# MEASUREMENT AND TECHNICAL REPORT ON THE MARCONI COMMERCE SYSTEMS TIRIS™ MAT READER RADIO FREQUENCY IDENTIFICATION DEVICE

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**6220 Culebra Road**
**San Antonio, Texas 78228-0510**

**Project 10.04567.01.001**
**Report Number EMCR 01/032**

**Prepared for:**

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# 1.0 GENERAL INFORMATION

## 1.1 Product Description

The Marconi Commerce Systems Incorporated TIRIS™ Mat Reader is a Radio Frequency Identification Device (RFID) that allows customers wishing to purchase products to interface directly with a Point-Of-Sale terminal via a handheld battery-less transponder (Texas Instruments Part # RI-TRP-Series). The TIRIS™ Mat Reader (TIRIS: Texas Instruments Registration and Identification System) transmits at 134.2kHz, which provides energy to the transponder. The handheld transponder, or tag, contains a unique and secure ID code so customers can be identified by their individual registered tag. The low frequency antennas of the system create magnetic charge-up fields, known as "read-zones". When a tag enters the read-zone, the reader receives the unique ID code. The transmitter portion of the Marconi TIRIS™ Mat Reader (Part # C00016-XXX) operates at 134.2kHz and is subject to FCC Part 15, Subpart C, "Intentional Radiator"; paragraphs 15.207 and 15.209. The digital electronics portion of the Marconi TIRIS™ Mat Reader is subject to FCC Part 15, Subpart B, "Unintentional Radiator", paragraph 15.109, under the Class A limits and as such, the TRIND™TIRIS™ Mat Reader is incorporated into an application that is subject to Class A limits. Attachment 1 contains a detailed technical description and functionality of the TIRIS™ Mat Reader and its components. Photos of the TIRIS™ Mat Reader are provided in Appendix D.

## 1.2 Related Grants

A handheld battery-less transponder (Texas Instruments RI-TRP-Series key ring tag) was used to demonstrate operation of the TIRIS™ Mat Reader during testing. The microreader module (Texas Instruments part No. RI-STU-MRD1) which provides the 134.2 kHz fundamental emission is a component of the TIRIS™ Mat Reader and has previously received certification under FCC ID: A92MICRO.

## 1.3 Tested System Details

The Marconi TIRIS™ Mat Reader System is mounted into an application such as a Point-of-Sale (POS) terminal or other similar industrial application. The system includes one Indoor Gateway/MicroReader Board (M01803), one mat reader assembly (M01787B001), and one LCD shutter. The mat reader assembly includes one 134.2 kHz low 'Q' printed circuit board antenna (T20645). The system also includes a 120 VAC to +12VDC LPS wall mounted transformer for input power. The components of the Marconi TIRIS™ Mat Reader System are listed in Table 1.1.

The Marconi TIRIS™ Mat Reader 134.2 kHz transmit signal originates on the MicroReader located on the Indoor MicroReader Board and is fed through a cable to the printed circuit board antenna where it is intentionally radiated. The Mat Reader operates from 120VAC converted to +12VDC using a Class II step-down transformer. The +12VDC is then converted to +26VDC and +5VDC by means of switching power supply circuits located on the Indoor Gateway/MicroReader Board. The system functional block diagram is located in Attachment 1.

**TABLE 1.1**
**TIRIS™ MAT READER COMPONENTS**

| Component Description | Marconi Part Number | Texas Instruments Part Number |
|---|---|---|
| Indoor MicroReader Board Assembly (1) | M01803 | N/A |
| MicroReader (1) | Q13551-01 | RI-STU-MRD1 |
| Antenna | T20645 | N/A |
| +12Vdc Wall Mounted Power Supply | M01878B001 | N/A |

## 1.4 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.4-1992, and the limits prescribed in CFR 47, FCC 15.207, 15.109, and 15.209. Radiated testing was performed at an antenna-to-EUT distance of 3, 10, 20, and 30 meters. The TIRIS™ Mat Reader was signature scanned for radiated emissions in a semi-anechoic chamber. The OATS testing was performed with the TIRIS™ Mat Reader antenna in a horizontal position for tests above 30 MHz, and a vertical position for tests below 30 MHz.

## 1.5 Test Facility

The Open Area Test Site (OATS) and the Radiated/Conducted Measurement Facility used to collect data are located at Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas. Details concerning the test site and measurement facility are found in a letter from SwRI to the FCC dated 23 May 2000, which is on file with the FCC Laboratory Division in Columbia, Maryland. On June 2, 2000, the FCC approved the sites for the purpose of providing test results for submission with equipment authorization applications under the Commission's Equipment Authorization Program.

# 2.0 PRODUCT LABELING

## 2.1 FCC ID Label

The FCC ID label is shown in the drawing in Attachment 3.

## 2.2 Location of Label on EUT

The location of the label is shown in the drawing in Attachment 3.

## 2.3 Supplemental Information to be in the Reader Manual

In addition to reiteration of required information as on intentional radiator, in keeping with sections 15.21 and 15.105 of the FCC rules, the manual supplied with the TIRIS™ Mat Reader will also include the following admonitions:

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference; in which case, the user will be required to correct the interference at his own expense.

NO MODIFICATIONS: Modifications to this device shall not be made without the written consent of Marconi Commerce Systems. Unauthorized modifications may void the authority granted under Federal Communications Commission Rules permitting the operation of this device.

# 3.0 SYSTEM TEST CONFIGURATION

## 3.1 Justification

Radiated tests were performed on the TIRIS™ Mat Reader intentional radiator from 110 kHz to 30 MHz for the highest fundamental and harmonics. Three polarizations of the receive loop antenna were used. Radiated tests were performed up to 1 GHz for spurious emissions related to the digital electronics portion of the unit. Both vertical and horizontal polarizations of the receive dipoles were tested. Radiated signature scans were made at 3 meters in a shielded anechoic chamber.

Conducted tests were performed on the AC power of the TIRIS™ Mat Reader from 450 kHz to 30 MHz.

## 3.2 EUT Exercise

The TIRIS™ Mat Reader is powered by 120VAC. A handheld battery-less transponder (Texas Instruments RI-TRP-Series key ring tag) was used to demonstrate operation of the TIRIS™ Mat Reader during testing. For radiated tests of the digital electronics, the 134 kHz microreader transmitter was disabled by inserting a tag into the read field of the antenna.

## 3.3 Special Accessories

To meet the FCC radiated limit for spurious emissions, the following modifications were made to the Mat Reader.

1. A ferrite bead (Fair-Rite p/n 0444164181) was added to the dc power input of the Indoor MicroReader Board Assembly M01803A.
2. A ferrite bead (Steward p/n 28S2023-000) was added to the ribbon cable connected to the Indoor MicroReader Board Assembly M01803A.
3. A .001uF ceramic capacitor was added across Antenna+ and Antenna- on the Indoor MicroReader Circuit Board.
4. A .001uF ceramic capacitor was added to bypass the dc input to the Indoor MicroReader Circuit Board.
5. A jumper was added on the Indoor MicroReader Circuit Board that connected Antenna- to PCB ground.
6. The Indoor MicroReader Circuit Board ground plane was improved by installing two jumpers.

## 3.4 Equipment Modification

The need for the special accessories described in paragraph 3.3 was determined during radiated emission testing.

## 3.5 Configuration of Tested System

Refer to Section 4.0 for a block diagram of the tested configuration.

## 4.0 BLOCK DIAGRAM OF THE TIRIS™ MAT READER SYSTEM

A block diagram of the TIRIS™ Mat Reader system is provided in Attachment 1.

## 5.0 CONDUCTED AND RADIATED MEASUREMENT PHOTOS

Refer to Appendix E for photographs of the conducted and radiated test setups.

# 6.0 CONDUCTED EMISSION DATA

## 6.1 Conducted Measurement Data

The TIRIS™ Mat Reader system was tested for conducted emissions. The initial step in collecting conducted data was to perform a spectrum analyzer peak scan of the measurement range to determine worst case. A computer-controlled spectrum analyzer was used to produce a peak measurement data plot. Quasi-peak measurements were made on signals that were close to or above the paragraph 15.207 limit. The worst case emission levels are provided in Table 6.1. Appendix A contains conducted emission measurement plots.

**TABLE 6.1**
**WORST CASE CONDUCTED EMISSION LEVELS**

| Judgment: EUT Passed By 1.5 dB | | | |
|---|---|---|---|
| **FREQUENCY** | **MEASURED LEVEL (dBuV)** | | **LIMIT (dBuV)** |
| | **LINE** | **NEUTRAL** | |
| 455 kHz | | 46.5[1] | 48 |
| 11.15 MHz | | 45[1] | 48 |
| 700 kHz | | 43[1] | 48 |
| 455 kHz | 46.5[1] | | 48 |
| 11.15 MHz | 45[1] | | 48 |
| 700 kHz | 43.5[1] | | 48 |

[1] Readings are quasi-peak measurements made with a receiver.

## 6.2 Conducted Test Instrumentation

The test instrumentation used to make conducted measurements is given in Appendix C.

## 7.0 RADIATED EMISSION DATA

The TIRIS™ Mat Reader system was tested for radiated emissions. The data below are the corrected highest level EME measurements taken from the radiated data sheets provided in Appendix B. The data sheets include the emission frequencies and the corrected level. An explanation of the field strength calculation is given in paragraph 7.3.

### 7.1 Radiated Measurement Data

Measurements were made of the fundamental frequency of 134.2 kHz at 20 meters (the fundamental could not be detected at 30 meters). Additionally, the spectrum was investigated for harmonics and spurious emissions to 30 MHz at either 20 or 30 meters. No harmonics of the fundamental emission were detected. All spurious emissions were at least 20 dB below the limit. The receive loop antenna was placed in three polarizations for the testing below 30 MHz. Scans were performed starting at 110 kHz to verify that neither the fundamental emission, nor any harmonic emission was in the 90-110 kHz restricted band. The measurement level of the fundamental is shown in Table 7.1.

**TABLE 7.1**
**MEASUREMENT OF FUNDAMENTAL FREQUENCY**

| Judgment: EUT Passed by 28.3 dB | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency** | **Receive Antenna Polarization** | **Corrected Level dB(uV/m)** | | **Limit @ 20 Meters[1] dB(uV/m)** | | **dB Under Limit** | |
| | | **Peak** | **Average** | **Peak** | **Average** | **Peak** | **Average** |
| 134.2kHz | Parallel to EUT | 52.6 | 43.7 | 92 | 72 | 39.4 | 28.3 |
| 134.2 kHz | Perpendicular to EUT | 44 | 34.1 | 92 | 72 | 48 | 37.9 |
| 134.2 kHz | Parallel to Ground | 43 | 34.1 | 92 | 72 | 49 | 37.9 |

[1] Measurements were made at a distance of 20 meters. The fundamental could not be detected at a 30 meter distance. A 40dB per decade roll-off was used to adjust the limit for the 20 meter distance.

The spectrum from 30 MHz to 1000 MHz was investigated for spurious emissions. The worst case spurious emission levels, taken from the data sheets in Appendix B, are given in Table 7.2. Plots of the peak signature scans are provided in Appendix B.

**TABLE 7.2**
**MEASUREMENT OF SPURIOUS EMISSIONS**

| Judgment EUT passed by 5.7 dB | | | |
|---|---|---|---|
| **Frequency** | **Corrected Level [1] dB(uV/m)** | **Limit[2] dB(uV/m)** | **dB under limit** |
| 182.153 MHz (vertical) | 37.8 | 43.5 | 5.7 |
| 167.157 MHz (vertical) | 36.5 | 43.5 | 7.0 |
| 181.661 MHz (vertical) | 35.1 | 43.5 | 8.4 |
| 176.252 MHz (vertical) | 34.3 | 43.5 | 9.2 |
| 157.325 MHz (vertical) | 33.5 | 43.5 | 10.0 |

[1] All readings are quasi-peak manual measurements made with a receiver.
[2] These emissions are related to the digital electronics and are compared to the 15.109 Class A limit.

The frequency stability of the TIRIS™ Mat Reader fundamental emission was verified by varying the AC input voltage between 85% and 115% of the nominal 120 VAC. The frequency of the fundamental emission changed by a maximum of 5 Hz.

## 7.2 Test Instrumentation for Radiated Measurements

Scans were made at an open area test site (OATS) and in an RF semi-anechoic chamber 28' long x 16' wide x 16' high with its interior lined on the ceiling and four walls with pyramidal absorber material up to four feet in length. Measurements were made with a spectrum analyzer and a quasi-peak adapter in the anechoic chamber and with a receiver at the OATS. The list of test instrumentation used to perform the testing is shown in Appendix C.

## 7.3 Field Strength Calculation

The field strength was calculated by adding the antenna factor and cable factor, and subtracting the amplifier gain (when used) from the measured reading. The basic equation with a sample calculation is provided below:

FS = RA + AF + CF - AG

Where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation
AG = Amplifier Gain

For example, reducing the first row of the enclosed radiated data sheet on page 24 (34.412 MHz):

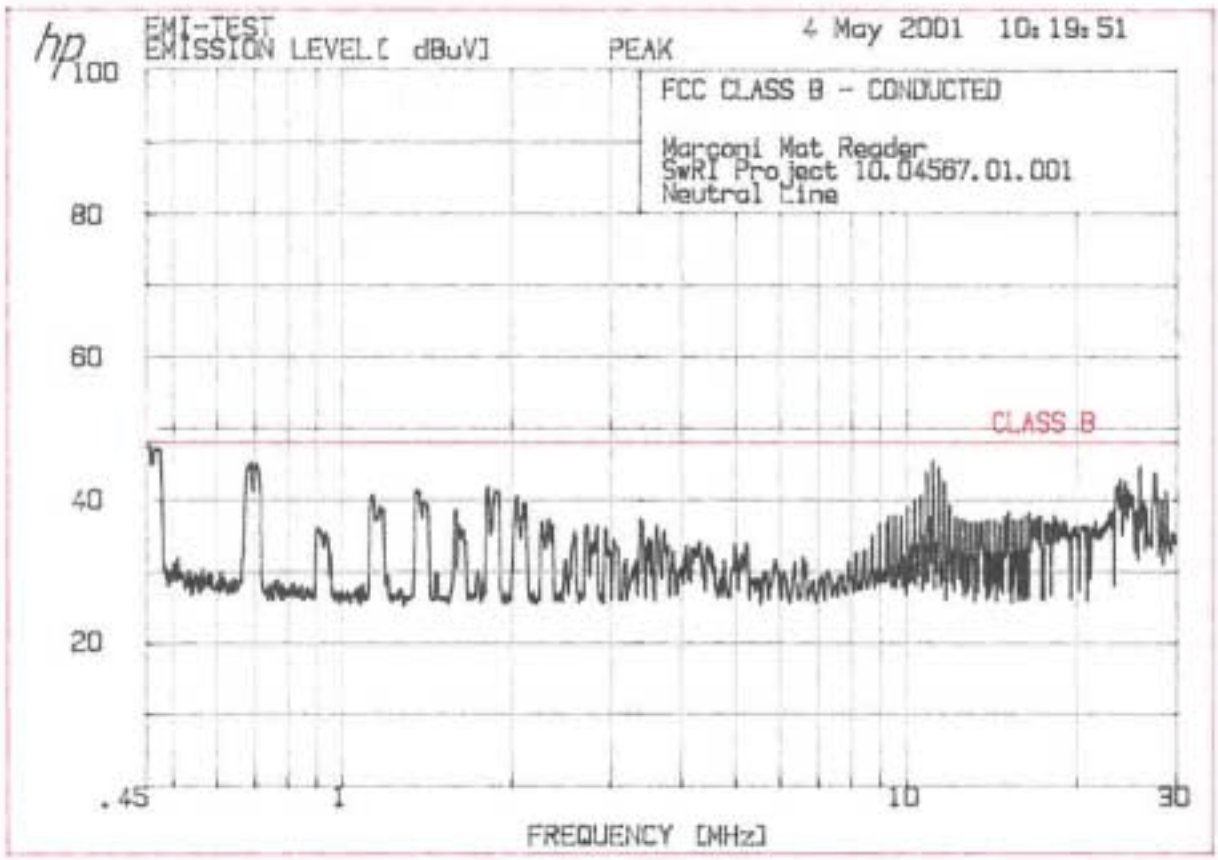
2.0 dB(uV)
20.1 dB(1/m)
2.3 dB (CF/AG FACTOR)
FS = 24.4 dB(uV/m)

To convert the dB(uV/m) value to its corresponding level in uV/m is as follows:

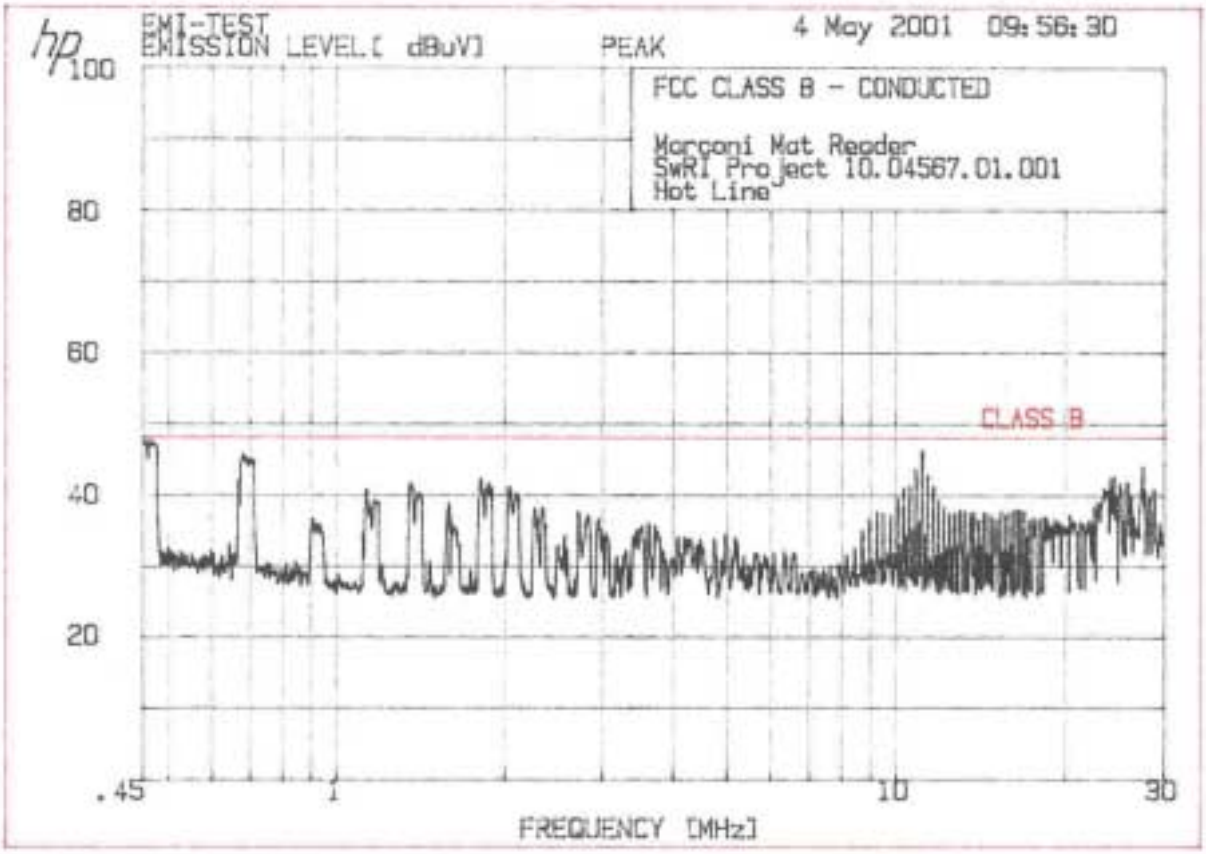
Level in uV/m Common Antilogarithm [(24.4 dBuV/m)/20] = 16.59 uV/m

# APPENDIX A

# CONDUCTED MEASUREMENT PLOTS


EMI-TEST
EMISSION LEVEL[ dBuV]
PEAK
4 May 2001 10:19:51
FCC CLASS B - CONDUCTED
Marconi Mat Reader
SwRI Project 10.04567.01.001
Neutral Line
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

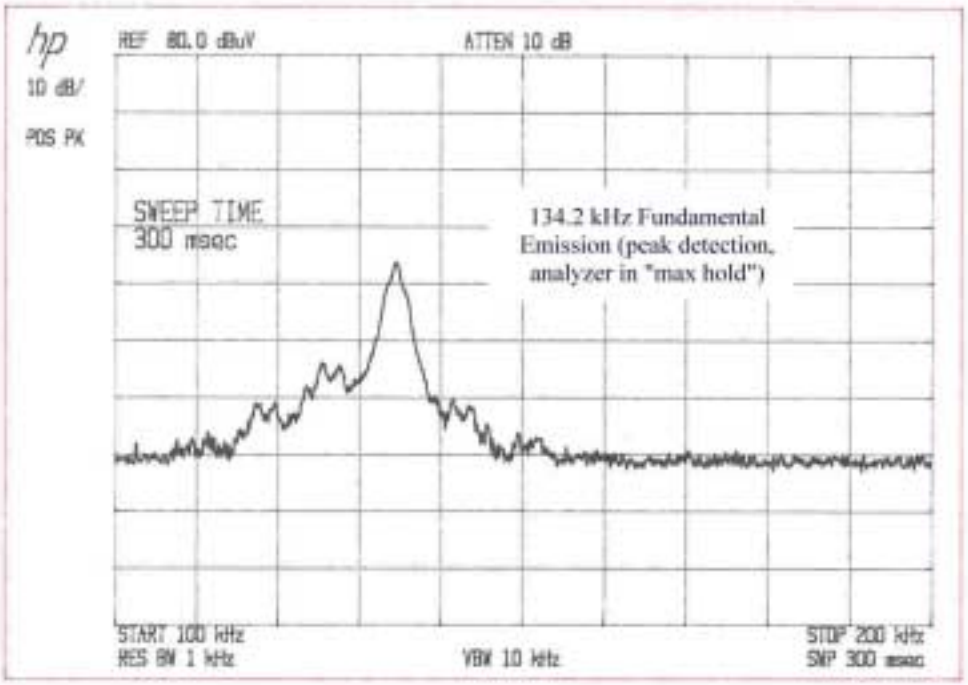

EMI-TEST
EMISSION LEVEL[ dBuV]
QUASI-PEAK
4 May 2001 10:19:51
FCC CLASS B - CONDUCTED
Marconi Mat Reader
SwRI Project 10.04567.01.001
Neutral Line
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

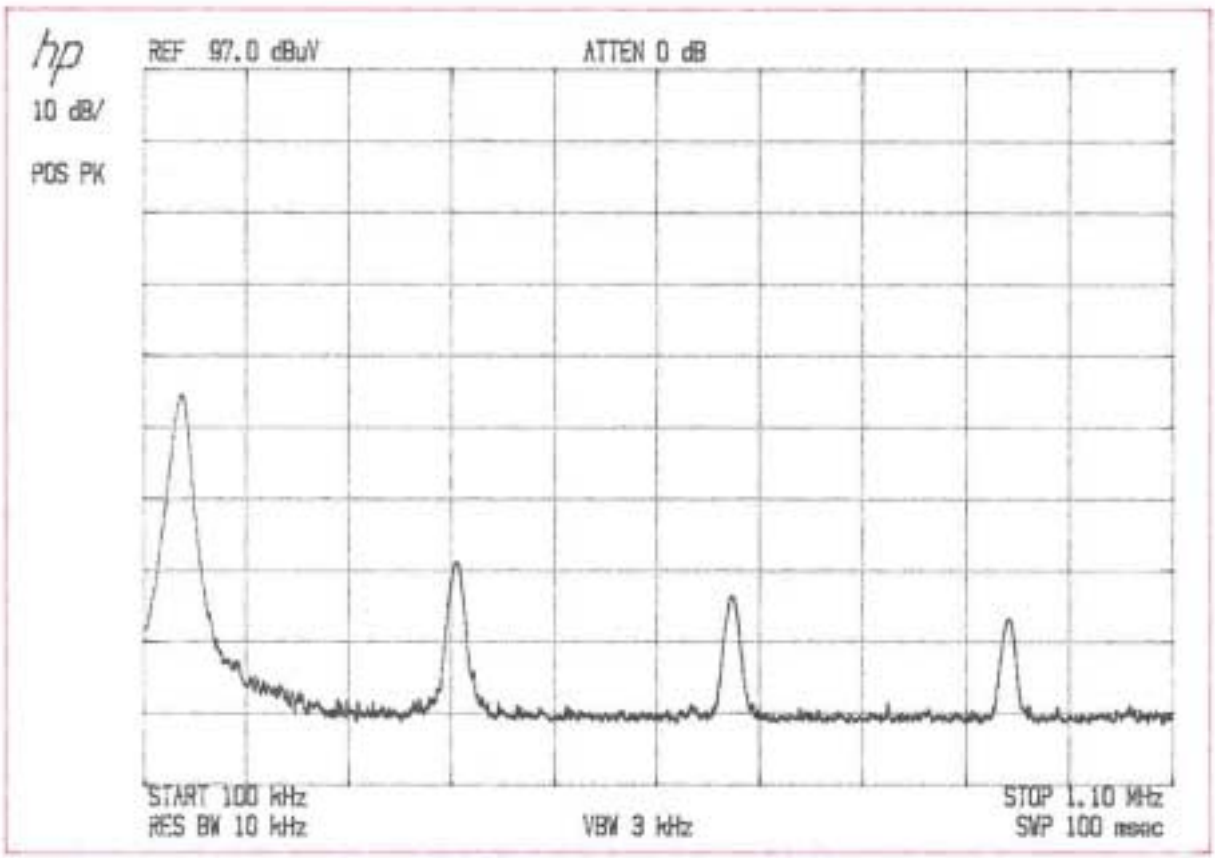

EMI-TEST
EMISSION LEVEL[ dBuV]
PEAK
4 May 2001 09:56:30
FCC CLASS B - CONDUCTED
Marconi Mat Reader
SwRI Project 10.04567.01.001
Hot Line
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

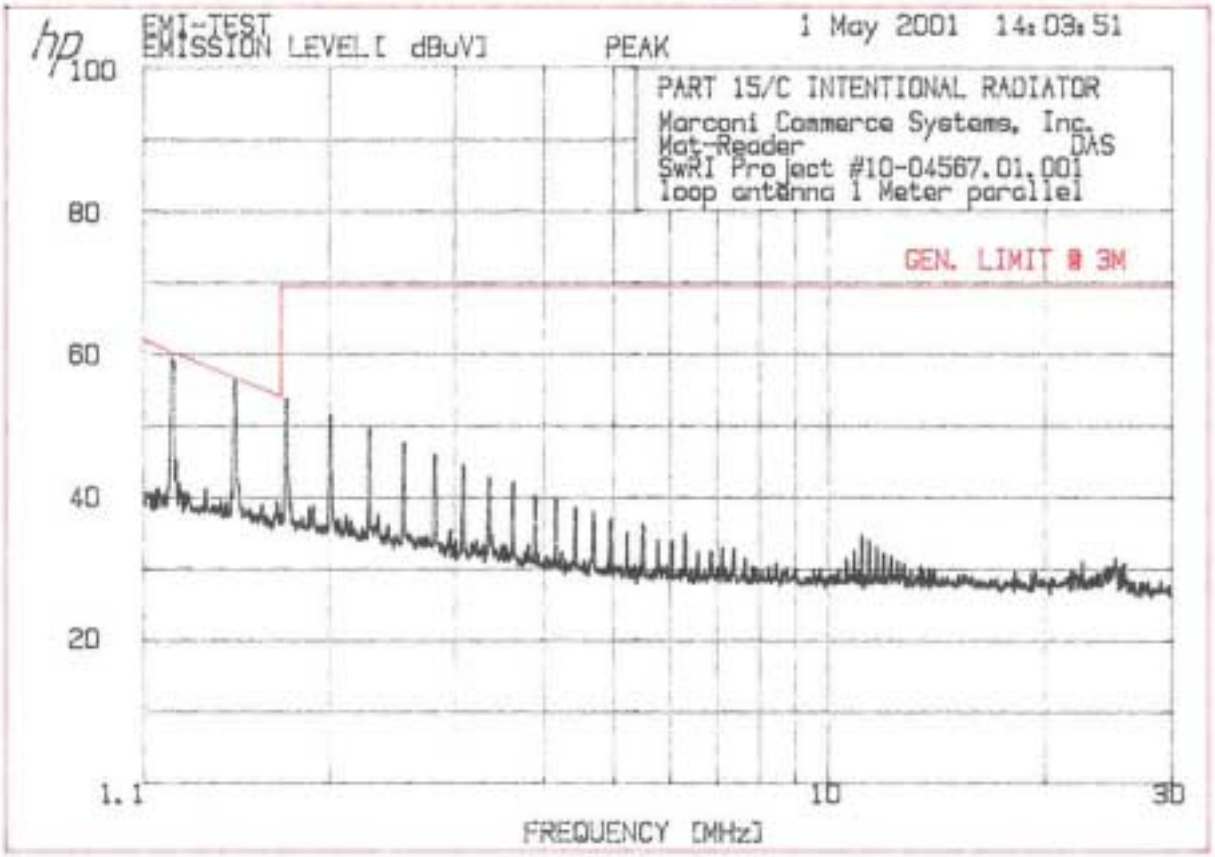

EMI-TEST
EMISSION LEVEL[ dBuV]
QUASI-PEAK
4 May 2001 09:56:30
FCC CLASS B - CONDUCTED
Marconi Mat Reader
SwRI Project 10.04567.01.001
Hot Line
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

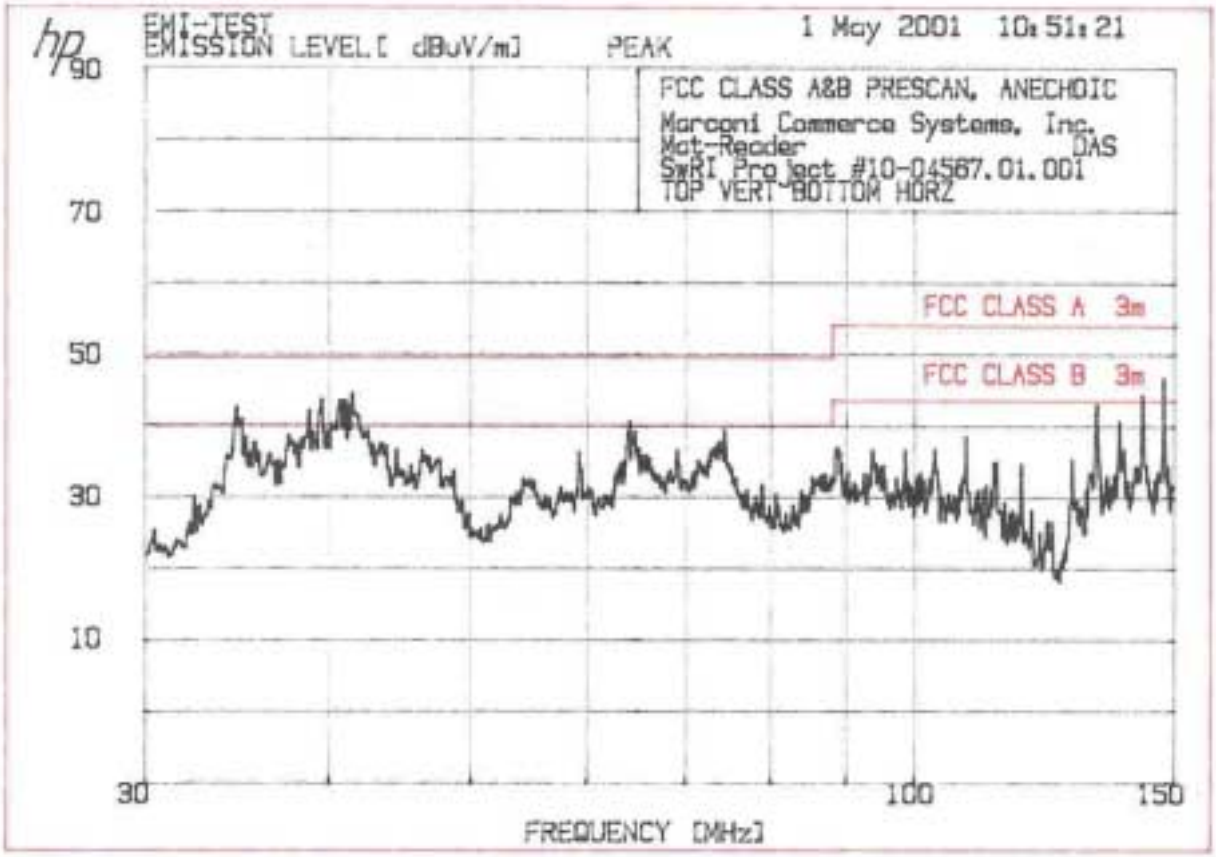
**APPENDIX B**

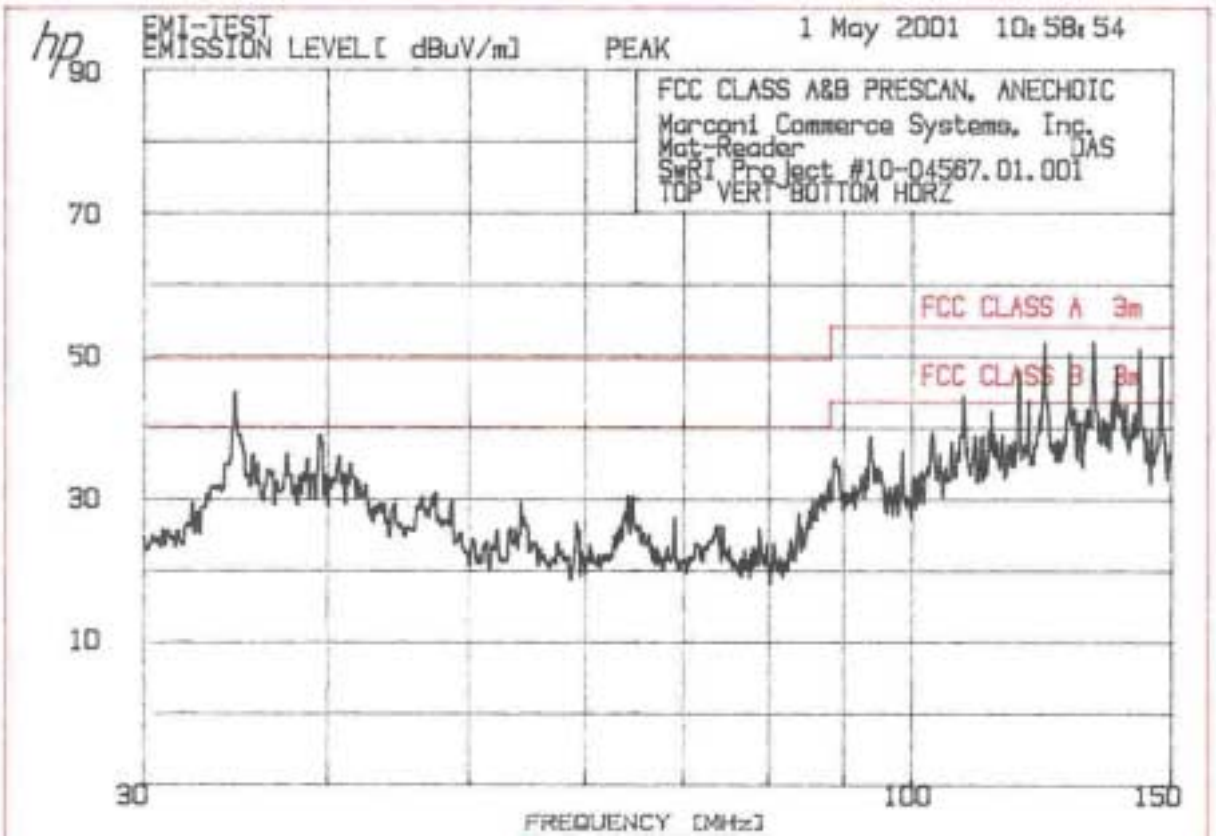
**RADIATED SIGNATURE SCAN PLOTS AND OATS DATA SHEETS**

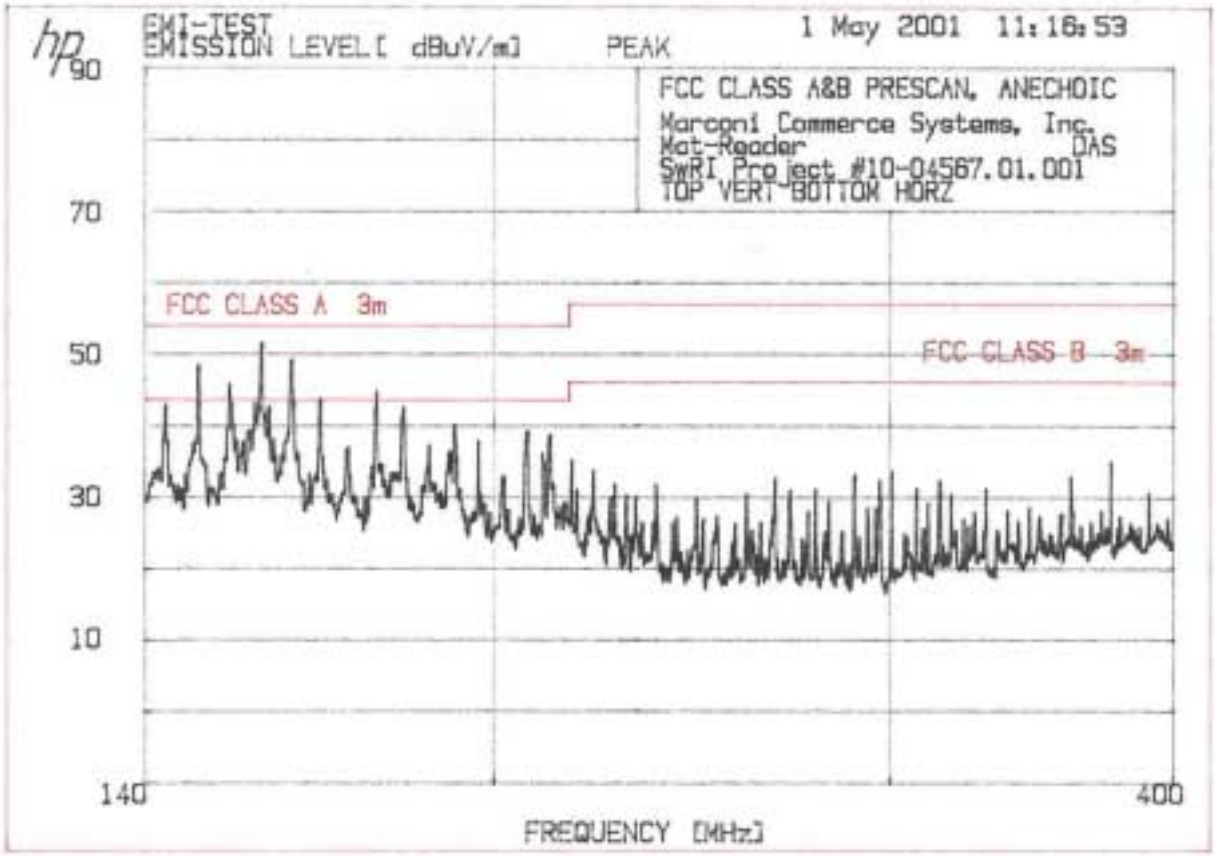

hp
REF 80.0 dBuV
ATTEN 10 dB
10 dB/
POS PK
SWEEP TIME
300 msec
134.2 kHz Fundamental
Emission (peak detection,
analyzer in "max hold")
START 100 kHz
RES BW 1 kHz
VBW 10 kHz
STOP 200 kHz
SWP 300 msec

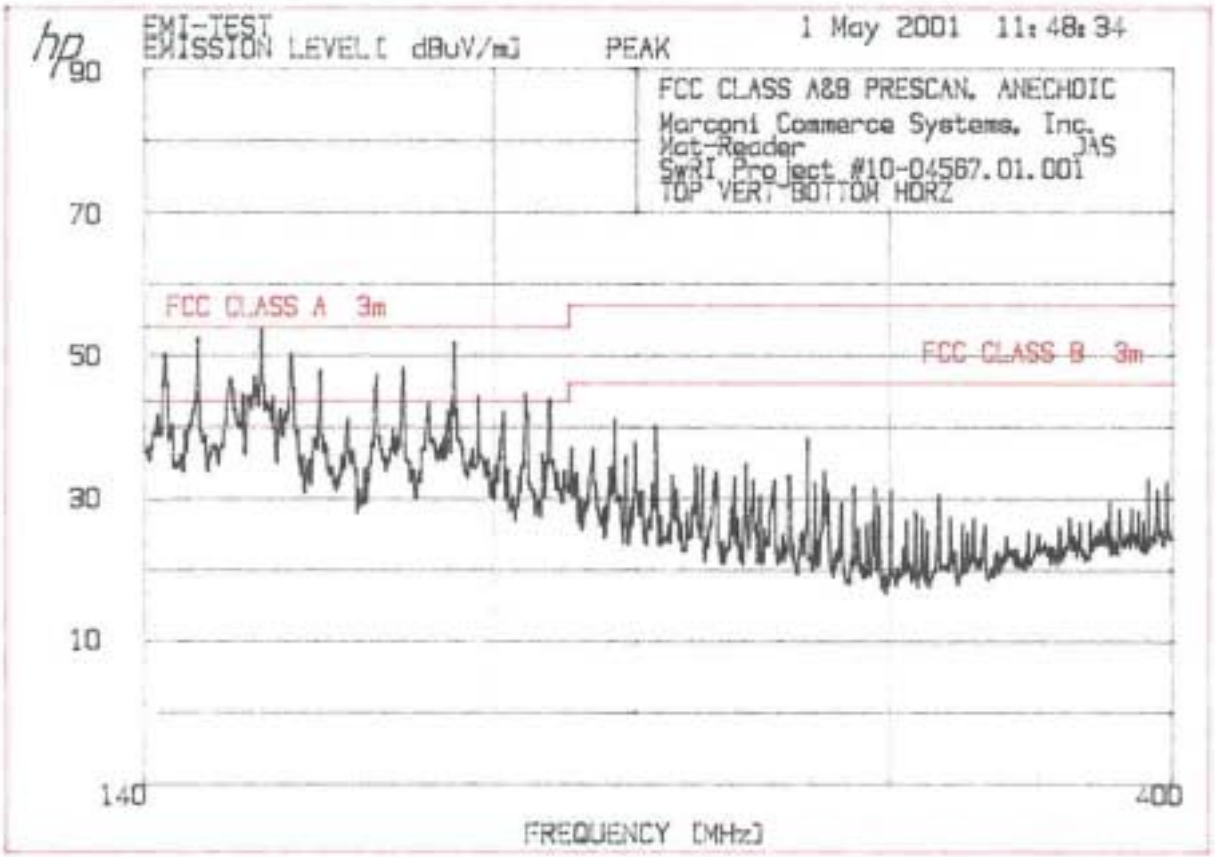

hp
REF 97.0 dBuV
ATTEN 0 dB
10 dB/
POS PK
START 100 kHz
RES BW 10 kHz
VBW 3 kHz
STOP 1.10 MHz
SWP 100 msec

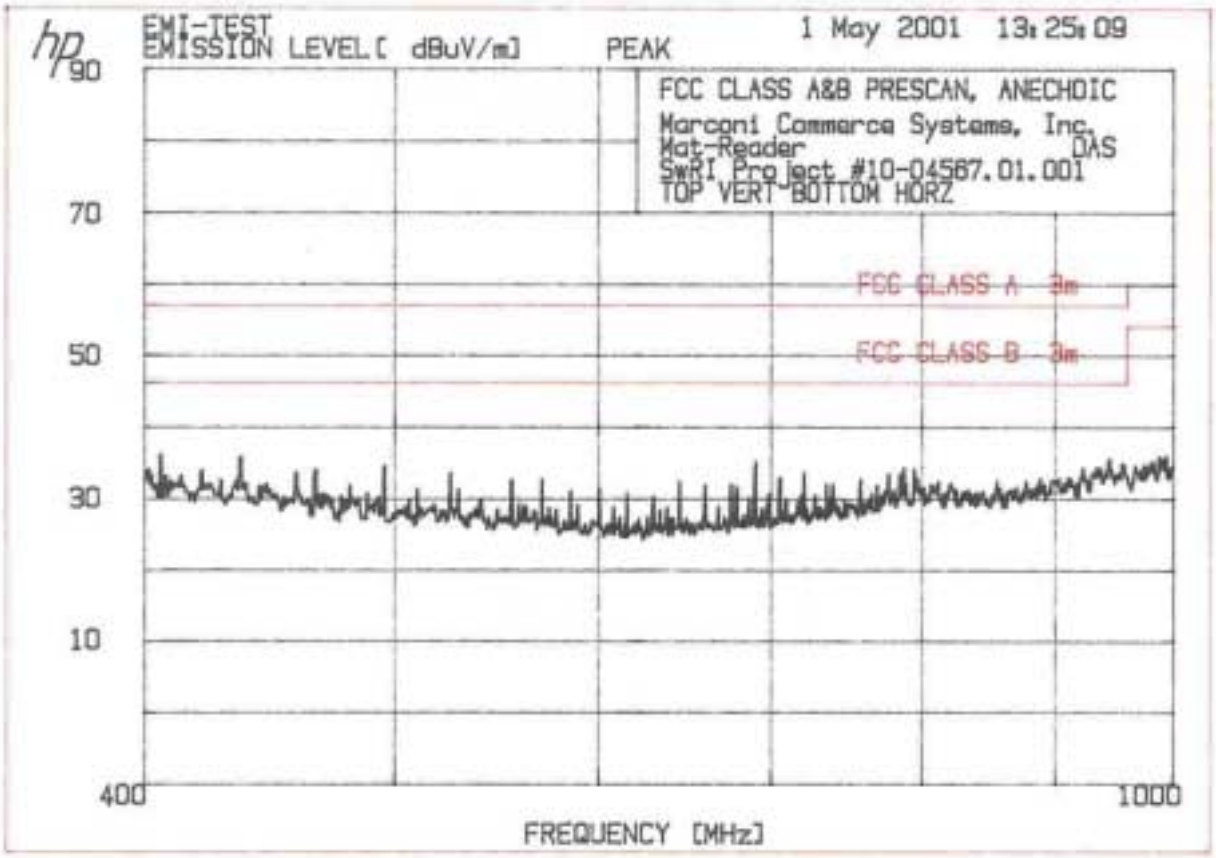

hp 100
EMI-TEST
EMISSION LEVEL[ dBuV]
PEAK
1 May 2001 14:03:51
PART 15/C INTENTIONAL RADIATOR
Marconi Commerce Systems, Inc.
Mat-Reader DAS
SwRI Project #10-04567.01.001
loop antenna 1 Meter parallel
GEN. LIMIT @ 3M
80
60
40
20
1.1
10
30
FREQUENCY [MHz]

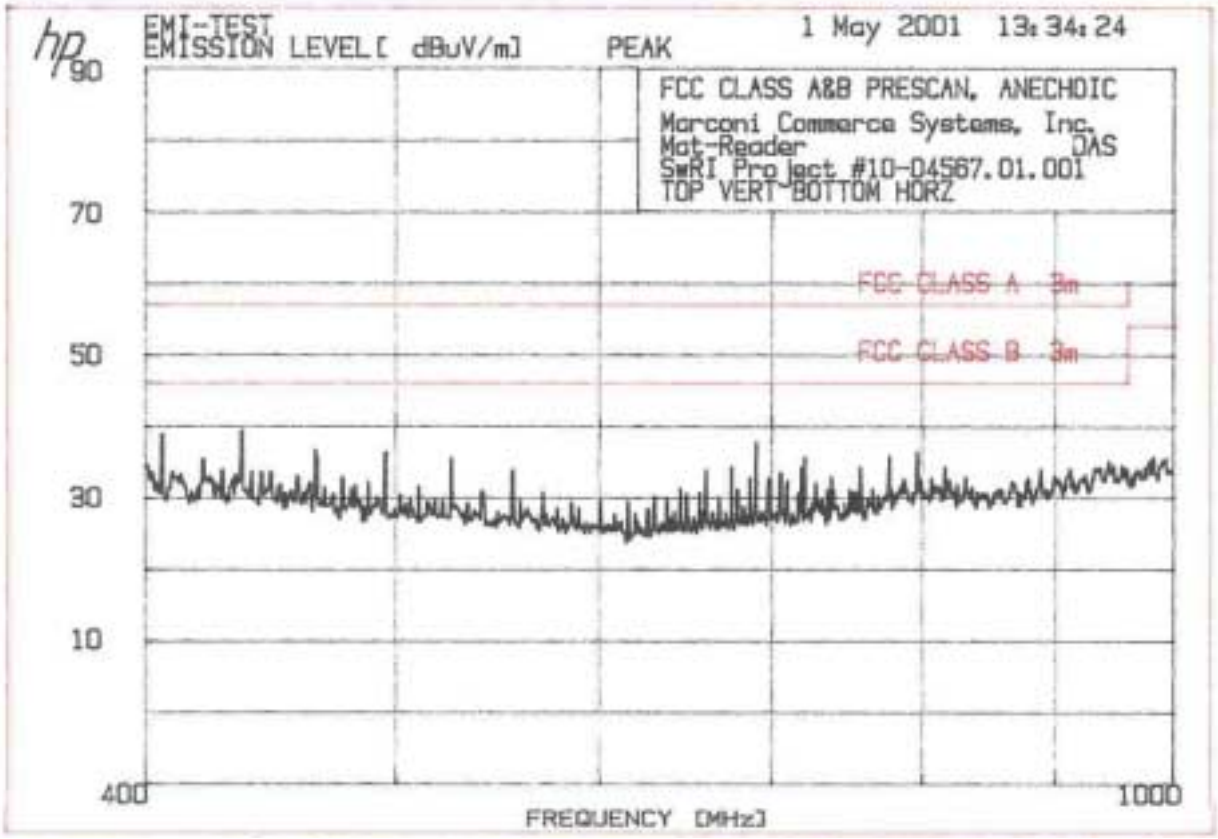

EMI-TEST
EMISSION LEVEL[ dBuV/m]
PEAK
1 May 2001 10:51:21
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi Commerce Systems, Inc.
Mat-Reader DAS
SwRI Project #10-04567.01.001
TOP VERT BOTTOM HORZ
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
30
100
150
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL[ dBuV/m]
PEAK
1 May 2001 10:58:54
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi Commerce Systems, Inc.
Mat-Reader DAS
SwRI Project #10-04567.01.001
TOP VERT BOTTOM HORZ
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
30
100
150
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL[ dBuV/m] PEAK
1 May 2001 11:16:53
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi Commerce Systems, Inc.
Mat-Reader DAS
SwRI Project #10-04567.01.001
TOP VERT-BOTTOM HORZ
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL[ dBuV/m] PEAK
1 May 2001 11:48:34
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi Commerce Systems, Inc.
Mat-Reader DAS
SwRI Project #10-04567.01.001
TOP VERT-BOTTOM HORZ
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL[ dBuV/m]
PEAK
1 May 2001 13:25:09
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi Commerce Systems, Inc.
Mat-Reader DAS
SwRI Project #10-04567.01.001
TOP VERT BOTTOM HORZ
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
400
1000
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL[ dBuV/m]
PEAK
1 May 2001 13:34:24
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi Commerce Systems, Inc.
Mat-Reader DAS
SwRI Project #10-04567.01.001
TOP VERT BOTTOM HORZ
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
400
1000
FREQUENCY [MHz]

**SwRI Open Area Test Site Radiated Emissions v2_2** **Project Number:** 10.04567.01.001

**Device Under Test:** Mat Reader **Detection Method:** peak/average/Q-peak **EUT Mode:** Transmit

**Date / Time:** 5/2/01 11:00 **Test Receiver:** Rohde&Schwarz ESS EMI sn: DE31157

**Test Standard**(primary limit): FCC, Part 15 (30 m, 15.209 intentional radiator) **Antenna:** EMCO 6512 Loop

**Test Standard**(optional limit):

**Test Sponsor:** Marconi

**Test Technician:** David Smith

**Temp.(°F)/Humidity(%):** 87.3 F 50.8 %

| FREQ | Orient. | Antenna | | | | UnCorr'd Level | Correction Factors (dB) | | Corr'd Level | Primary Limit | Optional Limit | Margin (Primary) | Comments (** denotes a measurement above the primary limit) Note: Cable factor includes preamplifier gain at frequencies above 200 MHz. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | θ° | I.D. | Pol. | Ht(m) | Dis(m) | (dBuV) | Ant | Cable | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dB) | |
| 0.134 | 0 | | par | 1.00 | 20 | -13.5 | 65.7 | 0.4 | 52.6 | 92.0 | | -39.4 | peak |
| 0.134 | 0 | | par | 1.00 | 20 | -22.4 | 65.7 | 0.4 | 43.7 | 72.0 | | -28.3 | average |
| 0.110 | 0 | | par | 1.00 | 20 | -30.2 | 65.9 | 0.4 | 36.1 | 73.8 | | -37.7 | average ambient |
| 0.110 | 0 | | par | 1.00 | 20 | -20.0 | 65.9 | 0.4 | 46.3 | 93.8 | | -47.5 | peak ambient |
| 0.134 | 0 | | per | 1.00 | 20 | -22.1 | 65.7 | 0.4 | 44.0 | 92.0 | | -48.0 | peak |
| 0.134 | 0 | | per | 1.00 | 20 | -32.0 | 65.7 | 0.4 | 34.1 | 72.0 | | -37.9 | average |
| 0.110 | 0 | | per | 1.00 | 20 | -32.7 | 65.9 | 0.4 | 33.6 | 73.8 | | -40.2 | average ambient |
| 0.110 | 0 | | per | 1.00 | 20 | -19.6 | 65.9 | 0.4 | 46.7 | 93.8 | | -47.1 | peak ambient |
| 0.134 | 0 | | pg | 1.00 | 20 | -23.1 | 65.7 | 0.4 | 43.0 | 92.0 | | -49.0 | peak |
| 0.134 | 0 | | pg | 1.00 | 20 | -32.0 | 65.7 | 0.4 | 34.1 | 72.0 | | -37.9 | average |
| 0.110 | 0 | | pg | 1.00 | 20 | -24.2 | 65.9 | 0.4 | 42.1 | 93.8 | | -51.7 | peak ambient |
| 0.110 | 0 | | pg | 1.00 | 20 | -34.8 | 65.9 | 0.4 | 31.5 | 73.8 | | -42.3 | average ambient |
| 0.403 | 0 | | par | 1.00 | 30 | -29.0 | 54.0 | 0.4 | 25.4 | 75.0 | | -49.6 | peak ambient |
| 0.403 | 0 | | par | 1.00 | 30 | -36.2 | 54.0 | 0.4 | 18.2 | 55.0 | | -36.8 | average ambient |
| 0.455 | 0 | | par | 1.00 | 30 | -35.0 | 54.0 | 0.4 | 19.4 | 54.4 | | -35.0 | average |
| 0.455 | 0 | | par | 1.00 | 30 | -18.6 | 54.0 | 0.4 | 35.8 | 74.4 | | -38.6 | peak |
| 3.000 | 0 | | par | 1.00 | 30 | -18.7 | 39.2 | 0.4 | 20.9 | 29.5 | | -8.6 | qp ambient |
| 30.000 | 0 | | par | 1.00 | 30 | -18.0 | 33.8 | 0.4 | 16.2 | 29.5 | | -13.3 | qp ambient |
| 30.000 | 0 | | per | 1.00 | 30 | -17.9 | 33.8 | 0.4 | 16.3 | 29.5 | | -13.2 | qp ambient |
| 3.000 | 0 | | per | 1.00 | 30 | -18.0 | 33.8 | 0.4 | 16.2 | 29.5 | | -13.3 | qp ambient |
| 0.455 | 0 | | per | 1.00 | 30 | -20.4 | 54.0 | 0.4 | 34.0 | 74.4 | | -40.4 | peak |
| 0.455 | 0 | | per | 1.00 | 30 | -35.7 | 54.0 | 0.4 | 18.7 | 54.4 | | -35.7 | average |
| 0.403 | 0 | | per | 1.00 | 30 | -40.7 | 54.0 | 0.4 | 13.7 | 55.0 | | -41.3 | average ambient |
| 0.403 | 0 | | per | 1.00 | 30 | -30.1 | 54.0 | 0.4 | 24.3 | 75.0 | | -50.7 | peak ambient |
| 0.403 | 0 | | pg | 1.00 | 30 | -30.5 | 54.0 | 0.4 | 23.9 | 75.0 | | -51.1 | peak ambient |
| 0.403 | 0 | | pg | 1.00 | 30 | -39.3 | 54.0 | 0.4 | 15.1 | 55.0 | | -39.9 | average ambient |
| 0.455 | 0 | | pg | 1.00 | 30 | -35.5 | 54.0 | 0.4 | 18.9 | 54.4 | | -35.5 | average |

**SwRI Open Area Test Site Radiated Emissions v2_2** **Project Number:** 10.04567.01.001

**Device Under Test:** Mat Reader **Detection Method:** peak/average/Q-peak **EUT Mode:** Transmit

**Date / Time:** 5/2/01 11:00 **Test Receiver:** Rohde&Schwarz ESS EMI sn: DE31157

**Test Standard**(primary limit): FCC, Part 15 (30 m, 15.209 intentional radiator) **Antenna:** EMCO 6512 Loop

**Test Standard**(optional limit):

**Test Sponsor:** Marconi

**Test Technician:** David Smith

**Temp.(°F)/Humidity(%):** 87.3 F 50.8 %

| FREQ | Orient. | Antenna | | | | UnCorr'd Level | Correction Factors (dB) | | Corr'd Level | Primary Limit | Optional Limit | Margin (Primary) | Comments (** denotes a measurement above the primary limit) Note: Cable factor includes preamplifier gain at frequencies above 200 MHz. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | θ° | I.D. | Pol. | Ht(m) | Dis(m) | (dBuV) | Ant | Cable | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dB) | |
| 0.455 | 0 | | pg | 1.00 | 30 | -21.1 | 54.0 | 0.4 | 33.3 | 74.4 | | -41.1 | peak |
| 3.000 | 0 | | pg | 1.00 | 30 | -20.3 | 33.8 | 0.4 | 13.9 | 29.5 | | -15.6 | qp ambient |
| 30.000 | 0 | | pg | 1.00 | 30 | -18.2 | 33.8 | 0.4 | 16.0 | 29.5 | | -13.5 | qp ambient |

| | | | |
|---|---|---|---|
| **SwRI Open Area Test Site Radiated Emissions v2_2** | | **Project Number:** | 10.04567.01.001 |
| **Device Under Test:** | Mat Reader Prototype | **Detection Method:** | QP **EUT Mode:** Powered |
| **Date / Time:** | 30 May 01/ 09:00 | **Test Receiver:** | Rohde&Schwarz ESS EMI sn: DE31157 |
| **Test Standard**(primary limit): | FCC Class A, Part 15 (10 m radiated) | **Antenna:** | 3: BDA25S sn:535 (primary) |
| **Test Standard**(optional limit): | CISPR 11 or 22A (10 m radiated) | | 4: T2 sn:L176 |
| **Test Sponsor:** | Marconi | | 6: T3 sn:L176 |
| **Test Technician:** | Charles Hale | | |
| **Temp.(°F)/Humidity(%):** | 75/65 | | Mat is flat |

| FREQ | Orient. | Antenna | | | | UnCorr'd Level | Correction Factors (dB) | | Corr'd Level | Primary Limit | Optional Limit | Margin (Primary) | Comments (** denotes a measurement above the primary limit) Note: Cable factor includes preamplifier gain at frequencies above 200 MHz. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | θ° | I.D. | Pol. | Ht(m) | Dis(m) | (dBuV) | Ant | Cable | (dBuV/m) | (dBuV/m) | (dBuV/m) | (dB) | |
| 34.412 | 180 | 3 | V | 1.41 | 10 | 2.0 | 20.1 | 2.3 | 24.4 | 39.0 | 40.0 | -14.6 | |
| 34.661 | 44 | 3 | V | 1.40 | 10 | 2.3 | 20.0 | 2.3 | 24.7 | 39.0 | 40.0 | -14.3 | |
| 38.592 | 46 | 3 | V | 1.40 | 10 | 3.5 | 17.8 | 2.5 | 23.8 | 39.0 | 40.0 | -15.2 | |
| 39.331 | 5 | 3 | V | 1.41 | 10 | 2.8 | 17.2 | 2.5 | 22.5 | 39.0 | 40.0 | -16.5 | |
| 58.995 | 48 | 3 | V | 1.41 | 10 | 11.6 | 7.6 | 3.3 | 22.4 | 39.0 | 40.0 | -16.6 | |
| 64.402 | 75 | 3 | V | 2.30 | 10 | 12.2 | 7.1 | 3.4 | 22.6 | 39.0 | 40.0 | -16.4 | |
| 68.829 | 75 | 3 | V | 1.42 | 10 | 14.1 | 7.4 | 3.6 | 25.0 | 39.0 | 40.0 | -14.0 | |
| 117.991 | 0 | 3 | V | 3.29 | 10 | 5.8 | 13.8 | 5.0 | 24.6 | 43.5 | 40.0 | -18.9 | |
| 122.912 | 336 | 3 | V | 1.39 | 10 | 6.5 | 14.1 | 5.1 | 25.7 | 43.5 | 40.0 | -17.8 | |
| 127.827 | 280 | 3 | V | 1.43 | 10 | 5.5 | 14.3 | 5.2 | 25.1 | 43.5 | 40.0 | -18.4 | |
| 157.325 | 137 | 3 | V | 1.33 | 10 | 11.3 | 16.2 | 5.9 | 33.5 | 43.5 | 40.0 | -10.0 | Digital |
| 167.157 | 114 | 3 | V | 1.40 | 10 | 13.1 | 17.2 | 6.2 | 36.5 | 43.5 | 40.0 | -7.0 | Digital |
| 176.252 | 121 | 3 | V | 1.39 | 10 | 9.9 | 17.9 | 6.4 | 34.3 | 43.5 | 40.0 | -9.2 | Digital |
| 180.011 | 228 | 3 | V | 1.38 | 10 | 7.5 | 18.4 | 6.5 | 32.4 | 43.5 | 40.0 | -11.1 | Digital |
| 181.661 | 107 | 3 | V | 2.25 | 10 | 10.1 | 18.4 | 6.6 | 35.1 | 43.5 | 40.0 | -8.4 | Digital |
| 182.153 | 91 | 3 | V | 2.24 | 10 | 12.8 | 18.4 | 6.6 | 37.8 | 43.5 | 40.0 | -5.7 | Digital |
| 157.324 | 310 | 3 | H | 4.00 | 10 | 9.6 | 16.2 | 5.9 | 31.7 | 43.5 | 40.0 | -11.8 | Digital |
| 167.156 | 301 | 3 | H | 3.58 | 10 | 9.8 | 17.2 | 6.2 | 33.2 | 43.5 | 40.0 | -10.3 | Digital |
| 176.252 | 141 | 3 | H | 3.61 | 10 | 4.5 | 17.9 | 6.4 | 28.8 | 43.5 | 40.0 | -14.7 | |
| 211.404 | 54 | 4 | V | 1.00 | 10 | 34.1 | 19.6 | -20.8 | 32.9 | 43.5 | 40.0 | -10.6 | |
| 275.318 | 64 | 4 | V | 1.00 | 10 | 29.5 | 20.4 | -19.7 | 30.2 | 46.5 | 47.0 | -16.3 | |
| 405.023 | 90 | 4 | V | 1.00 | 10 | 23.1 | 21.7 | -17.3 | 27.4 | 46.5 | 47.0 | -19.1 | |
| 420.025 | 227 | 4 | V | 1.00 | 10 | 19.3 | 22.2 | -17.1 | 24.4 | 46.5 | 47.0 | -22.1 | |
| 405.020 | 220 | 4 | H | 4.00 | 10 | 20.2 | 21.7 | -17.3 | 24.5 | 46.5 | 47.0 | -22.0 | |
| 650.000 | -2 | 6 | V | 1.05 | 10 | 10.3 | 26.2 | -13.9 | 22.6 | 46.5 | 47.0 | -23.9 | Ambient |
| 900.000 | 180 | 6 | V | 1.62 | 10 | 10.9 | 28.5 | -12.7 | 26.7 | 46.5 | 47.0 | -19.8 | Ambient |
| 550.000 | 180 | 6 | H | 4.00 | 10 | 10.6 | 22.6 | -15.2 | 18.0 | 46.5 | 47.0 | -28.5 | Ambient |
| 900.000 | 243 | 6 | H | 4.00 | 10 | 10.2 | 28.5 | -12.7 | 26.0 | 46.5 | 47.0 | -20.5 | Ambient |

# APPENDIX C

# TEST INSTRUMENTATION

**EQUIPMENT USE REPORT**

| MANUFACTURER | MODEL NO. | DESCRIPTION | SERIAL NO. | CAL DATE |
|---|---|---|---|---|
| **CONDUCTED EMISSIONS** | | | | |
| HP | 85650A | Quasi-Peak Adapter | 2043A00213 | 3 Nov 01 |
| HP | 8566B | Spectrum Analyzer | 2290A01333 | 12 Oct 01 |
| SwRI | --- | 3 dB Transient Suppressor | L-5 | Verified |
| Rhode & Schwarz | ESH2-Z5 | LISN | 872461/021 | 27 May 01 |
| HP | 2031 | Signal Generator | 119807/056 | 6 Aug 01 |
| **ANECHOIC CHAMBER** | | | | |
| Hewlett Packard | 8568B | Spectrum Analyzer | 2209A01333 | 12 Oct 01 |
| Hewlett Packard | 85650A | Quasi-Peak Adapter | 2043A00254 | 01 May 01 |
| SwRI | UTC10-221-1 | Pre-Amp | 9112SN15 | Verified |
| Hewlett Packard | 8447F | Pre-Amp | 2727A02261 | Verified |
| EMCO | 6512 | Loop Antenna | 0001-1265 | 31 Jul 01 |
| EMCO | 3121-DB2 | Dipole Antenna | 148 | Checked |
| EMCO | 3121-DB3 | Dipole Antenna | 148 | Checked |
| EMCO | 3121-DB4 | Dipole Antenna | 1097 | Checked |
| Rhode & Schwarz | ESI | EMI Test Receiver | 1088.7490.40 | 9 Jan 02 |
| **OATS** | | | | |
| Rhode & Schwarz | ESS | EMI Test Receiver | 848588/003 | 16 June 01 |
| SwRI | 2 MHz-1GHz | OATS Pre-Amp | 14-82-020 | verified |
| Electro Metrics | BDA-25S | Dipole Antenna | 535 | 30 Apr 02 |
| Empire | DM-105-T2 | Dipole Antenna | L-000176 | 30 Apr 02 |
| Empire | DM-105-T3 | Dipole Antenna | L-000108 | 30 Apr 02 |
| Empire | DM-105-T3 | Dipole Antenna | L-000176 | 30 Apr 02 |
| EMCO | 6512 | Loop Antenna | 0001-1265 | 31 Jul 01 |
| SwRI | - | Coax, RG223, 2.5m | 40 | verified |
| SwRI | - | Coax, underground | - | verified |
| SwRI | - | Coax, OATS 2, RG223 | 2 | verified |
| SwRI | - | Coax, OATS 1, RG214 | 1 | verified |
| **VOLTAGE VARIATION** | | | | |
| R&S | ESI | EMI Test Receiver | 1088.7490.40 | 9 Jan 02 |
| EMCO | 6512 | Loop Antenna | 0001-1265 | 31 Jul 01 |
| GR | U202A | Variac | 01 | Verified |
| Fluke | 87 | Digital Voltmeter | 64330-494 | 5 Feb 02 |

**APPENDIX D**

**PHOTOS OF TESTED EUT**

The photos of the tested EUT are in the electronic file “Appendix D Photos of Tested EUT.jpg”

## APPENDIX E

## PHOTOS OF TEST SETUPS

The test setup photos are in the electronic file “Appendix E Test Setup Photos.jpg”

**ATTACHMENT 1**

**FUNCTIONAL DESCRIPTION AND BLOCK DIAGRAM**

**ATTACHMENT 2**

**INSTALLATION INSTRUCTIONS**

**ATTACHMENT 3**

**FCC ID LABEL**

**ATTACHMENT 4**

**SCHEMATICS**