

DESIGN NOTES

Step-Down Converter Delivers 25A at 12V_{OUT} from Inputs Up to 60V

Design Note 1024

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Introduction

The LTC3890 (dual outputs) and LTC3891 (single output) step-down DC/DC controllers directly accept inputs from 4V to 60V. This wide input range covers input voltages for single or double battery automotive environments, thus eliminating the need for snubbers and voltage suppression circuitry typically required to protect ICs during load dumps. This range also encompasses 48V telecom applications. If no galvanic isolation is required between the input and output voltages, the LTC3890 and LTC3891 can replace expensive and bulky transformer-based converters. When compared to a transformer-based solution, an LTC3890 or LTC3891 step-down converter increases efficiency, reduces power loss in the supply lines, simplifies layout and significantly reduces the bill of materials.

High Efficiency 2-Phase Converter Produces 12V at 25A

Figure 1 shows the LTC3890 in a 2-phase single output step-down converter configuration that delivers 25A at 12V, which can be scaled up to 75A by adding more LTC3890 ICs to increase the number of power phases. For lower output current, the single-phase LTC3891 can be used. Implementing a 2-phase converter simply requires tying together the independent channel pins of the LTC3890, namely, FB1 and FB2, TRACK/SS1 and TRACK/SS2, RUN1 and RUN2, ITH1 and ITH2.

Although the ITH pins are connected together, each is terminated to a separate 47pF capacitor to compensate

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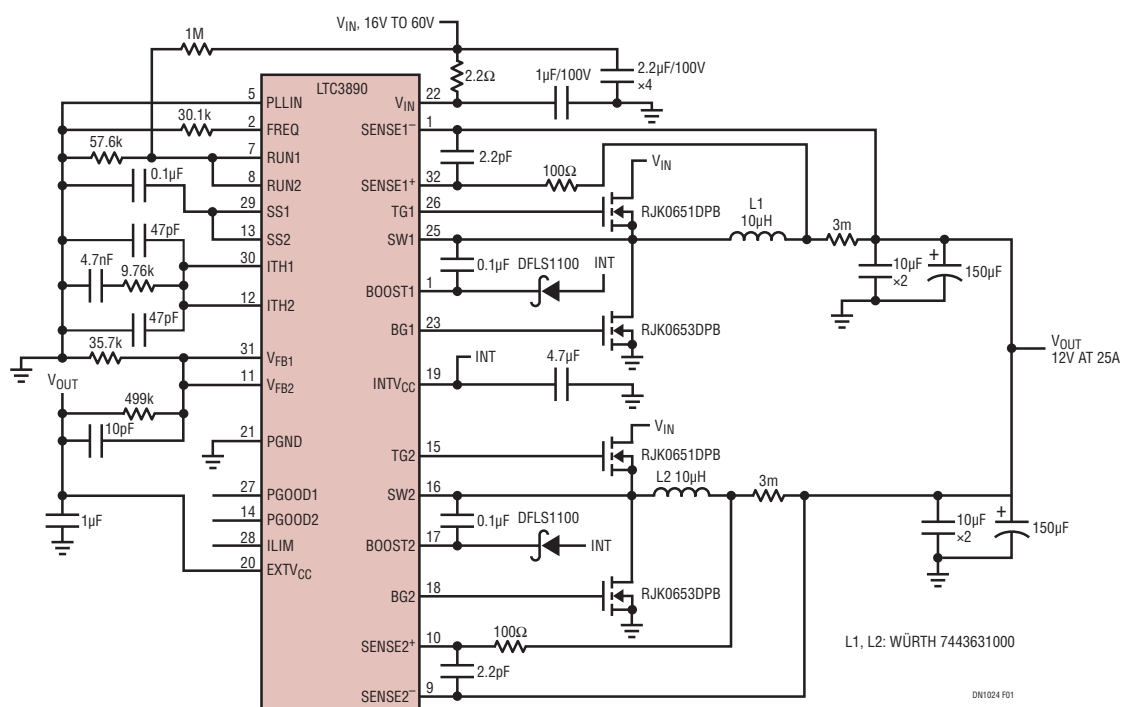


Figure 1. High Efficiency Converter Produces 25A at 12V_{OUT} from Inputs Up to 60V

for possible noise from interconnecting traces. A relatively low switching frequency, around 150kHz, and a relatively high phase inductance of 10µH are used to reduce switching losses at high input voltages. The output voltage is fed to the EXT_{V_{CC}} pin to reduce losses associated with biasing the chip and internal gate drivers at high input voltages.

Circuit Performance

Efficiency is shown in Figure 2, measured without cooling air flow. Efficiency peaks close to 98% in the middle of the load range and declines to 96% at the 25A maximum load. Figure 3 shows the average input current vs input voltage at no load in Burst Mode[®] operation. The value of this current is below 0.5mA. Figure 4 shows a thermal map of the board with no air flow present at V_{IN} = 20V and V_{OUT} = 12V at 25A (300W).

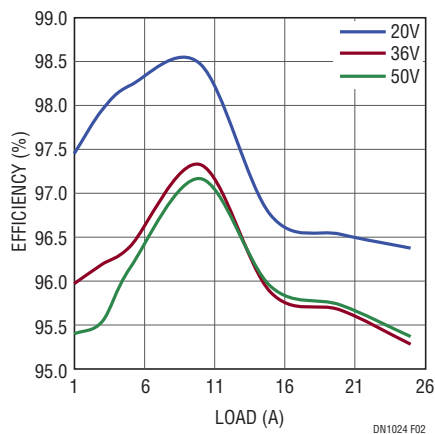


Figure 2. Efficiency at V_{IN} = 20V, 36V and 50V

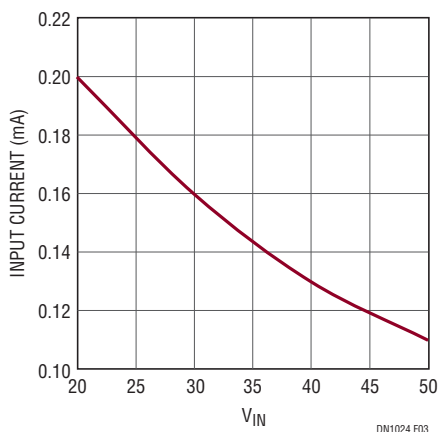


Figure 3. Average Input Current vs Input Voltage at No Load. V_{OUT} is 12V.

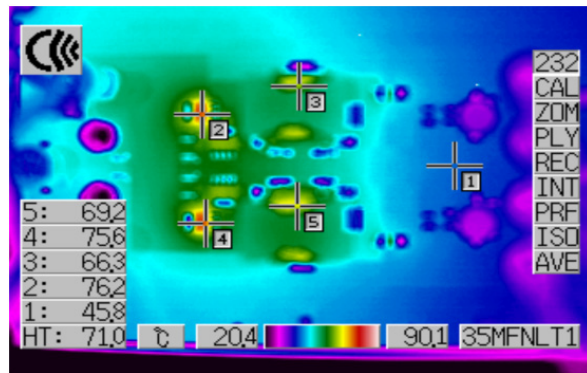


Figure 4. Temperature Hot Spots with No Air Flow

Component Selection

Two values define selection of the inductor: RMS current (I_{RMS}) and saturation current (I_{PK}):

$$I_{RMS} = \sqrt{(I_{PH})^2 + \frac{\Delta I^2}{12}}$$

$$\Delta I = \frac{(V_{IN} - V_{OUT}) \cdot D}{L \cdot f}$$

$$D = \frac{V_{OUT}}{V_{IN}}$$

$$I_{PH} = k \cdot \frac{I_{OUT}}{2}$$

$$I_{PK} = I_{PH} + \frac{\Delta I}{2}$$

where f is the switching frequency and k is a coefficient defined by the current imbalance between the phases. For converters based on the LTC3890, k = 1.08, assuming current sense resistors with a 1% tolerance.

Selection of power MOSFETs and input/output capacitors is described in detail in the LTC3890 data sheet. It is important to note that the typical internal V_{CC} voltage and, consequently, the MOSFET gate voltage is 5.1V. This means that logic level MOSFETs must be used in the design.

Conclusion

The LTC3890 dual output, synchronous step-down converter can be easily configured as a single output, dual phase converter for high input voltage, high output current automotive and telecom applications.

Data Sheet Download

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