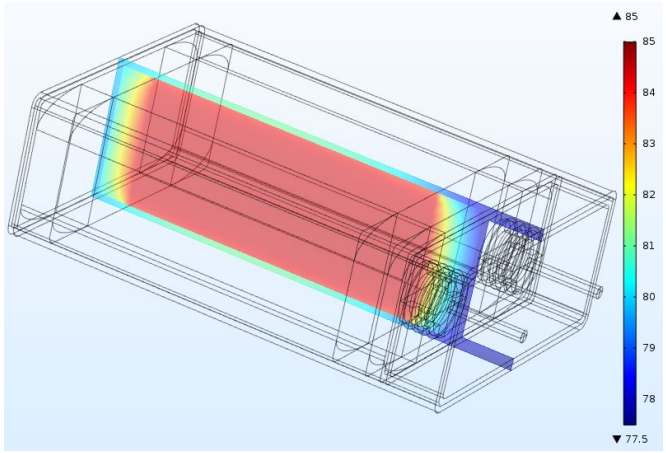
NHR Capacitors Withstand the Heat



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Type NHR, Electrolytic Capacitors Withstand the Heat

Offering the highest energy density at high temperature, we'll demonstrate how these low-profile aluminum electrolytic capacitors can replace large banks of wet tantalum capacitors

- Save board space
- Reduce weight
- Reduce Cost
- Improve Reliability

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Applications for High Temperature Capacitors (150 °C to 260 °C)

- Avionics
  - Engine Control Systems: -55 °C to 200 °C
- Automotive
  - Engine, Transmission and braking: Up to 250°C
- Down-Hole
  - Logging Tools: Up to 220 °C
  - Measurement While Drilling: Up to 200 °C
  - Completion Tools: Up to 175 °C
- Industrial Inverter
  - Wide Bandgap Semiconductors: Up to 150 °C

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Capacitors for High Temperature Application (150 °C to 260 °C)

	Temp Range	Cap Range	Voltage Range
MLCC - X7R	-55 to +260 °C	100 pF to 4 µF	50-100 Vdc
MLCC - COG	-55 to +260 °C	0.5 pF to 470 µF	10 - 4000 Vdc
Clad Mica	-55 to +200 °C	1 pF to 1500 pF	300-1000 Vdc
PPS	-55 to +150 °C	4.7 nF to 10 µF	50 - 400 Vdc
Reconstituted Mica paper	-65 to +260 °C	10 pF to 10 µF	1000-100,000 Vdc
PVDF	-55 to +200 °C	1 µF to 100 µF	100- 600 Vdc
Solid Tantalum	-55 to +200 °C	10 µF to 220 µF	4- 35 Vdc
Wet Tantalum	-55 to +200 °C	10 µF to 3000 µF	4 - 95 Vdc
Prismatic Aluminum Electrolytic	-55 to +200 °C	50 µF to 4700 µF	20- 300 Vdc

Best Options for High Bulk Storage Capacitance at High Voltage and Temperature

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Applications for High Temperature Prismatic Aluminum Electrolytic Capacitors

Harsh environments with extreme temperature: range -55°C to 150 °C

- High capacitance and high voltage power holdup
- Down-hole, mil-aero, and industrial power supplies

Alternative to series-parallel banks of wet tantalum capacitors

- Less weight
- Saves space
- Lower cost
- Improved system reliability

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Type NHR, High Temperature Prismatic Aluminum Electrolytic Capacitors

Offers the highest energy density available in low-profile aluminum electrolytic technology with rated voltages up to 300Vdc.

- 3,000 hr. life @ 150 °C
- Designed for high capacitance bulk storage and filtering applications without derating the voltage
- Laser welded seam prevents dry-out
- Alternative to wet tantalum capacitors
  - Save space, weight and cost
  - Increases reliability– one device vs. many; fewer PCB connection points

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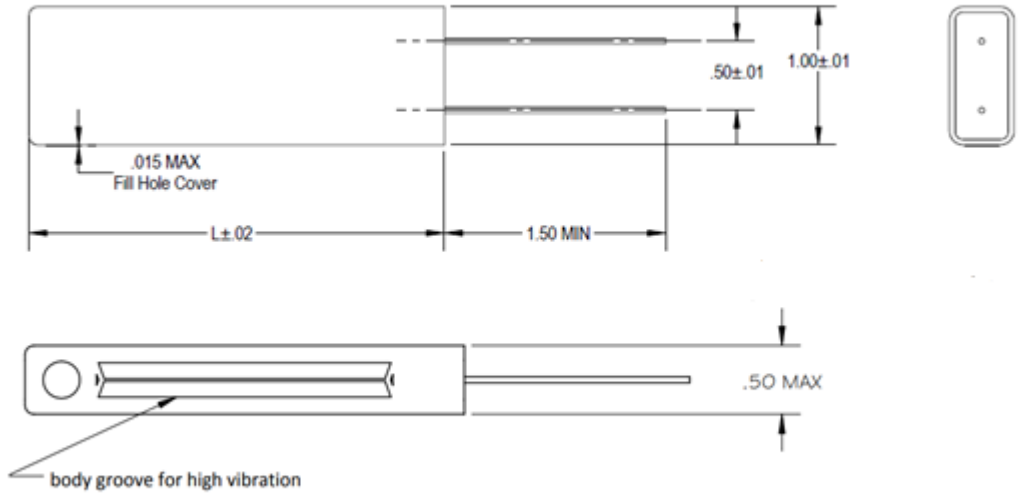
Type NHR, High Temperature Prismatic Aluminum Electrolytic Capacitors

Voltage Vdc	Cap µF	P/N	120Hz 25 °C Cat. ESR	20KHz 25 °C Cat. ESR	150 °C Ripple 120Hz	150 °C Ripple 20KHz	Case	Width (in)	Length (in)	Surge 25 °C Vdc
75	390	NHR391M075JK0	0.538	0.206	0.75	1.58	1X1.5	1	1.5	110
75	550	NHR551M075JA0	0.366	0.140	0.95	2.01	1X2	1	2.0	110
75	750	NHR751M075JH0	0.268	0.103	1.15	2.44	1X2.5	1	2.5	110
75	960	NHR961M075JB0	0.211	0.081	1.34	2.84	1X3	1	3.0	110
100	310	NHR311M100JK0	1.048	0.402	0.54	1.13	1X1.5	1	1.5	150
100	430	NHR431M100JA0	0.712	0.273	0.68	1.44	1X2	1	2.0	150
100	590	NHR591M100JH0	0.521	0.200	0.83	1.75	1X2.5	1	2.5	150
100	750	NHR751M100JB0	0.411	0.158	0.96	2.03	1X3	1	3.0	150
150	180	NHR181M150JK0	1.088	0.417	0.53	1.11	1X1.5	1	1.5	220
150	260	NHR261M150JA0	0.738	0.283	0.67	1.41	1X2	1	2.0	220
150	360	NHR361M150JH0	0.541	0.207	0.81	1.71	1X2.5	1	2.5	220
150	450	NHR451M150JB0	0.427	0.164	0.94	2.00	1X3	1	3.0	220
200	120	NHR121M200JK0	1.107	0.424	0.52	1.10	1X1.5	1	1.5	300
200	170	NHR171M200JA0	0.752	0.288	0.66	1.40	1X2	1	2.0	300
200	230	NHR231M200JH0	0.551	0.211	0.80	1.70	1X2.5	1	2.5	300
200	290	NHR291M200JB0	0.434	0.166	0.94	1.98	1X3	1	3.0	300
250	80	NHR800M250JK0	1.500	0.575	0.45	0.95	1X1.5	1	1.5	350
250	110	NHR111M250JA0	1.018	0.390	0.57	1.20	1X2	1	2.0	350
250	150	NHR151M250JH0	0.746	0.286	0.69	1.46	1X2.5	1	2.5	350
250	190	NHR191M250JB0	0.589	0.226	0.80	1.70	1X3	1	3.0	350
300	60	NHR600M300JK0	2.547	1.273	0.37	0.64	1X1.5	1	1.5	400
300	90	NHR900M300JA0	1.729	0.864	0.47	0.82	1X2	1	2.0	400
300	130	NHR131M300JH0	1.267	0.633	0.57	0.99	1X2.5	1	2.5	400
300	160	NHR161M300JB0	1.000	0.500	0.66	1.16	1X3	1	3.0	400

Highlights

- 3000 hrs @ rated voltage, 150 °C
- Stainless steel case
- Withstands more than 80,000 feet altitude
- 80 g vibration



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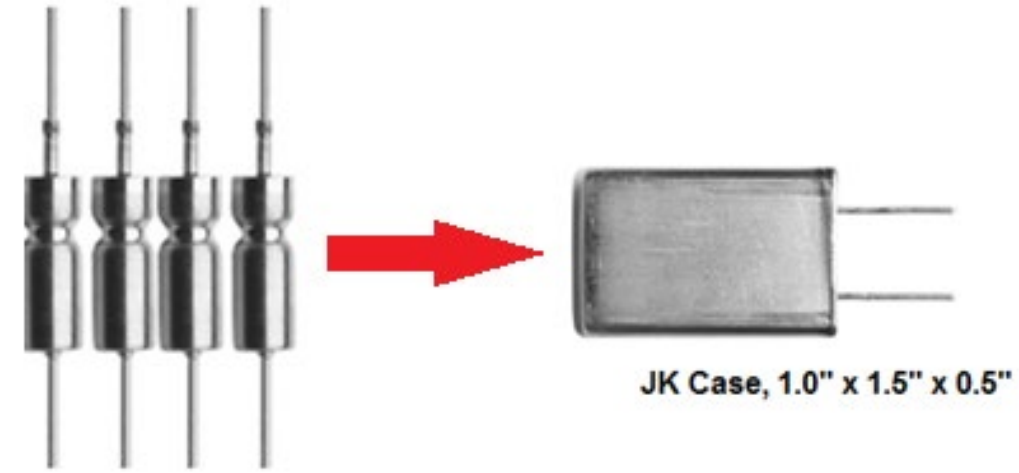
Prismatic Aluminum versus T4 Wet Tantalum in High Temperature Application

One NHR (JK case) is roughly the same size as 4 x T4 wet tantalum capacitors



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Prismatic Aluminum versus T4 Wet Tantalum in High Temperature Application

Type NHR capacitors offer significant size, weight and reliability advantages compared with arrays of Wet Tantalum capacitors

- NHR: Up to 300 Vdc @ 150 °C
- Wet Tantalum: Max voltage is 95 Vdc @ 150 °C
  - Wet Tantalum capacitors must be placed in series to achieve high voltage
  - High voltage applications require banks of series-parallel combinations of wet tantalum capacitors
- Using a fewer capacitors reduces size, weight, simplifies board layout and assembly
- Using fewer components improves reliability

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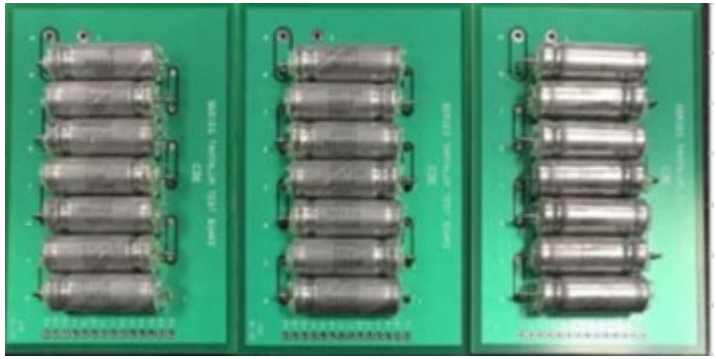
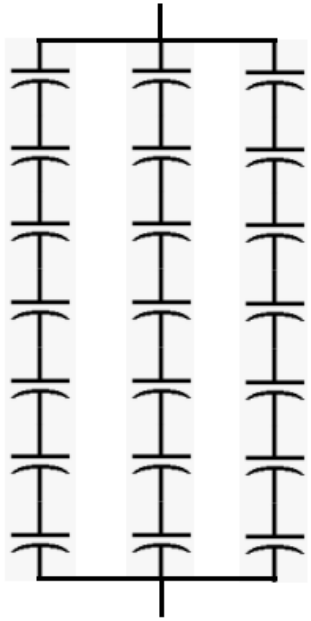
Example: Prismatic Aluminum versus Wet Tantalum in High Temperature Application:

- Customer using 21 Wet Tantalum in bank of 7(series) x 3(parallel)
- Each cap is rated at 220 µF, 100 Vdc @ 85 °C
- Application requires operation at 150°C
- Application requires 20g vibration withstand



Wet Tantalum Bank



Resulting capacitance of bank is 220 µF/7(s) x 3(p) = 94 µF

Due to derating requirements for wet Ta, voltage of each cap at 150 °C is 65 Vdc

Resulting voltage of bank is 65 Vdc x 7(s) = 455 Vdc

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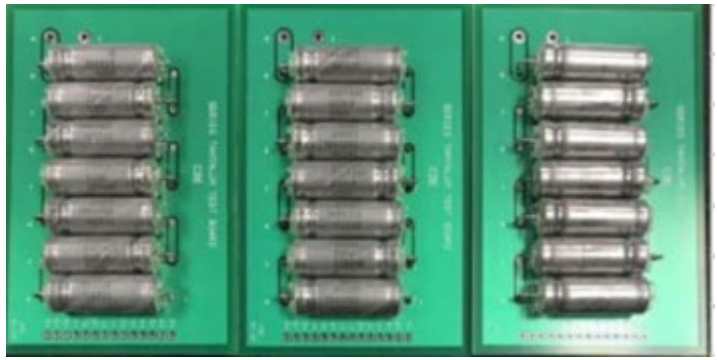
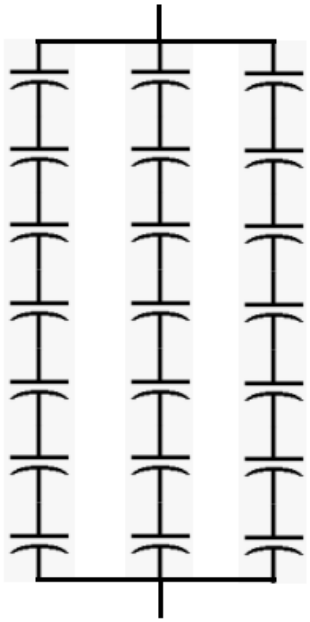
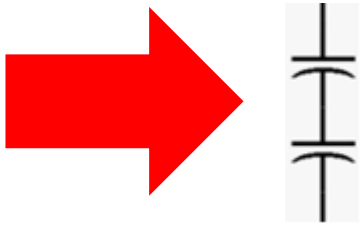
Example: Prismatic Aluminum versus Wet Tantalum in High Temperature Application:

- CDE offered prismatic capacitors, 2 in series
- Each capacitor is rated for 190µF, 250 Vdc @ 150 °C
- Resulting capacitor bank of the CDE solution is rated for 95 µF @ 500 Vdc @ 150 °C



Wet Tantalum Bank
94µF @ 455 Vdc, 150 °C





Prismatic Aluminum Electrolytic Bank

95µF @ 500 Vdc, 150 °C

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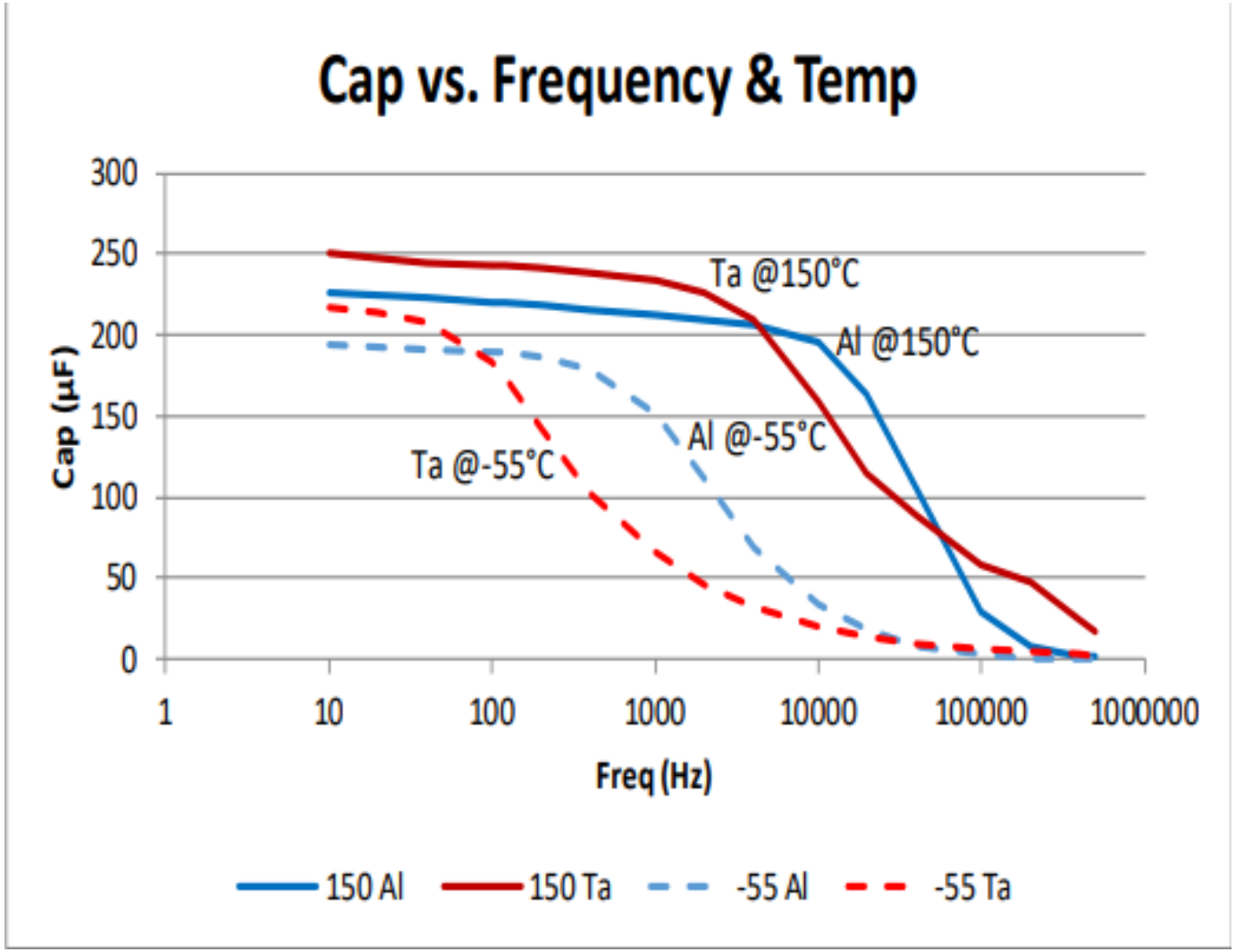
Example: Prismatic Aluminum versus Wet Tantalum in High Temperature Application:



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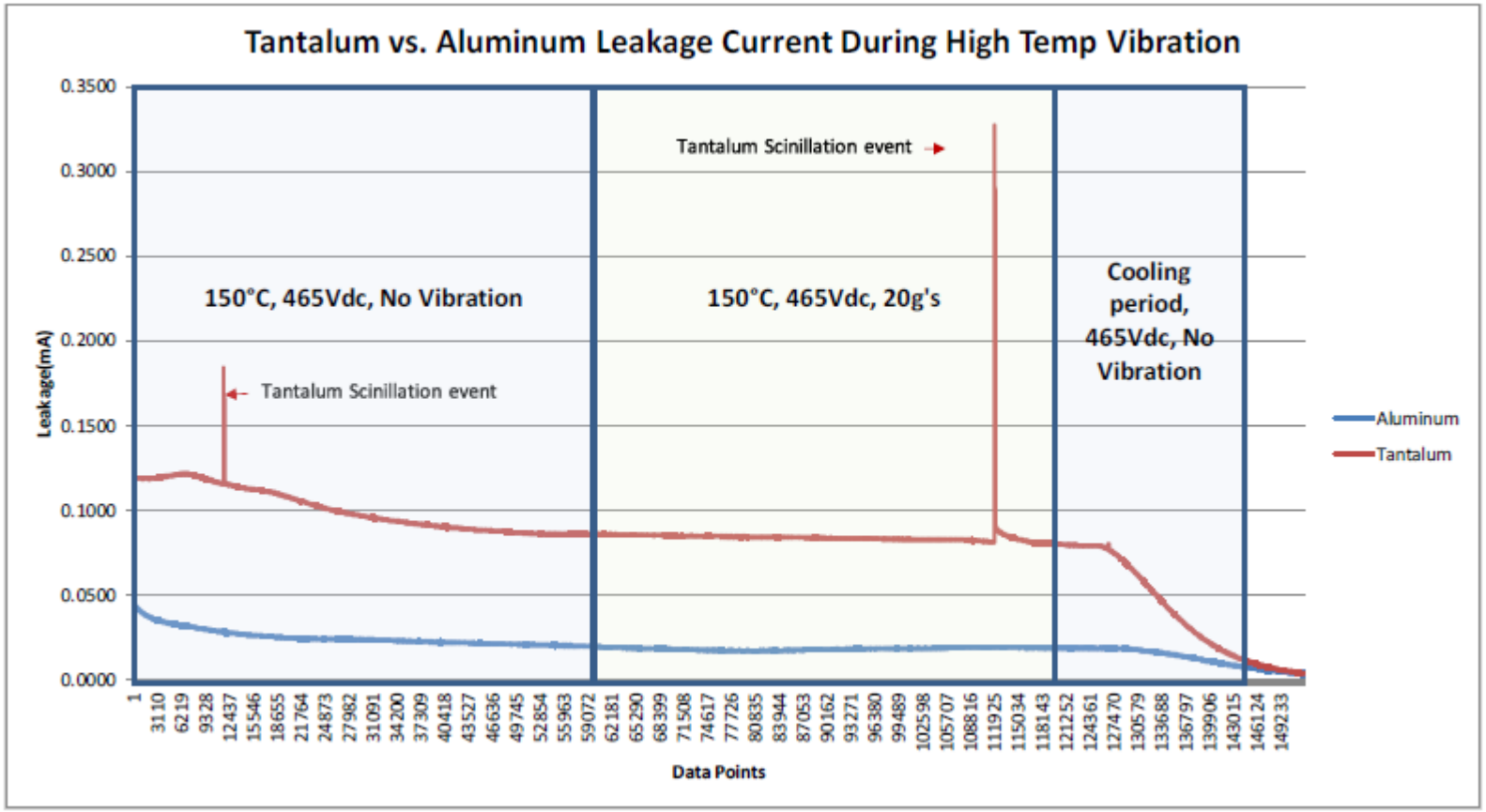
Example: Prismatic Aluminum versus Wet Tantalum in High Temperature Application: Leakage Current

Red: 21 Wet Tantalum in bank of 7(series) x 3(parallel)
Blue: 2 prismatic aluminum electrolytic capacitors in series



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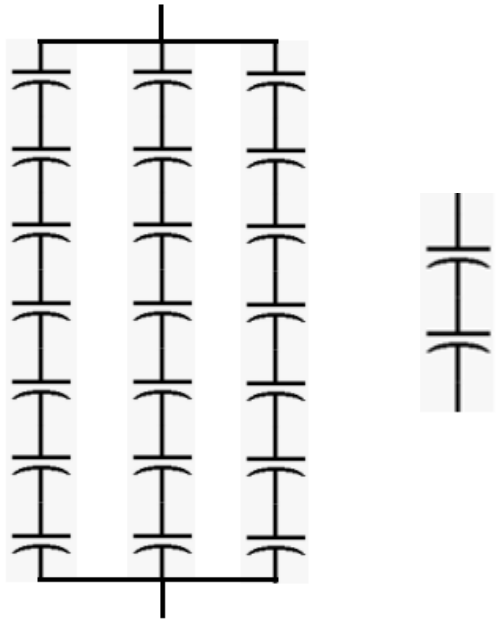
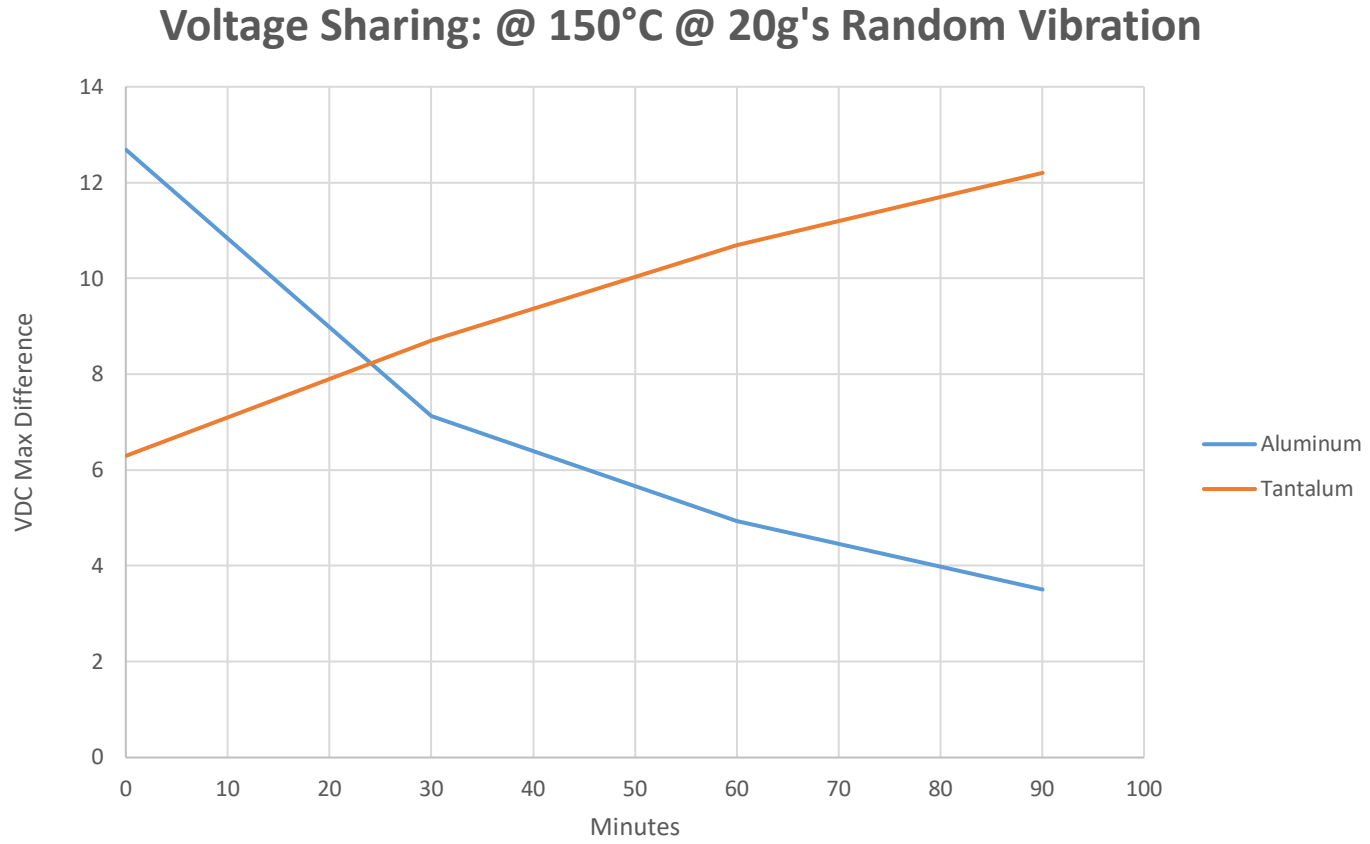
Example: Prismatic Aluminum versus Wet Tantalum in High Temperature Application: Voltage Sharing





- For both banks, the voltage drop across each capacitor was monitored during the vibration test.
- The Vdc Max Difference is the difference between the highest and lowest measured voltage within each bank.

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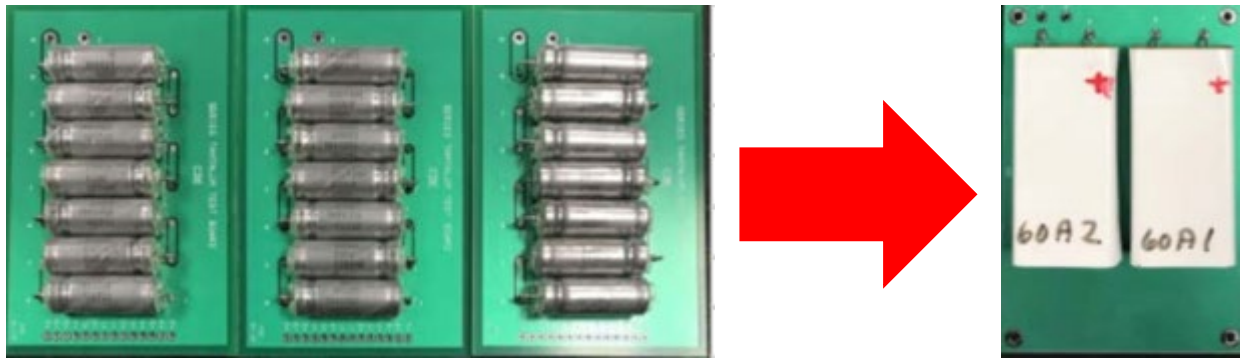
Example: Prismatic Aluminum versus Wet Tantalum in High Temperature Application: Summary

	Capacitance (µF)	Voltage Rating (Vdc) @ 150 °C	Case Volume (in^3)	Max AC 120Hz Ripple (mA)	Weight (g)	Cost($) of components
Wet Ta Bank 7(s) x 3(p)	94	455	3.6	2225	318	**1,500 -2,000**
Aluminum Bank 2(s)	95	550	2.0	1560	80	**400**



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Type NHR Summary

- 3,000 hours at rated voltage, 150 C
- Up to 80g vibration withstand
- Tested for altitudes up to 80,000 ft

Use fewer NHR aluminum capacitors versus banks of wet Tantalum capacitors

Advantages:

- Smaller size, weight and cost
- Simplifies board layout and assembly
- Improves reliability (fewer components and connection points)

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