Power Quality Concerns with LED Power Supplies

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July 17, 2015

When I was 13, I learned (a little) about DC electronic circuits, thanks to Electronics merit badge with the Boy Scouts of America. One of the things I learned was that Power was equal to current times voltage. Or

$$P=iV$$

As you may have learned as well. Of course, as soon as AC circuits came into the discussion, this equation changes and becomes:

$$P=iV(PF)$$

Where PF is power factor and a number less than 1.

Sadly, many times Power Factor is forgotten or ignored in LED power supply selection. This is a surprise because it was cussed and discussed ad nauseam 60 years ago or so when it became a huge factor in fluorescent lighting. Then it came up again in the 1980's when compact fluorescent took hold. And now, during the LED revolution, it has again reared its ugly head.

Why is it a recurring subject? You ask. Since it is a complicated discussion, many people let their eyes glaze over and default to buying the cheapest power supplies. However, let me assure you it is worthy of some discussion and it almost certainly is costing you or your customers money.

First of all Power Factor is of major concern to utilities as it represents a difference between the power actually delivered to a facility (Volt-Amps) and the power detected by a meter that determines the bill to a facility (Watts). Low power factor can be costly to a utility. The utility has to size transformers for the peak voltage and wires for the peak current and then they want to bill you for this capacity infrastructure. However, if your meter measures watts and it is less than the product of the current and voltage (since PF <1); they may not be recouping the cost of their infrastructure investment.

Before you get too excited about this potential windfall, remember that the utility companies have been doing this a long time and are completely aware of the situation. Consequently, they have other charges that may be called a demand surcharge or a capacity surcharge; but regardless of what they call it, it will be an extra penalty charged on your bill to offset revenue lost to the poor power factor. Be certain that your customers are including high PF into their driver specifications which is PF above 0.90. This is sometimes also called PFC for Power Factor Correction. (Recent European standards require PF as high as .97.) The default is referred to as normal power factor and implies any PF below 0.90. The actual performance could be as low as 0.40 in some of the least expensive lighting supplies.

The second major aspect of Power Factor correction is the loading on the electrical infrastructure in your (or your customers) building. For example: Let's suppose we have a 120V line protected by a 15A breaker. UL says that this line should not draw more than 12 Amps. So let us look at two power supply examples:

Example A: No PFC, PF=0.65, 85% Efficiency, 120 V, 12Amps max current

*Therefore: 120V * 12A * 0.85 * .65 = 796 watts of output power*

Example B: PFC used, PF=0.95, 85% Efficiency, 120 V, 12Amps max current

*Therefore: 120V * 12A * 0.85 *.95 = 1163 watts of output power*

As can be seen in Example B the power supplies with PFC can deliver 367 Watts more or 46% more power to their output load than non-PFC corrected power supplies. This will have major cost implications to the building layout and power handling requirements in your customers' customers' facilities!

And incidentally, High Power Factor is a requirement of DLC Qualification. If you're not familiar, DLC or DesignLights Consortium, is project of Northeast Energy Efficiency Partnerships (NEEP) that provides criteria with which to rate performance of luminaires in select classes in order to raise the overall level of performance in general lighting applications.

Furthermore, Total Harmonic Distortion, THD, is a key contributor to lower power factors with electronic (switch mode) power supplies. THD is the distortion of the (sinusoidal) waveform which can lead to potentially dangerous consequences, such as overloading the neutral wires in older installations, overheating of electrical equipment and even fires in transformers and switching stations. THD is becoming increasingly more important with the proliferation of switch mode power supplies in signage, lighting, and computer equipment. Today, THD below 20% is acceptable and crucial in the driver specification and also a requirement of DLC qualification.

So far, we've only been discussing power supplies, but, of course, for so called AC modules, the same performance specifications are also critical. When speaking to your customers about AC modules, always remember that the critical specifications are the same regardless of with-driver or driver-less performance:

In summary, incorporating minimum standards for PF of 0.9 or above and 20% or below for THD is a critical part of any driver or AC Module specification. Anything outside these standards may result in the aforementioned penalty assessed by the utility or even direr consequences of safety.