# MICROPOWER VFM SYNCHRONOUS STEP-UP DC/DC Converter

## ❖ GENERAL DESCRIPTION

The AX5505 is a high efficiency VFM synchronous Step-up DC/DC converter for small, low input voltage or battery powered systems with ultra-low quiescent supply current. The AX5505 accept a positive input voltage from start-up voltage to $V_{OUT}$ and convert it to a higher output voltage in the 2.1V to 5.0V range.

The AX5505 combine ultra-low quiescent supply current and high efficiency to give maximum battery life. The high switching frequency and the internally limited peak inductor current permits the use of small, low cost inductors. Only three external components are needed an inductor a diode and an output capacitor.

The AX5505 is suitable to be used in battery powered equipment where low noise, low ripple and ultra-low supply current are required. Operating shutdown function is outside controlling. If EN connects to GND, the IC was been shut down and then the supply current is lower to 1uA.The AX5505 is available in very small packages: SOT23-3L, SOT23-5L and SOT89-3L.

Typical applications are pagers, cameras and video camera, cellular telephones, wireless telephones, palmtop computer, battery backup supplies, battery powered equipment.

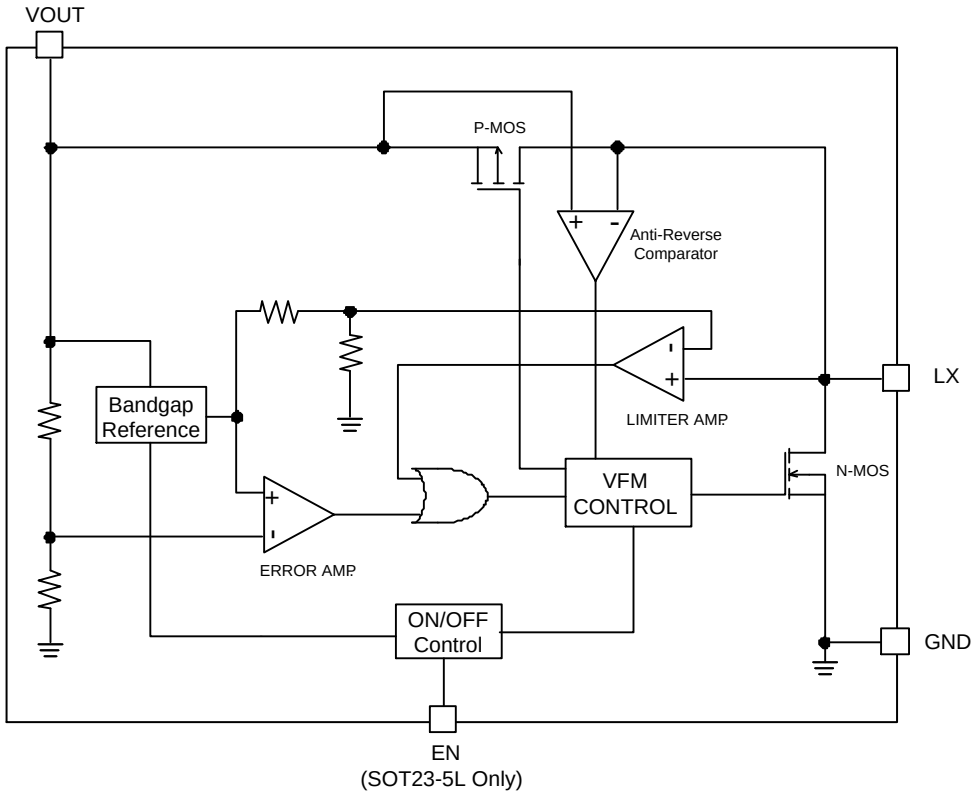
## ❖ FEATURES

- Very Low Supply Current is 13uA (typ.)
- Maximum shutdown current <1uA
- Output voltage is available form 2.1V to 5.0V by 0.1V steps
- Output Voltage Accuracy ±2%
- No Schottky Diode Required
- Output Current up to 100mA
- Low ripple and low noise
- Very low start-up voltage at 0.8V
- Few external components
- Low profile: SOT23-3L, SOT23-5L and SOT89-3L Pb-Free



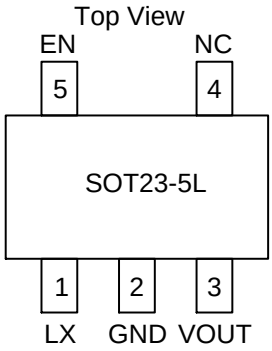
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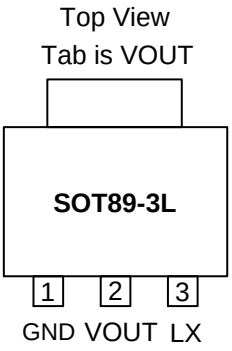
## ❖ BLOCK DIAGRAM

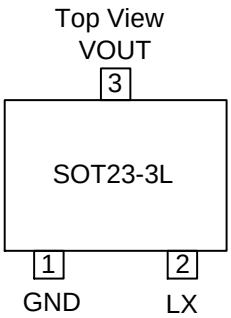



## ❖ PIN ASSIGNMENT

The packages type: SOT23-3L, SOT23-5L and SOT89-3L; the pin assignment is given by:




| Name | Description |
|---|---|
| **EN** | Chip Enable Pin (SOT23-5L Only) |
| **VOUT** | Output Voltage Pin |
| **NC** | No Connect Pin |
| **GND** | Ground Pin |
| **LX** | Switch input pin which connected to inductor. |



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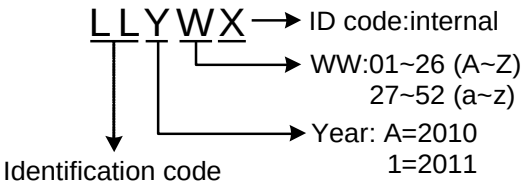
## ❖ ORDER/MARKING INFORMATION

**Order Information**

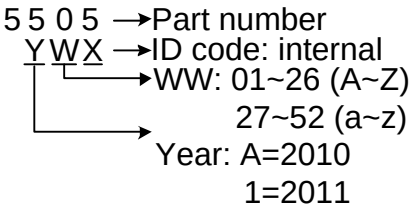
**AX5505 X XX X**

- Package Type: R: SOT23-3L; B: SOT23-5L; F: SOT89-3L
- $V_{OUT}$: 21 : 2.1V; 22 : 2.2V; : ; : ; 50 : 5.0V
- Packing: Blank : Bag; A : Taping

**Top Marking (SOT23-3L/SOT23-5L)**




**Top Marking (SOT89-3L)**




| Part Number | Identification Code | Part Number | Identification Code |
|---|---|---|---|
| AX5505-2.1V | WD | AX5505-3.6V | WU |
| AX5505-2.2V | WE | AX5505-3.7V | WV |
| AX5505-2.3V | WF | AX5505-3.8V | WW |
| AX5505-2.4V | WG | AX5505-3.9V | WX |
| AX5505-2.5V | WH | AX5505-4.0V | WY |
| AX5505-2.6V | WJ | AX5505-4.1V | WZ |
| AX5505-2.7V | WK | AX5505-4.2V | Wa |
| AX5505-2.8V | WL | AX5505-4.3V | Wb |
| AX5505-2.9V | WM | AX5505-4.4V | Wc |
| AX5505-3.0V | WN | AX5505-4.5V | Wd |
| AX5505-3.1V | WP | AX5505-4.6V | We |
| AX5505-3.2V | WQ | AX5505-4.7V | Wf |
| AX5505-3.3V | WR | AX5505-4.8V | Wg |
| AX5505-3.4V | WS | AX5505-4.9V | Wh |
| AX5505-3.5V | WT | AX5505-5.0V | Wi |



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## ❖ ABSOLUTE MAXIMUM RATINGS (at $T_A$ = 25°C)

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| $V_{IN}$ Pin Voltage | | $V_{IN}$ | 5.5 | V |
| LX Voltage | | $V_{LX}$ | 5.5 | V |
| OUT Pin Voltage | | $V_{OUT}$ | 5.5 | V |
| EN Pin Voltage | | $V_{EN}$ | -0.3 to $V_{OUT}$+0.3 | V |
| Storage Temperature Range | | $T_{STG}$ | -40 to +150 | °C |
| Operating Junction Temperature Range | | $T_J$ | -20 to +100 | °C |
| Power Dissipation | | PD | ( $T_J$-$T_A$ ) / $\theta_{JA}$ | mW |
| Thermal Resistance from Junction to case | SOT23-3L | $\theta_{JC}$ | 180 | °C/W |
| | SOT23-5L | | | |
| | SOT89-3L | | 100 | |
| Thermal Resistance from Junction to ambient | SOT23-3L | $\theta_{JA}$ | 250 | °C/W |
| | SOT23-5L | | | |
| | SOT89-3L | | 160 | |

Note: $\theta_{JA}$ is measured with the PCB copper area of approximately 1 $in^2$ (Multi-layer).

## ❖ ELECTRICAL CHARACTERISTICS

($V_{IN}$ = $V_{OUT}$ × 0.6, $I_{OUT}$=10mA, $T_A$ = 25°C, unless otherwise specified)

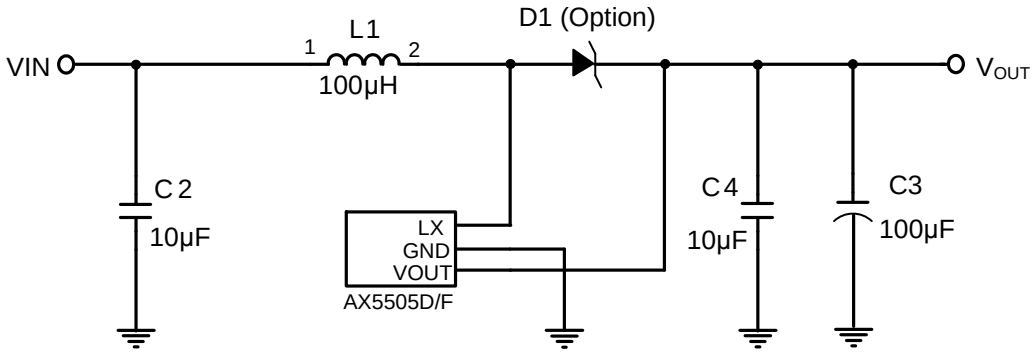
| Characteristics | Symbol | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Output Voltage Accuracy | △$V_{OUT}$ | | -2 | - | +2 | % |
| Start-up Voltage | $V_{START-UP}$ | $I_{OUT}$=1mA<br>$V_{IN}$ =rising from 0 to 2V | - | 0.8 | 0.95 | V |
| Hold-on Voltage | $V_{HOLD}$ | $I_{OUT}$=1mA<br>$V_{IN}$ =falling from 2 to 0V | 0.6 | - | - | V |
| Supply Current | $I_{SUPPLY}$ | No Load | - | 13 | - | uA |
| Quiescent Current | $I_Q$ | $I_{OUT}$ =0mA, $V_{IN}$=$V_{OUT}$ + 0.5V | - | 6 | - | uA |
| Shutdown Current (SOT23-5L Only) | $I_{SD}$ | $V_{EN}$=0V | - | - | 1 | uA |
| PMOS Switch ON Resistance P-$R_{DS(ON)}$ | | $I_{LX}$=100mA | - | 1000 | - | mΩ |
| NMOS Switch ON Resistance N-$R_{DS(ON)}$ | | $I_{LX}$=100mA | - | 600 | - | mΩ |
| Maximum Oscillator Frequency | $F_{OSC}$ | | - | 125 | - | KHz |
| Oscillator Duty On | $D_{ON}$ | To be measure on SW pin | - | 77 | - | % |
| Enable Input Threshold (SOT23-5L Only) | $V_{ENH}$ | Driver ON | 0.75 | - | - | V |
| | $V_{ENL}$ | Driver OFF | - | - | 0.2 | |
| Enable Input Current (SOT23-5L Only) | $I_{ENH}$ | $V_{EN}$=$V_{IN}$ | - | - | 0.1 | uA |
| | $I_{ENL}$ | $V_{EN}$=0V | - | - | 1 | |
| Efficiency | $\eta$ | $V_{IN}$=1.5V,<br>$V_{OUT}$=2.2V, $I_{OUT}$=10mA | - | 89 | - | % |
| | | $V_{IN}$=1.5V,<br>$V_{OUT}$=3.0V, $I_{OUT}$=10mA | - | 87 | - | % |



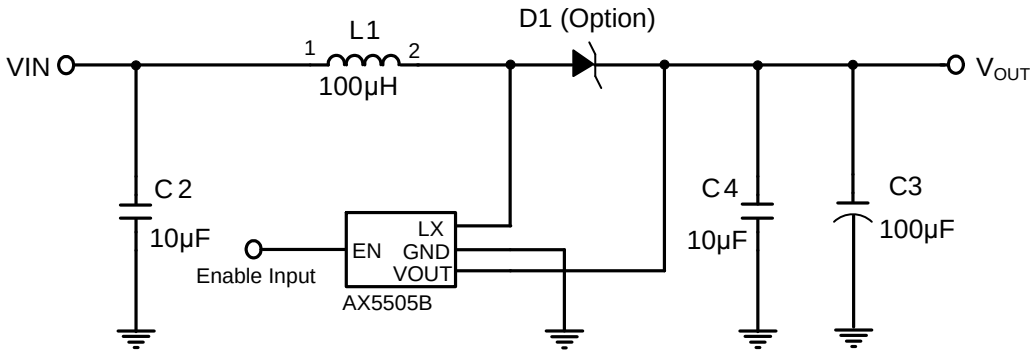
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## ❖ APPLICATION CIRCUIT

### (1) SOT23-3L/SOT89-3L




### (2) SOT23-5L




## ❖ OPERATION

The AX5505 architecture is built around a VFM CONTROL logic core, switching frequency is set through a built in oscillator. $T_{ON}$ time is fixed (Typ. 5uS) while $T_{OFF}$ time is determined by the error amplifier output, a logic signal coming from the comparison made by the Error Amplifier Stage between the signal coming from the output voltage divider network and the internal Band-Gap voltage reference (Vref). $T_{OFF}$ reaches a minimum (Typ. 1.7uS) when heavy load conditions are met (Clock frequency 125KHz). An over current conditions, through the internal power switch, causes a voltage drop $V_{LX}=R_{DSON} \times I_{SW}$ and the $V_{LX}$ limiter block forces the internal switch to be off, so narrowing $T_{ON}$ time and limiting internal power dissipation. In this case the switching frequency may be higher than the 125KHz set by the internal clock generator.



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VFM control ensures very low quiescent current and high conversion efficiency even with very light loads. Since the Output Voltage pin is also used as the device Supply Voltage, the versions with higher output voltage present an higher internal supply voltage that results in lower power switch $R_{DSON}$, slightly greater output power and higher efficiency. Moreover, bootstrapping allows the input voltage to sag to 0.6V (at $I_{OUT}$=1mA) once the system is started. If the input voltage exceeds the output voltage, the output will follow the input, however, the input or output voltage must not be forced above 5.5V.

## ❖ APPLICATION INFORMATION

### Input/output Capacitor Selection

The Output Ripple Voltage, as well as the Efficiency, is strictly related to the behavior of these elements. The output ripple voltage is the product of the peak inductor current and the output capacitor Equivalent Series Resistance (ESR). Best performances are obtained with good high frequency characteristics capacitors and low ESR. The recommended value of the Output Capacitance is 10µF Ceramic Capacitor; Connected a 100µF aluminum electrolytic capacitor in $V_{OUT}$ can reduce Output Ripple and improve Efficiency.

An Input Capacitor is required to compensate, if present, the series impedance between the Supply Voltage Source and the Input Voltage of the Application. A ceramic capacitor in 10µF is suitable for all application.

### Inductor Selection

A 100µH inductor is recommended for most AX5505 applications. However, the inductance value is not critical, and the AX5505 will work with inductors in the 82µH to 150µH.

### Diode Option

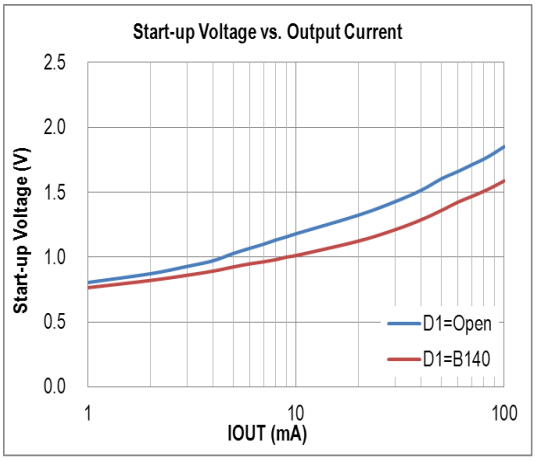
Need to add diode to improve systematic performance in two kinds of following situations.

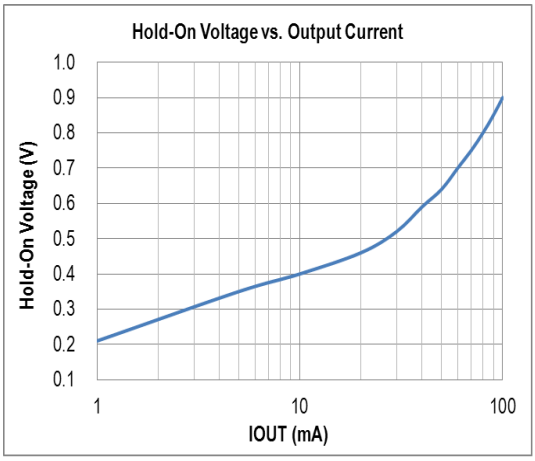
1. In the heavily loaded start to reduce start-up voltage.
2. Input voltage close to or exceed the output voltage (Vout-0.5V<$V_{IN}$<Vout+0.5V) reduces the output voltage ripple.

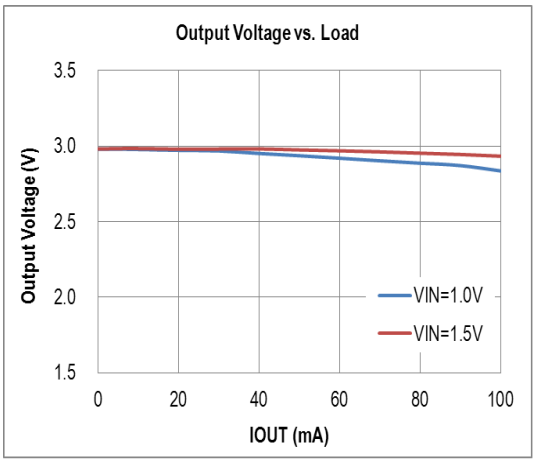


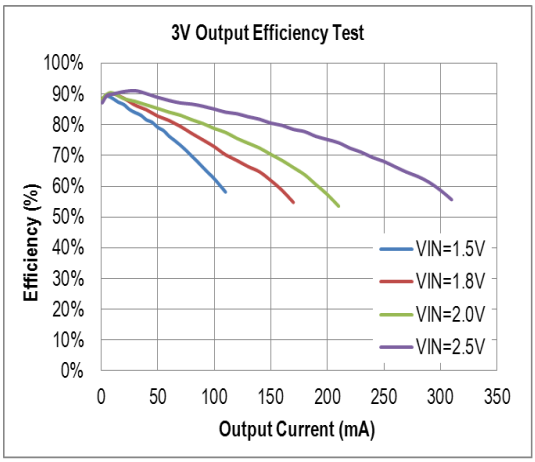
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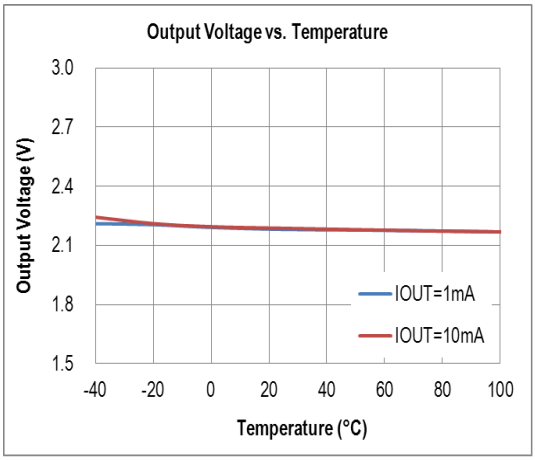
## ❖TYPICAL CHARACTERISTICS

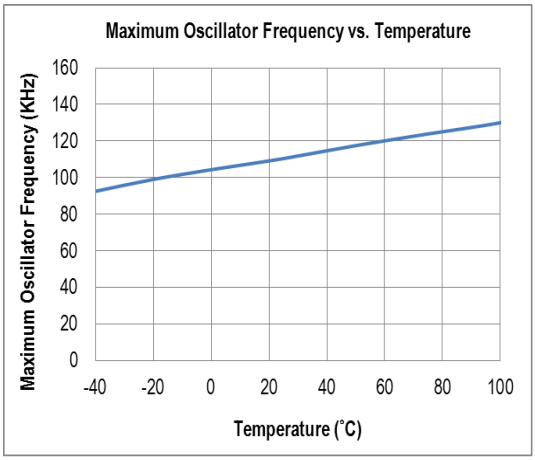


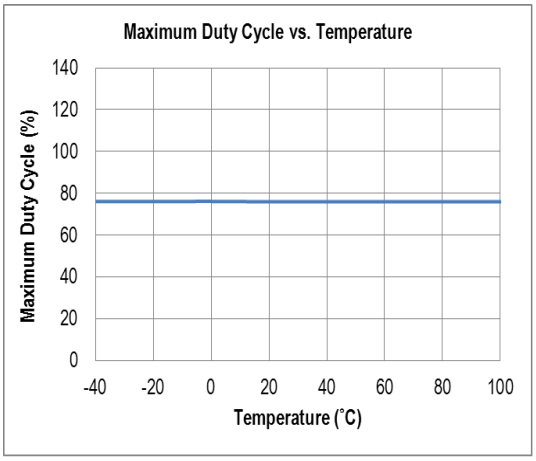



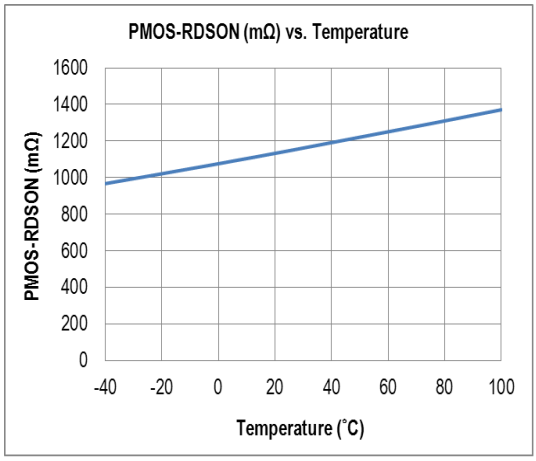



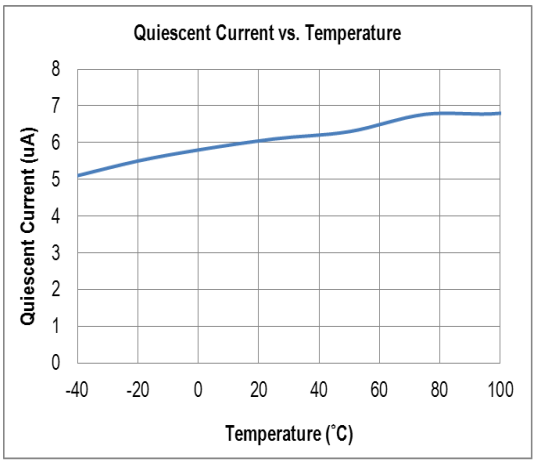


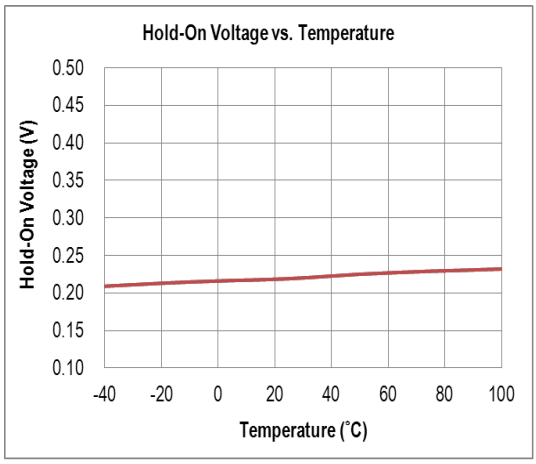

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## ❖TYPICAL CHARACTERISTICS (CONTINUOUS)



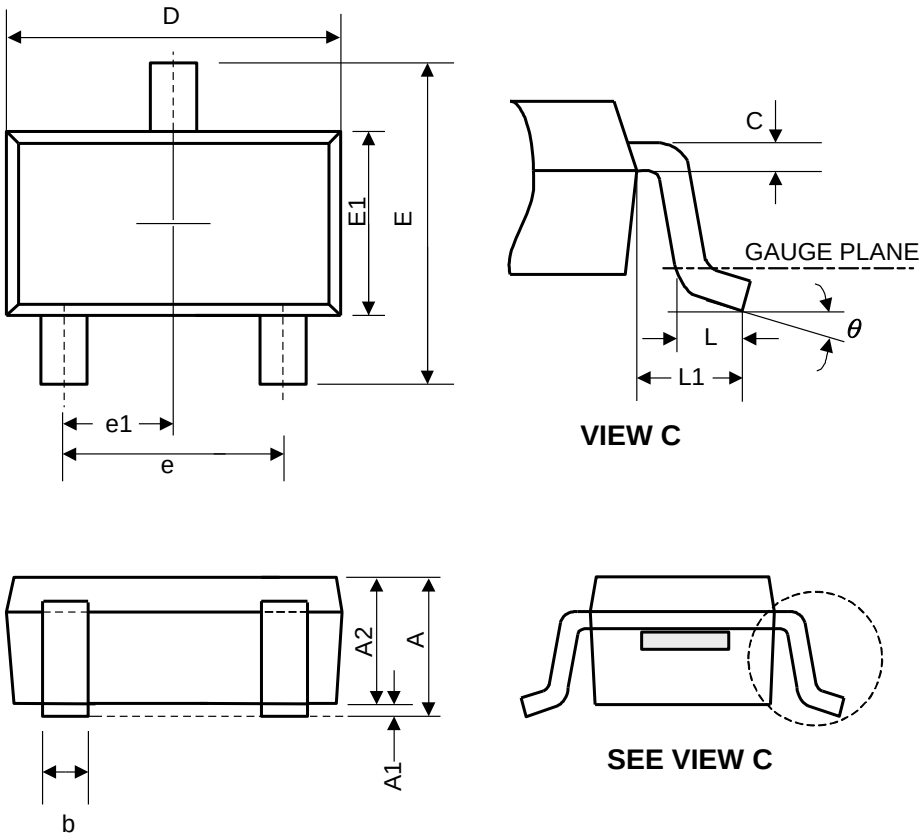






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## ❖ PACKAGE OUTLINES

### (1) SOT23-3L



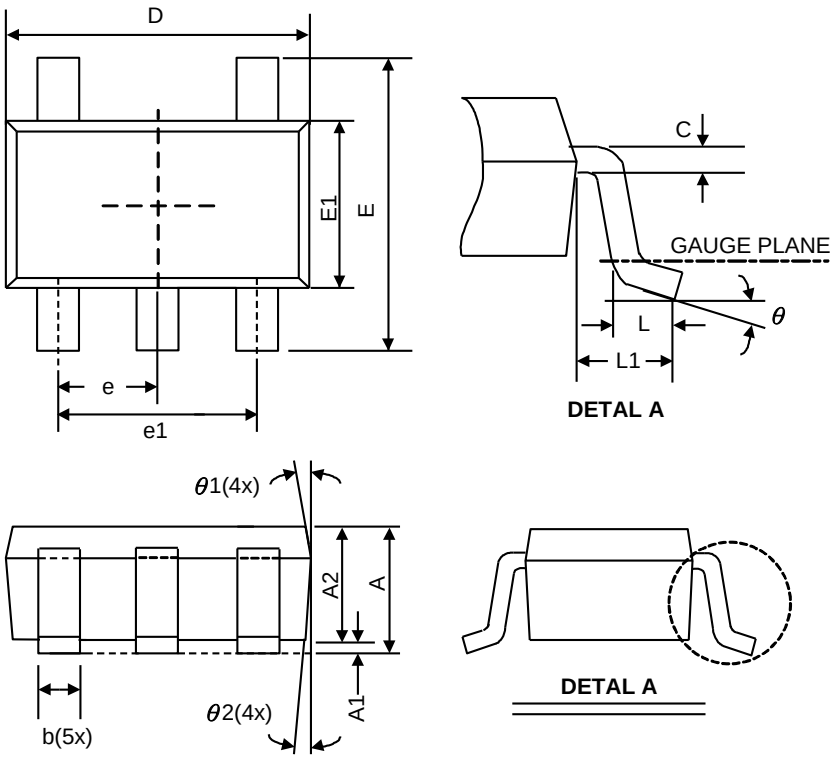

| Symbol | Dimensions in Millimeters | | | Dimensions in Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | - | - | 1.45 | - | - | 0.057 |
| A1 | 0.00 | 0.08 | 0.15 | - | - | 0.006 |
| A2 | 0.90 | 1.10 | 1.30 | 0.035 | 0.043 | 0.051 |
| b | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |
| C | 0.08 | 0.15 | 0.22 | 0.003 | 0.006 | 0.009 |
| D | 2.70 | 2.90 | 3.10 | 0.106 | 0.114 | 0.122 |
| E | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.118 |
| E1 | 1.40 | 1.60 | 1.80 | 0.055 | 0.063 | 0.071 |
| L | 0.30 | 0.45 | 0.60 | 0.012 | 0.018 | 0.024 |
| L1 | 0.50 | 0.60 | 0.70 | 0.020 | 0.024 | 0.028 |
| e | 1.9 BSC | | | 0.075 BSC | | |
| e1 | 0.95 BSC | | | 0.037 BSC | | |
| $\theta$ | 0° | 4° | 8° | 0° | 4° | 8° |

JEDEC outline: NA



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## (2) SOT23-5L



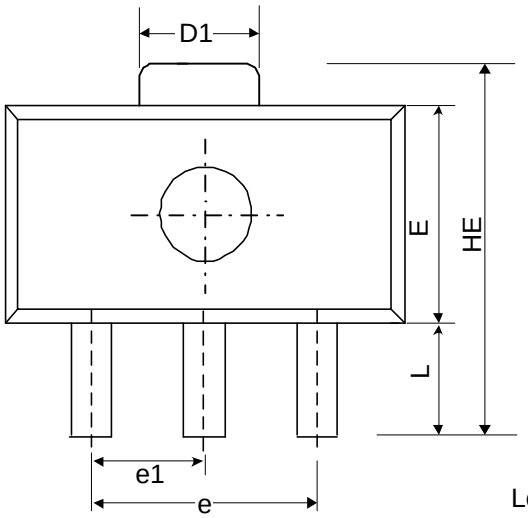

| Symbol | Dimensions in Millimeters | | | Dimensions in Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | - | - | 1.45 | - | - | 0.057 |
| A1 | 0.00 | 0.08 | 0.15 | 0 | 0.003 | 0.006 |
| A2 | 0.90 | 1.10 | 1.30 | 0.035 | 0.043 | 0.051 |
| b | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |
| C | 0.08 | 0.15 | 0.22 | 0.003 | 0.006 | 0.009 |
| D | 2.70 | 2.90 | 3.10 | 0.106 | 0.114 | 0.122 |
| E1 | 1.40 | 1.60 | 1.80 | 0.055 | 0.063 | 0.071 |
| E | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.118 |
| L | 0.30 | 0.45 | 0.60 | 0.012 | 0.018 | 0.024 |
| L1 | 0.50 | 0.60 | 0.70 | 0.020 | 0.024 | 0.028 |
| e1 | 1.9 BSC | | | 0.075 BSC | | |
| e | 0.95 BSC | | | 0.037 BSC | | |
| $\theta$ | 0° | 4° | 8° | 0° | 4° | 8° |
| $\theta$ 1 | 5° | 10° | 15° | 5° | 10° | 15° |
| $\theta$ 2 | 5° | 10° | 15° | 5° | 10° | 15° |

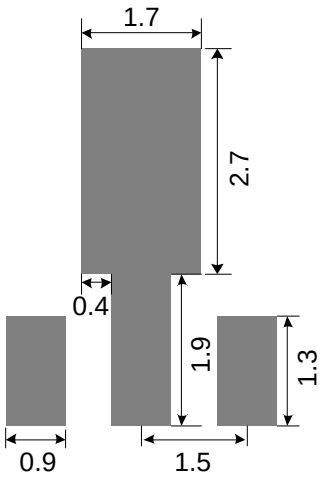
JEDEC outline: MO-178 AA



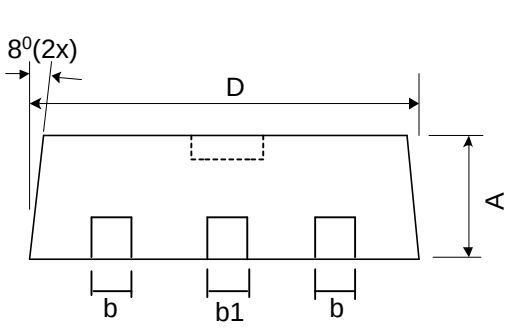
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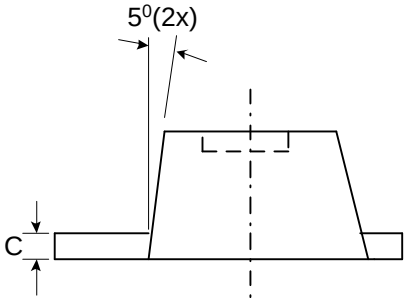
## (3) SOT89-3L




Lead Pattern Recommendation (Unit: mm)




| Symbol | Dimensions in Millimeters | | | Dimensions in Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| A | 1.40 | 1.50 | 1.60 | 0.055 | 0.059 | 0.063 |
| b | 0.36 | 0.42 | 0.48 | 0.014 | 0.017 | 0.019 |
| b1 | 0.44 | 0.50 | 0.56 | 0.017 | 0.02 | 0.022 |
| C | 0.35 | 0.40 | 0.44 | 0.014 | 0.016 | 0.017 |
| D | 4.40 | 4.50 | 4.60 | 0.173 | 0.177 | 0.181 |
| D1 | 1.35 | 1.59 | 1.83 | 0.053 | 0.063 | 0.072 |
| e | 3.0 BSC | | | 0.118 BSC | | |
| e1 | 1.5 BSC | | | 0.059 BSC | | |
| E | 2.29 | 2.45 | 2.60 | 0.09 | 0.097 | 0.102 |
| HE | 3.94 | 4.10 | 4.25 | 0.155 | 0.161 | 0.167 |
| L | 0.80 | 1.00 | 1.20 | 0.031 | 0.04 | 0.047 |

JEDEC outline: TO-243 AB



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