

## Ultra-Low Noise Ultra-Fast 300mA LDO Regulator

### General Description

The iD9309 is a 300mA, low dropout and low noise linear regulator with high ripple rejection ratio and fast turn-on time. It has fixed output voltage ranging from 1.5V to 3.3V.

The iD9309 includes a reference voltage source, an error amplifier, driver transistors and an internal current limiter. The current limiter's holdback circuit operates as a short protection.

The iD9309 works well with low ESR ceramic capacitors, suitable for portable RF and wireless battery-powered applications with stringent space requirements and demanding performance. It also offers ultra low noise output and has low quiescent current.

### Ordering Information

iD9309 -            

Package:  
A20:SOT-89-3  
A21:SOT-89-3-L TYPE  
A30:SOT-23-3  
B30-TSOT-23-3  
A51:SOT-23-5  
B51:TSOT-23-5  
C40:SC-82  
FA4:UDFN-4

Packing  
R: Tape and Reel

Output Voltage	Voltage Code
1.5	15
1.8	18
2.5	25
2.7	27
2.8	28
3.0	30
3.1	31
3.2	32
3.3	33

Other voltage outputs may be available. For further details, please contact an iDesyn sales or distributor.

### Features

- Ultra-Low-Noise Application
- Wide 2.5V to 7V Operating Range
- Quick Start-up
- Current Limiting Protection
- Thermal Shutdown Protection
- Low Dropout : 200mV @ 300mA
- High Ripple Rejection 65dB@1kHz
- Standby Current Less Than 0.1μA
- Auto Discharge

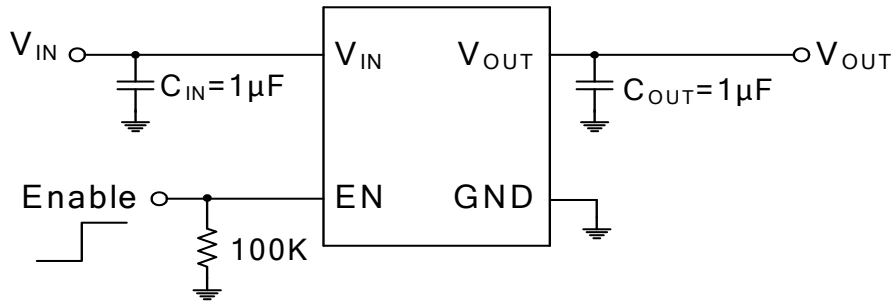
### Applications

- Battery-Powered Equipment
- Portable Instruments
- Digital Camera
- WLAN Communication
- Hand-Held Instruments

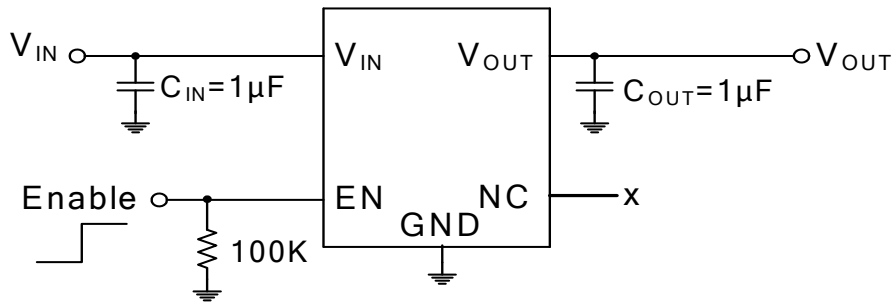
### Marking Information

For marking information, please contact our sales representative directly or through distributor around your location.

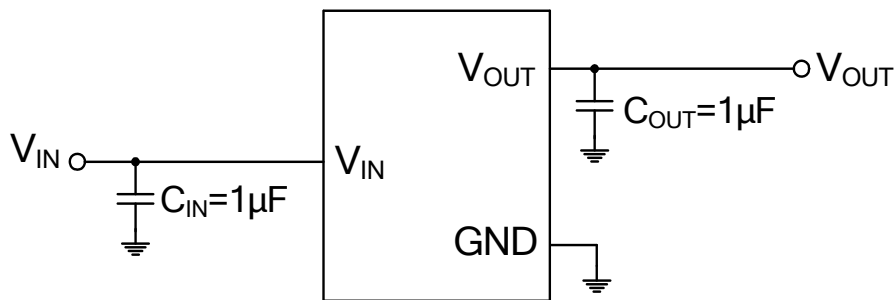
**Typical Application Circuit**



**Figure 1. SC-82 / UDFN-4 Package**



**Figure 2. (T)SOT-23-5 Package**



**Figure 3. (T)SOT-23-3 and SOT-89-3 Package**

**Absolute Maximum Ratings** (Note1)

Supply Voltage $V_{IN}$	8V
Power Dissipation, $P_D$ @ $T_A=25^\circ\text{C}$	
SOT-89-3	570mW
SC-82	300mW
(T)SOT-23-3 & (T)SOT-23-5	400mW
UDFN-4	400mW
Thermal Resistance, $\theta_{JA}$	
SOT-89-3	175°C/W
SC-82	333°C/W
(T)SOT-23-3 & (T)SOT-23-5	250°C/W
UDFN-4	250°C/W
Lead Temperature	260 °C
Storage Temperature	-65°C to 150°C
ESD Susceptibility	
HBM (Human Body Mode)	2kV
MM (Machine Mode)	200V

**Recommended Operating Conditions**

Input Voltage $V_{IN}$	2.5V to 7V
EN Input Voltage	0V to 7V
Junction Temperature	-40°C to 125°C
Ambient Operating Temperature	-40°C to 85°C

**Electrical Characteristics** (Unless otherwise specified  $V_{IN}=V_{OUT}+1V$ ,  $T_A=25^\circ C$ )

Parameters	Symbol	Condition	Min	Typ	Max	Units	
Operating Voltage Range (Note 2)	$V_{IN}$				7	V	
Standby Current	$I_{SBY}$	$V_{EN} = GND, Shutdown$		0.01	1	$\mu A$	
Supply Current Limit	$I_{LIMIT}$	$R_{LOAD} = 1\Omega$		600		mA	
Quiescent Current	$I_Q$	$V_{OUT} = 2.8V$		85		$\mu A$	
Dropout Voltage (Note 3)	$V_{DROP}$	$I_{OUT} = 300mA$	$V_{OUT} = 1.5V$	1150	1300	mV	
			$V_{OUT} = 1.8V$	800	1000	mV	
			$V_{OUT} = 2.5V$	320	500	mV	
			$V_{OUT} = 2.7V$	240	360	mV	
			$V_{OUT} = 2.8V$	200	300	mV	
			$V_{OUT} = 3.0V$	180	260	mV	
			$V_{OUT} = 3.1V$	160	230	mV	
		$V_{OUT} = 3.3V$	150	200	mV		
EN input Bias Current	$I_{IBSD}$	$V_{EN} = GND$ or $V_{IN}$		0	100	nA	
Line Regulation	$\Delta V_{LINE}$	$V_{IN} = (V_{OUT} + 1V)$ to 5.5V, $I_{OUT} = 1mA$			10	mV/V	
Load Regulation	$\Delta V_{LOAD}$	$1mA < I_{OUT} < 300mA$		15	25	mV	
		$1mA < I_{OUT} < 300mA$ (UDFN-4)		15	40	mV	
Output Noise Voltage	eNO	10Hz to 100kHz, $I_{OUT} = 200mA, C_{OUT} = 1\mu F$		100		$\mu V_{RMS}$	
Thermal Shutdown Temperature	$T_{SD}$			165		$^\circ C$	
Thermal Shutdown Temperature Hysteresis	$\Delta T_{SD}$			30		$^\circ C$	
Output Voltage Accuracy	$\Delta V_{OUT}$	$I_{OUT} = 1mA$	-2		+2	%	
Fast Discharge N-MOSFET Turn On Resistance	$R_{DISCHARGE}$	$V_{IN} = 4V, V_{EN} = 0V$		35		$\Omega$	
EN Threshold	Logic-Low V	$V_{IL}$	$V_{IN} = 3V$ to 5.5V, Shutdown			0.4	V
	Logic-High V	$V_{IH}$	$V_{IN} = 3V$ to 5.5V, Start-up	1.2			V
Power Supply Rejection Rate	$f = 100Hz$	PSRR	$C_{OUT} = 1\mu F, I_{OUT} = 10mA$		-70		dB
	$f = 10kHz$				-55		

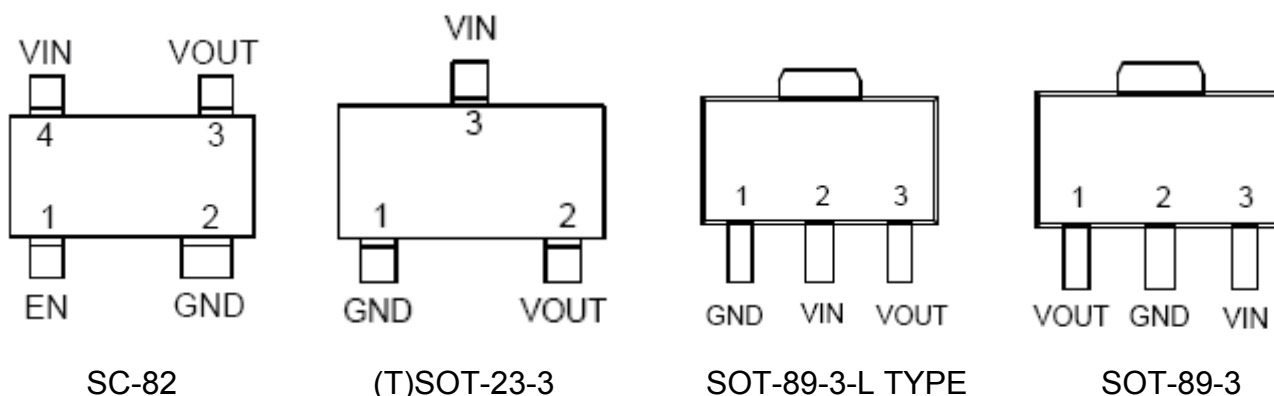
**Note 1:** Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

**Note 2:**  $V_{IN(MIN)} = V_{OUT} + V_{DROPOUT}$

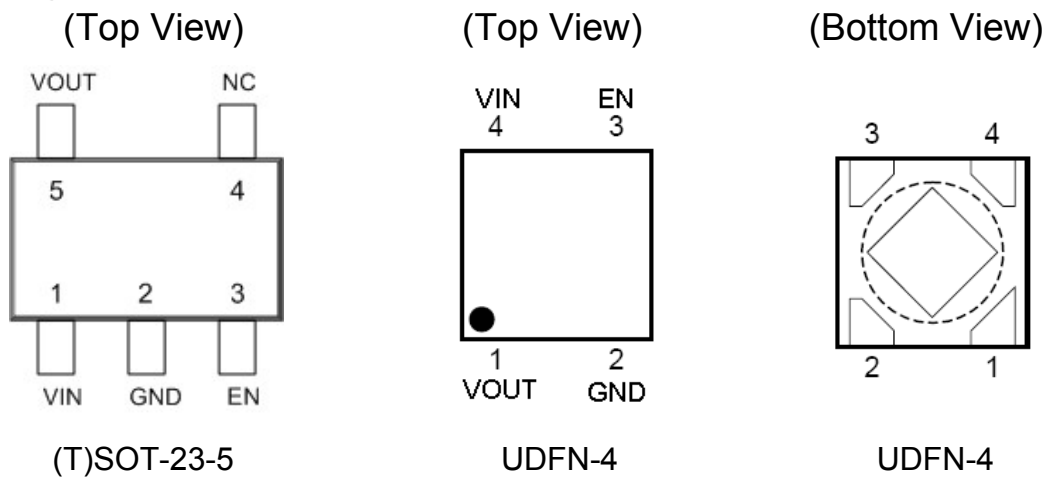
**Note 3:** The dropout voltage is defined as  $(V_{IN} - V_{OUT})$  when  $V_{OUT}$  is 100mV below the target value of  $V_{OUT}$ .

**Pin Configurations**

(Top View)



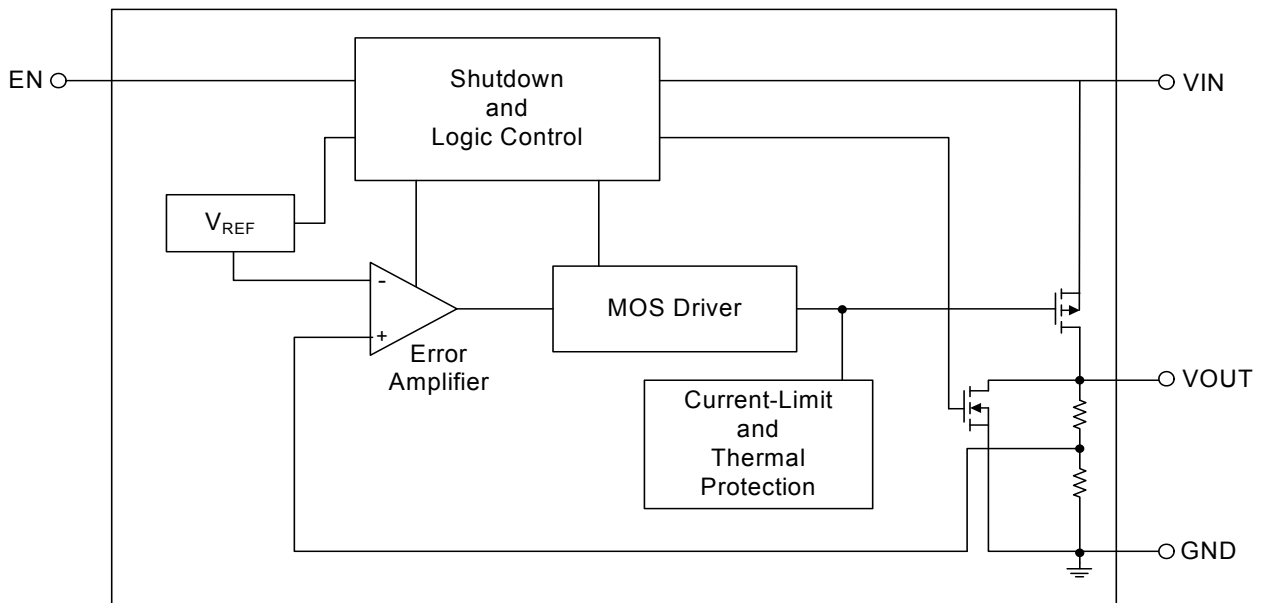
## Pin Configurations (Cont.)



## Pin Description

Pin Name	Pin Function
EN	Chip Enable (Active High). Note that this pin is high impedance. There should be a pull low 100k $\Omega$ resistor connected to GND when the control signal is floating.
GND	Ground
VOUT	Output Voltage
VIN	Input Voltage
NC	No Internal Connection (Floating or Connecting to GND)

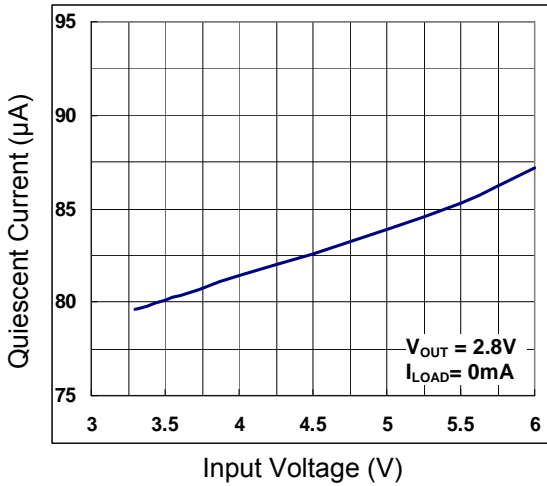
## Function Block Diagram



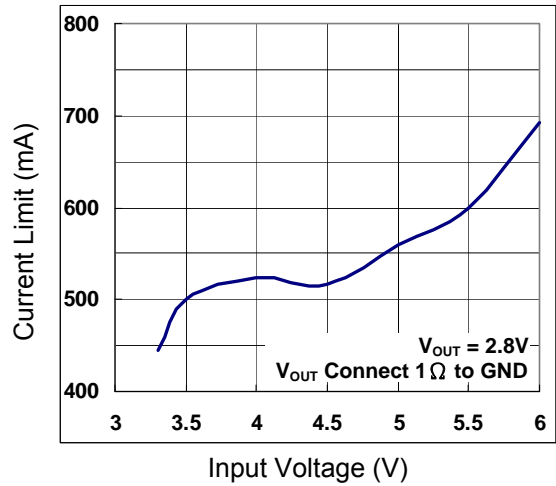
## Typical Operating Characteristics

(Unless otherwise specified  $V_{IN}=V_{OUT}+1V$ ,  $T_A=25^{\circ}C$ )

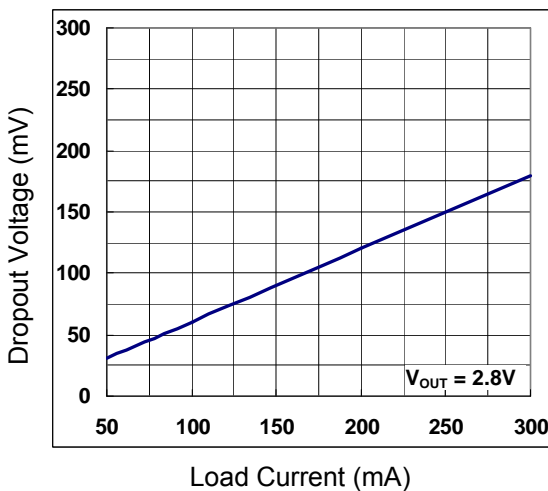
**Quiescent Current vs. Input Voltage**



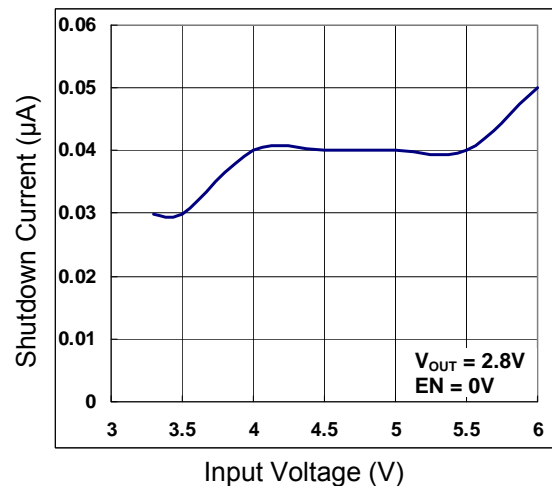
**Current Limit vs. Input Voltage**



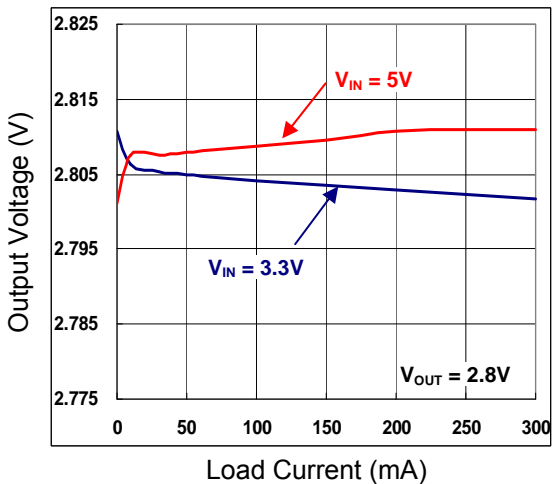
**Dropout Voltage vs. Load Current**



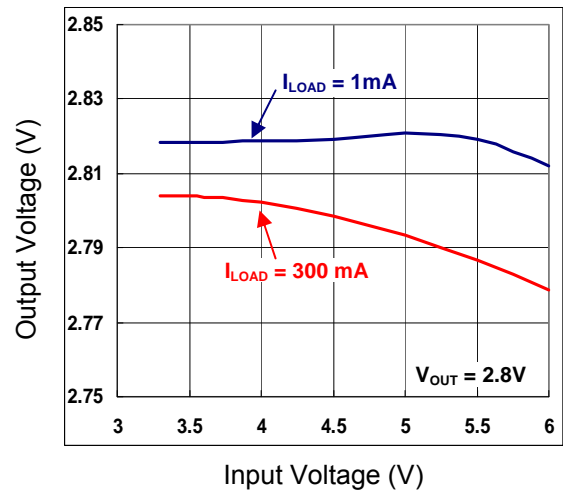
**Shutdown Current vs. Input Voltage**



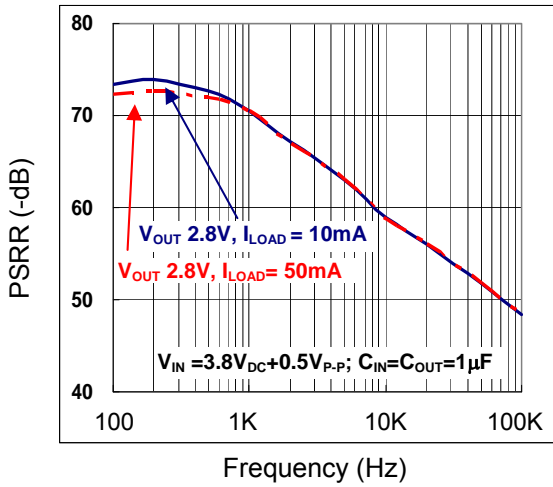
**Load Regulation**



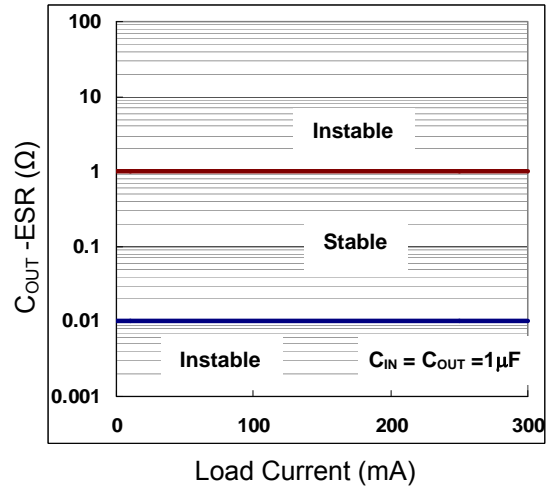
**Line Regulation**



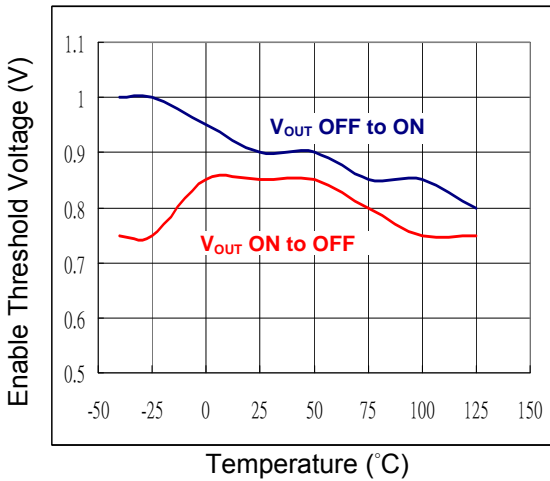
**PSRR**



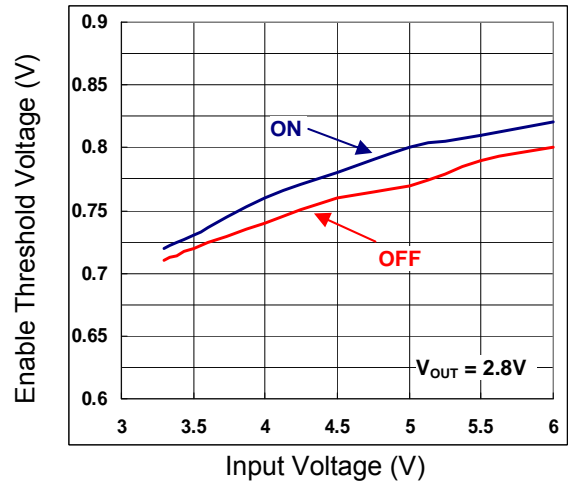
**Region of Stable  $C_{OUT}$  ESR vs. Load Current**



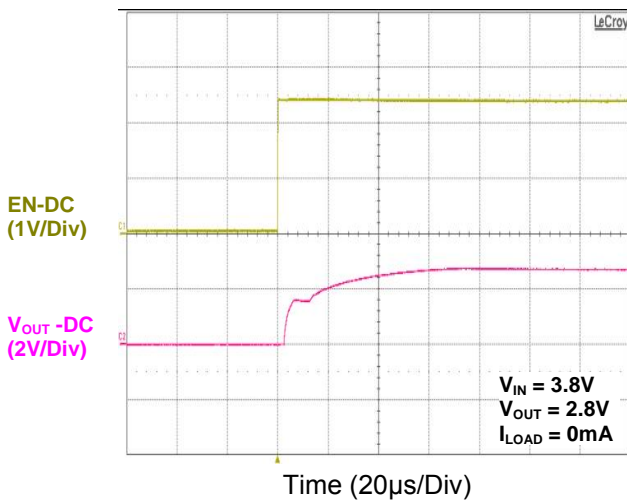
**Enable Threshold Voltage vs. Temperature**



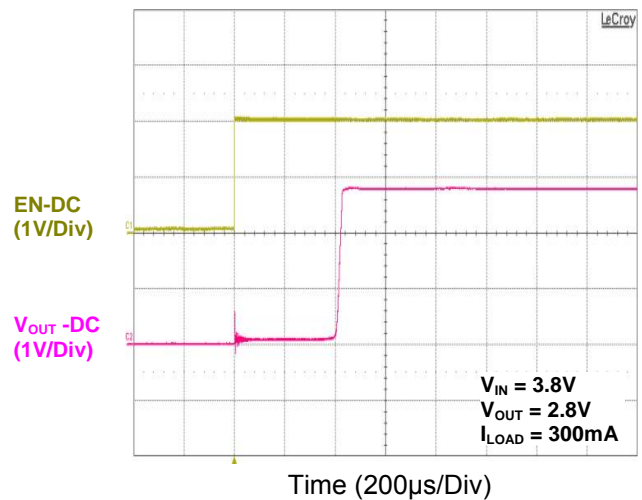
**Enable Threshold Voltage vs. Input Voltage**



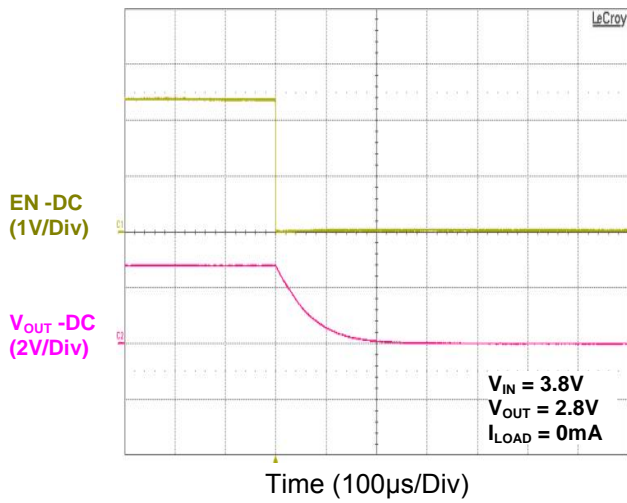
**Start-up from EN**



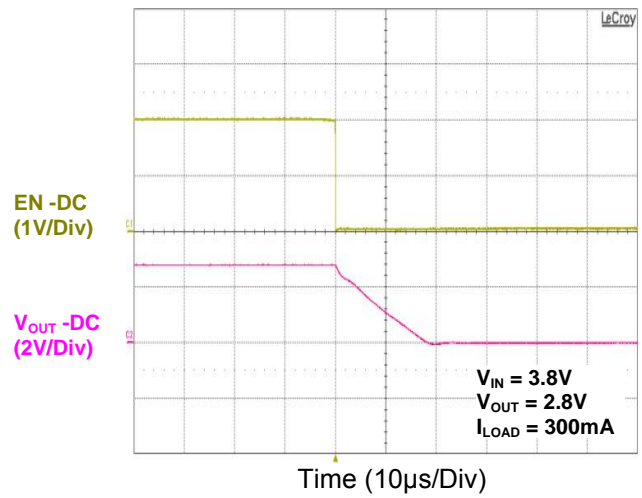
**Start-up from EN**



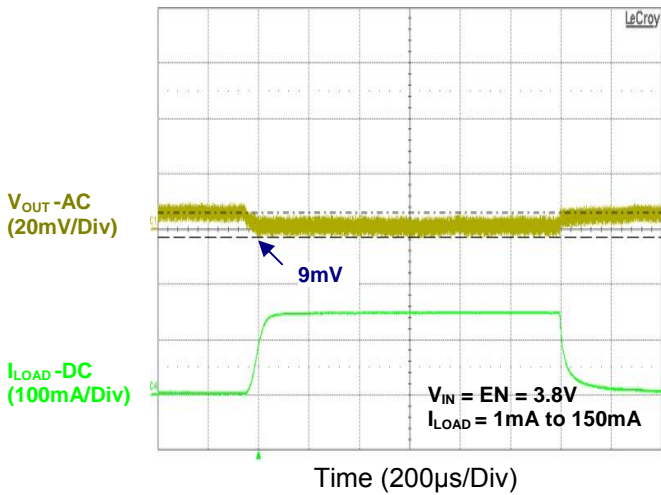
**Shutdown from EN**



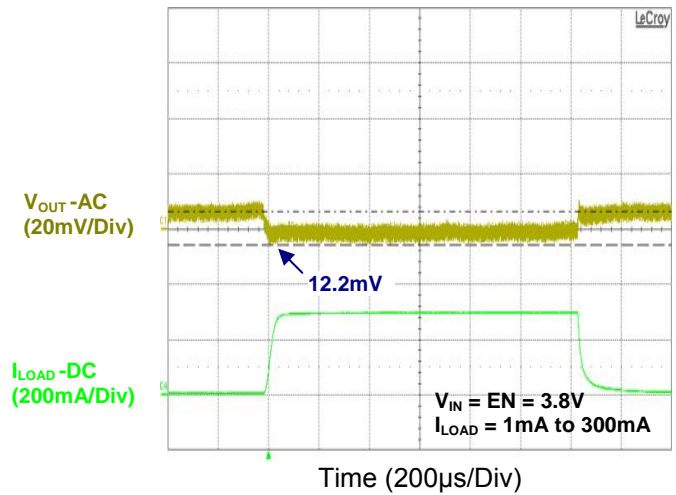
**Shutdown from EN**



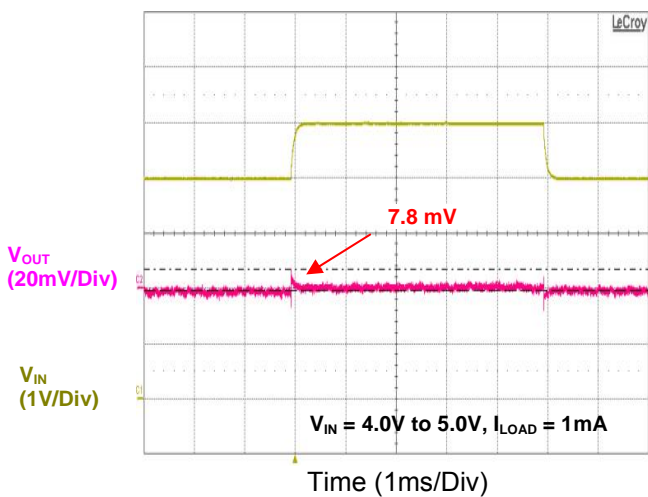
**Load Transient Response**



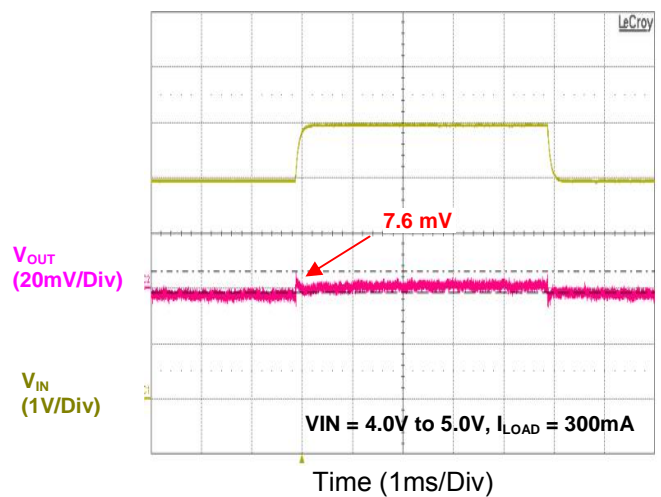
**Load Transient Response**



**Line Transient Response**



**Line Transient Response**





## Application Information

### Capacitor Selection and Regulator Stability

#### Input Capacitor

An input capacitance of 1 $\mu$ F is required between the device input pin and ground directly (the amount of the capacitance may be increased without limit). The input capacitor **MUST** be located less than 1 cm from the device to assure input stability (see PCB Layout Section). A lower ESR capacitor allows the use of less capacitance, while higher ESR type (like aluminum electrolytic) requires more capacitance. Capacitor types (aluminum, ceramic and tantalum) can be mixed in parallel, but the total equivalent input capacitance/ESR must be defined as above for stable operation. There are no requirements for the ESR on the input capacitor, but tolerance and temperature coefficient must be considered when selecting the capacitor to ensure the capacitance is 1 $\mu$ F over the entire operating range.

#### Output Capacitor

The iD9309 is designed specifically to work with very small ceramic output capacitors. The minimum capacitance recommended (temperature characteristics of X7R, X5R, Z5U or Y5V) is within the 1 $\mu$ F to 10 $\mu$ F range with 5m $\Omega$  to 50m $\Omega$  ESR range ceramic capacitor between LDO output and GND for transient stability, but it may be increased without limit. Higher capacitance values help to improve transient response. The output capacitor's ESR is critical because it forms a zero to provide phase lead which is required for loop stability.

#### Enable Function

The iD9309 is shut down by pulling the EN pin low and turned on by driving the input high. If the shutdown feature is not required, the EN pin should be tied to VIN to keep the regulator on at all times (the EN pin **MUST NOT** be left floating).

To assure proper operation, the signal source used to

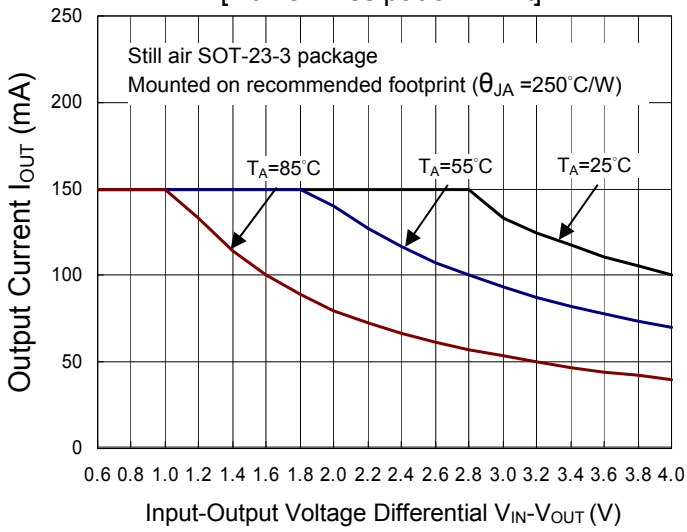
drive the EN pin must be able to swing above and below the specified turn-on/off voltage thresholds listed in the "Electrical Characteristics" under V<sub>IH</sub> and V<sub>IL</sub>. The ON/OFF signal may come from either CMOS output, or an open-collector output with pull-up resistor to the device input voltage or another logic supply. The high-level voltage may exceed the device input voltage, but must remain within the absolute maximum ratings for the EN pin.

#### Operating Region and Power Dissipation

Since the iD9309 is a linear regulator, its power dissipation is always given by  $P = I_{OUT} (V_{IN} - V_{OUT})$ . The maximum power dissipation is given by:  $P_{D(MAX)} = (T_J - T_A) / \theta_{JA} = (125^\circ\text{C} - 25^\circ\text{C}) / 250^\circ\text{C} / \text{W} = 400\text{mW}$  Where  $(T_J - T_A)$  is the temperature difference the iD9309 die and the ambient air,  $\theta_{JA}$  is the thermal resistance of the chosen package to the ambient air. For surface mount device, heat sinking is accomplished by using the heat spreading capabilities of the PC board and its copper traces. In the case of a SOT-23-3 package, the thermal resistance is typically 250 $^\circ\text{C} / \text{Watt}$ . Refer to Figure 4 & 5 for the iD9309 valid operating region (Safe Operating Area) and refer to Figure 6 for maximum power dissipation information of SOT-23-3.

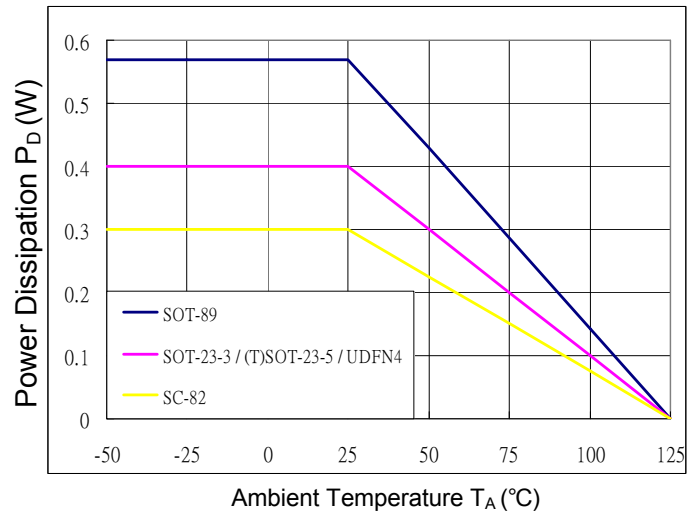
The die attachment area of the iD9309 lead frame is connected to pin 2, which is the GND pin. Therefore, the GND pin of iD9309 can dissipate the heat from the die very effectively. To improve the maximum power providing capability, connect the GND pin to ground using a large ground plane near the GND pin.

**Safe Operation Area of  $I_{OUT}=150mA$   
[Power Dissipation Limit]**



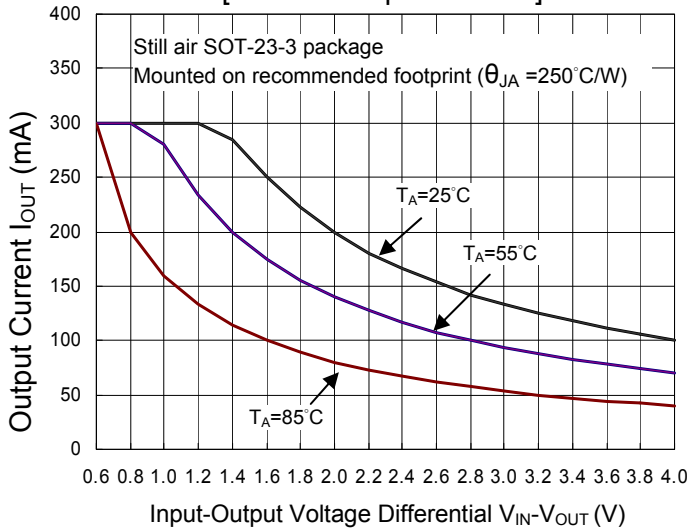
**Fig. 4**

**Maximum Power Dissipation**



**Fig. 6**

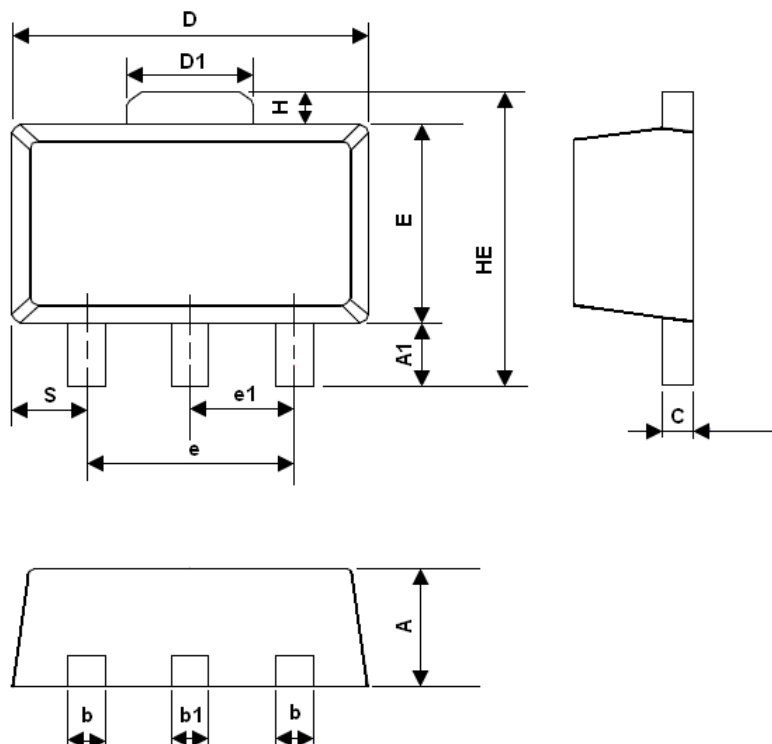
**Safe Operation Area of  $I_{OUT}=300mA$   
[Power Dissipation Limit]**



**Fig. 5**

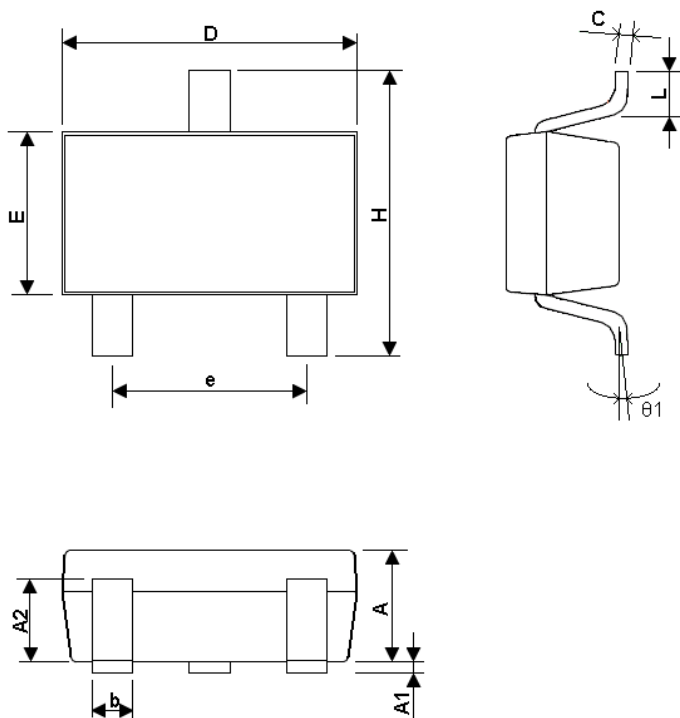
## Packaging

### SOT-89-3



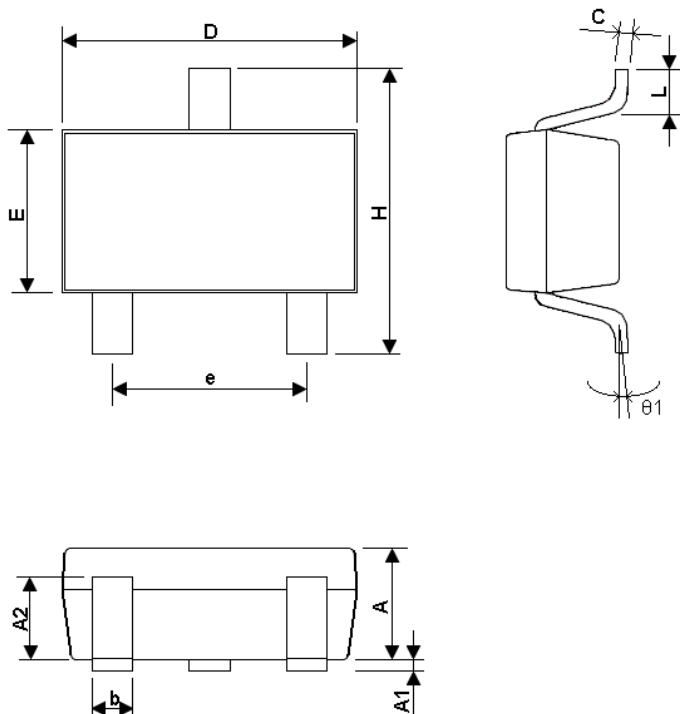
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.40	1.50	1.60	0.055	0.059	0.063
A1	0.80	1.04-	---	0.031	0.041	---
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.185	0.020
C	0.38	0.40	0.43	0.014	0.016	0.017
D	4.40	4.50	4.600	0.173	0.177	0.181
D1	1.40	1.60	1.75	0.055	0.062	0.069
HE	---	---	4.25	---	---	0.167
E	2.40	2.50	2.60	0.094	0.098	0.102
e	2.90	3.00	3.10	0.114	0.118	0.122
H	0.35	0.40	0.45	0.014	0.016	0.018
S	0.65	0.75	0.85	0.026	0.030	0.034
e1	1.40	1.50	1.60	0.054	0.059	0.063

## SOT-23-3



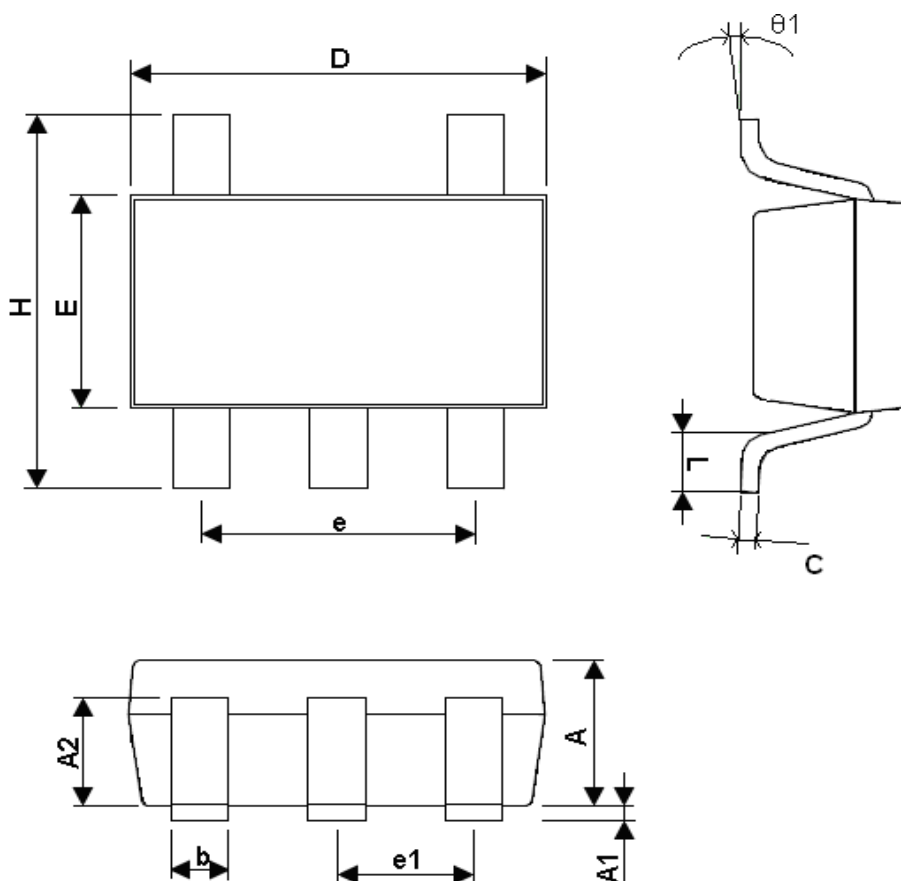
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.00	1.10	1.30	0.039	0.043	0.051
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.80	0.90	0.027	0.031	0.035
b	0.35	0.40	0.50	0.013	0.016	0.020
C	0.10	0.15	0.25	0.004	0.006	0.001
D	2.70	2.90	3.10	0.106	0.114	0.122
E	1.40	1.60	1.80	0.055	0.063	0.071
e	---	1.90(TYP)	---	---	0.075	---
H	2.60	2.80	3.00	0.102	0.110	0.118
L	0.370	---	---	0.015	---	---
Θ1	1°	5°	9°	1°	5°	9°

## TSOT-23-3



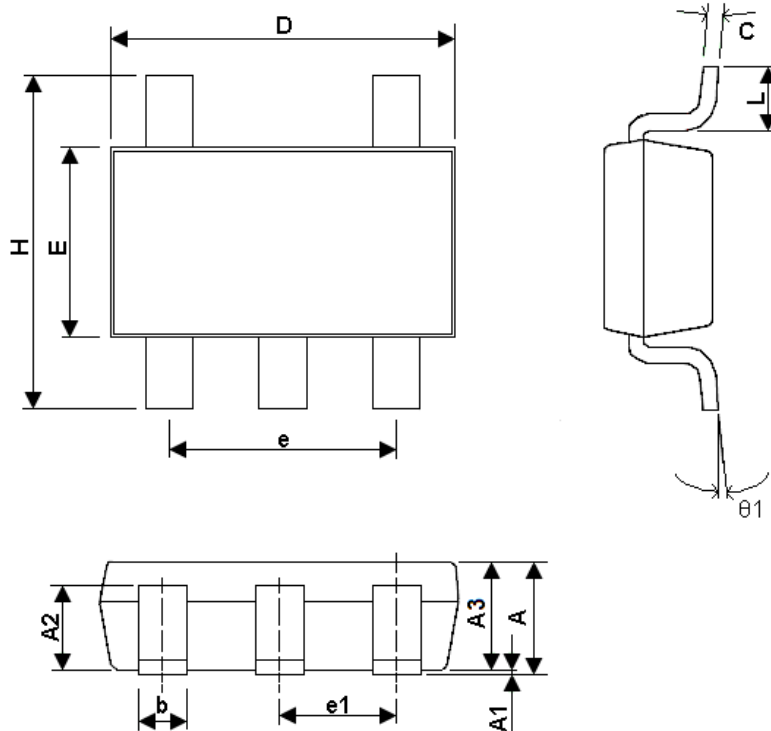
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.75	---	0.90	0.030	---	0.035
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.80	0.90	0.027	0.031	0.035
b	0.35	0.40	0.50	0.013	0.016	0.020
C	0.10	0.15	0.25	0.004	0.006	0.001
D	2.70	2.90	3.10	0.106	0.114	0.122
E	1.40	1.60	1.80	0.055	0.063	0.071
e	---	1.90(TYP)	---	---	0.075	---
H	2.60	2.80	3.00	0.102	0.110	0.118
L	0.370	---	---	0.015	---	---
Θ1	1°	5°	9°	1°	5°	9°

## SOT-23-5



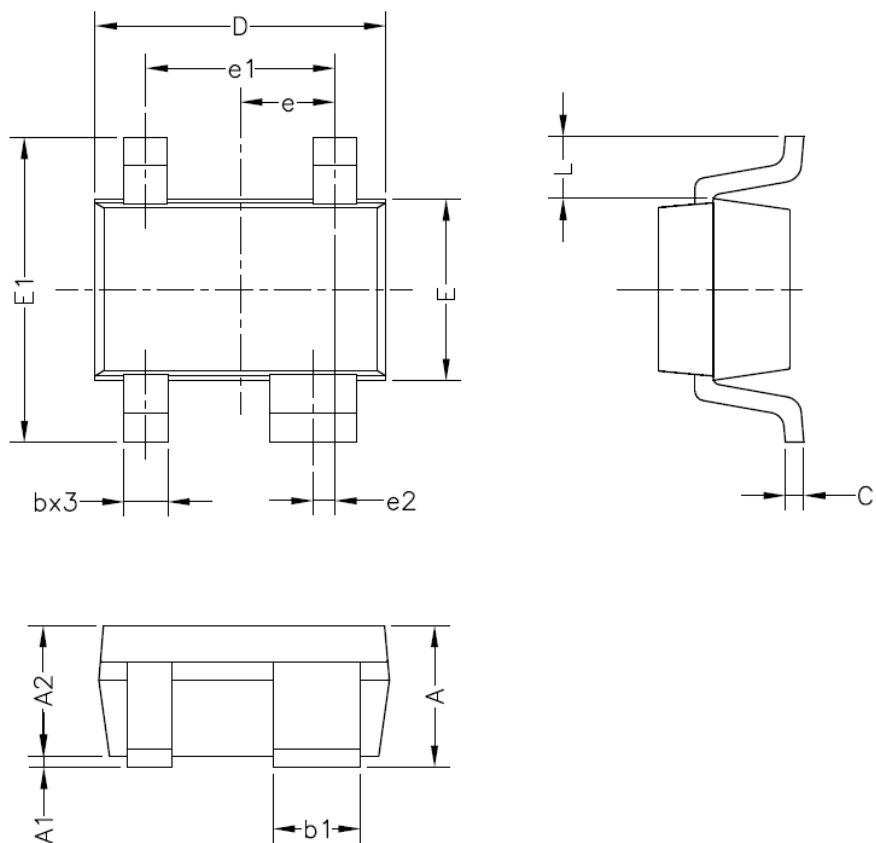
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.00	1.10	1.30	0.039	0.043	0.051
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.80	0.90	0.027	0.031	0.035
b	0.35	0.40	0.50	0.013	0.016	0.020
C	0.10	0.15	0.25	0.004	0.006	0.001
D	2.70	2.90	3.10	0.106	0.114	0.122
E	1.50	1.60	1.80	0.059	0.063	0.071
e	---	1.90(TYP)	---	---	0.075	---
H	2.60	2.80	3.00	0.102	0.110	0.118
L	0.370	---	---	0.015	---	---
$\Theta 1$	1°	5°	9°	1°	5°	9°
e1	---	0.95(TYP)	---	---	0.037	---

## TSOT-23-5



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	---	---	1.00	---	---	0.039
A1	0.00	---	0.10	0.000	---	0.004
A2	0.58	0.68	0.78	0.023	0.027	0.030
A3	0.84	0.87	0.90	0.033	0.034	0.035
b	0.35	0.40	0.50	0.014	0.016	0.020
C	0.10	0.125	0.15	0.004	0.005	0.006
D	2.70	2.90	3.10	0.106	0.114	0.122
E	1.50	1.60	1.80	0.059	0.063	0.071
e	---	1.90(TYP)	---	---	0.075(TYP)	---
H	2.60	2.80	3.00	0.102	0.110	0.118
L	0.370	---	---	0.015	---	---
θ1	1°	5°	9°	1°	5°	9°
e1	---	0.95(TYP)	---	---	0.037	---

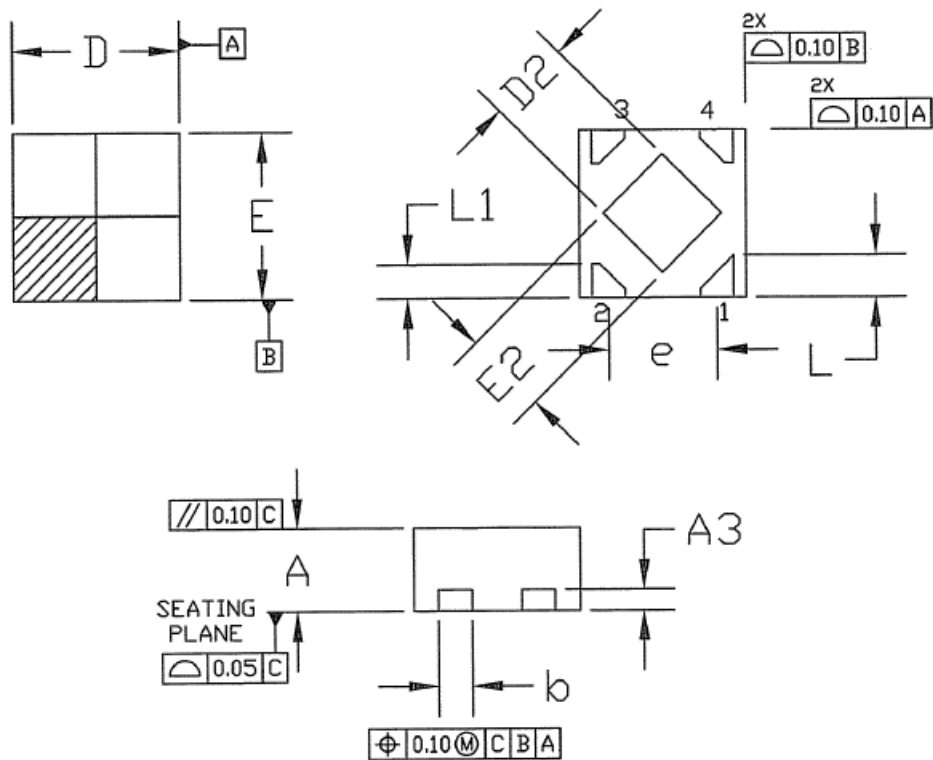
## SC-82



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.85	---	1.05	0.033	---	0.041
A1	0.00	---	0.10	0.000	---	0.004
A2	0.85	---	0.95	0.033	---	0.037
b	0.20	---	0.40	0.008	---	0.016
b1	0.5	---	0.7	0.020	---	0.028
C	0.10	---	0.15	0.004	---	0.006
D	1.90	---	2.10	0.075	---	0.083
E	1.15	---	1.35	0.045	---	0.053
E1	2.00	---	2.30	0.080	---	0.091
e	0.65 BSC.			0.026 BSC.		
e1	1.30 BSC.			0.052 BSC.		
e2	0.15 BSC.			0.006 BSC.		
L	0.425 REF.			0.017 REF.		



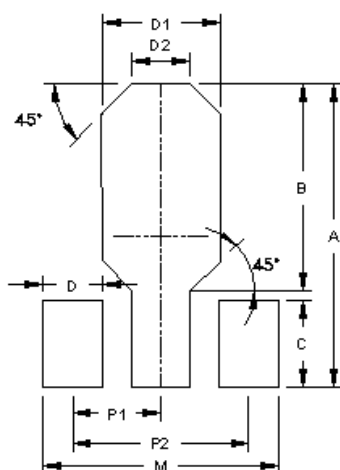
### UDFN-4



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.45	0.50	0.55	0.018	0.020	0.022
A3	0.100 REF			0.004 REF		
b	0.15	0.20	0.25	0.006	0.008	0.010
D	0.90	1.00	1.10	0.035	0.039	0.043
D2	0.40	0.50	0.60	0.016	0.020	0.024
E	0.90	1.00	1.10	0.035	0.039	0.043
E2	0.40	0.50	0.60	0.016	0.020	0.024
e	0.65 BSC			0.026 BSC		
L	0.20	0.25	0.30	0.008	0.010	0.012
L1	0.15	0.20	0.25	0.006	0.008	0.010

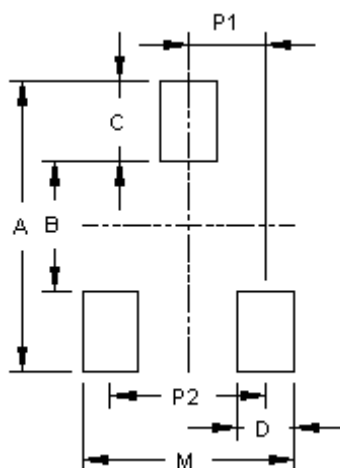
## Footprints

### SOT-89-3



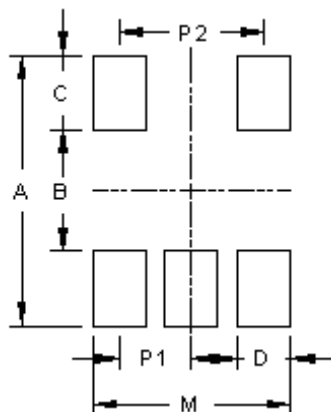
Package	Number of PIN	Footprint Dimension (mm)										Tolerance
		P1	P2	A	B	B1	C	D	D1	D2	M	
SOT-89-3	3	1.50	3.00	5.10	3.40	--	1.50	1.00	2.20	1.00	4.00	±0.10

### (T)SOT-23-3



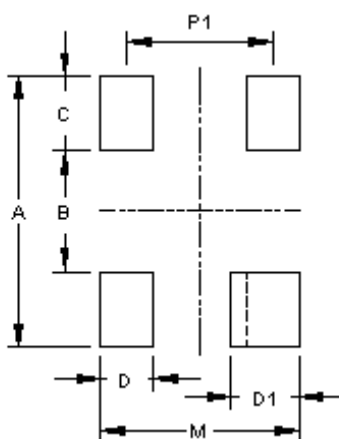
Package	Number of PIN	Footprint Dimension (mm)							Tolerance
		P1	P2	A	B	C	D	M	
SOT-23-3	3	0.95	1.90	3.60	1.60	1.00	0.80	2.70	±0.10

### (T)SOT-23-5



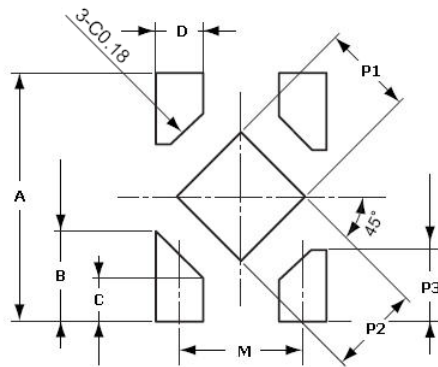
Package	Number of PIN	Footprint Dimension (mm)							Tolerance
		P1	P2	A	B	C	D	M	
(T)SOT-23-5	5	0.95	1.90	3.60	1.60	1.00	0.70	2.60	±0.10

### SC-82



Package	Number of PIN	Footprint Dimension (mm)								Tolerance
		P1	P2	A	B	C	D	D1	M	
SC-82	4	1.30	--	2.70	1.10	0.80	0.60	0.80	1.90	±0.10

## UDFN-4



Package	Number of PIN	Footprint Dimension (mm)								Tolerance
		P1	P2	P3	A	B	C	D	M	
UDFN-4	4	0.48	0.48	0.4	1.3	0.47	0.22	0.25	0.65	±0.10