DESIGN NOTES

20V, 2.5A Monolithic Synchronous Buck SWITCHER+ with Input Current, Output Current and Temperature Sensing/Limiting Capabilities

Design Note 511

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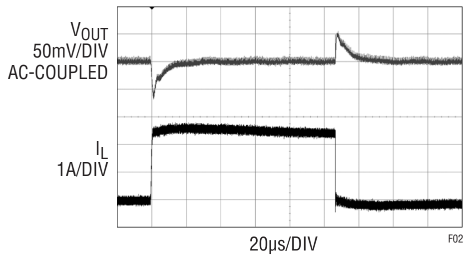
Introduction

The LTC®3626 synchronous buck regulator with current and temperature monitoring is the first of Linear's SWITCHER+™ line of monolithic regulators. It is a high efficiency, monolithic synchronous step-down switching regulator capable of delivering a maximum output current of 2.5A from an input voltage ranging from 3.6V to 20V (circuit shown in Figure 1). The LTC3626 employs a unique controlled on-time/constant-frequency, current-mode architecture, making it ideal for low duty cycle applications and high frequency operation, while yielding fast response to load transients (see Figure 2). It also features mode setting, tracking and synchronization capabilities. The LTC3626's 3mm × 4mm package has such low thermal impedance that it can operate without an external heat sink even while delivering maximum power to the load.



$12V_{IN}$ TO $1.8V_{OUT}$ LOAD STEP RESPONSE,
2.5A LOAD STEP, 2MHz SWITCHING FREQUENCY,
FORCED CONTINUOUS MODE, INTERNAL COMPENSATION

Figure 2. Load Step Response for Figure 1 Circuit

Beyond its impressive regulator capabilities, the LTC3626's current and temperature monitoring functions stand out. They offer both monitoring and control capabilities with minimal additional components.

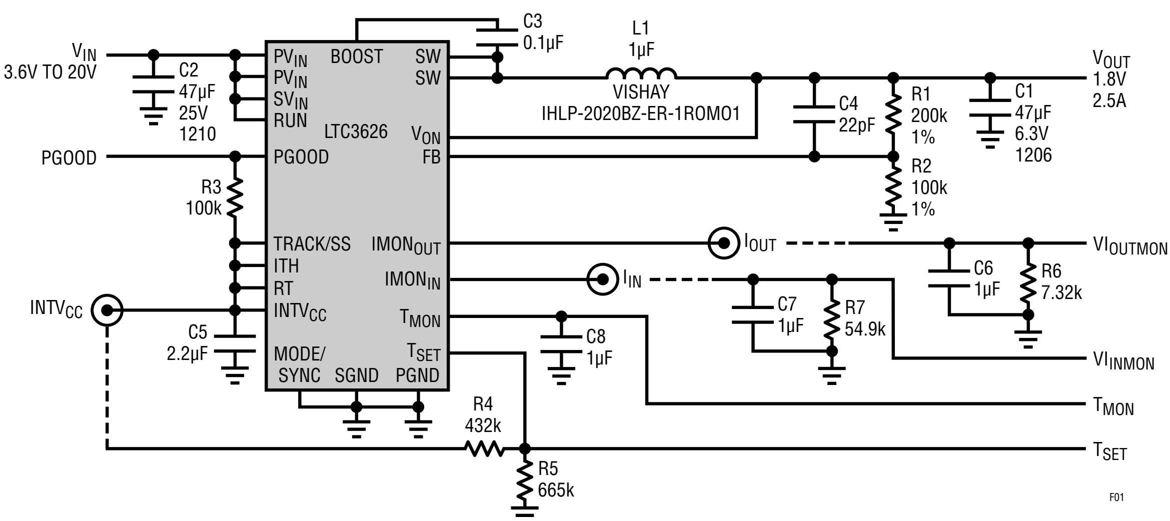


Figure 1. 20V Maximum Input, 2.5A, 2MHz Buck Regulator with Current and Temperature Monitoring

Output/Input Current Sensing

The LTC3626 senses the output current through the synchronous switch during the switch's on-time and generates a proportional current (scaled to 1/16000) at the $IMON_{OUT}$ pin. Figure 3 shows the accuracy of the $IMON_{OUT}$ output by comparing the measured output of the $IMON_{OUT}$ pin with calculated values. Error remains less than 1% over most of the output current range.

Likewise, this same sense current signal is combined with the buck regulator's duty cycle to produce a current proportional to the input current—again by 1/16000—at the $IMON_{IN}$ pin. A precision of better than 5% is achieved over a wide current range (see Figure 4).

Both current signals are connected to internal voltage amplifiers, referenced to 1.2V, that can shut down the part when tripped. So the input and output current limits are set by simply connecting a resistor to the $IMON_{IN}$ or $IMON_{OUT}$ pins, respectively, as shown in Figure 1. The relationship between the current limit and the resistor is:

$$I_{LIM} \simeq \frac{1.2V \bullet 16000}{R_{LIM}}$$

For example, a 10k resistor sets a current limit of approximately 2A.

This simple scheme allows both monitoring and active control of the input and output current limits—the latter can be implemented via external control circuitry, such as a DAC with a few passive components.

Temperature Sensing

The LTC3626 generates a voltage proportional to its own die temperature, which can be used to set a maximum temperature limit. The voltage at the temperature monitor pin (T_{MON}) is typically 1.5V at room temperature. To calculate the die temperature, T_J, multiply the T_{MON} voltage by the temperature monitor voltage-to-temperature conversion factor of 200°K/V, and subtract the 273°C offset. The LTC3626 also has a temperature limit comparator fed by the temperature limit set pin, T_{SET}, and the T_{MON} pin. Hence, by applying a voltage to the T_{SET} pin, a maximum temperature limit can be set according to the following:

$$V_{TSET} = \frac{T_J + 273}{200°K/V}$$

Choosing a maximum temperature limit of 125°C equates to an approximate 2V setting on the T_{SET} pin—the IC will shut down once the die temperature T_J reaches this limit.

Conclusion

The LTC3626 combines current and temperature monitoring capabilities with a high performance buck regulator in a compact package. A microprocessor or other external control logic can supervise conditions via easy-to-use input and output current and temperature monitor pins, and it can shut itself down by setting a threshold voltage on the temperature set limit pin.

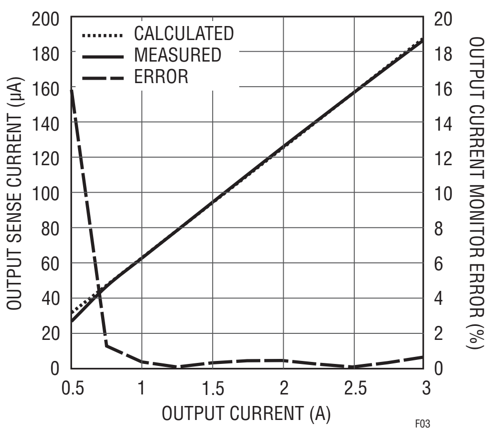


Figure 3. Output Current vs Output Current Monitor

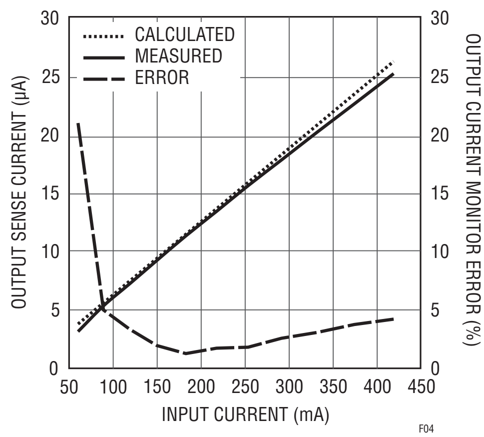


Figure 4. Input Current vs Input Current Monitor

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