

Hermetically Sealed Aluminum Electrolytic Capacitors



Welcome to the Cornell Dubilier's training module for hermetically sealed aluminum electrolytic capacitors.

Hermetically Sealed Aluminum Electrolytic Capacitors - Agenda

TRAINING AGENDA

- Flatpack aluminum electrolytic capacitors for Mil/Aero
- Advantages of the hermetic seal
- Type MLSH, the world's only hermetic aluminum electrolytic
- Hermetic aluminum electrolytics vs. wet tantalum capacitors



We will first have a look at our non-hermetic Flatpack aluminum electrolytic capacitor technology with applications in military and aerospace. We'll discuss the hermetic seal technology and its advantages over non-hermetic types. Then we'll introduce our type MLSH, the world's only hermetic sealed aluminum electrolytic capacitor. We will show how our MLSH capacitors can replace banks of wet tantalum capacitors.

Hermetically Sealed Aluminum Electrolytic Capacitors – Standard (non-hermetic) 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: KC135
F16
F18
F22
X33 Space Shuttle
JSF Joint Strike Fighter
E2C
Osprey



MLP, Aluminum Case (85°C)

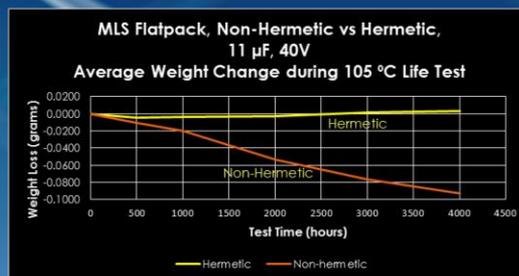


MLS, Stainless Steel Case (125°C)

CDE has been supplying Flatpack aluminum electrolytic capacitors into military and aerospace applications since the early 90's. These are ruggedized, flat capacitors, with a welded case and very long life. The MLP has an aluminum case, rated for 85 °C and the MLS is contained in a stainless steel case, rated for 125 °C. Many of the programs using our Flatpack capacitors had previously used large arrays of wet tantalum capacitors. Flatpack capacitors are found in the most advanced fighter aircraft, radar systems for missile defense, and in commercial aircraft programs.

Hermetically Sealed Aluminum Electrolytic Capacitors – *No Electrolyte Loss!*

- Conventional aluminum electrolytic capacitors (e.g. snap-ins, axial, radial) lose electrolyte over time.
- Out-gassing of electrolyte results in cap loss and increased ESR.
- Standard MLP and MLS Flatpacks have a welded case and lose very little electrolyte over their life.
- Hermetic Slimpack capacitors, with a glass-to-metal seal, lose no electrolyte.



Slight fluctuations in measured weight are probably due to measurement tolerance.

Early conventional aluminum electrolytic capacitors were known to lose electrolyte, through outgassing, over time. The loss of electrolyte, a.k.a. “dry-out” results in loss of capacitance and increases in ESR. Newer conventional package types such as snap-ins, screw terminal, axial and radial leaded parts are less likely to dry-out than the electrolytic types of yesteryear, but there is some loss of electrolyte over time; and some dry-out concerns persist today.

Mil/Aero engineers are designing in COTS parts where appropriate, but tend to favor our welded case Flatpacks and true hermetic capacitors, including hermetic wet tantalum capacitors, for their mission critical applications.

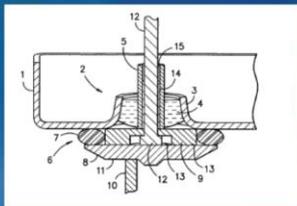
The graph shown compares the weight loss of electrolyte with time for a non-hermetic Flatpack versus a hermetically-sealed Flatpack. Although the weight loss for the standard (non-hermetic) Flatpack capacitors is minuscule as the orange curve shows, the yellow line of graph shows that the hermetically-sealed part has not lost electrolyte over time on test.

Hermetically Sealed Aluminum Electrolytic Capacitors - Patent

Details glass-to-metal shield

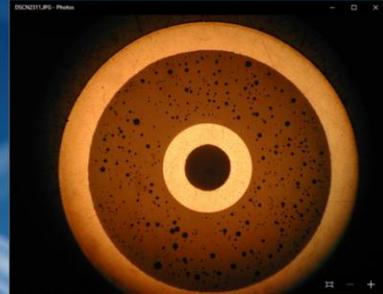
(54) HERMETICALLY SEALED ELECTROLYTIC CAPACITOR

(75) Inventors: **Phillip A. Knight**, Greer, SC (US);
Samuel G. Parker, Jr., Clemson, SC (US);
Jerry W. Norris, Greenville, SC (US)



(12) **United States Patent**
Knight et al.

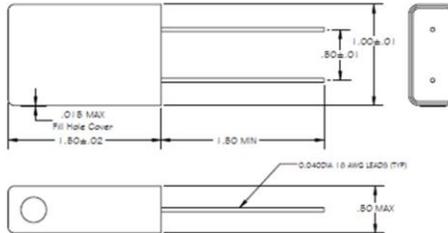
(10) Patent No.: **US 7,206,186 B1**
(45) Date of Patent: **Apr. 17, 2007**



For applications requiring hermeticity, CDE has patented a glass-to-metal seal for aluminum electrolytic capacitors enclosed in a steel case. Each capacitor coming off the production line is verified to be hermetic in accordance with MIL-STD-883 Method 1014.12.

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

The Cornell Dubilier Electronics Slimpack, type MLSH is the first in a series of hermetically-sealed aluminum electrolytic capacitors that will be introduced soon. With its glass-to-metal seal that prevents dry-out, this capacitor technology has extraordinarily long life, and is able to meet the most demanding long-term applications for military and aerospace.

With its long life and the ability to handle 80g 's of vibrations, this technology is poised to replace banks of wet tantalum capacitors for new and existing designs, especially where bulk storage is paramount. The MLSH Slimpack measuring 1.0" x 1.5" x 0.5" weighs less and has more capacitance than a parallel bank of three or more D-sized wet tantalum capacitors at -55 °C.

Hermetically Sealed Aluminum Electrolytic Capacitors - **MLSH**

<http://www.cde.com/resources/catalogs/MLSH.pdf>



MLSH	322	M	200	EB	0	A
Type	Capacitance	Tolerance	Rated Voltage	Case Code	Insulation	Mounting Style
MLSH	322 = 3200 μ F 222 = 2200 μ F 172 = 1700 μ F	M = \pm 20%	030 = 30 Vdc 075 = 75 Vdc 150 = 150 Vdc 200 = 200 Vdc	JK, L = 1.5 in.	0 = bare can 1 = polyester	C = two leads/no tabs

Voltage	Cap (μ F)	Catalog Part Number	Length	ESR max 25 °C (Ω)		Ripple (A) Case @ 85 °C	
				120 Hz	10 kHz	120 Hz	10 kHz
30 Vdc @ 125 °C	3200	MLSH322M030JK0C	1.5	0.103	0.098	6.6	6.8
40 Vdc @ 125 °C	2200	MLSH222M040JK0C	1.5	0.105	0.1	6.6	6.8
50 Vdc @ 125 °C	1700	MLSH172M050JK0C	1.5	0.108	0.101	6.6	6.8
60 Vdc @ 125 °C	1100	MLSH112M060JK0C	1.5	0.109	0.103	6.5	6.8
75 Vdc @ 125 °C	700	MLSH701M075JK0C	1.5	0.246	0.234	4.0	4.2
100 Vdc @ 125 °C	400	MLSH401M100JK0C	1.5	0.960	0.768	2.1	6.5
150 Vdc @ 125 °C	210	MLSH211M150JK0C	1.5	1.019	0.815	2.2	2.4
200 Vdc @ 125 °C	160	MLSH161M200JK0C	1.5	1.274	1.019	1.9	2.1
250 Vdc @ 125 °C	120	MLSH121M250JK0C	1.5	1.200	0.96	1.9	2.2

Standard datasheet ratings are available between 30 Vdc and 250 Vdc, For complete datasheet specifications go to <http://www.cde.com/resources/catalogs/MLSH.pdf>

Hermetically Sealed Aluminum Electrolytic Capacitors

Hermetic Aluminum vs. Wet Tantalum:

- Replaces 3 or more D-sized (a.k.a.T4) wet tantalum caps.
- Wet tantalums 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.



	MLSH, 2200 μ F, 40 Vdc @ 125 °C	4 x T4 Wet Ta 1000 μ F, 40 Vdc @ 125 °C
Capacitance @ 125 °C, 120 Hz	2100 μ F	4910 μ F
Cap Change at -55 °C, 120 Hz	-20%	-68%
Capacitance @ -55 °C, 120 Hz	1675 μ F	1580 μ F
Weight (g)	32	59
Cost	1X	2X

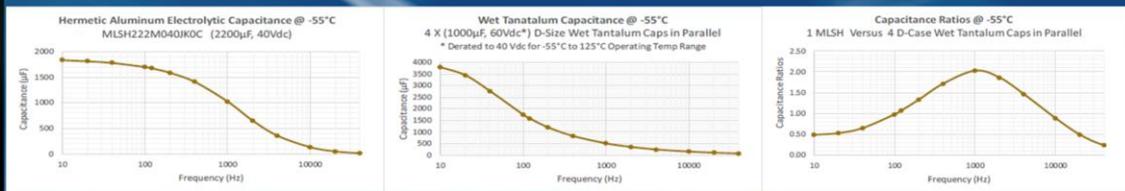
One MLSH capacitor can replace three or more D-sized wet tantalum capacitors. Most military aerospace electronics circuits must be designed to operate at -55 °C. Wet tantalum capacitors have poor capacitance retention at low temperatures making it necessary for the design engineer to “spec-in” more wet tantalum capacitors just to meet the minimum capacitance requirement at -55 °C.

The example shown in the picture and the table demonstrate how one MLSH capacitor can replace a parallel bank of four D-sized wet tantalum capacitors. The table compares one MLSH (2200 μ F @ 40 Vdc) with a parallel bank of 4 x (1000 μ F @ 40 Vdc) wet tantalum caps. The high temperature capacitance (@ 125 °C) of the wet tantalum bank is much higher, but as shown, at -55 °C, the roll-off in the wet tantalum capacitance is huge, measuring less than the single MLSH capacitor. The single MLSH capacitor also weighs less than four wet tantalums; and its cost is roughly 50 % of the wet tantalum solution.

Hermetically Sealed Aluminum Electrolytic Capacitors

Hermetic Aluminum vs. Wet Tantalum:

- Comparison of hermetic aluminum electrolytic capacitors to 4 wet tantalum caps in parallel. Capacitance vs. temperature and frequency.



The following graphs further illustrate the superior capacitance retention of the hermetic aluminum electrolytic technology. The first graph (to the left) shows capacitance changes with frequency while temperature is held constant at -55 °C. There is a lowering effect of capacitance as frequency is increased. The second graphs shows capacitance roll-off with frequency of four wet tantalum capacitors in parallel. The slope of the capacitance drop for the wet tantalum bank is much steeper. The third graph (to the right) is the ratio of the capacitance curves, i.e. the capacitance measured on one MLSH divided by the capacitance of the parallel bank of four wet tantalums across the entire frequency range. Where the ratio exceeds one (1), the MLSH solution has higher capacitance than the bank of 4 wet tantalum caps. Between the range of 100 Hz through 10 kHz, the single MLSH capacitance exceeds that of the four wet tantalum caps in parallel. At 1 kHz the MLSH capacitance is twice that of the parallel bank of 4 wet tantalum caps.

Hermetically Sealed Aluminum Electrolytic Capacitors

Hermetic Aluminum vs. 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.
- A single capacitor vs. multiple capacitors simplifies board layout and assembly.
- 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.

Here are some additional comparisons between type MLSH and wet tantalums:

- Many Mil/Aero application require performance over *the full temperature range* of -55 °C to +125 °C
- Type MLSH hermetic aluminum electrolytic capacitors have a rated nameplate voltage at +125 °C. There is no need to de-rate them for voltage. In fact, at lower temperatures, one can increase the applied voltage on the MLSH per the datasheet table as shown on an earlier slide.
- Wet tantalum capacitors have a rated voltage at 85 °C. In order to use them at +125 °C, wet tantalum capacitors must be de-rated by 33%.
- Hermetic aluminum electrolytic capacitors are available up to 250 Vdc at +125 Vdc. The maximum voltage for wet tantalum capacitor technology is 85 Vdc at 125 °C.
- For applications exceeding 85 Vdc @ 125 °C, it is necessary to place wet tantalum capacitors in series to stand up to the voltage. When two capacitors of the same value are placed in series, the voltage capability doubles, but the capacitance is cut in half. That effect reduces the capacitance for bulk storage and it becomes necessary to use large series-parallel banks of wet tantalum capacitor to meet the applied voltage at +125 °C and to get the capacitance needed at -55 °C.
- From a manufacturing standpoint, going from multiple components to a single component simplifies board layout and reduces assembly costs.

- From a reliability standpoint, a single component solution enhances system reliability.
- Tantalum is a mined material that has been subjected to severe shortages. When shortages occur, price increases sharply and lead times are severely extended.
- Tantalum is also a conflict material, which may make it undesirable from a social responsibility standpoint.

Hermetically Sealed Aluminum Electrolytic Capacitors – Related Links

[Datasheet: MLSH Hermetic Aluminum Electrolytic Capacitors](#)

Type MLSH 125 °C Hermetic Slim-pack, Ultra Long Life, Aluminum Electrolytic



The world's only hermetically sealed aluminum electrolytic capacitor with aluminum metal case, Type MLSH has microleakage less than 1000 pA and longest distribution for the most demanding power electronics applications.

Type MLSH has superior ripple-current capability compared to seal and tamper capacitors at 100 °C. Packaged in a robust hermetic steel case capable of withstanding 2000 V transients for stress and seal protection against moisture. Available in 1000-hour ultra-long life design at temperatures above 100 °C. Type MLSH capacitors are rated for full operating voltage at 125 °C and tested for 1000 hrs at rated voltage and temperature.

Highlights

- Hermetically sealed with no dry out
- Optimized for seal and temperature
- High ripple-current capability at 100 °C
- 1000-hr UL test
- Up to 1000-µF

Specifications

Temperature Range	-55 to +125 °C																								
Rated Voltage Range	50Vdc to 500Vdc																								
Capacitance Range	100µF to 1000µF																								
Construction Features	UL94V-0																								
Leakage Current	< 1.00E-10 µA at 125 °C and 100Vdc																								
Ripple Current Multiplier	<table border="1"> <tr> <td>40 °C</td> <td>100 °C</td> <td>125 °C</td> <td>150 °C</td> <td>175 °C</td> <td>200 °C</td> <td>225 °C</td> <td>250 °C</td> <td>275 °C</td> <td>300 °C</td> <td>325 °C</td> <td>350 °C</td> </tr> <tr> <td>1.00</td> </tr> </table>	40 °C	100 °C	125 °C	150 °C	175 °C	200 °C	225 °C	250 °C	275 °C	300 °C	325 °C	350 °C	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
40 °C	100 °C	125 °C	150 °C	175 °C	200 °C	225 °C	250 °C	275 °C	300 °C	325 °C	350 °C														
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00														
Life Expectancy (Hours/Parts)	<table border="1"> <tr> <td>1000</td> </tr> <tr> <td>1000</td> </tr> </table>	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000														
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000														
DC Life Test	10000 hr at rated voltage at 125 °C																								
Shock Life Test	10000 hr at 100Vdc, 100µF																								
Storage Life Test	1000000 hr at 100Vdc, 100µF 1000000 hr at 100Vdc, 100µF																								
Dimensions	Standard 1812 (36.83x25.40mm) 1812 (36.83x25.40mm)																								

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www.cde.com/MLSH/MLSHLanding.htm

www.cde.com/resources/catalogs/MLSH.pdf

For additional information on type MLSH Hermetic Aluminum Electrolytic Capacitors, visit the landing page at www.cde.com/MLSH/MLSHLanding.htm or the catalog datasheet.

Thank You!

