Technical Article

How to Approach a Power-Supply Design – Part 1

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Switch-mode power-supply design can be a mysterious thing if you do not know how and where to start, because there is a great variety of topologies and controller types from which to choose. In this blog series I will describe how to pick the most fitting power supply topology for your application and what you need to know to get there. The best starting point is usually a dedicated specification for your application. This specification should at least include information about the input-voltage range, output voltage and maximum load current. However, choosing the best-fitting topology and/or system solution will be easier if you can also answer some of the subsequent questions:

- Does your application need an isolation barrier between the input and the output? If yes, which insulation level do you need? Do you want to achieve your output-voltage regulation with primary- or secondary-side regulation?
- Is your power supply intended for DC-to-DC or for AC-to-DC conversion? Additional helpful information regarding the input can include the maximum in-rush current, the maximum input current and the maximum acceptable reflected ripple.
- What is the output power range for your application? In many cases, this information will decrease the number of usable topologies and controllers. Your specification should also include requirements for the power supply's output-voltage tolerance, maximum acceptable output-voltage ripple, average output current and peak output current. Additional demands for dynamic behavior like load regulation, transient response and line regulation (the latter is important for automotive cranking, for example) should also be in the specifications, because you might need to adjust your power stage accordingly to achieve them.
- What is your desired switching frequency? Do you need frequency dithering to lower peak emissions? Do you have more than one power supply in your system? If so, do the supplies need to be synchronized? For automotive applications, it is common practice to choose a switching frequency below 450kHz or above 2.1MHz to avoid interference with the AM band. For high-power applications, you might want to choose a low switching frequency for the best possible efficiency.
- What is the ambient and working temperature range? Which application segment is the design for? Are automotive or military-grade parts required?
- What is the main priority for your power supply? In general, for every power-supply design, you have to make trade-offs between performance, form factor and cost. It is important to know which of these factors has the highest priority, because it will directly impact the quality of your design.
- Does the power supply need to meet certain standards regarding efficiency, electromagnetic interference (EMI), power factor correction (PFC) or Underwriters Laboratories (UL) qualification? Is light load efficiency or a specific standby power level required?

Of course, all of this information is not always necessary. The more detailed your power-supply specification is, however, the easier it is to pick the best-fitting topology and the best performing components.

The most common switch-mode power-supply topologies are:

- Buck
- Boost
- Inverting buck-boost
- Single-ended primary-inductance converter (SEPIC)
- Ćuk
- Zeta
- Flyback
- Two-switch flyback
- Active-clamp forward

- Single-switch forward
- Two-switch forward
- Push-pull
- Weinberg
- Half bridge
- Full bridge
- Phase-shifted full bridge

These topologies are supported by TI's Power Stage Designer 3.0 tool.

Table 1 summarizes the most common parameters for power supply specifications.

Table 1. Summary of Helpful Specification Parameters

Input	• DC/DC or AC/DC • Voltage ripple • In-rush current
Output	• Voltage tolerance • Voltage ripple • Average current • Peak current • Transient response • Load regulation • Line regulation
Isolation	• None • Functional • Reinforced • Double • Safety category
Priority	• Performance • Form factor • Cost
Switching frequency	• Range • Synchronization • Dithering
Standards	• EMI • PFC • UL • Efficiency • Light load efficiency • Standby power

In my next post, I will describe how to pick the most fitting topology based on the parameters of your specification.

Additional resources:

- Take a look at the Powerstage Designer tool.
- Visit the training portal for more topology training.
- Check out the next post in this series: How to approach a power-supply design - part 2

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