

# IS32LT3140 & 41 Single Channel LED Driver for Automotive Rear Lighting Applications

Single channel 450mA, with thermal shunt resistor and single LED short detection



## AUTOMOTIVE REAR LIGHT

LED lighting is increasingly popular in automotive lighting due to lower cost, design flexibility and increased efficiency. LED drivers in various topologies such as Linear, Buck, Boost and Buck Boost are used in various automotive exterior lighting applications. The low-cost monolithic solution reduces the number of components and significantly improves current accuracy and reliability compared to discrete solutions.

## REAR LIGHT FUNCTION AND ARCHITECTURES

In a typical rear lamp, there are several light functions like stop, tail, turn, fog, and reverse. In a classic basic rear lamp system, each light function gets powered by the body control module from a dedicated high side switch. Also, the diagnostic is implemented in the high side switches in the BCM.

In automotive rear lighting applications, the LED driver power architectures can be split into a single stage or dual stage. In a single stage architecture, the LED drivers are supplied directly by the battery voltage. The dual stage architecture consists of a voltage pre-regulator followed by the LED drivers. Both of the architectures can be found in rear light applications.



- Rear light function
  - ✓ Stop
  - ✓ Tail
  - ✓ Turn indicate
  - ✓ Rear fog
  - ✓ Reverse/Back up
  - ✓ CHMSL

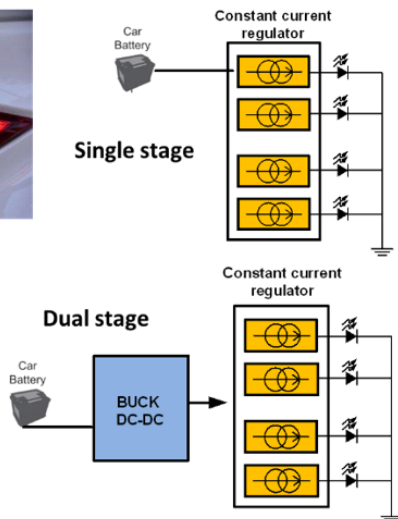


FIGURE 1 - REAR LIGHT FUNCTIONS AND ARCHITECTURES

## REAR LIGHT DESIGN CHALLENGES

The major challenges in Rear light design involves the addressing the following factors below:

- Higher power demand
- Thermal management
- Electromagnetic Interference (EMI)
- Fault detection and protection

## INTRODUCING IS32LT3140&41 FOR REAR LIGHT

The IS32LT3140&41 product family is a single output LED Driver capable of 450mA. To manage the thermals created by the high power demand, an optional thermal shunt resistor can be used to significantly optimize IC power dissipation. It supports either PWM dimming via a PWM pin or power supply modulation (PSM). In addition, the IS32LT3140&41 integrates fault protection for a single LED short, LED string open/short, output overcurrent (not reported), and over-temperature condition for robust operation. Detection of these failures is reported by the FAULTB pin. When a fault is detected the device will disable itself and output an active low open drain signal. Multiple devices can have their FAULTB pins connected to create a “one-fail-all-fail” condition. The device is offered in a small thermally enhanced eTSSOP-14 or SOP-8-EP package. In addition, IS32LT3141 support one-wire serial bus, An external MCU can easily control output ON/OFF of multiple IS32LT3141 slaves through a one-wire serial bus. Onewire bus control can save the MCU I/O. The product family is automotive AEC-Q100 qualified.

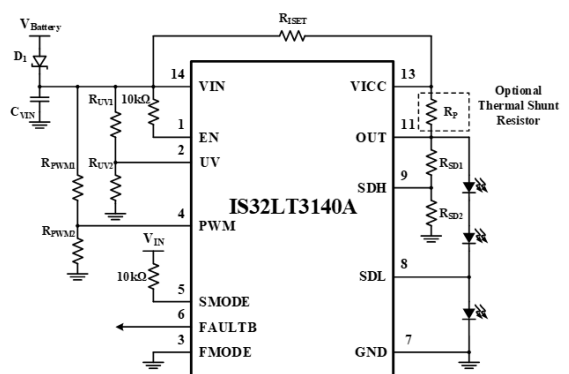


FIGURE 2 - IS32LT3140A TYPICAL CIRCUIT

**IS32LT3140&41: THERMAL SHARING**

IS32LT3140 & 41 device begins current regulation when the voltage drop on the output source, called headroom voltage  $V_{HR}$ , exceeds the min headroom voltage  $V_{HR\_MIN}$ . The power dissipation on the device will be proportional to the headroom voltage and LED current  $I_{LED}$ . With a given LED string voltage ( $V_{LED}$ ) and output current ( $I_{LED}$ ), the higher the input voltage the larger the power dissipation on the device. Linear drive heat dissipation problems lead to great limitations in the use of high currents in the design. To support the higher current, the thermal shunt resistor ( $R_p$ ) is essential.

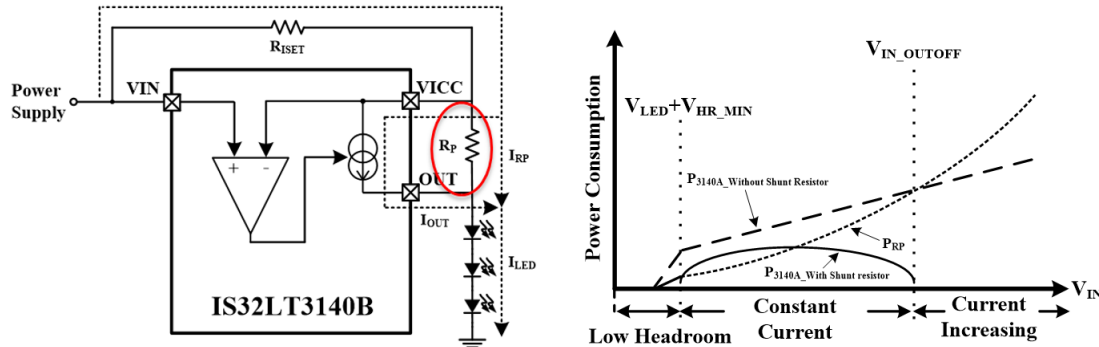
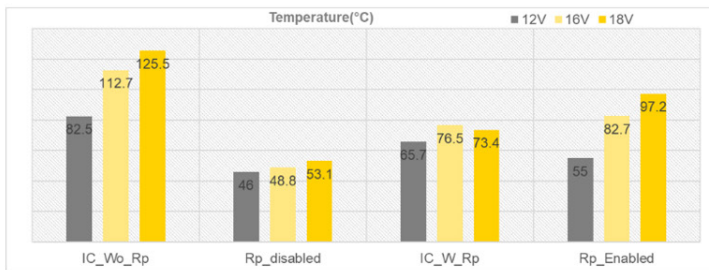


FIGURE 3 - THERMAL SHUNT RESISTOR AND POWER DISTRIBUTION

With the shunt resistor, it can optimize the IC power dissipation. The table below compares the temperature increase on the IC with and without the shunt resistor. Under the same test condition, the IC temperature sees significant reduction helping the overall system reliability.



IS32LT3140A	I <sub>out</sub> =200mA, V <sub>out</sub> =6V					
	Without R <sub>p</sub>			With R <sub>p</sub> =80R		
V <sub>IN</sub> (V)	IC (°C)	R <sub>p</sub> (°C)	LED(°C)	IC (°C)	R <sub>p</sub> (°C)	LED(°C)
12	82.5	46	72.4	65.7	55	72
16	112.7	48.5	72.3	76.5	82.7	76
18	125.5	53.1	76	73.7	97.2	74.8

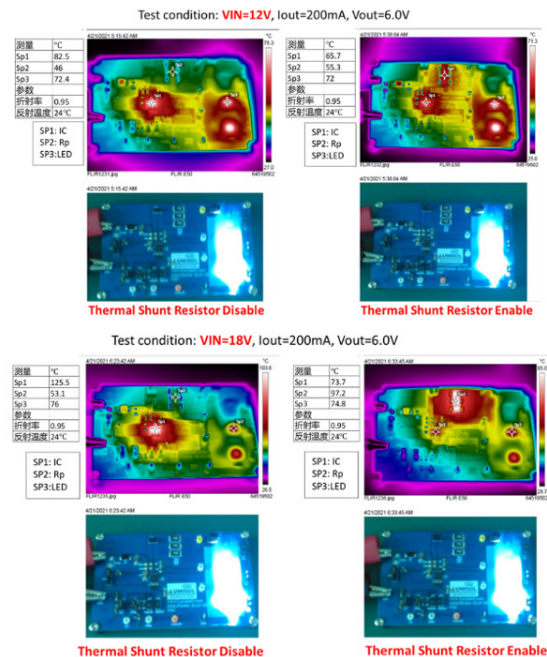


FIGURE 4 - WITH/WITHOUT THERMAL RESISTOR TEMPERATURE COMPARISON

Note the current through the R<sub>p</sub> shunt resistor is always present and CANNOT be shut off by the device. Therefore, the R<sub>p</sub> shunt resistor should not be implemented if the output current has to be turned off. If shutdown mode is Enabled, PWM dimming is needed or “one fail all fail” mode fault protection is to be implemented, the R<sub>p</sub> shunt resistor should not be used since they require turning off the output current. Only when using power supply modulation (PSM) for dimming then using R<sub>p</sub> shunt resistor can be used.

**IS32LT3140&41: FAULT DETECTION AND REPORTING**

For robust system reliability, the IS32LT314x family of products integrates the detection circuitry to protect under various fault conditions. It then reports the fault conditions on the FAULTB pin which can be monitored by an external host. The fault protections include LED string open/short, single LED short, output over-current (not reported) and thermal shutdown. IS32LT3140A&41A add two fault modes select pins to support more fault actions. Selectable ‘one fail all fail’ or ‘one fail

other on'. Multiple devices can have their FAULTB pins connected to create a "one-fail-all-fail" condition. IS32LT3140A & 41A option supports the single LED short detection but IS32LT3140B & 41B does not.

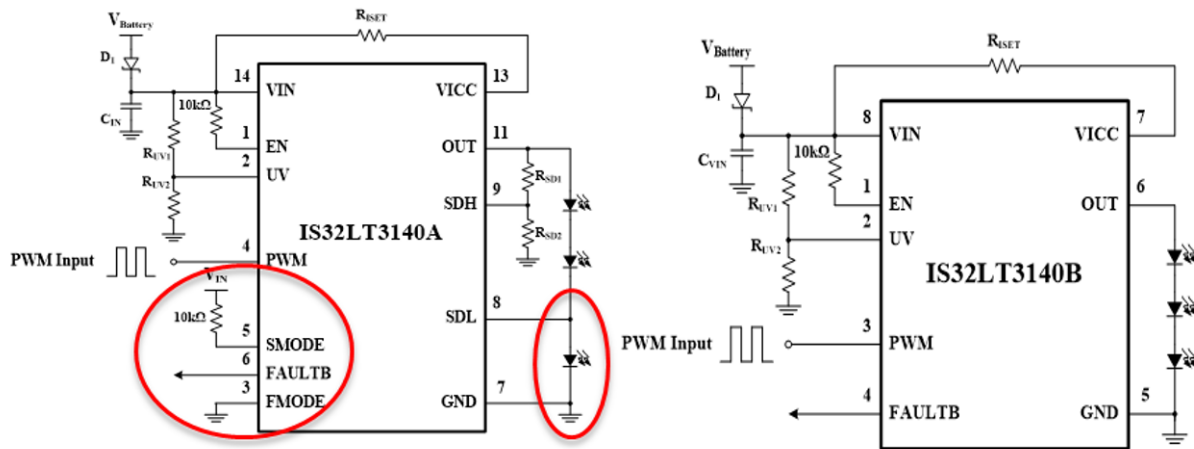


FIGURE 5 - IS32LT3140A VS IS32LT3140B

**IS32LT3141A/B: ONE-WIRE SERIAL BUS**

An external MCU can easily control the output ON/OFF for multiple IS32LT3141A/B slaves through an onewire serial BUS. The protocol uses a single data line with cascaded connection between slaves for data transmission. A clock is not required as each slave is clocked by an internal oscillator which is synchronized with an in-coming command frame from the MCU. Therefore, this protocol significantly simplifies the MCU I/O requirement. The onewire serial BUS implements simplex communication and a single push-pull I/O can control up to 30 slaves.

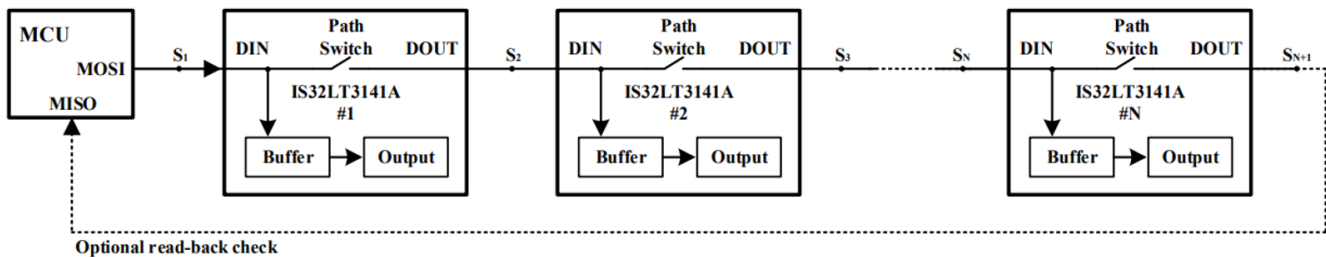


FIGURE 6 - ONE-WIRE SERIAL BUS CONNECTION

**IS32LT3140 & 41 PRODUCT DIFFERENTIATING FEATURE TABLE**

Device Number	Single LED short detection	Single LED short fault, output latch off	On fail other all	On fail all fail	Onewire serial BUS	Package Size
IS32LT3140A	Yes	Yes	Yes	Yes	No	eTSSOP-14
IS32LT3140B	No	No	No	Yes	No	SOP-8-EP
IS32LT3141A	Yes	Yes	Yes	Yes	Yes	eTSSOP-14
IS32LT3141B	No	No	No	Yes	Yes	SOP-8-EP

**SUMMARY**

IS32LT3140/41 family is a versatile family of single channel LED drivers for high current Automotive exterior lighting applications. It's thermal sharing scheme with serial communication bus and built in fault protection makes it easy to use and is thermally efficient providing a compact and cost effective solution.

**CONTACT:**

Questions or feedback may be sent to:

Ven Shan

Vice President, Lumissil Products

vshan@lumissil.com