Application Guide

Products for Traction Applications
Solutions for Propulsion, Auxiliary Power and HVAC inverters

Business groups supporting both TDK and EPCOS brand products, organized according to product categories.

Magneetics
- Ferrites
- Transformers
- Power Inductors
- Signal Use Inductors
- Multilayer Inductors
- Signal EMC Filters
- Power EMC Filters
- EMC and RF Engineering

Capacitors
- Screw Terminal Aluminum Electrolytic
- Snap-In Aluminum Electrolytic
- DC Box Film
- DC Plastic and Metal Can
- AC Box Film
- AC Plastic and Metal Can
- Power Electronic Film
- Power Factor Correction Film
- Power Quality Solutions

Sensors
- NTC Sensors
- Pressure Sensors
- Applied Sensors

Ceramic Capacitors
- General and Small Capacitors
- High Capacitance Capacitors
- Applied Products
- Dielectric Materials and Products

Protection Devices
- Piezo
- Inrush Current Limiters
- PTC
- Thermistors
- Disk Varistors
- Multilayer Varistors
- Surge Arresters

SAW and BAW Filter Products
- Multilayer Modules
- MEMS Products
- Multilayer HF Components
- Dielectric Components
- Isolators and Circulators

www.tdk.com
www.epcos.com
# Product Guide

## Aluminum Electrolytic Capacitors

<table>
<thead>
<tr>
<th>Series</th>
<th>Technical Data</th>
<th>Features</th>
<th>Series / Type</th>
</tr>
</thead>
</table>
| Screw Terminal | $V_C: 200 \ldots 600 \text{ V DC}$  
$C: 560 \ldots 33000 \mu\text{F}$  
Useful life up to +105 °C, 8000 h or +85 °C, 15000 h | • High ripple current capability  
• Long useful life, > 20 years possible  
• Compact can size  
• Special design for base cooling  
• Self-extinguishing electrolyte available | B4345x  
B434x4  
B435x4  
B437x0 |
| 4-/5-pin Snap-in Terminals & Solder Pins | $V_C: 350 \ldots 500 \text{ VDC}$  
$C: 330 \ldots 3300 \mu\text{F}$ | • High ripple current capability  
• Long useful life, > 20 years possible  
• Compact can size | B435x0  
B435x1  
B435x5 |
| Snap-in | $V_C: 160 \ldots 600 \text{ VDC}$  
$C: 47 \ldots 3300 \mu\text{F}$ | • High ripple current capability  
• Long useful life, > 20 years possible  
• Compact can size | B43305, B4350x  
B4354x, B43601  
B4364x |

## DC Film Capacitors

### MKP Snubber

<table>
<thead>
<tr>
<th>Series</th>
<th>Technical Data</th>
<th>Features</th>
<th>Series / Type</th>
</tr>
</thead>
</table>
| MKP DC | $V_C: 850 \ldots 2000 \text{ VDC}$  
$C: 47\text{nF} \ldots 3.3 \mu\text{F}$ | • Operating temperature up to +110 °C  
• Service life 200 kAh at 1.0 · $V_C$, +85 °C | B32656S |
| MKP DCI | $V_C: 1000 \ldots 2000 \text{ VDC}$  
$C: 22\text{nF} \ldots 0.68 \mu\text{F}$ | • Various terminal configurations  
• High dv/dt, current, & frequency | B32686S |
| MKP DC LSI | $V_C: 700 \ldots 1980 \text{ VDC}$  
$C: 30 \ldots 1500 \mu\text{F}$  
$T_{\text{op}}: -55 \ldots +70 ^\circ\text{C}$  
UL810, file# E183224 | • High peak current capability  
• Aluminum can  
• Optional plastic cap for increased creepage and clearance distances | B2562x |
| MKK DC | $V_C: 500 \ldots 1200 \text{ VDC}$  
$C: 50 \ldots 400 \mu\text{F}$  
$T_{\text{op}}: -55 \ldots +70 ^\circ\text{C}$ | • High peak current capability  
• Low self inductance  
• UL 94 V0 plastic can | B2563x |
| MKK DCI | $V_C: 700 \ldots 6000 \text{ VDC}$  
$C: 100 \ldots 30000 \mu\text{F}$ | • DC link and series resonant circuits  
• Rapseised oil or dry gas impregnation | B25656A  
B25650  
B25750 |
| MKK DCR | $V_C: 800 \ldots 1500 \text{ VDC}$  
$C: \text{to} 12500 \mu\text{F}$  
$T_{\text{op}}: -25 \ldots +80 ^\circ\text{C}$ | • Low ESL  
• Resin filled | B25640 |

## AC Film Capacitors

### MKP AC

<table>
<thead>
<tr>
<th>Series</th>
<th>Technical Data</th>
<th>Features</th>
</tr>
</thead>
</table>
| MKP AC | $V_{\text{rms}}: 250 \ldots 1500 \text{ VAC}$  
$C: 3 \ldots 600 \mu\text{F}, \text{3PH to} 150 \mu\text{F}$  
$T_{\text{op}}: -40 \ldots +70 ^\circ\text{C}$  
UL 810, file# E106388 | • High peak current capability  
• Customized configurations  
• Overpressure disconnector  
• Aluminum can |

## Protection Devices

### Varistors

<table>
<thead>
<tr>
<th>Series</th>
<th>Technical Data</th>
<th>Features</th>
</tr>
</thead>
</table>
| LS40 | $I_{\text{Max}}: 40 \ldots 75 \text{ kA (8/20 \mu s)}$  
$V_{\text{RMS}}: 130 \ldots 550 \text{ V}$ | • Strap MOV, 40 ... 50mm  
• Chassis or PCB mount |
| LS41 | $I_{\text{Max}}: 0.8 \ldots 20 \text{ kA (8/20 \mu s)}$  
$V_{\text{RMS}}: 130 \ldots 550 \text{ V}$ | • Disc MOV, 5 ... 25mm  
• PCB mounted; leaded |
| LS42 | $I_{\text{Max}}: 400 \ldots 2500 \text{ A}$  
$V_{\text{RMS}}: 255 \text{ VAC}$ | • CU3225, CU4032, CU4648  
• UL 94V0 Plastic case |

## Sensing Devices

### NTC Temp sensors

<table>
<thead>
<tr>
<th>Series</th>
<th>Technical Data</th>
<th>Features</th>
</tr>
</thead>
</table>
| B57703 | $T_{\text{set}}: -55 \ldots +200 ^\circ\text{C}$  
$R_{\text{res}}: 5 \Omega \ldots 100 \text{ k}\Omega$ | • Thermal coupling through metal tag  
• UL approval (E69802) for M703 |
| B57045K | $T_{\text{set}}: -55 \ldots +125 ^\circ\text{C}$  
$R_{\text{res}}: 1 \text{k}\Omega \ldots 150 \text{ k}\Omega$ | • Thermal coupling through screw case  
• 10 000hr at 100°C, <5% $\Delta R_{\text{set}}/R_{\text{set}}$ |
| B58100 | $T_{\text{set}}: -55 \ldots +100 ^\circ\text{C}$  
$R_{\text{res}}: 3300 \Omega$ | • Glass NTC element, surface probe  
• Thermal time constant ~5s |
Examples of Capacitors used for Light and Metro Rail

<table>
<thead>
<tr>
<th>Module OEM</th>
<th>Capacitor Ratings</th>
<th>Function</th>
<th>Capacitor Type</th>
<th>Series / Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propulsion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The main power electronics for propelling the vehicle. This system will use either aluminum electrolytic or power electronic film capacitors for the DC link circuit. There may also be potentials for snubbing or commutating capacitors on the IGBTs.

<table>
<thead>
<tr>
<th>OEM</th>
<th>Capacitor Ratings</th>
<th>Function</th>
<th>Capacitor Type</th>
<th>Series / Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABB</td>
<td>5,200μF, 450VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43564S5528...</td>
</tr>
<tr>
<td>Alstom</td>
<td>16,000μF, 350VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43564S4169...</td>
</tr>
<tr>
<td>Bombardier</td>
<td>11,000μF, 400VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43456S9119...</td>
</tr>
<tr>
<td>General Electric</td>
<td>17,000μF, 350VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43456S4179...</td>
</tr>
<tr>
<td>Siemens</td>
<td>1,800μF, 1200VDC</td>
<td>DC Link</td>
<td>Power Film Capacitor, Round Can</td>
<td>B25653V0188...</td>
</tr>
<tr>
<td></td>
<td>1,500μF, 1200VDC</td>
<td>DC Link</td>
<td>Power Film Capacitor, Round Can</td>
<td>B25653V0158...</td>
</tr>
<tr>
<td></td>
<td>2,040μF, 1100VDC</td>
<td>DC Link</td>
<td>Power Film Capacitor, Round Can</td>
<td>B25653V0208...</td>
</tr>
<tr>
<td>Rohr</td>
<td>1,500μF, 1500VDC</td>
<td>DC Link</td>
<td>Power Film Capacitor, Round Can</td>
<td>B25653V0158...</td>
</tr>
</tbody>
</table>

Low Voltage (LVPS) or Auxiliary (APS) Power Supply

These systems are for converting high voltage DC to standard AC voltage for running control systems, lighting, heating ventilation and air conditioning. Common components for these systems are both low voltage and high voltage aluminum electrolytic capacitors as well as AC capacitors and inductors for filtering the low frequency harmonics on the AC power line.

<table>
<thead>
<tr>
<th>OEM</th>
<th>Capacitor Ratings</th>
<th>Function</th>
<th>Capacitor Type</th>
<th>Series / Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alstom</td>
<td>3x153μF, 380VAC</td>
<td>AC Output Filter</td>
<td>AC Film Capacitor, Round Can</td>
<td>B32344E3251...</td>
</tr>
<tr>
<td>SEPSA</td>
<td>68,000μF, 63VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B41456S8689...</td>
</tr>
<tr>
<td>Toshiba</td>
<td>15,000μF, 400VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43456S9159...</td>
</tr>
<tr>
<td></td>
<td>10,000μF, 400VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43456S9109...</td>
</tr>
</tbody>
</table>

HVAC Inverter

Newer air conditioning systems often utilize inverter based systems for controlling compressors and blower fans for better efficiency and a higher degree of control. These inverter systems normally use aluminum electrolytic capacitors for the DC bus in the inverter.

<table>
<thead>
<tr>
<th>OEM</th>
<th>Capacitor Ratings</th>
<th>Function</th>
<th>Capacitor Type</th>
<th>Series / Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mistubishi Electric</td>
<td>8,200μF, 450VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43564S5628...</td>
</tr>
<tr>
<td>SEPSA</td>
<td>10,000μF, 450VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43456S6109...</td>
</tr>
<tr>
<td></td>
<td>8,200μF, 450VDC</td>
<td>DC Link</td>
<td>Screw Terminal Aluminum Electrolytic</td>
<td>B43456S6828...</td>
</tr>
</tbody>
</table>

Similar Traction Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>Example</th>
<th>Application Features</th>
<th>Capacitor Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining Truck</td>
<td><img src="example.png" alt="Image" /></td>
<td>Medium voltage drives for propulsion of the vehicle as well as actuation of additional moving components such as dumping truck bed or lifting shovels.</td>
<td>MKK DC, MKK DCI, MKK DCR, PCC HP</td>
</tr>
<tr>
<td>Mining Shuttle Car</td>
<td><img src="example.png" alt="Image" /></td>
<td>Medium voltage drives for propulsion of the vehicle. May also drive conveyor systems, or run cutting plows for longwall mining.</td>
<td>MKK DC, MKK DCI, MKK DCR, PCC HP</td>
</tr>
<tr>
<td>Electric Bus / Trolley</td>
<td><img src="example.png" alt="Image" /></td>
<td>Low voltage or medium voltage drives for propulsion of vehicle as well as powering auxiliary AC power for running lighting, control systems, heating, ventilation and air conditioning.</td>
<td>MKP DC LSI, MKK DCR, PCC HP, PCC LP</td>
</tr>
<tr>
<td>Locomotive</td>
<td><img src="example.png" alt="Image" /></td>
<td>In diesel locomotives the diesel engine is merely a generator of electricity, with the design similar to a series hybrid vehicle. A medium voltage drive is used for propulsion since extraordinary levels of torque are required for pulling heavy cargo.</td>
<td>MKK DC, MKK DCI, MKK DCR</td>
</tr>
<tr>
<td>Farm Equipment</td>
<td><img src="example.png" alt="Image" /></td>
<td>Low voltage or medium voltage drives for propulsion of the vehicle as well as actuation of additional moving components such rotating cutting tools.</td>
<td>MKK DCR, Screw Terminal Alu, PCC LP</td>
</tr>
<tr>
<td>Military Vehicle</td>
<td><img src="example.png" alt="Image" /></td>
<td>Low voltage or medium voltage drives for propulsion of the vehicle. These may be either series or parallel hybrid systems for either complete electric traction or electric assist for climbing steep grades. May also be parked and used as generators for field hospitals or temporary camps.</td>
<td>MKP DC, MKP DC LSI, MKK DCR, PCC HP, PCC LP</td>
</tr>
</tbody>
</table>
**Solutions for Traction Applications**

**Light Rail Propulsion**

- **A**: Varistors (leaded, strap & block)
- **B**: DC Link Film; MKP, PCC, MKV, or MKK
- **C**: DC Link Al Snap-in or Screw Terminal
- **D**: Snubbering or commutating capacitors
- **E**: Temperature sensors (NTC or PTC)
- **F**: Output Filtering Capacitors

**Hybrid Bus Propulsion**

- **G**: DC Link Capacitor
- **GB**: Gear Box
- **M**: Motors
- **EC**: Energy Converter

**Traction Converter**

**INPUT PROTECTION**

**CONVERSION DC LINK**

**ACTIVE**

**OUTPUT FILTERING**

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