

## Low Iq Synchronous Boost Converter with Output Disconnect

### FEATURES

- Up to 92% Efficiency.
- Low Start-Up Voltage: 0.8V
- Internal Synchronous Rectifier
- Up to 100KHz Switching Allows Tiny External Components
- 2.5V to 5V Output Range (Note 3)
- Fully Discharged Shutdown Output Voltage
- Logic Controlled Shutdown ( $<1\mu\text{A}$ )
- Pulse Skipping at Light Load for Extended Battery Life
- Generates 3.3V at 20mA from Single AA Cell
- Stable with Ceramic Output Capacitor
- 6L SOT-26 Package

### APPLICATIONS

- MP3 / MP4 players
- PDAs and Organizers
- Digital Cameras
- Wireless Mice / Keyboards
- Portable Medical Equipments
- GPS Receivers
- Remote controls
- Wireless Headsets

### DESCRIPTION

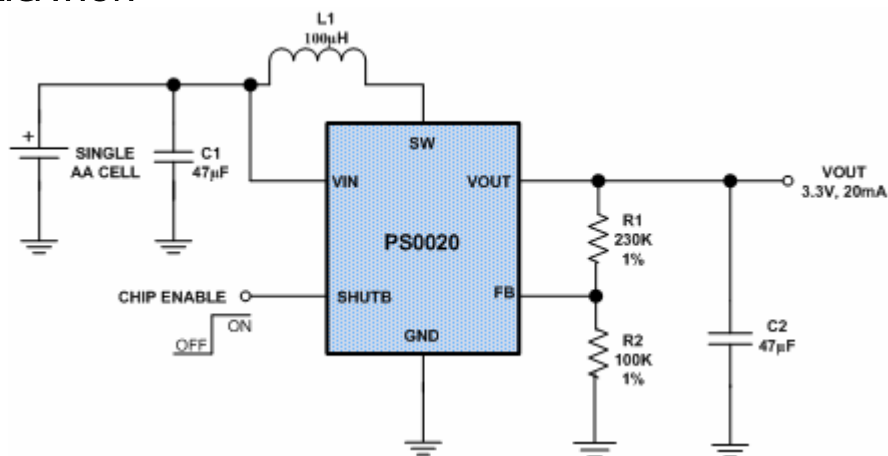
The PS0020 is a synchronous, step-up DC/DC converter delivering high efficiency in a 6-leads SOT-26 package. The device having an internal NMOS switch and PMOS synchronous rectifier has the capacity of supplying 3.3V at 20mA from a single AA cell input.

A high frequency switching minimizes board area by allowing the use of tiny, low profile inductors and ceramic capacitors.

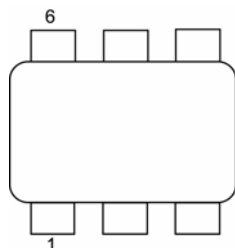
The PS0020 provides automatic pulse skipping at light loads reducing supply current for extended battery life. At shutdown the PS0020 fully discharges the output to ground and takes very low supply current.

The PS0020 is available in small SOT26 package with both fixed and adjustable output voltage versions.

### TYPICAL APPLICATION

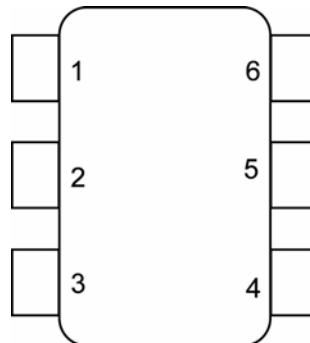


## MARKING DIAGRAMS



XX: PS0020  
Y : Adjustable/fixed voltage version, refer to ordering information  
M: Mask Version  
W: Week code  
A~Z=W1~W26  
A~Z=W27~W52  
Lead Free Package

## PIN CONFIGURATION



## PIN DESCRIPTION

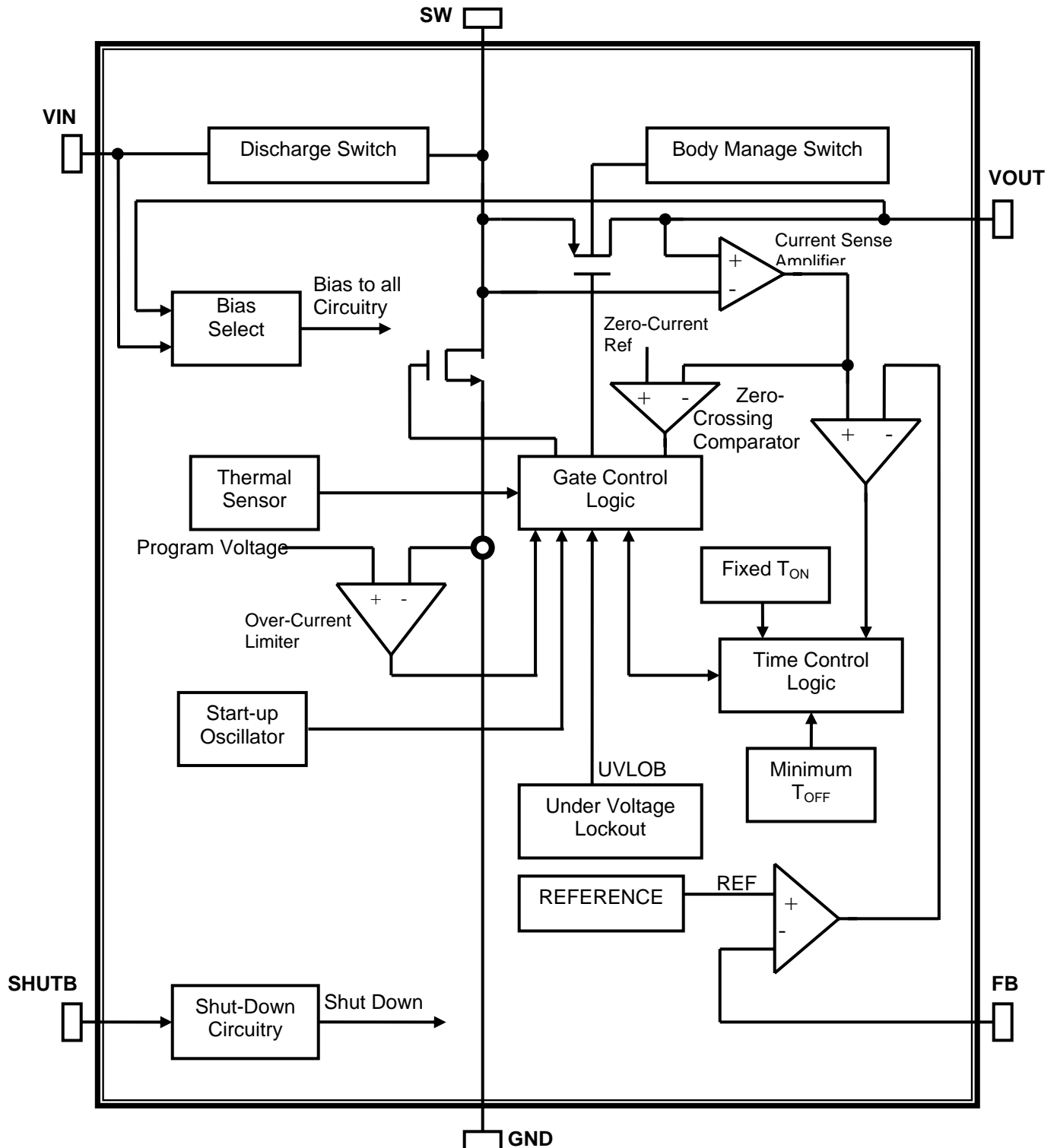
Name	Pin	Type	Function
SW	1	Switch	Connect inductor between SW and Vin.
GND	2	Ground	Ground pin
FB	3	Feedback	Adjustable feedback input, connect to resistor voltage divider.
SHUTB	4	Shutdown input.	SHUTB=High: normal operation. (Supports both TTL and CMOS Logic).
VOUT	5	Analog output.	Boost regulator output.
V <sub>IN</sub>	6	Battery input.	Boost regulator input.

## ORDERING INFORMATION

Part Number	Voltage	Marking	Junction Temp. Range	Package
PS0020A	Adj.	N/A	-40°C to 85°C	SOT-26
PS0020 – 2.5	2.5		-40°C to 85°C	SOT-26
PS0020 – 2.8	2.8		-40°C to 85°C	SOT-26
PS0020 – 3.0	3.0		-40°C to 85°C	SOT-26
PS0020 – 3.3	3.3		-40°C to 85°C	SOT-26

**Note 1** : Contact the factory for other output voltages that are not in the above table

## BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{IN}$	DC Supply Voltage at Pin 1	-0.3V to 6V	V
$V_{SW}$	SW Voltage – DC	-0.3V to 6V	V
	SW Voltage – Pulsed (<100nS)	-0.3V to 7V	V
$V_{SHUT}$	SHUTB Voltage	-0.3V to 6V	V
$V_{FB}$	FB Voltage	-0.3V to 6V	V
$V_{OUT}$	Output Voltage	-0.3V to 6V	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	3.0	kV

## ELECTRICAL CHARACTERISTICS

$T_A = 25^\circ\text{C}$ .  $V_{IN} = 1.5\text{V}$ ,  $V_{OUT} = 3.3\text{V}$ ,  $V_{SHUTB} = 1.5\text{V}$  (unless otherwise noted).

Parameter	Conditions	Min	Typ	Max	Unit
Min start-up Voltage	No load		0.8	0.95	V
Min 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	$T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$ (Note 4)	0.95	1.0	1.05	
Feedback Input Current	$V_{FB} = 1.2\text{V}$		1		nA
Load Regulation	$I_{LOAD} = 1\text{mA}$ to $20\text{mA}$		2.2		%
Quiescent Current (No-switching)	$V_{FB} = 1.2\text{V}$ , Measured at $V_{OUT}$		35		$\mu\text{A}$
Quiescent Current (Shut-down)	$V_{SHUTB} = 0\text{V}$ , $V_{OUT} = 0\text{V}$ , Including Switch Leakage		0.01	1	$\mu\text{A}$
NMOS Switch On Resistance	$V_{OUT} = 3.3\text{V}$		0.45		$\Omega$
PMOS Switch On Resistance	$V_{OUT} = 3.3\text{V}$		0.6		$\Omega$
NMOS Current Limit			300		mA
PMOS Turn-Off Current			0		mA
Current Limit Delay to Output			100		nS
Minimum Off-Time			1.2		$\mu\text{S}$
Maximum On-Time	$V_{IN} = 0.5\text{V}$		5		$\mu\text{S}$
Maximum On-Time to Minimum Off-Time Ratio	$V_{FB} = 0.95\text{V}$ , $V_{IN} = 0.5\text{V}$ , $T_A = -40^\circ\text{C}$ to $85^\circ\text{C}$ (Note 4)		4		

## ELECTRICAL CHARACTERISTICS ( continued )

$T_A = 25^\circ\text{C}$ .  $V_{IN} = 1.5\text{V}$ ,  $V_{OUT} = 3.3\text{V}$ ,  $V_{SHUTB} = 1.5\text{V}$  (UNLESS OTHERWISE NOTED).

Parameter	Conditions	Min	Typ	Max	Unit
SHUTB Input High		0.95			V
SHUTB Input Low				0.35	V
SHUTB Input Current				10	$\mu\text{A}$
Frequency in Start-up			100		kHz
Thermal Shutdown	15°C Hysteresis		145		$^\circ\text{C}$

**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 input voltage is greater than output voltage regulation point, the part is in track mode (see Track Mode).

**Note 3:** For applications where  $V_{OUT} > 4.3\text{V}$ , an external Schottky diode is required.

**Note 4:** Limits are 100% production tested at  $T_A = 25^\circ\text{C}$ . Limits over the operating temperature range are guaranteed by design.

## TYPICAL OPERATING CHARACTERISTICS

(VIN = 1.5V, Circuit of Typical Application Circuit, TA = +25°C, unless otherwise noted.)

## OPERATION DESCRIPTION

The PS0020 is a compact, high-efficiency, synchronous boost converter in a 6-leads SOT-26 package designed for space-restricted applications. The parts are available with adjustable output voltages ranging from 2.5V to 5.0V. They are 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 devices maintain high efficiency over a wide range of load current. As shown in the Block Diagram, the PS0020 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 PS0020 has ultra-fast line and improved load regulation. Moreover, the PS0020 provides real shutdown circuitry, which disconnects the output from the input in shutdown and results in discharge of the output to ground.

### Start-Up Mode:

The PS0020 will start up typically at 0.8V. When it is turned-on, the device gets its start up bias from  $V_{in}$ . A start-up oscillator, which runs typically at 100 KHz, brings the output voltage high enough so that  $V_{out}$  exceeds  $V_{in}$ . Once  $V_{out}$  exceeds  $V_{in}$ , internal bias switches from  $V_{in}$  to  $V_{out}$  by an internal bias-select circuit. Thus, once started (i.e.  $V_{out}$  exceeds  $V_{in}$ ), internal circuit bias is completely independent of  $V_{in}$ . The start-up oscillator runs at 66% duty cycle around 100KHz. 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 PS0020 features a  $0.45\Omega$  NMOS switch and a  $0.6\Omega$  PMOS switch. In normal operation these switches are alternatively turned-on and thus initiate charging of the inductor from  $V_{in}$  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 huge in-rush current from output to ground via switches. In the dead time, both switches remain off and the inductor discharges via body diode of the PMOS switch to the output.

### True Shutdown Mode

The PS0020 is designed to allow the 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 PS0020A features a user-adjustable output through an external feedback network. A voltage divider from  $V_{out}$  to ground programs the output voltage via FB from 2.5V to 5V using the following equation:

$$V_{out} = V_{ref} * [1 + (R1/R2)]$$

Where,  $V_{ref} = 1V$

### Thermal Overload Protection

Thermal-overload protection limits total power dissipation in the PS0020. When the junction temperature exceeds  $T_j = +145^\circ C$ , the thermal sensor signals the shutdown logic and turns off most of the internal circuitry. The thermal sensor turns internal circuitry on again after the IC's junction temperature drops by  $15^\circ C$ .

Thermal-Overload protection is designed to protect the PS0020 in the event of a fault condition. For continual operation, do not exceed the absolute maximum junction temperature rating of  $T_j = +125^\circ C$ .

### Current Limit and Short Circuit Protection

The PS0020 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 300mA. Because of its true shutdown feature, the IC is allowed to be short-circuited. The thermal shutdown turns off the regulator in case of excessive heating, when the die temperature reaches  $145^\circ C$ .

**Light Load Operation**

The PS0020 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 (50mA, typically). This prevents the inductor current from reversing its polarity, avoiding back-charging and thus improving efficiency at light load. 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, providing better efficiency.

**Anti-ringing Control**

When inductor current goes to zero, there arises a high frequency ringing of SW pin. To prevent this phenomenon, 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 goes too low (below 1.8V typ), the PS0020 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 that time, very few circuits are operational. When the oscillator raises the supply above 1.9V, UVLO signal is disabled and the normal PWM mode takes over the start-up oscillator operation. This mechanism protects the chip from producing false logic due to low input supply.

**Enable Input**

The PS0020 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. 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 threshold is TTL/CMOS compatible. Connect SHUTB to Vin for normal operation.

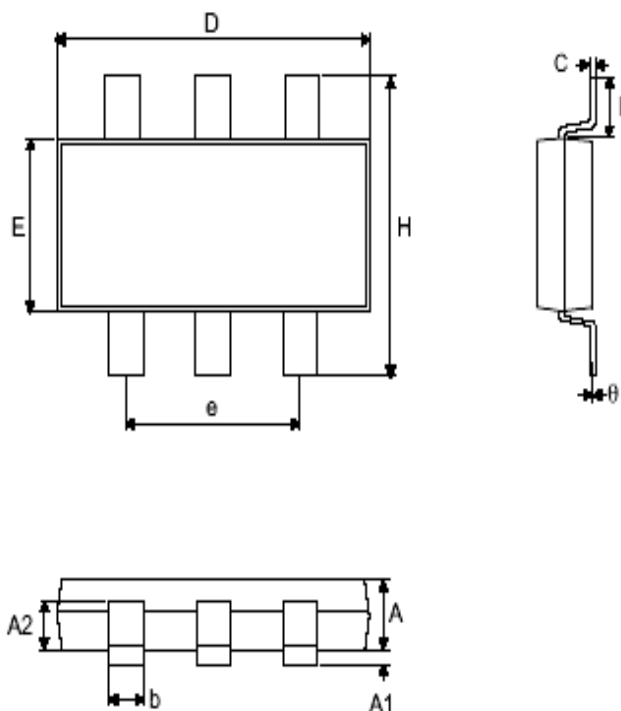
**Track Mode**

The PS0020 is in track mode when Vin is greater than the output voltage regulation point (in abnormal boost converter operation). In track mode, the regulator runs at fixed start-up oscillator frequency. The start-up oscillator runs freely until Vout exceeds Vin. When Vout falls below Vin, the start-up oscillator is enabled again. Thus in track mode, normal loop control of PWM operation remains off, rather 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	$\theta$
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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