Right Solution Voltage Conversion in Both Directions Up and Down

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This article addresses need and possibility of voltage conversion in both directions up and down (so called buck-boost conversion). The features of true buck-boost converter AS1331 are described and compared with the features of boost converter adapted with possibility for down conversion AS1337. The suggestion for using one of the described solutions depends on input voltage range for desired output voltage, and is also discussed.

Why the buck-boost DC/DC converter is needed?

The power management is more and more important for battery powered portable electronic devices. However voltage conversion only in one direction is for many applications not enough. Many batteries have wide range of function, and desired output voltage is between maximal and minimal input voltage. Widely used lithium ion batteries have 2.7V to 4.2V, and dual cell alkaline (NiCd or NiMH) batteries have 1.6V to 3.4V voltage range. For many applications that have these batteries (like handheld computers, handheld instruments, portable music players or similar), the stable output voltage of 2.5V, 3V or 3.3V is desired. This is only possible with buck-boost converts.

The most important issues for voltage conversion are efficiency and size. On one side the device should convert voltage with less energy loss as possible, and on the other side the device should be small to be suitable for small applications and to be possible to offer low price solution.

Comparison of the two solutions

AS1331 is buck-boost DC/DC converter that can handle battery voltages above, below or equal to the output voltage. This is provided with switching of 4 internal switches, what makes size of the device relative big, size is about 3mm^2. Efficiency is up to 90%, and pretty constant over all input voltage and load current region (see figure below). However the solution with 4 switches is not only size consuming, but also makes energy loss, because the coil current flows always through 2 switches in serial. Input voltage range is 1.8V to 5.5V and output voltage range is 2.5V to 3.3V. Typical application is presented in Figure below.

AS1337 is boost DC/DC converter with possibility for down conversion. This is provided with switching of only 2 internal switches. The coil current flows always through one of 2 switches, and the energy losses are small. Down conversion functions similar as up conversion, with forced destroying some energy, to be able to make down conversion with concept of up conversions. This makes device very small, size is only about 1.7 mm^2. Efficiency is up to 97%, and very high in boost mode, but much smaller (60-70%) if input voltage is bigger than output voltage, because of the destroying of the energy during down conversion (see figure below). Input voltage range is 0.85V to 4.5V and output voltage range is 2.5V to 5V. Typical application is presented in Figure below.

Figure 1. AS1331 - Typical Application Diagram

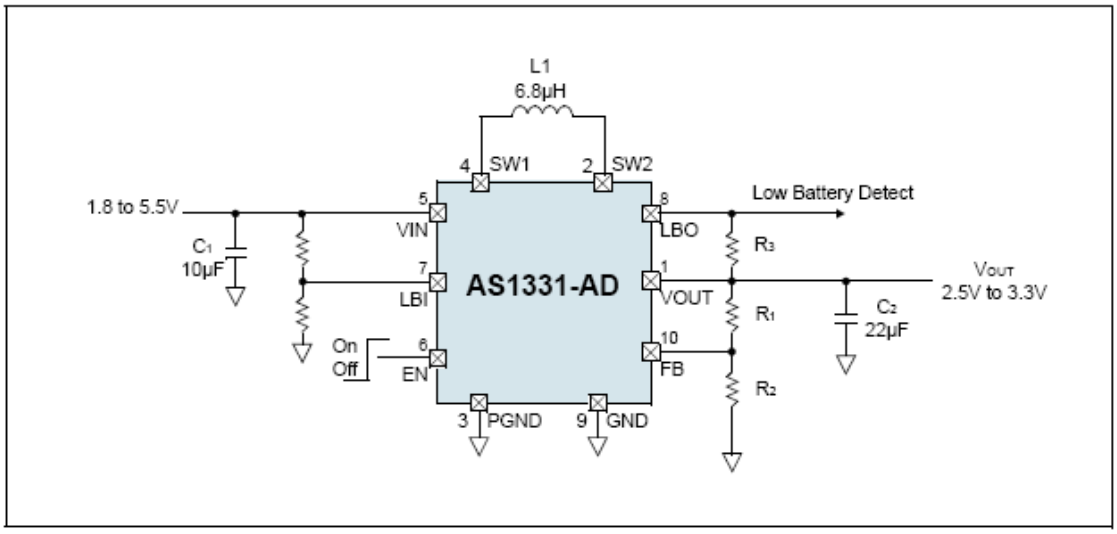
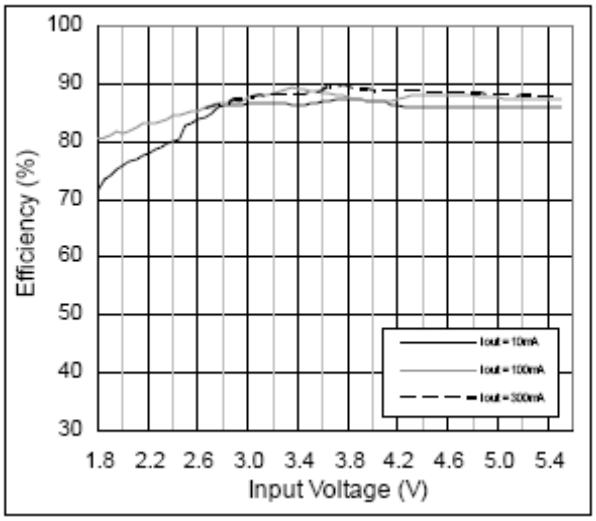


Figure 6. Efficiency vs. Input Voltage



AS1331 Efficiency

Figure 1. AS1337 - Typical Application Diagram – Dual Cell to 3.3V Synchronous Boost Converter

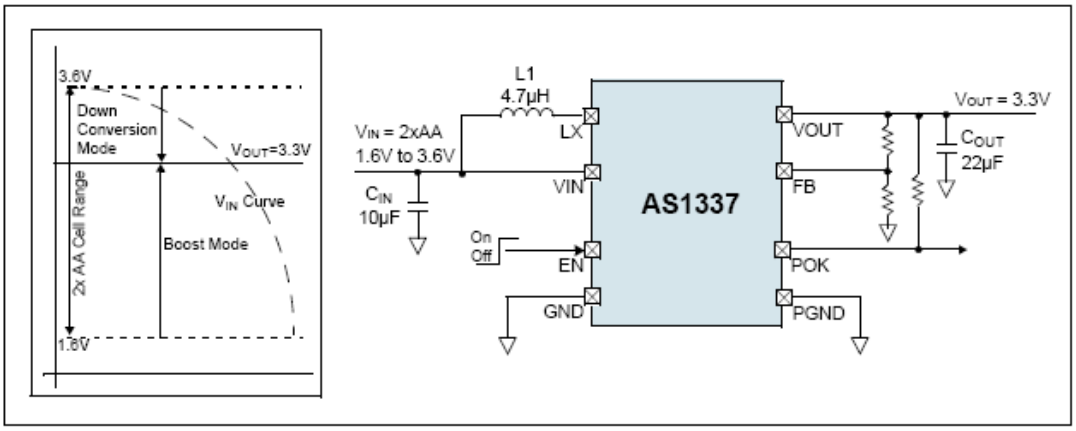
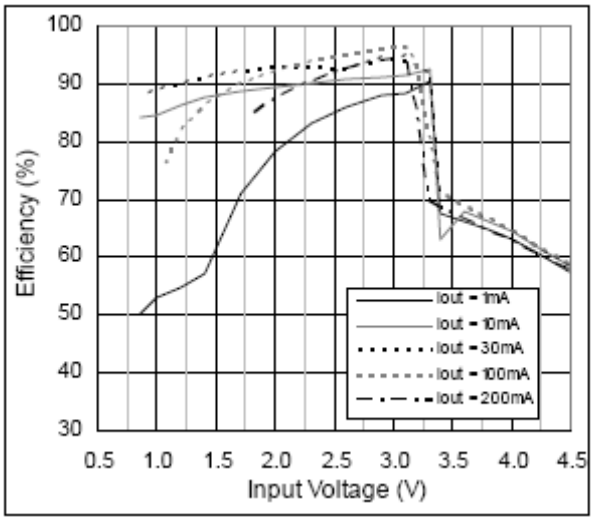


Figure 5. Efficiency vs. Input Voltage



AS1337 Efficiency

What to use?

For the application where the battery voltage is most of the time higher then output voltage, AS1331 would be the right solution, because of the high efficiency in whole input voltage domain. However, if the battery voltage is for more then at least 50% of the battery lifetime smaller than desired output voltage, than the AS1337 should be the right choice. Than the efficiency should be 80% or more (approximately, concerning whole input voltage domain).
All other parameters like output voltage ripples, line or load regulation, and similar, were not discussed. These are for both devices similar and for most applications acceptable.