

# CAT4134

## LED Driver, Dual Channel Movie/Flash, 500 mA

### Description

The CAT4134 is a high power, dual channel boost converter which provides two matched LED currents. Output current levels are controlled by one of two resistors RSET or RFLASH. When the FLASH input pin is low (movie mode), RSET sets the current. When FLASH is high (flash mode), the resistor RFLASH sets the LED current. Each channel drives two or three white LEDs in series and provides a regulated current to control their brightness. Input supply down to 3 V is supported, making the device ideal for Li-Ion battery applications.

High frequency low noise operation allows the device to be used with small external inductors and ceramic capacitors while still maintaining excellent efficiency. When not in use the device can be placed into a “zero” quiescent mode via the shutdown pin.

In addition to soft-start control and current limiting, the CAT4134 include thermal shutdown protection. A dedicated overvoltage pin (OVP) allows the user to limit the maximum LED supply voltage. The device is packaged in the 12-pad TDFN 3 mm x 3 mm.

### Features

- Dual Mode (Movie or Flash) Operation
- Independent Movie/Flash LED Current Control
- Can Drive 2, 3, 4 or 6 LEDs
- High LED Current (250 mA Max per Channel)
- Power Efficiency up to 85%
- Dual Frequency Mode 1.2 MHz and 900 kHz
- Soft-start Inrush Current
- Adjustable Overvoltage Protection
- Thermal Shutdown Protection
- Operating Temperature Range  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- 12-pad TDFN 3 mm x 3 mm Package
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

- Camera Flash
- Flash Light
- High-power White LEDs
- Digital Still Cameras
- Color LCD Backlighting



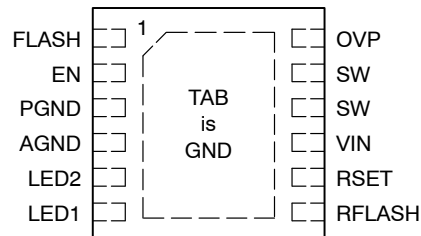
ON Semiconductor®

<http://onsemi.com>



TDFN-12  
HV2 SUFFIX  
CASE 511AN

### PIN CONNECTIONS



(Top View)

### MARKING DIAGRAM



HAAS = CAT4134HV2-T2  
HAAU = CAT4134HV2-GT2

### ORDERING INFORMATION

| Device                     | Package              | Shipping              |
|----------------------------|----------------------|-----------------------|
| CAT4134HV2-T2<br>(Note 1)  | TDFN-12<br>(Pb-Free) | 2,000/<br>Tape & Reel |
| CAT4134HV2-GT2<br>(Note 2) | TDFN-12<br>(Pb-Free) | 2,000/<br>Tape & Reel |

1. Matte-Tin Plated Finish (RoHS-compliant).
2. NiPdAu Plated Finish (RoHS-compliant)

## CAT4134

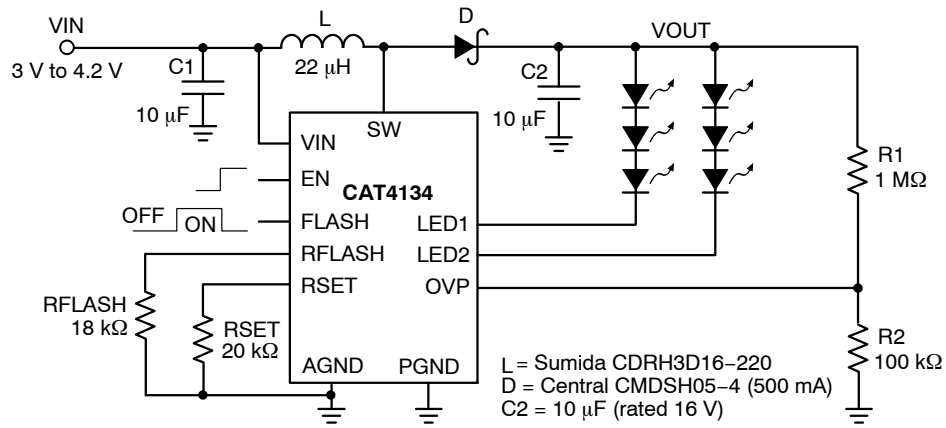


Figure 1. Typical Application Circuit

Table 1. ABSOLUTE MAXIMUM RATINGS

| Parameters                          | Ratings     | Units |
|-------------------------------------|-------------|-------|
| SW voltage                          | 20          | V     |
| VIN voltage                         | 8           | V     |
| EN, FLASH, RSET, RFLASH voltage     | VIN + 0.6 V | V     |
| LED1, LED2 voltage                  | 8           | V     |
| Output Current per Channel          | 300         | mA    |
| Storage Temperature Range           | -65 to +160 | °C    |
| Junction Temperature Range          | -40 to +125 | °C    |
| Lead Temperature                    | 300         | °C    |
| ESD Rating – Human Body Model (HBM) | 2,000       | V     |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Table 2. RECOMMENDED OPERATING CONDITIONS

| Parameters                     | Range      | Units |
|--------------------------------|------------|-------|
| VIN                            | 2.8 to 4.2 | V     |
| Ambient Temperature Range      | -40 to +85 | °C    |
| Flash mode current per channel | 25 to 250  | mA    |
| Movie mode current per channel | 5 to 50    | mA    |

**Table 3. ELECTRICAL OPERATING CHARACTERISTICS**

( $V_{IN} = 3.6\text{ V}$ ,  $EN = V_{IN}$  and at ambient temperature of  $25^{\circ}\text{C}$  (over recommended operating conditions unless otherwise specified))

| Symbol     | Parameter                              | Conditions                                            | Min        | Typ        | Max  | Unit               |
|------------|----------------------------------------|-------------------------------------------------------|------------|------------|------|--------------------|
| $I_Q$      | Quiescent Current (not switching)      | $V_{LED1} > 0.5\text{ V}$ , $V_{LED2} > 0.5\text{ V}$ |            | 100        | 250  | $\mu\text{A}$      |
| $I_{SD}$   | Shutdown Current                       | $EN = 0\text{ V}$                                     |            | 1          |      | $\mu\text{A}$      |
| $I_{SW}$   | Switch Current Limit                   | Movie Mode (FLASH = Low)<br>Flash Mode (FLASH = High) | 0.5<br>1.7 | 1<br>2     |      | A                  |
| $R_{SW}$   | Switch Resistance                      | $I_{SW} = 1000\text{ mA}$                             |            | 0.3        | 0.5  | $\Omega$           |
| $I_{LK}$   | Switch Leakage Current                 | Switch Off, $V_{SW} = 5\text{ V}$                     |            |            | 5    | $\mu\text{A}$      |
| $F_{OSC}$  | Oscillator Frequency                   | Movie Mode<br>Flash Mode                              |            | 1.2<br>0.9 |      | MHz                |
| $V_{OVP}$  | OVP pin threshold                      |                                                       | 1.10       | 1.20       | 1.30 | V                  |
| $\eta$     | Efficiency                             | $V_{OUT} = 10\text{ V}$ , Load = 200 mA               |            | 85         |      | %                  |
| $T_{SD}$   | Thermal Shutdown                       |                                                       |            | 150        |      | $^{\circ}\text{C}$ |
| $T_{HYST}$ | Thermal Hysteresis                     |                                                       |            | 20         |      | $^{\circ}\text{C}$ |
| $V_{UVLO}$ | Undervoltage Lock Out (UVLO) Threshold | Disabled when $V_{IN} < V_{UVLO}$                     |            | 1.9        | 2.2  | V                  |

**EN LOGIC CONTROL INPUT**

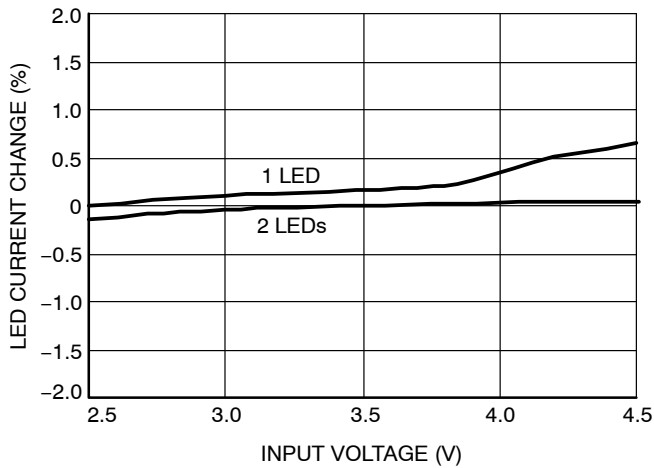
|                          |                                                    |                                                                                                           |         |                 |           |               |
|--------------------------|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------|---------|-----------------|-----------|---------------|
| $V_{SDHI}$<br>$V_{SDLO}$ | Logic High Threshold<br>Logic Low Threshold        | $EN > V_{SDHI}$ Enables Device                                                                            | 0.4     | 0.7<br>0.7      | 1.5       | V             |
| $I_{SDBIAS}$             | Input Bias current                                 | $EN = 3\text{ V}$                                                                                         |         | 10              | 40        | $\mu\text{A}$ |
| $V_{RSET}$               | RSET pin voltage                                   | $22\text{ k}\Omega < R_{SET} < 200\text{ k}\Omega$                                                        | 1.10    | 1.20            | 1.30      | V             |
| $V_{RFLASH}$             | RFLASH pin voltage                                 | $22\text{ k}\Omega < R_{FLASH} < 200\text{ k}\Omega$                                                      | 1.10    | 1.20            | 1.30      | V             |
| $V_{LED}$                | LED1, LED2 Pin Voltage<br>(whichever is the lower) | Both Flash and Movie Mode<br>(lower voltage pin is regulated)                                             |         | 400             |           | mV            |
| $I_{LED}$                | Programmed LED Current                             | $R_{SET} = 21.6\text{ k}\Omega$<br>$R_{FLASH} = 43.2\text{ k}\Omega$<br>$R_{FLASH} = 21.6\text{ k}\Omega$ |         | 20<br>50<br>100 |           | mA            |
| $I_{LED-RAN}$            | LED Current Adjust Range per LED output            | In Movie mode<br>In Flash mode                                                                            | 5<br>25 |                 | 50<br>200 | mA            |
| $I_{LED-ACC}$            | LED Current Accuracy                               |                                                                                                           |         | $\pm 5$         |           | %             |
| $I_{LED-DEV}$            | LED Current Matching                               |                                                                                                           |         | $\pm 5$         |           | %             |

**FLASH CONTROL LOGIC INPUT**

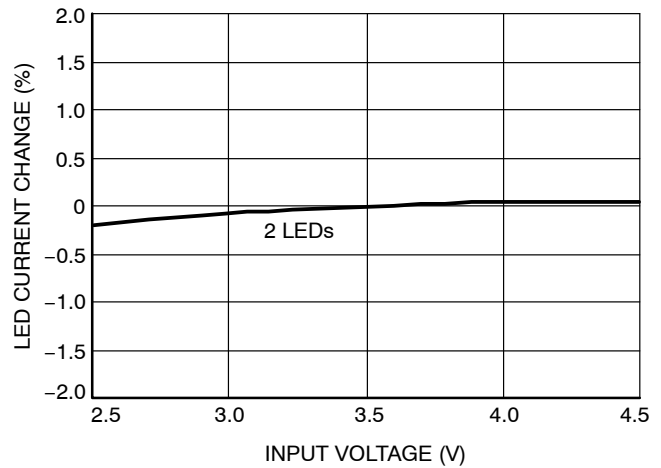
|                        |                                             |                                 |     |            |     |               |
|------------------------|---------------------------------------------|---------------------------------|-----|------------|-----|---------------|
| $V_{FHI}$<br>$V_{FLO}$ | Logic High Threshold<br>Logic Low Threshold | $FLASH > V_{FHI}$ Flash Enabled | 0.4 | 0.7<br>0.7 | 1.5 | V             |
| $I_{INPUT}$            | Input Bias current                          | $FLASH = 3\text{ V}$            |     | 10         | 40  | $\mu\text{A}$ |

## TYPICAL CHARACTERISTICS

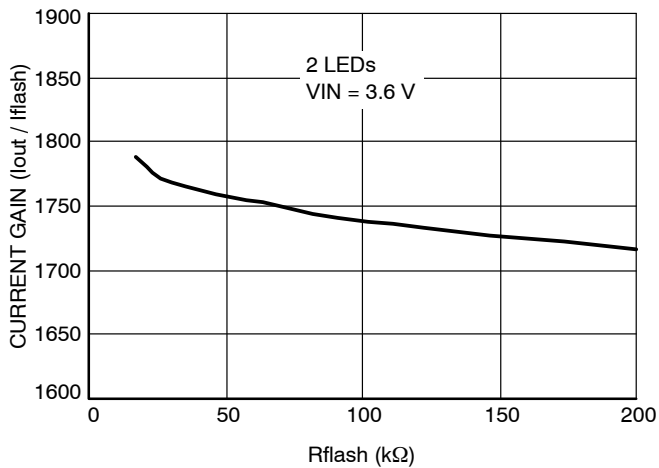
( $V_{IN} = 3.6\text{ V}$ ,  $FLASH = V_{IN}$ ,  $C_{IN} = 4.7\text{ }\mu\text{F}$ ,  $C_{OUT} = 10\text{ }\mu\text{F}$ ,  $L = 22\text{ }\mu\text{H}$  with 2 LEDs at 100 mA,  $T_{AMB} = 25^\circ\text{C}$ , unless otherwise specified.)



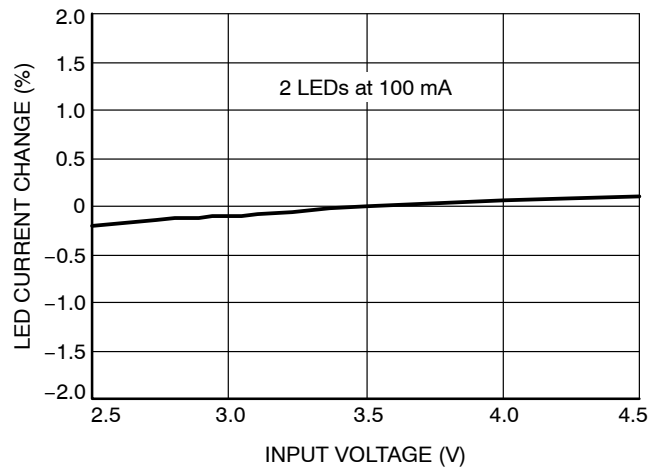
**Figure 2. LED Current Regulation  
(100 mA Load)**



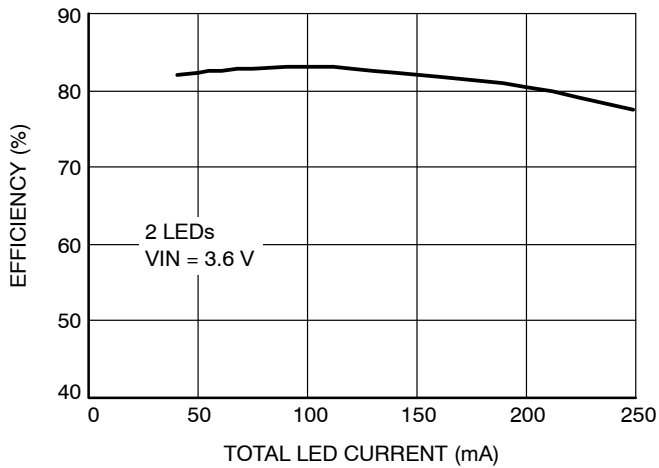
**Figure 3. LED Current Regulation  
(200 mA Load, Flash)**



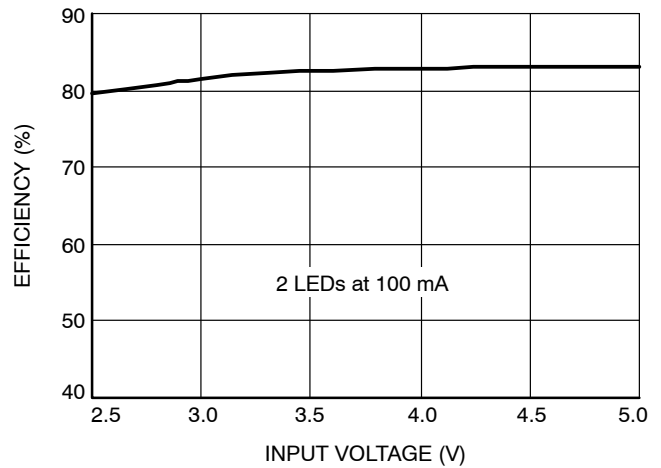
**Figure 4. Current Gain vs. RFLASH**



**Figure 5. LED Current Regulation  
(100 mA Load, Flash)**



**Figure 6. Efficiency vs. Output Current  
(Flash Mode)**



**Figure 7. Efficiency vs. Input Voltage  
(Flash Mode)**

## TYPICAL CHARACTERISTICS

(VIN = 3.6 V, FLASH = VIN, CIN = 4.7  $\mu$ F, COUT = 10  $\mu$ F, L = 22  $\mu$ H with 2 LEDs at 100 mA, TAMB = 25°C, unless otherwise specified.)

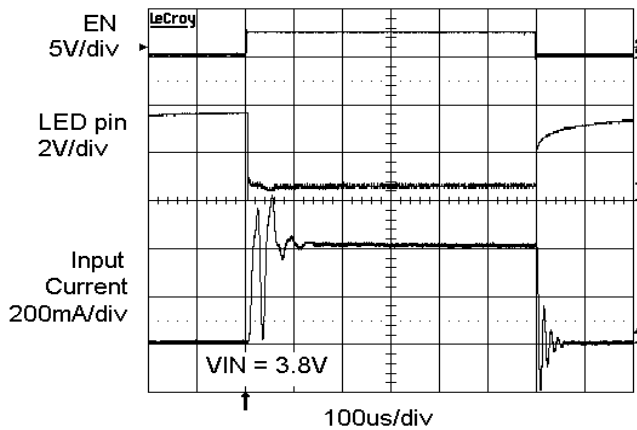


Figure 8. Power-up Transient  
(2 LEDs at 200 mA)

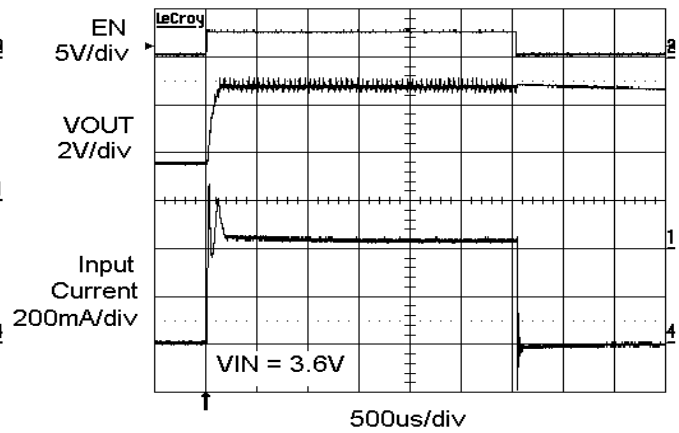


Figure 9. Power-up Transient  
(2 LEDs at 200 mA)

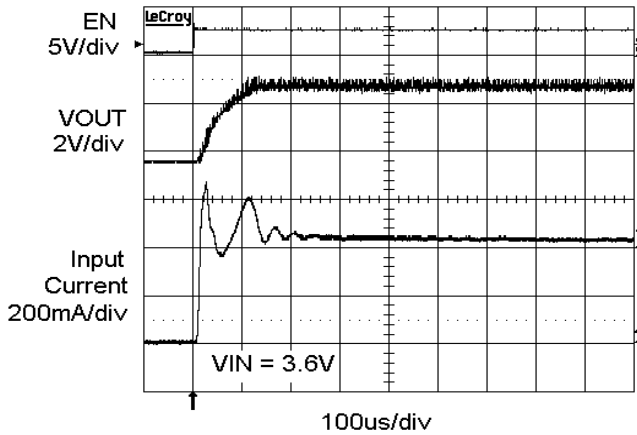


Figure 10. Power-up Transient  
(2 LEDs at 200 mA)

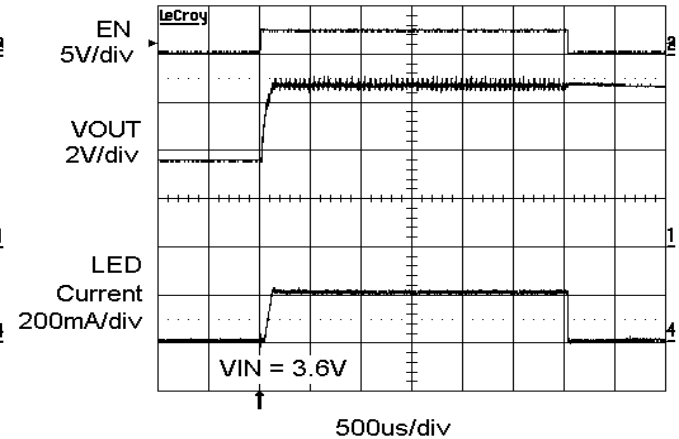


Figure 11. Power-up Transient  
(2 LEDs at 200 mA)

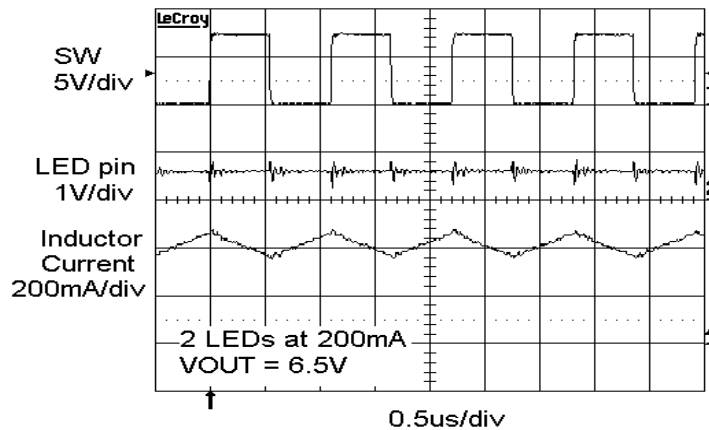
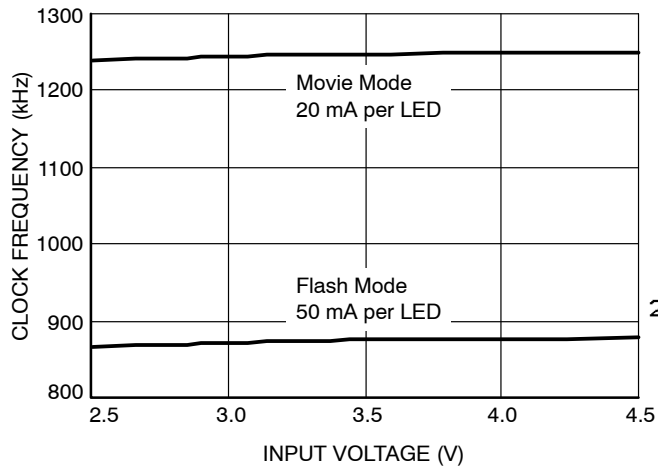


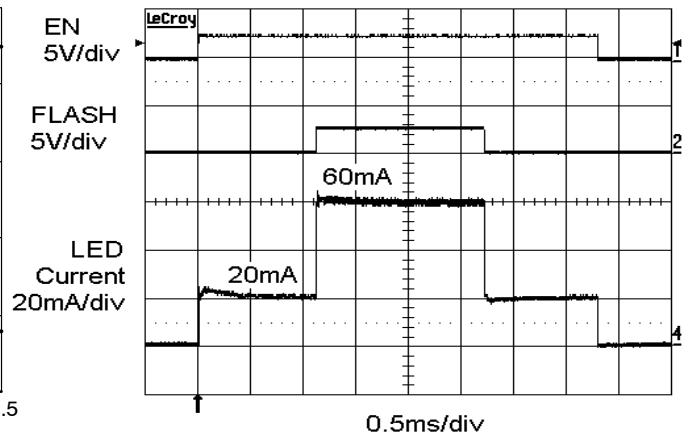
Figure 12. Switching Waveform in Flash Mode  
(2 LEDs)

**TYPICAL CHARACTERISTICS**

(VIN = 3.6 V, CIN = 4.7  $\mu$ F, COUT = 10  $\mu$ F, L = 22  $\mu$ H with 2 LEDs at 100 mA, TAMB = 25°C, unless otherwise specified.)



**Figure 13. Switching Frequency vs. Supply Voltage**



**Figure 14. Enable Flash Waveform**

Table 4. PIN DESCRIPTION

| Pin #  | Name   | Function                                           |
|--------|--------|----------------------------------------------------|
| 1      | FLASH  | Logic input, set high to select the flash mode.    |
| 2      | EN     | Enable control logic input (Active High).          |
| 3      | PGND   | Power ground reference.                            |
| 4      | AGND   | Analog ground reference.                           |
| 5      | LED2   | LED channel 2, connected to the LED cathode.*      |
| 6      | LED1   | LED channel 1, connected to the LED cathode.*      |
| 7      | RFLASH | Resistor connection to set Flash mode LED current. |
| 8      | RSET   | Resistor connection to set Movie mode LED current. |
| 9      | VIN    | Power supply input.                                |
| 10, 11 | SW     | Drain connection of low resistance power MOSFET.   |
| 12     | OVP    | Over Voltage Protection comparator input           |

\*LED1 or LED2 pin should not be left floating.

### Pin Function

**VIN** is the supply voltage input. The device is compatible with supply voltages down to 2.8 V and up to 4.2 V. Internal under-voltage lockout (UVLO) circuitry will automatically prevent the device from operating whenever the supply falls below 1.9 V. For operation up to maximum rated loads a bypass ceramic capacitor of 10  $\mu$ F is recommended between the VIN and GND pins near the device.

**EN** is the enable logic input (active high). When the pin voltage is taken below 0.4 V, the device enters shutdown mode, drawing nearly zero current. At pin voltages greater than 1.4 V, the device is fully enabled.

**FLASH** is the logic input (active high) used to control Flash mode operation. When the pin voltage is taken above 1.4 V, the device transitions from Movie mode to Flash mode. When the pin voltage is taken back below 0.4 V, the device returns back to Movie mode operation.

**RSET**, **RFLASH** pins allow to set the LED current respectively in Movie and Flash mode. These pins, regulated at 1.2 V, must be connected to a pull-down resistor tied to ground. The LED current is a function of the resistor value.

**GND** is the ground reference for the driver. The pin must be connected to the ground plane on the PCB.

**SW** pin is the drain terminal of the internal low resistance power switch. The inductor and the Schottky diode anode should be connected to the SW pin. Traces going to the SW pin should be as short as possible with minimum loop area. This pin contains over-voltage circuitry which becomes active above 18 V. In the event of an “open-LED” fault condition, the device will enter a low power mode and the SW pin will be clamped to approximately 21 V.

**LED1**, **LED2** provide the internal regulated current for each of the LED cathodes. These pins enter a high impedance zero current state whenever the device is placed in shutdown mode. In applications with only one string of LEDs, the two LED pins should be tied together. LED pins should not be left floating.

**OVP** is the overvoltage protection input pin. When the pin voltage exceeds the 1.2 V overvoltage threshold ( $V_{OVP}$ ), the driver stops switching. The output VOUT then drops down. As soon as the OVP pin voltage falls under the  $V_{OVP}$  threshold, the part starts switching again.

**TAB** is the exposed pad underneath the package. For best thermal performance, the tab should be soldered to the PCB and connected to the ground plane.

## Device Operation

The device is powered from the input pin VIN. A switching frequency of 1.2 MHz is used in Movie mode, when the FLASH input is low. Continuous LED current up to 50 mA is controlled by the RSET resistor. For higher load current, the Flash mode is selected by setting the FLASH input pin high. RFLASH now controls the LED current. In flash mode, the driver efficiency is kept high even under high load current by using a lower switching frequency of 900 kHz. In movie mode, the higher frequency of 1.2 MHz provides a lower noise operation.

## Overvoltage Protection (OVP)

To prevent the SW pin voltage from exceeding the internal switch maximum voltage rating, an overvoltage protection (OVP) function is supported. The OVP pin allows to set the

maximum operating voltage on the output VOUT using external resistors R1 and R2. The resistor ratio sets the maximum output voltage as shown in the equation below:

$$\frac{R1}{R2} = \left( \frac{VOUT_{MAX}}{1.2} \right) - 1.2$$

VOUT<sub>MAX</sub> should always be higher than the total LED forward voltage ( $\Sigma V_f$ ) plus 1.2 V. Also VOUT must be less than  $\Sigma V_f + 8$  V.

$$\Sigma V_f + 1.2 \text{ V} < VOUT_{MAX} < \Sigma V_f + 8 \text{ V} < 16 \text{ V}$$

If the overvoltage protection is not needed, then the OVP pin should be connected to Ground. In that case, the maximum voltage on the SW pin is set to 17 V.

## Block Diagram

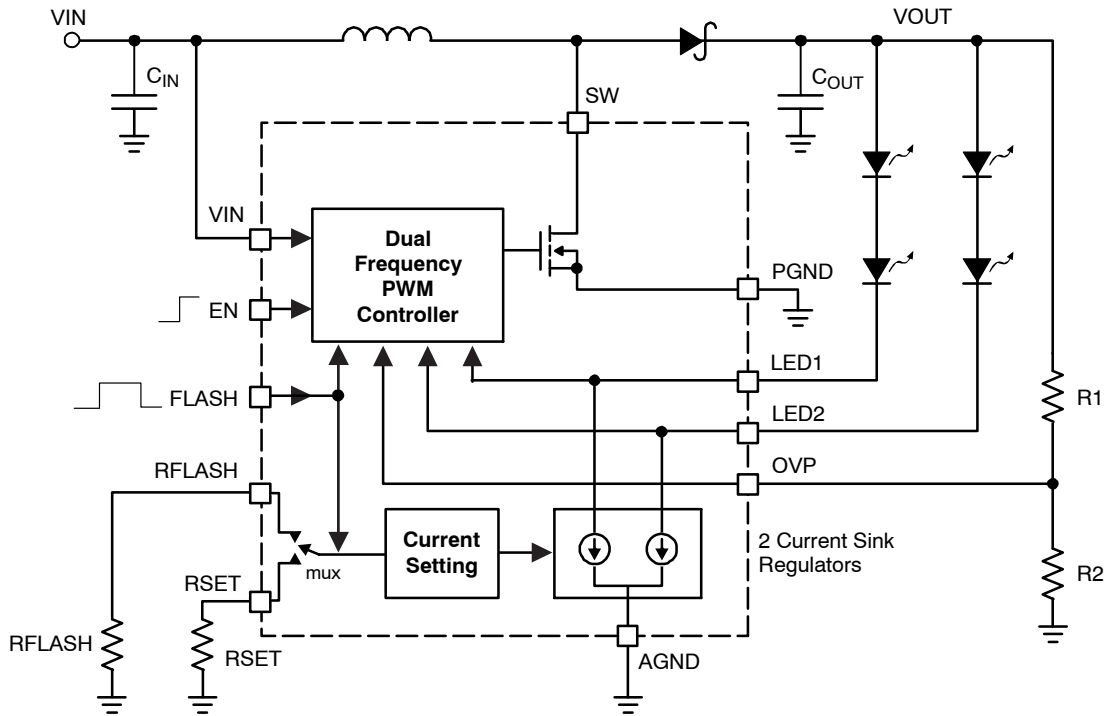
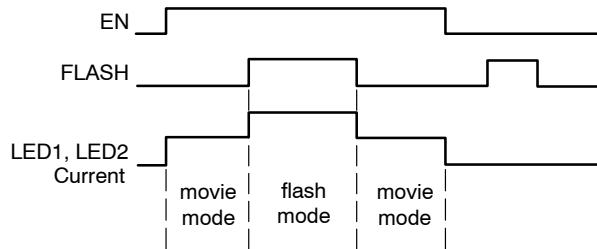


Figure 15. Block Diagram

## Application Information

The typical application for the CAT4134 is in a camera-equipped cellular phone where the LEDs are used for illumination in flash mode with short duration high-current pulse and in movie mode with continuous lighter load. In movie mode, the FLASH pin is set low.

**NOTE:** Hot-plugging the LEDs while the output is fully charged is not recommended. If the LEDs are disconnected, the device should first be powered-down and the output discharged before reconnecting the LEDs to the output and the LED pins.



**Figure 16. Timing Diagram**

## LED Current Setting

### Flash Mode

The enable EN and FLASH logic input signals control the LED current. When both the EN and FLASH inputs are high, the driver is in flash or strobe mode. In this mode, the LED1 and LED2 pin currents are set by the resistor RFLASH and are regulated to 1800 times the current in the RFLASH resistor and follows the equation:

$$\text{LED current} = 1800 \times \frac{1.2 \text{ V}}{\text{RFLASH}}$$

### Movie Mode

When the EN input is high and FLASH is low, the driver is in movie mode. In this mode, the LED1 and LED2 pin currents are set by the resistor RSET and are regulated to 360 times the current in the RSET resistor and follows the equation:

$$\text{LED current} = 360 \times \frac{1.2 \text{ V}}{\text{RSET}}$$

Table 5 lists the various LED currents and the associated resistor values in movie and flash modes.

**Table 5.**

**RESISTOR SELECTION IN MOVIE AND FLASH MODE**

| Movie Mode       |           | Flash Mode       |             |
|------------------|-----------|------------------|-------------|
| LED Current (mA) | RSET (kΩ) | LED Current (mA) | RFLASH (kΩ) |
| 5                | 86.4      | 50               | 43.2        |
| 10               | 43.2      | 75               | 28.8        |
| 20               | 21.6      | 100              | 21.6        |
| 30               | 14.4      | 150              | 14.4        |

### Shutdown Mode

When the EN input is low, the driver is in shutdown mode and there is no current flowing in either LED1 or LED2 pins.

# CAT4134

## Typical Applications

The CAT4134 can drive one or two strings of 2 to 3 LEDs in series resulting in combinations of 2, 3, 4, 6 LEDs.

The resistor ratio  $R1/R2$  sets the maximum  $V_{OUT}$  during an open-LED fault condition and provides the overvoltage protection.

For applications with 2 LEDs in series and  $V_{OUT\_MAX}$  at 10 V, the ratio  $R1/R2$  is 7.

For applications with 3 LEDs in series and  $V_{OUT\_MAX}$  at 13.5 V, the ratio  $R1/R2$  is 10.

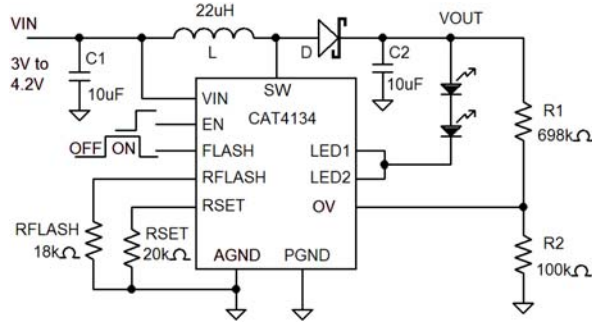


Figure 17. 2 LED Application

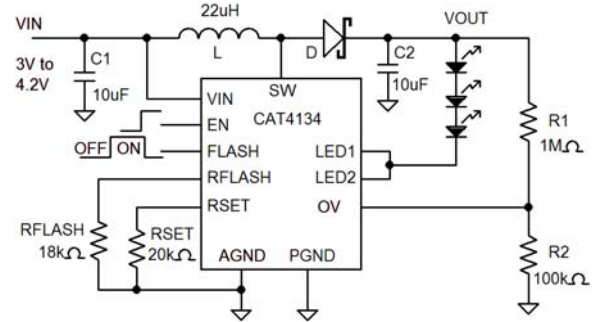


Figure 18. 3 LED Application

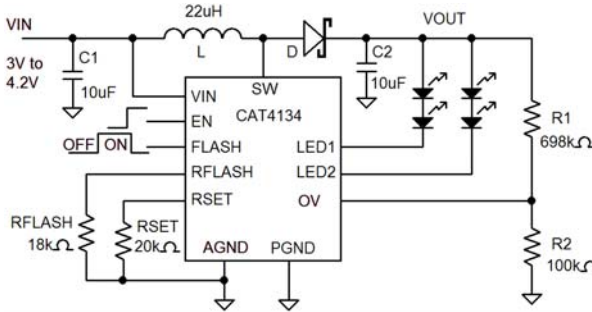


Figure 19. 4 LED Application

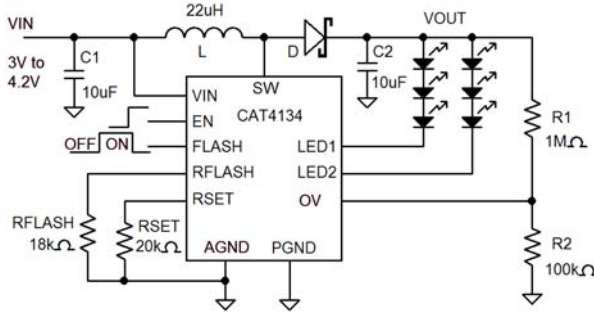
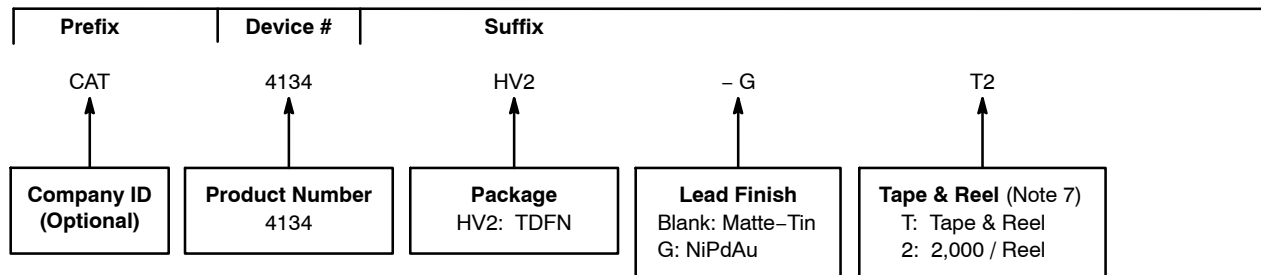


Figure 20. 6 LED Application

## CAT4134

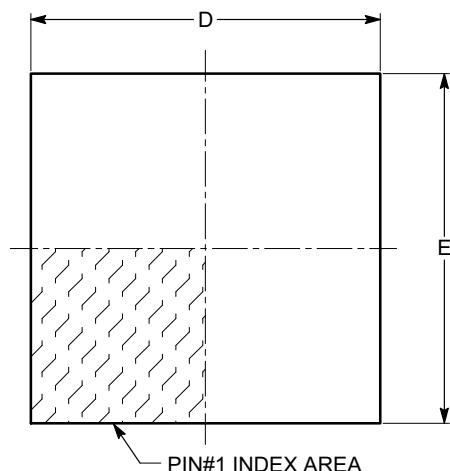
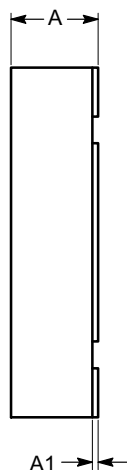
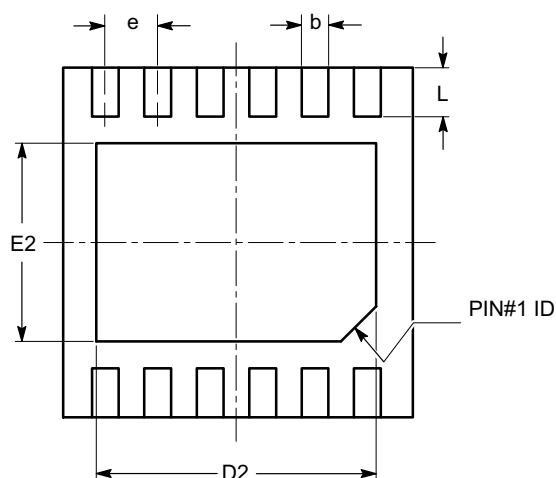
### Example of Ordering Information (Note 5)



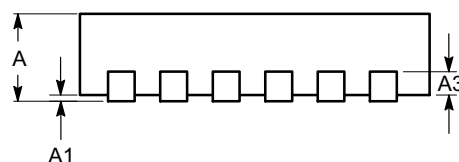
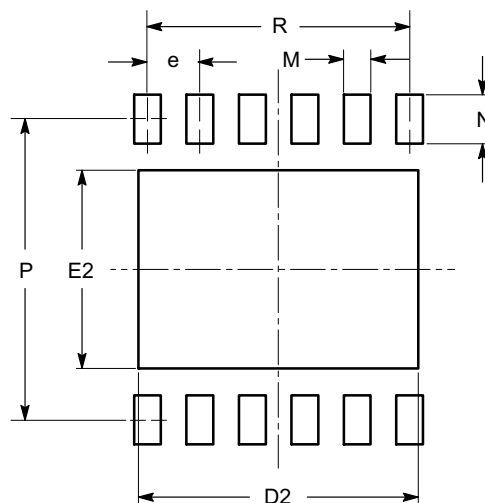
3. All packages are RoHS-compliant (Lead-free, Halogen-free).
4. The standard lead finish is NiPdAu.
5. The device used in the above example is a CAT4134HV2-GT2 (TDFN, NiPdAu, Tape & Reel, 2,000/Reel).
6. For additional package and temperature options, please contact your nearest ON Semiconductor Sales office.
7. 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.

**TDFN12, 3x3**  
**CASE 511AN**  
**ISSUE A**

DATE 18 MAR 2009


**TOP VIEW**

**SIDE VIEW**

**BOTTOM VIEW**

| SYMBOL | MIN      | NOM   | MAX   |
|--------|----------|-------|-------|
| A      | 0.70     | 0.75  | 0.80  |
| A1     | 0.00     | 0.02  | 0.05  |
| A3     | 0.178    | 0.203 | 0.228 |
| b      | 0.18     | 0.23  | 0.30  |
| D      | 2.90     | 3.00  | 3.10  |
| D2     | 2.30     | 2.40  | 2.50  |
| E      | 2.90     | 3.00  | 3.10  |
| E2     | 1.55     | 1.70  | 1.75  |
| e      | 0.45 BSC |       |       |
| L      | 0.30     | 0.40  | 0.50  |
| M      | 0.25     | 0.30  | 0.35  |
| N      | 0.60     | 0.70  | 0.80  |
| P      | 2.70     | 3.00  | 3.10  |
| R      | 2.25 TYP |       |       |


**FRONT VIEW**
**RECOMMENDED LAND PATTERN**

**Notes:**

- (1) All dimensions are in millimeters.
- (2) Complies with JEDEC MO-229.

|                         |                    |                                                                                                                                                                                     |
|-------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NUMBER:</b> | <b>98AON34357E</b> | Electronic versions are uncontrolled except when accessed directly from the Document Repository.<br>Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| <b>DESCRIPTION:</b>     | <b>TDFN12, 3X3</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

onsemi and Onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

**onsemi**, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## ADDITIONAL INFORMATION

### TECHNICAL PUBLICATIONS:

Technical Library: [www.onsemi.com/design/resources/technical-documentation](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

### ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at  
[www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)