



LC1984

PWM or Singl-Wire Dimming, 4-Channels WLED Linear Driver

DESCRIPTION

The LC1984 is a CMOS based White/Blue LED driver with stand-alone capability. The driver is primarily designed for LED backlighting of LCD display powered by Li-ion battery. With its high efficiency, low standby current and wide range of input supply voltage, the LC1984 is suitable for applications such as portable device display and keypad backlighting. There are four identical channels in LC1984, each of which can drive one LED by current rating of 20mA.

LC1984 is available with MSOP-8 or QFN 3X3 -16 package

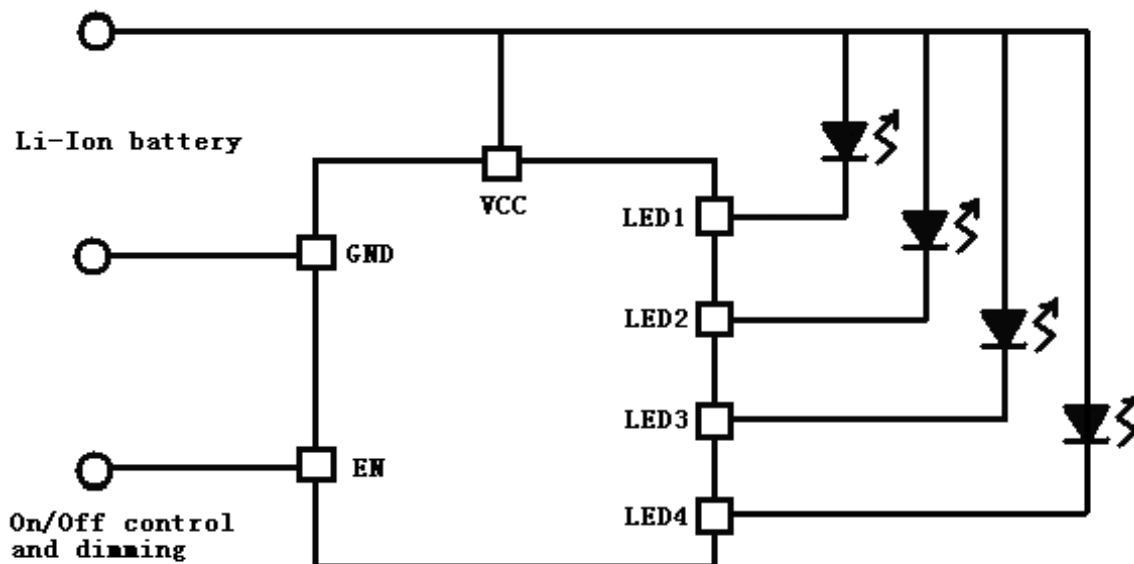
FEATURES

- 4-channels output
- 2.7 to 5.5V input range
- Single-wire dimming control with linear 16- steps or PWM dimming control
- LED sink current of max. 20mA
- Independent current sink circuit for each LED output
- Low standby current
- High accuracy current match on each channel

APPLICATIONS

- Small Size Color LCD Backlights Driver
- Mobile Phone, Portable DeviEN Keypad Backlights Driver

TYPICAL APPLICATION



MARKING INFORMATION

Product Classification		LC1984CE8TR
Marking		
KB YYNZZ	KB: Product Code YY: LOT No. N: FAB Code ZZ: Date Code	<p>Top view</p>
Product Classification		LC1984CJKATR
Marking		
KBA YYNZZ	KBA: Product Code YY: LOT No. N: FAB Code ZZ: Date Code	<p>Top view</p>
Product Classification		LC1984CJBTR
Marking		
KBB YYNZZ	KBB: Product Code YY: LOT No. N: FAB Code ZZ: Date Code	<p>Top view</p>
Product Classification		LC1984CJCTR
Marking		
KBC YYNZZ	KBC: Product Code YY: LOT No. N: FAB Code ZZ: Date Code	<p>Top view</p>

Notes: LC1984CJBTR and LC1984CJCTR can only be dimmed by PWM signal, but LC1984CE8TR and LC1984CJKATR can be dimmed by both single wire pulse string and PWM signal due to its extended dimming function. (Refer to DETAILED DESCRIPTION on page 4)

ORDERING INFORMATION

LC1984 [1](#) [2](#) [3](#)

Code	Description
1	Temperature&RoHS: C: -40~85°C, Pb Free RoHS Std.
2	Package type: E8: MSOP-8 JKA: QFN 3X3 -16 JKB: QFN 3X3 -16 JKC: QFN 3X3 -16
3	Packing type: TR:Tape&Reel (Standard)

PIN DESCRIPTION

Name	Function Description
LED1-LED4	RGB or WLED Cathode Connection Pin
EN	Chip Enable and Dimming Control
VCC	Power Supply
GND	Ground
NC	Not Connected

ABSOLUTE MAXIMUM RATING

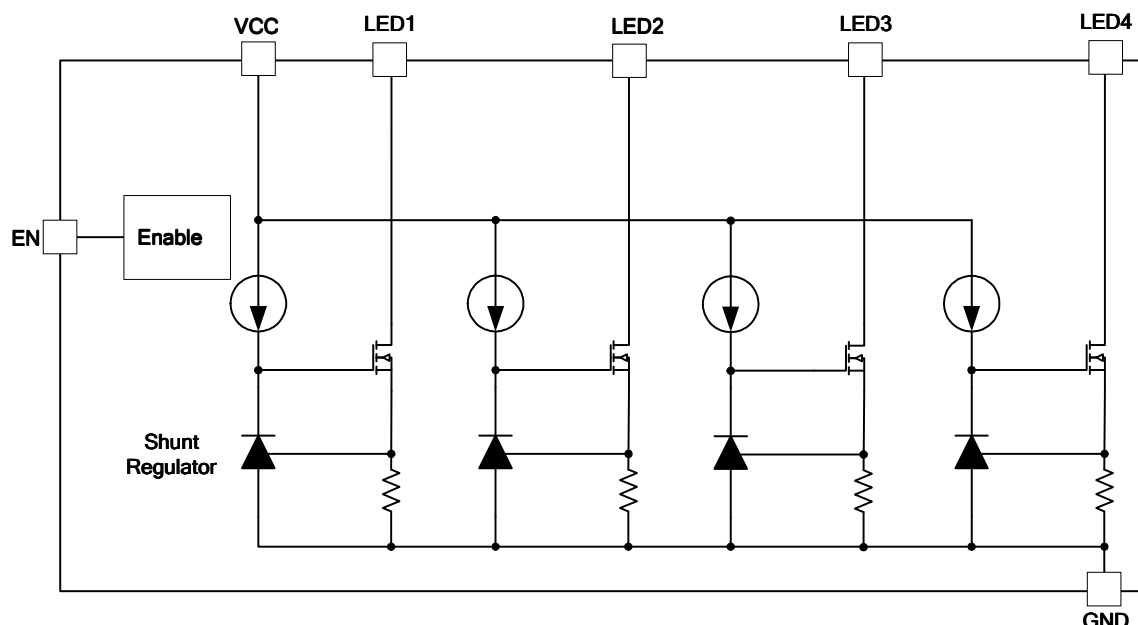
Supply voltage	-0.3V to 7V
Voltage of LEDn, EN pin	-0.3V to 7V
Maximum Junction Temperature	125°C
Operating Ambient Temperature Range	-40°C to 85°C
Storage Temperature Range	-40°C to 150°C
Lead Temperature (Soldering, 10 sec)	260°C

Note: Exceed these limits to damage to the device.
Note: Exposure to absolute maximum rating conditions may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

Items	MIN	MAX	Unit
Supply Voltage Range	2.7	5.5	V
Operating Temperature	-25	85	°C

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

VCC=3.7V, T_a=25°C, No Load, Input: VEN=3.7V. (Unless otherwise noted)

Symbols	Parameters	Conditions	MIN	TYP	MAX	Unit
V _{IL}	EN Pin "Low" Logic				0.4	V
V _{IH}	EN Pin "High" Logic		1.7			V
I _{IL}	EN Pin "Low" Input Current		-1			μA
I _{IH}	EN Pin "High" Input Current				1	μA
T _d	PWM dimming control delay time			20		μS
T _{lat}	Latch off time before transient to the new current level (see figure 2)			20		μS
T _{pulse}	Required positive and negative pulse width	Pulse dimming control	4		20	μS
V _{LEDL}	LEDn Dropout Voltage			100		mV
I _{LED}	LEDn Sink Current		18	20	22	mA
ΔI _{LEDn}	LEDn Sink Current Deviation		-3		3	%
I _Q	Quiescent Current			250	400	μA
I _{STBY}	Standby Supply Current	VEN="0"		0.5		μA

DETAILED DESCRIPTION

LC1984 works with a wide range of supply voltage, from 2.7V to 5.5V. The forward voltage of commercial white/blue LED is in the range of 2.9V to 3.5V at a current level of 20mA. Proper selection of the LED to match the supply voltage can fully utilize the Li-ion battery. For example, there is 1% ~ 3 % power left in the Li-ion battery when its voltage reaches 3.275V. So a LED with a forward voltage value of 3.2V can use up to 99% of the battery power under normal working condition. When the voltage of the battery drops below 3.2V, the current through the LED (hence the brightness) starts to decrease.

Startup sequence

LC1984 starts to work only when VCC powered on and the EN pin became high after a delay, the delay time is at least 4us. EN pin is not allowed to connect to VCC directly or keep it floating.

PWM dimming control

If the frequency of the PWM signal to the EN pin is less than 5KHz, the average LED current is proportional to the duty cycle of the PWM signal, and the EN works as a simple on/off control. A high level turns on and a low shuts down the LEDs. There is a delay time between the input PWM signal and the output LED current waveform, as shown in Fig.1, the T_D is about 20uS.

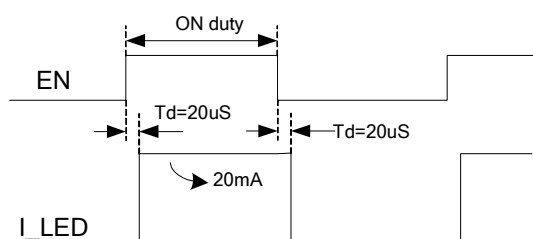


Fig. 1 PWM Dimming Control

Single-wire dimming control

The LEDs' brightness can also be controlled by the pulses applied to the EN pin, Refer to the Fig. 2. Inside the device there is a 4-bit counter connecting to the EN pin. The LED current can be programmed up to 16 levels depends on the number of rise edges of the input waveform. A high level input ("1") with

pulse width wider than 20uS is regarded as a signal to stop the build-in counter. The time between two wide high levels (more than 20uS) is a counting period. When some rise edges occur between two high level pulses of 20us, the equation as shown below can calculate the active pulse number, called Code_No.

$$Code_No = Mod(N,16),$$

In the equation, N is the number of rise edges of the input waveform and mod function returns the remainder of N divided by 16. For example, if N=0, 16, or other integral multiple of 16, the mod function returns a value of 0, if N=1, 17 or other integral multiple of 16 plus 1, the mod function returns a value of 1, and so on.

The relationship between LEDs' brightness and the Code_No is listed as the following table.

Code No	I _{SET} /20mA	Code No	I _{SET} /20mA
0	0	8	8/15
1	15/15	9	7/15
2	14/15	10	6/15
3	13/15	11	5/15
4	12/15	12	4/15
5	11/15	13	3/15
6	10/15	14	2/15
7	9/15	15	1/15

The frequency of the input pulse should be lower than 100KHz, and the width of the high level and low level larger than 4uS to prevent false trigger.

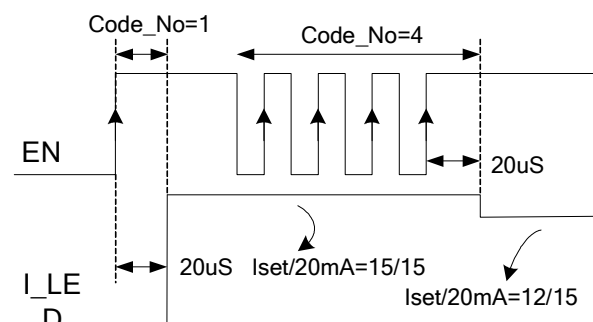
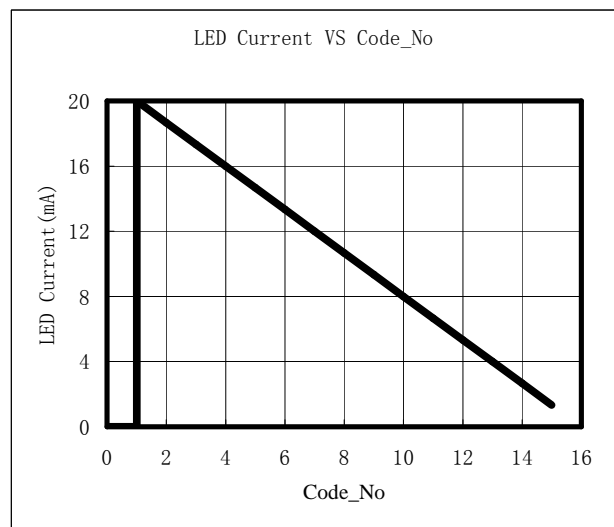
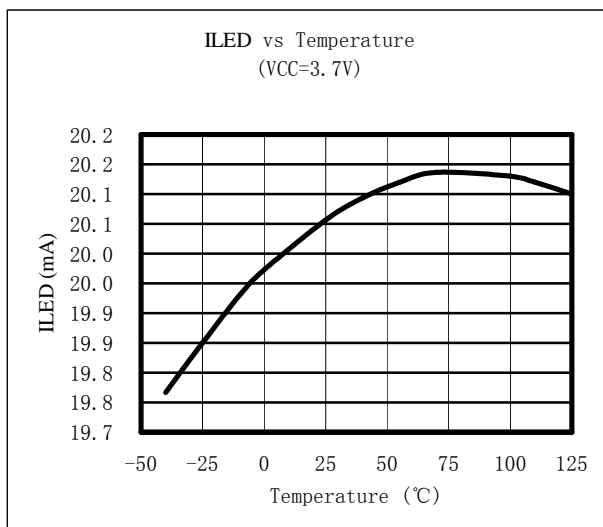
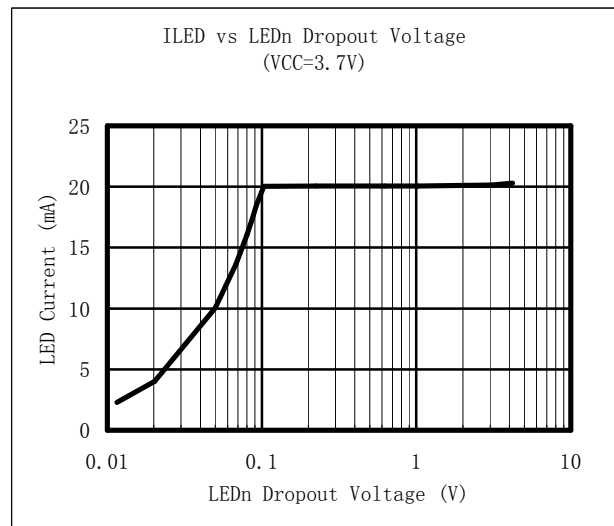
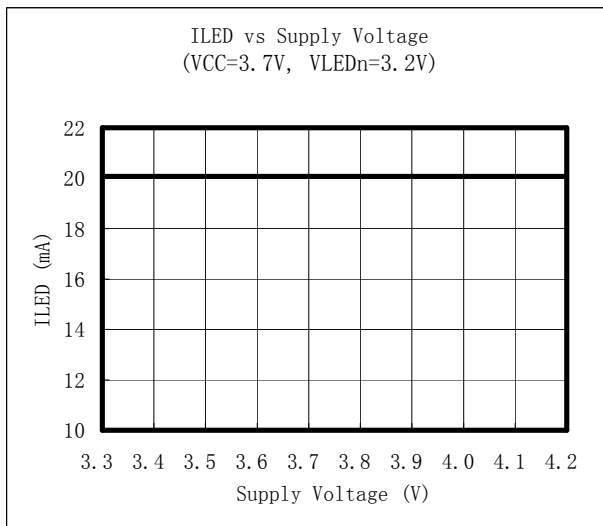
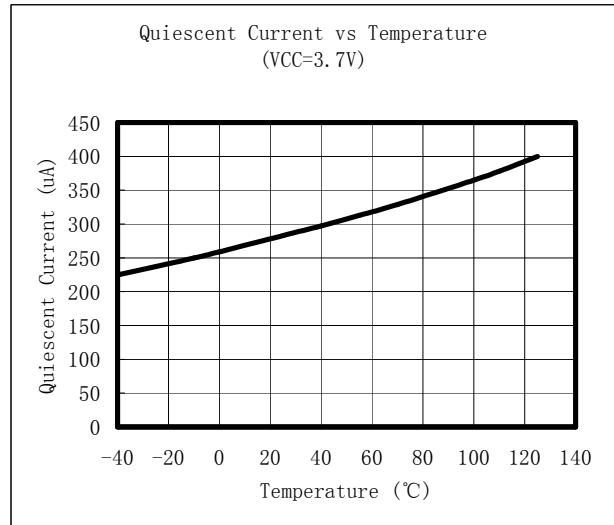
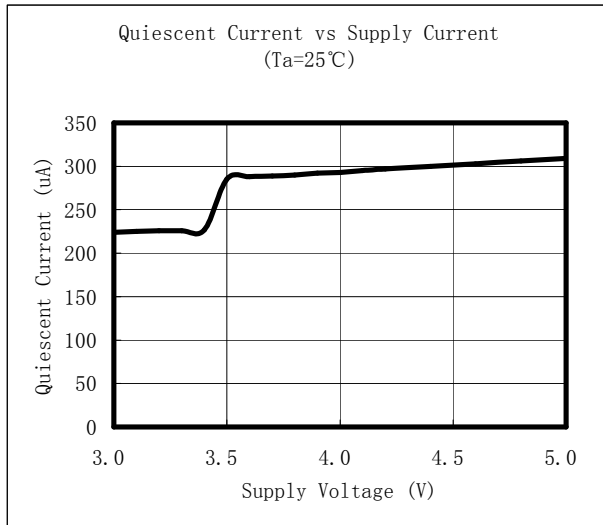


Fig. 2 Single-Wire Dimming Control

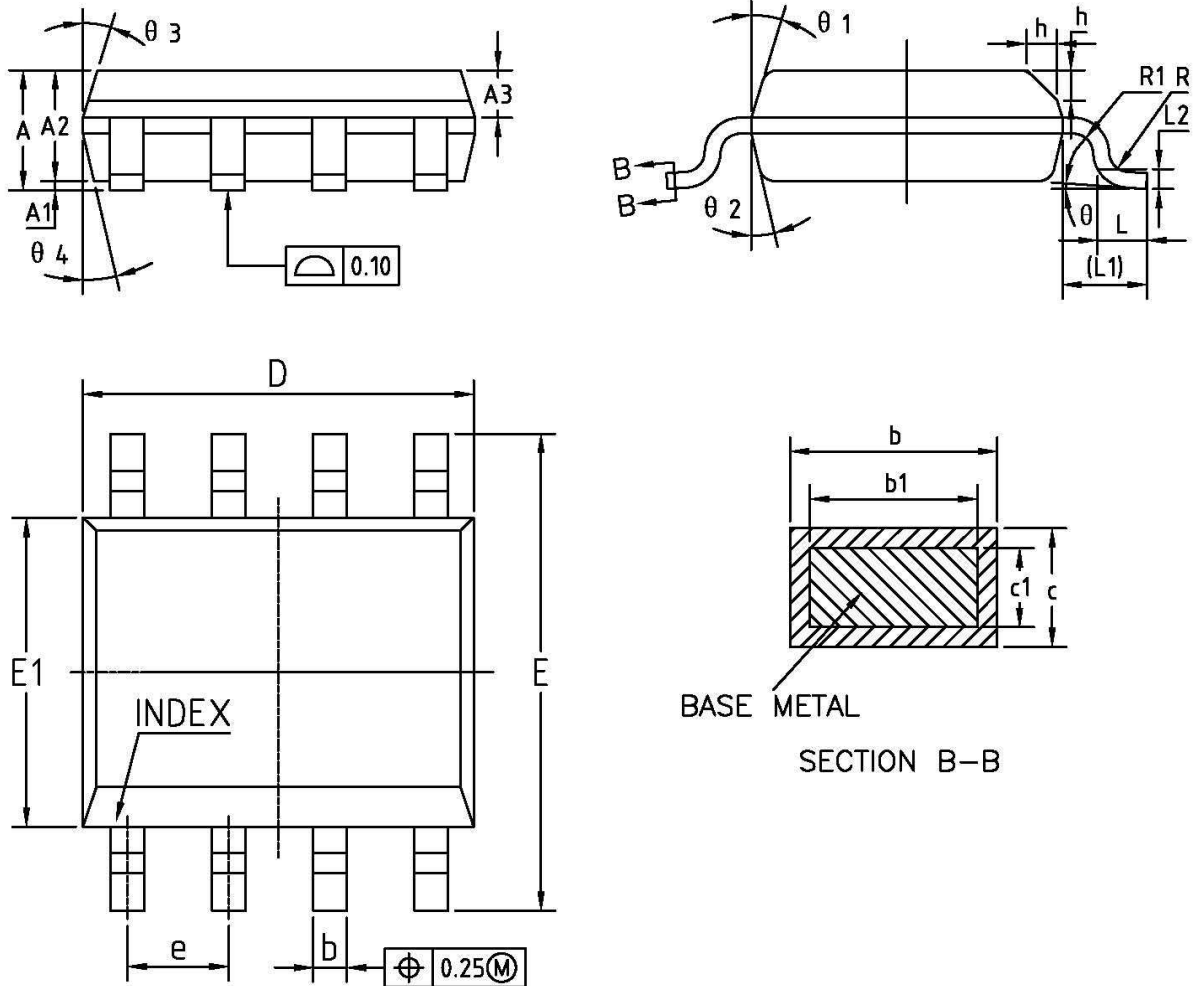
TYPICAL PERFORMANEN CHARACTERISTICS



PACKAGE INFORMATION

Package	MSOP-8	Devices per reel	3000Pcs	Unit	mm
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Package specification:



Symbol	Dimension (mm)			Symbol	Dimension (mm)		
	MIN	NOM	MAX		MIN	NOM	MAX
A	-	-	1.10	D	2.90	3.00	3.10
A1	0.05		0.15	E	4.70	4.90	5.10
A2	0.75	0.85	0.95	E1	2.90	3.00	3.10
A3	0.30	0.35	0.40	e	0.65BSC		
b	0.29	-	0.38	L	0.40	-	0.70
b1	0.28	0.30	0.33	L1	0.95BSC		
c	0.15	-	0.20	theta	0	-	8°
c1	0.14	0.152	0.16				

PACKAGE INFORMATION

Package	QFN3X3-16	Devices per reel	3000	Unit	mm
<p>The technical drawings provide the following dimensions for the QFN3X3-16 package:</p> <ul style="list-style-type: none"> Top View: <ul style="list-style-type: none"> Overall width: 2.900 (0.114) mm Width to Pin 1 Identification: 3.100 (0.122) mm Overall height: 2.900 (0.114) mm Height to Pin 1 Identification: 3.100 (0.122) mm Bottom View: <ul style="list-style-type: none"> Pin 1 Identification to Pin 1: 0.180 (0.007) mm Pin 1 to Pin 1: 0.280 (0.011) mm Pin 1 to Exposed Pad: 0.450 (0.018) mm Exposed Pad to Pin 1: 0.550 (0.022) mm Pin 1 to Pin 1: 1.500 (0.059) mm (Ref) Pin 1 to Pin 1: 0.350 (0.014) mm Pin 1 to Pin 1: 0.450 (0.018) mm Exposed Pad to Exposed Pad: 1.500 (0.059) mm (Ref) Side View: <ul style="list-style-type: none"> Overall height: 0.700 (0.028) mm Height to Pin 1 Identification: 0.900 (0.035) mm Pin 1 to Pin 1: 0.178 (0.007) mm Pin 1 to Pin 1: 0.228 (0.009) mm Pin 1 to Pin 1: 0.000 (0.000) mm Pin 1 to Pin 1: 0.050 (0.002) mm 					