OD/401

Radiated & Conducted Emissions & Unlicensed Transmitter Test Report

Product Tested:

Name: D401

Prepared for:

Datamatic
715 N. Glenville Drive, Suite 450
Richardson, TX 75081
Tel: (972) 234-5000
Fax: (972) 234-1134

Prepared by:

RheinTexas, Inc.
1701 East Plano Parkway, Suite 150
Plano, TX 75074
Tel: (972) 509-2566
Fax: (972) 509-0073

REPORT PREPARED BY: Kay Harris

Report Number: A0191-1
Issue Date: 24 May, 1999

NVLAP *Accredited by the National Voluntary Laboratory Accreditation Program for the specific scope of accreditation under laboratory code 200245-0*

EMC Engineering and Testing Services

Radiated & Conducted Emissions Conformance Statement

Report Number: A0191-1
Product Name: D401

We, the undersigned, hereby state that the proper standards and procedures were followed as detailed in this test record. Furthermore, we attest that the data contained within this report is accurate and concise within the bounds of the standards and our company procedures.

Daniel Wilkerson
Sr. EMC Technician

I, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this attached test record. There were no modifications made to the equipment in order to achieve compliance with these standards.

Furthermore, there was no deviation from, additions to or exclusions from the ANSI 63.4:1992 test methodology.

Signature: Michael Cantwell

Date: 24 May, 1999

Full Name: Michael Cantwell, PE

Location: Plano, Texas

Title: NARTE EMC Engineer (EMC-002019-NE)
Signatory for NVLAP

1701 East Plano Parkway, Suite 150
Plano, TX 75074
972 509-2566 FAX 972 509-0073

TABLE OF CONTENTS

FIGURE INDEX

TABLE INDEX

1. Executive Summary

The following report for EMC compliance of a combined unlicensed transmitter and digital device is prepared on behalf of Datamatic, Inc. in accordance with the rules of the Federal Communications Commission (47 CFR 15) and the EMC Directive (89/336/EEC as amended by 91/31/EEC) of the European Union.

This report covers testing for the D401 and all testing was performed on the 11th and 18th of May, 1999.

All equipment configurations and measurements contained in this report were performed in accordance with the revision of the standards listed in this report. Also, the instrumentation and facilities utilized for the measurements conform to all appropriate standards. Calibration checks are performed yearly on the instruments by a local calibration lab, with traceability to the National Institute of Standards and Technology (NIST).

All radiated and conducted emission measurements are performed manually at RheinTexas, Inc. The radiated emission measurements required by the rules were performed on a 10m open area test site (OATS) maintained by RheinTexas, Inc., 1701 East Plano Parkway, Suite 150, Plano, Texas 75074, USA. Complete site descriptions and site attenuation measurement data are maintained at the test facility and can be made available upon request. The Power Line Conducted Emission Measurements were performed in a shielded enclosure also located at the same facility. The radiated and conducted measurement sites have been listed with the Federal Communications Commission (FCC).

1.1 Modifications to EUT

An 8db pad was added between the transmitter output and antenna, which includes two 27Ω resistors in series from the transmitter output and the antenna, and one 33Ω resistor from the center connection of the two series resistors and ground.

1.2 Special Accessories

There were no special accessories found necessary as a result of this testing.

2. Test Facility

The open area test site used to collect the radiated emissions data and the shielded room used to collect the conducted emissions data have been listed by the Federal Communications Commission (FCC, per ANSI C63.4).

3. EUT Configuration

3.1 Technical Description

The Equipment under test is an Electric Meter Transmitter Unit. It's purpose is to be installed into an electric watt-hour meter and periodically transmits the meter reading and an identification of the meter.

3.2 Test Configuration(s)

PU = Power Unshielded

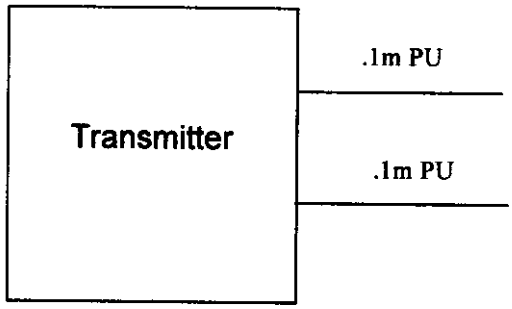

Figure 1 - Block Diagram of System Configuration

The system was configured for testing in a typical fashion (as a customer would normally use it). A list of the equipment under test (EUT) and its support equipment is found below.

Table 1 - Components in Block Diagram

Description	Manufacturer	Model	Serial No.	FCC I.D.
Electric Meter Transmitter	Datamatics	D401	None	None

3.3 Exercise Software

The EUT has embedded firmware which periodically transmits the meter identifier and meter reading.

3.4 Mode of Operation

The EUT transmits at 916.5 MHz. The data is pulse encoded, e.g. the 916.5 MHz carrier is keyed on and off and this pulse train contains the appropriate data.

4. Test Results

4.1 Emissions Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.4 1992 and CISPR 22:1993. Radiated testing was performed at an antenna to EUT distance of 10 meters.

CISPR-22:1993 was published in its entirety as EN55022:1994, for use within the European Union, in the *Official Journal of the European Communities*, reference 95C 241/02, 95C 325/05).

RheinTexas, Inc. has implemented procedures to minimize errors that occur from test instruments, calibration, procedures, and test setups. Test instrument and calibration errors are documented from the manufacturer or calibration lab. Other errors have been defined and calculated within the RheinTexas quality manual. RheinTexas implements these procedures to minimize errors that may occur: The highlights of the procedures are yearly as well as daily calibrations, technician training, and emphasis to employees on avoiding error.

4.1.1 Deviations from Test Methodology

There were no deviations from the test methodology during this test

4.2 Output Power

This device contains no connector on the antenna port. To measure the output power, a signal generator was connected directly to the receiver and an output of 79.8 dBμV was measured. An oscilloscope probe was then connected to the end of the coaxial cable and was used to measure the output of the signal generator. This measurement yielded 53.5 dBμV, an insertion loss of 26.3 dB. The probe was then used to measure the output of the EUT at the antenna port, producing a measurement of 70.7 dBμV. The insertion loss of the probe was then added to the EUT output power measurement resulting in an output power of 97.0 dBμV (-10 dBm).

4.3 Occupied Bandwidth

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency. Once the reference level is established, the equipment is conditioned with typical modulating signals to produce the worst-case (i.e. the widest) bandwidth. If no specific bandwidth requirement is specified, then measure the bandwidth at –26dB with respect to the reference level.

In order to measure the modulated signal properly, a resolution bandwidth that is small compared to the bandwidth required by the regulations shall be used on the measuring instrument. However, the 6 dB resolution bandwidth ov the measuring instrument shall be set to a value greater than 5% of the bandwidth requirements. When no bandwidth requirements are specified, the minimum 6 dB resolution bandwidth of the measuring instrument is given below.

Table 2 - Minimum Resolution Bandwidth

Fundamental Frequency	Minimum Resolution Bandwidth
9 kHz to 30 MHz	1 kHz
30 MHz to 1 GHz	10 kHz
1 GHz to 40 GHz	100 kHz

The display line of the spectrum analyzer was set to 26 dB below the peak level of the transmitted emission. The delta marker was then utilized to measure the intersection of the displayed waveform with

the display line with the change in frequency between the two markers recorded as the occupied bandwidth.

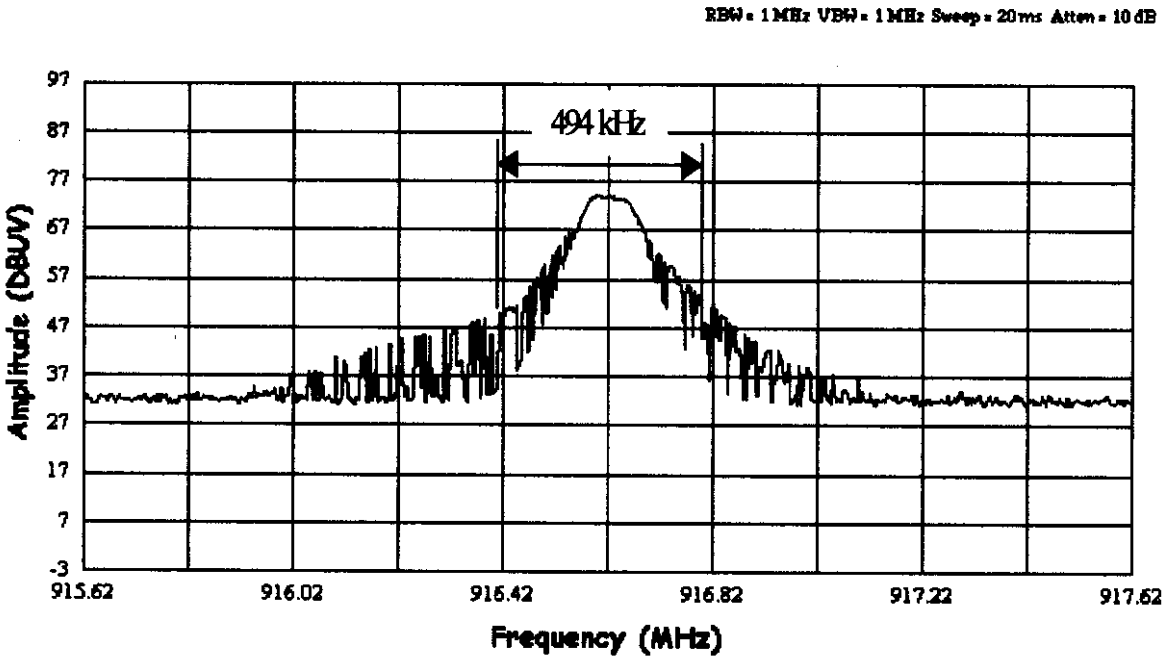

Figure 4 - Occupied Bandwidth

As noted in Figure 4, the occupied bandwidth is 494 kHz at –26 dBc with no modulation (this particular transmitter uses a keyed carrier to transmit data).

4.4 Transmitter Characteristics

4.4.1 Pulse Train Duration for Relaxation of Limit for Average Detector Measurements

The spectrum analyzer was used with a span of 0 Hz to provide a time domain display of the transmitted pulse-modulated data. The delta marker was used to measure the time difference between the begginning and end of the pulse train. This value was used to determine the duty cycle compared to a 100 msec period as follows:

$$Factor = 20\log\left(\frac{29.6m\sec}{100m\sec}\right) = -10.6dB$$

The above factor is added to the peak transmitted emission level. For convenience, the data recorded in this report is as measured and the above factor is subtracted from the limit.

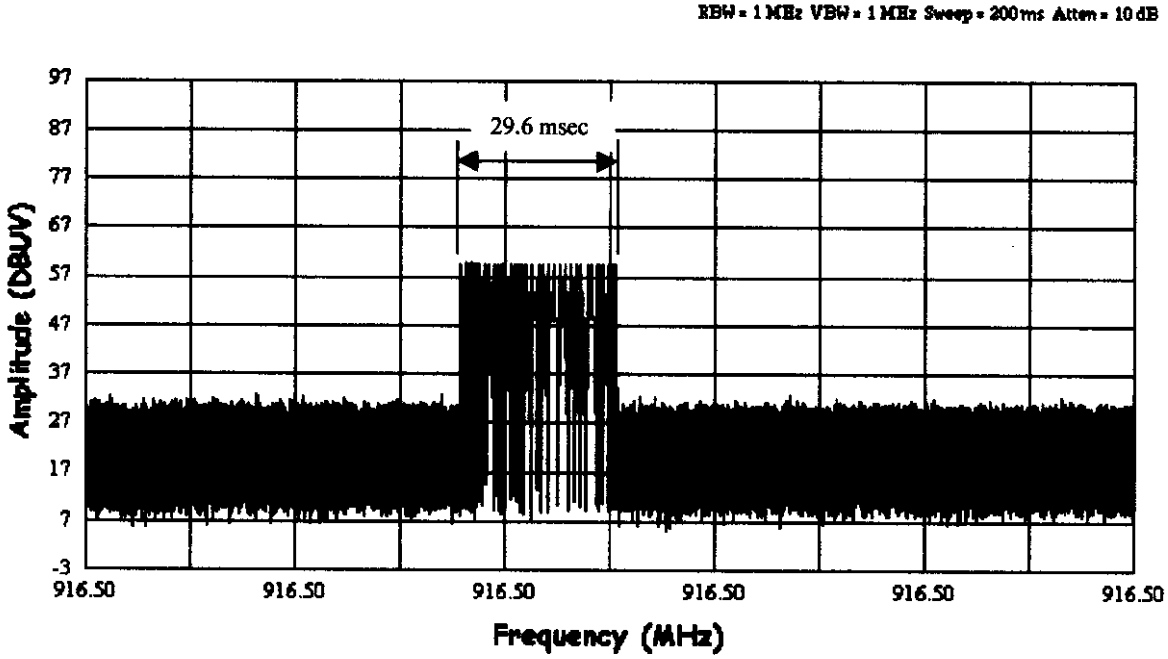

Figure 5 - Pulse Train Duration

4.4.2 Periodic Transmission Interval

This product transmits a pulse train similar to the one recorded above every 5 seconds.

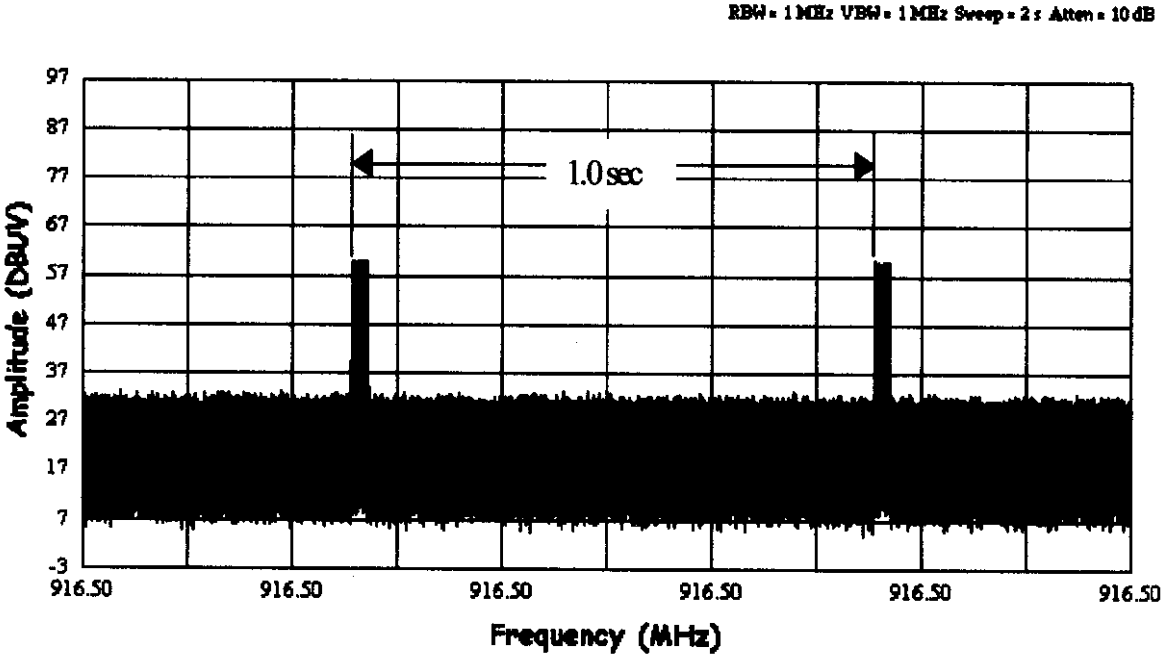

Figure 6 – Periodic Transmit Interval

4.5 Radiated Emissions Measurements

The limits utilized are from CISPR-22:1993/EN55022:1994.

4.5.1 Test Methodology

Whenever possible, and before final measurements of radiated emissions are made on the open-field three/ten meter range, the EUT is scanned indoors at a three meter distance (or one meter distance if necessary) in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process is either repeated, or performed, during final radiated emissions measurements on the open-field range, at each frequency, in order to insure that maximum emission amplitudes are obtained. RheinTexas works diligently to ensure that worst case modes, physical arrangement of the test system and associated cabling produce maximum emission levels.

Final radiated emissions measurements were made on the 10 meter, open-field test site. The EUT was placed on a nonconductive turntable approximately 0.8 meters above the ground plane. The spectrum was examined from 30 MHz to 1000 MHz. When any clock exceeds 108 MHz but less than 500 MHz, the emissions of the EUT are also measured between 1 to 2 GHz using an average detector with the resolution bandwidth set at 1 MHz. For clocks greater than 500 MHz and less than 1 GHz, the emissions of the EUT are also measured between 1 and 5 GHz.

At each frequency, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters in order to determine the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarizations. The spectrum analyzer's 6 dB bandwidth was set to 120 kHz, and the analyzer was operated in the CISPR quasi-peak detection mode. The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

4.5.2 Test Limits

The tables below list the EN55022 / CISPR-22 radiated emission limits. The EUT to antenna distance used at RheinTexas is always 10m unless otherwise noted. In addition to the CISPR 22 requirements, limits have been imposed above 1 GHz for compliance with the limits found in Part 15 of the FCC rules (47CFR).

Table 3 - CISPR-22 Class A Radiated Emissions

Frequency	Limit (dBµV/m)		
(MHz)	30m	10m	3 m
30 to 230	30	40	50
230 to 1000	37	47	57
≥ 1000[1]	--	49.5	60

Table 4 - CISPR-22 Class B Radiated Emissions

Frequency	Limit (dBµV/m)	
(MHz)	10m	3m
30 to 230	30	40
230 to 1000	37	47
≥ 1000[1]	43.5	54

[1] This FCC Limit actually begins at 960 MHz. The lower limit is used from 960 to 1000 MHz to fully comply with the requirements of CISPR 22.

4.5.3 Radiated Emissions Data

All readings are quasi-peak unless stated otherwise. The pk notation in the receiver reading denotes that this measurement was taken using the peak detector.

Table 5 - Radiated Emissions Data

Emission Frequency (MHz)	Det	Antenna Polarity (H/V)	Turntable Azimuth (deg)	Antenna Height (m)	Analyzer Reading (dBµV)	Site Correction Factor (dB/m)	Emission Level (dBµV/m)	EN55022 / CISPR22 Limit (dBµV/m)	EN55022 / CISPR22 Margin (dBµV/m)	Pass/ Fail	Comments
33.259	Qp	H	0	1.0	21.3	-1.9	19.4	40.0	-20.6	Pass	NF
39.982	Qp	V	40	1.0	19.3	-8.5	10.8	40.0	-29.2	Pass	NF
244.596	Qp	V	0	1.0	18.7	-7.5	11.2	46.0	-34.8	Pass	NF
253.287	Qp	H	0	1.0	20.0	-6.7	13.3	46.0	-32.7	Pass	NF
650.000	Qp	V	0	1.0	16.2	1.7	17.9	46.0	-28.1	Pass	NF
758.124	Qp	H	0	1.0	19.8	2.6	22.4	46.0	-23.6	Pass	NF
916.600	Qp	H	100	1.0	83.3	4.0	87.3	94.0	-6.7	Pass	
916.606	Qp	V	240	1.7	78.6	4.7	83.3	94.0	-10.7	Pass	
1833.143	Pk	H	245	1.2	45.2	11.7	56.9	64.6[1]	-7.7	Pass	
1833.143	Pk	V	180	1.0	46.0	11.9	57.9	64.6[1]	-6.7	Pass	
2749.500	Pk	H	100	1.0	41.8	5.1	46.9	64.6[1]	-17.7	Pass	
2749.710	Pk	V	130	1.0	38.7	5.1	43.8	64.6[1]	-20.8	Pass	
3666.000	Pk	H	145	2.0	47.5	11.3	58.8	64.6[1]	-5.8	Pass	
3666.000	Pk	V	130	1.0	50.1	11.3	61.4	64.6[1]	-3.2	Pass	
4582.500	Pk	H	300	1.0	46.2	10.1	56.3	64.6[1]	-8.3	Pass	
5498.400	Pk	H	230	2.0	43.2	6.7	49.9	64.6[1]	-14.7	Pass	
5498.400	Pk	V	200	1.0	54.3	6.7	61.0	64.6[1]	-3.6	Pass	
7332.000	Pk	H	340	2.3	41.6	12.1	53.7	64.6[1]	-10.9	Pass	
7332.000	Pk	V	185	2.1	42.3	12.1	54.4	64.6[1]	-10.2	Pass	
8248.000	Pk	H	140	1.0	37.4	13.2	50.6	64.6[1]	-14.0	Pass	
8248.000	Pk	V	170	1.5	38.3	13.2	51.5	64.6[1]	-13.1	Pass	
9165.000	Pk	H	180	1.3	31.7	13.9	45.6	64.6[1]	-19.0	Pass	
9165.000	Pk	V	245	1.4	34.6	13.9	48.5	64.6[1]	-16.1	Pass	

[1] The 54 dBµV/m limit was adjusted upward by 10.6 dB to account for the pulse train duration, adjusting it for an average measurement.

4.6.1 Test Methodology

The power line conducted emission measurements were performed in a shielded enclosure. The EUT was assembled on a wooden table 80 centimeters high. Power was provided to the EUT through a 50 Ω / 50 μH Line Impedance Stabilization Network (EUT LISN). The EUT LISN was provided power through an AC filter box on the outside of the shielded enclosure. The filter box and EUT LISN housing are bonded to the ground plane of the shielded enclosure. A second LISN, the peripheral LISN, provides isolated power for the EUT test peripherals. A metal power outlet box, which is bonded to the ground plane and electrically connected to the peripheral LISN, powers the EUT host peripherals.

The spectrum analyzer was connected to the AC line, which is bonded to the exterior of the shielded room. The 50 Ω output of the EUT LISN was connected to a high pass filter (>8 kHz), which is then connected to the spectrum analyzer input. Conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable). The analyzer's 6 dB bandwidth was set to 9 kHz. The emission spectrum was scanned from 150 kHz to 30 MHz. The highest emission amplitudes relative to the appropriate limit were measured and have been recorded in this report.

4.6.2 Test Limits

The tables below list the EN55022 / CISPR-22 conducted emissions limits.

Table 6 - CISPR-22 Class A Conducted Emissions Limits

	Limit (dBμV)	
Frequency (MHz)	**Quasi-Peak**	**Average**
0.15 to 0.5	79	66
0.5 to 30	73	60

Table 7 - CISPR-22 Class B Conducted Emissions Limits

	Limit (dBμV)	
Frequency (MHz)	**Quasi-Peak**	**Average**
0.15 to 0.5	66 to 56	56 to 46
0.5 to 5.0	56	46
5 to 30	60	50

4.6.3 Conducted Emissions Data

The initial step in collecting conducted data is a spectrum analyzer peak scan of the measurement range. All emission data is measured in peak mode. Any emissions within 4db of the average limit is then measured with a quasi-peak detector for final measurement. If the quasi-peak value exceeds the average limit but is below the quasi-peak limit, then the signal is re-measured using the average detector.

The quasi-peak measurement is then compared to the quasi-peak limit *and* the average measurement is compared to the average limit. In these instances, both readings must be below their appropriate limits to be considered compliant.

The conducted test was performed with the EUT exercise software running, and the emissions were scanned between 150 kHz to 30 MHz on the HOT SIDE and NEUTRAL SIDE, herein referred to as L2 and L1, respectively.

Table 8 - Conducted Emissions Data, D401 (EUT), Hot (L2)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC QP Limit (dBuV)	FCC QP Margin (dBuV)	FCC AV Limit (dBuV)	FCC AV Margin (dBuV)
0.450	Pk	24.0	9.4	33.4	48.0	-14.6	48.0	-14.6
0.614	Pk	25.1	9.2	34.3	48.0	-13.7	48.0	-13.7
4.573	Pk	26.8	9.4	36.2	48.0	-11.8	48.0	-11.8
6.958	Pk	25.9	9.6	35.5	48.0	-12.5	48.0	-12.5
13.301	Pk	26.5	9.8	36.3	48.0	-11.7	48.0	-11.7
20.132	Pk	24.4	10.4	34.8	48.0	-13.2	48.0	-13.2
29.794	Pk	26.3	11.0	37.3	48.0	-10.7	48.0	-10.7

Table 9 - Conducted Emissions Data, D401 (EUT), Neutral (L1)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC QP Limit (dBuV)	FCC QP Margin (dBuV)	FCC AV Limit (dBuV)	FCC AV Margin (dBuV)
0.451	Pk	23.7	9.5	33.2	48.0	-14.8	48.0	-14.8
0.614	Pk	25.7	9.2	34.9	48.0	-13.1	48.0	-13.1
1.537	Pk	24.2	9.1	33.3	48.0	-14.7	48.0	-14.7
4.078	Pk	23.0	9.3	32.3	48.0	-15.7	48.0	-15.7
4.504	Pk	26.9	9.4	36.3	48.0	-11.7	48.0	-11.7
12.500	Pk	24.0	9.8	33.8	48.0	-14.2	48.0	-14.2
23.220	Pk	26.3	10.4	36.7	48.0	-11.3	48.0	-11.3

(1)Pk = Peak; QP = Quasi-Peak; Av = Average

(2)Average limit (QP limit is provided only when a QP measurement fails the Average limit.)

5. Test Equipment

The following test equipment was used to perform the radiated and conducted emissions testing. All the equipment is calibrated by competent calibration laboratories traceable to NIST.

The Test column indicates which equipment was utilized to perform the radiated and conducted testing. An "R" in this column indicates that it was used for radiated emissions testing and a "C" in this column indicates that it was used for conducted emissions testing.

Table 10 - Test Equipment List

Test	Manufacturer	Model	Description	Serial Number	Last Cal	Next Cal
	Hewlett Packard	8566B	Spectrum Analyzer	2816A16178 2747A05126	29-Dec-98	29-Dec-99
	Hewlett Packard	85650A	Quasi-Peak Adapter	3303A01859	29-Dec-98	29-Dec-99
	Rhein Tech Labs	PR-1040	Amplifier	N/A	27-Mar-98	27-Mar-99
	RheinTexas	Radiated Cable	Site 1NE	R002	27-Mar-98	27-Mar-99
	Chase	CBL6112A	Bilog Antenna	2149	5-Nov-98	5-Nov-99
R	Hewlett Packard	8546A	EMI Receiver	3265A00348 3448A00288	21-Dec-98	21-Dec-99
R	RheinTexas	Radiated Cable	Site 2NW	R003	27-Mar-99	27-Mar-00
R	Chase	CBL6112A	Bilog Antenna	2150	7-May-98	7-May-99
R	EMC Test Systems	3115	Horn Antenna	5672	25-Jan-99	25-Jan-02
C	Hewlett Packard	8567A	Spectrum Analyzer	2602A00153 2542A11108	31-Jul-98	31-Jul-99
	Hewlett Packard	85650A	Quasi-Peak Adapter	3303A01832	31-Jul-98	31-Jul-99
C	Solar	9252-50-R-24-BNC	LISN	961023	19-Aug-98	19-Aug-99
C	RheinTexas	Conducted Cables	Coaxial Cables	C001	19-Aug-98	19-Aug-99