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Data Sheet

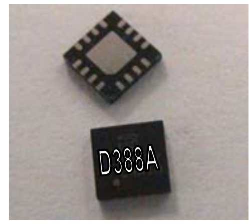
D388A Electroluminescent Lamp and White LED Driver IC
DLL3A Liquid Lens Driver IC

Features

- IC driver for EL lamps and up to 4HBLEDs
- Uses single low-profile inductor
- Regulated EL voltage and LED current
- Independent dimming control of LEDs and EL lamp
- Capable of over 200Vpp output to EL lamps
- External clock compatible
- Open load protection for EL and LED output
- Wave-shaping control for noise reduction
- Soft-start limiting inrush current
- Small 4x4mm QFN in Lead-free (Pb-Free) Green Package

Applications

- Handsets color STN/TFT LCDs
- DFLX™ EL lamp Keypads
- PDAs
- Handheld GPS
- MP3/GPS/Remote controls
- Multiple LCDs and back-to-back Displays



QFN - 16

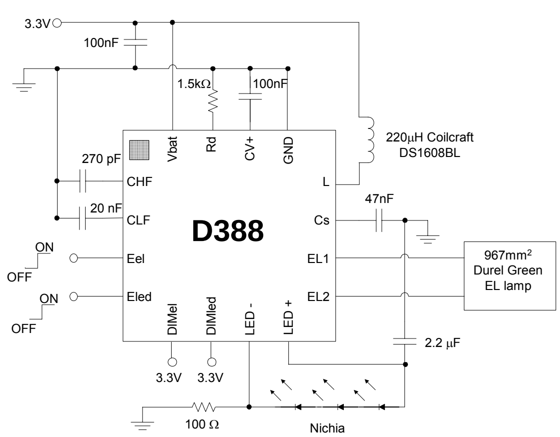
Rogers DUREL® D388A EL driver is an integrated solution for driving EL lamps and high brightness white LEDs independently with the minimum number of components. LED current control provides constant LED brightness and dimming options. This device uses a proprietary circuit design for programmable wave-shaping of the high voltage AC output to the EL lamp for low-noise performance in applications that are sensitive to audible and electrical noise.

Lamp Driver Specifications:

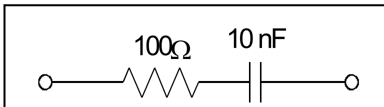
(Using Standard Test Circuit at Ta=25°C unless otherwise specified.)

Parameter	Symbol	Minimum	Typical	Maximum	Units	Conditions
Supply Current	Ibat		75		mA	E = 3.3 V+
Output Voltage	Vout	164	200		Vpp	E = 3.3 V+
Lamp Frequency	LF	400	500	600	Hz	CLF = 20.0 nF
LED Current	I		10		mA	

Sample Application Circuit:

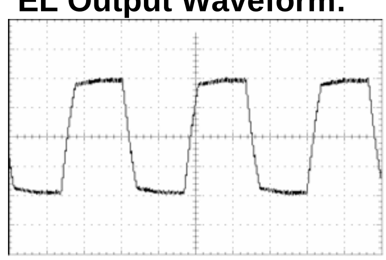


Load 2*



*Load 2 approximates a 3in^2 EL lamp

EL Output Waveform:



The information contained in this data sheet is intended to assist you in designing with Rogers Driver ICs. It is not intended to and does not create any warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose or that the results shown on the data sheet will be achieved by a user for a particular purpose. The user should determine the suitability of Rogers EL drivers for each application.

Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Unit	Comments
Supply Voltage Operating Range Withstand Range	Vbat	2.5 -0.4	7.0 7.0	V	E_{EL}, E_{LED} = Vbat E_{EL}, E_{LED} = GND
Enable Voltage	E_{EL}, E_{LED}	-0.4	7.0	V	
DIM Input Voltage	DIMel, DIMled	-0.4	7.0	V	
CHF Voltage	V_{CHF}	-0.4	7.0	V	External Clock Input
CLF Voltage	V_{CLF}	-0.4	7.0	V	External Clock Input
Output Voltage	EL1, EL2		110	V	EL Output Peak Voltage
Operating temperature	T_a	-40	85	°C	Ambient
Total Power Dissipation	P_{tot}		450	mW	
Average Thermal Resistance	θ_{ja}		142	°C/W	Junction to Ambient
Storage temperature	T_s	-55	150	°C	Ambient
Lead Soldering Temperature			260	°C	10 sec dwell
ESD Voltage Human Body Model (Note 1)	V_{ESD}		1000	V	Pin L (HBM Class1)
			2000	V	All Other Pins (HBM Class 2)
ESD Voltage Machine Model (Note 2)	V_{ESD}		100	V	Pin L (MM Class 1)
			200	V	All Other Pins (MM Class 2)

Note: The above table reflects the stress 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.

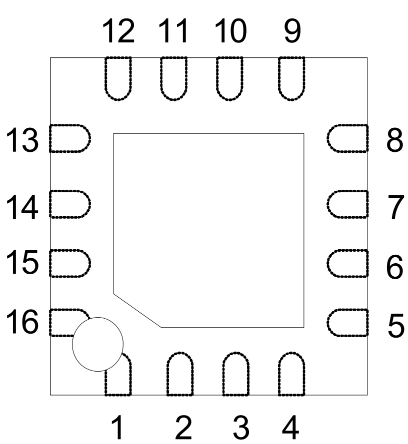
(1) Equivalent to discharging a 100pf capacitor through a 1.5KΩ resistor.
(2) Equivalent to discharging a 200pf capacitor through a 0.75µH coil and a 10Ω resistor.

Electrical Characteristics

(At Ta=25 °C unless otherwise noted.)

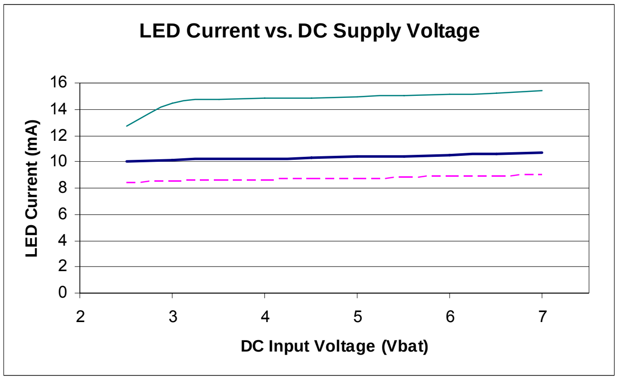
Parameter	Symbol	MIN	TYP	MAX	Units	Conditions
Quiescent Current	Ibat			1	µA	Eel = Eled = GND
Eel, Eled Input Threshold	VIH	1.3			V	
	VIL			0.4	V	
Eel, Eled Input Current	IIH, IIL			10	µA	Eel = Eled = Vbat

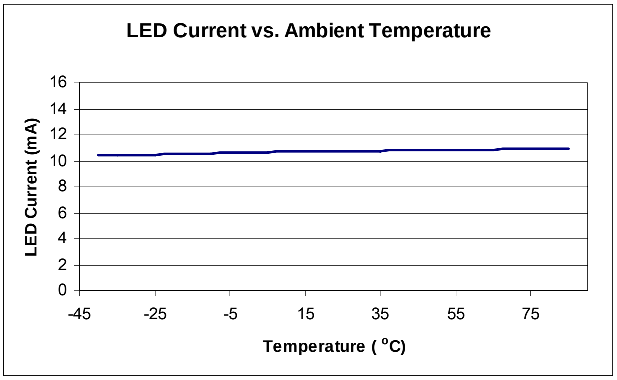
Physical Data

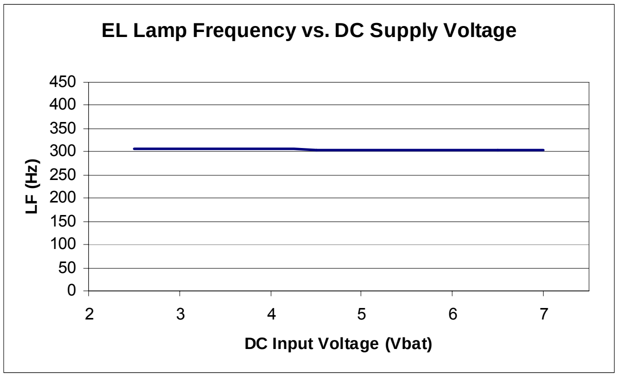


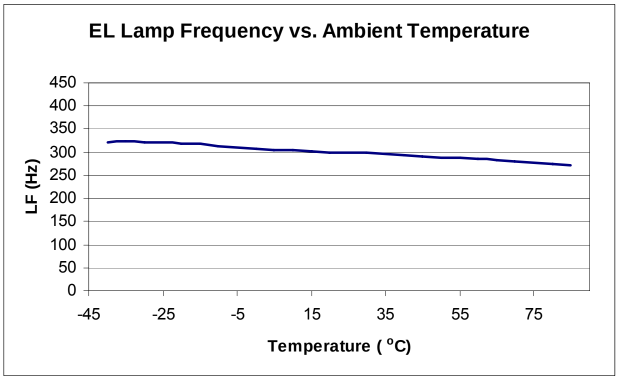
PIN #	NAME	FUNCTION
1	**CHF**	**Capacitor input to high frequency oscillator**
2	**CLF**	**Capacitor input to low frequency oscillator**
3	**Eel**	**EL Enable Pin**
4	**Eled**	**LED Enable Pin**
5	**DIMel**	**Dimming control for EL Lamp**
6	**DIMled**	**Dimming control input for LEDs**
7	**LED-**	**Cathode connection for LEDs in series**
8	**LED+**	**Anode connection for LEDs in series**
9	**EL2**	**EL Lamp terminal 2 connection**
10	**EL1**	**EL Lamp terminal 1 connection**
11	**Cs**	**EL storage capacitor input**
12	**L**	**Inductor connection**
13	**GND**	**System ground connection**
14	**CV+**	**Bypass capacitor of internal reference voltage**
15	**Rd**	**Resistor input to EL wave-shaping control**
16	**Vbat**	**Battery voltage input**

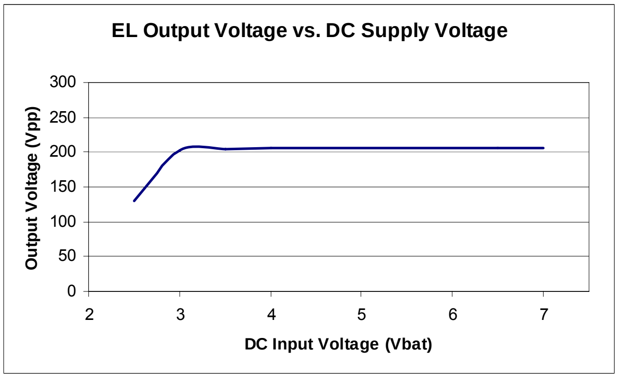
Typical Performance Characteristics

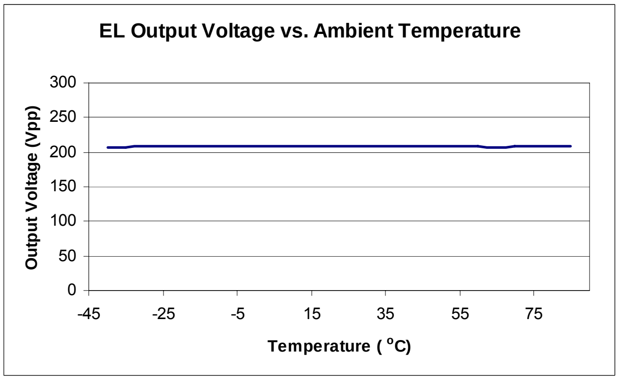


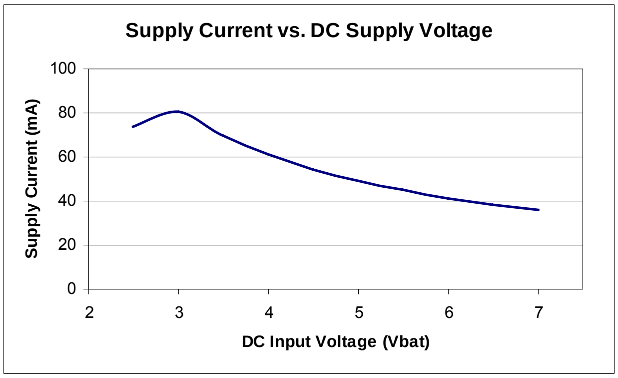












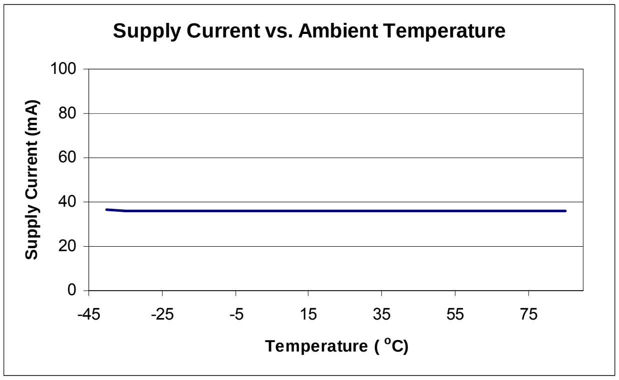
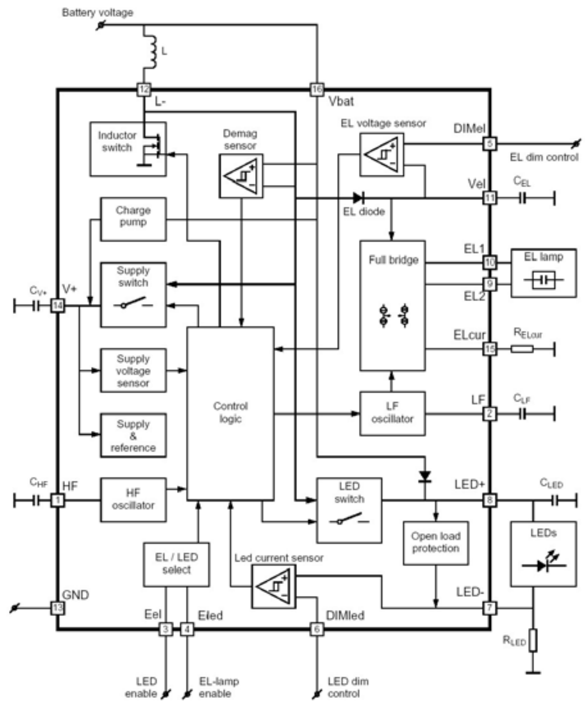


Diagram of the Driver Circuitry

Theory of Operation



The D388A IC can drive an electroluminescent (EL) lamp and high-brightness LEDs separately or simultaneously using a single inductor. An integrated switching power transistor is used to pump charge through the external inductor. Logic control signals trigger the operation of the high frequency oscillator which controls the inductor charging on-time, ratio, and frequency. The ratio of inductor charging pulses to transfer energy to the LED driving circuit and the EL driving circuit is determined by the three-state logic control on the Ratio pin.

EL lamps are essentially capacitors with one transparent electrode and a special phosphor material in the dielectric. When a strong AC voltage is applied across the EL lamp electrodes, the phosphor material emits light. The D388A IC powers the EL lamp by transferring the charge stored in L to a high voltage capacitor (Cs). The voltage at Cs is increased to a high DC value. The internal circuitry uses the full bridge configuration to discharge the energy in Cs to the two electrodes (Va and Vb) of the EL lamp. By alternating the state of the full bridge, at a frequency set by the lamp frequency (LF) oscillator, it is possible to achieve over 200V peak-to-peak across Va and Vb of the lamp.

The D388A IC is also ideal for simultaneously driving light emitting diodes (LEDs). Energy from the inductor is converted and stored in C_{LED} and subsequently released through the LEDs. The D388A IC uses a closed-loop current control scheme to regulate the output current to the LEDs. A single external current sense resistor (Rled) sets LED current, which can be adjusted also using an external dimming signal into the DIM pin.

The preceding block diagram for the D388A IC outlines the various subsystems of the device. The different on-chip logic blocks control the LF and HF oscillators, LED to EL pulse energy ratio, LED dimming level, and enable input processing. These signals are combined and buffered to control the high voltage output circuitry of the full bridge for driving the EL lamp. The selection of off-chip components provides device performance flexibility to accommodate various EL lamp sizes, number of LEDs, system input voltages, and brightness levels.

Rogers provides a D388A IC Designer's Kit, which includes a printed circuit evaluation board intended to aid you in developing an EL lamp driver configuration that meets your requirements using the D388A IC. A section on designing with the D388A IC is included in this datasheet to serve as a guide to help you select the appropriate external components to complete your D388A EL driver system.

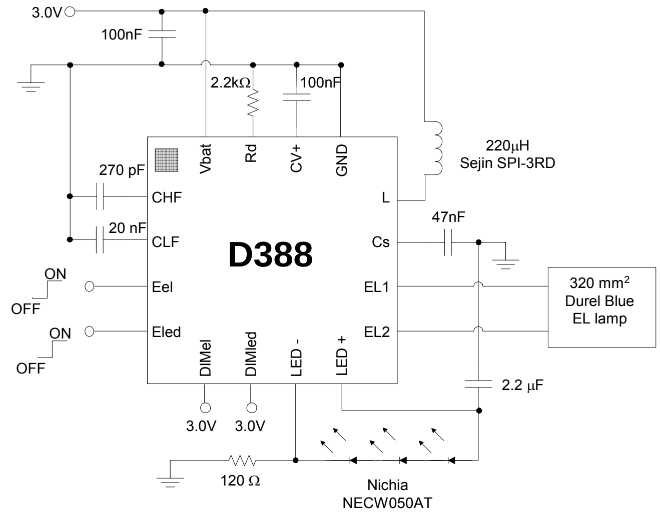
Typical D388A IC configurations for driving HBLEDs and EL lamps in various applications are shown below. The expected system outputs, such as lamp luminance, lamp output frequency and voltage and average supply current draw for the various sample configurations are also shown with each respective figure.

Reference D388A IC EL and HBLED Driver Configurations

Three White HBLEDs and 0.5 in^2 (320 mm^2) EL Lamp

Typical Output

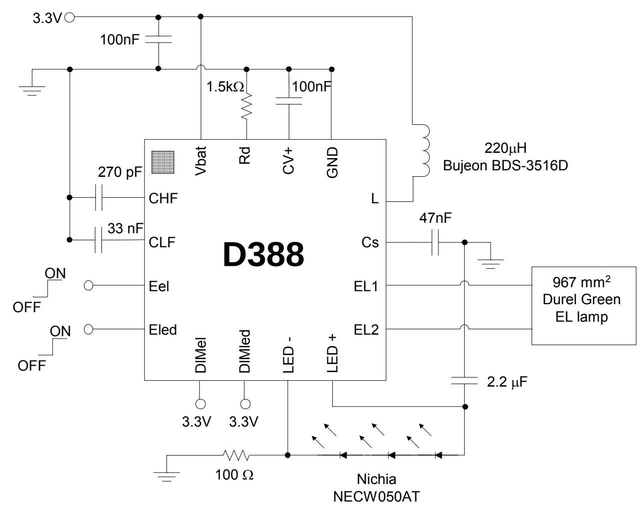
LED current = 8 mA
EL Luminance = 24 cd/m^2 (7.0 fL)
EL Lamp Frequency = 495 Hz
EL Vout = 200 Vpp
Ibat = 54 mA



Three White HBLEDs and 1.5 in^2 (967 mm^2) EL Lamp

Typical Output

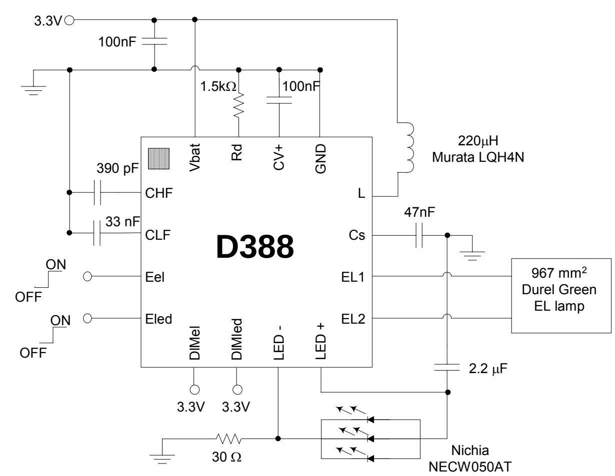
LED current = 10 mA
EL Luminance = 26.0 cd/m^2 (7.6 fL)
EL Lamp Frequency = 300 Hz
EL Vout = 200 Vpp
Ibat = 60 mA



Three Parallel HBLEDs and 1.0 in^2 (645 mm^2) EL Lamp

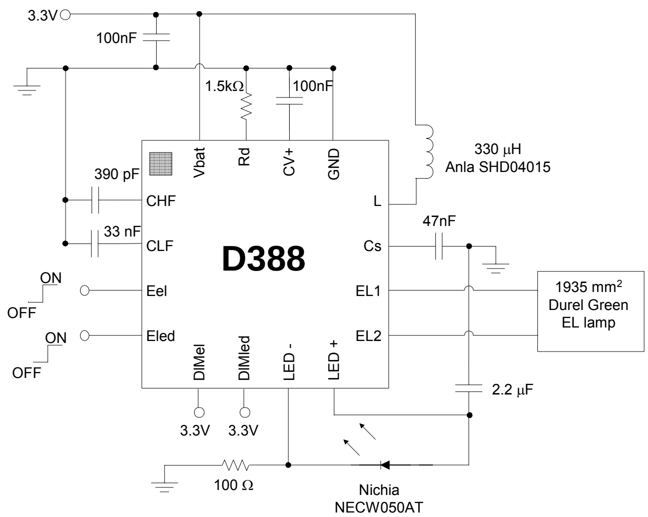
Typical Output

LED current = 10 mA (each LED)
EL Luminance = 22.0 cd/m^2 (6.5 fL)
EL Lamp Frequency = 300 Hz
EL Vout = 183 Vpp
Ibat = 89 mA



Reference D388A IC EL and HBLED Driver Configurations

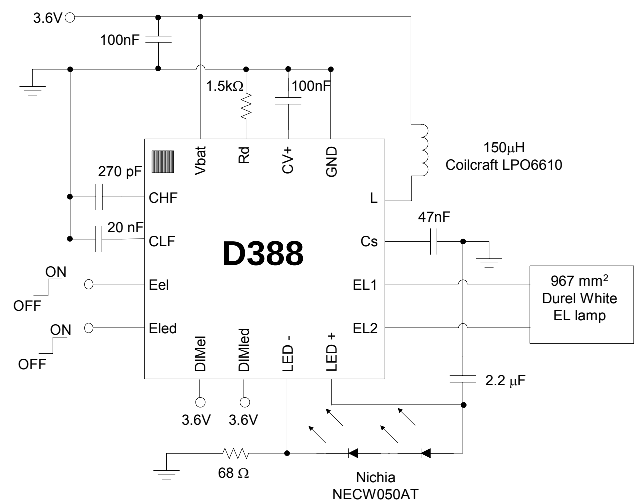
One White HBLED and 3.0 in^2 (1935mm^2) EL Lamp



Typical Output

LED current = 10 mA
EL Luminance = 24 cd/m^2 (7.0 fL)
EL Lamp Frequency = 300 Hz
EL Vout = 190 Vpp
Ibat = 57 mA

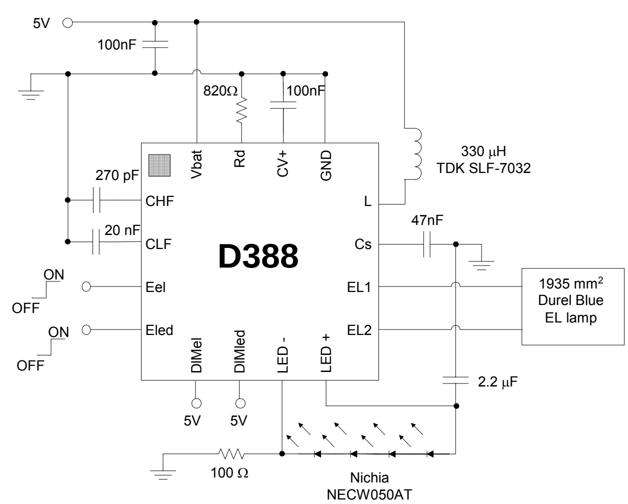
Two White HBLEDs and 1.5 in^2 (967 mm^2) EL Lamp



Typical Output

LED current = 15 mA
EL Luminance = 33 cd/m^2 (9.6 fL)
EL Lamp Frequency = 492 Hz
EL Vout = 204 Vpp
Ibat = 74 mA

Four White HBLEDs and 3.0 in^2 (1935 mm^2) EL Lamp



Typical Output

LED current = 10 mA
EL Luminance = 21 cd/m^2 (6.0 fL)
EL Lamp Frequency = 495 Hz
EL Vout = 200 Vpp
Ibat = 62 mA

Reference DLL3A IC Lens Driver Configurations†

Typical Output

Internal Bandgap Set-03FFh

Varioptic Arctic 320 Lens

V_{OUT} = 60 V_{RMS}

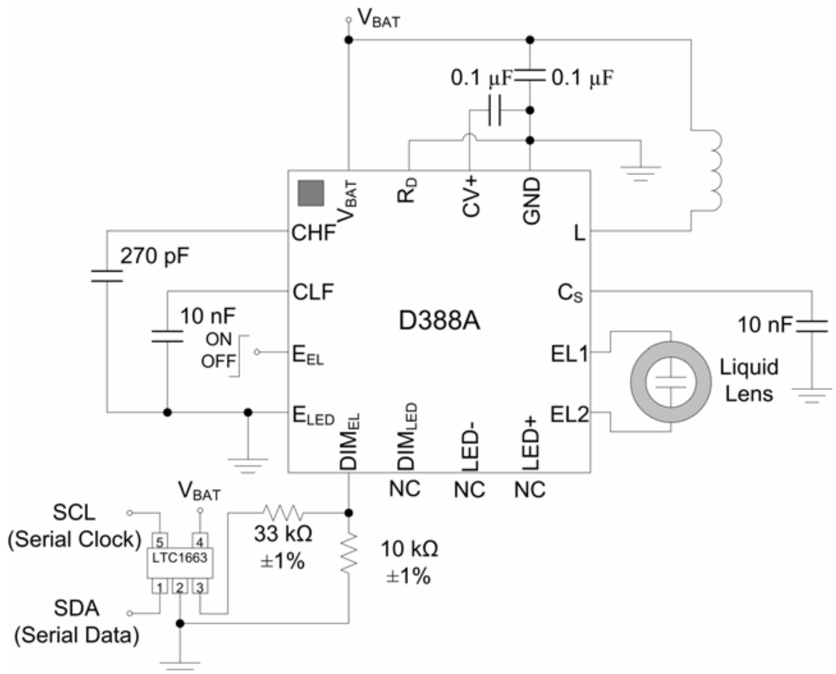
P_{IN} = 10 – 40 mW

Lens Frequency = 1 kHz

8 to 65 V_{RMS}

60 mV_{RMS} Steps

Response = 5 -15 ms (max)



Typical Output

At 100% Duty Cycle

Arctic 320 Lens

V_{OUT} = 60 V_{RMS}

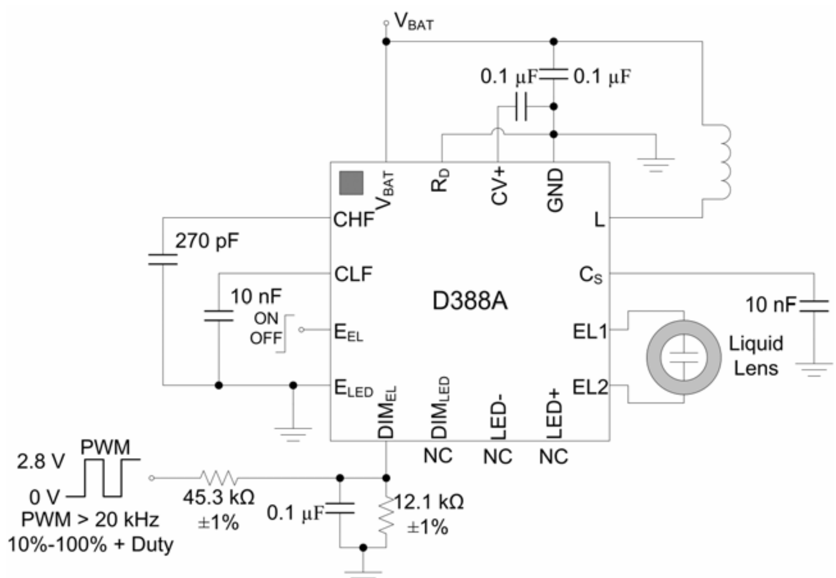
P_{IN} = 10 – 40 mW

Lens Frequency = 1 kHz

8 to 65 V_{RMS}

60 mV_{RMS} Steps

Response = 5 -15 ms (max)



† See http://www.varioptic.com/en/products/products05.php DrivIC 60 for more detailed application notes.

Designing with a D388A IC Combination EL Lamp and White LED Driver

I. EL/LED Enable Selection

The D388A IC has two enable pins that are independently controllable. The E_{EL} pin enables the EL lamp output and the E_{LED} enables the LED driver output. Table 1 demonstrates the EL/LED enable selection truth table.

E_{LED}	E_{EL}	LEDs	EL Lamp	Comments
> 1.3 V	> 1.3 V	ON	ON	IC enabled
> 1.3 V	< 0.4 V	ON	OFF	IC enabled
< 0.4 V	> 1.3 V	OFF	ON	IC enabled
< 0.4 V	< 0.4 V	OFF	OFF	IC disabled; Low standby current

Table 1 – EL/LED Enable Logic Definition

(The supply voltages for Vcc and Vbat must be connected high when either E_{EL} or E_{LED} is enabled high.)

Figure 1 graphically displays the LED current, EL lamp luminance, and supply current behavior for the four different enable logic states from table 1. Supply current (Iin) changes depending on the output enable selection for the application. Note that the LED current is unchanged whether the EL lamp in ON or OFF. Conversely, the EL lamp output is unaffected whether the LEDs are enabled or disabled by Eled.

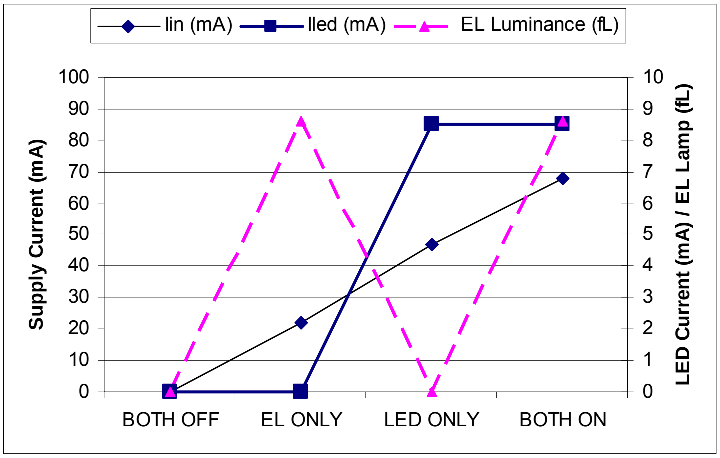


Figure 1 – Average Supply Current, LED Current, and EL Lamp Luminance vs. Eel/Eled (Vbat=Vcc=3.3V)

To ensure the device is enabled OFF for low standby current, both Eel and Eled must be less than 0.4 V. A floating Eel or Eled does not guarantee that the corresponding device output is disabled. It is therefore recommended that Eel and Eled are both connected to a low signal or GND before connecting the DC voltage to Vbat.

The supply voltage, Vbat, must be connected before enabling either Eel or Eled. A minimum of 1.3 V is required at Eel or Eled to ensure the corresponding D388a driver output is enabled.

II. Soft Start

The D388A includes a soft start function to reduce the high peak current during power up of the device. After one or both of the enable inputs Eel/Eled is switched high, the D388A starts building up its boosted supply voltage V+ first. Soft start is implemented internally via internal diodes that pre-charge the V+ voltage to the applied Vbat voltage. The same scheme is used for the LED+ output. These diodes prevent the high in rush current when the D388A is turned-on with discharge output capacitors.

III. Energy Distribution and Regulation

As soon as V+ has risen to operation voltage, all circuits of the D388A are enabled and inductor energy can also be delivered to the LED and EL outputs. The LED current, EL voltage and the supply voltage are measured by the corresponding sensor blocks in the IC and the controller sends the inductor energy to the output which requires energy.

If multiple outputs need energy at the same time, the following priority is used

1. IC supply (Supply switch on)
2. LED output (LED switch on)
3. EL output (both supply switch and LED switch off)

When none of the three output destinations needs energy, the switching of the inductor is paused by holding the HF oscillator at the low level. The system then waits until one of the outputs drops below the regulation level before it continues with a new fill inductor magnetizing cycle.

Since energy priority is given to the LED driver output, it is best during the design to begin with adjusting the circuit for the desired LED current. When this is accomplished, then design optimization can be performed to balance the EL lamp brightness with acceptable power consumption and other design constraints.

IV. High Frequency Capacitor (CHF) Selection

The frequency of the internal high frequency (HF) oscillator in the D388A IC is determined by the value of the external CHF capacitor and the internal resistors. Figure 2 shows the inverse proportional relationship the CHF value has with the HF frequency.

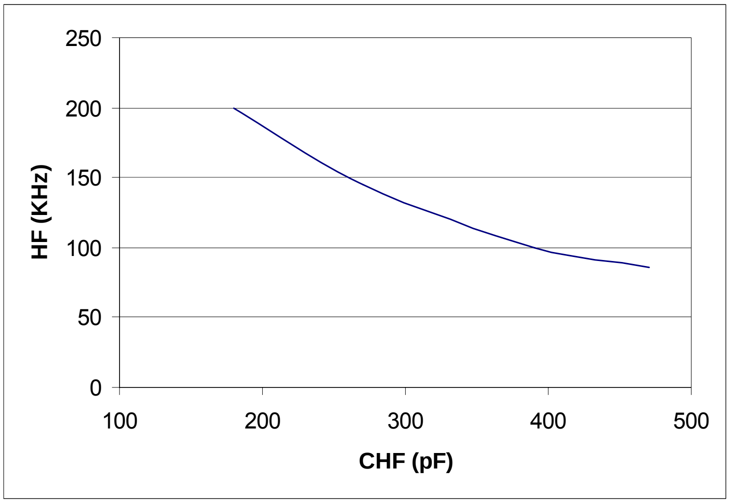


Figure 2 – Typical Inductor Frequency vs. CHF Capacitance

Multilayer X5R and X7R ceramic capacitors are recommended for CHF because they maintain their capacitance over wider voltage and temperature ranges. Use a capacitor with sufficient voltage rating above Vcc. Low profile ceramic capacitors with 1mm maximum thickness are available for designs with strict height requirements.

Alternatively, the HF frequency may also be controlled with an external clock signal from a microprocessor or other controller chip. The inductor will charge during the low portion of the clock signal and discharge to the EL lamp driver circuit or the LED driver circuit during the high period of the clock signal. The positive duty cycle used for the external high frequency clock signal is usually between 15%-75%, with a typical value of 30%-35% for maximum brightness. The clock signal input voltage should not exceed Vcc.

V. Lamp Frequency Capacitor (CLF) Selection

The frequency of the AC voltage output to the EL lamp is determined by the low frequency (LF) oscillator. The frequency of LF oscillation is determined by the value of the CLF capacitor and the internal resistors. The duty cycle of the LF oscillator is fixed at approximately 50%. Figure 3 shows the inversely proportional relationship between CLF capacitor value and the LF frequency at a given Vbat.

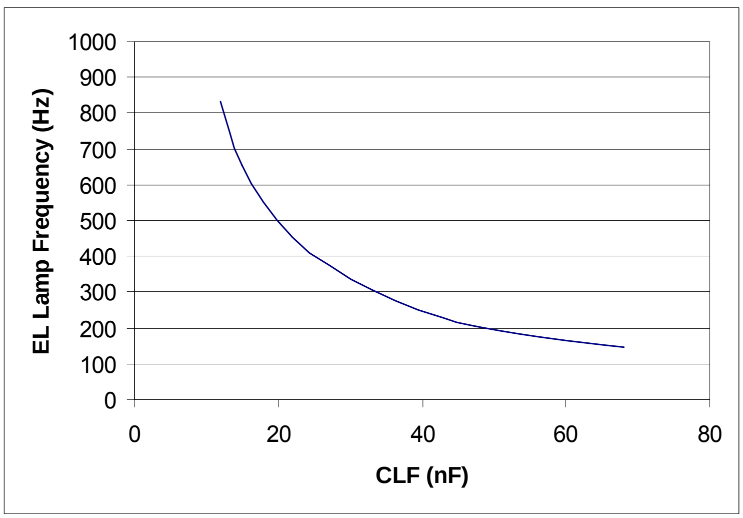


Figure 3 – Typical EL Output Frequency vs. CLF Capacitor (Vbat=Vcc=3.3V)

Multilayer X5R and X7R ceramic capacitors are recommended for CLF because they maintain their capacitance over wider voltage and temperature ranges. Use a capacitor with sufficient voltage rating above Vcc. Low profile ceramic capacitors with 1mm maximum thickness are available for designs with strict height requirements.

Lamp frequency can affect the brightness of the EL lamp. At the same output voltage, a higher lamp frequency will result in a brighter EL lamp output. Lamp frequencies of 200-500Hz are typically used.

Alternatively, the lamp frequency may also be controlled with an external clock signal from a microprocessor or other controller chip. To ensure a 50% duty cycle of the EL lamp output signal, the output signal of the LF oscillator first passes a divider block. Thus, the lamp frequency is a quarter of the LF oscillator frequency (LF/4). Because of the internal frequency divider in the device, the output lamp frequency will be a quarter of the input clock signal frequency. For example, if an 800Hz input clock signal is used, the resulting lamp frequency will be 200Hz. The clock signal input voltage should not exceed Vcc.

VI. Inductor (L) Selection

The value and efficiency of the inductor has a significant impact on the EL driver and LED driver output and the total current consumption of the D388A IC. Figure 4 shows the dependence of EL lamp luminance, LED current, and total average supply current on inductance value using Mouser leaded inductors. The D388A IC is driving a 967 mm^2 EL lamp load and three HBLEDs in series in this example.

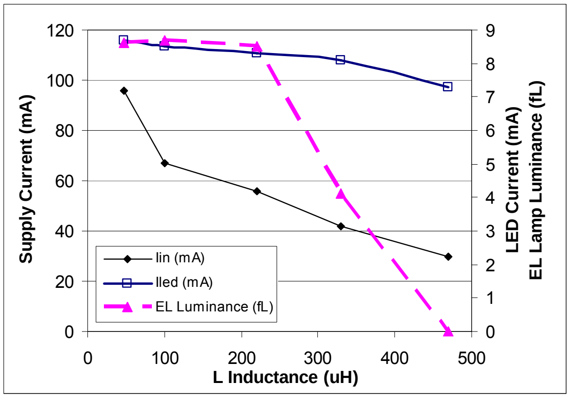


Figure 4 – EL Luminance, LED Current, and Average Supply Current vs. L Inductance (Vbat = 3.3 V, CHF = 270 pf)

Figure 5 and Figure 6 show typical EL lamp luminance and current draw of a D388A circuit with several different inductor and CHF values. Note that with higher inductor switching frequencies, a lower range of inductance can be used for maximum EL lamp brightness with lower current consumption.

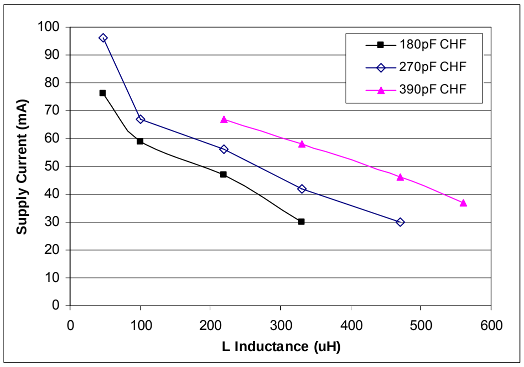


Figure 5 – Average Supply Current vs. L Inductance (Vbat=3.3V, 3HBLEDS and 967mm^2 Durel Green EL)

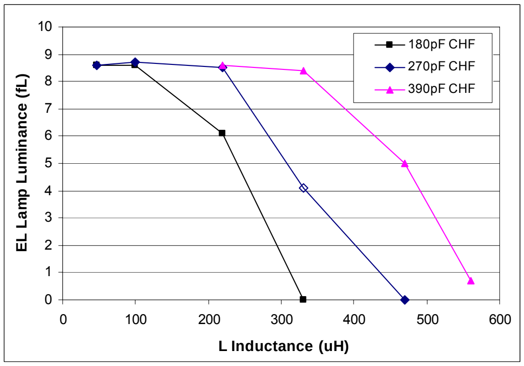


Figure 6 – EL Lamp Luminance vs. L Inductance (Vbat=3.3V, 3HBLEDS and 967mm2 Durel Green EL)

Note that the DC resistance (DCR) of inductors with the same nominal inductance value may vary with manufacturer type and inductor type. Choose an inductor that can handle at least 0.5A and ensure that the inductor has low DCR to minimize I^2R power losses.

Recommended inductance values can range from 470uH to 1500uH, depending on inductor manufacturer and type. Although lower inductor values tend to have lower DCR and higher current rating, they also result in higher peak currents in the inductor, higher supply current requirements, and lower efficiencies. Also, while low profile inductors may be a necessity in some designs, their smaller size gives higher DCR and core losses, resulting in poor output performance. Nevertheless, there are <2.0mm tall inductors currently available that provide low DCR and low core losses. Some low profile inductor recommendations that can provide good overall performance with the D388A IC are featured in the reference circuit configuration in this datasheet. Consult each inductor manufacturer for more detailed information and for their entire selection of related components for EL and LED drivers.

VII. LED Current Adjustment

The LED current can be adjusted with the single sensing resistor Rled. For the best accuracy, a 1% maximum resistor value tolerance should be used. Figure 7 demonstrates the effect of Rled value on the LED current given a fixed inductor value, Ratio adjustment, and constant voltage to the DIM pin equal to Vcc of 3.3V.

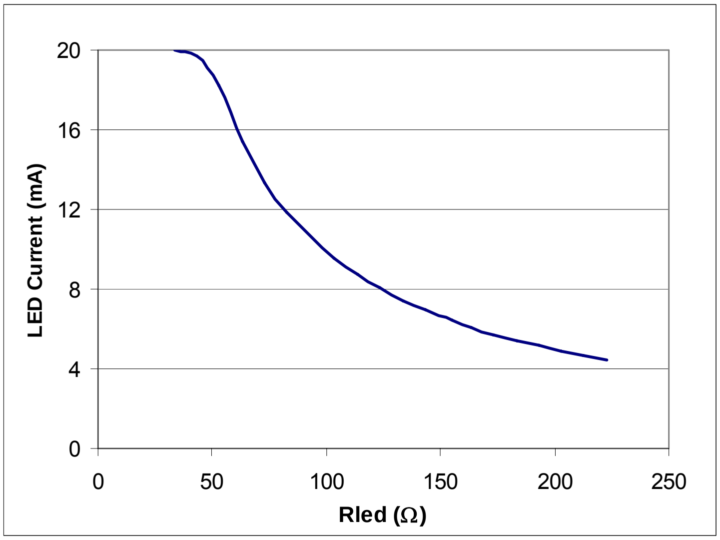


Figure 7 – Average Supply LED Current vs. Rled (Vbat=Vcc=3.3V)

LED current is also dependent on inductor selection and Ratio selection. In addition, external control of LED brightness regulation and dimming is possible using the DIM pin. When no LED dimming function is needed, the DIM pin should be connected to Vcc. If so, the D388A IC will use the internal band-gap reference level to regulate the LED current to maintain a constant brightness level.

LED current has a direct effect on supply current and LED brightness, but minimal effect on EL luminance during simultaneous EL and HBLED operation. Figure 8 shows typical effect of LED current on average supply current and EL luminance when adjusted using Rled value. The Ratio and inductor value are fixed.

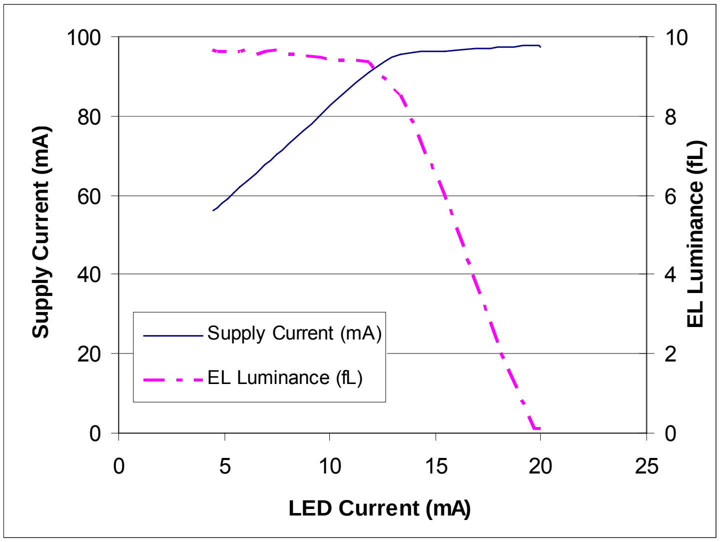


Figure 8 – Average Supply Current and EL Luminance vs. LED Current

VIII. <u>LED Dimming Function</u>

External control of LED brightness is possible using the DIM pin of the D388A IC. The preferred method of LED brightness control uses a variable DC voltage to the DIM pin to adjust the LED current. The DIM control voltage sensitivity is determined by Rled and inductor efficiency as demonstrated in Figure 9. DIM voltage input should not exceed Vcc.

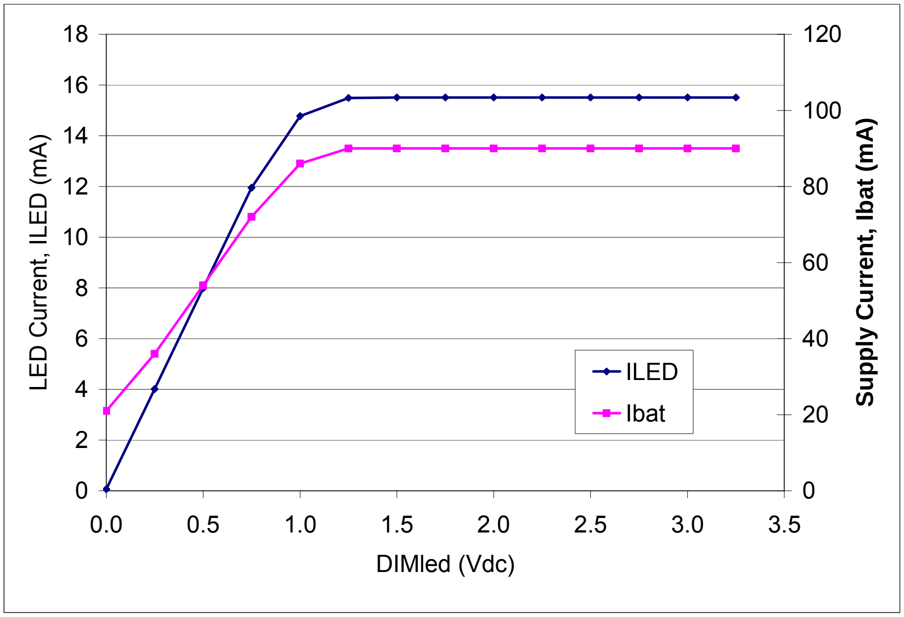


Figure 9 – DIMled input effect on LED Current and Average Supply Current (RLED = 100Ω)

For some applications, a pulse width modulated (PWM) signal is the preferred method of brightness control. The solution for LED dimming using PWM on the D388A IC is to filter the control signal by adding a 10KOhm resistor and a 0.1uF capacitor as shown in Figure 10, converting the PWM to a DC level before it reaches the DIM pin. The LED dimming then behaves similar to the trend in Figure 8 with the DIM supply voltage equivalent to the resulting DC voltage of the filtered PWM signal.

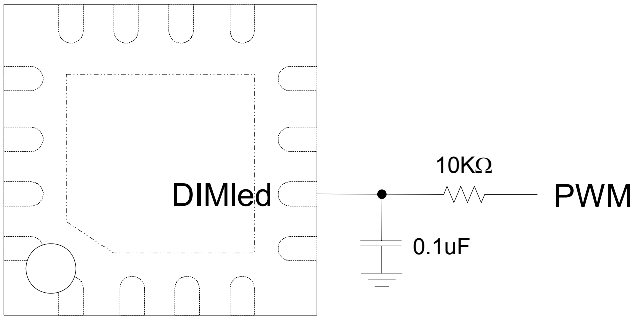


Figure 10 – Filtered PWM LED Dimming Control Method

It is recommended that the DIM pin be connected to the E_{LED} for minimum total standby current. Otherwise, the DIM pin will draw current even when the device is disabled. Alternatively, the PWM signal input to the DIM pin must be turned OFF when E_{LED} is disabled.

IX. EL Dimming Control

Brightness control and dimming of the EL lamp is possible using the DIMel pin. The preferred method of EL brightness control is a variable DC voltage to adjust the EL output voltage. This is simply accomplished via a DC voltage input to pin DIMel. The EL output voltage is measured by the EL voltage sensor at the Cs pin of the D388A via an internal voltage divider network. The measured EL lamp voltage is then compared with the reference level DIMel. The relationship between the DIMel input voltage the EL voltage output is similar to that of DIMled to the LED current level as shown in figure 9. A DC voltage range from 0 V to 1.0 V gives dimming control of the EL lamp. When no dimming function is needed, the DIMel pin can be connected to a fixed voltage above $V_{100\%}$ (eg. 1.3 V) as shown in Figure 11, or Vbat. If so, D388a will use the internal bandgap reference level to regulate the EL peak-to-peak voltage output to maintain 100% brightness level.

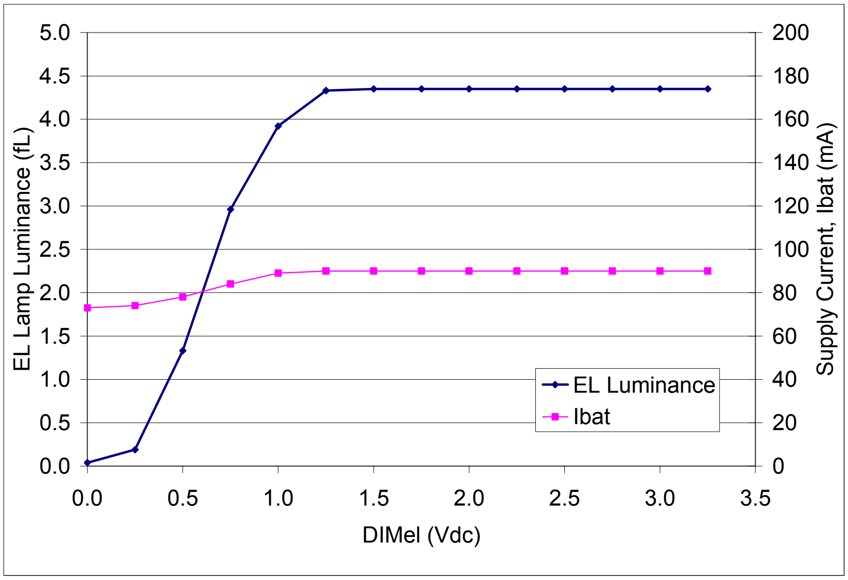


Figure 11 – Typical DIMel input effect on EL Lamp Luminance and Average Supply Current

While the EL lamp luminance is being controlled with DIMel, the total supply current is affected but the LED current would remain constant during operation. For some applications, a pulse width modulated (PWM) signal is the preferred method of brightness control. The solution for EL dimming using PWM on the D388A is to filter the control signal by adding a 10Kohm resistor and a 0.1μF capacitor as shown in Figure 11, converting the PWM to a DC level before is reaches the DIMel pin. EL lamp dimming then behaves similar to the trend in Figure 121 with the DIMel supply voltage equivalent to the resulting DC voltage of the filtered PWM signal.

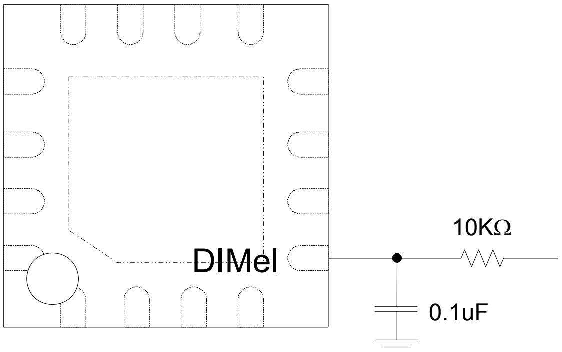


Figure 12: Filtered PWM ED Dimming Control Method

X. EL Output Wave-shape Selection

The D388A IC driver 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 EL wave-shaping control resistor (Rd). The optimal discharge level for an application depends on the lamp size, lamp brightness, and application conditions. To ensure that the D388A IC is configured optimally, various discharge levels should be evaluated. In many cases, the smoothest transition slope in the waveform results in the lowest audible noise from the EL lamp system. Typical wave-shapes corresponding to selection of Rd values for a 1.5 in^2 EL lamps are shown below.

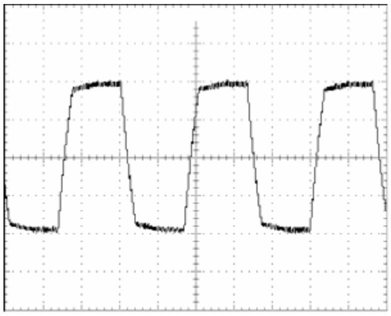


Figure 13 – Lamp Output Waveform
Rd = 1.5 KΩ

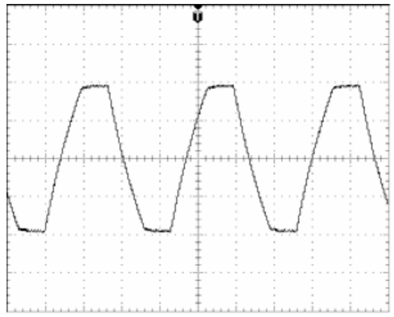


Figure 14 – Lamp Output Waveform
Rd = 3.9 KΩ

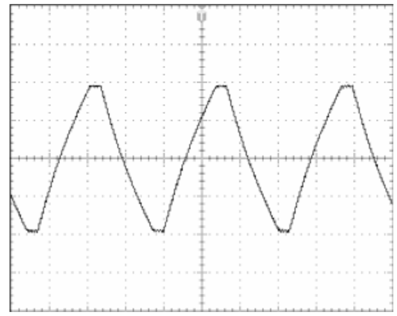


Figure 15 – Lamp Output Waveform
Rd = 5.6 KΩ

XI. Storage Capacitor C_{LED} and Cs Selection

The Cs and C_{LED} storage capacitors are used to store the energy transferred from the inductor before discharging the energy to the EL lamp or the HBLEDs, respectively. Cs capacitor must have minimum 100V rating. In general, the Cs value does not have a large affect on the output of the device. The typical Cs capacitor recommendation is 47nF with 100V rating.

The C_{LED} capacitor must have minimum voltage rating greater than the total forward voltage (V_F) required by the number of high-brightness white LEDs in series. In general, the C_{LED} value does not have a large affect on the output of the device. Typical C_{LED} capacitance can range from 6.8uF to 47uF.

Capacitors with low equivalent series resistance (ESR) should be used to minimize the output ripple voltage. Multilayer ceramic capacitors are a good choice because they have low ESR and are available in small packages. Always use capacitors with sufficient voltage ratings. Low profile ceramic capacitors with 1mm maximum height are available for designs with strict thickness requirements.

XII. Printed Circuit Board Layout

The high frequency operation and high voltage output of the D388A IC makes printed circuit board layout important. To prevent radiation and high frequency resonance, 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. The ground leads of the Cs, CLF, and CHF should be tied directly to the GND pin of the device to avoid electrical noise. If using bypass or decoupling 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. A 2.2uF or 4.7uF ceramic decoupling capacitor is sufficient for most applications.

XIII. Split Voltage Supply

The D388A IC allows for the use of a split voltage supply. With a split voltage supply, a regulated voltage supply (Vbat) ranging from 2.0 V to 6.5 V is applied to operate the on-chip logic while a separate supply voltage (V+) with higher current capability is applied to the inductor to supply the D388A IC with the necessary power to drive an EL lamp and the HBLEDs. The voltage range of V+ is determined by the following conditions: user application, lamp size, inductor selection, and power limitations of the battery.

An example of the split supply configuration is shown in Figure 16. This example shows a regulated 3.3 V applied to the Vbat pin, and a V+ voltage that may range from 3.6 V to 6.2 V or regulated at 5.0 V. The enable voltage is in the range of 2.0V to 3.0V. This is a typical setup used in PDA applications.

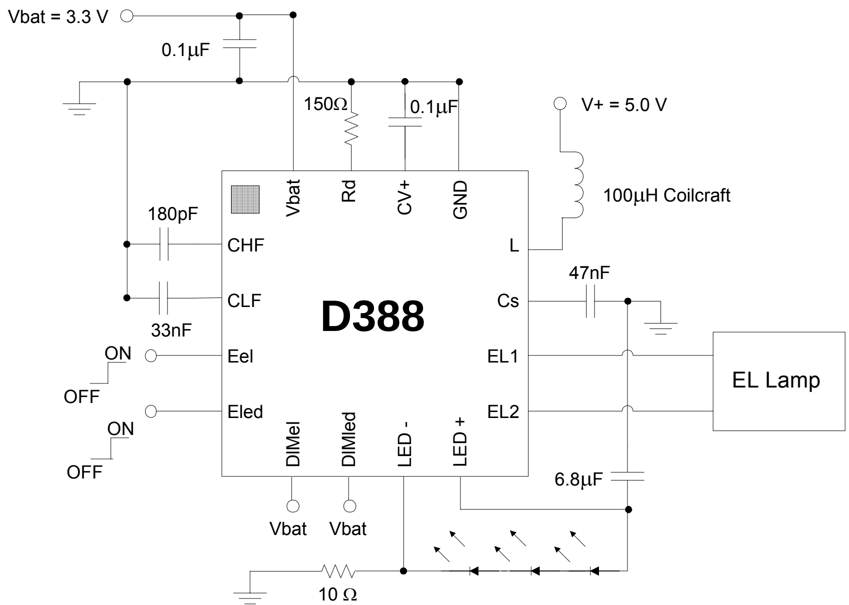


Figure 16 – Split Supply Circuit Example

Solder Re-Flow Recommendations

Profile Feature	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max.
Preheat -Temperature Min (Ts_{min}) -Temperature Max (Ts_{max}) -Time (min to max) (ts)	 150°C 200°C 60-180 seconds
Ts_{max} to T_L -Ramp-up Rate	3°C/second max.
Time maintained above: Temperature (T_L) -Time (T_L)	 217°C 60-150 seconds
Peak Temperature (T_P)	250 +0/-5°C
Time within 5°C of actual Peak Temperature (T_P)	20-40 seconds
Ramp-down Rate	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

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

IPC/JEDEC J-STD-020B July 2002

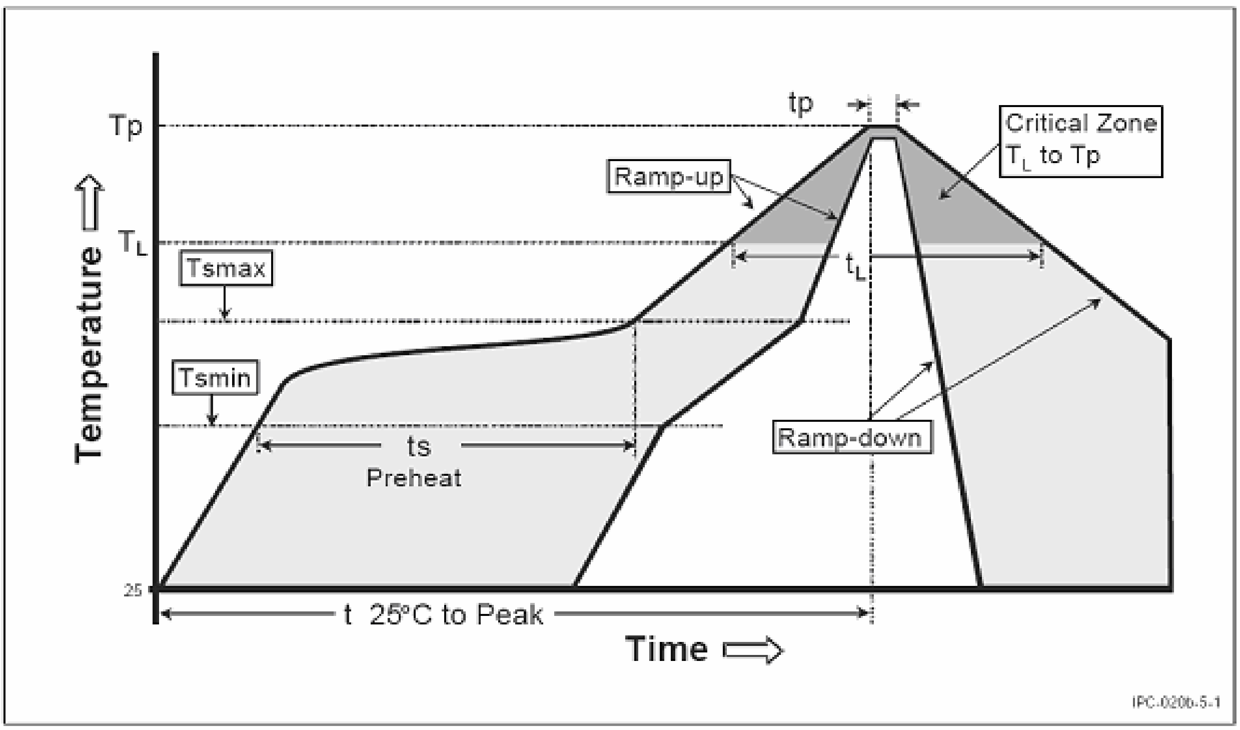
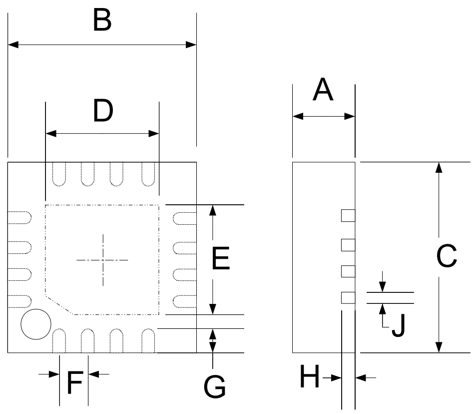


Figure 5-1 Classification Reflow Profile

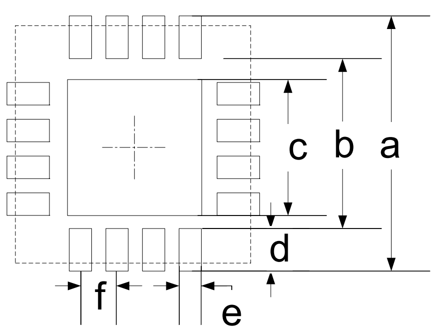
Ordering Information

Order Rogers' Part Number 1DDD388AA-P02/1DDDLL3AA-P02 for product to be shipped in QFN-16 plastic thermal enhanced quad flat package in embossed tape on 360mm diameter reel. A D388A/DLL3A IC Designer's Kit (1DDD388AA-K01/1DDDLL3AA-K01) provides a vehicle for evaluating and identifying the optimum component values for any particular application using D388A/DLL3A IC. Rogers' engineers also provide full support to customers, including specialized circuit optimization and application retrofits.



	QFN-16 DIMENSIONS					
	Min		Nominal		Max	
	mm	in	Mm	in	mm	in
A	0.70	0.027	0.75	0.029	0.8	0.031
B	3.925	0.155	4.00	0.157	4.075	0.160
C	3.925	0.155	4.00	0.157	4.075	0.160
D	0.75	0.029	1.70	0.067	2.25	0.088
E	0.75	0.029	1.70	0.067	2.25	0.088
F			0.65	0.026		
G	0.35	0.014	0.55	0.021	0.75	0.029
H			0.20	0.008		
J	0.25	0.010	0.30	0.012	0.35	0.014

Recommended Pad Layout

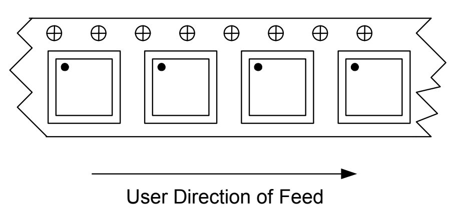


Devices marked with Rogers logo, part number (388A), and 4-digit code. Bottom of marking is on the Pin 1 side.

	QFN-16 PAD LAYOUT					
	Min		Typical		Max	
	mm	in	mm	in	mm	in
a	4.30	0.169	4.35	0.171	4.40	0.173
b	2.85	0.112	2.90	0.114	2.95	0.116
c	2.10	0.083	2.15	0.085	2.20	0.087
d	0.67	0.026	0.72	0.028	0.77	0.030
e	0.25	0.010	0.30	0.012	0.35	0.014
f			0.65	0.026		

D388A/DLL3A in Tape & Reel: 1DDD388AA-P02/1DDDLL3AA-P02

Embossed tape on 360 mm diameter reel.
6000 units per reel. Quantity marked on reel label.



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