HM3251
1A Buck/Boost Charge Pump LED Driver

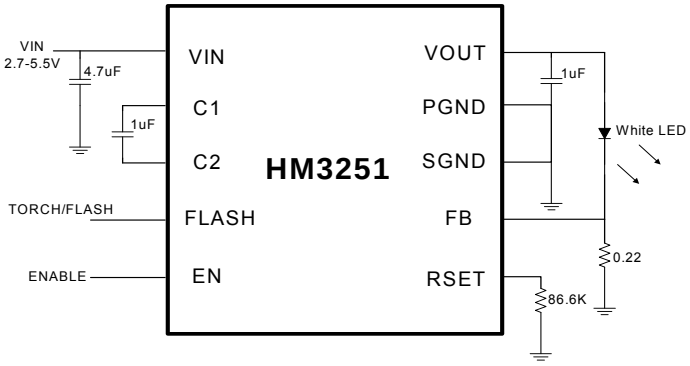
Features

- Output Current up to 1A
- Up to 90% Efficiency in Torch Mode
- Adjustable FLASH Mode Current
- 1× and 2× Automatic Modes for High Efficiency
- Input Voltage Range: 2.7V to 5.5V
- Minimum External Components: No Inductors
- High Frequency Operation: 2MHz
- Low 47mV Reference for Low Loss Sensing
- I_Q < 1μA in Shutdown
- Built-In Soft Start Limits Inrush Current
- Low Input and Output Ripple and Low EMI
- Output Over Voltage Protection
- Over-current and Over-temperature Protection
- Available in Green DFN3×3-10L Package

Applications

- Cellular Telephones
- Digital Still Cameras
- MP3 Players
- Bluetooth Applications
- Portable Devices
- USB Bus-Powered Chargers

Block Diagram



Descriptions

The HM3251 is a current-regulated charge pump ideal for powering high brightness LEDs for camera flash applications. The charge pump can be set to regulate two current levels for FLASH and TORCH modes.

The HM3251 automatically switches modes between step-up and step-down ensuring that LED current does not depend on the forward voltage. It switches at 2MHz, allowing the use of tiny components. The supply voltage ranges from 2.7V to 5.5V and is ideally suited for all applications powered by a single Li-Ion battery cell or three to four NiCd, NiMH, or Alkaline battery cells.

The HM3251 also features a very low shutdown current, an automatic soft-start mode to limit inrush current, as well as over current, over voltage and over thermal shutdown control. A low current sense reference voltage (47mV) allows the use of small 0603 current sensing resistors.

The HM3251 is available in Green DFN3×3-10L package and is specified over an ambient temperature range of -40°C to +85°C.

Ordering Information

Order Part Number	Top Marking		T_A	Package	
HM3251	D51B	Green	-40 to +85°C	DFN-10	Tape & Reel, 5000

Pin Assignment

DFN-10

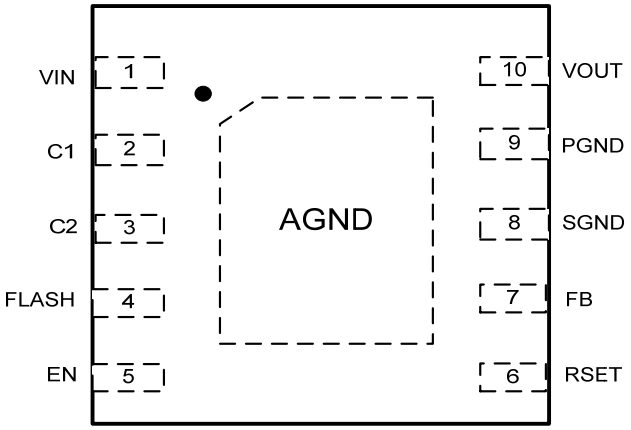


Figure 1 Pin Assignment (Top View)

Pin Descriptions

Pin	Name	Description
1	VIN	Input voltage for the charge pump. Decouple with 4.7μF or 10μF ceramic capacitor close to the pins of the IC.
2	C1	Positive input for the external flying capacitor. Connect a ceramic 1μF capacitor close to the pins of the IC.
3	C2	Negative input for the external flying capacitor. Connect a ceramic 1μF capacitor close to the pins of the IC.
4	FLASH	Logic input to toggle operation between FLASH and TORCH mode. In TORCH mode FB is regulated to the internal 47mV reference. In FLASH mode FB reference voltage can be adjusted by changing the resistor from R_{SET} pin to ground. Choose the external current sense resistor (R_{SENSE}) based on desired current in TORCH mode and Flash mode.
5	EN	Shutdown control input. Connect to VIN for normal operation, connect to ground for shutdown.
6	RSET	Connect a resistor from this pin to ground. When in FLASH mode (FLASH = High) this resistor sets the current regulation point according to the following: V_{FB} = (1.26V/ R_{SET}) × 10.2KΩ.
7	FB	Feedback input for the current control loop. Connect directly to the current sense resistor.
8	SGND	Internal ground pin. Control circuitry returns current to this pin.
9	PGND	Power ground pin. Flying capacitor current returns through this pin.
10	VOUT	Charge Pump Output Voltage. Decouple with an external capacitor. At least 1μF is recommended. If Higher value capacitor is used, output ripple is smaller.
Exposed Pad	GND	Exposed pad should be soldered to PCB board and connected to GND.

Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Rating” 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 maxim rating conditions for extended periods may affect device reliability.

Parameter	Rating	Unit
Supply Voltage Range	-0.3 to 6	V
EN Input Voltage	0-5.5	V
Output Current Pulse (Flash)	1	A
Output Current Continuous (Torch)	0.4	A
Package Thermal Resistance, DFN3*3-10	57	°C/W
Junction Temperature	150	°C
Storage Temperature	-40 to 150	°C
Lead Temperature (soldering, 10s)	260	°C
ESD (HBM) EN PIN	1000	V
ESD (HBM) ALL OTHERS	2000	V
ESD (MM)	200	V

Recommend Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended Operating conditions are specified to ensure optimal performance to the datasheet specifications. DIOO does not Recommend exceeding them or designing to Absolute Maximum Ratings.

Parameter	Rating	Unit
Input Supply Voltage	2.7 to 5.5	V
Operating Temperature Range	-40 to 85	°C

Electrical Characteristics

(V_{IN} = 3.6V, C_{IN} = 4.7μF, C_{OUT} = C_F = 1μF, V_{SHDN} = V_{IN}, typical values at +25°C, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Supply Voltage	V_{IN}		2.7		5.5	V
Quiescent Current	I_Q	V_{IN} = 2.7V to 5.5V, FLASH = 0V, I_{LOAD} = 100μA		0.3		mA
		FLASH = V_{IN}, 2× Mode		2		
Shutdown Current	I_{SHDN}	V_{EN} = 0V, V_{IN} = 5.5V			1	μA
Oscillator Frequency				2		MHz
Charge Pump Equivalent Resistance (2×mode)				5		Ω
Charge Pump Equivalent Resistance (1×mode)				0.6		Ω
FB Reference Voltage	V_{FB}	FLASH = V_{IN}, R_{SET} = 86.6KΩ		150		mV
		FLASH = GND		47		
FB Pin Current		V_{FB} = 0.3V			1	μA
EN, FLASH Logic Low					0.4	V
EN, FLASH Logic High		V_{IN} = 4.3V	1.2			V
EN, FLASH Pin Current				0.8		μA
V_{OUT} Turn-on Time		V_{IN} = 3.6V, FB within 90% of regulation		350		μs
Thermal Shutdown Temperature				145		°C

Specifications subject to changes without notice.

Typical Application

The HM3251 can be used with multiple LEDs in parallel as shown in figure 2. For best performance, the LEDs should be in a single package, preferably from a single die to have better matching for forward voltage V_F for a given forward current I_F. In practice, if the V_F of one LED is higher than the others, it will consume a larger I_F, which will raise its temperature which will then cause its V_F to reduce, correcting the imbalance. The overall current will be the sum of the individual currents, for example $I_{TOTAL} = 4 \times I_{LED}$.

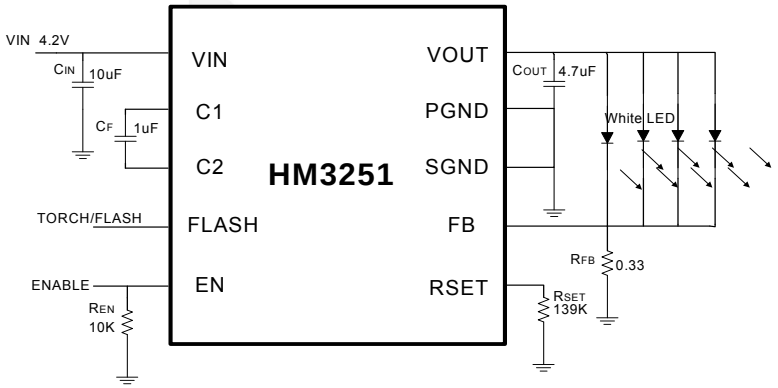


Figure 2. Multiple LEDs Flash Circuit

The HM3251 also can be used to drive two flash LEDs in portable equipments. The schematic is shown in

Figure 3.

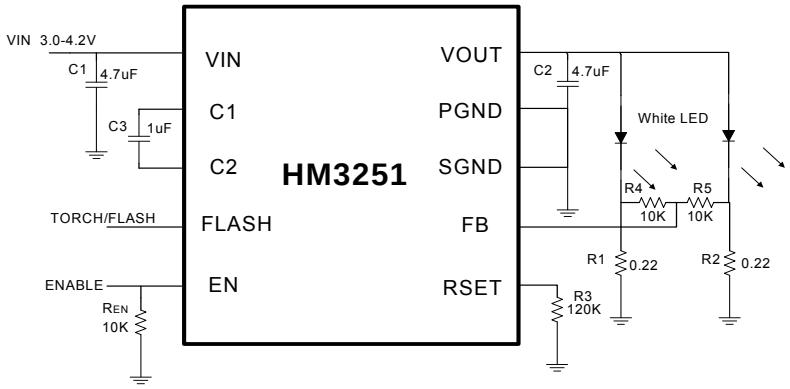


Figure 3. Two Flash LED Drive

Application Information

The HM3251 is a charge pump regulator designed for converting a Li-ion battery voltage of 2.7V to 4.2V to drive a white LED used in digital still camera flash and torch applications. The HM3251 has two modes of operation which are pin selectable for either Flash or Torch. Both modes can be used continuously unless thermal shutdown happens. Torch is often used for several seconds in a digital still camera “movie” mode.

The HM3251 also has two modes of operation to control the output current: the 1× mode and 2× mode. Operation begins after the enable pin EN receives a logic high, the band-gap reference wakes up after 50μs, and then HM3251 goes through a soft-start mode designed to reduce inrush current. The HM3251 starts in the 1× mode, which acts like a linear regulator to control the output current by continuously monitoring the feedback pin FB. In 1×mode, if the HM3251 auto detects a dropout condition, which is when the FB pin is below the regulation point for more than 15μs, the HM3251 automatically switches to the 2×mode. The HM3251

remains in the 2×mode until one of four things happens:

1) The enable pin EN has been toggled.

2) The Flash pin has changed from high to low.

3) V_{IN} is cycled or V_{IN} is at least 1V above V_{OUT}.

4) A thermal fault occurs.

The 2×mode is the charge pump mode where the output can be pumped as high as two times the input voltage, provided the output does not exceed the maximum voltage for the HM3251, which is internally limited to about 5.5V. In the 2× mode, as in the 1× mode, the output current is regulated by the voltage at the FB pin. In the Torch mode, (Flash = "GND") the Flash pin is set to logic low and the HM3251 FB pin regulates to 47mV output:

$$V_{FB} = 47mV \text{ (Torch Mode)}$$

When in Flash mode, (Flash = "High"), the FB regulation voltage is set by the resistor R_{SET} connected between the R_{SET} pin and SGND and the equation:

$$V_{FB} = (1.26V / R_{SET}) \times 10.2K\Omega \text{ (Flash Mode)}$$

Where 1.26V is the internal band-gap reference voltage and 10.2KΩ is an internal resistance used to scale the R_{SET} current. Typical values of R_{SET} are 42KΩ to 170KΩ for a range of V_{FB} = 300mV to 75mV in Flash mode. The output current is then set in either Flash or Torch mode by the equation:

$$I_{OUT} = V_{FB} / R_{SENSE}$$

Over temperature Protection

When the temperature of HM3251 rises above 145℃, the over temperature protection circuitry turns off the output switches to prevent damage to the device. If the temperature drops back down below 130℃, the part automatically recovers and executes a soft start cycle.

Overvoltage Protection

The HM3251 has over voltage protection. If the output voltage rises above the 5.5V threshold, the over voltage protection shuts off all of the output switches to prevent the output voltage from rising further. When the output decreases below 5.2V, the device resumes normal operation.

Over-current Protection

The over current protection circuitry monitors the average current out of the V_{OUT} = 47mV (Torch Mode) pin. If the average output current exceeds approximately 1Amp, then the over current protection circuitry shuts off the output switches to protect the chip.

Component Selection

The HM3251 charge pump circuit requires 3 capacitors: 4.7μF input, 1μF output and 1μF flying capacitors are typically recommended. For the input capacitor, a larger value of 10μF will help reduce input voltage ripple for applications sensitive to ripple on the battery voltage. All the capacitors should be surface mount ceramic for low lead inductance necessary at the 2MHz switching frequency of the HM3251 and to obtain low ESR, which improves bypassing on the input and output and improves output voltage drive by reducing output resistance.

Ceramic capacitors with X5R or X7R temperature grade are recommended for most applications.

The input and output capacitors should be located as close to the V_{IN} and V_{OUT} pins as possible to obtain best bypassing, and the returns should be connected directly to the PGND pin or to the thermal pad ground located under the HM3251. The flying capacitor should be located as close to the C1 and C2 pins as possible. To obtain lower output ripple, the C_{OUT} value can be increased from 1μF to 2.2μF or 4.7μF with a corresponding decrease in output ripple. For output currents of 500mA to 700mA, the recommended C_F flying capacitor value of 1μF should be used. Output currents in Flash of 100mA to 400mA can use a 0.47μF C_F but a minimum 1μF C_{OUT} is still needed.

Resister Selection

The sense resistor R_{SENSE} is determined by the value needed in the Torch mode for the desired output current by the equation:

$$R_{SENSE} = V_{FB}/ I_{OUT} \text{ where } V_{FB} = 47mV \text{ (Torch Mode)}$$

Once the R_{SENSE} resistor has been selected for Torch mode, the V_{FB} voltage can be selected for Flash mode using the following equation:

$$V_{FB} = I_{OUT} \times R_{SENSE} \text{ (Flash Mode) where } I_{OUT} \text{ is for Flash Mode.}$$

Next, the R_{SET} resistor can be selected for Flash mode using the following equation:

$$R_{SET} = (1.26V/ V_{FB}) \times 10.2K\Omega \text{ (Flash Mode)}$$

For an example of 190mA Torch mode and 600mA Flash mode, the values R_{SENSE} = 0.25Ω, V_{FB} = 150mV (Flash Mode), and R_{SET} = 86.6KΩ are calculated. The power obtained in the Flash mode would be:

$$P_{FLASH} = V_{FB} \times I_{OUT} = 150mV \times 600mA = 90mW.$$

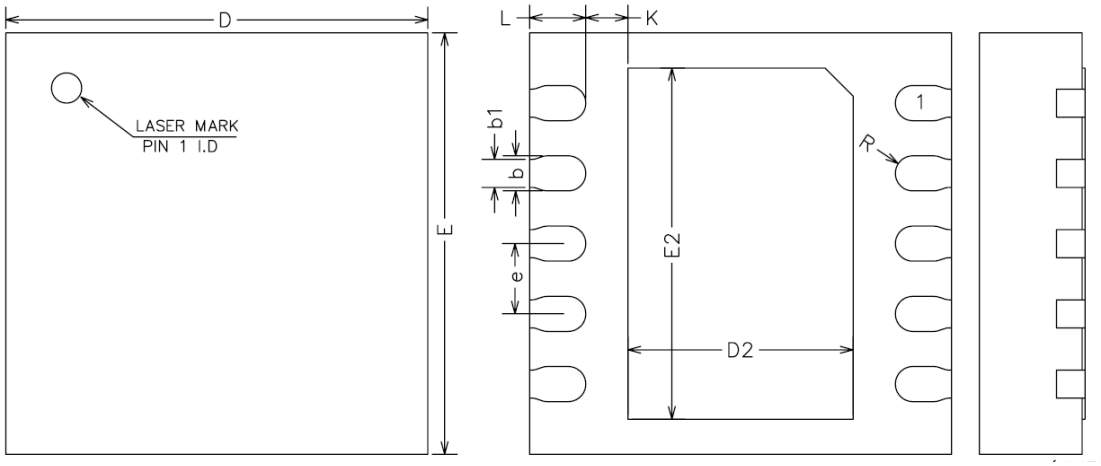
The typical 0603 surface mount resistor is rated 1/10 Watt continuous power and 1/5 Watt pulsed power, more than enough for this application. For other applications, the P_{FLASH} power can be calculated and resistor size selected. The R_{SENSE} resistor is recommended to be size 0603 for most applications. The range of typical resistor values and sizes are shown here in Table 1.

Table 1: Resistor values and sizes

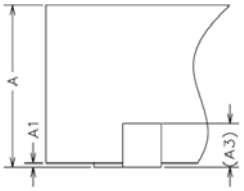
PART REFERENCE	VALUE	TOLERANCE	SIZE	MANUFACTURERS
RSET	68KΩ	5%	0402	any
RSET	75KΩ	5%	0402	any
RSET	82KΩ	5%	0402	any
RSET	91KΩ	5%	0402	any
RSET	100KΩ	5%	0402	any
RSET	110KΩ	5%	0402	any
RSET	120KΩ	5%	0402	any
RSET	130KΩ	5%	0402	any
RSET	140KΩ	5%	0402	any
RSET	150KΩ	5%	0402	any
RSENSE	0.22Ω	5%	0603	Panasonic or Vishay
RSENSE	0.27Ω	5%	0603	Panasonic or Vishay
RSENSE	0.33Ω	5%	0603	Panasonic or Vishay

RSENSE	0.39Ω	5%	0603	Panasonic or Vishay
RSENSE	0.47Ω	5%	0603	Panasonic or Vishay

Physical Dimensions: DFN-10 3*3







COMMON DIMENSIONS (UNITS OF MEASURE=MILLIMETER)			
Symbol	**MIN**	**NOM**	**MAX**
A	0.70	0.75	0.80
A1	0	0.02	0.05
A3		0.20REF	
b	0.20	0.25	0.30
b1		0.20REF	
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D2	1.50	1.60	1.70
E2	2.40	2.50	2.60
e	0.40	0.50	0.60
K	0.20	-	-
L	0.30	0.40	0.50
R	0.13	-	-