

# SK6086 65V/1.8uA, Ultra-Low Quiescent Current LDO

## General Description

SK6086 is a high voltage (up to 65V) ultra-low quiescent current low dropout voltage regulator (LDO) manufactured in CMOS processes. It can deliver up to 200mA of current while consuming only 2uA of quiescent current, and offers 2% initial accuracy and low dropout voltage, 70mV typical at 10mA.

The SK6086 is designed specifically for applications where very-low IQ is a critical parameter. This device maintains low quiescent current consumption even in dropout mode to further increase the battery life. Other features include short-circuit protection and thermal shutdown. When in shutdown or disabled mode, the device consumes less than 100-nA IQ even with input voltage of 65V that helps increase the shelf life of the battery.

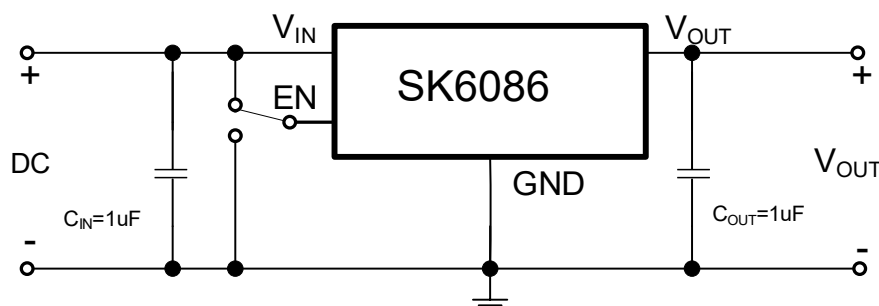
## Features

- Ultra Low Quiescent Current: 1.8uA(Typ.)
- Wide Operating Voltage:  $V_{OUT}+1V$  to 65V (max  $V_{in}$  can be up to 80V)
- High Accuracy Output Voltage:  $\pm 2\%$
- High output current:  $\geq 200mA$
- Low Dropout Voltages:
  - 70mV@10mA
  - 700mV@100mA
- System soft startup
- Short circuit protection is designed with no overshoot
- Output Capacitor: Low ESR Ceramic Capacitor Compatible
- Excellent power / load transient response
- Low temperature coefficient:  $\pm 100ppm/^{\circ}C$
- Thermal and Short-Circuit Protection
- With EN pin
- Available Packages: SOT23-3, SOT23-5, SOT89, EMSOP8, SOP8, TO252

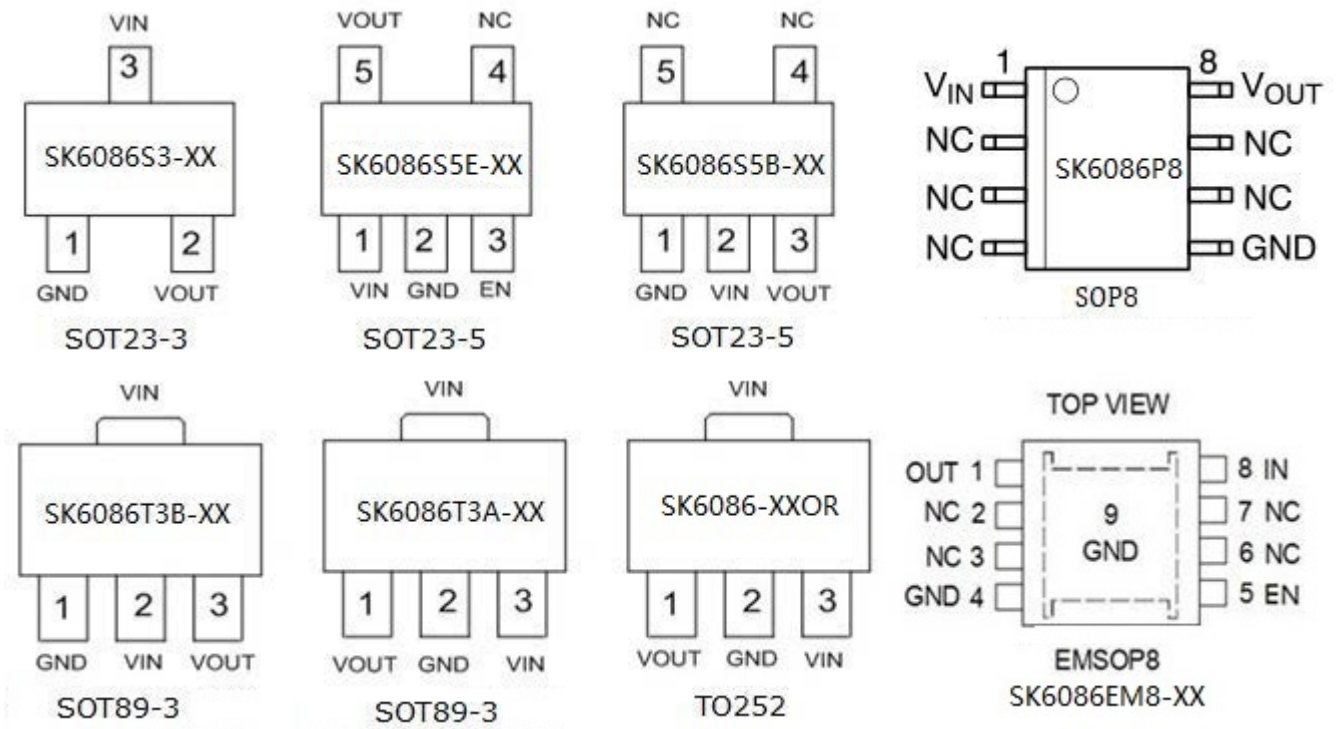
## Applications

- Battery-powered equipment
- Smoke detector and sensor
- Microcontroller Applications
- Smart electric meter

## Typical Application



## Pin Configuration



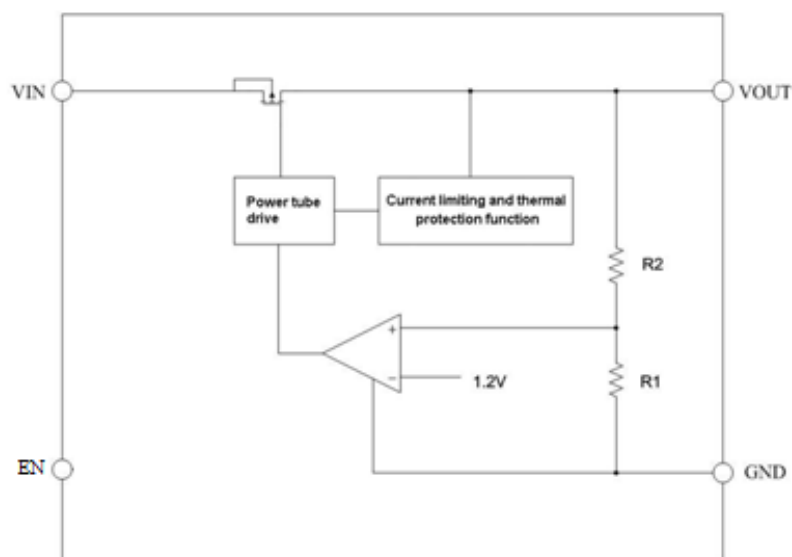
## Pin Description

Pin Name	Pin Function Description
VIN	In put pin
VOUT	Out put pin
GND	Ground pin
EN	Enable pin
NC	No connection

## Ordering Information

Part Number	Package	Quantity/Reel
SK6086S3-XX	SOT23-3	3000
SK6086S5E-XX	SOT23-5 with EN	3000
SK6086S5B-XX	SOT23-5	3000
SK6086T3A-XX	SOT89-3	1000
SK6086T3B-XX	SOT89-3	1000
SK6086-XXOR	TO252	2500
SK6086P8-XX	SOP8	4000
SK6086EM8-XX	EMSOP8	4000

## Functional Block Diagram



## Absolute Maximum Ratings

Symbol	Parameter	Value	Units
$V_{IN}$	Input Supply Voltage	80	V
EN	Enable Voltage	80	
$V_{OUT} \text{---} GND$	Output Voltage TO GND	6	
$V_{out} \text{---} V_{IN}$	Output Voltage TO VIN	-75	
$T_A$	Operating Temperature	-40---105	°C
$T_{STG}$	Storage Temperature	-40---150	
$T_J$	Maximum Junction Temperature	150	
$T_{LEAD}$	Lead Temperature (Soldering) 10 seconds	260	
$\theta_{JA}$	Thermal Resistance, Junction-to-Ambient	165(SOT89)	°C/W
		280(SOT23-3)	
		270(SOT23-5)	
		180(SOP8)	
		85(TO252)	
$P_D$	Power Consumption	750(SOT89)	mW
		446(SOT23-3)	
		465(SOT23-5)	
		700(SOP8)	
		1300(TO252)	
Electrostatic discharge rating	Human Body Model (HBM)	4	kV
	Charged Device Model (MM)	100	V

Note : Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device.

## Recommended Operating Conditions

Symbol	Parameter	Maximum	Units
$V_{IN}$	Input Supply Voltage	60	V
$T_A$	Operating Temperature	-20---85	°C
$T_{LEAD}$	Lead Temperature (Soldering) 10 seconds	230	°C

## Electrical Characteristics

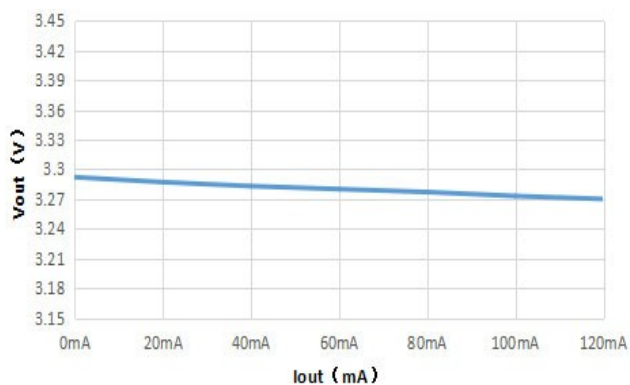
( TA=25°C, CIN=1μF, VIN=VOUT+1.0V, COUT=10μF, unless otherwise noted )

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>IN</sub>	Input Supply Voltage		2.8		60	V
V <sub>OUT</sub>	Output Voltage Accuracy	I <sub>OUT</sub> =10mA	V <sub>out(s)</sub> X 0.99	V <sub>out(s)</sub>	vout(s)X 1.01	V
			V <sub>out(s)</sub> X 0.98	V <sub>out(s)</sub>	vout(s) X1.02	V
V <sub>DROP</sub>	Dropout Voltage	I <sub>OUT</sub> =10mA ΔV <sub>OUT</sub> = - V <sub>OUT</sub> *2%		70		mV
		I <sub>OUT</sub> =100mA ΔV <sub>OUT</sub> = - V <sub>OUT</sub> *2%		700		mV
I <sub>Q</sub>	Quiescent Current	V <sub>IN</sub> =6V~60V		1.8	4	μA
I <sub>OUT</sub>	Output Current			200		mA
V <sub>LR</sub>	Load Regulation	1mA ≤ I <sub>OUT</sub> ≤ 100mA		20		mV
V <sub>SR</sub>	Line Regulation	I <sub>OUT</sub> =1mA, V <sub>IN</sub> =(V <sub>OUT</sub> +1V) to 30V		0.2		%/V
PSRR	Power Supply Rejection Ratio	I <sub>OUT</sub> =10mA F=1KHz, V <sub>OUT</sub> =3.3V	—	70	—	dB
V <sub>ENH</sub>	Enable High Level	Enabled	1	—	—	V
V <sub>ENL</sub>	Enable Low Level	Disabled		—	0.4	V
I <sub>EN</sub>	EN Current	EN=0~V <sub>IN</sub> (R <sub>EN</sub> =100K)		1		μA
I <sub>LIMIT</sub>	Current Limit	V <sub>IN</sub> =(V <sub>OUT</sub> +1V) to 60V		400		mA
T <sub>SHDN</sub>	Thermal Protection			150		°C
TC <sub>VOUT</sub>	Output Voltage Temperature Coefficient	I <sub>OUT</sub> =10mA -40°C ≤ T <sub>AMB</sub> ≤ 100°C		-17		ppm/°C

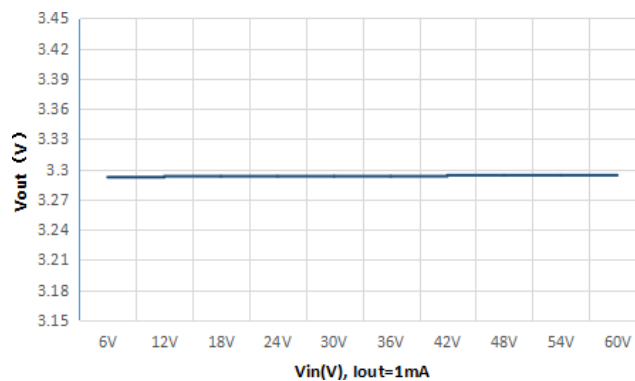
## Typical Performance Characteristics

( TA=25°C, CIN=1uF, VIN=VOUT (3.3V) +1.0V, COUT=10μF, unless otherwise noted )

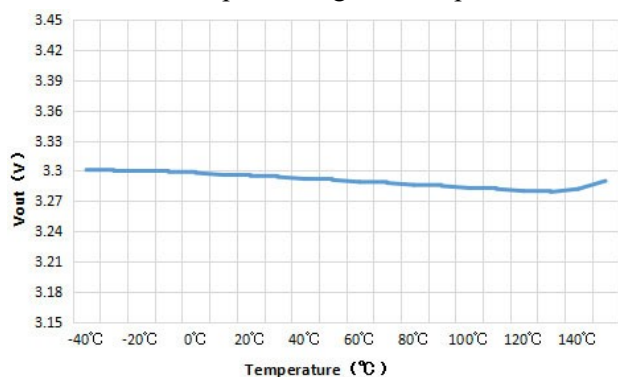
### Load Regulation (Vin=30V)



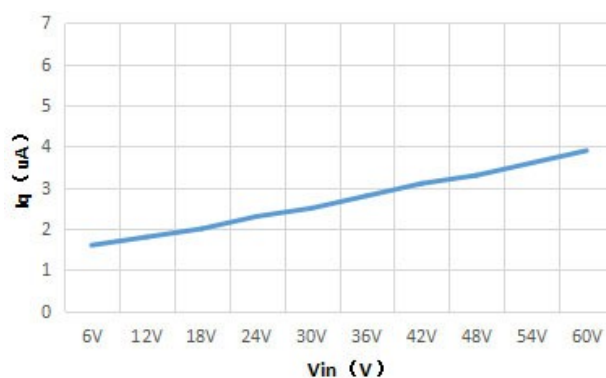
### Line Regulation



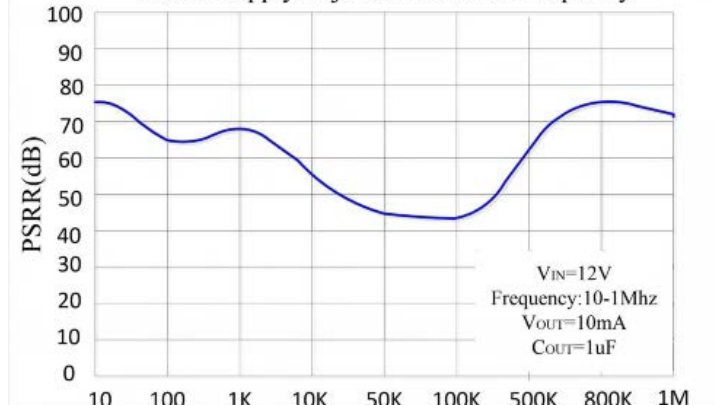
### Output Voltage vs Temperature



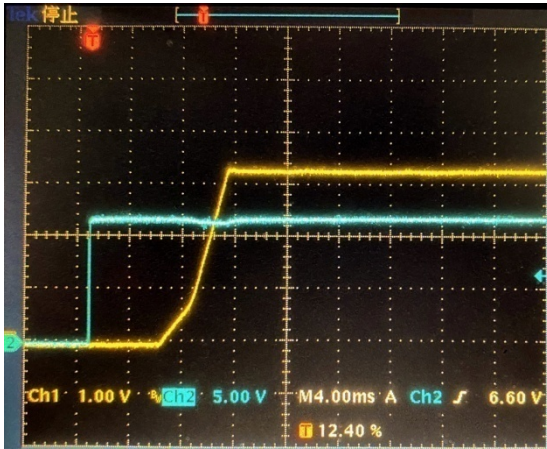
### Quiescent current vs Input Voltage



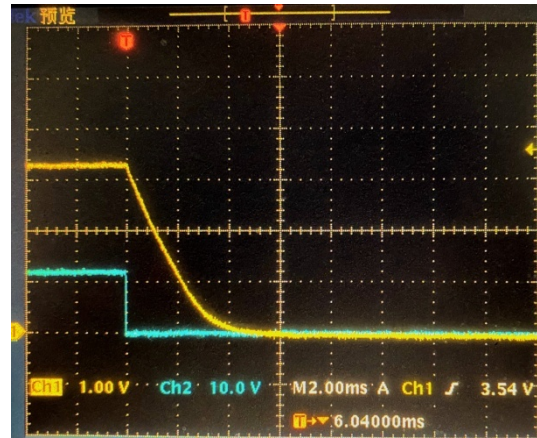
### Power-Supply Rejection Ratio vs. Frequency



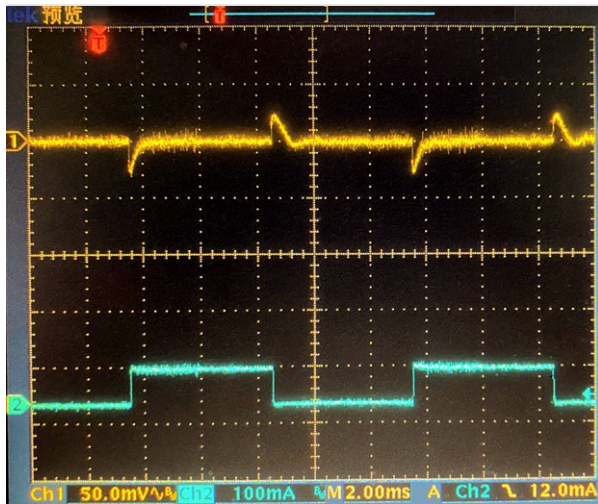
EN OFF → ON



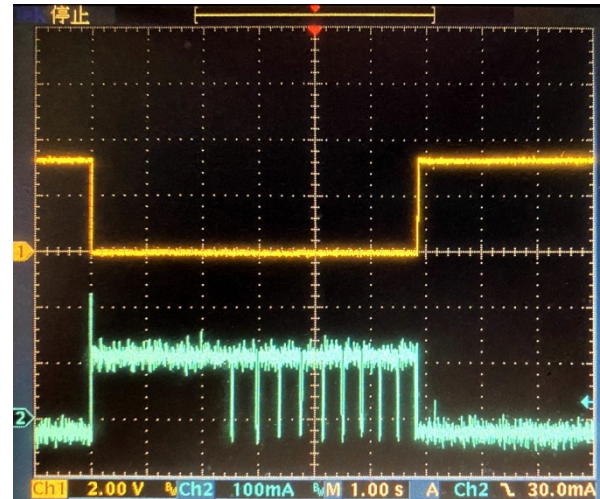
EN ON → OFF (No Load)  
Discharge



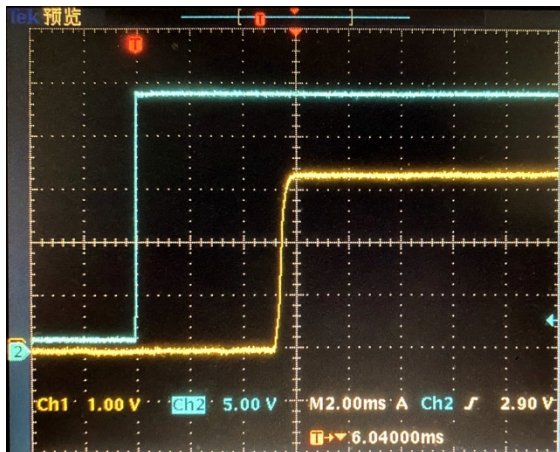
Load Transient (Vin=12V)  
10mA~100mA



Short-Circuit and OTP (Vin=24V)



VCC Power ON



## APPLICATION INFORMATION

### INPUT CAPACITOR

An input ceramic capacitor of  $1\mu\text{F}$  is required between the VIN and GND pin. The capacitor shall be placed as close as possible to VIN pin, and the wide copper trace is also recommended.

### OUTPUT CAPACITOR

The recommended is  $10\mu\text{F}$  ceramic capacitor. The minimum capacitance for stable and correct operation is  $1\mu\text{F}$ . The higher the value of this output capacitor, the lower the ripple during the operations. The output capacitor should be placed as close to the Output Pin as possible. The wide copper trace is recommended.

### NO-LOAD STABILITY

The SK6086 will remain stable and in regulation with no external load.

### FOLD-BACK SHORT-CIRCUIT PROTECTION

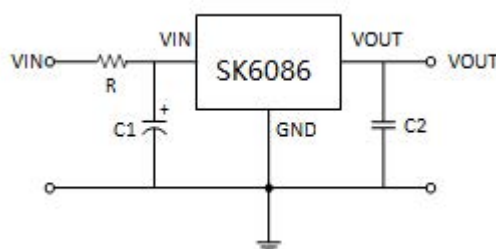
When short-circuit occurs, SK6086 will fold back the short-circuit currents to a pre-determined lower level, This will reduce excessive heat in otherwise large current conditions. This feature provides another level of protection to IC itself and also the whole system.

### EN Functions

EN is Hi-Z internally. EN must be connected to either to Vcc (through a resistor) or GND externally, if SOT23-5 package is used. If left floating, the Vout is unknown.

## IN-RUSH CURRENT AND VOLTAGE

The following figure shows a typical application circuit for the SK6086 devices. Please keep in mind that in-rush current can push up the Vin overshoot by as much as 50%. For example, when  $V_{in}=50\text{V}$ , the in-rush caused spike voltage can be as high as 75V. Therefore the voltage rating of  $C_{in}$  needs to be higher than 50% of the application.

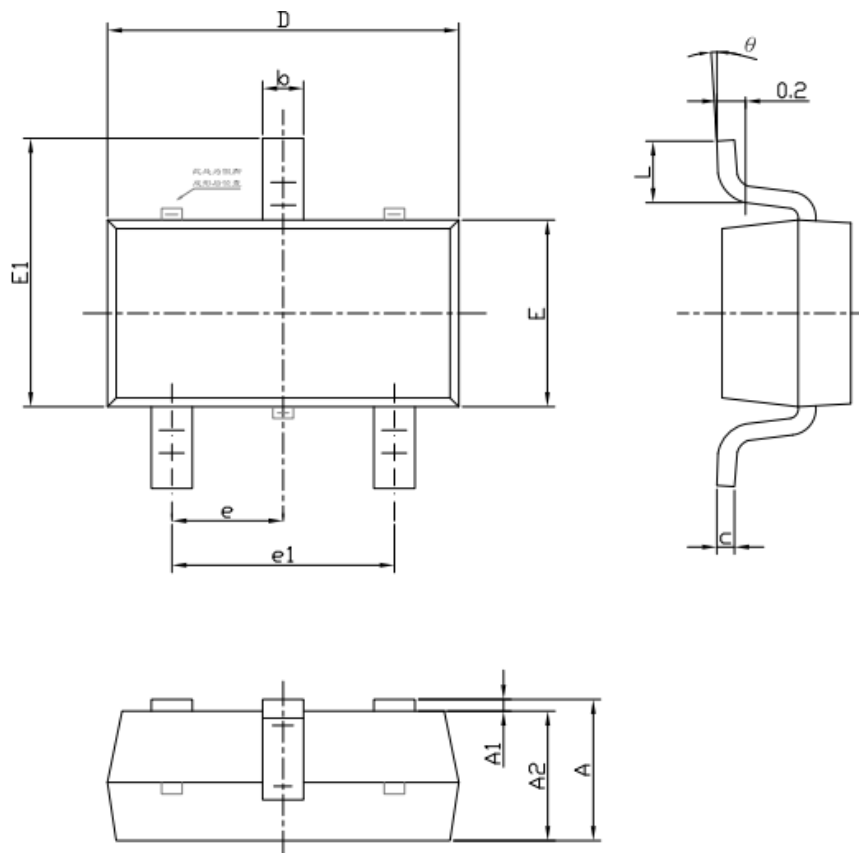


In live insertion application, it is suggested that R, C1 are selected as following:

1.  $C1=10\mu\text{F} \sim 100\mu\text{F}$  ceramic or electrolytic capacitor with maximum voltage greater than 80V,  $R=0$
2. If the average current is known, for example at 10mA, then for an input voltage of 55V, the  $C1=1\mu\text{F} \sim 10\mu\text{F}$  ceramic or electrolytic with maximum voltage greater than 80V and  $R=2\text{K}\Omega$  in the type of 1206 at 1/4W rating can be selected.

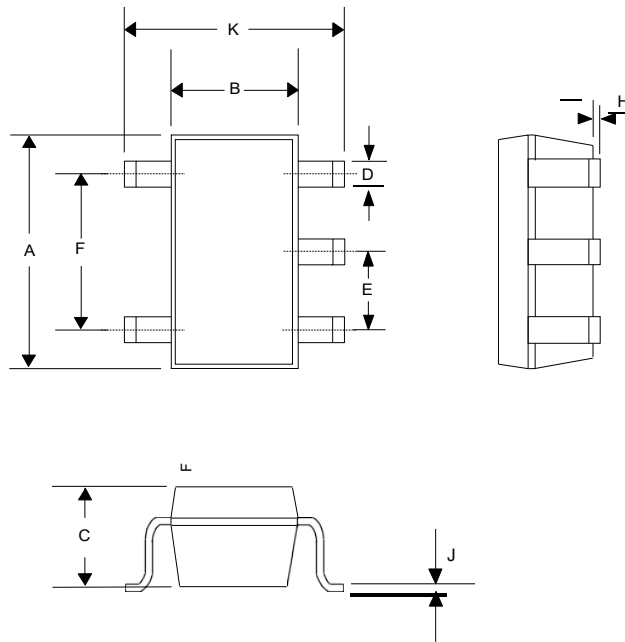


## Outline Drawing: SOT23-3



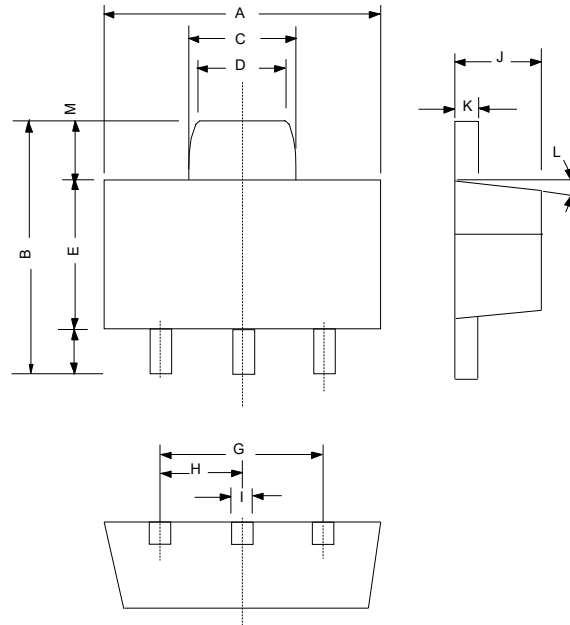
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)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

### Outline Drawing: SOT23-5



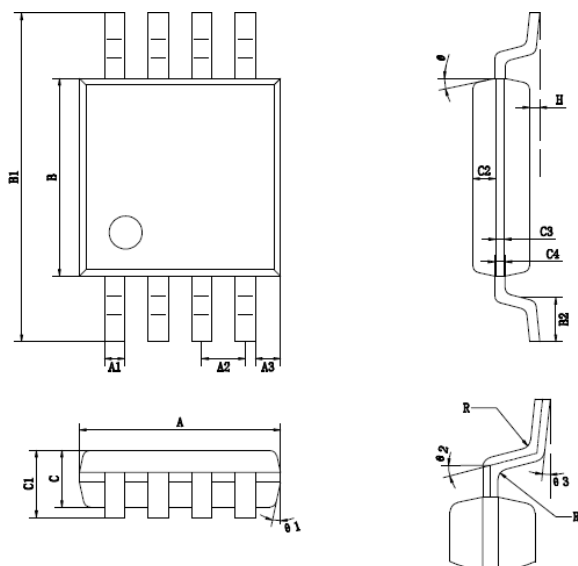
DIMENSIONS				
DIM <sup>N</sup>	INCHES		MM	
	MIN	MAX	MIN	MAX
A	0.110	0.120	2.80	3.05
B	0.059	0.070	1.50	1.75
C	0.036	0.051	0.90	1.30
D	0.014	0.020	0.35	0.50
E	-	0.037	-	0.95
F	-	0.075	-	1.90
H	-	0.006	-	0.15
J	0.0035	0.008	0.090	0.20
K	0.102	0.118	2.60	3.00

### Outline Drawing: SOT-89



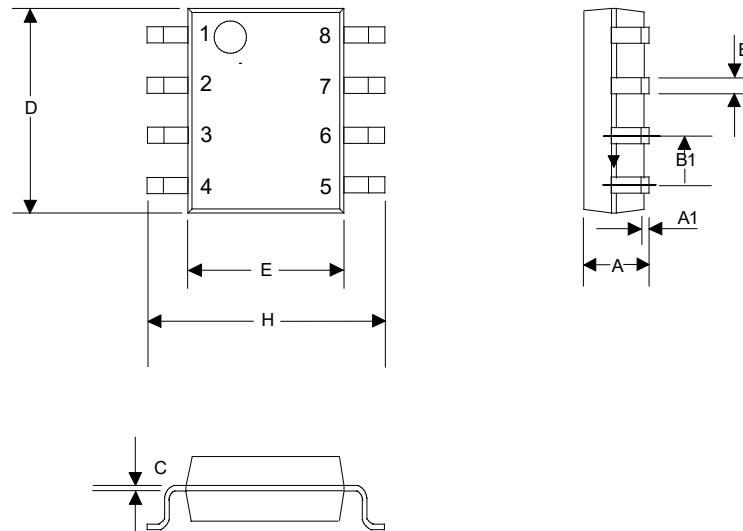
DIMENSIONS				
DIM <sup>N</sup>	INCHES		MM	
	MIN	MAX	MIN	MAX
A	0.173	0.181	4.400	4.600
B	0.159	0.167	4.050	4.250
C	0.067	0.075	1.700	1.900
D	0.051	0.059	1.300	1.500
E	0.094	0.102	2.400	2.600
F	0.035	0.047	0.890	1.200
G	0.118REF		3.00 REF	
H	0.059REF		1.50 REF	
I	0.016	0.020	0.400	0.520
J	0.055	0.063	1.400	1.600
K	0.014	0.016	0.350	0.410
L	10 °TYP		10 °TYP	
M	0.028REF		0.70 REF	

## Outline Drawing: EMSOP8



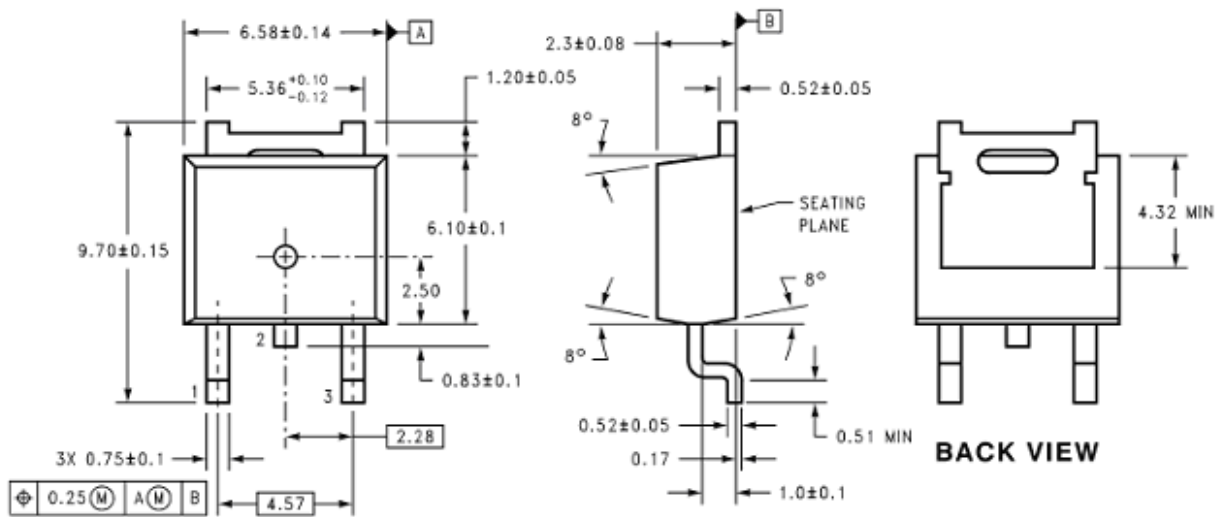
	Min (mm)	Max (mm)		Min (mm)	Max (mm)
A	2.90	3.10	C3	0.152	
A1	0.30TYP		C4	0.172	
A2	0.65TYP		H	0.02	0.15
A3	0.375TYP		θ	12° TYP4	
B	2.9	3.1	θ1	12° TYP4	
B1	4.70	5.1	θ2	14° TYP4	
B2	0.50	0.7	θ3	0°~6°	
C	0.70	0.96	R1	0.15TYP	
C1	--	1.10	R2	0.15TYP	
C2	0.37				

## Outline Drawing: SOP8



DIMENSIONS				
DIM <sup>N</sup>	INCHES		MM	
	MIN	MAX	MIN	MAX
A	0.0532	0.0688	1.35	1.75
A1	0.0040	0.0098	0.10	0.25
B	0.0130	0.0200	0.33	0.51
B1	0.050 BSC		1.27 BSC	
C	0.0075	0.0098	0.19	0.25
D	0.1890	0.1968	4.80	5.00
H	0.2284	0.2440	5.80	6.20
E	0.1497	0.1574	3.80	4.00

## Outline Drawing: TO252



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**3-Lead TO-252 Package**

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