Verifying power integrity for DDR memories

A key challenge for embedded devices with DDR memories is to maintain signal integrity in the presence of power and ground rail fluctuations. This becomes even more important as supply voltages decrease and switching speed increases leading to tighter power rail tolerances and jitter requirements.

Your task

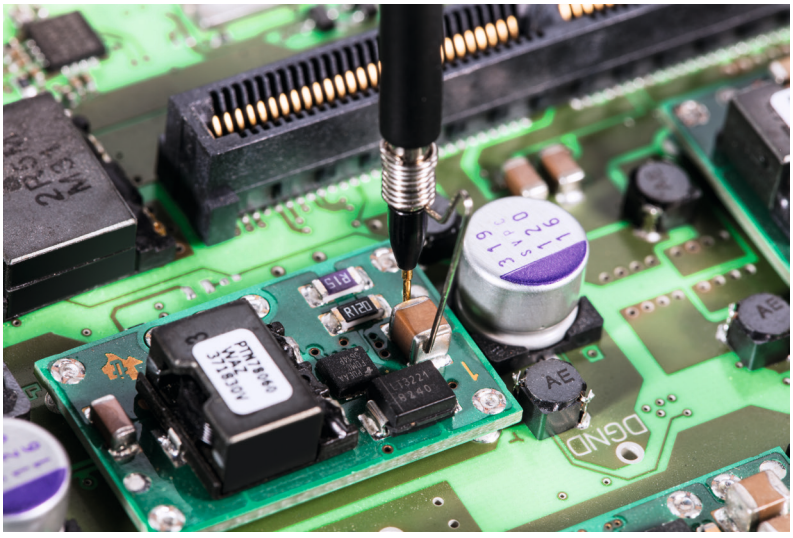
The stability of the power distribution network is very important for embedded designs with DDR memory interfaces. Whereas DDR3 memories tolerated 75 mV (V_{pp}) ripple, this has decreased to only 60 mV (V_{pp}) for DDR4 memories and is likely to decrease further in the future. Ripple and noise on the power distribution network negatively impact clock and data jitter, which has a direct impact on data transfer performance. Qualifying the power distribution network of embedded designs with DDR memories is therefore a crucial task.

T&M solution

The R&S®RT-ZPR20 power rail probe is a specialized oscilloscope probe for very low-noise measurements on power rails. This active 1:1 probe with integrated offset allows you to zoom in on the ripple sitting on top of the power rail voltage. It is compatible with the R&S®RTE and R&S®RTO digital oscilloscopes, adding only 10 % of noise to the oscilloscope for accurate measurement of ripple and noise components. The probe has a 2 GHz bandwidth to see high-frequency transients or unwanted RF signals coupled into the power rail. Due to the slow frequency rolloff, the 2.4 GHz band can be covered with only slightly more attenuation. At 50 kΩ, the probe has a much higher DC impedance than a direct coaxial connection and therefore does not significantly load the power distribution network.

Verifying the DC level of power supplies with a browser

The accuracy of DC supply voltages can easily be qualified with the R&S®ProbeMeter, a highly accurate DC voltmeter integrated into the probe head. It offers 0.1 % DC accuracy irrespective of the offset voltage and eliminates the need for a separate DC voltmeter. The 350 MHz browser extension makes checking all power rails on a PCB an easy task. A browser accessory such as the SMT clip or the dual pin adapter provides an alternative way of connecting to the DUT if measuring with the ground spring is not convenient.



The R&S®RT-ZPR20 probe's browser extension is the perfect tool for verifying the DC levels of multiple power supplies on a PCB.

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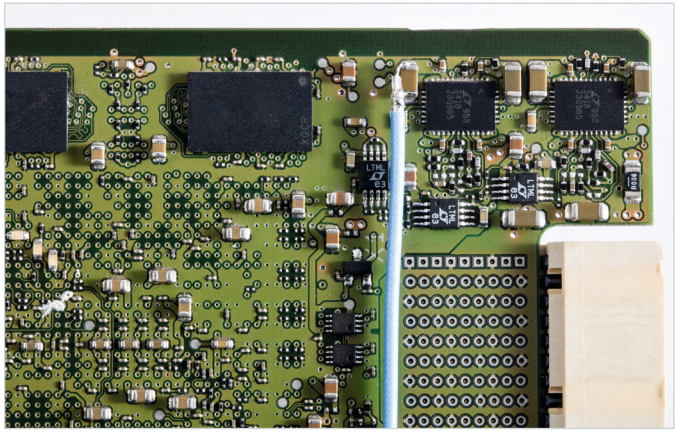
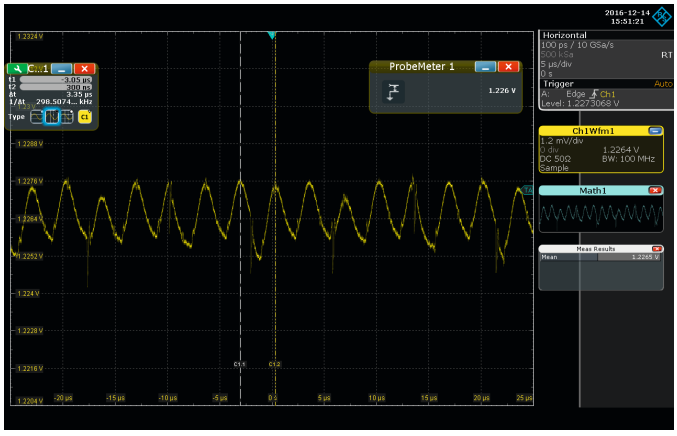
Setting up DDR4 power rail measurements

Realistic measurements on the DDR memory power supply require probing as close as possible to the DDR component. Pigtail cables are the right choice for such measurements. A typical setup – when the DDR memory is driven by an FPGA – is what is referred to as a spyhole measurement. An unused FPGA pin is utilized to probe the DDR core voltage right from inside the FPGA. This I/O pin is then driven to high or low DDR core voltage and probed externally with the power rail probe. This is often the closest possible location where the power supply can be probed. [1)]

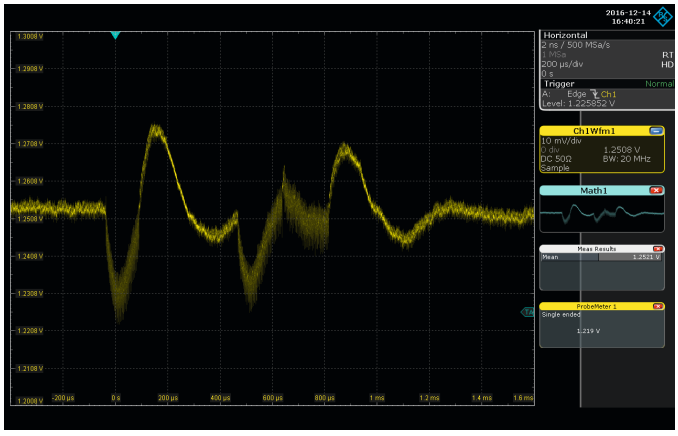
[1)] "7 Series FPGAs PCB Design Guide", UG483 (v1.12), Xilinx, January 10, 2017 at www.xilinx.com



Pigtail cables do not limit the bandwidth of the probe and provide excellent connectivity right where the measurement has to be taken.



Measuring remaining ripple on a 1.2 V DDR4 power supply and accurately verifying the DC level with the R&S®ProbeMeter, a DC voltmeter integrated into the probe head.



Load response measurement of a DDR4 power supply during initialization phase of the DDR memory.

Oscillscope measurement methods

Two methods are available for testing the remaining ripple and noise on a DC power rail [1)]:

- Use infinite persistence mode to capture and display all noise events. When combined with automatic V_{pp} measurement and statistics display, the maximum noise voltage can easily be measured. If an oscilloscope with a fast update rate, e.g the R&S®RTO or the R&S®RTE, is used (1 million waveforms/s can be acquired), a reliable measurement result can be achieved within seconds
- Place the oscilloscope in single or normal trigger mode and trigger on a known aggressor event. For DDR memory power supplies, these are typically load-response measurements during DDR initialization phase or stress tests

Summary

Accurate ripple and noise measurements on power rails require a high-bandwidth oscilloscope and a dedicated probe to perform low-noise measurements and provide the offset capability to zoom in on top of the DC voltage. The R&S®RT-ZPR20 power rail probe as well as the R&S®RTE and the R&S®RTO digital oscilloscopes are excellent tools for this measurements.

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Rohde&Schwarz GmbH&Co. KG
Europe, Africa, Middle East | +49 89 4129 12345
North America | 1 888 TEST RSA (1 888 837 87 72)
Latin America | +1 410 910 79 88
Asia Pacific | +65 65 13 04 88
China | +86 800 810 82 28 | +86 400 650 58 96
www.rohde-schwarz.com
customersupport@rohde-schwarz.com

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