MULTILAYER CERAMIC CHIP
HIGH VOLTAGE CAPACITORS

AVAILABLE RANGE

![Bar chart showing capacitance value vs. rated voltage for different grades of MLCC.]

FEATURES

- Reliable noble metal electrode (NME) system
- Polymer termination available
- 100% tested at min. 120% of rated voltage

ADVANTAGES OF HV MLCC CAPS OVER LEADED CAPS

- Smaller size is suitable for mobile devices
- Surface-mount package allows for lower cost assembly
- Multilayer design offers greater capacitance values
- No voltage or temperature dependence with C0G (NPO) Class I ceramic dielectric

FOOTPRINT

- C0G (NPO): 1808, 1812, 1825, 2220, 2225, 3640
- X7R

APPLICATIONS

- X-RAYS AND AIR PURIFYING
  - Voltage multiplier
- LASER
  - Marx bank

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Noble Metal Electrode (NME) System

HV
High Voltage Series

Capacitance Value (pF)

Rated Voltage (kVDC)

≥ 2 mm
LOW ESR TANTALUM CAPACITORS
FROM LOW ESR TO VERY LOW ESR SMD, TANTALUM, AND POLYMER TECHNOLOGIES

Capacitance and Voltage | ESR | Case Size
---|---|---
TR3 Tantalum
From 4 V to 75 V
From 0.47 µF to 1000 µF
Down to 45 mΩ | A, B, C, D, E, W
T55 Polymer
From 2.5 V to 63 V
From 3.3 µF to 1000 µF
Down to 6 mΩ | J, P, A, T, B, Z, V, D

Used for decoupling, smoothing, bulk energy storage, and filtering in:

- Solid State Drives (SSD)
- Infrastructure equipment
- Computer motherboards
- Computer servers
- Power conversion and distribution
- Gaming and video
- Smart meters
- Lighting

T55 SERIES

Performance Characteristics
TR3, T55

Applications
Industrial
Telecom
Consumer

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MAP POLYMER CAPACITORS
HIGH ENERGY DENSITY CAPACITORS

DERATING

<table>
<thead>
<tr>
<th></th>
<th>Standard Tantalum</th>
<th>Polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specified Derating</td>
<td>50 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>10 V</td>
<td>6.3 V</td>
</tr>
<tr>
<td>Design Voltage</td>
<td>5 V</td>
<td>5 V</td>
</tr>
</tbody>
</table>

Example:
- Voltage: Standard Tantalum vs. Polymer
- Derating: 50% vs. 20%
- Rated: 10 V vs. 6.3 V
- Design: 5 V vs. 5 V

VISHAY MAP MEANS MORE CAP
Large anode size

MAP

Molded

Examples:
- T58 – 330 µF at 6.3 V, BB case size
- T58 – 47 µF at 6.3 V, M0 case size
- T52 – 330 µF at 16 V, M1 case size
- T59 – 470 µF at 16 V, EE case size

IN A NUTSHELL

TERMINATIONS

<table>
<thead>
<tr>
<th></th>
<th>L-Shaped (T58, T52)</th>
<th>Wraparound (T59, T54)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

APPLICATIONS

AMS (AVIONICS, MILITARY, AND SPACE)

VISHAY FOOTPRINT AND PROFILE CAPABILITY

<table>
<thead>
<tr>
<th></th>
<th>T58</th>
<th>T52</th>
<th>T59</th>
<th>T54</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BB</td>
<td>B2</td>
<td>B0</td>
<td>A0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.138 (3.5)</td>
<td>0.138 (3.5)</td>
<td>0.138 (3.5)</td>
<td>0.138 (3.5)</td>
</tr>
<tr>
<td></td>
<td>0.126 (3.2)</td>
<td>0.063 (1.6)</td>
<td>0.063 (1.6)</td>
<td>0.063 (1.6)</td>
</tr>
<tr>
<td></td>
<td>0.079 (2.0)</td>
<td>0.049 (1.25)</td>
<td>0.049 (1.25)</td>
<td>0.049 (1.25)</td>
</tr>
<tr>
<td></td>
<td>0.063 (1.6)</td>
<td>0.033 (0.85)</td>
<td>0.033 (0.85)</td>
<td>0.033 (0.85)</td>
</tr>
<tr>
<td></td>
<td>0.079 (2.0)</td>
<td>0.079 (2.0)</td>
<td>0.079 (2.0)</td>
<td>0.079 (2.0)</td>
</tr>
<tr>
<td></td>
<td>0.035 (0.9)</td>
<td>0.035 (0.9)</td>
<td>0.035 (0.9)</td>
<td>0.035 (0.9)</td>
</tr>
</tbody>
</table>

Shown at actual size (when viewed or printed at 100%)

Profile in inches (millimeters)

For Technical Questions: polytech@vishay.com
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CLASS X
Differential Mode Filtering Across the Line

<table>
<thead>
<tr>
<th>Sub Class</th>
<th>Peak Impulse Voltage</th>
<th>Typical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>4.0 kV</td>
<td>High Pulse</td>
</tr>
<tr>
<td>X2</td>
<td>2.5 kV</td>
<td>General Purpose</td>
</tr>
</tbody>
</table>

CLASS Y
Common Mode Filtering Line to Ground

<table>
<thead>
<tr>
<th>Sub Class</th>
<th>Peak Impulse Voltage</th>
<th>Typical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y1</td>
<td>8.0 kV</td>
<td>High Pulse</td>
</tr>
<tr>
<td>Y2</td>
<td>5.0 kV</td>
<td>General Purpose</td>
</tr>
</tbody>
</table>

For a Full Overview of RFI Capacitors, Please Visit www.vishay.com/doc?48140
IN A NUTSHELL

LOW ESR, HIGH RIPPLE CURRENT CAPABILITIES

FILM CAPACITOR RIPPLE CURRENT CAPABILITY VS. ALUMINUM ELECTROLITICS

ADVANTAGES OF DC-LINK FILM CAPACITORS OVER ALUMINUM ELECTROLYTIC

- High voltage capability: no series connection; no balancing resistors
- Self healing technology
- Lifetime over 100,000 hours
- No dry out -> stable parameters until the end of life
- Stable electrical parameters across temperature range

APPLICATIONS

- On Board Chargers
- 48 V Board Net
- Forklifts
- Renewable Energy
- Welding Equipment
- Power Supplies
- Motor Drives

DC-LINK FILM CAPACITORS VOLTAGE VS. CAPACITANCE RANGE

MK1848 MKP1848C MKP1848S MKT1820

Automotive Grade DC-Link Film Capacitor (AEC-Q200 Compliant)
High Density DC-Link Film Capacitor Up to 1 µF/cm³
Low Profile DC-Link with Building Heights of 12 mm, 15 mm, 18 mm, and 24 mm
Low Voltage and High Temperature (Up to 150 ºC) DC-Link for 48 V Board Net
**196 HVC ENYCAP™ HYBRID ENERGY STORAGE CAPACITORS**

Electrostatic Storage + Electrochemical Storage = Hybrid Storage

**THE 196 HVC ENYCAP “SWEET SPOT”**

- **Energy Density (Wh/kg):**
  - Fuel Cells: 1000
  - Conventional Batteries: 100
  - 196 HVC: 10
  - Ultracapacitors: 0.1

- **Power Density (W/kg):**
  - Fuel Cells: 1000
  - Conventional Batteries: 100
  - 196 HVC: 10
  - Ultracapacitors: 0.01

**Higher Energy Density by Volume**

- EDLC Supercapacitor: 13 Ws/g
- 1/3 of the volume

**4 CAPACITANCE OPTIONS**

- 196 F
- 45 F
- 15 F
- 90 F

**196 HVC ENYCAP POWER SOURCE**

**NORMAL MODE**

- POWER MANAGEMENT UNIT
- CHARGE
- 196 HVC

**BACKUP MODE**

- POWER MANAGEMENT UNIT
- REVERSE
- 196 HVC

**STACKABLE**

- 1.4 V
- 8.4 V

**196 HVC ENYCAP vs. a Battery**

- More charge and discharge cycles: over 100 000
- No memory effect
- Longer lifetime

**196 HVC ENYCAP vs. a Traditional Supercapacitor**

- Lower self-discharge
- More than 3 times the energy density
- No cell balancing

**460 Ws OF STORED ENERGY (4 CELLS)**

Example: 1 A for 200 s

Not just a capacitor, it’s the 196 HVC ENYCAP hybrid energy storage capacitor!

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HIGH OPERATING TEMPERATURE IN A NUTSHELL

RADIAL-LEADED AUTOMOTIVE MLCCs

AEC-Q200 Qualified with PPAP Available

OPERATING TEMPERATURE IN AUTOMOTIVE

Not an ordinary CAPACITOR, it's built for the MOST EXTREME automotive operating conditions

KEY APPLICATIONS

- Engine control
- Engine sensor protection
- Exhaust system

Dielectric Dielectric

COG X0U

<table>
<thead>
<tr>
<th>Voltage $V_{dc}$</th>
<th>50</th>
<th>100</th>
<th>200</th>
<th>50</th>
<th>100</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. Cap.</td>
<td>100 pF</td>
<td>100 pF</td>
<td>100 pF</td>
<td>47 nF</td>
<td>47 nF</td>
<td>82 nF</td>
</tr>
<tr>
<td>Max. Cap.</td>
<td>12 nF</td>
<td>12 nF</td>
<td>8.2 nF</td>
<td>1 µF</td>
<td>470 nF</td>
<td>470 nF</td>
</tr>
</tbody>
</table>

SMD

- PCB bending and vibration may cause mechanical stress and capacitor cracks

BOARD DEFLECTION CRACKS

- More robust to thermo-mechanical stress and vibration
- Impact on the MLCC is reduced as the lead wires absorb the bending stress
- The capacitor can be welded or soldered directly to a lead frame and overmolded with plastic

Leaded MLCC

www.vishay.com

cmlf@vishay.com

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* 200 °C for max. 500 hours and 175 °C unlimited time
**220 EDLC**

**ENERGY STORAGE CAPACITORS**

**IN A NUTSHELL**

- **Higher discharge current**
- **> 500,000 charge / discharge cycles**
- **Superfast charge and discharge**
- **Category temperature -40 °C to +85 °C**

**Comparison of Alu vs. 220 EDLC**

- **Alu:** 15 F, 16 mm x 20 mm to 60 F, 18 mm x 40 mm
  - Voltage range: 25 V
  - Energy density: 90 mm³

- **220 EDLC:**
  - Capacitance: 1 F to 40 F
  - Voltage range: 2.7 V to 2.3 V
  - Energy density: 31 mm³

**Product Versions**

- **ENERGY**
  - Low leakage current
  - More capacity per volume

- **POWER**

**Multiple Capacitance Values**

- **Alu:** 15 F to 60 F
- **220 EDLC:** 1 F to 40 F

**Voltage vs. Temperature**

- **2.7 V - 65 °C**
- **2.3 V - 85 °C**

**Power Back-Up Applications**

- **Fuel Cells**
- **Conventional Batteries**
- **1 hour 196 HVC**
- **220 EDLC**

- **Conventional Capacitors**
  - 10 hours
  - 1 second
  - 0.03 seconds

**Comparison of Alu vs. 220 EDLC**

- **Voltage vs. Temperature**

**Multiple Capacitance Values**

- **Alu:** 15 F to 60 F
- **220 EDLC:** 1 F to 40 F

**Voltage vs. Temperature**

- **2.7 V - 65 °C**
- **2.3 V - 85 °C**
**POLYMER CAPACITORS**

**HIGH-CAPACITANCE, LOW-ESR CAPACITORS**

<table>
<thead>
<tr>
<th>DERATING</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specified Derating</td>
</tr>
<tr>
<td>Standard Tantalum</td>
<td>50 %</td>
</tr>
<tr>
<td>Polymer</td>
<td>20 %</td>
</tr>
</tbody>
</table>

**Ultra-Low ESR (10x improvement)**

<table>
<thead>
<tr>
<th>Capacitor Type</th>
<th>ESR (mΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Tantalum</td>
<td>125 mΩ</td>
</tr>
<tr>
<td>Polymer</td>
<td>12 mΩ</td>
</tr>
</tbody>
</table>

330 μF, 6.3 V, D CASE SIZE

**Polymer Cap Map**

- **Polymer Capacitors Advantages Over MLCC**
  - No piezo noise effect
  - No capacitance loss with DC bias
  - More robust design (no cracking)
  - Superior temperature stability

- **Polymer Capacitors Advantages Over Standard Tantalum**
  - Lower ESR
  - Non-burn feature
  - Better derating

- **Polymer Capacitors Advantages Over Aluminum**
  - Superior stability
  - Longer life
  - Higher operating temperature range
  - Better volumetric efficiency

**Applications**

- **AMS (Avionics, Military, and Space)**
- **Tablet**
- **Network Infrastructure**
- **Medical**

**Vishay Capability**

**Footprint + Profile**

**IN A NUTSHELL**

**APPLICATIONS**
POWER ELECTRONIC CAPACITORS
HIGH CURRENT, LOW INDUCTANCE

HDMKP SERIES

Vishay ESTA Capacitors

STANDARDS
IEC 61071, IEC 61881-1

RoHS COMPLIANT

VOLTAGE DC
• 900 V to 2700 V

CAPACITANCE
• 40 µF to 2235 µF

LIFE EXPECTANCY
• > 100 000 h
• < 100 FIT

FILLING AGENT
• ESTAdry resin
• UL94 V-0

FEATURES
• High RMS current rating
• High impulse current rating
• High reliability and lifetime expectation
• Resistance to heavy-duty shock vibration
• Non-polar, low loss dielectric
• Temperature class: -40 °C / 70 °C

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CONNECTION
Bolts M8
or
Inserts M8 x 12

SAFETY
• Self-healing film

OPTIONS
CUSTOMIZABLE

APPLICATIONS
WIND TURBINE
• DC-Link and DC filters for industrial and traction converters
• DC-Link for low power drives
• DC-Link for wind turbine converters
• Impulse discharge capacitors for magnetizing and welding
• Replacement of aluminum electrolytic capacitors

INDUSTRIAL

DC-LINK

TRANSPORTATION

VISHAY CAP MAP

VISHAY CAP MAP

1 V
10 V
100 V
1 kV
10 kV
100 kV
0.1 pF 1 pF 10 pF 0.1 nF 1 nF 10 nF 0.1 µF 1 µF 10 µF 0.1 mF 1 mF 10 mF 0.1 F
10 F 1 F

Voltage
Capacitance

Ceramic Multilayer
Ceramic Single Layer
Thin Film
Ceramic Multilayer
Polymer and Solid Tantalum
Wet Tantalum
Energy Storage
Heavy-Current Power Film (ESTA)

116 mm
105 mm to 260 mm
84 mm

116 mm
105 mm to 260 mm
84 mm

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THB AC FILTERING
ROBUST DESIGN FOR HIGH HUMIDITY ENVIRONMENTS

APPLICATIONS
• Outdoor applications – Inverters and converters
• High power supplies and large drives
• UPS
• Renewable energy
• Welding equipment
• AC harmonic filters

UL810-COMPLIANT SEGMENTED FILM

HIGH PERFORMANCE FREQUENCY FILTER: HARMONICS + SWITCHING NOISE

BROAD CAPACITANCE RANGE

<table>
<thead>
<tr>
<th>PITCH (mm)</th>
<th>C (µF)</th>
<th>CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>250 V AC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27.5</td>
<td>37.5</td>
</tr>
<tr>
<td>310 V AC</td>
<td>27.5</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>350 V AC</td>
<td>27.5</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>480 V AC</td>
<td>27.5</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For Technical Questions: dc-film@vishay.com

www.vishay.com
HIGH VOLTAGE CERAMIC CAPACITOR
RADIAL-LEAD SINGLE DISC

IN A NUTSHELL

2 nF HVCC Comparison
COMPETITOR SOLUTION
State of the art 12 stage multiplier, 15 kV, 2 x 1 nF in parallel

VISHAY REPLACEMENT
Unique 2 nF cap enables space saving 12 stage multiplier, 15 kV, 1 x 2 nF

<table>
<thead>
<tr>
<th>615R</th>
<th>Competitor</th>
<th>HVCC</th>
<th>HVCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 nF</td>
<td>1 nF</td>
<td>1 nF</td>
<td>2 nF</td>
</tr>
<tr>
<td>15 kV</td>
<td>15 kV</td>
<td>15 kV</td>
<td>15 kV</td>
</tr>
</tbody>
</table>

TEMPERATURE CHARACTERISTIC OF C AND DF

HVCC Series

<table>
<thead>
<tr>
<th>SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>( U_{\text{rated}} )</td>
</tr>
<tr>
<td>10, 15 kV (_{\text{dc}})</td>
</tr>
<tr>
<td>TCC / Operating Temperature</td>
</tr>
<tr>
<td>Y6P / ( \Delta C/C_0 ) less than ( \pm 10% ) from -30 °C to +105 °C</td>
</tr>
<tr>
<td>Capacitance Range</td>
</tr>
<tr>
<td>up to 2.0 nF</td>
</tr>
<tr>
<td>Life Performance</td>
</tr>
<tr>
<td>1.25 ( \times U_{\text{rated}} ) at 105 °C at 1000 h</td>
</tr>
</tbody>
</table>

For Technical Questions: slcap@vishay.com

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WET TANTALUM CAPACITORS
THE ULTIMATE RELIABILITY AND PERFORMANCE CHOICE
FOR EXTREME APPLICATIONS

KEY FACTORS
Capacitance
Performance
Energy
Temperature

QUALIFICATIONS
• M39006/09/21/22/25/30/31/33
• DLA 06013/06014/06015/06016
• DLA 04003/10004/10011/13017/15008/93026
• CECC 30202/001/002/004/005/801

LEAD CONFIGURATIONS
Axial
Radial
SMD

TERMINATION OPTIONS
Tin / Lead
Lead (Pb)-free (100 % tin)
RoHS-compliant

APPLICATIONS
AVIONICS
OIL and GAS
SPACE

VISHAY CAP MAP

VISHAY CAPABILITY

TERMINATION OPTIONS

For Technical Questions: tantalum@vishay.com
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HIGH TEMPERATURE ALUMINUM
SMD, RADIAL, AND AXIAL: +125 AND +150 °C

IN A NUTSHELL

LEAD (PB)-FREE SOLDERING ACCORDING TO JEDEC-J-STD-020

AEC-Q200 QUALIFIED WITH PPAP AVAILABLE

FEATURES
- up to 6800 µF
- up to 100 V
- up to 2000 h / 150°C

CASE SIZES (mm)
- SMD 8 x 10 up to 18 x 21
- Radial 10 x 12 up to 18 x 40
- Axial 10 x 30 up to 21 x 38

HAPPY HIGH TEMPERATURE CAPS

Aluminum electrolytic capacitors for harsh and high temperature operating conditions

APPLICATIONS

INDUSTRIAL
- CONTROL UNITS
- MACHINERY
AUTOMOTIVE
- UNDER THE HOOD
- CHASSIS
- POWER TRAIN

150 °C
125 °C

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MULTILAYER CERAMIC CHIP
HIGH FREQUENCY RF & MICROWAVE CAPACITORS

VJ HIFREQ SERIES
25 V to 250 V, up to 1500 pF

QUAD HIFREQ SERIES
50 to 7200 V, Up to 12 nF

VISHAY QUAD CAPACITORS
HANDLE 35 % MORE POWER

HIGH TEMPERATURE OPERATION
-55 °C to +200 °C

TERMINATION OPTIONS
- Lead (Pb)-free, RoHS-compliant: “X”
- Tin / lead (min. 4 % Pb): “L”
- Non-magnetic copper: “C”

FOOTPRINT
Actual size shown

EIA and QUAD

VJ HIFREQ
0402 0603 0805

QUAD HIFREQ
0505 1111 2525 3838

SMD MLCCS FOR RF & MICROWAVE APPLICATIONS
High Q, Ultra Low ESR, Stable COG (NPO) Dielectric

MORE EFFICIENT
Power Delivery for RF Amplifiers

APPLICATIONS
- MILITARY RADIOS
- WIRELESS POWER
- INSTRUMENTATION
- 5G NETWORKS

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mlccrf@vishay.com
www.vishay.com
SNAP-IN ALUMINUM CAPACITORS
4-TERMINAL SNAP-IN DC-LINK SOLUTION

IN A NUTSHELL

SNAP-IN SOLUTION

LONG LIFETIME
299 PHL-4TSI: 5000 h @ 105 °C
3000 h 105 °C 15 years
10000 h 85 °C 10 years
5000 h 85 °C 5 years

Datasheet Lifetime vs Application Lifetime

KEYED POLARITY = ONE-WAY MOUNTING

EFFICIENT ASSEMBLY
SOLDER ON HIGH CURRENT PCB

Power Electronics

SIZES BETWEEN SI AND ST

2-Pin SI (mm)
22 x 25
35 x 50

299 PHL-4TSI (mm)
35 x 60
45 x 100

ST (mm)
35 x 80
90 x 220

Less Manual Work Saves Time and Cost

Datasheet Lifetime vs Application Lifetime

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LVAC POWER CAPACITORS
LOW LOSS MKP TECHNOLOGY

FLEXIBLE DESIGN OPTIONS
FOOTPRINT
64 mm / 84 mm / 116 mm / 136 mm

HEIGHT
82 mm to 340 mm

IN A NUTSHELL

PhMKP Series
Vishay ESTA Capacitors

HIGHLIGHT
ESTAspring
maintenance-free, vibration-proof and reduce assembly times up to 60%

STANDARDS
IEC 60831

ESTAspring CONNECTION
Lever operated spring connection
Cable cross section: 2.5 mm² up to 25 mm²
Max. terminal current = 90 A<sub>RMS</sub>
Protection level: IP20

APPLICATIONS
WIND POWER PLANTS
HARMONIC FILTERS
THERMAL POWER STATIONS

TEMPERATURE CLASS
-40 °C / D

LIFE EXPECTANCY
> 130 000 h
100 FIT

SAFETY FEATURES
- Internal tear-off fuses
- Self-healing film
- Discharge resistor < 50 V/1 minute

FILLING AGENT
- ESTAdry gas
- ESTAprop oil

HIGHLIGHT
CONNECTION

POWER FACTOR
CORRECTION

≤ 1000 VAC<sub>RMS</sub>

VOLTAGE
3-Phase Delta Capacitance
Customizable

Voltage AC RMS
230 V
1000 V

Output
2.0 kVar
37.1 kVar

3-Phase Delta Capacitance
11.5 µF
335 µF

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esta@vishay.com
VMN-MS7367-1709
# AUTOMOTIVE GRADE CERAMIC SAFETY CAPACITORS

**LEADED CERAMIC SINGLE DISC AND SMD MLCCs**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Series</th>
<th>Rating</th>
<th>Rated Voltage</th>
<th>Capacitance</th>
<th>Peak Impulse Voltage</th>
<th>Features</th>
</tr>
</thead>
</table>
| Ceramic Single Disc         | AY1    | X1 / Y1 | X1: 760 V<sub>AC</sub>  
Y1: 500 V<sub>AC</sub>  
1500 V<sub>DC</sub> | 470 pF to 4.7 nF | X1: 4 kV  
Y1: 10 kV | 10 kV peak impulse voltage |
| Ceramic Single Disc         | AY2    | X1 / Y2 | X1: 440 V<sub>AC</sub>  
Y2: 300 V<sub>AC</sub>  
1000 V<sub>DC</sub> | 10 pF to 10 nF | X1: 4 kV  
Y2: 5 kV | Passes 3000 temperature cycles  
6.8 nF and 10 nF available |
| SMD MLCC C0G (NP0)          | VJ...A...X1A  
VJ...Y...X1A | X1 / Y2 | 250 V<sub>AC</sub> | C0G (NP0): 10 pF to 1 nF  
X7R : 100 pF to 4.7 nF | X1 / Y2: 5 kV | Small body size, low profile, min. 4 mm creepage,  
voltage-proof test min. 1500 V<sub>AC</sub>,  
Class I C0G (NP0), stable electric up to 1 nF,  
SMD reflow assembly |
| SMD MLCC C0G (NP0)          | VJ...A...X2A  
VJ...Y...X2A | X2      | 250 V<sub>AC</sub> | C0G (NP0): 10 pF to 390 pF  
X7R : 100 pF to 12 nF | X2: 2.5 kV | Small body size, low profile,  
voltage-proof test min. 1075 V<sub>DC</sub>,  
min. 4 mm creepage, SMD reflow assembly |

**Outstanding Qualification Test**

<table>
<thead>
<tr>
<th>IEC 60384-14.4 (Industry standard)</th>
<th>AEC-Q200 (Automotive standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature cycles</td>
<td></td>
</tr>
<tr>
<td>−40 °C / +125 °C 5 cycles</td>
<td>−55 °C / +125 °C 1000 cycles</td>
</tr>
<tr>
<td>Humidity (biased)</td>
<td></td>
</tr>
<tr>
<td>500 h at 40 °C</td>
<td>1000 h at 85 °C</td>
</tr>
<tr>
<td>90 to 95 % r.h., U&lt;sub&gt;rated&lt;/sub&gt;</td>
<td>85 % r.h., U&lt;sub&gt;rated&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

**Applications**

- On-board Charger
- External Charging Station
- Battery Management
- DC/DC Converter

**On-board voltage is changing from 12 V to 48 V**

**You need to bring more reliability to your OBC?**

**Your choice is Vishay**
CERAMIC RF POWER CAPACITORS
DETERMINED BY VOLTAGE, CURRENT, AND POWER

CUSTOMIZED PRODUCTS AVAILABLE

APPLICATIONS

HIGHEST PROVEN PERFORMANCE AND QUALITY IN THE MARKET

<table>
<thead>
<tr>
<th>Plate Caps</th>
<th>Barrel Caps</th>
<th>Water Cooled Pot Caps</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• High reliability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Wide range of capacitance values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Small size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Geometry minimizes inductance, optimizes voltage strength, and maximizes heat radiation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• High voltage, current, and power rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Water cooling and rugged mechanical construction for highest reliability</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For technical questions: powcap@vishay.com
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AUTOMOTIVE GRADE TANTALUM CAPACITORS
HIGH PERFORMANCE, HIGH TEMPERATURE, SMALL SIZES

<table>
<thead>
<tr>
<th>Solid Tantalum Surface-Mount Chip Capacitors, Molded Case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Series</strong></td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>TP3</td>
</tr>
<tr>
<td>TH3</td>
</tr>
<tr>
<td>TH4</td>
</tr>
<tr>
<td>TP8</td>
</tr>
</tbody>
</table>

AUTOMOTIVE APPLICATIONS

<table>
<thead>
<tr>
<th>Application</th>
<th>Power train</th>
<th>Passive safety</th>
<th>Active safety</th>
<th>Chassis</th>
<th>Body control</th>
<th>Battery management</th>
<th>Infotainment &amp; navigation</th>
<th>Surround view camera</th>
<th>Electric vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series</td>
<td>TP3</td>
<td>TP8</td>
<td>TH3</td>
<td>TH4</td>
<td>TP3</td>
<td>TP8</td>
<td>TH3</td>
<td>TH4</td>
<td>TP3</td>
</tr>
<tr>
<td>Gasoline direct injection</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil &amp; water pump</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil quality sensor</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airbag</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
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<tr>
<td>Tire pressure monitoring sensor (TPMS)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Anti-lock braking system (ABS)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane departure camera</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
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<tr>
<td>Electric stability program (ESP)</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
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<tr>
<td>Key less entry</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smart airbag igniter</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic power steering (EPS)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical park break</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating, ventilation, air-con</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LED lighting</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical test</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infotainment</td>
<td>Display and controller LDO</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surround view camera</td>
<td>FPGA power supply</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric vehicle</td>
<td>On-board charger</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

QUALITY
- IATF 16949
- AEC-Q200

AUTOMOTIVE GRADE FOR SUPERIOR QUALITY

<table>
<thead>
<tr>
<th>Station / process</th>
<th>Automotive Grade</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powder preparation</td>
<td>Use of single powder batch</td>
<td>Use of mixed powder batches</td>
</tr>
<tr>
<td>Pressing / Sintering</td>
<td>Pellet lot from single powder batch</td>
<td>No requirement</td>
</tr>
<tr>
<td>Formation</td>
<td>Visual inspection for coating dimensions: 5 pellet per bar x 3 bars per lot.</td>
<td>No requirement</td>
</tr>
<tr>
<td>Cap test</td>
<td>Conductivity monitoring</td>
<td>No requirement</td>
</tr>
<tr>
<td>Silver check</td>
<td>Visual inspection x3: 3 bars per rack (zero defect allowed)</td>
<td>Visual inspection, 4 bars per lot</td>
</tr>
<tr>
<td>Assembly</td>
<td>Inspection of each 5º LF (zero defect allowed)</td>
<td>Inspection of each 9º LF (specified allowed failure rate)</td>
</tr>
<tr>
<td>100 % VI after assembly</td>
<td>No requirement</td>
<td>No requirement</td>
</tr>
<tr>
<td>Special technician inspection and adjustment after each no weld detected</td>
<td>No requirement</td>
<td></td>
</tr>
<tr>
<td>Electrical test</td>
<td>Redundant test</td>
<td>Single test (A / B / C cases); redundant test (D / E cases)</td>
</tr>
<tr>
<td>Surge test</td>
<td>B, C, D, and E cases</td>
<td>D and E cases</td>
</tr>
<tr>
<td>Labeling</td>
<td>Autolabeling attachment only</td>
<td>No requirement</td>
</tr>
<tr>
<td>QC</td>
<td>Scan / scan verification of each reel</td>
<td>First and last reel only</td>
</tr>
<tr>
<td>LAT and Maverick lot inspection</td>
<td>No requirement</td>
<td></td>
</tr>
</tbody>
</table>

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WET TANTALUM CAPACITORS
HIGH ENERGY TYPES

KEY FACTORS
- Capacitance
- Performance
- Energy
- Temperature

QUALIFICATIONS
- DLA 04003/10004/10011/13017/15008/93026

Temperature range
-55 °C to +125 °C

Eight termination / mounting options

Voltage range: 25 V to 125 V

TERMINATION OPTIONS: Tin / Lead
- Lead (Pb)-free (100 % tin)
- RoHS-compliant

TERMINATION OPTIONS:
- Radial
- SMD

WET TANTALUM

VISHAY CAP MAP

APPLICATIONS
- AVIONICS
- SPACE

LEAD CONFIGURATIONS
- SMD
- Radial

HEIGHT
- Case A = 0.304
- Case B = 0.594
- Case C = 0.594

MAXIMUM CAPACITANCE
- Case A = 30 mF
- Case B = 55 mF
- Case C = 79 mF

For Technical Questions: tantalum@vishay.com

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HIGH VOLTAGE CERAMIC CAPACITORS
AVAILABLE AS DROP-IN REPLACEMENT PARTS

VISHAY FEATURES
- -30 °C to +85 °C
- AC rating available
- Many customization options
- Drop-in replacements
- Ultrastable capacitors with high capacitance values
- Widest capacitance range in the market
- 3D models available

715C AND 660R SERIES

<table>
<thead>
<tr>
<th>Series</th>
<th>Rated Voltage</th>
<th>Capacitance</th>
<th>Ceramic</th>
</tr>
</thead>
</table>
| 715C*  | 10 kVdc - 50 kVdc | 100 pF – 20 nF | Class 1: N4700, N3300  
Class 2: Y5U  |
| 660*   | 10 kVdc - 30 kVdc | 100 pF – 10 nF | Class 1: N4700  
Class 2: X7R, Z5U  |

715C AND 660R SERIES
MULTIPLE CUSTOMIZATION OPTIONS

HIGH VOLTAGE SENSING
ENERGY HARVESTING
ANTENNA COUPLING

APPLICATIONS
X-RAY AND AIR PURIFYING
LASER
WIND TURBINE

NEWS ON COMPETITION
MURATA
terminated DHS and DHK series

AVX
terminated HP and HD series

We offer drop-in replacements

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FEATURES

- High impulse current rating
- Low inductance
- High reliability and lifetime expectation
- Resistance to heavy duty shock vibration
- Non-polar dielectric
- Dry resin filled

APPLICATIONS

- DC-Link capacitors for HVDC / STATCOM
- Static converters for transportation:
  - Heavy haul locomotives
  - Light local trains
  - Trolley buses
  - Trams / streetcars
- Industrial converters
- DC supply equipment
- High voltage testing systems
- Impulse discharge energy
- Harmonic filtering

SAFETY

- Self-healing film
- Segmented film
- Pressure valve
- Pressure switch

STANDARDS

IEC 61071, IEC 61881-1

VOLTAGE DC

- 750 VDC to 10000 VDC

CAPACITANCE

- 50 uF to 20000 uF

LIFE EXPECTANCY

- < 100 Fit
- > 250 kh @ Undc / < 70 °C

FILLING AGENT

- ESTAdry resin

CASE MATERIAL

- Stainless steel (1.4301)
- Aluminum

FINISH

- Painting
- Shot blasting
- Chemical treatment

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**PHMKDG Series**

**HIGHLIGHT**
- Triangular design provides lowest height for 50 kVAR; custom heights for higher outputs on request
- Maintenance-free, vibration-proof bolt-terminal by counternuts, 20 Nm

**HEIGHT**
- 210 mm

**STANDARDS**
- IEC 60831

**CONNECTION**
- M10 threaded bolt, 20 Nm
- Max. terminal current = 110 A<sub>RMS</sub>
- Protection level: IP00, terminal covers upon request

**APPLICATIONS**
- Wind Power Plants
- Solar Panels and Inverters
- Pole-Mounted Outdoor
- Harmonic Filters
- Power Factor Correction

**VOLTAGE AC RMS**
- 230 V
- 1000 V

**Output**
- 30 kVAR
- 56.2 kVAR

**3-Phase Delta Capacitance**
- 115.5 µF
- 331.6 µF

**Also Customizable for Outdoor Applications**

**TEMPERATURE CLASS**
- -40 °C / D

**LIFE EXPECTANCY**
- > 130 000 h
- 100 FIT

**SAFETY FEATURES**
- Internal tear-off fuses
- Self-healing film
- Discharge resistor ≤ 50 V/1 minute (indoor)
  ≤ 75 V/3 minutes (outdoor)

**FILLING AGENT**
- ESTAdry solid resin

**THERMAL POWER STATIONS**

**ESTA Capacitors**

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[VMN-MS7671-1809]

[esta@vishay.com]
Vishay ESTA Capacitors

**APPLICATIONS**
- **INDUSTRIAL**
- **MEDICAL**
- **DRIVES**
- **TRANSPORTATION**
- **UPS**

**FEATURES**
- Very low inductance
- Extremely low losses at high frequencies
- Low serial resistance
- High current ratings
- High impulse discharge current capability
- Resistance to heavy-duty shock vibration
- High reliability and life expectation
- Integrated flanges for easy mounting

**STANDARDS**
- IEC 61071, IEC 61881-1

**FOOTPRINT**

**HEIGHT**
- 38 mm
- 56 mm
- 68 mm

**VOLTAGE DC**
- 700 V to 2150 V or customizable

**CAPACITANCE**
- 15 µF to 230 µF

**LIFE EXPECTANCY**
- > 100 000 h
- < 300 FIT

**FILLING AGENT**
- ESTAdry resin
- UL 94 V-0

**CONNECTION**
- Bolts M8
- Inserts M8 x 8

**SAFETY**
- Self-healing film

For technical questions: esta@vishay.com

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