DSOX3PWR/DSOX4PWR Power Measurement Application for InfiniiVision 3000 and 4000 X-Series Oscilloscopes

Data Sheet

Achieve cost-effective analysis of your switching mode power supply (SMPS) characteristics

Today's power supply designers are facing an increasing number of constraints in the development of high-efficiency, low-cost power supplies. Cost-effective solutions used to be the designer's key target. Today, rising energy costs bring power supply efficiency to the forefront. Additionally, other constraints such as design compactness, migration to digital control, tighter voltage tolerances, and regulations for power quality and EMI force the need for quick and thorough power supply testing. Increasing design constraints translate into more time dedicated to power device measurement and analysis for today's power supply designers.

In spite of the increasing analysis capability offered by many oscilloscopes over recent years, it is not uncommon to see designers perform measurements and analysis manually. These measurements typically take a considerable amount of time to capture, analyze and report.

Figure 1. Power measurement option integrated into the Agilent InfiniiVision X-Series making it a single-box test solution.

Agilent's DSOX3PWR and DSOX4PWR are power measurement and analysis options that are integrated into InfiniiVision 3000 and 4000 X-Series scopes. The embedded application provides a quick and easy way of analyzing the reliability and efficiency of your switching power supply. These power measurement options also come with the user license for the U1881A-003 PC-based power measurement and analysis software that provides even more powerful insight into your power supply measurements.

Type of Analysis	Measurements/Feature	Agilent Power Measurement Application for InfiniiVision 3000X	
		DSOX3PWR / DSOX4PWR Integrated	U1881A-003 PC based
Input line analysis	Current Harmonics	X	X
	Power factor	X	X
	True power	X	X
	Apparent power	X	X
	Crest Factor	X	X
	Phase Angle	X	
	Pre-compliance IEC61000-3-2 (class A,B,C and D)	X	X
	RTCA D0-160E		X
	Inrush current	X	X
Power device analysis	Switching loss	X	X
	Safe Operating Area(SOA)		X
	SOA Mask Editor		X
	Dynamic On resistance(Rds)		X
	dV/dt slew rate	X	X
	dI/dt slew rate	X	X
Modulation analysis	Pulse width vs. time	X	X
	Duty cycle vs. time	X	X
	Period vs. time	X	X
	Frequency vs. time	X	X
Output analysis	Output ripple	X	X
Deskew	Auto Deskew	X	X
Turn on/off analysis	Turn on time	X	X
	Turn off time	X	X
Transient response analysis	Transient response	X	X
Efficiency Analysis	Pout/Pin analysis	X	X
PSRR analysis	PSRR analysis	X	
On/off line analysis	On/off line analysis		X
Report generation	Report Generation		X

Power Device Analysis

The switching loss in a power supply determines its efficiency. You can easily characterize for instantaneous power loss and conduction power loss at the switching device over a designated switching cycle. To determine the efficiency of the power supply it is very important to measure the power loss during dynamic load changes.

By measuring the switching loss and conduction loss, you can characterize the instantaneous power dissipation in your switching power supply. Locating peak switching loss helps you analyze the reliability of the power supply. The di/dt and dv/dt represent the rate at which the current and voltage change at switching. This helps in analysis of reliable operation of the switching mode power supply.

Figure 2. By measuring the switching loss and conduction loss, you can characterize the instantaneous power dissipation in a switching power supply.

Line Power Analysis

Power supply designers need to characterize the line power for power quality, harmonics and conducted emissions under different operating conditions of the power supply. Some of the implicit measurements are real power, apparent power, reactive power, power and crest factor and graphical display of harmonics with respect to standards such as EN 61000-3-2 (Class A,B,C,D). By using a current probe and power measurement option, conducted power line harmonics can be measured. Also, line power analysis includes the inrush current measurement that shows the peak inrush current value when the power supply is first turned on.

Figure 3 Perform the pre-compliance line harmonic testing of your power supply to the IEC 61000 3-2 standards. This analysis presents up to 40 harmonics.

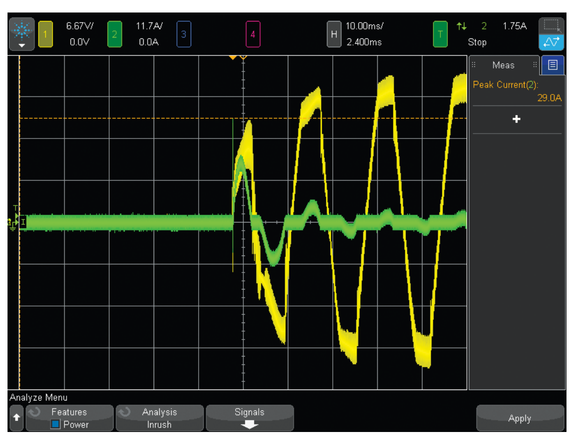


Figure 4 The Inrush current analysis measures the peak inrush current of the power supply when the power supply is first turned on.

Power Quality analysis

The Power Quality analysis shows the quality of the AC input line. Some AC current may flow back into and back out of the load without delivering energy. This current, called reactive or harmonic current, gives rise to an "apparent" power which is larger than the actual power consumed. Power quality is gauged by these measurements: power factor, apparent power, true power, reactive power, crest factor, and phase angle of the current and voltage of the AC line.

Figure 5 The power measurements option provides a results table with the following power quality measurements: Power Factor, Real Power, Apparent Power, Reactive Power, Crest Factor and Phase Angle.

Modulation Analysis

Modulation analysis allows designers to quickly see the on-time and off-time information of the PWM signal, which is difficult to visualize because the information bandwidth is much lower than the pulse switching frequency. Plotting the embedded variation of on time or off time in the PWM signal over a long period of time can reveal the control loop response of the feedback loop system. This measurement performs data trending on the switching variation of the acquired waveform in the following format.

- Frequency vs time
- Period vs time
- Duty Cycle vs time
- Positive pulse width vs time
- Negative pulse width vs time

Figure 6 Plotting the embedded variation of on time or off time in the PWM signal over a long period of time can reveal the control loop response of the feedback loop system.

Output Analysis

Output analysis includes characterization of the ripple component (either power line or switching) in output DC voltage. Ripple is the residual AC component that is superimposed on the DC output of a power supply. Line frequency as well as switching frequency can contribute to ripple. This measurement analyzes the output voltage ripple and presents the peak-to-peak value as well as the frequency response of the captured signal.

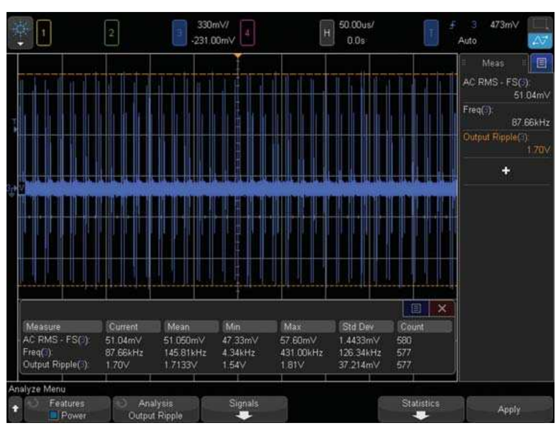


Figure 7 The output analysis includes characterizing the ripple component (either power line or switching) in output DC voltage.

Turn on/off Time Analysis

This analysis measures the time taken to get to the steady output voltage of the power supply after the input voltage is applied (turn on time) and for the output voltage of the power supply to turn off after the input voltage is removed (turn off time).

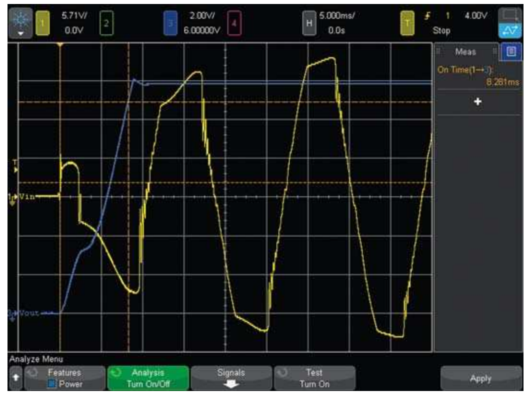


Figure 8 The turn-on analysis measures the time taken to get to the steady output voltage of the power supply after the input voltage is applied.

Transient Response Analysis

Power supplies are subject to transient conditions, such as turn-on and turn-off transients, as well as sudden changes in output load and line input voltage. These conditions lead to one of the key specifications of the power supplies; load transient response. This analysis measures the load transient response of the DC output, namely the time taken for the DC output to stabilize during a load change.

Figure 9 The transient analysis measures the load transient response of the DC output, namely the time taken for the DC output to stabilize during a load change.

PSRR (Power Supply Rejection Ratio)

Characterizing PSRR over frequency commonly involves the use of an expensive analyzer equipped with a DC bias port such as Agilent's ENA network analyzers.

The DSOX3PWR/DSOX4PWR option utilizes the InfiniiVision built-in WaveGen BNC output that generates a swept frequency, simplifying the test solution in one box and significantly reducing the cost.

The PSRR is defined as the ratio of the input ripple compared to the output ripple over a wide frequency range and is expressed in dB. The basic equation for PSRR is

$$\text{PSRR} = 20 \log \frac{\text{Ripple input } (V_{in})}{\text{Ripple output } (V_{out})}$$

There may be many different methods to measure PSRR. One thing to note here is that because the oscilloscope has a higher noise floor and lower vertical sensitivity compared to a network analyzer, it is difficult to measure PSRR any better than -60 dB. A PSRR test using an oscilloscope with an integrated generator is usually considered to be acceptable for spot-checking overall PSRR behavior of the power supply under test. Using a modulated power supply to power the power supply input would be very useful for testing PSRR at heavy load conditions.

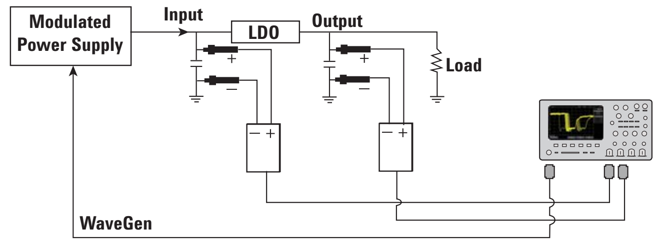


Figure 10 The PSRR is defined as the ratio of the output ripple compared to the input ripple over a wide frequency range.

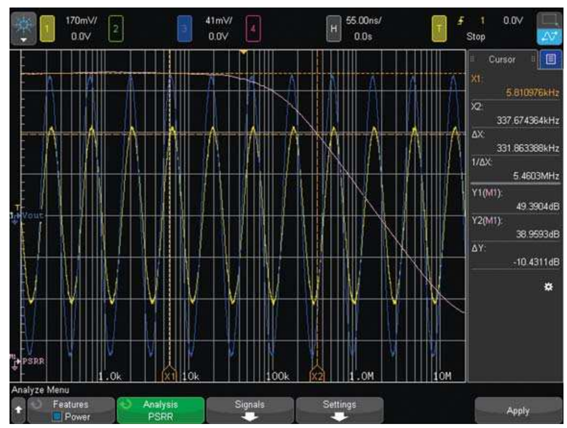


Figure 11 The PSRR is a measure of how well a circuit rejects ripple coming from the power supply input at various frequencies.

Efficiency Analysis

Efficiency analysis tests the overall efficiency of the power supply by measuring the output power over the input power. This analysis requires a 4- channel oscilloscope because input voltage, input current, output voltage, and output current are measured.

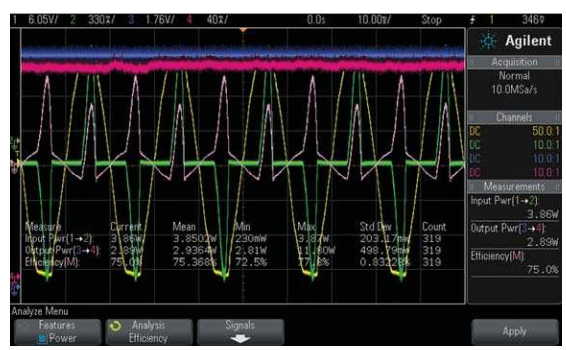


Figure 12: Efficiency analysis tests the overall efficiency of the power supply

Probe deskewing with the U1880A deskew fixture

Timing delay errors between voltage and current probes may have a significant impact on power measurements as each specific voltage and current probes have different propagation delays. To make accurate power measurements and calculations, it is extremely important to null out the time delay between the voltage and current probes using a procedure known as “deskewing.” This step is critically important since a small offset in the timing of the voltage and current traces can cause a large error in the instantaneous power reading. By performing probe deskew before making power measurements, you can ensure the most accurate measurement.

The Agilent U1880A deskew fixture allows you to quickly deskew your voltage and current probes, enabling accurate and precise measurements of power supply efficiency. The U1880A deskew fixture generates a built-in voltage and current test signal and allows you to probe the same electrical point with a variety of voltage and current probes. With only a single click in one of the power measurements setup, deskewing is automatically performed and the deskew factors are saved in the power measurement application, so the next time when you launch the power measurement application, you can use the saved deskew values or perform the deskewing again.

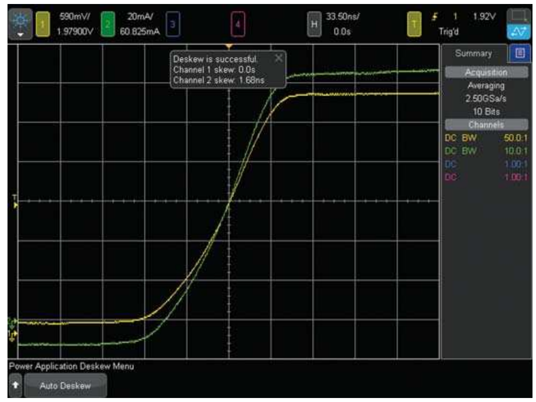


Figure 13 To make accurate power measurements and calculations, it is extremely important to null out the time delay between yout voltage and current probes.

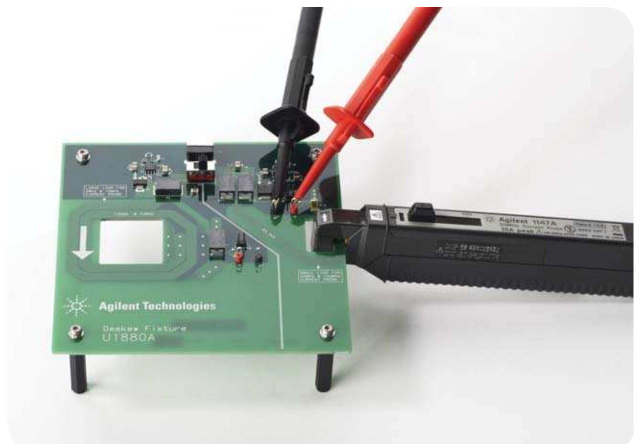


Figure 14 The Agilent U1880A deskew fixture allows you to quickly deskew your voltage and current probes, enabling accurate and precise measurements of power supply efficiency.

Ordering Information

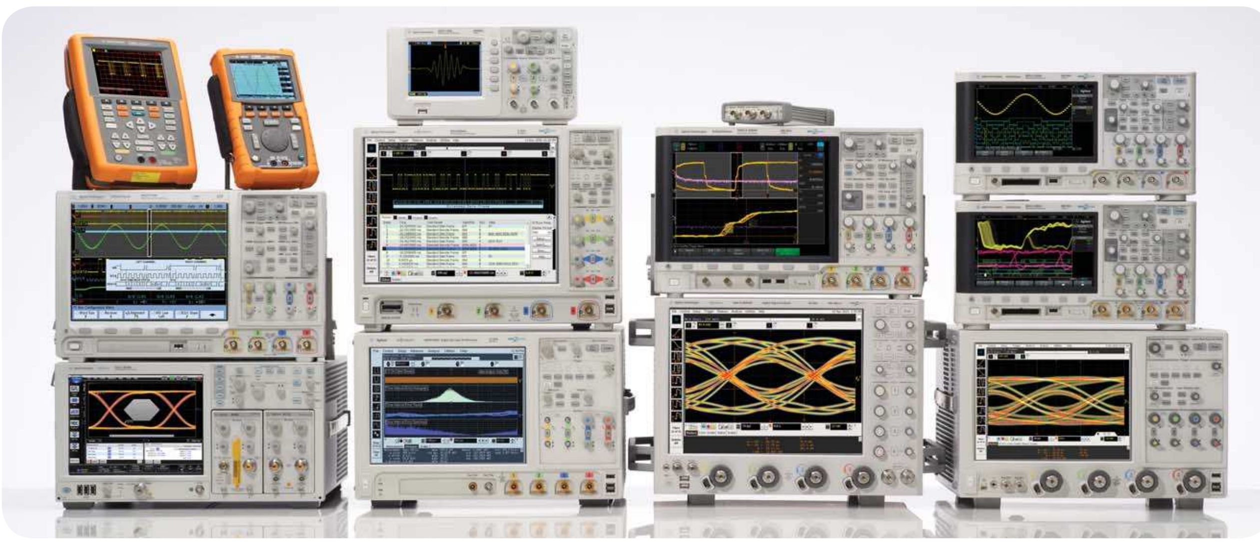
Note* To learn more about the U1881A Power measurement application for InfiniiVision oscilloscopes, refer to the U1881A data sheet with Agilent literature number 5989-7835EN.

Product Number	Description
DSOX3PWR	Power Measurement software integrated into the 3000 X-Series (also includes the U1881A PC-based Power Measurement and Analysis* software license)
DSOX4PWR	Power Measurement software integrated into the 4000 X-Series (also includes the U1881A PC-based Power Measurement and Analysis software license)
U1880A	Deskew fixture for voltage and current probe deskewing

Recommended Probes and Accessories

For more information about Agilent's scope probes and accessories, check out www.agilent.com/find/probes.

Recommended Probes
AC/DC current probes (one or more of these Agilent current probes) • 1147B 50MHz, 15A AC/DC current probe with AutoProbe interface • N2893A 100MHz, 15A AC/DC current probe with AutoProbe interface • N2780A 2MHz, 500A AC/DC current probe (requires N2779A power supply) • N2781A 2MHz, 150A AC/DC current probe (requires N2779A power supply) • N2782A 2MHz, 30A AC/DC current probe (requires N2779A power supply) • N2783A 2MHz, 30A AC/DC current probe (requires N2779A power supply)
Differential probes • N2790A 100MHz, 1.4 kV differential probe with AutoProbe interface • N2791A 25MHz 700 V differential probe • N2792A 200MHz +/-20V differential probe • N2793A 800MHz +/-15V differential probe • N2891A 70MHz 7kV differential probe
Passive probe (for measuring output noise and PSRR) • N2870A 1:1 35 MHz passive probe (with N2768A vertical mini probe socket adapter) • 10070D 1:1 20 MHz passive probe



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