1.0 PURPOSE

This test report applies to the Iolan Systems, Inc. (ISI) LA-WIW-PROXKEY-M badge reader (see Fig. 1). This wall-mount module is designed for identification purposes. Access to a facility or identity established when a badge is held close to the reader.

Figure 1

The purpose of this electromagnetic compatibility (EMC) Test Report is to give the FCC information on the radiated emission profile of the badge reader as required for *47 CFR Ch. I (10-1-97 Edition) Part 15-Radio Frequency Devices, Subpart C-Intentional Radiators* and *Subpart B-Unintentional Radiators*. For sake of brevity, this standard will be referred to as FCC Part 15.

The badge reader emits a weak RF field to activate the badge. Obviously, it is a Subpart C device. Since the badge reader contains a microcontroller and is part of a distributed network, it is a computer peripheral and is subject to Subpart B levels also.

FCC Part 15 testing is performed using the techniques and practices described in the "*American National Standard for Methods of Measurement of Radio Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9KHz to 40GHZ*", ANSIC63.4-1992. The target emissions levels are set using criterion set in FCC Part 15.

The badge reader is powered by a DC voltage via its controller, no conducted emissions testing was necessary. The heart of the device is a MIFARE Micro Module MF CM200 hybrid. Manufacturer's data sheet is available at:

http://www-us.semiconductors.com/identification/mfcm200.stm.html

2.0 EQUIPMENT

2.1 ISI Supplied Equipment

All tests described below were carried out on a system comprised of standard production units. The equipment defined below was available solely for the purposes of EMC testing during the test program.

Description	Serial Number
Door Controller Unit, LATCK2WI4I2Y	LA150201
Badge Reader, LAWIWPROXKEYM	LA140102
Mifare Badges	N/A

2.2 EMCA Test Equipment

Name and Model Number	Serial Number	Calibrated	Next Calibration
Hewlett-Packard HP8546A Receiver	3520A00237 3448A00238	13 Oct. 1998	13 Oct. 1999
EMCO Passive Loop 6512 Antenna 10KHz-30MHz	9905-212	21 May1999	21 May 2000
EMCO Biconilog 3142 Antenna 30MHz-1GHz	9803-1251	27 Mar. 1998	27 Sept. 1999

Transformer/Adapter U.S. 110Vac to European 220Vac	N/A	N/A	N/A
3M Semi-anechoic Chamber and Associated H/W (turntable, antenna mast, etc.)	N/A	N/A	N/A
EMCO 2075 Minimast	9707-2061	N/A	N/A
EMCO 2090 Multi-Device Controller	9704-1231	N/A	N/A
Pentium-based PC system	N/A	N/A	N/A
EMCA Radiated Emissions S/W Ver. 7.33	N/A	N/A	N/A

3.0 PROCEDURE and RESULTS

3.1 Equipment Configuration

The dates of the testing were April 9 & 10,1999 and June 28, 1999. Testing was done in the semi-anechoic chamber and the 10m Open Area Test Site (OATS). At both sites, the badge reader was placed on a wooden (non-conductive) table, 80cm high. The table was placed on a turntable. The badge reader controller was located on the ground plane beneath the wooden table on the turntable.

Testing was performed with/without a badge in close to the badge reader.

When a badge was used, it was mounted in a non-conductive holder in close proximity to the badge reader. Testing was performed to determine the exact position and orientation of the badge that maximized emissions.

The equipment was arranged in the manner recommended in Fig 9(c) *Test Configuration Tabletop Equipment Radiated Emissions* of ANSI C63.4-1992.

Figure 2

Figure 2 shows the test setup. When actual testing began, the power/data cable was wrapped non-inductively not coiled as seen in the photograph. Note the controller is sitting on the turntable.

Figure 3 shows the badge in it's holder held up the badge reader.

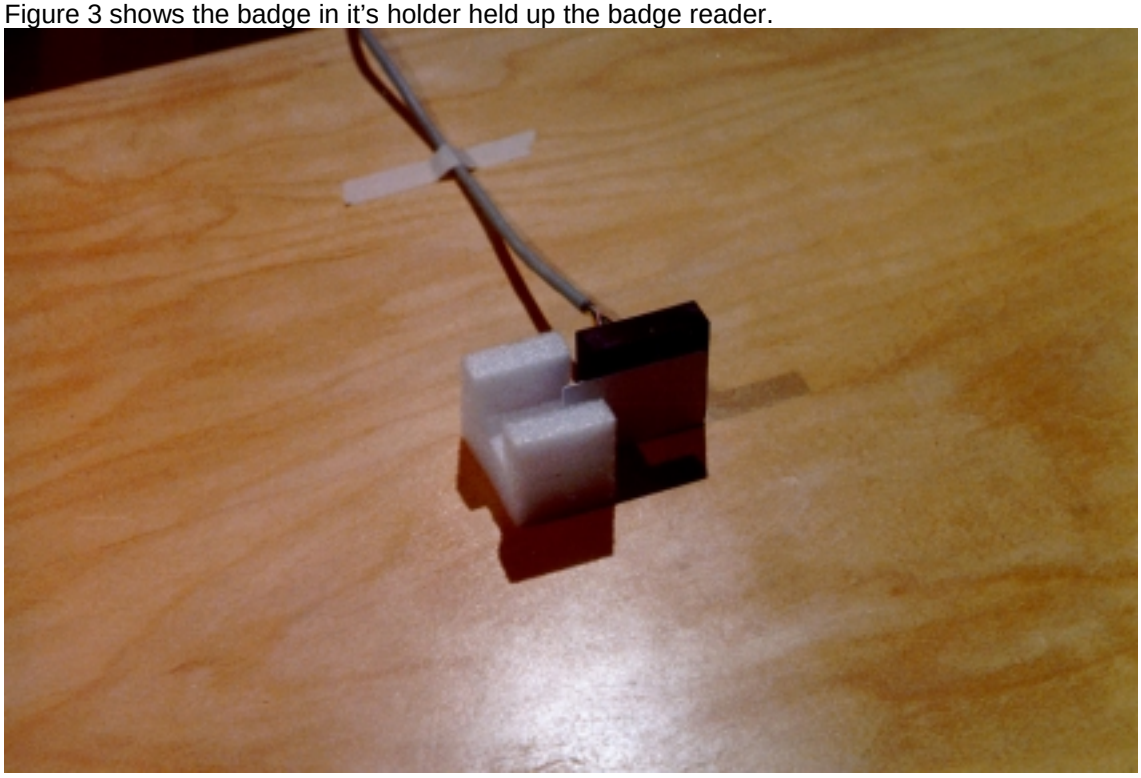

Figure 3

3.2 Environment

The temperature/humidity in the semianechoic chamber on April 9, 1999 was as follows:

Temperature	20°C
Humidity	30%

The temperature/humidity on the OATS on June 28, 1999 was as follows:

Temperature	25°C
Relative Humidity	54

3.3 Radiated Emissions

3.3.1 Preliminary Scan

It was found that the badge had no discernible affect on the emissions on the emissions levels of the badge reader.

The badge is an intentional radiator incorporating a Class A digital device.

During testing, the limit line was adjusted. All data was taken at a 3m distance both in the semianechoic chamber and on the OATS.

The test was computer driven/monitored. For prescans, the antenna was set at 1m, the turn table was rotated in 90° increments. The antenna was then raised to a height of 2m and the turntable was rotated in 90° increments. This was repeated for 3 and 4m. Initial sweeps were done with the antenna in vertical then horizontal polarity. The maximum peak value for each frequency was stored in computer memory and graphed.

All initial scanning was done in the semi-anechoic chamber. During the initial scans, the exact frequencies emitted by the EUT were identified. Initial scans used the Peak Detector. Any frequencies within 10dBuV of the limit line were identified. All radiated emissions measurements above 30MHz, emissions measurements were made with the bilog antenna (EMCO 3142).

Scans below 30MHz were made on the OATS. It is understood the FCC **does not** recognize semi-anechoic data below 30MHz.

The first scan covered a frequency range of 30MHz to 1000MHz. This data was taken with the biconilog antenna in both vertical and horizontal polarities.

Figure 5 shows the horizontal/vertical peak data. Please note all emissions (measured in peak mode) from 30MHz–1000MHz, are below the Quasi-Peak limit line.

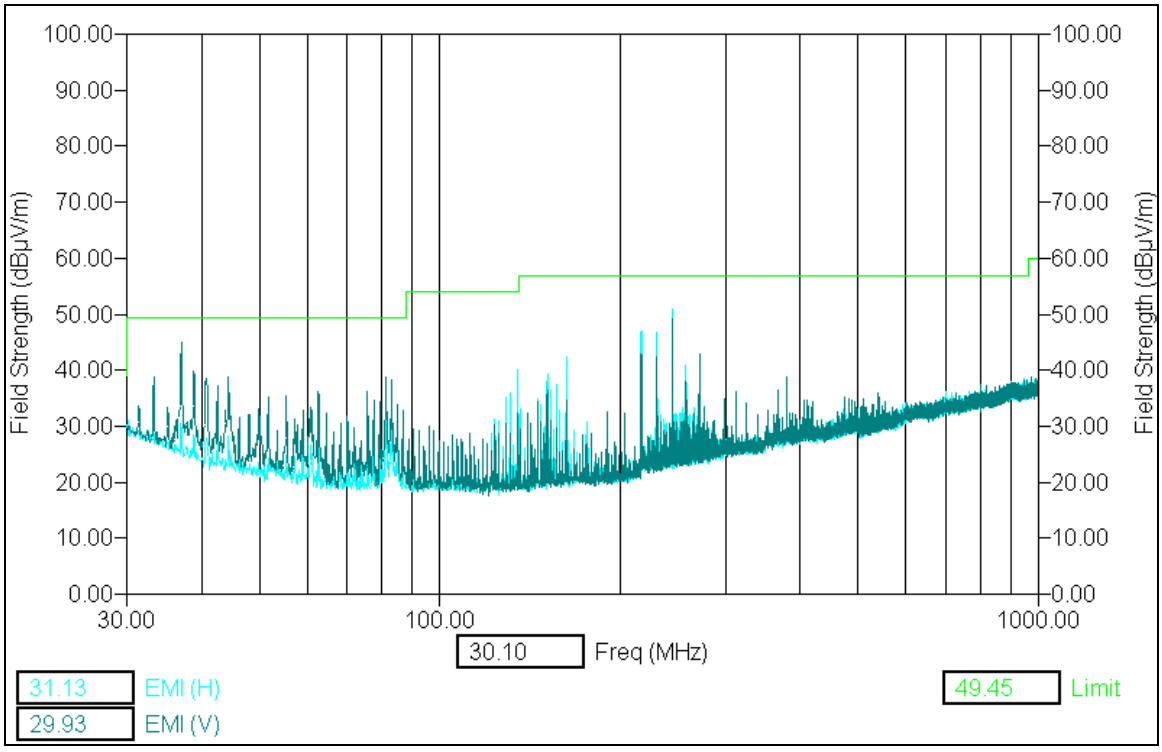

Figure 5

3.3.2 **Final Scan**

Final scans were run differently from the prescans. Peaks within 10dBuv of the limit were identified by the test S/W. These are the frequencies to be investigated using the quasi-peak detector.

Once a frequency has been identified, testing begins. The antenna is set initially at a height of 2m. The operating EUT is rotated/scanned continuously for 360°. The turntable rotates back to the angular position of maximum emissions. The antenna was then raised to a height of 4m. Scanning continued while the antenna height was adjusted. Once the scan was complete, the antenna was returned to the height of maximum emissions and the quasi-peak measurement completed.

For the frequency range of 30MHz-1000MHz, the following quasi-peak data collected:

Freq. (MHz)	Polarity	Q.P. Trace	Cable Trans-ducer	(QP) EMI (dBuV/m)	Ttbl Angle (deg)	Twr Ht (cm)	Limit (dBuV/ m	(QP) Margin (db)
36.89	V	26.48	-0.09	42.04	166.00	100.00	49.45	-7.41
38.73	V	24.53	-0.06	39.30	145.00	100.00	49.45	-10.15
217.00	H	34.92	0.73	47.45	76.00	145.00	56.85	-9.40
230.56	H	34.94	0.71	47.96	254.00	109.00	56.85	-8.89
244.12	H	40.32	0.76	53.88	247.00	118.00	56.85	-2.97
244.12	V	36.13	0.76	49.69	181.00	165.00	56.85	-7.16

Note the final column. All the Margin values are negative. **This means the device emissions are within the limits set for 30MHz-1000MHz.** Since the semianechoic chamber data taken from 30MHz-1000MHz is acceptable to the FCC, no further effort in this frequency range was required.

3.3.3 **Harmonics**

Specific measurements were also taken of the clock frequency and it's harmonics as well as the primary radiating frequency and it 's harmonics. The data below 30 MHz was taken with loop antenna on the OATS. Measurements on the OATS were taken manually.

The data listed in the tables was taken at a 3m distance in dBuV. For clarity, the data was converted to uV/m with the levels and limits raised to a 30m distance for the 30MHz and below frequencies.

First the clock frequency:

Clock Freq. Harmonics [MHz]	EMI Horizon-tal [uV/m]	EMI Vertical [uV/m]	EMI Limit [uV/m]	Horizon-Tal Margin [uV/m]	Vertical Margin [uV/m]
11.0592	8.84	*	90	-81.16	*
22.1192	8.22	*	90	-81.78	*
33.1788	4.03	10.12	90	-85.97	-79.88
44.2384	5.56	14.77	90	84.44	-75.23

55.298	5.54	14.77	90	84.46	-75.23
66.3576	3.67	7.04	90	-86.33	-82.96
77.4172	4.44	8.40	90	-85.56	-81.6
88.4768	3.50	5.17	150	-146.5	-144.83
99.5364	4.52	8.64	150	-145.48	-141.36
110.596	3.60	7.29	150	-146.4	-142.71
121.6556	11.21	10.51	150	-138.79	-139.49

** Loop antenna has only one polarity*.

Next the intentional radiating frequency of 13.56MHz and it's harmonics:

Primary Freq. Harmonics [MHz]	**EMI Horizon-tal [uV/m]**	**EMI Vertical [uV/m]**	**EMI Limit [uV/m]**	**Horizontal Margin [uV/m]**	**Vertical Margin [uV/m]**
13.56	74.47	*	10000	-9925.53	*
27.12	15.99	*	100	-84.01	*
40.68	25.35	63.09	100	-74.65	-36.91
54.24	10.68	26.70	100	-89.32	-73.3
67.8	9.44	13.66	100	-90.56	-86.34
81.36	14.50	23.17	100	-85.5	-76.83
94.92	9.43	9.43	150	-140.57	-140.57
108.48	15.79	12.75	150	-134.21	-137.25
122.04	17.26	12.05	150	-132.74	-137.95
135.6	8.31	10.10	150	-141.69	-139.9
149.16	9.68	9.15	150	-140.32	-140.85

** Loop antenna has only one polarity*.

All peak data measurements of the harmonics were well below the quasi-peak limits.

3.3.4 Occupied Bandwidth

The badge reader is an ASK-modulated device operating at 13.56MHz. Occupied bandwidth measurements were made to demonstrate compliance with CFR47, Part 15.225. This band is from 13.553 – 13.567MHz. The upper limit for this band is 10,000uV/m or 80dBuv/m. Outside of this band the limits are per CFR47, Part 15.209. Below 30 MHz, this is 30uV/m or 29.54dBuV/m. Figure 6 shows the full 1MHz bandwidth.

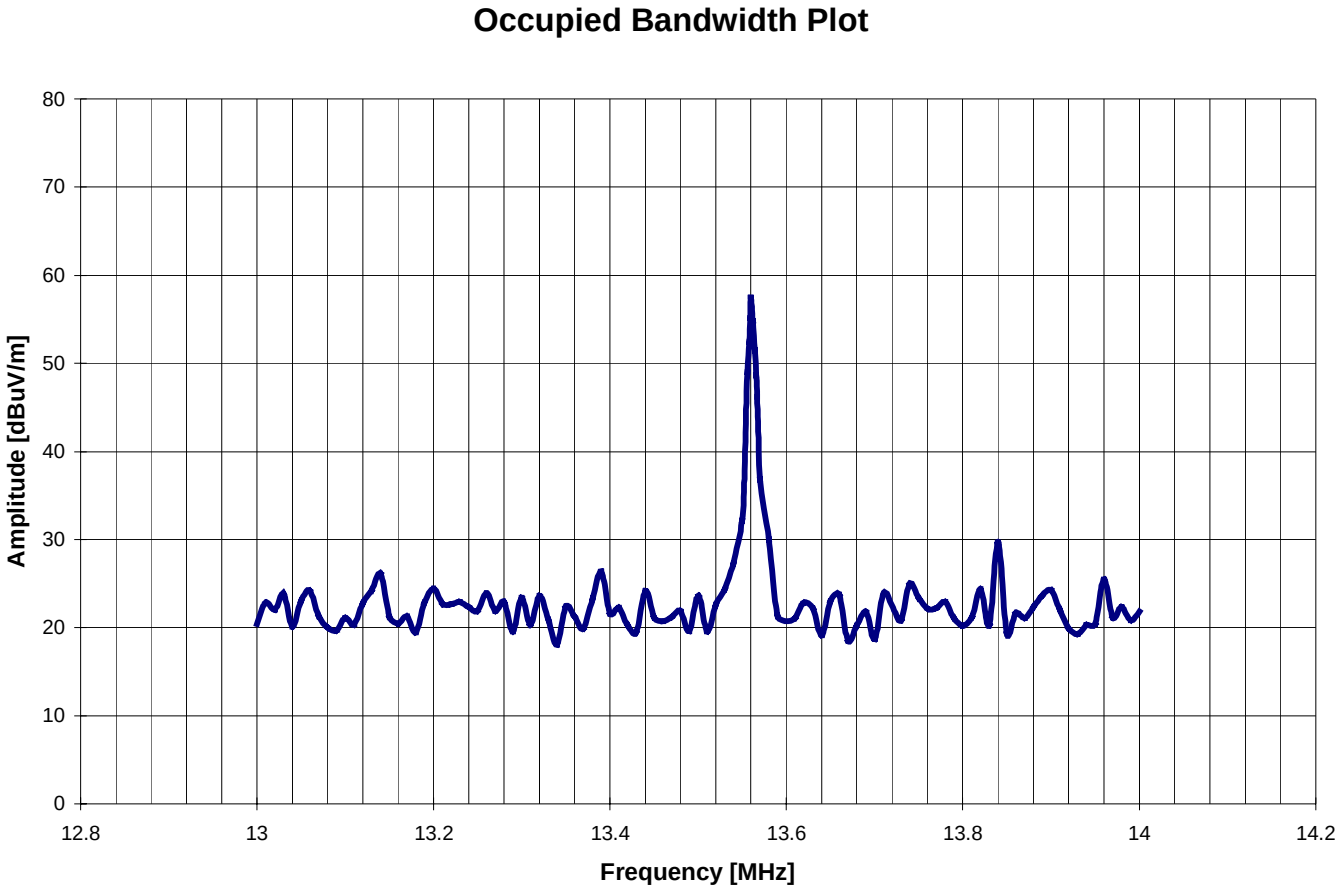

Figure 6

Figure 7 zooms in on the bandwidth in question. The bandwidth is shown by the vertical blue dashed lines. The upper limit of 10,000uV/mper 15.225 is not shown on this graph. However the 30uV/m limit of 15.209 is shown. The peak of 74.473uV/m is well below the 10,000uV/m limit. At the band boundary, The signal level of 20.488uV/m is below 30uV/m limit.

Occupied Bandwidth Plot

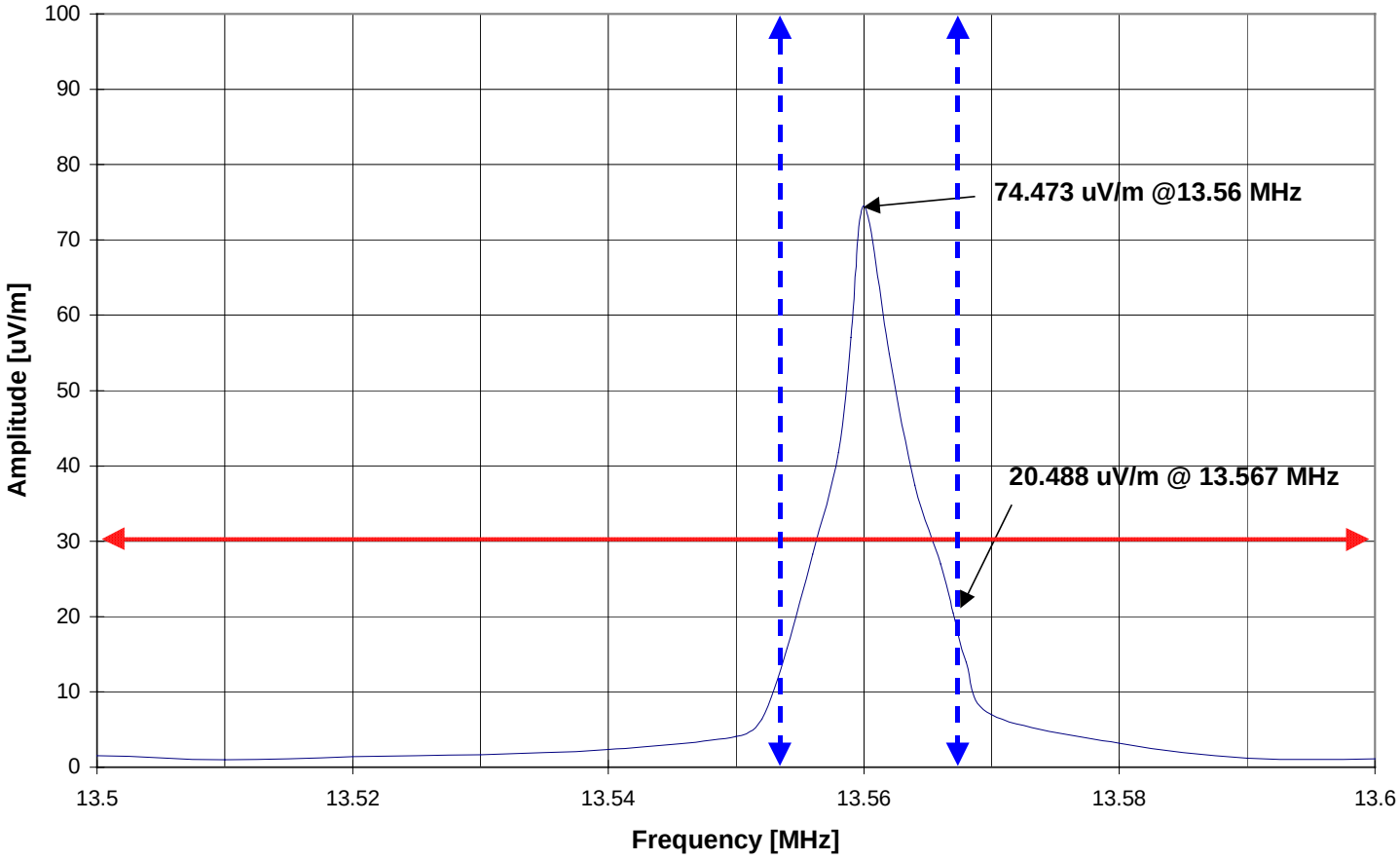

Figure 7

3.4 Frequency Stability Data (CFR47 Part 15.225(c))

3.4.1 Power Variation

The base frequency of the badge reader was recorded as read off the receiver display. The supply was delivering +5.0Vdc to the badge reader. The supply was raised to 5.75Vdc or 115% of it's nominal value.

The transmit frequency of the badge reader was recorded:

Time	Frequency
Startup	13.56113 MHz
2 min.	13.56113 MHz
5 min.	13.56113 MHz
10 min.	13.56113 MHz

The supply voltage was then turned down to 4.25Vdc or 85% of it's value and the same data recorded:

Time	Frequency
Startup	13.56113 MHz
2 min.	13.56113 MHz
5 min.	13.56113 MHz
10 min.	13.56113 MHz

Varying the supply voltage had no effect.

3.4.2 Temperature

The EUT temperature was raised to 50°C and the transmit frequency recorded. The temperature of the badge reader was lowered to -20°C and the frequency recorded.

The first data set taken after the EUT temperature was raised to 50°C and maintained at that temperature for thirty minutes. At this time, data collection began.

Time	Frequency
Startup	13.56113 MHz
2 min.	13.56113 MHz
5 min.	13.56113 MHz
10 min.	13.56113 MHz

The EUT temperature was then lowered to -20°C and maintained at that frequency for thirty minutes. Data collection was repeated and is shown below:

Time	Frequency
Startup	13.56113 MHz
2 min.	13.56113 MHz
5 min.	13.56113 MHz
10 min.	13.56113 MHz

The base frequency was still at 13.56113MHz at both temperature extremes.

4.0 Conclusion

Based on the data obtained it is the opinion of this test facility the EUT tested is compliant to CFR47 Part 15. The test results should be submitted to the FCC for their review and opinion.

Test Performed By:_____

Orlando Perez
EMC Technician

Approved By:_____

Michael E. Hill
Manager Test Facility