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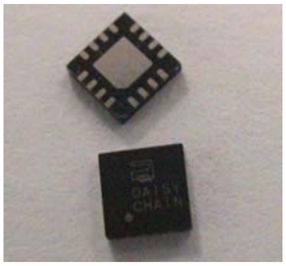
Data Sheet

D306A QFN Electroluminescent Lamp Driver IC

Features

- 2.0 – 12.0V_{DC} Battery Operation
- High AC Voltage Output To 400Vpp
- Very Low Standby Current
- Flexible Wave-shaping Capability
- QFN-16 Square Body with Heat Slug
- Lead-Free (Pb-free) Green Package



QFN – 16 with Heat Slug

Applications

- PDA
- Large Area LCD with EL lamp backlight
- Signage Backlight
- Graphics Display Lighting
- Automotive Interior Lighting

Rogers DUREL® D306A IC is a high-power IC inverter intended for driving EL lamps as large as 28.2in^2 (180cm^2). The D306A IC is equipped with many control functions (including wave-shaping programmability for minimizing audible noise) and features that allow for component cost savings, precision control of frequencies, and stability of lamp color over wide temperature extremes

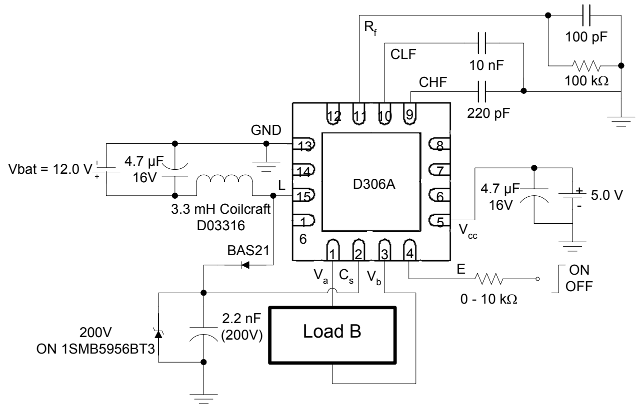
Lamp Driver Specifications for Circuit A:

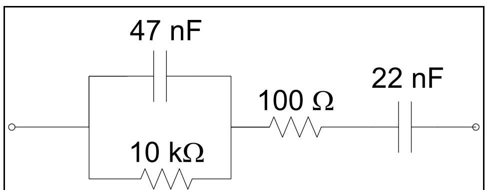
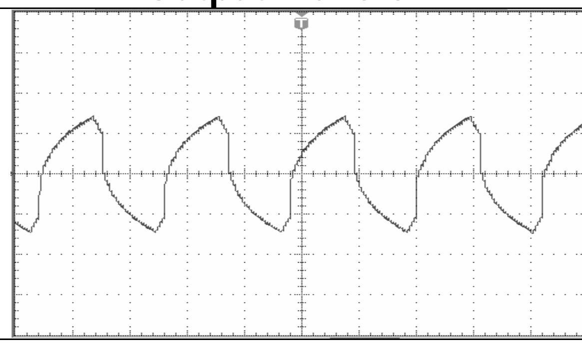
(Using Standard Test Circuit at Ta=25^{0}C unless otherwise specified)

Parameter	Symbol	Minimum	Typical*	Maximum	Units	Conditions
Standby Current	$I_{(V+)}$	0	0.01	1	uA	E = GND
Supply Current	$I_{(Vbat + Vcc)}$	55	65	80	mA	E = 5.0 V+
Enable Current	I_{ena}	0	0.4	1	mA	E = 5.0 V+
Output Voltage	V_{out}	350	380	400	Vpp	E = 5.0 V+
Lamp Frequency	LF	330	380	430	Hz	CLF = 10.0 nF

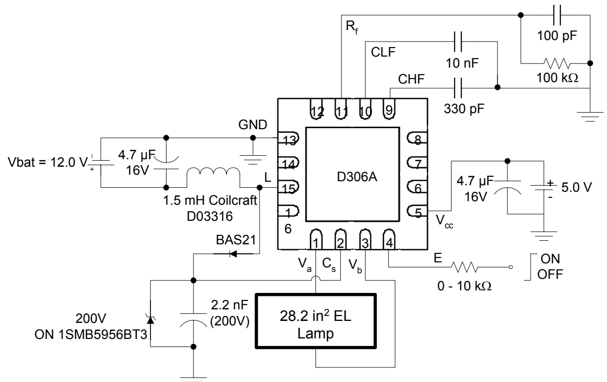
***Typical values should not be used for specification limits**

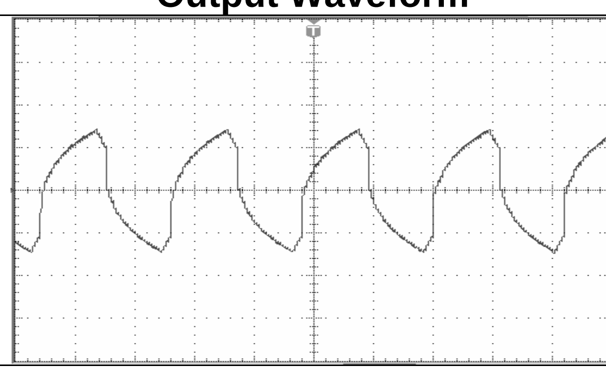
Sample Application Circuit A



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

Sample Application Circuit B



Load: 28.22in^2 (182.1cm^2) DUREL Automotive EL Lamp	Output Waveform
	

The information contained in this data sheet is intended to assist you in designing with Rogers EL systems. 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 systems for each application.

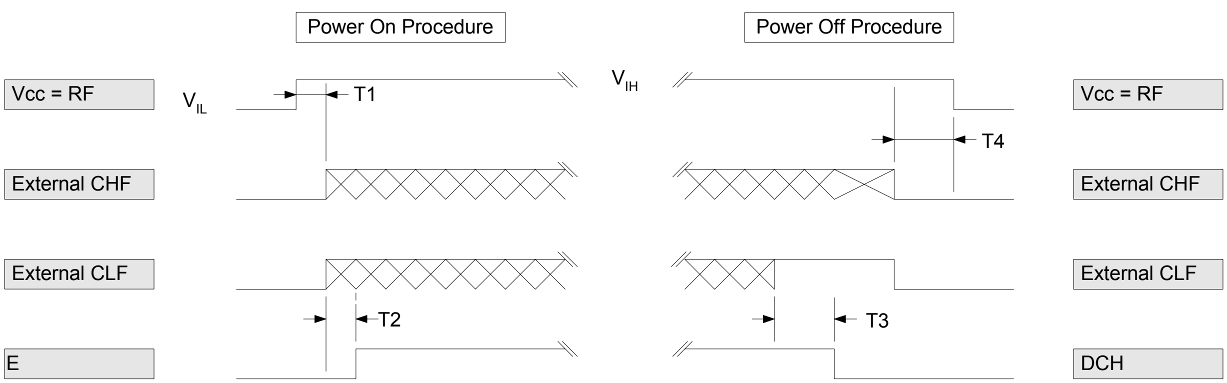
Absolute Maximum Ratings:

Parameter	Symbol	Minimum	Maximum	Unit	Comments
Supply Voltage Operating Range Withstand Range	Vbat	2.0 -0.5	12 16	V	E = Vcc E = GND
Logic Drive Voltage Operating Range Withstand Range	Vcc	2 -0.5	5 6	V	E = Vcc E = GND
Enable Voltage	E	-0.5	V_{CC} +0.5	V	
Vout	Va-Vb		410	Vpp	E = Vcc
Operating Temperature	T_a T_j	-40	85 125	°C °C	Ambient Junction
Average Thermal Resistance	Θ_{ja} Θ_{jc}		40.0 5.3	°C/W °C/W	Junction to Ambient Junction to case
Storage Temperature	T_s	-55	150	°C	

*At a given ambient temperature, the maximum power rating can be calculated with the following equation: $T_j = P (\Theta_{ja}) + T_a$.

Note: The above are 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.

Power on and off sequence of D306A IC

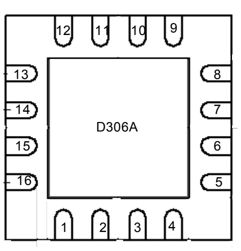


$T_1, T_2 \geq 20\ us$

$T_3 \geq \frac{2}{LF\ Frequency}$

$T_4 \geq 20\ us$

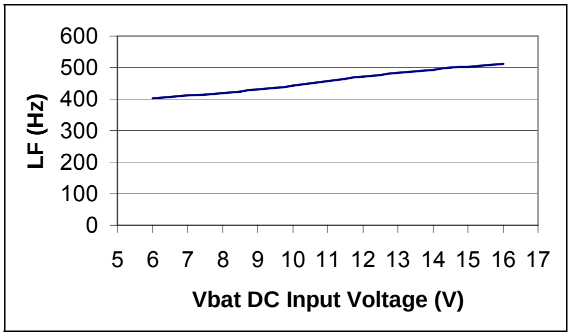
Physical Data:



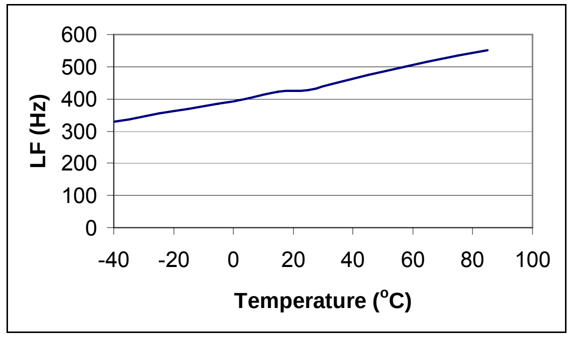
16-Pin QFN

PIN#	NAME	FUNCTION
1	Va	AC voltage output to EL lamp
2	Cs	High voltage storage capacitor to input
3	Vb	AC voltage output to EL lamp
4	E	System enable; Wave-shaping resistor control
5	Vcc	Logic drive voltage
6	NC	No connect
7	NC	No connect
8	NC	No connect
9	CHF	Capacitor input to high frequency oscillator
10	CLF	Capacitor input to low frequency oscillator
11	Rf	Resistor input for frequency control
12	NC	No connect
13	GND	Power ground
14	NC	No connect
15	L	Inductor input
16	NC	No connect

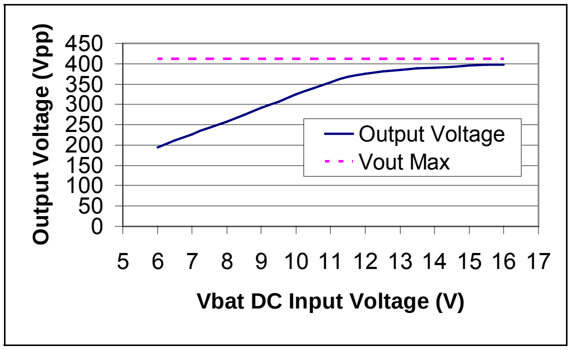
Typical Performance Characteristics Using Standard Test Circuit



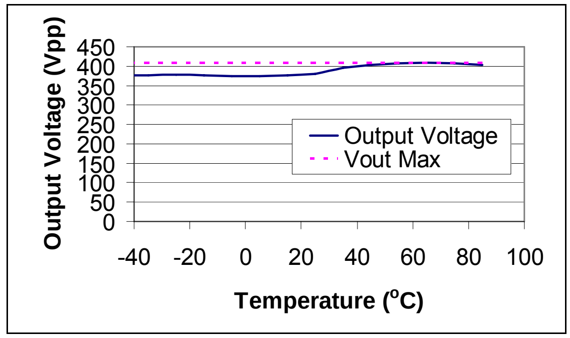
Output Frequency vs. DC Supply Voltage



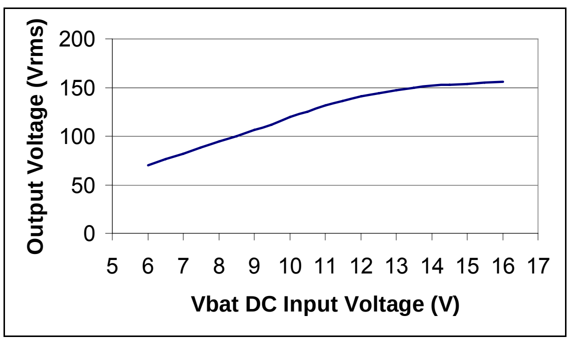
Output Frequency vs. Ambient Tempterature



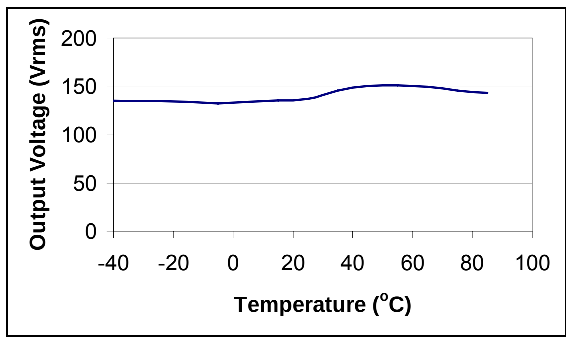
Output Voltage (V_{PP}) vs. DC Supply Voltage



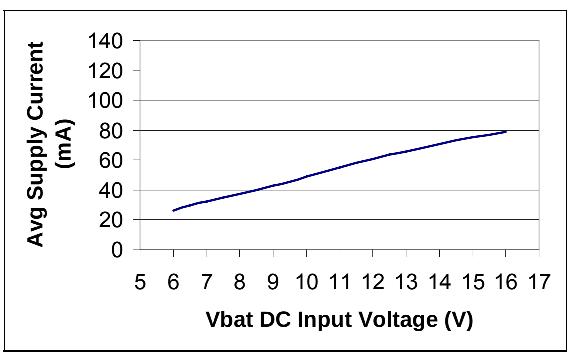
Output Voltage (V_{PP}) vs. Ambient Temperature



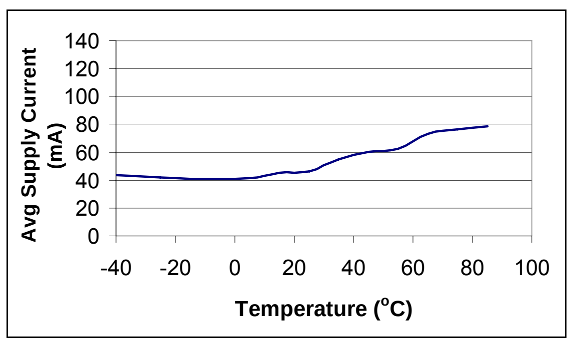
Output Voltage (V_{RMS}) vs. DC Supply Voltage



Output Voltage (V_{RMS}) vs. Ambient Temperature

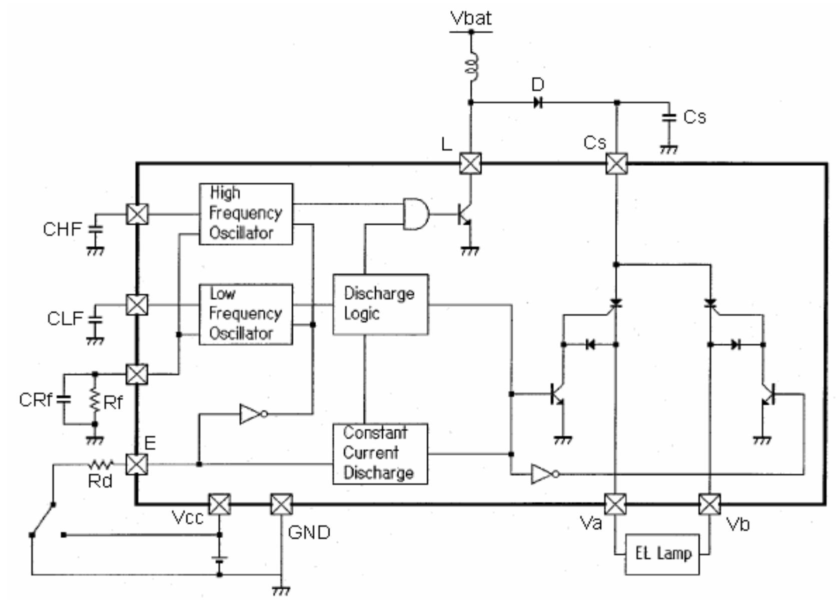


Supply Current (I_{BAT}) vs. DC Supply Voltage



Supply Current (I_{BAT}) vs. Ambient Temperature

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 D306A 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.

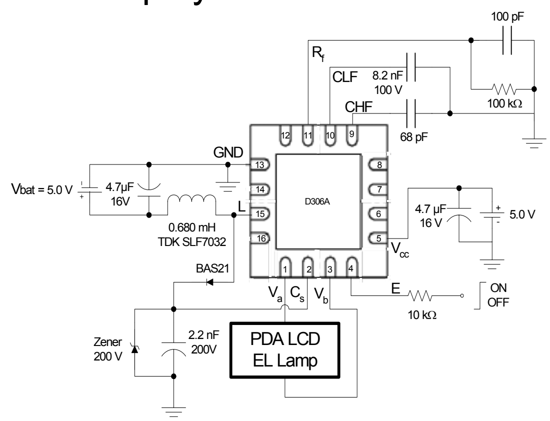
Typical D306A IC EL driving configurations for driving EL lamps in various applications are shown on the following page. The expected system outputs for the various circuit configurations are also shown with each respective figure. These examples are only guides for configuring the driver. Rogers provides a D306A IC Designer's Kit, which includes a printed circuit evaluation board intended to aid you in developing an EL lamp driver configuration using the D306A IC that meets your requirements. A section on designing with the D306A IC is included in this datasheet to serve as a guide to help you select the appropriate external components to complete your D306A IC EL driver system.

Reference D306A Driver Configurations

Typical D306A 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.

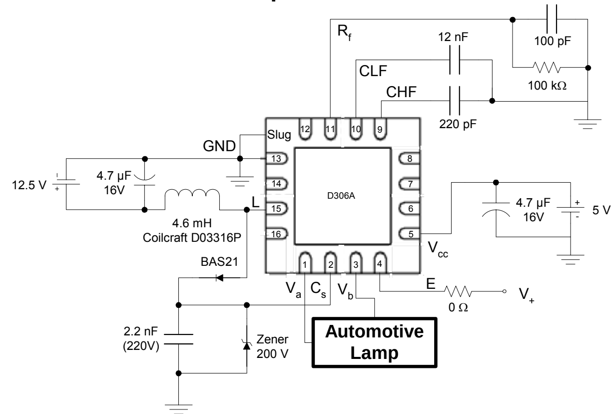
5.0V PDA Display

Typical Output
Brightness = 24.0 fL (82.23 cd/m^2)
Lamp Frequency = 425 Hz
Logic Supply Current = 23 mA
Power Supply Current = 115 mA
Vout = 334 Vpp
Load: 5in^2 (32.2cm^2) RBC-225 Green Lamp



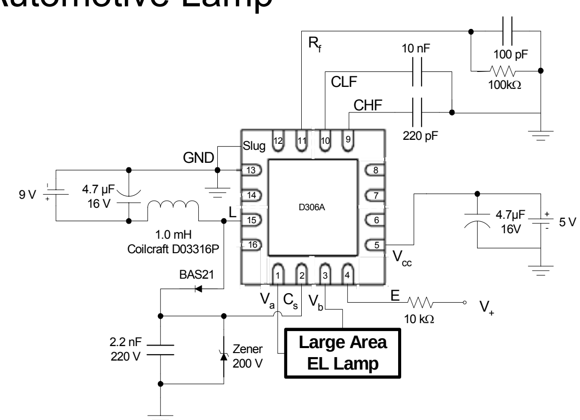
12.5V Automotive Lamp

Typical Output
Brightness = 3.33 fL (11.41 cd/m^2)
Lamp Frequency = 382 Hz
Logic Supply Current = 40 mA
Power Supply Current = 108 mA
Vout = 234 Vpp
Load = 26 in^2 (167.7 cm^2) RBC Automotive Lamp White



12.5V Automotive Lamp

Typical Output
Brightness = 7.49 fL (25.66 cd/m^2)
Lamp Frequency = 348 Hz
Logic Supply Current = 23 mA
Power Supply Current = 68 mA
Vout = 184 Vpp
Load: 24 in^2 (154.8 cm^2) RBC-225 Green Lamp



Designing With A D306A EL Driver IC

There are many variables which can be optimized to achieve the desired performance for specific applications. The luminance of the EL lamp is a function of the output voltage applied to the lamp by the IC, the frequency at which the voltage is applied, the lamp material properties, and the lamp size. Rogers offers the following component selection aids to help the designer select the optimum circuit configuration.

I. Lamp Frequency Capacitor (CLF) Selection

Selecting the appropriate value of capacitor (CLF) for the low frequency oscillator will set the output frequency of the D306A IC. Figure 1 graphically represents the effect of the CLF capacitor value on the oscillator frequency at Vbat = 13.5V, Vcc = 5.0V.

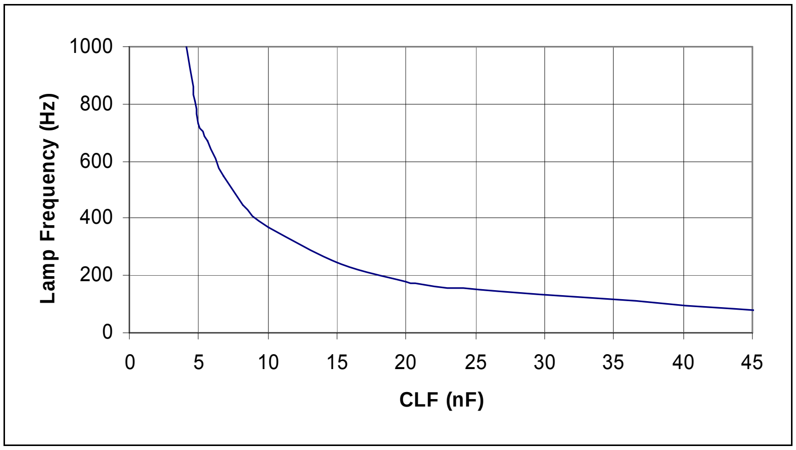


Figure 1—Typical lamp frequency vs. CLF capacitor

II. High Frequency Capacitor (CHF) Selection

Selecting the appropriate value of capacitor (CHF) for the high frequency oscillator will set the inductor switching frequency of the D306A IC. Figure 2 graphically represents the effect of the CHF capacitor value on the oscillator frequency at Vbat = 13.5V, Vcc = 3.0V.

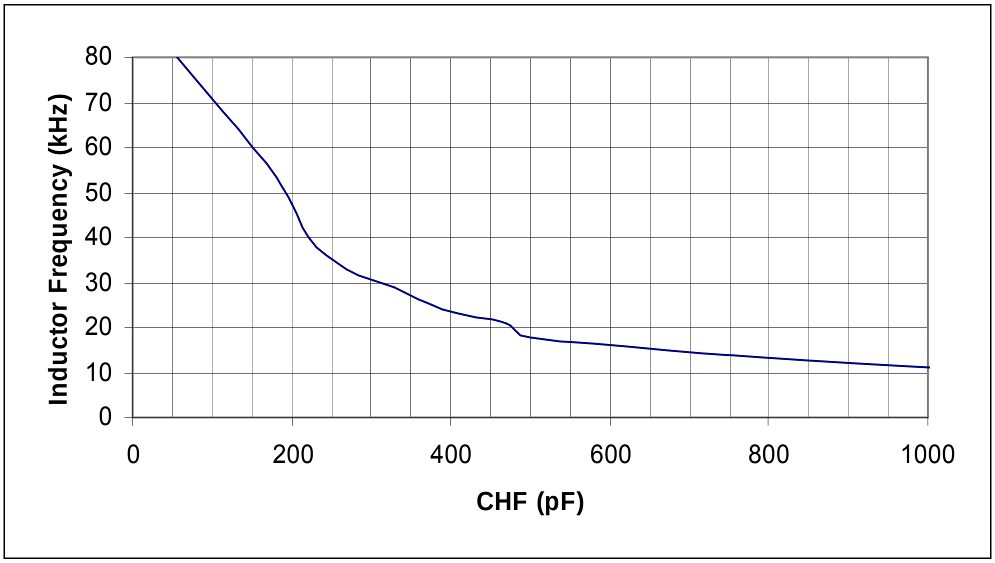


Figure 2—Typical inductor frequency vs. CHF capacitor

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 D306A IC 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.

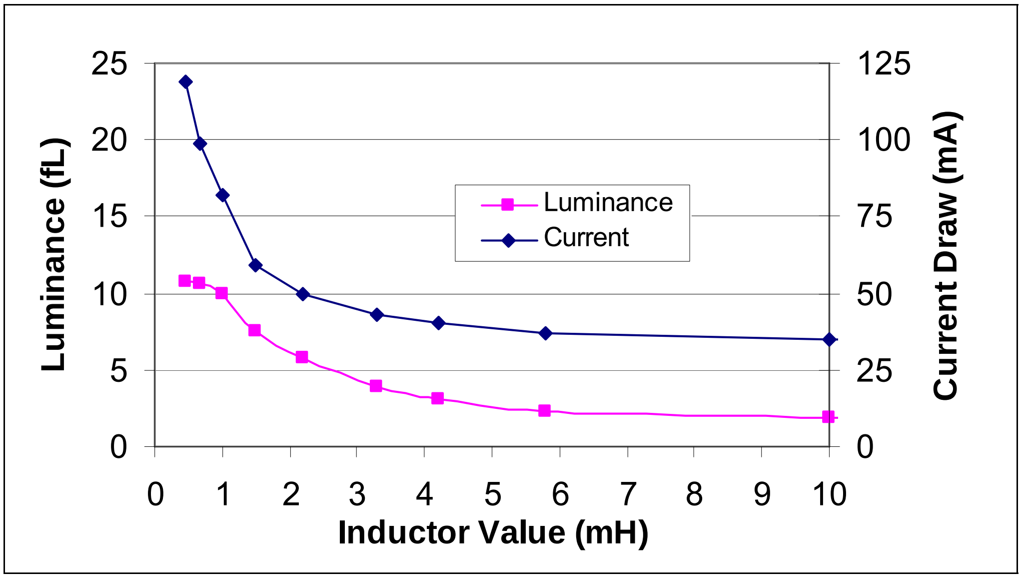


Figure 3—Luminance and current vs. inductor value
(Conditions: V_{CC}=5.0V, V_{BAT}=6.5V 5.96in^2 (38.5cm^2) RBC 665 EL Lamp)

IV. Wave-shape Selection

The D306A 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 (Rd) 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 D306A 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 Rd is 10 kΩ.

V. Storage Capacitor (Cs) Selection

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

VI. Rf and CRf Selection

The combination of Rf 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 is recommended for Rf = 100 kΩ.

The CRf capacitor is used as a stabilizing capacitor to filter noise on the Rf line. A small 100pF capacitor is typical and sufficient value for CRf.

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 D306A IC makes printed circuit board layout important for minimizing electrical noise. 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.

The higher than normal operating temperature of the D306A IC also requires additional ground heat planes on the printed circuit board layout. The D306A IC has a heat slug attached to the bottom of the package to provide additional heat dissipation. It is recommended that the PCB incorporate a complimentary grounded heat plane to solder connect to the heat slug of the package. It is also recommended that no electrical traces, which can be adversely affected by the temperature transfer and the high voltage output, be laid out underneath the device. The temperature transfer as well as high voltage output may adversely affect these electrical traces. Recommended pad layout dimensions can be found on the last page of the datasheet.

IX. Optional Zener Diodes

The D306A IC EL driver circuit should be designed such that the output voltage of the device does not exceed the maximum rated value of 400Vpp. Operating the D306A IC above this rating can cause irreversible damaged to the device. This condition is most likely in applications, such as in automotive instrument clusters, where the supply voltage (Vbat) is higher than 6.0V and can generate output voltage greater than 400Vpp. Extreme temperature change can also cause the output voltage to exceed the maximum rating, especially when the nominal operating voltage of the device is close to the maximum limit at room temperature. A 200V zener diode connected in parallel to the Cs capacitor and ground of the D306A IC is recommended to limit the device output to less than 400Vpp. This component is optional and may be eliminated in applications which are known to function only within safe operating conditions.

The D306A IC should be designed such that is never tested or operated without an EL lamp or equivalent capacitive load. In situations where there is a risk that power may be applied to D306A IC without a load, 200 volt zener diode should be added to Va and Vb pins. An example circuit is shown below in Figure 4.

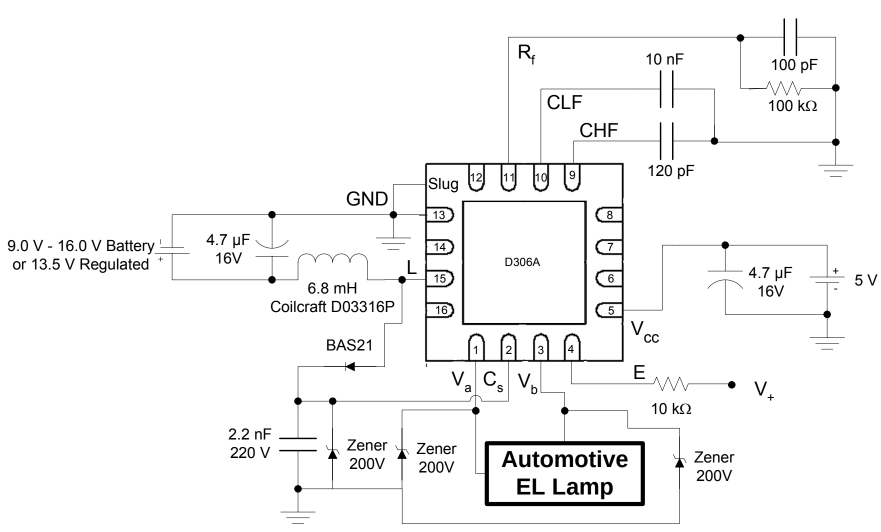


Figure 4—Split Voltage and 200V Zener Diode protection

IX. Split Voltage Supply

A split supply voltage is recommended to drive the D306A IC. To operate the on-chip logic, a regulated voltage supply (Vcc) ranging from 2.0V to 6.5V is applied. To supply the D306A IC with the necessary power to drive an EL lamp, another supply voltage (Vbat) with higher current capability is applied to the inductor. The voltage range of Vbat 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 4 above. This example shows a regulated 5.0V applied to the Vcc pin, and a Vbat voltage that may range from 9.0V to 16.0V or regulated at 13.5V. The enable voltage is in the range of 3.0V to 5.0V. This is a typical setup used in automotive.

D306A IC Design Ideas

I. Lamp Frequency Control with an External Clock Signal

External clock signals may be used to control the D306A IC oscillator frequencies instead of adding external passive components. When clocking signals provide both the inductor charging (HF) and lamp output (LF) oscillator frequencies to drive the D306A IC, the CLF, CHF, Rf, and CRf components are no longer required. A sample configuration demonstrating this cost-saving option is shown in Figure 5 below.

In this configuration, the lamp output frequency is controlled by the signal applied to the CLF pin. An internal divider network in the IC divides the frequency of the LF input signal by two. Thus, to get a 400Hz AC output waveform to drive the EL lamp, an 800Hz square-wave input signal should be connected to the CLF pin. Input clocking frequencies may range from 400 Hz to 2000 Hz, with 15-20% positive duty cycle for optimum brightness.

The high frequency oscillator that determines inductor charging frequency is controlled above by a digital AC signal into the CHF pin. The HF clock signal frequency may range from 20 KHz – 50 KHz, with 15-20% positive duty cycle for optimum lamp intensity.

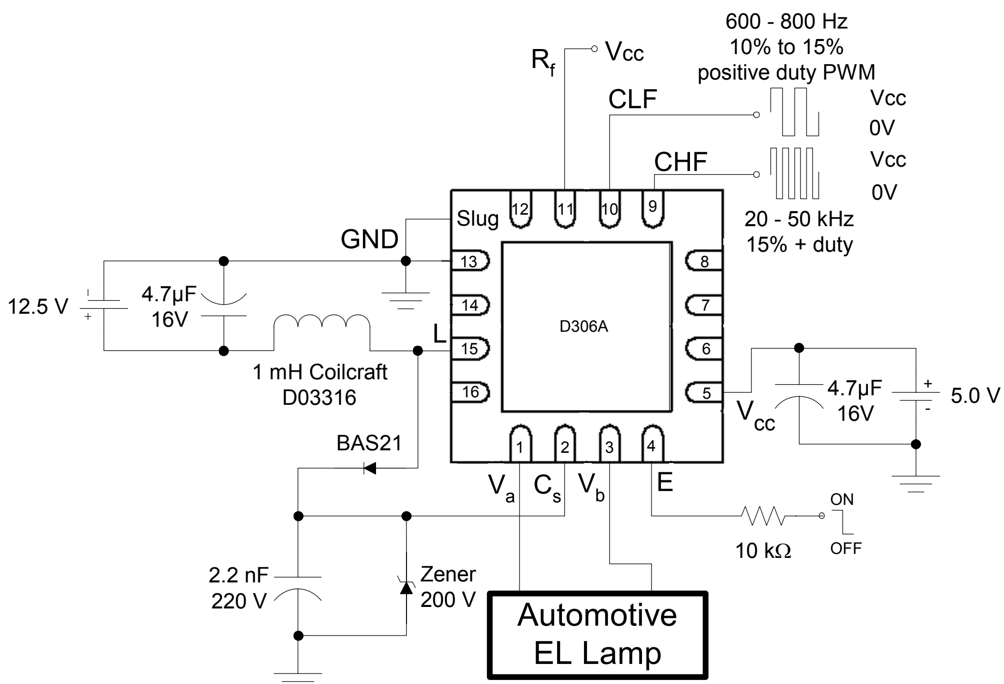


Figure 5—Lamp frequency control via external clock signal

II. EL Brightness Control through LF Clock Pulse Width Modulation

Pulse-width modulation of the external LF input signal may be used to regulate the brightness of the EL lamp. Figure 7, Figure 8, and Figure 9 below demonstrate examples of the D306A 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 10 shows a typical dimming curve with this technique. Operation at duty cycles lower than 10% is not recommended. Clocking frequency can range from 400 Hz to 2000 Hz.

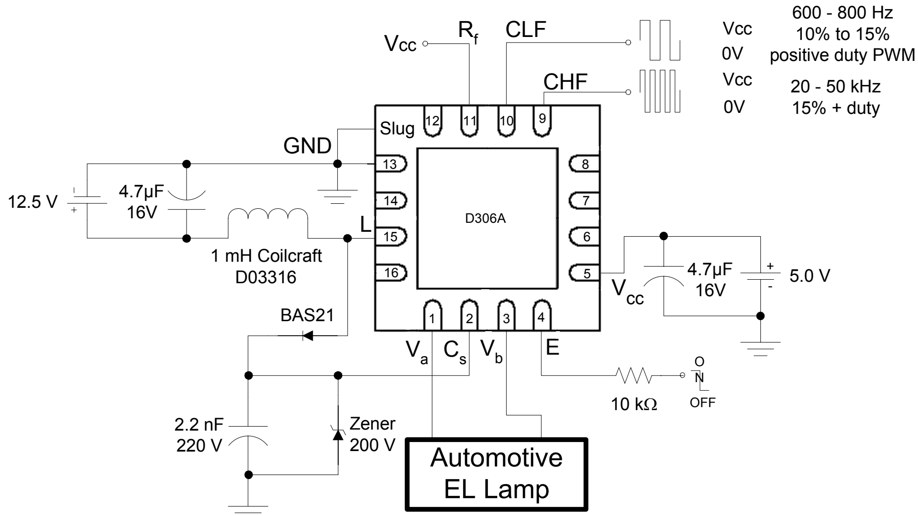


Figure 6—EL Brightness Control via HF Clock PWM

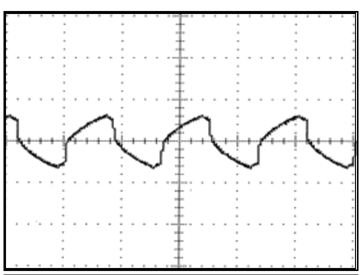


Figure 7—LF Duty Cycle = 15%

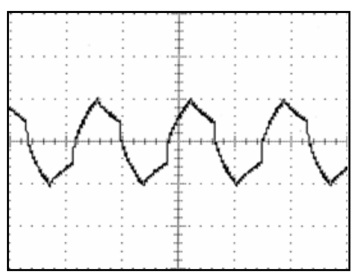


Figure 8— LF Duty Cycle = 50%

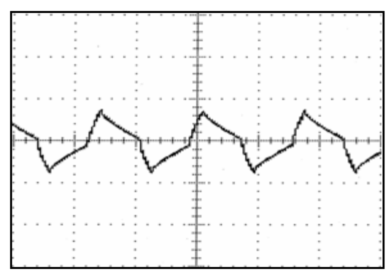


Figure 9— LF Duty Cycle = 75%

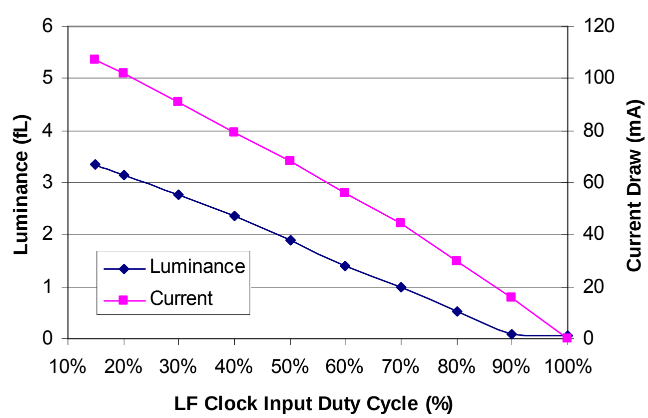


Figure 10—Luminance and current draw vs. LF duty cycle

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III. EL Brightness Control through HF Clock Pulse Width Modulation

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 decreases 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 D306A 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 11 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.

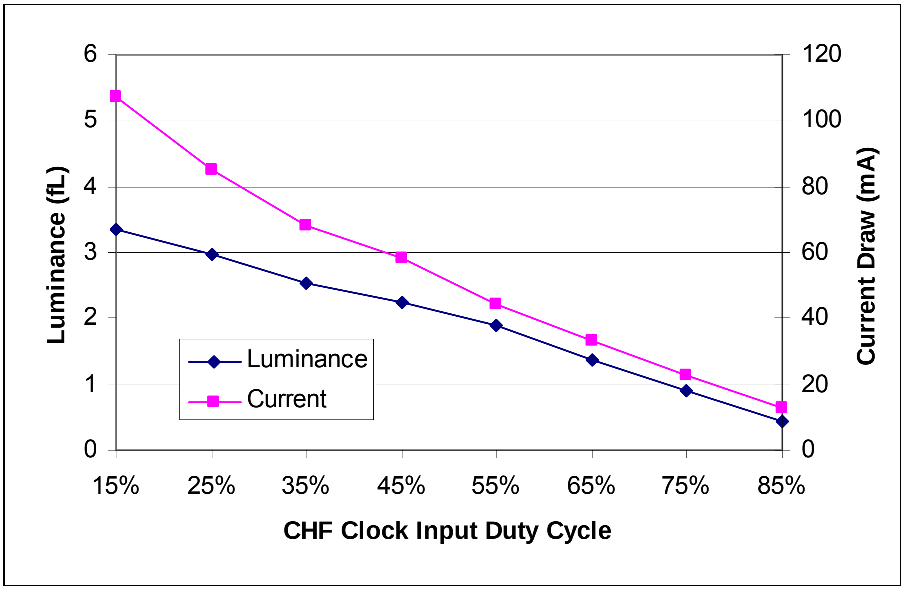


Figure 11—Luminance and current draw vs. LF duty cycle

VII. Solder Re-Flow Recommendations

Classification Reflow Profiles

Profile Feature	Pb-Free Assembly 1DDD306AA-P02
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 Time 25°C to Peak	 6°C/second max.
Temperature	8 minutes max.

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

IPC/JEDEC J-STD-020B July 2002

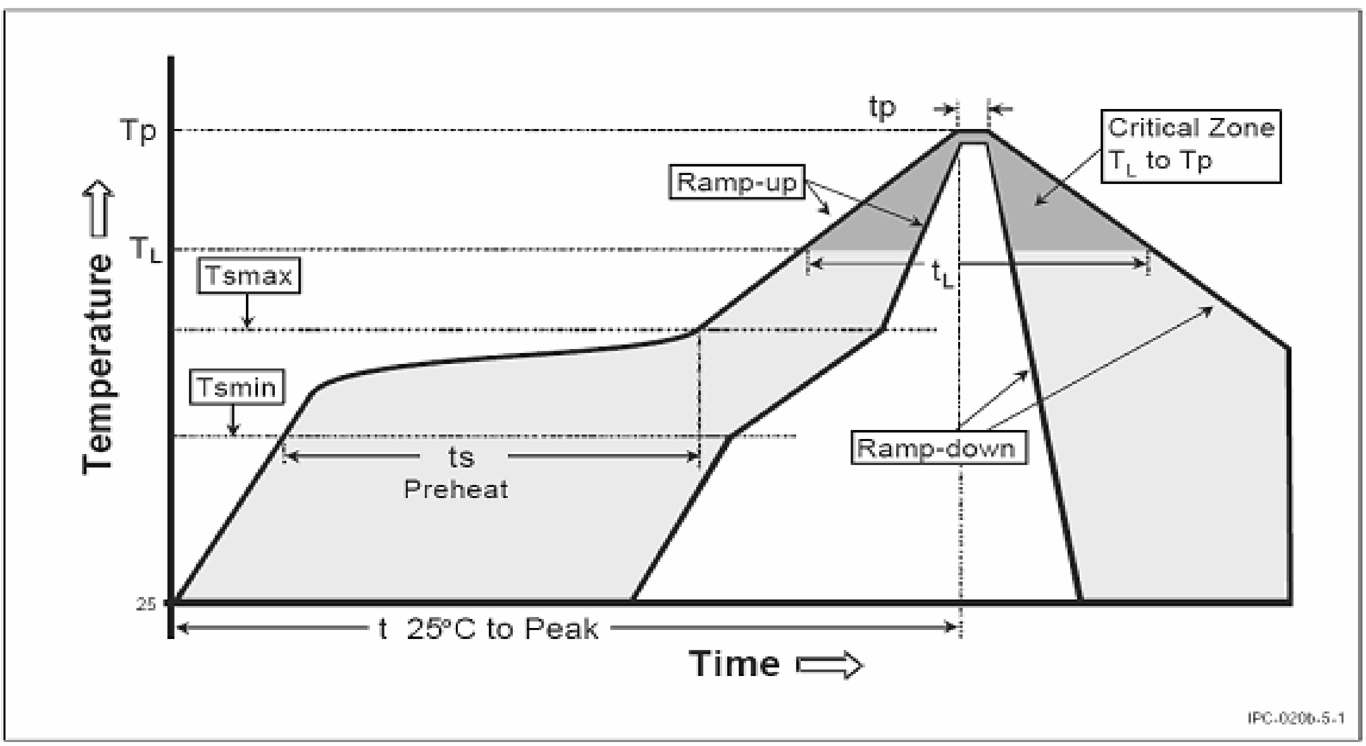


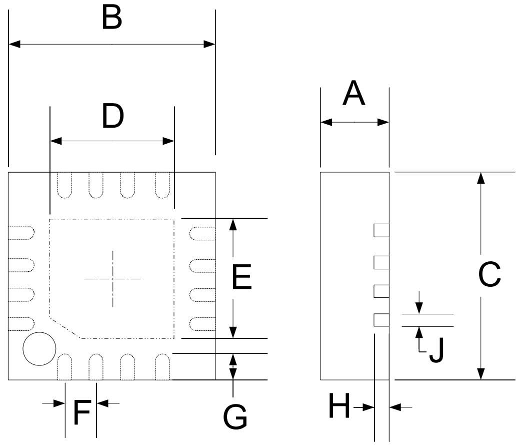
Figure 5-1 Classification Reflow Profile

The information contained in this data sheet is intended to assist you in designing with Rogers EL systems. 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 systems for each application.

Ordering Information

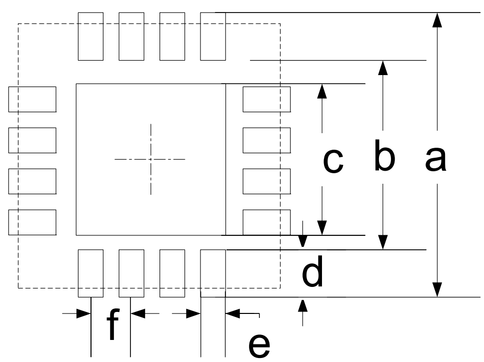
The D306A IC is available in standard Lead-free (Pb-Free) QFN with heat slug plastic package per tape and reel. A Rogers' D306A IC Designer's Kit (1DDD306AA-K01) provides a vehicle for evaluating and identifying the optimum component values for any particular application using D306A IC. Rogers' engineers also provide full support to customers including specialized circuit optimization and application retrofits upon request.

QFN-16 Dimensions



	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

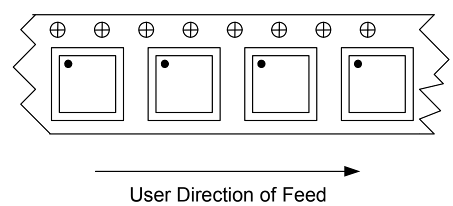


Devices are marked with Rogers' logo, part number, and 4-digit code. Bottom of marking is on the Pin 1 side.

	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		

D306A IC in Tape & Reel: 1DDD306AA-P02

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



ISO 9001:2000, ISO/TS 16949:2002, and ISO 14001:1996 Certified

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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