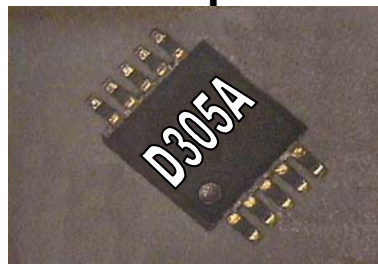


D305A IC Electroluminescent Lamp Driver IC

Features

- High AC Voltage Output Up To 400Vpp
- Very Low Standby Current
- Flexible Wave-shaping Capability
- External Clock Compatible
- Small MSOP-10 package
- Available in Lead-Free (Pb-free) and Green MSOP-10 package



MSOP-10

Applications

- White EL Lamp Backlight for Color LCD
- Wireless Handset
- PDA
- GPS
- Other Handheld Portable Electronics
- DFLX™ EL Keypad Lamps

Rogers DUREL® D305A IC is a high-power inverter intended for driving EL lamps as large as 100cm². The D305A IC is equipped with many control functions, including: wave-shaping programmability for frequencies, and stability of lamp color over wide temperature extremes.

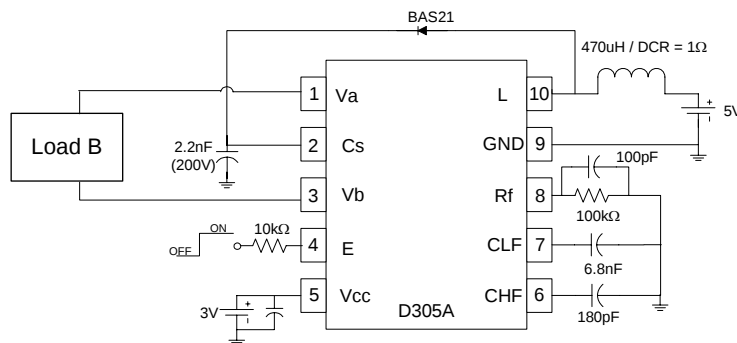
Lamp Driver Specifications:

(Using Standard Test Circuit at Ta=25°C unless otherwise specified)

Parameter	Symbol	Minimum	Typical*	Maximum	Units	Conditions
Standby Current			1	5	uA	E = GND
Supply Current	I _{bat}	85	99	115	mA	E = V _{cc}
Logic Supply Current	I _{cc}	16	17	19	mA	E = V _{cc}
Output Voltage	V _{out}	264	297	330	Vpp	E = V _{cc}
Lamp Frequency	LF	425	473	525	Hz	E = V _{cc}

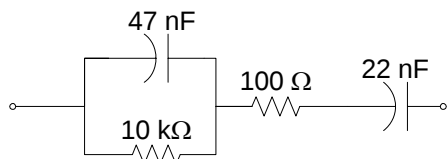
* Note - Typical values should not be used for specification limits.

Standard Test Circuit



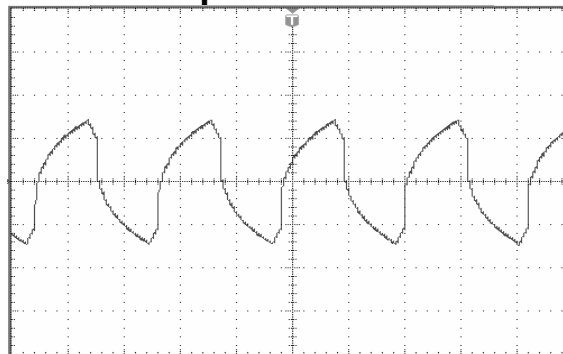
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Load B*



*Load B approximates a 5in^2 (32.3cm^2) EL lamp.

Output Waveform

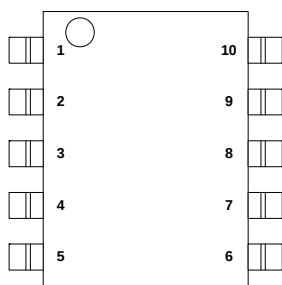


Absolute Maximum Ratings:

Parameter	Symbol	Minimum	Maximum	Unit	Comments
Supply voltage					
Operating Range	V_{bat}	2.5	7.0	V	$E = V_{\text{cc}}$
Withstand Range		-0.5	16		$E = \text{GND}$
Logic Drive Voltage					
Operating Range	V_{cc}	2	5	V	$E = V_{\text{cc}}$
Withstand Range		-0.5	6		$E = \text{GND}$
Enable Voltage	E	-0.5	$(V_{\text{cc}}) + 0.5$	V	
Lamp Output Voltage	$V_a - V_b$		410	V _{pk-pk}	$E = V_{\text{cc}}$
Operating Temperature	T_a	-40	85	°C	Ambient
Storage Temperature	T_s	-55	150	°C	

Note: The above table reflects ratings only. Functional operation of the device at these ratings or any other above those indicated in the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

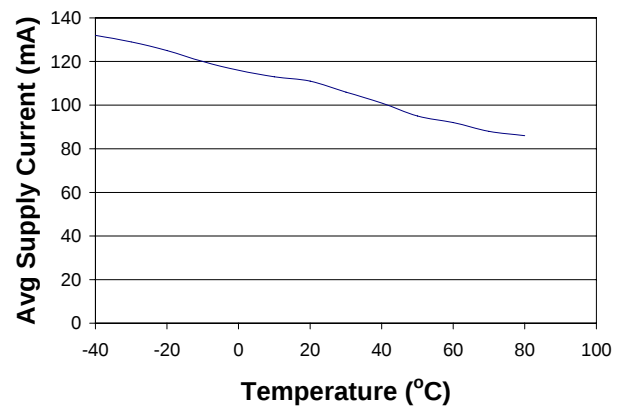
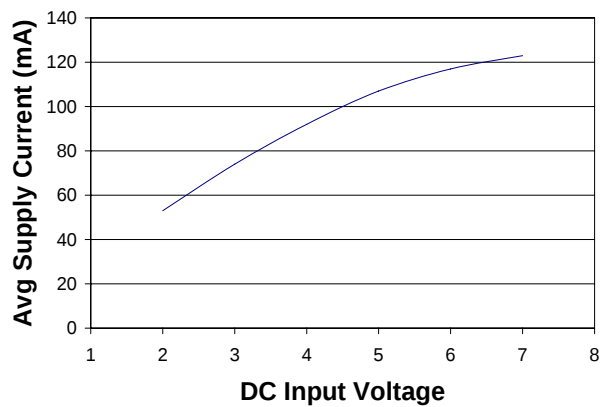
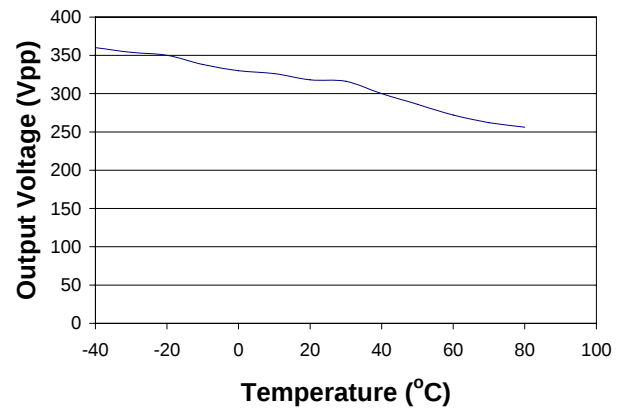
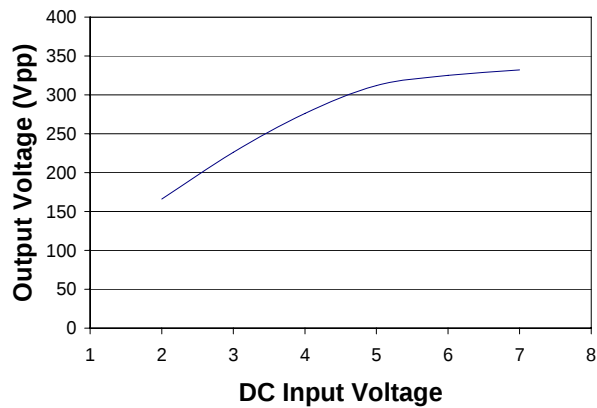
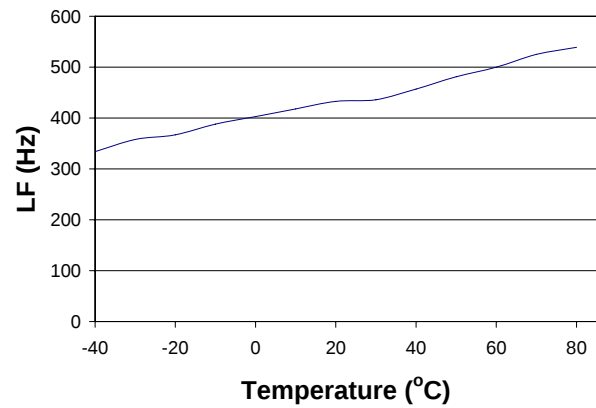
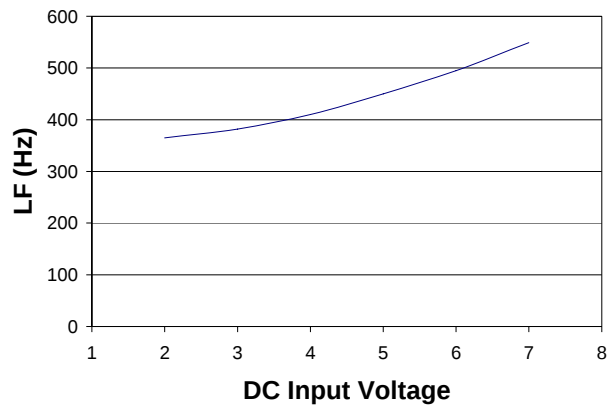
Physical Data:



PIN #	NAME	FUNCTION
1	V_a	AC voltage output to EL lamp
2	Cs	High voltage storage capacitor input
3	V_b	AC voltage output to EL lamp
4	E	System enable; Wave-shaping resistor control
5	V_{cc}	Logic drive voltage
6	CHF	Capacitor input to high frequency oscillator
7	CLF	Capacitor input to low frequency oscillator
8	Rf	Resistor input for frequency control
9	GND	Power ground
10	L	Inductor input

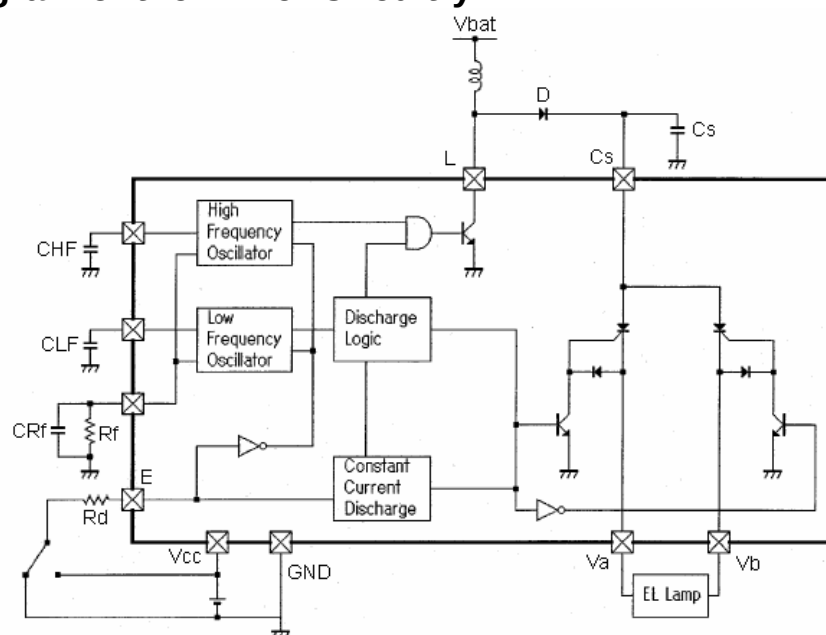
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Performance Characteristics



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Block Diagram of the Driver Circuitry



Theory of Operation

Electroluminescent (EL) lamps are essentially capacitors with one transparent electrode and a special phosphor material in the dielectric. The phosphor glows when a strong AC voltage is applied across the EL lamp electrodes. The required AC voltage is typically not present in most systems and must be generated from a low voltage DC source.

The D305A IC inverter drives the EL lamp by using a switching transistor to repeatedly charge an external inductor and discharge it to the high voltage capacitor Cs. The discharging causes the voltage at Cs to continually increase. When the voltage at Cs reaches a nominal value, the switching transistor is turned off. The internal circuitry uses the H-bridge technology, using both electrodes to drive the EL lamp. One of the outputs, Va or Vb, is used to discharge Cs into the EL lamp during the first half of the low frequency (LF) cycle. By alternating the state of the H-bridge, the other output is used to charge the EL lamp during the second half of the LF cycle. The alternating states make it possible to achieve 400V peak-to-peak across the EL lamp.

The EL driving system is divided into several parts: on-chip logic control, on-chip high voltage output circuitry, on-chip discharge logic circuitry, and off-chip components. The on-chip logic controls the lamp operating frequency (LF) and the inductor switching frequency (HF). These signals are used to drive the high voltage output circuitry (H-bridge) by delivering the power from the inductor to the lamp. The integrated discharge logic circuitry uses a patented wave-shaping technique for reducing audible noise from an EL lamp. Changing the Rd value changes the slope of the linear discharge as well as the shape of the waveform. The off-chip component selection provides a degree of flexibility to accommodate various lamp sizes, system voltages, and brightness levels.

Typical D305A IC EL driving configurations for driving EL lamps in various applications are shown on the following page. The expected system outputs for the various circuit configurations are also shown with each respective figure. These examples are only guides for configuring the driver. Rogers provides a D305A IC Designer's Kit, which includes a printed circuit evaluation board intended to aid you in developing an EL lamp driver configuration using the D305A IC that meets your requirements. A section on designing with the D305A IC is included in this datasheet to serve as a guide to help you select the appropriate external components to complete your D305A IC EL driver system.

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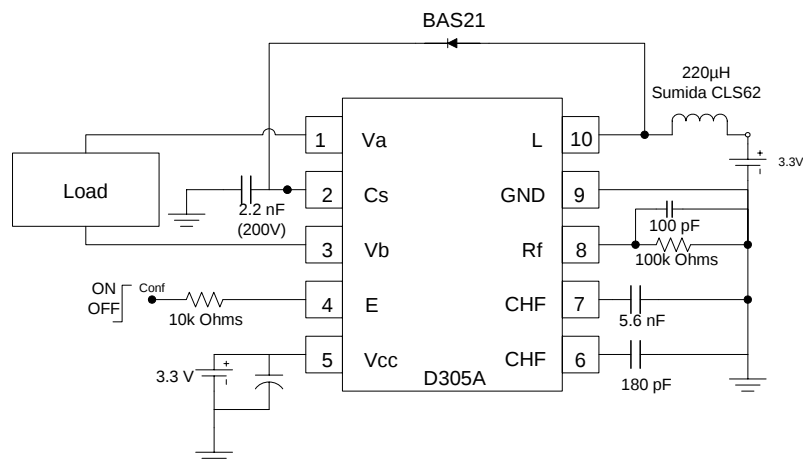
Reference D305A EL Driver Configurations

Several D305A IC configurations for driving EL lamps in various applications are shown below. The expected system outputs, such as lamp luminance, lamp output frequency and voltage and average supply current draw for the various sample configurations are also shown with each respective figure.

Handset Color LCD Backlight

Characteristic Output

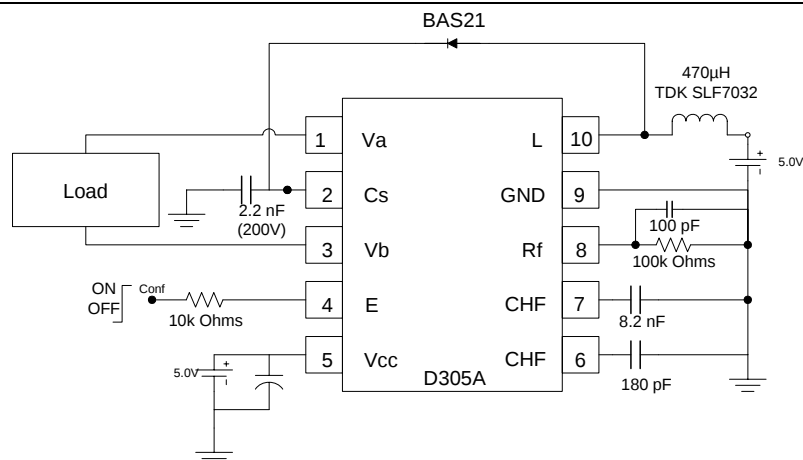
Brightness = 19.5 fL (66 cd/m²)
Lamp Frequency = 500 Hz
Logic Supply Current = 20 mA
Power Supply Current = 66 mA
Vout = 310 Vpp
Load: 2in² (12.9cm²) DUREL® 3 White EL



PDA Display

Characteristic Output

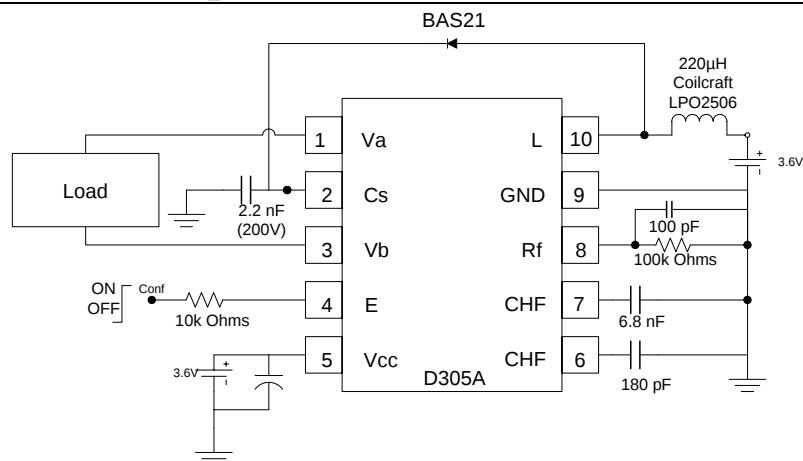
Brightness = 18.5 fL (63 cd/m²)
Lamp Frequency = 358 Hz
Logic Supply Current = 18 mA
Power Supply Current = 87 mA
Vout = 408 Vpp
Load: 5in² (32.2cm²) DUREL 3 Green EL



Bright Blue Backlight for LCD

Characteristic Output

Brightness = 21.5 fL (73 cd/m²)
Lamp Frequency = 415 Hz
Logic Supply Current = 19 mA
Power Supply Current = 68 mA
Vout = 408 Vpp
Load: 1in² (6.5 cm²) DUREL 3 Blue EL



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Designing With A D305A EL Driver IC

I. Lamp Frequency Capacitor (CLF) Selection

The output frequency of the D391A EL driver is determined by the lamp frequency capacitor (CLF) selection. Figure 1 graphically represents the inversely proportional relationship between the CLF capacitor value and the oscillator frequency when $V_{bat} = V_{cc} = 3.0V$.

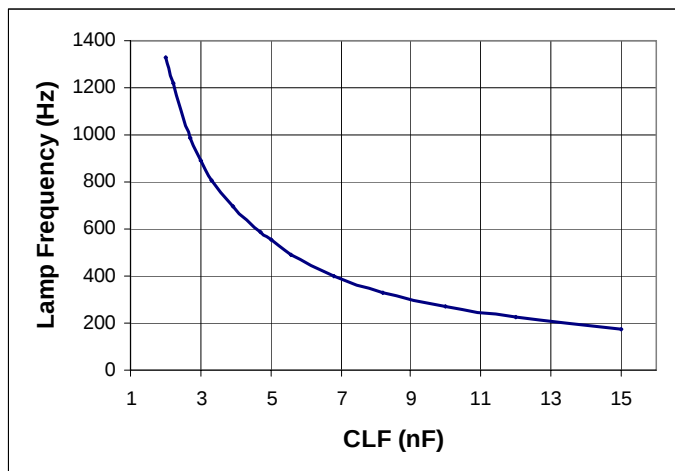


Figure 1—Lamp frequency vs. CLF capacitor

II. High Frequency Capacitor (CHF) Selection

The high frequency capacitor (CHF) will set the inductor switching frequency of the D305A IC. Figure 2 graphically represents the effect of the CHF value on the oscillator frequency when $V_{bat} = V_{cc} = 3.0 V$.

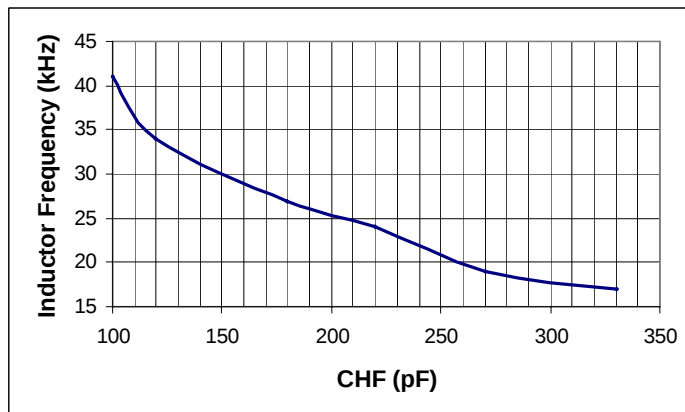


Figure 2—Inductor frequency vs. CHF capacitor

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III. Inductor (L) Selection

The inductor value has a large impact on the output brightness and current consumption of the driver. Figure 3 shows typical brightness and current draw of a D305A IC circuit with different inductor values. Please note that the DC resistance (DCR) and current rating of inductors with the same inductance value may vary with manufacturer and inductor type. Thus, inductors made by a different manufacturer may yield different outputs, but the trend of the different curves should be similar. This curve is intended to give the designer a relative scale from which to optimize specific applications. Absolute measurements may vary depending upon the type and brand of other external components selected.

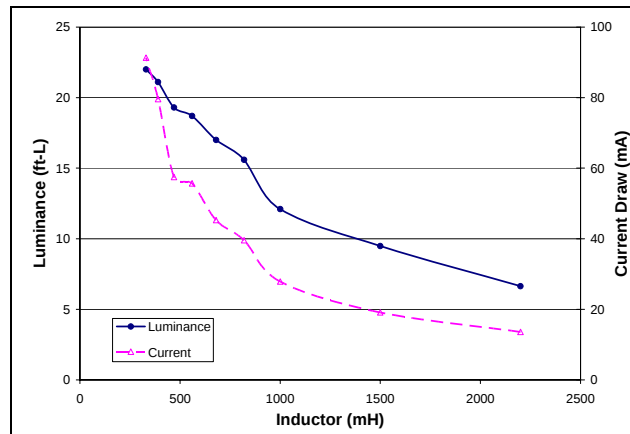


Figure 3—Luminance and current vs. inductor value
(Conditions: $V_{cc} = V_{bat} = 3.3V$, 12.9 cm^2 EL Lamp)

IV. Wave-Shape Selection

The D305A EL driver IC uses a patented wave-shaping technique for reducing audible noise from an EL lamp. The slope of the discharge section of the output waveform may be adjusted by selecting a proper value for the wave-shape discharge resistor (R_d) in series with the E pin input. The optimal discharge level for an application depends on the lamp size, lamp brightness, and application conditions. To ensure that the D305A IC is configured optimally, various discharge levels should be evaluated. In many cases, lower discharge levels may result in lower audible noise from the EL lamp. The recommended typical value for R_d is $10 \text{ k}\Omega$.

V. Storage Capacitor (Cs) Selection

The C_s capacitor is used to store the energy transferred from the inductor before discharging the energy to the EL lamp. C_s values can range from 1.5nF to 4.7nF and must have minimum $200V$ rating. In general, the C_s value does not have a large affect on the output of the device. The typical C_s capacitor recommendation is 2.2nF with $200V$ rating.

VI. R_f and CR_f Selection

The combination of R_f and the timing capacitors, CLF and CHF , determines the time constants for the low frequency oscillator and the high frequency oscillator, respectively. To simplify the tuning of the oscillator frequencies to the desired frequency range, a standard value of $100 \text{ k}\Omega$ is recommended for R_f .

The CR_f capacitor is used as a stabilizing capacitor to filter noise on the R_f line. A small 100pF capacitor is typically a sufficient value for CR_f .

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VII. Fast Recovery Diode

Energy stored by the coil is eventually forced through the external diode to power the switched H-bridge network. A fast recovery diode, such as BAS21, is recommended for this function for optimum operation.

VIII. Printed Circuit Board Layout

The high frequency operation and very high voltage output of the D305A IC makes printed circuit board layout important for minimizing electrical noise. The following are general PCB layout recommendations. Maintain the IC connections to the inductor as short as possible. Connect the GND of the device directly to the GND plane of the PCB. Keep the GND pin of the device and the ground leads of the Cs, CLF, and CHF less than 5mm apart. If using bypass capacitors to minimize ripple on the supply lines, keep the bypass caps as close as possible to the Vbat lead of the inductor and the Vcc pin.

IX. Split Voltage Supply

A split supply voltage is recommended to drive the D305A IC. To operate the on-chip logic, a regulated voltage supply (Vcc) ranging from 2.0V to 6.5V is applied. To supply the D305A IC with the necessary power to drive an EL lamp, another supply voltage (V_{bat}) with higher current capability is applied to the inductor. The voltage range of V_{bat} is determined by user application, lamp size, and inductor selection and power limitations of the battery.

An example of the split supply configuration is shown in Figure 4 below. This example shows a regulated 3.0V applied to the Vcc pin and a V_{bat} voltage that may range from 3.6V to 6.2V or regulated at 5.0V. The enable voltage is in the range of 2.0V to 3.0V. This is a typical setup used in PDA applications.

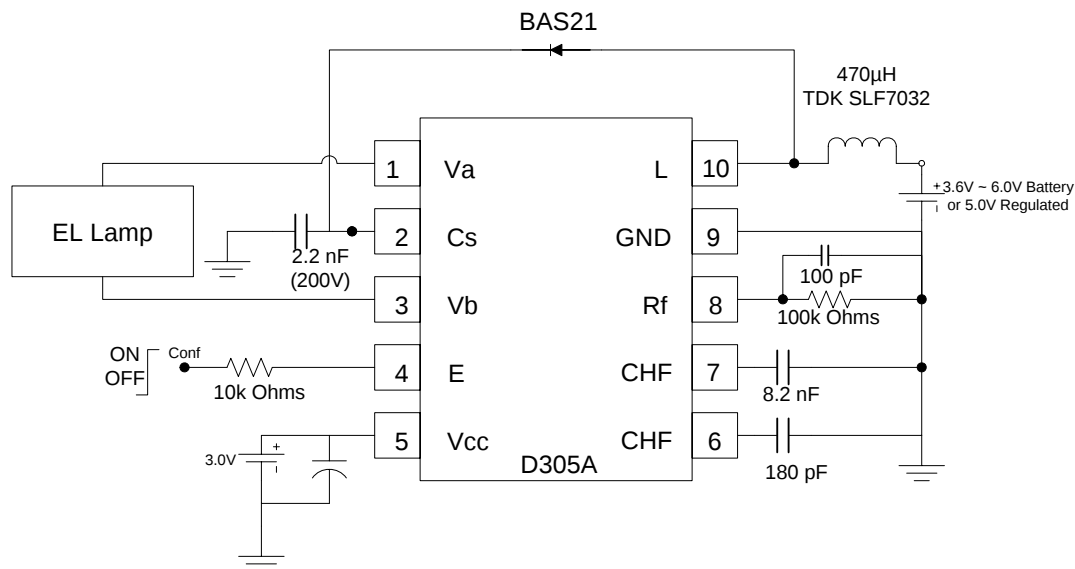


Figure 4—Split voltage supply example

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II. Controlling EL Brightness through Clock Pulse Width Modulation (Option 1)

Pulse width modulation of the external LF input signal may be used to regulate the brightness of the EL lamp. Figure 6 below demonstrate example of the D305A IC output waveform with pulse width modulation of the LF input signal. As the positive duty cycle of the LF input signal is increased from 15% to 100%, the charging period of the output waveform decreases, and the peak voltage of the output waveform also decreases towards zero output. Therefore, incremental dimming occurs as a result of the wave-shaping changes. This scheme may also be used inversely to regulate lamp brightness over the life of the battery or to compensate for lamp aging. Figure 7 below shows a typical dimming curve using this technique. Operation at duty cycles lower than 10% is not recommended. Clock frequency can range from 400 Hz to 2000 Hz. The maximum amplitude of the clock signal may range from 1.0V to V_{CC} . Refer back to Figure 5 for an example circuit.

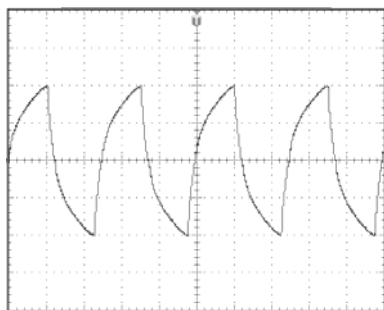


Figure 6a— LF Input Duty Cycle = +15%

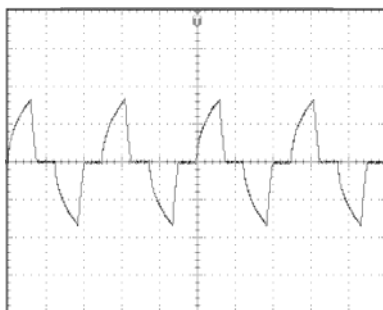


Figure 6b— LF Input Duty Cycle = +50%

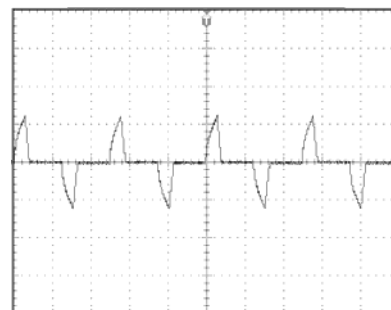


Figure 6c—LF Input Duty Cycle = +75%

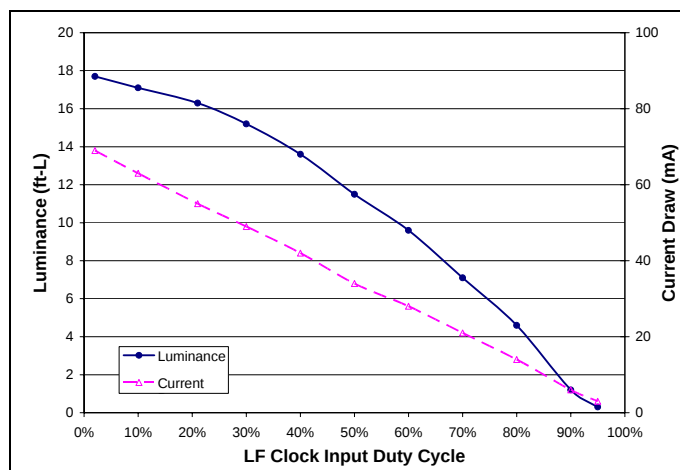


Figure 7—Luminance and current draw vs. LF duty cycle

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III. Controlling EL Brightness through Clock Pulse Width Modulation (Option 2)

Pulse width modulation of the external HF input signal also may be used to regulate the brightness of the EL lamp. As the positive duty cycle of the LF input signal is increased from 15% to 100%, the peak voltage of the output waveform decreased incrementally to zero output as the inductor charging period is affected by the HF duty cycle. Lamp dimming is thus achieved with pulse width modulation of the HF input signal to the D305A IC. This scheme may also be used inversely to regulate lamp brightness over the life of the battery or to compensate for lamp aging. Figure 8 shows a typical dimming curve with this technique. The recommended HF duty cycle range is from 10% to 95%. Clocking frequency can range from 20 KHz to 35 KHz. The maximum amplitude of the clock signal may range from 1.0V to V_{CC} . Refer back to Figure 5 for an example circuit.

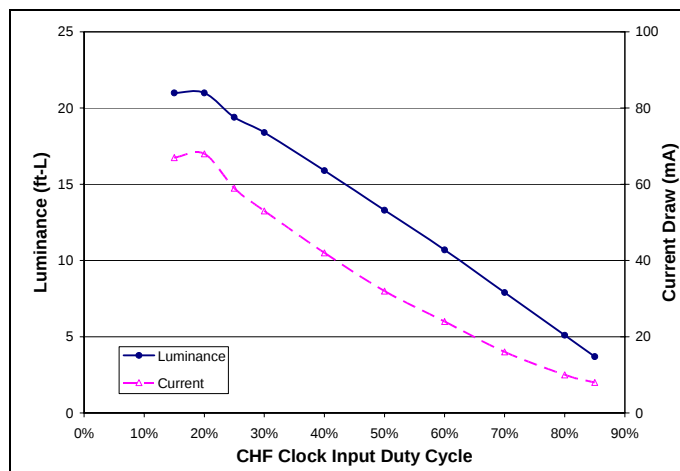


Figure 8—Luminance and current draw vs. CHF duty cycle

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IV. Solder Re-Flow Recommendations

Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly		Pb-Free Assembly	
	Large Body	Small Body	Large Body	Small Body
Average ramp-up rate (T_L to T_P)	3°C/second max.		3°C/second max.	
Preheat -Temperature Min (T_{smin}) -Temperature Max (T_{smax}) -Time (min to max) (ts)	100°C 150°C 60-120 seconds		150°C 200°C 60-180 seconds	
T_{smax} to T_L -Ramp-up Rate			3°C/second max.	
Time maintained above: Temperature (T_L) -Time (T_L)	183°C 60-150 seconds		217°C 60-150 seconds	
Peak Temperature (T_P)	225 +0/-5°C	240 +0/-5°C	245 +0/-5°C	250 +0/-5°C
Time within 5°C of actual Peak Temperature (T_P)	10-30 seconds	10-30 seconds	10-30 seconds	20-40 seconds
Ramp-down Rate Time 25°C to Peak	6°C/second max.		6°C/second max.	
Temperature	6 minutes max.		8 minutes max.	

Note: All temperatures refer to topside of the package, measured on the package body surface and refer to IPC/JEDEC J-STD-020B standards.

IPC/JEDEC J-STD-020B

July 2002

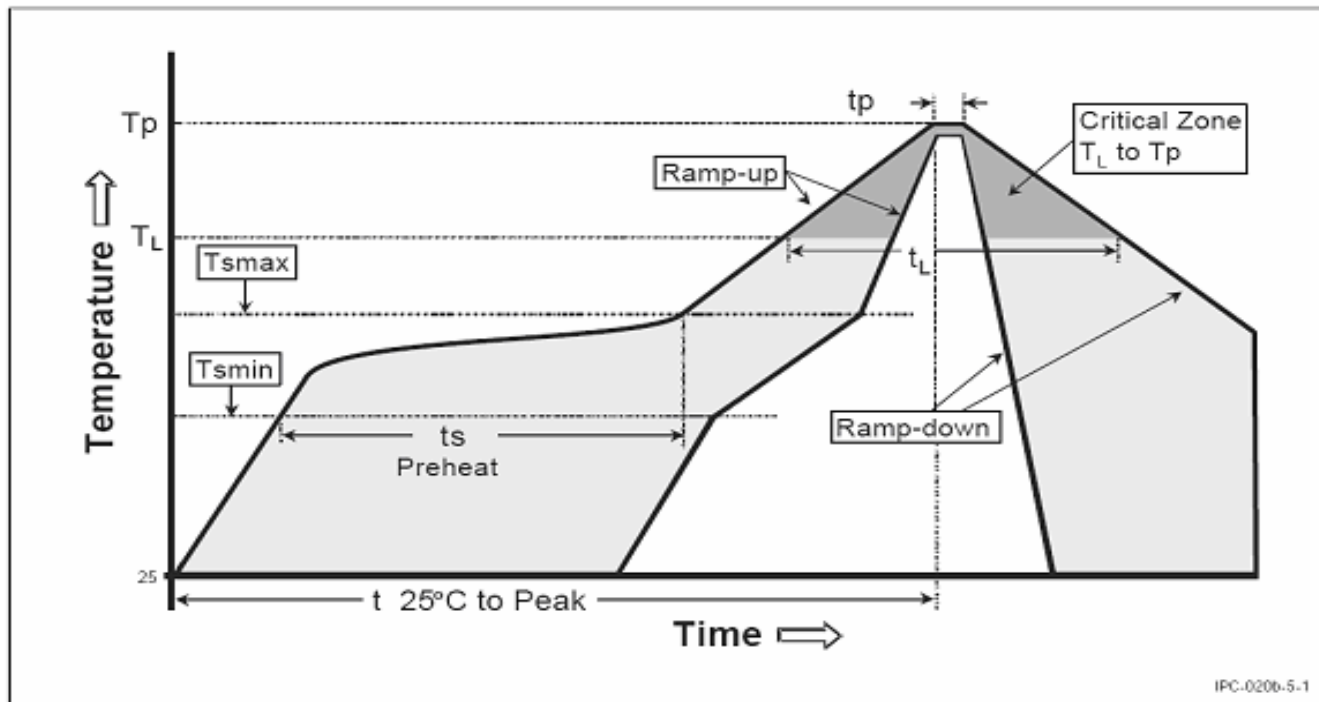
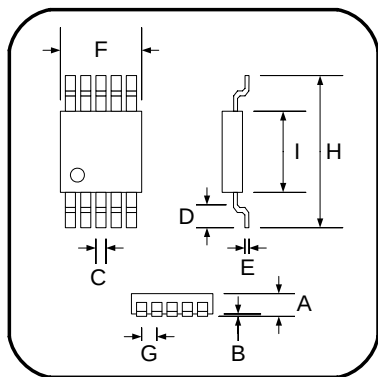


Figure 5-1 Classification Reflow Profile

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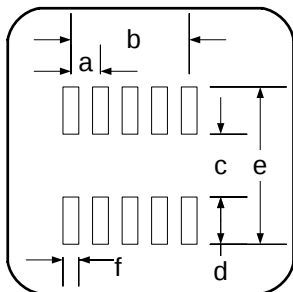
Ordering Information

The D305A IC is available in standard or Pb-free Green MSOP-10 plastic package per tape and reel. A Rogers' D305A IC Designer's Kit (1DDD305AA-K01) provides a vehicle for evaluating and identifying the optimum component values for any particular application using D305A IC. Rogers' engineers also provide full support to customers including specialized circuit optimization and application retrofits upon request.



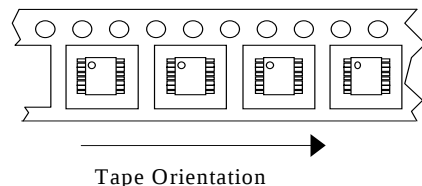
	MSOP-10					
	Min		Typical		Max	
	mm	in	mm	in	mm	in
A	0.92	0.036	1.00	0.039	1.08	0.043
B	0.05	0.002	0.10	0.004	0.15	0.006
C	0.15	0.006	0.23	0.009	0.31	0.012
D	0.40	0.016	0.55	0.022	0.70	0.028
E	0.13	0.005	0.18	0.007	0.23	0.009
F	2.90	0.114	3.00	0.118	3.10	0.122
G	0.35	0.014	0.50	0.020	0.65	0.026
H	4.75	0.187	4.90	0.193	5.05	0.199
I	2.90	0.114	3.00	0.118	3.10	0.122

Recommended Pad Layout:



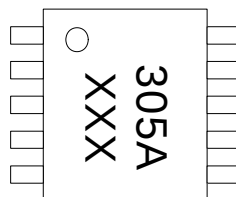
	MSOP-10 PAD LAYOUT					
	Min		Typical		Max	
	mm	in	mm	in	mm	in
a			0.50	0.0197		
b			2.00	0.0787		
c	3.3	0.130			3.45	0.136
d	0.89	0.035	0.97	0.038	1.05	0.041
e	5.26	0.207			5.41	0.213
f			0.30	0.012		

MSOP-10 ICs in Tape & Reel:



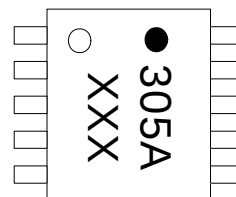
MSOP: Embossed tape on 360 mm diameter reel. 2500 units per reel. Quantity marked on reel label

Standard Package



1DDD305AA-MO4

Pb-free Green Package



1DDD305AA-NL4

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ISO 9001:2000, ISO/TS 16949:2002, and ISO 14001:2004 Certified

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Rogers EL drivers are covered by one or more of the following U.S. patents #5,313,141; #5,789,870; #5,677,599; #6,043,610, #7,009,346. Corresponding foreign patents are issued or pending.

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Revised 04/07 Publication #LIT-I9046 A05