High Voltage EL Lamp Driver IC's For Low Noise Applications

Features

- Patented audible noise reduction
- Patented lamp aging compensation
- 190 V_{PP} output voltage for higher brightness
- Patented output timing for high efficiency
- Single cell lithium ion compatible
- 150nA shutdown current
- Wide input voltage range 1.8V to 5.0V
- Separately adjustable lamp and converter frequencies
- Output voltage regulation
- Split supply capability
- Available in MSOP-8 and MLP-8 packages

Application

- LCD backlighting
- Mobile Cellular Phone
- PDAs
- Handheld wireless communication products
- Global Positioning Systems (GPS)

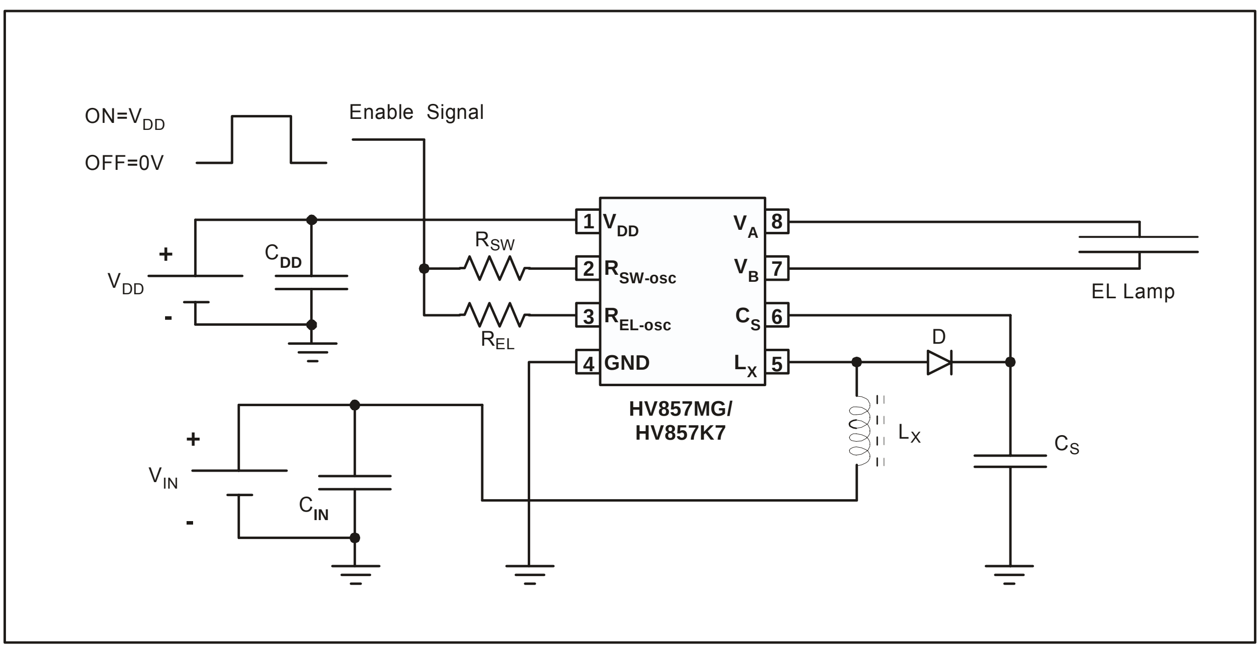
General Description

The Supertex HV857 is a high voltage driver designed for driving Electroluminescent (EL) lamps of up to 5 square inches. The input supply voltage range is from 1.8V to 5.0V. The device uses a single inductor and a minimum number of passive components. The nominal regulated output voltage that is applied to the EL lamp is ±95V. The chip can be enabled/disabled by connecting the resistor on $R_{SW\text{-}OSC}$ to V_{DD}/ground.

The HV857 has two internal oscillators, a switching MOSFET, and a high voltage EL lamp driver. The frequency for the switching MOSFET is set by an external resistor connected between the $R_{SW\text{-}OSC}$ pin and the supply pin V_{DD}. The EL lamp driver frequency is set by an external resistor connected between $R_{EL\text{-}OSC}$ pin and V_{DD} pin. An external inductor is connected between the L_X and V_{DD} pins or V_{IN} for split supply applications. A 0.003-0.1µF capacitor is connected between C_S and ground. The EL lamp is connected between V_A and V_B.

The switching MOSFET charges the external inductor and discharges it into the capacitor at C_S. The voltage at C_S will start to increase. Once the voltage at C_S reaches a nominal value of 95V, the switching MOSFET is turned OFF to conserve power. The outputs V_A and V_B are configured as an H bridge and are switching in opposite states to achieve ±95V across the EL lamp.

Typical Application



Electrical Characteristics

DC Characteristics *(Over recommended operating conditions unless otherwise specified T_A=25°C)*

Symbol	Parameter	Min	Typ	Max	Units	Conditions
$R_{DS(ON)}$	On-resistance of switching transistor			6.0	Ω	I=100mA
V_{CS}	Max. output regulation voltage	85	95	105	V	V_{DD}=1.8V to 5.0V
$V_A – V_B$	Peak to Peak output voltage	170	190	210	V	V_{DD}=1.8V to 5.0V
I_{DDQ}	Quiescent V_{DD} supply current			150	nA	$R_{SW\text{-}osc}$=Low
I_{DD}	Input current going into the V_{DD} pin			150	µA	V_{DD}=1.8V to 5.0V. See Figure 1.
I_{IN}	Input current including inductor current		20	25	mA	See Figure 1.*
V_{CS}	Output voltage on V_{CS}		84		V	See Figure 1.
f_{EL}	EL lamp frequency	205	240	275	Hz	See Figure 1.
f_{SW}	Switching transistor frequency		80		kHz	
D	Switching transistor duty cycle		88		%	See Figure 1.

* The inductor used is a 220µH Murata inductor, max DC resistance of 8.4Ω, part # LQH32CN221K21.

Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Units	Conditions
V_{DD}	Supply voltage	1.8		5.0	V	
f_{EL}	Output drive frequency			1	kHz	
T_A	Operating Temperature	-40		+85	°C	

Enable/Disable Function Table

Symbol	Parameter	Min	Typ	Max	Units	Conditions
EN-L	Logic input low voltage	0		0.2	V	V_{DD} = 1.8V to 5.0V
EN-H	Logic input high voltage	V_{DD} - 0.2		V_{DD}	V	V_{DD} = 1.8V to 5.0V

Absolute Maximum Ratings*

Supply Voltage, V_{DD}	-0.5V to 6.5V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
MSOP-8 Power Dissipation	300mW
MLP-8 Power Dissipation	1.6W
Output voltage, V_{CS}	-0.5 to +120V

*Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. Continuous operation of the device at the absolute rating level may affect device reliability. All voltages are referenced to device ground.

Ordering Information

Device	Package Options	
	MSOP-8[1]	MLP-8[2]
HV857	HV857MG	-
	HV857MG-G	HV857K7-G

1 Product supplied on 2500 piece carrier tape reels
2 Product supplied on 3000 piece carrier tape reels
-G indicates package is RoHS compliant ('Green')

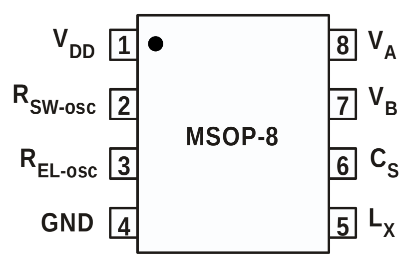
Thermal Resistance

(Mounted on FR4 board, 25mm x 25mm x 1.57mm)

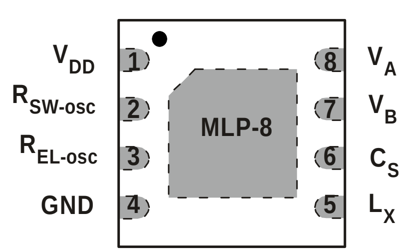
Package	θ_{ja}
MSOP-8	330°C/W
MLP-8	60°C/W

Pin Configuration

Top View



HV857MG



HV857K7

Pads are at the bottom of the package
Exposed center pad is at ground potential

Block Diagram

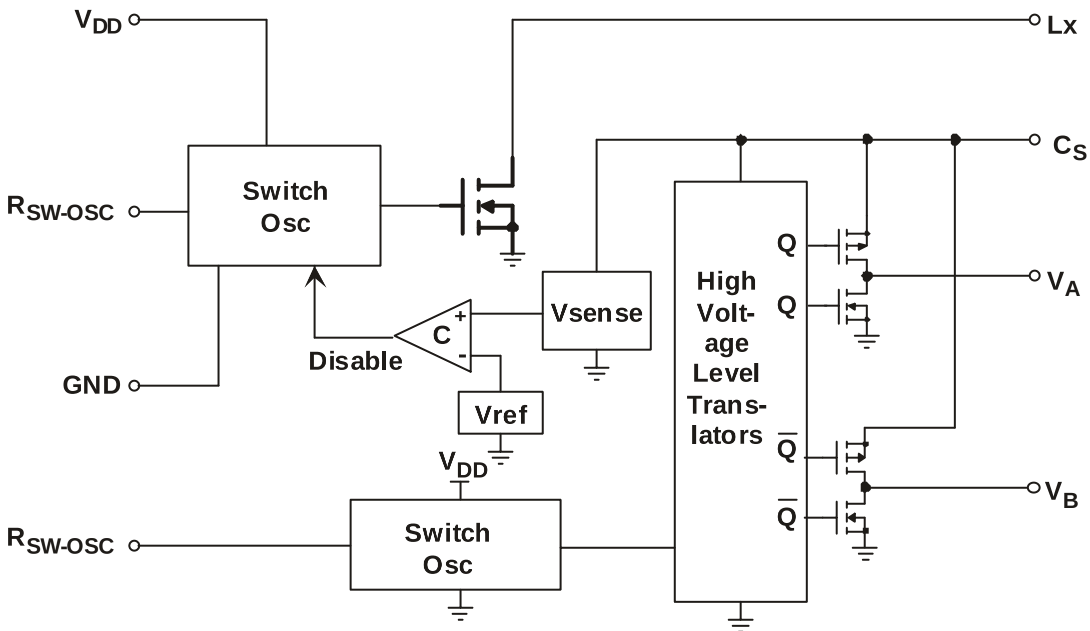
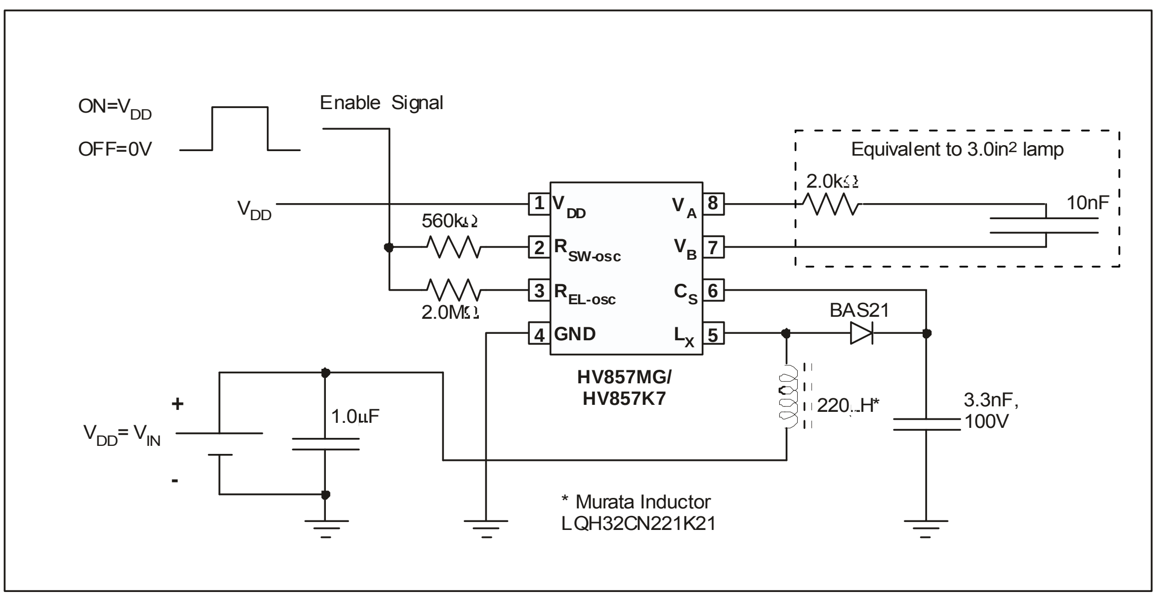


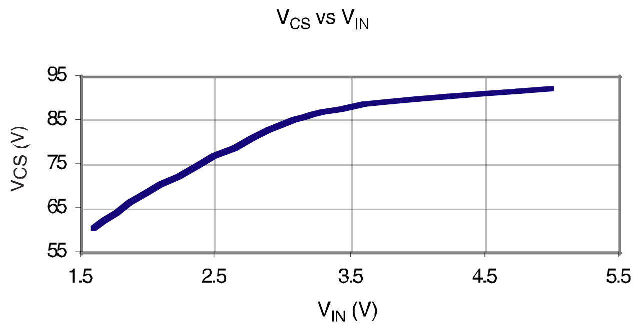
Figure 1: Typical Application / Test Circuit

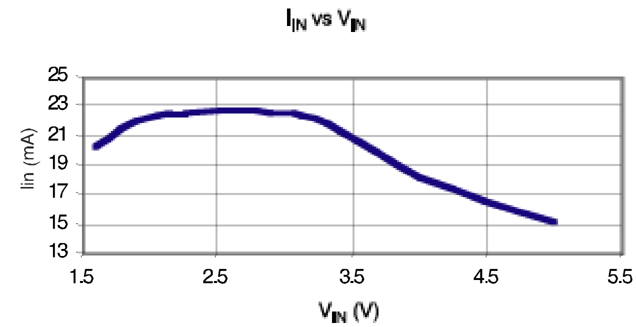


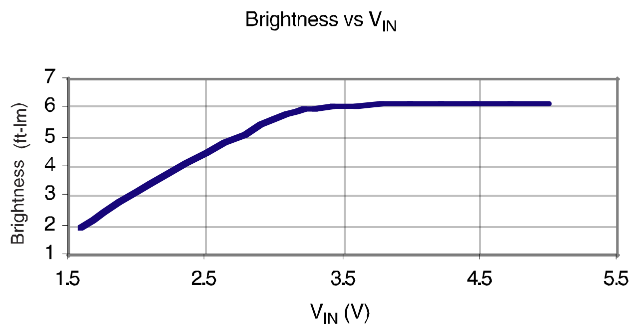
Typical Performance

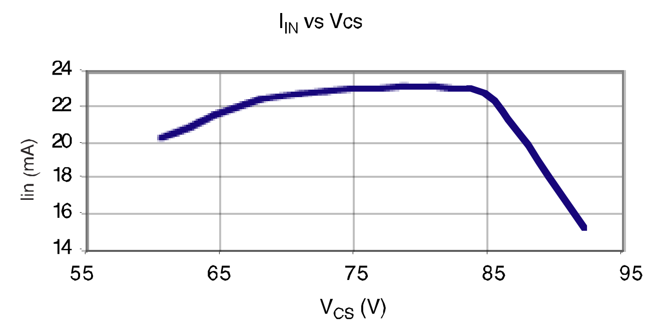
Device	Lamp Size	$V_{DD} = V_{IN}$	I_{IN}	V_{CS}	f_{EL}	Brightness
HV857MG	3.0in^2	3.3V	20.0mA	84V	240Hz	6.0ft-lm

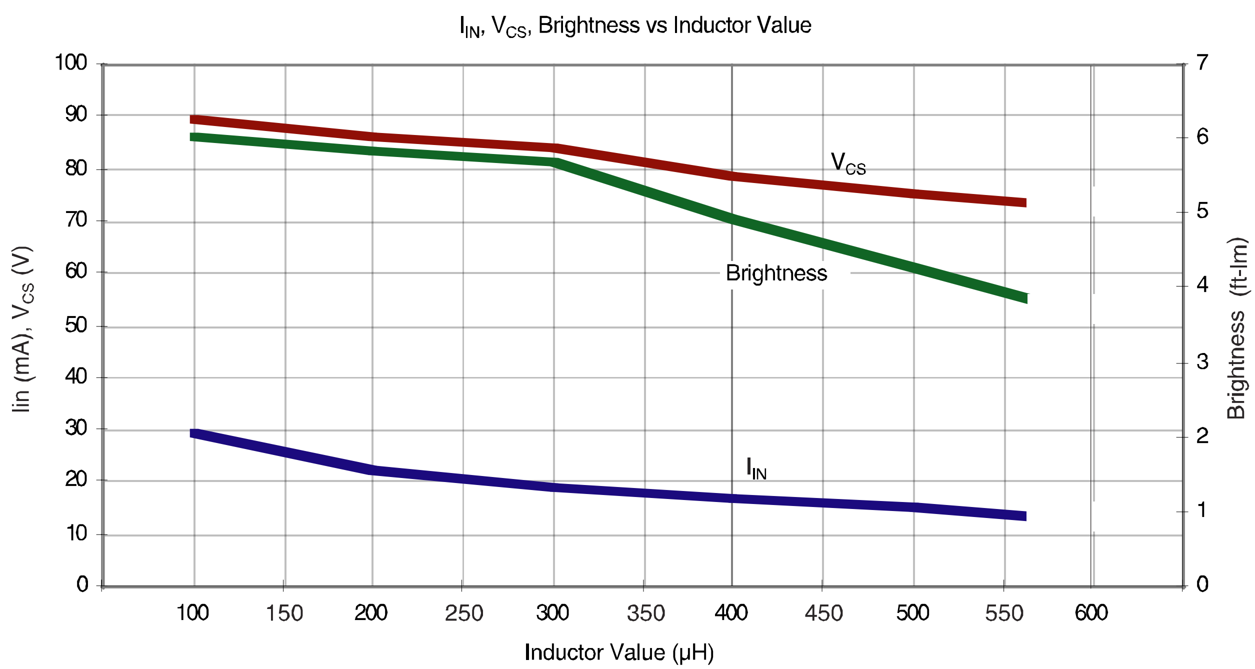
Typical Performance Curves for Figure 1 *(EL Lamp = 3.0in², V_{DD} = 3.0V)*











External Component Description

External Component	Selection Guide Line
Diode	Fast reverse recovery diode, BAS21 diode or equivalent.
C_S Capacitor	0.003µF to 0.1µF, 100V capacitor to GND is used to store the energy transferred from the inductor.
R_{EL} Resistor	The EL lamp frequency is controlled via an external R_{EL} resistor connected between R_{EL-OSC} and V_{DD} of the device. The lamp frequency increases as R_{EL} decreases. As the EL lamp frequency increases, the amount of current drawn from the battery will increase and the output voltage V_{CS} will decrease. The color of the EL lamp is dependent upon its frequency. A 2MΩ resistor would provide lamp frequency of 205 to 275Hz. Decreasing the R_{EL} resistor by a factor of 2 will increase the lamp frequency by a factor of 2.
R_{SW} Resistor	The switching frequency of the converter is controlled via an external resistor, R_{SW} between R_{SW-OSC} and V_{DD} of the device. The switching frequency increases as R_{SW} decreases. With a given inductor, as the switching frequency increases, the amount of current drawn from the battery will decrease and the output voltage, V_{CS}, will also decrease.
Lx Inductor	The inductor L_X is used to boost the low input voltage by inductive flyback. When the internal switch is on, the inductor is being charged. When the internal switch is off, the charge stored in the inductor will be transferred to the high voltage capacitor C_S. The energy stored in the capacitor is connected to the internal H-bridge, and therefore to the EL lamp. In general, smaller value inductors, which can handle more current, are more suitable to drive larger size lamps. As the inductor value decreases, the switching frequency of the inductor (controlled by R_{SW}) should be increased to avoid saturation. A 220µH Murata (LQH32CN221) inductor with 8.4Ω series DC resistance is typically recommended. For inductors with the same inductance value, but with lower series DC resistance, lower R_{SW} resistor value is needed to prevent high current draw and inductor saturation.
Lamp	As the EL lamp size increases, more current will be drawn from the battery to maintain high voltage across the EL lamp. The input power, (V_{IN} x I_{IN}), will also increase. If the input power is greater than the power dissipation of the package, an external resistor in series with one side of the lamp is recommended to help reduce the package power dissipation.

Split Supply Configuration

The HV857 can also be used for handheld devices operating from a battery where a regulated voltage is available. This is shown in Figure 2. The regulated voltage can be used to run the internal logic of the HV857. The amount of current necessary to run the internal logic is 150µA Max at a V_{DD} of 3.0V. Therefore, the regulated voltage could easily provide the current without being loaded down.

Enable/Disable Configuration

The HV857 can be easily enabled and disabled via a logic control signal on the R_{SW} and R_{EL} resistors as shown in Figure 2 below. The control signal can be from a microprocessor. The control signal has to track the V_{DD} supply. R_{SW} and R_{EL} are typically very high values. Therefore, only 10's of microamperes will be drawn from the logic signal when it is at a logic high (enable) state. When the microprocessor signal is high the device is enabled, and when the signal is low, it is disabled.

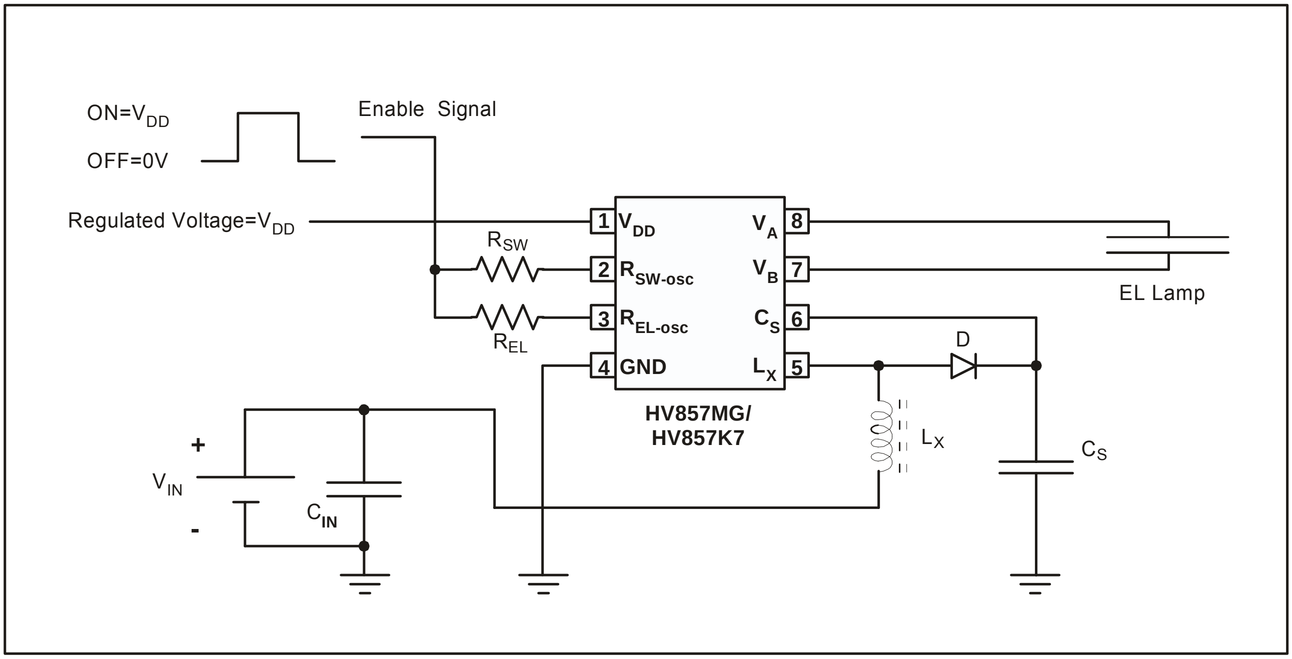


Figure 2: Split Supply and Enable/Disable Configuration

Audible Noise Reduction

This section describes a method (patented) developed at Supertex to reduce the audible noise emitted by the EL lamps used in application sensitive to audible noise. Figure 3 shows a general circuit schematic that uses the resistor, R_{SER}, connected in series with the EL lamp.

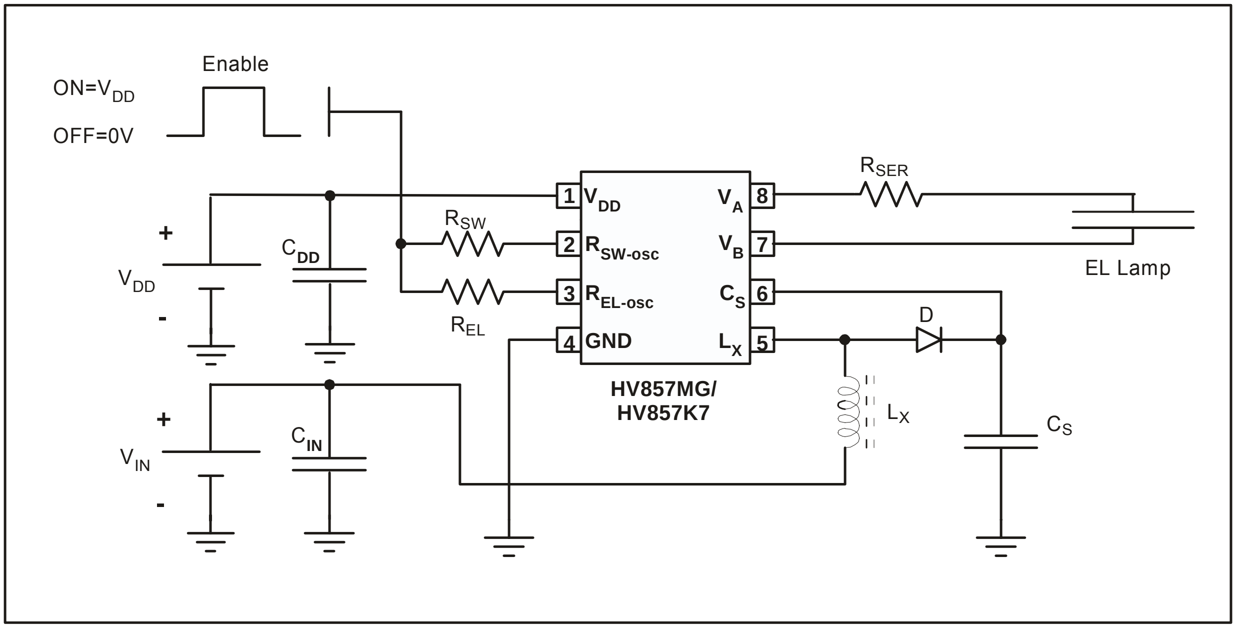


Figure 3: Typical Application Circuit for Audible Noise reduction

Minimization of EL Lamp Audible Noise

The EL lamp, when lit, emits an audible noise. This is due to EL lamp construction and it creates a major problem for applications where the EL lamp can be close to the ear such as cellular phones. The noisiest waveform is a square wave and the quietest waveform has been assumed to be a sine wave.

After extensive research, Supertex has developed a waveform that is quieter than a sine wave. The waveform takes the shape of approximately 2RC time constants for rising and 2RC time constants for falling, where C is the capacitance of the EL lamp, and R is the external resistor, R_{SER}, connected in series with the EL lamp. This waveform has been proven to generate less noise than a sine wave.

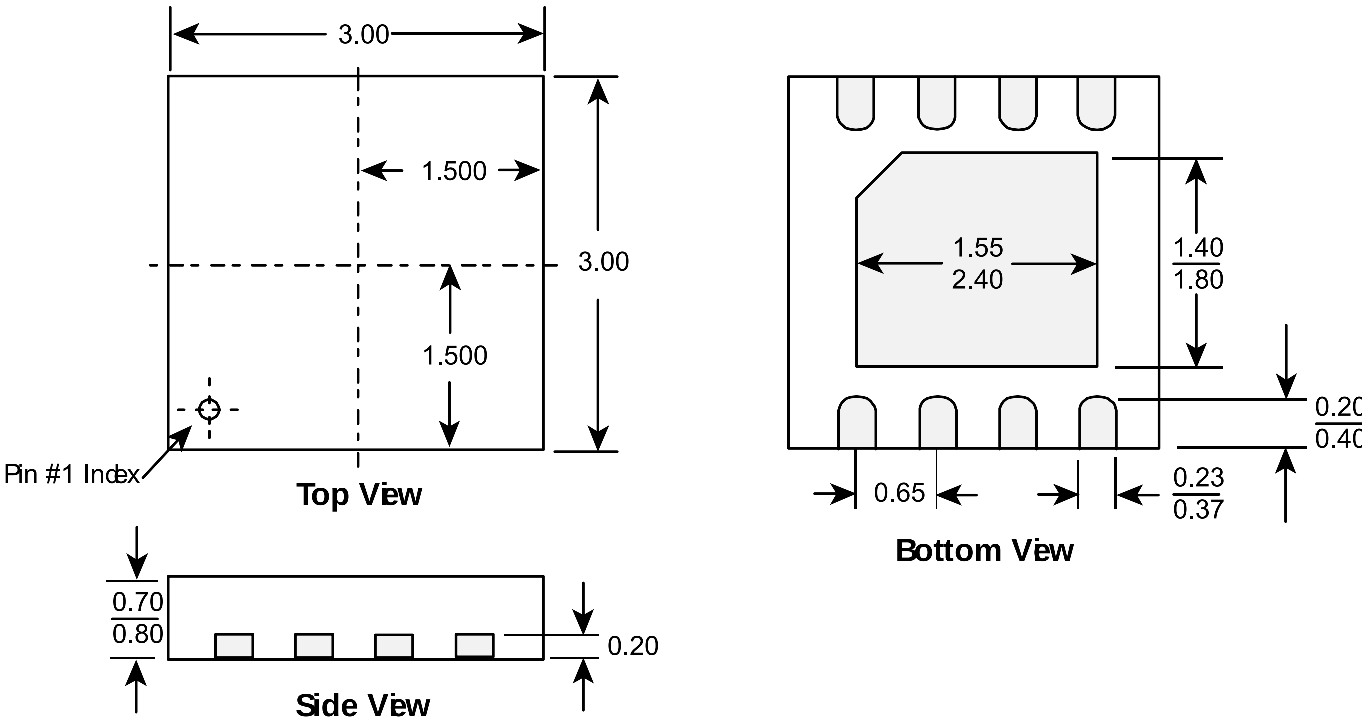
The audible noise from the EL lamp can be set at a desired level based on the series resistor value used with the lamp. It is important to note that use of this resistor will reduce the voltage across the lamp. Reduction of voltage across the lamp will also have another effect on the over all performance of the Supertex EL drivers, age compensation (patented). This addresses a very important issue, EL lamp life that most mobile phone manufacturers are concerned about.

As EL lamp ages, its brightness is reduced and its capacitance is diminished. By using the RC model to reduce the audible noise emitted by the EL lamp, the voltage across the lamp will increase as its capacitance diminishes. Hence the increase in voltage will compensate for the reduction of the brightness. As a result, it will extend the EL lamp's half-life (half the original brightness).

Effect of Series Resistor on EL Lamp Audible Noise and Brightness

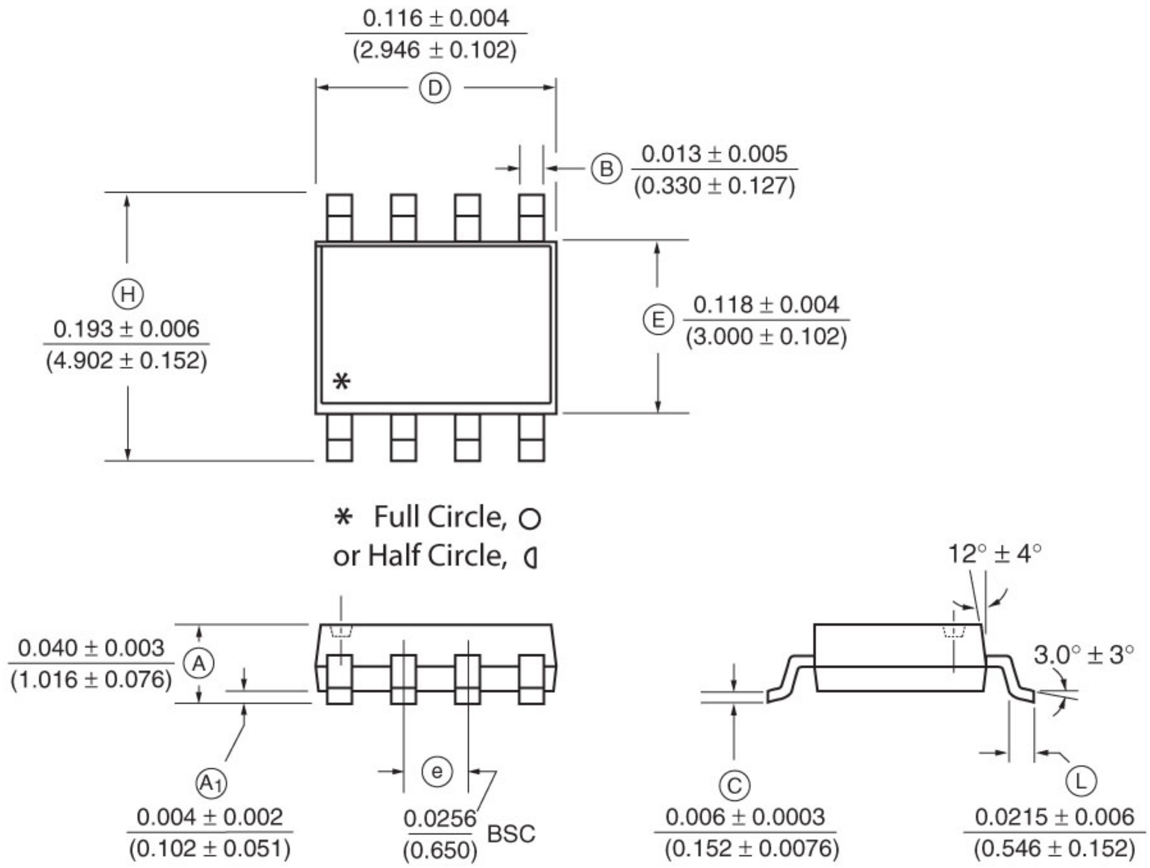
Increasing the value of the series resistor with the lamp will reduce the EL lamp audible noise as well as its brightness. This is due to the fact that the output voltage across the lamp will be reduced and the output waveform will have rounder edges.

8-Lead MLP Package Outline MLP-8 (K7)



All dimensions are in millimeters
Legend: min / max

8-Lead MSOP Package Outline (MG)



Note: Circle (e.g. (B)) indicates JEDEC Reference.

Measurement Legend = Dimensions in Inches / (Dimensions in Millimeters)

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