SGM37863
Synchronous Boost LED Flash Driver with 1.5A High-Side Current Source

GENERAL DESCRIPTION

The SGM37863 is a single LED flash driver that is compact and highly customizable. The constant current LED source allows for flexible adjustment from 16mA up to 1.5A in flash mode, and from 4mA up to 388mA or from 3mA up to 204mA in torch mode, each with 128 levels. It employs a synchronous Boost converter with a fixed frequency of 2MHz or 4MHz to automatically adjust the output voltage to maintain at least minimum headroom voltage V_{HR} across the current source, with V_{HR} being the difference between V_{OUT} and V_{LED}. The utilization of an adaptive control method ensures that the current source is regulated and efficiency is maximized.

The SGM37863 features include an I^2C interface for management, hardware flash enable pin (STROBE), and the options for 2MHz or 4MHz switching frequency, as well as 1.9A or 2.8A Boost current limit, making it possible to use small, low-profile inductors and ceramic capacitors. The protection functions include input voltage flash monitor (IVFM), over-voltage protection (OVP), LED and V_{OUT} short protection, thermal scale-back (TSB) and thermal shutdown (TSD). The recommended operating temperature range is from -40℃ to +85℃.

APPLICATIONS

Smart Phones, Tablets
Portable Internet Devices and Accessory
Action Cameras
IR LED Driver

FEATURES

- **Optional Working Mode and Programmable LED Currents**
  - **Flash/IR Mode: 16mA to 1.5A with 128 Levels**
  - **Torch Mode:**
    4mA to 388mA with 128 Levels when I_TORCH_SEL = 0
    3mA to 204mA with 128 Levels when I_TORCH_SEL = 1
- **2.7V to 5.5V Input Voltage Range**
- **Flash Timeout Ranges: 40ms to 1600ms**
- **Optional Switching Frequency: 2MHz or 4MHz**
- **Optional Current Limit: 1.9A or 2.8A**
- **I^2C Port for Flexible Working Mode Setting and Status Reporting**
- **Hardware Flash Enable (STROBE)**
- **Optimized Flash LED Current with Input Voltage Flash Monitor (IVFM)**
- **Over-Voltage Protection**
- **LED and V_{OUT} Short Fault Protection**
- **Thermal Scale-Back and Thermal Shutdown**
- **Available in a Green WLCSP-0.8×1.5-8B Package**

TYPICAL APPLICATION

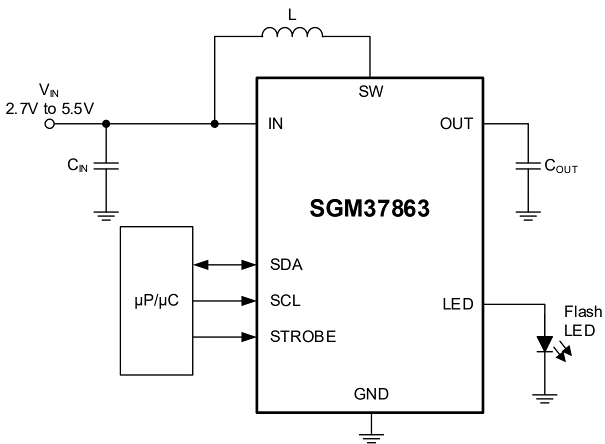


Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM37863	WLCSP-0.8×1.5-8B	-40℃ to +85℃	SGM37863YG/TR	XXXX 0M7	Tape and Reel, 5000

MARKING INFORMATION

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

XXXX

- 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)

IN, SW, OUT, LED .... -0.3V to 6V

SDA, SCL, STROBE ....-0.3V to (V_{IN} + 0.3V) with 6V max

Package Thermal Resistance

WLCSP-0.8×1.5-8B, θ_{JA} .... 126℃/W

Junction Temperature ....+150℃

Storage Temperature Range ....-65℃ to +150℃

Lead Temperature (Soldering, 10s) ....+260℃

ESD Susceptibility

HBM..2000V

CDM 1000V

RECOMMENDED OPERATING CONDITIONS

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

Operating Ambient Temperature Range........-40℃ to +85℃

Operating Junction Temperature Range......-40℃ to +125℃

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

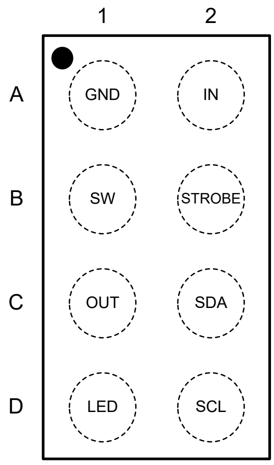
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

SGM37863 (TOP VIEW)



WLCSP-0.8×1.5-8B

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.
B1	SW	P	Switch Pin of the Boost DC/DC Converter.
B2	STROBE	I	Hardware Flash Enable Pin. Flash pulse is activated by driving STROBE pin high when this pin is enabled. A 300kΩ pull-down resistor is internally connected from STROBE pin to GND.
C1	OUT	P	Boost DC/DC Converter Output Pin. A 10μF or larger ceramic capacitor should be used from OUT pin to GND.
C2	SDA	I/O	I^2C Interface Data Line.
D1	LED	P	LED Current Source Output Pin.
D2	SCL	I	I^2C Interface Clock Line.

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

ELECTRICAL CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Current Source Specifications						
Current Source Accuracy	I_{LED}	V_{OUT} = 4V, I_FLASH[6:0] = 0x7F [2]	1.38	1.5	1.58	A
		V_{OUT} = 4V, I_TORCH[6:0] = 0x7F	350	388	426	mA
LED Current Source Regulation Voltage	V_{HR}	I_{LED} = 1.5A, Flash mode		570		mV
		I_{LED} = 388mA, Torch mode		380		
Over-Voltage Protection Threshold	V_{OVP_ON}	ON threshold	5.1	5.2	5.4	V
	V_{OVP_OFF}	OFF threshold	4.95	5.15	5.35	
Boost DC/DC Converter Specifications						
PMOS Switch On-Resistance	R_{PMOS}			135		mΩ
NMOS Switch On-Resistance	R_{NMOS}			125		mΩ
Switch Current Limit	I_{CL}	BOOST_ILIM = 0		1.9		A
		BOOST_ILIM = 1		2.8		
Under-Voltage Lockout Threshold	V_{UVLO}	V_{IN} falling	2.2	2.5	2.8	V
Input Voltage Flash Monitor Trip Threshold	V_{IVFM}	IVFM_VOL[2:0] = 000	2.8	2.9	2.98	V
Quiescent Supply Current	I_Q	Device not switching, in pass mode		0.6	0.85	mA
Standby Supply Current	I_{SB}	Device disabled, 2.7V ≤ V_{IN} ≤ 5.5V		1	2.5	μA
STROBE Voltage Specifications						
Input Logic Low	V_{IL}	2.7V ≤ V_{IN} ≤ 5.5V	0		0.4	V
Input Logic High	V_{IH}	2.7V ≤ V_{IN} ≤ 5.5V	1		V_{IN}	
I^2C-Compatible Interface Specifications (SCL, SDA)						
Input Logic Low	V_{IL}	2.7V ≤ V_{IN} ≤ 5.5V	0		0.4	V
Input Logic High	V_{IH}	2.7V ≤ V_{IN} ≤ 5.5V	1		V_{IN}	
Output Logic Low	V_{OL}	I_{LOAD} = 3mA			400	mV
Switching Characteristics						
Switching Frequency	f_{SW}	BOOST_FREQ = 0, 2.7V ≤ V_{IN} ≤ 5.5V		2		MHz
		BOOST_FREQ = 1, 2.7V ≤ V_{IN} ≤ 5.5V	3.5	4	4.5	

NOTES:
1. All voltages are referenced to the ground pin.
2. 1.5A LED output current capability highly depends on the input voltage, LED voltage, ambient temperature and PCB layout. Depending on system conditions, the internal thermal scale-back or thermal shutdown circuit may be triggered first before the flash timeout expires.

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

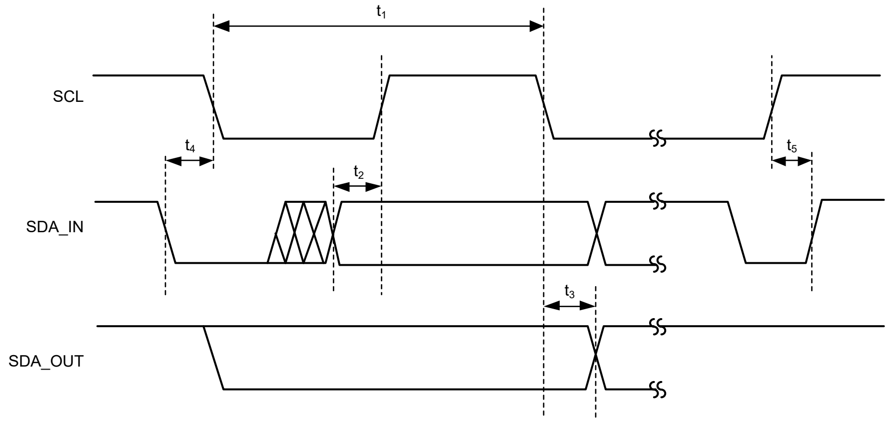
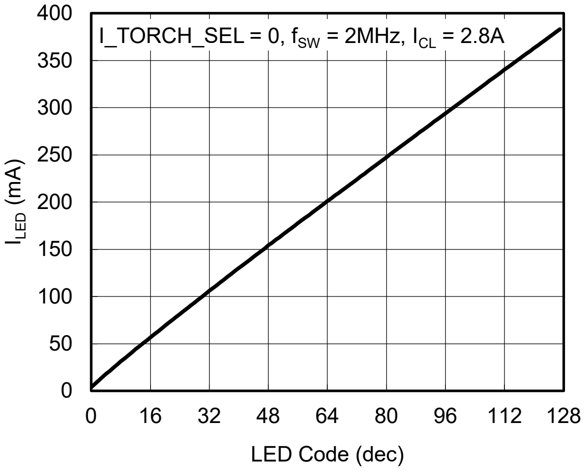


Figure 2. I²C-Compatible Interface Specifications

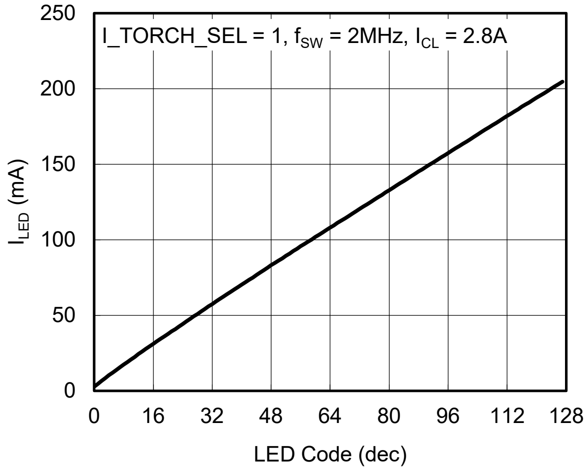
TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN} = 3.6V, C_{IN} = C_{OUT} = 10μF, L = 1μH, V_{LED} = 3.4V @1.5A, I_{CL} = 2.8A, T_J = +25℃, unless otherwise noted.

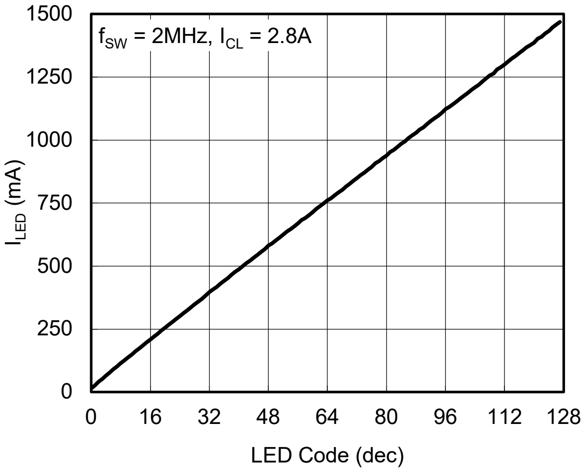
LED Torch Current vs. LED Torch Brightness Code



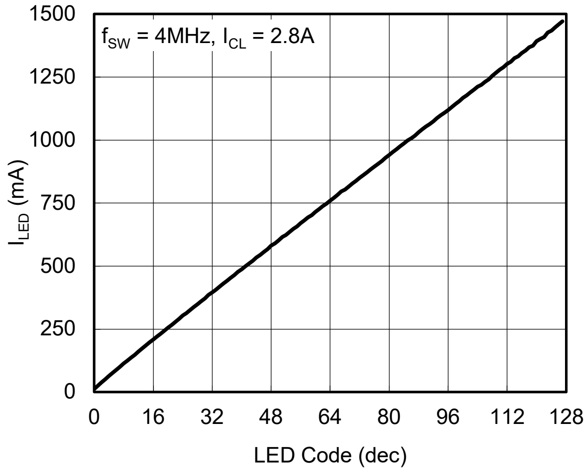
LED Torch Current vs. LED Torch Brightness Code



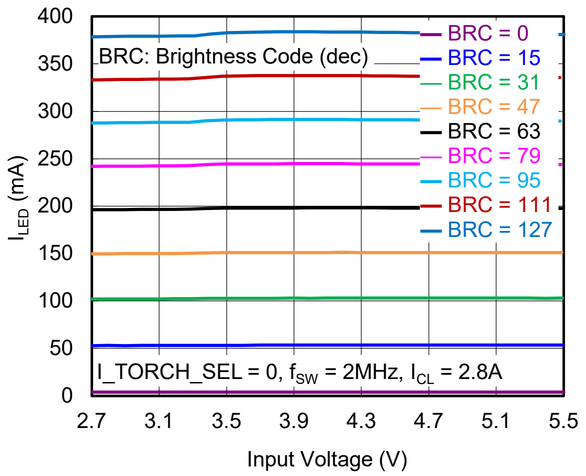
LED Flash Current vs. LED Flash Brightness Code



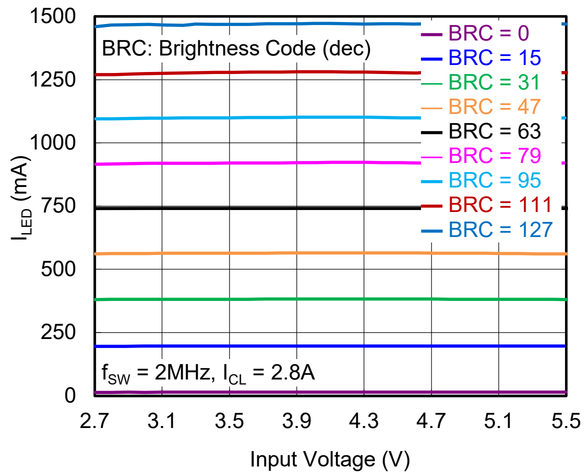
LED Flash Current vs. LED Flash Brightness Code



LED Torch Current vs. Input Voltage

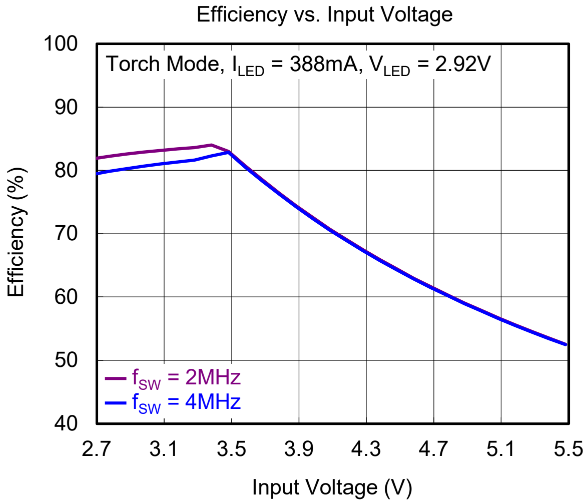


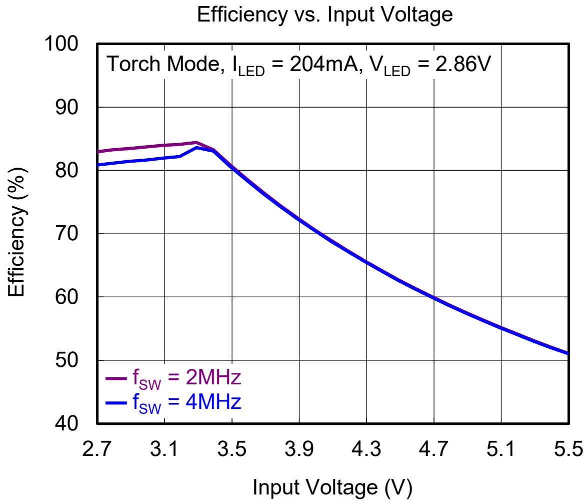
LED Flash Current vs. Input Voltage

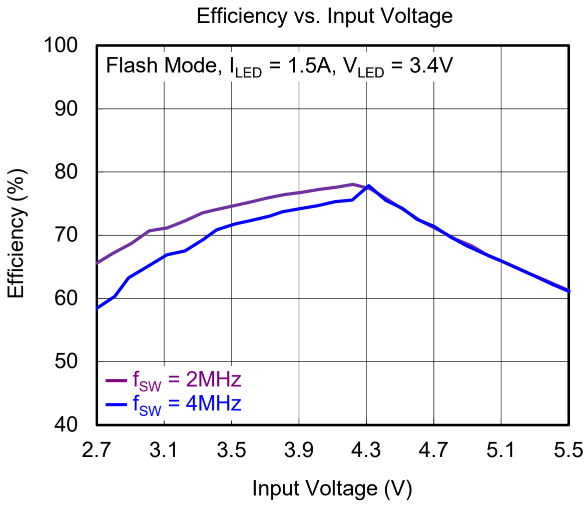


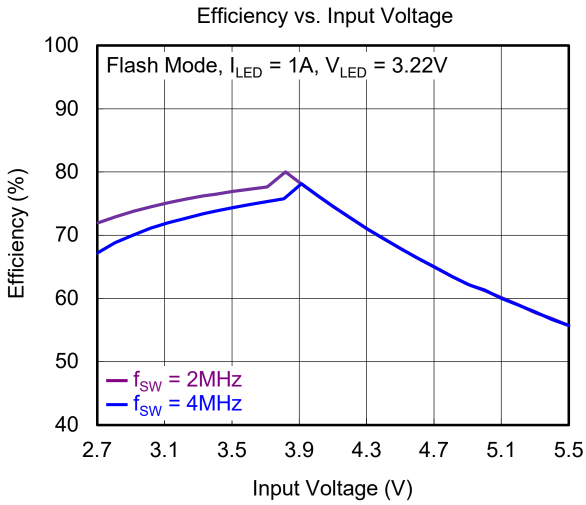
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

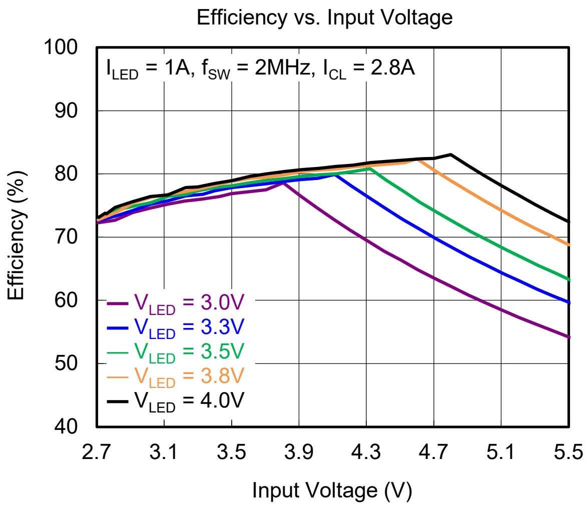
V_{IN} = 3.6V, C_{IN} = C_{OUT} = 10μF, L = 1μH, V_{LED} = 3.4V @1.5A, I_{CL} = 2.8A, T_J = +25℃, unless otherwise noted.

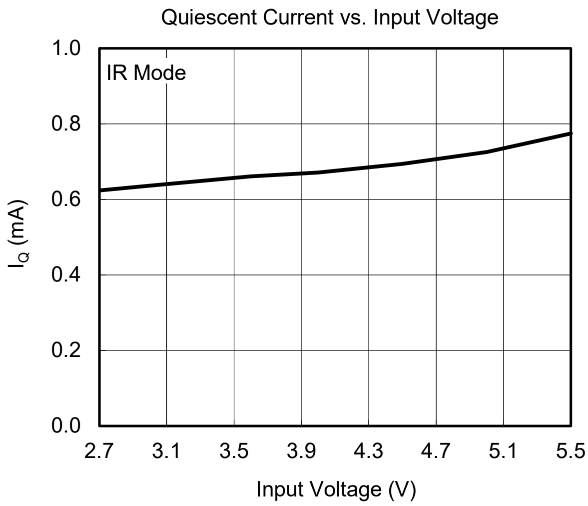






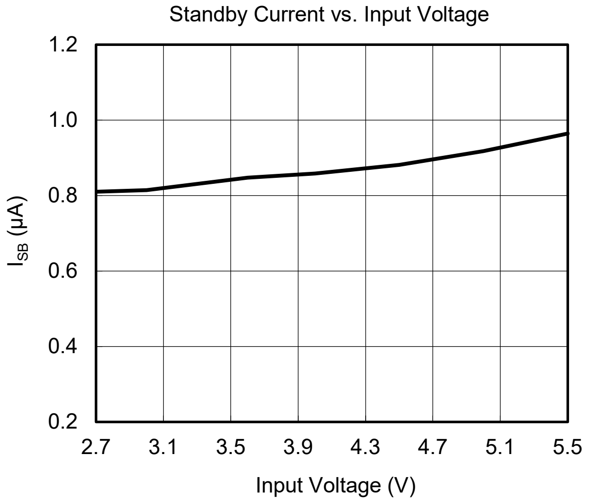


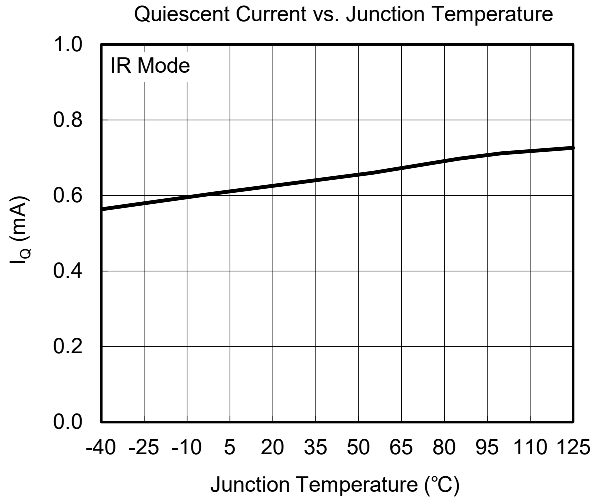


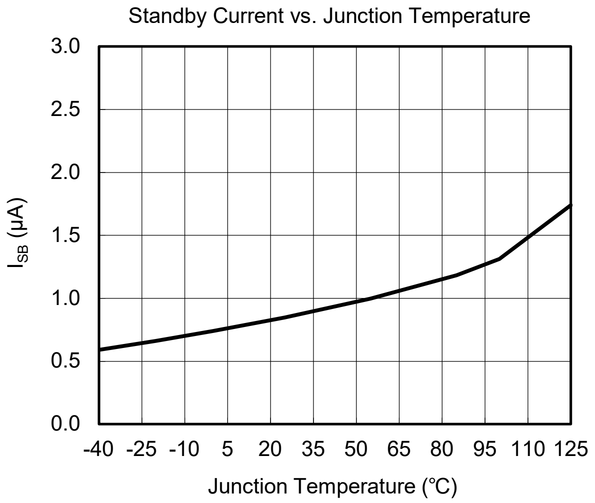


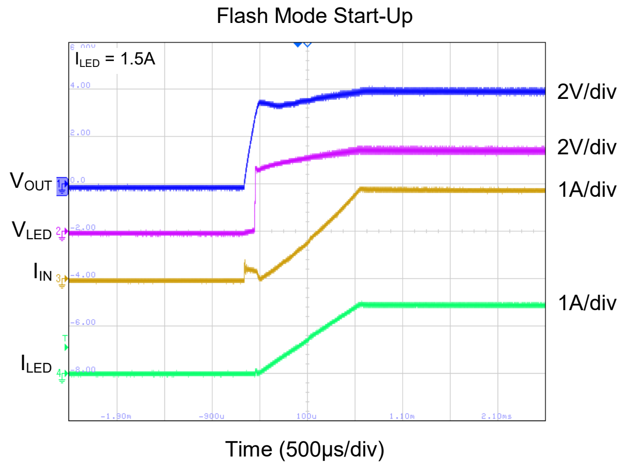
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

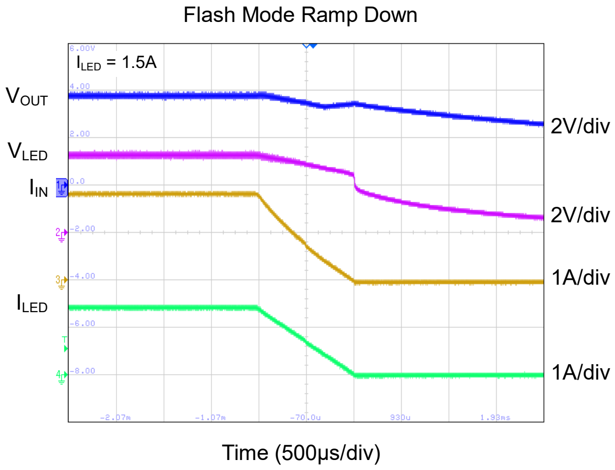
V_{IN} = 3.6V, C_{IN} = C_{OUT} = 10μF, L = 1μH, V_{LED} = 3.4V @1.5A, I_{CL} = 2.8A, T_J = +25℃, unless otherwise noted.

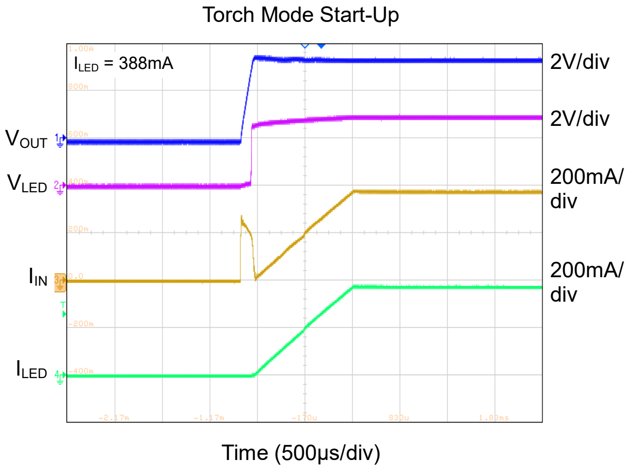








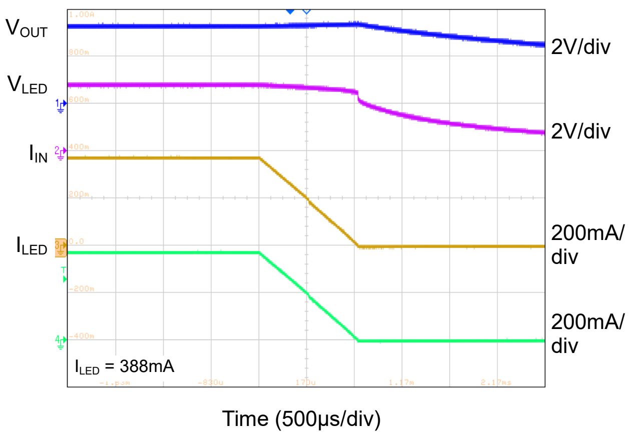




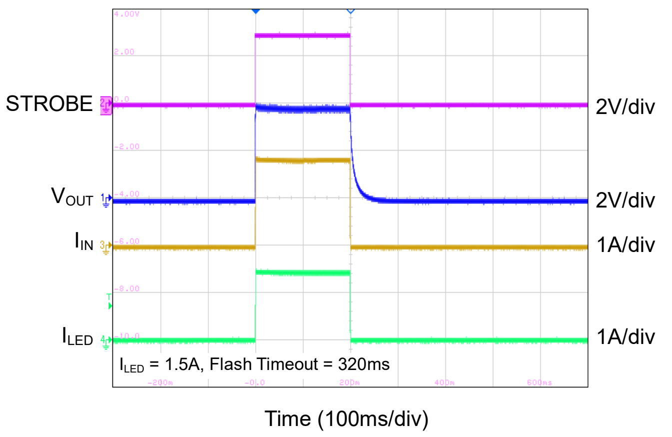
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_{IN} = 3.6V, C_{IN} = C_{OUT} = 10μF, L = 1μH, V_{LED} = 3.4V @1.5A, I_{CL} = 2.8A, T_J = +25℃, unless otherwise noted.

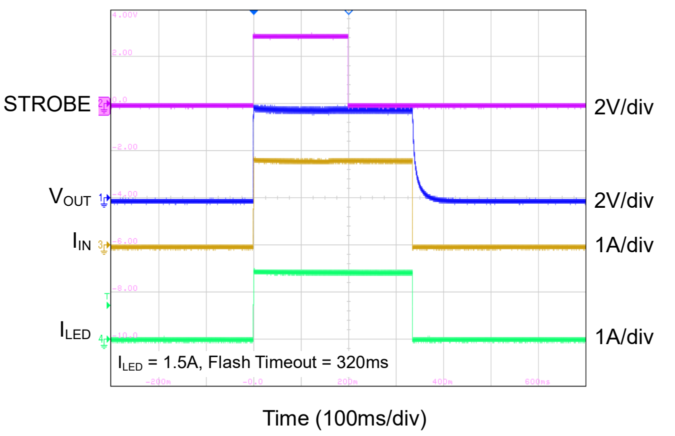
Torch Mode Ramp Down



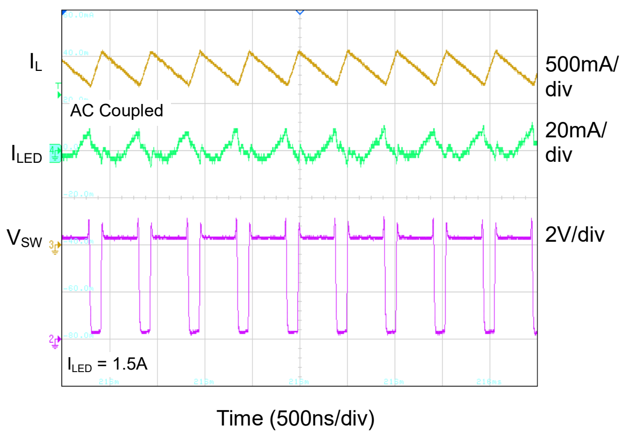
STROBE Level Triggered Flash



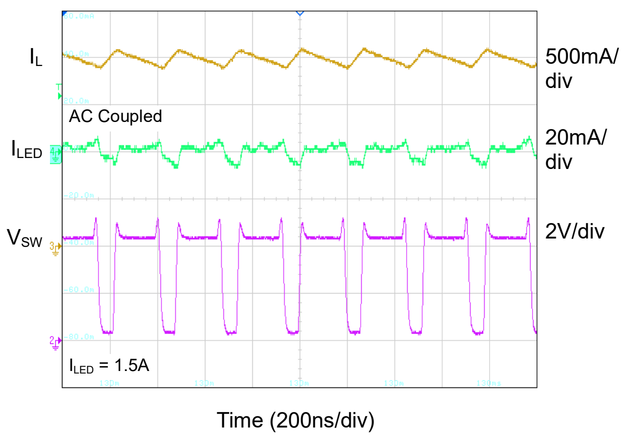
STROBE Edge Triggered Flash



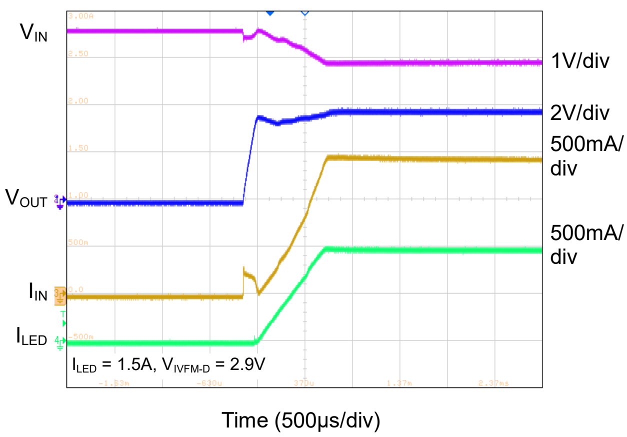
LED Current Ripple @ 2MHz



LED Current Ripple @ 4MHz



IVFM



FUNCTIONAL BLOCK DIAGRAM

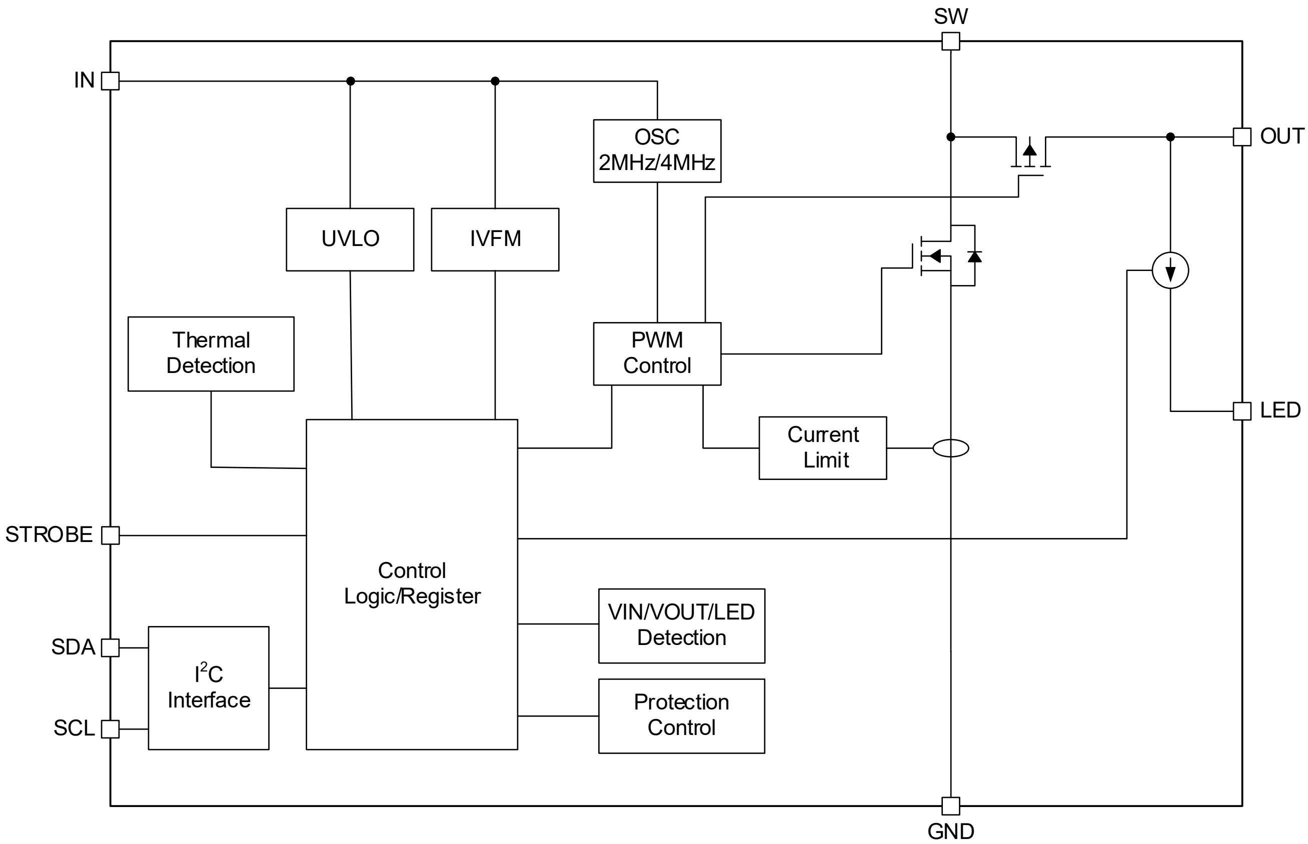


Figure 3. Functional Block Diagram

DETAILED DESCRIPTION

Overview

The SGM37863 is a high-performance LED flash driver designed for powering white LEDs with maximum flash current up to 1.5A. The device features a high-side current source to regulate LED current over a wide input voltage range of 2.7V to 5.5V.

The SGM37863 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 LED current source, with the headroom voltage being the difference between V_{OUT} and V_{LED}, ensuring the current source remains in regulation. If the input voltage V_{IN} exceeds V_{OUT} plus 300mV (TYP), the device enters the 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 SGM37863 utilizes the input voltage flash monitor (IVFM) function that reduces the flash current when the input voltage is low. In addition, when the device junction temperature reaches +125℃, the thermal scale-back (TSB) circuit works and forces the flash current to the set torch current.

Control of the SGM37863 is performed through an I^2C-compatible interface. It enables adjustments for the current levels of flash and torch mode, 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. The fault protections include flash timeout, output over-voltage, LED/V_{OUT} short circuit, thermal shutdown, and under-voltage lockout.

The SGM37863 also supports hardware flash enable (STROBE), and the STROBE pin is equipped with an internal 300kΩ pull-down resistor to GND.

Flash Mode

The flash mode 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 ramps up in 128 steps to reach the programmed flash current. The ramp time is constant 1ms.

The flash current can be programmed through the LED flash brightness level bits I_FLASH[6:0]. The LED current source provides 128 target levels ranging from 16mA to 1.5A.

When the flash timeout event occurs, the LED flash current ramps down to zero (the ramp time is also 1ms), and LED_MODE[1:0] bits are cleared to '00'. The flash timeout duration is determined by FLASH_TIMEOUT[3:0] bits that 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'. Upon activation of the torch sequence, the LED current source 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 maximum LED torch current can be set by I_TORCH_SEL bit. The LED torch brightness levels can be adjusted through I_TORCH[6:0] bits ranging from 4mA to 388mA or from 3mA to 204mA, each with 128 target levels. The time required for the torch current to ramp up to the target level is determined by the TORCH_TIMER bit and can set to no ramp time or 1ms.

IR Mode

The IR mode can be activated by setting the LED_MODE[1:0] bits to '01'. When IR mode is activated, the PFET is turned on as a 200mA current source, and charges the V_{OUT} until it reaches the input voltage (pass mode). In IR mode, the STROBE pin is only set as level sensitive, and the LED current source is externally controlled by toggling the STROBE pin to logic high or low.

In IR mode, the LED current source does 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 LED flash brightness level bits I_FLASH[6:0]. Note that IR mode would be exited if the flash timeout event occurs.

DETAILED DESCRIPTION (continued)

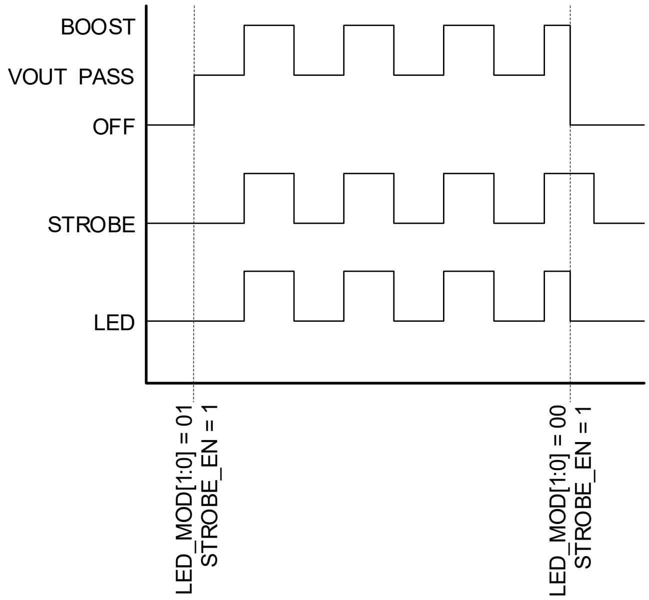


Figure 4. IR Mode with Boost

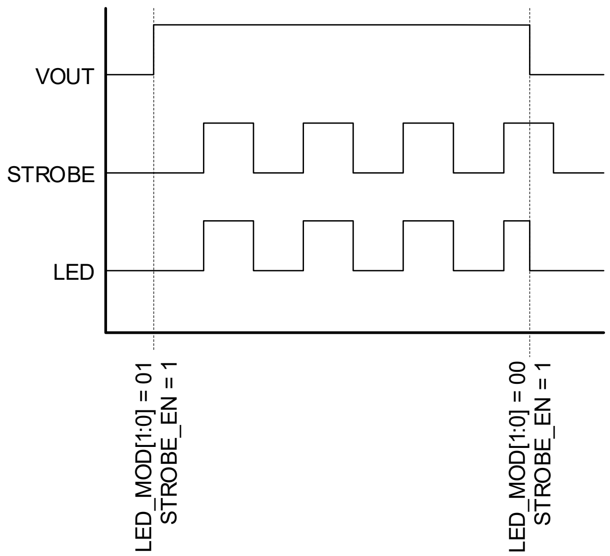


Figure 5. IR Mode Pass Only

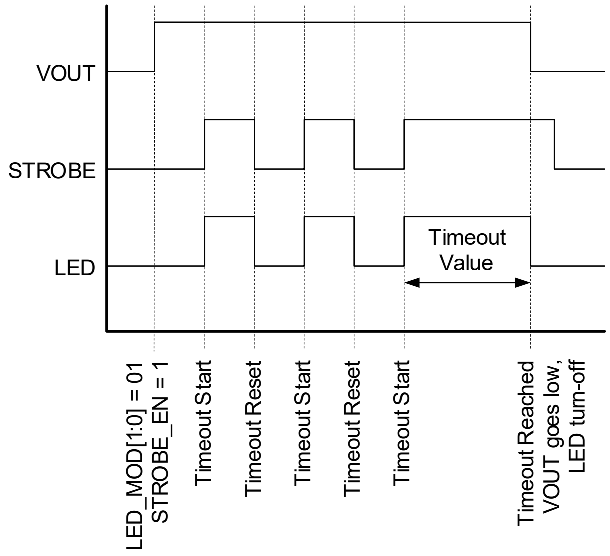


Figure 6. IR Mode Timeout

Start-Up

At startup, SGM37863 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 ramp time is constant 1ms, and it can be disabled by writing TORCH_TIMER = 0 for torch mode.

Pass Mode

The SGM37863 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 the minimum headroom voltage V_{HR}, the Boost converter starts switching and automatically regulates V_{OUT} to maintain V_{HR} across the LED current source. If the input voltage V_{IN} exceeds V_{OUT} plus 300mV (TYP), the device returns to pass mode.

DETAILED DESCRIPTION (continued)

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 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 threshold setting. The IVFM threshold can be programmed by the IVFM_VOL[2:0] bits ranging from 2.9V to 3.6V in 100mV steps. The IVFM_TRIP_FLAG bit is set to 1 when the input voltage is across the IVFM threshold value.

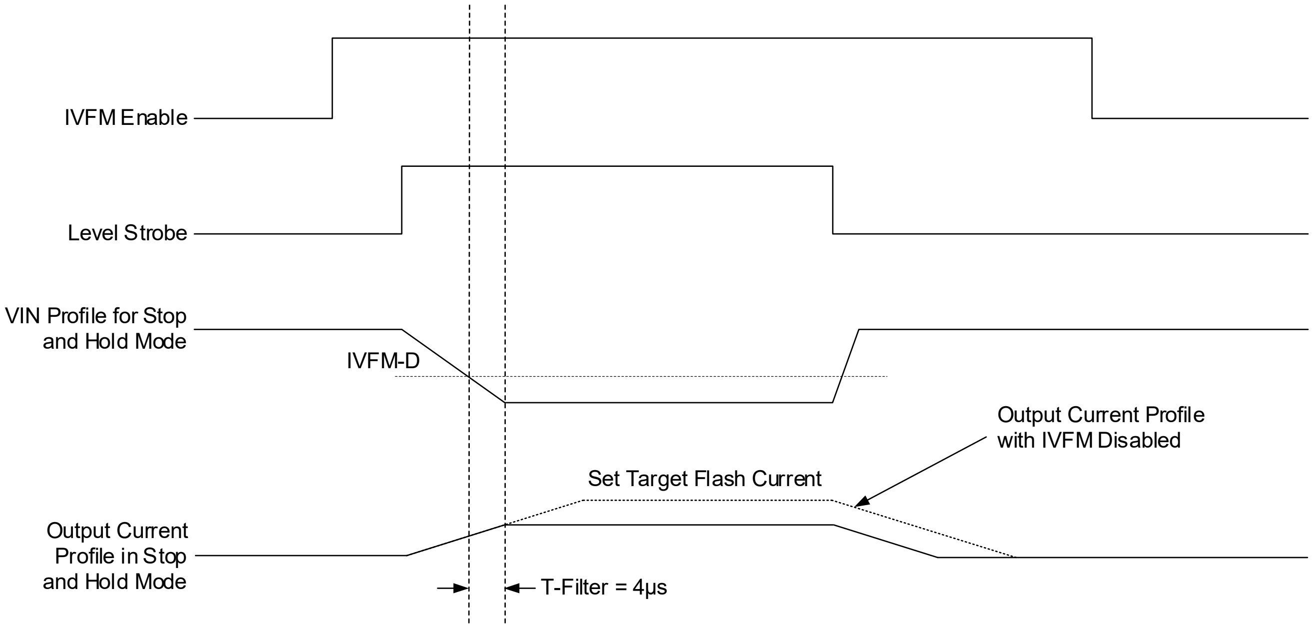


Figure 7. IVFM Mode

DETAILED DESCRIPTION (continued)

Protections in Fault Operation

Flash Timeout

The flash timeout feature 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 by the FLASH_TIMEOUT[3:0] bits ranging from 40ms to 1600ms with 16 levels. Flash timeout applies to both flash mode and IR mode. Upon a flash timeout event, the TIMEOUT_FLAG bit is set to 1 and can be cleared by reading back the register.

Under-Voltage Lockout (UVLO)

The SGM37863 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} (2.5V, 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 register when the input voltage rises above V_{UVLO}.

Over-Voltage Protection (OVP)

The SGM37863 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 stops switching until the V_{OUT} falls below V_{OVP_OFF}. If three rising OVP edges in Boost mode are detected within 32ms (TYP), the device enters standby mode, clearing LED_MODE[1:0] bits 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 register.

Current Limit (OCP)

The SGM37863 integrates a selectable inductor current limit options, 1.9A or 2.8A, which can be programmed by BOOST_ILIM bit. If the inductor peak current exceeds the current limit, the device will stop the charging phase of its switching cycle until the next cycle starts. If the over-current situation persists, the SGM37863 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 register, but the LED_MODE[1:0] 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 2.2V (TYP), 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_VLED_SHORT_FLAG bit is set to '1'. In order to resume normal operation, an I^2C reading of the 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 LED output, the SGM37863 will enter standby mode, with the LED_MODE[1:0] bits cleared and the appropriate VOUT_VLED_SHORT_FLAG bit set. An LED short condition is indicated if the voltage at the LED pin drops below 500mV (TYP) and holds for at least 256μs (TYP). In order to resume normal operation, an I^2C reading of the register is necessary.

Thermal Scale-Back (TSB)

When the SGM37863 junction temperature reaches +125℃ (TYP), the internal thermal scale-back (TSB) circuit works and forces the flash current to the torch current set by I_TORCH[6:0]. The TSB_FLAG is set when TSB triggered. Note that the flash timeout is also works during TSB and the current pulse would be off once the flash timeout event occurs.

Thermal Shutdown (TSD)

If the junction temperature (T_J) exceeds +150℃, the SGM37863 enters standby mode, and the TSD protection circuit prevents the device from overheating. TSD_FLAG bit is set to 1. The SGM37863 will not restart until the host reads REG05 register and the fault flag is cleared. After restarting, TSD_FLAG bit is reset to 1 and the SGM37863 enters standby mode again when T_J still exceeds +150℃.

Control Logic Table

LED_MODE[1:0]	STROBE_EN	STROBE Pin	Action
00	0	X	Standby
00	1	Posedge	Ext Flash
10	X	X	Int Torch
11	X	X	Int Flash
01	0	X	IR LED Standby
01	1	0	IR LED Standby
01	1	Posedge	IR LED Enabled

DETAILED DESCRIPTION (continued)

I^2C Serial Interface and Data Communication

The SGM37863 operates as a slave device with address 0x64 (64H). It has six 8-bit registers, numbered from REG01 to REG06.

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 8. All transactions begin by the master who 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.

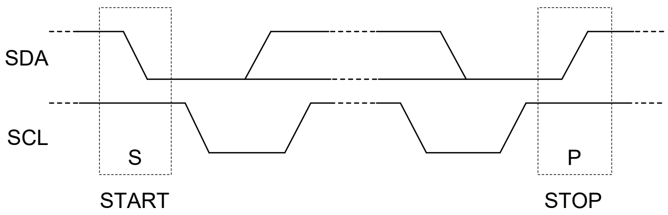


Figure 8. I^2C Bus in START and STOP Conditions

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.

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.

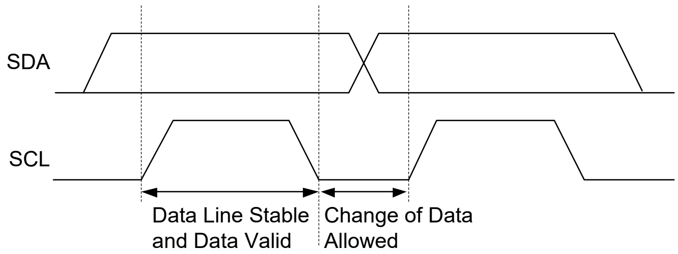


Figure 9. I^2C Bus Bit Transfer

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 and a read transaction are shown in Figure 10 and Figure 11, respectively.

DETAILED DESCRIPTION (continued)

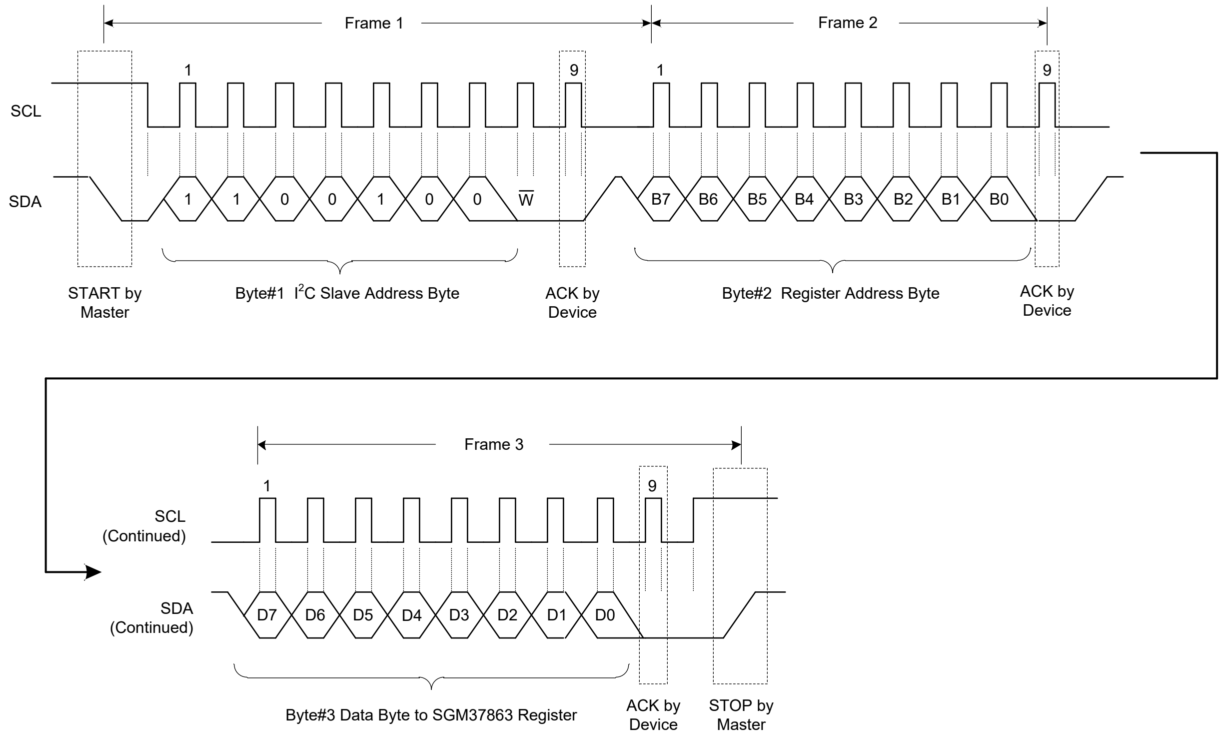


Figure 10. A Write Transaction

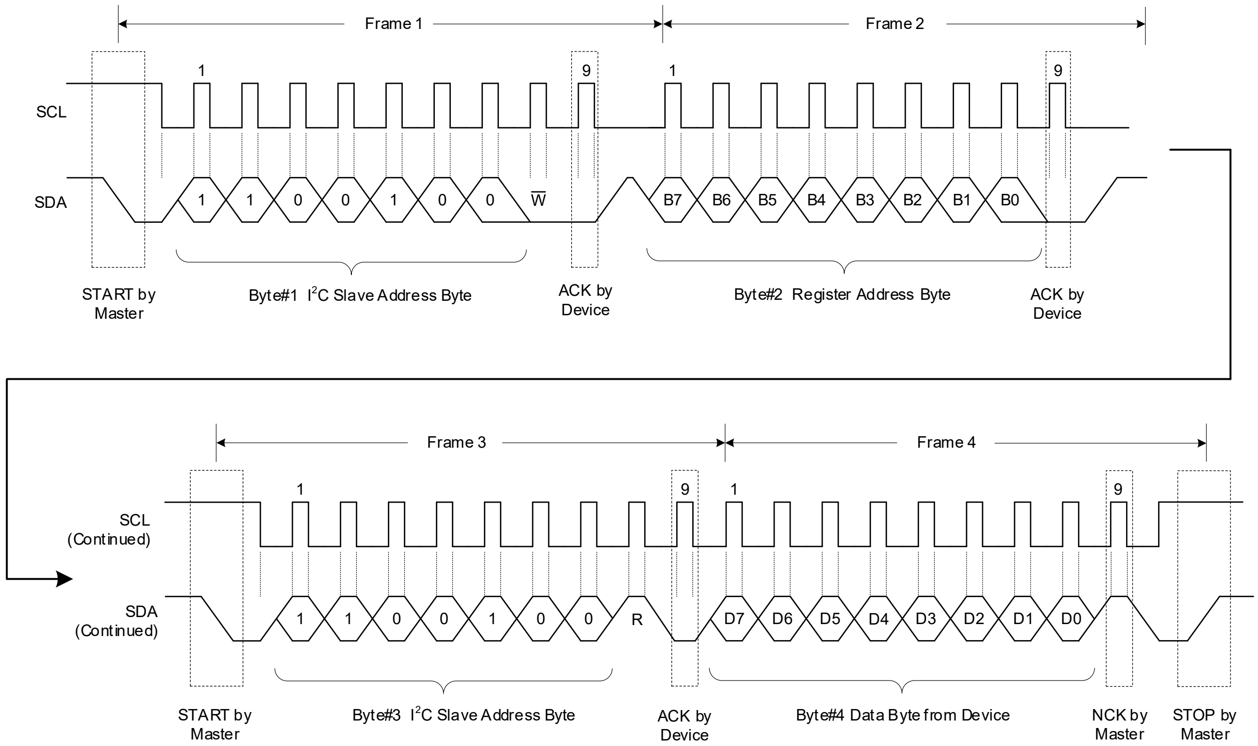


Figure 11. A Read Transaction

REGISTER MAPS

The I^2C slave address of SGM37863 is 1100100 (0x64).

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

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

I^2C 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	0x20	BOOST_ MODE	BOOST_ FREQ	BOOST_ ILIM	IVFM_EN	STROBE_ TYPE	STROBE_ EN	LED_MODE[1:0]	
Configuration Register	0x02	0x15	IVFM_VOL[2:0]			FLASH_TIMEOUT[3:0]				TORCH_ TIMER
LED Flash Brightness Register	0x03	0x00	TSB_EN	I_FLASH[6:0]						
LED Torch Brightness Register	0x04	0x00	I_TORCH_ SEL	I_TORCH[6:0]						
Flag Register	0x05	0x00	OVP_ FLAG	IVFM_ TRIP_ FLAG	VOUT_ VLED_ SHORT_ FLAG	ILIM_ FLAG	TSB_ FLAG	TSD_ FLAG	UVLO_ FLAG	TIMEOUT_ FLAG
Device ID Register	0x06	0x21	SOFT_RST	Reserved	DEVICE_ID[2:0]			DEVICE_REV[2:0]		

REG0x01: Enable Register [Reset = 0x20]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	BOOST_MODE	0	R/W	Boost Mode 0 = Normal (Default) 1 = Pass mode only	SOFT_RST
D[6]	BOOST_FREQ	0	R/W	Boost Frequency Select 0 = 2MHz (default) 1 = 4MHz	
D[5]	BOOST_ILIM	1	R/W	Boost Current Limit Setting 0 = 1.9A 1 = 2.8A (default)	
D[4]	IVFM_EN	0	R/W	IVFM Enable 0 = Disabled (Default) 1 = Enabled	
D[3]	STROBE_TYPE	0	R/W	Strobe 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[2]	STROBE_EN	0	R/W	Strobe Enable 0 = Disabled (default) 1 = Enabled	
D[1:0]	LED_MODE[1:0]	00	R/W	Mode Bits: M1, M0 00 = Standby mode (default) 01 = IR mode 10 = Torch mode 11 = Flash mode	

REGISTER MAPS (continued)

REG0x02: Configuration Register [Reset = 0x15]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7:5]	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	SOFT_RST
D[4:1]	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 exceeds 500ms, 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.	
D[0]	TORCH_TIMER	1	R/W	Torch Ramp 0 = No Ramp 1 = 1ms (default)	

REG0x03: LED Flash Brightness Register [Reset = 0x00]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	TSB_EN	0	R/W	Thermal Current Scale-Back 0 = Disabled 1 = Enabled (default) NOTE: If enabled, the LED current shifts to torch current level if T_J reaches +125℃.	SOFT_RST
D[6:0]	I_FLASH[6:0]	0000000	R/W	LED Flash Brightness Level I_{FLASH} (mA) ≈ (I_FLASH[6:0] × 11.98mA) + 15.85mA where I_FLASH[6:0] (Dec) = 0 ~ 30. I_{FLASH} (mA) ≈ (I_FLASH[6:0] × 11.65mA) + 20.36mA where I_FLASH[6:0] (Dec) = 31 ~ 127.	

REGISTER MAPS (continued)

REG0x04: LED Torch Brightness Register [Reset = 0x00]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	I_TORCH_SEL	0	R/W	Maximum LED Torch Current Setting 0 = 388mA Maximum Torch Current (default) 1 = 204mA Maximum Torch Current	SOFT_RST
D[6:0]	I_TORCH[6:0]	0000000	R/W	LED Torch Brightness Levels When I_TORCH_SEL = 0, I_{TORCH} (mA) ≈ (I_TORCH[6:0] × 3.22mA) + 4.21mA where I_TORCH[6:0] (Dec) = 0 ~ 30. I_{TORCH} (mA) ≈ (I_TORCH[6:0] × 2.98mA) + 9.24mA where I_TORCH[6:0] (Dec) = 31 ~ 127. When I_TORCH_SEL = 1, I_{TORCH} (mA) ≈ (I_TORCH[6:0] × 1.67mA) + 3.33mA where I_TORCH[6:0] (Dec) = 0 ~ 30. I_{TORCH} (mA) ≈ (I_TORCH[6:0] × 1.54mA) + 8.89mA where I_TORCH[6:0] (Dec) = 31 ~ 127.	

REG0x05: Flag Register [Reset = 0x00]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	OVP_FLAG	0	RC	OVP Fault Flag 0 = Normal (default) 1 = OVP detected	SOFT_RST
D[6]	IVFM_TRIP_FLAG	0	RC	IVFM Trip Flag 0 = Normal (default) 1 = IVFM triggered	
D[5]	VOUT_VLED_SHORT_FLAG	0	RC	VOUT/VLED Short Fault Flag 0 = Normal (default) 1 = VOUT or VLED short fault detected	
D[4]	ILIM_FLAG	0	RC	Current Limit Flag 0 = Current limit not triggered (default) 1 = Current limit triggered	
D[3]	TSB_FLAG	0	RC	Thermal Scale-back (TSB) Fault Flag 0 = Normal (default) 1 = Thermal scale-back 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	

REG0x06: Device ID Register [Reset = 0x21]

BITS	BIT NAME	DEFAULT	TYPE	DESCRIPTION	RESET BY
D[7]	SOFT_RST	0	R/WC	Software RESET 0 = Normal (default) 1 = Force device RESET	SOFT_RST
D[6]	Reserved	0	R	Reserved	N/A
D[5:3]	DEVICE_ID[2:0]	100	R	Device ID 100 = SGM37863	SOFT_RST
D[2:0]	DEVICE_REV[2:0]	001	R	Device Revision	

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 SGM37863. A 10μF/10V ceramic input capacitor is recommended for the typical application circuit. Placing the input capacitor as close as possible to the SGM37863 input (IN) pin is essential to minimize series resistance and inductance, which can introduce noise into the device due to input switching currents.

Inductor Selection

To minimize efficiency losses in the SGM37863 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 SGM37863 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:

$$I_{PEAK} = \frac{I_{LED} \times V_{OUT}}{\eta \times V_{IN}} + \Delta I_L \quad (1)$$

where

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

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

Output Capacitor Selection

The SGM37863 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:

$$\Delta V_Q = \frac{I_{LED} \times (V_{OUT} - V_{IN})}{V_{OUT} \times f_{sw} \times C_{OUT}} \quad (3)$$

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

$$\Delta V_{ESR} = R_{ESR} \times \left(\frac{I_{LED} \times V_{OUT}}{V_{IN}} + \Delta I_L\right) \quad (4)$$

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.

Layout Considerations

Proper layout is crucial for maintaining stability and LED current regulation across the intended voltage and current range of the SGM37863 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 SGM37863. C_{IN} should be connected to both the IN and GND pins through short and 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.

APPLICATION INFORMATION (continued)

3. The inductor should be connected to the SW node 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 STROBE, 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 cathode. When the Flash LED is routed at a distance from the SGM37863, the inductance of the LED current path can be reduced by sandwiching the forward and return current paths on two layers over each other. To prevent high amplitude LED current from entering the GND plane, it is recommended to use a dedicated path for routing the LED return if possible.

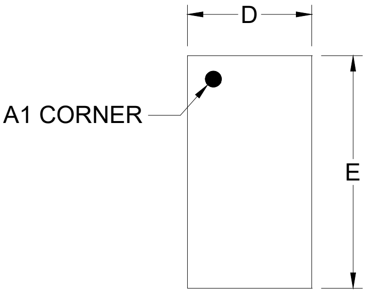
REVISION HISTORY

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

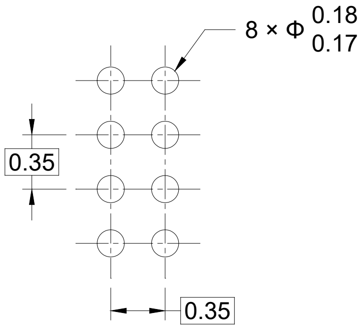
Changes from Original (JANUARY 2024) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

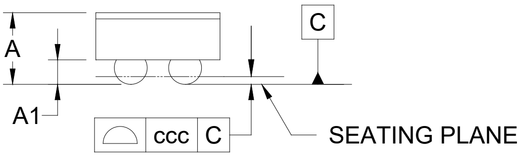
WLCSP-0.8×1.5-8B



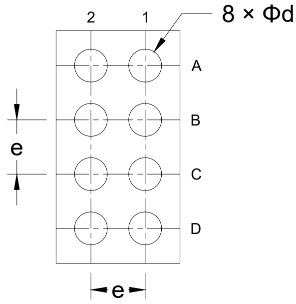
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



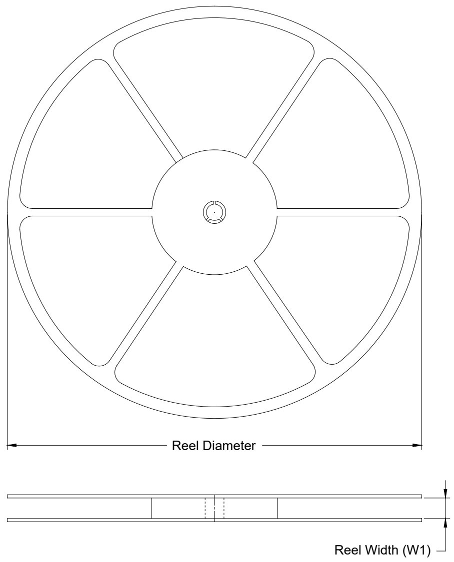
BOTTOM VIEW

Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	-	-	0.500
A1	0.138	-	0.178
D	0.770	-	0.830
E	1.470	-	1.530
d	0.182	-	0.242
e	0.350 BSC		
ccc	0.050		

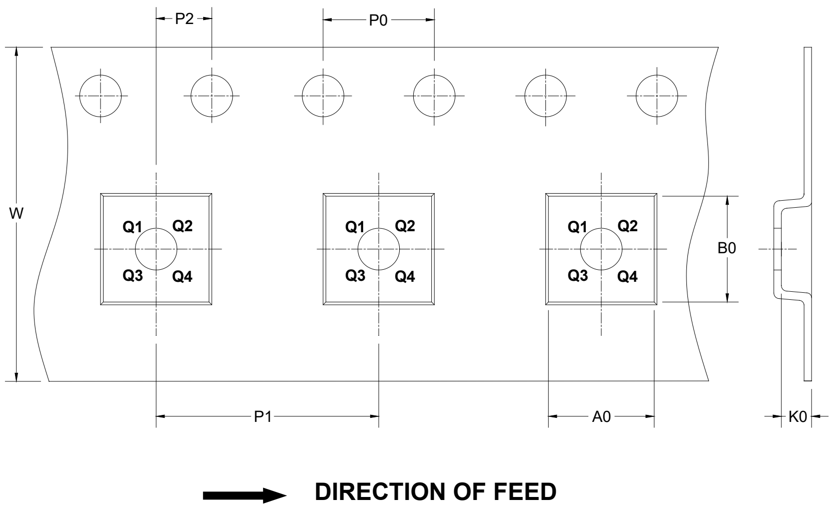
NOTE: This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



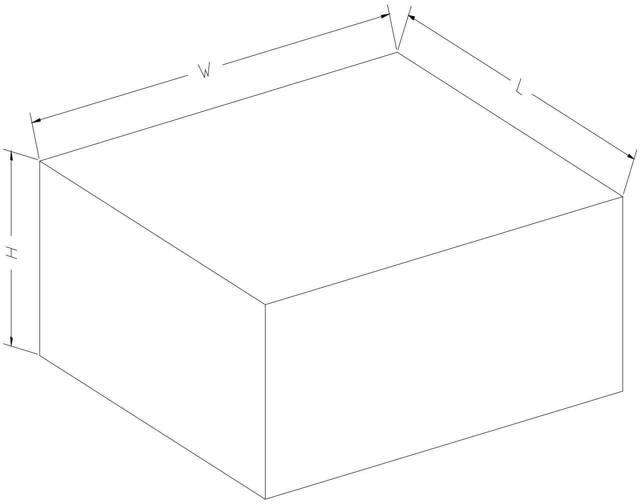
NOTE: The picture is only for reference. Please make the object as the standard.

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-0.8×1.5-8B	7"	9.5	0.90	1.66	0.57	4.0	2.0	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