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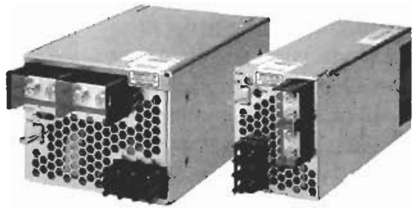
Save Costs With Peak-Related Power Supplies

Traditionally, the selection of power supplies is based upon the expected maximum total system power, calculated as volts × amps = watts. But for some applications, a power supply with a peak current or peak power rating may provide a significant cost savings. For example, if the power supply's load includes electric motors, disk drives, pumps, fans, actuators, or other components that require an initial startup current that's much higher than the steady state draw, a peak-rated power supply should be considered.

Electric motors including those in disk drives can exhibit a peak startup current that is anywhere from two to three times their normal operating current. This peak startup current may only last for 200 ms or a few seconds. Therefore, rather than size the system's power supply for the worst-case short-duration peak current, a cost-saving alternative would be to find a power supply that can handle the peak current, yet provide the normal (non-peak) system operating power.

Power supplies with peak power ratings can exceed their normal ratings for short specified durations without going into an overcurrent mode *(Fig. 1)*. For example, some power supplies can provide a peak current or power that is two to three times their normal output ratings. These types of supplies specify peak ratings for a limited time period and maximum duty cycle.



1. A typical peak-power-rated supply can exceed normal ratings for short, specific durations. Some can deliver up to three times the normal output rating.

PEAK-OUTPUT-POWER VS. PEAK DUTY-CYCLE CURVES

Figure 2 illustrates the peak-output-power versus the peak-duty-cycle curves for a typical peak-rated power supply with an output voltage of 48 V dc and 600-W average output power. The peak power duty cycle is definable as a percentage of the total operating time.

With an input voltage of 220 V ac, from the solid-line curve in Figure 2, we can see that if we needed to pull 1800 W of peak output power (three times the rated power) from this supply, we would be limited to a bit more than a 10% duty cycle.

Also in this example, from its datasheet, we know that this supply has a maximum peak power pulse width of 5 s. When using high-peak-power supplies, it is necessary to operate the supply below its continuous output power rating before the next peak-power pulse is drawn. This is necessary to avoid exceeding the average-power rating, which in this case is 600 W.

As another example from the solid-line curve in Figure 2, we can see that if our system needed a 35% peak-power duty cycle, the maximum output power would be limited to 1300 W, which is still more than twice the normal rated power. In many applications, it is not difficult to stay within the peak-power constraints of this type of power supply, and the resulting cost savings can be significant.

PEAK, NON-PEAK, AND AVERAGE POWER CONSIDERATIONS

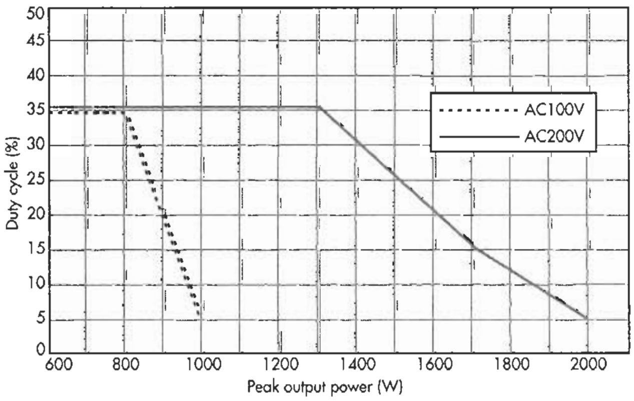
When using a peak-power-rated supply, we must take care not to exceed its specified average output power rating. Figure 3 shows a typical peak output power pulse waveform. Equation 1 below can be used to determine α, which is the available non-peak power from a peak-rated supply when driving peak loads.

$$\alpha = [(Wm \times T) - (Wp \times t)] \div (T - t) \quad (1)$$

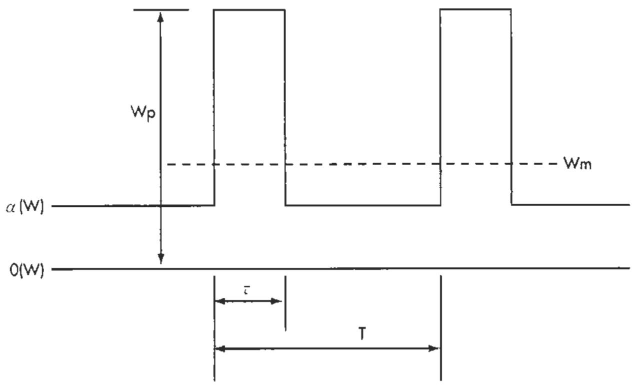
Definitions and example for Equation 1:

α = available non-peak power (watts – TBD)
Wm = maximum average output power (600 W per the power supply's datasheet)
Wp = peak pulse power (1800 W per this example)

2. This graph shows peak-output-power versus the peak-duty-cycle curves for a peak-rated power supply with a 48-V dc output voltage and an average output power of 600 W.



3. The drawing depicts a typical peak-output-power pulse waveform for a peak-rated supply where Wp is peak pulse power, Wm the maximum average output power, T the total period, t the pulse width during peak power, and α the available non-peak power.



T = total period (50 s, see *Note below)
t = pulse width during peak power (5 s maximum per the power supply's datasheet)
Duty cycle = peak output pulse width during each period (10% as per Figure 2)

*Note: To calculate "T" from the above, we know the peak pulse-width time "t" is 5 s maximum (specified). In this example, it has a duty cycle of 10% of the total period "T." Therefore:

$$T \times 0.10 = 5\ s$$
$$T = 5\ s \div 0.10 = 50\ s$$

Using Equation 1 with the given data for this example, we can now calculate α below:

$$\alpha = [(Wm \times T) - (Wp \times t)] \div (T - t) = [(600\ W \times 50\ s) - (1800\ W \times 5\ s)] \div (50\ s - 5\ s)$$
$$= (30{,}000 - 9000) \div 45$$
$$\alpha = 466.66\ W$$

Consequently, 466 W is the maximum available output power deliverable to the system's load during the non-peak period, which in this case would be 45 s. Since the output voltage of the supply in this example is 48 V dc, the non-peak period output current would be 9.7 A for 45 s (466 W ÷ 48 V = 9.7 A), the peak pulse current would be 37.5 A for 5 s (1800 W ÷ 48 V = 37.5 A), and the average current from the supply would be 12.5 A (600 W ÷ 48 V = 12.5 A).

If we were to reduce the peak-pulse period, or the required peak power, or the peak duty cycle, that would allow for more power to be available during the non-peak period. The table lists examples of various combinations of peak-power and non-peak-power pulse durations and duty-cycle conditions for this 48-V/600-W peak-rated power supply.

Notice in this table that in some instances we require different parameters for the peak power (Wp), peak duty cycle, and peak period (t = 5 s or less). In those cases, our non-peak power (α) changes accordingly. As long as we remain within the specified constraints, we can accommodate many different peak versus non-peak power and duty-cycle scenarios to fit different applications. The blue numbers in this table relate to parameters from the example described above.

COST SAVINGS & OTHER BENEFITS

Via the previous examples, we demonstrate that by using a 600-W power supply with a high peak-power rating, we can support a short-duration peak load of up to 2000 W, over three times normal. Obviously, the cost of the 600-W supply is significantly lower than employing an 1800- or 2000-W continuous-rated supply.

In OEM lots, the cost savings for using peak-rated supplies can amount to 75% or more. Additional benefits are possible since the 600-W supply is significantly smaller and lighter than a 1800-W supply: 83 in.^{3} versus 177 in.^{3} and 3.52 lb versus 8.36 lb, respectively. Also, the 600-W supply is environmentally friendlier.

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Peak-Rated Power Supply, Examples Of Operating Parameters: 220-V ac Input, 48-V dc Output, 600-W Average Output Power (Wavg)

Peak power (Wp)	Peak period (t)	Peak duty cycle	Non-peak power (α)	Non-peak period (T – t)	Total period (T)
1000 W	5 s	10%	522 W	45 s	50 s
1300 W	5 s	35%	224 W	9.3 s	14.3 s
1800 W	1 s	5%	537 W	19 s	20 s
1800 W	5 s	10%	466 W	45 s	50 s
2000 W	1 s	5%	526 W	19 s	20 s
2000 W	200 ms	1%	598 W	119.8 s	120 s