BCT3661B

White LED driver with digital pulse brightness control for up to 12 LEDs in Series

Features

· 3.0V to 5.5V Input Voltage Range
· 42V Open LED Protection For up To 12 LEDs
· 200mV Reference Voltage
·1-Wire 32 Level Digital Pulse Brightness Control
· Built-in Soft Start
· Up to 90% Efficiency
· DFN2x2 Package

Applications

· Cellular Phones
· Portable Media Players
· Ultra Mobile Devices
· GPS Receivers
· White LED Backlighting

Description

With 42V rated integrated switch FET, BCT3661B is a boost converter that drives up to 12 LEDs in series. The boost converter runs at 600kHz fixed switching frequency to reduce output ripple, improve conversion efficiency, and allows for the use of small external components. The default white LED current is set with the external sensor resistor Rset, and the feedback voltage is regulated to 200mV, as shown in the typical application. During the operation, the LED current can be controlled by using the 1-wire digital interface through the CTRL pin. BCT3661B does not burst LED current, therefore, it does not generate audible noises on the output capacitor. For maximum protection, the device integrated open LED protection that disables the BCT3661B to prevent the output from exceeding the absolute maximum ratings during open LED conditions.
The BCT3661B is available in a DFN2x2 space saving package.

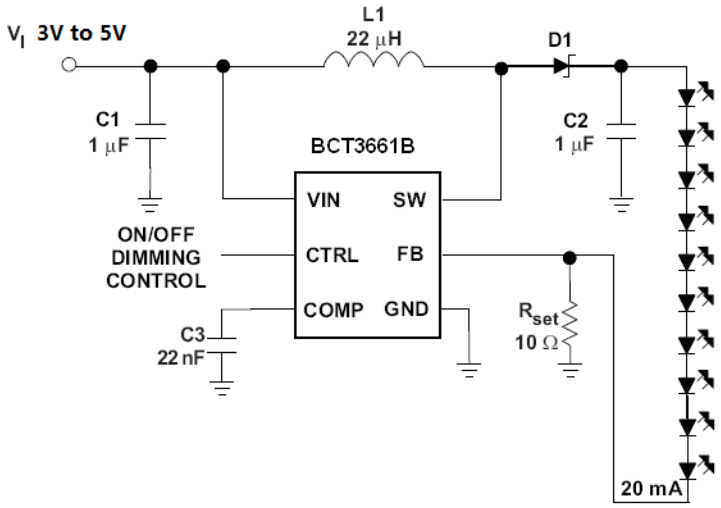
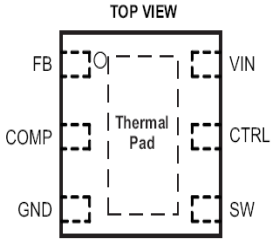


Figure 1. Typical Application of BCT3661B

Connection Diagram (Top View)



6-PIN 2mm x 2mm x 0.8mm DFN

PIN DESCRIPTION

NO	NAME	I/O	DESCRIPTION
6	VIN	I	The input supply pin for the IC. Connect VIN to a supply voltage between 3.0V and 5.5V.
4	SW	I	This is the switching node of the IC. Connect the inductor between the VIN and SW pin. This pin is also used to sense the output voltage for open LED protection
3	GND	O	Ground
1	FB	I	Feedback pin for current. Connect the sense resistor from FB to GND.
2	COMP	O	Output of the trans conductance error amplifier. Connect an external capacitor to this pin to compensate the regulator.
5	CTRL	I	Control pin of the boost regulator. It is a multi-functional pin which can be used for enable control for digital dimming.
0	Thermal Pad	-	The thermal pad should be soldered to the analog ground plane. If possible, use thermal via to connect to ground plane for ideal power dissipation.

ORDERING INFORMATION

PART	PIN-PACKAGE	Temp-Range	Top Mark	Supplied as:
BCT3661BELT-TR	DFN2x2-6	-40°C to +85°C	3661	3000units/Tape & Reel

ABSOLUTE MAXIMUM RATINGS(1)

		VALUE	UNIT
VI	Supply Voltages on VIN (2)	–0.3 to 6	V
	Voltages on CTRL(2)	–0.3 to 6	V
	Voltage on FB and COMP(2)	–0.3 to 6	V
	Voltage on SW(2)	–0.3 to 50	V
PD	Continuous Power Dissipation	See Dissipation Rating Table	
TJ	Operating Junction Temperature Range	–40 to 150	°C
TSTG	Storage Temperature Range	–65 to 150	°C

(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 under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to network ground terminal.

RECOMMENDED OPERATING CONDITIONS

		MIN	TYP	MAX	UNIT
VI	Input voltage range, VIN	3.0		5.5	V
VO	Output voltage range	VIN		42	V
L	Inductor(1)	10		22	μH
CIN	Input capacitor	1			μF
CO	Output capacitor(1)	0.47		10	μF
TA	Operating ambient temperature	–40		85	°C
TJ	Operating junction temperature	–40		125	°C

(1) These values are recommended values that have been successfully tested in several applications. Other values may be acceptable in other applications but should be fully tested by the user.

DISSIPATION RATINGS

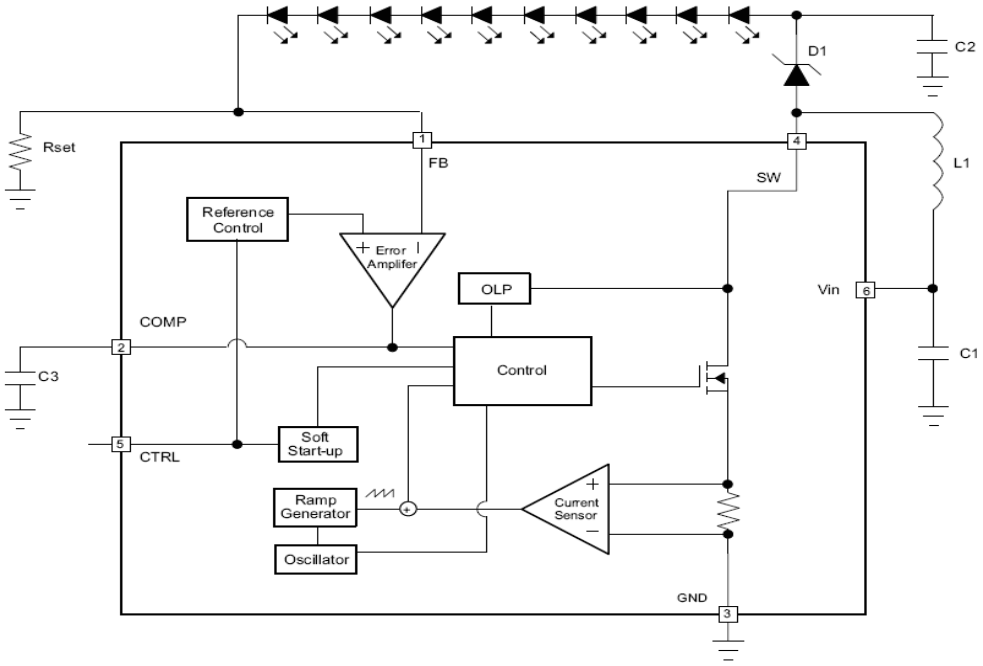
RqJC	RqJA	DERATING FACTOR ABOVE TA = 25°C	TA < 25°C	TA = 70°C	TA = 85°C
20°C/W	140°C/W	7.1 mW/°C	715 mW	395 mW	285 mW

ELECTRICAL CHARACTERISTICS

VIN = 3.6 V, CTRL = VIN, TA = –40°C to 85°C, typical values are at TA = 25°C (unless otherwise noted)

	PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY CURRENT							
VI	Input voltage range, VIN			3.0		5.5	V
IQ	Operating quiescent current into VIN		Device PWM switching no load			2.0	mA
ISD	Shutdown current		CRTL=GND, VIN = 4.2 V			2	µA
ENABLE AND REFERENCE CONTROL							
V(CTRLh)	CTRL logic high voltage		VIN = 3.0 V to 5.5 V	1.4			V
V(CTRLl)	CTRL logic low voltage		VIN = 3.0 V to 5.5 V			0.4	V
R(CTRL)	CTRL pull down resistor				800		kΩ
toff	CTRL pulse width to shutdown		CTRL high to low	1			ms
VOLTAGE AND CURRENT CONTROL							
VREF	Voltage feedback regulation voltage				200		mV
IFB	Voltage feedback input bias current		VFB = 200 mV			1	µA
fS	Oscillator frequency				600		kHz
Dmax	Maximum duty cycle		VFB = 100 mV		93		%
POWER SWITCH							
RDS(on)	N-channel MOSFET on-resistance		VIN = 3.3 V		0.5	1.0	Ω
ILN_NFET	N-channel leakage current		VSW = 42 V, TA = 25°C			1	µA
OC and OLP							
ILIM	N-Channel MOSFET current limit		D = Dmax		0.8		A
Vovp	Open LED protection threshold	BCT3661B	Measured on the SW pin		42		V
DIGITAL PROG TIMING							
tREADY	Start time of program pulse			30			µs
tHI	High time			1			µs
tL_LB	Low pulse width			1		50	µs
tSHDN	High time high bit			1			ms

Typical Function Diagram



DETAILED DESCRIPTION

OPERATION

The BCT3661B is a high efficiency, high output voltage boost converter in small package size, The device is ideal for driving up to 12 white LED in series. The serial LED connection provides even illumination by sourcing the same output current through all LEDs, eliminating the need for expensive factory calibration. The device integrates 50V/0.7A switch FET and operates in pulse width modulation (PWM) with 600kHz fixed switching frequency. For operation see the block diagram. The duty cycle of the converter is set by the error amplifier output and the current signal applied to the PWM control comparator. The control architecture is based on traditional current-mode control; therefore, a slope compensation is added to the current signal to allow stable operation for duty cycles larger than 50%. The feedback loop regulates the FB pin to a low reference voltage (200mV typical), reducing the power dissipation in the current sense resistor.

SOFT START-UP

Soft-start circuitry is integrated into the IC to avoid a high inrush current during start-up. After the device is enabled, the voltage at FB pin ramps up to the reference voltage in 32 steps, each step takes 213ms. This ensures that the output voltage rises slowly to reduce the input current. Additionally, for the first 5msec after the COMP voltage ramps, the current limit of the switch is set to half of the normal current limit spec. During this period, the input current is kept below 400mA (typical). See the start-up waveform of a typical example, Figure 11.

OPEN LED PROTECTION

Open LED protection circuitry prevents IC damage as the result of white LED disconnection. The BCT3661B monitors the voltage at the SW pin and FB pin during each switching cycle. The circuitry turns off the switch FET and shuts down the IC as soon as the SW voltage exceeds the Vovp threshold and the FB voltage is less than half of regulation voltage for 8 clock cycles. As a result, the output voltage falls to the level of the input supply. The device remains in shutdown mode until it is enabled by toggling the CTRL pin logic. To allow the use of inexpensive low-voltage output capacitor, the BCT3661B has different open lamp protection thresholds to prevent the internal 44V FET from breaking down. The threshold is set at 40V for the BCT3661B. The devices can be selected according to the number of external LEDs and their maximum forward voltage.

CURRENT PROGRAM

The FB voltage is regulated by a low 0.2V reference voltage. The LED current is programmed externally using a current-sense resistor in series with the LED string. The value of the RSET is calculated using Equation 1:

$$I_{LED} = V_{FB} / R_{SET} \quad (1)$$

Where

I_{LED} = output current of LEDs

V_{FB} = regulated voltage of FB

R_{SET} = current sense resistor

The output current tolerance depends on the FB accuracy and the current sensor resistor accuracy.

Also users can easily configure the LED current from 0.3mA to 20mA by 1-wire digital pulse control. The dimming can be achieved by applying a pulse signal to the CTRL pin. The number of falling edges is detected internally and decoded as illustrated in Table 1.There are totally 32 steps of current value can be set by users. When the CTRL pin is held low for 180us or more, the BCT3661B enters the shutdown mode and draw “zero” current from VIN.

Number of Pulse Falling Edge	I_DX (mA)
0	20
1	19.375
2	18.75
...	
N	20-(20/32) x N
...	
30	1.25
31	0.625

Table 1: Current Setting

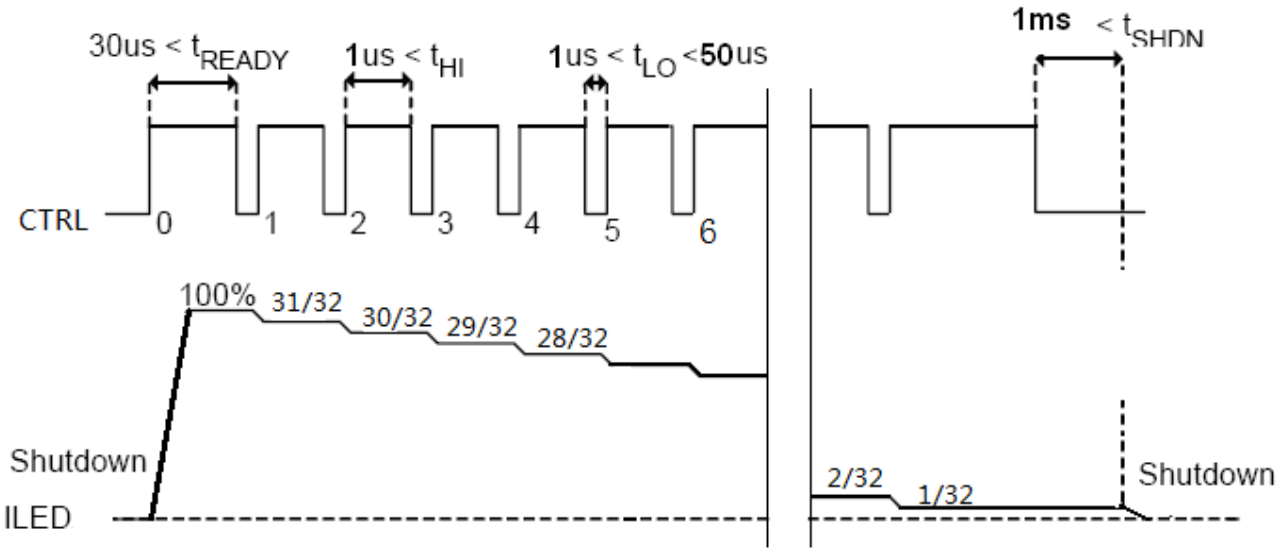


Figure 4: Brightness Control by Pulse Dimming

SHUTDOWN

The BCT3661B enters shutdown mode when the CTRL voltage is logic low for more than 180us. During shutdown, the input supply current for the device is less than 1mA (max). Although the internal FET does not switch in shutdown, there is still a DC current path between the input and the LEDs through the inductor and Schottky diode. The minimum forward voltage of the LED array must exceed the maximum input voltage to ensure that the LEDs remain off in shutdown. However, in the typical application with two or more LEDs, the forward voltage is large enough to reverse bias the Schottky and keep leakage current low.

UNDERVOLTAGE LOCKOUT

An under voltage lockout prevents operation of the device at input voltages below typical 2.2V. When the input voltage is below the under voltage threshold, the device is shutdown and the internal switch FET is turned off. If the input voltage rises by under voltage lockout hysteresis, the IC restarts.

THERMAL SHUTDOWN

An internal thermal shutdown turns off the device when the typical junction temperature of 160°C is exceeded. The device is released from shutdown automatically when the junction temperature decreases by 15°C.

PACKAGING INFORMATION