High Efficiency 1MHz, 1.5A Boost Regulator

YB1421 Series

■ INTRODUCTION:

The YB1421 is designed for single-cell or dual-cell or triangle-cell alkaline, NiMH, or NiCd or single-cell lithium-ion battery powered application. It is a high efficiency boost converter with 600mV feedback voltage. switching frequency of 1.0MHz minimizes solution footprint by allowing the use of tiny low profile inductors and ceramic capacitors. The current mode PWM design is internally compensated, and the device has a 0.9V start-up voltage with operation down to 0.65V. The YB1421 is rated over the -40°C to +85°C temperature range.

■ FEATURES:

- V_{IN} Operation Range: 0.65V to 6.0V
- 600mV Feedback Voltage
- Output Current 1.4A@VIN≧3.0V
- Up to 90% Efficiency
- Low Start-Up Voltage: 0.9V@Io=1mA
- Low Hold Voltage: 0.75V@Io=1mA
- 1.0MHz Fixed Switching Frequency
- PWM/PFM Auto Switching Maintains High Efficiency
- Over-Thermal and Over-Current Protection
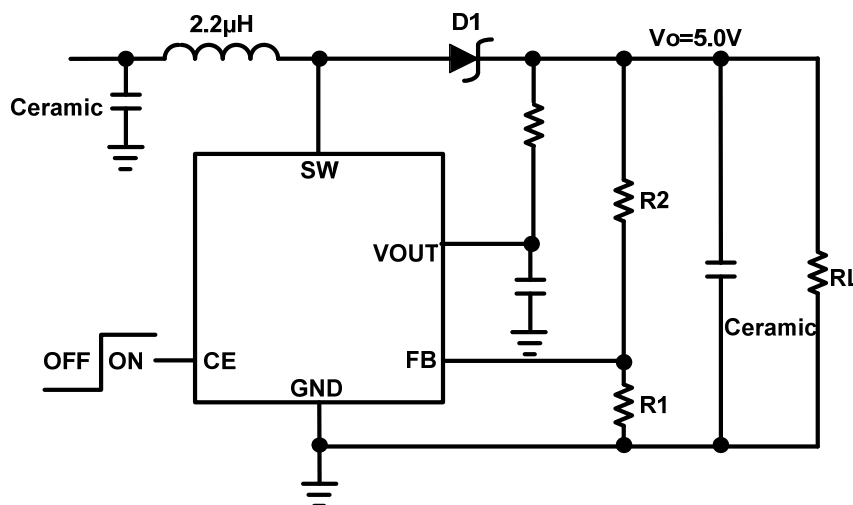- Low Shutdown Current: <1.0μA
- -40°C to +85°C Temperature Range

■ APPLICATIONS：

- Solar Battery Charger
- White LED Torch
- Backup Battery Charger
- Boost Application
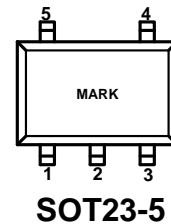
SOT23-5

■ TYPICAL APPLICATION CIRCUITS

PIN NUMBER	PIN NAME	FUNCTION
SOT23-5		
1	SW	Switch Pin. Connect inductor between SW and VIN
2	GND	Signal and Power Ground
3	FB	Feedback Input
4	CE	Chip Enable. High Active
5	VOUT	Chip Supply Voltage

■ **BLOCK DIAGRAM**
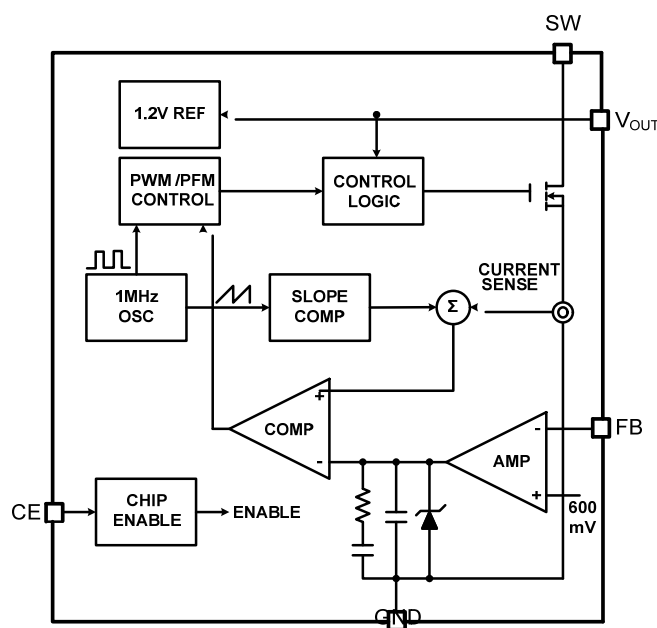
■ **ABSOLUTE MAXIMUM RATINGS**

(Unless otherwise specified, Ta=25°C)

PARAMETER		SYMBOL	RATINGS	UNITS
Voltage Output		V_{OUT}	$V_{SS}-0.3 \sim V_{SS}+7$	V
CE,SW,FB,V_{OUT} Voltage			$V_{SS}-0.3 \sim V_{OUT}+0.3$	V
Peak SW Sink and Source Current		I_{SWMAX}	3000	mA
Power Dissipation	SOT-23-5	P_d	300	mW
Operating Temperature		T_{opr}	$-40 \sim +85$	℃
Junction Temperature		T_j	125	℃
Storage Temperature		T_{stg}	$-40 \sim +125$	℃
Soldering Temperature & Time		T_{solder}	260℃, 10s	

ELECTRICAL CHARACTERISTICS

YB1421 (V$_{IN}$= 3.6V, Ta=25℃, Test Circuit Figure1, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Feedback Voltage	V$_{FB}$		588	600	612	mV
Minimum Start-Up Voltage	V$_{START}$	V$_{IN}$:0V→3V, I$_o$ =1mA		0.9		V
Minimum Hold Voltage	V$_{HOLD}$	V$_{IN}$:3V→0V, I$_o$ =1mA		0.75		V
Minimum Operating Voltage	V$_{IN}$			0.65		V
Quiescent Current	I$_{CC}$	Measured On V$_{OUT}$,V$_{FB}$=750mV, V$_{OUT}$=5.0V		130	300	μA
Max Duty Cycle		V$_{FB}$ = GND	80	87		%
Oscillator Frequency	f$_{osc}$			1.0		MHz
NMOS Current Limit	I$_{PK}$			3.0		A
Switch On Resistance				70		mΩ
NMOS Switch Leakage		V$_{CE}$=0,V$_{SW}$=5.0V		±0.01	±1	μA
CE "High" Voltage[1]	V$_{CE"H"}$		1.0		V$_{IN}$	V
CE "Low" Voltage[2]	V$_{CE"L"}$				0.4	V
CE Leakage Current	I$_{CE}$	V$_{CE}$=5.0V		±0.1	±1	μA
Over Thermal Shutdown				140		℃
Over Thermal Hysteresis				20		℃

NOTE :

1. High Voltage：Forcing CE above 1.0V enables the part.

2. Low Voltage：Forcing CE below 0.4V shuts down the device. In shutdown, all functions are disabled drawing <1μA supply current. Do not leave CE floating.
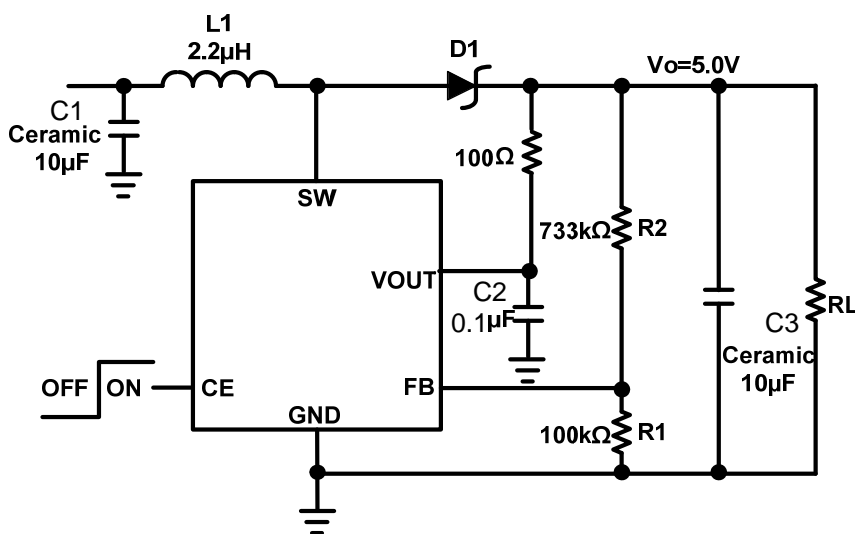
■ **TYPICAL APPLICATION CIRCUITS**

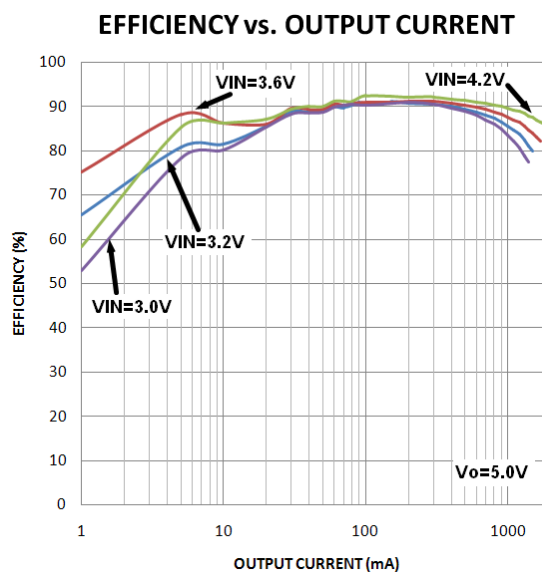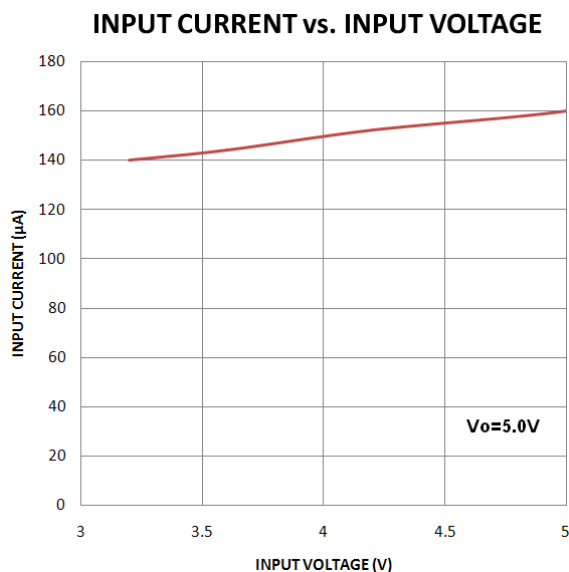**Figure1 Standard Application Circuit**

■ **TYPICAL PERFORMANCE CHARACTERISTICS**
(V_{IN}=3.6,Ta=25℃，Test Figure1 above unless otherwise specified)

INPUT CURRENT vs. INPUT VOLTAGE

EFFICIENCY vs. OUTPUT CURRENT

■ **OPERATION**

The YB1421 boost regulator is targeted for single-cell or dual-cell or triangle-cell alkaline, NiMH, and NiCd and single-cell lithium-ion battery applications. It has a 0.9V typical start-up voltage with operation after start-up to less than 0.65V. It can provide 1.4A output current when input voltage is larger than 3.0V.

The high 1.0MHz switching frequency of the YB1421 facilitates output filter component size reduction for improved power density and reduced overall footprint. It also provides greater bandwidth and improved transient response over other lower frequency step-up converters. With its low R_{DS}(ON) and 600mV feedback Voltage, the devices attain up to 90% efficiency.

SLOPE COMPENSATION

Slope compensation provides stability in constant frequency architecture by preventing sub-harmonic oscillations at high duty cycles. It is accomplished internally by adding a compensating ramp to the inductor current signal

at duty cycles in excess of 50%. This slope compensated current mode PWM control provides stable switching and cycle-by-cycle current limit for excellent load and line response.

CURRENT SENSING

A signal representing NMOS switch current is summed with the slope compensator. The summed signal is compared to the error amplifier output to provide a peak current control command for the PWM. Peak switch current is limited to approximately 3A independent of input or output voltage. The current signal is blanked for 40ns to enhance noise rejection.

PWM/PFM AUTO SWITCHING

The YB1421 offers PWM/PFM automatic switching operation. The PWM operation is shifted to the PFM operation automatically at light load so that it maintains high efficiency over a wide range of load currents.

■ APPLICATION INFORMATION

The basic YB1421 application circuits are shown in Figure 1. External component selection is driven by the load requirement and begins with the selection of L followed by C_{IN} and C_{OUT}.

OUTPUT AND INPUT CAPACITOR SELECTION

Surface mount X5R or X7R ceramic capacitors are suggested for both the output and the input. For the output capacitor (C2 in Figure 1) a 10μF, 10V, X5R ceramic capacitor is necessary for stability, transient response, and ripple performance.

The same 0805 sized capacitor is used for the input (C1 of Figure 1). If desired, a smaller, 0603 sized, 10μF, 6.3V, X5R ceramic capacitor can be substituted for the input capacitor (C1).

INDUCTOR SELECTION

The YB1421 is designed to operate with a 2.2μH inductor for all input/output voltage combinations. The inductor saturation current rating should be greater than the NMOS current limit specification listed in the Electrical Characteristics table. If necessary, the peak inductor current can exceed the saturation level by a small amount with no significant effect on performance.

Different core materials and shapes will change the size/current and price/current relationship of an inductor. The choice of which style inductor to use often depends more on the price vs. size requirements and any radiated field/EMI requirements than on what the YB1421 requires to operate. Table 7 shows some typical surface mount inductors that work well in YB1421 applications.

Table 7.Representative Surface Mount Inductors

PART NUMBER	VALUE (μH)	MAX DCR (mΩ)	MAX DC CURRENT (A)	SIZE W×L×H (mm³)
Sumida CDRH 3D16	2.2 3.3 4.7	75 110 162	1.20 1.10 0.90	3.8×3.8×1.8
Sumida CR43	2.2 3.3 4.7	71.2 86.2 108	1.75 1.44 1.15	4.5×4.0×3.5
Sumida CDRH 4D18	2.2 3.3 4.7	75 110 162	1.32 1.04 0.84	4.7×4.7×2.0

OUTPUT DIODE

Use a schottky diode such as an MBR0520L, PMEG2010EA, 1N5819 or equivalent with rated current over 3A. Do not use ordinary rectifier diodes, since the slow recovery times will compromise efficiency.

PCB LAYOUT GUIDANCE

When laying out the printed circuit board, the following suggestions should be taken to ensure proper operation of the YB1421. These items are also illustrated graphically in Figure 2.

The power traces, including the GND trace, the SW trace and the V_{IN} trace should be kept short, direct and wide to allow large current flow. Put enough multiply-layer pads when they need to change the trace layer. Keep the switching node, SW, away from the sensitive FB node.

1. The FB pin should directly connect to the feedback resistors. The divider LED/R1 must be connected between the (+) plate of C_{OUT} and ground.

2. Connect the (+) plate of C_{IN} to the V_{IN} pin as closely as possible.

3. Keep the (-) plate of C_{IN} and C_{OUT} as close as possible.

■ **PACKAGING INFORMATION**

■ **SOT-23-5L Package Outline Dimensions**
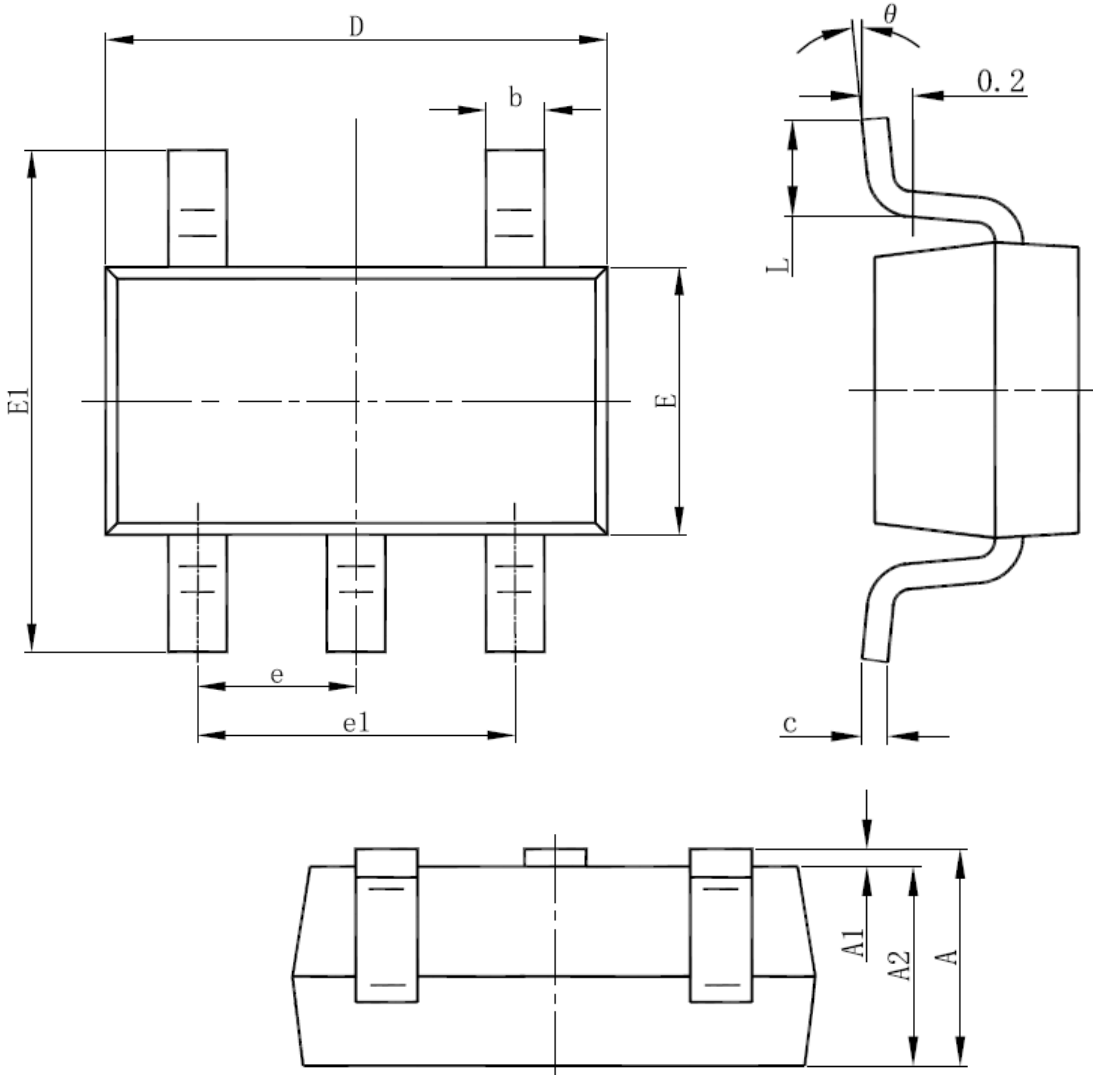
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°