NANOPLEX

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SOLUTION BRIEF

NANOPLEX™ FILMS HIGH FREQUENCY SWITCHING FOR POWER FACTORING

HIGH TEMP CAPACITORS FOR OPTIMIZED HIGH FREQUENCY SWITCHING

NANOPLEX FOR POWER TRANSMISSION

- NanoPlex based capacitors Provide temperate tolerance up to 135°C
- NanoPlex based capacitors are predicted to have 3-5X longer lifetimes than BOPP-based capacitors
- NanoPlex based capacitors enable faster discharge with lower impedance, making power factoring more efficient.
- Over 20 global patents for NanoPlex film technology.
- NanoPlex is 100% US-engineered and manufactured – no reliance on China.

NANOPLEX™

NANOPLEX™ FILMS HIGH FREQUENCY SWITCHING FOR POWER FACTORING

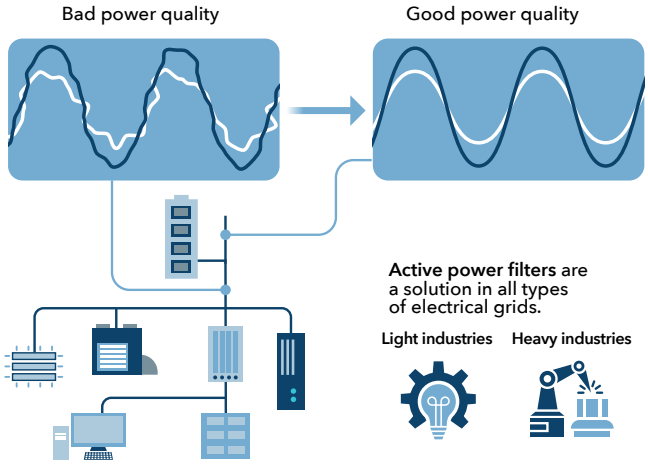
Step-up and Step-down Power Transmission

The power electronics industry is undergoing a significant shift in how power factor correction (PFC) is implemented, moving away from traditional inductor-based designs towards high-frequency switching topologies. The need for more compact, efficient, cost-effective power conversion solutions across various applications drives this trend. This brief will explore the reasons behind this transition, the benefits and challenges of high-frequency switching (HFS) PFC, and what it means for the future of power electronics.

Drivers of High-Frequency Switching

Several factors are accelerating the adoption of high-frequency switching for PFC:

- **Demand for Higher Power Density** - High-frequency operation enables the use of much smaller passive components, allowing for more compact designs.
- **Efficiency Improvements** - Advances in semiconductor technology and circuit topologies can achieve excellent efficiency across a wide load range.
- **Cost Reduction** - High-frequency switching designs enable more sophisticated control and higher-performance components that lower the cost of power factoring.
- **Weight Reduction** - HFS systems are also much lighter than large inducers, which makes them easier to install, service, and maintain.
- **Better Dynamic Response** - Higher switching frequencies allow for faster control loops and improved transient response.
- **Regulatory Pressures** - Increasingly stringent efficiency and power quality regulations are pushing manufacturers to explore more advanced PFC solutions that meet these requirements while remaining cost-competitive.



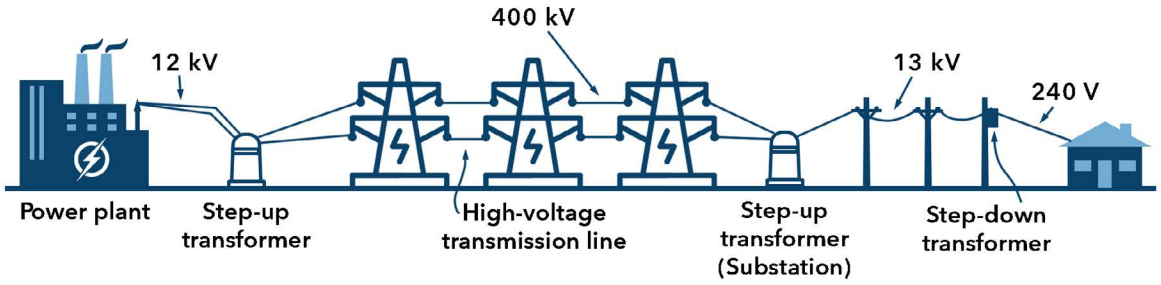
The Role of NanoPlex Based Capacitors in High Frequency Switching

The high-energy capacitor market for the power grid is evolving rapidly to meet the challenges of renewable energy integration, smart grid deployment, and power quality management. Key trends include higher energy densities, improved temperature tolerance, longer lifetimes, and enhanced connectivity.

As switching frequencies increase and duty cycles become more demanding, capacitor designs adapt with lower parasitic and more robust constructions. New dielectric materials and manufacturing techniques enable capacitors to meet the stringent requirements of modern grid infrastructure. Capacitors play several vital roles in enhancing the efficiency of high frequency switching:

- **Power Factor Correction:** Capacitors are commonly used for power factor correction in transformer systems. By adding capacitors to the AC input leads of a transformer, the power factor can be improved, making the power transmission more efficient. This allows a higher percentage of real power to be transferred from the source to the load.
- **Voltage Regulation:** Capacitor banks can help stabilize voltage levels in transmission and distribution systems. This is particularly important for maintaining consistent voltage output from transformers.
- **Harmonic Filtering:** When combined with inductors, capacitors can form harmonic filters to mitigate harmonic distortion in power systems, helping improve overall power quality.
- **Energy Storage:** While not their primary role, capacitors can provide short-term energy storage to help stabilize power flow in transformer systems.
- **Reactive Power Compensation:** Capacitors can provide reactive power compensation, which helps reduce losses in the transmission system.
- **Inrush Current Mitigation:** Capacitors can help mitigate inrush currents when energizing transformers, which can be up to 16x greater when reverse-feeding transformers.
- **Efficiency Improvement:** By correcting power factors and providing reactive power compensation, capacitors help reduce overall system losses, thereby improving the efficiency of step-up and step-down transformer systems.

HIGH FREQUECNY SWITCHING



It's important to note that while capacitors can significantly enhance transformer efficiency, their use must be carefully designed and implemented to avoid potential issues such as voltage instability or resonance problems. The specific capacitor values and configurations will depend on the transformer system's operating conditions.

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