



TEST REPORT

Report Number: 3125815LEX002
Project Number: 3125815

Evaluation of the iBOT
Model Number: 2032610

FCC ID: VDM2032610
Industry Canada ID: 7175A-2032610

FCC Part 15 Subpart B & FCC Part 15 Subpart C
ICES-003 & RSS-210 Issue 6

For

Opex Incorporated

Test Performed by:

Intertek
731 Enterprise Drive
Lexington, KY 40510

Test Authorized by:

Opex Incorporated
305 Commerce Drive
Moorestown, NJ 08057

Prepared By: Jason Centers Date: 11/14/2007

Jason Centers, Senior Project Engineer

Approved By: Bryan C. Taylor Date: 11/14/2007

Bryan C. Taylor, Team Leader

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Intertek

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1 JOB DESCRIPTION

1.1 Company Information

Company Information	
Manufacturer:	Opex Incorporated
Address:	305 Commerce Drive Moorestown, NJ 08057
Contact Name:	Michael Powell
Telephone Number:	(856) 727-1100
Email Address:	mpowell@opex.com

1.2 Test Sample Information

The Opex iBOT is a small radio controlled robotic vehicle which runs in a track system as part of a larger automated sorting machine.

Test sample	
Model Number:	2032610
Serial Number:	Not Labeled
FCC ID:	VDM2032610
Device Category:	Mobile
RF Exposure Category:	General Population/Uncontrolled Environment
Transmission:	Zigbee, 0-QPSK Modulation
Frequency Range (MHz)	2405-2480
Antenna Type:	PCB Antenna
Antenna Location:	Internal

1.3 System Support Equipment

The support equipment used during the evaluation is listed in the table below.

Support Equipment Used in Setup

Description	Manufacturer	Model Number	Serial Number
Laptop	Compaq	Evo N410c	7E32KX21C02H

Exhibit 1

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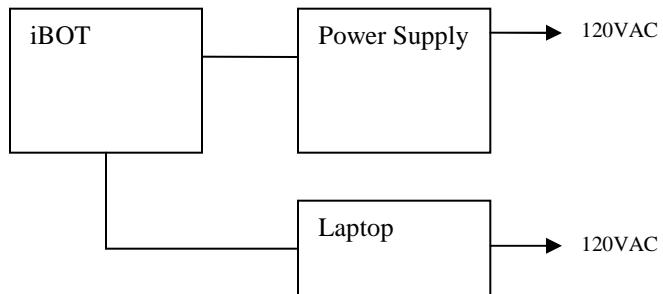
1.4 Cables Used During Testing

Description	Length	Shielding	Ferrites	Cables	
				Connection	
				From	To
CAT5 Cable	6 ft.	No	No	EUT	Controller Board
Twisted 14 AWG Wire	6 ft.	No	No	EUT	Power Supply
Power Cord	6 ft.	No	No	120VAC	Laptop & Power Supply

1.5 System Block Diagram(s)

The diagrams below detail the interconnection of the EUT and its accessories during the testing.

Figure 1-1: Test Configuration



1.6 Mode(s) of operation / Engineering Judgments

The iBOT was connected to a power supply which was powered by 120VAC. Opex Incorporated provided test commands to enable constant transmission at the maximum duty cycle that will be used in normal operation. Tests were performed on the high, middle, and low channels at maximum output power and in receive mode.

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2 EXECUTIVE SUMMARY

Testing performed for: Opex Incorporated

Equipment Under Test: 2032610

Receipt of Test Sample: 7/24/2007

Test Start Date: 7/24/2007

Test End Date: 8/4/2007

FCC RULE	IC RULE	DESCRIPTION OF TEST	RESULT	PAGE
§15.249, 15.209	RSS-210:2.6, RSS-210:A2.9	Field Strength of Spurious Radiation	Compliant	7
§15.109	ICES-003, RSS-Gen 6a	Radiated Receiver Emissions	Compliant	14
§15.207	ICES-003, RSS-Gen 7.2.2	Conducted Voltage Emissions	Compliant	17

2.1 Modifications required for compliance

No modifications were implemented by Intertek. All results in this report pertain to the un-modified sample provided to Intertek.

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3 TEST FACILITY

All testing was completed at the INTERTEK-Lexington location at 731 Enterprise Drive, Lexington Kentucky, 40510. The radiated emission test site is a 10-meter semi-anechoic chamber. The chamber meets the characteristics of CISPR 16-1: 1993 and ANSI C63.4: 1992. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters.

For radiated immunity testing, removable ferrite tiles are positioned between the transmitting antenna and the area occupied by the equipment under test. The remaining tests typically are performed outside the chamber on the conducting ground reference plane.



The Industry Canada filing number for this site is 2055. The FCC registration number is 485103. The VCCI registration numbers are R-2056, C-2214, and T-195.

3.1 Test Equipment

Description	Manufacturer	Model Number	Serial Number	Calibration due date
Horn Antenna	EMCO	3115	6556	8/2/2008
EMI Receiver	Rohde & Schwarz	ESI 26	1088.7490	9/6/2007
Bilog Antenna	EMCO	3142C	00051864	11/14/2007
Preamplifier	Miteq	AFS44-00102000-30-10P-44	987410	6/19/2008
LISN	Fischer Custom Communication	FCC-LISN-50-50-2M	1026	5/11/2008

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4 FIELD STRENGTH OF SPURIOUS RADIATION

FCC §15.209, §15.249

RSS-210:2.6, RSS-210:A2.9

4.1 Test Procedure

- Measurements are made over the frequency range of 30 MHz to ten times the highest frequency operating within the device.
- The measuring receiver meets the requirements of Section One of CISPR 16 and the measuring antenna correlates to a balanced dipole.
- From 30 to 1000 MHz, a quasi-peak detector was used for measurement. Above 1000 MHz, average measurements were performed.
- The antenna is adjusted between 1m and 4m in height above the ground plane for maximum meter reading at each test frequency.
- The antenna-to-EUT azimuth is varied during the measurement to find the maximum field-strength readings.
- The antenna-to-EUT polarization (horizontal and vertical) is varied during the measurements to find the maximum field-strength readings.
- The EUT was placed on a wooden table 80 cm above the ground reference plane. Measurements were made with the device oriented in three orthogonal axes and the highest level measured is reported.
- Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4.
- The test was performed on the low, middle, and highest transmitting frequencies at maximum output power.
- For fundamental emissions near the restricted bands of §15.205, measurements were performed to show compliance with the limits in the restricted band. If the fundamental emission is within two standard bandwidths of the restricted band, the “marker delta-method” was performed. The EUT azimuth and antenna height were varied to obtain a maximum field-strength reading. The analyzer reading was corrected for cable loss, antenna factor, and pre-amp gain. Using bandwidths and detectors required by ANSI C63.4 an in-band measurement of the fundamental emission was performed. After obtaining a corrected reading for the fundamental emission, the spectrum analyzer was setup with a span large enough to capture the fundamental emission and the band-edge under investigation. A resolution bandwidth of 1% of the span (not less than 30kHz) was used. Several sweeps were performed in peak-hold mode. The amplitude delta between the peak of the fundamental emission and the peak emission at the restricted band edge was recorded. The amplitude delta is subtracted from the maximized field strength reading to determine compliance at the band-edge.
- If the fundamental emission is more than two standard bandwidths from the restricted band, a spectrum analyzer was setup to sweep through the restricted band. The analyzer reading was corrected for cable loss, antenna factor, and pre-amp gain. The EUT azimuth and antenna height were varied to obtain a maximum field-strength reading. Several sweeps were performed in max-hold mode and the result was compared to the limits of §15.209.
- The readings obtained from the measurement receiver were corrected for antenna factor, cable loss, and pre-amp gain. An example calculation is shown below.

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Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculation are listed below.

Formula:

$$FS = RA + AF + CF$$

FS = Field Strength in dB μ V/m

RA = Receiver Amplitude (Quasi-Peak) in dB μ V

AF = Antenna Factor in dB

CF = Cable Attenuation Factor in dB

Example Calculation:

$$RA = 19.48 \text{ dB}\mu\text{V}$$

$$AF = 18.52 \text{ dB}$$

$$CF = 0.78 \text{ dB}$$

$$FS = 19.48 + 18.52 + 0.78 = 38.78 \text{ dB}\mu\text{V/m}$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(38.78 \text{ dB}\mu\text{V/m})/20] = 86.89 \mu\text{V/m}$$

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4.2 Test Results

The iBOT met the field strength requirements of FCC §15.249 for the fundamental, harmonics and spurious emissions. See Table 4-1 and for the measured fundamental and spurious emissions. All other spurious emissions not shown below were greater than 20dB below the limit.

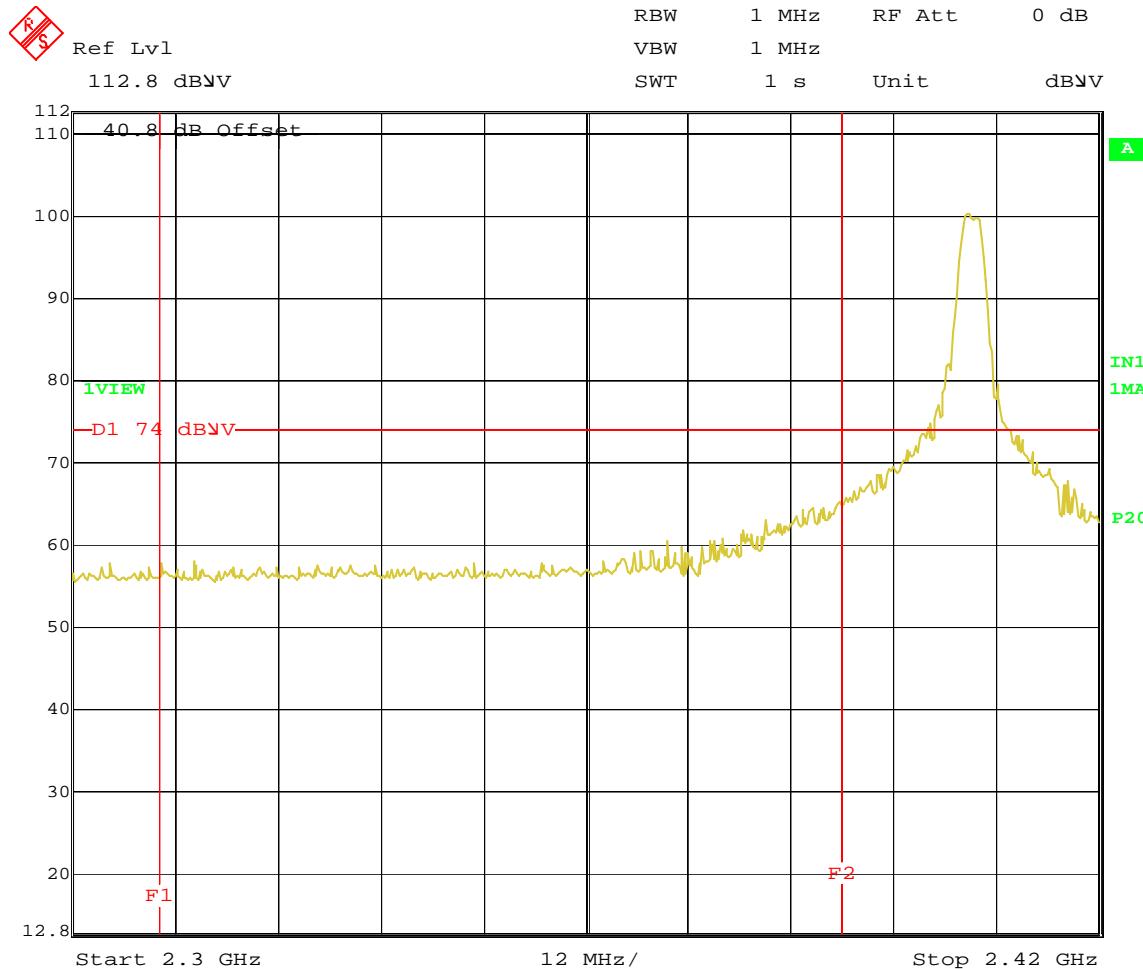
Table 4-1: Field Strength of Spurious Radiation

TX Channel	Frequency	Polarity	Corr. Peak Reading. (dBuV/m)	Peak Limit (dBuV/m)	Corr. QP Reading. (dBuV/m)	QP, Limit (dBuV/m)	Corr. Avg Reading. (dBuV/m)	Avg. Limit (dBuV/m)	Results	Comments
Low	2.4046 GHz	V	92.345	114	-	-	85.69	94	Compliant	Fundamental
Low	2.4046 GHz	H	99.718	114	-	-	88.61	94	Compliant	Fundamental
Low	240.0 MHz	V	40.606	-	39.67	46	-	-	Compliant	
Low	359.99 MHz	V	37.455	-	35.61	46	-	-	Compliant	
Low	4.8112 GHz	H	45.816	74	-	-	29.34	54	Compliant	
Low	7.2165 GHz	H	49.473	74	-	-	30.14	54	Compliant	
Low	4.8092 GHz	V	47.684	74	-	-	34.9	54	Compliant	
Low	7.2169 GHz	V	54.078	74	-	-	41.22	54	Compliant	
Middle	2.4396 GHz	H	98.59	114	-	-	80.96	94	Compliant	Fundamental
Middle	2.4395 GHz	V	96.382	114	-	-	78.46	94	Compliant	Fundamental
Middle	239.97 MHz	H	47.106	-	36.65	46	-	-	Compliant	
Middle	61.701 MHz	V	32.8	-	31.2	40	-	-	Compliant	
Middle	359.94 MHz	V	33.962	-	34.05	46	-	-	Compliant	
Middle	4.8791 GHz	H	44.749	74	-	-	36.42	54	Compliant	
Middle	7.3214 GHz	H	48.437	74	-	-	35.81	54	Compliant	
Middle	4.8812 GHz	V	50.53	74	-	-	39.18	54	Compliant	
Middle	7.3217 GHz	V	52.806	74	-	-	32.79	54	Compliant	
High	2.4795 GHz	H	98.739	114	-	-	81.34	94	Compliant	Fundamental
High	2.4796 GHz	V	93.123	114	-	-	73.39	94	Compliant	Fundamental
High	240.0 MHz	H	34.616	-	33.87	46	-	-	Compliant	
High	240.0 MHz	V	23.356	-	22.97	46	-	-	Compliant	
High	360.03 MHz	V	34.875	-	34.9	46	-	-	Compliant	
High	495.26 MHz	V	32.159	-	31.5	46	-	-	Compliant	
High	4.9611 GHz	H	49.204	74	-	-	32.3	54	Compliant	
High	7.4387 GHz	H	48.125	74	-	-	27.59	54	Compliant	
High	4.9592 GHz	V	49.277	74	-	-	35.25	54	Compliant	
High	7.4388 GHz	V	52.395	74	-	-	32.48	54	Compliant	

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Band-Edge Compliance: 2310MHz – 2390MHz Restricted Band, Low Channel - Peak Detector



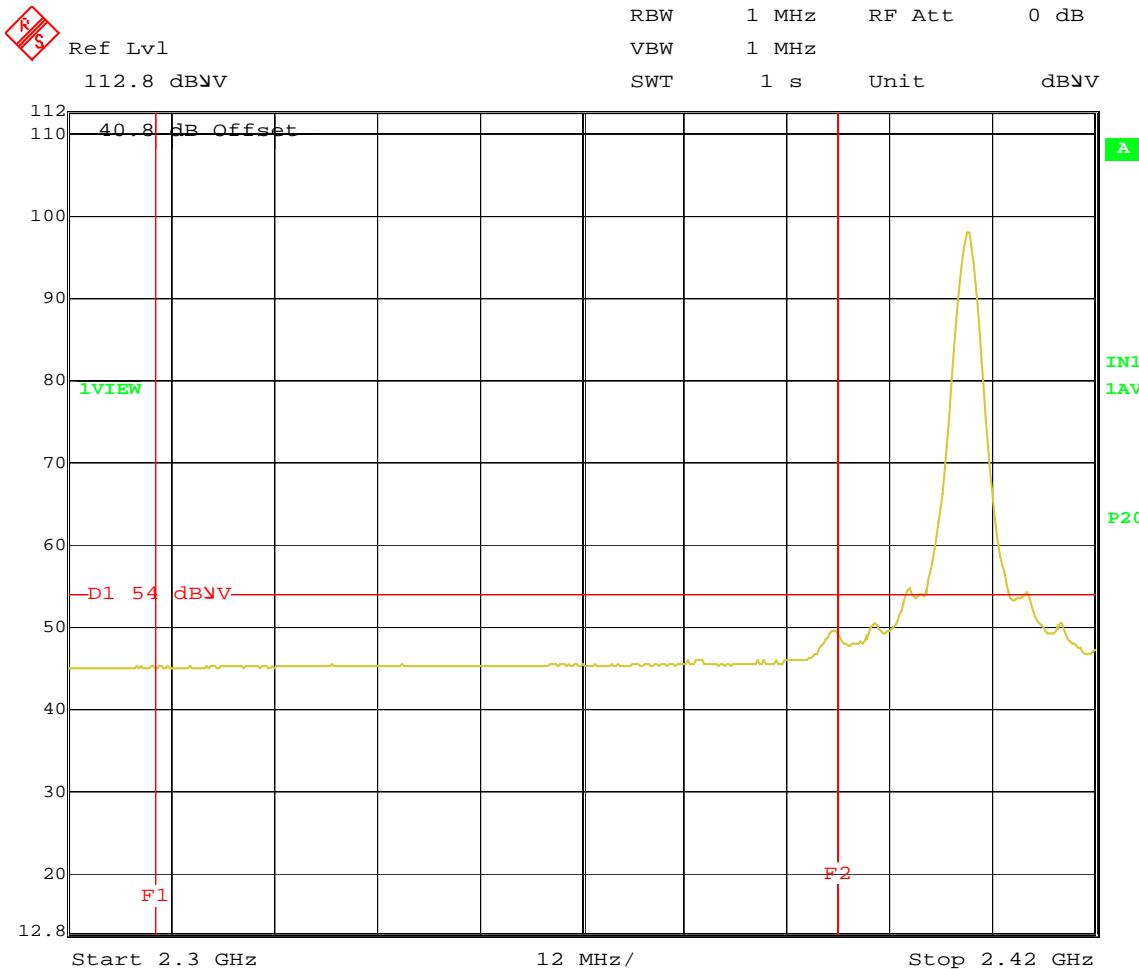
Date: 24.JUL.2007 12:31:17

Exhibit 2

Evaluation For:Opex Incorporated
Model No: 2032610

FCC ID: VDM2032610
IC ID: 7175A-2032610

Band-Edge Compliance: 2310MHz – 2390MHz Restricted Band, Low Channel – Average Detector



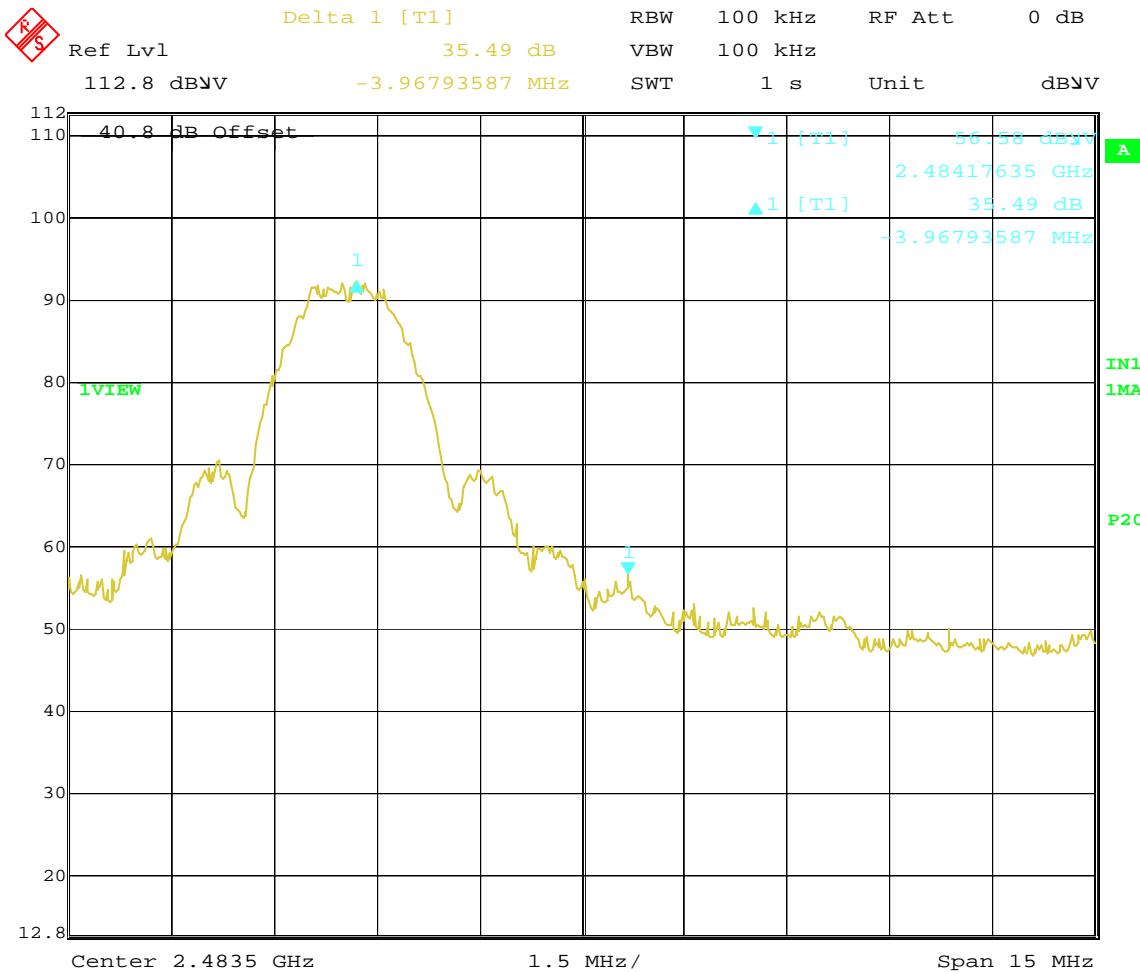
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Exhibit 3

Evaluation For:Opex Incorporated
Model No: 2032610

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IC ID: 7175A-2032610

Band-Edge Compliance (Marker-Delta Method): 2483.5MHz – 2500MHz Restricted Band, High Channel Peak Detector



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Exhibit 4

Peak Field Strength: 98.4 dBuV/m

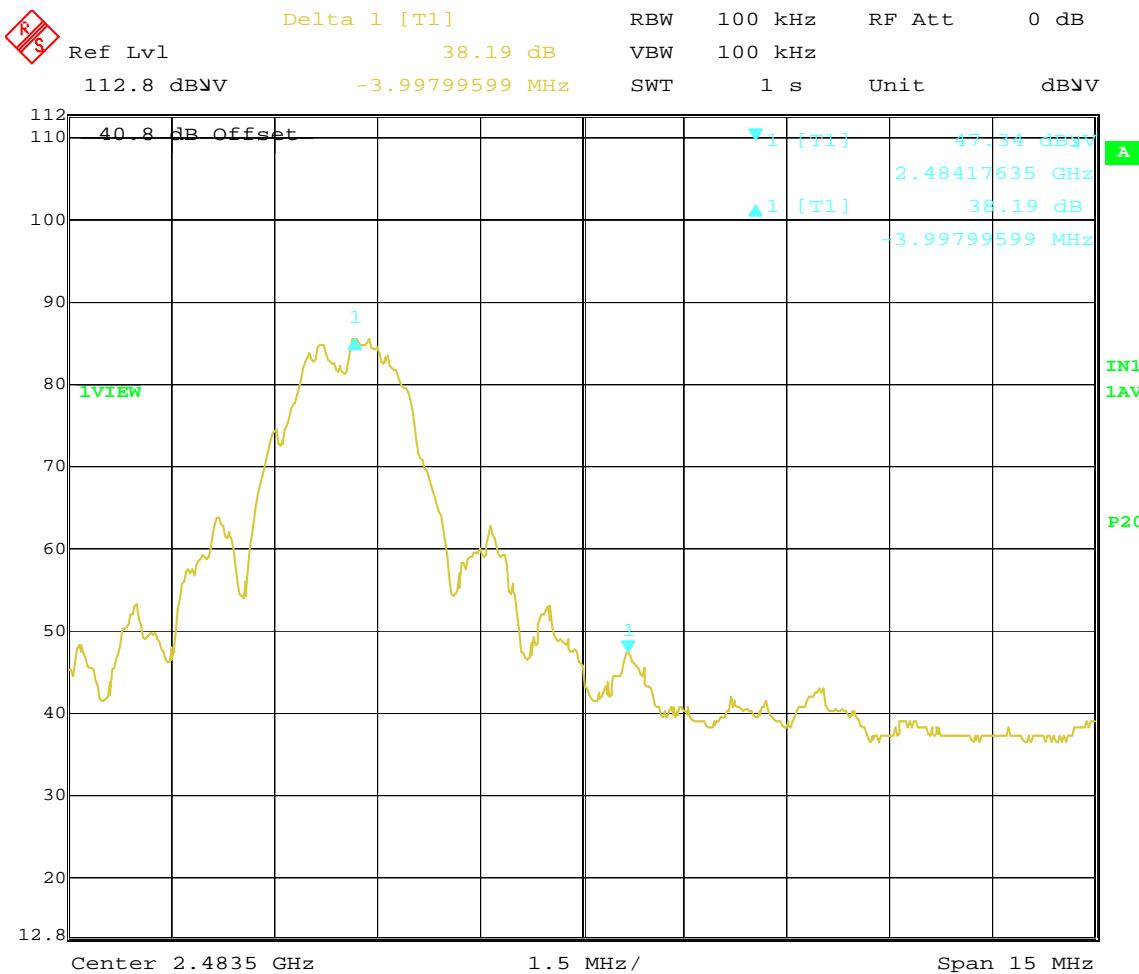
Marker Delta Peak: 35.49 dB

Band-Edge Measurement = 98.74 dBuV/m – 35.49 dB = 63.25 dBuV/m

Evaluation For:Opex Incorporated
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FCC ID: VDM2032610
IC ID: 7175A-2032610

Band-Edge Compliance (Marker-Delta Method): 2483.5MHz – 2500MHz Restricted Band, High Channel Average Detector



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Exhibit 5

Average Field Strength: 81.34 dBuV/m

Marker Delta Average: 38.19 dB

Band-Edge Measurement = 84.34 dBuV/m – 38.19 dB = 43.15 dBuV/m

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5 RADIATED RECEIVER EMISSIONS

FCC §15.109

ICES-003, RSS-Gen 6a

5.1 Test Procedure

- Measurements are made over the frequency range of 30 MHz to five times the highest frequency operating within the device.
- The measuring receiver meets the requirements of Section One of CISPR 16 and the measuring antenna correlates to a balanced dipole.
- From 30 to 1000 MHz, a quasi-peak detector was used for measurement. Above 1000 MHz, average measurements were performed.
- The antenna is adjusted between 1m and 4m in height above the ground plane for maximum meter reading at each test frequency.
- The antenna-to-EUT azimuth is varied during the measurement to find the maximum field-strength readings.
- The antenna-to-EUT polarization (horizontal and vertical) is varied during the measurements to find the maximum field-strength readings.
- The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.
- The test was performed on the device while in receive mode.
- Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4.
- The readings obtained from the measurement receiver were corrected for antenna factor, cable loss, and pre-amp gain. An example calculation is shown below.

Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculation are listed below.

Formula:

$$FS = RA + AF + CF$$

FS = Field Strength in dB μ V/m

RA = Receiver Amplitude (Quasi-Peak) in dB μ V

AF = Antenna Factor in dB

CF = Cable Attenuation Factor in dB

Example Calculation:

$$RA = 19.48 \text{ dB}\mu\text{V}$$

$$AF = 18.52 \text{ dB}$$

$$CF = 0.78 \text{ dB}$$

$$FS = 19.48 + 18.52 + 0.78 = 38.78 \text{ dB}\mu\text{V/m}$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(38.78 \text{ dB}\mu\text{V/m})/20] = 86.89 \mu\text{V/m}$$

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5.2 Test Results

The iBOT was **compliant** with the radiated emissions requirements of FCC §15.109 of Class B limits. The maximized radiated emissions data can be found in Exhibit 6. Graphical results are shown in Exhibit 7.

Maximized Quasi Peak and Average Emissions (Sorted by Delta)

Test Engineer: Jason Centers							
Test Start Date: 8/4/2007 Test End Date: 8/4/2007							
Emission Limit Tested To: Class B Test Distance (EUT to Antenna): 3m							
Frequency (MHz)	Polarity (H/V)	Cab. (dB)	Ant. (dB)	Corr. Reading. (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Results
91.7 MHz	V	1.3	8.91	40.5	43.52	-3.02	Compliant
122.9 MHz	V	1.51	7.62	29.63	43.52	-13.89	Compliant
239.98 MHz	V	2.13	12.3	22.33	46.02	-23.69	Compliant
360.0 MHz	V	2.66	15.6	34.55	46.02	-11.47	Compliant
495.26 MHz	V	3.15	17.69	33.81	46.02	-12.21	Compliant
240.0 MHz	H	2.13	12.1	33.91	46.02	-12.11	Compliant
360.0 MHz	H	2.66	15.7	35.59	46.02	-10.43	Compliant
801.8 MHz	H	4.1	22.04	35.28	46.02	-10.74	Compliant

Exhibit 6

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Graphical Peak Scan

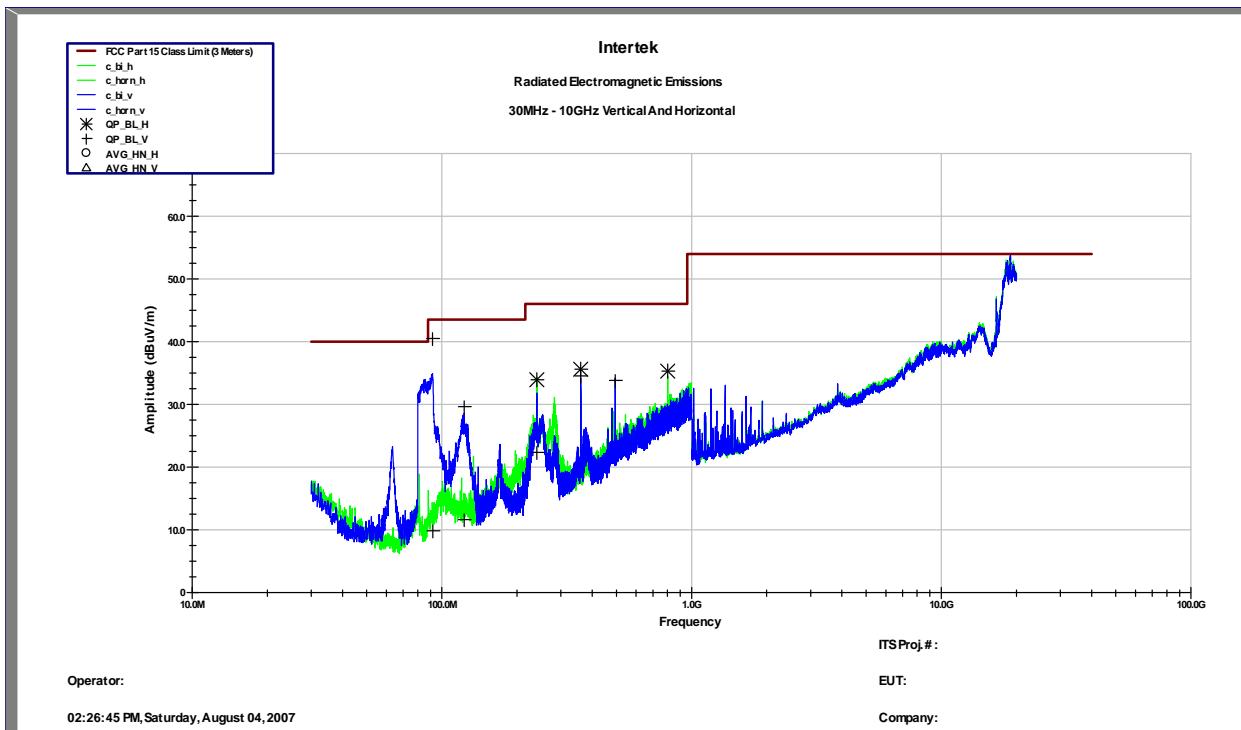


Exhibit 7

Evaluation For:Opex Incorporated
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6 CONDUCTED VOLTAGE EMISSIONS

§15.207

ICES-003

RSS-Gen 7.2.2

6.1 Test Method:

Conducted voltage emission measurements were performed as follows:

- The iBOT was connected to the power source using a Line Impedance Stabilization Network (LISN) in line with each current carrying conductor.
- A spectrum analyzer was connected to the RF port of the LISN installed on the line under test.
- The LISNs installed on all lines not under test were terminated into 50Ω .
- The iBOT was powered.
- The orientation of each connecting cable was varied to find the configuration that maximized the conducted emission.
- The insertion loss of the measurement cable, the LISN insertion loss, and the output of the spectrum analyzer were added together to give a corrected reading in dBuV.
- The corrected reading was compared to the limit above to determine compliance.
- A quasi-peak and/or average detector was used for measurements close to or exceeding the limit with a peak detector.
- The test was performed on the low, middle and highest transmitting frequencies at maximum output power.

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6.2 Test Results:

The iBOT was **compliant** with conducted voltage emissions requirements of Part 15.207. No conducted voltage emissions on the AC power interface exceeded the quasi-peak or average limits. See Exhibit 8 through Exhibit 11 for tabular and graphical results of conducted voltage emissions.

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Conducted Voltage Emissions Tabular Data (L1 & L2) – Low Channel

Test Engineer: Jason Centers

Test Start Date: 7/25/2007 **Test End Date:** 7/25/2007

Emission Limit Tested To: 15.207

General Notes / Comments / Performance Monitoring Method:

Device powered by 120VAC, 60Hz

Line	Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Delta (dB)	Average (dBuV)	Average Limit (dBuV)	Average Delta (dB)	Results
Phase	166.4 KHz	48.75	65.14	-16.39	44.38	55.14	-10.76	Compliant
Phase	5.424 MHz	43.52	60	-16.48	42.92	50	-7.08	Compliant
Phase	6.6559 MHz	44.57	60	-15.43	43.83	50	-6.17	Compliant
Phase	14.053 MHz	38.92	60	-21.08	36.72	50	-13.28	Compliant
Phase	16.523 MHz	43.55	60	-16.45	39.76	50	-10.24	Compliant
Neutral	166.4 KHz	48.57	65.14	-16.57	41.96	55.14	-13.18	Compliant
Neutral	5.424 MHz	43.45	60	-16.55	42.93	50	-7.07	Compliant
Neutral	6.6559 MHz	44.51	60	-15.49	43.83	50	-6.17	Compliant
Neutral	14.053 MHz	38.92	60	-21.08	36.5	50	-13.5	Compliant
Neutral	16.517 MHz	44.06	60	-15.94	41.48	50	-8.52	Compliant

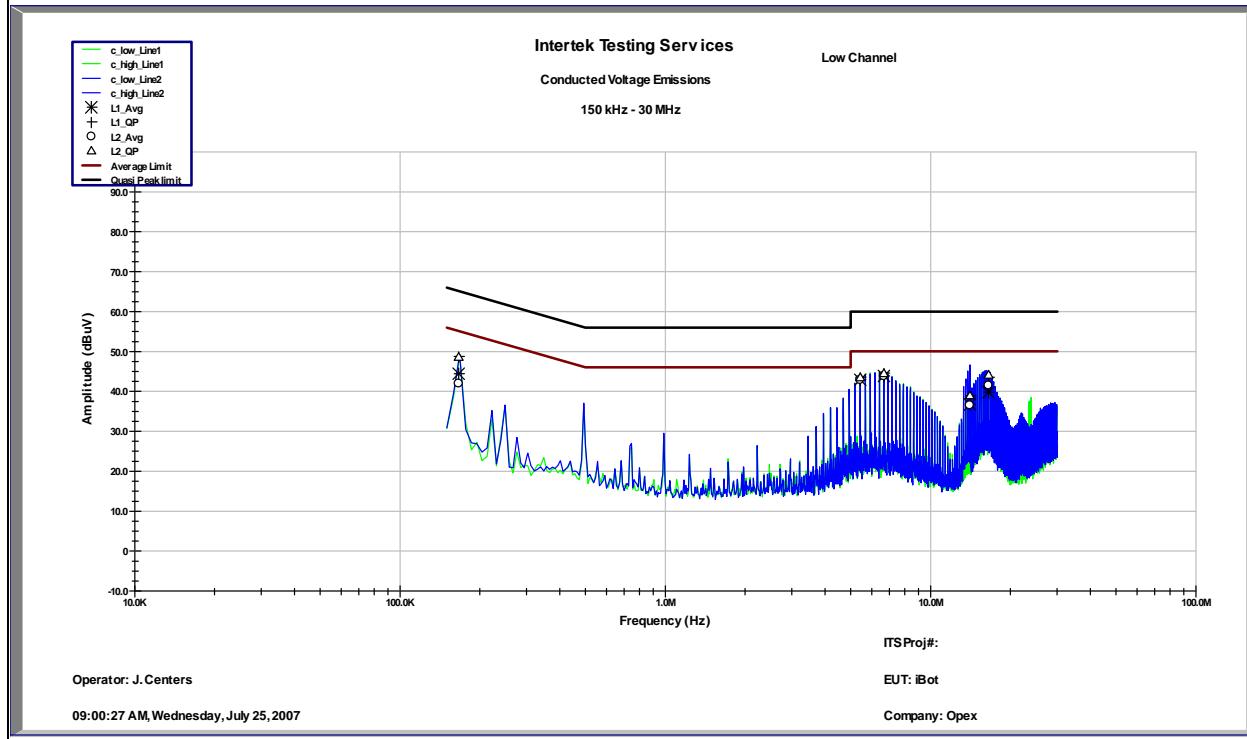


Exhibit 8

Evaluation For:Opex Incorporated
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Conducted Voltage Emissions Tabular Data (L1 & L2) – Mid Channel

Test Engineer: Jason Centers

Test Start Date: 7/25/2007 **Test End Date:** 7/25/2007

Emission Limit Tested To: 15.207

General Notes / Comments / Performance Monitoring Method:

Device powered by 120VAC, 60Hz

Line	Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Delta (dB)	Average (dBuV)	Average Limit (dBuV)	Average Delta (dB)	Results
Phase	166.3 KHz	48.75	65.14	-16.4	44.32	55.14	-10.83	Compliant
Phase	5.424 MHz	43.52	60	-16.48	42.99	50	-7.01	Compliant
Phase	6.657 MHz	44.6	60	-15.4	43.94	50	-6.06	Compliant
Phase	6.657 MHz	44.6	60	-15.4	43.94	50	-6.06	Compliant
Phase	8.1365 MHz	40.84	60	-19.16	39.92	50	-10.08	Compliant
Phase	16.271 MHz	44.51	60	-15.49	44.51	50	-5.49	Compliant
Neutral	164.2 KHz	47.96	65.25	-17.29	41.28	55.25	-13.97	Compliant
Neutral	5.424 MHz	43.45	60	-16.55	42.87	50	-7.13	Compliant
Neutral	6.657 MHz	44.51	60	-15.49	43.76	50	-6.24	Compliant
Neutral	16.271 MHz	44.26	60	-15.74	41.64	50	-8.36	Compliant

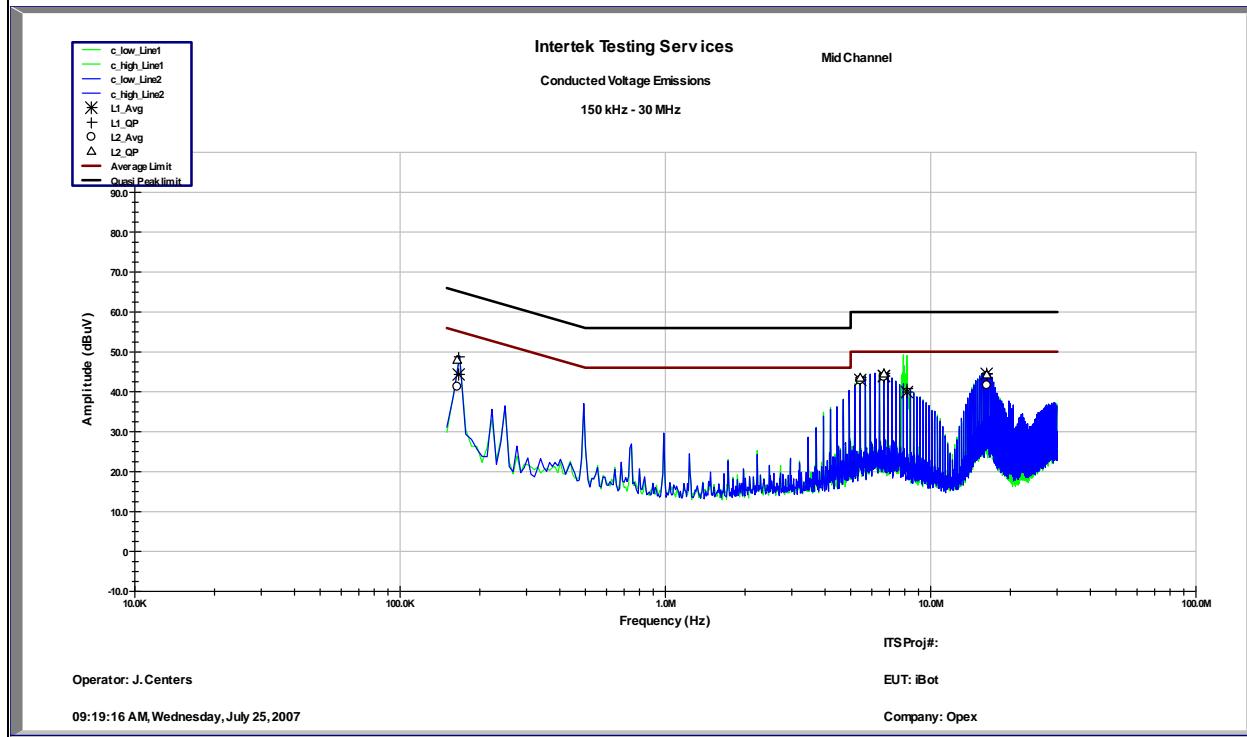


Exhibit 9

Evaluation For:Opex Incorporated
Model No: 2032610

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Conducted Voltage Emissions Tabular Data (L1 & L2) – High Channel

Test Engineer: Jason Centers

Test Start Date: 7/25/2007 **Test End Date:** 7/25/2007

Emission Limit Tested To: 15.207

General Notes / Comments / Performance Monitoring Method:

Device powered by 120VAC, 60Hz

Line	Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Delta (dB)	Average (dBuV)	Average Limit (dBuV)	Average Delta (dB)	Results
Phase	166.3 KHz	48.75	65.14	-16.4	44.38	55.14	-10.77	Compliant
Phase	6.1638 MHz	44.2	60	-15.8	43.56	50	-6.44	Compliant
Phase	6.657 MHz	44.6	60	-15.4	43.87	50	-6.13	Compliant
Phase	15.779 MHz	48.7	60	-11.3	41.06	50	-8.94	Compliant
Phase	16.521 MHz	43.99	60	-16.01	41.43	50	-8.57	Compliant
Phase	26.632 MHz	34.01	60	-25.99	29.88	50	-20.12	Compliant
Neutral	165.7 KHz	48.69	65.17	-16.48	42.13	55.17	-13.04	Compliant
Neutral	6.1638 MHz	44.16	60	-15.84	43.57	50	-6.43	Compliant
Neutral	6.657 MHz	44.51	60	-15.49	43.93	50	-6.07	Compliant
Neutral	15.779 MHz	43.94	60	-16.06	45.19	50	-4.81	Compliant
Neutral	16.521 MHz	44.09	60	-15.91	41.46	50	-8.54	Compliant

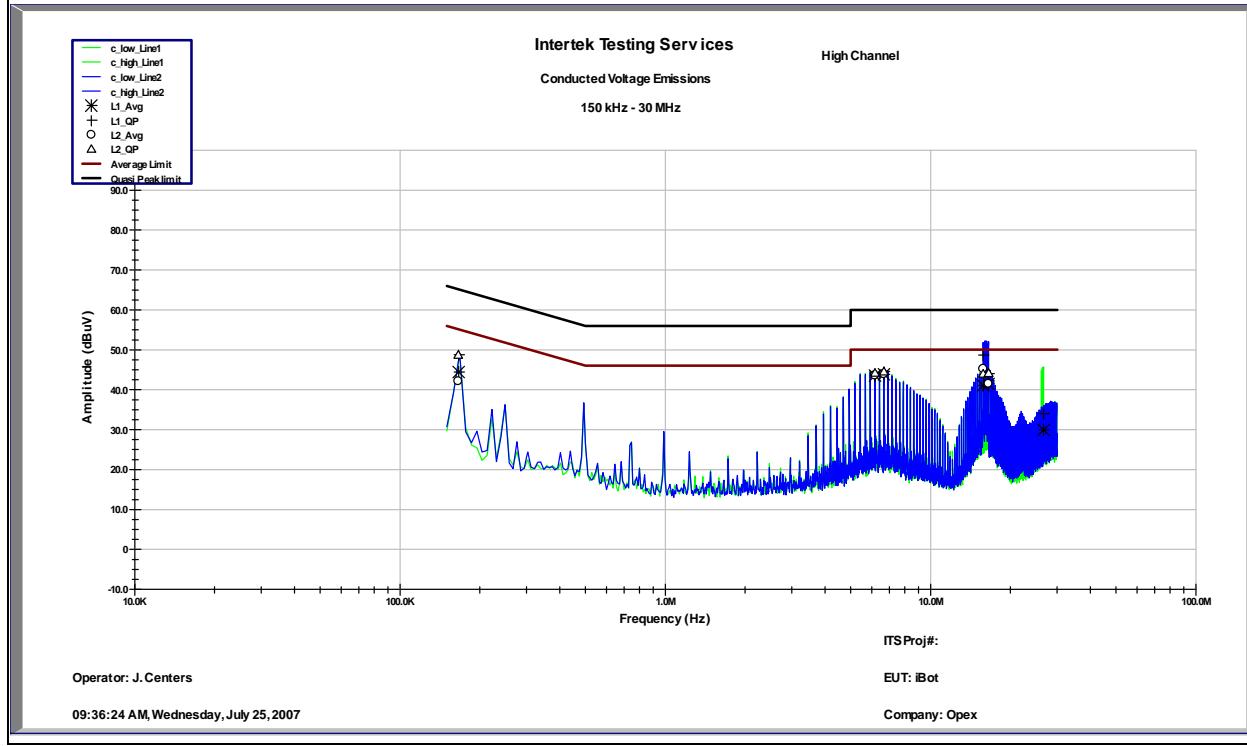


Exhibit 10

Evaluation For:Opex Incorporated
Model No: 2032610

FCC ID: VDM2032610
IC ID: 7175A-2032610

Conducted Voltage Emissions Tabular Data (L1 & L2) – Receive Mode Channel

Test Engineer: Jason Centers

Test Start Date: 7/25/2007 **Test End Date:** 7/25/2007

Emission Limit Tested To: 15.207

General Notes / Comments / Performance Monitoring Method:

Device powered by 120VAC, 60Hz

Line	Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Delta (dB)	Average (dBuV)	Average Limit (dBuV)	Average Delta (dB)	Results
Phase	166.7 KHz	48.6	65.12	-16.52	44.2	55.12	-10.92	Compliant
Phase	14.545 MHz	44.68	60	-15.32	42.49	50	-7.51	Compliant
Phase	16.764 MHz	43.31	60	-16.69	40.71	50	-9.29	Compliant
Neutral	164.3 KHz	48.09	65.24	-17.15	41.45	55.24	-13.79	Compliant
Neutral	14.053 MHz	44.3	60	-15.7	41.51	50	-8.49	Compliant
Neutral	14.789 MHz	44.75	60	-15.25	42.38	50	-7.62	Compliant
Neutral	21.447 MHz	36.24	60	-23.76	32.55	50	-17.45	Compliant

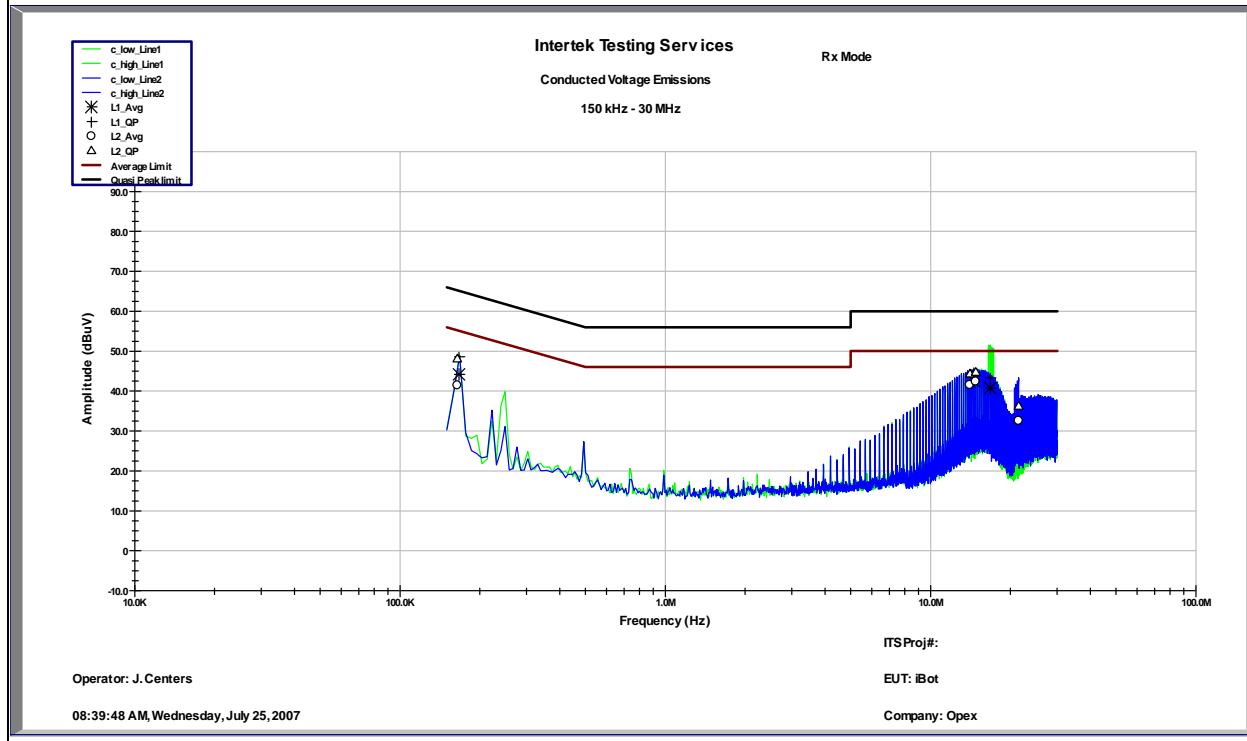


Exhibit 11