

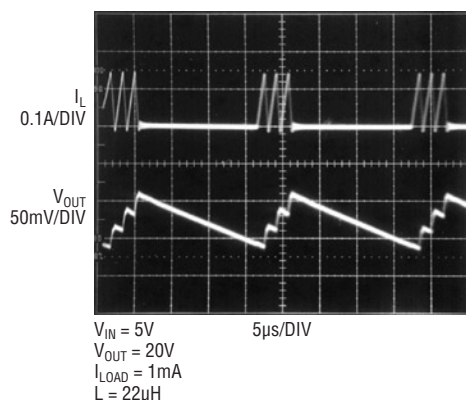
# Micropower SOT-23 Boost with Integrated Schottky Diode Provides Output Disconnect and Short Circuit Protection

by Leonard Shtargot

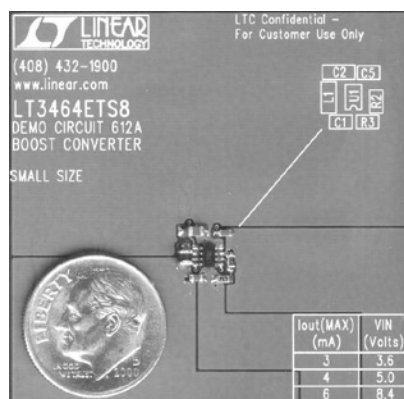
## Introduction

The LT3464 is the only micropower boost converter in the industry to combine a 36V NPN power switch, power Schottky diode, and output disconnect into an 8-lead ThinSOT. This unprecedented level of integration saves several external components while offering true output disconnect, making it possible to generate outputs of up to 34V with a zero current shut-down while using a mere 40mm<sup>2</sup> of board area (refer to Fig. 1).

In addition to component savings, the LT3464 offers a low typical switch current limit of 115mA and fast switching, a combination that allows the use of a tiny chip inductor and tiny ceramic capacitors. The LT3464 also features Burst Mode control (see Figure 2), which results in highly efficient operation over a wide range of load currents and a low quiescent current of only 25µA typical. The CTRL pin of the LT3464 acts much like a dial on a lab power supply—it allows the output voltage to be varied, which is useful in applications for purposes such as LCD contrast adjustment.



**Figure 2.** Burst Mode waveforms showing low output ripple. The LT3464 consumes only 25µA typical when not switching.

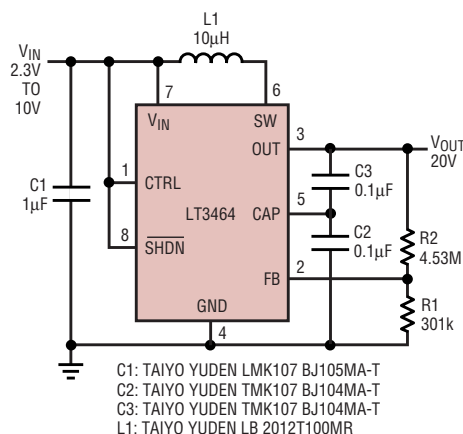


**Figure 1.** The integrated Schottky diode and output disconnect transistor result in a tiny solution occupying as little as 40mm<sup>2</sup>.

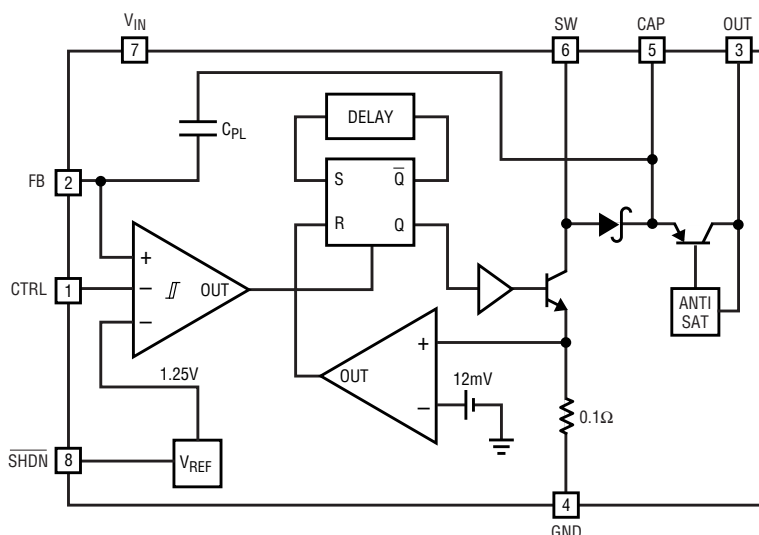
The LT3464's small size and high efficiency make it an especially attractive power solution for portable electronics requiring long battery life and compact circuitry. See Figure 3 for a simplified block diagram of the LT3464.

## Output Disconnect

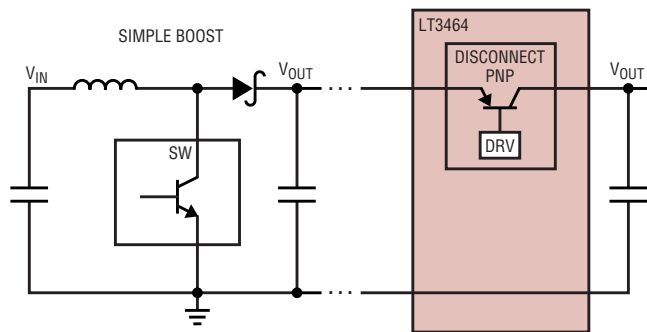
In a simple boost circuit (Figure 4) there exists a DC path from the input



supply ( $V_{IN}$ ) through the inductor and diode to the load ( $V_{OUT}$ ), effectively leaving the load connected to  $V_{IN}$  during shutdown. The resulting current drain during shutdown is unacceptable in many applications, requiring the addition of several external components to isolate the load from  $V_{IN}$ . To save space and complexity, the LT3464 is equipped with a PNP that completely



**Figure 3.** LT3464 block diagram showing integrated NPN switch, Schottky diode and output disconnect PNP.



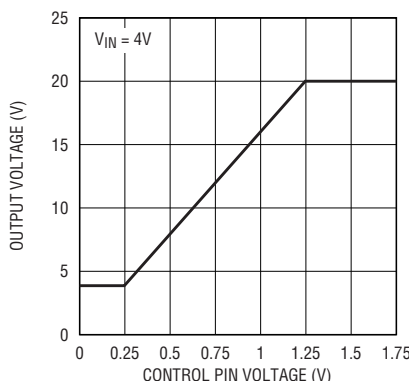
**Figure 4.** A simple boost circuit with LT3464's output disconnect allows the complete solution to draw less than 0.5 $\mu$ A during shutdown. The output disconnect is designed with a 25mA current limit to protect the circuit during short circuit conditions.

disconnects the load from the Schottky diode during shutdown (see Figures 4 and 5). During normal operation, the control circuitry turns on the PNP and keeps it just out of saturation, resulting in low  $V_{CE(SAT)}$  and low quiescent current. In addition, the disconnect circuit has a built in current limit

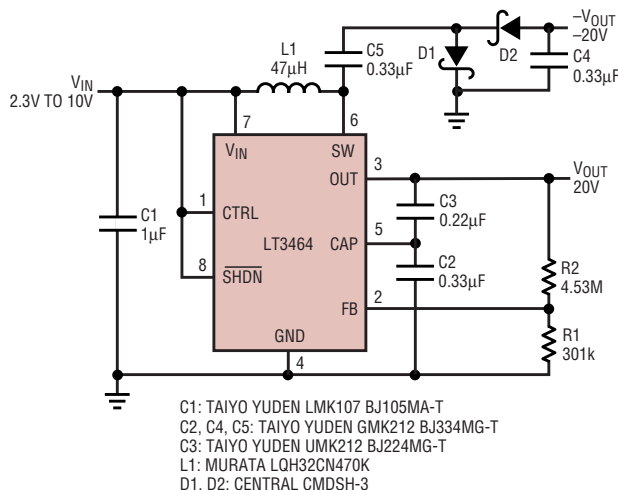
of 25mA to protect the chip during a short-circuit at the output. This feature allows the LT3464 to tolerate an indefinite short, but care must be taken to avoid exceeding the maximum junction temperature.

### Using the CTRL Pin

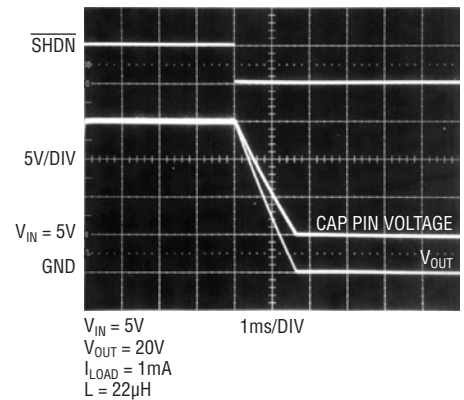
The LT3464 features an auxiliary reference input that provides an easy way to vary the output voltage for purposes such as LCD contrast adjustment or display dimming. When the CTRL pin held at or above 1.25V, the LT3464 uses the internal 1.25V reference, but when a voltage lower than 1.25V is applied to the CTRL pin, that voltage becomes the new reference. Figure 6 shows the output voltage versus the CTRL pin voltage for a 20V output circuit. Note that the LT3464 will not regulate the output to a voltage lower than the input.



**Figure 6:** Using the CTRL Pin as an auxiliary reference input to control the output voltage



**Figure 7.** ±20V Dual output converter



**Figure 5:** The output disconnect isolates the output load from the input supply during shutdown. CAP Pin voltage is the output of the Schottky in Figure 4.

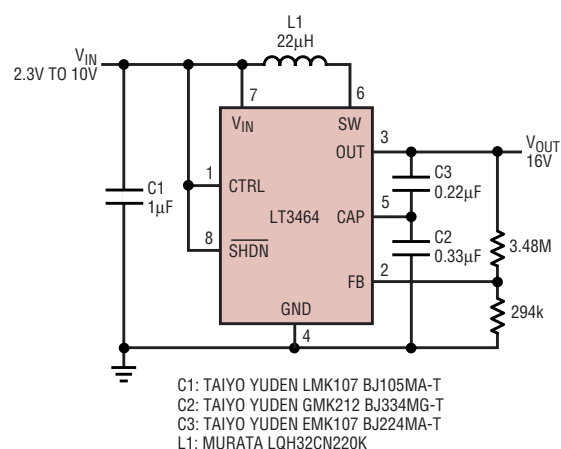
### LT3464 ±20V Dual Output Converter

Figure 7 shows a single-inductor dual-output converter for applications that require both a positive and negative voltage. The positive output is generated by a simple boost set up, whereas the negative output is generated using an inverting charge pump. Although well regulated, the negative output will have a slight offset from the positive output because the external diodes have a different on voltage when compared to the integrated Schottky diode.

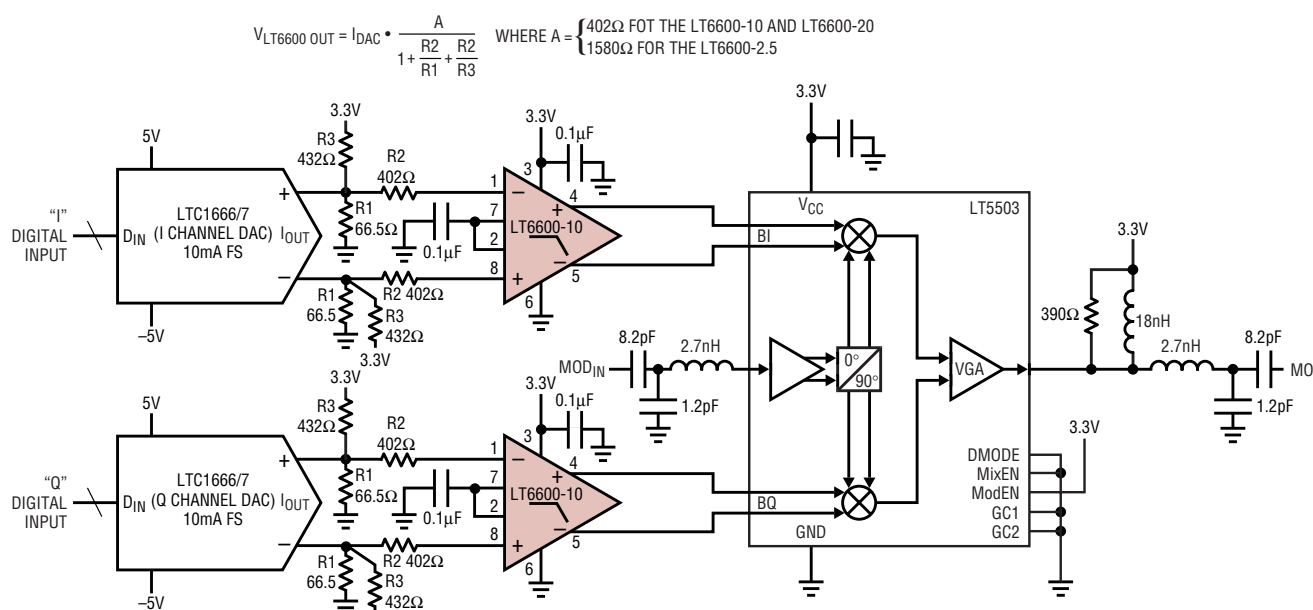
### 1-Cell Li-Ion to 16V Boost Converter

Figures 8 and 9 show that the LT3464 performs well in applications that need a high output voltage at a relatively

*continued on page 24*



**Figure 8.** Li-Ion to 16V boost converter



**Figure 7. Using the LT6600 as a transimpedance amplifier and smoothing filter in a base station application.**

mode level when it converts the single-ended input to differential. In Figure 6, the input signal is referenced to ground and the signal presented to the ADC is referenced to  $V_{CM}$ .

To illustrate the excellent dynamic range of the LT6600, consider Figure 6 with a 1MHz input signal of 800mV<sub>PP</sub> amplified by an LT6600-2.5. With  $R_{IN} = 402\Omega$ , the amplifier provides 12dB of voltage gain. The signal presented to the ADC converter is 3.2V<sub>P-P</sub>. The distortion components will be at least 82dB below the fundamental, and the signal-to-noise ratio will be 81dB in a 5MHz bandwidth.


The differential output DAC is another application where the LT6600 excels. Figure 7 shows the LT6600 acting as a transimpedance amplifier and a 4th order smoothing filter, in

a base station application. The input common mode range of the LT6600 accommodates the compliance range of the DAC. The output common mode voltage of the LT6600 is set to optimize the performance of the LT5503 direct I/Q modulator. The resistors between the DAC and the LT6600 allow the user to adjust the transimpedance gain. The LT6600 and LT5503 are operating on a 3.3V power supply.

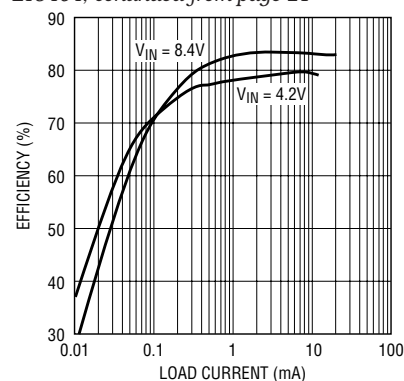
To illustrate the optimized filtering of the LT6600, consider the case where the DAC in Figure 7 has a sample rate of 50Msps and the baseband signal information extends to 10MHz. By using an LT6600-10, the attenuation of the images near 40MHz would be more than 50dB (filter response plus  $\sin(x)/x$  attenuation). The excellent rejection in the stopband is combined with

low delay distortion in the passband (Figure 2), making for an outstanding DAC smoothing solution.

## Conclusion

The LT6600 differential filter-amplifiers are the most compact ADC anti-aliasing and DAC smoothing solutions available in the 2.5MHz to 20MHz range. The combination of low noise, low distortion, and precision response are impossible to replicate with discrete designs. The LT6600 is pin compatible with standard differential output op amps and performs all of the same functions. The LT6600 improves the design of any system requiring differential signal buffering and filtering. 


*LT3464, continued from page 21*



**Figure 9. Efficiency for the circuit in Figure 7**

low current. As shown in Figure 9, high efficiency is maintained with low output currents.

## Conclusion

The LT3464 in the ThinSOT package produces an ultra compact boost solution featuring high efficiency, low quiescent current, true output disconnect, and low external parts count. 

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