1.5A Line Switch with Low On-Resistance

DESCRIPTION

The EUP3502A is a low dropout line switch IC with ON/OFF control and output current protection which integrates a P-channel MOSFET.

By connecting the EUP3502A to the output pin of a step-down DC/DC converter, the EN pin controls ON/OFF for each distribution switch to deliver power per requirements and maximize total power efficiency. As a result, the EUP3502A helps to extend battery life and product operation time.

The EUP3502A contains a current limit and protection circuit so these are not required externally unlike discrete circuit solutions where MOSFETs and resistors are used.

When a low signal is input to the EN pin, the IC enters shutdown mode. Even where a load capacitor is connected to the output pin during shutdown, the electric charge stored at the load capacitor is discharged through the internal switch. As a result, the VOUT pin voltage falls quickly to the GND level. The EUP3502A contains over current protection.

FEATURES

- 2.5V to 5.5V Input Voltage Range
- 100mΩ On Resistance
- Low Shutdown Current：<1μA
- ON/OFF Control Function
- High Speed Auto Discharge Function
- Operating Temperature Range: -40°C ~+85°C
- Output Current Limit
- Thermal Shutdown
- RoHS Compliant and 100% Lead (Fb)-Free Halogen-Free

APPLICATIONS

- Portable Equipment
- Laptop, Palmtops, Notebook Computers
- LCD Monitor TV

Typical Application Circuit

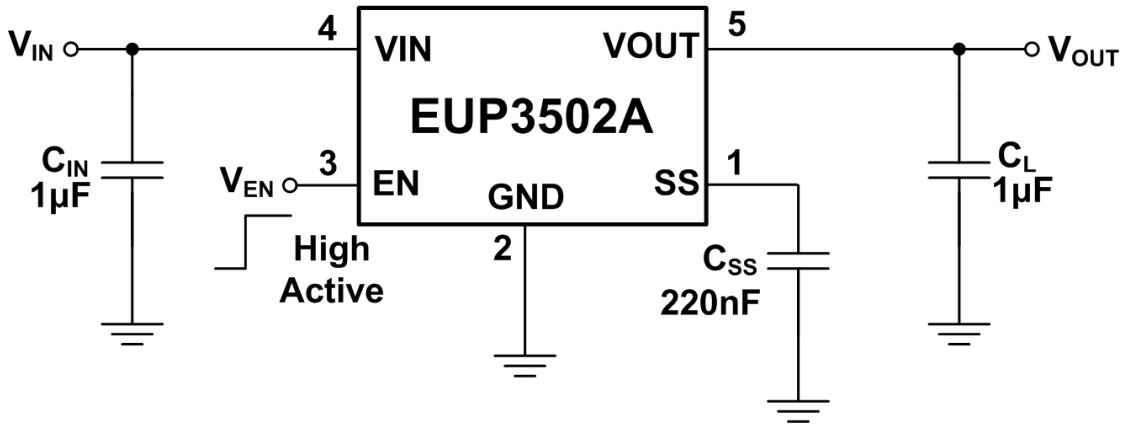


Figure 1.

Block Diagram

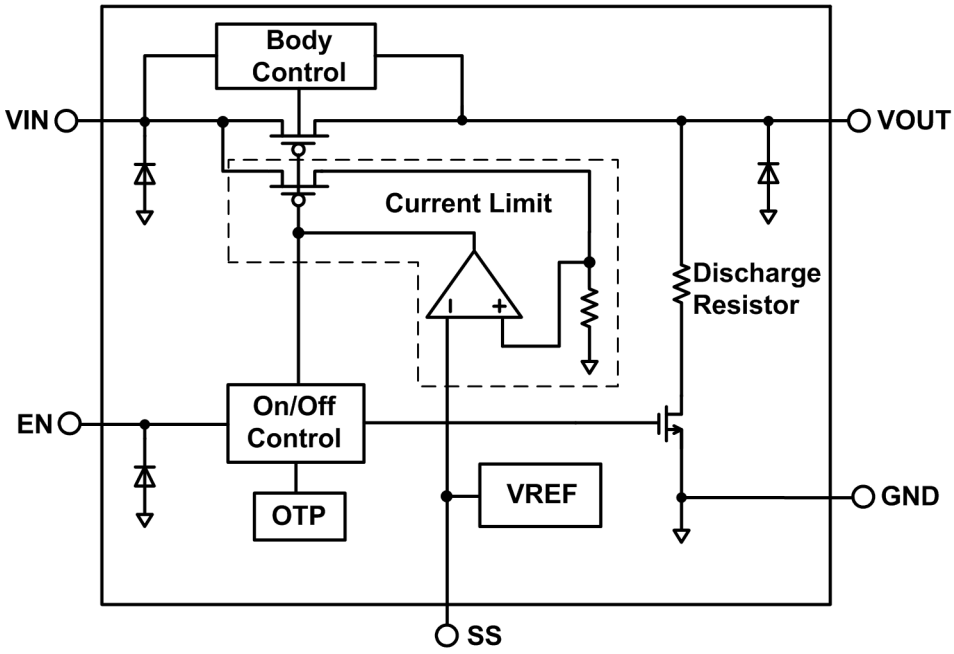
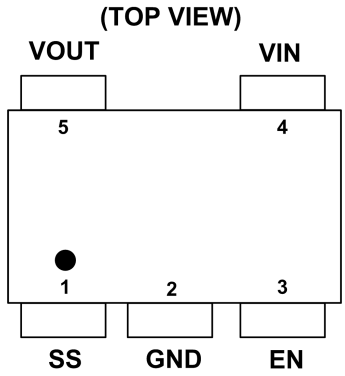


Figure 2.

Pin Configurations

Package Type	Pin Configurations
SOT23-5	

Pin Description

PIN	SOT23-5	DESCRIPTION
SS	1	Soft-start control. Connect a capacitor from SS to GND to set the soft-start period. See ***Soft-start Capacitor***.
GND	2	Ground.
EN	3	ON/OFF Control. Make sure EN pin never floating.
VIN	4	Input voltage of the line switch.
VOUT	5	Output voltage of the line switch.

Ordering Information

Order Number	Package Type	Marking	Current Limit	Continuous Load Current	Operating Temperature Range
EUP3502AVIR1	SOT23-5	xxxxx A600	2A	1.5A	-40°C to +85°C

EUP3502A □ □ □ □

- Lead Free Code
  1: Lead Free, Halogen Free
- Packing
  R: Tape & Reel
- Operating temperature range
  I: Industry Standard
- Package Type
  V: SOT-23

Absolute Maximum Ratings

- V_{IN}, V_{EN} ---------- -0.3 to 6V
- V_{OUT} ---------- -0.3 to (V_{IN}+0.3)
- I_{OUT} ---------- 2A
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- -65°C to +150°C
- Lead Temperature ---------- 260°C
- Thermal Resistance θ_{JA} (SOT23-5) ---------- 205°C /W
- ESD Rating
  Human Body Model ---------- 2kV

Recommend Operating Conditions

- V_{IN} ---------- 2.5 to 5.5V
- V_{EN} ---------- 0 to 5.5V
- Operating Temperature Range ---------- -40°C to +85°C

Electrical Characteristics

V_{IN}=5V, C_{IN}=1µF, C_L=1µF, C_{SS}=220nF, V_{EN}=V_{IN}, T_A=+25°C, unless otherwise noted [(1)].

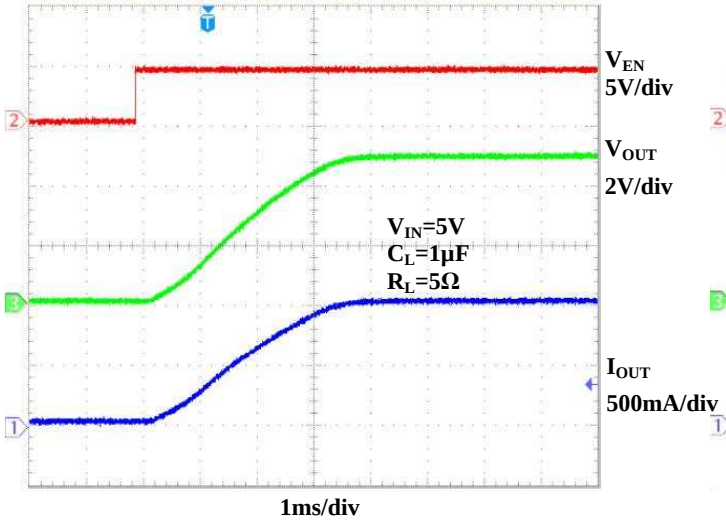
Symbol	Parameter	Conditions	EUP3502A			Unit
			Min.	Typ.	Max.	
Input Voltage						
V_{IN}	Input Voltage		2.5		5.5	V
I_Q	Quiescent Current	V_{IN}=5V,V_{EN} = V_{IN}, No load		70	100	µA
I_{SHDN}	Shutdown Current	V_{IN}=5V,V_{EN} = GND	--	0.1	1	
I_{LEAK}	Switch Leakage Current	V_{IN}=5V,V_{EN} = GND, V_{OUT}=0V		0.1	1	
R_{ON}	On Resistance	V_{IN} =5V,V_{EN} = V_{IN}		100		mΩ
ON/OFF Control						
V_{ENH}	EN High Level Voltage		2			V
I_{ENH}	EN High Input Current	V_{EN}= V_{IN}	-1		1	µA
V_{ENL}	EN Low Level Voltage				0.4	V
I_{ENL}	EN Low Input Current	V_{EN}=GND	-1		1	µA
I_{DCHG}	Auto Discharge Current	V_{EN}=GND, V_{OUT}=5V		175		mA
Protection						
I_{LIM}	Current Limit		1.6	2	2.5	A
V_{UVLO}	V_{IN} Under Voltage Lockout		1.9	2.1	2.3	V
$V_{UVLO-Hys}$	V_{IN} Under Voltage Hysteresis			200		mV
T_{SD}	Thermal Shutdown Temperature			165		°C
T_{SDHYS}	Thermal Shutdown Hysteresis			25		

Note 1: Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

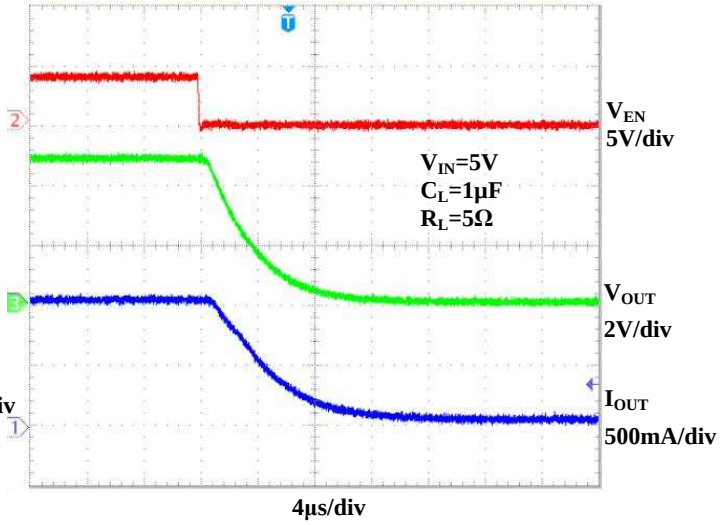
Typical Operating Characteristics

(V_{IN}=5V, C_{IN}=1μF, C_L=1μF, C_{SS}=220nF, V_{EN}=V_{IN}, T_A=25°C, unless otherwise noted.)

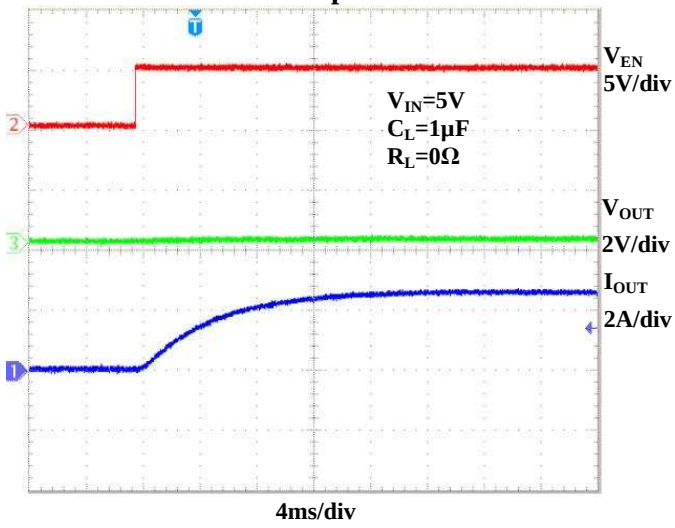
Turn on Delay Time and Rise Time



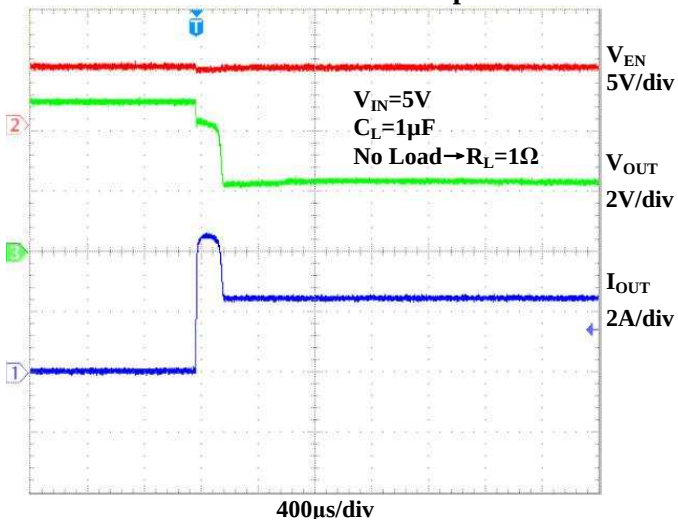
Turn off Delay Time and Fall Time



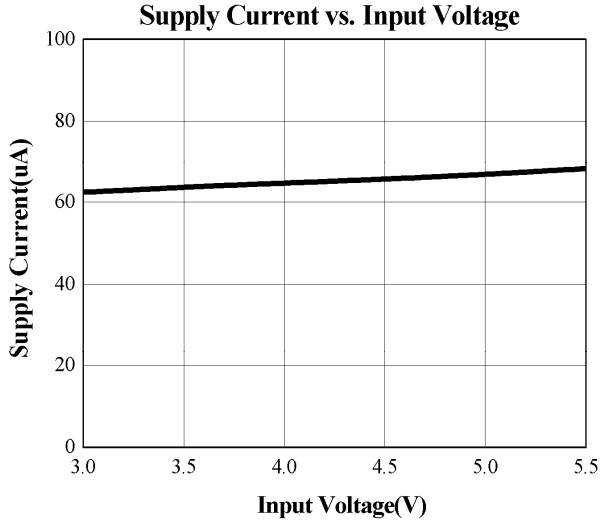
Short Circuit Response at Enable



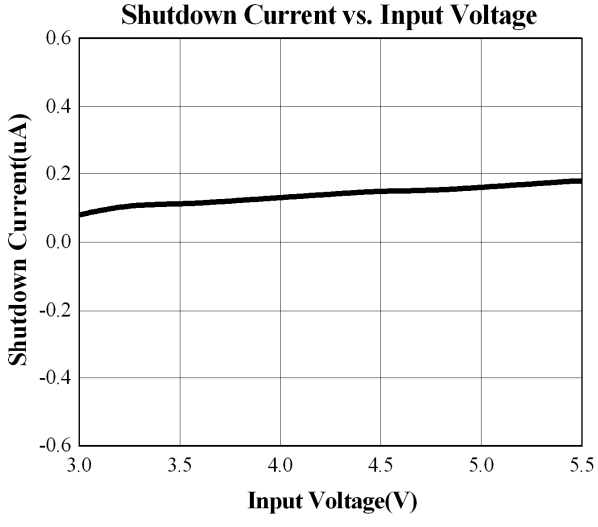
Resistance Load Inrush Response



Supply Current vs. Input Voltage

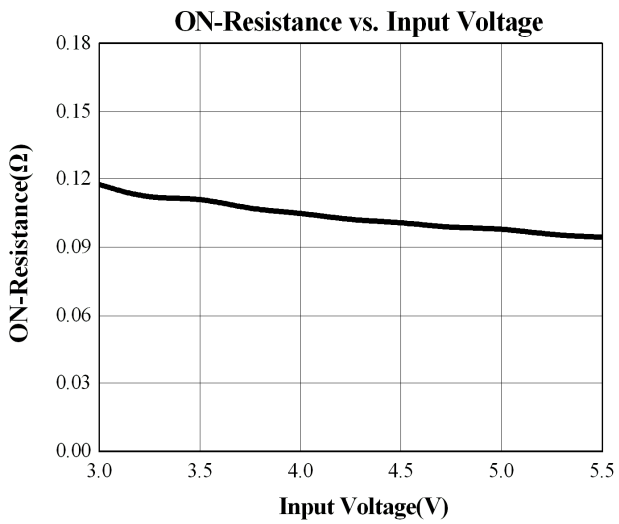


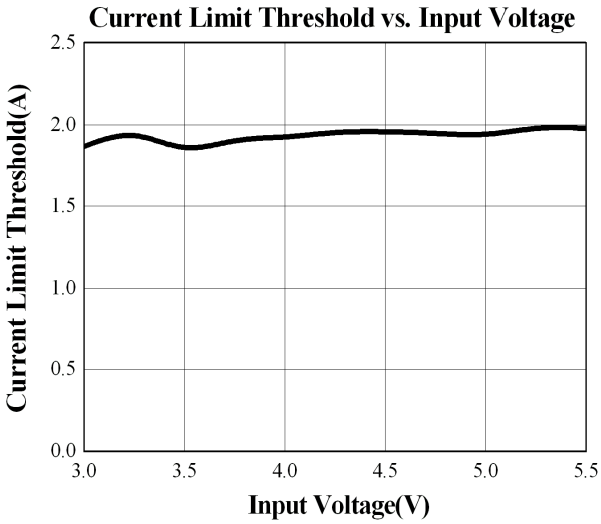
Shutdown Current vs. Input Voltage



Typical Operating Characteristics (continued)

(V_{IN}=5V, C_{IN}=1µF, C_L=1µF, C_{SS}=220nF, V_{EN}=V_{IN}, T_A=25°C, unless otherwise noted.)





Functional Description

Input and Output

V_{IN} (input) is the power supply connection to the logic circuitry and the source of the power MOSFET. V_{OUT} (output) is the drain of the power MOSFET. In a typical application, current flows through the switch from V_{IN} to V_{OUT} toward the load. All V_{OUT} pins must connect together to the load.

Current Limiting

With the present of a sense FET, over-current conditions can be detected without increasing the series resistance of the current path. Under over-current condition, the device maintains a constant output current and reduces the output voltage accordingly. Complete shutdown occurs only if the fault is present long enough to activate thermal limiting. There are several possible over-current conditions can occur.

- The output has been shorted before the device is enabled or before V_{IN} has been applied, the EUP3502A senses the short immediately switches into a constant-current limit mode.
- A short or an overload occurs while the device is enabled. At the instant the overload occurs, high currents may flow for a short period of time before the current-limit circuit can react. After the current limit circuit has tripped (reached the over-current trip threshold), the device switches into constant current mode.
- The load has been gradually increased beyond the recommended operating current. The current is permitted to rise until the current limit threshold is reached or until the thermal limit of the device is exceeded. The EUP3502A is capable of delivering current up to the current limit threshold without damaging the device. Once the threshold has been reached, the device switches into its constant current mode.

The current limit value refer to typical operating characteristics.

Thermal Shutdown

Thermal shutdown protects EUP3502A from excessive power dissipation. If the die temperature exceeds 165°C, the MOSFETS switch is shut off. 25°C of hystersis prevents the switch from turning on until the die temperature drops to 140°C. Thermal shutdown circuit functions only when the switch is enabled.

Under-Voltage Lockout

Whenever the input voltage falls below approximately 2.1V, the power switch is quickly turned off. This facilitates the design of hot-insertion systems where it is not possible to turn off the power switch before input power is removed. The UVLO also keeps the switch from being turned on until the power supply has reached at least 2.3V, even if the switch is enabled.

Application Information

Input Power Supply and Capacitance

Connect all V_{IN} inputs together externally. V_{IN} powers the internal control circuitry. A 1µF bypass capacitor from V_{IN} to GND, located near the EUP3502A, is strongly recommended to control supply transients. When driving inductive loads or operating from inductive sources, which may occur when the EUP3502A is powered by long leads or PC traces, larger input bypass capacitance is required to prevent voltage spikes from exceeding the EUP3502A's absolute maximum ratings (V_{INMAX} = 6V) during short-circuit events.

Output Capacitor

Bypass V_{OUT} to GND with a 1µF ceramic capacitor for local decoupling. Placing a high-value electrolytic capacitor on the output pin(s) is recommended when the output load is heavy. This precaution reduces power-supply transients that may cause ringing on the input and reduces output voltage transients under dynamic load conditions.

EN, the Enable Logic Input

EN must be driven logic low or logic high for a clearly defined input. Floating the input may cause unpredictable operation. EN should not be allowed to go negative with respect to GND.

Soft-start Capacitor

EUP3502A integrates a current soft-start function to avoid the inrush current at turn-on time. When EUP3502A is powered on or enabled, its current limit threshold is raised slowly to realize the current soft-start. The soft-start capacitor connected from SS pin to GND sets the soft-start time. Larger soft-start capacitor gives longer soft-start time. The recommend soft-start capacitor for different soft-start time is given by Table 1.

Table 1. Soft-start Time Setting Guide
(V_{IN}=5V, R_L=5Ω, C_{OUT}=1µF)

T_{SS} (ms)	2	3.5	5	7	8.2	10
C_{SS} (nF)	100	220	330	470	560	680

Layout and Thermal Dissipation

Keep all traces as short as possible to reduce the effect of undesirable parasitic inductance and optimize the switch response time to output short circuit conditions. Place input and output capacitors no more than 5mm from device leads. Connect V_{IN} and V_{OUT} to the power bus with short traces. Wide power bus planes at V_{IN} and V_{OUT} provide superior heat dissipation as well.
An active switch dissipates little power with minimal change in package temperature. Calculate the power dissipation for this condition as follows:

$$P = I_{OUT}^2 \times R_{(DS)ON}$$

Where I_{OUT} is the output current, $R_{(DS)ON}$ is the on resistance of the switch whose typical value is 100mΩ. The thermal resistance θ_{JA} of SOT23-5 package is 205°C/W and the EUP3502A's thermal shutdown threshold T_{SD} is 165°C. If we are operating the EUP3502A at room temperature (T_A=25°C), the maximum power dissipation P_{MAX} can be calculated as below:

$$P_{MAX} = \frac{(T_{SD} - T_A)}{\theta_{JA}} = \frac{(165 - 25)}{205} = 0.68(W)$$

In this case, the EUP3502A die temperature exceeds the 165°C thermal shutdown threshold, and the switch output shuts down until the junction temperature cools by 25°C. The duty cycle and period are strong functions of the ambient temperature and the PC board layout (see the Thermal Shutdown section).

Test Circuit

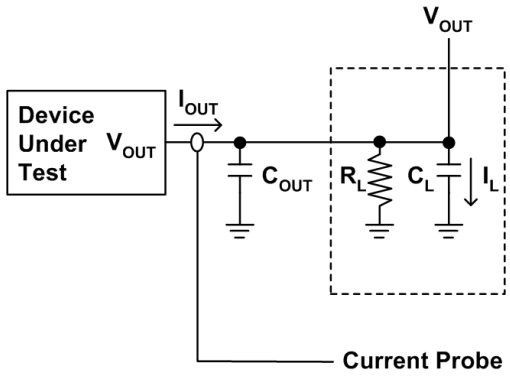


Figure 3.

Timing Diagrams

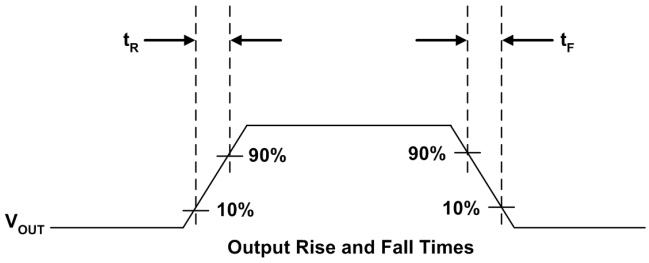
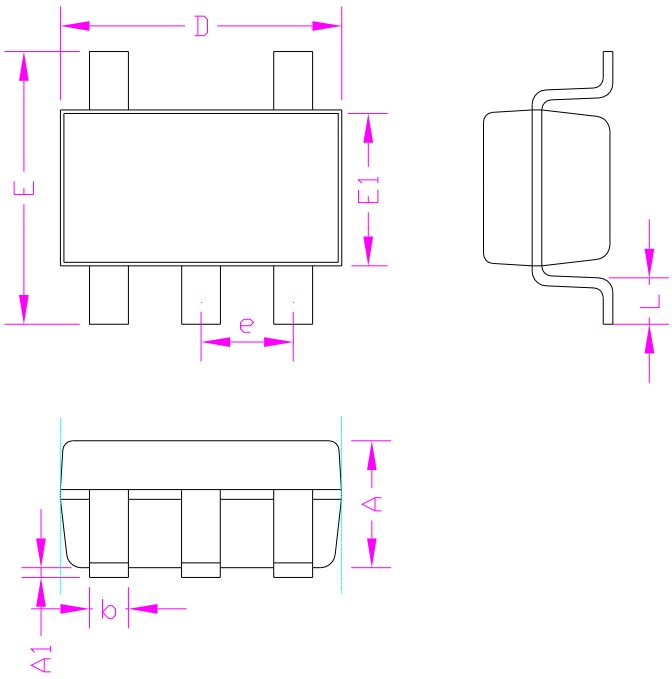


Figure 4.

Packaging Information

SOT23-5



SYMBOLS	MILLIMETERS			INCHES		
	MIN.	Normal	MAX.	MIN.	Normal	MAX.
A	-	-	1.40	-	-	0.055
A1	0.00	-	0.15	0.000	-	0.006
D	2.65	2.90	3.15	0.104	0.114	0.124
E1	1.40	1.60	1.80	0.055	0.063	0.071
E	2.60	2.80	3.00	0.102	0.110	0.118
L	0.30	0.45	0.60	0.012	0.018	0.024
b	0.30	-	0.50	0.012	-	0.020
e	0.95 REF			0.037REF		