IS32LT3168 SINGLE CHANNEL LINEAR LED DRIVER WITH HALL-EFFECT SWITCH AND FADE IN/FADE OUT

DESCRIPTION

The IS32LT3168 is a single channel linear programmable current regulator capable of up to 200mA. It operates as a stand-alone LED driver configurable with external resistors; a single external resistor programs the current level, while another resistor programs the Fade In/Out ramp rate for the channel.

The IS32LT3168 also integrates a low power and high sensitivity omnipolar Hall-effect switch to facilitate the use of a contactless control to the LEDs. The Hall-effect switch operates with either a north or a south magnetic pole. For different user requirements, the switch output polarity can be set by the dedicated POL pin to select whether the IS32LT3168 Hall-effect switch output goes low when a magnet is present or when the magnetic field is removed.

The device features 124 steps Fade In and Fade Out algorithm (Gamma correction) which causes the output LED current to gradually ramp up to the full source value after the ENB pin is pulled low. The same controller causes the LED current to gradually ramp down to zero if the ENB pin is pulled high. The fade ramp can be interrupted mid-cycle before completion of the ramp cycle. The ENB pin can be connected to either an external logic level for direct control, or the Hall-effect switch output for contactless control.

For 12V automotive applications the low dropout driver can support 1 to 3 LEDs per channel. It is offered in a small thermally enhanced SOP-8-EP package.

QUICK START

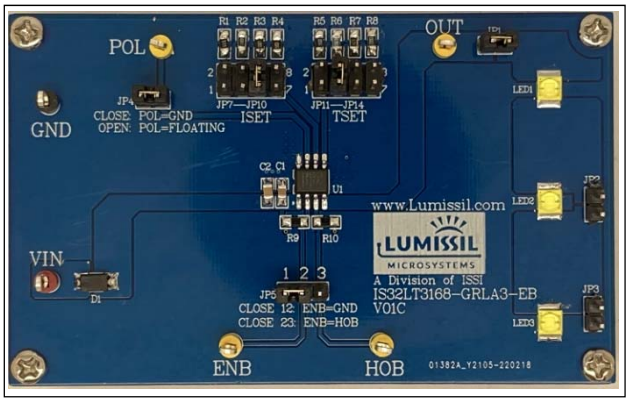

Figure 1: Photo of IS32LT3168 Evaluation Board

FEATURES

- Operating voltage 6.5V to 28V, maximum 36V
  - Withstand 40V load dump
- Super low standby current (50μA) when LED off
- Integrate omnipolar Hall-effect switch
- Hall-effect switch output
  - Drives additional circuits and/or LED drivers
  - Selectable output polarity
- Single channel current source
  - Programmable current via a single external resistor
  - Configurable from 20mA to 200mA
- ENB input pin driven for LED on/off with Fade In/Out effect
  - Gamma corrected Fade In/Out algorithm
  - Pull down resistors set Fade In/Out ramp time
- Fault Protection:
  - OUT pin shorted to GND
  - ISET pin shorted to GND
  - Thermal rolloff
  - Thermal shutdown
- SOP-8-EP package
- AEC-Q100 Qualified
- Operating temperature range from -40°C ~ +125°C

RECOMMENDED EQUIPMENT

- 12V, 1A DC power supply

ABSOLUTE MAXIMUM RATINGS

- ≤ 36V power supply

Caution: Do not exceed the conditions listed above, otherwise the board will be damaged.

PROCEDURE

The evaluation board is fully assembled and tested. Follow the steps listed below to verify board operation.

Caution: Do not turn on the power supply until all connections are completed.

1) Connect the ground terminal of the power supply to the GND and the positive terminal to the VIN. ***Note: The V_{CC} supply should be set close to the IS32LT3168 minimal headroom voltage of 1.5V (V_{CC} – Vout) for best thermal performance. The board can be operated with a larger headroom voltage as long as the increase in package temperature is monitored. Exceeding the device package temperature specification will cause the device to enter thermal protection mode.***

2) The output current can be adjusted by R1~R4 resistors using Table 1 jumpers (JP7~JP10) setting.

JP7	JP8	JP9	JP10	R_{ISET} (kΩ)	I_{OUT} (mA)
1	0	0	0	0.51	196
0	1	0	0	0.68	147
0	0	1	0	1	100
0	0	0	1	5.1	19.6

Table 1 Output Current Jumper Setting

Note: "1" means jumper close and "0" means jumper open.

3) The fade in/out time can be adjusted by R5~R8 resistors using Table 2 jumper (JP11~JP14) setting.

JP11	JP12	JP13	JP14	R_{TSET} (kΩ)	Fade time
1	0	0	0	15	240
0	1	1	0	40.88	654.1
0	1	0	1	48.37	773.9
0	1	0	0	62	992
0	0	1	1	77.65	1242.4
0	0	1	0	120	1920
0	0	0	1	220	3520

Table 2 Fade Time Jumper Setting

4) Polarity of HOB can be set by JP4. When JP4 open, POL pin is floating, and HOB pin will be active-low as the magnetic field is present. When JP4 close, POL pin is grounded, and HOB pin will be active-low as the magnetic field is removed.

5) There is an onboard LED string (LED1~LED3) which can be adjusted from 1 to 3 LEDs by jumpers, JP2 and JP3. Close the jumper to short the corresponding LED. Open jumper to enable the corresponding LEDs. JP1 is used to connect the IC OUT pin to the onboard LED string (LED1~LED3). If the JP1 is open, the onboard LED string will be disabled and the driver board can be used to drive a remote LED string, anode connected to OUT terminal and cathode connected to GND terminal.

6) ENB pin can be controlled by jumper JP5. When close JP5-1 and JP5-2, ENB pin is grounded, and LEDs are forced ON without internal Hall-effect switch control. When close JP5-2 and JP5-3, ENB pin is tied to HOB pin and LEDs are controlled by the integrated Hall-effect switch.

7) Turn on the power supply and an external magnet can be used to change the LED state.

POL	Magnet Field > $\|B_{OPx}\|$	ENB Pin	LED State
GND (JP4 Closed)	-	Close JP5-1/2	ON
	Present	Close JP5-2/3	OFF
	Remove	Close JP5-2/3	ON
Float (JP4 Open)	-	Close JP5-1/2	ON
	Present	Close JP5-2/3	ON
	Remove	Close JP5-2/3	OFF

Table 3 LED Control Setting

ORDERING INFORMATION

Part No.	Temperature Range	Package
IS32LT3168-GRLA3-EB	-40°C ~ +125°C (Automotive)	SOP-8-EP, Lead-free

Table 4: Ordering Information

For pricing, delivery, and ordering information, please contact Lumissil's analog marketing team at analog@Lumissil.com or (408) 969-6600.

EVALUATION BOARD OPERATION

The IS32LT3168 is a single channel linear current driver optimized to drive a high current LED string for automotive illumination applications which is frequently toggled between the ON and OFF condition. The LED activity can be controlled by the integrated omnipolar Hall-effect switch, external circuits or by a PWM signal from an MCU.

SETTING THE FADE TIME

The fade time (In or Out) is set by an external programming resistor, R_{TSET}, connected between the TSET pin and GND. The fade time (In or Out) is programmable by Equation (1):

$$t_{FADE} \approx R_{TSET} \times 16 \times 10^{-6} \qquad (1)$$

For example, R_{TSET}=20kΩ, Fade In/Out time is about 0.32s.

Note: In order to get the optimized effect, the recommended fading time is between 3.5s (R_{TSET}=219kΩ) and 0.25s (R_{TSET}=15.6kΩ).

If the TSET pin is tied directly to GND, the fade function is disabled and the ramp time is about 7μs (Typ.), or "instant on".

OUTPUT CURRENT SETTING

A single programming resistor (R_{ISET}) controls the maximum output current for output channel. The programming resistor may be computed using the following Equation (2):

$$R_{ISET} = \frac{100}{I_{OUT}} \qquad (2)$$

(0.5kΩ≤R_{ISET}≤5kΩ)

The device is protected from an output overcurrent condition caused by an accidental short circuit of the ISET pin, by internally limiting the maximum current in the event of an ISET short circuit to 255mA (Typ.).

THERMAL ROLLOFF

The output current will be equal to the set value as long as the die temperature of the IC remains below 145°C (Typ.). If the die temperature exceeds this threshold, the output current of the device will begin to reduce at a rate of 3.25%/°C (Typ.) until thermal shutdown (Typ. 165°C).

FAULT DETECTION

An output shorted to GND fault is detected if the output voltage on the channel drops below the low voltage threshold V_{SCD} and remains below the threshold for t_{FD}. The channel (OUT) with the short condition will reduce its output current to 3.6mA (Typ.). When the short condition is removed, the output current will recover to original value.

When the ISET pin is shorted to GND and output current is larger than limit value, about 255mA (Typ.), the output current will be clamped. Once the short fault condition is removed, the output current will recover to its original value.

OMNIPOLAR HALL-EFFECT SWITCH

The integrated Hall-effect switch in the IS32LT3168 is an omnipolar switch. The HOB pin is an open drain output of the Hall-effect switch, so it requires an external pull-up resistor for logic high output. The HOB output transistor is capable of sinking current up to a current limit I_{HOB_LIM}. It switches when a magnetic field B_{FIELD} perpendicular to the Hall sensor exceeds the operate point threshold, B_{OPx} (B_{FIELD} > B_{OPS} or B_{FIELD} < B_{OPN}). When magnetic field is reduced below the release point, B_{RPx} (B_{FIELD} < B_{RPS} or B_{FIELD} > B_{RPN}), the HOB output goes to the opposite state. The difference in the magnetic operate and release points is the hysteresis, B_{HYS}, of the device. This built-in hysteresis allows clean switching of the output even in the presence of external mechanical vibration and electrical noise.

The HOB output state polarity is determined by the POL pin, reference Table 5. The POL pin should only be tied to ground or floated to achieve the desired output polarity. The HOB output can be used to control either the LED driver and/or external circuit.

POL	$\|B_{FIELD}\|$	HOB State	LED State
GND	> $\|B_{OPx}\|$	Pulled High	Off
	< $\|B_{RPx}\|$	Low	On
Float	> $\|B_{OPx}\|$	Low	On
	< $\|B_{RPx}\|$	Pulled High	Off

Table 5 POL vs. HOB and LED State

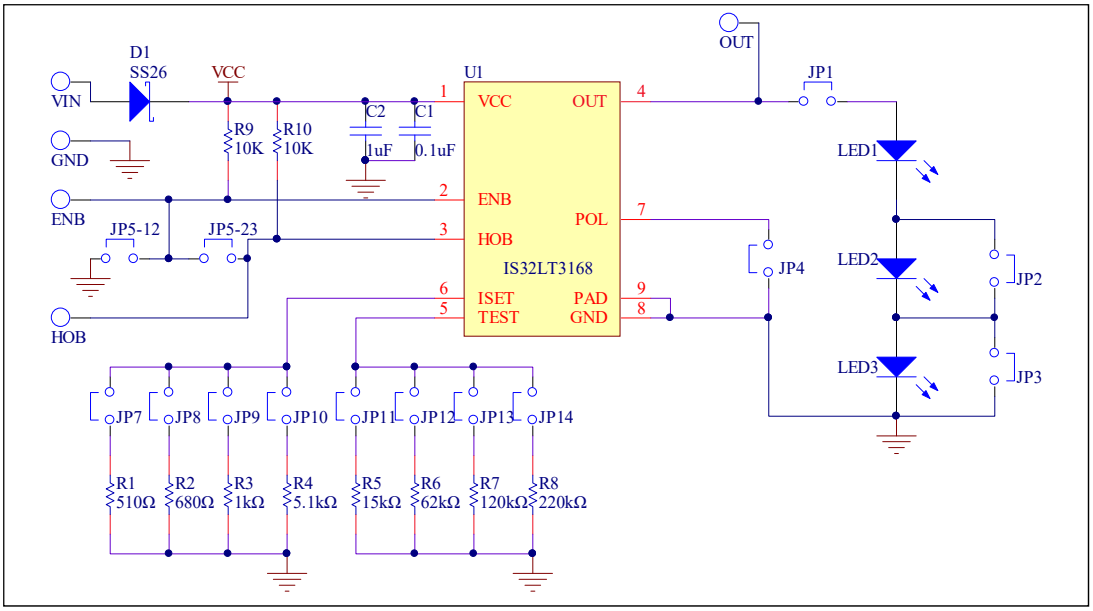

Figure 2: IS32LT3168 Application Schematic

BILL OF MATERIALS

Name	Symbol	Description	Qty	Supplier	Part No.
LED Driver	U1	LED Driver with Hall-effect swtich	1	Lumissil	IS32LT3168
Resistor	R9, R10	RES,10k,1/8W,±1%,SMD	2	YAGEO	AC0805FR-0710KL
Resistor	R1	RES,510R,1/8W,±1%,SMD	1	YAGEO	AC0805FR-07510RL
Resistor	R2	RES,680R,1/8W,±1%,SMD	1	YAGEO	AC0805FR-07680RL
Resistor	R3	RES,1k,1/8W,±1%,SMD	1	YAGEO	AC0805FR-071KL
Resistor	R4	RES,5.1k,1/8W,±1%,SMD	1	YAGEO	AC0805FR-075K1L
Resistor	R5	RES,15k,1/8W,±1%,SMD	1	YAGEO	AC0805FR-0715KL
Resistor	R6	RES,62k,1/8W,±1%,SMD	1	YAGEO	AC0805FR-0762KL
Resistor	R7	RES,120k,1/8W,±1%,SMD	1	YAGEO	AC0805FR-07120KL
Resistor	R8	RES,220k,1/8W,±1%,SMD	1	YAGEO	AC0805FR-07220KL
Capacitor	C2	CAP,1μF,50V,±10%,SMD	1	YAGEO	AC0805KKX7R9BB105
Capacitor	C1	CAP,0.1μF,50V,±10%,SMD	1	YAGEO	AC0805KKX7R9BB104
Diode	D1	2A,60V	1	Vishay	VSS8D2M6HM3/H

Bill of materials, refer to Figure 2 above.

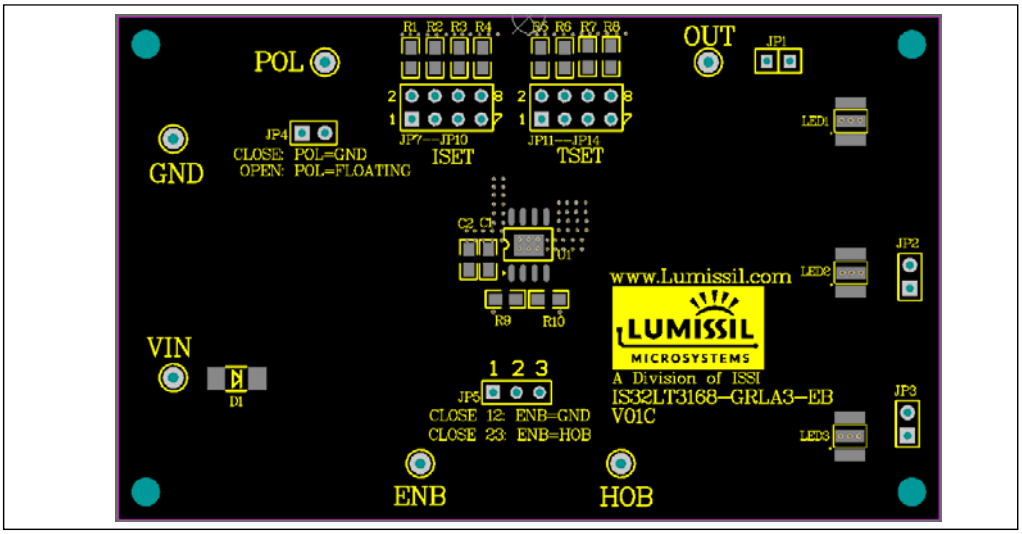

Figure 3: Board Component Placement Guide - Top Layer

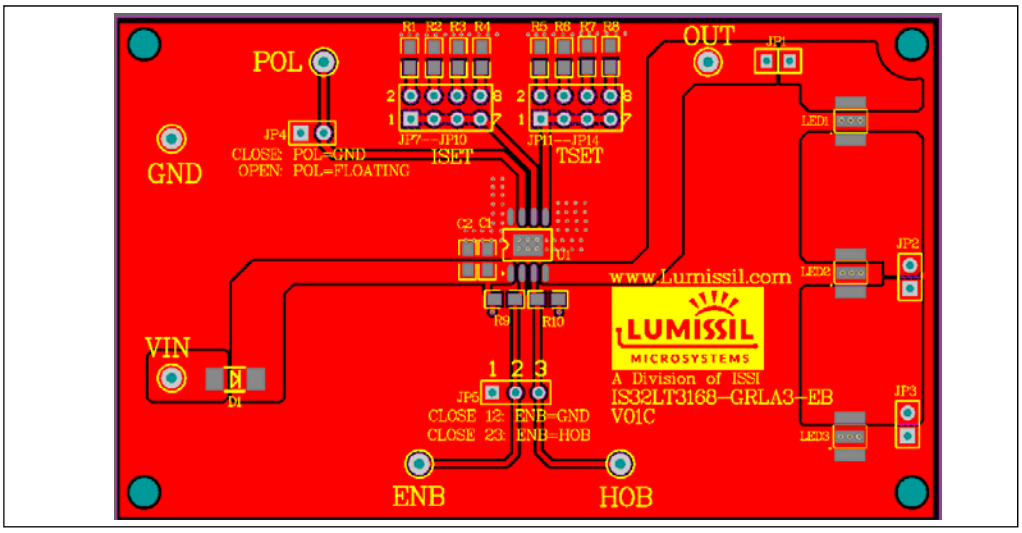

Figure 4: Board PCB Layout - Top Layer

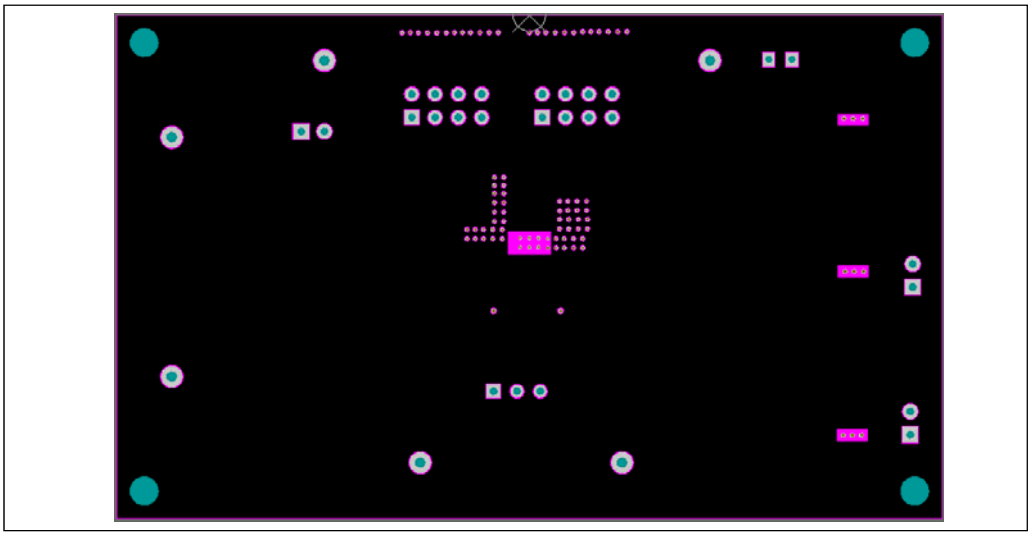

Figure 5: Board Component Placement Guide - Bottom Layer

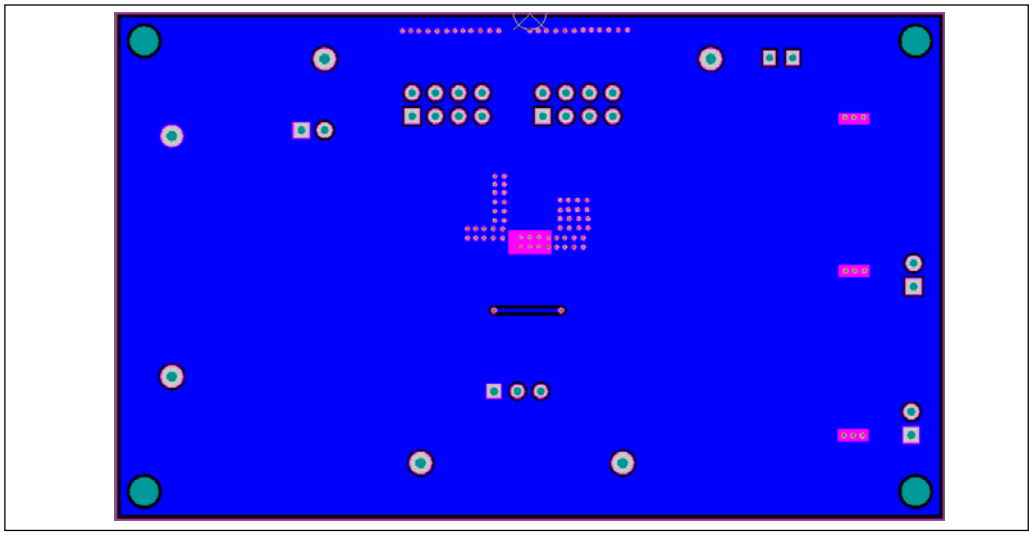

Figure 6: Board PCB Layout - Bottom Layer

REVISION HISTORY

Revision	Detail Information	Data
A	Initial Release	2022.05.09