Electronic Components

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New Polymer Capacitors for DC to DC Convertors in Automobile Infotainment Systems

APEC 2015: Jayson Young

Opening Statement

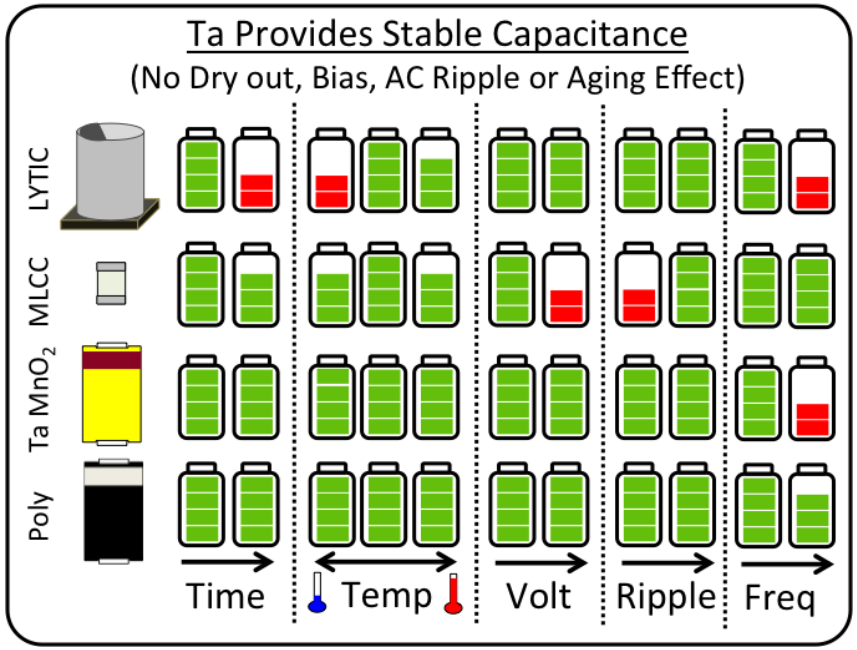
As more electronic systems continue to be integrated into our automobiles, the need for capacitor technologies that deliver high reliability, long life, stable performance, low ESR and low cost continue to grow.

Polymer Capacitors have met these needs in the enterprise, commercial, consumer, medical, military and aerospace segments for more than 15 years. But polymer technology has been challenged when it comes to meeting the AEC Q-200 requirements.

Today, these challenges are being overcome as polymer capacitor technology makes it entrance into the automotive segment.

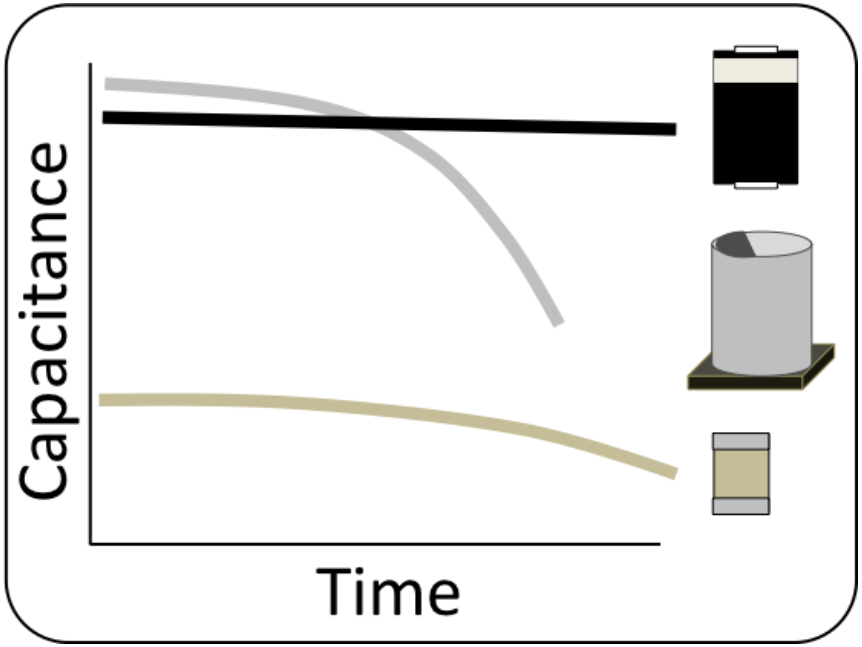
Advantages of Polymer Capacitors

Stable Capacitance Behavior



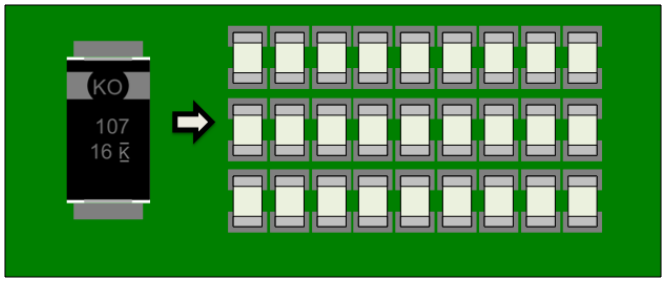
Want 100µF? – Get 100µF!

Long Life

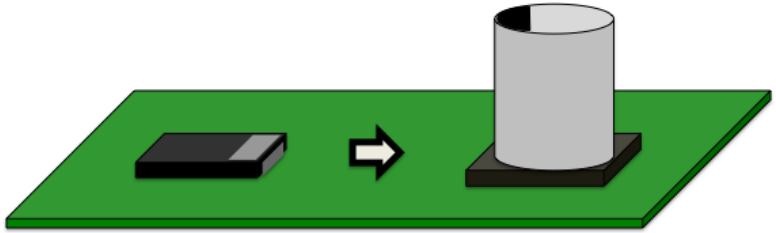


Advantages of Polymer Capacitors

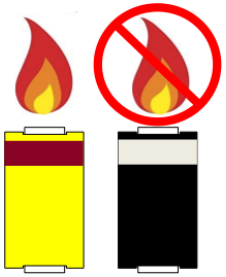
High Capacitance



Low Profile

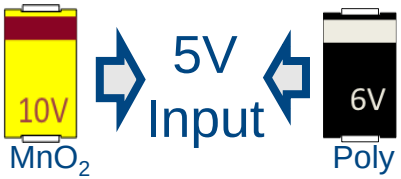


Safe Failure Mode



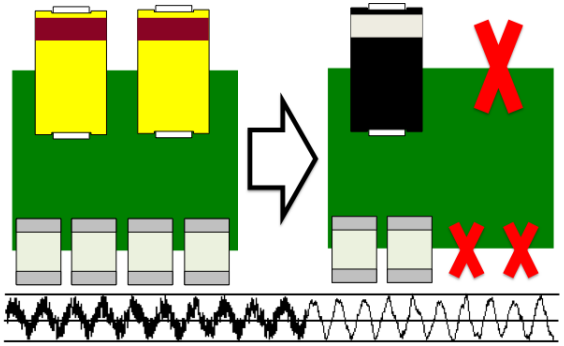
Improved Voltage Derating

MnO_2 = 50% Derating
Poly = 10-20% Derating

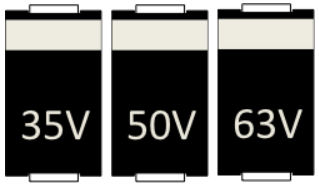


Low ESR

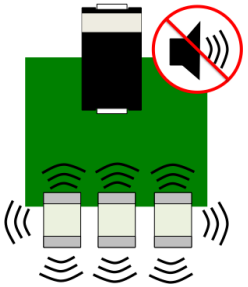
(High Cap Retention = Reduced Pc Count)



Higher Application Voltage Range



Replacement for MLCC Piezo Noise



Meeting the Q-200 Requirements

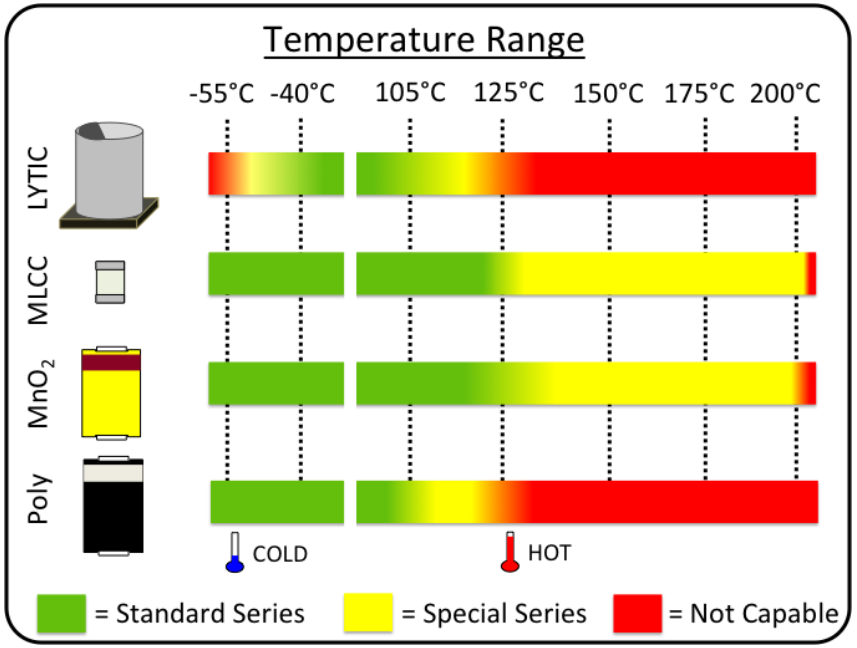
AEC Q-200 Rev D Table of Methods for Tantalum & Ceramic Capacitors			
Stress Test Name	**Conditions**	**MnO_2**	**Poly**
High Temp Exposure (Storage)	125° C, Unbiased, 1000 Hrs	✓	✗
Temperature Cycling	-55° C to 125° C, 1000 Cycles	✓	✓
Biased Humidity	85° C, 85% RH, Biased, 1000 Hrs	✓	✗
Operational Life	125° C, Biased, 1000 Hrs	✓	✗
Resistance to Solvents	Mil-Std-202, Meth. 215	✓	✓
Mechanical Shock	Mil-Std-202, Meth. 213, Cond F	✓	✓
Vibration	Mil-Std-202, Meth. 208, 5G's-20min	✓	✓
Resistance to Soldering Heat	Mil-Std-202, Meth. 210, Cond D	✓	✓
ESD	AEC-Q200- 002 or ISO/DIS 10605	✓	✓
Solderability	J-STD-002	✓	✓
Terminal Strength	AEC Q200-006	✓	✓

Testing that is challenging for Polymer Capacitors:

- High Temp Exposure: 125°C, 0Vr, 1000 hrs
- Operational Life: 125°C, 0.67Vr, 1000 hrs
- Biased Humidity: 85°C/85%RH, 1.0Vr, 1000 hrs

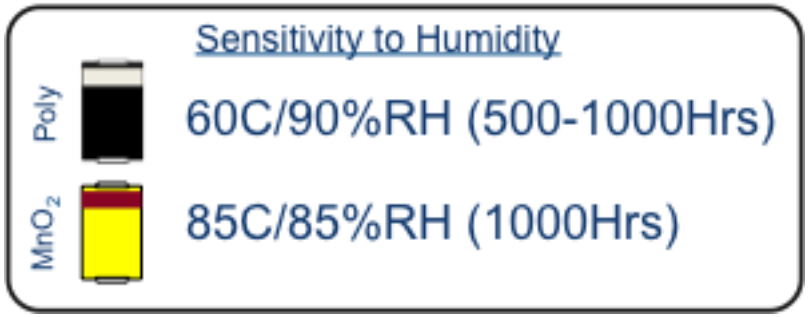
Disadvantages of Polymer Capacitors

High Temperature



AEC Q200 Requirement: 125°C

High Humidity



AEC Q200 Requirement: 85°C/85%RH

Issues with Polymer Cathode Systems

High Temperature:

- Polymer Oxidation: Extended exposure of polymer to air (primarily oxygen) at elevated temperature results in oxidation of the polymer. This breakdown of the conductive polymer's structure results in increasing DF and ESR of the component over time.

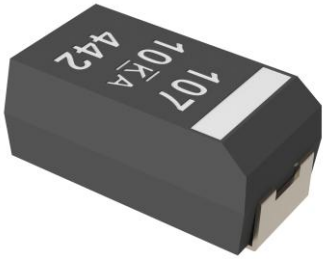
High Humidity:

- Polymer De-doping: De-doping of the conductive species within the polymer.
- Metal Migration: Migration of metallic species from the cathode and lead frame materials onto the dielectric surface result in increases in leakage and can lead to shorts.

Distinctive Characteristics

Technology Enhancements for Automotive Polymer

T591 Series



- Robust anode design
- Moisture protection system to minimize risk of humidity penetration and oxidation;
- Packaging System to reduce permeability and migration

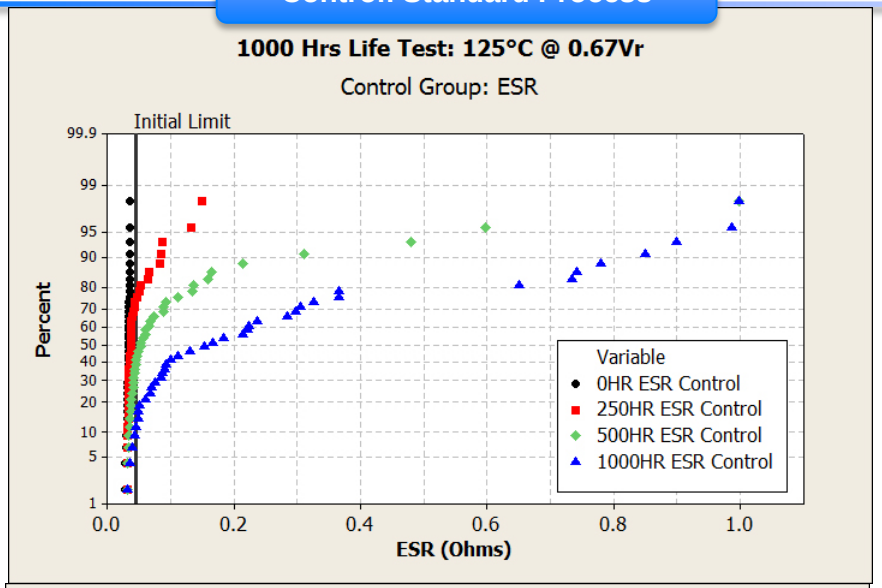
Initial Releases for 0.9V to 5V Rails

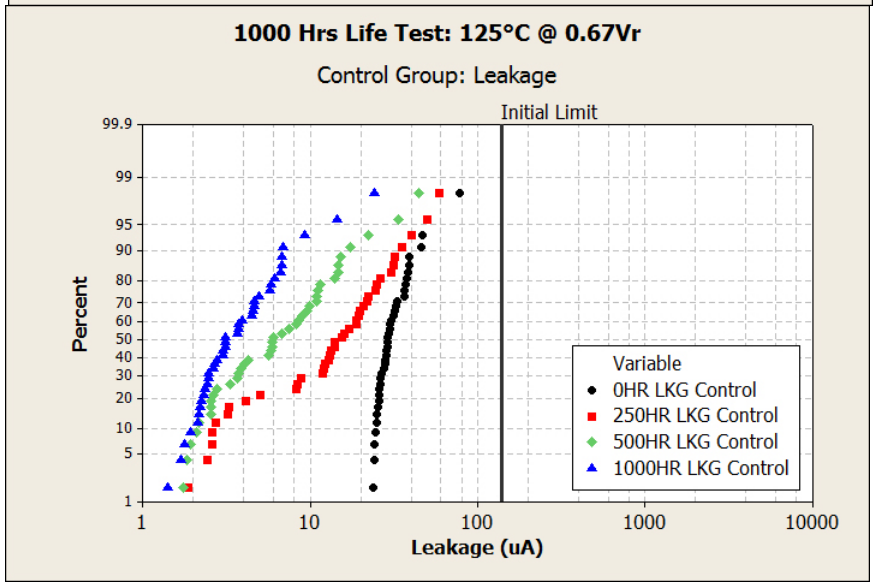
Series	Description	Part Number	Cap	Voltage	ESR (mΩ)	Temp	Size
T591	Polymer, Automotive	T591V227M2R5ATE009	220	2.5	9	105	7343-20
T591	Polymer, Automotive	T591B336M006ATE080	33	6	80	125	3528-21
T591	Polymer, Automotive	T591B336M010ATE080	33	10	80	125	3528-21
T591	Polymer, Automotive	T591B476M006ATE070	47	6	70	125	3528-21
T591	Polymer, Automotive	T591B476M010ATE070	47	10	70	125	3528-21
T591	Polymer, Automotive	T591D107M010ATE025	100	10	25	105	7343-31

Technical Improvements – AUTO Grade

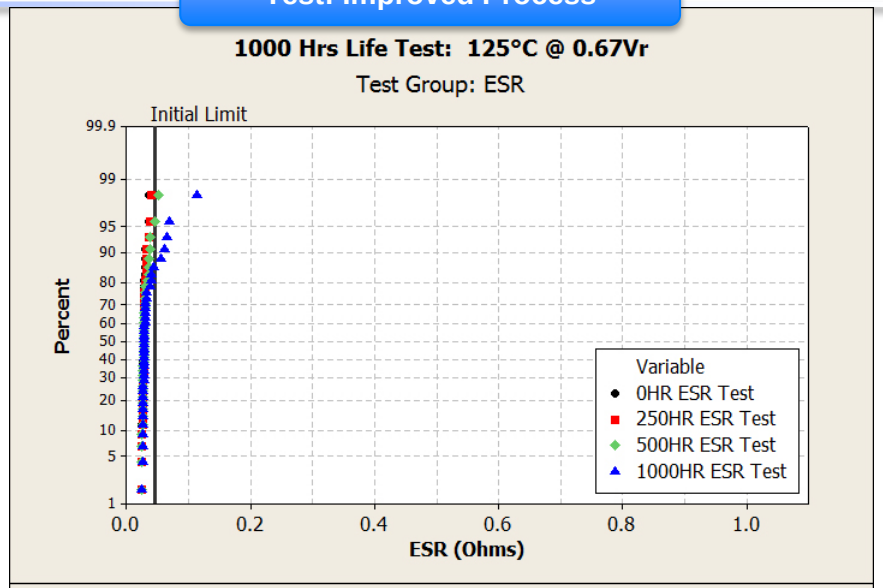
Life Test Improvement – 125ºC

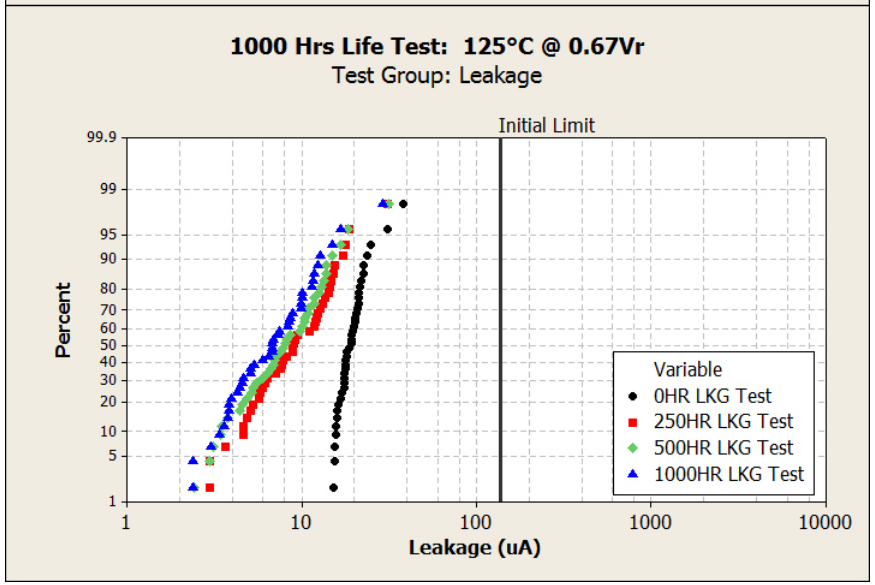
Control: Standard Process





Test: Improved Process





KEMET Ref: Polymer Tantalum Capacitors for Automotive Applications, CARTS 2014 – Jayson Young and Javaid Qazi

Technical Improvements – AUTO Grade

Humidity Improvement – 85ºC/85%RH

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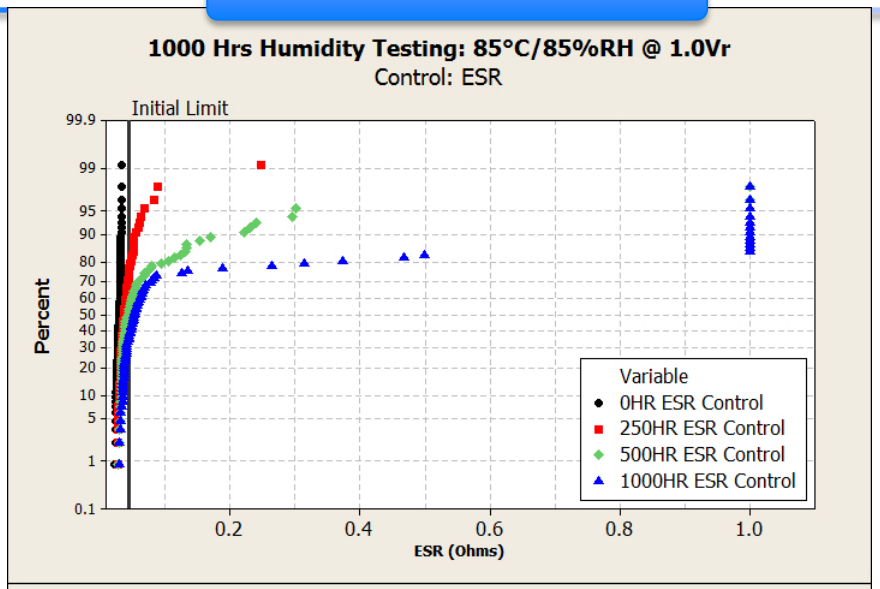
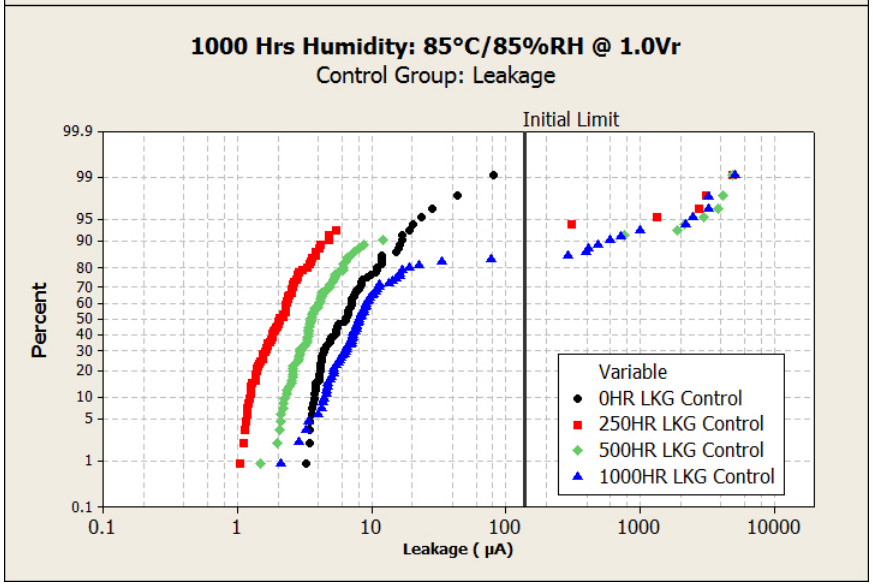
Control: Standard Process





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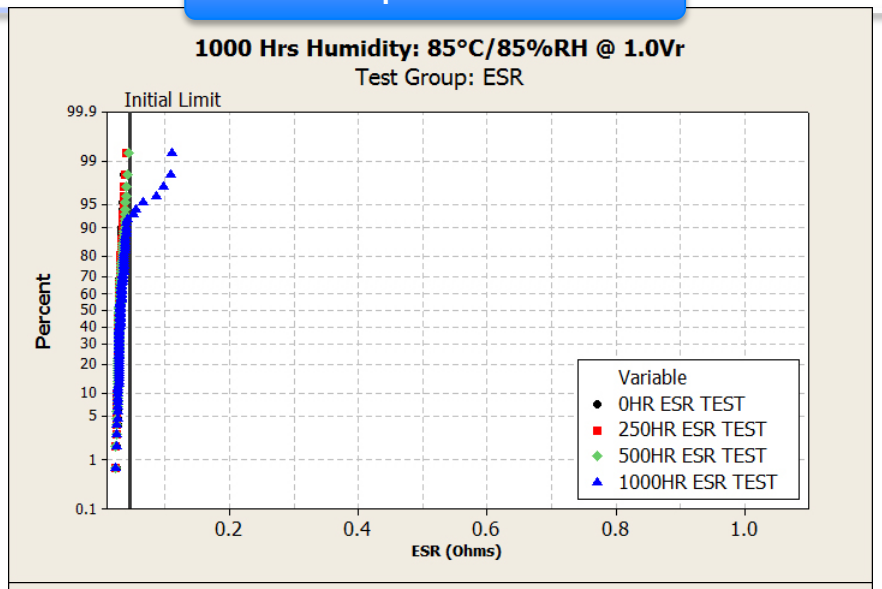

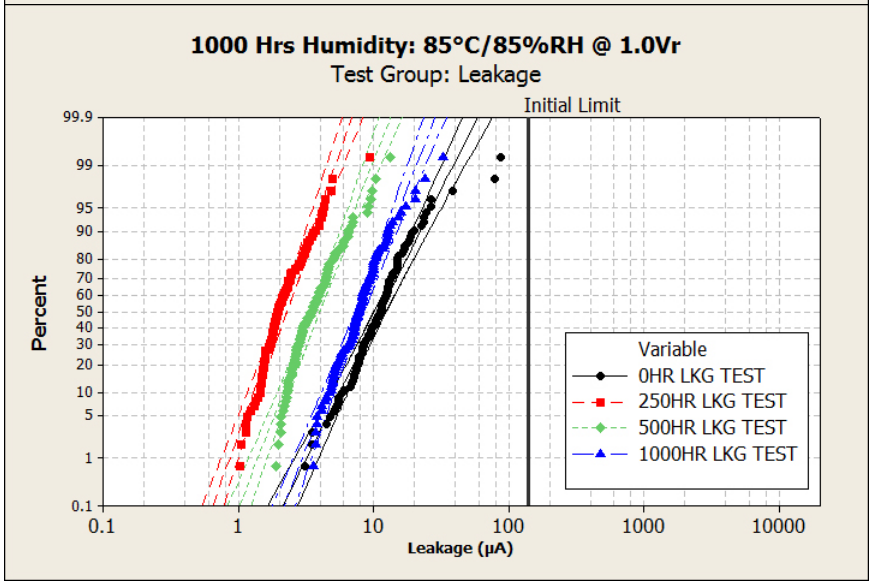

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Product Offerings, T591 Series

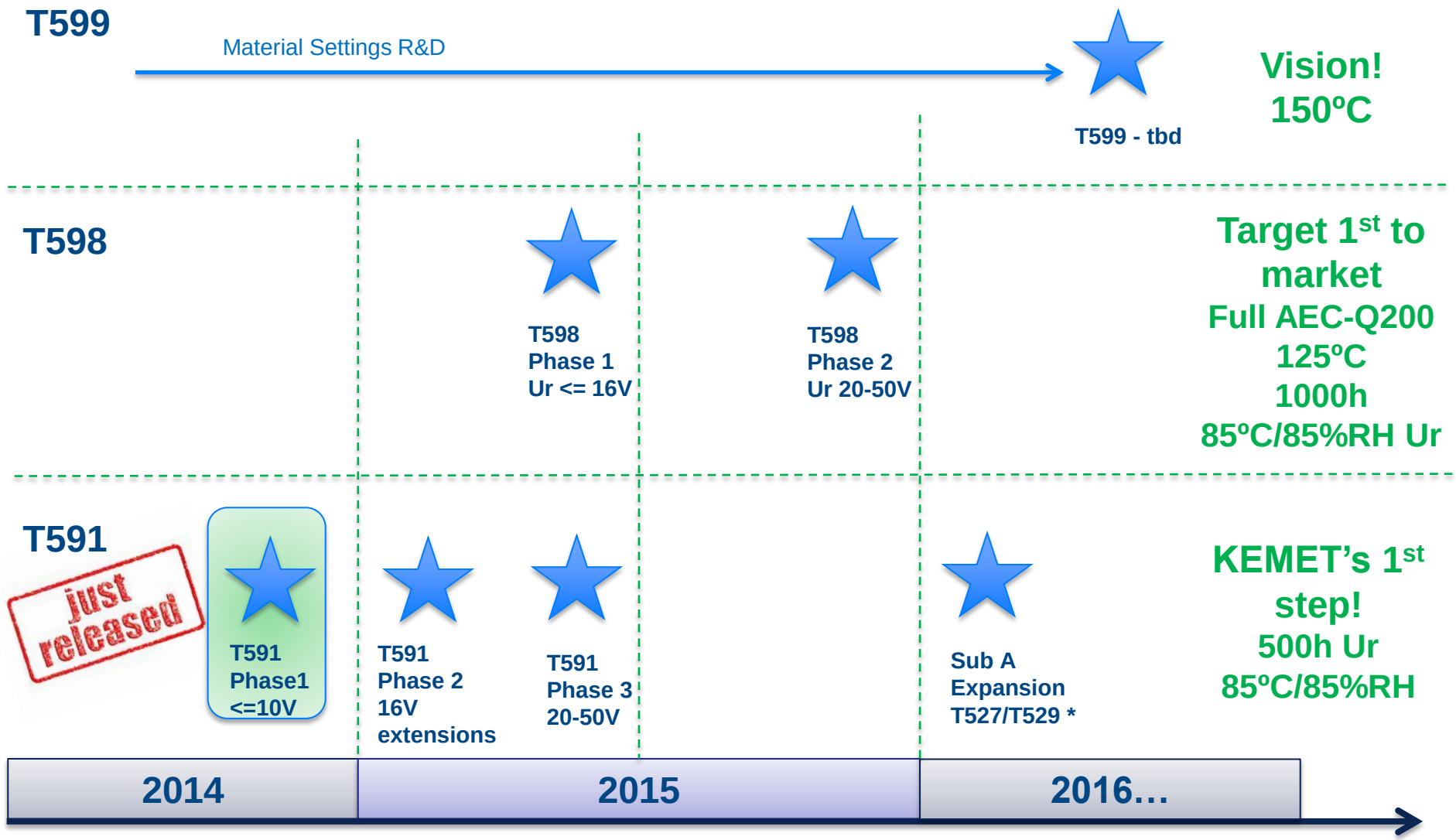
Existing and Under development Waterfall

Vr / Cap (µF)	2.5V	4V	6.3V	10V	16V	20V	25V	35V	50V
6,8								B(200)UD 2QCY2015	
10								V(120)UD 2QCY2015	D(90) UD 2QCY2015
15									
22									
33			B (80)	B (80)			D(65) UD 2QCY2015	D(65) UD 2QCY2015	X(75) UD 2QCY2015
47			B (70)	B (70)				X(75) UD 2QCY2015	
68									
100				V(45) UD 1QCY2015	D(50) UD 1QCY2015				
				D (80, 40, 25)					
150									
220	V (15, 12, 9)			D (25)UD 1QCY2015					
330	V(25) UD 1QCY2015		D (25) UD 1QCY2015						
470									

UD under development

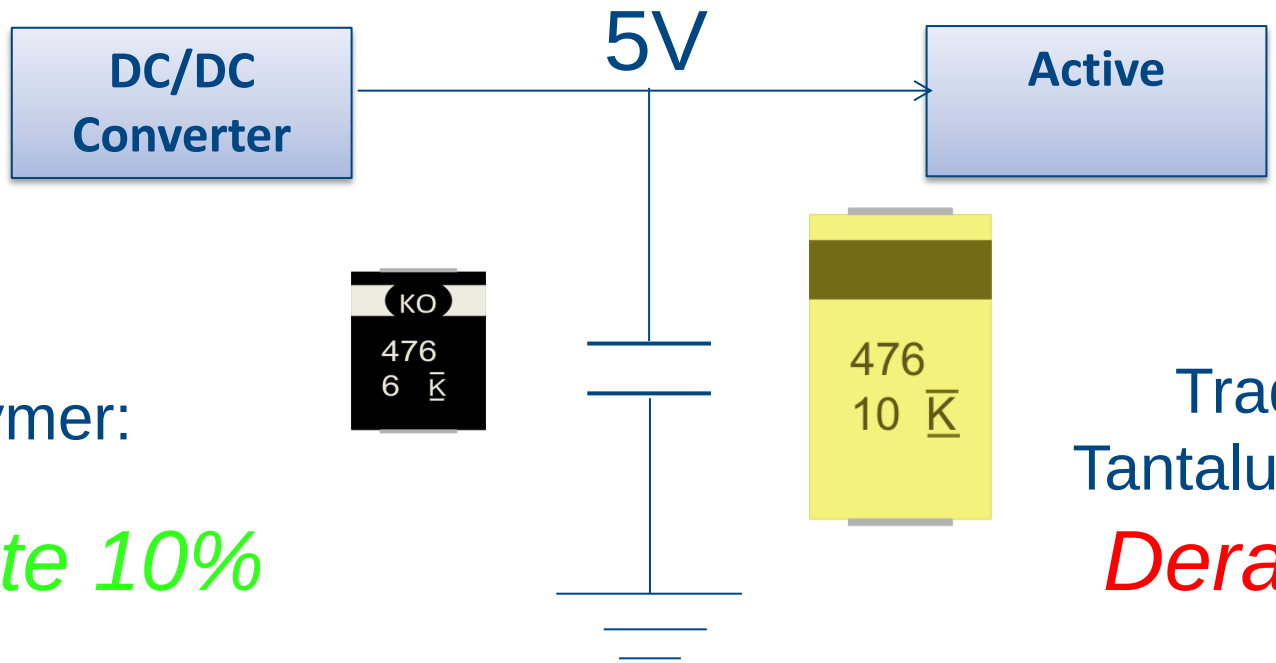
Product Roadmap

Short & Long Term Vision – Automotive Polymer



* New series name to be define

Replacing Traditional Tantalum with T591 Automotive Polymer



Polymer:

Derate 10%

Traditional Tantalum (MnO_2):

Derate 50%

6.3V	10V
47uF	47uF
70mΩ	80mΩ
B Case	D Case

Cost Study

The Need: ~47uF for a 5V Input

Part Type and Pc Count		Price: (Based on Digi-Key Full Reel Quantities)
MLCC: 2pcs Auto Grade 1210, 47uF, 6.3V, X7R		$0.6783 x 2 = $1.35
MLCC: 3pcs General Purpose 1210, 47uF, 6.3V, X5R		$0.1208 x 3 = $0.3624
Traditional Tantalum: 1pcs Auto Grade 7343, 47uF, 10V		$0.52 x 1 = $0.52
Polymer: 1pcs **T591 Series**, 3528, 47uF, 6.3V		$0.35 x 1 = $0.35

1210 Imperial = 3528 Metric

Closing

- To meet the requirements of the AEC Q-200 Document, improvements to the design of polymer capacitors have been implemented.
- The conductive polymer used in the construction of these devices is sensitive to extreme temperature and humidity.
- By enhancing the design, polymer capacitors can meet and exceed the requirements of these harsh environmental tests.
- Polymer Capacitors offer a series of technical advantages over other dielectric options. While the individual piece price may be higher, the total solution cost is often the lowest cost solution.