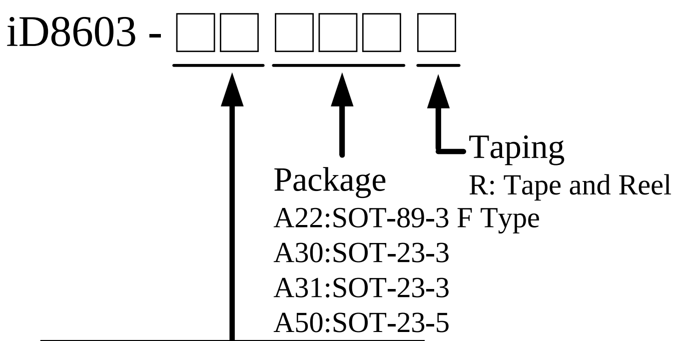
# PFM Step-Up DC-DC Converters with Internal Schottky Diode

## General Description

The iD8603 compact, high-efficiency, PFM step-up DC-DC converters are available in SOT-89-3,SOT-23-3 and SOT-23-5 packages. They feature an extremely low quiescent supply current to ensure the highest possible light-load efficiency. Optimized for operation from one to two alkaline or nickel-metal-hydride (NiMH) cells, or a single Li+ cell, these devices are ideal for applications where extremely low quiescent current and ultra-small size are critical.

The iD8603 includes an internal Schottky diode that reduces PCB board area and total BOM cost. The family offers different combinations of fixed or adjustable outputs, and shutdown control.

## Ordering Information




| Output Voltage | Voltage Code |
|---|---|
| 1.8 V | 18 |
| 1.9 V | 19 |
| 2.1 V | 21 |
| 2.5 V | 25 |
| 2.7 V | 27 |
| 2.8 V | 28 |
| 3.0 V | 30 |
| 3.3 V | 33 |
| 4.0 V | 40 |

## Applications

- Remote Wireless Transmitters
- Personal Medical Devices
- Digital Still Cameras
- Single-Cell Battery-Powered Devices
- Low-Power Hand-Held Instruments
- MP3 Players
- Personal Digital Assistants (PDA)

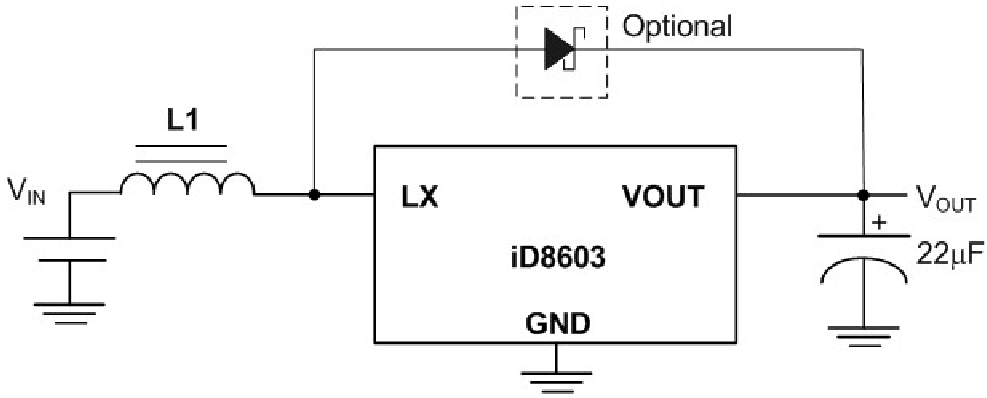
## Features

- Internal Schottky Diode
- Up to 80% Efficiency (External Schottky Diode)
- Ultra Low Input Current (9μA at Switch Off)
- ±2.0% Output Voltage Accuracy
- Fixed Output Voltage
- Up to 200mA Output Current
- 0.8V to 5.5V Input Voltage Range
- Low Start-up Voltage, 0.9V at 1mA
- SOT-23-3,SOT-23-5 and SOT-89-3 Package

## Marking Information

For marking information, please contact our sales representative directly or through distributor around your location.

## Typical Application Circuit



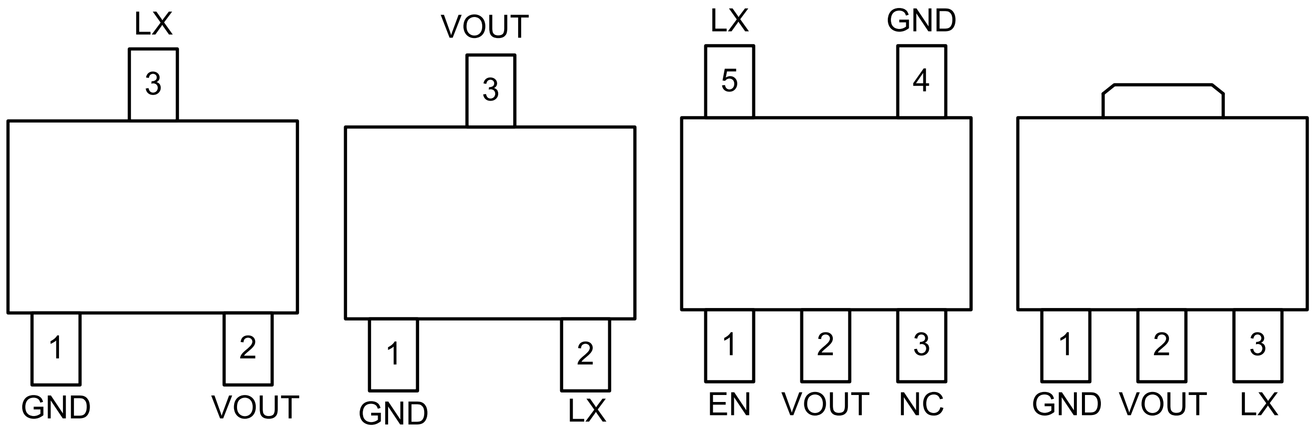

## Absolute Maximum Ratings

| | |
|---|---|
| Supply Voltage $V_{IN}$ | 7V |
| Power Dissipation, $P_D$ @ $T_A$=25°C | |
| SOT-89-3 | 571mW |
| SOT-23-3 / SOT-23-5 | 400mW |
| Thermal Resistance, θja | |
| SOT-89-3 | 175°C/W |
| SOT-23-3 / SOT-23-5 | 250°C/W |
| Lead Temperature | 260 °C |
| Storage Temperature | -65°C to 150°C |
| ESD Susceptibility | |
| HBM (Human Body Mode) | 4kV |
| MM (Machine Mode) | 300V |

## Recommended Operating Conditions

| | |
|---|---|
| Input Voltage $V_{IN}$ | 0.8V to 5.5V |
| Junction Temperature | -40°C to 125°C |
| Ambient Operating Temperature | -40°C to 85°C |

## Pin Configurations (TOP VIEW)




SOT-23-3 (A30) SOT-23-3 (A31) SOT-23-5 SOT-89-3

## Pin Description

| SOT-23-3 | SOT-23-5 | SOT-89-3 | Name | Description |
|---|---|---|---|---|
| 3 | 5 | 3 | LX | Pin for Switching |
| 1 | 4 | 1 | GND | Ground |
| -- | 1 | -- | EN | Chip Enable (Active High). Note that this pin is high impedance. There should be a pull low 100kΩ resistor connected to GND when the control signal is floating. |
| -- | 3 | -- | NC | No Connecting |
| 2 | 2 | 2 | VOUT | Output Voltage |

## Electrical Characteristics

All of the below electrical characteristics are tested at room temperature (25℃)

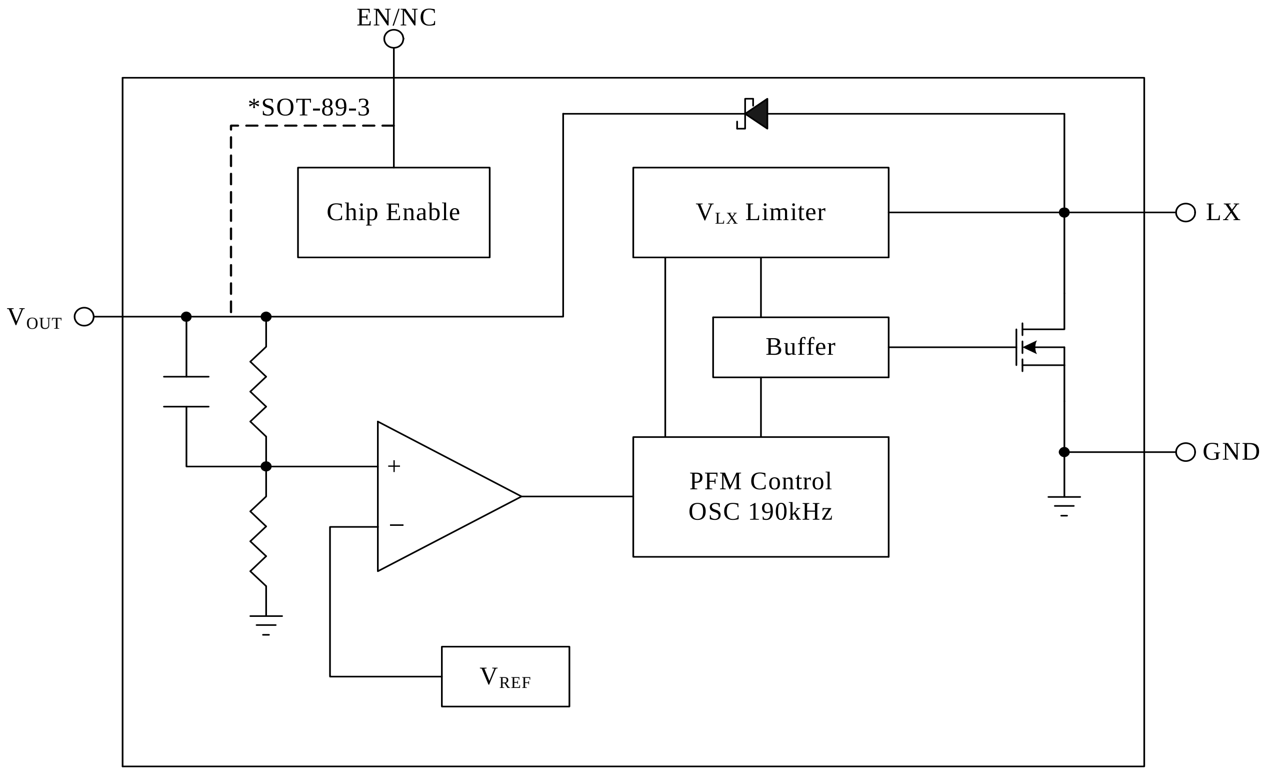
| Parameter | | Symbol | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| Output Voltage Accuracy | | $\Delta V_{OUT}$ | | -2 | -- | +2 | % |
| Input Voltage | | $V_{IN}$ | | -- | -- | 5.5 | V |
| Start-up Voltage | | $V_{ST}$ | $I_{OUT}$ = 1mA, $V_{IN}$: 0 → 2.0V | -- | 0.9 | 1 | V |
| Hold-on Voltage | | $V_{HO}$ | $I_{OUT}$ = 1mA, $V_{IN}$: 0 ← 2.0V | 0.7 | -- | -- | V |
| Input Current 1 | $V_{OUT} \leq 3.5V$ (1) | $I_{DD1}$ | To be measured at $V_{IN}$ continuous switching | -- | 35 | -- | µA |
| | $3.5V < V_{OUT} \leq 5.0V$ (2) | | | -- | 40 | -- | |
| Input Current 2 (1)(2) | | $I_{DD2}$ | To be measured at $V_{OUT}$ in switch off condition | -- | 9 | -- | µA |
| Input Current 3 | $V_{OUT} \leqq 3.5V$ (1) | $I_{IN}$ | To be measured at $V_{IN}$ in no load (guaranteed by $I_1$ and $I_2$) | -- | 23 | -- | µA |
| | $3.5V < V_{OUT} \leq 5.0V$ (2) | | | -- | 28 | -- | |
| LX Switching Current | $V_{OUT} \leqq 3.5V$ (1) | $I_{SWITCHING}$ | $V_{LX}$ = 0.4V | 120 | -- | -- | mA |
| | $3.5V < V_{OUT} \leq 5.0V$ (2) | | | 160 | -- | -- | |
| LX Leakage Current | | $I_{LEAKAGE}$ | $V_{LX}$ = 6.0V | -- | -- | 1.0 | µA |
| Maximum Oscillator Frequency | | $F_{MAX}$ | $V_{OUT}$ = 2.5V to 5.0V | 140 | 190 | 240 | kHz |
| | | | $V_{OUT}$ = 1.8V to 2.4V | 140 | 190 | 320 | kHz |
| Oscillator Duty Cycle | | $D_{OSC}$ | On ($V_{LX}$ "L") side | 65 | 75 | 85 | % |
| Efficiency | | | | -- | 80 | -- | % |
| $V_{LX}$ Voltage Limit | | | LX Switch on | 0.65 | 0.8 | 1.0 | V |
| EN "High" Voltage | | $V_{ENH}$ | Same as $I_{DD1}$, LX Pin Oscillation Start | 0.9 | -- | -- | V |
| EN "Low" Voltage | | $V_{ENL}$ | Same as $I_{DD1}$, LX Pin Oscillation Stop | -- | -- | 0.4 | V |
| EN Input Bias Current | | $I_{BIAS\text{-}EN}$ | Same as $I_{DD1}$, $V_{EN}$ = 0 → 2.0V | -- | -- | 0.5 | µA |
| Shut-down Current | | $I_{SHDN}$ | Same as $I_{DD1}$, $V_{EN}$ = 0V | -- | -- | 2 | µA |

Notes:

(1) $V_{IN}$ = 1.8V, $V_{SS}$ = 0V, $I_{OUT}$ = 1mA, $T_A$ = 25° C.

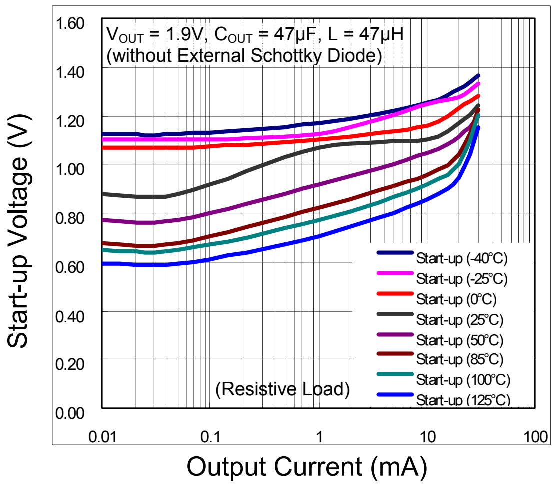
(2) $V_{IN}$ = 3.0V, $V_{SS}$ = 0V, $I_{OUT}$ = 1mA, $T_A$= 25°C.

## Function Block Diagram

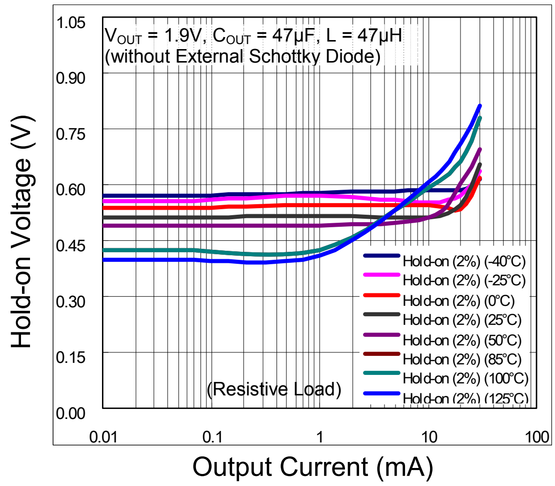


## Typical Operating Characteristics
($V_{OUT}$ = 1.9V, $C_{IN}$ = 10μ F (Ceramic) , $C_{OUT}$ = 47μ F (Tantalum), L = 47μ H (0.62A), without External Schottky Diode, $T_A$ = 25℃)

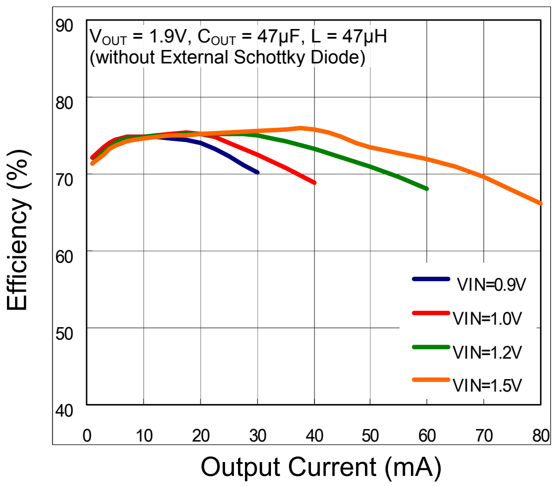
### Start-up Voltage vs. Output Current



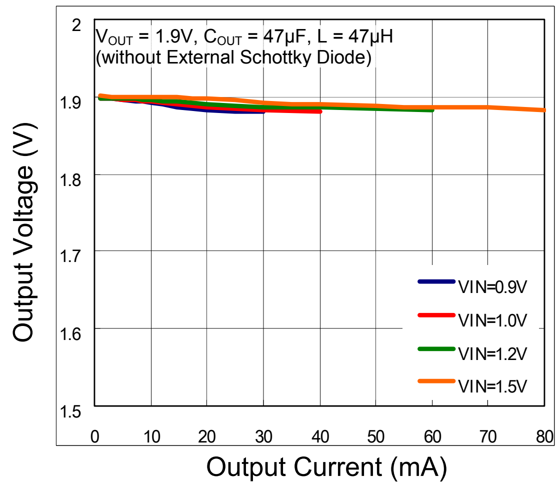

### Hold-on Voltage vs. Output Current



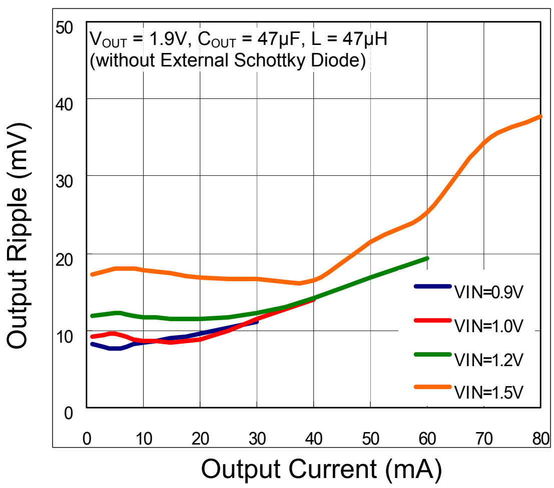

### Efficiency vs. Output Current



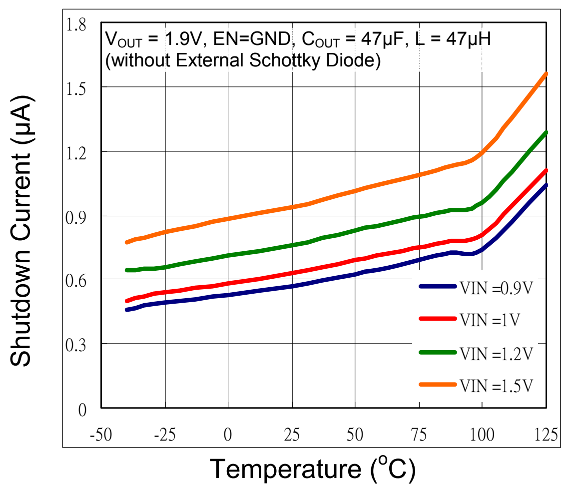

### Output Voltage vs. Output Current



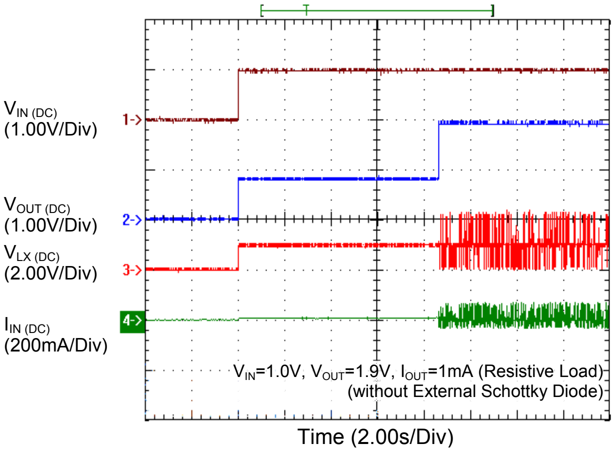

### Output Ripple vs. Output Current



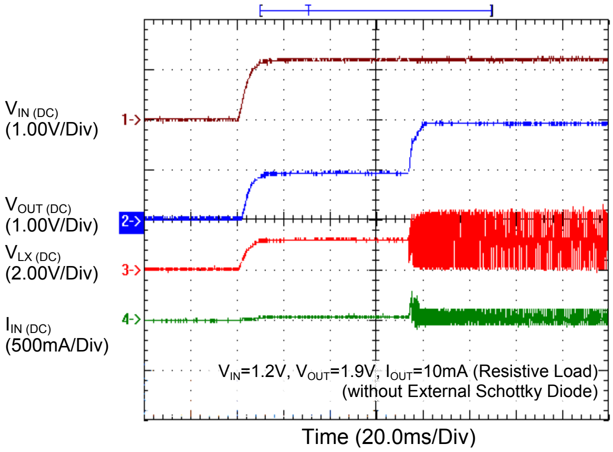

### Shutdown Current vs. Temperature



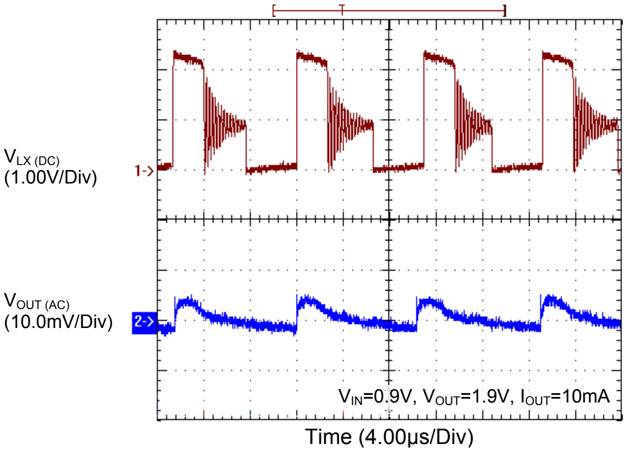
### Low Start-up Voltage at 1mA



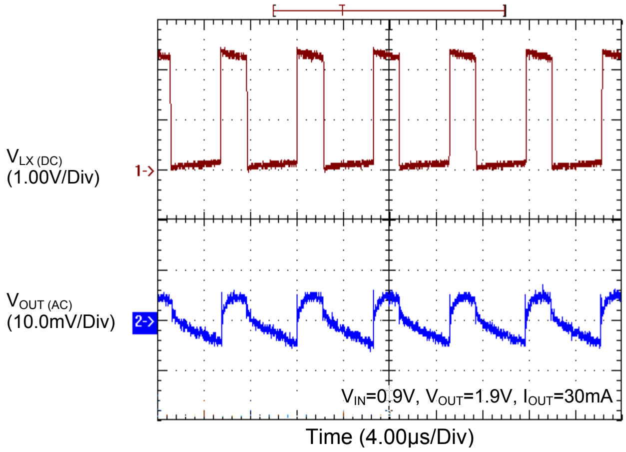

### Low Start-up Voltage at 10mA



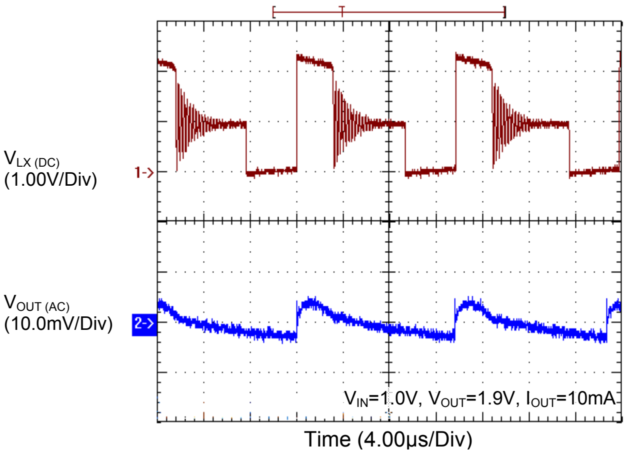

### Steady State Operation



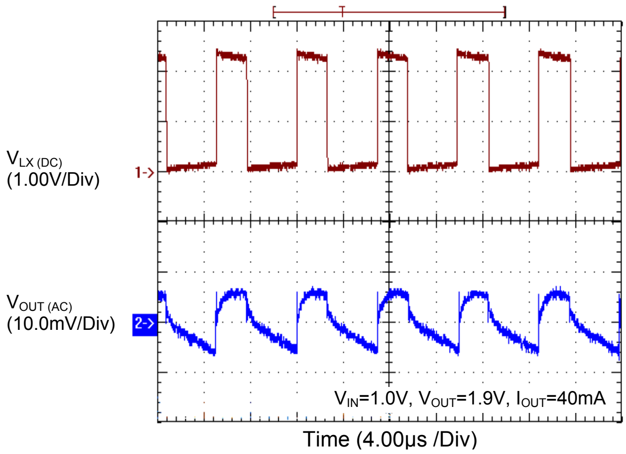

### Steady State Operation



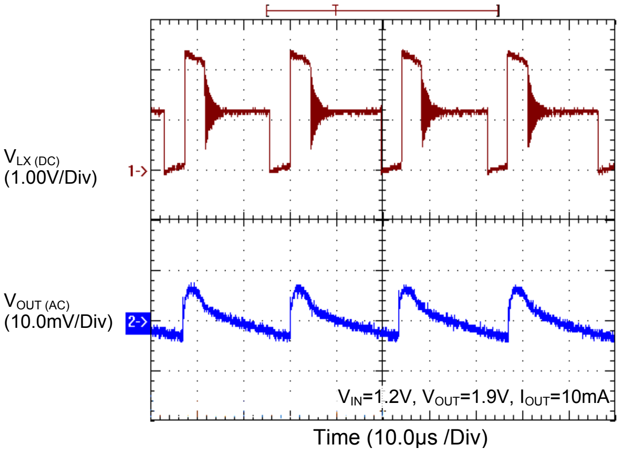

### Steady State Operation



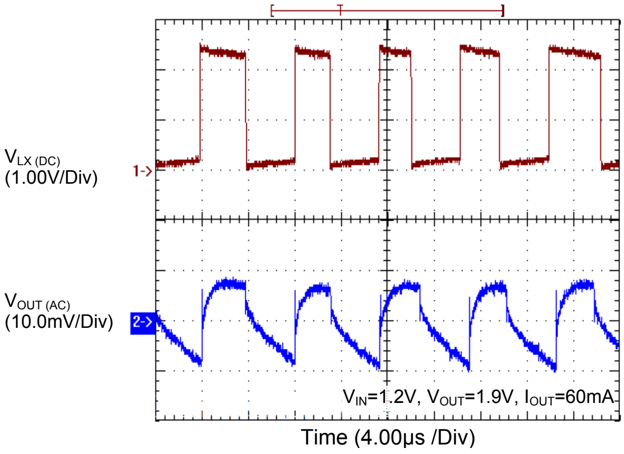

### Steady State Operation



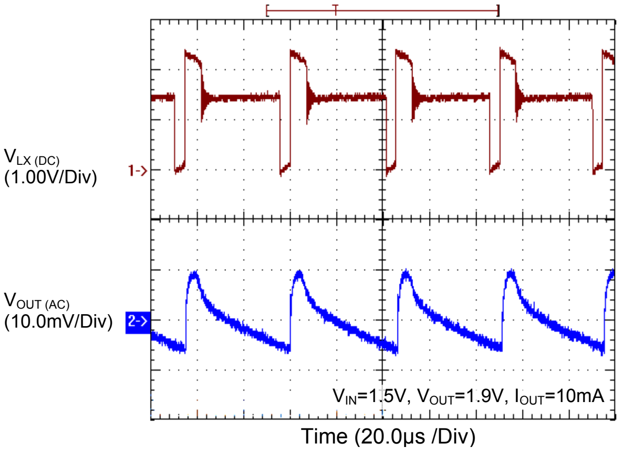
**Steady State Operation**



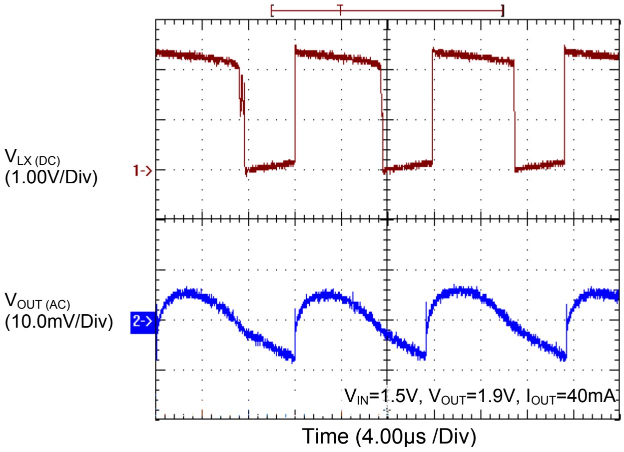

**Steady State Operation**




**Steady State Operation**




**Steady State Operation**



## Application Information

### Capacitor Selection

A 47μF tantalum (SMT) output filter capacitor typically provides 50mV to 100mV output ripple when stepping up from 3.0V to 5.0V at 1mA to 200mA. Smaller capacitors (down to 10μF with higher ESR) are acceptable for light loads or in applications that can tolerate higher output ripple. Values in the 10μF to 47μF range are recommended for the iD8603. The equivalent series resistance (ESR) of both bypass and filter capacitors affects efficiency and output ripple. The output voltage ripple is the product of the peak inductor current and the output capacitor's ESR. Use low-ESR capacitors for best performance, or connect two or more filter capacitors in parallel.

Figure 1: Typical Application Circuit for SOT-23-3

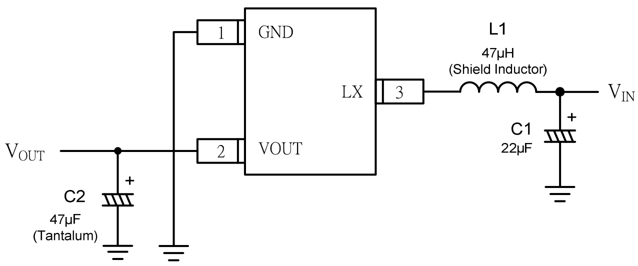



Figure 2: Typical Application Circuit for SOT-23-5

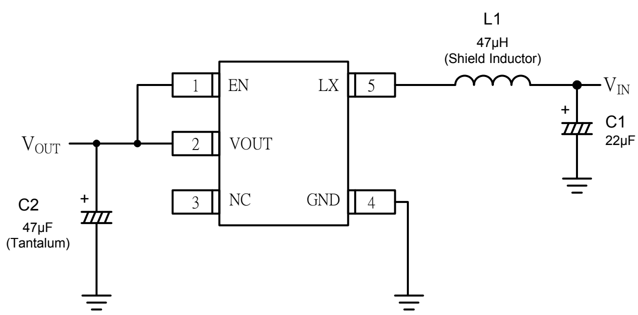
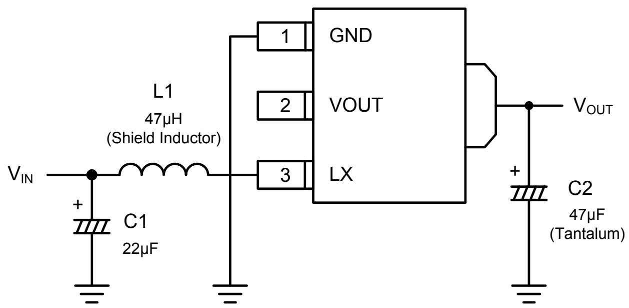



Figure 3: Typical Application Circuit for SOT-89-3




### Inductor Selection

An inductor value of 47μH performs well in iD8603 applications. However, the inductance value is not critical, and the iD8603 will work with inductors in the 10μH to 100μH range. Smaller inductance values typically offer a smaller physical size for a given series resistance, allowing the smallest overall circuit dimensions. However, due to higher peak inductor currents, the output voltage ripple also tends to be higher. Circuits using larger inductance values exhibit higher output current capability and larger physical dimensions for a given series resistance. The inductor's incremental saturation current rating should be greater than the peak switch-current limit, which is 240mA for the iD8603. However, it is generally acceptable to bias the inductor into saturation by as much as 20%, although this will slightly reduce efficiency. The inductor's DC resistance significantly affects efficiency.

### Thermal Considerations

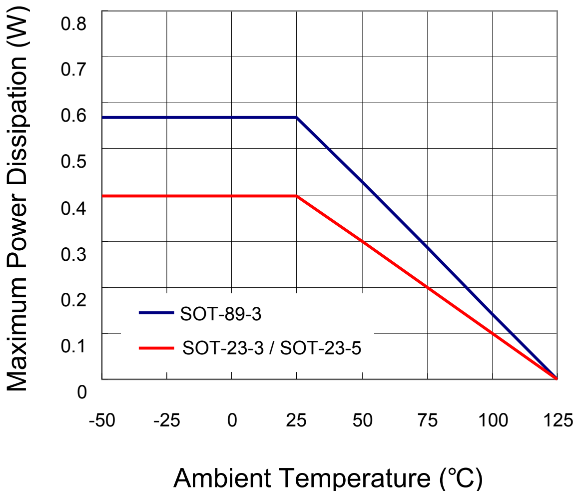
For continuous operation, do not exceed the maximum operation junction temperature 125℃. The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surroundings airflow and temperature difference between junctions to ambient. The maximum power dissipation can be calculated by following formula: $P_{D(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}}$

Where $T_{J\ (MAX)}$ is the maximum operation junction temperature 125℃, $T_A$ is the ambient temperature and the $\theta_{JA}$ is the junction to ambient thermal resistance. For recommended operating conditions specification of iD8603 where $T_{J\ (MAX)}$ is the maximum junction temperature of the die (125℃) and $T_A$ is the maximum ambient temperature. The junction to ambient thermal resistance $\theta_{JA}$ is layout dependent. For SOT-89-3 packages, the thermal resistance $\theta_{JA}$ is 175℃/W on the standard JEDEC 51-7 four-layers thermal test board. The maximum power dissipation at $T_A$ = 25℃ can be calculated by following formula:

$P_{D(MAX)}$ = (125℃ - 25℃) / (175℃/W) = 0.571W

for SOT-89-3 packages. The maximum power dissipation depends on operating ambient temperature for fixed $T_{J\ (MAX)}$ and thermal resistance $\theta_{JA}$. For iD8603 packages, the Figure 4 of de-rating curves allows the designer to see the effect of rising ambient temperature on the maximum power allowed.

Figure 4: Maximum Power Dissipation



## Layout Considerations

Careful PC board layout is important for minimizing ground bounce and noise. Keep the IC's GND pin and the ground leads of the input and output capacitors less than 0.2in (5mm) apart using a ground plane. In addition, keep all connections to VOUT and LX as short as possible.

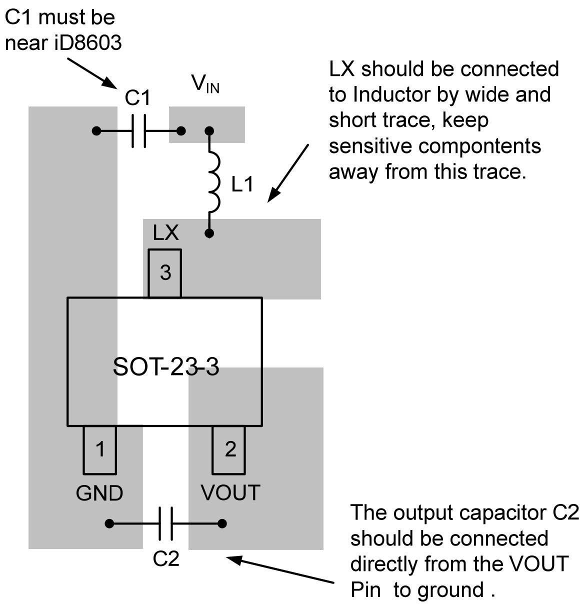



**Figure5. PCB Layout Guide (SOT-23-3)**

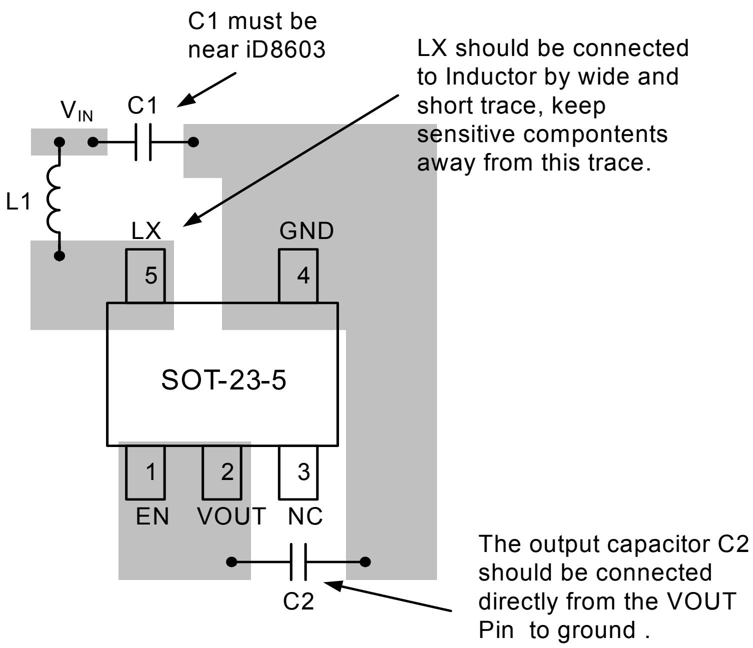



**Figure6. PCB Layout Guide (SOT-23-5)**

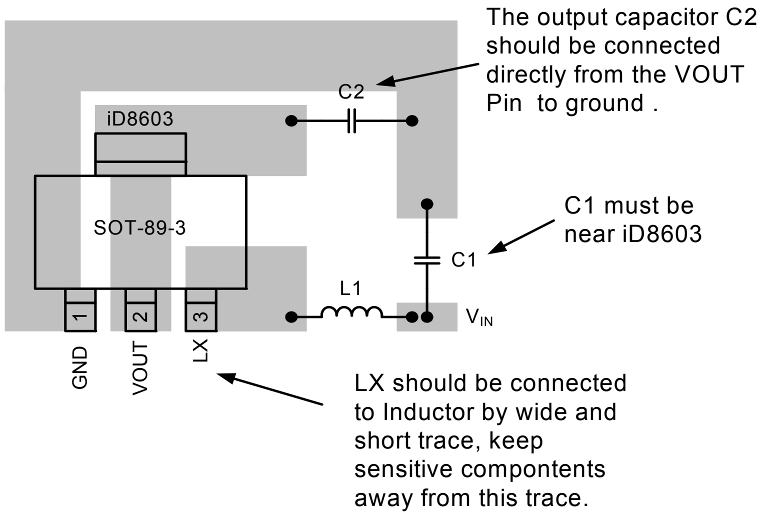
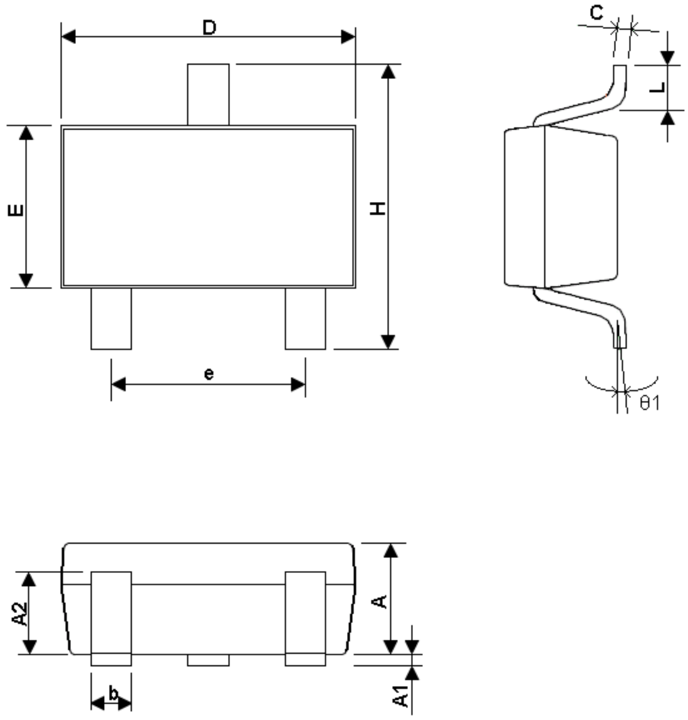



**Figure7. PCB Layout Guide (SOT-89-3)**

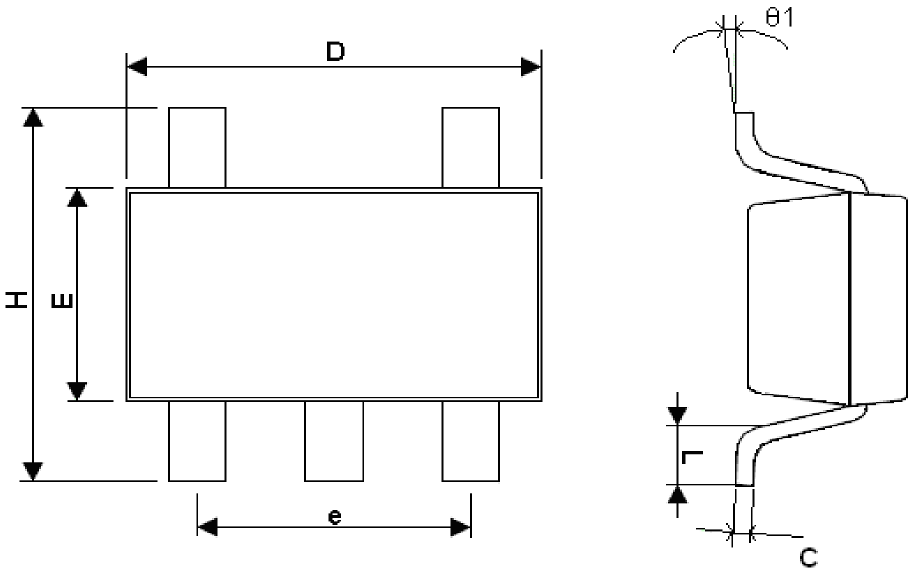
# Packaging

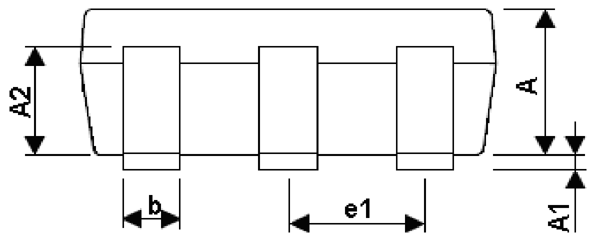
## SOT-23-3




| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.00 | 1.10 | 1.30 | 0.039 | 0.043 | 0.051 |
| A1 | 0.00 | --- | 0.10 | 0.000 | --- | 0.004 |
| A2 | 0.70 | 0.80 | 0.90 | 0.027 | 0.031 | 0.035 |
| b | 0.35 | 0.40 | 0.50 | 0.013 | 0.016 | 0.020 |
| C | 0.10 | 0.15 | 0.25 | 0.004 | 0.006 | 0.001 |
| D | 2.70 | 2.90 | 3.10 | 0.106 | 0.114 | 0.122 |
| E | 1.40 | 1.60 | 1.80 | 0.055 | 0.063 | 0.071 |
| e | --- | 1.90(TYP) | --- | --- | 0.075 | --- |
| H | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.118 |
| L | 0.370 | --- | --- | 0.015 | --- | --- |
| Θ1 | 1° | 5° | 9° | 1° | 5° | 9° |

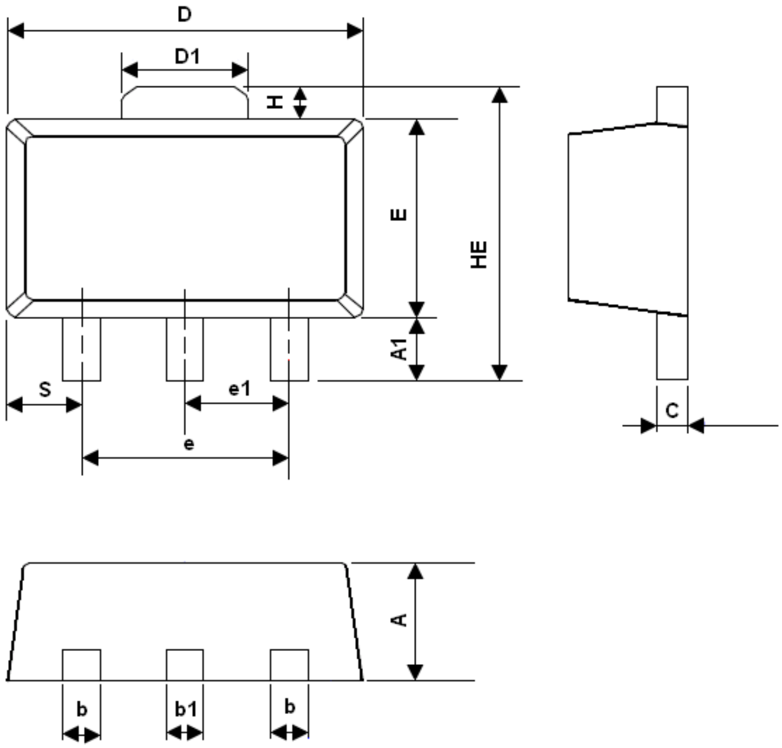
# SOT-23-5




| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.00 | 1.10 | 1.30 | 0.039 | 0.043 | 0.051 |
| A1 | 0.00 | --- | 0.10 | 0.000 | --- | 0.004 |
| A2 | 0.70 | 0.80 | 0.90 | 0.027 | 0.031 | 0.035 |
| b | 0.35 | 0.40 | 0.50 | 0.013 | 0.016 | 0.020 |
| C | 0.10 | 0.15 | 0.25 | 0.004 | 0.006 | 0.001 |
| D | 2.70 | 2.90 | 3.10 | 0.106 | 0.114 | 0.122 |
| E | 1.50 | 1.60 | 1.80 | 0.059 | 0.063 | 0.071 |
| e | --- | 1.90(TYP) | --- | --- | 0.075 | --- |
| H | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.118 |
| L | 0.370 | --- | --- | 0.015 | --- | --- |
| Θ1 | 1° | 5° | 9° | 1° | 5° | 9° |
| e1 | --- | 0.95(TYP) | --- | --- | 0.037 | --- |

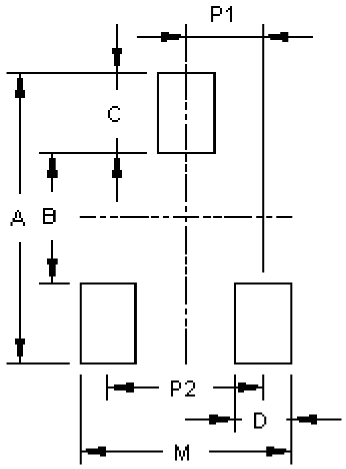
# SOT-89-3




| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCH | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.40 | 1.50 | 1.60 | 0.055 | 0.059 | 0.063 |
| A1 | 0.80 | 1.04- | --- | 0.031 | 0.041 | --- |
| b | 0.36 | 0.42 | 0.48 | 0.014 | 0.016 | 0.018 |
| b1 | 0.41 | 0.47 | 0.53 | 0.016 | 0.185 | 0.020 |
| C | 0.38 | 0.40 | 0.43 | 0.014 | 0.016 | 0.017 |
| D | 4.40 | 4.50 | 4.600 | 0.173 | 0.177 | 0.181 |
| D1 | 1.40 | 1.60 | 1.75 | 0.055 | 0.062 | 0.069 |
| HE | --- | --- | 4.25 | --- | --- | 0.167 |
| E | 2.40 | 2.50 | 2.60 | 0.094 | 0.098 | 0.102 |
| e | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| H | 0.35 | 0.40 | 0.45 | 0.014 | 0.016 | 0.018 |
| S | 0.65 | 0.75 | 0.85 | 0.026 | 0.030 | 0.034 |
| e1 | 1.40 | 1.50 | 1.60 | 0.054 | 0.059 | 0.063 |

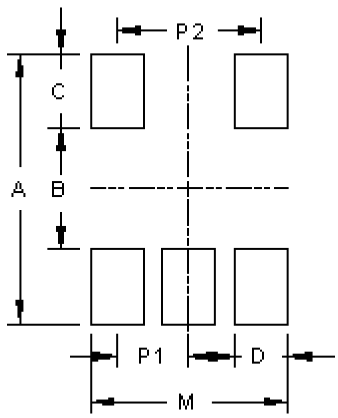
# Footprint

## SOT-23-3



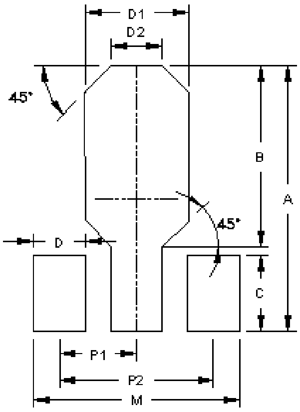

| Package | Number of PIN | Footprint Dimension (mm) | | | | | | | Tolerance |
|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | A | B | C | D | M | |
| SOT-23-3 | 3 | 0.95 | 1.90 | 3.60 | 1.60 | 1.00 | 0.80 | 2.70 | ±0.10 |

## SOT-23-5




| Package | Number of Pin | Footprint Dimension (mm) | | | | | | | Tolerance |
|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | A | B | C | D | M | |
| SOT-23-5 | 5 | 0.95 | 1.90 | 3.60 | 1.60 | 1.00 | 0.70 | 2.60 | ±0.10 |

# SOT-89-3




| Package | Number of Pin | Footprint Dimension (mm) | | | | | | | | | | Tolerance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | A | B | B1 | C | D | D1 | D2 | M | |
| SOT-89-3 | 3 | 1.50 | 3.00 | 5.10 | 3.40 | -- | 1.50 | 1.00 | 2.20 | 1.00 | 4.00 | ±0.10 |