**Use of Chokes and Resistors in Power Factor (PFC) Equipment**

Inductive loads—such as motors, welding machines, and transformers—cause a lagging power factor; this means more current is required to deliver the same amount of useful (real) power, which increases the burden on cables, transformers, switchgear, and other infrastructure. In practical terms, a low power factor leads to:

* Higher energy consumption and operational costs
* More significant current flow through conductors, increasing I²R losses
* Greater demand on electrical infrastructure and reduced system capacity
* Voltage drops and instability
* Penalty charges or reduced tariffs from utility providers

To quantify an installation's power factor (PF), the ratio of real power (kW) to apparent power (kVA)is taken. A system with a power factor of 1.0 (or 100%) uses all its electrical power for productive work, while a system with a power factor of 0.7 wastes 30% of its apparent power handling non-productive reactive energy. It may be surprising to know that since 2010 the UK's National Grid has been including an excessive reactive power charge for customers with a power factor of >0.95. **See https://www.nationalgrid.co.uk/smarter-networks/losses/what-causes-losses for more information.**

Power Factor Correction (PFC) reduces or eliminates reactive power in a system, bringing the power factor closer to unity (1.0). This is typically achieved by installing capacitor banks, which supply leading reactive power to offset the lagging reactive power drawn by inductive loads.

However, many loads in modern industrial environments are non-linear, such as variable speed drives (VSDs), UPS systems, or LED lighting, and generate harmonic currents. These harmonics can interact with capacitor banks and cause resonance conditions, amplifying current distortion and stressing components, leading to premature failure.

That's why the use of inductors in PFC equipment is often standard practice in quality-focused installations to detune the system to avoid the resonances at the triplen frequencies, odd multiples of the 3rd harmonic, which usually appear as a result of non-linear loads. - see Figure 1

Detuned systems incorporate series inductors (chokes) and other passive components, like resistors, to shift the resonant frequency away from potentially harmful harmonic frequencies, allowing capacitors to perform power factor correction safely and effectively.

The choke (or series reactor) in a detuned PFC system is more than just a simple coil—it plays a critical role in protecting capacitors, improving power quality, and ensuring the system's long-term reliability.

**Key Requirements for a High-Quality PFC Choke:**

**1. Low Parasitic Capacitance**

 Poorly designed chokes can exhibit unwanted parasitic capacitance, which alters the intended resonance characteristics of the detuned circuit. This may cause unintentional resonance at higher frequencies and lead to unintended problems.

**2. Low Flux Density to Prevent Magnetic Saturation**

 A high-quality choke is designed to operate at a low magnetic flux density, typically well below the material's saturation point; this ensures the inductor can maintain its inductance even under high current or harmonic loading. Operating too close to saturation can cause a reduction of inductance, distortion of current waveforms and increased core heating.

**3. Stable Inductance Across Operating Conditions**

A high-quality choke maintains its inductance over a wide range of temperatures and load currents. Cheaper alternatives may drift under thermal stress or magnetic saturation, compromising system performance.

**4. Minimal Core Losses and Noise**

Quality chokes use precision-wound coils and optimised core materials (e.g. low-loss iron or ferrite) to reduce heating, mechanical noise, and magnetic leakage, ensuring consistent performance and long service life.

**5. Mechanical Robustness and Low Vibration**

Industrial PFC systems often operate in environments with electrical noise, vibration, and temperature fluctuations. A mechanically sound choke reduces the risk of loosened windings, noise, and mechanical failure.

**6. High Thermal Class and Fire Safety**

 Chokes in detuned systems are often subject to elevated temperatures due to harmonic loading. Using materials and designs rated for higher thermal classes improves fire resistance and operational lifespan.

Choosing a high-quality choke ensures accurate detuning, reliable harmonic mitigation, and prolonged life of the choke and associated capacitor banks. In contrast, substandard inductors can introduce unpredictable behaviour, reduce system reliability, and entirely negate the benefits of PFC.

**The Supporting Role of High-Quality Resistors**

While inductors handle detuning and harmonic protection, resistors are essential for transient control and system safety. Critical Applications of Resistors in Detuned PFC Systems include inrush current limiting and system damping.

 When a capacitor bank is switched in, it can draw a very high initial current; resistors limit this surge, protecting contactors and the capacitors themselves. Poor-quality resistors may overheat, drift in resistance, or fail catastrophically under such stresses. Discharge resistors bleed off the residual charge from capacitors after disconnection. This is essential for maintenance safety. High-quality resistors ensure consistent and reliable discharge over many operating cycles.

 In dynamic or staged PFC systems, resistors are often paired with switching elements (e.g. thyristors or IGBTs) to manage voltage transients and reduce or dampen the oscillations that can occur in a circuit containing capacitance and inductance, known as ‘ringing’. Robust resistors with overload resistance and thermal stability are vital here, ensuring predictable switching and protecting semiconductors from overvoltage.

Just like inductors, resistors in PFC systems must be sized correctly, thermally stable, and mechanically robust. A failure in one resistor can compromise the entire capacitor stage, leading to downtime or even hazardous failures.

The best resistors for this application tend to be aluminium-clad, reducing the effects of environmental issues. It is essential to ensure that the resistors used in this application can withstand continuous use and will 'fail-safe'. The best aluminium-clad resistors have an internal lining to eliminate the chance of a fault condition where the ‘live’ winding touches the earthed housing; this lining should be tested to ensure isolation at least 1200 degs C.

**Conclusion**

In detuned PFC systems, the selection and quality of chokes and resistors directly affect performance, reliability, and safety. High-quality chokes ensure accurate detuning, low parasitic effects, and stable inductance. In contrast, robust resistors provide essential protection during inrush, discharge, and switching events.

With the rise in non-linear loads and harmonics in modern industrial environments, cutting corners on passive components is no longer an option. The price differential between low- and high-quality components is relatively small and doesn't offset the potential for downtime and catastrophic failure.

.

**Ends:** 1150 words

**Editor’s note:** If you want to ensure you keep up to date with press material, opinion focused blog content and case studies from REO UK, you can visit their news page: <http://www.reo.co.uk/news>

**For further information or Press Enquiries contact:** Steve Hughes or Michelle Gillam

REO (UK) Ltd, Units 2-4 Callow Hill Road, Craven Arms Business Park,

Craven Arms, Shropshire, SY7 8NT
**Telephone:** +44 (0)1588 673411

**Fax:** +44 (0)1588 672718

**www:** http://www.reo.co.uk

**e-mail:** marketing@reo.co.uk

**Twitter:** <https://twitter.com/REO_UK>

**Facebook:** <http://www.facebook.com/pages/REO-UK-Ltd/263330563768795>

**About REO:** REO specialises in providing an extensive array of electronic power controllers and resistive and inductive wound components tailored for industrial use, particularly in demanding environments. As the company expands its footprint in renewable energy technology, ensuring exceptional power quality has become a paramount focus. With manufacturing facilities in Germany, the US, China, and India, REO stands at the forefront of innovation across the globe.