Measuring current with the ADALM1000

The ADALM1000 is actually a Source/Measure Unit (SMU) at it's heart not a separate oscilloscope and function generator This can be confusing to some users who are maybe not so familiar with a SMU. We haven't made it all that easy at times either in that the ALICE software treats the two functions separately in the user interface. But in fact the ALM1000 can simultaneously measure both voltage and current. In this tutorial we demonstrate how to use this current measurement capability vs the way users normally think about measuring current with say a bench-top Oscilloscope.

In this tutorial a simple DC-DC boost converter circuit is used as the demonstration platform as shown in figure 1. We will be using a square wave from the ALM1000 Channel A output for the switch gate drive. The input source can be a AA battery. The circuit boosts the 1.5 V battery to a voltage large enough to light two LEDs in series.

There are two or three currents that we are interested in measuring, indicated by the green arrows. The first would be the waveform of the current being supplied by the 1.5 V input source (battery) to the inductor L1. The second would be the current in D1 that flows into the output load. A third would be the current in NMOS switch transistor M1.

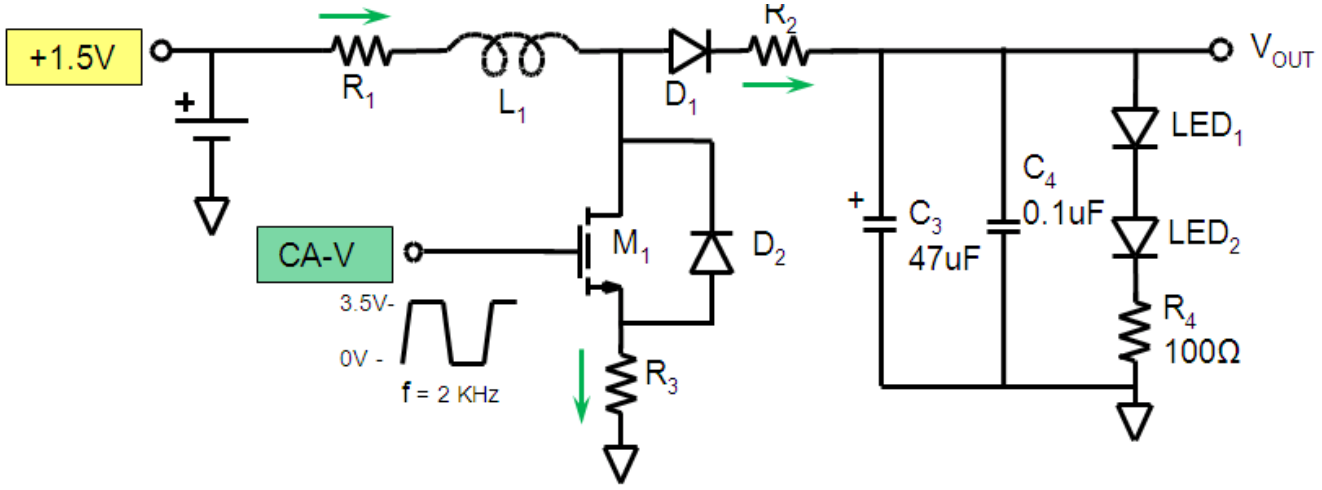

Figure 1, DC-DC Boost converter with current shunt resistors.

When using a voltage measuring instrument like an Oscilloscope (or Analog Discovery or ADALM2000) to measure currents you need to insert current shunts in series with whatever current branch you want to measure as in resistors R1, R2 and R3. These may need to be only 1 or 2 ohms depending on how sensitive the measuring instrument is. The current is simply the voltage measured across the shunt divided by the resistance of the shunt. It is also useful to note that resistors R1 and R2 are floating and you will need to make differential voltage measurements which can require two scope channels unless a differential voltage probe is available.

The ALM1000 SMU can greatly simplify the process of measuring these currents. The hardware inside the SMU channel includes the current measuring shunt resistor and an

AD8210 current shunt monitor chip. To measure the inductor current we can simply configure Channel B in the source voltage / measure current mode (SVMI) and set the DC voltage level to be the same 1.5 V of the battery as shown in figure 2. Note: all the shunt resistors have been removed from the circuit.

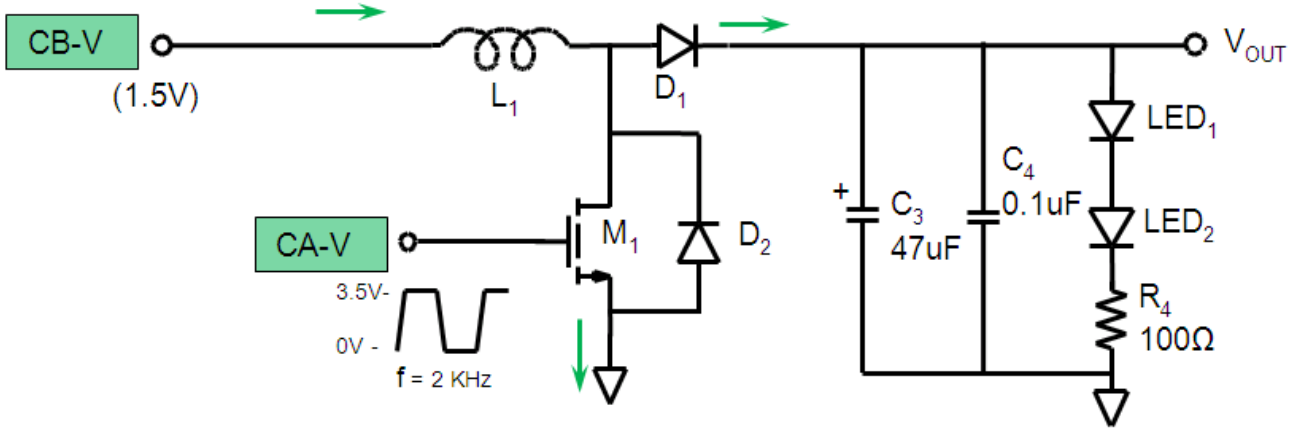

Figure 2, Channel B measures inductor current

Figure 3 is a screen shot showing the current waveform, yellow trace and switch gate drive voltage, green trace.

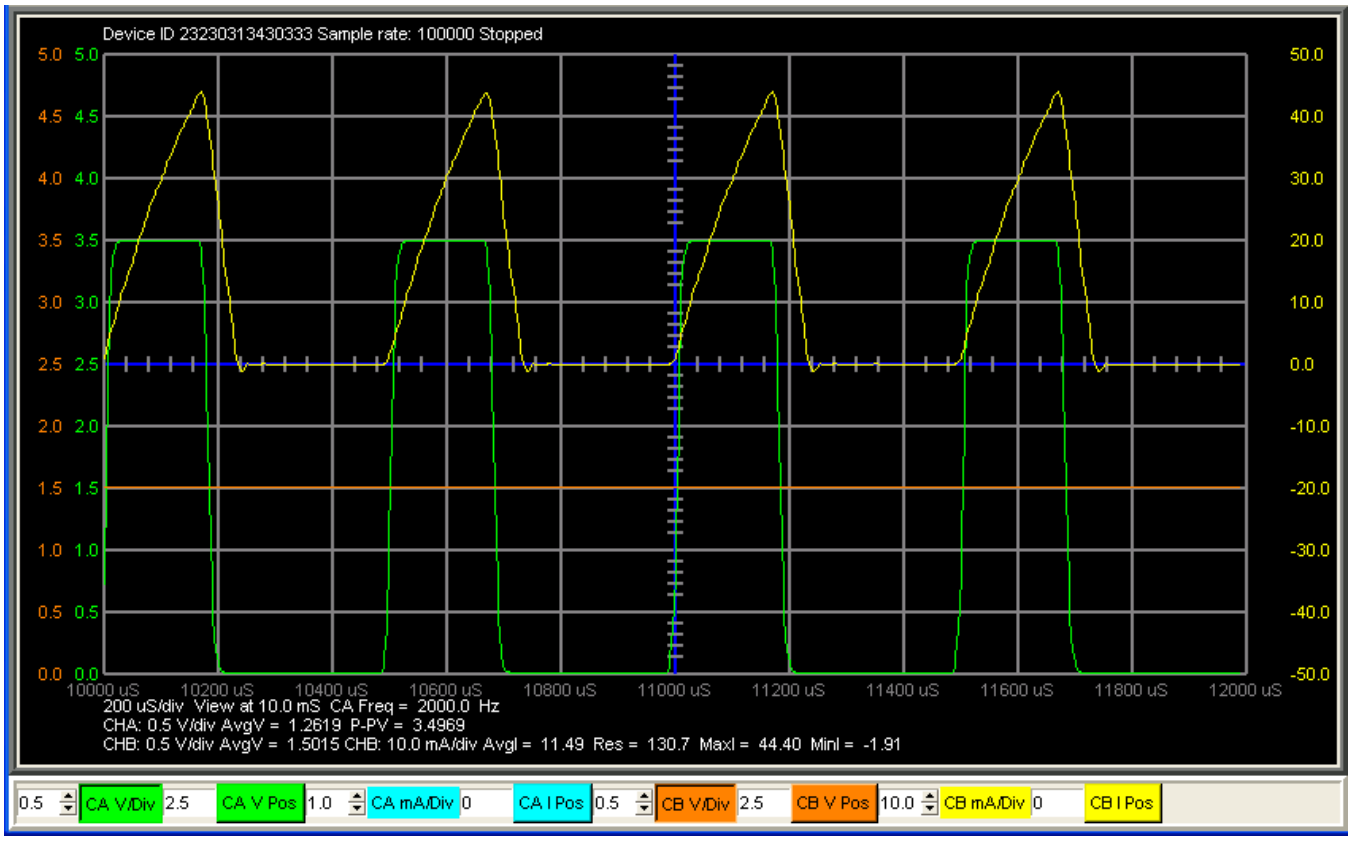

Figure 3, Inductor current waveform

To measure the diode current we can reconnect the battery and disconnect the LEDs and capacitors from the output. Now we can use SMU channel B as the load by connecting channel B to the end of D1 and set the DC voltage of CH B to the same average voltage the Vout was equal to, shown in figure 4. That was about 4.2 V in this case but any voltage greater than 1.5 V plus the forward voltage of D1 would work. It just has to be positive enough for D1 to turn off.

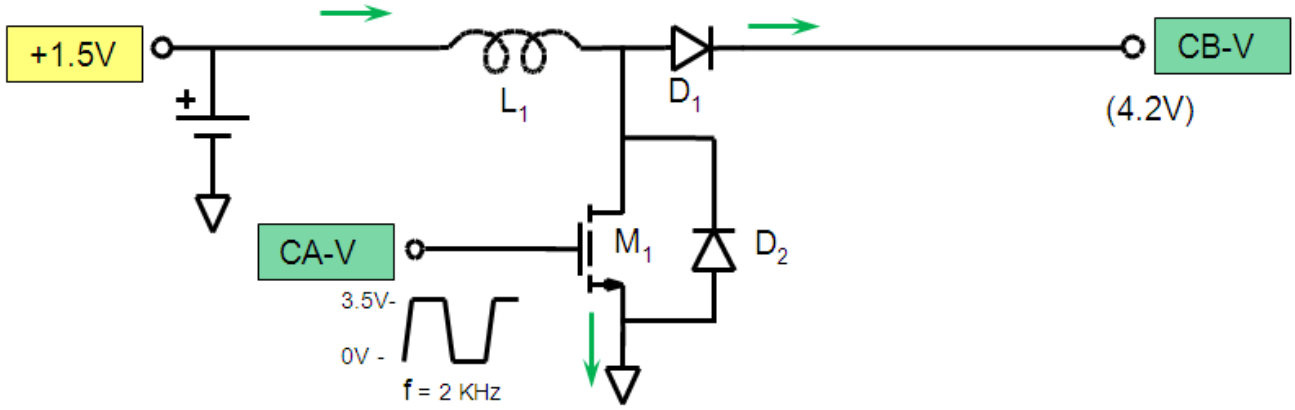

Figure 4, measuring the diode current.

Figure 5 is a screen shot showing the current waveform.

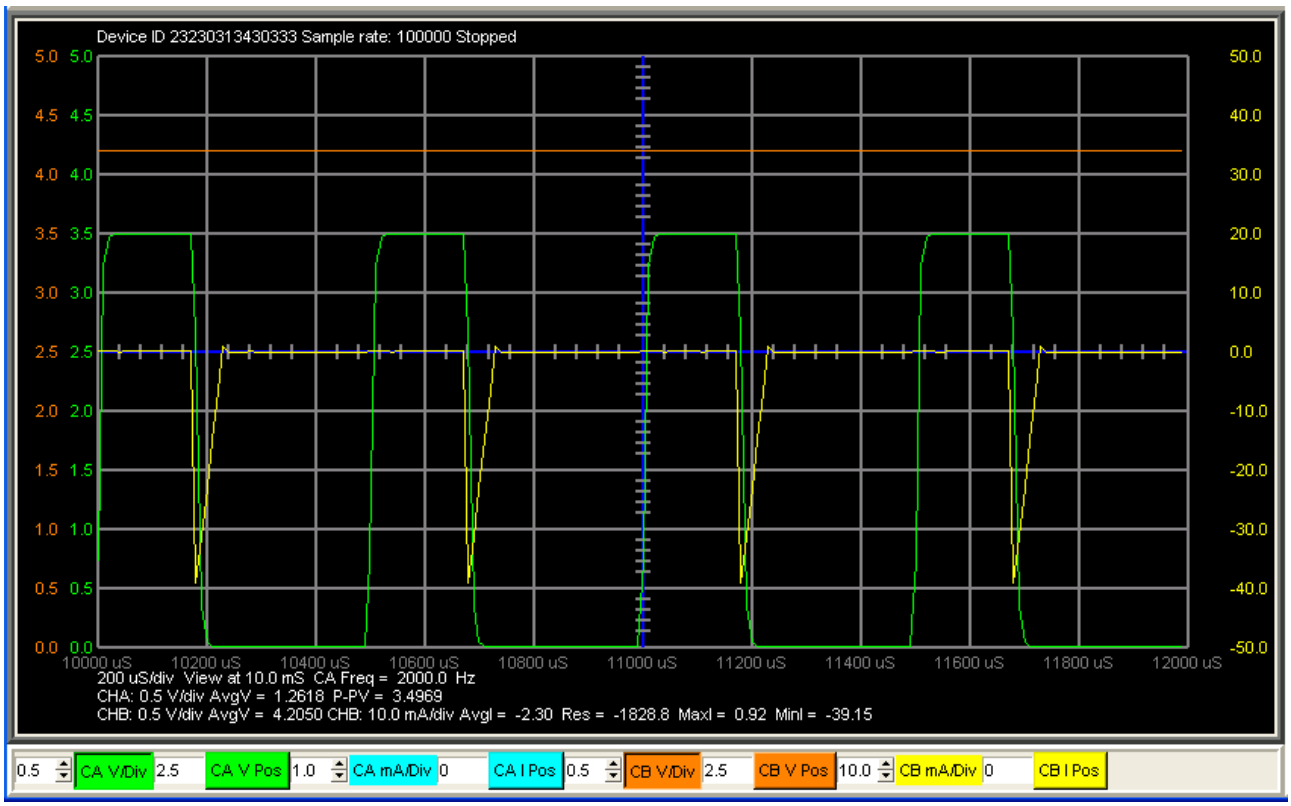

Figure 5, Diode current waveform

To measure the current in the switch, we add back the output load and disconnect the source of M1 from ground and connect it to SMU channel B. We set the DC level of CH B to 0 V, the same as ground, shown in figure 6.

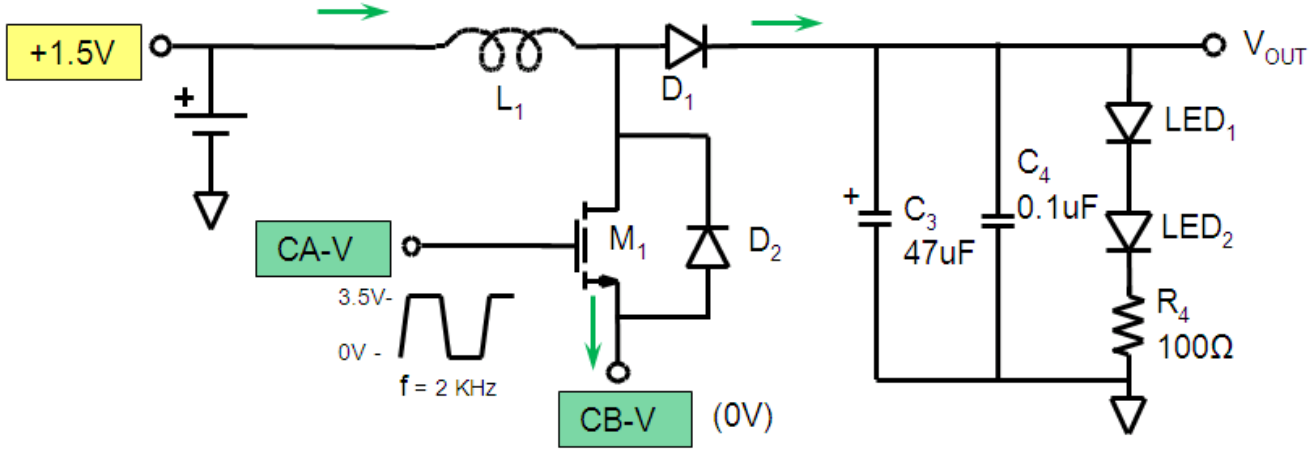

Figure 6, measuring the switch current

Figure 7 is a screen shot showing the current waveform.

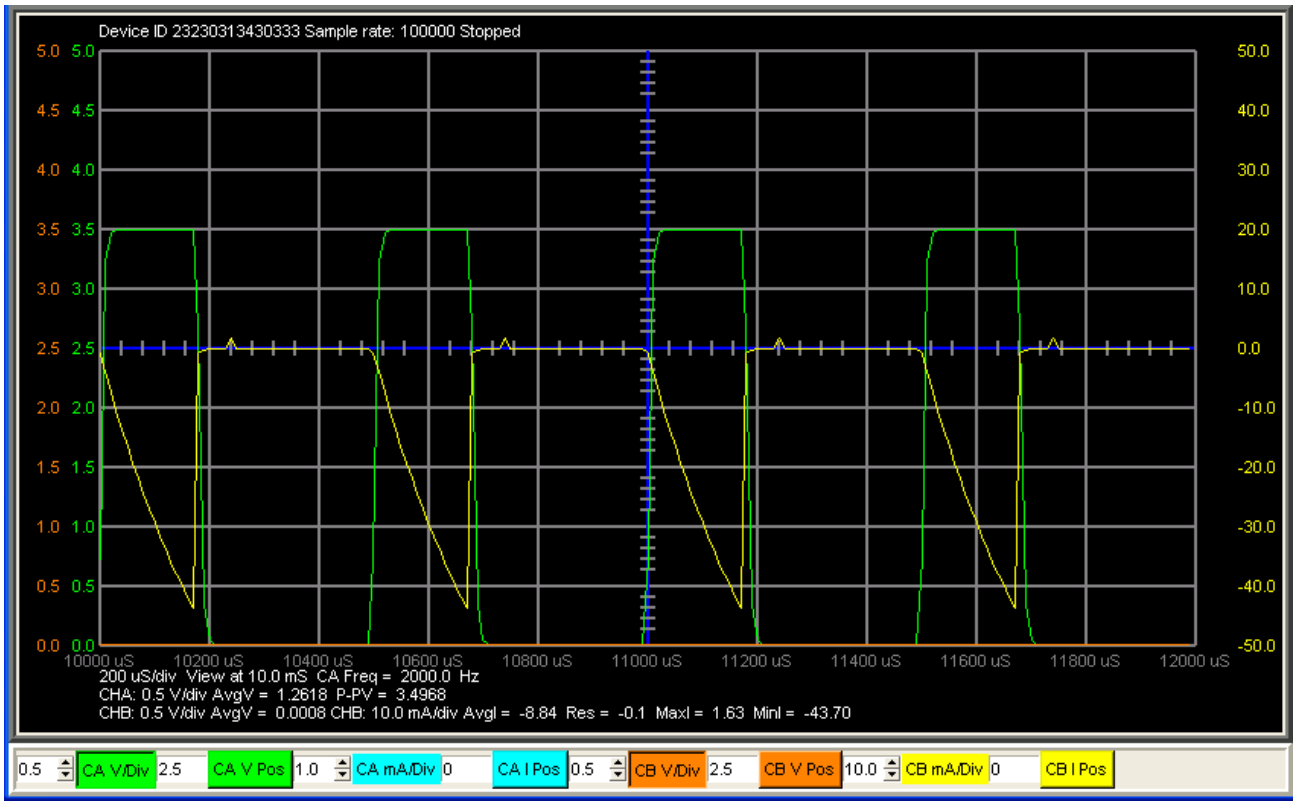

Figure 7, Switch current waveform

Looking at the three current waveforms we have shown that (taking current polarity into account) the inductor current waveform is indeed the sum of the diode and switch current waveforms.

So, as we have shown, making current measurements using the ALM1000 SMU channels can be simpler than inserting current sense resistors everywhere in your circuit as you would when using a voltage measuring instrument such as an Oscilloscope (or Analog Discovery or ADALM2000).