

## Single Cell Battery Powered Electroluminescent Lamp Driver/Inverter

The IMP525 is an Electroluminescent (EL) lamp driver designed for systems that must operate below 1 volt. The input supply voltage range is 0.9V to 2.5V. Typical output lamp drive voltage is 112V. All four EL lamp-driving functions are on-chip. These are the switch-mode power supply, its high-frequency oscillator, the high-voltage H-bridge lamp driver and its low-frequency oscillator. EL lamps of up to 6nF capacitance can be driven to high brightness.

The circuit requires few external components; one inductor, one diode, one capacitor and two resistors. The resistors set the frequency for the two oscillators.

A disable mode puts the chip into a low current-drain state. When disabled, quiescent current drops to 2 $\mu$ A maximum with a  $V_{DD}$  of 1.5V. The chip can be disabled by connecting  $R_{SW}$ , the oscillator frequency setting resistors, to ground. A disable pad, accessible only on the die, can also be used to disable the driver.

An internal circuit shuts down the switching regulator when the lamp drive voltage exceeds 112V peak-to-peak. This conserves power and extends battery life.

The IMP525 is available in MicroSO and SO-8 packages and in die form.

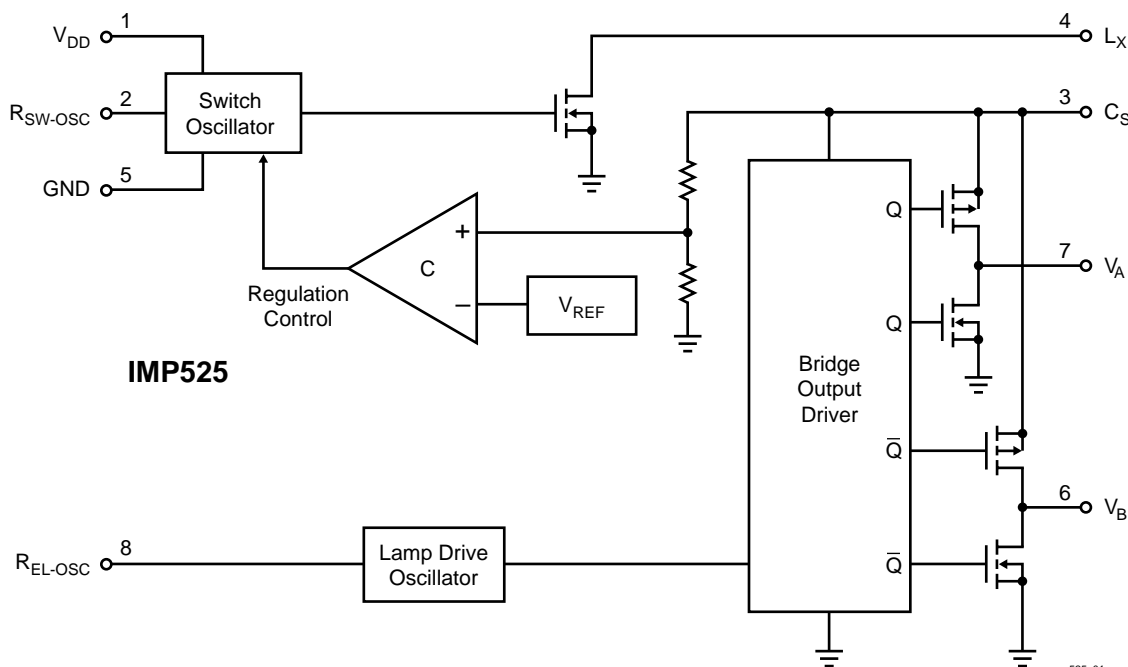
### Key Features

- ◆ Wide operating voltage range - from 0.9V to 2.5V
- ◆ Simple design requires few passive components
- ◆ 112V peak-to-peak typical AC output voltage
- ◆ Adjustable output frequency controls lamp color and power consumption
- ◆ Adjustable converter frequency minimizes circuit power consumption
- ◆ Disable mode extends battery life
- ◆ Disable current under 2 $\mu$ A
- ◆ Compact MicroSO package option

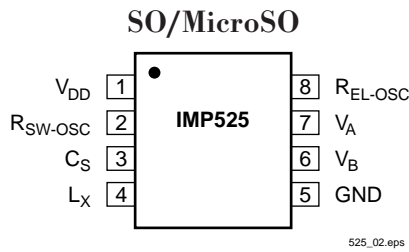
### Applications

- ◆ Audio/TV remote control units
- ◆ Pagers/Cellular phones
- ◆ PDAs
- ◆ Clocks and radios
- ◆ Portable GPS receivers
- ◆ LCD modules
- ◆ Toys

### Block Diagram



## Pin Configuration



## Ordering Information

Part Number	Input Voltage	Regulated Output Voltage	Temperature Range	Pins-Package
IMP525EMA	0.9V to 2.5V	YES	-40°C to +85°C	8-MicroSO
IMP525ESA	0.9V to 2.5V	YES	-40°C to +85°C	8-SO
IMP525/D	0.9V to 2.5V	YES	25°C	Dice

## Absolute Maximum Ratings

Supply Voltage,  $V_{DD}$ ,  $V_{RSW-OSC}$  and  $V_{REL-OSC}$  . . . -0.5V to +3.5V  
 Storage Temperature Range . . . . . -65°C to +150°C  
 Power Dissipation (SO package) . . . . . 400mW  
 Power Dissipation (MicroSO package) . . . . . 300mW

*Note: All voltages are referenced to GND.*

*These are stress ratings only and functional operation is not implied. Exposure to absolute maximum ratings for prolonged time periods may affect device reliability.*

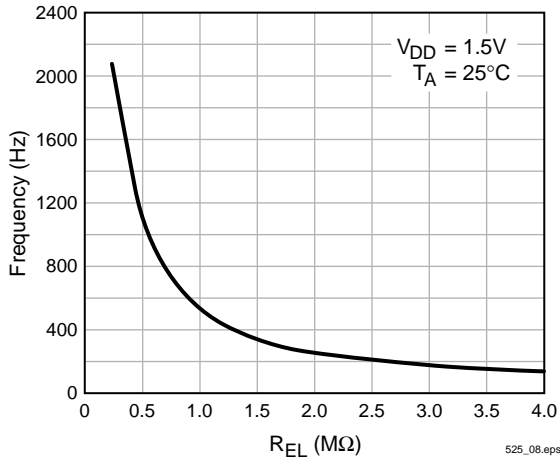
## Electrical Characteristics

Unless otherwise noted,  $V_{DD} = 1.5V$ ,  $R_{SW} = 1M\Omega$ ,  $R_{EL} = 1.0M\Omega$ , and  $T_A = 25^\circ C$ .

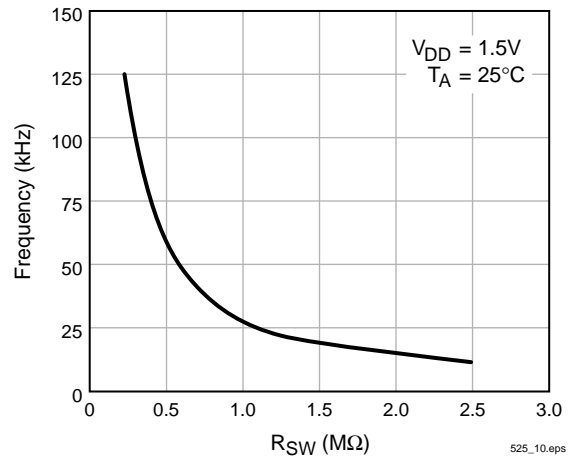
Parameter	Symbol	Conditions	Min	Typ	Max	Units
ON-resistance of MOS Switch	$R_{DS(ON)}$	$I = 50mA$			15	$\Omega$
Operating Voltage			0.9		2.5	V
Output Voltage at $C_S$	$V_{CS}$	$V_{DD} = 1.5V$ , See Figure 1, Table 1	52	58	65	V
Output Voltage at $C_S$	$V_{CS}$	$V_{DD} = 0.9V$ , See Figure 1, Table 2		50		V
Output Voltage Peak-to-Peak	$V_A - V_B$	$V_{DD} = 1.5V$ , See Figure 1	104	112	124	$V_{P-P}$
Quiescent $V_{DD}$ Supply Current, Disabled (Disable pin available on die only)	$I_{QDIS}$	Disable = HIGH		70		nA
Quiescent $V_{DD}$ Supply Current, Disabled	$I_{QDIS}$	$R_{SW-OSC} = GND$ $V_{DD} = 1.5V$		1.0	2.0	$\mu A$
Input Current at $V_{DD}$ Pin	$I_{DD}$	$V_{DD} = 0.9V$ to $1.5V$			1.5	mA
Input Current: $I_{DD}$ Plus Inductor Current	$I_{IN}$	$V_{DD} = 1.5V$		23	32	mA
$V_{A-B}$ Output Drive Frequency	$f_{EL}$	$V_{DD} = 1.5V$ , See Figure 1, Table 1		500		Hz
Boost Converter Switching Frequency	$f_{SW}$	$V_{DD} = 1.5V$ , See Figure 1, Table 1		26		kHz
Switching Duty Cycle	$D_{SW}$	$V_{DD} = 1.5V$ , See Figure 1		87.5		%
Disable Input LOW Voltage (Disable pin available on die only)	$V_{DISL}$		GND		0.2	V
Disable Input HIGH Voltage (Disable pin available on die only)	$V_{DISH}$		$V_{DD} - 0.5V$		$V_{DD}$	V

**Typical Characteristics**

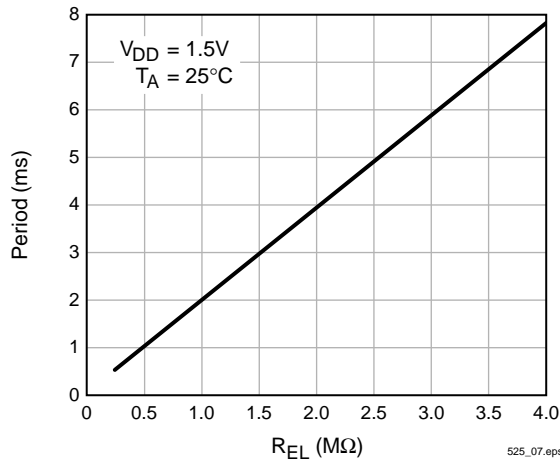
**EL Lamp Drive Frequency**



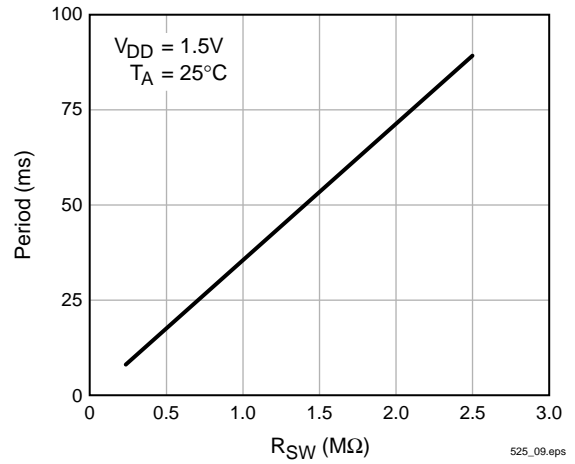
**Boost Converter Switching Frequency**



**EL Lamp Drive Period**



**Boost Converter Switching Period**



## Pin Descriptions

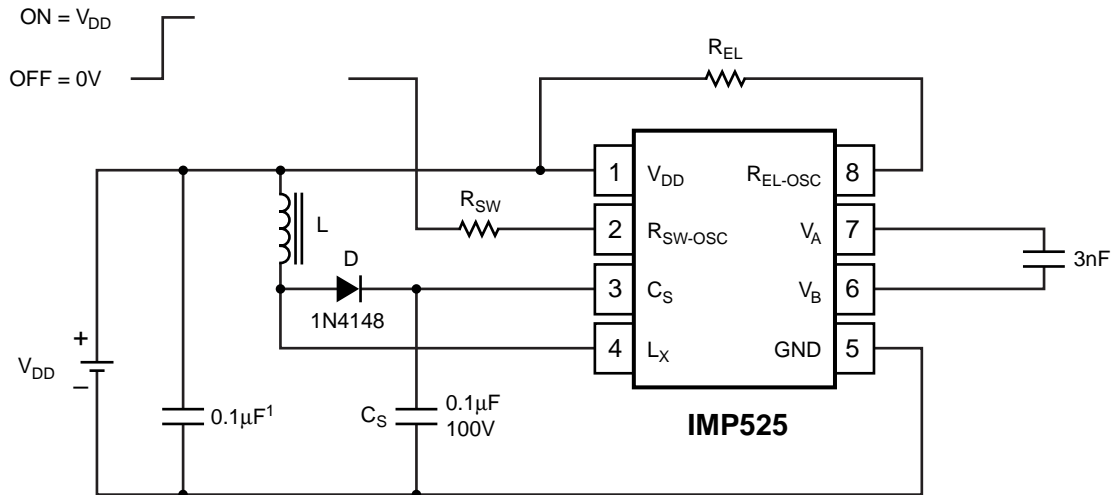
Pin Number	Name	Function
1	$V_{DD}$	Positive voltage supply for the IMP525. Inductor L may be connected here or to a separate supply.
2	$R_{SW-OSC}$	Switch-mode resistor pin. Switching frequency is determined by external resistor $R_{SW}$ , connected between pin 2 and $V_{DD}$ .
3	$C_S$	Boost converter storage capacitor. The voltage across the EL lamp is equal to twice the voltage at $C_S$ .
4	$L_X$	Connection to flyback inductance, L.
5	GND	Ground pin.
6	$V_B$	EL lamp drive. The lamp is connected to a high-voltage bridge circuit with $V_B$ providing the complementary connection to $V_A$ .
7	$V_A$	EL lamp drive. (See above)
8	$R_{EL-OSC}$	The EL lamp oscillator frequency-setting pin. The frequency is controlled by resistor $R_{EL}$ , connected from pin 8 to $V_{DD}$ .
Disable Pad	DIS	Available only in die form. Setting DIS HIGH disables the chip.

## External Components

External Component	Description and Selection Guide
Diode	A fast reverse recovery diode, with $BV > 100$ , such as a 1N4148.
Capacitor $C_S$	The high voltage capacitor that stores the inductive energy transferred through the catch diode. A 100 volt capacitor between 10nF and 100nF is recommended.
Resistor $R_{EL}$	The EL lamp oscillator frequency-setting resistor. $R_{EL}$ is connected between pin 8 and $V_{DD}$ , providing a frequency inversely proportional to $R_{EL}$ ; as $R_{EL}$ increases, the EL lamp frequency decreases along with the current drawn by the lamp. Lamp color is also determined by this frequency. A 1M $\Omega$ resistor between the $R_{EL-OSC}$ pin and the $V_{DD}$ supply results in a lamp frequency around 500Hz.
Resistor $R_{SW}$	Switching Oscillator frequency-setting resistor. $R_{SW}$ is connected between the $R_{SW-OSC}$ pin and the $V_{DD}$ supply. The switching frequency is inversely proportional to the resistor value, dropping as the resistance increases.
Capacitor $C_{SW}$	This is an optional noise-suppression capacitor connected from ground to the $R_{SW-OSC}$ pin. A 100pF capacitor is recommended.
Inductor L	<p>The inductor provides the voltage boost needed by means of inductive “flyback”. The internal MOSFET switch alternately opens and closes the ground connection for the inductor at the <math>L_X</math> pin. When the switch opens, the inductor potential will forward-bias the diode and the current will pass through to the storage capacitor <math>C_S</math>, charging it to a high voltage.</p> <p>As the value of the inductor is increased, the switching frequency set by <math>R_{SW}</math> should also be increased to prevent saturation. In general, smaller value inductors that can handle more current are more desirable when larger-area EL lamps must be driven.</p> <p>A small electrolytic capacitor (10<math>\mu</math>F, 16V), normally present across the inductor supply <math>V_{IN}</math>, will likely eliminate the need for <math>C_{SW}</math>.</p>

**Test Circuit**

Figure 1 shows the IMP525 configured to drive an EL lamp, represented as a 3nF capacitor.



Note:  
1. Larger values may be required depending upon supply impedance.

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Figure 1. Test Circuit

Table 1.  $V_{IN} = 1.5V$

Component	Connections	Value	Description
$R_{SW}$	$V_{DD}$ , $R_{SW-OSC}$	$1M\Omega$	Boost converter oscillator bias resistor
$R_{EL}$	$V_{DD}$ , $R_{EL-OSC}$	$1M\Omega$	EL lamp driver oscillator bias resistor
L	$V_{DD}$ , $L_X^2$	$330\mu H^2$	Boost converter inductor
$C_S$	$C_S$ , GND	$0.1\mu F/100V$	Boost converter storage capacitor
D	$L_X$ , $C_S$	1N4148	Switching diode

Notes. 2. Murata LQH4N331K04 (8.2Ω max. DCR)

Table 2.  $V_{IN} = 0.9V$

Component	Connections	Value	Description
$R_{SW}$	$V_{DD}$ , $R_{SW-OSC}$	$1.0M\Omega$	Boost converter oscillator bias resistor
$R_{EL}$	$V_{DD}$ , $R_{EL-OSC}$	$2.62M\Omega$	EL lamp driver oscillator bias resistor
L	$V_{DD}$ , $L_X^3$	$680\mu H^3$	Boost converter inductor
$C_S$	$C_S$ , GND	$0.1\mu F/100V$	Boost converter storage capacitor
D	$L_X$ , $C_S$	1N4148	Switching diode

Notes. 3. Coilcraft DS1608C-684 (2.2Ω max. DCR)

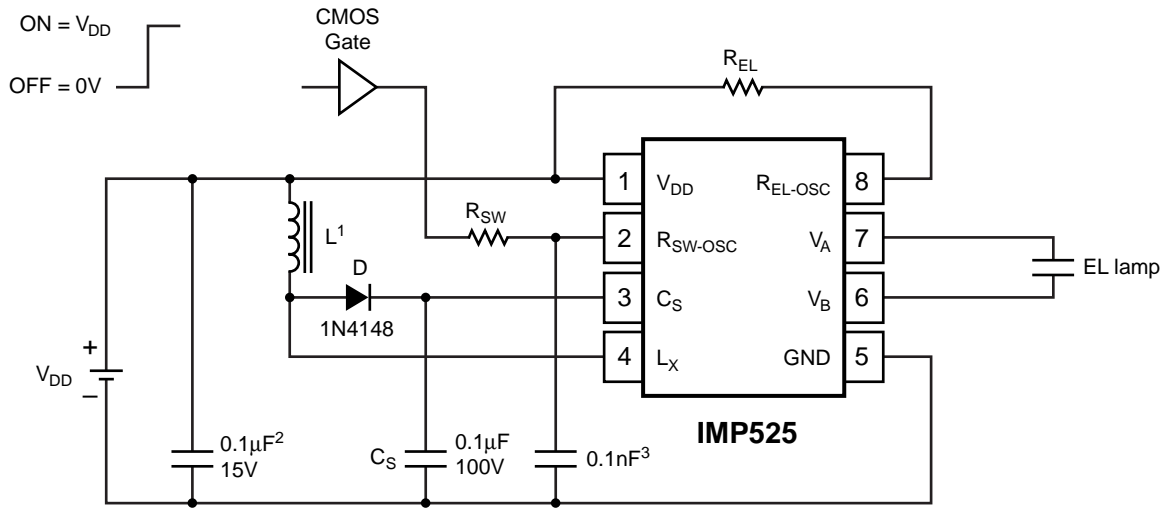
## Enable/Disable Operation

Figure 2 shows how the IMP525 can be enabled via a logic gate that connects  $R_{SW}$  to  $V_{DD}$ , and disabled by connecting it to ground.

The IMP525 can also be disabled using a pad on the die. The Disable function pin is not available in packaged parts.

Enable/Disable Table	
$R_{SW}$ Connection	IMP525 State
$V_{DD}$	Enabled
Ground	Disabled

Disable PAD Connection (Available only with dice)	IMP525 State
HIGH ( $V_{DD}$ )	Disabled
LOW (Ground)	Enabled



- Note:
1. Murata part # LQH4N561K04 (DC resistance <math>< 14.5 \Omega</math>)
  2. Larger values may be required depending upon supply impedance.
  3. Optional noise-suppression capacitor.

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Figure 2. Enable/Disable Operation

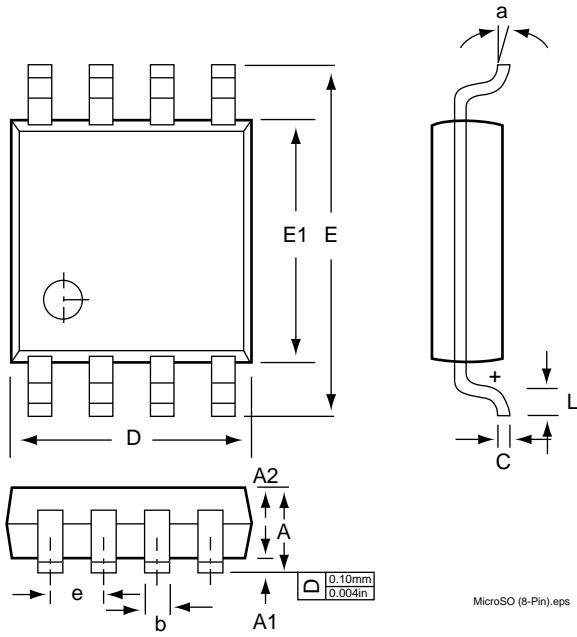
## High Voltages Present

The IMP525 generates high voltages and caution should be exercised.

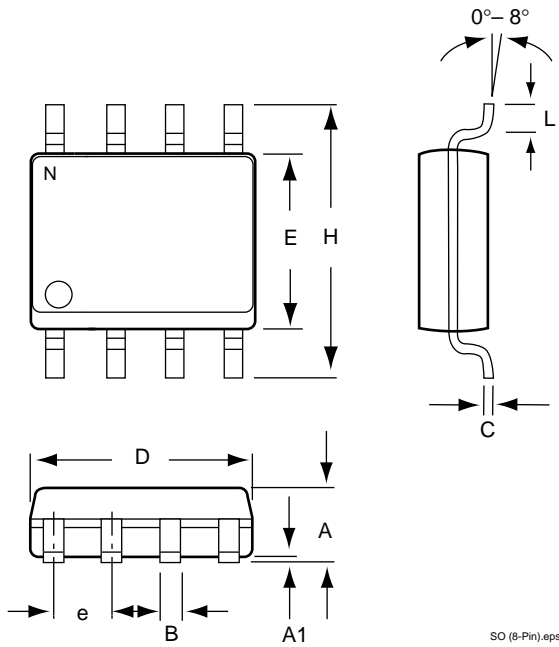
## Inductor Manufacturers

Manufacturer	Series	USA Phone Number
Toko	D52FU	(847) 297-0070
Coilcraft	DS1608, DO1608, DT1608	(847) 639-6400
River Electronics	FLC32	(310) 320-7488

**MicroSO (8-Pin)**



**SO (8-Pin)**



**Package Dimensions**

	Inches		Millimeters	
	Min	Max	Min	Max
<b>MicroSO (8-Pin)</b>				
A	—	0.0433	—	1.10
A1	0.0020	0.0059	0.050	0.15
A2	0.0295	0.0374	0.75	0.95
b	0.0098	0.0157	0.25	0.40
C	0.0051	0.0091	0.13	0.23
D	0.1142	0.1220	2.90	3.10
e	0.0256 BSC		0.65 BSC	
E	0.193 BSC		4.90 BSC	
E1	0.1142	0.1220	2.90	3.10
L	0.0157	0.0276	0.40	0.70
a	0°	6°	0°	6°
<b>SO (8-Pin)</b>				
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.013	0.020	0.33	0.51
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27
D	0.189	0.197	4.80	5.00



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