Brief 12: Low-Voltage Ride-Through Performance of a Modified Personal Computer Power Supply

Keywords:
Energy Storage Capacitors
Lightning Fault
Momentary Interruption
Motor Starting
Other Faults
PC
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Sag/Swell

Background

The use of desktop personal computers (PCs) is flourishing in business and home applications. Many of these applications require a continuous supply of electric power for continuous, undisturbed processing. Common disturbances in the electric power system caused by such things as wind, lightning, and falling tree branches can momentarily reduce the available power to below the limits required to maintain PC operation. Most PCs can ride through low ac voltages lasting one hundred milliseconds or less. Many low voltages, however, last longer than the PC ride-through limit. Increasing the energy stored in PCs can significantly increase ride-through limit. One way to increase stored energy is to add energy-storage capacitors in the PC power supply. Additional capacitors can increase a PC low-voltage ride-through time by tenfold. Figure 1 shows the location of supplemental energy-storage capacitors inside a typical PC.

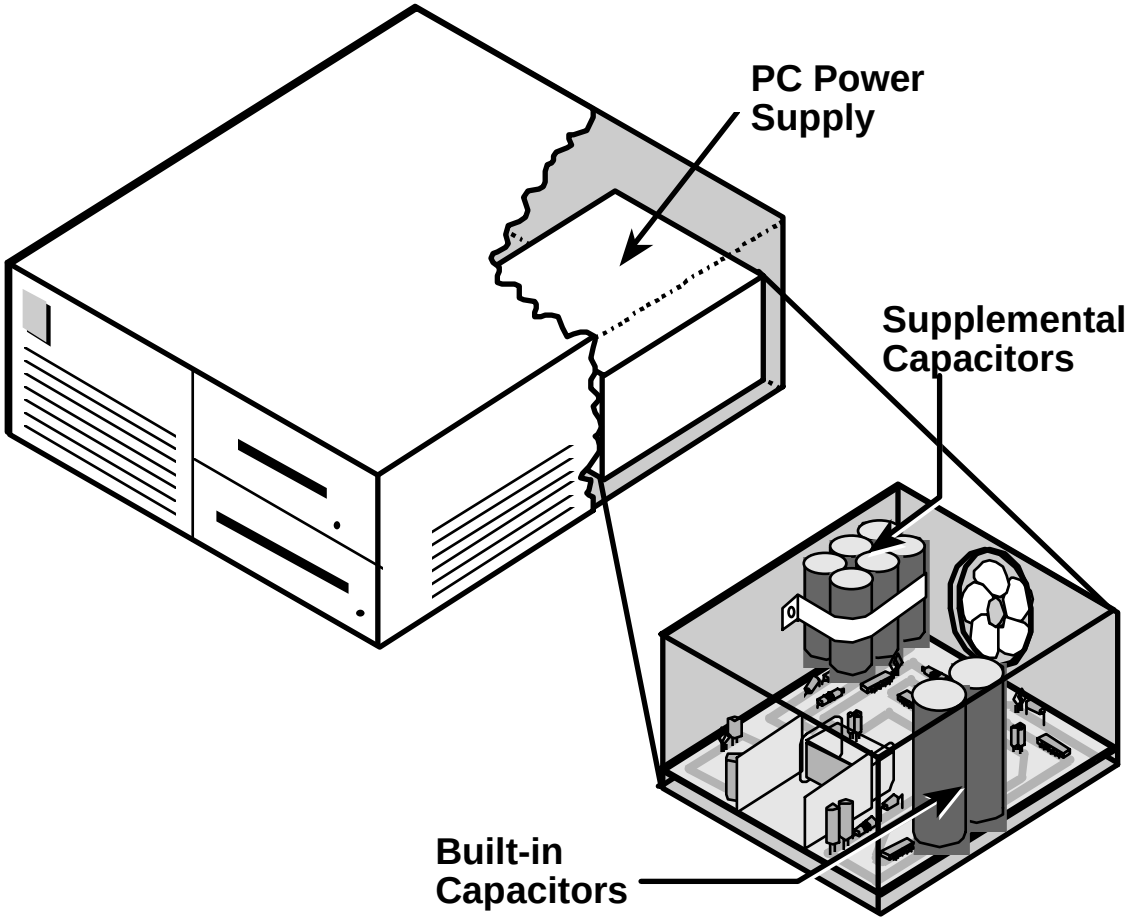

Figure 1: Supplemental Energy-Storage Capacitors in a Typical PC

Objective

The objective of the tests performed at the EPRI Power Electronics Applications Center (PEAC) Power Quality Test Facility was to investigate ride-through performance of a PC modified with additional energy-storage capacitors during typical low ac voltages.

Test Setup

A typical 80386-based PC modified by New England Electric Company to enhance low-voltage ride-through performance was tested. Energy-storage capacitors were selected and connected to the PC power supply based on methods developed at Dartmouth College under a research contract funded by New England Electric. The PC was powered at 120 Vac, with approximately 50 W of internal consumption. A separately powered computer monitor was connected, and a user-program was running and displayed on the monitor screen. Momentary voltage interruptions were created by switching from the 120 Vac line to an open circuit and then back. Interruptions were timed at zero-crossings. A digital storage oscilloscope monitored and recorded ac input voltage and current, unregulated dc voltage, and regulated dc voltage. Figure 2 shows a diagram of the test setup.

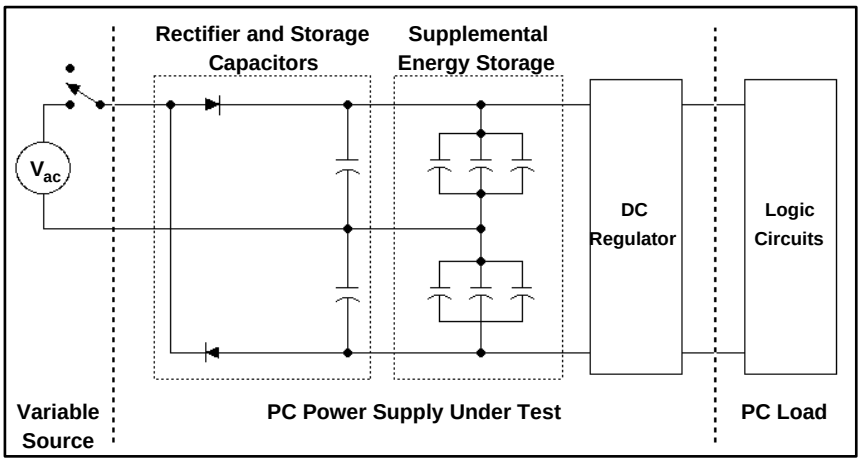

Figure 2: Diagram of Test Setup

Test Results

The energy storage of the PC power supply was increased tenfold with 4500 µF of additional capacitance at 400 Vdc (six 1500 µF at 200 Vdc each). The additional capacitors were connected at the output of the rectifier circuit and in parallel with the built-in storage capacitors (see "Supplemental Energy Storage" in Figure 2). Voltage across the two existing capacitors in series was about 340 Vdc under normal operation.

After an interruption of the ac voltage source, the PC continued operating with the regulated dc voltage at 5.1 Vdc as the unregulated dc voltage dropped from 340 to 170 Vdc. The PC then operated below 5.1 Vdc until the capacitor voltage dropped to 113 Vdc. At that voltage, the dc regulator shut down.

Test results show that the supplemental energy storage extended the ride-through time of the PC from about 10.5 cycles (175 ms) to 108 cycles (1800 ms) at 50-W loading. The measured PC ride-through time was about 200 ms (11%) longer than the calculated ride-through time (see Tutorial). The supplemental capacitors also reduced dc ripple at 340 Vdc from 9.6 Vpp to 0.8 Vpp, but increased the ac-input current harmonic distortion by 4%, from 129% to 133%. Lower dc ripple improves the under- and overvoltage trip limits for the dc regulator, and may account for the 11% difference between the calculated and measured ride-through times.

Discussion

Test results demonstrate that a typical PC can be modified to improve immunity to low voltages. For a 50-W PC, additional energy storage in the power supply can extend ride-through time by one or more seconds. This modification is expected to be effective for

most voltage disturbances, and to cost significantly less than external power conditioning, as much as 10 times less than an uninterruptible power supply. Nevertheless, built-in supplemental energy storage is not commercially available. Approval from both PC manufacturers and Underwriters' Laboratories will be needed to market the product.

Significance

For many applications, the modern desktop PC and the public power supply are not fully compatible. Better understanding of incompatibilities will facilitate practical improvements to PC power supplies and will help to create options for consumers. Because extended ride-through time is so important for continuous, undisturbed processing, PC original equipment manufacturers and computer retail stores may find a market for energy-storage options.

Acknowledgements

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