Application Brief

How to Approach a Power-Supply Design – Part 1

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Switch-mode power-supply design can be a mysterious thing because there is a great variety of topologies and controller types from which to choose. This application brief series describes how to pick the most fitting power supply topology for an application and the knowledge needed to get there. The best starting point is usually a dedicated specification for the application. This specification should at least include information about the input-voltage range, output voltage, and maximum load current. However, choosing the most fitting topology, system design, or both is easier if some of the subsequent questions can be answered:

- Does the application need an isolation barrier between the input and the output? If yes, which insulation level is needed? Can the output-voltage regulation be achieved with primary- or secondary-side regulation?
- Is the power supply intended for DC-to-DC or for AC-to-DC conversion? Additional helpful information regarding the input can include the maximum inrush current, the maximum input current, and the maximum acceptable reflected ripple.
- What is the output power range for the application? In many cases, this information decreases the number of usable topologies and controllers. The specification should also include requirements for the output-voltage tolerance of the power supply, 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) must also be in the specifications, because the power stage sometimes needs to be adjusted accordingly to meet the specifications.
- What is the desired switching frequency? Is frequency dithering needed to lower peak emissions? Is there more than one power supply in the system? If so, do the supplies need to be synchronized? For automotive applications, choose a switching frequency below 450 kHz or above 2.1 MHz to avoid interference with the AM band. For high-power applications, 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 commercial, automotive, military, or space-grade parts required?
- What is the main priority for the power supply? In general, for every power-supply design, trade-offs are made between performance, form factor, and cost. Know which of these factors has the highest priority, because these factors directly impact the quality of the 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?

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

The most common switch-mode power-supply topologies are included in the following list:

- 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
- LLC Half-Bridge
- Push-pull
- Weinberg
- Half bridge
- Full bridge
- Phase-shifted full bridge
- LLC Full-Bridge

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

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

Table 1. Summary of Helpful Specification Parameters

Description	Parameter
Input	• DC/DC or AC/DC • Voltage ripple • Inrush 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, Spread-Spectrum
Standards	• EMI • PFC • UL • Efficiency • Light load efficiency • Standby power

Part 2 of this series describes how to pick the most fitting topology based on the parameters of the specification.

Additional Resources

- Power Stage Designer™ software tool
- Visit the training portal for more topology training
- See the next application brief in this series: *How to Approach a Power-Supply Design – Part 2*