Rarely Asked Questions—Issue 156 Optimized Power Supply Measurement Setup

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Question:

How can I make sure I'm testing my switching regulator as efficiently as possible?

Answer:

Before a circuit designer decides on a particular power supply, he or she will first want to test it carefully. The data sheet for a switching regulator IC provides valuable information on how the complete power supply could behave in real life, as well as how its respective behavior is always obtained through the testing of a circuit in the lab. Circuit simulations, such as with LTspice®, are useful and can be helpful in circuit optimization. However, simulation does not take the place of hardware testing. With respect to this, parasitic effects are either difficult to estimate or hard to simulate.

Power supplies are thus thoroughly tested in the laboratory. Either a prototype developed in-house or, in most cases, an existing evaluation board from the manufacturer of the respective power supply IC is used for this.

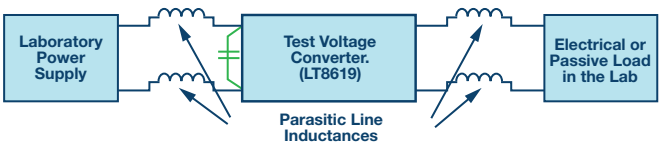

Figure 1. Connections for operation of a power supply.

When connecting the test circuit, a few points should be considered. Figure 1 shows a schematic of the test setup. The design under test must be connected to a power supply on the input side and a load on the output side. This sounds trivial, but there are some important details that must be heeded.

Minimization of Line Inductances

Figure 1 shows a schematic of the setup for evaluation of a power converter. We want to test the behavior of the power circuit and not the effect of the connection lines between the test board and the lab power supply or the load at the output. Two important measures should be taken to reduce the effects of these connection lines. For one, the connection lines should be kept as short as possible. Short lines have lower line inductance values than long lines do. Second, minimization of the current path area further reduces the parasitic inductance. An obvious way to accomplish this is to twist the lines. This results in the current path area only being dependent on the line length and the thickness of the stranded wire sheath. Figure 2 shows the connection of a test voltage converter with twisted connection lines for reduced parasitic line inductances.

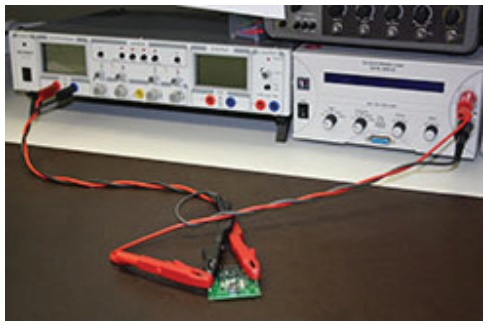

Figure 2. Practical operational setup with short twisted cables.

In power supplies based on switching regulators, ac is found both on the input side and on the output side. Depending on the circuit topology, a pulsed current can occur at the input side, for example, in step-down converters (buck controllers). The start-up behavior and operation under load transients must also be tested. Under these operating conditions, the connection lines in the test setup also carry ac.

Addition of a Local Energy Storage Device on the Input

If a power supply is tested with respect to how quickly it can respond to load transients, sufficient energy must be available at the design under test. The energy source on the input side of the design under test should not be the limiting factor. To ensure that this is not the case, placement of a larger bulk capacitor at the voltage supply input is recommended. This is shown in green in Figure 1. It ensures that load transient tests can be performed properly.

However, it must be ensured that the later use of the power supply is subject to very specific conditions. The effect of the energy storage device at the input must be well understood so that the input capacitor for the power supply can be dimensioned correctly.

Another aspect of the bulk capacitor in Figure 1 must also be considered. If voltage transients need to be applied at the input of the power supply to test the resulting behavior, the bulk capacitor would considerably slow down the voltage transients seen by the circuit under test. Thus, for these tests, the capacitor should be removed.

In conclusion there are quite a few things that must be considered in apparently simple tasks related to the design of the voltage supply—for example, connecting a circuit to the laboratory bench. Power lines to the circuit under test, as well as power lines away from the circuit under test, need to be treated as ac circuits and, thus, these cables need to be short and twisted to reduce parasitic inductance in these connecting cables. It is not more effort for the circuit designer to do so and the test results come close to what we actually intend to test. If influences from the test setup are reduced, the rest results will have more value. Over time, experienced power supply engineers have developed methods that optimize the evaluation of circuits. If all the tips in this article are followed, evaluation can be performed smoothly.

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