DN0007
Design note

DESIGNS from our LABS

STBB1 buck-boost converter used as a 500mA LED driver with 1.8VDC-5.5VDC Vin

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By Patrick Jankowiak

Main components	
STBB1-APUR	1 A, high efficiency adjustable single inductor dual mode buck-boost DC-DC converter

Specification

- Output current = 500mA (1.2A max)
- Input Voltage Range 2.1VDC-5.5VDC
- 300mA LED current @ 1.8VDC Input Voltage.
- 800mA LED current @ 3.3VDC Input Voltage.

Circuit description

A buck-boost converter with a wide input voltage range is useful for current-limited or LED power applications where it is desired to take advantage of low input voltages, to ensure start-up under battery end-of-life conditions, or in a battery-powered application where maintaining illumination in an emergency is more important than other considerations. The STBB1 was designed as a buck-boost voltage regulator, but it also lends itself very well to a current regulated voltage source.

The circuit shown in Figure 1 was developed to operate a 500mA white LED from a single Li-ion or LiPo cell, two alkaline or NiCd cells, or any other power source within the acceptable voltage range. At higher voltages, where the STBB1 operates in buck mode, the LED current may be up to 1A, limited only by thermal factors and the switch current rating. When Vin drops to 1.8V, the circuit still supplies 300mA. A 100uF capacitor, C1, helps the circuit start at low voltages by applying voltage to the FB pin. A 1K resistor, R1, serves to discharge C1 when the circuit is not operating. A 3.9V Zener diode, D2, limits the output voltage to a safe value in case the LED opens or is removed.

The circuit shown in Figure 2 was developed to operate a 200mA LED and uses a slightly different starting and protection scheme. When power is applied to Vin, a 100nF capacitor, C2, provides an initial FB voltage of about 3.7V until sufficient output voltage is generated to forward bias the LED. Resistor R4 prevents the FB voltage pulse from C2 from being absorbed by current programming resistor R2. Once the LED is conducting, a feedback voltage of 0.5V is provided by the voltage drop across R3. Diode D2 prevents the resistor

network R1-R2 from influencing the FB voltage provided by R3. Should the LED open, D2 conducts and FB voltage is provided through the R1-R2 voltage divider and the output voltage is limited to a safe value until the LED can be replaced.

Figure 1. **Circuit diagram – 500mA**

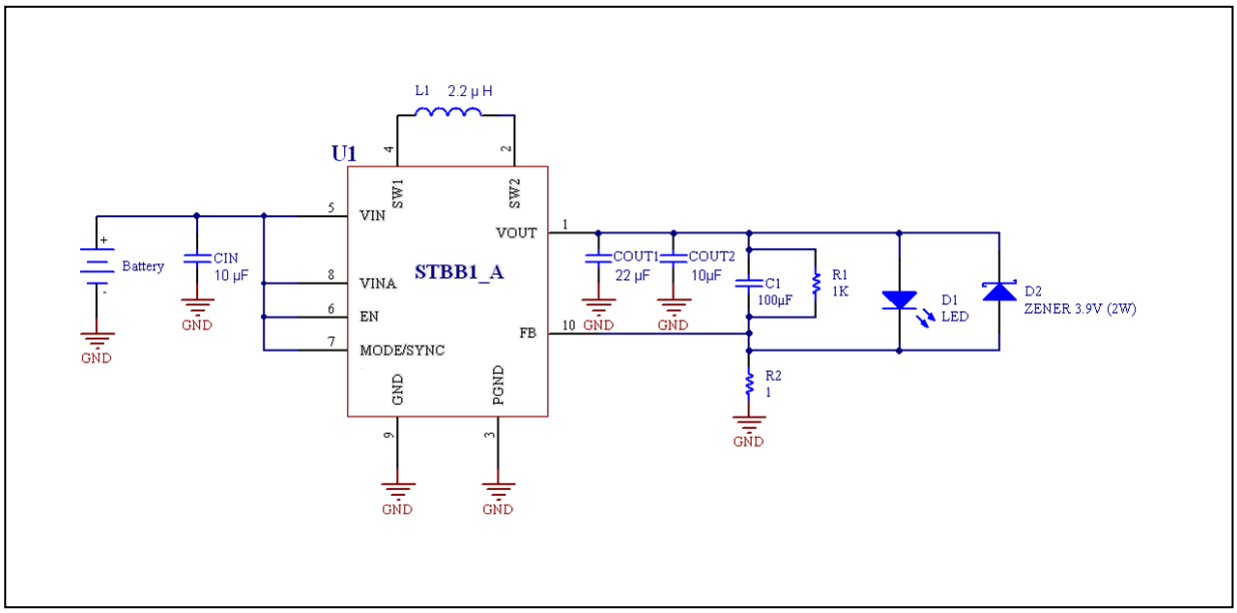


Table 1. BOM for Figure 1

Reference	Manufacturer	Part Number/ Description	Value	Size
U1	STMicroelectronics	STBB1-APUR		DFN10 (3 x 3 mm)
CIN	Murata	GRM21BR71A106KE51L	10 µF	0805
COUT1	Murata	GRM21BR60J226ME39L	22 µF	0805
COUT2	Murata	GRM21BR71A106KE51L	22 µF	0805
L1	TDK	VLCF4020T-2R2N1R7	2.2 µH	4 x 4 x 2 mm
	Coilcraft	XFL4020-222ME		
C1	Any	Capacitor, 6VDC	100uF	
R1	Any	Resistor, Chip, 1/16W, 1%	1K	0603
R2	Any	Resistor, Chip, 1W, 1%	1 Ω	2512
D1	Any	LED White		
D2	Any	Zener diode, 2W	3.9V	
Battery	Any	2 x Battery Lithium AA		

Figure 2. **Circuit diagram – 200mA**

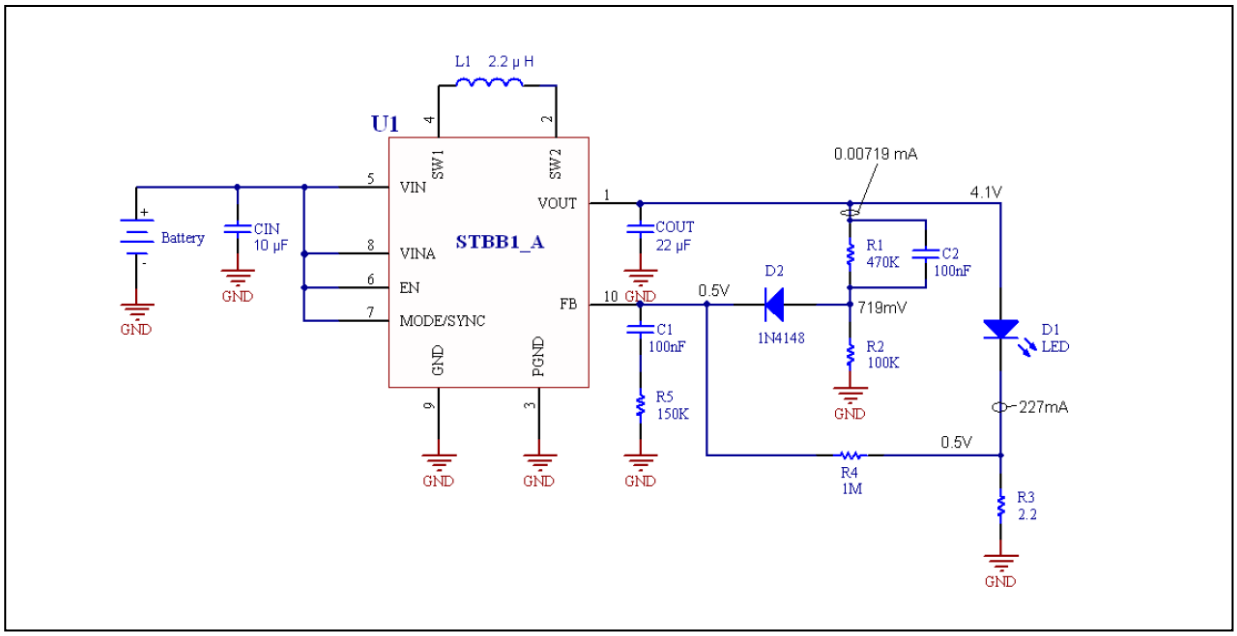


Table 2. BOM for Figure 1

Reference	Manufacturer	Part Number/ Description	Value	Size
U1	STMicroelectronics	STBB1-APUR		DFN10 (3 x 3 mm)
CIN	Murata	GRM21BR71A106KE51L	10 µF	0805
COUT	Murata	GRM21BR60J226ME39L	22 µF	0805
L1	TDK	VLCF4020T-2R2N1R7	2.2 µH	4 x 4 x 2 mm
	Coilcraft	XFL4020-222ME		
C1,C2	Murata	GRM188R71C104KA01D	100nF	0603
R1	Any	Resistor, Chip, 1/16W, 1%	470K	0603
R2	Any	Resistor, Chip, 1/16W, 1%	100K	0603
R3	Any	Resistor, Chip, 1/2W, 1%	2.2 Ω	2010
R4	Any	Resistor, Chip, 1/16W, 1%	1M	0603
R5	Any	Resistor, Chip, 1/16W, 1%	150K	0603
D1	Any	LED White		
D2	FAIRCHILD	1N4148WS		SOD-323F
Battery	Any	2 x Battery Lithium AA		

Measurement results

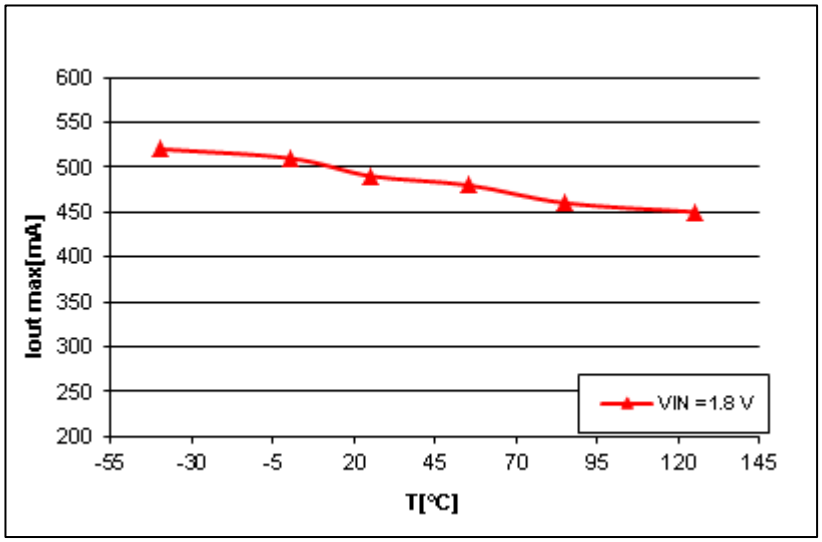
Measurements were made of the input voltage and LED current in the basic circuit of Figure 1, using a high power white LED with Vf of about 3.7V. These figures should be considered guidelines and not absolute. Slightly more or less current may be available depending on the individual circuit and layout, but ultimately the device will limit the current

and internal temperature to a safe value while providing as much as possible under the circumstances.

- Vin=1.8V: I_{LED} =300mA
- Vin = 3.3V: I_{LED} =800mA
- Vin = 5.5V: I_{LED}=1000mA

Current output capability of the STBB1 was also measured with a load requiring 2.5V. The graph is the maximum output current at VIN = 1.8 V with VOUT = 2.5V. The maximum output current at VIN = 1.8 V with VOUT = 3.3 V is around 400 mA.

Figure 3. **Output current vs. Temperature at Vin=1.8VDC**



Support material

Documentation
Datasheet STBB1-AXX, 1 A, high efficiency single inductor dual mode buck-boost DC-DC converter

Revision history

Date	Version	Changes
6-Jun-2012	1	Initial release

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