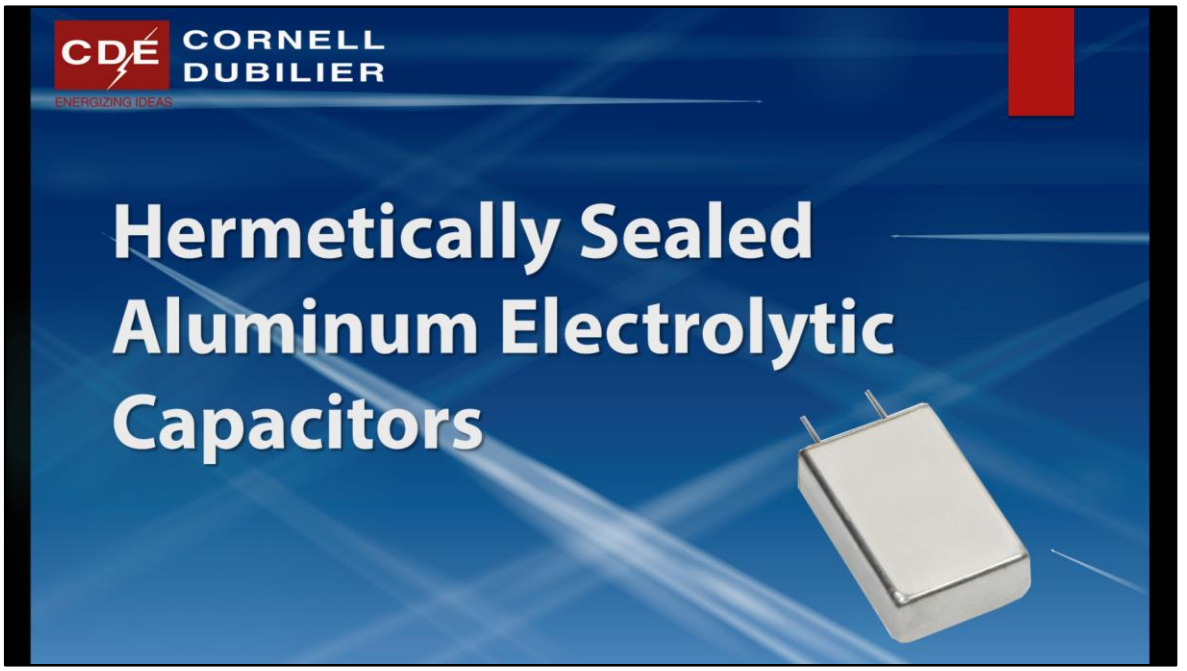
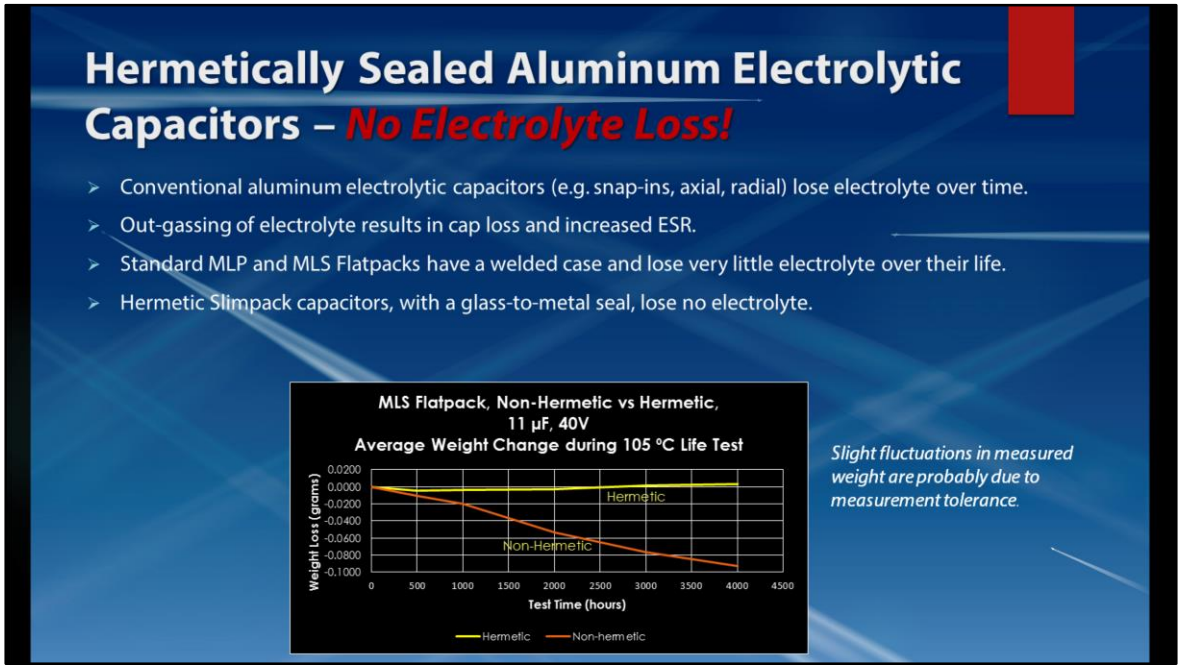



Welcome to the Cornell Dubilier's training module for hermetically sealed aluminum electrolytic capacitors.


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 it's 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.

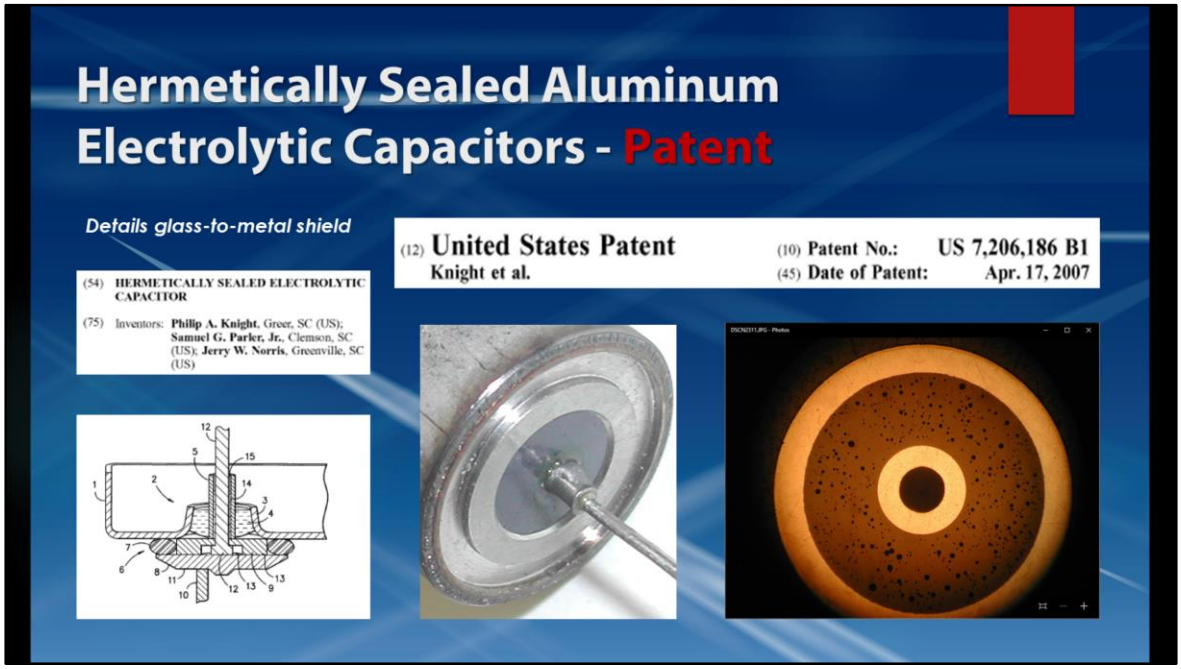

CDE has been supplying Flatpack aluminum electrolytic capacitors into military and aerospace applications since the early 90's. These are ruggedized, flat capacitors, with a welded case and very long life. The MLP has an aluminum case, rated for 85 °C and the MLS is contained in a stainless steel case, 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.



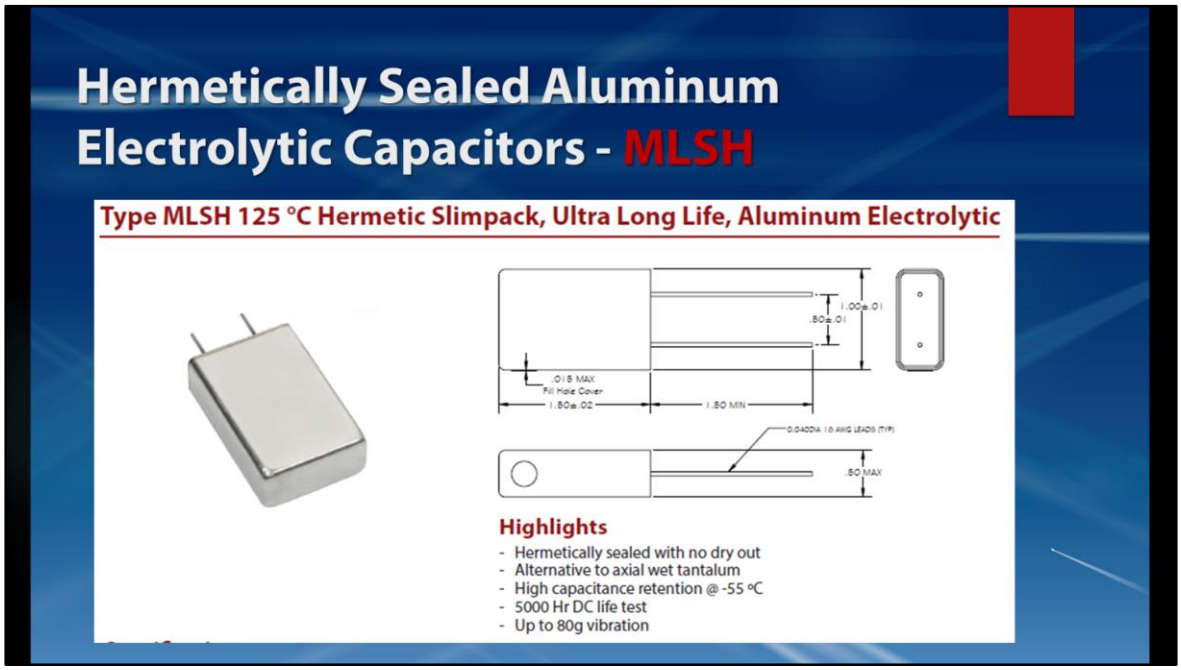

Early conventional aluminum electrolytic capacitors were known to lose electrolyte, through outgassing, over time. The loss of electrolyte, a.k.a. “dry-out” results in loss of capacitance and increases in ESR. Newer conventional package types such as snap-ins, screw terminal, axial and radial leaded 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.




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.




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 µF<br>**222** = 2200 µF<br>**172** = 1700 µF | **M**=±20% | 030 = 30 Vdc<br>075 = 75 Vdc<br>150 = 150 Vdc<br>200 = 200 Vdc | **JK,** L=1.5 in. | **0** = bare can<br>**1** = polyester | **C** = two leads/no tabs |

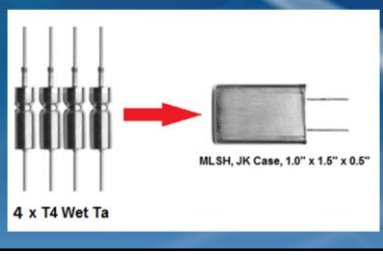
| Voltage | Cap (µF) | Catalog Part Number | Length | ESR max 25 °C (Ω) 120 Hz | ESR max 25 °C (Ω) 10 kHz | Ripple (A) Case @ 85°C 120 Hz | Ripple (A) Case @ 85°C 10 kHz |
|---|---|---|---|---|---|---|---|
| 30 Vdc @ 125 °C | 3200 | MLSH322M030JK0C | 1.5 | 0.103 | 0.098 | 6.6 | 6.8 |
| 40 Vdc @ 125 °C | 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:**

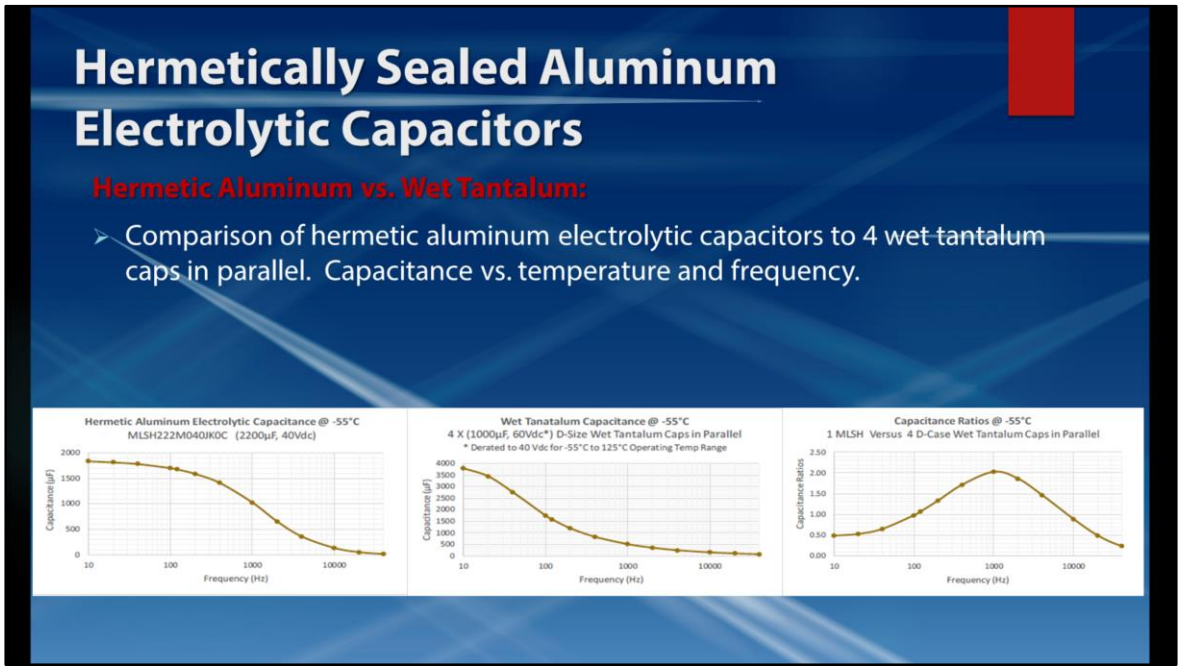
- Replaces 3 or more D-sized (a.k.a.T4) wet tantalum caps.
- Wet tantalums have poor capacitance retention at low temperature.
- Almost all MIL/Aero applications specify parts using the full temp range of -55 °C to 125 °C.
- A single hermetically sealed aluminum electrolytic capacitor saves weight, size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




| | MLSH, 2200µF, 40 Vdc @ 125 °C | 4 x T4 Wet Ta 1000µF, 40 Vdc @ 125 °C |
|---|---|---|
| Capacitance @ 125 °C, 120 Hz | 2100µF | 4910µF |
| Cap Change at -55 °C, 120 Hz | -20% | -68% |
| Capacitance @ -55 °C, 120 Hz | 1675µF | 1580µF |
| 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 µF @ 40 Vdc) with a parallel bank of 4 x (1000µF @ 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.

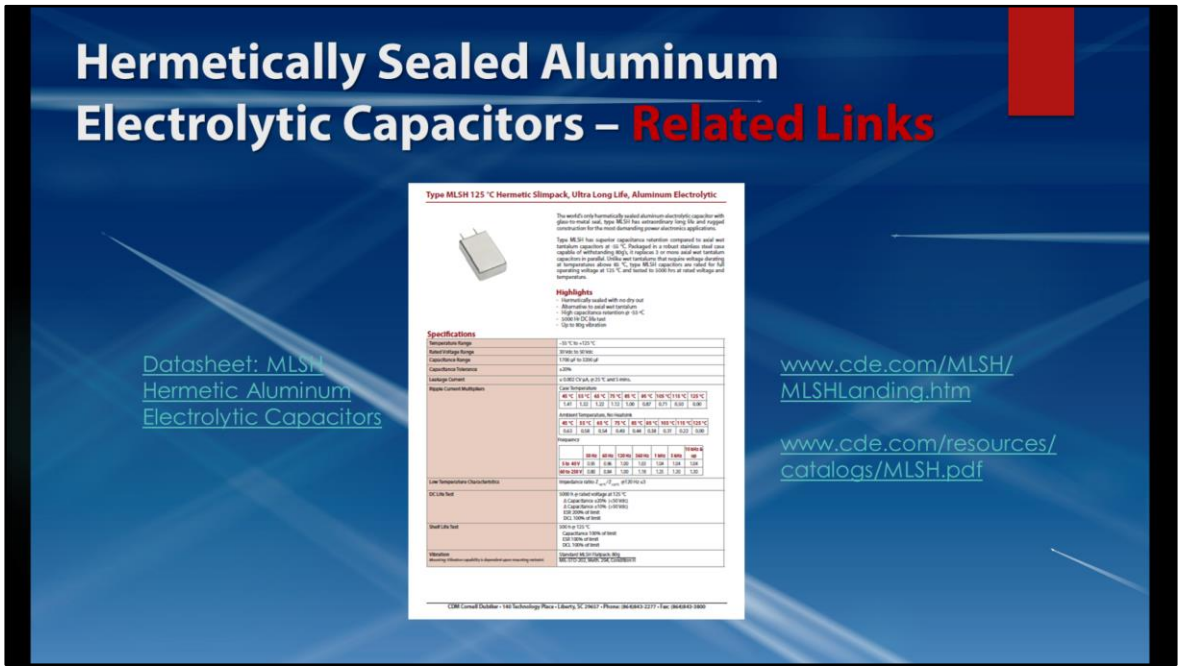



The following graphs further illustrate the superior capacitance retention of the hermetic aluminum electrolytic technology. The first graph (to the left) shows capacitance changes with frequency while temperature is held constant at -55 °C. There is a lowering effect of capacitance as frequency is increased. 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.


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. If 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 capacity 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.




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!

CDE CORNELL DUBILIER

ENERGIZING IDEAS