

## Introduction

Based on the recommendations issued by the ZVEI (German Electrical and Electronic Manufacturers' Association), this document shall help identifying the key application criteria for a secure and economic solution in Power Factor Correction (PFC).

## 1 Which loads have to be provided with Power Factor Correction?

### Inductive loads

- motors  transformers

### Non-linear loads

- converters, rectifiers, inverters, choppers  thyristor controls, three-phase controllers  
 electronic valves  phase controls  
 UPS units (inverter technology)  discharge lamps with magnetic ballasts

**Attention!** Non-linear loads generate harmonics.

## 2 What are the power demand and the duty cycle of the loads?

### Power demand, duty cycle

- constant power demand and long duty cycle single- or group- fixed PFC  
 variable power demand and/or variable duty cycle controlled central PFC

## 3 What reactive power shall the PFC system have?

- known: original power factor of the site  $\cos\varphi_1$ , active power, target power factor  $\cos\varphi_2$

active power of the site ...kW x factor F ... = reactive power ...kvar

original power factor $\cos\varphi_1$	conversion factor F for a target power factor $\cos\varphi_2$									
	0.70	0.75	0.80	0.85	0.90	0.92	0.94	0.96	0.98	1.00
0.20	3.879	4.017	4.149	4.279	4.415	4.473	4.536	4.607	4.696	4.899
0.25	2.853	2.991	3.123	3.253	3.389	3.447	3.510	3.581	3.670	3.873
0.30	2.160	2.298	2.430	2.560	2.695	2.754	2.817	2.888	2.977	3.180
0.35	1.656	1.795	1.926	2.057	2.192	2.250	2.313	2.385	2.473	2.676
0.40	1.271	1.409	1.541	1.672	1.807	1.865	1.928	2.000	2.088	2.291
0.45	0.964	1.103	1.235	1.365	1.500	1.559	1.622	1.693	1.781	1.985
0.50	0.712	0.85	0.982	1.112	1.248	1.306	1.369	1.440	1.529	1.732
0.55	0.498	0.637	0.768	0.899	1.034	1.092	1.156	1.227	1.315	1.518
0.60	0.313	0.451	0.583	0.714	0.849	0.907	0.97	1.042	1.130	1.333
0.65	0.149	0.287	0.419	0.549	0.685	0.743	0.806	0.877	0.966	1.169
0.70		0.138	0.27	0.4	0.536	0.594	0.657	0.729	0.817	1.020
0.75			0.132	0.262	0.398	0.456	0.519	0.59	0.679	0.882
0.80				0.13	0.266	0.324	0.387	0.458	0.547	0.75
0.85					0.135	0.194	0.257	0.328	0.417	0.62
0.90						0.058	0.121	0.193	0.281	0.484
0.95								0.037	0.126	0.329

- known: reactive power tariff, monthly costs for reactive energy, monthly operating hours

$$\frac{\text{monthly costs for reactive energy ...€}}{\text{monthly operating hours ...h * reactive power tariff ...€/kvarh}} = \text{reactive power ...kvar}$$

- known: monthly calculated reactive energy in kvarh, monthly operating hours

$$\frac{\text{monthly calculated reactive energy ...kvarh}}{\text{monthly operating hours ...h}} = \text{reactive power ...kvar}$$

#### 4 When is it necessary to install a detuned PFC system?

Please use the following chart to find out whether a detuned system is needed:

$S_{os} : S_T$	Detuning
<input type="checkbox"/> 0%... 10%	non-detuned
<input type="checkbox"/> >10%... 50%	detuned
<input type="checkbox"/> >40%...100%	detailed calculation needed, if necessary use of filter circuit

abbreviations:  $S_{os}$  power of the harmonic generator in the own network  
 $S_T$  rated transformer power or installed load

A detuned PFC system is also necessary:

- if one or more harmonic voltages in the MV mains are >2%, and/or  
 if certain audio frequency control signals are used (see point 5)

**Attention!** Non-detuned and detuned capacitors must never be combined together.

#### 5 Does the MV mains contain audio frequency control signals ?

Capacitor/ PFC system	audio frequency	reactive power	activity
<input type="checkbox"/> non-detuned	< 250Hz	$Q_c \leq 35\%$ of $S_T$	no specific activity
		$Q_c > 35\%$ of $S_T$	consult your power supply company and conduct mains analysis
	> 250Hz	$Q_c \leq 10$ kvar	no specific activity
		$Q_c > 10$ kvar	consult your power supply company and consider special PFC system
<input type="checkbox"/> detuned	< 250Hz	no restrictions	consult your power supply company and consider special PFC system
	250Hz till 350Hz	no restrictions	detuning factor $\geq 7\%$
	> 350Hz	no restrictions	detuning factor $\geq 5\%$

#### 6 Summarizing General Technical Data

##### Type of PFC

- fixed PFC  
 automatic control system

##### parameters of the mains

- rated mains voltage/frequency ...V / ...Hz  
 control voltage/frequency ...V / ...Hz

##### PFC data

- reactive power by rated mains voltage ...kvar  
 stages (sections) x reactive power ...x...kvar  
 detuning factor ...%

##### ambient conditions

- protection IP ...  
 ambient temperature min ... °C  
max ... °C