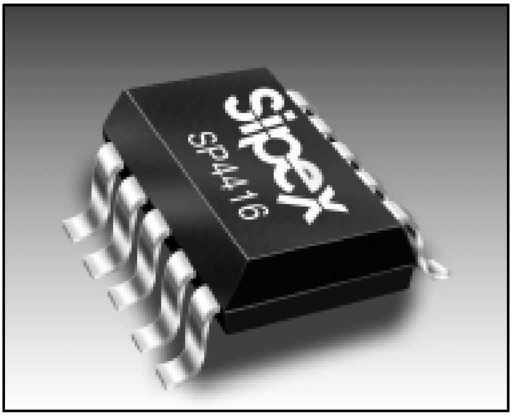
SP4416

Electroluminescent Lamp Driver with 4-Level Light Intensity Selection Feature

- 4-Level, Software Selectable Light Intensity Function
- 75%-80%-85%-100% Intensity Level Options
- Extends Standby Time & Battery Life when used in Conjunction with Power Management Devices
- Requires only 2 External Components: Oscillator Setting Capacitor and Inductor
- Low Power +3.3V Operation
- 100nA Standby Current
- Space-Saving 10-pin µSOIC Package

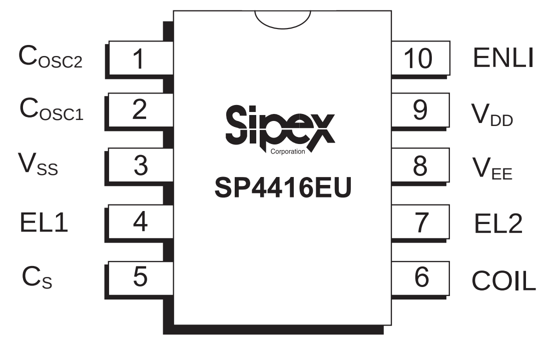


APPLICATIONS

- Cellular Phones
- LCD Displays & Keypads
- PDAs
- Handheld Portable Electronic Devices

DESCRIPTION

The **SP4416** is a high voltage output DC-AC converter that operates from a 3.3V battery and generates up to $220V_{PP}$ AC output. As with **Sipex's** other electroluminescent driver products, the AC output is used to generate light in an electroluminescent lamp. The **SP4416** incorporates an intensity select feature within the enable circuit so that the user can program the desired light intensity. The **SP4416** uses only two external components to generate light; the oscillator capacitor and inductor. The ENLI pin is used for either an enable function or a step-up intensity function. Four light intensities can be set by strobing the ENLI pin in a defined time period. The **SP4416** with the intensity function can be used in cellular phone applications, PDA's, and other hand-held CPU controlled equipment.



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_{OUT} to GND)....................-0.3V, +7V
Operating Temperature.......................-40˚C to +85˚C
Storage Temperature........................-65˚C to +150˚C

Power Dissipation Per Package
10-pin µSOIC (derate 8.84mW/°C above +70°C).......720mW

ELECTRICAL CHARACTERISTICS

T_A= -40°C to +85°C and V_{DD} = +3.0V, unless otherwise noted. L1 = 2.7mH/45Ω, C_{OSC} = 330pF, C_{LOAD} = 8nF

PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Supply Voltage, V_{DD}	2.3	3.0	4.5	V	
Supply Current, $I_{COIL}+I_{DD}$		25	40	mA	EN=V_{DD}
Coil Voltage, V_{COIL}	3.0		6.0	V	
ELEN Input Voltage, V_{ELEN} LOW: EL off HIGH: EL on	 -0.25 V_{DD}-0.25	 0 V_{DD}	 0.25V V_{DD}+0.25	V	
Shutdown Current, $I_{SD}=I_{COIL}+I_{DD}$		0.1	1.0	µA	EN=LOW,V_{DD}=typical value, T_{AMB} = 25°C
Input Impedance	1	3		MΩ	
INDUCTOR DRIVE					
Coil Frequency, f_{COIL}		8		kHz	
Coil Duty Cycle		75		%	
Peak Coil Current, $I_{PK-COIL}$		45	100	mA	
Intensity Level 1 Intensity Level 2 Intensity Level 3 Intensity Level 4		7 9 12 16		pulses	
EL LAMP OUTPUT					
EL Lamp Frequency, f_{LAMP}	125	250	563	Hz	
Peak to Peak Output Voltage, V_{PK-PK}	140	186		V	
AC CHARACTERISTICS					
ENLI - Maximum Interval Between Pulses (t_F to t_R)	0.8		8	ms	
ENLI - Minimum Pulse Width	10		800	µs	Guaranteed by design
ENLI - On Delay			1	ms	refer to *Figures 6* to *8* for t_{DELAY}
ENLI - Increment Delay			10	µs	Guaranteed by design

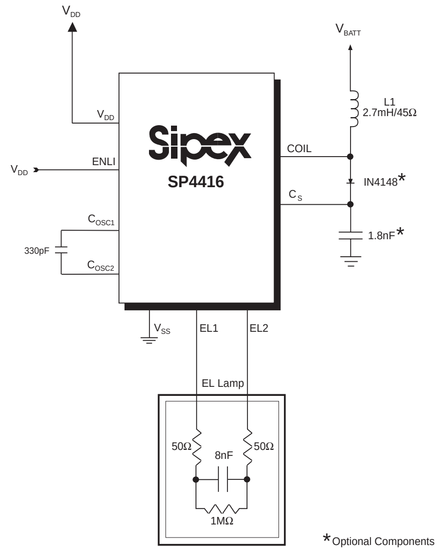


Figure 1. Typical Operating Circuit of the SP4416

PIN	NAME	FUNCTION
1	C_{OSC2}	Oscillator capacitor input 2
2	C_{OSC1}	Oscillator capacitor input 2
3	V_{SS}	Logic Supply Common - typically connected to ground
4	EL1	EL Driver Output; connected to EL lamp
5	C_S	Optional Integrating Capacitor Input. Connect a 1.8nF capacitor from this input pin to ground to filter out any coil switching spikes or ripple present in the output waveform to the EL lamp. Connecting an optional fast recovery diode, 1N4148, from COIL to this input pin increases the light output of the EL lamp.
6	COIL	Inductor input; Other end of inductor is connected to the battery
7	EL2	EL Driver Output; connected to EL lamp
8	V_{EE}	High Voltage Supply Common; typically connected to ground
9	V_{DD}	Power Supply Pin; connected to voltage source or positive battery terminal
10	ENLI	Enable and Lamp output intensity select

FUNCTIONAL DESCRIPTIONS

Oscillator Section

The **SP4416** uses an internal oscillator circuit that has the frequency set by C_{OSC}. The oscillator produces a 32kHz clock signal used internally and is divided down to create f_{COIL} and f_{LAMP}. The ratio of the coil frequency (f_{COIL}) and the H-bridge (f_{LAMP}) is fixed.

Intensity Setting

As with the SP4415, the **SP4416** incorporates an intensity select pin that will select one of four light output intensity levels. The ENLI pin serves as both an enable function and level select. This pin is edge triggered and enables on the rising edge or LOW-HIGH transition. The ENLI input is not debounced requiring chatterless ENLI transitions. In order to set a level, the ENLI pin should be asserted with a logic HIGH, and then asserted with a logic LOW. An internal pull-down resistor will keep the EL driver disabled unless defined by a logic HIGH. To increment the intensity sequence, the ENLI should be asserted with another LOW-HIGH transition within the next 800µS in order to step to the next light intensity. From power-up, the first enable high will produce 100% of the output. The next LOW-HIGH transition will start the output back at the first level of intensity. The next set of four LOW-HIGH transitions will increment the output to the highest intensity at 100%. If set to a desired intensity, the ENLI pin should remain HIGH to maintain the desired intensity. Refer to ***Figure 6*** for a timing diagram.

A time greater than 8ms between the falling edge of the previous transition to the next ENLI transition will leave the EL driver output disabled until a logic HIGH is asserted back into the ENLI pin. A timing less than 800µs between the falling edge of the previous transition to the next ENLI transition will increment to the next output intensity. Refer to ***Figure 7*** for timing diagram.

When the ENLI sees the next LOW-HIGH transition, longer than 8ms, the output will revive to the output intensity (VPEAK) just before being disabled. Refer to ***Figure 8*** for timing diagram.

Coil

As in our other EL drivers, the **SP4416** uses the coil to generate current to drive the H-bridge. Energy is stored in the coil according to the equation $E_L = 1/2LI_P^2$ where I_P, to the first approximation, is the product $I_P = (t_{ON})(V_{BATTERY} - V_{CE})/L)$, 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 for f_{COIL}, 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.

The f_{COIL} signal controls a switch that connects the end of the coil at pin 6 to ground or to open circuit. During the time when the f_{COIL} signal is HIGH, the coil is connected from $V_{BATTERY}$ to ground and a charged magnetic field is created in the coil. When the f_{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. As a result, charge pulses are delivered to the lamp at a rate defined by f_{COIL}. Each pulse increases the voltage drop across the lamp in discrete steps. As the voltage potential approaches its maximum, the steps become smaller.

The preferred coil has a typical height of 2.0mm and a maximum height of 2.2mm. The Toko D52FU family with part number 875FU-272M, which offers a 2.7mH/45ohm coil that complies with the height requirement.

H-Bridge

The H-bridge consists of two SCR structures that act as high voltage switches. These two switches control the polarity of how the lamp is charged. The SCR switches are controlled by the f_{LAMP} signal which is the oscillator frequency divided by 32. When the energy from the coil is released, a high voltage spike is created triggering the SCR switches. The direction of current flow is determined by which SCR is enabled.

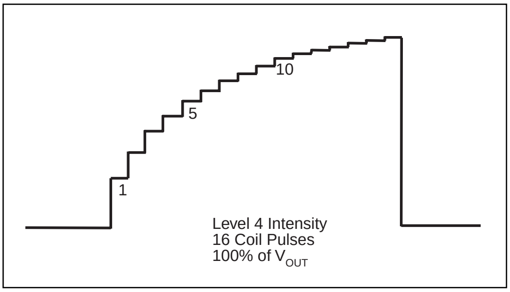


Figure 2. Level 4 Output for EL1

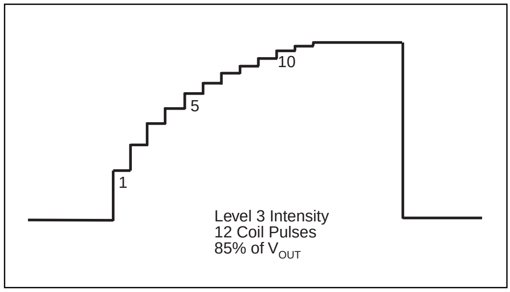


Figure 3. Level 3 Output for EL1

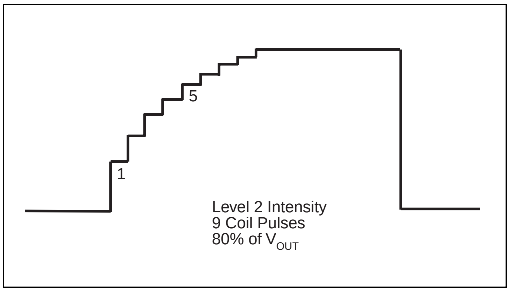


Figure 4. Level 2 Output for EL1

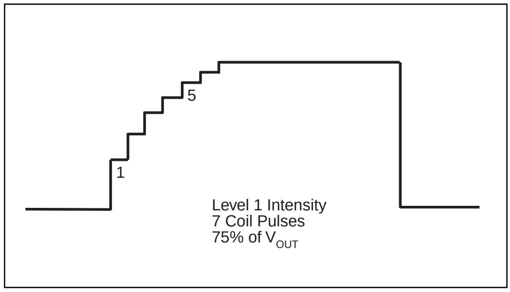


Figure 5. Level 1 Output for EL1

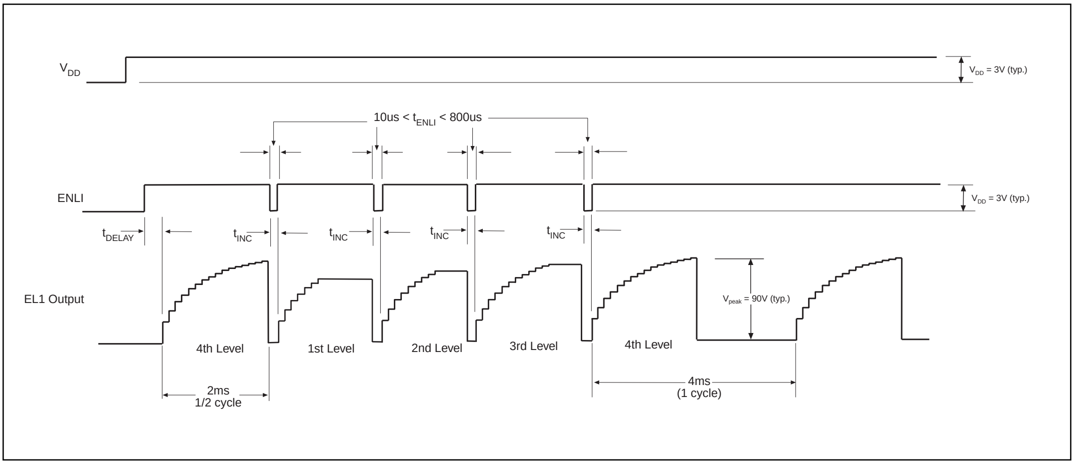


Figure 6. Typical ENLI Timing for Intensity Strobing

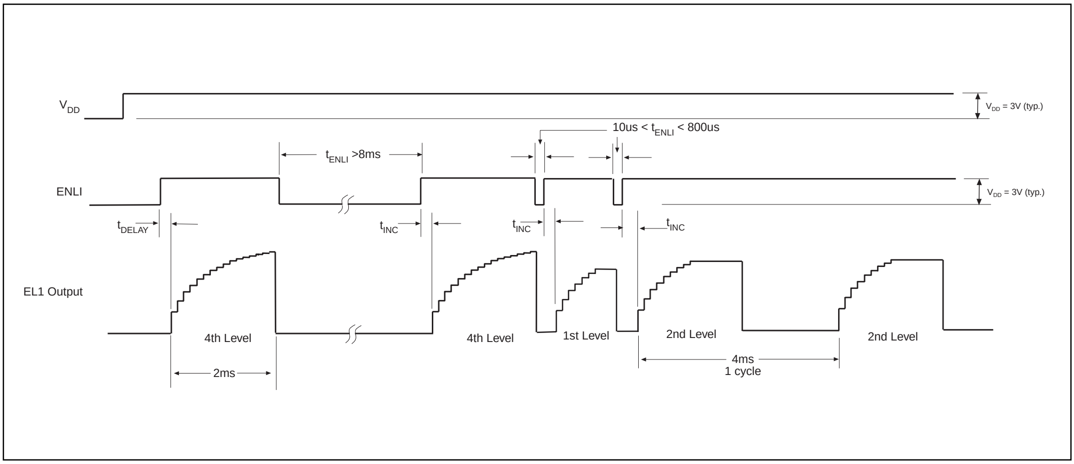


Figure 7. Typical ENLI Timing for Cases where t_{ENLI} < 1ms or t_{ENLI} > 8ms

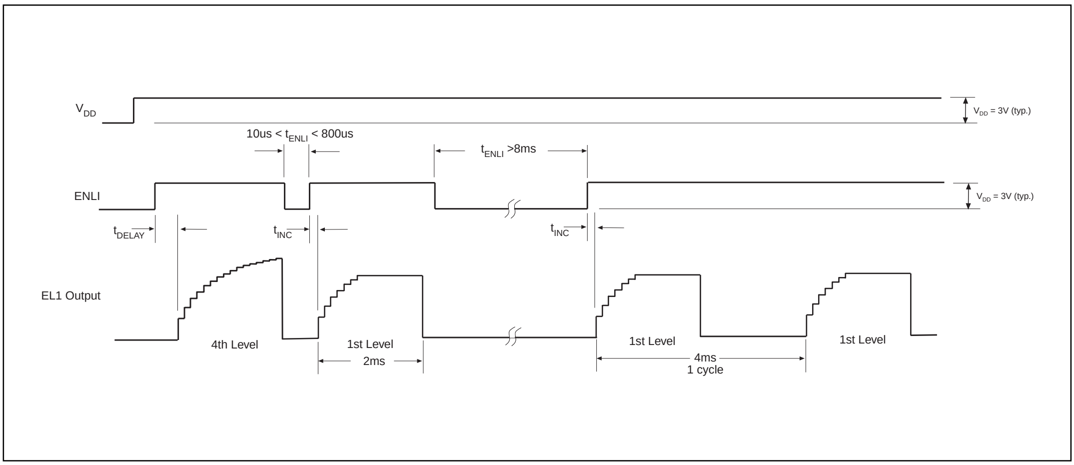


Figure 8. ENLI Timing Recall

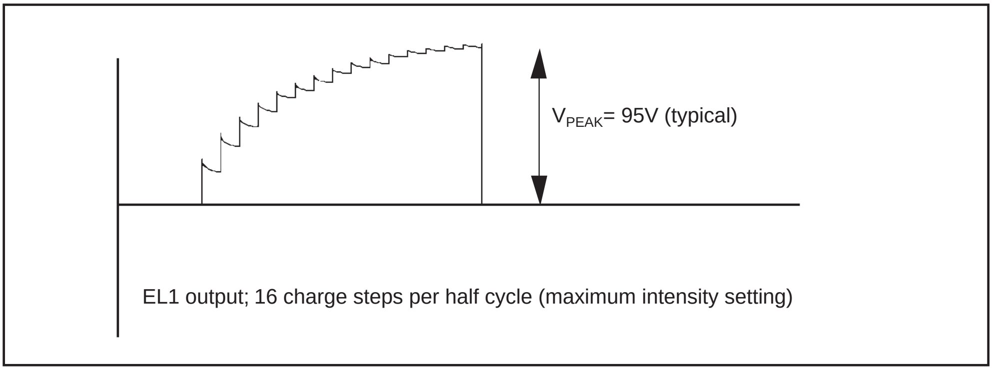


Figure 9. EL Output Voltage in Discrete Steps at EL1 Output

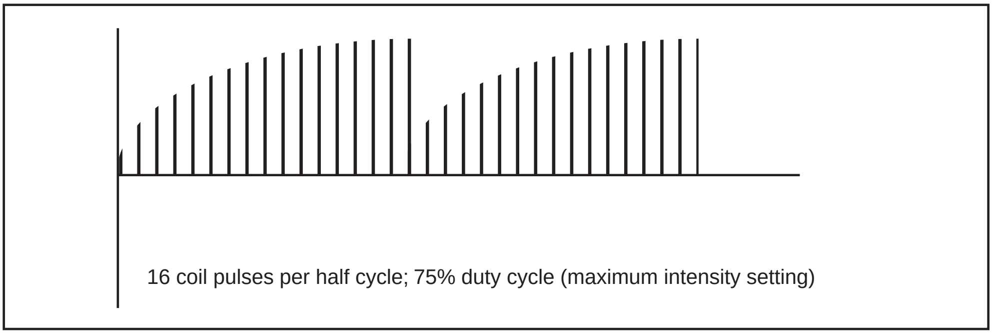


Figure 10. Voltage Pulses Released from the Coil to the EL Driver Circuitry

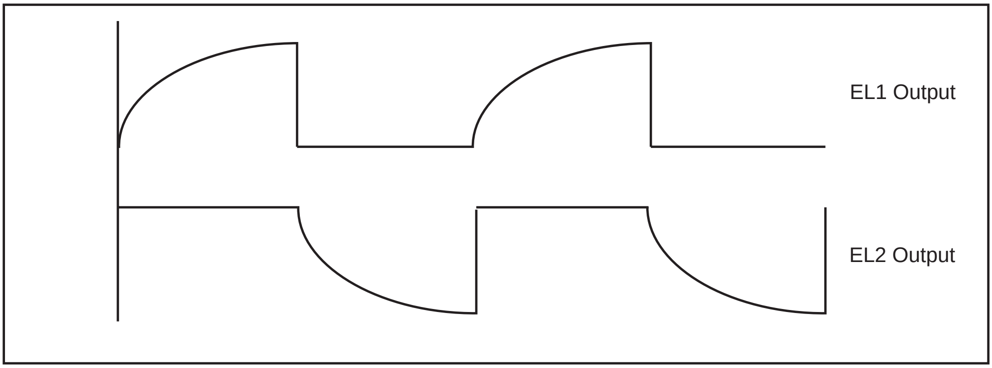


Figure 11. EL Voltage Waveforms from the EL1 and EL2 Outputs

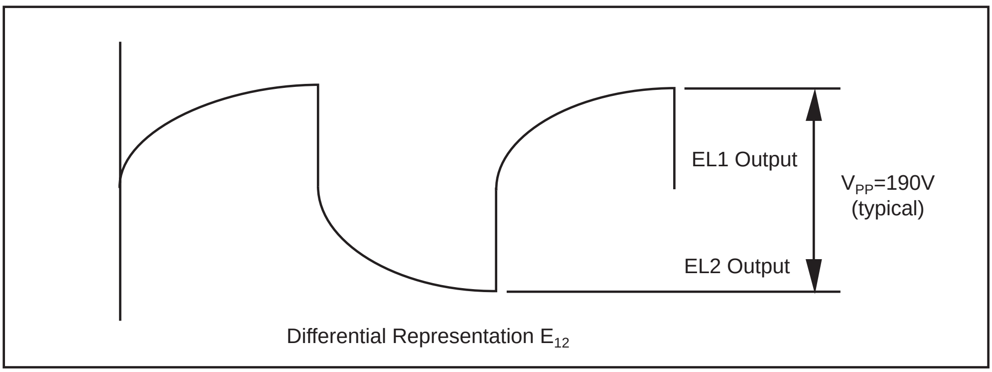


Figure 12. EL Differential Output Waveform of the EL1 and EL2 Outputs

PERFORMANCE CHARACTERISTICS

The following performance curves are intended to give the designer a relative scale from which to optimize specific applications. Absolute measurements may vary depending upon the brand of components chosen.

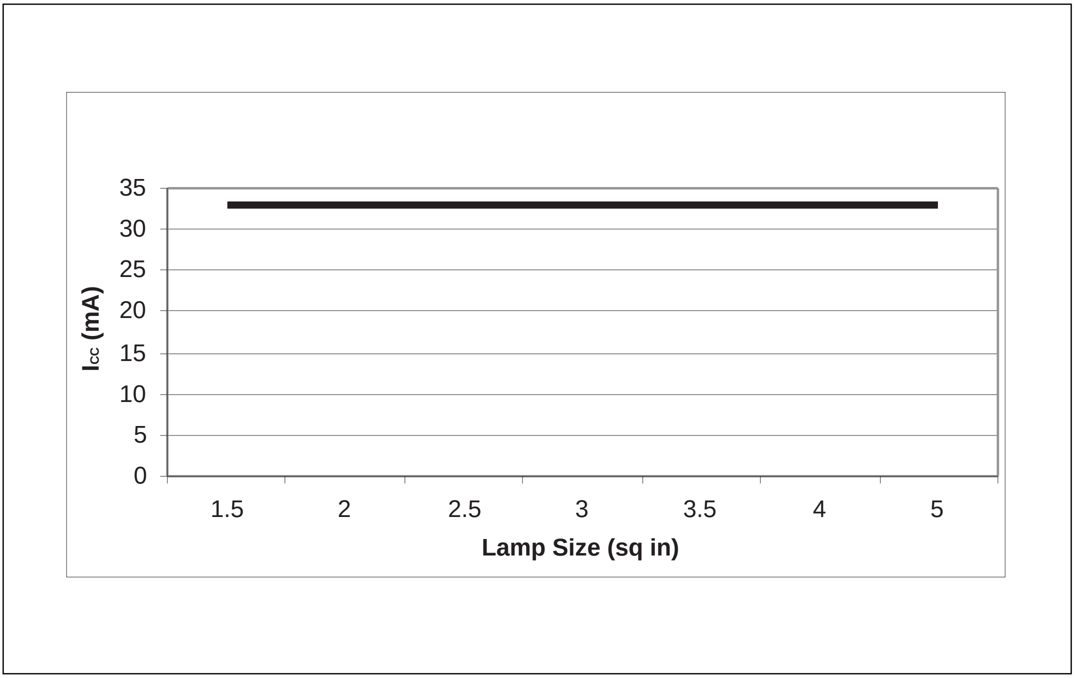


Figure 13. I_{TOTAL} vs Lamp Size

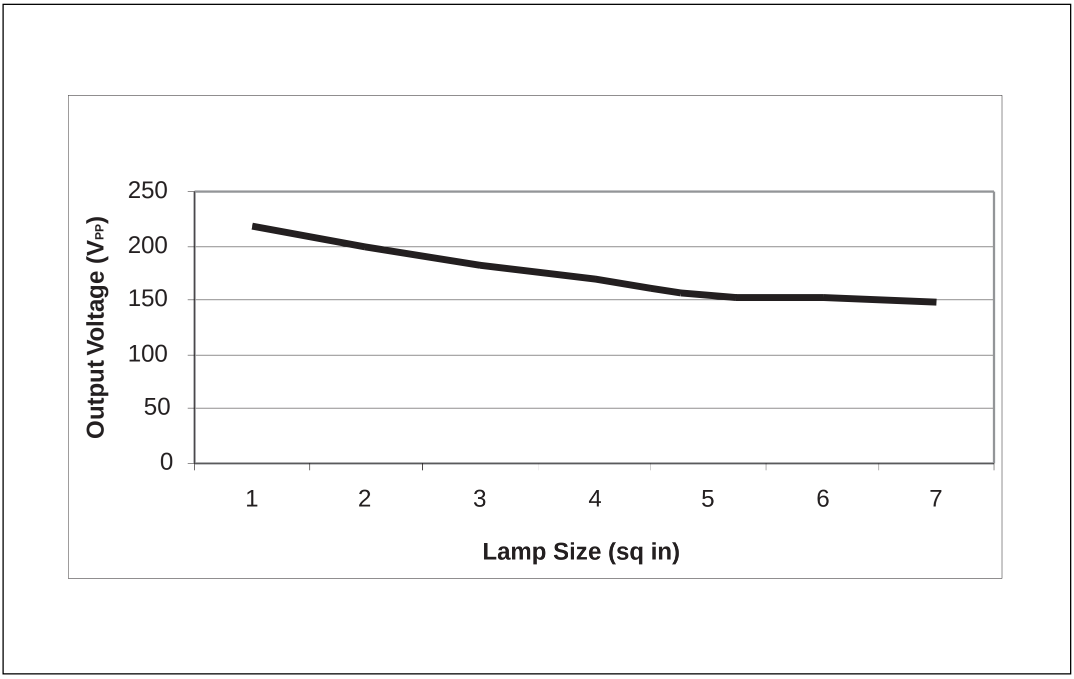


Figure 14. Output Voltage vs Lamp Size

PERFORMANCE CHARACTERISTICS

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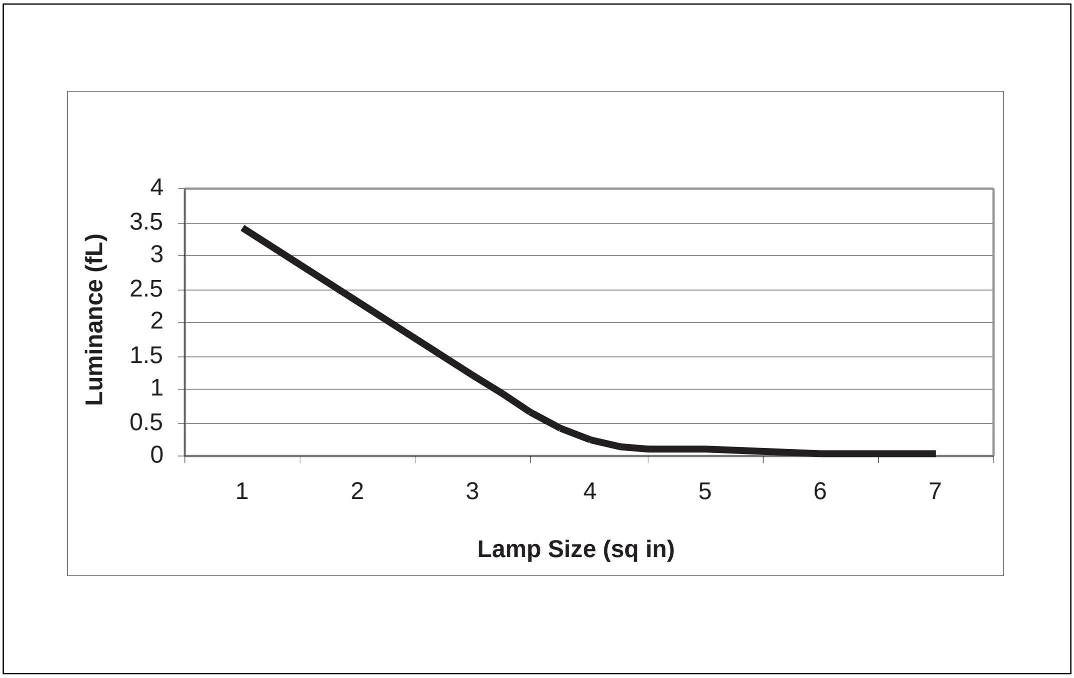

Figure 15. Luminance (Foot-Lamberts) vs Lamp Size

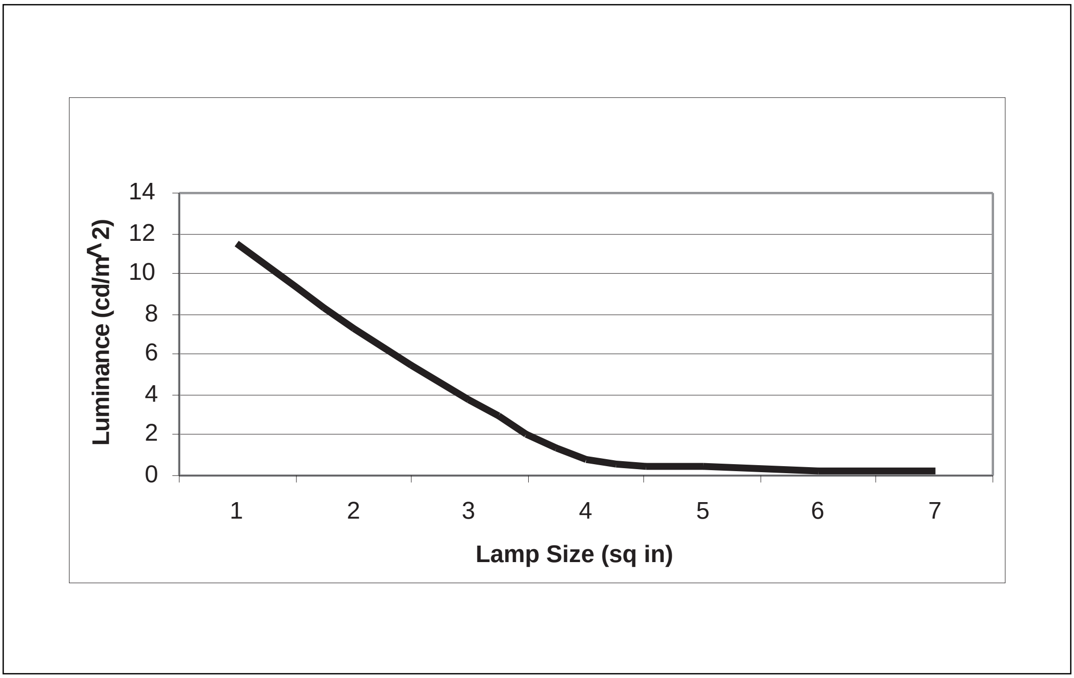

Figure 16. Luminance (Candela per Meter Square) vs Lamp Size

PERFORMANCE CHARACTERISTICS

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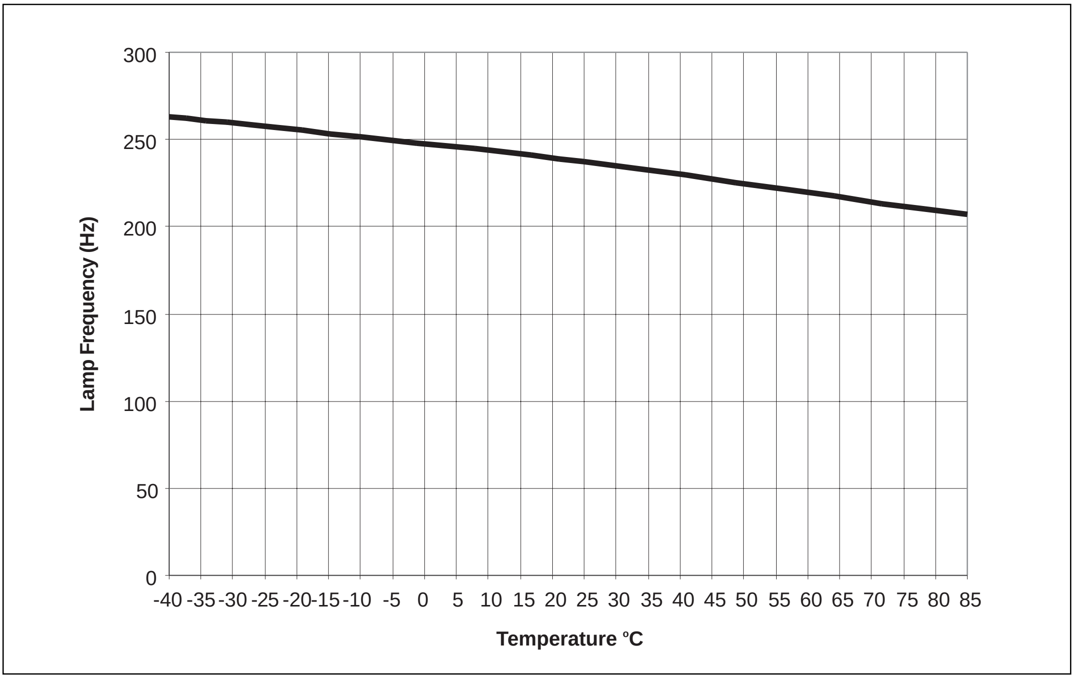

Figure 17. Lamp Frequency vs Temperature, V_{DD} = 3.0V

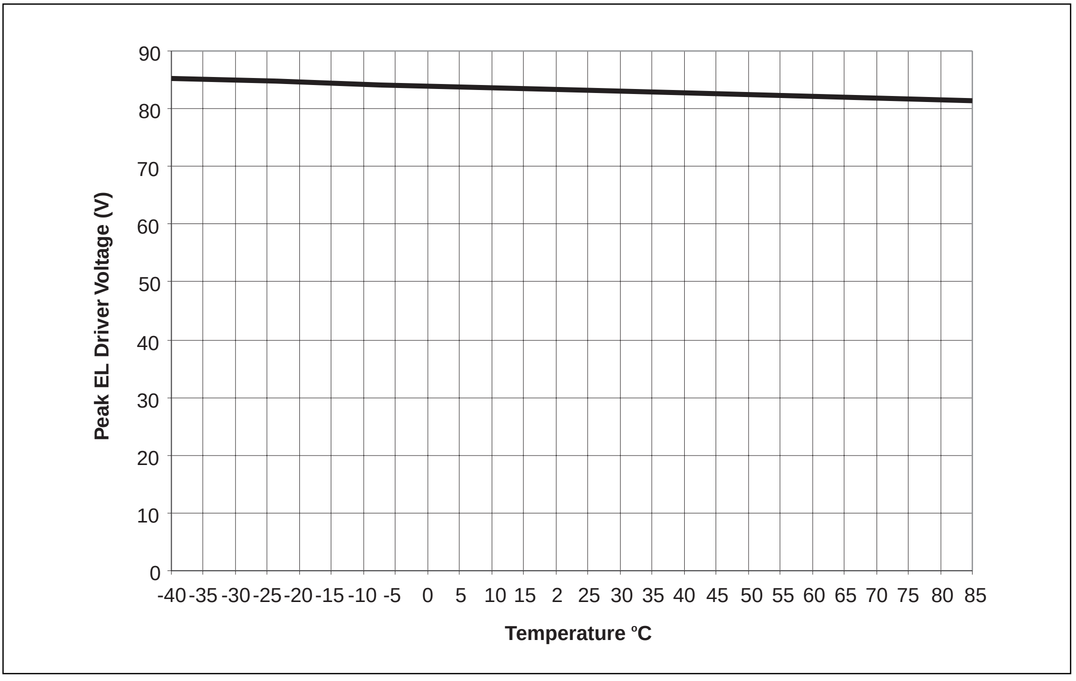

Figure 18. Peak EL Driver Voltage vs Temperature, V_{DD} = 3.0V

PERFORMANCE CHARACTERISTICS

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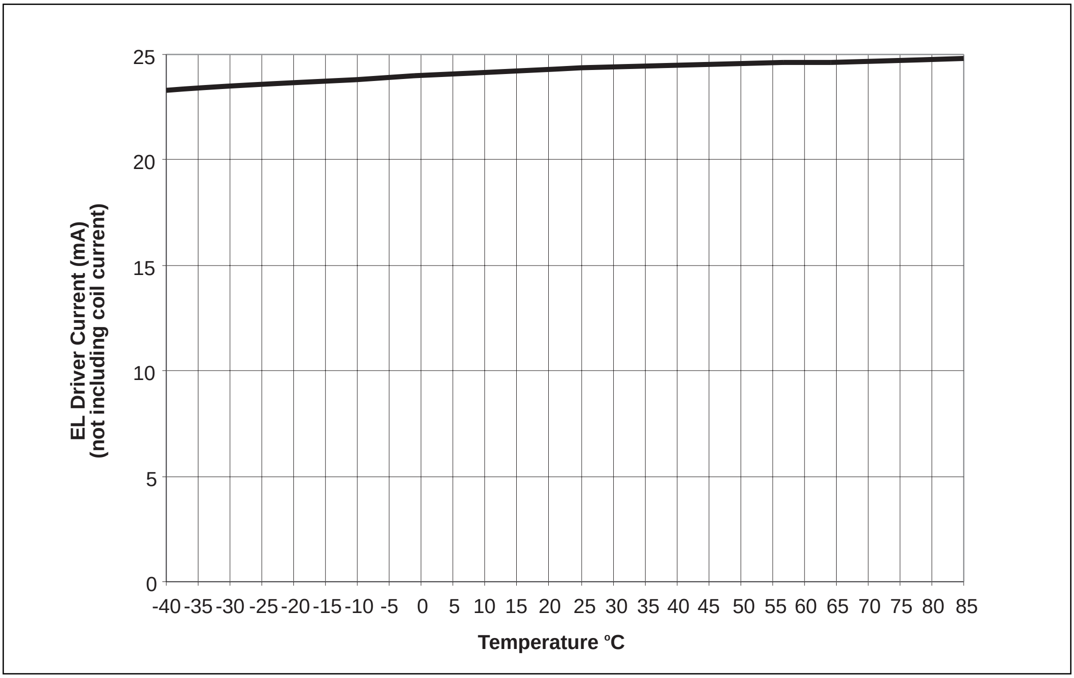
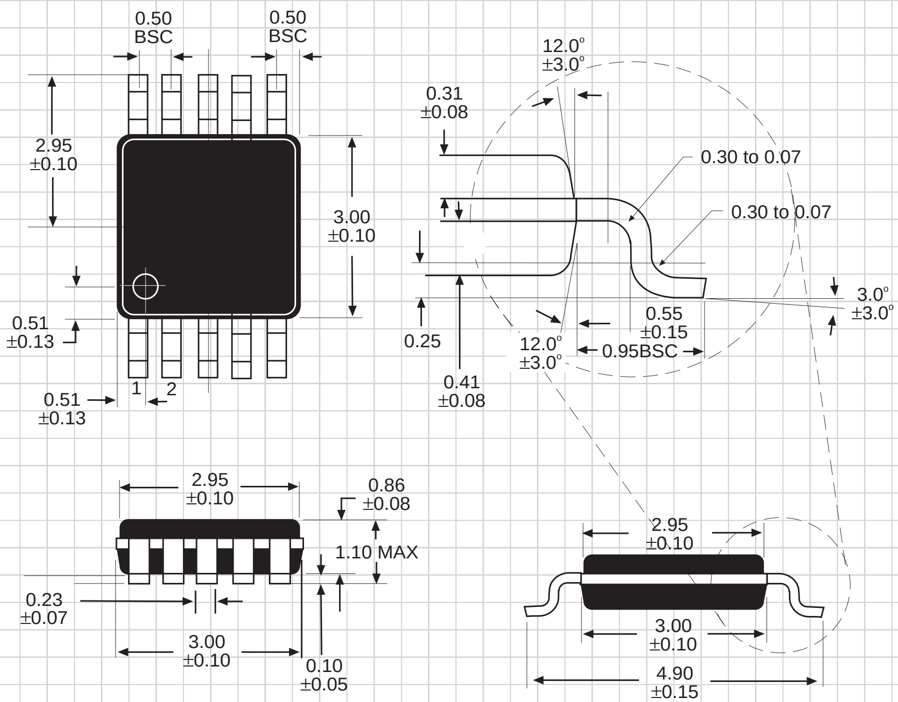


Figure 19. EL Driver Current (not including Coil Current) vs Temperature, V_{DD} = 3.0V

PACKAGE: 10-pin µSOIC Package

(ALL DIMENSIONS IN MILLIMETERS)



ORDERING INFORMATION

Model	Operating Temperature Range	Package Type
SP4416EU	-40˚C to +85˚C	10-Pin µSOIC
SP4416UEB	NA	Evaluation Board

Please consult the factory for pricing and availability on a Tape-On-Reel option.

Sipex Corporation

SIGNAL PROCESSING EXCELLENCE

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