DATE: 26 August 1998

EMC Test Report

from

ITL (Product Testing) Ltd.

for

Master Meter Inc.

Equipment under test:

Hand-held Data Terminal

MINT

Prepared by:

_____

I. Raz, EMC Laboratory Manager
ITL (Product Testing) Ltd.

Approved by:

_____

Jon Griver, Vice President, Operations
ITL (Product Testing) Ltd.

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This report relates only to item(s) tested.

Measurement/Technical Report for

Master Meter Inc.

Equipment under test:

Hand-held Data Terminal

MINT

This report concerns: Original Grant **_X_** Class II change

Class B verification _ Class A verification_ Class I change

Equipment type: DCD – Low Power Transmitter Below 1705 KHz

Request Issue of Grant: **_X_** Immediately upon completion of review

Limits used: CISPR 22 ___ Part 15 **_X**

Measurement procedure used is ANSI C63.4-1992.

Application is for Certification.

Applicant for this device:

prepared by:

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(different from "prepared by")

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TABLE OF CONTENTS

1 General Information

1.1 Product Description

Master Meter, Inc. hand-held data terminal MINT is used for remote water meter reading and to initialize parameters of water meters. The unit is a stand alone unit based on a NEC-V53 (24 MHz crystal/2) microprocessor. MINT has an LCD display unit, keyboard, rechargeable battery pack, real-time clock and a magnetic coupler for communication with meters, all installed in a rigid plastic case.

In regular mode the MINT communicates with the meter in a baud rate of 300 baud and transmits bursts of up to 100 msec. Its transmission frequency is 77 kHz. In fast mode the baud rate of the burst is 1200 baud, with the other parameters identical. The MINT has an internal passive envelope detector connected to its internal coupling coil used for reception data from meters. Note - there is no local oscillator in reception mode (passive detector)

The MINT has a standard D-9 type RS232 connector for loading software and battery charging.

1.2 Tested System Details

The FCC IDs for all equipment, plus description of all cables used in the tested system are:

Description	Model No.	Serial No.	FCC ID	Cable Description
EUT Hand-held Terminal	MINT	-	MXN-MINT	1) for Conducted Emmission - 1.5 m, unshielded 2) for Radiated Emission - communication cable 1.5 m, unshielded
Plug-in Power Supply by ITE	UP02511050	-	-	-
Internal Battery 2.4 V, 1850 mAh by Micronet Ltd.	GBAT-158	-	-	-

1.3 Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.4:1992. Radiated testing was performed at an antenna to EUT distance of 3 meters.

1.4 Test Facility

The open area test site and conducted measurement facility used to collect the data is located at Kfar Bin Nun, Israel. This site has been fully described in reports dated April 10, 1995 and May 8, 1995, submitted to your office, and accepted in a letter dated July23, 1998 (31040/SIT 1300F2).

1.5 Measurement Uncertainty

a) Radiated Emission

The Open Site complies with the 4dB Normalised Site Attenuation requirements of ANSI C63.4-1992. In accordance with Paragraph 5.4.6.2 of this standard this tolerance includes instrumentation calibration errors, measurement technique errors, and errors due to site anomalies.

b) Conducted Emission

The uncertainty for this test is 2dB.

2 System Test Configuration

2.1 Justification

The unit was configured for testing to create to worst case emissions. In this test the unit was programmed to transmit a continuous stream of bits (1010) in a baud rate of 1200 baud, which modulated the 77 kHz oscillator and transmitted through the coupling coil. These conditions are not the typical conditions of use where the unit does not work continuously. Usually the unit transmits bursts up to 100 msec. in a baud rate of 300 baud. Fast mode bursts up to 100 msec. in a baud rate of 1200. In a typical use, the duty cycle between transmission and reception is very low. During the test, the processor, real-time clock, LCD unit and coupler were "On." During transmission and reception of data in regular use, the RS232 output connector automatically disconnects. The system test configuration caused worse emission condition, which added a few more dB's than emission in typical uses.

2.2 Special Accessories

No special accessories were needed to achieve compliance.

2.3 Equipment Modifications

(a) One 10 nF ceramic capacitor soldered between positive pins 2,4 and negative pins 14, 16 of the coupler PCB connector on the component side was added.

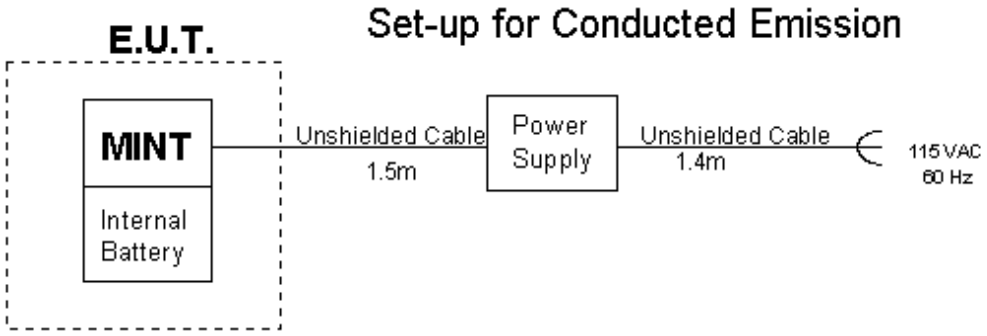
See Fig. 12.6.

(b) Chip capacitor C_{23} was changed from 200pf to 270pf.

The above modification will be implemented in all production units of this equipment.

2.4 Configuration of Tested System

The configuration of the tested system is described below.



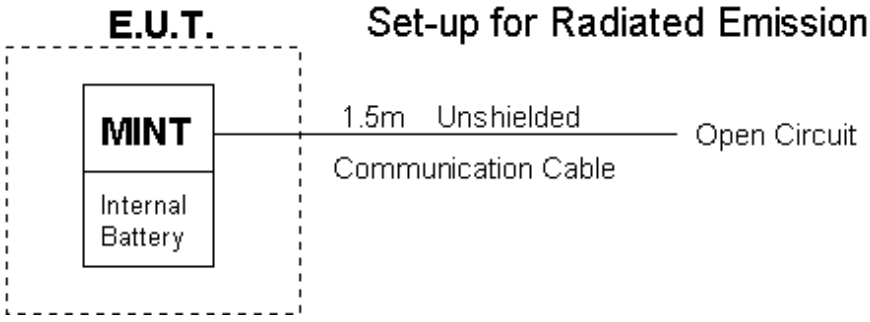


Figure 1 Configuration of Tested System

3 Conducted Emission Data

3.1 Conducted Emission

0.45- 30 MHz, F.C.C., Part 15, Subpart C: CLASS B

The E.U.T operation mode and test set-up are as described in Section 2. In order to minimise background noise interference, the conducted emission testing was performed inside a shielded room, with the E.U.T placed on an 0.8 meter high wooden table, 0.4 meter from the room's vertical wall.

The E.U.T was powered from 115 V AC / 60 Hz via 50 Ohm / 50 µHn Line Impedance Stabilisation Network (LISN) on the phase and neutral lines. The LISN's were grounded to the shielded room ground plane (floor), and were kept at least 0.8 meters from the nearest boundary of the E.U.T

The centre of the E.U.T AC cable was folded back and forth, in order to form a bundle less than 0.40 meters and a total cable length of 1 meter.

The effect of varying the position of the cables was investigated to find the configuration that produces maximum emission.

The emission voltages at the LISN's outputs were measured using a computerised receiver, complying to CISPR 16 requirements. The specification limits are loaded to the receiver via a 3.5" floppy disk and are displayed on the receiver's spectrum display.

A frequency scanbetween 0.45 and 30 MHz was performed at 9 kHz I.F. band width, and using peak detection.

The spectral components having the highest level on each line were measured using a quasi-peak detector.

3.2 Measured Data

JUDGEMENT: Passed by 17.2 dbµV.

The EUT met the requirements of the specification.

The details of the highest emissions are given in Figures 3.1 to 3.4

TEST PERSONNEL:

Tester Signature: _____ DATE:

T yped/Printed name Y. Mordukhovitch

Conducted Emission

E.U.T Description: Hand-held Data Terminal
Type: MINT
Serial Number: Not designated
Specification**:** F.C.C., Part 15, Subpart C: Class B
Lead: **Phase**. Detectors: **Peak, Quasi-peak**
Remarks: Charge Mode

Frequency	**Meas. Level (dBµV)**		**Specification**	**Pass/Fail**	**Margin**
(MHz)	**Peak**	**Quasi- Peak**	**(dB µV)**		**(dB)**
0.52	32.9	30.8	48.0	Pass	-17.2
1.50	28.1	26.0	48.0	Pass	-22.0
9.93	24.2	22.4	48.0	Pass	-25.6
10.73	22.5	19.3	48.0	Pass	-28.7
12.04	25.2	20.7	48.0	Pass	-27.3
21.33	30.0	28.4	48.0	Pass	-19.6

Figure 3.1 Conducted Emission: Phase.

Detectors: Peak, Quasi-peak

TEST PERSONNEL:
Tester Signature: _____ DATE:

typed/printed name: Y. Mordukhovitch

Conducted Emission

E.U.T Description: Hand-held Data Terminal
Type: MINT
Serial number: Not designated
Specification: F.C.C., Part 15, Subpart C: Class B
Lead: **Neutral**. Detectors: **Peak, Quasi-peak**
Remarks: Charge Mode

Frequency (MHz)	**Meas. Level (dBµV) Peak**	**Quasi- Peak**	**Specification (dB µV)**	**Pass/Fail**	**Margin (dB)**
0.46	30.2	29.6	48.0	Pass	-18.4
2.08	32.4	30.7	48.0	Pass	-17.3
9.95	29.1	27.4	48.0	Pass	-20.6
11.78	27.7	25.5	48.0	Pass	-22.5
13.54	25.3	23.1	48.0	Pass	-24.9
29.43	24.2	19.7	48.0	Pass	-28.3

Figure 3.2 Conducted Emission: Neutral.

Detectors: Peak, Quasi-peak.

TEST PERSONNEL:
Tester Signature: _____ DATE:

typed/printed name: Y. Mordukhovitch

Conducted Emission

E.U.T Description: Hand-held Data Terminal
Type: MINT
Serial number: Not designated
Specification: F.C.C., Part 15, Subpart C: Class B
Lead: **Phase** Detectors: **Peak, Quasi-peak**
Remarks: Charge Mode

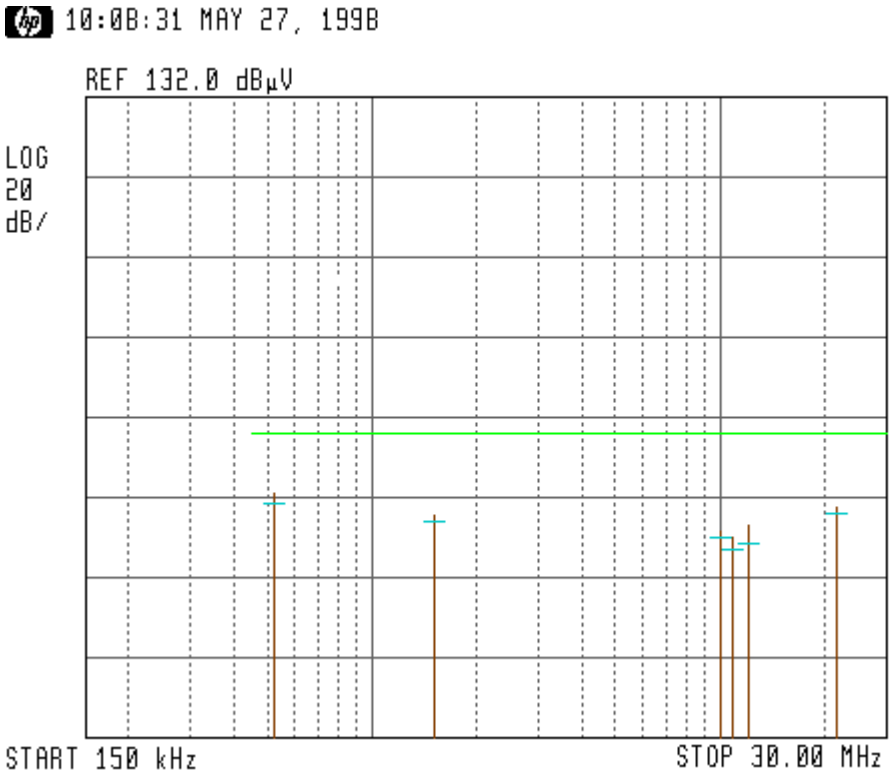


Figure 3.3 Conducted Emission: Phase. Detectors: Peak, Quasi-peak

Notes:

1. Horizontal axis shows logarithmic frequency scale.

2. The vertical axis shows amplitude (in dB µV).

3. Peak detection is designated by the top of each vertical line.

4. Quasi-peak detection is designated by the first dash mark (from the top) of each vertical line.

Conducted Emission

E.U.T Description: Hand-held Data Terminal
Type: MINT
Serial number: Not designated
Specification: F.C.C., Part 15, Subpart C: Class B
Lead: **Neutral**. Detectors: **Peak, Quasi-peak**
Remarks: Charge Mode

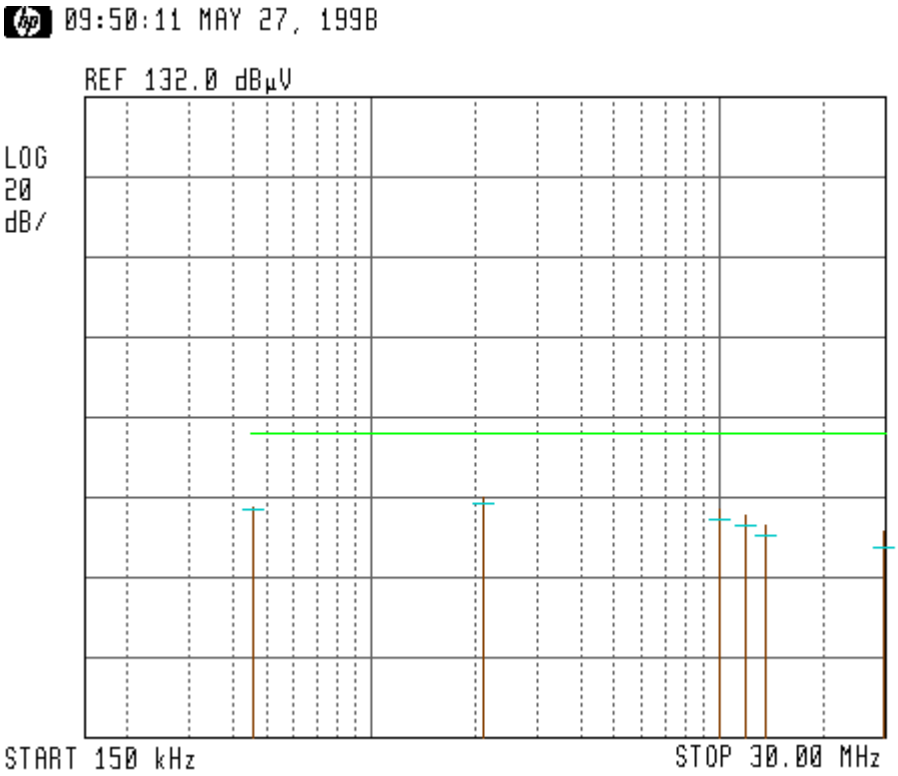


Figure 3.4 Conducted Emission: Neutral. Detectors: Peak, Quasi-peak

Notes:

1. Horizontal axis shows logarithmic frequency scale.

2. The vertical axis shows amplitude (in dB µV).

3. Peak detection is designated by the top of each vertical line.

4. Quasi-peak detection is designated by the first dash mark (from the top) of each vertical line.

3.3 Test Instrumentation Used, Conducted Measurement

Instrument	Manufacturer	Model	Serial No.	Calibration	
				Last Cal.	Period
LISN	Fischer	FCC-LISN-2A	127	May 18, 1998	1 year
LISN	Fischer	FCC-LISN-2A	128	May 18, 1998	1 year
Receiver	HP	85420E/85422E	3427A00103/34	Oct. 26, 1997	1 year
Printer	HP	ThinkJet2225	2738508357	N/A	N/A

4 Radiated Emission Data

4.1 Radiated Emission

77 kHz-1000 MHz F.C.C., Part 15, Subpart C: CLASS B

The E.U.T. operation mode and test set-up are as described in Section 2.

A preliminary measurement to characterise the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The effect of varying the position of the cables was investigated to find the configuration that produces maximum emission.

The frequency range 77 kHz-1000 MHz was scanned, and the list of the highest emissions was verified and updated accordingly.

The emissions were measured using a computerised EMI receiver complying to CISPR 16 requirements. The specification limits and applicable correction factors are loaded to the receiver via a 3.5" floppy disk.

The readings were maximised by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarisation.

Verification of the E.U.T emissions was based on the following methods:

Turning the E.U.T on and off.

Using a frequency span less than 10 MHz.

Observation of the signal level during turntable rotation. Background noise is not affected by the rotation of the E.U.T.

4.2 Measured Data

JUDGEMENT: Passed by 1.5 dB.

The EUT met the requirements of the specification.

Note - One 10 nF ceramic capacitor soldered between positive pins 2,4 and negative pins 14, 16 of the coupler PCB connector on the component side was added to achieve compliance

The details of the highest emissions are given in Figures 4.1 to 4.8.

TEST PERSONNEL:

Tester Signature: _____ DATE:

typed/printed name: Y. Mordukhovitch

Radiated Emission

E.U.T Description: Hand-held Data Terminal

Type: MINT

Serial number: Not designated

Specification: F.C.C., Part 15, Subpart C: CLASS B

Antenna Polarisation: **Horizontal** Detector: **Quasi-peak**

REMARKS: Antenna at 3 meters distance, Frequency range: 75 kHz to 300 MHz.

Freq	**QP Amp**	**Specification**	**Margin**	**Correction Factor (dB)**	
(MHz)	(dB µV/m)	(dB µV/m)	(dB µV/m)	**Ant**	**Cable**
84.01	34.5	40.0	-5.5	9.2	1.8
182.72	29.7	43.5	-13.8	13.6	2.9
186.98	30.6	43.5	-12.9	13.9	2.9
194.73	33.6	43.5	-9.9	14.4	2.9
258.6	31.1	46.0	-14.9	18.2	3.5
276.04	36.5	46.0	-9.5	18.6	3.7
288.04	36.8	46.0	-9.2	19.1	3.8

Figure 4.1 Radiated Emission. Antenna Polarisation: Horizontal.

Detectors: Quasi-peak

Note: Margin refers to the test results obtained minus specified requirement; thus a negative result indicates that the product passes the test, and a positive number indicates failure.

TEST PERSONNEL:

Tester Signature: _____ DATE:

typed/printed name: Y. Mordukhovitch

Radiated Emission

E.U.T Description: Hand-held Data Terminal
Type: MINT
Serial number: Not designated
Specification: F.C.C., Part 15, Subpart C**:** CLASS B
Antenna Polarisation: **Horizontal** Detector: **Quasi-peak**
REMARKS: Antenna at 3 meters distance, Frequency range: 77 kHz to 300 MHz.

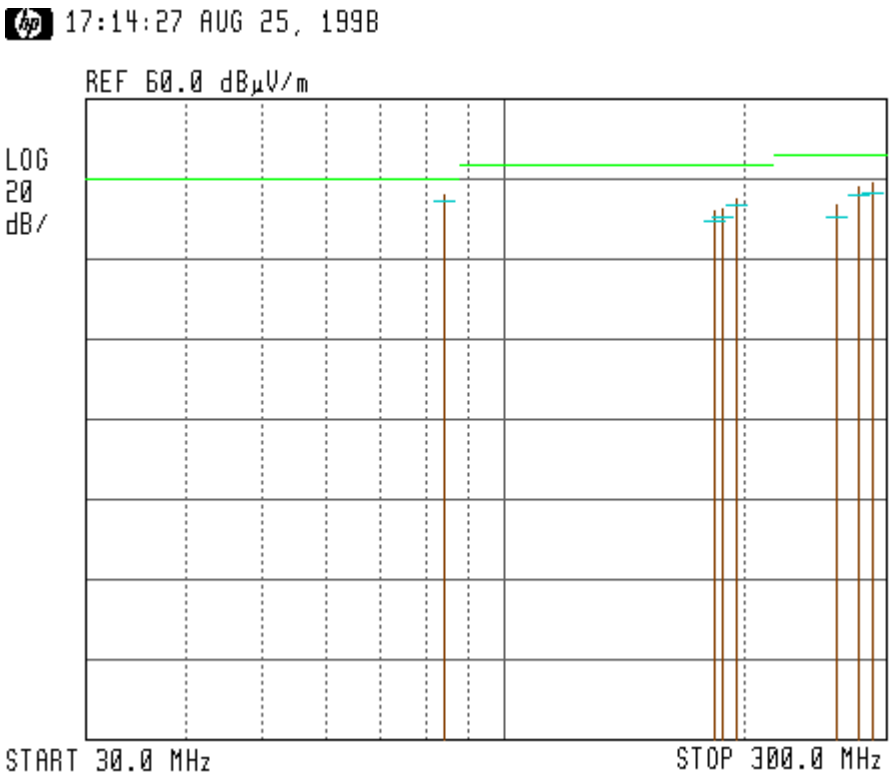


Figure 4.2 Radiated Emission. Antenna Polarisation: Horizontal.

Detector: Quasi-peak

Note:

1. Horizontal axis shows logarithmic frequency scale.

2. The vertical axis shows amplitude (in dB µV/m).

3. Peak detection is designated by the top of each vertical line.

4. Quasi-peak detection is designated by the first dash mark (from the top) of each vertical line.

Radiated Emission

E.U.T Description: Hand-held Data Terminal

Type: MINT

Serial Number: Not designated

Specification: F.C.C., Part 15, Subpart C: CLASS B

Antenna Polarisation: **Horizontal** Detector: **Quasi-peak**

REMARKS: Antenna at 3 meters distance, Frequency range: 300 MHz to 1 GHz.

Freq	**QP Amp**	**Specification**	**Margin**	**Correction Factor (dB)**	
(MHz)	(dBµV/m)	(dB µV/m)	(dB µV/m)	**Ant**	**Cable**
384.05	44.5	46.0	-1.5	14.0	4.4
456.07	43.1	46.0	-2.9	14.8	5.0
564.07	43.8	46.0	-2.2	16.5	5.5
576.09	42.7	46.0	-3.3	16.7	5.6
624.1	43.0	46.0	-3.0	17.7	5.8
648.1	42.7	46.0	-3.3	18.2	5.9
672.1	41.9	46.0	-4.1	18.5	6.1

Figure 4.3 Radiated Emission. Antenna Polarisation: Horizontal.

Detectors: Quasi-peak

Note: Margin refers to the test results obtained minus specified requirement; thus a negative result indicates that the product passes the test, and a positive number indicates failure.

TEST PERSONNEL:

Tester Signature: _____ DATE:

typed/printed name: Y. Mordukhovitch

Radiated Emission

E.U.T Description: Hand-held Data Terminal
Type: MINT
Serial Number: Not designated
Specification: F.C.C., Part 15, Subpart C: CLASS B
Antenna Polarisation: **Horizontal** Detectors: **Peak, Quasi-peak**
REMARKS: Antenna at 3 meters distance, Frequency range: 300 MHz to 1 GHz.

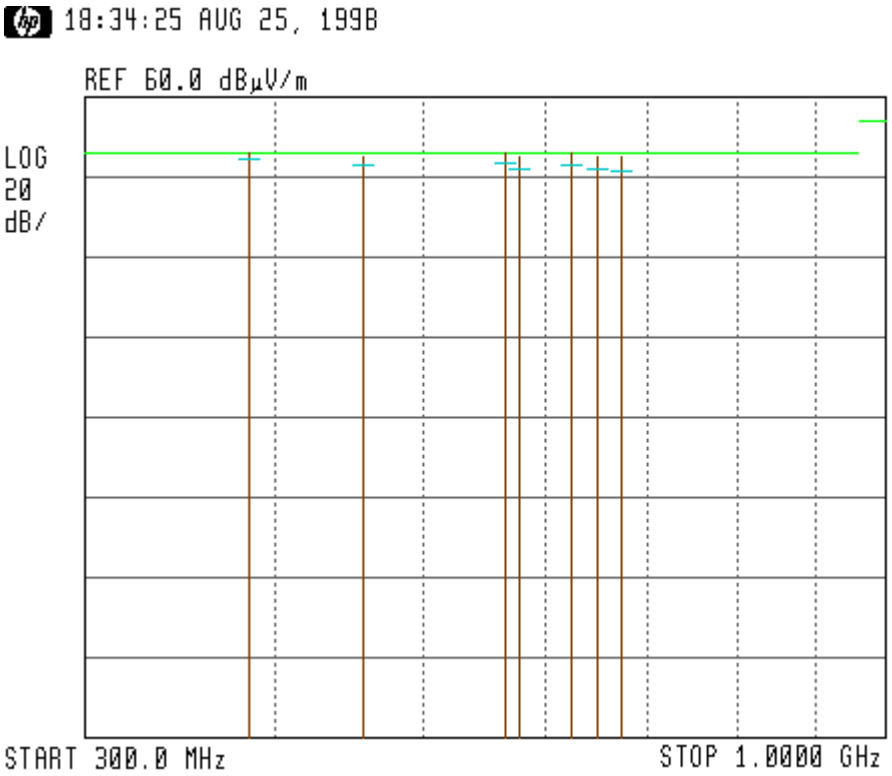


Figure 4.4 Radiated Emission. Antenna Polarisation: Horizontal.

Detector: Quasi-peak

Note:

1. Horizontal axis shows logarithmic frequency scale.

2. The vertical axis shows amplitude (in dB µV/m).

3. Peak detection is designated by the top of each vertical line.

4. Quasi-peak detection is designated by the first dash mark (from the top) of each vertical line.

Radiated Emission

E.U.T Description: Hand-held Data Terminal

Type: MINT

Serial Number: Not designated

Specification: F.C.C., Part 15, Subpart C: CLASS B

Antenna Polarisation: **Vertical** Detector: **Quasi-peak**

Remarks: Antenna at 3 meters distance, Frequency range: 77 kHz to 300 MHz.

Freq.	**QP Amp**	**Specification**	**Margin**	**Correction Factor (dB)**	
(MHz)	(dBµV/m)	(dB µV/m)	(dB µV/m)	**Ant**	**Cable**
.077	65.1(2)	69.9(3)	-4.8	11.9	0
.155	62(2)	63.8(3)	-1.8	11.9	0
.232	50.4(2)	60.3(3)	-9.9	12.3	0
.308	46.7(2)	57.8(3)	-11.1	12.5	0
.387	40.2(2)	55.9(3)	-15.7	12.7	0
.464	37.9(2)	54.3(3)	-16.4	12.8	0
108.2	25.9	43.5	-17.6	10.9	2.2
113.42	18.7	43.5	-24.8	11.3	2.2
116.14	16.9	43.5	-26.6	11.4	2.3
120.02	25.4	43.5	-18.1	11.6	2.3
144.01	25.6	43.5	-17.9	12.2	2.7
202.7	19.1	43.5	-24.4	15.0	3.0

Figure 4.5 Radiated Emission. Antenna Polarisation: Vertical. Detectors: Quasi-peak

Notes:

(1) Margin refers to the test results obtained minus specified requirement; thus a negative result indicates that the product passes the test, and a positive number indicates failure.

(2) Measurement was performed using an average detector.

(3) Limit 2400/F(kHz) was interpolated from 300m to 3m by adding 20log 300/3=40dB factor.

TEST PERSONNEL:

Tester Signature: _____ DATE:

typed/printed name: Y. Mordukhovitch

Radiated Emission

E.U.T Description: Hand-held Data Terminal

Type: MINT

Serial Number: Not designated

Specification: F.C.C., Part 15, Subpart C: CLASS B

Antenna Polarisation: **Vertical** Detector: **Quasi-peak**

Remarks: Antenna at 3 meters distance, Frequency range: 30 MHz to 300 MHz.

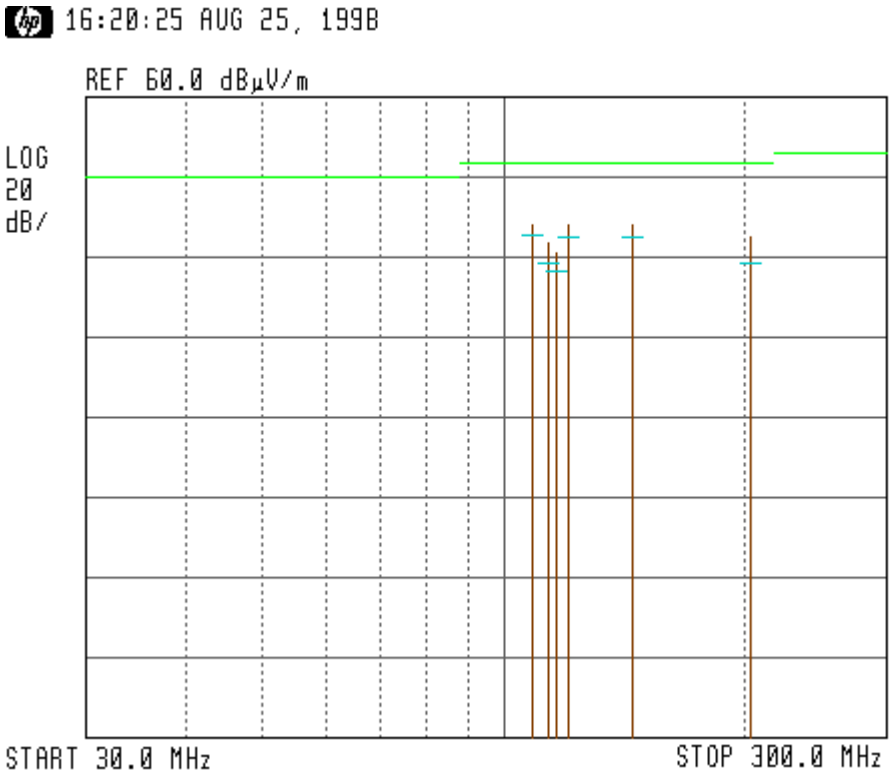


Figure 4.6 Radiated Emission. Antenna Polarisation: Vertical.

Detectors: Quasi-peak

Note:

1. Horizontal axis shows logarithmic frequency scale.

2. The vertical axis shows amplitude (in dB µV/m).

3. Peak detection is designated by the top of each vertical line.

4. Quasi-peak detection is designated by the first dash mark (from the top) of each vertical line.

Radiated Emission

E.U.T Description: Hand-held Data Terminal

Type: MINT

Serial Number: Not designated

Specification: F.C.C., Part 15, Subpart C: CLASS B

Antenna Polarisation: **Vertical** Detector: **Quasi-peak**

Remarks: Antenna at 3 meters distance, Frequency range: 300 MHz to 1 GHz.

Freq	**QP Amp**	**Specification**	**Margin**	**Correction Factor (dB)**	
(MHz)	(dBµV/m)	(dB µV/m)	(dB µV/m)	**Ant**	**Cable**
384.05	38.2	46.0	-7.8	14.1	4.3
408.06	41.0	46.0	-5.0	14.6	4.5
432.06	41.6	46.0	-4.4	14.8	4.6
456.06	42.6	46.0	-3.4	15.0	4.8
480.06	43.0	46.0	-3.0	15.0	5.0
540.08	42.0	46.0	-4.0	16.1	5.3
564.08	41.2	46.0	-4.8	16.5	5.5

Figure 4.7 Radiated Emission. Antenna Polarisation: Vertical.

Detectors: Quasi-peak

Note: Margin refers to the test results obtained minus specified requirement; thus a negative result indicates that the product passes the test, and a positive number indicates failure.

TEST PERSONNEL:

Tester Signature: _____ DATE:

typed/printed name: Y. Mordukhovitch

Radiated Emission

E.U.T Description: Hand-held Data Terminal

Type: MINT

Serial Number: Not designated

Specification: F.C.C., Part 15, Subpart C: CLASS B

Antenna Polarisation: **Vertical** Detectors: Quasi-peak

Remarks: Antenna at 3 meters distance, Frequency range: 300 MHz to 1 GHz.

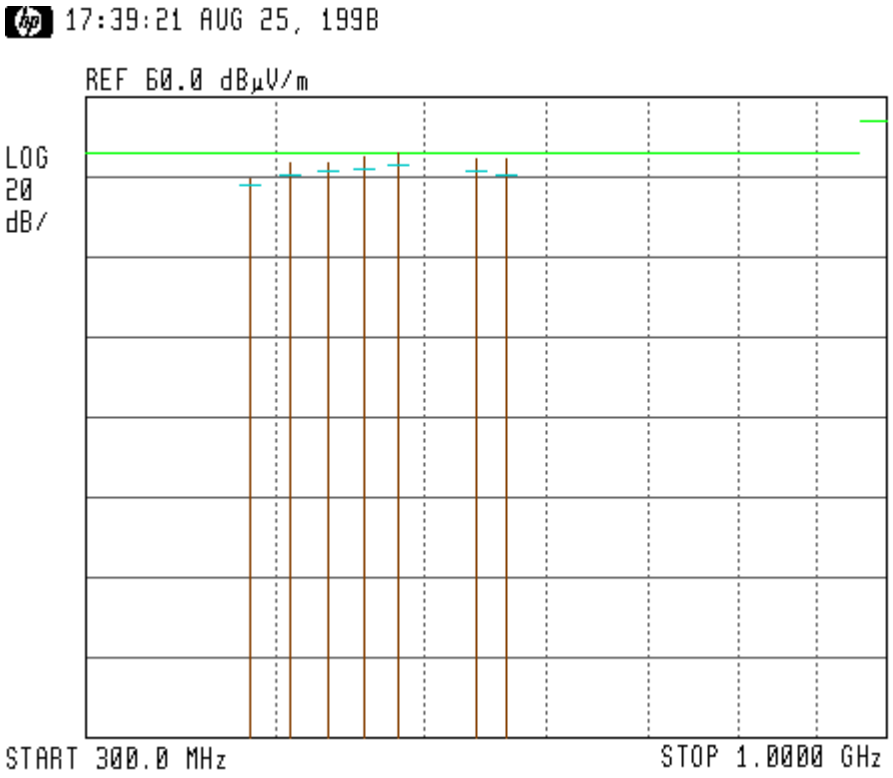


Figure 4.8 Radiated Emission. Antenna Polarisation: Vertical.

Detector: Quasi-peak

Note:

1. Horizontal axis shows logarithmic frequency scale.

2. The vertical axis shows amplitude (in dB µV/m).

3. Peak detection is designated by the top of each vertical line.

4. Quasi-peak detection is designated by the first dash mark (from the top) of each vertical line.

4.3 Test Instrumentation Used, Radiated Measurements

Instrument	Manufacturer	Model	Serial Number	Calibration	
				Last Cal..	Period
Receiver	HP	85420E/85422E	3427A00103/34	Oct. 26, 1997	1 year
Loop Antenna	EMCO	6502	2950	Oct.1, 1997	1 year
Antenna - Biconical HP	ARA	BCD-235/B	1041	April 2, 1998	1 year
Antenna - Log Periodic	ARA	LPD-2010/A	1037	March 12, 1998	1 year
Antenna - Log Periodic	ARA	LPD-2010/A	1038	March 12, 1998	1 year
Antenna Mast	ARA	AAM-4A	1001	N/A	N/A
Turntable	ARA	ART-1001/4	1001	N/A	N/A
Mast & Table Controller	ARA	ACU-2/5	1001	N/A	N/A
Printer	HP	ThinkJet2225	2738508357	N/A	N/A

4.4 Field Strength Calculation

The field strength is calculated directly by the EMI Receiver software, and a "Correction Factors" data disk, using the following equation:

$$[dB\mu v/m]FS = RA + AF + CF$$

FS:	Field Strength [dB v/m]
RA:	Receiver Amplitude [dB v]
AF:	Receiving Antenna Correction Factor [dB/m]
CF:	Cable Attenuation Factor [dB]

No external pre-amplifiers are used.