Power Factor

What is power factor?

This is a very involved subject that will be dealt with in terms of field application and typical questions from end-users.

Power factor is characteristic of alternating current (AC) circuits. Always a value between (0.0) and (1.0), the higher the number the greater/better the power factor.

Circuits containing only heating elements (filament lamps, strip heaters, cooking stoves, etc.) have a power factor of 1.0. Other circuits containing inductive or capacitive elements (ballasts, motors, personal computer, etc.) usually have a power factor below 1.0. Normal power factor ballasts (NPF) typically have a value of (0.4) - (0.6). Ballasts with a power factor greater than (0.9) are considered high power factor ballasts (HPF).

The significance of power factor lies in the fact that utility companies supply customers with **volt-amperes**, but bill them for **watts**. The relationship is (watts = volts x amperes x power factor). It is clear that power factors below 1.0 require a utility to generate more than the minimum volt-amperes necessary to supply the power (watts). This increases generation and transmission costs. Good power factor is considered to be greater than 0.85 or 85%. Utilities may impose penalties on customers who do not have good power factors on their overall buildings.

Watts, or real power, is what a customer pays for. VARS is the extra "power" transmitted to compensate for a power factor less than 1.0. The combination of the two is called "apparent" power (VA or volt-amperes).

Consider this popular analogy to clarify the relationship between real and apparent power.

We all know a glass of draft beer generally has a "head" on it. Let's say your favorite pub institutes a new policy - you only pay for the beer, not the foam. While the foam is just aerated beer, it is not really usable in that form. If the glass of beer is half foam, you pay half the price.

This is the same principle as electricity generation - the consumer only pays for the beer (real power), not the foam (the "VARS" mentioned above).

SYLVANIA

Illustration of Effect of Power Factor

The effect of power factor on both the utility and the customer. Note that the utility bills the customer for **watts** but generates **volt-amperes** (VA), and that (watts = volts x amperes x power factor).

Four applications will be discussed:

1.   60 watt incandescent lamp (PF=1.0)
2.   15 watt medium-based compact fluorescent lamp, electronic ballast, normal power factor (PF = 0.6)
3.   15 watt medium-based compact fluorescent lamp, electronic ballast, high power factor (PF = 0.95)
4.   13 watt medium-based compact fluorescent lamp, magnetic adapter unit (PF =0.25)

For the 60 watt incandescent lamps:
*   Customer pays for 60 watts of power
*   Utility generates 60 watts ÷ 1.0 PF = 60 VA

For the 15 watt medium-based compact fluorescent lamp, electronic ballast, normal power factor:
*   Customer pays for 15 watts of power.
*   Utility generates 15 watts ÷ 0.6 PF = 25 VA

For the 15 watt medium-based compact fluorescent lamp, electronic ballast, high power factor:
*   Customer pays for 15 watts of power
*   Utility generates 15 watts ÷ 0.95 PF = 15.8 VA

For the 13 watt medium-based compact fluorescent lamp, magnetic adapter unit:
*   Customer pays for 16 watts of power
*   Utility generates 16 watts ÷ 0.25 PF = 64 VA

While the consumer saves watts with any of the compact fluorescent alternatives, the utility must generate nearly the same amount of VA for the magnetic adapter unit as for the incandescent lamp. While this is an extreme case, it does illustrate the effect of power factor. Some "better" retrofit units have power factors ranging from 30% - 50% (0.3 to 0.5). High power factor products do offer the customer an additional benefit as well. On a one for one replacement/retrofit onto existing circuits for incandescent lamps (15 or 20 amperes), multiple normal power factor units may trip the breakers. High power factor ballasts allow more lamps per circuit than do normal power factor ballasts. Note that these high power factor units will be slightly higher in cost.

Typical Questions and Answers From End-Users

Q: What is meant by a "High Power Factor" ballast?

A: Ballast designated High Power Factor (HPF) must have a power of 90% (0.90) or greater. Ballast factors lower than a 0.90 are called Normal Power Factor (NPF).

Q: Will large scale use of NPF compact fluorescent lamps in a building have any detrimental effects?

A: The harmonic generation and resulting power factor of these lamps may cause the neutral wire in a four wire system (WYE) to be overloaded but only if the "maximum number per circuit" specification is exceeded. HPF compact fluorescent lamps will have no detrimental effect on the electrical system.

Q: Is an HPF ballast more efficient than an NPF Ballast?

A: Yes, but only in terms of how well it uses the apparent power (volt-amperes), not the metered power (watts). Remember that the user pays for watts, not volt-amperes. Therefore, if the wattage ratings are the same for both the HPF and NPF units, then the user will not see a difference in the electric bill. However, if the user's electric rate includes a low power factor penalty and if enough NPF units are in use, there may be an increase in the electric bill.

The other issue concerns circuiting. Use of HPF ballast will allow more fixtures per circuit.