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How to spec a reliable custom power supply

5 secrets not to keep from your vendor

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When reliable power matters – such as in commercial, industrial and medical systems – even the most careful designers fail to include some essential information in their power supply specification. Here are five tips for specifying a reliable power supply unit (PSU) with the right balance of performance and cost for your application.

1 What is the *real* operating temperature?

Consider your system's mechanical packaging and location in order to understand the *real* operating temperature you need to specify. One of the most common errors is to use the expected ambient as the operating temperature. However, the "local ambient" at the PSU is usually higher.

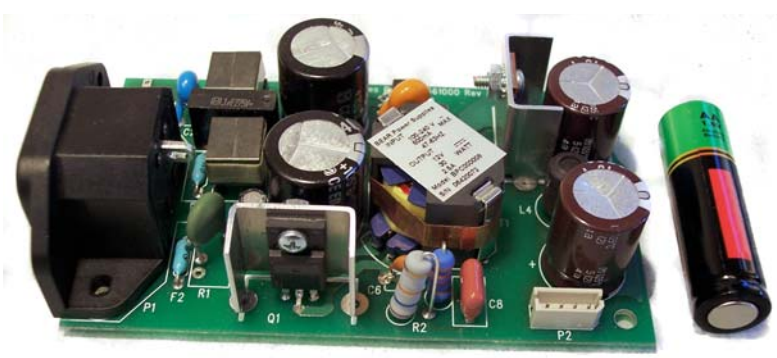
For example, it is not uncommon for the temperature in an un-vented plastic enclosure (commonly used in outdoor, factory and medical settings) to be 20°C hotter than the ambient outside the box. You can estimate the actual temperature by connecting a bench supply to a resistive load that will dissipate power equal to the expected load plus PSU efficiency losses. Place the load in a mock-up of your enclosure and use a thermocouple to measure the temperature rise.

Similarly, designers of rack-mounted equipment must consider that the temperature on the top rack will be higher than on the bottom rack, which will be higher than the ambient. In this case you will need to specify the top-rack temperature for all PSUs.

2 What type of load will you have?

Will you have reactive loads or large ripple currents? Some load types to watch out for include motors (inductive sine waves), digital logic that is poorly filtered, or DC/DC converters (which tend to pull short, large current pulses from the AC/DC supply).

High-reactive loads may require special PSU design considerations to ensure proper start-up, overshoot and stability. For example, one BEAR customer requested a 1-watt 200-volt PSU and specified the ripple voltage with a 0.1 µF load. The PSU, designed for a 0.1 µF load, failed to start in the system. A discussion of the complete system design revealed



Since this power supply is used in an un-vented plastic enclosure, the specified operating temperature is much higher than the ambient hospital room temperature.
(Photo by BEAR Power Supplies)

a 10 μF capacitor on the load. A large capacitance on the load demands a large amount of energy from the PSU to charge the capacitor on start-up. The problem was resolved by implementing a “soft start” in the PSU to ramp up the output voltage more slowly (over 50 msec rather than 1 msec).

Most engineers spec the ripple voltage allowed on the power supply output. Few specify the ripple current that their system will draw from the PSU. It is important to specify the peak current, not just the average current, to be drawn. Pulling a steady 1-amp current from a 1-amp power supply is much different than pulling 2 amps half the time. Drawing a larger current than the PSU is designed for causes excess heating and shortens the lifetime of the internal capacitors.

3 How long do you expect the PSU to last?

Expected lifetime separates consumer-grade PSUs from commercial- and industrial-grade units. For commercial applications such as telecom and radar systems, a 10-year life expectancy is typical – compared to a three-year life for a personal computer.

The most common MTBF standards describe temperature-controlled, humidity-controlled test environments without shock and vibration. A PSU with good MTBF in these conditions may fail rapidly in a harsher, “real-world” environment. So while expected lifetime can be difficult to specify in hard numbers, you should include life expectancy in your RFQ as a guide to the level of quality you need.

Your expectations will directly drive the cost. Power supplies designed for long life will incorporate more expensive components, such as high-ripple-current capacitors and larger heat sinks. These components will greatly improve the life of the power supply and can also improve efficiency.

4 How clean is the input line voltage?

Most input voltage specs state universal input (90 to 264 volts) or the local line voltage. For outdoor and industrial applications, this may not be enough.

For example, if a system is mounted on a pole outdoors, it will be subject to high voltage transients from lightning and this should be included in the spec. Industrial systems on the same phase as large machinery can experience periodic power dips – for example, large motors and compressors can draw down the power every time they kick on, and welding machines can cause a power dip every time they strike an arc. If it will be a problem that your PSU goes out of regulation when the input voltage droops, then you should specify these low-voltage conditions.

5 In what sort of creative ways will the end user abuse the system?

The task of specifying the power supply usually falls upon an electrical engineer, who thinks in terms of volts, watts and amps – and may overlook important environmental and mechanical criteria. Companies with the resources to create detailed, formal specification documents usually include shock, vibration and temperature specs. For other companies, just quantifying the shock and vibe requirements can be a major task. Including information in your RFQ about your system’s expected end use may be sufficient.

For example, one customer requested a power supply for what appeared to be a benign indoor environment. Further discussions revealed that the system would be rolled around a warehouse on a cart, so that jolting and banging into walls could be expected. While a formal shock and vibration specification would have been overkill, this end-use information allowed us to recommend potting or conformal coating to prevent loosening of components inside the PSU.

Knowledge is power

It can be difficult to quantify and specify every electrical and mechanical detail for a PSU. When buying a high-reliability power supply, covering these five points will allow you to avoid the most common pitfalls.

Finally, by including as much information as possible in your RFQ about your intended application and environment, you will improve your ability to get a PSU with the right balance of performance and cost for your application.

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