Technical Article

A Simple Six-channel Power-rail Sequencing Solution

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Multichannel power-up and power-down sequencing has become a necessity in many power-supply systems. As the complexity of these systems increase, engineers must design for tighter timing specifications, power down in the reverse sequence, and handle a greater number of power rails.

The LM3880/LM3881 simple power-supply sequencer offers a simple and precise method to control the power-up and power-down sequencing of three independent power supplies – although with the complexity of power-supply systems today, three-channel sequencing may not be enough. So for systems that require sequencing more rails, you can cascade two LM3880/LM3881 devices for six-channel power sequencing. In this blog post, I'll discuss how to cascade these devices for this application.

1 X LM3880 for Three-channel Sequencing

The LM3880 is typically used for power-up and power-down sequencing of three power supplies and provides a very simple solution with precise timing capability over a wide temperature range. This is especially important when the reverse sequence is required during power down, a requirement found in many microprocessors and field-programmable gate arrays (FPGAs). Figure 1 shows an example use of the LM3880 to correctly power-sequence the V_{CORE}, V_{IO} and V_{AUX} rails of an FPGA in the correct order, both during power up and power down.

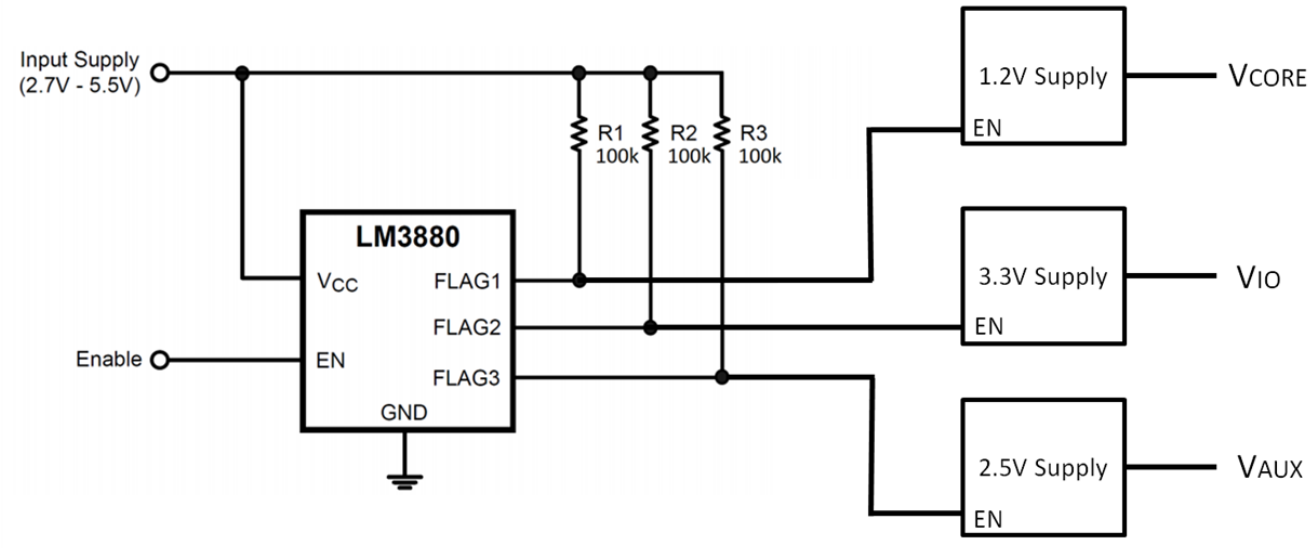

Figure 1. Three-channel Power-supply Sequencing with the LM3880.

Figure 2 shows the timing diagram during power up and power down. In this example, the three FPGA supplies will be enabled starting with V_{CORE} with 30ms of time in-between, and powered down in the reverse order, starting with V_{AUX}. What engineers often overlook is that the reverse power-down order is just as important as the power-up order to prevent spurious current paths, for example, through internal P-N junctions of an FPGA. Therefore, proper sequencing will increase the longevity of the end product and improve product reliability.

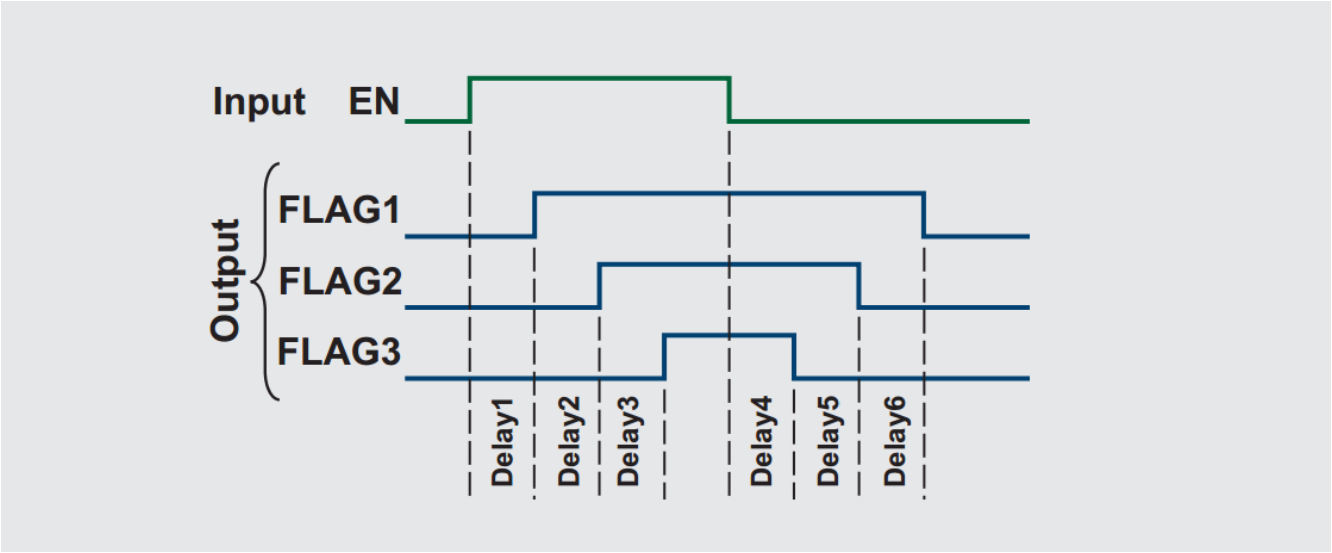

Figure 2. Three-channel Timing Diagram.

2 X LM3880 for Six-channel Sequencing

What about applications that require more than three rails? Is there a simple way to sequence these systems? Thankfully, there is! You can cascade two LM3880 integrated circuits (ICs) to enable six-channel power-up and power-down sequencing with only an external AND gate and OR gate. Figure 3 shows a simplified example of this, with the pull-up resistors omitted for simplicity.

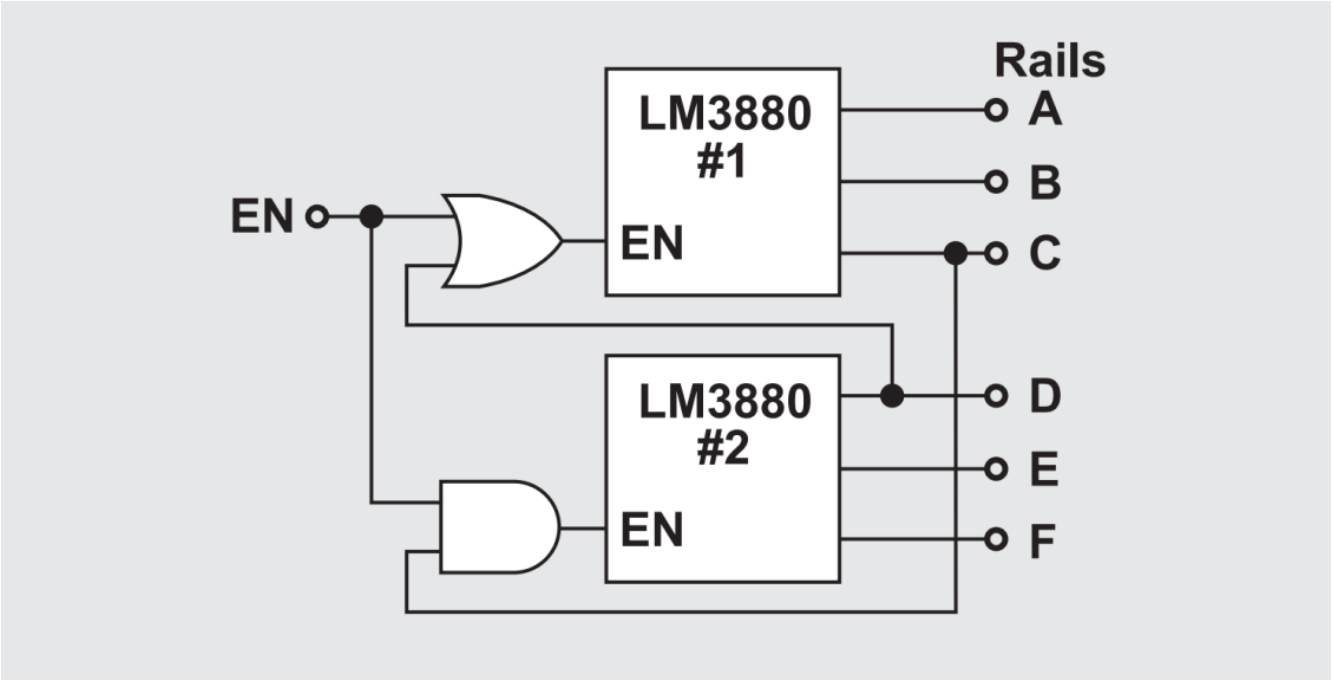

Figure 3. Six-channel Power-supply Sequencing with 2 X LM3880.

How Does the Cascading Scheme Work?

Upon power up, the OR gate ensures that LM3880 No. 1 is triggered with the EN rising edge and rails A, B and C begin powering up in order. The AND gate ensures that LM3880 No. 2 does not trigger until it has received both an EN signal and rail C has triggered.

On power down, the AND gate ensures that LM3880 No. 2 sees the EN falling edge and rails F, E and D powering down in order. The OR gate ensures that the first sequencer can't see the EN falling edge until D has fallen.

Key Design Considerations for the Cascading Scheme

When deciding on the AND gate and OR gate, here are some key considerations:

- The AND gate and OR gate outputs should be able to swing high enough and low enough such that the EN threshold of LM3880 can be triggered on both the rising and falling edge.
- It is ideal to use the same supply for both LM3880 ICs, as well as the AND gate and OR gate.
- The flag outputs of the LM3880 ICs must be able to trigger the AND gate and OR gate inputs on both the rising and falling edge. This means that when picking the AND gate and OR gate, you must consider their input thresholds and any hysteresis they have and ensure that the logic levels of the LM3880 flag outputs can trigger the input thresholds of the logic gates.

For the reasons I've mentioned, the LM3880 simple power-supply sequencer provides an easy-to-use and accurate solution to sequence up to six power-supply rails. With today's very tight timing requirements and the need for reverse power-down sequencing, there is no simpler solution.

Additional Resources:

- For a complete test report, which includes test waveforms and complete schematics, see the Simple 6-Channel Power Supply Sequencing Reference Design for Multi-rail Outputs TI Designs reference design, which highlights the use of the LM3880 for six-channel power sequencing.
- Quickly create a complete sequencer design with WEBENCH® Power Designer:
  - LM3880 for three-channel sequencing
  - LM3880 for six-channel sequencing

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