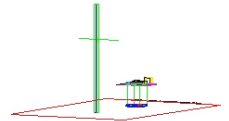


# PCTEST Engineering Laboratory, Inc.

6660-B Dobbin Road • Columbia, MD 21045 • U.S.A.

TEL (410) 290-6652 • FAX (410) 290-6654

<http://www.pctestlab.com>



## CERTIFICATE OF COMPLIANCE

Symbol Technologies Inc.  
1 Symbol Plaza  
Holtsville, NY 11742-1300  
Attn: Mark Luksich, Regulatory Engineer

Dates of Tests: December 5, 2001  
Test Report S/N: 15.211127701.H9P  
Test Site: PCTEST Lab, Columbia MD U.S.A.

FCC ID

**H9PLA4137**

APPLICANT

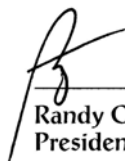
**SYMBOL TECHNOLOGIES INC.**

|                     |                                               |
|---------------------|-----------------------------------------------|
| FCC Rule Part(s):   | § 15.247; ANSI C-63.4 (1992)                  |
| Classification:     | Spread Spectrum Transceiver (DSS)             |
| Method/System:      | Direct Sequence Spread Spectrum System (DSSS) |
| Equipment Type:     | DSSS Radio Card (PCMCIA)                      |
| Max Radiated Power: | 0.02 Watts (13.07 dBm)                        |
| Frequency Range:    | 2412 – 2462 MHz                               |
| Trade/Model No(s):  | SYMBOL / CC-4137-1000-WW                      |

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C-63-4.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

*PCTEST certifies that no party to this application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 862.*

  
Randy Ortanez  
President



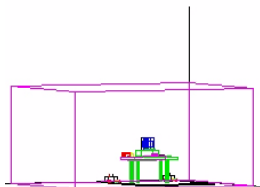
**NVLAP**  
LAB CODE 100431-0

## TABLE OF CONTENTS

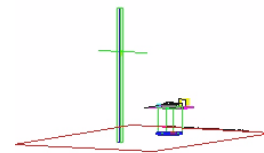
---

|                                                 |    |
|-------------------------------------------------|----|
| SCOPE                                           | 1  |
| INTRODUCTION (SITE DESCRIPTION)                 | 2  |
| PRODUCT INFORMATION                             | 3  |
| DESCRIPTION OF TESTS                            |    |
| A.    CONDUCTED EMISSIONS                       | 4  |
| B.    RADIATED EMISSIONS                        | 5  |
| C.    RESTRICTED BANDS                          | 6  |
| D.    ANTENNA REQUIREMENT                       | 7  |
| E.    DIRECT SEQUENCE BANDWIDTH                 | 8  |
| F.    MAXIMUM PEAK POWER OUTPUT                 | 9  |
| G.    POWER DENSITY                             | 10 |
| RADIATED MEASUREMENTS (FUNDAMENTAL & HARMONICS) | 11 |
| LIST OF TEST EQUIPMENT                          | 12 |
| CONCLUSION                                      | 13 |
| ATTACHMENT A - TEST PLOTS                       |    |
| ATTACHMENT B - FCC ID LABEL & LOCATION          |    |
| ATTACHMENT C - EXTERNAL PHOTOGRAPHS             |    |
| ATTACHMENT D - INTERNAL PHOTOGRAPHS             |    |
| ATTACHMENT E - TEST SETUP PHOTOGRAPHS           |    |
| ATTACHMENT F - SAR MEASUREMENT REPORT           |    |
| ATTACHMENT G - SAR TEST DATA                    |    |
| ATTACHMENT H - SAR TEST SETUP PHOTOGRAPHS       |    |
| ATTACHMENT I - DIPOLE VALIDATION PLOTS          |    |
| ATTACHMENT J - PROBE CALIBRATION DATA           |    |

## MEASUREMENT REPORT



*Scope - Measurement and determination of electromagnetic emissions (EME) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission.*



### §2.983(a) General Information

|                        |                                                     |
|------------------------|-----------------------------------------------------|
| <b>Applicant Name:</b> | <b>SYMBOL TECHNOLOGIES INC.</b>                     |
| <b>Address:</b>        | <b>1 Symbol Plaza<br/>Holtsville, NY 11742-1300</b> |
| <b>Attention:</b>      | <b>Mark Luksich, Regulatory Engineer</b>            |

- FCC ID: **H9PLA4137**
- Class: Spread Spectrum Transceiver (DSS)
- Type: DSSS Radio Card (PCMCIA)
- Freq. Range: 2412 – 2462 MHz
- Method/System: Direct Sequence Spread Spectrum System (DSSS)
- Model No(s): **CC-4137-1000-WW**
- Max. RF Output Power: 0.02 Watts (13.07 dBm)
- Rule Part(s): § 15.247
- Dates of Tests: December 5, 2001
- Place of Tests: PCTEST Lab, Columbia, MD U.S.A.
- Test Report S/N: 15.211127701.H9P

## INTRODUCTION

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz (ANSI C63.4-1992) and FCC Public Notice dated July 12, 1995 entitled "Guidance on Measurement for Direct Sequence Spread Spectrum Systems" were used in the measurement of **SYMBOL** DSSS Radio Card (PCMCIA).

These measurement tests were conducted at **PCTEST Engineering Laboratory, Inc.** facility in New Concept Business Park, Guilford Industrial Park, Columbia, Maryland. The site address is 6660-B Dobbin Road, Columbia, MD 21045. The test site is one of the highest points in the Columbia area with an elevation of 390 feet above mean sea level. The site coordinates are 39° 11'15" N latitude and 76° 49'38" W longitude. The facility is 1.5 miles North of the FCC laboratory, and the ambient signal and ambient signal strength are approximately equal to those of the FCC laboratory. There are no FM or TV transmitters within 15 miles of the site. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4 on October 19, 1992.

### PCTEST Location

The map at right shows the location of the PCTEST Lab, its proximity to the FCC Lab, the Columbia vicinity area, the Baltimore-Washington International (BWI) airport, and the city of Baltimore, and the Washington, D.C. area. (see Figure1).

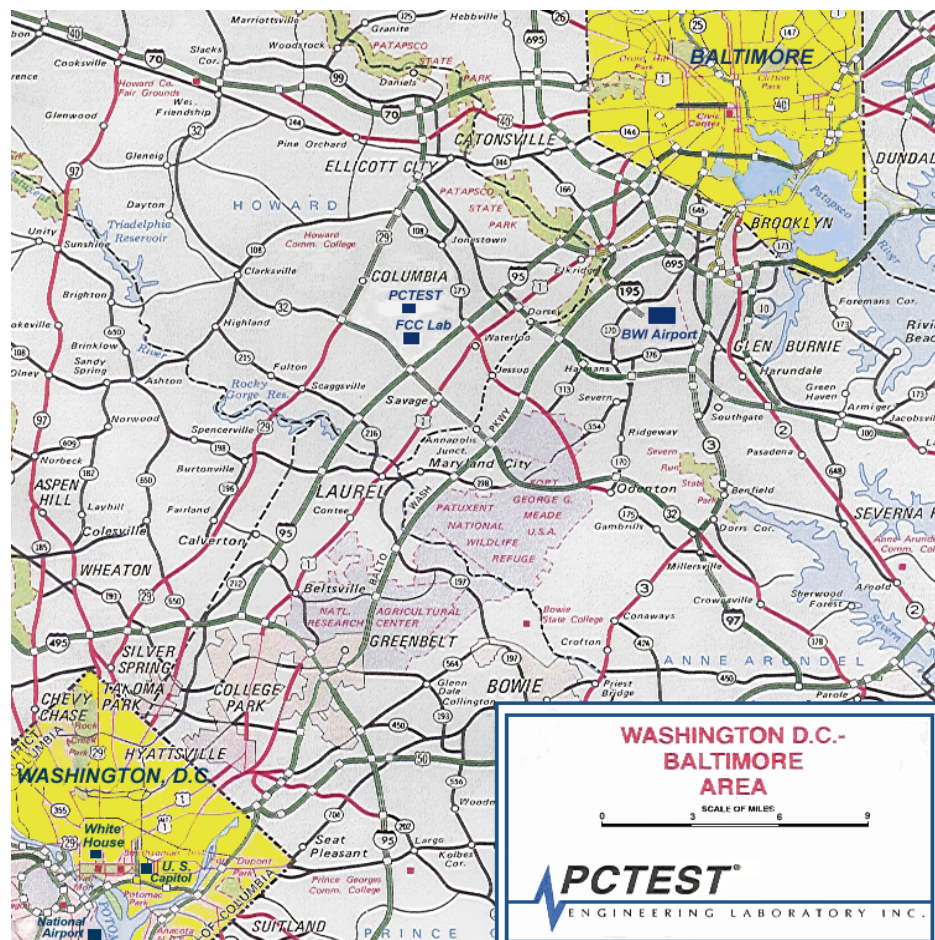


Figure 1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area.

## PRODUCT INFORMATION

---

### Equipment Description:

The Equipment under test (EUT) is the **SYMBOL CC-4137-1000-WW** DSSS Radio Card (PCMCIA) using spread spectrum direct sequence and time division duplex techniques.

Frequency Range: 2412 – 2462 MHz  
Spread Spectrum Method: Direct Sequence (DBPSK modulation)  
Max RF Output Power: 0.02 Watts

| CH | Rx/Tx<br>Freq. (MHz) |
|----|----------------------|
| 01 | 2412                 |
| 06 | 2437                 |
| 11 | 2462                 |

## Description of Tests

### Conducted Emissions

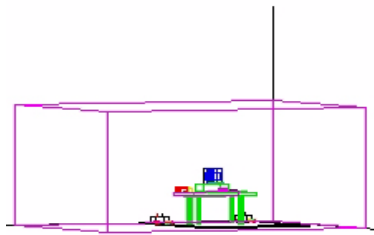


Figure 4. Shielded Enclosure  
Line-Conducted Test Facility

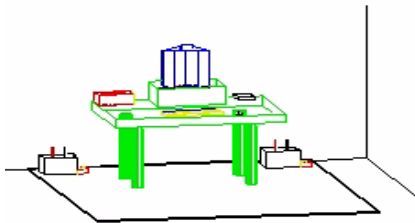


Figure 2. Line Conducted  
Emission Test Set-Up

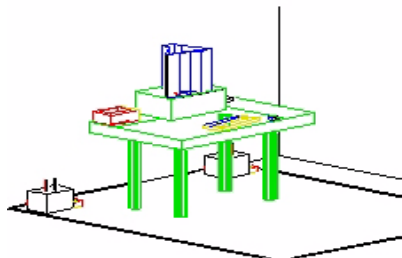


Figure 3. Wooden Table &  
Bonded LISNs

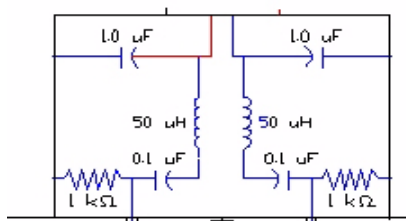


Figure 5. LISN Schematic  
Diagram

The line-conducted facility is located inside a 16'x20'x10' shielded enclosure. It is manufactured by Ray Proof Series 81 (see Figure 2). The shielding effectiveness of the shielded room is in accordance with MIL-Std-285 or NSA 65-6. A 1m. x 1.5m. wooden table 80cm. high is placed 40cm. away from the vertical wall and 1.5m away from the side wall of the shielded room (see Figure 3). Solar Electronics and EMCO Model 3725/2 (10kHz-30MHz) 50Ω/50μH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room (see Figure 4). The EUT is powered from the Solar LISN and the support equipment is powered from the EMCO LISN. Power to the LISNs are filtered by a high-current high-insertion loss Ray Proof power line filters (100dB 14kHz-10GHz). The purpose of the filter is to attenuate ambient signal interference and this filter is also bonded to the shielded enclosure. All electrical cables are shielded by braided tinned copper zipper tubing with inner diameter of 1/2". If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply lines will be connected to the Solar LISN. LISN schematic diagram is shown in Figure 5. All interconnecting cables more than 1 meter were shortened by non-inductive bundling (serpentine fashion) to a 1-meter length. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer to determine the frequency producing the maximum EME from the EUT. The spectrum was scanned from 450kHz to 30MHz with 20 msec. sweep time. The frequency producing the maximum level was reexamined using EMI/ Field Intensity Meter and Quasi-Peak adapter. The detector function was set to CISPR quasi-peak mode. The bandwidth of the receiver was set to 10 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each EME emission. Each emission was maximized by: switching power lines; varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and/or support equipment, and powering the monitor from the floor mounted outlet box and the computer aux AC outlet, if applicable; whichever determined the worst-case emission. Photographs of the worst-case emission can be seen in Appendix C. Each EME reported was calibrated using the HP8640B signal generator.

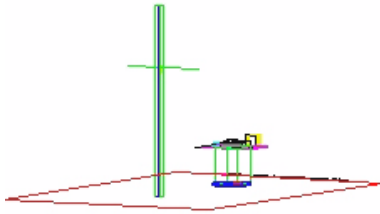


Figure 6. 3-Meter Test Site

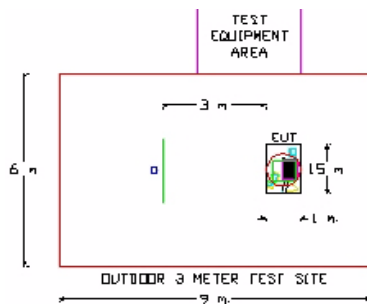


Figure 7. Dimensions of Outdoor Test Site

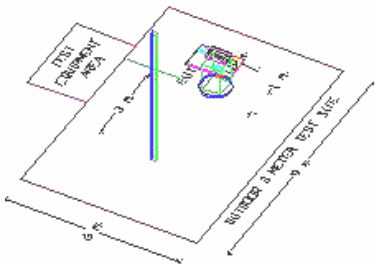


Figure 8. Turntable and System Setup

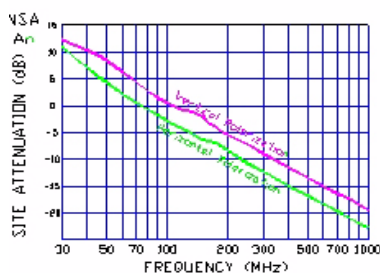


Figure 9. Normalized Site Attenuation Curves (H&V)

## Description of tests (Continued)

### Radiated Emissions

Preliminary measurements were made indoors at 1 meter using broadband antennas, broadband amplifier, and spectrum analyzer to determine the frequency producing the maximum EME. Appropriate precaution was taken to ensure that all EME from the EUT were maximized and investigated. The system configuration, clock speed, mode of operation or video resolution, turntable azimuth with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 to 200 MHz using biconical antenna and from 200 to 1000 MHz using log-spiral antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used.

Final measurements were made outdoors at 3-meter test range using Roberts™ Dipole antennas or horn antenna (see Figure 6). The test equipment was placed on a wooden and plastic bench situated on a 1.5 x 2 meter area adjacent to the measurement area (see Figure 7). Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined and investigated using EMI/Field Intensity Meter and Quasi-Peak Adapter. The detector function was set to CISPR quasi-peak mode and the bandwidth of the receiver was set to 100kHz or 1 MHz depending on the frequency or type of signal.

The half-wave dipole antenna was tuned to the frequency found during preliminary radiated measurements. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0.8-meter high non-metallic 1 x 1.5 meter table (see Figure 8). The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each EME emission. The turntable containing the system was rotated; the antenna height was varied 1 to 4 meters and stopped at the azimuth or height producing the maximum emission. Each emission was maximized by: varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and/or support equipment, and powering the monitor from the floor mounted outlet box and the computer aux AC outlet, if applicable; and changing the polarity of the antenna, whichever determined the worst-case emission. Photographs of the worst-case emission can be seen in Appendix C. Each EME reported was calibrated using the HP8640B signal generator. The Theoretical Normalized Site Attenuation Curves for both horizontal and vertical polarization are shown in Figure 9.

## § 15.205 Restricted Bands

---

Special attention is made for the EUT's harmonic and spurious radiated emission in the restricted bands of operation. The EUT was tested from 9kHz and up to the tenth harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average measurements was used using RBW 1 MHz – VBW 10Hz and linearly polarized horn antennas. In addition, peak measurements were taken to ensure that the peak levels are not more than 20dB above the average limit. All out of band emissions, other than those created by the spreading sequence, data sequence, and the carrier modulation must not exceed the limits show int Table 2 per 15.209.

| Frequency<br>(MHz) | F/S<br>(UV/m) | Meas. Dist.<br>(Meters) |
|--------------------|---------------|-------------------------|
| 0.009-0.490        | 2400/F (kHz)  | 300                     |
| 0.490-1.705        | 24000/F (kHz) | 30                      |
| 1.705-30.00        | 30            | 30                      |
| 30.0-88.0          | 100           | 3                       |
| 88.0-216.0         | 150           | 3                       |
| 216.0-960.0        | 200           | 3                       |
| Above 960          | 500           | 3                       |

Tab. 2. Radiated Emission Limits Per 15.209

### Test Equipment

|                  |                                               |
|------------------|-----------------------------------------------|
| HP 8566B         | Spectrum Analyzer 100Hz-22GHz                 |
| HP83017A         | Microwave Analyzer 40dB Gain (0.5 – 26.5 GHz) |
| HP 3784A         | Digital Transmission Analyzer                 |
| Gigatronics      | POWER METER MODEL 8651A                       |
| EMCO 3115        | Horn Antenna (1 – 18GHz)                      |
| HP 8495A         | 20dB Attenuator (DC-40GHz) 0-70dB             |
| HP 8493B         | 10dB Attenuator                               |
| MicroCoax Cables | Low Loss Microwave Cables (1-26.5 GHz)        |
| CDI Dipoles      | Dipole Antennas (30 – 1000 MHz)               |

## § 15.203 Antenna Requirement

---

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the applicant can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with this requirement.

### **CONCLUSION**

The **SYMBOL CC-4137-1000-WW** complies with the requirement of §15.203. The antenna is a **permanently attached omni-directional antenna**.

## § 15.247(a)(2) – Direct Sequence Bandwidth

---

Minimum Standard – The transmitter shall have a minimum 6dB bandwidth 500kHz. These are conducted measurements.

Res. Bandwidth = 100 kHz (5dB/div)  
Vid. BW = 100 kHz  
Span = 30 MHz  
Ref. Level -43 dBm  
Sweep 7.5ms

(see attached spectrum plots)

| FREQUENCY<br>(MHz) | Channel | 6dB Bandwidth<br>(MHz) |
|--------------------|---------|------------------------|
| 2412               | 01      | 11.25                  |
| 2437               | 06      | 11.48                  |
| 2462               | 11      | 12.00                  |

Table 3. 6dB Bandwidth measurements

REMARKS:

PASS

## § 15.247(b) Maximum Peak Output Power

---

Minimum Standard – The maximum peak output power of the transmitter shall not exceed 1 watt.  
These are radiated measurements.

Res. Bandwidth = 3 MHz (5dB/div)  
Vid. BW = 3 MHz  
Span = 30 MHz  
Ref. Level -30 dBm  
Sweep 4.0ms

| FREQUENCY<br>(MHz) | Channel | Power Output<br>Radiated<br>EIRP (dBm) |
|--------------------|---------|----------------------------------------|
| 2412               | 01      | 12.17                                  |
| 2437               | 06      | 12.87                                  |
| 2462               | 11      | 13.07                                  |

Table 4. Output Power Measurements

REMARKS:

PASS

## § 15.247(c) Power Density

---

Minimum Standard – The transmitted power density averaged over any 1 second interval shall not be greater than 8dBm. These are radiated measurements.

Res. Bandwidth = 3 kHz (5dB/div)  
Vid. BW = 3 kHz  
Span = 30 MHz  
Ref. Level -30 dBm  
Sweep 1000 sec

Peak + Atten = dBm  $\Rightarrow$  (Limit < 8dBm)

| FREQ<br>(MHz) | Channel | Power Density<br>(dBm) |
|---------------|---------|------------------------|
| 2412          | 01      | -13.49                 |
| 2437          | 06      | -13.13                 |
| 2462          | 11      | -12.12                 |

Table 5. Output Power Density Data.

REMARKS:

PASS

## RADIATED Measurements (Fundamental & Harmonics)

Operating Frequency: 2462 MHz  
 Distance of Measurements: 3 meters  
 Channel: 11

| FREQ.<br>(MHz) | Level*<br>(dBm) | AFCL<br>(dB) | POL<br>(H/V) | DET<br>QP/AVG | F/S<br>( $\mu$ V/m) | F/S<br>(dB $\mu$ V/m) | Margin<br>(dB) |
|----------------|-----------------|--------------|--------------|---------------|---------------------|-----------------------|----------------|
| 2484.1         | - 89.6          | 33.0         | V            | Peak          | 331.1               | 50.4                  | 3.6            |
| 2484.3         | - 88.8          | 33.1         | V            | Peak          | 366.0               | 51.3                  | 2.7            |
| 2484.4         | - 90.0          | 33.1         | V            | Peak          | 319.9               | 50.1                  | 2.7            |
| 2485.6         | - 88.0          | 33.1         | V            | Peak          | 402.7               | 52.1                  | 1.9            |
| 2490.0         | - 89.0          | 33.2         | V            | Peak          | 363.1               | 51.2                  | 2.8            |
| 2491.3         | - 88.0          | 33.2         | V            | Peak          | 407.4               | 52.2                  | 1.8            |

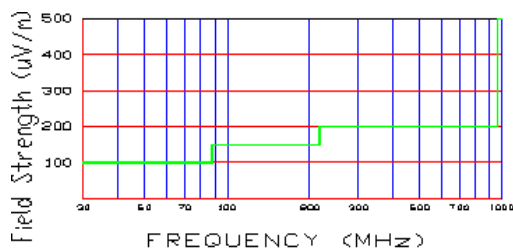


Figure 10. Restricted band harmonics and spurious limits.

Above 1 GHz limit is 500 uV/m (54dBu/m)

### NOTES:

1. All harmonics in the restricted bands specified in §15.205 are below the limit shown in table 2. (note: \* Restricted Band)
2. All harmonics/spurs are at least 20 dB below the highest emission in the authorized band using RBW = 100kHz
3. Average Measurements > 1GHz using RBW = 1 MHz VBW = 10 Hz
4. The peak emissions above 1 GHz are not more than 20 dB above the average limit.
5. The antenna is manipulated through typical positions, polarity and length during the tests.
6. The EUT is supplied with nominal AC voltage or/and a new/fully recharged battery.
7. The spectrum is measured from 9kHz to the 10<sup>th</sup> harmonic and the worst-case emissions are reported.
8. < - 132 are below the analyzer floor level.

## TEST EQUIPMENT

| Type                             | Model                                                                       | Cal. Due Date | S/N                    |
|----------------------------------|-----------------------------------------------------------------------------|---------------|------------------------|
| Microwave Spectrum Analyzer      | HP 8566B (100Hz-22GHz)                                                      | 12/05/02      | 3638A08713             |
| Microwave Spectrum Analyzer      | HP 8566B (100Hz-22GHz)                                                      | 04/17/02      | 2542A11898             |
| Spectrum Analyzer/Tracking Gen.  | HP 8591A (9kHz-1.8GHz)                                                      | 06/02/02      | 3144A02458             |
| Spectrum Analyzer                | HP 8591A (9kHz-1.8GHz)                                                      | 10/15/02      | 3108A02053             |
| Spectrum Analyzer                | HP 8594A (9kHz-2.9GHz)                                                      | 11/02/02      | 3051A00187             |
| Signal Generator*                | HP 8640B (500Hz-1GHz)                                                       | 06/02/02      | 2232A19558             |
| Signal Generator*                | HP 8640B (500Hz-1GHz)                                                       | 06/02/02      | 1851A09816             |
| Signal Generator*                | Rohde & Schwarz (0.1-1000MHz)                                               | 09/11/02      | 894215/012             |
| Ailtech/Eaton Receiver           | NM 37/57A-SL (30-1000MHz)                                                   | 04/12/02      | 0792-03271             |
| Ailtech/Eaton Receiver           | NM 37/57A (30-1000MHz)                                                      | 03/11/02      | 0805-03334             |
| Ailtech/Eaton Receiver           | NM 17/27A (0.1-32MHz)                                                       | 09/17/02      | 0608-03241             |
| Quasi-Peak Adapter               | HP 85650A                                                                   | 08/09/02      | 2043A00301             |
| Ailtech/Eaton Adapter            | CCA-7 CISPR/ANSI QP Adapter                                                 | 03/11/02      | 0194-04082             |
| RG58 Coax Test Cable             | No. 167                                                                     |               | n/a                    |
| Harmonic/Flicker Test System     | HP 6841A (IEC 555-2/3)                                                      |               | 3531A00115             |
| Broadband Amplifier (2)          | HP 8447D                                                                    |               | 1145A00470, 1937A03348 |
| Broadband Amplifier              | HP 8447F                                                                    |               | 2443A03784             |
| Transient Limiter                | HP 11947A (9kHz-200MHz)                                                     |               | 2820A00300             |
| Horn Antenna                     | EMCO Model 3115 (1-18GHz)                                                   |               | 9704-5182              |
| Horn Antenna                     | EMCO Model 3115 (1-18GHz)                                                   |               | 9205-3874              |
| Horn Antenna                     | EMCO Model 3116 (18-40GHz)                                                  |               | 9203-2178              |
| Biconical Antenna (4)            | Eaton 94455/Eaton 94455-1/Singer 94455-1/Compliance Design 1295, 1332, 0355 |               |                        |
| Log-Spiral Antenna (3)           | Ailtech/Eaton 93490-1                                                       |               | 0608, 1103, 1104       |
| Roberts Dipoles                  | Compliance Design (1 set) A100                                              |               | 5118                   |
| Ailtech Dipoles                  | DM-105A (1 set)                                                             |               | 33448-111              |
| EMCO LISN (2)                    | 3816/2                                                                      |               | 1077, 1079             |
| EMCO LISN                        | 3725/2                                                                      |               | 2009                   |
| Microwave Preamplifier 40dB Gain | HP 83017A (0.5-26.5GHz)                                                     |               | 3123A00181             |
| Microwave Cables                 | MicroCoax (1.0-26.5GHz)                                                     |               |                        |
| Ailtech/Eaton Receiver           | NM37/57A-SL                                                                 |               | 0792-03271             |
| Spectrum Analyzer                | HP 8591A                                                                    |               | 3034A01395             |
| Modulation Analyzer              | HP 8901A                                                                    |               | 2432A03467             |
| NTSC Pattern Generator           | Leader 408                                                                  |               | 0377433                |
| Noise Figure Meter               | HP 8970B                                                                    |               | 3106A02189             |
| Noise Figure Meter               | Ailtech 7510                                                                |               | TE31700                |
| Noise Generator                  | Ailtech 7010                                                                |               | 1473                   |
| Microwave Survey Meter           | Holaday Model 1501 (2.450GHz)                                               |               | 80931                  |
| Digital Thermometer              | Extech Instruments 421305                                                   |               | 426966                 |
| Attenuator                       | HP 8495A (0-70dB) DC-4GHz                                                   |               |                        |
| Bi-Directional Coax Coupler      | Narda 3020A (50-1000MHz)                                                    |               |                        |
| Shielded Screen Room             | RF Lindgren Model 26-2/2-0                                                  |               | 6710 (PCT270)          |
| Shielded Semi-Anechoic Chamber   | Ray Proof Model S81                                                         |               | R2437 (PCT278)         |
| Environmental Chamber            | Associated Systems Model 1025 (Temperature/Humidity)                        |               | PCT285                 |

\* Calibration traceable to the National Institute of Standards and Technology (NIST).

## CONCLUSION

---

The data collected shows that the **SYMBOL FCC ID: H9PLA4137 DSSS Radio Card (PCMCIA)** complies with Part 15.247 of the FCC Rules.