1.1 MHz, 3A Synchronous Step-Down Converter

FEATURES

- High Efficiency: Up to 96%
- 1.1MHz Constant Frequency Operation
- 3A Output Current
- No Schottky Diode Required
- 2.5V to 6.0V Input Voltage Range
- Output Voltage as Low as 0.6V
- PFM Mode for High Efficiency in Light Load
- 100% Duty Cycle in Dropout Operation
- Low Quiescent Current: 40μA
- Short Circuit Protection
- Thermal Fault Protection
- Inrush Current Limit and Soft Start
- DFN 3X3-10 package

APPLICATIONS

- Cellular and Smart Phones
- Microprocessors and DSP Core Supplies
- Wireless and DSL Modems
- PDA
- MP3 Player
- Digital Still and Video Cameras
- Portable Instruments

GENERAL DESCRIPTION

The HX3432 are high-efficiency, high frequency synchronous step-down DC-DC regulator ICs capable of delivering up to 3A output currents. The HX3432 can operate over a wide input voltage range from 2.5V to 6.0V and integrate main switch and synchronous switch with very low RDS(ON) to minimize the conduction loss.

It is ideal for powering portable equipment that runs from a single cell Lithium-Ion (Li+) battery. The output voltage can be regulated as low as 0.6V. The HX3432 can also run at 100% duty cycle for low dropout operation, extending battery life in portable system. This device offers two operation modes, PWM control and PFM Mode switching control, which allows a high efficiency over the wider range of the load.

The HX3432 is offered in a low profile 10-pin, thin DFN3X3 package, and is available in an adjustable version.

TYPICAL APPLICATION

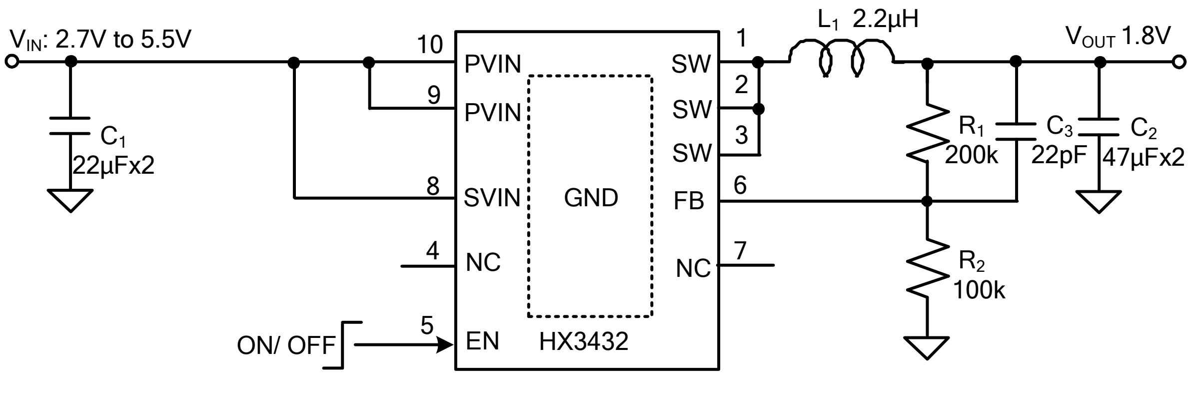
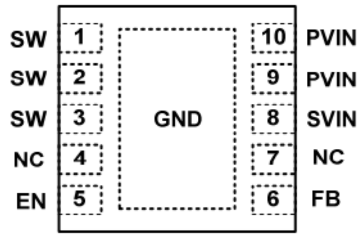
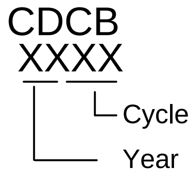


Figure 1: Typical application circuit diagram (V_{OUT}=1.8V)

Package/Order Information



Part Number	Top Mark	Temp Range
HX3432	CDCB XXXX	-40°C to +85°C



Pin Description

Pin Name	Pin Number	Pin Description
EN	5	Enable control. Pull high to turn on.
GND	11	Ground pin.
SW	1,2,3	Phase node pin. Connect this pin to the inductor.
SVIN	8	Signal power input Supply Voltage.
PVIN	9,10	Power input pin. Decouple this pin to GND pin with at least 22µF ceramic cap.
FB	6	Output feedback pin. Connect this pin to the center point of the output resistor divider (as shown in Figure 1) to program the output voltage: $V_{OUT}=0.6\times(1+R_1/R_2)$.
NC	4,7	Not Connected

Functional Block Diagram

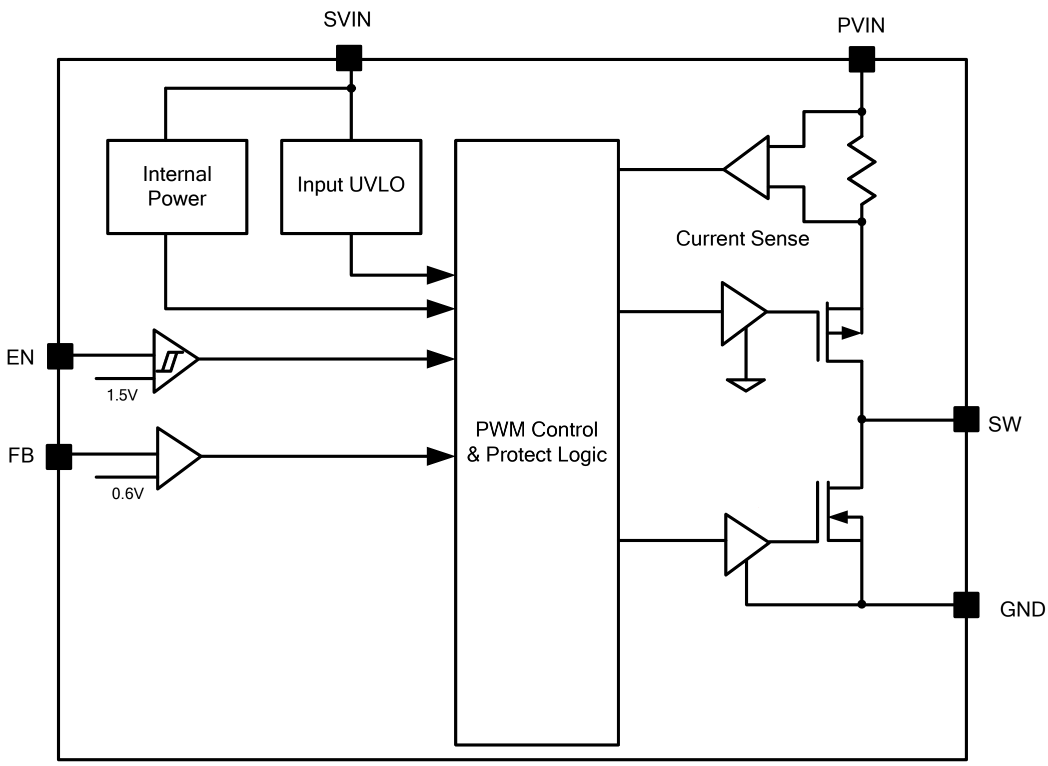


Figure 2. HX3432 Block Diagram

Absolute Maximum Rating (Note 1)

Input Supply Voltage…………..….-0.3V to +7.5V
EN, V_{FB} Voltages.................... -0.3V to V_{IN}+0.3V
SW, Vout Voltages................. -0.3V to V_{IN}+0.3V
Peak SW Sink and Source Current...........3.5A

Operating Temperature Range -40°C to +85°C
Junction Temperature (Note 2)................. +125°C
Storage Temperature Range. -65°C to +150°C
Lead Temperature (Soldering, 10S)..... +300°C

Electrical Characteristics (Note 3)

(V_{IN}=V_{RUN}=3.6V, V_{OUT}=1.8V, T_A = 25°C, unless otherwise noted.)

Parameter	Conditions	MIN	TYP	MAX	unit
Input Voltage Range		2.5		6.0	V
UVLO Threshold			2.4		V
OVP Threshold			6.0		V
Input DC Supply Current					μA
PWM Mode	Vout = 90%, Iload=0mA		150	300	μA
PFM Mode	Vout = 105%, Iload=0mA		40	70	μA
Shutdown Mode	V_{EN} = 0V, V_{IN}=4.2V		0.1	1.0	μA
Regulated Feedback Voltage	T_A = 25°C	0.588	0.600	0.612	V
	T_A = 0°C ≤ T_A ≤ 85°C	0.586	0.600	0.613	V
	T_A = -40°C ≤ T_A ≤ 85°C	0.585	0.600	0.615	V
Reference Voltage Line Regulation	Vin=2.5V to 5.5V		0.04	0.40	%/V
Output Voltage Line Regulation	V_{IN} = 2.5V to 5.5V		0.04	0.4	%
Output Voltage Load Regulation			0.5		%
Oscillation Frequency			1.1		MHz
On Resistance of PMOS	I_{SW}=100mA		0.08		Ω
ON Resistance of NMOS	I_{SW}=-100mA		0.06		Ω
Peak Current Limit	V_{IN}= 3V, Vout=90%	3			A
EN Threshold		1.5			V
EN Leakage Current			±0.01	±1.0	μA
SW Leakage Current	V_{EN}=0V,V_{IN}=Vsw=5V		±0.01	±1.0	μA
Thermal Shutdown			160		℃

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

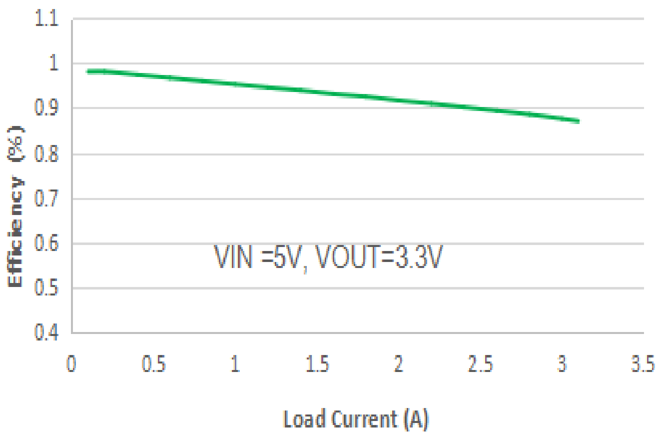
Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula:

$T_J = T_A + (P_D) \times (250°C/W)$.

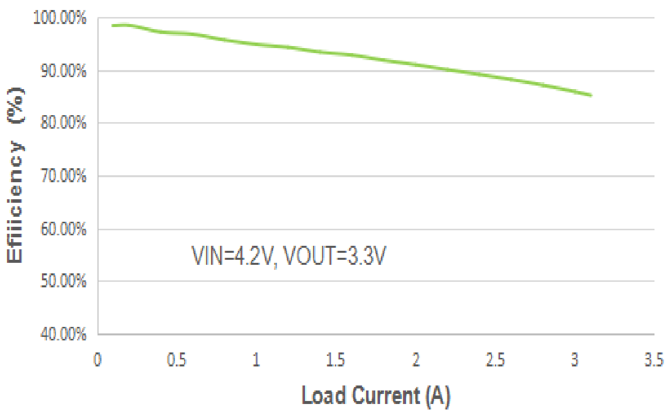
Note3: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

Typical Performance Characteristics

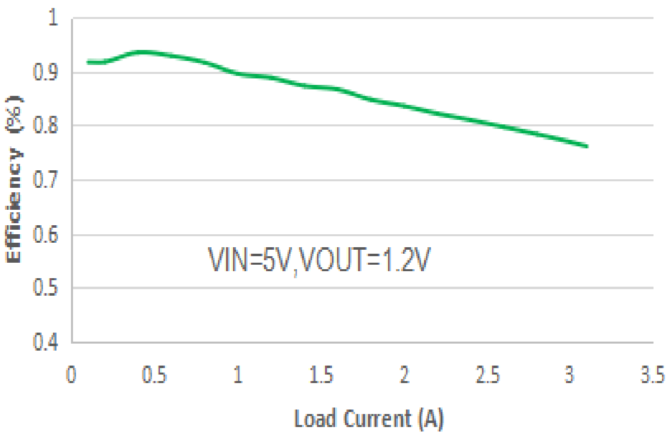
Efficiency vs. Load Current



Efficiency vs. Load Current



Efficiency vs. Load Current



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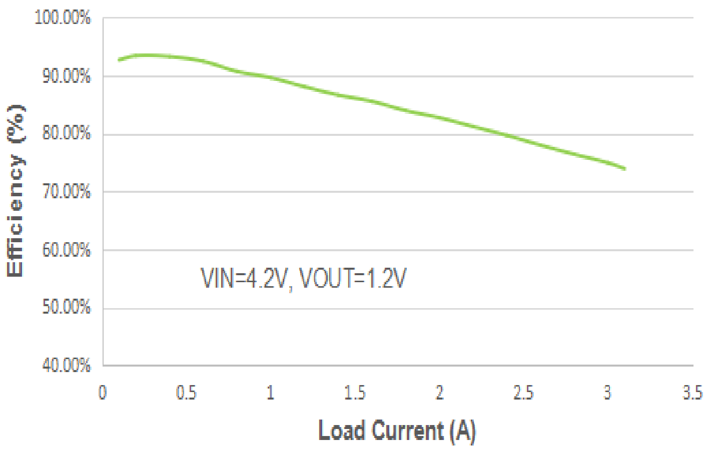
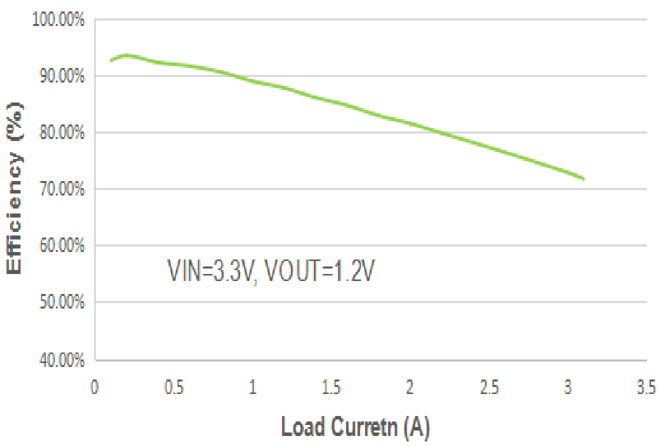


Efficiency vs. Load Current



FUNCTIONAL DESCRIPTION

HX3432 is a synchronous buck regulator IC that integrates the PWM/PFM control, top and bottom switches on the same die to minimize the switching transition loss and conduction loss. With ultra-low RDS(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 HX3432 requires only three external power components (Cin, Cout and L). The adjustable version can be programmed with external feedback to any voltage, ranging from 0.6V to the input voltage. At dropout, the converter duty cycle increases to 100% and the output voltage tracks the input voltage minus the Rdson 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

Figure 1 above shows the basic application circuit with HX3432 adj ustable output version. The external resistor sets the output voltage according to the following equation:

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

Table 1 Resistor select for output voltage setting

V_{OUT}	R2	R1
1.2V	100k	100k
1.5V	100k	150k
1.8V	100k	200k
2.5V	100k	316k
3.3V	100k	453k

Note: R2 Resistor must be lower than 100K.

APPLICATIONS INFORMATION

Setting the Output Voltage

The external resistor divider is used to set the output voltage (see Typical Application on page 1). The feedback resistor R1 also sets the feedback loop bandwidth with the internal compensation capacitor. Choose R1 to be around 100kΩ for optimal transient response. R2 is then given by:

$$R_2 = \frac{R_1}{V_{out} / V_{FB} - 1}$$

Inductor Selection

For most designs, the HX3432 operates with inductors of 1μH to 4.7μH. 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 150mΩ range.

Input Capacitor Selection

With the maximum load current at 3A, the maximum ripple current through input capacitor is about 0.6Arms. A typical X7R or better grade ceramic capacitor with 6V rating and greater than 22uF capacitance can handle this ripple current well. To minimize the potential noise problem, place this ceramic capacitor really close to the IN and GND pins. Care should be taken to minimize the loop area formed by CIN, and IN/GND pins.

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 V_{OUT} is determined by:

$$\Delta V_{OUT} \le \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left(ESR + \frac{1}{8 \times f_{osc} \times C3} \right)$$

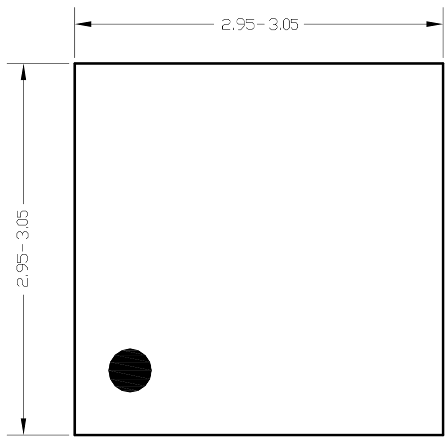
A 10μF ceramic can satisfy most applications.

PC Board Layout Checklist

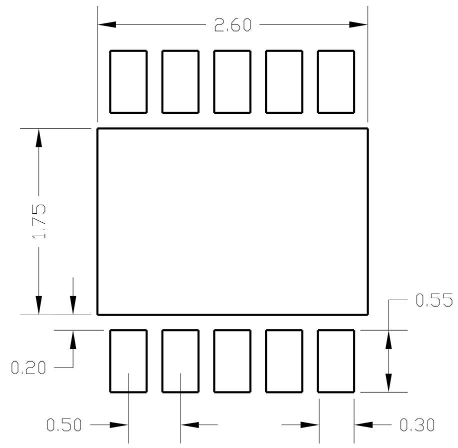
When laying out the printed circuit board, the following checking should be used to ensure proper operation of the HX3432. Check the following in your layout:

1. The power traces, consisting of the GND trace, the SW trace and the VIN trace should be kept short, direct and wide.
2. Does the (+) plates of Cin connect to VIN as closely as possible? This capacitor provides the AC current to the internal power MOSFETs.
3. Keep the switching node, SW, away from the sensitive VOUT node.
4. Keep the (-) plates of Cin and Cout as close as possible.

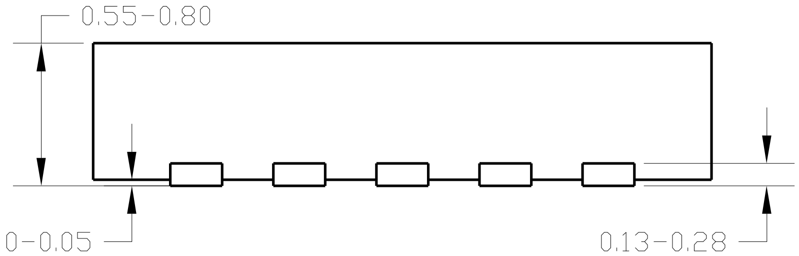
DFN3x3-10 Package outline



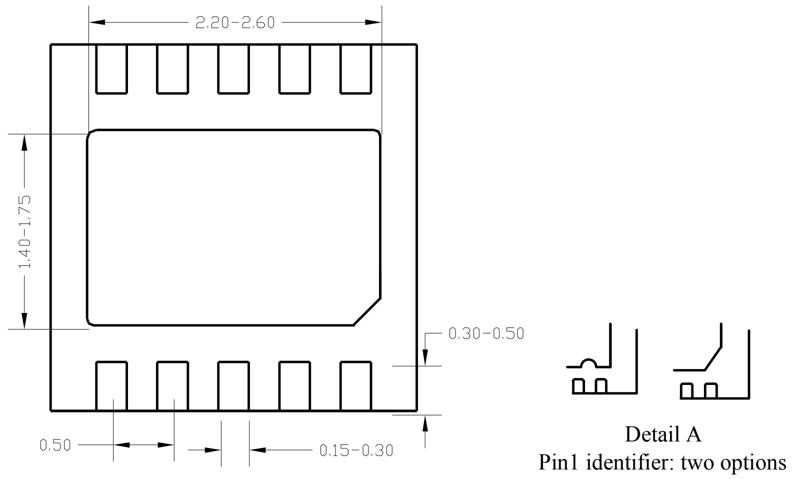
Top View



PCB layout (recommended)



Side View



Bottom View

Notes: All dimensions are in millimeters and exclude mold flash & metal burr.