Radiated & Conducted Emissions Test Report for an Unlicensed Transmitter

Product Tested:

Name: Meter Reading Device and Receiver Unit
Model: D121R2 and D231

Prepared for:

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Report Number: A0127-1 (9901017)
Issue Date: 13 April, 1999

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EMC Engineering and Testing Services

Radiated & Conducted Emissions Conformance Statement

Report Number: A0127-1
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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.

Lonnie Smoots
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. The modifications made to the equipment in order to achieve compliance with these standards is located in the Executive Summary of this report.

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

Signature: Michael Cantwell

Date: 13 April, 1999

Full Name: Michael Cantwell, PE

Location: Plano, Texas

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TABLE OF CONTENTS

FIGURE INDEX

TABLE INDEX

1. Executive Summary

The following report for EMC compliance of an unlicensed transmitter, per 47CFR15.249, 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 Meter Reading Device and all testing was performed on the 17th, 22nd, 23rd and 31st of March, 1999 and the 1st, 8th, and 9th of April, 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 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 radiated sites have been listed with the Federal Communications Commission (FCC).

1.1 Modifications to EUT

The modifications made to the EUT in order to achieve compliance is as follows:

1. A standard Tee attenuator was placed between the RF Monolithics transmitter component and the antenna. The value of the series resistors was 27.4 Ω and from the center of these resistors to ground the resistor value was 33.2 Ω.

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) and approved by the Voluntary Control Council on Interference (VCCI, Japan).

3. EUT Configuration

3.1 Technical Description

The EUT is a Meter Reading Device (Transmitter D121R2 and Receiver D231). It continually takes meter readings and transmits the results every 4 to 5 seconds on 916.5 MHz. The data is not modulated in any fashion, the carrier is turned on and off the resulting pulse train contains the appropriate data.

4. Test Results

4.1 Emissions Test Methodology

Radiated testing was 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 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.

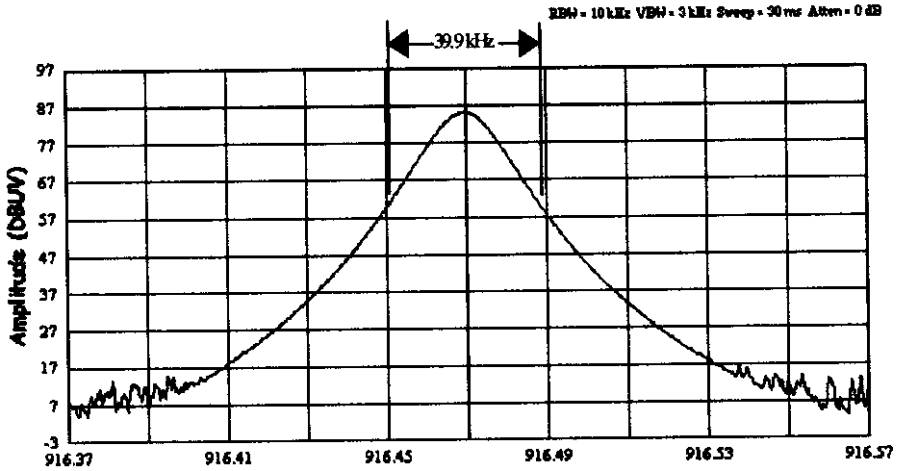

Figure 4 - Occupied Bandwidth

As noted in Figure 4, the occupied bandwidth is 39.9 kHz at –26 dBc with no modulation (this particular transmitter uses a keyed carrier to transmit data).

4.3 Transmitter Characteristics

4.3.1 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:

$$Factor = 20\log\left(\frac{25.4m\sec}{100m\sec}\right) = -11.9dB$$

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.

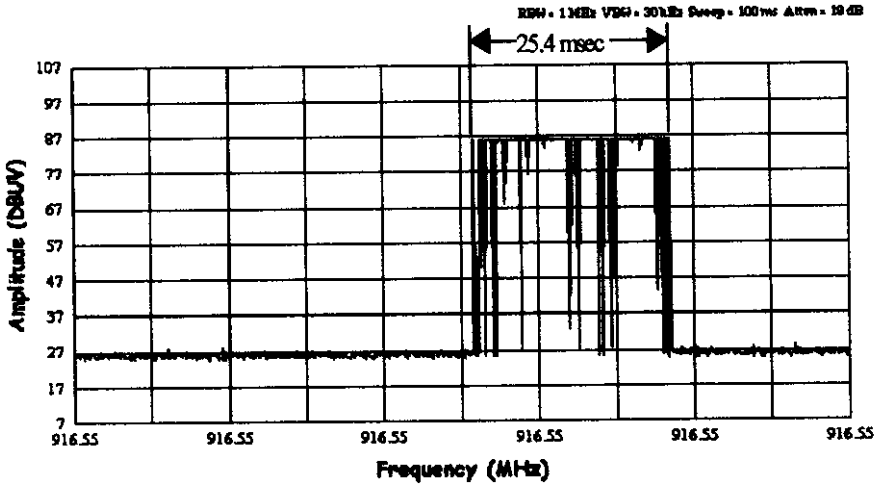

Figure 5 - Pulse Train Duration

4.3.2 Periodic Transmission Interval

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

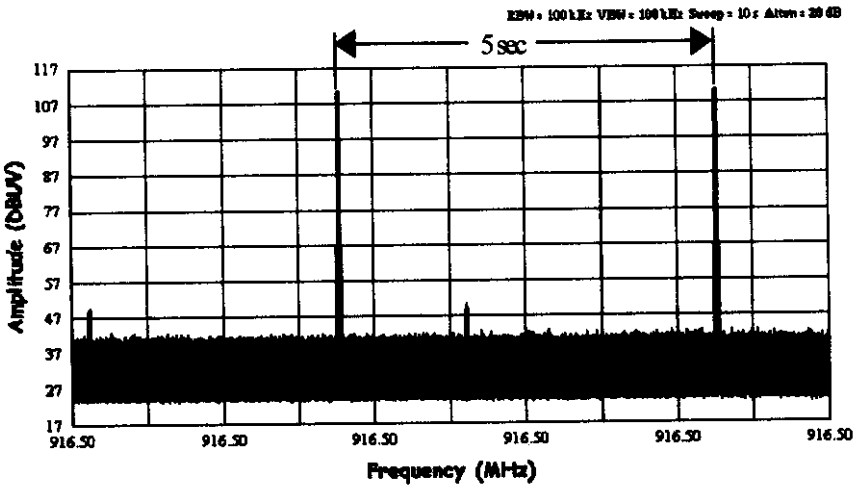

Figure 6 – Periodic Transmit Interval

4.4 Radiated Emissions Measurements

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

4.4.1 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.

4.4.2 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.

4.4.3 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 (Digital Device/Receiver)

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[2] (dBμV/m)	EN55022 / CISPR22 Margin (dBμV/m)	Pass/ Fail	Comments
141.262	Qp	V	180	1.0	12.6	13.2	25.8	43.5	-17.7	Pass	
195.415	Qp	H	135	3.5	17.1	11.6	28.7	43.5	-14.8	Pass	
217.540	Qp	H	125	3.5	20.5	12.6	33.1	46.4	-13.3	Pass	
232.290	Qp	H	140	3.5	18.7	13.3	32.0	46.4	-14.4	Pass	
235.425	Qp	V	240	1.0	12.0	13.5	25.5	46.4	-20.9	Pass	
250.200	Qp	V	255	1.0	15.7	14.3	30.0	46.4	-16.4	Pass	
267.340	Qp	H	90	3.5	13.5	14.9	28.4	46.4	-18.0	Pass	
294.915	Qp	H	100	3.0	12.5	15.7	28.2	46.4	-18.2	Pass	
447.140	Qp	H	125	3.0	11.3	19.1	30.4	46.4	-16.0	Pass	
556.325	Qp	V	0	1.0	5.2	21.0	26.2	46.4	-20.2	Pass	
664.910	Qp	H	35	3.0	2.3	22.2	24.5	46.4	-21.9	Pass	
744.525	Qp	V	35	1.0	5.8	22.9	28.7	46.4	-17.7	Pass	

Note: The receiver has no Local Oscillator (LO)

Table 6 - Radiated Emissions Data (Transmitter)

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[1] (dBµV/m)	EN55022 / CISPR22 Margin (dBµV/m)	Pass/ Fail	Comments
916.53	Qp	H	0	1.0	67.8	21.3	89.1	94.0	-4.9	Pass	
916.519	Qp	V	350	1.0	65.4	21.3	86.7	94.0	-7.3	Pass	
1833.030	Pk	H	350	1.0	18.2	27.5	45.7	65.9	-20.2	Pass	
1833.030	Pk	V	0	1.0	21.7	27.5	49.2	65.9	-16.7	Pass	
2744.942	Pk	V	350	1.0	45.9	7.3	53.2	65.9	-12.7	Pass	
2745.165	Pk	H	0	1.0	40.1	7.3	47.4	65.9	-18.5	Pass	
3665.920	Pk	V	0	1.0	47.2	11.3	58.5	65.9	-7.4	Pass	
3665.977	Pk	H	350	1.0	45.5	11.3	56.8	65.9	-9.1	Pass	
4582.490	Pk	V	350	1.0	42.5	10.1	52.6	65.9	-13.3	Pass	
4582.504	Pk	H	0	1.0	44.6	10.1	54.7	65.9	-11.2	Pass	
5498.930	Pk	V	350	1.0	39.8	6.7	46.5	65.9	-19.4	Pass	
5498.991	Pk	H	350	1.0	45.7	6.7	52.4	65.9	-13.5	Pass	
6412.512	Pk	V	0	1.0	27.5	9.8	37.3	65.9	-28.6	Pass	
7332.000	Pk	V	350	1.0	27.8	8.3	36.1	65.9	-29.8	Pass	
8248.011	Pk	V	0	1.0	27.3	13.2	40.5	65.9	-25.4	Pass	
9165.669	Pk	V	350	1.0	26.7	13.9	40.6	65.9	-25.3	Pass	

[1] The limit for the fundamental is that shown in 47CFR15.249, the limit for the harmonics is 11.9 dB higher than that shown in 47CFR15.249. See section 4.3.1 of this report for details.

4.4.4 Radiated Test Configuration Photographs

Figure 7 - Radiated Setup (Transmitter)

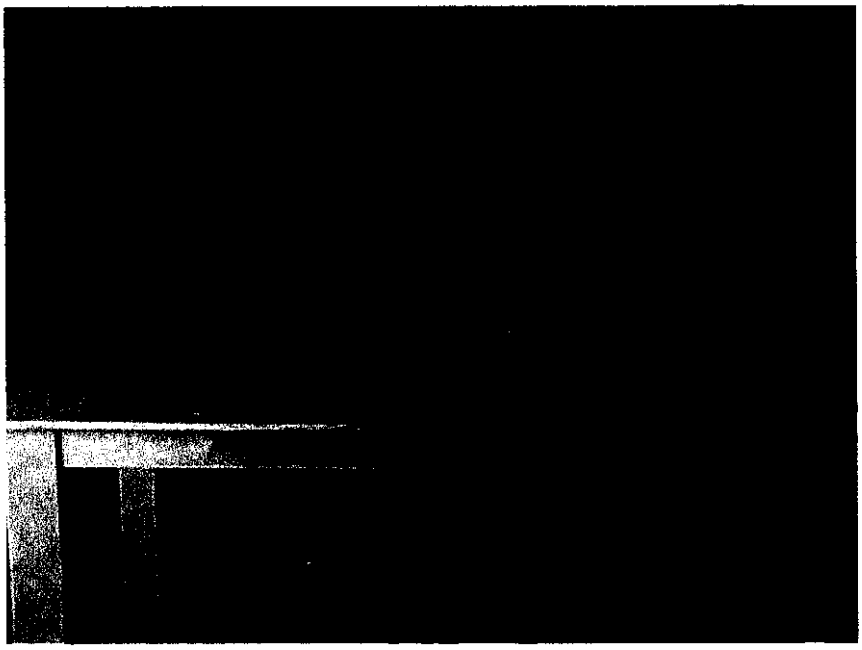

Figure 8 - Radiated Setup (Digital Device/Receiver)

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 7 - Test Equipment List

Test	Manufacturer	Model	Description	Serial Number	Last Cal	Next Cal
R	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
R	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
	Hewlett Packard	8546A	EMI Receiver	3265A00348 3448A00288	21-Dec-98	21-Dec-99
R	RheinTexas	Radiated Cable	Site 2NW	R003	27-Mar-98	27-Mar-99
R	Chase	CBL6112A	Bilog Antenna	2150	7-May-98	7-May-99
	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
	Solar	9252-50-R-24-BNC	LISN	961023	19-Aug-98	19-Aug-99
	RheinTexas	Conducted Cables	Coaxial Cables	C001	19-Aug-98	19-Aug-99
R	EMCO	3115	Horn	5672	25-Jan-99	25-Jul-00
R	Hewlett Packard	8449B	Pre-Amplifier	3008A00244	25-Feb-99	25-Feb-01

3.2 Test Configuration(s)

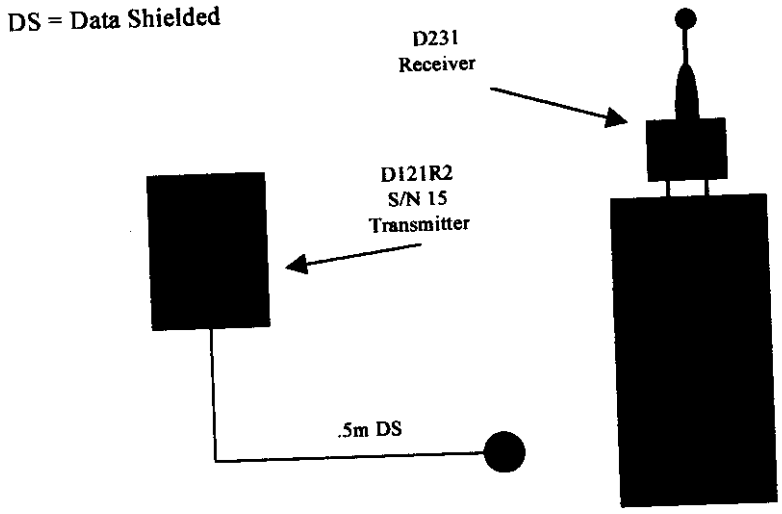

Figure 1 - Block Diagram of System Configuration

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 ID
Transmitter (EUT)	Datamatic, Inc	D121R2	S/N 15	None
Receiver (EUT)	Datamatic, Inc.	D231	None	None

3.3 Exercise Software

The EUT exercise program used during radiated testing continuously sends data every 4 to 5 seconds via the transmitter.

3.4 Mode of Operation

The radiated emissions were measured with the device operating in its normal mode of operation. The transmitter was sending data every 4 to 5 seconds and the receiver recorded the data. The receiver has no Local Oscillator (LO) circuits. The fundamental transmitter frequency and its harmonics were measured with the transmitter transmitting continusously.