SGM37864
Dual 2A Current Source Camera Flash LED Driver

GENERAL DESCRIPTION

The SGM37864 is a dual LED flash driver that is compact and highly customizable. It employs a synchronous Boost converter with a fixed frequency of 2MHz or 4MHz to drive the dual constant current LED sources, each up to 2A. The dual current sources, each with 256 levels, allow for flexible adjustment of the current ratios between LED1 and LED2. The utilization of an adaptive control method ensures that the current sources are regulated and efficiency is maximized.

The device's features include an I^2C interface for management, hardware flash and torch pins (STROBE and TORCH/TEMP), an NTC thermistor monitor, and a TX interrupt. The LEDs can operate in either flash or torch mode, with independently programmable currents in each output leg.

The SGM37864 also includes options for 2MHz or 4MHz switching frequency, adjustable current limit, input voltage flash monitor (IVFM) and over-voltage protection (OVP), making it possible to use small, low-profile inductors and 10μF ceramic capacitors. It operates within a temperature range of -40℃ to +85℃.

APPLICATIONS

Smart Phones, EPOS
Portable Internet Devices and Accessory
Action Cameras

FEATURES

- **Dual Independent Programmable LED Current Source up to 2A**
- **Flash Mode: 9.45mA to 2A with 256 Levels**
- **Torch Mode:**
  - **2.35mA to 510mA with 256 Levels (ILED_TOR_SEL = 0)**
  - **2mA to 360mA with 256 Levels (ILED_TOR_SEL = 1)**
- **Flash Timeout Ranges: 40ms to 1600ms**
- **Up to 85% Efficiency in Torch Mode and Flash Mode**
- **Switching Frequency Options: 2MHz or 4MHz**
- **Current Limit Options: 3.2A or 3.9A**
- **I^2C Port for Flexible Working Mode Setting and Status Reporting**
- **Hardware Flash Enable (STROBE)**
- **Hardware Torch Enable (TORCH/TEMP)**
- **Remote NTC Monitoring (TORCH/TEMP)**
- **Synchronization Input for Pulse Events of the RF Power Amplifier (TX)**
- **Optimized Flash LED Current with Input Voltage Flash Monitor (IVFM)**
- **Small Solution Size: Less than 16mm²**
- **Available in a Green WLCSP-1.2×1.6-12B Package**

TYPICAL APPLICATION

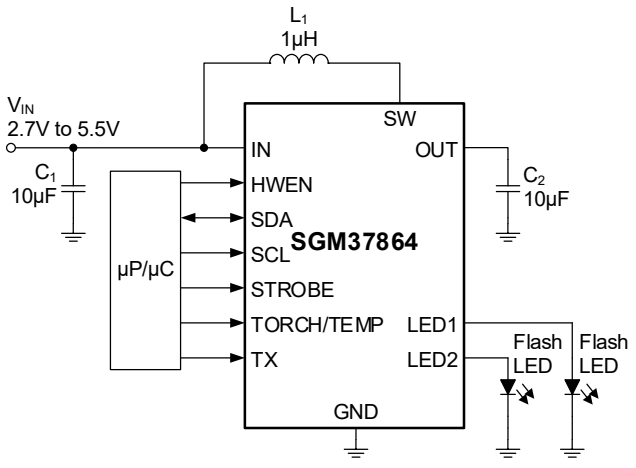


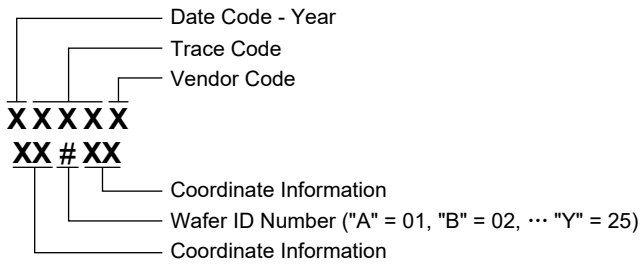
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM37864	WLCSP-1.2×1.6-12B	-40℃ to +85℃	SGM37864YG/TR	0M9YG XXXXX XX#XX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code. XX#XX = Coordinate Information and Wafer ID Number.



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)
IN, SW, OUT, LED1, LED2 ..... -0.3V to 6V
SDA, SCL, TX, TORCH/TEMP, HWEN, STROBE
..... -0.3V to the lesser of (V_{IN} + 0.3V) with 6V MAX
Package Thermal Resistance
WLCSP-1.2×1.6-12B, θ_{JA} ..... 105.5℃/W
Junction Temperature .....+150℃
Storage Temperature Range .....-65℃ to +150℃
Lead Temperature (Soldering, 10s) .....+260℃
ESD Susceptibility
HBM.....3000V
CDM 1500V

RECOMMENDED OPERATING CONDITIONS

Input Voltage, V_{IN}.....2.7V to 5.5V
Operating Ambient 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

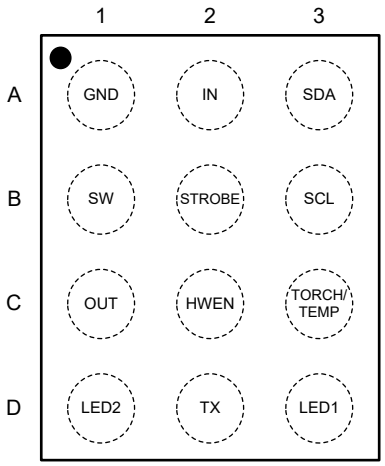
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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

SGM37864 (TOP VIEW)



WLCSP-1.2×1.6-12B

PIN DESCRIPTION

PIN	NAME	TYPE	FUNCTION
A1	GND	G	Ground Pin.
A2	IN	P	Input Voltage Connection. Connect this pin to the input supply. A 10μF or larger ceramic capacitor should be used to bypass to the GND pin.
A3	SDA	I/O	I^2C Interface Data Line.
B1	SW	P	Switch Pin of the Boost DC/DC Converter.
B2	STROBE	I/O	Hardware Flash Enable Pin. Flash pulse is activated by driving STROBE pin high. A 300kΩ pull-down resistor is internally connected from STROBE pin to GND.
B3	SCL	I	I^2C Interface Clock Line.
C1	OUT	P	Boost DC/DC Converter Output Pin. A 10μF ceramic capacitor should be used from OUT pin to GND.
C2	HWEN	I/O	Hardware Enable Pin. Global hardware enable/disable function. High = standby, Low = shutdown/reset. A 300kΩ pull-down resistor is internally connected from HWEN pin to GND.
C3	TORCH/TEMP	I/O	Hardware Torch Enable Pin or Threshold Detector for NTC Thermistors. The TORCH/TEMP function can be selected by TORCH_TEMP_SEL bit.
D1	LED2	P	The LED2 Current Source Output Pin.
D2	TX	I/O	Power Amplifier Synchronization Input Pin. A 300kΩ pull-down resistor is internally connected from TX pin to GND.
D3	LED1	P	The LED1 Current Source Output Pin.

NOTE: I = input, I/O = input or output, P = power, G = ground.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3.6V, HWEN = V_{IN}, T_J = +25℃, unless otherwise noted. (1))

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Current Source Specifications						
Current Source Accuracy	$I_{LED1/2}$	V_{OUT} = 4V, I_FLASH1/2[7:0] = 0xFF	1.82	2.00	2.08	A
		V_{OUT} = 4V, ILED_TOR_SEL = 0, I_TORCH1/2[7:0] = 0x7F	235	260	285	mA
LED1 and LED2 Current Source Regulation Voltage	V_{HR}	$I_{LED1/2}$ = 360mA, torch mode	130	185	240	mV
		$I_{LED1/2}$ = 360mA, flash mode	235	300	365	
Over-Voltage Protection Threshold	V_{OVP_ON}	ON threshold	5.05	5.2	5.35	V
	V_{OVP_OFF}	OFF threshold	4.95	5.1	5.25	
Boost DC/DC Converter Specifications						
PMOS Switch On-Resistance	R_{PMOS}			73	110	mΩ
NMOS Switch On-Resistance	R_{NMOS}			75	120	mΩ
Switch Current Limit	I_{CL}	BOOST_ILIM = 0		3.2		A
		BOOST_ILIM = 1		3.9		
Under-Voltage Lockout Threshold	V_{UVLO}	V_{IN} falling	2.35	2.56	2.75	V
NTC Comparator Trip Threshold	V_{TRIP}	TEMP_VDET[2:0] = 100	0.525	0.580	0.640	V
NTC Current	I_{NTC}		46	50	54	μA
Input Voltage Flash Monitor Trip Threshold	V_{IVFM}	IVFM_VOL[2:0] = 000	2.850	2.940	3.030	V
Quiescent Supply Current	I_Q	Pass mode, not switching		0.72	0.95	mA
Shutdown Supply Current	I_{SD}	Shutdown mode, HWEN = 0V, 2.7V ≤ V_{IN} ≤ 5.5V		0.01	1	μA
Standby Supply Current	I_{SB}	Standby mode, HWEN = 1.8V, 2.7V ≤ V_{IN} ≤ 5.5V		3.6	6	μA
HWEN, TORCH/TEMP, STROBE, TX Voltage Specifications						
Input Logic Low	V_{IL}	2.7V ≤ V_{IN} ≤ 5.5V			0.4	V
Input Logic High	V_{IH}	2.7V ≤ V_{IN} ≤ 5.5V	1			
I^2C-Compatible Interface Specifications (SCL, SDA)						
Input Logic Low	V_{IL}	2.7V ≤ V_{IN} ≤ 5.5V			0.4	V
Input Logic High	V_{IH}	2.7V ≤ V_{IN} ≤ 5.5V	1			
Output Logic Low	V_{OL}	I_{LOAD} = 3mA			300	mV
Switching Characteristics						
Switching Frequency	f_{SW}	BOOST_FREQ = 0, 2.7V ≤ V_{IN} ≤ 5.5V	1.75	2	2.25	MHz
		BOOST_FREQ = 1, 2.7V ≤ V_{IN} ≤ 5.5V	3.50	4	4.50	

NOTE: 1. All voltages are with respect to the potential at the GND pin.

TIMING REQUIREMENTS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
SCL Clock Period	t_1	2.4			μs
Data In Set-Up Time to SCL High	t_2	100			ns
Data Out Stable after SCL Low	t_3	0			ns
SDA Low Set-Up Time to SCL Low (Start)	t_4	100			ns
SDA High Hold Time after SCL High (Stop)	t_5	100			ns

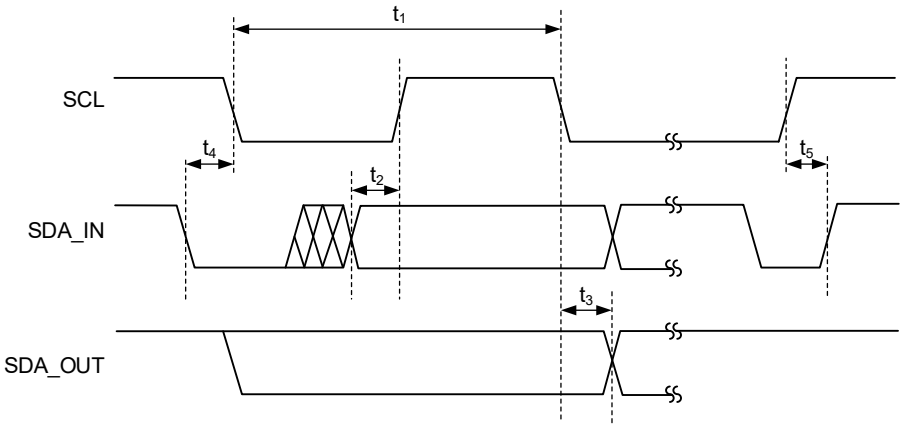
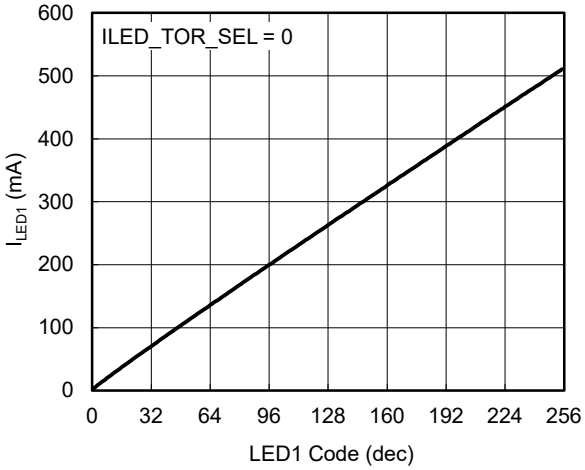


Figure 2. I²C-Compatible Interface Specifications

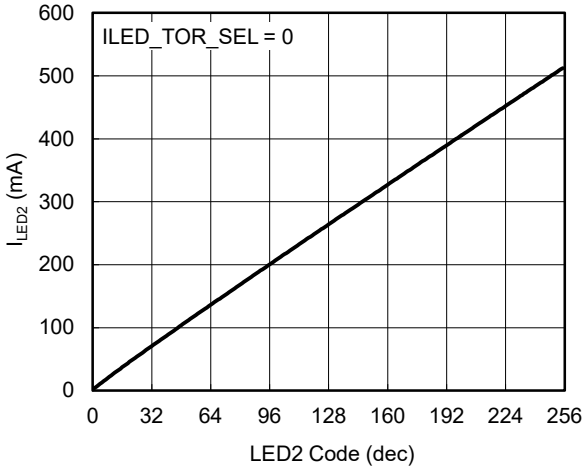
TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN} = 3.6V, HWEN = V_{IN}, L = 1μH, C_{IN} = C_{OUT} = 2 × 10μF, T_J = +25℃, unless otherwise noted.

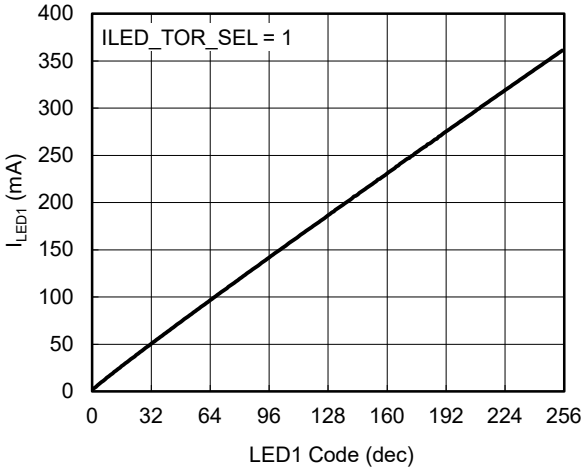
LED1 Torch Current vs. LED1 Torch Brightness Code



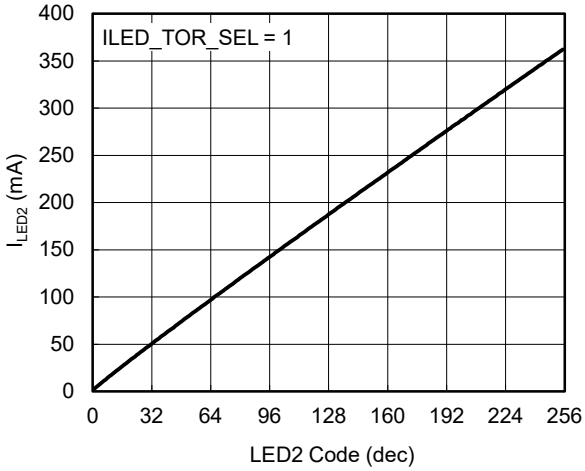
LED2 Torch Current vs. LED2 Torch Brightness Code



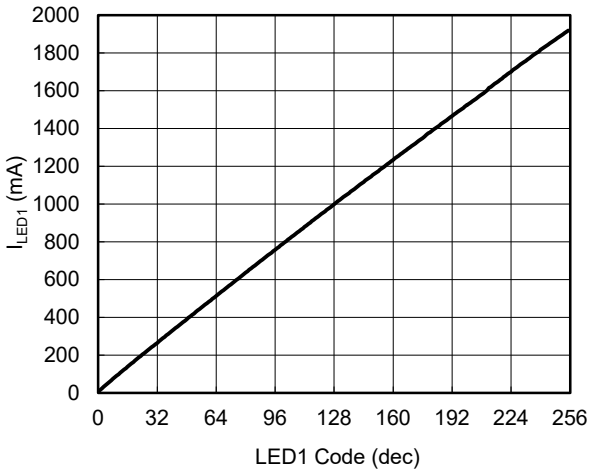
LED1 Torch Current vs. LED1 Torch Brightness Code



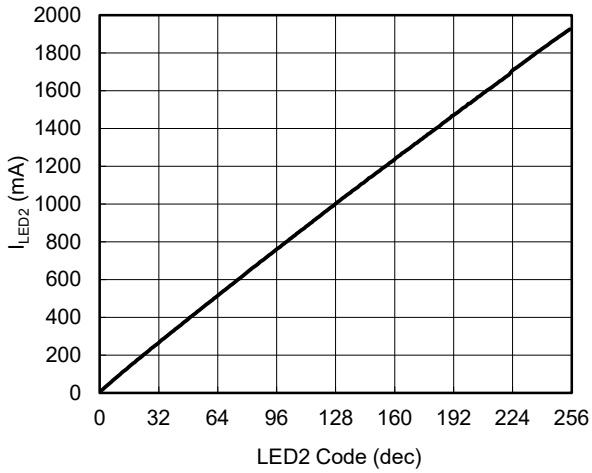
LED2 Torch Current vs. LED2 Torch Brightness Code



LED1 Flash Current vs. LED1 Flash Brightness Code



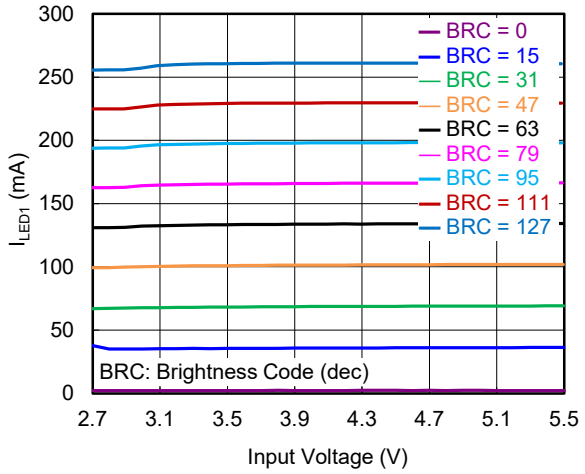
LED2 Flash Current vs. LED2 Flash Brightness Code



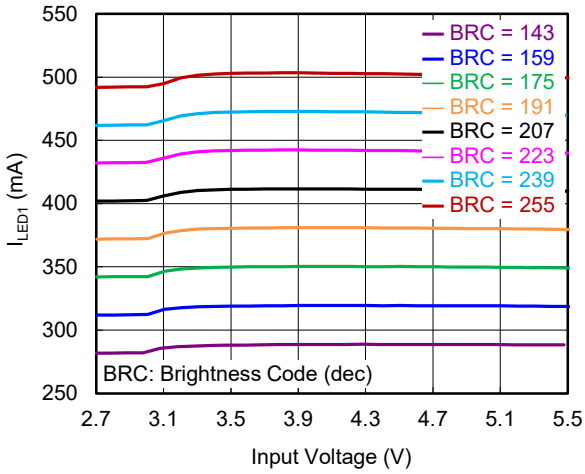
TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN} = 3.6V, HWEN = V_{IN}, L = 1μH, C_{IN} = C_{OUT} = 2 × 10μF, T_J = +25℃, unless otherwise noted.

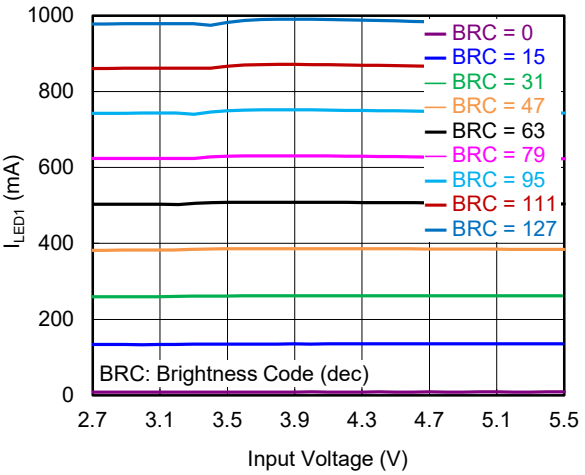
LED1 Torch Current vs. Input Voltage



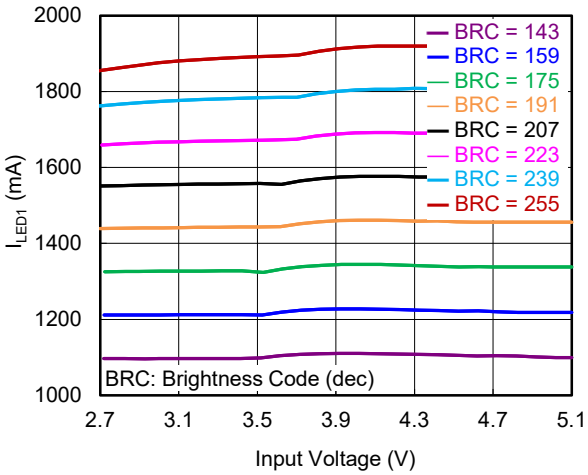
LED1 Torch Current vs. Input Voltage



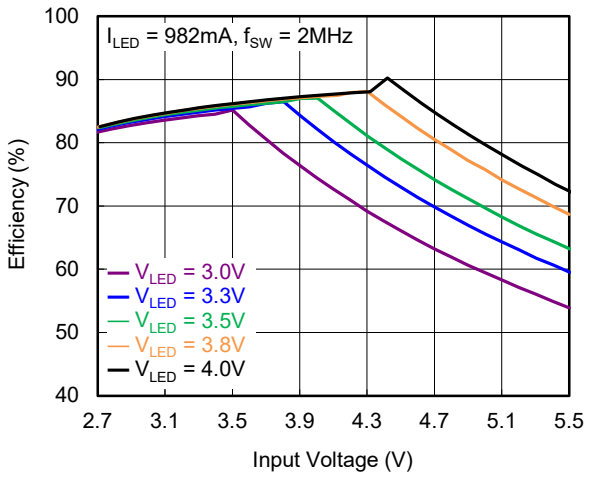
LED1 Flash Current vs. Input Voltage



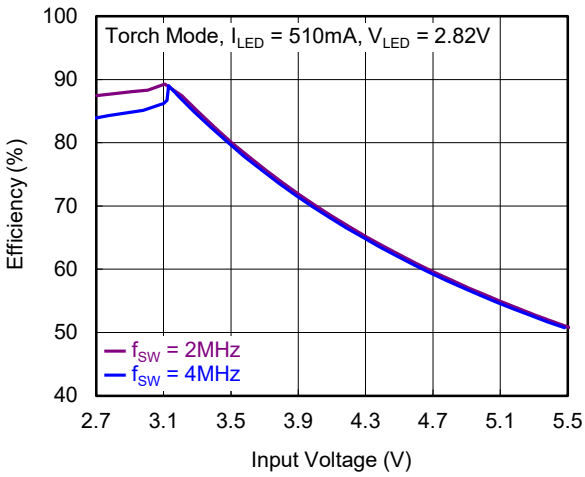
LED1 Flash Current vs. Input Voltage



Efficiency vs. Input Voltage



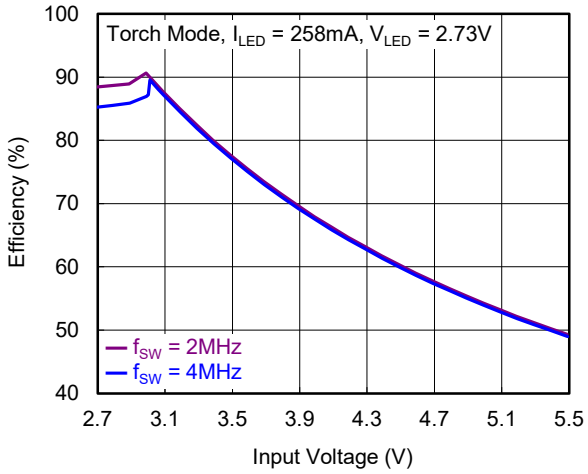
Efficiency vs. Input Voltage



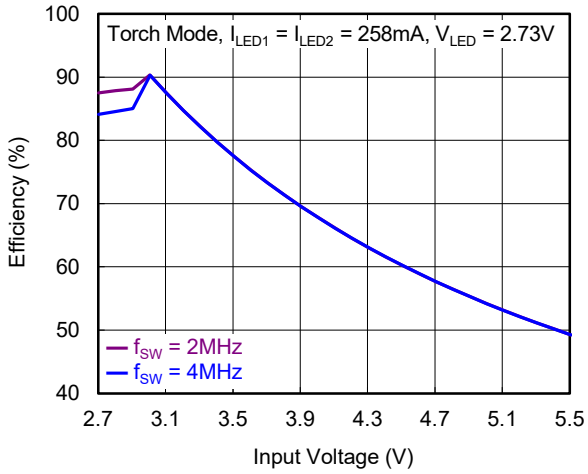
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_{IN} = 3.6V, HWEN = V_{IN}, L = 1μH, C_{IN} = C_{OUT} = 2 × 10μF, T_J = +25℃, unless otherwise noted.

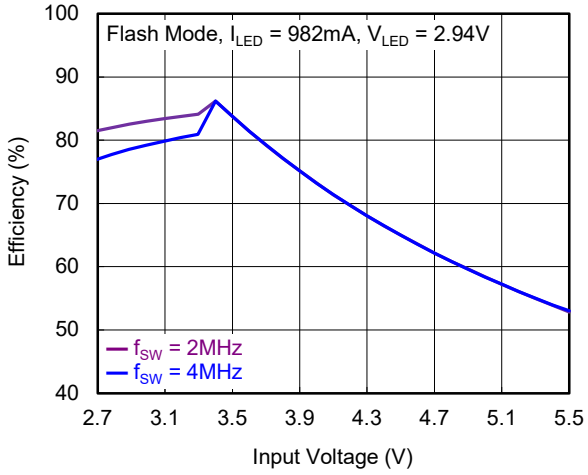
Efficiency vs. Input Voltage



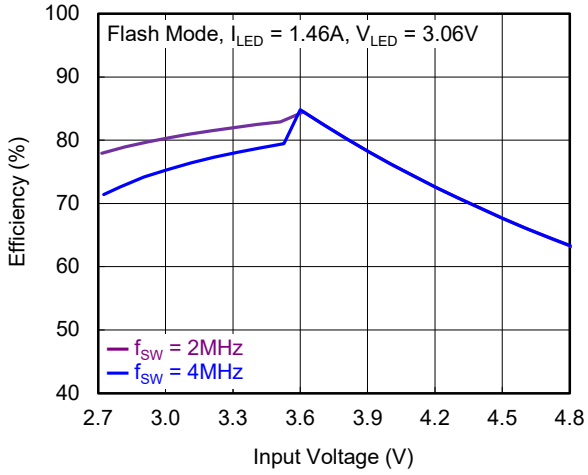
Efficiency vs. Input Voltage



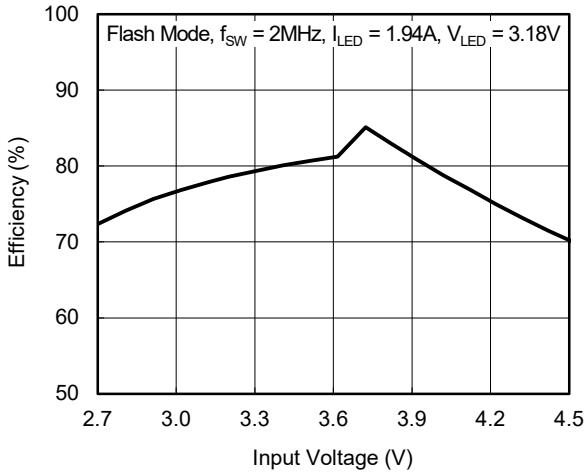
Efficiency vs. Input Voltage



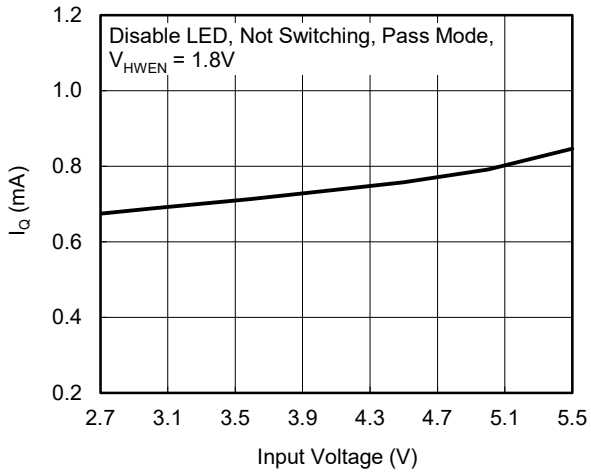
Efficiency vs. Input Voltage



Efficiency vs. Input Voltage



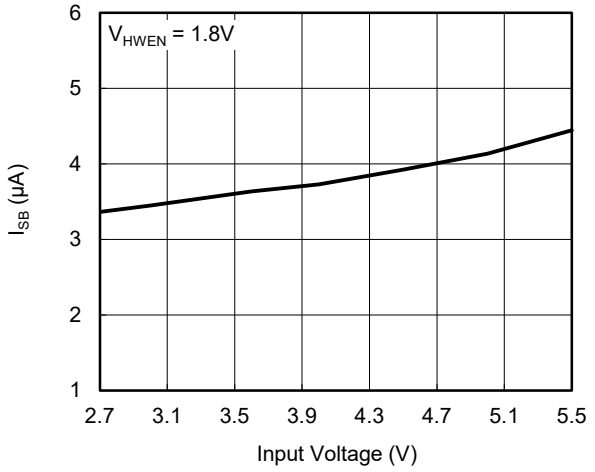
Quiescent Current vs. Input Voltage



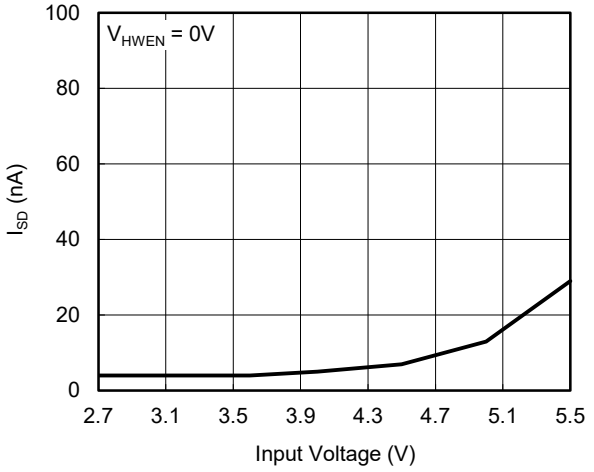
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_{IN} = 3.6V, HWEN = V_{IN}, L = 1μH, C_{IN} = C_{OUT} = 2 × 10μF, T_J = +25℃, unless otherwise noted.

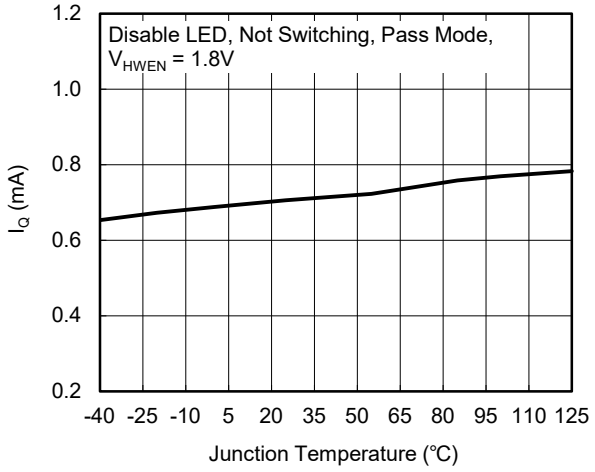
Standby Current vs. Input Voltage



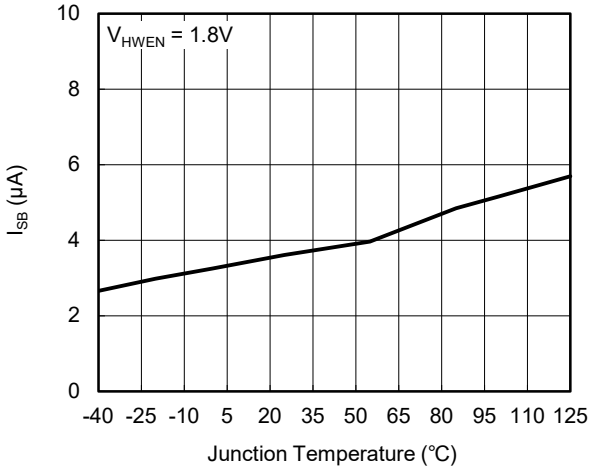
Shutdown Current vs. Input Voltage



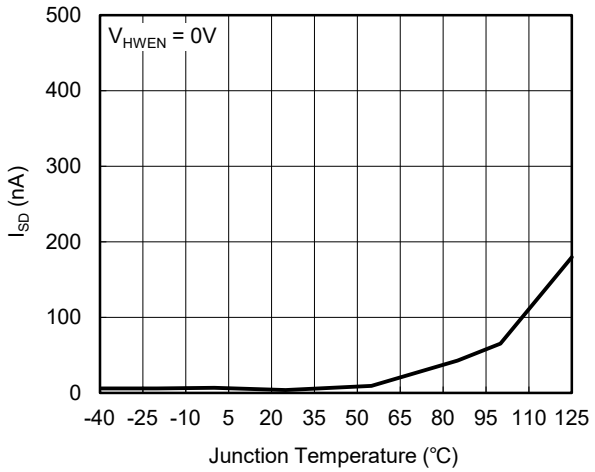
Quiescent Current vs. Junction Temperature



Standby Current vs. Junction Temperature



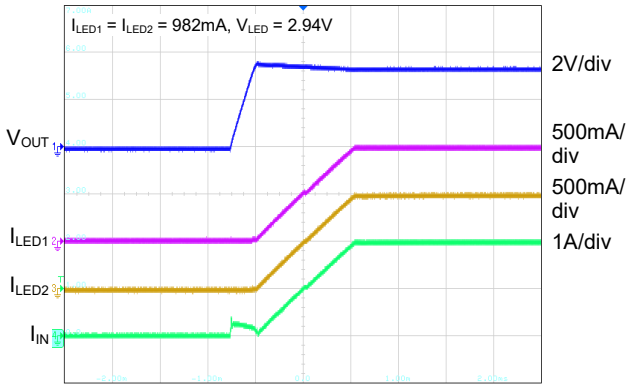
Shutdown Current vs. Junction Temperature



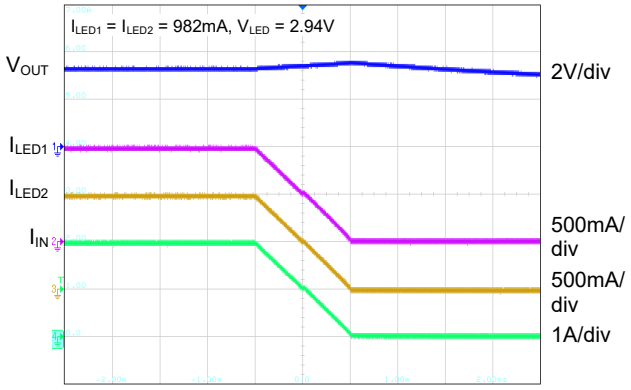
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_{IN} = 3.6V, HWEN = V_{IN}, L = 1μH, C_{IN} = C_{OUT} = 2 × 10μF, T_J = +25℃, unless otherwise noted.

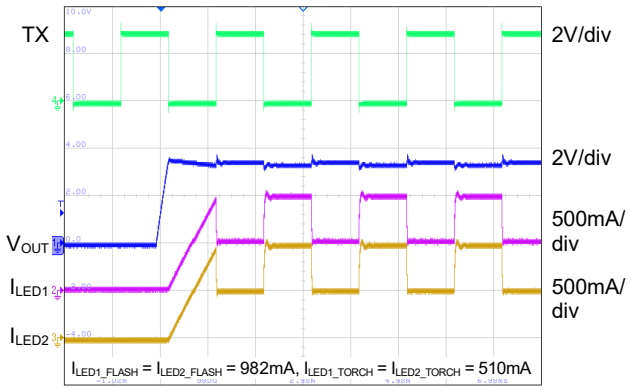
Startup



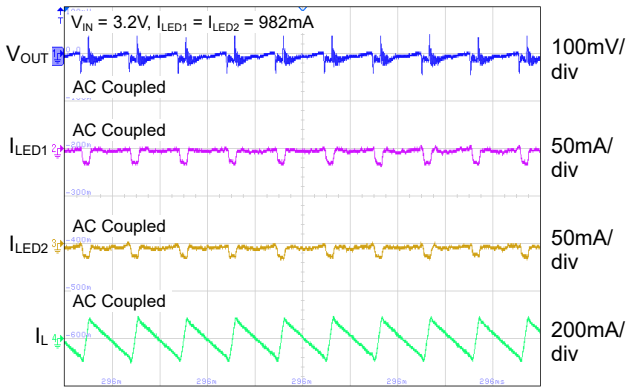
Ramp Down



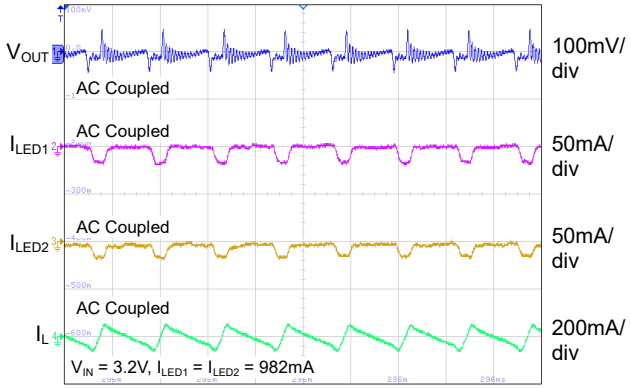
TX Interrupt



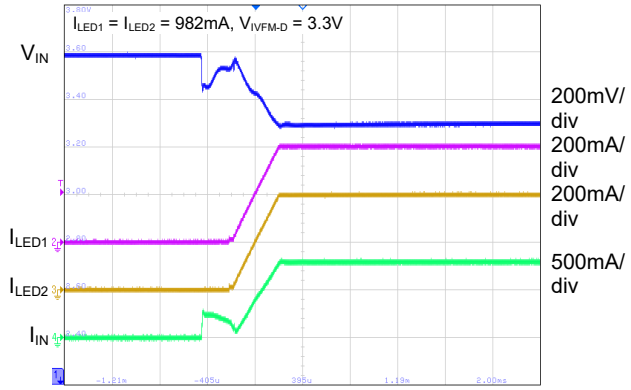
Ripple @ 2MHz



Ripple @ 4MHz



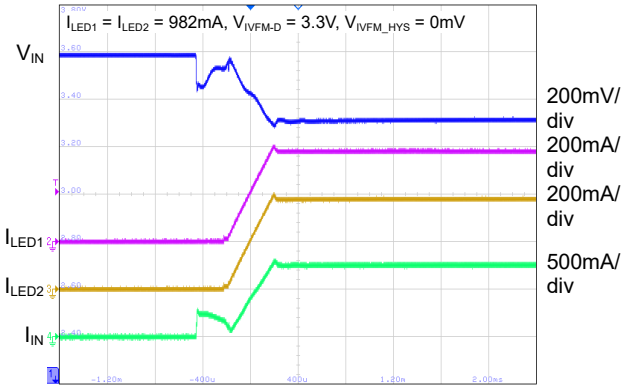
IVFM - Stop and Hold Mode



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

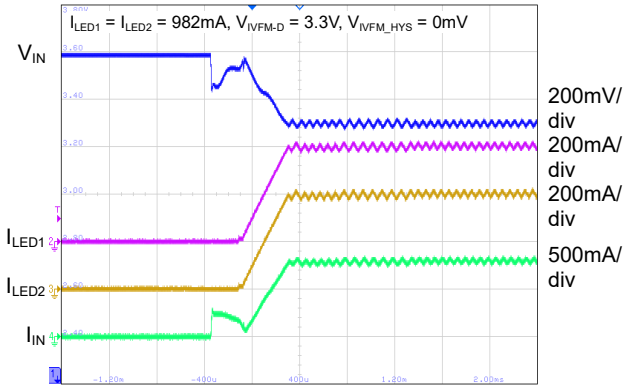
V_{IN} = 3.6V, HWEN = V_{IN}, L = 1μH, C_{IN} = C_{OUT} = 2 × 10μF, T_J = +25℃, unless otherwise noted.

IVFM - Down Mode



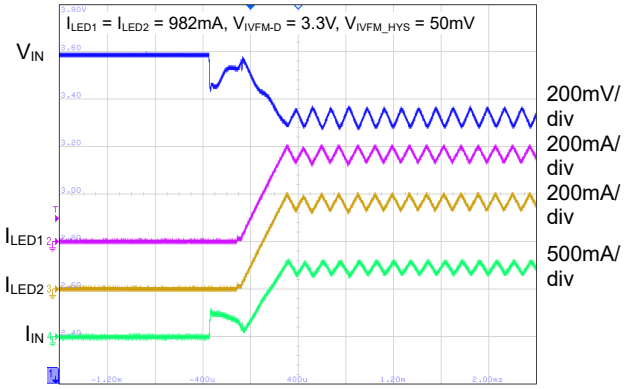
Time (400μs/div)

IVFM – Up and Down Mode



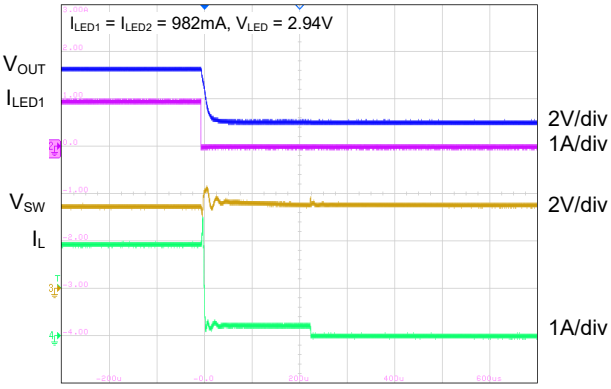
Time (400μs/div)

IVFM - Up and Down Mode



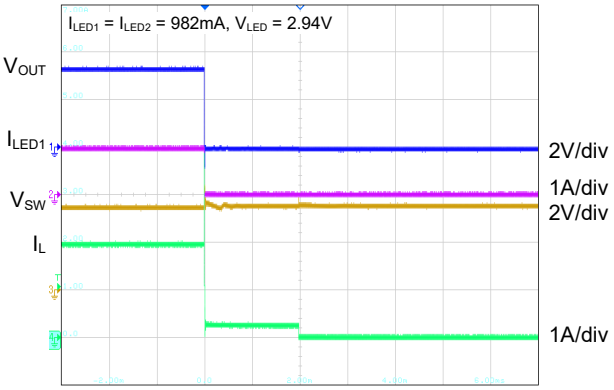
Time (400μs/div)

LED Short Protection



Time (100μs/div)

VOUT Short Protection



Time (1ms/div)

FUNCTIONAL BLOCK DIAGRAM

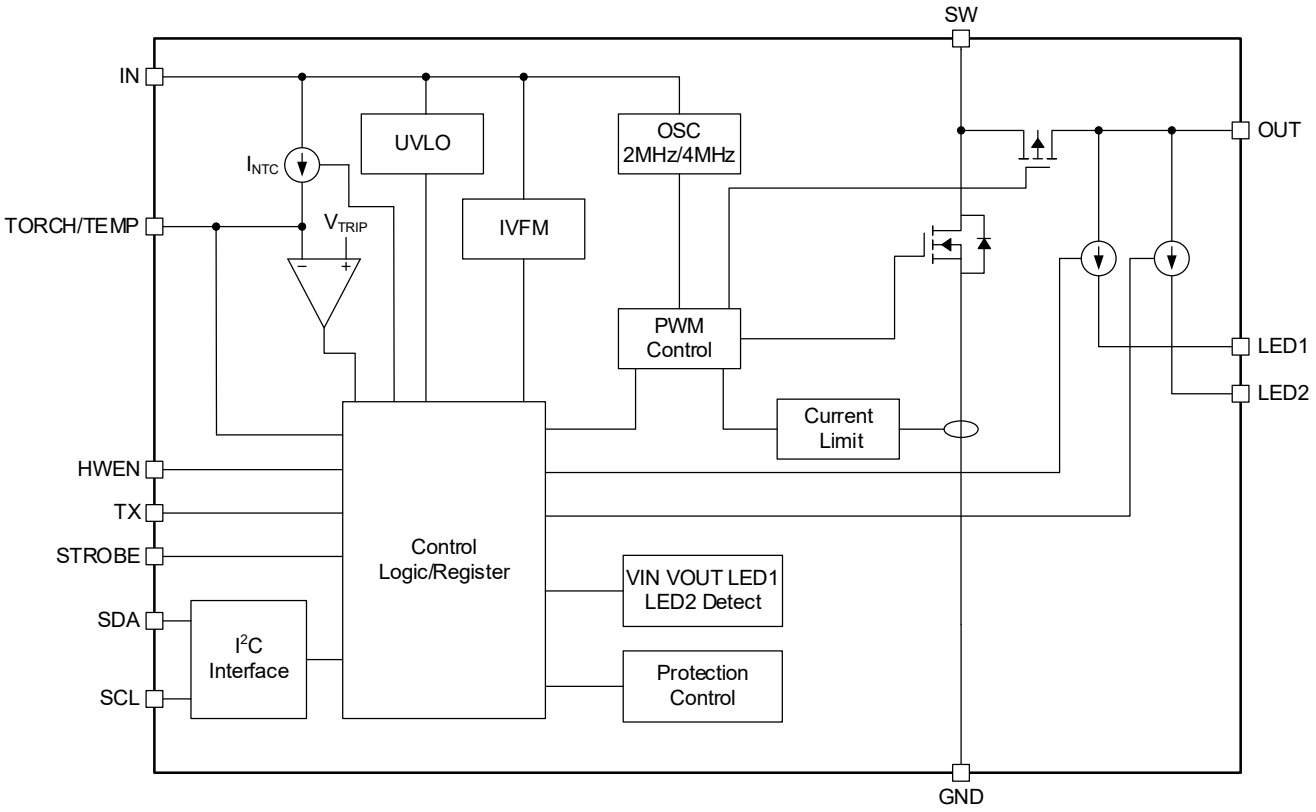


Figure 3. Functional Block Diagram

DETAILED DESCRIPTION

Overview

The SGM37864 is a high-performance LED flash driver designed for powering white LEDs with maximum current up to 2A per channel in parallel. The device features dual independent high-side current sources to regulate LED current over a wide input voltage range of 2.7V to 5.5V.

The SGM37864 employs a fixed 2MHz or 4MHz switching frequency synchronous Boost converter to automatically adjust the output voltage to maintain at least minimum headroom voltage V_{HR} across each of LED1 and LED2 current sources, with the headroom voltage being the difference between V_{OUT} and V_{LED}, ensuring that both current sources remain in regulation. If the input voltage V_{IN} exceeds V_{OUT} plus 300mV (TYP), the device enters a pass mode in which the PFET is turned on continuously, and the voltage difference between V_{OUT} (which equals to V_{IN} - I_{LED} × R_{PFET}) and V_{LED} is dropped across the current source.

The SGM37864 supports three external logic input pins for device control, including a hardware flash enable (STROBE), a hardware torch enable (TORCH/TEMP), and a flash interrupt input (TX). These pins are all equipped with internal 300kΩ pull-down resistors to GND. These pins are utilized to configuring operation modes (specified in Table 1). In addition, the device has an internal comparator that senses the temperature of the LED through an external NTC thermistor, as well as an input voltage flash monitor (IVFM) that reduces the flash current when the input voltage is low.

Control of the SGM37864 is performed through an I^2C-compatible interface. It enables adjustments to the current levels of the flash and torch, the duration of the flash timeout, and the current limit of the switch. The device also features fault registers with flag and status bits that can be read back to determine the cause of a fault condition. Fault conditions include flash timeout, output over-voltage, LED/V_{OUT} short circuit, thermal shutdown, under-voltage lockout, current limit, NTC temp trip, NTC short, NTC open, and IVFM triggered conditions.

The state of the SGM37864 device and its registers can be reset by pulling the hardware enable (HWEN) pin to ground. This allows the user to return the device to its default state and clear any previous configuration or faults.

Flash Mode

The flash mode in the SGM37864 can be activated either by setting the LED_MODE[1:0] bits to '11', or by pulling the STROBE pin high when the pin is enabled (STROBE_EN = 1). Once activated, the LED current source (LED1/2_EN = 1) ramps up in 128 steps to reach the programmed flash current. The ramp time is constant 1ms and cannot be configured in the flash mode.

The flash current for each LED can be programmed independently through the flash brightness level bits I_FLASH1/2[7:0]. The LED current sources provide 256 target levels ranging from 9.45mA to 2A.

When the flash timeout event occurs, the LED flash current ramps down to zero, and LED_MODE[1:0] bits are cleared. The flash timeout duration is determined by FLASH_TIMEOUT[3:0] bits and can be set from 40ms to 1600ms.

Torch Mode

The torch mode can be activated by setting the LED_MODE[1:0] bits to '10' or by pulling the TORCH/TEMP pin high when the pin is enabled (TORCH_TEMP_EN = 1). Torch mode also can be enabled by TORCH/TEMP pin pull-down and TORCH/TEMP pull-down resistor is disabled when TORCH_POL bit set to 1. Upon activation of the torch sequence, the active LED current sources will ramp up through 128 steps until the programmed Torch current is reached, at which point it will remain until the torch mode is exited.

The LED Torch brightness levels can be adjusted through I_TORCH1/2[7:0] bits ranging from 2.35mA to 510mA (ILED_TOR_SEL = 0) or 2mA to 360mA (ILED_TOR_SEL = 1). The time required for the torch current to ramp up to the target level is determined by TORCH_TIMER[2:0] bits and can range from no ramp time to 1024ms.

It is worth noting that the torch mode is not influenced by the flash timeout or a TX interrupt event.

DETAILED DESCRIPTION (continued)

IR Mode

The IR mode is activated by setting the LED_MODE[1:0] bits in the enable register to '01'. When this mode is activated, the PFET is turned on as a 200mA current source, and charges the output voltage until it reaches the input voltage (pass mode). In IR mode, the STROBE pin can only be set as Level sensitive, and the LED1/2 current sources are externally controlled by toggling the STROBE pin to high or low. In this mode, the LED1/2 current sources do not ramp but instead immediately shift between the target current and off, providing a fast on/off rate. The target current is determined by the value stored in the LED1/2 flash brightness registers, making it convenient to control the IR pulse timing by providing the STROBE signal. Note that IR mode would be exited if the flash timeout event occurs.

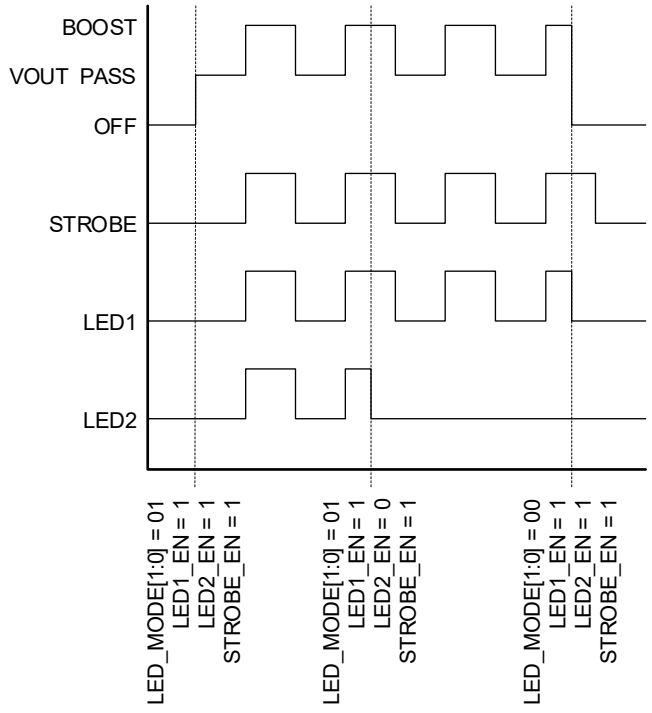


Figure 4. IR Mode with Boost

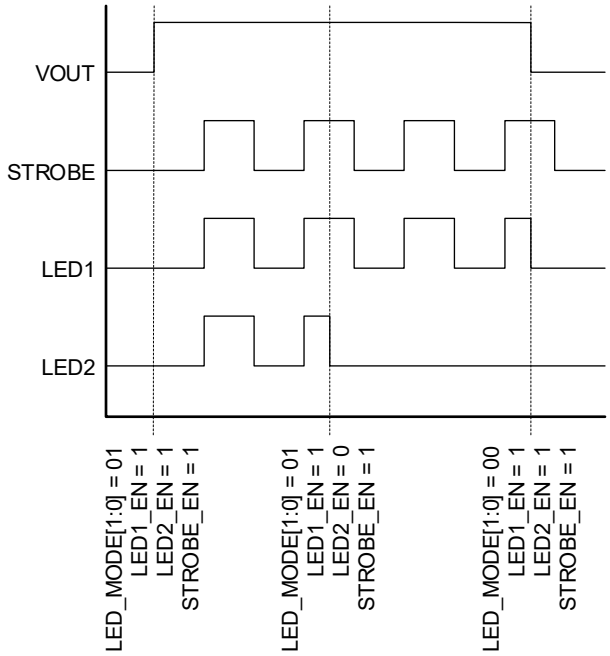


Figure 5. IR Mode Pass Only

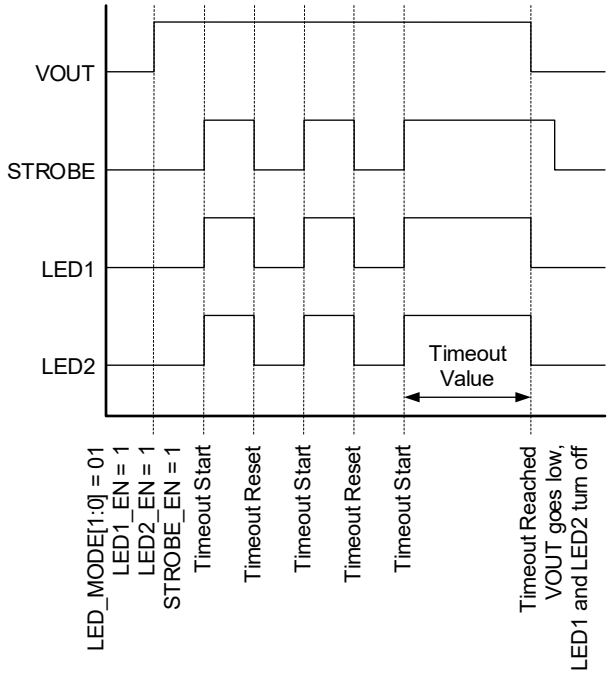


Figure 6. IR Mode Timeout

DETAILED DESCRIPTION (continued)

Hardware Enable (HWEN)

The hardware enable (HWEN) pin is a logic level input that serves as the global hardware enable/disable function for the SGM37864. This input must not be left floating, as it is a high-impedance input. When the HWEN pin is driven low, the device enters a low-power shutdown mode, in which the Boost converter and current sources are turned off and the registers are reset to their default state, while the I^2C bus remains inactive. Conversely, when the HWEN pin is pulled high, the device is enabled, allowing I^2C writes and reads to be performed.

Software Reset

The SGM37864 allows the software reset of the internal circuit and configuration registers by setting SOFT_RST bit to 1 through the I^2C interface. Once the soft reset command is received, the device must wait for a minimum of 2ms before accepting any other I^2C command.

Startup

The SGM37864 is equipped with two separate current sources (LED1 and LED2) that can be controlled individually via the enable register. At startup, the device uses the synchronous PFET as a 200mA current source to charge the output capacitor, ensuring a controlled startup process and limiting inrush current from the input voltage (V_{IN}). The LED current source remains off during this period and turns on once the output voltage (V_{OUT}) reaches 2.2V (TYP). When the V_{OUT} reaches the level of V_{IN}, the PFET switches to full conduction and the LED current source ramps up to the target current for flash or torch mode in 128 steps. The STROBE/TORCH pin and enable register can be used to enable and control the flash and torch mode.

Pass/Boost Mode

The SGM37864 operates in pass mode until boost mode is required based on the voltage difference between V_{OUT} and V_{LED}. In pass mode, the synchronous PFET is completely turned on, V_{OUT} is equal to V_{IN} - I_{LED} × R_{PFET}, and the inductor current is not restricted by the internal current limit. When the voltage difference between V_{OUT} and V_{LED} is less than V_{HR}, the Boost converter starts switching and automatically regulates V_{OUT} to maintain V_{HR} across the current source (LED1/2). If the input voltage V_{IN} exceeds V_{OUT} plus 300mV (TYP), the device enters a pass mode in which the PFET is turned on continuously.

Power Amplifier Synchronization (TX)

The SGM37864 has a feature that allows for the limitation of battery current during high current events such as PA transmissions by reducing the flash LED current. This is achieved through the use of the TX pin, which functions as a power amplifier synchronization input. When in flash mode and the TX pin is pulled high, the flash LED current immediately changes to the torch mode brightness setting that has been set. If the TX pin is then pulled low before flash mode expires, the LED current reverts to its prior flash brightness level. The TX pin can be disabled by setting the TX_EN bit in the enable register.

Input Voltage Flash Monitor (IVFM)

The input voltage flash monitor (IVFM) feature utilizes an internal comparator at the IN pin to monitor the input voltage level and adjust the flash current during startup process. The IVFM register programs the IVFM_VOL[2:0] threshold ranging from 2.9V to 3.6V in 100mV steps as well as adjustable hysteresis IVFM_HYS, and offers the option to select operation modes by IVFM_MODE[1:0] bits, including stop and hold mode, down mode, up and down mode, or disabling the IVFM feature. IVFM_TRIP_FLAG bit is set to 1 when the input voltage is across the IVFM threshold value. The IVFM_VOL[2:0] threshold serves as the input voltage boundary that determines the behavior of the SGM37864 in the different IVFM operating modes.

1. Stop and hold mode: the LED current will stop ramping up and hold the current level for the remaining duration of the flash pulse once the input voltage (V_{IN}) falls below the IVFM_VOL[2:0] threshold setting.

2. Down mode: if V_{IN} drops below the IVFM_VOL[2:0] threshold value, the LED current will decrease and hold until V_{IN} rises above the IVFM_VOL[2:0] threshold plus a hysteresis (set by IVFM_HYS bit). The SGM37864 will continuously adjust the current throughout the flash pulse anytime V_{IN} falls below the IVFM threshold.

3. Up and down mode: the LED current will continually adjust with the rising and falling of V_{IN} throughout the entire flash pulse. If V_{IN} drops below the IVFM threshold value, the current will decrease. If V_{IN} rises above the IVFM threshold plus a hysteresis, the current will increase.

DETAILED DESCRIPTION (continued)

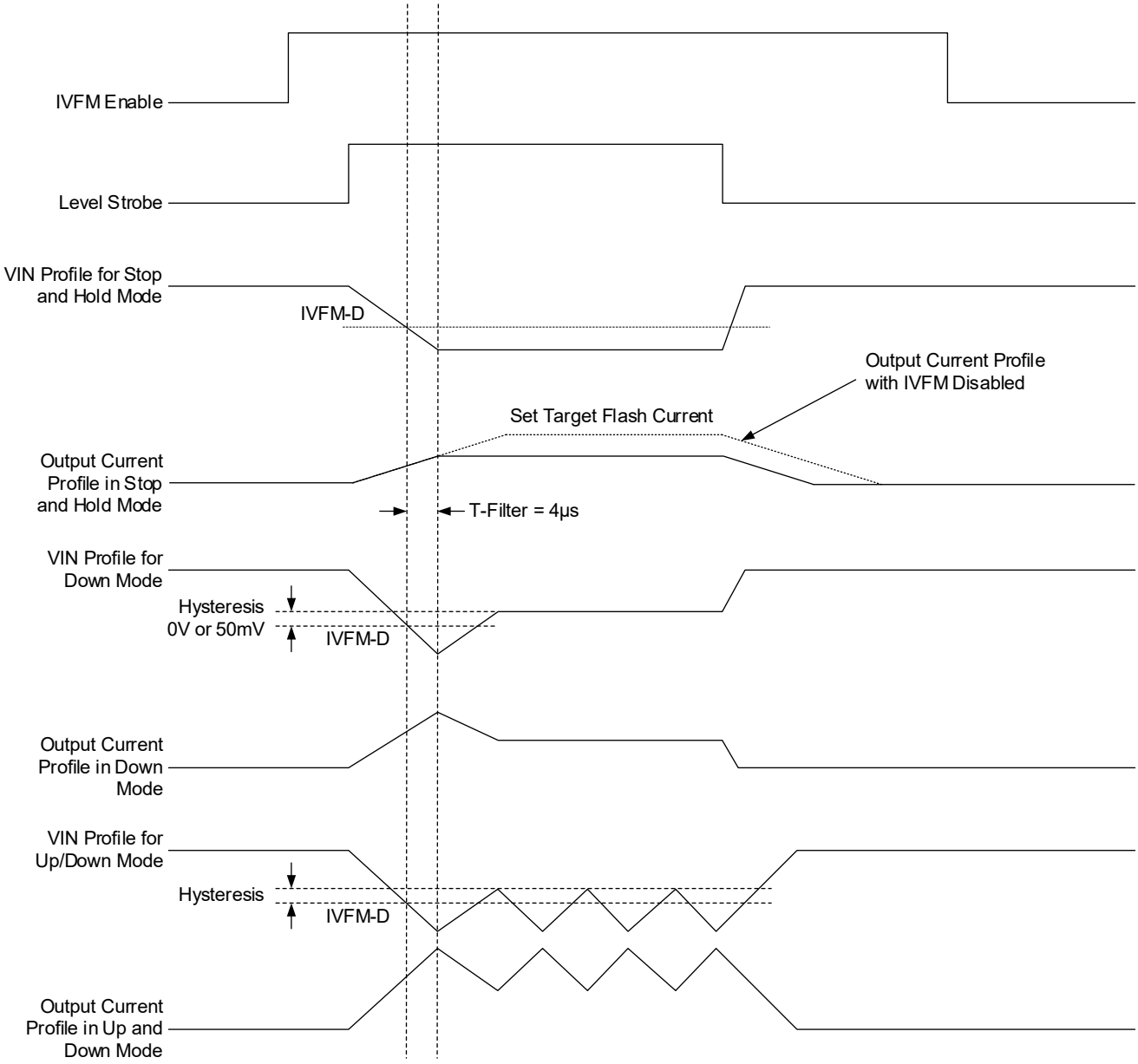


Figure 7. IVFM Modes

DETAILED DESCRIPTION (continued)

Protections in Fault Operation

The SGM37864 provides the fault flags that can be found in the flags1 and flags2 registers (REG0x0A and REG0x0B). In the event of a fault condition, the device sets the corresponding flag and clears the LED_MODE[1:0] bits, returning the device to standby mode. The device will remain in standby mode until an I^2C read of the flags1/2 register is performed. Reading a '1' in a flag event indicates that the event has occurred. A read of the flags register will reset these flag bits, and allow the device to enter different modes (flash, torch, or IR mode) again. If the fault is still present, the fault flag will be reported and the device will return back to standby mode again.

Under-Voltage Lockout (UVLO)

The SGM37864 integrates an under-voltage lockout (UVLO) circuit that prevents the device from operating until the input voltage reaches a sufficient level for normal operation. Once the input voltage falls below the threshold V_{UVLO} (2.56V, TYP), the device is forced into standby mode and UVLO_FLAG bit is set to '1'. To resume normal operation, the UVLO_FLAG bit must be cleared by reading the flags1 register when the input voltage rises above 2.56V. The UVLO function can be enabled or disabled by setting UVLO_EN bit. This feature is particularly useful in battery-powered applications to prevent operation when the battery voltage is too low.

NTC Thermistor Input (TORCH/TEMP)

The TORCH/TEMP pin can function as a bias source and threshold detector for negative temperature coefficient (NTC) thermistors when this pin is set to TEMP mode by writing the TORCH_TEMP_SEL bit to ‘1’. The SGM37864 enters standby mode and TEMP_TRIP_FLAG is set to '1' when the voltage at TEMP pin falls below the pre-programmed threshold. The threshold voltage TEMP_VDET[2:0] for the NTC is adjustable in steps of 100mV between 200mV and 900mV. The NTC bias current is 50μA, and the NTC detection circuitry can be enabled or disabled through the TORCH_TEMP_EN bit. During the beginning and end of a flash/torch event, the NTC block is turned on and off if enabled.

The NTC input also checks for open or shorted NTC connections. If the NTC input falls below 100mV, the device is disabled and the NTC_SHORT_FLAG is set. Conversely, if the NTC input exceeds 2.3V, the device is also disabled and the NTC_OPEN_FLAG is set. The fault detections can be independently enabled or disabled via the NTC_OPEN_EN bit and the NTC_SHORT_EN bit in TEMP register.

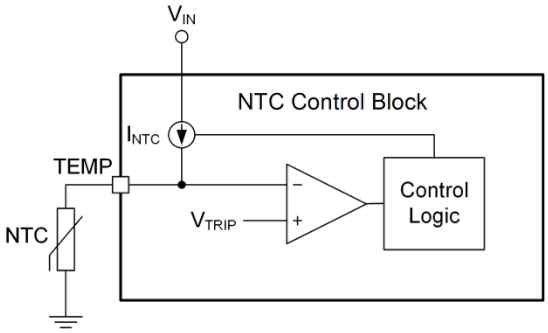


Figure 8. TEMP Detection

Flash Timeout

Flash Timeout feature of the SGM37864 sets the maximum duration time of the flash LED current pulse, whether a flash stop command is received or not. The timeout duration can be configured in 16 different levels ranging from 40ms to 1600ms using the FLASH_TIMEOUT[3:0] bits. Flash timeout applies to both flash and IR modes and continues to count even when the flash mode is temporarily changed to the torch mode during a high TX event. Upon a flash timeout event, the TIMEOUT_FLAG bit is set to 1 and can be cleared by reading back the flags1 register.

Over-Voltage Protection (OVP)

The SGM37864 features an over-voltage protection mechanism, where the output voltage is monitored to ensure it stays within safe operating limits. The typical over-voltage threshold is set at 5.2V. In the event that the output voltage exceeds this threshold, such as in an LED open condition, the device stop switching until the V_{OUT} falls below V_{OVP_OFF}. If three rising OVP edges are detected within 32ms (TYP), the device enters standby mode, clearing LED_MODE[1:0] bits in the enable register and setting the OVP_FLAG bit. This protects the device from shutdown due to momentary OVP events. The OVP_FLAG bit can be reset by removing the fault condition and reading back the flags2 register.

DETAILED DESCRIPTION (continued)

Thermal Shutdown (TSD)

If the junction temperature (T_J) exceeds +150℃, the SGM37864 enters standby mode, and the TSD protection circuit prevents the device from overheating. TSD_FLAG bit in flags1 register is set to '1'. The SGM37864 will not restart until the host reads the flags1 register and the fault flag is cleared. After restarting, TSD_FLAG bit is reset to '1' and the SGM37864 enters standby mode again when T_J still exceeds +150℃.

Current Limit

The SGM37864 integrates a selectable inductor current limit options, 3.2A or 3.9A, which can be programmed by BOOST_ILIM bit in the Boost configuration register. If the inductor current exceeds the specified limit, the device will stop the charging phase of its switching cycle until the next cycle starts. If the over-current situation persists, the SGM37864 will continuously operate in the current limit state. ILIM_FLAG bit will be set in the event of a current limit occurrence, which can be reset by reading back the flags1 register, but the mode bits will not be cleared.

When the device operates in pass mode, there is no way to restrict the current because it does not pass through the NFET switch.

VOUT Short Fault

If the output voltage falls below 2.1V (TYP) in Boost mode or pass mode, the device will stop switching and the PFET will function as a current source, limiting the current to 200mA to charge the output capacitor. After a 2ms (TYP) deglitch time, the device enters standby mode and the VOUT_SHORT_FLAG bit is set to '1'. In order to resume normal operation, an I^2C reading of flags1 register is necessary. This function is helpful to prevent damage to the device and excessive battery drain in the event of an output short circuit.

LED Short Fault

In the event of a short condition on the active LED output, the SGM37864 will enter standby mode, with the LED_MODE[1:0] bits cleared and the appropriate VLED1/2_SHORT_FLAG bit of flags1 Register set. If the LED voltage falls below 500mV (TYP) in Boost mode or Pass mode, the device will stop switching and the PFET will function as a current source, limiting the current to 200mA to charge the output capacitor. After a 256μs (TYP) deglitch time, the device enters standby mode and the VLED1/2_SHORT_FLAG bit is set to '1'. In order to resume normal operation, an I^2C reading of flags1 register is necessary. The LED short fault detect can be disabled by configuring LED_SHORT_DET bit.

DETAILED DESCRIPTION (continued)

Control Truth Table

Table 1. Control Logic Table

LED_MODE[1:0] (REG0x01[3:2])	STROBE EN (REG0x01[5])	TORCH EN (REG0x01[4])	STROBE Pin	TORCH Pin	State	Note
00 (Standby)	0	0	X	X	Standby	
	0	1	X	Active	External Torch	TORCH pin can be set to active high or active low by TORCH_POL bit. LED is on during TORCH pin is active.
	1	1	Inactive	Active	External Torch	
	1	0	Active	X	External Flash	STROBE pin can be set to level triggered or edge triggered by STROBE_TYPE bit. 1) Level trigger: If STROBE on-time < timeout, the LED on/off is controlled by STROBE pin. If the STROBE on-time > timeout, LED is off when timeout occurs and LED is on when STROBE pin changes to high again. 2) Edge trigger: LED is on when STROBE rising edge comes, and LED is off when flash timeout occurs. The rising edge before flash timeout will be ignored.
	1	1	Active	Inactive	External Flash	
	1	1	Active	Active	External Flash	Flash mode has higher priority.
01 (IR)	0	X	X	X	IR LED Standby	The IR mode cannot be controlled by TORCH pin. When STROBE pin is inactive, the IC is in IR LED standby mode (VOUT ready, I_{LED} = 0).
	1	X	Inactive	X	IR LED Standby	
	1	X	Active	X	IR LED Enabled	The STROBE pin can only be set to level triggered when it is used to control LED on/off in IR mode. If STROBE on-time < timeout, the LED on/off is controlled by STROBE pin. If the STROBE on-time > timeout, LED is off when timeout occurs and IC returns to standby mode (REG0x01[3:2] back to 00).
10 (Torch)	X	X	X	X	Internal Torch	The torch or flash mode setting by register has the highest priority, regardless of the external STROBE pin or TORCH pin status.
11 (Flash)	X	X	X	X	Internal Flash	

I²C Serial Interface and Data Communication

The SGM37864 operates as a slave device with address 0x63 (63H). It has thirteen 8-bit registers, numbered from REG0x01 to REG0x0D.

START and STOP Conditions

A transaction is started by taking control of the bus by master if the bus is free. The transaction is terminated by releasing the bus when the data transfer job is done as shown in Figure 9. All transactions begin by the master that applies a START condition on the bus lines to take over the bus and exchange data. At the end, the master terminates the transaction by applying one (or more) STOP condition. START condition is when SCL is high and a high to low transition on the SDA is generated by master. Similarly, a STOP is defined when SCL is high and SDA goes from low to high. START and STOP are always generated by a master. After a START and before a STOP the bus is considered busy.

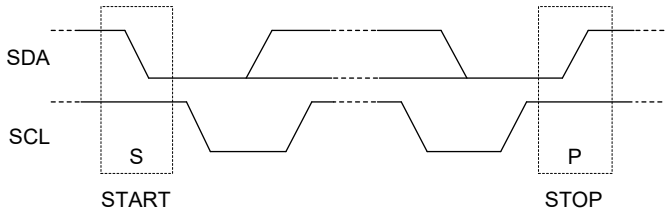


Figure 9. I²C Bus in START and STOP Conditions

Data Bit Transmission and Validity

The data bit (high or low) must remain stable on the SDA line during the HIGH period of the clock. The state of the SDA can only change when the clock (SCL) is LOW.

DETAILED DESCRIPTION (continued)

To meet the V_{OL} requirement on SDA, the pull-up resistor between the VIO line and SDA on the controller must be greater than [(V_{IO} - V_{OL}) / 3mA]. Slower edges result from using a larger pull-up resistor due to lower switching current while faster edges result from using a smaller pull-up resistor due to higher switching currents.

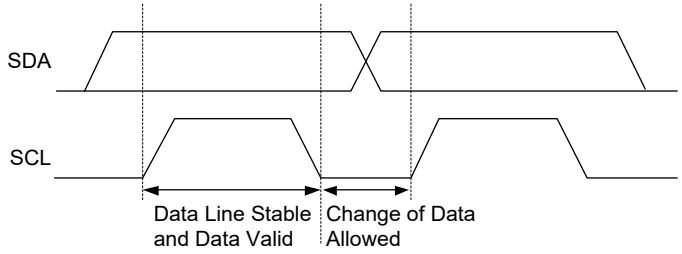


Figure 10. I²C Bus Bit Transfer

Transferring Data and Addressing Slaves

Data is transmitted in 8-bit packets (one byte at a time). In each packet the 8 bits are sent successively with the Most Significant Bit (MSB) first. After transmission of each byte by transmitter, an acknowledge bit (ACK) is replied by the receiver as a ninth bit. This bit informs the transmitter whether the receiver is ready to proceed for the next byte or not. Clock (SCL) is always generated by the master, including for the acknowledge clock pulse. SDA line is released for receiver control during the acknowledge clock pulse and the receiver can pull the SDA line low as ACK (reply a 0 bit) or let it be high as NCK during the SCL high pulse.

The first byte sent by master after the START is always the target slave address (7 bits) and an eighth data-direction bit (R/W). R/W bit is 0 for a WRITE transaction and 1 for READ (when master is asking for data). Data direction is the same for all next bytes of the transaction. To reverse it, a new START or repeated START condition must be sent by master (STOP will end the transaction). Usually the second byte is a WRITE sending the register address that is supposed to be accesses in the next byte. The third byte is a data byte that is written to the register addressed in the second byte. A Write transaction is shown in Figure 11.

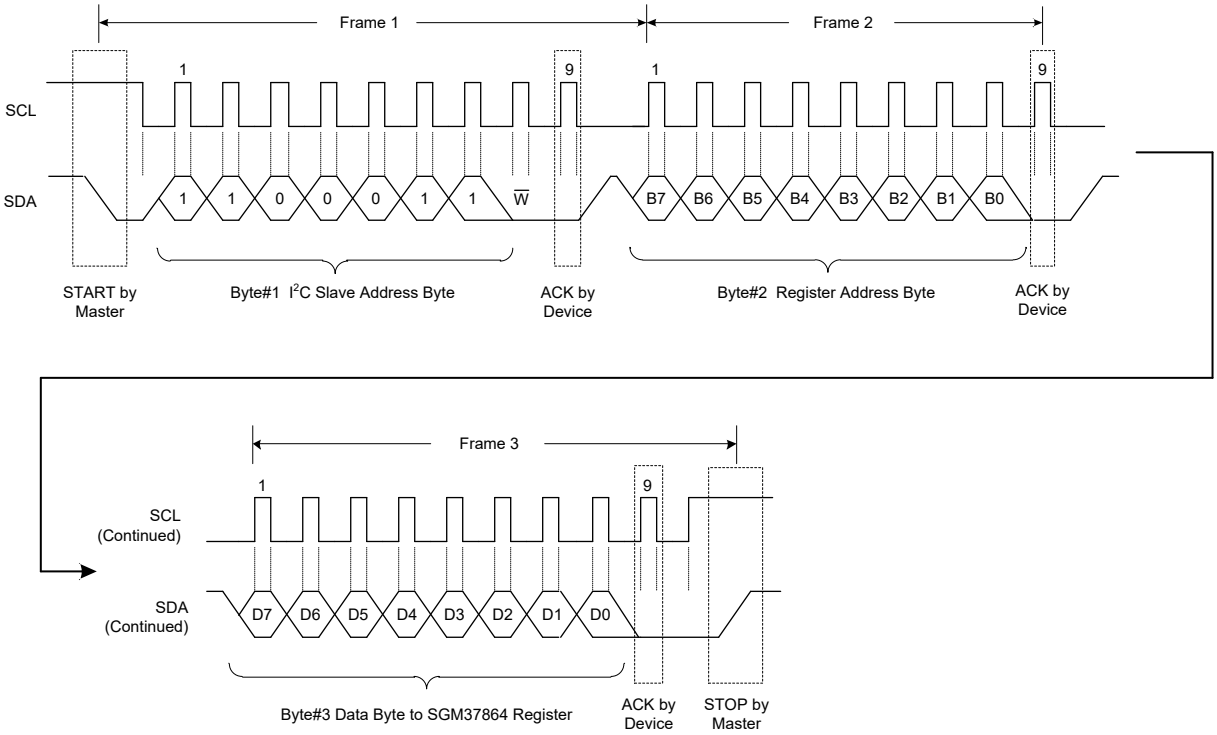


Figure 11. A Write Transaction

REGISTER MAPS

The 7-bit device address for the SGM37864 is 1100011 (0x63).
All registers are 8-bit and individual bits are named from D[0] (LSB) to D[7] (MSB).

Bit Types:
R: Read only.
R/W: Read/Write.
R/WC: Read/Write. Writing a '1' clears the bit. Writing a '0' has no effect.

I²C Register Address Map

REGISTER NAME	ADDRESS	DEFAULT	BIT NAME							
			D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
Enable Register	0x01	0x80	TX_EN	STROBE_TYPE	STROBE_EN	TORCH_TEMP_EN	LED_MODE[1:0]		LED2_EN	LED1_EN
IVFM Register	0x02	0x01	ILED_TOR_SEL	UVLO_EN	IVFM_VOL[2:0]			IVFM_HYS	IVFM_MODE[1:0]	
LED1 Flash Brightness Register	0x03	0x7F	I_FLASH1[7:0]							
LED2 Flash Brightness Register	0x04	0x7F	I_FLASH2[7:0]							
LED1 Torch Brightness Register	0x05	0x7F	I_TORCH1[7:0]							
LED2 Torch Brightness Register	0x06	0x7F	I_TORCH2[7:0]							
Boost Configuration Register	0x07	0x09	SOFT_RST	Reserved			LED_SHORT_DET	BOOST_MODE	BOOST_FREQ	BOOST_ILIM
Timing Configuration Register	0x08	0x1A	Reserved	TORCH_TIMER[2:0]			FLASH_TIMEOUT[3:0]			
TEMP Register	0x09	0x08	Reserved	TORCH_POL	NTC_OPEN_EN	NTC_SHORT_EN	TEMP_VDET[2:0]			TORCH_TEMP_SEL
Flags1 Register	0x0A	0x00	TX_FLAG	VOUT_SHORT_FLAG	VLED1_SHORT_FLAG	VLED2_SHORT_FLAG	ILIM_FLAG	TSD_FLAG	UVLO_FLAG	TIMEOUT_FLAG
Flags2 Register	0x0B	0x00	Reserved			NTC_SHORT_FLAG	NTC_OPEN_FLAG	IVFM_TRIP_FLAG	OVP_FLAG	TEMP_TRIP_FLAG
Device ID Register	0x0C	0x11	Reserved		DEVICE_ID[2:0]			DEVICE_REV[2:0]		
Last Flash Register	0x0D	0x00	I_LAST_IVFM[7:0]							

REGISTER MAPS (continued)

REG0x01: Enable Register [Reset = 0x80]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	TX_EN	1	R/W	TX Pin Enable 0 = Disabled 1 = Enabled (default)	HWEN Reset or SOFT_RST
D[6]	STROBE_TYPE	0	R/W	STROBE Pin Triggered Type 0 = Level triggered (default) 1 = Edge triggered NOTES: 1. The Edge triggered type is invalid in IR mode. 2. It is not advisable to switch between level and edge triggered types while the device is enabled. 3. For proper device turn-on in edge or level triggered types, it is recommended to set the trigger pulse width to more than 1ms.	
D[5]	STROBE_EN	0	R/W	STROBE Pin Enable 0 = Disabled (default) 1 = Enabled	
D[4]	TORCH_TEMP_EN	0	R/W	TORCH/TEMP Pin Enable 0 = Disabled (Default) 1 = Enabled	
D[3:2]	LED_MODE[1:0]	00	R/W	Mode Bits: M1, M0 00 = Standby mode (default) 01 = IR mode 10 = Torch mode 11 = Flash mode	
D[1]	LED2_EN	0	R/W	LED2 Current Source Enable 0 = OFF (default) 1 = ON	
D[0]	LED1_EN	0	R/W	LED1 Current Source Enable 0 = OFF (default) 1 = ON	

REG0x02: IVFM Register [Reset = 0x01]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	ILED_TOR_SEL	0	R/W	LED Torch Current Range Selection 0 = 2.35mA to 510mA (default) 1 = 2mA to 360mA	HWEN Reset or SOFT_RST
D[6]	UVLO_EN	0	R/W	UVLO Circuitry Enable 0 = Disabled (default) 1 = Enabled	
D[5:3]	IVFM_VOL[2:0]	000	R/W	IVFM Levels 000 = 2.9V (default) 001 = 3.0V 010 = 3.1V 011 = 3.2V 100 = 3.3V 101 = 3.4V 110 = 3.5V 111 = 3.6V	
D[2]	IVFM_HYS	0	R/W	IVFM Hysteresis 0 = 0mV (default) 1 = 50mV	
D[1:0]	IVFM_MODE[1:0]	01	R/W	IVFM Mode Selection 00 = Disabled 01 = Stop and Hold Mode (default) 10 = Down Mode 11 = Up and Down Mode NOTE: Once the device is enabled in torch, flash or IR mode, the IVFM_MODE[1:0] bits remain unchanged. To update the IVFM mode, first disable the device and then adjust the IVFM_MODE[1:0] bits to the desired state.	

REGISTER MAPS (continued)

REG0x03: LED1 Flash Brightness Register [Reset = 0x7F]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7:0]	I_FLASH1[7:0]	01111111	R/W	LED1 Flash Brightness Level I_{FLASH1} (mA) ≈ (I_FLASH1[7:0] × 8.04mA) + 9.45mA where I_FLASH1[7:0] (Dec) = 0 ~ 30. I_{FLASH1} (mA) ≈ (I_FLASH1[7:0] × 7.51mA) + 28.34mA where I_FLASH1[7:0] (Dec) = 31 ~ 255.	HWEN Reset or SOFT_RST

REG0x04: LED2 Flash Brightness Register [Reset = 0x7F]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7:0]	I_FLASH2[7:0]	01111111	R/W	LED2 Flash Brightness Level I_{FLASH2} (mA) ≈ (I_FLASH2[7:0] × 8.04mA) + 9.45mA where I_FLASH2[7:0] (Dec) = 0 ~ 30. I_{FLASH2} (mA) ≈ (I_FLASH2[7:0] × 7.51mA) + 28.34mA where I_FLASH2[7:0] (Dec) = 31 ~ 255.	HWEN Reset or SOFT_RST

REG0x05: LED1 Torch Brightness Register [Reset = 0x7F]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7:0]	I_TORCH1[7:0]	01111111	R/W	LED1 Torch Brightness Level When ILED_TOR_SEL = 0, I_{TORCH1} (mA) ≈ (I_TORCH1[7:0] × 2.11mA) + 2.35mA where I_TORCH1[7:0] (Dec) = 0 ~ 30. I_{TORCH1} (mA) ≈ (I_TORCH1[7:0] × 1.97mA) + 7.33mA where I_TORCH1[7:0] (Dec) = 31 ~ 255. When ILED_TOR_SEL = 1, I_{TORCH1} (mA) ≈ (I_TORCH1[7:0] × 1.5mA) + 2mA where I_TORCH1[7:0] (Dec) = 0 ~ 30. I_{TORCH1} (mA) ≈ (I_TORCH1[7:0] × 1.4mA) + 5.7mA where I_TORCH1[7:0] (Dec) = 31 ~ 255.	HWEN Reset or SOFT_RST

REG0x06: LED2 Torch Brightness Register [Reset = 0x7F]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7:0]	I_TORCH2[7:0]	01111111	R/W	LED2 Torch Brightness Level When ILED_TOR_SEL = 0, I_{TORCH2} (mA) ≈ (I_TORCH2[7:0] × 2.11mA) + 2.35mA where I_TORCH2[7:0] (Dec) = 0 ~ 30. I_{TORCH2} (mA) ≈ (I_TORCH2[7:0] × 1.97mA) + 7.33mA where I_TORCH2[7:0] (Dec) = 31 ~ 255. When ILED_TOR_SEL = 1, I_{TORCH2} (mA) ≈ (I_TORCH2[7:0] × 1.5mA) + 2mA where I_TORCH2[7:0] (Dec) = 0 ~ 30. I_{TORCH2} (mA) ≈ (I_TORCH2[7:0] × 1.4mA) + 5.7mA where I_TORCH2[7:0] (Dec) = 31 ~ 255.	HWEN Reset or SOFT_RST

REGISTER MAPS (continued)

REG0x07: Boost Configuration Register [Reset = 0x09]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	SOFT_RST	0	R/WC	Software Reset Bit 0 = Not reset (default) 1 = Reset	HWEN Reset or SOFT_RST
D[6:4]	Reserved	000	R	Reserved	N/A
D[3]	LED_SHORT_DET	1	R/W	LED Pin Short Fault Detect 0 = Disabled 1 = Enabled (default)	HWEN Reset or SOFT_RST
D[2]	BOOST_MODE	0	R/W	Boost Mode 0 = Normal (default) 1 = Pass mode only	
D[1]	BOOST_FREQ	0	R/W	Boost Frequency Select 0 = 2MHz (default) 1 = 4MHz	
D[0]	BOOST_ILIM	1	R/W	Boost Current Limit Setting 0 = 3.2A 1 = 3.9A (default)	

REG0x08: Timing Configuration Register [Reset = 0x1A]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	Reserved	0	R	Reserved	N/A
D[6:4]	TORCH_TIMER[2:0]	001	R/W	Torch Current Ramp Time 000 = No ramp 001 = 1ms (default) 010 = 32ms 011 = 64ms 100 = 128ms 101 = 256ms 110 = 512ms 111 = 1024ms	HWEN Reset or SOFT_RST
D[3:0]	FLASH_TIMEOUT[3:0]	1010	R/W	Flash Timeout Duration 0000 = 40ms 0001 = 80ms 0010 = 120ms 0011 = 160ms 0100 = 200ms 0101 = 240ms 0110 = 280ms 0111 = 320ms 1000 = 360ms 1001 = 400ms 1010 = 600ms (default) 1011 = 800ms 1100 = 1000ms 1101 = 1200ms 1110 = 1400ms 1111 = 1600ms NOTE: When using timeout values exceeding 400ms, thermal management must be carefully considered. The internal thermal shutdown circuit may trip before reaching the desired flash timeout value depending on factors such as PCB layout, input voltage and output current.	

REGISTER MAPS (continued)

REG0x09: TEMP Register [Reset = 0x08]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	Reserved	0	R	Reserved	N/A
D[6]	TORCH_POL	0	R/W	TORCH Polarity 0 = Active high (default) (pull-down resistor enabled) 1 = Active low (pull-down resistor disabled) NOTE: Once the device is enabled in torch, flash or IR mode, the TORCH_POL bit remains unchanged. To update the TORCH_POL bit, first disable the device and then adjust the TORCH_POL bit to the desired state.	HWEN Reset or SOFT_RST
D[5]	NTC_OPEN_EN	0	R/W	NTC Open Fault Enable 0 = Disabled (default) 1 = Enabled	
D[4]	NTC_SHORT_EN	0	R/W	NTC Short Fault Enable 0 = Disabled (default) 1 = Enabled	
D[3:1]	TEMP_VDET[2:0]	100	R/W	TEMP Detect Voltage Threshold 000 = 0.2V 001 = 0.3V 010 = 0.4V 011 = 0.5V 100 = 0.6V (default) 101 = 0.7V 110 = 0.8V 111 = 0.9V	
D[0]	TORCH_TEMP_SEL	0	R/W	TORCH/TEMP Pin Function Select 0 = TORCH (default) 1 = TEMP	

REG0x0A: Flags1 Register [Reset = 0x00]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	TX_FLAG	0	RC	TX Interrupt Flag 0 = No TX interrupt (default) 1 = TX interrupt detected	HWEN Reset or SOFT_RST
D[6]	VOUT_SHORT_FLAG	0	RC	VOUT Short Fault Flag 0 = Normal (default) 1 = VOUT short fault detected	
D[5]	VLED1_SHORT_FLAG	0	RC	VLED1 Short Fault Flag 0 = Normal (default) 1 = VLED1 short fault detected	
D[4]	VLED2_SHORT_FLAG	0	RC	VLED2 Short Fault Flag 0 = Normal (default) 1 = VLED2 short fault detected	
D[3]	ILIM_FLAG	0	RC	Current Limit Flag 0 = Current limit not triggered (default) 1 = Current limit triggered	
D[2]	TSD_FLAG	0	RC	Thermal Shutdown (TSD) Fault Flag 0 = Normal (default) 1 = Thermal shutdown triggered	
D[1]	UVLO_FLAG	0	RC	UVLO Fault Flag 0 = Normal (default) 1 = UVLO detected	
D[0]	TIMEOUT_FLAG	0	RC	Flash Timeout Flag 0 = Normal (default) 1 = Flash Timeout expired	

REGISTER MAPS (continued)

REG0x0B: Flags2 Register [Reset = 0x00]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7:5]	Reserved	000	R	Reserved	N/A
D[4]	NTC_SHORT_FLAG	0	RC	NTC Short Fault Flag 0 = Normal (default) 1 = NTC short fault detected	HWEN Reset or SOFT_RST
D[3]	NTC_OPEN_FLAG	0	RC	NTC Open Fault Flag 0 = Normal (default) 1 = NTC open fault detected	
D[2]	IVFM_TRIP_FLAG	0	RC	IVFM Trip Flag 0 = Normal (default) 1 = IVFM triggered	
D[1]	OVP_FLAG	0	RC	OVP Fault Flag 0 = Normal (default) 1 = OVP detected	
D[0]	TEMP_TRIP_FLAG	0	RC	TEMP Trip Flag 0 = Normal (default) 1 = TEMP detect voltage threshold triggered	

REG0x0C: Device ID Register [Reset = 0x11]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7:6]	Reserved	00	R	Reserved	N/A
D[5:3]	DEVICE_ID[2:0]	010	R	Device ID 010 = SGM37864	HWEN Reset or SOFT_RST
D[2:0]	DEVICE_REV[2:0]	001	R	Device Revision	

REG0x0D: Last Flash Register [Reset = 0x00]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7:0]	I_LAST_IVFM[7:0]	00000000	R	The stored value always reflects the most recent current value set by the IVFM detection block. $I_{LED} = I_{FLASH\_TARGET} \times ((I\_LAST\_IVFM[7:0] + 1) / 128)$	HWEN Reset or SOFT_RST

APPLICATION INFORMATION

Input Capacitor Selection

To minimize voltage ripple and reduce noise on the Boost converter input pin that can affect internal analog signals, it is crucial to choose the correct size and type of input capacitor for the SGM37864. A 10μF/10V ceramic input capacitor is recommended for the typical application circuit. Placing the input capacitor as close as possible to the SGM37864 input (IN) pin is essential to minimize series resistance and inductance, which can introduce noise into the device due to input switching currents.

Output Capacitor Selection

The SGM37864 Boost converter is optimized to operate with a 10μF/10V ceramic output capacitor. This capacitor serves as the primary power source for the load during the on-time of the Boost converter. When the NFET switch is turned off, the energy stored in the inductor is released via an internal PFET switch. This results in the output capacitor's charge being restored and power being supplied to the load. During this process, the output voltage experiences a temporary drop during on-time and a rise during off-time, and causes an output ripple. The capacitor is selected to ensure the output ripple is maintained within acceptable levels, taking into account load current, input/output voltage differentials, and converter stability. To achieve a lower output voltage ripple, larger capacitors such as 22μF or capacitors in parallel can be utilized.

Two equations are utilized to estimate the output voltage ripple: one calculates the ripple due to capacitor discharge (ΔV_Q) and the other calculates the ripple due to the capacitor's equivalent series resistance (ΔV_{ESR}). In continuous conduction mode, the output voltage ripple due to capacitor discharge is calculated by:

$$\Delta V_Q = \frac{I_{LED} \times (V_{OUT} - V_{IN})}{V_{OUT} \times f_{sw} \times C_{OUT}} \quad (1)$$

The output voltage ripple due to the output capacitors ESR can be calculated by:

$$\Delta V_{ESR} = R_{ESR} \times (\frac{I_{LED} \times V_{OUT}}{V_{IN}} + \Delta I_L) \quad (2)$$

where

$$\Delta I_L = \frac{V_{IN} \times (V_{OUT} - V_{IN})}{2 \times f_{sw} \times L \times V_{OUT}}$$

For the best performance, low ESR ceramic capacitors are recommended.

Inductor Selection

To minimize efficiency losses in the SGM37864 Boost converter circuit, it is important to choose an inductor with low series resistance and a saturation rating greater than the maximum peak current of the device. The SGM37864 is designed to use a 0.47μH or 1μH inductor. The inductor saturation and peak current limit should be greater than I_{PEAK} for proper circuit performance, where I_{PEAK} is calculated using the equation given below:

$$I_{PEAK} = \frac{I_{LED} \times V_{OUT}}{\eta \times V_{IN}} + \Delta I_L \quad (3)$$

where

$$\Delta I_L = \frac{V_{IN} \times (V_{OUT} - V_{IN})}{2 \times f_{sw} \times L \times V_{OUT}}$$

where f_{SW} is either 2MHz or 4MHz.

APPLICATION INFORMATION (continued)

Layout Considerations

Proper layout is crucial for maintaining stability and LED current regulation across the intended voltage and current range of the SGM37864 due to its high switching frequency and large switching currents. To ensure optimal performance, the following layout guidelines should be followed:

1. The input capacitor C_{IN}, should be placed as close as possible to the device on the same layer as the SGM37864. C_{IN} should be connected to both the IN and GND pins through short, wide traces to minimize inductive voltage spikes during switching and to detect current spikes above 1A in amplitude.

2. The output capacitor C_{OUT}, should also be placed on the top layer close to the OUT and GND pins. A single point near the GND pin is where both C_{IN} and C_{OUT} returns should converge. The use of short and wide traces for C_{OUT} reduces the series inductance on the OUT and GND pins, minimizing excessive noise in the device and surrounding circuitry.

3. The inductor should be connected to the SW pin on the top layer with a low-impedance connection due to the large DC inductor current. To reduce the capacitive coupling of the high dV/dt present at SW that can interfere with nearby traces, the SW node should occupy a small area.

4. To prevent capacitive coupling from SW node onto high-impedance logic lines such as TORCH/TEMP, STROBE, HWEN, SDA and SCL, it is important to avoid routing logic traces near the SW node. An inner layer GND plane can be used as a shield from the electric field generated at SW node by placing it underneath the SW node and between any nearby routed traces.

5. It is important to establish a direct connection between the GND pin and the flash LED cathodes. When the flash LEDs are routed at a distance from the SGM37864, the inductance of the LED current paths can be reduced by sandwiching the forward and return current paths on two layers over each other. To prevent high amplitude LED currents from entering the GND plane, it is recommended to use a dedicated path for routing the LED returns if possible.

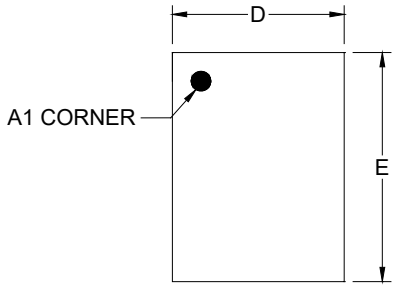
REVISION HISTORY

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

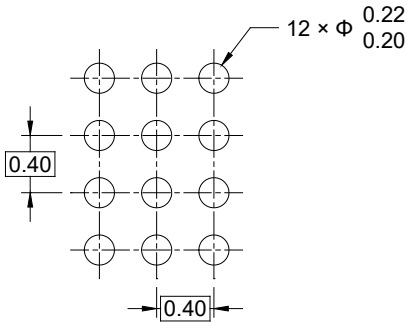
Changes from Original (MARCH 2024) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

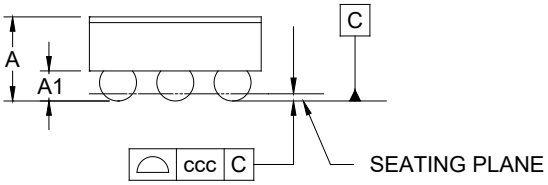
WLCSP-1.2×1.6-12B



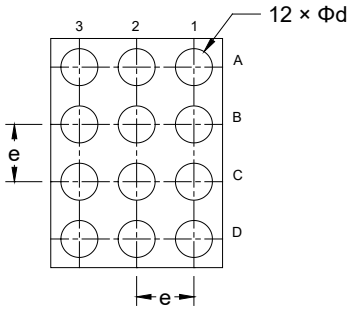
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



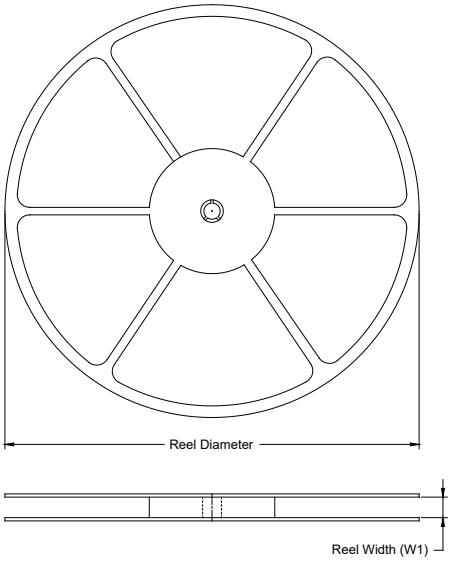
BOTTOM VIEW

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	-	-	0.625
A1	0.190	-	0.230
D	1.170	-	1.230
E	1.570	-	1.630
d	0.228	-	0.288
e	0.400 BSC		
ccc	0.050		

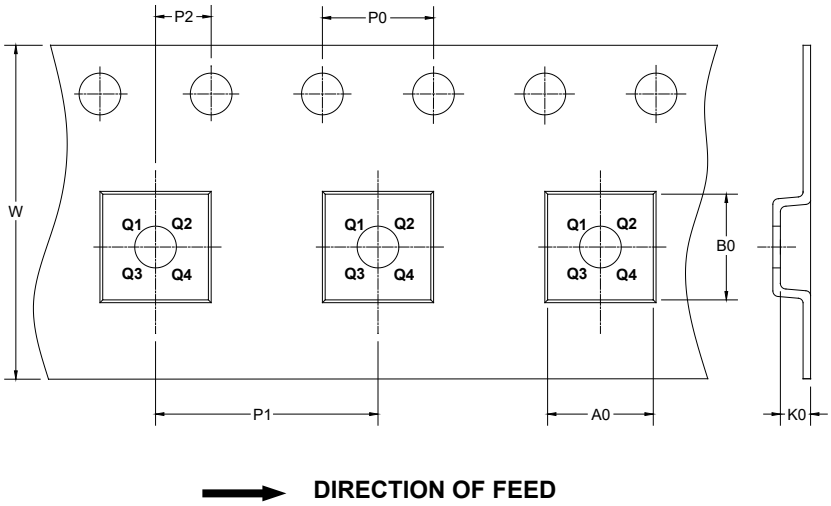
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



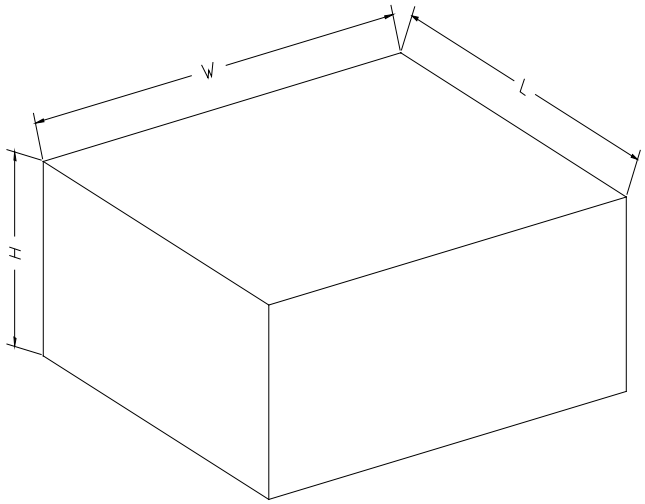
NOTE: The picture is only for reference. Please make the object as the standard.

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
WLCSP-1.2×1.6-12B	7"	9.5	1.31	1.87	0.71	4.0	4.0	2.0	8.0	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

DD0002