LM3644YFFR-TP

High Efficiency Synchronous Boost Converter With Dual Independent 2A Current Sources

GENERAL DESCRIPTION

The is a dual LED flash driver that provides a high level of adjustability within a small solution size. The utilizes a 2-MHz or 4-MHz fixedfrequency synchronous boost converter to provide power to the dual 2A constant current LED sources. The total LED current the boost can deliver is 2A (ILED1+ ILED2). The dual 128 level current sources provide the flexibility to adjust the current ratios between LED1 and LED2 with each driver capable of delivering a maximum of 2A. An adaptive regulation method ensures the current sources remain in regulation and maximizes efficiency.

Features of the are controlled via an I2C-compatible interface. These features include: hardware flash and hardware torch pins (STROBE and TORCH/TEMP), a TX interrupt, and an NTC thermistor monitor. The device offers independently programmable currents in each output leg to drive the LEDs in a Flash or Movie Mode (Torch) condition.

The 2-MHz or 4-MHz switching frequency options, over voltage protection (OVP), and adjustable current limit allow for the use of tiny, low-profile inductors and (10-µF) ceramic capacitors. The device operates over a –40°C to 85°C ambient temperature range.

FEATURES

- 2A Total Allowed LED Current During Operation
- Dual Independent LED Current Source Programmability
- Accurate and Programmable LED Current Range from 3.9mA to 2A
- Optimized Flash LED Current During Low Battery Conditions (IVFM)
- Grounded Cathode LED Operation for Improved Thermal Management
- Small Solution Size:<16mm2
- Hardware Strobe Enable (STROBE)
- Synchronization Input for RF Power Amplifier Pulse Events (TX)
- Hardware Torch Enable (TORCH/TEMP)
- Remote NTC Monitoring (TORCH/TEMP)
- 400-kHz I2C-Compatible Interface

  -LM3644YFFR-TP(I2C Address=0x63)
- -40℃ to +85℃ Operating Temperature Range
- Available in Green WLCSP-12L Packages

APPLICATIONS

Camera Phone White LED Flash

ABSOLUTE MAXIMUM RATINGS

V_{IN} V_{SW},V_{LED1},V_{LED2} Pins to GND.....-0.3V to 6.0V
All Other Pins to GND to GND…..-0.3V to (Vin+0.3V)/6.0V
Continuous power dissipation..... Internally limited
Package Thermal Resistance
WLCSP-12B, θ_{JA}.....67.8℃/W
Junction Temperature..... .-40℃ to 150℃
Lead Temperature (Soldering, 10 sec).....300℃

RECOMMENDED OPERATING CONDITIONS

Operating Voltage Range.....2.7V to 5.5V
Operating Temperature Range ……..-40℃ to +85℃

OVERSTRESS CAUTION

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD SENSITIVITY CAUTION

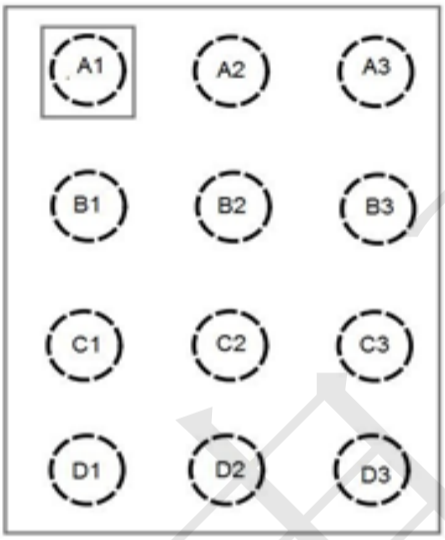
This integrated circuit can be damaged by ESD if you don’t pay attention to ESD protection. Broadchip recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

DISCLAIMER

Broadchip reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact Broadchip sales office to get the latest datasheet.

PIN CONFIGURATION

WLCSP-12L (Top View)



PIN DESCRIPTION

Pin Name	Pin No. WLCSP-12L	I/O	Pin Function
GND	A1	P	Ground
IN	A2	I	Input voltage connection. Connect IN to the input supply and bypass to GND with a 10μF or larger ceramic capacitor.
SDA	A3	I/O	Serial data input/output in the I^2C Mode on
SW	B1	P	Drain Connection for Internal NMOS and Synchronous PMOS Switches.
STROBE	B2	I/O	Active high hardware flash enable. Drive STROBE high to turn on Flash pulse. Internal pulldown resistor 300kΩ between STROBE and GND
SCL	B3	I/O	Serial clock input for
OUT	C1	O	Step-up DC/DC Converter Output. Connect a 10μF ceramic capacitor between this terminal and GND.
HWEN	C2	I	Active high enable pin. High= Standby, Low = Shutdown/Reset. Internal pulldown resistor of 300kΩ between HWEN and GND.
TORCH/TEMP	C3	I	Torch terminal input or threshold detector for NTC temperature sensing and current scale back.
LED2	D1	O	High-side current source output for flash LED.
TX	D2	I	Configurable dual polarity power amplifier synchronization input. Internal pulldown resistor of 300kΩ between TX and GND.
LED1	D3	O	High-side current source output for flash LED.

ELECTRICAL CHARACTERISTICS

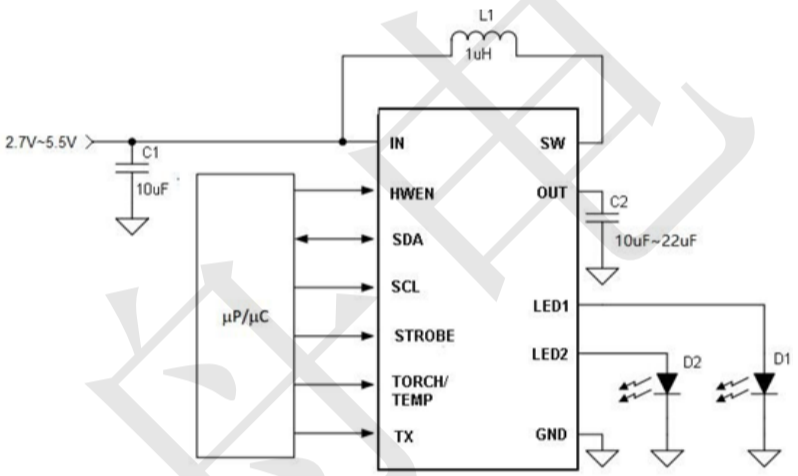
(Typical limits tested at T_A= 25°C. Unless otherwise specified, V_{IN}= 3.6V, HWEN=V_{IN}.)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
CURRENT SOURCE SPECIFICATIONS						
$I_{LED1/2}$	Current source accuracy	flash ,V_{OUT}= 4 V, flash code=0x3F=1A,	-7%	1.0	+7%	A
		torch ,V_{OUT}= 4 V, code =0x3F=249.6mA	-10%	249.6	+10%	mA
V_{OVP}		ON threshold	5	5.2	5.4	V
		OFF threshold	-	5	-	
STEP-UP DC/DC CONVERTER SPECIFICATIONS						
R_{NMOS}	NMOS Switch On-Resistance		-	100	-	mΩ
R_{PMOS}	PMOS Switch On-Resistance		-	100	-	mΩ
I_{CL}	Switch Current Limit	Reg0x07, bit[0]=0	-	1.9	-	A
		Reg0x07, bit[0]=1	-	2.8	-	
UVLO	Undervoltage lockout threshold	Falling V_{IN}	-	2.5	-	V
V_{TRIP}	NTC comparator trip threshold	Reg0x09, bits[3:1]='100'	-	0.6	-	V
V_{IVFM}	Input voltage flash monitor tripthreshold	Reg0x02, bits[5:3]='000'	-	2.9	-	V
I_Q	Quiescent supply current	Device not switching pass mode	-	0.6	-	mA
I_{SD}	Shutdown supply curren	Device disabled, HWEN=0V,2.7 V≤VIN≤5.5V	-	0.1	4	uA
I_{SB}	Standby supply current	Device disabled, HWEN=1.8V,2.7V≤VIN≤5.5V	-	2.5	10	uA
HWEN, TORCH/TEMP, STROBE, TX VOLTAGE SPECIFICATION						
V_{IL}	Input logic low	2.7V≤VIN≤5.5V	0	-	0.4	V
V_{IH}	Input logic high		1.2	-	V_{IN}	
I²C-COMPATIBLE INTERFACE SPECIFICATIONS (SCL, SDA)						
V_{IL}	Input logic low	2.7V≤VIN≤5.5V	0	-	0.4	V
V_{IH}	Input logic high		1.2	-	V_{IN}	
V_{OL}	Output logic low	I_{LOAD}=3mA	-	-	400	mA
Switching Characteristics						
f_{SW}	Switching frequency	Reg0x07, bit[1]=0	-	2	-	MHz
		Reg0x07, bit[1]=1	-	4	-	

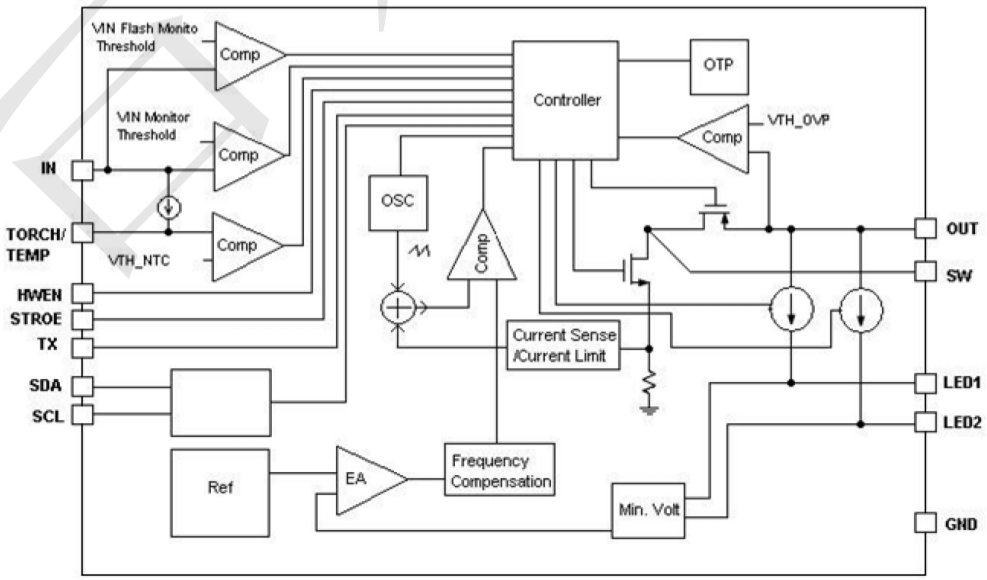
Timing Requirements

Symbol	Parameter	Min.	Typ.	Max.	Unit
t1	SCL clock period	2.4	-	-	uS
t2	Data in set-up time to SCL high	100	-	-	nS
t3	Data out stable After SCL low	0	-	-	
t4	SDA low set-up time to SCL Low (start)	100	-	-	
t5	SDA high hold time after SCL high (stop)	100	-	-	

TYPICAL APPLICATION CIRCUIT



Block Diagram



Feature Description

Flash Mode

In Flash Mode, the LED current sources (LED1/2) provide 128 target current levels from 15.63mA to 2A.The total allowed LED current during operation is 2A (I_{LED1}+I_{LED2}=2A). Once the Flash sequence is activated the current source(LED) ramps up to the programmed Flash current by stepping through all current steps until the programmed current is reached. The headroom in the two current sources can be regulated to provide 15.63mA to 2A on each of the two output legs. There is an option in the register settings to keep the two currents in the output leg the same.

When the device is enabled in Flash Mode through the Enable Register, all mode bits in the Enable Register are cleared after a flash time-out event.

Torch Mode

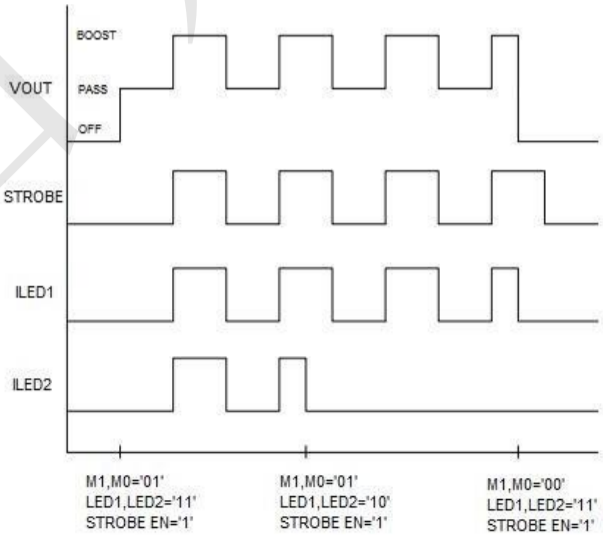
In Torch mode, the LED current sources (LED1/2) provide 128 target current levels from 3.9mA to 499.2mA. The Torch currents are adjusted via the LED1 and LED2 LED Torch Brightness Registers. Torch mode is activated by the Enable Register (setting M1, M0 to '10'), or by pulling the TORCH/TEMP pin HIGH when the pin is enabled (Enable Register) and set to Torch Mode. Once the TORCH sequence is activated the active current sources (LED1/2) ramps up to the programmed Torch current by stepping through all current steps until the programmed current is reached. The rate at which the current ramps is determined by the value chosen in the Timing Register.

Torch Mode is not affected by Flash Timeout or by a TX Interrupt event.

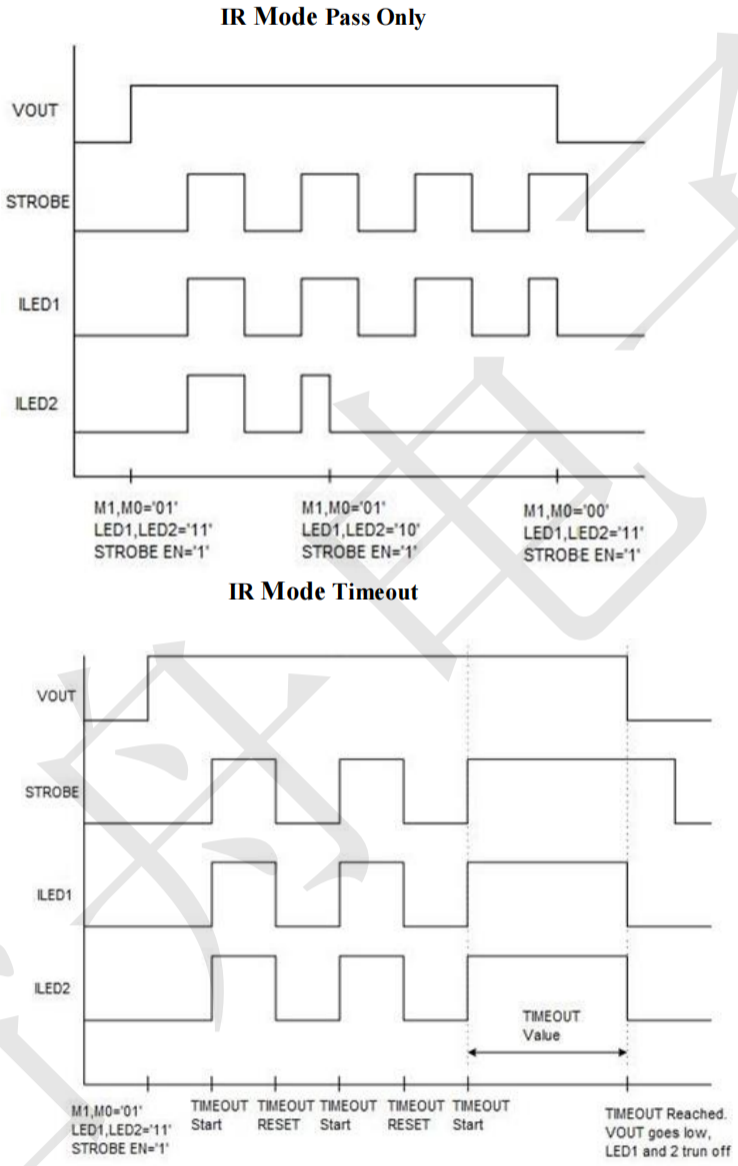
IR Mode

In IR Mode, the target LED current is equal to the value stored in the LED1/2 Flash Brightness Registers. When IR mode is enabled (setting M1, M0 to '01'), the boost converter turns on and set the output equal to the input (pass-mode). At this point, toggling the STROBE pin enables and disables the LED1/2 current sources (if enabled). The strobe pin can only be set to be Level sensitive, meaning all timing of the IR pulse is externally controlled. In IR Mode, the current sources do not ramp the LED outputs to the target. The current transitions immediately from off to on and then on to off.

IR Mode with Boost



Feature Description (continued)



Start-Up (Enabling The Device)

Turn on of the Torch and Flash modes can be done through the Enable Register. On start-up, when VOUT is less than VIN the internal synchronous PFET turns on as a current source and delivers 200mA (typ.) to the output capacitor. During this time the current source (LED) is off. When the voltage across the output capacitor reaches 2.2V(typ.) the current source turns on. At turn on the current source steps through each FLASH or TORCH level until the target LED current is reached. This gives the device a controlled turn on and limits inrush current from the VIN supply.

Feature Description (continued)

Pass Mode

The starts up in Pass Mode and stays there until Boost Mode is needed to maintain regulation. If the voltage difference between V_{OUT} and V_{LED} falls below V_{HR}, the device switches to Boost Mode. In Pass Mode the boost converter does not switch, and the synchronous PFET turns fully on bringing V_{OUT} up to $V_{IN} – I_{LED}$ x R_{PMOS}. In Pass Mode the inductor current is not limited by the peak current limit.

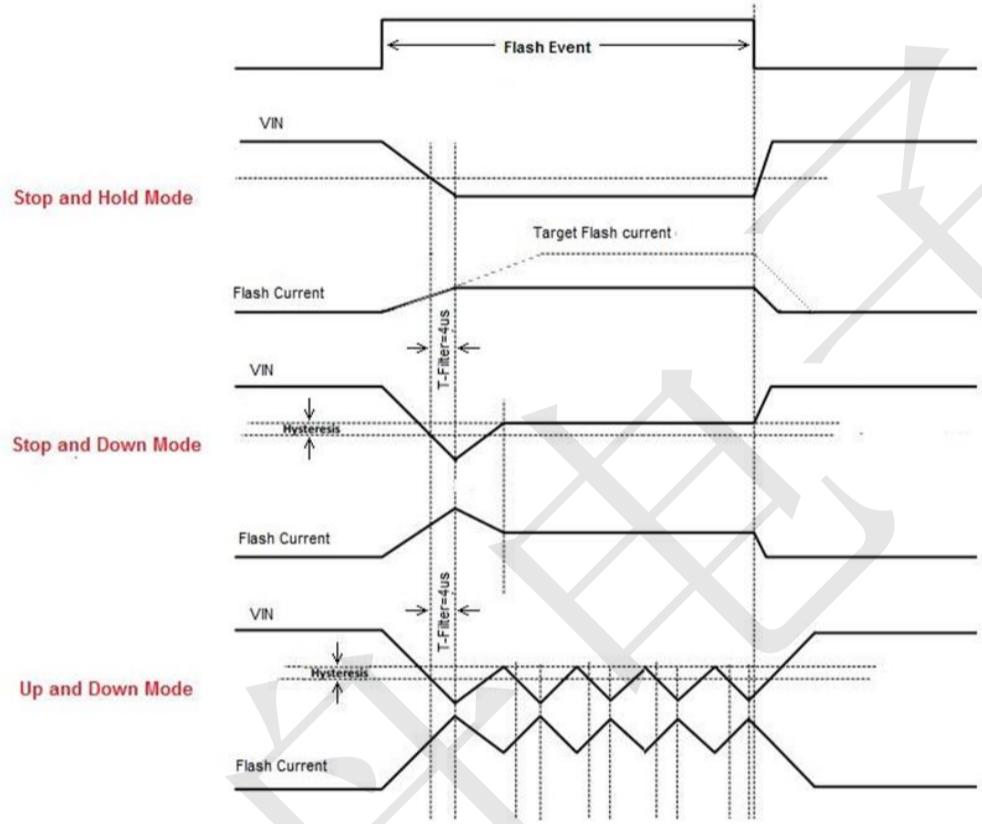
Power Amplifier Synchronization (TX)

The TX pin is a Power Amplifier Synchronization input. This is designed to reduce the flash LED current and thus limit the battery current during high battery current conditions such as PA transmit events. When the is engaged in a Flash event, and the TX pin is pulled high, the LED current is forced into Torch Mode at the programmed Torch current setting. If the TX pin is then pulled low before the Flash pulse terminates, the LED current returns to the previous Flash current level. At the end of the Flash time-out, whether the TX pin is high or low, the LED current turns off.

Input Voltage Flash Monitor (IVFM)

The has the ability to adjust the flash current based upon the voltage level present at the IN pin utilizing the Input Voltage Flash Monitor (IVFM). The adjustable threshold IVFM-D ranges from 2.9 V to 3.6 V in 100-mV steps, with three different usage modes (Stop and Hold, Adjust Down Only, Adjust Up and Down). The Flags2 Register has the IVFM flag bit set when the input voltage crosses the IVFM-D value. Additionally, the IVFM-D threshold sets the input voltage boundary that forces the to either stop ramping the flash current during start-up (Stop and Hold Mode) or to start decreasing the LED current during the flash (Down Adjust Only and Up and Down Adjust). In Adjust Up and Down mode, the IVFM-D value plus the hysteresis voltage threshold set the input voltage boundary that forces the to start ramping the flash current back up towards the target.

Feature Description (continued)



IVFM Modes

Fault Operation

If the enters a fault condition, the device sets the appropriate flag in the Flags1 and Flags2 Registers (0x0A and 0x0B), and place the device into standby by clearing the Mode Bits ([1], [0]) in the Enable Register. The remains in standby until an I²C read of the Flags1 and Flags2 Registers are completed. Upon clearing the flags/faults, the device can be restarted (Flash, Torch, IR). If the fault is still present, the re-enters the fault state and enters standby again.

Flash Time-Out

The Flash Time-Out period sets the amount of time that the Flash Current is being sourced from the current sources (LED1/2). The has 16 timeout levels ranging from 40ms to 1600ms (see Timing Configuration Register (0x08) for more detail).

Feature Description (continued)

Overvoltage Protection (OVP)

The output voltage is limited to typically 5.2V (see V_{OVP} spec in the Electrical Characteristics). In situations such as an open LED, the raises the output voltage in order to try and keep the LED current at its target value. When V_{OUT} reaches 5.2V (typ.) the overvoltage comparator trips and turns off the internal NFET. The mode bits are cleared and the OVP flag is set.

Current Limit

The features two selectable inductor current limits that are programmable through the I^2C-compatible interface. When the inductor current limit is reached, the terminates the charging phase of the switching cycle. Switching resumes at the start of the next switching period. If the over current condition persists, the device operates continuously in current limit.

Since the current limit is sensed in the NMOS switch, there is no mechanism to limit the current when the device operates in Pass Mode (current does not flow through the NMOS in pass mode). In Boost mode or Pass mode if V_{OUT} falls below 2.3V, the device stops switching, and the PFET operates as a current source limiting the current to 200mA. This prevents damage to the and excessive current draw from the battery during output short-circuit conditions. The mode bits are not cleared upon a Current Limit event, but a flag is set.

NTC Thermistor Input (Torch/Temp)

The TORCH/TEMP pin, when set to TEMP mode, serves as a threshold detector and bias source for negative temperature coefficient (NTC) thermistors. When the voltage at TEMP goes below the programmed threshold, the is placed into standby mode. The NTC threshold voltage is adjustable from 200mV to 900mV in 100mV steps. The NTC bias current is set to 50µA. The NTC detection circuitry can be enabled or disabled via the Enable Register. If enabled, the NTC block turns on and off during the start and stop of a Flash/Torch event.

Additionally, the NTC input looks for an open NTC connection and a shorted NTC connection. If the NTC input falls below 100mV, the NTC short flag is set, and the device is disabled. If the NTC input rises above 2.3V, the NTC Open flag is set, and the device is disabled. These fault detections can be individually disabled/enabled via the NTC Open Fault Enable bit and the NTC Short Fault Enable bit.

Under voltage Lockout (UVLO)

The has an internal comparator that monitors the voltage at IN and forces the into standby if the input voltage drops to 2.5V. If the UVLO monitor threshold is tripped, the UVLO flag bit is set in the Flags1 Register (0x0A). If the input voltage rises above 2.5V, the is not available for operation until there is an I^2C read of the Flags1 Register (0x0A). Upon a read, the Flags1 register is cleared, and normal operation can resume if the input voltage is greater than 2.5V.

Feature Description (continued)

Thermal Shutdown (TSD)

When the die temperature reaches 150°C, the thermal shutdown detection circuit trips, forcing the into standby and writing a '1' to the corresponding bit of the Flags1 Register (0x0A) (Thermal Shutdown bit). The is only allowed to restart after the Flags1 Register (0x0A) is read, clearing the fault flag. Upon restart, if the die temperature is still above 150°C, the resets the Fault flag and re-enters standby.

LED and/or VOUT Short Fault

The LED Fault flags read back a '1' if the device is active in Flash or Torch mode and either active LED output experiences a short condition. The Output Short Fault flag reads back a '1' if the device is active in Flash or Torch mode and the boost output experiences a short condition. An LED short condition is determined if the voltage at LED1 or LED2 goes below 500mV (typ.) while the device is in Torch or Flash mode. There is a deglitch time of 256µs before the LED Short flag is valid and a deglitch time of 2.048ms before the VOUT Short flag is valid. The LED Short Faults can be reset to '0' by removing power to the , setting HWEN to '0', setting the SW RESET bit to a '1', or by reading back the Flags1 Register (0x0A on LM3644YFFR-TP). The mode bits are cleared upon an LED and /or V_{OUT} short fault.

Programming

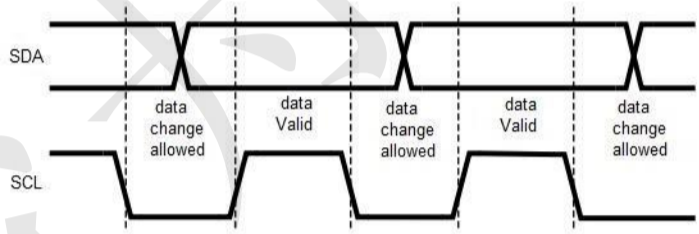
Control Truth Table

MODE1	MODE0	STROBE EN	TORCH EN	STROBE PIN	TORCH PIN	ACTION
0	0	0	0	X	X	Standby
0	0	0	1	X	pos edg	Ext Torch
0	0	1	0	pos edg	X	Ext Flash
0	0	1	1	0	pos edg	Standalone Torch
0	0	1	1	pos edg	0	Standalone Flash
0	0	1	1	pos edg	pos edg	Standalone Flash
1	0	X	X	X	X	Int Torch
1	1	X	X	X	X	Int Flash
0	1	0	X	X	X	IRLED Standby
0	1	1	X	0	X	IRLED Standby
0	1	1	X	pos edg	X	IRLED enabled

I2C-Compatible Interface

Data Validity

The data on SDA must be stable during the HIGH period of the clock signal (SCL). In other words, the state of the data line can only be changed when SCL is LOW.



Data Validity Data

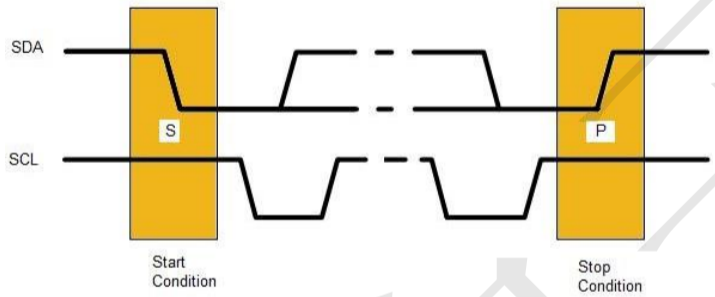
A pull up resistor between the controller's VIO line and SDA must be greater than [(VIO-VOL)/3mA] to meet the VOL requirement on SDA. Using a larger pull up resistor results in lower switching current with slower edges, while using a smaller pull up results in higher switching currents with faster edges.

Start and Stop Conditions

START and STOP conditions classify the beginning and the end of the I²C session. A START condition is defined as the SDA signal transitioning from HIGH to LOW while SCL line is HIGH. A STOP condition is defined as the SDA transitioning from LOW to HIGH while SCL is HIGH. The I²C master always generates START and STOP conditions. The I²C bus is considered busy after a START condition and free after a STOP condition. During data transmission, the I²C master can generate

Programming(continued)

repeated START conditions. First START and repeated START conditions are equivalent, function-wise.

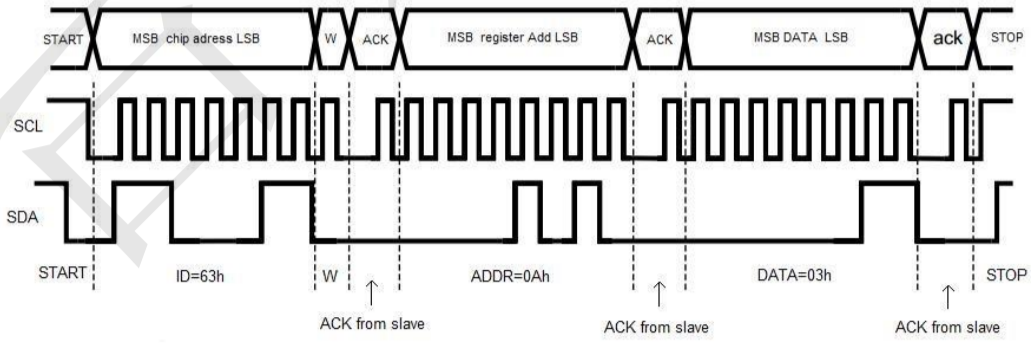


Start and Stop Conditions

Transferring Data

Every byte put on the SDA line must be eight bits long, with the most significant bit (MSB) transferred first. Each byte of data has to be followed by an acknowledge bit. The acknowledge related clock pulse is generated by the master. The master releases the SDA line (HIGH) during the acknowledge clock pulse. The pulls down the SDA line during the 9th clock pulse, signifying an acknowledge. The generates an acknowledge after each byte is received. There is no acknowledge created after data is read from the device.

After the START condition, the I2C master sends a chip address. This address is seven bits long followed by an eighth bit which is a data direction bit (R/W). The 7-bit address is 0x63. For the eighth bit , a '0' indicates a WRITE and a '1' indicates a READ. The second byte selects the register to which the data is written. The third byte contains data to write to the selected register.

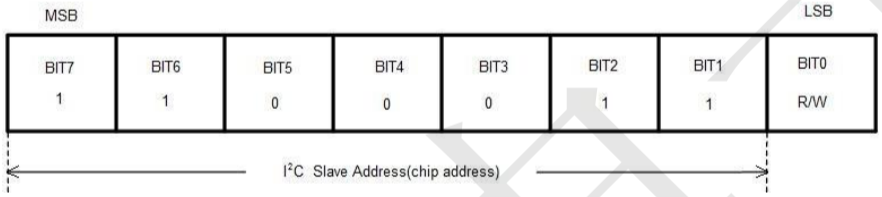


Write Cycle W = Write (SDA = "0") R = Read (SDA = "1") Ack = Acknowledge (SDA Pulled Down by Either Master or Slave) ID = Chip Address, 63h for LM3644YFFR-TP

Programming(continued)

I²C-Compatible Chip Address

The device address for the is 1100011(0x63). After the START condition, the I²C-compatible master sends the 7-bit address followed by an eighth read or write bit (R/W). R/W = 0 indicates a WRITE and R/W = 1 indicates a READ. The second byte following the device address selects the register address to which the data is written. The third byte contains the data for the selected register.



I²C-Compatible Chip Address

Register Descriptions

REGISTER NAME	INTERNAL HEX ADDRESS	POWER ON/RESET VALUE
Enable Register	0x01	0x80
IVFM Register	0x02	0x01
LED1 Flash Brightness Register	0x03	0xBF
LED2 Flash Brightness Register	0x04	0x3F
LED1 Torch Brightness Register	0x05	0xBF
LED2 Torch Brightness Register	0x06	0x3F
Boost Configuration Register	0x07	0x09
Timing Configuration Register	0x08	0x1A
TEMP Register	0x09	0x08
Flags1 Register	0x0A	0x00
Flags2 Register	0x0B	0x00
Device ID Register	0x0C	0x3A
Last Flash Register	0x0D	0x00

Programming(continued)

Enable Register (0x01)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
TX Pin Enable 0 = Disabled 1 = Enabled (Default)	Strobe Type 0 = Level Triggered (Default) 1 = Edge Triggered	Strobe Enable 0 = Disabled (Default) 1 = Enabled	TORCH/TEMP Pin Enable 0 = Disabled (Default) 1 = Enabled	Mode Bits:M1, M0 '00'=Standby (Default) '01' = IR Drive '10' = Torch '11' = Flash		LED2 Enable 0 = OFF (Default) 1 = ON	LED1 Enable 0 = OFF (Default) 1 = ON

NOTE:

1. Edge Strobe Mode is not valid in IR MODE. Switching between Level and Edge Strobe Types while the device is enabled is not recommended.
2. In Edge or Level Strobe Mode, it is recommended that the trigger pulse width be set greater than 1 ms to ensure proper turn-on of the device.

IVFM Register (0x02)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	UVLO Circuitry (Default) 0=Disabled (Default) 1=Enabled	IVFM Levels 000=2.9V (Default) 001=3V 010=3.1V 011=3.2V 100=3.3V 101=3.4V 110=3.5V 111=3.6V			IVFM Hysteresis 0=0mV (Default) 1=50mV	IVFM Selection 00=Disabled 01=Stop and Hold Mode (Default) 10=Down Mode 11=Up and Down Mode	

NOTE:

1. IVFM Mode Bits are static once the is enabled in Torch, Flash or IR modes. If the IVFM mode needs to be updated, disable the device and then change the mode bits to the desired state.

LED1 Flash Brightness Register (0x03)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LED2 Flash Current Override: 0=LED2 Flash Current is not set to LED1 Flash Current 1 = LED2 Flash Current is set to LED1 (Default)	LED1 Flash Brightness Level I_{FLASH}(mA)≈(Brightness Code×15.63mA)+15.63mA ..... 0111111=1000mA (Default) ..... 1111111=2A						

Programming(continued)

LED2 Flash Brightness Register (0x04)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	LED2 Flash Brightness Level I_{FLASH}(mA)≈(Brightness Code×15.63mA)+15.63mA ..... 0111111=1000mA (Default) ..... 1111111=2A						

LED1 Torch Brightness Register (0x05)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
LED2 Torch Current Override: 0 = LED2 Torch Current is not set to LED1 Torch Current 1=Torch Current is set to LED1 Torch Current (Default)	LED1 Torch Brightness Levels I_{TORCH} (mA)≈(Brightness Code×3.90mA)+ 3.90mA 0000000=3.90mA ..... 0111111=249.6mA (Default) ..... 1111111=499.2mA						

LED2 Torch Brightness Register (0x06)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	LED2 Torch Brightness Levels ITORCH (mA)≈(Brightness Code×3.90mA)+ 3.90mA 0000000=3.90mA ..... 0111111=249.6mA (Default) ..... 1111111=499.2mA						

Boost Configuration Register (0x07)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Software Reset Bit 0=Not Reset (Default) 1=Reset	RFU	RFU	RFU	LED Pin Short Fault Detect 0=Disabled 1=Enabled (Default)	Boost Mode 0=Normal (Default) 1=Pass Mode Only	Boost Frequency Select 0=2MHz (Default) 1=4MHz	Boost Current Limit Setting 0=1.9A 1=2.8A (Default)

Programming(continued)

Timing Configuration Register (0x08)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	Torch Current Ramp Time 000=No Ramp 001=1ms (Default) 010=32ms 011=64ms 100=128ms 101=256ms 110=512ms 111=1024ms			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			

TEMP Register (0x09)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	TORCH Polarity 0=Active High (Default)	NTC Open Fault Enable 0=Disabled (Default) 1=Enable	NTC Short Fault Enable 0=Disabled (Default) 1=Enable	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			TORCH/TEMP Function Select 0=TORCH (Default) 1=TEMP

NOTE: 1: The Torch Polarity bit is static once the is enabled in Torch, Flash or IR modes. If the Torch Polarity bit needs to be updated, disable the device and then change the Torch Polarity bit to the desired state.

Programming(continued)

Flags1 Register (0x0A)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
TX Flag	V_{OUT} Short Fault	V_{LED1} Short Fault	V_{LED2} Short Fault	Current Limit Flag	Thermal Shutdown (TSD) Fault	UVLO Fault	Flash Time-Out Flag

Flags2 Register (0x0B)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	RFU	RFU	NTC Short Fault	NTC Open Fault	IVFM Trip Flag	OVP Fault	TEMP Trip Fault

Device ID Register (0x0C)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	RFU	Device ID '111'			Silicon Revision Bit '010'		

Last Flash Register (0x0D)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
RFU	The value stored is always the last current value the IVFM detection block set. $I_{LED}= I_{FLASH-TARGET}\times((Code+1)/128)$						

Design Requirements

Input Capacitor Selection

Choosing the correct size and type of input capacitor helps minimize the voltage ripple caused by the switching of the boost converter and reduce noise on the boost converter's input pin that can feed through and disrupt internal analog signals. In the typical application circuit a 10-µF ceramic input capacitor works well. It is important to place the input capacitor as close as possible to the input (IN) pin. This reduces the series resistance and inductance that can inject noise into the device due to the input switching currents.

Output Capacitor Selection

When the boost converter is running, the output capacitor supplies the load current during the boost converter on-time. When the NMOS switch turns off, the inductor energy is discharged through the internal PMOS switch, supplying power to the load and restoring charge to the output capacitor. This causes a sag in the output voltage during the on-time and a rise in the output voltage during the off-time. The output capacitor is therefore chosen to limit the output ripple to an acceptable level depending on load current and input/output voltage differentials and also to ensure the converter remains stable. The output capacitance require depends on required current. A 10uF to 22uF ceramic capacitor works well in most situations.

Inductor Selection

The is designed to use a 0.47-µH or 1-µH inductor. When the device is boosting (VOUT> VIN) the inductor is typically the largest area of efficiency loss in the circuit. Therefore, choosing an inductor with the lowest possible series resistance is important. Additionally, the saturation rating of the inductor should be greater than the maximum operating peak current of the . This prevents excess efficiency loss that can occur with inductors that operate in saturation. For proper inductor operation and circuit performance, ensure that the inductor saturation and the peak current limit setting of the are greater than I_{PEAK} in the following calculation:

$$I_{PEAK} = \frac{I_{LOAD}}{\eta} \times \frac{V_{OUT}}{V_{IN}} + \Delta I_L$$

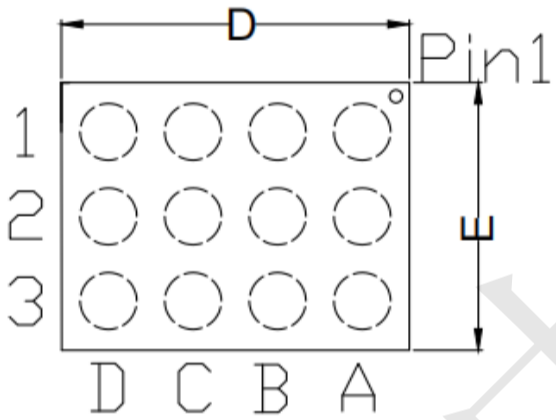
Where

$$\begin{cases} \Delta I_L = \dfrac{V_{IN} \times (V_{OUT} - V_{IN})}{2 \times f_{SW} \times L \times V_{OUT}} \\ f_{SW} = 2 \text{ or } 4MHz \end{cases}$$

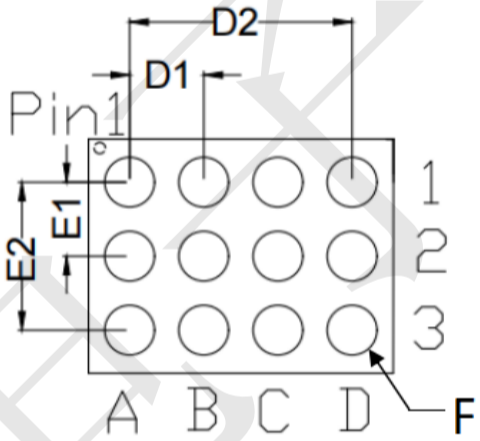
PACKAGE OUTLINE DIMENSIONS

WLCSP-12L

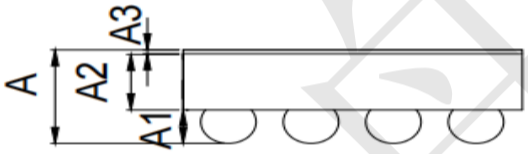
Top View



Bottom View



Side View



Symbol	Dimensions In Millimeters (Unit: mm)		
	Min	Mean	Max
A	0.5475	0.585	0.6225
A1	0.190	0.210	0.230
A2	0.3375	0.350	0.3625
A3	0.020	0.025	0.030
D	1.620	1.645	1.670
E	1.240	1.265	1.290
F	Φ0.248	Φ0.268	Φ0.288
D1		0.400	
D2		1.200	
E1		0.400	
E2		0.800	