

Description

The YB1521 is a step-up DC-DC converter which operating as current source to drive up 45 white LEDs (3S15P) in parallel / series configuration from a 5V system rail. Series connecting of LEDs provides identical LED currents resulting in uniform brightness and eliminating the need for ballast resistors. The light intensity of these LEDs is proportional to the current passing through them. The YB1521 is a fixed frequency of 1.3MHz, allowing the use of tiny low profile inductors and capacitors to minimize footprint and cost in space consideration applications for cellular phone backlighting or other hand held equipment.

The wide input voltage range from 2.5V to 5.5V is idea for portable applications with higher conversion efficiency. To control LED brightness, the LED current can be pulsed by applying a PWM signal with a frequency which is typically 50 KHz to the EN pin.

Features

- 2.5V to 5.5V Input Voltage Range
- Built In Power MOSFET
- Drive Up to 15V @400mA at 5V Vin
- Less than 1μA Shutdown Current
- Up to 94% efficiency
- Over Voltage Protection@18V
- UVLO, Thermal Shutdown
- Internal 1.6A Current Limit
- 200mv Low Reference Voltage
- Built In Soft Start
- PWM Dimming
- SOT23-5 Package
- Green Package (RoHS) Available

Applications

- Cellular and Smart Phones
- Handheld Computers and PDAs
- Small LCD Displays
- GPS Terminals
- MP3 Players
- Digital Still and Video Cameras
- Electronic Books

Typical Application Circuit

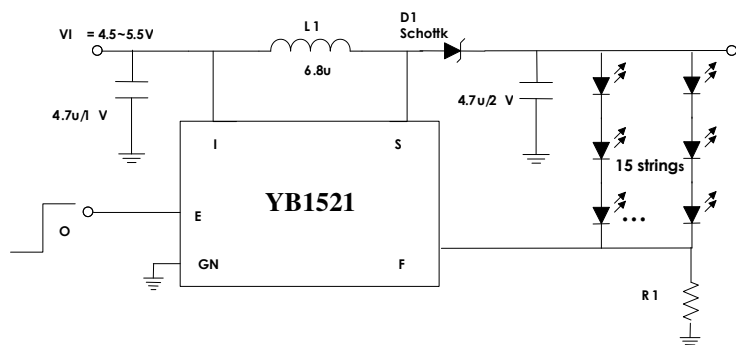


Figure 1: Typical Application Circuit

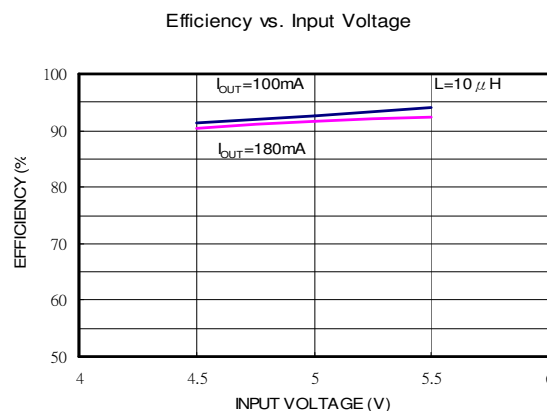


Figure 2: Efficiency

Pin Configuration

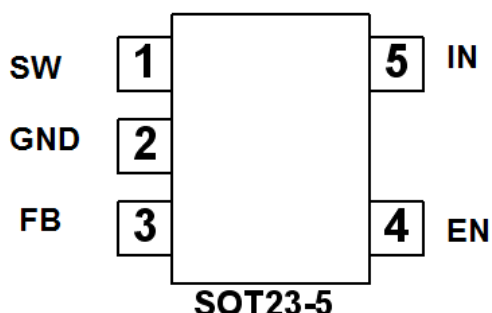


Figure 3: Pin Configuration

Pin Assignment & Description

Table1

Pin	NAME	Description
1	SW	Switching Pin. This is the drain of internal power MOSFET switch. Connect the power inductor and output rectifier to SW.
2	GND	Ground pin. Connect directly to local ground plane.
3	FB	Feedback Pin. Reference voltage is 200mV. Connect LEDs and a resistor at this pin. LED current is determined by the resistance and FB voltage.
4	EN	Shutdown Pin and Dimming Control Pin. PWM duty cycle controls the LED current.
5	IN	Input Supply Pin. Bypass this pin with a capacitor as close to the device as possible.

Ordering Information

Table2

Order Number	Package Type	Supplied As	Package Marking
YB1521ST25	SOT23-5	3000 Units Tape & Reel	Y521

Absolute Maximum Ratings (Note 1)

V_{IN} to GND	-0.3V to 6V
V_{EN} to GND	-0.3V to 6V
V_{SW} to GND.....	-0.3V to 18V
Junction Temperature	150°C
Storage Temperature	-55°C to 150°C
Lead Temperature	300°C
ESD HBM	3KV
ESD MM	250V

Recommended Operating Conditions

(Note 2)

Supply Voltage V_{IN}	2.5V to 5.5V
Operating Temperature	-40°C to 85°C
Output Voltage	0V to 15V

Thermal Information

(Note 3)

θ_{JA}	220°C / W
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Note:

1. Exceeding these ratings may damage the device.
2. The device is not guaranteed to function outside of its operating conditions.
3. θ_{JA} is measured in free air at $T_A = 25^\circ\text{C}$ on a low effective thermal conductivity board.

Electrical Characteristics

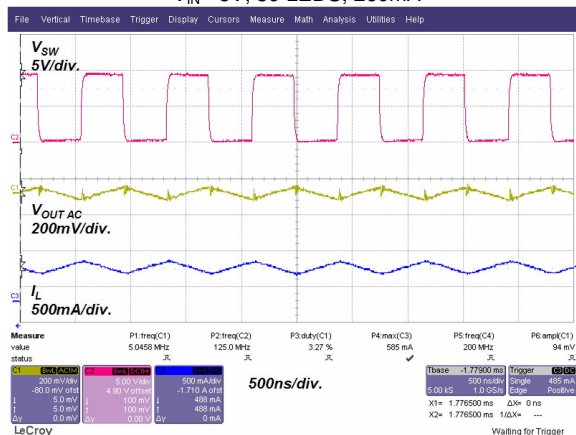
Table4 ($V_{IN}=5V$, $V_{EN}=5V$, $T_A=25^{\circ}C$, unless otherwise noted.)

Parameters	Symbol	Test Conditions	MIN	TYP	MAX	Units
Input Voltage Range	V_{IN}		2.5	5	5.5	V
Quiescent Current	I_Q	$V_{FB}=0.3V$		0.2	0.8	mA
Shutdown Current	I_{SD}	$V_{EN}=0V$, $I_{OUT}=0mA$		0.1	1	μA
Feedback Voltage	V_{FB}	$I_{OUT} = 260mA$, $V_{OUT} = 10.5V$	180	200	220	mV
FB Input Bias Current		$V_{FB} = 0.2V$			0.1	μA
Switch On-Resistance	$R_{DS(on)}$			0.4		Ω
Maximum Duty Cycle	DTMX	$V_{FB} = 0V$	85	92		%
Switching Frequency	F_{SW}		1	1.3	1.6	MHz
EN Threshold	V_{ENH}	V_{EN} Rising, $V_{IN} = 5V$	1	1.5	2	V
EN Threshold	V_{ENL}	V_{EN} Rising, $V_{IN} = 2.5V$	0.8			V
EN Dimming Frequency			20	50		KHz
Switch Current Limit	I_{ILM}		1	1.6		A
Under Voltage Lock Out	UVLO	V_{IN} Rising		2.25	2.45	V
UVLO Hysteresis				100		mV
Over Voltage Protection	OVP		16	18	22	V
Thermal Shutdown	T_{SD}	The Hysteresis = $20^{\circ}C$		160		$^{\circ}C$

Typical Performance Characteristics

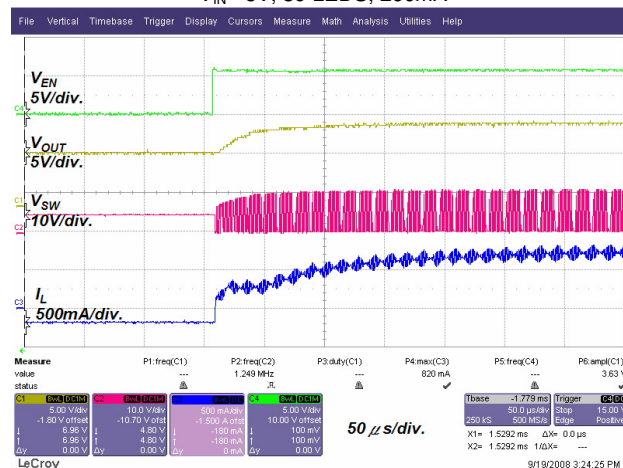
Steady State Operation

$V_{IN} = 5V$, 39 LEDS, 260mA



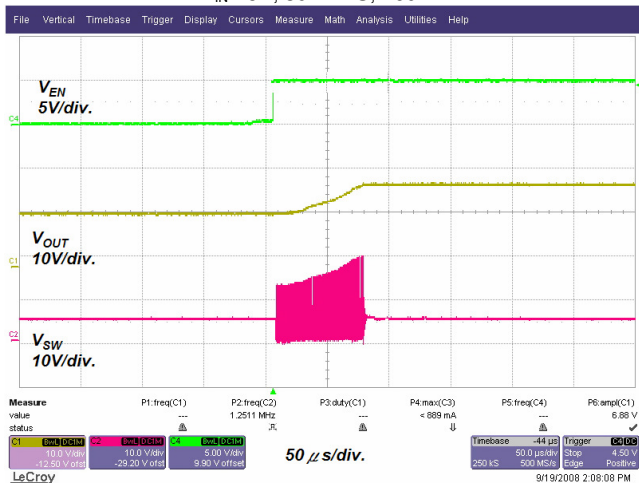
Startup Waveforms

$V_{IN} = 5V$, 39 LEDS, 260mA



Startup Waveforms into an Open Load

$V_{IN} = 5V$, 39 LEDS, 260mA



Functional Block

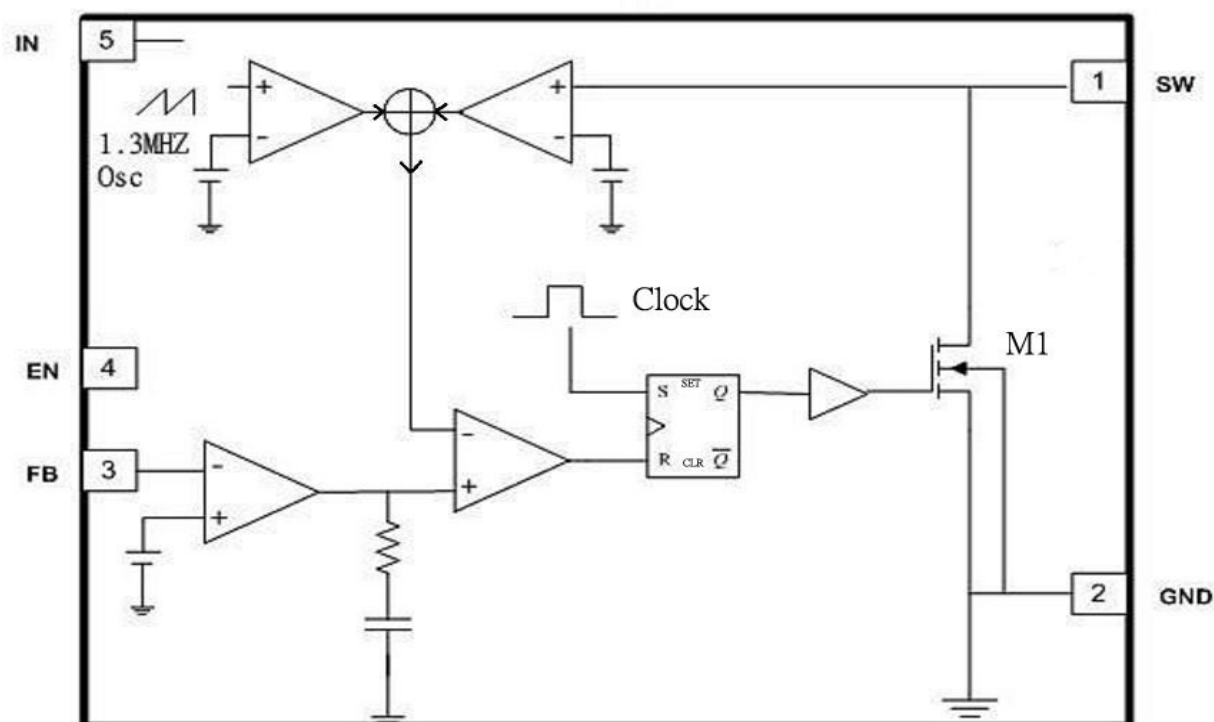


Figure 4: Function Block

Operation

The YB1521 features a constant frequency, current mode control scheme to regulate the output LED current. Its operation can be understood by referring to the block diagram in Figure 3. At the start of each oscillator cycle, a voltage proportional to the switch current is added to a ramp output and the resulting sum is fed into the positive terminal of the PWM comparator. When this voltage exceeds the level of the comparator negative input, the peak current has been reached, and the SR latch is reset and turns off the power switch. The voltage at the negative input of the comparator comes from the output of the error amplifier. The error amplifier sets the correct peak current level to keep the output in regulation. If the output of error

amplifier increases, more current is delivered to the output; if it decreases, less current is delivered.

Application Information

Inrush Current

The YB1521 has internal soft-start to limit the amount of current through the IN pin at startup and to also limit the amount of overshoot on the output. The current limit is increased by 4 steps to give a total soft-start time of 160μs.

LED Current and Dimming Control

The LED's current is set by a resistor connected at FB pin to GND:

$$I_{LED} = 200\text{mV} / R_1.$$

The maximum LED current set initially can

be reduced by pulse width modulating the EN. A better approach is to adjust the internal reference voltage for dimming control by a logic signal illustrated in Figure 5. YB1521 contains circuitry to support this automatically. The typical dimming frequency is 50KHz and recommended not to lower than 20KHz. Besides the EN dimming control scheme, either a DC level signal or a filtered PWM signal can be used to control the LED current as illustrated in Figure 6 and Figure 7 respectively. The average current through the LEDs will increase linearly to the duty cycle of the controlling PWM signal.

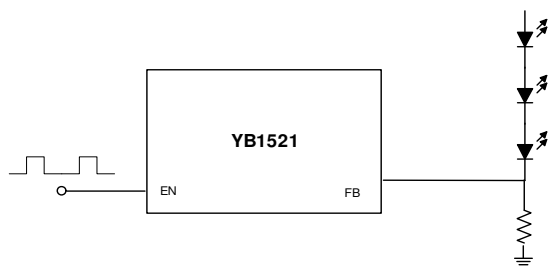


Figure 5: PWM Dimming Control Using a Logic Signal

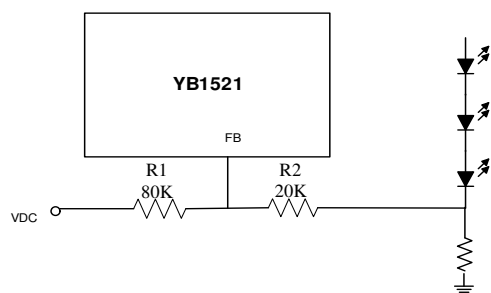


Figure 6: Dimming Control Using a DC Voltage

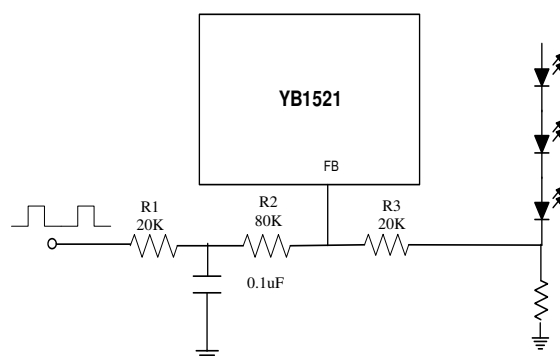


Figure 7: Dimming Control Using a Filtered PWM Signal

Over Voltage Protection

The YB1521 has an internal over voltage protection circuit which also acts as an open-circuit protection. In the case of open circuit or the LEDs failure, the LEDs are disconnected from the circuit, and the feedback voltage will be zero. The YB1521 will then switch to a high duty cycle resulting in a high output voltage, which may cause SW voltage to exceed its maximum 18V rating. The YB1521 will shutdown automatically until the power is recycled.

Inductor Selection

A 6.8μH is recommended to drive 39 LEDs in series/parallel. Although small size and high efficiency are major concerns, the inductor should have low core losses at 1.3MHz and low DCR (copper wire resistance). A higher 10μH inductor is recommended to improve efficiency.

Diode Selection

To maintain high efficiency, the average current rating of the Schottky diode should be larger than the peak inductor current. Schottky diode with a low forward drop and fast switching speeds are idea for increasing efficiency in portable application. Choose a reverse breakdown of the

Schottky diode large than the output voltage.

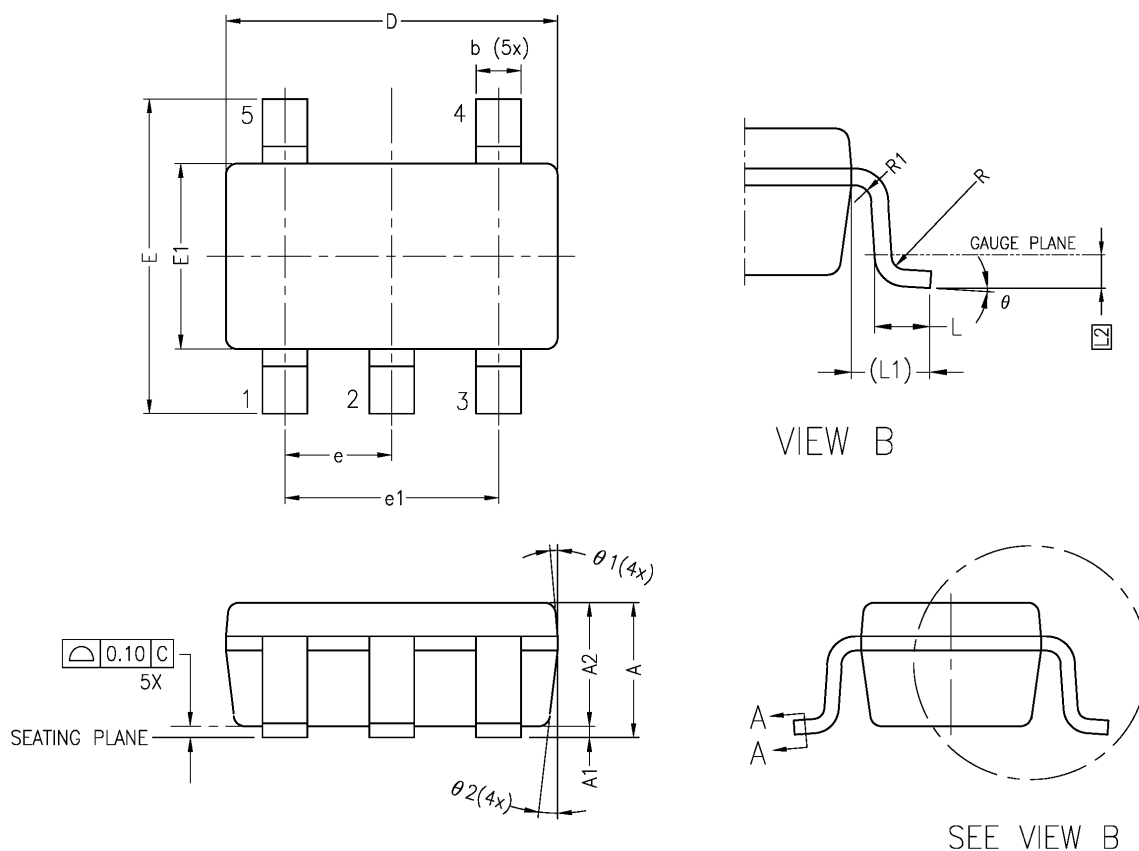
Capacitor Selection

Choose low ESR capacitors for the output to minimize output voltage ripple. The ceramic capacitor is a good choice for this as well. A 4.7 μ F output capacitor is sufficient for most applications. For applications desire a smaller output capacitance, a 2.2 μ F may be used. A 4.7 μ F ceramic capacitor is recommended for the input capacitance in the real system.

PCB Layout Consideration

Proper layout of the high frequency switching path is critical to prevent from noise and electromagnetic interference problems. Due to high frequency switching, the length and area of all the traces connected to the switch node should be minimized.

Package Information (SOT23-5)



SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	1.05	1.20	1.35
A1	0.05	0.10	0.15
A2	1.00	1.10	1.20
b	0.35	—	0.50
b1	0.35	0.40	0.45
c	0.08	—	0.22
c1	0.08	0.13	0.20
D	2.80	2.90	3.00
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
e	0.95 BSC		
e1	1.90 BSC		
L	0.35	0.43	0.60
L1	0.60 REF		
L2	0.25 BSC.		
R	0.10	—	—
R1	0.10	—	0.25
θ	0°	4°	8°
θ1	5°	6°	15°
θ2	5°	8°	15°

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