Datasheet

FS8802

High Efficiency Low Start-up Voltage Step-up DC-DC Converter

Fortune Semiconductor Corporation
富晶電子股份有限公司
28F., No.27, Sec. 2, Zhongzheng E. Rd.,
Danshui Town, Taipei County 251, Taiwan
Tel.：886-2-28094742
Fax：886-2-28094874
www.ic-fortune.com

1. General Description

The FS8802 is a compact, high-efficiency, step-up DC/DC converter that operates from an input voltage as low as 1Volt. The low start-up input voltage makes the device suitable for 1 to 4 battery cell applications delivering up to 400mA load current.

FS8802 features a voltage mode PWM control loop, providing stable and high-efficiency operation over a broad load current range without external compensation. High frequency 550KHz switching allows the use of small size external components.

The 2.5V to 6V output voltage is set with 2 external resistors. Both internal 2A NMOS power switch and driver for external power switch (NMOS or NPN) are provided for design flexibility.

A low battery detector with 0.86V detection voltage is included. The device is available in SOP-8 package.

2. Typical Application

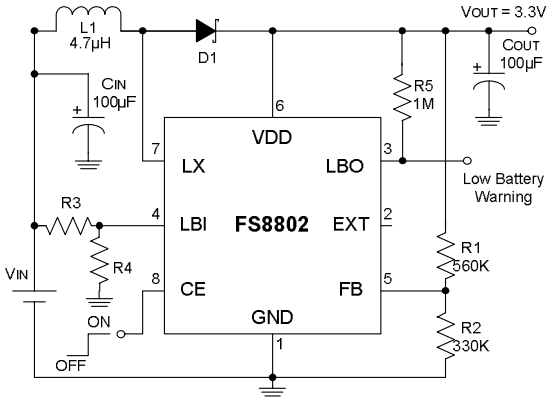


Fig 1. FS8802 Typical Application for 3.3V Output

3. Features

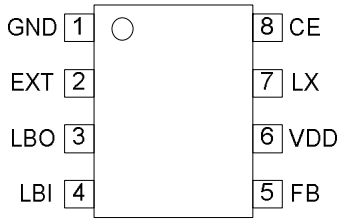
- 1.0V Low Start-up Input Voltage at 1mA Load
- Deliver 3.3V at 100mA with 1V Input Voltage
- 90% High Efficiency (VIN=3V/VOUT=3.3V)
- 550KHz Fixed Switching Frequency
- Flexibility to Use 2A Internal NMOS and External Power Switch
- 1uA Low Shutdown Current
- Built-in 0.86V Voltage Detector
- 8-pin SOP Package

4. Applications

- DSC
- PDA
- MP3 Players
- Wireless Equipments
- Electronic Games
- Camcorders
- Portable Devices
- Single- and Dual-Cell Battery Operated Products
- Battery Backup Supplies

5. Pin Configurations

SOP-8 (TOP VIEW)



6. Ordering Information

FS8802-xS

- Package Type
  S : SOP-8
- Operating Temperature Range
  C : Commercial Standard
  P : Commercial Standard, Lead(Pb) Free and Phosphorous(P) Free Package

7. Package Marking Information

Part Number	Marking
FS8802-CS	FS8802 yyww
FS8802-PS	FS8802 Pyyww

Date Code: yy-year, ww-week

8. Pin Description

Pin No.	Symbol	Description
1	GND	Ground.
2	EXT	Output pin for driving external NMOS or NPN. When driving an NPN, a resistor should be added for limiting base current.
3	LBO	Drain output pin (open collector) of the NMOS of the built-in low battery detector. This pin will be internally pulled low when the voltage at LBI pin drops to below 0.86V
4	LBI	Input pin of the built-in low battery detector. Trip point = 0.86V
5	FB	Feedback input pin. Internal reference voltage for the error amplifier is 1.25V. Connect resistive divider tap here.
6	Vout	Input power supply pin
7	LX	Switch pin. Connect inductor/diode here.
8	CE	Chip enable. Set CE pin to low to shutdown the device. Must be set to Vout or higher voltage to enable the device. Do not float this pin.

9. Functional Block Diagram

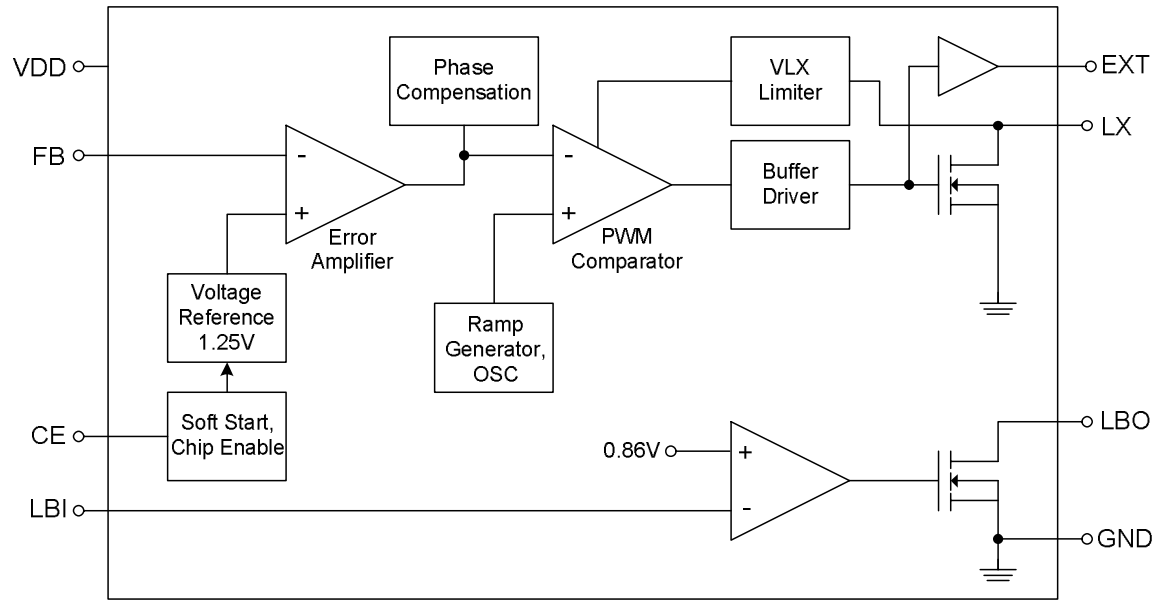


Fig 2. FS8802 Functional Block Diagram

10. Typical Application Circuit

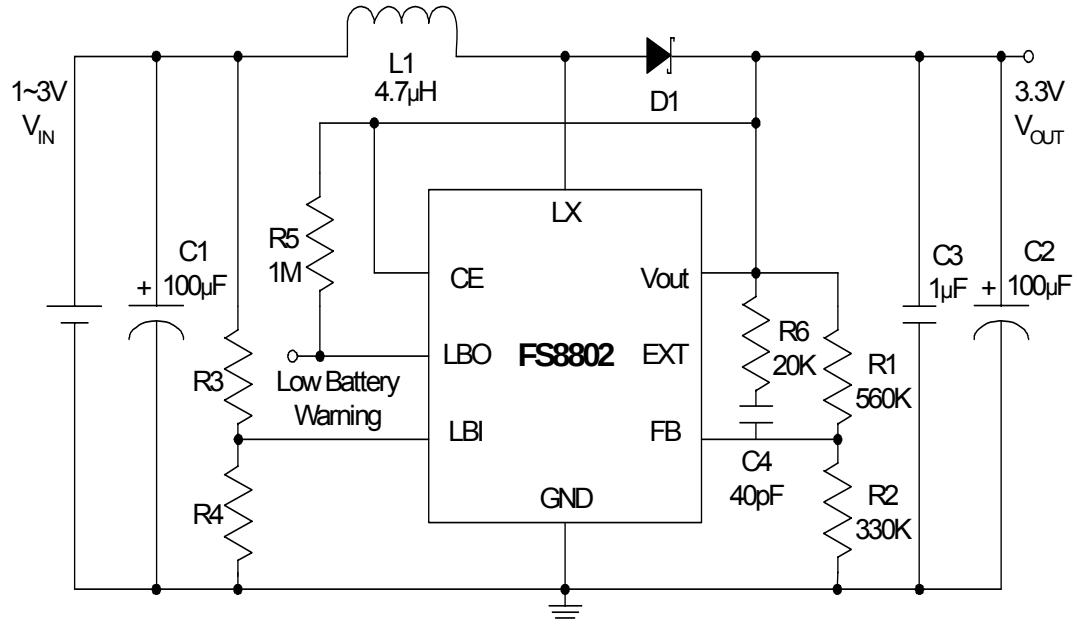


Fig 3. FS8802 Typical Application for 3.3V output below 400mA

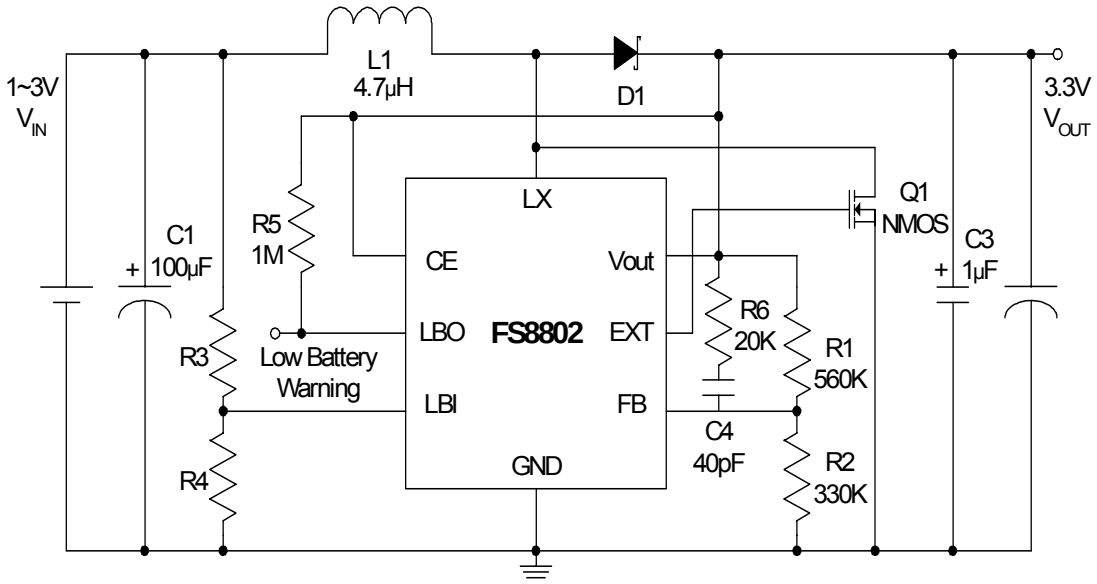


Fig 4. 0.4A ~ 2A Output Current Application

11. Absolute Maximum Ratings

Supply Voltage ---------- -0.3V to 6V
LX Pin Switch Voltage ---------- -0.3V to (Vout+0.3V)
Other I/O Pin Voltages ---------- -0.3V to (Vout+0.3V)
LX Pin Switch Current ---------- 2.5A
EXT Pin Drive Current ---------- 30mA
LBO Current ---------- 30mA
Continuous power dissipation, PD @ TA = 25˚C
SOP-8 ---------- 0.625W
Package Thermal Resistance
SOP-8, θJA ---------- 160˚C /W
Maximum Operating Junction Temperature ---------- 150˚C
Operating temperature range ---------- -20˚C to +70˚C
Storage temperature range, TSTG ---------- -55˚C to +150˚C
Lead temperature (soldering, 10sec) ---------- 260˚C
ESD ratings
Human Body Model, per MIL-STD-883D-3015.7 ---------- 1.5KV
Machine Model, MIL-STM5.2-1999 ---------- 250V

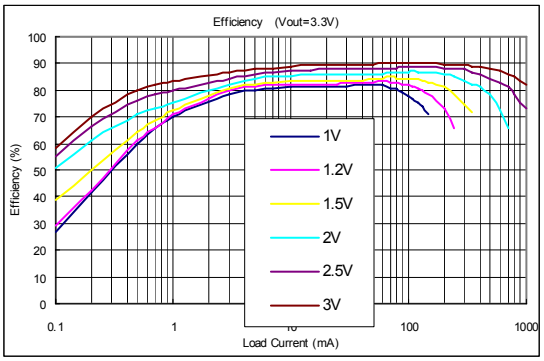
12. Electrical Characteristics

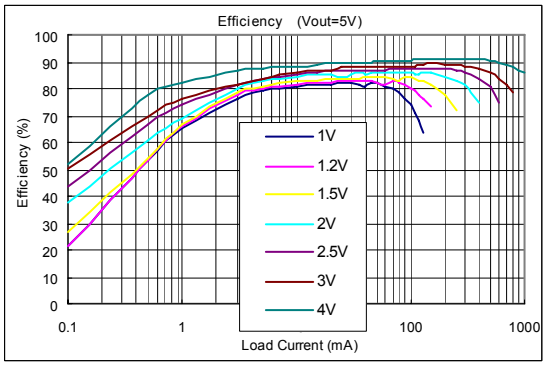
(VIN=1.5V, Vout=3.3V, Load Current=0, TA=25˚C, unless otherwise noted.)

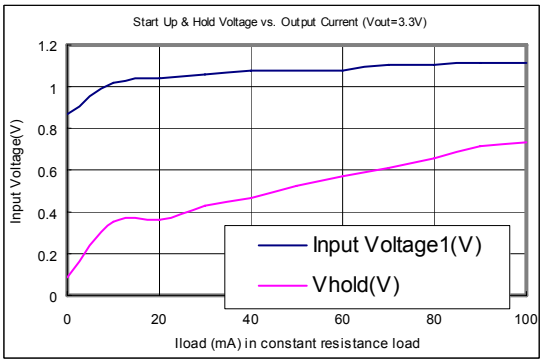
Symbol	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{ST}	Start-up Voltage	I_L = 1mA	--	0.95	1.10	V
V_{ST}	Start-up Voltage	I_L = 100mA	--	1.20	1.30	V
V_{HOLD}	Holding Voltage	I_L = 20mA	--	0.60	--	V
Vout	Operating Voltage Range	Start-up to I_{DD1} > 250μA	2.2	--	6.0	V
I_{DD1}	No Load Current (V_{IN})	V_{IN} = 1.5V, V_{OUT} = 3.3V	--	60	--	μA
I_{DD2}	Switch Off Current (Vout)	Vout = 3.3V	--	35	--	μA
I_{OFF}	Shutdown Current (V_{IN})	CE = 0V, V_{IN} = 4.5V		0.1	1	μA
V_{REF}	Feedback Reference Voltage		1.220	1.250	1.280	V
	LBI Input Voltage Threshold		0.83	0.86	0.89	V
	CE Input Voltage Threshold		0.2	0.6	1.4	V
F_{SW}	Switching Frequency		440	550	660	KHz
D_{MAX}	Maximum Duty Cycle		--	78	--	%
$R_{DS(on)}$	Switch ON Resistance			0.25	--	Ω
V_{LXLIM}	Switch Voltage Limit			0.6		V
	EXT ON Resistance to Vout	Vout = 3.3V		40	45	Ω
	EXT ON Resistance to GND	Vout = 3.3V		12	15	Ω
	LBO ON Resistance	Vout = 3.3V		40	45	Ω
ΔV_{LINE}	Line Regulation	VIN = 1.5~2.5V, IL=1mA		10		mV/V
ΔV_{LOAD}	Load Regulation	VIN = 1.5V, IL=1~100mA		0.25		mV/mA

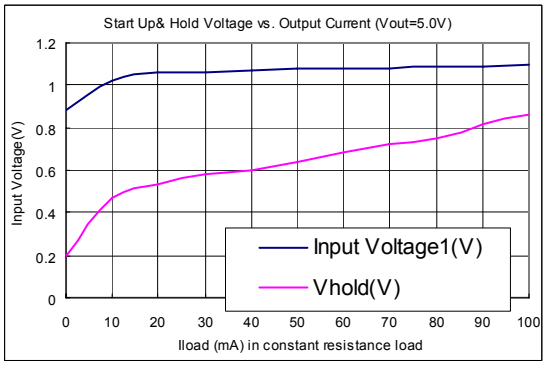
13. Typical Operating Characteristics

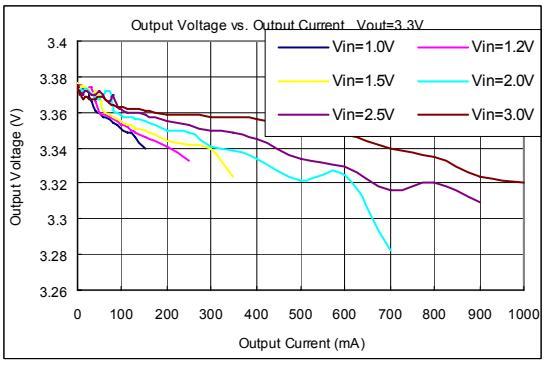
(VIN=+2.5V, VOUT=3.3V, L1=4.7μH, C2=100μF, TA=+25℃, unless otherwise noted.)

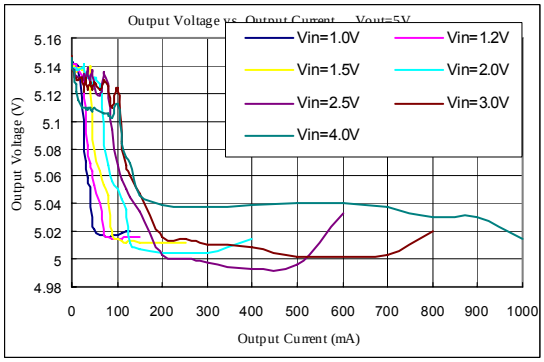


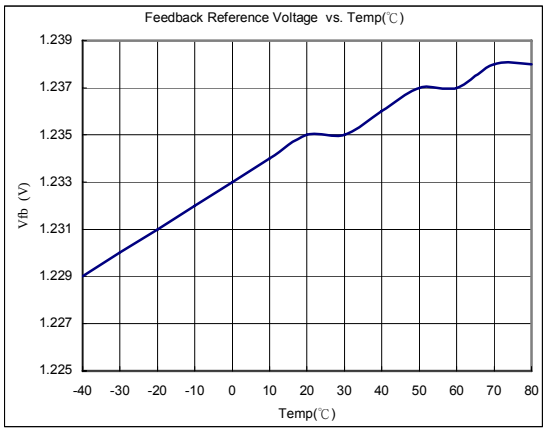


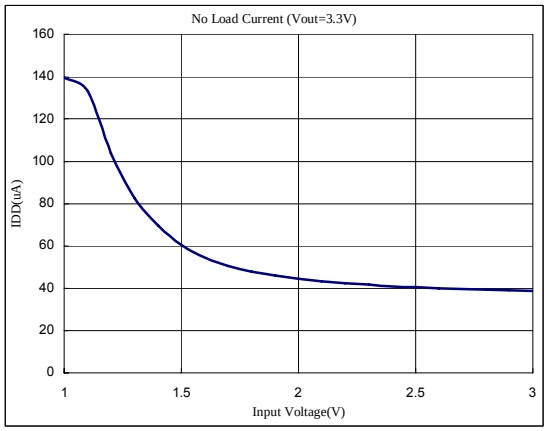




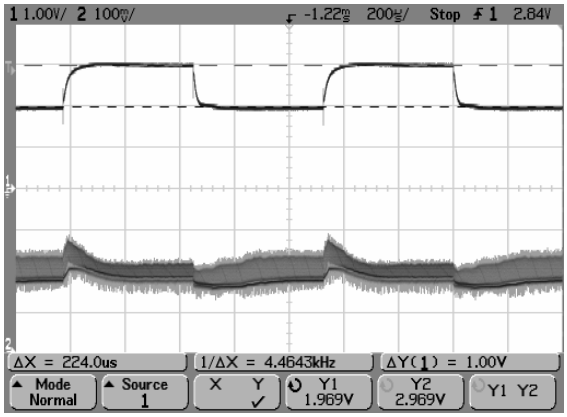




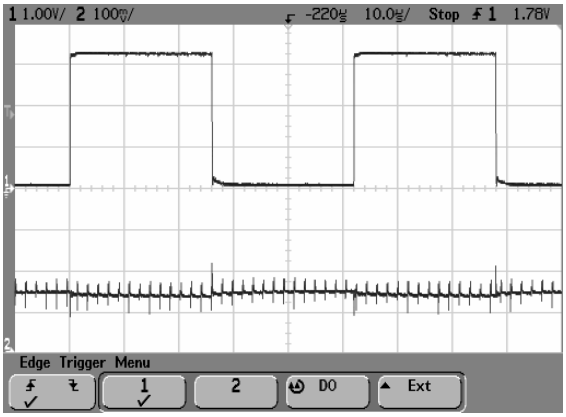




Line Transient Response
Vin=2-3V, Vout=3.3V, I load=50mA, Cin=2.2uF



Load Transient Response
Vin=3V, Vout=3.3V, I load=0-50mA, Cin=1uF



14. Detail Description

The FS8802 is a high-efficiency, step-up DC-DC converter for portable devices like DSC and PDA. The FS8802 combines a boost switching regulator, 2A/0.25Ω N-channel power MOSFET, 1.25V precision reference, soft start, shutdown control, and a low-battery comparator. The switching DC-DC converter boosts a 1- to 4-cell input to an adjustable output between 2.5V and 6.0V. The FS8802 starts from a low 1.0V input and remains operational down to 0.6V at 20mA load current.

14.1 Step-Up Converter

The step-up DC-DC converter operation can be understood by referring to the block diagram in Figure 2. The error amplifier monitors the output voltage by comparing the feedback voltage with the 1.25V reference voltage. When the feedback voltage is lower than the reference voltage, the error amplifier output will decrease. The error amplifier output is then compared with the oscillator ramp voltage at the PWM controller. When the ramp voltage is higher than the error amplifier output, the buffer driver is turned on which will then switch on the internal N-channel MOSFET; and vice versa. As the error amplifier output decreases, the buffer driver turn-on time increases and duty cycle increases. When the feedback voltage is higher than the reference voltage, the error amplifier output increases and the duty cycle decreases.

During the first part of each switching cycle, the internal N-channel MOSFET switch is turned on. This allows current to ramp up in the inductor and store energy in a magnetic field. During the second part of each cycle, the MOSFET is turned off, the voltage across the inductor reverses and forces current through the diode to the output filter capacitor and load. As the energy stored in the inductor is depleted, the current ramps down and the output diode turns off. The output filter capacitor stores the charge while the inductor current is higher than the output current, then sustains the output voltage until the next switching cycle.

14.2 Output Voltage Selection

Referring to Fig.3 and Fig.4, select an output voltage for FS8802 by connecting FB to a resistive divider between the output and GND. The V_{OUT} can be set as:

V_{OUT} = (1+R1/R2) x 1.25V

Higher R1,R2 values reduce quiescent current, but give bad noise immunity. To keep stable feedback loop operation and better noise immunity, select (R1+R2) value less than 1MΩ.

Compensation

An internal compensation circuit is designed to guarantee stability over the full input/output voltage and median output load range. To increase loop stability at heavy output load, an optional RC compensation network can be added between Vout and FB, as the R6 and C4 shown in Fig.3. Select R6 and C4 values to meet the equation:

$\sqrt{L1C2} \approx (R1+R6) \times C4$

And keep the R6C4 network frequency value

$1/(2\pi R6C4)$,

between one third and half of switching frequency, i.e. from 183KHz to 275KHz.

Low-Battery Detection

The FS8802 contains a built-in comparator for low-battery detection. If the voltage at LBI falls below the internal reference voltage (0.86V), LBO (an open-drain output) sinks current to GND. The low-battery threshold is set by two resistors, R3 and R4 (Fig3. & 4.). Since the LBI current is less than 50nA, large resistor values can be used to minimize loading of the input supply. Determine the low battery trip voltage using the following equation:

V_{TRIP}=(1+R3/R4) x 0.86V

V_{TRIP} is the level where the low-battery detector output goes low. Connect a pull-up resistor of 100kΩ or greater from LBO to V_{OUT} when driving CMOS circuits. LBO is an open-drain output, and can be pulled as high as 6V regardless of the voltage at V_{OUT}. When LBI is above the threshold, the LBO output is high impedance. If the low-battery comparator is not used, LBI and LBO should be tied to ground.

14.3 Low-Voltage Start-Up Oscillator

The FS8802 use a CMOS, low-voltage start-up oscillator for a 1.0V guaranteed minimum startup input voltage at +25˚C. On start-up, the low-voltage oscillator switches the N-channel MOSFET until the output voltage reaches 2.2V. Above this level, the normal boost-converter feedback and control circuitry take over. Once the device is in regulation, it can operate down to a 0.8V input since internal power for the IC is bootstrapped from the output voltage. Do not apply full load until the output exceeds 2.4V.

Soft Start

The FS8802 has internal soft start circuit that limits current draw at startup, reducing transients on the input source. Soft-start is particularly useful for higher impedance input sources, such as Li+ and alkaline cells. When power is applied to the device, the soft start circuit first pumps up the output voltage to approximately 2.2 V at a fixed duty cycle. This is the voltage level at which the controller can operate normally. In addition to that, the start up capability with heavy loads is also improved.

14.4 Shutdown

The FS8802 enters shutdown to reduce quiescent current to typically 0.1 μA when CE pin is low . For normal operation, drive CE high or connect CE to V_{OUT}. During shutdown, the reference, low-battery comparator, gain block, and all feedback and control circuitry are off. The boost converter's output drops to one Schottky diode voltage drop below the input voltage and LX remains high impedance. The capacitance and load at V_{OUT} determine the rate at which V_{OUT} decays. Shutdown can be pulled as high as 6V, regardless of the voltage at V_{OUT}.

15. Application Information

15.1 Inductor Selection

The FS8802 is designed to work well with a 4.7μH to 10μH inductor in most applications. Low inductance values supply higher output current, but also increase the ripple and reduce efficiency. Higher inductor values reduce ripple and improve efficiency, but also limit output current. Choose a low DC-resistance inductor, usually less than 1Ω to minimize loss. It is necessary to choose an inductor with saturation current greater than the peak current that the inductor will encounter in the application. Saturation occurs when the inductor's magnetic flux density reaches the maximum level the core can support and inductance falls.

15.2 Capacitor Selection

Use a 47uF to 100uF SMT tantalum output capacitor with about 50mΩ to 150mΩ equivalent series resistance (ESR) to provide stable switching while minimizing output ripple. Smaller capacitors are acceptable for light loads or in applications that can tolerate higher output ripple. The input capacitor reduces peak currents and noise at the voltage source. Input capacitors must meet the input ripple requirements and voltage rating. The ESR of both input and output capacitors affects efficiency and output ripple. Output voltage ripple is the product of the peak inductor current and the output capacitor ESR. Use low ESR capacitors for best performance, or connect two or more output capacitors in parallel.

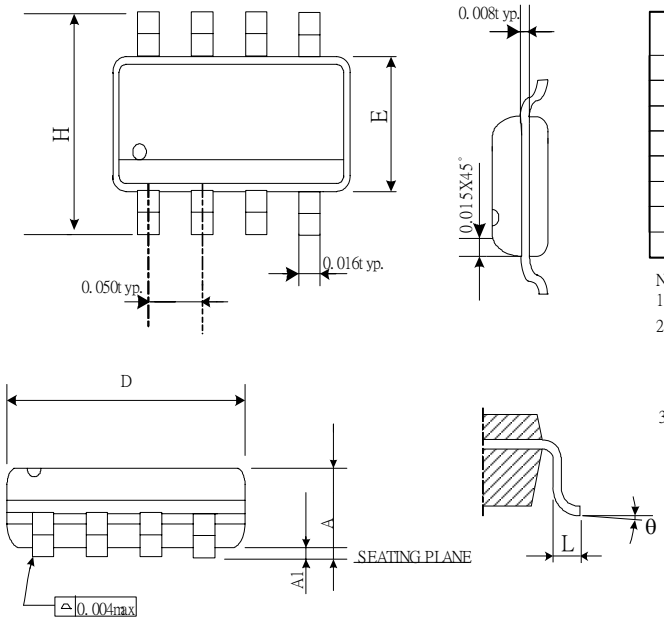
15.3 Layout Considerations

High switching frequencies make PC board layout a very important part of design. Good design minimizes excessive EMI on the feedback paths and voltage gradients in the ground plane, both of which can result in instability or regulation errors. Connect the inductor, input filter capacitor, and output filter capacitor as close to the device as possible, and keep their traces short, direct, and wide to reduce power loss so as to improve efficiency. Connect their ground pins at a single common node in a star ground configuration, or at a full ground plane. The external voltage feedback network should be very close to the FB pin, within 5mm. Keep noisy traces, such as the LX trace, away from the voltage feedback network; also keep them separate, using grounded copper.

The output capacitor should be placed close to the output terminals to obtain better smoothing effect on the output ripple. A 1μF bypass capacitor (Fig. 3 & 4) should be placed close to the V_{OUT} pin and GND pin of the FS8802 to filter the switching spikes in the output voltage to provide more stability.

16. Package Outline

16.1 SOP-8



Unit : inch		
SYMBOL	MIN.	MAX.
A	0.053	0.069
A1	0.004	0.010
D	0.189	0.196
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
θ	0°	8°

NOTES:
1.JEDEC OUTLINE :MS-012 AA
2.DIMENSION "D" DOES NOT INCLUDE MOLD FLASH PROTRUSIONS OR GATE BURRS.MOLD FLASH,PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED .15mm (.006in) PER SIDE
3.DIMENSIONS "E" DOES NOT INCLUDE INTER-LEAD FLASH. OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED .25mm (.010in) PER SIDE