VPE2506
1MHz, 3A Synchronous Step-Down Regulator

Description

VPE2506 is a high efficiency step down DC/DC converter. It features an extremely low quiescent current, which is suitable for reducing standby power consumption, especially for portable applications.

The device can accept input voltage from 2.6V to 5.5V and deliver up to 3A output current. High 1MHz switching frequency allows the use of small surface mount inductors and capacitors to reduce overall PCB board space. Furthermore, the built-in synchronous switch improves efficiency and eliminates external Schottky diode. VPE2506 uses different modulation modes for various loading conditions: (1) Pulse Width Modulation (PWM) for low output voltage ripple and fixed frequency noise, (2) Pulse Frequency Modulation (PSM) for improving light load efficiency. In addition VPE2506 also build in short circuit and over voltage protection.

The adjustable version of this device is available in SOT-23-6L and TDFN-8L packages.

Key Features

- Achieve 95% efficiency
- Input voltage: 2.6V to 5.5V
- Output current up to 3A
- Reference voltage: 0.6V
- Quiescent current 45μA
- Internal switching frequency: 1MHz
- No Schottky diode needed
- Low dropout operation: 100% duty cycle
- Shutdown current $< 1\mu A$
- Excellent line and load transient response
- Over-temperature protection
- Over Voltage protection
- Hiccup mode Short circuit protection

Applications

- Blue-Tooth devices
- Cellular and Smart Phones
- LCD TV Power Supply
- Wireless networking
- Portable applications

Typical Application

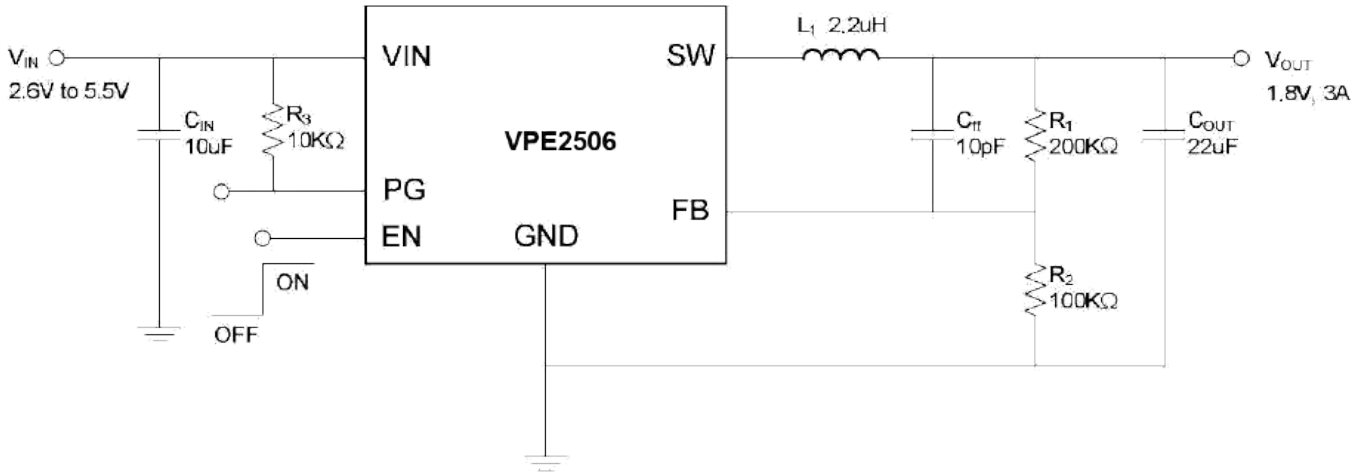
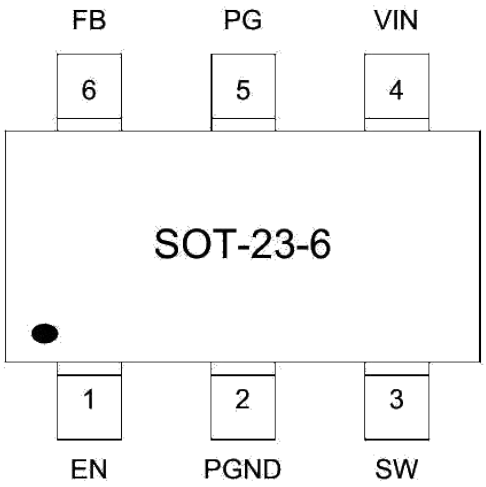


Figure 1. VPE2506 Typical Application Circuit

Package Configuration



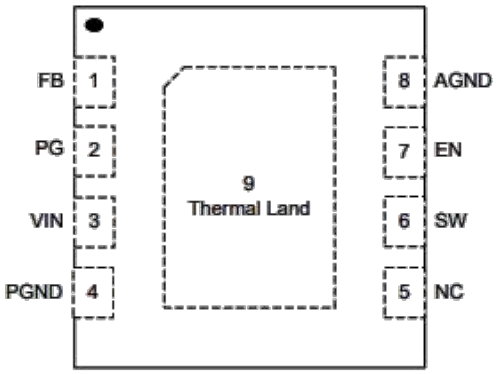
SOT-23-6L

VPE2506-00VN06NRR

00 Adjustable Output

VN06 SOT-23-6L Package

NRR RoHS & Halogen free package
Commercial Grade Temperature
Rating: -40 to 85℃
Package in Tape & Reel



TDFN-8L (2mm×2mm)

VPE2506-00FK08NRR

00 Adjustable Output

FK08 TDFN-8L (2mm×2mm) 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
SOT-23-6L	Adjustable	VPE2506-00VN06NRR	2506	Tape & Reel 3K units
TDFN-8L	Adjustable	VPE2506-00FK08NRR	2506	Tape & Reel 3K units

Pin Functions

Name	SOT-23-6L	TDFN-8L	Function
EN	1	7	**Enable Pin.** Minimum 1.5V to enable the device. Maximum 0.4V to shut down the device.
PGND	2	4	**Power Ground Pin.**
SW	3	6	**Switch Pin.** Must be connected to Inductor. This pin connects to the drains of the internal main and synchronous power MOSFET switches.
VIN,PVIN	4	3	**Power Input Pin.** Must be closely decoupled to GND pin with a 4.7µF or greater ceramic capacitor.
SVIN	N/A	N/A	**Signal Power Input Pin.**
PG	5	2	**Power Good Indicator.** The output of this pin is an open-drain. If the output is within 90% of regulation, it's low otherwise.
FB	6	1	**Feedback Pin.** Receives the feedback voltage from an external resistive divider across the output.
NC	N/A	5	**N.C.**
AGND	N/A	8	**Analog Ground Pin.**
Thermal Land	N/A	9	**Connected it to GND.**

Functional Block Diagram

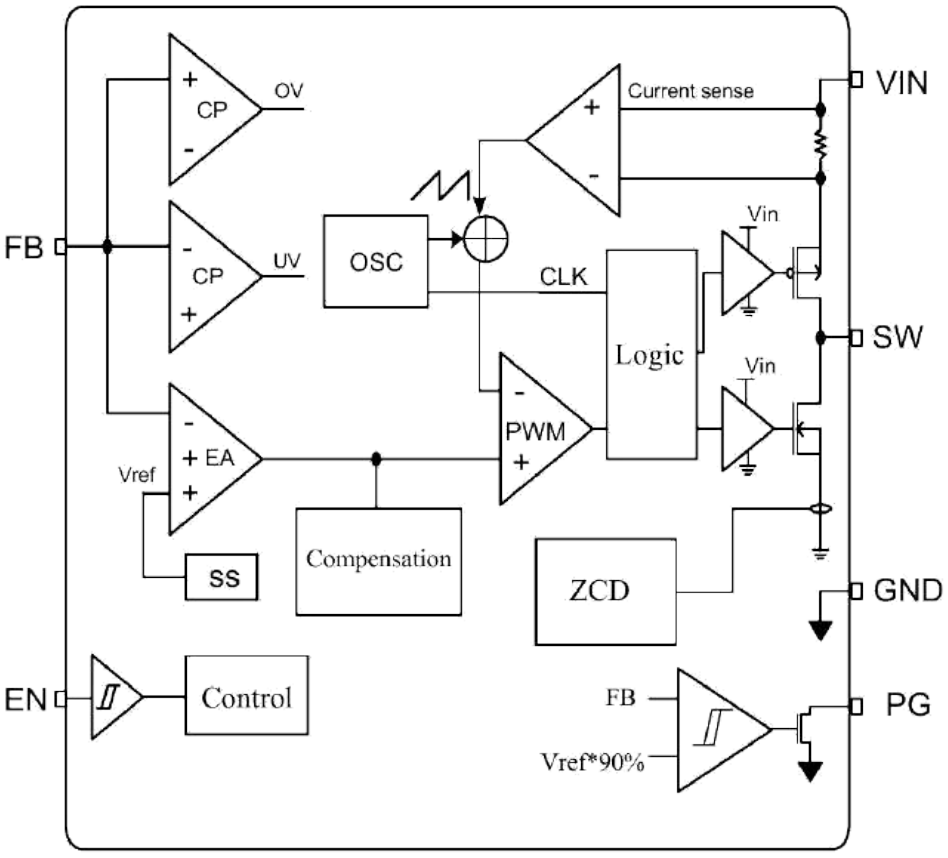


Figure 2. Functional Block Diagram of VPE2506

Absolute Maximum Ratings

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

Input Voltage ..... –0.3V to 6V
EN, FB, PG Voltages ..... –0.3V to V_{IN}
SW Voltage ..... –0.3V to (V_{IN} + 0.3V)
Lead Temperature (Soldering, 10 sec) ..... 260°C

Operating Temperature Range ..... –40°C to 85°C
Junction Temperature (Notes 1, 3) ..... 150°C
Storage Temperature Range ..... –65°C to 150°C
ESD Susceptibility HBM 2KV
ESD Susceptibility CDM 500V

Recommended Operating Conditions

Input Voltage (V_{IN}) ..... +2.6V to +5.5V

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

Thermal data

Package	Thermal Resistance	Parameter	Value
SOT-23-6L	θ_{JA} (Note 4)	Junction-ambient	134.5°C/W
	θ_{JC} (Note 5)	Junction-case	81°C/W
TDFN-8L (2mm×2mm)	θ_{JA} (Note 4)	Junction-ambient	74.7°C/W
	θ_{JC} (Note 5)	Junction-case	24°C/W

Electrical Characteristics

V_{IN}=3.6V, T_A=+25°C, unless otherwise specified.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range	V_{IN}	-	2.6	-	5.5	V
Feedback Current	I_{VFB}	-	-	-	±100	nA
Regulated Feedback Voltage	V_{FB}	-	0.588	0.600	0.612	V
Peak Inductor Current	I_{PK}	V_{FB} = 0.5V	4.0	-	-	A
Quiescent Current	I_Q	V_{FB} = 0.65V	-	45	-	μA
Shutdown Current	I_{SD}	V_{EN} = 0V	-	0.1	-	μA
Oscillator Frequency	f_{OSC}	V_{FB} = 0.6V	-	1	-	MHz
$R_{DS(ON)}$ of PMOS	R_{ON}	I_{SW} = 100mA	-	90	-	mΩ
$R_{DS(ON)}$ of NMOS		I_{SW} = -100mA	-	60	-	mΩ
VIN UVLO Threshold	V_{UVLO}	-	-	2.2	2.4	V
VIN UVLO Hysteresis		-	-	150	-	mV
Maximum Duty cycle	D	-	100	-	-	%
Short circuit protection Threshold	V_{SCP}	V_{FB}	-	0.2	-	V
SW Leakage	I_{LSW}	V_{EN} = 0V, V_{SW} = 0V or 5V, V_{IN} = 5V	-	-	±1	μA
Enable Threshold	V_{EN}	-	1.5	-	-	V
Shutdown Threshold		-	-	-	0.4	V
EN Leakage Current	I_{EN}	-	-	-	±1	μA
Thermal Shutdown	T_{SD}	-	-	160	-	°C
Thermal Shutdown Hysteresis		-	-	30	-	°C
Soft start time	T_{SS}	-	-	1.0	-	mS
PG Pin Threshold raising	PG	-	-	0.54	-	V
PG Pin Threshold falling		-	-	0.5	-	V
PG Open Drain impedance		-	-	-	100	Ω

- **Note 1:** T_J is a function of the ambient temperature T_A and power dissipation P_D (T_J = T_A + (P_D * 134.5°C/W)).
- **Note 2:** Dynamic quiescent current is higher due to the gate charge being delivered at the switching frequency.
- **Note 3:** This IC has a built-in over-temperature protection to avoid damage from overloaded conditions.
- **Note 4:** θ_{JA} is measured in the natural convection at T_A=25°C on a highly effective thermal conductivity test board (2 layers, 2S0P) according to the JEDEC 51-7 thermal measurement standard.
- **Note 5:** θ_{JC} represents the heat resistance between the chip and the package top case.

Typical Performance Characteristics

V_{IN}=5.0V, T_A=25°C, unless otherwise specified.

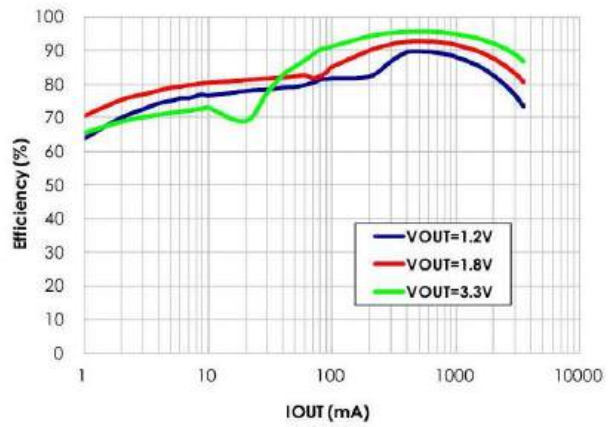


Figure 3. Efficiency vs. Output Current (V_{IN}=5V)

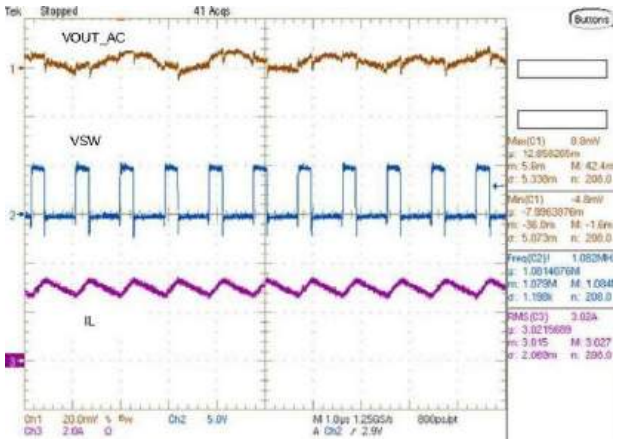


Figure 4. Output Ripple Voltage

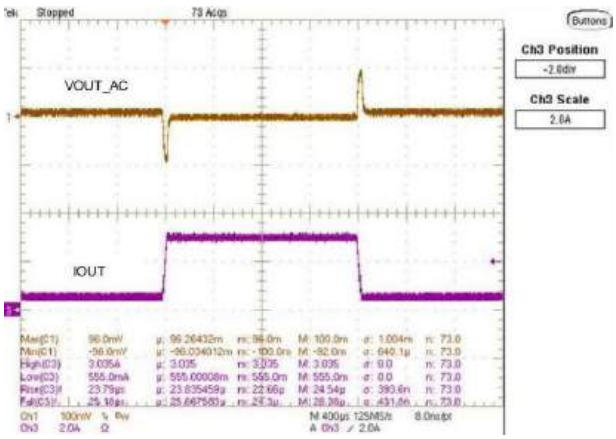


Figure 5. Load Transient (500mA→3A→500mA)

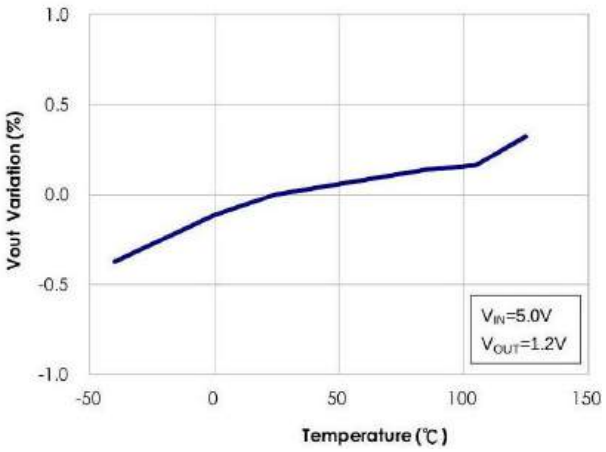


Figure 6. Vout Variation vs. Temperature

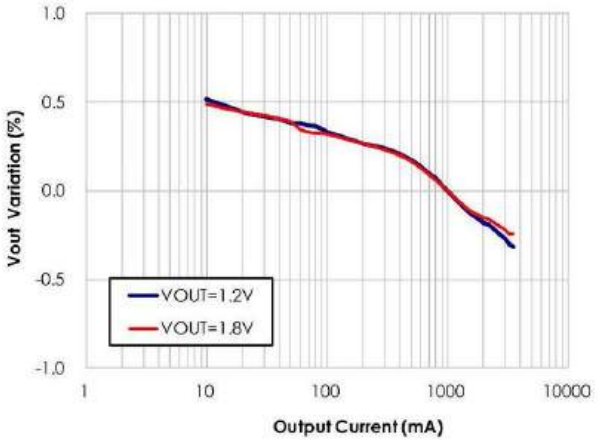


Figure 7. Load Regulation (V_{IN}=5V)

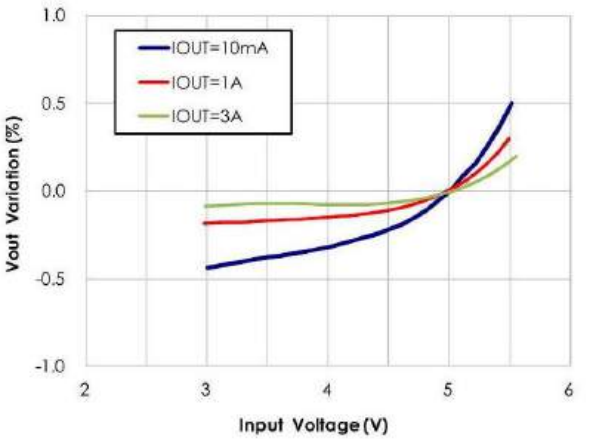


Figure 8. Line Regulation (V_{OUT}=1.2V)

Typical Performance Characteristics (Cont.)

V_{IN}=5.0V, T_A=25°C, unless otherwise specified.

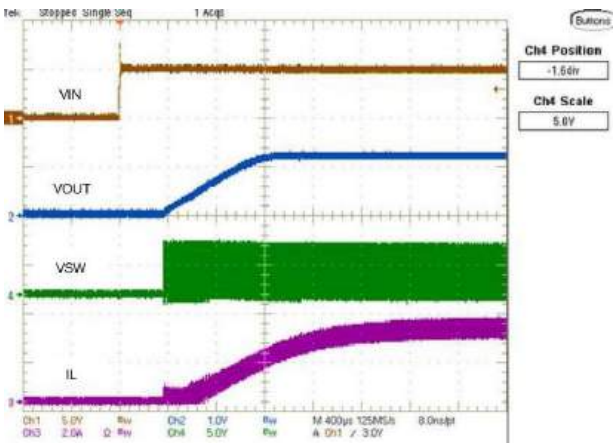


Figure 9. Power ON with 3A load

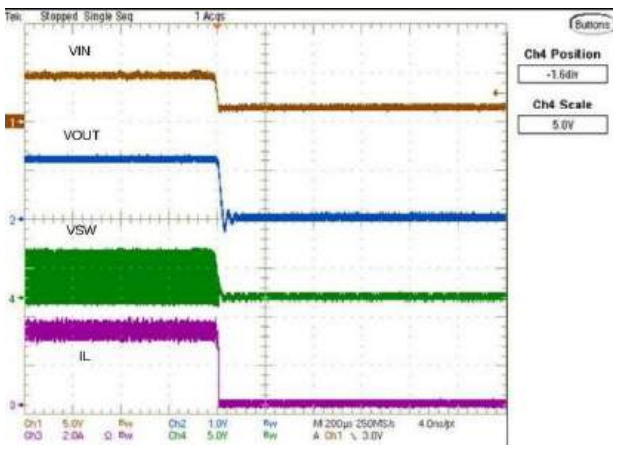


Figure 10. Power OFF with 3A load

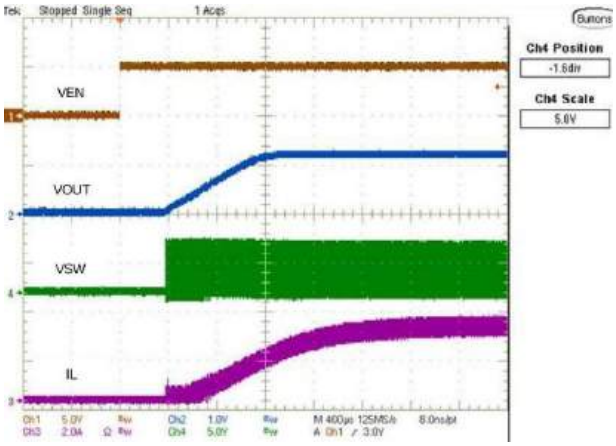


Figure 11. EN ON with 3A load

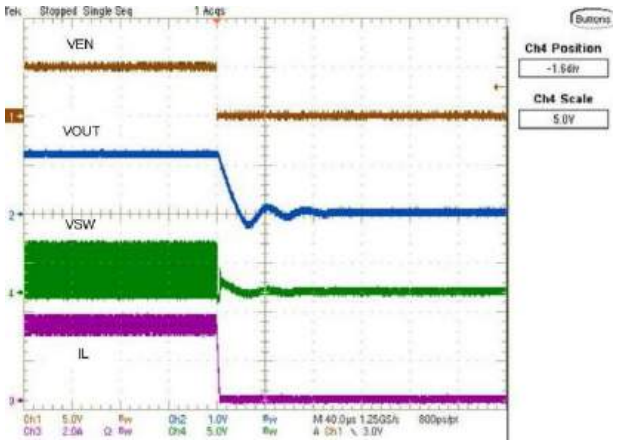


Figure 12. EN OFF with 3A load

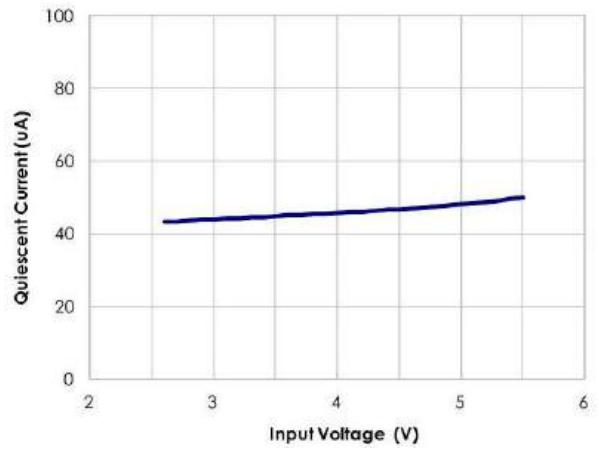


Figure 13. Quiescent Current vs. Input Voltage

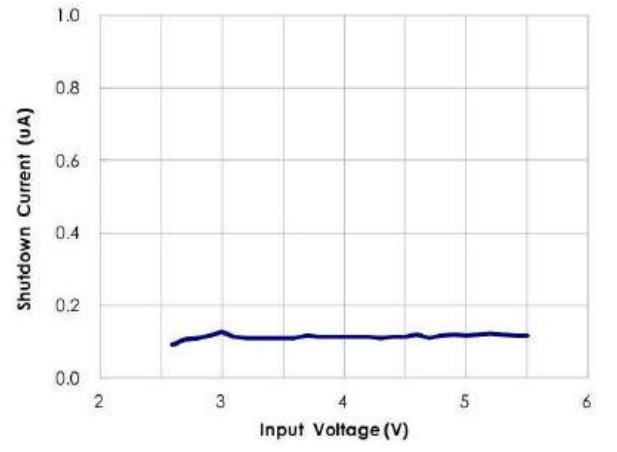


Figure 14. Shutdown Current vs. Input Voltage

Application Information

Inductor Selection

Inductor ripple current and core saturation current are the two main factors that decide the Inductor value. A low DCR inductor is preferred.

C_{IN} and C_{OUT} Selection

A low ESR input capacitor can prevent large voltage transients at V_{IN}. The RMS current of input capacitor is required larger than I_{RMS} calculated by:

$$I_{RMS} \cong I_{OMAX} \frac{\sqrt{V_{OUT}(V_{IN} - V_{OUT})}}{V_{IN}}$$

ESR is an important parameter to select C_{OUT}, which can be seen in the following output ripple V_{OUT} equation:

$$\Delta V_{OUT} \cong \Delta I_L \left(ESR + \frac{1}{8 f C_{OUT}} \right)$$

Cheaper and smaller ceramic capacitors with higher capacitance values are now commercially available. These ceramic capacitors have low ripple currents, high voltage ratings and low ESR which make them suitable for switching regulator applications. It is feasible to optimize very low output ripples by C_{OUT} since Cout does not affect the internal control loop stability. X5R or X7R types are recommended since they have the best temperature and voltage characteristics of all ceramics capacitors.

Output Voltage (VPE2506 adjustable)

In the adjustable version, the output voltage can be determined by:

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

Some recommended value for common output voltage is listed below Table.1 :

Table.1- Recommended Component Selection

V_{OUT}(V)	R_1(KΩ)	R_2(KΩ)	C_{OUT}(μF)	C_{FF}(pF)	L(μH)
1.2	100	100	22*2	22	1.5
1.8	200	100	22	10	2.2
3.3	450	100	22	5	2.2

Thermal Considerations

Although the thermal shutdown circuit is designed in VPE2506 to protect the device from thermal damage, the total power dissipation that VPE2506 can sustain depends on the thermal capability of the package. The formula to ensure the safe operation is shown in note 1 on page 5. To avoid the VPE2506 from exceeding the maximum junction temperature, the user should perform some thermal analysis during PCB design.

PCB Layout Guidelines

To ensure proper operation of the VPE2506, please note the following PCB layout guidelines:

1. The GND, SW and the VIN trace should be kept short, direct and wide.
2. VFB pin must be connected directly to the feedback resistors. Resistive divider R_2/R_1 must be connected parallel to the output capacitor C_{OUT}.
3. The Input capacitor C_{IN} must be connected to the pin VIN as close as possible.
4. Keep SW node away from the sensitive VFB node since this node has high frequency and voltage swing.
5. Keep the (-) plates of C_{IN} and C_{OUT} as close as possible.

Applications

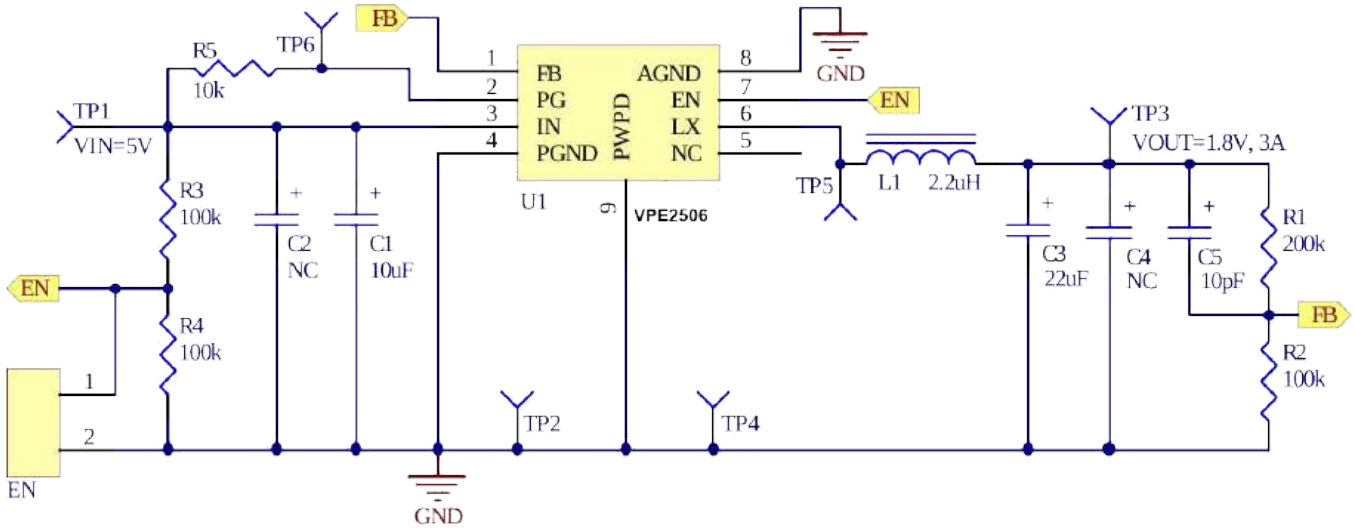


Figure 15. Typical Schematic for PCB layout

PCB Layout

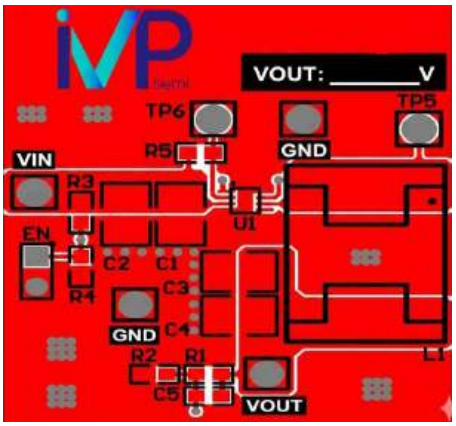


Figure 16. Top Layer

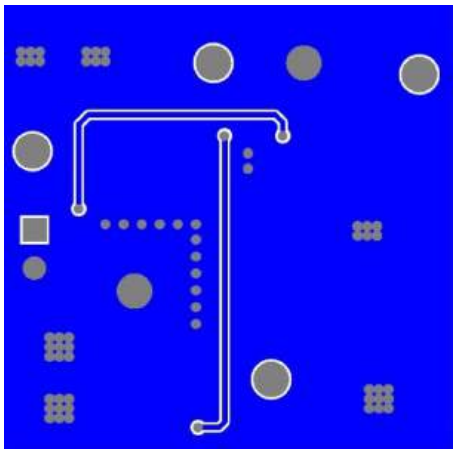
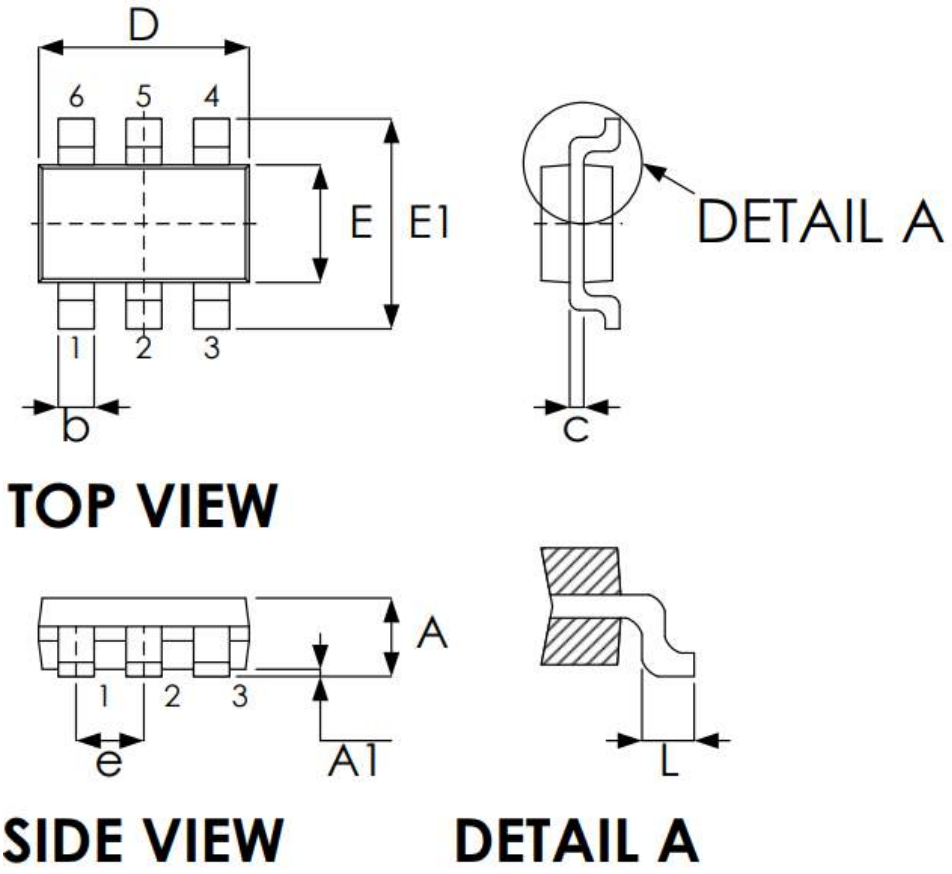


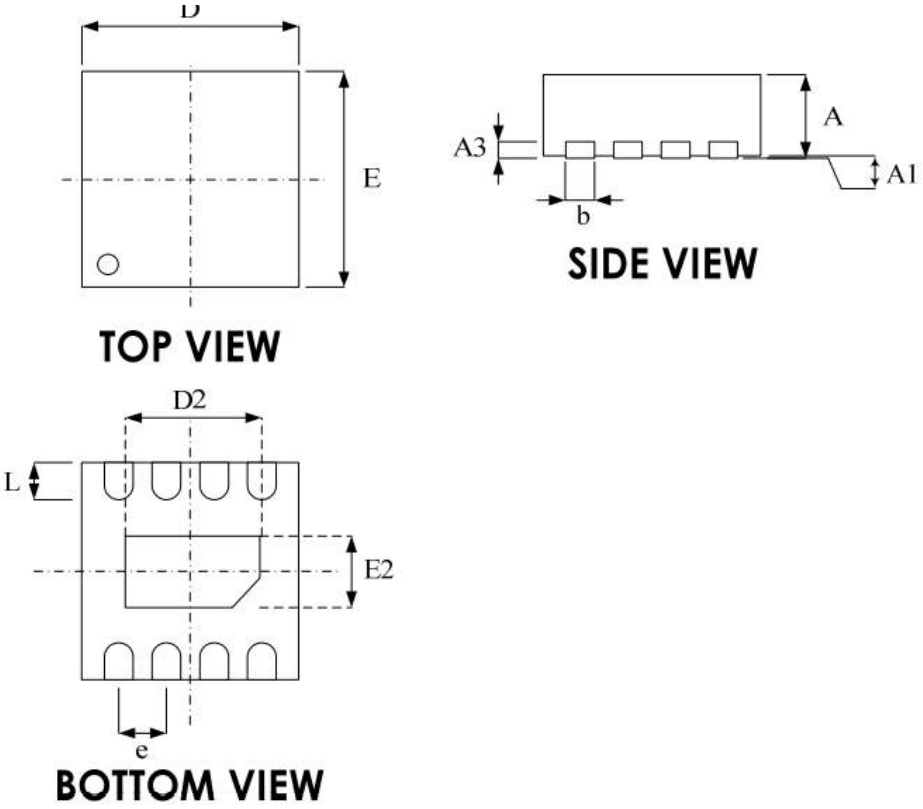
Figure 17. Bottom Layer

Package Outline Drawing (SOT-23-6L)



Symbol	Dimension in mm	
	Min.	Max.
A	0.90	1.45
A1	0.00	0.15
b	0.30	0.50
c	0.08	0.25
D	2.70	3.10
E	1.40	1.80
E1	2.60	3.00
e	0.95 BSC	
L	0.30	0.60

Package Outline Drawing (TDFN-8L (2*2 mm))



Symbol	Dimension in mm	
	Min.	Max.
A	0.70	0.80
A1	0.00	0.05
A3	0.18	0.25
b	0.18	0.30
D	1.90	2.10
E	1.90	2.10
e	0.50 BSC	
L	0.20	0.45
Exposed Pad		
D2	1.15	1.65
E2	0.65	0.95

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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