

# POWER SEQUENCING AND SOFT-START

*Some chips need their rails to come up in order, and slamming every rail on at once can latch up. What sequencing and soft-start do, and when a board needs them.*

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Some chips insist their power rails arrive in a particular order, and a board that switches every rail on at once can latch up or surge. Sequencing brings the rails up in the right order; soft-start brings each one up gently. Together they make a multi-rail board turn on cleanly.

## WHY THE ORDER MATTERS

A part with more than one rail, an FPGA or a processor with a separate core and IO supply, often specifies which rail must come up first. Power the IO before the core, or the other way when the datasheet demands it, and internal protection diodes can conduct or the chip can latch into a stuck, high-current state. The datasheet's sequencing requirement is binding.

## THE LATCH-UP AND SURGE RISK

Latch-up is a parasitic path inside a chip that, once triggered by a bad rail order or an overshoot, shorts power to ground until you remove power entirely. Even short of a full latch-up, slamming several rails on together stacks their inrush surges into one big spike. Sequencing and soft-start defuse both.

## SOFT-START: RAMPING A RAIL UP

Soft-start ramps a regulator's output up smoothly over a few milliseconds instead of stepping it on instantly. The gentle ramp limits the inrush into the downstream capacitors and gives the rest of the board time to react. Many regulators have a soft-start pin or a fixed internal ramp for exactly this.

$$V(t) = V_{\text{final}} \times (1 - e^{-t/RC})$$

## SIMPLE WAYS TO SEQUENCE

You do not always need a dedicated sequencer chip. A common trick is an enable chain: the first regulator's power-good output enables the second, which enables the third, so they come up in order by construction. An RC delay on an enable pin staggers a rail by a set time. A board with tight requirements uses a purpose-built sequencer, but many get by with an enable chain.

RAILS COME UP IN ORDER, EACH WITH A GENTLE SOFT-START RAMP RATHER THAN AN INSTANT STEP.

**DEEP DIVE · SEQUENCING ON THE WAY DOWN MATTERS TOO**

Bringing rails up in order is only half the job. Some chips are just as unhappy if their rails collapse in the wrong order at power-off, with the same latch-up or back-feed risk as a bad turn-on. A careful design sequences the shutdown as well, holding one rail up until another has safely drained, often by reversing the enable chain. When a datasheet gives a power-up order, check whether it also specifies a power-down order, because ignoring the second can be as damaging as ignoring the first.

- [Texas Instruments. Power supply sequencing overview \(sequencers, enable chains, power-good\).](#) ti.com

**CHECKPOINT****1. What problem does power sequencing avoid?**

- Rails coming up in a bad order, risking latch-up or a surge**
- A regulator running above its rated temperature
- Excess ripple on a single rail

ANSWER · A

*Some chips require a rail order; violating it can latch the chip up or stack inrush surges.*

**2. What does soft-start do to a rail?**

- Clamps the rail to a lower final voltage
- Ramps it up gently instead of stepping it on instantly**
- Raises it above its rated voltage

ANSWER · B

*The smooth ramp limits inrush and gives the rest of the board time to react.*

**3. A simple way to sequence rails without a dedicated chip is what?**

- Adding more decoupling capacitors
- Raising every rail's voltage together
- An enable chain, where one rail's power-good enables the next**

ANSWER · C

*Chaining enables, or an RC delay on an enable pin, orders the rails by construction.*

- Prerequisite: power rails and a power budget
- Next: measuring power and battery runtime