

42V High Power Density Buck Regulators in a Tiny QFN Package

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Power dissipation is a significant problem facing the designers of DC/DC converters in industrial and automotive applications, where high currents are required, but space is limited. It is possible to produce a highly efficient regulator from high performance discrete components, but expense and solution footprint make this approach prohibitive. The LT8612/LT8613 high efficiency buck regulators integrate all the necessary components into a single IC, significantly reducing the DC/DC converter size, even when faced with high step-down ratios. These devices can also be paralleled to increase the output current capability and spread the load and heat.

Other desirable features included in these regulators are ultralow quiescent current to maximize battery life, and high switching frequency to minimize solution size and avoid noise-sensitive frequency bands.

HIGHLY EFFICIENT 42V, 6A REGULATORS IN 3mm × 6mm PACKAGE

The LT8612/LT8613 are 42V, 6A step-down monolithic regulators. The low power dissipation of the integrated high efficiency power switches allows these switches, the boost diode, internal compensation and all necessary circuitry to be encapsulated in a tiny 3mm × 6mm QFN package without overheating. Figure 1 shows a typical 5V/30W LT8612 converter; its efficiency and power loss are demonstrated in

Figure 1. A 5V/30W step-down converter using the LT8612

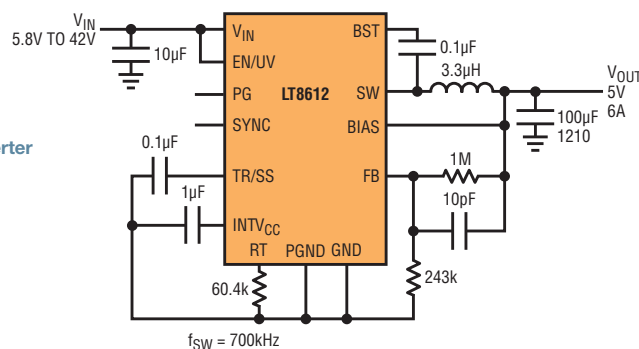


Figure 2. Even with an input voltage of 24V, the LT8612 can produce a 30W output with no more than 50°C temperature rise. At the other end of the load spectrum, the LT8612/LT8613 uses low ripple Burst Mode® operation to enhance efficiency in ultralow load situations.

The minimum on-times of LT8612/LT8613 are as low as 40ns, allowing for high VIN/VOUT ratios even at high switching frequencies. High switching frequencies, up to 2.2MHz, minimize the size and value of the power inductor and output capacitor. Furthermore, the inductor can be confidently sized based on the output load requirement—no need to use a larger inductor to provide design overhead—a result of the devices’

high speed peak-current mode architecture and robust switch design.

MULTIPHASE DESIGN TO INCREASE OUTPUT CURRENT CAPABILITY

Loads more than 6A are not uncommon in automotive and industrial applications. For these relatively high current conditions, a multiphase design can extend the output capabilities of the LT8612/LT8613 regulators. The LT8613 has a built-in rail-to-rail current sense amplifier with monitor and control pins, enabling accurate input or output average current regulation. This current loop modulates

Figure 2. Efficiency and power loss of the 5V/30W LT8612 step-down converter in Figure 1.

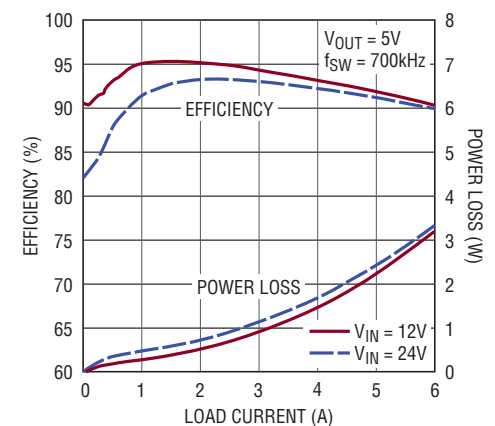


Figure 3. Three parallel LT8613s in a 3-phase design deliver 16A at 4V V_{OUT}

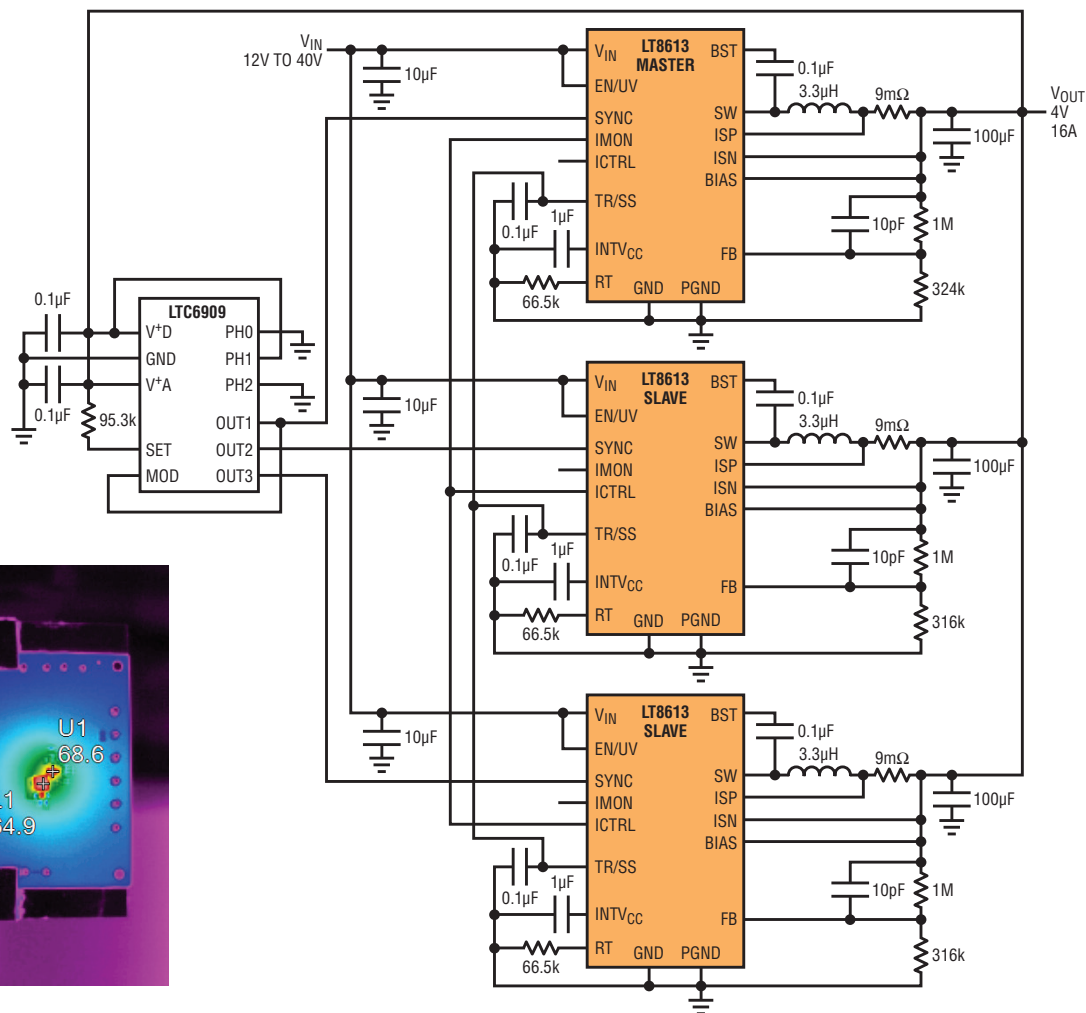


Figure 4. Thermal image of 3-phase LT8613 design shows balanced current sharing

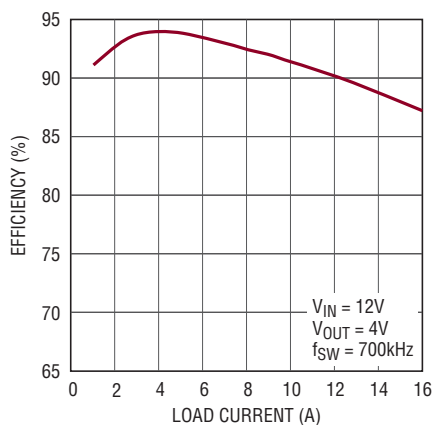
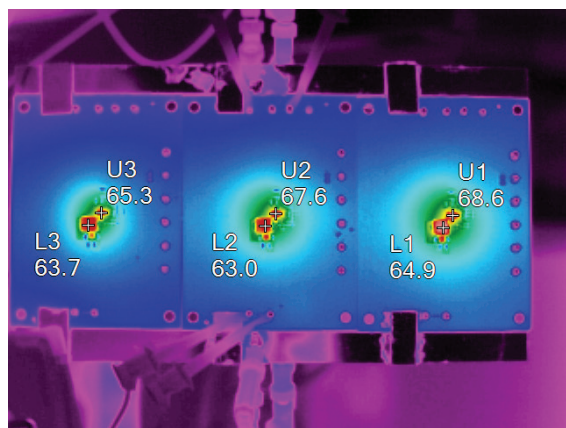


Figure 5. Typical efficiency of 3-phase LT8613 design shown in Figure 3

the internal switch current limit such that the voltage across the ISP/ISN pins does not exceed the voltage set by the ICTRL pin. Another IMON pin is used to monitor the average current that is measured

through the ISP/ISN pins. This current control feature makes accurate current sharing among several LT8613s possible without any additional control circuitry.

Figure 3 shows three LT8613s paralleled for up to 16A output. The top LT8613 is the master regulator with its output voltage set to 4V, while the other two LT8613s are slave regulators with their output voltages set a little higher than 4V.

In order to share current among the three LT8613 regulators, the IMON pin of the master LT8613 is connected to the ICTRL pins of the slave LT8613s. The three LT8613 regulators are synchronized by the 3-phase 700kHz clock signals (120° phase shift) generated from the LTC6909 oscillator. Figure 4 shows a thermal image of this 3-phase LT8613 design.

The similarity in temperatures of the LT8613s indicates even current sharing among the three phases. The efficiency of this design is shown in Figure 5.

If it is desirable to weight the current sharing among the phases—that is to unbalance the current sharing—simply adjust the values of the sense resistors across ISP and ISN pins.

CONCLUSION

The LT8612 and LT8613 are fully integrated high power density monolithic step-down regulators that satisfy challenging automotive and industrial requirements. They can be easily paralleled for efficient, high current applications and compact solution footprints. ■