DESCRIPTION

The SP4439 device is a low noise, high voltage output DC-AC inverter designed to drive electroluminescent lamps that backlight liquid crystal display and keypads used in cellular phones, cordless phones, 2-way radios, and other wireless communication products. The output waveform of the SP4439 device is ideal for cell phone applications requiring low acoustic noise performance. One external resistor is used to set the internal oscillator frequency and one inductor is required to generate the high voltage AC output to drive an EL lamp up to 6 square inches in size. The device gives the customer flexibility to define waveform rise and fall times, to optimize noise performance, and to optimize efficiency for customer specific applications. The SP4439 typically operates from a +3.0V battery source and has a low power standby mode that draws less than 125nA, making it ideal for low-power cellular applications. All input pins are ESD protected with internal diodes to \( V_{DD} \) and \( V_{SS} \). The SP4439 is offered in a space-saving 10-pin MSOP package.

APPLICATIONS

- Cellular Radios
- Wireless Communication Products
ABSOLUTE MAXIMUM RATINGS
These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

Supply Voltage \((V_{DD} \text{ to } V_{SS})\) .......................-0.3V, +5V
Operating Temperature .......................-40˚C to +85˚C
Storage Temperature .........................-65˚C to +150˚C

Power Dissipation Per Package
10-pin MSOP
(derate 4.85mW/°C above +70°C) .....................720mW

STORAGE CONSIDERATIONS
Storage in a low humidity environment is preferred. Large high density plastic packages are moisture sensitive and should be stored in Dry Vapor Barrier Bags. Prior to usage, the parts should remain bagged and stored below 40°C at 60%RH. If the parts are removed from the bag, they should be used within 48 hours or stored in an environment at or below 20%RH. If the above conditions cannot be followed, the parts should be baked for four hours at 125°C in order remove moisture prior to soldering. Sipex ships product in Dry Vapor Barrier Bags with a humidity indicator card and desiccant pack. The humidity indicator should be below 30%RH.

CAUTION: ESD (Electrostatic Discharge) sensitive devices. Permanent damage may occur on unconnected devices subject to high energy electrostatic fields. Unused devices must be stored in conductive foam or sheets. Personnel should be properly grounded prior to handling this device. The protective foam should be discharged to the destination socket before devices are removed.

SPECIFICATIONS
\(V_{DD} = +3.0V, \ L_{COIL} = 820\mu H/14\Omega, \ R_{OSC} = 714k\Omega, \ EL \ Lamp \ Load = (8nF + 2.5k\Omega)/1M\Omega, \) and \(T_{AMB} = -40^\circ C \text{ to } +85^\circ C. \ T_{AMB} = 25^\circ C\) for typical values unless otherwise noted.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNITS</th>
<th>CONDITIONS</th>
</tr>
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<tbody>
<tr>
<td>INPUT CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage, (V_{DD})</td>
<td>2.7</td>
<td>3.0</td>
<td>5.0</td>
<td>V</td>
<td>(V_{DD} = +3.0V)</td>
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<tr>
<td>Supply Current, (I_{COIL} + I_{DD})</td>
<td></td>
<td>30</td>
<td>mA</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Coil Voltage, (V_{COIL})</td>
<td>(V_{DD})</td>
<td>9</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELEN Input Voltage, (V_{ELEN})</td>
<td></td>
<td></td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>LOW: (EL_{OFF})</td>
<td>(-0.25)</td>
<td>0</td>
<td>(0.25V)</td>
<td>(V_{DD})</td>
<td></td>
</tr>
<tr>
<td>HIGH: (EL_{on})</td>
<td>(V_{DD} \times 0.25)</td>
<td>(V_{DD} \times 0.25)</td>
<td>(V)</td>
<td>(V_{ELEN} = \text{LOW}, V_{DD} = +3.0V)</td>
<td></td>
</tr>
<tr>
<td>ELEN Input Impedance</td>
<td>1</td>
<td>3</td>
<td>MΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shutdown Current, (I_{SD} + I_{COIL} + I_{DD})</td>
<td>0.150</td>
<td>1</td>
<td>(\mu A)</td>
<td>(V_{ELEN} = \text{LOW}, V_{DD} = +3.0V)</td>
<td></td>
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<tr>
<td>INDUCTOR DRIVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil Frequency, (f_{COIL})</td>
<td>26</td>
<td>32</td>
<td>43</td>
<td>kHz</td>
<td>(R_{OSC} = 714k\Omega, T_{AMB} = +25^\circ C)</td>
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<tr>
<td></td>
<td>23</td>
<td></td>
<td>45</td>
<td></td>
<td>(T_{AMB} = -40^\circ C \text{ to } +85^\circ C)</td>
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<tr>
<td>Coil Duty Cycle</td>
<td>90</td>
<td></td>
<td>%</td>
<td></td>
<td></td>
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<tr>
<td>Peak Coil Current, (I_{PK,COIL})</td>
<td></td>
<td>100</td>
<td>mA</td>
<td></td>
<td></td>
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<tr>
<td>EL LAMP OUTPUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL Lamp Frequency, (f_{LAMP})</td>
<td>190</td>
<td>250</td>
<td>336</td>
<td>Hz</td>
<td>(T_{AMB} = +25^\circ C, V_{DD} = +3.0V, \text{with load})</td>
</tr>
<tr>
<td></td>
<td>175</td>
<td></td>
<td>348</td>
<td></td>
<td>(T_{AMB} = -40^\circ C \text{ to } +85^\circ C)</td>
</tr>
<tr>
<td>Peak to Peak Output Voltage, (V_{P-P})</td>
<td>130</td>
<td>145</td>
<td>140</td>
<td></td>
<td>(T_{AMB} = +25^\circ C, V_{DD} = +3.0V, \text{with load})</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td></td>
<td>140</td>
<td></td>
<td>(T_{AMB} = -40^\circ C \text{ to } +85^\circ C)</td>
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<tr>
<td>Audible Noise</td>
<td>26</td>
<td></td>
<td>dB_{SPL}</td>
<td></td>
<td>(T_{AMB} = +25^\circ C, V_{DD} = +3.0V, \text{NOTE 1})</td>
</tr>
<tr>
<td>Rise Time</td>
<td>0.55</td>
<td>0.8</td>
<td>1.0</td>
<td>ms</td>
<td>(T_{AMB} = +25^\circ C, V_{DD} = +3.0V, \text{with load, measured from 10 to 90%})</td>
</tr>
</tbody>
</table>

NOTE 1: Audible Noise is measured inside an acoustic sound chamber. The Sound Level Meter is a B&K Mediator 2238, A-weighted with Condenser Mic type 4188 positioned 1/4 inch above the lamp in an 8 cubic inch volume. See Figure 5 on page 6.
PIN ASSIGNMENTS

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Pin Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R&lt;sub&gt;D&lt;/sub&gt;</td>
<td>Discharge Rate Set Resistor. Connect the discharge rate set resistor from this pin to ground.</td>
</tr>
<tr>
<td>2</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt;</td>
<td>Positive Battery Power Supply. Connect such that +2.2V &lt; V&lt;sub&gt;DD&lt;/sub&gt; &lt; +5.0V.</td>
</tr>
<tr>
<td>3</td>
<td>ELEN</td>
<td>Electroluminescent Lamp Enable. When driven HIGH, this input pin enables the EL driver outputs for EL1 and EL2. This pin has an internal pulldown resistor.</td>
</tr>
<tr>
<td>4</td>
<td>R&lt;sub&gt;OSC&lt;/sub&gt;</td>
<td>Oscillator Resistor. Connecting a resistor to this input pin sets the frequency of the internal clock.</td>
</tr>
<tr>
<td>5</td>
<td>V&lt;sub&gt;SS&lt;/sub&gt;</td>
<td>Power Supply Common. Connect to the lowest circuit potential, typically ground.</td>
</tr>
<tr>
<td>6</td>
<td>COIL</td>
<td>The inductor for the EL lamp is connected from V&lt;sub&gt;DD&lt;/sub&gt; to this input pin.</td>
</tr>
<tr>
<td>7</td>
<td>C&lt;sub&gt;INT&lt;/sub&gt;</td>
<td>Integrating Capacitor. An integrating capacitor (47nF typical) connected from this pin to ground filters out any coil switching spikes or ripple present in the output waveform to the EL lamp. Connecting a fast recovery diode from COIL to C&lt;sub&gt;INT&lt;/sub&gt; increases the light output of the EL lamp.</td>
</tr>
<tr>
<td>8</td>
<td>EL2</td>
<td>Electroluminescent Lamp Output 2. This is a high voltage lamp driver output pin to connect to the EL lamp.</td>
</tr>
<tr>
<td>9</td>
<td>R&lt;sub&gt;C&lt;/sub&gt;</td>
<td>Charge Rate Set Resistor. Connect the charge rate set resistor from this pin to pin 7, the integrating capacitor.</td>
</tr>
<tr>
<td>10</td>
<td>EL1</td>
<td>Electroluminescent Lamp Output 1. This is a high voltage lamp driver output pin to connect to the EL lamp.</td>
</tr>
</tbody>
</table>
**Figure 1:** Typical Operating Circuit for the SP4439

**Figure 2:** Internal Block Diagram of the SP4439

**Figure 3:** EL Differential Output Waveform of the EL1 and EL2 Outputs of the SP4439

**Figure 4:** Dual Supply Application Circuit for the SP4439

**Figure 5:** Electroluminescent Lamp Noise Measurement Setup for the SP4439
DESCRIPTION

The SP4439 electroluminescent lamp (EL) driver is a low-cost low voltage device ideal for the replacement of LED backlighting designs in cell phones, PDAs and other portable designs requiring low acoustic noise. The SP4439 contains a DC-AC inverter that can produce an AC output of 160Vp-p (typical) from +3.0V input voltage. An internal block diagram of the SP4439 can be found in Figure 2.

The SP4439 is built on Sipex's dielectrically isolated BiCMOS process that provides the isolation required to separate the high voltage AC signal used to drive the EL lamp from the low voltage logic and signal processing circuitry. This ensures latch-up free operation in the interface between the low voltage CMOS circuitry and the high voltage bipolar circuitry. The SP4439 is ideal for applications driving EL lamps to backlight LCD displays and keypads, used in cellular radios.

Electroluminescent Technology

An EL lamp is a strip of plastic that is coated with a phosphorous material which emits light (fluoresces) when a (>40V) AC signal is applied across it. Long periods of DC voltages applied to the lamp tends to breakdown the material and reduce its lifetime. With these considerations in mind, the ideal signal to drive an EL lamp is a high voltage sine wave. Traditional approaches to achieving this type of waveform included discrete circuits incorporating a transformer, transistors, and several resistors and capacitors. This approach is large and bulky, and cannot be implemented in most hand held equipment. Sipex offers low power single chip driver circuits specifically designed to drive small to medium sized electroluminescent panels.

Market Applications

Electroluminescent backlighting is ideal when used with LCD displays, keypads, or other backlit readouts. Its main use is to illuminate displays in dim to dark conditions for momentary periods of time. EL lamps consume less power than LEDs or incandescent bulbs making them ideal for battery powered products. Also, EL lamps are able to evenly light an area without creating any undesirable "hot spots" in the display.

THEORY OF OPERATION

The SP4439 is a DC-AC inverter made up of an oscillator/frequency divider, a coil/boost converter, a switched H-bridge network, and a precision bridge control logic.

The Oscillator/Frequency Divider

The oscillator provides the SP4439 with an on-chip clock used to control the coil switch (f_COIL) and the H-bridge network (f_LAMP). Although the oscillator frequency can be varied to optimize the lamp output, the ratio of f_COIL/f_LAMP will always equal 128.

Figure 2 shows the oscillator output driving the coil and through 7 flip flops, driving the lamp. The suggested oscillator frequency is 32kHz for f_COIL. The oscillator output is internally divided down by 7 flip flops to create a second internal control signal at 250Hz for f_LAMP.

The Coil/Boost Converter

The supply V_COIL can range from +2.7V to +9V. See figure 4 on page 6. V_COIL should be chosen such that I_COIL does not exceed the maximum coil current specification. The majority of the current goes through the coil and is typically much greater than I_DD.

The inductor is an external component connected from V_COIL to the COIL pin of the SP4439. Energy is stored in the coil according to the equation

$$E_L = \frac{1}{2} \times L \times I_p^2$$

where $I_p$, to the first approximation, is the product

$$I_p = (t_{ON}) \times ((V_{BATT} - V_{CE})/L)$$

where $t_{ON}$ is the time it takes for the coil to reach its peak current. $V_{CE}$ is the voltage drop across the internal NPN transistor and L is the inductance of the coil. When the NPN transistor switch is off, the energy is forced through an internal diode which drives the switched H-bridge network. This energy recovery is directly related to the brightness of the EL lamp output. There are many variations among coils; magnetic material differences, winding differences and parasitic capacitances.
The \( f_{\text{COIL}} \) signal controls a switch that connects the coil at the COIL pin to ground or to open circuit. The \( f_{\text{COIL}} \) signal is a 90% duty cycle signal switching at the oscillator frequency, 32kHz. During the time when the \( f_{\text{COIL}} \) signal is HIGH, the coil is connected from \( V_{\text{COIL}} \) to ground and a charged magnetic field is created in the coil. When the \( f_{\text{COIL}} \) signal is LOW, the ground connection is switched open, the field collapses, and the energy in the inductor is forced to flow toward the high voltage H-bridge switches.

The Switched H-Bridge Network
Current sources and precision controlled timing of the SP4439 switched H-bridge network are designed to reduce EMI emissions, extend EL lamp life, and reduce the overall power dissipation of the device.

Current sources were added to the high and low side of the H-bridge network to ensure control of the charge and discharge of the EL lamp. The precision MOSFET timing of the SP4439 allows for controlled charging and discharging of the EL lamp to minimize EMI and audible noise. Refer to Figure 7 for the single ended and differential output waveforms to the EL lamp.

The Precision Bridge Control Circuitry
This circuitry is driven by the internal oscillator to control the timing of the charge and discharge of the EL lamp to eliminate EMI and noise concerns. This control circuitry drives the H-bridge timing. Refer to Figure 2 for the internal block diagram of the SP4439.

Fine Tuning Performance
Circuit performance of the SP4439 can be improved with some of the following suggestions:

Increase EL Lamp Light Output: By connecting a fast recovery diode from COIL (pin 5) to \( C_{\text{INT}} \) (pin 6), the internal diode of the switched H-bridge network is bypassed resulting in an increase in light output at the EL lamp. We suggest a fast recovery diode, such as the industry standard 1N4148, be used for D1. This circuit connection can be found in Figures 1 and 2.

By adjusting the values of \( R_{\text{C}} \) and \( R_{\text{D}} \) the rate of change and discharge can be adjusted. Faster rise time typically means greater light output and greater noise. The more gradual the rise and fall edges are, the less noise is produced by the lamps. For example a sign wave would not generate any noise.

Changing the EL Lamp Output Voltage Waveform: Designers can alter the trapezoidal output voltage waveform to the EL Lamp. Changing the capacitance of the integrating capacitor, \( C_{\text{INT}} \), will ideally integrate the output waveform making it appear more sinusoidal. This will minimize any noise inherent to the application.

Programming the Ultra-Quiet SP4439 Output Voltage Wave-shape: The optimal low noise wave-form to drive an EL lamp is a sinusoid. The drawbacks of using a sine wave to drive an EL lamp are twofold. First, the luminance of an EL lamp is proportional to the root mean square value of the applied voltage. Second, a high voltage sine wave generator is difficult to design due to inefficiencies and space constraints.

The first problem can be overcome by using a square wave to drive the lamp. This is the most efficient waveform and has the highest RMS voltage but it creates the highest noise when applied to an EL lamp. Sipex has found the best trade off between noise and luminance is a trapezoid or clipped sinusoid waveform.

The SP4439 output wave-shape is programmable in terms of its rise and fall times. The output waveform seen across the lamp terminals is actually generated as a single ended waveform and is measured differentially. This is shown in figure 7.

The single ended waveform can be broken up into three regions: A charge region, a hold region and a discharge region. The differential rise-time actually encompasses both a charge and a discharge region.

The charge and discharge regions are controlled independently by two resistors: RC is the charge resistor and RD is the discharge resistor. The rise-time (\( t_r \)) is defined as 800\( \mu \)S for the differential waveform. Therefore the single ended charge time is one half that or 400\( \mu \)S. Use the following to find the full-scale charge time:

\[
 t_r = \frac{T_2 - T_1}{1.25} \quad \therefore (1.25) \text{ where } T_2 - T_1 \text{ is the full scale}
\]
This simply means that for a rise-time measurement of 400μs, the full-scale time is 500μS.

The ultimate goal here is to calculate the values for the charge and discharge resistors $R_C$ and $R_D$ respectively. These two resistors define a constant charge current $I_C$ and discharge current $I_D$. The combination of the lamp capacitance and the constant charge currents results in the rise and fall waveform. Let's start by calculating the constant currents.

The charge current is defined as:

$$I_C = \frac{V_{BIASC}}{R_C} \quad (1)$$

where $V_{BIASC}$ is defined internally to be 2.8V.

The discharge current is defined as:

$$I_C = \frac{V_{BIASD}}{R_D} \quad (2)$$

where $V_{BIASD}$ is defined internally to be 1.4V.

The charge and discharge currents should be equal to give smooth rise and fall times. Once the currents are known, the charge or discharge time is defined by:

$$\Delta T = C_{EL} \frac{\Delta V}{I_{C,D}} \quad (3)$$

where $C_{EL}$ is the lamp capacitance, and $\Delta V$ is the output voltage at the $C_{INT}$ node.

Substituting equations 1 or 2 into equation 3 gives the equation to calculate the charge resistor directly:

$$\Delta T = C_{EL} \frac{\Delta V}{I_{C}} \Delta T = C_{EL} \frac{\Delta V \times R_C}{V_{BIASC}} \quad R_C = \frac{V_{BIASC} \times \Delta T}{\Delta V \times C_{EL}} \quad (4)$$

The proper way to approach the SP4493 system design is to first measure the capacitance of the lamp intended for the application. The capacitance of an EL lamp is proportional to the area of the lamp. Lamps from different manufacturers will exhibit different capacitance/area values. Therefore it is important to measure a lamp from the lamp manufacturer that will be used in production. The following examples assume the nominal lamp frequency is set to 250Hz. This defines a rise-time of 800μS, a total time of 1ms, and a charge or discharge time of 500μS. $V_{BIASC} = 2.8V$, $V_{BIASD} = 1.4V$.

**Example 1 - Lamp Size = 2in² (12.9cm²):**

A typical 2in² (12.9cm²) lamp has a capacitance of 8nF. Given the typical output peak voltage of 80V, the charge resistor can be calculated using equation 4.

$$R_C = (2.8V \times 500\mu S) / (80V \times 8nF) = 2188\Omega \quad R_D = (1.4V \times 500\mu S) / (80V \times 8nF) = 1094\Omega$$

**Example 2 - Lamp Size = 4in² (25.8cm²):**

If we assume the lamp capacitance doubles to 16nF then:

$$R_C = (2.8V \times 500\mu S) / (80V \times 16nF) = 1094\Omega \quad R_D = (1.4V \times 500\mu S) / (80V \times 16nF) = 547\Omega$$

**Notes:**

If the factors such as peak voltage and lamp frequency are different, adjustment must be made to those values in the resistance equations. There are limitations to what the waveform will look like. For example if the resistors are set small, the times become fast and a step will appear at the zero crossing point of the waveform. The intent of the waveform programmability is to allow the use of a wide range of lamp sizes while maintaining a smooth waveform to minimize audible noise.

Keep in mind that coil values and the oscillator frequency may have to be changed to support a given luminance for a particular lamp size. It is best to define these parameters first and then go back and calculate the charge and discharge resistors.

**Audio Noise Considerations:**

A system can have different sources of audio noise. The coil the filter capacitor, and the EL lamp itself may be a source of audio noise if operated in the audio frequency range.

Designers should select either the coil or coil frequency such that the coil is not in continuous mode as this will greatly decrease efficiency and contribute to noise.

Close attention should be given to the mounting
of the filter capacitor where the mounting can act as an amplifier, such as in a speaker box. Film capacitors do not exhibit audio noise concerns but certain ceramic capacitors subjected to a high voltage source can exhibit a piezoelectric effect. This can be a source of concern in the audio range.

The EL lamp itself can also exhibit audible noise as a result of high voltage swings at frequencies within the audio range. Close attention should be given to the physical mounting of the EL lamp to diminish this concern that can generate both EMI and audio noise.

**Electromagnetic Interference (EMI) Considerations:** Electromagnetic Interference (EMI) concerns are rooted in uncontrolled high voltage swings on the EL lamp. The controlled charging and discharging of the EL lamp by the SP4439 minimizes EMI effects.

**Printed Circuit Board Layout Suggestions:** The SP4439's high voltage operation makes PC layout important for minimizing ground bounce and noise. Keep the IC's GND pin and the ground leads of C1 and C\text{INT} less than 0.2 in (5mm) apart. Also keep the connections to COIL as short as possible. To maximize output power and efficiency and minimize output ripple voltage, use a ground plane and solder the IC's V\text{SS} directly to the ground plane.

**EL Lamp Driver Design Challenges**

There are many variables which can be optimized for specific applications. The amount of light emitted is a function of the voltage applied to the lamp, the frequency at which it is applied, the lamp material and the lamp size.

A number of characterization curves to assist in the selection of lamp size and performance optimization have been included here (Figures 8 to 17). In addition, Sipex will perform customer application evaluations, using the customer's actual EL lamp to determine the optimum operating conditions for specific applications. For customers considering an EL backlighting solution for the first time, Sipex is able to offer retrofit solutions to the customer's existing LED or non-backlit product for a thorough electrical and cosmetic evaluation. Refer to Figure 6 for an enlargement and actual size evaluation board layout. Please contact your local Sales Representative for Sipex or the Sipex factory directly to initiate this valued service.

![Evaluation Board Layout for the SP4439](image-url)
Figure 7. Single Ended and Differential Output Waveforms for the SP4439. CH1 and CH2 are single ended waveform. CH4 is a differential waveform.

Figure 8. The SP4439 supply current remains at 20mA, independent of EL lamp area.

Figure 9. The $V_{pp}$ lamp voltage decreases with increasing EL lamp size for a fixed set of circuit conditions like those identified in Figures 1 and 2. Lower $V_{pp}$ means a less brightly lit lamp.

Figure 10. Luminance of the EL lamp as a function of its size. For a fixed set of circuit conditions, lamp brightness decreases as a function of lamp size.

Figure 11. Lamp frequency remains relatively constant over the bias supply voltage. Lamp light does not visibly decrease over the typical battery operating range.

Figure 12. Peak lamp voltage increases almost linearly with increasing supply bias voltage. Increasing the supply increases lamp brightness.
Figure 13. Overall supply current increases almost linearly with increasing bias supply voltage.

Figure 14. EL lamp brightness increases with increasing bias supply voltage.

Figure 15. Lamp frequency remains stable over the operating temperature range for a fixed set of circuit conditions.

Figure 16. Lamp peak voltage remains relatively constant over the typical operating temperature range.

Figure 17. Circuit supply current is very stable over the typical operating range.
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Fax: (516)-868-2371
<table>
<thead>
<tr>
<th>Model</th>
<th>Operating Temperature Range</th>
<th>Package Type</th>
</tr>
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<tbody>
<tr>
<td>SP4439EU</td>
<td>-40˚C to +85˚C</td>
<td>10-Pin MSOP</td>
</tr>
<tr>
<td>SP4439UEB</td>
<td></td>
<td>Evaluation Board</td>
</tr>
</tbody>
</table>

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