Application Note: 26-03-2014

AS1337A

DC-DC Step-Up Converter with Buck Mode and Battery Connected in Shutdown

Table of Contents

Revision History

Revision	Date	Owner	Description
1.0	26.03.2014		

1 Need for buck-boost voltage conversion

Power management is an important issue for battery powered portable electronic devices. However, buck or boost voltage conversion is not enough for many applications. Many batteries have wide voltage ranges and the desired supply voltage for many integrated circuits inside of the portable devices is between maximal and minimal battery voltage. Widely used lithium ion batteries have 2.7V to 4.2V, and dual cell alkaline (NiCd or NiMH) batteries have a 1.6V to 3.4V voltage range. For many applications that use these batteries (like handheld computers, handheld instruments, portable music players or similar), the desired stable output voltage is 2.5V, 3V or 3.3V. This is only possible with buck-boost converts. The AS1337 is a DC-DC boost converter with buck mode and an optimal solution for buck-boost conversion. The operating modes example is presented in Fig.1.

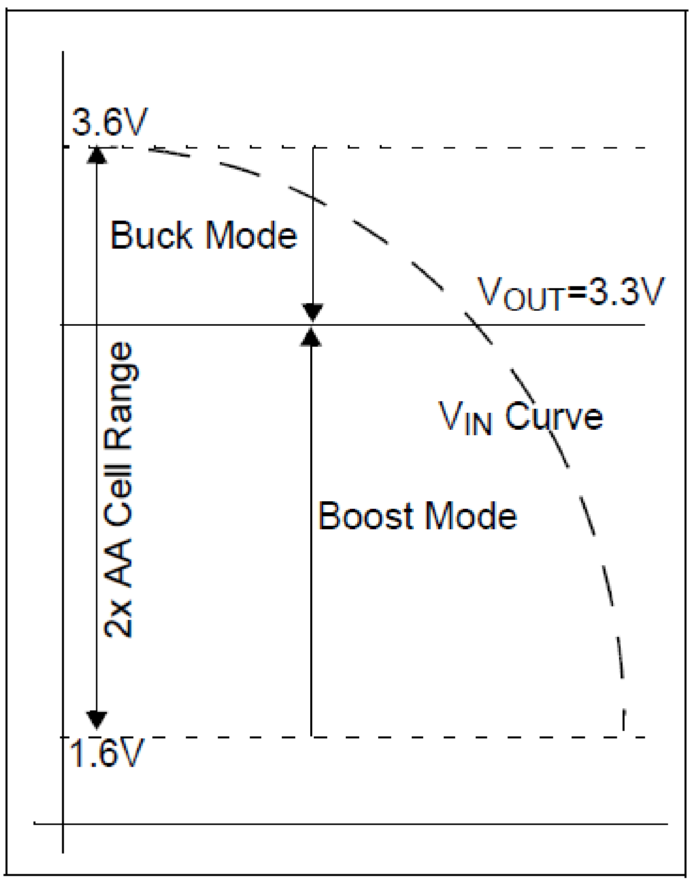

Fig.1: Typical operating modes of AS1337A

2 Boost converter with buck mode and battery connected in shutdown

AS1337A works as a boost DC-DC converter with the possibility for down conversion of buck mode. This is provided with switching of only 2 internal switches. The coil current always flows through one of 2 switches, and the energy losses are small. Down conversion functions similarly to up conversion, with forced destroying some energy, to be able to make down conversion with concept of up conversions. Internal comparator desides which mode to take: if VIN < VOUT it works as boost converter, if VIN > VOUT it works as buck converter. Fig. 2 shows the typical application diagram.

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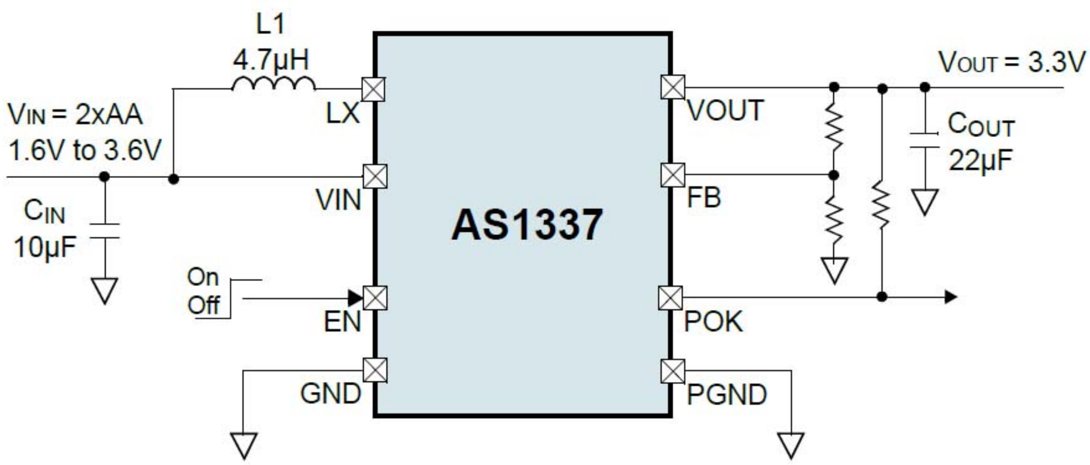

Fig.2: Typical application diagram of AS1337A

During Shut Down or Power Down, as soon as the EN is LOW, VIN is direcly through internal switch connected to VOUT. This is suited only for the applications where VOUT voltage can be acceped in the whole domain of VIN. Otherwise it could destroy the supplied cicuits. For example, if VIN=4V, during Shut Down, it becomes VOUT=4V also, even if by FB divider a lower value for VOUT is selected to lower value, such as 3.3V. During shut down all internal blocks are turned off, so the current flowing into the device is less than 1uA. There is no coil current flowing.

3 Soft start up

The AS1337A has an implemented soft start up function. This provides limitation of the input current to about 200-300mA for the first 1ms after enabling the chip by EN pin.

Normally this is enough for whole start up if output capacitor is 4.7uF, 10uF of even 22uF. In the Bolck Diagramm in Fig.3 output capacitor of 4.7uF is used, while input capacitor of 1uF is used. If the application needs a very big output capacitor (for example 220uF) to hold VOUT without ripples, this is also possible to realize, but the start up will last longer, and it will not be possible to limit this current for the whole start up range. But for such applitions the soft start up is generaly not needed after a certain period of time. A big input capacitor is desired. Otherwise voltage of the input could be discharge to a lower value during start up. But even with 0.85V on the input, AS1337 does not have difficulty operating, so this will not make problems in operating.

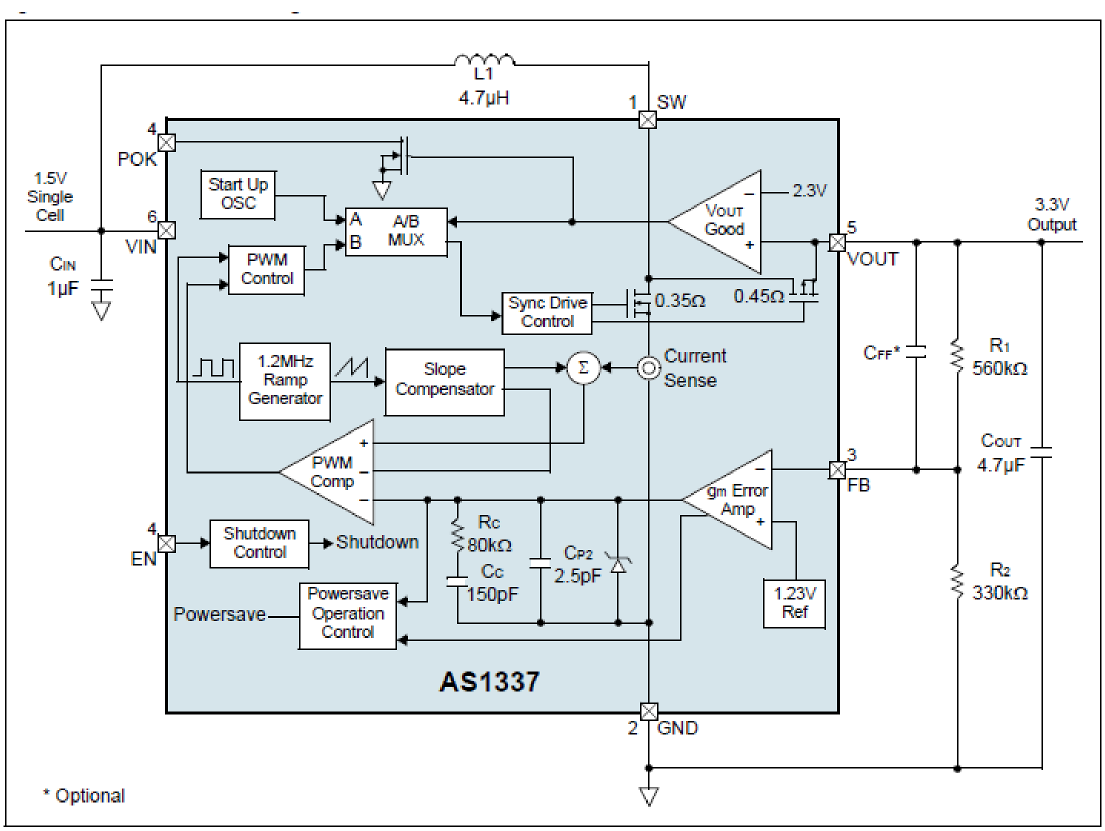

Fig. 3: AS1337A block diagramm

Power applied to a DC-DC converter causes a large peak inrush current due to the application of the high dv/dt to the input filter capacity. These filter capacitors initially act like a short circuit, allowing an immediate inrush current with a fast rise time. The peak inrush current can be significantly greater than the steady-state current. With soft start up, this problem is solved, because the inrush current is limited. The peak current and current ramp should be controlled to prevent potential damage to the circuit, what is realized for 1ms in AS1337A.

4 Results

The AS1337A has 2 Modes: boost (step up) and buck (step down). While the boost mode has great efficiency, up to 97%, the buck mode has low efficiency with maximum 72%. COUT used for the measurements is 22uF.

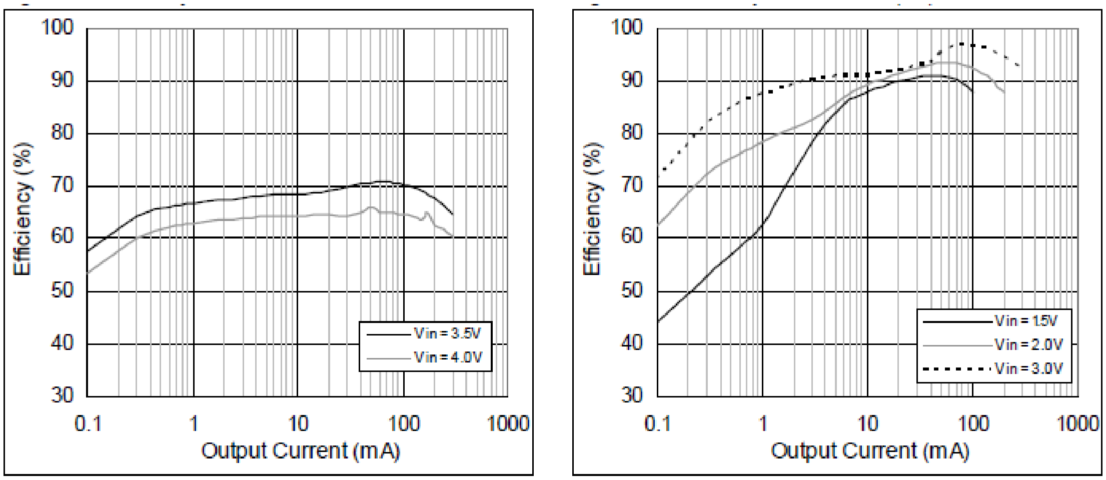

Fig. 4: Efficiency vs. load current, VOUT=3.3V: Comparion between buck mode (left) and boost mode (right)

In Fig.5 the efficiency for the whole input range is presented, so both modes are in one diagram. We see that down mode has significantly lower efficiency. However, AS1337A is generally used in applications where most of the time the device works in boost mode. For example, 2 AA battery cells give voltage 1.8V to 3.6, but battery discharge in the beginning is high, so most of the time (about 90%) battery voltage is less than 3.3V. If the output voltage is 3.3V, the device will work about 90% of the time in boost mode with great efficiency. And approximate efficiency will be about 85-90%, depending on the needed output (load) current.

Using a bigger output capacitor to make VOUT more stable would also have very good efficiency, In this case, only slower and smaller change on the VOUT is expected.

Load current capability is about 200mA, if input voltage is bigger than 1.5V (Fig.6). During buck mode, the capability is much higher. During switching between buck and boost mode the capability is 200mA, and that is why the capability is limited for whole boost mode to that value.

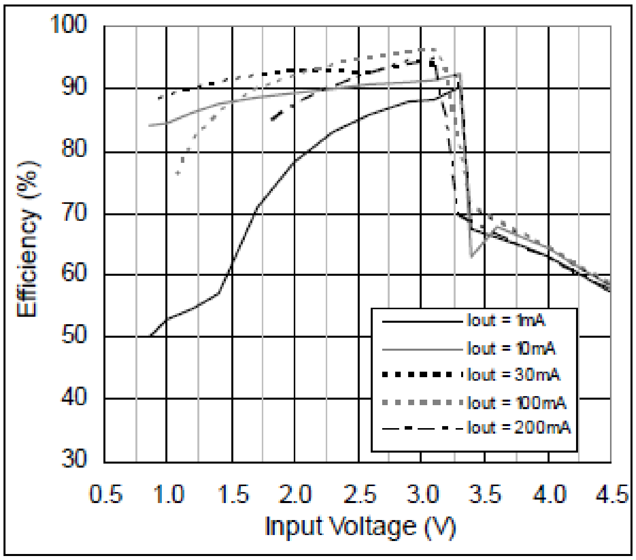

Fig. 5: Efficiency vs. input voltage for VOUT = 3.3V

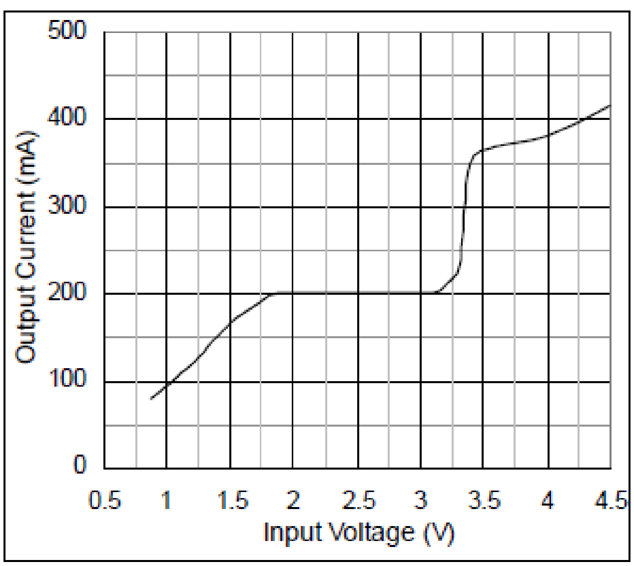

Fig. 6: Load current capability

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