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EMI TEST REPORT
for
CERTIFICATION to
FCC PART 15.225

Test Sample: Digital Identification Tag Reader

Tested for: 3M Library Systems

Report Number: M021210R_Cert_Tx

Issue Date: 30th July 2004

NATA Accredited Laboratory
Number: 5292

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Report Number:	**M021210R_Cert_Tx**
Test Sample:	Digital Identification Tag Reader
Manufacturer:	3M Library Systems
Equipment Type:	Intentional Radiator
Tested For:	3M Library Systems
Address:	Unit 3, 14 Lionel Road Mount Waverley VIC 3149, Australia
Phone:	+61 3 9535 8100
Fax:	+61 3 9535 8111
Responsible Party:	Alan A Butters
Test Standards:	FCC Part 15, Subpart C – Intentional Radiators FCC Part 15.225: Operation within the band 13.110 – 14.010 MHz ANSI C63.4 – 1992 OET Bulletin No. 63
Test Dates:	24th February to 31st March 2003
Test Officer:	**Chieu Huynh** **B.Eng (Hons) Electronics**
Attestation:	*I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*
Authorised Signatory:	**Chris Zombolas** **Technical Director** **EMC Technologies Pty Ltd**

EMI TEST REPORT FOR CERTIFICATION
to
FCC PART 15.225

1.0 INTRODUCTION

This report details the results of EMI tests and measurements performed on the Digital Identification Tag Reader.

Test results and procedures were performed in accordance with the following Federal Communications Commission (FCC) standards/regulations:

47 CFR, Part 15, Subpart C:	Rules for intentional radiators (particularly section 15.225)
Section 15.225:	Operation within the band 13.110 – 14.010 MHz
Section 15.203:	Antenna requirements
Section 15.205:	Restricted bands of operation
Section 15.207:	Conducted Emission Limits
Section 15.209:	Radiated Emission Limits, General Requirements

The test sample **complied** with the requirements of 47 CFR, Part 15 Subpart C - Section 15.225: Operation within the band 13.110 – 14.010 MHz, except section 15.225(e): Frequency Tolerance – Not tested at client's request.

1.1 Summary of Results

FCC Part 15, Subpart C Clauses	Test Performed	Result
15.203	Antenna Requirement	**Not Applicable**
15.205	Operation in Restricted Band	**Complies**
15.207	Conducted Emissions	**Complies**
15.209	Radiated Emissions	**Complies**
15.225	Operation within the band 13.110 – 14.010 MHz	***Complies**

*Frequency Tolerance – Not tested at client's request.

The measurement procedure used was in accordance with ANSI C63.4-1992 and OET Bulletin No. 96-43. The instrumentation conformed to the requirements of ANSI C63.2-1987.

1.2 Modifications by EMC Technologies

No modifications were required.

2.0 GENERAL INFORMATION

(Information supplied by the Client)

2.1 Product Details

Test Sample: Digital Identification Tag Reader.

Equipment Type: Intentional Radiator

2.2 Test Sample Operational Description and Configuration

The Digital Identification Tag Reader was installed with the Smart Check system to identify library books that have been fitted with an appropriate Digital Identification Tag. The DID Readers transmitter operates at a frequency of 13.56 MHz. The Transmitter is capable of 1000 mW continuous wave RF Output Power.

The 3M Book Smart Check, Model 888 is a master device that can operate stand-alone or alternatively control a 3M BookSort machine via J205. The Model 888 Smart Check J205 connector must only be connected to other 3M Slave devices due to proprietary nature of this inter-machine control connection. The electrical characteristics, pin outs and communication protocol of connector J205 are all peculiar to the Smart Check family of products.

2.3 Test Sample Support Equipment

Host:	Smart Check
Model Number:	888
Serial Number:	00021
Input Supply:	240 Volts AC, 50 Hz, 600 VA
Intentional Transmit Frequency:	13.56 MHz, 1000mW
Crystal Frequencies:	7.3728 MHz
Manufacturer:	3M Library Systems

2.4 Test Procedure

Emissions measurements were performed in accordance with the procedures of ANSI C63.4-1992. Radiated emissions tests were performed at a distance of 3 and 10 metres from the EUT. OET Bulletin 63 dated October 1993 was used for reference.

2.5 Test Facility

2.5.1 General

Radiated Emission measurements were performed at EMC Technologies open area test site (OATS) situated at Lerderderg Gorge, near the township of Bacchus Marsh in Victoria, Australia. Bandwidth measurements were performed at EMC Technologies' laboratory in Tullamarine, (Melbourne) Victoria Australia.

The above sites have been fully described in a report submitted to the FCC office, and accepted in a letter dated June 14, 2002, **FCC Registration Number 90560**.

2.5.2 NATA Accreditation

EMC Technologies is accredited in Australia to test to the following standards by the National Association of Testing Authorities (NATA).

"FCC Part 15 unintentional and intentional emitters in the frequency range 9kHz to 18 GHz excluding TV receivers (15.117 and 15.119), TV interface devices (15.115), cable ready consumer electronic equipment (15.118), cable locating equipment (15.213) and unlicensed national information infrastructure devices (Sub part E)."

The current full scope of accreditation can be found on the NATA website: www.nata.asn.au
It also includes a large number of emission, immunity, SAR, EMR and Safety standards.

NATA is the Australian national laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Laboratory (NML) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A^2LA).

2.6 Units of Measurements

Radiated Emissions
Measurements are reported in units of dB relative to one microvolt per metre (dBμV/m).

2.7 Test Equipment Calibration

All measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Laboratory (NML). All equipment calibration is traceable to Australia national standards at the National Measurements Laboratory. The reference antenna calibration was performed by NML and the working antennas (loop, biconical and log-periodic) calibrated by the NATA approved procedures. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A.

2.8 Ambients at OATS

The Open Area Test Site (OATS) is an area of low background ambient signals. No significant broadband ambients are present however commercial radio and TV signals exceed the limit in the FM radio, VHF and UHF television bands. Radiated prescan measurements were performed in the shielded enclosure to check for possible radiated emissions at the frequencies where the OATS ambient signals exceeded the test limit.

3.0 CONDUCTED EMISSION MEASUREMENTS

The Digital Identification Tag Reader was installed with the Smart Check system.

The Digital Identification Tag Reader transmits continuously on 13.56 MHz with load connected. Testing was performed in accordance with the requirements of FCC Part 15.207

3.1 Test Procedure

The arrangement specified in ANSI C63.4-1992 was adhered to for the conducted EMI measurements. The EUT was placed in the RF screened enclosure and a CISPR EMI Receiver as defined in ANSI C63.2-1987 was used to perform the measurements.

The EMI Receiver was operated under program control using the Max-Hold function and automatic frequency scanning, measurement and data logging techniques. The specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all short duration peaks were captured.

3.2 Peak Maximising Procedure

The various operating modes of the system were investigated. For each of the sub-ranges, the EMI receiver was set to continuous scan with the Peak detector set to Max-Hold mode. The Quasi-Peak detector and the Average detector were then invoked to measure the actual Quasi-Peak and Average level of the most significant peaks, which were detected.

3.3 Calculation of Voltage Levels

The voltage levels were automatically measured in software and compared to the test limit. The method of calculation was as follows:

VEMI = VRx + LBPF

Where: **VEMI =** the Measured EMI voltage in dBµV to be compared to the limit.
VRx = the Voltage in dBµV read directly at the EMI receiver.
LBPF = the insertion loss in dB of the cables and the Limiter and Pass Filter.

3.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were then concatenated to form a single graph of (peak) amplitude versus frequency. This was performed for both Active and Neutral lines and the composite graph were subsequently plotted. A list of the highest relevant peaks and the respective Quasi-Peak and Average values were also plotted on the graph.

3.5 Results of Conducted Emission Measurements (AC Mains Ports)

All recorded emissions complied with the Class B quasi peak and average limits by margins of greater than 20 dB. The measurement uncertainty for conducted EMI was 2.0 dB.
Refer to Appendix C, Graphs 1 and 2.

4.0 RADIATED EMISSION MEASUREMENTS

4.1 Test Procedure

The Digital Identification Tag Reader transmits continuously on 13.56 MHz. Testing was performed in accordance with the requirements of FCC Part 15.225.

Radiated emission measurements were performed to the limits as per section 15.209.

The EUT was set up on the table top (placed on turntable) of total height 80 cm above the ground plane, and operated as described in section 2 of this report. The EMI Receiver was operated under software control via the PC Controller through the IEEE.488 Interface Bus Card Adaptor. The test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. A calibrated Biconical antenna was used for measurements between 30 MHz to 232 MHz, a calibrated Logperiodic antenna used for measurements between 230 MHz to 1000 MHz and a calibrated Loop antenna was used for measurements between 0.009 MHz to 30 MHz. Calibrated EMCO 3115 Horn antenna was used for measurements between 1 to 8.5 GHz.

The measurement of emissions between 0.009 - 30 MHz was measured with the resolution bandwidth of 9 kHz and the video bandwidth of 30 kHz.

The measurement of emissions between 30 - 1000 MHz was measured with the resolution bandwidth of 120 kHz and the video bandwidth of 300 kHz.

The measurement of emissions above 1000 MHz was made using an average detector with the resolution bandwidth of 1.0 MHz.

The EUT was slowly rotated with the Peak Detector set to Max-Hold. This was performed for two antenna heights. Each significant peak was then investigated and maximised with the Quasi-Peak detector. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both parallel and perpendicular antenna polarisations.

4.2 Plotting of Measurement Data for Radiated Emissions

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 0.009-30 MHz and 30-1000 MHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI *peak* measurements as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the "**#**" symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with the "#" symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, quasi-peak field strength and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit.

At times, the quasi peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector, after the peak trace is recorded. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level.

4.3 Calculation of Peak and Average Field Strength

The peak field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

E = V + AF - G + L

Where:

E = Radiated Peak Field Strength in dBµV/m.
V = EMI Receiver Voltage in dBµV. (measured value)
AF = Antenna Factor in dB(m^{-1}). (stored as a data array)
G = Preamplifier Gain in dB. (stored as a data array)
L = Cable insertion loss in dB. (stored as a data array of Insertion Loss versus frequency)

- **Example Peak Field Strength Calculation**

Assuming a receiver reading of 34.0 dBµV is obtained at 90 MHz, the Antenna Factor at that frequency is 9.2 dB. The cable loss is 1.9 dB while the preamplifier gain is 20 dB. The resulting Field Strength is therefore as follows:

34.0 + 9.2 + 1.9 - 20 = 25.1 dBµV/m

4.4 Results

4.4.1 0.009 to 30 MHz

The measurements were made at the open area test site at a distance of 3 metres.

Frequency MHz	Polarisation	Level Measured dBµV/m	Limit dBµV/m	Δ ± dB
13.56	Perpendicular	74.3	124.0	-49.8
13.56	Parallel	68.4	124.0	-55.6

The highest radiated field strength emission complied with FCC limits by a margin of 49.8 dB at 13.56 MHz (transmitter fundamental). No harmonics or spurious emissions (0.009 to 30 MHz) were found within 20 dB of the limits. The measurement uncertainty for radiated field strength emissions was ±3.7 dB. Refer to Appendix C, graphs 3 and 4.

Conclusion: Complies.

4.4.2 30 – 1000 MHz

The measurements were made at the open area test site at a distance of 10 metres.

Vertical Polarity

Frequency MHz	Polarisation	QP Measured dBμV/m	QP Limit dBμV/m	ΔQP ± dB
400.00	Vertical	35.2	36.0	-0.8
30.03	Vertical	29.1	30.0	-1.0
31.79	Vertical	28.9	30.0	-1.1
32.32	Vertical	28.7	30.0	-1.4
397.55	Vertical	33.6	36.0	-2.4
800.05	Vertical	33.0	36.0	-3.0
34.22	Vertical	26.9	30.0	-3.1
110.93	Vertical	29.3	33.5	-4.2
146.71	Vertical	28.8	33.5	-4.7
152.36	Vertical	28.6	33.5	-4.9
153.23	Vertical	27.9	33.5	-5.7
35.74	Vertical	23.9	30.0	-6.1
125.00	Vertical	27.4	33.5	-6.1
333.30	Vertical	29.2	36.0	-6.8
151.10	Vertical	26.7	33.5	-6.8
55.01	Vertical	22.7	30.0	-7.3

Horizontal Polarity

Frequency MHz	Polarisation	QP Measured dBμV/m	QP Limit dBμV/m	ΔQP ± dB
400.00	Horizontal	34.3	36.0	-1.7
800.02	Horizontal	33.3	36.0	-2.7
397.59	Horizontal	32.6	36.0	-3.4
216.96	Horizontal	28.1	36.0	-7.9
333.26	Horizontal	28.1	36.0	-8.0
151.84	Horizontal	25.5	33.5	-8.0
154.42	Horizontal	21.9	33.5	-11.7
50.96	Horizontal	17.6	30.0	-12.4
73.20	Horizontal	16.8	30.0	-13.2
624.93	Horizontal	22.3	36.0	-13.7
233.90	Horizontal	21.6	36.0	-14.4
101.51	Horizontal	17.5	33.5	-16.0
107.90	Horizontal	15.8	33.5	-17.7
109.38	Horizontal	15.5	33.5	-18.0

The worst case radiated EMI occurred at 400.0 MHz and complied with the Class B quasi peak limit by a margin of 0.8 dB. The measurement uncertainty for radiated emissions was ±3.7 dB. Refer to Appendix C, graphs 5 & 6.

Conclusion: Complies.

4.4.3 1 – 8.5 GHz

The measurements were made at the open area test site at a distance of 3 metres.

No emissions were found within 20dB of the FCC Class B average limit. The measurement uncertainty for radiated emissions in this band was ±4.1 dB.

Conclusion: Complies.

5.0 FREQUENCY TOLERANCE

Not tested at client's request.

6. 0 ANTENNA REQUIREMENT

Testing to the requirements of FCC Part 15.203 was not applicable as this intentional radiator was designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

7.0 COMPLIANCE STATEMENT

The Digital Identification Tag Reader, tested on behalf of 3M Library Systems, **complies** with the requirements of 47 CFR, Part 15 Subpart C - Rules for Radio Frequency Devices (intentional radiators), Section 15.225: Operation within the band 13.110 – 14.010 MHz, except section 15.225(e): Frequency Tolerance – Not tested at client's request.

Results were as follows:

FCC Part 15, Subpart C Clauses	Test Performed	Result
15.203	Antenna Requirement	**Not Applicable**
15.205	Operation in Restricted Band	**Complies**
15.207	Conducted Emissions	**Complies**
15.209	Radiated Emissions	**Complies**
15.225	Operation within the band 13.110 – 14.010 MHz	***Complies**

*Frequency Tolerance – Not tested at client's request.

APPENDIX A
MEASUREMENT INSTRUMENTATION DETAILS

EQUIPMENT TYPE	MAKE/MODEL SERIAL NUMBER	LAST CAL. DD/MM/YY	DUE DATE DD/MM/YY	CAL. INTERVAL
EMI RECEIVER	HP 8574B System Components	26/09/03	26/09/04	1 YEAR *2
EMI RECEIVER	HP 8546A, Sn: 3549A00290	13/02/04	13/02/05	1 YEAR *2
SPECTRUM ANALYSER	HP 8593EM Sn. 3146A-01297 9 kHz –26 GHz	23/05/02	23/05/03	1 YEAR *2
ANTENNAS	EMCO 93110B BICONICAL	20/08/03	20/08/04	1 YEAR *1
	20 - 300 MHz Sn. 9804-3092			
	EMCO 93146A LOG PERIODIC	11/07/03	11/07/04	1 YEAR *1
	200 -1000MHz Sn. 5033			
	EMCO 6502 ACTIVE LOOP ANTENNA 0.009 – 30 MHz Sn: 9609-3065	04/07/03	04/07/04	1 YEAR *1
	EMCO 3115 DOUBLE RIDGED HORN 1 - 18 GHz Sn: 8908-3282	29/01/03	29/01/06	3 YEAR *1
PREAMPLIFIER	HP 8449B PREAMPLIFIER	29/05/02	29/05/03	1 YEAR *1
LISN	EMCO 3810/2 50ohm / 50 microH	05/04/04	05/04/05	1 YEAR *1
	0.009 – 30MHz Model: L-19			

Note *1. In-house calibration. Refer to Quality Manual.
Note *2. NATA calibration by Agilent Technologies (Aust) Pty Ltd

TEST SITES

Shielded Room Test Laboratory	**Melbourne** 11m x 8m x 4m Chamber-semi-anechoic 8.8m x 5.8m x 3.1m Test Chamber 3.4m x 6.1m x 2.5m Test Chamber 3.4m x 7.3m x 7.5m Test Chamber	Feb 04 N/A N/A N/A	Feb 05 N/A N/A N/A	1 Year *1 N/A N/A N/A
Open Area Test Site	**Melbourne** 3/10 Metre site. 1-4 metre antenna mast. 1.2 metre/400 kg Turntable. (Situated at Lerderderg Gorge, near Bacchus Marsh, Victoria)	11/02/04	11/02/05	1 Year *1

Note *1. In-house calibration. Refer to Quality Manual.

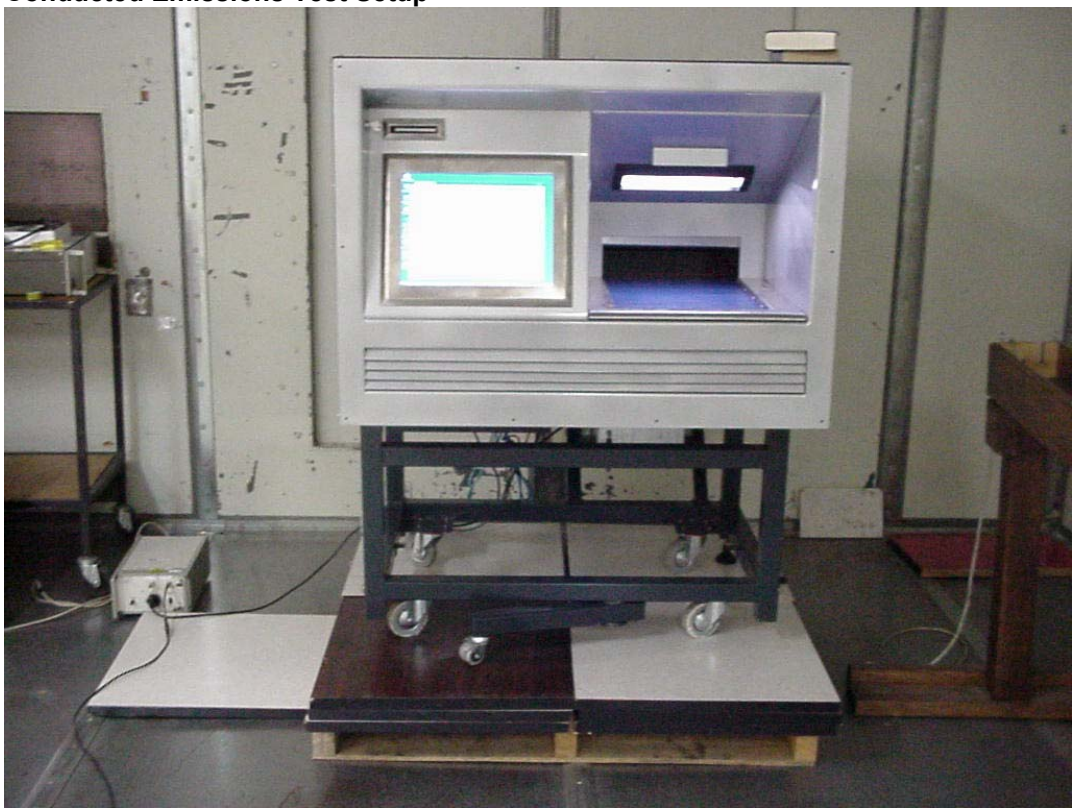
APPENDIX B1
Test Setup Photographs

Radiated Emissions at 3m

Radiated Emissions at 10m

APPENDIX B2
Test Setup Photographs

Conducted Emissions Test Setup



APPENDIX C

Graphs of EMI Measurements

CONDUCTED EMI

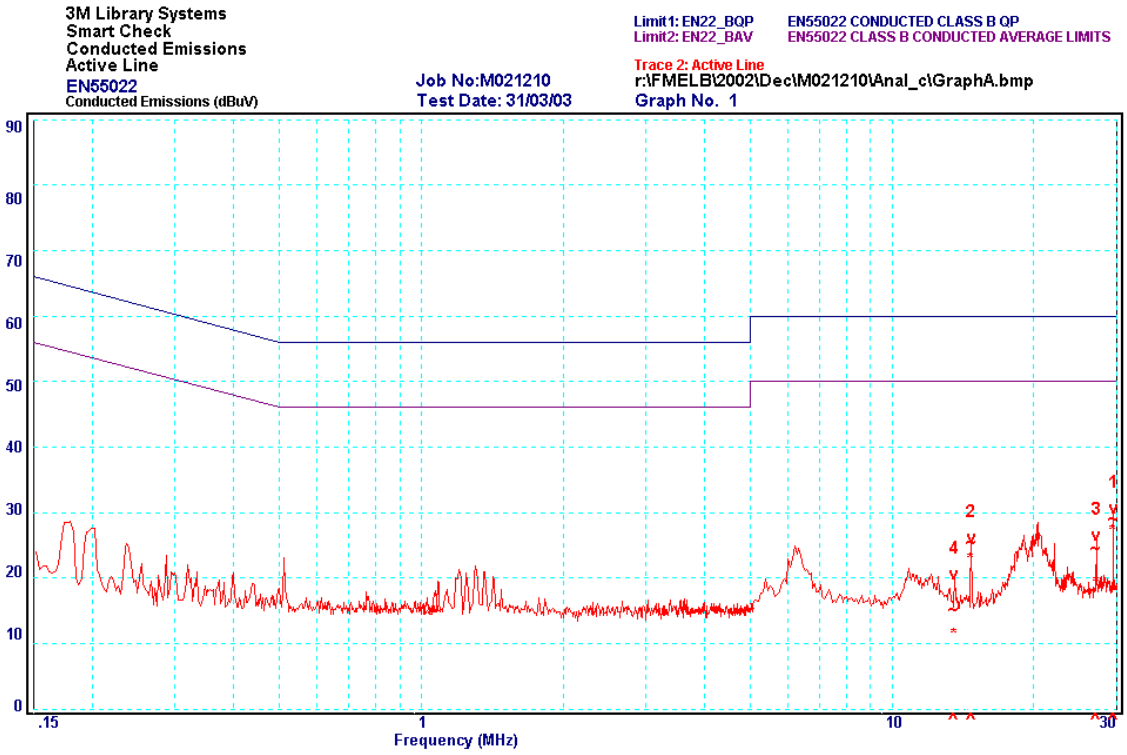
Graph 1:	Active Line,	0.15 MHz - 30 MHz
Graph 2:	Neutral Line,	0.15 MHz - 30 MHz

RADIATED EMI

Graph 3:	Antenna Perpendicular	0.009 MHz - 30 MHz
Graph 4:	Antenna Parallel	0.009 MHz - 30 MHz
Graph 5:	Vertical Polarisation	30 MHz - 1000 MHz
Graph 6:	Horizontal Polarisation	30 MHz - 1000 MHz

CONDUCTED EMI

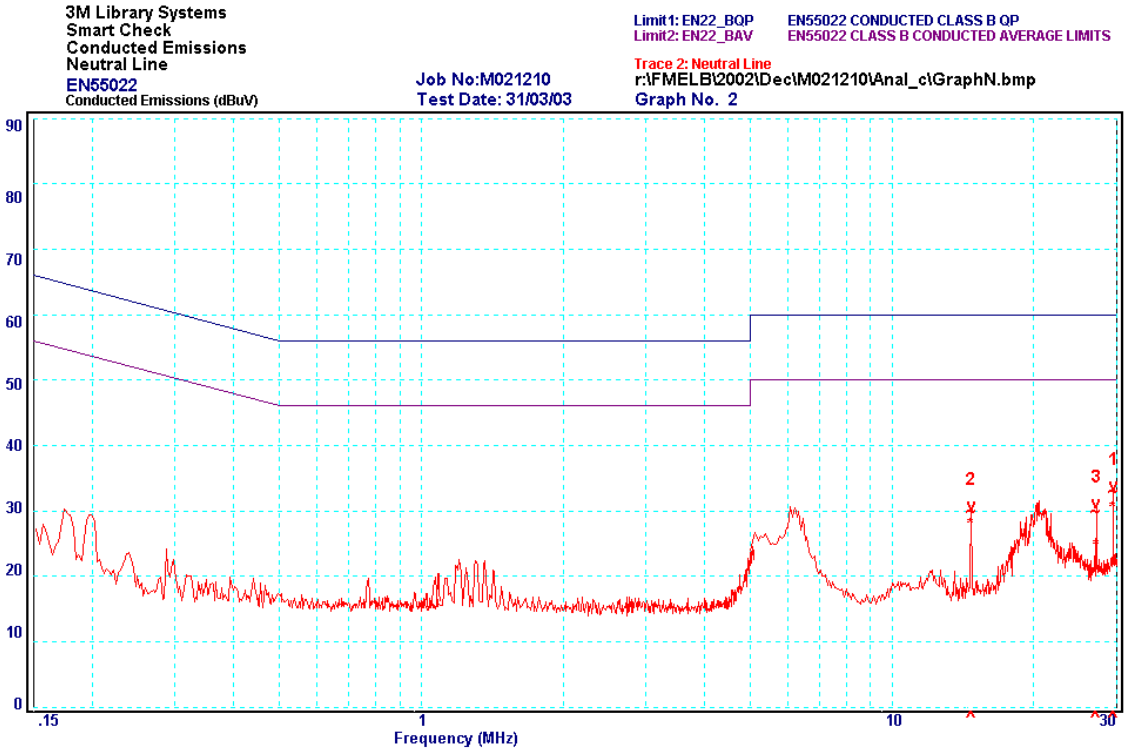
Graph 1: Active Line, 0.15 MHz - 30 MHz



Peak	Frequency MHz	Line	QP Measured dBμV	QP Limit dBμV	ΔQP ±dB	Average Measured dBμV	AV Limit dBμV	ΔAV ±dB
1	29.49	Active	28.5	60.0	-31.5	26.6	50.0	-23.4
2	14.75	Active	24.8	60.0	-35.2	22.4	50.0	-27.6
3	27.12	Active	23.9	60.0	-36.1	18.8	50.0	-31.2
4	13.56	Active	14.7	60.0	-45.3	10.8	50.0	-39.2

CONDUCTED EMI

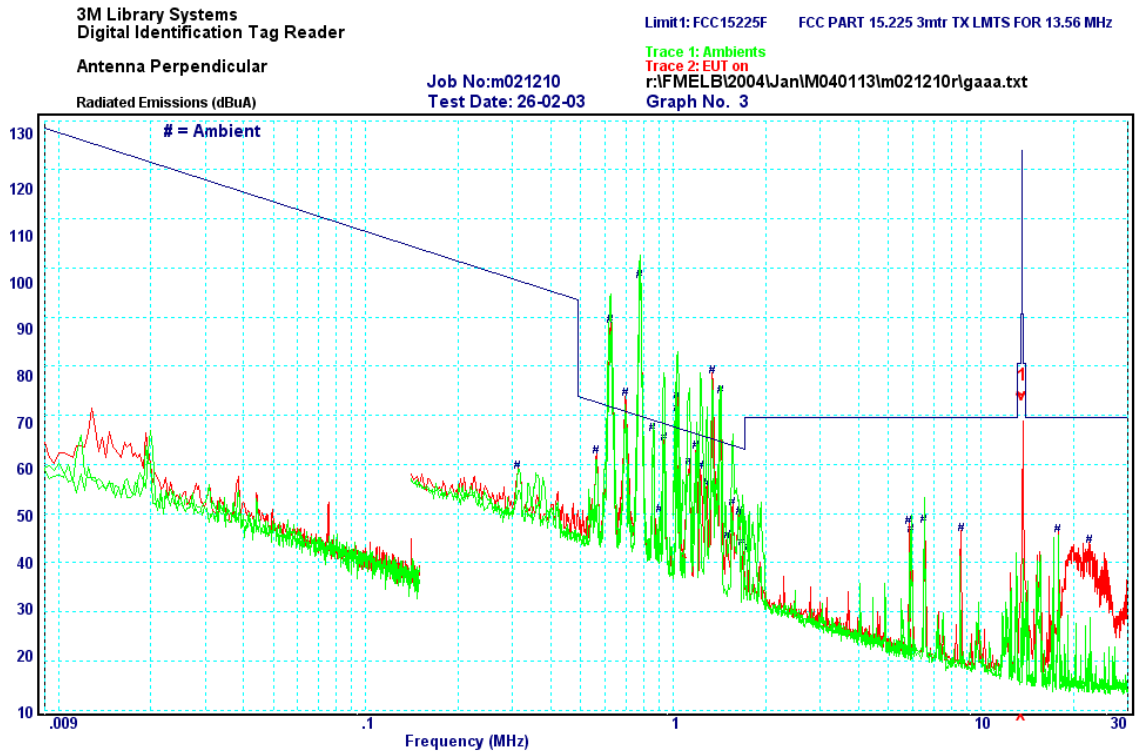
Graph 2: Neutral Line, 0.15 MHz - 30 MHz



Peak	Frequency MHz	Line	QP Measured dBμV	QP Limit dBμV	ΔQP ±dB	Average Measured dBμV	AV Limit dBμV	ΔAV ±dB
1	29.49	Neutral	32.4	60.0	-27.6	29.9	50.0	-20.1
2	14.74	Neutral	29.4	60.0	-30.6	27.4	50.0	-22.6
3	27.12	Neutral	29.3	60.0	-30.7	24.1	50.0	-25.9

RADIATED EMI

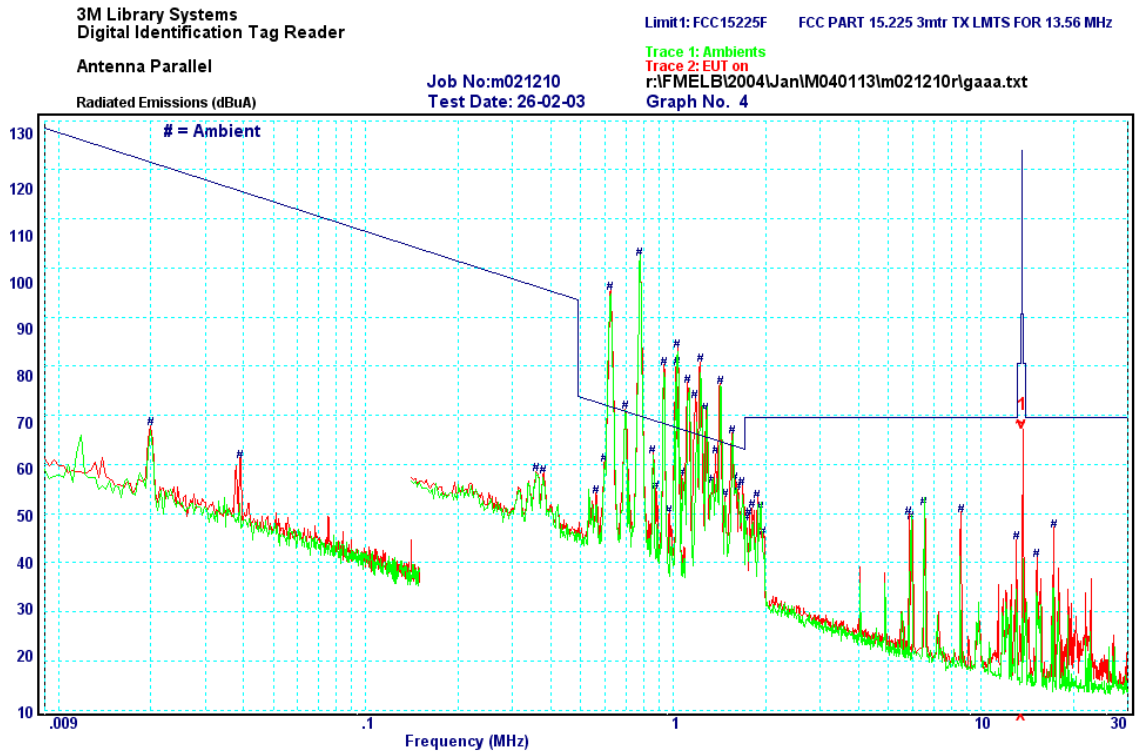
Graph 3: Vertical Polarisation, 30 MHz - 150 MHz



Peak	Frequency MHz	Polarisation	QP Measured dBμV/m	QP Limit dBμV/m	ΔQP ± dB
1	13.56	Perpendicular	74.3	124.0	-49.8

RADIATED EMI

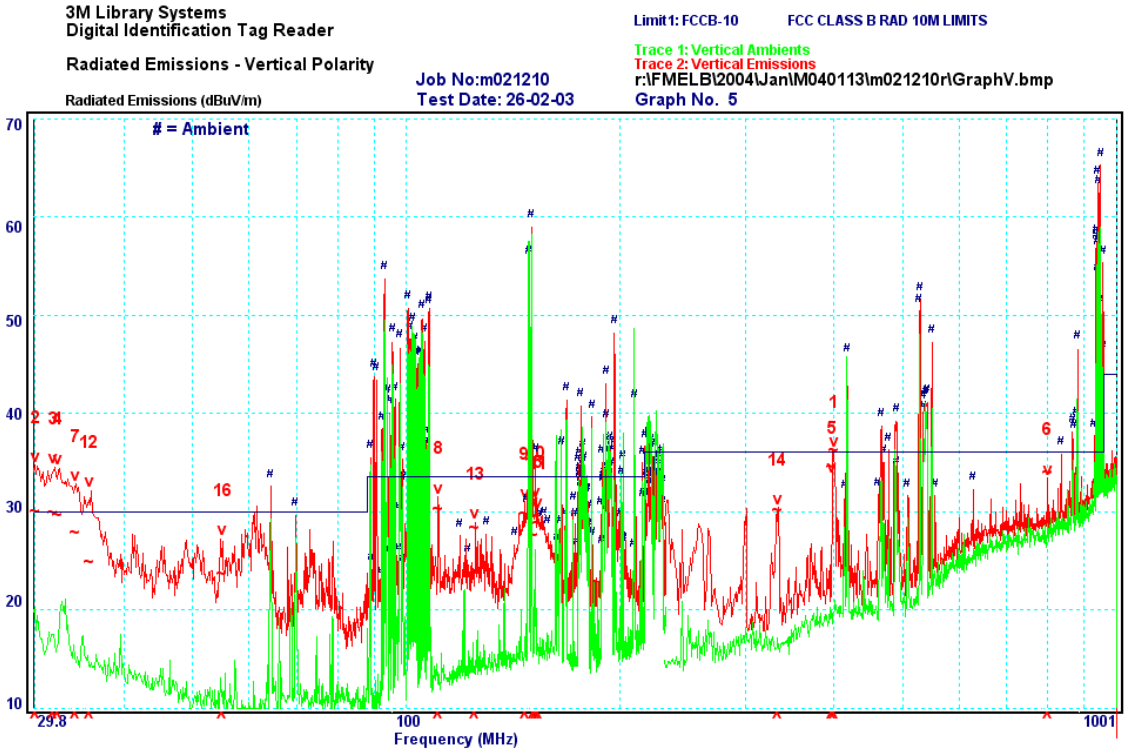
Graph 4: Vertical Polarisation, 145 MHz - 1000 MHz



Peak	Frequency MHz	Polarisation	QP Measured dBμV/m	QP Limit dBμV/m	ΔQP ± dB
1	13.56	Parallel	68.4	124.0	-55.6

RADIATED EMI

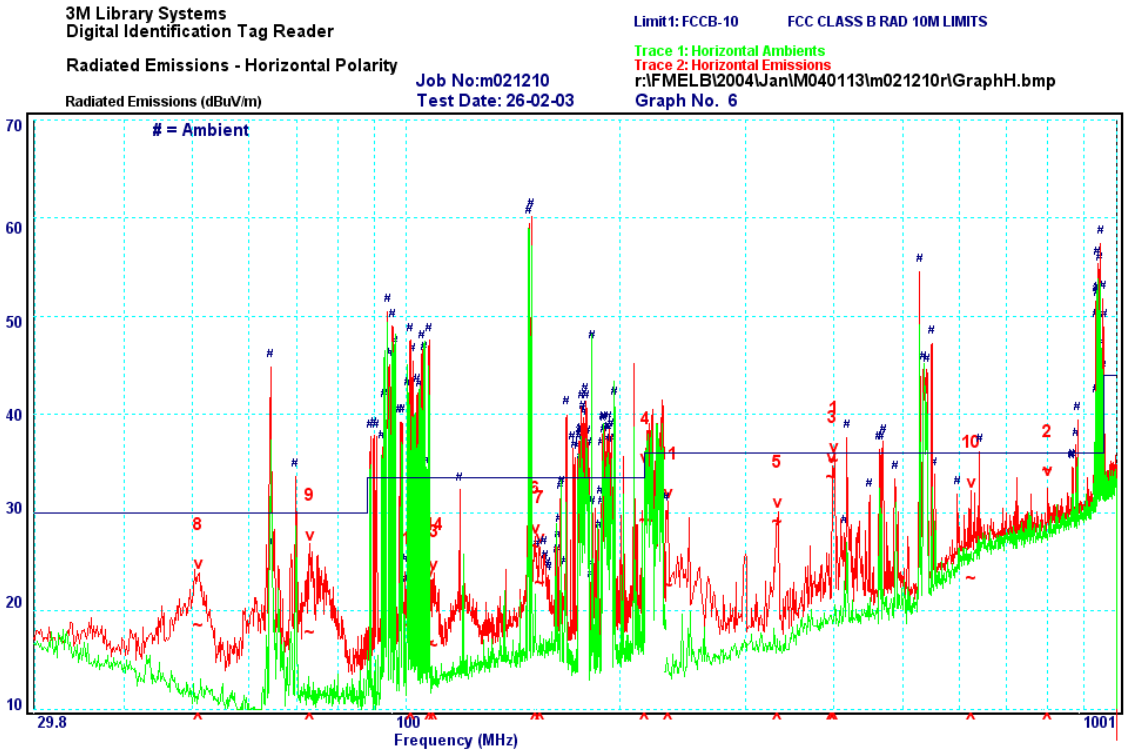
Graph 5: Vertical Polarisation 30 MHz - 150 MHz



Peak	Frequency MHz	Polarisation	QP Measured dBμV/m	QP Limit dBμV/m	ΔQP ± dB
1	400.00	Vertical	35.2	36.0	-0.8
2	30.03	Vertical	29.1	30.0	-1.0
3	31.79	Vertical	28.9	30.0	-1.1
4	32.32	Vertical	28.7	30.0	-1.4
5	397.55	Vertical	33.6	36.0	-2.4
6	800.05	Vertical	33.0	36.0	-3.0
7	34.22	Vertical	26.9	30.0	-3.1
8	110.93	Vertical	29.3	33.5	-4.2
9	146.71	Vertical	28.8	33.5	-4.7
10	152.36	Vertical	28.6	33.5	-4.9
11	153.23	Vertical	27.9	33.5	-5.7
12	35.74	Vertical	23.9	30.0	-6.1
13	125.00	Vertical	27.4	33.5	-6.1
14	333.30	Vertical	29.2	36.0	-6.8
15	151.10	Vertical	26.7	33.5	-6.8
16	55.01	Vertical	22.7	30.0	-7.3

RADIATED EMI

Graph 6: Horizontal Polarisation 145 MHz - 1000 MHz



Peak	Frequency MHz	Polarisation	QP Measured dBμV/m	QP Limit dBμV/m	ΔQP ± dB
1	400.00	Horizontal	34.3	36.0	-1.7
2	800.02	Horizontal	33.3	36.0	-2.7
3	397.59	Horizontal	32.6	36.0	-3.4
4	216.96	Horizontal	28.1	36.0	-7.9
5	333.26	Horizontal	28.1	36.0	-8.0
6	151.84	Horizontal	25.5	33.5	-8.0
7	154.42	Horizontal	21.9	33.5	-11.7
8	50.96	Horizontal	17.6	30.0	-12.4
9	73.20	Horizontal	16.8	30.0	-13.2
10	624.93	Horizontal	22.3	36.0	-13.7
11	233.90	Horizontal	21.6	36.0	-14.4
12	101.51	Horizontal	17.5	33.5	-16.0
13	107.90	Horizontal	15.8	33.5	-17.7
14	109.38	Horizontal	15.5	33.5	-18.0