

# PT3409A/B

## 3MHz 1.5A/2A High $\eta$ Step-Down Converter in SOT23-5 Package

### DESCRIPTION

The PT3409A/B is a high-efficiency DC-to-DC step-down switching regulator, capable of delivering up to 1.5A/2A of output current. The devices operate from an input voltage range of 2.6V to 5.5V and provide output voltages from 0.6V to  $V_{IN}$ , making the PT3409A/B ideal for low voltage power conversions. Running at a fixed frequency of 3MHz allows the use of small inductance value and low DCR inductors, thereby achieving higher efficiencies. Other external components, such as ceramic input and output caps, can also be small due to higher switching frequency, while maintaining exceptional low noise output voltages. Built-in EMI reduction circuitry makes this converter ideal power supply for RF applications. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal-overload protection improves design reliability.

PT3409A/B is housed in a tiny SOT23-5L package.

### FEATURES

- ◆  $\eta$  up to 96%
- ◆ Up to 1.5A Max output current for PT3409A
- ◆ Up to 2A Max output current for PT3409B
- ◆ 3MHz Frequency
- ◆ Internal Compensation
- ◆ Clock Dithering
- ◆ Tiny SOT23-5 Package

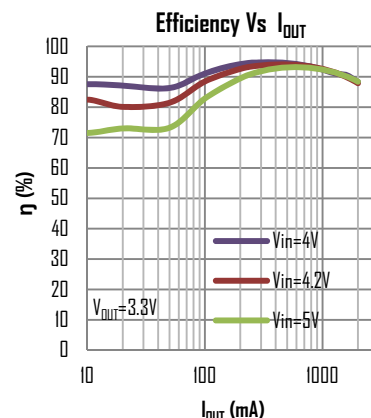
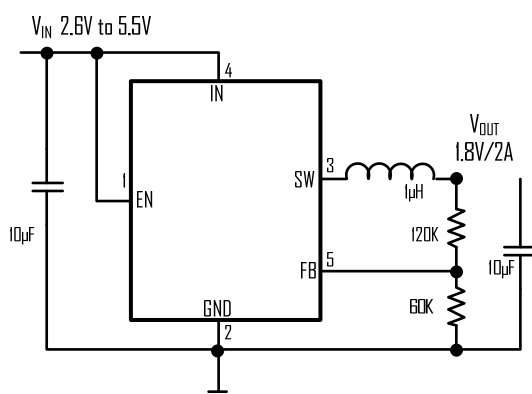
### APPLICATIONS

- ◆ USB ports/Hubs, Set Top Boxes
- ◆ Portable Devices
- ◆ Cellphones
- ◆ Tablet PC

### ORDERING INFORMATION

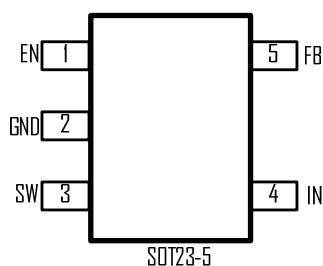
PART	PACKAGE PIN	TOP MARK
PT3409A-S2F PT3409B-S2F	SOT23-5	<div><div>CQYW</div><div>CYYW</div><div>Product Number</div><div>Date Code</div></div>

### TYPICAL APPLICATION



# PT3409A/B

## PIN CONFIGURATION



## ABSOLUTE MAXIMUM RATINGS

(Note: Exceeding these limits may damage the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

IN, SW, FB, EN Voltage	–0.3V to 6V
SW to ground current	Internally limited
Maximum Power Dissipation	600mW
Operating Temperature Range	–40°C to 85°C
Storage Temperature Range	–55°C to 150°C

## ELECTRICAL CHARACTERISTICS

( $V_{IN} = 3.6V$ , unless otherwise specified. Typical values are at  $T_A = 25^{\circ}C$ .)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range		2.6		5.5	V
Input UVLO	Rising, Hysteresis=200mV		2.1		V
Input Supply Current	$V_{FB} = 0.65V$		30		$\mu A$
Input Shutdown Current			0.1	1	$\mu A$
FB Feedback Voltage	$V_{IN} = 2.5$ to $5.5V$	0.588	0.6	0.612	V
FB Input Current			0.01		$\mu A$
Output Voltage Range		0.6		$V_{IN}$	V
Load Regulation			0.15		%/A
Line Regulation	$V_{IN} = 2.7$ to $5.5V$		0.04		%/V
Switching Frequency		2.4	3	3.6	MHz
NMOS Switch On Resistance	PT3409A, $I_{SW} = 200mA$		120		$m\Omega$
	PT3409B, $I_{SW} = 200mA$		100		
PMOS Switch On Resistance	PT3409A, $I_{SW} = 200mA$		100		$m\Omega$
	PT3409B, $I_{SW} = 200mA$		80		
PMOS Switch Current Limit	PT3409A		2		A
	PT3409B		2.5		
SW Leakage Current	$V_{OUT} = 5.5V, V_{SW} = 0$ or $5.5V, EN = GND$			10	$\mu A$
EN Input Current	$EN = MODE = GND$			1	$\mu A$
EN Input Low Voltage		0.4			V
EN Input High Voltage				1.5	V
Thermal Shutdown	Rising, Hysteresis = $15^{\circ}C$		160		$^{\circ}C$

## PIN DESCRIPTION

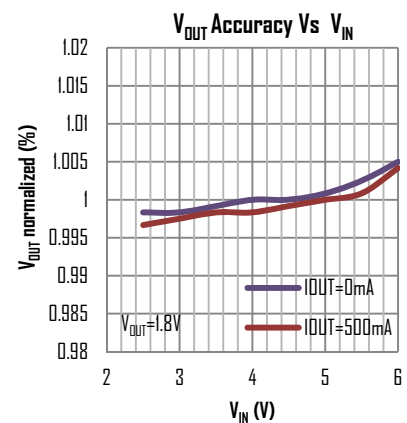
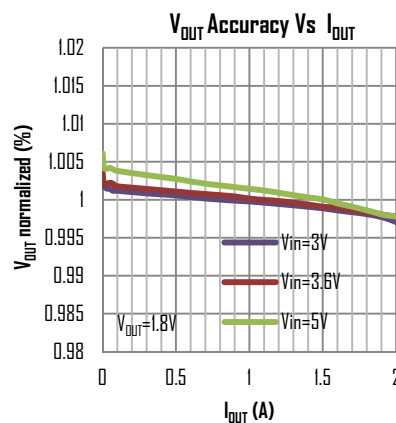
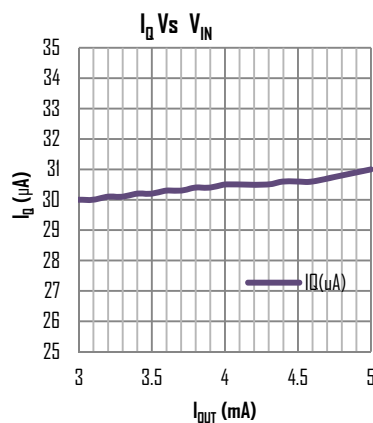
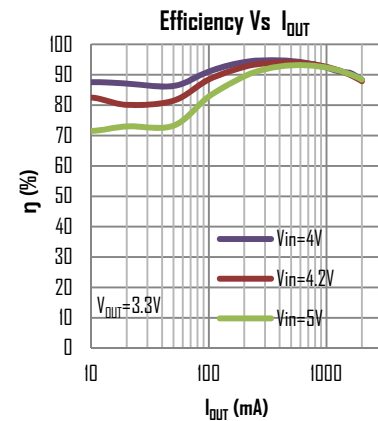
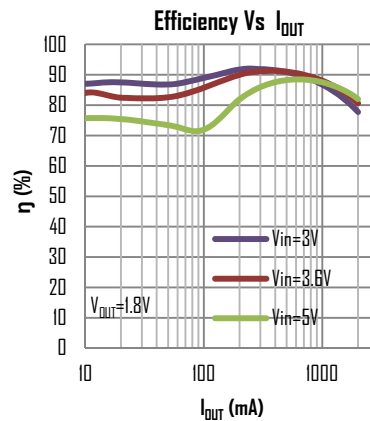
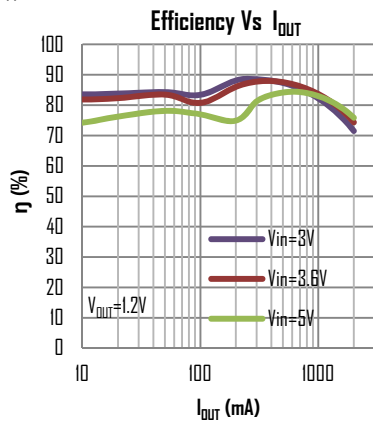
PIN #	NAME	DESCRIPTION
1	EN	Enable pin for the IC. Drive this pin to high to enable the part, low to disable.
2	GND	Ground

# PT3409A/B

PIN #	NAME	DESCRIPTION
3	SW	Inductor Connection. Connect an inductor Between SW and the regulator output.
4	IN	Supply Voltage. Short to PIN. Bypass with a 10 $\mu$ F ceramic capacitor to GND
5	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set the output to a voltage between 0.6V and VIN

## TYPICAL CHARACTERISTICS

(Typical values are at TA = 25°C unless otherwise specified.)

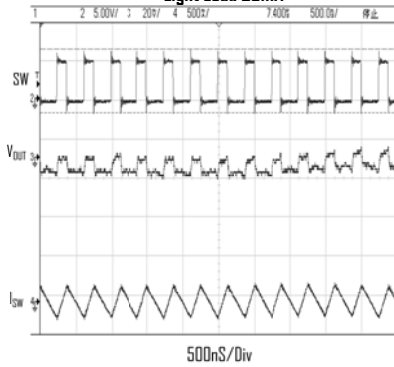


# PT3409A/B

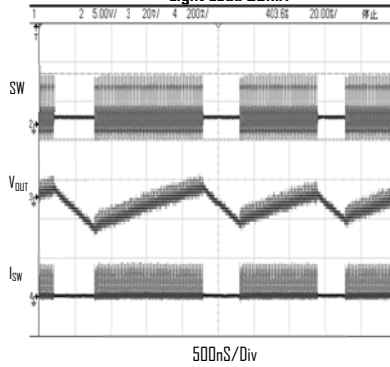
## TYPICAL CHARACTERISTICS

(Typical values are at  $T_A = 25^{\circ}\text{C}$  unless otherwise specified.)

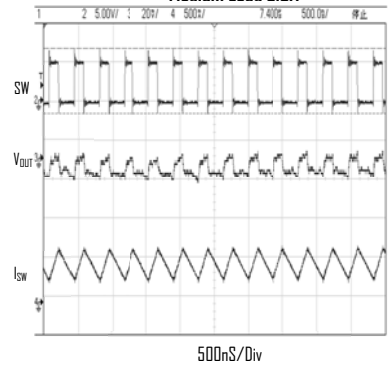
**SWITCHING WAVEFORMS**  
Light Load 20mA



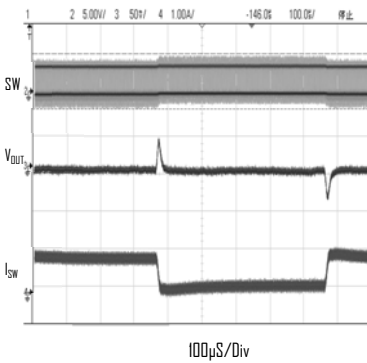
**SWITCHING WAVEFORMS**  
Light Load 20mA



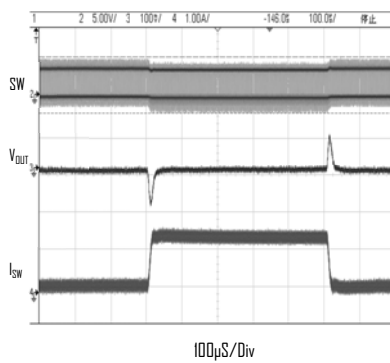
**SWITCHING WAVEFORMS**  
Medium Load 0.5A



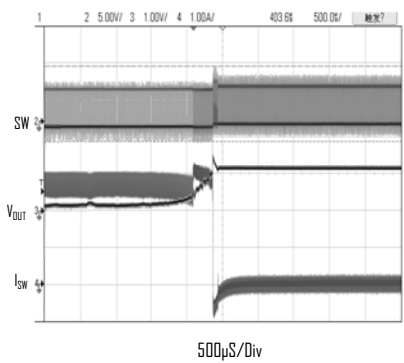
**Load Transient**  
 $V_{OUT}=1.2\text{V } 0.2\text{A to } 1.0\text{A}$



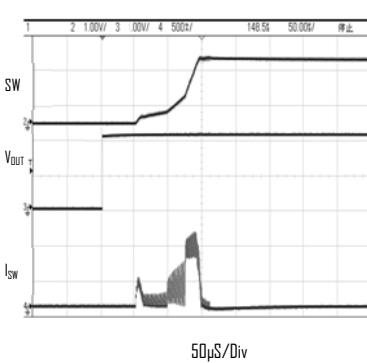
**Load Transient**  
 $V_{OUT}=1.8\text{V } 0.2\text{A to } 1.5\text{A}$



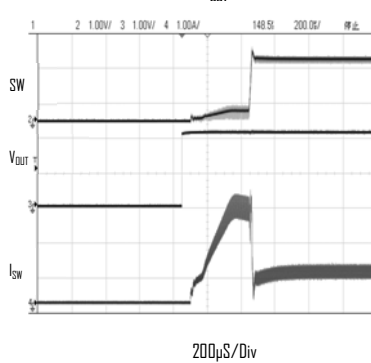
**Short-Circuit Recovery**



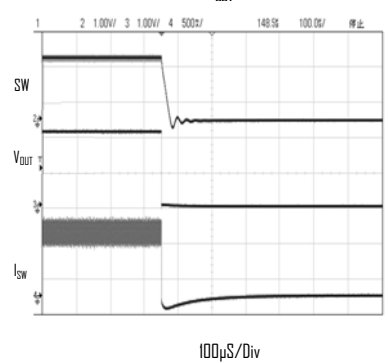
**Start-Up Waveform**  
No Load



**Start-Up Waveform**  
 $I_{OUT}=1\text{A}$



**Shutdown Waveform**  
 $I_{OUT}=1\text{A}$



# PT3409A/B

## FUNCTION DESCRIPTION

The PT3409A/B high efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 2A of output current. The device operates in pulse-width modulation (PWM) at 3MHz from a 2.6V to 5.5V input voltage and provides an output voltage from 0.6V to  $V_{IN}$ , making the PT3409A/B ideal for on-board post-regulation applications. An internal synchronous rectifier improves efficiency and eliminates the typical Schottky free-wheeling diode. Using the on resistance of the internal high-side MOSFET to sense switching currents eliminates current-sense resistors, further improving efficiency and cost.

### Loop Operation

PT3409A/B uses a PWM current-mode control scheme. An open-loop comparator compares the integrated voltage-feedback signal against the sum of the amplified current-sense signal and the slope compensation ramp. At each rising edge of the internal clock, the internal high-side MOSFET turns on until the PWM comparator terminates the on cycle. During this on-time, current ramps up through the inductor, sourcing current to the output and storing energy in the inductor. The current mode feedback system regulates the peak inductor current as a function of the output voltage error signal. During the off cycle, the internal high-side P-channel MOSFET turns off, and the internal low-side N-channel MOSFET turns on. The inductor releases the stored energy as its current ramps down while still providing current to the output.

### Current Sense

An internal current-sense amplifier senses the current through the high-side MOSFET during on time and produces a proportional current signal, which is used to sum with the slope compensation signal. The summed signal then is compared with the error amplifier output by the PWM comparator to terminate the on cycle.

### Current Limit

There is a cycle-by-cycle current limit on the high-side MOSFET. When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. PT3409A/B utilizes a frequency fold-back

mode to prevent overheating during short-circuit output conditions. The device enters frequency fold-back mode when the FB voltage drops below 200mV, limiting the current to  $I_{PEAK}$  and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

### Soft-start

PT3409A/B has a internal soft-start circuitry to reduce supply inrush current during startup conditions. When the device exits under-voltage lockout (UVLO), shutdown mode, or restarts following a thermal-overload event, the soft-start circuitry slowly ramps up current available at SW.

### UVLO and Thermal Shutdown

If  $I_{IN}$  drops below 1.9V, the UVLO circuit inhibits switching. Once  $I_{IN}$  rises above 2.1V, the UVLO clears, and the soft-start sequence activates. Thermal-overload protection limits total power dissipation in the device. When the junction temperature exceeds  $T_J = +160^{\circ}\text{C}$ , a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by  $15^{\circ}\text{C}$ , resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.

## Design Procedure

### Setting Output Voltages

Output voltages are set by external resistors. The FB threshold is 0.6V.

$$V_{OUT} = 0.6 \times [1 + (R_{TOP} / R_{BOTTOM})]$$

### Inductor Selection

The peak-to-peak ripple is limited to 30% of the maximum output current. This places the peak current far enough from the minimum overcurrent trip level to ensure reliable operation while providing enough current ripples for the current mode converter to operate stably. In this case, for 2A maximum output current, the maximum inductor ripple current is 667 mA. The inductor size is estimated as following equation:

$$L_{IDEAL} = (V_{IN(MAX)} - V_{OUT}) / I_{RIPPLE} * D_{MIN} * (1 / F_{OSC})$$

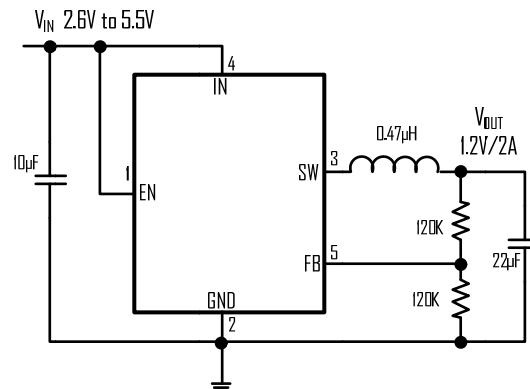
Therefore, for  $V_{OUT} = 1.8\text{V}$ ,

The inductor value is calculated to be  $L = 0.60\mu\text{H}$ .



# PT3409A/B

## TYPICAL APPLICATION

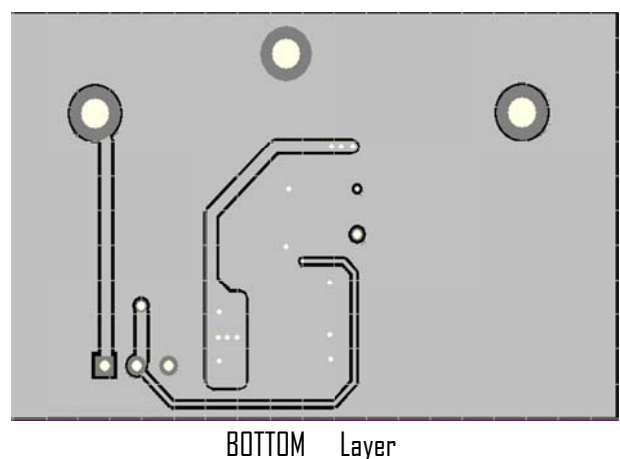
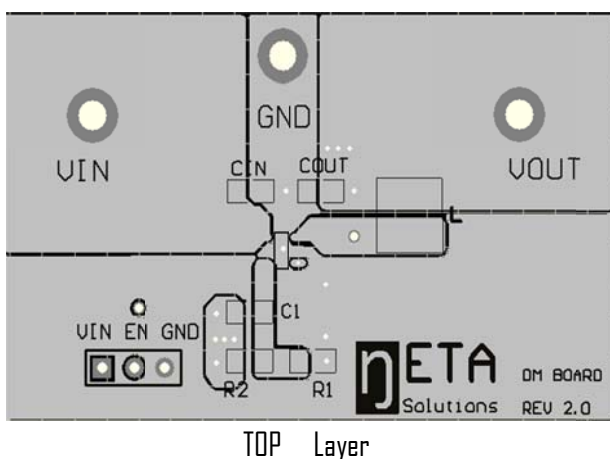


### PCB LAYOUT GUIDE

PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout for optimum performance.

If change is necessary, please follow these guidelines and take Figure for reference.

- 1) Keep the path of switching current short and minimize the loop area formed by input cap, high-side MOSFET and low-side MOSFET.
- 2) Bypass ceramic capacitors are suggested to be put close to the Vin pin.
- 3) Ensure all feedback connections are short and direct. Place the feedback resistors and compensation components as close to the chip as possible.
- 4) Route SW away from sensitive analog areas such as FB.
- 5) Connect IN, SW, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.



## SOT23-5L PACKAGE OUTLINE AND DIMENSIONS

