CircuitClarity RESOURCE

Power-converter design workflow

https://circuitclarity.com/resources/power-converter-design-workflow/

The decision this guide supports

A converter is a system, not an inductor formula. The useful sequence begins with source and load envelope, then carries duty, ripple, stress, loss, thermal, control, layout, and protection through to validation.

A useful calculation is not the finish line. It becomes useful when its method, units, source conditions, and omitted effects fit the actual design question. Use this reference to identify that boundary before treating a nominal result as an implementation decision.

DECISION MAP

From first estimate to defensible next step

1. **Define source, load, regulation, and transient envelope.**
   Start by naming the physical quantity, operating condition, and decision at stake. A number without that context cannot establish a design margin.

2. **Select a topology and calculate a first-pass power stage.**
   Keep this check explicit. It separates a useful first-pass model from an answer that only looks precise.

3. **Check component stress, loss, thermal, and control requirements.**
   Keep this check explicit. It separates a useful first-pass model from an answer that only looks precise.

4. **Validate layout, startup, protection, stability, and transient behavior.**
   Treat this as the handoff point. Compare the result with selected-part evidence, the real layout or assembly, and a measurement method that can reveal the remaining uncertainty.

Worked design review

Consider a designer using this method to make a first selection. The initial estimate establishes the nominal target, but it should not silently absorb a rating, curve, parasitic, temperature condition, or measurement setup from a different scenario. The correct outcome is often not a single chosen value: it is a short list of conditions that must be satisfied together.

Begin with the first two steps above, then ask whether the value still fits when the most consequential real-world condition changes. If it does, the estimate has earned a more detailed check. If it does not, the discrepancy identifies the design variable that deserves attention before a board, part, or test plan is committed.

> **Practical interpretation**
>
> Ideal CCM equations do not design compensation, layout, EMI, protection, or component qualification. That is not a weakness in the method. It is the cue to use the correct next source of evidence.

Questions to take into a design review

Has the power stage been checked at the lightest expected load, where DCM behavior is most likely, not just at full load?

Is there a separate loop-compensation analysis, not just an ideal power-stage calculation, backing the stability of this design?

Have startup inrush and worst-case load-transient corners been validated, not just the steady-state operating point?

These questions prevent a common failure mode: moving a correct equation into a context where its assumptions no longer hold. They also make it easier for another engineer to reproduce the reasoning and identify which condition needs more evidence.

Common ways this reasoning goes wrong

Sizing the power stage without checking DCM behavior at light load

Many converters cross into discontinuous conduction mode well before zero load. A power stage and control loop validated only for full-load CCM operation can behave very differently, including instability, at light load.

Treating loop stability as automatically satisfied by an ideal power-stage calculation

The power-stage equations set component values; they do not analyze loop gain, phase margin, or compensation network design, which is a separate control-theory step.

Skipping the startup and transient-load corners in validation

A converter that regulates cleanly at steady-state load can still fail during startup inrush or a large load-step transient if those corners were never separately checked.

Where this guide stops

Ideal CCM equations do not design compensation, layout, EMI, protection, or component qualification.

For a consequential design, preserve the inputs and conditions used here, then compare them with the selected component or system evidence. That makes the follow-up review faster and keeps a useful first estimate from becoming an unsupported claim.

Frequently asked questions

▶ **Why does my converter work in simulation but oscillate on the bench?**

▶ **Do I need a different power-stage design for CCM versus DCM operation?**

▶ **How much design margin should I add to a first-pass loss and thermal estimate?**

Related engines

Buck converter design workspace

Boost converter design workspace

- Inverting buck-boost designer
- Non-inverting buck-boost planner
- Flyback first-pass stress estimator
- LDO power and thermal planner
- Switching versus linear regulator comparison
- Converter efficiency and loss budget
- Hot-swap MOSFET stress planner
- Ideal-diode ORing planner
- Power multiplexer priority planner
- Charge-pump voltage and ripple estimator
- Constant-current LED driver planner

Method authorities and source conditions

Use this guide alongside the engine-specific method and selected component or system data. The underlying reference families are TI power design references. Those sources establish condition-specific behavior; CircuitClarity uses them to frame the decision and its limits.