PFM Step-Up DC-DC Converters

General Description

The iD8602 compact, high-efficiency, PFM step-up DC-DC converters are available in SOT-89-3 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.

It also feature proprietary noise-reduction circuitry, which suppresses electromagnetic interference (EMI) caused by the inductor in many step-up applications. The family offers different combinations of fixed or adjustable outputs, shutdown, and EMI reduction.

Ordering Information

iD8602 - □□ □□□ □

Taping
R: Tape and Reel

Package
A22:SOT-89-3 F Type
A50:SOT-23-5

Output Voltage	Voltage Code
3.0 V	30
3.3 V	33
5.0 V	50

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)

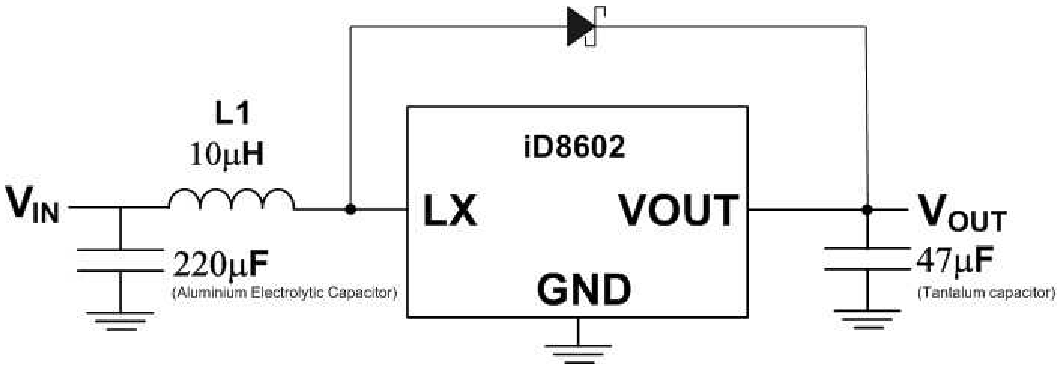
Features

- Up to 85% Efficiency
- Ultra Low Input Current (9µA at Switch Off)
- 0.1µA Logic-Controlled Shutdown
- ±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, 0.8V at 1mA
- Internal EMI Suppression
- 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



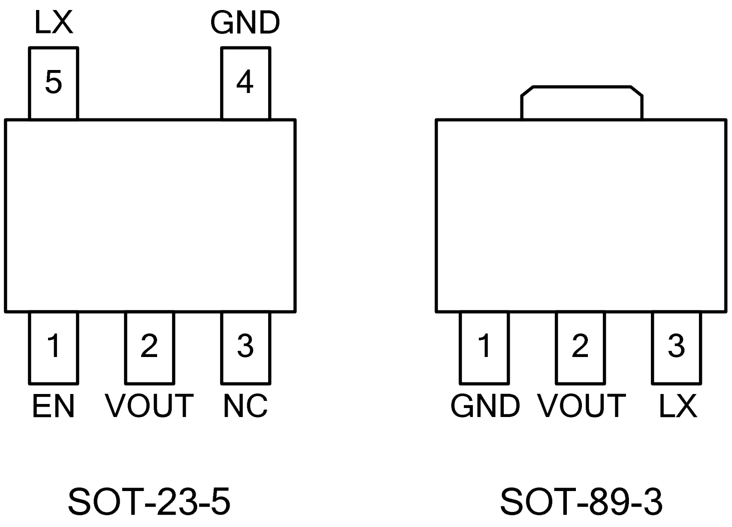
Absolute Maximum Ratings

Supply Voltage V_{IN}	7V
Power Dissipation, P_D @ T_A=25℃	
SOT-89-3	571mW
SOT-23-5	400mW
Thermal Resistance, θja	
SOT-89-3	175°C/W
SOT-23-5	250℃/W
Lead Temperature	260 ℃
Storage Temperature	-65℃ to 150℃
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℃ to 125℃
Ambient Operating Temperature	-40℃ to 85℃

Pin Configurations (TOP VIEW)



Pin Description

SOT-23-5	SOT-89	Name	Description
5	3	LX	Pin for Switching
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	VOUT	Output Voltage

Electrical Characteristics

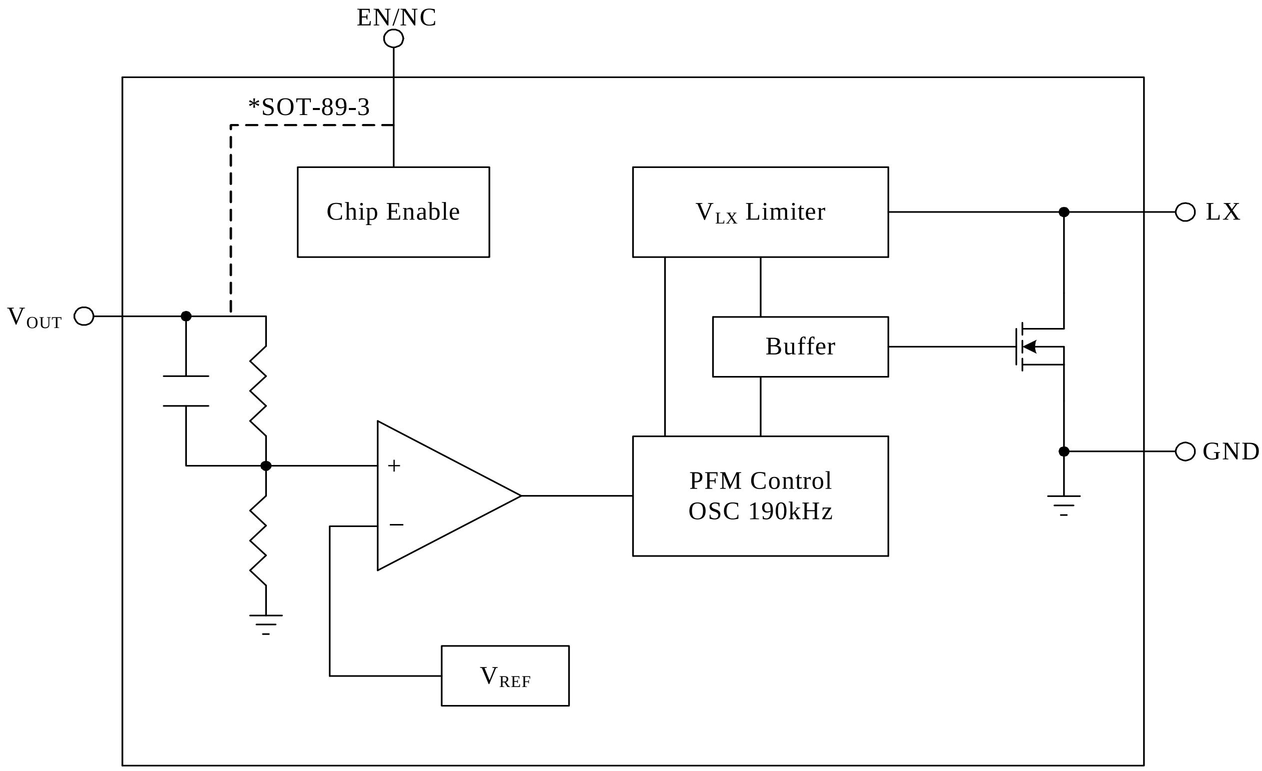
<table>
<tr><th colspan="2">Parameter</th><th>Symbol</th><th>Test Conditions</th><th>Min</th><th>Typ</th><th>Max</th><th>Units</th></tr>
<tr><td colspan="2">Output Voltage Accuracy</td><td>ΔV_{OUT}</td><td></td><td>-2</td><td>--</td><td>+2</td><td>%</td></tr>
<tr><td colspan="2">Input Voltage</td><td>V_{IN}</td><td></td><td>--</td><td>--</td><td>7</td><td>V</td></tr>
<tr><td colspan="2">Start-up Voltage</td><td>V_{ST}</td><td>I_{OUT} = 1mA, V_{IN}: 0 → 2.0V</td><td>--</td><td>0.8</td><td>1</td><td>V</td></tr>
<tr><td colspan="2">Hold-on Voltage</td><td>V_{HO}</td><td>I_{OUT} = 1mA, V_{IN}: 0 ← 2.0V</td><td>0.7</td><td>--</td><td>--</td><td>V</td></tr>
<tr><td rowspan="2">Input Current 1</td><td>V_{OUT} ≤3.5V [1]</td><td rowspan="2">I_{DD1}</td><td rowspan="2">To be measured at V_{IN} continuous switching</td><td>--</td><td>35</td><td>--</td><td rowspan="2">μA</td></tr>
<tr><td>3.5V＜V_{OUT} ≤5.0V [2]</td><td>--</td><td>40</td><td>--</td></tr>
<tr><td>Input Current 2 [1][2]</td><td></td><td>I_{DD2}</td><td>To be measured at V_{OUT} in switch off condition</td><td>--</td><td>9</td><td>--</td><td>μA</td></tr>
<tr><td rowspan="2">Input Current 3</td><td>V_{OUT} ≦3.5V [1]</td><td rowspan="2">I_{IN}</td><td rowspan="2">To be measured at V_{IN} in on load (guaranteed by I_1 and I_2)</td><td>--</td><td>23</td><td>--</td><td rowspan="2">μA</td></tr>
<tr><td>3.5V＜V_{OUT} ≤5.0V [2]</td><td>--</td><td>28</td><td>--</td></tr>
<tr><td rowspan="2">LX Switching Current</td><td>V_{OUT} ≦3.5V [1]</td><td rowspan="2">$I_{SWITCHING}$</td><td rowspan="2">V_{LX} = 0.4V</td><td>120</td><td>--</td><td>--</td><td rowspan="2">mA</td></tr>
<tr><td>3.5V＜V_{OUT} ≤5.0V [2]</td><td>160</td><td>--</td><td>--</td></tr>
<tr><td colspan="2">LX Leakage Current</td><td>$I_{LEAKAGE}$</td><td>V_{LX} = 6.0V</td><td>--</td><td>--</td><td>1.0</td><td>μA</td></tr>
<tr><td colspan="2" rowspan="2">Maximum Oscillator Frequency</td><td rowspan="2">F_{MAX}</td><td>V_{OUT} = 2.5V to 5.0V</td><td>140</td><td>190</td><td>240</td><td>kHz</td></tr>
<tr><td>V_{OUT} = 1.8V to 2.4V</td><td>140</td><td>190</td><td>320</td><td>kHz</td></tr>
<tr><td colspan="2">Oscillator Duty Cycle</td><td>D_{OSC}</td><td>On (V_{LX} “L”) side</td><td>65</td><td>75</td><td>85</td><td>%</td></tr>
<tr><td colspan="2">Efficiency</td><td></td><td></td><td>--</td><td>80</td><td>--</td><td>%</td></tr>
<tr><td colspan="2">V_{LX} Voltage Limit</td><td></td><td>LX Switch on</td><td>0.65</td><td>0.8</td><td>1.0</td><td>V</td></tr>
</table>

Notes:

(1) V_{IN} = 1.8V, V_{SS} = 0V, I_{OUT} = 1mA, T_A = 25°C, and use External Circuit of Typical Applic ation

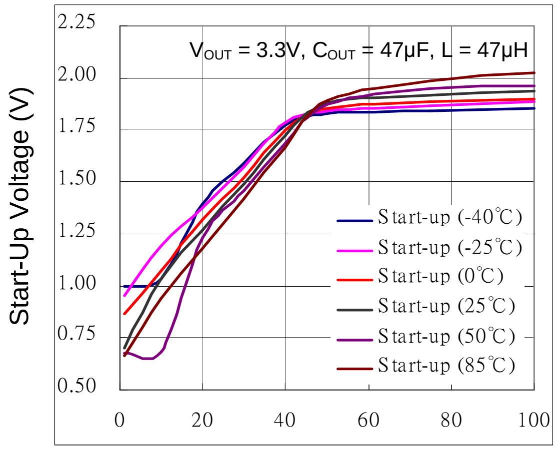
(2) V_{IN} = 3.0V, V_{SS} = 0V, I_{OUT} = 1mA, T_A= 25℃, and External Circuit of Typical Application

Function Block Diagram

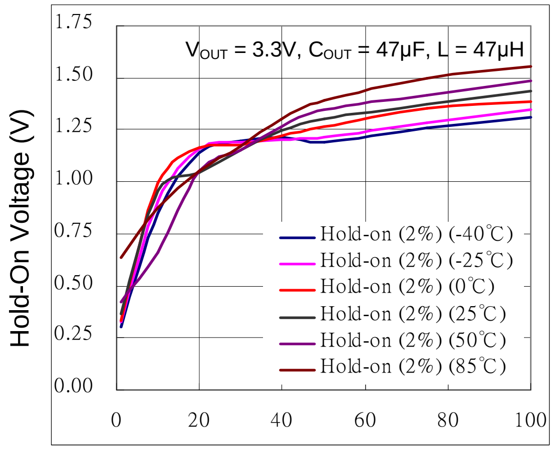


Typical Operating Characteristics

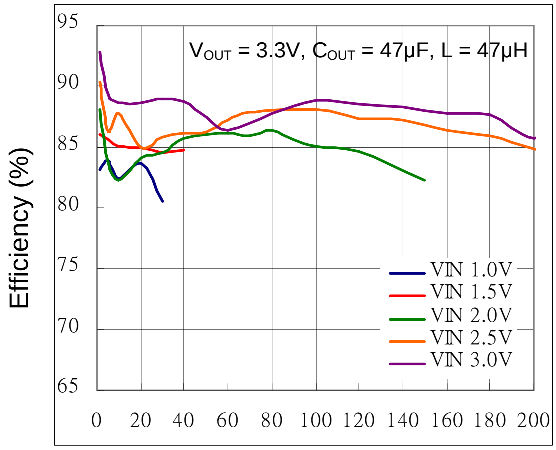
Start-Up Voltage vs. Temperature



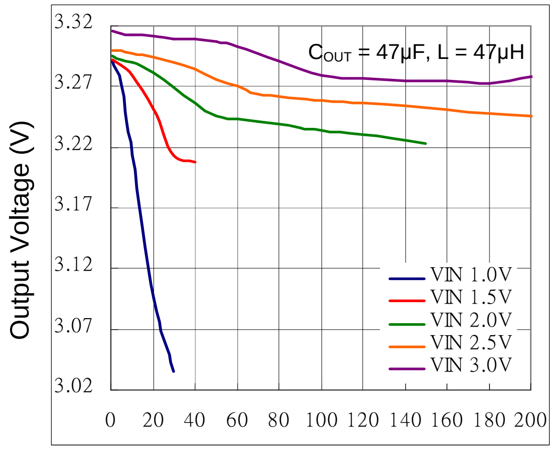
Hold-On Voltage vs. Temperature



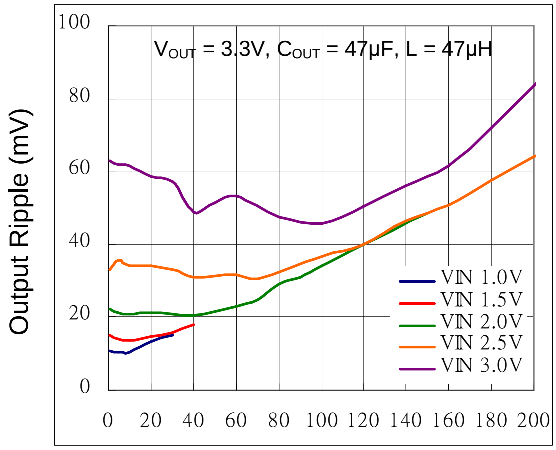
Efficiency vs. Output Current



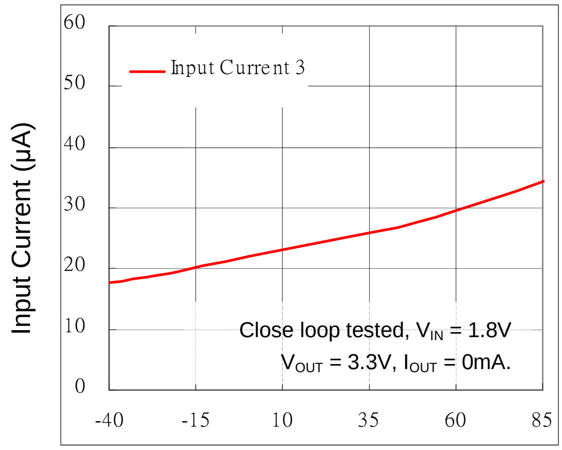
Output Voltage vs. Output Current



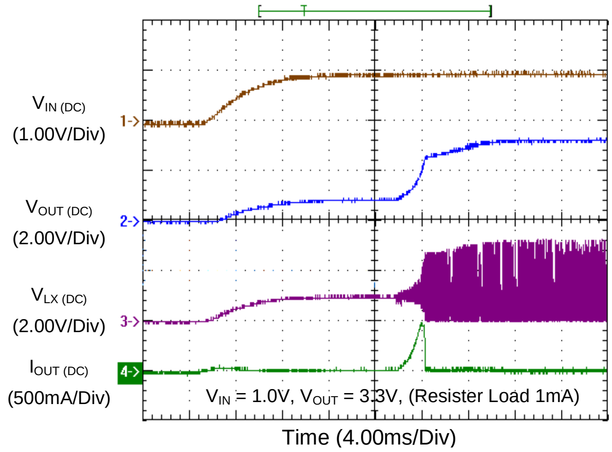
Output Ripple vs. Output Current



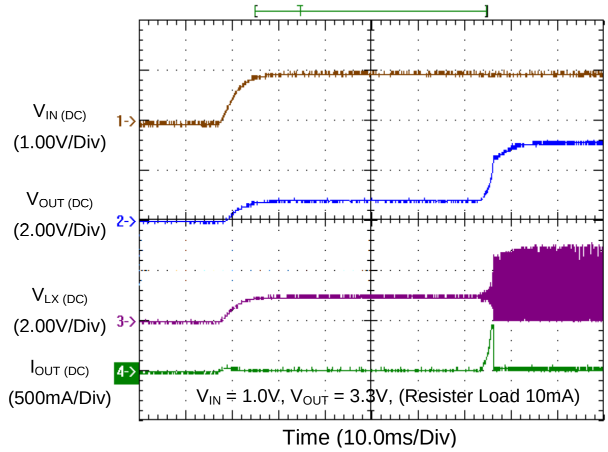
Input Current vs. Temperature



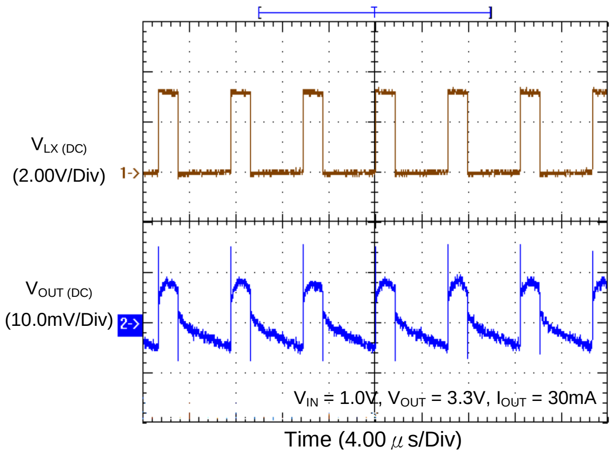
Low Start-up Voltage at 1mA



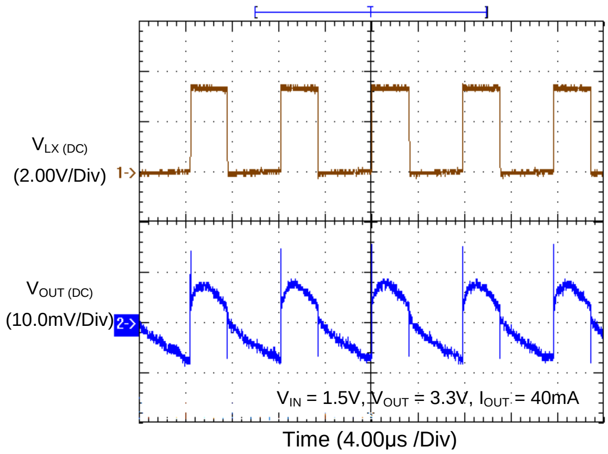
Low Start-up Voltage at 10mA



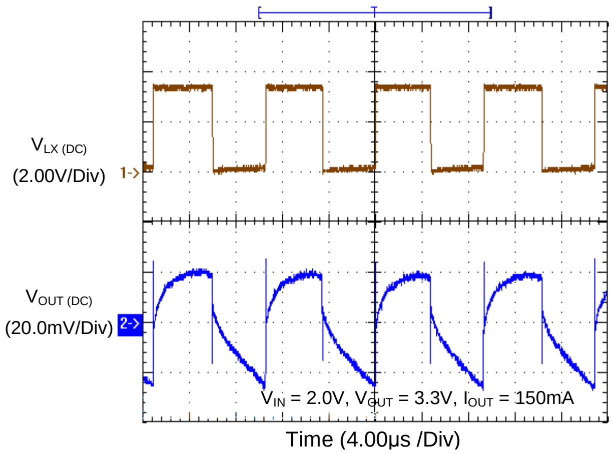
Steady State Operation (V_{IN} = 1.0V)



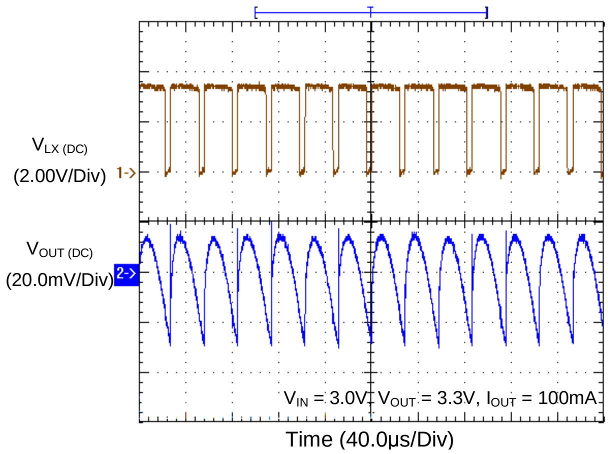
Steady State Operation (V_{IN} = 1.5V)



Steady State Operation (V_{IN} = 2.0V)



Steady State Operation (V_{IN} = 3.0V)



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 ESRs) 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 iD8602. 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.

Inductor Selection

An inductor value of 47μH performs well in iD8602 applications. However, the inductance value is not critical, and the iD8602 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 iD8602. 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.

Rectifier Diode

For optimum performance, a switching Schottky diode is recommended. For low output power applications, a PN-junction switching diode will also work well, although its greater forward voltage drop will reduce efficiency.

Thermal Considerations

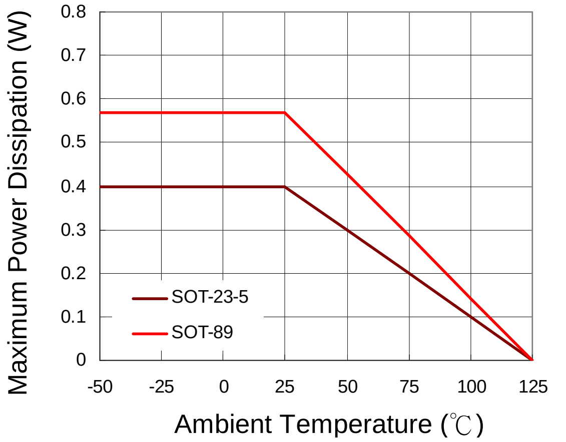
For continuous operation, do not exceed the maximum operation junction temperature 125℃. The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surroundings airflow and temperature difference between junctions to ambient. The maximum power dissipation can 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 θ_{JA} is the junction to ambient thermal resistance. For recommended operating conditions specification of iD8602 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 θ_{JA} is layout dependent. For SOT-89-3 packages, the thermal resistance θ_{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 θ_{JA}. For iD8602 packages, the Figure 3 of de-rating curves allows the designer to see the effect of rising ambient temperature on the maximum power allowed.

Figure 3: 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.

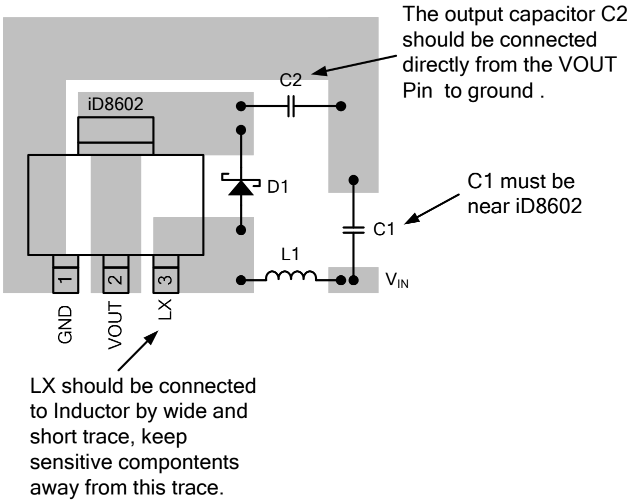


Figure1. PCB Layout Guide (SOT-89-3)

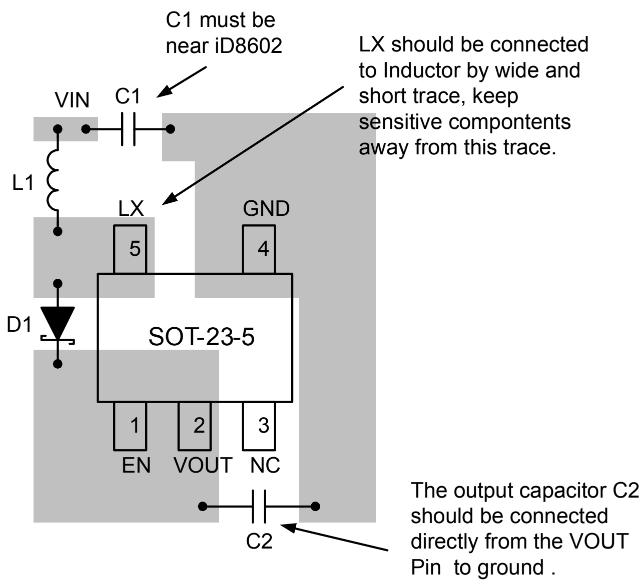
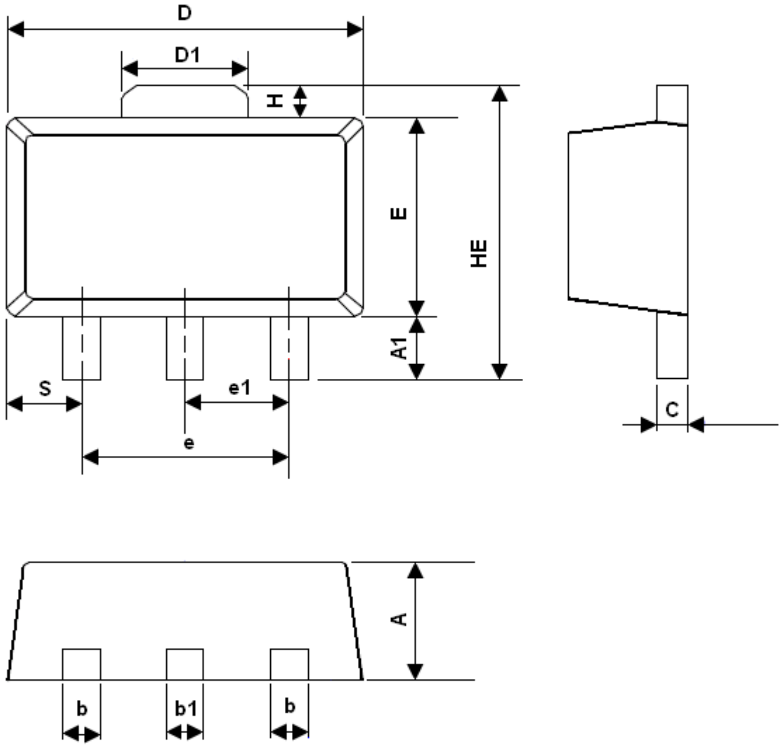


Figure2. PCB Layout Guide (SOT-23-5)

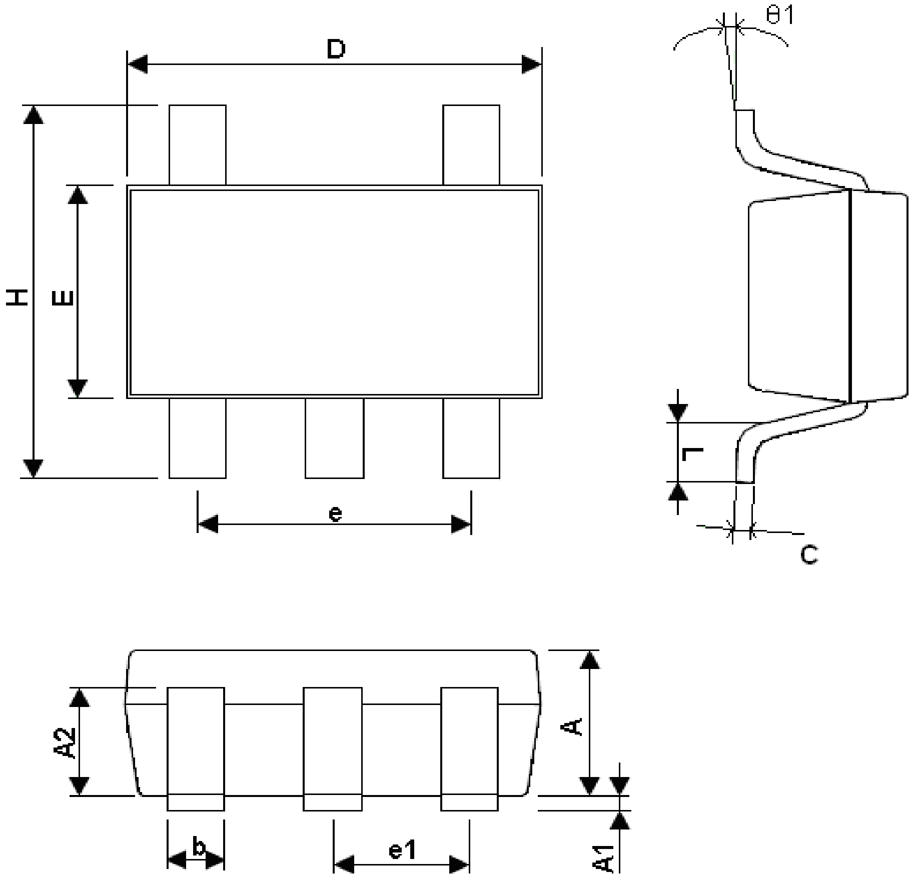
Packaging

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

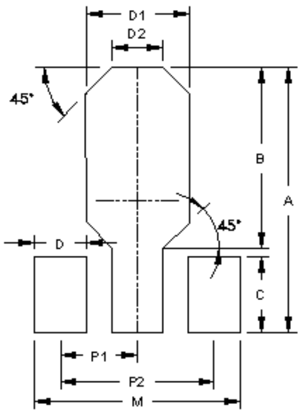
SOT-23-5



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MAX	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	---

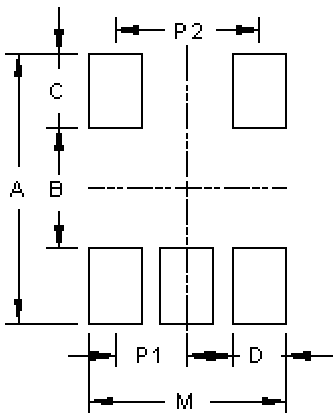
Footprint

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

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