General Description

The EC9203 is a compact, high-efficiency, PFM step-up DC-DC converter, which is available in SOT89-3,SOT23-3 and SOT23-5 packages. The EC9203 features an extremely low quiescent supply current to ensure the highest possible light-load efficiency. Optimized for operation from one or two alkaline or nickel-metal-hydride (NiMH) battery cells, or a single Li+ cell, the EC9203 is ideal for applications where extremely low quiescent current and ultra-small size are critical.

The EC9203 also integrates an internal Schottky diode to reduces PCB board area, lower BOM cost and increase overall conversion efficiency. The EC9203 family offers different combinations of fixed or adjustable output voltage.

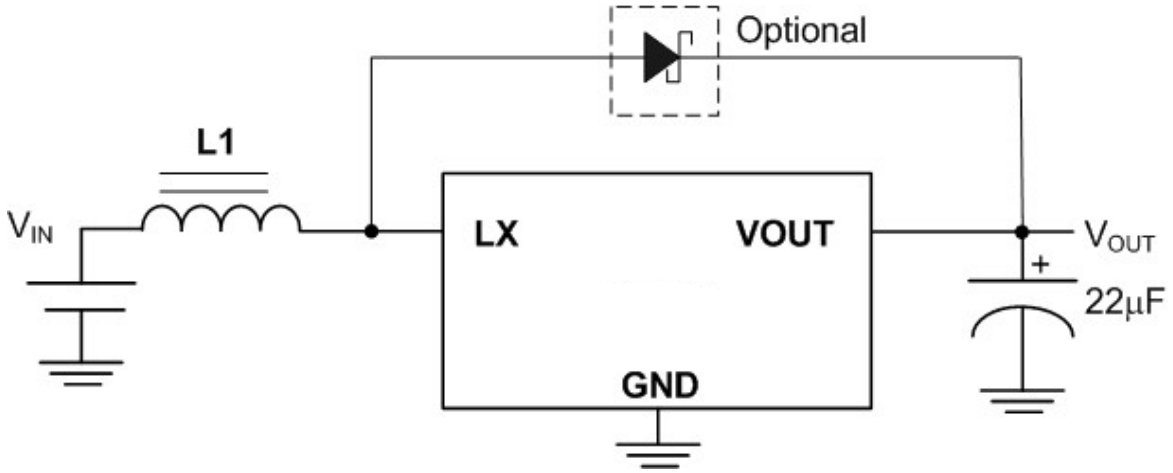
Features

- Remote Wireless Transmitters
- Personal Medical Devices
- Digital Still Cameras
- Single-Cell Battery-Powered Devices
- Low-Power Hand-Held Instruments
- Wireless Mouse

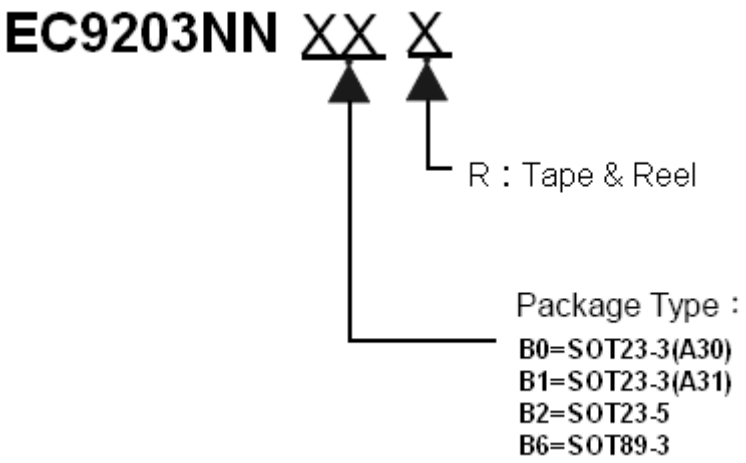
Applications

- Up to 200mA Output Current
- Internal Schottky Diode
- Up to 81% Efficiency (External Schottky Diode)
- Ultra Low Input Current (9μA at Switch Off)
- ±2.0% Output Voltage Accuracy
- Fixed Output Voltage
- 0.8V to 5.5V Input Voltage Range
- Low Start-up Voltage, 0.9V at 1mA
- SOT23-3,SOT23-5 and SOT89-3 Package

Typical Application Circuit



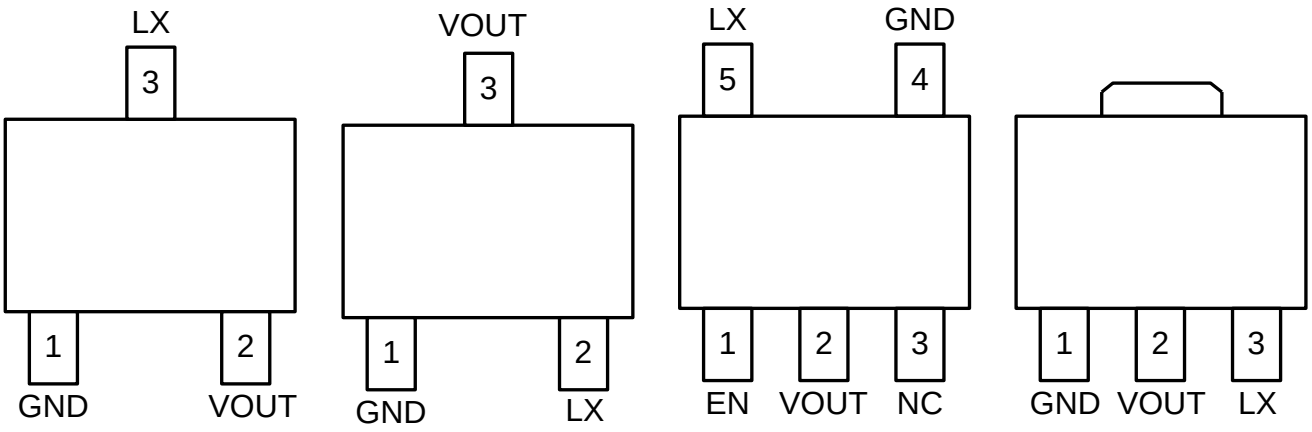
Ordering Information



Device	Marking Information	Package Type	Remarks
EC9203NNB0R	9203 LLLL0	SOT23-3 (A30)	1. LLLL：Lot No
EC9203NNB1R	9203 LLLL1	SOT23-3 (A31)	
EC9203NNB2R	9203 LLLL	SOT23-5	
EC9203NNB6R		SOT89-3	

Pin Configurations

(TOP VIEW)



SOT23-3 (A30) SOT23-3 (A31) SOT23-5 SOT89-3

Pin Description

SOT23-3 (A30)	SOT23-3 (A31)	SOT23-5	SOT89-3	Name	Description
3	2	5	3	LX	Pin for Switching
1	1	4	1	GND	Ground
--	--	1	--	EN	Chip Enable (Active High). Note that this pin is high impedance. There should be a pull low 100k resistor connected to GND when the control signal is floating.
--	--	3	--	NC	No Connecting
2	3	2	2	VOUT	Output Voltage

Absolute Maximum Ratings (Note1)

Supply Voltage V_{IN} 7V

Power Dissipation, P_D @ T_A=25°C

SOT89-3 571mW

SOT23-3 & SOT23-5 400mW

Thermal Resistance, θ_{JA}

SOT89-3 175°C/W

SOT23-3 & SOT23-5 250°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

Electrical Characteristics

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

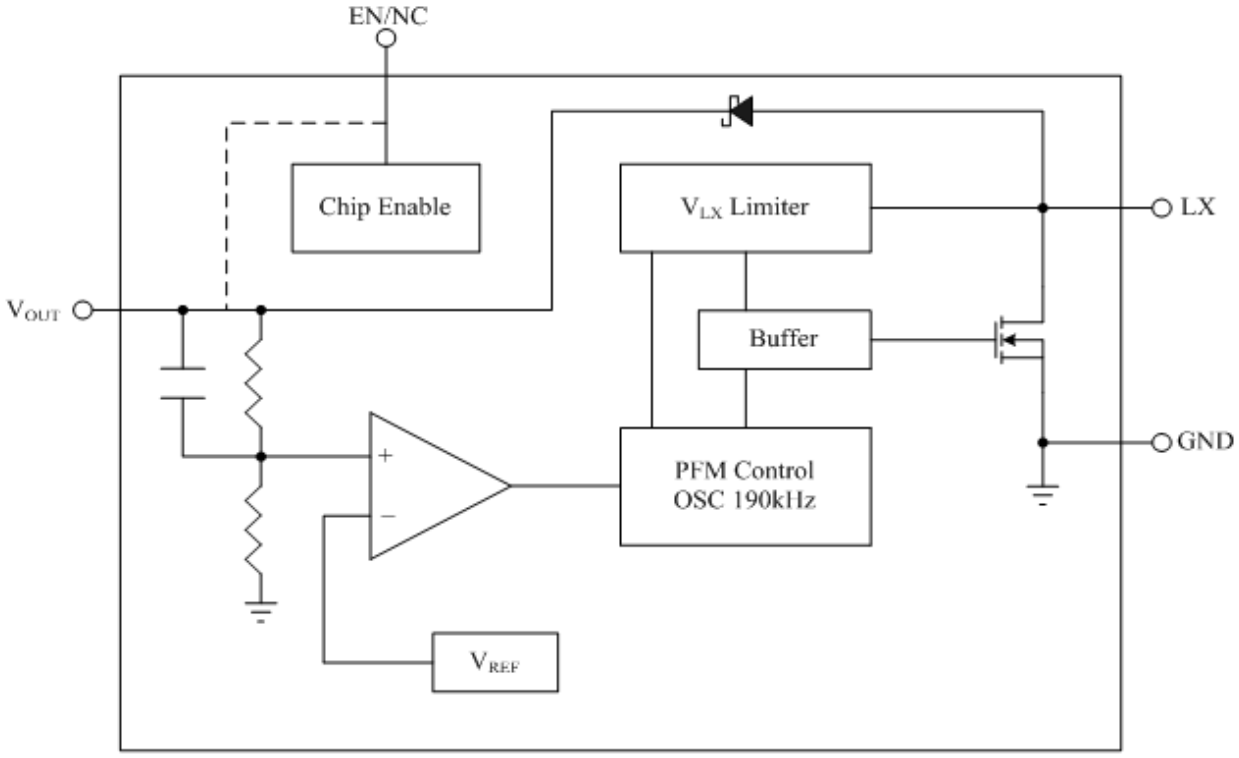
Notes:

(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.

Parameter		Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage Accuracy		ΔV_{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} ≤3.5V (1)	I_{DD1}	To be measured at V_{IN} continuous switching	--	35	--	μA
	3.5V < V_{OUT} ≤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} ≦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} ≤5.0V (2)			--	28	--	
LX Switching Current	V_{OUT} ≦3.5V (1)	$I_{SWITCHING}$	V_{LX} = 0.4V	120	--	--	mA
	3.5V < V_{OUT} ≤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		$I_{BIAS-EN}$	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

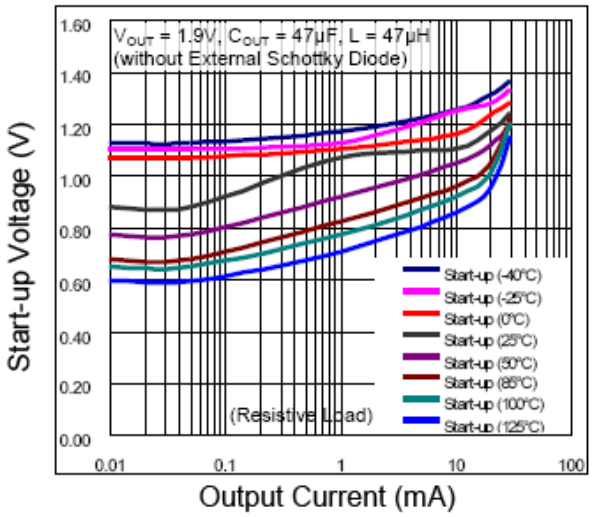
Function Block Diagram



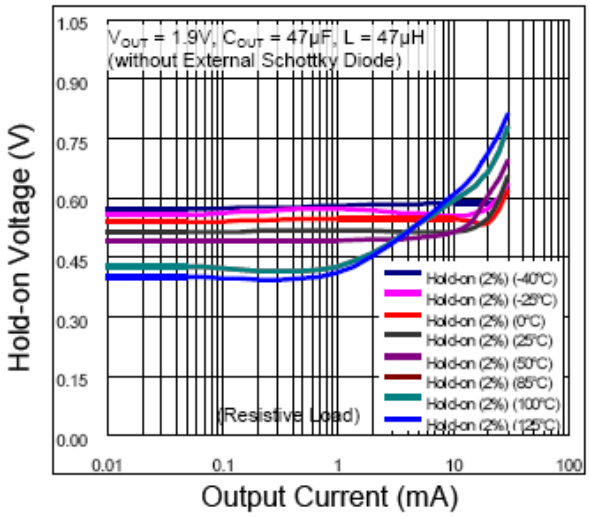
Typical Operating Characteristics

(V_{OUT} = 1.9V, C_{IN} = 10μF (Ceramic) , C_{OUT} = 47μF (Tantalum), L = 47μH (0.62A), without External Schottky Diode, T_A = 25℃)

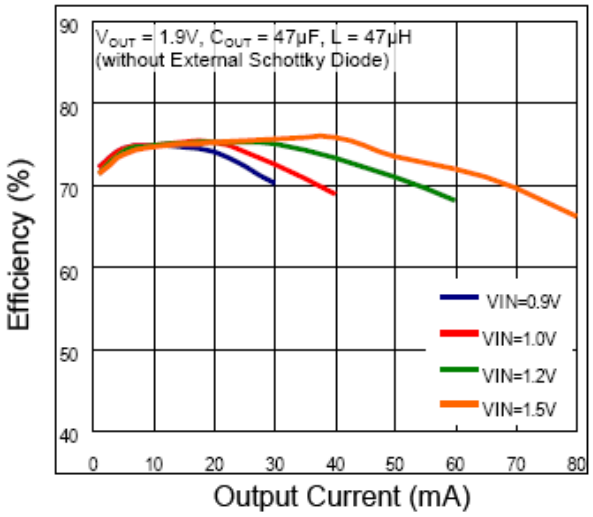
Start-up Voltage vs. Output Current



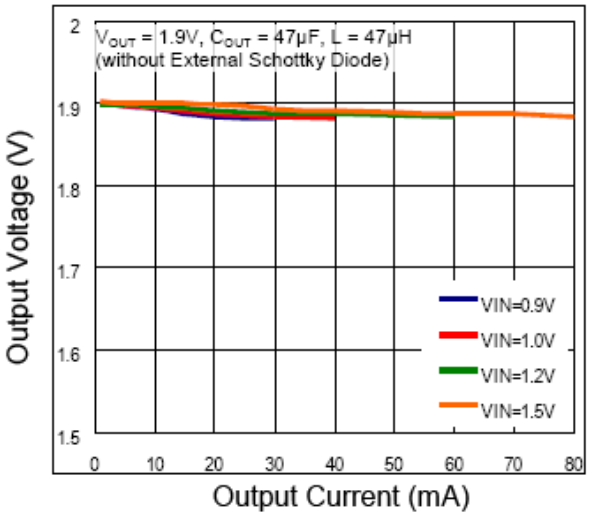
Hold-on Voltage vs. Output Current



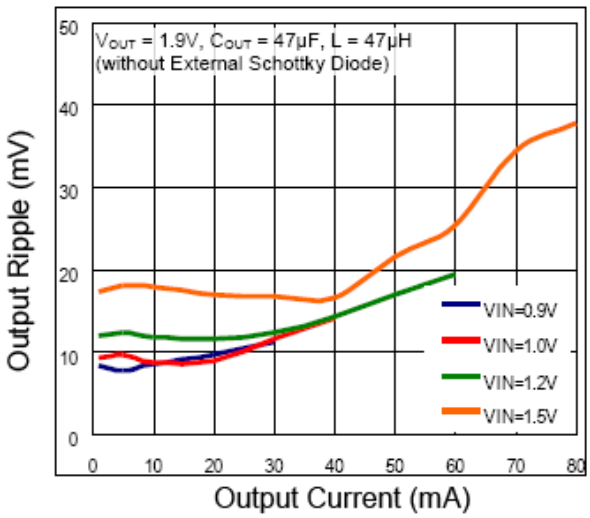
Efficiency vs. Output Current



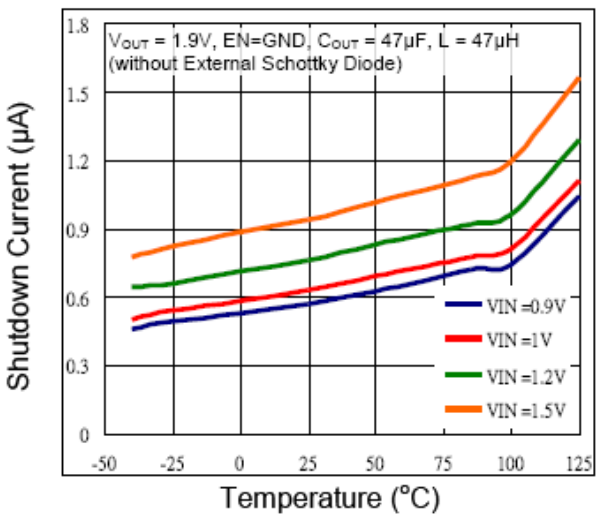
Output Voltage vs. Output Current



Output Ripple vs. Output Current

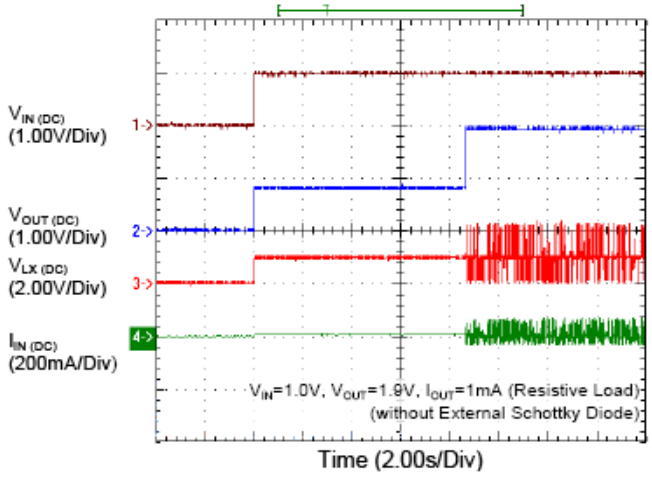


Shutdown Current vs. Temperature

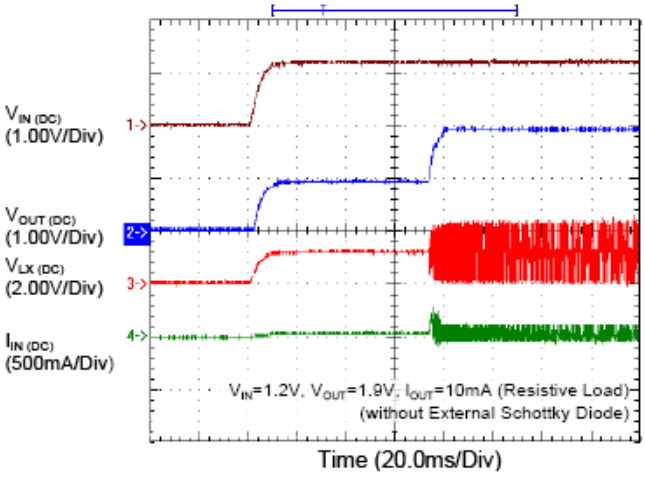


Typical Operating Characteristics(Cont.)

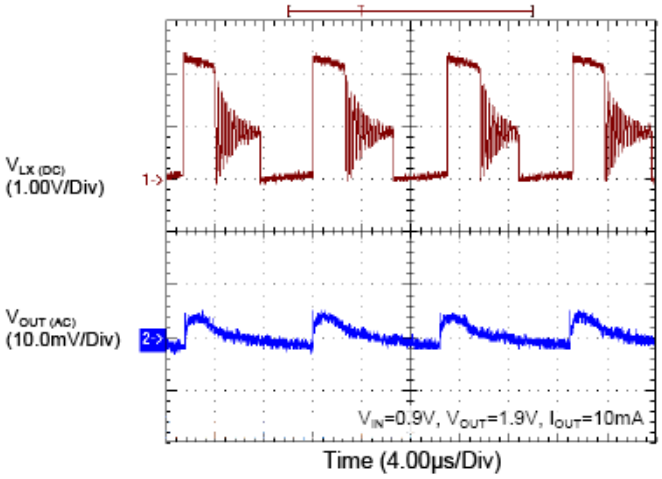
Low Start-up Voltage at 1mA



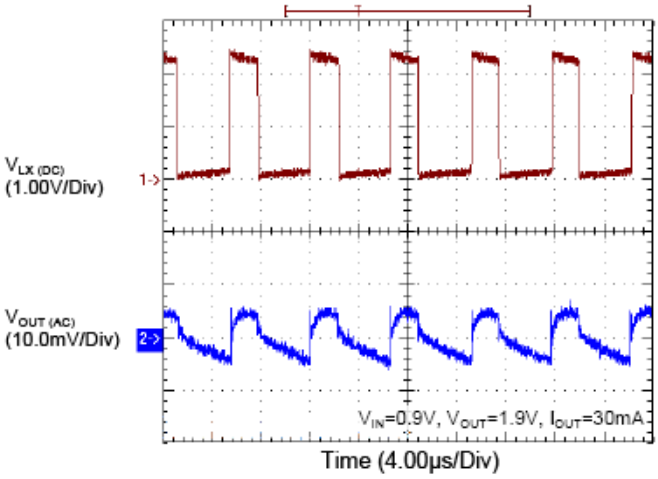
Low Start-up Voltage at 10mA



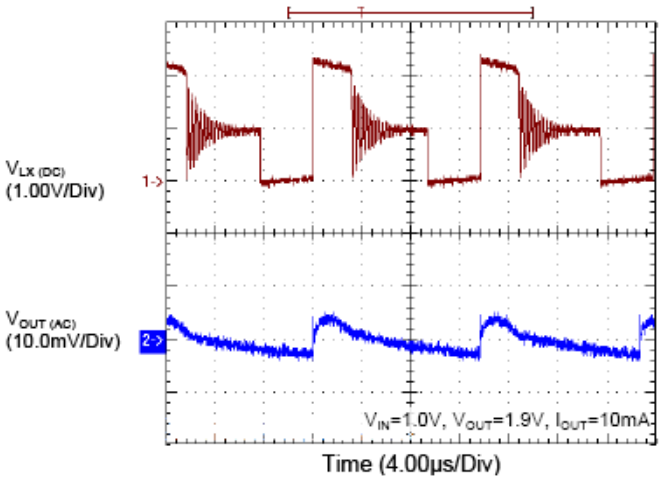
Steady State Operation



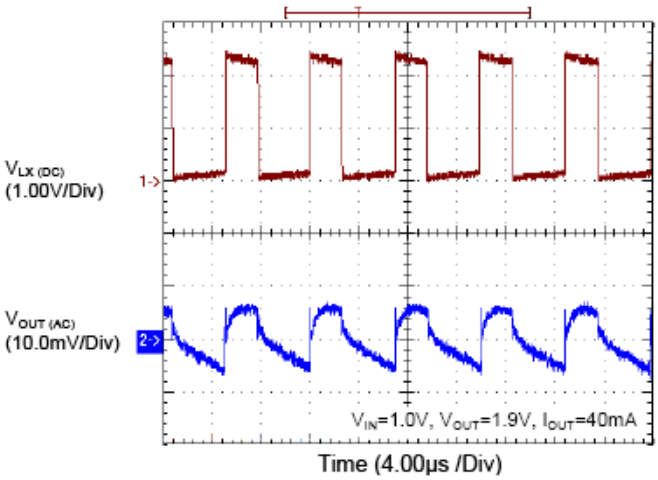
Steady State Operation



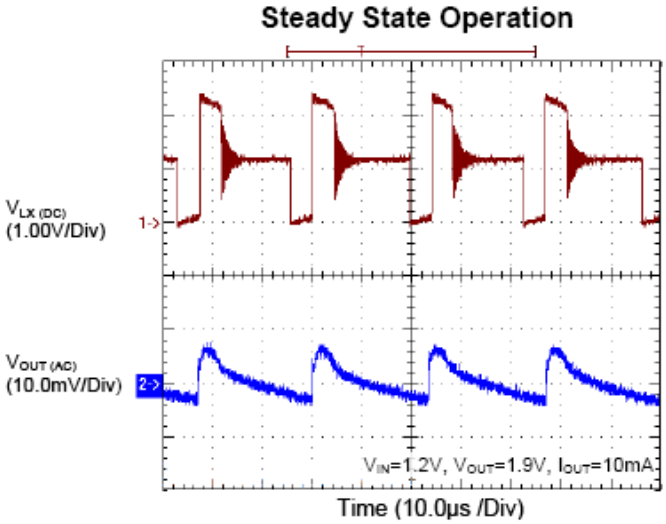
Steady State Operation

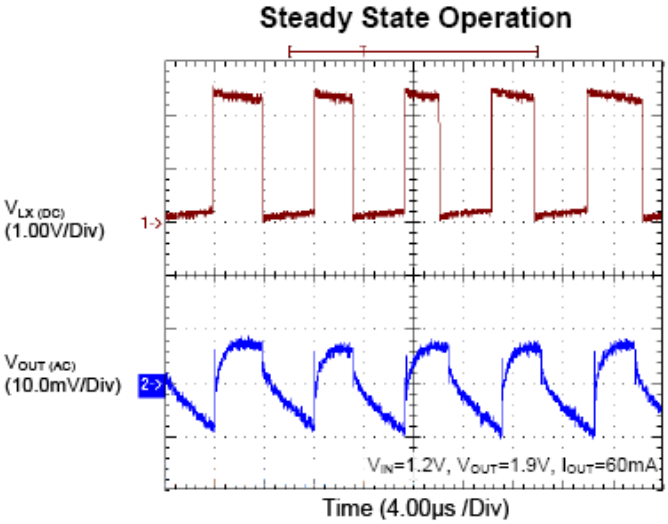


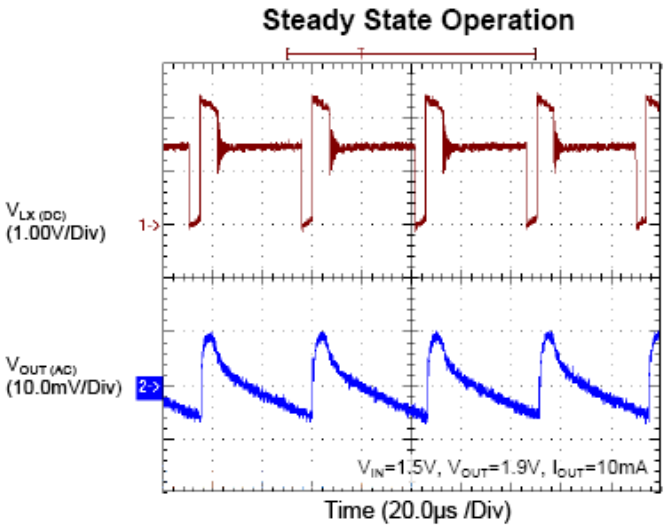
Steady State Operation

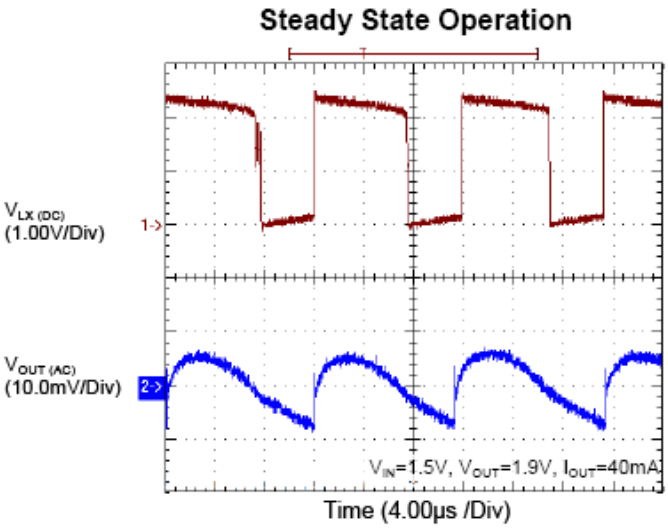


Typical Operating Characteristics(Cont.)









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 EC9203. 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 SOT23-3

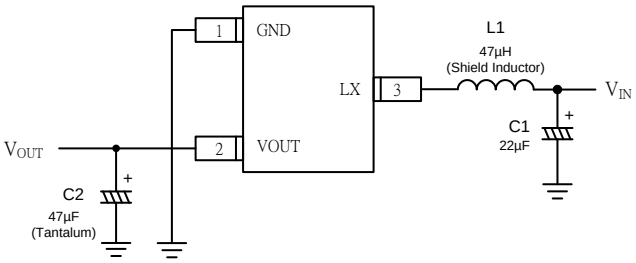


Figure 2: Typical Application Circuit for SOT23-5

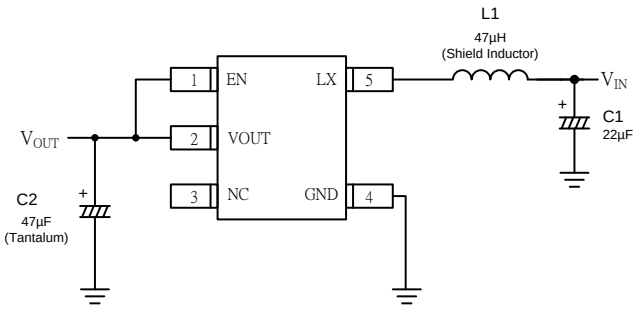
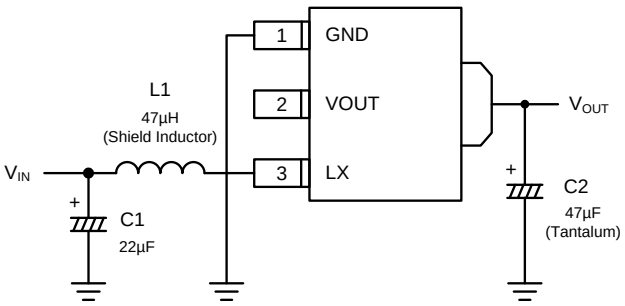


Figure 3: Typical Application Circuit for SOT89-3



Inductor Selection

An inductor value of 47μH performs well in EC9203 applications. However, the inductance value is not critical, and the EC9203 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 EC9203. 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:

$$P_{D(MAX)} = \frac{(T_{J(MAX)} - T_A)}{\theta_{JA}}$$

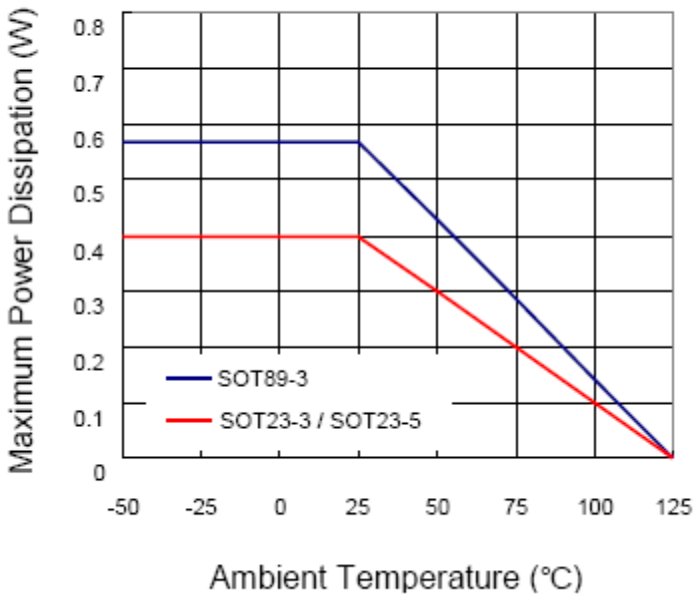
Where $T_{J\ (MAX)}$ is the maximum operation junction temperature 125℃, T_A is the ambient temperature and the

θ_{JA} is the junction to ambient thermal resistance. For recommended operating conditions specification of EC9203 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 SOT89-3 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

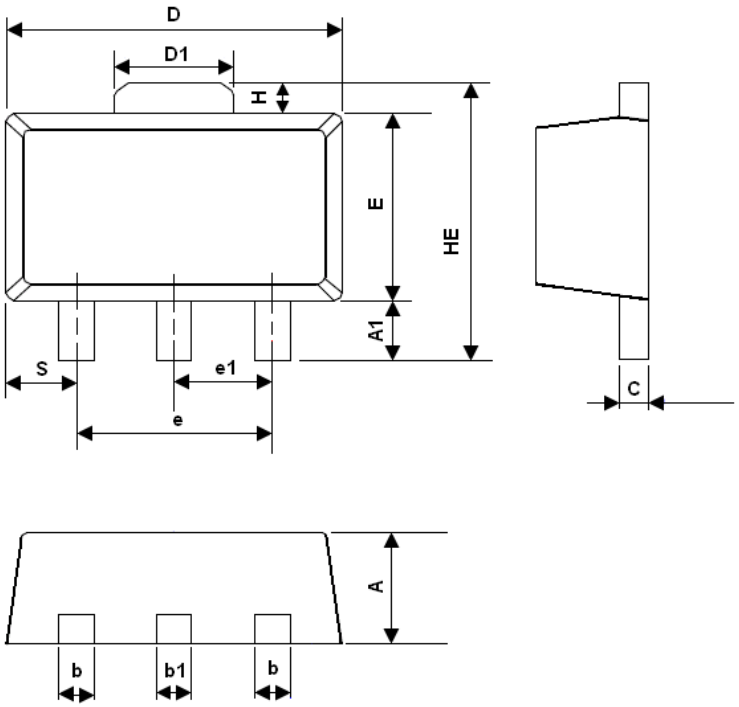
for SOT89-3 packages. The maximum power dissipation depends on operating ambient temperature for fixed $T_{J\,(MAX)}$ and thermal resistance θ_{JA}. For EC9203 packages, the Figure 4 of de-rating curves allows the designer to see the effect of rising ambient temperature on the maximum power allowed.

Figure 4: Maximum Power Dissipation



Package Outline Information

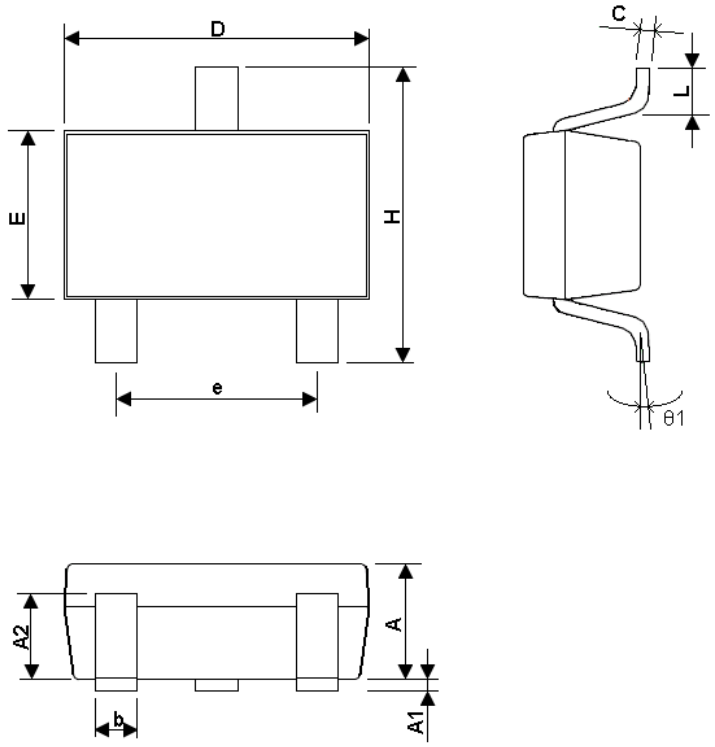
Outline Drawing For SOT89-3



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

Package Outline Information(Cont.)

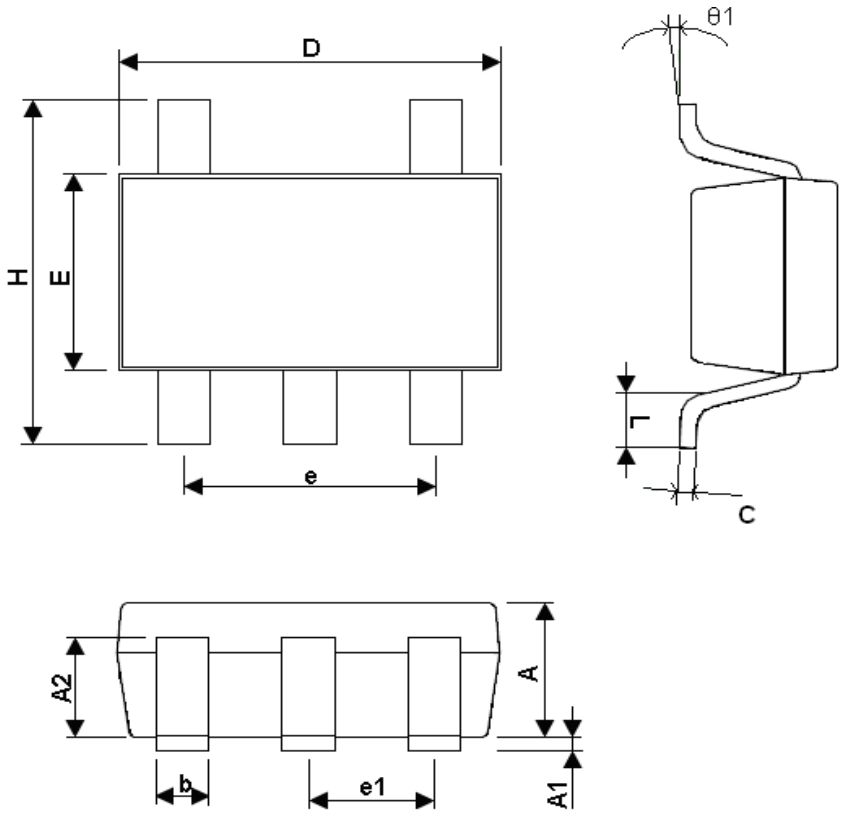
Outline Drawing For SOT23-3



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°

Package Outline Information(Cont.)

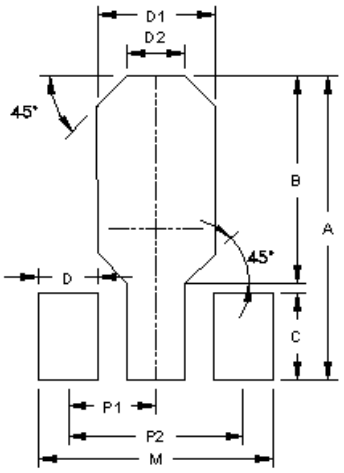
Outline Drawing For SOT23-5



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	---

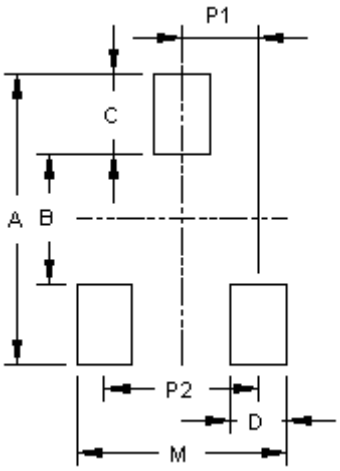
Footprints

SOT89-3



Package	Number of PIN	Footprint Dimension (mm)										Tolerance
		P1	P2	A	B	B1	C	D	D1	D2	M	
SOT89-3	3	1.50	3.00	5.10	3.40	--	1.50	1.00	2.20	1.00	4.00	±0.10

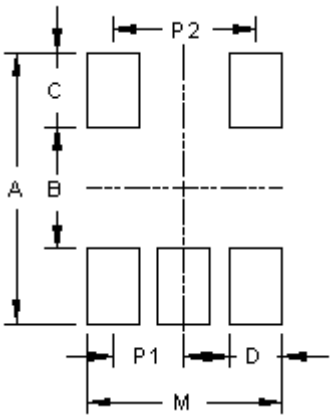
SOT23-3



Package	Number of PIN	Footprint Dimension (mm)							Tolerance
		P1	P2	A	B	C	D	M	
SOT23-3	3	0.95	1.90	3.60	1.60	1.00	0.80	2.70	±0.10

Footprints(Cont.)

SOT23-5



Package	Number of PIN	Footprint Dimension (mm)							Tolerance
		P1	P2	A	B	C	D	M	
SOT23-5	5	0.95	1.90	3.60	1.60	1.00	0.70	2.60	±0.10