PCTEST Engineering Laboratory, Inc.

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CERTIFICATE OF COMPLIANCE
FCC Part 15.245 Certification

SPORTS SENSORS, INC.
P.O. Box 46198
Cincinati, OH 45246-0198
Attn: Telemachos J. Manolatos, Vice President

Dates of Tests: January 9-10, 2003
Test Report S/N: TX.230110008.NVE
Test Site: PCTEST Lab, Columbia MD

FCC ID	**NVE363**
APPLICANT	**SPORTS SENSORS INC.**

FCC Rule Part(s):	**§ 15.245**
Classification:	**Part 15 Field Disturbance Sensor (FDS)**
EUT Type:	**GLOVE RADAR TM**
Frequency Range:	**10.5 – 10.55 GHz**
Trade Name:	**SPORTS SENSORS**
Model:	**363**

This device 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 is ANSI C63.4-1992 with the following remarks (Note Codes): 37.

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.

Alfred Cirwithian
Vice President Engineering

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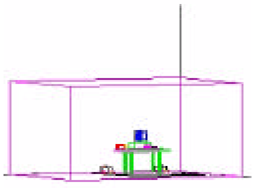
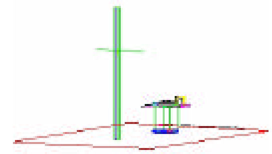
MEASUREMENT REPORT





1.1 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.

Company Name:	**SPORTS SENSORS INC.**
Address:	**P.O. Box 46198** **Cincinati, OH 45246-0198**
Attention:	**Mr. Telemachos J. Manolatos, Vice President**

- FCC ID: **NVE363**
- Model: **363**
- Trade Name: ***SPORTS SENSORS***
- EUT Type: GLOVE RADAR TM
- Equipment Class: Part 15 Field Disturbance Sensor (FDS)
- Application Type: Certification
- Frequency Range: 10.5 – 10.55 GHz
- FCC Rule Part(s): § 15.245
- Dates of Tests: January 9-10, 2003
- Place of Tests: PCTEST Lab, Columbia, MD U.S.A.
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2.1 INTRODUCTION

The measurement procedure described in Section 15.249 of FCC Rules, and 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) was used in determining radiated and conducted emissions emanating from **SPORTS SENSORS Inc. GLOVE RADAR TM FCC ID: NVE363.**

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.

2.2 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 Figure 1).

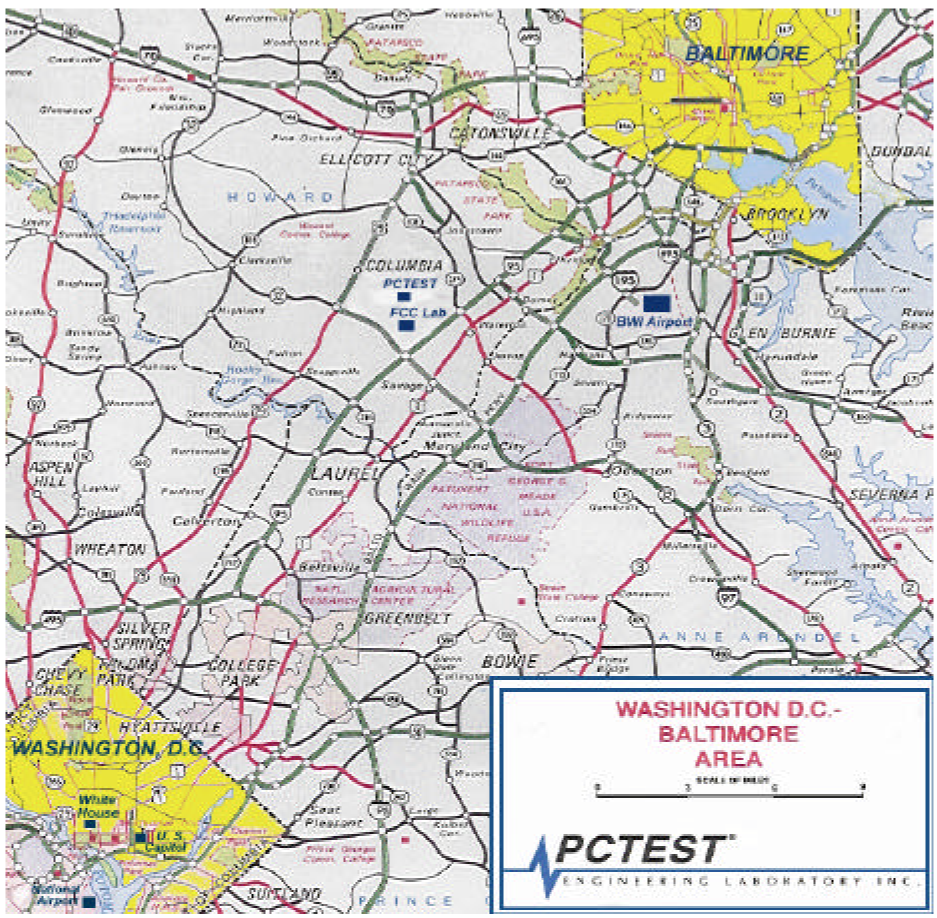


Figure 1. Map of the Greater Baltimore and Metropolitan Washington, D.C. area.

3.1 Product Information

3.2 Equipment Description

The Equipment Under Test (EUT) is the **SPORTS SENSORS Inc. GLOVE RADAR TM FCC ID: NVE363.**

- **Tx Freq. Range(Base):** **10.5 – 10.55 GHz**
- **Antenna:** **Permanently Attached, Omni-Directional**
- **Power Supply:** **3AA Batteries**

4.1 Description of Tests

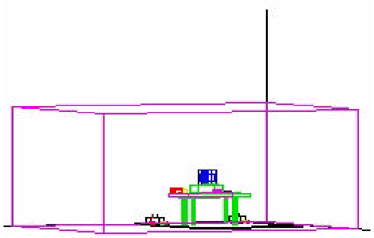
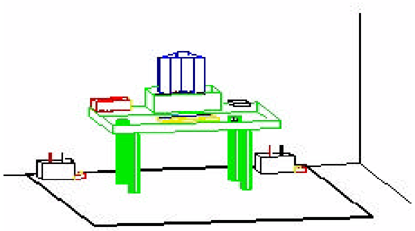


Figure 2. Shielded Enclosure Line-Conducted Test Facility



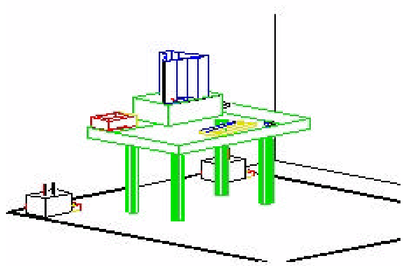


Figure 4. Wooden Table & Bonded LISNs

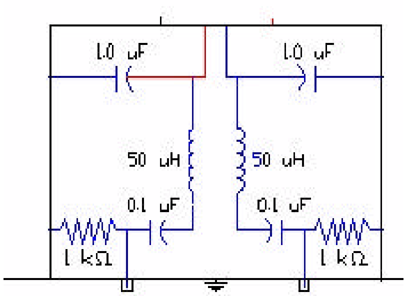


Figure 5. LISN Schematic Diagram

4.2 Conducted Emissions

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 an 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 Attachment I. Each EME reported was calibrated using the HP8640B signal generator.

4.1 Description of Tests (continued)

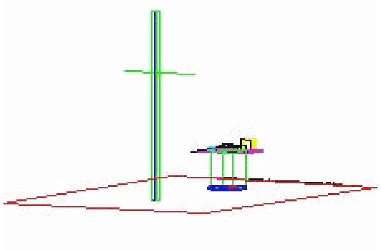


Figure 6. 3-Meter Test Site

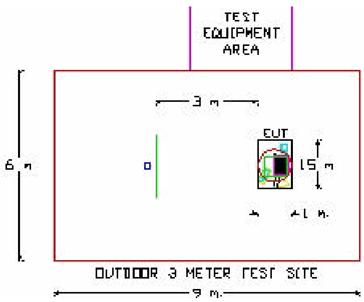


Figure 7. Dimensions of Outdoor Test Site

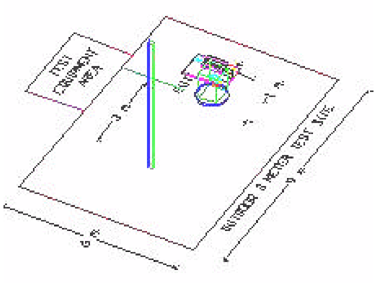


Figure 8. Turntable and System Setup

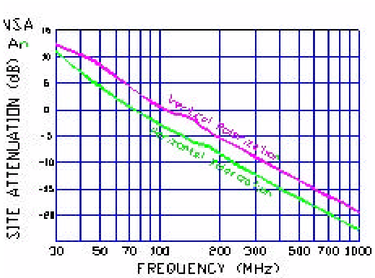


Figure 9. Normalized Site Attenuation Curves (H&V)

4.3 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; 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 Attachment I. 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 according to ANSI C63.4.

5.1 §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.

Unit

The Sports Sensors Inc. **GLOVE RADAR TM** unit complies with the requirement of §15.203.
The antenna is a permanently attached Telescopic Omni-directional Antenna.

CONCLUSION

For the unit, there are no provisions for connection to an external antenna.
Sport Sensors Inc. GLOVE RADAR TM unit meets the Antenna Requirements of §15.203.

6.1 FREQUENCY MEASUREMENTS (FUNDAMENTAL & HARMONICS)

A. Transmitter Portion (Base) - Model: 363

Operating Frequency: 10.525 MHz

Distance of Measurements: 3 meters

Channel: Low

FREQ. (MHz)	**Level** (dBm)	**AFCL** (dB)	**POL** (H/V)	**DET** QP/AVG	**F/S** (μV/m)	**Margin** (dB)
10,525	- 51.550	43.00	V	PEAK	83656.600	28.55
21,050	- 114.600	50.00	V	PEAK	131.826	11.60
31,575	- 118.500	57.30	V	PEAK	194.984	8.20
42,100	- 132.300	63.00	V	PEAK	76.736	16.30
52,625	- 135.000	70.00	V	PEAK	125.893	12.00

Fundamental Frequency (MHz)	Field Strength of Fundamental (millivolts/meter)	Field strength of harmonics (millivolts/meter)
2435 - 2465	500	1.6
5785 - 5815	500	1.6
10500 - 10550	2500	25.0
24075 - 24175	2500	25.0

Figure 12. Radiated limits at 3 meters

NOTES:

1. The limit at fundamental freq. is 2500 mV/m @ 3m. using average detector (RBW = 1 MHz VBW = 3Hz).

2. All emissions exceeding 20mV/m @3m. are reported.

3. All spurious emissions in the restricted bands specified in §15.205 are below the limit shown in Fig. 10.

4. Measurements are made at 20° or between +15° C to +25° C.

5. The antenna is manipulated through typical positions and length during the tests.

6. The emissions are maximized by changing polarity of the antenna.

7. The EUT is supplied with the nominal AC voltage and/or a new/fully recharged battery.

8. All channels were investigated and the worst-case are reported.

7.1 Frequency Measurements (Radiated Spurious)

7.1 Radiated Emissions

FREQ. (MHz)	Level* (dBm)	AFCL** (dB)	POL (H/V)	Height (m)	Azimuth (° angle)	F/S (µV/m)	Margin*** (dB)
39.6	- 82.70	1.10	V	2.6	80	18.67	- 14.6
79.2	- 87.80	7.40	H	2.2	190	21.43	- 13.4
170.3	- 93.21	13.22	H	2.1	180	22.44	- 16.5
468.3	- 105.33	25.34	V	1.8	10	22.44	- 19.0
601.5	- 107.17	28.18	V	1.4	20	25.17	- 18.0
906.0	- 109.68	32.68	V	1.3	90	31.67	- 16.0

Table 1. Radiated Measurements at 3-meters.

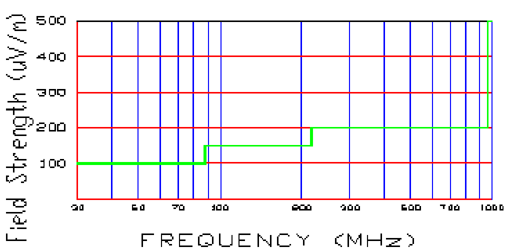


Figure 13. Limits at 3 meters

NOTES:

1. All modes of operation were investigated and the worst-case emissions are reported.

2. The radiated limits are shown on Figure 10. Above 1 GHz the limit is 500μV/m

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* *All readings are calibrated by HP8640B signal generator with accuracy traceable to the National Institute of Standards and Technology (formerly NBS).*

** *AFCL = Antenna Factor (Roberts dipole) and Cable Loss (30 ft. RG58C/U).*

*** *Measurements using CISPR quasi-peak mode. Above 1GHz, peak detector function mode is used using a resolution bandwidth of 1MHz and a video bandwidth of 1MHz. The peak level complies with the average limit. Peak mode is used with linearly polarized horn antenna and low-loss microwave cable.*

8.1 Line-Conducted Test Data

8.2 Conducted Emissions

(See Data under PLOTS – Attachment D)

NOTES:

1. **All frequencies, channels, & modes of operation were investigated and the worst-case emissions are reported.**
2. **The limit for Class B device is 250μV from 450kHz to 30MHz.**
3. **Line A = Phase; Line B = Neutral**
4. **Deviations to the Specifications: None**

9.1 Sample Calculations

dBmV = 20 $\log_{10}$ (mV/m)

dBmV = dBm + 107

9.2 Example 1:

@ 20.3 MHz

Class B limit = 250 µV = 47.96 dBµV

Reading = - 67.8 dBm (calibrated level)

Convert to dbµV = - 67.8 + 107 = 39.2 dBµV

$10^{(39.2/20)}$ = 91.2 µV

Margin = 39.2 - 47.96 = - 8.76

= 8.8 dB below limit

9.3 Example 2:

@ 66.7 MHz

Class B limit = 100 µV/m = 47.96 dBµV/m

Reading = - 76.0 dBm (calibrated level)

Convert to dbµV/m = - 76.0 + 107 = 31.0 dBµV/m

Antenna Factor + Cable Loss = 5.8 dB

Total = 36.8 dBµV/m

Margin = 36.8 - 40.0 = - 3.2

= 3.2 dB below limit

10.1 Accuracy of Measurement

10.2 Measurement Uncertainty Calculations:

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994).

Contribution (Line Conducted)	Probability Distribution	Uncertainty (± dB)	
		9kHz-150MHz	150-30MHz
Receiver specification	Rectangular	1.5	1.5
LISN coupling specification	Rectangular	1.5	1.5
Cable and input attenuator calibration	Normal (k=2)	0.3	0.5
Mismatch: Receiver VRC $\Gamma_1 = 0.03$ LISN VRC Γ_R = 0.8 (9kHz) 0.2 (30MHz) Uncertainty limits $20\mathrm{Log}(1 \pm \Gamma_1 \Gamma_R)$	U-Shaped	0.2	0.35
System repeatability	Std. deviation	0.2	0.05
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	1.26	1.30
Expanded uncertainty	Normal (k=2)	2.5	2.6

Calculations for 150kHz to 30MHz:

$$u_C(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)} = \pm\sqrt{\frac{1.5^2 + 1.5^2}{3} + \left(\frac{0.5}{2}\right)^2 + 0.35} = \pm 1.298\text{dB}$$

$$U = 2U_C(y) = \pm 2.6\text{dB}$$

Contribution (Radiated Emissions)	Probability Distribution	Uncertainties (± dB)	
		3 m	10 m
Ambient Signals		-	-
Antenna factor calibration	Normal (k=2)	± 1.0	± 1.0
Cable loss calibration	Normal (k=2)	± 0.5	± 0.5
Receiver specification	Rectangular	± 1.5	±1.5
Antenna directivity	Rectangular	+ 0.5 / - 0	+ 0.5
Antenna factor variation with height	Rectangular	± 2.0	± 0.5
Antenna phase centre variation	Rectangular	0.0	± 0.2
Antenna factor frequency interpolation	Rectangular	±. 0.25	± 0.25
Measurement distance variation	Rectangular	± 0.6	± 0.4
Site imperfections	Rectangular	± 2.0	± 2.0
Mismatch: Receiver VRC $\Gamma_1 = 0.2$ Antenna VRC Γ_R = 0.67 (Bi) 0.3 (Lp) Uncertainty limits $20\mathrm{Log}(1 \pm \Gamma_1 \Gamma_R)$	U-Shaped	+ 1.1 - 1.25	± 0.5
System repeatability	Std. Deviation	± 0.5	± 0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+ 2.19 / - 2.21	+ 1.74 / - 1.72
Expanded uncertainty U	Normal (k=2)	+ 4.38 / - 4.42	+ 3.48 / - 3.44

Calculations for 3m biconical antenna. Coverage factor of k=2 will ensure that the level of confidence will be approximately 95%, therefore: $U=2u_C(y) = 2 \times \pm 2.19 = \pm 4.38\text{dB}$

11.1 Test Equipment

Type	Model	Cal. Due Date	S/N
Microwave Spectrum Analyzer	HP 8566B (100Hz-22GHz)	2/05/03	3638A08713
Microwave Spectrum Analyzer	HP 8566B (100Hz-22GHz)	04/17/03	2542A11898
Spectrum Analyzer/Tracking Gen.	HP 8591A (9kHz-1.8GHz)	06/02/03	3144A02458
Spectrum Analyzer	HP 8591A (9kHz-1.8GHz)	10/15/03	3108A02053
Spectrum Analyzer	HP 8594A (9kHz-2.9GHz)	11/02/03	3051A00187
Signal Generator*	HP 8640B (500Hz-1GHz)	06/02/03	2232A19558
Signal Generator*	HP 8640B (500Hz-1GHz)	06/02/03	1851A09816
Signal Generator*	Rohde & Schwarz (0.1-1000MHz)	09/11/03	894215/012
Ailtech/Eaton Receiver	NM 37/57A-SL (30-1000MHz)	04/12/03	0792-03271
Ailtech/Eaton Receiver	NM 37/57A (30-1000MHz)	03/11/03	0805-03334
Ailtech/Eaton Receiver	NM 17/27A (0.1-32MHz)	09/17/03	0608-03241
Quasi-Peak Adapter	HP 85650A	08/09/03	2043A00301
Ailtech/Eaton Adapter	CCA-7 CISPR/ANSI QP Adapter	03/11/03	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
Spectrum Analyzer	HP 8562A		
Mixers	11517A, 11970A, 11970K, 11970U, 11970V, 11970W		
HP Adapters	11518, 11519, 11520		

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

12.1 Conclusion

The data collected shows that the **Sports Sensors Inc. GLOVE RADAR TM FCC ID: NVE363** complies with Part 15 Subpart C of the FCC Rules.

No modifications were made to the device.