GENERAL DESCRIPTION

The SGM3795 is a general purpose high voltage quad channel LED driver. 4 LED sink channels are well matched with up to 175mA per channel and suitable for high brightness LEDs or infrared LEDs. Each LED pin is capable of supporting voltage up to 22V, which is suitable for long strings of LED applications.

The SGM3795 integrates device enable and external PWM dimming control via the EN/PWM pin. Higher dimming frequency, up to 50kHz with a minimal duty cycle of 10% or higher, is allowed. The device also implements LED sink current adjustment via the ISET pin.

The SGM3795 implements various protection features such as thermal shutdown and LED short protection.

The SGM3795 is available in a Green TDFN-2×3-8L package. It operates over the -40℃ to +85℃ temperature range.

FEATURES

- **Quad LED Sink Channels up to 175mA each**
- **Up to 22V LED Pin Operation Voltage**
- **0.275V LED Dropout Voltage at 175mA Sink Current**
- **Programmable LED Sink Current**
- **Programmable PWM Dimming Frequency**
- **Less than 1µA Shutdown Current**
- **LED Short Protection**
- **Thermal Shutdown**
- **Available in a Green TDFN-2×3-8L Package**

APPLICATIONS

Motion Tracking LED Sinks

General Lighting Applications
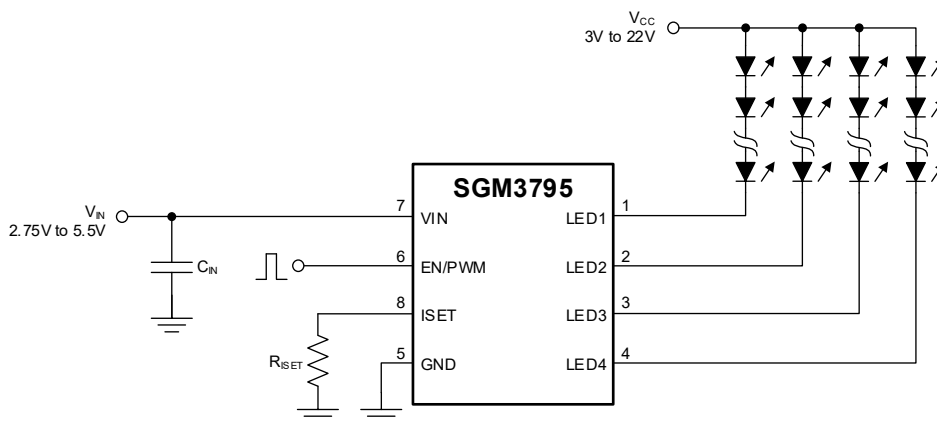
TYPICAL APPLICATION
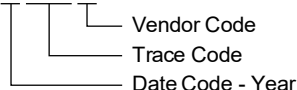

Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM3795	TDFN-2×3-8L	-40℃ to +85℃	SGM3795YTDC8G/TR	3795 XXXX	Tape and Reel, 3000

MARKING INFORMATION

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

X X X X
— 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

Voltage Range (with Respect to GND)
  VIN, ISET, EN/PWM...0.3V to 6V
  LED1, LED2, LED3, LED4................................-0.3V to 22.5V
Package Thermal Resistance
  TDFN-2×3-8L, θ_{JA} .... 51.7℃/W
Junction Temperature...+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)...........................+260℃
ESD Susceptibility
HBM...4000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range, V_{IN}...................................2.75V to 5.5V
LED Voltage Output Off, LEDx.................................. up to 22V
LED Voltage Output On, LEDx............................. up to 6V [1]
I_{LED} per LED Pin...10mA to 175mA
Operating Ambient Temperature Range.........-40℃ to +85℃
Operating Junction Temperature Range, T_J
....-40℃ to +125℃

NOTE:

1. In order to effectively reduce the temperature loss in this package, it is recommended to control the voltage of the LEDX pin below 6V.

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)

TDFN-2×3-8L
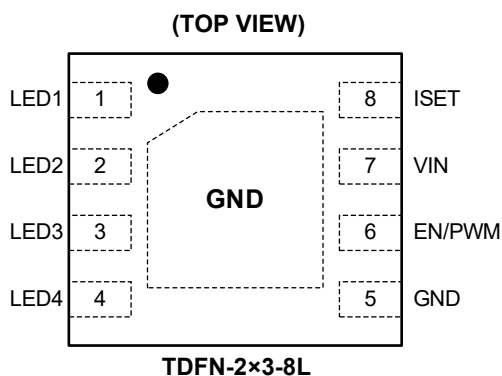
PIN DESCRIPTION

PIN	NAME	TYPE [1]	FUNCTION
1	LED1	P	Regulated Current Sink 1 Input Pin.
2	LED2	P	Regulated Current Sink 2 Input Pin.
3	LED3	P	Regulated Current Sink 3 Input Pin.
4	LED4	P	Regulated Current Sink 4 Input Pin.
5	GND	P	Ground Pin.
6	EN/PWM	I	Enable and PWM Dimming Pin.
7	VIN	I	Output Voltage Sense Pin of the Boost Converter.
8	ISET	I	LED Sink Current Program Pin.
Exposed Pad	—	P	The exposed pad should be soldered to the analog ground plane. If possible, use thermal via to connect to ground plane for ideal power dissipation.

NOTE:
1. I = input, P = power.

ELECTRICAL CHARACTERISTICS

(Min and max values are over the recommended operating conditions. T_A = -40℃ to +85℃, typical values are at V_{IN} = 5.0V, T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
LED Current Accuracy	$I_{LED-ACC}$	$\frac{I_{LEDNOM} - I_{LED}}{I_{LEDNOM}}$, V_{IN} = 3.5V		±1		%
LED Channel Matching [(1)]	$I_{LED-DEV}$	$\frac{I_{LED} - I_{LEDAVG}}{I_{LEDAVG}}$, V_{IN} = 3.5V, T_A = +25℃	-1.5	±1	1.5	%
Dropout Voltage	V_{DOUT}	I_{LED} = 175mA		275		mV
ISET Pin Voltage	V_{ISET}		1.185	1.21	1.235	V
Quiescent Current	I_Q	No LED, R_{ISET} = Floating		0.7		mA
		No LED, R_{ISET} = 750Ω		5.6		mA
Shutdown Current	I_{QSHDN}	V_{EN} = 0V			1	µA
EN/PWM Internal Pull-Down Resistance	$R_{EN/PWM}$			210		kΩ
EN/PWM Pin Logic High Level	V_{HI}		1.2			V
EN/PWM Pin Logic Low Level	V_{LO}				0.4	V
ISET to LED Current Gain Ratio	I_{LED}/I_{ISET}	25mA LED current		110		
Under-Voltage Lockout (UVLO) Threshold	V_{UVLO}	V_{IN} rising		2.5		V
		V_{IN} falling		2.4		
Thermal Shutdown Temperature	T_{SD}			150		℃
Thermal Shutdown Hysteresis	T_{HYS}			20		℃
EN/PWM Timing						
Turn-On Time, EN/PWM Rising to I_{LED} from Shutdown	t_{PS}	I_{LED} = 175mA		0.8		µs
		I_{LED} = 80mA		0.8		µs
Turn-On Time, EN/PWM Rising to I_{LED}	t_{P1}	I_{LED} = 175mA		150		ns
Turn-Off Time, EN/PWM Falling to I_{LED}	t_{P2}	I_{LED} = 175mA		820		ns
		I_{LED} = 80mA		600		ns
LED Rise Time	t_R	I_{LED} = 175mA		200		ns
		I_{LED} = 80mA		100		ns
LED Fall Time	t_F	I_{LED} = 175mA		500		ns
		I_{LED} = 80mA		400		ns
EN/PWM Low Time	t_{LO}		1.5			µs
EN/PWM High Time	t_{HI}		3.0			µs
EN/PWM Low Time to Shutdown Delay	t_{PWRDWN}			3.5	6.0	ms

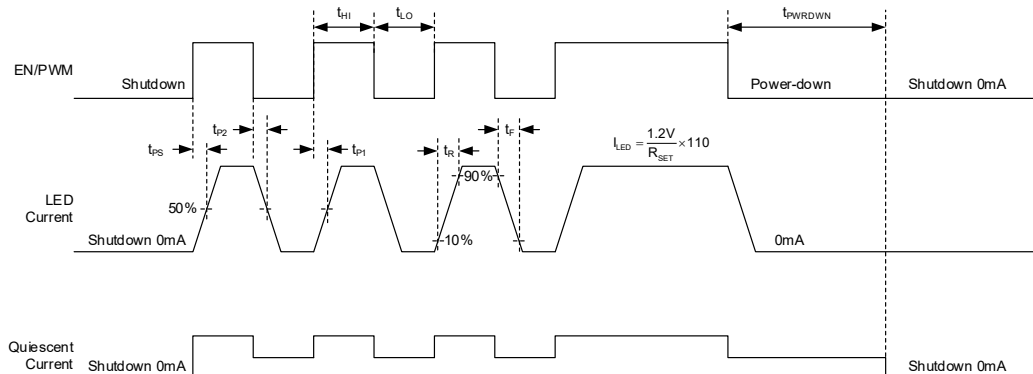NOTE: 1. Min and max values are tested for I_{LED} = 50mA, V_{IN} = 3.5V, V_{LEDx} = 0.4V, T_A = +25℃.

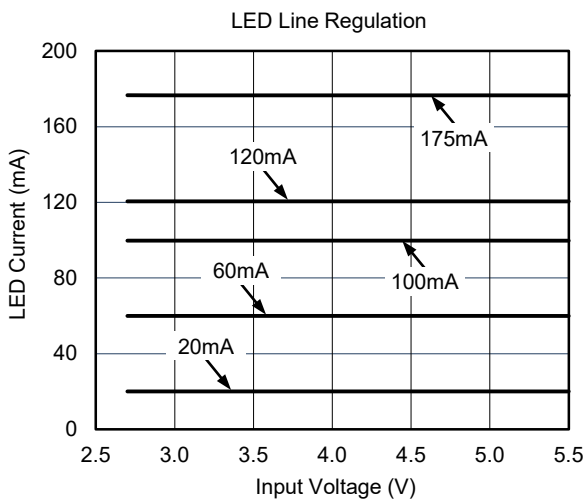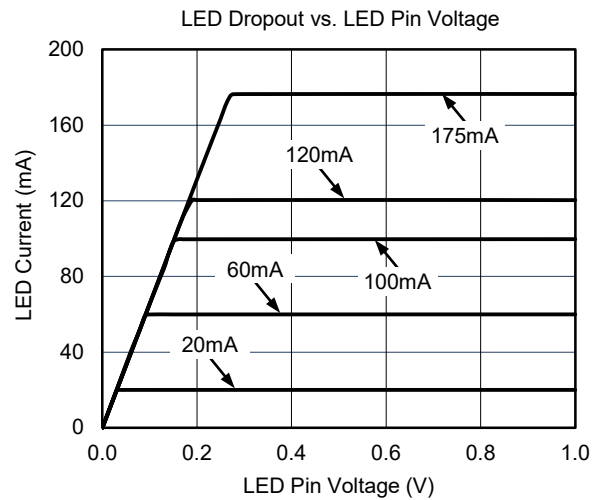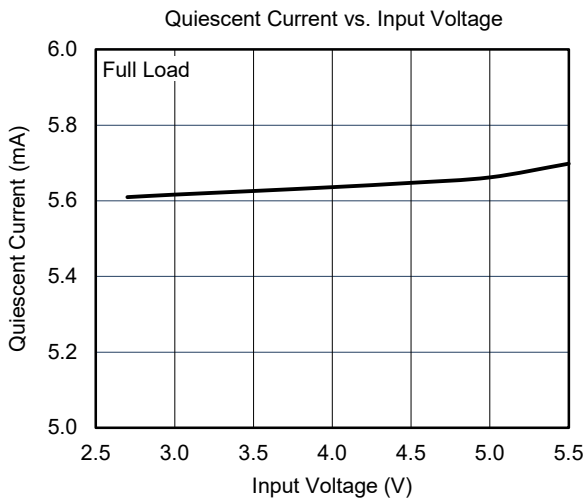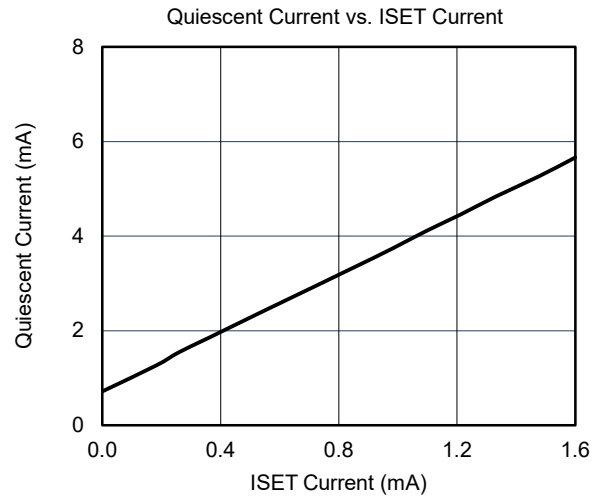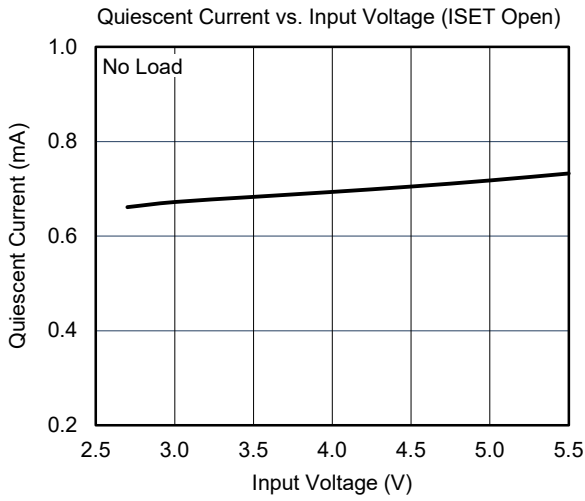**Figure 2. SGM3795 EN/PWM Timing**
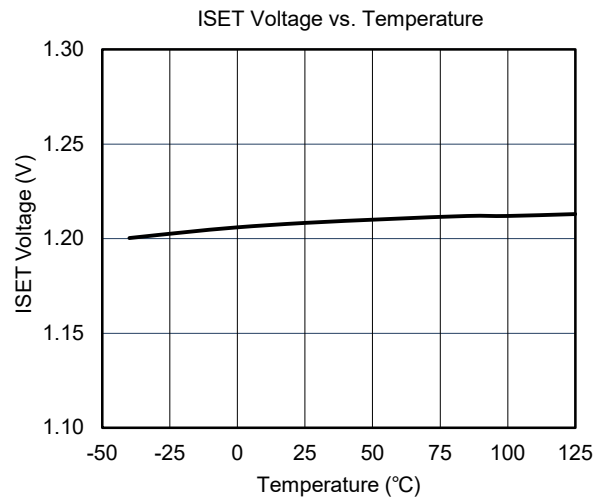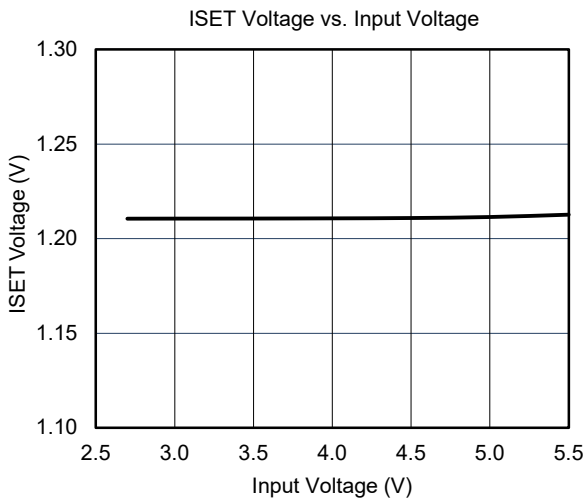
FUNCTIONAL BLOCK DIAGRAM
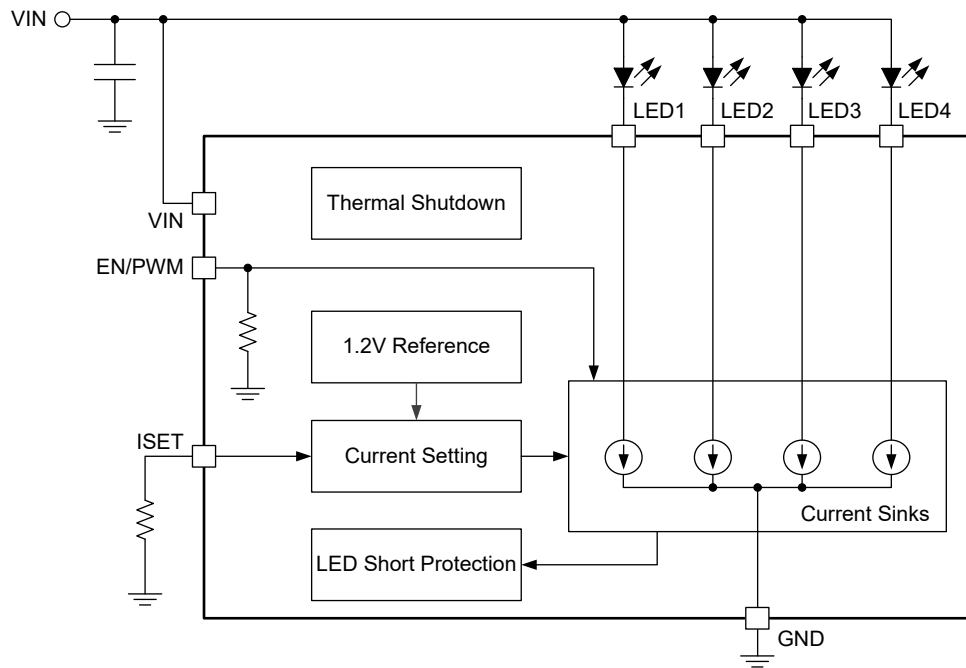
Figure 3. Functional Block Diagram

TYPICAL PERFORMANCE CHARACTERISTICS

(V_{IN} = 5V, V_{CC} = 5V, LED forward voltage = 3.5V, C_{IN} = 1µF, T_A = +25℃, unless otherwise specified.)
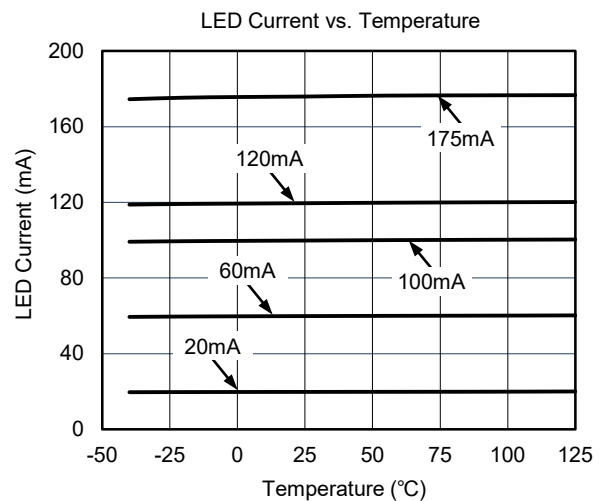
Quiescent Current vs. Input Voltage (ISET Open)

Quiescent Current vs. ISET Current

Quiescent Current vs. Input Voltage

LED Dropout vs. LED Pin Voltage
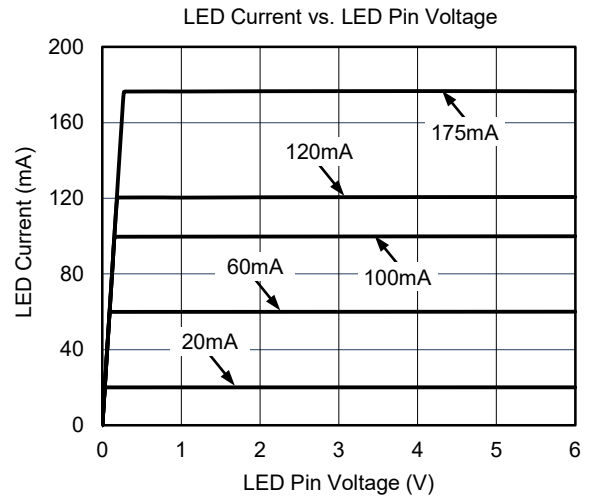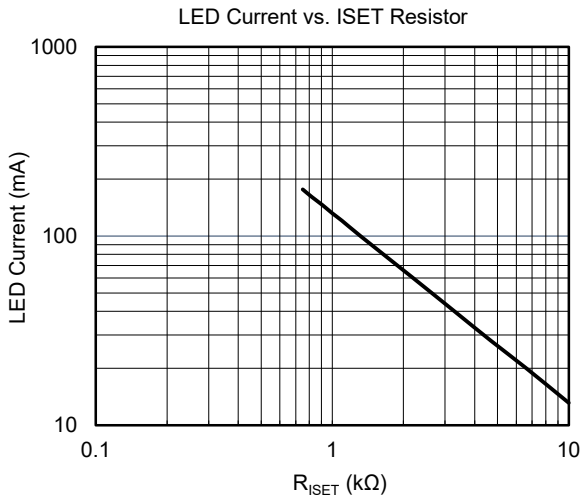
LED Line Regulation

LED Current vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

(V_{IN} = 5V, V_{CC} = 5V, LED forward voltage = 3.5V, C_{IN} = 1µF, T_A = +25℃, unless otherwise specified.)

LED Current vs. ISET Resistor

LED Current vs. LED Pin Voltage

ISET Voltage vs. Input Voltage

ISET Voltage vs. Temperature

LED Off Current vs. LED Pin Voltage

EN/PWM Pull-Down Current vs. Enable Voltage

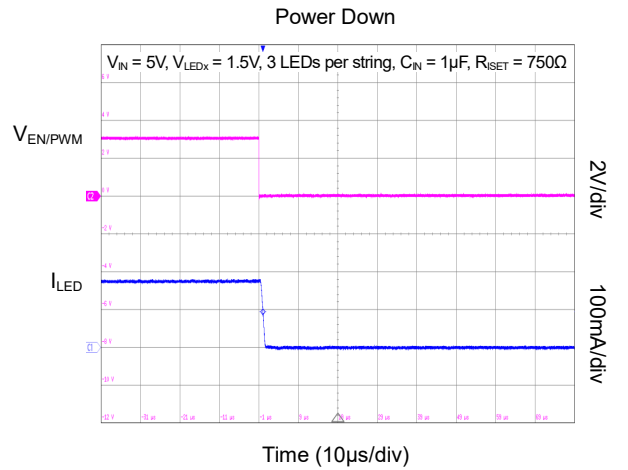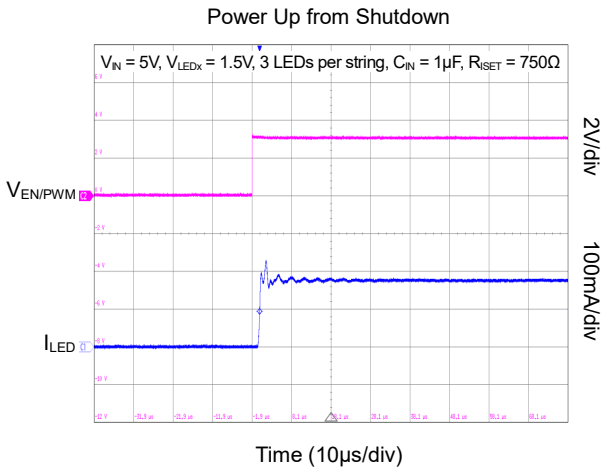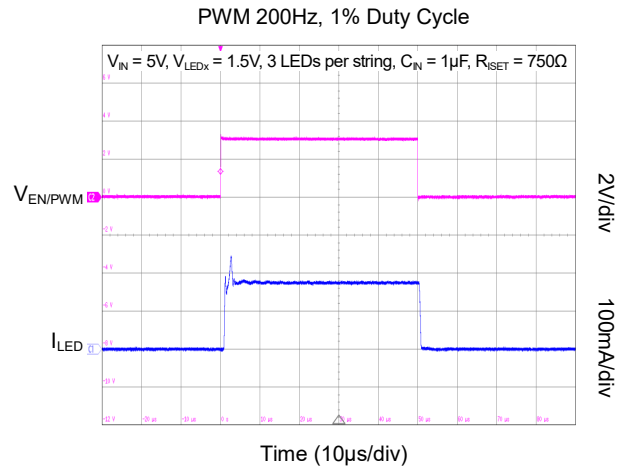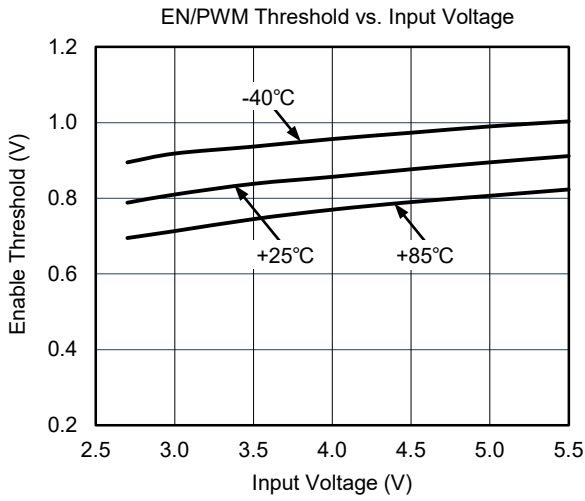## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

(V_{IN} = 5V, V_{CC} = 5V, LED forward voltage = 3.5V, C_{IN} = 1µF, T_A = +25℃, unless otherwise specified.)

EN/PWM Threshold vs. Input Voltage

PWM 200Hz, 1% Duty Cycle

Power Up from Shutdown

Power Down
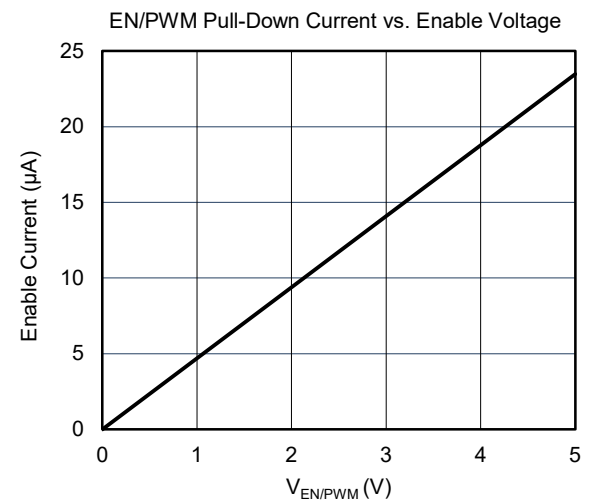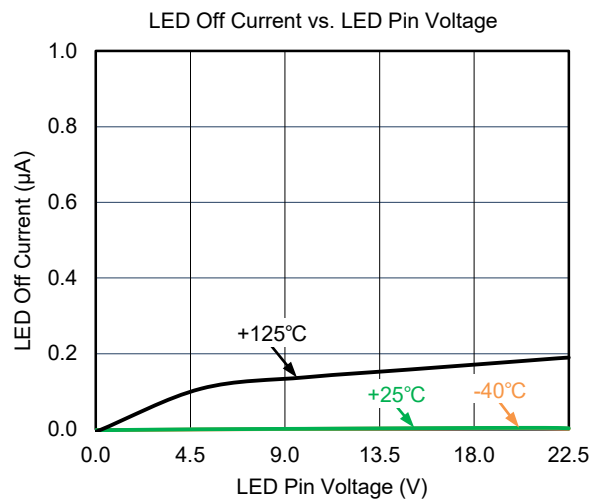
DETAILED DESCRIPTION

EN/PWM Operation

The EN/PWM pin is a multi-function pin. The first function of the EN/PWM pin is to enable the device. Set EN/PWM high to enable the device from the shutdown state. The device will enter shutdown mode if the EN/PWM remains low and the holding time exceeds t_{PWRDWN}. The second function is to realize the current sink ON and OFF control, to achieve the PWM dimming control. When EN/PWM = high, the LED channel current will quickly rise to I_{SET}. When EN/PWM = low, the LED channel current will quickly drop to 0.

The SGM3795 allows the LED channel to be turned ON or OFF in a very short time.

It is recommended to use PWM signals from 100Hz to 5kHz for linear dimming, and the duty cycle can support a minimum of 1%. In addition, the PWM frequency can be up to 50kHz, but the duty cycle must be greater than 10%.

When operating at a low PWM frequency or low PWM duty cycle, the SGM3795 may enter shutdown mode due to PWM low time longer than t_{PWRDWN}. However, PWM dimming accuracy is not affected, because the turn-on time t_{PS} is less than 1μs and much shorter than the PWM high or low time.

The EN/PWM high time must be longer than 3μs and the EN/PWM low time must be longer than 1.5μs. In this case, the PWM pulse can be reliably detected.

Basic Operation

By connecting an appropriate resistance in series at the ISET pin, the SGM3795 can achieve four-channel high-precision dimming control with a high matching rate. The four LED channel currents obtain the same reference current with the help of the current mirror, and the formula is as follows:

$$I_{LED} \cong 110 \times \frac{1.2V}{R_{ISET}} \qquad (1)$$

The selections of typical resistance values and LED channel current values are shown in Table 1.

Table 1. R_{ISET} Resistor Settings

LED Current (mA)	ISET (kΩ)
20	6.57
60	2.20
100	1.33
120	1.10
175	0.750

Each current channel is equipped with an independent current control loop that ensures accurate current regulation over a range of current sink voltages. However, too high of a current sink voltage will lead to more power loss and overheating of the device. Therefore, the current sink voltage is recommended to control below 1.5V.

The SGM3795 supports up to 175mA per channel, and headroom voltages higher than 275mV per LED channel are required to ensure accurate channel currents. Once V_{IN} voltage drops below 2.4V, the device will disable all LED channels due to UVLO. Leave the unused pin open.

Tying the LED channels together allows the device to be used for high than 175mA current application. The SGM3795 supports up to 700mA application when all 4 LED channels are connected together.

In order to ensure the safe operation of the SGM3795, the voltage of the LED channel needs to be controlled below 22V.

LED Short Protection

The SGM3795 can detect an LED string short event. When any LED pin's current sink voltage is higher than 9.5V, a short event is detected, and the LED channel's current will drop to 40% of I_{SET} to reduce the power dissipation. The LED channel current will return to I_{SET} when the current sink voltage is dropped below 7.0V.

Thermal Shutdown

Thermal shutdown (TSD) is triggered when the device die temperature reaches +150℃, and all LED channels are disabled. The LED channels automatically starts up again when the die temperature drops to +130℃.

APPLICATION INFORMATION

12V Power Supply Application

A typical circuit diagram for a 12V power supply application based on SGM3795 is shown in Figure 4. By adding resistor R_2, Zener diode Z, and an N-channel transistor M, SGM3795 can be powered with supply voltage above 5.5V. On Semiconductor MM3Z6V2 Zener diode and 2N7002L N-channel transistor are recommended.
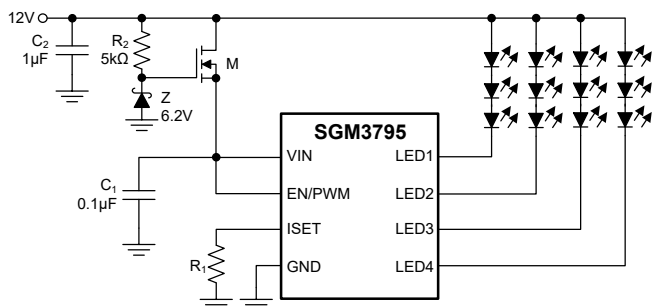

Figure 4. 12V Power Supply Application with 12LEDs

Daylight Detection

SGM3795 can be used as a daylight detection circuit with a light sensor, as shown in Figure 5. With light sensor sensing the ambient brightness, the SGM3795 can be enabled during the day and disabled at night. A resistor R_1 is used to properly regulate the voltage of the EN/PWM pin. Microsemi LX1972 is recommended as the light sensor.
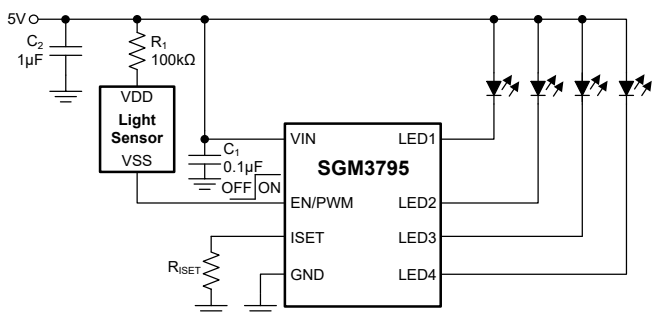

Figure 5. Daylight Detection

Nightlight Detection

SGM3795 can also be used as a nightlight detection circuit with a light sensor, as shown in Figure 6. With light sensors sensing the ambient brightness, the SGM3795 can be disabled during the day and enabled at night. In order to properly configure SGM3795 for night detection, five external components need to be configured in Figure 6. Similarly, Microsemi LX1972 is recommended as the light sensor and ON

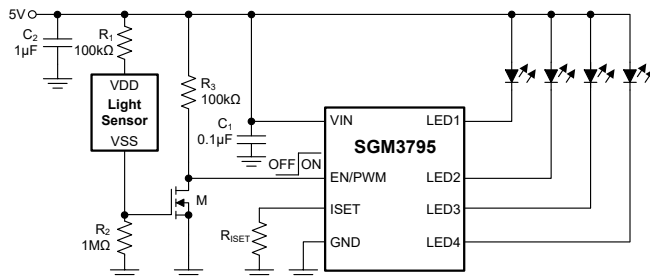Semiconductor 2N7002L is recommended as the N-Channel transistor.

Figure 6. Nightlight Detection

LED Current Derating

The circuit shown in Figure 7 protects the LED from over-heating by derating the LED current to avoid over-driving the LED in a high-temperature environment. In practical applications, a thermistor R_{PTC} can be used to sense the temperature of the LED, and the R_{PTC} should be placed as close as possible to the LED. When the LED temperature increases, the gate voltage of MOSFET M1 decreases, which leads to an increase in the M1 on-resistance, resulting in a decrease in the LED current. Vishay PTCSS12T071DTE is recommended as the thermistor and ON Semiconductor 2N7002L N-channel transistor are recommended.

The PCB and heat dissipation for the LED should be considered so that the LED current is constant within the normal temperature range. However, once the ambient temperature exceeds the maximum threshold, this circuit will reduce the LED current to avoid LED burnout.
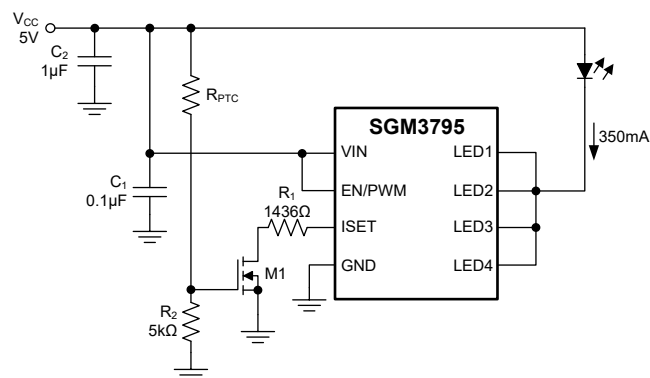

Figure 7. LED Current Derating

APPLICATION INFORMATION (continued)

Power Dissipation

The power consumption (P_D) of the SGM3795 can be calculated as follows:

$$P_D = (V_{IN} \times I_{IN}) + \Sigma(V_{LEDN} \times I_{LEDN}) \qquad (2)$$

where V_{LEDN} is the voltage at the LED pin, and I_{LEDN} is the LED current. High V_{LEDN} voltage and I_{LEDN} current will cause the SGM3795 to frequently enter the thermal shutdown, especially in high temperature environments. By inserting a suitable resistor with the LED string, the V_{LEDN} can be reduced to reduce the power consumption.

Two main heat dissipation paths determine the thermal resistance. The first path is determined by the package, which is the thermal resistance (θ_{JC}) of the connection to the shell. The other path, depending on the layout, is the thermal resistance (θ_{CA}) of the shell to the environment. In summary, the thermal resistance to the environment (θ_{JA}) is equal to:

$$\theta_{JA} = \theta_{JC} + \theta_{CA} \qquad (3)$$

When the package and layout are determined, the operating junction temperature can be calculated by the following equation:

$$T_J = T_{AMB} + P_D(\theta_{JC} + \theta_{CA}) = T_{AMB} + P_D\theta_{JA} \qquad (4)$$

When mounted on a two-sided printed circuit board with two square inches of copper, the θ_{JA} in the TDFN-2×3-8L package is 51.7°C/W.

For example, the maximum power consumption for the TDFN-2×3-8L at +30℃ is as follows:

$$P_D = \frac{T_{JMAX} - T_{AMB}}{\theta_{JA}} = \frac{150 - 30}{51.7} = 2.32W \qquad (5)$$
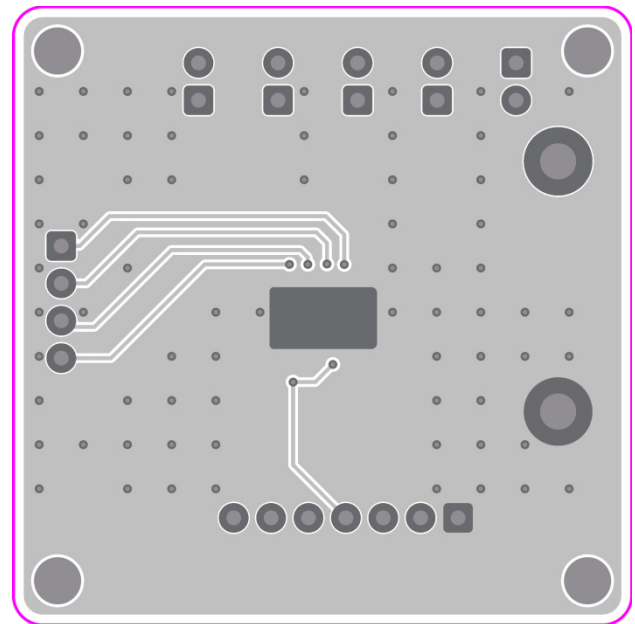
Recommended Layout

A small ceramic capacitor should be placed as close as possible to the VIN pin to filter and regulate the power supply. The R_{ISET} resistor is connected to the GND pin of the SGM3795 by Kelvin connection. GND plane must be as close as possible to the GND of LED power to provide shortest possible return path and smallest possible current loops.

Figure 8 shows the layout recommendation for the SGM3795 in the TDFN package, which uses a through-hole to connect the exposed pad to the large ground plane underneath, allowing the board layout to provide good heat consumption.
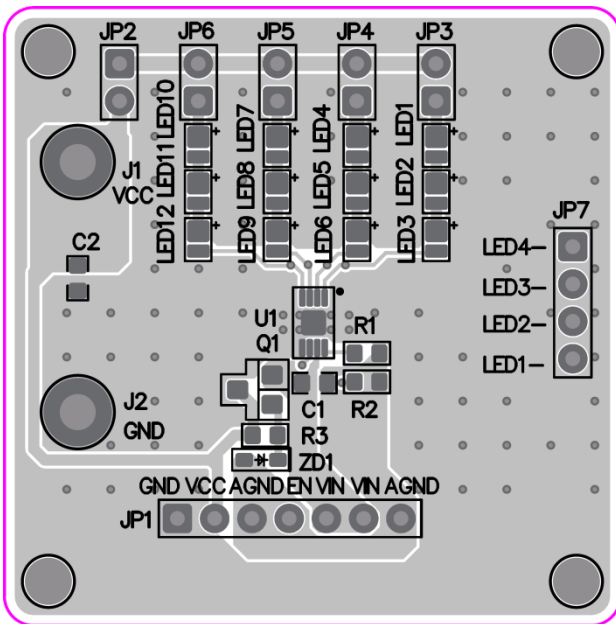
TDFN-2×3-8L Top Layer

TDFN-2×3-8L Bottom Layer

Figure 8. SGM3795 Recommended Layout

REVISION HISTORY

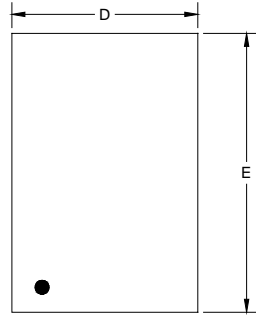NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (NOVEMBER 2023) to REV.A   **Page**

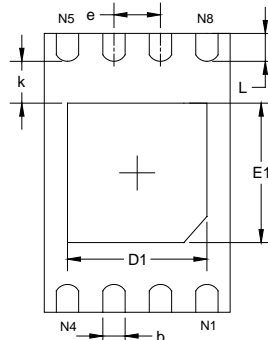Changed from product preview to production data...All

PACKAGE OUTLINE DIMENSIONS

TDFN-2×3-8L

TOP VIEW

BOTTOM VIEW

SIDE VIEW

1.50

0.60

1.50   3.00

0.25   0.50
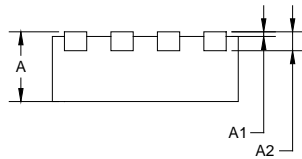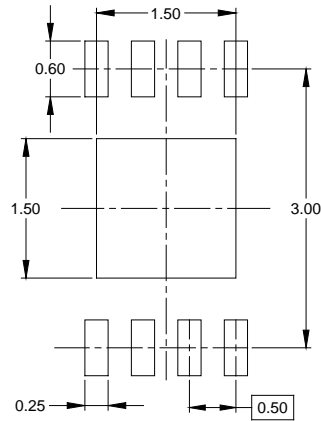
RECOMMENDED LAND PATTERN (Unit: mm)

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	1.924	2.076	0.076	0.082
D1	1.400	1.600	0.055	0.063
E	2.924	3.076	0.115	0.121
E1	1.400	1.600	0.055	0.063
k	0.200 MIN		0.008 MIN	
b	0.200	0.300	0.008	0.012
e	0.500 TYP		0.020 TYP	
L	0.224	0.376	0.009	0.015

NOTE: This drawing is subject to change without notice.

SG Micro Corp
www.sg-micro.com

TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSIONS

DIRECTION OF FEED

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
TDFN-2×3-8L	7"	9.5	2.30	3.30	1.10	4.0	4.0	2.0	8.0	Q2
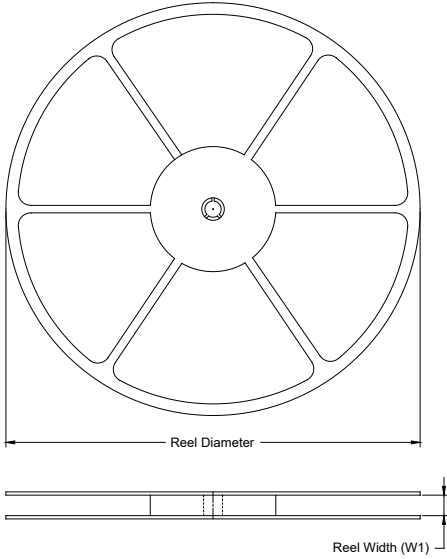
CARTON BOX DIMENSIONS

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
7″ (Option)	368	227	224	8
7″	442	410	224	18

DD0002