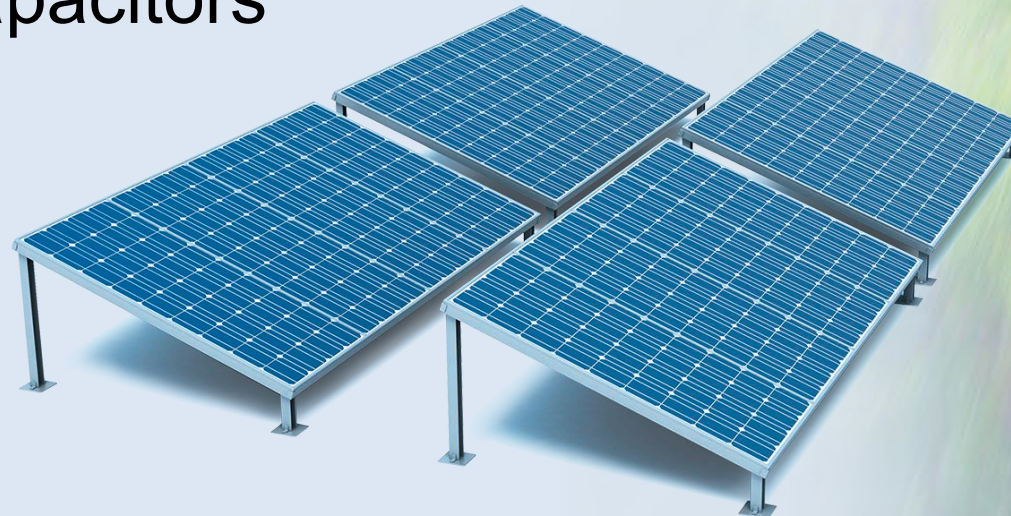


Attracting Tomorrow



# PEC MKP Capacitors

Aluminum & Film Capacitors  
Business Group



**TDK Electronics AG**  
Munich, Germany  
July 2022



# Aluminum & Film Capacitors Business Group at a glance

## Key data

|                  |  |
|------------------|--|
| Headquarters     | <b>Munich, Germany</b>   |
| Number of plants | <b>8</b>   |
| Employees total  | <b>6300</b>  |
| Management       | <b>Bernhard Koch</b><br>CEO<br><br><b>Karl Stoll</b><br>Deputy General Manager<br><br><b>Helmut Schilling</b><br>CFO |

## Portfolio

### Aluminum electrolytic capacitors

- ▮ Screw terminals
- ▮ Snap-in / Solder pins / Large size
- ▮ Axial-lead / Soldering star
- ▮ Single-ended
- Hybrid polymer aluminum electrolytic capacitors
  - ▮ SMD
  - ▮ Axial-lead / Soldering star

### Film capacitors for Industrial and for Automotive

- DC capacitors
- AC capacitors
- Power capacitor chips for low power (PCC LP)

### ● Power electronic capacitors (MKP)

### Film capacitors for Energy Solutions

- Power electronic capacitors for high power (PEC HP)
- Power electronic capacitors for low power (PEC LP MKP)
- Power factor correction (PFC) capacitors and key components for low and medium voltage (LV, MV)
- Power quality solutions (PQS)

# Our Aluminum & Film Capacitors Business Group has a global manufacturing presence





# Plant in Zhuhai, China

## Product range

### Aluminum & Film Capacitors BG

#### Film capacitors

- DC capacitors
- Power capacitor chips for low power (PCC LP)
- Power electronic capacitors for high power (PEC HP MKP)
- Power electronic capacitors for low power (PEC LP MKP)
- Power factor correction (PFC) capacitors and key components for low voltage (LV)
- Power quality solutions (PQS)

### Piezo & Protection Devices BG

- Disk, Energy, Strap and Block varistors
- SMD disc varistors (CU)
- Inrush current limiters (ICLs)
- PTC thermistors



70,100 m<sup>2</sup>

Founded in 1998

## Certification

- |             |                       |
|-------------|-----------------------|
| ● ISO 3834  | ● IRIS (ISO/TS 22163) |
| ● ISO 9001  | ● IATF 16949          |
| ● ISO 14001 |                       |

# Plant in Gravataí, Brazil

## Product range

### Aluminum & Film Capacitors BG

- Aluminum electrolytic capacitors
  - Axial-lead / Soldering star
  - Single-ended
  - Screw terminals
  - Snap-in / Solder pins
- Hybrid polymer aluminum electrolytic capacitors
  - SMD

### Film capacitors

- DC capacitors
- AC capacitors
- Power factor correction (PFC) capacitors and key components for low voltage (LV)
- Power electronic capacitors for defibrillators (MKP)



43,000 m<sup>2</sup>  
Founded in 1954

## Certification

- ISO 9001
- ISO 14001
- IATF 16949

# PEC MKP capacitors portfolio

## MKP AC



Input / Output filter

## MKP DC



DC link

## Defibrillator



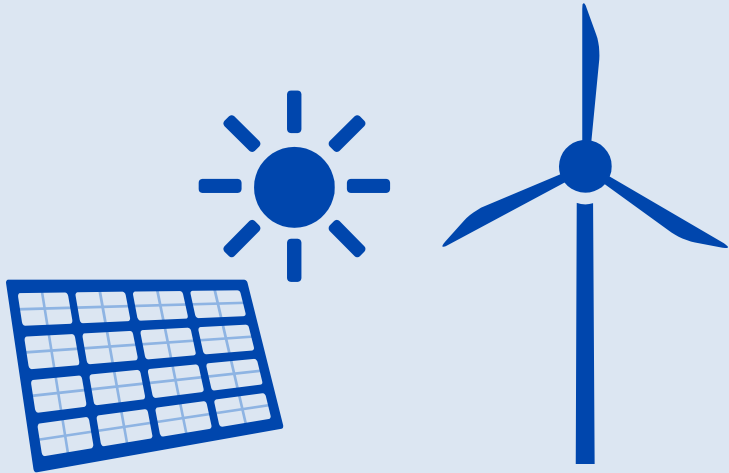
Defibrillator

## HVDC-C

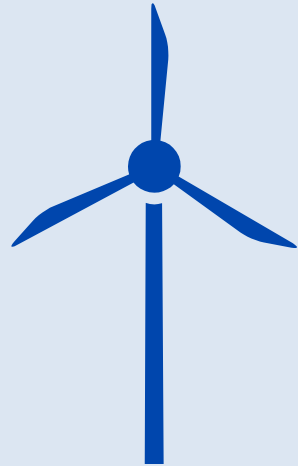


Power transmission

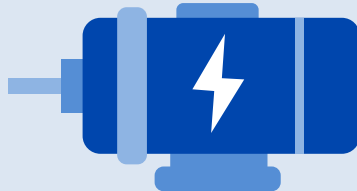
# Power capacitors for wide area of applications



Solar



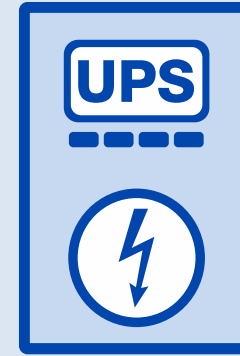
Wind



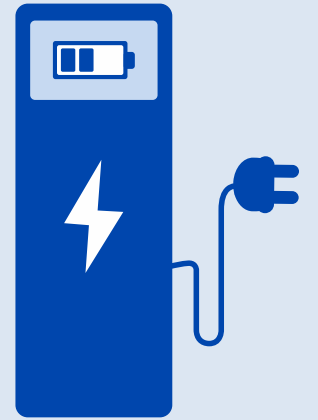
Drives



Traction



UPS



EV charger



# AC filter capacitors for industrial applications



Series  
B32361\*  
B32362\*

## Features

- Capacitance range 20  $\mu\text{F}$  to 600  $\mu\text{F}$ , 250  $\text{V}_{\text{RMS}}$  to 480  $\text{V}_{\text{RMS}}$
- IEC 61071, GB/T17702 and UL 810 compliant
- Temperature up to 85 °C hotspot
- Single-phase (1 Ph) capacitors

## Applications

- Capacitor for AC input/output filtering for industrial applications, converters, UPS, drives and wind/solar inverters

## Benefits

- Self-healing properties
- Safety mechanism, tear-off fuse overpressure disconnecter



# Defibrillator capacitor for medical application



Series  
B32365\*

## Features

- Capacitance range 30  $\mu$ F to 200  $\mu$ F, Voltage up to 5 kV
- Cylindrical and oval design (Plastic or metal case)
- Terminals cable design upon request (Straight/Flag fast-on & Stripped)
- Temperature up to 60 °C hotspot

## Applications

- AED (Automated External Defibrillator) and manual defibrillator

## Benefits

- Self-healing properties
- Low leakage current. High charge and discharge pulse capability
- Life expectancy up to 10,000 cycles

# DC-link filter capacitors for industrial applications



Series  
 B2568\* **New**  
 B2569\* **New**  
 B2562\*  
 B2563xB\*  
 B2563xE\* **New**

## Features

- Capacitance range 40  $\mu\text{F}$  to 4000  $\mu\text{F}$ , 500 V DC to 3000 V DC
- Low ESR  $<1 \text{ m}\Omega$  & low ESL  $<12 \text{ nH}$  (B2563\*E series, ultra low ESL design)
- Temperature up to 85 °C hotspot
- IEC 61071, RoHS compliant and UL 810 compliant

## Applications

- DC link for renewable energy inverters, industrial drives, e-mobility, medical and traction

## Benefits

- Hermetically sealed (B2568\* series)
- Self-healing properties
- 85 °C/85% RH  $V_N$  1000 h (B2568\*/B2569\* series)
- Life expectancy up to 100,000 hours at hot spot temperature +75 °C

# MKP DC filter capacitors product range

|                    | Rated DC<br>V <sub>R</sub> DC [V] | C <sub>R</sub> [μF]<br>tol. +/- 10% | Diameter<br>[mm] | Height<br>H <sub>C</sub> [mm] | Features   |
|--------------------|-----------------------------------|-------------------------------------|------------------|-------------------------------|--|
| Standard           | 700                               | 40                                  | 85               | 70                            | <b>B2562* series</b><br>• DC link for renewable energies, industrial drives and traction   |
|                    | ...                               | ...                                 | ...              | ...                           |  |
|                    | 3000                              | 4000                                | 116              | 345                           |  |
| Low LSI<br>ULSI HF | 500                               | 50                                  | 85               | 50                            | <b>B2563* series</b><br>• L <sub>s</sub> <13 nH<br>• DC link for e-mobility                |
|                    | ...                               | ...                                 | ...              | ...                           |  |
|                    | 2000                              | 400                                 | 85               | 65                            |  |
| Heavy<br>duty      | 900                               | 60                                  | 85               | 99                            | <b>B2568* series</b><br>• Metal top, hermetically sealed<br>• L <sub>S</sub> <14nH with 4T |
|                    | ...                               | ...                                 | ...              | ...                           |  |
|                    | 3000                              | 4000                                | 136              | 368                           |  |
| High PD            | 700                               | 45                                  | 75               | 95                            | <b>B2569* series</b><br>• Resin top, high humidity resistance and partial discharge        |
|                    | ...                               | ...                                 | ...              | ...                           |  |
|                    | 3000                              | 5500                                | 136              | 370                           |  |

## B2562\* series



## B2563\* series



New



New

## B2568\* series



- Hermetically closed for operations in harsh environment
- Fire and smoke classification according to EN 45545
- Ultra low ESL (4 terminals upon request)
- Customized designs (high frequency and segmented film) upon request

## B2569\* series



- Resin top with improved partial discharge capabilities
- High humidity resistance 1.3 V<sub>N</sub>, 85 °C/85%/500 hours
- Improved high Partial Discharge (PD) extinction voltage >1.6 kV AC (10 pC)

# Power capacitors in round can for DC applications

| MKP DC standard   | MKP DC HF   | MKP DC Resin top   | MKP DC Metal top  | MKP DC 4T   | MKP DC LSI  | MKP DC ULSI   |
|---|---|--|---|---|---|---|
| B2562   |   | B2569  | B2568   | B25689  | B2563*B   | B2563*E   |
|  |  |  |  |  |  |  |
| 40 $\mu$ F<br>4000 $\mu$ F  | Customized  | 40 $\mu$ F<br>5500 $\mu$ F   | 40 $\mu$ F<br>4000 $\mu$ F  | 80 $\mu$ F<br>3000 $\mu$ F  | 20 $\mu$ F<br>270 $\mu$ F   | 20 $\mu$ F<br>270 $\mu$ F   |
| 700 V DC<br>3 kV DC   | 700 V DC<br>3 kV DC   | 700 V<br>3 kV  | 900 V DC<br>3 kV DC   | 900 V DC<br>3 kV DC   | 700 V DC<br>2000 V DC   | 700 V DC<br>2000 V DC   |
| HF version available  | High frequency till 100 kHz   | High humidity HF version available   | Hermetically sealed   | Special types<br>Very low ESL < 10 nH<br>Hermetically sealed                        |   | Very low ESL<br>High frequency design   |



# Recommendations for EV charging

## High power density

- Trend to develop high-power density converters using SiC semiconductors
- Capacitors with high current capability, ultra low ESL and lower ESR at high frequencies are requested.



# MKP DC ultra low inductance series B2563\*E

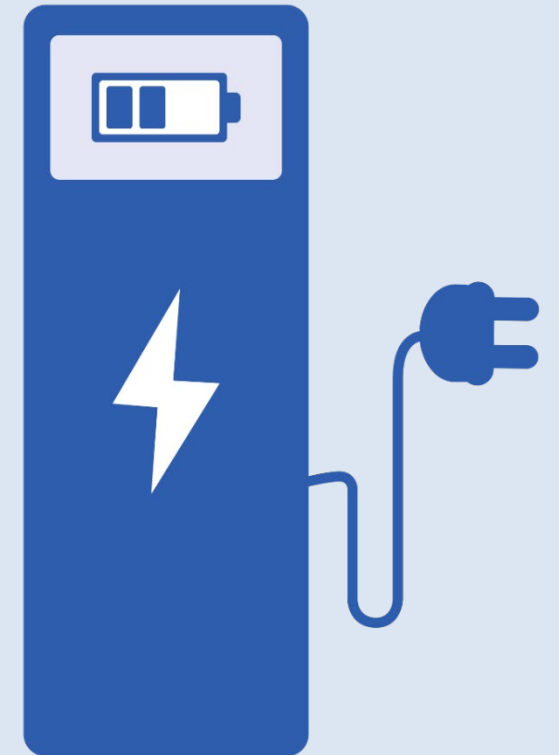
## Ultra low ESL < 13 nH

### Main applications

- DC fast charging
- Solar string inverters
- Induction heating
- Traction
- High speed switching applications

### Product description

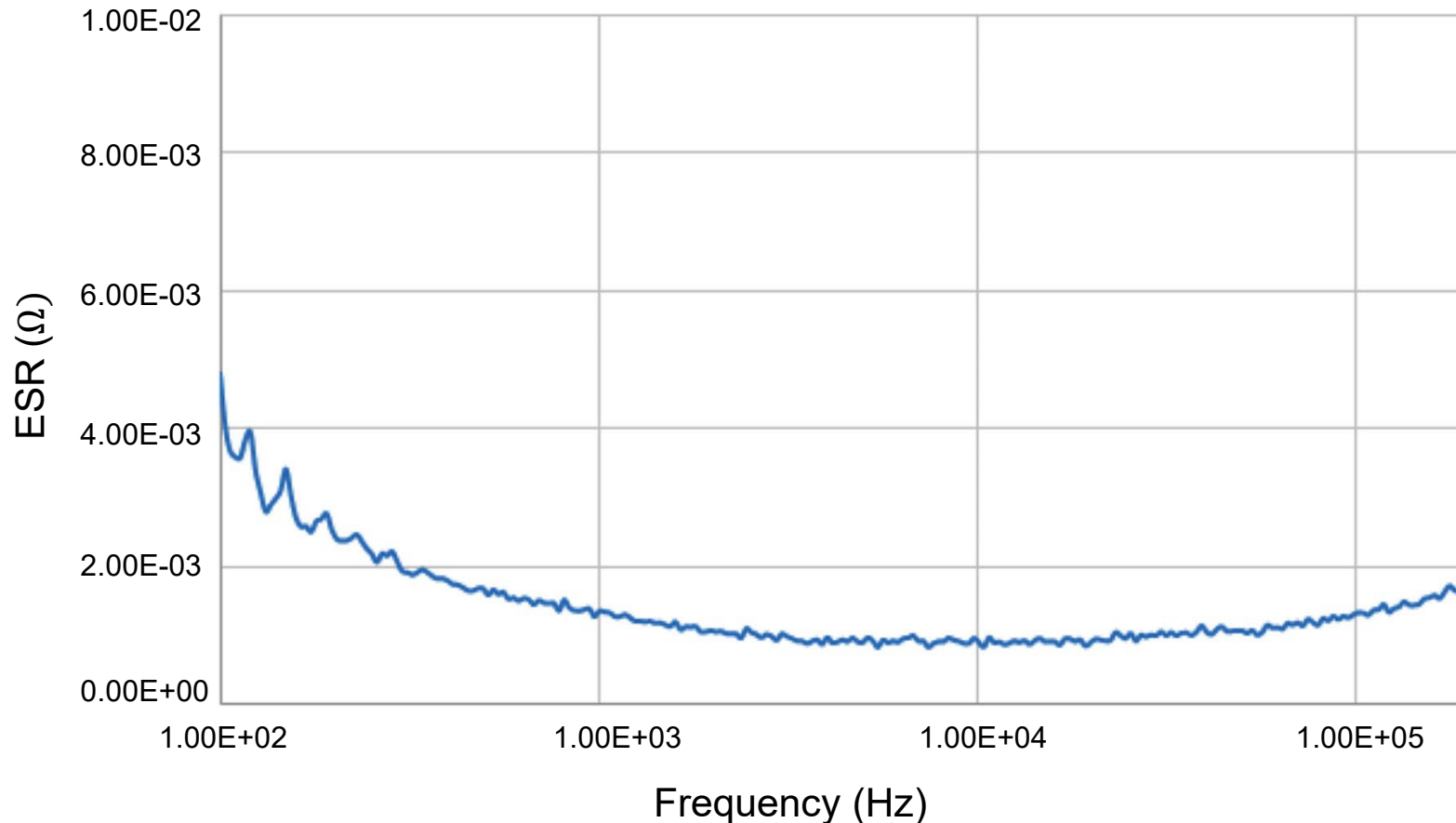
- Capacitance range 20  $\mu$ F to 270  $\mu$ F; V DC: 700 V to 2 KV
- **ESL < 13 nH**
- **Low ESR** over frequency
- Diameter: 85 mm
- Height: 50 mm and 65 mm
- Male (M8) or female (M5) terminals
- High current capability
- DC link for SiC power modules and Si modules with high speed switching
- For 85 °C HS, (samples available at higher temperatures)



# MKP DC ULSI HF

## ESR versus frequency

**B25632E1117K000 (110  $\mu$ F, 1000 V DC)**



### Typical switching frequency power module

20 kHz to 40 kHz, so it is important to characterize the capacitor to low/stable ESR values until several hundreds kHz and consider all the harmonics for the thermal considerations

### 110 $\mu$ F, 1000 V DC:

10 kHz: 1.18 m $\Omega$   
100 kHz: 1.38 m $\Omega$   
160 kHz: 1.5 m $\Omega$

### Low ESR in the working frequency range

# MKP DC metal top B2568\*

## Hermetically sealed MKP DC series with metal top disk (B2568\*)

- **Range:** 900 V to 3 kV, 50  $\mu$ F to 4 mF
- Main DC link voltage for traction: 1 kV for 1.7 kV IGBTs and 2 kV for 3.3 kV IGBTs
- **Target applications:**
  - ▢ Traction inverters
  - ▢ Commercial agricultural vehicles (CAV)
  - ▢ Medium-voltage drives (MVD)
- **Humidity:** 85 °C/85% RH 1000 hours
- **Fire & smoke classification acc. to EN 45545:** R22: HL3 R23,: HL2
- **Dimensions:** Ø 85, Ø 116 and Ø 136 mm; height 74 mm to 368 mm
- **Light weight** (aluminum)
- Good cooling (normally stacked 2 windings)
- Ultra low ESL with 4 terminals design (<14 nH, in some cases <10 nH possible)

**Standard datasheet available under:**

[www.tdk-electronics.tdk.com/en/power\\_capacitors](http://www.tdk-electronics.tdk.com/en/power_capacitors)





# MKP DC 4T: The hermetically sealed DC capacitor with ultra low ESL

Hermetically sealed MKP DC series with 4 terminals  
for ESL <14 nH (B25689\* series)

- **Range:** 900 V to 3 kV, 50  $\mu$ F to 3 mF
- Main DC link voltage for traction: 1 kV for 1.7 kV IGBTs and 2 kV for 3.3 kV IGBTs
- **Target applications:**
  - Traction inverters
  - All high-speed switching applications
- **Humidity:** 85 °C/85% RH 1000 hours
- **Fire & smoke classification acc. to EN 45545:** R22: HL3 R23: HL2
- **Dimensions:** Ø116; Height: 74 mm to 345 mm
- **Light weight** (aluminum)
- Good cooling (normally stacked 2 windings)
- Approx. **60% less ESL** than standard capacitor with 2T
- Typical ESL 12 to 15 nH (special designs with 10 nH possible)
- Lifetime up to 200,000 hours
- Samples available

**Standard datasheet available under:** [www.tdk-electronics.tdk.com/en/power\\_capacitors](http://www.tdk-electronics.tdk.com/en/power_capacitors)

**NEW**



**For harsh  
operating conditions  
especially traction  
applications**

# MKP DC metal top: Modular approach

Typical values requested – diameter = 116 mm:

| Hc (mm) | 1000 V DC<br>(1.7 kV power modules) | 1800 V DC<br>(3.3 kV power modules) | 2000 V DC<br>(3.3 kV power modules) | ESL<br>2 terminals | ESL<br>4 terminals |
|---------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------|--------------------|
| 75      | 360 µF                              | 100 µF                              | 80 µF                               | 32                 | 13                 |
| 100     | 550 µF                              | 165 µF                              | 130 µF                              | 25                 | 10                 |
| 179     | 1100 µF                             | 330 µF                              | 260 µF                              | 34                 | 14                 |
| 229     | 1500 µF                             | 450 µF                              | 360 µF                              | 38                 | 15                 |

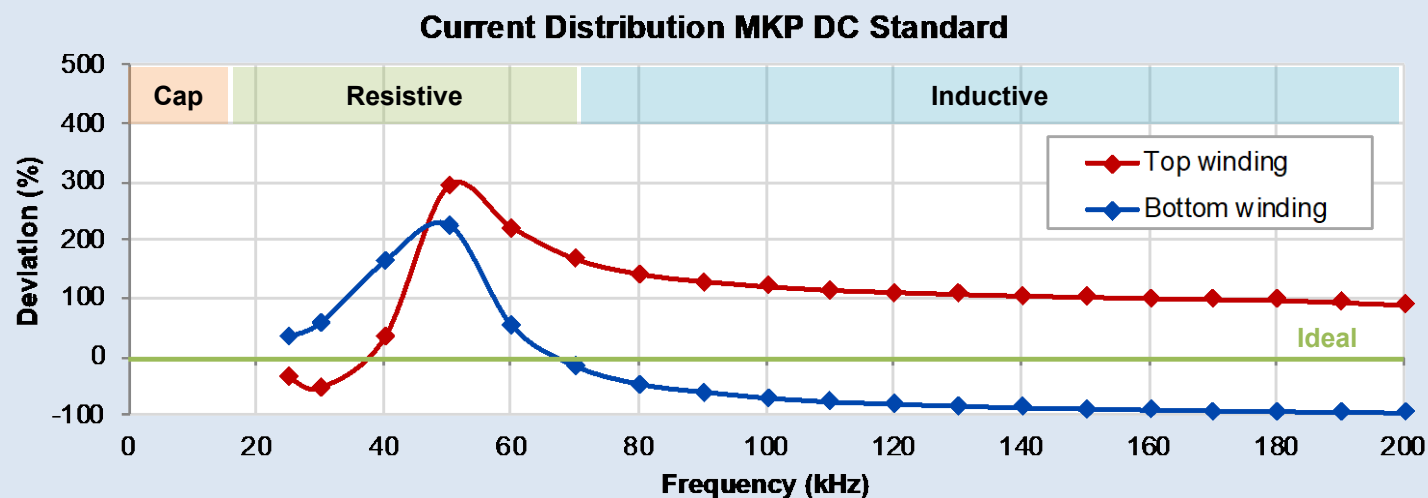
Typical values requested – diameter = 85 mm:

| Hc (mm) | 1000 V DC<br>(1.7 kV power modules) | 1800 V DC<br>(3.3 kV power modules) | 2000 V DC<br>(3.3 kV power modules) | ESL<br>(typical nH) |
|---------|-------------------------------------|-------------------------------------|-------------------------------------|---------------------|
| 179     | 550 µF                              | 160 µF                              | 130 µF                              | 22 nH               |
| 229     | 740 µF                              | 220 µF                              | 180 µF                              | 25 nH               |
| 252     | 810 µF                              | 240 µF                              | 195 µF                              | 28 nH               |

\* Special types with even lower ESL upon request



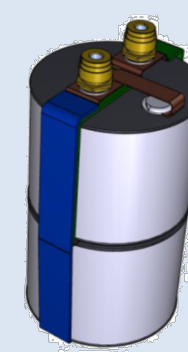
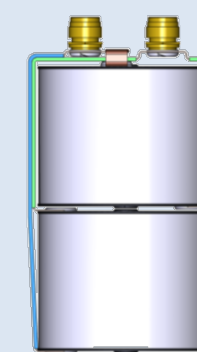
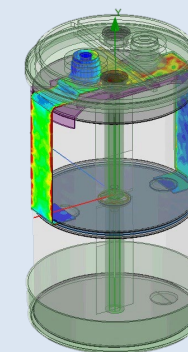
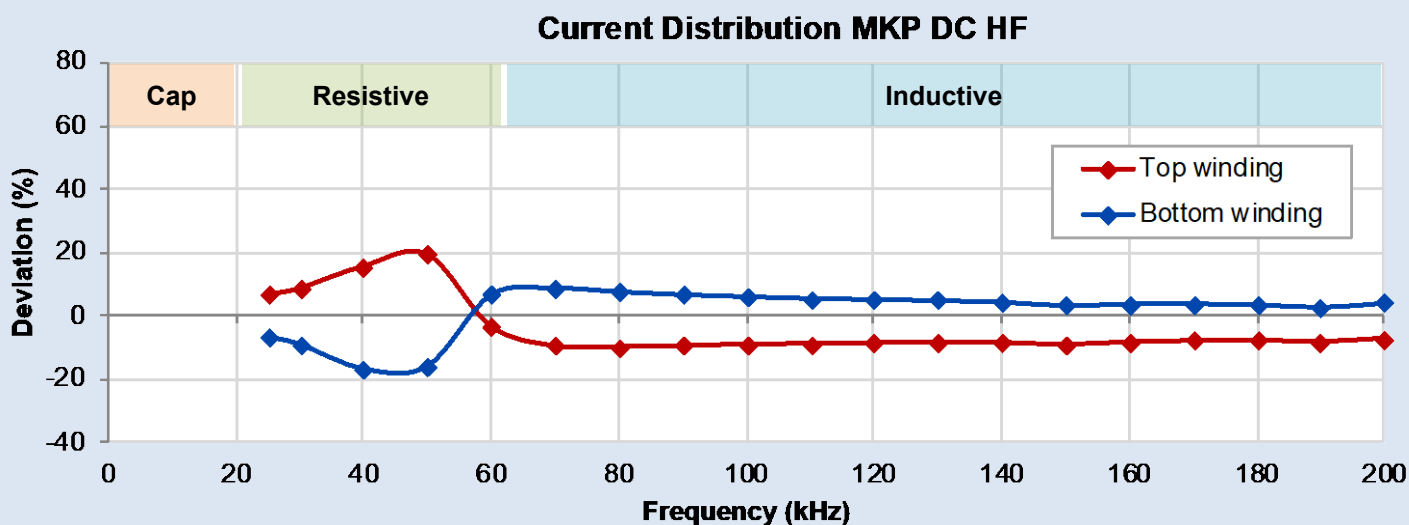
# MKP DC high frequency vs MKP DC standard



- Operation above its resonance frequency
- Homogeneous current distribution
- Internal resonance avoidance

**Solution:** Same impedance vs frequency for all the internal capacitance elements

- Operative capacitor up to 200 kHz
- Reduced inductance



**MKP DC high frequency**

# Recommendations for renewable energies solar & wind

## Better efficiency

- **Solar.** Since PV is strongly influenced by cost pressure then new inverters are forced to offer very high efficiency (97% to 98%) with longer maintenance periods.
- Application is demanding cost optimized standard products with higher nominal voltages and reduced ESR/ESL. Capacitors should be optimized to work at higher frequencies.
- **Wind** is as well strongly influenced by cost pressure with a trend to increase the output power specially in off-shore application.
- Both applications are demanding higher current densities.



Semikron Skiip4 module  
with our resin top DC link series



Full SiC String inverter using our  
ULSI capacitors family



# Recommendations for traction

## High power density

- In light train application, the use of light and low volume converters is a must, so standardization of components (modular platforms) together compact designs is highly appreciated.
- Becoming more popular the use of fast switching IGBTs and SiC semiconductors with higher switching frequencies. This requires low ESL capacitors. Two good series are our MKP 4 terminal capacitor with ESL as low as 10 nH.





[www.tdk-electronics.tdk.com](http://www.tdk-electronics.tdk.com)