

# IS31BL3231

## FLASH LED DRIVER

July 2015

### GENERAL DESCRIPTION

The IS31BL3231 is a current-regulated charge pump and ideal for powering high brightness LEDs for camera flash and torch applications. The charge pump can be set to regulate two current levels for FLASH and TORCH modes. The IS31BL3231 automatically switches between linear and boost modes ensuring that LED current does not depend on the LED forward voltage.

IS31BL3231 provides low cost, space saving solution for driving LED. It also integrates thermal and short circuit protection function.

IS31BL3231 is available in DFN-10 (3mm × 3mm). It operates from 2.7V to 5.5V over the temperature range of -40°C to +85°C.

### FEATURES

- Operates from 2.7V to 5.5V
- Up to 90% efficiency in Torch Mode
- Output current up to 750mA
- Adjustable output current in Flash Mode
- Minimum external components, no external inductor required
- Automatic boost mode
- Less than 1μA shutdown current
- Low ripple and EMI
- Over voltage protection on output
- Short and over temperature protections
- Available in DFN-10 (3mm × 3mm) package

### APPLICATIONS

- White LED backlighting
- Cellular phones
- Generic lighting/flash/strobe applications

### TYPICAL APPLICATION CIRCUIT

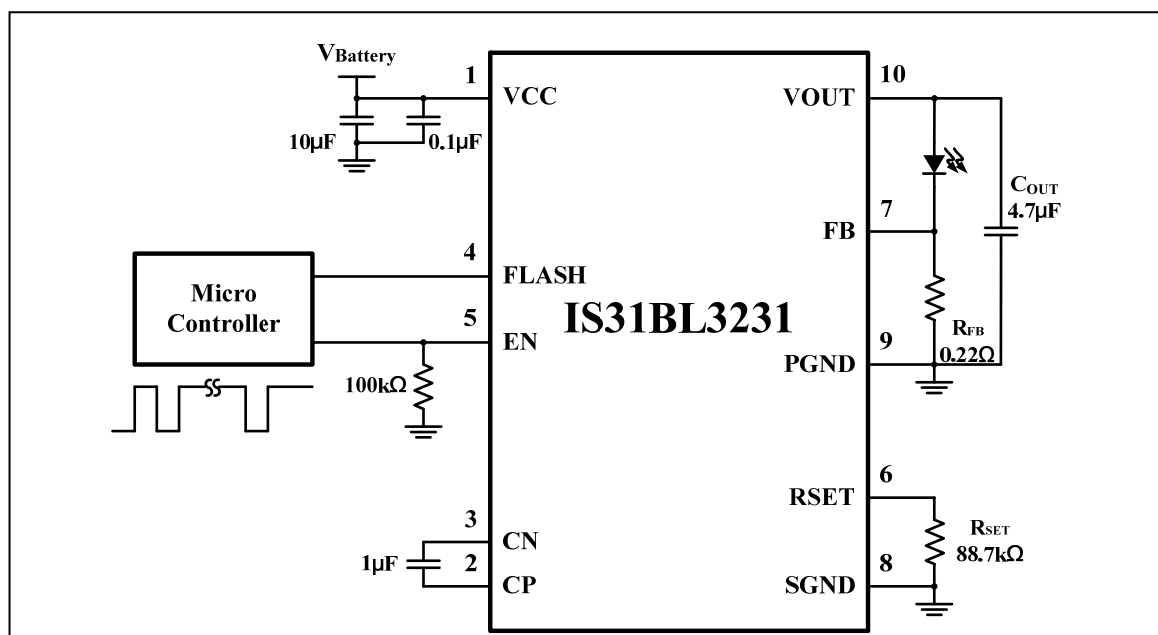
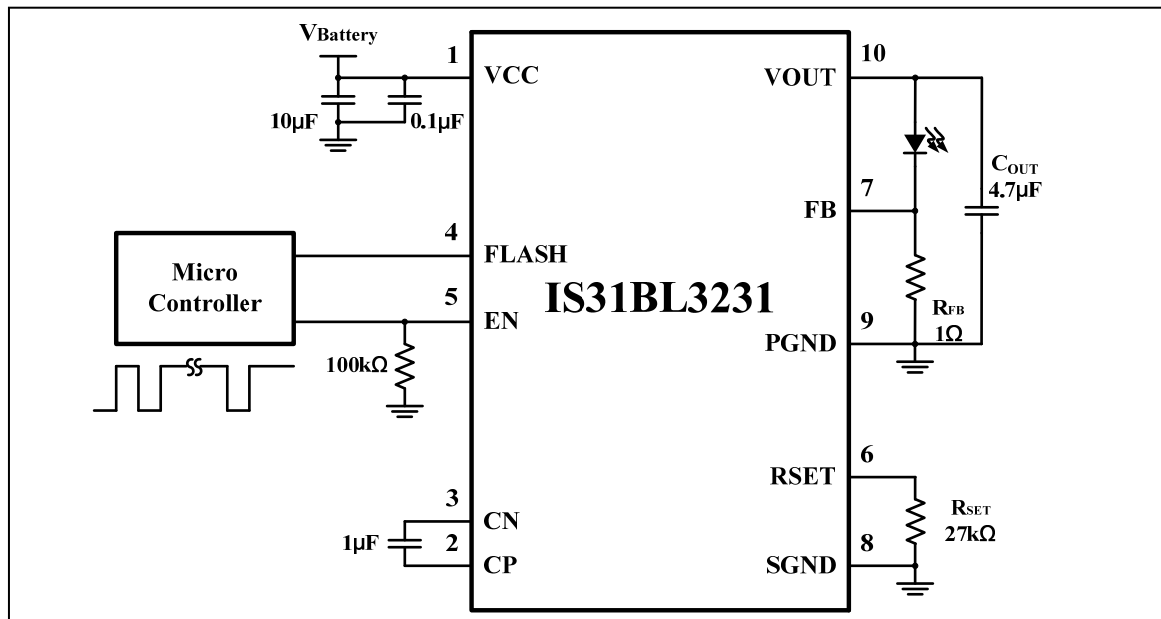


Figure 1 Typical Application Circuit (Torch Mode Lv1-227mA, Flash Mode 718mA)

# IS31BL3231



**Figure 2** Typical Application Circuit (Torch Mode Lv1-50mA, Flash Mode 518mA)

## PIN CONFIGURATION

| Package | Pin Configuration (Top View)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------|---|-----|---|----|---|----|---|-------|---|----|---|------|---|----|---|------|---|------|----|------|
| DFN-10  | <p>Pin Configuration (Top View) for DFN-10 package:</p> <table border="1"> <thead> <tr> <th>Pin</th> <th>Function</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>VCC</td> </tr> <tr> <td>2</td> <td>CP</td> </tr> <tr> <td>3</td> <td>CN</td> </tr> <tr> <td>4</td> <td>FLASH</td> </tr> <tr> <td>5</td> <td>EN</td> </tr> <tr> <td>6</td> <td>RSET</td> </tr> <tr> <td>7</td> <td>FB</td> </tr> <tr> <td>8</td> <td>SGND</td> </tr> <tr> <td>9</td> <td>PGND</td> </tr> <tr> <td>10</td> <td>VOUT</td> </tr> </tbody> </table> | Pin | Function | 1 | VCC | 2 | CP | 3 | CN | 4 | FLASH | 5 | EN | 6 | RSET | 7 | FB | 8 | SGND | 9 | PGND | 10 | VOUT |
| Pin     | Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 1       | VCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 2       | CP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 3       | CN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 4       | FLASH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 5       | EN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 6       | RSET                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 7       | FB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 8       | SGND                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 9       | PGND                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |
| 10      | VOUT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |          |   |     |   |    |   |    |   |       |   |    |   |      |   |    |   |      |   |      |    |      |

## PIN DESCRIPTION

| No. | Pin         | Description                                                                                                                                                                      |
|-----|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | VCC         | Power supply.                                                                                                                                                                    |
| 2   | CP          | Positive input for external flying cap.                                                                                                                                          |
| 3   | CN          | Negative input for external flying cap.                                                                                                                                          |
| 4   | FLASH       | Input pin to toggle operation between Flash Mode and Torch Mode.                                                                                                                 |
| 5   | EN          | Shutdown control input and Torch reference select pin. The intensity can be modulated by PWM signal via EN pin. It is recommended to use 100Hz and 5%~95% duty cycle PWM signal. |
| 6   | RSET        | Set the FB voltage in Flash Mode.<br>$V_{FB} = (1.25V / R_{SET}) \times 11.2k\Omega$                                                                                             |
| 7   | FB          | Feedback input for the current control loop.<br>$I_{LED} = V_{FB} / R_{FB}$                                                                                                      |
| 8   | SGND        | Internal ground pin.                                                                                                                                                             |
| 9   | PGND        | Power ground pin.                                                                                                                                                                |
| 10  | VOUT        | Charge pump output voltage.                                                                                                                                                      |
|     | Thermal Pad | Connect to GND.                                                                                                                                                                  |



# IS31BL3231

## ORDERING INFORMATION

Industrial Range: -40°C to +85°C

| Order Part No.     | Package           | QTY/Reel |
|--------------------|-------------------|----------|
| IS31BL3231-DLS2-TR | DFN-10, Lead-free | 2500     |

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- b.) the user assume all such risks; and
- c.) potential liability of Integrated Silicon Solution, Inc is adequately protected under the circumstances

# IS31BL3231

## ABSOLUTE MAXIMUM RATINGS

|                                          |                |
|------------------------------------------|----------------|
| Supply voltage, $V_{CC}$                 | -0.3V ~ +6.0V  |
| Voltage at EN pin                        | 0V ~ 7V        |
| Output current pulse (Flash Mode)        | 1A             |
| Output current pulse (Torch Mode)        | 0.4A           |
| Maximum junction temperature, $T_{JMAX}$ | 150°C          |
| Storage temperature range, $T_{STG}$     | -65°C ~ +150°C |
| Operating temperature range, $T_A$       | -40°C ~ +85°C  |
| ESD (HBM)                                | 7kV            |
| ESD (CDM)                                | 1kV            |

### Note:

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 condition 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.

## DC CHARACTERISTICS

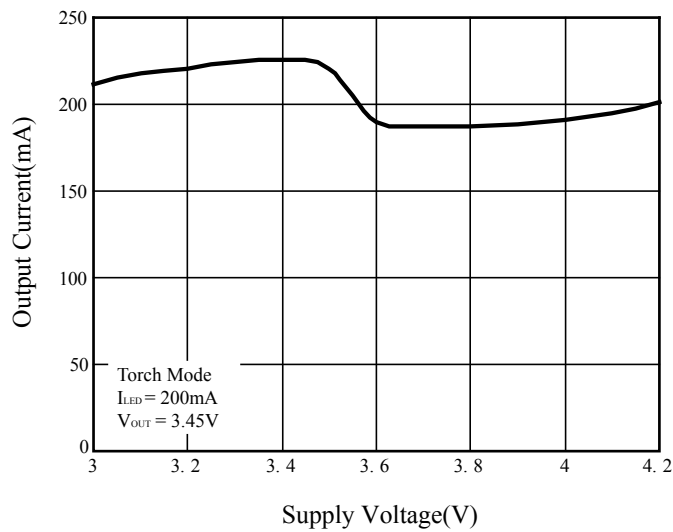
$T_A = +25^\circ\text{C}$ ,  $V_{CC} = 2.7\text{V} \sim 5.5\text{V}$ , unless otherwise stated. Typical value are  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 4.2\text{V}$ .

| Symbol        | Parameter                    | Condition                                             | Min. | Typ. | Max. | Unit             |
|---------------|------------------------------|-------------------------------------------------------|------|------|------|------------------|
| $V_{CC}$      | Supply voltage               |                                                       | 2.7  |      | 5.5  | V                |
| $I_{CC}$      | Quiescent current            | $V_{CC} = 4.2\text{V}$ , $V_{FLASH} = 0\text{V}$      |      | 0.6  |      | mA               |
| $I_{SD}$      | Shutdown current             | $V_{CC} = 5.5\text{V}$ , $V_{EN} = 0\text{V}$         |      |      | 1    | $\mu\text{A}$    |
| $t_{ON}$      | Charge pump soft start time  |                                                       |      | 550  |      | $\mu\text{s}$    |
| $V_{FB}$      | FB reference voltage         | $V_{FLASH} = V_{CC}$ , $R_{SET} = 88.7\text{k}\Omega$ |      | 150  |      | mV               |
|               |                              | $V_{FLASH} = 0\text{V}$                               |      | 50   |      |                  |
| $V_{FB\_MAX}$ | Maximum FB reference voltage | (Note 1)                                              | 550  |      |      | mV               |
| $T_{OVP}$     | Over temperature protection  |                                                       |      | 160  |      | $^\circ\text{C}$ |
| $V_{IH}$      | Input logic high             |                                                       | 1.4  |      |      | V                |
| $V_{IL}$      | Input logic low              |                                                       |      |      | 0.4  | V                |
| $t_{LO}$      | EN low time                  | (Note 1)                                              | 0.3  |      | 75   | $\mu\text{s}$    |
| $t_{HI}$      | EN high time                 | (Note 1)                                              | 0.1  |      | 75   | $\mu\text{s}$    |
| $t_{OFF}$     | EN shutdown timeout          | (Note 1)                                              |      | 500  |      | $\mu\text{s}$    |
| $t_{LAT}$     | EN latch timeout             | (Note 1)                                              |      | 500  |      | $\mu\text{s}$    |

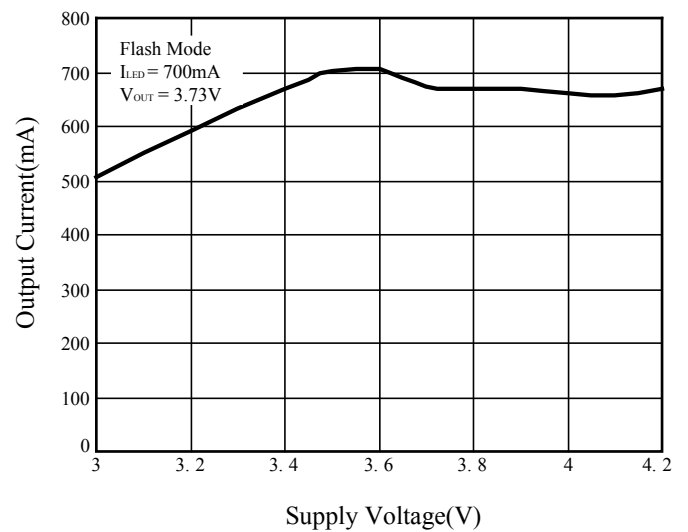
**Note 1:** Guaranteed by design.

# IS31BL3231

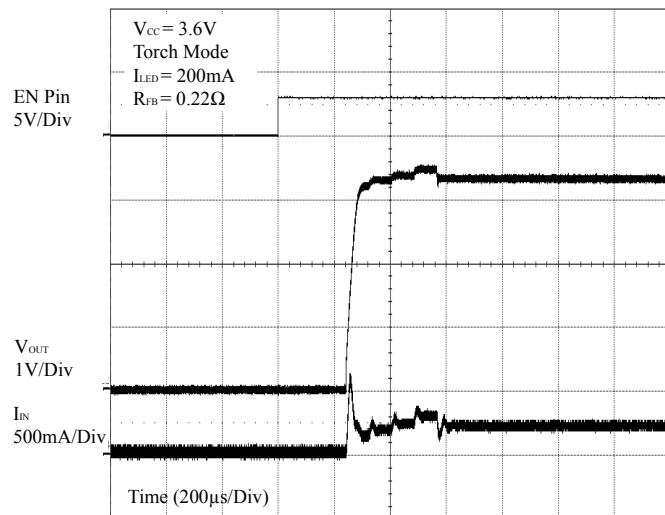
## TYPICAL PERFORMANCE CHARACTERISTICS



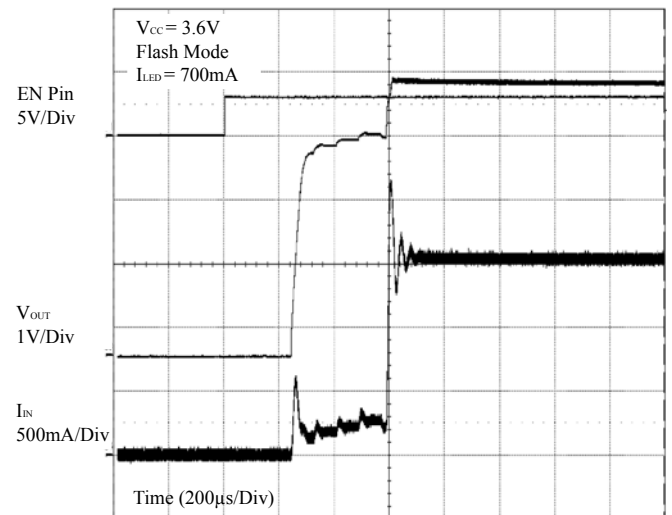
**Figure 3** Supply Voltage vs. Output Current (Torch Mode)



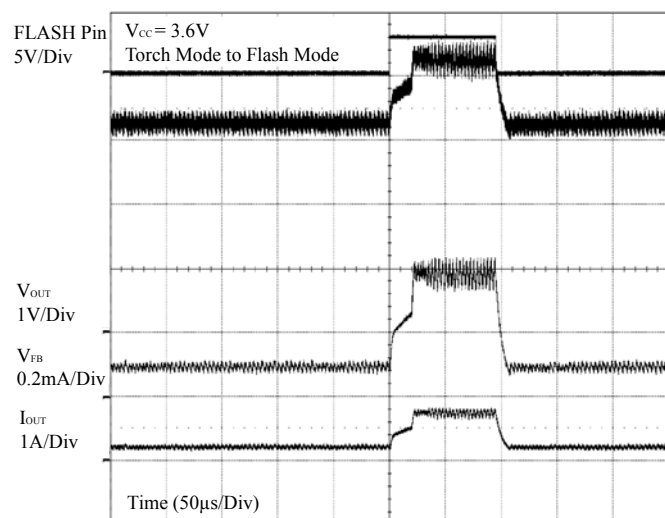
**Figure 4** Supply Voltage vs. Output Current (Flash Mode)



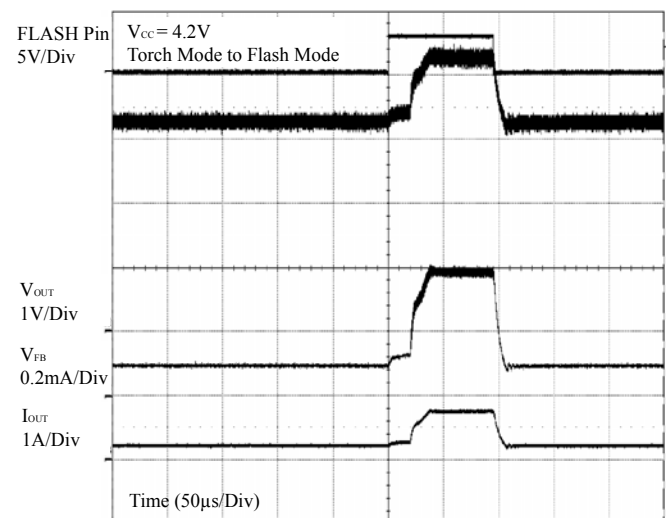
**Figure 5** EN On (Torch Mode)



**Figure 6** EN On (Flash Mode)

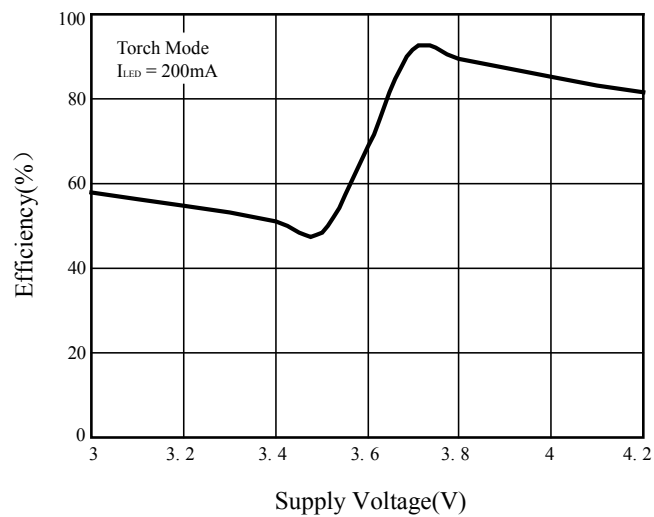


**Figure 7** Torch Mode to Flash Mode

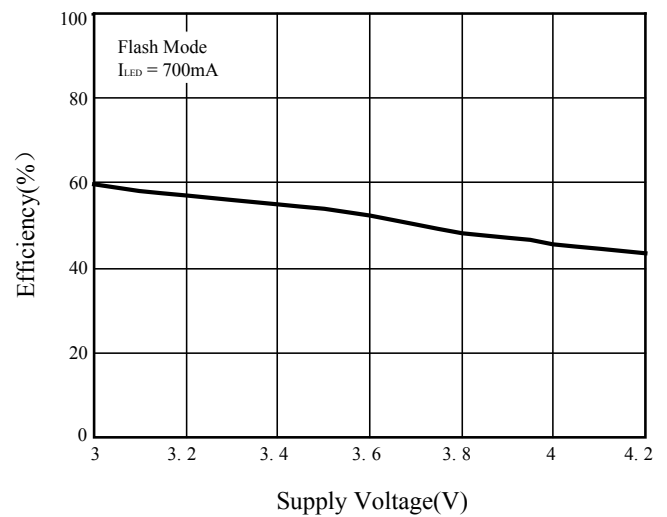


**Figure 8** Torch Mode to Flash Mode

# IS31BL3231



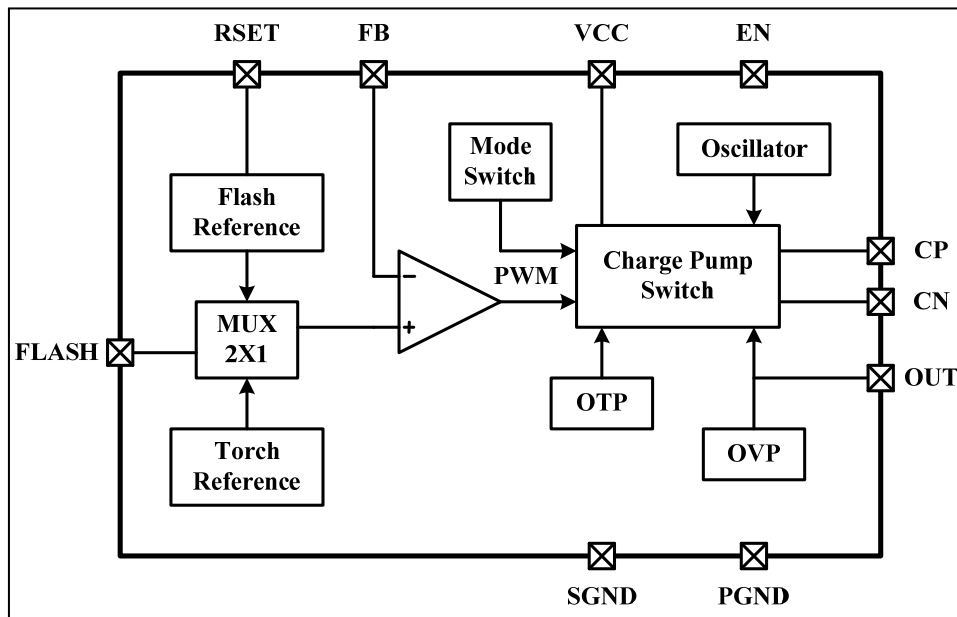
**Figure 9** Supply Voltage vs. Efficiency (Torch Mode)



**Figure 10** Supply Voltage vs. Efficiency (Flash Mode)

# IS31BL3231

## FUNCTIONAL BLOCK DIAGRAM



# IS31BL3231

## APPLICATION INFORMATION

### GENERAL DESCRIPTION

The IS31BL3231 is a current-regulated charge pump and ideal for powering high brightness LEDs for camera flash and torch applications.

### CHARGE PUMP

The charge pump converter boosts input supply voltage ( $V_{CC}$ ) up to a higher output voltage ( $V_{OUT}$ ) to drive LED.

The charge pump converter only requires three external components: supply decoupling capacitor, output bypass capacitor and flying capacitor.

Choose low ESR capacitors to ensure the best operating performance and place the capacitors as close as possible to the IS31BL3231.

The charge pump will start up automatically to offer a higher output voltage when  $V_{FB}$  is lower than the setting value.

### CURRENT SETTING

The LED current is set by the external resistor,  $R_{FB}$ , following the Equation (1) below.

$$I_{LED} = V_{FB} / R_{FB} \quad (1)$$

$V_{FB}$  is calculated by the Equation (2) when IS31BL3231 operates in the Flash Mode.  $V_{FB}$  is set in the Table 1 when IS31BL3231 operates in the Torch Mode.

### OPERATING MODE

#### FLASH MODE

By pulling the FLASH pin to high, IS31BL3231 operates in the Flash Mode.  $V_{FB}$  is set by the  $R_{SET}$ .

$$V_{FB} = (1.25V / R_{SET}) \times 11.2k\Omega \quad (2)$$

For example, in Figure 1,

$R_{FB} = 0.22\Omega$ ,  $R_{SET} = 88.7k\Omega$ ,

So,  $V_{FB} = (1.25V / 88.7k\Omega) \times 11.2k\Omega \approx 158mV$

$$I_{LED} = 158mV / 0.22\Omega \approx 718mA$$

The maximum  $V_{FB}$  shouldn't be over 550mV or the actual current will be large difference from then calculated current.

### TORCH MODE

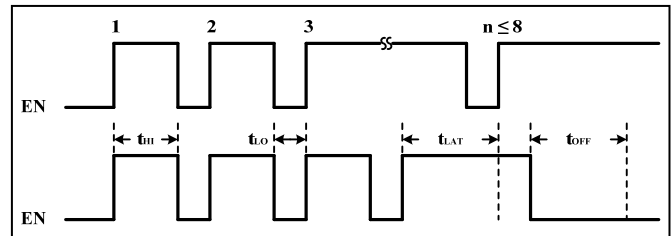
By pulling the FLASH pin to low, IS31BL3231 operates in the Torch Mode. The  $V_{FB}$  is controlled by Pulse Count Control (PCC wire) serial interface. The interface records rising edges of the EN pin and decodes them into 8 different states. The 8 voltage level settings available are indicated in Table 1.

**Table 1**  $V_{FB}$  Control

| Pulse    | $V_{FB}$ (Typ.) | $I_{LED}$ (Typ.)      |                    |
|----------|-----------------|-----------------------|--------------------|
|          |                 | $R_{FB} = 0.22\Omega$ | $R_{FB} = 1\Omega$ |
| 1        | 50mV            | 227mA                 | 50mA               |
| 2        | 60mV            | 273mA                 | 60mA               |
| 3        | 70mV            | 318mA                 | 70mA               |
| 4        | 85mV            | 386mA                 | 85mA               |
| 5        | 100mV           | 455mA                 | 100mA              |
| 6        | 120mV           | 545mA                 | 120mA              |
| 7        | 140mV           | 636mA                 | 140mA              |
| $\geq 8$ | 170mV           | 773mA                 | 170mA              |

### TIMING CONTROL

The EN pin should be configured as the Figure 11.  $t_{LAT}$  is the latch time. High level should be at last  $t_{LAT}$  to active the pulse signal.  $t_{OFF}$  is the shutdown time. EN pin is pulled low at last  $t_{OFF}$  the IC will be shutdown.



**Figure 11** EN pin timing

### THERMAL PROTECTION

The IS31BL3231 has a thermal protection circuit that will shut down the chip if the die temperature rises above the thermal limit until the temperature falls down.

# IS31BL3231

## CLASSIFICATION REFLOW PROFILES

| Profile Feature                                                                                                                                                       | Pb-Free Assembly                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>Preheat &amp; Soak</b><br>Temperature min (T <sub>sm</sub> )<br>Temperature max (T <sub>sm</sub> )<br>Time (T <sub>sm</sub> to T <sub>sm</sub> ) (t <sub>s</sub> ) | 150°C<br>200°C<br>60-120 seconds |
| Average ramp-up rate (T <sub>sm</sub> to T <sub>p</sub> )                                                                                                             | 3°C/second max.                  |
| Liquidous temperature (T <sub>L</sub> )<br>Time at liquidous (t <sub>L</sub> )                                                                                        | 217°C<br>60-150 seconds          |
| Peak package body temperature (T <sub>p</sub> )*                                                                                                                      | Max 260°C                        |
| Time (t <sub>p</sub> )** within 5°C of the specified classification temperature (T <sub>c</sub> )                                                                     | Max 30 seconds                   |
| Average ramp-down rate (T <sub>p</sub> to T <sub>sm</sub> )                                                                                                           | 6°C/second max.                  |
| Time 25°C to peak temperature                                                                                                                                         | 8 minutes max.                   |

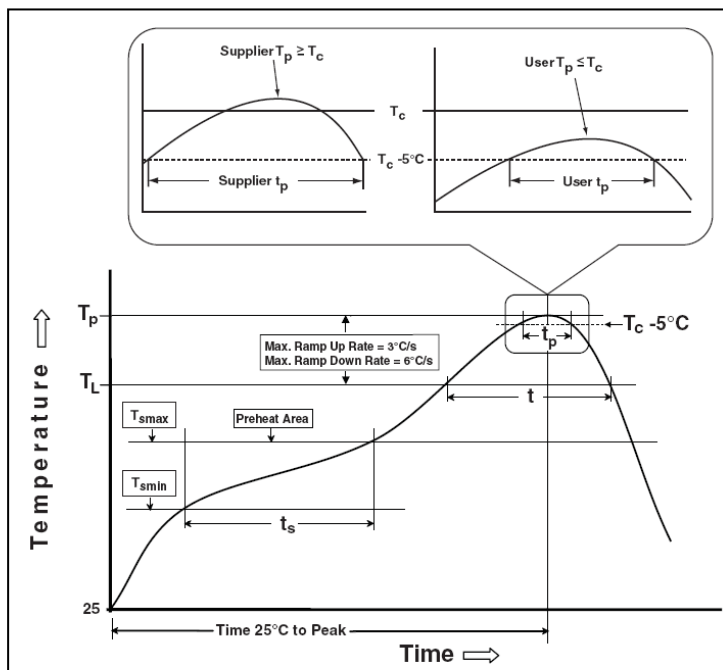
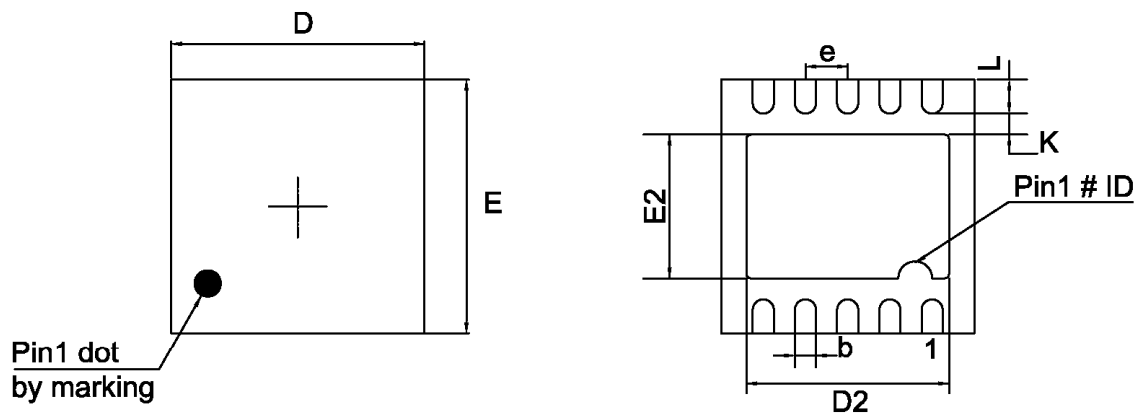


Figure 12 Classification Profile

# IS31BL3231

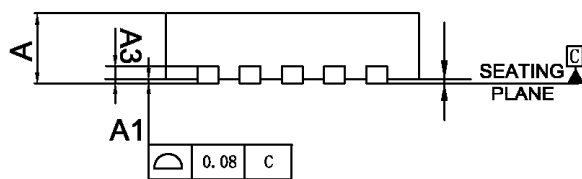
## PACKAGE INFORMATION

### DFN-10



TOP VIEW

BOTTOM VIEW



SIDE VIEW

#### NOTE:

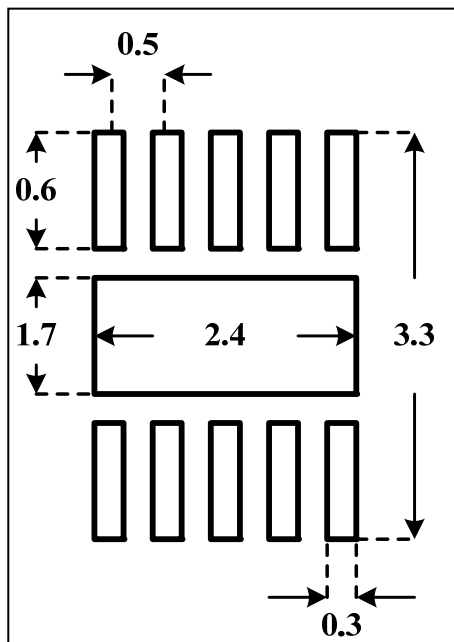
1. CONTROLLING DIMENSION : MM
2. REFERENCE DOCUMENT: JEDEC MO-229F
3. THE PIN'S SHARP AND THERMAL PAD SHOWS DIFFERENT SHAPE AMONG DIFFERENT FACTORIES.

| SYMBOL | MILLIMETER |      |      |
|--------|------------|------|------|
|        | MIN        | NOM  | MAX  |
| A      | 0.70       | 0.75 | 0.80 |
| A1     | 0.00       | —    | 0.05 |
| A3     | 0.20REF    |      |      |
| D      | 2.90       | 3.00 | 3.10 |
| E      | 2.90       | 3.00 | 3.10 |
| E2     | 1.40       | —    | 1.75 |
| D2     | 2.20       | —    | 2.70 |
| b      | 0.18       | 0.25 | 0.30 |
| L      | 0.30       | 0.40 | 0.50 |
| K      | 0.20       | —    | —    |
| e      | 0.50 BSC   |      |      |

**Note:** All dimensions in millimeters unless otherwise stated.

# IS31BL3231

## RECOMMENDED LAND PATTERN



### Note:

1. Land pattern complies to IPC-7351.
2. All dimensions in MM.
3. This document (including dimensions, notes & specs) is a recommendation based on typical circuit board manufacturing parameters. Since land pattern design depends on many factors unknown (eg. user's board manufacturing specs), user must determine suitability for use.

# IS31BL3231

## REVISION HISTORY

| Revision | Detail Information                                                                                                                                | Date       |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| A        | Initial release                                                                                                                                   | 2012.01.16 |
| B        | 1. P.7 add efficiency chart<br>2. P.2 add application figure in 50mA(Torch), 500mA(Flash)<br>3. P.3 add PWM dimming function<br>4. P.5 remove ESD | 2012.12.03 |
| C        | 1. Add land pattern<br>2. Correct 100kHz to 100Hz in Pin Description<br>3. Add ESD value                                                          | 2015.06.12 |