Power Devices

Importance of Probe Calibration When Measuring Power: Deskew

Even when devices used for measurement are calibrated regularly, they will give incorrect results if calibration is not performed for the measurement environment. This application note explains the importance of probe calibration in power measurement environments.

Measurement of switching loss

Figure 1 shows an example of a switching circuit using a SiC MOSFET. Switching loss is measured by measuring each point with a voltage and current probe and multiplying the obtained voltage and current waveforms at each point. Figure 2 shows the waveforms at each point, and the shaded areas are the switching loss.

Problem of propagation delay

The probes and cables used for measuring the waveforms have propagation delays. This delay time differs depending on the probe. In the example of measuring switching loss shown above, a voltage probe and a current probe are used in combination, but in other cases, an active differential probe may be used for voltage measurement or an optical probe may be used in combination with a passive probe. In these cases too, a propagation delay error occurs between the probes.

This delay time error does not cause a problem for waveforms that change slowly over time, but it greatly affects switching waveforms, which change in tens of nsec or less.

Figure 3 shows the effect of the propagation delay error between probes on the measurement results. In this example, the current probe has been measured as is, without accounting for the fact that it has a longer propagation time than the voltage probe. Compared with Figure 2, which shows the correct waveforms, a false result is obtained where the turn on loss appears smaller and the turn off loss appears larger. Depending on the measurement environment, large errors may occur.
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### Probe deskew

In order to measure power accurately, the propagation delay time for each probe must match. A procedure called “deskew” or “skew correction” is used to achieve this.

The left side of Figure 4 shows the measurement of a signal where the voltage and current rise at the same time, but are observed to have a time lag. This is called the skew error.

Some digital oscilloscopes have a “deskew” function that adjusts the skew error to zero, so this function should be used. With the deskew function, the oscilloscope automatically corrects for the delay time of each probe. As shown on the right side of Figure 4, in the corrected waveform, the two waveforms match perfectly. For more accurate deskew, measurement instrument manufacturers offer “deskew fixtures.” Figure 5 shows a photo of a device made by Tektronix.

### Case study

Here, we introduce the effect on the measurement result in the case that deskew is not performed using an example of measuring a switching waveform.

Figure 6 shows the results of measuring the turn on waveform of a switching circuit composed of SiC MOSFETs using a voltage probe and a current probe. The upper waveform is the voltage, the middle waveform is the current, and the lower waveform is the amount of power consumed by switching. The current waveform is delayed by 24 ns after deskew compared to before deskew. The amount of power consumed is 794 µJ before deskew and 1,691 µJ after deskew, an error of +113%.

Similarly, Figure 7 shows the result of measuring the waveforms at turn off. The amount of power consumed is 2,083 µJ before deskew and 1,161 µJ after deskew, an error of -44%. With errors of this size, an error of several tens of watts or more will occur in the power loss during switching operation, which will have a significant impact on the heat dissipation design.

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The total amount of power consumed is 2,877 µJ before deskew and 2,852 µJ after deskew, an error of -0.9%. In this measurement example, the error at turn on coincidentally offsets the error at turn off and the measurement appears to be correct. Cases such as this can occur where serious measurement errors are not detected.

**Summary**

- Probes have a propagation delay between the measurement point and the oscilloscope input.
- The propagation delay time differs depending on the probe.
- If different types of probes are used to make synchronous measurements across multiple channels, the waveform measurements may be incorrect.
- Different types of probes include various combinations such as voltage probe and current probe, passive probe and active differential probe, low voltage probe and high voltage probe, and probes with different frequency bands.
- Always use deskew to correct for differences in propagation delay.
- For measurements that are affected by errors of a few nsec, use deskew even when using probes of the same type.
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