600mA Synchronous Boost Converter with Output Disconnect

FEATURES

- Up to 92% efficiency
- Low start-up voltage 0.8V
- Internal synchronous rectifier
- Up to 2MHz switching allows for tiny external components
- 0.5V to 4.4V input range
- 2.5V to 5.0V output range (Note 3)
- Fully discharged shutdown output voltage
- Logic controlled shutdown (<1μA)
- Low 250μA operating supply current (measured at VOUT)
- Pulse skipping at light load for extended battery life
- Generates 3.3V at 100mA from single AA cell
- Stable with ceramic output capacitor
- Low profile 6-Leads SOT-26 package

APPLICATIONS

- MP3 / MP4 players
- PDAs and organizers
- Digital cameras
- Wireless mice/ keyboards
- Portable medical equipment
- Cordless phones
- Wireless Headsets

DESCRIPTION

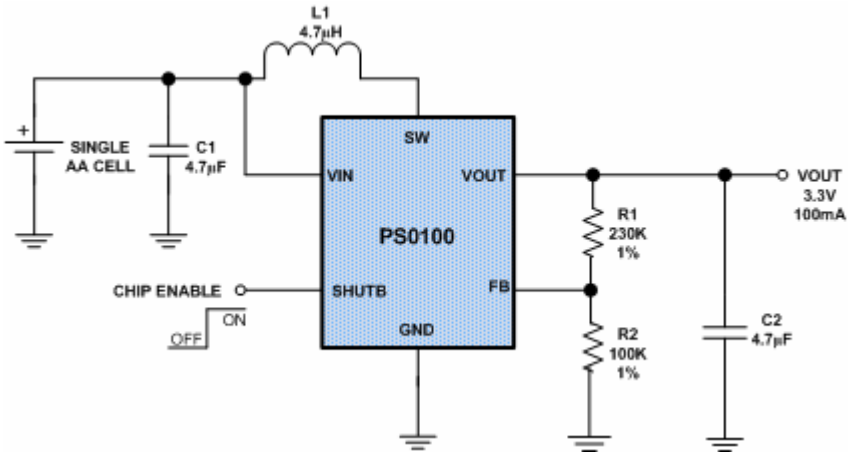
The PS0100 is a synchronous, step-up DC/DC converter delivering high efficiency in a SOT-26 package. The device has an internal NMOS switch and PMOS synchronous rectifier and has the capacity of supplying 3.3V at 100mA from a single AA cell input.

High frequency switching (up to 2MHz) minimizes the board area by allowing the use of tiny, low profile inductors and ceramic capacitors.

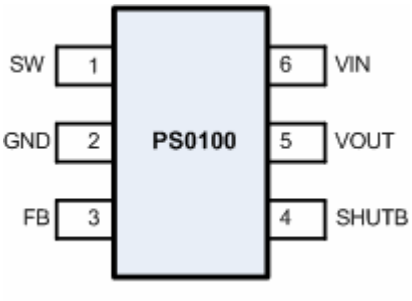
The PS0100 provides automatic pulse skipping at light loads, thus reducing the supply current for extended battery life. At shutdown, the PS0100 fully discharges the output to ground and draws no supply current.

The PS0100 is available in small SOT-26 package with both fixed and adjustable output voltage versions.

TYPICAL APPLICATION CIRCUIT



PIN CONFIGURATION



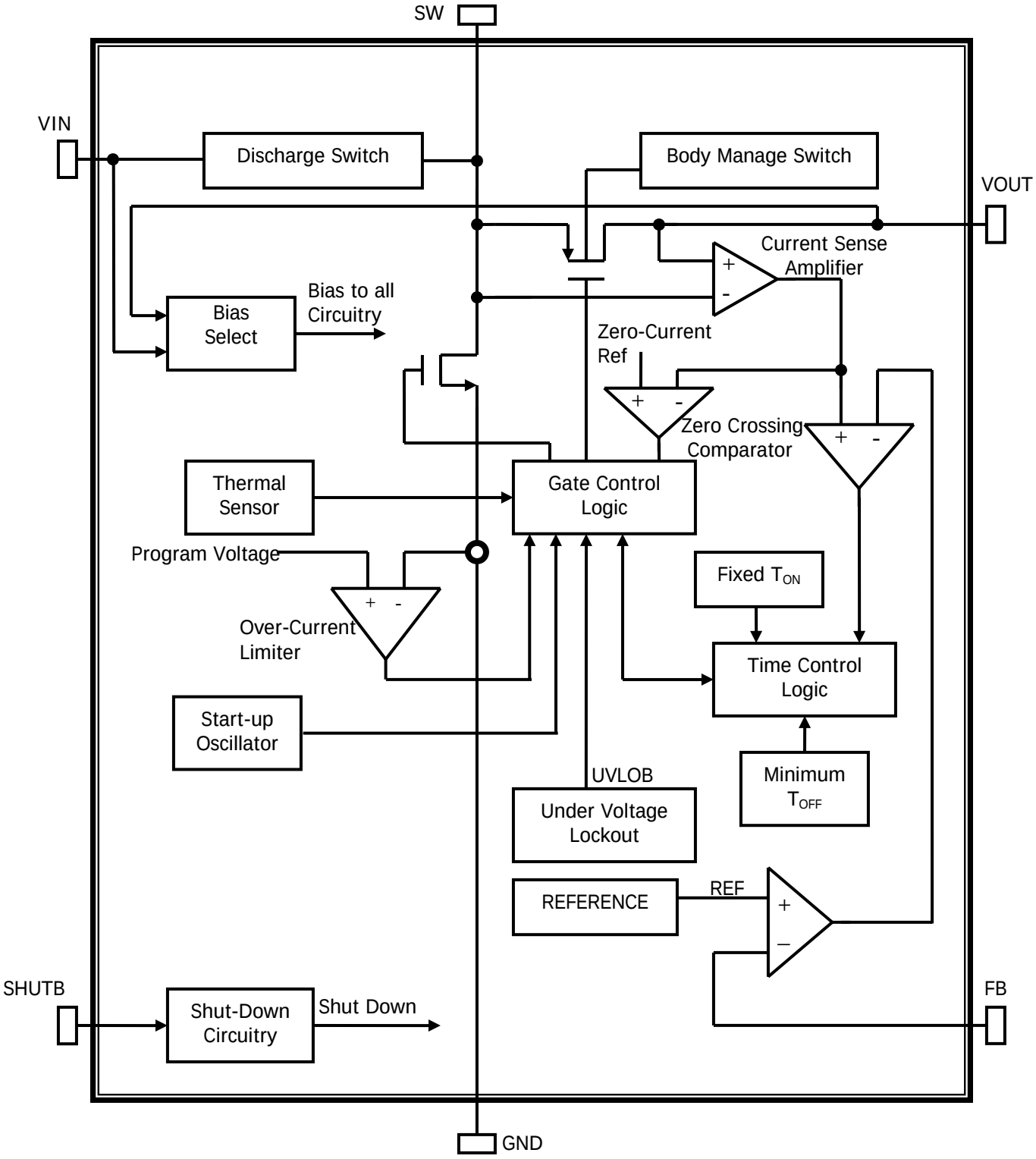
PIN DESIGNATOR

Name	Pin	Type	Function
SW	1	Switch	Connects inductor between SW and VIN
GND	2	Ground	Ground pin
FB	3	Feedback	Adjustable feedback input, connects to resistor voltage divider
SHUTB	4	Shutdown input	SHUTB = High: normal operation (Supports both TTL and CMOS logic)
VOUT	5	Analog output	Boost regulator output
VIN	6	Battery input	Boost regulator input

ORDERING INFORMATION

Part Number	Voltage	Junction Temperature Range	Package
PS0100A	Adj.	-40°C to 85°C	SOT-26
PS0100 – 2.5	2.5	-40°C to 85°C	SOT-26
PS0100 – 2.8	2.8	-40°C to 85°C	SOT-26
PS0100 – 3.0	3.0	-40°C to 85°C	SOT-26
PS0100 – 3.3	3.3	-40°C to 85°C	SOT-26

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{IN}	DC Supply Voltage at Pin 6	-0.3 to 6.0	V
V_{SW}	SW Voltage - DC	-0.3 to 6.0	V
	SW Voltage–Pulsed (<100nS)	-0.3 to 7.0	V
V_{SHUTB}	SHUTB Voltage	-0.3 to 6.0	V
V_{FB}	FB Voltage	-0.3 to 6.0	V
V_{OUT}	Output Voltage	-0.3 to 6.0	V
I_{SW}, I_{OUT}, I_{GND}	Switch Current	0 to 1A	A
T_{STG}	Storage Temperature Range	-65 to +125	°C
$R_{\theta JA}$	Thermal Resistance, Junction-To-Air	N/A	°C/W
$T_{A, MAX}$	Operating Temperature Range (Note 4)	-40 to +85	°C
T_L	Lead Temperature (Soldering, 10sec)	260	°C
ESD	ESD Capability, HBM model	2.0	KV

ELECTRICAL CHARACTERISTICS

(All specifications are at T_A = 25°C, V_{IN} = 1.5V, V_{OUT} = 3.3V, V_{SHUTB} = 1.5V, unless otherwise specified.)

Parameter	Conditions	Min	Typ	Max	Unit
Minimum Start-Up Voltage	No load		0.8	0.95	V
Minimum Operating Voltage	Note 1		0.5		V
Maximum Input Operating Voltage	Note 2		4.4		V
Output Voltage Adjust Range	Note 3	2.5		5.0	V
Feedback Voltage	T_A = -40°C to 85°C (Note 4)	0.97	1.0	1.03	V
Feedback Input Current	V_{FB} = 1.2V		1		nA
Load Regulation	I_{LOAD} = 10mA to 100mA		2.2		%
Quiescent Current (No-Switching)	V_{FB} = 1.2V, measured at VOUT		250	420	µA
Quiescent Current (Shut-down)	V_{SHUTB} = 0V, V_{OUT} = 0V, including switch leakage		0.01	1	µA
NMOS Switch On Resistance	V_{OUT} = 3.3V		0.45		Ω
PMOS Switch On Resistance	V_{OUT} = 3.3V		0.6		Ω
NMOS Current Limit		600			mA
PMOS Turn-Off Current			50		mA
Current Limit Delay to Output			100		nS
Minimum Off-Time			0.13		µS
Maximum On-Time	V_{IN} = 0.5V	0.6	0.95	1.4	µS
Maximum On-Time to Minimum Off-Time Ratio	V_{FB} = 0.95V, V_{IN} = 0.5V, T_A = -40°C to 85°C (Note 4)	4	7.3		

ELECTRICAL CHARACTERISTICS (continued)

(All specifications are at T_A = 25°C, V_{IN} = 1.5V, V_{OUT} = 3.3V, V_{SHUTB} = 1.5V, unless otherwise specified.)

Parameter	Conditions	Min	Type	Max	Unit
SHUTB Input High		0.95			V
SHUTB Input Low				0.35	V
SHUTB Input Current				100	nA
Frequency at Start-Up			650		KHz
Thermal Shutdown	15°C Hysteresis		145		°C

Note 1: Minimum operating input voltage is fixed by the battery's ability to provide necessary power at that (terminal) voltage. Below this voltage, the battery fails to deliver required power as it enters into deeply discharged state. This voltage can be lower if the required duty cycle is less.

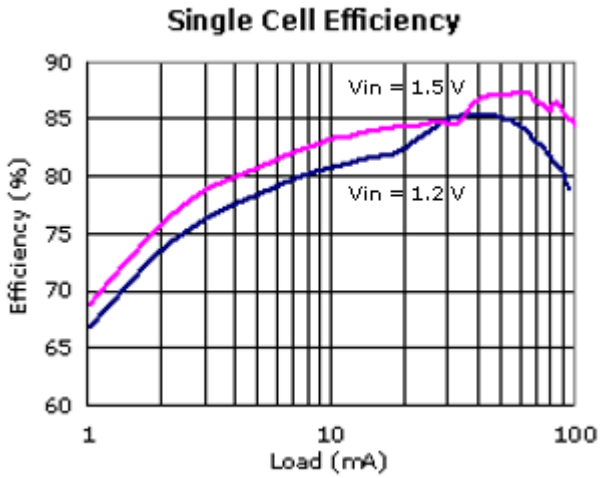
Note 2: When the input voltage is greater than the output voltage regulation point, the part operates in track mode (see Track Mode).

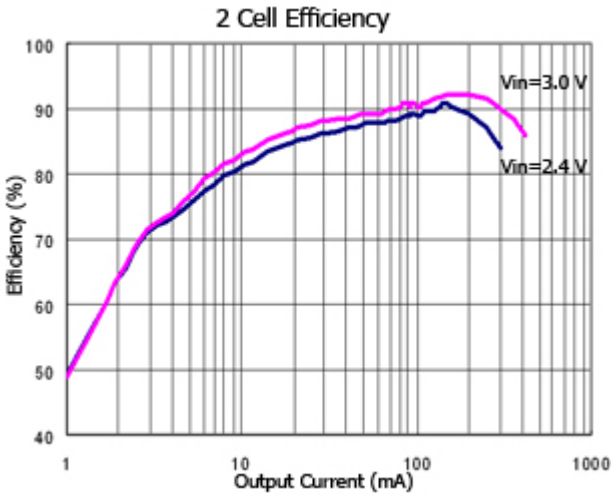
Note 3: For applications where V_{OUT} > 4.3V, an external Schottky diode is recommended.

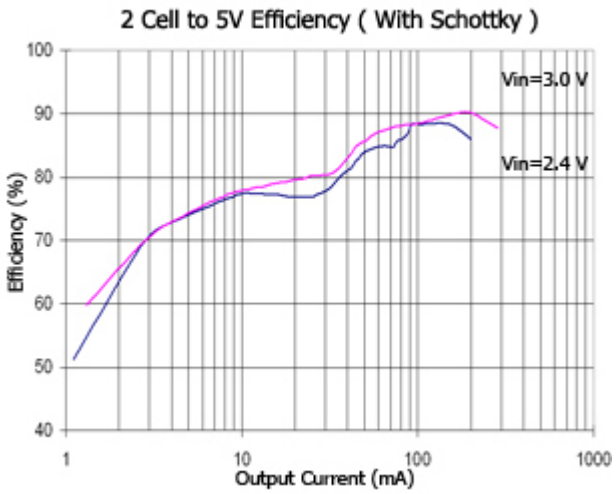
Note 4: Limits are 100% production tested at T_A=25°C. Specifications over the -40°C to +85°C operating temperature range are assured by design.

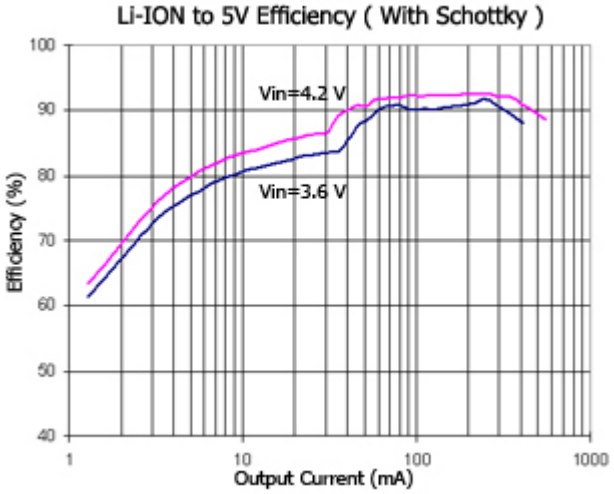
TYPICAL OPERATING CHARACTERISTICS

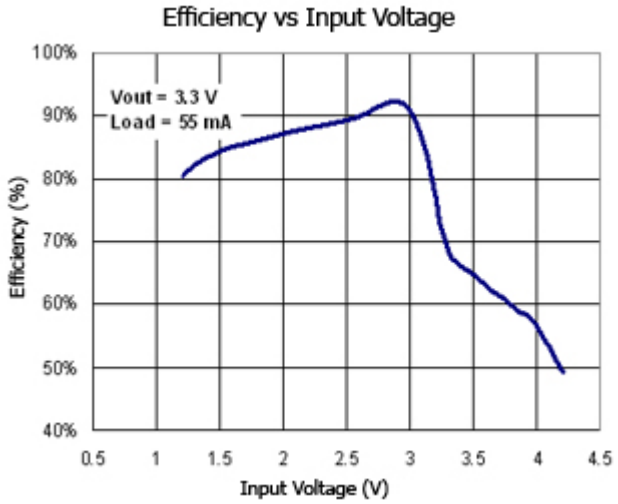
(All specifications are at T_A =+25°C, V_{IN} = 1.5V, circuit of typical application circuit, unless otherwise specified.)

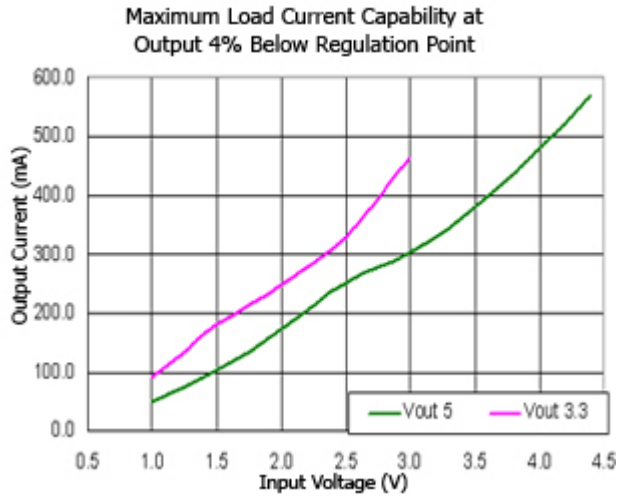






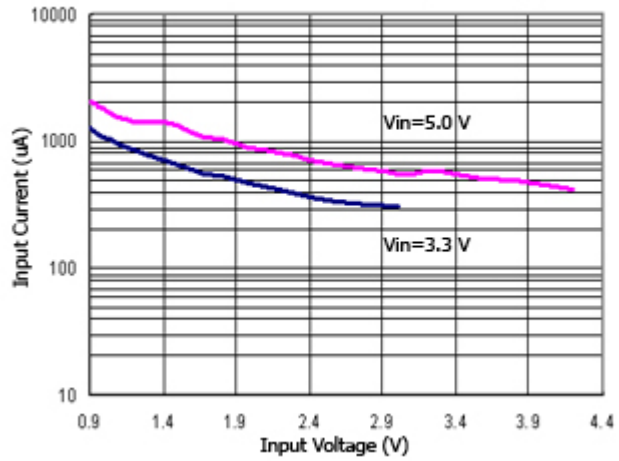




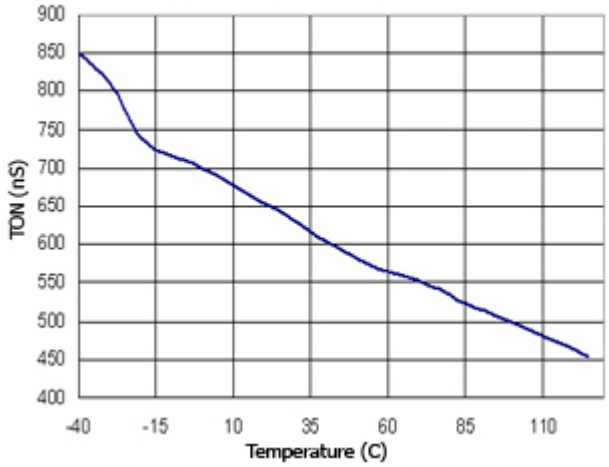


TYPICAL OPERATING CHARACTERISTICS (continued)

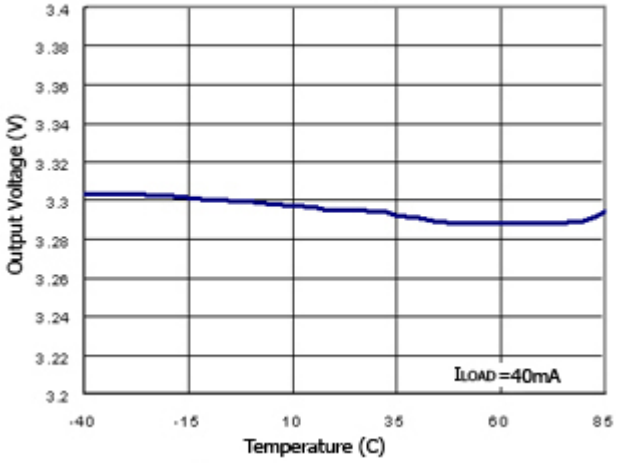
No Load Input Current vs Input Voltage



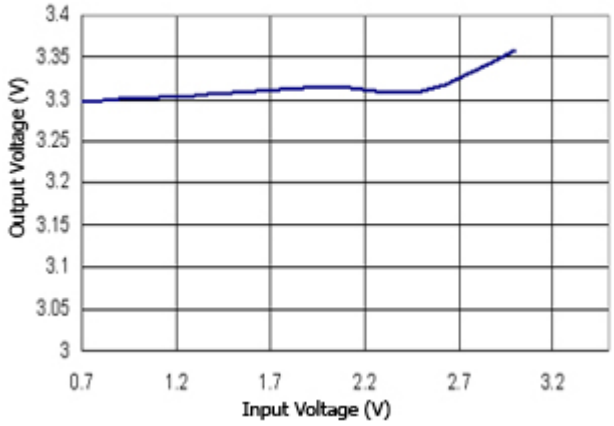
TON (vin = 1.5V) vs Temperature



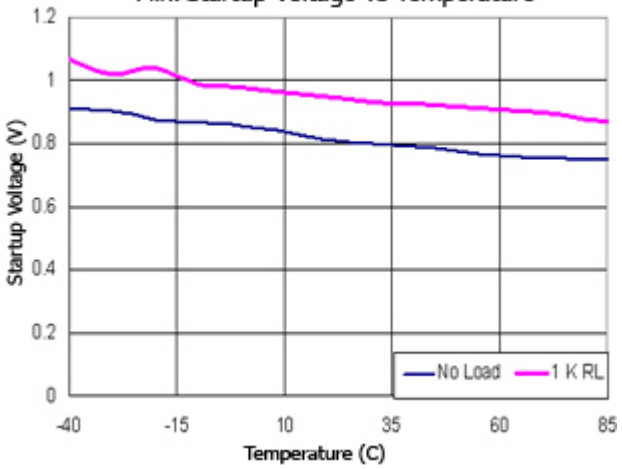
Vout vs Temperature



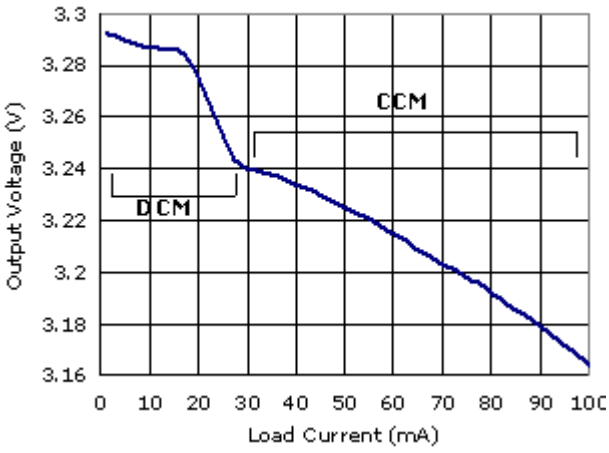
No Load Output Voltage vs Input Voltage



Min. Startup Voltage vs Temperature

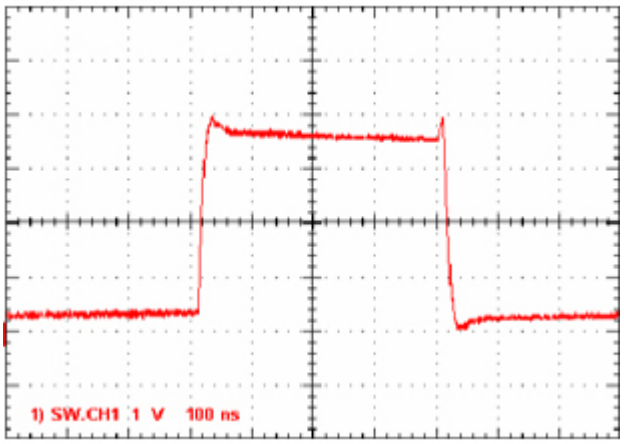


Output Voltage vs Load Current



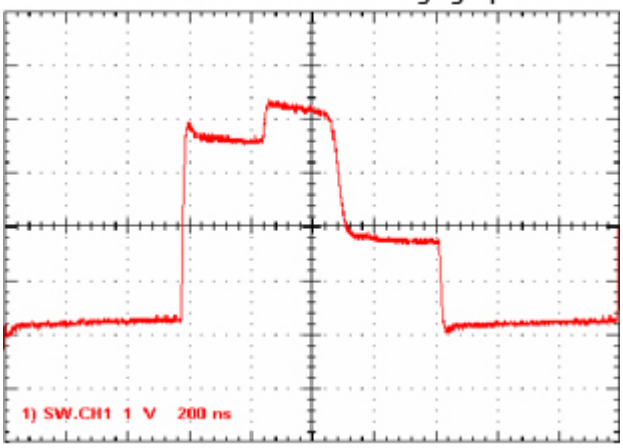
TYPICAL OPERATING CHARACTERISTICS (continued)

SW Pin Continuous Mode Operation



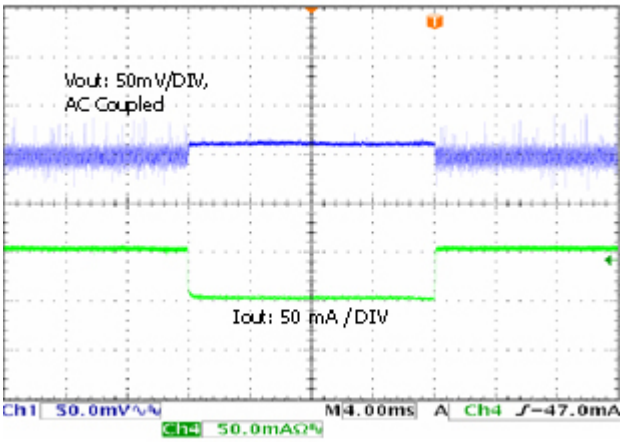
Vin=1.5V, Vout=3.3V, Iout=100mA, L=10uF, Cout=10uF

SW Pin Discontinuous Mode Antiringing Opearation



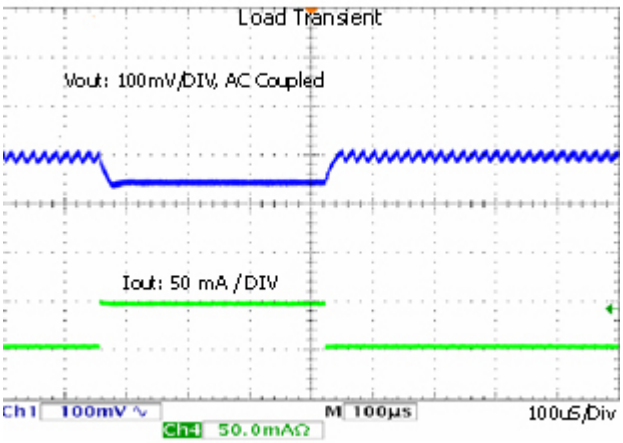
Vin=1.5V, Vout=3.3V, Iout=10mA, L=10uH Cout=10uF

Output Voltage Transient Response -1



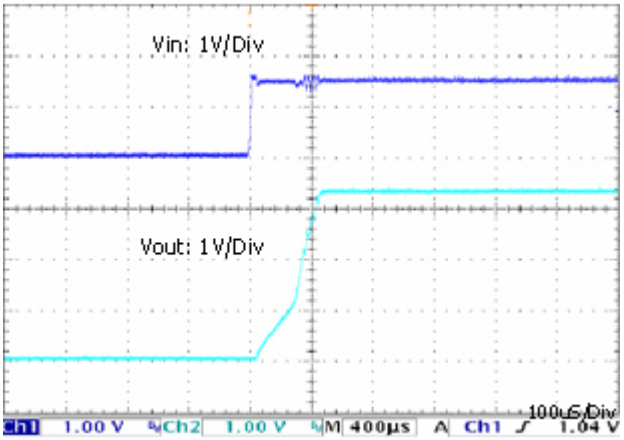
Vin=1.5V, Vout=3.3V, Iout=0-50 mA, L=10uH, Cout=10uF

Output Voltage Transient Response -2



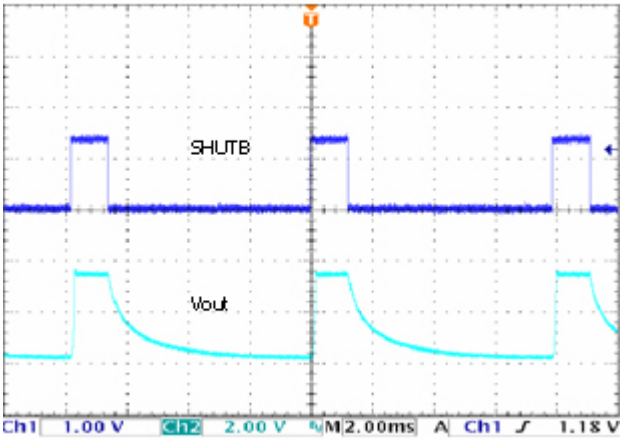
Vin=1.5V, Vout=3.3V, Iout=40-90 mA, L=10uH, Cout=10uF

Power ON Reset Waveforms



Load=10mA (Resistive)

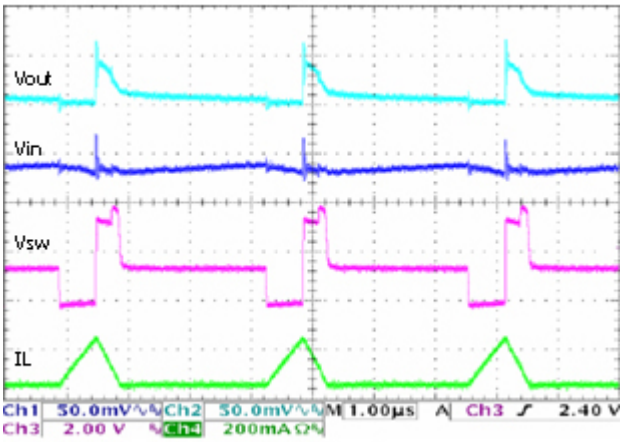
Shut Cycle (Exiting and Entering Shutdown)



Load=10mA (Resistive)

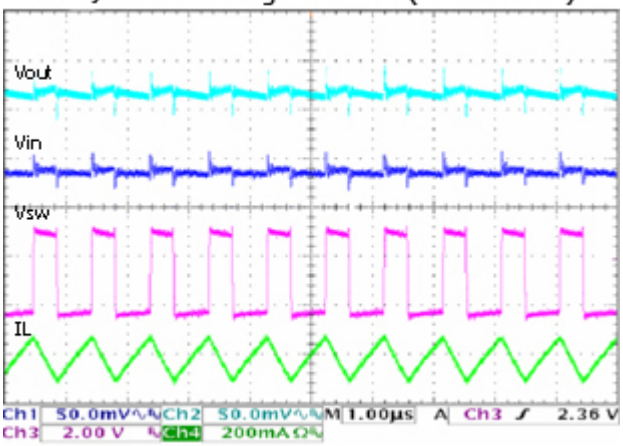
TYPICAL OPERATING CHARACTERISTICS (continued)

Light Load Switching WaveForm (Load=10mA)



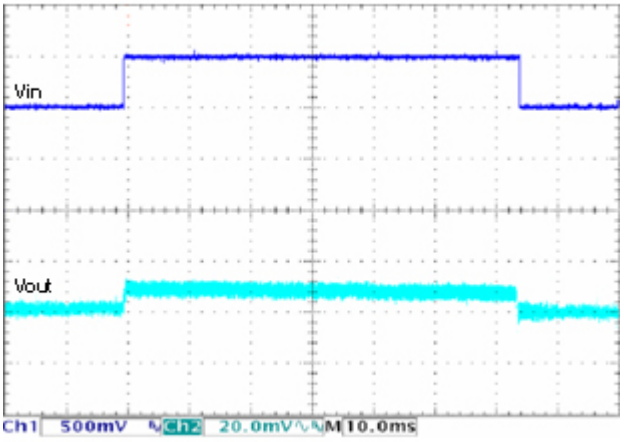
L=4.7uH, Cin=10uF, Cout=10uF, Load = 10mA

Heavy Load Switching WaveForm (Load=100mA)



L=4.7uH, Cin=10uF, Cout=10uF, Load = 100mA

Line Transient



Vin=1V to 1.5V, Load=10mA, Cin= 10 uF, Cout=10 uF, L=10 uH

OPERATION

The PS0100 is a compact, high-efficiency, synchronous boost converter in a SOT-26 package designed for space-restricted applications. The part is available with adjustable output voltages ranging from 2.5V to 5.0V. It is able to start up with input voltages as low as 0.8V and operate with input voltages down to 0.5V. With its internal synchronous rectifier and low on-resistance of the internal NMOS switch, the device maintains high efficiency over a wide range of load current. As shown in the Block Diagram, the PS0100 consists of accurate band gap core, error amplifier, start-up oscillator and control logic unit along with PMOS and NMOS switches. With current mode PWM control, the PS0100 has ultra-fast line and improved load regulation. Moreover, the PS0100 provides real shutdown circuitry which disconnects the output from the input during shutdown and results in the discharge of the output to ground.

Start-Up Mode

The PS0100 starts up typically at 0.8V. When it is turned on, the device gets its start up bias from VIN. A start-up oscillator, which runs typically at 650 KHz, takes the output voltage high enough so that V_{OUT} exceeds V_{IN}. Once V_{OUT} exceeds V_{IN}, the internal bias switches from V_{IN} to V_{OUT} by an internal bias-select circuit. Thus, once started (i.e. V_{OUT} exceeds V_{IN}), the internal circuit bias is completely independent of V_{IN}. The start-up oscillator runs at 66% duty cycle at around 650KHz. Once V_{OUT} exceeds V_{IN} (typically 1.9V), the start-up oscillator is disabled and the normal fixed T_{ON} PWM operation takes over.

Internal PMOS and NMOS Switches

The PS0100 features a 0.45Ω NMOS switch and a 0.6Ω PMOS switch. In normal operation, these switches are alternatively turned on and thus initiate the charging of the inductor from VIN and then discharging of it to the output capacitor and the load. However, between the event of one switch turning off and the other turning on, a dead time is provided to avoid a huge in-rush current from the output to ground via switches. During the dead time, both switches remain off and the inductor discharges via the body diode of the PMOS switch to the output.

True Shutdown Mode

The PS0100 is designed to allow for true shutdown by managing the body diode of the PMOS switch. As the PMOS switch is turned off and there is no conductive path through the body of the PMOS, the output is allowed to go to zero during shutdown, drawing zero current from the input.

Output Voltage Selection

The PS0100 features a user-adjustable output through an external feedback network. A voltage divider from VOUT to ground programs the output voltage via FB from 2.5V to 5V using the following equation:

$$V_{OUT} = V_{REF} \times [1 + (R1/R2)]$$

where, V_{REF} = 1.0V

Thermal Overload Protection

Thermal overload protection limits the total power dissipation in the PS0100. When the junction temperature exceeds T_J = +145°C, the thermal sensor signals the shutdown logic and turns off most of the internal circuitry. The thermal sensor turns the internal circuitry on again after the IC's junction temperature drops by 15°C.

Thermal overload protection is designed to protect the PS0100 in the event of a fault condition. For continuous operation, do not exceed the absolute maximum junction temperature rating of T_J = +125°C.

Current Limit and Short Circuit Protection

The PS0100 includes a current limiter that monitors the peak inductor current through the NMOS switch and turns the NMOS switch off when the inductor peak current exceeds 850mA. Because of its true shutdown feature, the IC is allowed to be short-circuited. The thermal shutdown turns off the regulator in the event of excessive heating when the die temperature reaches 145°C.

Light Load Operation

The PS0100 provides improved light load efficiency. The internal zero current comparator monitors the inductor current to the load and shuts off the PMOS switch once this current reduces to some low value (typically 50mA). This prevents the inductor current from reversing its polarity, avoiding back-charging and thus improving the efficiency at light loads. At that time, both the NMOS and PMOS switches remain off. However, normal operation starts again when the output voltage falls below the regulation point. The IC automatically skips pulses at light load, thus providing better efficiency.

Anti-Ringing Control

When the inductor current goes to zero, there arises a high frequency ringing at the SW pin. To prevent this, a 100Ω discharge switch is provided between SW and VIN, so that this high frequency ringing is damped out.

Under Voltage Lockout

When the supply becomes too low (typically below 1.8V), the PS0100 produces an internal UVLO (Under Voltage Lockout) signal that disables the normal PWM operation and enables the start-up oscillator to run at a fixed frequency. At this stage, very few circuits are operational. When the oscillator raises the supply to above 1.9V, the UVLO signal is disabled and the normal PWM mode takes over the operation of the start-up oscillator. This mechanism protects the chip from producing false logic due to low input supply.

Enable Input

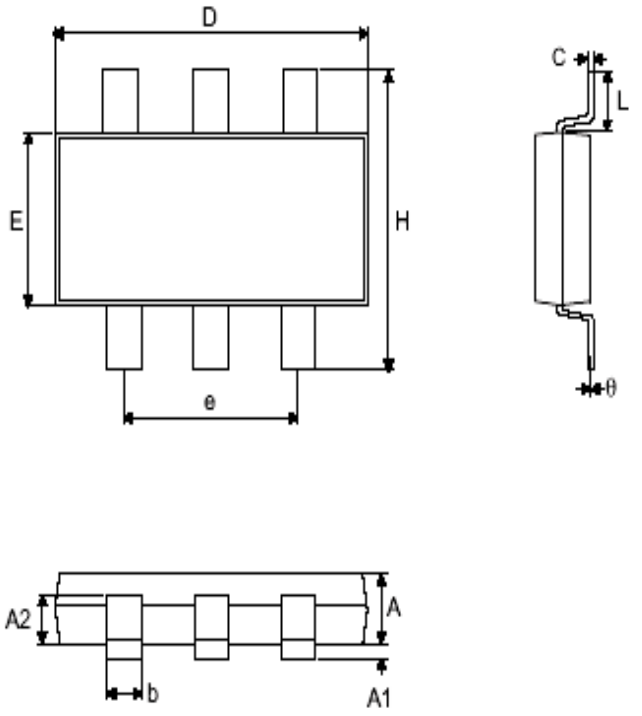
The PS0100 features an active-high CMOS input enable pin (SHUTB) that allows on/off control of the regulator. When SHUTB=Low, shutdown of the chip occurs and at that time almost no quiescent current (<1μA) flows. The output capacitor can be completely discharged through the load or the feedback resistors for real output shut-down. A discharge switch is internally connected between VIN and SW. The Enable (SHUTB) input is TTL/CMOS compatible. Connect SHUTB to VIN for normal operation.

Track Mode

The PS0100 is in track mode when V_{IN} is greater than the output voltage regulation point. In track mode, the regulator runs at a fixed start-up oscillator frequency. The start-up oscillator runs freely until V_{OUT} exceeds V_{IN}. When V_{OUT} falls below V_{IN}, the start-up oscillator is enabled again. Thus, in track mode, the regular loop control of PWM operation remains off. Instead, the regulator runs by intermittent oscillator operation.

PACKAGE INFORMATION

SOT-26 Outline Dimensions (Unit: mm)



Pin	Parameter										
	A	A1	A2	b	C	D	E	e	H	L	θ
6	1~1.3	0.1 max.	0.7~0.9	0.35~0.5	0.1~0.25	2.7~3.1	1.4~1.8	1.9 typ.	2.6~3	0.37 min.	1°~9°

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