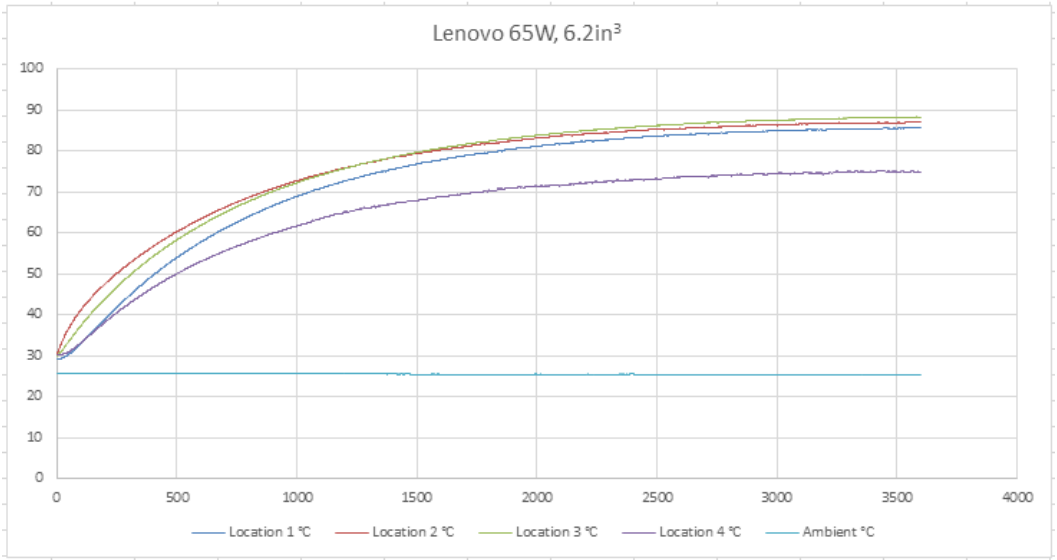
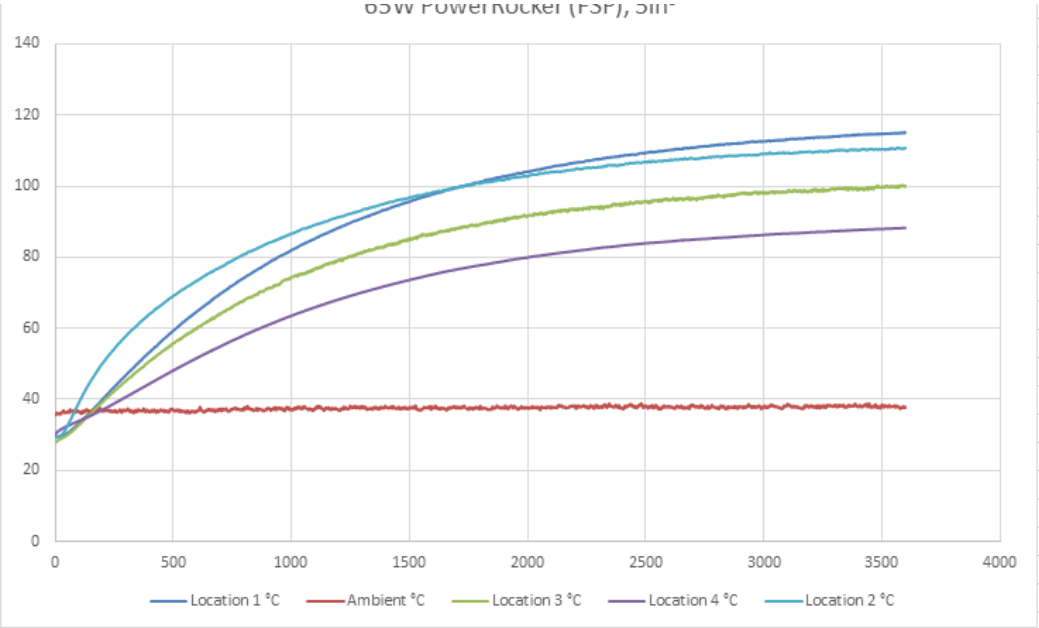
MAKING SMALL, SAFE & ELEGANT POWER SUPPLIES

BULKY OR UNSAFE – THE CHOICES TODAY

Today's consumer devices are smaller and sleeker than ever before. But the AC-DC power supplies that are used to power our sleek laptops and phones still remain bulky and add a significant amount of weight and volume to the load an average person carries around each day. There is very strong demand for smaller, lighter power supplies, but fundamental problems remain to be solved. To meet this demand, products have been created that skirt and sometimes outright violate basic safe operating standards. Here are examples of a couple of such products.



The picture above shows temperature measured at the outer case of a 65W laptop power adapter. After one hour, the hot spots on the case have risen to just under 90C or 193F! This adapter carries the brand of a well known OEM, and carries the UL safety mark.



Another laptop power supply tested under the same conditions reaches 107C or 224F ! This is well over the temperature of boiling water! This adapter was not an OEM branch, and did not carry a UL mark.

Clearly 90C and 107C are close to or beyond the temperature of boiling water and will be very uncomfortable or just plain unsafe to touch!

The adapters above are considered small – about 125cc (6in3) and 80cc(5in3) respectively. Larger power supplies – about 150cc (7in3) – top out at about 65C, a temperature which is acceptable to the touch. So the consumer today must really make a choice between bulky or unsafe power adapters.

Avogy, through its Zolt brand offers Small, Safe and Elegant power supplies. This is made possible because Avogy has technology that is not available to the rest of the market today.

UNDERSTANDING SAFETY & RELIABILITY

Consumer Power Supplies such as those used for laptops convert electric power from 115V/230V AC to the 15-20V DC that's used by the laptop. There are basic safety standards that if followed by a product will prevent the risk of injury due to

- electric shock : internal voltages in a power supply can be as high as 600V. these voltages are prevented from reaching a user through a combination of minimum spacing and insulation.
- fire : high voltages can cause fire due to poor quality components, or components being operated outside their ratings of voltage, current and temperature. Breakdown of these components can cause fire.
- Skin burn : the external case is the area touched by a user, and these can cause skin burns if the external case temperature approaches 95C.

To achieve small form factors with existing technology, power supply vendors may sacrifice spacing to high voltage components (fire/shock risk), or use components with lower temperature and voltage ratings as these tend to be physically smaller (fire/shock), or operate at unsafe case temperatures (skin burn).

Safe power supplies typically carry the 'UL' mark – a sign that the supply has passed the testing criteria for safety. However, this is not a requirement for all power supplies to have, and several of the 'small' products available to the consumer simply do not pass the Safety standards. The first graph above is one such product. A power supply can still be rated safe if for example; it just stays below the maximum case temperature of 95C. However, the ambient temperature, or surrounding air has an additive effect. The second graph shows a UL passed power supply reaching 90C with an ambient of 25C (77F). On a warmer day such as can be experienced in most parts of the world of 30C(86F) the 95C limit will be exceeded.

The case temperature maximum limit of 95C notwithstanding, in user testing done at Avogy, we've determined that 70C feels borderline hot to the user. So a 90C case, while unlikely to cause lasting burn, will still cause momentary discomfort, and in the spirit of good product design, should be avoided.

HOW TO BUILD SMALL POWER SUPPLIES THAT ARE SAFE

What makes power supplies hot ? The magic word is efficiency, or the lack of it.

A power supply converts input power at a certain voltage and current to an output power at a different voltage and current. In an ideal power supply, the input and output power would be the same and the power supply's circuits would use no power at all to do the work of power conversion. Since efficiency is the ratio of output to input power, an ideal convertor has 100% efficiency. Convertors though, are not ideal, and need a certain amount of power to run the circuits. This power is eventually converted into heat dissipated by the circuit components as they operate. This heat generated in a small space causes the case of the power supply and the internal ambient within the case to rise to high temperatures. A power supply architecture with higher efficiency will require less power to operate the internal circuits, see less heat generation, and therefore not cause high temperatures.

What makes power supplies large ? The magic words here are high frequency, or the lack of it.

Power supplies are composed of capacitors, inductors, resistors and switches. Capacitors and Inductors store energy, and Switches are used to chop this energy up in interesting ways to do power conversion. Most of the internal volume of a power supply is set by the physical size of the Inductors and Capacitors used to store energy. The physical size of these components is inversely proportional to the frequency at which they operate. So if the Switch can be operated at a high enough frequency the size of the power supply can be shrunk by virtue of smaller components.

So to make small and safe power supplies, we need a high frequency switch, and a high efficiency circuit architecture. Next we discuss Avogy's TrueGaN /XX platform that uses high frequency GaN switches in combination with a high efficiency circuit architecture, to enable at a fundamental level, the change required to build small power supplies, safely.

TRUE GAN / XX POWER PLATFORM

Resonant circuits, low loss switching, waveforms showing high frequency operation.