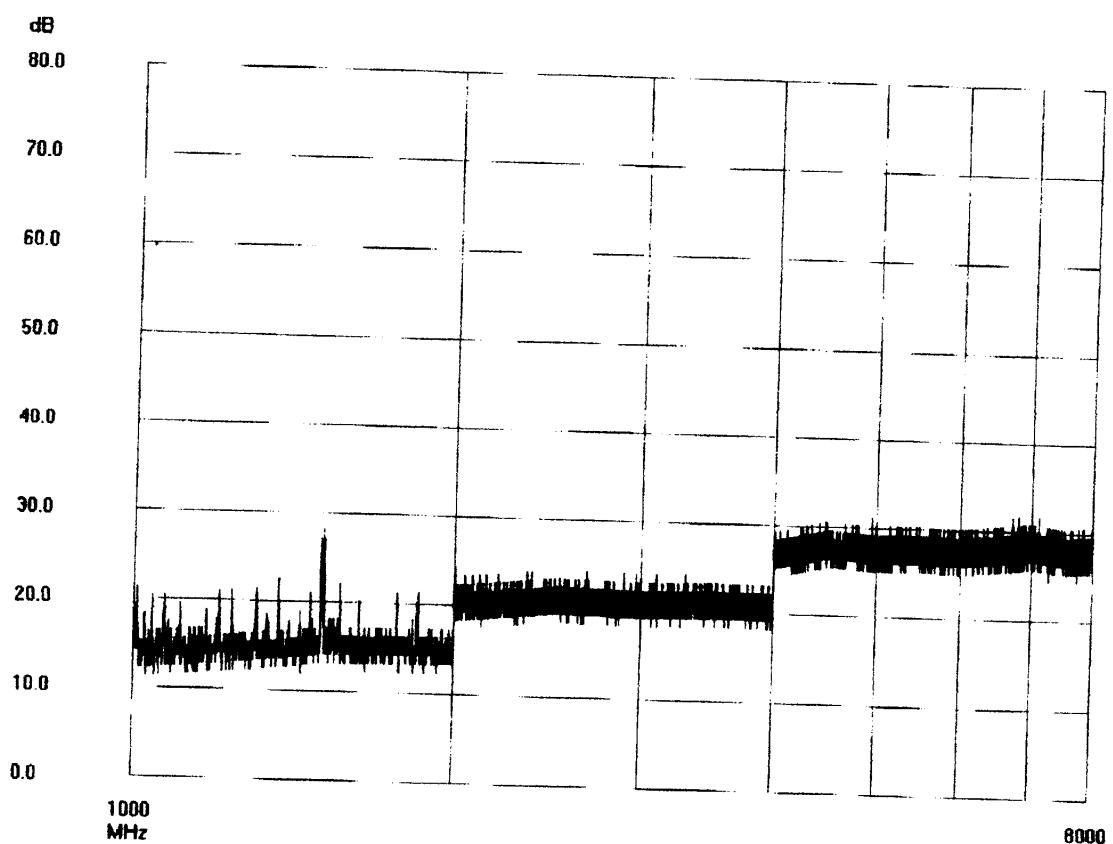
**8.2.6 Test 2 - Figure 5 - Screened Room Emission Measurements - Uncorrected**

P2843 DENSITRON RADIATED EMISSIONS, EMC TEST SOFTWARE  
PLOT NO 15, PEAK DET, VERTICAL POLARISATION.

**8.2.7 Test 2 - Figure 6 - Screened Room Emission Measurements – Antenna corrected**  
**densitron rear face vertical**

Files :-

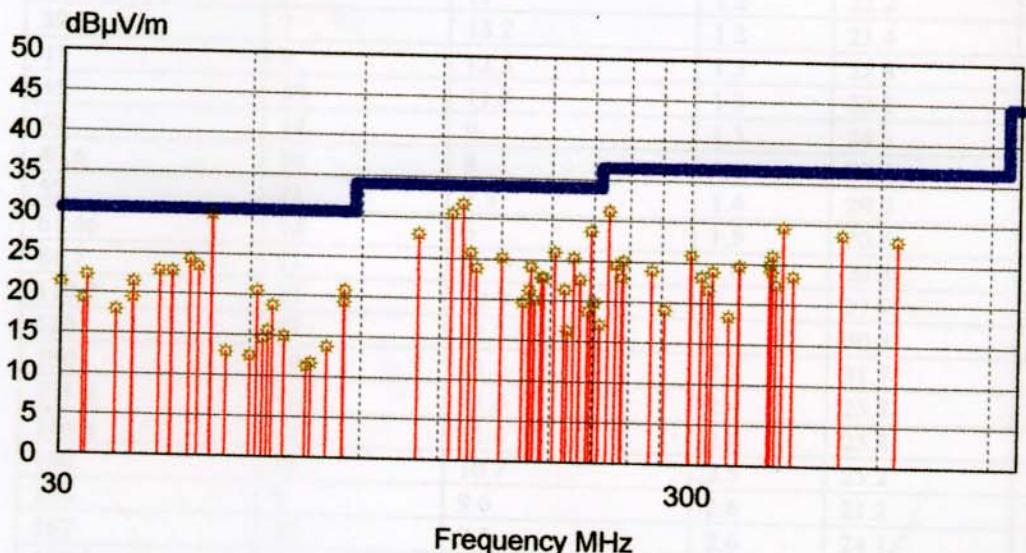
Peak — v2.dat



## 8.2.8 Test 2 - Figure 7 - Radiated Emissions 10m OATS

## DENSITRON "CASSIUS"

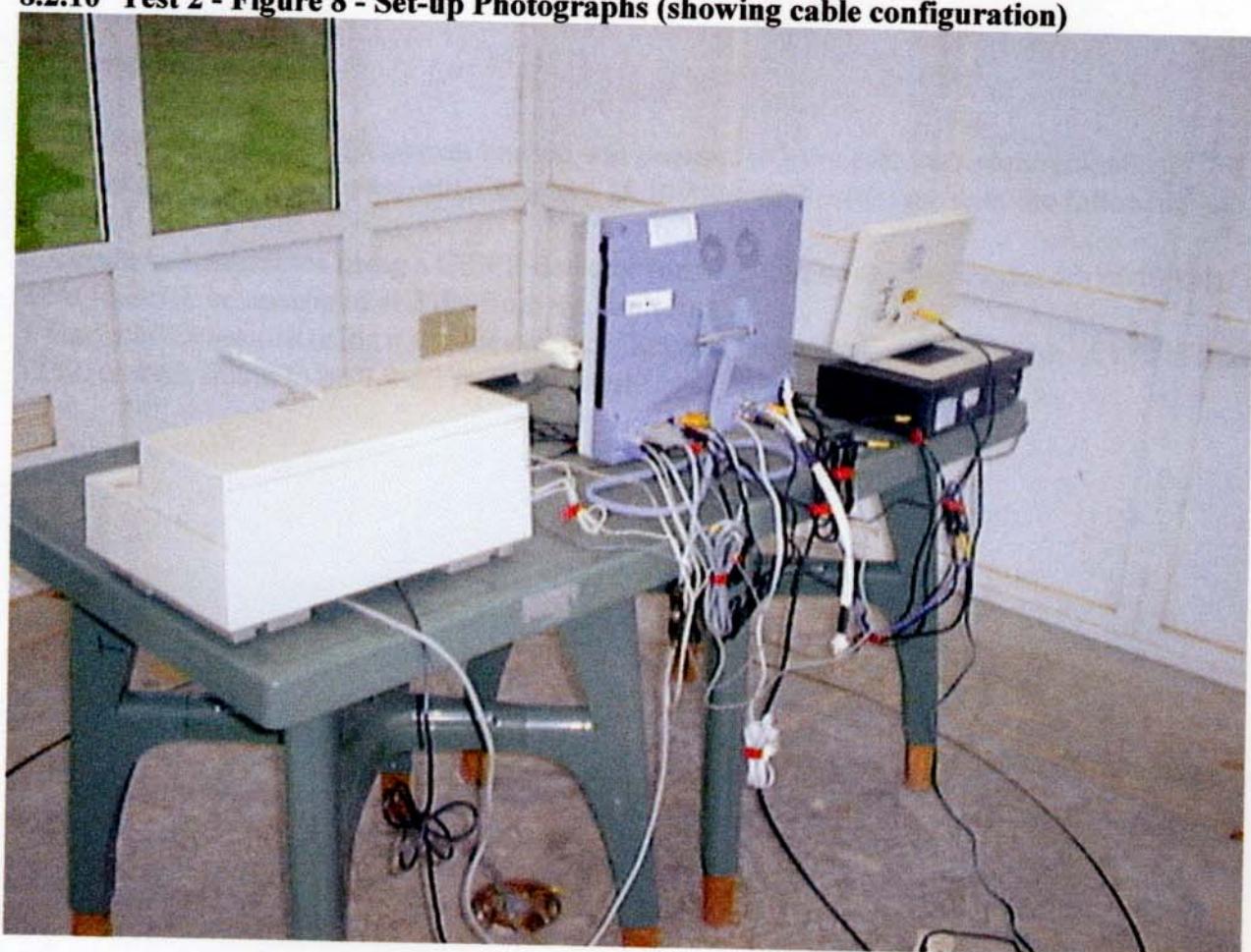
P2843



DATE 05-01-01

**8.2.9 Test 2 - Table 1- Radiated Emissions, Data worst case**  
 (no measurements below 20 dB $\mu$ V/m)

FREQUENCY	READING	CORRECTION	CABLE	total;	Polarization of highest recorded level
30	2	18.2	1.1	21.3	Vertical
33	6	15	1.2	22.2	Vertical
39.1	7	13.2	1.2	21.4	Vertical
43	9	12.5	1.3	22.8	Vertical
45	10	11.5	1.3	22.8	Vertical
48	14	9	1.3	24.3	Vertical
49.6	14	8	1.4	23.4	Vertical
52	21	7.5	1.4	29.9	Vertical
61.46	14	5	1.5	20.5	Vertical
84.7	11	8	1.8	20.8	Vertical
110.7	15	10.9	2	27.9	Vertical
125	17	11.3	2.2	30.5	Vertical
130	18	11.5	2.2	31.7	Vertical
133.8	12	11.4	2.4	25.8	Vertical
136.8	10	11.4	2.4	23.8	Vertical
150	12	10.7	2.5	25.2	Vertical
166	9	9.6	2.6	21.2	Vertical
167	12	9.5	2.6	24.1	Vertical
169.3	8	9.4	2.6	20	Vertical
173.7	11	9.1	2.7	22.8	Vertical
175	11	9	2.7	22.7	Vertical
182	15	8.5	2.5	26	Vertical
189	10	8.5	2.8	21.3	Vertical
195.4	14	8.4	2.9	25.3	Vertical
200	11	8.5	3.1	22.6	Vertical
208	17	8.6	3.1	28.7	Vertical
222	19	9	3.2	31.2	Vertical
228	12	9.3	3.2	24.5	Vertical
233	10	9.7	3.2	22.9	Vertical
234	12	9.8	3.2	25	Vertical
260	8	12.5	3.4	23.9	Horizontal
300	9	12.9	4	25.9	Vertical
312	6	13.1	4.1	23.2	Vertical
320	4	13.5	4.1	21.6	Vertical
325	6	13.8	4.1	23.9	Vertical
358	6	14.3	4.3	24.6	Vertical
400	4	16	4.8	24.8	Vertical
403	3	16.2	4.8	24	Horizontal
404	5	16.2	4.8	26	Vertical
410	1	16.5	4.8	22.3	Vertical
420	8	16.7	4.8	29.5	Vertical
436	2	16.4	5	23.4	Horizontal
521	5	18	5.6	28.6	Vertical
639	1	20.4	6.5	27.9	Horizontal

**8.2.10 Test 2 - Figure 8 - Set-up Photographs (showing cable configuration)**

## 9. CONCLUSIONS

The EUT as supplied by Densitron limited was deemed to have met with requirements of CFR 47 sections 15.107 conducted emissions and 15.109 radiated emissions with the following margins.

1. Conducted emissions using a CISPR detector function and a receiver bandwidth of 10 kHz were found to be measured at 3 dB from the limit line.
2. Radiated emissions using a CISPR detector function and a receiver bandwidth of 120 kHz at 52 MHz were found to be 0.9 dB from the limit.

## 10. ANNEX A - TEST EQUIPMENT LIST

Plant No	Cal Due	Cal Interval	Manufacturer	Description	Serial No
L2/1	31/01/01	12 month	EMC Projects Ltd.	CISPR16 9kHz-30MHz (6A,50 /50 $\mu$ H), MIL STD 461D	001-8
L2/2	31/01/01	12 month	EMC Projects Ltd.	CISPR16 9kHz-30MHz (6A,50 /50 $\mu$ H), MIL STD 461D	002-8
SA8	13/09/01	12 month	Anritsu	Spectrum Analyser MS2601B	MW39953
RX5	08/03/01	12 month	Rhode & Schwarz	Receiver ESH3	879676/11
LHR1	10/09/01	12 month	Chase	Receiver LHR 7000	1028
RX1	09/08/01	12 month	Rhode & Schwarz	Receiver ESH3	860318/008
RX2	17/09/01	12 month	Rhode & Schwarz	Receiver ESVP	894790/005
RX3	16/09/01	12 month	Rhode & Schwarz	Spectrum Monitor EZM	861 192/009
RX4	04/03/01	12 month	Rhode & Schwarz	Spectrum Monitor EZM	894 987/018
UHR1	13/09/01	12 month	Chase	Receiver UHR4000	6000
RX6	28/07/01	12 month	Rhode & Schwarz	Receiver ESVP	880726/012
BA3	17/03/01	24 month	Chase	Bilog Antenna,CBL6111A	1733
BA4	17/03/01	24 month	Chase	Bilog Antenna,CBL 6111A	1667
DB1	26/01/01	12 month	Texscan	Variable Attenuator RA51	7725
OTS2	24/11/01	12 month	EMC Projects Ltd.	Open test site 2	
SR1	23/11/01	12 month	Ray Proof	Screen room 3.7m x 5m x3m	1662
OTS2/1	24/11/01	12 month	EMC Projects Ltd.	Installed Receive Coax Cable on OTS2	
OTS2/2	24/11/01	12 month	EMC Projects Ltd.	Installed Receive Coax Cable on OTS2	
DRG2	09/03/04	60 month	Electro-Metrics	Double Ridged Guide Antenna 3115	5167
OTS2/3	24/11/01	12 month	EMC Projects Ltd.	Installed Coax Cable on OTS2	
OTS2/4	24/11/01	12 month	EMC Projects Ltd.	Installed Coax Cable on OTS2	