

# HIGH-FREQUENCY SWITCHING

ENABLING SMARTER, SMALLER, AND FASTER POWER CONVERSION WITH NANOPLEX

SMARTER  
SMALLER  
FASTER

POWER CONVERSION

## THE RISE OF HIGH-FREQUENCY SWITCHING

### FROM BULKY INDUCTORS TO COMPACT, SMARTER POWER DELIVERY

High-frequency switching (HFS) is transforming power factor correction (PFC) units – essential systems for maximizing electrical efficiency by minimizing wasted power.

Traditional PFC circuits relied on large inductors. While effective, these components were bulky, heavy, inefficient in space and power density, and expensive to cool. High-frequency PFC circuits are now replacing these legacy designs with faster, smarter alternatives.

By operating at hundreds of kHz to MHz, HFS dramatically reduces the size of inductors and capacitors—enabling PFC units that are smaller, lighter, and more efficient, without compromising performance.



79%  
SURGE

IN POWER DEMAND

## A GRID UNDER PRESSURE

### WHY HIGH FREQUENCY SWITCHING IS CRITICAL TO RESILIENCE, EFFICIENCY, AND SCALABILITY

The global power grid is under pressure from surging energy demand, aging infrastructure, and the growing complexity of renewable integration. High-frequency switching (HFS) plays a critical role in overcoming these challenges by enabling compact, efficient, and scalable power systems.

| PRESSURE POINT                                                                                                   | HIGH FREQUENCY SWITCHING                                                                         |
|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Global energy demand is projected to rise <b>79% by 2050</b> , driven by EVs, AI, increased electrification      | HFS boosts system efficiency and power throughput <b>without major infrastructure overhauls</b>  |
| Today's infrastructure is decades old and struggling to support fast-changing, high-load conditions              | HFS enables <b>real-time response and high dynamic performance</b> , keeping the grid stable     |
| Solar, wind, and distributed energy resources require fast, agile control to stabilize voltage and power quality | HFS provides the <b>speed and control precision</b> needed for modern grid management            |
| Utilities must expand capacity within existing substations and spaces                                            | HFS circuits allow <b>higher power density</b> , making upgrades scalable and space-efficient    |
| Systems like Solid-State Transformers and Hybrid PFC operate at high switching frequencies                       | HFS is a foundation for digital grids, supporting <b>smarter energy distribution and control</b> |

HFS supports faster load response, smarter control, and greater efficiency – all while maximizing use of limited space. As the grid modernizes, HFS isn't optional, it's essential.

UNRELIABLE  
SYSTEM

PERFORMANCE

## THE BOPP BOTTLENECK

### WHY TRADITIONAL CAPACITORS STRUGGLE WITH HIGH-FREQUENCY SWITCHING

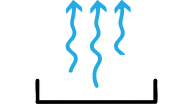
While high-frequency switching (HFS) offers major performance advantages, it also places extreme demands on capacitors – demands that traditional BOPP film cannot meet.

#### WHY TRADITIONAL BOPP CAPACITORS BREAK DOWN



#### Heat is the Enemy

HFS environments push operating temperatures to 150°C. BOPP capacitors degrade above 85°C, requiring derating and active cooling, increasing system cost and complexity.



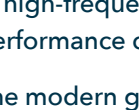
#### Rapid Cycling Stress

BOPP struggles with fast charge & discharge cycles. Dielectric losses increase, material fatigue sets in, and reliability declines – leading to premature failure.



#### Thermal Instability

At elevated temperatures, BOPP film can shrink, warp, or deform, causing a loss in capacitance and even dielectric breakdown, undermining long-term stability.



#### Limited Lifespan

When pushed beyond its limits, BOPP's service life shortens dramatically, leading to more frequent replacements, higher maintenance costs, and reduced system uptime.

In high-frequency environments, traditional BOPP capacitors become a bottleneck. Their performance drops, size and cooling requirements increase, and reliability suffers.

The modern grid needs capacitors that remain stable, efficient, and durable—no matter the thermal or electrical stress.

BUILT FOR THE

HEAT

SPEED

STRESS



## THE NANOPLEX FILM ADVANTAGE

### PURPOSE-BUILT FOR THE HEAT, SPEED, AND STRESS OF HIGH-FREQUENCY SWITCHING

High-frequency switching (HFS) pushes capacitors beyond the limits of traditional BOPP film. Capacitor OEMs need a material that can handle higher temperatures, faster switching, and tighter design constraints – without sacrificing reliability and performance.

**Next-generation NanoPlex film delivers.** Engineered specifically for high-temperature, high-frequency environments, it operates up to 135°C, lasts up to 5x longer, and offers 4x the energy density while enabling compact, high-efficiency capacitor designs. By moving beyond BOPP's limitations, NanoPlex enables a new generation of capacitors to match and exceed the performance demands of grid modernization.

#### ADVANTAGE OF NANOPLEX CAPACITORS VS. BOPP CAPACITORS

|                           | NanoPlex                                                   | BOPP                                                     |
|---------------------------|------------------------------------------------------------|----------------------------------------------------------|
| Max Operating Temperature | Up to 135°C without derating                               | Up to 85 °C without derating                             |
| Thermal Stability         | No film shrinkage up to 135°C                              | Noticeable film shrinkage and degradation beyond 85 °C   |
| Operational Lifespan      | 5x longer operational life                                 | Significantly shorter under HFS stress                   |
| Dissipation Factor        | 50% lower losses, much higher efficiency                   | Higher losses, greater self-heating and inefficiency     |
| Energy Density            | Up to 4x energy storage per volume                         | Much lower, limiting miniaturization                     |
| Size & Weight             | Up to 50% smaller and 30% lighter                          | Larger and heavier to achieve equivalence                |
| Design Compatibility      | Plug-and-play replacement for existing designs & equipment | Default film for legacy designs                          |
| Manufacturing & Design    | 100% USA engineered & manufactured                         | 80% of BOPP film supply sourced overseas, 70% from China |
| Supply Chain              | 100% allied nation sourced and secured                     | Geopolitically instable                                  |

UNRELIABLE  
SYSTEM

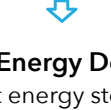
PERFORMANCE

## ENGINEERED TO OUTPERFORM

### NANOPLEX DELIVERS UNMATCHED EFFICIENCY, RESILIENCE, AND SCALABILITY IN HIGH-FREQUENCY SWITCHING

NanoPlex isn't just a better film – it's a generational leap forward for high-frequency switching (HFS). It enables inverters, converters, and PFC units to switch faster without sacrificing reliability, efficiency, or lifespan – driving a new generation of compact, resilient, and energy-efficient systems built for the modern grid.

#### ADVANTAGES OF NANOPLEX FOR HFS



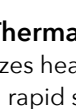
**High Energy Density**  
Compact energy storage for filtering & smoothing



**Fast Energy Response**  
Quick, stable support without sacrificing capacitance



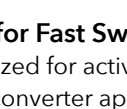
**Space-Saving Capacitance**  
High capacitance filtering in tight layouts without added bulk



**Low Thermal Losses**  
Minimizes heat buildup during rapid switching cycles



**Resilient & Self-Healing**  
5x longer life under sustained high-frequency stress



**Built for Fast Switching**  
Optimized for active PFC & power converter applications

From grid modernization to fast-switching applications, NanoPlex capacitor film is the foundation of tomorrow's compact, resilient, and energy-efficient HFS infrastructure.