How to Measure Switching Loss and Conduction Loss

This article aims to elaborate the measurement methods and precautions of simplified parameter measurement (Area) and automated measurement software

Introduction: In order to achieve energy efficiency goals, 80 Plus stipulates that power supplies must have a conversion efficiency of over 80%. For 80 PLUS Titanium, the highest level, a conversion efficiency of 90% or higher is required (varies with different input voltages and load specifications). Given the significance of minimizing losses, utilizing an oscilloscope to measure switching and conduction losses is an indispensable skill for power engineers and the measurement results become a basis for component selection and design verification.

Precautions before measurement:

1. Vertical zero calibration for the oscilloscope: If you are using both Channel 1 and Channel 2 for measurements, please remove the probe first. After powering up the oscilloscope for 30 minutes, observe the time traces of channel 1 and channel 2 and the ground level to see if there is an offset. If there is an offset, vertical zero calibration must be performed. It is called signal path compensation (SPC) in GW Instek's oscilloscopes. After SPC, this offset can be effectively reduced. Failure to zero will cause measurement errors of conduction loss.
2. Zero calibration of the voltage probe and current probe: After the oscilloscope is zeroed vertically, connect the probe with the oscilloscope. If there is an offset from the ground level at this time, since the oscilloscope has been zeroed, the offset at this time can be confirmed that it is an offset from the probe. At this time, adjust the zero reset on the probe. Failure to zero will cause measurement errors of conduction loss.
3. Delay time difference calibration of the voltage probe and current probe: Since the length of the voltage probe and current probe are different, even if the same point is measured, there will still be time difference due to the difference in conduction delay. If this time difference is not calibrated, it will lead to measurement errors of switching losses. Because the voltage waveform and current waveform have a time difference, the power waveform of the multiplication result will definitely be distorted. However, the voltage probe and the current probe have different mechanisms for connecting to the DUT, therefore, they cannot measure the same point. In this case, the purpose of calibration must be achieved via a layout to connect a precisely designed

Deskew Fixture. Figure 1 is a product diagram of GW Instek GKT-100. Although the voltage probe and current probe in the diagram measure different points, the two points on the calibration fixture are regarded as the same point.

Figure 1: Schematic diagram of Deskew board

Connect the circuit under test:

Before connecting to the circuit under test, the differential voltage probe needs to be twisted if it is a long wire and the current probe needs to be degaussed.

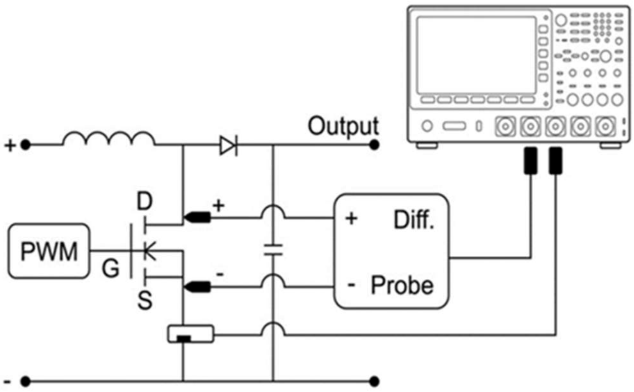

Figure 2: Connection between the oscilloscope and the circuit under test (channel 1 measures voltage V_{DS}), channel 2 measures current I_{DS})

Measure switching component losses:

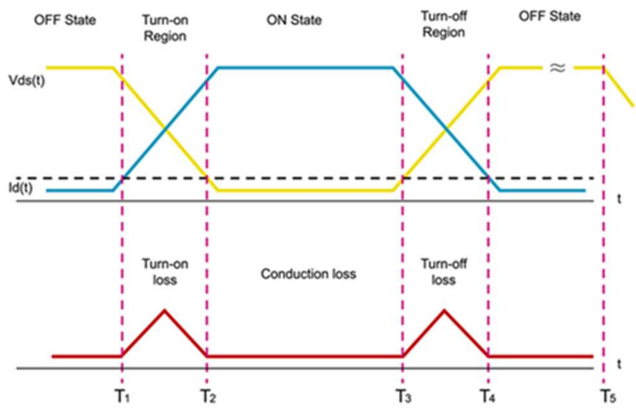

Figure 3: Waveform diagram of losses

As shown in Figure 3:

T1~T2 is the period during which turn on switching losses occur.

T2~T3 is the period when conduction losses occur.

T3~T4 is the period during which turn off switching losses occur.

Functions required for an oscilloscope to measure the above losses:

Method 1: Manual measurement

The oscilloscope has multiplication and division functions. Multiply the voltage waveform and the current waveform to obtain the power waveform and divide the voltage waveform by the current waveform to obtain the dynamic resistance waveform.

The oscilloscope measurement parameters have the function of Area: This parameter can integrate the power waveform to obtain the energy result of P*t (Joule: Watt * second)

The oscilloscope has a local measurement (Gating) function. Use the cursor to measure the energy of the local waveform of T1~T2 and then divide it by the time of T1~T2 to get the turn on switching loss in watts. Repeat the above operation, measure the energy of the local waveforms of T3~T4 through the cursor and then divide it by the time of T3~T4 to obtain the turn off switching loss in watts. If the local measurement area is T2 ~ T3, then dividing the energy of the local waveform by the time of T2 ~ T3, the conduction loss in watts can be obtained. In this interval, the value of R_{DS} on can also be obtained through division.

Method 2: Automatic measurement

GW Instek GDS-3000A series oscilloscopes provide automated measurement solutions for power supply measurement, which can save measurement time through automatic calculations. Figure 4 is an example of automatic measurement results of a GW Instek GDS-3000A oscilloscope.

Figure 4: Example of the automatic measurement results from an oscilloscope

Figure 5: Important specifications of GDS-3000A

In addition to the switching loss measurement function, GDS-3000A provides a total of 13 power supply measurement functions (as shown in Figure 6), which completely cover AC input, DC output, switching component analysis, magnetics analysis and frequency response analysis to accelerate power supply verification.

Figure 6: GDS-3000A power supply analysis display

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