Single-cell Power Supply

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Many modern electronic devices and microcontroller-based circuits need a 5 V or 3.3 V power supply. It is important that these voltages are constant and so a regulator of some kind is essential, including in battery-powered devices. The simplest approach is to select a (perhaps rechargeable) battery whose voltage is rather higher than that required by the circuit and use an ordinary linear voltage regulator. Unfortunately this solution is rather wasteful of precious energy and space: for a 5 V circuit at least six NiCd or NiMH cells would be required.

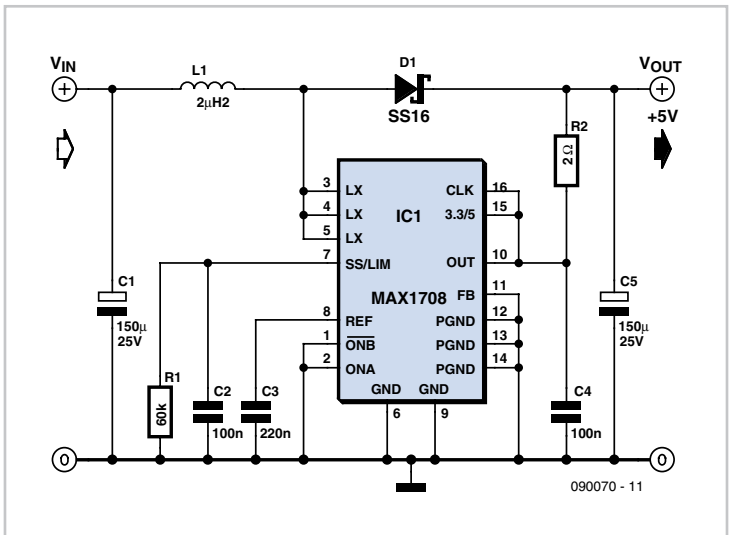
Both these disadvantages can be tackled using a little modern electronics. A good way to minimise energy losses is to use a switching regulator, and if we use a regulator with a step-up topology then we can simultaneously reduce the number of cells needed to power the circuit. Fortunately it is not too difficult to design a step-up converter suitable for use in portable equipment as the semiconductor manufacturers make a wide range of devices aimed at exactly this kind of application. The Maxim MAX1708 is one example. It is capable of accepting an input voltage anywhere in the range from 0.7 V to 5 V, and with the help of just five external capacitors, one resistor, a diode and a coil, can generate a fixed output voltage of 3.3 V or 5 V. With two extra resistors the output voltage can be set to any desired value between 2.5 V and 5.5 V.

The technical details of this integrated circuit can be found on the manufacturer's website [1], and the full datasheet is available for download. An important feature of the device is that it includes an internal reference and integrated power switching MOSFET, capable of handling currents of up to 5 A. It is, for example, possible to convert 2 V at 5 A at the input to the circuit into 5 V at 2 A at the output, making it feasible to build a 5 V regulated supply powered from just two NiCd or NiMH cells. With a single cell the maximum

Characteristics

- Input voltage from 0.7 V to 5 V
- Output voltage from 2.5 V to 5.5 V
- Maximum output current 2 A
- Can run from a single cell

possible current at 5 V would be reduced to around 1 A.
The example circuit shown here is configured for an output voltage of 5 V. The capacitor connected to pin 7 of the IC enables the 'soft start' feature. R2 provides current limiting at slightly more than 1 A. For maximum output current R2 can be dispensed with. Pins 1 and 2 are control inputs that allow the device to be shut down. To configure the device for 3.3 V output, simply connect pin 15 to ground.



The coil and diode need to be selected carefully, and depend on the required current output. To minimise losses D1 must be a Schottky type: for a 1 A output current the SB140 is a suitable choice. For L1 a fixed power inductor, for example from the Fastron PISR series, is needed. A fundamental limitation of the step-up converter is that the input voltage must be lower than the output voltage. For example, it is not possible to use a 3.7 V lithium-polymer cell (with a terminal voltage of 4.1 V fully charged) at the input and expect to be able to generate a 3.3 V output, as diode D1 would be permanently conducting. On the other hand, there is no difficulty in generating a 5 V output from a lithium-polymer cell.

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Internet Link

[1] www.maxim-ic.com/quick_view2.cfm/qv_pk/3053