Current Limited Load Switch

DESCRIPTION

The EUP3510 is a Current Limited P-channel MOSFET power switch designed for high-side load-switching applications. An integrated current-limiting circuit protects the input supply against large currents which may cause the supply to fall out of regulation. It can be used to control loads that require up to 1A. In order to fit different application, current limit threshold is programmed with a resistor from SET Pin to ground. The quiescent supply current is typically a low 8μA, making the device ideal for portable battery-operated equipment. In shutdown mode, the supply current decreases to less than 0.1μA.

Additional features include thermal shutdown to prevent catastrophic switch failure from high current loads, under-voltage lockout (UVLO) to ensure that the device remains off unless there is a valid input voltage present.

The EUP3510 is available in a 5 pin SOT-23 package.

FEATURES

- 2.4V to 5.5V Input voltage range
- Programmable over current threshold
- Fast transient response:
- Low quiescent current
  - 8μA typical
  - 1μA max with shutdown
- 135mΩ typical $R_{DS(ON)}$
- Only 1.8V needed for ON/OFF Control
- Under-Voltage Lockout
- Thermal shutdown
- Temp range -40 to 85°C
- Available in SOT23-5 package
- RoHS Compliant and 100% Lead(Pb)-Free

APPLICATIONS

- Peripheral ports
- Notebook computers
- Personal communication devices
- Hot swap supplies

Typical Application Circuit

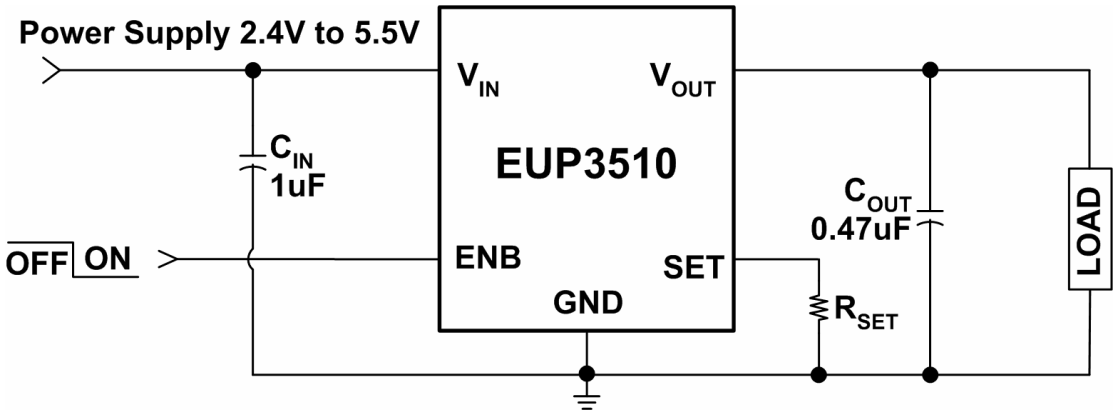


Figure 1.

Block Diagram

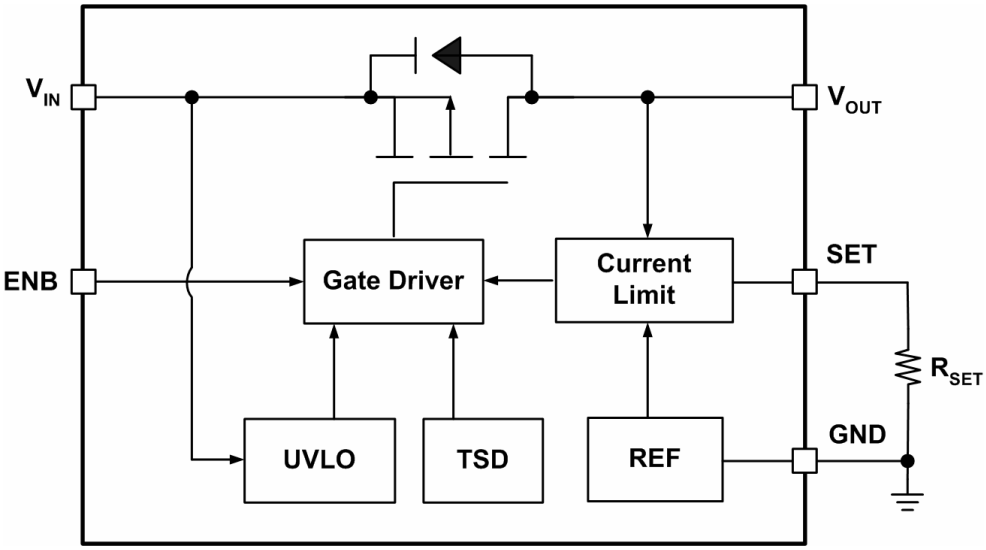
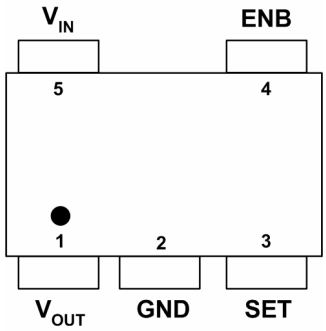


Figure 2.

Pin Configurations

Package Type	Pin Configurations
SOT23-5	(Top View) 

Pin Description

PIN	NAME	DESCRIPTION
1	V_{OUT}	P-type MOSFET Drain, connect 0.47uF capacitor from V_{OUT} to Ground
2	GND	Ground
3	SET	Current-Limit Set Input. A resistor R_{SET} from SET to ground sets the current limit for the switch
4	ENB	Enable Input, active-low
5	V_{IN}	P-channel MOSFET Source, connect 1uF capacitor from V_{IN} to Ground

Ordering Information

Order Number	Package Type	Marking	Operating Temperature Range
EUP3510VIR1	SOT23-5	40xxxx	-40 °C to 85°C

EUP3510 □ □ □ □

- Lead Free Code
  1: Lead Free 0: Lead
- Packing
  R: Tape & Reel
- Operating temperature range
  I: Industry Standard
- Package Type
  V:SOT23

Absolute Maximum Ratings

- Supply Voltage (V_{IN} to GND) ---------- -0.3V to 6V
- Supply Voltage (ENB to GND) ---------- -0.3V to V_{IN}+0.3
- Output Voltages (SET,V_{OUT} to GND) ---------- -0.3V to V_{IN}+0.3
- Storage Temperature ---------- -65°C to 150°C
- Reflow Temperature (soldering,10sec) ---------- 260°C
- Thermal Resistance θ_{JA} (SOT23-5) ---------- 220°C/W
- ESD Rating
  Human Body Model ---------- 2kV

Operating Ratings

- Supply Voltage (V_{IN}) ---------- 2.4V to 5.5V
- Operating Temperature (T_A) ---------- -40°C to +85°C

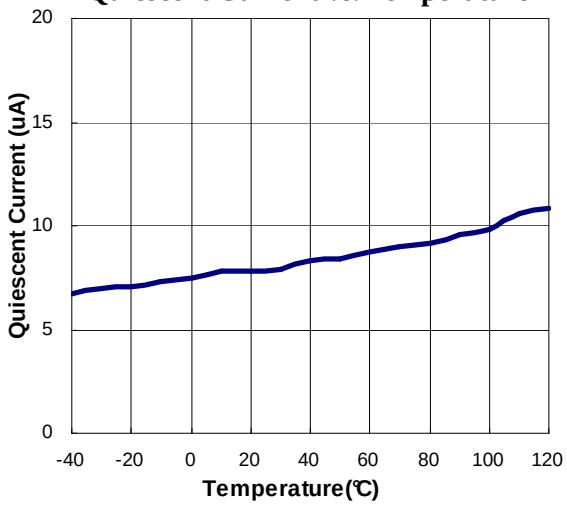
Electrical Characteristics

Unless otherwise specified, V_{IN} = 5V,C_{IN}=1uF,C_{OUT}=0.47uF, T_A=-40℃~+85℃.

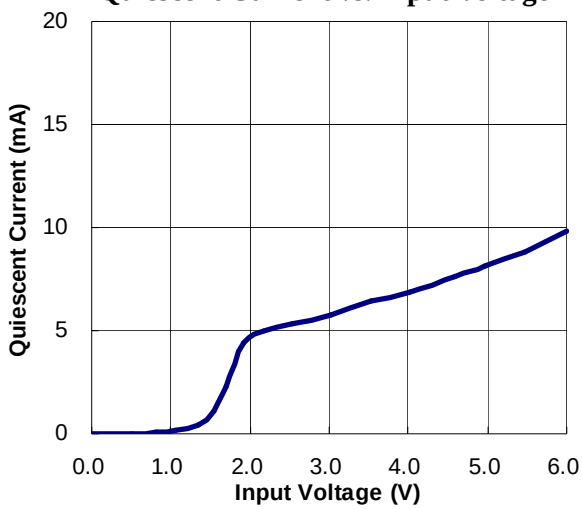
Symbol	Parameter	Conditions	EUP3510			Units
			Min.	Typ.	Max.	
V_{IN}	Operating Voltage		**2.40**	--	**5.50**	V
$R_{DS(ON)}$	On-Resistance	V_{IN}=5V		135	**205**	mΩ
		V_{IN}=4.5V		140	**210**	mΩ
		V_{IN}=3V		160	**240**	mΩ
I_{LIM}	Current Limit	V_{OUT}=0V,Rset=6.8KΩ	**750**	1035	**1225**	mA
I_Q	Quiescent Current	V_{IN}=5V, V_{ON}=0V, I_{OUT}=0A		8.1	**11.5**	uA
$I_{Q(OFF)}$	Off Supply Current VIN Under Voltage Lockout	V_{IN}=5V, V_{ON}=5V, I_{OUT}=0A		0.1	**1**	uA
V_{UVLO}		V_{IN} Falling	**1.22**	1.55	**1.91**	V
$V_{UVLO-HYS}$	VIN Under Voltage Hysteresis	V_{IN} Rising		185		mV
$V_{ON(L)}$	ON Input Low Voltage	V_{IN}=5V	**1.16**	1.30	**1.36**	V
$V_{ON(H)}$	ON Input Hige Voltage		**1.26**	1.51	**1.55**	V
$I_{ON(SINK)}$	ON Input leakage	V_{ON}=5V		0.1	**1**	uA
TOFF	Turn_Off Time	V_{IN}=5V, R_L=10Ω		12		us
TON	Turn_On Time	V_{IN}=5V, R_L=10Ω		20		us
T_{SD}	Thermal Shutdown Temp.			135		℃
T_{SD-HYS}	T_{SD} Hysterisis			20		℃

Typical Operating Characteristics (unless otherwise noted ,V_{IN}=5V, T_A=25°C.)

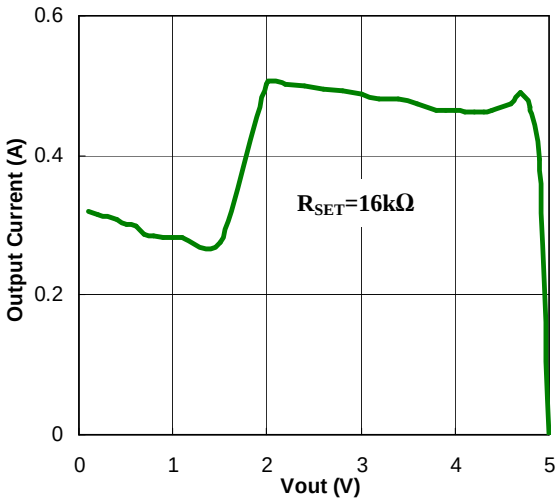
Quiescent Current vs. Temperature



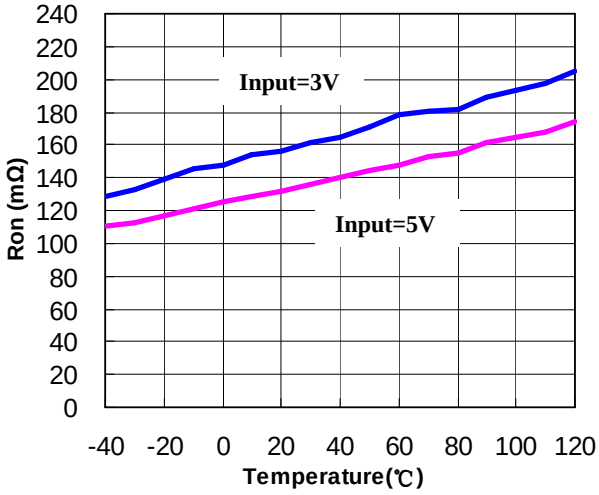
Quiescent Current vs. Input Voltage



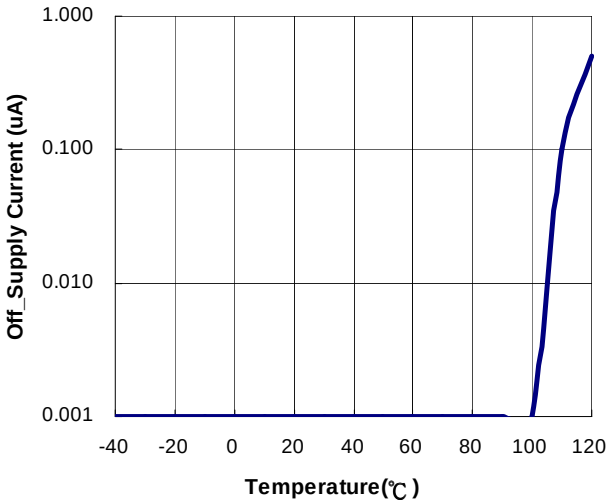
Output Current vs VOUT



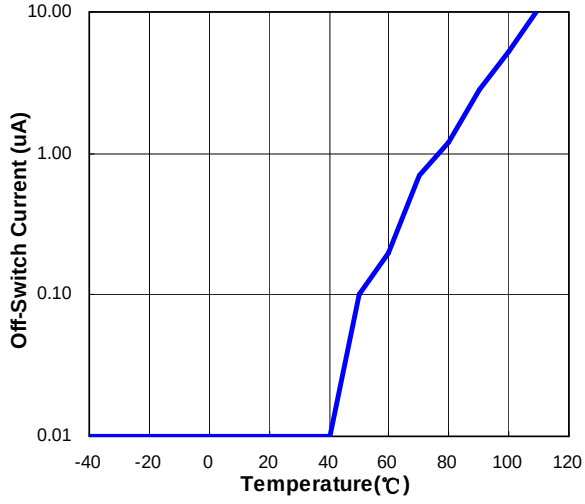
$R_{DS(ON)}$ vs. Temperature



Off-Supply Current vs. Temperature

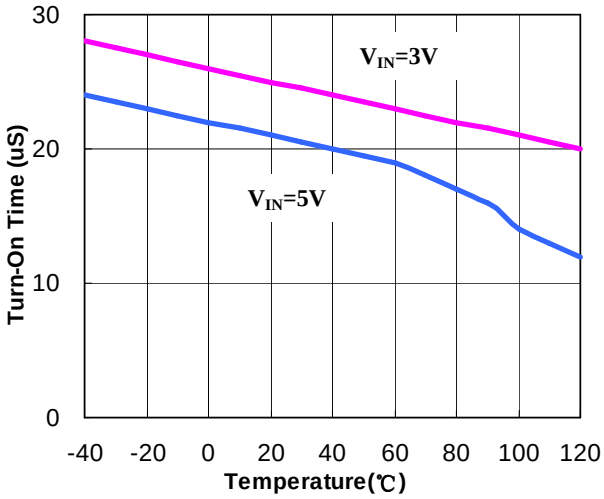


Off-Supply Current vs. Temperature

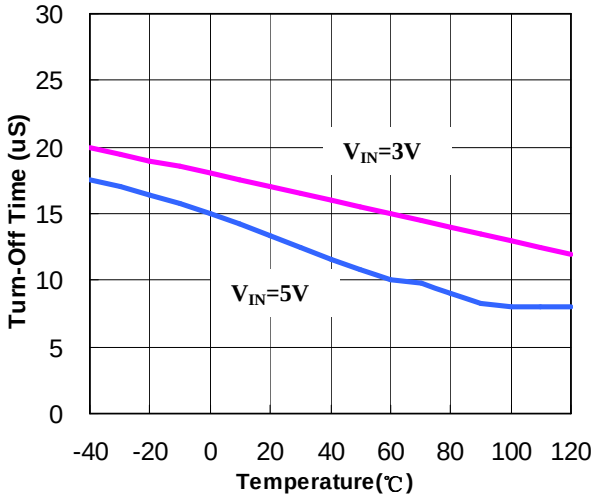


Typical Operating Characteristics (unless otherwise noted ,V_{IN}=5V, T_A=25°C.)

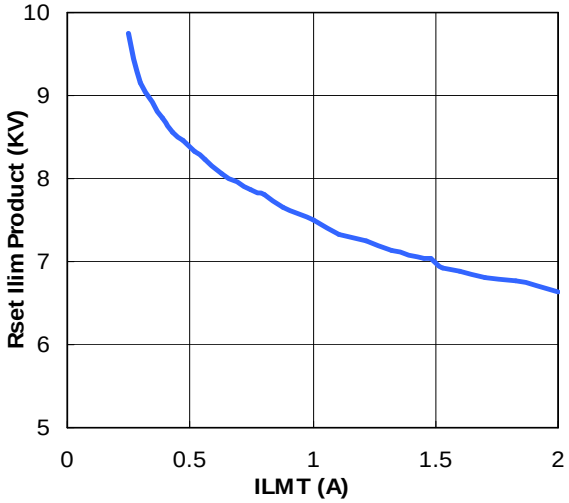
Turn-On vs. Temperature
R_{LOAD}=10Ω, C_{LOAD}=0.47μF



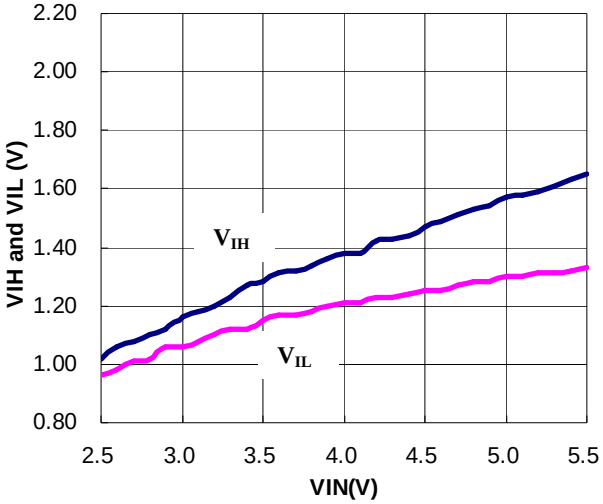
Turn-On vs. Temperature
R_{LOAD}=10Ω, C_{LOAD}=0.47μF



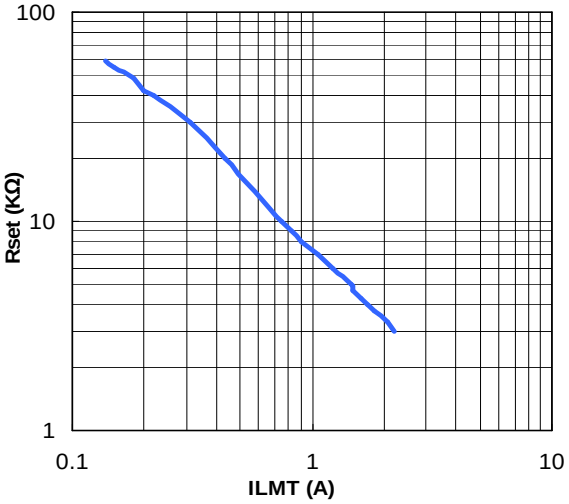
R_{SET} Coefficient vs. ILMT



V_{IH} and V_{IL} vs. V_{IN}



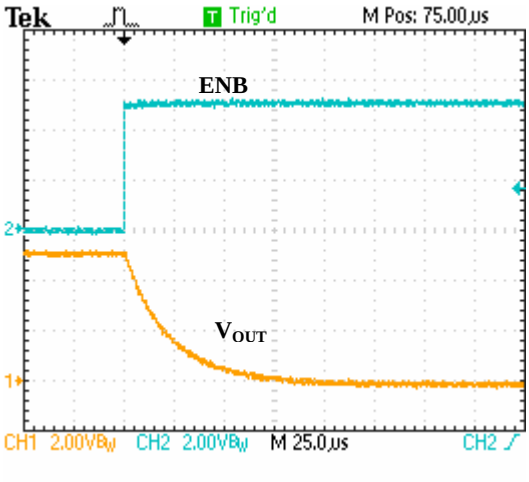
R_{SET} vs. ILMT



Typical Operating Characteristics (unless otherwise noted ,V_{IN}=5V, T_A=25°C.)

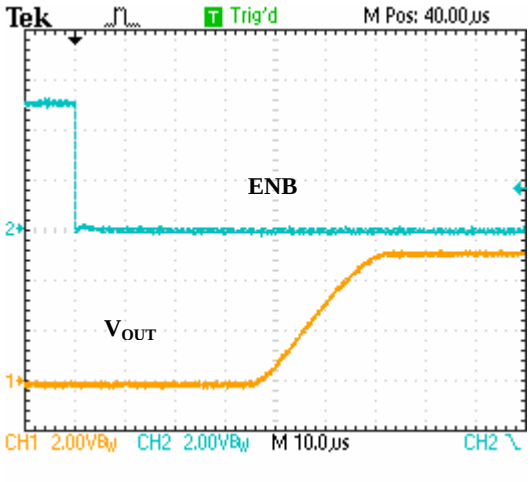
Turn-Off

R_L=10Ω, C_L=0.47μF

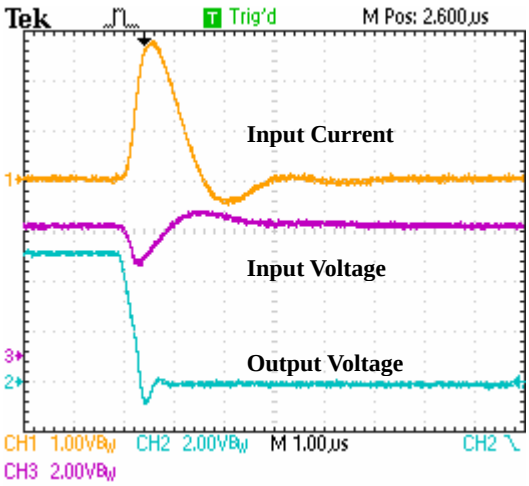


Turn-On

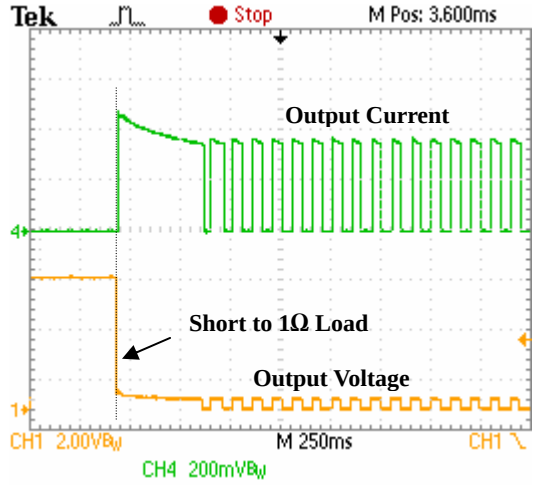
R_L=10Ω, C_L=0.47μF



Short Circuit through 0.3Ω



Output Short-Circuit Response



Detailed Description

The EUP3510 limits load current by sampling the pass transistor current and passing that through an external resistor, R_{SET}. The voltage across R_{SET}, V_{SET}, is then compared with an internal reference voltage, V_{REF}. In the event that load current surpasses the set limit current, V_{SET} will exceed V_{REF} causing the pass transistor gate voltage to increase, thereby reducing the gate to source voltage of the PMOS switch and regulating its current back down to I_{LIMIT}.
When the device detect V_{OUT} is less than 1V, the limit current will fold-back to about 60% of I_{LMT}.

Setting the Current Limit Level

Setting the current limit level on the EUP3510 requires some care to ensure the maximum current required by the load will not trigger the current limit circuitry. The minimum current limit threshold should be determined by taking the maximum current required by the load, I_{LOAD}, and adding 25 % headroom. The EUP3510 has a current limit tolerance of 25 %, which is largely a result of process variations from part to part, and also temperature and V_{IN}/V_{OUT} variances. Thus, to ensure that the actual current limit is never below the desired current limit a 1/0.75 = 1.33 coefficient needs to be added to the calculations. Knowing the maximum load current required, the value of R_{SET} is calculated as follows.

$$R_{SET} = R_{SET}\text{cofficient} / I_{LIMIT}$$

where I_{LIMIT} = (I_{LOAD}×1.33) × 1.25 and R_{SET} coefficient is 7500 for a 1A current limit. For typical R_{SET} coefficient values given a limit current refer to the "Typical Characteristics" section.

Operating at Current Limit and Thermal Shutdown

In the event that a load higher than I_{LIMIT} is demanded of the EUP3510, the load current will stay fixed at the current limit established by R_{SET}. However, since the required current is not supplied, the voltage at OUT will drop. The increase in V_{IN} -V_{OUT} will cause the chip to dissipate more heat. The power dissipation for the EUP3510 can be expressed as

$$P = I_{LOAD} \times (V_{IN} - V_{OUT})$$

Once this exceeds the maximum power dissipation of the package, the die temperature will rise. When the die temperature exceeds an over-temperature limit of 135 °C, the EUP3510 will shut down until it has cooled down to 115°C, before starting up again. As can be seen in the figure below, the EUP3510 will continue to cycle on and off until the load is reduced or the part is turned off.

The maximum power dissipation in any application is dependant on the maximum junction temperature, $T_{J(MAX)}$=125°C, the junction-to-ambient thermal resistance for the SOT23-5 package, θ_{JA}=220 °C/W, and the ambient temperature, T_A, which may be formulaically expressed as:

$$P(\max) = \frac{T_{J(\max)} - T_A}{\theta_{JA}} = \frac{125 - T_A}{220}$$

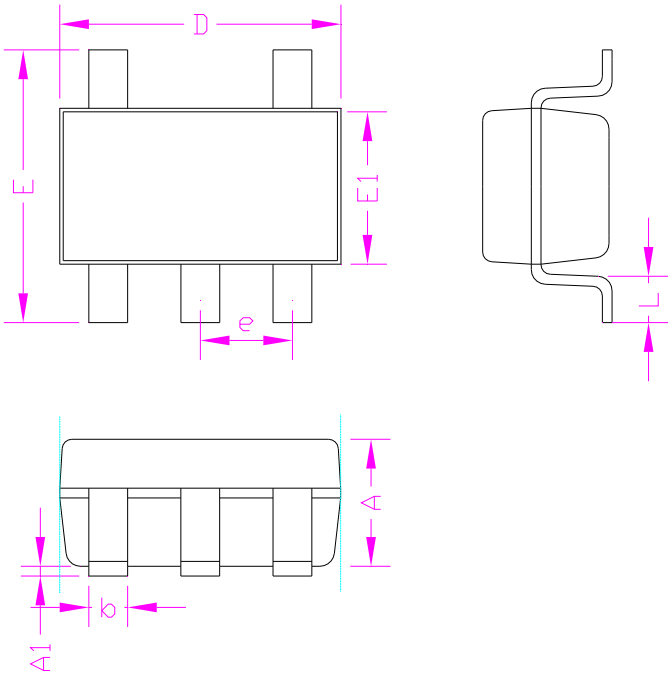
It then follows that assuming an ambient temperature of 60°C, the maximum power dissipation will be limited to about 295 mW.

Reverse Voltage

The EUP3510 is designed to control current flowing from IN to OUT. If the voltage on OUT is raised higher than IN current will flow from OUT to IN but the current limit function will not be available, as can be inferred from the block diagram in Figure 2. Thus, in applications were OUT is used to charge IN, careful considerations must be taken to limit current through the device and protect it from becoming damaged.

Packaging Information

SOT23-5



SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	-	1.30	-	0.052
A1	0.00	0.15	0.000	0.006
D	2.90		0.114	
E1	1.60		0.063	
E	2.60	3.00	0.102	0.118
L	0.30	0.60	0.012	0.024
b	0.30	0.50	0.012	0.020
e	0.95		0.037	