

DESIGN NOTES

Techniques for Deriving 3.3V from 5V Supplies – Design Note 74

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Microprocessor chip sets and logic families that operate from 3.3V supplies are gaining acceptance in both desktop and portable computers. Computing rates, and in most cases, energy consumed by these circuits show a strong improvement over 5V technology. The main power supply in most systems is still 5V, necessitating a local 5V to 3.3V regulator.

Linear regulators are viable solutions at lower ($I_0 \leq 1A$) currents, but they must have a low dropout voltage in order to maintain regulation with a worst case input of only 4.5V.

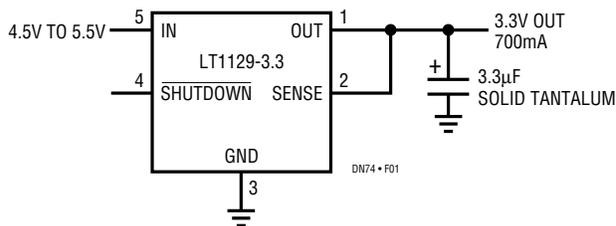


Figure 1. Low Dropout Regulator Delivers 3.3V from 5V Logic Supply

Figure 1 shows a circuit that converts a 4.5V minimum input to 3.3V with an output tolerance of only 3% (100mV). The LT1129-3.3 can handle up to 700mA in surface mount configurations, and includes both 16µA shutdown and 50µA standby currents for system sleep modes. Unlike other linear regulators, the LT1129-3.3 combines both low dropout and low voltage operation. Small input and output capacitors facilitate compact, surface mount designs.

For the LT1129-3.3, dissipation amounts to a little under 1.5W at full output current. The 5-lead surface mount DD package handles this without the aid of a heat sink, provided the device is mounted over at least 2500mm² of ground or power supply plane. Efficiency is around 62%.

Dissipation in linear regulators becomes prohibitive at higher current levels where they are supplanted by high efficiency switching regulators. A 2A, 5V to 3.3V switching regulator is shown in Figure 2. This synchronous buck converter is implemented with an LTC1148-3.3 converter. The LTC1148 uses both Burst Mode™ operation and continuous, constant off-time control to regulate the output

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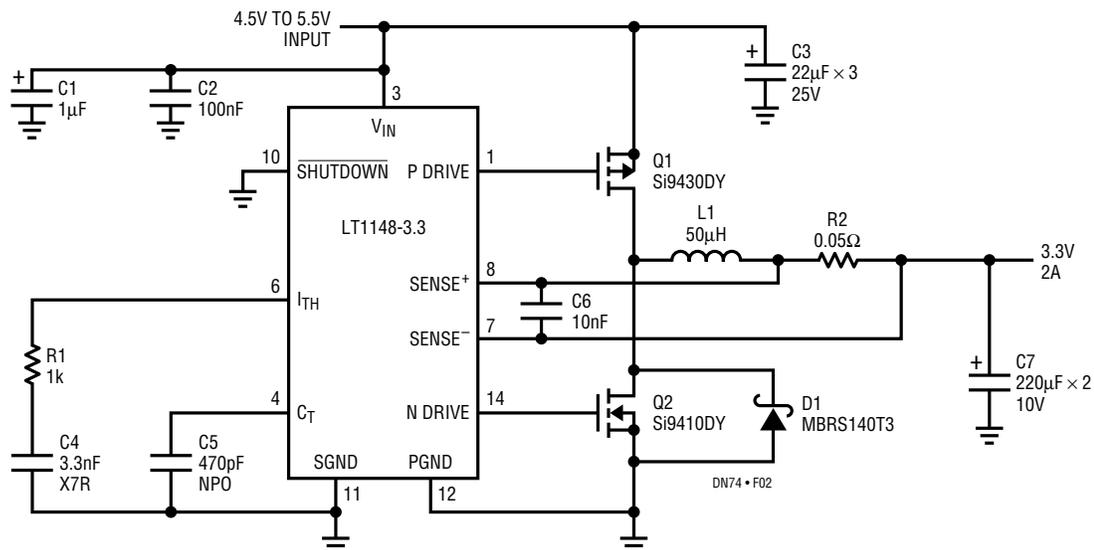


Figure 2. 94% Efficiency Synchronous Buck Regulator Pumps Out 2A at 3.3V from 5V Logic Supply

voltage, and maintain high efficiency across a wide range of output loading conditions. Efficiency as a function of output current is plotted in Figure 3.

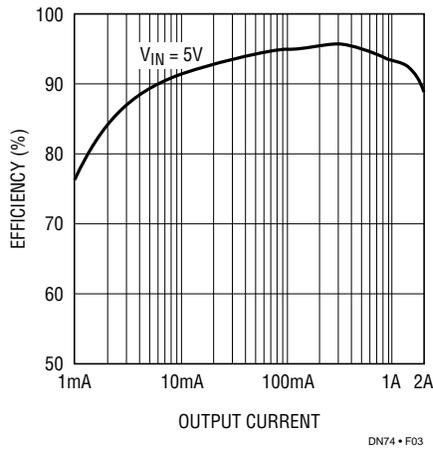


Figure 3. LTC1148-3.3: Measured Efficiency

All of the components used in the Figure 2 switching regulator are surface mount types, including the inductor and shunt resistor, which are traditionally associated with through hole assembly techniques.

Depending on the application, a variety of linear and switching regulator circuits are available for output currents ranging from 150mA to 20A. Choices in linear regulators are summarized in Table 1. There are some cases, such as in minicomputers and workstations, where higher dissipations may be an acceptable compromise against the circuit complexity and cost of a switching regulator, hence the >1A entries. Heat sinks are required.

Table 2 summarizes the practical current range of a number of switching regulators for 5V to 3.3V applications, along with their typical efficiencies.

A 5V to 3.3V converter circuit collection is presented in Application Note 55, covering the entire range of currents listed in Tables 1 and 2.

Table 1. Linear Regulators for 5V to 3.3V Conversion

| LOAD CURRENT | DEVICE | FEATURES |
|--------------|----------------------------|---------------------------------------------------|
| 150mA | LT1121-3.3 | Shutdown, Small Capacitors |
| 700mA | LT1129-3.3 | Shutdown, Small Capacitors |
| 800mA | LT1117-3.3 | SOT-223 |
| 1.5A | LT1086 | DD Package |
| 3A to 7.5A | LT1083 LT1084 LT1085 | High Current, Low Quiescent Current at High Loads |
| 10A | 2 × LT1087 | Parallel, Kelvin Sensed |

Table 2. Switching Regulators for 5V to 3.3V Conversion

| LOAD CURRENT | DEVICE | EFFICIENCY | FEATURES |
|----------------|-------------|------------|---------------------------------------------|
| 200mA to 400mA | LTC1174-3.3 | 90% | Internal P-Channel Switch, 1µA Shutdown |
| 0.5A to 2A | LTC1147-3.3 | 92% | 8-Pin SO, High Efficiency Converter |
| 1A to 5A | LTC1148-3.3 | 94% | Ultra-High Efficiency Synchronous Converter |
| 5A to 20A | LT1158 | 91% | Ultra-High Current Synchronous Converter |

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