

Reversal of fortune



Years ago, I had to design a dc/dc converter, or SMPS (switched-mode power supply), to generate isolated 48V dc from a 5V rail. A manager asked why I could not just use an off-the-shelf 48V-to-5V converter and run it in reverse. I explained about output-rectifier diodes and their one-way characteristics.

Years later, SMPS conversion efficiencies had reached 90% or more. Designers achieved this advancement by using low-

on-resistance, low-forward-voltage-drop FETs as synchronously driven rectifiers in place of diodes.

A recent project for a high-current server power supply required running two SMPSs in parallel with current sharing for fail-safe redundancy. Each SMPS could support the full load should the other fail. To maintain efficiency, we used back-to-back series FETs instead of diodes at each SMPS output to combine the two outputs into a common rail. The advantage was low FET forward-voltage drop, but, unlike diodes, the FETs conduct in both directions and needed a controller to moni-

tor forward and reverse currents and voltages and to turn these FETs on and off (**Reference 1**). Reverse current is most troublesome during start-up when the SMPS voltage and current-share control loops are stabilizing. The controller temporarily blanks its reverse-current sensing to allow for this problem and keeps the FETs turned on.

A common 48V rail powered both SMPS devices. If the 48V rail should momentarily droop due to the finite-response time to isolate a short elsewhere, series diodes would reverse-bias, and storage capacitors would keep each SMPS running during the few

microseconds of droop.

The first prototype units turned out to be disasters. The SMPSs would not start up properly; if one was a slightly lower voltage than the other, it received reverse current and would continuously shut down and then restart, only to shut down again. The SMPS manufacturer said the SMPS should not shut down in the event of reverse current into its output. A colleague had seen this happen before, and he suggested measuring the input voltage to the SMPS that was shutting down.

Huh? The input is 48V, right? Wrong. The input voltage started at 48V and ramped up to 57V, at which point the SMPS detected excessive input voltage and shut down just as it was supposed to. Then, the input dropped back to 48V, and the cycle repeated. The synchronous-FET rectifiers were chopping the reverse current and causing current to flow from the SMPS input. This current flow caused the input isolation diode to reverse-bias, and the current had nowhere to go but into the input storage capacitor, where it ramped the voltage upward.

I was amazed by this revelation and remembered that meeting long ago when I told the manager that dc/dc converters do not work in reverse. It seems that I was wrong in the case of synchronous-FET rectifiers.

The solution was to include a temporary switched-FET path between the two 48V SMPS inputs to circulate reverse current during the 40-msec start-up phase. After these changes and a few others for different problems, it worked great. **EDN**

REFERENCE

1 "ORing MOSFET Controllers with Fastest Fault Isolation for Redundant Power Supplies," Maxim Integrated Products, 2004, <http://datasheets.maxim-ic.com/en/ds/MAX8535-MAX8585.pdf>.

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