What is the difference between power supply operating efficiency and average efficiency?

Operating efficiency and average efficiency are not measured and/or calculated using the same methodology. Both values are useful, however, and can provide a quick indication of the power supply's overall performance.

In this white paper, which is intended for electronics engineers and designers working with power systems for medical, scientific, broadcast or general industrial equipment, David Buck, Market Development Manager, TDK-Lambda, explains the difference between operating efficiency and average efficiency.

References

www.emea.lambda.tdk.com/uk//medical
www.emea.lambda.tdk.com/uk/industrial
www.emea.lambda.tdk.com/uk/cus150m

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David Buck, Market Development Manager, TDK-Lambda

Before the energy efficiency standards were introduced, the power supply product datasheet and specifications referred only to the operating efficiency. As the actual efficiency varies with the output load, input voltage and component tolerance, this is stated as either a typical or a minimum figure. The conditions are often written as “typically 93% efficient at 230Vac input, 100% load” and a stated ambient temperature, but this is likely to be a best-case scenario.

Efficiency changes with input voltage; this is primarily due to wound component and MOSFET semiconductor resistance losses (Power = Current2 x Resistance). It also reduces at lighter output loads; this is due to the internal fixed losses from the control circuitry or internal fan, and the effect of the switch-mode converter running at a narrower (sub-optimum) pulse width. The output voltage of the power supply can also impact efficiency. Different output rectification techniques, such as low loss synchronous rectification, may be used on lower output voltage models. A 12V model will have a higher current rating than a 24V or 48V model and hence higher resistance losses.

Most power supplies operate at 115V / 230Vac and are seldom run at full load. Without an efficiency curve, system designers cannot correctly predict the amount of heat that the power supply will dissipate. As the internal temperatures rise, component reliability reduces resulting in a shorter equipment lifetime. To compensate for this, a fan cooled power supply or additional system cooling fans may be used.

Figure 1 shows the effect of both load, input and output voltage on TDK-Lambda’s CUS150M AC-DC power supply series. Armed with this information, a more informed decision can be made with regard to system cooling.

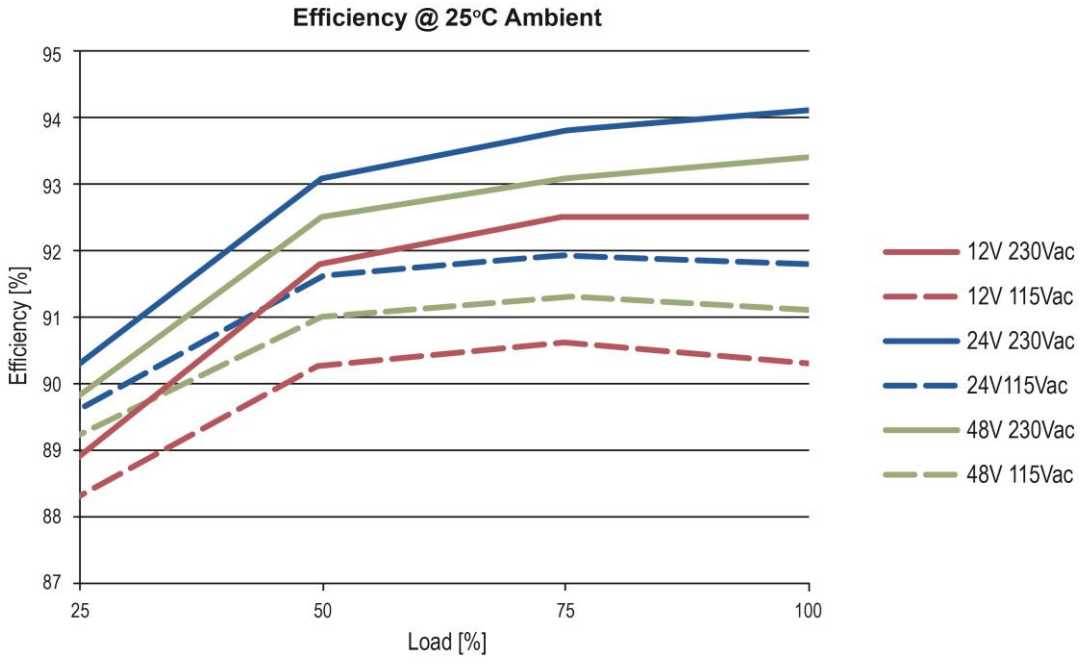

Figure 1: Efficiency versus 115/230Vac input, output voltage and load conditions

The term average efficiency was introduced when energy efficiency legislation was passed for external power supplies (desktop) used with consumer devices. A power supply for a laptop, tablet or phone charger will operate at low loads for the majority of the time once the device's battery is charged. As hundreds of millions of these power supplies are operated daily world-wide, the intent of the legislation was to ensure that energy losses were minimised.

Average efficiency is calculated by measuring the power supply's efficiency at 25%, 50%, 75% and 100% output loads. The sum of these four measurements are added together and divided by four to obtain an average efficiency figure. To comply with the latest DoE Level VI & EU Tier 2 Efficiency standards, the average efficiency for an external power supply rated between 49-250W has to be at least 89%.

Although designed for internal use and not classified as an external power supply, the average efficiency of the 24V output CUS150M operating at 230Vac is calculated to be 92.8%. The product datasheet states that the operating efficiency is up to 94% with an average efficiency of >91%, which is better than the >89% legislation requirement.

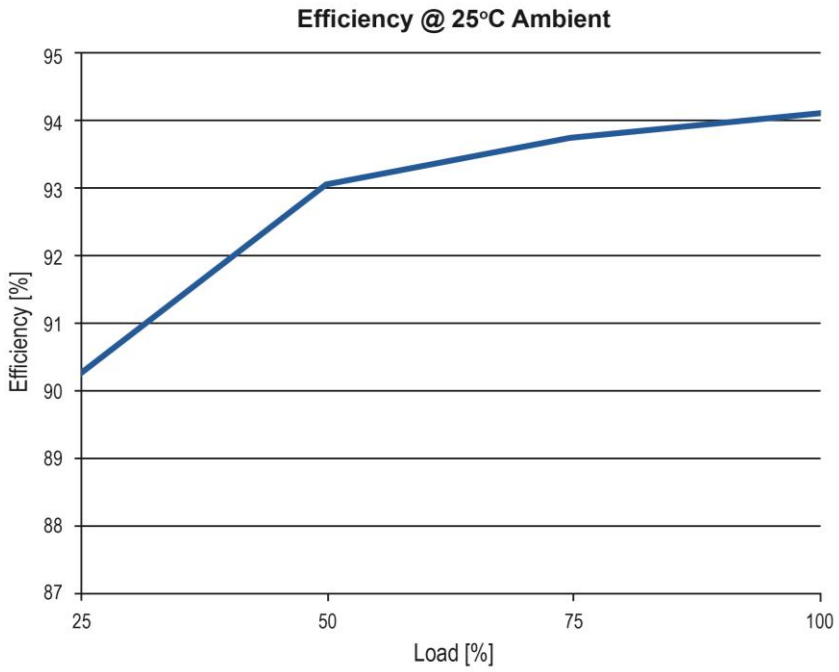

Figure 2: CUS150-24 efficiency vs load at 230Vac input

Load (%)	Efficiency (%)
25	90.3
50	93.1
75	93.8
100	94.2
Sum	371.4
Average efficiency	371.4 ÷ 4 = **92.8%**

Table 1: Average efficiency measurement load calculation

In summary, operating efficiency and average efficiency are not measured and/or calculated using the same methodology. Both values are useful, however, and can provide a quick indication of the product's overall performance. In anticipation that the scope does extend to other product types, system manufacturers are starting to specify internal power supplies that meet this legislation. An added benefit is that it also enables them to differentiate their end equipment by reducing operating costs.

For more information about medical power supplies from TDK-Lambda, please visit:

www.emea.lambda.tdk.com/uk//medical
www.emea.lambda.tdk.com/uk/industrial
www.emea.lambda.tdk.com/uk/cus150m

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