Capacitors for Military/Aerospace
Capacitors for Military/Aerospace

What types of capacitors go into Military/Aerospace Applications?

- Ruggedized
- High Vibration
- Wide temp range, especially -55 °C at the low end
- High Altitude
- Stable & Long-Life
- Hermetic
- Established reliability
- Burn-in
- Compact, Low-profile
- Light weight
- Non RoHS (No tin whiskers)
Applications for Aluminum Electrolytic Capacitors in Military – Aerospace

- Most are used for bulk storage, holdup applications in power supplies, communications and radar systems.
  - Radar
  - Onboard communications
  - Aircraft Power Supplies
  - Programs examples: KC-135, F-18, F-22, X-33 Space Shuttle, JSF Joint Strike Fighter, F-16, E-2C, Osprey

- Customers: Lockheed, Raytheon, Rockwell Collins, Northrup Grumman, UTC, Boeing, L-3, BAE, General Dynamics
# Capacitors for Military/Aerospace

## RADIAL ALUMINUM ELECTROLYTICS

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Form Factor</th>
<th>Temperature (°C)</th>
<th>Voltage (Vdc)</th>
<th>Load Life (h@°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300/301</td>
<td>Long Life, Switching Power Grade, 105°C</td>
<td><img src="image1" alt="Form Factor Image" /></td>
<td>-55 to +105</td>
<td>6.3-250</td>
<td>4000 @ +105</td>
</tr>
</tbody>
</table>

## SCREW TERMINAL ALUMINUM ELECTROLYTICS

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Form Factor</th>
<th>Temperature (°C)</th>
<th>Voltage (Vdc)</th>
<th>Load Life (h@°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>101C</td>
<td>Low-ESR, Wide-Temperature Grade</td>
<td><img src="image2" alt="Form Factor Image" /></td>
<td>-55 to +105</td>
<td>7.5-250</td>
<td>2000 @ +105</td>
</tr>
<tr>
<td>125</td>
<td>Ultra-High Temperature, Military Grade, 125°C</td>
<td><img src="image3" alt="Form Factor Image" /></td>
<td>-55 to +125</td>
<td>6.3-40</td>
<td>2000 @ +125</td>
</tr>
</tbody>
</table>
# Capacitors for Military/Aerospace

## FLATPACK ALUMINUM ELECTROLYTICS

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Form Factor</th>
<th>Temperature (°C)</th>
<th>Voltage (Vdc)</th>
<th>Load Life (h@°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLP</td>
<td>Aluminum Case, 85°C, 10g, 80K altitude, long life</td>
<td>![MLP icon]</td>
<td>-40/55 to +85</td>
<td>7.5-420</td>
<td>2000 @ +85</td>
</tr>
<tr>
<td>MLS</td>
<td>Stainless Steel Case, 125°C, 50g, 80K altitude, long life</td>
<td>![MLS icon]</td>
<td>-55 to 125</td>
<td>5-250</td>
<td>2000 @ 125</td>
</tr>
<tr>
<td>MLSG</td>
<td>125 °C, 5000 hr, Stainless Steel Flatpack, 50g, 80K altitude, longest life under rated conditions</td>
<td>![MLSG icon]</td>
<td>-55 to +125</td>
<td>20-250</td>
<td>5000 @ 125</td>
</tr>
</tbody>
</table>

*For new designs please review the MLSG series*
Flatpack Capacitors

- Standard (non-hermetic) Flatpack capacitors, types MLP (85°C) and MLS (125°C) have been used extensively in military/aerospace applications for more than 20 years.
  - Radar
  - Cockpit communications
  - Aircraft Power Supplies
  - Programs

KC 135
F 18
F 22
X 33 Space Shuttle
JSF Joint Strike Fighter
F 18
F 16
E 2 C
Osprey

MLP, Aluminum Case (85°C)

MLS, Stainless Steel Case (125°C)
Benefits of MLP/MLSG Capacitors

- High capacitance density in 12.5 mm profile
- Efficient stackable form factor
- Heatsinking is simple and effective
- Extremely long life due to near-hermetic seal and high-purity materials.
  - Recent electrolyte developments have allowed us to assign a 5000 hr life rating (Vr @ 125 °C) to the MLSG series. Previously 2000 hr.
- Superior low-temperature impedance up to 250 V
Flatpack Capacitors

Efficient Stacking / Packaging
Recent Additions to Aluminum Capacitor Technology for Military-Aerospace

- MLSG-S, Slimpack
  - 1.00” wide, 5000 hr
- MLSH, Hermetic Slimpack
- HHT, 175°C Axial
- THA & THAS Thinpack
  - THA (8.2mm, 85 °C)
  - THAS (9.0mm, 105 °C)
MLSH, Hermetically Sealed Aluminum Electrolytic Capacitors

- Convention aluminum electrolytic capacitors (e.g. snap-ins, axial, radial) lose electrolyte over time.
- The out-gassing of electrolyte results in cap loss and increased ESR
- Standard MLP and MLSG Flatpacks have a near-hermetic seal and lose very little electrolyte over their life.
- Hermetic Slimpack capacitors lose no electrolyte.
Hermetically Sealed Aluminum Electrolytic Capacitors - **MLSH**

**Type MLSH 125 °C Hermetic Slimpack, Ultra Long Life, Aluminum Electrolytic**

**Highlights**
- Hermetically sealed with no dry out
- Alternative to axial wet tantalum
- High capacitance retention @ -55 °C
- 5000 Hr DC life test
- Up to 80g vibration
Hermetically Sealed Aluminum Electrolytic Capacitors

**Hermetic Aluminum versus Wet Tantalum:**

- Replaces 3 or more D-sized (a.k.a.T4) wet tantalum caps
- Wet tantalum caps have poor capacitance retention at low temperature.
- Almost all mil/aero applications specify parts using the full temp range of -55 °C to 125°C.
- A single hermetically sealed aluminum electrolytic capacitor saves weight, size and cost when compared to banks of wet tantalum capacitors.

<table>
<thead>
<tr>
<th></th>
<th>MLSH, 2200µF, 40 Vdc @125 °C</th>
<th>4 x T4 Wet Ta 1000µF, 40 Vdc @125 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitance @ 125 °C</td>
<td>2100µF</td>
<td>4910µF</td>
</tr>
<tr>
<td>Cap Change at -55 °C</td>
<td>-20%</td>
<td>-68%</td>
</tr>
<tr>
<td>Capacitance @ -55 °C</td>
<td>1675µF</td>
<td>1580µF</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>32</td>
<td>59</td>
</tr>
<tr>
<td>Cost</td>
<td>1X</td>
<td>2X</td>
</tr>
</tbody>
</table>
Hermetically Sealed Aluminum Electrolytic Capacitors

Hermetic Aluminum versus Wet Tantalum:

- Tantalum caps require derating at higher temps, 33% voltage derating at 125 °C. aluminum electrolytics do not require derating.
- Hermetic aluminum electrolytics are available up to 250 Vdc @ 125 °C, Wet Tantalum max voltage is 85 Vdc @ 125 °C.
- Using a single capacitor versus multiple capacitors simplifies board layout and assembly.
- A single cap solution enhances reliability.
- Tantalum is a mined material that has cyclical supply shortages (price goes up, lead times go out).
- Tantalum is a conflict material.
CDE HHT Series Axial-Lead Aluminum Electrolytic Capacitors

175 °C, RUGGEDIZED DESIGN FOR MISSION CRITICAL APPLICATIONS
CDE HHT Series Ruggedized Axial-Leaded Aluminum Electrolytic Capacitors

The HHT is the only axial-lead electrolytic featuring a glass-to-metal seal to prevent dry-out of the capacitor electrolyte.

- Rated at 175 °C, for 2,000 hours and an industry-best 5,000 hours at 150 °C with ripple current ratings up to 10 Arms
- Withstands vibrations up to 20 g’s

In short, HHT capacitors go where others can’t.
THA and THAS, Thinpack, Aluminum Electrolytic Capacitors

HIGHEST ENERGY-DENSITY ELECTROLYTIC IN A VERY LOW-PROFILE DESIGN
CDE THA and THAS Thinpack High-Energy Density Aluminum Electrolytic Capacitors.

Offers the highest energy density available in low-profile aluminum electrolytic technology.

- Ideal for the lowest-profile circuits
- THA 8.2mm thin, offers 3,000 hr. life @ 85 °C
- THAS 9.0 mm thin offers 3,000 hr. life @ 105 °C
- Designed for high capacitance bulk storage and filtering applications
- Can replace arrays of SMT, radial or axial aluminum electrolytic and solid tantalum capacitors
- Increases reliability – one device vs. many; fewer PCB connection points
- Less weight, lower cost.
Mica Capacitor Technology for Mil-Aero Applications
Mica Capacitor Technology for Mil-Aero Applications

Why Mica?

- Superb performance in RF Applications (e.g. military radios, cockpit communications)
- Capacitance stability with temperature, voltage and frequency.
- Robust package can withstand high shock & vibration and high altitudes.
- Wide temp range: (-55 °C to 125 °C standard, up to 200 °C)
- Tight capacitance tolerance
- Established reliability for military applications
  - Burn-in
Mica Capacitor Technology for Mil-Aero Applications - CMR

High-Reliability Dipped Capacitors/MIL-PRF-39001

Type CMR meets requirement of MIL-PRF-39001. Type CMR high-reliability dipped silvered mica capacitors are ideal for high-grade ground, airborne, and spaceborne devices, such as computers, jetcraft, and missiles.

Specifications

- **Voltage Range:** 50 Vdc to 500 Vdc
- **Capacitance Range:** 1 pF to 91,000 pF
- **Capacitance Tolerance:** ±½ pF (D), ±1% (F), ±2% (G), ±5% (J)
- **Temperature Range:** −55 °C to +125 °C (O), −55 °C to 150 °C (P)

P temperature range available only for CMR04, CMR05, CMR06, CMR07, CMR08

- **Reliability:** Meets Requirements of MIL-PRF-39001
  Established reliability to .01%/1,000 hours failure rate
Mica Capacitor Technology for Mil-Aero Applications – Standard Dipped

Mica Capacitors, Standard Dipped
Types CD10, D10, CD15, CD19, CD30, CD42, CDV19, CDV30

Stability and mica go hand-in-hand when you need to count on stable capacitance over a wide temperature range. CDE's standard dipped silvered mica capacitors are the first choice for timing and close tolerance applications. These standard types are widely available through distribution.

**Highlights**
- Reel packaging available
- High temperature – up to +150 °C
- Dimensions meet EIA RS153B specification
- 100,000 V/μs dV/dt pulse capability minimum
- Non-flammable units that meet IEC 695-2-2 are available

**Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitance Range</td>
<td>1 pF to 91,000 pF</td>
</tr>
<tr>
<td>Capacitance Tolerance</td>
<td>±1/2 pF (D), ±1 pF (C), ±1/2% (E), ±1% (F), ±2% (G), ±5% (J)</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>100 Vdc to 2500 Vdc</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>–55 °C to +125 °C (O), –55 °C to +150 °C (P)*</td>
</tr>
<tr>
<td>Dielectric Strength Test</td>
<td>200% of rated voltage</td>
</tr>
</tbody>
</table>

*RohS Compliant

*P temperature range available for types CD10, CD15, CD19, CD30 and CD42
**Mica Capacitor Technology for Mil-Aero Applications – Metal Clad**

**Types MCM and MIN SMT Clad RF Capacitors**

**Multilayer High Power, High Temperature Mica and PTFE Capacitors**

Types MCM and MIN SMT clad PTFE and mica capacitors are top performers for high power applications requiring low inductance at high frequencies and can operate at temperatures up to 200 °C and voltages to 1000 Vdc. Choosing from 16 different configurations offers easy mounting with options for surface mount as well as through-hole and mechanical assembly. To assure high current capability in the smallest capacitors, low-capacitance ratings use polytetrafluorethylene (PTFE) that has ultra-low dielectric absorption - better than polypropylene, polystyrene and NPO ceramic.

**Highlights**

- 200 °C rated with no voltage derating
- Wave solderable
- No cracking or delaminating
- CTE ≈ 18 ppm/°C compatible with FR4 PCBs
- Highly thermal conductive package
- Gull-wing terminal minimizes stress
- Typical 100 pF ESR, <1 mΩ @ 100 MHz
- Nonmagnetic for minimal RF loss
- Very low ESL for excellent by-pass action
- Ultra stable: no change with (t), (V) and (f)
- Exact capacitance with tolerances from ±0.25 pF
Applications for Mica Capacitors in Military – Aerospace

- Most are used for communications or in power supplies.
  - Onboard communications
  - Aircraft Power Supplies
  - Two-Way mobile radios
  - Customers: Lockheed, Raytheon, Rockwell Collins, Northrup Grumman, UTC, Boeing, L-3, BAE, General Dynamics
## Capacitors for Military/Aerospace - High Vibration

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Temperature Range</th>
<th>Life</th>
<th>Aura Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLSG</td>
<td>125 °C, 5000 hr, Stainless Steel Flatpack, 50g, 80K altitude, longest life under rated conditions</td>
<td>-55 to +125</td>
<td>20-250</td>
<td>5000 @ 125</td>
</tr>
<tr>
<td>MLSG-S</td>
<td>125 °C, 5000 hr, Stainless Steel Slimpack, 80g, 80K altitude, volume constrained conditions</td>
<td>-55 to +125</td>
<td>10-250</td>
<td>5000 @ 125</td>
</tr>
<tr>
<td>MLSH</td>
<td>125 °C, Hermetic Aluminum Electrolytic Slimpack, 80g, 80K altitude, volume constrained conditions</td>
<td>-55 to +125</td>
<td>30-250</td>
<td>5000 @ 125</td>
</tr>
<tr>
<td>AFK_V</td>
<td>High Vibration withstands 30 G</td>
<td>V-Chip -55°C to +105°C</td>
<td>6.3-100</td>
<td>10-6800</td>
</tr>
<tr>
<td>HZAV</td>
<td>High Vibration, Very Low ESR</td>
<td>V-Chip -55°C to +105°C</td>
<td>25-90</td>
<td>22-330</td>
</tr>
<tr>
<td>HZC_V</td>
<td>High Vibration, Very Low ESR</td>
<td>V-Chip -55°C to +125°C</td>
<td>25-63</td>
<td>33-330</td>
</tr>
</tbody>
</table>
Military/Aerospace At A Glance

Capacitors for Military/Aerospace Applications:

- High Capacitance Retention at -55°C
- Low Form Factor for Tight Spaces
- High Reliability
- Available in Hermetic Case
- High Altitude up to 30,000 ft

**FLATPACK ALUMINUM ELECTROLYTIC CAPACITORS**

**FEATURES**
- High Capacitance Retention at -55°C
- Low Form Factor for Tight Spaces
- High Reliability
- Available in Hermetic Case
- High Altitude up to 30,000 ft

**TYPES**
- MLF - Aluminum Case, 85°C
- MLF - Stainless Steel Case, 125°C
- HWLS - High Vibration up to 50g
- HWHLS - High Reliability Components
- MLFH - Hermetic Flatpack - RG5
- MLFG - Flatpack and Stackpack - RH5

**APPLICATIONS**
- Ground-based and Shipboard Radar
- EW/Power Supplies
- Commercial and Military Aircraft

For more high performance capacitors for military/aerospace visit: http://www.cde.com/solutions/military-aerospace

http://www.cde.com/solutions
Thank You!