Application Note

AS1343

Where is the limit for the boost conversion?

Content Guide

1 Where is the limit for the boost conversion?

Almost all portable devices are powered by low voltage batteries. However, in the same devices there are some circuits like LEDs that need high voltage supply. So, there is a need for voltage conversion. This article shows the possible solution with boost DCDC converters and the limits for this.

2 Where the boost conversion is used

The mostly batteries used in portable devices are lithium-ion batteries that operate at between 2.7V and 4.2V, and dual-cell alkaline (NiCd or NiMH) batteries that have a 1.6V-3.4V range. The next generations will have even lower battery supply voltage range.

However the typical application circuits require a stable high voltage supply bus of 12V or higher for supplying internal LEDs. Producing such a stable output from a low voltage battery is possible with boost converters that have big transformation factor.

3 Where is the limit for transformation factor in boost conversion

The mostly used DCDC boost converter is presented in Fig. 1. Usually, the switch S1 between coil and ground is realized as NMOS transistor and the switch S2 between coil and output as PMOS transistor or diode. To produce the high voltage, instead of PMOS usually the diode is used, and the operation of the circuit will be described with coil, NMOS and diode.

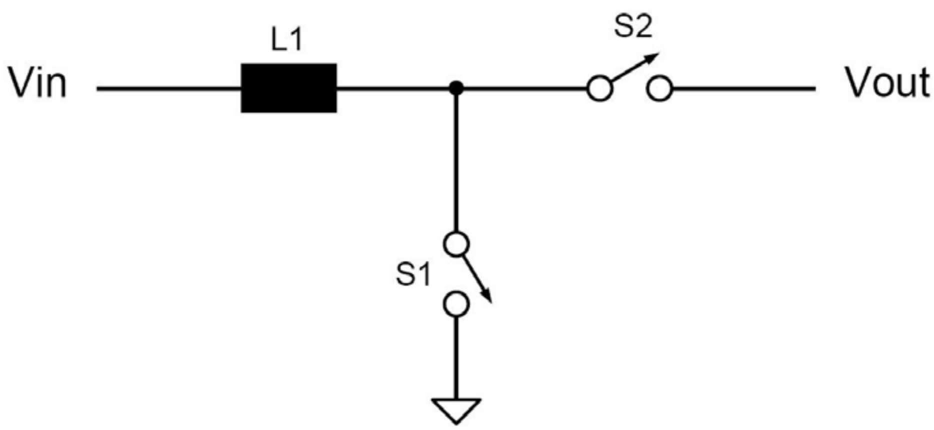

Fig. 1: Simple schematic of the boost converter

During the boost conversion there are two states. During the first one, the NMOS is ON, the current flowing through coil rises and the energy from the input is saved into the coil. During the second one the NMOS is OFF, but the current still must flow through coil and the saved energy is transferred to the output through diode.

The transformation factor Vout/Vin is mostly dependent on the duty cycle D. It represents the fraction of the commutation period T during which the NMOS switch is ON. In ideal case (no energy losses) Vout=Vin/(1-D). So if the NMOS is ON 50% of the period time, D=0.5 and Vout=2*Vin. Similar if we need Vout that is 10 times higher than Vin, we have to realize in ideal case D=0.9, or NMOS ON time is 90%.

For the real case, we have to add different losses, like resistive and switching losses, what means that D should be bigger. However, the feedback loop is hard to stabilize if D>0.9. Also the changes of the states (ON state to OFF state and vice versa) require some time, and during one period T usually few percents of it are spent on this.

Because of these reasons, many designer say it makes no sense to try to get transformation factor bigger than 6. But this means that if the supply bus of 12V is needed, minimum battery voltage of 2V is needed.

4 Real-world implementation and performance

AS1343 is DCDC boost converter, with low voltage input and high voltage output. The output is adjustable with two external resistors (see Fig 2).

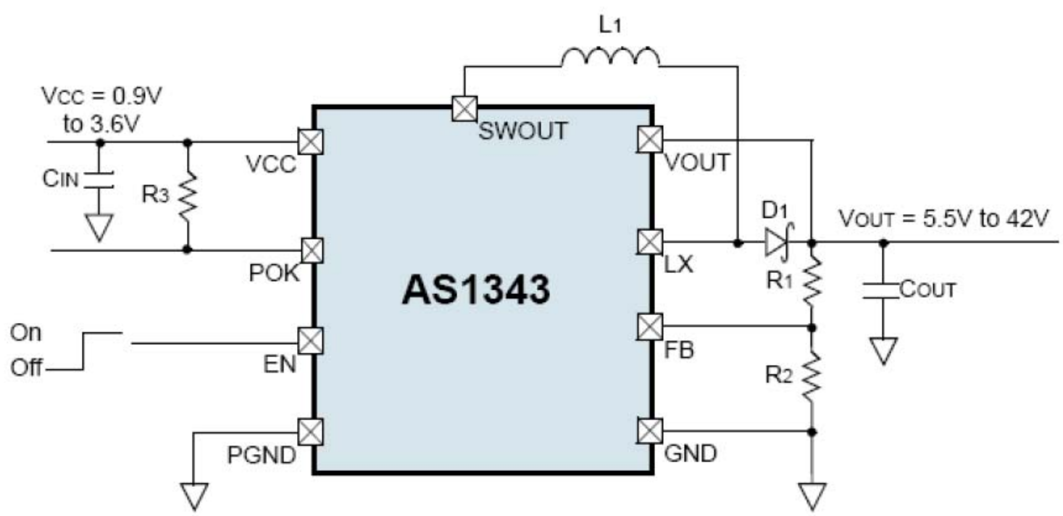

Fig. 2: AS1343 – Typical application diagram

The efficiency for some conditions is presented in the next figures. In Fig 3 we can see that even the transformation factor bigger then 10 (for example producing 15V from 1.2V) is possible with efficiency of 55% for 10mA load. However the Fig. 4 shows that big transformation factor (for example producing 18V from 2V or even 1.5V) is possible, but the energy losses for small loads are so big that the efficiency is less than 50%, what means that more than half of the energy is spent just to perform the conversion. So, the voltage conversion, where the output voltage is 10 or more times higher than input voltage, is possible, but we have to take in account big energy losses. But with two batteries (min. battery voltage 1.8V) we can supply even 15V buses with good efficiency.

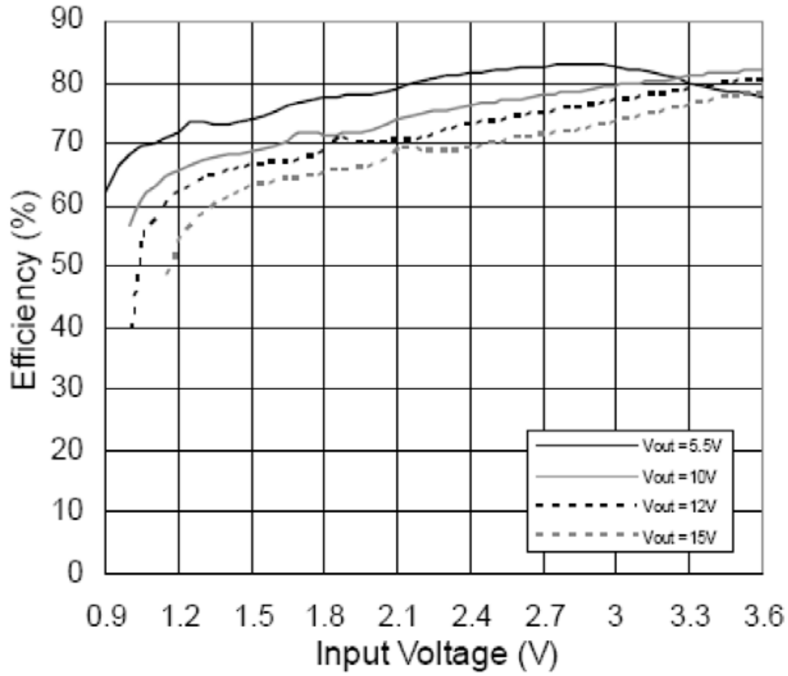

Fig 3: Typical efficiency (with constant Iout) of AS1343

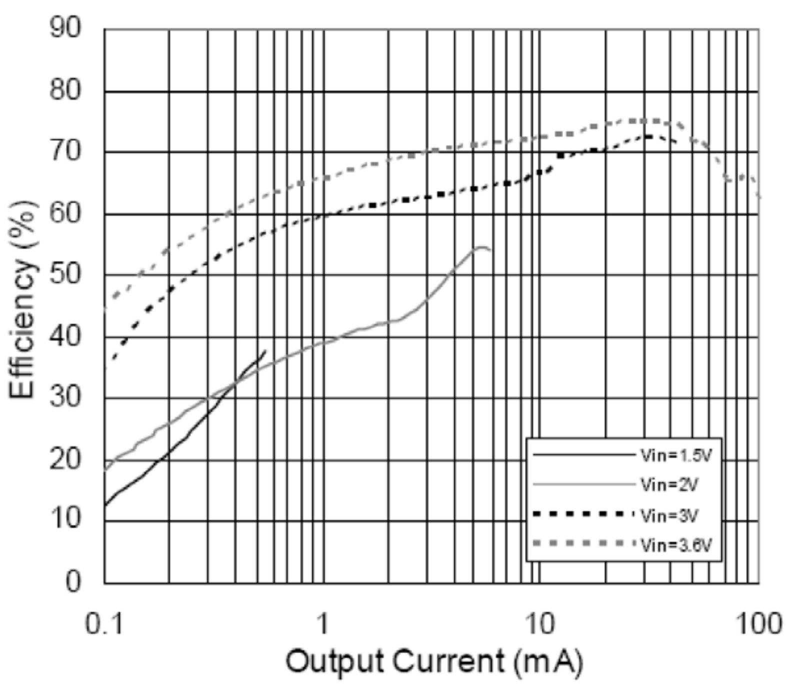

Fig 4: Typical efficiency (with constant Vout) of AS1343

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7 Revision Information

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