SGM37604A
High Efficiency 4-String White LED Driver

GENERAL DESCRIPTION

The SGM37604A is a high efficiency 4-string white LED driver with a 1.2MHz boost converter. The supply voltage operates from 3V to 24V. The SGM37604A is capable of driving up to 8 LEDs in series for 40mA maximum LED current per string while achieving high conversion efficiency. An adaptively current-regulated method allows different LED string voltages while LED current remains in regulation. The LED current is programmed through an I^{2}C interface or a PWM signal input. These features make it optimized for compact solutions and ideal for LCD display backlighting.

The SGM37604A is available in Green WLCSP-1.78×1.36-12B and TDFN-3×3-12L packages. It operates over the -40℃ to +85℃ temperature range.

APPLICATIONS

Power Source for Smart Phone and Tablet Backlighting

FEATURES

- **12-Bit Resolution for Dimming Control**
- **Up to 90% Boost Efficiency**
- **Switching Frequency: 1.2MHz**
- **Support 1 to 4 LED Strings in Parallel at Maximum 29.5V Output**
- **11% LED Current Matching across Process, Voltage and Temperature at I$_{LED}$ = 12.21μA**
- **1% LED Current Matching across Process, Voltage and Temperature at I$_{LED}$ = 25mA**
- **11% LED Current Accuracy across Process, Voltage and Temperature at I$_{LED}$ = 12.21μA**
- **3% LED Current Accuracy across Process, Voltage and Temperature at I$_{LED}$ = 25mA**
- **PWM Dimming Interface**
- **Programmable I^{2}C Interface**
- **Phase Shift Function**
- **Hybrid PWM + Current Dimming for Higher LED Driver Optical Efficiency**
- **Low EMI by Conducting Ringing Cancelling**
- **Protection Features**
  - **Over-Voltage Protection**
  - **Over-Current Protection**
  - **Thermal Shutdown**
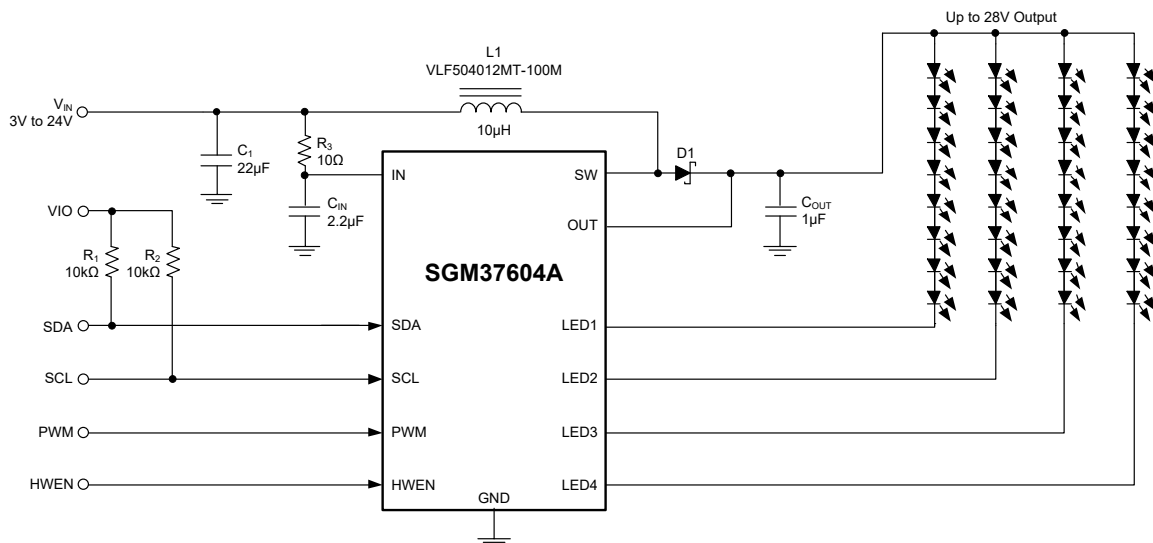
TYPICAL APPLICATION

Figure 1. Typical Application
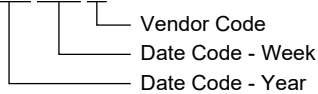
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM37604A	WLCSP-1.78×1.36-12B	-40℃ to +85℃	SGM37604AYG/TR	XXXXX GX4	Tape and Reel, 3000
	TDFN-3×3-12L	-40℃ to +85℃	SGM37604AYTDF12G/TR	SGM B4DF XXXXX	Tape and Reel, 4000

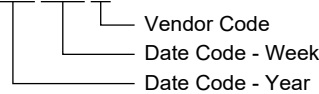## MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.

WLCSP-1.78×1.36-12B

X X X X X
— Vendor Code
— Date Code - Week
— Date Code - Year

TDFN-3×3-12L

X X X X X
— Vendor Code
— Date Code - Week
— 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

IN .... -0.3V to 28.6V
OUT .... -0.3V to 40V
SW .... -0.3V to 40V
LED1, LED2, LED3, LED4 .... -0.3V to 17V
HWEN, PWM, SDA, SCL................................... -0.3V to 6V
Package Thermal Resistance
WLCSP-1.78×1.36-12B, θ_{JA} .... 82℃/W
TDFN-3×3-12L, θ_{JA} .... 50℃/W
Junction Temperature..+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)...........................+260℃
ESD Susceptibility
HBM...2000V
MM..200V
CDM 500V

RECOMMENDED OPERATING CONDITIONS

IN ....3V to 24V
OUT ....0V to 30.5V
SW ....0V to 30.5V
LED1, LED2, LED3, LED4 ....0V to 12V
HWEN, PWM, SDA, SCL......................................0V to 5.5V
Operating Temperature Range ....-40℃ to +85℃

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.
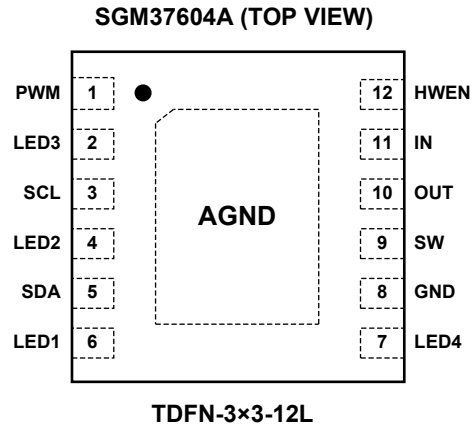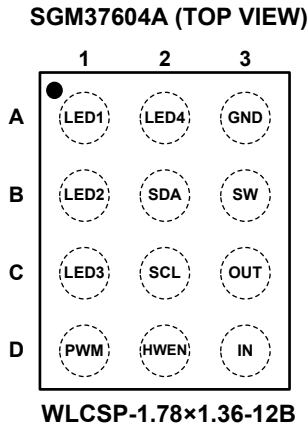
ESD SENSITIVITY CAUTION

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

SGM37604A (TOP VIEW)

WLCSP-1.78×1.36-12B

SGM37604A (TOP VIEW)

TDFN-3×3-12L

PIN DESCRIPTION

PIN		NAME	I/O	FUNCTION
WLCSP-1.78×1.36-12B	TDFN-3×3-12L			
A1	6	LED1	I	Current Sink 1. The boost converter regulates the minimum voltage between current sinks to V_{HR}.
A2	7	LED4	I	Current Sink 4. The boost converter regulates the minimum voltage between current sinks to V_{HR}.
A3	8	GND	O	Ground Pin.
B1	4	LED2	I	Current Sink 2. The boost converter regulates the minimum voltage between current sinks to V_{HR}.
B2	5	SDA	I/O	I²C Data Signal.
B3	9	SW	I	Drain Connection for Internal Low-side N-Channel MOSFET. Connect to the anode of an external Schottky diode.
C1	2	LED3	I	Current Sink 3. The boost converter regulates the minimum voltage between current sinks to V_{HR}.
C2	3	SCL	I	I²C Clock Signal.
C3	10	OUT	I	Output Voltage Sense Pin. It is used for sensing the output voltage for over-voltage protection. Connect to the positive terminal of the output capacitor.
D1	1	PWM	I	PWM Dimming Signal Input.
D2	12	HWEN	I	Hardware Enable Input Pin. Drive HWEN high to enable the device and allow I²C write commands or PWM control.
D3	11	IN	I	Input Supply Pin. Connect a at least 2.2µF bypass capacitor from IN to GND.
—	Exposed Pad	AGND	—	Power Ground Exposed Pad. It should be connected to ground plane.

NOTE: I: input; O: output; I/O: input or output.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3.6V, Full = -40℃ to +85℃, typical values are at T_A = +25℃, unless otherwise noted.)

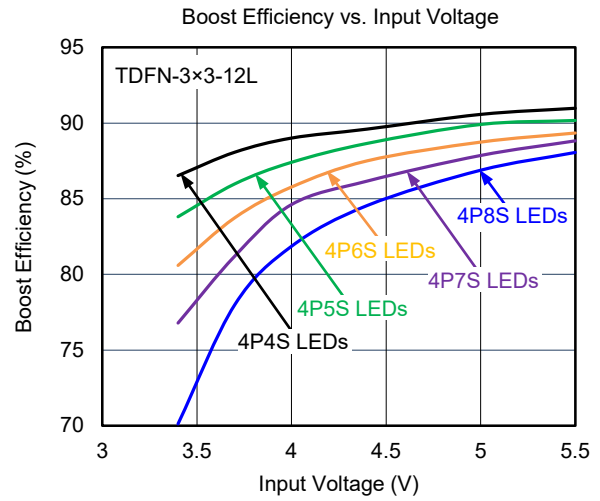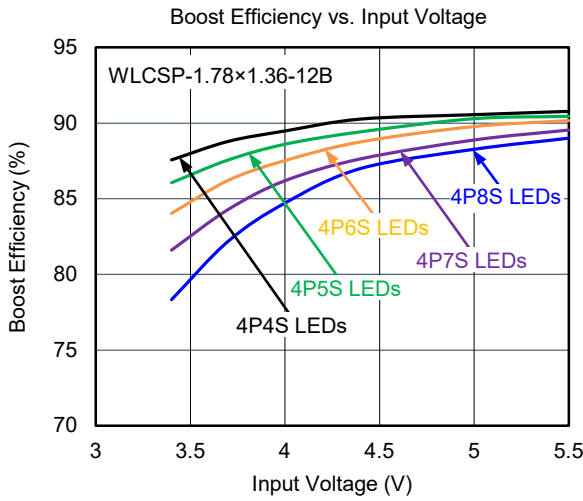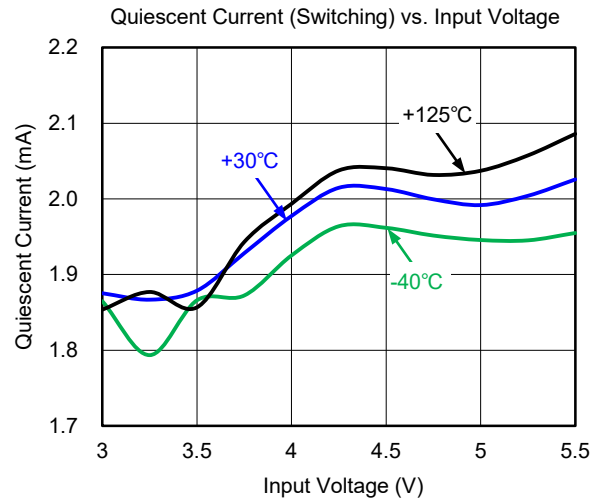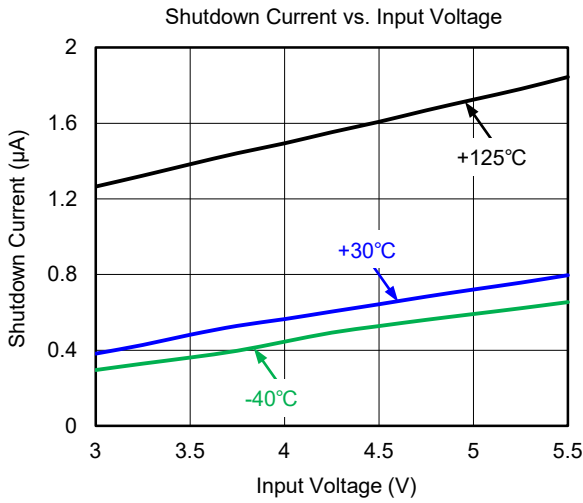| PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Boost							
LED Current Matching I_{LED1} to I_{LED2} to I_{LED3} to I_{LED4}	I_{MATCH} [(1)]	I_{LED} = 12.21µA, V_{LED} = 300mV	+25℃		11		%
		I_{LED} = 25mA, V_{LED} = 180mV	+25℃		1		
Absolute Accuracy (I_{LED1}, I_{LED2}, I_{LED3}, I_{LED4})		I_{LED} = 12.21µA, V_{LED} = 300mV	+25℃		11		%
		I_{LED} = 25mA, V_{LED} = 180mV	+25℃		3		
Minimum LED Current (per string)	I_{LED_MIN}		+25℃		12.21		µA
Maximum LED Current (per string)	I_{LED_MAX}		+25℃		25		mA
Regulated Current Sink Headroom Voltage	V_{HR}	I_{LED} = 25mA	+25℃		180		mV
NMOS Switch On-Resistance	R_{NMOS}	I_{SW} = 250mA	+25℃		0.25	0.35	Ω
NMOS Switch Current Limit	I_{CL}		+25℃	1.7	2.2	2.7	A
Output Over-Voltage Protection	V_{OVP}		Full	28.5	29.5	30.5	V
OVP Hysteresis			+25℃		3		V
Switching Frequency	f_{SW}		Full	950	1200	1400	kHz
Maximum Boost Duty Cycle	D_{MAX}		Full	90	94		%
Shutdown Current	I_{SHDN}	Chip enable bit = 0, SDA = SCL = IN or GND	+25℃		0.5	1.5	µA
Thermal Shutdown	T_{SD}				160		℃
Thermal Shutdown Hysteresis					20		
PWM Input							
PWM Dimming Frequency Range	DFR		+25℃	20		100	kHz
Turn-On Delay from Shutdown to Backlight On	$t_{START-UP}$	PWM input active, PWM = logic high, HWEN input from low to high, f_{PWM} = 20kHz (50% duty cycle)	+25℃		10		ms
Input Logic High	V_{IH}	HWEN, SCL, SDA, PWM inputs	Full	1.4			V
Input Logic Low	V_{IL}	HWEN, SCL, SDA, PWM inputs	Full			0.4	

NOTE:

1. LED Current Matching between strings is given as the worst case matching between any two strings. Matching is calculated as (I_{LEDX} - I_{LEDY})/(I_{LEDX} + I_{LEDY}) × 100.

I^{2}C TIMING REQUIREMENTS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
SCL Clock Period	t_1	2.5			µs
Data in Setup Time to SCL High	t_2	100			ns
Data Out Stable After SCL Low	t_3	0			ns
SDA Low Setup Time to SCL Low (Start)	t_4	100			ns
SDA High Hold Time After SCL High (Stop)	t_5	100			ns

TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_{IN} = 3.7V, L1 = 10µH (VLF504012MT-100M), D1 = NSR0530P2T5G, unless otherwise noted.

Shutdown Current vs. Input Voltage

Quiescent Current (Switching) vs. Input Voltage

Boost Efficiency vs. Input Voltage

Boost Efficiency vs. Input Voltage

Boost Efficiency vs. LED Current

Boost Efficiency vs. LED Current
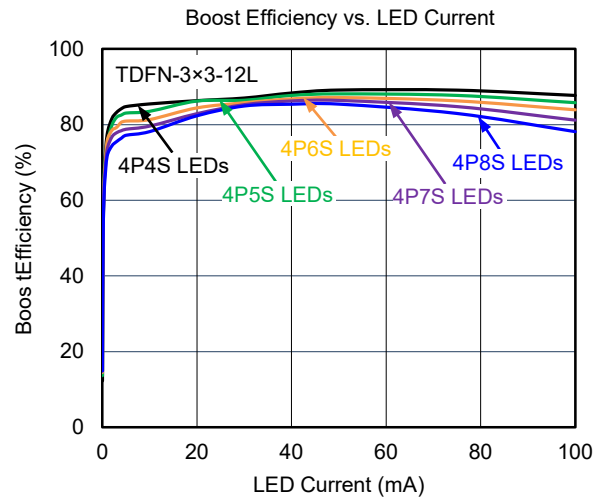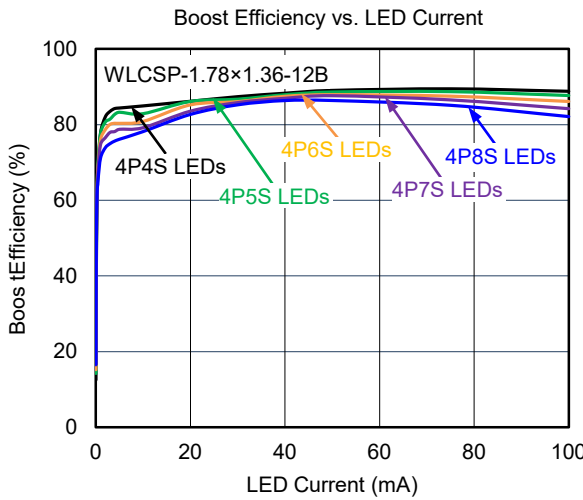
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_{IN} = 3.7V, L1 = 10µH (VLF504012MT-100M), D1 = NSR0530P2T5G, unless otherwise noted.

NMOS Switch On-Resistance vs. Temperature

Output Over-Voltage Protection Threshold vs. Temperature

LED Current Production Distribution
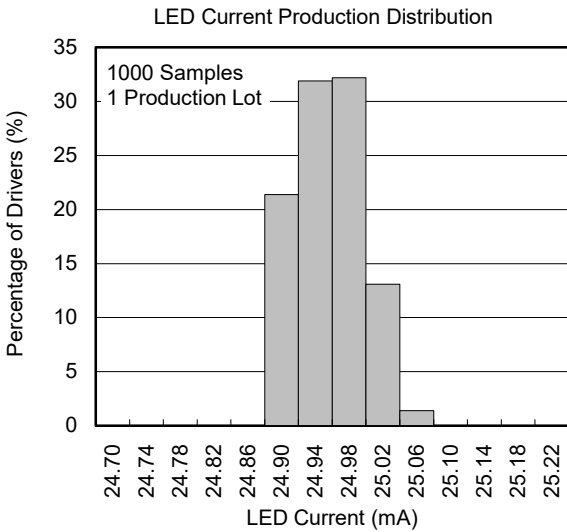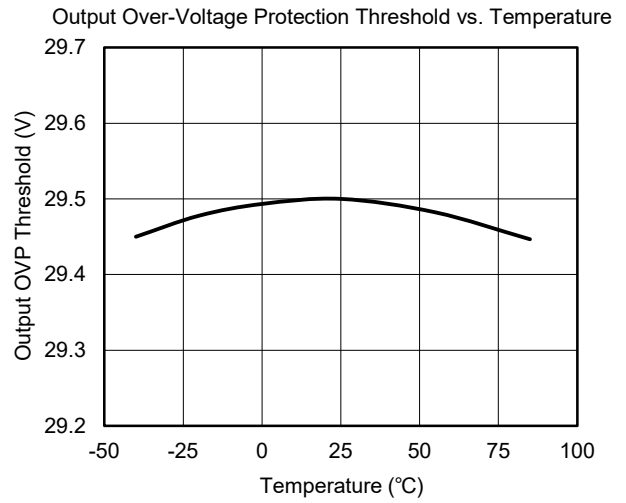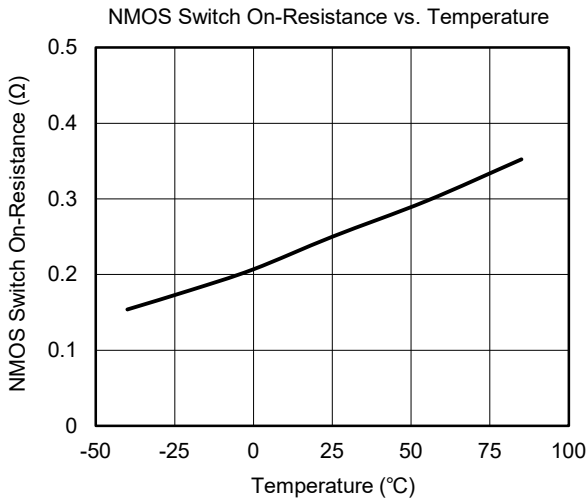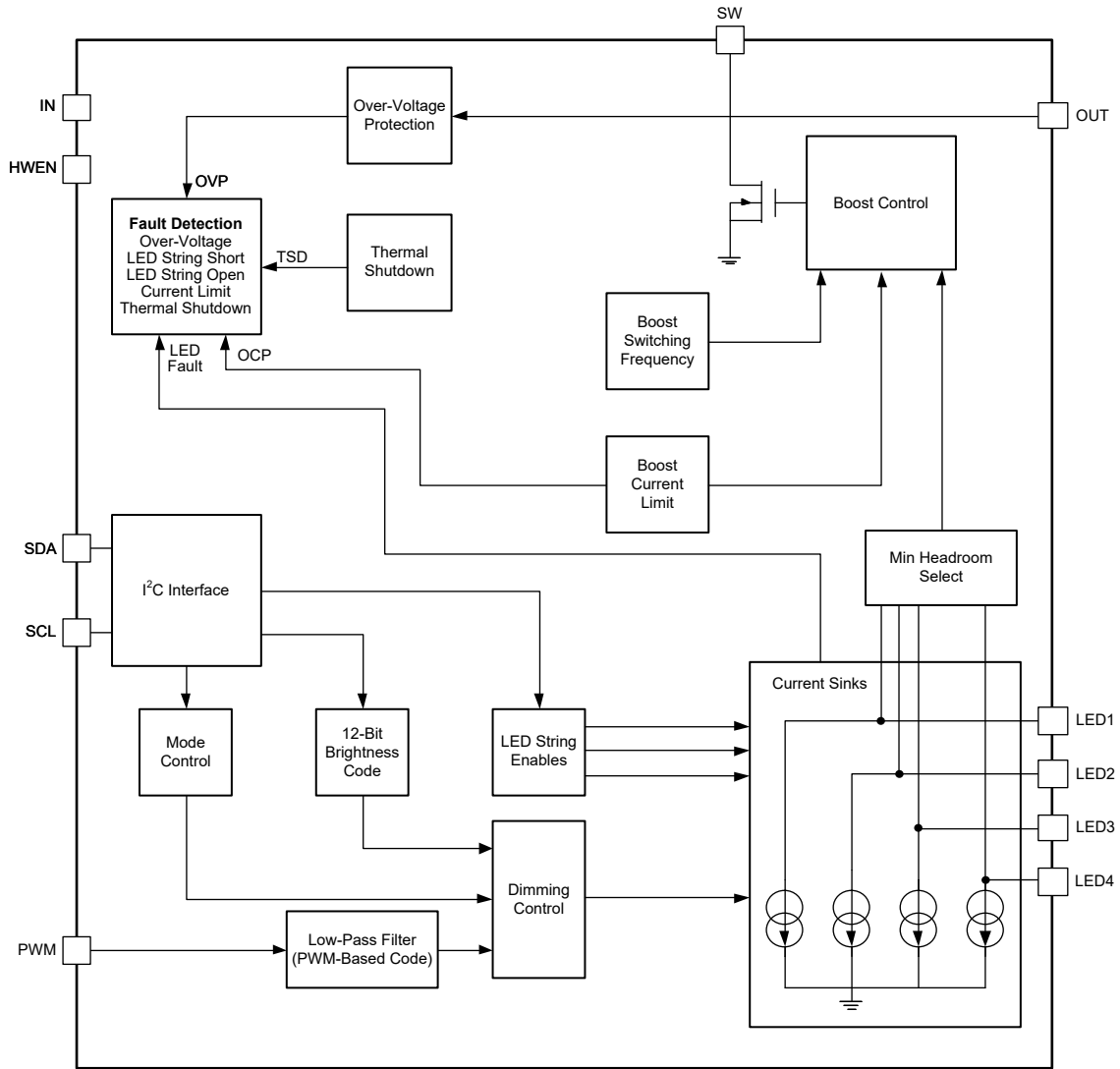
FUNCTIONAL BLOCK DIAGRAM

Figure 2. Functional Block Diagram

REGISTER MAPS

Note: Read of Reserved (R) register returns 0/1 as below.

All registers are 8-bit and individual bits are named from D[0] (LSB) to D[7] (MSB).

R/W: Read/Write bit(s)
R: Read only bit(s)
PORV: Power-On Reset Value

I^{2}C Slave Address of SGM37604A is: 0x36 (0b0110110 + R/W)

Table 1. Register Map

ADDRESS	REGISTER NAME	D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
0x01	Software Reset	Reserved							SOFT_RST
0x10	Enable Control	Reserved			LED4_EN	LED3_EN	LED2_EN	LED1_EN	DEV_EN
0x11	Brightness Control	Reserved	LED_MOD[1:0]		RAMP_EN	Reserved			
0x1A	Brightness Code 0	Reserved				BRT_COD[3:0]			
0x19	Brightness Code 1	BRT_COD[11:4]							
0x1F	Fault Information	Reserved			SO_FLAG	SC_FLAG	TSD_FLAG	OC_FLAG	OVP_FLAG
0x1B	Maximum LED Current	Reserved						ILED_MAX[1:0]	

Table 2. Software Reset Register Details (Register Address: 0x01)

BITS	BIT NAME	DESCRIPTION	PORV	TYPE
D[7:1]	Reserved	Reserved	0000000	R
D[0]	SOFT_RST	Software Reset 0 = Normal Operation 1 = Reset the device. It will return 0 automatically.	0	R/W

Table 3. Enable Control Register Details (Register Address: 0x10)

BITS	BIT NAME	DESCRIPTION	PORV	TYPE
D[7:5]	Reserved	Reserved	000	R
D[4]	LED4_EN	LED4 Enable 0 = Disabled 1 = Enabled (default)	1	R/W
D[3]	LED3_EN	LED3 Enable 0 = Disabled 1 = Enabled (default)	1	R/W
D[2]	LED2_EN	LED2 Enable 0 = Disabled 1 = Enabled (default)	1	R/W
D[1]	LED1_EN	LED1 Enable 0 = Disabled 1 = Enabled (default)	1	R/W
D[0]	DEV_EN	Device Enable 0 = Disabled 1 = Enabled (default)	1	R/W

REGISTER MAP (continued)

Table 4. Brightness Control Register Details (Register Address: 0x11)

BITS	BIT NAME	DESCRIPTION	PORV	TYPE
D[7]	Reserved	Reserved	0	R
D[6:5]	LED_MOD[1:0]	00 = I^{2}C Only 01 = PWM Only 10 = I^{2}C × PWM 11 = I^{2}C × PWM (default)	11	R/W
D[4]	RAMP_EN	Ramp Enable 0 = Disabled (default) 1 = Enabled	0	R/W
D[3:0]	Reserved	Reserved	0101	R

Table 5. Brightness Code 0 Register Details (Register Address: 0x1A)

BITS	BIT NAME	DESCRIPTION	PORV	TYPE
D[7:4]	Reserved	Reserved	1111	R
D[3:0]	BRT_COD[3:0]	Lower 4 Bits of the 12-Bit Brightness Code	1111	R/W

Table 6. Brightness Code 1 Register Details (Register Address: 0x19)

BITS	BIT NAME	DESCRIPTION	PORV	TYPE
D[7:0]	BRT_COD[11:4]	High Byte of the 12-Bit Brightness Code	11111111	R/W

Table 7. Fault Information Register Details (Register Address: 0x1F)

BITS	BIT NAME	DESCRIPTION	PORV	TYPE
D[7:5]	Reserved	Reserved	000	R
D[4]	SO_FLAG	LED String Open Fault Flag 0 = No LED Open Fault (default) 1 = LED Open Fault	0	R
D[3]	SC_FLAG	Short Circuit Fault Flag 0 = No short-circuit fault (default) 1 = Short-circuit fault	0	R
D[2]	TSD_FLAG	Thermal Shutdown Fault Flag 0 = No thermal shutdown fault (default) 1 = Thermal shutdown fault	0	R
D[1]	OC_FLAG	Current Limit Fault Flag 0 = No current limit fault 1 = Current limit fault	0	R
D[0]	OVP_FLAG	Output Over-Voltage Fault Flag 0 = No over-voltage fault (default) 1 = Over-voltage fault	0	R

Table 8. Maximum LED Current Register Details (0x1B)

BITS	BIT NAME	DESCRIPTION	PORV	TYPE
D[7:2]	Reserved	Reserved	000000	R
D[1:0]	ILED_MAX[1:0]	Maximum LED Current Setting 00 = Maximum LED Current of 25mA (default) 01 = Maximum LED Current of 30mA 10 = Maximum LED Current of 35mA 11 = Maximum LED Current of 40mA	00	R/W

DETAILED DESCRIPTION

Table 9. SGM37604A Operating Modes

Device Enable DEV_EN Bit	LED Enable LED1_EN & LED2_EN & LED3_EN & LED4_EN Bits	PWM Input	I²C Brightness Code BRT_COD[11:0]	Brightness Mode LED_MOD[1:0]	LED Current
0	XXXX	X	XXX	XX	Off, device disabled
1	0000	X	XXX	XX	Boost enabled, LED current disabled
1	At least one enabled	X	000	00	Off, device in standby mode
1	At least one enabled	X	Code > 000	00	See [1]
1	At least one enabled	0	XXX	01	Off, device in standby mode
1	At least one enabled	PWM Signal	XXX [2]	01	See [1]
1	At least one enabled	0	XXX	10 or 11	Off, device in standby mode
1	At least one enabled	X	000	10 or 11	Off, device in standby mode
1	At least one enabled	PWM Signal	Code > 000	10 or 11	See [1]

NOTE:

1. I_{LED} is calculated by the equations from Equation 1 to Equation 8 below in Brightness Control Modes.

2. Code is forbidden to set to 0.

Brightness Control Modes

The SGM37604A has 3 brightness control modes:

1. I²C Only (brightness mode 00)

2. PWM Only (brightness mode 01)

3. I²C × PWM (brightness mode 10 or 11)

DETAILED DESCRIPTION (continued)

I²C Only (Brightness Mode 00)

In brightness control mode 00, only the I²C Brightness registers control the LED current. The 12-bit code (0 to 4095) is in control of the LED current as follows:

When the code is from 256 to 4095, the average LED current increases proportionally to the brightness code and follows the below relationship (see Figure 4).

When the code is an odd integer,

$$I_{LED\_AVG} = 12.21\mu A \times 0.5 \times (code - 1) \qquad (1)$$

When the code is an even integer,

$$I_{LED\_AVG} = 12.21\mu A \times 0.5 \times code \qquad (2)$$

Where:

I_{LED_AVG} = average LED current

When the code is from 16 to 255, the average LED current is calculated by Equation 1 and Equation 2 and the LED current is in current-to-PWM control (see Figure 4) with a constant maximum current, while the duty cycle changes following the code.

When the code is from 1 to 15, the average LED current increases exponentially to the brightness code

and follows the relationship by Equation 3 (see Figure 4). The LED current is also in current-to-PWM control, and the duty cycle is 16/256 constantly, and the amplitude of current pulse is 16 times of its corresponding average current.

$$I_{LED\_AVG} = 12.21\mu A \times 1.149^{(code - 1)} \qquad (3)$$

Code 1 programs the LED current to 12.21µA with 25mA maximum LED current. If the bits[1:0] are not set to all 0 in register 0x1B, the maximum LED current will increase and the minimum current (code = 1) will proportionally increase. Code 0 programs 0 current.

When bit[4] is set to 1 in register 0x11, ramp function is enabled. Then when bits[7:4] in registers 0x19 are not all 0 (codes from 256 to 4095), the ramp rate is 128µs/step. When bits[7:4] in registers 0x19 are all 0 (codes from 1 to 255), the ramp rate is 1024µs/step. For example, if the code is set from 2000 to 4001, I_{LED_AVG} will change from 12.21mA to 24.42mA, the corresponding ramp rate = 128µs/step, so the ramp time for I_{LED_AVG} = [(4001 - 1) × 0.5 - 2000 × 0.5] × 128µs = 128ms.
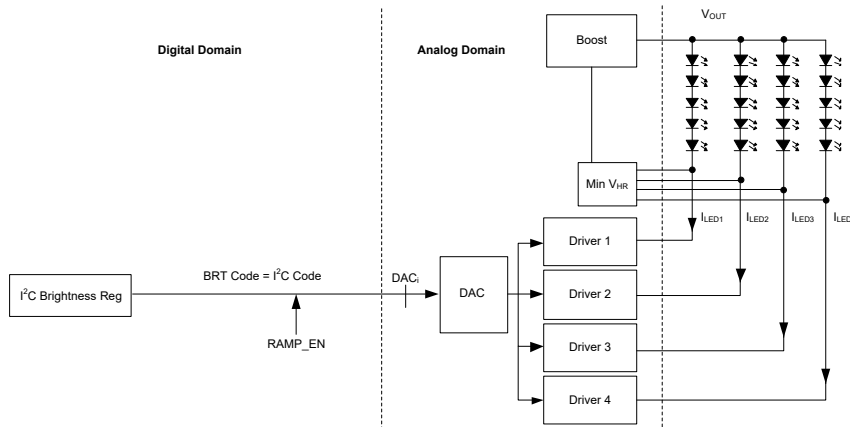

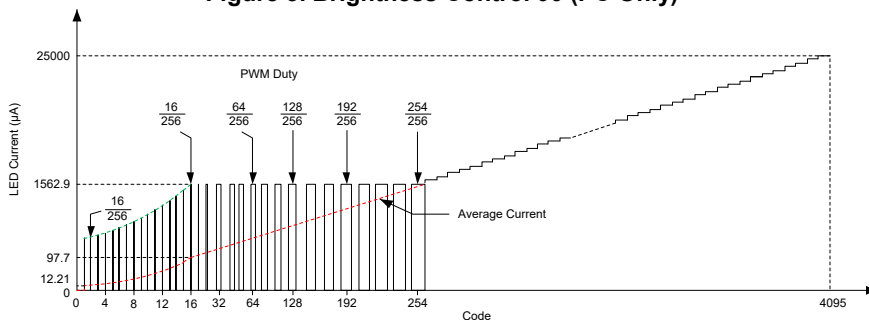**Figure 3. Brightness Control 00 (I²C Only)**

Figure 4. LED Current vs. Brightness Code (Mode 00)

DETAILED DESCRIPTION (continued)

PWM Only (Brightness Mode 01)

In brightness mode 01, only the PWM signal input sets the brightness. The I^{2}C code is ignored and forbidden to set to 0. The LED current is proportional with the PWM duty cycle and the maximum LED current is 25mA.

When the PWM pin is constantly high, the V_{REF} voltage is regulated to 2048mV typically. When the duty cycle of the input PWM signal is low, the regulation voltage is reduced, and the LED current is reduced; therefore, it achieves LED brightness dimming. The relationship between the duty cycle and V_{REF} regulation voltage is given by Equation 4:

$$V_{REF} = Duty \times 2048mV \qquad (4)$$

Where:
Duty = duty cycle of the PWM signal
2048mV = internal reference voltage

Then the value of V_{REF} is the PWM-based code for brightness dimming. The LED current increases proportionally to the brightness code and follows the relationship (see Figure 6):

$$I_{LED\_AVG} = 12.21\mu A \times code \qquad (5)$$

This is valid from codes 1 to 2048. Code 0 programs 0 current. When the code < 16, the LED current is in current-to-PWM control. The duty cycle of the PWM is 1/8, and the amplitude of current pulse is 8 times of its corresponding average current. Figure 6 (a) shows the zoomed graph from codes 0 to 16 in Figure 6. There is no ramp function in this mode.

Thus, the user can easily control the WLED brightness by controlling the duty cycle of the PWM signal. The PWM frequency is in the range from 20kHz to 100kHz.
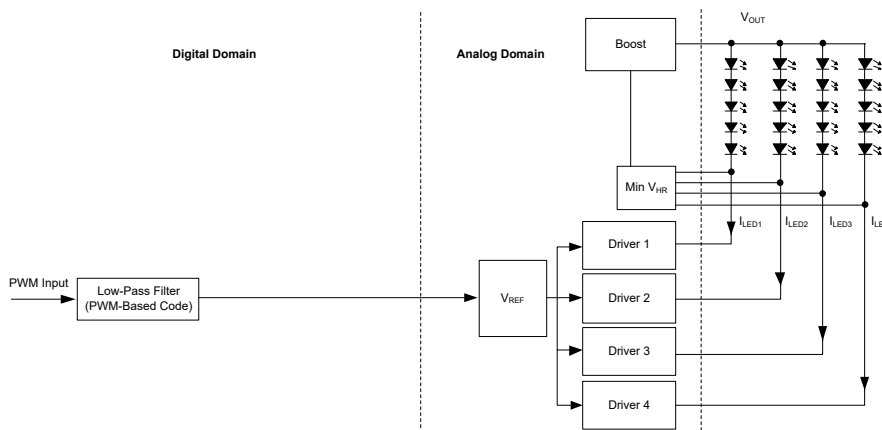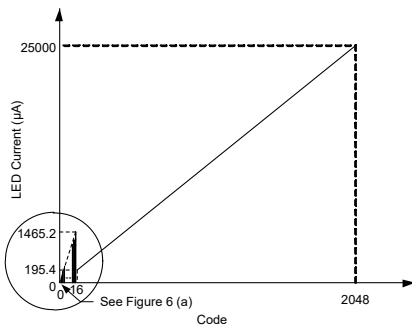

Figure 5. Brightness Control 01 (PWM Only)

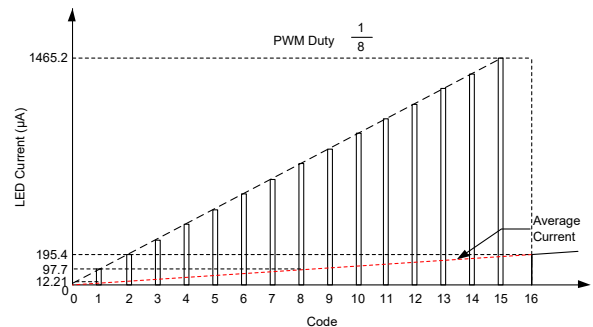**Figure 6. LED Current vs. Brightness Code (Mode 01)**

Figure 6 (a).

DETAILED DESCRIPTION (continued)

I²C + PWM (Brightness Mode 10 or 11)

In brightness control mode 10 or 11, both the I²C code and the PWM duty cycle control the LED current. The brightness code is calculated by PWM duty cycle and the I²C brightness code, and follows the relationship (see Figure 7):

When the I²C code is an odd integer,

$$\text{BRT code} = (\text{I}^2\text{C code} - 1) \times 0.5 \times \text{PWM duty cycle} \quad (6)$$

When the I²C code is an even integer,

$$\text{BRT code} = \text{I}^2\text{C code} \times 0.5 \times \text{PWM duty cycle} \quad (7)$$

Where:
BRT code = the brightness code
I²C codes are valid from 0 to 4095. The codes should be integers.

The average LED current increases proportionally to the brightness code and is calculated by Equation 8.

$$I_{LED\_AVG} = 12.21\mu A \times \text{code} \quad (8)$$

This is valid from codes 1 to 2047 and the codes could be integers or decimals. Code 1 programs the LED current to 12.21µA with 25mA maximum LED current. If the bits[1:0] are not set to all 0 in register 0x1B, the maximum LED current will increase and the minimum current (code = 1) will proportionally increase. Code 0 programs 0 current (see Figure 8). When the brightness code < 16, the LED current is in current-to-PWM control. The duty cycle of the PWM is 1/8, and the amplitude of current pulse is 8 times of its corresponding average current. Figure 8 (a) shows the zoomed graph from codes 0 to 16 in Figure 8.

When bit[4] is set to 1 in register 0x11, ramp function is enabled . When bits[7:4] in registers 0x19 are not all 0 (codes from 256 to 4095), regardless of PWM duty cycle, the ramp rate is 128µs/step. When bits[7:4] in registers 0x19 are all 0 (codes from 1 to 255), regardless of PWM duty cycle, the ramp rate is 1024µs/step. For example, if PWM duty cycle is set to 10% and the code is set from 2000 to 4001, when bit[1:0] in register 0x1B is 00, I_{LED_AVG} will change from 1.221mA to 2.442mA, the corresponding ramp rate = 128µs/step, so the ramp time for I_{LED_AVG} = [(4001 - 1) × 0.5 - 2000 × 0.5] × 128µs = 128ms.
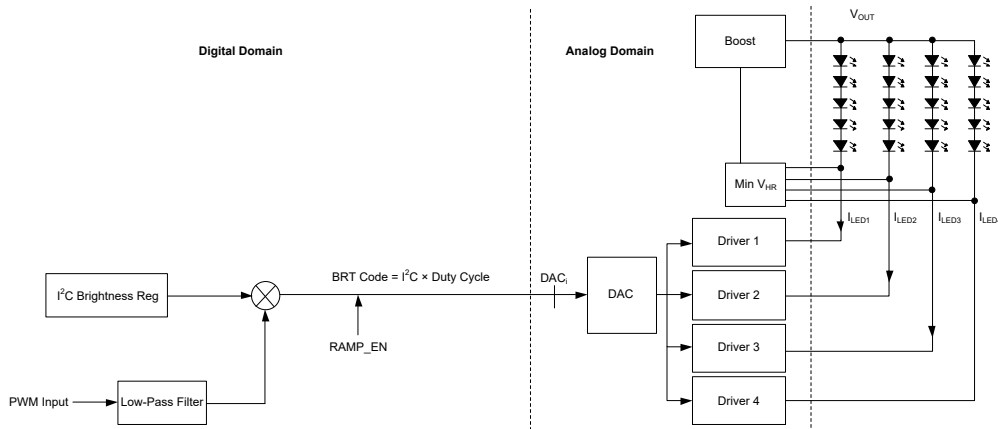

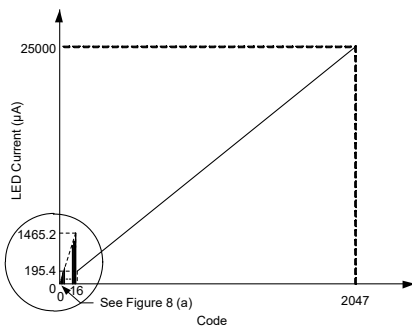**Figure 7. Brightness Control 10 or 11 (I²C + PWM)**

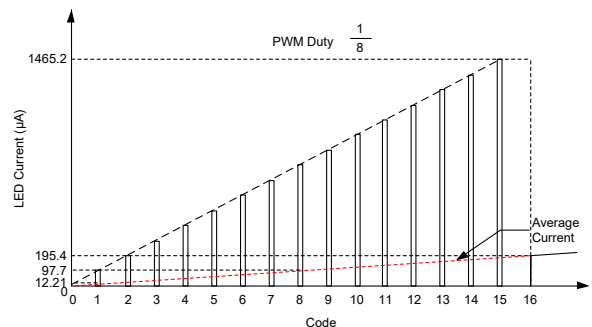**Figure 8. LED Current vs. Brightness Code (Mode 10 or Mode 11)**

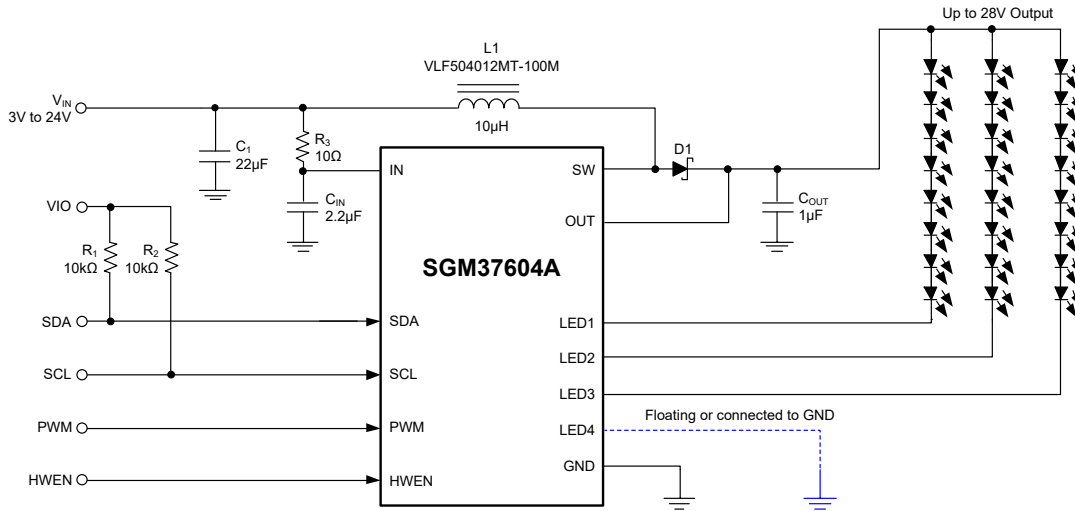**Figure 8 (a).**

DETAILED DESCRIPTION (continued)

Figure 9. Typical Application for Less than Four Parallel LED Strings

REVISION HISTORY

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

PACKAGE OUTLINE DIMENSIONS
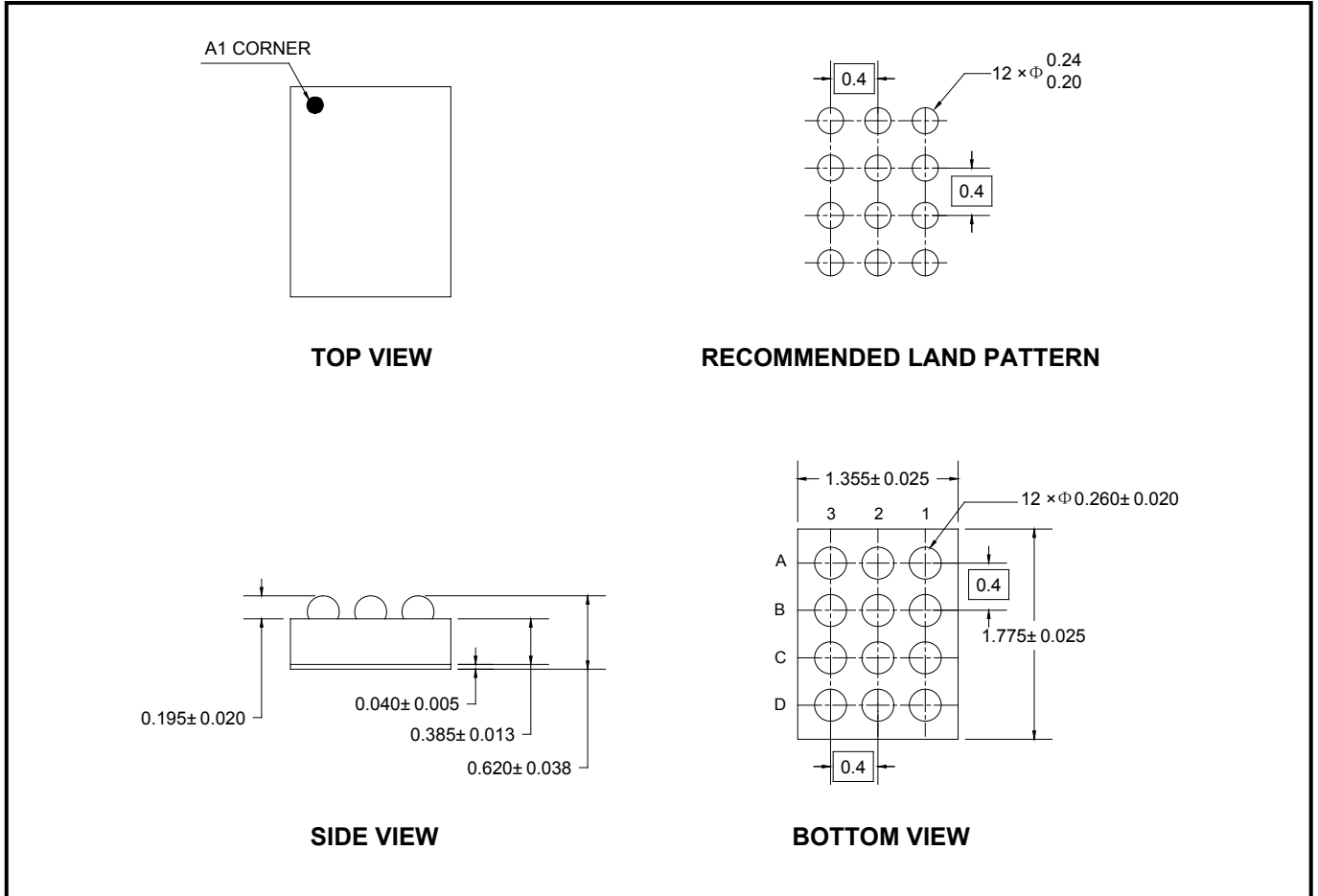
WLCSP-1.78×1.36-12B

A1 CORNER

TOP VIEW

$12 \times \Phi \, {}^{0.24}_{0.20}$

0.4

0.4

RECOMMENDED LAND PATTERN

0.195± 0.020

0.040± 0.005

0.385± 0.013

0.620± 0.038

SIDE VIEW

1.355± 0.025

3 2 1

$12 \times \Phi \, 0.260± 0.020$

A

B

C

D

0.4

1.775± 0.025

0.4

BOTTOM VIEW

NOTE: All linear dimensions are in millimeters.

SG Micro Corp
www.sg-micro.com

TX00137.000

PACKAGE OUTLINE DIMENSIONS

TDFN-3×3-12L
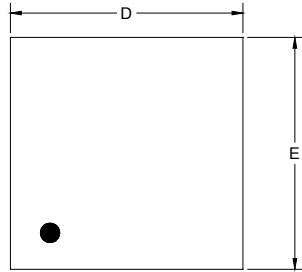
TOP VIEW
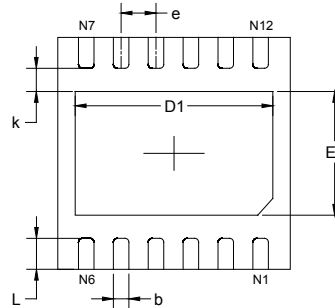
BOTTOM VIEW

SIDE VIEW
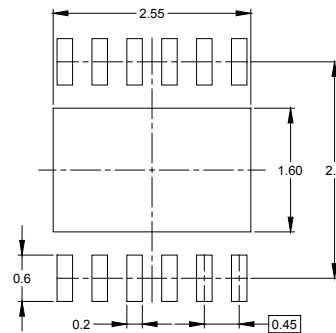
RECOMMENDED LAND PATTERN (Unit: mm)

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	2.924	3.076	0.115	0.121
D1	2.450	2.650	0.096	0.104
E	2.924	3.076	0.115	0.121
E1	1.500	1.700	0.059	0.067
k	0.200 MIN		0.008 MIN	
b	0.150	0.250	0.006	0.010
e	0.450 TYP		0.018 TYP	
L	0.324	0.476	0.013	0.019

TAPE AND REEL INFORMATION

REEL DIMENSIONS

Reel Diameter

Reel Width (W1)

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
WLCSP-1.78×1.36-12B	7″	9.2	1.46	1.90	0.81	4.0	4.0	2.0	8.0	Q1
TDFN-3×3-12L	13″	12.4	3.30	3.30	1.10	4.0	8.0	2.0	12.0	Q1

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
7″ (Option)	368	227	224	8
7″	442	410	224	18
13″	386	280	370	5

DD0002