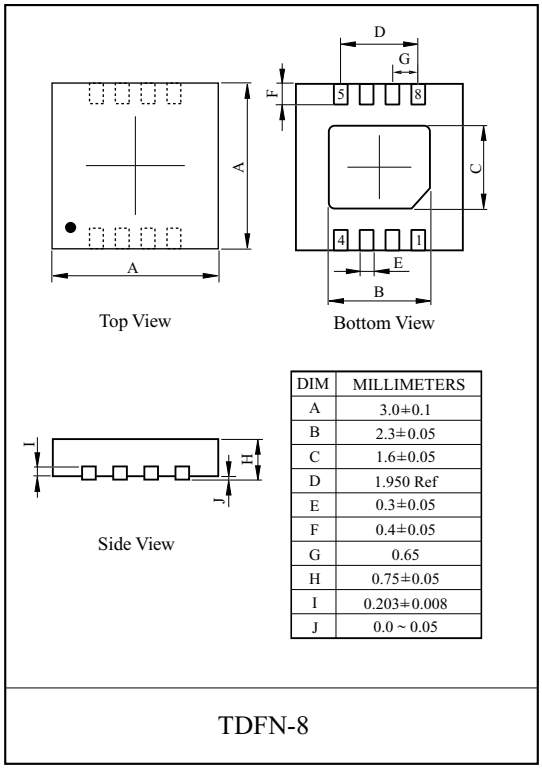
700mA White LED Regulating Charge Pump for Camera Flashes and Movie Lights

The KAC3305DN is charge pumps drive white LEDs, including camera strobes, with regulated current up to 700mA. The very low open-loop output resistance allows high flash brightness, even from a low battery input voltage. The adaptive 1×/2× regulating charge pump operation provides high efficiency while in movie mode or backlighting. Fast switching allows the use of tiny external components. The KAC3305DN use an external resistor to set the full-scale LED current.



DIM	MILLIMETERS
A	3.0±0.1
B	2.3±0.05
C	1.6±0.05
D	1.950 Ref
E	0.3±0.05
F	0.4±0.05
G	0.65
H	0.75±0.05
I	0.203±0.008
J	0.0 ~ 0.05

TDFN-8

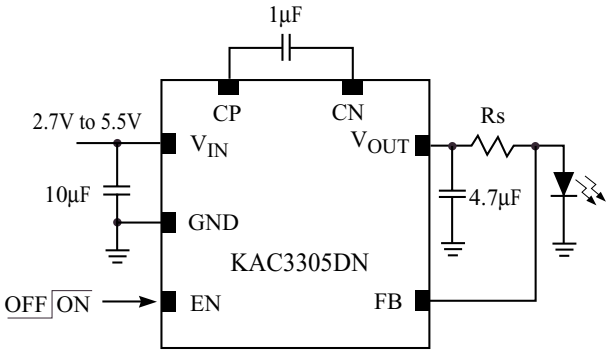
Features

- Up to 700mA Output Drive Capability
- Current Regulation for Flash
- 2.7V to 5.5V Supply voltage Range
- PWM Dimming Control
- Soft-Start Limits Inrush current
- Over Voltage Protection on Output
- Low Shutdown Current
- Thermal Shutdown Protection

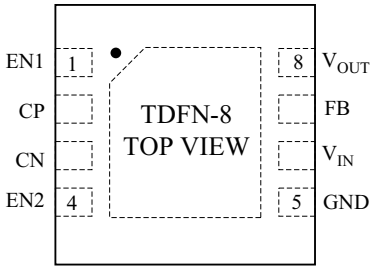
Applications

- White LED Flashes Strobes, and Movie Lights LCD Backlighting
- Camera Phones, Cell Phones, and Smart Phones, PDAs, Digital Cameras, and camcorders
- Generic Lighting Flash, and Strobo applications

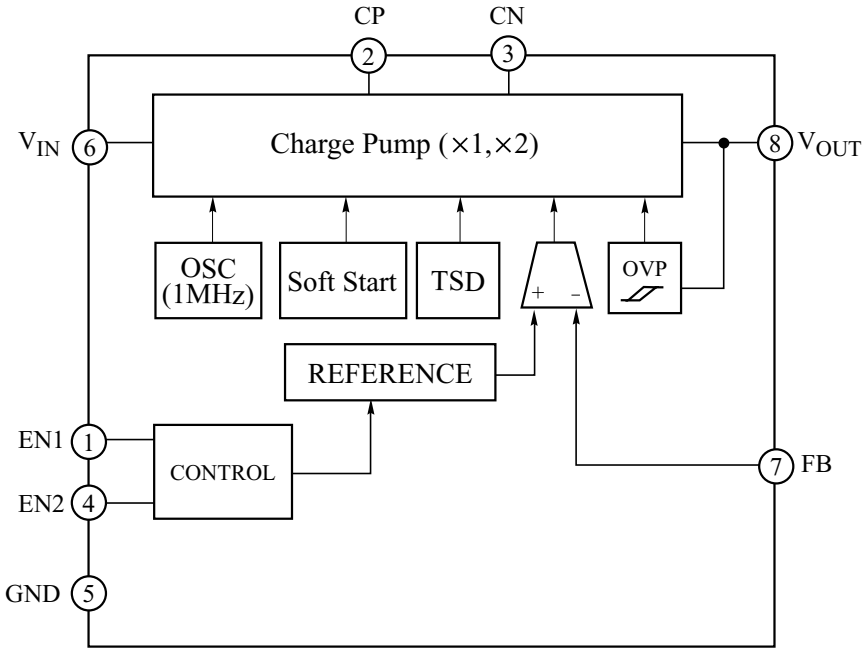
Typical operating Circuit



Pin Configuration



Block Diagram



Pin Descriptions

Pin	Name	Function
1	EN1	Current and Shutdown Control Input
2	CP	Positive terminal of switched capacitor
3	CN	Negative terminal of switched capacitor
4	EN2	Current and Shutdown Control Input
5	GND	Ground.
6	V_{IN}	Power supply voltage Input
7	FB	Feedback Input for the Current Control
8	V_{OUT}	Output of the charge pump

Absolute Maximum Ratings

Characteristics	Symbol	Rating	Units
Input supply voltage	V_{IN}	-0.3 to +6.0	V
Input pin	EN1, EN2	-0.3 to (V_{IN} +0.2)	V
Maximum Power Dissipation, (@Ta=25℃)	P_D	1.6	W
Thermal Resistance	θ_{JA}	62.43	℃/W
Operating Ambient	Ta	-40 to +85	℃
Junction Temperature Range	T_j	150	℃
Storage Temperature Range	T_{stg}	-65 to +150	℃
Lead Temperature	T_{LEAD}	300	℃

Electrical Characteristics

(V_{IN} = 3.6V, C_{IN}=10㎌, C=1㎌, C_{OUT}=4.7㎌, Ta= 25℃, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Supply voltage	V_{IN}		2.7	-	5.5	V
Supply Current	I_{IN}	no load	-	1	2	mA
Shutdown Supply Current	I_{SHUT}	EN1=EN2=GND	-	-	1	㎂
Soft Start time	t_{soft}		-	0.3	-	ms
OUT Overvoltage Protection	V_{OVP}		-	5.3	-	V
FB Regulation Voltage (V_{OUT}-V_{FB})	$V_{Reg(FB)}$	EN1=EN2=V_{IN}	270	300	330	mV
Maximum OUT Current	I_{OUT}	V_{LED}=3.8V	500	700	-	mA
Open Loop OUT Resistance	R_{OUT}	×1 mode	-	1	-	Ω
		×2 mode	-	4.5	-	Ω
OUT Internal Pulldown in Shutdown		EN1=EN2=GND	-	5	-	kΩ
Switching Frequency	F_{OSC}		-	1	-	MHz
EN Logic High Voltage	V_{EN_IH}	V_{IN}=2.7V to 5.5V	1.4	-	-	V
EN Logic Low Voltage	V_{EN_IL}	V_{IN}=2.7V to 5.5V	-	-	0.4	V
Logic Input Current	I_{EN}	V_{EN}=0V to 5.5V	-	-	1	㎂
Thermal Shutdown Threshold	T_{SD}		-	150	-	℃

Application Information

• Output Current

The KAC3305DN is designed to deliver 200mA of continuos current and up to 700mA of pulsed current(about 500ms). The charge pump switching frequency is approximately 1MHz, enabilng the use of small external flying capacitor.

• Mode Switching

The KAC3305DN has two modes of operation to control the output current : the 1× mode and 2× mode. When V_{IN} is greater than V_{OUT}, the KAC3305DN regulate the current through Rs. As V_{IN} decreases and detects a dropout condition, the 2× charge pump starts boosting the output to maintain the regulation current.

• Shutdown (EN1=EN2=Low)

When voltage of the ENABLE pin goes under 0.4V, the KAC3305DN enter the shutdown mode. In shutdown mode, input current of IC go to zero and there are no current between output capacitors and transfer capacitor.

• Soft-Start

To limit excessive inrush current at turn-on, the KAC3305DN employs built-in soft-start circuitry. When starting up with an output voltage that is not near the input voltage, the output capacitor and flying capacitor are charged directly from the input until the output voltage approaches the input voltage. Soft-start is achieved a period of approximately 300㎲. If detects a dropout condition, the KAC3305DN automatically switches to the 2 × mode soft-start.

• Short protection

If output is shorted to ground, output current is limited until V_{OUT} exceeds 2.3V.

• Overvoltage Protection

The KAC3305DN has over voltage protection. If the output voltage rises above the 5.3V threshold, the over voltage protection shuts off all of the output switches to prevent the output voltage from rising further.

• Thermal Protection

When the temperature of the KAC3305DN rises above 150 ℃, the over temperature protection circuitry turns off the output switches to prevent damage to the device. If the temperature drops back down below 110℃, the part automatically recovers.

• Setting the Output Current

The output regulation current is set by Rs by the equation :

$$Rs=(V_{OUT}-V_{FB})/I_{OUT}$$

Where I_{OUT} is the output current and $(V_{OUT}-V_{FB})$ is the reference voltage.

The resistor power obtained in the full current would be :

$$P=(V_{OUT}-V_{FB}) \cdot I_{OUT} = 300mV \cdot 700mA=210mW$$

For this application, the over 210mW resistor is recommended.

• Capacitor Selection

To reduce noise and ripple, it is recommended that low equivalent series resistance(ESR) ceramic capacitors be used for both C_{IN} and C_{OUT}. Tantalum and aluminum capacitors are not recommended because of their high ESR. The flying capacitors control the strength of the charge pump. In order to achieve the rated output current it is necessary to have at least 1㎌ of actual capacitance.

Ceramic capacitors with X5R or X7R temperature grade are recommended for most applications.

• Power Efficiency

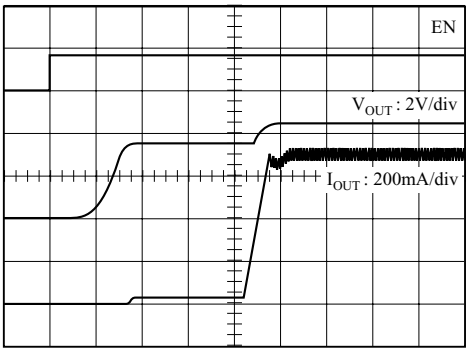
To calculate the power efficiency of a white LED driver chip, the LED power should be compared to the input power. The difference between these two numbers represents lost power whether it is in the charge pump or the current sources. The power efficiency is given by

$$\eta = P_{LED}/P_{IN}=(V_{LED} \cdot I_{LED})/(V_{IN} \cdot 2 \cdot I_{LED}) \approx V_{LED}/2 \cdot V_{IN}$$

• Layout Considerations

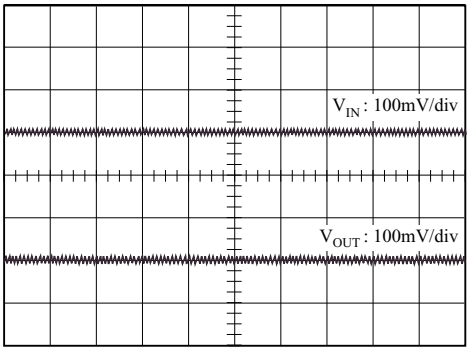
Due to its high switching frequency and the transient currents produced the KAC3305DN, careful board layout is necessary. The input and output capacitors should be located as close to the V_{IN} and V_{OUT} as possible to obtain best bypassing. The flying capacitor should be located as close to the CP and CN as possible. Connect the exposed pad to GND directly under the IC and allow sufficient copper area for cooling

Start Up
[I_{OUT} =700mV]



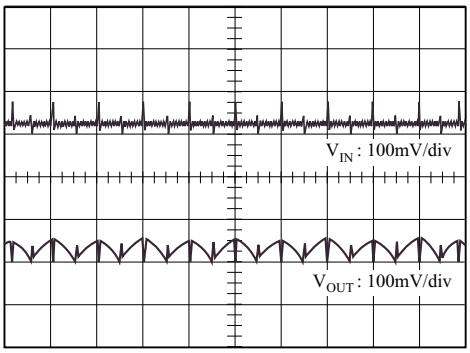
40μS/div

Input and Output Ripples in 1×Mode



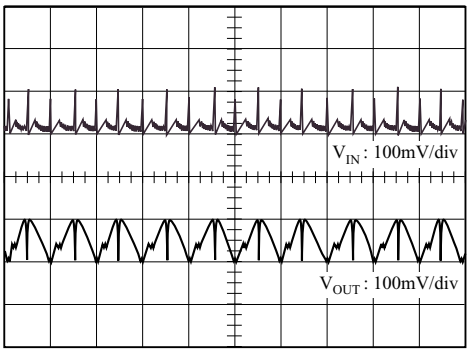
1μS/div, AC Coupled

Input and Output Ripples in 2×Mode
[I_{OUT}=200mA]



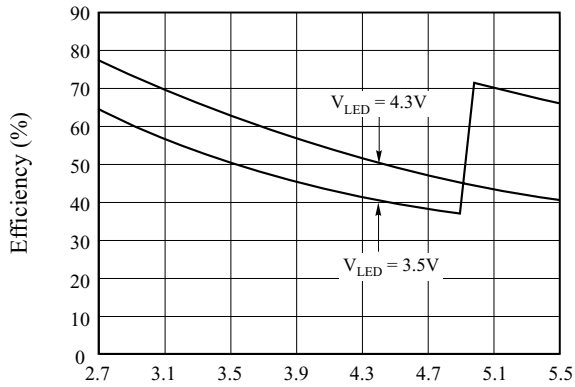
1μS/div, AC Coupled

Input and Output Ripples in 2×Mode
[I_{OUT}=700mA]



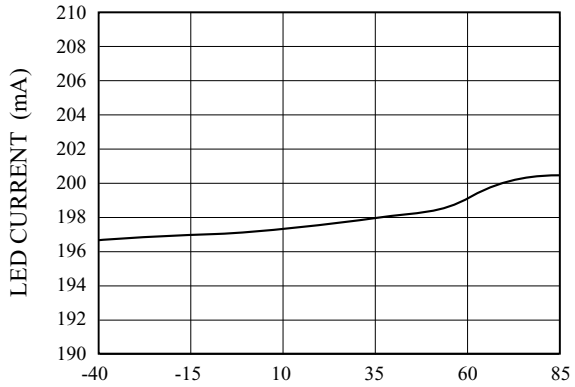
1μS/div, AC Coupled

Efficiency vs. Supply Voltage
[I_{OUT} = 700mA]



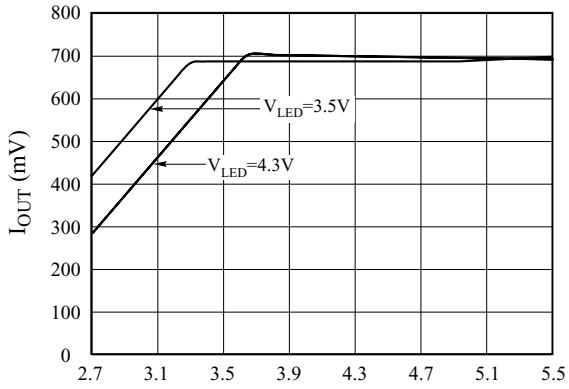
V_{IN} (V)

LED Current vs. Temperature
[I_{OUT}=200mA]

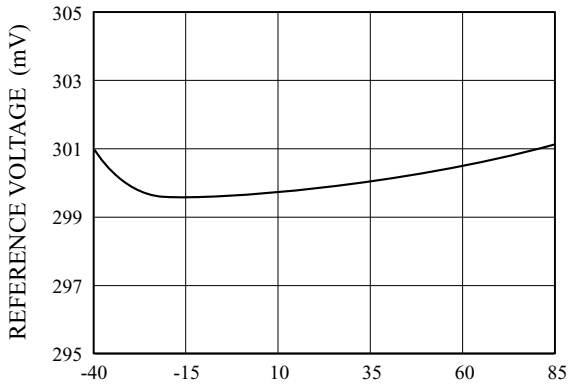


TEMPERATURE (℃)

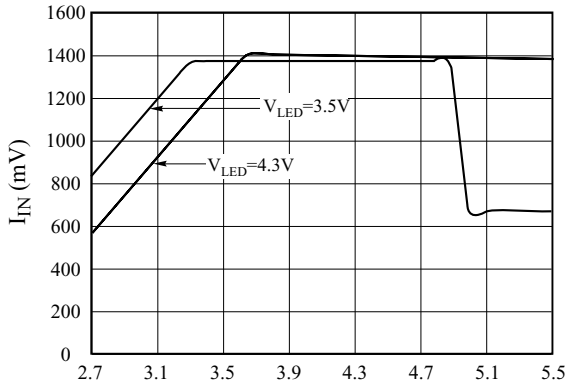
LED Current vs. Supply Voltage
[I_{OUT}=700mA]



Reference Voltage vs. Temperature



Battery Current vs. Supply Voltage
[I_{OUT}=700mA]



LED Current vs. R_S