Pre-biased Output Voltage Startup Operation of the UCC28950 Phase-Shifted Full-Bridge Controller

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ABSTRACT

Some applications where the UCC28950 controller finds use include power systems where it is paralleled with 1 or many additional power-supplies, often a copy of its own control and power stages. This could provide redundancy for systems that use backup supplies to maintain high reliability or for those systems that use paralleling techniques to achieve higher output current and power. A possible structure for this system can be seen in Figure 1. (Note that the load-sharing controllers themselves usually do not prevent reverse current flow during startup; so it is the UCC28950 that prevents such action).

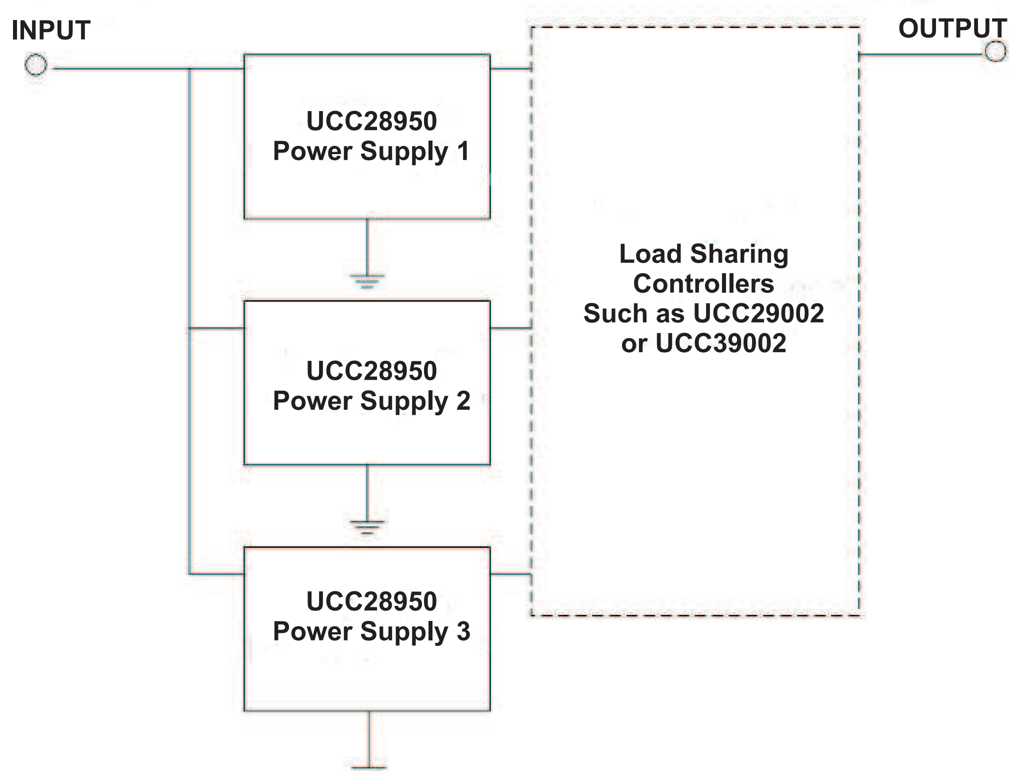
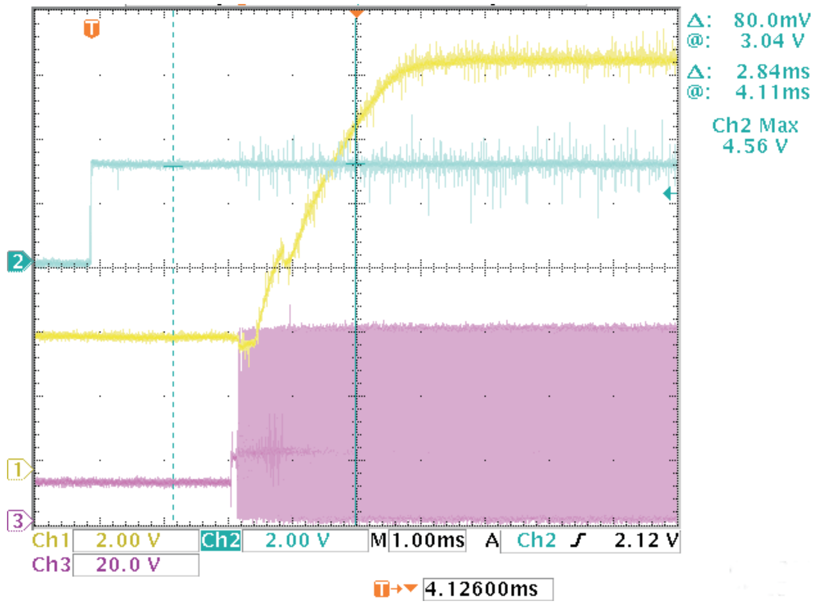


Figure 1. Paralleled Power Structure

In such a structure, a variety of combinations of supplies being on and off could be possible. Further, there could perhaps be some intelligent order needed in how the supplies turn on. Regardless, it can be seen that some or all of the supplies will experience a turn on condition where there is already some voltage present on the output. This structure can be impractical for some power-supply controllers because having this pre-biased output voltage can cause startup glitches, output overshoot, or false shutoffs that result in the controller not starting at all. “Glitching”, or non-monotonic voltage rise, can occur from the control system undershooting or overshooting due to the presence of the pre-existing output voltage. An example of this can be seen in Figure 2.



Ch. 1 = Output Voltage of Supply (4 V Pre-bias on a 12 V Output)

Ch. 2 = Enable Signal to the controller IC

Ch. 3 = An output signal from the controller IC

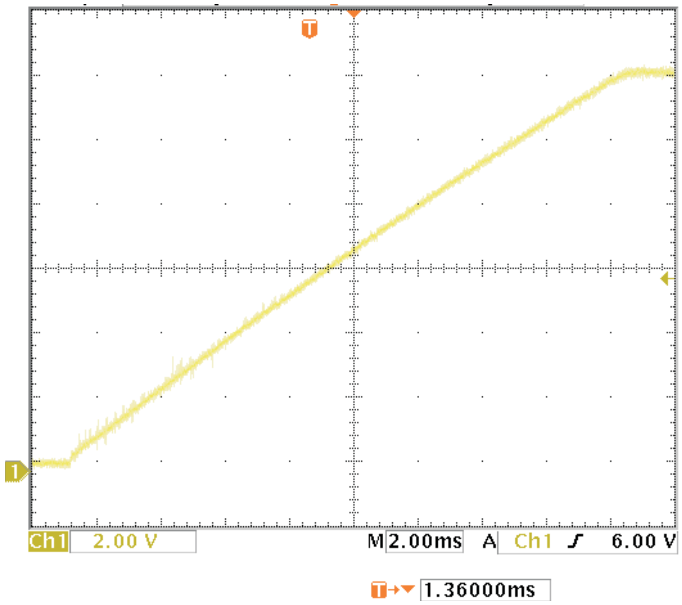
Figure 2. Example of the Problems of Pre-biased Output Voltage Startup with Some Power-Supply Controllers

From Figure 2, after this controller (in a supply with synchronous rectifiers) is enabled to startup, the output (starting at 4 V pre-bias) undershoots, rises, glitches, and then finally rises to its 12 V set-point. This 12-V example was used for illustration, but similar behavior might be observed at lower voltages required for microcontrollers and DSPs.

1 Pre-bias Output Voltage Startup of the Texas Instruments UCC28950 Phase-Shifted Full-Bridge Controller

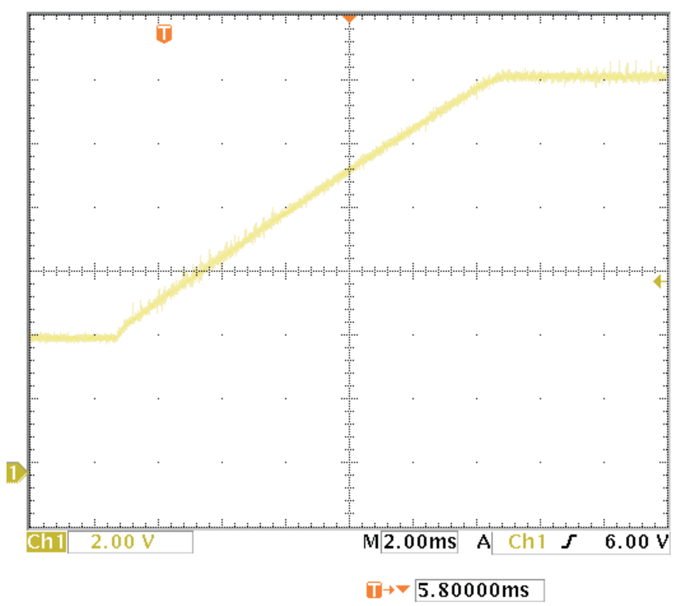
One of the power-saving features of the UCC28950 is the ability to shutoff the gate drive output signals OUTE and OUTF (going to the synchronous rectifiers) at low output currents determined by the user and set by programming the voltage at the DCM pin. When the current sense CS pin voltage is lower than the user-programmed threshold at the DCM pin, OUTE and OUTF are shutoff and the synchronous MOSFETs function as diodes.

Since a pre-bias startup condition is with no load current being drawn, the DCM feature ensures the synchronous rectifiers function as diodes during a pre-biased startup. As such, negative current flow is prevented. (This differs from when the synchronous rectifiers are still being actively driven and function as bi-directional short-circuits, causing negative current flow back into the supply and thus can result in undershoot and glitching (and possible damage to the IC). This smooth startup of the UCC28950 is demonstrated in the figures below: (Note that the pre-biased output voltage was added to the output by connecting an external supply through a diode to the output of the UCC28950EVM. Also note that these test waveforms are with 0 A load current and a 12 V bias to the UCC28950.)



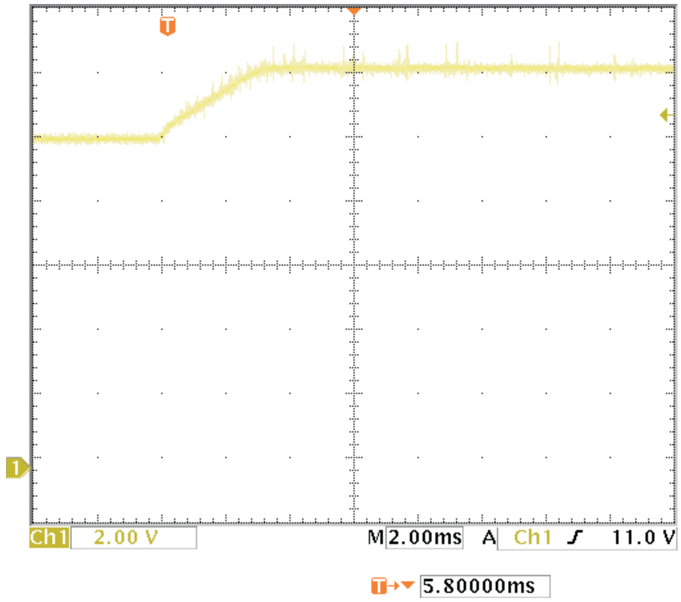
Ch. 1 = Output Voltage of Supply (0 V Pre-bias on a 12 V Output)

Figure 3. 12 V Output Waveform Startup with No Pre-biased Output Voltage



Ch. 1 = Output Voltage of Supply (4 V Pre-bias on a 12 V Output)

Figure 4. 12 V Output Waveform Startup with 4V Pre-biased Output Voltage



Ch. 1 = Output Voltage of Supply (10V Pre-bias on a 12V Output)

Figure 5. 12 V Output Waveform Startup with 10 V Pre-biased Output Voltage

2 Conclusions

It has been demonstrated that the Texas Instruments' UCC28950 Phase-Shifted Full-Bridge controller can maintain a smooth startup during the condition where an output voltage is already present. This provides flexibility to the power supply designer to which applications they can use the UCC28950 and its advanced efficiency saving features and prevents having to add additional circuitry or make concessions on other performance characteristics to maintain an ideal startup.

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