Ultra Low Current Consumption 500mA CMOS Voltage Regulator

■ INTRODUCTION

The SML122 series are a group of positive voltage regulators manufactured by CMOS technologies with ultra low power consumption and low dropout voltage, which provide large output currents even when the difference of the input-output voltage is small. The SML122 series can deliver 500mA output current and allow an input voltage as high as 8V. The series are very suitable for the battery-powered equipments, such as RF applications and other systems requiring a quiet voltage source.

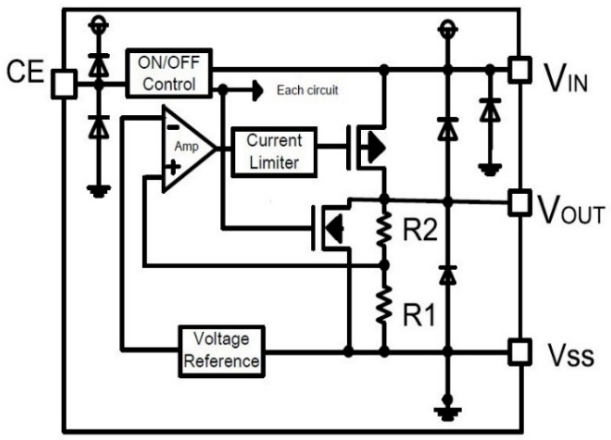
■ FEATURES

- Low Quiescent Current: 0.8μA
- Operating Voltage Range: 1.8V ~ 8V
- Output Current: 500mA
- Low Dropout Voltage:
  110mV @ 100mA (V_{OUT} = 3.3V)
- Output Voltage: 1.2 ~ 5.0V
- High Accuracy: ±2% / ±1% (Typ.)
- High Power Supply Rejection Ratio:
  50dB @ 1kHz
- Low Output Noise:
  27 x V_{OUT} μV_{RMS} (10Hz ~ 100kHz)
- Excellent Line and Load Transient Response
- Built-in Current Limiter, Short-Circuit Protection

■ APPLICATIONS

- Portable consumer equipments
- Radio control systems
- Laptop, Palmtops and PDAs
- Wireless Communication Equipments
- Portable Audio Video Equipments
- Ultra Low Power Microcontroller

■ BLOCK DIAGRAM



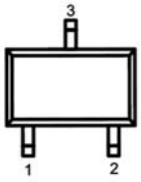
■ ORDER INFORMATION

SML122①②③④⑤⑥

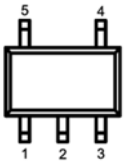
DESIGNATOR	SYMBOL	DESCRIPTION
①	-	A Version Number
②	A	Standard
	B	High Active, pull-down resistor built in, with C_{OUT} discharge resistor
③④	Integer	Output Voltage e.g.1.8V = ③: 1,④: 8
⑤	F	Package: DFN1X1-4
	M/MC/MY	Package: SOT-23-3
	M	Package: SOT-23-5
	P/PT/PL	Package: SOT-89-3 Package: SOT-89-5
	T/TA/TB	Package: TO-92
⑥	-	2% Accuracy
	1	1% Accuracy

■ PIN CONFIGURATION (Top View)

SOT-23-3

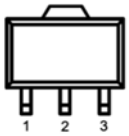


SOT-23-5

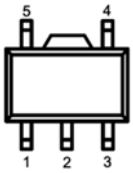


DFN1X1-4

SOT-89-3

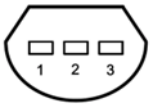


SOT-89-5



TO-92

(Bottom View)



SML122AXX

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

SML122BXXM（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

SML122BXXF（DFN1X1-4）

PIN NUMBER	SYMBOL	FUNCTION
F		
1	V_{OUT}	Output Pin
2	V_{SS}	Ground
3	CE	Chip Enable Pin
4	V_{IN}	Power Input Pin
EP	Thermal PAD	Ground

SML122BXXP（SOT-89-5）

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

■ ABSOLUTE MAXIMUM RATINGS(1)

(Unless otherwise specified, T_A = 25°C)

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage(2)		V_{IN}	-0.3 ~ 10	V
Output Voltage(2)		V_{OUT}	-0.3 ~ V_{IN} + 0.3	V
Output Current		I_{OUT}	600	mA
Power Dissipation	SOT-23-3/5	P_D	400	mW
	DFN1X1-4		400	mW
	TO-92		500	mW
	SOT-89-3/5		600	mW
Operating free air temperature range		T_A	-40 ~ +85	°C
Operating Junction Temperature Range		T_j	-40 ~ +150	°C
Storage Temperature		T_{stg}	-55 ~ +150	°C
Lead Temperature(Soldering, 10sec)		T_{solder}	260	°C
ESD rating: Human Body Model		HBM	≥ 2	kV
ESD rating: Machine Model		MM	≥ 200	V

Note:

(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 my affect device reliability.

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

■ ELECTRICAL CHARACTERISTICS

SML122 Series(V_{IN} = V_{OUT} + 1V, C_{IN} = C_{OUT} = 1μF, T_A = 25℃, unless otherwise specified)

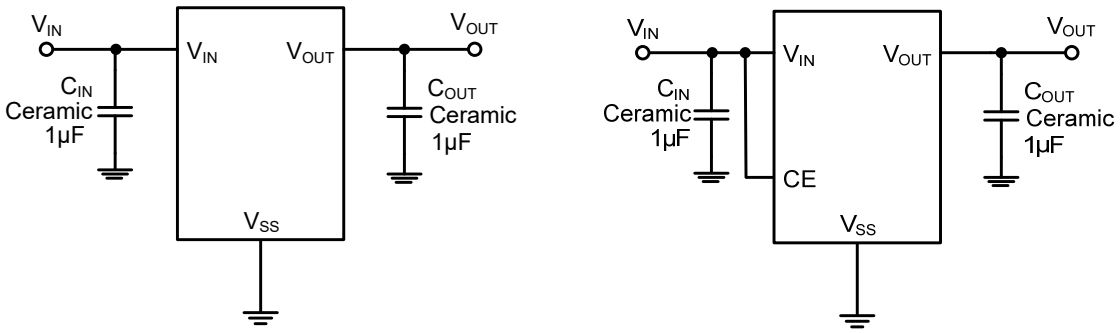
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP(3)	MAX	UNITS
Input Voltage	V_{IN}			1.8	—	8	V
Output Voltage Range	V_{OUT}			1.2	—	5	V
DC Output Accuracy		I_{OUT} = 1mA		-2	—	2	%
				-1	—	1	%
Dropout Voltage	V_{dif}(4)	I_{OUT} = 100mA, V_{OUT} = 3.3V		—	110	—	mV
Supply Current	I_{SS}	I_{OUT}= 0	1.2V ≤ V_{OUT} ≤ 3.3V	—	0.8	1.3	μA
			3.3V < V_{OUT} ≤ 5.0V		1.0	1.5	μA
Standby Current	I_{STBY}	CE = V_{SS}				0.2	μA
Line Regulation	$\frac{\Delta V_{OUT}}{V_{OUT} \times \Delta V_{IN}}$	I_{OUT} = 10mA V_{OUT} + 1V ≤ V_{IN} ≤ 8V		—	0.05	0.3	%/V
Load Regulation	ΔV_{OUT}	V_{IN} = V_{OUT} + 1V, 1mA ≤ I_{OUT} ≤ 100mA		—	10	—	mV
Temperature Coefficient	$\frac{\Delta V_{OUT}}{V_{OUT} \times \Delta T_A}$	I_{OUT} = 10mA, -40°C < T_A < 125°C			100		ppm
Output Current Limit	I_{LIM}	V_{OUT} = 0.5 x $V_{OUT(Normal)}$, V_{IN} = 5V		550	700	850	mA
Short Current	I_{SHORT}	V_{OUT} = V_{SS}		—	20	—	mA
Power Supply Rejection Ratio	PSRR	I_{OUT} = 50mA	100Hz		70		dB
			1kHz	—	50	—	
			10kHz	—	40	—	
			100kHz	—	35	—	
Output Noise Voltage	V_{ON}	BW = 10Hz to 100kHz		—	27xV_{OUT}	—	μV_{RMS}
CE "High" Voltage	V_{CE}"H"			1.5		V_{IN}	V
CE "Low" Voltage	V_{CE}"L"					0.3	V
C_{OUT} Auto-Discharge Resistance	$R_{DISCHRG}$	V_{IN} = 5V, V_{OUT} = 3.0V, V_{CE} = V_{SS}			200		Ω

Note:

(3) Typical numbers are at 25°C and represent the most likely norm.

(4) V_{dif}: The Difference Of Output Voltage And Input Voltage When Input Voltage Is Decreased Gradually Till Output Voltage Equals To 98% Of V_{OUT}(E).

■ TYPICAL APPLICATION



■ APPLICATION INFORMATION

Selection of Input/ Output Capacitors

In general, all the capacitors need to be low leakage. Any leakage the capacitors have will reduce efficiency, increase the quiescent current.

A recent trend in the design of portable devices has been to use ceramic capacitors to filter DC-DC converter inputs. Ceramic capacitors are often chosen because of their small size, low equivalent series resistance (ESR) and high RMS current capability. Also, recently, 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 3Ω resistor in series with an X5R ceramic capacitor will minimize start-up voltage transients.

The LDO also requires an output capacitor for loop stability. Connect a 1μF tantalum capacitor from OUT to GND close to the pins. For improved transient response, this output capacitor may be ceramic.

C_{OUT} Auto-Discharge Function

SML122B series can discharge the electric charge in the output capacitor (C_{OUT}), when a low signal to the CE pin, which enables a whole IC circuit turn off, is inputted via the N-channel transistor located between the V_{OUT} pin and the V_{SS} pin (cf. BLOCK DIAGRAM). The C_{OUT} auto-discharge resistance value is set at 200Ω (V_{OUT} = 3.0V @ V_{IN} = 5.0V at typical). The discharge time of the output capacitor (C_{OUT}) is set by the C_{OUT} auto-discharge resistance (R) and the output capacitor (C_{OUT}). By setting time constant of a C_{OUT} auto-discharge resistance value [$R_{DISCHRG}$] and an output capacitor value (C_{OUT}) as τ ($\tau = C \times R_{DISCHRG}$), the output voltage after discharge via the N-channel transistor is calculated by the following formulas.

$V = V_{OUT(E)} \; X \; e^{-t/\tau}$, *or* $t = \tau / n \; (V / V_{OUT(E)})$

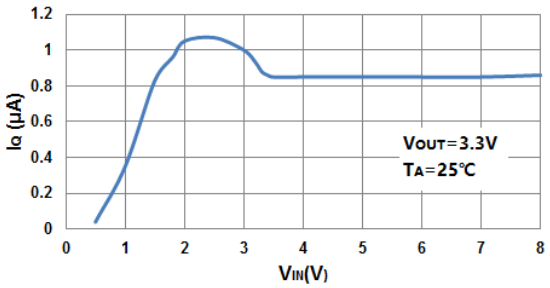
(V: Output voltage after discharge, $V_{OUT(E)}$: Output voltage, t: Discharge time,

τ: C_{OUT} auto-discharge resistance $R_{DISCHRG}$ × Output capacitor (C_{OUT}) value C)

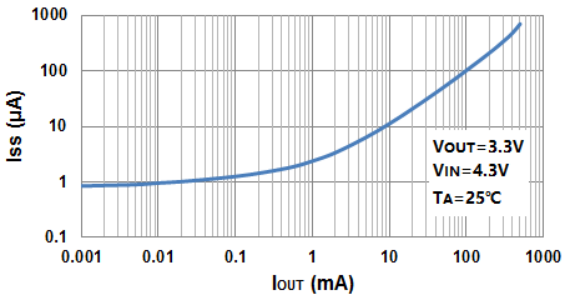
■ TYPICAL PERFORMANCE CHARACTERISTICS

(V_{IN} = V_{OUT} + 1V, C_{IN} = C_{OUT} = 1μF, T_A = 25℃, unless otherwise specified)

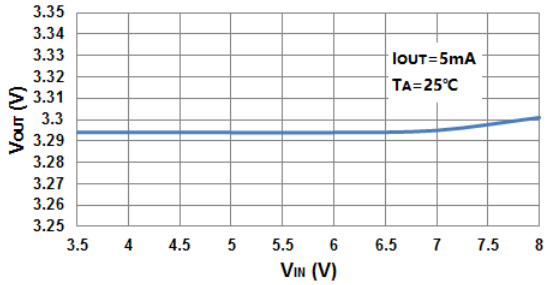
I_Q vs. V_{IN}



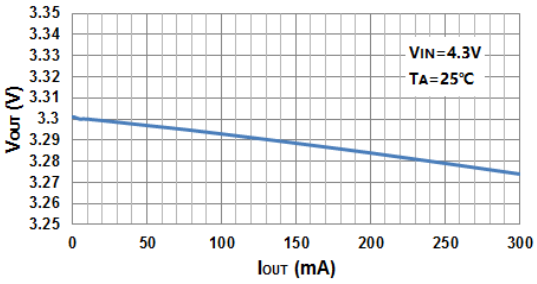
Iss vs. IOUT



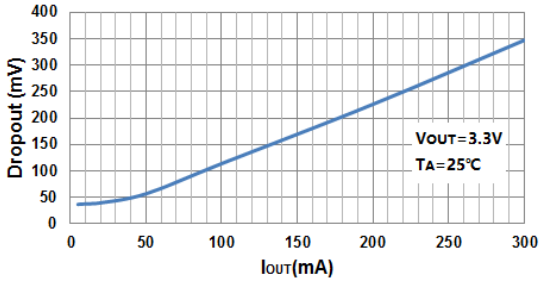
V_{OUT} vs. V_{IN}



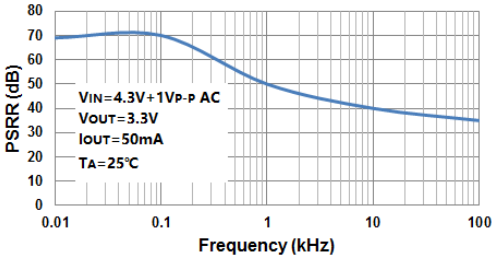
V_{OUT} vs. I_{OUT}

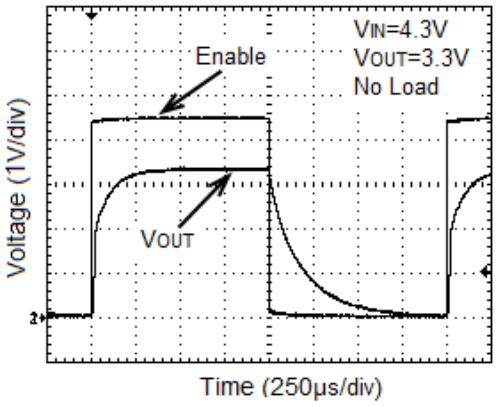


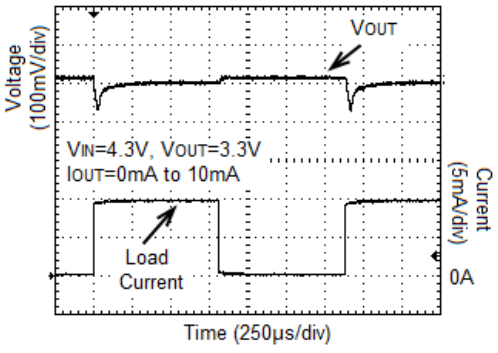
Dropout vs. IOUT



PSRR vs. Frequency

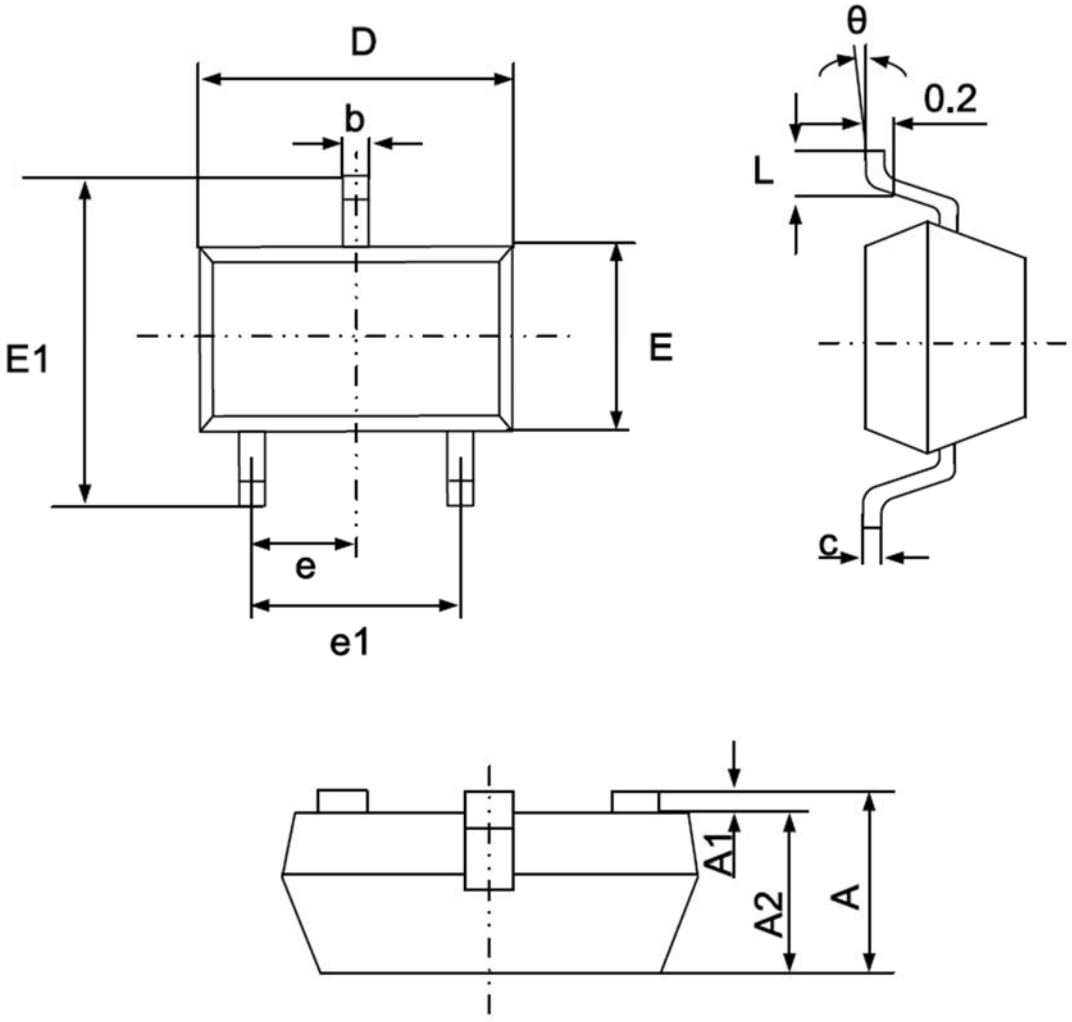






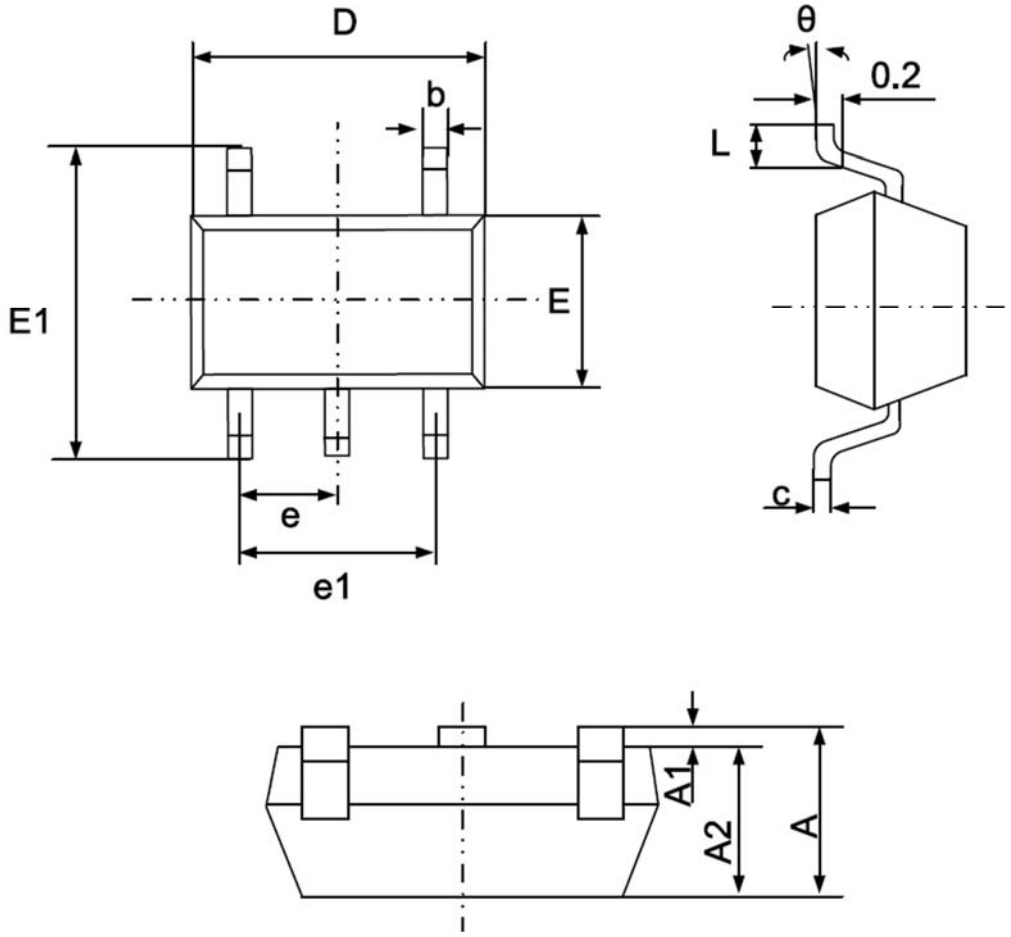
■ PACKAGING INFORMATION

● SOT-23-3 PACKAGE OUTLINE DIMENSIONS



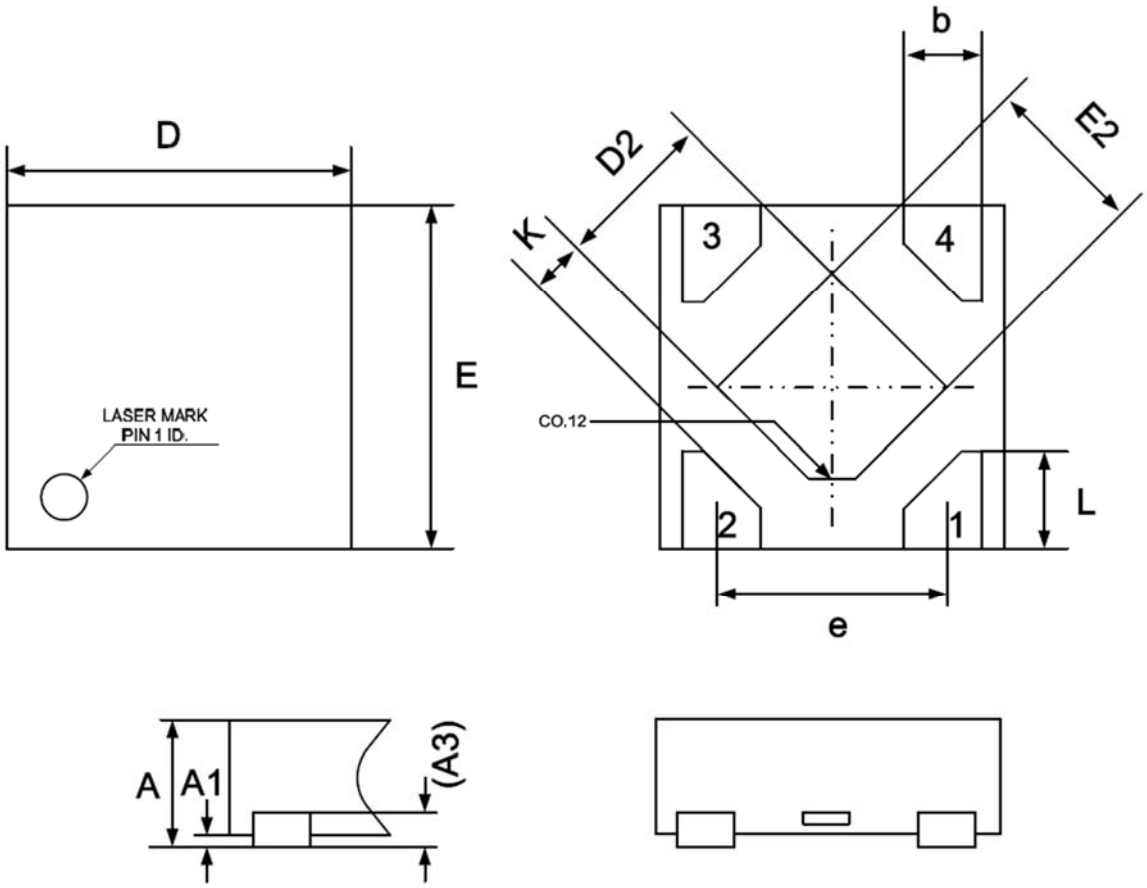
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)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



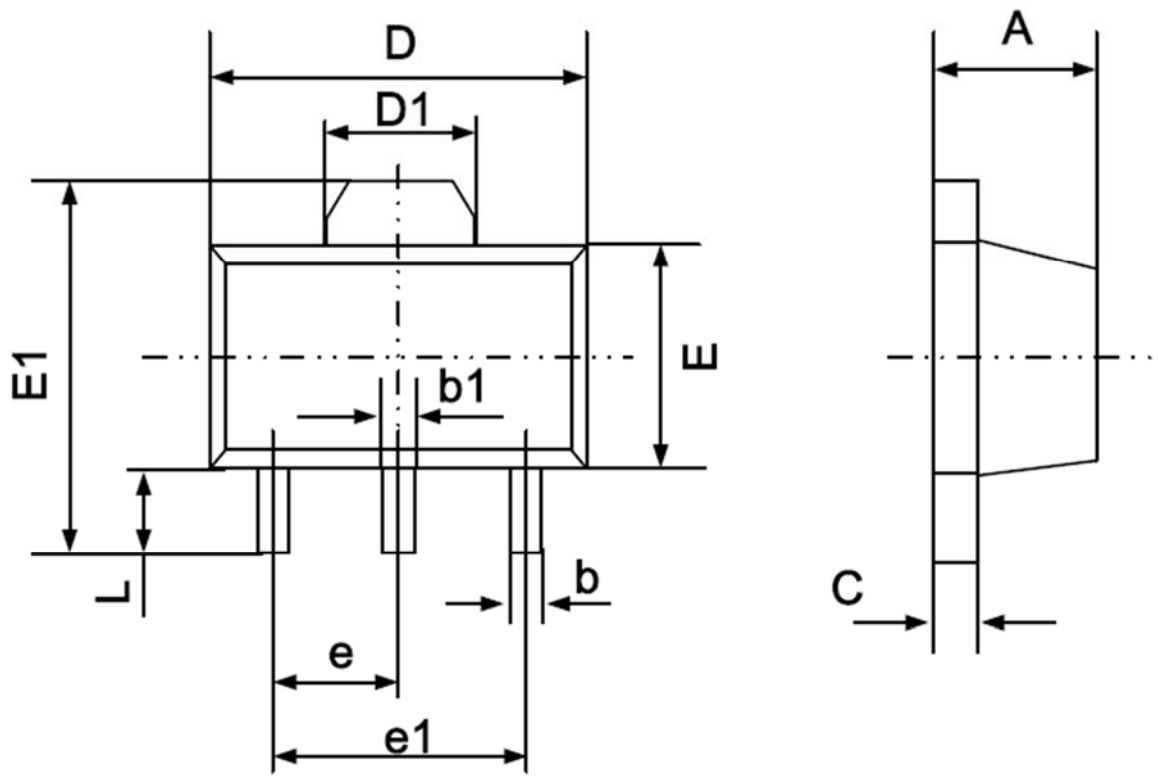
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)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

- **DFN1X1-4 PACKAGE OUTLINE DIMENSIONS**



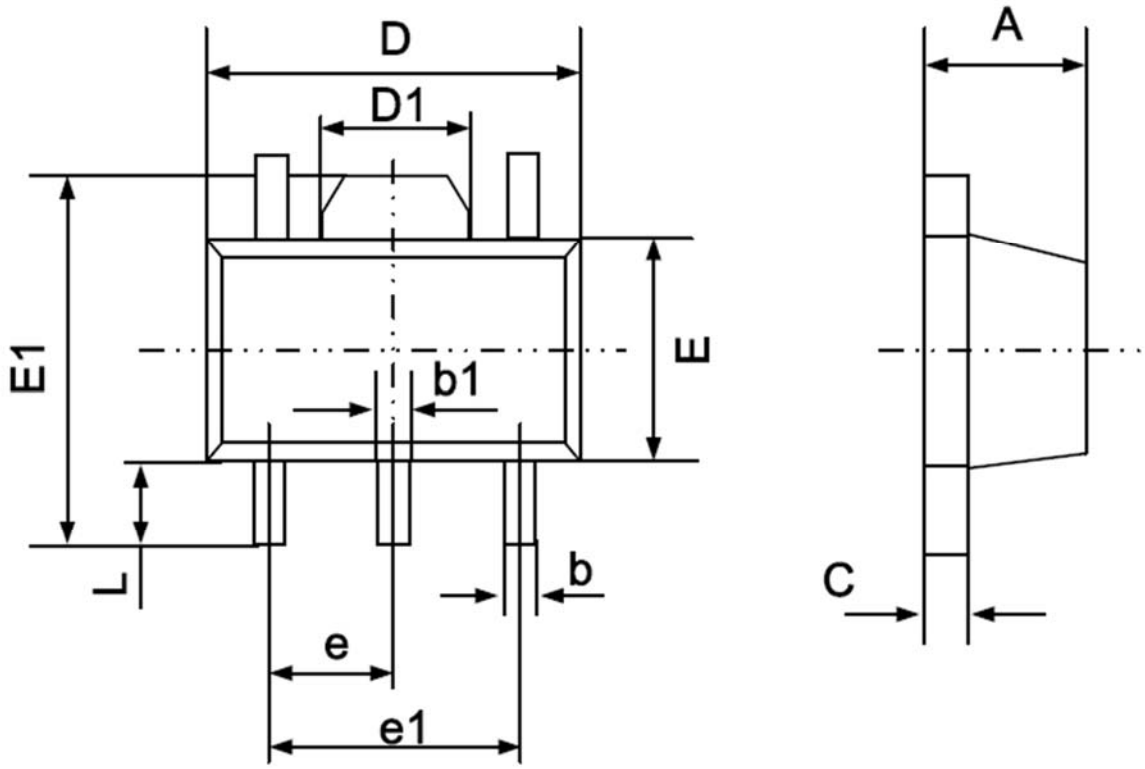
Symbol	Dimensions In Millimeters		
	Min.	Nom.	Max.
A	0.340	0.370	0.400
A1	0.000	0.020	0.050
A3		0.100REF	
b	0.170	0.220	0.270
D	0.950	1.000	1.050
E	0.950	1.000	1.050
D2	0.430	0.480	0.530
E2	0.430	0.480	0.530
L	0.200	0.250	0.300
e	-	0.650	-
K	0.150	-	-

- **SOT-89-3 PACKAGE OUTLINE DIMENSIONS**



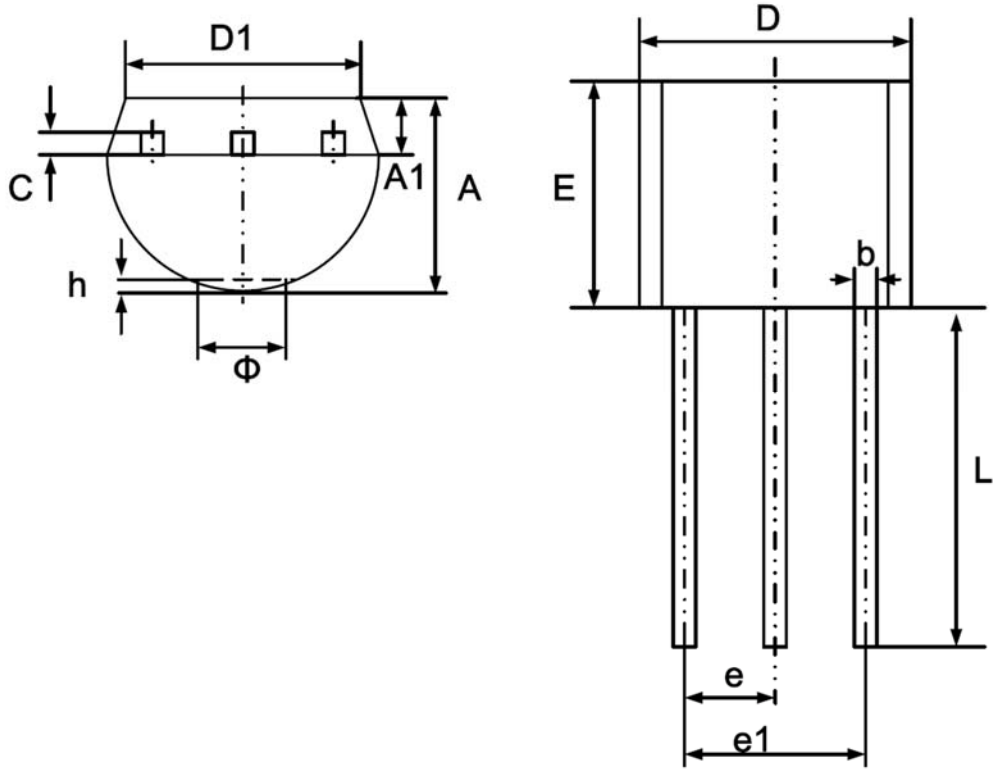
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF		0.061 REF	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060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