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.

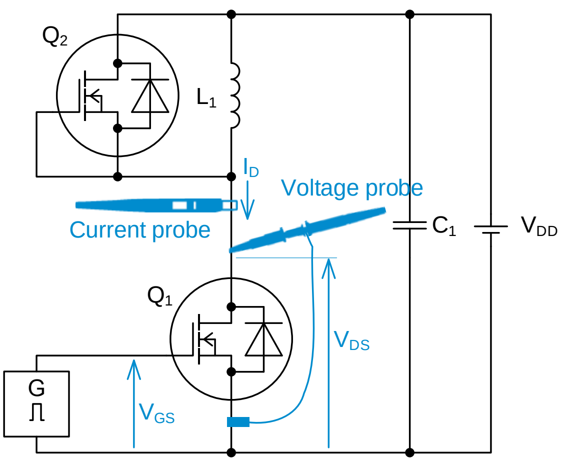

Figure 1. Example of a switching circuit

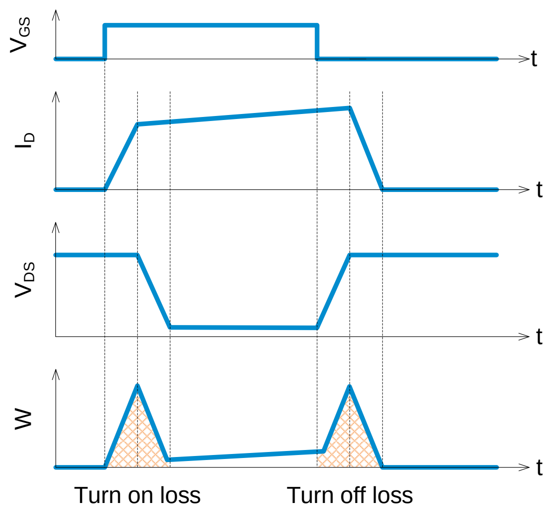

Figure 2. Waveform at each point and switching loss

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.

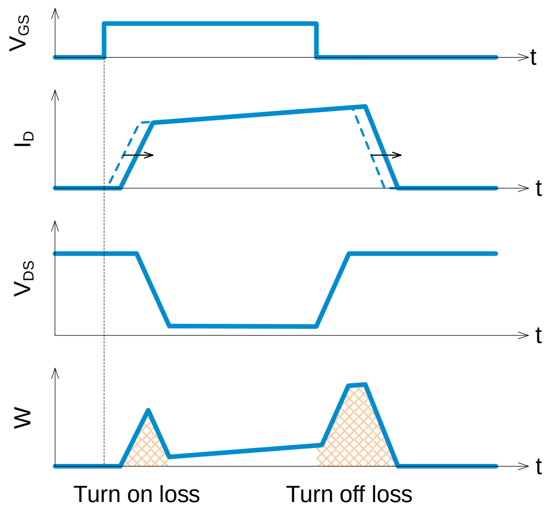

Figure 3. Effect of difference in propagation delay between probes on measurement results

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.

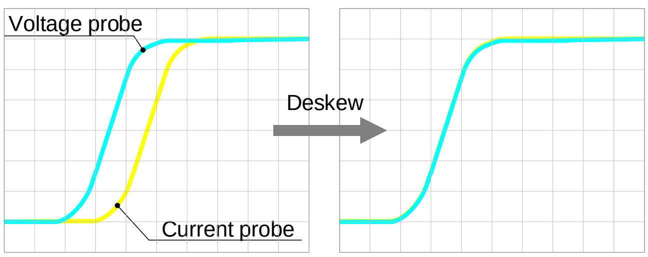

Figure 4. Waveform before deskew (left) and after deskew (right)

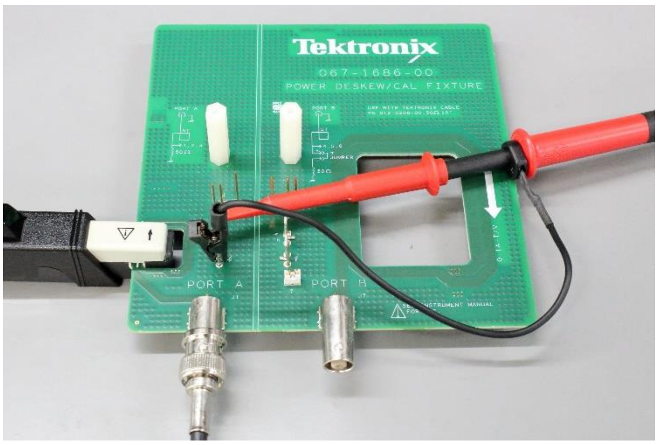

Figure 5. Deskew fixture made by Tektronix

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%.

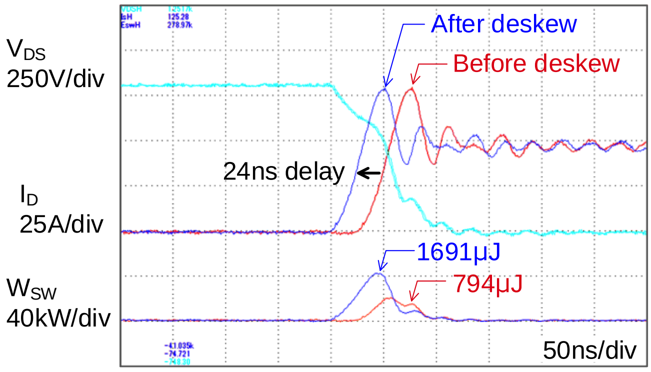

Figure 6. Turn on waveforms

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.

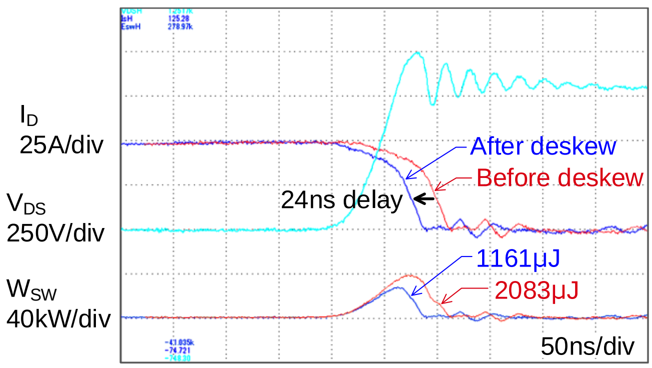

Figure 7. Turn off waveforms

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.

No. 63AN149E Rev.001
NOVEMBER 2020

Notes

1) The information contained herein is subject to change without notice.

2) Before you use our Products, please contact our sales representative and verify the latest specifications :

3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors.
Therefore, in order to prevent personal injury or fire arising from failure, please take safety measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures. ROHM shall have no responsibility for any damages arising out of the use of our Poducts beyond the rating specified by ROHM.

4) Examples of application circuits, circuit constants and any other information contained herein are provided only to illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

5) The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM or any other parties. ROHM shall have no responsibility whatsoever for any dispute arising out of the use of such technical information.

6) The Products specified in this document are not designed to be radiation tolerant.

7) For use of our Products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a ROHM representative : transportation equipment (i.e. cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, servers, solar cells, and power transmission systems.

8) Do not use our Products in applications requiring extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters.

9) ROHM shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions and specifications contained herein.

10) ROHM has used reasonable care to ensure the accuracy of the information contained in this document. However, ROHM does not warrants that such information is error-free, and ROHM shall have no responsibility for any damages arising from any inaccuracy or misprint of such information.

11) Please use the Products in accordance with any applicable environmental laws and regulations, such as the RoHS Directive. For more details, including RoHS compatibility, please contact a ROHM sales office. ROHM shall have no responsibility for any damages or losses resulting non-compliance with any applicable laws or regulations.

12) When providing our Products and technologies contained in this document to other countries, you must abide by the procedures and provisions stipulated in all applicable export laws and regulations, including without limitation the US Export Administration Regulations and the Foreign Exchange and Foreign Trade Act.

13) This document, in part or in whole, may not be reprinted or reproduced without prior consent of ROHM.

ROHM SEMICONDUCTOR

Thank you for your accessing to ROHM product informations.
More detail product informations and catalogs are available, please contact us.

ROHM Customer Support System

http://www.rohm.com/contact/