

LC410592

Current Regulated White LED driver with Brightness Control (for Dual-Display systems)

/// General Description ///

The LC410592 is a current regulated white LED driver with charge pump system that changes the boosting steps of x1 and x(-0.5) automatically according to an output load. It provides seven regulated current sources. It accepts an input voltage range from 2.7V to 5.5V and maintains a constant current. An external sense resistor determines 100% full scale LED current.

The LC410592 delivers the LED current up to 140mA to drive maximum seven White LEDs. There are two groups (Group A and Group B). Group A consists of 4LEDs controlled constant current, and Group B does 3LEDs similarly. When it drives seven LEDs, maximum 20mA current of each LED is available. It can operate the Group A and Group B respectively. A luminosity adjustment is possible into each group. The luminosity adjustment of Group A is controlled PWM pulse into ENA pin. It is possible similarly to control Group B by PWM pulse into ENB pin. If ENA and ENB inputs are kept low, it functions as shutdown mode.

The LC410592 operates with 500 kHz fixed-frequency switching without inductors; therefore the EMI noise is very limited.

The LC410592 is available in a VQFN20.

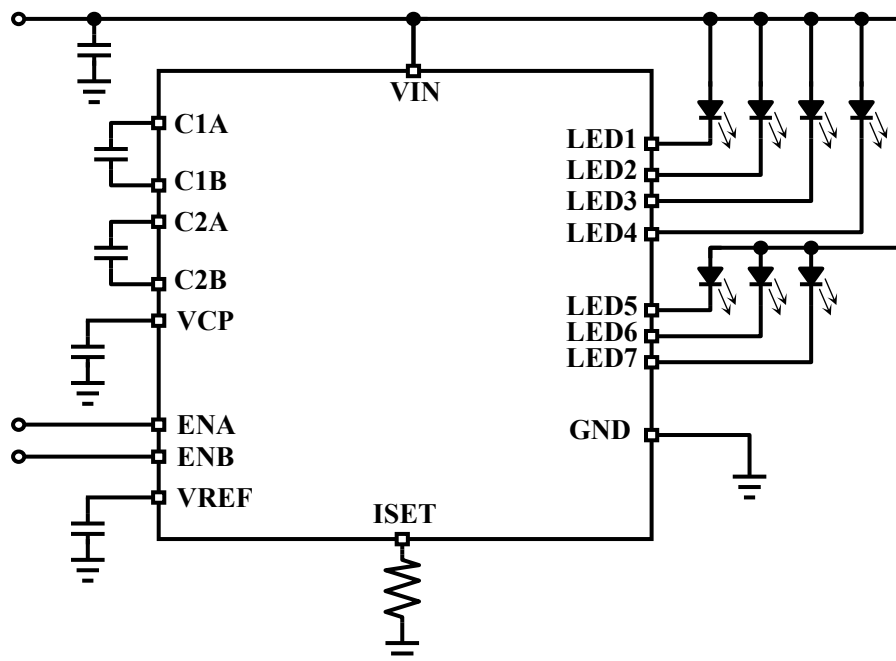
//// Features ////

- Low noise, high efficiency CMOS charge pump
- Built-in constant current circuit
- 2.7V to 5.5V input voltage
- Drives up to seven white LEDs with maximum total current 140mA
- Self-changing of High-Efficiency charge pump mode (1x/-0.5x mode)
- Typical +-1% current matching of any two LED outputs
- Charge pump frequency 500kHz
- Brightness controlled by PWM pulse
(Group A and Group B are individually controllable, respectively.)
- Maximum 1uA shutdown current

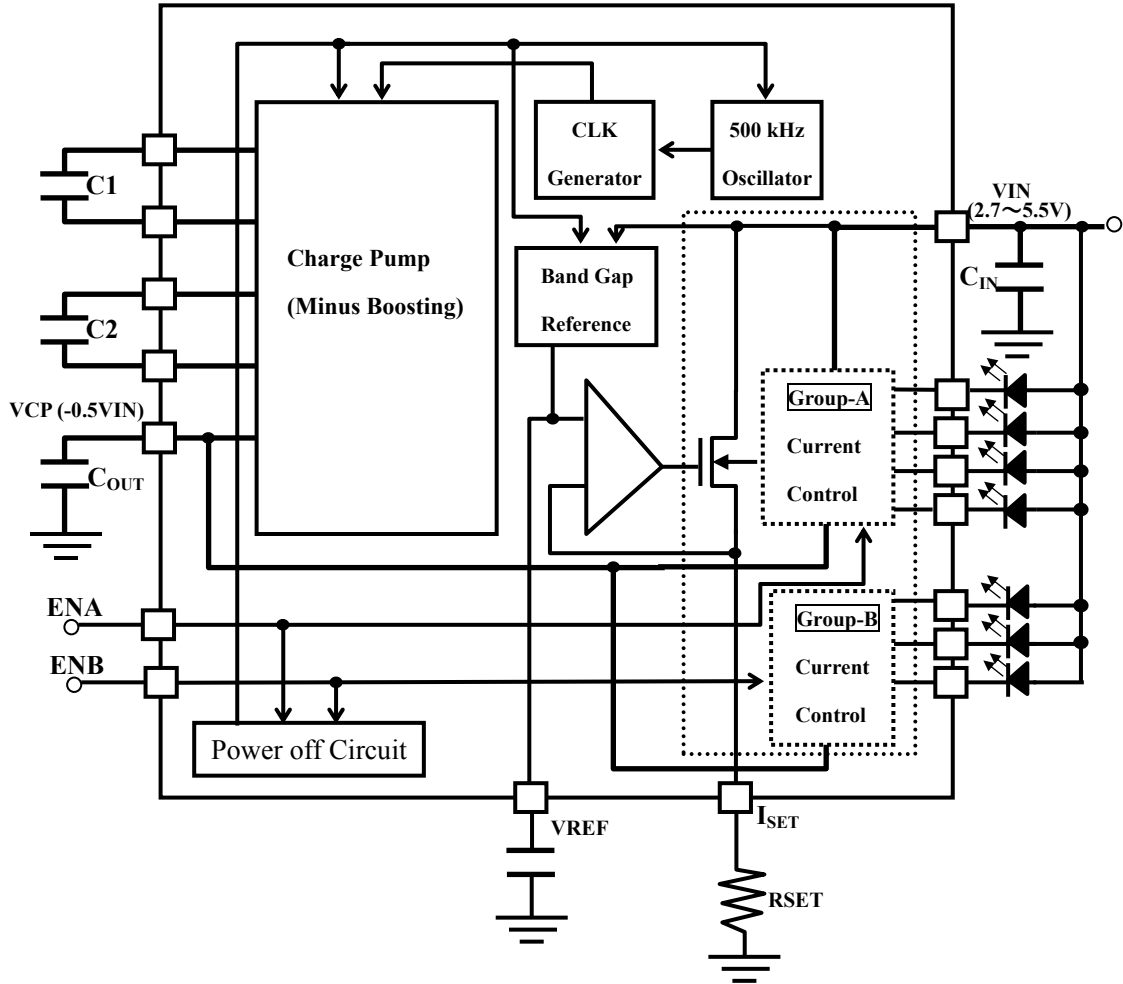
//// Applications ////

- White LED display backlights
- LED keypad backlights
- 1-Cell Li-Ion battery-operated equipment including PDAs, hand-held PCs, cellular phones
- Flat panel displays

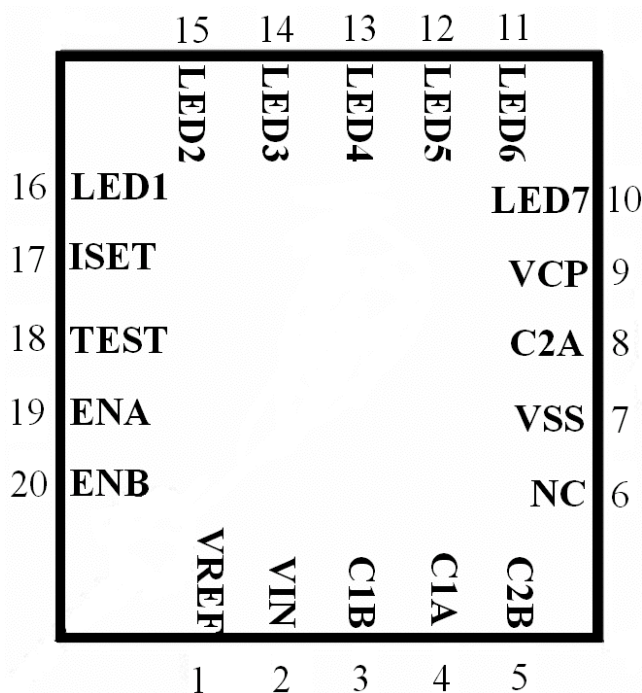
///Typical Application Circuit///



//// Block Diagrams ////



//// Pin Assignment ////



Pin Name	Pin #.	機能
VIN	2	Power supply input. Bypass VIN to GND with a 2.2uF capacitor.
C1A	4	Flying capacitor (1) +
C1B	3	Flying capacitor (1) -
C2A	8	Flying capacitor (2) +
C2B	5	Flying capacitor (2) -
ENA	19	Logic input. Enable for Group-A (LED1 - 4) LEDs. High: Group-A LEDs ON. Low: Group-A LEDs OFF. Pulsing this pin with a PWM signal (100-50k Hz) can be used to dim LEDs. When both ENA and ENB are held low for more than 20 ms (typ), the IC goes into shutdown mode.
ENB	20	Logic input. Enable for Group-B (LED5 - 7) LEDs. High: Group-B LEDs ON. Low: Group-B LEDs OFF. Pulsing this pin with a PWM signal (100-50k Hz) can be used to dim LEDs. When ENA and ENB are both held low for more than 20 ms (typ), the IC goes into shutdown mode.
ISET	17	Current-Set Input. Connect a resistor (Rset) from ISET to GND to set the maximum LED current. $I_{LED}(mA)=60/R_{SET}(k\Omega)$
VREF	1	VREF output (typically 1.2V). Bypass VREF to GND with a 1nF capacitor. VREF output must be kept high-impedance.
GND	7	Power supply ground. Charge pump switching current flows through this pin.
LED1-7	10-16	LED cathode Connection. Connect a LED between VCP and LED1-7.
VCP	9	Charge pump output. Bypass VCP to GND with a 2.2uF capacitor.
TEST	18	Not use, but internally connected. *This pin must be open.

//// Electrical Characteristics ////

Unless otherwise specified, VIN=3.6V, Rset=6kohms, C1=C2=1uF, CIN=COUT=2.2uF, Ta=25C, VF=3.2V,

Group-A and Group-B LEDs are not ON simultaneously (ENA=VIN and ENB=GND, or ENA=GND and ENB=VIN);

Parameter	Conditions	Min	Typ	Max	Unit
Operating Voltage		2.7		5.5	
Total Output Current	ENA=ENB=VIN 7LEDs ON		140		mA
Available LED Current	3.0<=VIN<=5.5 Rset=3.0k [ohm]		20		mA
	2.7<=VIN<=5.5 Rset=6.0k [ohm]		10		
Inside consumption current in case there is no output load	Boosting Mode		3.5		mA
	No Boosting Mode		0.6		
Charge Pump Frequency			500k		Hz
Shutdown Supply Current	VIN = 2.7 to 5.5V ENA = ENB = GND		0.01	1	μA
Input Charge Pump Mode Hysteresis			0.2		V
LED Current Accuracy	VIN = 2.7 to 5.5V		+3		%
LED Current Matching	VIN = 2.7 to 5.5V		+1		%
LED Leakage in Shutdown	VIN = 2.7 to 5.5V ENA=ENB=GND V _{LED} =VIN		0.01	1	μA
LED Leakage in Pull-Up	VIN = 2.7 to 5.5V ENA=VIN or ENB=VIN V _{LED} =VIN		0.01	1	μA
Drive LEDs	Group A Group B			4 3	
Available PWM Frequency	VIN = 2.7 to 5.5V	0.1		50	kHz
Shutdown Delay	2.7<=VIN<=5.5 From failing edge of ENA and ENB	12	20	30	mS

//// Operation ////

1. Circuit Description

The LC410592 is a white LED supplies that accepts the input voltage from the Li-Ion battery. While the Li-Ion battery can have an output voltage range from 2.7 to 5.5V, the forward voltage (V_F) of the white LED is about 3.6V typically. So when the battery degrades the output voltage to about 3.6V, the higher voltage must be generated internally. The LC410592 employs a charge pump to step up the output voltage to minus 0.5 times the input voltage. This charge pump selects the optimum boost mode, and changes the boost mode automatically.

LED current (I_{LED}) is determined by an internal standard voltage generation source ($V_{REF} \approx 1.2$) and the resistance of the external resistor. Same voltage of V_{REF} is forced on the external resistor with high accuracy by an internal Op-Amp, so the current passing through the external resistor (I_{RSET}) will be $I_{RSET} = 1.2 / R_{SET}$. LC410592 includes the current regulator to deliver the regulated current to the LEDs, which are composed of current mirrors with 50 times the ratio of this. For example, $R_{SET} = 3000\Omega$, then $I_{RSET} = 0.4\text{mA}$, and $I_{LED} = I_{RSET} \times 50 = 20\text{mA}$. If seven LEDs are attached, the device drive up a total of $20\text{mA} \times 7 = 140\text{mA}$ through the LEDs.

$$I_{LED} [\text{mA}] = 60 / R_{SET} [\text{k}\Omega]$$

The LED Brightness can be controlled by PWM input. (Group A and Group B are individually controllable, respectively.)

2. Shutdown Mode

A shutdown pin is available to disable the LC410592 and reduce the quiescent current to $1\mu\text{A}$ maximum. If ENA and ENB inputs are kept low, it functions as shutdown mode. ($I_{DD} < 1\mu\text{A}$)

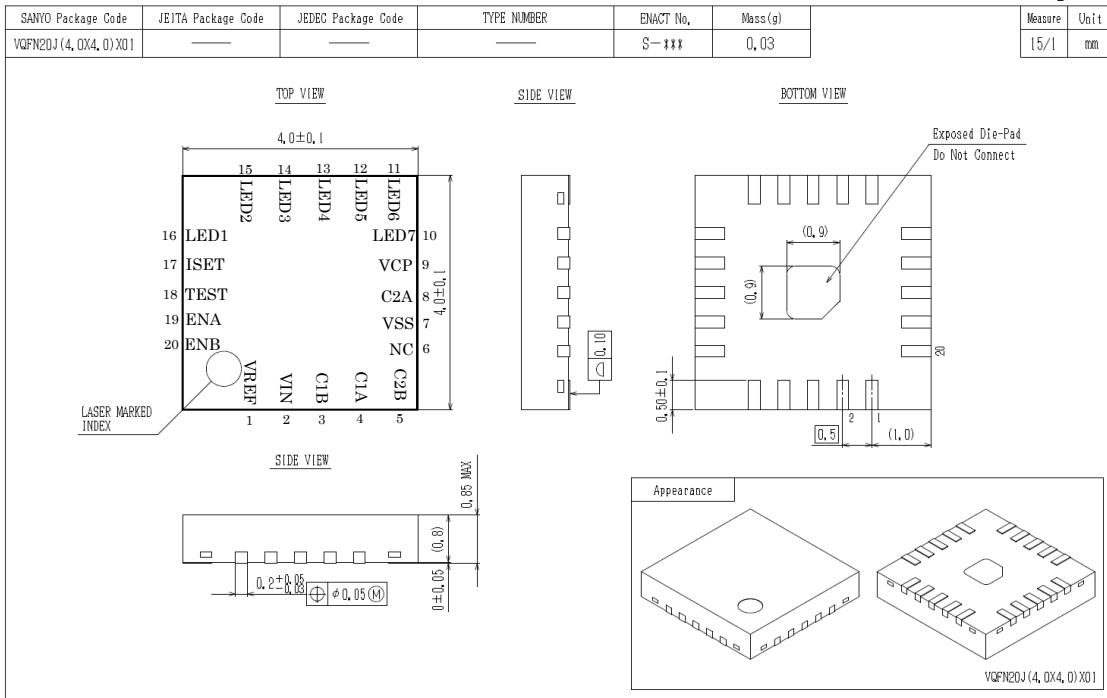
3. Brightness Control

LC410592 can control by PWM input. Group-A (4Outputs) and Group-B (3Outputs) are individually controllable, respectively. The luminosity adjustment of Group-A and Group-B are controlled by PWM pulse up to 50 kHz. If both ENA and ENB inputs are kept low, it functions as shutdown mode.

//// Package ////

1. VQFN20 Outline Drawing

OUTLINE DRAWING



REVISION : 1

SANYO : Very Thin Quad Flat Non-leaded Package

Note: Do not connect the TEST pin with any pattern, please.

Please always connect the LED3 pin with LED.

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