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

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San Antonio, Texas 78228-0510

Project 10.04025.01.007
Report Number EMCR 01/045

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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 13.56 MHz, which provides energy to a handheld tag (transponder). The handheld transponder contains a unique and secure ID code so customers can be identified by their individual registered tag. The loop antenna of the system creates 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 13.56 MHz and is subject to FCC Part 15, Subpart C, "Intentional Radiator", paragraph 15.225 (13.553-13.567 MHz). Radiated emissions from the intentional radiator portion of the device is subject to the limits in Section 15.209 of the Rules outside of the 13.56 +/- 0.007 MHz band. Radiated emissions from the digital electronics portion of the device is subject to FCC Part 15, Subpart B, Unintentional Radiator, paragraph 15.109, under the Class A limits and as such, the device is incorporated into an application that is subject to Class A limits. Conducted emissions from on the AC power line are subject to FCC Part 15, Subpart C, Intentional Radiator, paragraph 15.207. 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

There are no related grants.

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 Integrated RFID Gateway Board (M01803A002), one Multi-Protocol Reader board (Q13786-02), one M01787B002 mat reader assembly, which includes one 13.563MHz low 'Q' printed circuit board antenna (M01566A001) and one LCD shutter. The system also includes a 120 VAC to +12VDC Class II Wall Mounted Transformer for input power. The components of the Marconi TIRIS™ Mat Reader System are listed in Table 1.1.

The 13.56 MHz transmit signal originates on the Multi-Protocol Reader board (Marconi part number Q13786-02/ Texas Instruments part number RI-STU-TRDB-01) from which the signal is sent via the Antenna Signal/Ground cable to the Mat Reader Antenna where it is intentionally radiated. The Marconi TIRIS™ 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 a switching power supply located on the Board. A detailed functional description and system functional block diagram is located in Attachment 1.

TABLE 1.1
TIRIS™ MAT READER COMPONENTS

Component Description	Marconi P/N	Texas Instruments P/N
Integrated RFID Gateway Board Assembly (1)	M01803A002	N/A
Multi-Protocol Reader (1) (one per M01803A002)	Q13786-02	RI-STU-TRDB-01
Marconi TIRIS™ Mat Reader Antenna (1)	M01566A001	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 15.225, 15.209, 15.207, and 15.109. Radiated testing was performed at an antenna-to-EUT distance of 3, 10, 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 April 30, 2001, which is on file with the FCC Laboratory Division in Columbia, Maryland. On May 30, 2001, 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, and 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 13 MHz 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 was used to demonstrate operation of the TIRIS™ Mat Reader during testing. During radiated tests of the digital electronics, emissions related to the digital electronics were verified by disabling the 13.56 MHz transmitter.

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 (Marconi p/n Q11433-107; Fair-Rite p/n 0444164181) was added to the dc power input (2 loops).
2. A ferrite bead (Marconi p/n Q11433-110; 28S2023-0M0 Steward p/n 28S2023-0M0) was added to the ribbon cable that connects to plug P3.
3. A ferrite bead (Marconi p/n Q11433-106; Fair-Rite p/n 0444164951) was added to the antenna cable coax.

The exact locations of the above ferrite beads are shown in the EUT photos attached to this test report.

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 1.0 dB			
FREQUENCY	**MEASURED LEVEL (dBuV)**		**LIMIT (dBuV)**
	LINE	**NEUTRAL**	
450 kHz		47[1]	48
680 kHz		44[1]	48
450 kHz	46.5[1]		48
680 kHz	44.5[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 13.56 MHz at 30 meters. Additionally, the spectrum was investigated for harmonics and spurious emissions up to 30 MHz at 30 meters. No harmonics or other spurious emissions were detected. The receive loop antenna was placed in three polarizations for the testing below 30 MHz. Scans were performed starting at 13 MHz to verify that neither the fundamental emission, nor any harmonic emission was in the 13.36 – 13.41 MHz restricted band. The measurement level of the fundamental at the center frequency, as well as the level of the fundamental at the band edges at 30 meters, is shown in Table 7.1.

TABLE 7.1
MEASUREMENT OF FUNDAMENTAL FREQUENCY

Judgment: EUT Fundamental Passed by 36.3 dB				
Receive Antenna Configuration	**Frequency (MHz)**	**Corrected Level[1] dB(µV/m)**	Limit 30 meters **dB(µ)V/m**	**dB Under Limit**
Perpendicular (worst case)	13.56	43.7	80	36.3
	13.553	28.3	29.5	1.2
	13.567	28.8	29.5	0.7

1 All readings are quasi-peak manual measurements made with a receiver.

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 0.3 dB			
Frequency	**Corrected Level [1] dB(µV/m)**	**Limit[2] dB(µ)V/m**	**dB under limit**
189.838 MHz (horizontal)	43.2	43.5	0.3
54.240 MHz (vertical)	34	43.5	5.0
203.398 MHz (horizontal)	35.7	43.5	7.8
298.315 MHz (vertical)	37.3	46.5	9.2

[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 tolerance of the TIRIS™ Mat Reader 13.56 MHz fundamental emission was verified to be within the +/-0.01% (+/-1.356 kHz) requirement from Part 15, paragraph 15.225, when exposed to temperature variations of –20 degrees to +50 degrees C. The fundamental emission was monitored on a spectrum analyzer as the TIRIS™ Mat Reader was exposed to +50 degrees C for 10 minutes and –20 degrees C for 10 minutes. The frequency varied by approximately 700 Hz. In addition, the 120 VAC supply voltage was varied from 85% to 115% at room temperature in accordance with paragraph 15.225. The frequency of the fundamental emission did not vary more than approximately 400 Hz during the entire procedure.

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 21 (189.838 MHz):

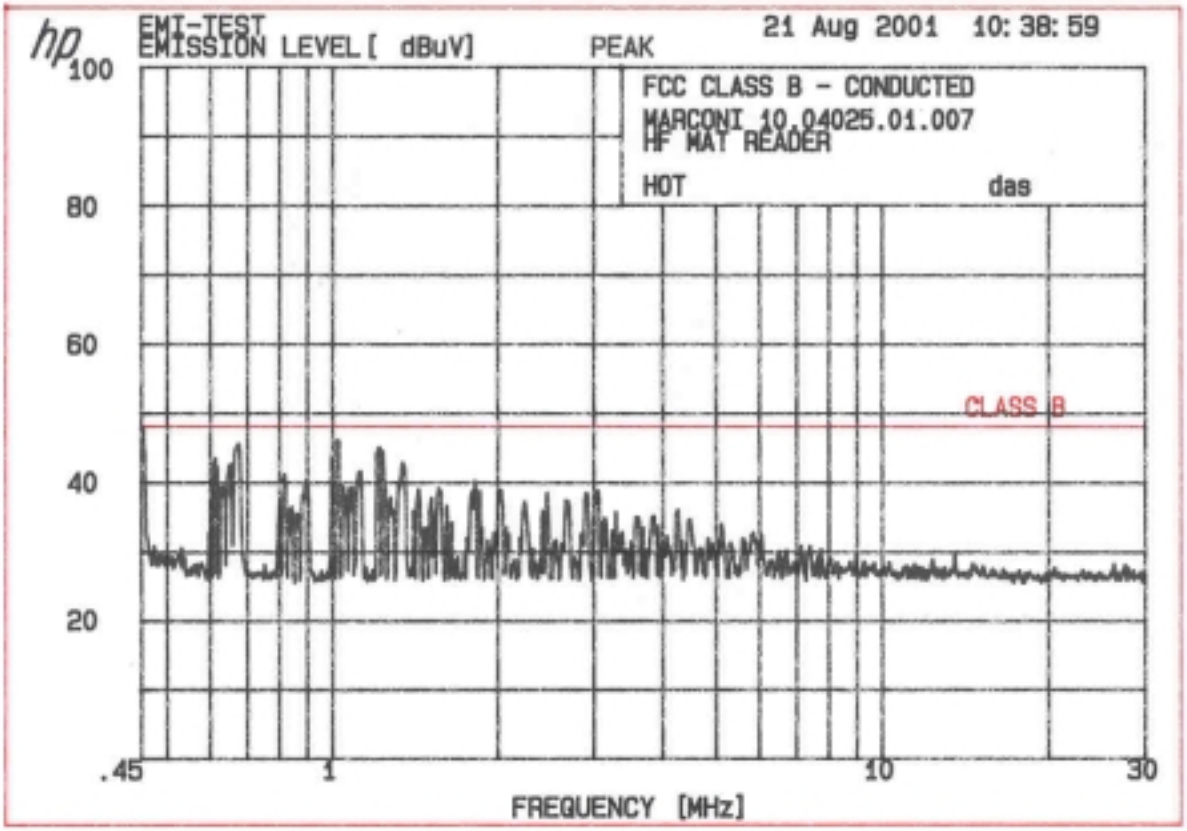
17.6 dB(uV)
18.7 dB(1/m)
6.7 dB (CF/AG FACTOR)
FS = 42.9 dB(uV/m)

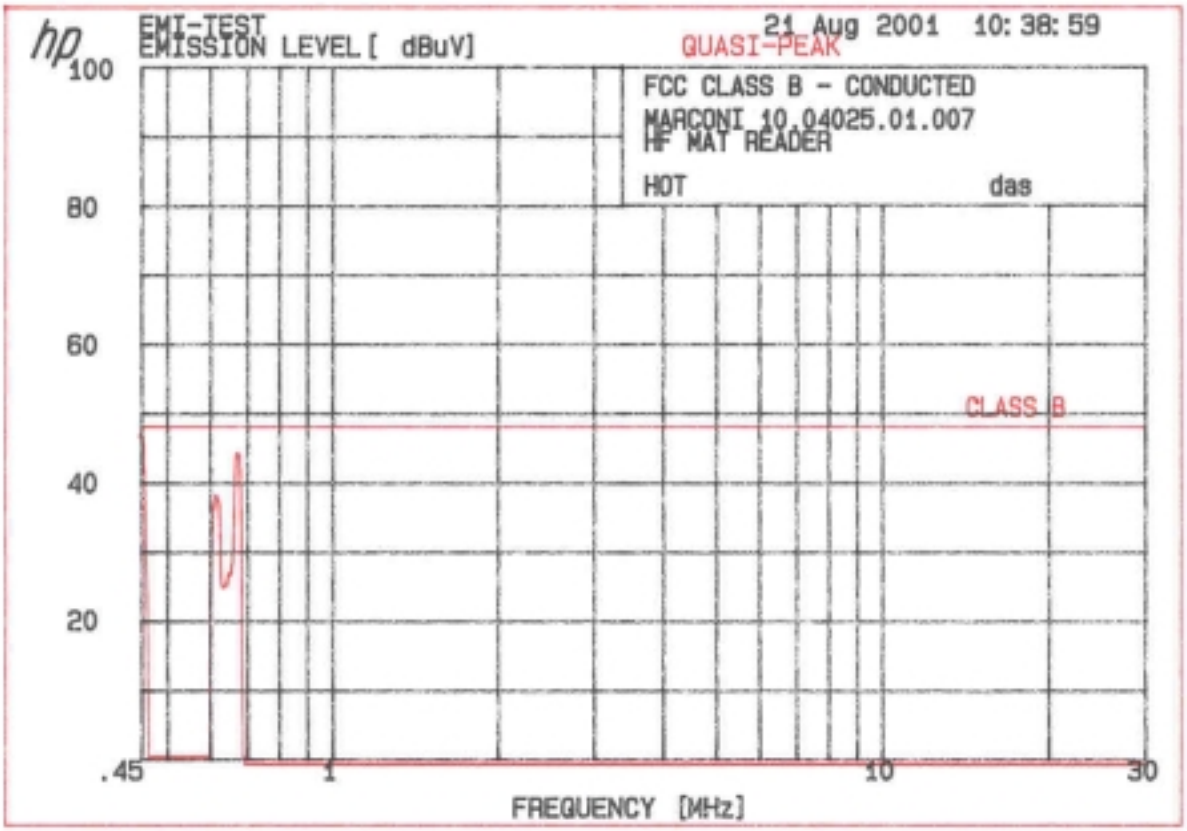
To convert the dB(uV/m) value to its corresponding level in uV/m is as follows:

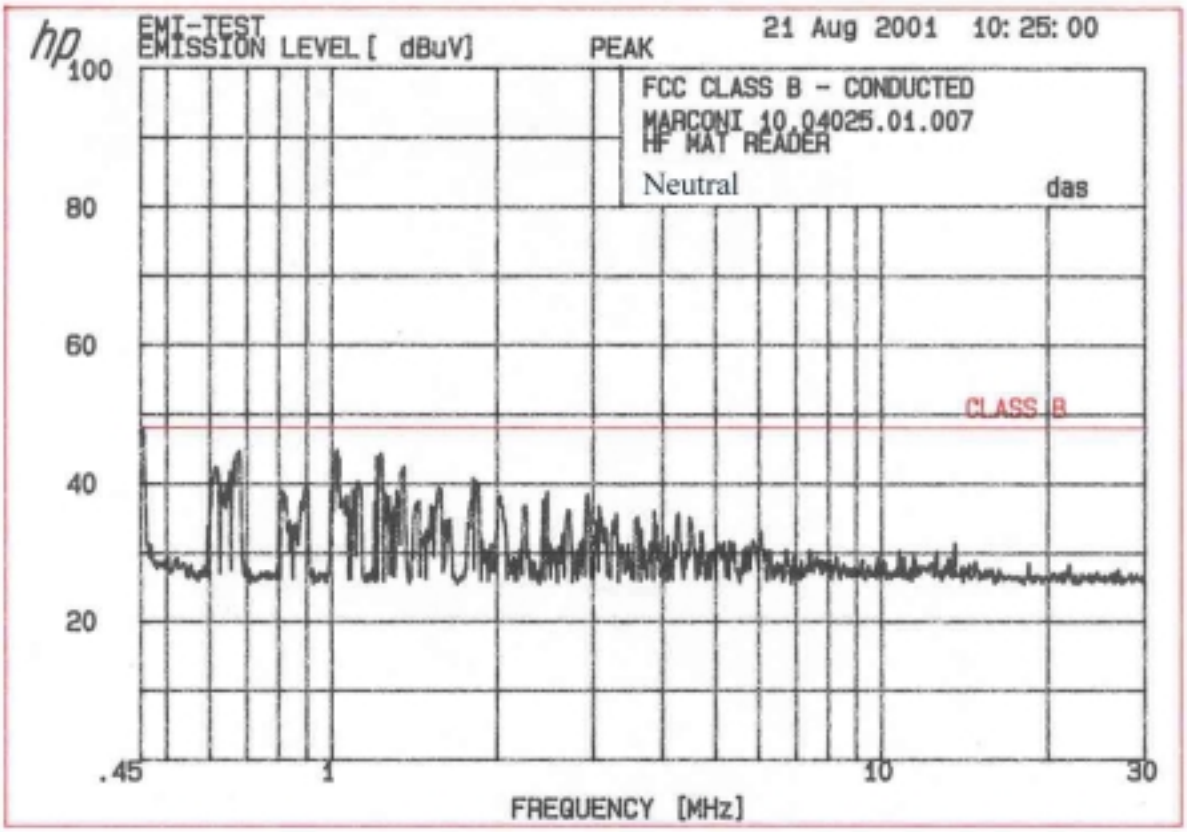
Level in uV/m Common Antilogarithm [(42.9 dBuV/m)/20] = 139.63 uV/m

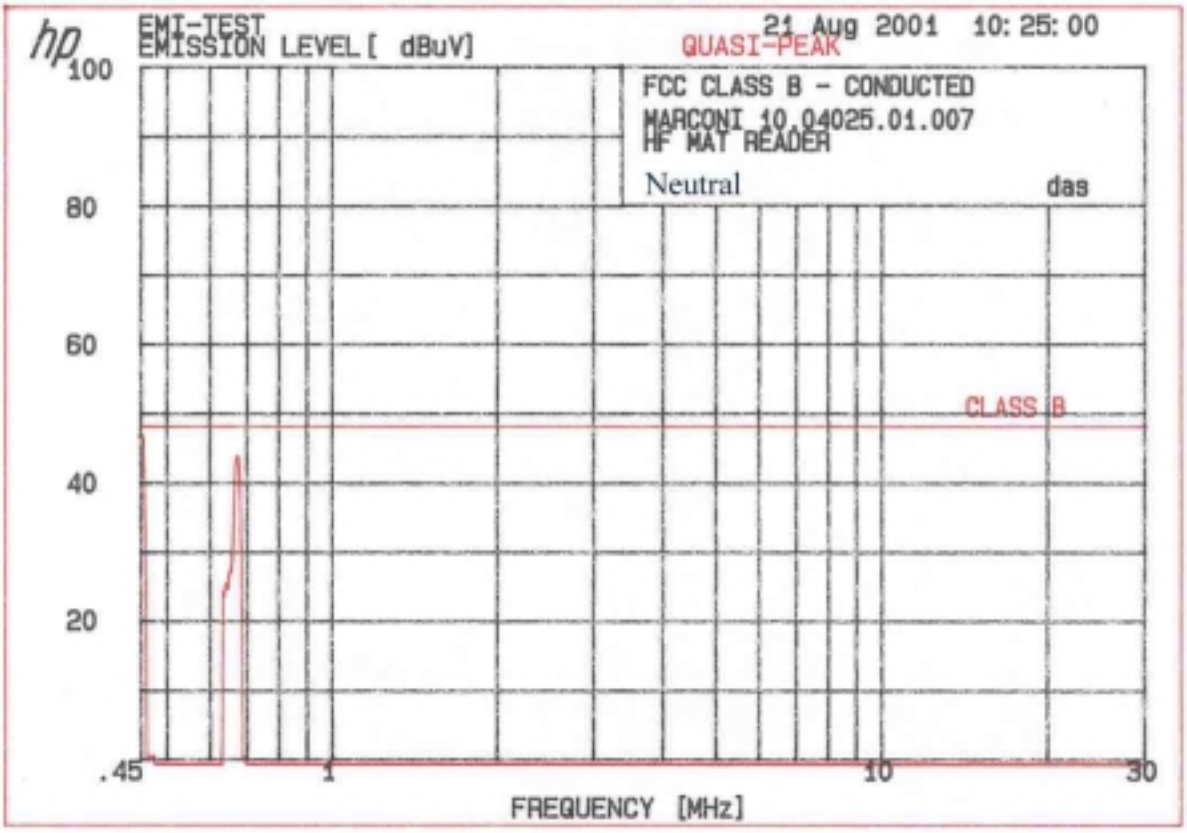
APPENDIX A

CONDUCTED MEASUREMENT PLOTS


EMI-TEST
EMISSION LEVEL [dBuV]
PEAK
21 Aug 2001 10:38:59
FCC CLASS B - CONDUCTED
MARCONI 10,04025.01.007
HF MAT READER
HOT
das
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

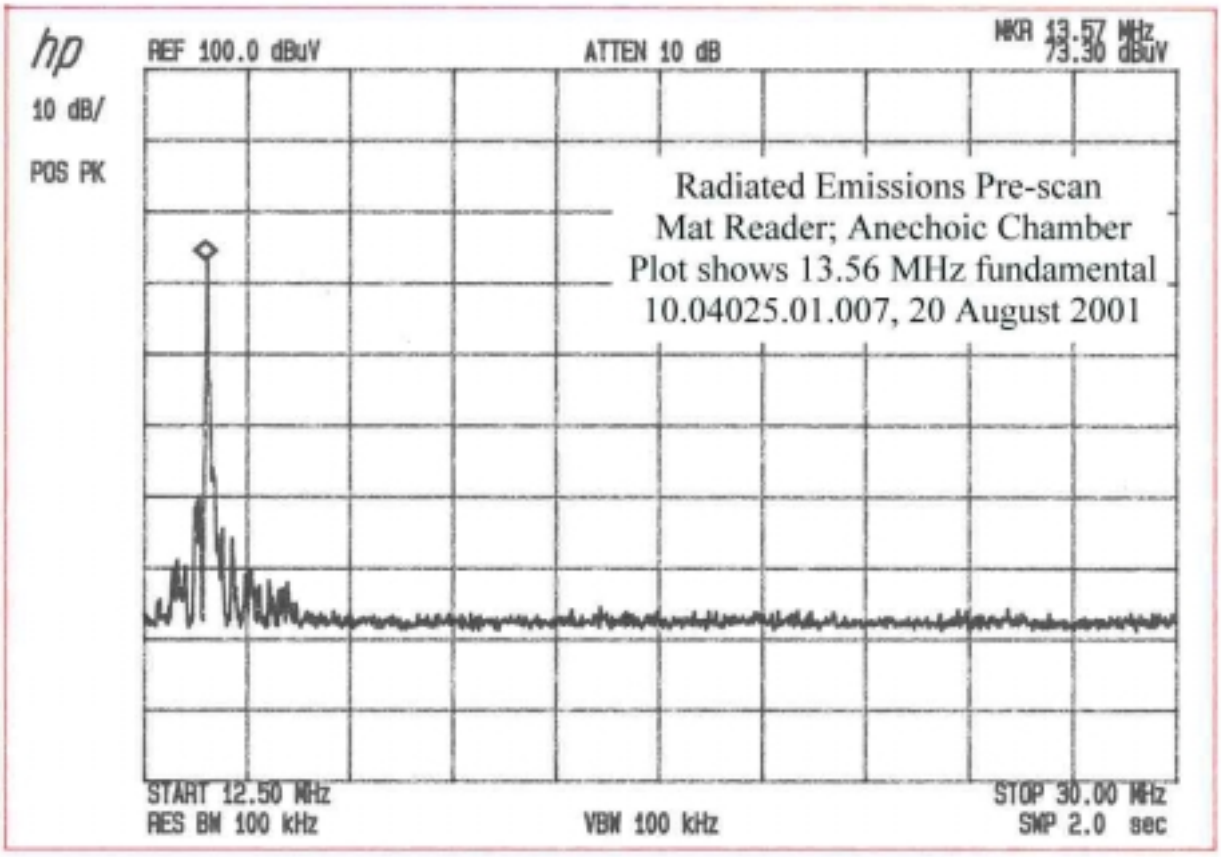

EMI-TEST
EMISSION LEVEL [dBuV]
QUASI-PEAK
21 Aug 2001 10:38:59
FCC CLASS B - CONDUCTED
MARCONI 10,04025.01.007
HF MAT READER
HOT
das
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

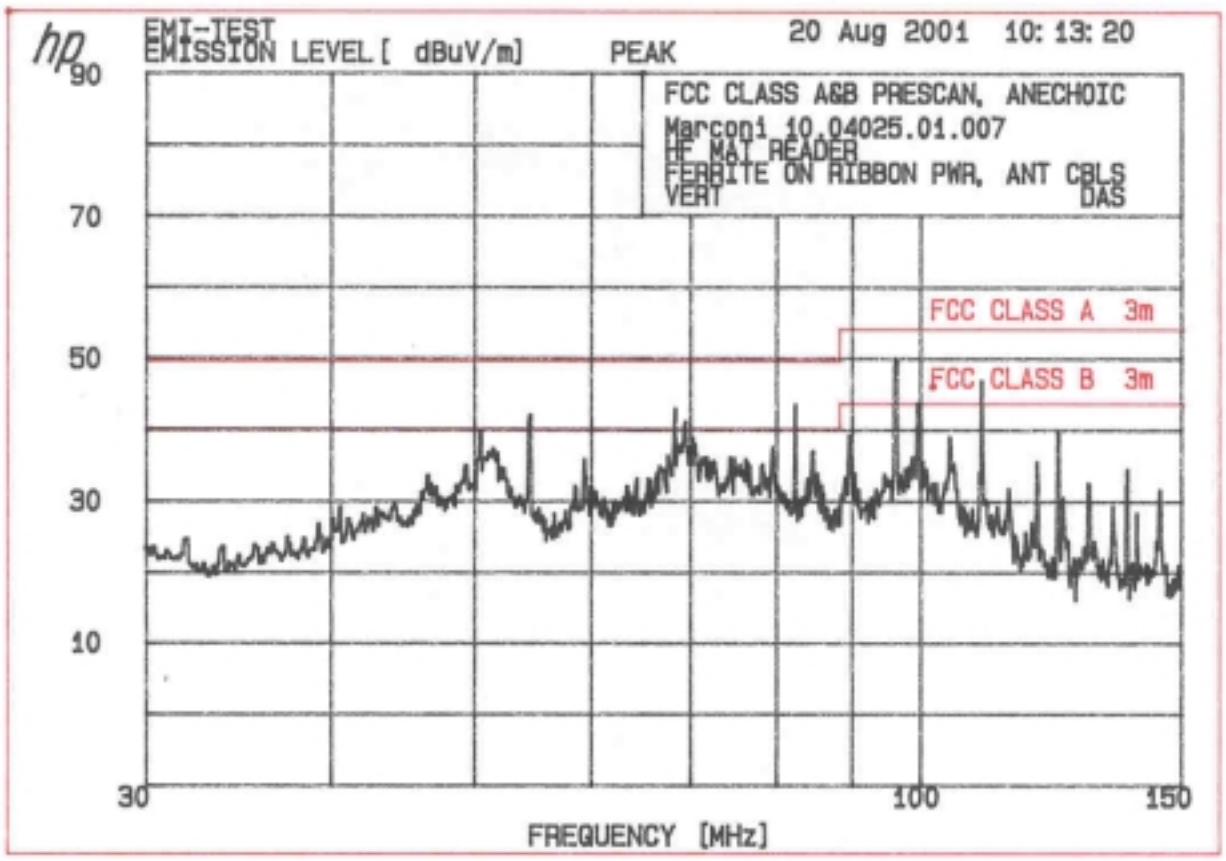

EMI-TEST
EMISSION LEVEL [dBuV]
PEAK
21 Aug 2001 10:25:00
FCC CLASS B - CONDUCTED
MARCONI 10.04025.01.007
HF MAT READER
Neutral
das
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

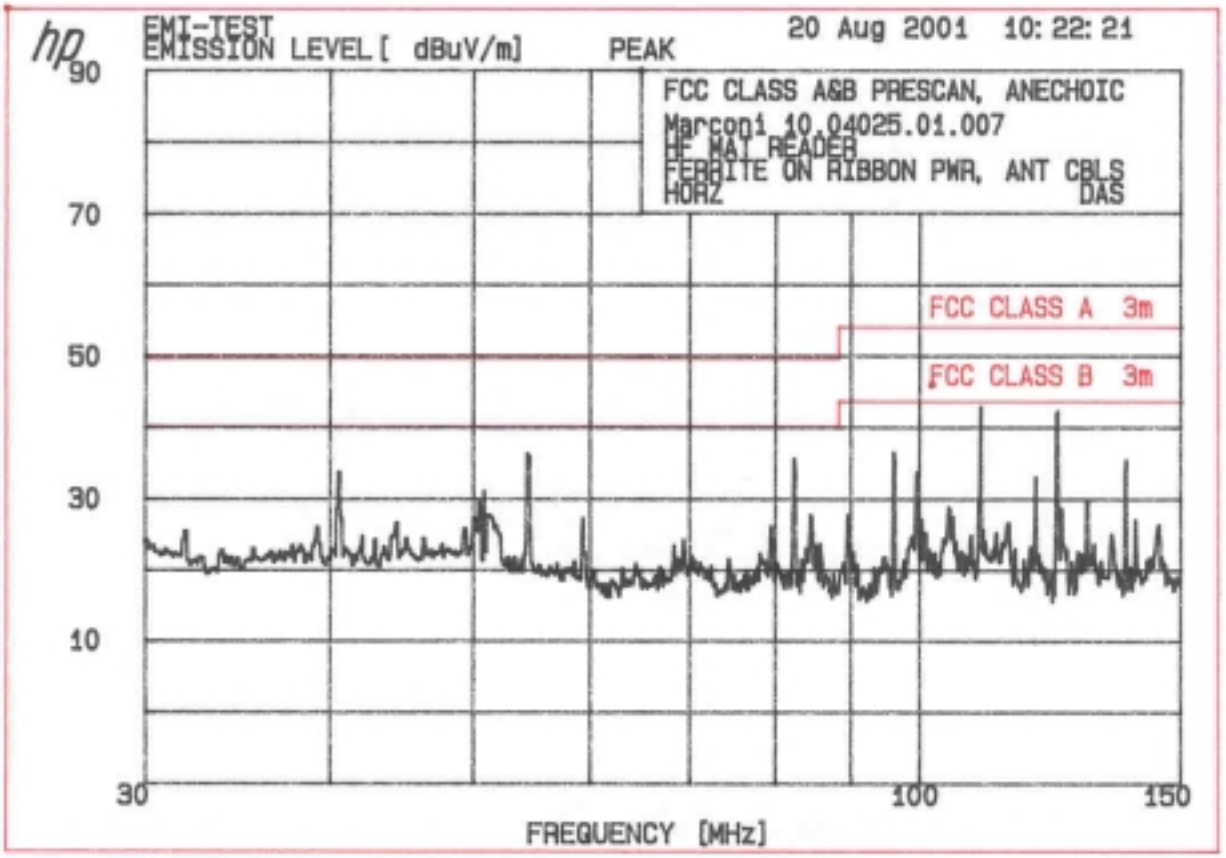

EMI-TEST
EMISSION LEVEL [dBuV]
QUASI-PEAK
21 Aug 2001 10:25:00
FCC CLASS B - CONDUCTED
MARCONI 10.04025.01.007
HF MAT READER
Neutral
das
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]

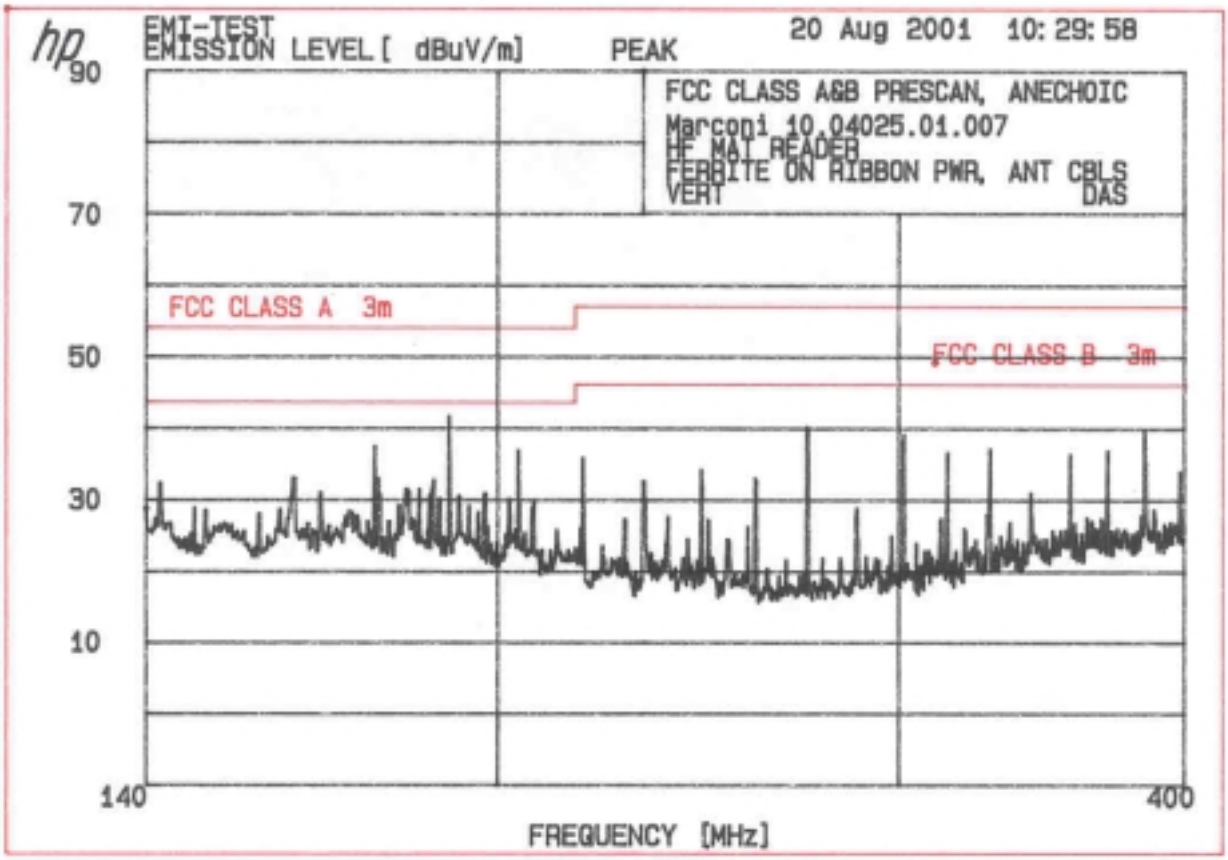
APPENDIX B

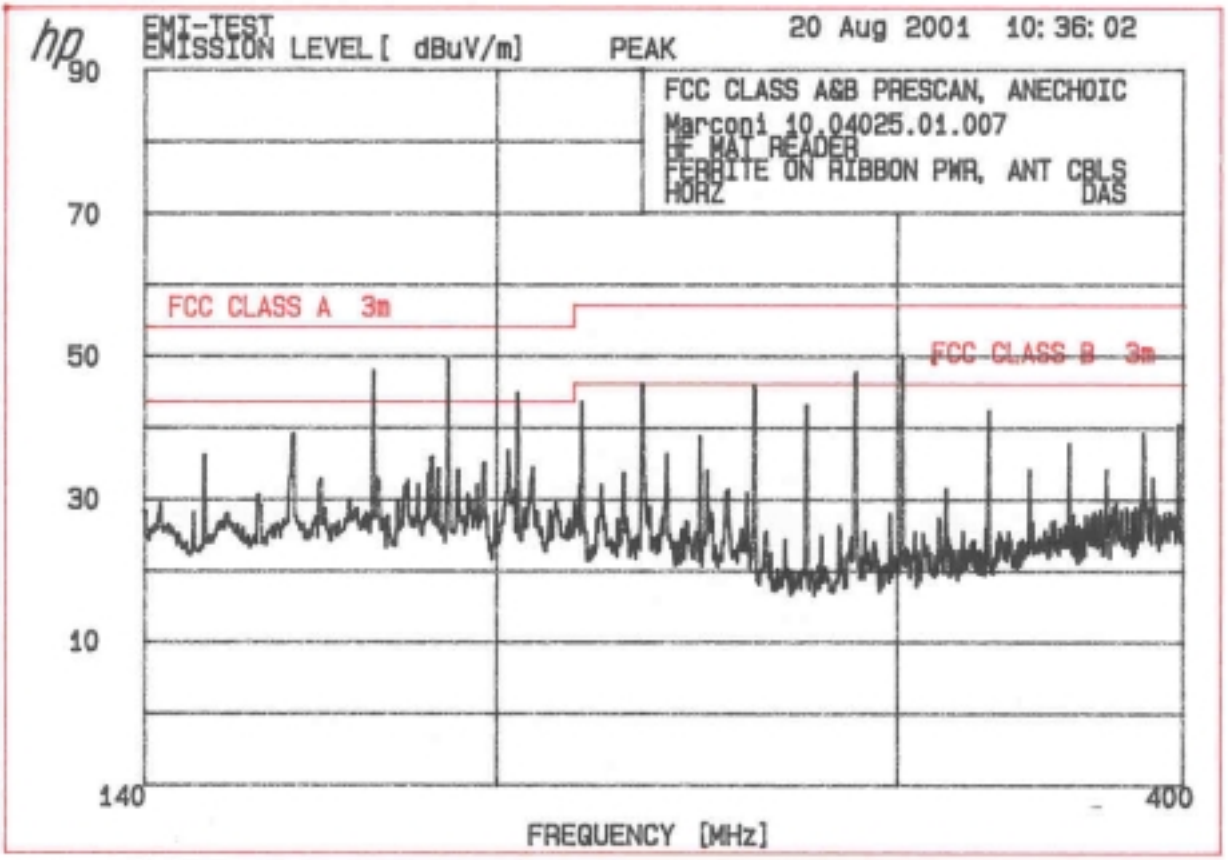
RADIATED SIGNATURE SCAN PLOTS AND OATS DATA SHEETS

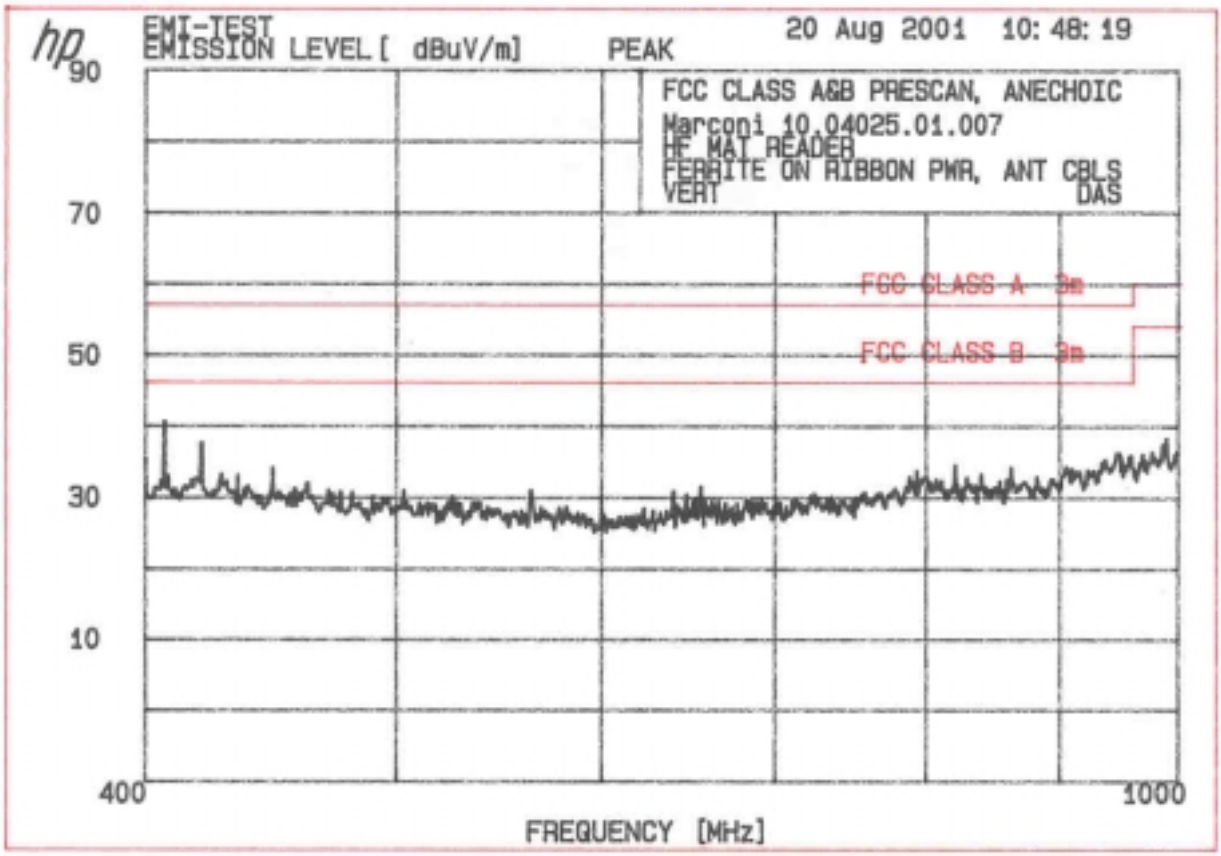

hp
REF 100.0 dBuV
ATTEN 10 dB
MKR 13.57 MHz
73.30 dBuV
10 dB/
POS PK
Radiated Emissions Pre-scan
Mat Reader; Anechoic Chamber
Plot shows 13.56 MHz fundamental
10.04025.01.007, 20 August 2001
START 12.50 MHz
RES BW 100 kHz
VBW 100 kHz
STOP 30.00 MHz
SWP 2.0 sec

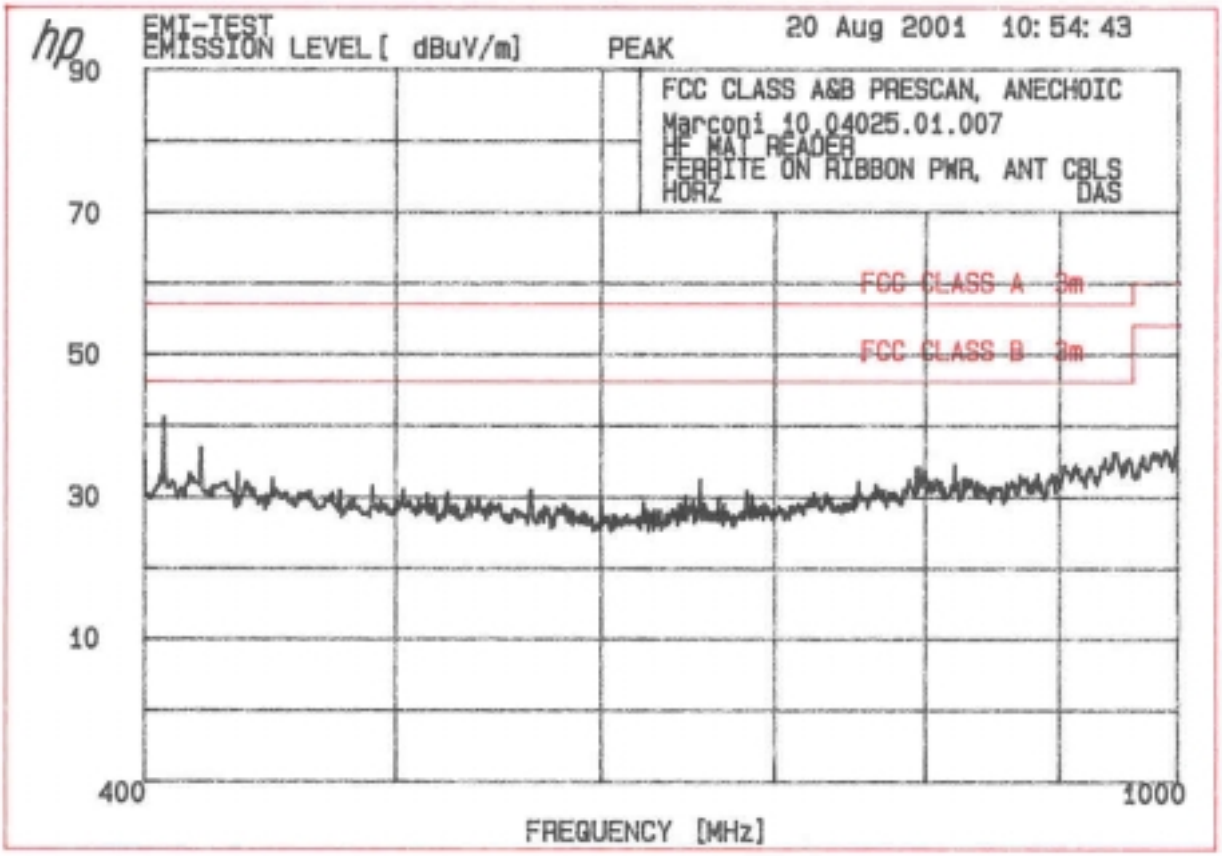

EMI-TEST
EMISSION LEVEL [dBuV/m]
PEAK
20 Aug 2001 10:13:20
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi 10.04025.01.007
HF MAT READER
FERRITE ON RIBBON PWR, ANT CBLS
VERT
DAS
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
30
100
150
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL [dBuV/m]
PEAK
20 Aug 2001 10:22:21
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi 10.04025.01.007
HF MAT READER
FERRITE ON RIBBON PWR, ANT CBLS
HORZ
DAS
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
20 Aug 2001 10:29:58
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi 10.04025.01.007
HF MAT READER
FERRITE ON RIBBON PWR, ANT CBLS
VERT
DAS
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL [dBuV/m]
PEAK
20 Aug 2001 10:36:02
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi 10.04025.01.007
HF MAT READER
FERRITE ON RIBBON PWR, ANT CBLS
HORZ
DAS
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL [dBuV/m]
PEAK
20 Aug 2001 10:48:19
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi 10.04025.01.007
HF MAT READER
FERRITE ON RIBBON PWR, ANT CBLS
VERT
DAS
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
400
1000
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL [dBuV/m]
PEAK
20 Aug 2001 10:54:43
FCC CLASS A&B PRESCAN, ANECHOIC
Marconi 10.04025.01.007
HF MAT READER
FERRITE ON RIBBON PWR, ANT CBLS
HORZ
DAS
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: 10.04025.01.007
Device Under Test: HF MAT READER
Detection Method: QP
EUT Mode: Operating
Date / Time: 8/21/01 14:20
Test Receiver: Rohde&Schwarz ESS EMI sn: DE31157
Test Standard(primary limit): FCC Class A, Part 15 (10 m radiated)
Antenna:
Test Standard(optional limit): CISPR 11 or 22A (10 m radiated)
Test Sponsor: MARCONI
Test Technician: D. Smith
Temp.(°F)/Humidity(%): 92 F / 38%

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)	
189.838	270	3	V	1.26	10	17.6	18.7	6.7	42.9	43.5	40.0	-0.6	digital
189.838	183	3	H	1.26	10	17.8	18.7	6.7	43.2	43.5	40.0	-0.3	digital
135.601	340	3	V	1.26	10	12.1	14.9	5.4	32.3	43.5	40.0	-11.2	
108.480	165	3	V	1.25	10	14.6	13.1	4.8	32.4	43.5	40.0	-11.1	
54.240	318	3	V	1.61	10	21.7	9.2	3.1	34.0	39.0	40.0	-5.0	digital
40.677	97	3	V	2.07	10	3.5	16.5	2.5	22.6	39.0	40.0	-16.4	
46.769	171	3	V	1.14	10	4.2	13.3	2.9	20.3	39.0	40.0	-18.7	
49.630	360	3	V	1.19	10	7.8	11.7	3.0	22.5	39.0	40.0	-16.5	
149.154	310	3	V	1.85	10	10.6	15.8	5.8	32.2	43.5	40.0	-11.3	digital
135.597	200	3	H	3.95	10	6.7	14.9	5.4	27.0	43.5	40.0	-16.5	
54.242	0	3	H	3.67	10	4.7	9.2	3.1	17.0	39.0	40.0	-22.0	
203.400	124	4	V	1.16	10	36.3	19.6	-21.0	35.0	43.5	40.0	-8.5	digital
216.960	172	4	V	1.00	10	30.6	20.0	-20.8	29.7	46.5	40.0	-16.8	
284.754	75	4	V	1.22	10	35.2	19.3	-19.6	34.9	46.5	47.0	-11.6	digital
298.315	286	4	V	1.04	10	38.4	18.1	-19.2	37.3	46.5	47.0	-9.2	digital
325.438	319	4	V	1.04	10	34.7	19.4	-18.7	35.4	46.5	47.0	-11.1	digital
366.116	308	4	V	1.03	10	29.5	21.7	-17.9	33.3	46.5	47.0	-13.2	
379.676	312	4	V	1.09	10	31.4	22.5	-17.7	36.3	46.5	47.0	-10.2	digital
406.796	0	4	V	1.09	10	22.5	21.8	-17.0	27.3	46.5	47.0	-19.2	
203.398	276	4	H	3.68	10	37.0	19.6	-21.0	35.7	43.5	40.0	-7.8	digital
216.958	277	4	H	3.52	10	27.2	20.0	-20.8	26.3	46.5	40.0	-20.2	
284.758	205	4	H	3.49	10	33.6	19.3	-19.6	33.2	46.5	47.0	-13.3	
298.318	219	4	H	3.41	10	34.7	18.1	-19.2	33.6	46.5	47.0	-12.9	

SwRI Open Area Test Site Radiated Emissions v2_2

Project Number: 10.04025.01.007
Device Under Test: HF MAT READER
Detection Method: QP
EUT Mode: Operating
Date / Time: 8/21/01 14:20
Test Receiver: Rohde&Schwarz ESS EMI sn: DE31157
Test Standard(primary limit): FCC Class A, Part 15 (10 m radiated)
Antenna:
Test Standard(optional limit): CISPR 11 or 22A (10 m radiated)
Test Sponsor: MARCONI
Test Technician: D. Smith
Temp.(°F)/Humidity(%): 92 F / 38%

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	(°)	I.D.	Pol.	Ht(m)	Dis(m)	(dBuV)	Ant	Cable	(dBuV/m)	(dBuV/m)	(dBuV/m)	(dB)	
461.036	224	4	H	2.75	10	17.7	26.5	-16.5	27.8	46.5	47.0	-18.7	
237.007	101	4	H	2.75	10	19.1	21.7	-20.3	20.6	46.5	47.0	-25.9	
311.873	195	4	H	3.07	10	30.6	18.1	-18.9	29.9	46.5	47.0	-16.6	
311.879	81	4	V	1.24	10	30.1	18.1	-18.9	29.4	46.5	47.0	-17.1	
608.292	114	7	V	1.24	10	12.8	26.4	-14.4	24.8	46.5	47.0	-21.7	ambient
900.146	216	7	V	1.24	10	11.1	33.8	-12.7	32.2	46.5	47.0	-14.3	ambient
999.946	216	7	V	1.24	10	11.0	33.0	-11.2	32.8	49.5	47.0	-16.7	ambient
608.346	152	7	H	3.41	10	11.6	26.4	-14.4	23.6	46.5	47.0	-22.9	ambient
999.465	224	7	H	3.41	10	10.4	33.1	-11.1	32.3	49.5	47.0	-17.2	ambient
13.559	10		par	1.00	30	0.2	34.0	1.0	35.2	80.0		-44.8	fundamental (par = parallel)
20.000	10		par	1.00	30	-9.0	33.5	1.0	25.5	29.5		-4.0	ambient
27.120	10		par	1.00	30	-12.0	32.8	1.0	21.8	29.5		-7.7	ambient
13.553	10		par	1.00	30	-10.4	34.0	1.0	24.6	29.5		-4.9	
13.567	10		par	1.00	30	-10.0	34.0	1.0	25.0	29.5		-4.5	
13.410	10		par	1.00	30	-12.7	34.0	1.0	22.3	29.5		-7.2	ambient
13.559	10		per	1.00	30	8.7	34.0	1.0	43.7	80.0		-36.3	fundamental (per = pependicular)
13.553	10		per	1.00	30	-6.7	34.0	1.0	28.3	29.5		-1.2	
13.567	10		per	1.00	30	-6.2	34.0	1.0	28.8	29.5		-0.7	
13.410	10		per	1.00	30	-12.9	34.0	1.0	22.1	29.5		-7.4	ambient
20.000	10		per	1.00	30	-12.7	33.5	1.0	21.8	29.5		-7.7	ambient
27.120	10		per	1.00	30	-12.7	32.8	1.0	21.1	29.5		-8.4	ambient
13.559	70		ptg	1.00	30	-8.8	34.0	1.0	26.2	80.0		-53.8	fundamental (ptg = parallel to ground)
13.533	70		ptg	1.00	30	-18.5	34.0	1.0	16.5	29.5		-13.0	ambient
13.567	70		ptg	1.00	30	-18.2	34.0	1.0	16.8	29.5		-12.7	ambient
13.410	70		ptg	1.00	30	-19.0	34.0	1.0	16.0	29.5		-13.5	ambient
20.000	70		ptg	1.00	30	-18.8	33.5	1.0	15.7	29.5		-13.8	ambient
27.120	70		ptg	1.00	30	-19.0	32.8	1.0	14.8	29.5		-14.7	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	8568B	Spectrum Analyzer	2140A01685	7 Nov 01
SwRI	---	3 dB Transient Suppressor	L-5	Verified
Rhode & Schwarz	ESH2-Z5	LISN	872461/017	15 Feb 02
RADIATED EMISSIONS - ANECHOIC CHAMBER				
HP	85650A	Quasi-Peak Adapter	2043A00213	3 Nov 01
HP	8568B	Spectrum Analyzer	2140A01685	7 Nov 01
SwRI	UTC10-221-1	Pre-Amp	9112SN15	Verified
Hewlett Packard	8447F	Pre-Amp	2727A02261	Verified
EMCO	6512	Loop Antenna	0001-1265	10 Aug 02
EMCO	3121-DB2	Dipole Antenna	148	Checked
EMCO	3121-DB3	Dipole Antenna	149	Checked
EMCO	3121-DB4	Dipole Antenna	1097	Checked
RADIATED EMISSIONS – OATS				
Rhode & Schwarz	ESS	EMI Test Receiver	848588/003	23 Jul 02
SwRI	2 MHz - 1GHz	OATS Pre-Amp	14-82-020	verified
Electro Metrics	BDA-25S	Dipole Antenna	535	21 Mar 02
Empire	DM-105-T2	Dipole Antenna	L-000176	15 Mar 02
Empire	DM-105-T3	Dipole Antenna	L-000108	15 Mar 02
EMCO	6512	Loop Antenna	0001-1265	10 Aug 02
VOLTAGE VARIATION				
HP	8447F	Pre-amp	2727A02261	NCR
EMCO	6512	Loop Antenna	0001-1265	10 Aug 02
HP	85650A	Quasi-Peak Adapter	2043A00213	3 Nov 01
HP	8568B	Spectrum Analyzer	2140A01685	7 Nov 01
Fluke	52	Thermometer	4275099	1 Nov 01
Tenney	Tenney Jr	Temperature Chamber	6606-68T238	NCR
General Radio	U20	Variac	01	Verified
Fluke	89	Digital Voltmeter	74330-134	3 Jul 02

APPENDIX D

PHOTOS OF TESTED EUT

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

APPENDIX E

PHOTOS OF TEST SETUPS

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

ATTACHMENT 1

FUNCTIONAL DESCRIPTION AND BLOCK DIAGRAM

ATTACHMENT 2

INSTALLATION INSTRUCTIONS

ATTACHMENT 3

FCC ID LABEL

ATTACHMENT 4

SCHEMATICS