■ DESCRIPTION:

MD88XX series are high efficiency, low ripple PFM step-up DC-DC Converter. The converter can start up by supply voltage as low as 0.75V, and capable of delivering maximum 300mA output current at 5V output with 3V input voltage. Quiescent current drawn from power source is as low as 4uA. All of these features make MD88XX series be suitable for portable devices, which are supplied by a single battery to four-cell batteries.

MD88XX integrates output voltage feedback and compensation networks, startup circuits, oscillation circuits, PFM control circuits, stable reference circuits, overcurrent protection circuits and trimming technology, so it can afford high precision and low temperature-drift coefficient of the output voltage.

MD88XX is available in SOT-89-3, SOT-23-3, SOT-89-5 and SOT-23-5 packages, which is PB free. And in 5-pin packages, such as SOT-23-5, the device can be switch on or off easily by CE pin, to minimize the standby supply current.

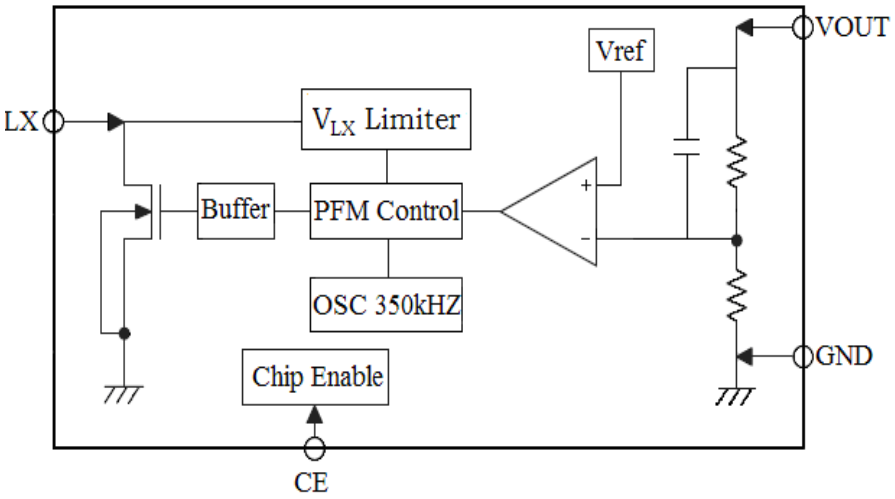
■ FEATURES:

- ✧ Low Start-up voltage (when Iout is 1mA): 0.75V
- ✧ Deliver 300mA at 5.0V Output voltage with 3.0V input Voltage
- ✧ Low quiescent current: 4uA(TYP)
- ✧ Low Shutdown current: 0.1uA
- ✧ High power conversion efficiency: 85%(TYP)
- ✧ Output voltage accuracy: ±2.5%

■ APPLICATIONS:

- ✧ Power Source for PDA, DSC, MP3 Player, Electronic toy and wireless mouse
- ✧ Power Source for a Single or Dual-cell Battery-Powered Equipments
- ✧ Power Source for LED

■ BLOCK DIAGRAM:

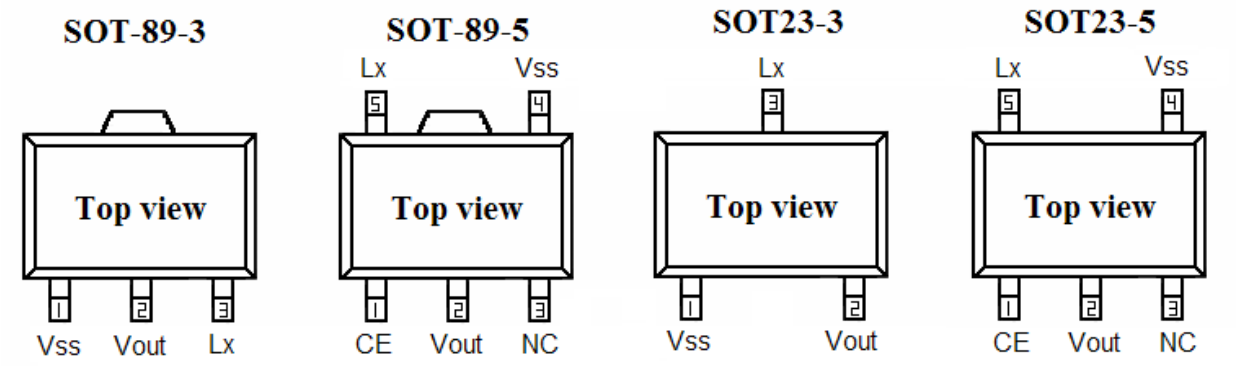


■ ORDERING INFORMATION (MD88XX)

Code	Output Voltage	Package Type	Marking
MD8818*	1.8V	SOT-89-3 SOT-89-5 SOT-23-3 SOT-23-5	MD88XX
MD8827*	2.7V		
MD8830	3.0V		
MD8833	3.3V		
MD8836	3.6V		
MD8850	5.0V		

Note: “XX” represents output voltage. “*” indicates out of stock, and reservation must be made in advance.

■PIN CONFIGURATION：



PIN DEFINATION

PIN Code				Symbol	Description
SOT-89-3	SOT-89-5	SOT-23-3	SOT-23-5		
1	4	1	4	Vss(GND)	Ground
2	2	2	2	Vout	Output Feedback Pin, Power supply for internal
3	5	3	5	Lx	Switching Pin
—	3	—	3	NC	No Connection
—	1	—	1	CE	Chip Enable

■ ABSOLUTE MAXIMUM RATING：

Parameter		Symbol	Value	Unit
Output Voltage Range		V_{OUT}	V_{SS}-0.3～V_{SS}+12	V
CE Pin Voltage		V_{CE}	V_{SS}-0.3～V_{OUT}+0.3	V
LX Voltage		V_{LX}	V_{SS}-0.3～V_{SS}+12	V
LX Pin Output Current		I_{LX}	1000	mA
Power Dissipation	SOT-89-3	P_D	0.5	W
	SOT-89-5		0.5	W
	SOT-23-3		0.25	W
	SOT-23-5		0.25	W
Ambient Temperature		Ta	-40～85	℃
Storage Temperature		Ts	-40～125	℃
Lead Temperature & Time		Ts	260 ℃,10S	℃,S

■ ELECTRICAL CHARACTERISTICS：

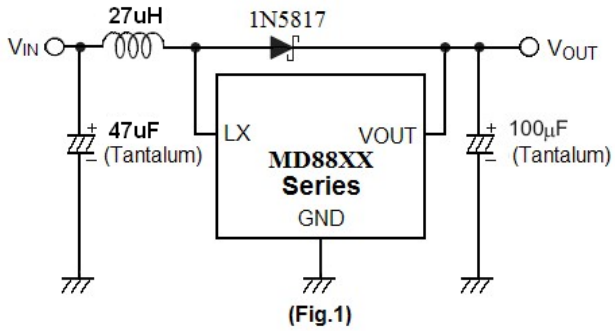
V_{IN}=V_{OUT}*0.6；I_{OUT}=10mA；Ta=25℃ (Except special instruction)

Parameter	Symbol	Test Condition	Value			Unit
			MIN	TYP	MAX	
Output Voltage Accuracy	△Vout	—	-2.5	—	+2.5	%
Input Voltage	Vin	—	—	—	10	V
Start-up Voltage	Vstart (Fig.1)	Iout=1mA， Vin ： 0→2V	—	0.75	0.9	V
Hold-on Voltage	Vhold (Fig.1)	Iout=1mA， Vin ： 2→0V	—	—	0.7	V
Input Current	Iin (Fig.1)	Iout=0mA	—	15	20	uA
Quiescent Current	I_{DD} (Fig.2)	V_S = V_{OUT}+0.5V	—	4	7	uA
Shutdown Current	I_{SHDN}	CE=GND	—	—	0.5	uA

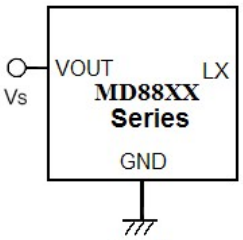
CE “H” threshold voltage	V_{CEH}	—	0.9	—	—	V
CE “H” threshold voltage	V_{CEL}	—	—	—	0.6	V
Switch ON Resistance	R_{SWON}	—	—	0.4	0.5	Ω
Switch Leakage Current	I_{LEAK}(Fig.3)	$V_S = V_{OUT}$+0.5V，V_X=6V	—	—	0.5	uA
Oscillator Frequency	F_{OSC}(Fig.3)	$V_S = V_{OUT}$*0.95	300	350	400	kHz
Oscillator Duty Cycle	D_{OSC}(Fig.3)	$V_S = V_{OUT}$*0.95	65	75	85	%
Efficiency	η	—	—	85	—	%

Note: “F1g.1”, “Fig.2” and “Fig.3” in the table above indicate the label of the test circuit below.

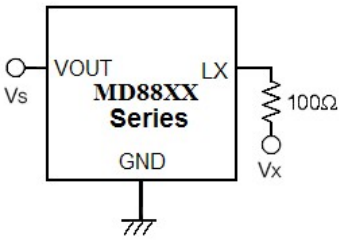
■ TEST CIRCUITS：



(Fig.1)



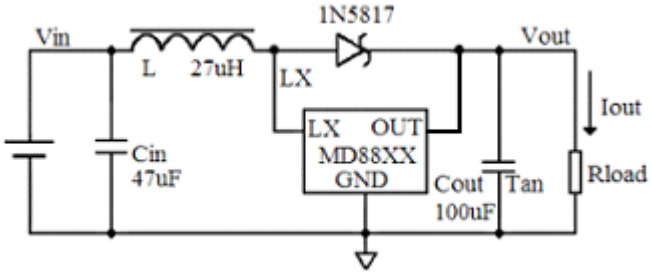
(Fig.2)



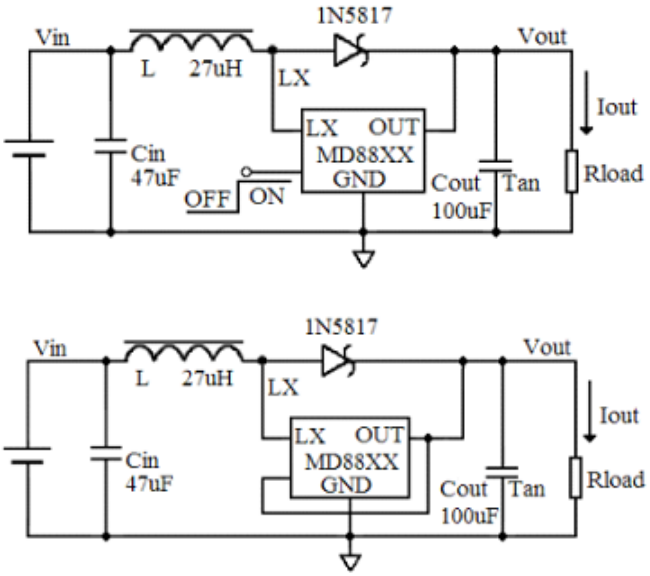
(Fig.3)

■ APPLICATION CIRCUITS：

SOT-89-3 and SOT-23-3 footprint



SOT-89-5 and SOT-23-5 footprint



■ SELECTION THE EXTERNAL COMPONENTS：

The four main energy loss of Boost structure DC-DC converter in full load are the ESR of inductor, the voltage of Schottky diode, on resistor of internal N-channel MOSFET and its driver. Though at very low load condition, the quiescent current of chip do affect efficiency certainly. In order to improve the efficiency, MD88XX integrates low on-resistor N-channel MOSFET and well design driver circuits. The switch energy loss is limited at very low level.

Thus it can be seen, the inductor and schottky diode affect the conversion efficiency greatly. The inductor and the capacitor also have great influence on the output voltage ripple of the converter. So it is necessary to choose a suitable inductor, a capacitor and a right schottky diode to obtain high efficiency, low ripple and low noise.

1、INDUCTOR SELECTION

The following aspects need to be considered when selecting inductor:

Firstly, we should define the minimum value of the inductor that can ensure the boost DC-DC to operate in the continuous current-mode condition.

$$L\min \geq \frac{D(1-D)^2 R_L}{2f}$$

The above expression is got under conditions of continuous current mode, neglect Schottky diode's voltage, ESR of both inductor and capacitor. The actual value is greater that it. If inductor's value is less than Lmin， the efficiency of DC-DC converter will drop greatly, and the DC-DC circuit will not be stable.

Secondly, consider the ripple of the output voltage,

$$\Delta I = \frac{D \bullet Vin}{Lf} \qquad \text{Im}ax = \frac{Vin}{(1-D)^2 R_L} + \frac{DVin}{2Lf}$$

If inductor value is too small, the current ripple through it will be great. Then the current through diode and power switch will be great. Because the power switch on chip is not ideal switch, the energy of switch will improve. The efficiency will fall.

Thirdly, in general, smaller inductor values supply more output current while larger values start up with lower input voltage and acquire high efficiency.

The working frequency of MD88XX is up to 350kHz, the purpose of which is to decrease the size of external inductor. An inductor value of 3uH to 1mH works well in most applications. If DC-DC converter delivers large output current (for example: output current is great than 50mA), large inductor value is recommended in order to improve efficiency.

The ESR of inductor will affect efficiency greatly. Suppose ESR value of inductor is rL，Rload is load resistor，then the energy can be calculated by following expression:

$$\Delta\eta \approx \frac{r_L}{R_{load}(1-D)^2}$$

Consider all above，inductor value of 27uH, ESR<0.5Ω is recommended in most applications. Large value is recommended in high efficiency applications and smaller value is recommended.

2、CAPACITOR SELECTION

Ignore ESR of capacitor，the ripple of output voltage is:

$$r = \frac{\Delta Vout}{Vout} = \frac{D}{R_{load}Cf} + \frac{\mathrm{Im}ax \bullet R_{ESR}}{Vout}$$

So large value capacitor is needed to reduce ripple. But too large capacitor value will slow down system reaction and cost will improve. So 100uF capacitor is recommended. If fewer ripples are needed, larger capacitor value should be used.

When current is large, ripple caused by ESR will be main factor. It may be greater than 100mV. The ESR will affect efficiency and increase energy loss. So low-ESR capacitor (for example: tantalum capacitor) is recommend or connect two or more filter capacitors in parallel.

3、DIODE SELECTION

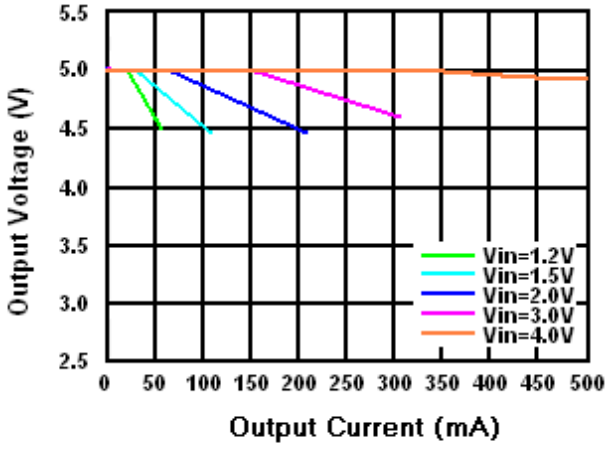
Rectifier diode will affects efficiency greatly, though a common diode (such as 1N4148) will work well for light load, it will reduce about 5%~10% efficiency for heavy load, for optimum performance, a Schottky diode (such as 1N5817, 1N5819, 1N5822) is recommended.

4、INPUT CAPACITOR

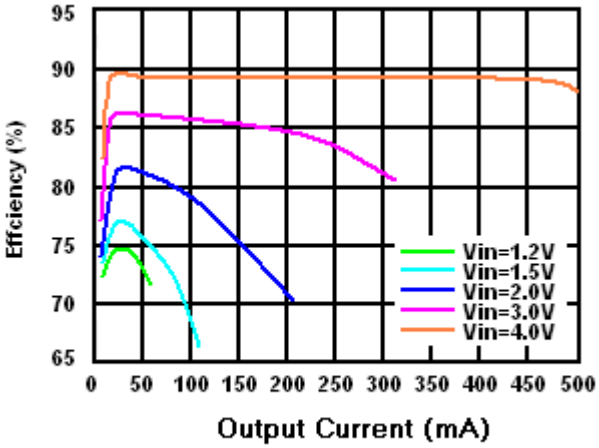
If supply voltage is stable, the DC-DC circuit can output low ripple, low noise and stable voltage without input capacitor. If voltage source is far away from DC-DC circuit, input capacitor value greater than 10uF is recommended.

■ TYPICAL PERFORMANCE CHARACTERISTICS：

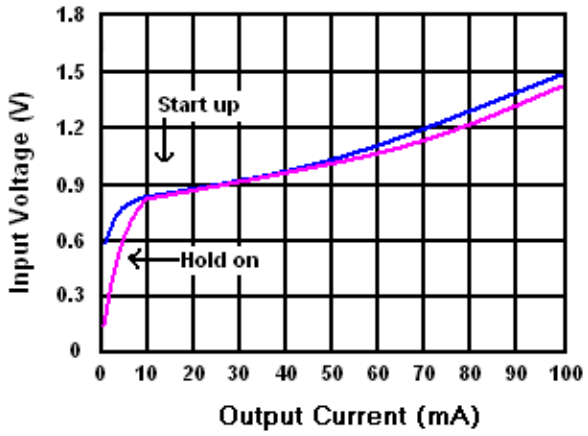
（Test Conditon：Cin=47uF，L=27uH，Cout=100uF，Vin=0.6*Vout，Ta=25℃，unless otherwise noted）



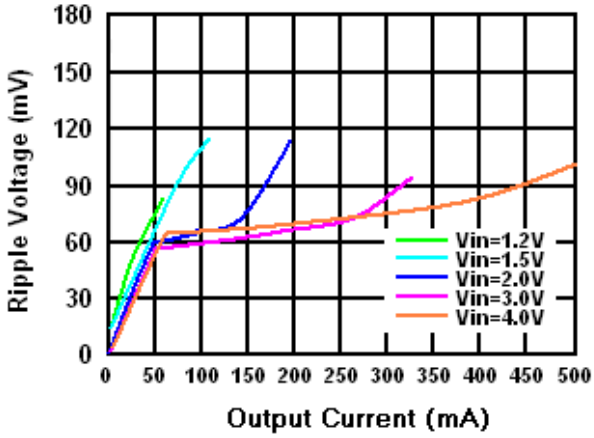
MD8850 Output Voltage v.s Output Current



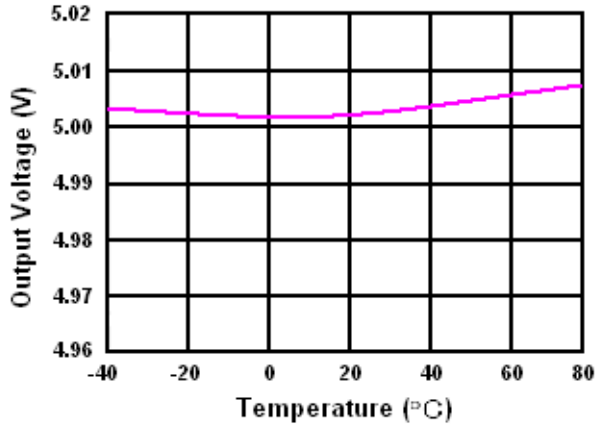
MD8850 Effciency v.s Output Current



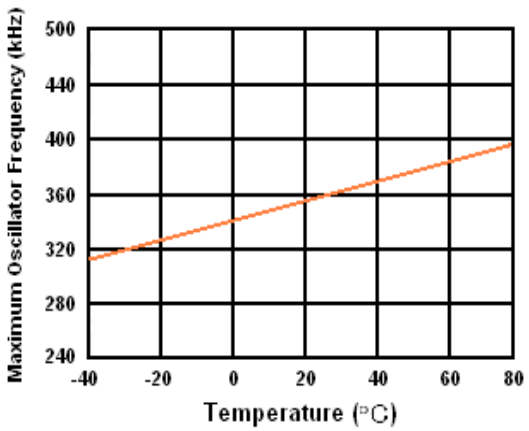
MD8850 Start-Up & Hold-On Voltage



MD8850 Ripple Voltage v.s Output Current



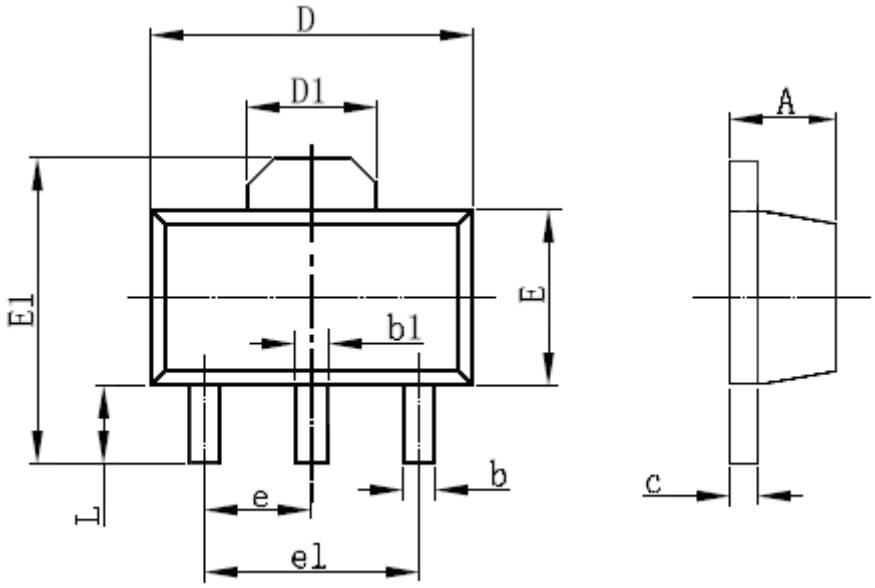
MD8850 Output Voltage v.s Temperature



MD8850 Maximum Oscillator Frequency v.s Temperature

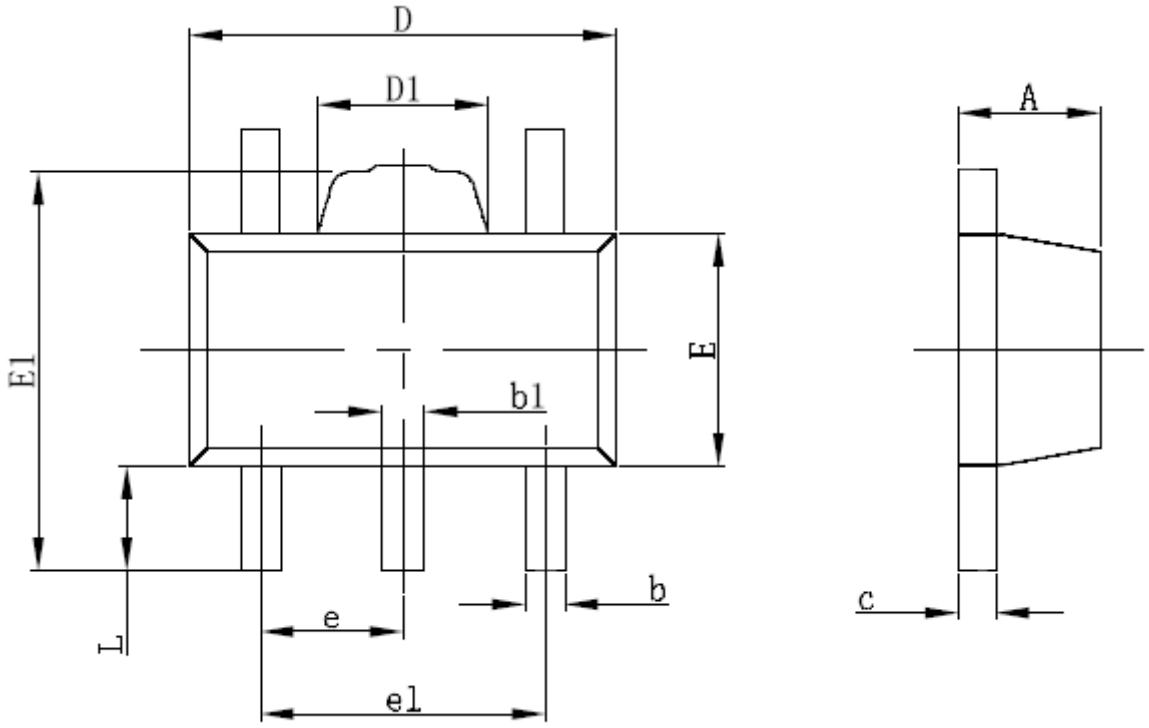
■ FOOTPRINT SIZE：

SOT-89-3L PACKAGE OUTLINE DIMENSIONS



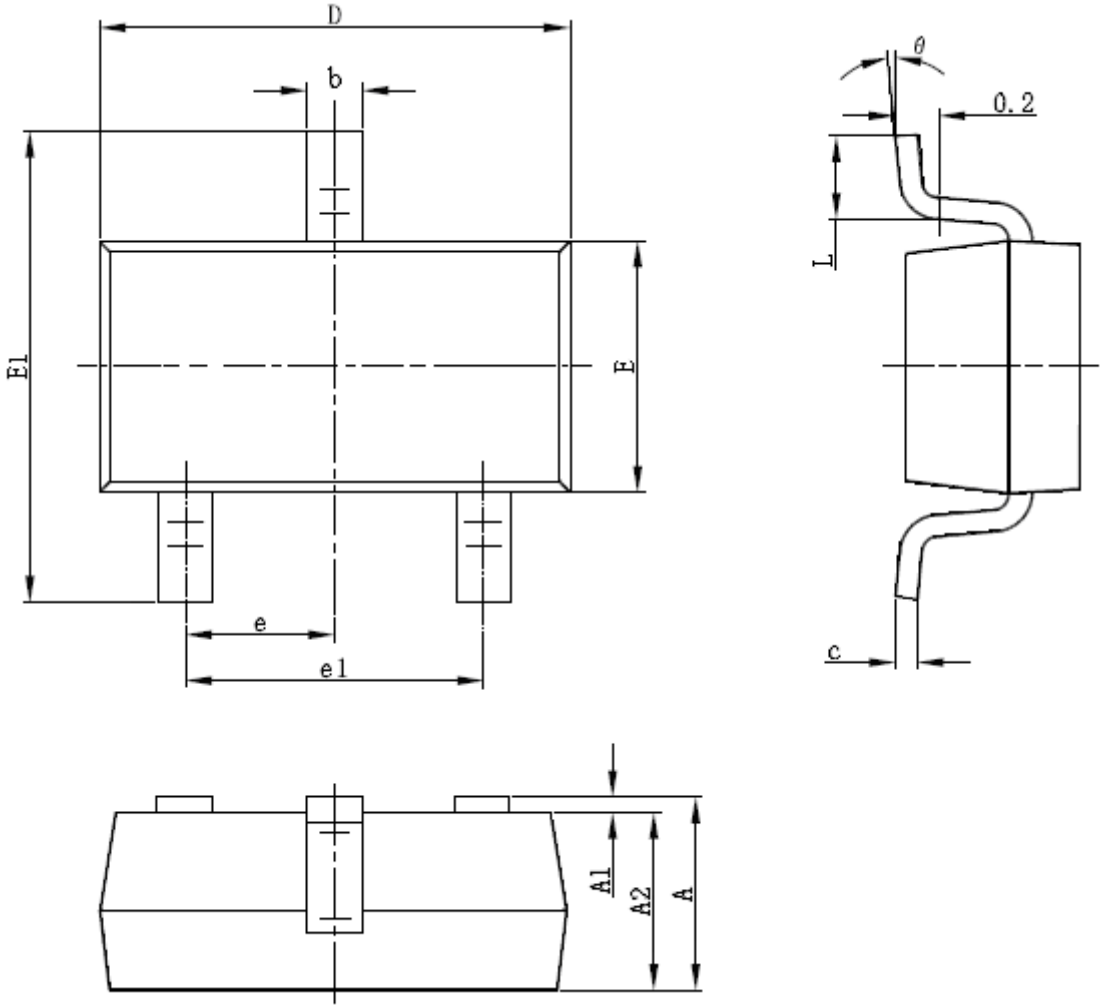
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF		0.061 REF	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060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

SOT-89-5L PACKAGE OUTLINE DIMENSIONS



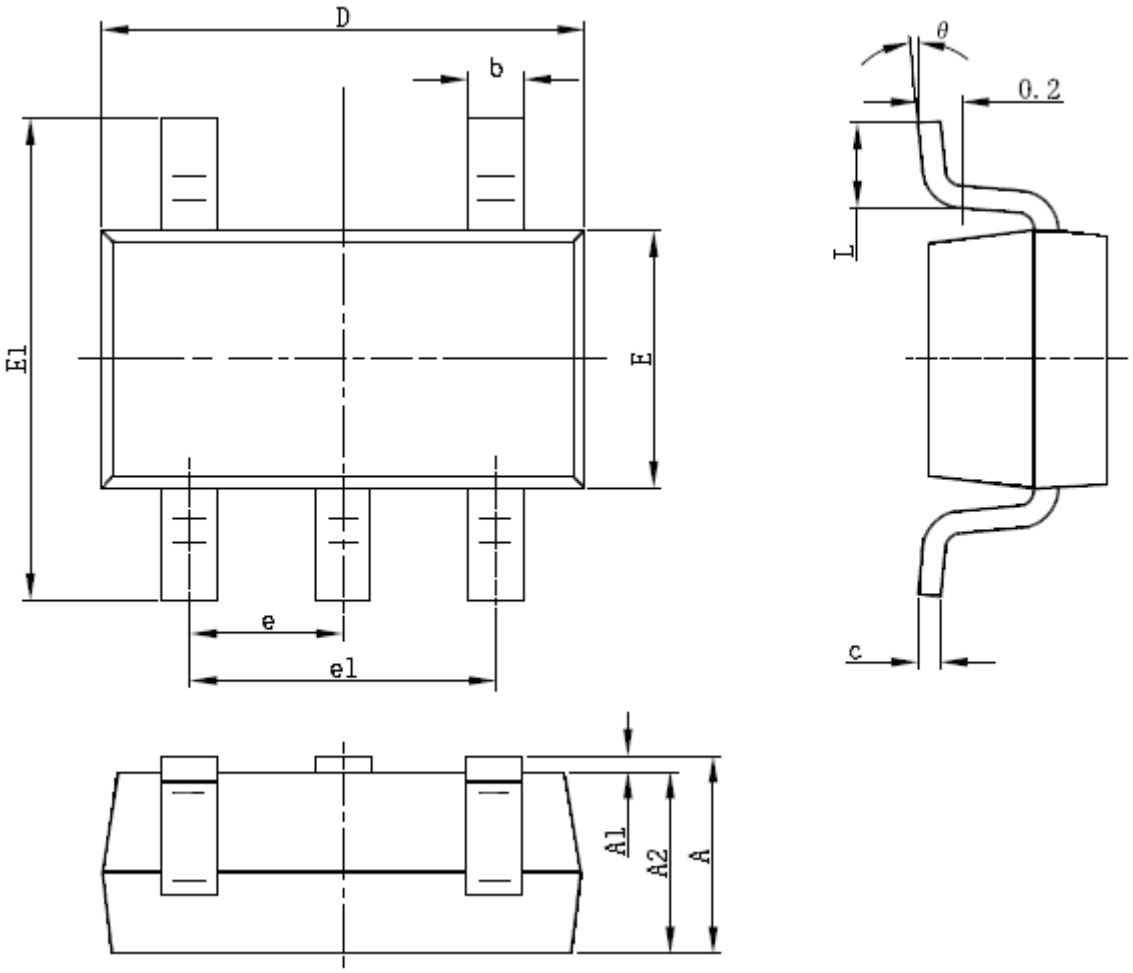
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.360	0.560	0.014	0.022
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.400	1.800	0.055	0.071
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060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

SOT-23-3L 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-23-5L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
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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°

Custom Service Center

Shang Hai MingDa Microelectronics Corporation

Address： 上海市虹梅南路 1781 弄 143 号
Telephone： 021-64104739
FAX： 021-64103832
E-Mail：sales@md-ic.com.cn
Web： www.md-ic.com.cn