Höcherl & Hackl
The electronic load

Application Note #8

Non-Linear AC Loads with ZSAC Series Loads

Frequently the requirement appears to load AC voltages with non-linear loads. Terms like cos phi, crest factor and power factor are used which sometimes causes confusion.

Terminology

Power Factor PF
A power factor can be detected when the product of voltage measurement and current measurement does not match with the actual appearing real power. The power factor is applicable in a wide range and covers sinusoidal signals as well as other signal waveforms.

cos phi (displacement power factor)
cos phi is a special case of the power factor. It is only true when the waveforms have sinusoidal shape as with inductive and capacitive loads.

Crest Factor (CF)
The crest factor defines the ratio between the peak value and the average value of a voltage. A sine wave has a crest factor of 1.41.

Principle of Electronic AC Loads

In general, electronic AC loads work in the same way like DC loads with a rectifier in the input. The control voltage for the setting of the load level is not a static DC level as with DC loads but a half-wave shaped signal like a rectified sine wave.
In this way a sinusoidal current is produced at the input of the rectifier.
Due to rectifier function in the input the direction of the energy flow can be only in direction to the electronic load and never in reverse direction to the source.

Your contact:

Schulz Electronic
Professional Power Supplies

Schulz-Electronic GmbH
Dr.-Rudolf-Eberle-Straße 2
D-76534 Baden-Baden
Fon + 49.7223.9636.0
Fax + 49.7223.9636.90
vertrieb@schulz-electronic.de
www.schulz-electronic.de

Höcherl & Hackl
The electronic load

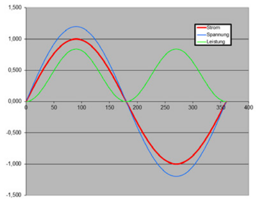
How does the current and voltage look like with nonlinear loads?

To define what kind of loading can be done with a electronic AC Load and what not it is useful to consider some load examples.
Special attention is paid to the direction of the energy flow, because the electronic Load can only consume electrical power and not generate some.

The following diagrams show
voltage (blue), current (red) and power (green).

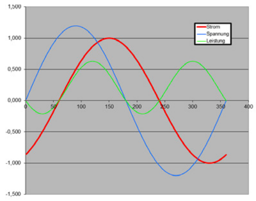
Example 1:
Ohmic load

CF = 1.41, phi = 0°
Current and voltage are “in phase”.
The power is only positive.
This means that the load can simulate this application
(typical application).



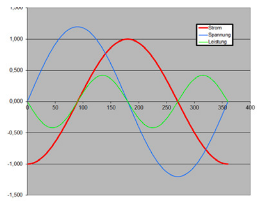
Example 2:

CF = 1.41, phi = 60° lagging
Current and voltage are phaseshifted.
There are areas where the
power diagram is negative.
The load can not simulate this applicat



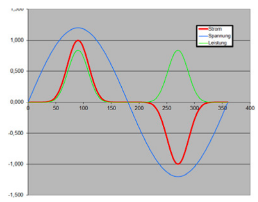
Example 3:

CF = 1.41, phi = 90° lagging
Current and voltage are phaseshifted .
The power has the same share in the positive as well as in the negative (pure reactive power).
The load can not simulate this application.



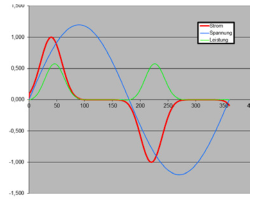
Example 4:

CF = 5, phi = 0°
Current and voltage are in phase.
There are no areas where the
power diagram is negative.
The load can simulate this application.



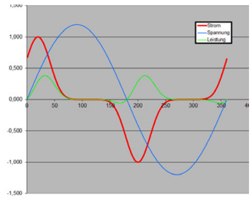
Example 5:

CF = 5, phi = 45° leading
Current and voltage are phaseshifted.
There are no areas where the power diagram is negative.
The load can still simulate this application.



Example 6:

CF = 1.41, phi = 70° lagging
Current and voltage are phaseshifted. There are already small areas where the power diagram is negative.
The load can not simulate this application.



Result:

Phase shift can be only realized in combination with a crest factor setting with values higher than 1.41.
The higher the crest factor (the narrower the current peak), the wider the phase angle can be shifted.
Phase shift with sinusoidal waveforms as from inductive and capacitive loadings are not possible because for any setting different from 0° a power recovery into the mains would be required.