APPLICATION

FOR

CERTIFICATION

INTENTIONAL RADIATOR

UNDER 47 CFR, PART 15.231(e)

SmarTire Systems, Inc.

FCC ID: NATTX433VM

JUNE 28, 2000

Prepared By:

Spectrum Technology, Inc.
209 Dayton Street
Edmonds, WA 98020

CERTIFICATION

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TEST: FIELD STRENGTH OF RADIATED EMISSIONS

Grantee: SmarTire Systems, Inc.

FCC ID: NATTX433VM

Setup:

The equipment under test (EUT) was configured and operated in accordance with the applicable provisions of ANSI C63.4-1992, Section 6, 13. Measurements were made in accordance with applicable paragraphs of Section 8.2.3, 8.2.4, Section 13.1.1, 13.1.4 Appendix D, and I.

The EUT was placed on a 1 by 1.5 meter table located 40 cm above a 2 meter diameter non-metallic turntable that sits 40 cm above the 15 X 30-meter ground plane at Spectrum's Open Area Test Site. The bi-conical or log-periodic antenna was mounted on a tower spaced at a three meters distance, and arranged for adjustment in height (1-4 meters) and vertical/horizontal polarization to maximize the emissions levels when combined with turntable rotation of the EUT. The dual ridged guide antenna was mounted on a tripod at one-meter height and adjusted for vertical or horizontal antenna orientation. An HP 8562A spectrum analyzer with an HP 8447F, Option H64 amplifier and an HP 83006A pre-amplifier were used for the measuring instrumentation.

Discussion:

No modifications required for compliance prior to the final radiated emissions measurements reported herein.

The EUT is the transmitter for the Smartire Passenger Car Monitoring System which uses four 433 MHz transmitter sensors. A 433 MHz receiver used in the SmartTire Passenger Car Tire Monitoring system would be installed in a passenger vehicle and used to receive signals and display status of passenger tire pressure sensors installed on the wheels. The transmitter and sensor would be mounted at the base of the valve stem on each of the four wheels. Each transmitter reports back to the receiver approximately every four to six minutes continuously with pressure and temperature status. If a reduction in pressure is sensed the sensor will transmit more frequently. The information being considered a safety issue, as in the case of a punctured tire and an alarm is displayed on the receiver.

The EUT would be installed as the valve stem for a standard automotive steel wheel rim with typical steel belted radial passenger tire mounted. For the radiated emissions test, the transmitter was set on the table and tested while positioned in three orthogonal planes. The position with the valve stem positioned up was observed to be the worst case by a small margin and is reported herein. The EUT was carefully centered on the table to maintain a 3-meter distance during rotation. The radiated tests were conducted this way based on correspondence previous correspondence for the lab requiring testing the EUT off the rim.

The transmitter was jumpered with two leads brought out externally to allow continuous repetitive transmission at its maximum date rate. This made it much more convenient to observe maximum emission levels when the turntable was rotated and antenna height and polarization adjusted.

Measurements were made for the single frequency AM pulse modulated intentional radiator operating at its nominal operating frequency 433 MHz =/- 75 kHz.

Preliminary measurements were made as described in Section 8.3.11 and 13.1.4.1 with the EUT operating as described.

The final set of measurements as specified in Section 8.3.1.2 and 13.1.4.2 were made as specified in Section 13.1.1. The transmitter was observed stand alone while positioned on the turntable three meters from the receive antenna. We rotated the turntable and varied antenna height and polarization endeavoring to maximize the signal being measured. The EUT was powered with a new battery during the measurements. RBW and VBW of 100 kHz were used for measurements below 1 GHz. Above 1 GHz peak measurements were made with a RBW and VBW of 1 MHz.

Most of the harmonics through 10 Fo were measurable at 3 meters during the final detailed radiated emissions measurements. An HP pre-amplifier was used along with a band pass filter to attenuated the 433 MHz signal and avoid overloading the front end of the spectrum analyzer.

Conclusion:

The SmarTire Systems, Inc., FCC ID: NATTX433VM, when operated and measured as discussed above, complies with the field strength of the fundamental limit and limits for spurious emissions requirements under Title 47, CFR Part 15.232(e). Duty cycle averaging is applied to the peak reading to comply with the average limit. **This device has shown compliance with the current rules and is not subject to the transition provisions of Part 15.37.**

SPECTRUM TECHNOLOGY, INC.

Field Strength of Radiated Fundamental and Spurious Emissions

47 CFR Part 15.231 - Final Data - Ref. _SMARTIR .R6

Grantee: SmarTire Systems, Inc. 06/12/00
FCC ID: NATTX433VM

	Freq Limit in MHz	Vert Rdg. dBuV	Horz Rdg. dBuV	Ant-F Loss	Cable & BPF dB	Amp Gain dBuV/m	Corrected Rdg in **Peak Det.**	Limit **Peak Det.**
Fo	433.92	61.83	63.00	21.60	1.66 0	86.26	20558	4399
2Fo	867.84	NF	27.00	26.30	2.67 inc.	55.97	629	500
3Fo	1.30176	35.33	38.33	24.46	1.81 27.04	37.56	75	" "
4Fo	1.73568	43.83	47.17	26.95	2.0 25.32	50.83	348	" "
5Fo	2.16960	37.33	33.83	27.15	2.09 23.30	43.27	146	" "
6Fo	2.60325	37.67	31.83	28.37	2.25 22.10	46.19	204	" "
7Fo	3.03744	30.67	30.67	29.93	2.4 21.34	41.66	121	" "
8Fo	3.471360	41.50	38.33	31.01	2.54 21.23	53.82	491	" "
9Fo	3.905280	33.33	34.33	32.45	2.67 21.65	47.8	245	" "
10Fo	3.905280	NF	28.17	31.98	2.79 22.5	40.44	105	" "

Note: The highest level of the Vertical or Horizontal Reading in dBuV is calculated above. NF = Noise Floor of Analyzer

In accordance with Section 15.35(c) when the radiated emissions limits are expressed in terms of the average value of the emission [as in Section 15.231(b)(2)], and pulsed operation is employed, the field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative where the pulse train exceeds 0.1 seconds , the measured field strength shall be determined from the average absolute voltage during a 0.1-second interval during which its field strength is at its maximum value

ANSI C63.4-1992 Appendix I4 (10) also describes a method which we used to correct for

duty cycle when average detector function limits are specified for a pulse-modulated transmitter, the average level of emissions may be found by measuring the peak level of emissions and correcting them with duty cycle.

When the pulse train exceeds 100 ms calculate the duty cycle by averaging the sum of the pulse widths with the highest average over the 100 ms width with the highest average value. The duty cycle is the value of the sum of the pulse widths in one period (or 100 ms) divided by the length of the period (or 100 ms).

We multiplied the peak detector field strength in uV/m of the emission from the transmitter using pulsed modulation by the duty cycle calculated to determine the average detector field strength of the emission for comparison to the average detector limit in Part 15.231.

The TRW specification for the part is as follows:

The packet length is a total of 18.5 ms. There are 2 packets in 100 ms period.

Therefore a total packet length of 37 ms in 100 ms. Since the transmission

is BiPhase @ 50% on off duty cycle the EUT total on time in 100 ms is 18.5 %

18.5 ms + 18.5 ms = 37 ms packet length at a 50% duty cycle = 18.5% duty cycle/ 100 ms

Sum of the pulse widths with highest average value / 100ms = Duty Cycle

Peak detector field strength was measured at 20558 uV/m.

20558 uV/m X (18.5% duty cycle) = 3803 uV/m calculated average detector field strength.

Limit for the band 260 - 470 MHz, uV/m at 3 meters = 16.6667(F) - 2833.3333.

Limit at 433.92 MHz = 4399 uV/m Average Detector Limit, Section 15.231(e).

ANTENNA FACTORS FOR EMCO 3104 BICONICAL ANTENNA AND EMCO 3146 LOG PERIODIC ANTENNA INCLUDING CONVERSION TO OPEN CIRCUIT VOLTAGE.

Antenna Factor and Field Strength Formula

level as measured with Spectrum Analyzer

converts to dBuV @ 50 ohms

converts to dBuV/m

$$uV/m = \log^{-1}\left(\frac{dBm + 107 + AF + 6}{20}\right)$$ - converts to open circuit voltage

converts to uV/m

IF FREQ => 20	AND	FREQ =< 26.5	THEN ANTF = 12.5
IF FREQ => 26.6	AND	FREQ =< 28	THEN ANTF = 13.5
IF FREQ => 28.1	AND	FREQ =< 33	THEN ANTF = 14.5
IF FREQ => 33.1	AND	FREQ =< 35	THEN ANTF = 13.5
IF FREQ => 35.1	AND	FREQ =< 45	THEN ANTF = 13
IF FREQ => 45.	AND	FREQ =< 57	THEN ANTF = 12
IF FREQ => 57.1	AND	FREQ =< 63	THEN ANTF = 11
IF FREQ => 63.1	AND	FREQ =< 66	THEN ANTF = 10
IF FREQ => 66.1	AND	FREQ =< 75	THEN ANTF = 9
IF FREQ => 75.1	AND	FREQ =< 83	THEN ANTF = 8
IF FREQ => 83.1	AND	FREQ =< 86	THEN ANTF = 9
IF FREQ => 86.1	AND	FREQ =< 90	THEN ANTF = 10
IF FREQ => 90.1	AND	FREQ =< 95	THEN ANTF = 11
IF FREQ => 95.1	AND	FREQ =< 97.5	THEN ANTF = 12.5
IF FREQ => 97.6	AND	FREQ =< 101	THEN ANTF = 13.5
IF FREQ => 101.1	AND	FREQ =< 105	THEN ANTF = 14.5
IF FREQ => 105.1	AND	FREQ =< 108	THEN ANTF = 15.5
IF FREQ => 108.1	AND	FREQ =< 115	THEN ANTF = 16.5
IF FREQ => 115.1	AND	FREQ =< 123	THEN ANTF = 15.5
IF FREQ => 123.1	AND	FREQ =< 148	THEN ANTF = 14.5
IF FREQ => 148.1	AND	FREQ =< 151.5	THEN ANTF = 15.5
IF FREQ => 151.6	AND	FREQ =< 167.5	THEN ANTF = 17
IF FREQ => 167.6	AND	FREQ =< 182.5	THEN ANTF = 18
IF FREQ => 182.6	AND	FREQ =< 200	THEN ANTF = 19
IF FREQ => 200.1	AND	FREQ =< 202	THEN ANTF = 14.7
IF FREQ => 202	AND	FREQ =< 205	THEN ANTF = 14.5
IF FREQ => 205	AND	FREQ =< 215	THEN ANTF = 14.6
IF FREQ => 215	AND	FREQ =< 230	THEN ANTF = 14.55
IF FREQ => 230	AND	FREQ =< 235	THEN ANTF = 14.5
IF FREQ => 235	AND	FREQ =< 240	THEN ANTF = 14.8
IF FREQ => 240	AND	FREQ =< 242.5	THEN ANTF = 14.9

IF FREQ => 242.5	AND	FREQ =< 245	THEN ANTF = 15.1
IF FREQ => 245	AND	FREQ =< 247.5	THEN ANTF = 15.5
IF FREQ => 247.5	AND	FREQ =< 250	THEN ANTF = 15.7
IF FREQ => 250	AND	FREQ =< 252	THEN ANTF = 15.9
IF FREQ => 252	AND	FREQ =< 254	THEN ANTF = 16
IF FREQ => 254	AND	FREQ =< 256	THEN ANTF = 16.1
IF FREQ => 256	AND	FREQ =< 258	THEN ANTF = 16.2
IF FREQ => 258	AND	FREQ =< 260	THEN ANTF = 16.3
IF FREQ => 260	AND	FREQ =< 263.5	THEN ANTF = 16.4
IF FREQ => 263.5	AND	FREQ =< 265	THEN ANTF = 16.4
IF FREQ => 265	AND	FREQ =< 267.5	THEN ANTF = 16.6
IF FREQ => 267.5	AND	FREQ =< 271	THEN ANTF = 16.7
IF FREQ => 271	AND	FREQ =< 274	THEN ANTF = 16.8
IF FREQ => 274	AND	FREQ =< 276	THEN ANTF = 16.9
IF FREQ => 276	AND	FREQ =< 278	THEN ANTF = 17
IF FREQ => 278	AND	FREQ =< 280	THEN ANTF = 17.1
IF FREQ => 280	AND	FREQ =< 282	THEN ANTF = 17.3
IF FREQ => 282	AND	FREQ =< 284	THEN ANTF = 17.6
IF FREQ => 284	AND	FREQ =< 286	THEN ANTF = 18
IF FREQ => 286	AND	FREQ =< 288	THEN ANTF = 18.2
IF FREQ => 288	AND	FREQ =< 295	THEN ANTF = 18.4
IF FREQ => 290	AND	FREQ =< 295	THEN ANTF = 15.8
IF FREQ => 295	AND	FREQ =< 305	THEN ANTF = 18.6
IF FREQ => 305	AND	FREQ =< 310	THEN ANTF = 18.4
IF FREQ => 310	AND	FREQ =< 311	THEN ANTF = 18.3
IF FREQ => 311	AND	FREQ =< 312	THEN ANTF = 18.1
IF FREQ => 312	AND	FREQ =< 313	THEN ANTF = 18
IF FREQ => 313	AND	FREQ =< 340	THEN ANTF = 17.9
IF FREQ => 340	AND	FREQ =< 343	THEN ANTF = 18.1
IF FREQ => 343	AND	FREQ =< 350	THEN ANTF = 18.2
IF FREQ => 350	AND	FREQ =< 357	THEN ANTF = 18.3
IF FREQ => 357	AND	FREQ =< 360	THEN ANTF = 18.5
IF FREQ => 360	AND	FREQ =< 365	THEN ANTF = 18.6
IF FREQ => 365	AND	FREQ =< 375	THEN ANTF = 18.7
IF FREQ => 375	AND	FREQ =< 378	THEN ANTF = 19
IF FREQ => 378	AND	FREQ =< 381	THEN ANTF = 19.1
IF FREQ => 381	AND	FREQ =< 383	THEN ANTF = 19.2
IF FREQ => 383	AND	FREQ =< 385	THEN ANTF = 19.3
IF FREQ => 385	AND	FREQ =< 387.5	THEN ANTF = 19.4
IF FREQ => 387.5	AND	FREQ =< 390	THEN ANTF = 19.5
IF FREQ => 390	AND	FREQ =< 392	THEN ANTF = 19.7
IF FREQ => 392	AND	FREQ =< 394	THEN ANTF = 18.8
IF FREQ => 394	AND	FREQ =< 396	THEN ANTF = 19.9
IF FREQ => 396	AND	FREQ =< 398	THEN ANTF = 20
IF FREQ => 398	AND	FREQ =< 402	THEN ANTF = 20.1
IF FREQ => 402	AND	FREQ =< 405	THEN ANTF = 20.2
IF FREQ => 405	AND	FREQ =< 410	THEN ANTF = 20.3
IF FREQ => 410	AND	FREQ =< 415	THEN ANTF = 20.4
IF FREQ => 415	AND	FREQ =< 420	THEN ANTF = 20.6
IF FREQ => 420	AND	FREQ =< 425	THEN ANTF = 20.8
IF FREQ => 425	AND	FREQ =< 430	THEN ANTF = 21
IF FREQ => 430	AND	FREQ =< 435	THEN ANTF = 21.2
IF FREQ => 435	AND	FREQ =< 440	THEN ANTF = 21.3
IF FREQ => 440	AND	FREQ =< 445	THEN ANTF = 21.4
IF FREQ => 445	AND	FREQ =< 450	THEN ANTF = 21.5
IF FREQ => 450	AND	FREQ =< 455	THEN ANTF = 21.6
IF FREQ => 455	AND	FREQ =< 460	THEN ANTF = 21.8
IF FREQ => 460	AND	FREQ =< 465	THEN ANTF = 21.9
IF FREQ => 465	AND	FREQ =< 470	THEN ANTF = 22
IF FREQ => 470	AND	FREQ =< 472.5	THEN ANTF = 22.1
IF FREQ => 472.5	AND	FREQ =< 475	THEN ANTF = 22.2
IF FREQ => 475	AND	FREQ =< 477	THEN ANTF = 22.4
IF FREQ => 477	AND	FREQ =< 478	THEN ANTF = 22.5
IF FREQ => 478	AND	FREQ =< 481	THEN ANTF = 22.6

IF FREQ => 481	AND	FREQ =< 482.5	THEN ANTF = 22.7
IF FREQ => 482.5	AND	FREQ =< 485	THEN ANTF = 22.8
IF FREQ => 485	AND	FREQ =< 488	THEN ANTF = 22.9
IF FREQ => 488	AND	FREQ =< 515	THEN ANTF = 23.1
IF FREQ => 515	AND	FREQ =< 540	THEN ANTF = 23.3
IF FREQ => 540	AND	FREQ =< 560	THEN ANTF = 23.6
IF FREQ => 560	AND	FREQ =< 570	THEN ANTF = 23.7
IF FREQ => 570	AND	FREQ =< 580	THEN ANTF = 23.9
IF FREQ => 580	AND	FREQ =< 590	THEN ANTF = 24
IF FREQ => 590	AND	FREQ =< 610	THEN ANTF = 24.2
IF FREQ => 610	AND	FREQ =< 615	THEN ANTF = 24.4
IF FREQ => 615	AND	FREQ =< 620	THEN ANTF = 24.5
IF FREQ => 620	AND	FREQ =< 625	THEN ANTF = 24.6
IF FREQ => 625	AND	FREQ =< 630	THEN ANTF = 24.8
IF FREQ => 630	AND	FREQ =< 635	THEN ANTF = 24.9
IF FREQ => 635	AND	FREQ =< 640	THEN ANTF = 25
IF FREQ => 640	AND	FREQ =< 645	THEN ANTF = 25.1
IF FREQ => 645	AND	FREQ =< 647.5	THEN ANTF = 25.3
IF FREQ => 647.5	AND	FREQ =< 650	THEN ANTF = 25.4
IF FREQ => 650	AND	FREQ =< 652.5	THEN ANTF = 25.6
IF FREQ => 652.5	AND	FREQ =< 655	THEN ANTF = 25.7
IF FREQ => 655	AND	FREQ =< 660	THEN ANTF = 25.8
IF FREQ => 660	AND	FREQ =< 665	THEN ANTF = 26.1
IF FREQ => 665	AND	FREQ =< 670	THEN ANTF = 26.3
IF FREQ => 670	AND	FREQ =< 680	THEN ANTF = 26.6
IF FREQ => 680	AND	FREQ =< 690	THEN ANTF = 26.7
IF FREQ => 690	AND	FREQ =< 720	THEN ANTF = 26.9
IF FREQ => 720	AND	FREQ =< 760	THEN ANTF = 26.8
IF FREQ => 760	AND	FREQ =< 800	THEN ANTF = 27
IF FREQ => 800	AND	FREQ =< 802.5	THEN ANTF = 27.3
IF FREQ => 802.5	AND	FREQ =< 805	THEN ANTF = 27.5
IF FREQ => 805	AND	FREQ =< 807.5	THEN ANTF = 27.6
IF FREQ => 807.5	AND	FREQ =< 810	THEN ANTF = 27.7
IF FREQ => 810	AND	FREQ =< 815	THEN ANTF = 27.8
IF FREQ => 815	AND	FREQ =< 820	THEN ANTF = 27.9
IF FREQ => 820	AND	FREQ =< 840	THEN ANTF = 28.2
IF FREQ => 840	AND	FREQ =< 860	THEN ANTF = 28.4
IF FREQ => 860	AND	FREQ =< 870	THEN ANTF = 28.8
IF FREQ => 870	AND	FREQ =< 880	THEN ANTF = 29.3
IF FREQ => 880	AND	FREQ =< 890	THEN ANTF = 29.4
IF FREQ => 890	AND	FREQ =< 910	THEN ANTF = 29.6
IF FREQ => 910	AND	FREQ =< 920	THEN ANTF = 29.7
IF FREQ => 920	AND	FREQ =< 930	THEN ANTF = 29.9
IF FREQ => 930	AND	FREQ =< 940	THEN ANTF = 30
IF FREQ => 940	AND	FREQ =< 960	THEN ANTF = 30.2
IF FREQ => 960	AND	FREQ =< 970	THEN ANTF = 30.6
IF FREQ => 970	AND	FREQ =< 975	THEN ANTF = 30.8
IF FREQ => 975	AND	FREQ =< 980	THEN ANTF = 31
IF FREQ => 980	AND	FREQ =< 985	THEN ANTF = 31.1
IF FREQ => 985	AND	FREQ =< 990	THEN ANTF = 31.3
IF FREQ => 990	AND	FREQ =< 1000	THEN ANTF = 31.4

Serial Number 6225	ELECTO-METRICS GAIN AND ANTENNA FACTORS MODEL RGA-60	1 METER CALIBRATION

FREQUENCY MHz	14 FOOT CABLE LOSS FSJI-50A	ANTENNA FACTOR
1000	.84	23.21
1500	1.05	25.70
2000	1.22	27.15
2500	1.38	28.37
3000	1.53	29.93
3500	1.67	31.01
4000	1.80	32.45
4500	1.92	31.98
5000	2.04	33.33
5500	2.15	34.24
6000	2.27	34.48
6500	2.37	35.19
7000	2.48	36.05
7500	2.58	36.77
8000	2.68	37.33
8500	2.78	37.38
9000	2.87	37.14
9500	2.96	37.55
10000	3.06	38.33

TEST EQUIPMENT LIST A
SPECTRUM TECHNOLOGY, INC.

Equipment	Manufacturer	Serial Number	Cal Date/Due Date	
Spectrum Analyzer	Hewlett-Packard 8562A	08562-60062	11/04/99	11/04/00
Amplifier 9 kHz-1300 MHz	Hewlett-Packard 8447F OPT H64	2727A02208	11/04/99	11/04/00
Service Monitor	IFR FM/AM 500A	4103	---	
Oscilloscope	Kikusui C055060	6132295	---	
Power Supply	Astron VS35	8601266	---	
Voltmeter	Fluke 8020A	N2420658	---	
Multimeter	Fluke 25	3710310	---	
Wattmeter	Bird 43	56227	---	
RF Termination	Bird 8135	10004	---	
Dual Phase LISN 50 ohm/50 uH	STI per MP-4	02	1/8/00	1/9/01
Dual Phase LISN 50 ohm/50 uH	Compliance Design	8012-50R-24-BNC	1/8/00	1/9/01
Audio Generator	Hewlett-Packard 205-AG	8689	---	
Thermometer	Fluke 52	3965185	---	
Test Line	Simulator, Teltone TLS-2	none	---	
Turn Table, RC	EMCO 1060-2M	8912-1415	---	
Antenna Mast, RC	Compliance Design, Inc.	M100	---	
Antennas:				
Dipole Set	EMCO Model: 3121C	1335	reference only	
Dipole Set	EMCO Model: 3121C	1336	reference only	
Bi-Conical	EMCO 3104	3763	reference only	
Bi-Conical	EMCO 3104C	9401-4635	01/25/00	1/25/01
Log-Periodic	EMCO 3146	1754	01/25/00	1/25/01
BiConiLog	EMCO 3141	1125	04/28/00	04/28/01
Active Loop	EMCO 6502	9107-2645	reference only	

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