

General Description

The SE3608 is a high efficiency current-mode boost converter with a fixed operation frequency. The SE3608 integrates a very low Rds-on NMOSFET to reduce power loss and achieve higher efficiency. The maximum efficiency is up to 93%. SE3608 can output 2A current when Vin is higher than 3.3V and output is 5V. The high 1.2MHz operation frequency minimizes L and C value. The internal compensation network reduces external component counts. Small foot print SOT23-6 package provides the best solution for PCB layout area.

SE3608 is designed with 10V process. This allows SE3608 to be used in applications where higher voltage is needed, such as charging two Lithium batteries in series. The other possible application where the higher voltage is needed is Qualcomm Quick Charge 2.0 compatible portable chargers. SE3608 can support 9V Vout for this application.

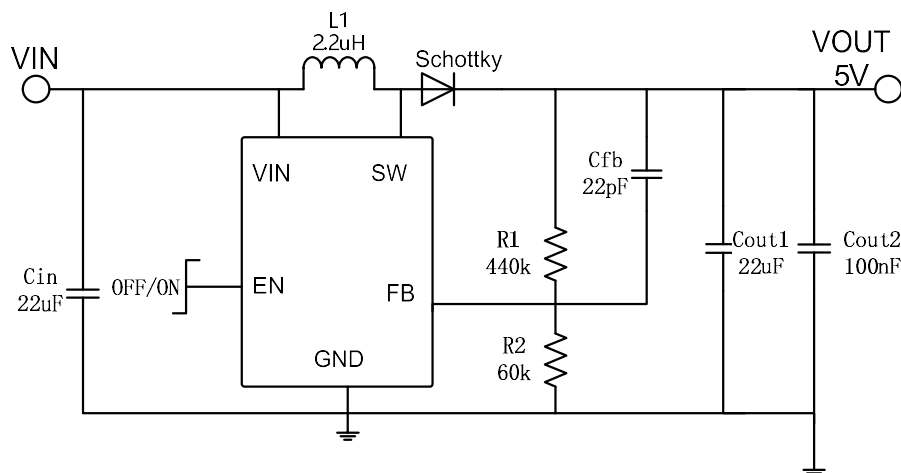
Features

- Wide Input Range: 2.5-5.8V Input
- **Up to 2A Output Current**
- Maximum 9V Output Voltage
- 1.2MHz Switching Frequency
- Low RDS(ON): 70mΩ
- Up to 93% Efficiency
- Under-Voltage Lockout Protection
- Over-Temperature Protection
- Internal Soft Start
- 1uA Shutdown Current
- Accurate Reference: 0.6V V_{REF}
- Compact package: PSOP8, SOT23-6

Applications

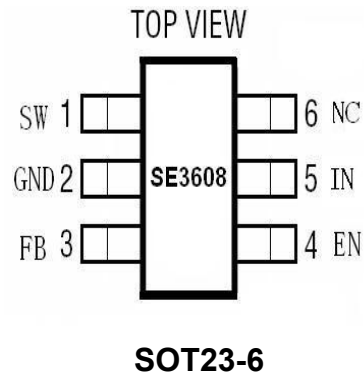
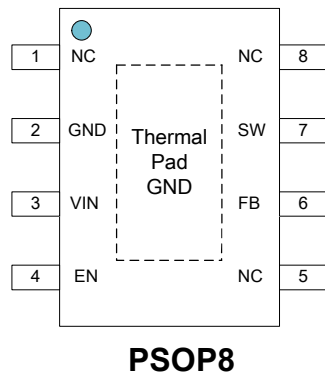
- Chargers
- LCD Displays
- Digital Cameras
- Handheld Devices
- Portable Products

Typical Application





Pin Configuration

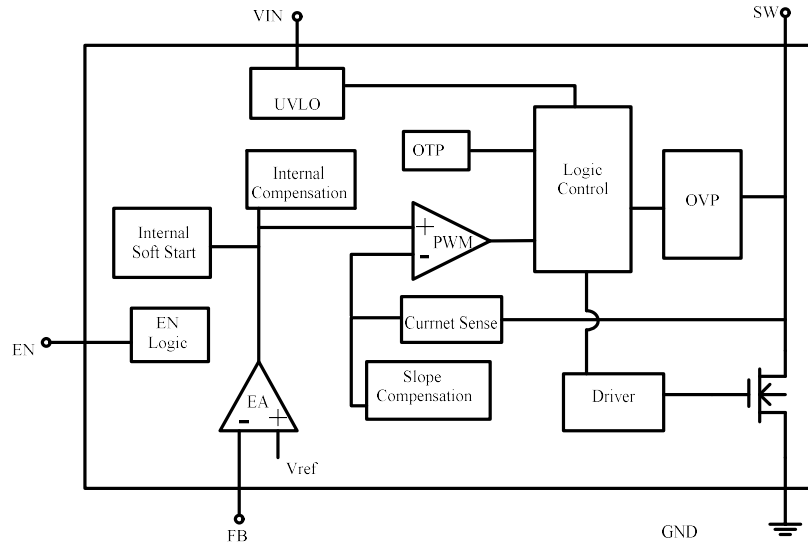


Pin Description

PSOP8	SOT23-6	Pin Name	Pin Function Description
1, 5, 8	6	NC	No Internal Connection
2	2	GND	GND
3	5	VIN	Input Supply Pin. Must be locally bypassed.
4	4	EN	Enable pin. A high input at EN enables the device and a low input disables the devices. When not used, connect EN to the input source for automatic startup.
6	3	FB	Feedback
7	1	SW	Power Switch Output. Connect the inductor and the blocking Schottky diode to SW.
9		Thermal Pad	GND



Functional Block Diagram



Absolute Maximum Ratings

Symbol	Parameter	Maximum	Units
V _{IN}	V _{IN} Supply Voltage	-0.3 ~ 6.5	V
V _{SW}	Voltage at SW Pin	-0.5 ~ 12	V
V _{IO}	All Other I/O Pins	GND-0.3 to VDD+0.3	V
P _{TR1}	Thermal Resistance(SOT23-6) Θ _{JA}	220	°C/W
T _{stg}	Storage Temperature	-55 to 150	°C
T _{solder}	Package Lead Soldering Temperature (10s)	260	°C
ESD Susceptibility	HBM(Human Body Mode)	2	kV

Note: Exceeding these ratings may damage the device.

Recommended Operating Conditions

Symbol	Parameter	Maximum	Units
V _{IN}	Input Voltage	2.5 to 6	V
V _{SW}	Output Voltage	V _{IN} to 10	V
T _A	Ambient Temperature	-40 to +85	°C
T _J	Junction Temperature	-40 to +125	°C

Note: The device is not guaranteed to function outside of its operating rating.



Electrical Characteristics

($V_{IN} = 3.3V$, $V_{OUT}=5V$, $I_{OUT}=100mA$, $T_A = 25^{\circ}C$ unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage		2.5		6	V
Feedback						
V_{FB}	Feedback Voltage		588	600	612	mV
I_{bias}	FB Pin Input Bias Current			0.05	1	μA
UVLO						
UVLO	Under Voltage Lock Out			2.1		V
Operating Current						
I_{off}	Operating Current (Shutdown)			0.1	1	μA
I_{sby}	No Switching	$V_{in}=3V$ $V_{FB}=0.7V$		100		μA
F_{sw}	Switching Frequency			1.2		MHz
D_{max}	Maximum Duty Cycle	$V_{FB}=0V$		90		%
Chip Enable						
V_{EN_H}	EN Minimum High Level		1.5			V
V_{EN_L}	EN Maximum Low Level				0.4	V
V_{HYS}	EN Hysteresis			90		mV
I_{EN}	EN Input Bias Current				1	μA
OTP						
OTP				120		$^{\circ}C$
OTP Hysteresis				20		$^{\circ}C$
Output Switch						
R_{ON}	SW On Resistance (Note 3)			70		m Ω
I_{LIMIT}	SW Current Limit			5		A
I_{LEAK}	SW Leakage Current	$V_{sw} = 5V$		0.01	1	μA
Open Circuit Protection						
V_{OV}	SE3608			$V_{OUT} \times 112\%$		V
Soft Start						
t_{ss}	Soft Start Time (Note 3)	V_{IN} Power On		400		μS

Note3: Guaranteed by design.



Typical Performance Characteristics

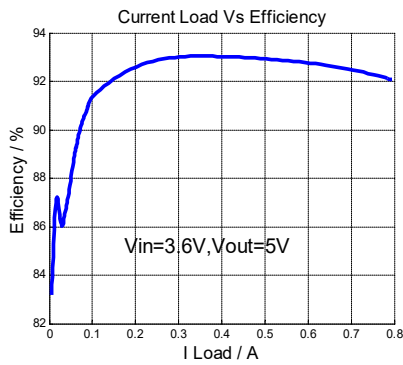


Fig 1 Efficiency Vs Light Load

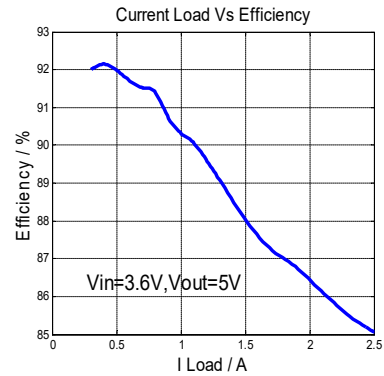


Fig 2 Efficiency Vs Heavy Load

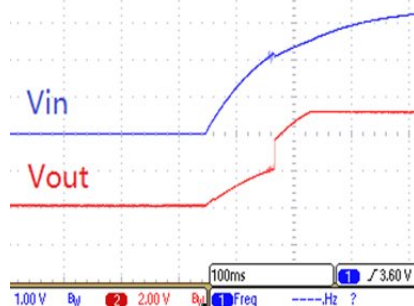


Fig 3 Startup with V_{in}

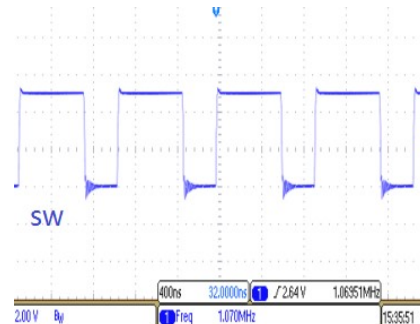


Fig 4 SW Waveform

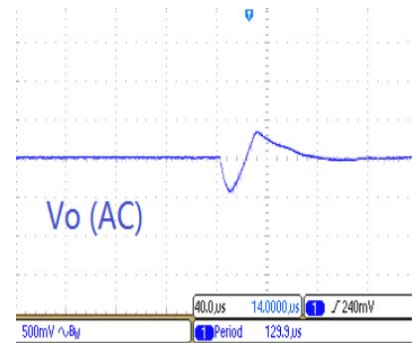


Fig 5 Transient Response

($V_{IN}=3.6V$, $V_{out}=5V$, $I_{load}=0.9A$ to $0.15A$)

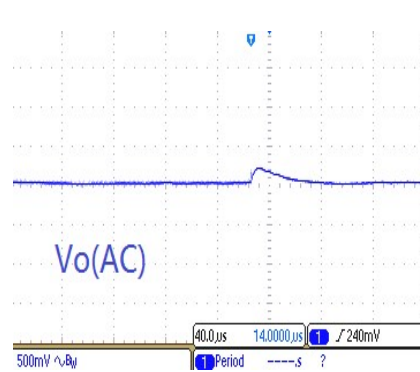


Fig 6 Transient Response

($V_{IN}=3.6V$, $V_{out}=5V$, $I_{load}=0.15A$ to $0.9A$)

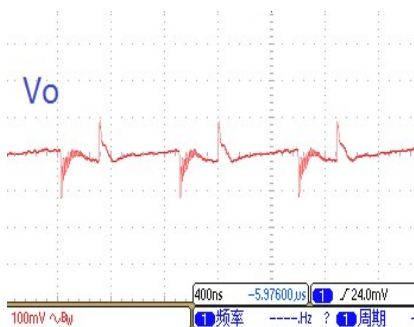


Fig 7 Vout Ripple

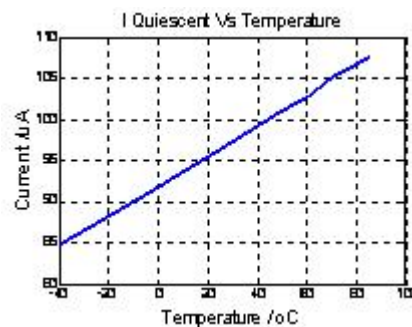


Fig 8 Quiescent Current Vs Temperature



Operation Description

The SE3608 adopts a fixed frequency, peak current mode boost regulator architecture to regulate output voltage. The operating principle of the SE3608 can be easily understood by referring to the functional block diagram. At the beginning of each oscillator cycle the MOSFET is turned on by the control circuit. To prevent sub-harmonic oscillations at duty cycle larger than 50 percent, a stabilizing ramp is added to the output of the current sense amplifier and the result is fed into the negative input of the PWM comparator. When this voltage equals the output voltage of the error amplifier, the power MOSFET is turned off. The voltage at the output of the error amplifier is an amplified result of the difference between the 0.6V reference voltage and the feedback voltage. In this way the peak current level keeps the output voltage in regulation. If the feedback voltage starts to drop, the output of the error amplifier increases, resulting in more current to flow through the power MOSFET, thus increasing the power delivered to the output. The SE3608 has internal soft start to avoid rush input current during the startup and also to avoid overshoot on the output.

Applications Information

Because of the high integration in the SE3608, the application circuit based on this regulator IC is rather simple. Only input capacitor C_{IN} , output capacitor C_{OUT1} and C_{OUT2} , inductor L, Schottky diode and feedback resistors (R1 and R2) need to be selected for the targeted applications.

Feedback Resistor Divider R1 and R2:

R1 and R2 should be chosen to program the proper output voltage. To minimize the power consumption under light loads, it is desirable to choose large resistance values for both R1 and R2. A value of between 330K Ω and 5M Ω is recommended for both resistors. The V_{out} is determined by the following equation:

$$V_{out} = 0.6V \cdot (1 + R1/R2)$$

Feedback Capacitor C_{FB} :

In order to enhance response speed of the convertor, feedback capacitor C_{FB} should be added to the loop. Its value should not be less than 22pF.

Input Capacitor C_{IN} :

To minimize the potential noise problem, place a typical X5R or better grade ceramic capacitor really close to the IN and GND pins. Care should be taken to minimize the loop area formed by C_{IN} , and IN/GND pins. In this case a 10uF low ESR ceramic is recommended.

Output Capacitor C_{OUT1} and C_{OUT2} :

The output capacitor is selected to meet the output ripple noise requirements. Both steady state ripple and



transient requirements must be taken into consideration when selecting these capacitors. For the best performance, it is recommended C_{OUT1} should be X5R or better grade ceramic capacitor with 10V rating and more than two pieces of 22uF Capacitors. Only when C_{OUT1} is big enough, it can absorb the energy of inductor and prevent the V_{out} to shoot up too high when there is a sudden reduction in the current load. It is recommended C_{OUT2} is 100nF. It can also reduce the ripple of output voltage.

Boost Inductor L:

The recommended value of inductor is 1u H. Small size and better efficiency are the major concerns for portable devices. The inductor should have low core loss at 1.2MHz and low DCR for better efficiency. To avoid inductor saturation the current rating should be considered.

Diode Selection:

Schottky diode is a good choice for SE3608 because of its low forward voltage drop and fast reverses recovery in order to get better efficiency. The high speed rectification is also a good characteristic of Schottky diode for high switching frequency. The diode reverse breakdown voltage should be larger than the output voltage, and its forward voltage should be less than 0.6V.

Start-up and Inrush Current:

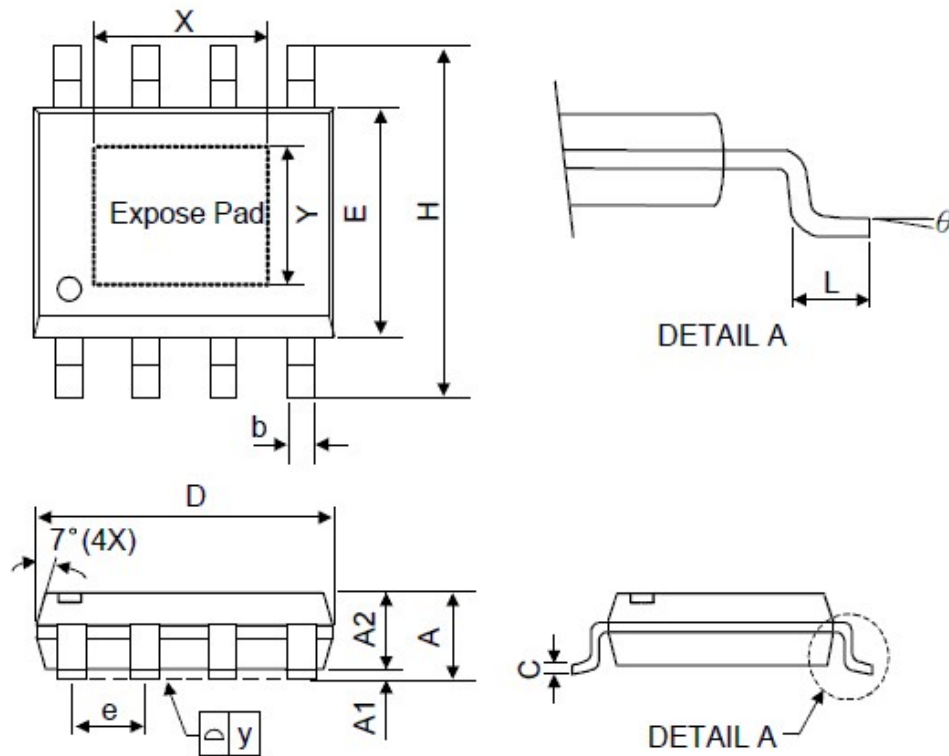
The SE3608 has internal soft start to limit the value of current through V_{IN} during the startup and also to avoid overshoot on the output. The soft start is realized by gradually increasing the output of error amplify during start-up.

Over Voltage Protection:

The SE3608 has integrated over voltage protection function. If the output voltage exceeds the predetermined value of 12%, the internal circuit will shut power MOS, until V_{OUT} voltage falls down.



Outline Drawing For PSOP8



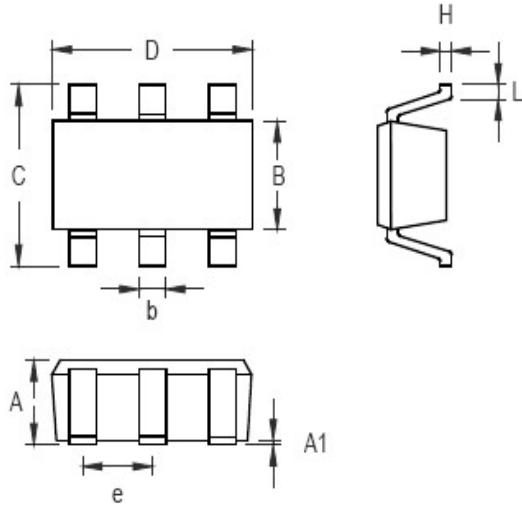
Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.75	-	-	0.069
A1	0	-	0.15	0	-	0.06
A2	1.25	-	-	0.049	-	-
C	0.1	0.2	0.25	0.0075	0.008	0.01
D	4.7	4.9	5.1	0.185	0.193	0.2
E	3.7	3.9	4.1	0.146	0.154	0.161
H	5.8	6	6.2	0.228	0.236	0.244
L	0.4	-	1.27	0.015	-	0.05
b	0.31	0.41	0.51	0.012	0.016	0.02
e	1.27 BSC			0.050 BSC		
y	-	-	0.1	-	-	0.004
X	-	2.34	-	-	0.092	-
Y	-	2.34	-	-	0.092	-
θ	0°	-	8°	0°	-	8°

Mold flash shall not exceed 0.25mm per side

JEDEC outline: MS-012 BA



Outline Drawing For SOT23-6



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.031	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.250	0.560	0.010	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

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