Description

The YB1303 provides a simple solution for driving three channels of any color LEDs with current matching ability. The ultra low dropout LED driver features higher peak efficiency and very low shutdown current. The LED current can be adjusted by an external resistor or the control voltage. The YB1303 can work independently or combine with any boost converters which need to have current matching function for LED drivers. The YB1303 is available in 6-pin tiny SC70-6 package.

Features

- LED Drivers for Parallel Connected LEDs
- Only One External Resistor is Needed
- PWM and Analog Brightness Control
- No EMI and Switching Noise
- Power Saving Shutdown Mode (<0.1μA)
- Small Footprint SC70-6 Package

Applications

- LCD Display Modules
- Keyboard Backlight
- PDA, DSC, MP3 players
- LED Displays
- Handheld Computers
- Cell Phones

Typical Application Circuit

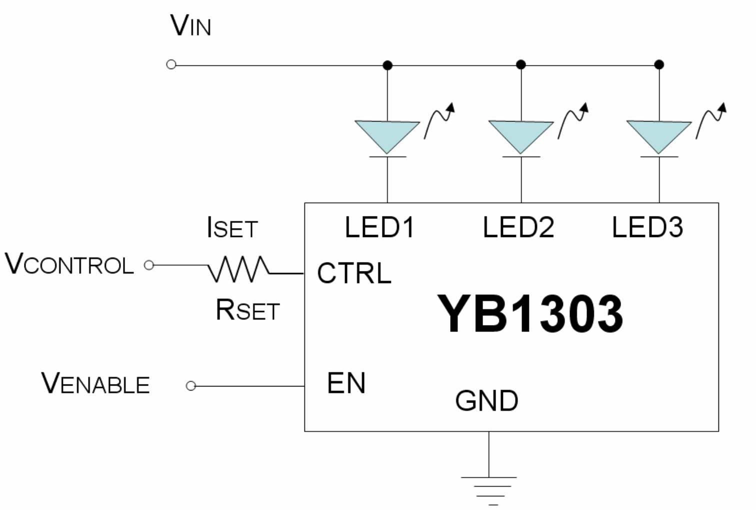


Figure 1: Typical Application Circuit

Pin Configuration

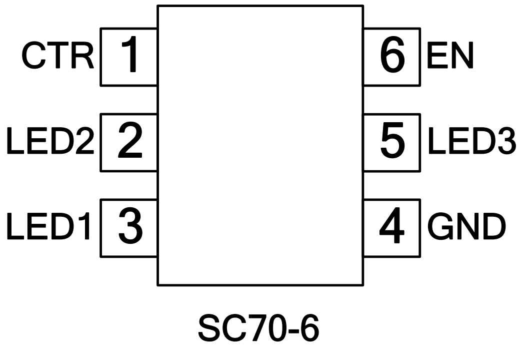


Figure 2: Pin Configuration

Pin Assignment &Description

Table 1

Pin	Name	Description
1	CTR	Connect this pin with a resistor to set the LED current.
2	LED2	Connect this pin to LED cathode.
3	LED1	Connect this pin to LED cathode.
4	GND	Ground pin.
5	LED3	Connect this pin to LED cathode.
6	EN	Connect this pin to logic high to enable this chip, logic low to disable this chip.

Ordering Information

Table 2

Order Number	Package Type	Supplied As	Package Marking
YB1303SC76A	SC70-6	3000 Units Tape & Reel	Please contact sales representative

Absolute Maximum Ratings

LED1, LED2, LED3 to GND .... -0.3V to 6V
EN to GND .... -0.3V to 6V
CTR to GND .... -0.3V to 3V
Power Dissipation by SC70-6 T_A=85℃ 133mW
Junction Temperature Range ....150℃
Storage Temperature Range .....-55℃ to 150℃
Lead Temperature ....250℃
ESD HBM 1.5KV
ESD CDM 750V

Recommended Operating Conditions

LED Cathode Voltage 0.3V to1V
Operating Temperature.........-40℃ to 85℃

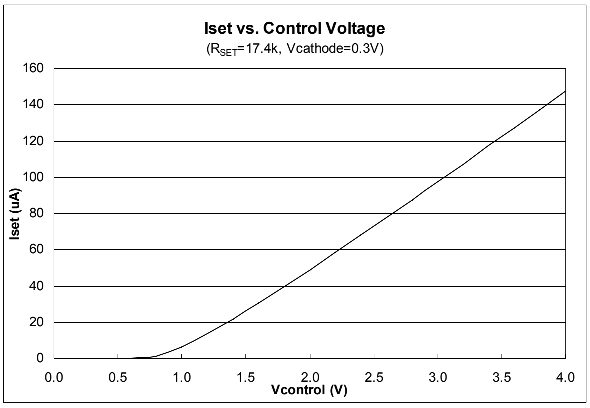
Electrical Characteristics

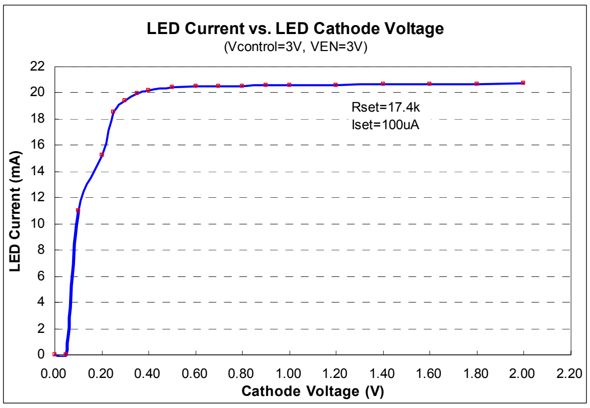
Table 3 (V_{IN}=3.3 to 5.5V, V_{EN}=3V, T_A=25°C, unless otherwise noted. V_F is LED forward voltage.)

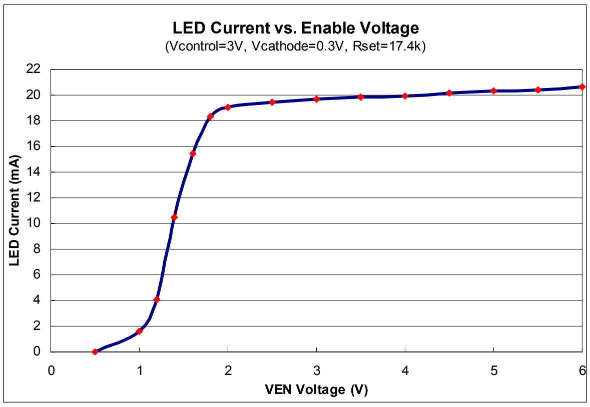
Description	Symbol	Test Conditions	MIN	TYP	MAX	Units
LED Cathode Voltage	$V_{CATHODE}$		0.3	0.5	1	V
Output Current Multiplication Factor		I_{SET} = 100µA, V_{LED} = 300mV	140	200	260	
Shutdown Current	I_{SD}	V_{EN} = 0V		0.1	1	µA
LED Current	I_{LED}	I_{SET} = 100µA		20		mA
LED to LED Current Matching			-3		+3	%
Efficiency	η	V_{IN} =3.3V, $(V_{IN} – V_{CATHODE}) / V_{IN}$		90		%
SHDN Logic Low Level	V_{IL}	I_{LED} < 1µA			0.5	V
SHDN Logic High Level	V_{IH}	I_{SET} = 100µA	3			V

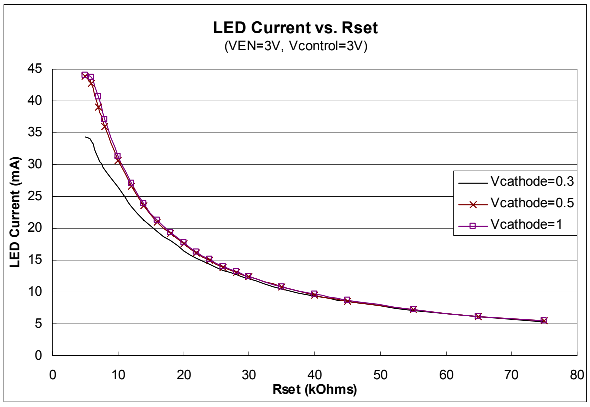
Typical Performance Characteristics

V_{IN}=3.3 to 5.5V, V_{EN}=3V, T_A=25°C, unless otherwise noted. V_F is LED forward voltage.

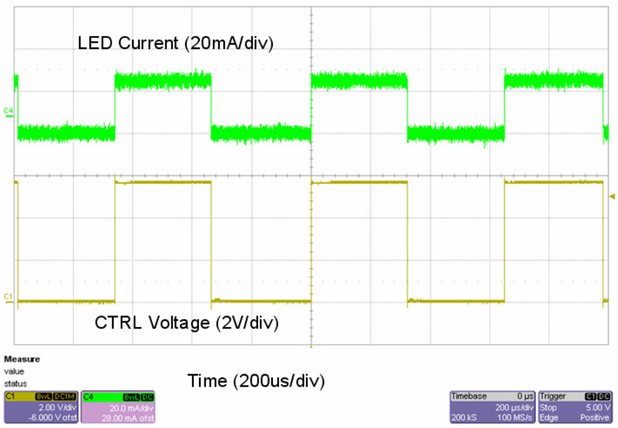




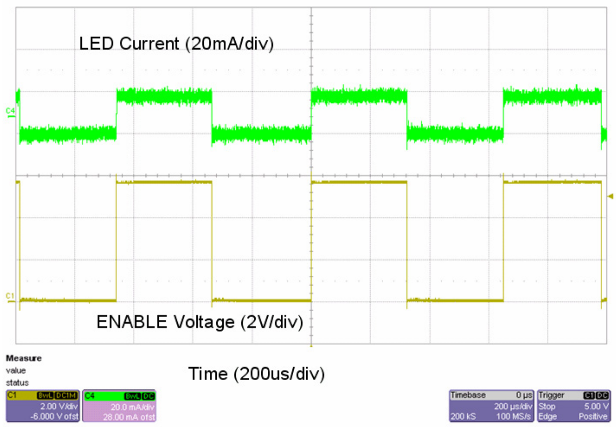




Control Voltage Transient Response



Enable Voltage Transient Response



Application Information

Analog Dimming Control Table

Table 4
V_{EN}=3V, $V_{CONTROL}$=3V

I_{LED} (mA)	R_{SET} (kΩ)
5	75
10	34
15	24
20	17.4
25	13

Table 5
V_{EN}=3V, R_{SET}=17.4k

I_{LED} (mA)	$V_{CONTROL}$ (V)
5	1.5
10	2.1
15	2.5
20	3
25	3.6

Setting the LED Current

The LED current can be set by the control voltage and the R_{SET} resistor from the following equation.

$$I_{LED}=200\times(V_{CONTROL}-V_{CTR})/R_{SET}$$

The suggested values and relations between $V_{CONTROL}$ and R_{SET} can also be found in the diagram of typical characteristics and table 4 and table5. The LED brightness can be controlled by either the above equation or applying a PWM signal to the EN pin. The driving signal frequency should be greater than 100Hz to avoid flickering, and increased to more than 1MHz if necessary.

Efficiency Considerations

The YB1303 featured low drop out can achieve excellent efficiency performance. The efficiency is mainly dominated by V_{LED} voltage. The lower the V_{LED} voltage, the higher the system efficiency. The system efficiency can be calculated as follows:

$$Efficiency = (V_{IN}-V_{CATHODE}) / V_{IN}$$

Thermal Considerations

At any given ambient temperature, the maximum package power dissipation can be determined by the following equation:

$$P_{D(MAX)} = [T_{J(MAX)}-T_A] / \theta_{JA}$$

Constraints for the YB1303 are maximum junction temperature $T_{J(MAX)}$=125℃, and package thermal resistance, θ_{JA}=300℃/W. The maximum total LED current for YB1303 depends on package power dissipation and the LED cathode voltage at $T_{J(MAX)}$. At 85℃, $P_{D(MAX)}$=133mW. At T_A = 25℃, $P_{D(MAX)}$=333mW.
The maximum current is calculated by the following equation:

$$I_{LED} < (P_{D(MAX)} / V_{LED(MAX)})$$

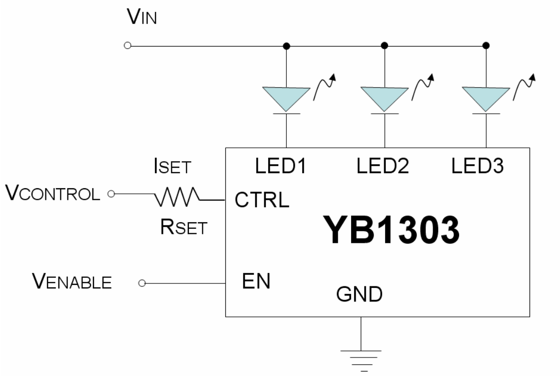
For example, if I_{LED} = 60mA, and T_A = 85℃, $V_{LED(MAX)}$ = 2.2V.
If the ambient temperature were to increase, the internal die temperature would increase, and the device would be damaged.

Application Examples

The ultra-low voltage drop across the YB1303 allows the devices to drive white, blue and any color LEDs in a wide range of input voltages. The driver can be used in many applications presented in this document, due to their similar operation.

Example 1:
Drive low V_F white or blue LEDs directly from single cell Li-Ion battery

When using white or blue low V_F LEDs, and utilizing the driver's low voltage drop, only 3.4V in V_{IN} is needed for the full 20mA LED current. At 3.2V, there is still 5mA typical current available for the LEDs. The single cell Li-Ion battery is utilized in many applications like cell-phones and digital still cameras. In most cases, the Li-Ion battery voltage level only goes down to 3V, and not down to the full discharged level (2.7V) before requesting the charger.



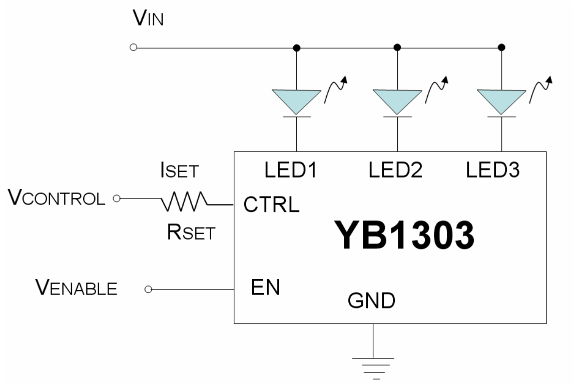
-V_{DROP} < 0.3V
-V_F (@20mA) < 3.1V (Low V_F)
-V_{IN} (@20mA) = -V_{DROP}+V_F=3.4V
-V_{IN} (@5mA typical) ~3.1V
Where V_{IN} = Single cell Li-Ion Voltage

Key advantages:

- No boost circuit needed for the LCD or keyboard backlight.
- Drivers directly connected to a Li-Ion battery.
- No EMI, no switching noise, no boost efficiency lost, no capacitor and no inductor.

Example 2:
Drive high VF white or blue LEDs from exiting bus from 4.0V to 6V

High V_F white or blue LEDs have forward voltage drop in the range of 3.2V to 4.0V. To drive these LEDs with the maximum current of 20mA for maximum brightness, usually requires a boost circuit for a single cell Li-Ion voltage range. In some cases, there is already a voltage bus in the system, which can be utilized. Due to the ultra-low voltage drop of the YB1303 to drive high V_F white or blue LEDs, the V_{IN} needs to be only 300mV higher than the highest V_F in the circuit.



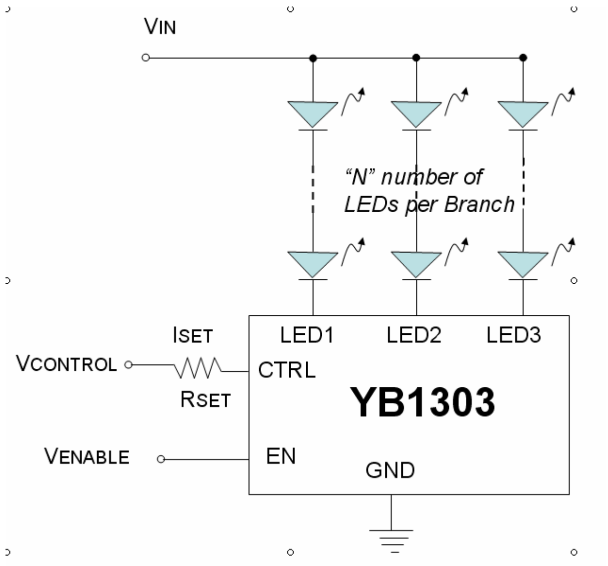
-V_{DROP} < 0.3V
-V_F (@20mA) < 3.3V to 4.0V (High V_F)
-V_{IN} (@20mA) = -V_{DROP}+V_F=3.6V to 4.3V
-V_{IN} (@5mA typical) ~3.3V
Where V_{IN} = Existing bus = 3.3V to 4.3V

Key advantages:

- No boost circuit needed for the LCD or keyboard backlight.
- Driver utilizes the existing bus.
- Ultra-low voltage drop provides the full 20mA LED current at the lowest possible voltage level.

Example 3:
Drive white, blue, red, amber LEDs string

Assuming boost circuit, or existing voltage bus, the YB1303 can be used to drive a whole string of LEDs and flexible brightness control – whether using analog or PWM (Notes).



-V_{DROP} < 0.3V

-$V_{IN\_MIN} = N \times V_F + V_{DROP}$

- $V_{IN\_MAX} = N \times V_F + 6V$

-V_{IN} (@5mA typical) ~3.3V

Where V_{IN} = Existing Bus / Boost Voltage

Key advantages:

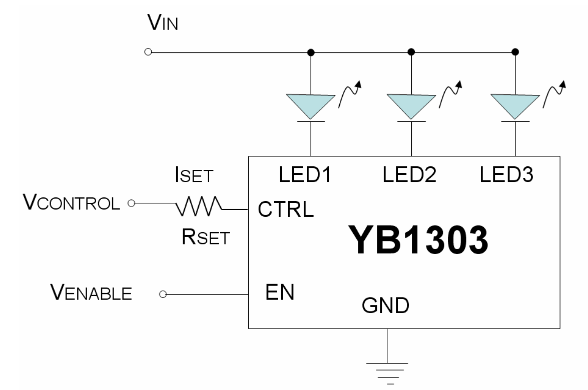
- No need for current matching resistors and discrete transistor for brightness control.

Notes:

1. Whether using analog or PWM signal, please notice to avoid from exceeding the absolute maximum rating claimed in this document.
2. EN must be turned on prior to V_{IN} (delivered by boost circuit or existing bus) and avoid from V_{IN} > 6V when EN is off.

LED Brightness Control

The YB1303 LED drivers feature analog and PWM controls to give designers flexible brightness control. These control methods can be applied to the circuit in two different ways which provide flexible solution. To determine the value of R_{SET}, use the "I_{SET} vs. V_{CTR}" graph under the "typical characteristics" section.



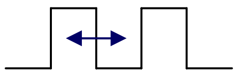
Scenario 1 - Analog

Set $V_{CONTROL}$ and R_{SET} for LED current

$I_{LED}=200 \times (V_{CONTROL}-V_{CTR})/R_{SET}$

Scenario 2 – PWM - 1

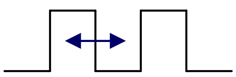
$I_{LED}=200 \times (V_{CONTROL}-V_{CTR})/R_{SET}$

$V_{CONTROL}$ = PWM 

- Amplitude sets maximum LED current
- Pulse width controls between 0 and maximum

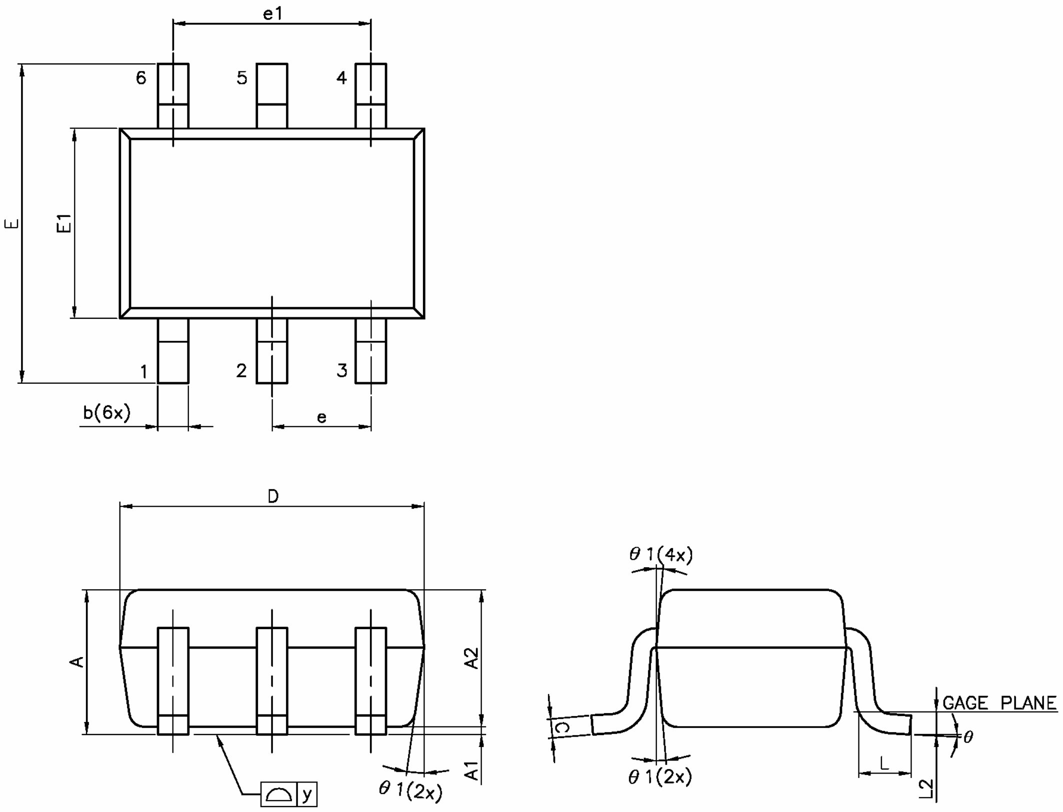
Scenario 3 – PWM - 2

$I_{LED} \sim 200 \times I_{SET}$

V_{EN} = PWM 

- Amplitude has no effect on current
- Pulse width controls between 0 and maximum

Package Information (SC70-6)



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	——	1.10	0.031	——	0.043
A1	0.00	——	0.10	0.000	——	0.004
A2	0.70	0.90	1.00	0.028	0.035	0.039
b	0.15	——	0.30	0.006	——	0.012
C	0.08	——	0.22	0.003	——	0.009
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E1	1.15	1.25	1.35	0.045	0.049	0.053
e	——	0.65	——	——	0.026	——
e1	——	1.30	——	——	0.051	——
L	0.26	0.36	0.46	0.010	0.014	0.018
L2	——	0.15	——	——	0.006	——
y	——	——	0.10	——	——	0.004
θ	0°	4°	8°	0°	4°	8°
θ_1	4°	——	12°	4°	——	12°

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