Understanding peak power

Abstract
Traditionally, the selection of power supplies is based upon the expected maximum total system power – calculated as Volts × Amps = Watts. David Buck at TDK-Lambda suggests that, for some applications, looking more closely at the peak current or peak power rating of the module may provide a significant cost saving.

Introduction
Electromechanical equipment, such as motors, disk drives, pumps, fans and actuators, require an initial start-up current that is much higher than the steady state draw; it can often be anywhere from two to three times their normal operating current but will often only last for 200 milliseconds or a few seconds at the very most.

Therefore, rather than size the system's power supply for the worst case short-duration peak current, a good alternative would be to find a power supply that can handle the peak current, yet provide the normal (non-peak) system operating power. This is because power supplies with a peak power rating have the ability to exceed their normal ratings for short specified durations without going into an over-current mode.

Understanding peak power
Some power supplies can provide peak currents or power that is two to three times their normal output ratings. With these types of supplies, the peak ratings are specified for a limited time period and maximum duty cycle. To illustrate this Fig. 1 shows the "peak-output power" versus the "peak-duty-cycle" curves for a typical peak-rated power supply with an output voltage of 48Vdc and 600-watts average output power. The peak power duty-cycle is defined as a percentage of the total operating time.

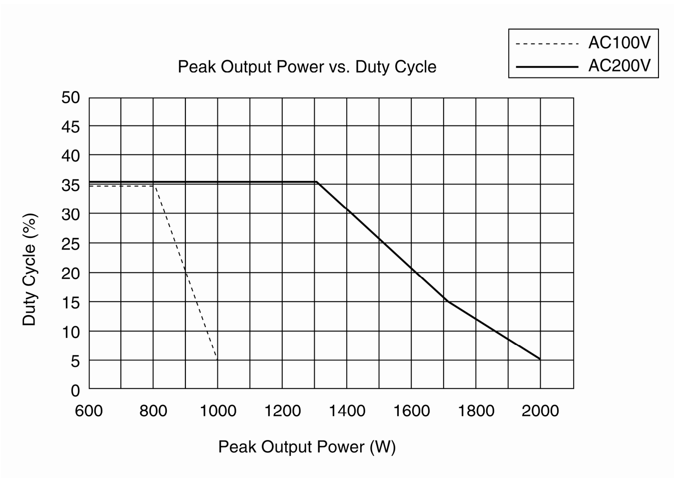

Fig. 1: Peak Output Power vs. Peak Duty Cycle Curves

With an input voltage of 200Vac, per the solid-line curve in Fig. 1, we can see that if we needed to pull 1800-Watts 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 the manufacturer's datasheet, we know that this supply has a maximum peak power pulse-width of five seconds. 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 required so that the "average power" rating, in this case 600W, is not exceeded.

As another example, from the solid-line curve in Fig. 1, we can see that if our system needed a 35% peak power duty cycle, the maximum output power would be limited to 1300W – 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 & Average Power Considerations

When using a peak-power rated supply, care must be taken not to exceed its specified "Average Output Power" rating. A typical peak output power pulse waveform is shown in Fig. 2 and Equation 1, which can be used to determine " **α** ", which is the "Available Non-Peak Power" from a peak-rated supply when driving peak loads.

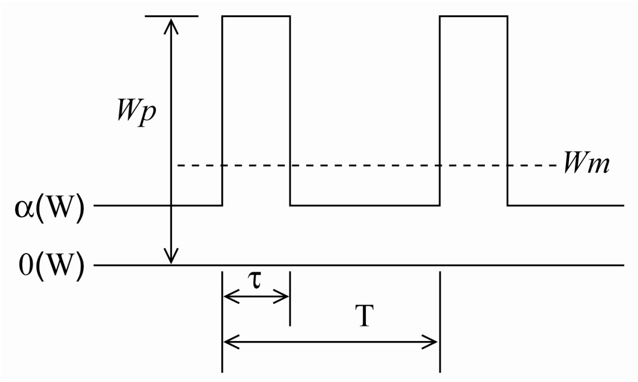

Fig. 2: Peak, Non-Peak and Average Output Power Waveform

Equation 1: α = [(Wm x T) - (Wp x t)] ÷ (T – t) .

Definitions & Calculation Example for Equation 1:

α = Available Non-Peak Power (Watts - TBD)
Wm = Max Average Output Power (600-Watts, per the power supply's datasheet)
Wp = Peak Pulse Power (1800-Watts, per this example)
T = Total Period (50 sec, see *Note below)
t = Pulse Width during Peak-Power (5 sec max., per the power supply's datasheet)
Duty-Cycle = Peak Output Pulse-Width during Each Period (10%, per Fig. 1)

**Note: To calculate "T" from the above, we know the peak pulse-width time "t" is 5 sec max. (specified) and, in this example, it has a Duty-Cycle of 10% of the total period "T".*

Therefore:

T x 0.10 = 5 sec
T = 5 sec ÷ 0.10 = **50 sec**

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

α = [(Wm x T) - (Wp x t)] ÷ (T – t)
= [(600W x 50 sec) – (1800W x 5 sec)] ÷ (50 sec – 5 sec)
= (30,000 – 9,000) ÷ 45
α = **466.66W** = Available Non-Peak Power (Watts)

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

If we were to reduce the peak-pulse's period, or the required peak-power, or the peak duty-cycle, this would allow for more power to be available during the non-peak period. The table lists examples of various combinations of peak and non-peak power pulse durations and duty-cycle conditions for this 48V/600W peak-rated power supply (refer to Fig. 1 andEquation 1).

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

Peak-Rated Power Supply, Examples of Operating Parameters: 220Vac Input, 48Vdc Output, 600W Avg. Output Power (Wavg)					
Peak Power (Wp)	Peak Period (t)	Peak Duty Cycle	Non-Peak Power (α)	Non-Peak Period (T- t)	Total Period (T)
1000W	5 sec.	10%	522W	45 sec.	50 sec.
1300W	5 sec.	35%	224W	9.3 sec	14.3 sec.
1800W	1 sec.	5%	537W	19 sec.	20 sec.
1800W	5 sec.	10%	466W	45 sec.	50 sec.
2000W	1 sec.	5%	526W	19 sec.	20 sec.
2000W	200 ms	1%	598W	119.8 sec.	120 sec.

Examples of Peak & Non-Peak Power Parameters

Cost Savings & Other Benefits

From the above examples we have demonstrated that, by using a 600-Watt power supply with a high-peak-power rating, we can support a short duration peak load of up to 2000-Watts (over three-times normal). Obviously, the cost of the 600W supply is significantly lower than if an 1800W or 2000W continuous-rated supply was employed.

In OEM quantities, the cost savings for using peak-rated supplies can amount to 75% or more. And, additional benefits are gained since the 600W supply is much smaller (only 83 in3 versus 177 in3 for an 1800W supply), much lighter in weight (only 1.6 Kg versus 3.8 Kg), and more environmentally friendly.

For further information

To learn more about the HWS-P series, please visit:
http://uk.tdk-lambda.com/hws

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