C 7692

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The NCV7692 is a device which uses an external NPN bipolar device combined with feedback resistor(s) to regulate a current for use in driving LEDs. The target application for this device is automotive rear combination lamps. A single driver gives the user flexibility to add single channels to multichannel systems. A dedicated dimming feature is included via the PWM input pin. The individual driver is turned off when an open load or short circuit is detected.

LED brightness levels are easily programmed using an external resistor in series with the bipolar transistor. The use of the resistor gives the user the flexibility to use the device over a wide range of currents. Multiple strings of LEDs can be operated with a single NCV7692 device. Set back power limit reduces the drive current during overvoltage conditions.

The device is available in a SOIC−8 package.

Features

- Constant Current Output for LED String Drive
- External Bipolar Device for Wide Current Range Flexibility
  - With BCP56 Transistor, Can Drive Multiple Strings Concurrently (ref. Datasheet Info)
- External Programming Current Resistor
- Pulse Width Modulation (PWM) Control
- Negative Temperature Coefficient Current Control Option
- Open LED String Diagnostic
- Short−Circuit LED String Diagnostic
- Multiple LED String Control
- Overvoltage Set Back Power Limitation
- SOIC−8 Package
- AEC−Q100 Qualified and PPAP Capable
- These are Pb−Free Devices

Applications

- Rear Combination Lamps (RCL)
- Daytime Running Lights (DRL)
- Fog Lights
- Center High Mounted Stop Lamps (CHMSL) Arrays
- Turn Signal and Other Externally Modulated Applications
- General Automotive Linear Current LED Driver

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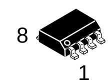
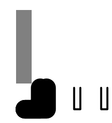


SOIC−8
CASE 751AZ

MARKING DIAGRAM



IC (Pb−Free)

ORDERING INFORMATION

Device	Package	Shipping†
NCV7692D10R2G	SOIC−8 (Pb−Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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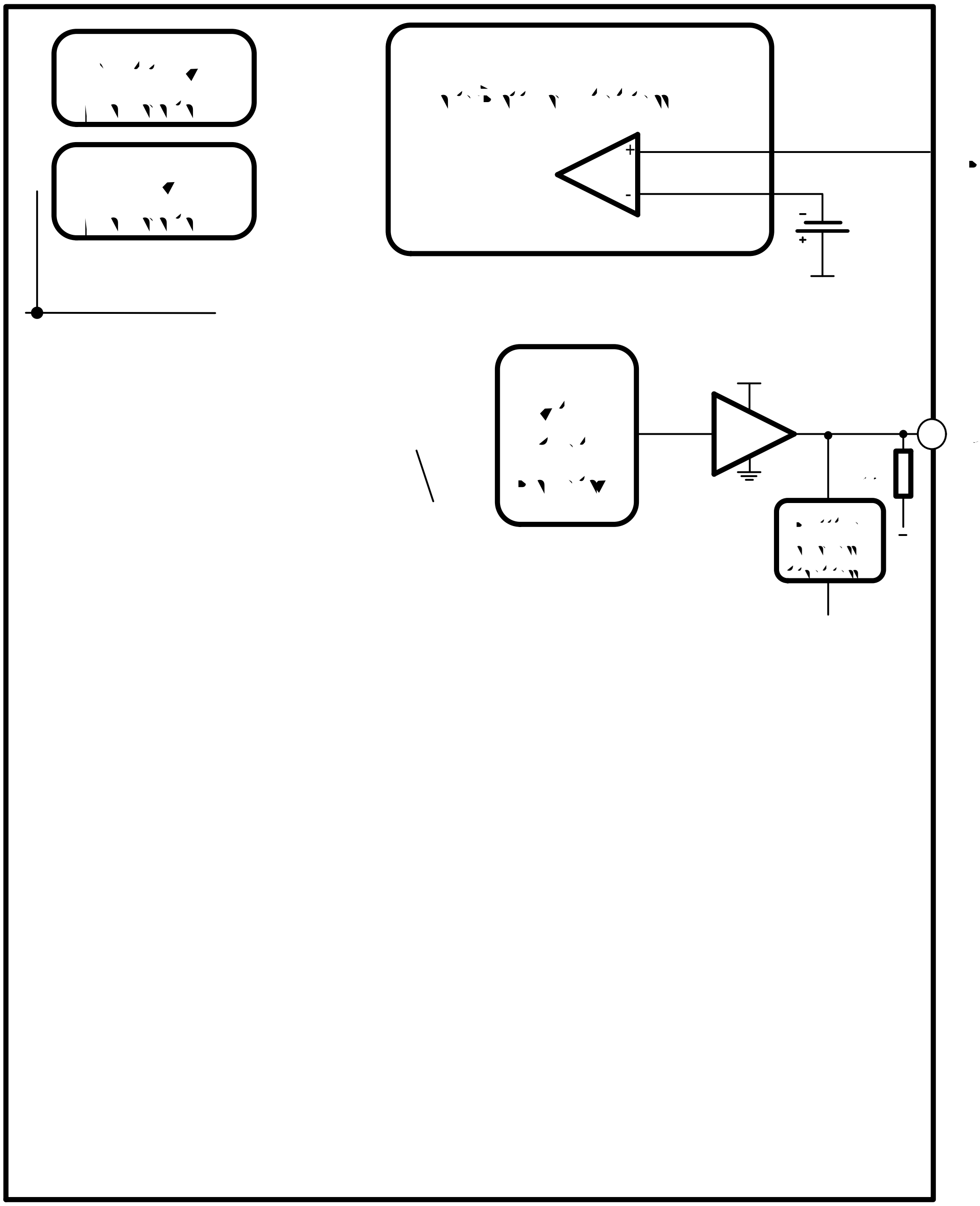


Figure 3. Block Diagram

MAXIMUM RATINGS
(Voltages are with respect to GND, unless otherwise specified)

Rating	Symbol	Value	Unit
Supply Voltage (VS) DC Peak Transient	V_S	 −0.3 to 50 50	V
High Voltage Pins (PWM, SC)	V_{HV}	−0.3 to (VS + 0.3)	V
Low Voltage Pins (FB, NTC)	V_{LV}	−0.3 to 3.6	V
Low Voltage Pin (BASE)	V_{BASE}	−0.3 to 3.6 or VS + 0.6, whichever is lower	V
Fault Input / Output (FLTS)	V_{FLTS}	−0.3 to (VS + 0.3) *Internally limited charge voltage	V
Junction Temperature, T_J	T_J	−40 to +150	°C
Peak Reflow Soldering Temperature: Pb−Free, 60 to 150 seconds at 217°C (Note 1)	T_P	260 peak	°C

Stresses

ELECTRICAL CHARACTERISTICS

(4.5 V < VS < 18 V, C_{FLTS} = 0.1 μF, R1 = 1 Ω, Transistor NPN = BCP56, −40°C ≤ T_J ≤ 150°C, unless otherwise specified) (Note 4)

Characteristic	Conditions	Min	Typ	Max	Unit
General Parameters					
Supply Current in normal condition	VS = 14 V, PWM = High, Base Current subtracted	−	3.0	4.0	mA
	VS = 14 V, PWM = 0	−	1.6	2.5	mA
Supply Current in fault condition	VS = 14 V, PWM = High V_{FLTS} ≥ FLTS Clamp (5.0 V typ.)	−	1.8	2.8	mA
Under Voltage Lockout	VS rising	3.5	4.0	4.5	V

[redacted]

− VS rising

ELECTRICAL CHARACTERISTICS

(4.5 V < VS < 18 V, C_{FLTS} = 0.1 μF, R1 = 1 Ω, Transistor NPN = BCP56, −40°C ≤ T_J ≤ 150°C, unless otherwise specified) (Note 4)

Characteristic	Conditions	Min	Typ	Max	Unit
Short Circuit					
Short Circuit Detection Threshold		VS − 1.7	VS − 2	VS − 2.3	V

APPLICATIONS INFORMATION

Detailed Operating Description

The NCV7692 device provides low−side current drive via an external bipolar transistor. The low voltage (152 mV) current sense threshold allows for maximum dropout voltage in the system. Dimming is performed using the dedicated PWM pin on the IC. Average output current is directly related to the intensity of the LED (or LED string).

Output Drive

Figure 4 shows the typical output drive configuration. A feedback loop regulates the current through the external LED. U1 monitors the voltage across the external sense resistor (R1). When the voltage exceeds the 152 mV reference, the output of U1 goes from high to low sending a signal the buffer (U2) decreasing the base drive to the external transistor (BCP56). For loads above 150 mA, a PZT651device (replacing the BCP56) is recommended for stable operation.

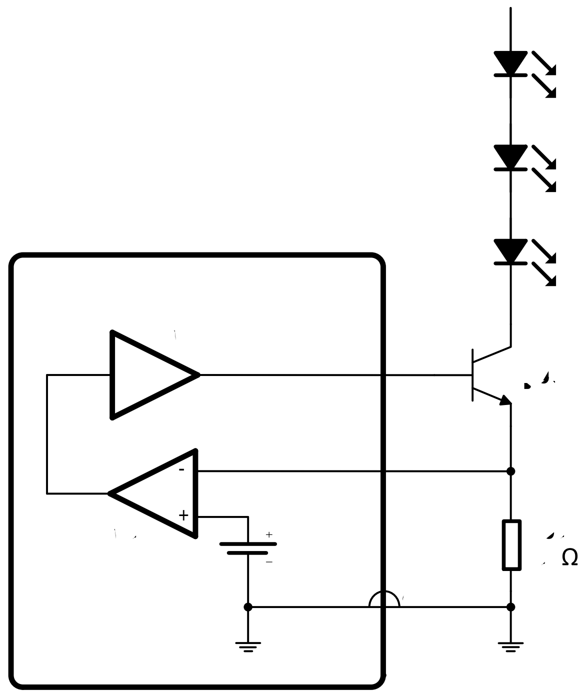


Figure 4. Output Drive Configuration

Open Load Detection

Faulted output strings due to open load conditions sometimes require the complete shutdown of illumination within an automotive rear lighting system. The NCV7692

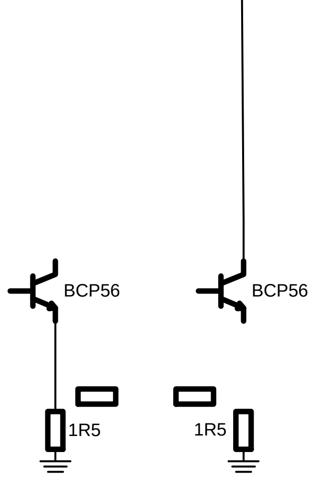


Figure 6. Improved Open Load Detection for Multiple Strings

Temperature Compensation

The NCV7692 device typically operates with a zero TC output current source. The NTC (Negative Temperature Coefficient) pin provides an alternative for an output current which degrades with temperature as defined by the designer's external components.

Zero TC operation is provided when the NTC pin is connected to GND. When a negative temperature coefficient output current is desired to compensate for effects of external LED illumination, the setup shown in Figure 9 will provide the function. On the NTC pin, a comparator detects when the voltage is higher than typ 220 mV, and this voltage is used to provide the feedback reference voltage for the current feedback regulation loop.

The zener provides a reference voltage for the negative temperature coefficient NTC device through an external divider. Be careful of your choice of the zener diode as the temperature coefficients of the devices have a wide variation with the low voltage zeners having a high negative temperature coefficient and the high voltage zeners having a positive temperature coefficient. The regulation loop voltage on NTC should be sufficiently higher than the 220 mV reference voltage to avoid interactions. A typical regulation voltage of 1.6 V is suggested.

The overall tolerance specification for the NTC functionality is broken down into two components.

1. Absolute error. A ±2% tolerance is attributed to the expected value as a result of internal circuitry (most predominantly the 1/10 resistor divider).
2. Reference error. A ± 7mV offset mismatch in the circuitry referenced to FB.

This provides a part capability of $(V(NTC)/10) \times 0.98 - 7mV < V(FB) < (V(NTC)/10) \times 1.02 + 7mV$.

In addition to the temperature coefficient of the Zener diode (D1), a PTC resistor (R2) can be used to enhance the effect of the overall negative temperature coefficient. A positive temperature coefficient resistor at the top of the resistor divider creates a negative temperature coefficient at the resistor divider output. Alternatively, a negative temperature coefficient resistor for R3 would have the same effect.

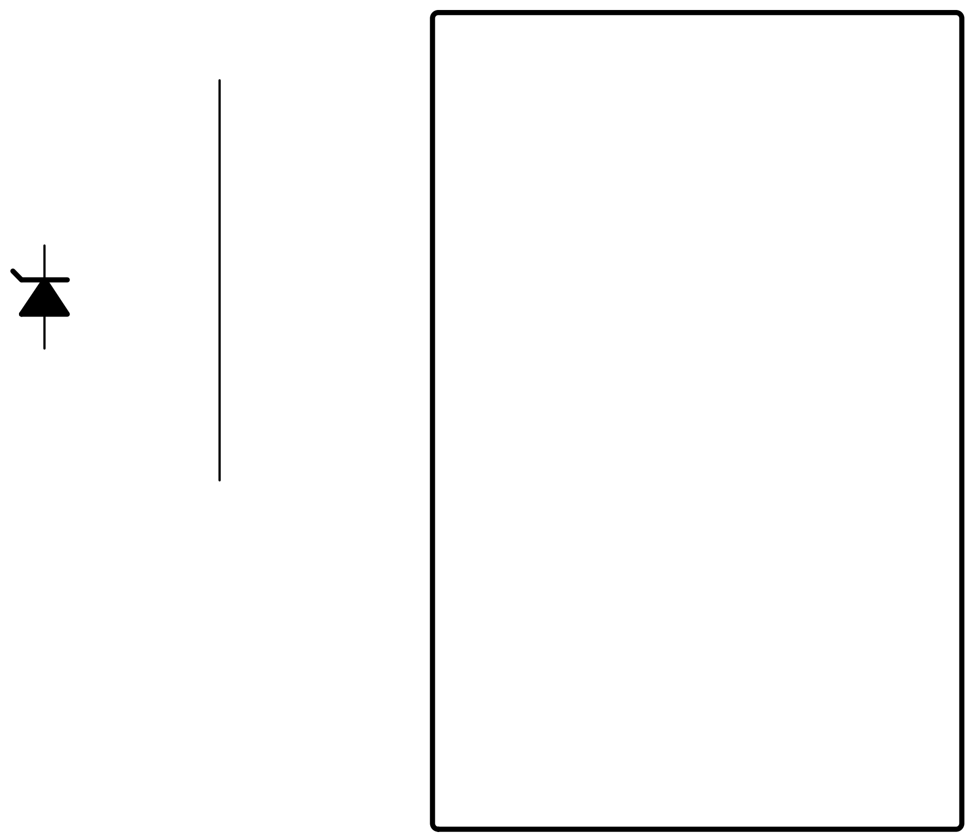


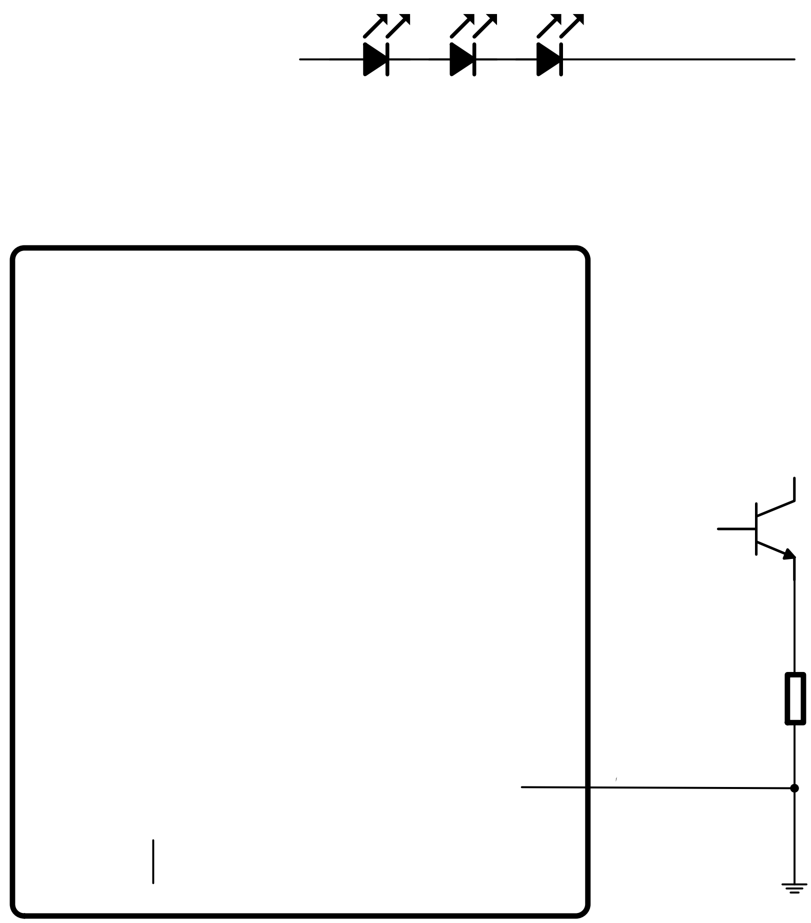
Figure 9. Negative Temperature Compensation Operation

Short Circuit Detection

The short circuit (SC) pin of the device is used as an input to detect a fault when the collector of the external bipolar transistor is shorted to the battery voltage. The threshold voltage detection is referenced 2.0 volts down from the VS pin. A voltage of less than 2.0 volts between VS and SC will latch the device off. The PWM pin must be toggled or UVLO event must occur to reinitiate a turn−on. The detection time for this event is swift to protect the external transistor. To maintain operation during transient events down to 4.5 V, the short circuit detection circuitry is inactive below VS = typ 5.1 V. (the same Open Load Disable voltage as used to disable Open load detection). Otherwise false short circuit events could be falsely triggered due to non−conduction of the external LEDs during transients. Figure 10 shows a short circuit event modeled as a switch (S1). The comparator connected between VS and SC is referenced to a voltage 2.0 V down from VS. A detection voltage less than 2.0 V will toggle a signal from the comparator to the output drive buffer turning off output drive (BASE) to the external bipolar transistor. An initial blanking time of 23 μs is used during turn−on of the device to ignore false detections. This is beneficial during normal operation and when the device is used without a microprocessor input (PWM) interface as in Figure 10.

Switching off the Base−driver in case of SC, will also make the FLTS charge active, indicating the error to the microprocessor.

When having multiple channels an isolation might be needed to provide the appropriate voltage back to the SC pin during short circuit. Figure 11 shows how external diodes can provide this feature.



Short Circuit Detection is disabled below 5.1 V (typ).

Figure 10. Short Circuit Detection

Short Circuit Detection with 4 or more Channels

Interfacing the short circuit detection for multiple channels with one NCV7692 driver system is done easily using diodes or a diode resistor combination depending on your system requirements.

Figure 11 shows the implementation using 4 individual diodes which will work for all applications.

Figure 12 shows an implementation which will work provided the drop across the loads is < 3.4 V. This limitation is due to the SC minimum specification of VS − 1.7 V. This setup saves the user 2 diodes.

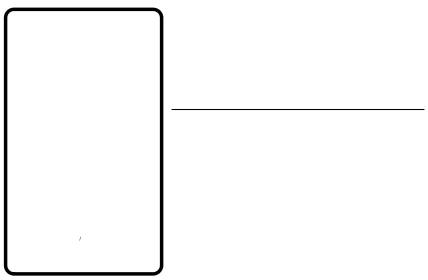


Figure 11. Short Circuit Detection with 4 or more Channels

Thermal ShutDown

The thermal shut down circuit checks the internal junction temperature of the device. When the internal temperature rises above the Thermal shutdown threshold for greater than the thermal shutdown filter time (23 μs [typ]) the device is switched off. The filter is implemented to achieve a clean detection.

Switching off the Base−driver in case of TSD, will also make the FLTS charge active, indicating the error to the microprocessor.

Applications

Direct Drive without direct battery connection:

Some applications may not allow for a direct connection of VS to the battery voltage. These applications require a connection with a smart−FET. Figure 13 highlights this setup.

Stoplight / Tail Light Application

Automotive applications have a need to drive the RCL (Rear Combination Light). Combining the NCV7692 with the NCV1455B device accomplishes that task. Figure 14 shows the interface of the two ICs using an additional diode (D2). The STOP input signal provides a signal to the NCV7692 which will provide a 100% duty cycle output to the LED strings whenever STOP is high. When only TAIL is high, a modulated duty cycle input is provided to the PWM input and also provides power to the NCV7692 and the LED string. The NCV1455B can provide up to 200 mA (albeit with a 2.5 V drop at 200 mA) of output drive current.

If your application exceeds the current capability of the NCV1455B (200mA) two extra diodes will be required as shown in Figure 15. In this case, the current flow through the LEDs will come from STOP and/or TAIL eliminating the high current from the NCV1455B.

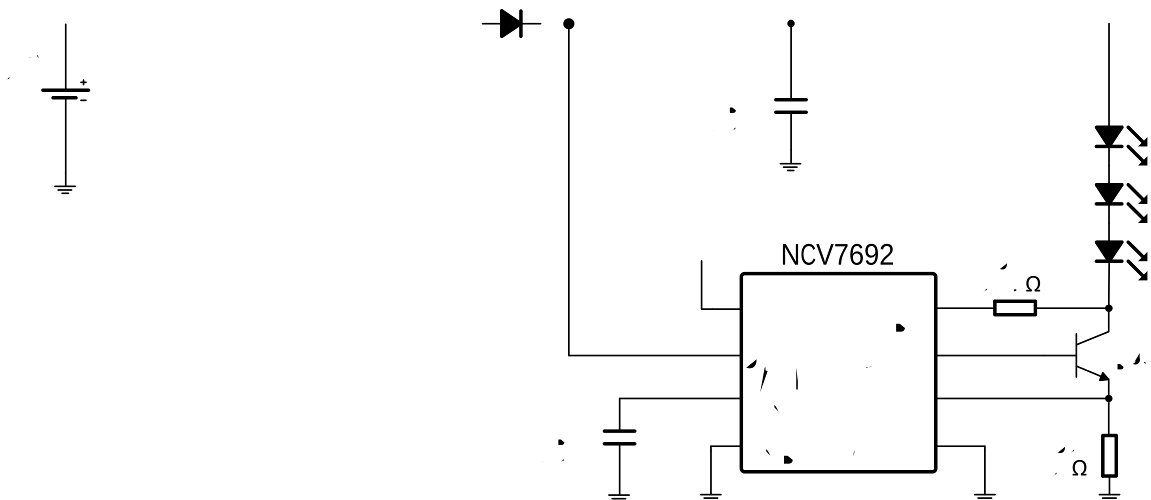


Figure 13. SmartFET Control

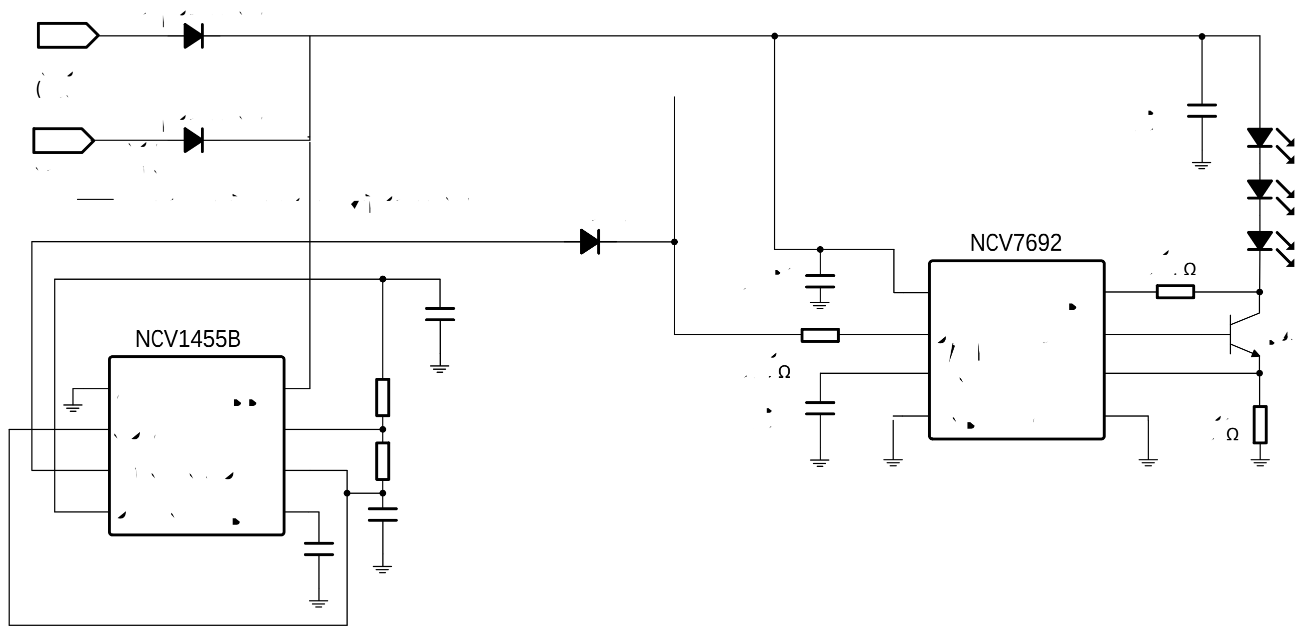


Figure 14. Stoplight / Taillight Application

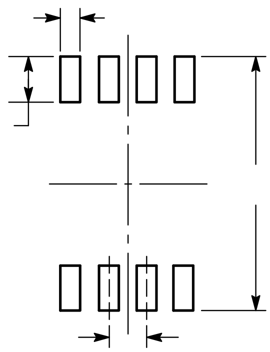
Table 2. FAULT HANDLING TABLE

Fault	Fault Memory	Sense

SCALE 1:1

SOIC 8

RECOMMENDED
SOLDERING FOOTPRINT*



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