VPE2502
6A HV Asynchronous 500kHz Boost Converter

Description

The VPE2502 is a monolithic asynchronous boost DC-DC converter. Its PWM circuitry with built-in 6A 60mΩ power MOSFET make this regulator highly power efficient.

The VPE2502 has wide input voltage range from 2.9V~12V to support applications with single-cell or two-cell lithium batteries. The device could have 6A switching current capacity to provide an output voltage up to 14V.

The VPE2502 uses current mode PWM control topology to regulate the output voltage. That works into power saving mode to get better efficiency for battery in light load condition. In heavy load condition, the VPE2502 works into PWM operating mode.

The VPE2502 non-inverting input of error amplifier connects to 0.6V precision reference voltage and internal soft-start function can reduce the inrush current. In addition, overvoltage protection, cycle by cycle over current protection, and thermal shutdown protection are designed into this chip.

The VPE2502 is available in E-SOP-8L package and provides space-saving PCB for the application fields.

Key Features

- Input Voltage Range 2.9V~12V
- Adjustable Output Voltage Range 5V~14V
- Internal Fixed PWM frequency: 500kHz
- Precision Feedback Reference Voltage: 0.6V (±2%)
- Internal 60mΩ, 6A, 16V Power MOSFET
- Internal Soft-start
- Over Temperature Protection
- Over Voltage Protection
- Cycle by Cycle Over Current Protection
- Package: E-SOP-8L

Applications

- Chargers
- LCD Displays
- LED Application
- Bluetooth Speaker
- Power Bank
- Handheld or Portable Devices

Typical Application

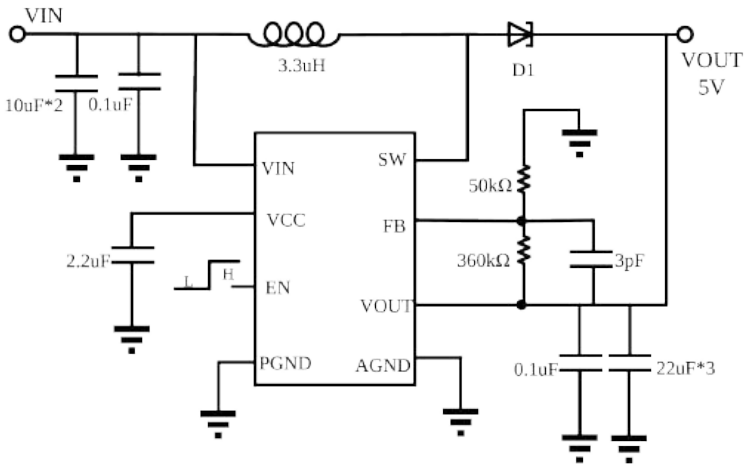
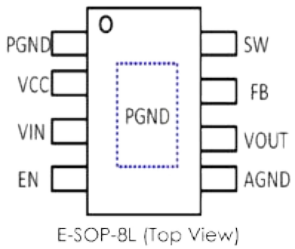


Figure. 1 VPE2502 application circuit

Package Configuration



E-SOP-8L (Top View)

VPE2502-00SG08NRR

00 Adjustable Output

SG08 E-SOP-8L Package

NRR RoHS & Halogen free package

Commercial Grade Temperature

Rating: -40 to 85℃

Package in Tape & Reel

Order, Mark & Packing information

Package	Vout(V)	Product ID	Marking Code	Packing
E-SOP-8L	Adjustable	VPE2502-00SG08NRR	2502	Tape & Reel 3K units

Pin Functions

Name	E-SOP-8L	Function
PGND	1	**Power Ground Pin.** Connect exposed pad to GND plane for optimal thermal performance.
VCC	2	**Output of Internal Regulator.** A ceramic capacitor of more than 2.2μF required between this pin and GND.
VIN	3	**Supply Voltage.** Must be closely decoupled to GND pin with 10μF*2 or greater ceramic capacitor.
EN	4	**Enable Pin.** High: Enable; Low: Disable.
AGND	5	**Analog Ground Pin.** Signal ground of the IC.
VOUT	6	**Input of Internal Regulator.** Boost converter output for internal regulator.
FB	7	**Feedback Pin.** Receives the feedback voltage from an external resistive divider across the output.
SW	8	**Switch Out.** Must be connected an Inductor from VIN pin to SW pin.
PGND	9	**Power Ground Pin/Thermal Pad.** This pin must be connected to ground. The thermal pad with large thermal land area on the PCB will be helpful for chip power dissipation.

Functional Block Diagram

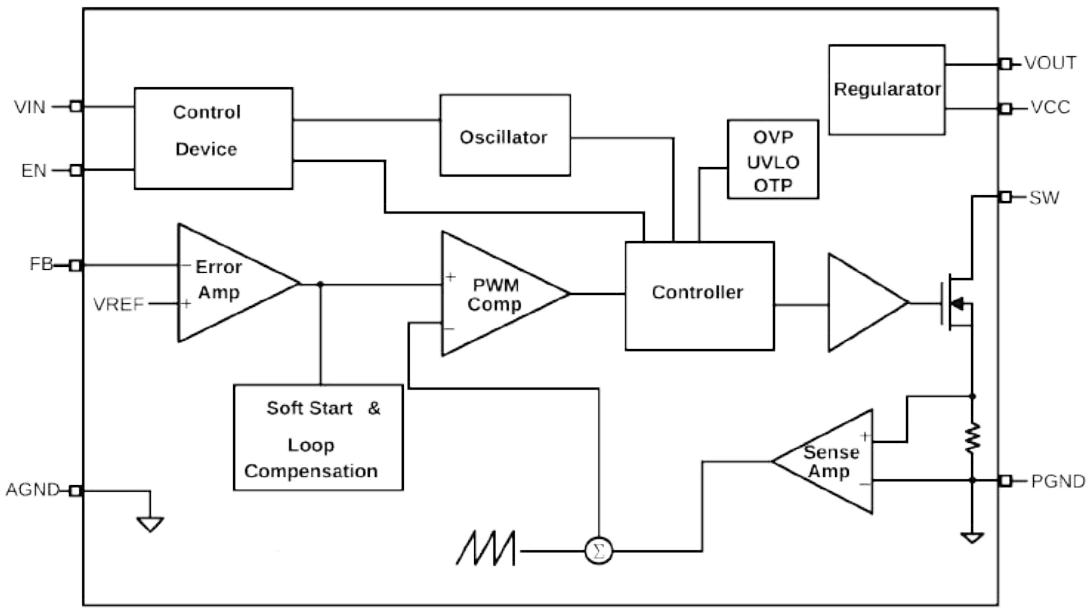


Fig. 2 Functional Block Diagram

Absolute Maximum Ratings

Devices are subjected to fail if they stay above absolute maximum ratings.

Supply Voltage (VIN, VOUT) ..... –0.3V to 16V
EN, FB, VCC Voltages .....–0.3V to 6V
SW Voltage ..... –0.3V to (16V + 0.3V)
Lead Temperature (Soldering, 10 sec) ..... 260°C
ESD Susceptibility HBM 2KV
ESD Susceptibility CDM 500V

Operating Temperature Range ..... –40°C to 85°C
Junction Temperature (Note 1) ..... 150°C
Storage Temperature Range ..... –65°C to 150°C

Recommended Operating Conditions

Input Voltage (V_{IN}) .....2.9V to 12V
Output Voltage (V_{OUT}) .....5V to 14V

Junction Operating Temperature ..... –40°C to 125°C

Thermal data

Package	Thermal Resistance	Parameter	Value
E-SOP-8L	θ_{JA} (Note 2)	Junction-ambient	50°C/W
	$\theta_{JC(top)}$ (Note 3)	Junction-case (top)	39°C/W
	$\theta_{JC(bottom)}$ (Note 4)	Junction-case (bottom)	10°C/W

- **Note 1:** T_J is a function of the ambient temperature T_A and power dissipation P_D ($T_J = T_A + (P_D * \theta_{JA})$).
- **Note 2:** θ_{JA} is simulated in the natural convection at T_A=25°C on a highly effective thermal conductivity (thermal land area completed with >3*3cm² area) board (2 layers, 2SOP) according to the JEDEC 51-7 thermal measurement standard.
- **Note 3:** $\theta_{JC(top)}$ represents the heat resistance between the chip junction and the top surface of package.
- **Note 4:** $\theta_{JC(bottom)}$ represents the heat resistance between the chip junction and the center of the exposed pad on the underside of the package.

Electrical Characteristics

V_{IN}=3.6V, V_{OUT}=5.0V, T_A=25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Feedback Voltage	V_{FB}	2.9V≤V_{IN}≤12V	0.588	0.6	0.612	V
Feedback Voltage UV Threshold	V_{FB_UV}	2.9V≤V_{IN}≤12V	-	0.1	-	V
Switch On Resistance	$R_{DS(ON)}$	V_{IN}=3.6V, V_{OUT}=5V	-	60	-	mΩ
Switch Leakage	I_{SW}	V_{IN}=6V, V_{OUT}=6V, V_{EN}=1.2V, V_{SW}=15V	-	-	5	μA
Current Limit	I_{LIM}	V_{IN}=6V, V_{OUT}=6V, V_{EN}=1.2V	-	6.5	-	A
V_{IN} UVLO Threshold	V_{IN_UVLO}	V_{IN} rising	2.55	2.6	2.9	V
V_{IN} UVLO Threshold	-	V_{IN} falling	2.35	2.4	2.65	V
VCC Regulation	-	V_{IN}=8V, V_{OUT}=8V, V_{EN}=1.2V	4.2	4.6	5.3	V
Oscillation Frequency	F_{OSC}	V_{FB}=0.4V	380	500	620	kHz
Max Duty Cycle	D_{max}	-	85	90	95	%
Shutdown Supply Current	-	V_{EN}=0	1	5	7	μA
Quiescent Supply Current	-	V_{EN}=1.2V, V_{FB}=1V	110	130	150	μA
Quiescent Supply Current (Switching)	-	V_{EN}=1.2V, V_{FB}=0.4V	1	1.5	2	mA
Thermal Shutdown	T_{SD}	-	-	160	-	°C
Thermal Shutdown Hysteresis	-	-	-	30	-	°C
EN Input Low Voltage	-	-	-	-	0.4	V
EN Input High Voltage	-	-	1.2	-	-	V
EN Pull down Resistor	-	-	600	800	1000	kΩ

Typical Performance Characteristics

V_{IN}=3.6V, V_{OUT}=5.0V, T_A=25℃, L=3.3μH, C_{IN}=10μF*2, C_{OUT}=22μF*3, unless otherwise specified.

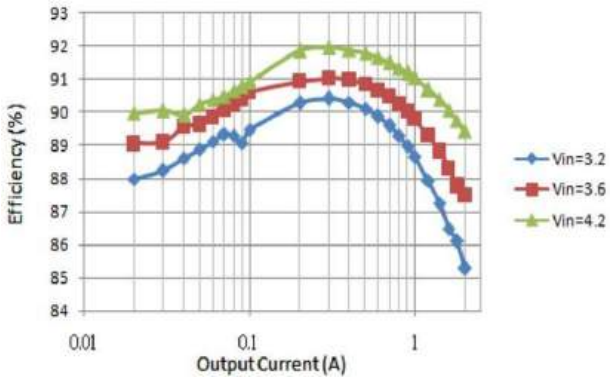


Figure 3. Efficiency (V_{OUT}=5V)

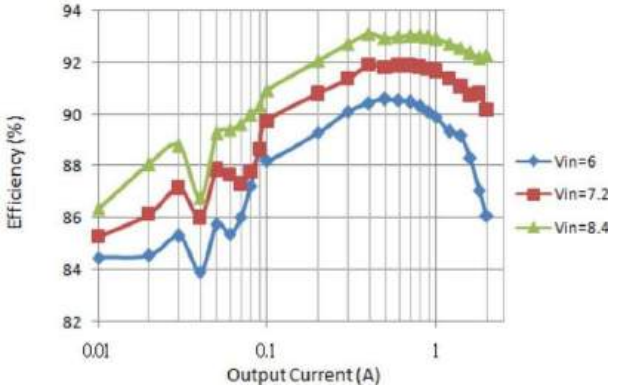


Figure 4. Efficiency (V_{OUT}=12V)

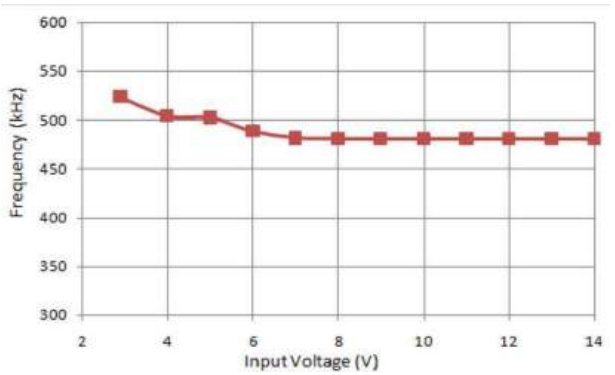


Figure 5. Operation Frequency vs. Input Voltage

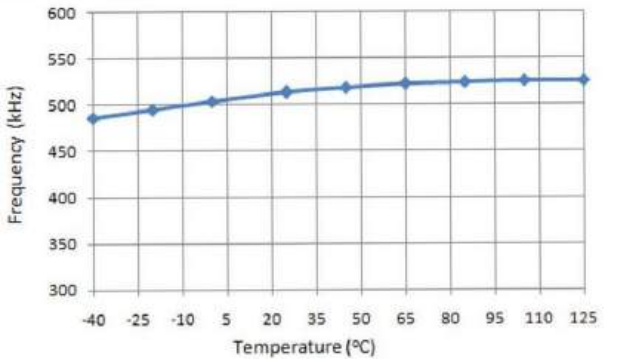


Figure 6. Operation Frequency vs. Temperature

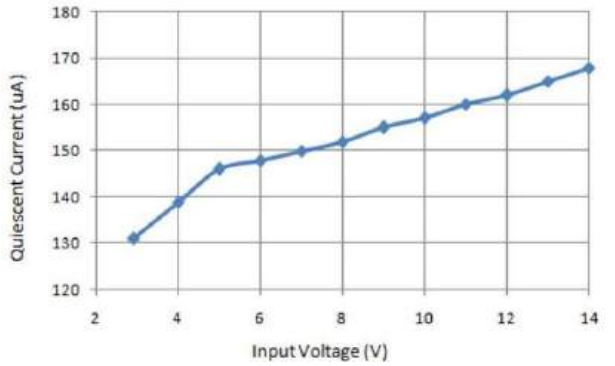


Figure 7. Quiescent Current vs. Input Voltage

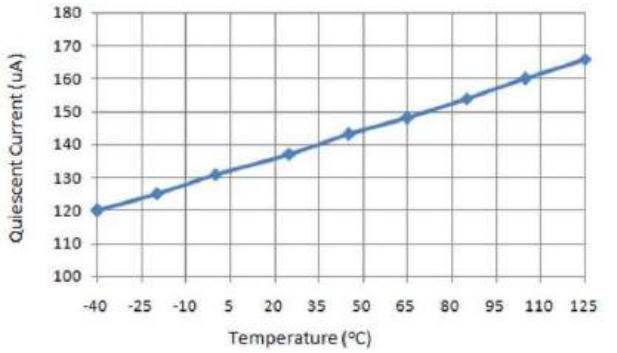


Figure 8. Quiescent Current vs. Temperature

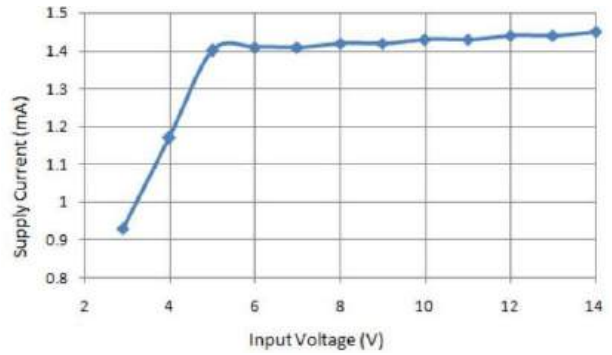


Figure 9. Supply Current vs. Input Voltage

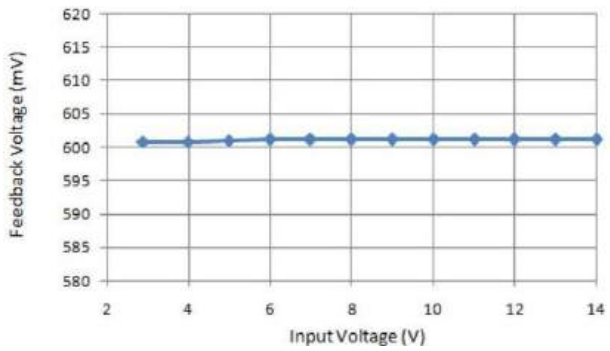


Figure 10. Feedback Voltage vs. Input Voltage

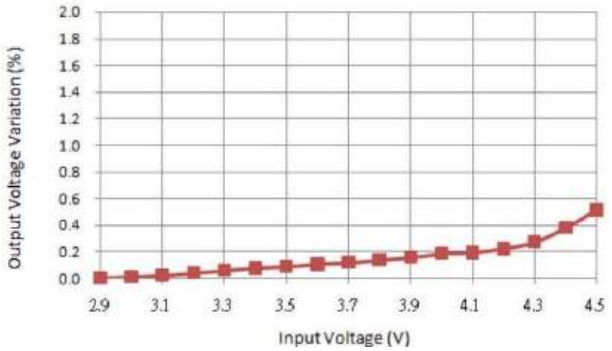


Figure 11. Output Voltage Variation vs. Input Voltage (V_{OUT}=5V)

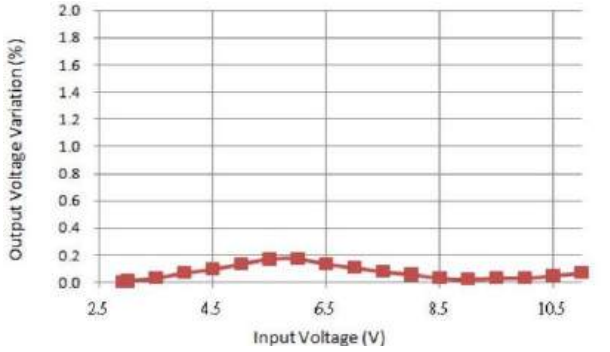


Figure 12. Output Voltage Variation vs. Input Voltage (V_{OUT}=12V)

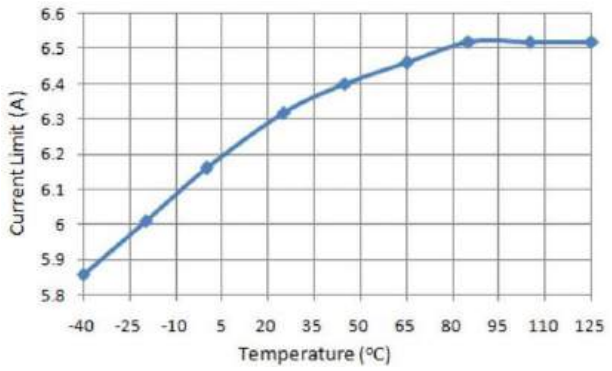


Figure 12-1. Current Limit vs. Temperature

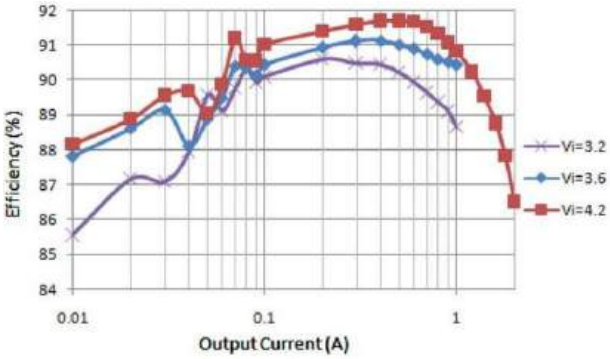


Figure 12-2. Efficiency (V_{OUT}=8V)

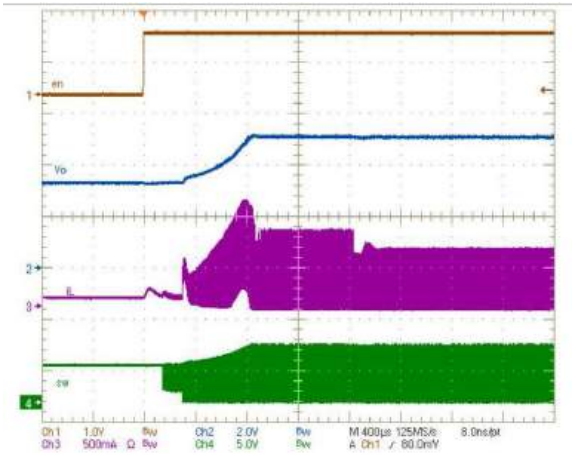


Figure 13. Power On from EN
V_{IN}=3.6V, V_{OUT}=5V

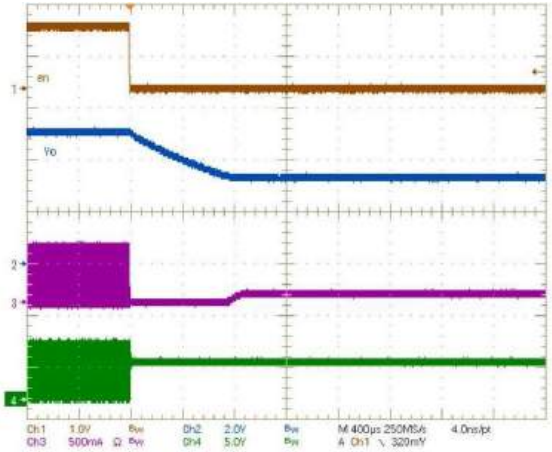


Figure 14. Power Off from EN
V_{IN}=3.6V, V_{OUT}=5V

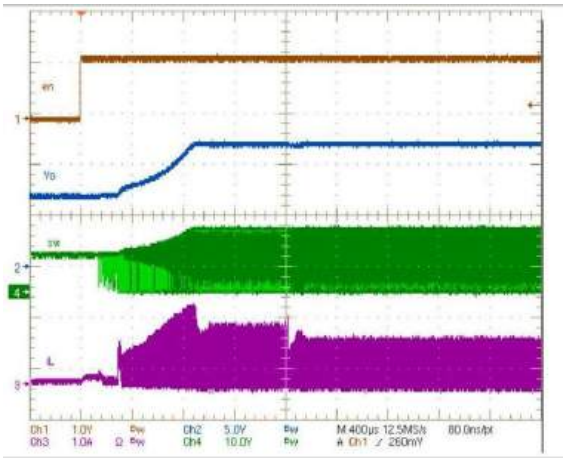


Figure 15. Power On from EN
V_{IN}=7.2V, V_{OUT}=12V

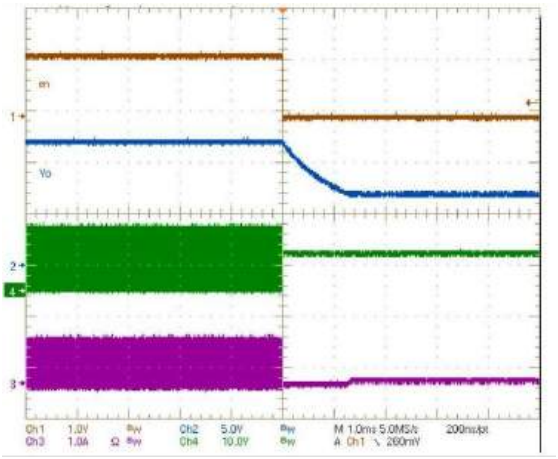


Figure 16. Power Off from EN
V_{IN}=7.2V, V_{OUT}=12V

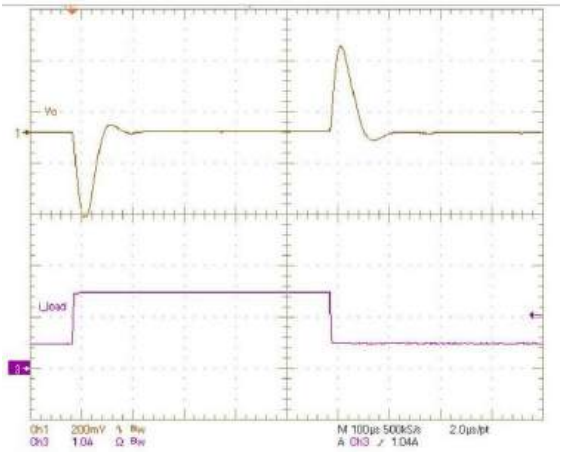


Figure 17. Load Transient Response
V_{IN}=3.6V, V_{OUT}=5V, I_{OUT}=0.5A→1.5A

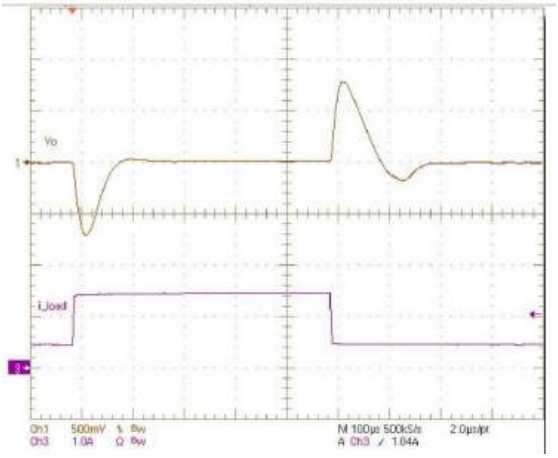


Figure 18. Load Transient Response
V_{IN}=7.2V, V_{OUT}=12V, I_{OUT}=0.5A→1.5A

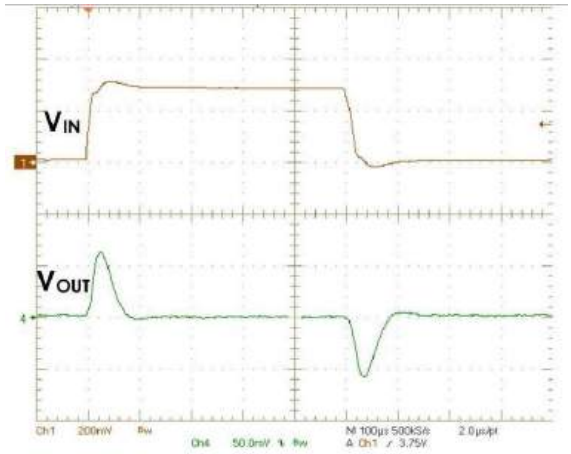


Figure 19. Line Transient Response
V_{IN}=3.6V→3.9V, V_{OUT}=5V, I_{OUT}=1A

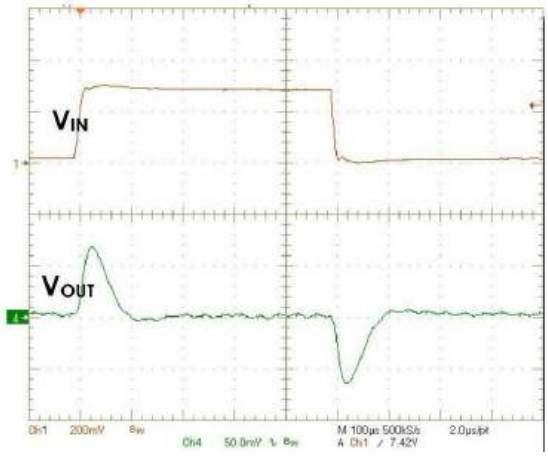


Figure 20. Line Transient Response
V_{IN}=7.2V→7.5V, V_{OUT}=12V, I_{OUT}=1A

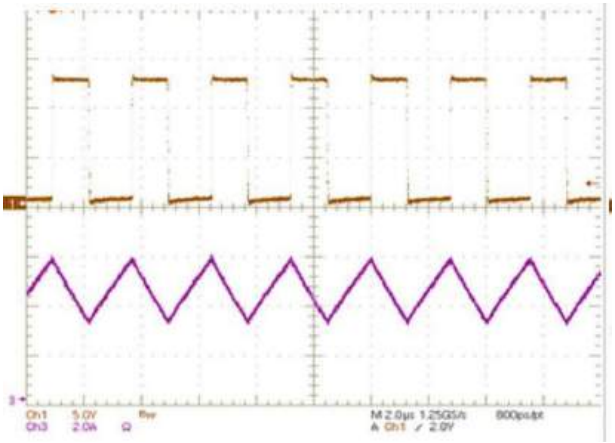


Figure 21. Heavy Load PWM Operation
V_{IN}=6V, V_{OUT}=12V, I_{OUT}=2A

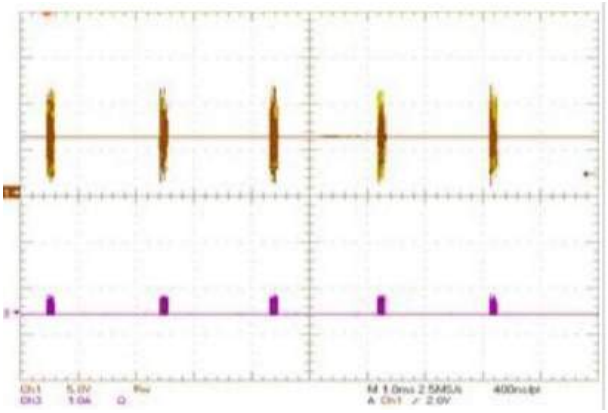


Figure 22. Light Load PSM Operation
V_{IN}=6V, V_{OUT}=12V, I_{OUT}=1mA

Function Description

Detailed Description

The VPE2502 is a current mode boost converter. The constant switching frequency is 500kHz and operates with pulse width modulation (PWM). Built-in 16V/6A MOSFET provides a high output voltage. The control loop architecture is peak current mode control; therefore slope compensation circuit is added to the current signal to allow stable operation for duty cycles larger than 50%.

Soft Start

Soft start circuitry is integrated into VPE2502 to avoid inrush current during power on. After the IC is enabled, the output of error amplifier is clamped by the internal soft-start function, which causes PWM pulse width increasing slowly and thus reducing input surge current.

Over Temperature Protection

VPE2502 will turn off the power MOSFET automatically when the internal junction temperature is over 160°C. The power MOSFET will wake up when the junction temperature drops 30°C under the OTP threshold temperature.

Over Voltage Protection

The VPE2502 has output over-voltage protections. The threshold output OVP circuit is minimum 118% $*$ V_{OUT}. Once the output voltage is higher than the threshold, the NMOS driver is turned off. When the output voltage drops lower than the threshold, the NMOS will be turned on again.

Over Current Protection

The VPE2502 cycle-by-cycle limits the peak inductor current to protect NMOS driver. The NMOS driver will turn off when switching current reaches OCP level.

UVP Protection

If the output voltage falls below 16% of the regulation level, IC will turn off power switches into UVP protection. It will remain in this state until the VIN or EN voltage is recycled or FB voltage $>$0.15V.

Application Information

Inductor Selection

Inductance value is decided based on different conditions. 2.2μH or 3.3μH inductor value is recommended for general application circuit. There are three important inductor specifications: DC resistance, saturation current, and core loss. Low DC resistance has better power efficiency.

Capacitor Selection

The output capacitor is required to maintain the DC voltage. Low ESR capacitors are preferred to reduce the output voltage ripple. Ceramic capacitors of X5R and X7R are recommended, which have low equivalent series resistance (ESR) and wider operation temperature range.

Diode Selection

Schottky diodes with fast recovery times and low forward voltages are recommended. Ensure the diode average and peak current rating exceed the average output current and peak inductor current. In addition, the diode's reverse breakdown voltage must exceed the output voltage.

Output Voltage Setting

The output voltage of VPE2502 can be adjusted by a resistive divider according to the following formula:

$$V_{OUT} = V_{REF}\left(1 + \frac{R_1}{R_2}\right) = 0.6\left(1 + \frac{R_1}{R_2}\right)$$

The resistive divider senses the fraction of the output voltage (see Fig. 23). Using large feedback resistor can increase efficiency, but too large a value affects the device's output accuracy because of leakage current going into the device's FB pin. The recommended value for R_2 is therefore in the range of 10∼50kΩ.

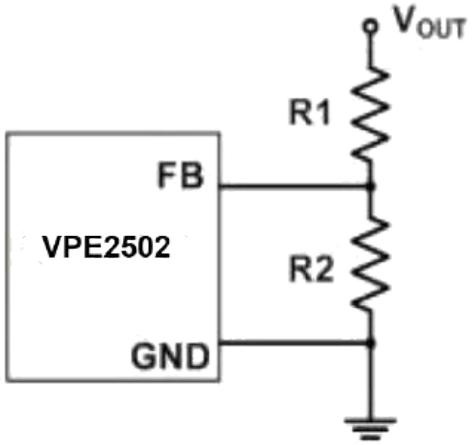


Fig. 23 Setting the Output Voltage

Applications

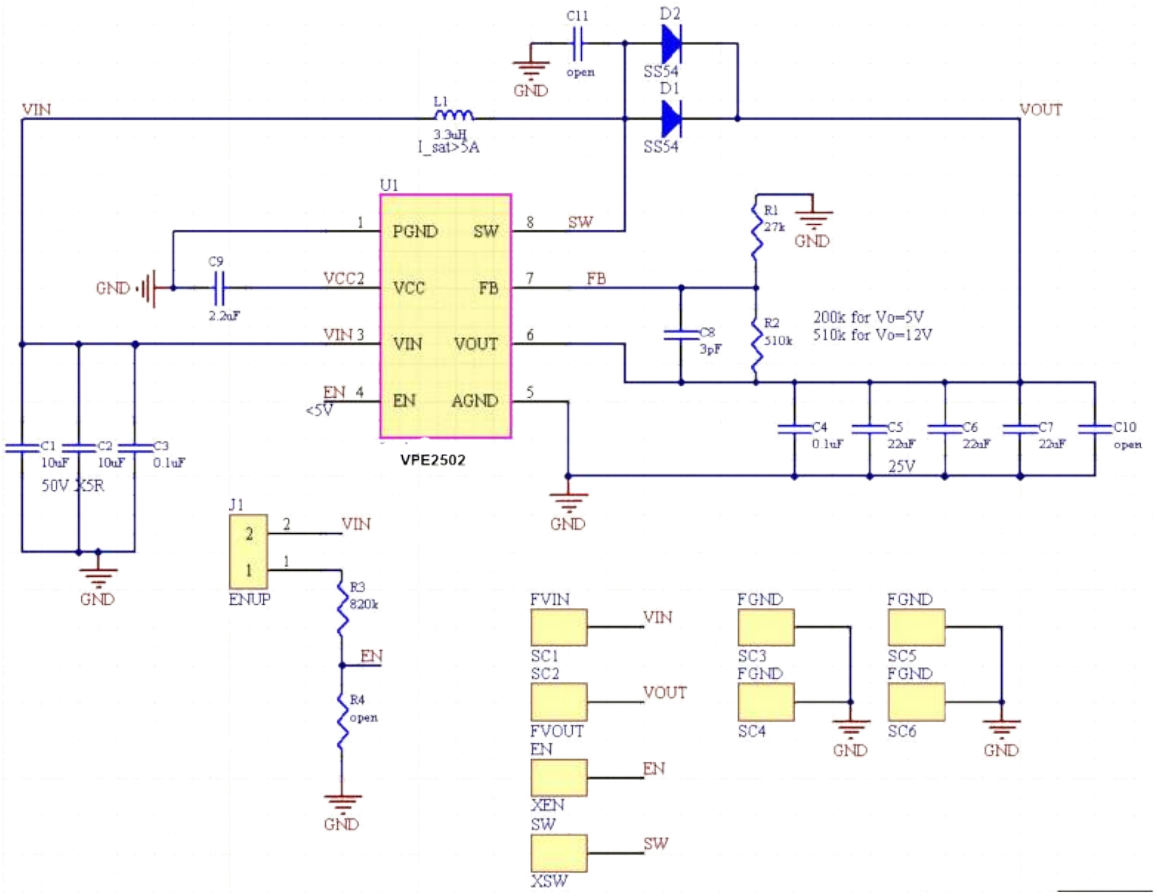


Figure 24. Typical Schematic for PCB layout

Bill of Materials

QTY	RefDes	Value	Description	Size
2	C1, C2	10μF	Capacitor, ceramic, 50V, X5R	1206
2	C3, C4	0.1μF	Capacitor, ceramic, 50V, X5R	0603
3	C5, C6, C7	22μF	Capacitor, ceramic, 25V, X5R	1206
1	C8	3pF	Capacitor, ceramic	0603
1	C9	2.2μF	Capacitor, ceramic	0805
2	D1, D2	5A/20V	Diode, Schottky	-
1	J1	-	Jumper, 2 pin	-
1	L1	3.3μH	Inductor, SMT, 5A	-
1	R1	27k	Resistor, chip, 1/16W	0603
1	R2	510k	Resistor, chip, 1/16W	0603
1	R3	820k	Resistor, chip, 1/16W	0603
1	U1	VPE2502	IC, 6-A, 14-V, Boost Converter	E-SOP-8

PCB Layout Guidelines

When laying out the printed circuit board, the following checklist should be used to optimize the performance of VPE2502.

1. The power traces, consisting of the GND trace, the SW trace and the VCC trace should be kept short, direct and wide.
2. SW, L and D switching node, wide and short trace to reduce EMI.
3. Place C_{IN} near VCC pin as closely as possible to maintain input voltage steady and filter out the pulsing input current.
4. The resistive divider R1 and R2 must be connected to FB pin directly as closely as possible.
5. FB is a sensitive node. Please keep it away from switching node, SW.
6. The GND of the IC, C_{IN} and C_{OUT} should be connected close together directly to a ground plane.

Typical Schematic for PCB layout (cont.)

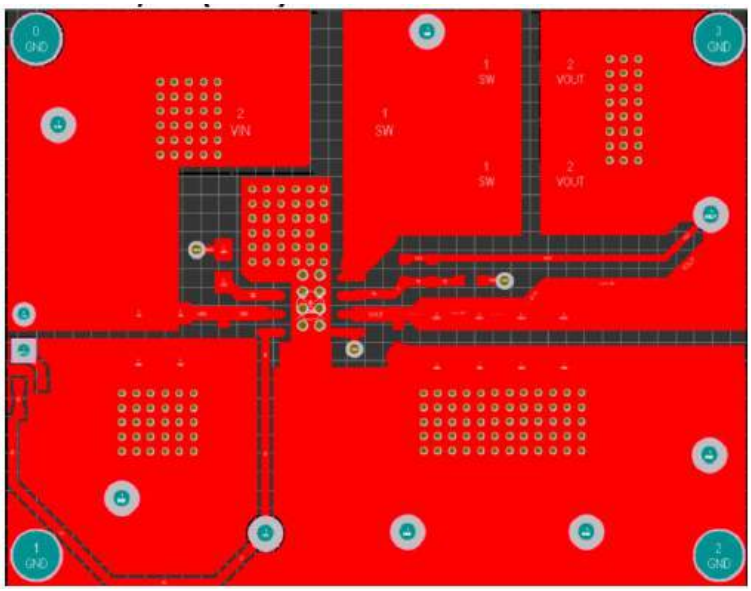


Figure 25. Top layer of PCB layout

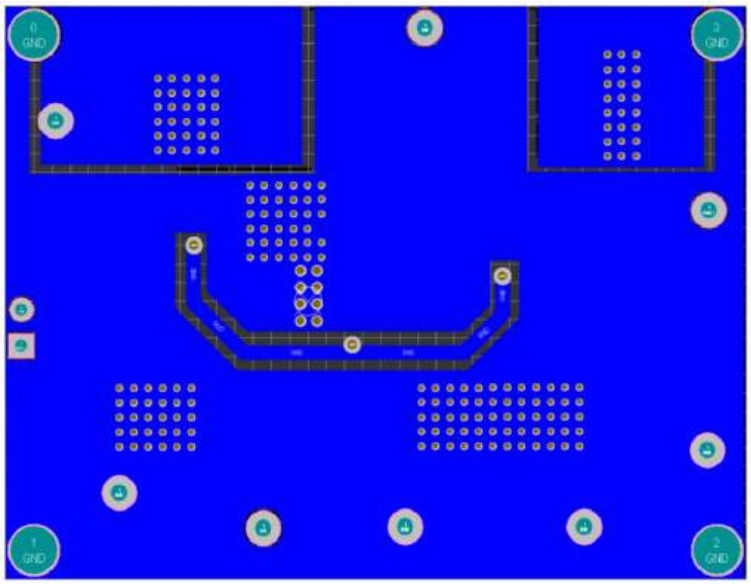
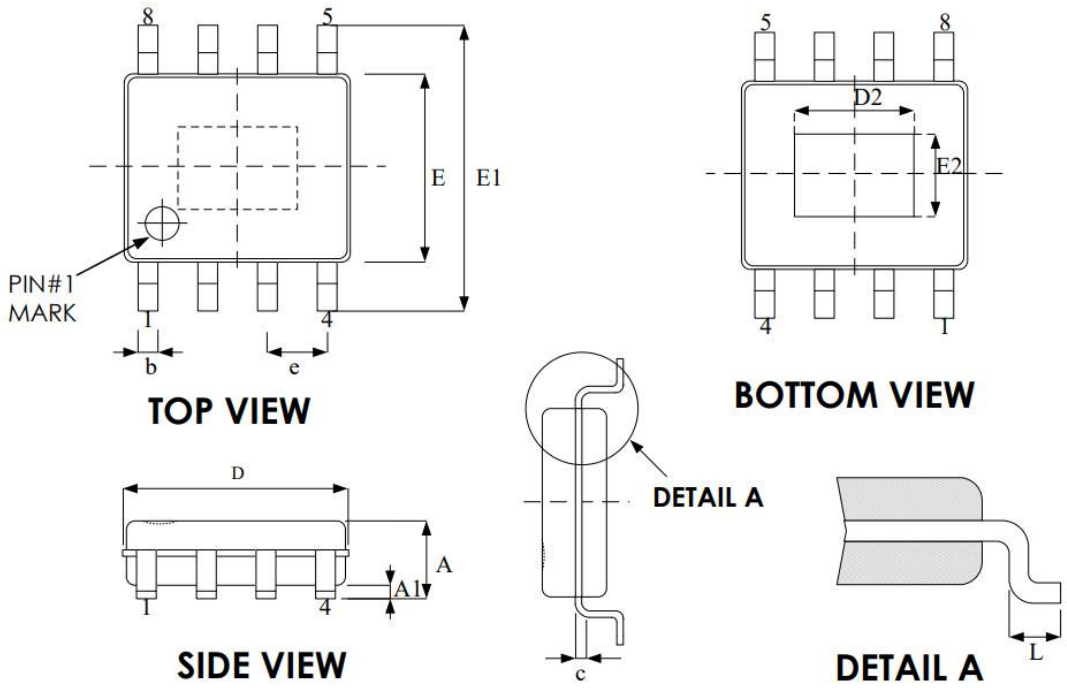


Figure 26. Bottom layer of PCB layout

Package Outline Drawing



E-SOP-8L

Symbol	Dimension in mm	
	Min.	Max.
A	-	1.70
A1	0.00	0.15
b	0.31	0.51
c	0.10	0.25
D	4.80	5.00
E	3.81	4.00
E1	5.79	6.20
e	1.27 BSC	
L	0.40	1.27

Exposed pad

Symbol	Dimension in mm	
	Min.	Max.
D2	2.80	3.50
E2	2.00	2.60

Disclaimer

The information provided in this datasheet is believed to be accurate and reliable. Errors or omissions are expected. indiaVP Semiconductor Pvt. Ltd. reserves the right to make changes to the product specifications without prior notice. Users should verify the suitability of the product for their specific applications. Please visit our website for the latest datasheet.

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