Output Cutoff for Step-Up Switching Regulator

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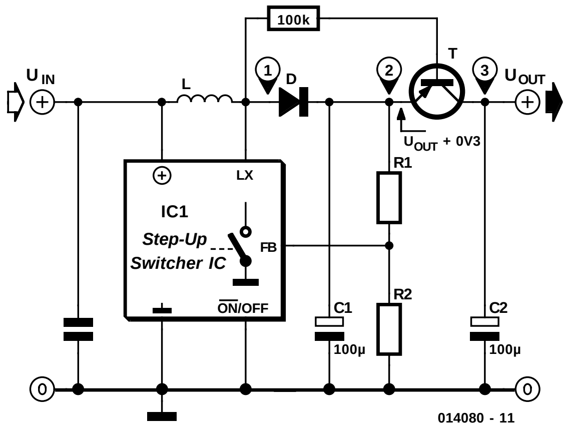

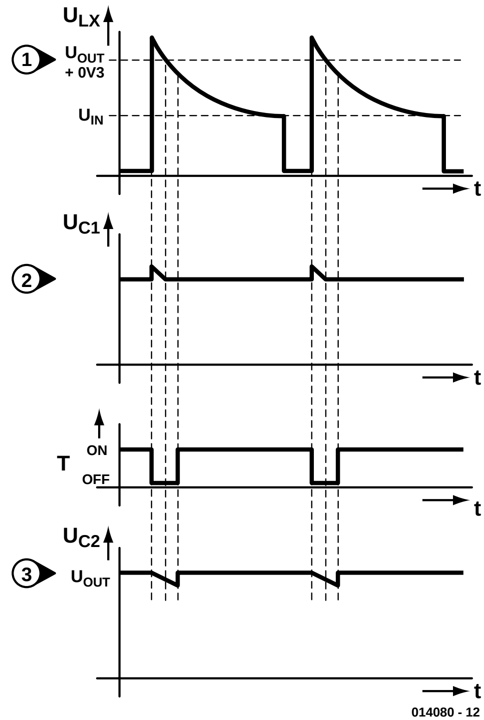

$$V_{out} + 0{,}3V = V_{ref} \cdot \left(1 + \frac{R1}{R2}\right)$$

Nowadays, there is a whole series of switching regulator ICs that work according to the step-up principle and thus convert the input voltage to a higher output voltage. This takes place using coil L, which is periodically switched to ground via the LX connection of the IC. This causes a magnetic field to build up in the coil L, and this field stores energy. When the step-up regulator IC switches off, the collapsing magnetic field in L forces the current to continue to flow. Now, however, the current must flow through diode D to the output capacitor and the external load connected to Vout. In this way, a voltage is generated that is greater than the input voltage. Resistors R1 and R2 form a voltage divider that is used to set the value of the output voltage, according to the formula shown. The value of V_{ref} is usually around 1.2 V.

One problem with the step-up regulator is that if the IC is inactive, there is always a current path from the input to the output via coil L and diode D. This means that the output voltage is not zero, but instead Vin. This problem can be eliminated with the aid of a simple transistor and a series base resistor. The pnp transistor, in this case a BCP69, is placed in series with the output circuit and periodically passes the dc output voltage of the switching regulator to output capacitor C2. The base of transistor T is connected via the series resistor R to the switch pin LX of the step-up regulator IC.

The voltage waveforms are shown in the diagram. Pin LX is periodically switched to ground. As soon as the switch goes open, a voltage pulse that adds to the input voltage appears at LX. Diode D conducts briefly and passes this voltage on to C1, which charges up to a voltage, determined by the voltage divider R1/R2, that is 0.3 V higher than the output voltage. The small charging peaks shown in curve 2 are not drawn to scale. If V_{LX} is more than 0.7 V lower than V_{C1}, transistor T conducts and passes the voltage across C1 on to C2. The small voltage sags shown in curve 3 are also not drawn to scale, for the sake of clarity. If the step-up regulator IC is disabled, the voltage across C1 will be only as high as the input voltage. This voltage is also present at LX, so there is not enough base bias voltage to switch on the transistor, and it is cut off.

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