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Data Sheet

D355B Electroluminescent Lamp Driver IC

Features
- High Efficiency
- Low Voltage Operation
- Small System Footprint
- Controlled Current Discharger for Low EMI
- Capacitor or External Clock LF Control
- Available in Lead-Free (Pb-Free) and Green MSOP-8 package

MSOP-8

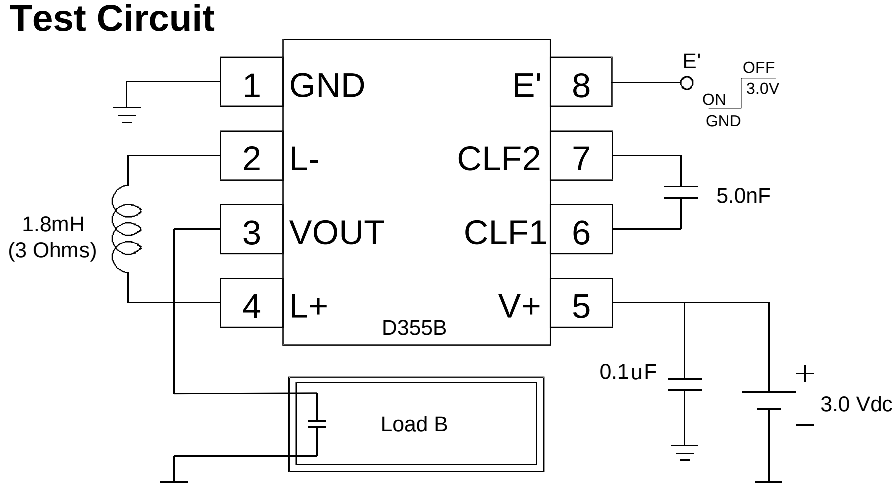
Applications
- Watches
- Data Organizer / PDAs
- Pagers
- MP3/GPS/Remote control

Rogers DUREL® D355B IC driver is part of a family of highly integrated EL drivers based on Rogers' patented three-port (3P) topology, which offers built-in EMI shielding. This high efficiency device is well suited for backlighting most timepieces and liquid crystal displays for portable electronic applications.

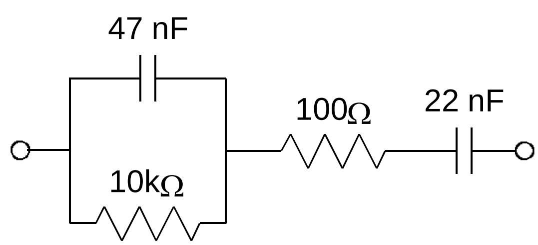
Lamp Driver Specifications:
(Using Standard Test Circuit at Ta=25°C unless otherwise specified.)

Parameter	Symbol	Minimum	Typical	Maximum	Units	Conditions
Standby Current			10	1000	nA	E' = 3.0V
Supply Current	I		23	30	mA	E' = GND
Enable Current			-10	-35	uA	E' = GND
Output Voltage	Vout	110	145	220	Vpp	E' = GND
Lamp Frequency	LF	230	310	390	Hz	CLF = 5.0 nF
Inductor Frequency	HF	10	16	23	kHz	

Standard Test Circuit

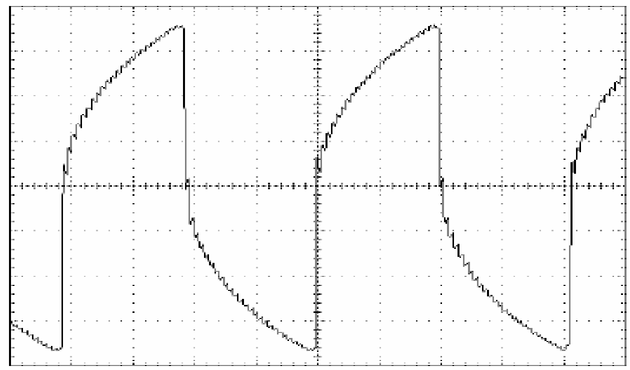


Load B*



* Load B approximates a 5in² (32.3cm²) EL lamp.

Typical Output Waveform

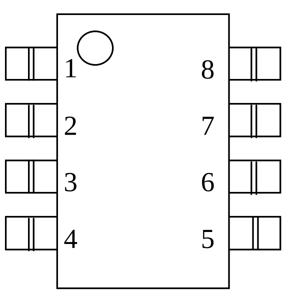


Absolute Maximum Ratings:

Parameter	Symbol	Minimum	Maximum	Unit	Comments
Supply voltage Operating Range Withstand Range	V+	1.0 -0.5	7.0 10.0	V	E = V+ E = GND
Enable voltage Enable on Enable off	E' E'_{ON} E'_{OFF}	-0.5 0.8	(V+) + 0.5 0.6	V	
Output Voltage	V_{OUT}		220	Vpp	Peak-to-peak Voltage
CLF Voltage	V_{CLF}	0	(V+) + 0.3	V	External clock input
Operating temperature	T_a	-40	85	°C	
Storage temperature	T_s	-65	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.

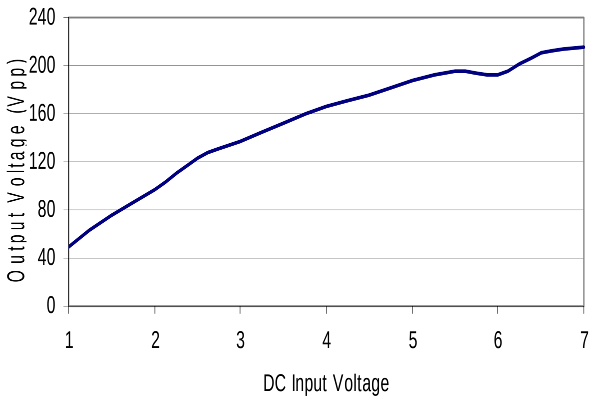
Physical Data:



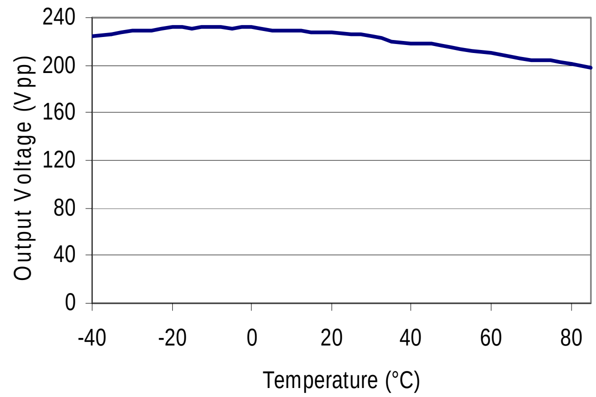
PIN #	NAME	FUNCTION
1	GND	System ground connection
2	L-	Negative input to inductor
3	VOUT	High voltage AC output to lamp
4	L+	Positive input to inductor
5	V+	DC power supply input
6	CLF1	Lamp frequency capacitor/clock input
7	CLF2	Lamp frequency capacitor/clock input
8	E'	System enable

Note: Please consult factory for bare die dimensions and bond pad locations.

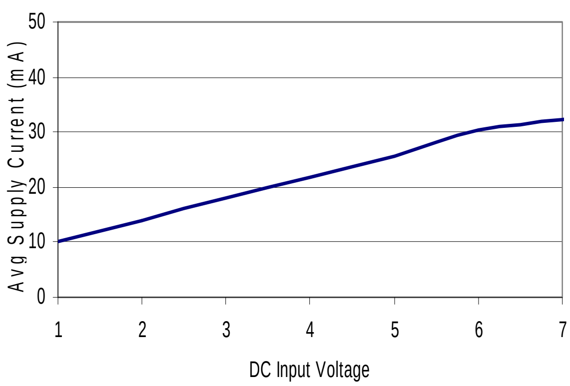
Typical Performance Characteristics Using Standard Test Circuit



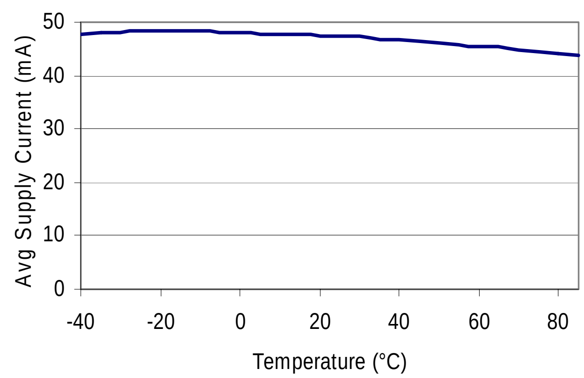
Output Voltage vs. DC Supply Voltage



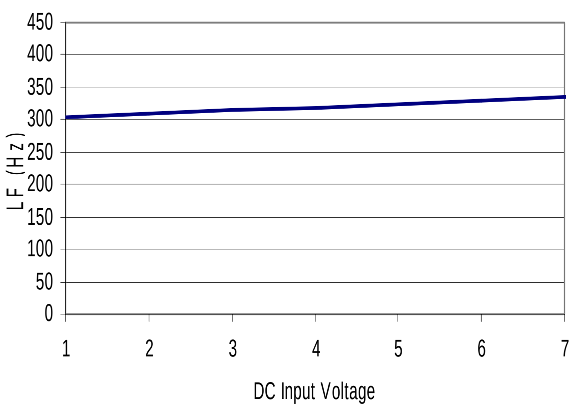
Output Voltage vs. Ambient Temperature



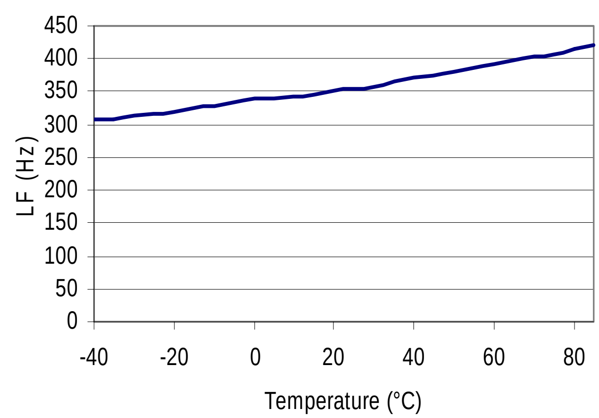
Supply Current vs. DC Supply Voltage



Supply Current vs. Ambient Temperature

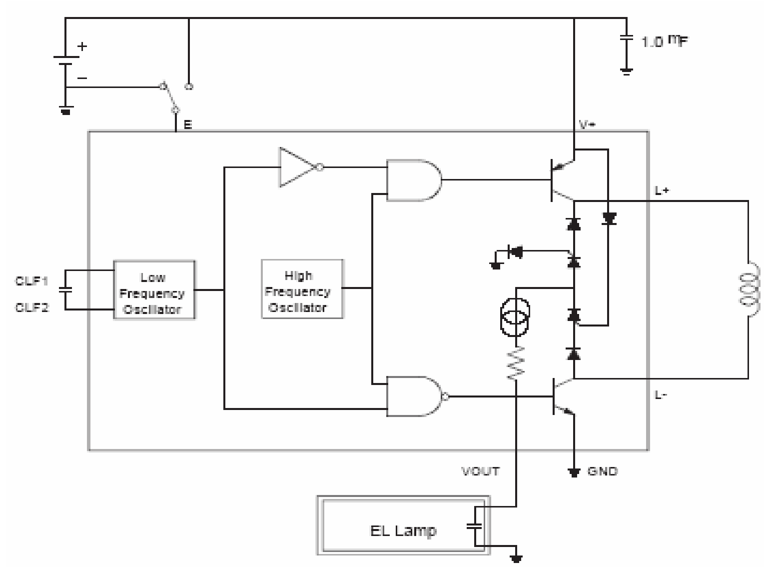


Output Frequency vs. DC Supply Voltage



Output Frequency vs. Ambient Temperature

Block Diagram of the Inverter 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. Rogers developed its patented three-port (3P) switch-mode inverter circuit to convert the available DC supply to an optimal drive signal for high brightness and low-noise EL lamp applications. The Rogers 3P topology offers the simplicity of a single DC input, single AC output, and a shared common ground that provides an integrated EMI shielding.

The D355B IC drives the EL lamp by repeatedly pumping charge through an external inductor with current from a DC source and discharging into the capacitance of the EL lamp load. With each high frequency (HF) cycle the voltage on the lamp is increased. At a period specified by the lamp frequency (LF) oscillator, the voltage on the lamp is discharged to ground and the polarity of the inductive charging is reversed. By this means, an alternating positive and negative voltage is developed at the single output lead of the device to one of the electrodes of the EL lamp. The other lamp electrode is commonly connected to a ground plane, which can then be considered as electrical shielding for any underlying circuitry on the application.

The EL driving system is divided into several parts: on-chip logic and control, on-chip high voltage output circuitry, discharge logic circuitry, and off-chip components. The on-chip logic controls the output frequency (LF), as well as the inductor switching frequency (HF), and HF and LF duty cycles. These signals are combined and buffered to regulate the high voltage output circuitry. The output circuitry handles the power through the inductor and delivers the high voltage to the lamp. The selection of off-chip components provides a degree of flexibility to accommodate various lamp sizes, system voltages, and brightness levels. Since a key objective for EL driver systems is to save space and cost, required off-chip components are kept to a minimum.

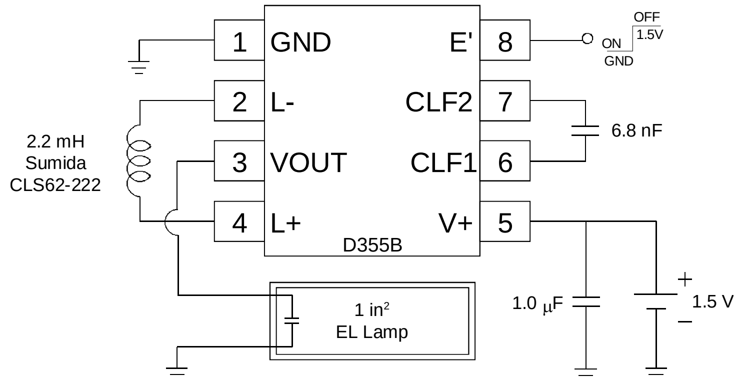
Rogers provides a D355B IC Designer's Kit, which includes a printed circuit evaluation board intended to aid you in developing an EL lamp driver configuration that meets your requirements using the D355B IC. A section on designing with the D355B IC is included in this datasheet to serve as a guide to help you select the appropriate external components to complete your D355B EL driver system.

Typical D355B 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.

Typical D355B EL Driver Configurations

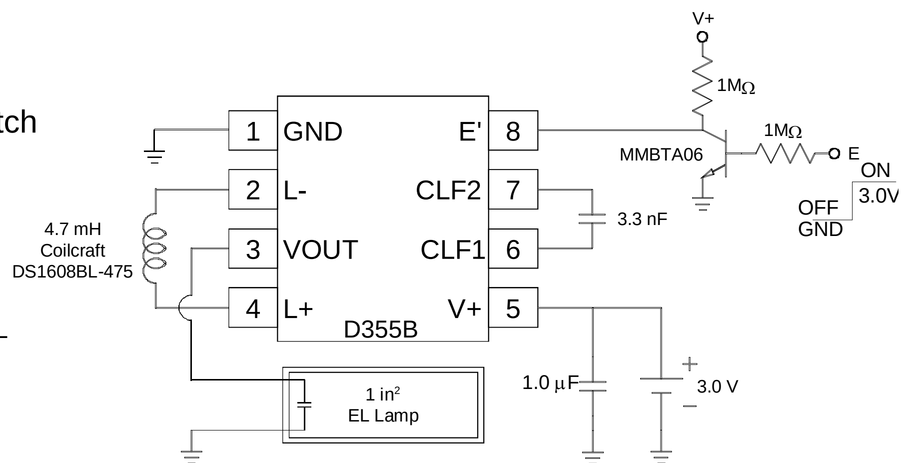
1.5V Analog Watch

Typical Output
Luminance = 3.5 fL (12 cd/m^2)
Lamp Frequency = 220 Hz
Supply Current = 10 mA
Vout = 178 Vpp
Load: 1 in^2 (6.45 cm^2) DUREL 3 Green EL



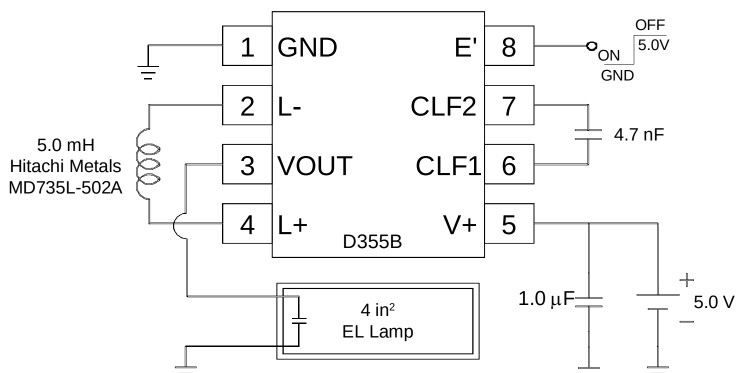
3.0V Handset LCD or Digital Watch

Typical Output
Luminance = 8.6 fL (29.5 cd/m^2)
Lamp Frequency = 475 Hz
Supply Current = 14 mA
Vout = 208 Vpp
Load: 1 in^2 (6.45 cm^2) DUREL 3 Green EL



5.0V PDA

Typical Output
Luminance = 7.7 fL (26.4 cd/m^2)
Lamp Frequency = 360 Hz
Supply Current = 19 mA
Vout = 220 Vpp
Load: 4 in^2 (25.8 cm^2) DUREL 3 Green EL



Designing with A D355B IC Driver

I. Lamp Frequency Capacitor (CLF) Selection

Selecting the appropriate value of capacitor for the low frequency oscillator (CLF) will set the output frequency of the D355B IC inverter. Figure 1 graphically represents the inversely proportional relationship between the CLF capacitor value and the oscillator frequency. In this example at V+=3.0V, LF = 400Hz at 3.9nF.

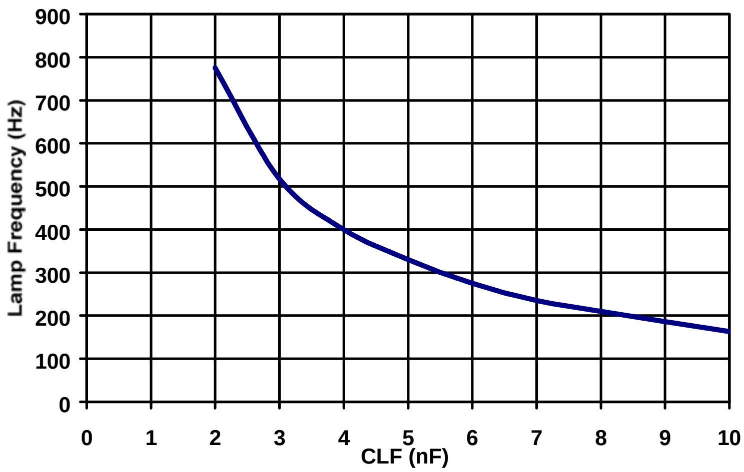


Figure 1: Typical Lamp Frequency vs. CLF Capacitor

Alternatively, the lamp frequency may also be controlled with an external clock signal with a 50% duty cycle. The output lamp frequency will be the same frequency as the input clock signal. For example, if a 250Hz input clock signal is used; the resulting lamp frequency will be 250Hz. The clock signal input voltage should not exceed V+.

The selection of the CLF value can also affect the brightness of the EL lamp because of its control of the lamp frequency (LF). Although input voltage and lamp size can change EL lamp frequency as well, LF mainly depends on the CLF value selected or the frequency of the input clock signal to CLF. The luminance of various sizes of a blue-green EL lamp driven by a D355B IC at V+ = 3.0V using the same inductor value is shown in Figure 2 with respect to lamp frequency.

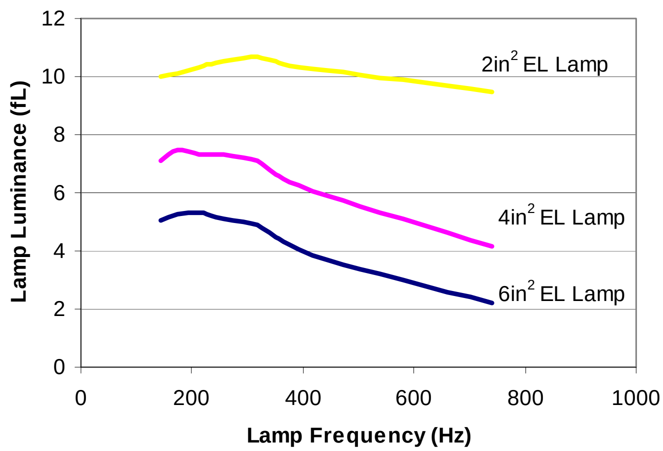


Figure 2: Typical Lamp Luminance vs. Lamp Frequency

II. Inductor (L) Selection

The external inductor (L) selection for a D355B IC circuit greatly affects the output capability and current draw of the driver. A careful designer will balance current draw considerations with output performance in the choice of an ideal inductor for a particular application. Figure 3, 4, and 5 show typical brightness and current draw of a D355B IC circuit with different inductor values, lamp sizes, and supply voltages while keeping the LF constant. Please note that the DC resistance (DCR) of inductors with the same nominal inductance value may vary with manufacturer and inductor type. Therefore, inductors made by a different manufacturer may yield different outputs, but the trend of the different curves should be similar. Lamp luminance is also a function of lamp size. In each example, a larger lamp will have less luminance with approximately the same current draw.

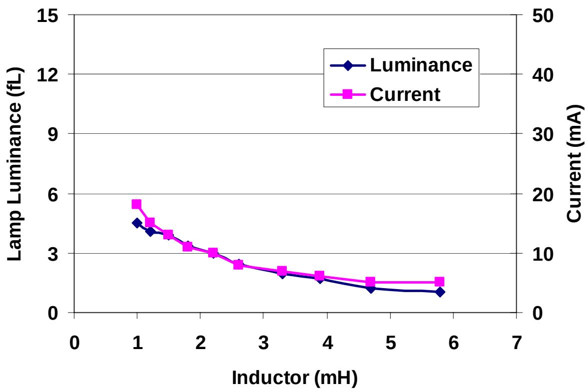


Figure 3: V+=1.5V, $1in^2$ ($6.45cm^2$) EL Lamp

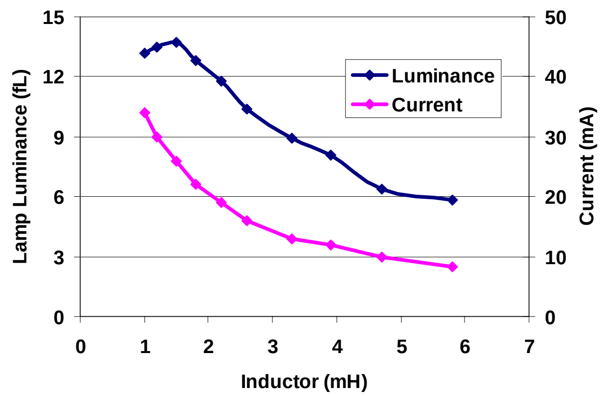


Figure 4: V+=3.0V, $1in^2$ ($6.45cm^2$) EL Lamp

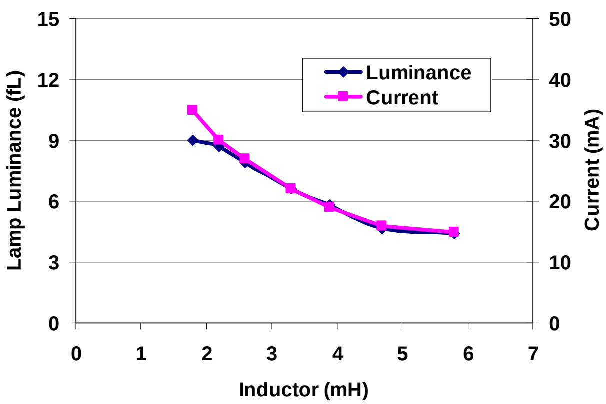
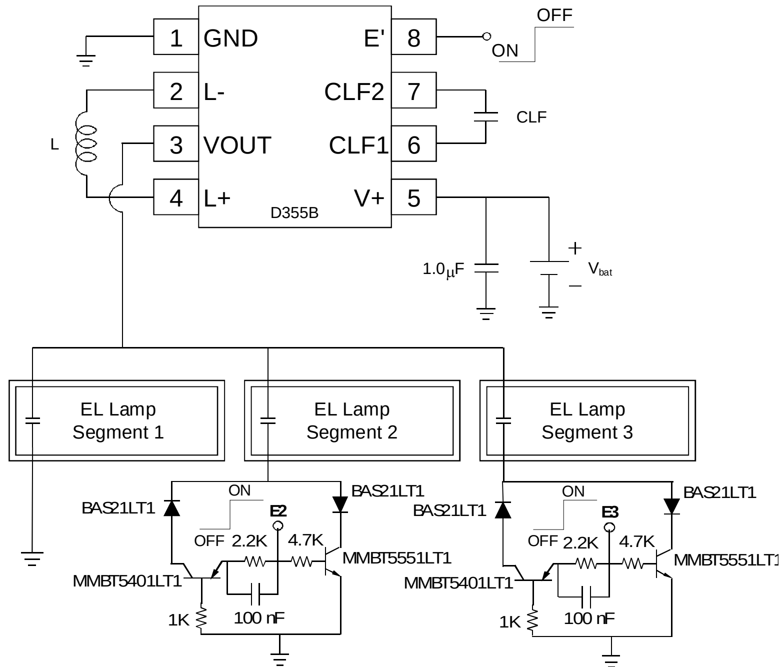


Figure 5: V+=5.0V, $4in^2$ ($25.8cm^2$) EL Lamp

D355B IC Design Ideas

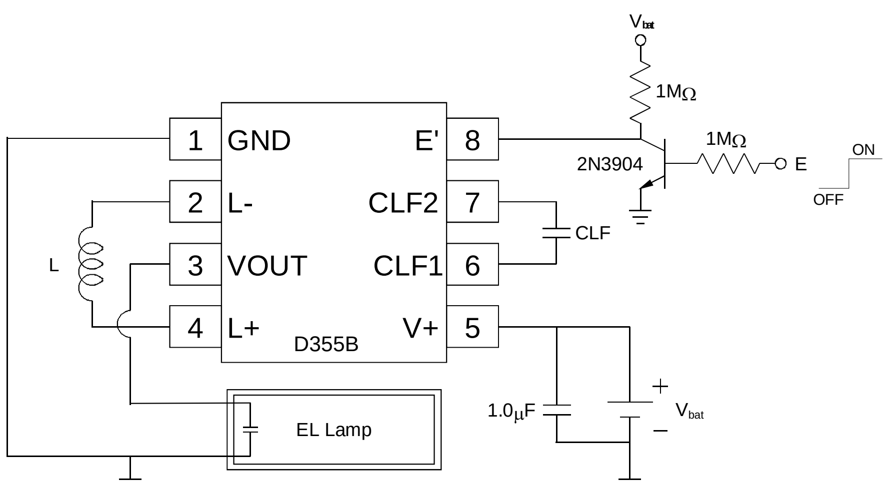
I. Driving Multi-segment Lamps

The D355B IC may be used to drive two or more EL lamps or EL lamp areas independently. An external switching circuit can be used to turn each lamp segment on or off. A high signal at the E input for the corresponding EL lamp will power the segment when the IC is enabled. In this example, Segment 1 is always on when the D355B IC is enabled. Otherwise, always make sure that at least one segment is switched on when the driver IC is activated.



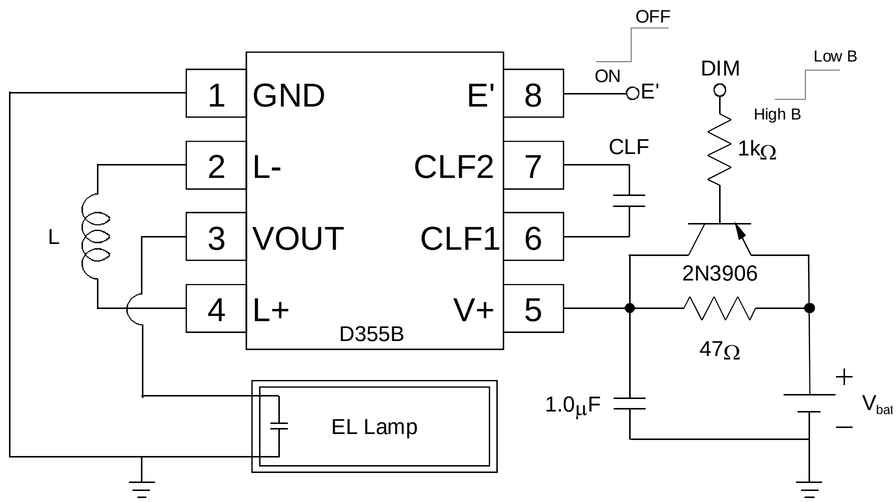
II. Enabling the D355B IC with a High Logic Signal

A low logic signal at the E' pin will enable the D355B IC. Adding a transistor and two resistors will allow the D355B IC to be enabled with a high voltage signal.



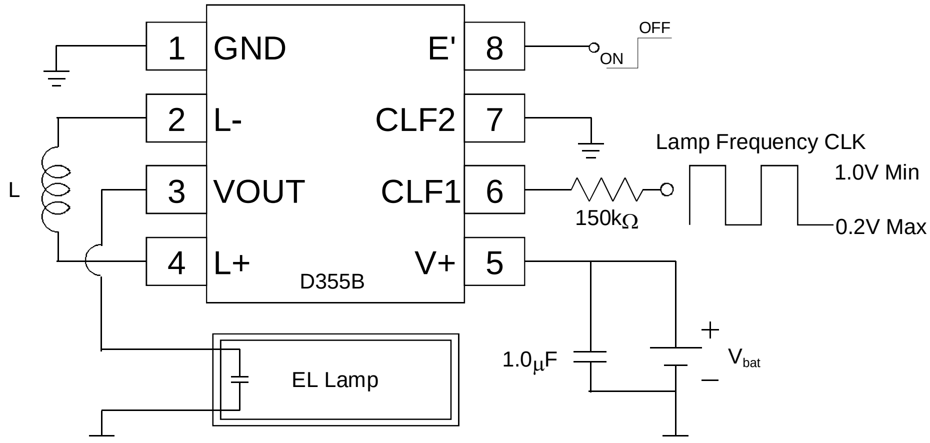
III. Two-Level Dimming

Toggle switching between two different EL lamp brightness levels may be achieved, as captioned in the circuit shown below. When DIM is low, the external PnP transistor is saturated and the EL lamp runs at full brightness. When DIM is high, the external PnP turns off and the 47Ω resistor reduces the voltage at (V+) and dims the EL lamp.



IV. Lamp Frequency Control with an External Clock Signal

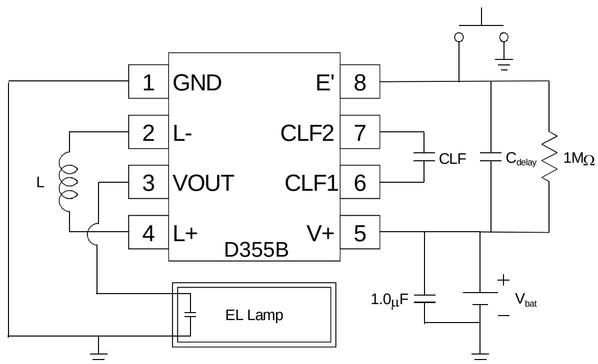
An external clock signal with a 50% duty cycle may be used to control the EL lamp frequency (LF). This technique allows the designer flexibility to synchronize the El driver IC with other elements in the application. The output lamp frequency will be the same frequency as the input clock signal. For example, if a 250Hz input clock signal is used, the resulting lamp frequency will be 250Hz. The clock signal voltage should not exceed V+.



V. Automatic Turn-Off after Short Time Delay

It is sometimes desirable for the EL lamp to turn off automatically after a few seconds of operation. Typically, a mechanical switch pulls E' low to initially turn on the device. When the switch is released, Cdelay keeps the D355B IC operating for a short period before turning off. The following table shows typical delay on-times.

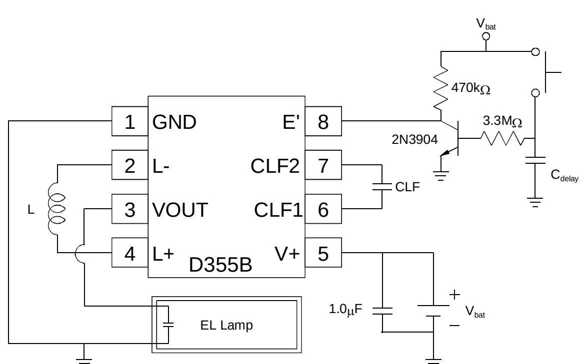
	Vbat		
C_{delay} (uF)	1.5V	3.0V	5.0V
5	2.4 s	4.0 s	6.0 s
7	3.3 s	5.5 s	7.8 s
10	5.1 s	8.6 s	12.5 s
15	7.2 s	12.7 s	19.3 s
20	9.9 s	17.2 s	27.0 s



VI. Automatic Turn-Off after Long Time Delay

Longer on-times can be achieved with the addition of an external transistor. Typically, a mechanical switch pulls E' low to initially turn on the device. When the switch is released, Cdelay keeps the D355B IC operating for a period before turning off. The following table and drawing show typical delay on-times using the D355B IC circuit with smaller capacitor values.

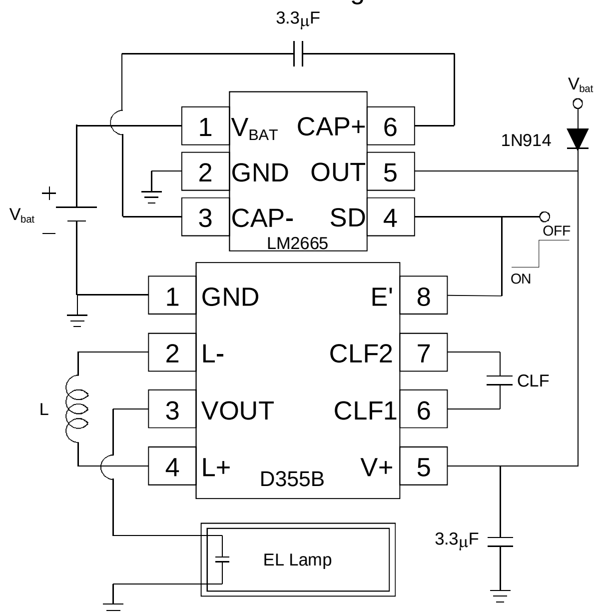
	Vbat		
C_{delay} (uF)	1.5V	3.0V	5.0V
1	9.5 s	13.0 s	15.6 s
2	17.8 s	24.0 s	29.0 s
3	26.5 s	36.0 s	42.0 s



VII. High EL Brightness Through Supply Voltage Doubling (Option 1)

Maximum brightness from a D355B IC is achieved at relatively high supply voltages (>3.0V). An external voltage boost circuit may be used to increase the voltage supplied to the D355B IC. In the circuit shown below, the LM2665 boost converter is used to double the voltage supplied to the D355B IC. This can produce about twice the brightness of the D355B IC alone.

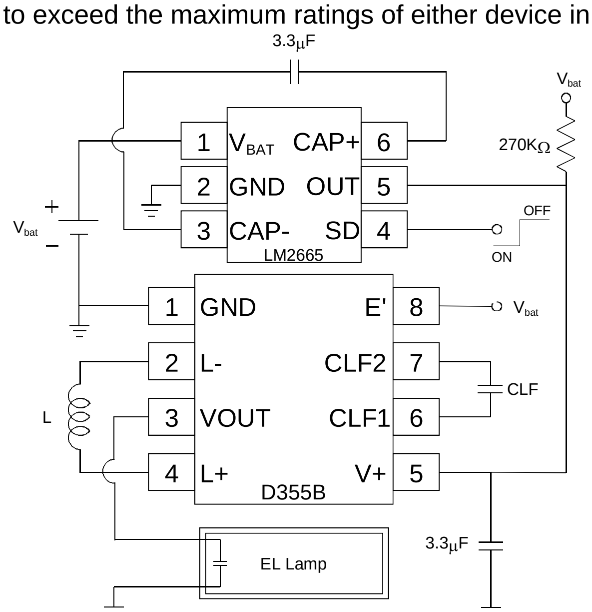
Note: It is important not to exceed the maximum ratings of either device in this circuit.



VIII. High EL Brightness Through Supply Voltage Doubling (Option 2)

In many cases, a resistor may replace the diode in the previously shown circuit. The diode is used by the LM2665 converter during startup (see LM2665 converter datasheet). The circuit diagram shown below ensures that the LM2665 converter starts properly before the D355B IC is turned on.

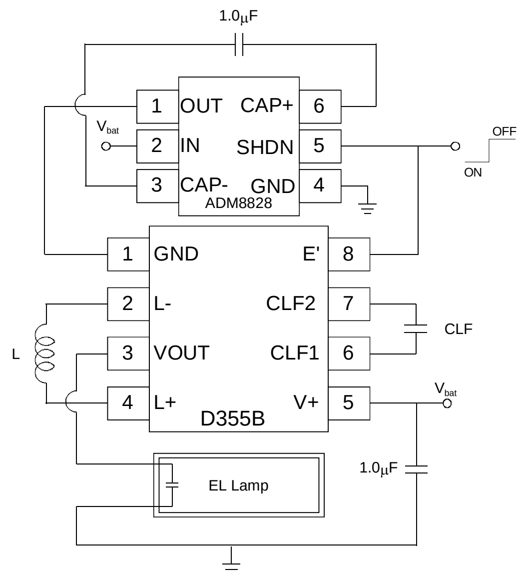
Note: It is important not to exceed the maximum ratings of either device in this circuit.



IX. High EL Brightness Through Supply Voltage Doubling (Option 3)

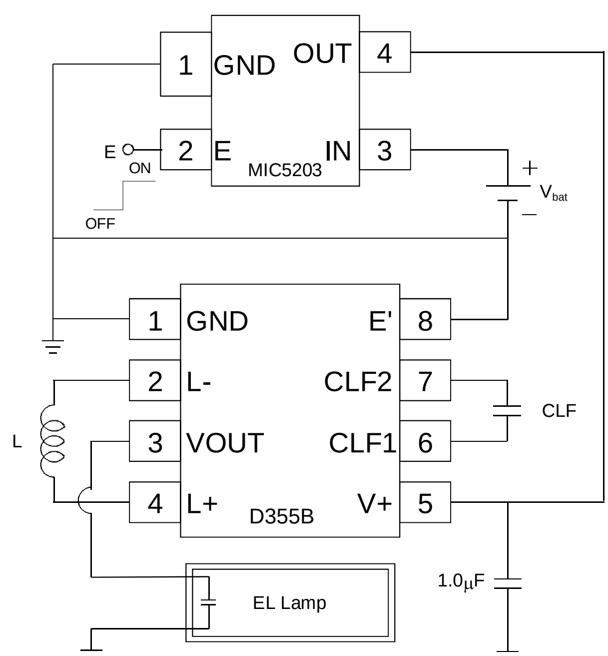
In the circuit configuration shown below, the ADM8828 boost converter produces a negative Vbat voltage. This voltage may be connected to the GND pin on the D355B IC to double the differential voltage supplied to the D355B IC. This can produce about twice the brightness of the D355B IC alone.

Note: It is important not to exceed the maximum ratings of either device in this circuit.



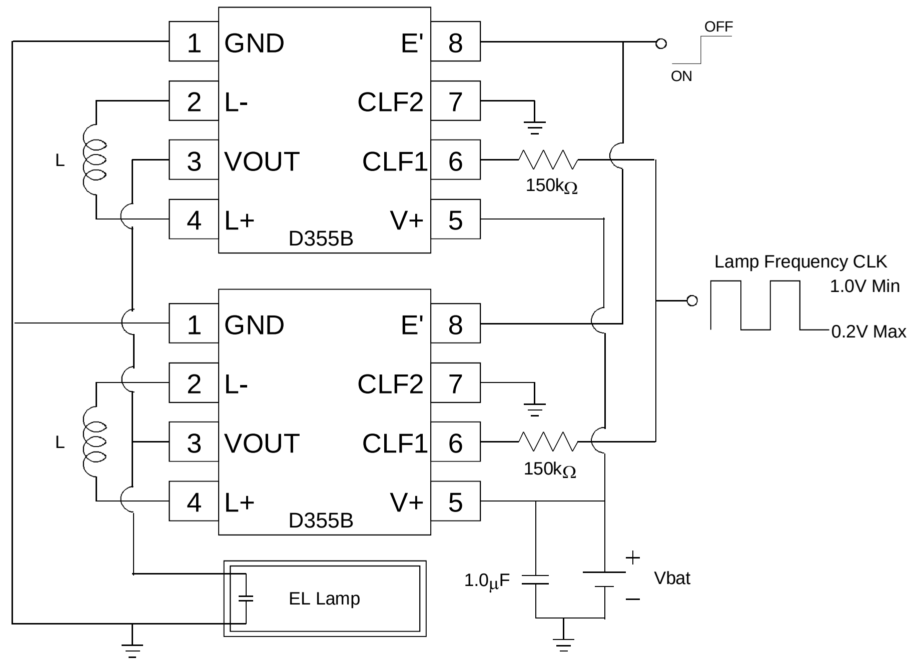
X. EL Lamp Brightness Regulation

Regulating the DC supply input voltage to the D355B IC will result in a constant brightness level from the EL lamp, regardless of battery voltage. In the next example, a voltage regulator is used.



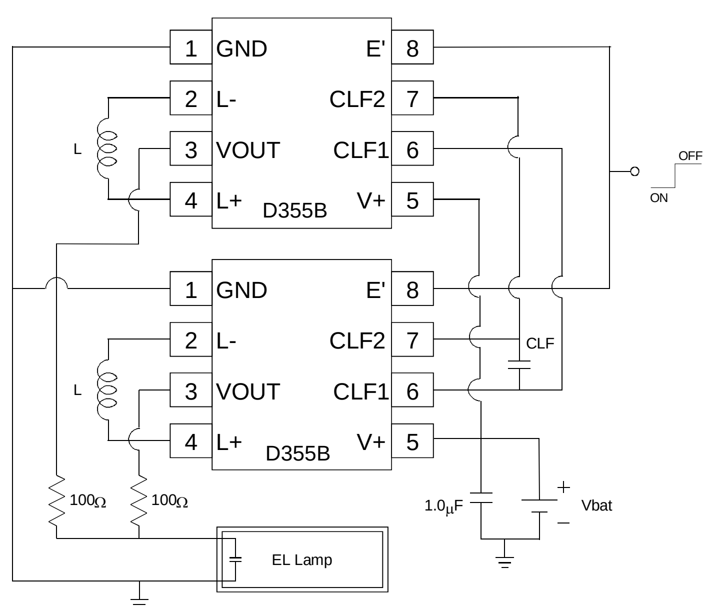
XI. High EL Brightness with Parallel D355B IC Drivers (Option 1)

Two or more D355B IC drivers may be operated in parallel to increase the brightness of the EL lamp by 50-100%. In this example, an external clock signal with 50% duty cycle is needed to synchronously drive both D355B ICs. The clock signal voltage should not exceed V+.



XII. High EL Brightness with Parallel D355B IC Drivers (Option 2)

Two or more D355B IC drivers may be operated in parallel to increase the brightness of the EL lamp by 50-100%. In the following diagram, two D355B ICs are operating synchronously using their internal oscillators. The lamp frequency is controlled by a shared CLF capacitor.



XIII. 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 (Ts_{min}) -Temperature Max (Ts_{max}) -Time (min to max) (ts)	100°C 150°C 60-120 seconds		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)	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
Note: All Temperatures refer to IPC/JEDEC J-STD-020B

IPC/JEDEC J-STD-020B July 2002

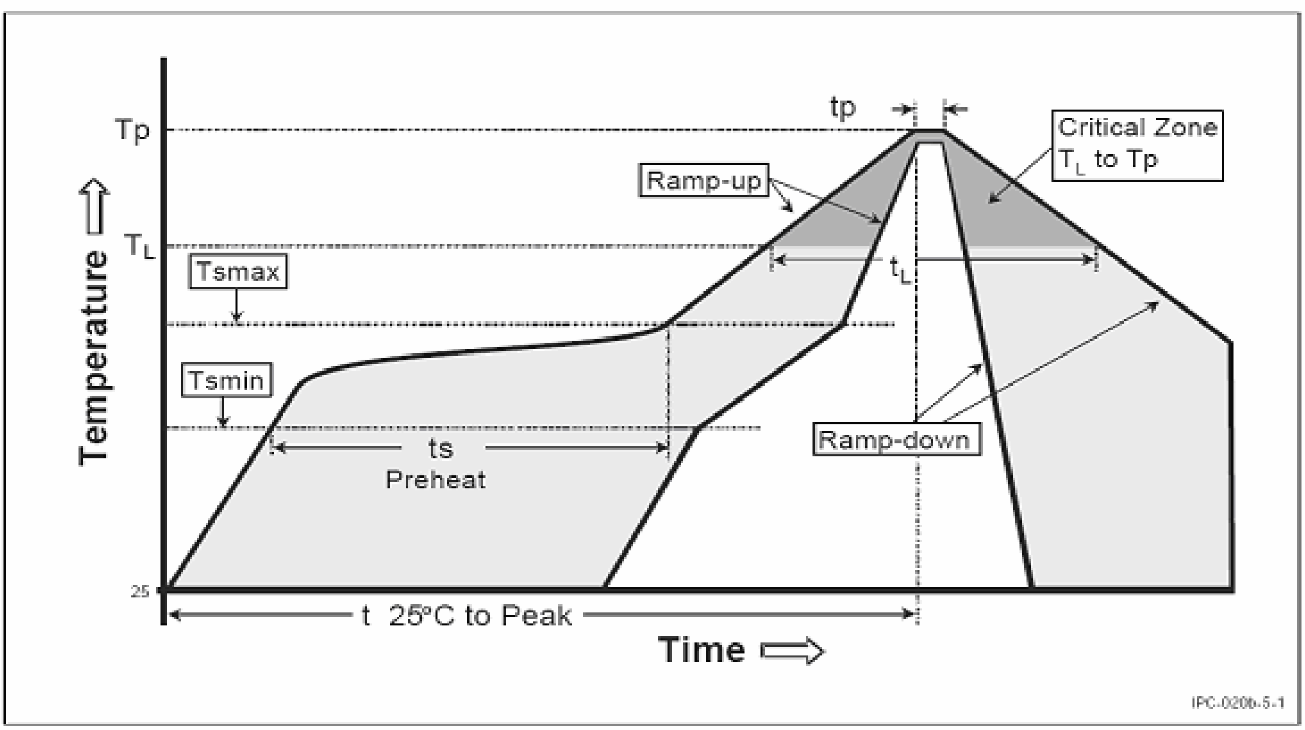
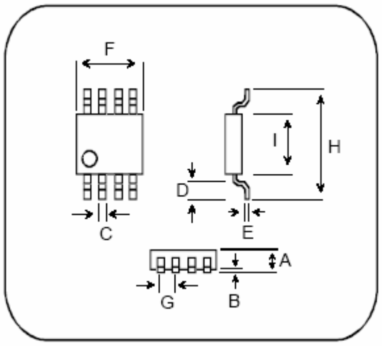


Figure 5-1 Classification Reflow Profile

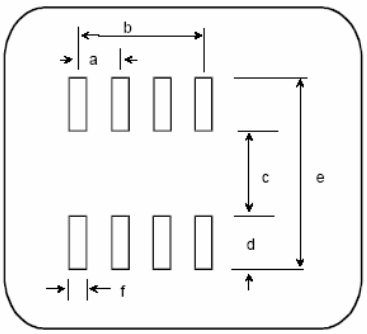
Ordering Information

The D355B IC is available as bare die in probed wafer form or in die tray, and in standard or Pb-free Green MSOP-8 package per tape and reel. A D355B IC Designer's Kit (1DDD355BB-K01) provides a vehicle for evaluating and identifying the optimum component values for any particular application using D355B IC. Rogers' engineers also provide full support to customers, including specialized circuit optimization and application retrofits.



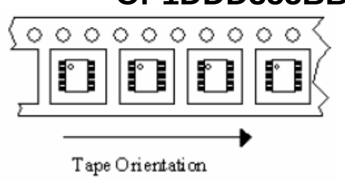
	MSOP-8					
	Min		Typical		Max	
	mm	in	Mm	in	mm	in
A	0.94	0.037	1.02	0.040	1.09	0.043
B	0.05	0.002	0.10	0.004	0.15	0.006
C	0.20	0.008	0.33	0.013	0.46	0.018
D	0.41	0.016	0.53	0.021	0.65	0.026
E	0.13	0.005	0.18	0.007	0.23	0.009
F	2.84	0.112	3.00	0.118	3.15	0.124
G	0.43	0.017	0.65	0.026	0.83	0.033
H	4.70	0.185	4.90	0.193	5.11	0.201
I	2.84	0.112	3.00	0.118	3.25	0.128

RECOMMENDED PAD LAYOUT



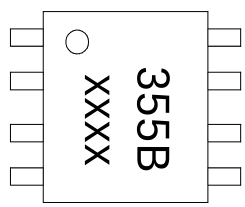
	MSOP-8 PAD LAYOUT					
	Min		Typical		Max	
	mm	in	Mm	in	mm	in
a	0.60	0.0236	0.6	0.0256	0.70	0.0276
b	1.90	0.0748	1.9	0.0768	2.00	0.0788
c	3.3	0.130			3.45	0.136
d	0.89	0.035	0.9	0.038	1.05	0.041
e	5.26	0.207			5.41	0.213
f	0.41	0.016	0.4	0.018	0.51	0.020

Tape & Reel: 1DDD355BB-M02 Or 1DDD355BB-NL2



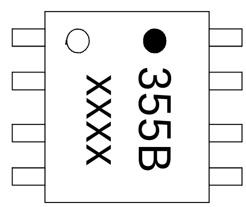
Embossed tape on 360mm diameter reel per EIA-481-2.
2500 units per reel. Quantity marked on reel label.

1DDD355BB-MO2



Standard MSOP-8

1DDD355BB-NL2



Pb-free Green MSOP-8

ISO9001:2000, ISO/TS 16949:2002, and ISO14001:1996 Certified

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.

These EL drivers are covered by one or more of the following U.S. patents: #5,313,141; #5,347,198; #5,677,599; #5,789,870; #6,043,610. Corresponding foreign patents are issued and pending.

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