

---

## FCC Part 15 Certification Test Report

### 2402MHz – 2474MHz Frequency Hopping Spread Spectrum Transceiver

FCC ID: R2K-IES-SP-BLUE

FCC Rule Part: 15.249

ACS Report Number: 04-0116-15C249

Manufacturer: Industrial Electronics Services  
Model: Serial Pup

Test Begin Date: April 26, 2004  
Test End Date: May 10, 2004

Report Issue Date: May 13, 2004



Prepared by: \_\_\_\_\_  
  
Hernando Orozco  
EMI/EMC Approvals Engineer  
ACS, Inc.

Reviewed by: \_\_\_\_\_  
  
R. Sam Wismer  
Engineering Manager  
ACS, Inc.

This test report shall not be reproduced except in full. This report may be reproduced in part with prior written consent of ACS, Inc. The results contained in this report are representative of the sample(s) submitted for evaluation.

This report contains 13 pages

# Table of Contents

---

<b>1.0 General</b>	<b>3</b>
1.1 Introduction	3
1.2 Product Description	3
1.2.1 Intended Use	3
<b>2.0 Location of Test Facility</b>	<b>3</b>
2.1 Description of Test Facility	3
2.1.2 Open Area Test Site	4
2.1.2 Conducted Emissions Test Site	5
<b>3.0 Applicable Standards and References</b>	<b>6</b>
<b>4.0 List of Test Equipment</b>	<b>6</b>
<b>5.0 EUT Setup Block Diagram</b>	<b>7</b>
<b>6.0 Summary of Tests</b>	<b>7</b>
6.1 Section 15.207 - Power Line Conducted Emissions	7
6.1.1 Test Methodology	7
6.1.2 Test Results	7
6.2 Section 15.209 - Radiated Emissions (Unintentional Radiation)	12
6.2.1 Test Methodology	12
6.2.2 Test Results	12
6.3 Section 15.249(a) – Field Strength of Emissions	12
6.3.1 Test Requirement	12
6.3.1 Test Methodology	12
6.3.2 Test Results	13
<b>7.0 CONCLUSION</b>	<b>13</b>

**Additional Exhibits Included In Filing**

**Internal Photographs**  
**External Photographs**  
**Test Setup Photographs**  
**Product Labeling**  
**RF Exposure – MPE Calculations**  
**Installation/Users Guide**  
**Theory of Operation**  
**System Block Diagram**  
**Schematics**  
**Bill of Materials**

## 1.0 GENERAL

### 1.1 Introduction

The purpose of this report is to demonstrate compliance with 15.249 of the FCC's Code of Federal Regulations.

### 1.2 Product Description

The serial pup device is a wireless serial cable replacement transceiver, which operates in the 2.4GHZ ISM band, and is capable of data rates of up to 921Kbps. It utilizes frequency hopping spread spectrum technology along with Bluetooth®™ protocols to provide a wireless means of transmitting serial data.

#### 1.2.1 Intended Use

The Serial Pup is designed for industrial or home use where wireless data transmission is required.

## 2.0 LOCATION OF TEST FACILITY

All testing was performed by qualified ACS personnel located at the following address:

ACS, Inc.  
5015 B.U. Bowman Drive  
Buford, GA 30518

## 2.1 DESCRIPTION OF TEST FACILITY

Both the Open Area Test Site (OATS) and Conducted Emissions site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 89450  
Industry Canada Lab Code: IC 4175  
VCCI Member Number: 1831  
■ VCCI OATS Registration Number R-1526  
■ VCCI Conducted Emissions Site Registration Number: C-1608

### 2.1.1 Open Area Test Site

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane, however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.1-1 below:

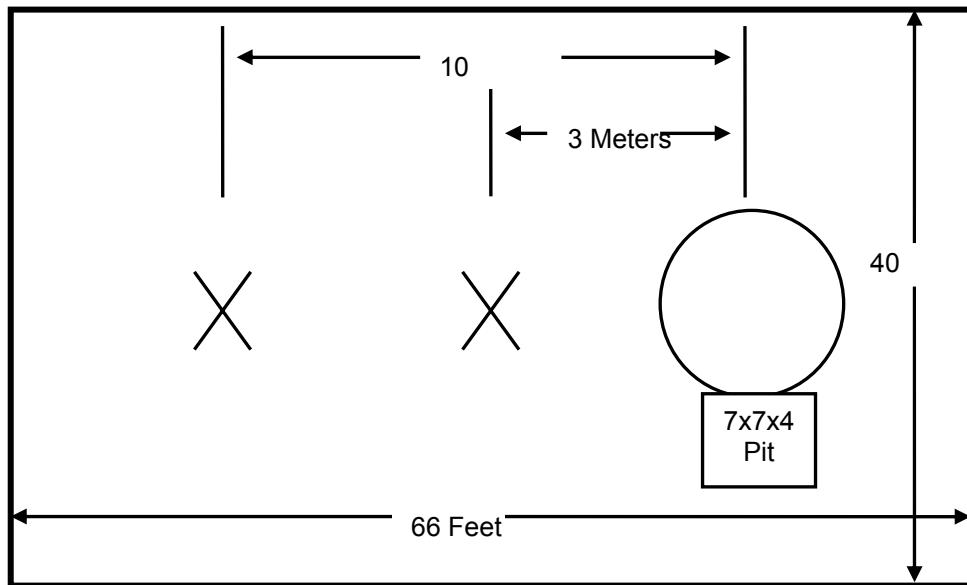


Figure 2.1-1: Open Area Test Site

### 2.1.2 Conducted Emissions Test Site Description

The AC mains conducted EMI site is a shielded room with the following dimensions:

- Height: 3.0 Meters
- Width: 3.6 Meters
- Length: 4.9 Meters

The room is manufactured by Rayproof Corporation and installed by Panashield, Inc. Earth ground is provided to the room via an 8' copper ground rod. Each panel of the room is connected electrically at intervals of 4".

Power to the room is filtered to prevent ambient noise from coupling to the EUT and measurement equipment. Filters are models 1B42-60P manufactured by Rayproof Corporation.

The room is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 2.1.2-1:

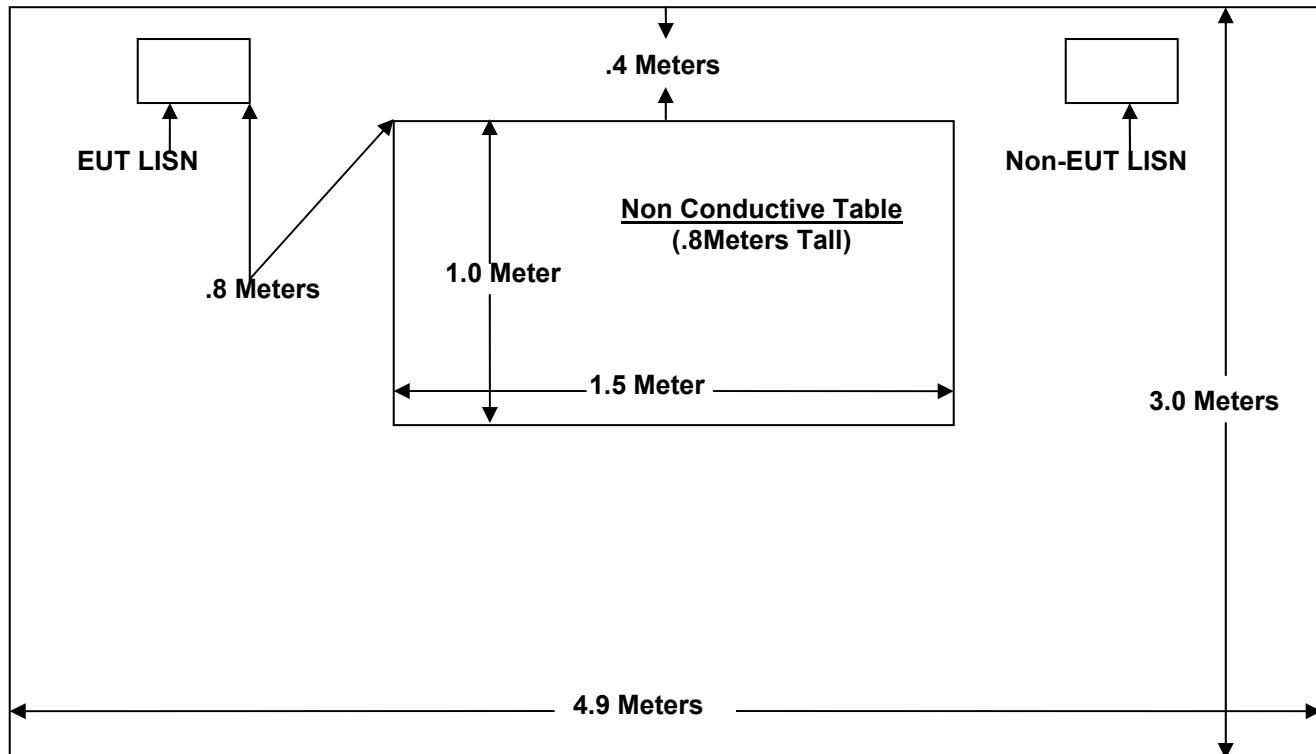


Figure 2.1.2-1: AC Mains Conducted EMI Site

### 3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ❖ ANSI C63.4-: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures (October 2002)
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators (October 2002)
- ❖ FCC OET Bulletin 65 Appendix C - Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
- ❖ ANSI/TIA/EIA – 603 – A – 2001: Land Mobile or PM Communications Equipment and Performance Standards (August 15, 2001)

### 4.0 LIST OF TEST EQUIPMENT

All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications.

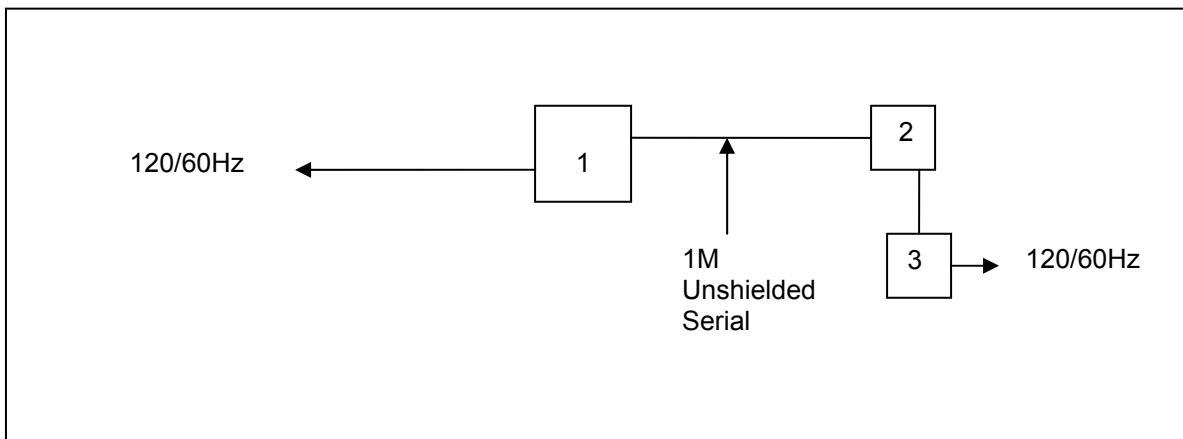
**Table 4-1: Test Equipment**

Equipment Calibration Information					
ACS #	Mfg.	Eq. type	Model	S/N	Cal. Due
---	Agilent	Spectrum Analyzer	E7402A	US40240259	11/08/04
---	Agilent	Spectrum Analyzer	8563EC	4111A01283	10/10/04
26	Chase	Bi-Log Antenna	CBL6111	1044	10/14/04
152	EMCO	LISN	3825/2	9111-1905	1/08/05
153	EMCO	LISN	3825/2	9411-2268	12/11/04
193	ACS	OATS Cable Set	RG8	193	1/09/05
167	ACS	Conducted EMI Cable Set	RG8	167	1/09/05
5	Harbour Industries	Cable	LL-335	None	8/20/04
6	Harbour Industries	Cable	LL-335	None	8/6/04
22	Agilent	Pre-Amplifier	8449B	3008A00526	9/18/04
73	Agilent	Pre-Amplifier	8447D	272A05624	05/15/04
30	Spectrum Technologies	Horn Antenna	DRH-0118	970102	5/8/04
105	Microwave Circuits	High Pass Filter	H1G810G1	2123-01 DC0225	6/17/04
40	EMCO	Biconical Antenna	3104	3211	9/19/04

## 5.0 SYSTEM BLOCK DIAGRAM

**Table 5.0: System Block Diagram**

Diagram Number	Manufacturer	Equipment Type	Model Number	Serial Number	FCC ID
1	Industrial Electronics Services	EUT	Serial Pup	None	R2K-IES-SP-BLUE
2	IBM	Laptop	Thinkpad 600E	78-GCPT7	N/A
3	IBM	PowerBrick	AA20210	02k6491	N/A



**Figure 5.0-1: EUT Test Setup**

## 6.0 SUMMARY OF TESTS

## 6.1 Power Line Conducted Emissions - FCC Section 15.207

### 6.1.1 Test Methodology

ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz.

## 6.1.2 Test Results

### 6.1.2.1 Conducted Emissions

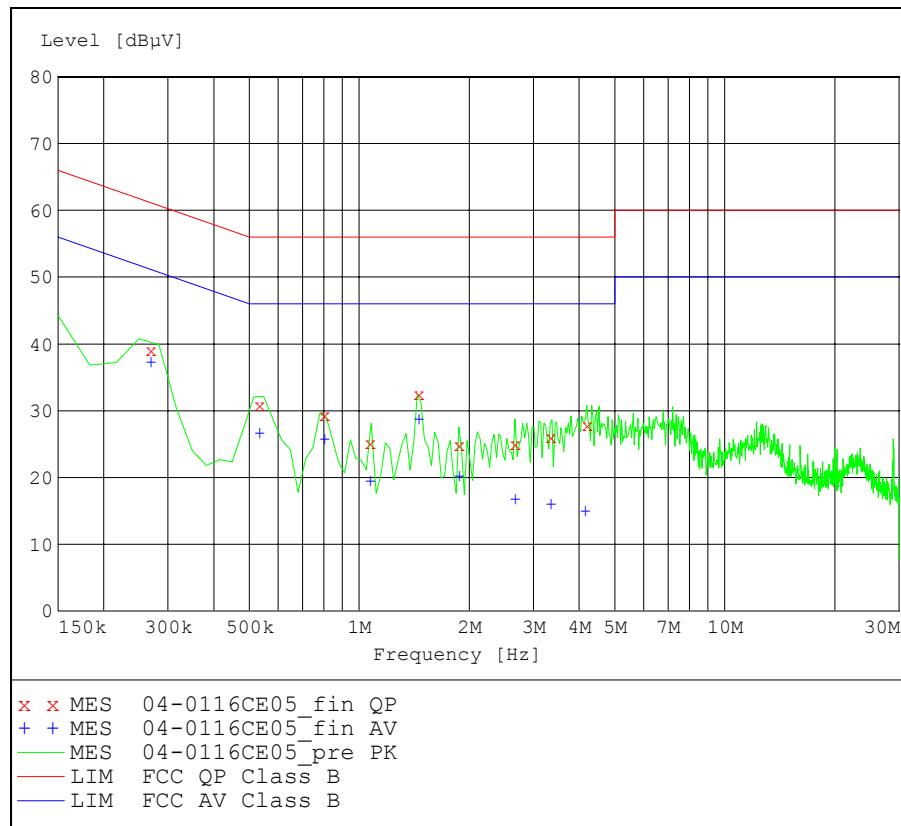
Tabulated conducted emissions data is reported in tables 6.1-1 thru 6.1-4 below:

**TABLE 6.1-1: CONDUCTED EMISSIONS: LINE 1-QUASI-PEAK**

Frequency MHz	Level dB $\mu$ V	Transd dB	Limit dB $\mu$ V	Margin dB	Line	PE
0.270	39.10	9.5	61.1	22.0	L1	GND
0.534	30.90	9.5	56.0	25.0	L1	GND
0.804	29.40	9.6	56.0	26.5	L1	GND
1.074	25.30	9.6	56.0	30.6	L1	GND
1.458	32.60	9.5	56.0	23.3	L1	GND
1.878	24.90	9.6	56.0	31.0	L1	GND
2.676	25.10	9.5	56.0	30.8	L1	GND
3.354	26.10	9.5	56.0	29.8	L1	GND
4.206	27.90	9.6	56.0	28.0	L1	GND

**TABLE 6.1-2: CONDUCTED EMISSIONS: LINE 1-AVERAGE**

Frequency MHz	Level dB $\mu$ V	Transd dB	Limit dB $\mu$ V	Margin dB	Line	PE
0.270	37.30	9.5	51.1	13.8	L1	GND
0.534	26.70	9.5	46.0	19.2	L1	GND
0.804	25.80	9.6	46.0	20.1	L1	GND
1.074	19.50	9.6	46.0	26.4	L1	GND
1.458	28.80	9.5	46.0	17.1	L1	GND
1.878	20.30	9.6	46.0	25.6	L1	GND
2.676	16.80	9.5	463.0	29.1	L1	GND
3.354	16.10	9.5	46.0	29.8	L1	GND
4.158	15.00	9.6	46.0	30.9	L1	GND



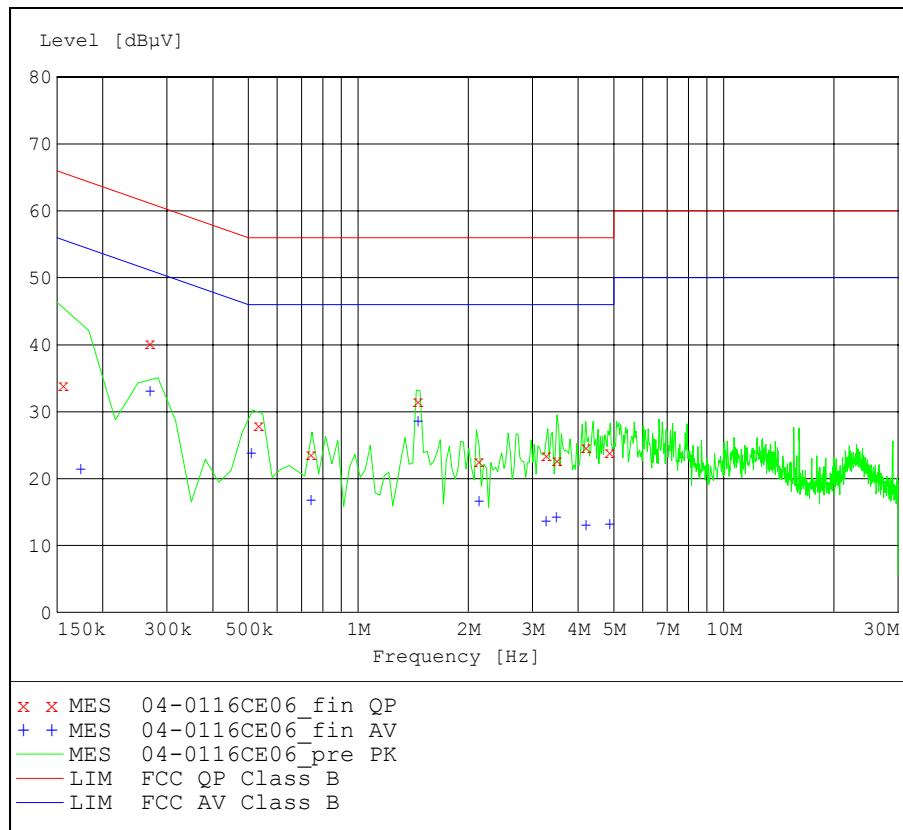
GRAPHIC 6.1-1 CONDUCTED EMISSIONS: LINE 1

**TABLE 6.1-3: CONDUCTED EMISSIONS: L2-QUASI-PEAK**

Frequency MHz	Level dB $\mu$ V	Transd dB	Limit dB $\mu$ V	Margin dB	Line	PE
0.156	34.00	9.6	65.6	31.5	L2	GND
0.270	40.40	9.5	61.1	20.6	L2	GND
0.534	28.00	9.5	56.0	27.9	L2	GND
0.744	23.70	9.5	56.0	32.2	L2	GND
1.458	31.70	9.5	56.0	24.2	L2	GND
2.142	22.70	9.5	56.0	33.2	L2	GND
3.270	23.60	9.5	56.0	32.3	L2	GND
3.498	22.80	9.5	56.0	33.1	L2	GND
4.194	24.80	9.6	56.0	31.1	L2	GND
4.878	24.10	9.7	56.0	31.8	L2	GND

**TABLE 6.1-4: CONDUCTED EMISSIONS: L2-AVERAGE**

Frequency MHz	Level dB $\mu$ V	Transd dB	Limit dB $\mu$ V	Margin dB	Line	PE
0.174	21.40	9.5	54.7	33.3	L2	GND
0.270	33.20	9.5	51.1	17.8	L2	GND
0.510	23.90	9.5	46.0	22.0	L2	GND
0.744	16.80	9.5	46.0	29.1	L2	GND
1.458	28.60	9.5	46.0	17.3	L2	GND
2.142	16.70	9.5	46.0	29.2	L2	GND
3.264	13.70	9.5	46.0	32.2	L2	GND
3.486	14.30	9.5	46.0	31.6	L2	GND
4.194	13.10	9.6	46.0	32.8	L2	GND
4.884	13.30	9.7	46.0	32.6	L2	GND



GRAPHIC 6.1-2 CONDUCTED EMISSIONS: LINE 2

## 6.2 Radiated Emissions - FCC Section 15.209(Unintentional Radiation)

### 6.2.1 Test Methodology

ANSI C63.4 Sections 6 and 8 were the guiding documents for this evaluation. Radiated emissions tests were performed over the frequency range of 30MHz to 1000. Measurements of the radiated field strength were made at a distance of 3m from the boundary of the equipment under test (EUT) and the receiving antenna. The antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Radiated measurements were made with the Spectrum Analyzer's resolution bandwidth set to 120KHz for measurements above 30MHz.

The EUT was caused to go into a Standby mode for this test.

### 6.2.2 Test Results

Results of the test are given in Table 6.2.2-1 below:

**Table 6.2.2-1: Radiated Emissions Tabulated Data (Unintentional Radiators)**

Frequency (MHz)	Uncorrected Reading (dB $\mu$ V)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Position (°)	Total Correction Factor (dB)	Corrected Reading (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Results
30.00	12.68	H	100	541	19.99	32.67	40.0	7.3	Pass
120.24	13.95	V	100	0	13.01	26.96	43.5	16.5	Pass
129.84	13.60	V	100	541	13.26	26.86	43.5	16.6	Pass
198.96	18.20	H	200	0	11.20	29.40	43.5	14.1	Pass
240.48	17.11	H	100	541	12.27	29.38	46.0	16.6	Pass
681.52	26.38	V	100	541	2.06	28.44	46.0	17.6	Pass
960.00	20.50	H	100	0	6.84	27.34	46.0	18.7	Pass

## 6.3 FCC Section 15.249 (a) – Field Strength of Emissions

### 6.3.1 Test Requirement

In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

Fundamental Frequency	Field Strength of Fundamental (Millivolts/meters)	Field Strength of Harmonics (Millivolts/meters)
902-928MHz	50	500
2400-2483.5MHz	50	500
5725-5875MHz	50	500
24.0-24.25MHz	250	2500

### 6.4.2 Test Methodology

ANSI C63.4 Sections 6 and 8 were the guiding documents for this evaluation. Radiated emissions tests were performed over the frequency range of 30MHz to 10000MHz. Measurements of the radiated field strength were made at a distance of 3m from the boundary of the equipment under test (EUT) and the receiving antenna. The antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Radiated measurements were made with the Spectrum Analyzer's resolution bandwidth set to 120KHz for measurements below 1000MHz and 1Mhz for measurements above 1000MHz. All measurements were made using a CISPR Quasi Peak Detector as allowed by 15.249.

The EUT was caused to go into a continuous mode of operation for this test.

**6.4.3 Test Results**

The results are shown in the table 6.4.3-1 below.

**Table 6.4.3-1: Fundamental Field Strength Radiated Measurements**

Channel	Low	Mid	High
<b>Fundamental Freq (MHz):</b>	<b>2401.7</b>	<b>2439.0</b>	<b>2474.9</b>
<b>Fund. Field Strength (dBuV):</b>	86.19	86.72	89.23
<b>Limit(dBuV/m)</b>	93.97	93.97	93.97
<b>Margin:</b>	7.78	7.25	4.74
<b>Result:</b>	<b>Pass</b>	<b>Pass</b>	<b>Pass</b>

**Table 6.4.3-2: Radiated Spurious Emissions Measurements**

Frequency (MHz)	Level (dBuV)	Detector (P/A)	Antenna Polarity (H/V)	Turntable Position (o)	Correction Factors (dB)	Corrected Level (dBuV)	Limit (dBuV)	Margin (dB)
<b>Low Channel</b>								
4803	41.94	p	v	0	7.69	49.63	74.00	24.37
4803	29.32	a	v	0	-10.31	19.01	54.00	34.99
7205	39.99	p	v	0	12.84	52.83	74.00	21.17
7205	28.81	a	v	0	-5.16	23.65	54.00	30.35
<b>Mid Channel</b>								
4878	41.26	p	v	0	8.02	49.28	74.00	24.72
4878	28.99	a	v	0	-9.98	19.01	54.00	34.99
7317	41.41	p	v	0	12.57	53.98	74.00	20.02
7317	28.69	a	v	0	-5.43	23.26	54.00	30.74
<b>High Channel</b>								
4949	40.62	p	v	0	8.33	48.95	74.00	25.05
4949	28.84	a	v	0	-9.67	19.17	54.00	34.83
7424	43.01	p	v	0	12.31	55.32	74.00	18.68
7424	28.69	a	v	0	-5.69	23.00	54.00	31.00

**7.0 CONCLUSION**

In the opinion of ACS, Inc. the Serial Pup, manufactured by Industrial Electronics Services meets the relevant requirements of FCC Part 15.249 as required.