Ultra Low-Dropout, Constant-Current White LED Bias

■ General Description

The LN5921 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. For dimming control, an enable input pin is controlled by processor GPIO output pulses for 32 level linear current. Using a low frequency PWM waveform to this enable input pin also controls the average LED current which is proportional to the PWM duty.

The LN5921 is suitable for single cell Li-ion bat-tery 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

- Ultra Low 200mV Dropout at 20mA
- 0.6% High Accuracy Current Matching
- 20mA Full Scale Current
- 32 Level Linear Current Brightness Control
- PWM Brightness Control
- 2.5V to 5.5V Supply Voltage Range
- Thermal shutdown function
- Under-voltage protection function

■ Package

- SOT-23-8L
- MSOP-8
- QFN3×3-16

■ Applications

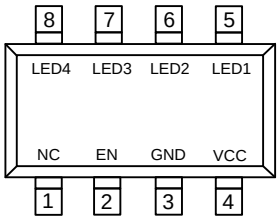
- Mobile Phones
- White LED backlighting
- Camera Flash LED Lighting

■ Ordering Information

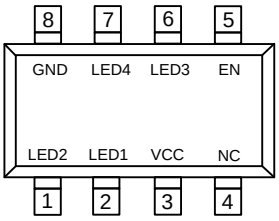
LN5921 ①② **(Eg:** LN5921SR**)**

Item	Symbol	Function
①	S	Denotes Package Type: SOT23-8L
	Q	Denotes Package Type: QFN3×3-16
	M	Denotes Package Type: MSOP-8
②	D	Customer requirements
	R	Embossed Tape :Standard Feed
	L	Embossed Tape :Reverse Feed

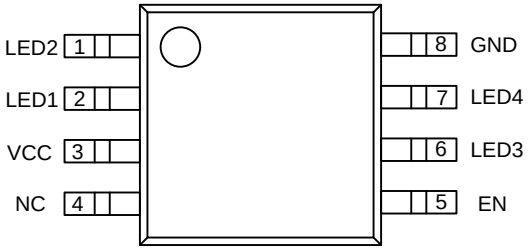
■ Pin Assignment



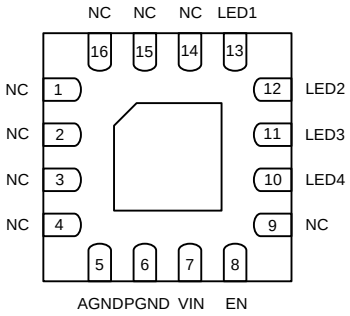
LN5921SD(SOT-23-8)



LN5921SR(SOT-23-8)



LN5921MR(MSOP-8)



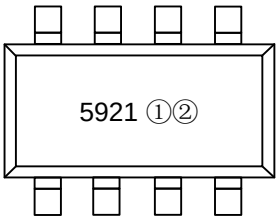
LN5921QR(QFN3*3-16)

■ Functional Pin Description

Pin Number				Pin Name	Function
SD	SR	MR	QR		
6	1	1	12	LED2	LED2 bias current input.
3	8	8	5，6	GND	Ground.
7	6	6	11	LED3	LED3 bias current input.
2	5	5	8	EN	Enable Dimming control.
4	3	3	7	VCC	Power supply.
5	2	2	13	LED1	LED1 bias current input.
8	7	7	10	LED4	LED4bias current input.
1	4	4	1，2，3 4，9，14 15，16	NC	No connect

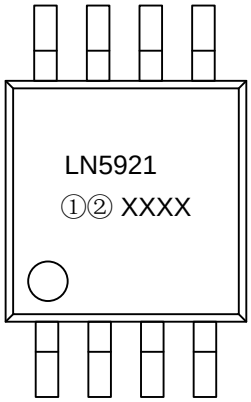
■ Marking Rule

- **SOT-23-8(LN5921SR/SD)**



Eg：LN5921AC

MSOP-8(LN5921MR)

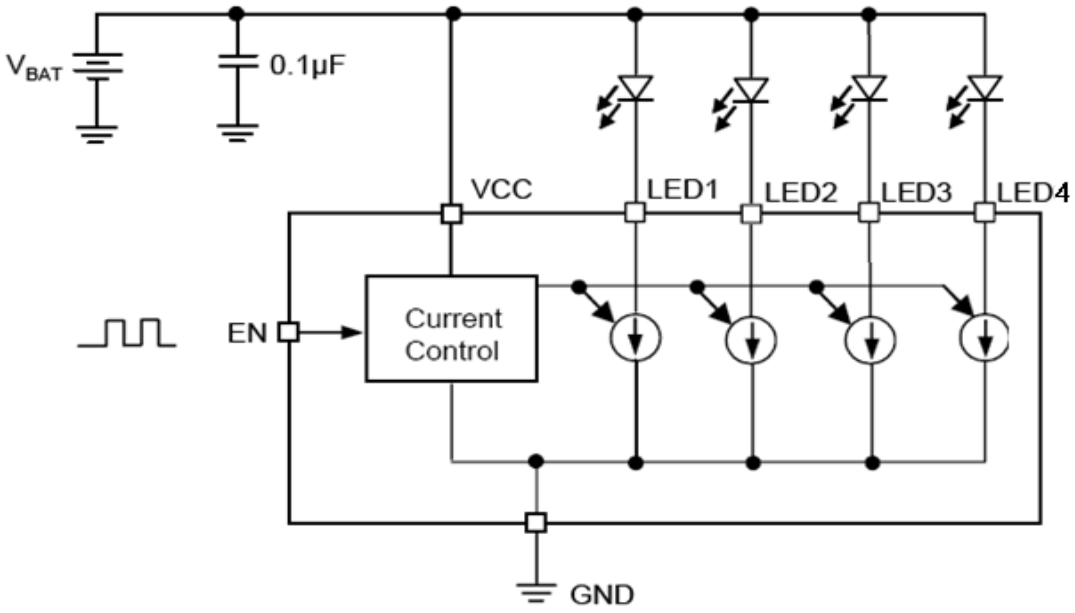


LN5921
AC091

QFN3*3-16(LN5921QR)

LN5921
AC0903

■ Function Block Diagram



■ Absolute Maximum Ratings

(Ta=25°C)

Item	Symbol		Absolute maximum ratings	Unit
VCC to GND	V_{CC}		GND-0.3～7	V
EN to GND	V_{EN}		GND-0.3～V_{CC}+0.3	V
LED1,LED2,LED3 to GND	V_{LED}		GND-0.3～GND+0.3	V
Power Dissipation	P_D	SOT-23-6	250	mW
		MSOP-8	500	
		QFN3×3-16	1000	
Operating Temperature range	Topr		-40～＋85	℃
Junction Temperature	Tjun		125	
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.

■ Function Description

LN5921 LED pins act as well matched current source driving LED diode to ground. An EN pin is used to turn on and turn off LN5921.When applying a lower frequency (less than 2kHz) PWM waveform to EN pin, the average LED current will be duty*20mA(typical). Refer to Fig.1

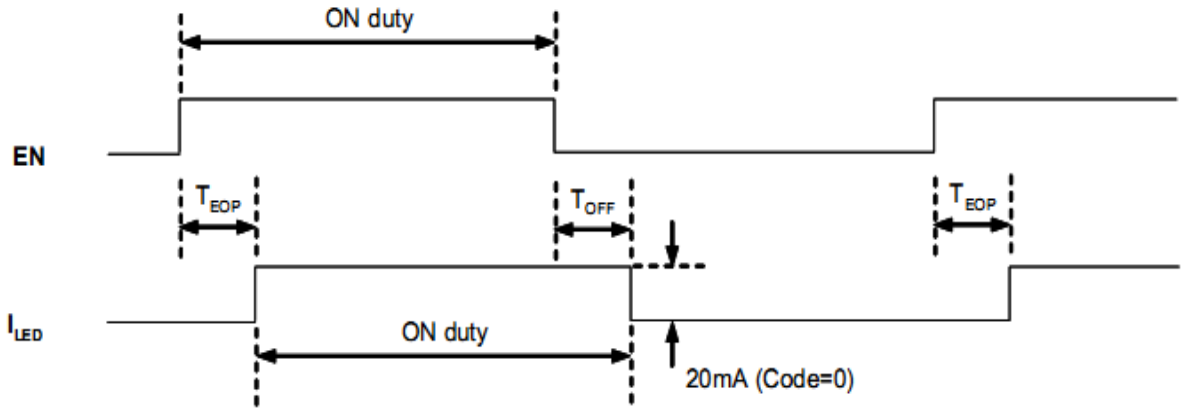


Fig1. Turn On To PWM Dimming

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

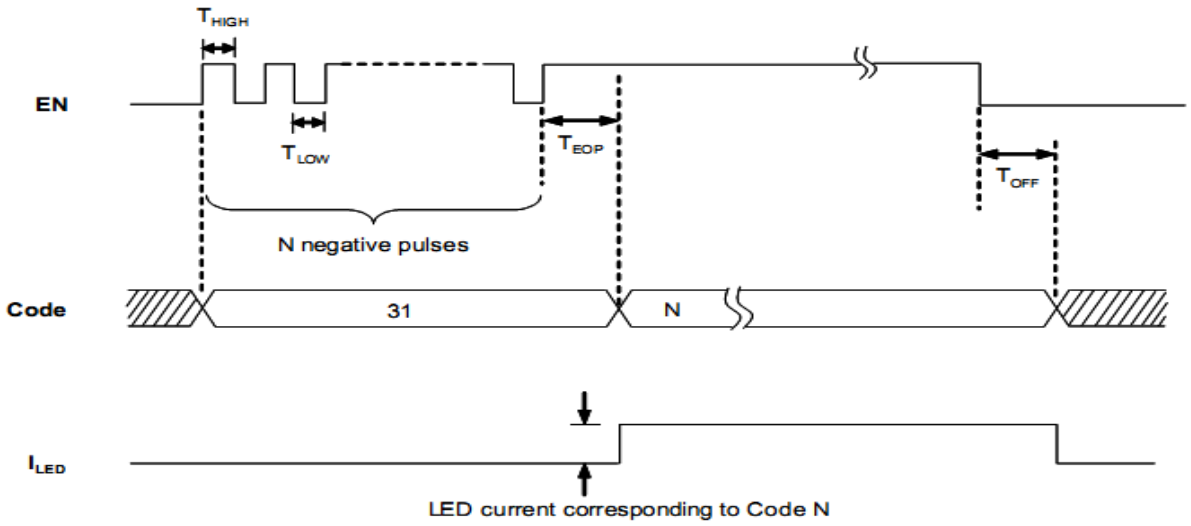
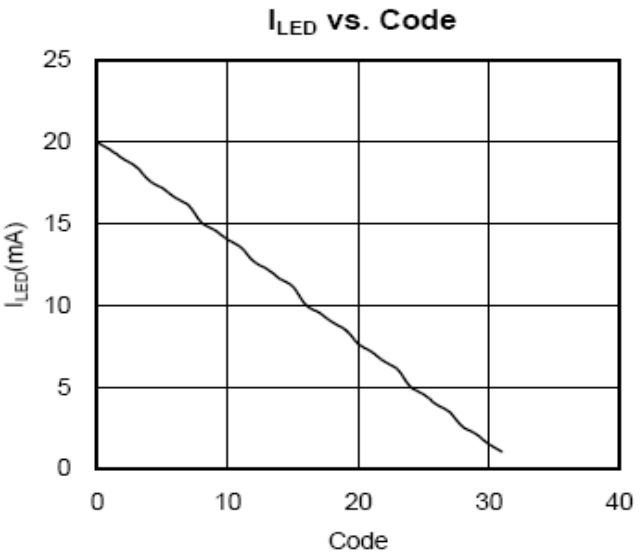


Fig2. Turn On And Config Code N

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.

- **Code And Current Trend Of Corresponding Table**

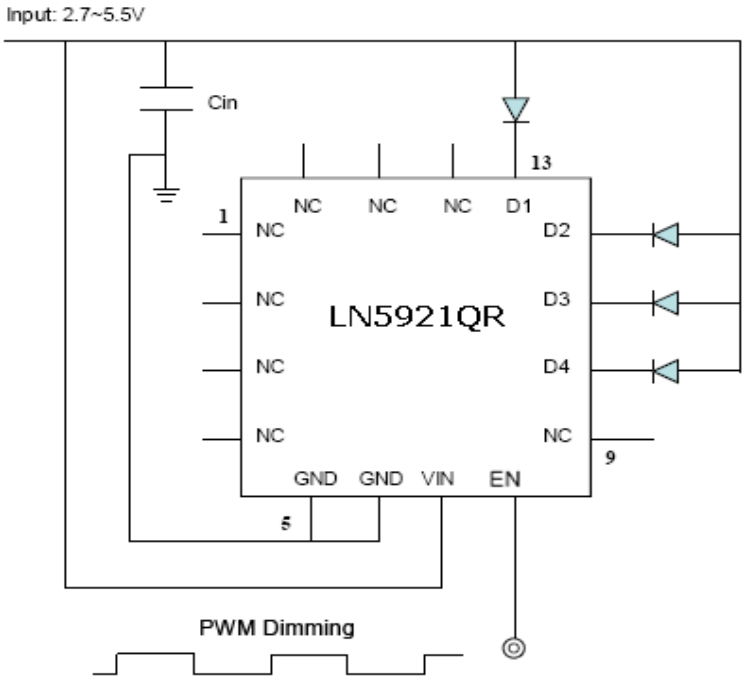
CODE	I（mA）	CODE	I（mA）
0	20.0	16	10.0
1	19.375	17	9.375
2	18.75	18	8.75
3	18.125	19	8.125
4	17.5	20	7.5
5	16.875	21	6.875
6	16.25	22	6.25
7	15.625	23	5.625
8	15.0	24	5.0
9	14.375	25	4.375
10	13.75	26	3.75
11	13.125	27	3.125
12	12.5	28	2.5
13	11.875	29	1.875
14	11.25	30	1.25
15	10.625	31	0.625



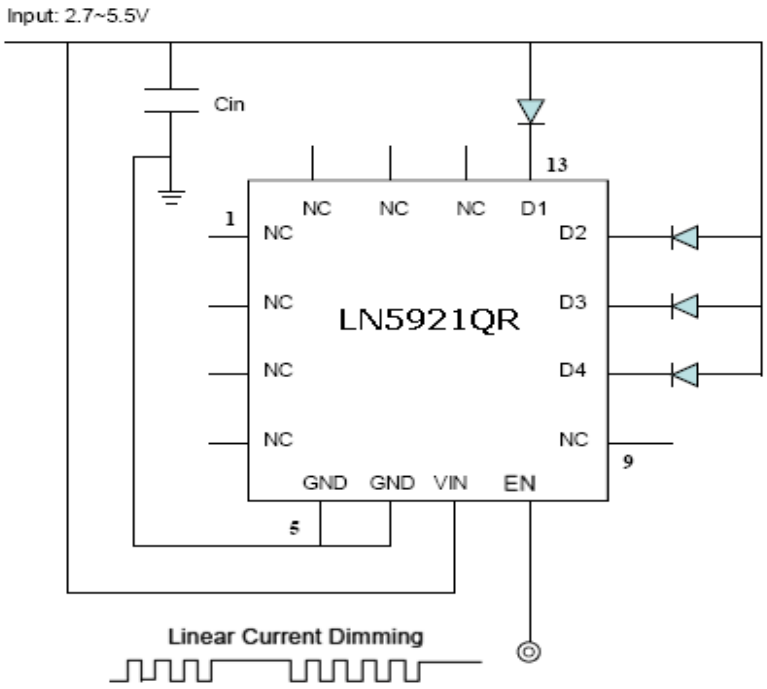
Above current and code corresponding relation is a design, individual differences between the different temperature, voltage and current inaccurate will lead to the Current is not accurate. Please use the actual measurement results.

■ Typical Application Circuit

- **PWM brightness mode (For example with LN5921QR, other packages are similar to it.)**



- **32 linear current brightness adjustment mode(For example with LN5921QR, other packages are similar to it.)**



■ Electrical Characteristics

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

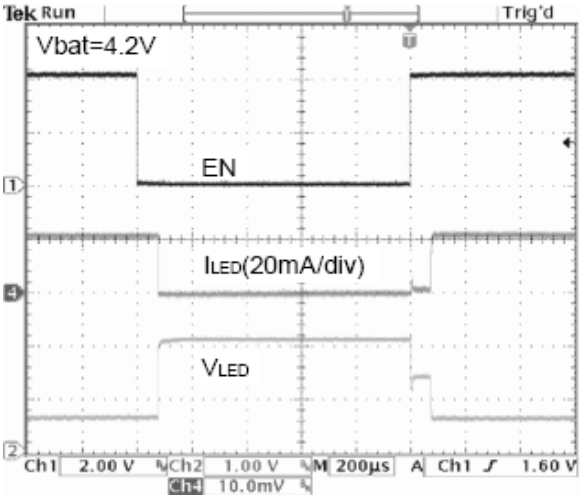
Parameter	Symbol	Test Condtion	Min.	Typ.	Max.	Units
Input Supply Voltage	VI_N		2.5		5.5	V
Undervoltage Lockout Threshold	V_{UVLO}		-	1.8	-	V
Current into LED 1,2,3 and 4	I_{LED}	MAX ILED	18	20	22	mA
Shutdown Current	I_{SHDN}	VIN=5V, EN=0V	-1	-	+1	μA
Quiescent Current	I_Q			180	230	μA
LED Pin Voltage Dropout	$V_{LED-DROP}$	VLED(DROP), 90% Max ILED		150	200	mV
Output Current Line Regulation	$I_{LED-LINEAR}$	VLED = 0.5V~2V	-0.6	-	+0.6	%/V
Current Matching	$I_{LED-LED-ERR}$	2mA<ILED<20mA	-4	-	+4	%
Thermal Shutdown Threshold				150		℃
EN Pin Input Voltage High	V_{IH}		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	80	200	μS
EN Pin End of Pulse Timeout	T_{EOP}		40	80	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

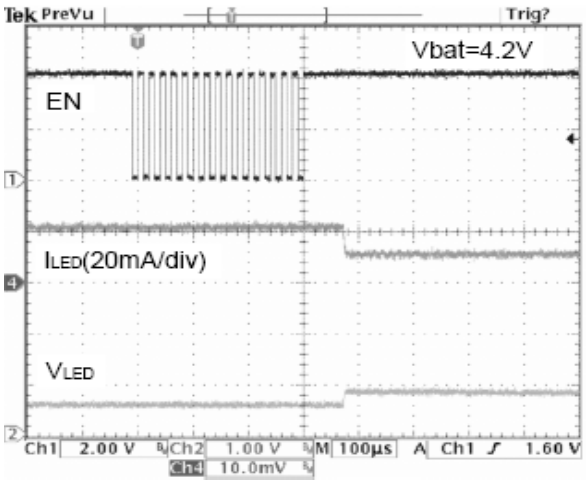
■ Typical Performance Characteristics

(VCC =VEN =3.6V, VLED=0.5V, T=25°C, unless otherwise noted.)

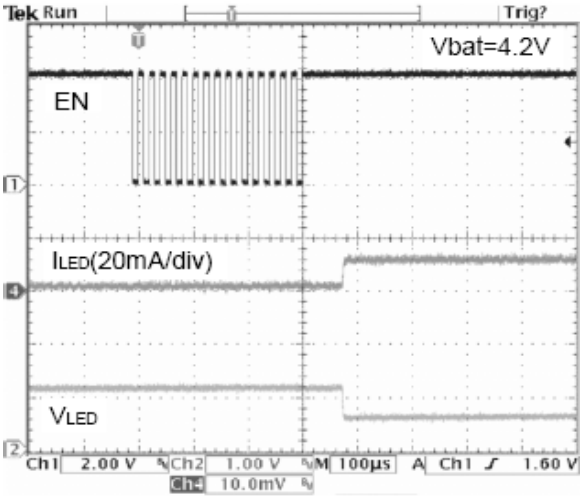
PWM Diming Waveform



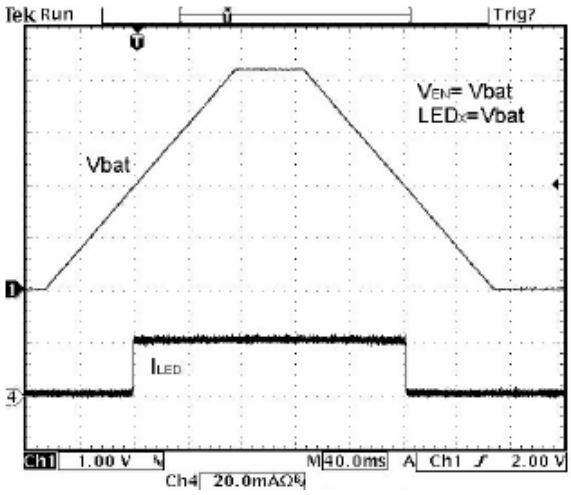
Linear Dimming Waveform I



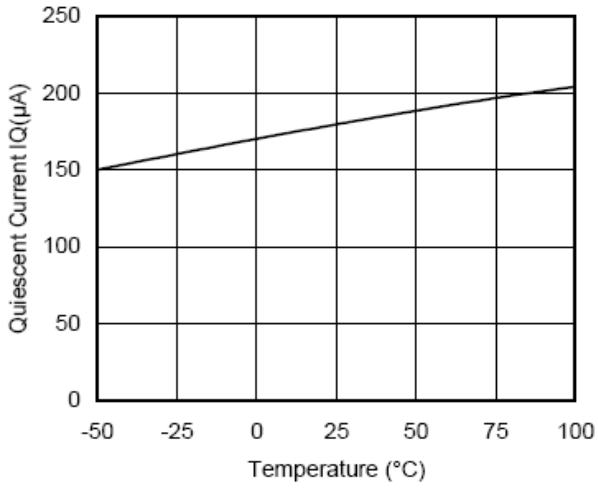
Linear Dimming Waveform II



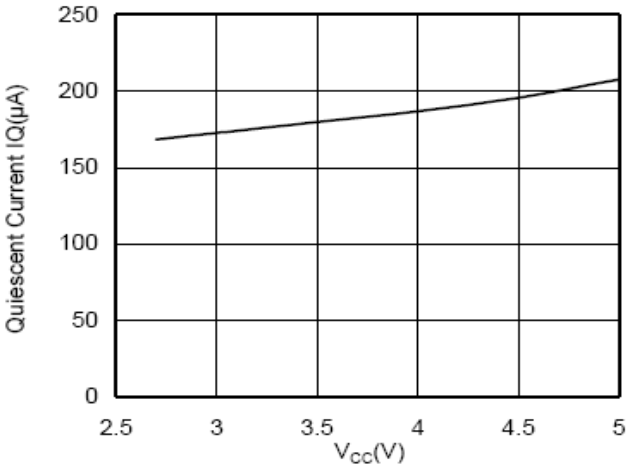
Input Voltage UVLO

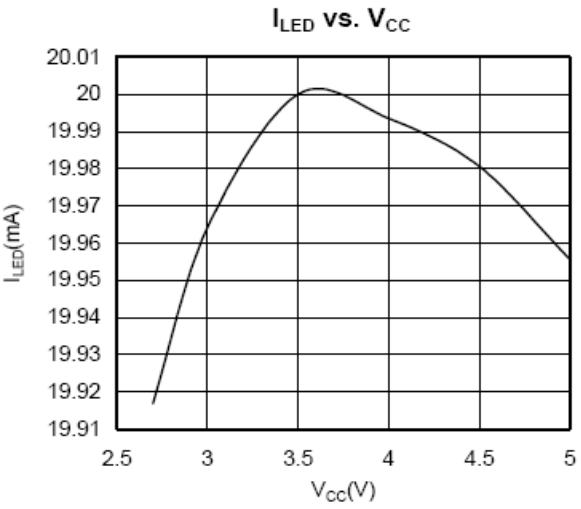


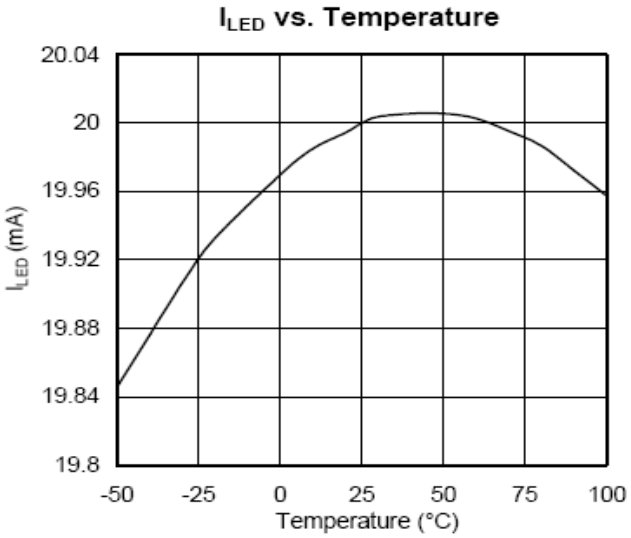
Quiescent Current vs. Temperature

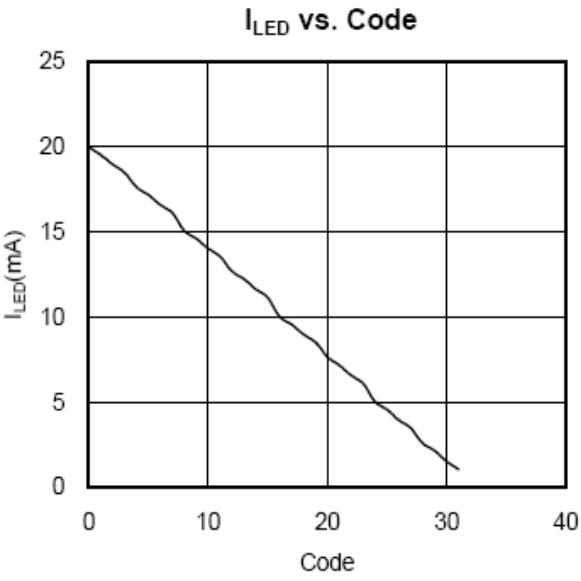


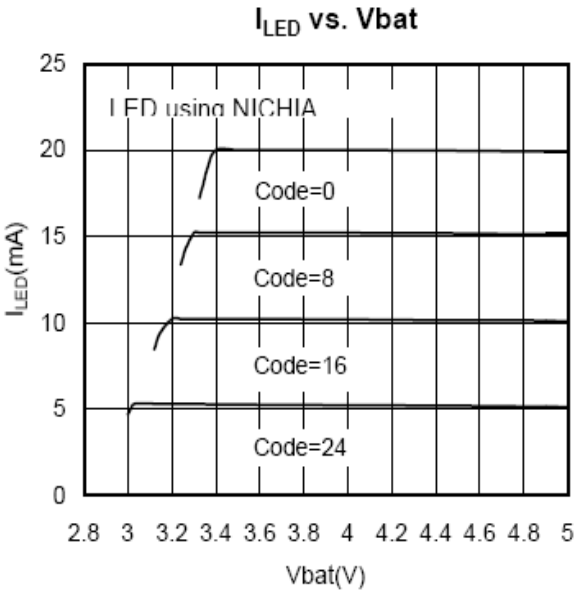
Quiescent Current vs. V_{CC}




I_{LED} vs. V_{CC}
20.01
20
19.99
19.98
19.97
19.96
19.95
19.94
19.93
19.92
19.91
I_{LED}(mA)
2.5
3
3.5
4
4.5
5
V_{CC}(V)

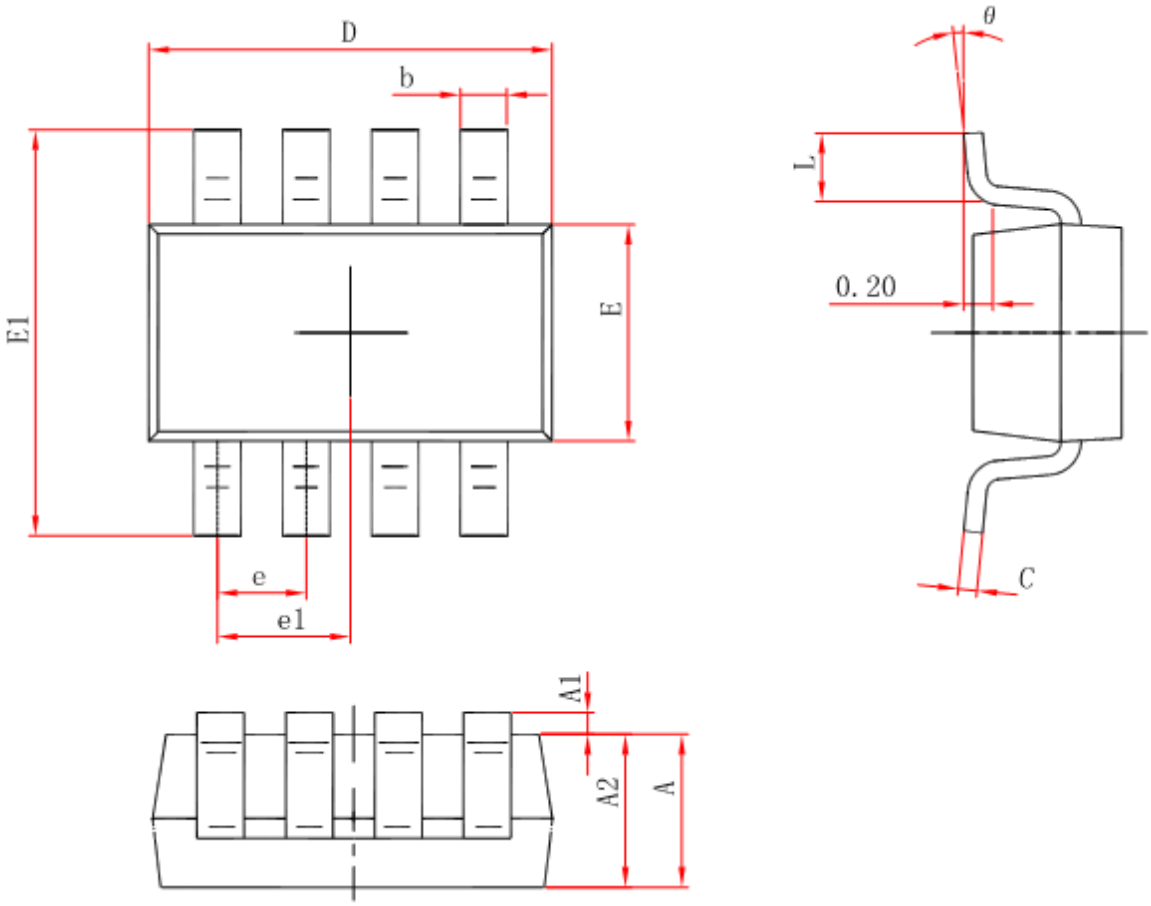

I_{LED} vs. Temperature
20.04
20
19.96
19.92
19.88
19.84
19.8
I_{LED} (mA)
-50
-25
0
25
50
75
100
Temperature (°C)


I_{LED} vs. Code
25
20
15
10
5
0
I_{LED}(mA)
0
10
20
30
40
Code


I_{LED} vs. Vbat
LED using NICHIA
Code=0
Code=8
Code=16
Code=24
25
20
15
10
5
0
I_{LED}(mA)
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
5
Vbat(V)

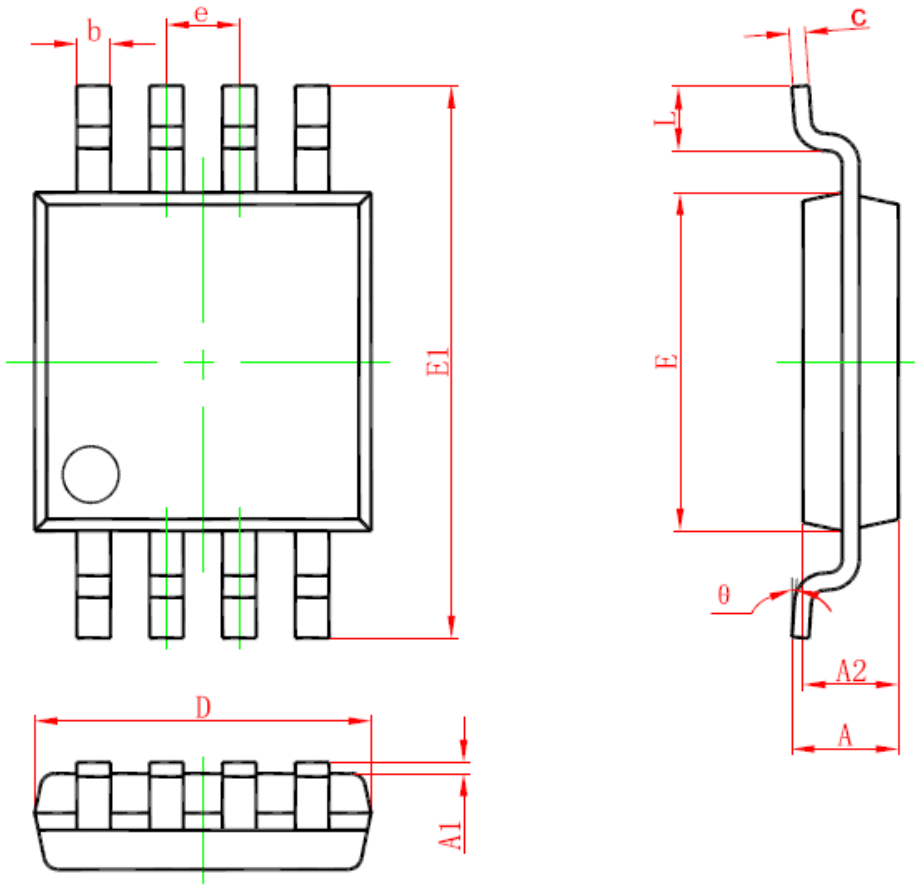
■ Package Information

- **SOT-23-8L**



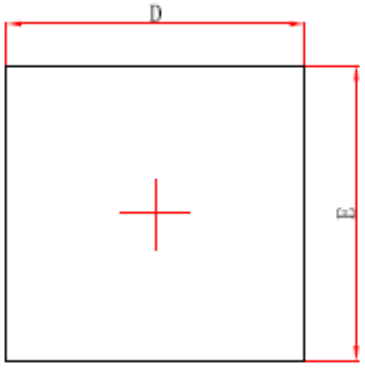
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.65（BSC）		0.026(BSC)	
e1	0.975（BSC）		0.038(BSC)	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

- **MSOP-8**

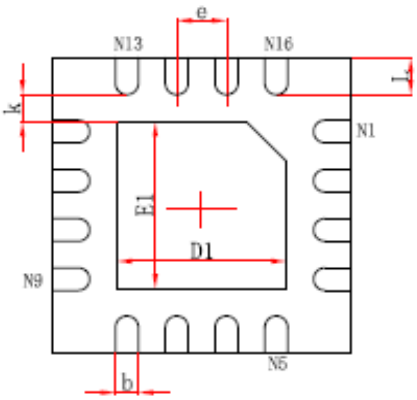


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

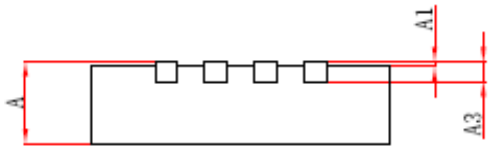
- **QFN3*3-16**



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