Technical Article

How to Keep Your Power Switching Frequency above the AM Radio Band

Chris Glaser

We've all been there before. After selecting a particular power-supply device, you build a printed circuit board (PCB) and evaluate it in your lab. You measure some basic parameters, such as efficiency and switching frequency, and compare it to the device's data sheet specifications. While many engineers understand why their circuit – with its different components, settings and operating conditions – doesn't obtain the peak efficiency shown in the data sheet, differences in switching frequency beg further investigation. After all, shouldn't the switching frequency be fixed by the device, independent of your particular circuit?

For many modern power-supply integrated circuits (ICs), the answer is actually no. While many of us learned about the traditional, oscillator-based voltage- and current-mode control topologies in school, numerous modern power-supply ICs are either on-time- or off-time-based and do not use an oscillator. Rather, the device controls the on-time or off-time to provide a regulated (as opposed to a fixed) switching frequency. This small change in architecture – from fixed to regulated frequency – is one of many trade-offs made in the design of a power-supply IC and provides some advantages: improved transient response, higher power-supply rejection ratio (PSRR) and lower output-voltage ripple.

In certain automotive applications, such as infotainment, variations in switching frequency can cause concerns about interference with the AM radio band. Generally, the switching frequency is set above 1.8MHz to stay out of band. If the switching frequency varies lower, it could come in band and possibly interfere with certain AM radio frequencies. While there are certainly ways to mitigate such interference through system design – such as through the shielding and spacing of the antenna from the power supplies – one method is to control the switching frequencies of every power supply in the infotainment system.

The DCS-Control topology is one type of control topology used in automotive infotainment systems. The TPS62130A-Q1 is a highly integrated and efficient $12V_{IN}$ converter for 3A voltage rails that uses DCS-Control. While DCS-Control does not use an oscillator, the switching frequency is regulated through an on-timer. To learn more about where and why the frequency varies, see my application note "Understanding frequency variation in the DCS-Control topology."

Here are a few key points from that application note for a typical $12V_{IN}$ automotive system:

- For higher output-voltages, which have moderate duty cycles, the switching frequency is very well regulated and as expected – near the 2.5MHz typical value.
- As the required duty cycle becomes lower for lower output voltages, the corresponding on-time pushes the limits of many power-supply ICs because of their minimum on-times.
- The 80ns minimum on-time of the TPS62130A-Q1 allows operation at 1.8MHz for a 1.8V output.
- If you require lower output voltages or higher frequency operation (and you also have to keep all switching frequencies above the AM band), consider a two-stage conversion via a 5V rail.

For the full explanation and lots of measured data, please read the full application note. I hope it helps explain why the switching frequency of your power supply isn't where you expect.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265