

60V Low Current Consumption 150mA CMOS Voltage Regulator

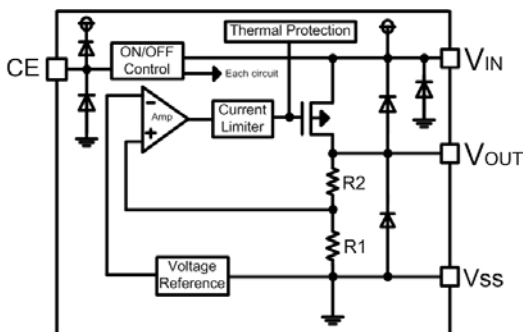
■ INTRODUCTION

The SML601 series are a group of positive voltage regulators manufactured by CMOS technologies with low power consumption and low dropout voltage, which provide large output currents even when the difference of the input-output voltage is small. The SML601 series can deliver 150mA output current and allow an input voltage as high as 60V. The series are very suitable for the battery-powered equipments, such as RF applications and other systems requiring a quiet voltage source.

■ APPLICATIONS

- Cordless Phones
- Radio control systems
- Laptop, Palmtops and PDAs
- Single-lens reflex DSC
- PC peripherals with memory

■ BLOCK DIAGRAM



■ FEATURES

- Low Quiescent Current: 3 μ A
- Operating Voltage Range: 2.5V ~ 60V
- Output Current: 150mA
- Low Dropout Voltage:
500mV @ 50mA ($V_{OUT} = 3.3V$)
- Output Voltage: 1.2V ~ 12.0V
- High Accuracy: $\pm 2\%$ / $\pm 1\%$ (Typ.)
- High Power Supply Rejection Ratio:
80dB @ 1kHz
- Low Output Noise:
 $27 \times V_{OUT} \mu V_{RMS}(10Hz \sim 100kHz)$
- Excellent Line and Load Transient Response
- Built-in Current Limiter, Short-Circuit Protection
- Over-Temperature Protection

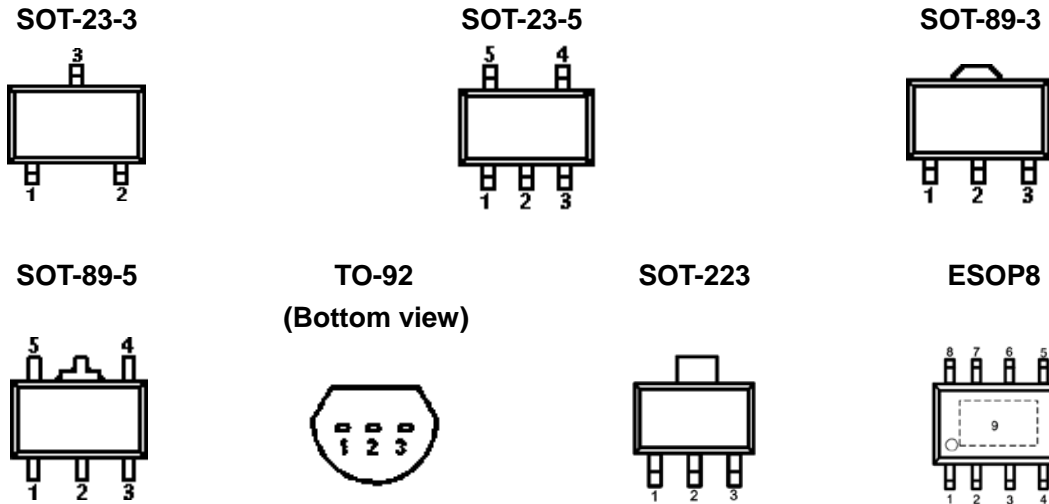
- Wireless Communication Equipments
- Portable Audio Video Equipments
- Car Navigation Systems
- LAN Cards
- Ultra Low Power Microcontroller

■ ORDER INFORMATION

SML601①②③④⑤⑥

DESIGNATOR	SYMBOL	DESCRIPTION
①	A	Standard
	B	With Shutdown Function
②③④	Integer	Output Voltage e.g.3.3V = ②: Default, ③: 3, ④: 3 e.g.12.0V = ②: 1, ③: 2, ④: 0
⑤	M/MC/MY	Package: SOT-23-3/5
	P/PT/PL	Package: SOT-89-3/5
	T/TA/TB	Package: TO-92
	G	Package: SOT-223
	ES	Package: ESOP8
⑥	-	2% Accuracy
	1	1% Accuracy

■ PIN CONFIGURATION(Top view)



SML601AXX

PIN NUMBER										PIN NAME	FUNCTION
SOT-23-3			SOT-89-3			TO-92			SOT-223		
M	MC	MY	P	PT	PL	T	TA	TB	G		
1	3	3	1	2	2	1	2	2	1	V _{SS}	Ground
2	2	1	3	1	3	3	3	1	3	V _{OUT}	Output
3	1	2	2	3	1	2	1	3	2	V _{IN}	Power input

SML601BXXM (SOT-23-5)

PIN NUMBER	SYMBOL	FUNCTION
1	V _{IN}	Power Input Pin
2	V _{SS}	Ground
3	CE	Chip Enable Pin
4	NC	No Connection
5	V _{OUT}	Output Pin

SML601BXXP (SOT-89-5)

PIN NUMBER	SYMBOL	FUNCTION
1	V _{OUT}	Output Pin
2	V _{SS}	Ground
3	NC	No Connection
4	CE	Chip Enable Pin
5	V _{IN}	Power Input Pin

SML601BXXES (ESOP8)

PIN NUMBER	SYMBOL	FUNCTION
1	V _{OUT}	Output Pin
2, 3, 5, 6, 7, 9	V _{SS}	Ground
4	CE	Chip Enable Pin
8	V _{IN}	Power Input Pin

■ ABSOLUTE MAXIMUM RATINGS⁽¹⁾

(Unless otherwise specified, $T_A = 25^\circ\text{C}$)

PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage ⁽²⁾	V_{IN}	-0.3 ~ 65	V
Output Voltage ⁽²⁾	V_{OUT}	-0.3 ~ 15	V
CE Pin Voltage ⁽²⁾	V_{CE}	-0.3 ~ $V_{IN} + 0.3$	V
Output Current	I_{OUT}	400	mA
Power Dissipation	SOT-23-3/5	400	mW
	TO-92	500	mW
	SOT-89-3/5	600	mW
	SOT-223	800	mW
	ESOP8	1500	mW
Operating free air temperature range	T_A	-40 ~ +85	$^\circ\text{C}$
Operating Junction Temperature Range	T_j	-40 ~ +150	$^\circ\text{C}$
Storage Temperature	T_{stg}	-55 ~ +150	$^\circ\text{C}$
Lead Temperature(Soldering, 10sec)	T_{solder}	260	$^\circ\text{C}$
ESD ⁽³⁾ rating: Human Body Model	HBM	≥ 2	kV
ESD ⁽³⁾ rating: Machine Model	MM	≥ 200	V

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltages are with respect to network ground terminal.

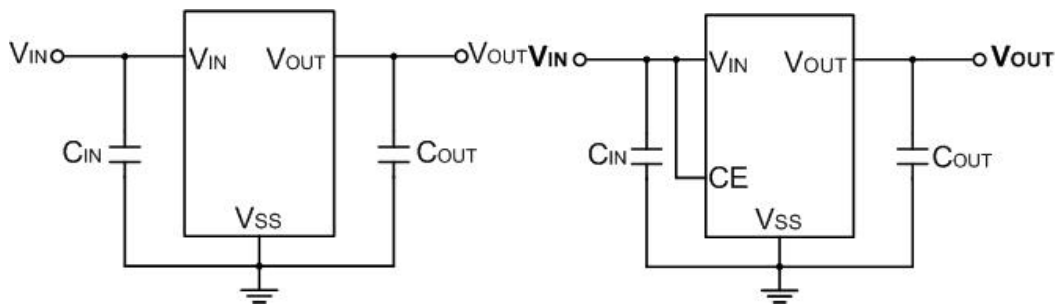
(3) ESD testing is performed according to the respective JEDEC standard. The human body model is a 100pF capacitor discharged through a 1.5k Ω resistor into each pin. The machine model is a 200pF capacitor discharged directly into each pin.

■ ELECTRICAL CHARACTERISTICS

SML601 Series ($V_{CE} = V_{IN} = V_{OUT} + 2V$, $C_{IN} = C_{OUT} = 1\mu F$, $T_A = 25^\circ C$, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Input Voltage	V_{IN}		2.5	—	60	V	
Output Voltage Range	V_{OUT}		1.2	—	12	V	
DC Output Accuracy		$I_{OUT} = 1mA$	-2	—	2	%	
			-1	—	1	%	
Dropout Voltage	V_{dif}	$I_{OUT} = 50mA$, $V_{OUT} = 3.3V$	—	500	—	mV	
Supply Current	I_{SS}	$I_{OUT} = 0A$	$V_{OUT} \leq 5.0V$	—	3	6	μA
			$V_{OUT} > 5.0V$		5	10	μA
Standby Current	I_{STBY}	$CE = V_{SS}$		0.1	0.5	μA	
Line Regulation	$\frac{\Delta V_{OUT}}{V_{OUT} \times \Delta V_{IN}}$	$I_{OUT} = 10mA$, $V_{OUT} + 1V \leq V_{IN} \leq 18V$	—	0.01	0.3	%/V	
Load Regulation	ΔV_{OUT}	$V_{IN} = V_{OUT} + 1V$, $1mA \leq I_{OUT} \leq 100mA$	—	10	—	mV	
Temperature Coefficient	$\frac{\Delta V_{OUT}}{V_{OUT} \times \Delta T_A}$	$I_{OUT} = 10mA$, $-40^\circ C < T_A < 125^\circ C$		50		ppm	
Output Current Limit	I_{LIM}	$V_{OUT} = 0.5 \times V_{OUT(Normal)}$, $V_{IN} = 5V$	150	250		mA	
Short Current	I_{SHORT}	$V_{OUT} = V_{SS}$	—	20	—	mA	
Power Supply Rejection Ratio	PSRR	$I_{OUT} = 50mA$	100Hz		75		dB
			1kHz	—	80	—	
			10kHz	—	60	—	
			100kHz	—	45	—	
Output Noise Voltage	V_{ON}	BW = 10Hz to 100kHz	—	$27 \times V_{OUT}$	—	μV_{RMS}	
Thermal Shutdown Temperature	T_{SD}	—	—	170	—	$^\circ C$	
Thermal Shutdown Hysteresis	ΔT_{SD}	—	—	20	—	$^\circ C$	
CE "High" Voltage	$V_{CE"H"}$		1.5		V_{IN}	V	
CE "Low" Voltage	$V_{CE"L"}$				0.3	V	

■ TYPICAL APPLICATION CIRCUIT



External Components List

Symbol	Description
C_{IN}	1.0 μ F or more
C_{OUT}	1.0 μ F or more, 10 μ F is recommended

■ APPLICATION INFORMATION

Selection of Input/ Output Capacitors

Phase compensation is provided to secure operation even when the load current is varied. For this purpose, use a 1.0 μ F or more output capacitor (C_{OUT}) with good frequency characteristics and proper ESR (Equivalent Series Resistance). Connect a 1.0 μ F or more input capacitor (C_{IN}) between the V_{IN} pin and the V_{SS} pin as close as possible to the pins.

The value of the output overshoot or undershoot transient response varies depending on the value of the output capacitor.

When selecting the output capacitor, perform sufficient evaluation, including evaluation of temperature characteristics, on the actual device.

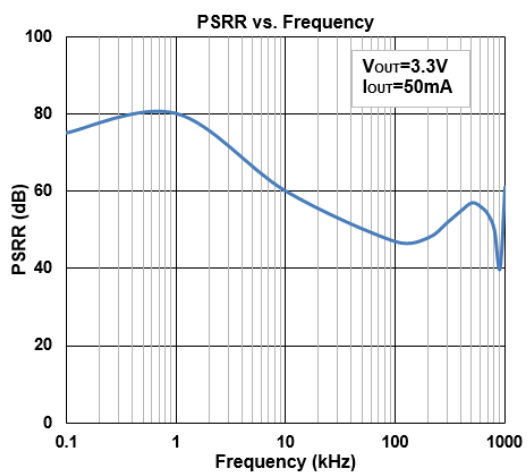
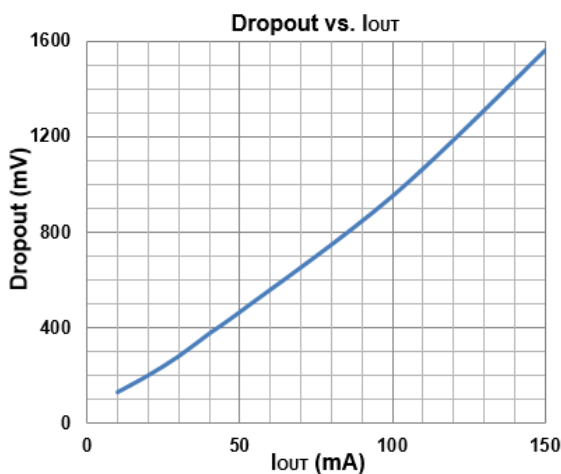
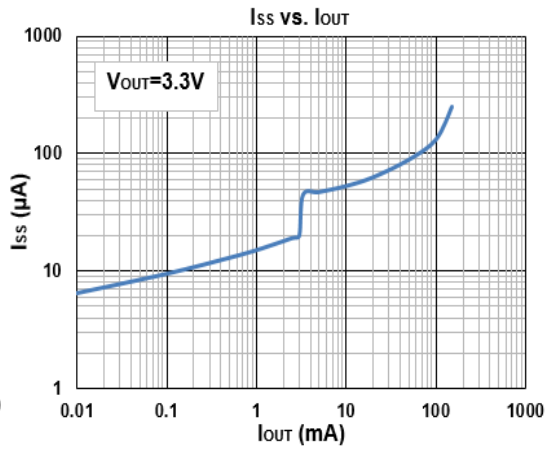
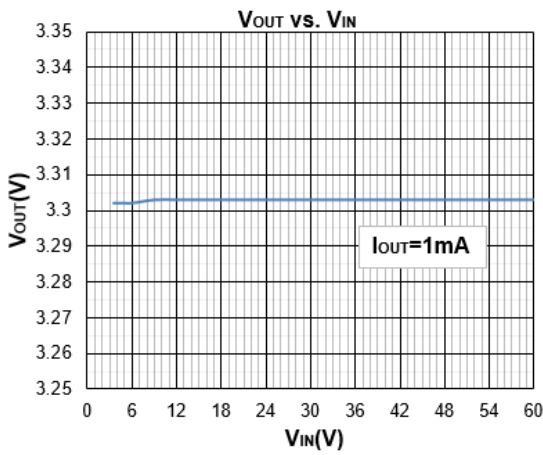
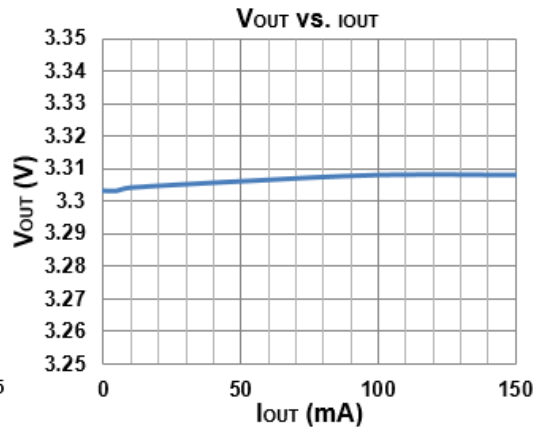
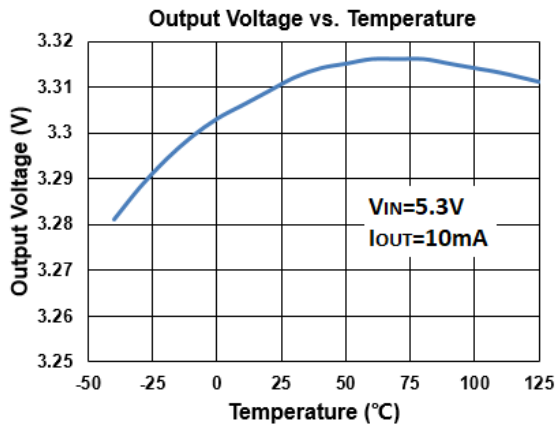
In the design of portable devices the ceramic capacitors are often chosen because of their small size, low equivalent series resistance (ESR) and high RMS current capability. Also, designers have been looking to ceramic capacitors due to shortages of tantalum capacitors.

Unfortunately, using ceramic capacitors for input filtering can cause problems. Applying a voltage step to a ceramic capacitor causes a large current surge that stores energy in the inductances of the power leads. A large voltage spike is created when the stored energy is transferred from these inductances into the ceramic capacitor. These voltage spikes can easily be twice the amplitude of the input voltage step.

Many types of capacitors can be used for input by passing, however, caution must be exercised when using multilayer ceramic capacitors (MLCC). Because of the self-resonant and high Q characteristics of some types of ceramic capacitors, high voltage transients can be generated under some start-up conditions, such as connecting the LDO input to a live power source. Adding a 3 Ω resistor in series with an X5R ceramic capacitor will minimize start-up voltage transients.

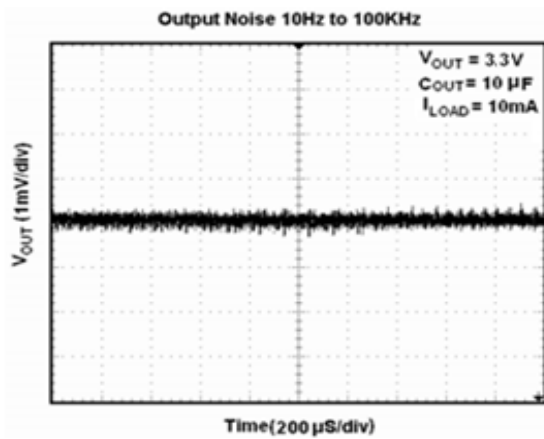
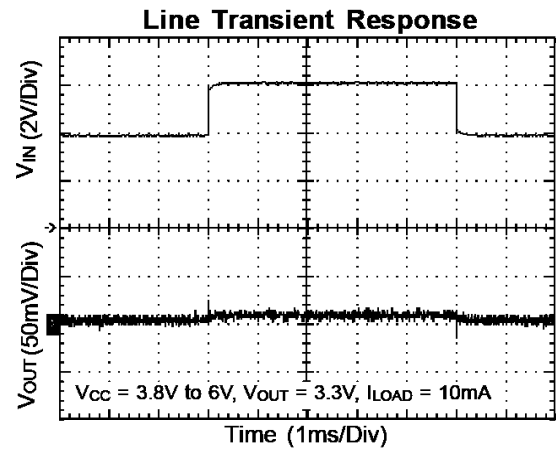
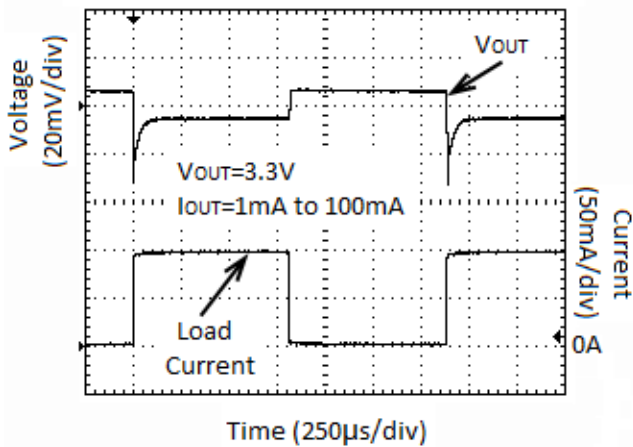
■ TYPICAL PERFORMANCE CHARACTERISTICS

($V_{CE} = V_{IN} = V_{OUT} + 2V$, $C_{IN} = 1\mu F$, $C_{OUT} = 10\mu F$, $T_A = 25^\circ C$, unless otherwise specified)



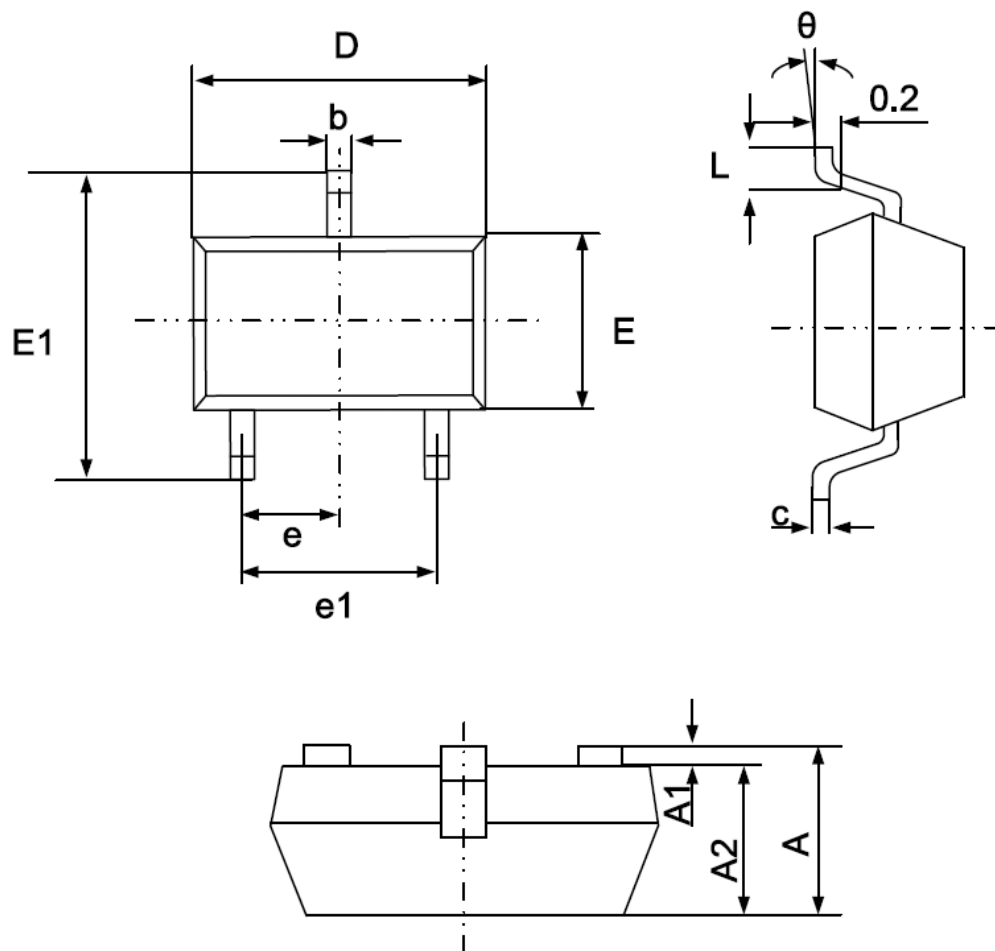
■ TYPICAL PERFORMANCE CHARACTERISTICS

($V_{CE} = V_{IN} = V_{OUT} + 2V$, $C_{IN} = 1\mu F$, $C_{OUT} = 10\mu F$, $T_A = 25^\circ C$, unless otherwise specified)



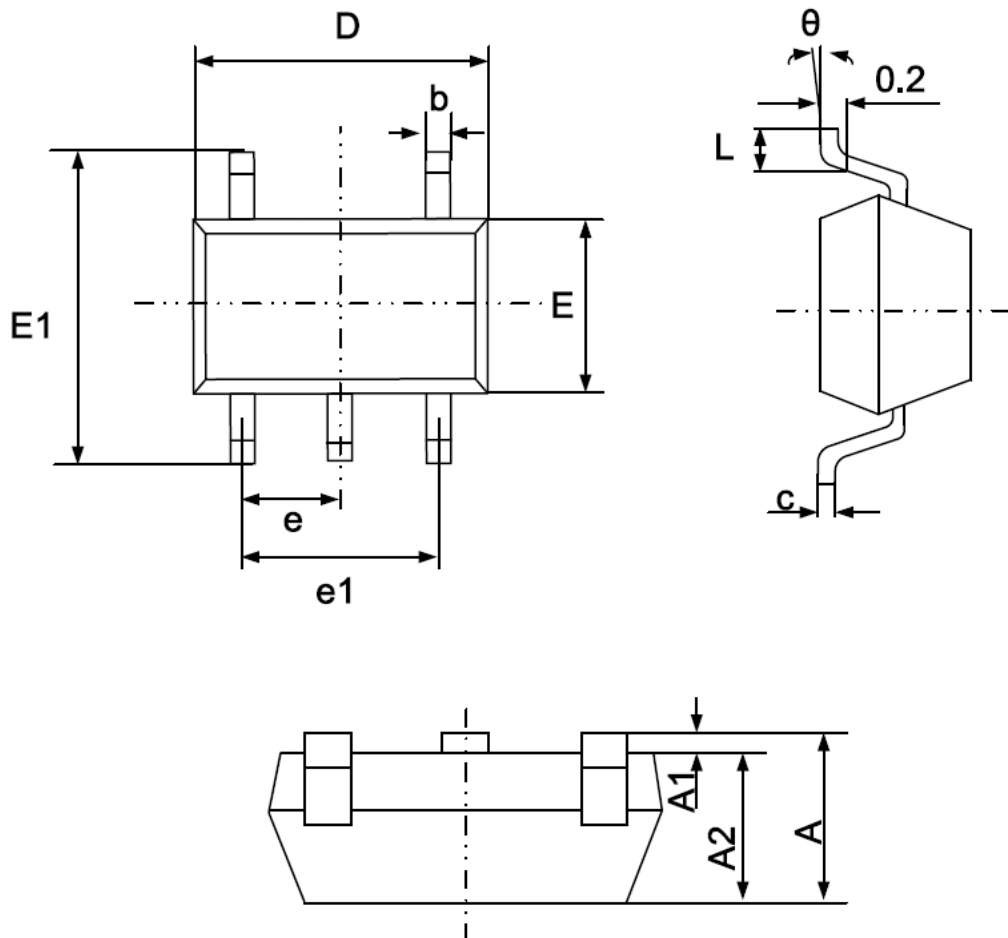
■ PACKAGING INFORMATION

● SOT-23-3 PACKAGE OUTLINE DIMENSIONS



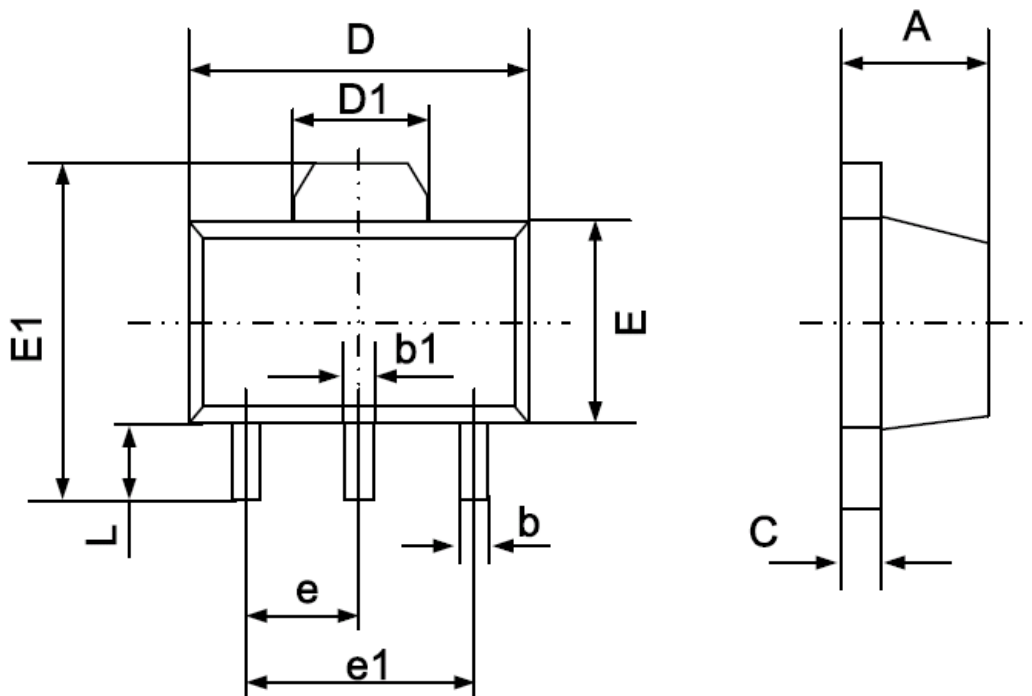
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		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°

• SOT-23-5 PACKAGE OUTLINE DIMENSIONS



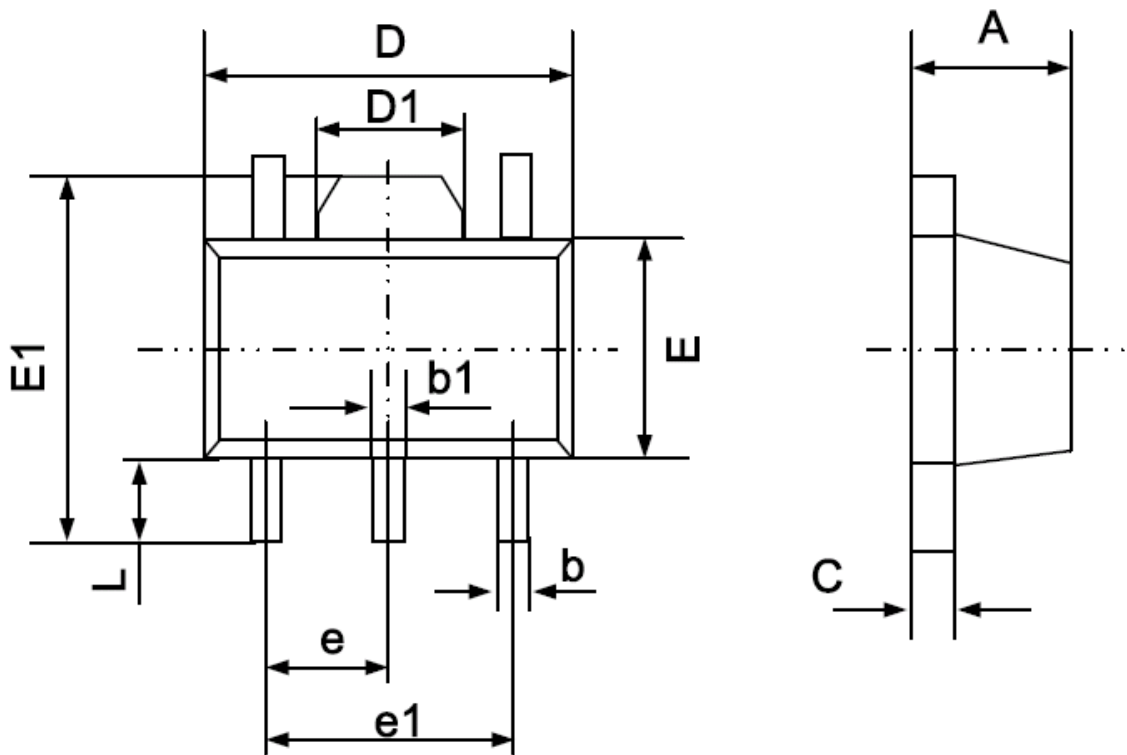
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		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°

• SOT-89-3 PACKAGE OUTLINE DIMENSIONS



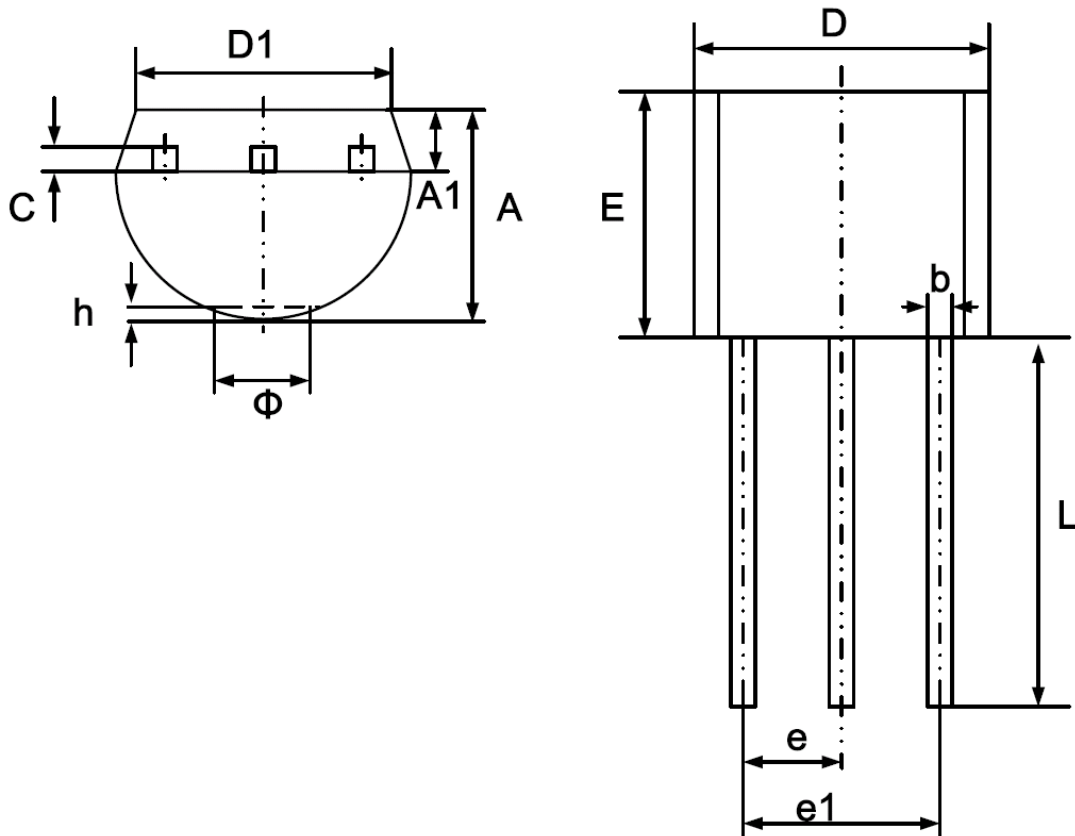
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF		0.061 REF	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060 TYP	
e1	3.000 TYP		0.118 TYP	
L	0.900	1.200	0.035	0.047

• SOT-89-5 PACKAGE OUTLINE DIMENSIONS



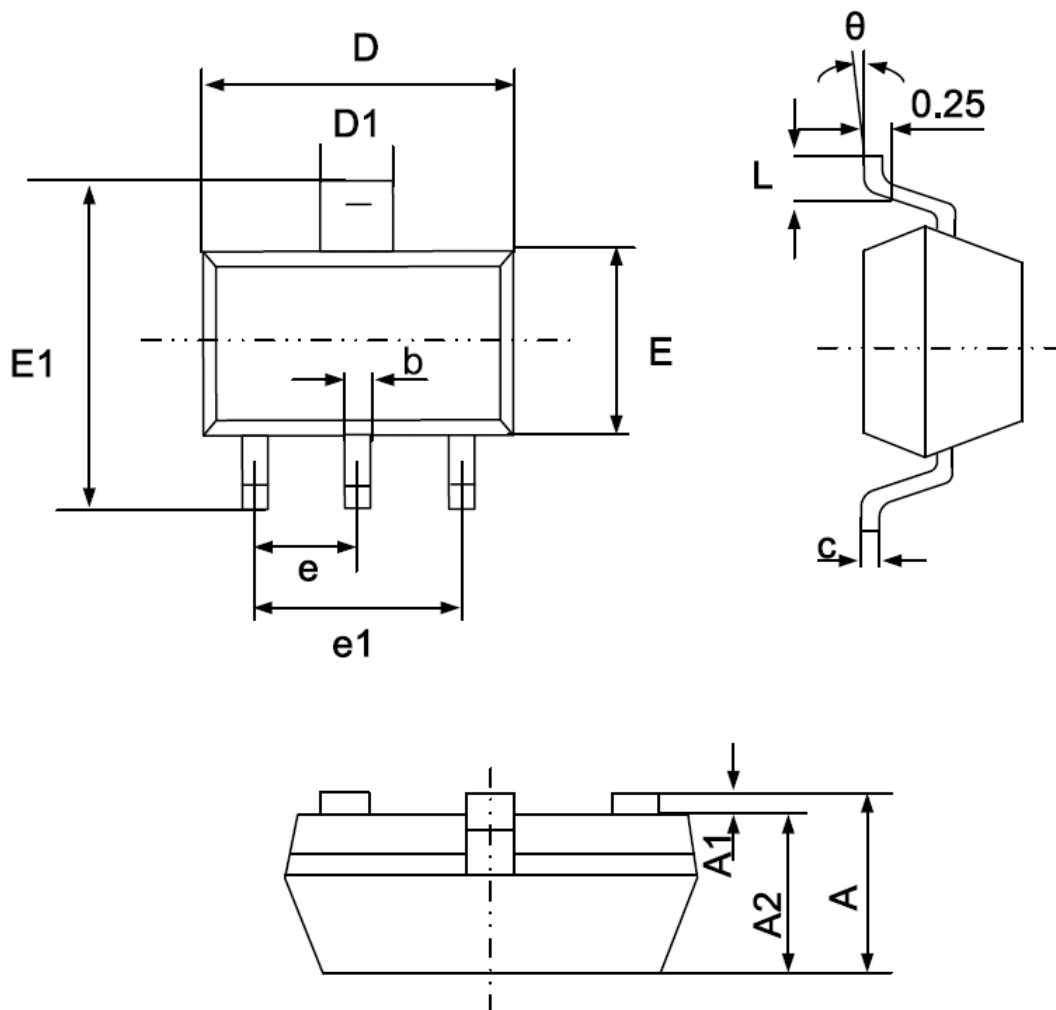
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.360	0.560	0.014	0.022
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.400	1.800	0.055	0.071
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060 TYP	
e1	2.900	3.100	0.114	0.122
L	0.900	1.100	0.035	0.043

• TO-92 PACKAGE OUTLINE DIMENSIONS



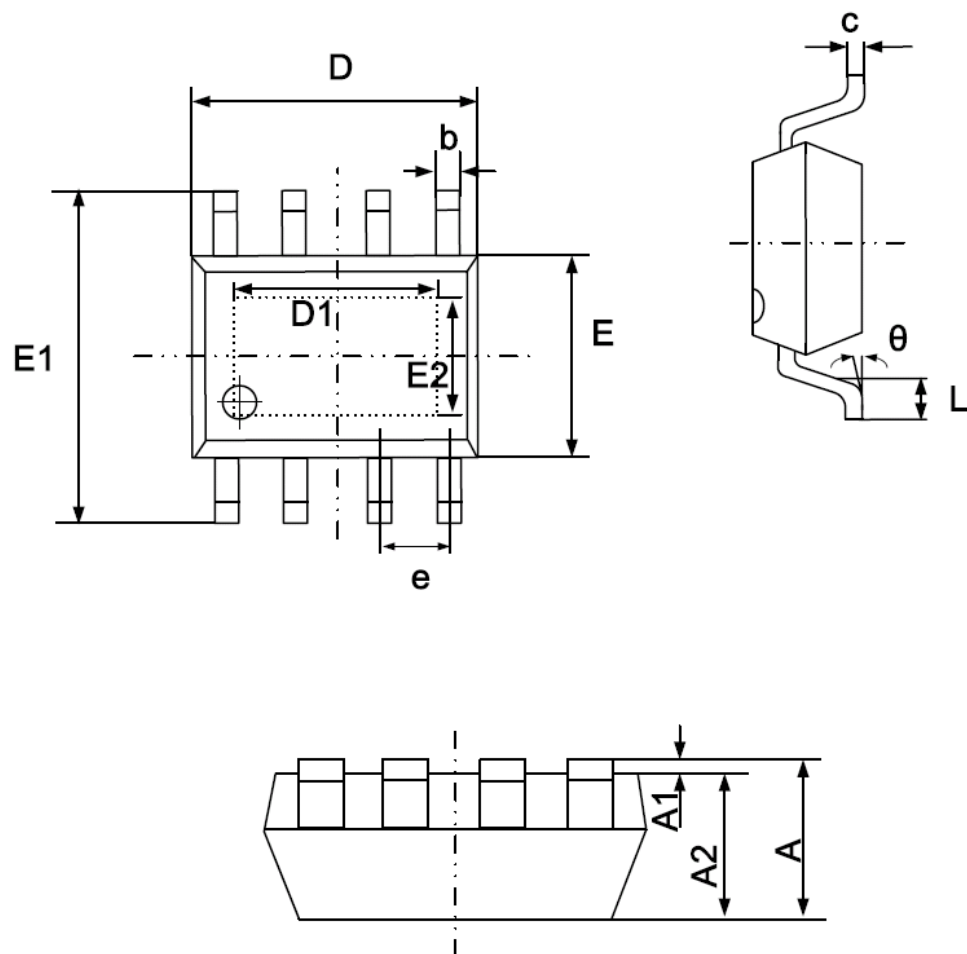
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	3.300	3.700	0.130	0.146
A1	1.100	1.400	0.043	0.055
b	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.400	4.700	0.173	0.185
D1	3.430		0.135	
E	4.300	4.700	0.169	0.185
e	1.270 TYP		0.050 TYP	
e1	2.440	2.640	0.096	0.104
L	14.100	14.500	0.555	0.571
Φ		1.600		0.063
h	0.000	0.380	0.000	0.015

• SOT-223 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.520	1.800	0.060	0.071
A1	0.000	0.100	0.000	0.004
A2	1.500	1.700	0.059	0.067
b	0.660	0.820	0.026	0.032
c	0.250	0.350	0.010	0.014
D	6.200	6.400	0.244	0.252
D1	2.900	3.100	0.114	0.122
E	3.300	3.700	0.130	0.146
E1	6.830	7.070	0.269	0.278
e	2.300 (BSC)		0.091 (BSC)	
e1	4.500	4.700	0.177	0.185
L	0.900	1.150	0.035	0.045
θ	0°	10°	0°	10°

- ESOP8 Package Outline Dimensions



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.100	3.500	0.122	0.137
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.200	2.600	0.086	0.102
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

© SMTES TECHNOLOGY PTE. LTD.

SMTES cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a SMTES product. No circuit patent license, copyrights or other intellectual property rights are implied. SMTES reserves the right to make changes to their products or specifications without notice. Customers are advised to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete.