BL9382C

2A, 24V Synchronous Step-Down Converter

DESCRIPTION

The BL9382C is a current mode monolithic buck voltage converter. Operating with an input range of 4.5-24V, the BL9382C delivers 2A of continuous output current with two integrated N-Channel MOSFETs. At light loads, regulators operate in low frequency to maintain high efficiency and low output ripple.

The BL9382C guarantees robustness with over current protection, thermal protection, start-up current run-away protection, and input under voltage lockout.

The BL9382C is available in a 8-pin SOP8 package, which provides a compact solution with minimal external components.

FEATURES

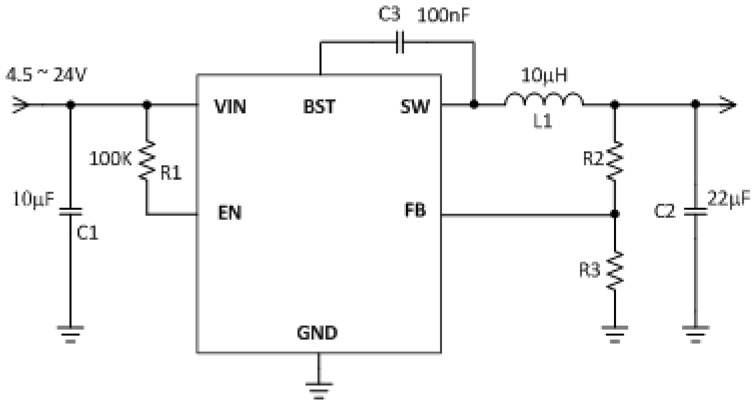
- 4.5V to 24V operating input range
  2A output current
- Up to 94% efficiency
- High efficiency (85>%) at light load
- Fixed 500kHz Switching frequency
- Input under voltage lockout
- Available in SOP8 package
- Start-up current run-away protection
- Over current protection
- Thermal protection

APPLICATIONS

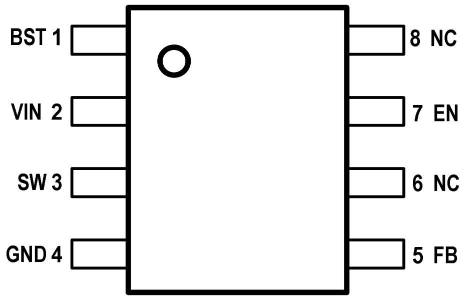
- Distributed Power Systems
- Networking Systems
- FPGA, DSP, ASIC Power Supplies
- Green Electronics/ Appliances
- Notebook Computers

TYPICAL APPLICATION

2A Buck Voltage Converter



PIN CONFIGURATION



ABSOLUTE MAXIMUM RATING[1]

VIN, EN, SW Pin .... -0.3V to 24V
BST Pin .... SW-0.3V to SW+5V
All other Pins .... -0.3V to 6V
Junction Temperature[2) 3)] 150ºC
Lead Temperature 260ºC
Storage Temperature .... -65ºC to +150ºC

RECOMMENDED OPERATING CONDITIONS

Input Voltage VIN ....4.5V to 24V
Output Voltage Vout.. 0.6V to 22V
Operating Junction Temperature(T_J)..-40ºC to 125ºC

THERMAL PERFORMANCE[4]

θ_{JA} θ_{Jc}

SOP8 .... 90...45ºC/W

Note：

1) Exceeding these ratings may damage the device.
2) The BL9382C guarantees robust performance from -40°C to 150°C junction temperature. The junction temperature range specification is assured by design, characterization and correlation with statistical process controls.
3) The BL9382C includes thermal protection that is intended to protect the device in overload conditions. Thermal protection is active when junction temperature exceeds the maximum operating junction temperature. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.
4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARACTERISTICS

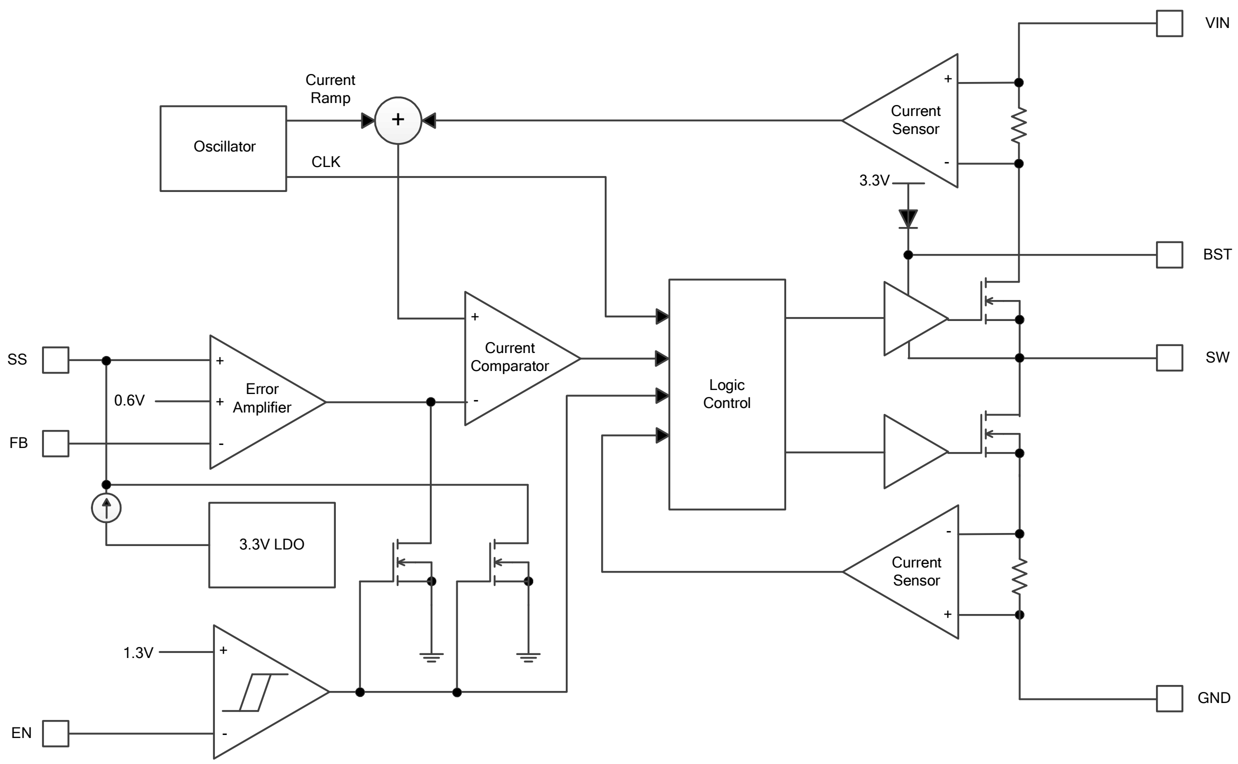
VIN=12V, T_A=25℃, unless otherwise stated.

Item	Symbol	Condition	Min.	Typ.	Max.	Units
V_{IN} Undervoltage Lockout Thershold	V_{IN_MIN}	V_{IN} falling		3.8		V
V_{IN} Undervoltage Lockout Hysteresis	$V_{IN\_MIN\_HYST}$	V_{IN} rising		300		mV
Shutdown Supply Current	I_{SD}	V_{EN}=0V			1	μA
Supply Current	I_Q	V_{EN}=5V, V_{FB}=2V		50		μA
Feedback Voltage	V_{FB}		0.895	0.923	0.951	V
Top Switch Resistance	$R_{DS(ON)T}$			170		mΩ
Bottom Switch Resistance	$R_{DS(ON)B}$			110		mΩ
Top Switch Leakage Current	I_{LEAK_TOP}	V_{IN}=24V, V_{EN}=0V, V_{SW}=0V			0.5	uA
Bottom Switch Leakage Current	I_{LEAK_BOT}	V_{IN}=24V, V_{EN}=0V, V_{SW}=0V			0.5	uA
Top Switch Current Limit	I_{LIM_TOP}	Minimum Duty Cycle		3.8		A
Switch Frequency	F_{SW}			500		kHz
Minimum On Time	T_{ON_MIN}			100		ns
Minimum Off Time	T_{OFF_MIN}	V_{FB}=0.7V		100		ns
EN shut down threshold voltage	V_{EN_TH}	V_{EN} falling, FB=0V		1.2		V
EN shut down hysteresis	V_{EN_HYST}	V_{EN} rising, FB=0V		100		mV
Thermal Shutdown	T_{TSD}			145		℃
Temperature Hysteresis	T_{HYS}			19		℃

PIN DESCRIPTION

PIN	NAME	Description
1	BST	Boostrap pin for top switch. A 0.01uF or larger capacitor should be connected between this pin and the SW pin to supply current to the top switch and top switch driver.
2	IN	Input voltage pin. VIN supplies power to the IC. Connect a 4.6V to 24V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
3	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
4	GND	Power ground pin.
5	FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to 0.8V. Connect a resistive divider at FB.
6	NC	Not Connected.
7	EN	Drive EN pin high to turn on the regulator and low to turn off the regulator.
8	NC	Not Connected.

BLOCK DIAGRAM



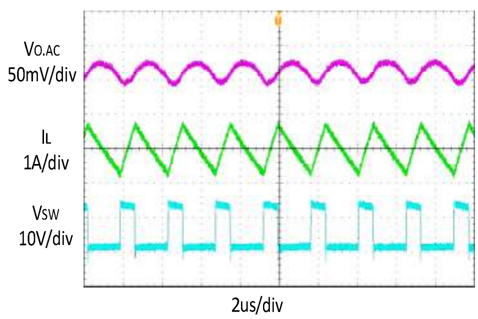
TYPICAL PERFORMANCE CHARACTERISTICS

Vin =12V, Vout = 3.3V, L = 4.7μH, Cout = 22μF, TA = +25°C, unless otherwise noted

Steady State Test

VIN=12V, Vout=3.3V

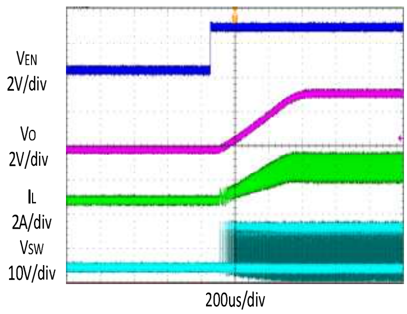
Iout=2A



Startup through Enable

VIN=12V, Vout=3.3V

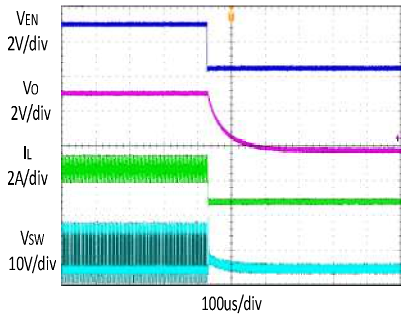
Iout=2A(Resistive load)



Shutdown through Enable

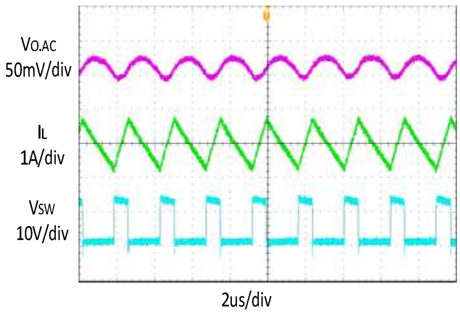
VIN=12V, Vout=3.3V

Iout=2A(Resistive load)



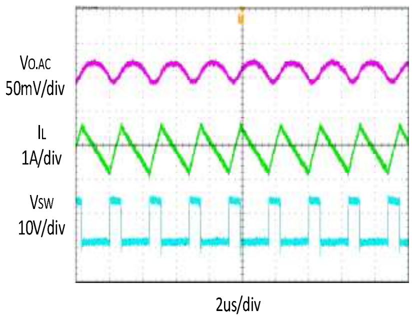
Heavy Load Operation

2A LOAD



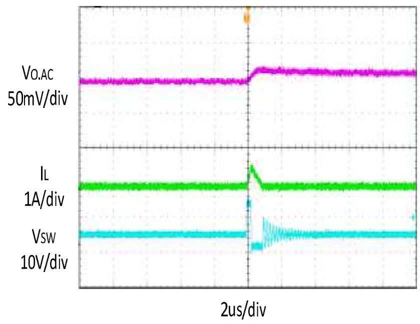
Medium Load Operation

1A LOAD



Light Load Operation

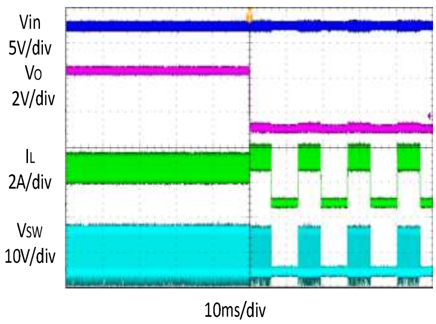
0 A LOAD



Short Circuit Protection

VIN=12V, Vout=3.3V

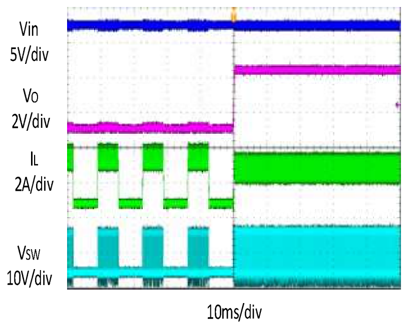
Iout=2A- Short



Short Circuit Recovery

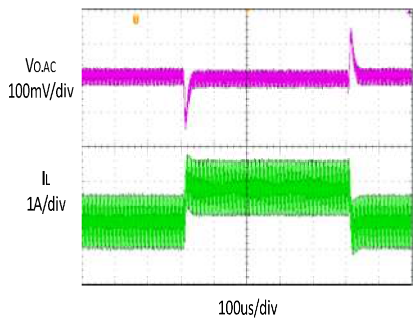
VIN=12V, Vout=3.3V

Iout= Short-2A



Load Transient

1A LOAD → 2A LOAD → 1A LOAD



FUNCTIONAL DESCRIPTION

The BL9382C is a synchronous, buck voltage converter.

Current-Mode Control

The BL9382C utilizes current-mode control to regulate the FB voltage. Voltage at the FB pin is regulated at 0.923V so that by connecting an appropriate resistor divider between VOUT and GND, designed output voltage can be achieved.

PFM Mode

The BL9382C operates in PFM mode at light load. In PFM mode, switch frequency is continuously controlled in proportion to the load current, i.e. switch frequency is decreased when load current drops to boost power efficiency at light load by reducing switch-loss, while switch frequency is increased when load current rises, minimizing both load current and output voltage ripples.

Internal Soft-Start.

Soft-start makes output voltage rising smoothly by following an internal SS voltage until SS voltage is higher than the internal reference voltage. It can prevent the overshoot of output voltage during startup.

Power Switch

N-Channel MOSFET switches are integrated on the BL9382C to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage greater than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 3.3V rail when SW is low.

Vin Under-Voltage Protection

A resistive divider can be connected between Vin and ground, with the central tap connected to EN, so that when Vin drops to the pre-set value, EN drops below 1.2V to trigger input under voltage lockout protection.

Output Current Run-Away Protection

At start-up, due to the high voltage at input and low voltage at output, current inertia of the output inductance can be easily built up, resulting in a large start-up output current. A valley current limit is designed in the BL9382C so that only when output current drops below the valley current limit can the bottom power switch be turned off. By such control mechanism, the output current at start-up is well controlled.

Over Current Protection and Hiccup

BL9382C has a cycle-by-cycle current limit. When the inductor current triggers current limit, BL9382C enters hiccup mode and periodically restart the chip. BL9382C will exit hiccup mode while not triggering current limit.

Short Circuit Protection

If a current higher than 5A is detected through TOP FET when it’s on, we consider SW is shorted to GND. The chip stops switching for few cycles and switch once to check whether SW is still shorted to GND. This cycle will be repeated until SW is not shorted to GND.

If FB voltage is detected lower than 100mV for few cycles and chip triggers current limit meanwhile, FB pin is considered shorted to GND. The chip won’t switching unless restart.

Thermal Protection

When the temperature of the BL9382C rises above 140°C, it is forced into thermal shut-down.

Only when core temperature drops below 130°C can the regulator becomes active again.

APPLICATION INFORMATION

Output Voltage Set

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage ratio is:

$$V_{FB} = V_{OUT} \cdot \frac{R_3}{R_2 + R_3}$$

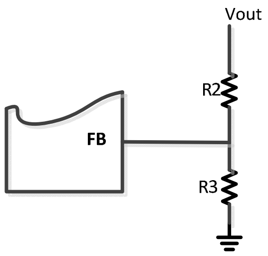
where V_{FB} is the feedback voltage and V_{OUT} is the output voltage.

Choose R_3 around 10kΩ, and then R_2 can be calculated by:

$$R_2 = R_3 \cdot \left(\frac{V_{OUT}}{0.923\,V} - 1\right)$$

The following table lists the recommended values.

VOUT(V)	R3(kΩ)	R2(kΩ)
2.5	10	17
3.3	10	26.1
5	11	48.4



Input Capacitor

The input capacitor is used to supply the AC input current to the step-down converter and maintaining the DC input voltage. The ripple current through the input capacitor can be calculated by:

$$I_{C1} = I_{LOAD} \cdot \sqrt{\frac{V_{OUT}}{V_{IN}} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

where I_{LOAD} is the load current, V_{OUT} is the output voltage, V_{IN} is the input voltage.

Thus the input capacitor can be calculated by the following equation when the input ripple voltage is determined.

$$C_1 = \frac{I_{LOAD}}{f_S \cdot \Delta V_{IN}} \cdot \frac{V_{OUT}}{V_{IN}} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

where C_1 is the input capacitance value, f_S is the switching frequency, △V_{IN} is the input ripple current.

The input capacitor can be electrolytic, tantalum or ceramic. To minimizing the potential noise, a small X5R or X7R ceramic capacitor, i.e. 0.1uF, should be placed as close to the IC as possible when using electrolytic capacitors.

A 10uF ceramic capacitor is recommended in typical application.

Output Capacitor

The output capacitor is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \cdot L} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \cdot \left(R_{ESR} + \frac{1}{8 \cdot f_S \cdot C_2}\right)$$

where C_2 is the output capacitance value and R_{ESR} is the equivalent series resistance value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage.

The output capacitors also affect the system stability and transient response, and a 22uF ceramic capacitor is recommended in typical application.

Inductor

The inductor is used to supply constant current to the output load, and the value determines the ripple current which affect the efficiency and the output voltage ripple. The ripple current is typically allowed to be 30% of the maximum switch current limit, thus the inductance value can be calculated by:

$$L = \frac{V_{OUT}}{f_S \cdot \Delta I_L} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

where V_{IN} is the input voltage, V_{OUT} is the output voltage, f_S is the switching frequency, and $\triangle I_L$ is the peak-to-peak inductor ripple current.

External Boostrap Capacitor

A boostrap capacitor is required to supply voltage to the top switch driver. A 0.1uF low ESR ceramic capacitor is recommended to connected to the BST pin and SW pin.

External Soft-start Capacitor

A soft-start capacitor is required to set the soft-start period，which controls the rate of the output voltage rise. Take the startup current and voltage rise rate into consideration, a 0.1uF ceramic capacitor is recommended.

PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

1. Place the input decoupling capacitor as close to BL9382C (VIN pin and PGND) as possible to eliminate noise at the input pin.

   The loop area formed by input capacitor and GND must be minimized.

2. Put the feedback trace as far away from the inductor and noisy power traces as possible.

3. The ground plane on the PCB should be as large as possible for better heat dissipation.

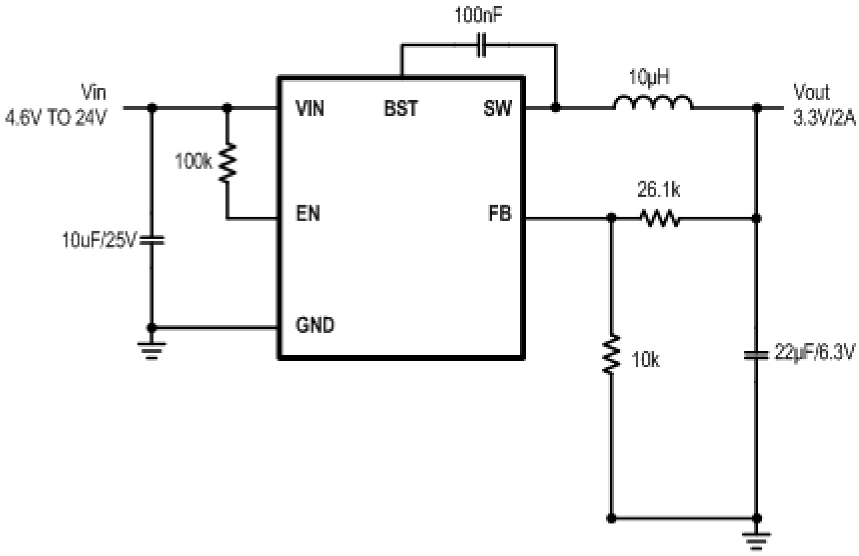
REFERENCE DESIGN

Reference 1:

V_{IN}: 4.5V ~ 24V

V_{OUT}: 3.3V

I_{OUT}: 0~2A

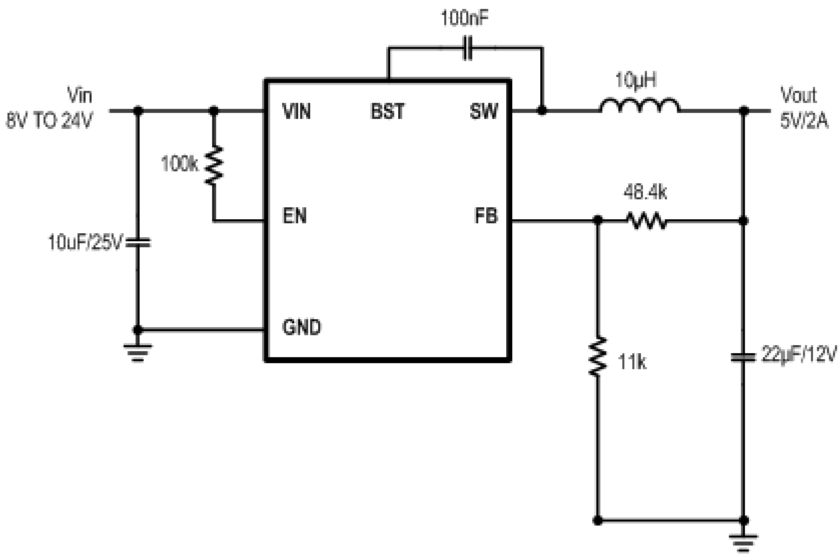


Reference 2:

V_{IN}: 8V ~ 24V

V_{OUT}: 5V

I_{OUT}: 0~2A



PACKAGE OUTLINE

SOP8 UNIT: mm