Power Supply Linear Sequencing Using the ispPAC-POWR604

May 2003 Application Note AN6053

Introduction

The ispPAC®-POWR604 is a reduced-cost addition to Lattice Semiconductor's family of mixed-signal power-supply manager ICs. The ispPAC-POWR604 is useful in cost-sensitive applications requiring simple control logic and which do not require the high-side MOSFET drive capabilities of the ispPAC-POWR1208. Table 1 summarizes and compares the total resources available on each of these devices. Where the full resources of the ispPAC-POWR1208 are not required, the ispPAC-POWR604 can often be an economical alternative in many designs.

Table 1. Resource Comparison Between ispPAC-POWR604 and ispPAC-POWR1208

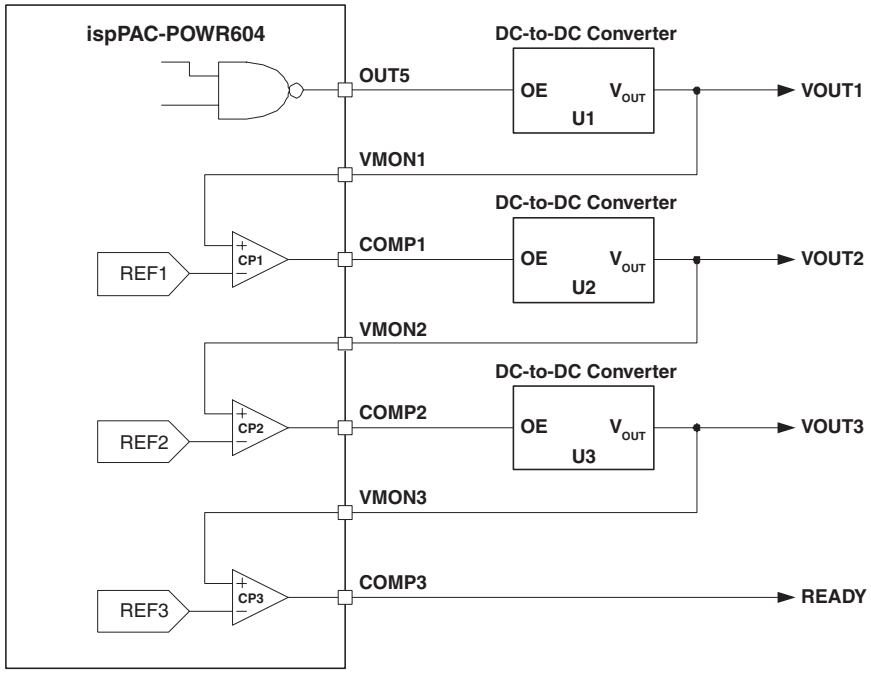
Feature	ispPAC-POWR604	ispPAC-POWR1208
Analog Inputs/Comparators	6	12
Digital Inputs	4	4
Logic Macrocells	8	16
Timers	2	4
Logic Outputs	4	8
Hi-V MOSFET-driver Outputs	0	4

While complex power supply sequences can be implemented using the state machine capabilities of either the ispPAC-POWR604 or ispPAC-POWR1208, it is often possible to implement simple, self-timed turn-on sequences using just the programmable comparators, leaving logic resources free for other purposes. This application note will describe how the ispPAC-POWR family's programmable comparators can be used to implement simple linear sequences for turning on modular DC-to-DC converters.

Implementation

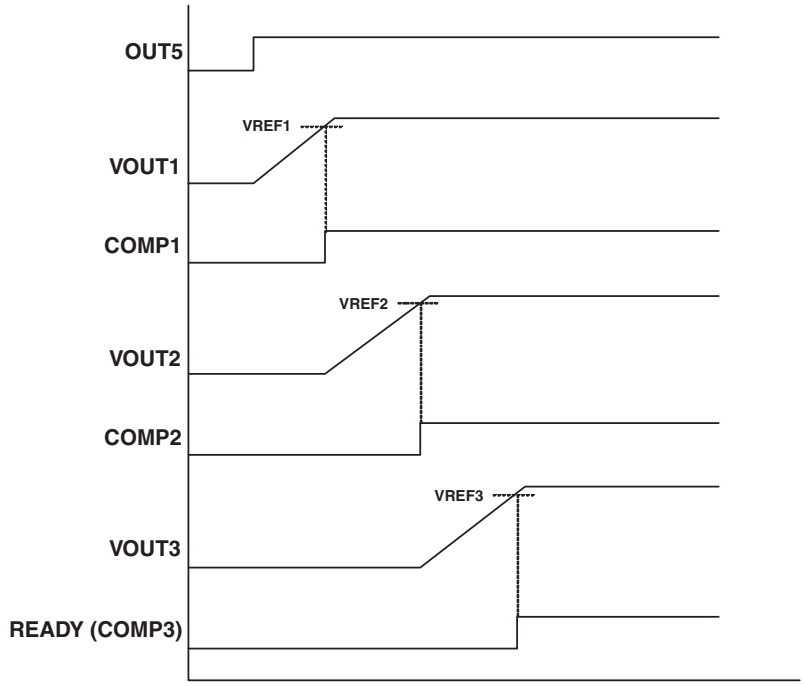
In cases where several converters need to be turned on in a specific order, it is possible to implement a simple sequencer using the ispPAC-POWR604's programmable comparators, as shown in Figure 1. In this scheme, the first converter U1 is turned on in response to a HIGH output on OUT5. Alternately, it could be allowed to come up on its own when power is applied to its inputs. Comparator CP1 then monitors its output, and triggers when U1's output voltage (VOUT1) exceeds the VREF1 trip-point. This event turns on the second converter U2. This converter is in turn monitored by another one of the ispPAC-POWR604's comparators (CP2) which turns on converter U3 when it sees a sufficiently high voltage. A final comparator (CP3) may be used to generate a READY signal to indicate that all converters have been turned on.

Figure 1. Sequencing DC-to-DC Converters with the ispPAC-POWR604 Comparators



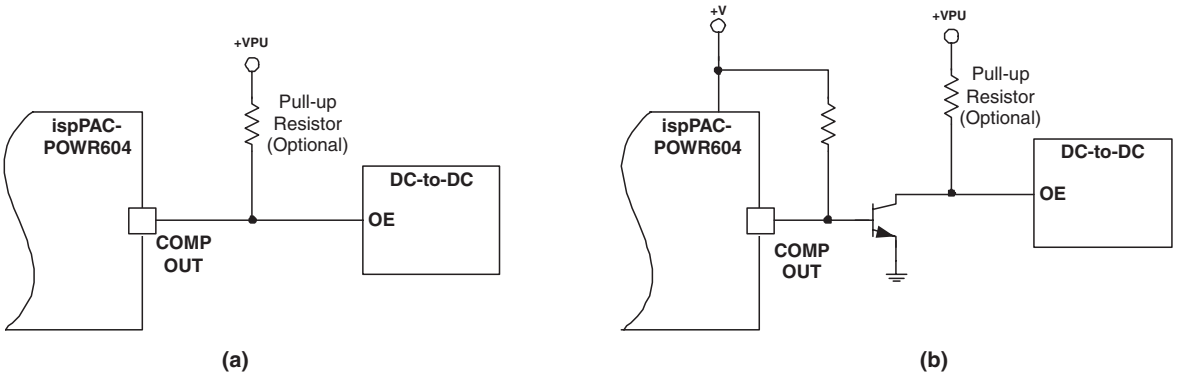
While the order in which the converters turn on is determined by the interconnection of comparators and converters, the actual timing is dependent on both the levels of the various references and the response of the converters themselves. This results in a self-timed system, where the actual turn-on response (Figure 2) will adapt to the behavior of the components used. One consequence of self-timing is that one does not need to insert artificial delays to account for the worst-case (slowest) behavior of the system's individual components.

Figure 2. Timing Behavior of Figure 1 Circuit



While the example shown in Figure 1 assumes that all of the converters turn ON in response to an open input and OFF in response to a pulled-down input, it is straightforward to interface to supplies with other input characteristics. For example, a positive-logic, logic-level input converter (turns ON in response to a logic HIGH input) would typically need a pull-up resistor (Figure 3a) to turn on. Negative-logic controlled converters (those turned ON by a low input signal) can be controlled by the interface circuit shown in Figure 3b. Note that depending on the converter's control requirements, the pull-up resistor may not be required. For more information on interfacing to DC-to-DC converters, please refer to Lattice application note AN6046, *Interfacing the ispPAC-POWR1208 with Modular DC-to-DC Converters.*

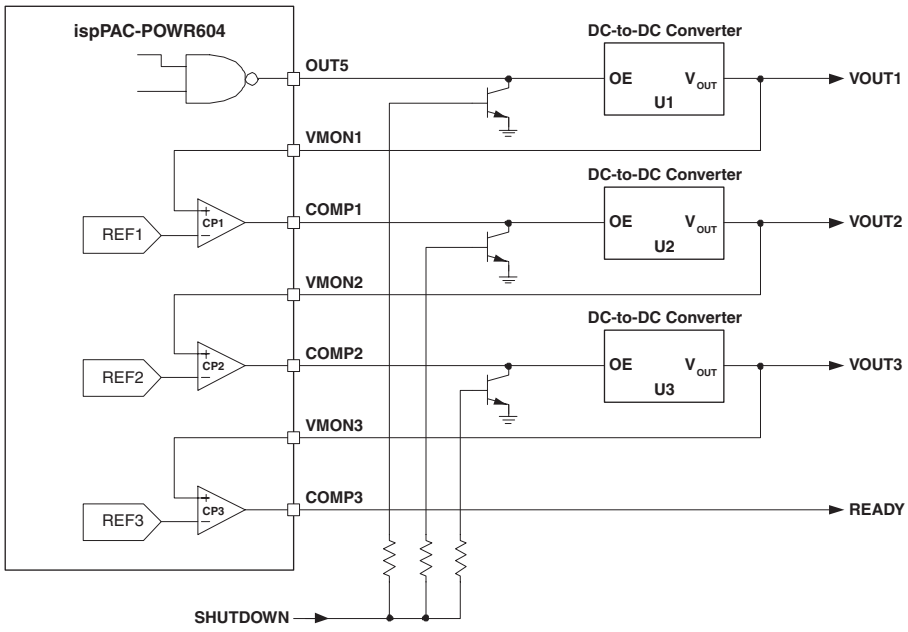
Figure 3. Circuits for Converters Needing an Input Pull-up (a) and Negative Logic (b) Interfaces



The turn-off sequence for the circuit of Figure 1 is the same as the turn-on sequence, and may be initiated by bringing OUT5 LOW. The converters will then proceed to turn off in the order in which they turned on. When the last converter begins to shut down the READY line will go LOW.

In cases where this default sequence is not acceptable, it is possible to disable all of the converters simultaneously by adding a few external transistors in parallel with the comparator outputs, as shown in Figure 4. Bringing the SHUTDOWN line HIGH turns all of the transistors on and pulls down all of the converter OE inputs, shutting them down. This circuit is useful in situations where all power supplies must be brought down simultaneously, such as when an emergency shutdown function is required. This technique can also be used in cases which require additional interface circuitry, such as that shown in Figure 3a and 3b.

Figure 4. Shutting All Converters Off Simultaneously



When using the supply sequencing technique described in this application note, special attention must be paid when programming the device in-system, because the comparator output states may be unstable during the programming cycle. This problem can be completely avoided either by pre-programming the parts before assembling them onto the board or by powering up only the ispPAC-POWR604 for the programming operation. For details on how to selectively power the ispPAC-POWR604 device for in-system programming, please refer to AN6047, *Powering Up and Programming the ispPAC-POWR1208.* The techniques described in this application note are also suitable for use with the ispPAC-POWR604.

Conclusion

Simple linear turn-on sequences for DC-to-DC converters can be implemented using the ispPAC-POWR604's programmable comparators. This technique requires minimal use of the device's internal logic resources, freeing them for other supervisory and control tasks. This application note has shown an example of how this technique can be applied, and has also described some simple interface circuits for interfacing to negative-logic controlled converters and for shutting down groups of converters simultaneously.

Related Literature

- ispPAC-POWR604 Data Sheet
- ispPAC-POWR1208 Data Sheet
- Application Note AN6046 - *Interfacing the ispPAC-POWR1208 with Modular DC-to-DC Converters*

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