Tantalum-Polymer Capacitors for Power Applications

KEMET CHARGED.™

TTI Web Broadcast

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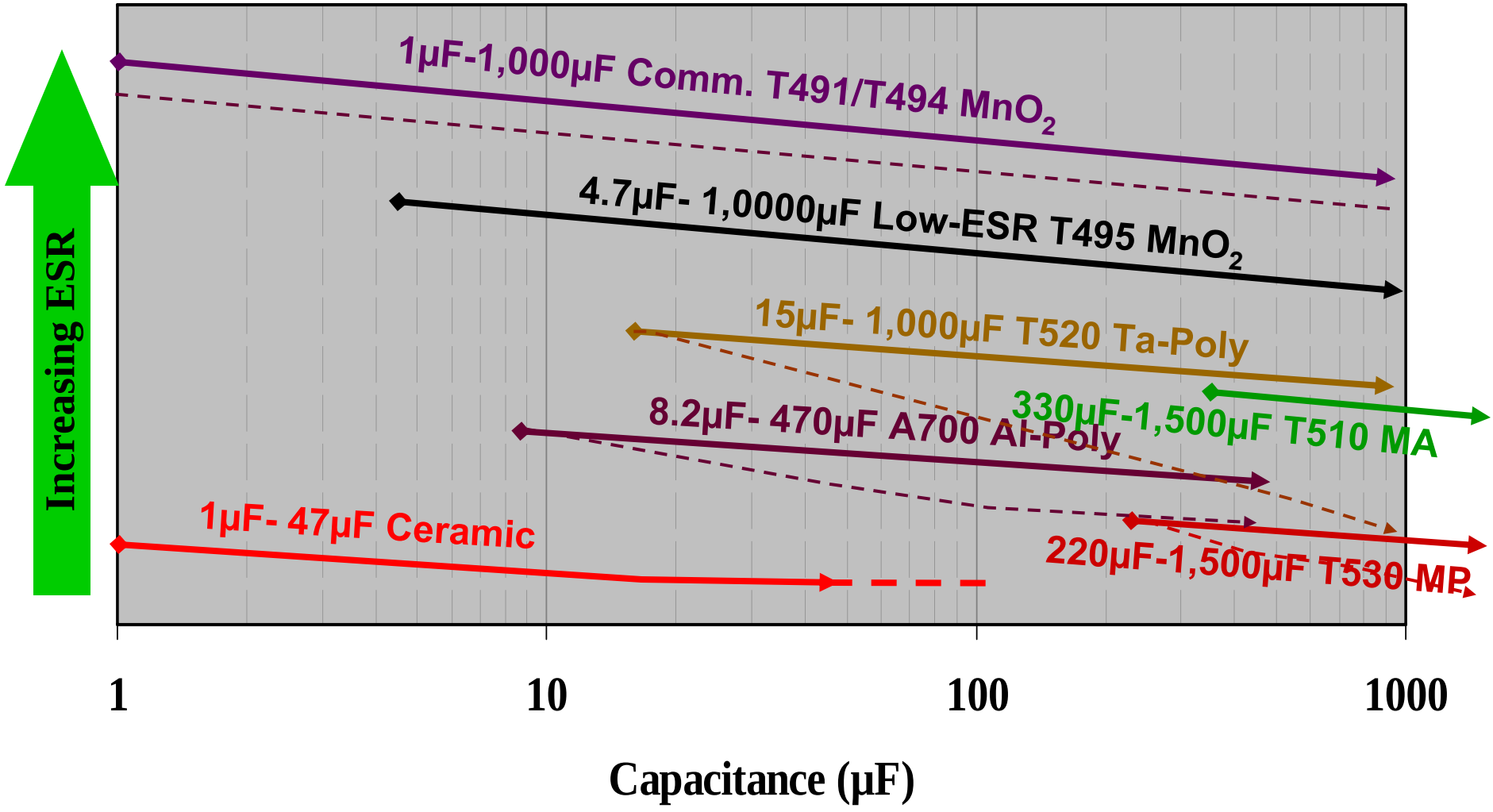
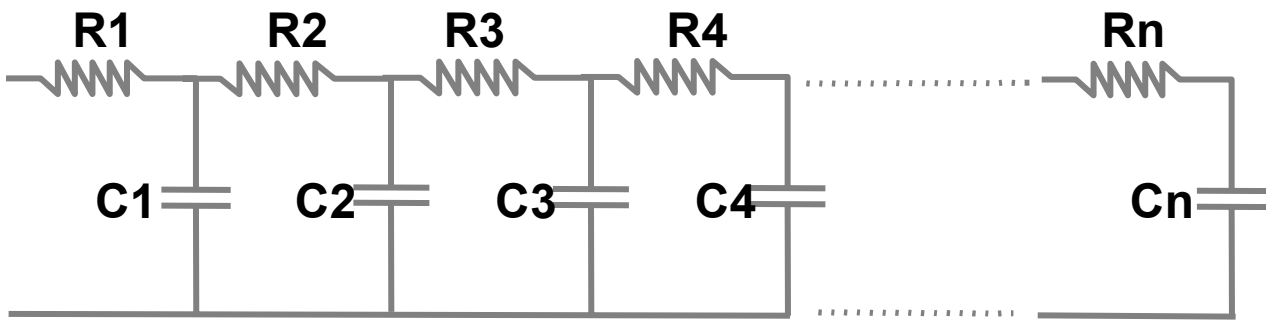
Applications Director

Capacitance & ESR



Electrolytic RC-Ladder Structure

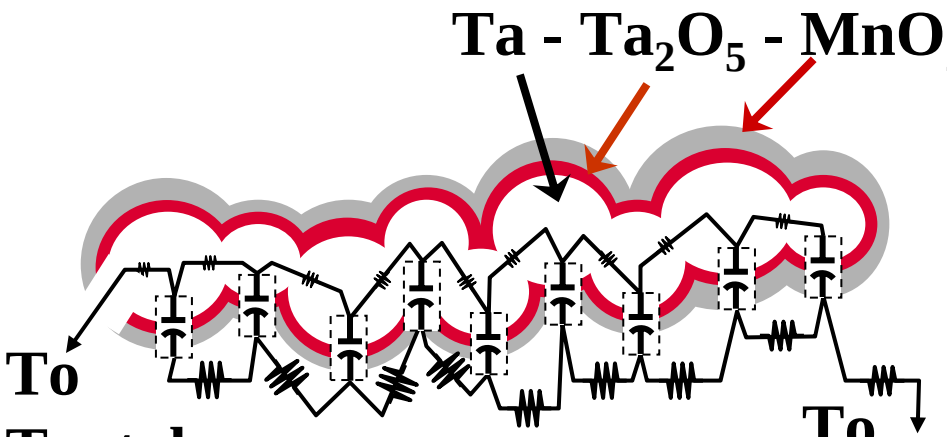
RC-Ladder Effects



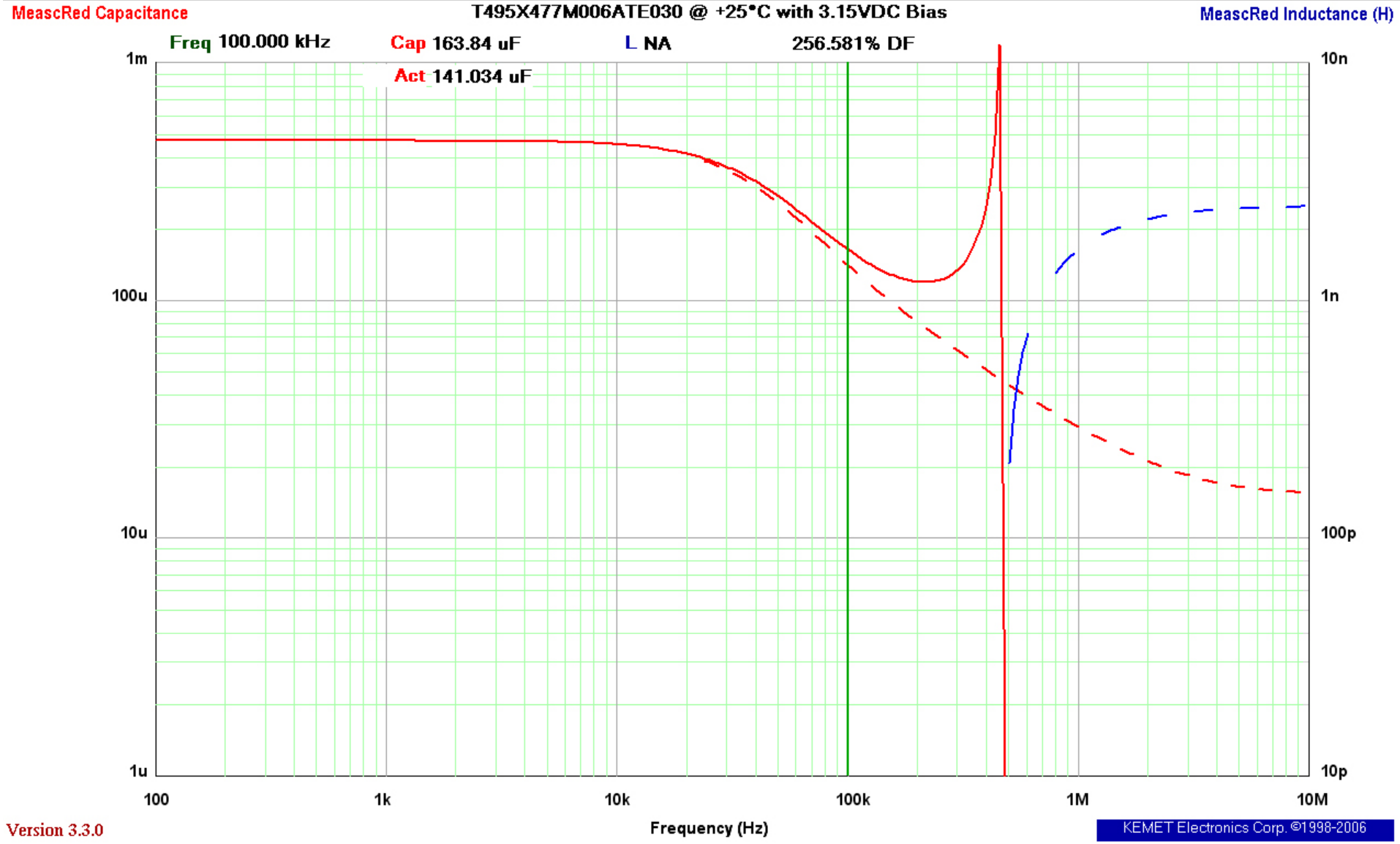
tc1 = C1 x R1
tc2= C2 x (R1+R2)
tc3= C3 x (R1+R2+R3)

tcn= Cn x (R1+R2+R3...+Rn)

RC-Ladder effects are factored by both capacitance and resistance.

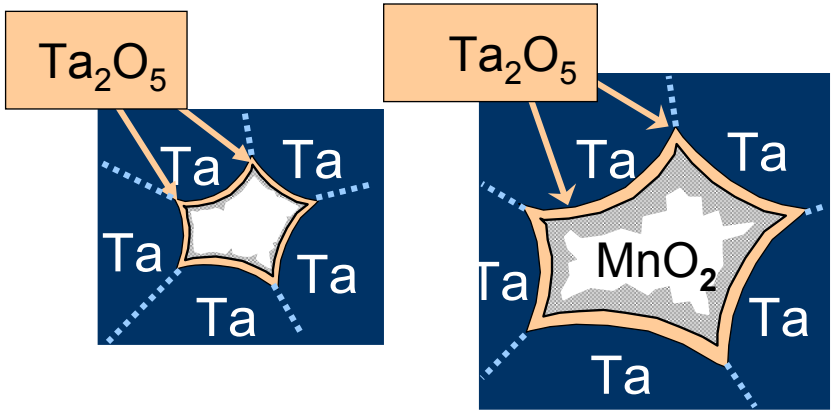


Electrolytic's Loss of Capacitance



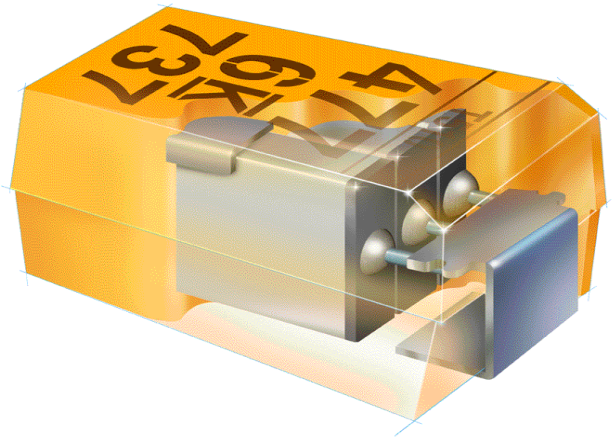
Quick review ESR Reduction in Tantalum …

Lower Capacitance Loss with Frequency

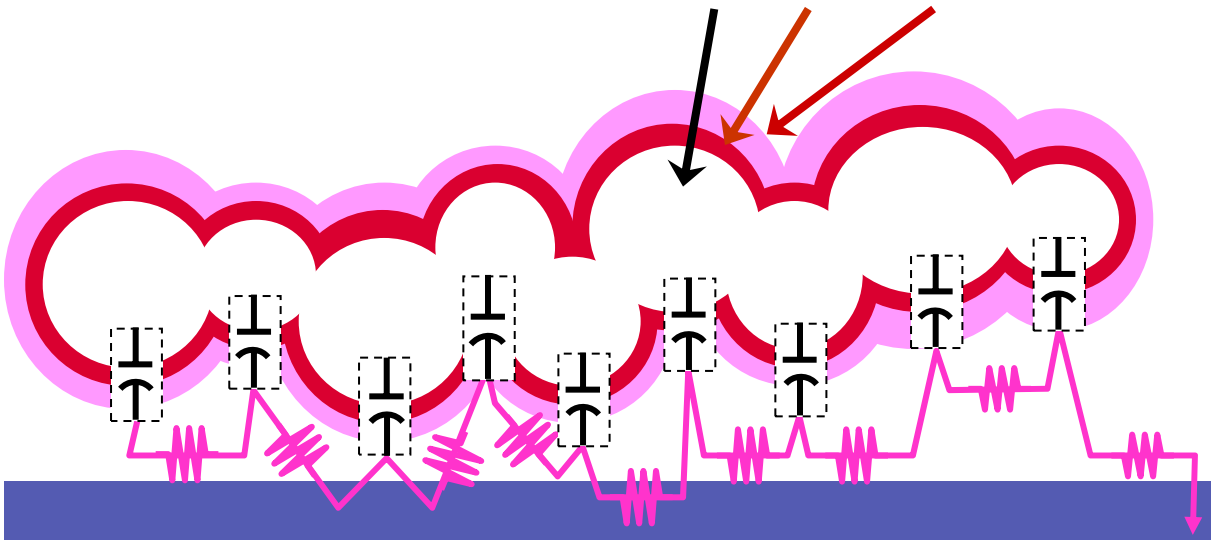


T495
Larger Pores
More MnO2
Lower ESR

T510
Multiple-pellets
Lower ESR

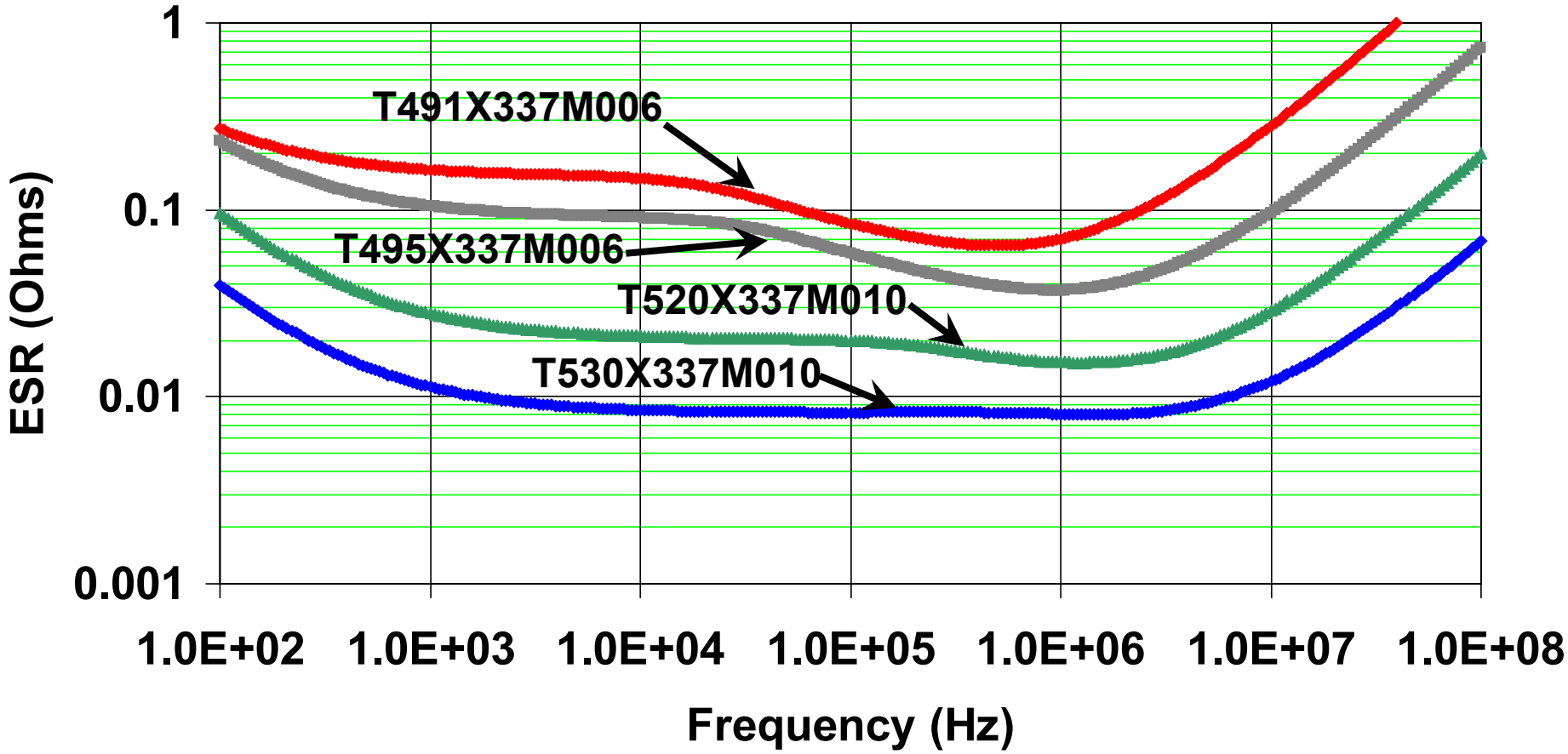


Ta - Ta_2O_5 - Polymer



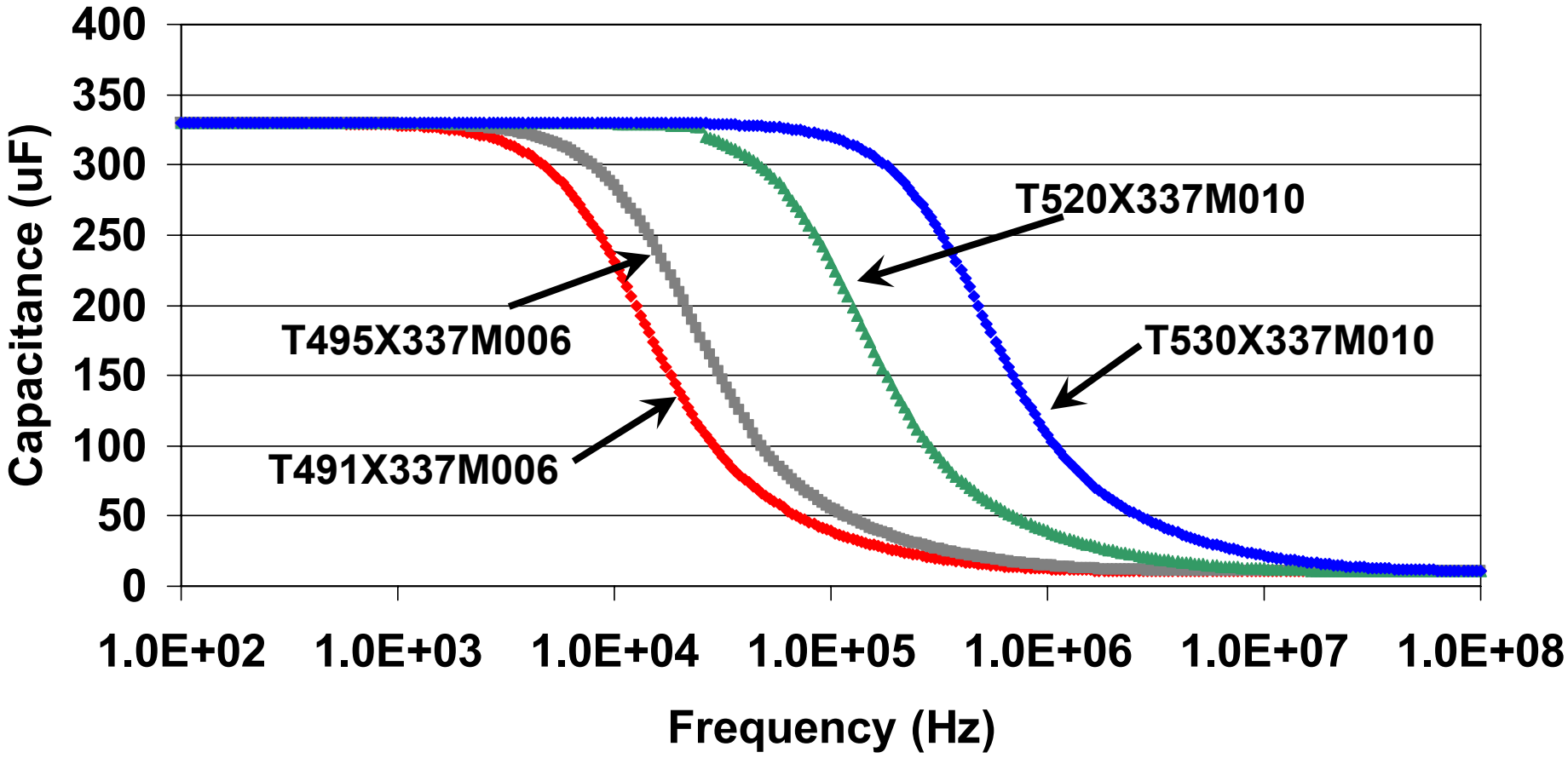
T520
Polymer
Replaces MnO2
Lower ESR

330 uF SMT Tantalum Chips

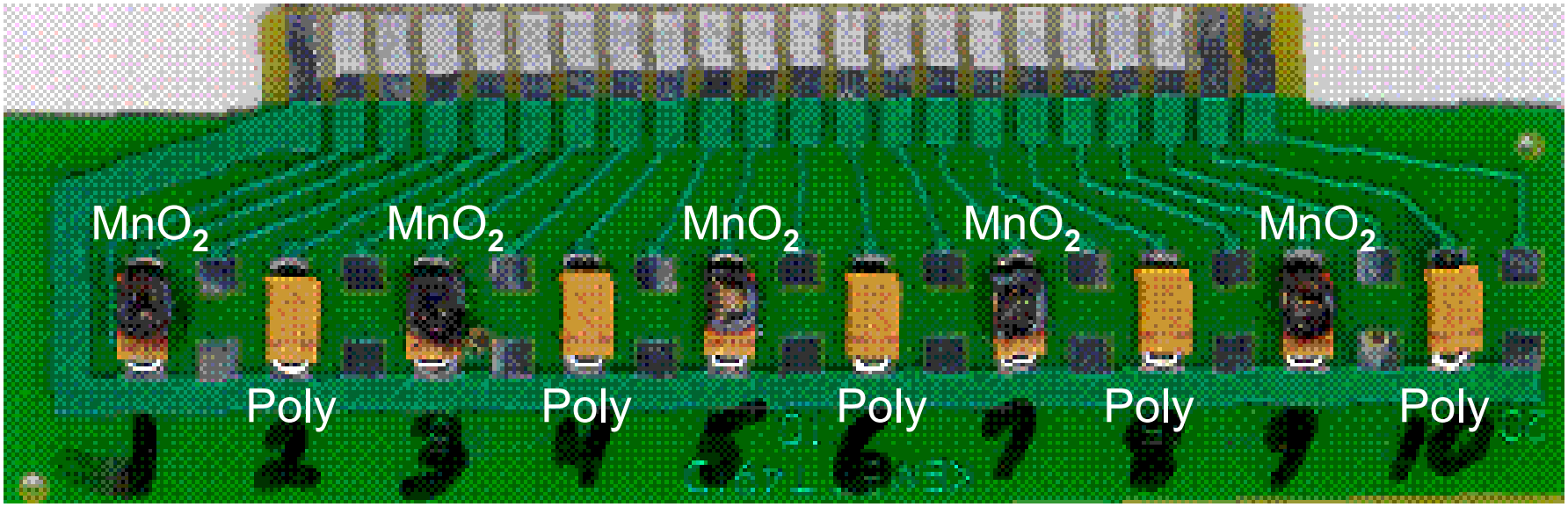


Improvements in Tantalum – MnO_2 to Polymer

330 uF SMT Tantalum Chips



MnO_2 vs. Polymer - Ignitions

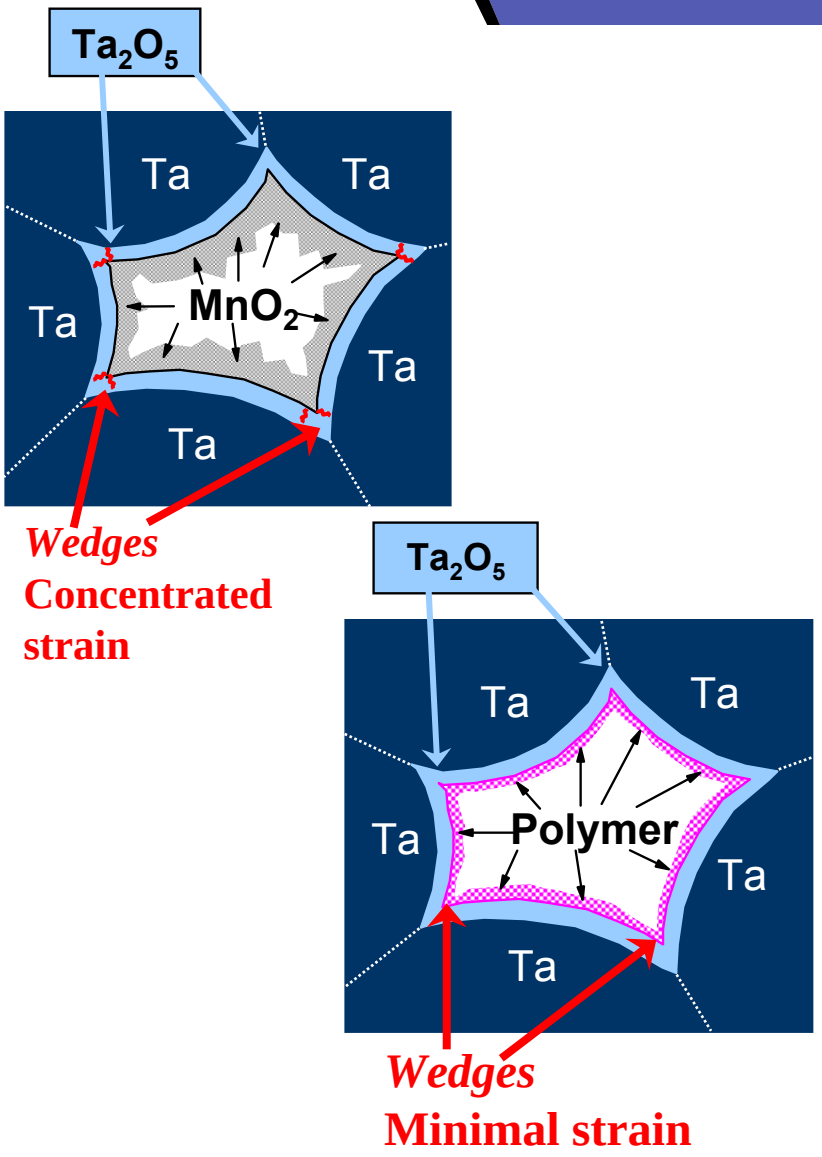


Test card with capacitors subjected to 2x Rated Voltage, applied with reverse polarity and > 20 amperes current capability.

Median Values

	$Ta\text{-}MnO_2$	Ta-Poly KO $V_R>10$	Ta-Poly KO $V_R<=10$
100 PPM FR % V_{Rated}	68%	126%	197%
@50% V_{Rated} FR(PPM)	9	0	0
@80% V_{Rated} FR(PPM)	458	4	1
@90% V_{Rated} FR(PPM)	1,700	12	2
@100% V_{Rated} FR(PPM)	6,310	35	8

Reduced Process Stress – MnO_2 vs. Polymer



The MnO_2 filling this enclosure is a <u>hard</u>, <u>crystalline</u> material. Impregnation process involves dip at +25°C and conversion at +270°C. Forces in the "*wedges*" may be concentrated to cause defects.

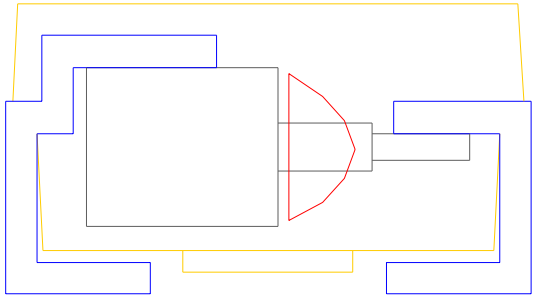
The polymer material is soft and elastic. The process is at or near room temperature The forces generated because of mismatches in CTEs are insignificant when compared to MnO_2.

ESRs for T520/T530 → 4 mΩ

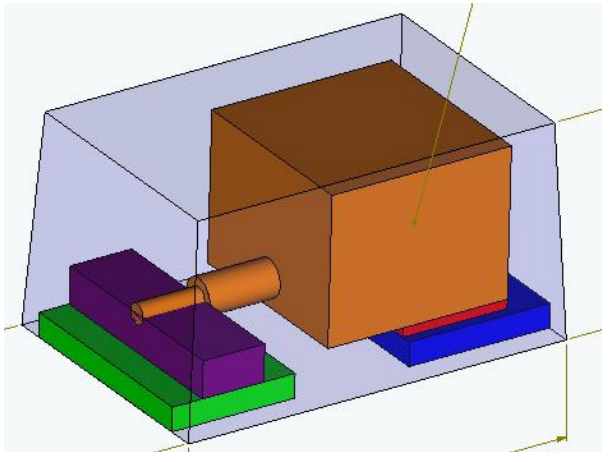
- There are several styles and values where the maximum ESRs are now at 4 milliohms with nominal values at 3 milliohms.
- As the ESR is being diminished, ESL is now of major concern.

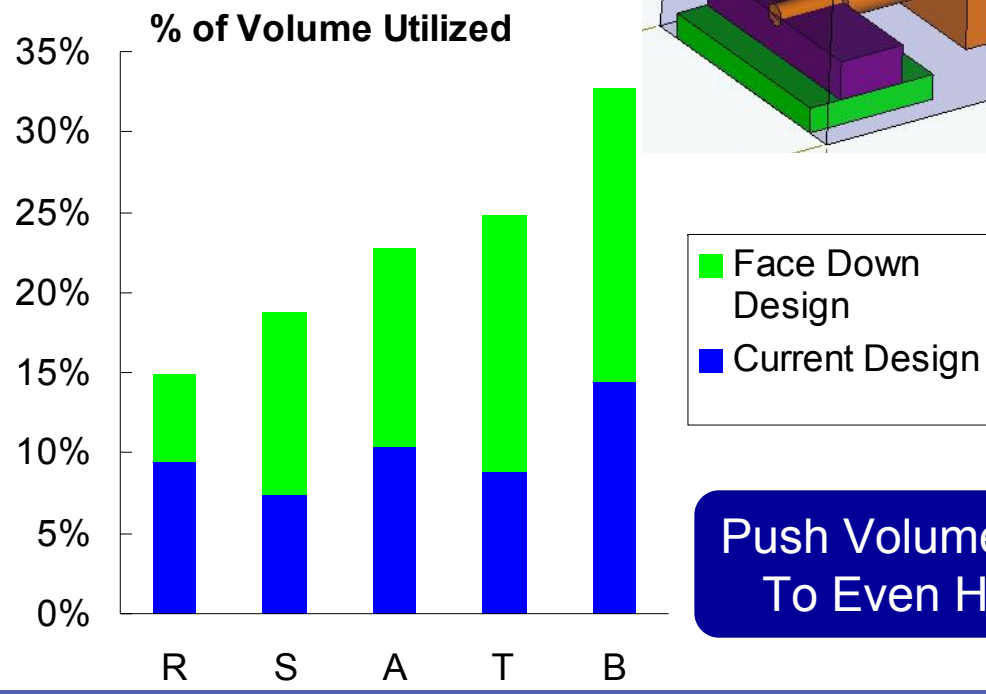
Construction Improvements

Standard Construction



Facedown Termination

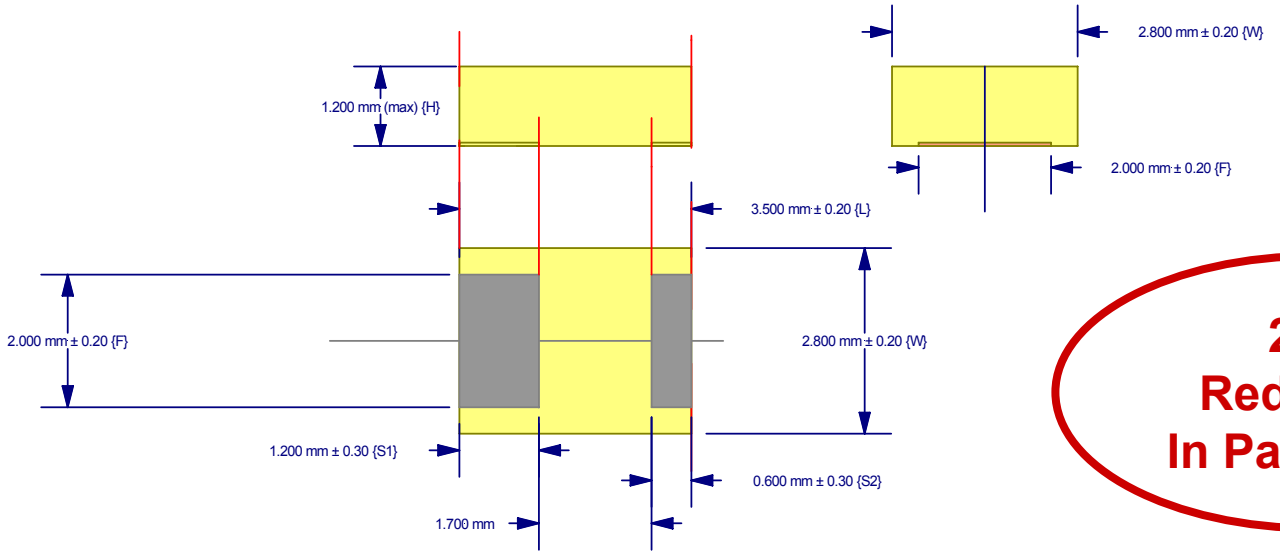




Push Volumetric Efficiency To Even Higher Levels

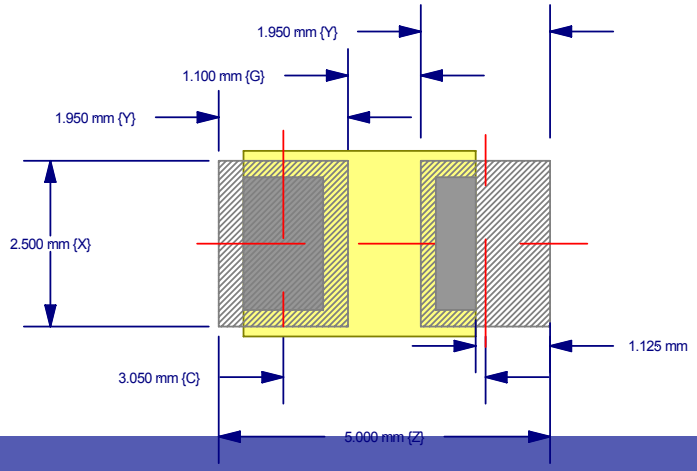
Recommended Pad Layouts – T Case

T3528-12 Face-Down

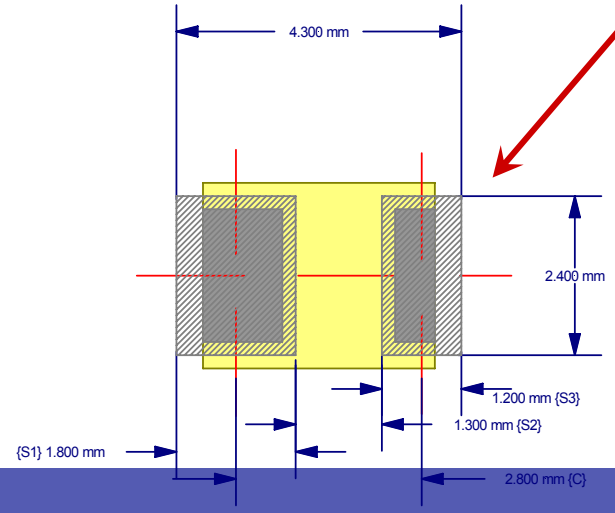


20% Reduction In Pad Space

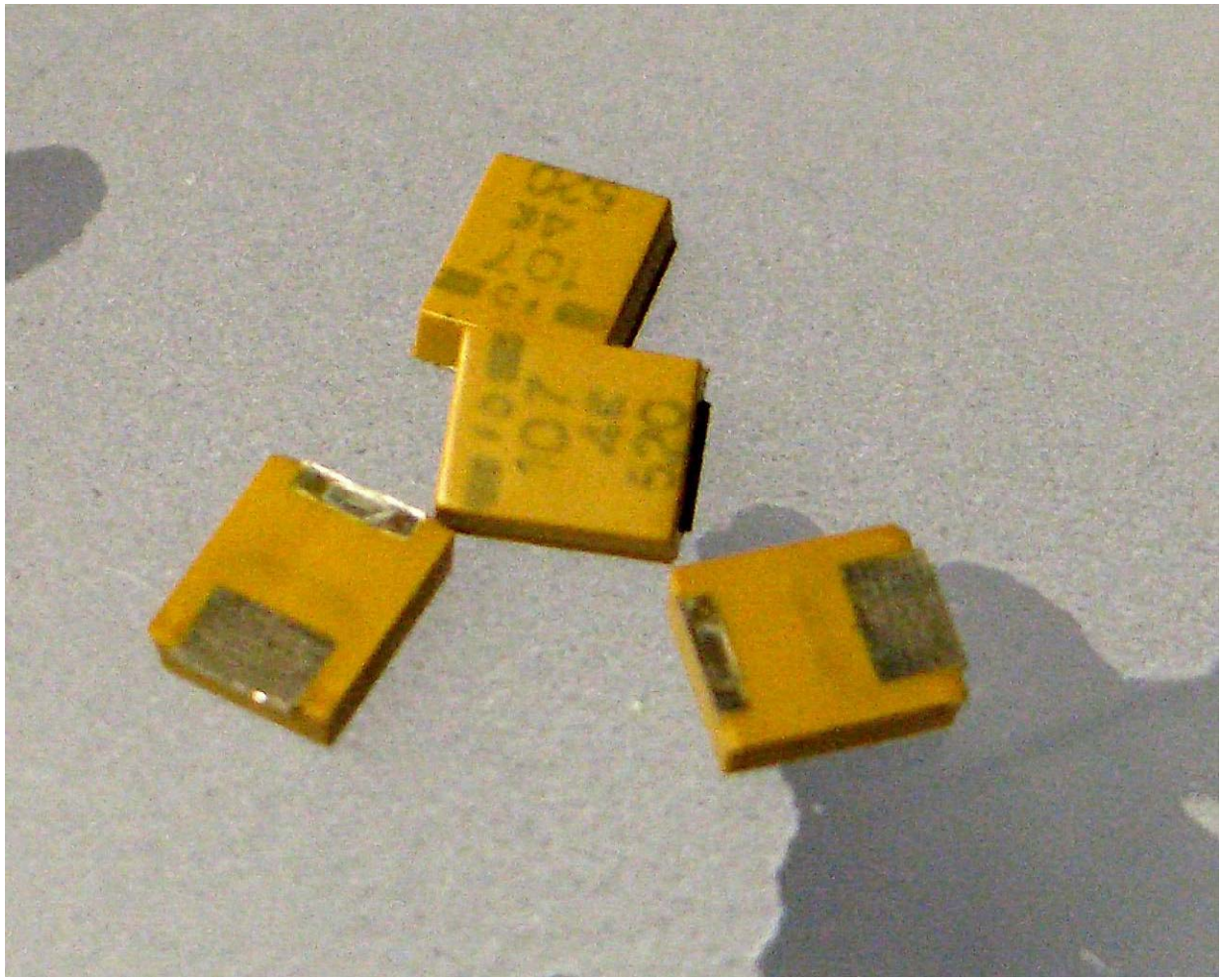
Using Standard 3528 Solder Pads



Using 3528/FD Solder Pads



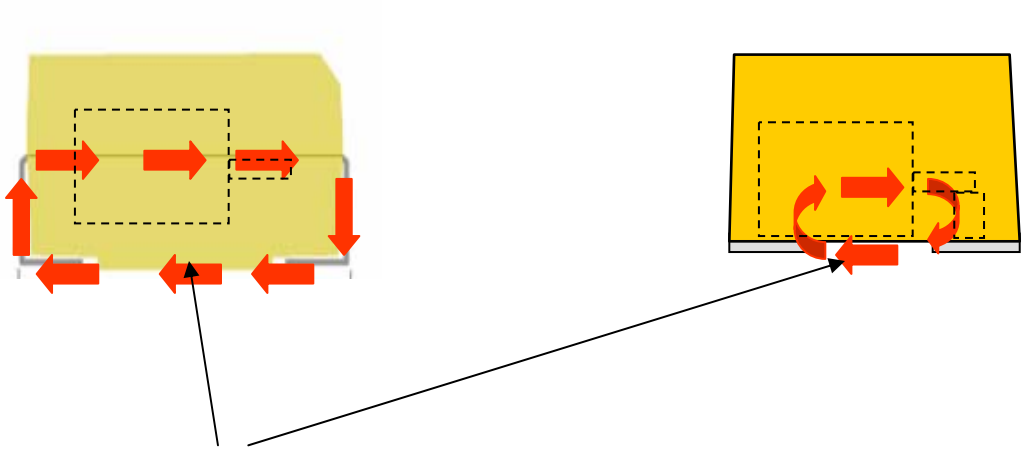
“T” Case (3528-12) / Facedown



Reduced Current Loop Areas = Reduced ESL

STD
Ta/Poly Chip

Face-Down
Ta/Poly Chip



Reduction in current "loop area" creates proportional reduction in ESL.

Inductance for Solenoid:

$$L = \mu_f n^2 A l$$

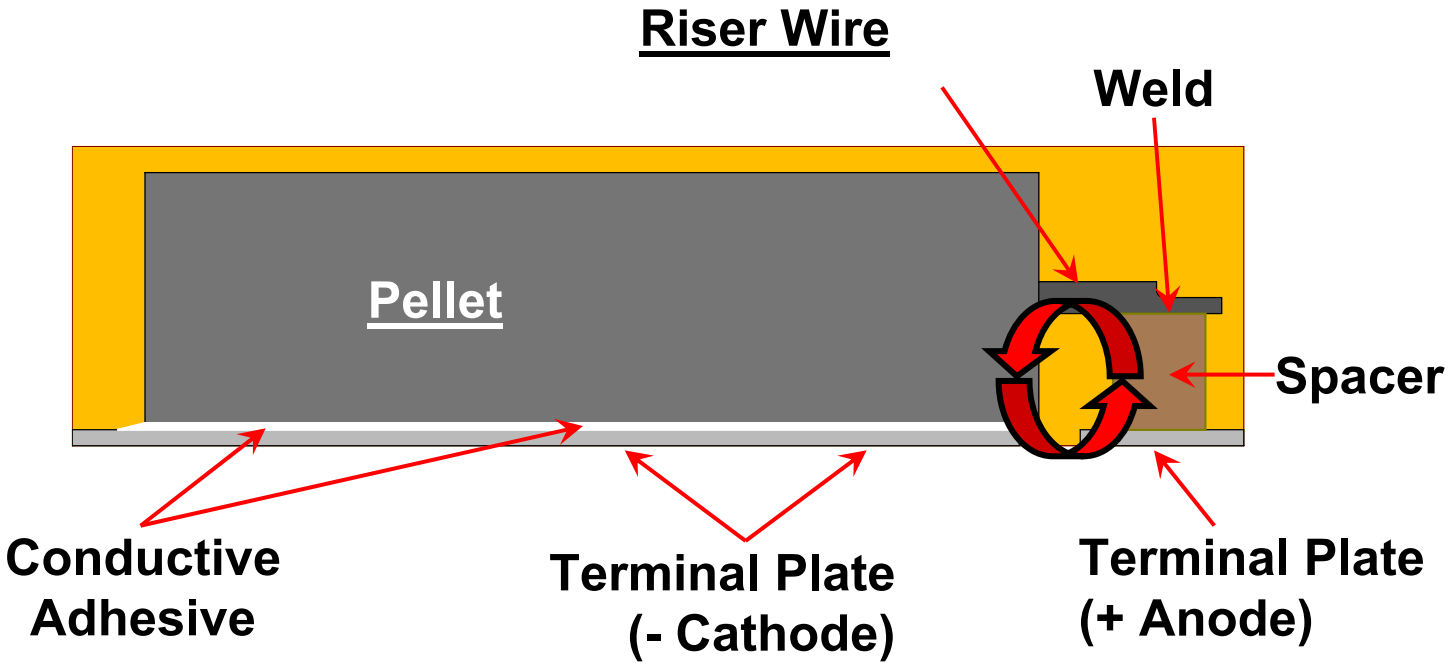
Where:

- L = inductance (henries)
- μ_f = permeability factor
- n = number turns per unit length
- A = Area of loop
- l = length

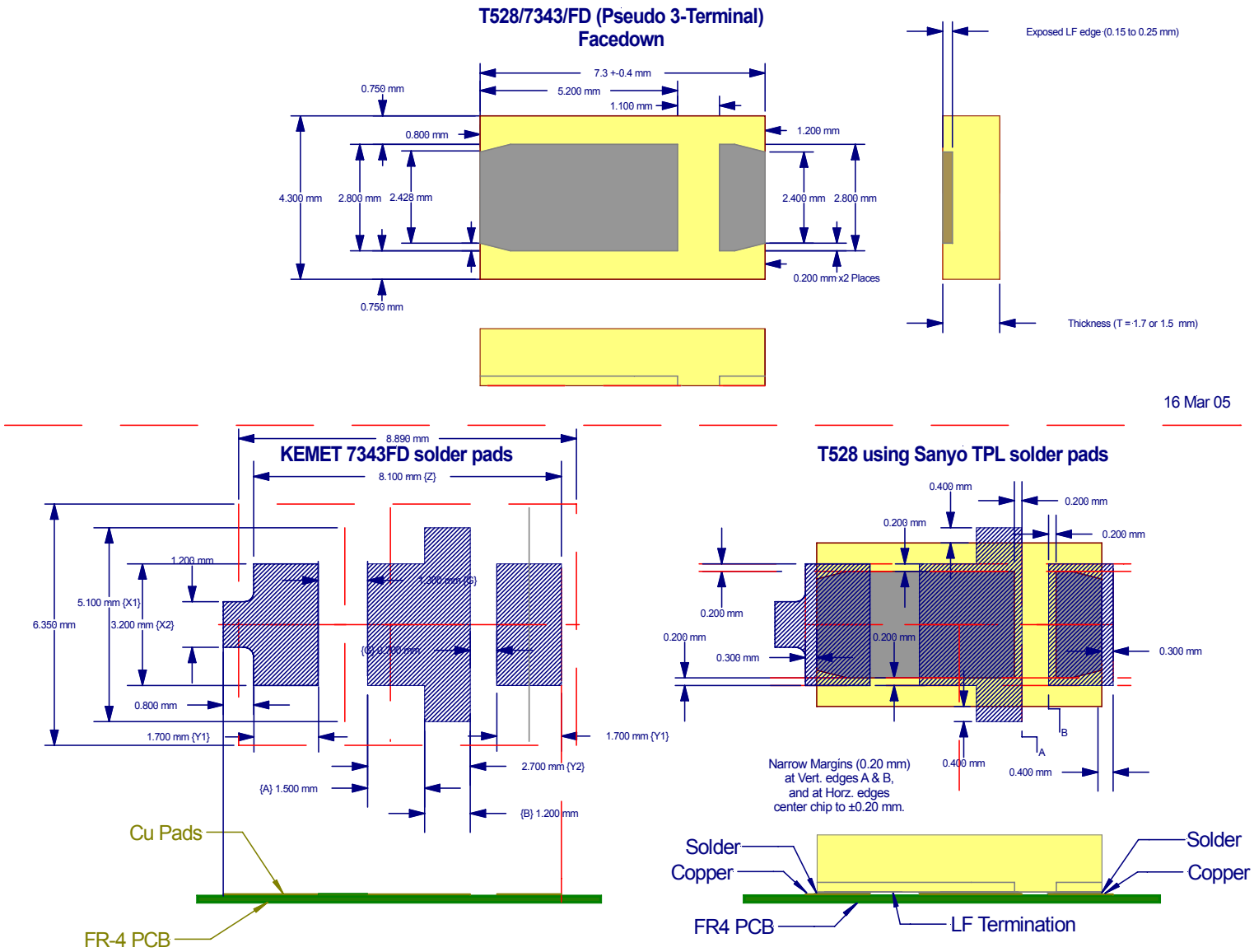
Inductance for loop:

$$L \propto A$$

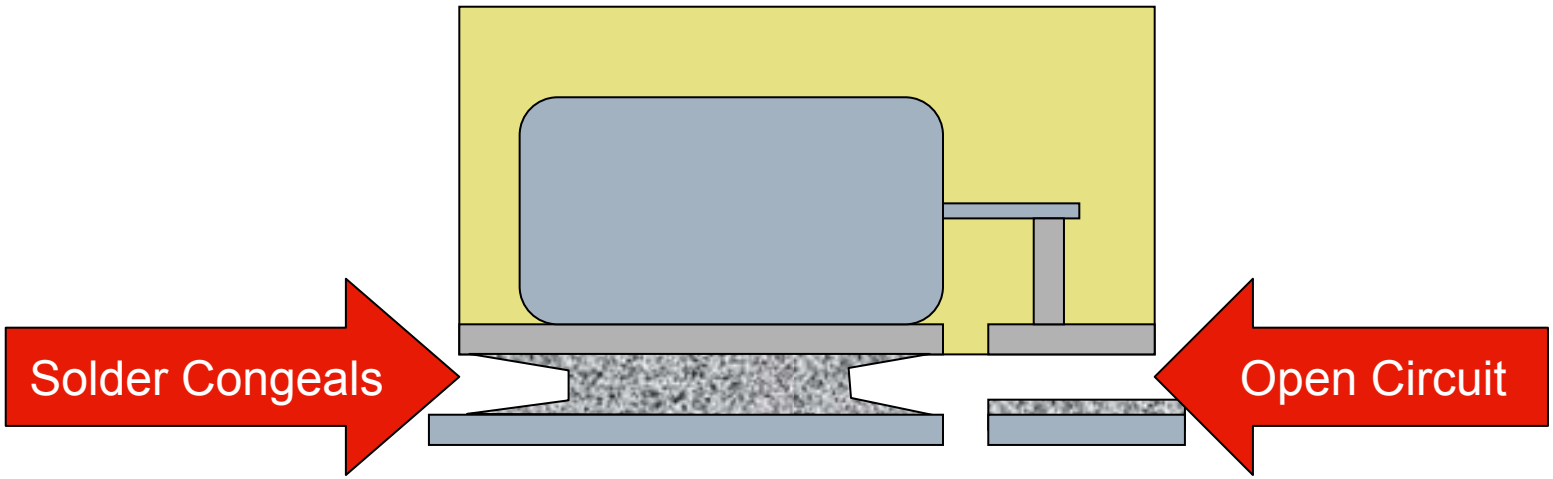
Optimized design for Low ESL



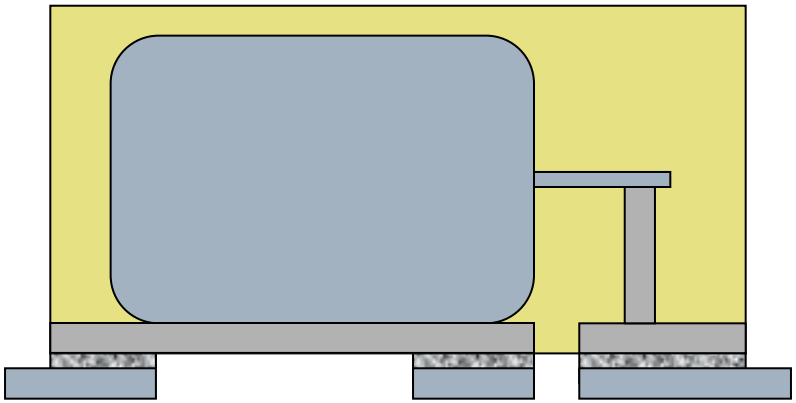
Recommended Pad Size – V,W,Z Case



Solder Lift on Large Pad

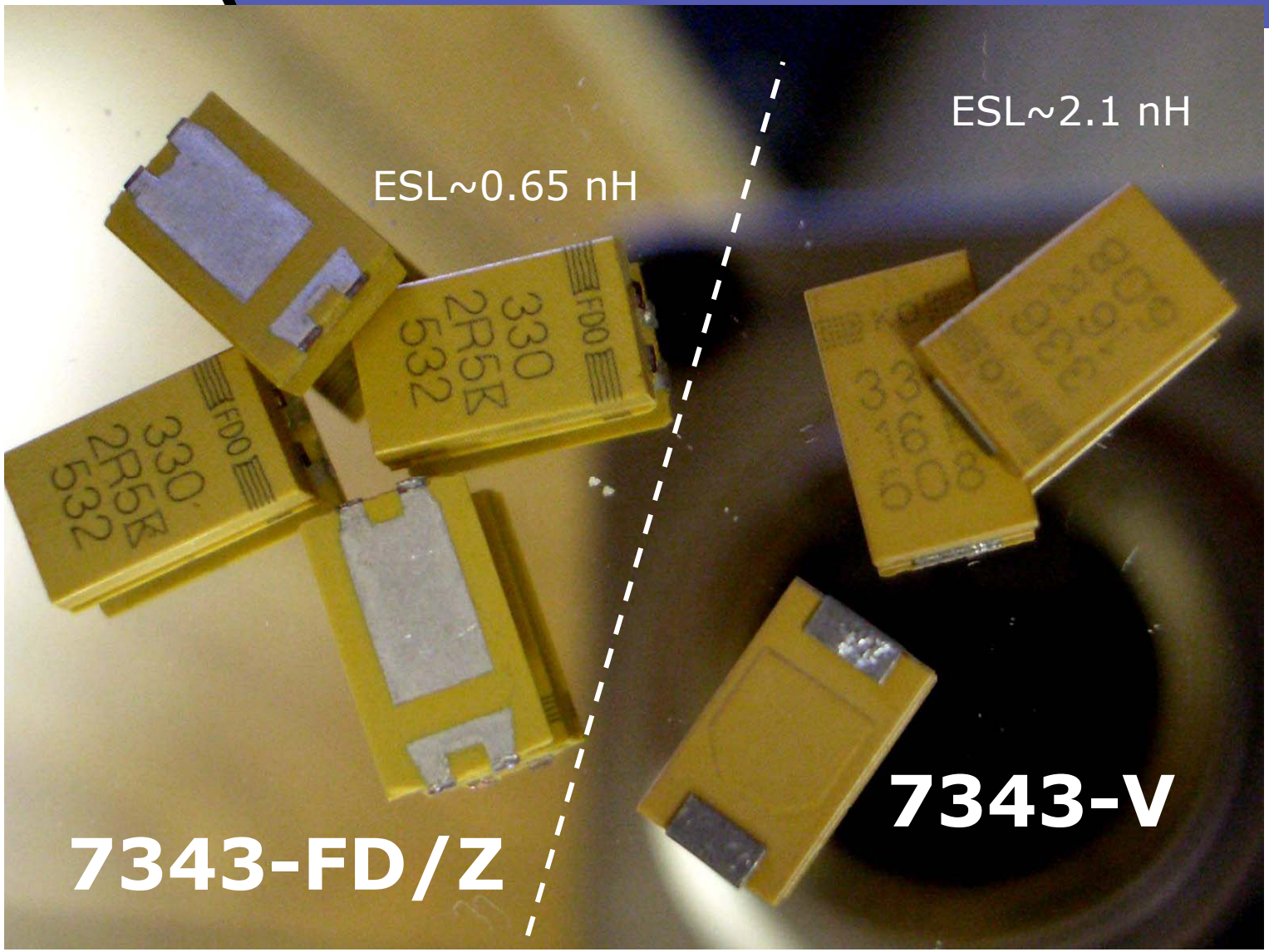


KEMET 2-Pad/Pseudo 3-Pad Design22



Requires 3 Solder Pads to prevent large pad from lifting.

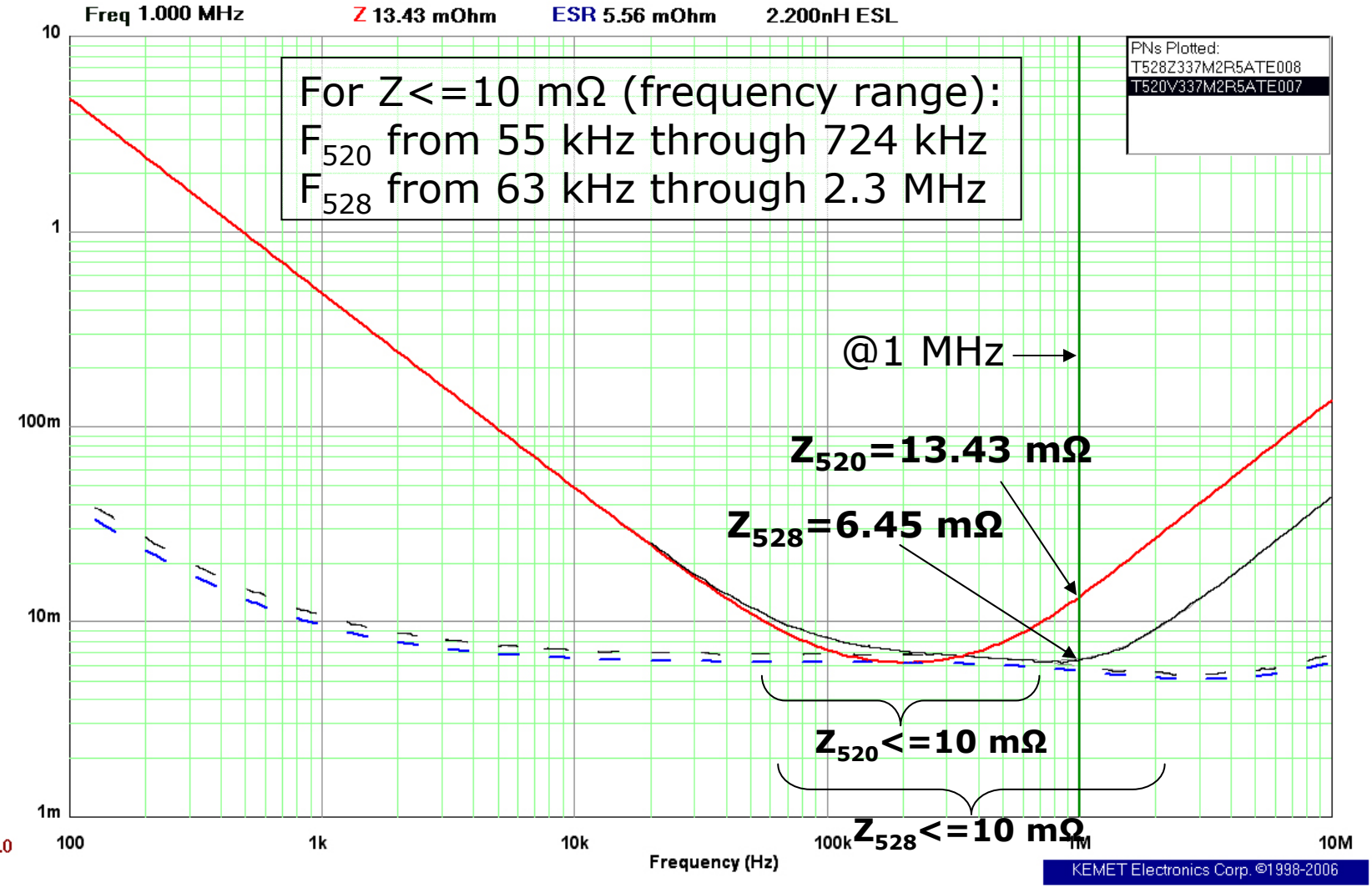
7343-FD/Z vs. 7343-V



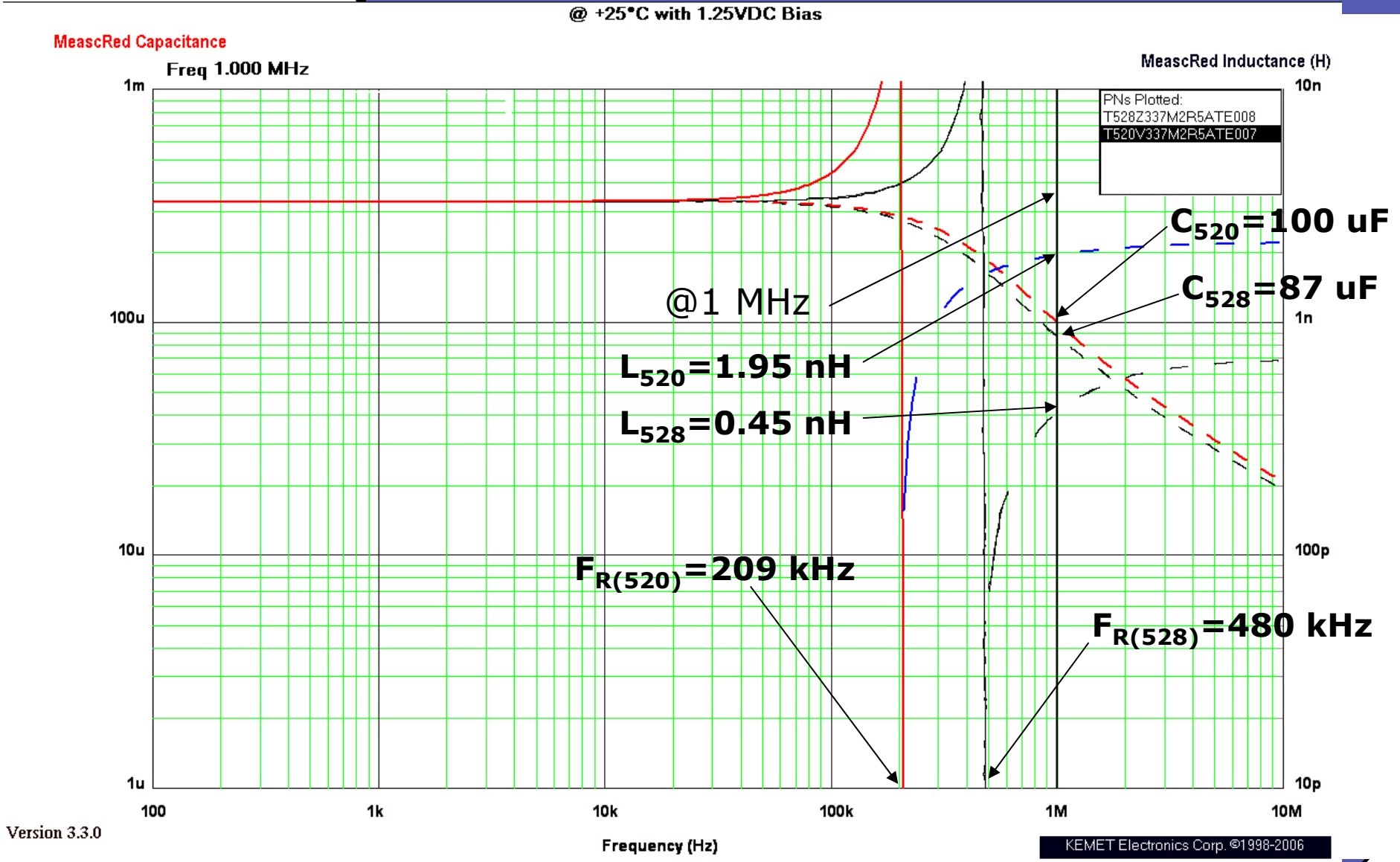
T528 vs. T520 (Z/ESR) 330 uF / 2.5 WVDC

Impedance and ESR

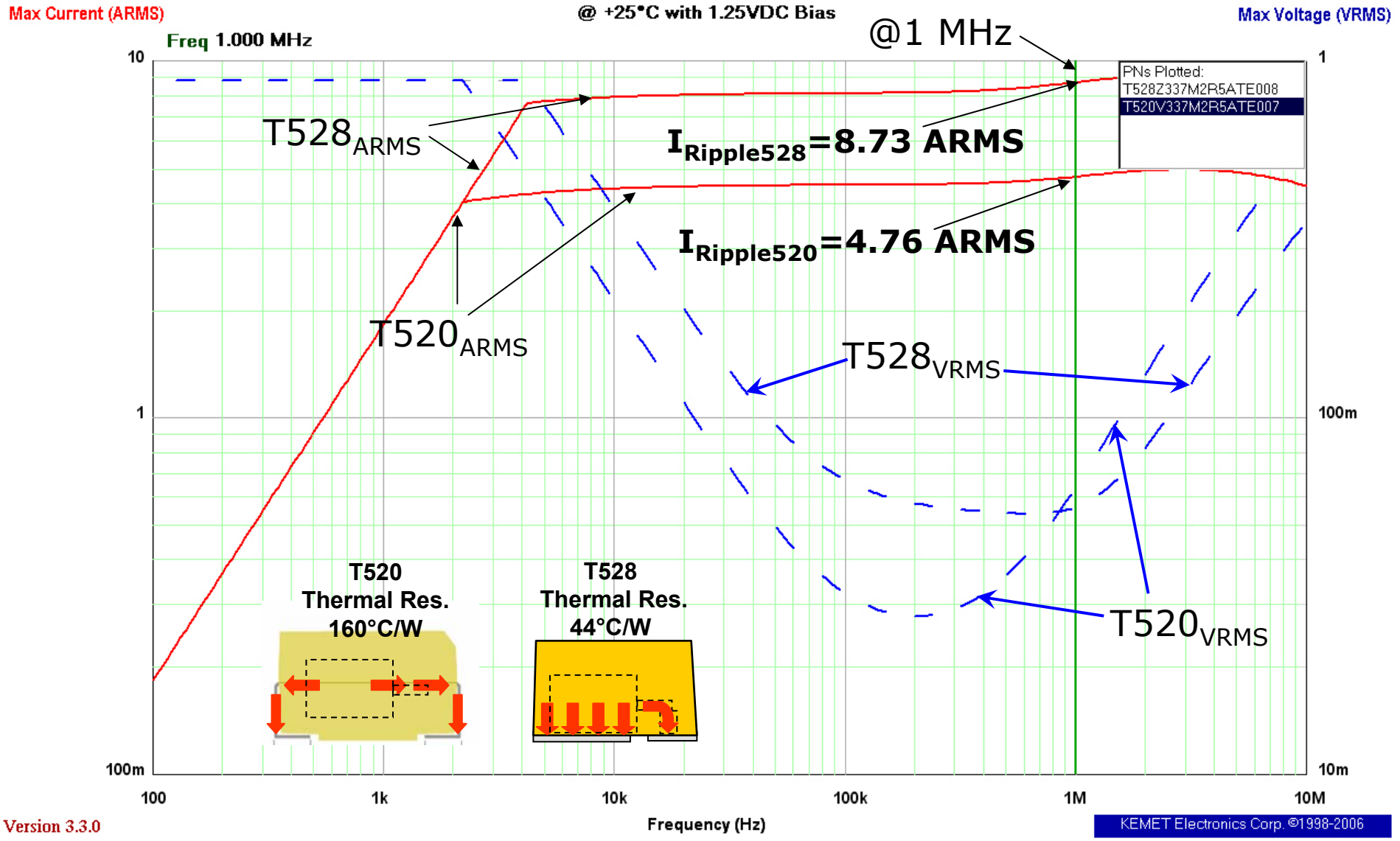
@ +25°C with 1.25VDC Bias



T528 vs. T520 (C/L) 330 uF / 2.5 WVDC



T528 vs. T520 (I/V) 330 uF / 2.5 WVDC



Summary of benefits, conductive-polymer Ta

- Higher performance & efficiency (compared to MnO_2)
  - Lower ESRs
  - Better capacitance retention
  - Lowers piece count
- In conjunction with facedown designs
  - Lower ESL
  - Higher thermal conductivity
  - Higher ripple current
- Eliminates exothermic reactions at failure (ignitions)
- Benefits of Ta_2O_5 dielectrics
  - No voltage coefficients
  - No piezoelectric effects
  - High Capacitance/Volume
- T52x and T53x are RoHS compliant, and 260 capable.