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.

4.3.2 Periodic Transmission Interval

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

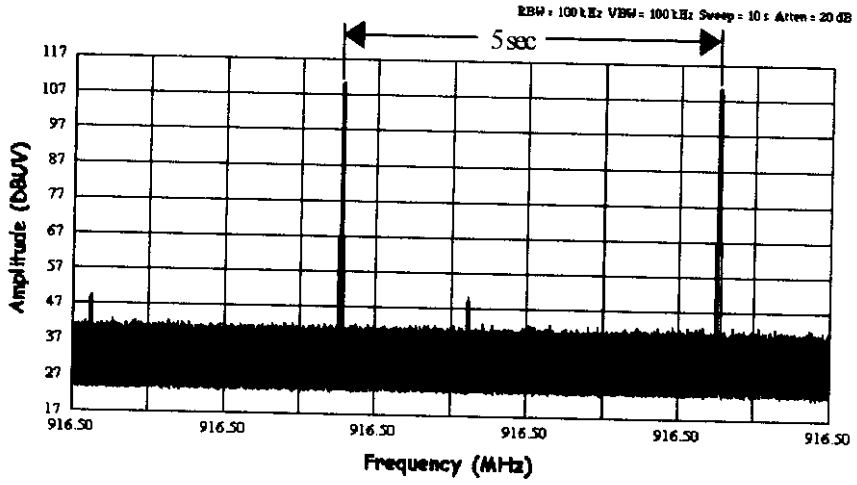

Figure 6 – Periodic Transmit Interval

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[1] (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.

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