

VRM Current Sensing

by Dr. Ray Ridley

In the last issue of Switching Power Magazine, we talked about current sensing for VRM supplies. An engineer from Semtech called us to point out that using a current sense resistor can make good sense for the right applications.

The special case of VRM converters which provide a large step-down ratio allows the use of a sense resistor to good effect without too much detriment to the efficiency. It just depends on where the sense resistor is placed.

As discussed in our July 2001 article, each of the different waveform segments shown in Figure 1 introduce no additional loss. However, the signals are all prone to signal-to-noise issues due to the large switching voltage waveforms, and the small amount of current information. There are also issues with the accuracy of the current information which depends upon component parasitics.

From a control point of view, it's much better to sense the current with a precision resistive element. Most makers of VRMs do not consider that option since it requires a drop in efficiency, a crucial measure of VRM performance.

The best control place to put the sense resistor is in series with the output inductor (on the load side, where it is quiet) as shown in Fig. 2. This provides the cleanest signal which can easily be processed with a differential amplifier and used for accurate current sharing, current limiting, and instantaneous duty cycle control. However, it also produces a lot of loss. For the 200 mV sense signal shown, the efficiency of the system drops by 2% - an unacceptable number.

A 200 mV control signal can also be generated on the input to the power supply. In this position, with a 10:1 step down ratio in the converter, the efficiency of the system drops by only 0.2%. This signal is noisier than the output signal, since the blue part of the waveform shown does not convey useful information, and converter parasitics (not shown here) will cause overshoot and ringing of the sense signal. This was discussed in detail in our April 2000 current-mode article.

In comparing the two sense resistor locations, this difference in noise levels must be factored in. It may be possible in the above example to use a 1 mOhm sense resistor on the output where this value would not be practical on the input.

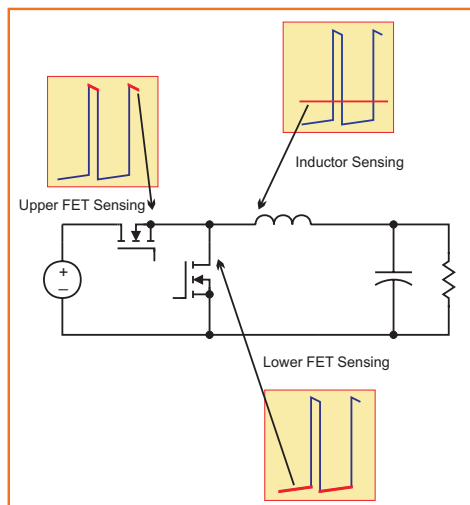


Figure 1: Three different ways to sense buck converter current with no loss.

So the issue of current sensing is by no means resolved with one best way to do it. Companies doing away with

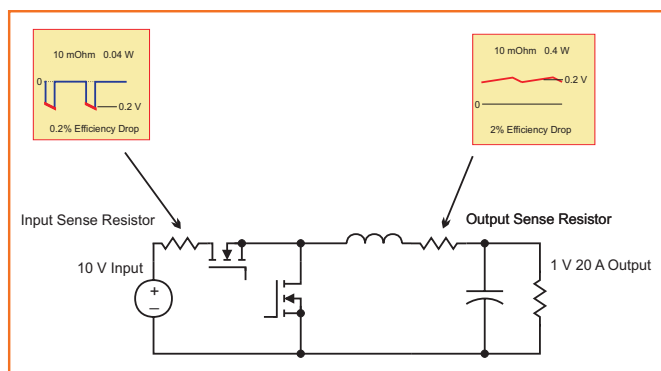


Figure 2: Two different applications of resistive current sensing.

the sense resistor will continue to wrestle with noise problems. The cleaner the signal that you need, the more costly it will be in terms of efficiency or parts.