

**Low-Dropout, Constant-Current  
White LED Bias Supply****FEATURES**

- Low 200mV Dropout at 9mA
- Up to 150mA LED Bias Current
- 0.3% LED Current Matching
- Simple LED Brightness Control
- Low 40uA Supply Current
- Low 0.05uA Shutdown Current
- 2.5V to 5.5V Supply Voltage Range
- SOP-8 and SOT23-6 Package
- Output channel :
  - SOP-8 package for four channel
  - SOT23-6 package for three channel

**Applications**

- Cellular Phones
- Portable Communication Devices
- Handheld Electronics
- Digital Cameras
- PDAs
- LED/Display Back Light Driver
- LEDs for Camera Flash

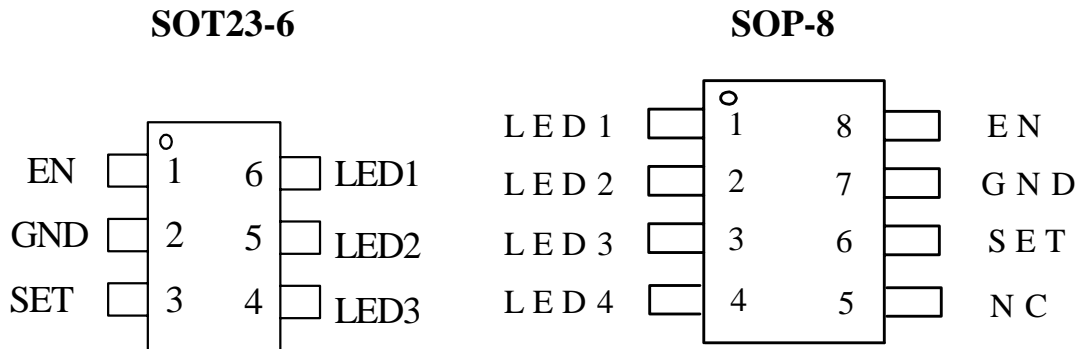
**PART NUMBER EXAMPLES**

<b>PART NO.</b>	<b>PACKAGE</b>
T6311A-D	SOP-8
T6311A-X	SOT23-6

**GRNERAL DESCRIPTION**

The T6311A low-dropout bias supply for white LEDs is a high-performance alternative to the simple ballast resistors used in conventional white LED designs. The T6311A uses a single resistor to set the bias current for four LEDs, which are matched to 0.3%. The T6311A consumes only 40uA of supply current when enabled and 0.05uA when disabled. The T6311A advantages over ballast resistors include significantly better LED to LED bias matching, much lower bias variation with supply voltage variation, significantly lower dropout voltage, and in some applications, significantly improved efficiency. The T6311A requires a 200mV dropout at a 9mA load on each output to match the LED brightness. The T6311A is available in SOP-8 and SOT23-6 package.

**PIN ARRANGEMENT(Top view)**



**PIN DESCRIPTION**

SYMBOL	Pin no.		DESCRIPTION
	SOP-8	SOT23-6	
EN	8	1	Enable Input/Power Input. Drive high (> 2.5V) to enable; drive low (< 2.2V) to disable. When disabled, SET, LED1, LED2, LED3 and LED4 are high impedance. When enabled, EN is the power input for the T6311A.
GND	7	2	Ground
SET	6	3	Bias Current Set Input. The current flowing into SET sets the bias current into each LED by $I_{LED\_} = 240 \times I_{SET}$ . VSET is internally biased to 1.2V. SET is high impedance when EN is low.
NC	5	-	No connection.
LED4	4	-	LED 4 Cathode Connection. Current flowing into LED4 is 240 times the current flowing into SET. LED4 is high impedance when EN is low.
LED3	3	4	LED 3 Cathode Connection. Current flowing into LED3 is 240 times the current flowing into SET. LED3 is high impedance when EN is low.
LED2	2	5	LED 2 Cathode Connection. Current flowing into LED2 is 240 times the current flowing into SET. LED2 is high impedance when EN is low.
LED1	1	6	LED 1 Cathode Connection. Current flowing into LED1 is 240 times the current flowing into SET. LED1 is high impedance when EN is low.

**BLOCK DIAGRAM**

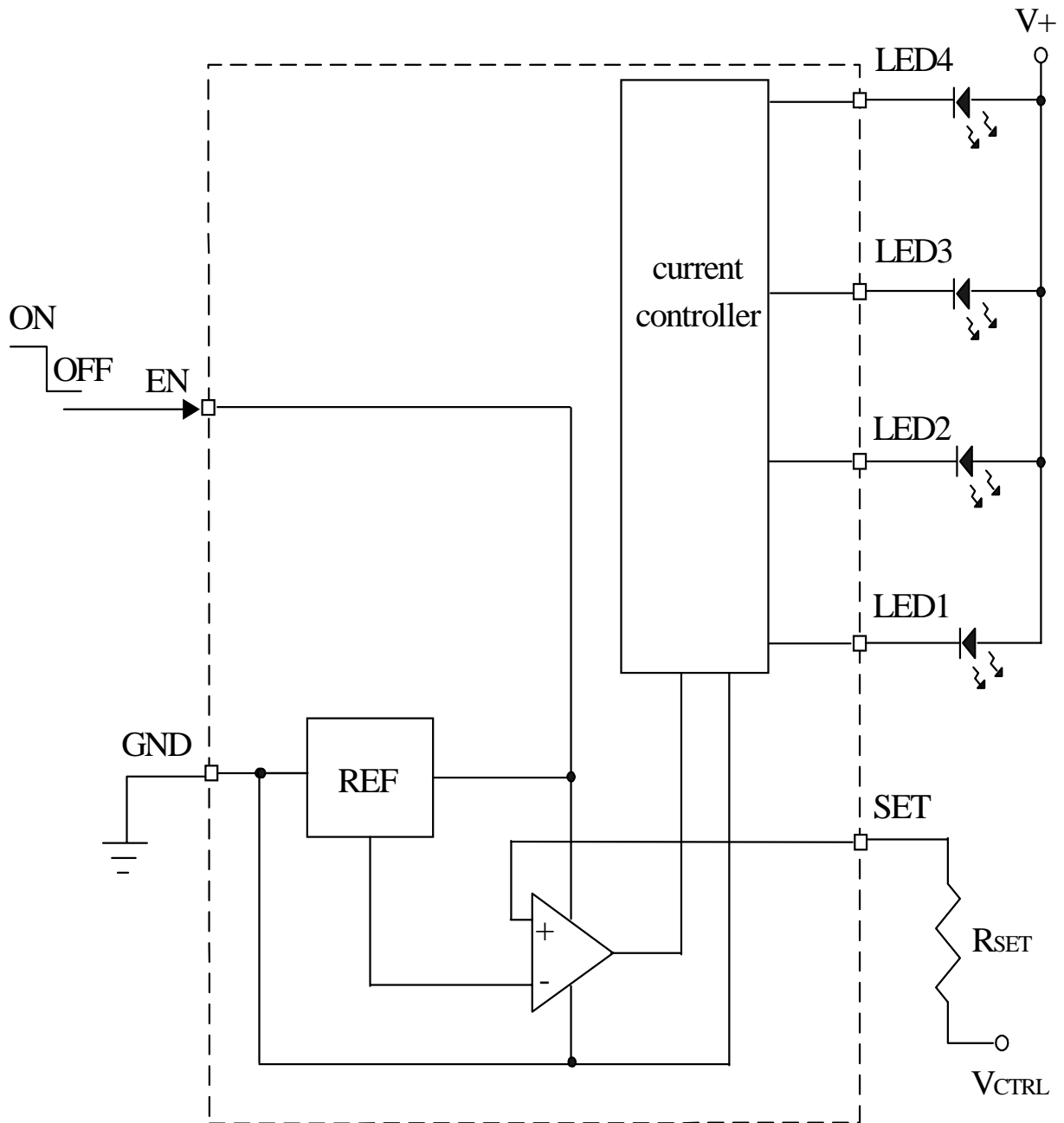


Fig. 1

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Value	Unit
Voltage on any pin relative to GND	V <sub>IN</sub>	-0.3 to 6	V
Operating Temperature Rang	T <sub>A</sub>	-40 to +85	°C
Maximum Soldering Temperature (at leads, 10 sec)	T <sub>LEAD</sub>	300	°C
Storage Temperature Rang	T <sub>S</sub>	-65 to +150	°C
Continuous Power Dissipation ( T <sub>A</sub> = +70°C )		1	W

**Electrical Characteristics**

(T<sub>A</sub> = -40 to 85°C unless otherwise noted. Typical values are at T<sub>A</sub> =25°C, V<sub>EN</sub> =3.3V, V<sub>LED1</sub> = V<sub>LED2</sub>= V<sub>LED3</sub>= V<sub>LED4</sub>= 1V) (Note 1)

Symbol	Description	Conditions	Min.	Typ.	Max	Unit
V <sub>EN</sub>	Operating voltage range	EN is power supply input	2.5		5.5	V
I <sub>SET</sub>	SET input current range		5		260	uA
	SET to LED current ratio	I <sub>LED</sub> / I <sub>SET</sub> , I <sub>SET</sub> =42uA	220	240	260	A/A
V <sub>SET</sub>	SET bias voltage	I <sub>SET</sub> =42uA	1.08	1.2	1.32	V
	SET leakage current in Shutdown	EN=GND, V <sub>SET</sub> =3.3V	T <sub>A</sub> = -40 to +25°C	0.01	1	uA
			T <sub>A</sub> = -40 to +85°C		5	uA
	LED to LED current matching	I <sub>SET</sub> =42uA		0.3		%
I <sub>LED</sub>	Maximum LED sink current	Each LED		100	150	mA
	LED dropout voltage	I <sub>SET</sub> =20uA (Note 2)		100	180	mV
		I <sub>SET</sub> =40uA (Note 3)		200	360	mV
		I <sub>SET</sub> =80uA (Note 3)		230	410	mV
	LED leakage current in shutdown	V <sub>LED1</sub> =V <sub>LED2</sub> =V <sub>LED3</sub> =V <sub>LED4</sub> = 3.3V, EN=GND, T <sub>A</sub> =+25°C, each LED		0.01	1	uA
V <sub>IH</sub>	Input high voltage	V <sub>EN</sub> >V <sub>IH</sub> for enable	2.5			V
V <sub>IL</sub>	Input low voltage	V <sub>EN</sub> <V <sub>IL</sub> for disable			2.2	V
I <sub>EN</sub>	EN input bias current	V <sub>EN</sub> = 2.50V to 5.5V, EN is power supply input		40	100	uA
		V <sub>EN</sub> = 0.4V, T <sub>A</sub> =+25°C		0.05	1	uA

**Note 1:** Limits are 100% production tested at T<sub>A</sub> = +25°C. Limits over the operating temperature range are guaranteed through correlation using statistical quality control (SQC) methods.

**Note 2:** Dropout Voltage is defined as the LED to GND voltage at which current sink into LED drops 20% from the value at V<sub>LED</sub> = 1V.

**Note 3:** Dropout Voltage is defined as the LED to GND voltage at which current sink into LED drops 10% from the value at V<sub>LED</sub> = 1V.

**Typical Operating Characteristics**

(VEN=+3.3V, VCTRL= 3.3V, RSET=24.9k ohm, V+=3.3V, TA=+25 °C, unless otherwise noted.)(circuit of Fig. 1)

TBD

## Functional Description

The T6311A provides constant current bias supply for white LED designs. The T6311A uses a single resistor to set the bias current for up to three LEDs. LED bias currents are matched to 0.3% by the T6311A current matching architecture (Fig. 1). Supply current ( $I_{EN}$ ) is a low 40 $\mu$ A in normal operation and 0.05 $\mu$ A when disabled. The T6311A offers several advantages over using ballast resistors, such as improved LED to LED brightness matching, lower bias variation with supply voltage changes, significantly lower dropout voltage, and in some applications, significantly improved efficiency. The T6311A achieves a 200mV dropout with a 9mA load on each output. For circuits requiring only one or two LEDs, leave unused LED outputs unconnected.

### Enable Input

EN powers the input of the T6311A. Drive EN high (> 2.5V) to enable the device; drive EN low (< 2.2V) to disable the device. When driven high, EN draws 40 $\mu$ A to power the IC. Driving EN low forces LED1, LED2, LED3, LED4 and SET into a high-impedance state.

### Setting the Output Current

SET controls the LED bias current. Current flowing into LED1, LED2, LED3 and LED4 is 240 times greater than the current flowing into SET. Set the output current as follows:

$$I_{LED} = 240 ( V_{CTRL} - V_{SET} ) / R_{SET}$$

where  $V_{SET} = 1.2V$ ,  $V_{CTRL}$  is an external voltage between 1.8V and 5.5V, and  $R_{SET}$  is the resistor connected between  $V_{CTRL}$  and SET (Fig. 1).

## Applications Information

**Very Low-Cost, High-Efficiency Solution** (Fig. 2). A battery (single Li+ or three NiMH cells) powers the LEDs directly. This is the least expensive and most efficient architecture. Due to the high forward voltage of white LEDs (3.3V), the LED brightness may dim slightly at the end of battery life. The T6311A current regulating architecture and low dropout greatly minimize this effect compared to using simple ballast resistors. The enable function of the T6311A turns on and off the LEDs. An existing low-dropout regulator is used as  $V_{CTRL}$ .

**Brightness Adjustment Using a DAC** (Fig. 3). A DAC is used as  $V_{CTRL}$  such that the LED brightness may be dynamically adjusted to eliminate factory calibration. A battery (single Li+ or three NiMH cells) or a regulated power source drives the LEDs.

**TYPICAL APPLICATION CIRCUITS**

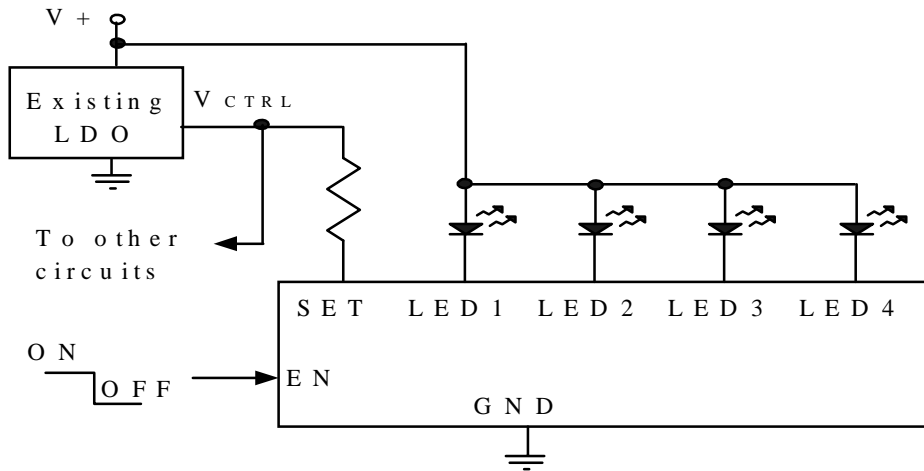


Fig. 2 Very low-cost, high-efficiency solution

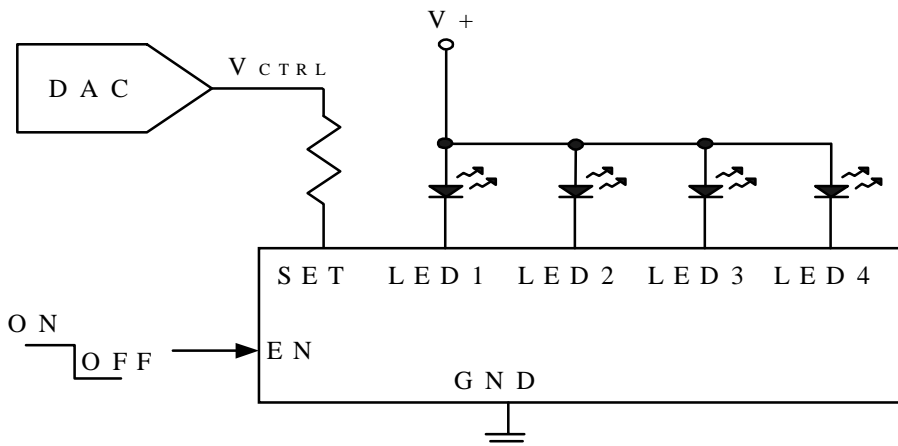
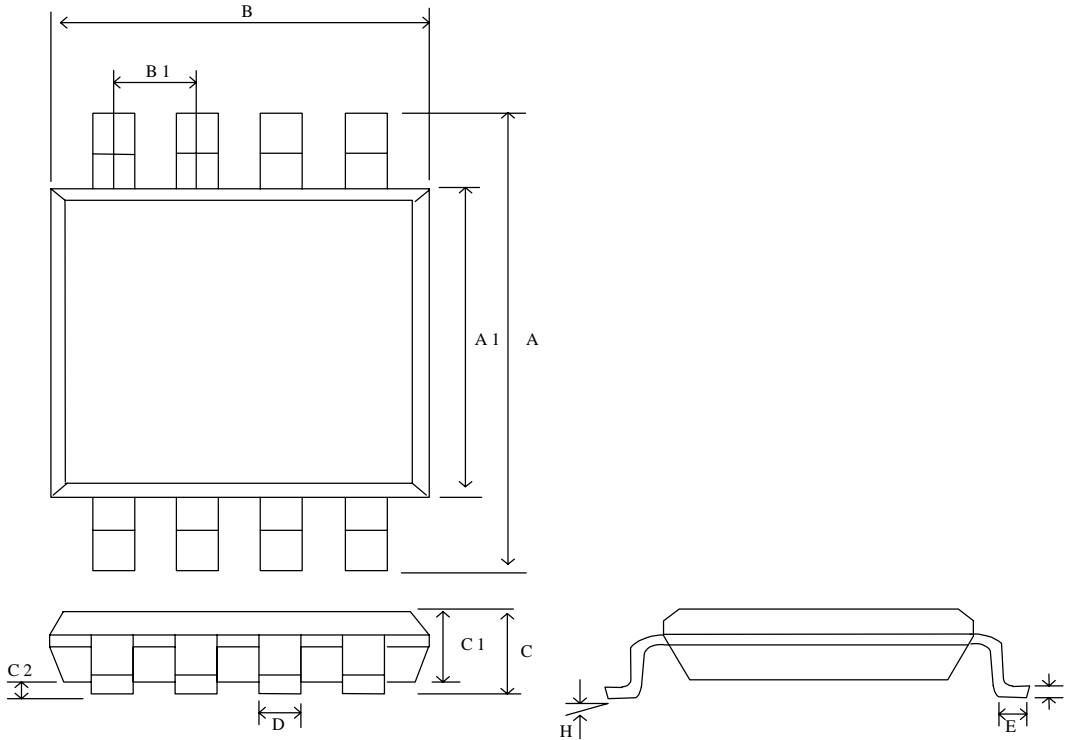


Fig. 3 Brightness adjust using DAC

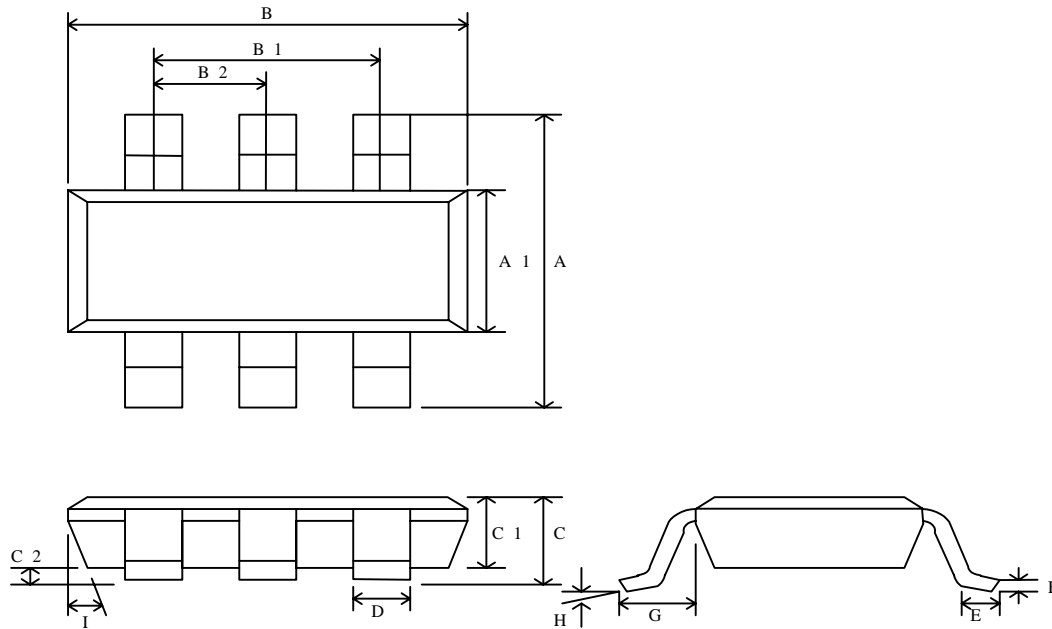
**PACKAGE DIMENSIONS**  
**8-LEAD SOP**



Symbol	Dimension in mm			Dimension in inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	5.70	6.00	6.30	0.224	0.236	0.248
A1	3.75	3.95	4.10	0.148	0.156	0.164
B	-	-	5.13	-	-	0.202
B1	-	1.27	-	-	0.050	-
C	-	-	1.80	-	-	0.071
C1	1.35	1.55	1.75	0.052	0.061	0.069
C2	0.10	-	0.25	0.001	-	0.004
D	0.31	0.41	0.51	0.012	0.016	0.020
E	0.30	0.50	0.70	0.012	0.020	0.028
F	0.10	0.15	0.25	0.004	0.006	0.010
H	0~8°			0~8°		



**PACKAGE DIMENSIONS**  
**SOT23-6**



Symbol	Dimension in mm			Dimension in inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.60	2.80	3.00	0.102	0.110	0.118
A1	1.40	1.575	1.60	0.055	0.062	0.063
B	2.70	2.85	3.00	0.106	0.112	0.118
B1		1.90(BSC)			0.075(BSC)	
B2		0.95(BSC)			0.037(BSC)	
C	0.95	1.20	1.45	0.037	0.047	0.057
C1	0.90	1.10	1.30	0.035	0.043	0.051
C2	0	0.075	0.150	0	0.003	0.06
D		0.40			0.015	
E	0.30	0.45	0.60	0.012	0.018	0.023
F	0.08	0.15	0.22	0.003	0.006	0.009
G		0.60(REF)				
H	0~8°			0~8°		
I	5~15°			5~15°		