



# TANTALUM CAPACITORS DIVISION

## CMSE – 2017 ADVANCED POLYMER CAPACITORS

A **WORLD OF**  
**SOLUTIONS**





# ABOUT THE AUTHORS

Alex Eidelman, VP R&D

E-mail: [alex.eidelman@vishay.com](mailto:alex.eidelman@vishay.com)

Charles Pothier, Marketing Director

E-mail: [Charles.Pothier@vishay.com](mailto:Charles.Pothier@vishay.com)

Yongjian Qiu, Sr. R&D Specialist

E-mail: [Yongjian.Qiu@vishay.com](mailto:Yongjian.Qiu@vishay.com)

Pavel Vaisman, Sr. R&D Manager

E-mail: [pavel.vaisman@vishay.com](mailto:pavel.vaisman@vishay.com)

Yuri Stangrit, R&D Project Leader

E-mail: [Yuri.Stangrit@vishay.com](mailto:Yuri.Stangrit@vishay.com)



# AGENDA

1. Vishay's traditional strength in Tantalum technology.
2. Vishay's patented MicroTan<sup>®</sup> packaging technology for best-in-class performance.
3. Failure rate of Vishay Polymer capacitors.
4. Product screening for improved reliability performance.
5. Vishay T54 HiRel COTS Polymer capacitors' performance.



## ADVANTAGES of VISHAY ANODE TECHNOLOGY

Process step	Industry practice	Vishay practice	Advantage of Vishay technology
Anode Delubrication	Thermal [Burn out @1000°C] Carbon content ~ 300ppm	Liquid [Wash out @85°C] Carbon content ~ 30ppm	Defect free Dielectric Low DC Leakage Long term reliability
Magnesium Deoxidation	Not applied Oxygen content ~5000ppm	Applied Oxygen content ~4000ppm	
Wire attachment	<u>Embedded</u> Good strength attachment Not compatible with Deox	<u>Welded</u> Excellent strength attachment Compatible with Deox	Improved ability to withstand Reflow stress

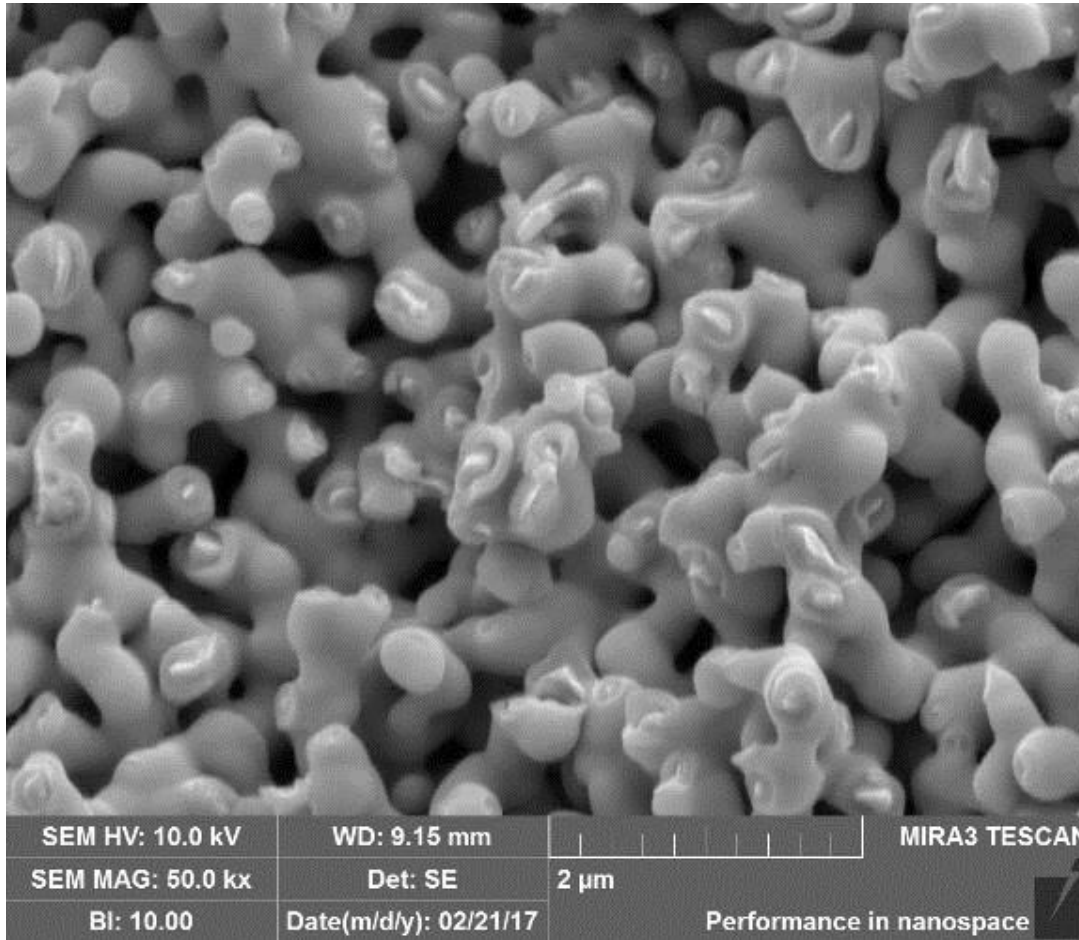


April 2017

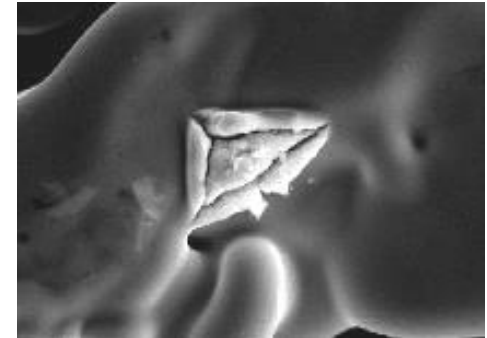
© 2017 VISHAY INTERTECHNOLOGY, INC. ALL RIGHTS RESERVED.



# ADVANTAGES of VISHAY ANODE TECHNOLOGY



Typical appearance  
of crystals in Ta<sub>2</sub>O<sub>5</sub>  
dielectric



Defect free Ta<sub>2</sub>O<sub>5</sub> dielectric  
formed over High CV sintered  
Ta slug by anodization at 50V.  
No crystals found!



April 2017

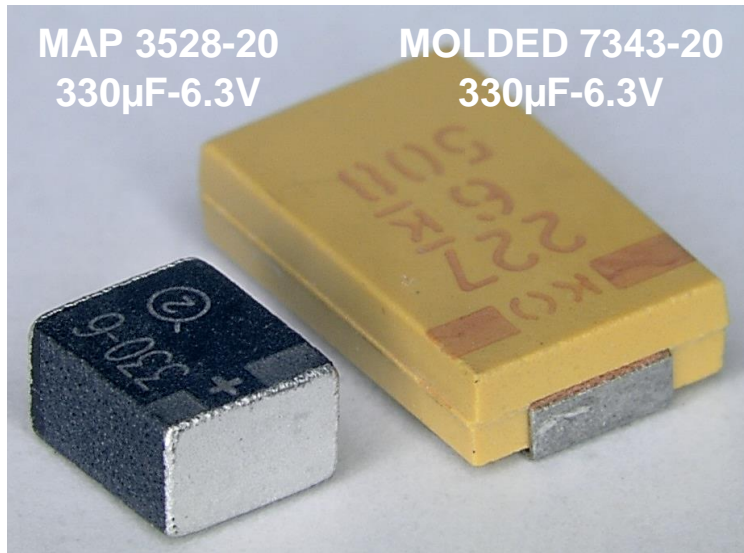
© 2017 VISHAY INTERTECHNOLOGY, INC. ALL RIGHTS RESERVED.





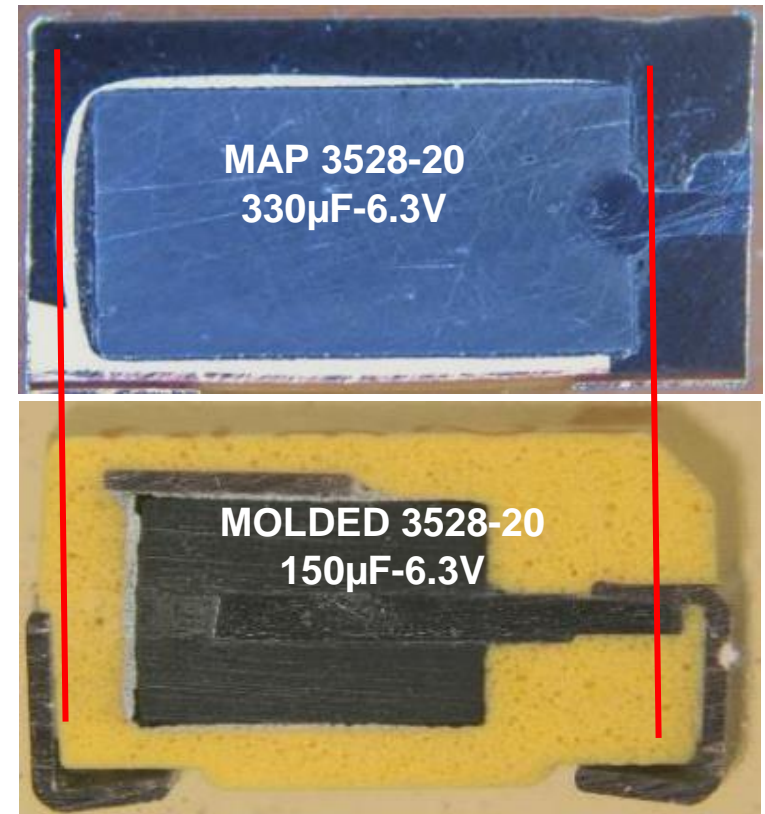
# HIGHER VOLUMETRIC EFFICIENCY MULTI ARRAY PACKAGING

**Same CAP value in smaller package**



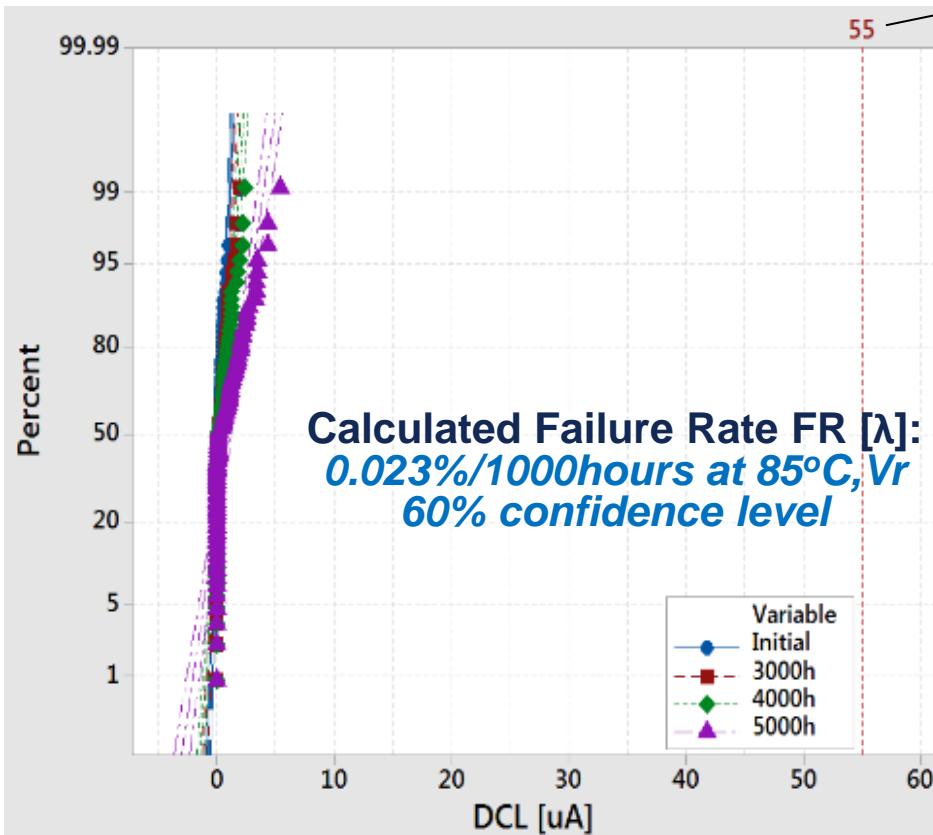
**Robust design with lower DCL  
and ESR by use of lower CV  
Ta powder and/or higher  
formation voltage**

**Higher CAP value in the same package**





# 105°C, VR LOAD LIFE FOR T58 22μF-25V BB CASE



0.1CV value

$$\lambda_{hour} = \frac{Chi^2(\alpha, \nu)}{2 \times D \times H \times Af_{total}} = \frac{Chi^2(\alpha, \nu)}{2 \times EDH}$$

$\lambda$  hour: Failure rate

$\alpha$ : confidence level (90%)

$\nu=2 \cdot n+2$ ; n: number of observed failures

D: tested units

H: test hour/unit

$Af$ : acceleration factor

EDH:  $H \times D \times Af$

- Advance anode technology provides DC leakage values well below traditional 0.1CV limit.
- DC leakage stays extremely low and stable over 5000hours of Life test at full rated conditions!

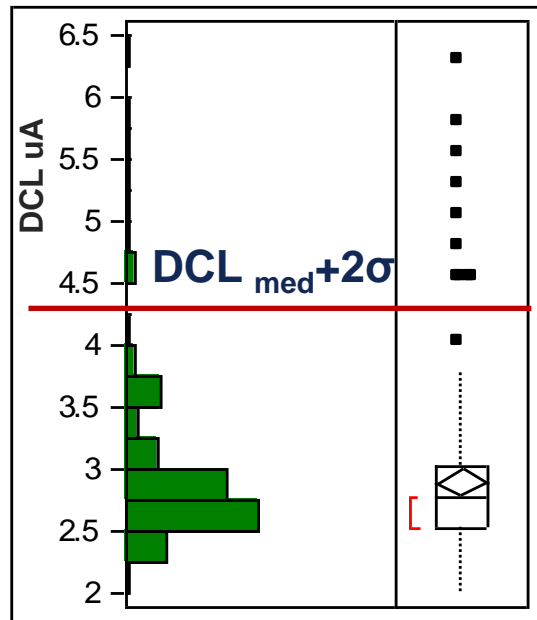
# DC LEAKAGE SCREENING at ELEVATED TEMPERATURE and VOLTAGE.

## T58 22 $\mu$ F-25V BB CASE

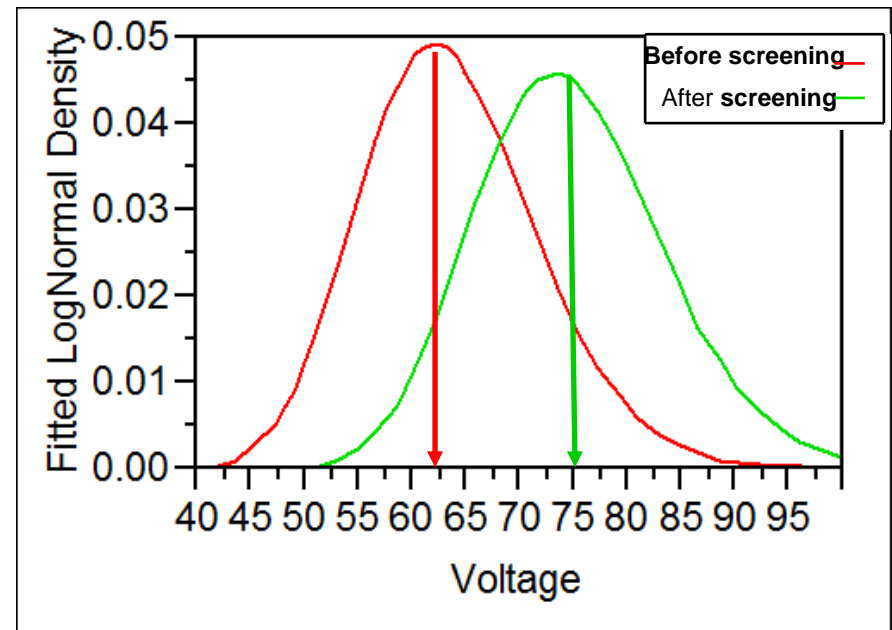
- Determine Breakdown Voltage [BDV] of representative sample.
- Sample test DCL at 125°C at Voltage < Average BDV; define [Med+2 $\sigma$ ] limit.
- Screen entire lot at [Med+2 $\sigma$ ] limit.

**Avg. BDV significantly increases!**

**What about reliability?**



**DCL distribution at 125°C**

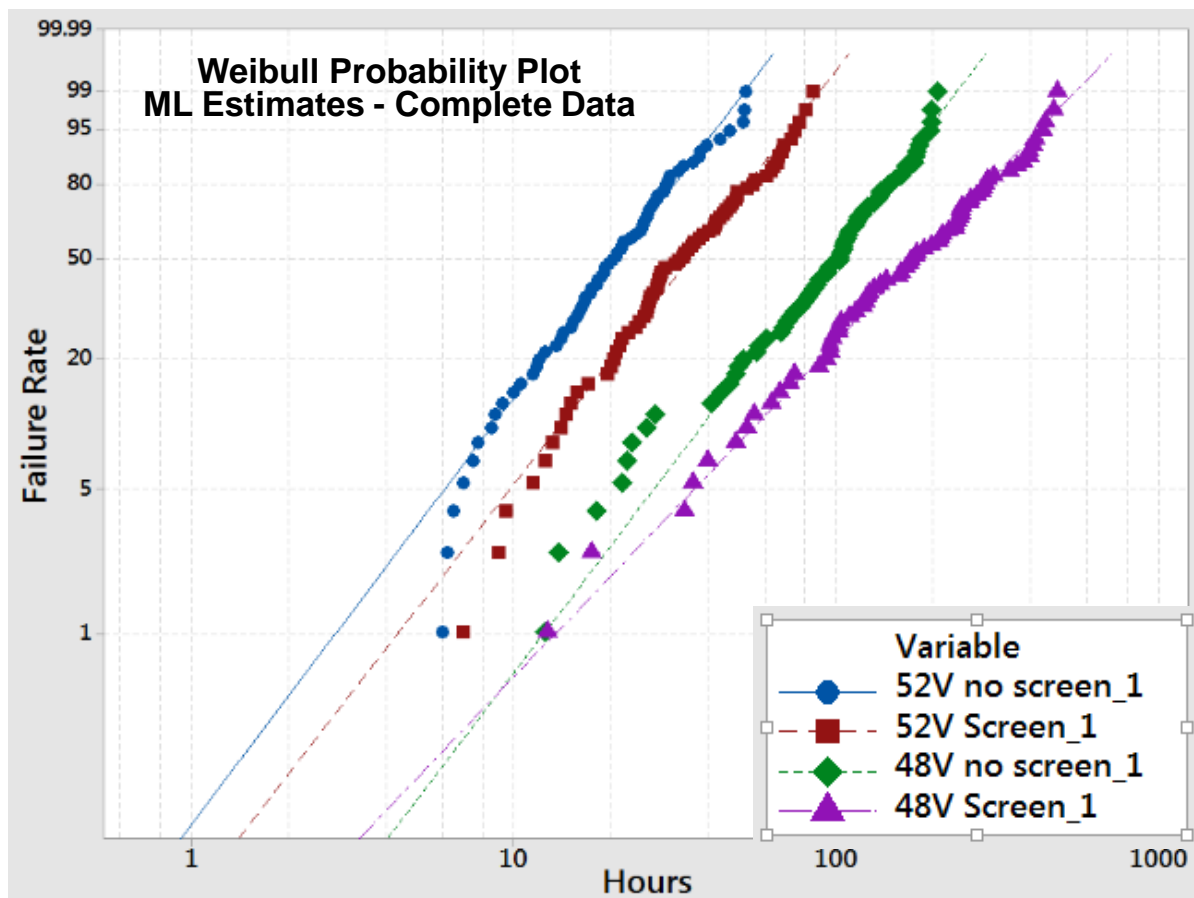


**BDV distribution**



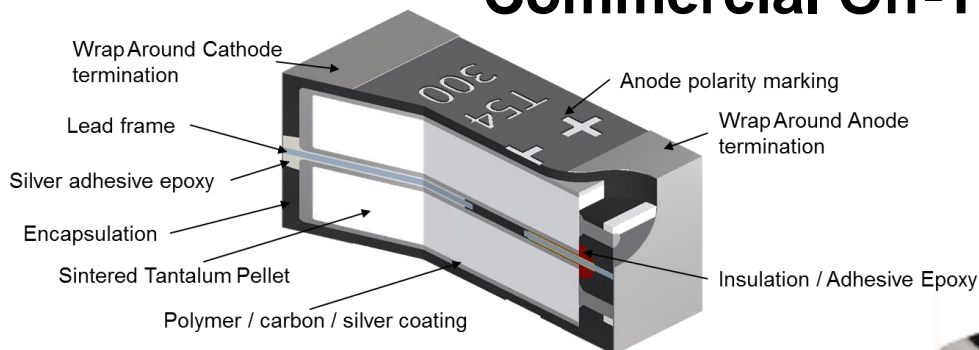
# IMPACT of SCREENING on FAILURE RATE

Since tests at rated conditions do not produce failures, **Accelerated Test at 105°C and elevated voltage applied.**



Test Voltage	FR [%/1000h]
48V	0.005
<b>48V Screen</b>	<b>0.003</b>
52V	0.012
<b>52V Screen</b>	<b>0.009</b>

# vPolyTan™ Polymer Surface Mount Chip Capacitors, Low ESR, Leadframeless Molded Type, Commercial Off-The-Shelf (COTS)



## FEATURES

- Ultra-low ESR
- High Reliability Processing including:
  - 100% Surge Current Tested
  - Accelerated Aging
  - Thermal Shock
  - Statistical DC Leakage screening at elevated temperature and Voltage
- Molded case 7343 EIA size
- Terminations: wraparound



## KEY PERFORMANCE CHARACTERISTICS

ITEM	CONDITION
Life test at +105 °C	2000 h application of rated voltage at 105 °C, MIL-STD-202 method 108
Shelf life test at +105 °C	2000 h no voltage applied at 105 °C, MIL-STD-202 method 108
Humidity tests	At 60 °C / 90 % RH 500 h, no voltage applied
Surge voltage	105 °C, 1000 successive test cycles at 1.3 of rated voltage in series with a 33Ω resistor at the rate of 30s ON, 30s OFF

## PERFORMANCE / ELECTRICAL CHARACTERISTICS

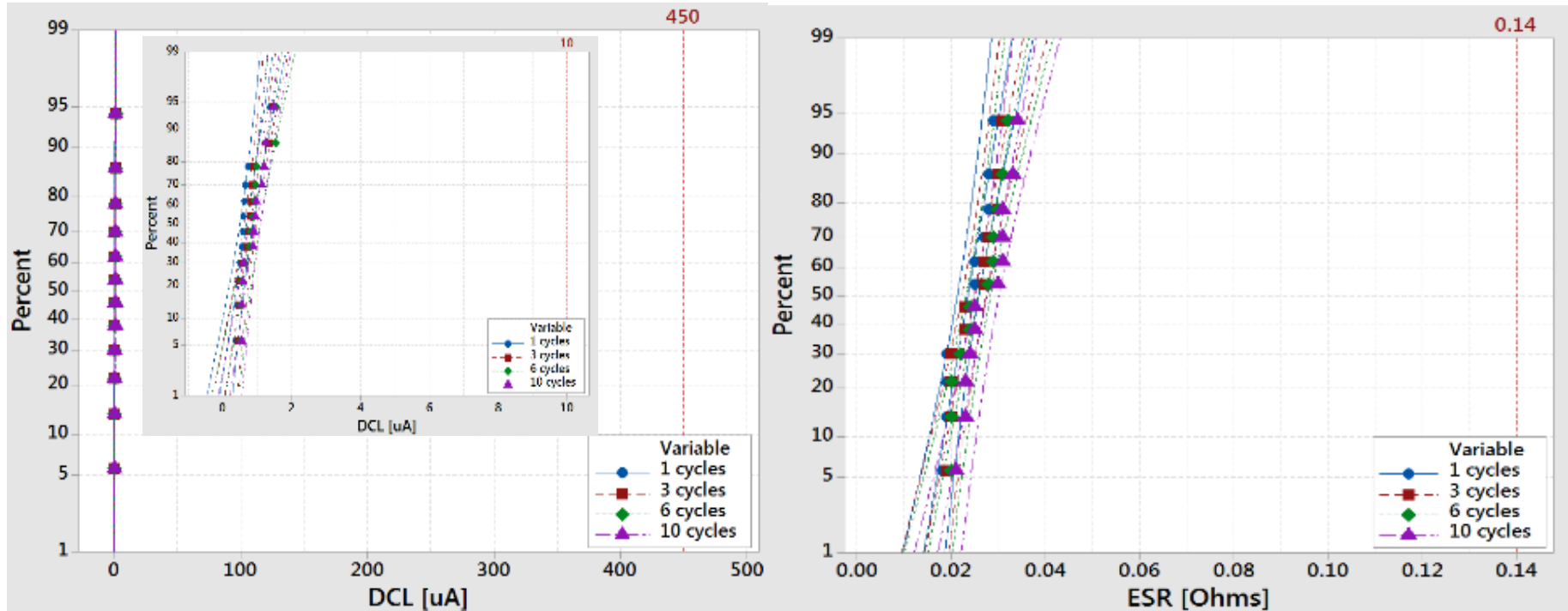
Operating Temperature: -55°C to +105°C  
 Capacitance Range: 15μF to 470μF  
 Capacitance Tolerance: ± 20 %  
 Voltage Rating: 16 V<sub>DC</sub> to 75 V<sub>DC</sub>

April 2017

© 2017 VISHAY INTERTECHNOLOGY, INC. ALL RIGHTS RESERVED.

# T54 150 $\mu$ F-30V EE-CASE 10X- REFLOW

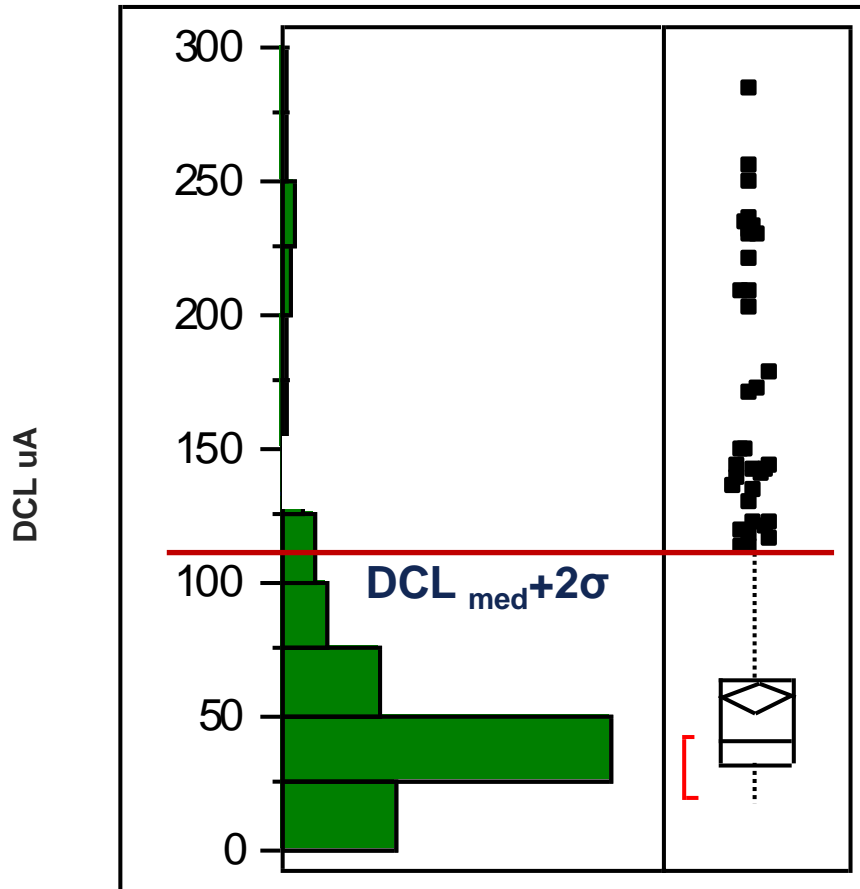
0.1CV value



- Extremely low and stable DC Leakage achieved through use of **Deoxidation and welded wire anode technology.**
- Double-anode construction provides low and stable ESR after 10 Reflow cycles.**

# DC LEAKAGE SCREENING at ELEVATED TEMPERATURE and VOLTAGE.

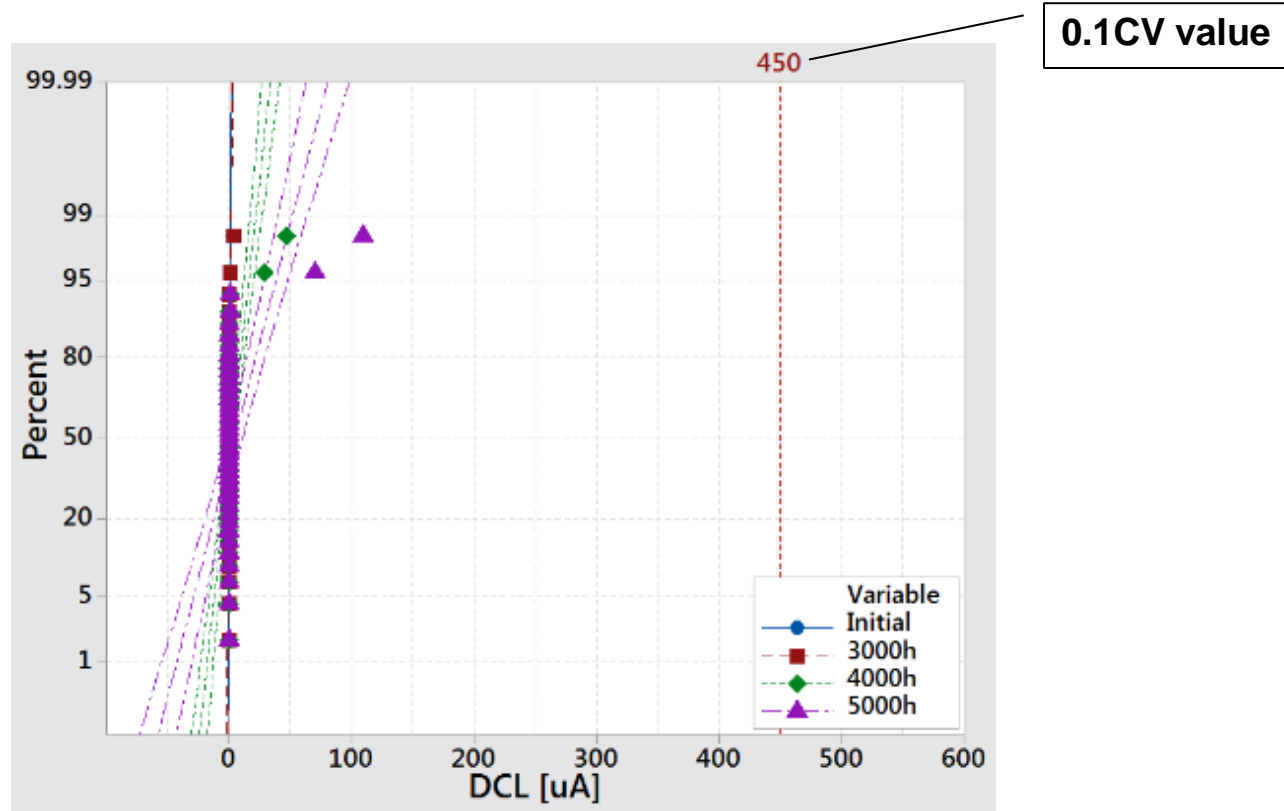
## T54 150 $\mu$ F-30V EE-CASE



DC Leakage screening to [Med+2 $\sigma$ ] limit at 125°C and Elevated Voltage removes outliers, which are potential long term reliability failures.



# 105°C, Vr LOAD LIFE for T54 150μF-30V EE CASE



- DC leakage stays extremely low and stable.
- Slight DCL increase appears on several units only after 3000hours of Life test at full rated conditions, which confirms the efficacy of screening method.





## CONCLUSIONS

1. **Vishay advanced anode technology in combination with robust product design provides highly reliable Polymer capacitors reaching failure rates below 0.1%/1000hours.**
2. **Application of DC Leakage screening at elevated temperature and voltage further reduces failure rates below 0.01%/1000hours.**
3. **Further testing is underway in order to define failure rate levels for variety of T54 HiRel COTS Polymer capacitors.**

