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Measured Radio Frequency Emissions
From

Advantage PressurePro Composite Device
Transmitter Report
Model(s): ABPER

Report No. 415031-302
June 19, 2006

For:
Advantage PressurePro
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Summary

Tests for compliance with FCC Regulations Part 15, Subpart C, and Industry Canada RSS-210, were performed on Advantage PressurePro model(s) ABPER. This device is subject to the Rules and Regulations as a Transmitter.

In testing completed on March 24, 2006, the device tested in the worst case met the allowed FCC specifications for radiated emissions by 0.9 dB (see p. 6). Besides harmonics, there were no other significant spurious emissions found; emissions from digital circuitry were negligible. The conducted emission tests do not apply, since the device is powered from a 12 VDC battery.

1. Introduction

Advantage PressurePro model ABPER was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989 as subsequently amended, and with Industry Canada RSS-210/Gen, Issue 6, September 2005. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057).

2. Test Procedure and Equipment Used

The pertinent test equipment commonly used in our facility for measurements is listed in Table 2.1 below. The middle column identifies the specific equipment used in these tests.

Table 2.1 Test Equipment.

Test Instrument	Eqpt. Used	Manufacturer/Model
Spectrum Analyzer (0.1-1500 MHz)		Hewlett-Packard, 182T/8558B
Spectrum Analyzer (9kHz-22GHz)	X	Hewlett-Packard 8593A SN: 3107A01358
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131
Spectrum Analyzer (9kHz-26GHz)		Hewlett-Packard 8563E, SN: 3310A01174
Spectrum Analyzer (9kHz-40GHz)		Hewlett-Packard 8564E, SN: 3745A01031
Power Meter		Hewlett-Packard, 432A
Power Meter		Anritsu, ML4803A/MP
Harmonic Mixer (26-40 GHz)		Hewlett-Packard 11970A, SN: 3003A08327
Harmonic Mixer (40-60 GHz)		Hewlett-Packard 11970U, SN: 2332A00500
Harmonic Mixer (75-110 GHz)		Hewlett-Packard 11970W, SN: 2521A00179
Harmonic Mixer (140-220 GHz)		Pacific Millimeter Prod., GMA, SN: 26
S-Band Std. Gain Horn		S/A, Model SGH-2.6
C-Band Std. Gain Horn		University of Michigan, NRL design
XN-Band Std. Gain Horn		University of Michigan, NRL design
X-Band Std. Gain Horn		S/A, Model 12-8.2
X-band horn (8.2- 12.4 GHz)		Narda 640
X-band horn (8.2- 12.4 GHz)		Scientific Atlanta , 12-8.2, SN: 730
K-band horn (18-26.5 GHz)		FXR, Inc., K638KF
Ka-band horn (26.5-40 GHz)		FXR, Inc., U638A
U-band horn (40-60 GHz)		Custom Microwave, HO19
W-band horn(75-110 GHz)		Custom Microwave, HO10
G-band horn (140-220 GHz)		Custom Microwave, HO5R
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2
Dipole Antenna Set (30-1000 MHz)	X	University of Michigan, RLDP-1,-2,-3
Dipole Antenna Set (30-1000 MHz)		EMCO 2131C, SN: 992
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan
Amplifier (5-1000 MHz)	X	Avantak, A11-1, A25-1S
Amplifier (5-4500 MHz)	X	Avantak
Amplifier (4.5-13 GHz)		Avantek, AFT-12665
Amplifier (6-16 GHz)		Trek
Amplifier (16-26 GHz)		Avantek
LISN Box		University of Michigan
Signal Generator		Hewlett-Packard 8657B

3. Configuration and Identification of Device Under Test

The DUT is a composite device, consisting of a 433.92 MHz transmitter and superheterodyne receiver. This report details the emissions relating to the transmitter portion of the device. The DUT contains a 433.92 MHz FSK transmitter which re-transmits encoded Tire Pressure data it receives after decoding and identification. The device is designed for onboard automobile Tire Pressure data re-transmission, and as such, it is powered from an automotive 12 VDC source. It is housed in a plastic case approximately 12 by 3 by 0.5 inches. Antenna is an integral dipole. For testing, a generic power cable was provided by the manufacturer. The DUT was designed by Lectronix, Inc., 5858 Enterprise Drive, Lansing, MI 48842.
It is identified as:

Advantage PressurePro Composite Device
Model(s): ABPER
FCC ID: RMDABPER
IC: 4785A-ABPER

Note: The duration of each transmission is less than one second and the silent period between transmissions is more 30 times the duration of the transmission, never less than 10 seconds. See figure 6.1.

3.1 Modifications Made

There were no modifications made to the DUT by this laboratory. However, pretest measurements indicated the output power of the device exceeded the limits, so the antenna matching circuitry was adjusted by a Lectronix, Inc. employee to bring the device into compliance.

4. Emission Limits

The DUT tested falls under the category of an Intentional Radiators and the Digital Devices. For FCC, it is subject to Part 15, Subpart C, (Section 15.231), Subpart B, (Section 15.109), and Subpart A, (Section 15.33). For Industry Canada it is subject to RSS-210, (Sections 6.1 and 6.3). The applicable testing frequencies with corresponding emission limits are given in Tables 4.1 and 4.2 below. As a digital device, the DUT is considered as a Class B device.

4.1 Radiated Emission Limits

Table 4.1. Radiated Emission Limits (FCC: 15.33, 15.35, 15.109; IC: RSS-210, 6.2.2(r)).
(Digital Class B)

Freq. (MHz)	E_{lim} (3m) μV/m	E_{lim} dB(μV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-2000	500	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW)
Quasi-Peak readings apply to 1000 MHz (120 kHz BW)

Table 4.2. Radiated Emission Limits (FCC: 15.231(e), 15.205(a); IC: RSS-210; 2.7 Table 5). (Transmitter)

Frequency	Fundamental Ave. E_{lim} (3m)		Spurious** Ave. E_{lim} (3m)	
(MHz)	(μV/m)	dB (μV/m)	(μV/m)	dB (μV/m)
260.0-470.0	1500-5000*		150-500	
315.0	2418	67.7	241.8	47.7
322-335.4 399.9-410 608-614	Restricted Bands		200	46.0
960-1240 1300-1427 1435-1626.5 1660-1710 1718.9-1722.2 2200-2300	Restricted Bands		500	54.0

* Linear interpolation, formula: E = -2833.2 + 16.67*f (MHz)
** Measure up to tenth harmonic; 120 kHz RBW up to 1 GHz, 1 MHz RBW above 1 GHz

4.3 Conducted Emissions Limits

The conductive emission limits and tests do not apply here, since the DUT is powered by a 12 VDC battery.

5. Radiated Emission Tests and Results

5.1 Semi-Anechoic Chamber Measurements

To familiarize with the radiated emission behavior of the DUT, the DUT was first studied and measured in a shielded semi-anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with a turntable, an antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

In testing for radiated emissions, a transmitter was provided by the manufacturer that is capable of repeated pulse emissions. It was placed on the test table flat, on its side, or on its end.

In the chamber we studied and recorded all the emissions using a Bicone antenna up to 300 MHz and a ridged horn antenna above 200 MHz. The measurements made in the chamber below 1 GHz are used for pre-test evaluation only. The measurements made above 1 GHz are used in pre-test evaluation and in the final compliance assessment. We note that for the horn antenna, the antenna pattern is more directive and hence the measurement is essentially that of free space (no ground reflection). Consequently it is not essential to measure the DUT for both antenna polarizations, as long as the DUT is measured on all three of its major axis. In the chamber we also recorded the spectrum and modulation characteristics of the carrier. These data are presented in subsequent sections. We also note that in scanning from 30 MHz to 4.5 GHz using Bicone and the ridge horn antennas, there were no other significant spurious emissions observed.

5.2 Open Site Radiated Emission Tests

After the chamber measurements, the emissions were re-measured on the outdoor 3-meter site at fundamental and harmonics up to 1 GHz using tuned dipoles and/or the high frequency Bicone. Photographs included in this filing show the DUT on the Open Area Test Site (OATS).

5.3 Computations and Results for Radiated Emissions

To convert the dBm's measured on the spectrum analyzer to dB(μV/m), we use expression

$$E_3(\text{dB}\mu\text{V/m}) = 107 + P_R + K_A - K_G$$

where P_R = power recorded on spectrum analyzer, dB, measured at 3m
K_A = antenna factor, dB/m
K_G = pre-amplifier gain, including cable loss, dB

When presenting the data, at each frequency the highest measured emission under all of the possible orientations is given. Computations and results are given in Table 5.1. There we see that the DUT meets the limit by 0.9 dB.

5.4 Conducted Emission Tests

These tests do not apply, since the DUT is powered from a 12 VDC battery.

6. Other Measurements

6.1 Correction For Pulse Operation

The DUT will, in the worst case, automatically transmit 9 words of tire pressure data (that it has received in the previous 10 second interval) in a total period of 256.25 ms. Each word consists of FSK modulated data with an on time of 3.95 ms. In any given 100 ms window, a maximum of 7 words will occur. See Figure 6.1. Computing the duty factor results in:

$$K_E = (7 \text{ x } 3.95 \text{ ms}) / 100 \text{ ms} = 0.277 \text{ or } -11.2 \text{ dB}$$

6.2 Emission Spectrum

Using the ridge-horn antenna and DUT placed in its aperture, emission spectrum was recorded and is shown in Figure 6.2.

6.3 Bandwidth of the Emission Spectrum

The measured spectrum of the signal is shown in Figure 6.3. The allowed (-20 dB) bandwidth is 0.25% of 433.92 MHz, or 1.0848 MHz. From the plot we see that the -20 dB bandwidth is 105.0 kHz.

6.4 Effect of Supply Voltage Variation

The DUT has been designed to be powered by a 12 VDC battery. For this test, the battery was replaced by a laboratory variable power supply. Relative power radiated was measured at the fundamental as the voltage was varied from 6 to 18 volts. The emission variation is shown in Figure 6.4.

6.5 Input Voltage

V = 12.0 V
I = 15 mADC

Table 5.1 Highest Emissions Measured

Radiated Emission - RF											ctronix/APP ABPER, FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	433.9	Dip	H	-24.5	Pk	21.5	21.8	71.1	72.9	1.8	flat
2	433.9	Dip	V	-23.6	Pk	21.5	21.8	72.0	72.9	**0.9**	side
3	867.8	Dip	H	-62.0	Pk	27.8	18.5	43.2	52.9	9.7	flat
4	867.8	Dip	V	-69.7	Pk	27.8	18.5	35.5	52.9	17.4	end
5	1301.8	Horn	H	-55.6	Pk	20.7	28.0	32.9	54.0	21.1	flat
6	1735.7	Horn	H	-48.7	Pk	21.9	28.0	41.0	52.9	11.9	flat
7	2169.6	Horn	H	-53.8	Pk	22.9	28.0	36.9	52.9	16.0	flat
8	2603.5	Horn	H	-54.4	Pk	24.1	28.0	37.5	52.9	15.4	side
9	3037.4	Horn	H	-61.6	Pk	25.5	28.1	31.6	52.9	21.3	side
10	3471.4	Horn	H	-60.5	Pk	26.8	28.3	33.8	52.9	19.0	max all, noise
11	3905.3	Horn	H	-61.2	Pk	28.1	28.2	34.5	54.0	19.5	max all, noise
12	4339.2	Horn	H	-63.0	Pk	29.5	27.9	34.4	54.0	19.6	max all, noise
13											
14											
15											
16											
17											
18	* Includes 11.6 dB duty factor										
19											
20											
21											
22	Digital emissions more than 20 dB below FCC/IC Class B Limit.										
23											
24											
25											
26											
27											

Conducted Emissions							
#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
	Not applicable						

Meas. 03/24/2006; U of Mich.

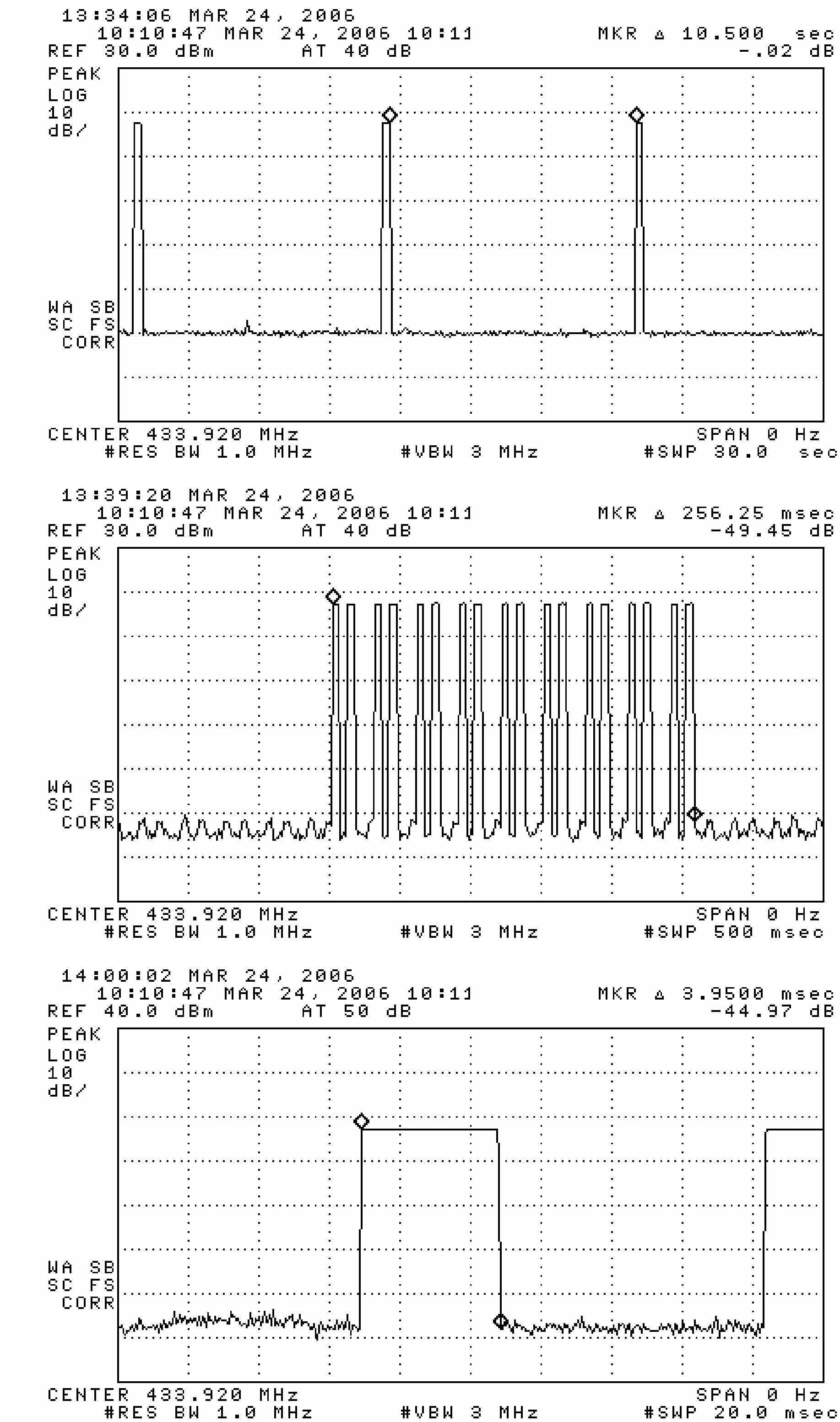

Figure 6.1. Transmissions modulation characteristics: (top) complete transmission, (center) expanded packets, (bottom) expanded word.

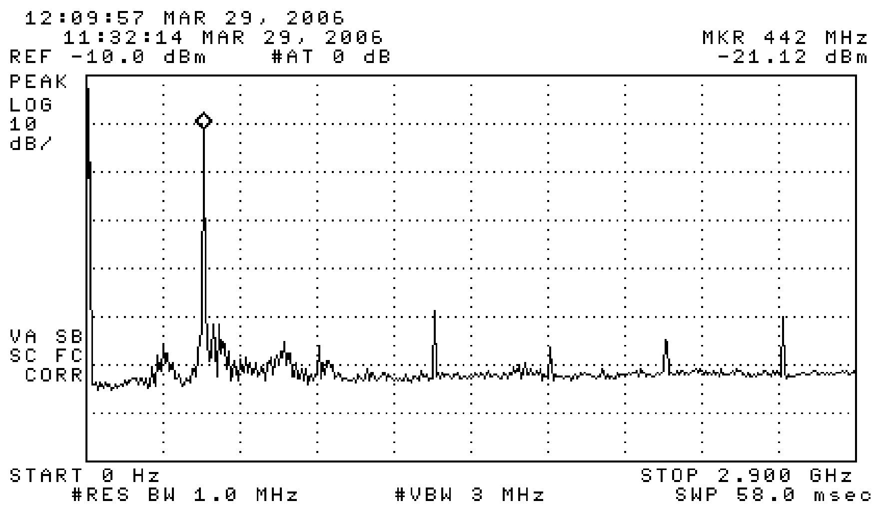

Figure 6.2. Emission spectrum of the DUT (pulsed emission).
The amplitudes are only indicative (not calibrated).

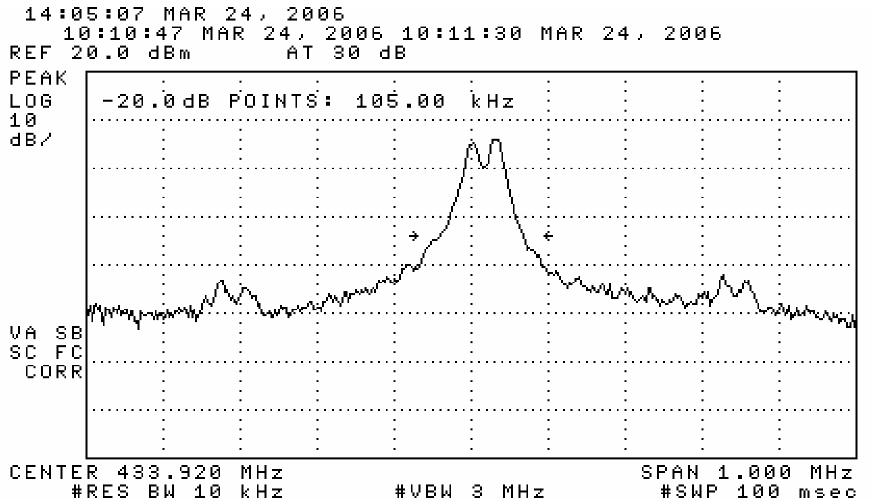

Figure 6.3. Measured bandwidth of the DUT (pulsed emission).

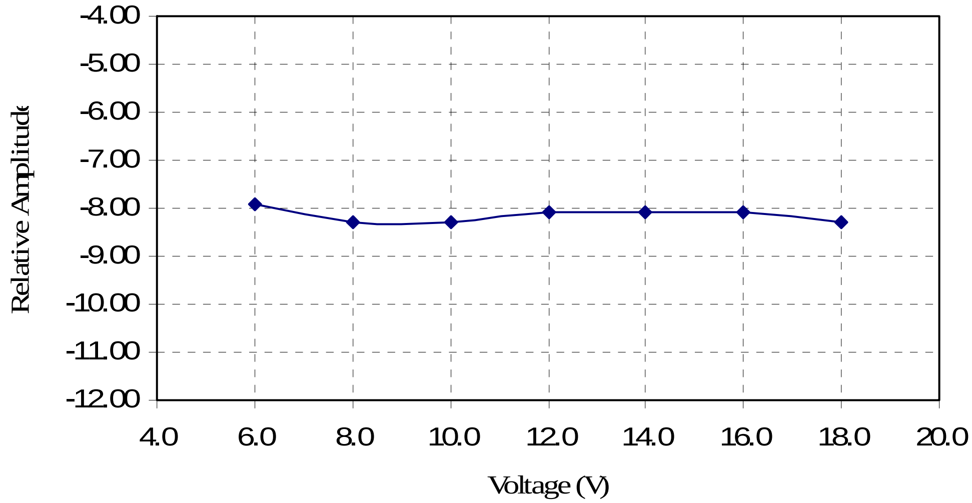

Figure 6.4. Relative emission at 433.92 MHz vs. supply voltage (pulsed emission).

DUT on OATS

DUT on OATS (close-up)

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Measured Radio Frequency Emissions
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Advantage PressurePro Composite Device Receiver Report Model(s): ABPER

Report No. 415031-303
June 19, 2006

For:
Advantage PressurePro
205 West Wall St
Harrisonville Missouri, 64701

Contact:
Earl Goodrich, goodrich@lectronix.biz
Tel: (517) 492-1900
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PO: Verbal

Measurements made by: Joseph D. Brunett

Tests supervised by:
Report approved by: Valdis V. Liepa
Research Scientist

Summary

Tests for compliance with FCC Regulations Part 15, Subpart B, and Industry Canada RSS-210/GEN, were performed on Advantage PressurePro model ABPER. This device is subject to the Rules and Regulations as a Receiver. As a Digital Device it is exempt, but such measurements were made to assess the receiver's overall emissions.

In testing completed on March 24, 2006, the device tested in the worst case met the allowed Class B specifications for radiated emissions by 9.9 dB (see p. 6). The conducted emissions tests do not apply, since the device is powered from a 12 VDC system.

1. Introduction

Advantage PressurePro model ABPER was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989 as subsequently amended, and with Industry Canada RSS-210, Issue 6 and RSS-Gen, Issue 1, September, 2005. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057).

2. Test Procedure and Equipment Used

The pertinent test equipment commonly used in our facility for measurements is listed in Table 2.1 below. The middle column identifies the specific equipment used in these tests.

Table 2.1 Test Equipment.

Test Instrument	Eqpt. Used	Manufacturer/Model
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Spectrum Analyzer (9kHz-22GHz)	X	Hewlett-Packard 8593A SN: 3107A01358
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131
Spectrum Analyzer (9kHz-26GHz)		Hewlett-Packard 8563E, SN: 3310A01174
Spectrum Analyzer (9kHz-40GHz)		Hewlett-Packard 8564E, SN: 3745A01031
Power Meter		Hewlett-Packard, 432A
Power Meter		Anritsu, ML4803A/MP
Harmonic Mixer (26-40 GHz)		Hewlett-Packard 11970A, SN: 3003A08327
Harmonic Mixer (40-60 GHz)		Hewlett-Packard 11970U, SN: 2332A00500
Harmonic Mixer (75-110 GHz)		Hewlett-Packard 11970W, SN: 2521A00179
Harmonic Mixer (140-220 GHz)		Pacific Millimeter Prod., GMA, SN: 26
S-Band Std. Gain Horn		S/A, Model SGH-2.6
C-Band Std. Gain Horn		University of Michigan, NRL design
XN-Band Std. Gain Horn		University of Michigan, NRL design
X-Band Std. Gain Horn		S/A, Model 12-8.2
X-band horn (8.2- 12.4 GHz)		Narda 640
X-band horn (8.2- 12.4 GHz)		Scientific Atlanta , 12-8.2, SN: 730
K-band horn (18-26.5 GHz)		FXR, Inc., K638KF
Ka-band horn (26.5-40 GHz)		FXR, Inc., U638A
U-band horn (40-60 GHz)		Custom Microwave, HO19
W-band horn(75-110 GHz)		Custom Microwave, HO10
G-band horn (140-220 GHz)		Custom Microwave, HO5R
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2
Dipole Antenna Set (30-1000 MHz)	X	University of Michigan, RLDP-1,-2,-3
Dipole Antenna Set (30-1000 MHz)		EMCO 2131C, SN: 992
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan
Amplifier (5-1000 MHz)	X	Avantak, A11-1, A25-1S
Amplifier (5-4500 MHz)	X	Avantak
Amplifier (4.5-13 GHz)		Avantek, AFT-12665
Amplifier (6-16 GHz)		Trek
Amplifier (16-26 GHz)		Avantek
LISN Box		University of Michigan
Signal Generator	X	Hewlett-Packard 8657B

3. Configuration and Identification of Device Under Test

The DUT is a composite device, consisting of a 433.92 MHz Tire Pressure Data re-transmitter and superheterodyne receiver. This report details the emissions relating to the receiver portion of the device. This device contains a 433.92 MHz superheterodyne receiver with 376.2 MHz LO, designed for onboard automobile Tire Pressure data re-transmission, and as such, it is powered from an automotive 12 VDC source. It is housed in a plastic case approximately 12 by 3 by 0.5 inches. Antenna is an integral dipole. For testing, a generic power cable was provided by the manufacturer. In the receiver digital section, the decoding, signal processing, etc. are performed by a microprocessor timed by a 10.0 MHz crystal. The DUT was designed by Lectronix, Inc., 5858 Enterprise Drive, Lansing, MI 48842.
It is identified as:

Advantage PressurePro Composite Device
Model(s): ABPER
FCC ID: RMDABPER
IC: 4785A-ABPER

3.1 Modifications Made

There were no modifications made to the DUT by this laboratory. However, pretest measurements indicated the output power of the device exceeded the limits, so the antenna matching circuitry was adjusted by a Lectronix, Inc. employee to bring the device into compliance.

4. Emission Limits

The DUT tested falls under Part 15, Subpart B, "Unintentional Radiators". The pertinent test frequencies, with corresponding emission limits, are given in Tables 4.1 and 4.2 below.

4.1 Radiated Emission Limits

Table 4.1. Radiated Emission Limits (Ref: FCC 15.33, 15.35, and 15.109; IC RSS-210, 2.6 Table 2).

Freq. (MHz)	E_{lim} (3m) μV/m	E_{lim} (3m) dB(μV/m)
30-88	100	40.0
88-216	150 μV/m	43.5
216-960	200 μV/m	46.0
960-2000	500 μV/m	54.0

Note: Quasi-Peak readings apply to 1000 MHz (120 kHz BW)
Average readings apply above 1000 MHz (1 MHz BW)

4.2 Power Line Conducted Emission Limits

Table 4.3 Conducted Emission Limits (FCC:15.107 (CISPR); IC: RSS-Gen, 7.2.2 Table 2).

Frequency	Class A (dBμV)		Class B (dBμV)	
MHz	Quasi-peak	Average	Quasi-peak	Average
.150 - 0.50	79	66	66 - 56*	56 - 46*
0.50 – 5.0	73	60	56	46
5.0 – 30.0	73	60	60	50

Notes:
1. The lower limit shall apply at the transition frequency
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15-0.50 MHz:

*Class B Quasi-peak: dBμV = 50.25 - 19.12*log(f)

*Class B Average: dBμV = 40.25 - 19.12*log(f)

3. 9 kHz RBW

4.3 Antenna Power Conduction Limits
Ref: FCC 15.111(a). Pmax = 2 nW; for frequency range see Table 4.1.

5. Emission Tests and Results

NOTE: Even though the FCC and/or Industry Canada specify that both the radiated and conductive emissions be measured using the Quasi-Peak and/or average detection schemes, we normally use peak detection since Quasi-Peak is cumbersome to use with our instrumentation. In case the measurement fails to meet the limits, or the measurement is near the limit, it is re-measured using appropriate detection. We note that since the peak detected signal is always higher or equal to the Quasi-Peak or average detected signal, the margin of compliance may be better, but not worse, than indicated in this report. The type of detection used is indicated in the data table, Table 5.1.

5.1 Anechoic Chamber Radiated Emission Tests
To familiarize with the radiated emission behavior of the DUT, it was studied and measured in the shielded anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with turntable, antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

To study and test for radiated emissions, the DUT was powered by a laboratory power supply at 12 VDC. A 433.92 MHz CW signal was injected (radiated) from a nearby signal generator using a short wire antenna. The DUT was taped to a Styrofoam block and placed on the test table on each of the three axis. At each orientation, the table was rotated to obtain maximum signal for vertical and horizontal emission polarizations. This sequence was repeated throughout the required frequency range.

In the chamber we studied and recorded all the emissions using a ridge-horn antenna, which covers 200 MHz to 5000 MHz, up to 2 GHz. In scanning from 30 MHz to 2.0 GHz, there were no spurious emissions observed other than the LO and injection signal (433.92 MHz), and the LO harmonics. Figures 5.1 and 5.2 show emissions measured 0-1000 MHz and 1000-2000 MHz, respectively. These measurements are made with a ridge-horn antenna at 3m, with spectrum analyzer in peak hold mode and the receiver rotated in all orientations. The measurements up to 1000 MHz (Fig. 5.1) are used for initial evaluation only, while those above 1000 MHz (Fig. 5.2) are used in final assessment for compliance.

5.2 Open Area Test Site Radiated Emission Tests
The DUT was then moved to the 3 meter Open Area Test Site where measurements were repeated up to 1000 MHz using a small Bicone, or dipoles when the measurement is near the limit. The DUT was exercised as described in Sec. 5.1 above. The measurements were made with a spectrum analyzer using 120 kHz IF bandwidth and peak detection mode, and, when appropriate, using Quasi-Peak or average detection (see 5.0). Sometimes lower IF bandwidth is used to help bring signals out of noise and this is noted in the data table. Photographs included in this filing show the DUT on the Open Area Test Site (OATS).

The emissions from digital circuitry were measured using a standard Bicone. These results are also presented in Table 5.1.

5.3 Computations and Results for Radiated Emissions
To convert the dBm's measured on the spectrum analyzer to dB(μV/m), we use expression

$$E_3(\text{dB}\mu\text{V/m}) = 107 + P_R + K_A - K_G$$

where	P_R	=	power recorded on spectrum analyzer, dB, measured at 3m
	K_A	=	antenna factor, dB/m
	K_G	=	pre-amplifier gain, including cable loss, dB

When presenting the data, at each frequency the highest measured emission under all of the possible orientations is given. Computations and results are given in Table 5.1. There we see that the DUT meets the limit by more than 9.9 dB.

5.4 Conducted Emission Tests
These tests do not apply, since the DUT is powered from a 12 VDC system.

6. Other Measurements

6.1 Emission Spectrum
The only detectable RF emission occurs at the LO and 2 x LO. The emission spectrum is measured typically over 1 MHz span with and without injection signal. This data is taken with the DUT close to antenna and hence amplitudes are relative. The plot is shown in Figure 6.1.

6.2 Effect of Supply Voltage Variation
The DUT has been designed to operate from 12 VDC power. Using a spectrum analyzer, relative radiated emissions were recorded at the LO (752.4 MHz) as voltage was varied from 6.0 to 18.0 VDC. Figure 6.2 shows the emission variation.

6.3 Operating Voltage and Current

V = 12 VDC
I = 15.0 mADC

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Table 5.1 Highest Emissions Measured

Radiated Emission - RF											ctronix/APP ABPER, FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	376.2	Sbic	H	-85.3	Pk	20.5	17.6	24.6	46.0	21.4	noise
2	376.2	Sbic	V	-84.6	Pk	20.5	17.6	25.3	46.0	20.7	nose
3	752.4	Sbic	H	-86.0	Pk	26.8	14.4	33.4	46.0	12.6	background
4	752.4	Sbic	V	-83.3	Pk	26.8	14.4	36.1	46.0	**9.9**	background
5	1075.0	Horn	H	-61.0	Pk	20.6	28.1	38.5	54.0	15.5	flat
6	1090.0	Horn	H	-61.9	Pk	21.0	28.1	38.0	54.0	16.0	flat
7	1200.0	Horn	H	-68.0	Pk	21.3	28.3	32.0	54.0	22.0	max. of all, noise
8	1300.0	Horn	H	-69.0	Pk	21.4	28.2	31.2	54.0	22.8	max. of all, noise
9	1400.0	Horn	H	-68.0	Pk	21.8	27.9	32.9	54.0	21.1	max. of all, noise
10	1500.0	Horn	H	-70.0	Pk	22.2	28.2	31.0	54.0	23.0	max. of all, noise
11	1600.0	Horn	H	-67.9	Pk	22.4	28.3	33.2	54.0	20.8	max. of all, noise
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22	Digital emissions more than 20 dB below FCC/IC Class B Limit.										
23											
24											
25											
26											
27											

Conducted Emissions							
#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
	Not applicable						

Meas. 03/24/2006; U of Mich.

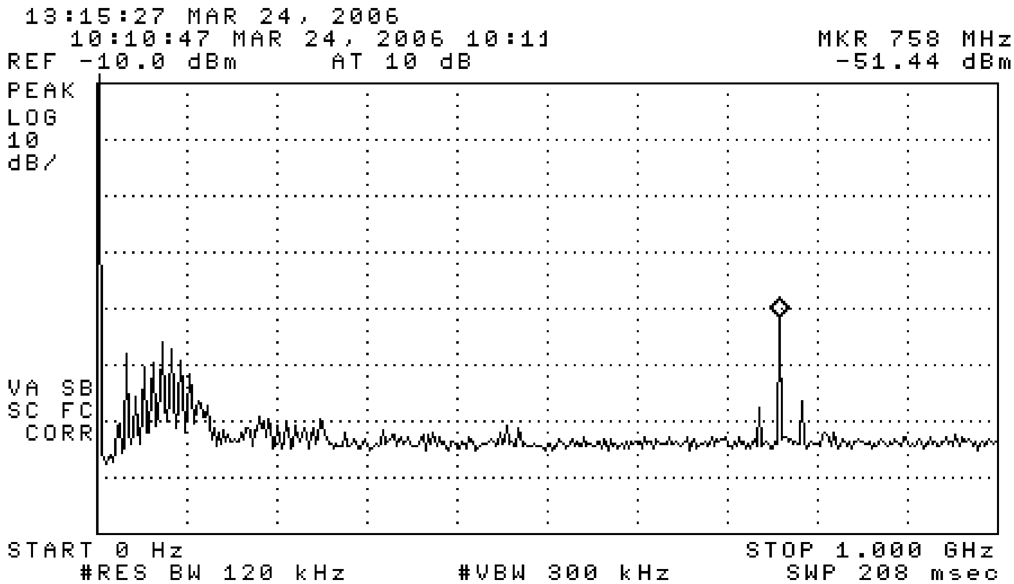


Figure 5.1. Emissions measured at 3 meters in chamber, 0-1000 MHz.
(emission at marker is spurious)

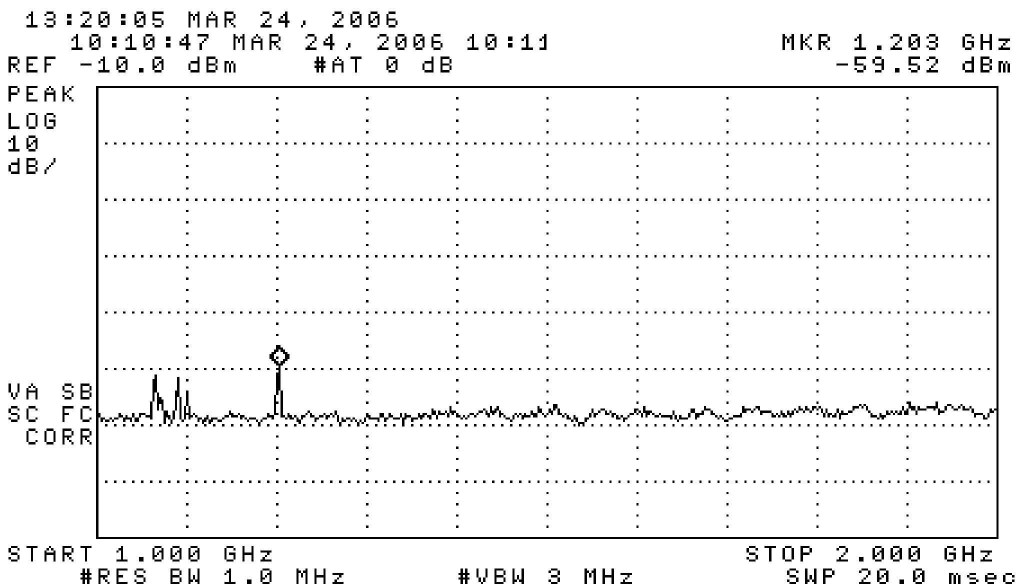


Figure 5.2. Emissions measured at 3 meters in chamber, 1000-2000 MHz.
(emission at marker is background)

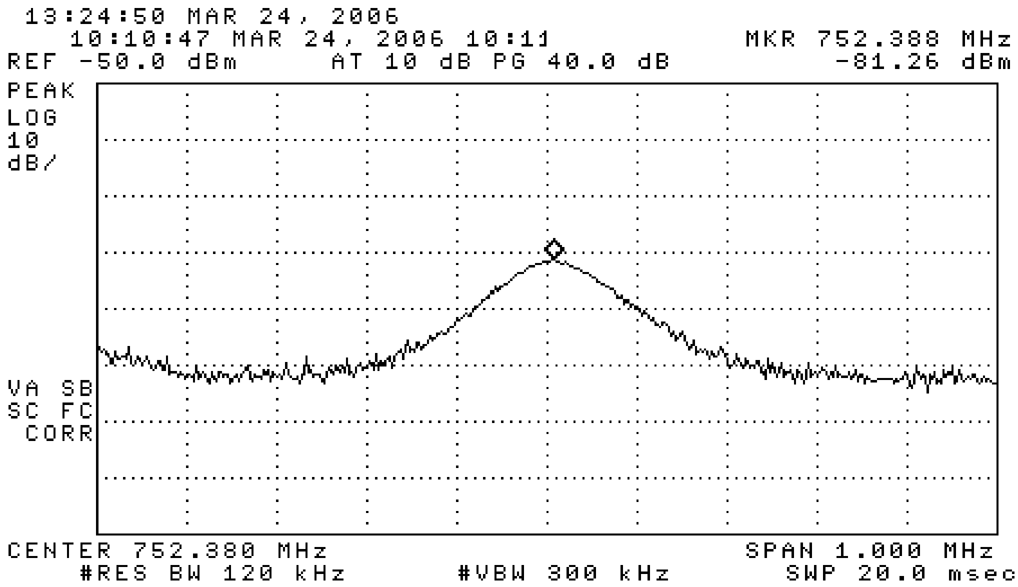


Figure 6.1. Relative receiver emissions.

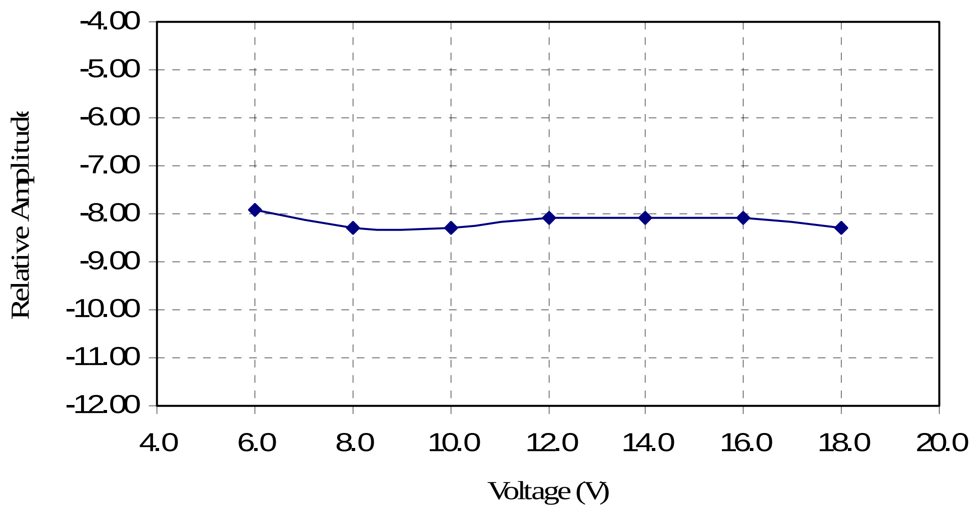
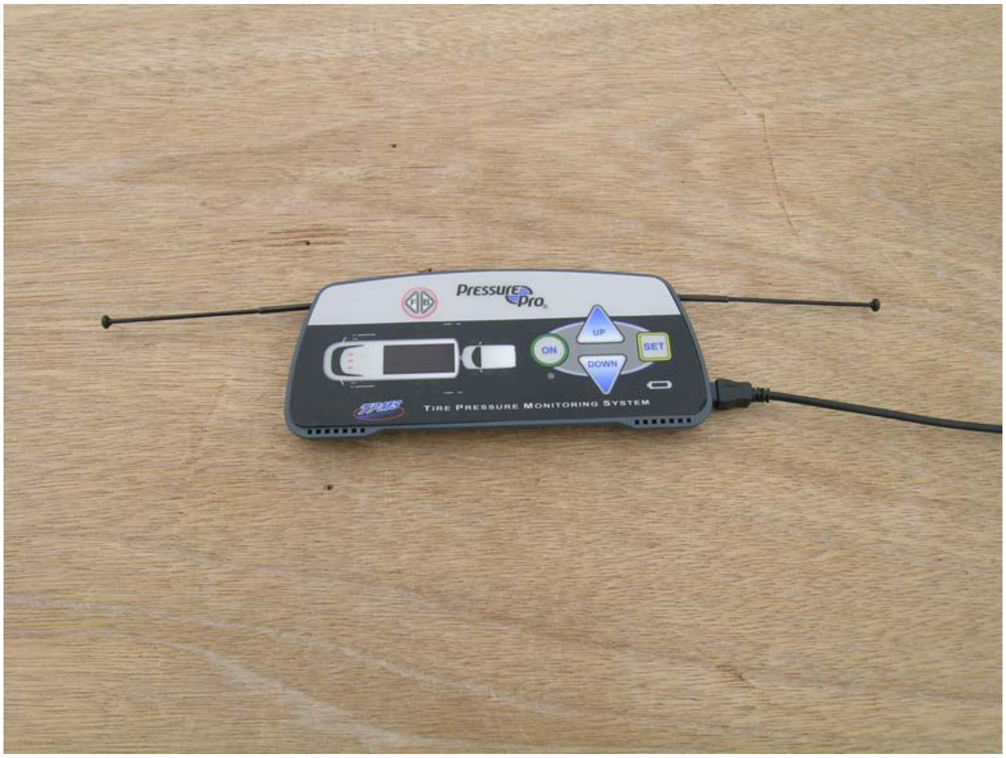


Figure 6.2. Relative emission vs. supply voltage.

DUT on OATS



DUT on OATS (close-up)