LINEAR TECHNOLOGY

DESIGN NOTES

42V Quad Monolithic Synchronous Step-Down Regulator with 30µA Quiescent Current

Design Note 544

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Introduction

Industrial and automotive applications require robust, easy-to-use, compact DC/DC converters to produce a variety of low voltage power supplies. The LT8602 monolithic quad synchronous step-down converter in a 6mm × 6mm package is capable of providing four outputs from a wide input range of 3V to 42V. It is versatile and easy to use with features such as low EMI and adjustable operating frequency up to 2.2MHz. It consumes only 30µA quiescent current from the input source even when regulating the outputs.

Small Size, Low EMI, Quad Step-Down Solution

The LT®8602 integrates two high voltage (HV) and two low voltage (LV) synchronous regulators in a QFN (6mm × 6mm) package. Replacing external Schottky diodes with internal synchronous switches minimizes the solution size and also increases efficiency, reducing power dissipation.

The two HV channels (1 and 2) are capable of supporting 1.5A and 2.5A loads respectively, from an input of 3V to 42V. The two LV channels (3 and 4) can support up to 1.8A each from an input of 2.6V to 5.5V. Figure 1 shows the top center view of the demo circuit DC1949A. A simplified schematic with four outputs: 5V, 3.3V, 1.8V and 1.2V is shown in Figure 3. One LT8602 replaces four individual regulators, reducing overall solution size and cost. All four regulators in the LT8602 are synchronized to a single oscillator programmed at 2MHz, allowing the channels to operate anti-phase. The LT8602 reduces the input ripple current by operating channels 1 and 3 out of phase from channels 2 and 4, simplifying EMI filter design. The demonstration circuit DC1949A includes a small EMI filter. Figure 2 shows the radiated EMI performance of the board. It passes the CISPR25 class 5 peak limits with good margin.

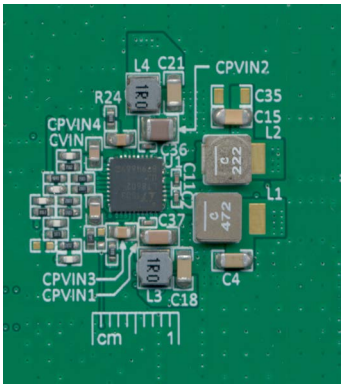

Figure 1. Top Center View of the Demo Board DC1949A

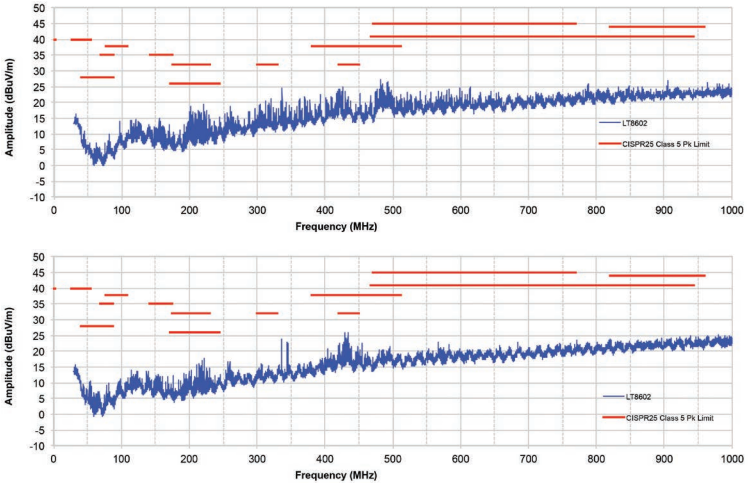

Figure 2. Radiated EMI Performance (CISPR25, Class 5, Peak Detector), 14V_{IN}, 1A at All Outputs, Switching Frequency = 2MHz

Wide Input Range Even at High Switching Frequencies

A high switching frequency can be used to minimize DC/DC solution size, but increasing frequency usually comes with a trade-off: reduced input voltage range. This is a significant concern in automotive and industrial environments, giving designers pause when considering the advantages of increasing the switching frequency.

With low minimum on-time and low dropout, the LT8602 allows a wide input range, even at 2MHz. Figure 4 shows the dropout performance of channel 1. As the input voltage decreases toward the programmed output voltage, LT8602 maintains regulation by skipping switch-off times and decreasing the switching frequency up to a maximum duty cycle of 99.6%. If the input voltage decreases further, the output voltages remain 50mV–550mV below the input voltage, depending on the load. The boost capacitor is charged during dropout conditions, maintaining high efficiency.

Flexible Sequence Control

The LT8602 has a track and soft-start pin for each HV channel. For each LV channel, it has an internal soft-start of ~1ms. Each channel also has a power good indicator. Those pins simplify output tracking or sequencing.

Conclusion

The LT8602 integrates four synchronous buck regulators in a 6mm × 6mm QFN package, enabling compact, low EMI, high efficiency, fault robust solutions requiring only 30µA quiescent current. Individual inputs for each converter allow design freedom, while separate PG indicators and TRK/SS pins further extend tracking and sequencing flexibility. These features make the LT8602 ideal for the harsh environments common to automotive and industrial applications.

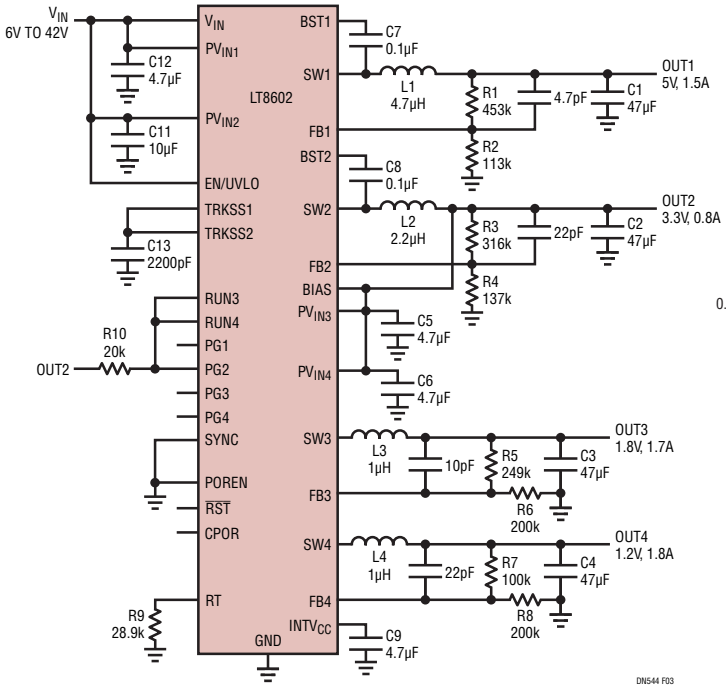

Figure 3. Schematic. 5V, 3.3V, 1.8V, 1.2V, f_{SW} = 2MHz Outputs

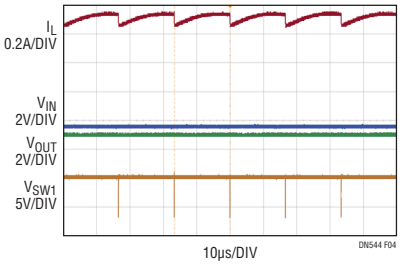

Figure 4. Dropout Performance at I_{OUT} = 1.5A

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