600KHz 36V/1.2A Synchronous Step-down Converter

General Description

The LP6498A is a synchronous step-down regulator from a high voltage input supply.

Operating with an input voltage range from 4.5V to 30V.1.2A continuous output current .The converter integrates a main switch and a synchronous rectifier for high efficiency without an external Schottky diode. LP6498A Requires a minimum number of readily available standard external components.over current protection and thermal shutdown . output short circuit protection.

The LP6498A converters are available in the industry standard SOT23-6 packages.

Features

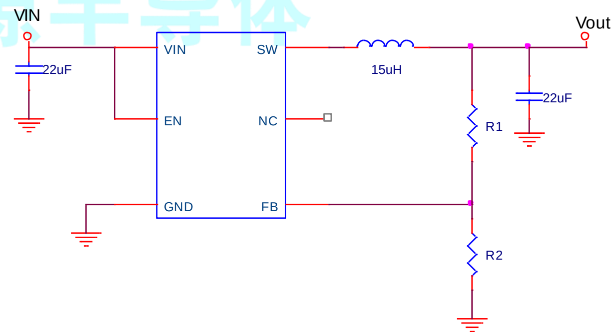
- Input Voltage Range: 4.5V to 30V
- Output Voltage Range: 0.8V to 12V
- 1200mA Load Current
- Up to 93% Efficiency
- 600KHz Switching Frequency
- Short Circuit Protection
- Thermal Fault Protection
- SOT23-6 Package
- RoHS Compliant and 100% Lead (Pb)-Free

Order Information

LP6498A □ □ □

- F: Pb-Free
- Package Type
  B6:SOT23-6

Typical Application Circuit



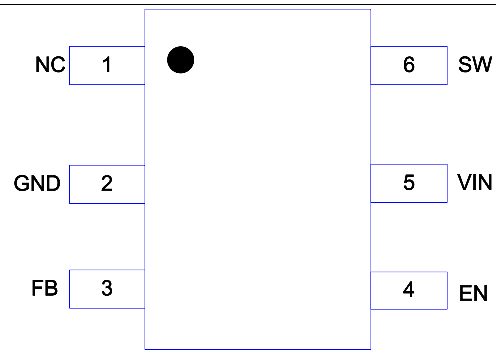
Applications

- ✧ Car Charger / Adaptor
- ✧ Pre-Regulator for Linear Regulators
- ✧ Distributed Power Systems
- ✧ USB Dedicated Charging Ports (DCP)

Marking Information

Device	Marking	Package	Shipping
LP6498AB6F	LP6498A YWXXX	SOT23-6	3K/REEL
Marking indication: Y: Year code. W: Week code. X: Batch numbers.			

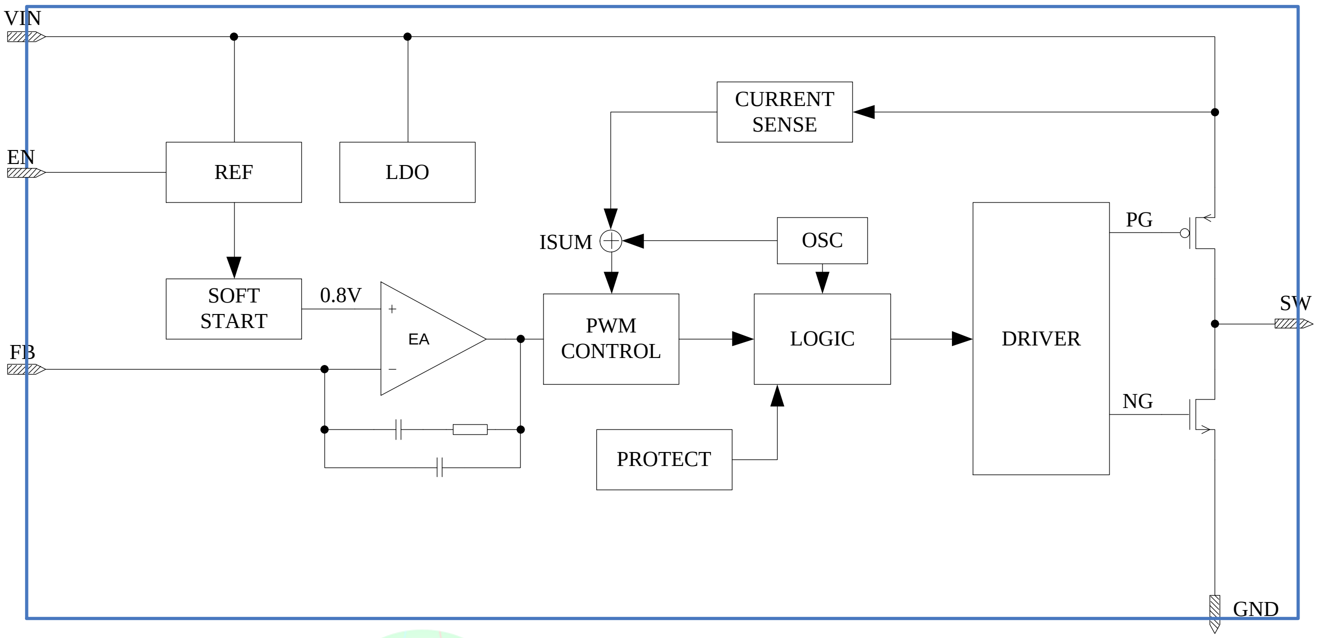
Functional Pin Description

Package Type	SOT23-6(Top View)
Pin Configurations	

Pin Description

PIN	Name	Description
1	NC	No connection.
2	GND	Ground.
3	FB	Feedback Input. $\mathrm{Vout} = \left(\frac{R1}{R2}+1\right)\times V_{FB}$
4	EN	Enable Pin(active high).
5	VIN	Voltage supply.
6	SW	Switch Mode Connection to Inductor. This pin connects to the drains of the internal main and synchronous power MOSFET switches.

Function Diagram



Absolute Maximum Ratings Note 1

- ✧ VIN\SW \EN to GND --- -0.3V to 36V
- ✧ FB to GND -- -0.3V to 6.5V
- ✧ Maximum Junction Temperature -- 150°C
- ✧ Storage Temperature -- -60℃ to 125℃
- ✧ Maximum Soldering Temperature (at leads, 10 sec) -- 260°C

Note 1. Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Information

- ✧ Maximum Power Dissipation (SOT23-6, P_D, T_A=25℃) -- 0.6W
- ✧ Thermal Resistance (SOT23-6, $θ_{JA}$) -- 200℃/W

ESD Susceptibility

- ✧ HBM(Human Body Mode) --- 2KV
- ✧ MM(Machine Mode) --- 200V

Recommended Operating Conditions

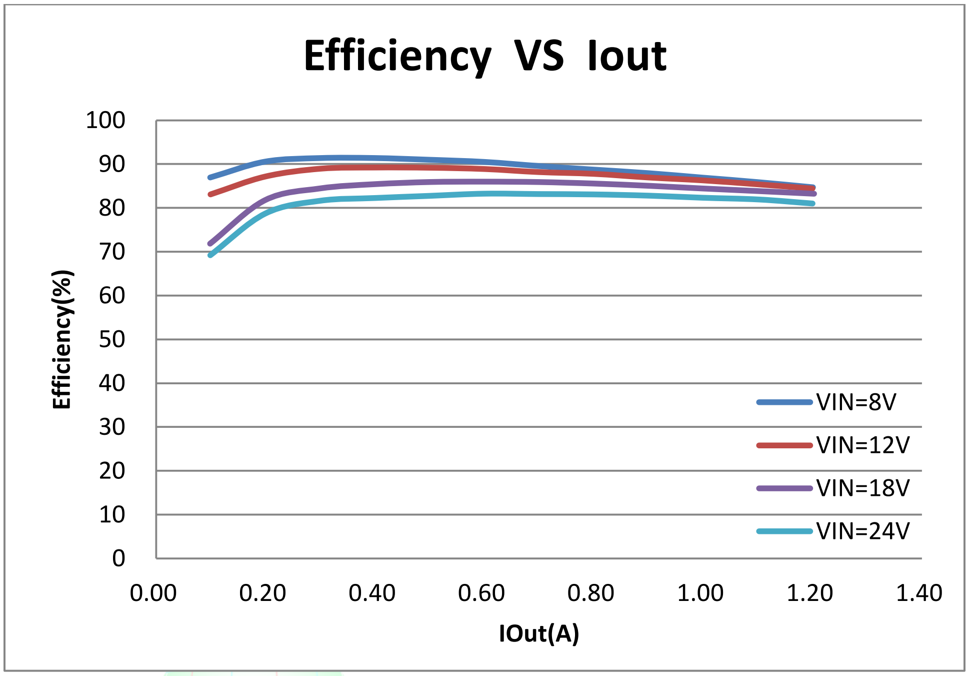
- ✧ Ambient Temperature Range -- -20℃ to 85℃

Electrical Characteristics

V_{IN}=12V, V_{EN}=5V, T_A=25℃, unless otherwise noted

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{IN}	Input Voltage		4.5		30	V
V_{FB}	Feedback Threshold Voltage Accuracy		0.784	0.8	0.816	V
I_Q	Quiescent Current	Iload=0mA		8		mA
V_{UVLO}	V_{IN} Under Voltage Lockout Threshold	V_{IN} Rising	3.5	4	4.5	V
$V_{UVLO-HYS}$	UVLO Hysteresis			0.5		V
I_{LIM}	P-Channel Current Limit	T_J=25℃		2.4		A
		T_J=150℃		1.6		
$R_{DS(ON)\_H}$	High-Side Switch On Resistance			240		mΩ
$R_{DS(ON)\_L}$	Low-Side Switch On Resistance			130		mΩ
T_{HICCUP}	Hiccup Time			6		mS
T_{SS}	Soft-start Time			0.8		mS
f_{OSC}	Oscillator Frequency		480	600	720	KHz
$V_{EN(L)}$	Enable Threshold Low		0		1	V
$V_{EN(H)}$	Enable Threshold High		2.1		V_{IN}	V
t_{SD}	Over-Temperature Shutdown Threshold			150		℃
T_{HYS}	Over-Temperature Shutdown Hysteresis			20		℃

Typical Operating Characteristics



Operation Information

Functional Description

The LP6498A is a switch-mode step-down DC-DC converter. The device operates at a fixed 600KHz switching frequency, and uses a slope compensated current mode architecture. This step-down DC-DC converter can supply up to 1.2A output current at input voltage range from 4.5V to 30V. It minimizes external component size and optimizes efficiency at the heavy load range. The integrated slope compensation allows the device to remain stable over a wider range of inductor values so that smaller values (6.8μH to 22μH) with lower DCR can be used to achieve higher efficiency.

Setting the Output Voltage

The LP6498A can be externally programmed. Feedback resistors R1 and R2 program the output to regulate at a voltage higher than 0.8V. Although a larger value will further reduce quiescent current, it will also increase the impedance of the feedback node, making it more sensitive to external noise and interference. The external resistor sets the output voltage according to the following equation:

$$\mathbf{V_{OUT}} = \mathbf{0.8V} \times (\mathbf{1} + \frac{\mathbf{R_1}}{\mathbf{R_2}})$$

$$\mathbf{R_1} = (\frac{\mathbf{V_{OUT}}}{\mathbf{0.8V}} - \mathbf{1}) \times \mathbf{R_2}$$

Enable Function

The enable pin is active high. When pulled low, the enable input (EN) forces the LP6498A into a low-power, non-switching state.

Current Limit and Over-Temperature Protection

For overload conditions, the peak input current is limited to 2.4A to minimize power dissipation and stresses under current limit and short-circuit conditions, switching is terminated after entering current limit condition. The termination lasts for seven consecutive clock cycles after a current limit has been sensed during a series of four consecutive periods of oscillations. Thermal protection completely disables switching when internal dissipation becomes excessive. The junction over-temperature threshold is 150℃ with 20℃ of hysteresis. Once an over-temperature or over-current fault conditions is removed, the output voltage automatically recovers.

Thermal Calculations

There are three types of losses associated with the LP6498A step-down converter: switching losses, conduction losses, and quiescent current losses. Conduction losses are associated with the $R_{DS(ON)}$ characteristics of the power output switching devices. Switching losses are dominated by the gate charge of the power output switching devices.

At full load, assuming continuous conduction mode (CCM), a simplified form of the losses is given by:

$$P_{TOTAL} = \frac{{I_{OUT}}^2\left(R_{DSON(HS)} \times V_{OUT} + R_{DSON(LS)} \times (V_{IN} - V_{UTO})\right)}{V_{IN}} + (t_{SW} \times f \times I_{OUT} + I_Q) \times V_{IN}$$

I_Q is the step-down converter quiescent current. The term t_{sw} is used to estimate the full load step-down converter switching losses.

For the condition where the step-down converter is in dropout at 95% duty cycle, the total device dissipation reduces to:

$$P_{TOTAL} = I_{OUT}^{2} \times R_{DSON(HS)} + I_{Q} \times V_{IN}$$

Since $R_{DS(ON)}$, quiescent current, and switching losses all vary with input voltage, the total losses should be investigated over the complete input voltage range. Given the total losses, the maximum junction temperature can be derived from the θ_{JA} for the SOT23-6 package which is 250℃/W.

$$T_{J(MAX)} = P_{TOTAL} \times \theta_{JA} + T_{AMB}$$

Output Capacitor Selection

The function of output capacitance is to store energy to attempt to maintain a constant voltage. The energy is stored in the capacitor's electric field due to the voltage applied. The value of output capacitance is generally selected to limit output voltage ripple to the level required by the specification. Since the ripple current in the output inductor is usually determined by L, V_{OUT} and V_{IN}, the series impedance of the capacitor primarily determines the out-put voltage ripple. The three elements of the capacitor that contribute to its impedance (and output voltage ripple) are equivalent series resistance (ESR), equivalent series inductance (ESL), and capacitance (C). The output voltage droop due to a load transient is dominated by the capacitance of the ceramic output capacitor. During a step increase in load current, the ceramic output capacitor alone supplies the load current until the loop responds. Within three switching cycles, the loop responds and the inductor current increases to match the load current demand. The relationship of the output voltage droop during the three switching cycles to the output capacitance can be estimated by:

$$C_{OUT} = \frac{3 \times \Delta I_{LOAD}}{V_{DROP} \times f_{S}}$$

In many practical designs, to get the required ESR, a capacitor with much more capacitance than is needed must be selected. For continuous or discontinuous inductor current mode operation, the ESR of the C_{OUT} needed to limit the ripple to ΔV_{OUT}, V peak-to-peak is:

$$ESR \le \frac{\Delta V_{OUT}}{\Delta I_{L}}$$

Ripple current flowing through a capacitor's ESR causes power dissipation in the capacitor. This power dissipation causes a temperature increase internal to the capacitor. Excessive temperature can seriously shorten the expected life of a capacitor. Capacitors have ripple current ratings that are dependent on ambient temperature and should not be exceeded. The output capacitor ripple cur-rent is the inductor current, I_L, minus the output current, I_{OUT}.

Inductor Selection

For most designs, the LP6498A operates with inductor values of 10μH to 22μH. 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 lower ripple current and small value inductors result in high ripple currents. Choose inductor ripple current approximately60% of the maximum load current 2A, or

ΔI_L=1200mA.

Manufacturer's specifications list both the inductor DC current rating, which is a thermal limitation, and the peak current rating, which is determined by the saturation characteristics. The inductor should not show any appreciable saturation under normal load conditions. Some inductors may meet the peak and average current ratings yet result in excessive losses due to a high DCR.

Always consider the losses associated with the DCR and its effect on the total converter efficiency when selecting an inductor. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 20mΩ to 100mΩ range. For higher efficiency at heavy loads (above 200mA), or minimal load regulation (but some transient overshoot), the resistance should be kept below 100mΩ. The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation (2A + 600mA).

Layout Guidance

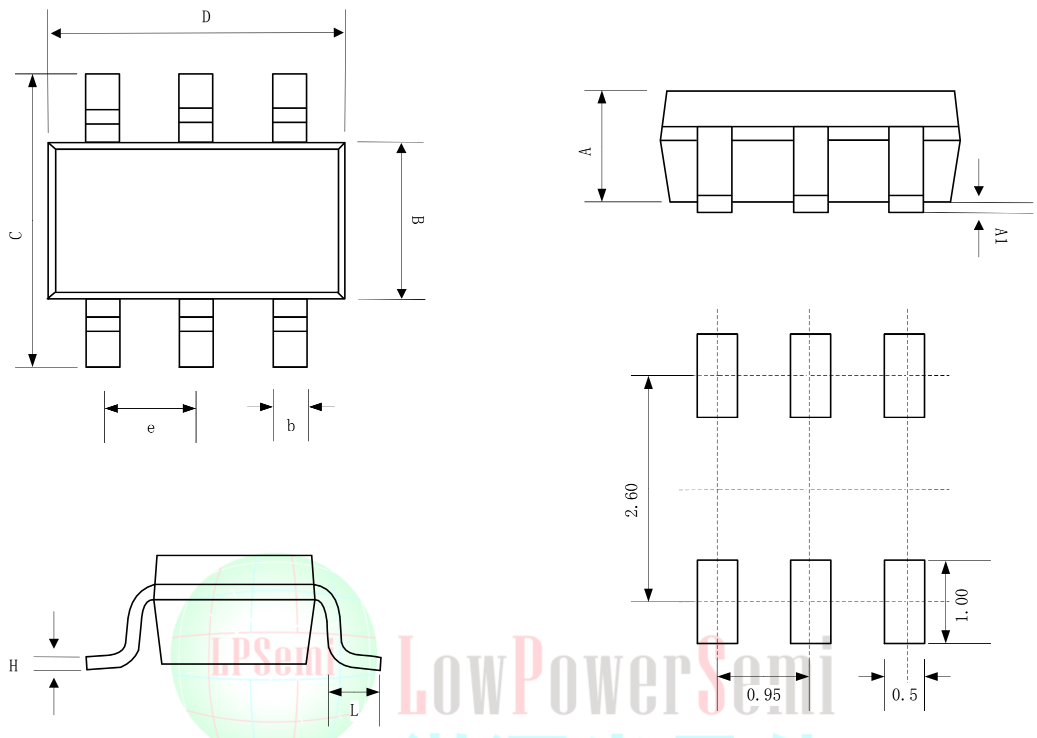
When laying out the PCB board, the following layout guideline should be followed to ensure proper operation of the LP6498A:

1. The power traces, including the GND trace, the SW trace and the IN trace should be kept short, direct and wide to allow large current flow. The L connection to the SW pins should be as short as possible. Use several VIN pads when routing between layers.

2. The input capacitor (C_{IN}) should connect as closely as possible to VIN and GND to get good power filtering.

Packaging Information

SOT23-6



Recommended Land Pattern

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.889	1.100	1.295
A1	0.000	0.050	0.152
B	1.397	1.600	1.803
b	0.28	0.35	0.559
C	2.591	2.800	3.000
D	2.692	2.920	3.120
e	0.95BSC		
H	0.080	0.152	0.254
L	0.300	0.450	0.610