1A, 1.5MHz Step-Down Constant Current, High Efficiency LED Driver

DESCRIPTION

The ETA3421B is a high-efficiency, DC-to-DC step-down constant current LED driver, capable of delivering up to 1A of output current. The device operates from an input voltage range of 3V to 5.5V and use 0.1V FB voltage to achieve high efficiency. Running at a fixed frequency of 1.5MHz allows the use of small inductance value and low DCR inductors, thereby achieving higher efficiencies. Other external components, such as ceramic input and output caps, can also be small due to higher switching frequency. The incorporated 20-100KHz true PWM-Dimming feature by EN pin can be used to digitally program the LED current. The internal soft-start control circuitry reduces inrush current. Short and open LED protection improves design reliability.

ETA3421B is housed in a tiny SOT23-5 package.

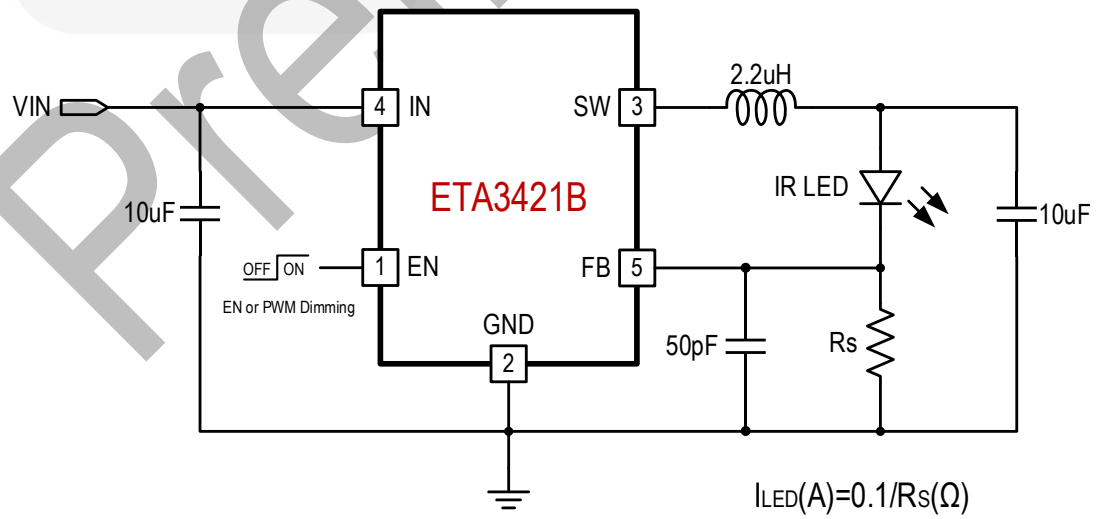
FEATURES

- Up to 90% Efficiency
- 1.5MHz Switching Frequency
- 0.1V FB Voltage
- True PWM Current Program
- Open LED Protection
- Short LED Protection
- Tiny SOT23-5 Package
- Pb Free, RoHS and REACH Compliant
- Halogen Free and " Green" Device

APPLICATIONS

- IP CAM
- 1 Cell Li-Ion Battery Powered Flashlight

TYPICAL APPLICATION

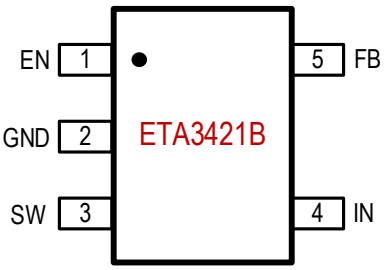


ORDERING INFORMATION

PART No.	PACKAGE	TOP MARK	Pcs/Reel
ETA3421BS2F	SOT23-5	RvYW	3000

PIN CONFIGURATION

Top View



SOT23-5

ABSOLUTE MAXIMUM RATINGS

(Note: Exceeding these limits may damage the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

IN, EN, SW Voltage .....-0.3V to 7.5V
FB Voltage.....-0.3V to 6V
Operating Temperature Range .....–40°C to 85°C
Storage Temperature Range .....–55°C to 150°C

Thermal Resistance	Θ_{JA}	Θ_{JC}	
SOT23-5	220	110	°C/W

Lead Temperature (Soldering 10sec) .....260°C

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, unless otherwise specified. Typical values are at T_A = 25°C.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range		3		5.5	V
Input UVLO	Rising, Hysteresis=300mV		2.35	2.45	V
Input OVP	Rising, Hysteresis=500mV		7		V
Input Supply Current	V_{FB}=0.65V, no switching		50	70	μA
Input Shutdown Current	V_{EN}=0V		2	5	μA
FB Voltage	3V≤V_{IN}≤5.5V， D_{DIM}=100%	97	100	103	mV
FB Input Current	V_{FB}=1V		0.01	1	μA
PWM Dimming Frequency		20		100	KHz
Switching Frequency			1.5		MHz
PMOS Switch On Resistance	I_{SW}=200mA		200		mΩ
NMOS Switch On Resistance	I_{SW}=200mA		180		mΩ
High Side Current Limit		1.4			A
SW Leakage Current	V_{IN}=5.5V, V_{SW}=0 or 5.5V, EN= GND			5	μA
EN Logic High Threshold	Rising	1.2			V
EN Logic Low Threshold	Falling			0.4	V
EN Input Current	V_{EN}=5V		1	2	uA
Thermal Shutdown	Hysteresis=20°C		160		°C

1.Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions. 2. Guaranteed by design, no production test

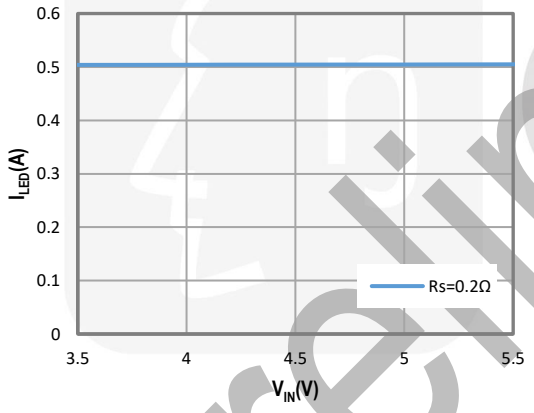
PIN DESCRIPTION

PIN #	NAME	DESCRIPTION
1	EN	Enable pin for the IC. Drive this pin high to enable the part, low to disable. The default is low when floating. It is a multi-function pin for enable control and PWM dimming.
2	GND	Ground
3	SW	Inductor connection. Connect an inductor Between SW and the regulator output.
4	IN	Supply voltage. Bypass with a 10μF ceramic capacitor to GND
5	FB	Feedback Input pin for LED current. Bypass with a 50pF ceramic capacitor to GND. Connect an external resistor from FB to GND to set I_{LED}, which is calculated by the following formula: I_{LED} (A)=0.1/R_S (Ω)

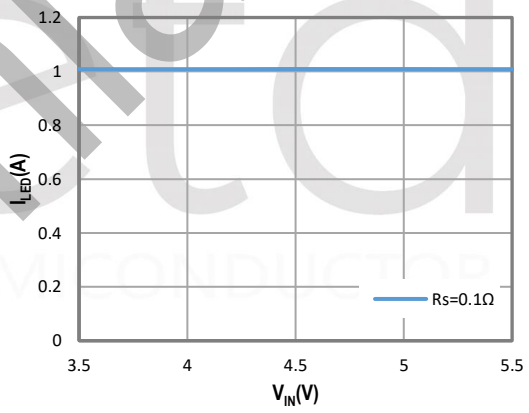
TYPICAL CHARACTERISTICS

(Typical values are at T_A = 25°C unless otherwise specified.)

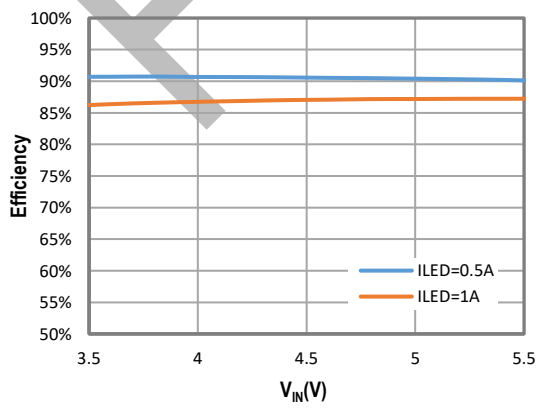
I_{LED} Vs. V_{IN}



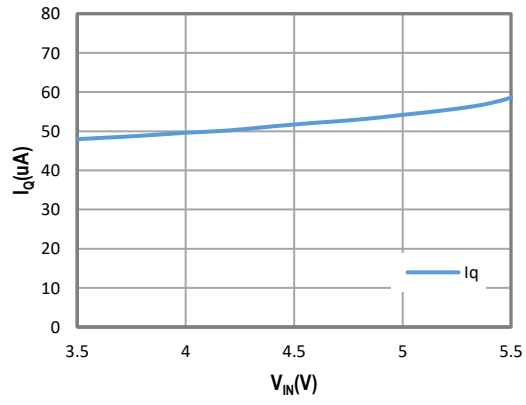
I_{LED} Vs. V_{IN}



Eff. Vs. V_{IN}



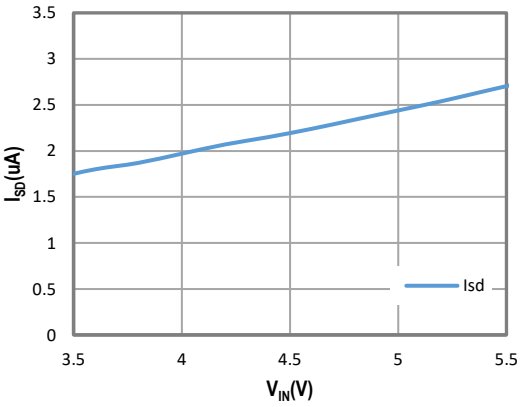
I_Q Vs. V_{IN}



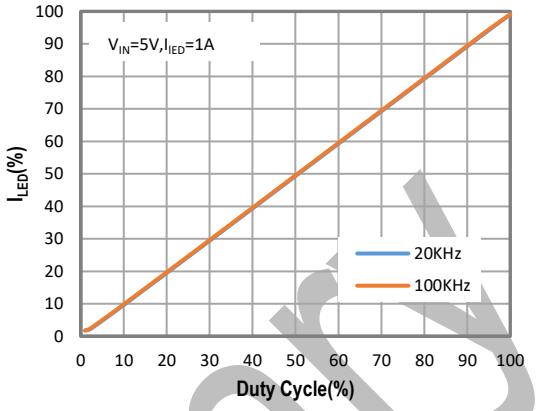
TYPICAL CHARACTERISTICS (cont')

(Typical values are at T_A = 25°C unless otherwise specified.)

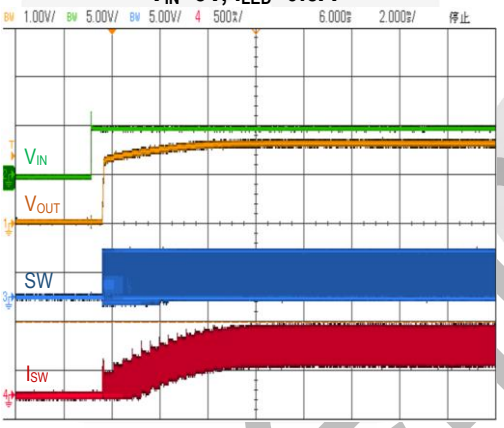
I_{SD} Vs. V_{IN}



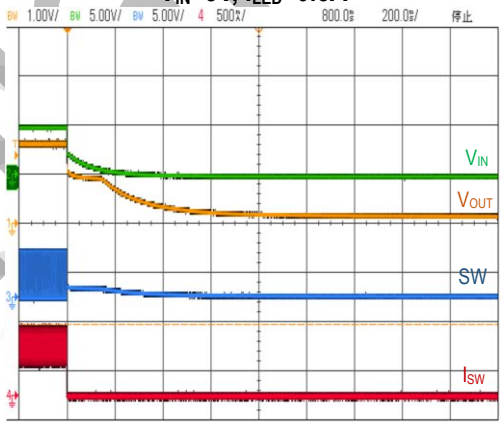
PWM Dimming: I_{LED} Vs. Duty Cycle



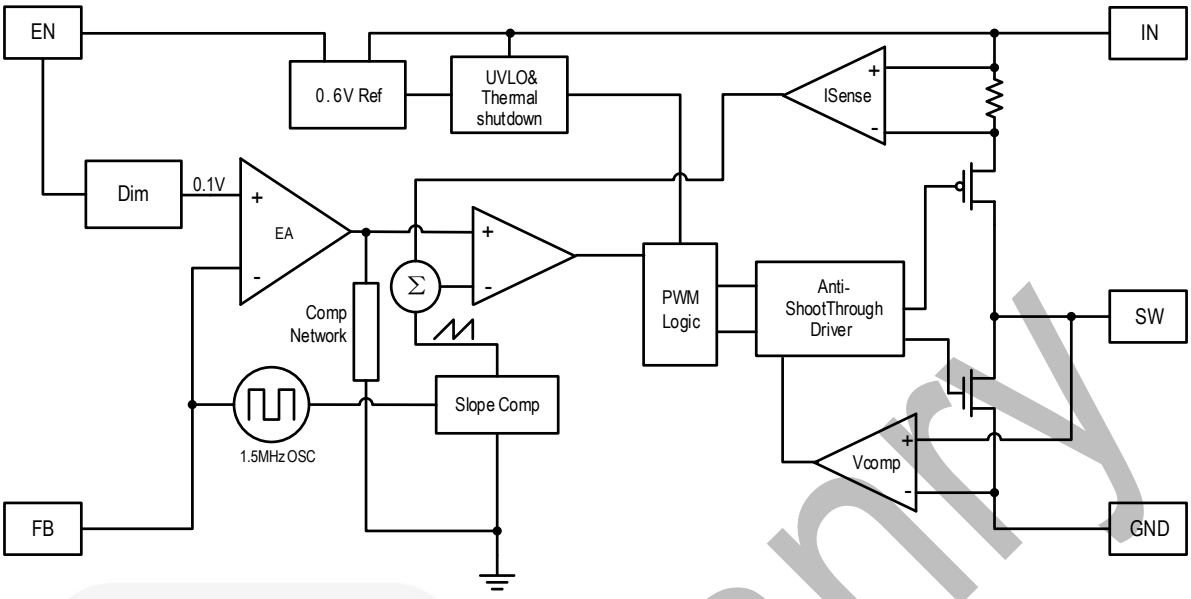
Start Up from VIN
V_{IN}=5V, I_{LED}=0.5A



Shut Down from VIN
V_{IN}=5V, I_{LED}=0.5A



FUNCTIONAL BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

The ETA3421B is a high-efficiency, DC-to-DC step-down constant current LED driver, capable of delivering up to 1A of output current. The device supports the input voltage range of 3V to 5.5V and FB voltage is only 0.1V to achieve high efficiency. The LED driver features 20-100KHz true PWM-Dimming by using EN pin to program the LED current digitally. The internal soft-start control circuitry reduces inrush current. Thermal shutdown, UVLO, short and open LED protection can ensure the reliability of design.

Shutdown

The ETA3421B enters shutdown mode when the EN voltage is logic low for more than 3ms. During shutdown, the input supply current of the device is less than 5μA (max).

LED Driving Current Setting

The FB voltage is regulated by a low 0.1V reference voltage. The LED current is set externally by using a current-sense resistor in series with the LED. The value of the R_S is calculated as below:

$$I_{LED}\ (A)=0.1/R_S\ (\Omega)$$

Where, I_{LED} = output current of LED, R_S = current-sense resistor
The output current tolerance depends on the FB accuracy and the current sensor resistor accuracy.

PWM Dimming Control

When the EN pin is constantly high, the FB voltage is regulated to 100mV typically. However, the EN pin allows a PWM signal to reduce this regulation voltage; therefore, it achieves LED brightness dimming. The relationship between the duty cycle and FB voltage is given as below:

$$V_{FB}=Duty*100(mV)$$

Where, Duty = duty cycle of the PWM signal, 100mV = internal reference voltage

This PWM dimming eliminates the audible noise which often occurs when the output current is pulsed in replica of the frequency and duty cycle of PWM control. Unlike other scheme which filters the PWM signal for analog dimming, ETA3421B regulation voltage is independent of the PWM logic voltage level which often has large variations. For the optimum performance, the PWM dimming frequency is from 20KHz to 100KHz.

UVLO and Thermal Shutdown

If VIN drops below 2.05V, the UVLO circuit inhibits switching. Once VIN rises above 2.35V, the UVLO clears, and the soft-start sequence activates. Thermal protection limits total power dissipation in the device. When the junction temperature exceeds T_J= +160°C, a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by 20°C, resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.

DESIGN PROCEDURE

Input Capacitor and Output Capacitor Selection

The input capacitor in a DC-to-DC converter reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching currents do not pass through the input source. Input ripple with a ceramic capacitor is approximately as follows:

$V_{RIPPLE} = IL_{(PEAK)}[1 / (2\pi \times f_{OSC} \times C_{IN})]$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

$V_{RIPPLE(ESR)} = IL_{(PEAK)} \times ESR$

The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance.

Inductor Selection

A reasonable inductor value (LIDEAL) can be derived from the following:

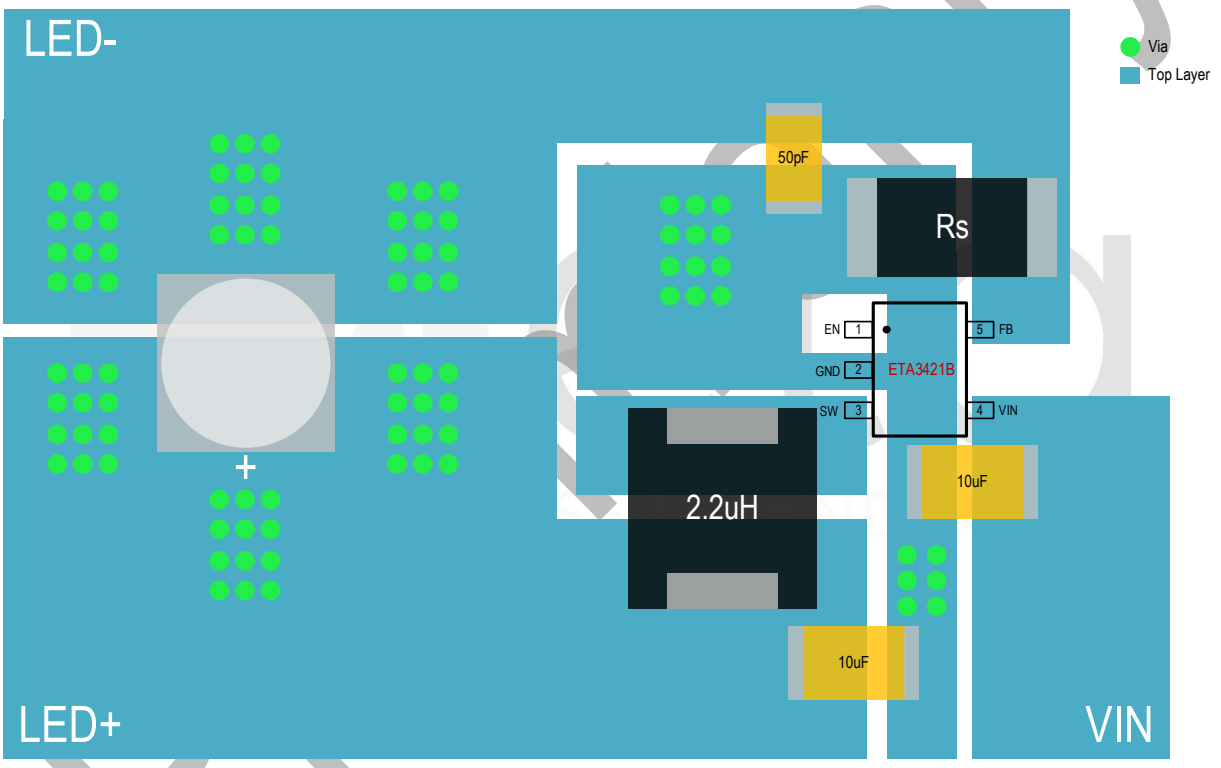
$L_{IDEAL} = [2(VIN) \times D (1 - D)] / I_{OUT} \times f_{OSC}$

PCB LAYOUT GUIDE

PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout for optimum performance.

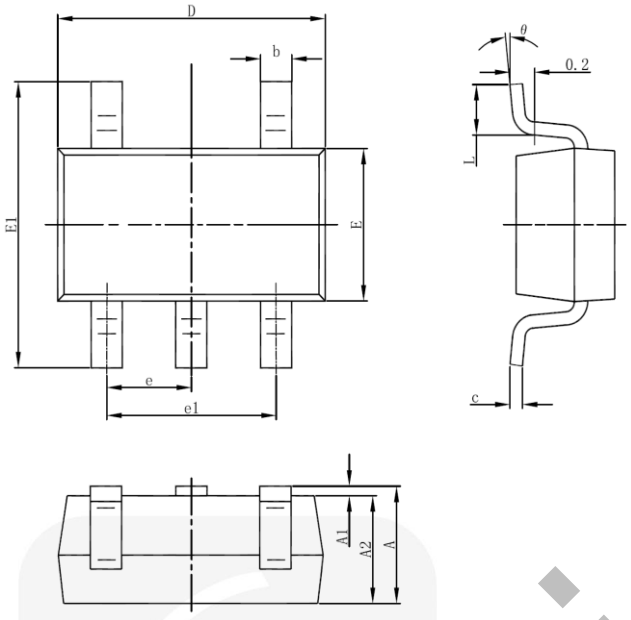
If change is necessary, please follow these guidelines and take Figure for reference.

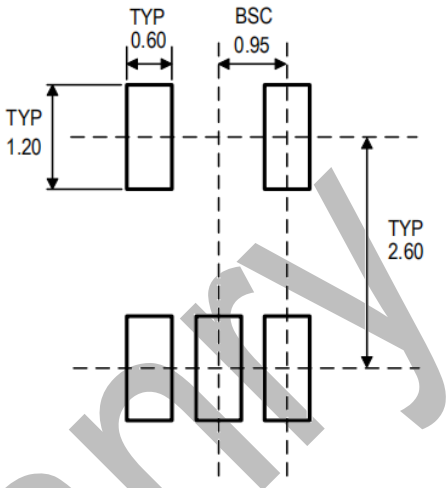
1) Keep the path of switching current short and minimize the loop area formed by input cap, high-side MOSFET and low-side MOSFET.
2) Bypass ceramic capacitors are suggested to be put close to the Vin pin.
3) Ensure all feedback connections are short and direct. Place the feedback resistors and compensation components as close to the chip as possible.
4) Rout SW away from sensitive analog areas such as FB.
5) Connect IN, SW, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.



PACKAGE OUTLINE

Package: SOT23-5

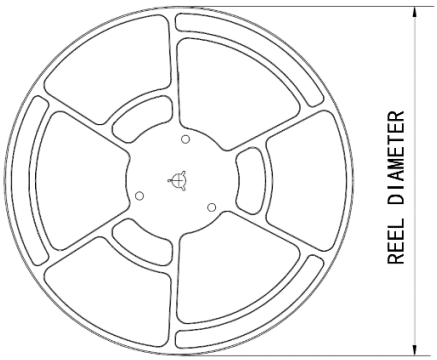


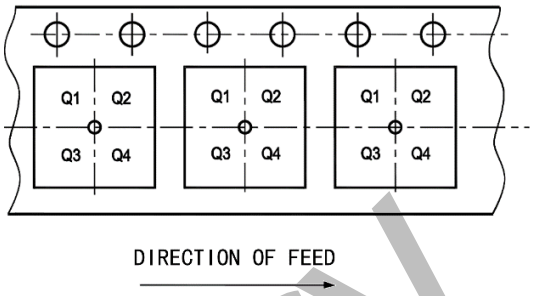


RECOMMENDED LAND PATTERN

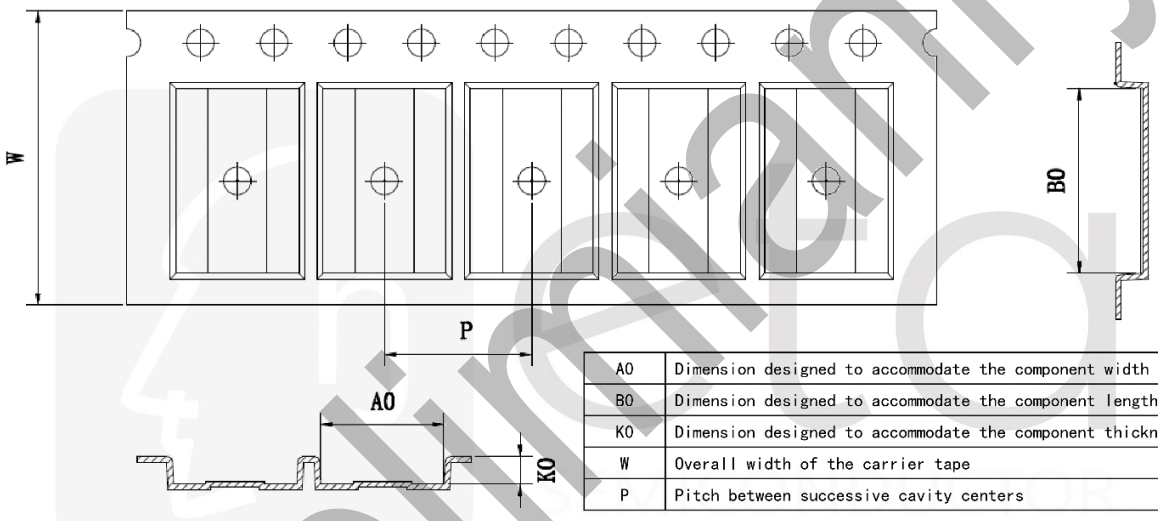
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION





DIRECTION OF FEED



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P	Pitch between successive cavity centers

Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P (mm)	W (mm)	Pin1 Quadrant
ETA3421BS2F	SOT23-5	5	3000	180	9.5	3.17	3.23	1.37	4	8	Q3