TEMPEST INC.

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**** Our 15th Year in Business: 1985 - 2000 ****

Report of Electromagnetic Interference Testing Performed in Accordance with the Rules of the Federal Communications Commission (Title 47, Para. 15.249 of the United States Code) on the "Caddie Command" Remote Control Unit Model TX600-845C made by Kangaroo Products Company P.O. Box 607, Columbus North Carolina 28722

by_____
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January 3, 2000

Abstract

As requested by Kangaroo products, Inc. During the Period of December 28, 1999 - January 3, 2000 TEMPEST INC. performed Electromagnetic Compatibility tests in accordance with Title 47, Para. 15.285 Of The United States Code, on the Model TX600-845C "Caddie Command" made by Kangaroo Products, Inc. of Columbus, North Carolina, hearin called the Equipment Under Test (EUT.)

The Equipment Under Test produces signals at approximately 910 MHz with a maximum field strength of 35.5 millivolts per meter (peak) measured at a distance of 3 meters. This is in compliance with Title 47, Para. 15.249 of the United States Code which requires the signal to have an average value of 50 millivolts per meter or less.

These signals have a duty cycle of approximately 6% whenever a button is pushed. Because of the application, it is estimated that this will occur less than 1% of the time that the device is in use, for an overall duty cycle of 0.06% or less.

The emissions produced by the Equipment Under Test comply with the requirements of Title 47, Para. 15.249 of the United States Code. We recommend that production units maintain the same configuration as the sample tested.

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TITLE 47, PARA. 15.285 OF THE UNITED STATES CODE

1.0 Introduction.

As requested by Kangaroo Products, Inc. During the Period of December 28, 1999 - January 3, 2000 TEMPEST INC. performed Electromagnetic Compatibility tests in accordance with Title 47, Para. 15.285 Of The United States Code, on the Model TX600-845C "Caddie Command" hereafter called the Equipment Under Test, made by Kangaroo Products, Inc. of P.O. Box 607, Columbus, North Carolina.

1.1 Purpose.

The purpose of this test was to determine if the Equipment Under Test complies with the requirements of Title 47, Para. 15.285 of The United States Code, otherwise known as the Rules of the Federal Communications Commission.

1.2 Test Location.

All testing was performed in the Open Area Test Site or in the laboratory facilities of TEMPEST INC. 112 Elden St. Herndon,. Virginia 20170

1.3 Cognizant Personnel.

The following personnel conducted, witnessed, or are cognizant of the test:

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2.0 Description of the Equipment Under Test.

The Equipment Under Test is a hand held remote control unit operating in the 902 - 928 MHz frequency band. It is used to send commands to a remotely controlled golf caddie, which carries a set of golf clubs. As shown in figure 1, the Equipment Under Test is 2 3/8 inches wide, 1 inch high, and 4 3/4 inches long and is powered by a 9 volt battery. When a button is pushed, it transmits commands in 15 millisecond bursts, randomly spaced in increments of 250 milliseconds apart, with an overall duty cycle of approximately 6% whenever a button is pushed. Because of the application, it is estimated that this will occur less than 1% of the time that the device is in use, for an overall duty cycle of 0.06% or less. Figures 1 and 2 depict the Equipment Under Test .

3.0 Test Procedures.

As described below, all testing was performed in accordance with Title 47, Para. 15.285 Of The United States Code, using TEMPEST INC.'s FCC-listed Open Area Test Site (OATS.)

3.1 Test Equipment.

Table 1 is a list of the test equipment used. As shown in the table, a Double Ridged Waveguide Horn antenna and a Hewlett-Packard spectrum analyzer were used to detect the emissions produced by the Equipment Under Test.

3.2 Calibration Check.

Using its internal calibration source, the calibration of the spectrum analyzer was verified both immediately before and immediately after the test.

3.3 Dynamic Range and Detection System Sensitivity Tests.

Before testing, the dynamic range of the instrumentation was determined to be 80 dB, and the detection system sensitivity was -80 dBm.

3.4 Frequency Stability Test.

The Equipment Under Test and the receive antenna were moved to verify that the signal did not drift off the display. No such drift was found.

3.5 Local Interference Test.

At each test frequency, the Equipment Under Test was turned on and off to verify that the signal being measured was coming from the Equipment Under Test, and not from other local sources, such as cellular telephones. The frequency and signal strength of the ambient signals made them easily identifiable, and they did not interfere with the test.

3.6 Case Leakage Test.

A case leakage test was conducted at each test frequency as follows: Immediately after measuring the emission, the receive antenna cable was disconnected at the input to the spectrum analyzer. Any signals remaining at the test frequency would have been due to either case leakage or spurious responses. No such signals were found.

3.7 Spurious Response Test.

Spurious responses were identified using the signal identifier feature of the spectrum analyzer. Closing this switch causes an image appear 2 divisions to the left of a questionable signal. Spurious responses produce no such image.

3.8 Operational Test.

Using a receiving unit provided by the manufacturer, the Equipment Under Test was first operated normally to verify that it caused the receiving unit to respond properly, as indicated by a two color light emitting diode on the receiving unit.

3.9 Cursory Tests.

Before starting the measurements, cursory tests were performed with the Equipment Under Test within 2 feet of the receive antenna. The Equipment Under Test was rotated about all three axes to determine the orientations that produced the strongest received signal, and the intentional emission and its harmonics were identified. In this test it was found that the strongest signals were received when the Equipment Under Test was held parallel to the antennas ridges (horizontal polarization,) as shown in Fig. 2.

3.10 Measurements.

The Equipment Under Test was placed 3 meters from the antenna hoist, and rotated about 360 degrees in 45 degree increments. At each increment, the receive antenna was raised from 10 cm to 4 meters above the ground plane while the emissions were measured in both the horizontal and vertical planes. Emissions were measured over the 900 MHz - 12 GHz frequency range. The peak values of the strongest signals were recorded in dBm. These was converted to μV/m using the following formulas:

level (dBm) +107 dB + antenna factor (dB) = level in dBμV/m

level in dBμV/m = 20 Log $_{10}$ (level in μV/m)

4.0 Results.

As shown in Table 2, the Equipment Under Test produces signals at approximately 910 MHz with a maximum field strength of 35.5 millivolts per meter (peak) measured at a distance of 3 meters. This is in compliance with Title 47, Para. 15.249 of the United States Code which requires the signal to have an average value of 50 millivolts per meter or less.

5.0 Conclusions and Recommendations.

The emissions produced by the Equipment Under Test comply with the requirements of Title 47, Para. 15.249 of the United States Code. We recommend that production units maintain the same configuration as the sample tested.

Appendix A: Illustrations

Figure 1: Equipment Under Test.

Figure 2: Enclosure Under Test

Appendix B: Tables.

Table 1: List of Test Equipment Used

all equipment was calibrated within 9 months of the test
spectrum analyzer calibration was spot checked both before and after test.

Manufacturer	Model	Name	Serial No.
Hewlett-Packard	140S	Spectrum Analyzer Display	91000352
" "	8555A	RF Section 1.5 MHz-40 GHz	1326A 02829
" "	8552B	Display Section	1107A
EMCO	3105	Double Ridged WG Horn Antenna	2067
Tensor	4104	Biconical	2154
Tensor	4101	Log Spiral	2105

Table 2: Test Data

Freq. MHz	peak measured level dBm	+107 dB = dBµV	Antenna factor, dB	dBµV/m	mV/m (peak)	Limit mV/m (avg.)
910	-50	+67	24	91	35.5	50

Appendix C: Glossary

a.c.	alternating current
d.c.	direct current
cm	centimeters
dB	decibels
dBi	dB ref. an isotropic radiator.
dBm	dB reference 1 milliwatt
dBµV	dB reference 1 microvolt
dBµV/m	dB reference 1 microvolt/meter
EMC	Electromagnetic Compatibility
EUT	Equipment Under Test
ft	feet
Hz	Hertz (cycles per second)
in.	inches
m	meters
mV	millivolts
mV/m	millivolts per meter
NARTE	National Association of Radio and Telecommunications Engineers, Inc.: The United States certification body for Electromagnetic Compatibility professionals.
V	Volts