

### Inductorless 700mA Flash LED Driver in 2x3mm Package

#### Features

- Input voltage range: 2.7V~5.5V
- Drive up to 700mA
- High efficiency LED driver
- Independent flash-mode enable and movie/torch-mode enable pins
- Movie/torch-mode dimming via PWM control
- One resistor sets flash-mode LED current
- One resistor sets movie/torch-mode LED current
- Integrated thermal regulation control
- LED short protection
- 0.1  $\mu$ A shutdown current
- Pb-free Package: TDFN2x3-14
- -40°C to +85°C Temperature Range

#### Applications

- Mobile Phones
- Smart Phones and PDAs
- Digital Still Cameras

#### Brief Description

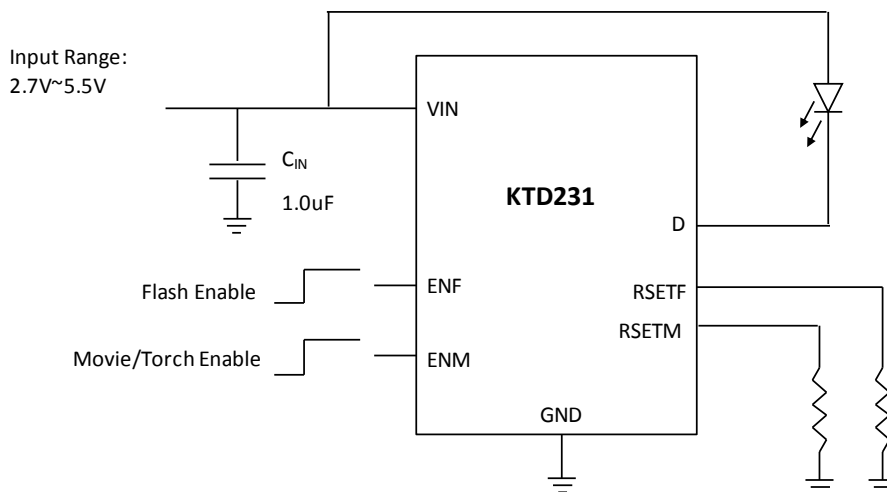
The KTD231 is the ideal power solution for flash LEDs used with cell phone camera modules or digital still cameras. It is a highly integrated linear flash LED driver, providing a very small total solution for portable photo flash with minimum external components. The KTD231 has separate flash-mode and movie/torch-mode enable pins for maximum flexibility. The flash-mode and movie/torch-mode LED current is programmed by external resistors respectively, making the flash LED solution simple to control. If both enable pins are at logic high, the LED current will be programmed by the movie/torch-mode setting resistor.

The LED output sink can drive flash LEDs up to 700mA continuous LED current. Thermal regulation is integrated in flash mode to limit the IC's temperature and continuously provide the maximum allowed output current.

Various protection features are built into the KTD231, LED fault (short circuit) protection and thermal shutdown protection. The leakage current in shutdown mode is 0.1 $\mu$ A.

The KTD231 is available in a RoHS compliant 14-lead 2x3x0.75mm ThinDFN.

#### Typical Application

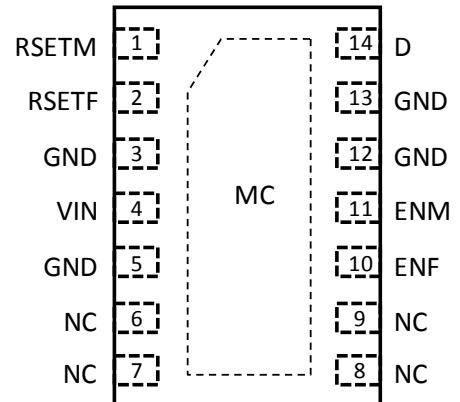


### Pin Descriptions

#### TDFN2x3-14

Pin #	Name	Function
1	RSETM	Movie/torch-mode current setting pin
2	RSETF	Flash-mode current setting pin
3, 5, 12, 13	GND	Ground pin. All GND pins must be connected together for proper operation.
4	VIN	Input supply pin for the IC
6, 7, 8, 9	NC	Not internally connected
10	ENF	Flash-mode enable pin. This pin has an internal 300kΩ pull-down resistor to AGND.
11	ENM	Movie/torch-mode enable pin. This pin has an internal 300kΩ pull-down resistor to AGND.
14	D	Regulated output current sink, up to 700mA current.
	MC	Metal chassis. Connect to ground for electrical and thermal usage. MC is internally connected to Ground pin.

#### TDFN2x3-14 (Top View)



### Absolute Maximum Ratings <sup>1</sup>

(TA=25°C unless otherwise noted)

Symbol	Description	Value	Units
V <sub>IN</sub> , D	Input voltage, output pins	-0.3 to 6	V
ENF, ENM, RSETF, RSETM	Control pins	-0.3 to V <sub>IN</sub> +0.3	V
T <sub>J</sub>	Operating Temperature Range	-40 to 150	°C
T <sub>s</sub>	Storage Temperature Range	-65 to 150	°C
T <sub>LEAD</sub>	Maximum Soldering Temperature (at leads, 10 sec)	300	°C
ESD	HBM electrical static discharge	2.0	kV

1. Stresses above those listed in Absolute Maximum Ratings may cause permanent damage to the device. Functional operation at conditions other than the operating conditions specified is not implied. Only one Absolute Maximum rating should be applied at any one time.

### Thermal Capabilities

Symbol	Description	Value	Units
θ <sub>JA</sub>	Thermal Resistance – Junction to Ambient <sup>2</sup>	78	°C/W
P <sub>D</sub>	Maximum Power Dissipation at T <sub>A</sub> axim°C	1.28	W
ΔP <sub>D</sub> /ΔT	Derating Factor Above T <sub>A</sub> = 25°C	-12.8	mW/°C

2. Junction to Ambient thermal resistance is highly dependent on PCB layout. Values are based on thermal properties of the device when soldered to an EV board.

### Recommended Operating Range

Description	Value
V <sub>IN</sub> , and D Voltages	2.7V – 5.5V

### Ordering Information

Part Number	Marking <sup>3</sup>	Operating Temperature	Package
KTD231EJH-TR	DAYYZ	-40°C to +85°C	TDFN23-14

3. "YYZ" is the date code and assembly code.

### Electrical Characteristics <sup>4</sup>

Unless otherwise noted, the *Min* and *Max* specs are applied over the full operation temperature range of -40°C to +85°C, while *Typ* values are specified at room temperature (25°C).  $V_{IN} = 3.6V$ .

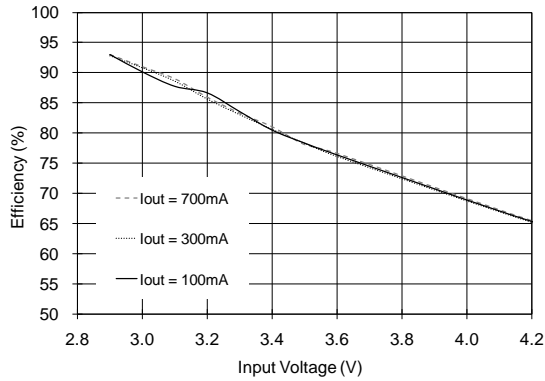
Symbol	Description	Conditions	Min	Typ	Max	Units
<b>IC Supply</b>						
$V_{IN}$	Input operating range		2.7		5.5	V
UVLO	Input under voltage lockout	Rising edge	2.1	2.4	2.68	V
UVLO <sub>HYST</sub>	UVLO hysteresis			0.1		V
$I_Q$	IC operating current			3.5		mA
$I_{SHDN}$	$V_{IN}$ pin shutdown current	ENF = ENM = GND		0.1	1	μA
<b>Current Sink</b>						
ID	Total Output Current, Movie/Torch Mode	ENM = HIGH, R <sub>SETM</sub> = 68kΩ, T <sub>A</sub> = 25°C	89	100	111	mA
	Total Output Current, Flash Mode	ENF = HIGH, ENM = GND, R <sub>SETF</sub> = 13.5kΩ, T <sub>A</sub> = 25°C	435	500	565	mA
$I_{SHORT}$	LED Short Checking Current			2.5		mA
<b>Control</b>						
$V_{TH-L}$	ENF, ENM pin logic low threshold				0.4	V
$V_{TH-H}$	ENF, ENM pin logic high threshold		1.4			V
R <sub>PD(ENF)</sub>	ENF Internal Pull-down Resistance			300		kΩ
R <sub>PD(ENM)</sub>	ENM Internal Pull-down Resistance			300		kΩ
T <sub>J-TH</sub>	IC junction thermal shutdown threshold			150		°C
	IC junction thermal shutdown hysteresis			20		°C

4. The KTD231 is guaranteed to meet performance specifications over the -40°C to +85°C operating temperature range by design, characterization and correlation with statistical process controls.

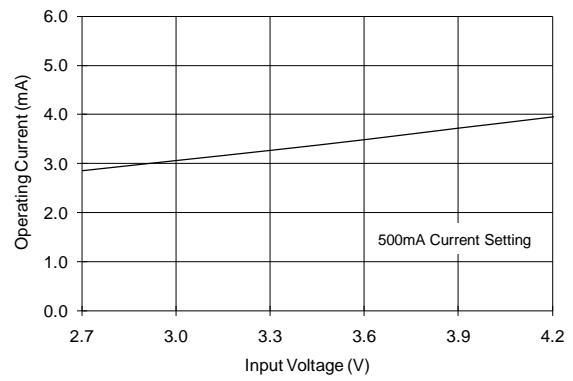
### Typical Characteristics

$V_{IN} = 3.6V$ ,  $I_{LED} = 100mA$ ,  $C_{in} = 1.0\mu F$ ,  $Temp = 25^{\circ}C$  unless otherwise specified.

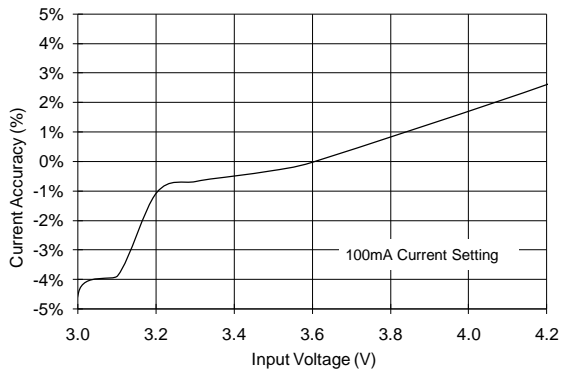
Efficiency vs Input Voltage



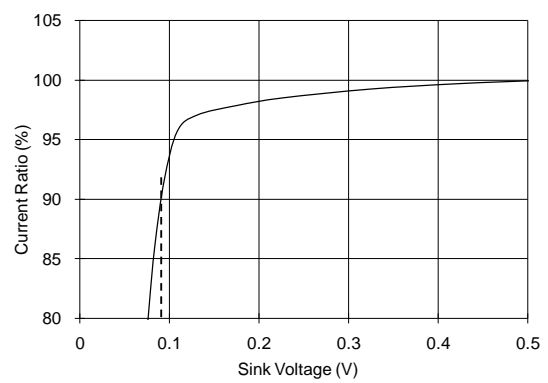
Operating Current



Line Regulation (Movie-mode)

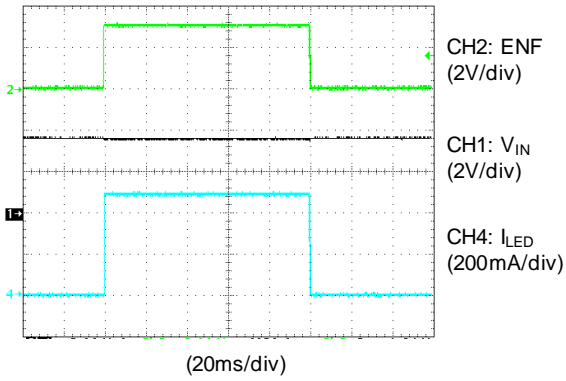


Dropout Voltage ( $V_{in}=3.6V$ , 500mA)

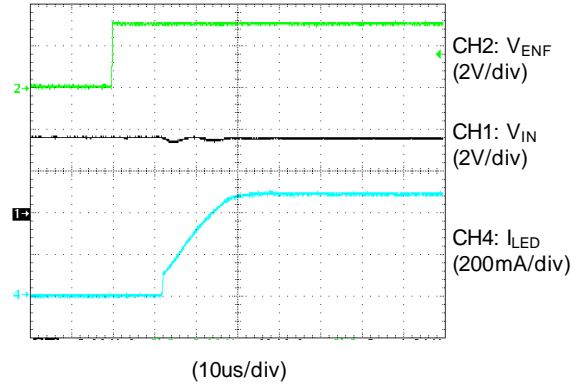


### Typical Characteristics (continued)

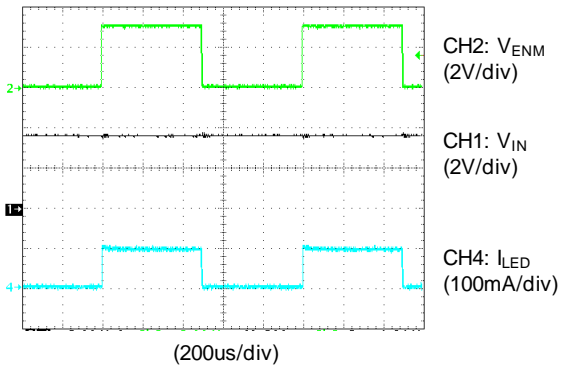
Flash Operation ( $V_{in} = 3.6V, 500mA$ )



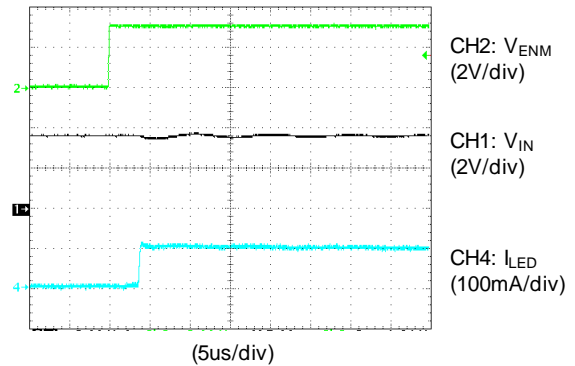
Soft Start: Flash Turn On ( $V_{in} = 3.6V, 500mA$ )



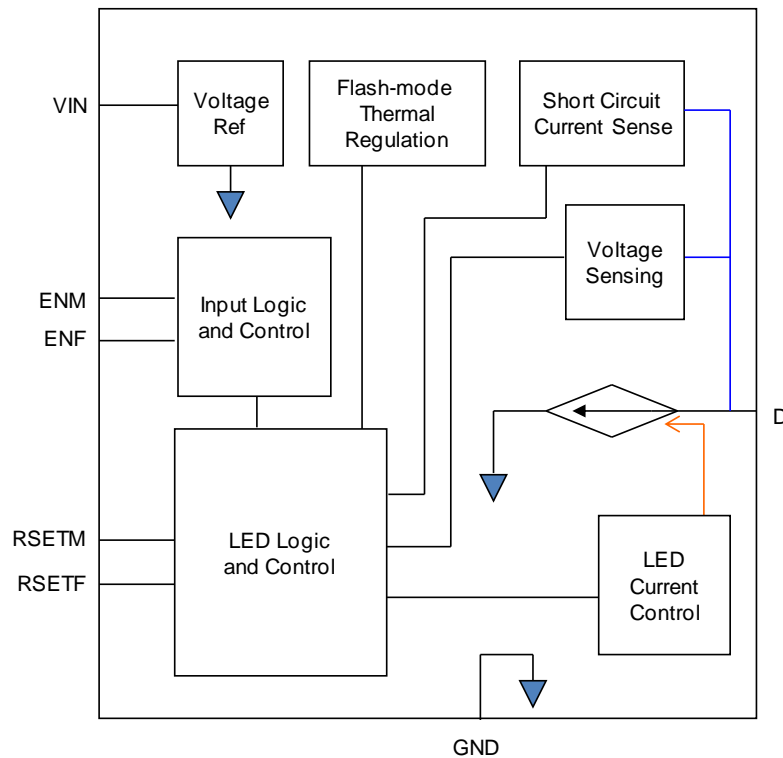
Movie-mode Operation ( $V_{in} = 3.6V, 100mA$ )



Soft Start: Movie-Mode Turn On ( $V_{in} = 3.6V, 100mA$ )



### Functional Block Diagram



### Functional Description

The KTD231 is a highly integrated flash LED driver. A high current regulating device is integrated to drive up to 700mA flash LEDs.

The current regulation is accomplished by using a no-noise linear topology. The KTD231 eliminates the external components used for conventional charge pump and DC/DC boost circuits, while still maintaining high power efficiency. The use of unique control schemes maintains accurate current regulation in the current sink while leaving the regulation voltage headroom at a minimum, increasing the usable battery voltage range. The current sink can drive up to 700mA flash LED.

The control interface is designed for maximum design flexibility and compatibility with various types of system controls. When the ENF is pulled high while the ENM is low, the LED current will be ramped up to the flash-mode current level which is programmed by RSETF resistor. When ENM is pulled high while the ENF is low, the LED current will be ramped up to the movie/torch-mode current level which is programmed by RSETM resistor. However, if both ENM and ENF are high, the LED current will be set to movie/torch-mode current. The driver IC and the flash LEDs will be shutdown when both ENF and ENM are at logic low.

### Flash-Mode LED Current

Flash-mode LED current can be programmed up to a maximum total current of 700mA. The flash-mode current is set by the RSETF resistor. For the desired flash-mode current, the resistor value can be calculated using the following equation:

$$I_{FLASH} = 6800 / R_{RSETF}$$

**Table 1. Current Setting Resistor (1% Values)**

R <sub>SETF</sub> (kΩ) 1% Values	Current (mA)
137 kΩ	50 mA
68.1 kΩ	100 mA
45.3 kΩ	150 mA
34 kΩ	200 mA
22.6 kΩ	300 mA
16.9 kΩ	400 mA
13.7 kΩ	500 mA
11.3 kΩ	600 mA
9.76 kΩ	700 mA

A flash event is initiated by asserting the ENF pin while ENM is at logic low level. A flash event is automatically terminated when ENF is deasserted or when ENM is asserted.

Automatic thermal regulation control is active when KTD231 is in flash mode. If flash mode is enabled and the flash current is set to a high current value, the temperature of the IC can increase quickly. Once the IC's temperature goes above 100°C, the sink's current will be automatically decreased according to the thermal regulation control loop. This can prevent the IC from triggering thermal shutdown and causing the LEDs to flicker. Depending on the thermal layout of the PCB and the flash mode current setting, the KTD231 sink current can be lower than the programmed value due to the thermal regulation protection feature.

### Movie/Torch-Mode LED Current

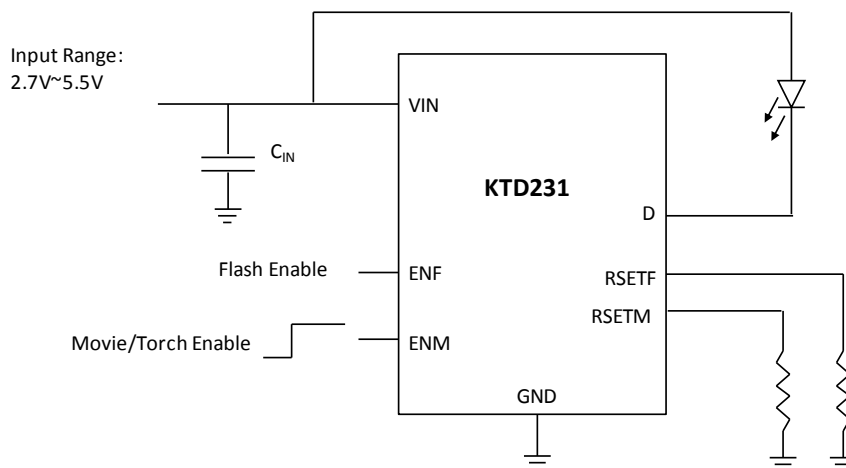
Movie/torch-mode LED current can be programmed up to a maximum total current of 200mA. The movie/torch-mode current is set by the RSETM resistor. For the desired movie/torch-mode current, the resistor value can be calculated using the following equation:

$$I_{MOVIE} = 6800 / R_{RSETM}$$

**Table 2. Current Setting Resistor (1% Values)**

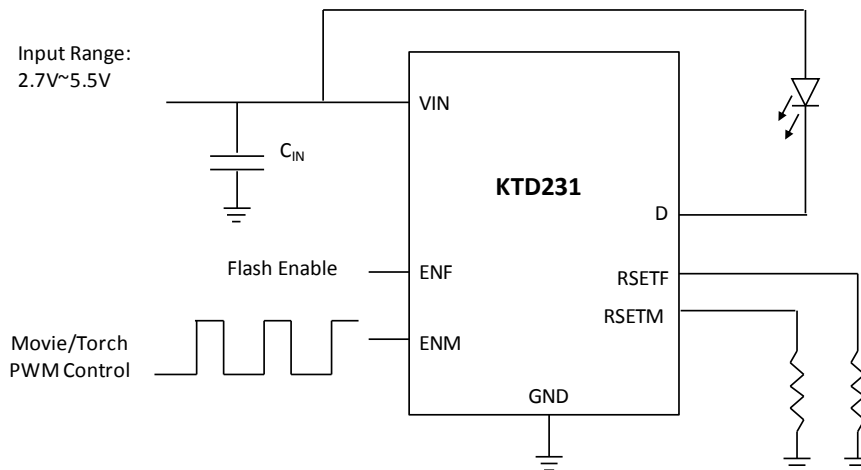
R <sub>SETM</sub> (kΩ) 1% Values	Current (mA)
137 kΩ	50 mA
68.1 kΩ	100 mA
45.3 kΩ	150 mA
34 kΩ	200 mA





**Figure 1. Controlling Movie/Torch-mode with Simple Enable ON/OFF Pulse**

A movie/torch-mode event is initiated by asserting the ENM pin. For additional flexibility, a lower movie/torch-mode current than the value calculated above can be realized by applying a PWM dimming signal (see Figure 2) at ENM pin while ENF is held low. The average movie/torch-mode current will be proportional to the PWM duty ratio.



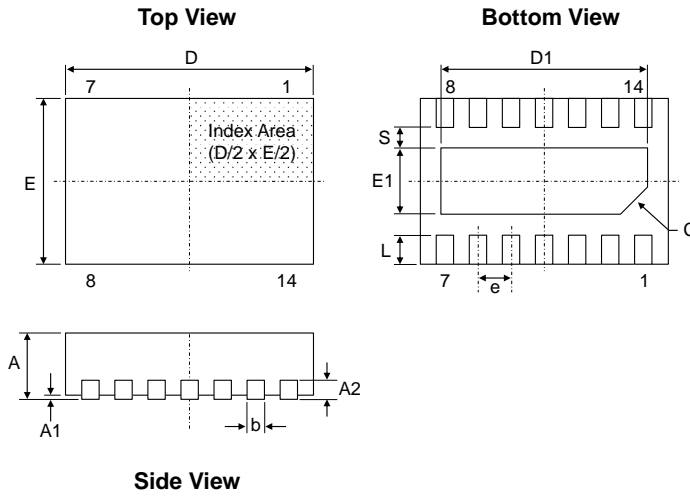
**Figure 2. Controlling Movie/Torch-mode with PWM Dimming Signal**

### LED Short Protection

When the KTD231 is enabled, there is a 2.5mA (typical) LED sensing current through the current sink. It is used to detect whether the LED is shorted by generating a voltage drop through the LED. The IC internally compares the voltage difference between  $V_{IN}$  and the sink node (D pin). If this difference is below a preset threshold, the IC will treat the LED as shorted and disable its Flash/Movie mode current through the D pin. However, the 2.5mA sensing current will be kept to generate the LED's voltage drop. Because some normal flash LEDs may have larger than desired leakage current (up to hundreds of microamps) even if it's not fully turned on, this 2.5mA sensing current can guarantee that a properly functioning LED will not mistakenly be treated as a shorted LED. If the short circuit is removed during operation, the LED will automatically recover to the programmed current setting.

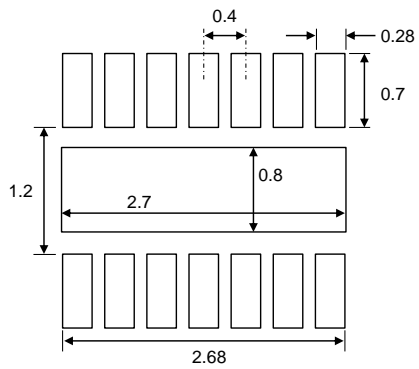
### Packaging Information

TDFN23-14



Dimension	mm		
	Min.	Typ.	Max.
A	0.70	0.75	0.85
A1	0.00	0.05	0.10
A2	0.18	0.23	0.28
b	0.14	0.21	0.28
c	0.35 REF		
D	2.90	3.00	3.10
D1	2.35	2.50	2.65
E	1.90	2.00	2.10
E1	0.70	0.80	0.90
e	0.40BSC		
L	0.30	0.35	0.40
S	0.125 MIN		

### Recommended PCB Landing Pattern – Top View



\*Dimensions are in millimeters

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