

Photoflash Capacitor Chargers Keep Up with Shrinking Cameras

by Mike Negrete

Introduction

Camera-phones have come a long way since the first generation of integrated cameras offered low-resolution CMOS images through the eye of a plastic lens. Now PDAs and high-end cell phones include high quality cameras with 2 megapixel resolutions and glass optics. Since these devices are carried by most users at all times, size is of the utmost importance. LED flashes were introduced in early model cell phone cameras, but they cannot produce enough light and lack the spectral quality required for higher-end cameras. Although xenon flashes are an optimal source of light for photography, they required substantially more board space than LED flashes until

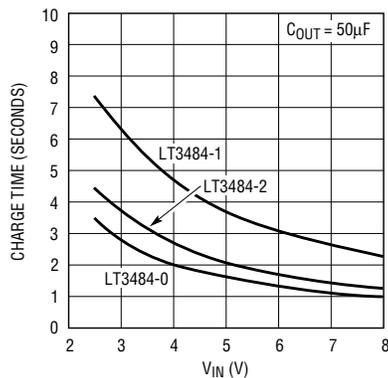
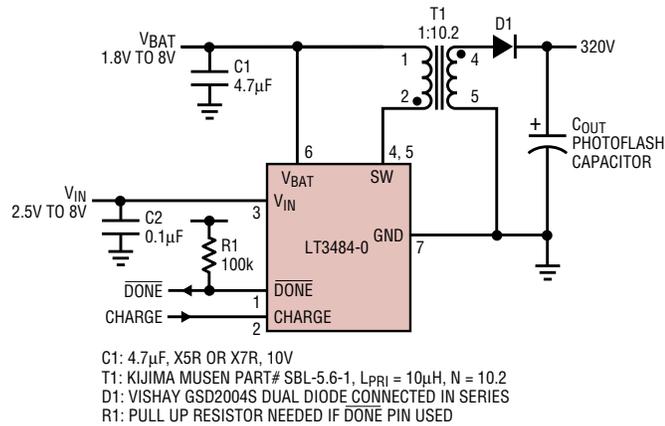


Figure 2. Charge time for the LT3484

Figure 1. Compact, 320V photoflash capacitor charging circuit needs no external Schottky diode



the LT3468 allowed xenon flashes to fit into the spaces of cell phones and PDAs. The LT3484 and LT3485 photoflash capacitor chargers improve upon the LT3468.

The LT3484 and LT3485 are based on the LT3468's patented control scheme, providing well controlled battery current, fast charge times and high efficiency. Both series of parts use the same tiny, low-profile transformers as the LT3468. Available in a 6-Lead 2mm × 3mm DFN, the LT3484 reduces the board space significantly with its smaller package and total solution size compared to the

LT3468. The LT3484 has also added an additional pin, V_{BAT}, to allow it to operate from two alkaline cells. For xenon photoflash applications with an IGBT, the LT3485 decreases the solution size further with the same photoflash functionality as the LT3484 and an integrated IGBT driver in its 10-Lead 3mm × 3mm DFN package. The LT3485 also features an output voltage monitor pin.

Overview

A typical application circuit for the LT3484 is shown in Figure 1. With a high level of integration inside the part,

Table 1. Photoflash capacitor charger features

	LT3484-0	LT3484-1	LT3484-2	LT3485-0	LT3485-1	LT3485-2	LT3485-3
Peak SW Current (A)	1.4	0.7	1.0	1.4	0.7	1.0	2.0
Average Input Current (mA) (V _{IN} = 3.6V, V _{OUT} = 225V)	500	250	400	500	250	400	750
Charge Time Coefficient Kijima (τ)	0.65	0.30	0.50	0.75	0.34	0.51	NA
Charge Time Coefficient TDK (τ)	0.62	0.32	0.51	0.73	0.37	0.51	1.10
Minimum Battery Voltage(V)		1.8			1.8		
Integrated IGBT Drive + V _{OUT} Monitor		No			Yes		
External Schottky Diode Required		No			No		
Package		2mm × 3mm DFN 6L			3mm × 3mm DFN 10L		

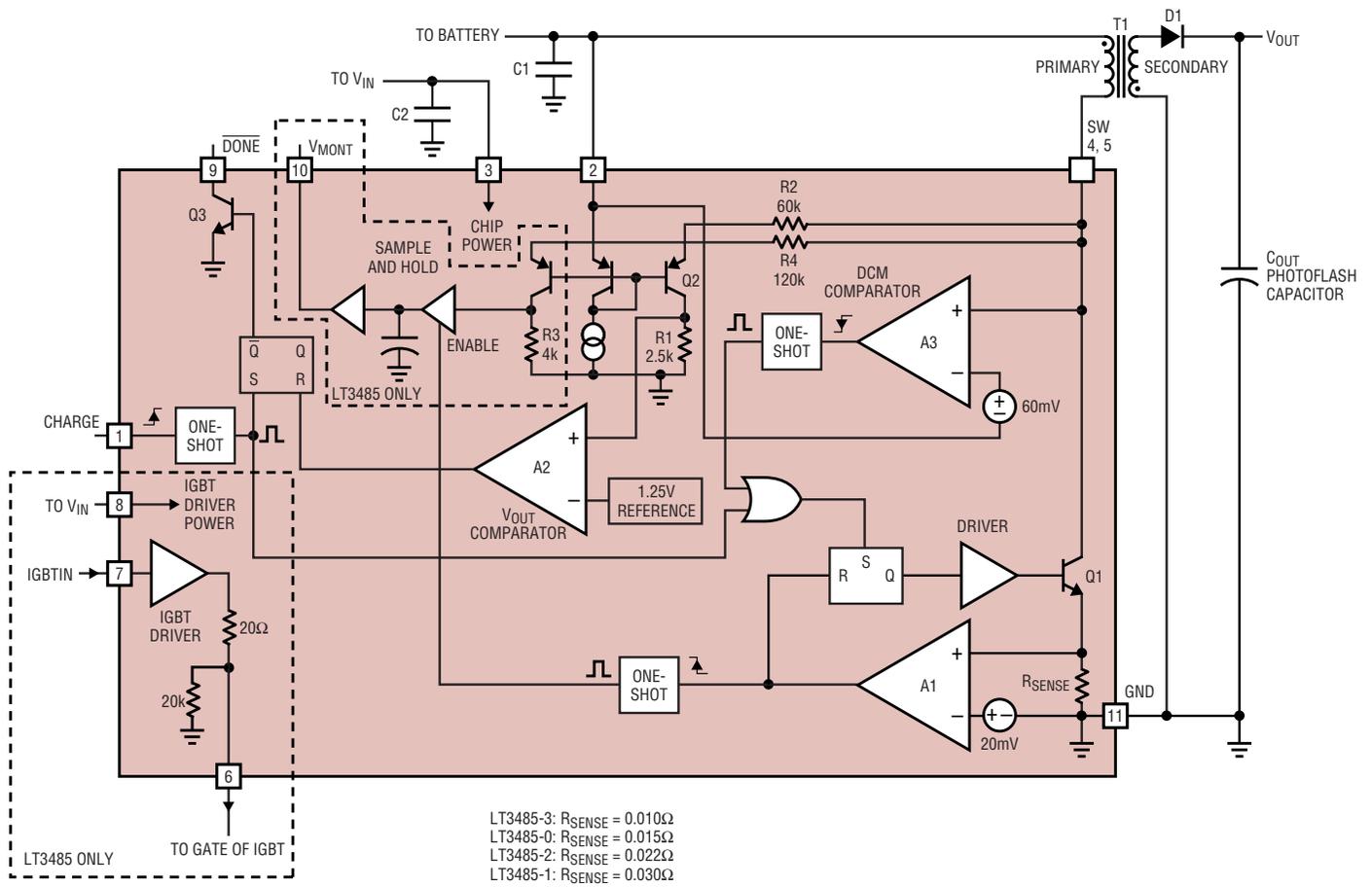


Figure 5. Block diagram for the LT3484 and the LT3485

the voltage on the SW pin collapses to V_{BAT} , or lower. As a result, the output of the DCM comparator goes low, which triggers the one-shot. This leads to Q1 turning on again and the cycle repeats.

Output voltage detection is accomplished via comparator A2. When the SW pin is 31.5V higher than V_{BAT} on any cycle, the output of A2 goes high. This resets the master latch and the part stops delivering power to the photoflash capacitor. Power delivery can only restart by taking the CHARGE pin low and then high.

Note that the flux in the flyback transformer is brought to zero on each switching cycle. This is generally referred to as boundary mode operation since the transformer is operated in between continuous conduction mode and discontinuous conduction mode (CCM and DCM respectively). When the CHARGE pin is forced low at any time, the LT3484/LT3485 ceases power delivery and goes into shutdown mode, thus reducing quiescent current to less than 1µA. Figure 6 shows some typical waveforms for the LT3484 and LT3485.

output, V_{MONT} , proportional to the capacitor voltage. This output can easily be read by a microcontroller with an ADC.

Figure 7 shows the measured output of V_{MONT} . Because of the high speed nature of the circuit and the high dV/dt of the switch pin, there is a small amount of ripple on the V_{MONT} output, which can be reduced by adding a 0.1µF capacitor to the output or by using the ADC to sample the V_{MONT} output multiple times and taking the average.

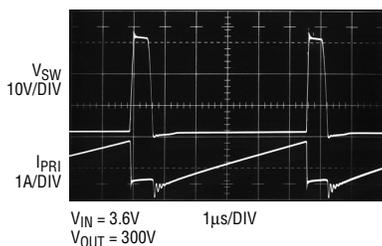


Figure 6. A LT3485 switching waveform at 300V output

Voltage Output Monitor

Camera manufacturers continue to try to differentiate their product with novel features such as strobe shots and sequential shots. These new features rely on fast capacitor charging to be done in the time between shots. If the capacitor is not fully charged, is the voltage high enough to produce a flash? The LT3485 addresses this problem by including a 1V full-scale

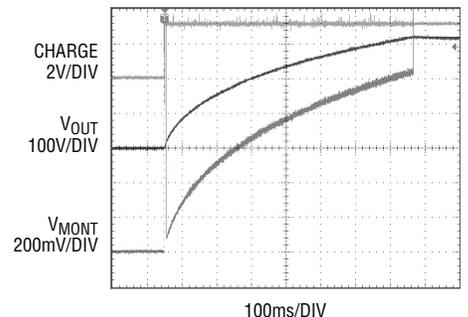


Figure 7. Voltage output monitor waveform during charging

IGBT Drive

Most camera flashes are capable of reeye reduction and light-feedback flashing. These features quench, or stop, the flash before the capacitor drains completely. This added level of control requires a high current, high voltage Insulated Gate Bipolar Transistor (IGBT). An IGBT has the advantage of a BJT's high voltage and high current capabilities but does not need base current since it has a MOSFET gate as the input. The tradeoff for these two advantages is speed. Since a flash is on the order of milliseconds, speed is not an issue in this application and an IGBT fits perfectly for the role.

Like a MOSFET, the gate acts like a capacitor. The IGBT driver's job is to charge and discharge the gate. The IGBT driver does not need to be fast, and actually a fast driver can potentially destroy the device. The IGBT turns on when the IGBTIN pin is above 1.5V and turns off when the IGBTIN pin is below 0.3V. When the input is high, the driver draws a small amount of current to hold the gate high with a PNP. When the input is low, the driver has zero quiescent current. During transitions the driver is capable of delivering 150mA of current.

The speed of the driver needs to be carefully controlled or the IGBT may be destroyed. The IGBT driver does not need to pull up the gate fast because of the inherently slow nature of the IGBT. A rise time of 2 μ s is sufficient to charge the gate of the IGBT and create a trigger pulse. With slower rise times, the trigger circuitry does not have a fast enough edge to create the required 4kV pulse. The fall time of the IGBT drive is critical to the safe operation of the IGBT. The IGBT gate

is a network of resistors and capacitors. When the gate terminal is pulled low too quickly, the capacitance closest to the terminal goes low but the capacitance further from the terminal remains high, causing a small portion of the IGBT device to handle the full 100A of current which quickly destroys the device. The pull down circuitry therefore needs to be slower than the internal RC time constant in the gate of the IGBT. To slow down the driver, a 20 Ω series resistor is integrated into the LT3485.

Which Part to Use

The LT3484 and LT3485 families of photoflash capacitor chargers suit about any photoflash need. The basic photoflash functionality in each part is identical and both parts are capable of operating from 2AA cells. The integrated IGBT drive and voltage output monitor differentiate the LT3485 from the LT3484, along with its higher current capabilities. The LT3484 is the smallest solution available if quenching the bulb is not needed. When using an IGBT to trigger the flash, the LT3485 offers valuable board space savings over the LT3484 by eliminating several external components. Table 1 shows the major functional differences between these seven parts.

Once the decision is made on the integrated IGBT driver, choosing a current option is a matter of balancing the inherent trade-off between input current and charge time. For a given photoflash capacitor size, the device which results in the highest input current offers the fastest charge time. The limit on how much current the photoflash charger can draw is usually set by the battery technology used, and how much load they

can handle. The LT3485-3 offers the fastest charge times of the chargers discussed here.

The following equation predicts the charge times (T) in seconds for the seven parts:

$$T = \frac{C_{OUT} \cdot (V_{OUT(FINAL)}^2 - V_{OUT(INIT)}^2)}{\tau \cdot V_{IN}}$$

where C_{OUT} is the value of the photoflash capacitor in Farads, $V_{OUT(FINAL)}$ is the target output voltage, $V_{OUT(INIT)}$ is the initial output voltage, V_{IN} is the battery voltage to which the flyback transformer is connected, and τ is the charge time coefficient listed in Table 1.

The charge time coefficients for each part are different depending on the transformer due to differences in efficiency and average input current. The charge time coefficients are given for Kijima Musen and TDK transformers, with part numbers and typical specifications for these transformers listed in Table 2.

Conclusion

The LT3484 and LT3485 provide simple, efficient capacitor charging solutions for digital still cameras and integrated digital cameras in cell phones. The high level of integration reduces the amount of external components while also producing tightly controlled output voltage and average input current distributions. The three current limits in the LT3484 family and the four current limits in the LT3485 family allow for flexibility in the trade-off between input current and charge time. The LT3485 saves even more space for some applications by integrating an IGBT driver and voltage output monitor. 

LT6555/56, continued from page 22

Demonstration Circuits Available

The LT6555 and LT6556 have Demo Boards available that make evaluation of these parts a simple plug-and-play operation. To evaluate the LT6555 ask for DC858A (SSOP-24 package) or DC892A-A (QFN package). To evalu-

ate the LT6556 ask for DC892A-B (in QFN package). All three of these demo circuits have high-quality 75 Ω BNC connections for best performance and illustrate high-frequency layout practices that are important to obtaining the best performance from these super-fast amplifiers. 

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