Minimizing Emissions from a Ćuk Regulator

Frederik Dostal, Field Applications Engineer

The Ćuk topology is ideal for generating a negative output voltage from a positive supply voltage. Negative voltages are needed in many systems to enable useful readout of signals from certain sensors. For this, a signal chain may need to be supplied, for example, with +5 V and –5 V or even +15 V and –15 V. Negative voltages are also used for safely switching certain switching elements such as silicon carbide (SiC).

The Ćuk topology is also known as a 2L inverting topology because it requires two inductors in the power path. Figure 1 shows a circuit diagram of the Ćuk topology.

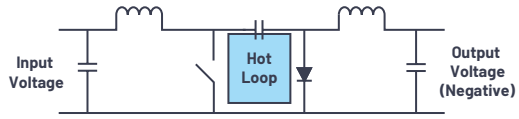

Figure 1. Schematic diagram of a Ćuk topology for generating negative voltages.

It is important to ensure that there is a feedback pin for a negative voltage when selecting a suitable switching regulator IC. Analog Devices has a large number of appropriate monolithic switching regulator ICs with integrated switches and also controller ICs with external switching transistors.

Above all, the two required inductors represent a cost and space factor. However, these two components also lead to an inductance in the power path on both the input side and the output side. This prevents rapidly switching currents at the input and also at the output. As a result, the Ćuk topology is generally considered to be a particularly low noise topology. Of course, just like every other switching regulator, a Ćuk topology has switched currents. They are shown in Figure 1 as the hot loop in blue. By the term hot loop, we mean the group of traces with fast di/dt transitions. In order to minimize the interference generated by the switched currents, the parasitic inductance and, with it, the spatial expansiveness of this loop must be designed to be as small as possible.

Therefore, in an optimal board layout for a Ćuk converter, the freewheeling diode D, the coupling capacitor C, and the switch S1 must be brought very close together. With the corresponding pinout of an IC such as the LT8330, compact arrangement of these lines is no problem. Figure 2 shows the region of the power paths of the switched currents (hot loop) in a concrete board layout.

The critical loop is made up of the external diode D, the coupling capacitor C, and an internal connection between GND and the SW pin within the LT8330 switching regulator IC. The hot loop is designed to be as small and compact as possible.

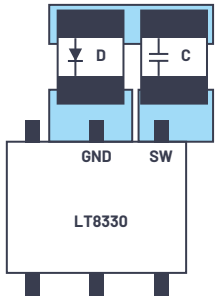

Figure 2. Board layout optimized for the Ćuk topology.

Figure 3 shows an example of a circuit with an LT8330 that is suitable as a regulator in a Ćuk topology. An important feature is the FBX pin. It is a special type of FB pin that can process both negative voltages, as are required in a Ćuk topology, and positive voltages. If the LT8330 is used in a boost or SEPIC topology, a positive feedback pin polarity is required.

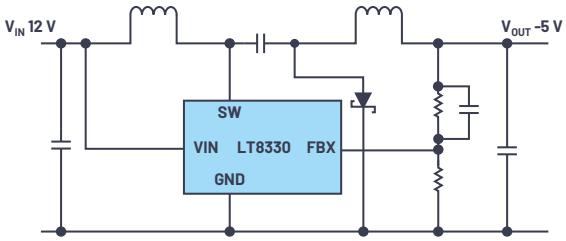

Figure 3. Example of a circuit for a Ćuk regulator with an LT8330.

The inductance on both the input side and the output side of a regulator influences the amount of conducted emission it creates. If an optimized board layout with a very compact hot loop is implemented, a very low noise solution is the result. These features make Ćuk regulators extremely suitable for generating low noise, negative voltages.

About the Author

Frederik Dostal studied microelectronics at the University of Erlangen in Germany. Starting in the power management business in 2001, he has held various applications positions, including four years in Phoenix, Arizona where he worked on switch-mode power supplies. He joined Analog Devices in 2009 and works as a field applications engineer for power management at Analog Devices in Munich. He can be reached at frederik.dostal@analog.com.