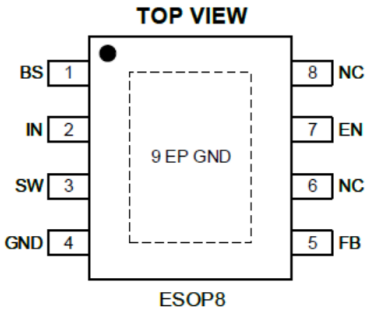
3A, 30V, 500 kHz Synchronous Rectified Step-Down

Features

- 3A Output Current
- Wide 4V to 30V Operating Input Range
- Fixed 500KHZ Frequency
- Integrated Power MOSFET switches
- Output Adjustable from 0.925V to 0.8Vin
- Up to 93% Efficiency
- Programmable Soft-Start
- Stable with Low ESR Ceramic Output Capacitors
- Cycle by Cycle Over Current Protection
- Short Circuit Protection
- Input Under Voltage Lockout
- Package： ESOP-8L

General Description

The FS1068E is a monolithic synchronous buck regulator. The device integrates 1100 mΩ MOSFETS that provide 3A continuous load current over a wide operating input voltage of 4V to 30V. Current mode control provides fast transient response and cycle by cycle current limit. An adjustable soft-start prevents inrush current at turn on.

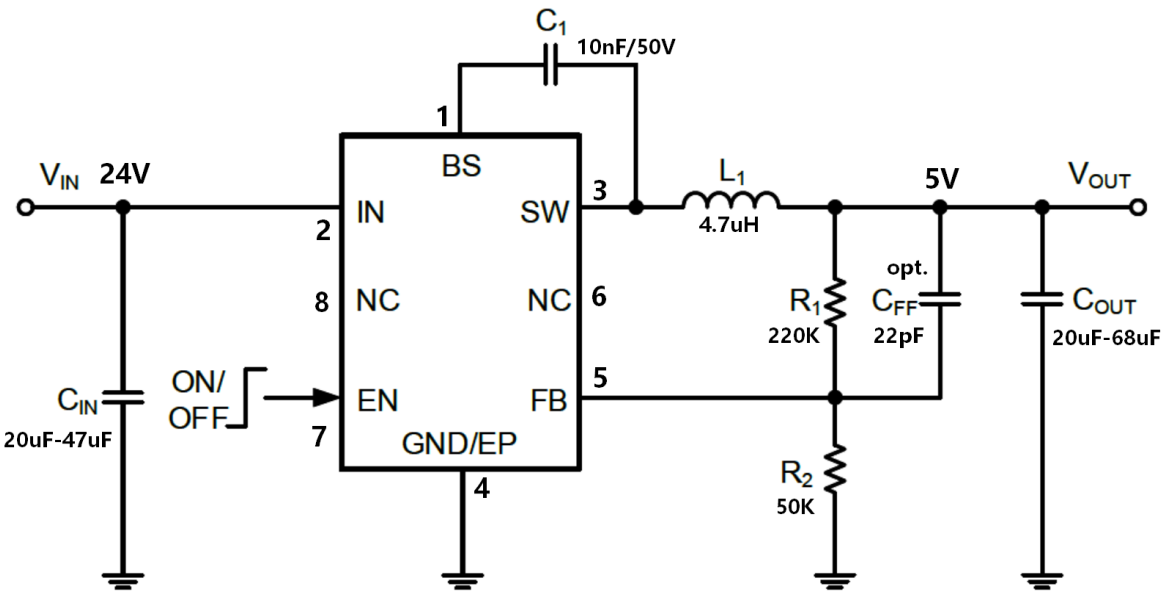


Package Information

Applications

- TFT LCD Monitors
- Portable DVDs, Headphones, MP3 Players, etc.
- Car-Powered or Battery-Powered Equipment
- Set-Top Boxes
- Telecom Power Supplies
- DSL and Cable Modems and Routers

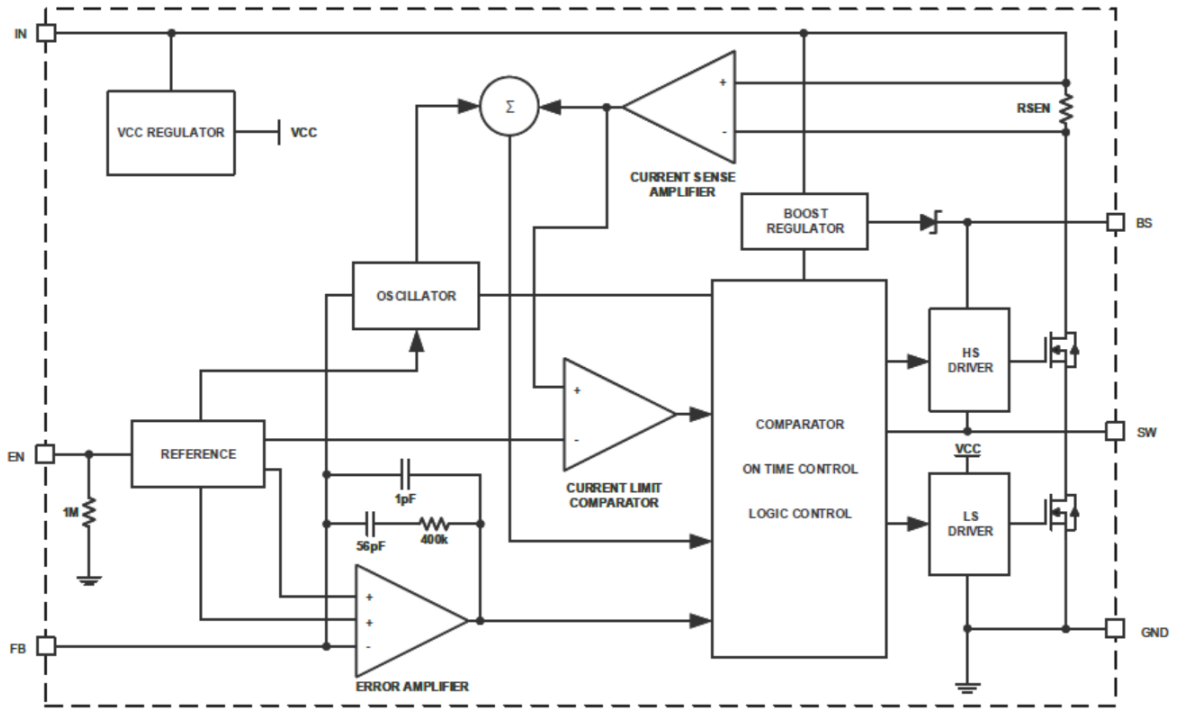
Typical Application



- **PIN DESCRIPTIONS**

Pin Number	Name	Description
1	BS	Bootstrap. This pin acts as the positive rail for the high-side switch's gate driver. Connect a 0.01uF capacitor between BS and SW.
2	VIN	Input Supply. Bypass this pin to GND with a low ESR capacitor. See Input Capacitor in the Application Information section.
3	SW	Switch Output. Connect this pin to the switching end of the inductor.
4	GND	Ground.
5	FB	Feedback Input. The voltage at this pin is regulated to 0.925V. Connect to the resistor divider between output and ground to set output voltage.
6	NC	
7	EN	Enable Input. When higher than 2.7V, this pin turns the IC on. When lower than 1.1V, this pin turns the IC off. Output voltage is discharged when the IC is off. This pin should not be left open. Recommend to put a 100KΩ pull-up resistor to Vin for startup.
8	NC	
9	Exposed Pad	Exposed Pad. Need to connect to GND pin.

- **Functional Block Diagram**



- **Absolute Maximum Ratings** @T_A=25℃ unless otherwise noted

Parameter	Value	Unit
Input Supply Voltage	-0.3 to 30	V
SW Voltage	-0.3 to VIN + 0.3	V
BS Voltage	VSW – 0.3 to VSW + 6	V
EN, FB, COMP Voltage	-0.3 to 5	V
Continuous SW Current	Internally limited	A
Junction to Ambient Thermal Resistance (θJA) (Test on Approximately 3 in2 Copper Area 1oz copper FR4 board)	20	°C/W
Junction to Ambient Case Resistance (θJC)	10	°C/W
SOP-8L Power Dissipation	Internally limited	W
Maximum Junction Temperature	150	°C
Storage Temperature Range	-65 to 150	°C
Moisture Sensitivity (MSL)	Please refer the MSL label on the IC package bag/carton for detail	

(Note: Exceeding these limits may damage the device. Even the duration of exceeding is very short. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

Recommended Operating Conditions

Parameter	Min	Max	Unit
Input Supply Voltage	4.5	27 (1)	V
Operating Junction Temperature	-20	+125 (2)	°C

Note 1:

Operating the IC over this voltage is very easy to cause over voltage condition to VIN pin, SW pin, BS pin & EN pin

Note 2:

If the IC experienced OTP, then the temperature may need to drop to <125 degree C to let the IC recover.

- **Electrical Characteristics @T_A=25℃ unless otherwise noted**

VIN = 12V, TA = +25°C, unless otherwise noted.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Feedback Voltage	**VFB**	4V ≤ VIN ≤ 30V	0.900	0.923	0.946	V
Feedback Overvoltage Threshold				1.1		V
High-Side Switch-On Resistance*				110		mΩ
Low-Side Switch-On Resistance*				70		mΩ
High-Side Switch Leakage		VEN = 0V, VSW = 0V		0.1	10	uA
Upper Switch Current Limit*		Minimum Duty Cycle	3.8	4.5		A
Lower Switch Current Limit*		From Drain to Source		1.2		A
COMP to Current Sense Limit Transconductance*	**GCS**			5.2		A/V
Error Amplifier Transconductance*	**GEA**	ΔICOMP = ±10uA		900		uA/V
Error Amplifier DC Gain*	**AVEA**			400		V/V
Switching Frequency	**f_{SW}**			500		KHz
Short Circuit Switching Frequency		VFB = 0		100		KHz
Minimum Duty Cycle*	**Dmin**		7.5			%
Maximum Duty Cycle	**Dmax**			92		%
EN Shutdown Threshold Voltage					1.1	V
EN Shutdown Voltage ThresholdHysteresis				180		mV
EN on			2.7			V
EN Lockout Hysteresis				150		mV
Supply Current in Shutdown		VEN = 0		0.3	3.0	uA
IC Supply Current in Operation		VEN = 3V, VFB = 1.1V		0.4	0.6	mA
Input UVLO Threshold Rising	UVLO			4.0		V
Input UVLO Threshold Hysteresis				150		mV
Soft Start				1.2		mS
Thermal Shutdown Temperature*				160		°C
Thermal Hysteresis				20		°C

Note: * Guaranteed by design, not tested

Functions Description

Internal Regulator

The FS1068E is a current mode step down DC/DC converter that provides excellent transient response with no extra external compensation components. This device contains an internal, low resistance, high voltage power MOSFET, and operates at a high 500KHz operating frequency to ensure a compact, high efficiency design with excellent AC and DC performance.

Error Amplifier

The error amplifier compares the FB pin voltage with the internal FB reference (VFB) and outputs a current proportional to the difference between the two. This output current is then used to charge or discharge the internal compensation network, which is used to control the power MOSFET current. The optimized internal compensation network minimizes the external component counts and simplifies the control loop design.

Internal Soft-Start

The soft-start is implemented to prevent the converter output voltage from overshooting during startup. When the chip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V to 0.923V. When it is lower than the internal reference (REF), SS overrides REF so the error amplifier uses SS as the reference. When SS is higher than REF, REF regains control. The SS time is internally max to 1.2ms.

Over Current Protection & Hiccup

The FS1068E has cycle-by-cycle over current limit when the inductor current peak value exceeds the set current limit threshold. Meanwhile, output voltage starts to drop until FB is below the Under-Voltage (UV) threshold, typically 25% below the reference. Once a UV is triggered, the FS1068E enters hiccup mode to periodically restart the part. This protection mode is especially useful when the output is dead-short to ground. The average short circuit current is greatly reduced to alleviate the thermal issue and to protect the regulator. The FS1068E exits thehiccup mode once the over current condition is removed.

Startup and Shutdown

If both VIN and EN are higher than their appropriate thresholds, the chip starts. The reference block starts firstgenerating stable reference volage and currents, and then the internal regulator is enabled. The regulator providesstable supply for the remaining circuitries. Three events can shut down the chip: EN low, VIN low and thermalshutdown. In the shutdown procedure, the signaling path is first blocked to avoid any fault triggering. The com.voltage and the internal supply rail are then pulled down. The floating driver is not subject to this shutdowrcommand.

Applications Information

Setting the Output Voltage

FS1068E require an input capacitor, an output capacitor and an inductor These components are critical to theperformance of the device. FS1068E are internally compensated and do not require external components to achievestable operation. The output voltage can be programmed by resistor divider

$$V_{OUT} = V_{FB} \times \frac{R1 + R2}{R2}$$

V_{OUT}	R1	R2	$L1_{MIN}$	$L1_{TYP}$	$L1_{MAX}$	C_{IN}	C_{OUT}
1V	4.05	50	2.2uH	2.2 uH	4.7 uH	20-47uF	20-68uF
1.05V	6.76	50	2.2 uH	2.2 uH	4.7 uH	20-47uF	20-68uF
1.2V	14.9	50	2.2 uH	2.2 uH	4.7 uH	20-47uF	20-68uF
1.5V	31.1	50	2.2 uH	2.2 uH	4.7 uH	20-47uF	20-68uF
3.3V	128.4	50	3.3 uH	3.3 uH	4.7 uH	20-47uF	20-68uF
5.0V	220	50	3.3 uH	4.7 uH	4.7 uH	20-47uF	20-68uF

Selecting the Inductor

The recommended inductor values are shown in the Application Diagram. It is important to guarantee the inductoicore does not saturate during amy foreseeable operational situation. The inductor should be rated to handle thepeak load current plus the ripple current: Care should be taken when reviewing the different saturation currentratings that are specified by different manufacturers. Saturation current ratings are typically specified at 25℃, soratings at maximum ambient temperature of the application should be requested from the manufacturer.

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times F_{OSC}}$$

Where AIL is the inductor ripple curent. Choose inductor ripple current to be approximately 30% if the maximum load current. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

Selecting the Output Capacitor

Special attention should be paid when selecting these components. The DC bias of these capacitors can result in acapacitance value that falls below the minimum value given in the recommended capacitor specifications table.The ceramic capacitor's actual capacitance can vary with temperature. The capacitor type X7R, which operate.over a temperature range of-55℃ to +125°, will only vary the capacitance to within +15%. The capacitor typeX5R has a similar tolerance over a reduced temperature range of -55℃ to +85℃. Many large

value ceramiccapacitors. larger than luF are manufactured with Z5U or Y5V temperature characteristics. Their capacitance candrop by more than 50% as the temperature varies from 25℃ to 85℃. Therefore X5R or X7R is recommendedover Z5U and Y5V in applications where the ambient temperature will change significantly above or below 25℃.Tantalum capacitors are less desirable than ceramic for use as output capacitors because they are more expensivewhen comparing equivalent caacitance and voltage ratings in the 0.47uF to 44uF range. Another importantconsideration is that tantalum capacitors have higher ESR values than equivalent size ceramics. This means thatwhile it may be possible to find a tantalum capacitor with an ESR value within the stable range, it would have tobe larger in capacitance (which means bigger and more costly) than a ceramic capacitor with the same ESR valuet should also be noted that the ESR of a typical tantalum will increase about 2:1 as the temperature goes from25℃ down to -40℃. so some guard band must be allowed.

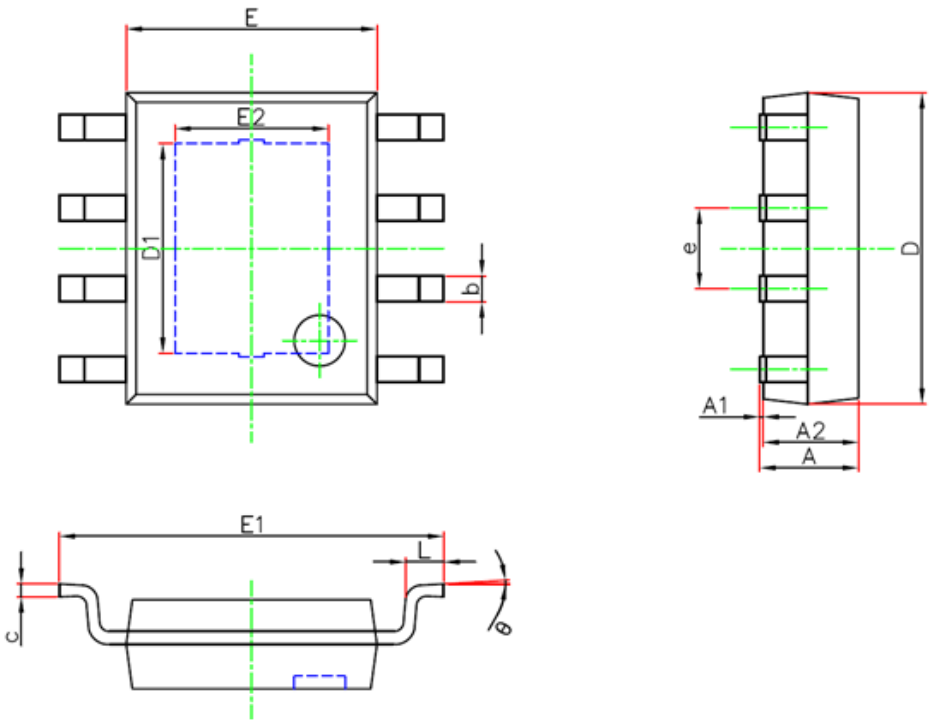
PC Board Layout Consideration

PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout foroptimum performance. If change is necessary. please follow these guidelines for reference.

1. Keep the path of switching current short and minimize the loop area formed by Input capacitor, high-sideMOSFET and low-side MOSFET.
2. Bypass cerammic 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. VOUT 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 thermalperformance and long-term reliability.

- Package Information

E-SOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.300	1.700	0.051	0.067
A1	0.000	0.100	0.000	0.004
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°