功率器件

功率测量中探针校正的重要性 倾斜校正篇

即使定期校正用于测试的器材，如果对测试环境不及时校正的话，也会得到错误的结果。这个应用手册说明了在功率测量环境中探针校正的重要性。

开关损耗的测试

如 Figure1 中使用 SiC MOSFET 的开关电路为例。开关损耗的测量是用电压和电流探测针测量各部分，将得到的电压和电流波形按点相乘。Figure 2 的斜线部分由于各部分的波形而造成开关损失。

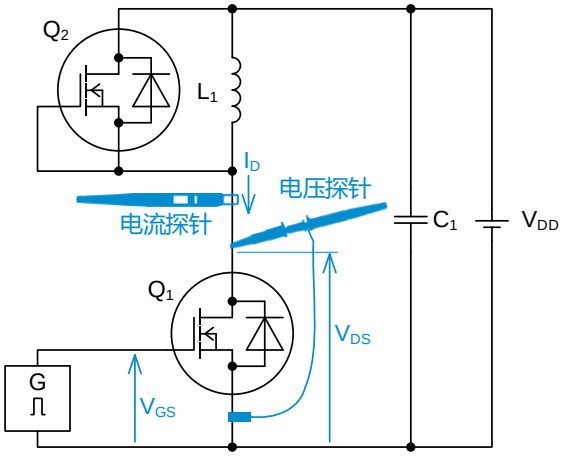

Figure 1. 开关电路的一例

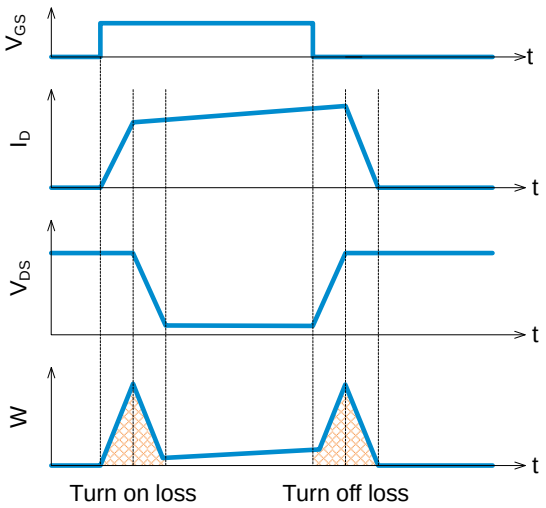

Figure 2. 各部分的波形和开关损失

传输延迟的问题

获取波形时探针和导线的使用会产生传输延迟。根据探针的不同，延迟时间也不同。上述的开关损失的测量例子，是电压探针和电流探针的组合，不过，除此之外也有差动有源探头和光探头与无源探头组合情况。此时也会发生探针之间传输延迟的误差。

这个延迟时间的误差在变化时间长的波形上是没有问题的，但是像开关波形那样，几十 nsec 以下变化的波形会受到很大的影响。

在 Figure 3 中表示探针之间的传输延迟差对测定结果有影响。在这个例子中，没有注意到电流探测的传输时间比电压探测时间长，而是直接测试的状态。与正确的波形 Figure 2 相比，Turn on loss 小，Turn off loss 看起来大等错误的结果。根据测试环境的不同，可能会产生很大的误差。

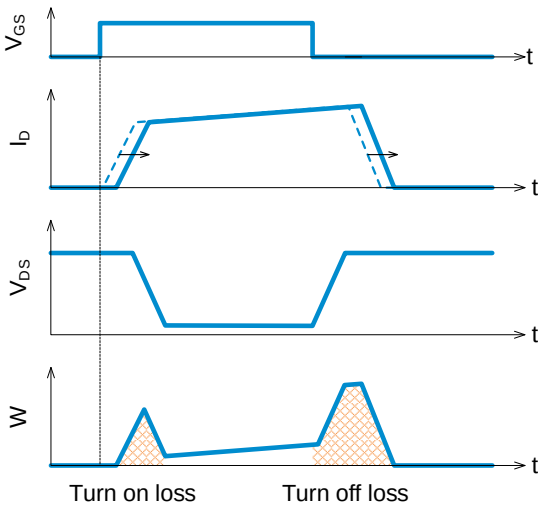

Figure 3. 探针间的传输延迟差会影响测试结果

探针倾斜校正(Deskew)

为了进行正确的功率测量，需要使探针之间的传输延迟时间一致。这是一种叫做“倾斜校正”的修正方法。

Figure 4 左边是测量电压和电流同时上升的信号，不过，象有时间差一样的现象被观测到。这叫做倾斜误差。

数字示波器中有将倾斜误差调整为零的“倾斜校正”功能，请使用此功能。根据倾斜校正功能，可以在示波器内部自动修正每一个探针的延迟时间。校正后的波形与 Figure 4 右边的波形一致。为了更准确地进行倾斜校正，测量仪器制造商还设置了“调试器”功能。Figure 5 是 Tektronix 公司测试作业图。

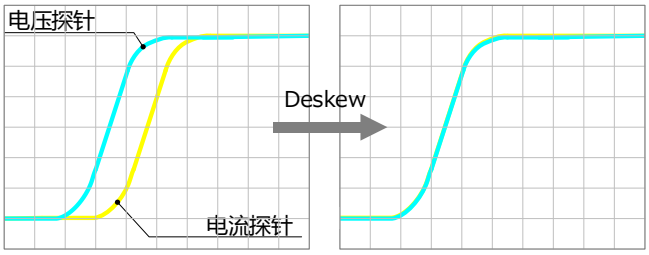

Figure 4. 倾斜校正前(左)と后(右)的波形

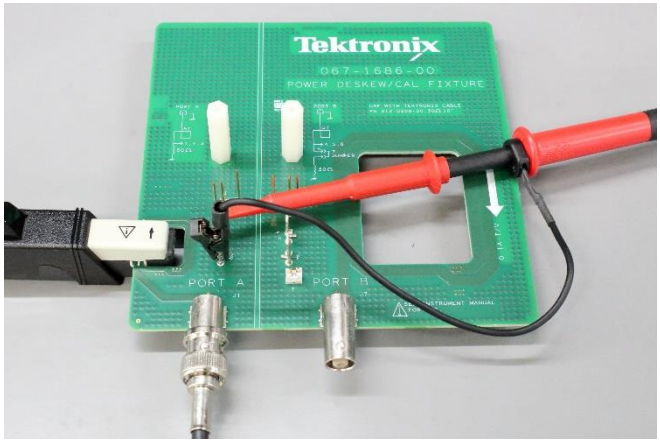

Figure 5. Tektronix 公司 倾斜校正夹具

事例

不实施倾斜校正的情况，用使用开关波形的测量例子来介绍对测量结果的影响。

Figure 6 是利用电压探查针和电流探查法测试由 SiC MOSFET 构成的开关电路导通时波形的结果。上面是电压波形，中间是电流波形，下面是开关消耗的电量。倾斜校正前和之后的电流波形延迟了 24ns。耗电量在倾斜校正前为 794μJ，倾斜校正后为 1691μJ，因而产生了+113%的误差。

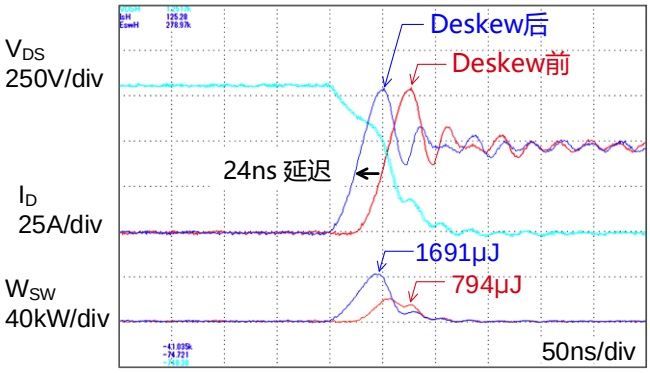

Figure 6. turn-on 波形

同样 Figure 7 是测得关断时波形的结果。耗电量在倾斜校正前为 2083μJ，倾斜校正后为 1161μJ，因此产生了-44%的误差。如果存在如此大的误差，在开关动作时会产生几十 W 以上的功率损耗误差，对散热设计会产生巨大影响。

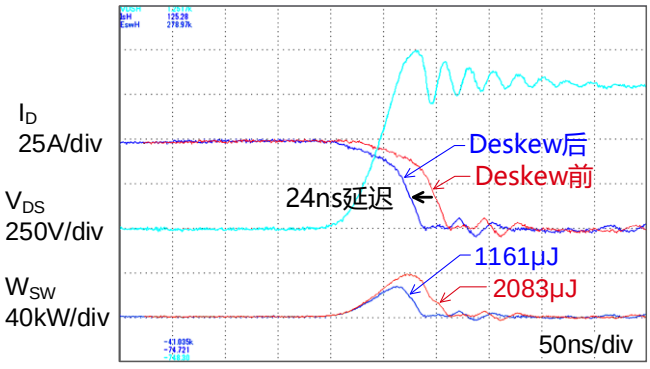

Figure 7. trun-off 波形

总消耗的电力量，倾斜校正前为 2877μJ，倾斜校正后为 2852μJ，误差为-90%。在这个测量例子中，偶然地消除了导通和关断时的误差，看起来是正确测量出来的结果，也有没有注意到重大测量错误的情况。

总结

・探针在检测点到示波器的输入之间会发生传输延迟。

・传输延迟的时间因探针而异。

・如果使用不同种类的指针，在多个频道上进行同步测量，则有可能获得与实际不同的波形。

・不同种类的方针有电压探查针和电流探查针、无源探查针和主动差动探查针、低电压探查和高电压探查针、频带不同的探查等各种各样的组合。

・为了补偿输送延迟的差异，必须实施倾斜校正。

・在受数 nsec 误差影响的测试中，即使是相同种类的探测针也要进行倾斜校正。

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

https://www.rohm.com.ch/contactus