2A, 2.3V-6V input,1.5MHz

Description

The VB9002 is a high efficiency, high frequency synchronous DC-DC Step Down converter capable of delivering up to 2A output currents. The VB9002 can operate over a wide input voltage range from 2.3V to 6V and integrates main switch and synchronous switch with very low $R_{DS(ON)}$ to minimize the conduction loss. It is ideal for powering portable equipment that runs from a single cell Lithium-Ion(Li+) battery. This device offers two operation modes, PWM mode and PFM mode switching control, which allows a high efficiency over the wide range of the lode. The VB9002 is offered in a low profile 6-pin SOT package, and is available in an adjustable version.

Features

- High Efficiency: up to 96%
- Wide Supply Voltage: 2.3V-6V
- 2A Output Current
- Output Voltage as Low as 0.6V
- PFM Mode for High Efficiency in Light Lode
- Low Quiescent Current: 40μA
- Short Circuit Protection
- Thermal Fault Protection
- Inrush Current Limit and Soft Start
- Sot23-6 Package

Applications

- Wireless and DSL Modems
- PDAS
- Portable Instruments
- Step Top Box

Ordering Information

Part No.	Package	Top Marking
VB9002	Sot23-6	AS20BW

PIN Assignments

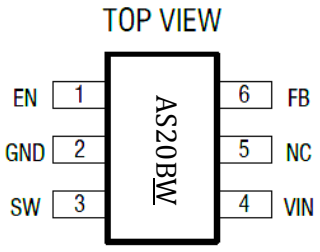


Figure1. The Assignments of VB9002

Functional Pin Description

Pin No.	Pin Name	Pin Function Description
1	EN	Chip Enable Pin. Drive EN above 1.5V to turn on the part. Drive EN below 0.3V to turn it off. Do not leave EN floating.
2	GND	Analog ground pin.
3	SW	Power Switch Output. It is the switch node connection to Inductor. This pin connects to the drains of the internal P-ch and N-ch MOSFET switches.
4	VIN	Power Supply Input. Must be closely decoupled to GND with a 10μ F or greater ceramic capacitor.
5	NC	NO Connect.
6	FB	Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage.

Internal Block Diagram

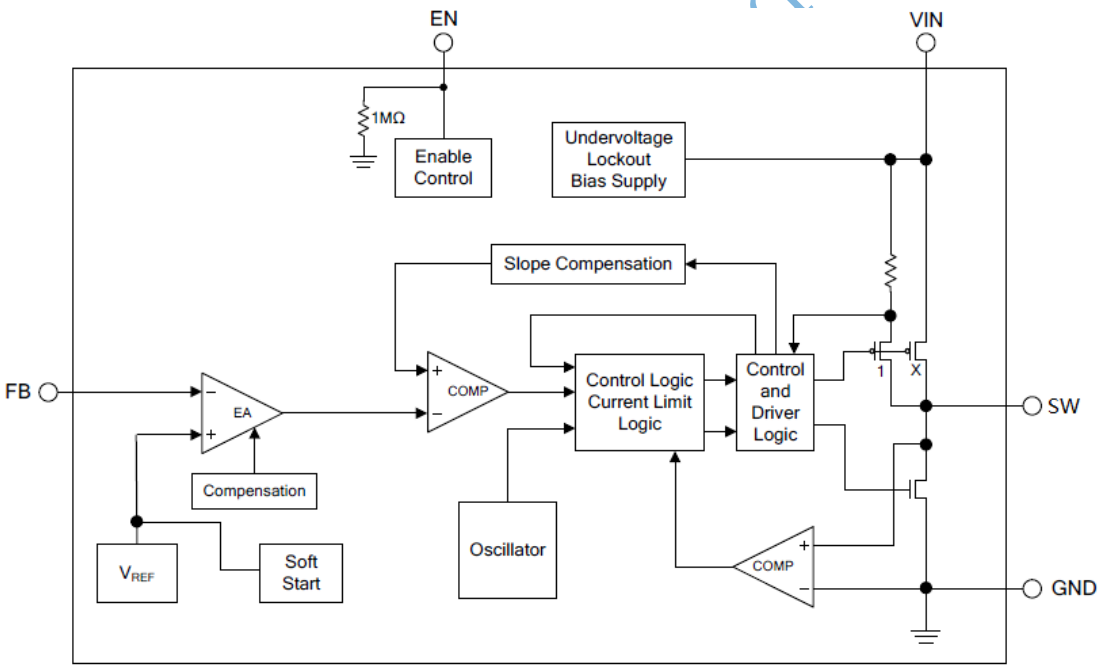


Figure2. Block Diagram of VB9002

Typical Application Circuit

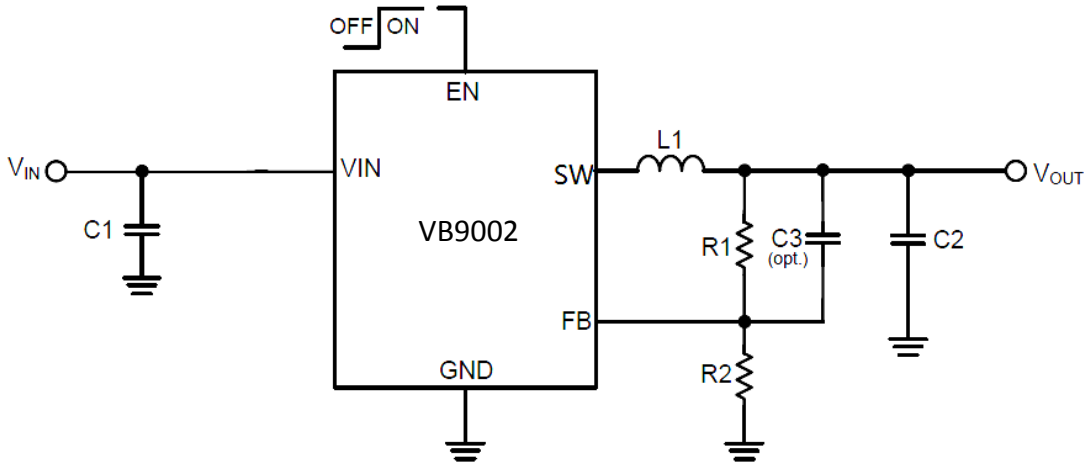


Figure3. Schematic Diagram

Vin=5V, the recommended Bom list is as below.

V_{OUT}	C1	R1	R2	L1	C2
3.3V	22μF	453K	100K	2.2μH	22μF MLCC
2.5V	22μF	316K	100K	2.2μH	22μF MLCC
1.8V	22μF	200K	100K	2.2μH	22μF MLCC
1.5V	22μF	150K	100K	1.8μH	22μF MLCC
1.2V	22μF	100K	100K	1.8μH	22μF MLCC

Absolute Maximum Rating

Input Supply Voltage.....-0.3V to 6.5V
EN,FB Voltages.....-0.3V to (V_{IN}+0.3V)
SW Voltage.....-0.3V to (V_{IN}+0.3V)
Power Dissipation.....0.6W
Thermal Resistanceθ_{JC}.....130℃/W
Thermal Resistanceθ_{JA}(Note1).....250℃/W
Junction Temperature.....150℃
Operating Temperature Range.....-40℃ to 85℃
Lead Temperature(soldering,10s).....300℃
Storage Temperature Range.....-65℃ to 150℃
ESD HBM(Human Body Mode).....2kV
ESD MM(Machine Mode).....200V

Electrical Characteristics (Note2)

(V_{IN} = V_{EN} = 3.6V, V_{OUT} = 1.8V, T_A=25℃, unless otherwise noted)

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range		2.3		6	V
UVLO Threshold		1.7	1.9	2.1	V
Input DC Supply Current PWM Mode PFM Mode Shutdown Mode	 V_{OUT}= 90%, I_{LODE}=0mA V_{OUT}= 105%, I_{LODE}=0mA V_{EN} = 0V, V_{IN} = 4.2V		 150 40 0.1	 300 75 1.0	μA μA μA mA
Regulated Feedback Voltage V_{FB}	T_A=25℃	0.588	0.600	0.612	V
	T_A=0℃≤T_A≤85℃	0.586	0.600	0.613	V
	T_A=-40℃≤T_A≤85℃	0.585	0.600	0.615	V
Reference Voltage Line Regulation	V_{IN} = 2.5V to 5.5V		0.1		%/V
Output Voltage Accuracy	V_{IN} = 2.5V to 5.5V I_{OUT}=10mA to 2000mA	-3		+3	%V_{OUT}
Output Voltage Load Regulation	I_{OUT}=10mA to 2000Ma		0.2		%/A
Oscillation Frequency	V_{OUT} = 100%		1.5		MHz
	V_{OUT} = 0V		300		KHz
On Resistance of PMOS	I_{SW} = 100mA		100	150	mΩ
On Resistance of NMOS	I_{SW} = - 100mA		80	150	mΩ
Peak Current Limit	V_{IN} = 3V, V_{OUT} = 90%		4		A
EN Threshold		0.30	1.0	1.5	V
EN Leakage Current			±0.01	±0.1	μA
SW Leakage Current	V_{EN} = 0V, V_{IN}=V_{SW}=5V		±0.01	±0.1	μA

Note1: The power dissipation is given by

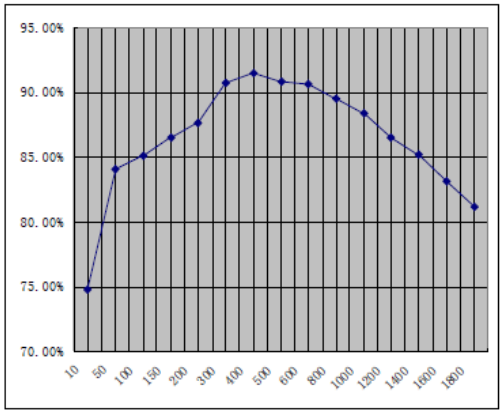
$$P_D = (T_J - T_A)/\theta_{JA}$$

T_J is the operating temperature, T_A is the ambient temperature. The thermal resistance refers to JESD 51-7.

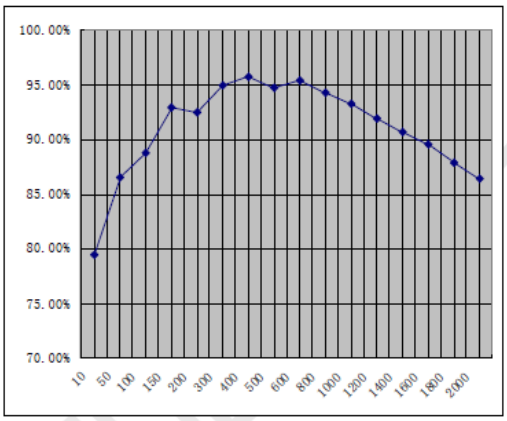
Note2: 100% Production test at +25℃. Specifications over the temperature range are guaranteed by design and characterization.

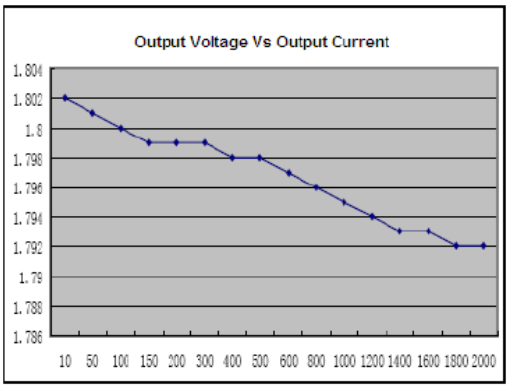
Electrical Characteristic Curves

Efficiency vs. Load Current
V_{OUT}=1.8V

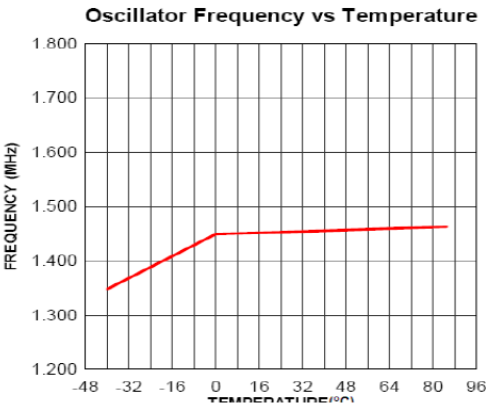


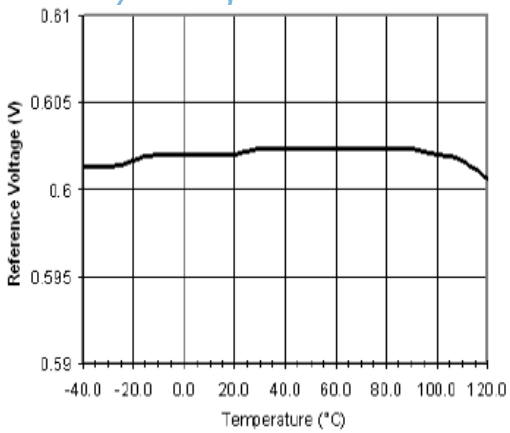
Efficiency vs. Load Current
V_{OUT}=3.3V



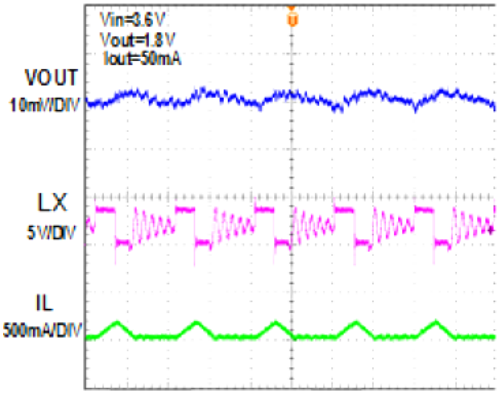


Vin=3.6V,Vout=1.8V

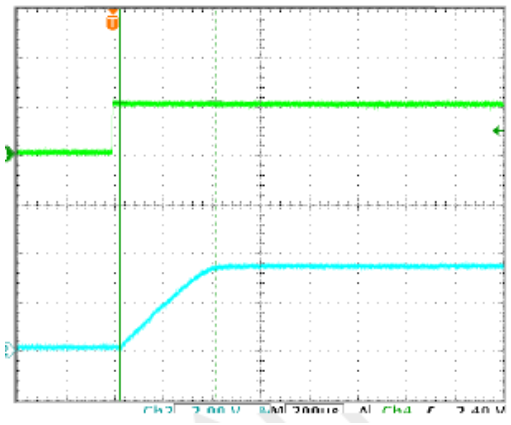




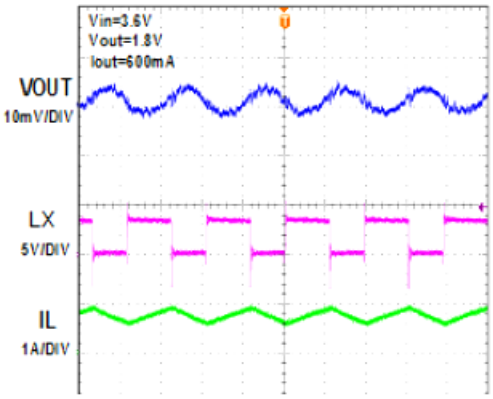
PFM MODE



Start Up Response



PWM MODE



Functional Description

VB9002 is a high output current monolithic switch mode step-down DC-DC converter that integrates the PWM/PFM control, high-side and low-side MOSFETs on the same die to minimize the switching transition loss and conduction loss. With ultra low $R_{DS(ON)}$ power switches and proprietary PWM control, this regulator IC can achieve the highest efficiency and the highest switch frequency simultaneously to minimize the external inductor and capacitor size, and thus achieving the minimum solution footprint. The VB9002 requires only three external power components (C_{IN}, C_{OUT} and L). The adjustable version can be programmed with external feedback to any voltage, ranging from 0.6V to the input voltage. At dropout operation, the converter duty cycle increases to 100% and the output voltage tracks the input voltage minus the $R_{DS(ON)}$ drop of the high-side MOSFET. The internal error amplifier and compensation provides excellent transient response, load and line regulation. Soft start function prevents input inrush current and output overshoot during start up.

Setting the Output Voltage

The internal reference voltage VREF is 0.6V (typ.),the output voltage is set by a resistive divider according to the following formula:

$$V_{OUT} = 0.6 \times \left(1 + \frac{R1}{R2}\right)$$

The external resistive divider is connected to the output, allowing remote voltage sensing as shown in Figure3. To limit the bias current required for the external feedback resistor string while maintaining good noise immunity, the minimum suggested value for R2 is 59kΩ.

Inductor Selection

For most designs, the VB9002 operates with inductors of 1μ H to 4.7μ H. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

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

Where ΔI_L is inductor Ripple Current. Large value inductors result in lower ripple current and small value inductors result in high ripple current. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150 mΩ range.

Input Capacitor Selection

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency should be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 22μ F ceramic capacitor for most applications is

sufficient. A large value may be used for improved input voltage filtering.

Output Capacitor Selection

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current ratings. The output ripple ΔV_{OUT} is determined by:

$$\Delta V_{OUT} = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{osc} \times L} \times \left(ESR + \frac{1}{8 \times f_{osc} \times C_{OUT}}\right)$$

A 22μ F ceramic can satisfy most applications.

PCB layout Recommendations

When laying out the printed circuit board, the following checking should be used to ensure proper operation of the VB9002. Check the following in your layout:

- The power traces, consisting of the GND trace, the SW trace and the VIN trace should be kept short, direct and wide.
- Does the (+) plates of C_{IN} connect to VIN as closely as possible. This capacitor provides the AC current to the internal power MOSFETs.
- Keep the switching node, SW, away from the sensitive V_{OUT} node.
- Keep the (-) plates of C_{IN} and C_{OUT} as close as possible.

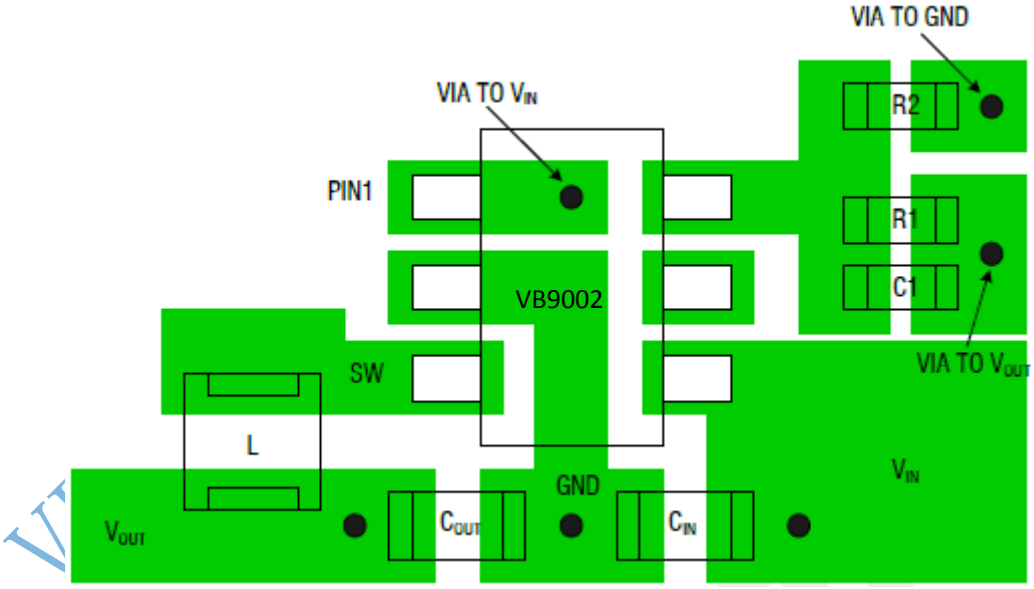
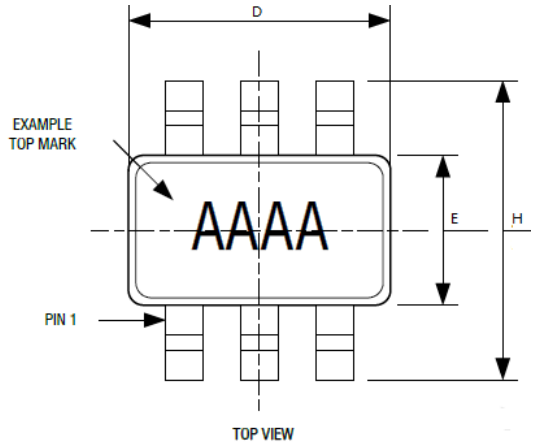


Figure4. VB9002 Suggested PCB layout

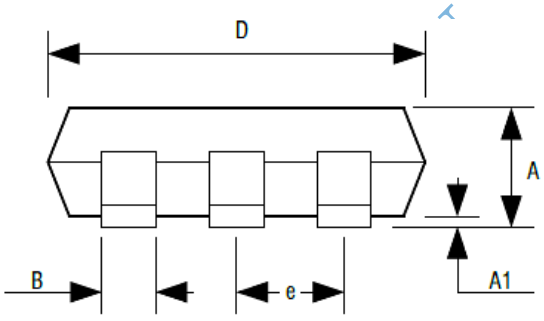
Package Description

SOT23-6

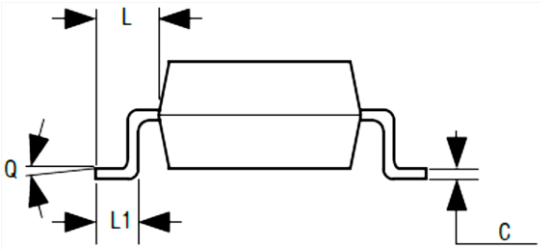
6LD SOT-23 PACKAGE OUTLINE DIMENSION



Demension	Min.	Max.
A	1.05	1.35
A1	0.04	0.15
B	0.3	0.5
C	0.09	0.2
D	2.8	3.0
H	2.5	3.1
E	1.5	1.7
e	0.95 REF	
e1	1.90 REF	
L1	0.2	0.55
L	0.35	0.8
Q	0°	10°



FRONT VIEW



SIDE VIEW

Note:

1. DIMENSIONS ARE IN MILLIMETERS
2. DRAWING NOT TO SCALE
3. DIMENSIONS ARE INCLUSIVE OF PLATING
4. DIMENSIONS ARE EXCLUSIVE OF MOLDFLASH AND METAL BURR

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