SGM3133
4-Channel Charge Pump White LED Driver with Low Dropout Current Source

GENERAL DESCRIPTION

The SGM3133 is a high efficiency and cost effective charge pump white LED driver. It supports up to 4 white LEDs and regulates a constant current for uniform intensity. The part maintains the high efficiency by utilizing a 1×/1.5× fractional charge pump and low dropout current sources. The small equivalent 1× mode open loop resistance and ultra-low dropout voltage of current source extend the operating time of 1× mode and optimize the efficiency of Li-ion battery in white LED applications.

User can easily configure each LED current from 1.25mA to 20mA by a pulse dimming control. The dimming of white LEDs current can be achieved by applying a pulse signal to the EN/SET pin. There are totally 16 steps of current could be set by users. The operating voltage range is 2.7V to 5.5V. Internal soft start circuitry effectively reduces the in-rush current while both start-up and mode transition.

The SGM3133 is available in Green TQFN3×3-16L package and is specified over an ambient temperature range of -40℃ to +85℃.

FEATURES

- **Input Voltage Range: 2.7V to 5.5V**
- **Drives up to 4 LEDs at 20mA Each**
- **16-Step Brightness Control**
- **High Efficiency by Fractional Conversion with 1× and 1.5× Modes**
- **Automatic Charge Pump Mode Selection**
- **Switching Frequency: 1MHz**
- **1% Typical LED Current Matching**
- **Internal Soft-start Limits Inrush Current**
- **Low Input Noise and Low EMI**
- **Over Current and Over Temperature Protection**
- **Output Over Voltage Protection**
- **Under Voltage Lockout with Hysteresis**
- **Available in Green TQFN3×3-16L Package**

APPLICATIONS

Mobile Phone, DSC, MP3
White LED Backlighting
LCD Display Supply

PACKAGE/ORDERING INFORMATION

MODEL	ORDER NUMBER	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	PACKAGE OPTION	MARKING INFORMATION
SGM3133	SGM3133YTQ16G/TR	TQFN3×3-16L	-40℃ to +85℃	Tape and Reel, 3000	3133TQ

ABSOLUTE MAXIMUM RATINGS

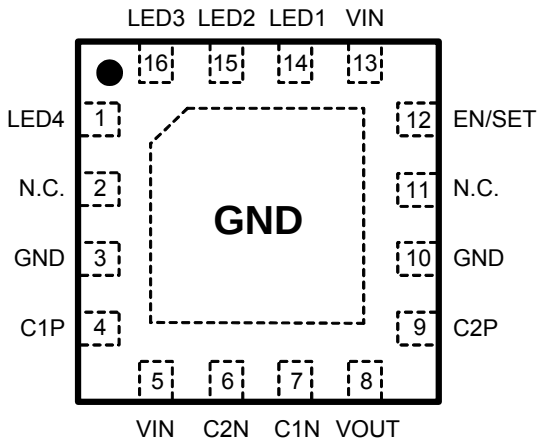
VIN to GND……..……..-0.3V to 6.0V
The Other Pins to GND…….. -0.3V to 6.0V
Package Thermal Resistance
TQFN3×3-16L, θ_{JA}……..68℃/W
Storage Temperature Range..……...-65℃ to +150℃
Junction Temperature …..…..…..……..…..…..……...150℃
Operating Temperature Range..……-40℃ to +85℃
Lead Temperature Range (Soldering 10 sec)
……..…..……..…..……..260℃
ESD Susceptibility
HBM…….. 2000V
MM…….……..……..…200V

NOTE:
Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.
ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PIN CONFIGURATION (TOP VIEW)



TQFN3×3-16L

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	LED4	Output Current for LED4.
2,11	N.C.	No Internal Connection.
3,10	GND	Ground.
4	C1P	Positive Input for the External Flying Capacitor C1. Connect a ceramic 1μF capacitor close to the pins of the IC.
5,13	VIN	Power Input Voltage.
6	C2N	Negative input for the External Flying Capacitor C2. Connect a ceramic 1μF capacitor close to the pins of the IC.
7	C1N	Negative input for the External Flying Capacitor C1. Connect a ceramic 1μF capacitor close to the pins of the IC.
8	VOUT	Output Voltage Source.
9	C2P	Positive Input for the External Flying Capacitor C2. Connect a ceramic 1μF capacitor close to the pins of the IC.
12	EN/SET	Chip Enable (Active High) and Dimming Control.
14	LED1	Output Current for LED1.
15	LED2	Output Current for LED2.
16	LED3	Output Current for LED3.
Exposed Pad	GND	Exposed pad should be soldered to PCB board and connected to GND.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 2.7V to 5.5V, C_{IN} = C_{OUT} = C_{FLY} = 1μF, T_A = 25℃, unless otherwise specification.)

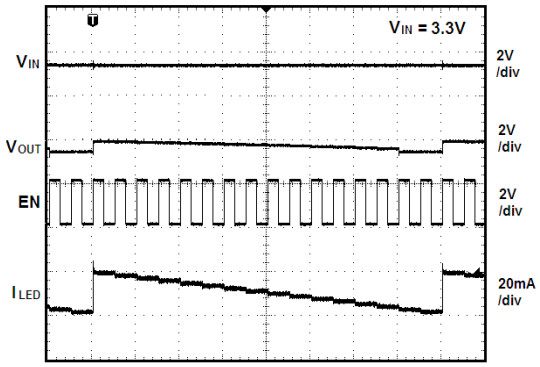
PARAMETER		SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input							
Input Supply Voltage		V_{IN}		2.7		5.5	V
Under-voltage Lockout Threshold			V_{IN} Rising		2.2		V
Under-voltage Lockout Hysteresis					100		mV
Quiescent Power Supply Current		I_Q	1 × Mode, V_{IN} = 4V		0.3		mA
		I_Q	1.5 × Mode, V_{IN} = 3.3V		1		mA
Shutdown Current		I_{SHDN}	V_{EN} = 0.4V		0.1		μA
1 × Mode to 1.5 × Mode Transition Voltage (V_{IN} falling)		$V_{TS\_\times1.5}$	V_F = 3.25V, I_{OUT} = 80mA, I_{LEDx} = 20mA		3.45		V
Hysteresis of Mode Transition					250		mV
Output							
Output Current		I_{LEDx}	V_{IN} = 3.5V, 100% Setting	18	20	22	mA
Current Matching			V_{IN} = 3.5V, 100% Setting		1		%
EN/SET Logic							
Threshold	Logic-High Voltage	V_{IH}		1.5			V
	Logic-Low Voltage	V_{IL}				0.4	V
Low Time for Dimming		T_{LO}		0.5		500	μs
High Time for Dimming		T_{HI}		0.5			μs
EN/SET Current	High Current	I_{IH}	V_{IH} = V_{IN}		0.01		μA
	Low Current	I_{IL}	V_{IL} = GND		0.01		μA
Low Time for Shutdown		T_{SHDN}	PWM Dimming		1.5		ms
Frequency							
Oscillator Frequency		f_{OSC}			1000		kHz

Specifications subject to changes without notice.

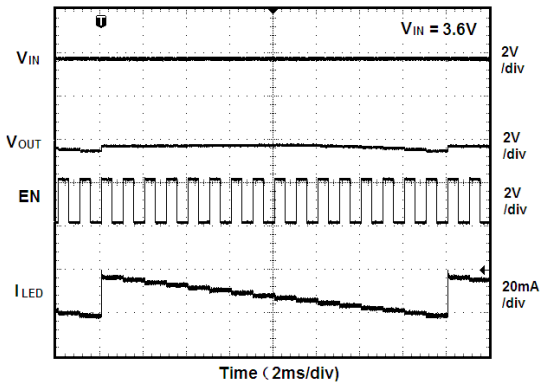
TYPICAL PERFORMANCE CHARACTERISTICS

C_{IN} = C_{OUT} = C1 = C2 = 1μF, T_A = +25℃, unless otherwise noted

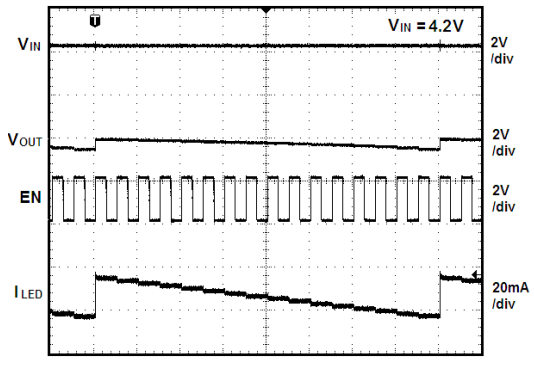
Dimming Operation



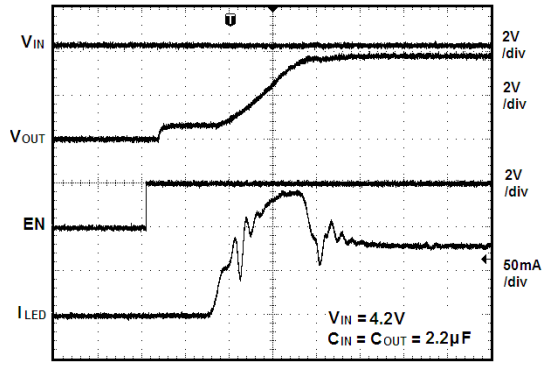
Dimming Operation



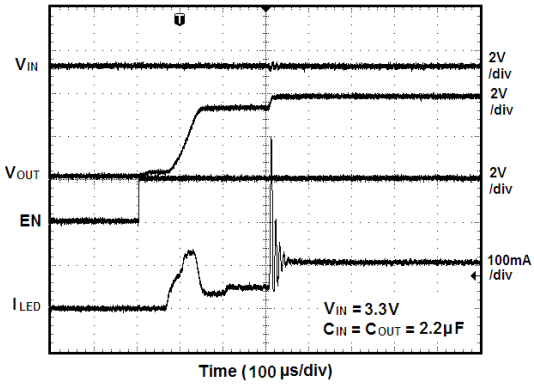
Dimming Operation



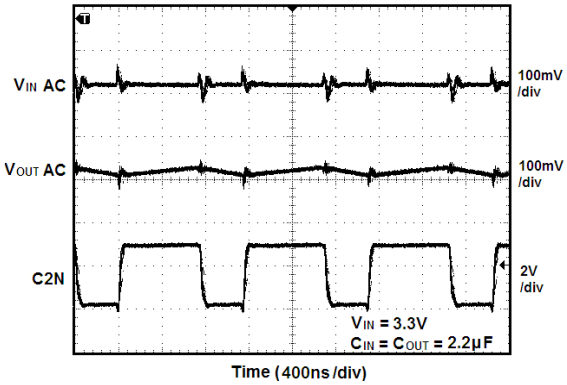
1x Mode Inrush Current Response



1.5x Mode Inrush Current Response



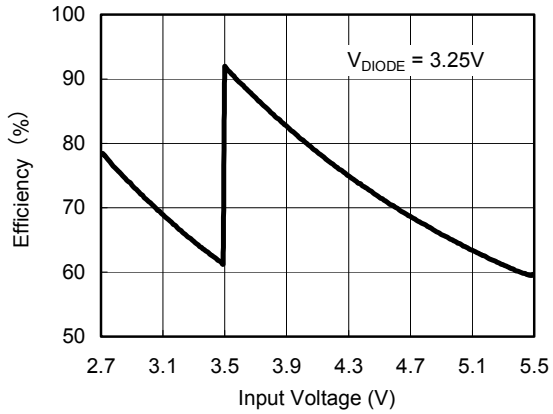
1.5x Mode Ripple & Spike



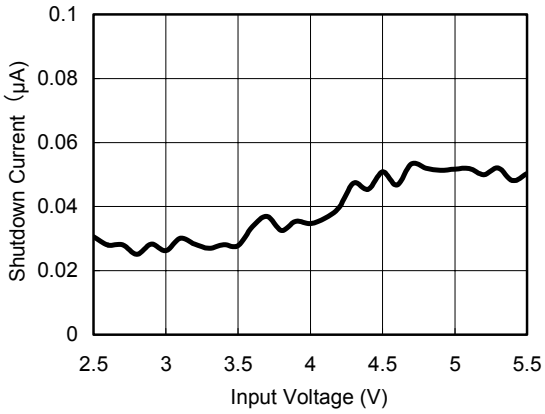
TYPICAL PERFORMANCE CHARACTERISTICS

C_{IN} = C_{OUT} = C1 = C2 = 1μF, T_A = +25℃, unless otherwise noted

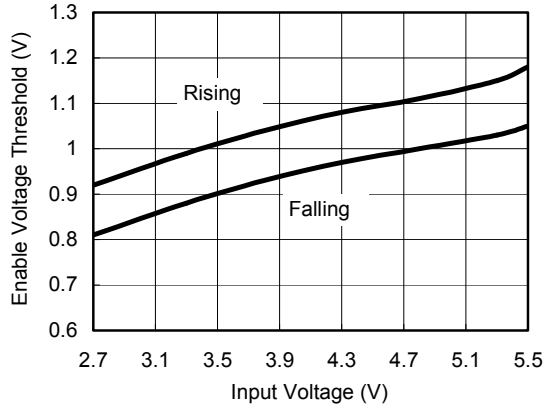
Efficiency vs. Input Voltage



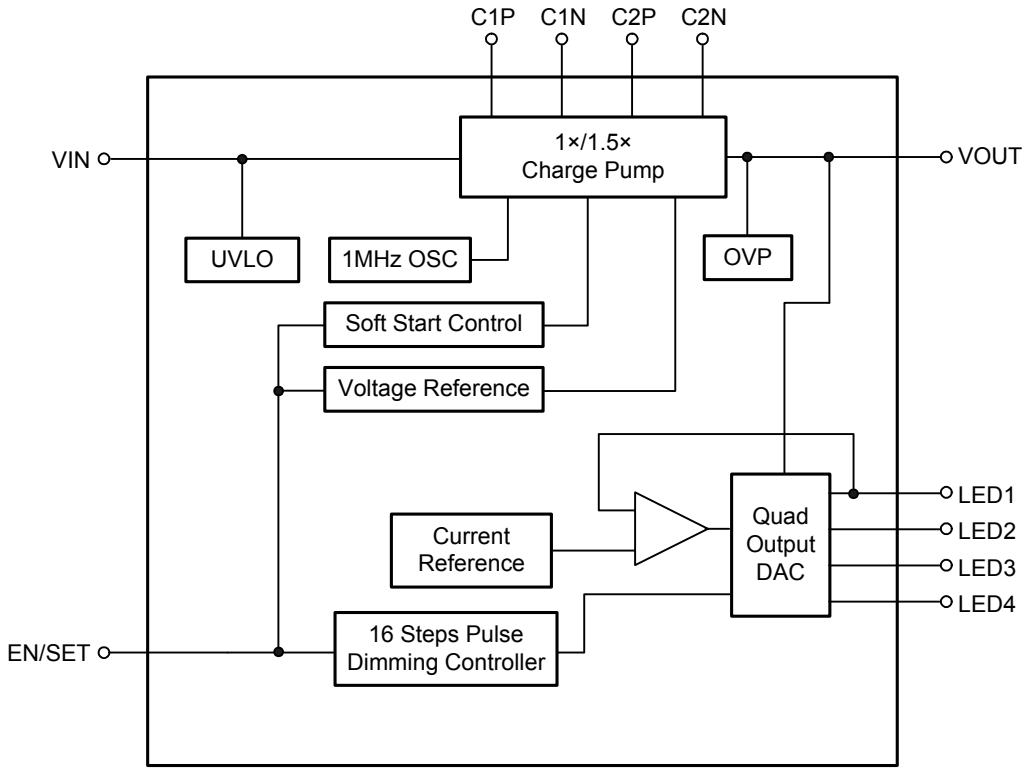
Shutdown Current vs. Input Voltage



Enable Voltage vs. Input Voltage



FUNCTION BLOCK DIAGRAM



TYPICAL APPLICATION

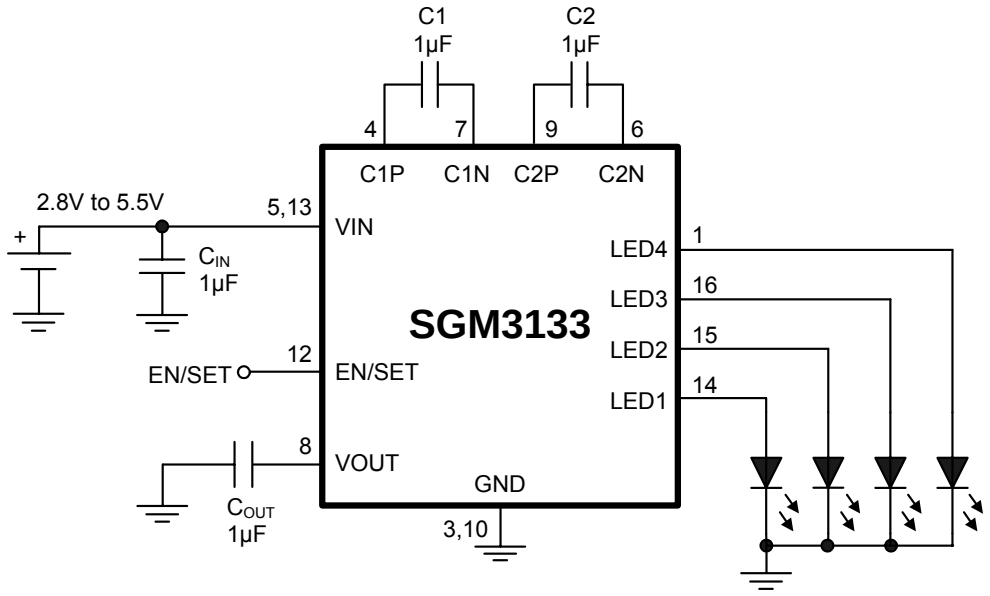


Figure 1. For 4-WLEDs Application Circuit

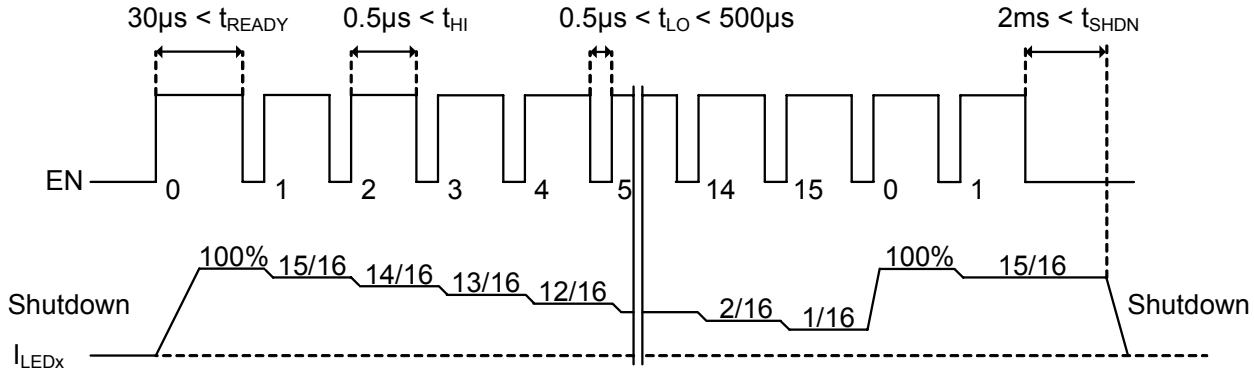


Figure 2. Brightness Control by Pulse Dimming

TYPICAL APPLICATION CIRCUITS

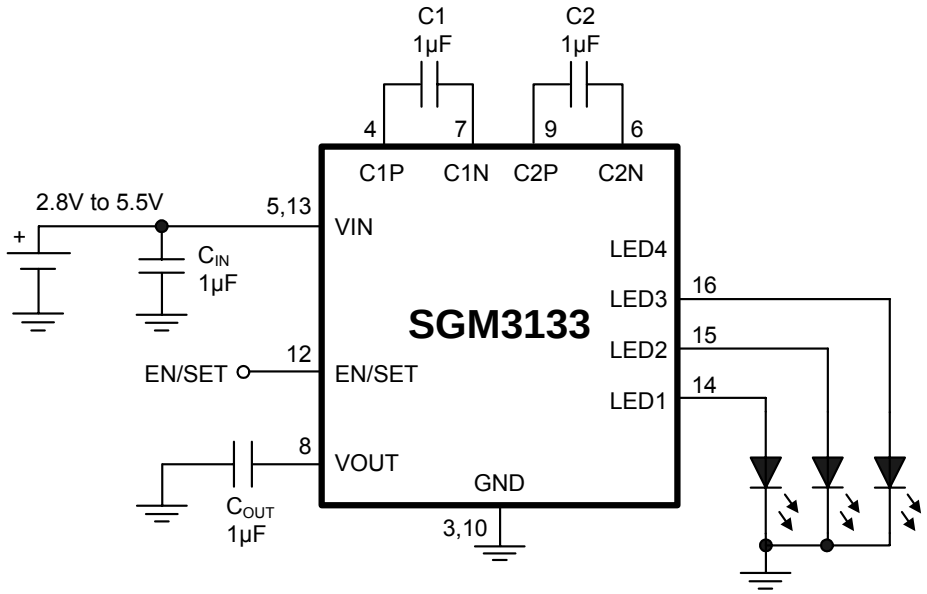


Figure 3. For 3-WLEDs Application Circuit

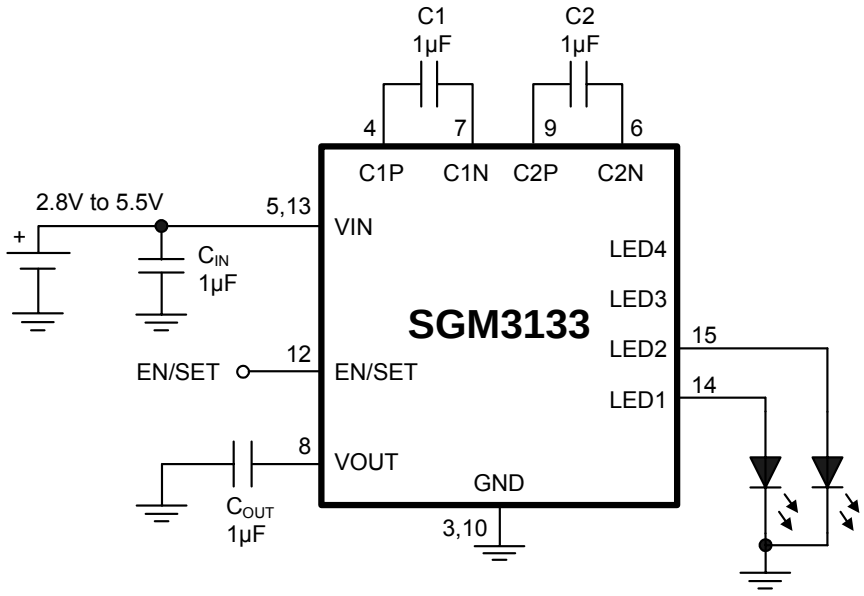


Figure 4. For 2-WLEDs Application Circuit

APPLICATIONS INFORMATION

The SGM3133 is a high efficiency charge pump white LED driver. It provides 4 channels low dropout voltage current source to regulated 4 white LEDs current. For high efficiency, the SGM3133 implements a smart mode transition for charge pump operation. The SGM3133 provides pulse dimming function for LED brightness control.

Soft Start

The SGM3133 includes a soft start circuit to limit the inrush current at power on and mode switching. Soft start circuit limits the input current before output voltage reaching a desired voltage level.

Input UVLO

The input operating voltage range of the SGM3133 is 2.7V to 5.5V. An input capacitor at the VIN pin could reduce ripple voltage. It is recommended to use a ceramic 1μF or larger capacitance as the input capacitor. This IC provides an under voltage lockout (UVLO) function to prevent it from unstable issue when startup. The UVLO threshold of input rising voltage is set at 2.2V typically with a hysteresis 100mV.

Thermal Protection

The SGM3142 has a thermal protection circuit that will shut down the internal LDO and charge pump if the die temperature rises above the thermal limit.

Mode Decision

The SGM3133 uses a smart mode selection method to decide the working mode for optimizing the efficiency. Mode decision circuit senses the output and LED voltage for up/down selection. The SGM3133 automatically switches to 1.5× mode whenever the dropout condition is detected from the current source and returns to 1× mode whenever the dropout condition releases.

LED Connection

The SGM3133 supports up to 4 white LEDs. The four LEDs are connected from VOUT to pin 14, 15, 16 and 1 respectively (Figure 1). If the LED is not used, the LED pin should be left floating directly. But LED1 should always be connected. Figure 3 shows the connection for 3-WLEDs application.

Brightness Control

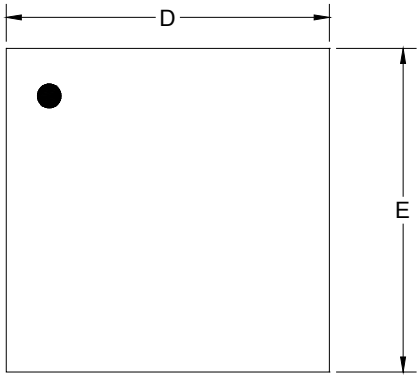
The SGM3133 implements the pulse dimming method being used to control the brightness of white LEDs. The part implements a 4-bit DAC for brightness control. Users can easily configure the LED current from 1.25mA to 20mA by a serial pulse. The maximum LED current is up to 20mA that is sufficient for most application in backlight. The dimming of white LEDs' current can be achieved by applying a pulse signal to the EN/SET pin. There are totally 16 steps of current could be set by users. The detail operation of brightness dimming is showed in the Figure 2.

Selecting Capacitors

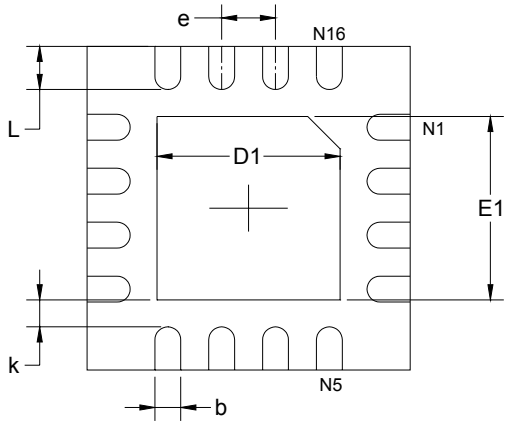
Careful selection of the four external capacitors C_{IN}, C1, C2, C_{OUT} is important because they will affect some parameters such as input and output ripple, power efficiency, maximum supply current by charge pump, and start-up time. To reduce the input and output ripple effectively, the low ESR ceramic capacitors are recommended. Generally, to reduce the output ripple, increasing the output capacitance C_{OUT} is necessary. However, this will increase the startup time of output voltage. For LED driver applications, the input voltage ripple is more important than output ripple. Input ripple is controlled by input capacitor C_{IN}, increasing the value of input capacitance can further reduce the ripple. Practically, the input voltage ripple depends on the power supply's impedance. If a single input capacitor C_{IN} cannot satisfy the requirement of application, it is necessary to add a low-pass filter. C-R-C filter used to reduce input ripple. The flying capacitor C1 and C2 determine the supply current capability of the charge pump. The lower value will limit the LED' s current at low input voltage. For 4 × 20mA load over the entire input range of 2.7V to 5.5V, it is recommended to use a 1μF ceramic capacitor on the flying capacitor C1 and C2.

PACKAGE OUTLINE DIMENSIONS

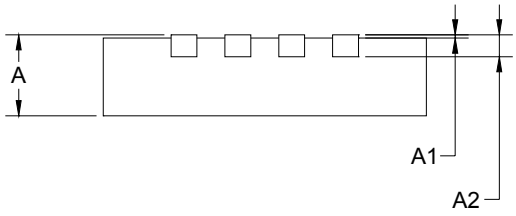
TQFN3×3-16L



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	2.900	3.100	0.114	0.122
D1	1.600	1.800	0.063	0.071
E	2.900	3.100	0.114	0.122
E1	1.600	1.800	0.063	0.071
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.500 TYP		0.020 TYP	
L	0.300	0.500	0.012	0.020

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