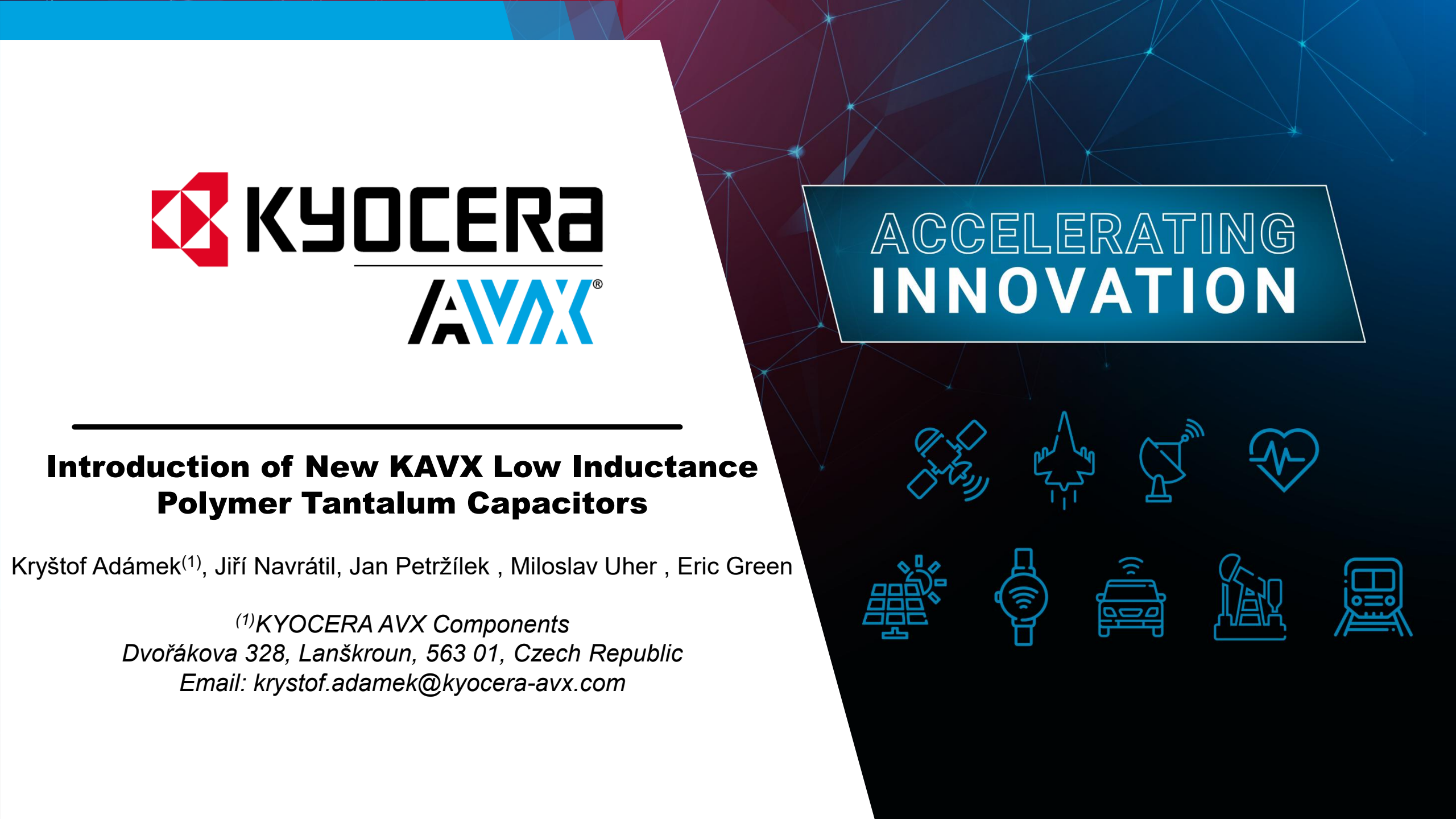


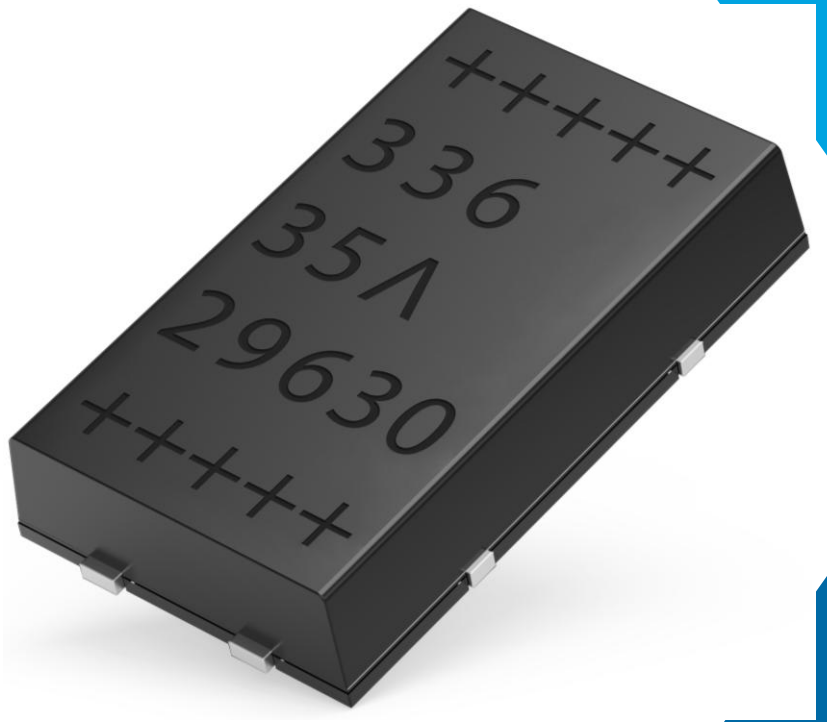
Introduction of New KAVX Low Inductance Polymer Tantalum Capacitors

Kryštof Adámek[1], Jiří Navrátil, Jan Petržílek , Miloslav Uher , Eric Green

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Outline

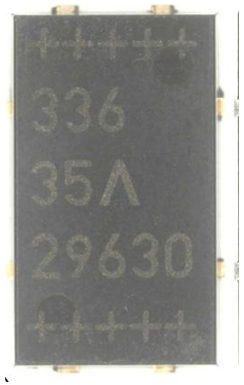
- Low Inductance Polymer Tantalum Capacitor
- Attenuation
- DC Parameters
- Basic EI. Parameters
- Reliability testing performance
- Applications
- Summary

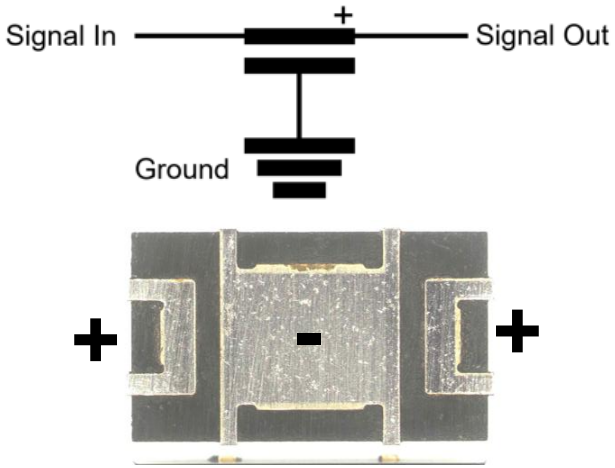


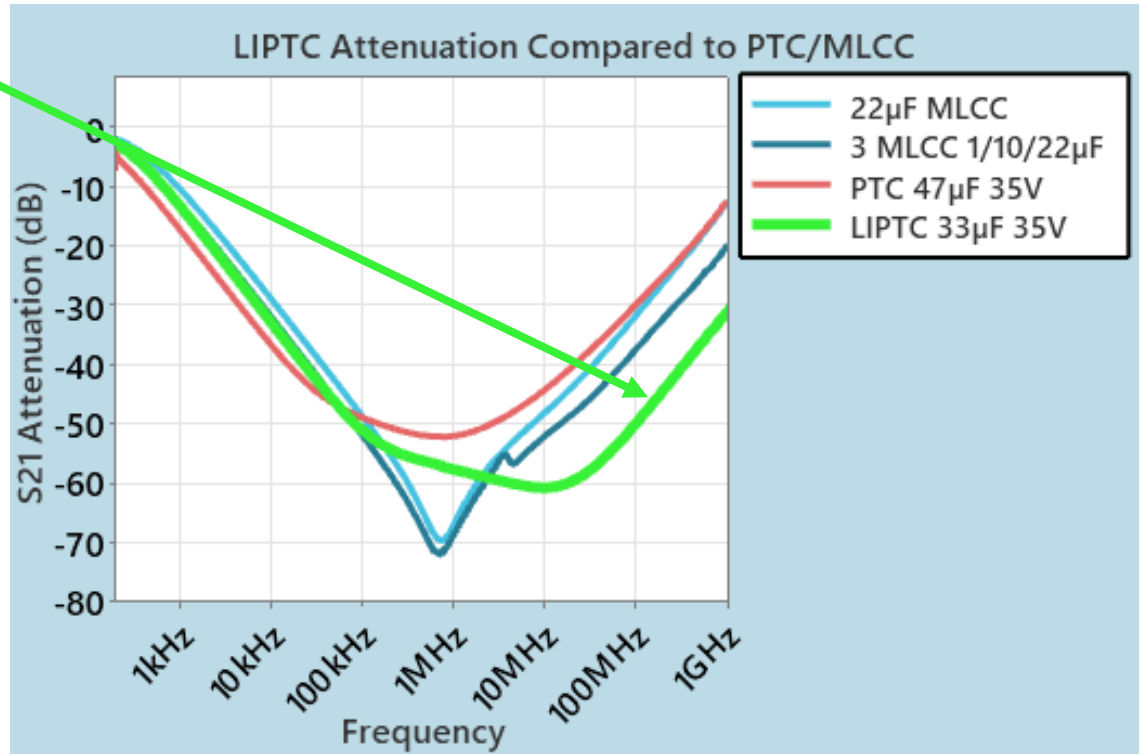
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Low Inductance Polymer Tantalum Capacitor

- Kyocera AVX new product LIPTC can work as wide frequency AC filter up to GHz range
- Polymer Tantalum Capacitors (PTC) with two positive terminals
- Case size: 7343-15 (metric)



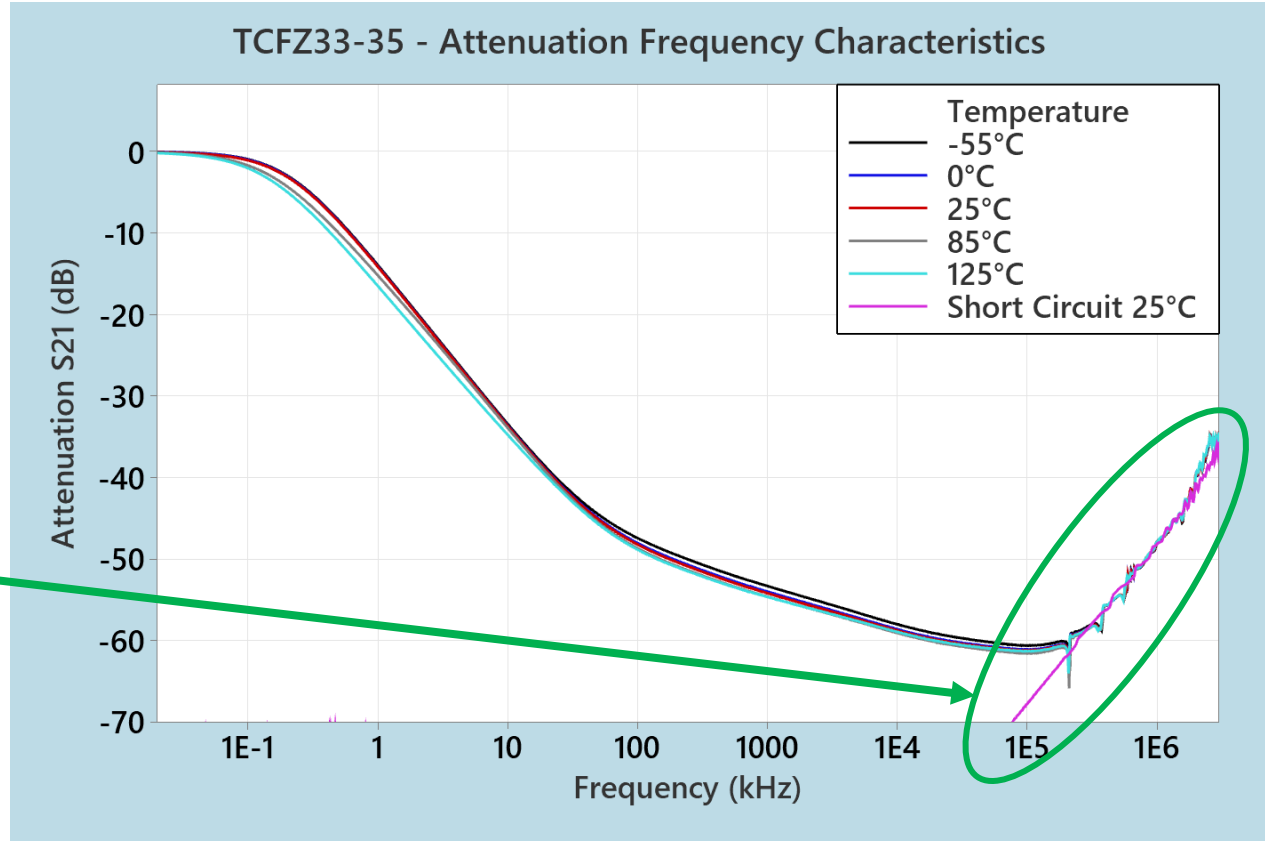


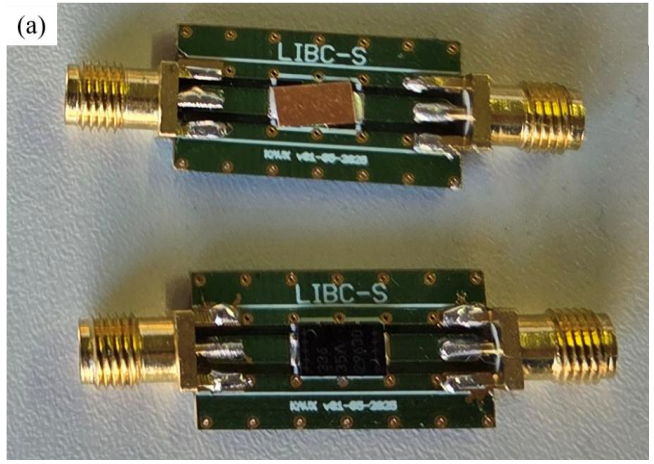


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Attenuation

- S21 attenuation below -30 dB 6 kHz – 3 GHz
- -55 °C up to 125 °C small difference at frequencies below 10 kHz
  - Due to capacitance dependency on temperature
- High frequency attenuation limited by measurement jig





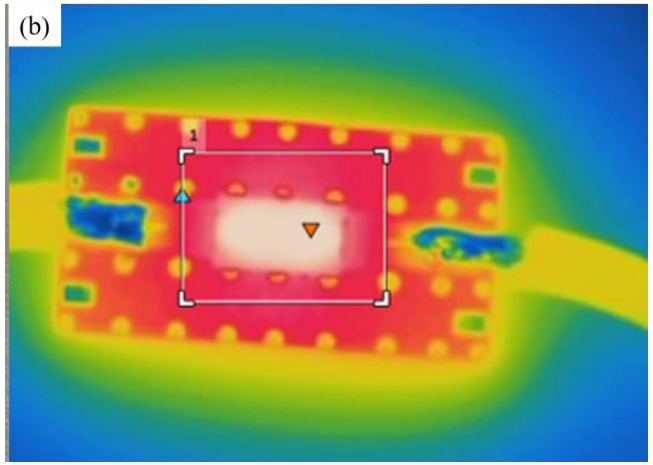
f = 5 Hz – 3 GHz; 10 minutes for each temperature stabilization; 1 pc

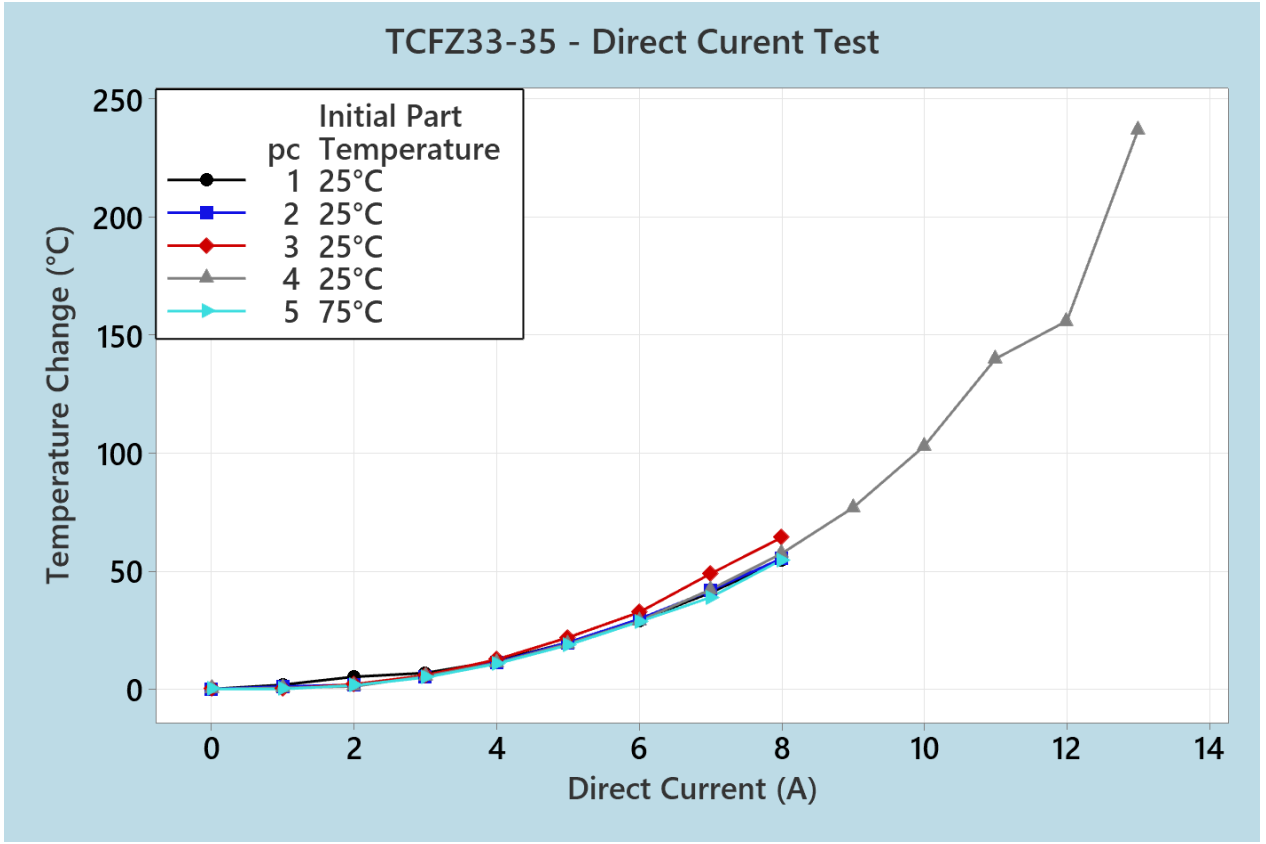
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DC Parameters

DC Current Testing

- At 3A temperature change below 10 °C
- At 6A temperature change of 33.7 °C
- Identical ΔT performance when heated to 75 °C
- Failure at 13 A and surface temperature 260 °C





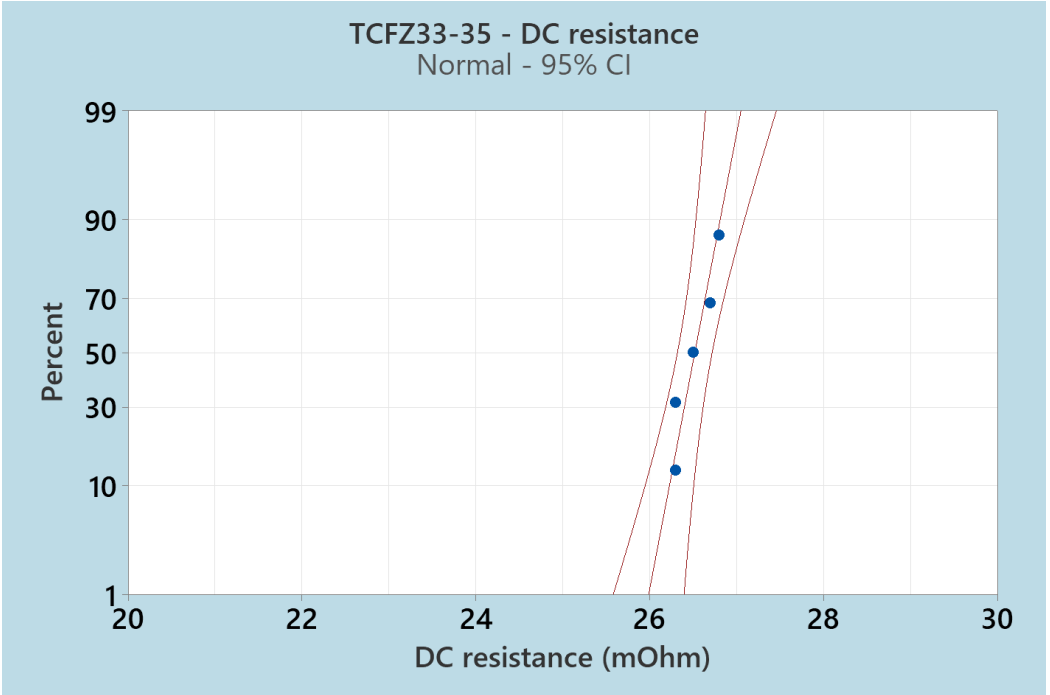
Monitored by Thermal Camera.
DC current was applied gradually from 0 A in 1 A steps with 5 minutes stabilization at each condition.
Part tested at 75 °C heated on hot plate for 15 min.

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DC Parameters

DC Resistance

- DC resistance of parts 26.5 mΩ
- Theoretical tantalum wire resistance = 19.5 mΩ
- Using 0.5 mm wire could lower DC resistance by 15 mΩ
- Can result in 52 % higher applicable DC current



$$R_t = \rho \frac{L}{\pi r^2} = 1.337 \cdot 10^{-7} \frac{6.6 \cdot 10^{-3}}{\pi (1.2 \cdot 10^{-4})^2} = 19.5\ \text{m}\Omega$$

R_t…Theoretical wire resistance
L…Wire length $6.6 \cdot 10^{-3}$ m
r…Wire radius $1.2 \cdot 10^{-4}$ m
ρ…Resistivity of tantalum $(1.337 \pm 0.003) \cdot 10^{-3}\ \Omega \cdot \text{m}$ [1]

[1] K.E. Gilchrist, and S.D. Preston, Thermophysical property measurements on some neutron absorbing materials. *High Temperatures - High Pressures*, pp 643-651, 1979.

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Basic El. Parameters

TCF Series PRELIMINARY

LIBC Low ESL Conductive Polymer Chip Capacitors Undertab

KYOCERA AVX

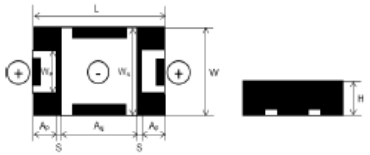


▪ FEATURES
- Low ESL
- Excellent performance of noise absorption at GHz
- Highest CV/cc of Low Profiles
- Low ESR based on Conductive Polymer Electrode
- Undertab terminations layout:
  → High Volumetric Efficiency
  → High PCB assembly density
  → High capacitance in smaller dimensions
- 3x Reflow 260°C Compatible
- 100% Surge Current Tested

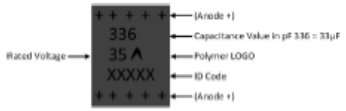
RoHS COMPLIANT

LEAD-FREE COMPATIBLE COMPONENT

▪ APPLICATIONS
- Power Tree Bulk capacitor
- Output capacitor in power conversion circuitry
- Bias bank filters in RF PA's
- Power isolation of RF pallets
- Broadband power Filtering
- Pulsed power delivery (gate drivers LIDAR)



MARKING



CASE DIMENSIONS: millimeters (inches)

Code	EIA Code	EIA Metric	L±0.30 (0.012)	W+0.30 (0.012)	H max.	W1±0.10 (0.004)	W2±0.10 (0.004)	A1±0.30 (0.012)	A2±0.30 (0.012)	S Min.
Z	2917	7343-15	7.30 (0.287)	4.30 (0.169)	1.50 (0.059)	2.40 (0.094)	4.30 (0.169)	1.30 (0.051)	3.70 (0.146)	0.35 (0.014)

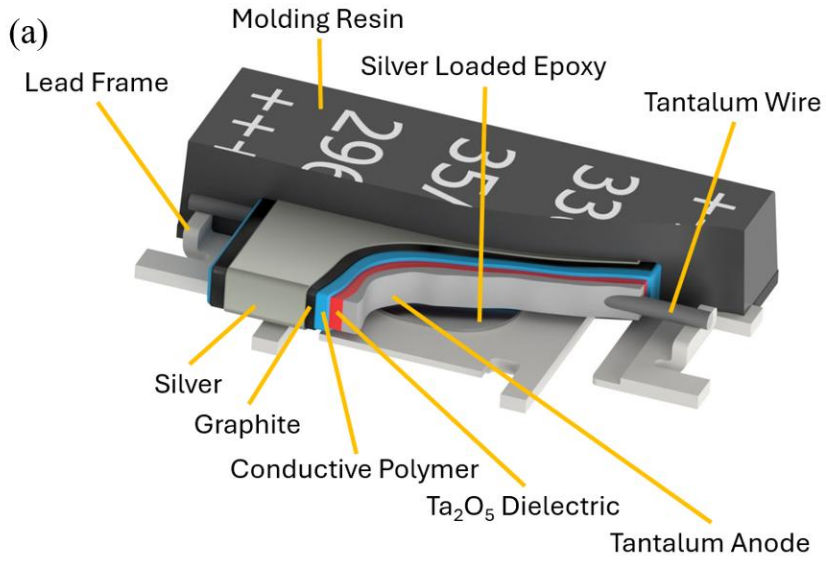
HOW TO ORDER

TCF	Z	336	M	035	R	0150	E
Type	Case Size See table above	Capacitance Code pF code: 1st two digits represent significant figures 3rd digit represents multiplier (number of zeros to follow)	Tolerance M=±20%	Rated DC Voltage 002=2.5Vdc 004=4Vdc 006=6.3Vdc 010=10Vdc 025=25Vdc 035=35Vdc	Packaging R= Leadfree 7"Reel	ESR in mΩ	Additional Character E=Black resin

TECHNICAL SPECIFICATIONS

Technical Data:		All technical data relate to an ambient temperature of +25°C						
Capacitance Range:		33µF to 330µF						
Capacitance Tolerance:		±20%						
Leakage Current DCL:		0.1CV						
Rated Voltage (V_R)	≤+85°C:	2.5	4	6.3	10	25	35	
Category Voltage (V_C)	≤+125°C:	1.7	2.7	4	7	17	23	
Surge Voltage (V_S)	≤+85°C:	3.3	5.2	8	13	33	46	
Surge Voltage (V_S)	≤+125°C:	2.2	3.4	5	8	20	28	
Temperature Range:		-55°C to +125°C						
Terminals:		3 (Undertab NiPdAu Termination)						
Approvals:		In accordance to MIL 32700						
Reverse Voltage:		10% of the rated d.c. working voltage to a maximum of 1.0v at 25°C						

- Capacitor design based on facedown polymer tantalum capacitors with long history in enterprise SSD market
- Only difference are two positive terminations connected by wire through

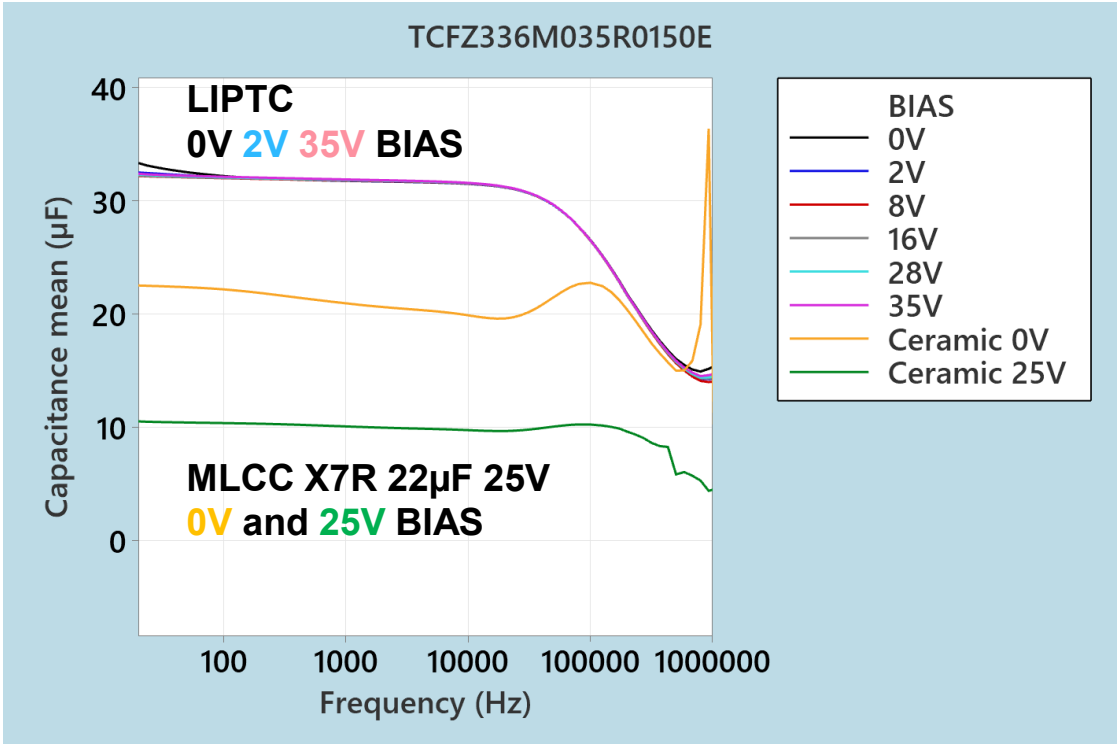


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Basic El. Parameters

Effect of DC Bias on Capacitance

- LIPTC capacitance is stable with applied BIAS
- Class II/III MLCC can loose 50 – 90 % capacitance with rated voltage
- Capacitance loss with BIAS deteriorates filtering capability at low frequencies
  - LIPTC will provide stable low frequency filtering with BIAS change

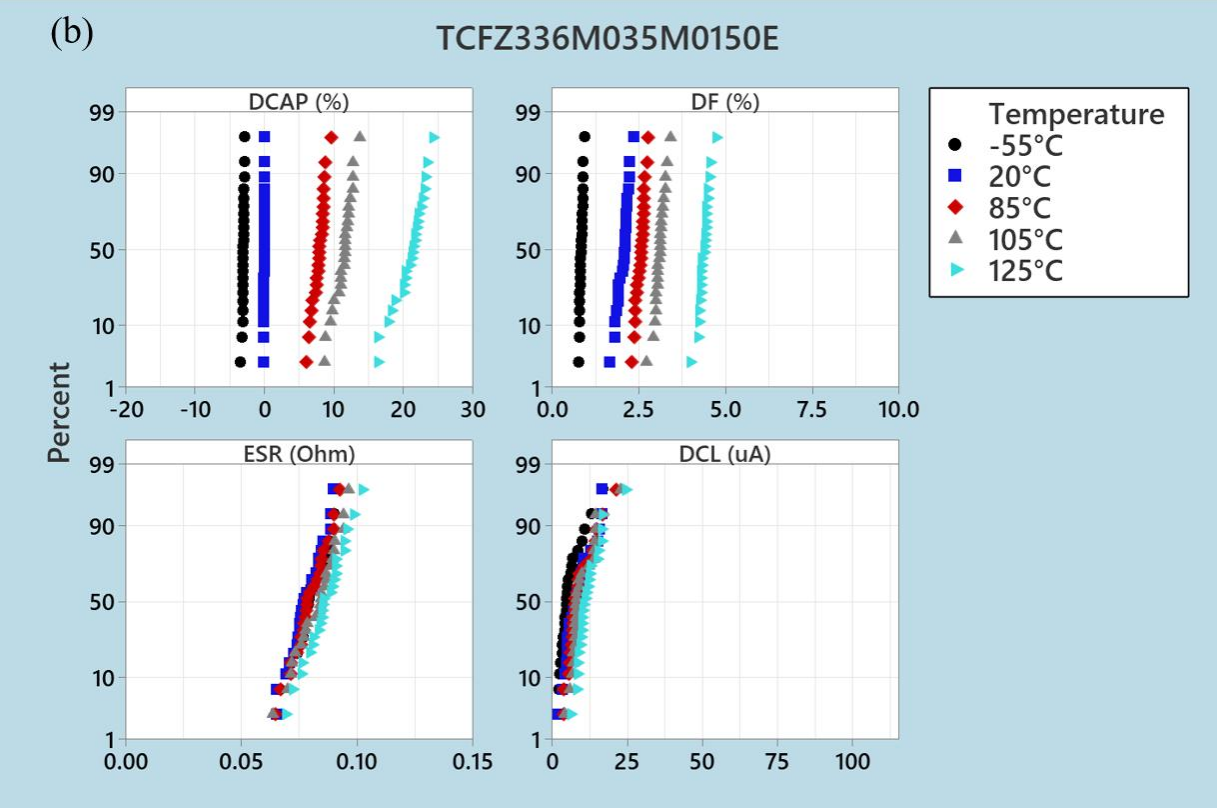


f = 120 Hz, AC = 1 V, T = 25 °C, 10 pcs

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Effect of Temperature on Basic El. Parameters

- CAP compared to 25°C
  - 8 % at 85 °C
  - 11 % at 105 °C
  - 21 % at 125 °C
  - -3 % at -55 °C
- DF correlates with CAP
- Negligible effect on ESR and DCL



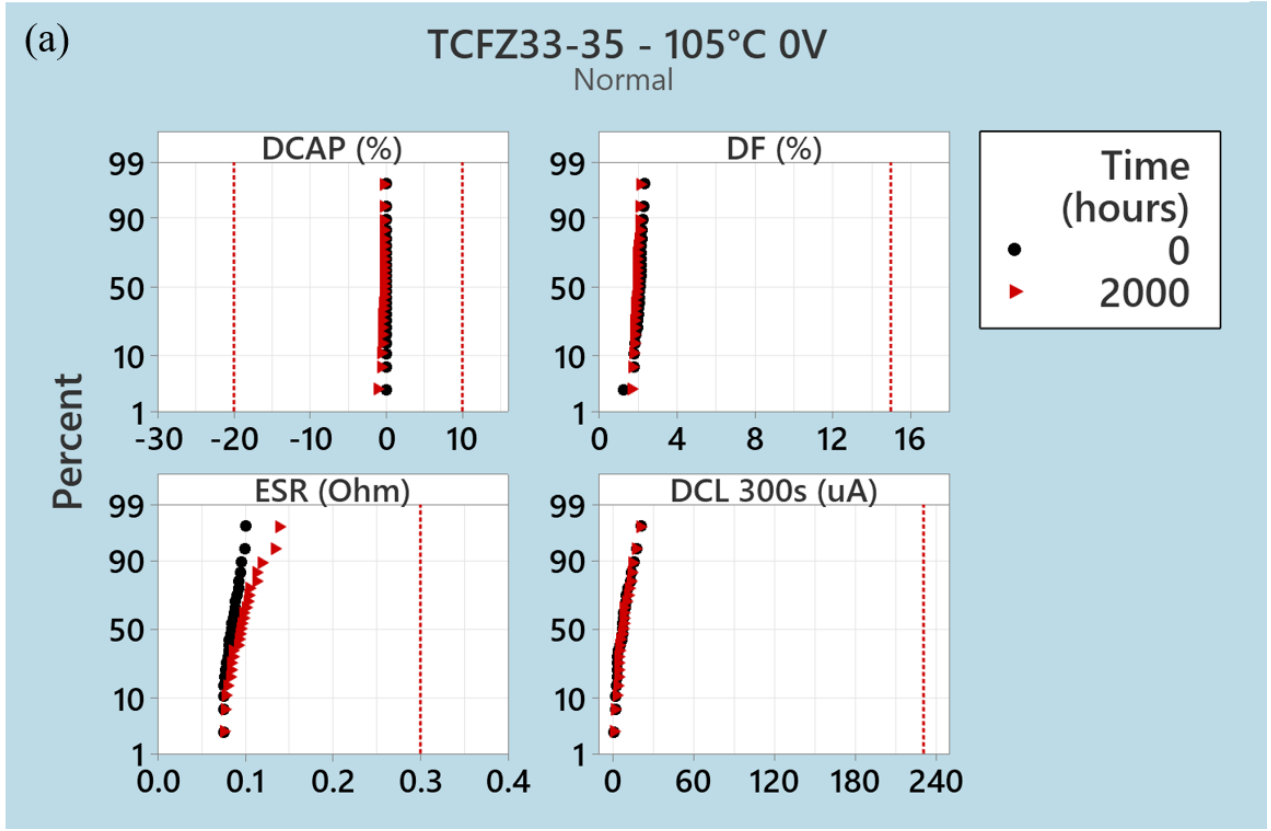
CAP, DF: f = 120 Hz, AC = 1 V, DC = 2 V; ESR: f = 100 kHz, AC = 1 V; DCL: R = 1 kΩ, t = 300 s; 24 pcs

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Reliability Testing Performance

Dry Heat Test

- Same performance as PTCs
- Small ESR shift
- All other parameters are stable
- No DCL shift = Mitigated ACC

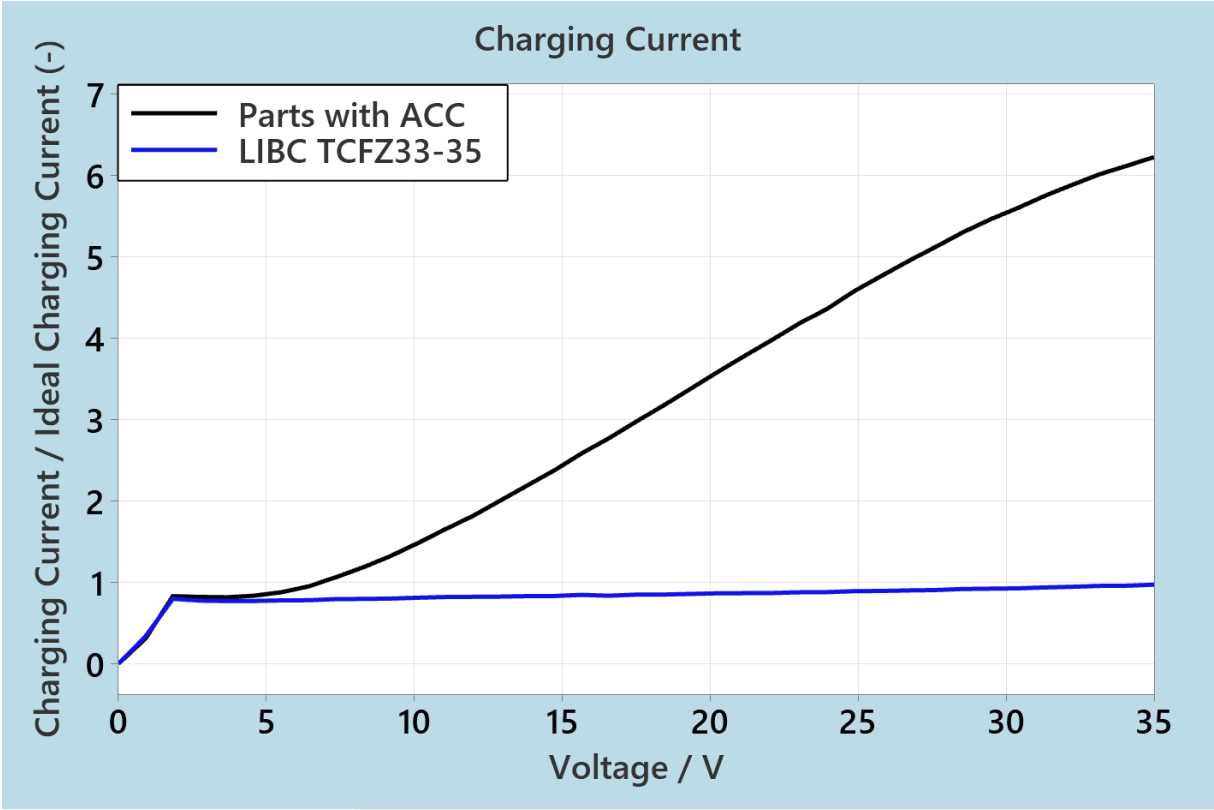


CAP, DF: f = 120 Hz, AC = 1 V, DC = 2 V; ESR: f = 100 kHz, AC = 1 V; DCL: R = 1 kΩ, t = 300 s; T = 25°C; 24 pcs

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Anomalous Charging Currents = ACC

- Transient current spike during fast charging of *polymer tantalum capacitors (PTCs)*
  - Can be accompanied with slow DCL decrease
- Short-term non-destructible phenomenon
- Typically, during turn-on after long period turned off
- KAVX process for 16V+ capacitors mitigates ACC
- Standardized method to be introduced in MIL-PRF-32700



Mounting on PCB
100 hours 125°C drying
Slow ramp rate (100V/s); 25°C

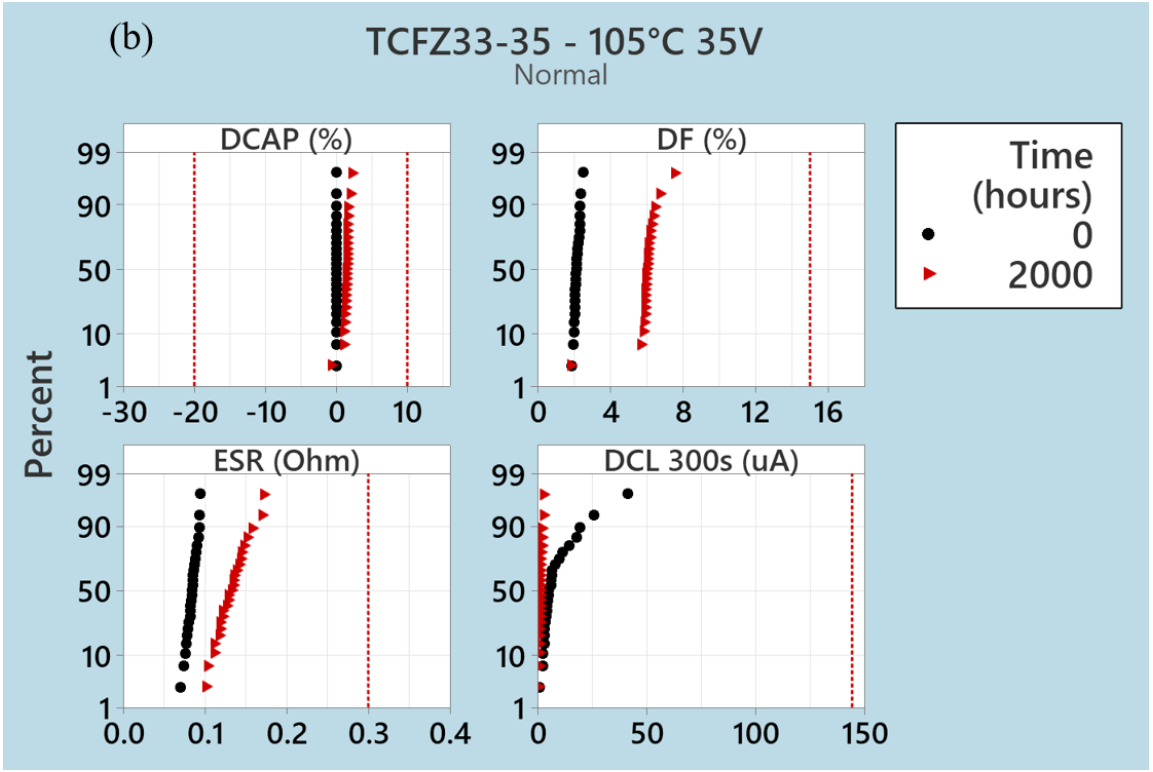
$$I_{ideal} = CAP \times {}^{dU}/_{dt}$$

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Reliability Testing Performance

Dry Heat Test with Applied Voltage

- Same performance as PTCs
- Small DF and ESR shift
- Other parameters are stable



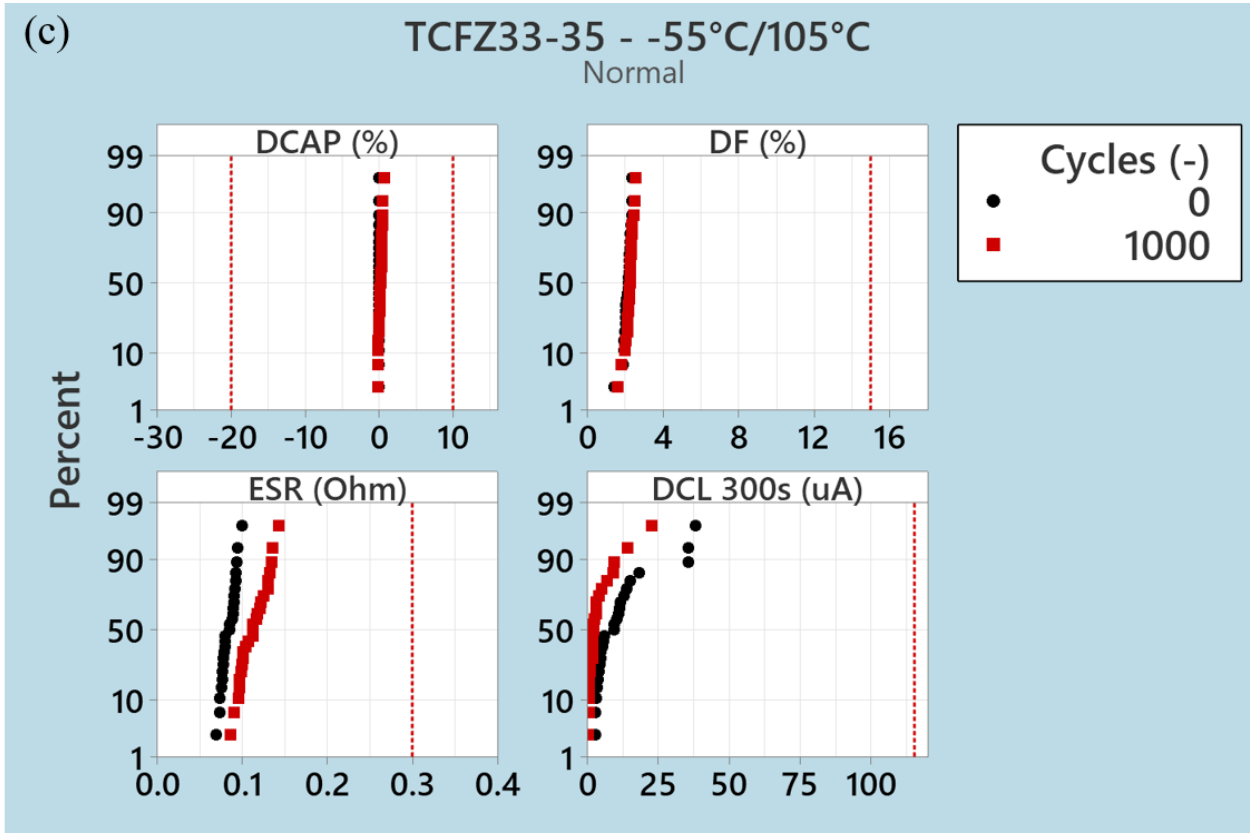
Test circuit impedance < 3 Ω, each pc in series with 1 A fuse
CAP, DF: f = 120 Hz, AC = 1 V, DC = 2 V; ESR: f = 100 kHz, AC = 1 V; DCL: R = 1 kΩ, t = 300 s; T = 25°C; 24 pcs

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Reliability Testing Performance

Temperature Cycling Test

- Same performance as PTCs
- Small ESR shift
- All other parameters are stable



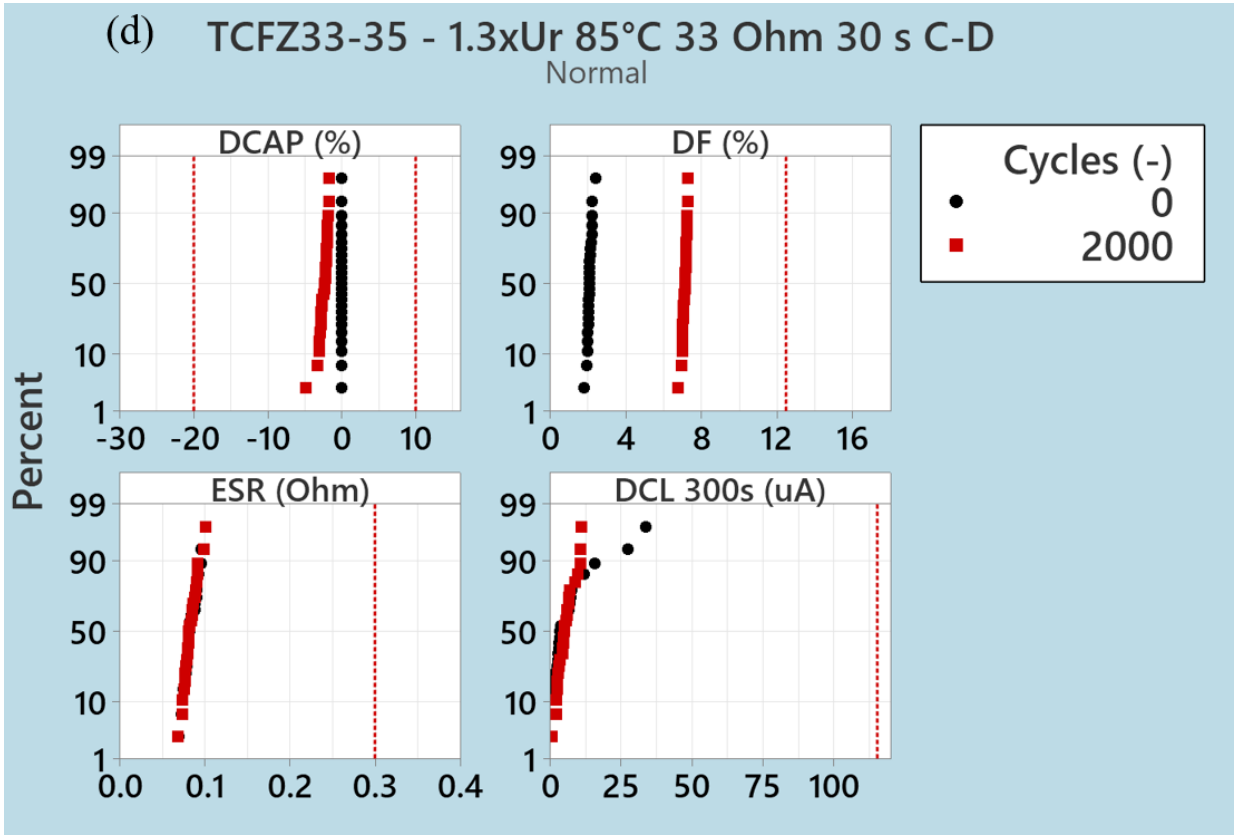
Delay on each temperature 15 minutes.
CAP, DF: f = 120 Hz, AC = 1 V, DC = 2 V; ESR: f = 100 kHz, AC = 1 V; DCL: R = 1 kΩ, t = 300 s; T = 25°C; 24 pcs

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Reliability Testing Performance

Surge Voltage Test

- Same performance as PTCs
- DF shift and CAP decrease
- Other parameters are stable

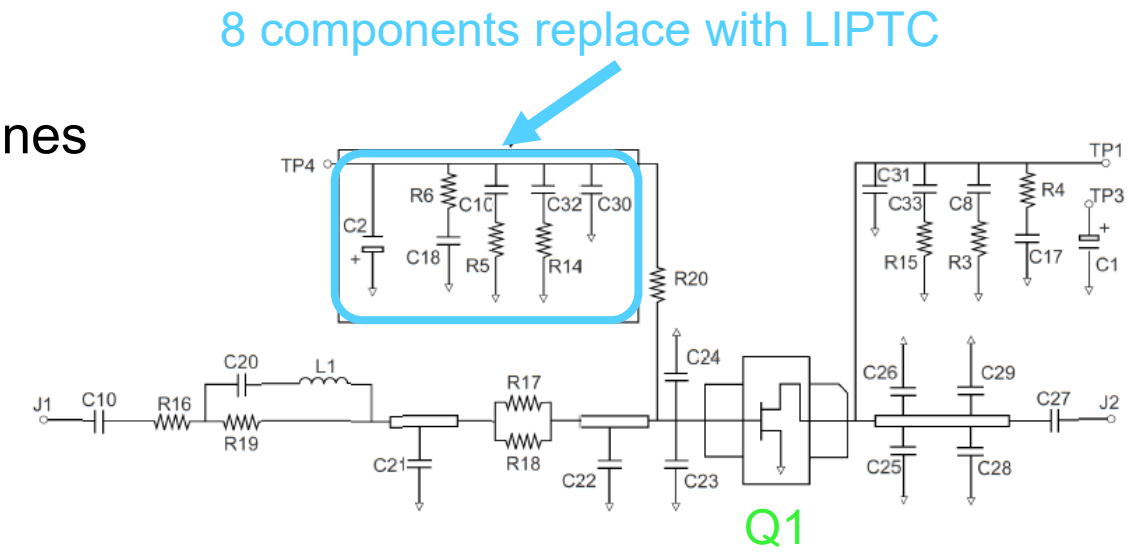


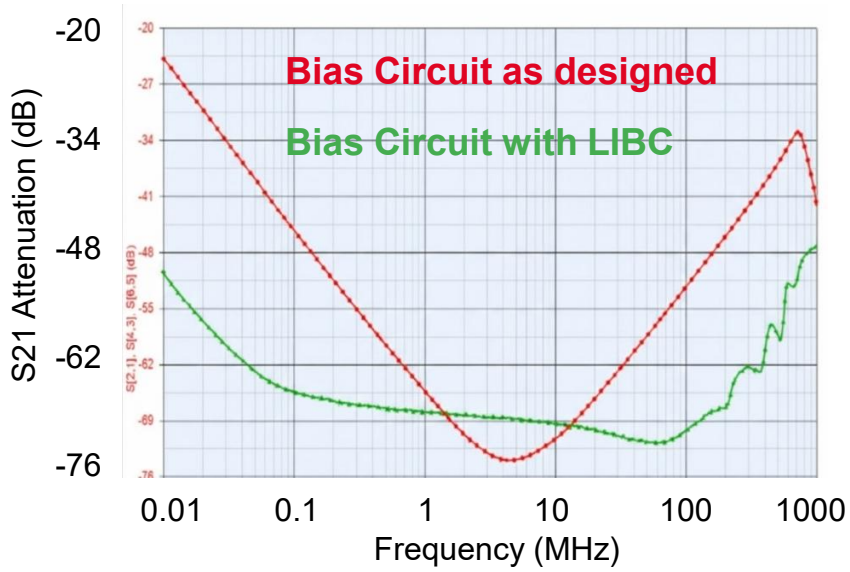
Test circuit impedance < 33 Ω, Each cycle charging from 0 V up to 45.5 V and discharging to 0 V, 30 s delay for both. CAP, DF: f = 120 Hz, AC = 1 V, DC = 2 V; ESR: f = 100 kHz, AC = 1 V; DCL: R = 1 kΩ, t = 300 s; T = 25°C; 24 pcs

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Applications

- **Wide frequency filtering**
  - EMI suppression in power supply and signal lines
  - Broadband I/O filtering
- **In applications:**
  - Micro power supplies
  - Pulsed power delivery (gate drivers LIDAR)
  - Microswitches
  - Decoupling on FPGA
- **Replace multicomponent network with single chip solution**
  - Improving system reliability, size and weight.





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Summary

- New Kyocera AVX Polymer Tantalum Product
- Reliability performance of Polymer Tantalum Capacitor
- Wide frequency filtering 6 kHz – 3 GHz+
- DC current rating 3 – 6 A
- DC current and CAP improvements in future

Hand-made proof of concept samples were tested by NASA

https://nepp.nasa.gov/docs/tasks/003-Evaluation-Polymer-Tantalum-Capacitors-for-Space-Applications/NEPP-CP-2024-LIBC-Teverovsky-Evaluation-Feed-Through-Polymer-Tantalum-Capacitors-20240011873.pdf

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THANK YOU.

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