Power Factor Correction

General Explanation

SERMA PRODUCTIVITY ENGINEERING

What is PFC?

Power Factor describes how efficiently an electrical device draws power from the power lines. Sometimes it is being confused for the efficiency of the device itself. We all know the power triangle from the physics education. We remember a phase shift between current and voltage where we have inductive and capacitive load aside from pure resistive loads where there is no phase shift. The best situation is when the load equipment draws AC current that is directly proportional to the AC line voltage. This would cause a Power Factor of one.
As soon as the current waveform is shifted in time from the voltage waveform or it is not sinusoidal the Power Factor is less than one. The power grid must supply extra current that delivers no power to the load. It creates extra resistive losses in the distribution system. Power Factor Correction or PFC eliminates the extra current and thus reduces the total amount of current that must be supplied to the load. Physically you would find the PFC inside the power supply unit of your device, let's say a TV set or your PC.

What kind of applications requires PFC?

Resistive loads like conventional incandescent light bulbs have a Power Factor of one when there is no dimming involved. Motors like the one in your vacuum cleaner and electronic equipment with switched mode power supplies have a Power Factor less than one. This includes also new types of light sources, e.g. LED light stripes or very often fluorescent lamps. Some countries started already to ban the old fashion light bulbs by law because of their low light efficiency but seem to forget that new problems will arise from the currently existing power factor regulations for these loads. For light applications only single loads larger than 25 watts require PFC by European regulations. Other equipment starting at power consumption of 75 watts in Europe also requires PFC. One should keep in mind, this is real power that is being drawn from the net and has to be generated in the power plants world wide, and also pollutes our planet unnecessarily. A typical LED lamp or single fluorescent lamp consumes less than 25 watts, hence today there is no mandatory demand for PFC. Also these applications are subject to future government regulation initiatives, since they still draw apparent power that the power grid has to provide and generate harmonics on the grid.
Larger commercial power customers already pay an extra for their real power including the apparent power. Residential power customers don't today.

What would it mean if all electrical equipment would be equipped with Power Factor Correction?

How about saving 48TWh per year or reducing the annual CO_2 emission by 19 million tons? Fewer power plants would be needed for the same amount of loads, some estimate up to 10% of power could be saved. This becomes more important since the number of resistive loads will further decrease with LED lamps as well as power and weight saving electronic devices. This has to be modeled by government regulations since PFC costs money in devices and people typically would not want to pay more for their equipment. It has to be observed on a larger economic scale. The results for all will be conservation of natural resources, reduction of atmospheric pollution and a healthier planet.

What is the contribution of PE in this green initiative?

Since a while, PE is developing integrated circuits for PFC applications, such as efficiency optimized SMPS for LED lighting as well as power saving lamps. Our reference designs reach from miniaturized PFC boards for standard E27 sockets up to high efficient power supplies for LED light strips. We build not only the ICs, but support our customers solving problems on application level. We sell solutions.

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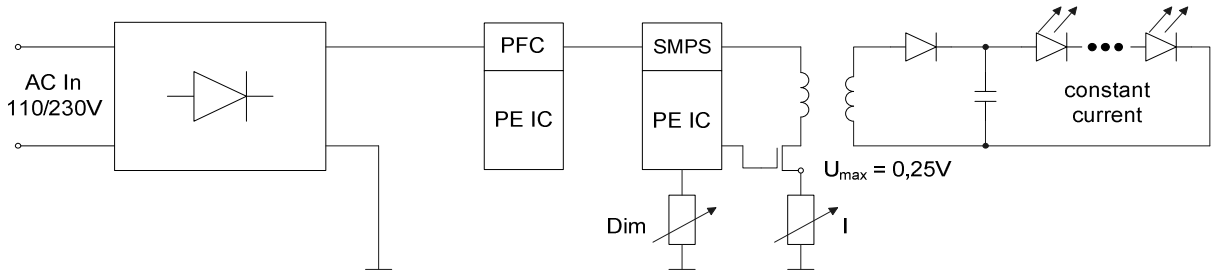
Application example “LED light strip”:



To demonstrate the advantages of PE’s PFC solution, here is a comparison:
Image1 shows the current of a fluorescent lamp without PFC. The power factor is measured with 0.6, whereas the same lamp with PFC achieves a power factor of 0.98, as shown in image2.

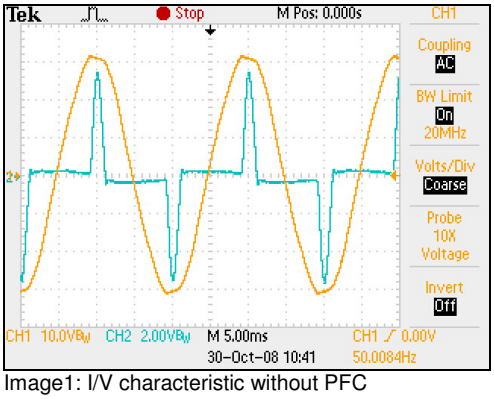


Image1: I/V characteristic without PFC

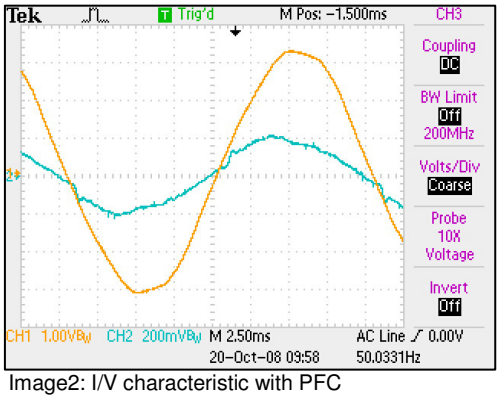


Image2: I/V characteristic with PFC

Another example related to above mentioned LED lighting applications:
PE does not only develop and deliver PFC ICs, but also generates reference designs and application boards. On another case, a non-PFC power supply for LED stripes had to be equipped with a PFC circuitry. Another requirement has been the optimization of the overall efficiency and adding dimming functionality. The following table documents the results.

	Efficiency	Power Factor
Original SMPS without PFC	< 50%	< 0.6
PE solution with PFC	> 70%	> 0.9

What does this mean?
Using PEs solution, one not only saves power due to the higher efficiency and the reduced portion of reactive power, but is also able to build cost optimized products.

PE is positioned to support customers with demands for high quality power optimized applications.
We invite you to benefit from our experience and know how in that area.