SGM37602
6-Channel 43V Boost WLED Driver with High Efficiency and Accuracy

GENERAL DESCRIPTION

The SGM37602 is a high-performance white LED driver meticulously designed for LCD panels that utilize LED arrays as backlighting source. The SGM37602 adopts peak current mode control, and the minimum LED string cathode voltage is regulated to an adequate operating headroom voltage, which produces sufficient voltage margin to guarantee the accuracy of the current.

The SGM37602 equips six internal current sinks for 1% current matching, ensuring superior brightness uniformity across LED strings.

The device integrates PWM and mixed dimming mode for precise LED current regulation. The range of the PWM signal dimming frequency is from 100Hz to 20kHz. The configuration range of maximum LED current per string is from 5mA to 50mA. Moreover, the LED current and brightness can be further adjusted by the duty cycle of the PWM signal. In PWM dimming mode, the voltage-holding method of the unique current sink ensures excellent LED current accuracy and matching, even at extremely low duty cycles.

The SGM37602 features a 2.7V to 24V input voltage range. An internal 43V power switch with 180mΩ R_{DSON}, combined with peak current mode control, provides high efficiency performance and cycle-by-cycle over-current protection.

The SGM37602 is available in a Green TQFN-3×3-20DL package.

FEATURES

- **Wide Input Voltage: 2.7V to 24V**
- **High Output Voltage: up to 43V**
- **Programmable LED Current (100% PWM Duty Cycle): 5mA to 50mA per Channel**
- **LED Current Matching: ±1%**
- **Typical LED Current Accuracy: ±2.5%**
- **Dimming Controls**
  - **Direct PWM Dimming**
  - **Mixed Dimming**
  - **Up to 12-Bit Resolution in DC Dimming of Mixed Mode**
- **Built-In Soft-Start Function**
- **LED Disconnection in Shutdown**
- **Protection**
  - **LED Open and Short Protection**
  - **Cycle-by-Cycle Over-Current Protection**
  - **Programmable Over-Voltage Protection**
  - **Over-Temperature Protection**
- **Available in a Green TQFN-3×3-20DL Package**

APPLICATIONS

Notebook Computer Display Backlight

UMPC Display Backlight

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM37602	TQFN-3×3-20DL	-40℃ to +85℃	SGM37602YTWW20G/TR	1TETW XXXXX	Tape and Reel, 4000

MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code.

XXXXX
- Vendor Code
- Trace Code
- Date Code - Year

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

Supply Input Voltage, VIN to GND .... -0.3V to 26.5V
EN, PWM, ISET, COMP, MIX, FREQ to GND
.... -0.3V to 26.5V
SW, OVP, LED1 to LED6 to GND...................... -0.3V to 46V
SW to GND .... -0.3V to 46V
SW to GND (< 500ns).. -1V to 46V
VDC to GND .... -0.3V to 7V
Package Thermal Resistance
TQFN-3×3-20DL, θ_{JA} .... 38.3℃/W
TQFN-3×3-20DL, θ_{JB} .... 12.3℃/W
TQFN-3×3-20DL, $\theta_{JC\ (TOP)}$ .... 39.6℃/W
TQFN-3×3-20DL, $\theta_{JC\ (BOT)}$ .... 3.4℃/W
Junction Temperature...+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)............................+260℃
ESD Susceptibility [1][2]
HBM...±3000V
CDM ....±1000V

NOTES:

1. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.

2. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

RECOMMENDED OPERATING CONDITIONS [1]

Supply Input Voltage, V_{IN} ....2.7V to 24V
Output Voltage Range ....43V (MAX)
Operating Ambient Temperature Range.........-40℃ to +85℃
Operating Junction Temperature Range......-40℃ to +125℃

NOTE:
1. There is no guarantee that the device will operate properly when used beyond its specified operating conditions.

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

ESD SENSITIVITY CAUTION

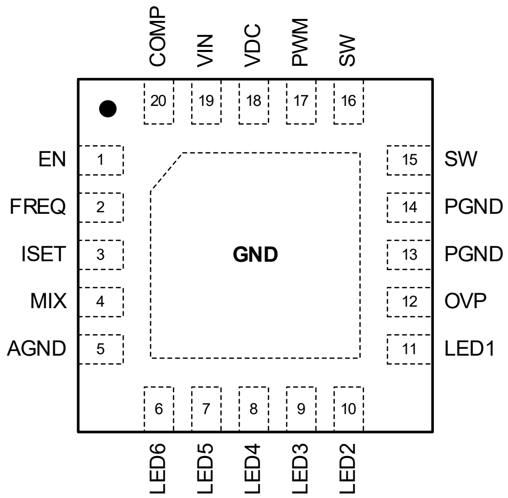
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION

(TOP VIEW)



TQFN-3×3-20DL

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	EN	Device Enable Pin. When this pin is left floating, it is disabled by default due to an internal 400kΩ pull-down resistor.
2	FREQ	Boost Switching Frequency Setting Pin. Connect a resistor between this pin and AGND to set Boost switching frequency based on the following formula. $R_{FSW} = 1.1\times(\frac{25}{f_{SW}(MHz)} - 6)(k\Omega)$
3	ISET	LED Current Setting Pin. Connect a resistor between this pin and AGND to set the LED current of each channel when the PWM duty cycle is 100% based on the following formula. $I_{LED}(mA) = \frac{240}{R_{ISET}(k\Omega)}$
4	MIX	Dimming Mode Selection Pin: The MIX pin is equipped with an internal 400kΩ pull-up resistor to VDC. 1. Set this pin floating or high for mixed mode dimming. 2. Set this pin low for direct PWM mode dimming.
5	AGND	Analog Ground Pin.
6 - 11	LED6 to LED1	LED Current Sink Channel Pins. If an LED string is unused, the corresponding pin can be left unconnected or grounded.
12	OVP	Over-Voltage Protection Detection Pin.
13, 14	PGND	Power Ground Pin.
15, 16	SW	Boost Converter Switching Pin.
17	PWM	PWM Dimming Signal Input Pin.
18	VDC	Internal LDO Output Pin. Add a capacitor with a sufficient and effective capacitance between this pin and ground.
19	VIN	Device Supply Input Pin.
20	COMP	Boost Converter Compensation Pin. Connect a compensation network to adjust system stability.
Exposed Pad	GND	Ground. To enhance heat dissipation and guarantee the normal operation of the chip, the exposed pad should be soldered to a large area on the PCB and then linked to the ground.

TYPICAL APPLICATION CIRCUIT

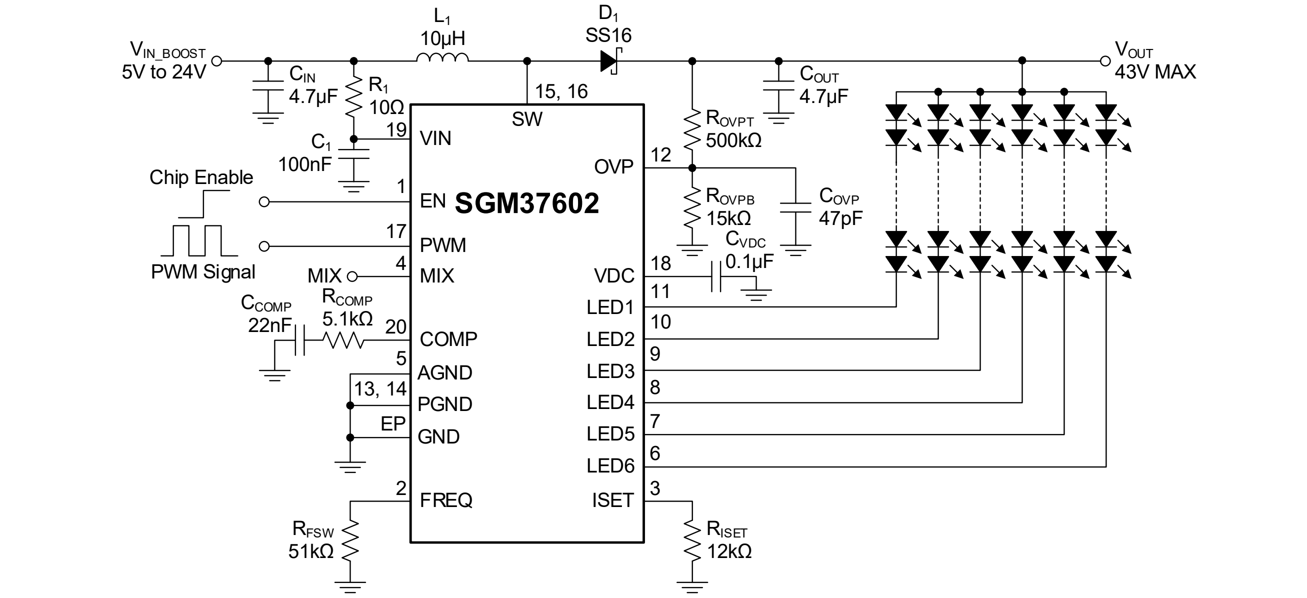


Figure 1. Typical Application Diagram

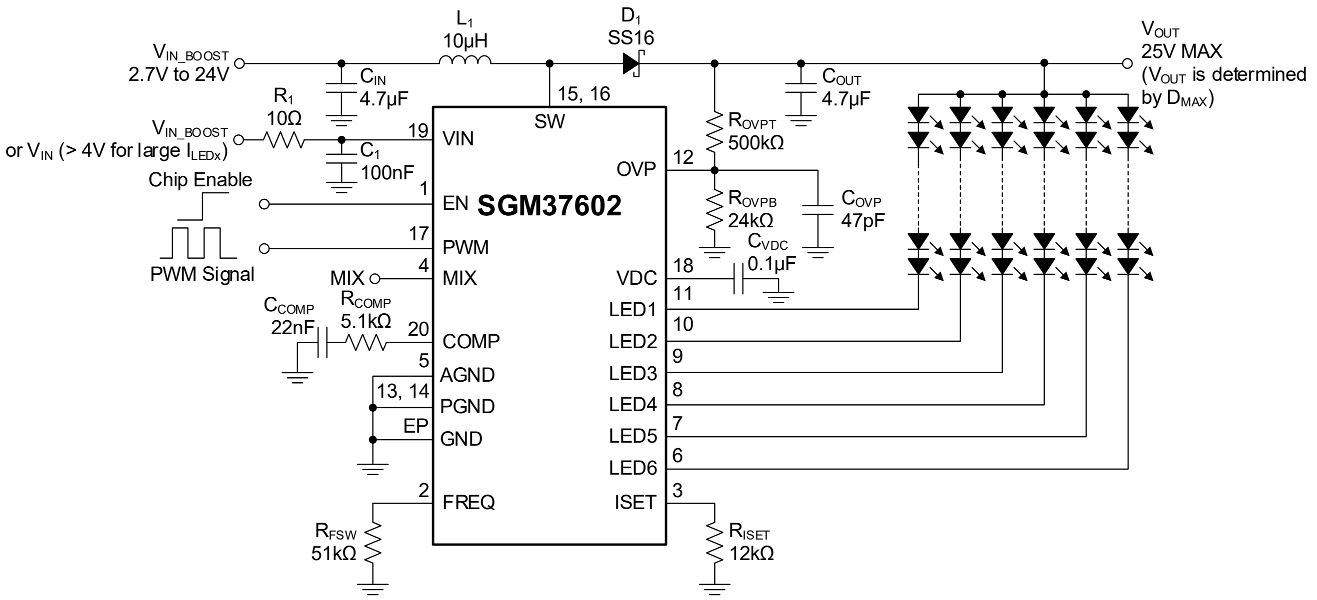


Figure 2. Separate Boost and SGM37602 Input Application Diagram

ELECTRICAL CHARACTERISTICS

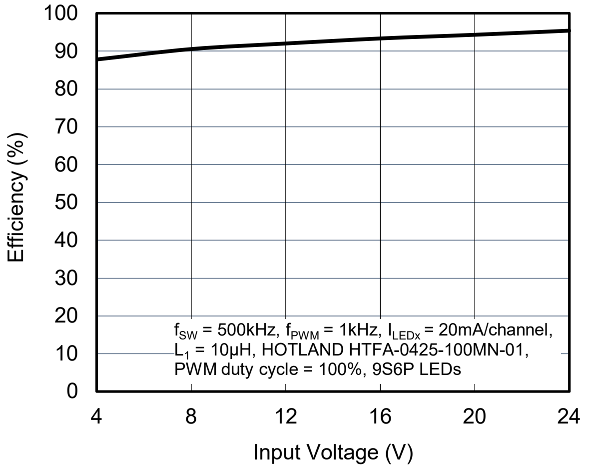
(V_{IN} = 5.0V, T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
VIN Quiescent Current	I_{VIN}	V_{PWM} = 2V, V_{COMP} = 0V, not switching		2.3		mA
	I_{VIN_SW}	V_{PWM} = V_{COMP} = 2V, f_{SW} = 500kHz, switching		2.6		
VIN Shutdown Current	I_{SHDN}	V_{EN} = 0V		0.3	2	μA
VIN Under-Voltage Lockout Threshold	V_{UVLO}	V_{IN} rising		2.45		V
		V_{IN} falling		2.41		
PWM Dimming Frequency	f_{PWM}		0.1		20	kHz
Control Input						
EN, PWM High Input Voltage	V_{IH}	V_{IN} = 2.7V to 24V, T_A = -40℃ to +85℃	1.2		24	V
EN, PWM Low Input Voltage	V_{IL}	V_{IN} = 2.7V to 24V, T_A = -40℃ to +85℃			0.5	
Boost Converter						
Switching Frequency	f_{SW}	R_{FSW} = 22kΩ	0.85	1	1.15	MHz
		R_{FSW} = 51kΩ	0.4	0.5	0.6	
On-Resistance (N-MOSFET)	R_{SW}	V_{IN} > 4.5V	0.15	0.18	0.22	Ω
Minimum On-Time	t_{ON_MIN}	R_{FSW} = 22kΩ		60		ns
Maximum Duty	D_{MAX}	R_{FSW} = 22kΩ	90	94		%
Peak Current Limit	I_{LIM}		2.4	2.7	3.1	A
Regulated V_{LEDx}	V_{LEDx}	Highest LED string, I_{LED} = 20mA	0.5	0.6	0.7	V
Low Dropout Linear Regulator						
LDO Output Voltage Range	V_{DC}		3.6	3.8	4.0	V
LED Current Programming						
LED Current Accuracy	I_{LEDA}	0.5V < V_{LEDx} < 2V, R_{ISET} = 12kΩ	19.5	20	20.5	mA
LED Current Matching	I_{LEDM}	0.5V < V_{LEDx} < 2V, R_{ISET} = 12kΩ, formulated by (I_{LEDx} - I_{AVG}) / I_{AVG} × 100%	-1		1	%
ISET Pin Voltage	V_{ISET}		0.9	1.0	1.1	V
Fault Protection						
OVP Threshold	V_{OVP}		1.16	1.2	1.24	V
OVP UVLO Threshold	V_{OVPF}			50		mV
Thermal Shutdown Temperature	T_{SD}			150		℃
OTP Hysteresis	T_{OTP_HYS}			30		℃
LED Pin Under-Voltage Threshold	V_{LSD}	Un-connection		0.1		V
LED Pin Over-Voltage Threshold	V_{SCP}	LED pin shorted to VOUT		16		V

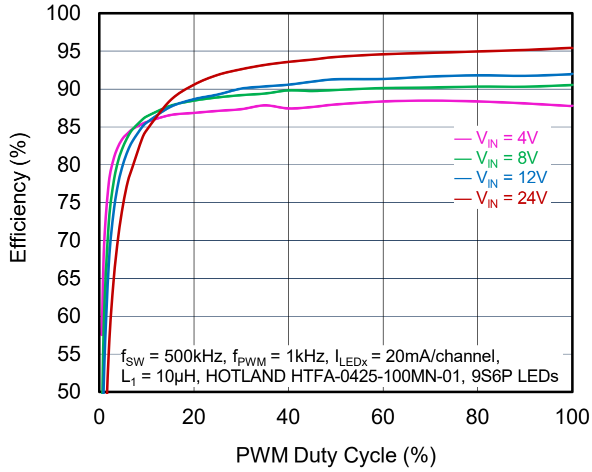
TYPICAL PERFORMANCE CHARACTERISTICS

T_A = +25℃, unless otherwise noted.

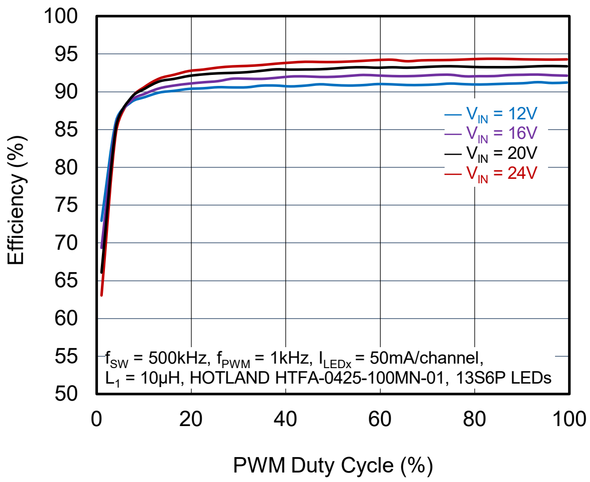
Boost Efficiency vs. Input Voltage



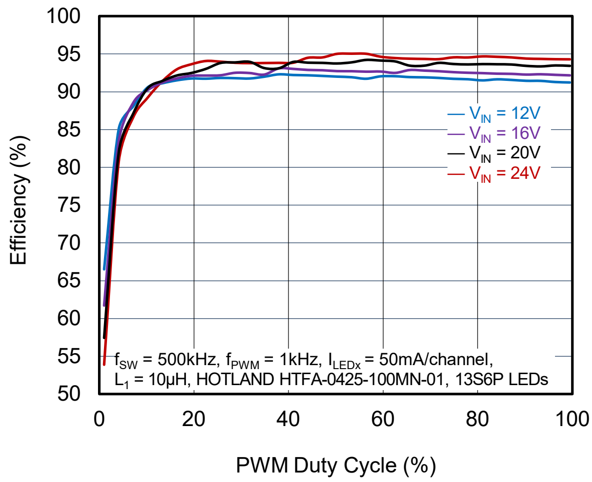
Boost Efficiency vs. PWM Duty Cycle (Mixed Mode)



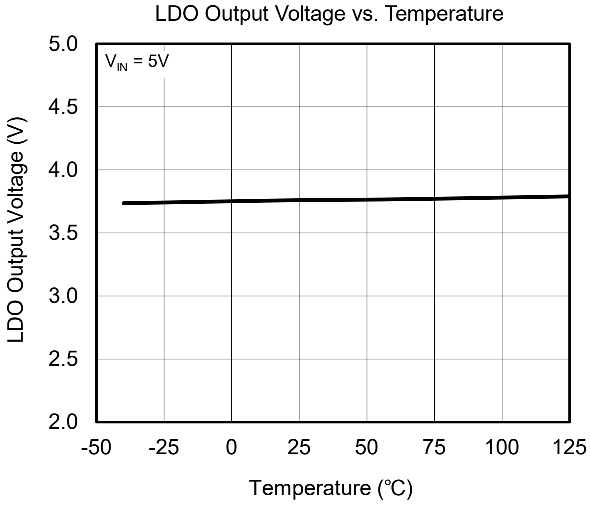
Boost Efficiency vs. PWM Duty Cycle (Mixed Mode)



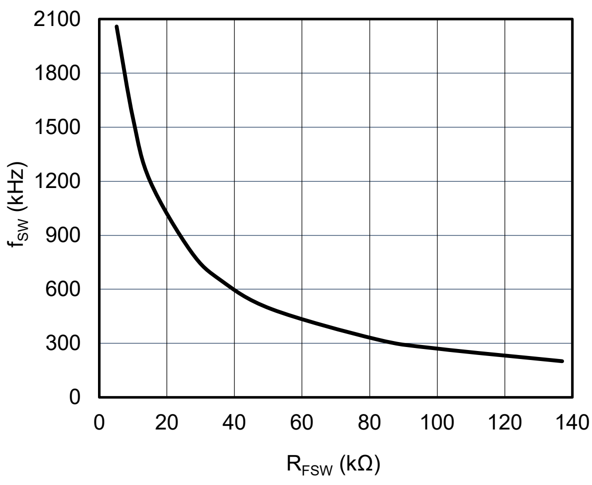
Boost Efficiency vs. PWM Duty Cycle (PWM Mode)



LDO Output Voltage vs. Temperature

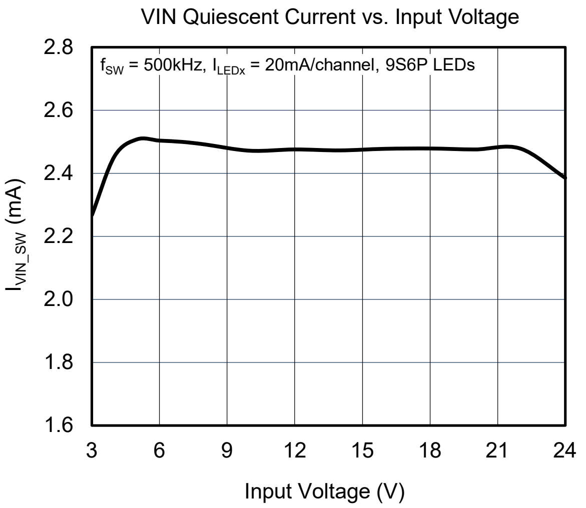


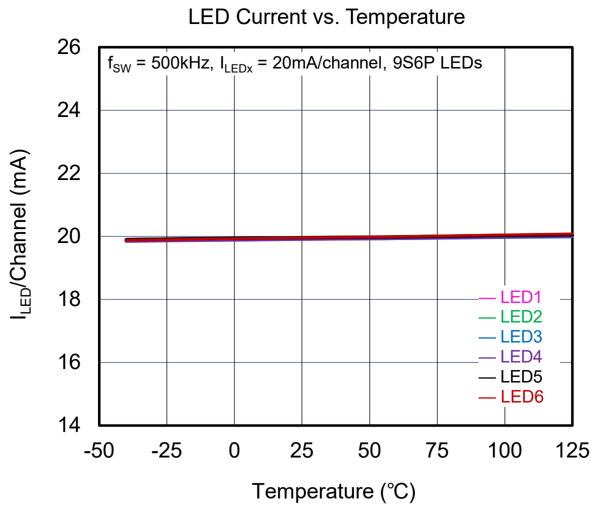
f_{SW} vs. R_{FSW}

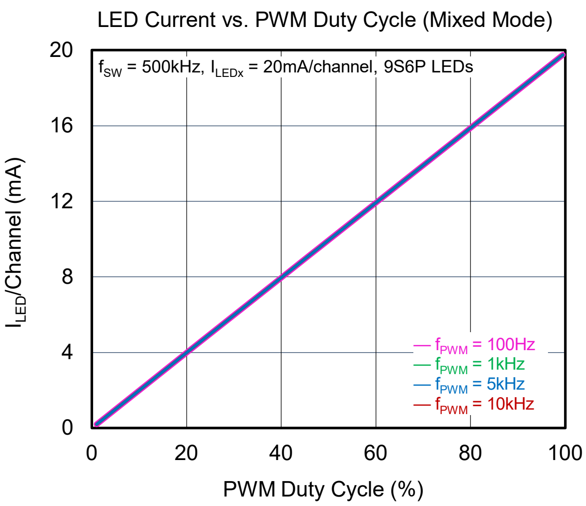


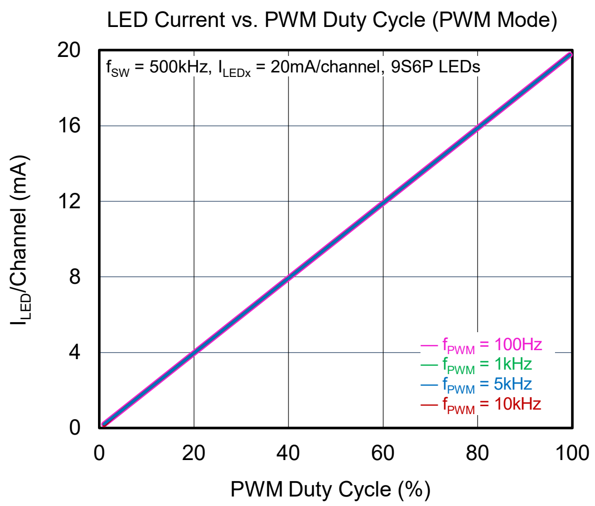
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

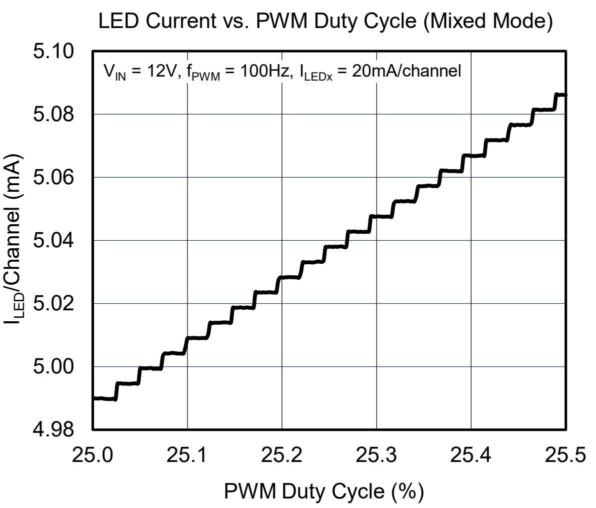
T_A = +25℃, unless otherwise noted.

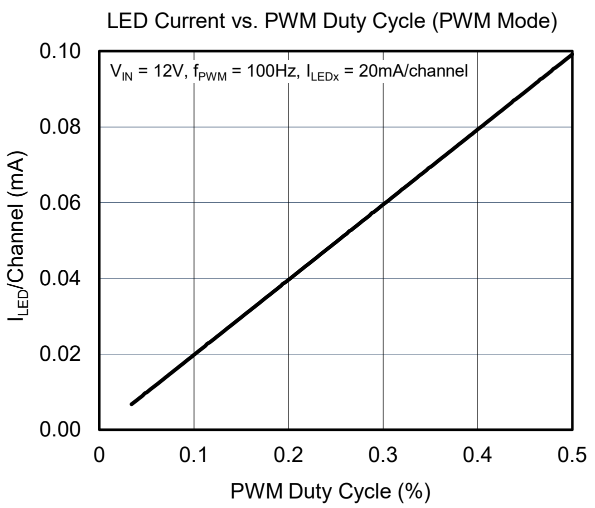








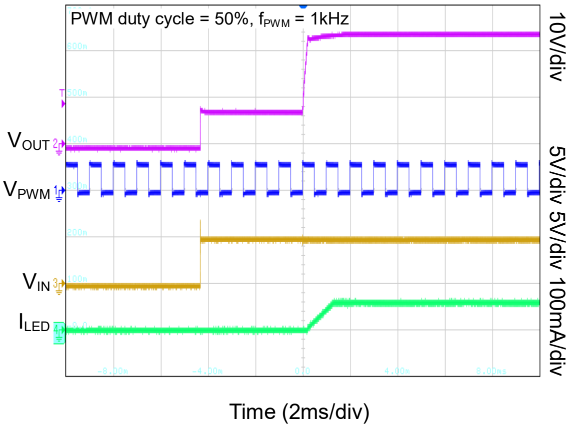




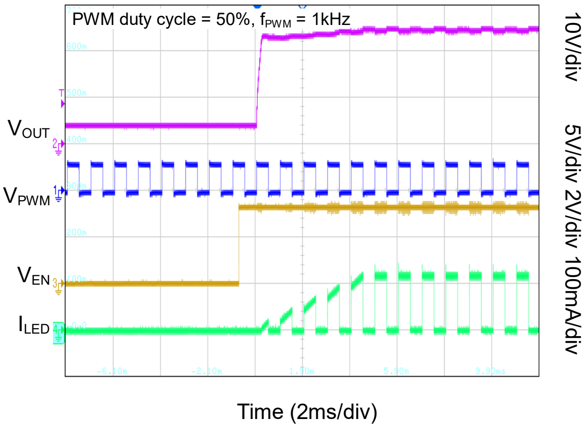
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, V_{IN} = 5V, 9S6P LEDs, I_{LEDx} = 20mA/channel, I_{LED} = 6 × I_{LEDx}, unless otherwise noted.

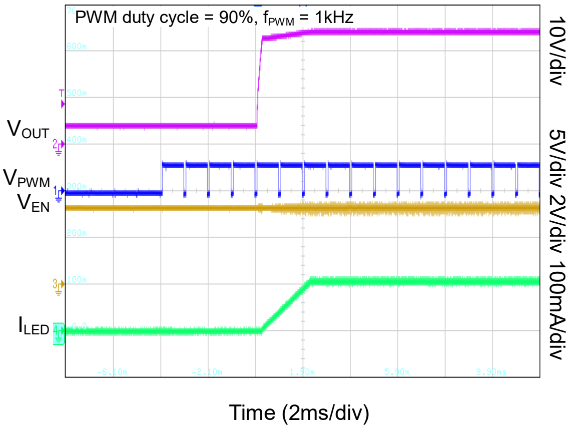
VIN Start-Up (Mixed Mode)



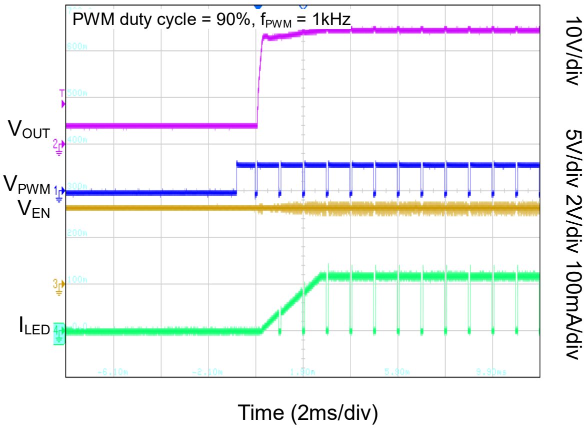
EN Start-Up (PWM Mode)



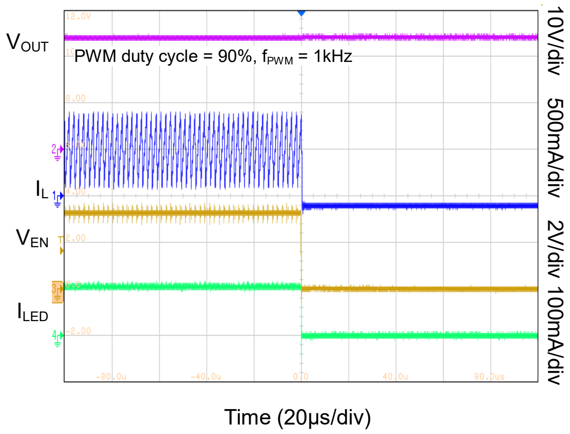
PWM Start-Up (Mixed Mode)



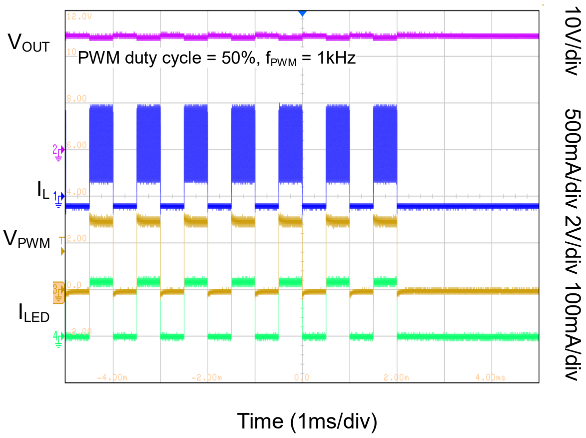
PWM Start-Up (PWM Mode)



EN Shutdown (Mixed Mode)



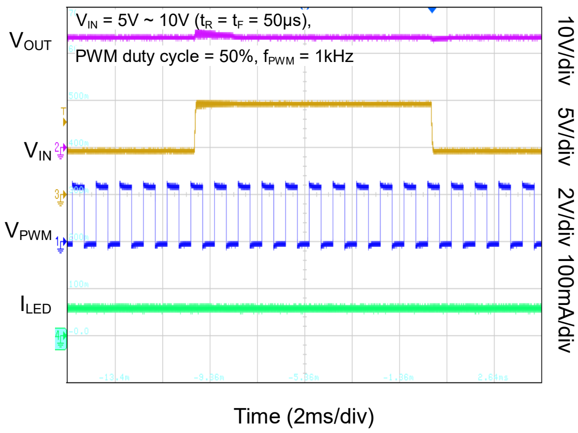
PWM Shutdown (PWM Mode)



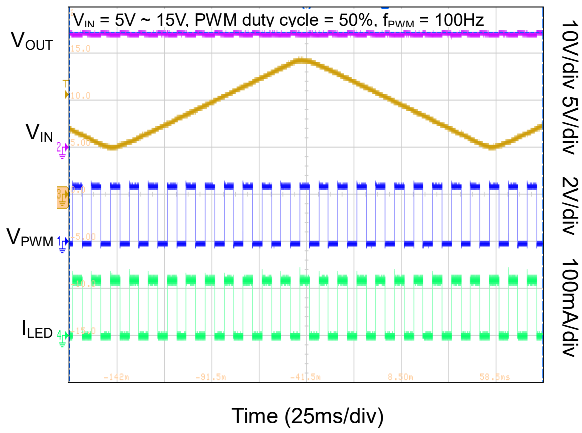
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

T_A = +25℃, V_{IN} = 5V, 9S6P LEDs, I_{LEDx} = 20mA/channel, I_{LED} = 6 × I_{LEDx}, unless otherwise noted.

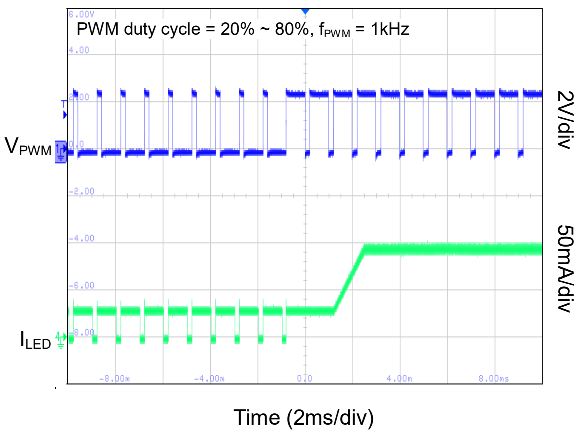
Line Transient (Mixed Mode)



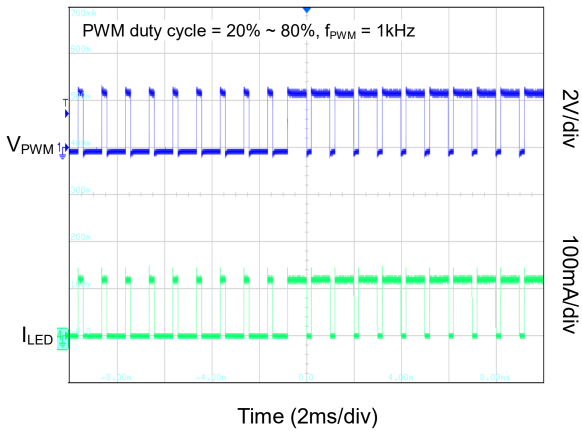
VIN Sweep (PWM Mode)



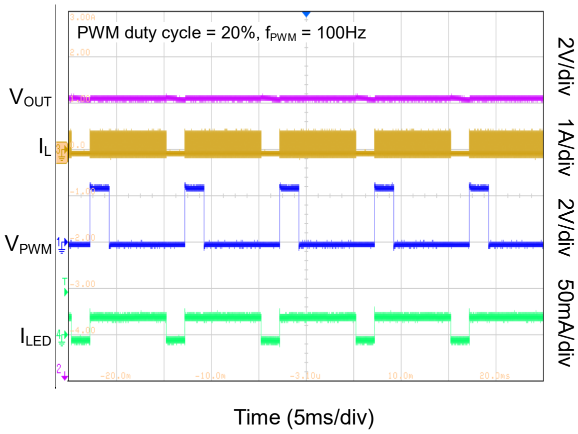
Adjust Brightness (Mixed Mode)



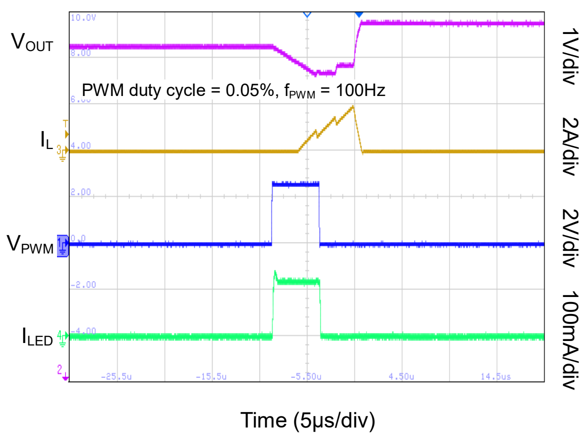
Adjust Brightness (PWM Mode)



Steady State (Mixed Mode)



Steady State (PWM Mode)



FUNCTIONAL BLOCK DIAGRAM

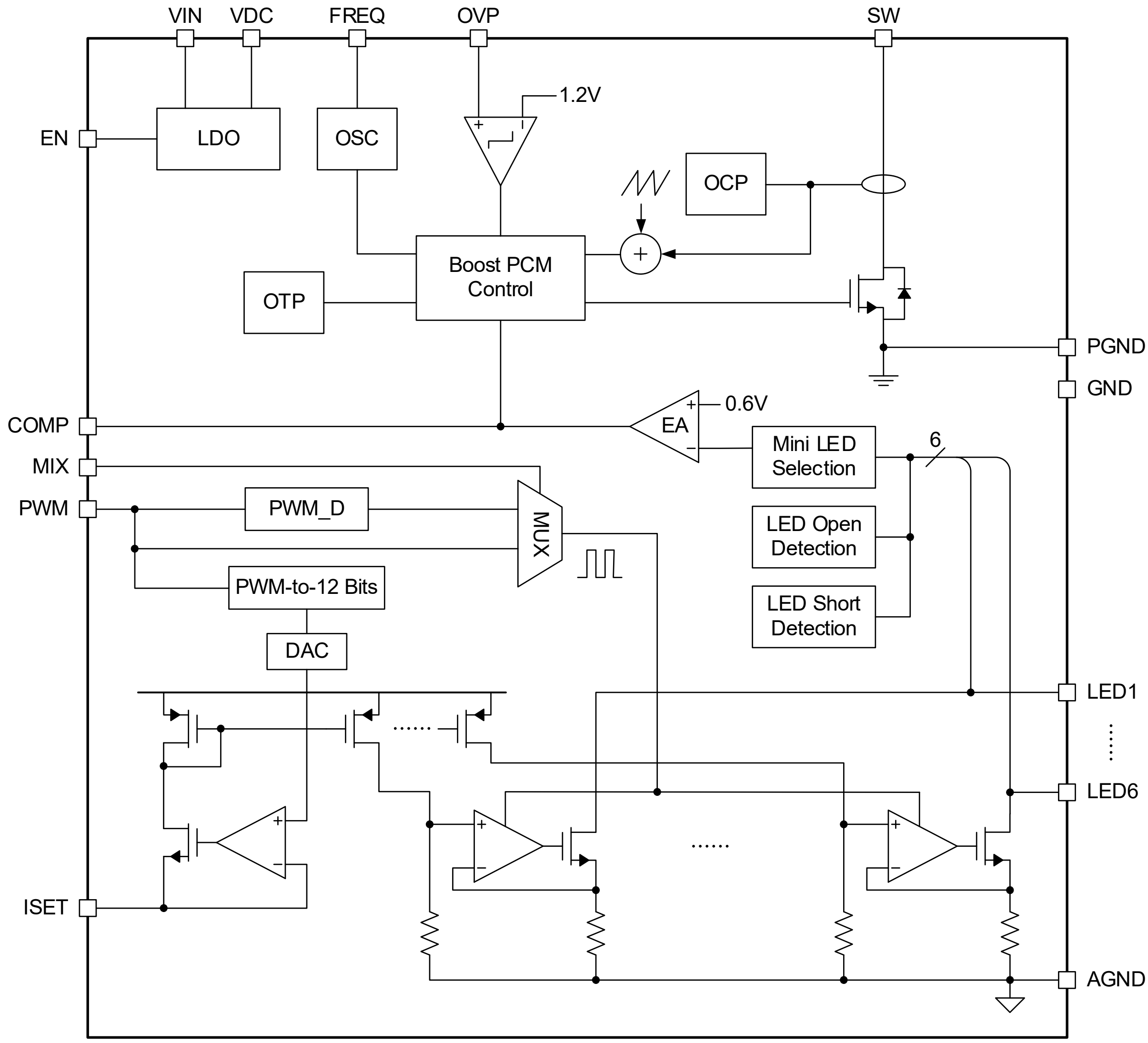


Figure 3. Functional Block Diagram

APPLICATION INFORMATION

The SGM37602 is a 6-channel LED driver that can supply an adjustable LED current ranging from 5mA to 50mA. As a current-mode Boost converter, it integrates a 43V/2.7A power switch, and can work with an input voltage from 2.7V to 24V. This device integrates a soft-start function and PWM dimming control. Besides, it provides protections such as OVP, OTP, and OCP. It also has two accurate LED current dimming methods. The PWM dimming frequency can vary from 100Hz to 20kHz. The advantages of SGM37602 are high efficiency, high accuracy and excellent matching of the LED channel current.

Input Capacitor Selection

The input of the entire controller can be divided into two parts. One part is the input of the Boost converter. Boost converter input capacitor has continuous current throughout the entire switching cycle. A 4.7μF ceramic capacitor is recommended to place as close as possible between the VIN pin and GND pin. The other input is the input of the chip. High-frequency noise suppression can be achieved by configuring an RC filter to prevent false triggering of the under-voltage lockout (UVLO). It is recommended to use a resistor of 10Ω and a capacitor of 100nF.

Output Capacitor Selection

The output capacitor in a power supply or LED driver must meet ripple voltage requirement.

This ripple section is composed of two components. One component results from the voltage variations caused by the charging and discharging of the capacitor, while the other is the product of the inductor current ripple and the equivalent series resistance (ESR) of the output capacitor.

Calculating the value of ΔV_{OUT1} based on the below formula:

$$\Delta V_{OUT1} = \frac{D \times I_{OUT}}{\eta \times C_{OUT} \times f_{SW}} \tag{1}$$

where η = power efficiency.

Ultimately, taking the equivalent series resistance (ESR) into account, the total output ripple voltage can be calculated by the below formula:

$$\Delta V_{OUT} = I_{IN} \times ESR + \frac{D \times I_{OUT}}{\eta \times C_{OUT} \times f_{SW}} \tag{2}$$

Ensure the capacitor ESR (Equivalent Series Resistance) low enough to prevent excessive power dissipation and thermal stress.

Inductor Selection

The selection of the inductor for SGM37602 should be based on the configuration of the input voltage, output voltage, LED channel current, and switching frequency. Under normal circumstances, it is recommended to use an inductor with an inductance value of 10μH or 4.7μH to keep the inductor current ripple within 40%. The inductance value can ultimately be calculated by the below formula:

$$L_1 = \frac{\eta \times (V_{IN})^2 \times (V_{OUT} - V_{IN})}{0.4 \times (V_{OUT})^2 \times I_{OUT} \times f_{SW}} \tag{3}$$

where

I_{OUT} = the sum of the currents from every LED channel.

V_{IN} = the minimum input voltage.

f_{SW} = the Boost switching frequency.

V_{OUT} = the maximum output voltage.

In addition to the inductance value, the DCR (DC resistance) of the inductor, as well as its saturation current and rated current, needs to be considered. It is advisable that the rated current of the inductor be greater than the maximum possible peak value of the inductor current in the application scenario. Generally, it should meet the peak current-limiting value of SGM37602.

Soft-Start Function

The SGM37602 integrates a soft-start function. When the PWM, EN and VIN signals are fully ready, after a short delay time, the LED current starts gradually and linearly ramps up to the current value determined by R_{ISET}.

The soft-start time varies in the range of several tens of milliseconds, which depends on the operating mode (PWM mode or mixed mode) and the PWM duty cycle. This function can enhance the user experience and avoid rapid brightness changes. It should be noted that the order in which PWM, EN, and VIN are readied can be arbitrary. Figure 4 shows the different power on sequences in the PWM mode.

In mixed mode, the power-on sequences are same as PWM mode. Only when the rising edge counts 4 times after PWM becomes high, the SGM37602 starts. However, in PWM mode, the rising edge just needs to count 1 time after PWM is high for startup.

APPLICATION INFORMATION (continued)

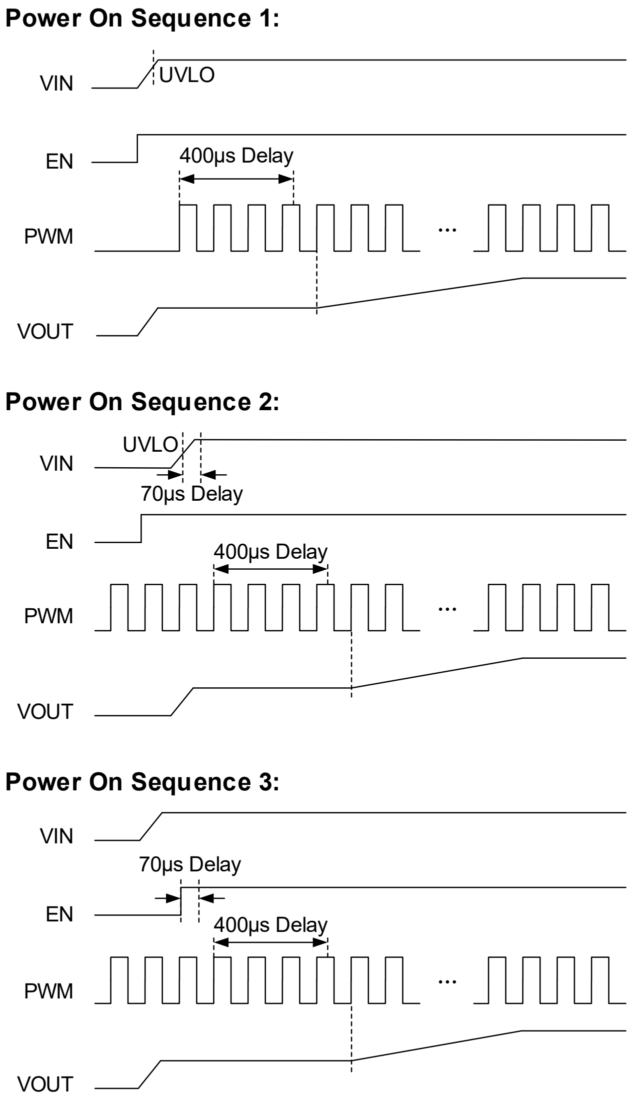


Figure 4. Power On Sequence 1/2/3

Compensation

The COMP pin is the output pin of the internal EA and is used to configure the compensation parameters. Generally speaking, the compensation parameters should be configured according to the situation of the lowest input and the maximum LED current. There are three key components in the compensation network, namely R_{COMP}, C_{COMP} and C_{HF}. For the application scenario using ceramic capacitors as output capacitors, C_{HF} is not needed. C_{COMP} and R_{COMP} can form a compensation zero. Additionally, the resistor R_{COMP} is crucial for optimizing the mid-band gain. By adjusting its value, the circuit can achieve a rapid transient response, ensuring efficient and stable operation under different conditions. In conclusion, it is essential to ensure the stability of the loop and guarantee that the Boost operates in a steady state. Otherwise, it will affect the brightness of the LED.

Diode Selection

The selection of diodes for an asynchronous Boost converter is crucial to the efficiency and overall performance of the Boost circuit. It is recommended to use Schottky diode with lower junction capacitance, shorter recovery time and lower V_F as rectifier diodes. The average current of the selected Schottky diode should be greater than the sum of the maximum currents of all channels, with a certain margin ensured. Meanwhile, the withstand voltage capacity of the Schottky diode should be greater than the set value of OVP, with a certain margin ensured.

LED Current Setting

Connect a resistor (R_{ISET}) between LEDx pin and AGND to configure I_{LED} (the LED current of each channel) based on the following formula.

$$I_{LED}(mA) = \frac{240}{R_{ISET}(k\Omega)} \quad (4)$$

The DC/DC converter regulates the LED current according to this setting to ensure stable LED operation.

Brightness Dimming Mode Setting

The SGM37602 features two dimming modes.

PWM Dimming

When the PWM signal transitions from low to high, all LED channels are turned on, and the current of each LED channel is ramped up to the I_{LED} value. When the PWM signal switches from high to low, all LED channels are turned off. Therefore, in this situation, if the PWM duty cycle changes suddenly, the average current of the LEDs will also change abruptly.

Moreover, the switching time in the PWM mode is restricted by the pulse width of the PWM signal. Sometimes, a narrow pulse width may lead to insufficient LED current.

APPLICATION INFORMATION (continued)

Mix Dimming Mode

When the PWM duty cycle ranges from 25% to 100%, the current source provides DC dimming, and the duty cycle of the PWM signal modulates the current amplitude. The actual channel current follows the product of the duty cycle and the I_{LED} current value. As the duty cycle of PWM signal varies, LED current starts to change after 2 cycles. Unlike PWM mode, LED current in DC mode increases or decreases linearly. The actual LED current is adjusted by internal 12-bit DAC. The minimum D/A converter resolution for I_{LED} regulation is 4096-step, and the time interval is 500ns between two steps.

When the PWM duty cycle is less than 25% and the PWM signal changes from low to high, after a short delay, all LED channel currents are turned on and the current is equal to one-quarter of the I_{LED} value. After the PWM signal changes from high to low, the pulse width time is recorded, and the LED channels are kept on for 4 times the pulse width time before being turned off.

Brightness Control

The brightness adjustment of the SGM37602 is based on the duty cycle of the PWM signal. A smaller duty cycle results in lower brightness, while the brightness reaches its maximum when the PWM signal is at a high level.

Meanwhile, the higher the frequency of the PWM signal is, the more prone to distortion the brightness is under a low pulse width. Therefore, the applicable frequency range of the PWM signal is from 100Hz to 20kHz, and the recommended frequency range is from 100Hz to 10kHz.

In typical applications, the recommended pulse widths to ensure no brightness distortion are shown in the following table. See Table 1 for mixed mode and Table 2 for PWM mode for details.

Table 1. Mixed Dimming Mode

Dimming Frequency	Duty Cycle (MIN)	Duty Cycle (MAX)
100Hz < f_{PWM} ≤ 200Hz	0.03%	100%
200Hz < f_{PWM} ≤ 500Hz	0.03%	100%
500Hz < f_{PWM} ≤ 1kHz	0.03%	100%
1kHz < f_{PWM} ≤ 2kHz	0.06%	100%
2kHz < f_{PWM} ≤ 5kHz	0.12%	100%
5kHz < f_{PWM} ≤ 10kHz	0.3%	100%
10kHz < f_{PWM} ≤ 20kHz	0.6%	100%

Table 2. PWM Dimming Mode

Dimming Frequency	Duty Cycle (MIN)	Duty Cycle (MAX)
100Hz < f_{PWM} ≤ 200Hz	0.02%	100%
200Hz < f_{PWM} ≤ 500Hz	0.02%	100%
500Hz < f_{PWM} ≤ 1kHz	0.04%	100%
1kHz < f_{PWM} ≤ 2kHz	0.06%	100%
2kHz < f_{PWM} ≤ 5kHz	0.12%	100%
5kHz < f_{PWM} ≤ 10kHz	0.3%	100%
10kHz < f_{PWM} ≤ 20kHz	0.6%	100%

As illustrated in the previous section about the PWM mode, if the pulse width is very narrow, the time permitted for switching will be limited, resulting in insufficient V_{OUT} and making it impossible to establish the desired LED channel current, especially when the frequency of the PWM signal is greater than 10kHz.

Under-Voltage Lockout (UVLO)

When the input voltage exceeds 2.45V, the SGM37602 can be enabled and start operating. If both the PWM signal and the EN signal are ready, the SGM37602 soft-start will implement. When the input voltage drops below 2.41V, the SGM37602 will shut down.

Over-Temperature Protection

When the device die temperature reaches +150℃, over-temperature protection (OTP) is triggered and the SGM37602 stops switching. The Boost automatically starts up again when the die temperature cools down to +120℃.

Over-Voltage Protection

The SGM37602 is equipped with an over-voltage protection (OVP) function. The OVP feature is implemented through a comparator. When the voltage detected at the OVP pin exceeds the OVP threshold, after a delay of several microseconds, the switching is halted to reduce the energy transfer from the input side to the output. During the OVP event, the COMP voltage will also be clamped to a relatively low voltage. The Boost converter starts switching once the voltage at OVP drops the hysteresis value. The V_{OUT} voltage corresponding to the triggering of OVP can be calculated by the following formula:

$$V_{OUT,OVP} = 1.2 \times \left(1 + \frac{R_{OVPT}}{R_{OVPB}}\right) \quad (5)$$

APPLICATION INFORMATION (continued)

where R_{OVPT} and R_{OVPB} are the resistors in the voltage-dividing circuit linked to the OVP pin. To minimize power losses, it is recommended to use a 500kΩ resistor for R_{OVPT}.

LED Open Protection

When an open fault occurs, the corresponding LEDx pin voltage will drop below the open entering threshold voltage. SGM37602 will automatically turn off the corresponding fault open channel until it detects the OVP. When the channel with the open fault is reconnected, the voltage of the corresponding LEDx pin will rise above open exiting threshold voltage, and the SGM37602 will sink the corresponding channel again.

LED Short Protection

When a short fault occurs, the corresponding LEDx pin voltage will increase. When enough LEDs are shorted and it causes the LEDx Pin voltage to rise above the short protection threshold (16V, TYP), the SGM37602 will automatically turn off the corresponding channel after 100ms (TYP, counted when channel sinks). When the channel that has triggered the LED short protection recovers, the SGM37602 resumes sinking the channel current to the proper value.

Thermal Considerations

During continuous operation, ensure the absolute maximum junction temperature is not exceeded. The maximum power dissipation is determined by the IC package thermal resistance, PCB layout, ambient airflow rate, and the temperature difference between the junction and the ambient. It can be calculated by the following formula:

$$P_{D\_MAX} = (T_{J\_MAX} - T_A) / \theta_{JA} \quad (6)$$

where

T_{J_MAX} = the maximum junction temperature.

T_A = the ambient temperature.

θ_{JA} = the junction-to-ambient thermal resistance given under absolute maximum ratings section.

Layout Considerations

A well-designed PCB layout is critical for power switching converter circuits. To maximize the SGM37602's performance, strictly follow these layout guidelines:

Place power components L_1, D_1, C_{IN}, and C_{OUT} close together to minimize the AC current loop. Place the PCB traces between these components as short and wide as possible due to the large current flow during operation.

Place L_1 and D_1 close to the SW pins. Place the traces short and wide.

Place C_1 (input capacitor) close to the VIN pin.

Place the R_{COMP}, C_{COMP} and C_{HF} (compensation components) close to COMP pin.

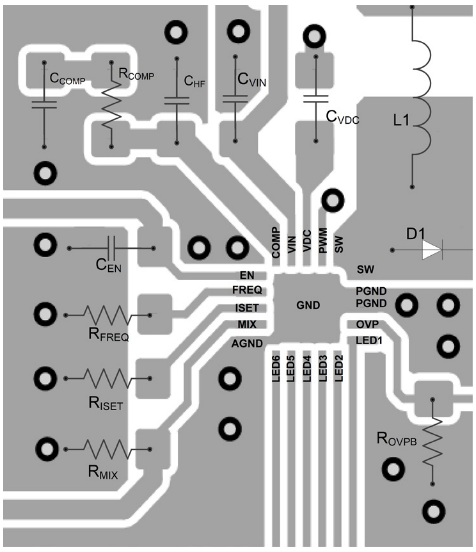


Figure 5. Recommended PCB Layout

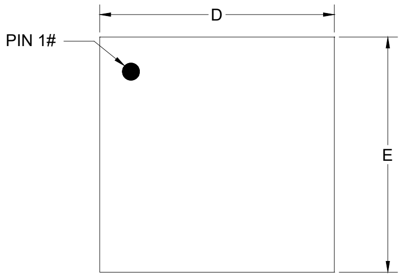
REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

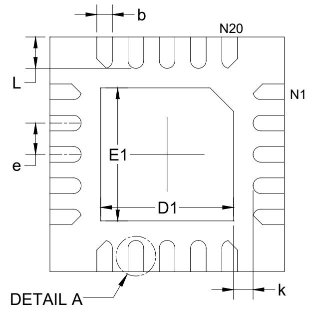
Changes from Original to REV.A (OCTOBER 2025)	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

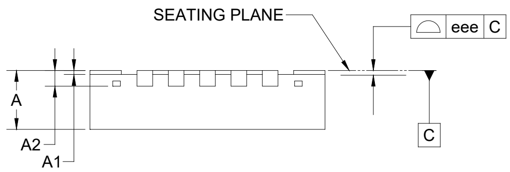
TQFN-3×3-20DL



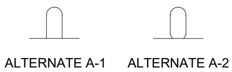
TOP VIEW



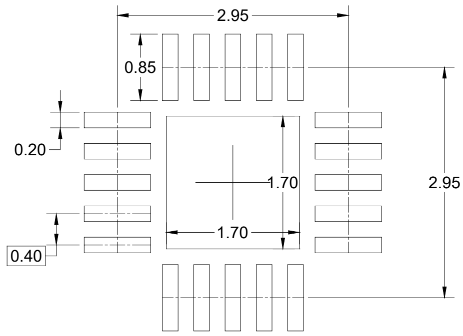
BOTTOM VIEW



SIDE VIEW



DETAIL A
ALTERNATE TERMINAL
CONSTRUCTION



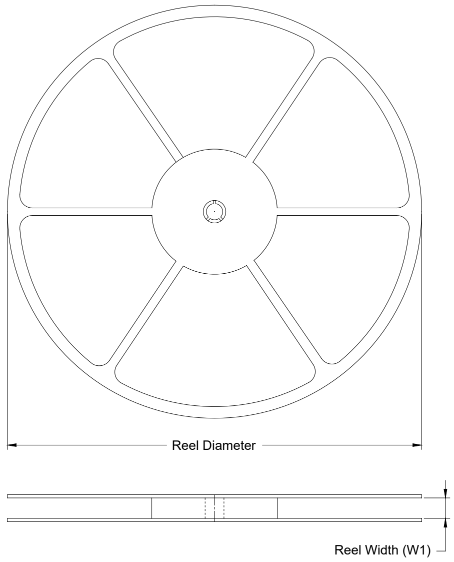
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	0.700	-	0.800
A1	0.000	-	0.050
A2	0.200 REF		
b	0.150	-	0.250
D	2.900	-	3.100
D1	1.600	-	1.800
E	2.900	-	3.100
E1	1.600	-	1.800
e	0.400 BSC		
k	0.150 MIN		
L	0.300	-	0.500
eee	0.080		

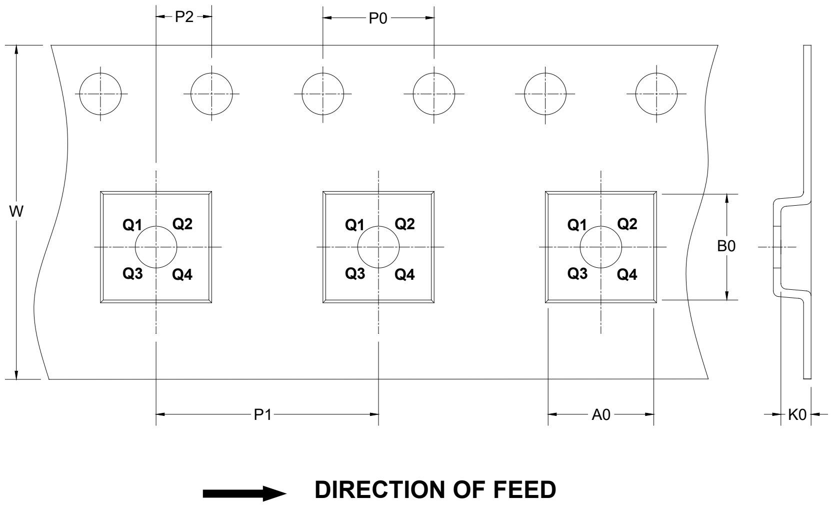
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



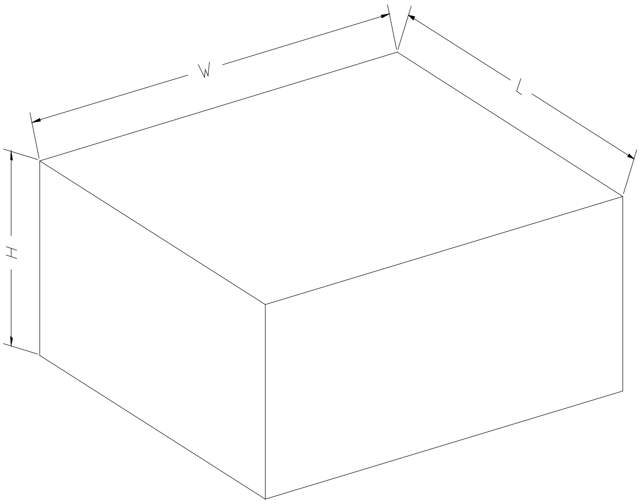
NOTE: The picture is only for reference. Please make the object as the standard.

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-3×3-20DL	13"	12.4	3.30	3.30	1.10	4.0	8.0	2.0	12.0	Q2

DD0001

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