



SGM3142

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

GENERAL DESCRIPTION

The SGM3142 is a high efficiency and cost effective charge pump white LED driver. It supports up to 6 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 SGM3142 is available in Green TQFN-4×4-16L package and is specified over an ambient temperature range of -40°C to +85°C.

FEATURES

- **Input Voltage Range: 2.7V to 5.5V**
- **Drives up to 6 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 TQFN-4×4-16L Package**

APPLICATIONS

White LED Backlighting
White Photo-Flash for DSCs
Color (RGB) Lighting
Programmable Current Source



PACKAGE/ORDERING INFORMATION

| MODEL | ORDER NUMBER | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | PACKAGE OPTION | MARKING INFORMATION |
|---------|-------------------|---------------------|-----------------------------|---------------------|---------------------|
| SGM3142 | SGM3142YTQE16G/TR | TQFN-4x4-16L | -40°C to +85°C | Tape and Reel, 3000 | SGM3142YTQE16 |

ABSOLUTE MAXIMUM RATINGS

VIN to GND.....-0.3V to 6.0V
 The Other Pins to GND..... -0.3V to 6.0V
 Package Thermal Resistance
 TQFN-4x4-16L, θ_{JA}50°C/W
 Storage Temperature Range.....-65°C to +150°C
 Junction Temperature..... 150°C
 Operating Temperature Range.....-40°C to +85°C
 Lead Temperature (Soldering 10 sec)
260°C
 ESD Susceptibility
 HBM..... 2000V
 MM.....300V

NOTE:

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

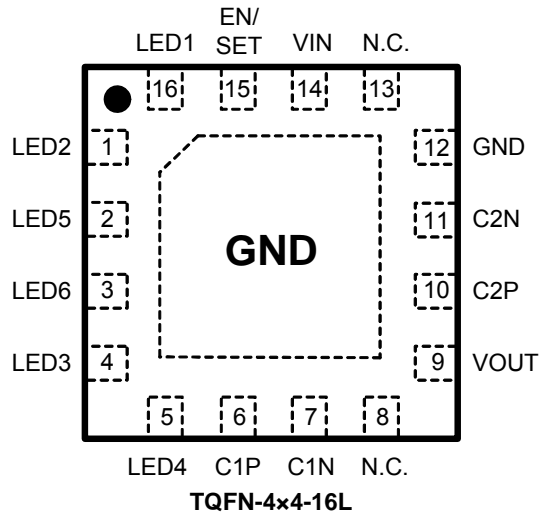
CAUTION

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.

SGMICRO reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact SGMICRO sales office to get the latest datasheet.



PIN CONFIGURATION (TOP VIEW)



PIN DESCRIPTION

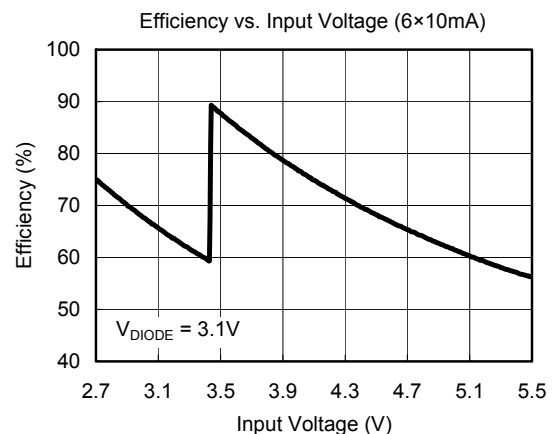
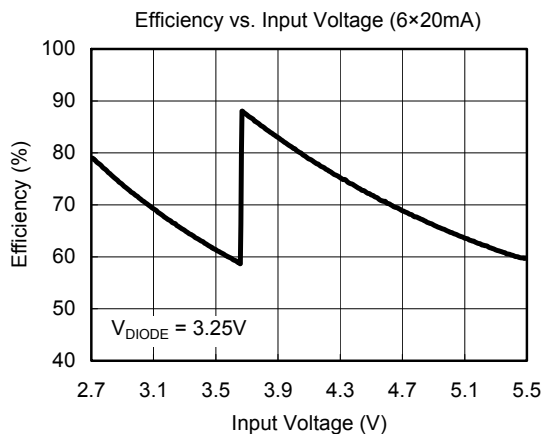
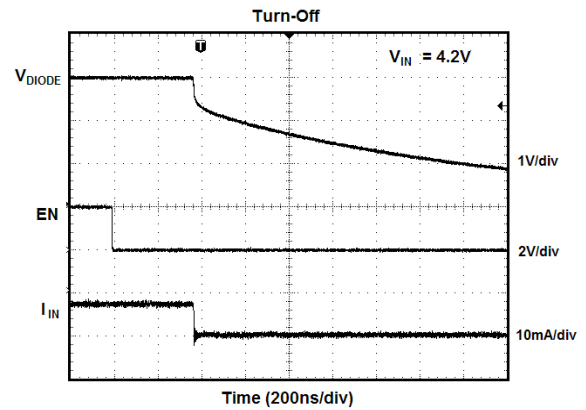
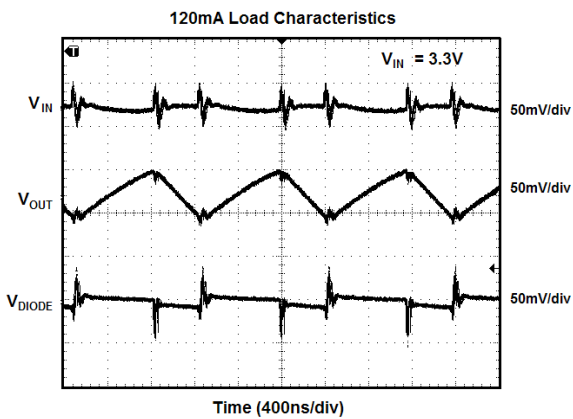
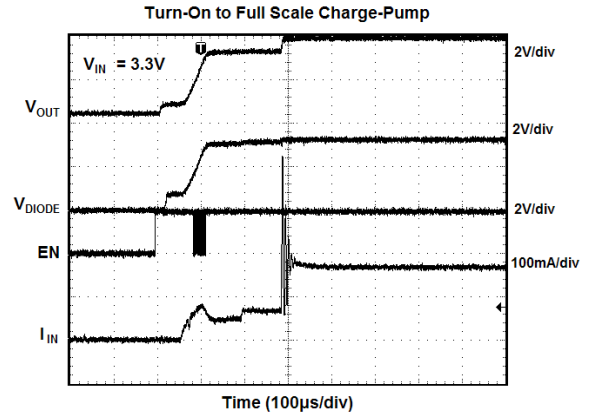
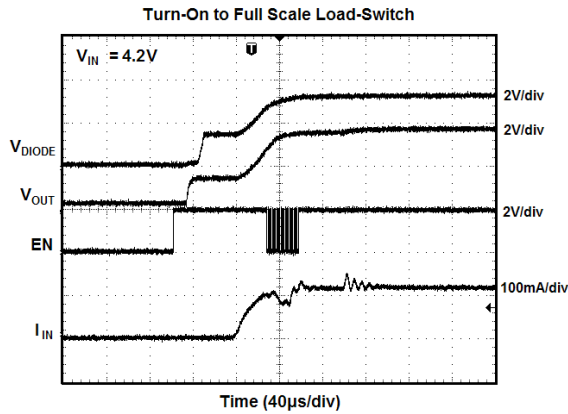
| PIN | NAME | FUNCTION |
|-------------|--------|---|
| 16 | LED1 | Output Current for LED1. |
| 1 | LED2 | Output Current for LED2. |
| 2 | LED5 | Output Current for LED5. |
| 3 | LED6 | Output Current for LED6. |
| 4 | LED3 | Output Current for LED3. |
| 5 | LED4 | Output Current for LED4. |
| 6 | C1P | Positive Input for the External Flying Capacitor C1. Connect a ceramic 1 μ F capacitor close to the pins of the IC. |
| 7 | C1N | Negative Input for the External Flying Capacitor C1. Connect a ceramic 1 μ F capacitor close to the pins of the IC. |
| 8,13 | N.C. | No Internal Connection. |
| 9 | VOUT | Output Voltage Source. |
| 10 | C2P | Positive Input for the External Flying Capacitor C2. Connect a ceramic 1 μ F capacitor close to the pins of the IC. |
| 11 | C2N | Negative Input for the External Flying Capacitor C2. Connect a ceramic 1 μ F capacitor close to the pins of the IC. |
| 12 | GND | Ground. |
| 14 | VIN | Power Input Voltage. |
| 15 | EN/SET | Chip Enable (Active High) and Dimming Control. |
| 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} = C1 = C2 = 1μF, T_A = +25°C, unless otherwise noted.)

| PARAMETER | | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|--------------------|----------------------|--|-----|------|-----|-------|
| Input Power Supply | | | | | | | |
| Input Supply Voltage | | V _{IN} | | 2.7 | | 5.5 | V |
| Under-Voltage Lockout Threshold | | | V _{IN} Rising | 1.8 | 2.2 | 2.5 | V |
| Under-Voltage Lockout Hysteresis | | | | | 100 | | mV |
| Quiescent Power Supply Current | I _Q | | 1× Mode, V _{IN} = 4V | | 0.3 | 1 | mA |
| | I _Q | | 1.5× Mode, V _{IN} = 3.3V | | 1 | 3.5 | |
| Shutdown Current | | I _{SHDN} | V _{EN} = 0.4V | | 0.1 | 10 | μA |
| 1× Mode to 1.5× Mode Transition Voltage (V _{IN} falling) | | V _{TS_×1.5} | V _F = 3.25V, I _{OUT} = 120mA, I _{LEDx} = 20mA | | 3.68 | | V |
| Hysteresis of Mode Transition | | | | | 350 | | mV |
| Output | | | | | | | |
| Output Current | | I _{LEDx} | V _{IN} = 3.5V, 100% Setting | 18 | 20 | 22 | mA |
| Current Matching | | | V _{IN} = 3.5V, 100% Setting | -4 | 1 | 4 | % |
| 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 | | 75 | μs |
| High Time for Dimming | | T _{HI} | | | 0.25 | | μs |
| EN/SET Current | High Current | I _{IH} | V _{IH} = V _{IN} | | 0.01 | 1 | μA |
| | Low Current | I _{IL} | V _{IL} = GND | | 0.01 | 1 | μA |
| Low Time for Shutdown | | T _{SHDN} | PWM Dimming | | 0.3 | 0.5 | ms |
| Frequency | | | | | | | |
| Oscillator Frequency | | f _{OSC} | | | 1000 | | kHz |

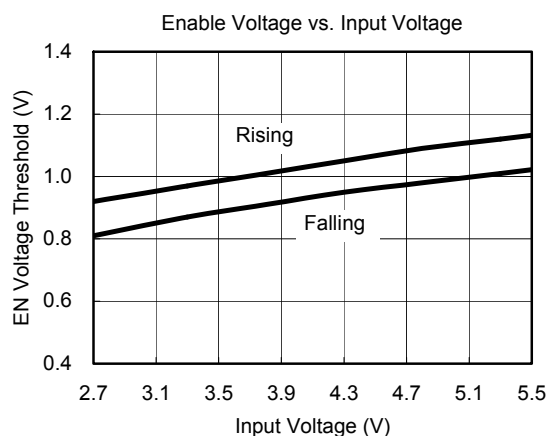
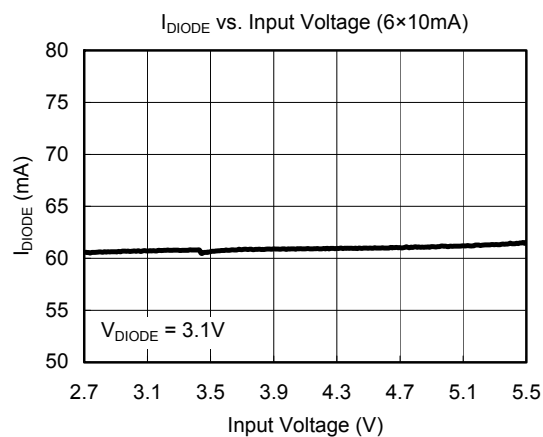
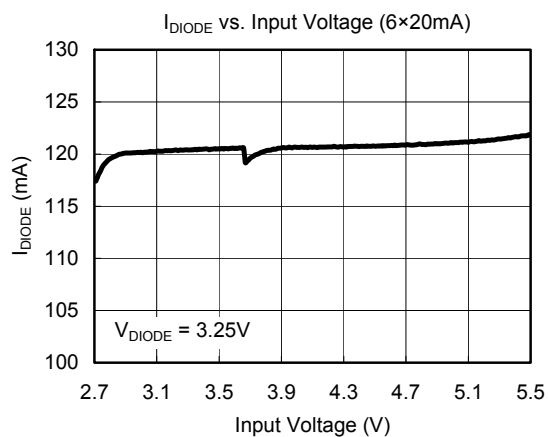
TYPICAL PERFORMANCE CHARACTERISTICS

$C_{IN} = C_{OUT} = C1 = C2 = 1\mu F$, $T_A = +25^\circ C$, unless otherwise noted.

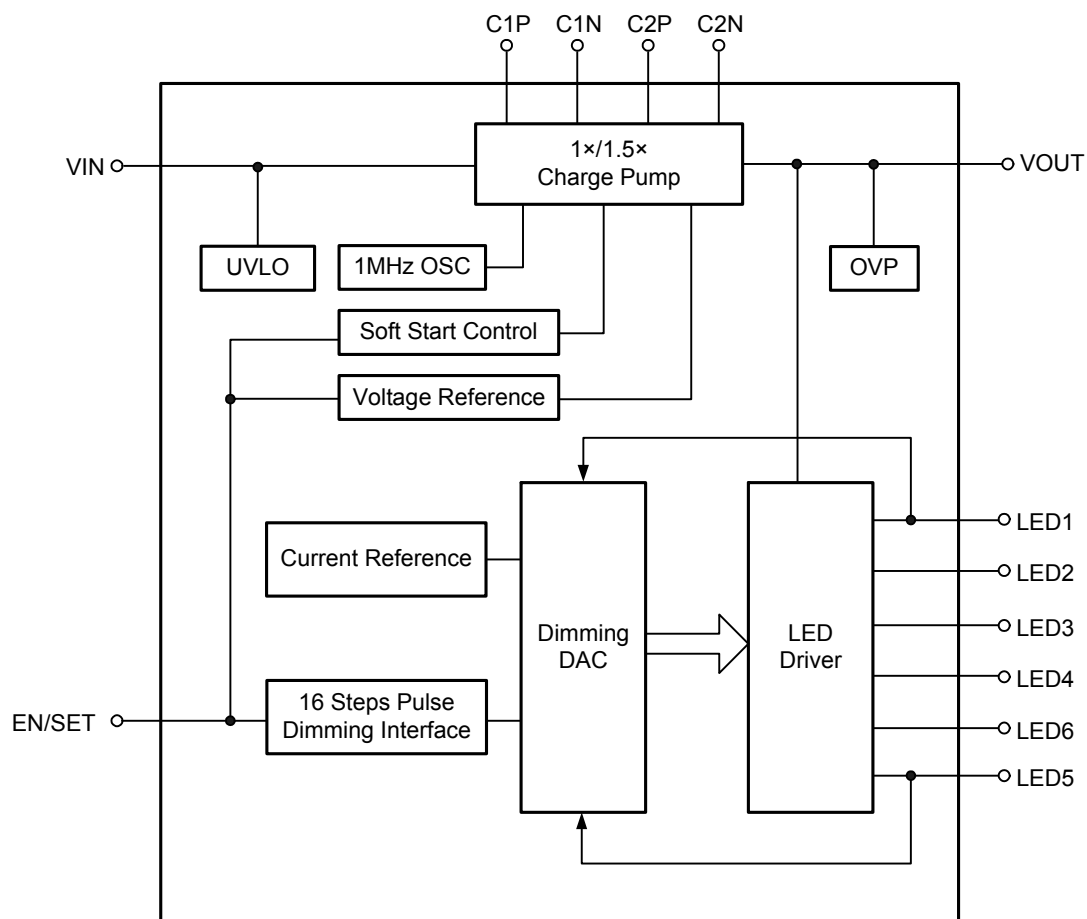


TYPICAL PERFORMANCE CHARACTERISTICS

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FUNCTION BLOCK DIAGRAM



TYPICAL APPLICATION

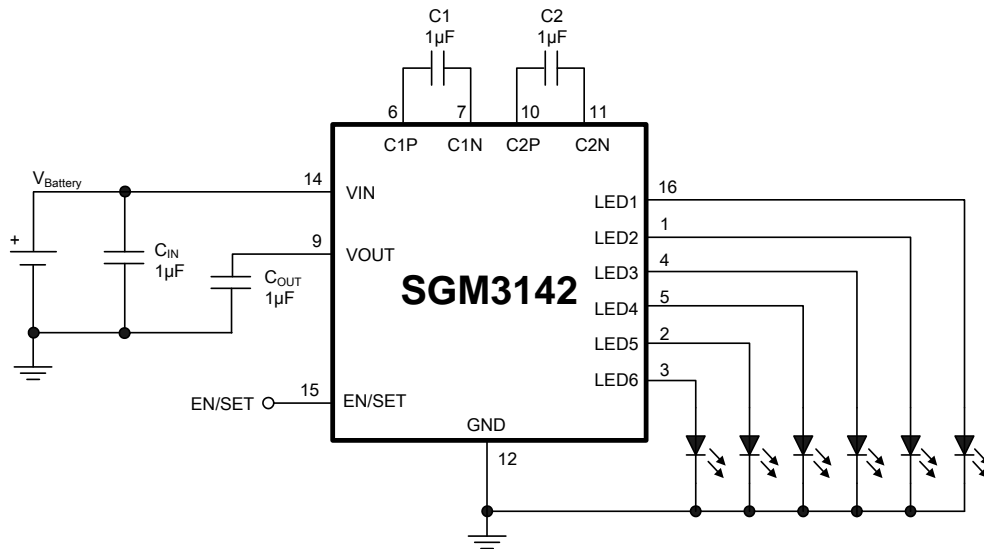


Figure 1. For 6-WLEDs Application Circuit

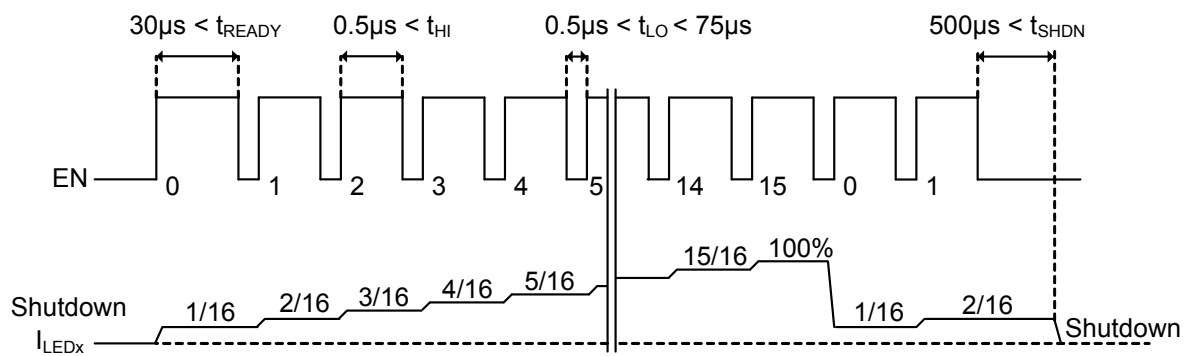


Figure 2. Brightness Control by Pulse Dimming

TYPICAL APPLICATION CIRCUITS

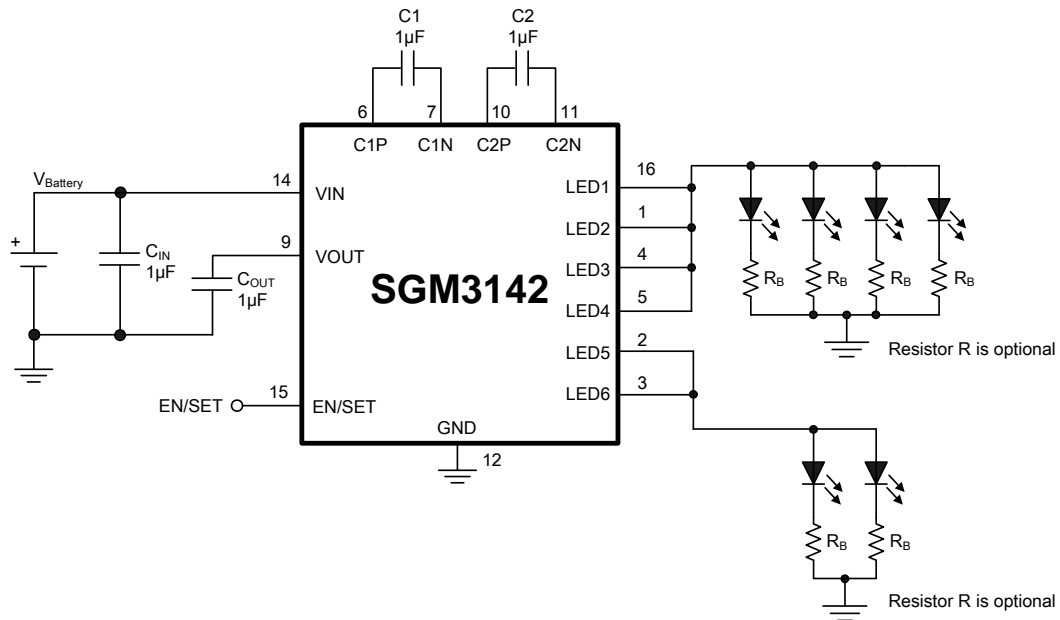
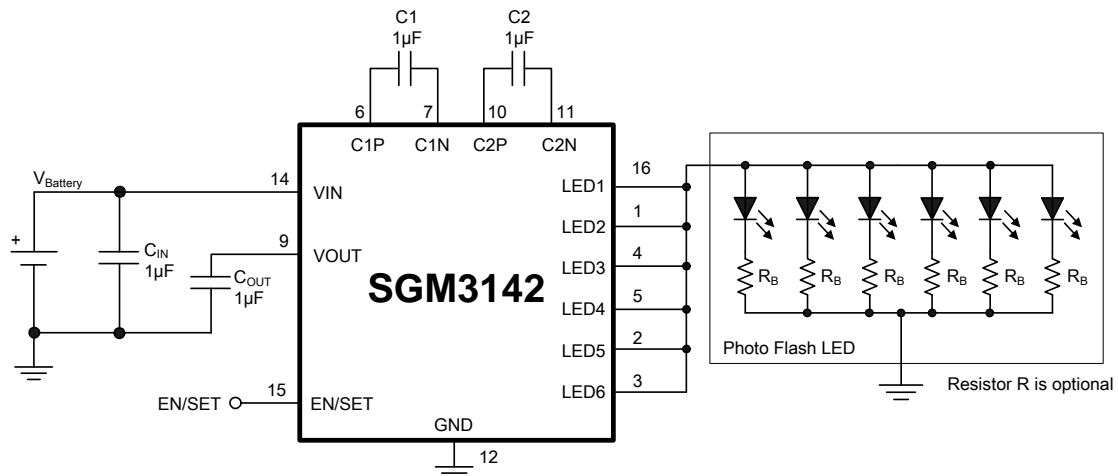


Figure 3. Driving Two Groups of Paralleled White LED's



In some applications, white LED forward voltages (V_F) can vary significantly. Ballast resistors between the LED cathodes and ground are recommended for balancing the forward voltage differences. The ballast resistor value may be approximated by the following equation:

$$R_B = \frac{V_{SOURCE} - V_F}{I_F}$$

Figure 4. Driving High Current Photo-Flash LED

APPLICATION INFORMATION

The SGM3142 is a high efficiency charge pump white LED driver. It provides 6 channels low dropout voltage current source to regulated 6 white LEDs current. For high efficiency, the SGM3142 implements a smart mode transition for charge pump operation. The SGM3142 provides pulse dimming function for LED brightness control.

Soft-Start

The SGM3142 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 SGM3142 is 2.7V to 5.5V. An input capacitor at the VIN pin could reduce ripple voltage. It is recommended to use a ceramic 1 μ F 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 SGM3142 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 SGM3142 automatically switches to 1.5 \times mode whenever the dropout condition is detected from the current source and returns to 1 \times mode whenever the dropout condition releases.

Brightness Control

The SGM3142 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 6 \times 20mA load over the entire input range of 2.7V to 5.5V, it is recommended to use a 1 μ F ceramic capacitor on the flying capacitor C1 and C2.

APPLICATION INFORMATION

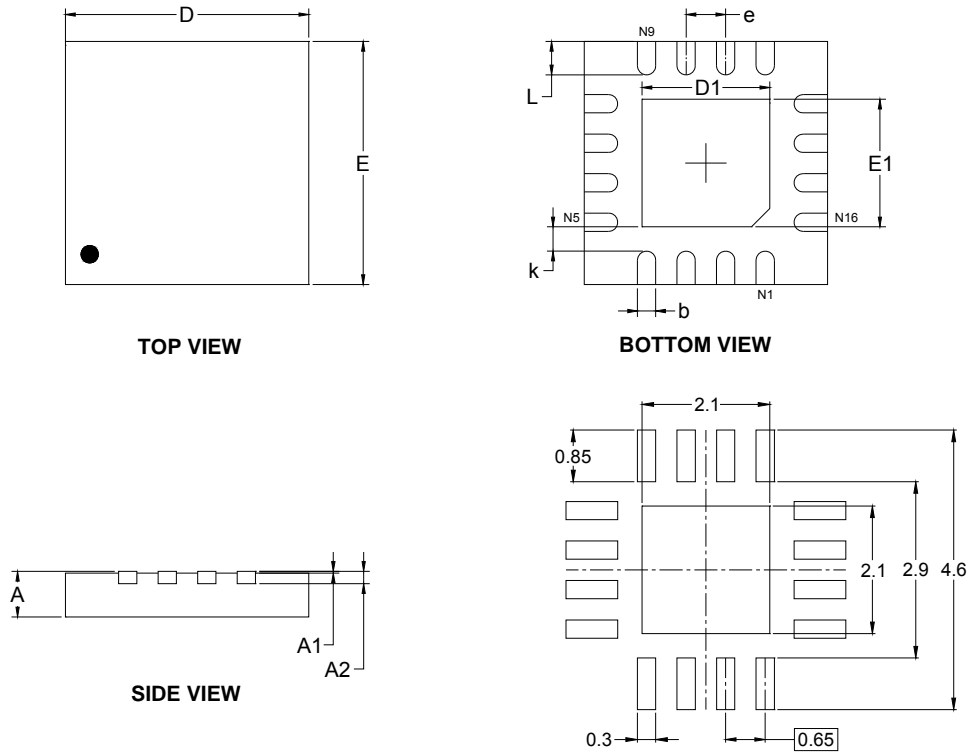
Driving Multiple LED's, White LED Display Module Back Lights

The SGM3142 LED1 to LED6 outputs are true constant current sources capable of driving up to 20mA each over the operation input voltage range. Since these outputs are true constant current sources, they may be connected in parallel to drive a single power output. Any combination of outputs (LED1 to LED6) may be connected in parallel. The maximum total output current is a sum of how many current sources are parallel connected. This feature is particularly useful to power pre-manufactured display modules which are pre-wired with white LED backlights connected in a parallel circuit configuration. Any combination of outputs may be connected in parallel to drive groups of LED's. The SGM3142 internal current source reference circuit bases feedback from current sensed on the LED1 and LED5 outputs. For best operation, the only requirement for this type of application is the output LED1 and LED5 should always be connected to the load circuit.

The SGM3142 may be used to drive multiple LED's having differing forward voltages. Using feedback techniques, the current in LED1 to LED4 output currents sources are referenced to the current in the LED connected to LED1. The LED5 and LED6 output current sources are referenced to the current in LED5, not to LED1. If all six LED's are of similar type, the diodes will be matched in current, maintaining uniform LED brightness despite variations in manufacturer, production, etc.

PACKAGE OUTLINE DIMENSIONS

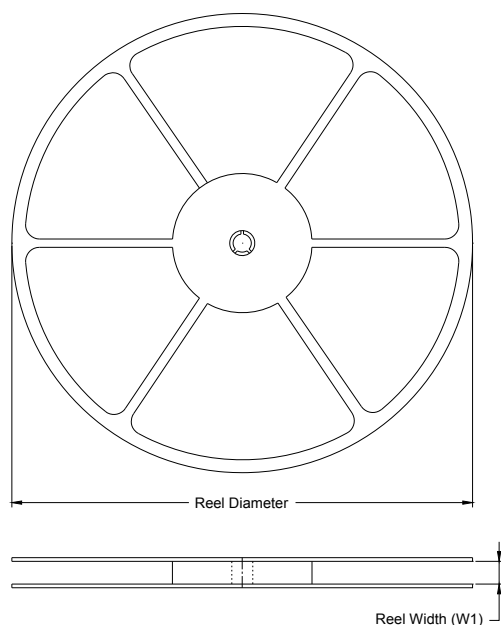
TQFN-4×4-16L



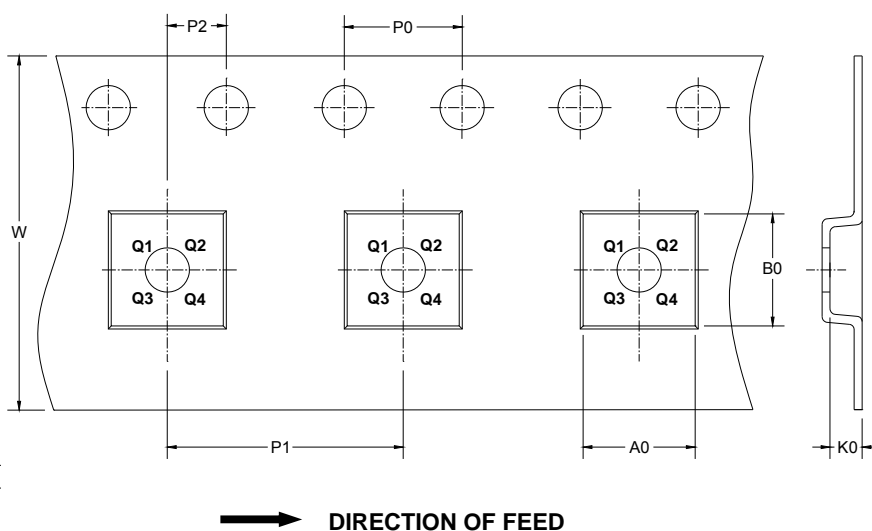
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|------------------------------|-------|-------------------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A2 | 0.203 REF | | 0.008 REF | |
| D | 3.900 | 4.100 | 0.154 | 0.161 |
| D1 | 2.000 | 2.200 | 0.079 | 0.087 |
| E | 3.900 | 4.100 | 0.154 | 0.161 |
| E1 | 2.000 | 2.200 | 0.079 | 0.087 |
| k | 0.200 MIN | | 0.008 MIN | |
| b | 0.250 | 0.350 | 0.010 | 0.014 |
| e | 0.650 TYP | | 0.026 TYP | |
| L | 0.450 | 0.650 | 0.018 | 0.026 |

TAPE AND REEL INFORMATION

REEL DIMENSIONS



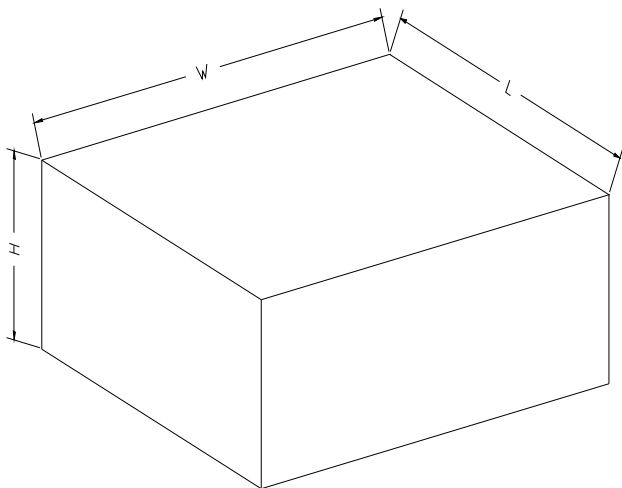
TAPE DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|--------------|---------------|--------------------------|------------|------------|------------|------------|------------|------------|-----------|------------------|
| TQFN-4×4-16L | 13" | 12.4 | 4.3 | 4.3 | 1.1 | 4.0 | 8.0 | 2.0 | 12.0 | Q1 |

CARTON BOX DIMENSIONS

NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

| Reel Type | Length (mm) | Width (mm) | Height (mm) | Pizza/Carton |
|-----------|----------------|---------------|----------------|--------------|
| 13" | 386 | 280 | 370 | 5 |