# Power Device Analysis

## Measuring Power Loss in Switched Mode Power Supplies

Design goals for switched mode power supplies include designing more efficient power supplies that effectively reduce the size and costs of those supplies. Having tools that provide more insight into these circuits supports these goals, as well as providing a designer with more confidence in power supply reliability under all operating conditions.

One of the ways to improve the efficiency of your designs is to reduce the power losses within the circuit. LeCroy's PMA2 Power Measure Analysis Software, which runs on X-Stream™ digital oscilloscopes, provides exceptional ability to measure and analyze the operating characteristics of power conversion devices and circuits. All aspects of device analysis such as power loss measurement, saturation voltage, high side gate drive, dynamic on-resistance, and safe operating area are easily performed.

PMA2 simplifies the measurement of in-circuit power device switching characteristics. Figure 1 shows drain-source voltage, drain current, and power dissipation of a MOSFET switch. The parameters, shown under the graticule, measure peak power, energy, and average power loss. The measurement gate (vertical line on the power trace, allows users to select the portion of the cycle over which the measurement is made. In this example the switching loss is 2.8 µJoules of energy. Note that PMA2 fully integrates voltage and current probes with the internal math, and shows trace values in amps, watts and joules.

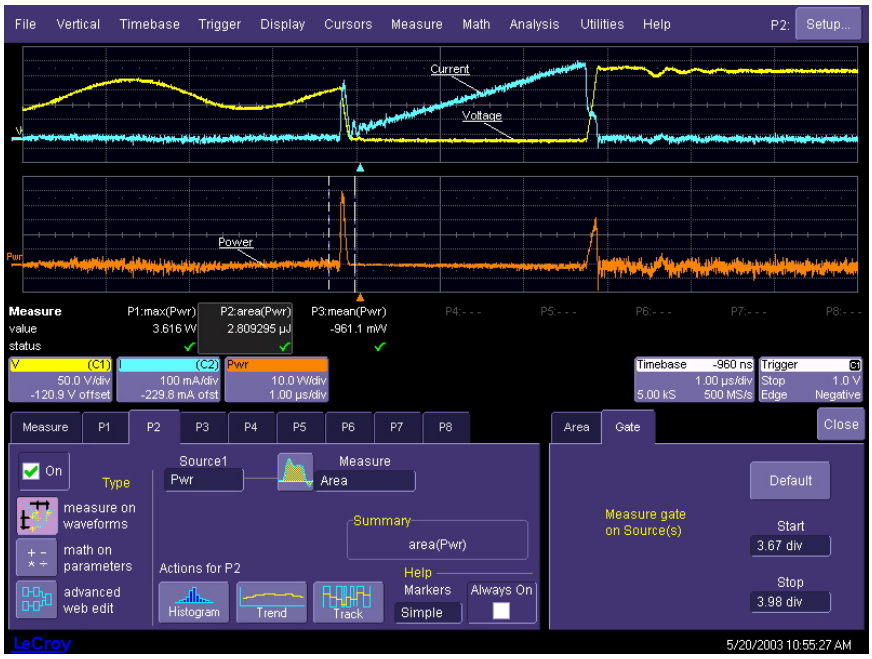


**Figure 1 The measurement gates can be used to selectively measure turn-on, conduction, turn-off, and single or multiple cycle power loss**

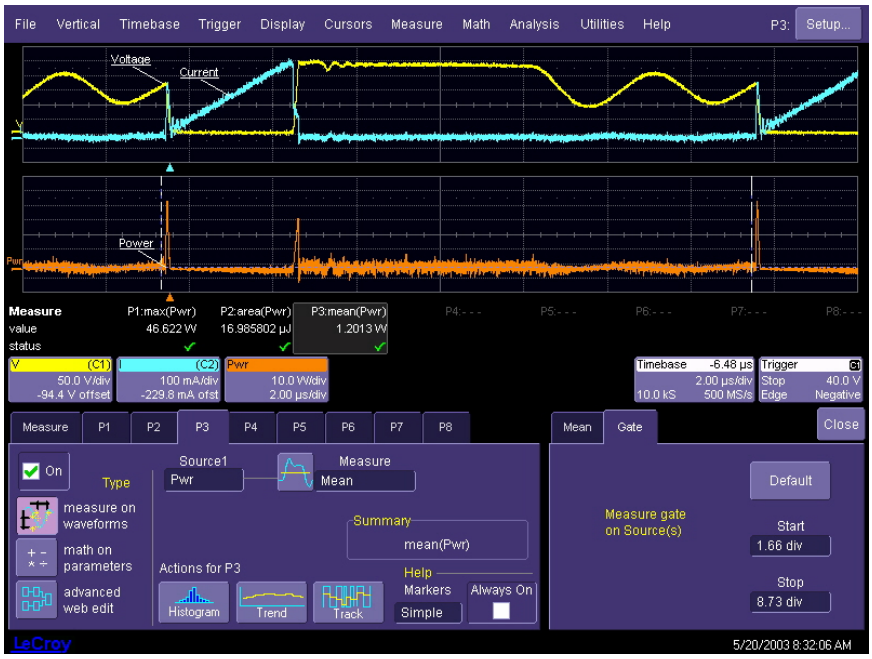


**Figure 2 Measuring the average power loss per cycle**

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Figure 2 shows the measurement of one full switching cycle of voltage and current through the MOSFET in the top grid. The lower grid contains the instantaneous power waveform (voltage times the current). The average loss per cycle is easily calculated as 1.2 watts.

LeCroy's high performance DA1855 differential amplifiers provide large dynamic range and excellent common mode rejection, which allows precise voltage studies. Small voltage signals riding on top of large swings can be measured accurately. They also allow precise measurement of saturation voltages of an in-circuit device. A primary application of this type of measurement is the determination of MOSFET dynamic on-resistance illustrated in figure 3

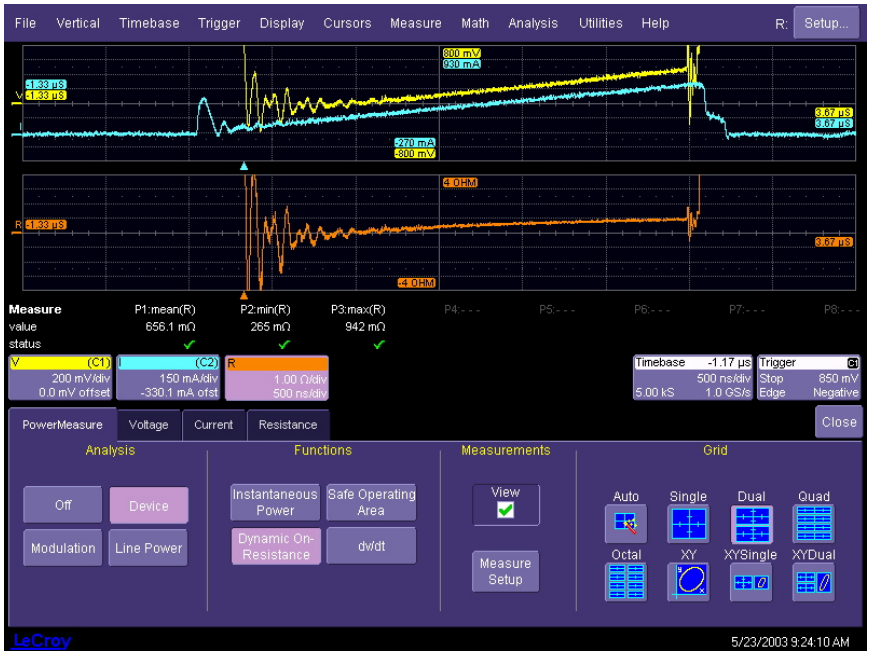


**Figure 3-Measurement of the dynamic on-resistance of a MOSFET switch.**

Confirming that voltage and current through a MOSFET does not exceed the manufacturer's design limits is critical for power supply reliability. A supply must be tested for all possible operating conditions (load-changes, line changes, short circuits, open loads, etc.). Figure 4 shows Safe Operating Area (SOA) and Y-T waveforms (voltage and current) for 20 milliseconds of data when capturing a power supply start up. The long acquisition memory in the scope allows capture of over 1300 switching cycles at 500 MS/s with plenty of resolution to zoom and see details of each switching cycle's waveform.

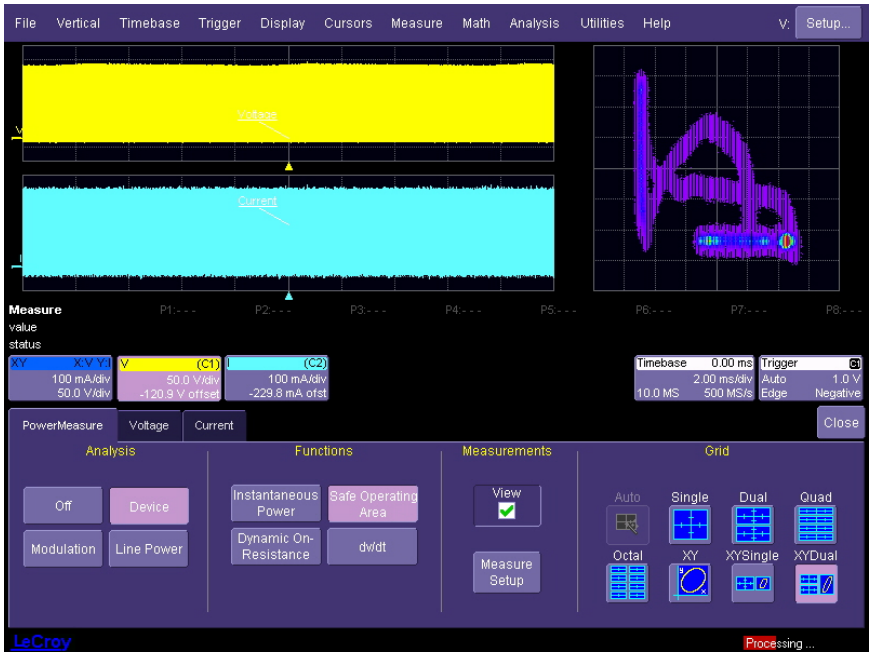


**Figure 4 A plot of Safe Operating Area over 1 cycle of the 60 Hz line**

As can be seen in these few examples, all aspects of device analysis such as power losses, saturation voltage, high-side gate drive, dynamic on-resistance, safe operating area, and dv/dt can be easily performed with the tools available in PMA2. None of these measurements is more than a button push away.

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