

GENERAL DESCRIPTION

The TCS9208 step-up switching regulator generates an output voltage of up to 6V from an input voltage as low as 1.6V. Ideal for applications where space is limited, it switches at 1.2MHz, allowing the use of tiny, low cost and low profile external components. Its internal 2A, 100mΩ NMOS switch provides high efficiency even at heavy load, while the constant frequency, current mode architecture results in low, predictable output noise that is easy to filter. Internal frequency compensation is designed to accommodate ceramic output capacitors, further reducing noise. The device features very low shutdown current of 0.5uA.

The TCS9208 is available in the 6-lead SOT-23 package.

FEATURES

- Internal 2A MOSFET Switch
- 1.2MHz Switching Frequency
- Integrated Soft-Start
- Low 1.6V Vin Operation
- Low $R_{ds(on)}$ Switch :100mΩ at 5V Output
- Delivers 5V at 800mA from a 3.3V input
- Delivers 3V at 800mA from a 2.5V input
- Uses Small,Low Profile External Components
- Low profile(1mm):SOT-23(Thin SOT)package

APPLICATIONS

- White LED Driver Supply
- Local 3.3V or 5V supply
- Battery Back-up

3.3V to 5V Boost Converter

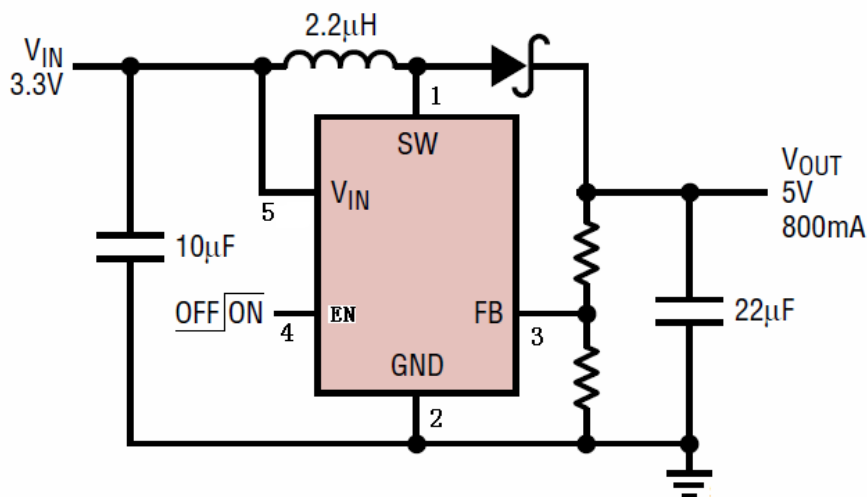


Figure 1. Typical Application Circuit

ORDERING INFORMATION

PART NUMBER	TEMP RANGE	SWICHING FREQUENCY	OUTPUT VOLTAGE (V)	CURRENT LIMIT(A)	PACKAGE	PINS
TCS9208_F	-40°C to 85°C	1.2MHz	Adjustable	2	SOT23-6	6

PIN CONFIGURATION

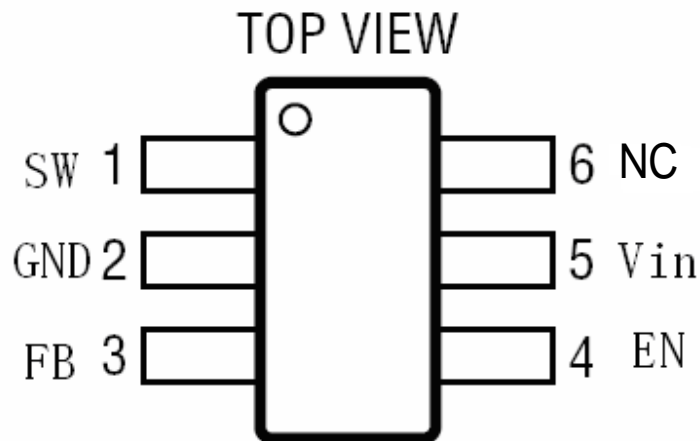


Figure 2. PIN Configuration

PIN DESCRIPTION

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1	SW	Switch Output. Connect this pin to the inductor.
2	GND	Ground.
3	FB	Feedback Input. The voltage at this pin is regulated to 0.6V. Connect to the resistor divider between output and ground to set output voltage
4	EN	Enable Input. When higher than 1.5V, this pin turns the IC on. When lower than 0.3V, this pin turns the IC off.
5	Vin	Power Supply
6	NC	NC

ABSOLUTE MAXIMUM RATINGS

(Note: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

PARAMETER	VALUE	UNIT
Supply Voltage VIN	-0.3 to 6.5	V

FB, EN Voltage	-0.3 to VIN+0.3	V
SW Voltage	-0.3 to VIN+0.3	V
Operating Ambient Temperature	-40 to 85	°C
Maximum Junction Temperature	125	°C
Storage Temperature	-55 to 150	°C
Lead Temperature (Soldering, 10 sec)	300	°C

ELECTRICAL CHARACTERISTICS

(VIN = 3.6V, TA = 25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range	VIN		1.6		6.0	V
Quiescent Current	Iq	VFB = 0.7V EN = Vin, ILoad = 0		65		uA
Shutdown Current		VEN = 0V, VIN = 3.3V		0.5		
Regulated Feedback Voltage	VFB	Ta = 25°C	0.588	0.6	0.612	V
		0 < Ta < 85°C	0.6865	0.6	0.6135	
		-40°C < Ta < 85°C	0.585	0.6	0.615	
Reference Voltage Line Regulation		VIN = 1.6V to 5.5V		0.05	0.5	%
Output Voltage Load Regulation				0.5		%
Current Limit	IPEAK			2	2.4	A
Oscillator Frequency	FOSC	VFB = 0.6V or VOUT = 100%		1.2		MHz
Rds(ON) of N-channel FET		ISW = -100mA		100		Ohm
Enable Threshold		VIN = 1.6V to 5.5V	0.3	1	1.5	V
Enable Leakage Current			-0.1		0.1	uA
SW Leakage Current		VEN = 0V, VSW = 0V or 5V, VIN = 5V			1	uA

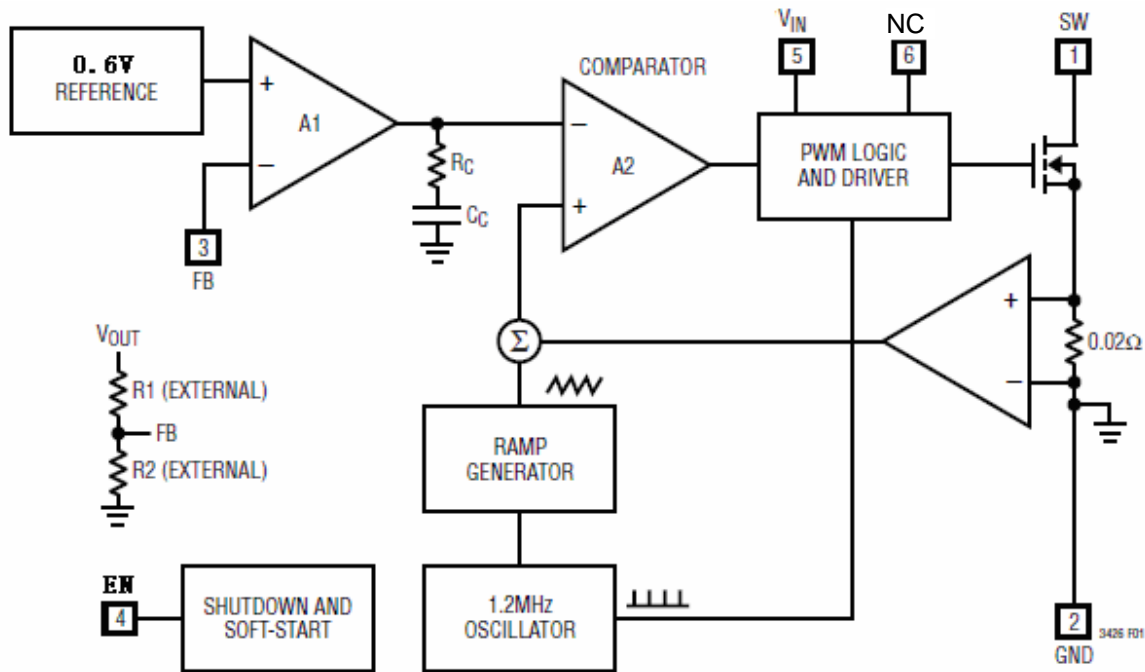


Figure 3. Functional Block Diagram

FUNCTIONAL DESCRIPTION

NORMAL OPERATION

The TCS9208 is a monolithic 1.2MHz boost converter housed in a 6-lead SOT-23 package. The device features fixed frequency, current mode PWM control for excellent line and load regulation. The low $R_{ds(on)}$ NMOS switch enables the device to maintain high efficiency over a wide range of load current. Operation of the feedback loop which sets the peak inductor current to keep the output in regulation can be best understood by referring to the Block Diagram in Figure 1. At the start of each clock cycle a latch in the PWM logic is set and the NMOS switch is turned on. The sum of a voltage proportional to the switch current and a slope compensating voltage ramp is fed to the positive input to the PWM comparator. When this voltage exceeds either a voltage proportional to the 2A current limit or the PWM control voltage, the latch in the PWM logic is reset and NMOS switch is turned off. The PWM

control voltage at the output of the error amplifier is the amplified and compensated difference between the feedback voltage on the FB pin and the internal reference voltage of 0.6V. If the control voltage increases, more current is delivered to the output. When the control voltage exceeds the I_{LIMIT} reference voltage, the peak current is limited to a minimum of 2A. The current limit helps protect the TCS9208 internal switch and external components connected to it. If the control voltage decreases, less current is delivered to the output. During load transients control voltage may decrease to the point where no switching occurs until the feedback voltage drops below the reference. The TCS9208 has an integrated soft-start feature which slowly ramps up the feedback control node from 0V. The soft-start is initiated when EN is pulled high.

APPLICATION INFORMATION

INDUCTOR SELECTION

The TCS9208 can utilize small surface mount

inductors due to its 1.2MHz switching frequency. A 2.2 μ H or 4.7 μ H inductor will be the best choice for

most TCS9208 applications.

The inductor should have low DCR (DC resistance) to reduce the I²R power losses, and must be able to handle the peak inductor current without saturating.

Several inductor manufacturers are listed in Table 1 Selected inductor by actual application:

Manufacturer	Part Number	Inductance(uH)	DCR max (Ohms)	Dimensions L*W*H(mm)
Murata	LQH5BPN	2.2	0.03	5*5*2
	LQH32PN	2.2	0.06	3.2*2.5*1.7
Sumida	CDRH3D16	2.2	0.03	4*4*1.8
		4.7	0.07	

Table 1. Recommend Surface Mount Inductors

Diode Selection

A Schottky diode is recommended for use with the TCS9208. Use of a low forward voltage diode such as the ON Semiconductor MBRA210LT3 is recommended. A Schottky diode rated at 2A is recommended for use with the TCS9208.

INPUT CAPACITOR SELECTION

The input capacitor reduces input voltage ripple to the converter, low ESR ceramic capacitor is highly recommended. For most applications, a 10~22uF capacitor is used. The input capacitor should be placed as close as possible to VIN and GND.

Recommended: Murata GRM32ER61A106KA01L

Murata GRM32NR61A226KE19L

OUTPUT CAPACITOR SELECTION

A low ESR output capacitor is required in order to maintain low output voltage ripple. In the case of ceramic output capacitors, capacitor ESR is very small and does not contribute to the ripple, so a lower capacitance value is acceptable when ceramic capacitors are used. A 22uF ceramic output capacitor is suitable for most applications.

Recommended: Murata GRM32NR61A226KE19L

OUTPUT VOLTAGE PROGRAMMING

In the adjustable version, the output voltage is set by a resistive divider according to the following equation:

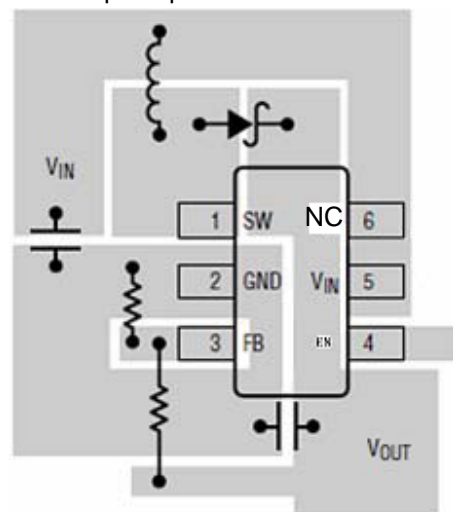
$$R_2 = R_1 \times \left(\frac{V_{OUT}}{0.6} - 1 \right)$$

Typically choose R1=100K and determine R2 from the following equation:

Connect a small capacitor across R1 feed forward capacitance at the FB pin for better performance.

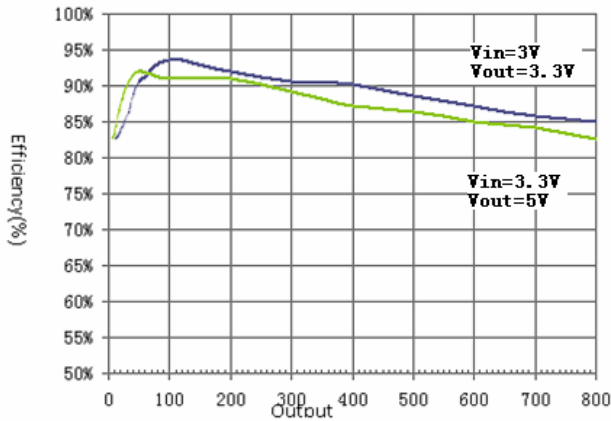
PCB Layout Guidelines

The high speed operation of the TCS9208 demands careful attention to board layout. You will not get advertised performance with careless layout. Figure as below shows the recommended component placement. A large ground pin copper area will help to lower the chip temperature.

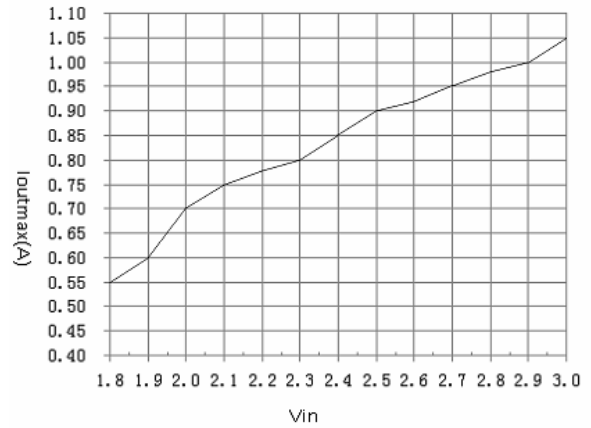


TYPICAL PERFORMANCE CHARACTERISTICS

Efficiency vs. Output Current

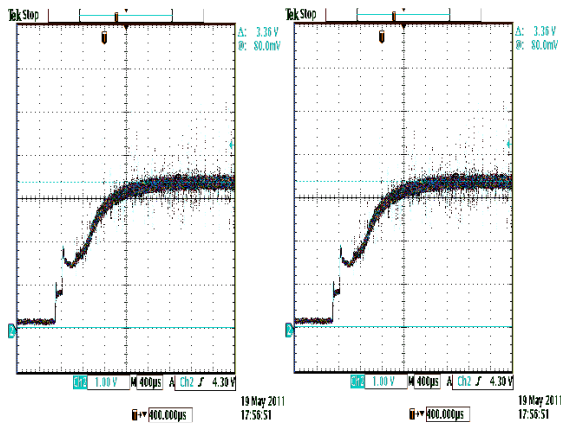


IOUT(MAX) vs VIN(Vout=3.3V)

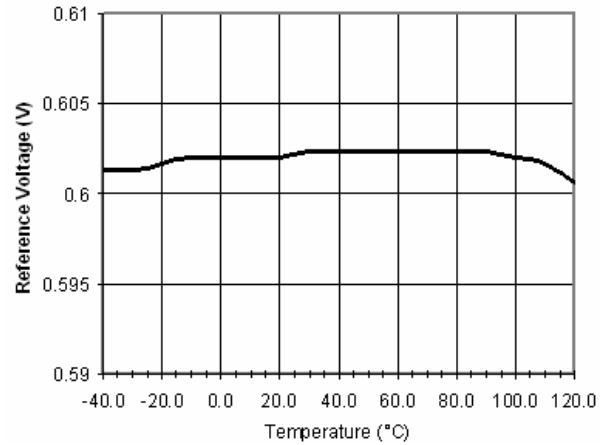


Startup waveform

(V_{in}=EN=1.8V V_{out}=3.3V)

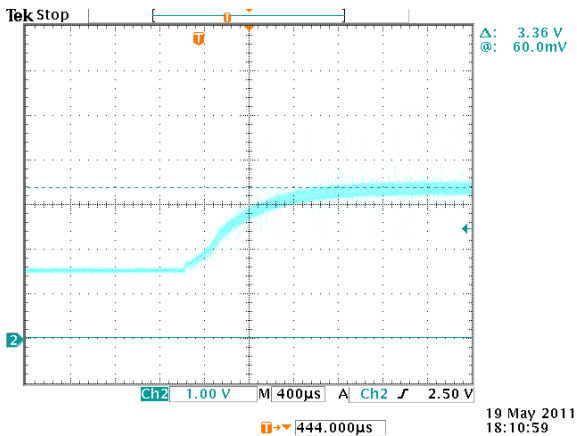


Reference Voltage vs. Temperature



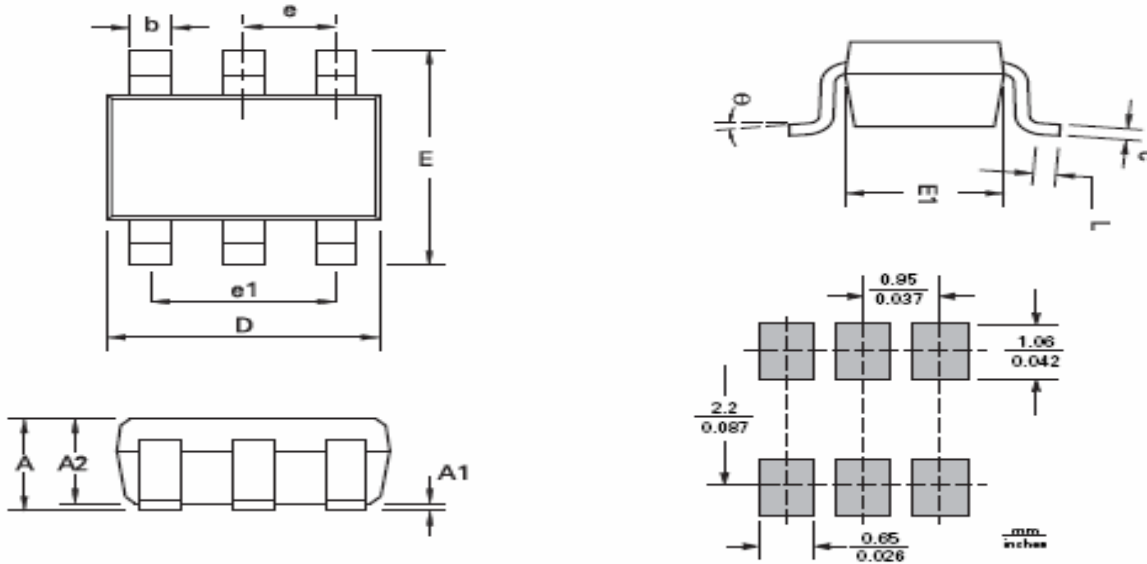
Startup through Enable Waveform

(V_{in}=1.8V EN=0->1.8V V_{out}=3.3V)



PACKAGE OUTLINE

SOT23-6 PACKAGE OUTLINE AND DIMENSIONS



DIM	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.90	1.05	0.0354	0.0413
A1	0.90	0.15	0.00	0.0059
A2	0.90	1.30	0.0354	0.0512
b	0.36	0.60	0.0142	0.0236
C	0.40	0.28	0.0157	0.0110
D	2.70	3.10	0.1063	0.1220
E	2.20	3.20	0.0866	0.1260
E1	1.30	1.80	0.0512	0.0709
L	0.10	0.60	0.0039	0.0236
a	0.95 REF		0.0374 REF	
e1	1.90 REF		0.0748 REF	
L	0°	30°	0°	30°

Note: Controlling dimensions are in millimeters. Approximate dimensions are provided in inches.

DIM	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.90	1.05	0.0354	0.0413
A1	0.90	0.15	0.00	0.0059
A2	0.90	1.30	0.0354	0.0512
b	0.36	0.60	0.0142	0.0236
C	0.40	0.28	0.0157	0.0110
D	2.70	3.10	0.1063	0.1220
E	2.20	3.20	0.0866	0.1260
E1	1.30	1.80	0.0512	0.0709
L	0.10	0.60	0.0039	0.0236
a	0.95 REF		0.0374 REF	
e1	1.90 REF		0.0748 REF	
L	0°	30°	0°	30°

Note: Controlling dimensions are in millimeters. Approximate dimensions are provided in inches.