



SGM3738

High Efficiency, 2-Channel, 38V Step-Up WLED Driver

GENERAL DESCRIPTION

The SGM3738 is a 2-channel step-up DC/DC converter designed for driving the white LEDs with an internal 25mA constant current per channel. This device features integrated, 38V power MOSFETs that is capable of driving up to 10 white LEDs per channel, providing inherent current matching for uniform brightness. The SGM3738 supports PWM and one-wire digital interface to control the backlight brightness. The PWM frequency is in the range from 2kHz to 60kHz to avoid audible noise from inductor or ceramic capacitor, combining PWM and one-wire to get very wide brightness dimming range. PWM pin is always used for Content Adaptive Brightness Control (CABC) schemes. Constant 600kHz switching frequency is used in SGM3738.

The SGM3738 features a variety of protection circuits, including integrated 38.5V over-voltage protection (OVP), soft-start, cycle-by-cycle current limiting, and thermal shutdown protection circuitry.

SGM3738 supports 3V to 18V input voltage, and then SGM3738 can be used in one cell or two-cell battery equipments.

The SGM3738 has 1.65A current limit. It is available in Green TQFN-3×3-16L package. It operates over an ambient temperature range of -40°C to +85°C.

FEATURES

- High-Efficiency Boost DC/DC WLED Bias Supply
- Internal 38V, 0.25Ω Power MOSFET
- 3V to 18V Input Voltage Range
- 600kHz Constant Switching Frequency
- Up to 10 Serial White LEDs per Channel
- 25mA Constant Current per Channel
- Switch Current Limit: 1.65A
- Dual Dimming Scheme for Large Dimming Range
 - ◆ One-Wire Enable and 32-Step Dimming
 - ◆ PWM Dimming
- 2kHz to 60kHz PWM Dimming Frequency
- Internal 1MΩ Pull-Down Resistor at CTRL Pin
- Internal 500kΩ Pull-Up Resistor at PWM Pin
- Internal 38.5V Over-Voltage Protection
- Cycle-by-Cycle Over-Current Protection
- Soft-Start Function
- No Leakage from V_{IN} to GND through LED String
- Thermal Shutdown
- -40°C to +85°C Operating Temperature Range
- Available in Green TQFN-3×3-16L Package

APPLICATIONS

TFT LCD Displays
Smart Phones

PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---------|---------------------|-----------------------------|------------------|-----------------|---------------------|
| SGM3738 | TQFN-3x3-16L | -40°C to +85°C | SGM3738YTQ16G/TR | 3738TQ XXXXX | Tape and Reel, 4000 |

NOTE: XXXXXX = Date Code and Vendor Code.

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

SW, VOUT, CH1, CH2 to GND.....-0.3V to 40V
 VIN to GND.....-0.3V to 20V
 CTRL, PWM to GND.....-0.3V to 6V
 Continuous SW Current..... Internally limited to 1.65A
 Operating Temperature Range..... -40°C to +85°C
 Storage Temperature Range -65°C to +150°C
 Junction Temperature 150°C
 Lead Temperature (Soldering 10 sec)260°C
 ESD Susceptibility
 HBM.....2000V
 MM..... 200V

OVERSTRESS CAUTION

Stresses beyond those listed may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

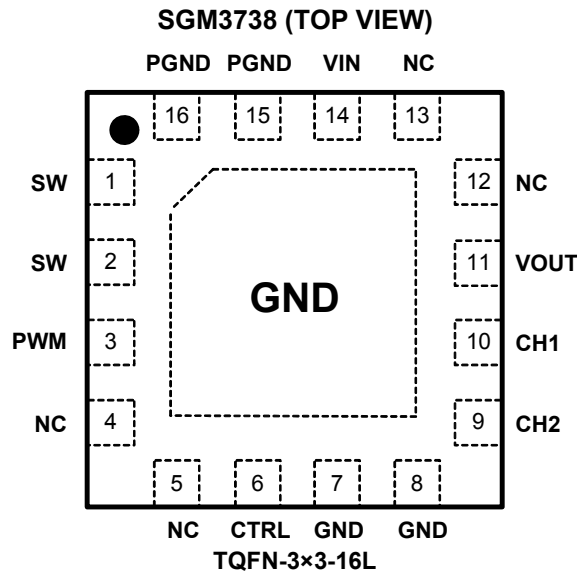
ESD SENSITIVITY CAUTION

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.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time.

PIN CONFIGURATION



PIN DESCRIPTION

| PIN | NAME | FUNCTION |
|--------------|------|---|
| 1, 2 | SW | Switch Output. Connect this pin to the inductor and the Schottky diode. |
| 3 | PWM | Pulse Width Controlled Dimming Input. Connect this pin to logic “High” or floating when not used. |
| 4, 5, 12, 13 | NC | No Connection. |
| 6 | CTRL | IC Enable and One-Wire Interface LED Dimming Control. |
| 7, 8 | GND | Ground. |
| 9 | CH2 | LED String 2 Current Input. Connect the LED String 2 cathode to this pin. |
| 10 | CH1 | LED String 1 Current Input. Connect the LED String 1 cathode to this pin. |
| 11 | VOUT | Output Voltage Pin. |
| 14 | VIN | Input Supply Pin. |
| 15, 16 | PGND | Power Ground Pin. |
| Exposed Pad | GND | Exposed pad should be soldered to PCB board and connected to GND. |

ELECTRICAL CHARACTERISTICS

($V_{IN} = 3.6V$, $V_{CTRL} = V_{PWM} = 3V$, $L = 10\mu H$, $C_{IN} = 22\mu F$, $C_{OUT} = 1\mu F$, Full = $-40^{\circ}C$ to $+85^{\circ}C$, typical values are at $T_A = 25^{\circ}C$, unless otherwise specified.)

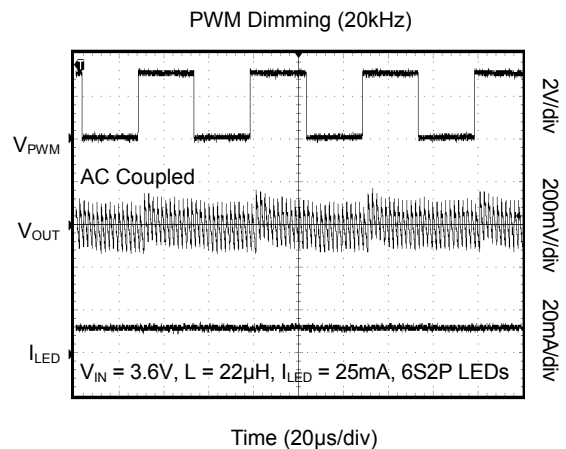
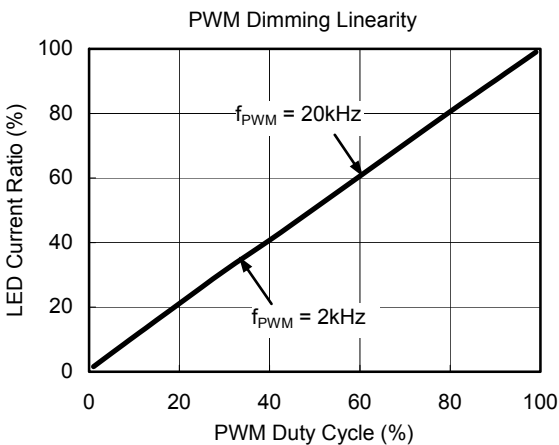
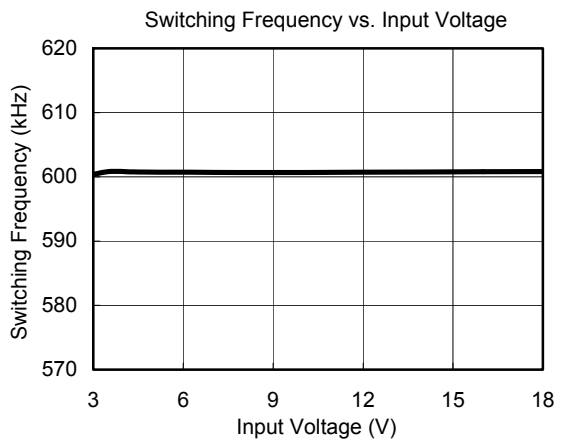
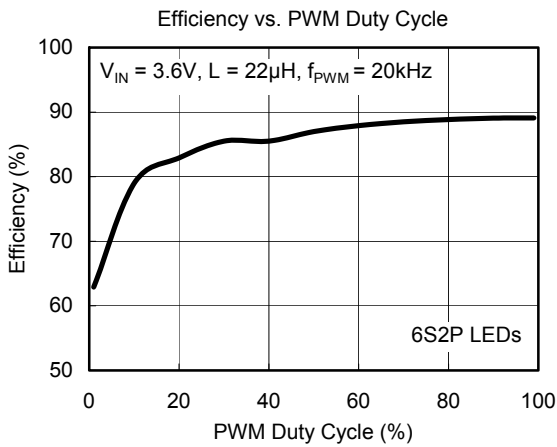
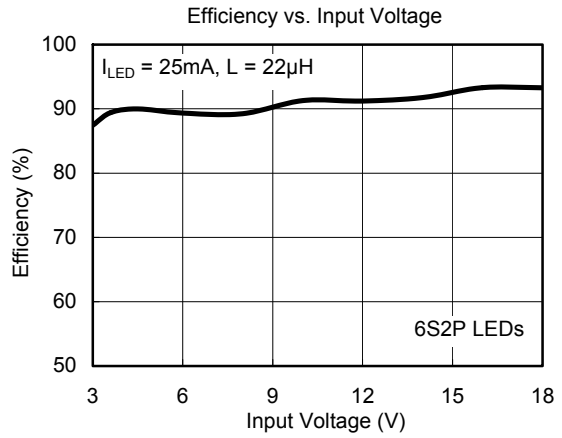
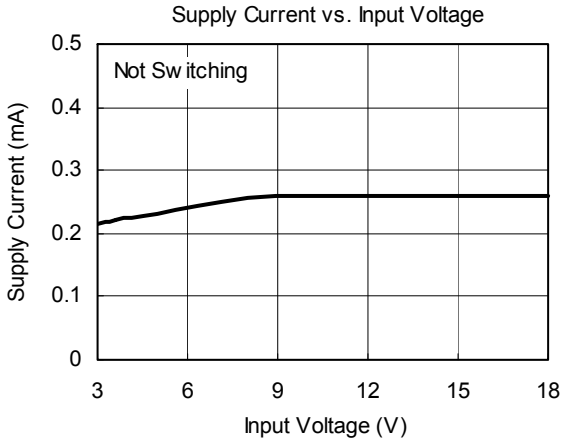
| PARAMETER | SYMBOL | CONDITIONS | TEMP | MIN | TYP | MAX | UNITS |
|--|--------------------|-----------------------------|------------------------|------|------|------|-------------|
| Input Voltage | V_{IN} | | Full | 3 | | 18 | V |
| Power Switch Voltage Rating | | | Full | | | 38 | V |
| Switch Frequency | | | Full | 480 | 600 | 700 | kHz |
| Under-Voltage Lockout Threshold | V_{UVLO} | V_{IN} Rising | $+25^{\circ}C$ | | 2.3 | 2.5 | V |
| Under-Voltage Lockout Hysteresis | | | $+25^{\circ}C$ | | 90 | | mV |
| Supply Current | | Not Switching | $+25^{\circ}C$ | | 0.24 | | mA |
| | | Switching | $+25^{\circ}C$ | | 0.8 | | mA |
| Supply Current in Shutdown | I_{SHDN} | CTRL = GND, $V_{IN} = 3.6V$ | $+25^{\circ}C$ | | 0.4 | 1 | μA |
| Switch Current Limit | I_{LIM} | | $+25^{\circ}C$ | 1.30 | 1.65 | 2.00 | A |
| Switch On Resistance | $R_{DS(ON)}$ | $V_{IN} = 3.6V$ | $+25^{\circ}C$ | | 0.25 | 0.39 | Ω |
| Switch Leakage Current | | $V_{SW} = 35V$, CTRL = GND | $+25^{\circ}C$ | | 0.1 | 1 | μA |
| Internal LED Current per Channel | | | $+25^{\circ}C$ | 23.7 | 25 | 25.9 | mA |
| LED Current Matching | | $I_{LED} = 25mA$ | $+25^{\circ}C$ | -1.1 | | 1.1 | % |
| Over-Voltage Protection Threshold | | Measured at VOUT pin | Full | 37.0 | 38.5 | 40.0 | V |
| Thermal Shutdown Temperature | | | | | 145 | | $^{\circ}C$ |
| Thermal Shutdown Hysteresis | | | | | 15 | | $^{\circ}C$ |
| CONTROL | | | | | | | |
| CTRL, PWM Threshold | Logic-High Voltage | V_{IH} | $V_{IN} = 3V$ to $18V$ | Full | 1.5 | | V |
| | Logic-Low Voltage | V_{IL} | $V_{IN} = 3V$ to $18V$ | Full | | 0.4 | V |
| Pull-Down Resistor | | $R_{PULL-DOWN}$ | $+25^{\circ}C$ | | 1 | | $M\Omega$ |
| Pull-Up Resistor | | $R_{PULL-UP}$ | $+25^{\circ}C$ | | 0.5 | | $M\Omega$ |
| CTRL Pin Logic High Pulse Width Timing | | $t_{HIGH(MIN)}$ | $+25^{\circ}C$ | 0.4 | | | μs |
| CTRL Pin Logic Low Pulse Width Timing | | t_{LOW} | $+25^{\circ}C$ | 0.4 | | 1000 | μs |
| CTRL Pin Shutdown Pulse Width Timing | | t_{OFF} | $+25^{\circ}C$ | 5.5 | | | ms |
| Minimum PWM On-Time | | | $+25^{\circ}C$ | 0.08 | | | μs |
| PWM Dimming Frequency | | | Full | 2 | | 60 | kHz |
| PWM Dimming Duty Cycle ⁽¹⁾ | | CTRL = HIGH | $+25^{\circ}C$ | 0.5 | | | % |

NOTE:

1. If one-wire dimming is also used, the minimum PWM duty cycle for no blind dimming is decided by the following conditions: the minimum LED current dimmed by one-wire and PWM is 0.5% of the internal LED current per channel.

TYPICAL PERFORMANCE CHARACTERISTICS

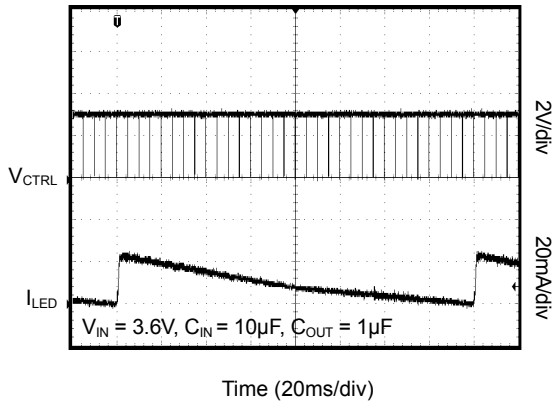
$V_{IN} = 3.6V$, $I_{LED} = 25mA$, 6-Series 2-Parallel LEDs, $L = 22\mu H$ (DCR = $70m\Omega$), $C_{IN} = 10\mu F$, $C_{OUT} = 1\mu F$, $T_A = +25^\circ C$, unless otherwise noted.



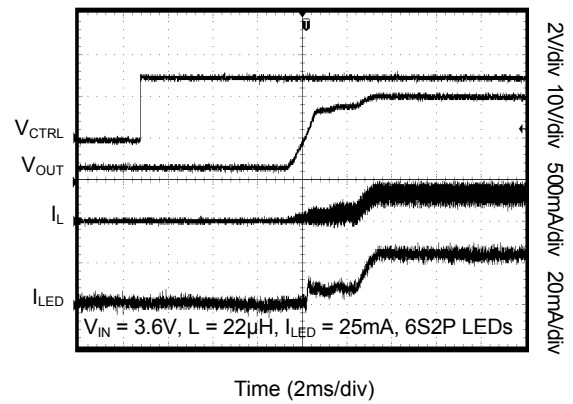
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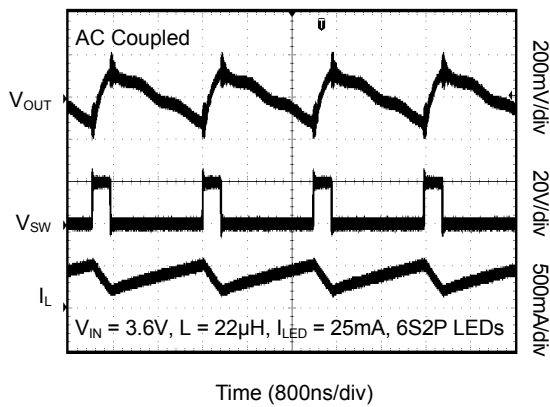
Transition from DATA1 to DATA33 (Full Cycle)



Soft-Start

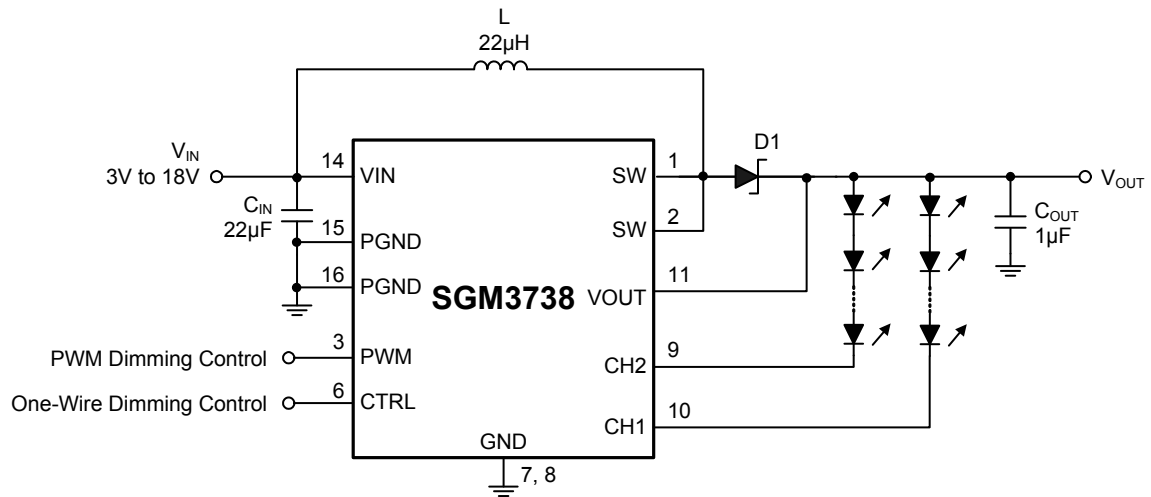


Steady State Switching



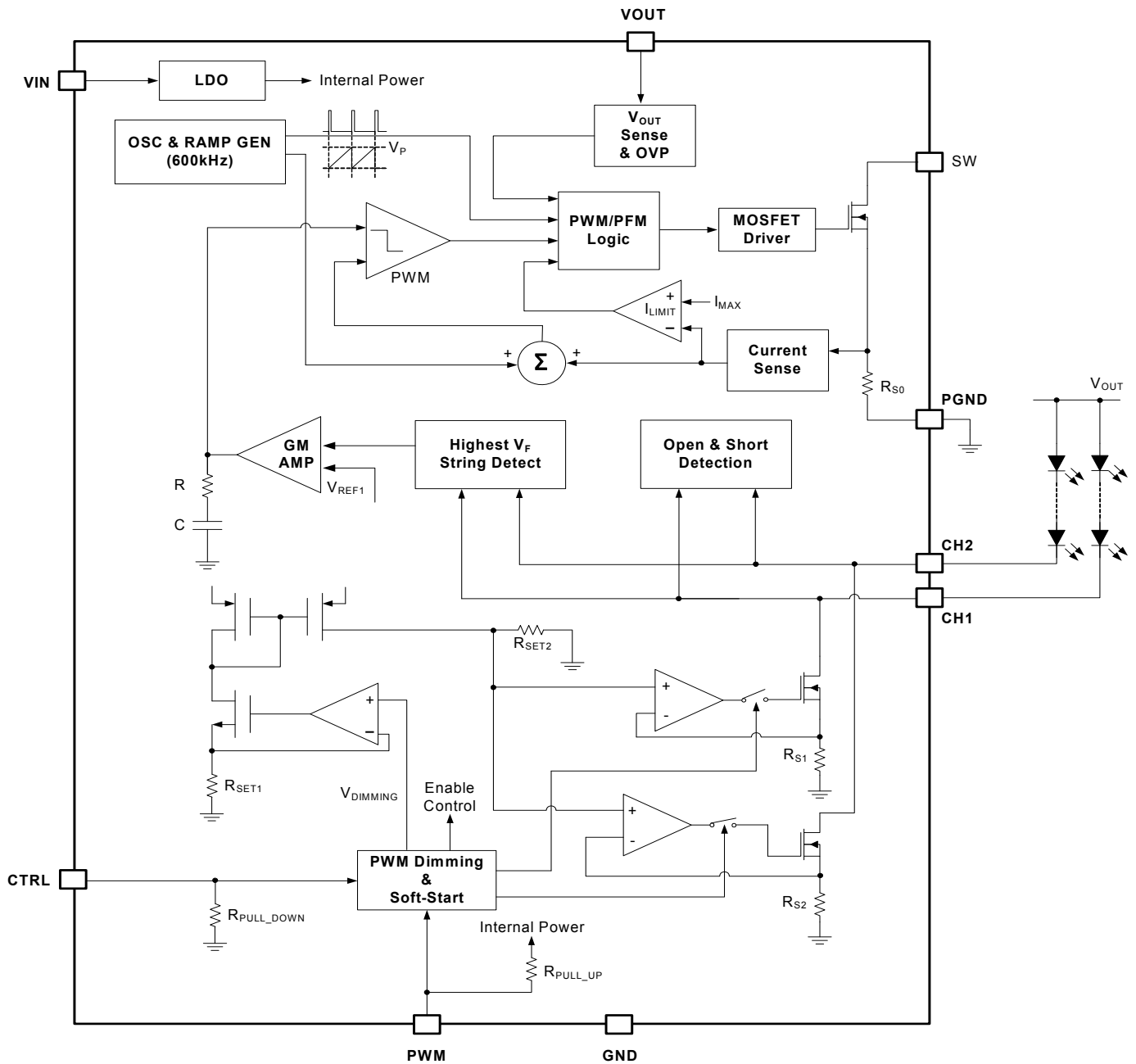
SGM3738

TYPICAL APPLICATION



SGM3738

FUNCTIONAL BLOCK DIAGRAM



APPLICATION INFORMATION

Inductor Selection

The SGM3738 was designed for operation with inductors in the 10µH to 22µH range. Keep in mind that larger-valued inductors (usually requiring higher V_{IN}) generally yield higher efficiency due to lower switching frequency, while smaller inductors typically yield a smaller footprint but at the cost of lower efficiency. For best results, choose an inductor with a low DC-Resistance (DCR) and be sure to choose an inductor with a saturation current that exceeds the current limit 1.65A.

Diode Selection

The SGM3738 requires a Schottky diode as the rectifier. Select a low forward voltage drop Schottky diode with forward current (I_F) rating that exceeds the peak current limit 1.65A and a peak repetitive reverse voltage (V_{RRM}) rating that exceeds the maximum output voltage, typically set by the OVP threshold.

Capacitor Selection

The SGM3738 only requires a tiny 1µF output capacitor for most applications. For better output voltage filtering, a low ESR output capacitor is recommended. The selection of the output capacitor value directly influences the output voltage ripple of the converter which also influences line regulation.

An input capacitor in the range of 1µF to 22µF is suggested for 10/8/6 series LED applications.

Ceramic capacitors are recommended for most applications. For best performance, use X5R and X7R type ceramic capacitors, which possess less degradation in capacitance over voltage and temperature.

Shutdown

The SGM3738 features low-current shutdown mode. In shutdown mode, the control circuitry is disabled, the LEDs are disconnected and the quiescent supply current drops to less than 1µA. To disable the SGM3738, simply drive CTRL pin logic “low” for more than 5.5ms. To enable the ICs, drive CTRL pin to a logic “high”.

CHx Pin Unused

A user can easily disable the unused channel by connecting its CHx pin to VOUT pin.

PWM Brightness Dimming

The SGM3738 supports direct PWM dimming control, allowing LED current to be adjusted via a PWM signal. The LED current is proportional with the PWM duty cycle. For best results, using PWM frequencies in the 2kHz to 60kHz range to adjust LED current.

When the PWM pin is constantly high, the control voltage is regulated to V_{BG} typically, V_{BG} is programmed by CTRL one-wire interface. The PWM pin allows a PWM signal to reduce this regulation voltage; therefore, it achieves LED brightness dimming. The relationship between the duty cycle and dimming voltage is given by Equation 1:

$$V_{DIMMING} = \text{Duty} \times V_{BG} \quad (1)$$

Where:

Duty = duty cycle of the PWM signal

V_{BG} is the internal reference voltage controlled by CTRL one-wire interface

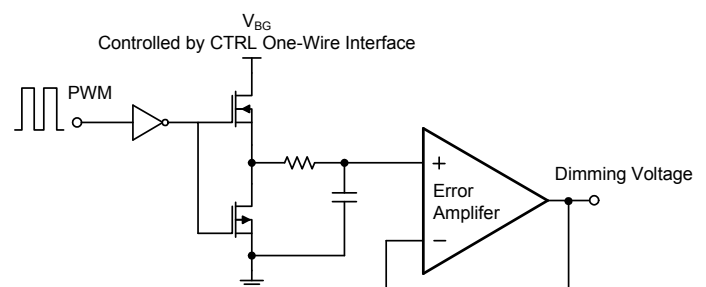


Figure 1. Block Diagram of PWM Dimming

APPLICATION INFORMATION

As shown in Figure 1, the IC chops up the internal V_{BG} reference voltage at the duty cycle of the PWM signal. The pulse signal is then filtered by an internal low pass filter. The output of the filter is connected to the error amplifier as the reference voltage to control output current. Therefore, although a PWM signal is used for brightness dimming, only the WLED DC current is modulated, which is often referred as analog dimming. This eliminates the audible noise which often occurs when the LED current is pulsed in replica of the frequency and duty cycle of PWM control. Unlike other scheme which filters the PWM signal for analog dimming, SGM3738 regulation voltage is independent of the PWM logic voltage level which often has large variations.

SGM3738 allows maximum flexibility with a PWM signal control input which can be used for dimming. The IC must remain enabled at CTRL pin during PWM dimming, which means the step-up converter is active to reduce the response time. For the widest range of control, serial interface programming at CTRL pin can be used in conjunction with PWM dimming.

Brightness Dimming Using CTRL Pin

The current level decoding happens immediately after detecting 0.4µs pulse. The first logic high or pulse at the CTRL pin takes the current level to the preset value (25mA). Each subsequent qualified rising edge will reduce the output current. See Table 1 for detailed current level versus number of pulses. The current level maintains unchanged as long as the CTRL pin stays high. The longest low pulse guaranteed not to be mistaken as a shutdown command should not exceed 1ms. However, the IC is guaranteed to be shutdown after the CTRL is kept low for at least 5.5ms.

An example for programming the output current is shown in Figure 2.

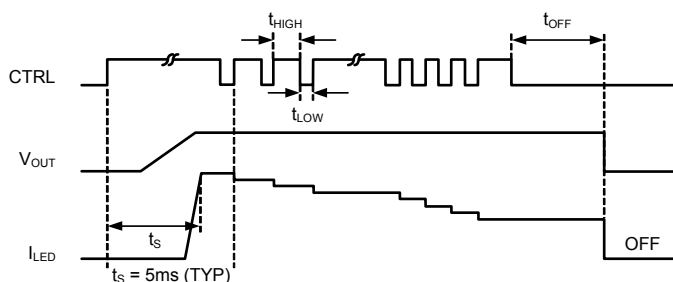


Figure 2. Output Current Programming via CTRL Pin

The output current can be decreased by simply adding the number of pulses according to Table 1. For example, when the maximum LED current is 25mA, add 8 pulses to change current from 25mA to 18.1mA (changing from data 1 to data 8).

Increasing the current level requires a simple translation. Since the data in Table 1 automatically circles around, adding 32 to the data in the target current level to figure out the number of pulses needed.

Example: To change from 1.1mA (data 31) to 12.8mA (data 13), send in 14 pulses ($13 + 32 - 31 = 14$).

Table 1. Current Settings

| DATA | I_{sx} (mA) Nominal | DATA | I_{sx} (mA) Nominal |
|------------|-----------------------|------|-----------------------|
| 1 (Preset) | 25 | 17 | 8.6 |
| 2 | 24 | 18 | 8 |
| 3 | 23 | 19 | 7.5 |
| 4 | 22 | 20 | 6.9 |
| 5 | 21 | 21 | 6.4 |
| 6 | 20 | 22 | 5.8 |
| 7 | 19.1 | 23 | 5.3 |
| 8 | 18.1 | 24 | 4.7 |
| 9 | 17 | 25 | 4.2 |
| 10 | 16 | 26 | 3.6 |
| 11 | 14.9 | 27 | 3.1 |
| 12 | 13.9 | 28 | 2.6 |
| 13 | 12.8 | 29 | 2.1 |
| 14 | 11.8 | 30 | 1.6 |
| 15 | 10.7 | 31 | 1.1 |
| 16 | 9.7 | 32 | 0.6 |

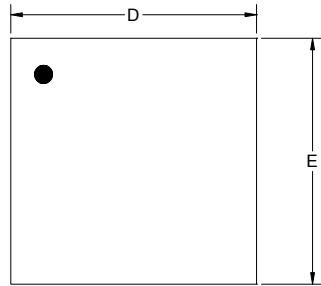
Low Input Voltage Application

In applications that have low input voltage range, such as those powered from 2-3 AA cells, the SGM3738 may still be used if there is a suitable system supply (such as 3.3V) available to power the controller. In such an application, the inductor may be connected directly to the battery, while the IC power is supplied by the system supply.

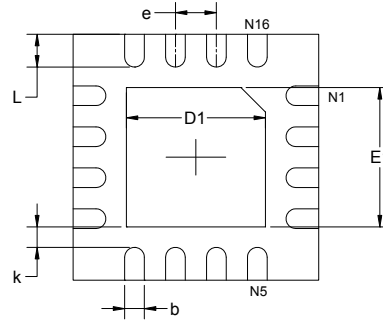
PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

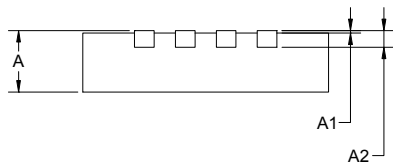
TQFN-3x3-16L



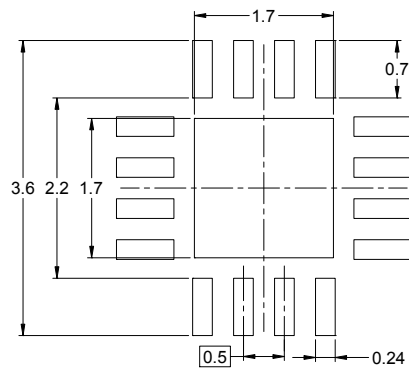
TOP VIEW



BOTTOM VIEW



SIDE VIEW

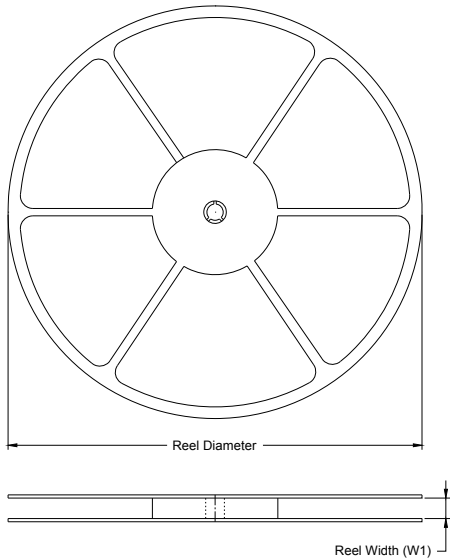


RECOMMENDED LAND PATTERN (Unit: mm)

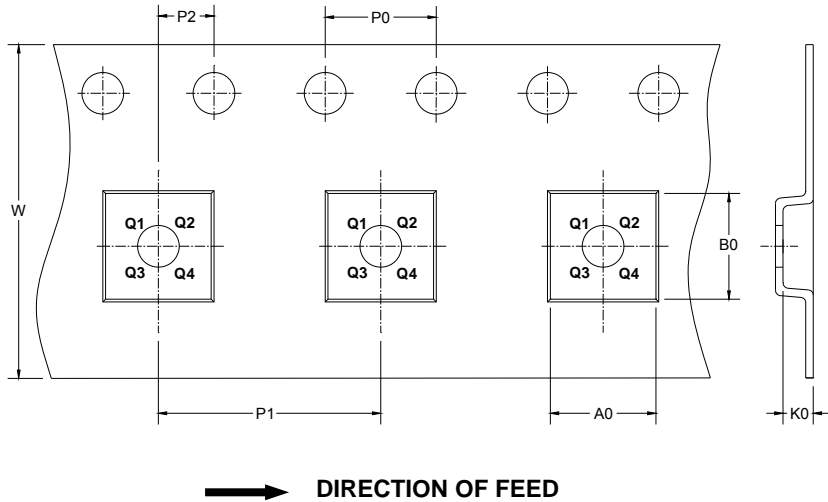
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|------------------------------|-------|-------------------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A2 | 0.203 REF | | 0.008 REF | |
| D | 2.900 | 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 |

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



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

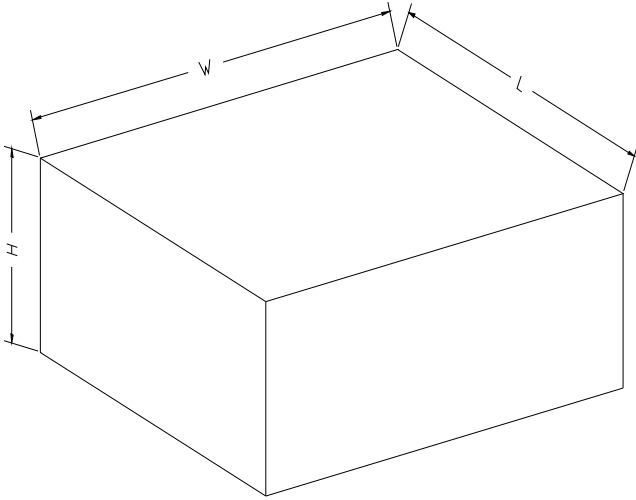
KEY PARAMETER LIST OF TAPE AND REEL

| 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-3×3-16L | 13" | 12.40 | 3.35 | 3.35 | 1.13 | 4.00 | 4.00 | 2.00 | 12.00 | Q1 |

DD0001

PACKAGE INFORMATION

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 |

DD0002