

dBi Corporation
FCC Certification Test Report
Point Six HWSO Wireless Sensor
Report Number 07dB*i*002a
(this test report replaces test report 07dB*i*002)



Testing Certificate #1985.01

ADMINISTRATIVE INFORMATION

Historical record:

Because dBi Corporation is a testing entity, and not a manufacturer, this original test report of the HWSO wireless sensor is being transmitted to the manufacturer, Point Six. dBi will keep a copy for its historical records and to satisfy A2LA-Audit requirements. We strongly recommend archiving the unit that we tested, to facilitate answering future inquiries regarding this products.

Retention of records:

The FCC requires the records for a Class A or Class B product to be retained by the responsible party for at least two years after the manufacture of said product has been permanently discontinued. These records should include the original certification or verification test report, quality audit data, and the test procedures used.

The European Union requires the Declaration of Conformity (DoC) and all supporting data for a product bearing the CE Marking to be retained, and available for inspection by enforcement authorities, for 10 years after placing the product on the market.

Australia and New Zealand require the Declaration of Conformity, test reports, a description of the product, documentation that clearly identifies the product, and paperwork showing the product's brand name, model number, etc. to be kept for at least five years after the product ceases to be supplied to Australia or New Zealand.

Measurement uncertainties:

The Lexmark Electromagnetic Compatibility Laboratory (EMC Lab) has a documented calculation of the measurement uncertainties associated with tests performed at the Lexmark site.

Ongoing compliance:

This report applies only to the sample tested. The manufacturer is responsibility for ensuring that the production models of this wireless sensor comply with the FCC and CE Marking requirements, and continue to comply throughout their manufacturing life. The manufacturer should check any changes to the product that could change its interference profile.

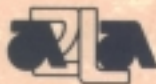
A2LA approval:

dBi Corporation has been accredited by the American Association for Laboratory Accreditation (A2LA) for Radiated Emissions and Conducted Emissions, Electromagnetic Interference, and Electrostatic Discharge testing. Copies of our Accreditation Certificate and Scope of Accreditation follow.

The Federal Communications Commission (FCC) recognized the Lexmark site as meeting the requirements of section 2.948 of the FCC Rules in a letter dated December 10, 2001. This information is on file with the FCC under Registration No. 949691.

Please note: This report may be copied as needed, as long as it is copied in its entirety.





American Association for Laboratory Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

dBi CORPORATION¹
216 Hillsboro Avenue
Lexington, KY 40511-2105
John R. Barnes Phone: 859 253 1178

ELECTRICAL (EMC)

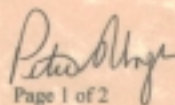
Valid To: September 30, 2008

Certificate Number: 1985.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests:

| <u>Test Technology</u> | <u>Test Method(s)</u> |
|---------------------------------|---|
| Radiated Emissions | CFR 47, FCC Method Part 15, Class A and B (using ANSI C63.4:2003) AS/NZS 3548:1995, AS/NZS CISPR 22:2004, 2002 CISPR 22:2003, 1997, 1993 EN 55022:1994, 1998 VCCI 2002, 2006 |
| Conducted Emissions | CFR 47, FCC Method Part 15, Class A and B (using ANSI C63.4:2003) AS/NZS 3548:1995; AS/NZS CISPR 22:2004, 2002; CISPR 22:2003, 1997, 1993 EN 55022:1994, 1998 VCCI 2002, 2006 |
| Harmonics | IEC 61000-3-2:2000, EN 61000-3-2:2000 |
| Flicker | IEC 61000-3-3:1994, 2002; EN 61000-3-3:1995 |
| <u>Immunity</u> | |
| Electrostatic Discharge (ESD) | IEC 61000-4-2:1995 EN 61000-4-2:1995 |
| Radiated Immunity | IEC 61000-4-3:1995, 2002 EN 61000-4-3:1996 |
| Electrical Fast Transient/Burst | IEC 61000-4-4:1995 EN 61000-4-4:1995 |

(A2LA Cert. No. 1985.01) 10/30/06


Page 1 of 2

5301 Buckeystown Pike, Suite 350 • Frederick, MD 21704-8373 • Phone: 301-644 3248 • Fax: 301-662 2974

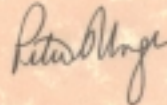


| <u>Test Technology</u> | <u>Test Method(s)</u> |
|---|--|
| Surge Immunity | IEC 61000-4-5:1995 EN 61000-4-5:1995 |
| Conducted Immunity | IEC 61000-4-6:1996 EN 61000-4-6:1996 |
| Magnetic Field Immunity | IEC 61000-4-8:1993, 2001 EN 61000-4-8:1993 |
| Voltage Dips/Interruption Immunity | IEC 61000-4-11:1994, 2001 EN 61000-4-11:1994 |
| ITE Product Family | CISPR 24:1997 EN 55024:1998 |
| Generic Devices for Residential, Commercial, and Light Industrial Use | EN 61000-6-1:2001; EN 61000-6-3:2001; AS/NZS 4251.1-1999 |
| Generic Devices for Industrial Use | EN 61000-6-2:1999, 2001 |
| Electrical Equipment for Measurement, Control, and Laboratory Use | IEC 61326:1997, 2002 EN 61326:1997 |

On materials and products related to the following:

Information Technology Equipment - Computers, Printers, Peripheral Devices;
Generic Devices for residential, commercial, and light industrial use;
Generic Devices for industrial use;
Electrical equipment for measurement, control and laboratory use

¹ NOTE: Testing is performed using the equipment and facilities at Lexmark International EMC Laboratory (A2LA Accreditation Certificate 0872.01)



ADMINISTRATIVE DATA

Manufacturer:

Point Six, Inc.
2333 Alumni Park Plaza, Suite 305
Lexington, KY 40517

Appliance/Product: analog/digital sensor

Model/Type Number: P6HWSO

FCC ID: M5ZP6HWSO

Rating: 3.6Vdc (Lithium batteries)

Suppression Components: see attached sheet

Measurement Equipment used: see attached sheets.

Measurements According to, and Sample Units Comply with: FCC 47 CFR Part 15-2006

Report Prepared By: John R. Barnes KS4GL, PE, NCE, NCT, ESDC Eng, ESDC Tech, PSE,
SM IEEE

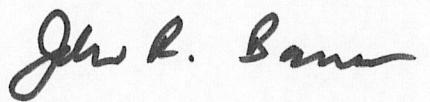
Testing Performed by:

dBi Corporation
216 Hillsboro Avenue
Lexington, KY 40511-2105, USA

Testing Performed on: February 16-17, 2007, and March 8, 2007 **at:**

Lexmark International, Inc.
Development Lab.
Lexington, KY 40550, USA

Reviewed and Approved by: John R. Barnes KS4GL, PE, NCE, NCT, ESDC Eng, ESDC Tech,
PSE, SM IEEE



SIGNED _____ **DATE** March 8, 2007
John R. Barnes, PRESIDENT dBi Corp.

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| INFORMATION RELATING TO PRODUCT RF INTERFERENCE |
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Appliance/Product: analog/digital sensor

Model/Type Number: P6HWSO

FCC ID: M5ZP6HWSO

Rating: 3.6Vdc (Lithium batteries)

Suppression Components: none

Clock Frequencies: 8MHz and 418MHz

Cables: none.

Electronic Printed Circuit Boards:

HWSO board

P/N P2706

Size of Product: 71mm x 28mm x 114mm high

Weight of Product: 110g

Radiated Emissions 30-4,180 MHz (Internal Batteries)

Radiated Emission Standards:

FCC 47 CFR Part 15-2006, using ANSI C63.4-2003; section 15.231(e) limits for 418MHz.

Appliance/Product: analog/digital sensor

Model/Type Number: P6HWSO

FCC ID: M5ZP6HWSO

Rating: 3.6Vdc (Lithium batteries)

Serial Number: 70255004

Host and Other Peripherals: None

Name of Test: Radiated Interference

Test Procedure: ANSI C63.4-2003

Test Location: 5m semianechoic chamber

Test Distance: 3m

Test Instrumentation: See attached sheets

Notes: Transmitting at 1 second intervals to speed up testing.

Based on our experiences testing previous FCC Part 15.231(e) products, we put a calibrated 20dB attenuator right after the bi-con antenna to prevent signal compression in the preamp/receiver chain. for measurements from 30-1000MHz. We added its loss (20.194dB at 418MHz, 20.15dB at 836MHz) to the field strengths measured by the receiver in this band. We used a different antenna and preamp for measurements above 1GHz. The FCC Part 15.231(e) limits above 1GHz are lower than the FCC Class A limits above 1GHz, thus any linearity concerns had already been addressed during equipment calibration.

Due to software limitations, we had to measure PK+, QP, and AVE for 418MHz and its harmonics in manual mode, as follows:

1. With the equipment-under-test (EUT) upright, measure 418MHz and 836MHz in QP mode with the bi-con antenna vertical and horizontal (Lexmark's EMC software records the azimuth and antenna elevation for the highest QP emissions).
2. Repeat step 1 with the EUT on its back.
3. Repeat step 1 with the EUT on its right side.
4. Study the plots to determine which orientation of the EUT had the highest emissions in QP mode.
5. Return the EUT to this position. With the bi-con antenna vertical, go back to the azimuth and antenna elevation that maximized the QP emissions at a given frequency.
6. Using a 1 second sampling time, measure PK+ and QP, taking the maximum values seen on the receiver over 10-20 seconds. If we still suspected signal compression, we increased the attenuation of the receiver's front-end by 10dB. If the measurement stayed the same, we used the previous reading. If the value increased, we continued increasing the attenuation in 10dB steps until the measurement stayed the same, then reduced the attenuation 10dB for the official measurement.

7. Using a 100 millisecond sampling time, measure AVE, taking the maximum value seen on the receiver over 10-20 seconds. (Since we could only catch the top 2 digits, we used 0.99dB as the fractional part to be conservative.)
8. In the calculations, add the attenuator's loss to the measured value to get the true field strength.
9. Repeat steps 5 to 8 with the bi-con antenna horizontal.
10. Put the EUT(s) on the table in the position(s) that maximized 418MHz Radiated Emissions.
11. Measure 1254MHz, 1672MHz, ..., 4180MHz in PK+ mode with the horn antenna vertical and horizontal (the software records the azimuth of the PK+ and AVE peaks, elevation was 1m).
12. With the horn antenna vertical, go to the azimuth that maximized each PK+ peak.
13. Using a 1 second sampling time, measure PK+, taking the maximum values seen on the receiver over 10-20 seconds.
14. Using a 100 millisecond sampling time, measure AVE, taking the maximum value seen on the receiver over 10-20 seconds. (Since we could only catch the top 2 digits, we used 0.99dB as the fractional part to be conservative.)
15. Repeat steps 12 to 14 with the horn antenna horizontal.

For measurements from 30MHz-1,000 MHz the 6dB resolution bandwidth (RBW) was 120kHz. Above 1,000MHz the 6dB RBW was 1MHz. All measurements were made in EMI Receiver mode, so according to the receiver specifications, video bandwidth (VBW) doesn't apply, the bandwidth error is under 10% and the shape factor (B(60dB)/B(6dB)) is under 10.

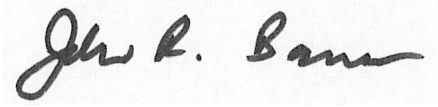
Under Section 15.231(e), the average limit for the fundamental is calculated by linear interpolation from 1500uV/m at 260MHz to 5000uV/m at 470MHz when measured at 3m. Average limit = $((5000\text{uV/m} - 1500\text{uV/m}) * (418\text{MHz} - 260\text{MHz}) / (470\text{MHz} - 260\text{MHz})) + 1500\text{uV/m} = 4133\text{uV/m}$
 $= 20 * \log(4133) \text{ dB(uV/m)} = 72.33\text{dB(uV/m)}$. Section 15.35(b) sets the peak limit for the fundamental to 20 dB above the average limit, or 92.33dB(uV/m) at 3m. For spurious emissions, Section 15.231(e) sets the average limit to 20dB below the maximum permitted fundamental level, or 52.33dB(uV/m) at 3m, with the peak limit 20dB higher at 72.33dB(uV/m).

The maximum transmit time for these sensors is 8ms. Averaged over a 100ms sample time, the AVE measurement should be about $20 * \log(8\text{ms}/100\text{ms}) = -21.938\text{dB}$ from PK+ measurements. The measured difference may be less if the AVE signal level is under the noise floor of the receiver, artificially increasing its value. On a previous product we were told that for pulsed emissions, that the AVE emissions must be calculated by *subtracting* a duty-cycle correction factor = $20 * \log(\text{worst case ON-TIME (ms) in any 100ms window} / 100 \text{ ms})$ from the peak value, with the duty-cycle correction factor between 0dB and 20dB. (There is a sign error in the description we were given, because log of a number between 0 and 1 is negative.) We have not found this requirement documented anywhere in the FCC Regulations or in ANSI C63.4-2003, but to keep everyone happy, we show both *measured* AVE values and *calculated* AVE values for this sensor.

As first tested, the second harmonic (836MHz) was over the FCC Part 15.231(e) limit. We fixed this by lowering a light-emitting diode (LED) whose leads were about 8mm long, putting it within 2mm of the HWSO's antenna.

dBi Corporation

Test Results: With this modification, Tables 1 through 4, and the Transmitted Bandwidth Data, show that this unit meets the radiated interference requirements of FCC Part 15 Section 15.231(e).

A handwritten signature in black ink, reading "John R. Barnes", is positioned above the signature line.

SIGNED _____ **DATE** March 8, 2007
John R. Barnes, PRESIDENT dBi Corp.

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| Radiated Emissions Data 30-4,180MHz |
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TABLE 1 PEAK EMISSIONS

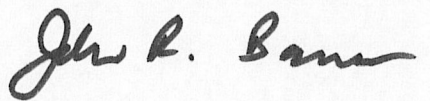
| Receiver Meas. Freq. MHz | Receiver Reading | | Cable Correction | Antenna | Radiated Interference | | 15.231(e) |
|-----------------------------------|-----------------------|------------------|---------------------|---------------|-----------------------|-----------------|-----------------|
| | <u>Field Strength</u> | | | | <u>Peak</u> | | |
| | Vert. | Horiz. | Factor | Factor | Vert. | Horiz. | Limit |
| | <u>dB(uV)*</u> | <u>(dB(uV))*</u> | <u>dB</u> | <u>dB(/m)</u> | <u>dB(uV/m)</u> | <u>dB(uV/m)</u> | <u>dB(uV/m)</u> |
| 418.05 | 90.964 | 67.674 | -25.210 | 16.720 | 82.474 | 59.184 | 92.33 |
| 836.11 | 70.850 | 65.450 | -23.631 | 23.241 | 70.460 | 65.060 | 72.33 |
| 1254.17 | 68.435 | 61.825 | -29.787 | 23.562 | 62.210 | 55.600 | 72.33 |
| 1672.22 | 67.779 | 62.199 | -28.236 | 24.817 | 64.360 | 58.780 | 72.33 |
| 2090.28 | 63.683 | 59.083 | -27.522 | 26.179 | 62.340 | 57.740 | 72.33 |
| 2508.34 | 51.252 | 48.552 | -27.197 | 27.935 | 51.990 | 49.290 | 72.33 |
| 2926.39 | 41.775 | 39.545 | -26.406 | 29.691 | 45.060 | 42.830 | 72.33 |
| 3344.45 | 40.077 | 45.077 | -25.881 | 30.344 | 44.540 | 49.540 | 72.33 |
| 3762.51 | 56.603 | 44.903 | -25.025 | 30.762 | 62.340 | 50.640 | 72.33 |
| 4180.57 | 48.085 | 41.995 | -24.719 | 31.524 | 54.890 | 48.800 | 72.33 |

Sample Calculation: Receiver reading dB(uV) plus cable correction factor (dB) plus antenna factor dB(/m) equals Radiated Interference Field Strength dB(uV/m).

TABLE 2 QUASIPEAK EMISSIONS

| Receiver Meas. Freq. MHz | Receiver Reading | | Cable Correction | Antenna | Radiated Interference | | 15.231(e) |
|-----------------------------------|-----------------------|------------------|---------------------|---------------|-----------------------|-----------------|-----------------|
| | <u>Field Strength</u> | | | | <u>Quasipeak</u> | | |
| | Vert. | Horiz. | Factor | Factor | Vert. | Horiz. | Limit |
| | <u>dB(uV)*</u> | <u>(dB(uV))*</u> | <u>dB</u> | <u>dB(/m)</u> | <u>dB(uV/m)</u> | <u>dB(uV/m)</u> | <u>dB(uV/m)</u> |
| 418.05 | 86.724 | 61.594 | -25.210 | 16.720 | 78.234 | 53.104 | |
| 836.11 | 65.820 | 57.060 | -23.631 | 23.241 | 65.430 | 56.670 | |

Sample Calculation: Receiver reading dB(uV) plus cable correction factor (dB) plus antenna factor dB(/m) equals Radiated Interference Field Strength dB(uV/m).



Signed _____ Date March 8, 2007
John R. Barnes, PRESIDENT dBi Corporation

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| Radiated Emissions Data 30-4,180MHz (BA/WT-D-BB, cont.) |
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TABLE 3 MEASURED AVERAGE EMISSIONS

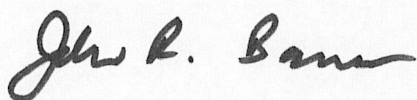
| Receiver Meas. Freq. MHz | Receiver | | Cable | Antenna Factor dB(/m) | Radiated Interference | | 15.231(e) |
|-----------------------------------|----------------|------------------|------------|-----------------------------|-----------------------|-----------------|-----------------|
| | Reading | | Correction | | Field Strength | | Average |
| | Vert. | Horiz. | Factor | | Vert. | Horiz. | Limit |
| | <u>dB(uV)*</u> | <u>(dB(uV))*</u> | <u>dB</u> | | <u>dB(uV/m)</u> | <u>dB(uV/m)</u> | <u>dB(uV/m)</u> |
| 418.05 | 71.674 | 50.674 | -25.210 | 16.720 | 63.184 | 42.184 | 72.33 |
| 836.11 | 52.530 | 45.530 | -23.631 | 23.241 | 52.140 | 45.140 | 52.33 |
| 1254.17 | 49.215 | 43.215 | -29.787 | 23.562 | 42.990 | 36.990 | 52.33 |
| 1672.22 | 44.409 | 39.409 | -28.236 | 24.817 | 40.990 | 35.990 | 52.33 |
| 2090.28 | 44.333 | 40.333 | -27.522 | 26.179 | 42.990 | 38.990 | 52.33 |
| 2508.34 | 33.252 | 30.252 | -27.197 | 27.935 | 33.990 | 30.990 | 52.33 |
| 2926.39 | 25.705 | 22.705 | -26.406 | 29.691 | 28.990 | 25.990 | 52.33 |
| 3344.45 | 23.527 | 26.527 | -25.881 | 30.344 | 27.990 | 30.990 | 52.33 |
| 3762.51 | 38.253 | 26.253 | -25.025 | 30.762 | 43.990 | 31.990 | 52.33 |
| 4180.57 | 30.185 | 23.185 | -24.719 | 31.524 | 36.990 | 29.990 | 52.33 |

Sample Calculation: Receiver reading dB(uV) plus cable correction factor (dB) plus antenna factor dB(/m) equals Radiated Interference Field Strength dB(uV/m).

TABLE 4 CALCULATED AVERAGE EMISSIONS

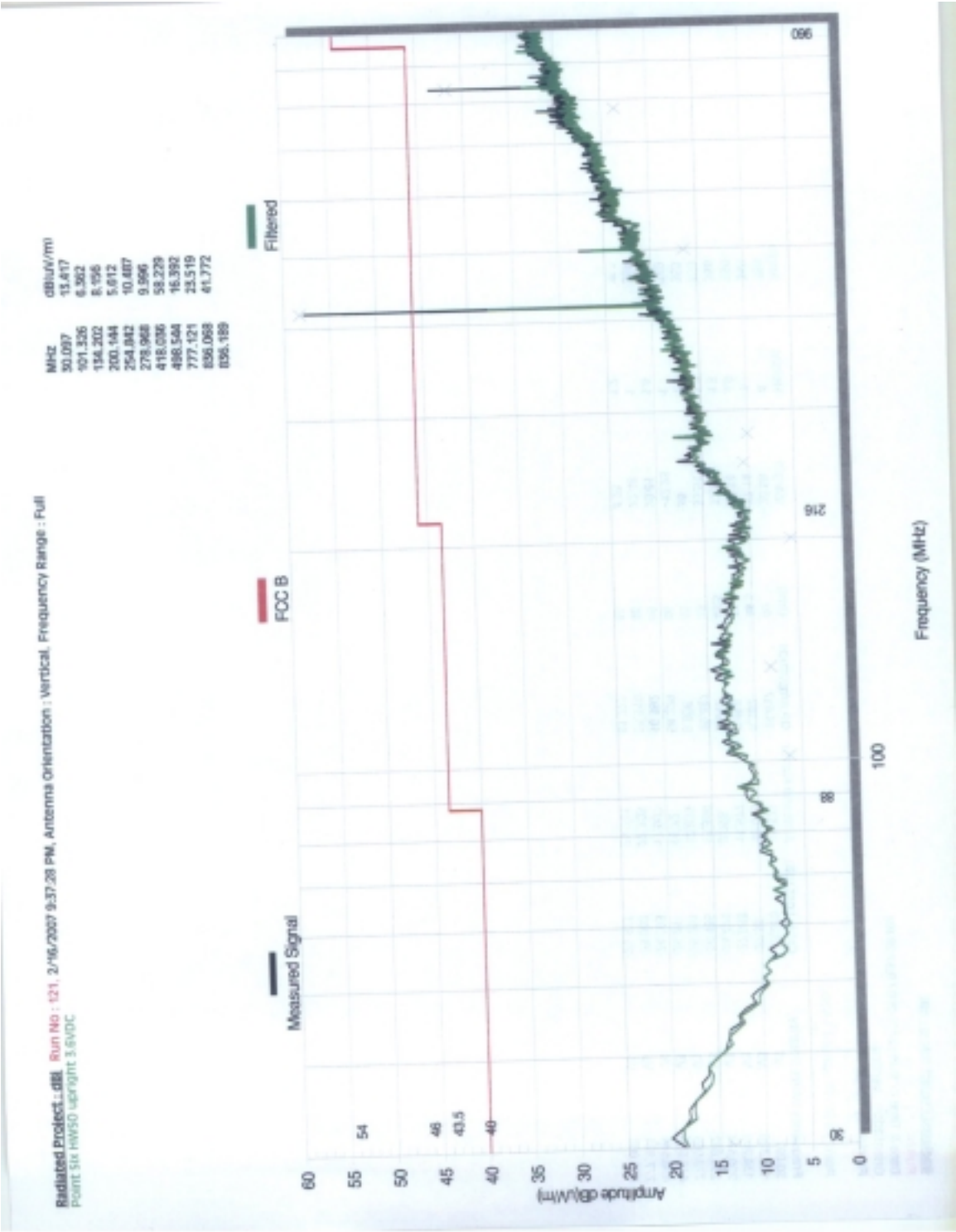
| Receiver Meas. Freq. MHz | Receiver | | Cable | Antenna Factor dB(/m) | Duty-cyc. | Radiated Interf. | | 15.231e |
|-----------------------------------|----------------|------------------|-----------|-----------------------------|-------------|------------------|-----------------|-----------------|
| | Reading | | Corr. | | Corr. | Field Strength | | Average |
| | Vert. | Horiz. | Factor | | Factor | Vert. | Horiz. | Limit |
| | <u>dB(uV)*</u> | <u>(dB(uV))*</u> | <u>dB</u> | | <u>dB**</u> | <u>dB(uV/m)</u> | <u>dB(uV/m)</u> | <u>dB(uV/m)</u> |
| 418.05 | 90.964 | 67.674 | -25.210 | 16.720 | -20.000 | 62.474 | 39.184 | 72.33 |
| 836.11 | 70.850 | 65.450 | -23.631 | 23.241 | -20.000 | 50.460 | 45.060 | 52.33 |
| 1254.17 | 68.435 | 61.825 | -29.787 | 23.562 | -20.000 | 42.210 | 35.600 | 52.33 |
| 1672.22 | 67.779 | 62.199 | -28.236 | 24.817 | -20.000 | 44.360 | 38.780 | 52.33 |
| 2090.28 | 63.683 | 59.083 | -27.522 | 26.179 | -20.000 | 42.340 | 37.740 | 52.33 |
| 2508.34 | 51.252 | 48.552 | -27.197 | 27.935 | -20.000 | 31.990 | 29.290 | 52.33 |
| 2926.39 | 41.775 | 39.545 | -26.406 | 29.691 | -20.000 | 25.060 | 22.830 | 52.33 |
| 3344.45 | 40.077 | 45.077 | -25.881 | 30.344 | -20.000 | 24.540 | 29.540 | 52.33 |
| 3762.51 | 56.603 | 44.903 | -25.025 | 30.762 | -20.000 | 42.340 | 30.640 | 52.33 |
| 4180.57 | 48.085 | 41.995 | -24.719 | 31.524 | -20.000 | 34.890 | 28.800 | 52.33 |

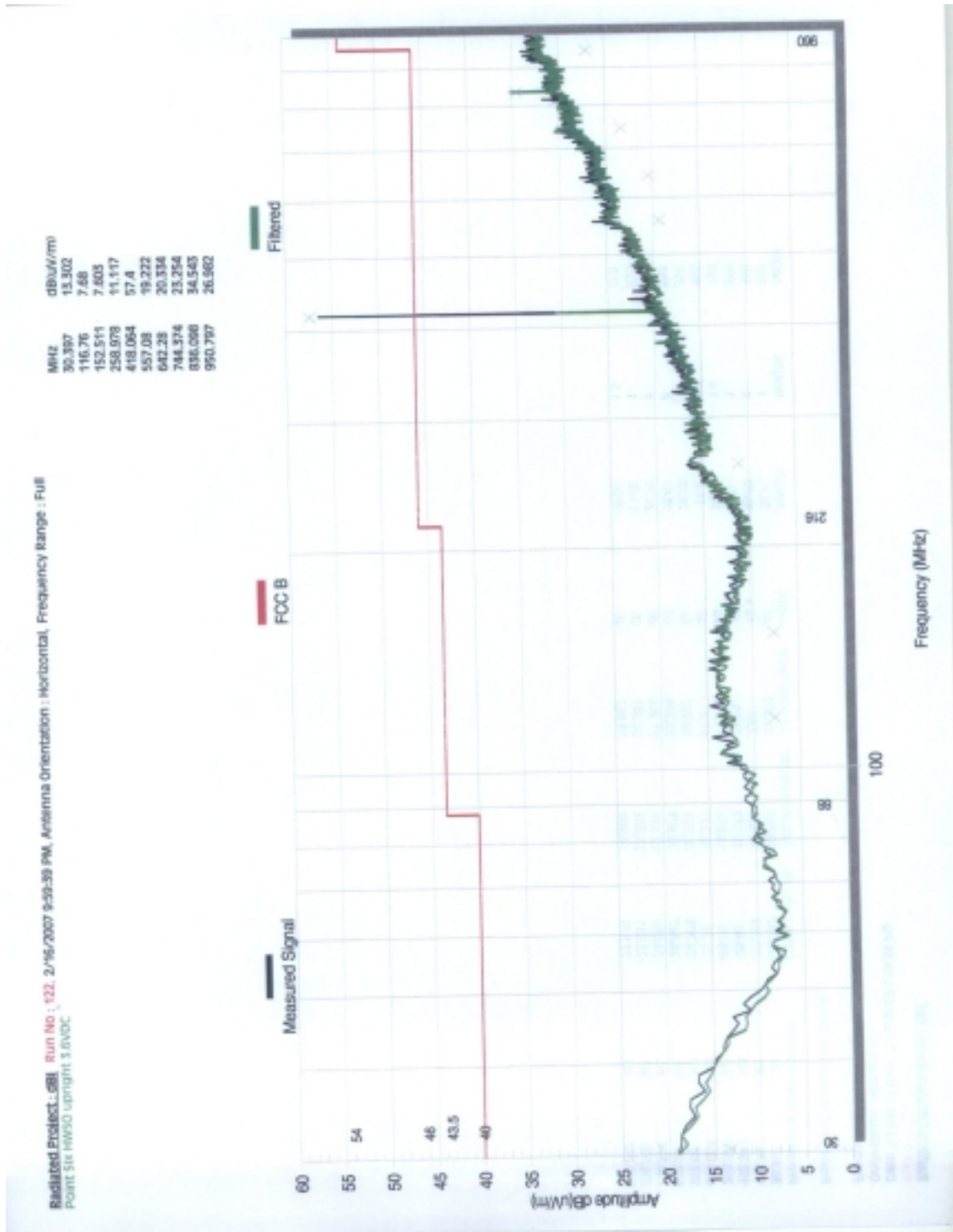
Sample Calculation: Receiver reading dB(uV) plus cable correction factor (dB) plus antenna factor dB(/m) plus duty-cycle correction factor equals Radiated Interference Field Strength dB(uV/m).

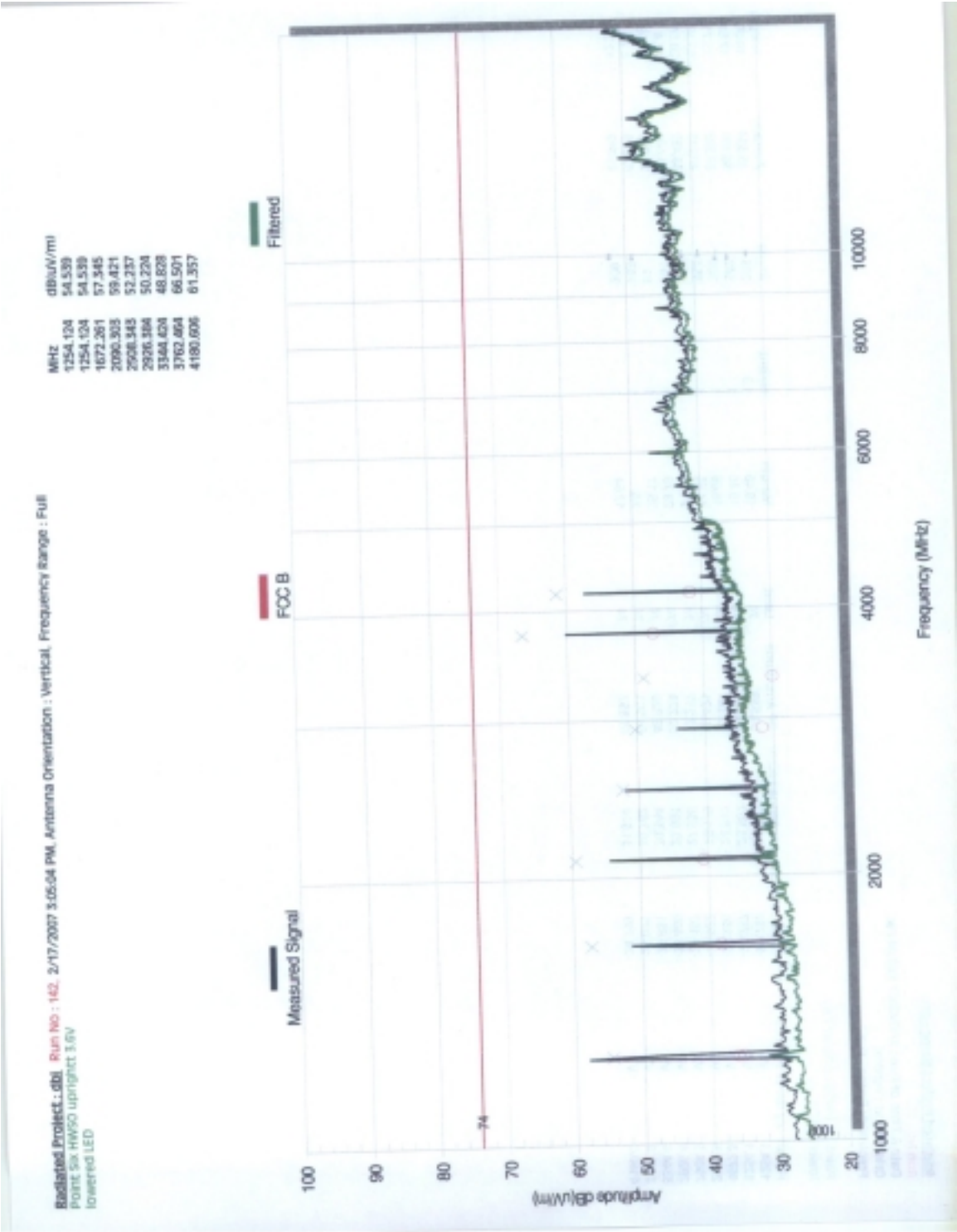


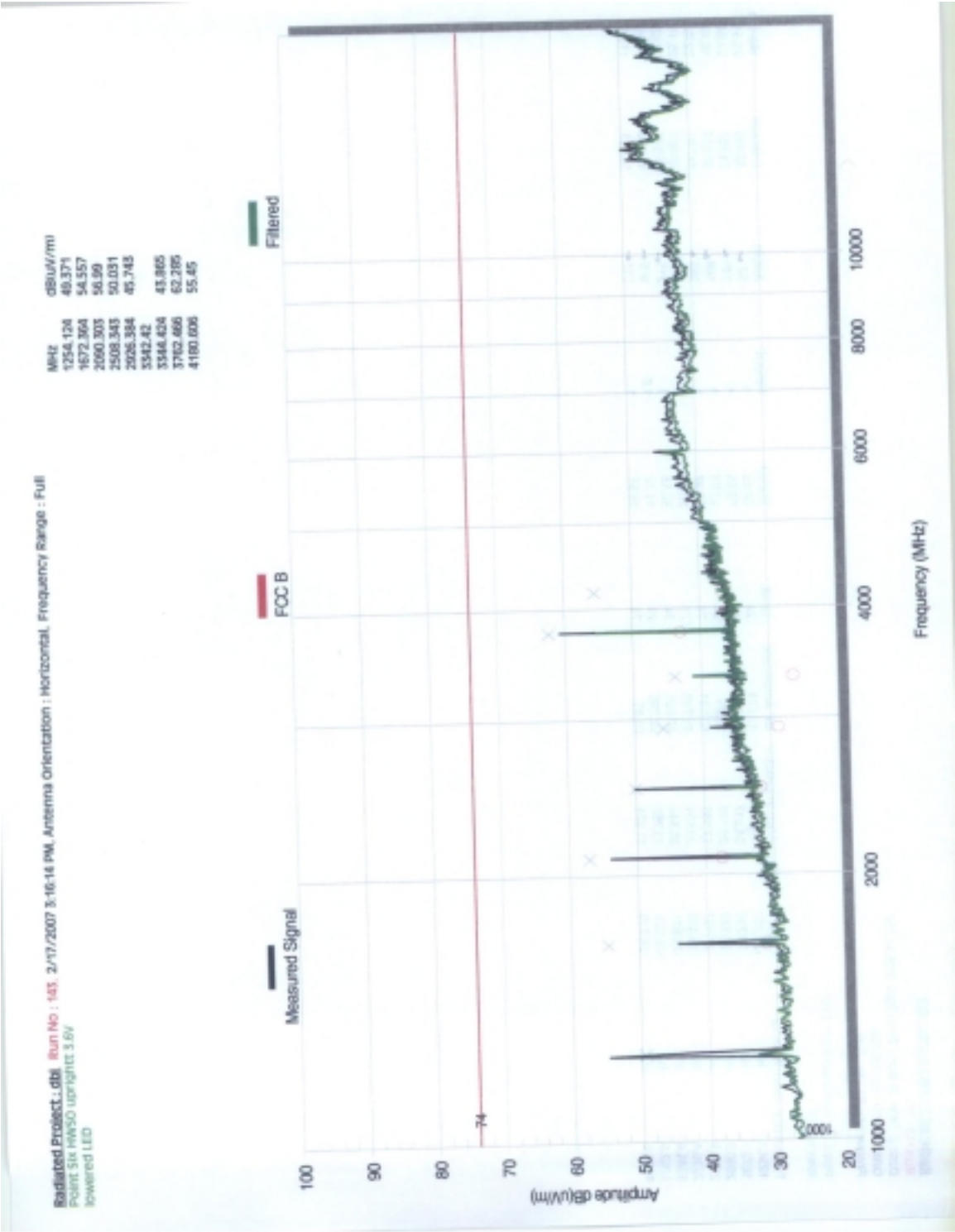
Signed _____ Date March 8, 2007

John R. Barnes, PRESIDENT dBi Corporation









Transmitted Bandwidth Data

Appliance/Product: analog/digital sensor

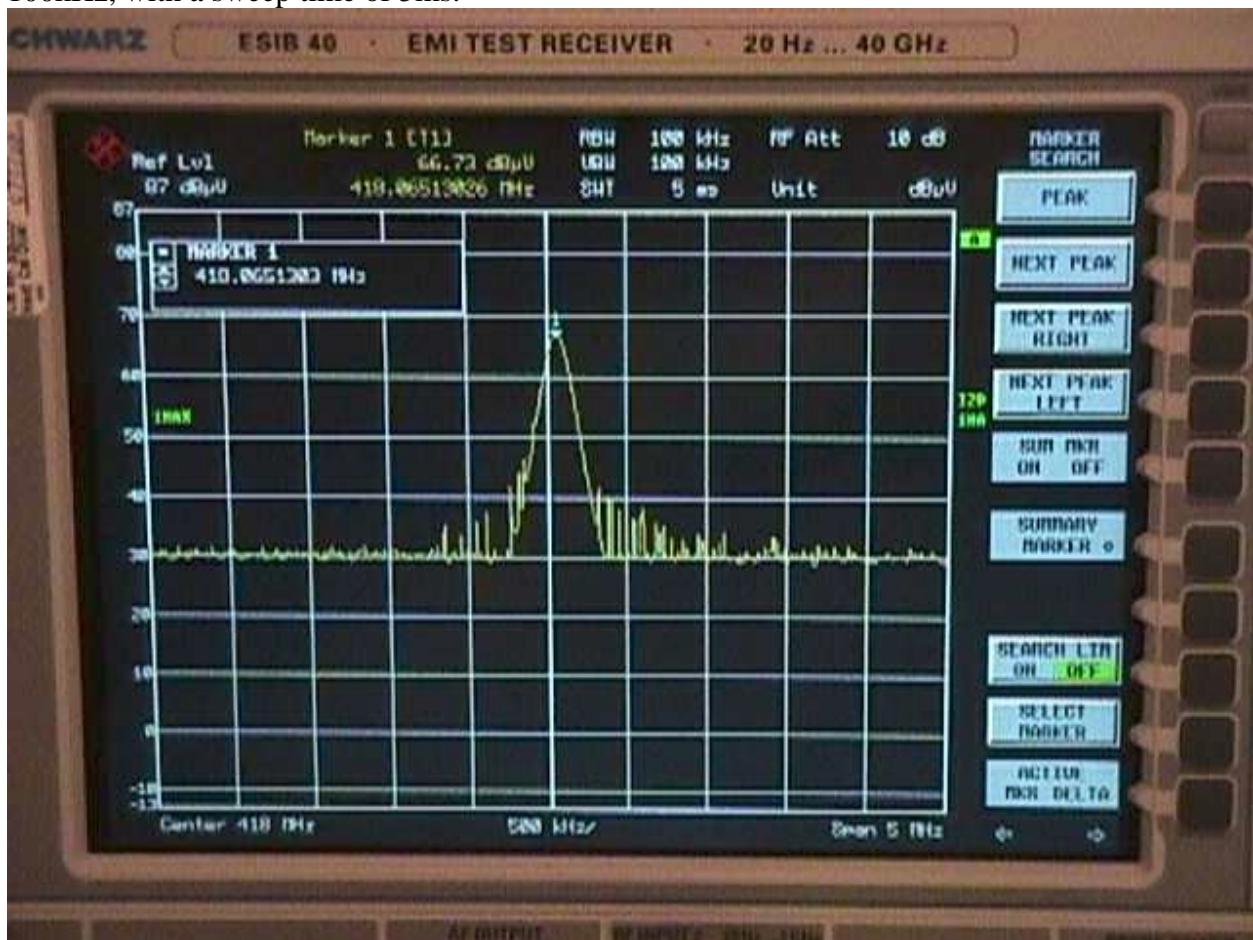
Model/Type Number: P6HWSO

FCC ID: M5ZP6HWSO

Rating: 3.6Vdc (Lithium batteries)

Serial Number: 70255004

Test Results: The 20dB transmitted bandwidth of the HWSO is 350.7kHz (417.8848MHz to 418.2355MHz), well within the 1045kHz (0.25% of 418MHz) maximum bandwidth permitted by FCC Part 15 Section 15.231(c). In the photo, each horizontal division is 500kHz, and each vertical division is 10dB. The RBW bandwidth was 100kHz, and the VBW bandwidth was 100kHz, with a sweep time of 5ms.



PROCEDURE: Test Performed Per ANSI 63.4 – 2003.

John R. Barnes

Signed _____ Date March 8, 2007

John R. Barnes, PRESIDENT dBi Corporation

Conducted Emissions 150 kHz-30 MHz (Internal Batteries)

Conducted Emission Standards:

FCC 47 CFR Part 15-2005, using ANSI C63.4-2003

Appliance/Product: analog/digital sensor

Model/Type Number: P6HWSO

FCC ID: M5ZP6HWSO

Rating: 3.6Vdc (Lithium batteries)

Serial Number: 70255004

Host and Other Peripherals: None

Name of Test: Powerline Conducted Interference

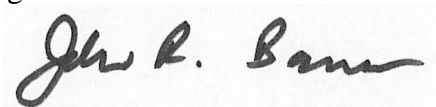
Test Procedure: ANSI C63.4-2003

Test Location: All welded 18 ft x 18 ft shielded enclosure, Lexmark test facility, located in
Lexington, Kentucky

Test Instrumentation: See attached sheets

Note: none

Test Results: This unit gets power from internal batteries and has no connection to AC power lines.
Therefore it meets the Class B conducted interference requirements of FCC Part 15 without testing.



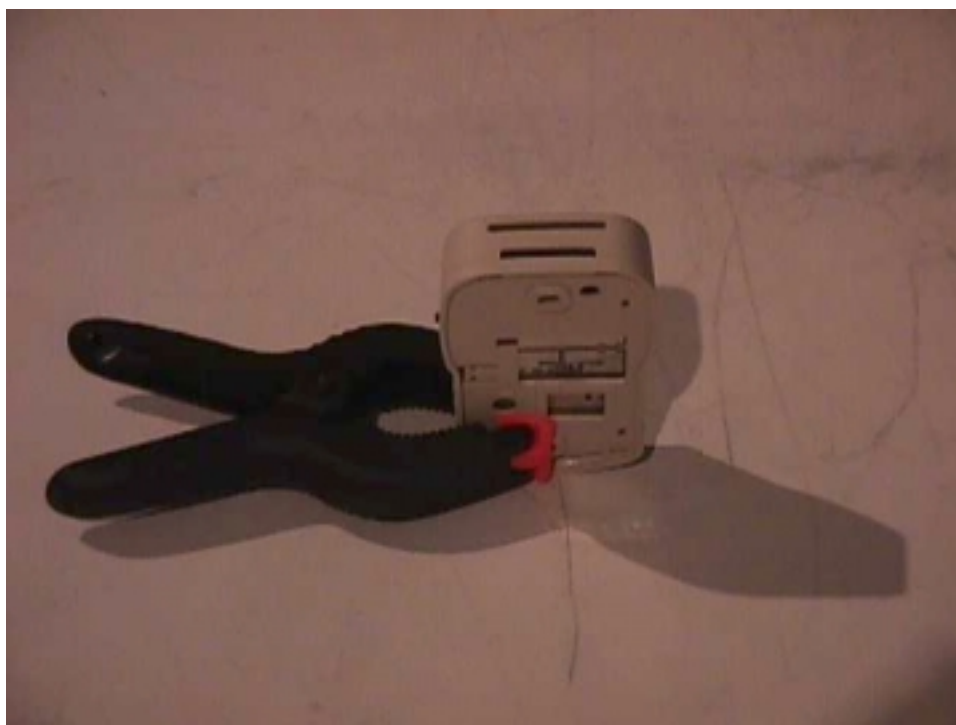
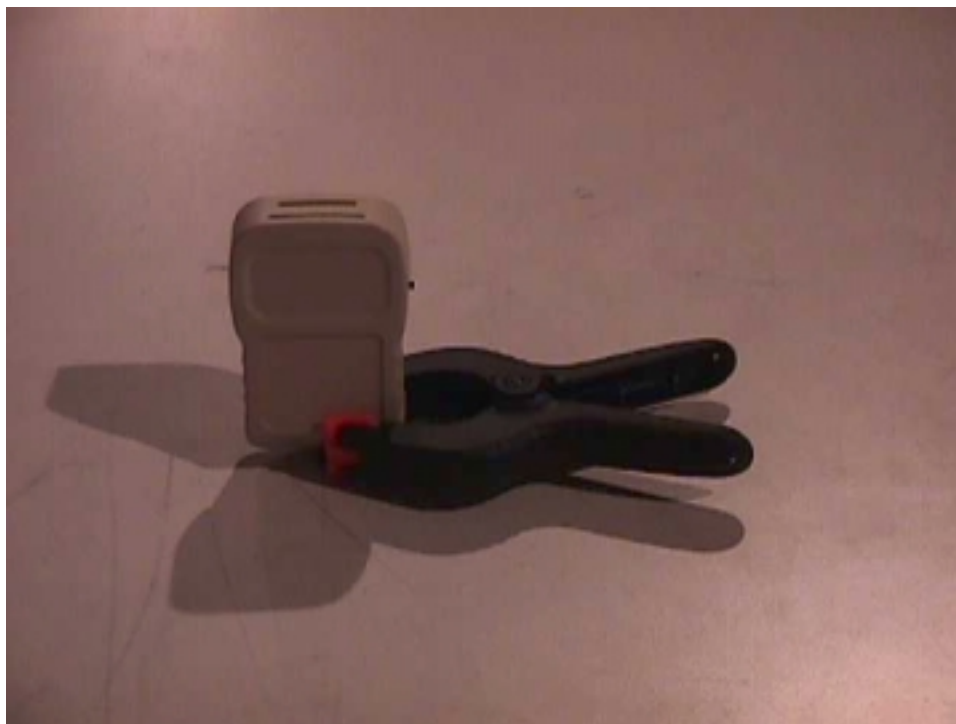
SIGNED _____ **DATE** March 8, 2007
John R. Barnes, PRESIDENT dBi Corp.

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| TESTING AND MEASURING EQUIPMENT USED AT LEXMARK |
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Radiated Interference and Bandwidth Measurements 30-4,180MHz:

| | |
|-------------------------------------|---|
| Rohde & Schwarz | ESIB40, S/N 100148 |
| EMI Test Receiver #0700 | (Cal date: 5/5/05, Cal due date: 5/5/07) |
| Schaffner-Chase | CBL6111C, S/N 2460 |
| BI-Log Antenna 30 to 1000 MHz #0507 | (Cal date: 10/2/06, Cal due date: 10/2/08) |
| ARA | DRG-118/A, S/N 1091 |
| Horn Antenna, 1GHz to 18GHz #0389 | (Cal date: 12/1997, Cal due date: not needed) |

Calibration: The measuring equipment used at Lexmark is calibrated according to the instruction manual once a day. Once a week the accuracy of the test system is checked. This includes the test equipment, associated cables, and antennas. This is accomplished with a calibrated radiating source for the radiated measurements, and a synthesized signal generator for the conducted measurements.



**FCC RADIATED-EMISSIONS & BANDWIDTH TEST CONFIGURATION
HWSO
5m SEMIANECHOIC CHAMBER
LEXMARK INTERNATIONAL, LEXINGTON KY.**