LN9358

Ultra Low-Dropout, Constant-Current White LED Bias

■ General Description

The LN9358 is a high performance ultra low- dropout constant current bias supply for white LEDs. It can be used as an alternative to the simple ballast resistors in conventional parallel white LEDs applications.

It's in the voltage range of 2.5V~6V to provide a stable 11 roads 20mA current input, no external capacitance , no inductance resistors, no noise and small size. LN9358 not only provide PWM brightness control, but also provide single-wire serial mode for 16 level linear current brightness control.

The LN9358 is suitable for single cell Li-ion battery power device that using low forward voltage white LEDs. The white LEDs can be powered directly from battery without extra external components. This takes an advantage of highest efficiency and creates no EMI problem.

■ Features

- 11 channals output
- Ultra Low 60mV dropout at 20mA
- 0.5% High Accuracy Current Matching
- 20mA Full Scale Current
- 16 Level Linear Current Brightness Control
- PWM Brightness Control
- 2.5V to 6.0V Supply Voltage Range
- Thermal shutdown function
- Under-voltage protection function

■ Applications
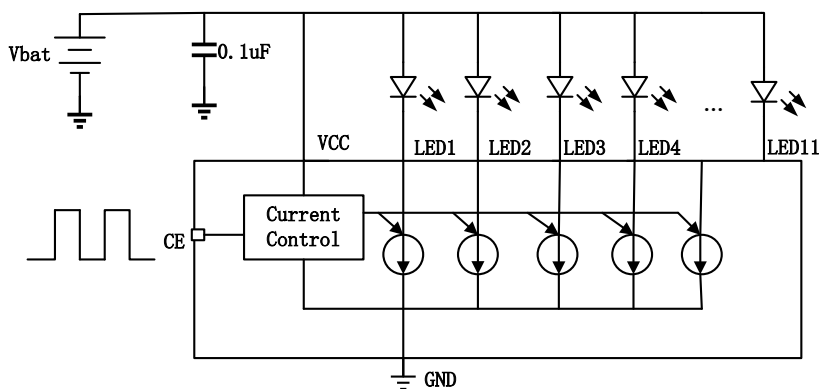
- Mobile Phones
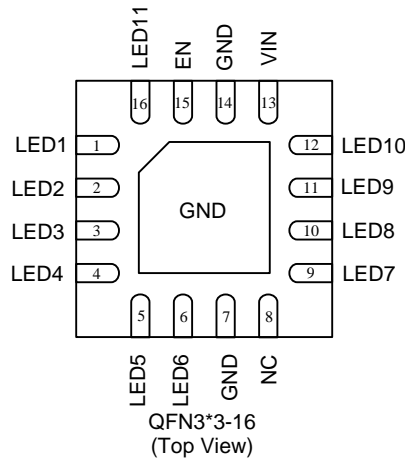- MP3
- White LED backlighting

■ Package

- QFN3×3-16

■ Ordering Information

LN9358 ①② **(Eg:** LN9358QR**)**

Item	Symbol	Function
①	S	Package Type: SOP-16
	Q	Package Type: QFN33-16
	M	Package Type: MSOP16
	T	Package Type: TSSOP16
②	D	Customer ordered
	R	Embossed Tape :Standard Feed
	L	Embossed Tape :Reverse Feed

■ Function Block Diagram

■ Functional Pin Description

QFN3*3-16
(Top View)

Pin Number	Pin Name	Function Description
1,2,3,4,5,6,9,10,11,12,16	LEDX	LEDX bias current input
7，14	GND	Ground
13	VIN	Power supply
15	EN	Enable Dimming control, can input PWM or waveform signal.
8	N.C.	Not connect
Expose PAD	GND	Ground

■ Absolute Maximum Ratings

(Ta=25°C)

Item	Symbol	Absolute maximum ratings	Unit
VIN to GND	V_{IN}	GND-0.3～GND+7	V
EN to GND	V_{EN}	GND-0.3～V_{CC}+0.3	V
Operating Temperature range	Topr	-40～+85	℃
Storage Temperature range	Tstg	-65～+150	
Reflow Temperature (soldering, 10sec)	Tref	260	

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage.

These values must therefore not be exceeded under any conditions.

■ Electrical Characteristics

VIN= 3.6V，EN=3.6V   (Ta=25℃, unless otherwise noted)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Units
Input Supply Voltage	V_{IN}		2.5		6.0	V
Under voltage Lockout Threshold	V_{UVLO}		-	2.1	-	V
Current into LED 1,2,3 and 4	I_{LED}	MAX I_{LED}	18	20	22	mA
Shutdown Current	I_{SHDN}	V_{IN}=5V, EN=0V	-1	-	+1	µA
Quiescent Current	I_Q		-	1000	-	µA
LED Pin Voltage Dropout	$V_{LED-DROP}$	V_{LED}(DROP), 90% Max I_{LED}		60	80	mV
Output Current Line Regulation	ILED-LINEAR	V_{LED} = 0.5V~2V	-1	-	+1	%/V
Current Matching	ILED-LED-ERR	2mA < I_{LED}< 20mA	-5	-	+5	%
Thermal Shutdown Threshold				150		℃
EN Pin Input Voltage High	V_{IH}		1.2	-	-	V
EN Pin Input Voltage Low	V_{IL}		-	-	0.8	V
EN Pin Input Current	I_{EN}		-1	-	+1	µA
EN Pin Off Timeout	T_{OFF}		40	120	200	µS
EN Pin End of Pulse Timeout	T_{EOP}		40	120	200	µS
EN Pin Pulse High Time	T_{HIGH}		5	-	30	µS
EN Pin Pulse Low Time	T_{LOW}		5	-	30	µS

(*1)   Vfbt may take between 0.01V-1.49V certain value, now a major center value 0.01V, 0.2V,0.23V,0.25V

■ Typical Application Circuit

● **PWM brightness or waveform pulse brightness application circuit**
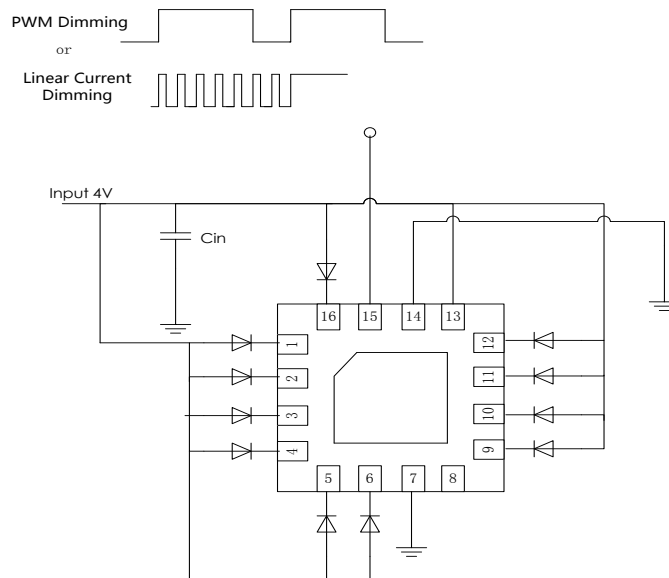
■ Function Description

LN9358 LED pins act as well matched current source driving LED diode to ground. An EN pin is used to turn on and turn off LN9358.When applying a lower frequency (less than 1KHz) PWM waveform to EN pin, the average LED current will be duty× 20mA(typical). Refer to Fig.1
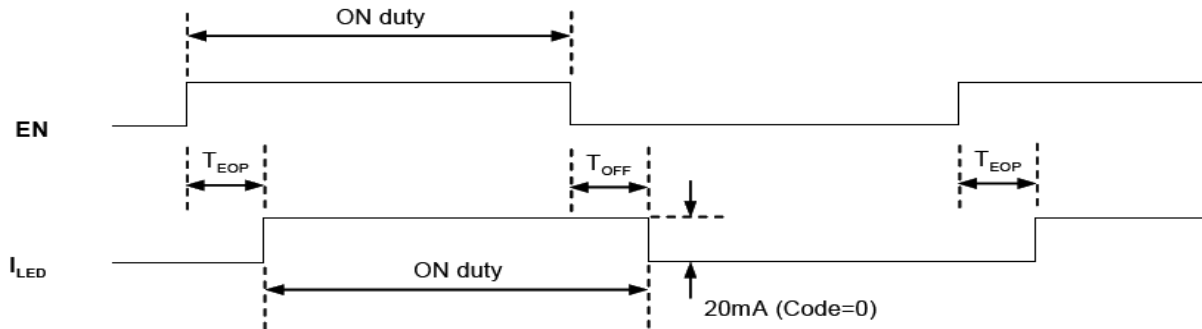

Fig1. Turn On To PWM Dimming

EN pin can also input the negative pulse to set the continuous LED current, suggesting pulse frequency using 25K~ 40K. Input pulse set the current, EN pin maintain high level can maintain the brightness. When no initial input pulses, internal registers Set the maximum LED current (CODE = 0), usually 20mA, After inputing N pulses, EN maintains high about 120μS, register will be set up to the corresponding N LED current level, usually for $\dfrac{16 - N}{16} \times 20$ mA, and reference below chart and typical chart.
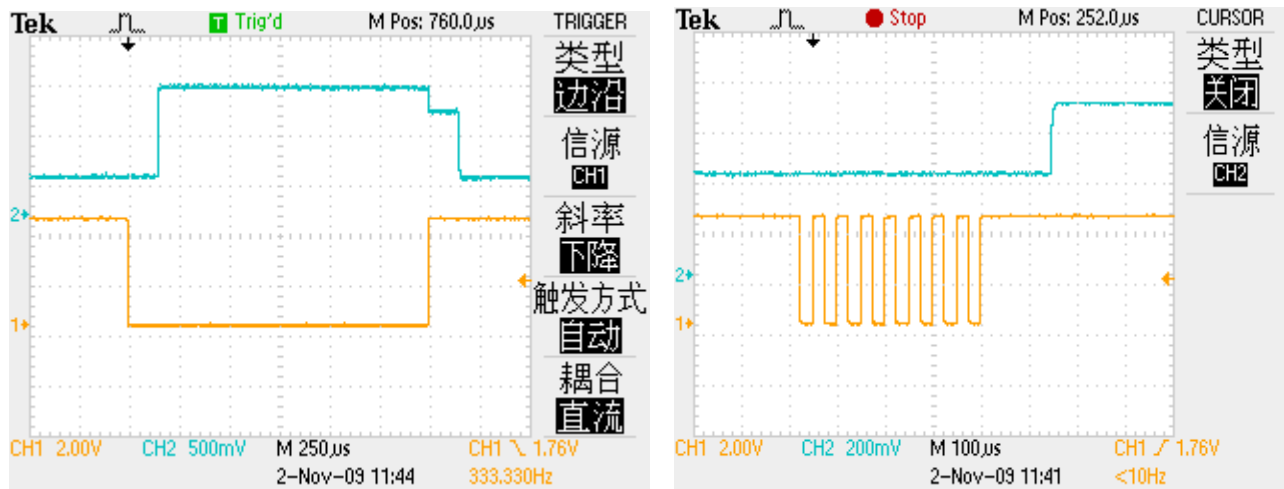
Note: the yellow as CTRL waveform，Blue is the LED voltage waveform，the below is in the same way.

If the application is not suitable to apply such a low frequency PWM dimming waveform, this EN pin can be negatively pulsed to set continuous LED current. When no negative pulse is input to EN pin (Code=0), the internal register will latched to set the maximum LED current, typically 20mA. Whenever input N negative pulses to the EN pin, it will get a LED current corresponding to Code N. In this manner, LED current will changed from previous value to new value after the last pulse for typical 80μs (TEOP). Please refer to Fig.2
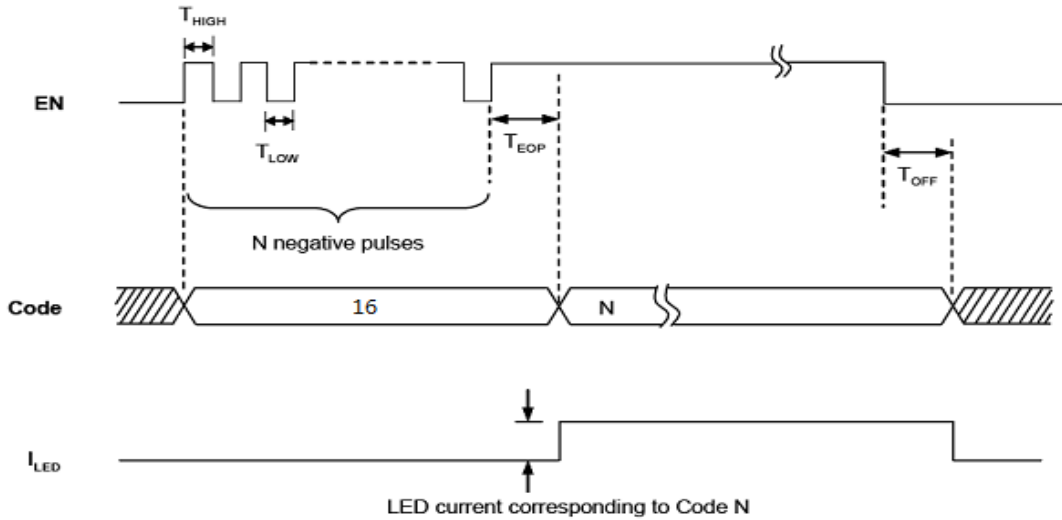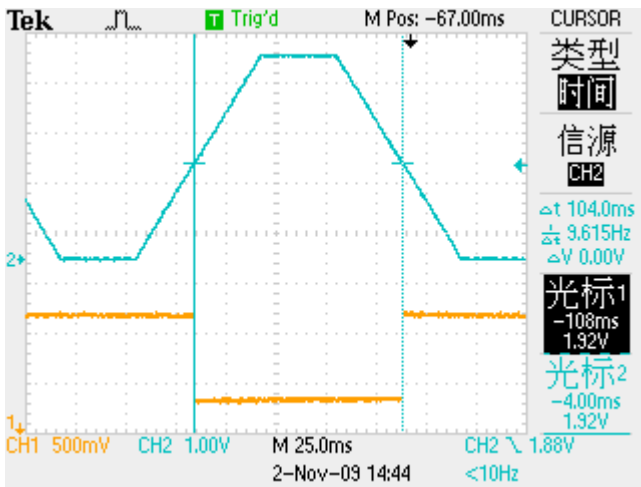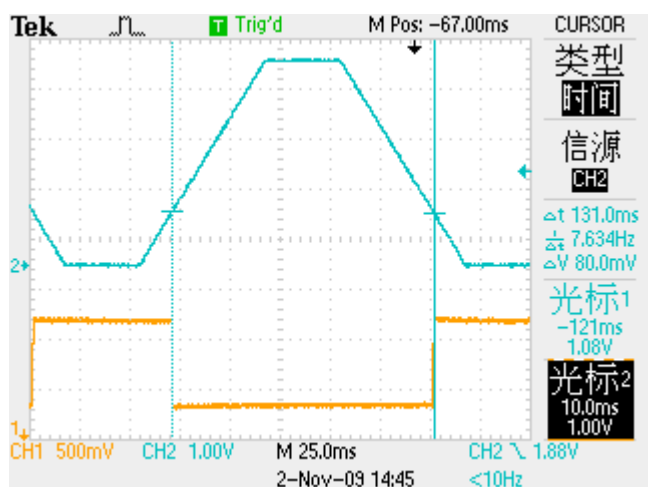
Fig2. Turn On And Config Code N

**The effective level waveform about EN Pin**

Under-Voltage protection waveform

Note: once after the input, must ensure that the EN pin keep high level, or setting brightness will change. Maintain a high level of EN after a period of time, the internal counter has cleared, but the latches maintain the LEDs brightness have not unchanged. If you want to adjust current , please input from CODE = 0. The EN pin matain low-level longer than a certain time Toff, the chip off into save electricity mode.
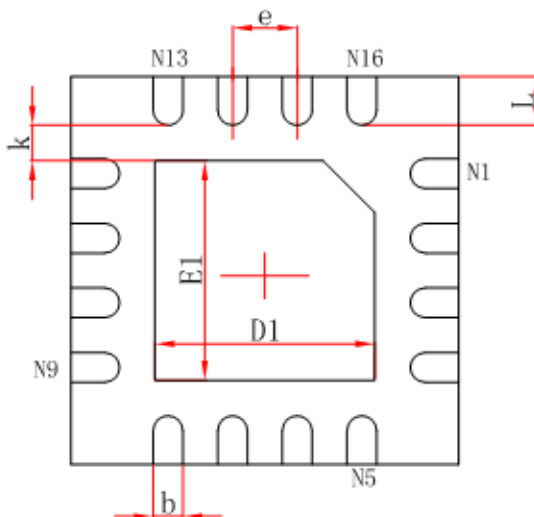
Above current and code corresponding relation is a design, individual differences between the different temperature, voltage and current inaccurate will lead to the Current is not accurate. Please use the actual measurement results.
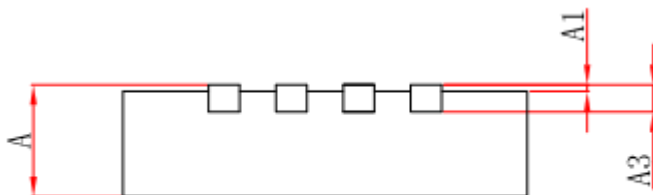
■ Package Information

● QFN3×3-16
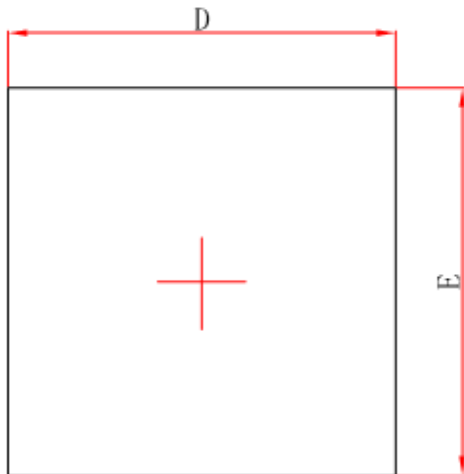
Top View

Bottom View

Side View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
D1	1.600	1.800	0.063	0.071
E1	1.600	1.800	0.063	0.071
k	0.200MIN.		0.008MIN.	
b	0.180	0.300	0.007	0.012
e	0.500TYP.		0.020TYP.	
L	0.300	0.500	0.012	0.020