Enabling Advanced Power Electronics Technologies for the Next Generation Electric Utility Grid

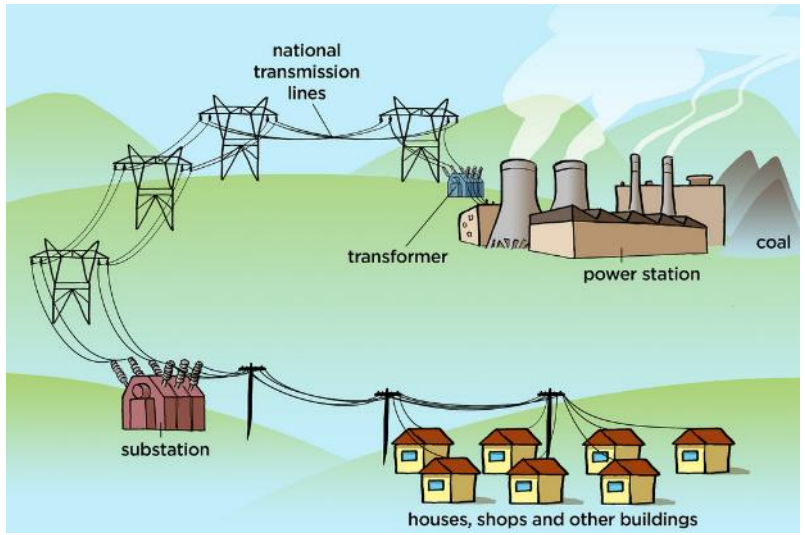
Workshop hosted by Sandia National Laboratories

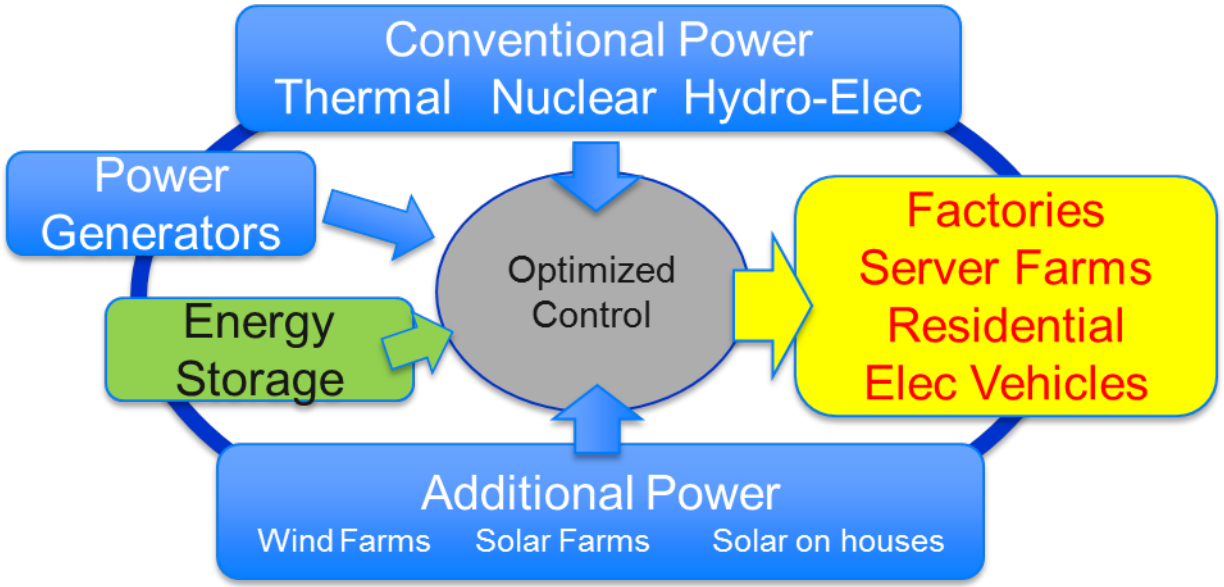
Electronic Components
KEMET
CHARGED.®

Session – 3
Components Needed: Capacitors

Abhijit Gurav, Ph.D., VP Ceramic Technology
KEMET Electronics Corporation
July 17, 2018

Power Grid of Tomorrow





Future Power Grid

- Distributed generation, microgrids
- Smart automated distribution
- Distributed storage
- Smart, dynamic demand response
- Growing server farms and other end use
- Electric vehicles – charging everywhere

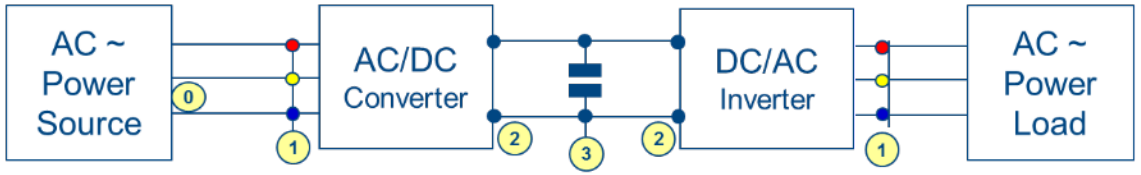
✓ **Seamless, Stable and Robust Integration**

✓ **EFFICIENCY!!! → WBG Solutions**

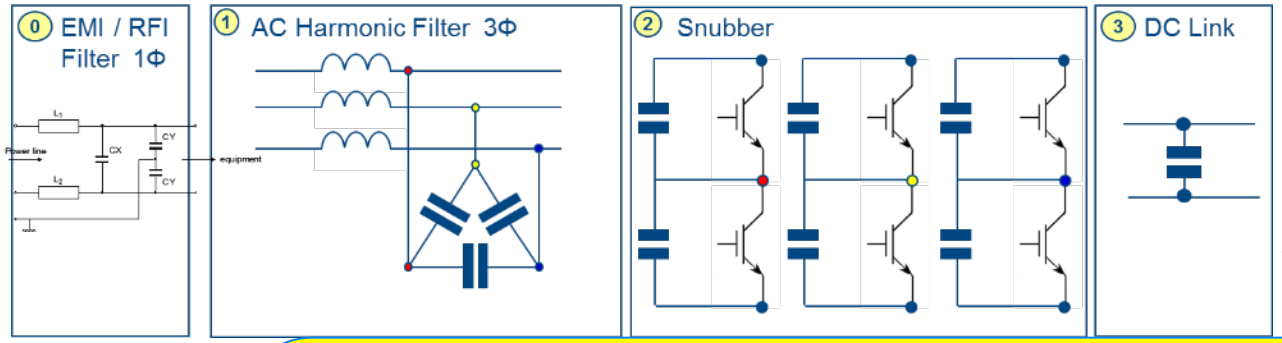
Capacitors in Power Electronics

Electronic Components KEMET CHARGED.

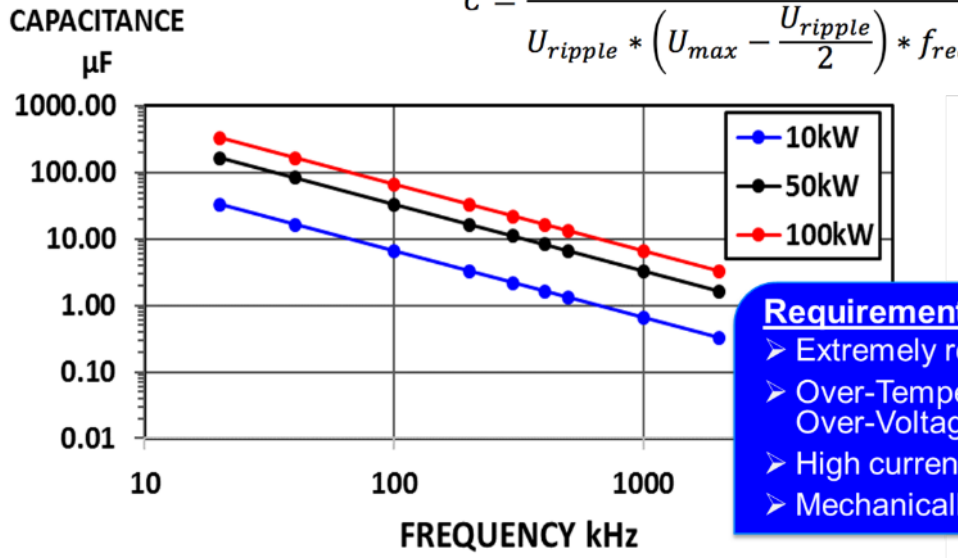
System Overview:



Typical Capacitor Types:



$$C = \frac{P_{load}}{U_{ripple} * \left(U_{max} - \frac{U_{ripple}}{2}\right) * f_{rectifier}}$$



Requirements
- Extremely reliable
- Over-Temperature and Over-Voltage Capable
- High current capable
- Mechanically Robust

** Source: Prof. R. Kennel, Technical University Munich, Germany*

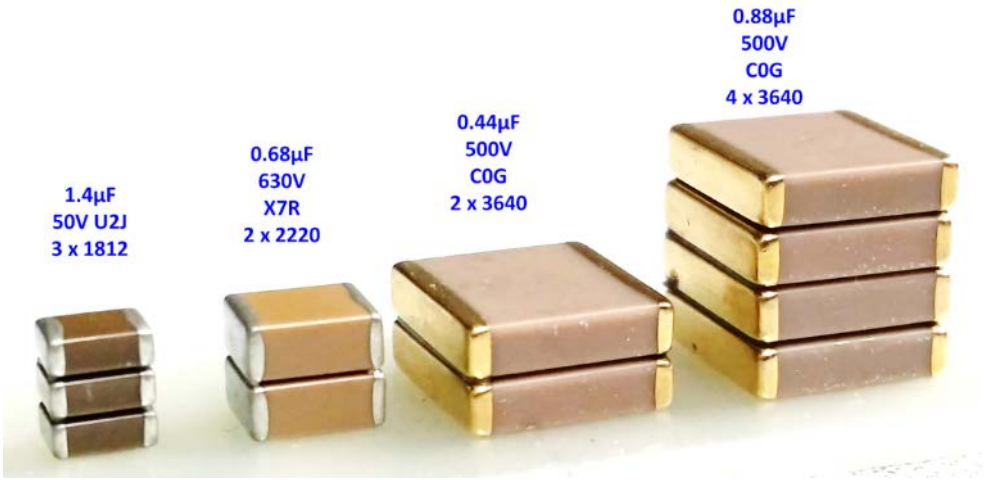
Trends in Capacitors for Power Electronics

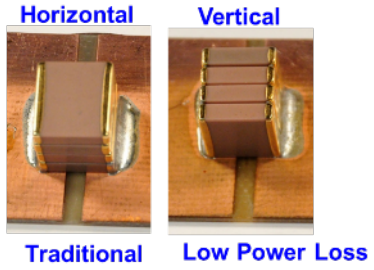
- Need for improved power conversion efficiency is driving the development of new systems and components: WBG Semi's
- These trends are changing the requirements for capacitors used in Power Electronics:
  - Higher switching frequencies → Need low loss capacitor with high ripple current capability
  - High operating voltages → GaN (to 650V), SiC (to >1700V)
  - Higher temperatures → 125°C, 150°C, > 200°C for SiC

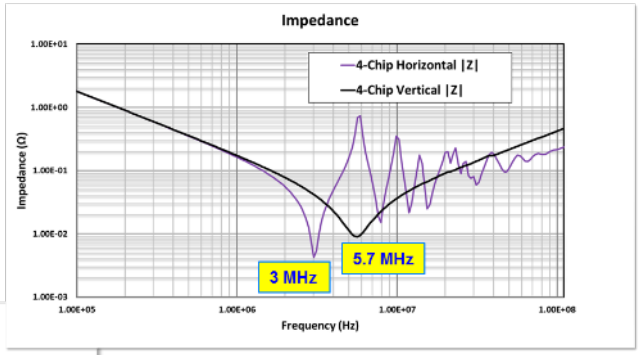
Capacitors for Future Power Applications

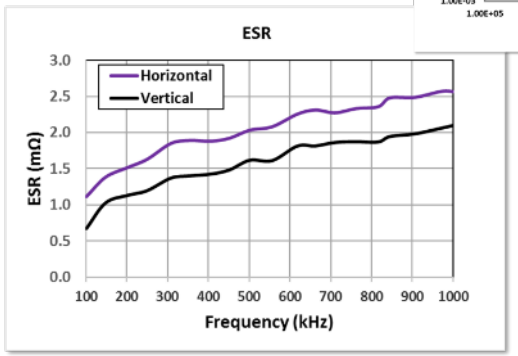
High Voltage Ni BME C0G MLCC are an excellent choice in power applications because of their:

- Reliable performance at high temperatures (125-300°C)
- Stable capacitance with temperature and voltage
- High voltage ratings (no derating required!)
- **Very low dissipation factors (low loss) (<<0.1%)**
- **High IR (low leakage) & high breakdown voltages**
- **High ripple current capability**









Vertical Orientation has:

- Higher SRF
- Lower ESR

C0G-0.88uF 3640 Stack