Rubycon

hYBRID ARS II™ technology

PZ-CAP™

Rubycon CAPACITORS

HYBRID TECHNOLOGY

NON ELECTROLYTE TYPE

Ultra Low ESR

Extreme Reliability

Temperature Stability

EXTREME

PERFORMANCE

Conductive Polymer Aluminum Solid Hybrid Type Type Capacitors

65 YEARS Rubycon CAPACITORS

• Quality • Reliability • Precision

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Conductive Polymer Aluminum Solid Hybrid Capacitors

PZ-CAP™

PRESENTATION MENU

CLICK COLOR TO ADVANCE PRESENTATION IN SLIDE SHOW MODE

- WHATS INSIDE
- vs Electrolytic TECHNOLOGY
- COMP. LIFE CHARACTERISTICS
- COMP. TEMP CHARACTERISTICS

- FREQUENCY CHARACTERISTICS
- ESR DISTRIBUTION
- HUMIDITY
- LEAKAGE CURRENT
- INRUSH CURRENT
- COST/SIZE SAVINGS
- APPLICATIONS
- AUTOMOTIVE

- LIFE CALCULATION
- REFLOW SOLDERING
- LOAD DUMP for 12/24V Systems
- REV VOLTAGE
- VIBRATION
- THERMAL MODELING
- THERMAL RESISTANCE
- THERMAL CAPACITANCE

- SERIES TREE
- PRODUCT SELECTOR

Radial	DATA SHEETS	SMD
PZE SERIES	105°C	PEV SERIES
PZF SERIES	125°C	PFV SERIES
PZJ SERIES	125°C	PJV SERIES
PZH SERIES	135°C	PHV SERIES
	150°C	PLV SERIES

- ROAD MAP
- THRESHOLD TESTING
- RUBBER BUNG TEST
- PROCESS FLOW CHART

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Differentiation

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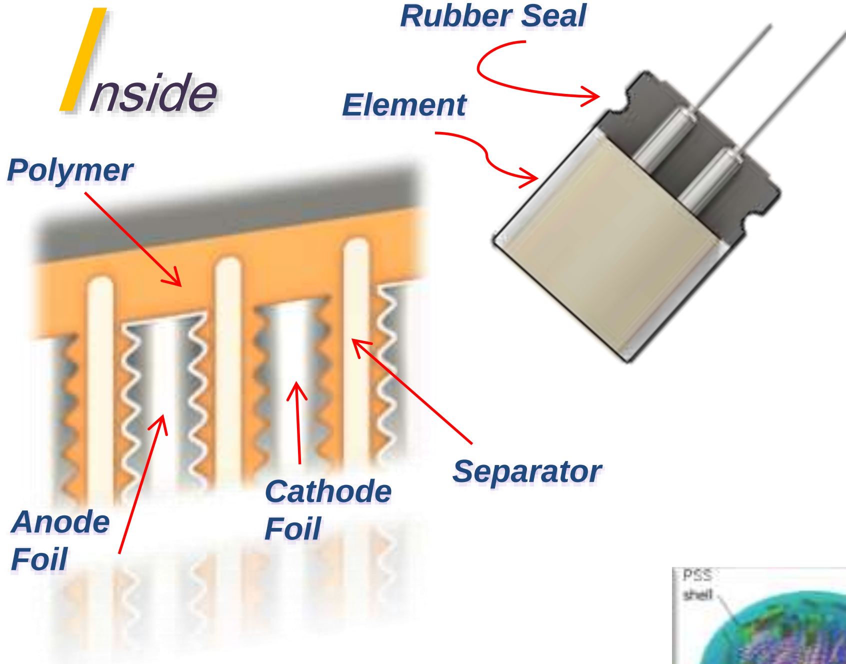
Inside



Conventional - Hybrid

Others

Electrolyte Based

Finite Life – Due to Dry Up Speed
Higher Leakage Current
Lower Self Healing Affect

VS

KEY POINT

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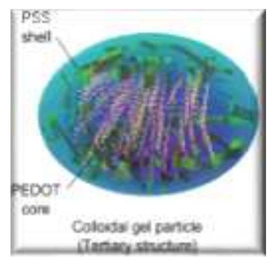
Non- Electrolyte Based

Functional Liquid & Pedot not Electrically conductive so safer than electrolytic type



Higher Capacitance

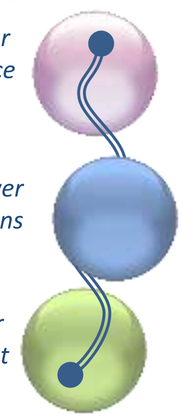
Inhibits Polymer Degradation

Reforming of Oxide Layer Due to stress conditions

Increased Reliability/ LIfe

Lower Leakage Current

Ideal for Miniaturization



PEDOT

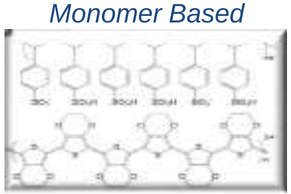
Combining to create Colloidal Structure

\+ Patent Pending

FUNCTIONAL LIQUID

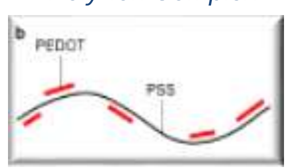
ARS II™ Technology

Monomer Based



Primary Structure

Poly-Ion Complex



Secondary Structure

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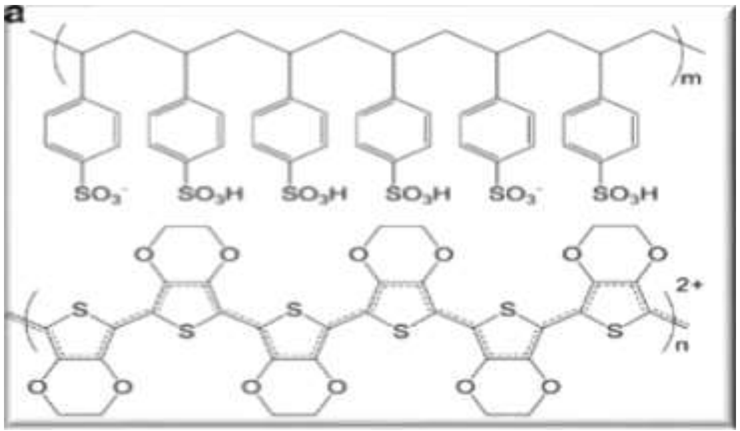
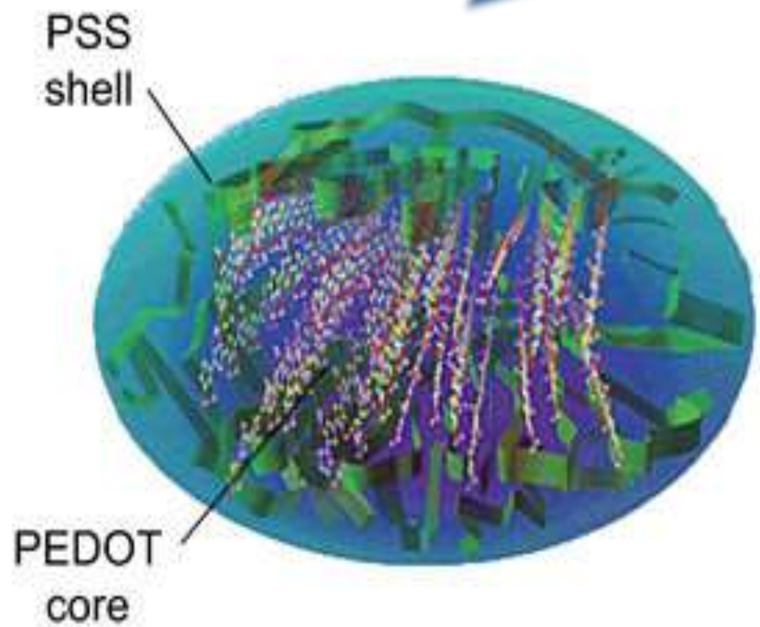
Material Background

PEDOT = PRIMARY POLYMER



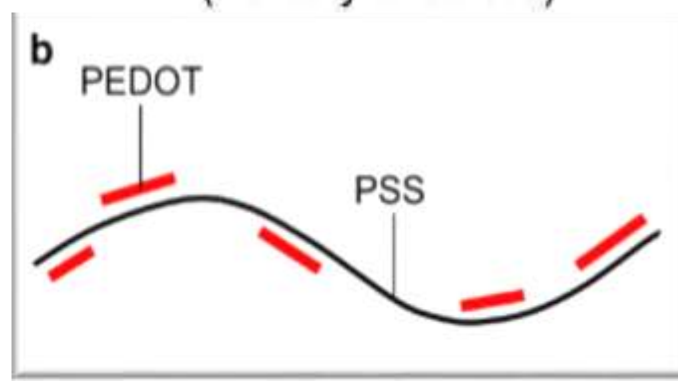


Colloidal gel particle
(Tertiary structure)

ARS2
FUNCTIONAL LIQUID=
SECONDARY SUBSTANCE

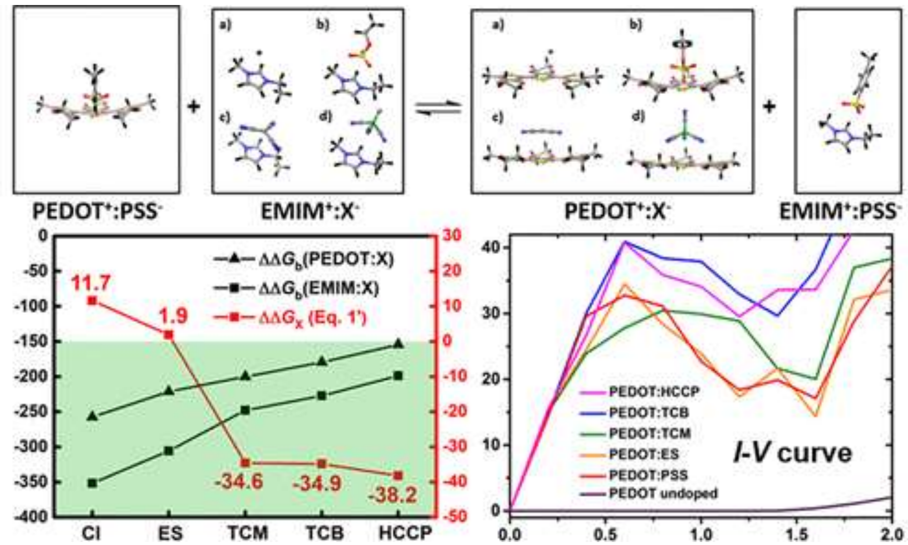
Polyethylene Glycol Solution

CREATING: Poly-Ion Complex



…Material Background

Poly-3,4-ethylenedioxythiophene:polystyrenesulfonate (PEDOT:PSS) is a water-processable conducting polymer with promise for use in transparent flexible electrodes and thermoelectric devices, but its conductivity is not satisfactory. Its low conductivity is attributed to the formation of hydrophilic/insulating PSS outer layers encapsulating the conducting/hydrophobic *p*-doped PEDOT cores. Recently a significant conductivity enhancement has been achieved by adding ionic liquid (IL). It is believed that ion exchange between PEDOT:PSS and IL components helps PEDOT to decouple from PSS and to grow into large-scale conducting domains, but the exact mechanism is still under debate.



Here we show through free energy calculations using density functional theory on a minimal model that the most efficient IL pairs are the least tightly bound ones with the lowest binding energies, which would lead to the most efficient ion exchange with PEDOT:PSS. This spontaneous ion exchange followed by nanophase segregation between PEDOT and PSS, with formation of a π-stacked PEDOT aggregate decorated by IL anions, is also supported by molecular dynamics performed on larger PEDOT:PSS models in solution. We also show that the most efficient IL anions would sustain the highest amount of charge carriers uniformly distributed along the PEDOT backbone to further enhance the conductivity, providing that they remain in the PEDOT domain after the ion exchange. Hence, our design principle is that the high-performance IL should induce not only an efficient ion exchange with PEDOT:PSS to improve the PEDOT morphology (to increase mobility) but also a uniform high-level *p*-doping of PEDOT (to enhance intrinsic conductivity). Based on this principle, a promising (electron-withdrawing, but bulky, soft, and hydrophobic) new IL pair is proposed.

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Conductive Polymer Aluminum Solid Hybrid Capacitors

Applications

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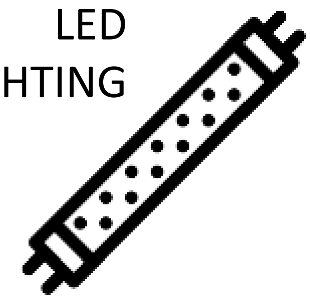
ELECTRIC TOOL

MOTOR INVERTER

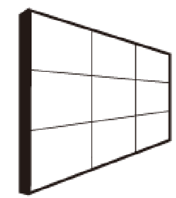
TELCOM

DRONE

LED LIGHTING



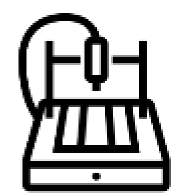
DIGITAL SIGNS



E-BIKE

POWER SUPPLY

INDUSTRIAL MACHINERY



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Automotive

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Electric Pumps

WATER

OIL

FUEL

LED LAMPS

El. Compressor

EPS

COOLING FAN

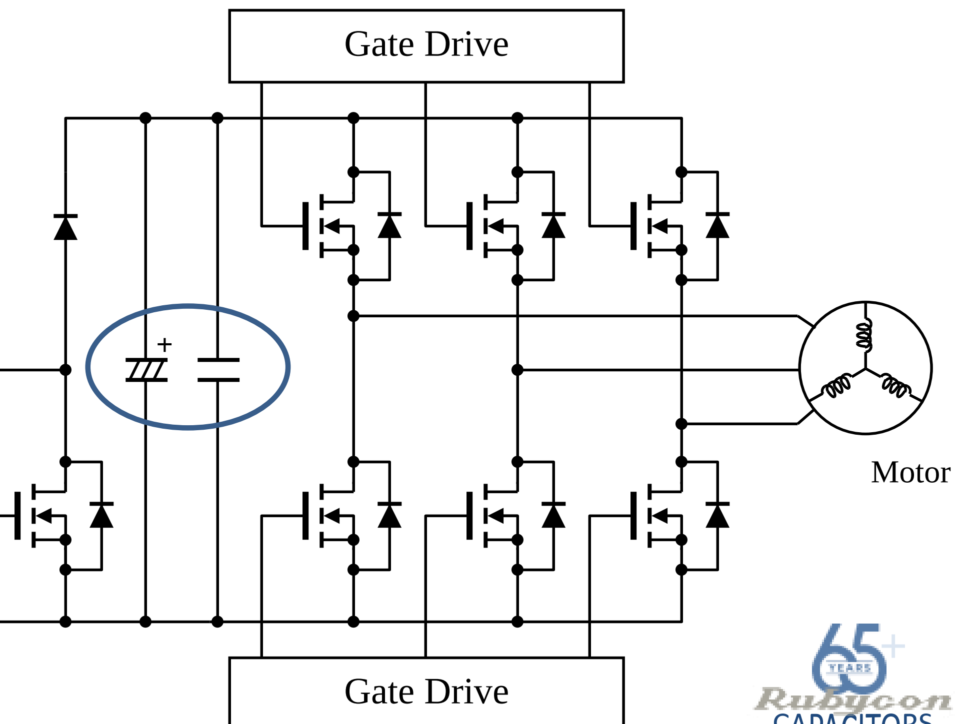
ABS

Power

BATTERY MANAGEMENT

DC/DC

DC/AC



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Savings..

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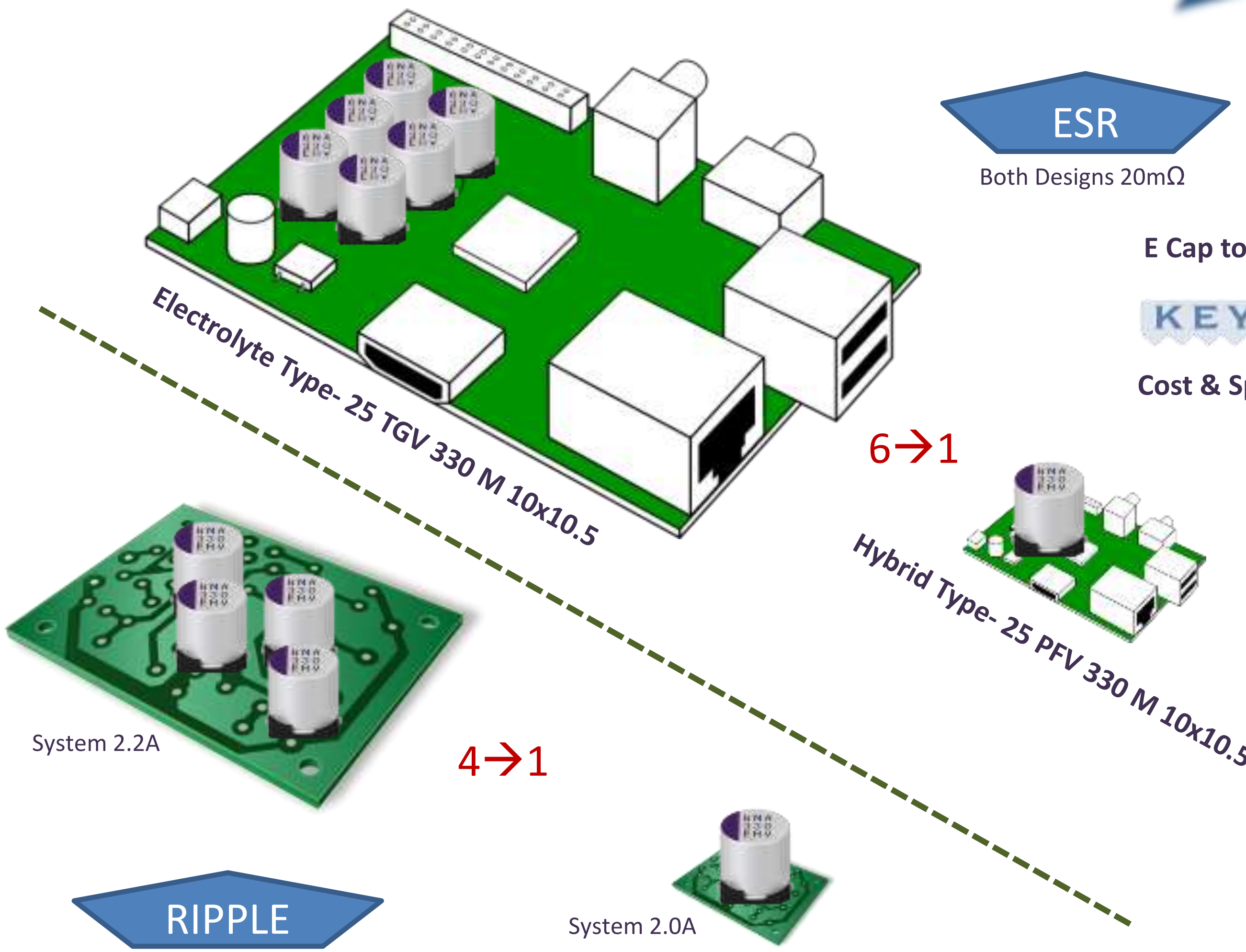
ESR

Both Designs 20mΩ

E Cap to Hybrid

KEY POINT

Cost & Space Savings



RIPPLE

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Conductive Polymer Aluminum Solid Hybrid Capacitors

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TECHNOLOGY

RUBYCON HYBRID VS. WET TYPE ELECTROLYTIC

COMPARISON

SURFACE MOUNT

PARAMETER	Hybrid Polymer 35PFV270M10X10.5	+/-	Wet Type Ecap 35TGV220M10X10.5
Temperature Range	-55℃～+125℃	+	-40℃～+125℃
Size (ΦDXL)	10X10.5	/	10X10.5
Rated Voltage	35V	/	35V
Capacitance	270uF	+	220uF
Leakage Current (WV 2min)	94.5uA (0.01CV)	-	77uA (0.01CV)
Ripple Current (100kHz)	2000mA	+	550mA
ESR(100kHz 20℃)	20mΩ (10.9 Measured)	+	120mΩ
Lifetime (125℃)	4000 Hrs	+	3000 Hrs

RADIAL

PARAMETER	Hybrid Polymer 35PZH330M10X9	+/-	Wet Type Ecap 25HRX5100M18X25
Temperature Range	-55℃～+125℃	+	-40℃～+125℃
Size (ΦDXL)	10X9	+	18X25
Volume	$0.71cm^3$	+	$6.36cm^3$
Weight	1.3 grams	+	10 grams
Ripple Current (100kHz)	3600mA	/	3620mA
ESR(100kHz 20℃)	20mΩ	+	32mΩ
Lifetime (125℃)	4000 Hrs	+	3000 Hrs

Hybrid type achieve higher capacitance and lower leakage current in comparison with conventional solid polymer technologies.

ESR 1/6 and Ripple current 4 times are achieved in comparison with Non-solid type electrolytic.

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Conductive Polymer Aluminum Solid Hybrid Capacitors

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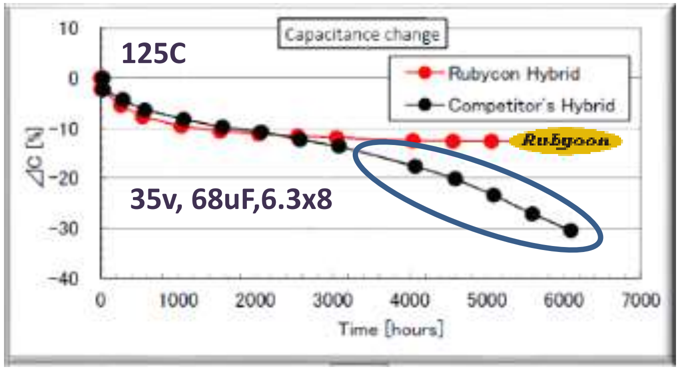
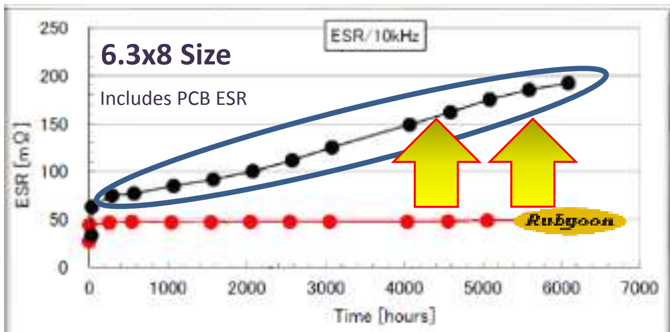
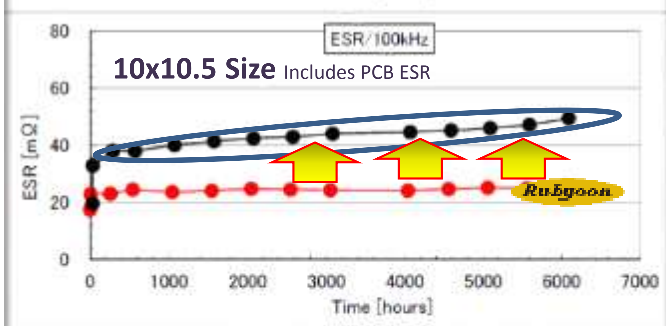
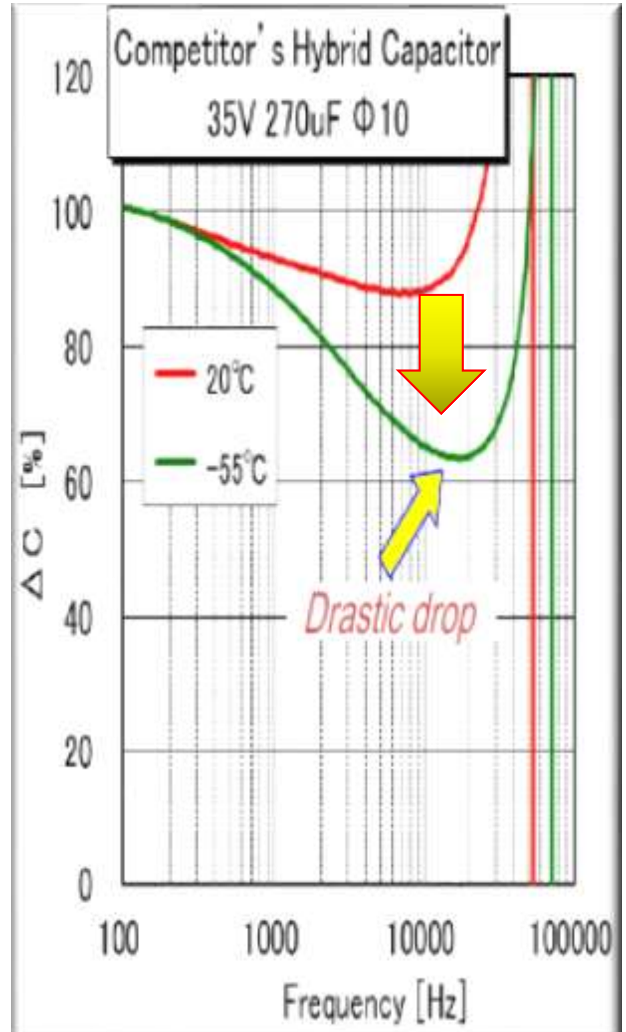
RUBYCON VS. OTHERS- CHARACTERISTICS VS LIFE









KEY POINT

Electrolyte Based
Vs.
Functional Liquid

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SLIDE NAVIGATION

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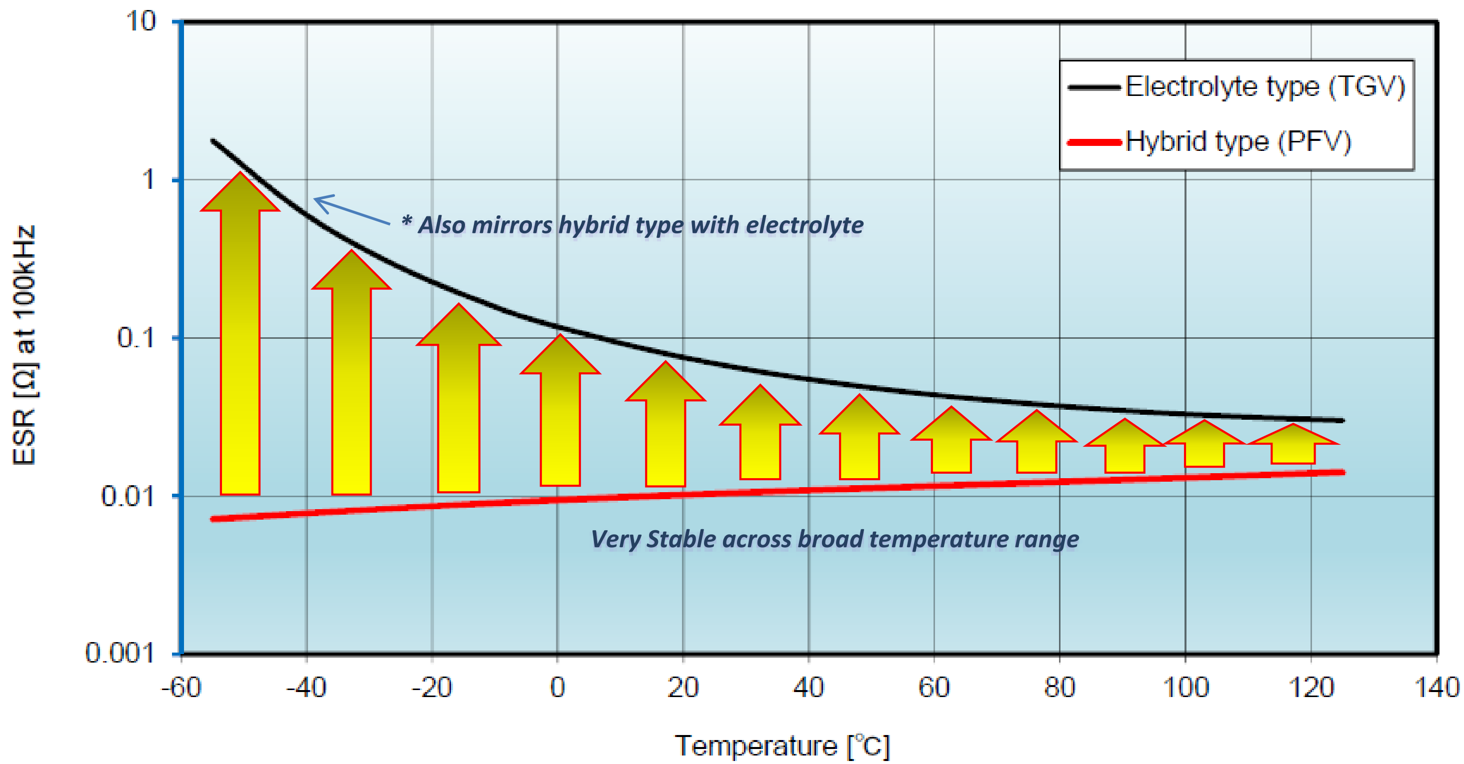
Performance.. PZ-CAP™

RUBYCON HYBRID vs ELECTROYTE- CHARACTERISTICS VS TEMP



25v 330uf 10x10 Shown

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performance..

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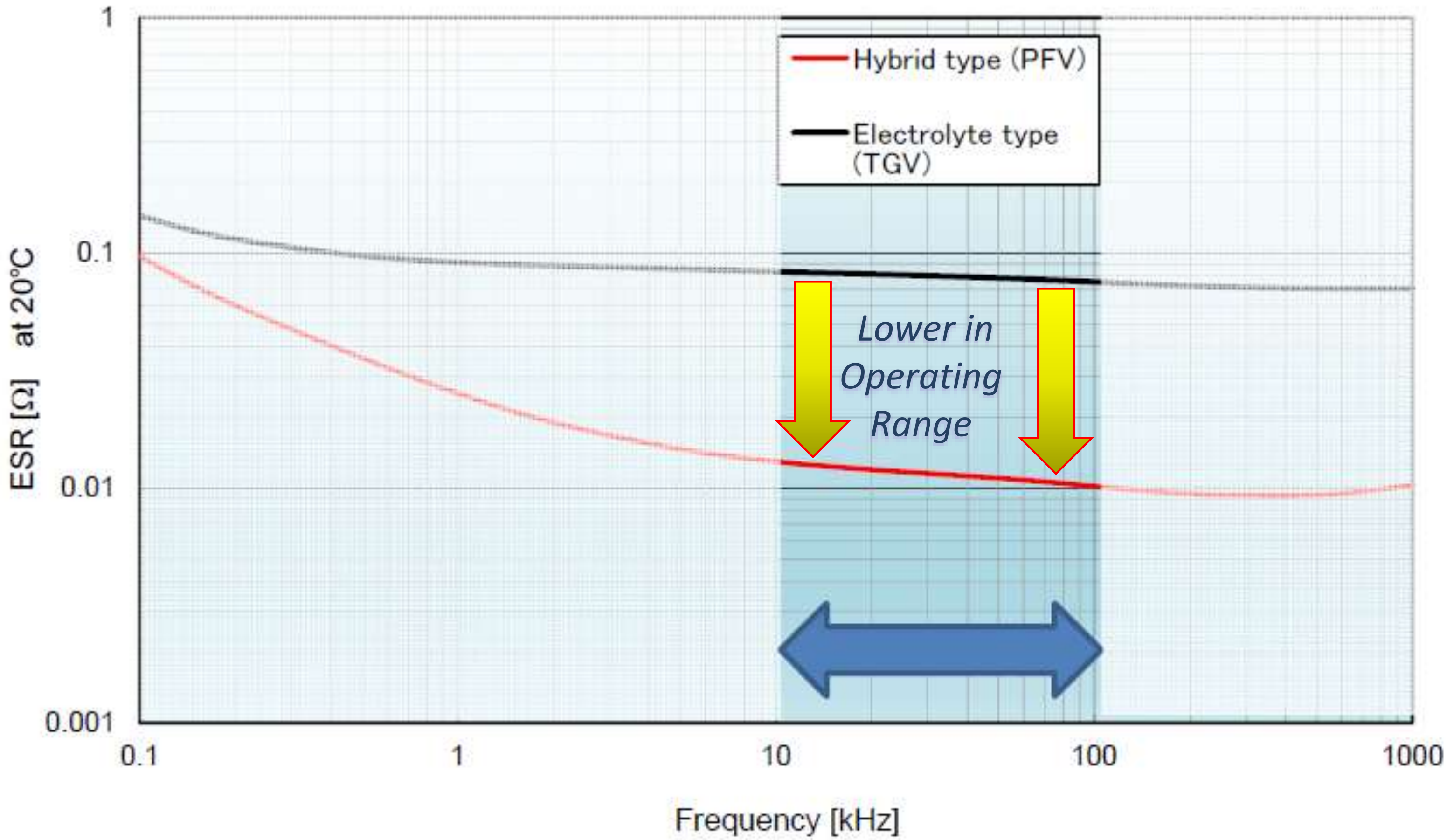
RUBYCON HYBRID vs ELECTROLYTE- frequency vs ESR



25v 330uf 10x10 Shown

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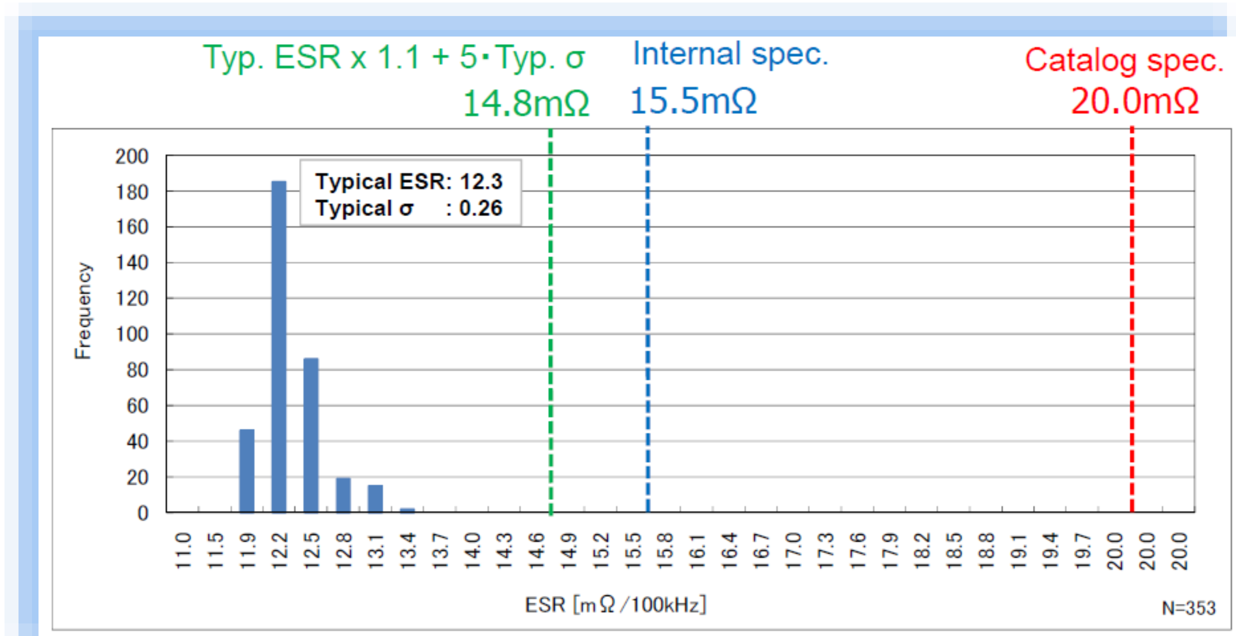
RUBYCON HYBRID

ESR DISTRIBUTION @ 20◦C, 100KHz



TEST ITEM

25PFV330M10X10.5

CATALOG SPECIFICATION

ESR: 20mΩ @ 20◦C, 100KHz

RIPPLE CURRENT: 2Arms/125◦C, 100KHz

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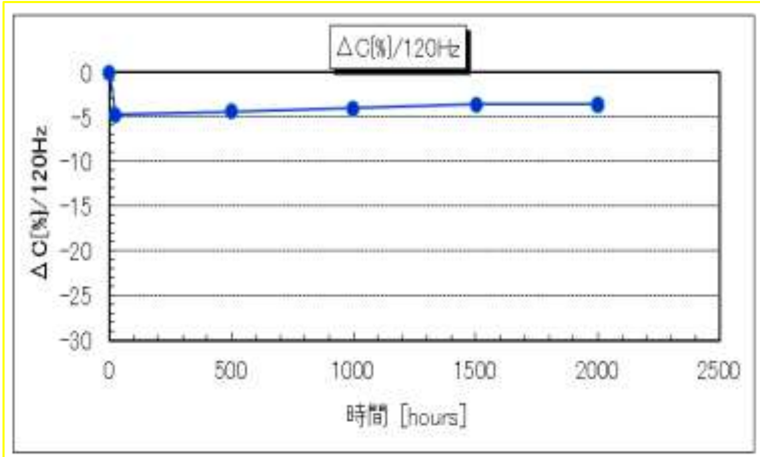
RUBYCON HYBRID

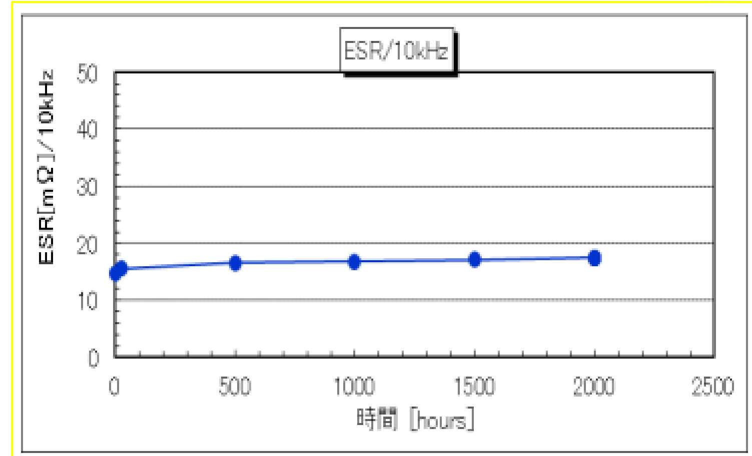
Humidity Endurance Testing

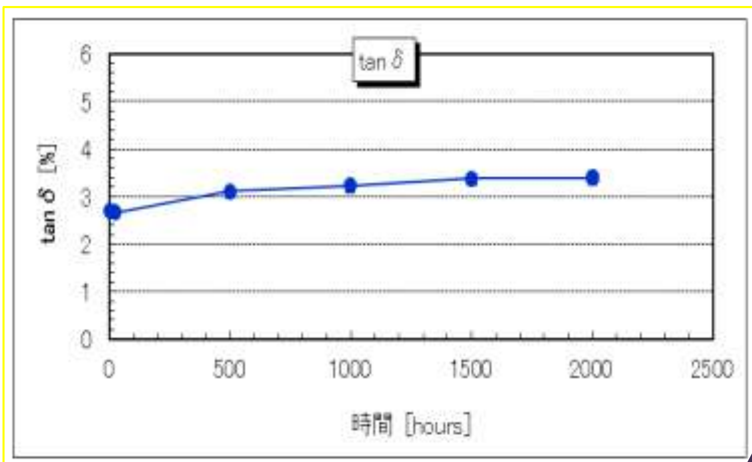
PZ-CAP™ PfV

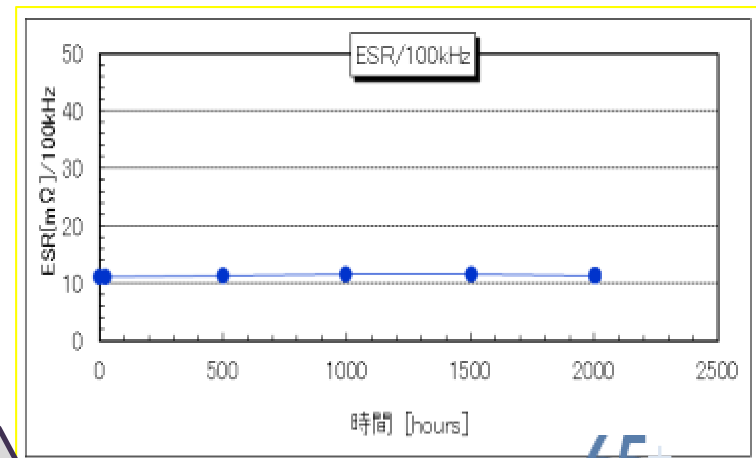
RH
TESTING

85°C,85% RH Rated Voltage Applied
(After reflow soldering X2)









2000 Hour Testing

85 RH
85 °C

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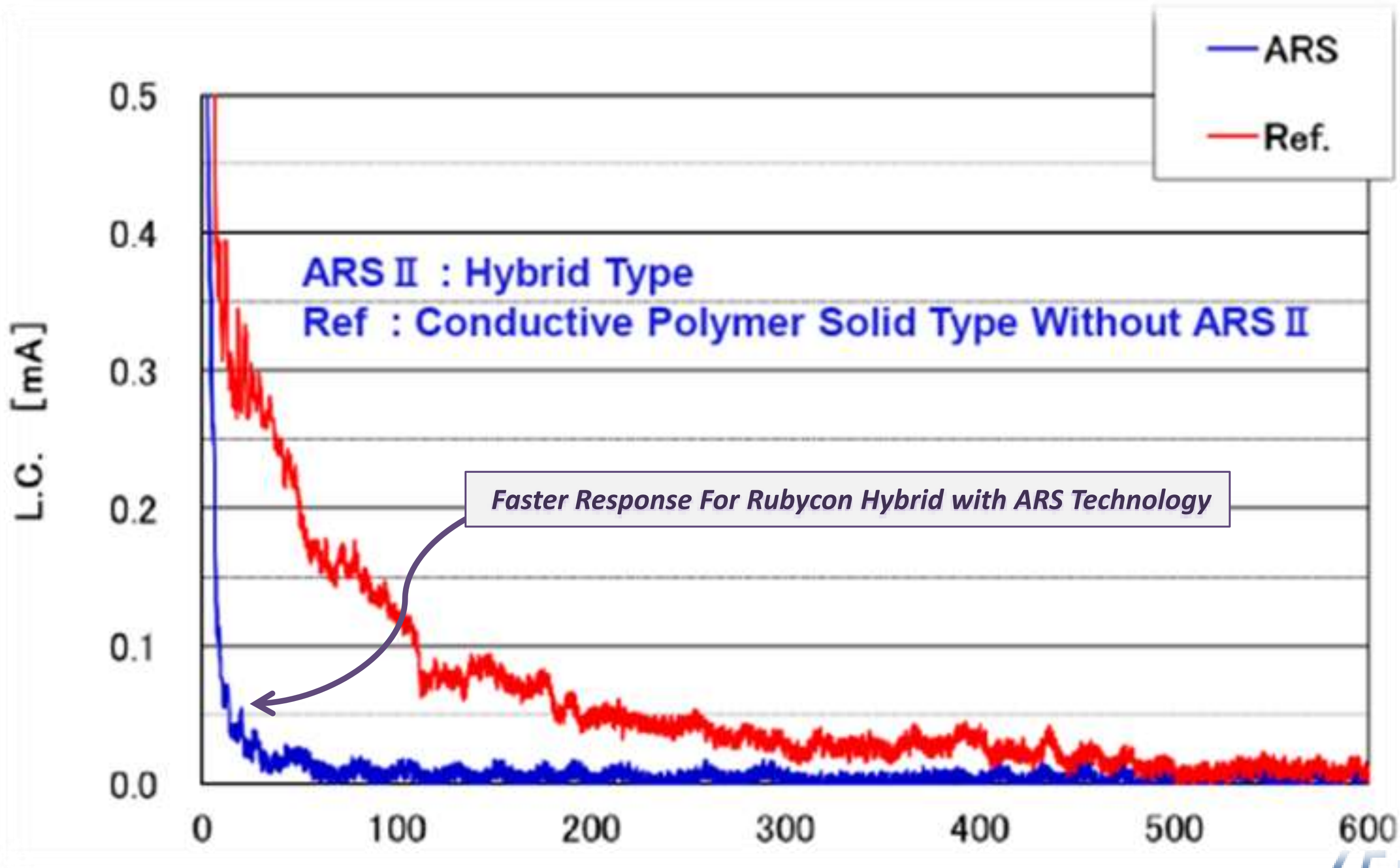
LEAKAGE CURRENT TEST

35V, 270µF, 10x10 Size



Time (Seconds)

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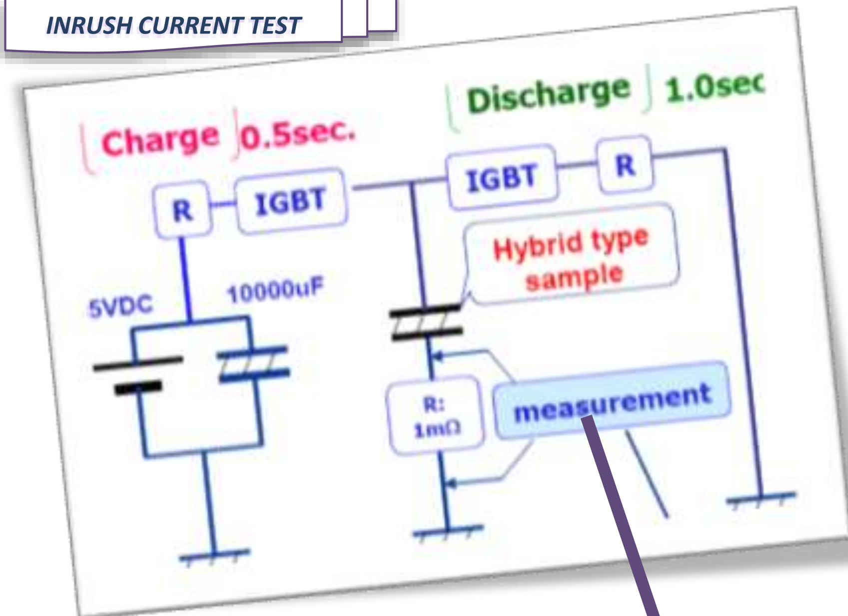
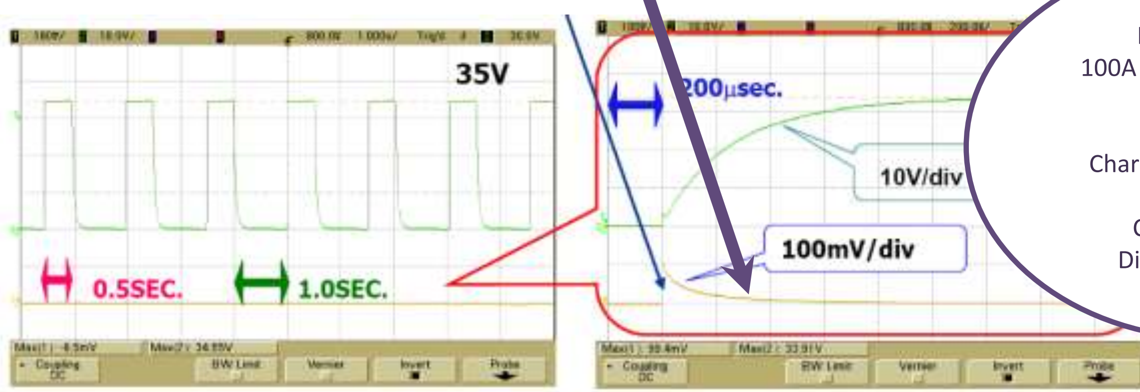
INRUSH CURRENT TEST



TEST RESULT:

Before			
Cap [µF]	Tanδ [%]	L.C. [µA]	E.S.R. [mΩ]
235	2.6	6.3	9.8
After	1000 times		
ΔC [%]	Tanδ [%]	L.C. [µA]	E.S.R. [mΩ]
-0.9	3.0	8.8	9.9



Inrush Current
100A Peak @ 35V (Room Temp)

Charge/Discharge 1000 Times
Charge: 0.5 Sec
Discharge: 1.0 Sec

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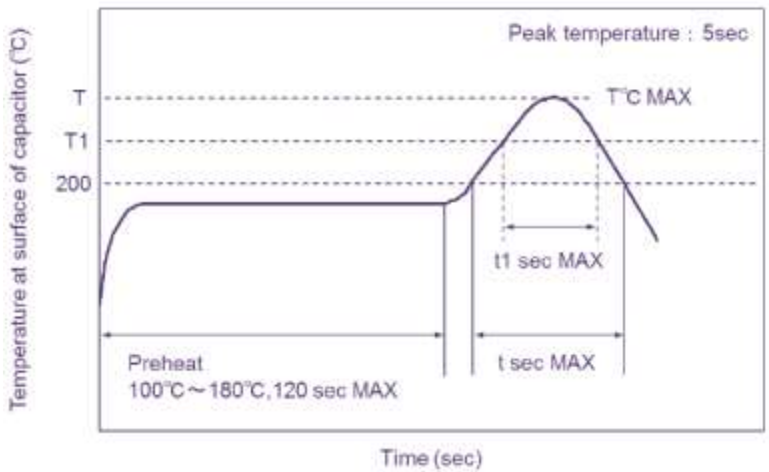
REFLOW SOLDERING



Peak Temp (T)	T1	The time of 200°C or more (t)	The time of 230°C or more (t1)
260°C	230°C	60 sec (max)	40 sec (max)
250°C	230°C	60 sec (max)	40 sec (max)

2X Reflow Testing at 260◦C

before			
Cap. [μF]	Tanδ [%]	L.C. [μA]	E.S.R. [μΩ]
330	3.0	7.3	10.5
after			
ΔC [%]	Tanδ [%]	L.C. [μA]	E.S.R. [μΩ]
-4.2	3.1	30.6	10.2

SPECIFICATION

- -Cap :+/-10% of initial value
- -Tanδ : Not more than 14%
- -L.C. : 0.01CV/2min. (Max.)
- -E.S.R.: Not more than 20mW

SINGLE REFLOW

DUAL REFLOW

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SLIDE NAVIGATION

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Road vehicles — Environmental conditions and testing for electrical and electronic equipment

In general, 35v/63v capacitors are typically used to satisfy 12/24v battery load dump conditions. With our hybrid polymer caps 25/50v capacitors can be employed instead which will increase options for capacitance and size reduction.

24v Battery Systems

ISO 7637-2 Test pulse 5b
(ISO 16750-2 load dump Test B)
Surge voltage (Us) : 65V
Duration of pulse: 350ms
Test cycle: 5 pulses at interval of 1min.
Temperature : Room temp. (25ºC)

Use 50v Hybrid

12v Battery Systems

ISO16750-2 Test B
DUT 20ºC below max rated temp
Supply Voltage Max for nominal 12V system = 16VDC
Apply 18VDC for 60 Min at above temp

Use 25v Hybrid

Advantage?

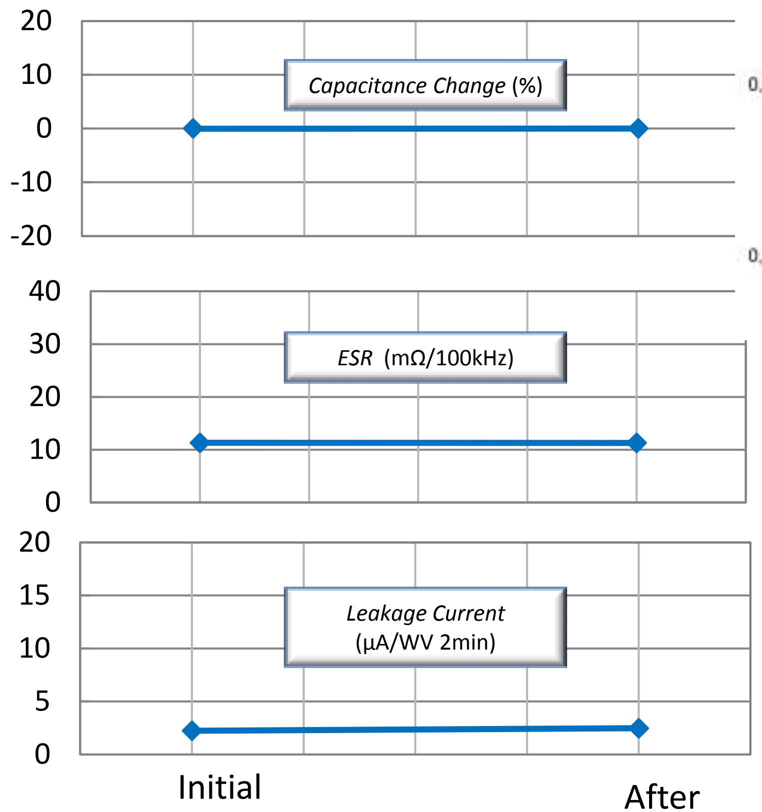
10x12.5 Size
From 390μF To 560μF
Increase in Capacitance

270μF
From 10x10.5 to 8x10.5
Decrease in Size

Test Results:

Test temperature: Room temp.

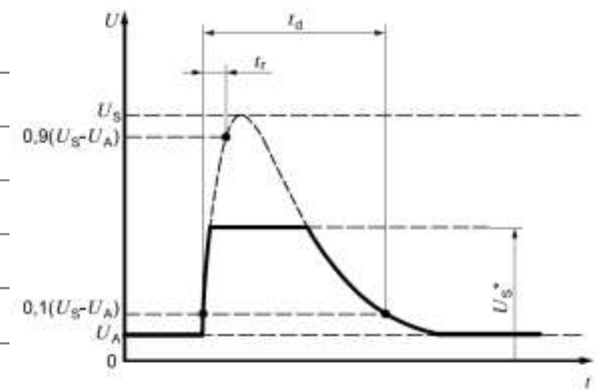
Reference standard:
ISO 16750-2: 2010 Load dump Test B



Test item:

25 PFV 330 M 10X10.5

Test condition:



Parameter	12V system
U_A	14V
U_S*	35V
t_d	400ms
t_r	< 10ms
Test cycles	5 pulses at intervals of 1min

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LOAD DUMP- HIGH CYCLE

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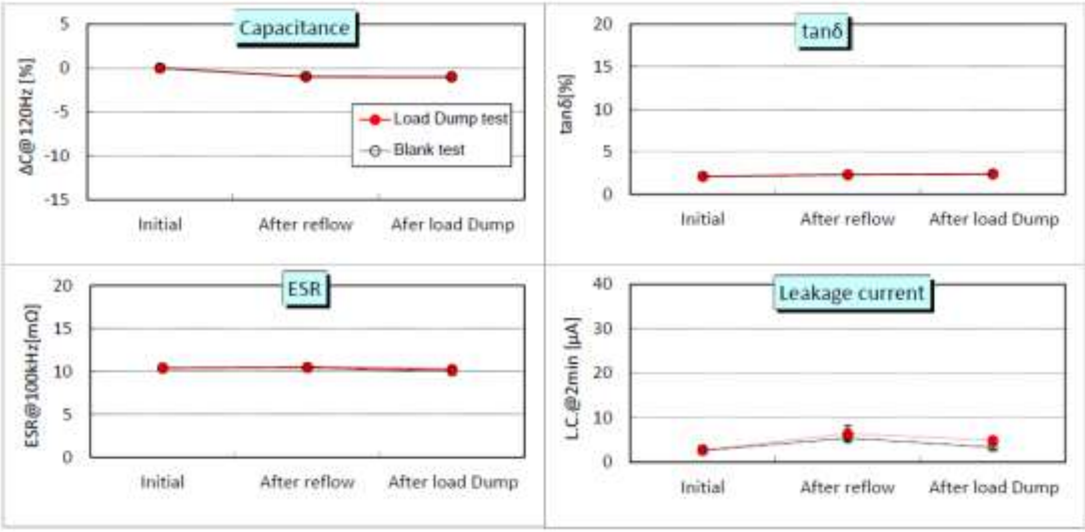
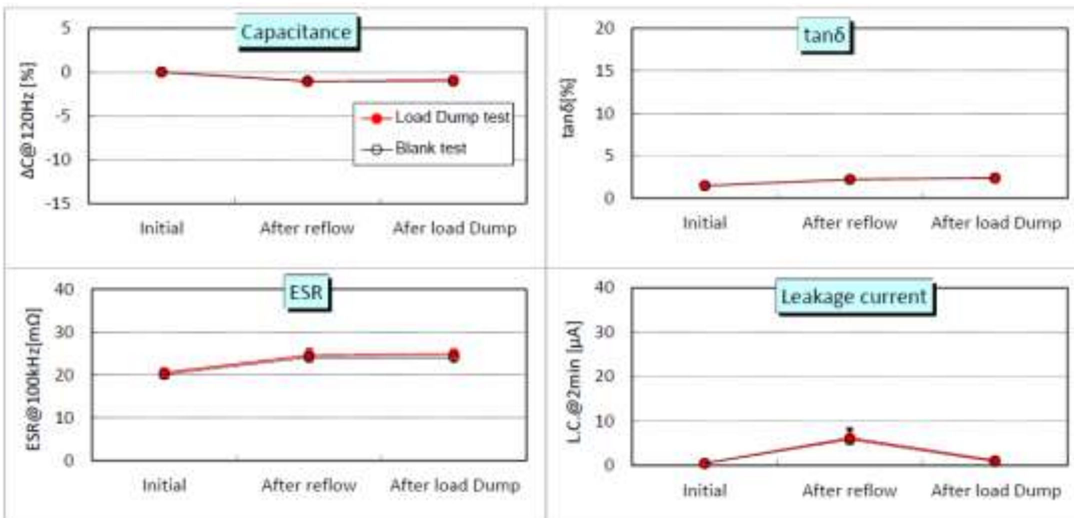
Test Results:

25 PFV 330 M 10X10.5



25 PFV 56 M 6.3x6.1



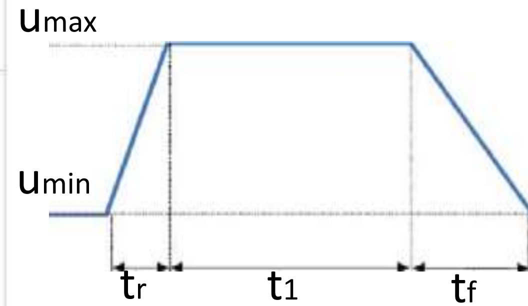
Test item:

25 PFV 330 M 10X10.5

25 PFV 56 M 6.3x6.1

Reflow Condition: 260C Peak x 2 times

Test Conditions:



Parameter	12V system
Temperature	125C
U_{min}	13.5v
U_{max}	35V
t_r	2 ms
T_1	400 ms
t_f	30 ms
Interval	15 sec
# cycles	1000
# items tested	10

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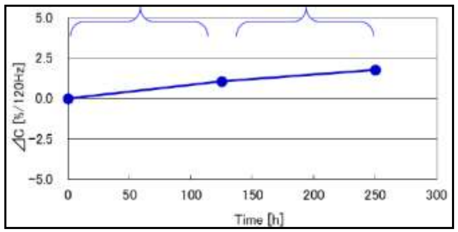
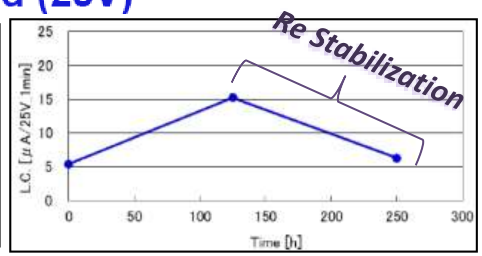
REVERSE VOLTAGE TEST 1

Reverse Voltage -1VDC is applied at 125◦C for 125 Hours, Then normal rated voltage is applied for 125 Hours 25V, 330µF, 10x10 Tested

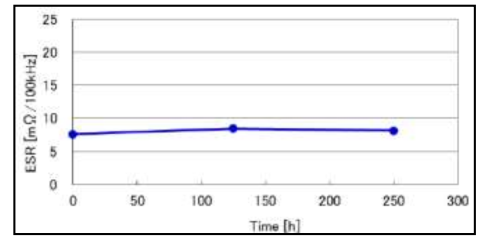
Reverse (-1V) DC load (25V)



CAPACITANCE



LEAKAGE CURRENT



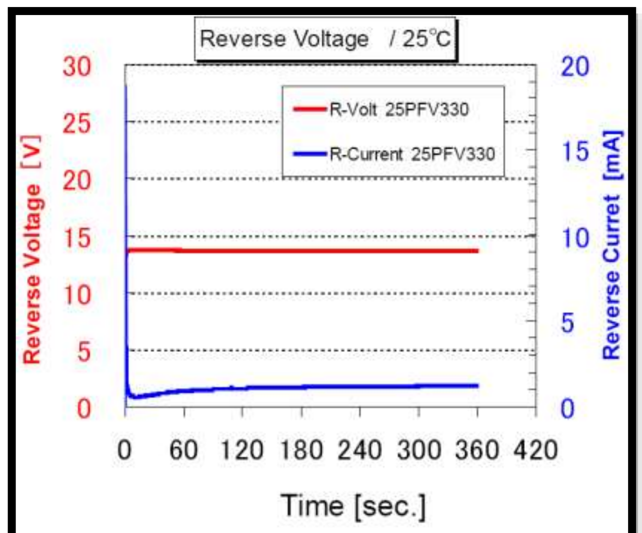
ESR

REVERSE VOLTAGE TEST 2

Reverse Voltage -14VDC is applied at 25◦C for 6 Minutes 25V, 330µF, 10x10 Tested

TEST RESULT:

Before			
Cap. [µF]	Tanδ [%]	L.C. [µA]	E.S.R. [mΩ]
297	2.7	2.2	11.9
After			
ΔC [%]	Tanδ [%]	L.C. [µA]	E.S.R. [mΩ]
-5.5	2.7	4.6	10.9



Robust Against Reverse Voltage

65 YEARS Rubycon CAPACITORS

• Quality • Reliability • Precision

VIBRATION TESTING – 10X10 SIZE

Size (D x L)	Normal 	Vibration proof 
6.3x6.1 6.3x8	30G MAX	----
8X10.5	20G MAX	30G MAX
10X10.5	20G MAX	30G MAX

Sine wave vibration	
Frequency	10 ⇔ 2000Hz
Cycle	15min
Direction	X-Y-Z
Duration	Each 4 hours/axis

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HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

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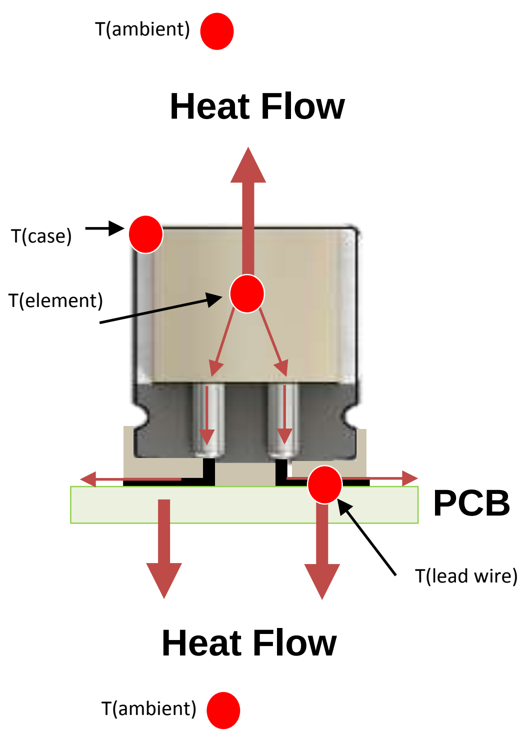
Enhancing Performance with Thermal Considerations

Natural Convection



Heat Sink

Liquid Cooling

Forced Convection

KEY POINT

Lowering Core Temp Results in

Higher Ripple Current → Longer Life

Rubycon

Life Can be calculated by measuring case & lead wire temperature

Rubycon CAPACITORS

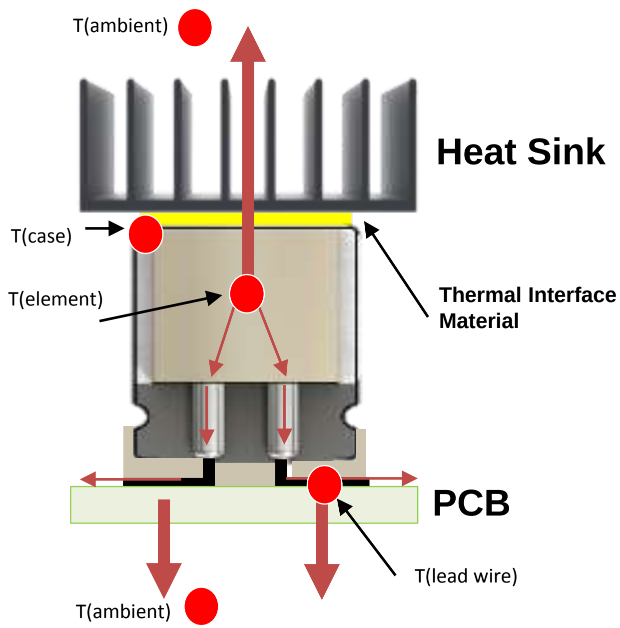
Estimating Power Loss

For Varying Ripple Current With Top Heat Sink

ΔT Element to Case/Lead Wire

Natural Convection

Cooling Method: Top Heat Sink



KEY: Measure Case Temp & Lead Wire Temp

(˚C/W)		
~15	Ambient to Heat Sink	
~3	Heat Sink to Thermal Interface	
15	Case to Element	R_{ec}
37.9	Element to Lead Wire	R_{el}
~ 70	Lead Wire to Ambient	

Total Heat Flow

75% Core (Element) To top Ambient

25% Core (Element) To bottom Ambient

I: 8Arms
ESR=*15.6mΩ
*Factory Control Spec

Calculated Value:

$P_{loss} = I^2 \cdot ESR$ $P_{loss} = 8^2 \cdot 0.0156 = 1.0W$

$\Delta T_{\text{Element to Case}} = R_{ec} \cdot P_{loss} \cdot 0.75 \rightarrow 11.3$ [˚C]

$\Delta T_{\text{Element to Lead}} = R_{el} \cdot P_{loss} \cdot 0.25 \rightarrow 9.5$ [˚C]

≈

Measured Value:

11.6 [˚C]

8.9 [˚C]

Rubycon

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HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

Estimating Power Loss

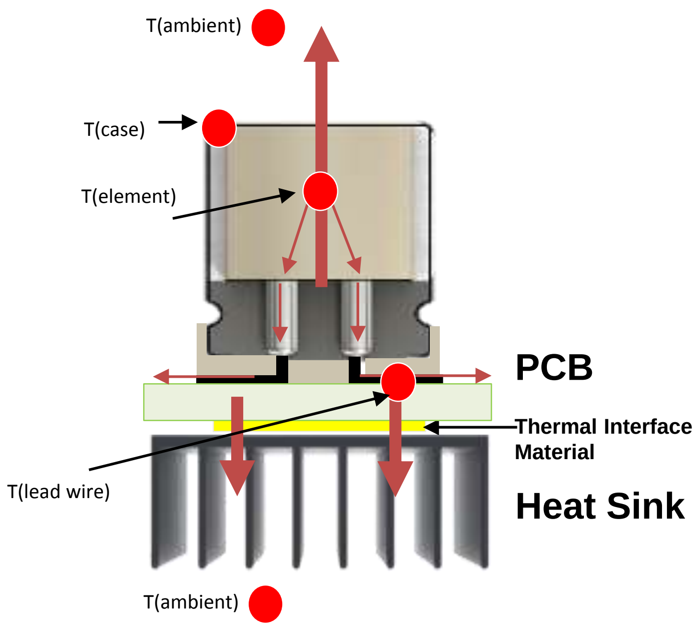
For Varying Ripple Current With Top Heat Sink

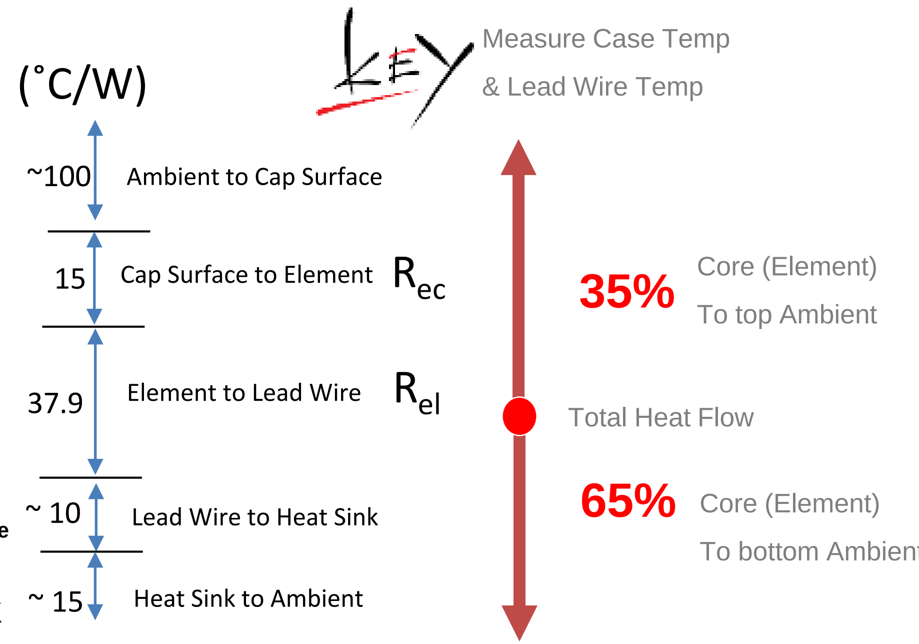
ΔT Element to Case/Lead Wire

PZ-CAP™

Natural Convection

Cooling Method: Bottom Heat Sink





Calculated Value:

I: 8Arms
ESR=*15.6mΩ
*Factory Control Spec

$P_{loss} = I^2 \cdot ESR$ $P_{loss} = 8^2 \cdot 0.016 = 1.0W$

$\Delta T_{\text{Element to Case}} = R_{ec} \cdot P_{loss} \cdot 0.35 \rightarrow 5.3\ [^\circ C]$

$\Delta T_{\text{Element to Lead}} = R_{el} \cdot P_{loss} \cdot 0.65 \rightarrow 24.6\ [^\circ C]$

≈

Measured Value:

6.4 [˚C]

25 [˚C]

65 YEARS Rubycon CAPACITORS

• Quality • Reliability • Precision

Lifetime Table for 25PFV330MBPH10X10.5

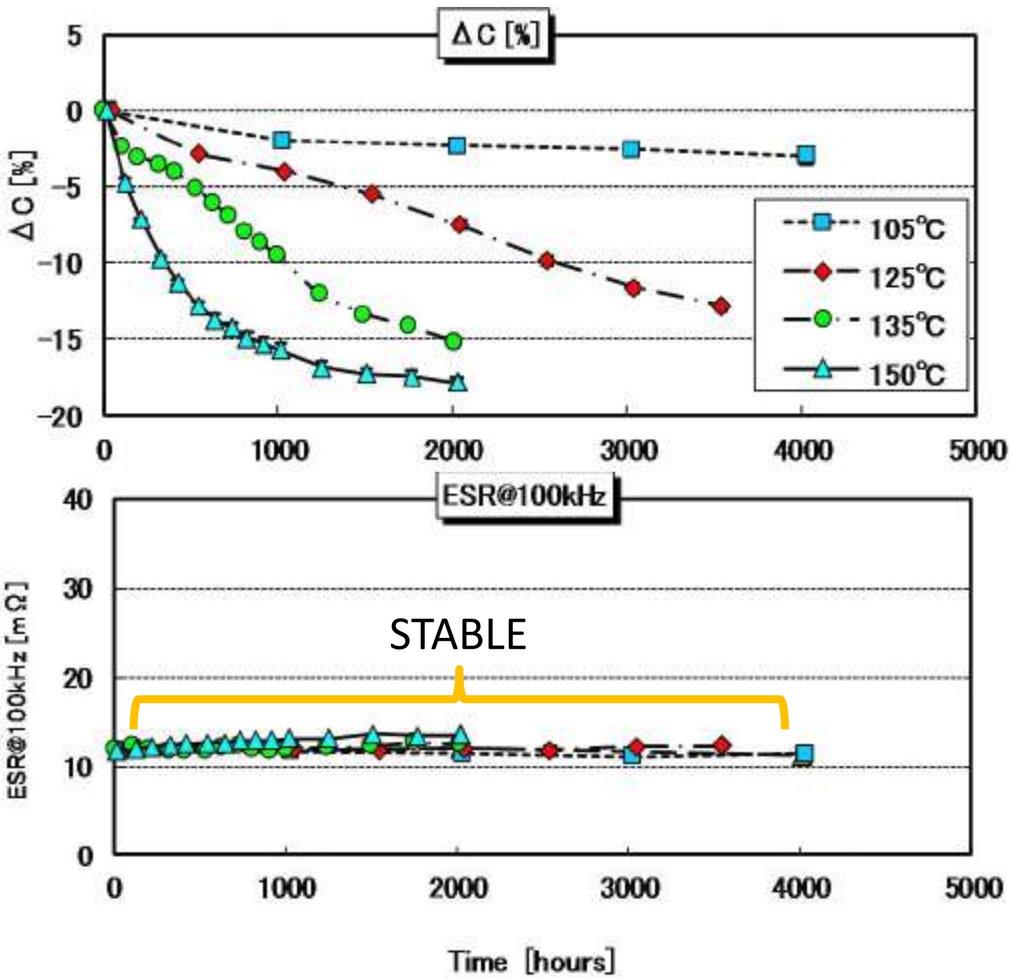
T_b [°C]	Irms @100kHz [A]									
	0	1	2	3	4	5	6	7	8	9
30	3,030,909	3,030,909	3,030,909	3,030,909	3,030,909	3,030,909	3,030,909	3,030,909	2,118,364	1,602,196
40	3,030,909	2,981,525	2,838,149	2,614,347	2,330,356	2,010,077	1,677,776	1,355,148	1,059,182	801,098
50	1,515,454	1,490,763	1,419,075	1,307,173	1,165,178	1,005,038	838,888	677,574	529,591	400,549
60	757,727	745,381	709,537	653,587	582,589	502,519	419,444	338,787	264,795	200,274
70	378,864	372,691	354,769	326,793	291,295	251,260	209,722	169,394	132,398	100,137
80	189,432	186,345	177,384	163,397	145,647	125,630	104,861	84,697	66,199	50,069
90	94,716	93,173	88,692	81,698	72,824	62,815	52,431	42,348	33,099	25,034
95	66,974	65,883	62,715	57,769	51,494	44,417	37,074	29,945	23,405	17,702
100	47,358	46,586	44,346	40,849	36,412	31,407	26,215	21,174	16,550	12,517
105	33,487	32,942	31,357	28,885	25,747	22,208	18,537	14,972	11,702	8,851
110	23,679	23,293	22,173	20,425	18,206	15,704	13,108	10,587	8,275	6,259
115	16,744	16,471	15,679	14,442	12,874	11,104	9,268	7,486	5,851	4,425
120	11,839	11,647	11,087	10,212	9,103	7,852	6,554	5,294	4,137	3,129
125	8,372	8,235	7,839	7,221	6,437	5,552	4,634	3,743	2,926	2,213
130	5,920	5,823	5,543	5,106	4,551	3,926	3,277	2,647	2,069	1,565
135	4,186	4,118	3,920	3,611	3,218	2,776	2,317	1,872	1,463	1,106
140	2,960	2,912	2,772	2,553	2,276	1,963	1,638	1,323	1,034	782
145	2,093	2,059	1,960	1,805	1,609	1,388				
150	1,480	1,456	1,386	0	0	0				

You can universally use the above lifetime table, which is independent of ECU design.

$$|T_c - T_l| \le 5 \Rightarrow T_b = Max(T_c, T_l)$$

$$|T_c - T_l| > 5 \Rightarrow T_b = 0.65T_c + 0.35T_l$$

Measuring the effect on temperature for capacitance & ESR



Item Tested:
25 PFV 330 M 10X10.5

Yes → Capacitance component
No → ESR component

So, end of life characteristic will be based upon the change in capacitance.

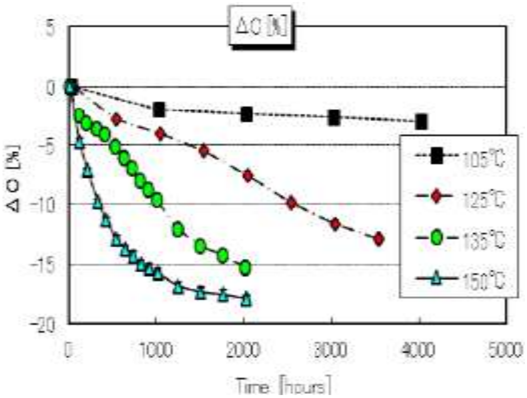
HYBRID TECHNOLOGY

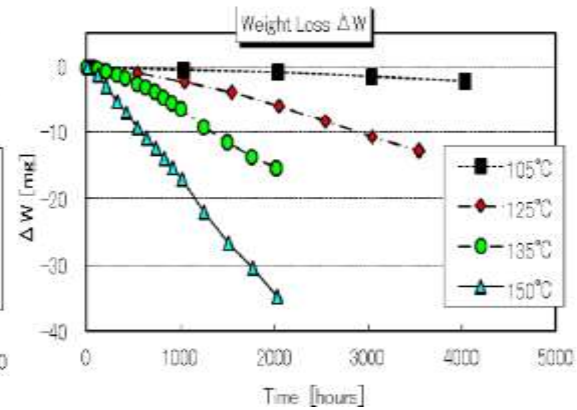
Conductive Polymer Aluminum Solid Hybrid Capacitors

LIFE CALCULATION

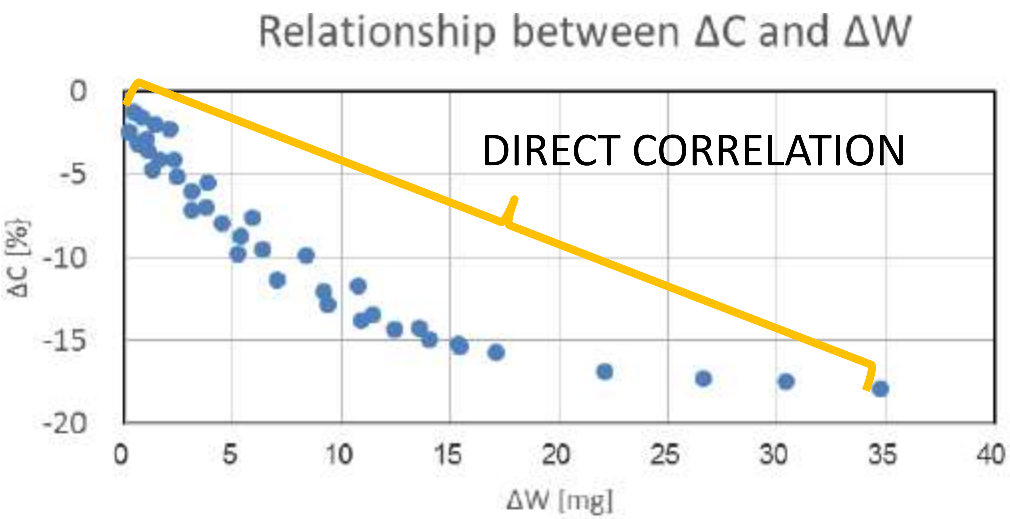
PZ-CAP™

Relationship between capacitance and weight change

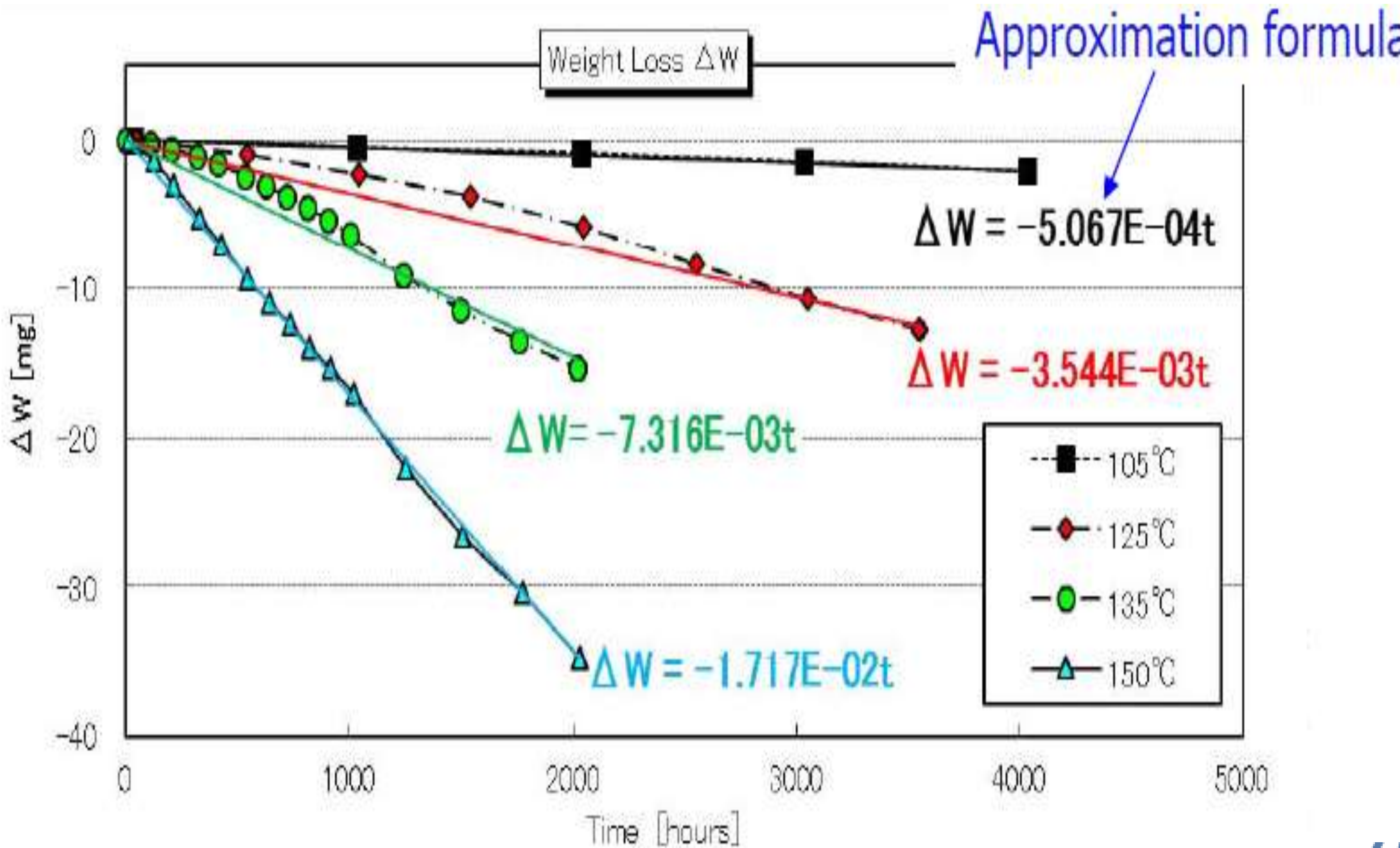




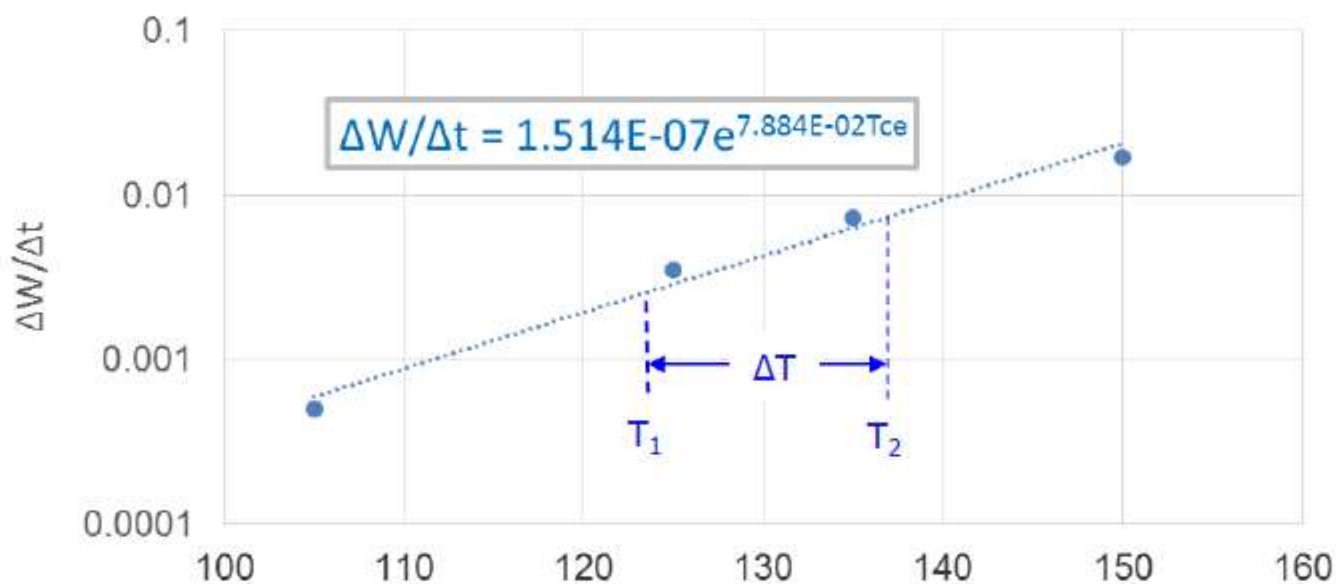
Test Conditions
150ºC
135ºC
125ºC
105ºC



Item Tested:
25 PFV 330 M 10X10.5


Weight Loss ΔW
Approximation formula
ΔW = −5.067E−04t
ΔW = −3.544E−03t
ΔW= −7.316E−03t
ΔW = −1.717E−02t
105℃
125℃
135℃
150℃
0
-10
-20
-30
-40
ΔW [mg]
0
1000
2000
3000
4000
5000
Time [hours]

Every 10ºC drop in temperature results in what life multiplier?



$\alpha(Tce) = Ae^{\beta T_{ce}}$

- α: Dry-up speed @ T_{ce}
- A: Constant value
- T_{ce}: Ambient temperature [°C]
- β: Acceleration factor (7.884×10^{-2})

Dry-up speed ratio (κ(ΔT)) between T_2 and T_1

$$\kappa(\Delta T) = \frac{\alpha(T_2)}{\alpha(T_1)} = \frac{Ae^{\beta T_2}}{Ae^{\beta T_1}} = e^{\beta(T_2 - T_1)} = e^{\beta \Delta T} \cdots ①$$

Law of 10℃ B times

$$\kappa(\Delta T) = B^{\frac{\Delta T}{10}} \cdots ②$$

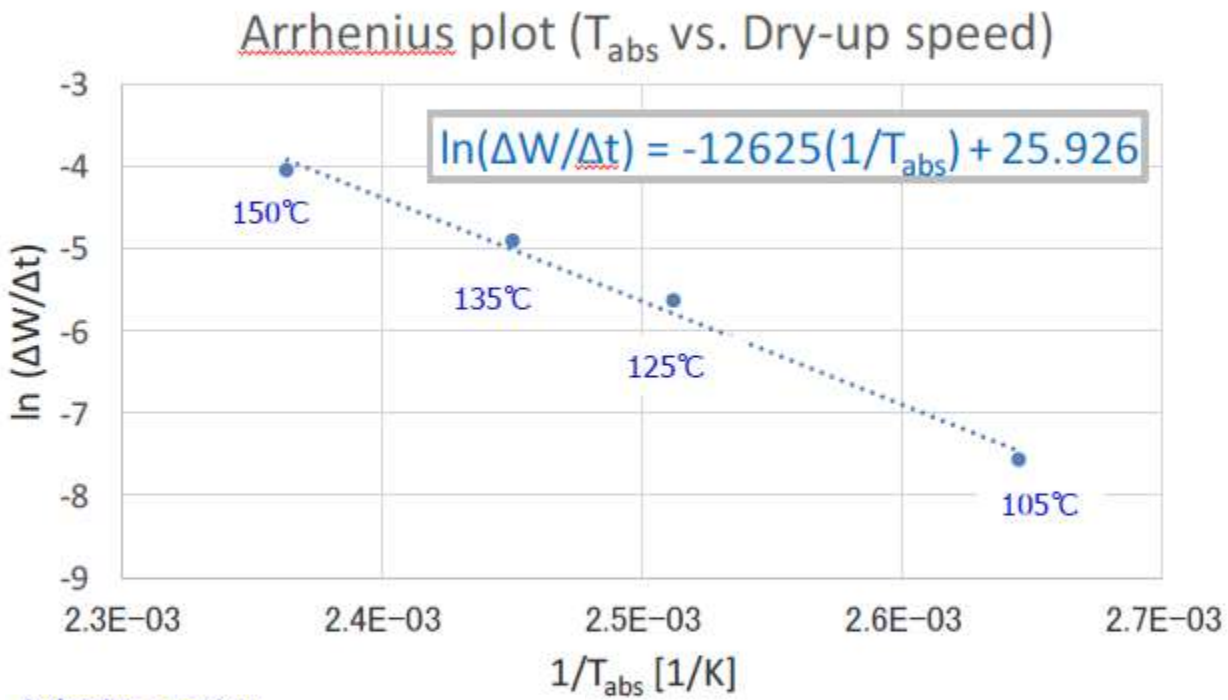
From formula ①&②

$$e^{\beta \Delta T} = B^{\frac{\Delta T}{10}}$$

$$B = e^{10\beta}$$

$$= e^{10 \cdot 7.884 \cdot \times 10^{-2}}$$

$$= 2.20$$



Arrhenius equation

$$K = Ae^{\frac{-E}{RT}}$$

$$lnK = \left(\frac{-E}{R}\right)\frac{1}{T} + lnA \cdots ①$$

Approximation formula from Arrhenius plot

$$ln\left(\frac{\Delta W}{\Delta t}\right) = -12625\frac{1}{T_{abs}} + 25.926 \cdots ②$$

From formula ①&②

$$\left(\frac{-E}{R}\right) = -12625$$

Activation energy

$$E = 12625 \cdot R$$
$$= 12625 \times 8.31$$
$$= 104.9\ [{}^{kJ}/_{mol}]$$

Life Expectancy based upon life @ 150°C

Temperature	150℃	135℃	125℃	105℃
Experimental value	1.0	2.3	4.8	33.9
Law of 10℃ 2.2 times	1.0	3.3	7.2	34.7
Arrhenius' Law	1.0	3.0	6.5	34.9
Law of 10°C 2.0 times	1.0	2.8	5.7	22.6

Life Expectancy based upon life @ 125°C

Temperature	150℃	135℃	125℃	105℃
Experimental value	0.18	0.43	1.0	6.2
Law of 10℃ 2.2 times	0.14	0.45	1.0	4.8
Arrhenius' Law	0.15	0.46	1.0	5.4
Law of 10°C 2.0 times	0.18	0.50	1.0	4.0

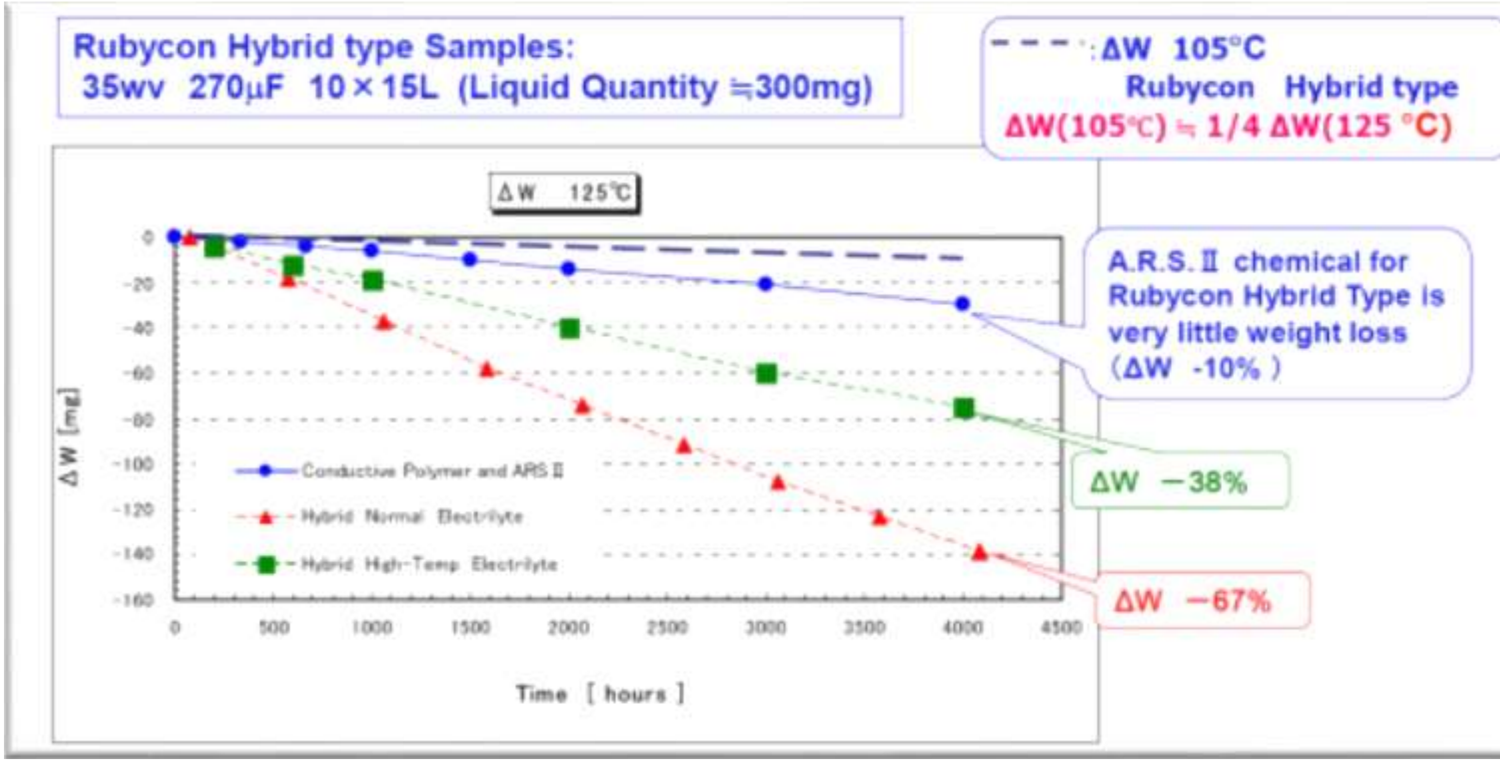
Result: Doubling of life every 10 degree drop
Standard Arrhenius' calculation can be used.

Arrhenius' Formula

$$L = L_b \times 2^{\frac{T_{\max} + \Delta T_o - T_c}{10}}$$

L: Life expectancy under operated condition
L_b: Lifetime at basis temperature
T_{max}: Category upper temperature
ΔT_o : Heat rise by rated ripple current applied
T_c: surface temperature

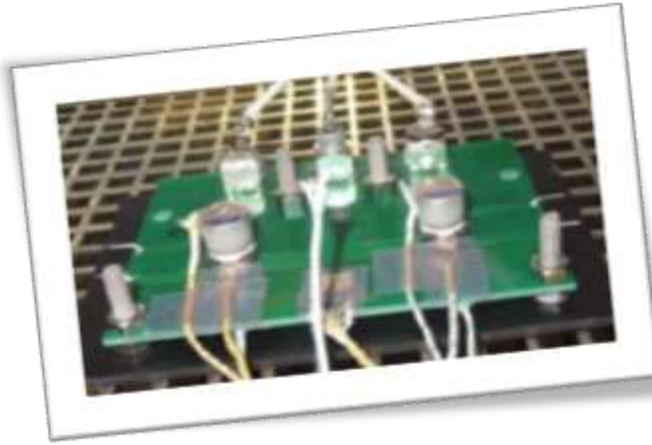
Comparison of liquid loss of Rubycon hybrid polymer vs other hybrid technologies

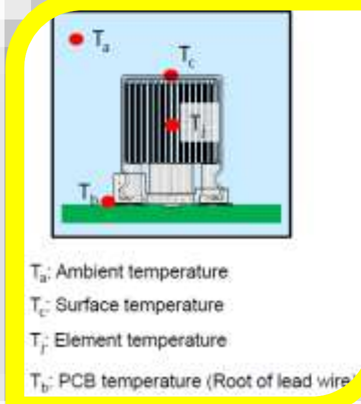


Use Caution as doubling of life with 10 degree drop might not be possible with other hybrids.

THERMAL MODELING

Step 1: Measurement of Temperature With ripple current applied





Actual measurement value

unit: °C

	T_a	T_j	T_c	T_b
4A	84.9	99.2	97.6	93.2
6A	85.0	116.5	112.9	103.0
8A	84.8	143.1	136.1	117.9

TEST ITEM

25PFV330M10X10.5

CATALOG SPECIFICATION
ESR: 20mΩ @ 20◦C, 100KHz
RIPPLE CURRENT: 2Arms/125◦C, 100KHz

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

THERMAL MODELING

Step 2: Thermal Resistance Via Radiation

Basic formula (Stefan-Boltzmann law)

$$Q_{rad} = \sigma \varepsilon A(T_c^{\,4} - T_a^{\,4})$$

$$R_{rad} = \frac{T_c - T_a}{Q_{rad}}$$

R_{rad}: Thermal resistance by radiation [K/W]
T_c: Surface temperature of capacitor (abs [K])
T_a: Ambient temperature of capacitor (abs [K])
Q_{rad}: Thermal radiation from capacitor [W]
σ: thermal emissivity
ε: Stefan-Boltzmann constant (5.67×10^{-8}[$W/m^2 \cdot K^4$])
A: Thermal radiation area [m^2]

σ	Thermal emissivity of plastic material	0.95
ε	Stefan-Boltzmann constant	5.67×10^{-8} $W/m^2 \cdot K^4$
A	Surface area of case	0.000393 m^2
T_c	Actual measurement value (abs 273+97.6)	370.6 K
T_a	Actual measurement value (abs 273+84.9)	357.9 K

$$Q_{rad} = 0.95 \cdot 5.67 \times 10^{-8} \cdot 0.000393(370.6^4 - 357.9^4) = 0.0519\ [W]$$

$$R_{rad} = \frac{370.6 - 357.9}{0.0519} = 245\ [K/W]$$

TEST ITEM

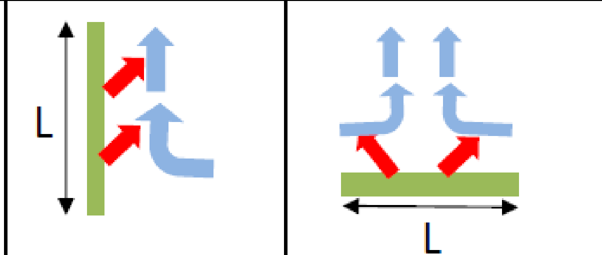
25PFV330M10X10.5

CATALOG SPECIFICATION
ESR: 20mΩ @ 20◦C, 100KHz
RIPPLE CURRENT: 2Arms/125◦C, 100KHz

THERMAL MODELING

Step 3: Thermal Resistance via Convection

R_{con}: Thermal resistance by convection [K/W]
ΔT: Temperature difference between T_c and T_a [K]
Q_{con}: Thermal radiation from capacitor [W]
α: Heat transfer coefficient [W/m²·K]
C: Coefficient by shape
A: Surface area [m²]
L : Characteristic length [m]



	Side area	Top area
C	0.56	0.52
L	0.0097 m	0.0090 m

Basic formula (Newton's law of cooling)

$$Q_{con} = A \cdot \alpha \cdot \Delta T \qquad \alpha = 2.51 \cdot C \cdot \left(\frac{\Delta T}{L}\right)^{0.25}$$

$$Q_{con} = A \cdot 2.51 \cdot C \cdot \left(\frac{1}{L}\right)^{0.25} \cdot \Delta T^{1.25}$$

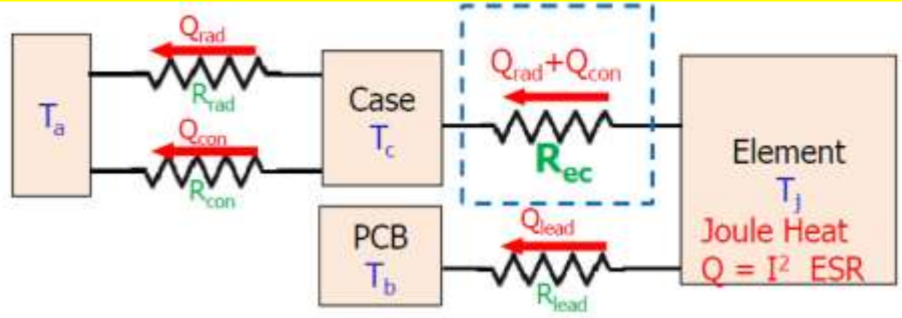
$$R_{con} = \frac{\Delta T}{Q_{con}}$$

	Side area	Top area
A	0.000311 m²	0.000082 m²
C	0.56	0.52
L	0.0097 m	0.0090 m
ΔT	12.7 K	12.7K
Q_{con}	0.0334 W	0.0083 W
Total Q_{con}	0.0417 W	

$$R_{con} = \frac{12.7}{0.0417} = 305\ [K/W]$$

THERMAL MODELING

Step 4: Thermal Resistance Element to Case



$$R_{ec} = \frac{T_j - T_c}{Q_{rad} + Q_{con}}$$

R_{ec}: Thermal resistance between element to case [K/W]
T_c: Surface temperature of capacitor [°C]
T_j: Element temperature of capacitor [°C]
Q_{rad}: Thermal radiation from capacitor [W]
Q_{con}: Thermal convection from capacitor [W]

TEST ITEM

25PFV330M10X10.5

CATALOG SPECIFICATION
ESR: 20mΩ @ 20◦C, 100KHz
RIPPLE CURRENT: 2Arms/125◦C, 100KHz

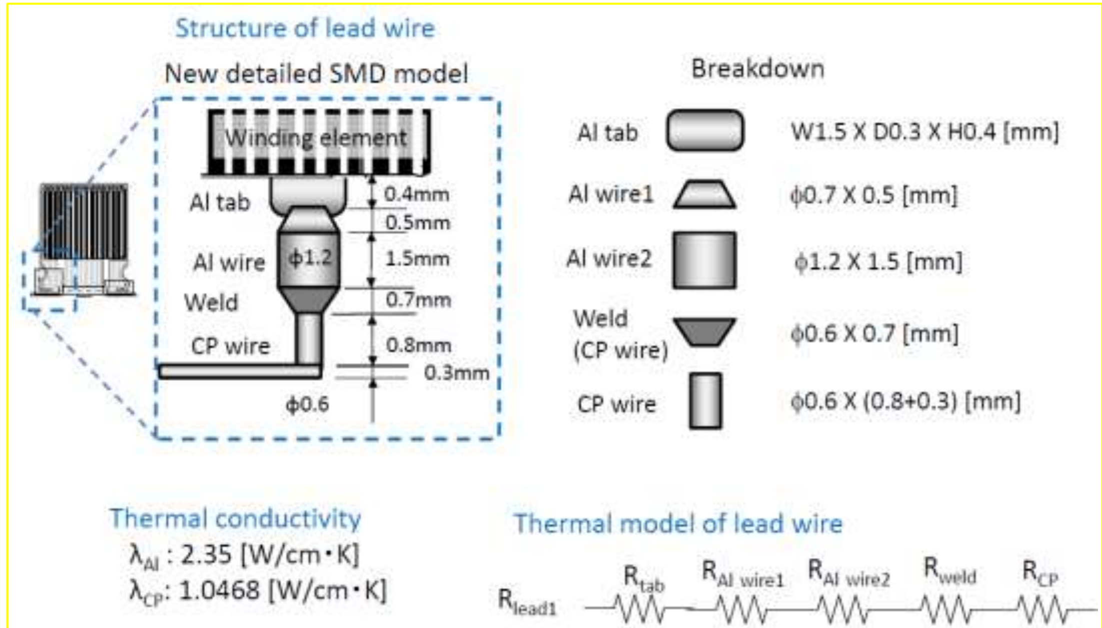
T_j	99.2°C
T_c	97.6°C
Q_{rad}	0.0519 W
Q_{con}	0.0417 W

$$R_{ec} = \frac{99.2 - 97.6}{0.0519 + 0.0417} = 17.1\ [K/W]$$

NEW

THERMAL MODELING

Step 5: Theoretical Calculation Of lead wire resistance



TEST ITEM

25PFV330M10X10.5

CATALOG SPECIFICATION
ESR: 20mΩ @ 20◦C, 100KHz
RIPPLE CURRENT: 2Arms/125◦C, 100KHz

THERMAL MODELING

Step 5: Continued Theoretical Calculation Of lead wire resistance

Breakdown

	Dimensions	Calculation
Al tab	W1.5 X D0.3 X H0.4 [mm]	$R_{Al\ tab} = \frac{0.04}{2.35 \cdot 0.15 \cdot 0.03} = 3.78\ [K/W]$
Al wire1	ϕ0.7 X 0.5 [mm]	$R_{Al\ wire1} = \frac{0.05}{2.35 \cdot \pi \cdot 0.035^2} = 5.53\ [K/W]$
Al wire2	ϕ1.2 X 1.5 [mm]	$R_{Al\ wire2} = \frac{0.15}{2.35 \cdot \pi \cdot 0.06^2} = 5.64\ [K/W]$
Welding (CP wire)	ϕ0.6 X 0.7 [mm]	$R_{Weld} = \frac{0.07}{1.0468 \cdot \pi \cdot 0.03^2} = 23.65[K/W]$
CP wire	ϕ0.6 X (0.8+0.3)[mm]	$R_{CP\ wire} = \frac{0.11}{1.0468 \cdot \pi \cdot 0.03^2} = 37.17\ K/W]$

Lead wire X 2

$$R_{lead} = 37.9[K/W]$$

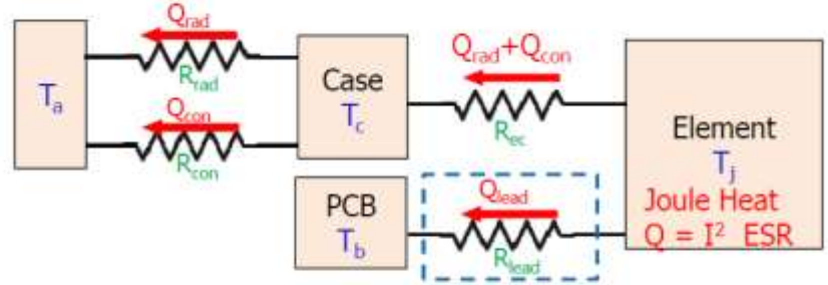
TEST ITEM

25PFV330M10X10.5

CATALOG SPECIFICATION
ESR: 20mΩ @ 20◦C, 100KHz
RIPPLE CURRENT: 2Arms/125◦C, 100KHz

THERMAL MODELING

Step 6: Thermal Energy Flow Via lead terminal



$$Q_{lead} = \frac{T_j - T_b}{R_{lead}}$$

R_{ec}: Thermal resistance between element to case [K/W]
T_c: Surface temperature of capacitor [°C]
T_j: Element temperature of capacitor [°C]
Q_{rad}: Thermal radiation from capacitor [W]
Q_{con}: Thermal convection from capacitor [W]

T_j	99.2°C
T_b	93.2°C
R_{lead}	37.9 W

$$Q_{lead} = \frac{99.2 - 93.2}{37.9} = 0.158\ [W]$$

TEST ITEM

25PFV330M10X10.5

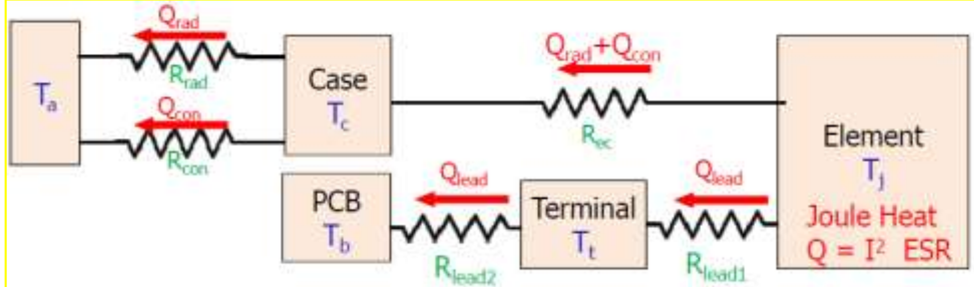
CATALOG SPECIFICATION
ESR: 20mΩ @ 20◦C, 100KHz
RIPPLE CURRENT: 2Arms/125◦C, 100KHz

HYBRID TECHNOLOGY
Conductive Polymer Aluminum Solid Hybrid Capacitors

PZ-CAP™

THERMAL MODELING

Step 7: Compare Actual vs Theoretical for Q -> Calculated vs Actual from ESR and I ripple



Experimentally derived Q

Q_{lead}	0.158 W
Q_{rad}	0.052 W
Q_{con}	0.042 W
Q_{total}	0.252 W

Q derived from ESR and I_{ripple}

$ESR_{estimated}$	14.7m Ω/120Hz,99°C
I_{ripple}	4.0Arms/100kHz
Q_{total}	0.235 W

TEST ITEM

25PFV330M10X10.5

CATALOG SPECIFICATION
ESR: 20mΩ @ 20◦C, 100KHz
RIPPLE CURRENT: 2Arms/125◦C, 100KHz

• Quality • Reliability • Precision

Rubycon

hYBRID ARS II™ technology

HYBRID TECHNOLOGY

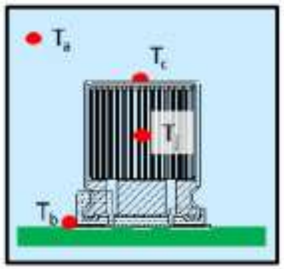
Conductive Polymer Aluminum Solid Hybrid Capacitors

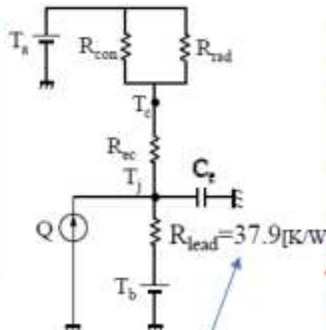
PZ-CAP™

THERMAL RESISTANCE

Rubycon Hybrid Type φ10x10.5

Thermal model





Condition

Unit: ℃

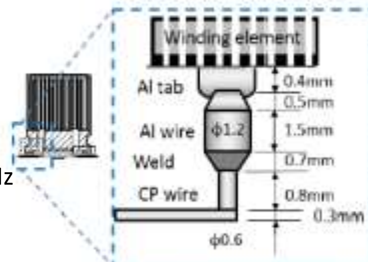
	T_a	T_j	T_c	T_b
4A	84.9	99.2	97.6	93.2
6A	85.0	116.5	112.9	103.0
8A	84.8	143.1	136.1	117.9

Thermal resistance & Thermal energy

Applied ripple [Arms/120Hz]		4A	6A	8A
R_{lead1} [K/W]		37.9		
R_{rad} [K/W]		245	229	209
R_{con} [K/W]		305	250	215
R_{ec} [K/W]		17.1	15.4	14.5
Q_{total} [W]	$Q_{con+rad+lead}$	0.252	0.589	1.15
	$ESR*I^2$	0.235	0.558	1.06

Structure of lead wire

New detailed SMD model



$R_{lead} = 37.9[K/W]$

TEST ITEM

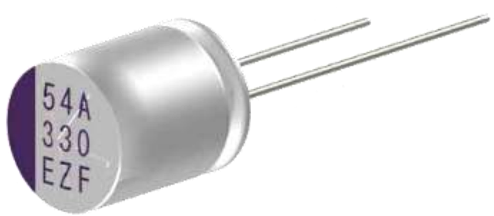
25PFV330M10X10.5

CATALOG SPECIFICATION

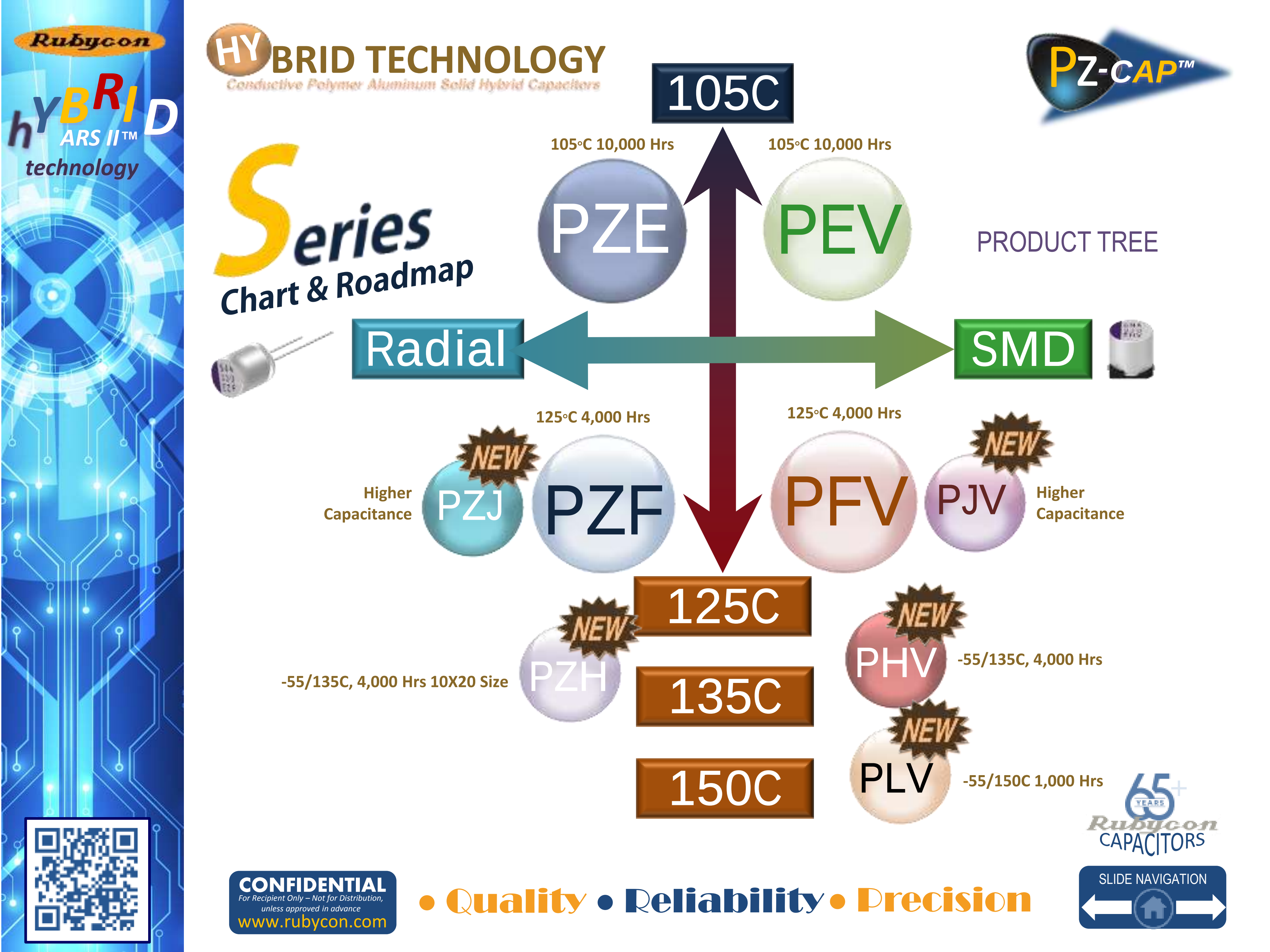
ESR: 20mΩ @ 20◦C, 100KHz

RIPPLE CURRENT: 2Arms/125◦C, 100KHz

THERMAL CAPACITANCE



SMD 10X10.5	: 1.88 J/K (Ce: 0.88J/K , Cc: 0.31J/K)
SMD 10X12.5	: 2.25J/K (Ce: 1.14J/K , Cc: 0.35J/K)
THT 10X9	: 1.69 J/K (Ce: 0.88J/K , Cc: 0.31J/K)
THT 10X11	: 2.06J/K (Ce: 1.14J/K , Cc: 0.35J/K)
THT 10X20	: 3.50J/K (Ce: 2.33J/K , Cc: 0.58J/K)


Rubycon
hYBRID
ARS II™
technology
HYBRID TECHNOLOGY
Conductive Polymer Aluminum Solid Hybrid Capacitors
Series
Chart & Roadmap
PZ-CAP™
105C
105◦C 10,000 Hrs
PZE
105◦C 10,000 Hrs
PEV
PRODUCT TREE
Radial
SMD
125◦C 4,000 Hrs
125◦C 4,000 Hrs
NEW
PZJ
Higher Capacitance
PZF
PFV
NEW
PJV
Higher Capacitance
125C
NEW
PZH
-55/135C, 4,000 Hrs 10X20 Size
135C
NEW
PHV
-55/135C, 4,000 Hrs
NEW
PLV
-55/150C 1,000 Hrs
150C
65+ YEARS
Rubycon CAPACITORS
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• Quality • Reliability • Precision
SLIDE NAVIGATION

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PZ-CAP™

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PRODUCT MASTER (Radial Type)

25-63v Options

Click for Data Sheet

Radial	Temp
PZE SERIES	105°C
PZF SERIES	125°C
PZJ SERIES	125°C
PZH SERIES	135°C

[1] Sample/Release Schedule may be adjusted without notice.

[V]	Series	[µF]	φD×L [mm]	[mΩ] 100KHz 20°C	[mA] @ Max Ambient	Type	Max Ambient °C	AECQ200 Samples	Mass Production
25	PZE	220	8 x 9	27	2300	RADIAL	105	Available	Available
25	PZF	220	8 x 9	27	1600	RADIAL	125	Available	Available
25	PZJ	270	8 x 9	25	1920	RADIAL	125	Available	Available
25	PZE	330	10 x 9	20	2500	RADIAL	105	Available	Available
25	PZF	330	10 x 9	20	2000	RADIAL	125	Available	Available
25	PZF	470	10 x 11	14	2600	RADIAL	125	Available	Dec 2019
25	PZJ	470	10 x 9	20	2800	RADIAL	125	Available	Available
25	PZJ	560	10 x 11	14	3200	RADIAL	125	Available	Dec 2019
25	PZH	820	10 x 20	12	3000	RADIAL	135	Available	Dec 2019
25	PZF	820	10 x 20	12	3000	RADIAL	125	Available	Dec 2019
35	PZE	150	8 x 9	27	2300	RADIAL	105	Available	Available
35	PZF	150	8 x 9	27	1600	RADIAL	125	Available	Available
35	PZJ	180	8 x 9	25	1920	RADIAL	125	Available	Available
35	PZE	270	10 x 9	20	2500	RADIAL	105	Available	Available
35	PZF	270	10 x 9	20	2000	RADIAL	125	Available	Available
35	PZF	330	10 x 11	14	2600	RADIAL	125	Available	Dec 2019
35	PZJ	330	10 x 9	20	2800	RADIAL	125	Available	Available
35	PZJ	390	10 x 11	14	3200	RADIAL	125	Available	Dec 2019
35	PZH	680	10 x 20	12	3000	RADIAL	135	Available	Dec 2019
35	PZF	680	10 x 20	12	3000	RADIAL	125	Available	Dec 2019
50	PZE	68	8 x 9	30	1800	RADIAL	105	Available	Available
50	PZF	68	8 x 9	30	1250	RADIAL	125	Available	Available
50	PZF	100	10 x 9	28	1600	RADIAL	125	Available	Available
50	PZE	100	10 x 9	28	2000	RADIAL	105	Available	Available
50	PZF	150	10 x 11	22	2000	RADIAL	125	Available	Dec 2019
50	PZH	220	10 x 20	16	2500	RADIAL	135	Available	Dec 2019
50	PZF	220	10 x 20	16	2500	RADIAL	125	Available	Dec 2019
63	PZE	33	8 x 9	40	1700	RADIAL	105	Available	Available
63	PZF	33	8 x 9	40	1100	RADIAL	125	Available	Available
63	PZE	56	10 x 9	30	1800	RADIAL	105	Available	Available
63	PZF	56	10 x 9	30	1400	RADIAL	125	Available	Available
63	PZF	68	10 x 11	24	1800	RADIAL	125	Available	Dec 2019
63	PZH	150	10 x 20	18	2200	RADIAL	135	Available	Dec 2019
63	PZF	150	10 x 20	18	2200	RADIAL	125	Available	Dec 2019

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PZ-CAP™

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PRODUCT MASTER

(SMD Options)

25-35v Options,

50-80v Next Page

Click for Data Sheet

Temp	SMD
105°C	PEV SERIES
125°C	PFV SERIES
125°C	PJV SERIES
135°C	PHV SERIES
150°C	PLV SERIES

[1] Sample/Release Schedule may be adjusted without notice.

[V]	Series	[µF]	ϕDxL [mm]	[mΩ] 100KHz 20°C	[mA] @ Max Ambient	Type	Max Ambient °C	AECQ200 Samples	Mass Prod.
25	PEV	56	6.3 x 6.1	50	1300	SMD	105	Available	Available
25	PFV	56	6.3 x 6.1	50	900	SMD	125	Available	Available
25	PHV	56	6.3 x 6.1	50	900	SMD	135	Available	Available
25	PJV	68	6.3 x 6.1	50	1080	SMD	125	Available	Jan-19
25	PEV	100	6.3 x 8	30	2000	SMD	105	Available	Available
25	PFV	100	6.3 x 8	30	1400	SMD	125	Available	Available
25	PHV	100	6.3 x 8	30	1400	SMD	135	Available	Available
25	PLV	150	8 x 10.5	27	1400	SMD	150	Available	Jan-19
25	PJV	150	6.3 x 8	30	1680	SMD	125	Available	Available
25	PEV	220	8 x 10.5	27	2300	SMD	105	Available	Available
25	PFV	220	8 x 10.5	27	1600	SMD	125	Available	Available
25	PHV	220	8 x 10.5	22	1600	SMD	135	Available	Available
25	PJV	270	8 x 10.5	25	1920	SMD	125	Available	Available
25	PLV	270	10 x 10.5	20	1800	SMD	150	Available	Jan-19
25	PEV	330	10 x 10.5	20	2500	SMD	105	Available	Available
25	PFV	330	10 x 10.5	20	2000	SMD	125	Available	Available
25	PHV	330	10 x 10.5	20	2000	SMD	135	Available	Available
25	PJV	470	10 x 10.5	20	2800	SMD	125	Available	Available
25	PFV	470	10 x 12.5	14	2600	SMD	125	Available	Dec 2019
25	PHV	470	10 x 12.5	14	4100	SMD	135	Available	Dec 2019
25	PJV	560	10 x 12.5	14	3200	SMD	125	Available	Dec 2019
35	PEV	47	6.3 x 6.1	60	1300	SMD	105	Available	Available
35	PFV	47	6.3 x 6.1	60	900	SMD	125	Available	Available
35	PHV	47	6.3 x 6.1	60	900	SMD	135	Available	Available
35	PJV	56	6.3 x 6.1	50	1080	SMD	125	Available	Jan-19
35	PEV	68	6.3 x 8	35	2000	SMD	105	Available	Available
35	PFV	68	6.3 x 8	35	1400	SMD	125	Available	Available
35	PHV	68	6.3 x 8	35	1400	SMD	135	Available	Available
35	PLV	100	8 x 10.5	27	1400	SMD	150	Available	Jan-19
35	PJV	100	6.3 x 8	30	1680	SMD	125	Available	Jan-19
35	PEV	150	8 x 10.5	27	2300	SMD	105	Available	Available
35	PFV	150	8 x 10.5	27	1600	SMD	125	Available	Available
35	PHV	150	8 x 10.5	22	1600	SMD	135	Available	Available
35	PLV	150	10 x 10.5	20	1800	SMD	150	Available	Jan-19
35	PJV	180	8 x 10.5	25	1920	SMD	125	Available	Available
35	PEV	270	10 x 10.5	20	2500	SMD	105	Available	Available
35	PFV	270	10 x 10.5	20	2000	SMD	125	Available	Available
35	PHV	270	10 x 10.5	20	2000	SMD	135	Available	Available
35	PJV	330	10 x 10.5	20	2800	SMD	125	Available	Available
35	PFV	330	10 x 12.5	14	2600	SMD	125	Available	Dec 2019
35	PHV	330	10 x 12.5	14	2300	SMD	135	Available	Dec 2019
35	PJV	390	10 x 12.5	14	3200	SMD	125	Available	Dec 2019

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PZ-CAP™

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PRODUCT MASTER

(SMD Options)

50-80v

Click for Data Sheet

Temp	SMD
105°C	PEV SERIES
125°C	PFV SERIES
125°C	PJV SERIES
135°C	PHV SERIES
150°C	PLV SERIES

[1] Sample/Release Schedule may be adjusted without notice.

[V]	Series	[µF]	ϕDxL [mm]	[mΩ] 100KHz 20°C	[mA] @ Max Ambient	Type	Max Ambient °C	AECQ200 Samples	Mass Prod.
50	PEV	22	6.3 x 6.1	80	1100	SMD	105	Available	Available
50	PFV	22	6.3 x 6.1	80	750	SMD	125	Available	Available
50	PEV	33	6.3 x 8	40	1600	SMD	105	Available	Available
50	PFV	33	6.3 x 8	40	1100	SMD	125	Available	Available
50	PLV	56	8 x 10.5	35	1000	SMD	150	Sep-18	Jan-19
50	PEV	68	8 x 10.5	30	1800	SMD	105	Available	Available
50	PFV	68	8 x 10.5	30	1250	SMD	125	Available	Available
50	PHV	68	8 x 10.5	30	1250	SMD	135	Available	Available
50	PEV	100	10 x 10.5	28	2000	SMD	105	Available	Available
50	PFV	100	10 x 10.5	28	1600	SMD	125	Available	Available
50	PLV	100	10 x 10.5	28	1300	SMD	150	Sep-18	Jan-19
50	PHV	100	10 x 10.5	28	1600	SMD	135	Available	Available
50	PFV	150	10 x 12.5	22	2000	SMD	125	Available	Dec 2019
63	PEV	10	6.3 x 6.1	120	1000	SMD	105	Available	Available
63	PFV	10	6.3 x 6.1	120	700	SMD	125	Available	Available
63	PEV	22	6.3 x 8	80	1500	SMD	105	Available	Available
63	PFV	22	6.3 x 8	80	900	SMD	125	Available	Available
63	PEV	33	8 x 10.5	40	1700	SMD	105	Available	Available
63	PFV	33	8 x 10.5	40	1100	SMD	125	Available	Available
63	PLV	33	8 x 10.5	40	900	SMD	150	Sep-18	Jan-19
63	PHV	33	8 x 10.5	40	1100	SMD	135	Available	Available
63	PJV	47	8 x 10.5	35	1550	SMD	125	Available	Available
63	PEV	56	10 x 10.5	30	1800	SMD	105	Available	Available
63	PFV	56	10 x 10.5	30	1400	SMD	125	Available	Available
63	PLV	56	10 x 10.5	30	1100	SMD	150	Sep-18	Jan-19
63	PHV	56	10 x 10.5	30	1400	SMD	135	Available	Available
63	PFV	68	10 x 12.5	24	1800	SMD	125	Available	Dec 2019
63	PJV	82	10 x 10.5	28	2300	SMD	125	Available	Available
63	PJV	100	10 x 10.5	22	3000	SMD	125	Available	Available
80	PFV	22	8 x 10.5	45	1100	SMD	125	Available	Jan-19
80	PFV	39	10 x 10.5	35	1200	SMD	125	Available	Jan-19

INTERNAL ONLY

Rubycon

hYBRID ARS II™ technology

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PZE Series

PZ-CAP™

105°C

AEC-Q200

featuring:

- AECQ-200
- AUTOMOTIVE GRADE
- HIGH VIBRATION
- LONG LIFE
- REVERSE BATTERY
- LOAD DUMP
- DOUBLE RIPPLE OPERATION[1]

options:

- 25-63 VDC
- 33-330 µFd
- 8-10 mm Dia
- 20-40 mΩ

applications:

- POWER
- AUTOMOTIVE
- INDUSTRIAL

TEMPERATURE RANGE	-55°C to +105°C
LIFE (ENDURANCE)- HRS	10,000 @ 105°C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/°C)

Rubycon's PZE series conductive polymer (hybrid) capacitors are designed for applications requiring ultra miniaturization with high temperature/performance endurance.

Designed to operate in extreme environments with excellent low temperature characteristics.

Double Ripple Current operational testing can be provided upon request.[1]

Specifications:

ARS II™ technology

Rated Voltage [V]	Capacitance [µF]	Size (mm) D x L	E. S.R.[mΩ] /100kHz, 20°C	Rated Ripple Current [mA] /100kHz,105°C
25	220	8 x 9	27	2300
	330	10 x 9	20	2500
35	150	8 x 9	27	2300
	270	10 x 9	20	2500
50	68	8 x 9	30	1800
	100	10 x 9	28	2000
63	33	8 x 9	40	1700
	56	10 x 9	30	1800

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65+ YEARS Rubycon CAPACITORS

INTERNAL ONLY

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hYBRID ARS II™ technology

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PZF Series

125°C

PZ-CAP™

featuring:

- AECQ-200
- AUTOMOTIVE GRADE
- HIGH VIBRATION
- LONG LIFE
- REVERSE BATTERY
- LOAD DUMP
- DOUBLE RIPPLE OPERATION[1]

options:

- 25-63 VDC
- 33-330 μFd
- 8-10 mm Dia
- 20-40 mΩ

AEC-Q200

applications:

- POWER
- AUTOMOTIVE
- INDUSTRIAL

TEMPERATURE RANGE	-55°C to +125°C
LIFE (ENDURANCE)- HRS	4,000 @ 125°C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/°C)

ARS II™ technology

Rubycon's PZF series conductive polymer (hybrid) capacitors are designed for applications requiring ultra miniaturization with high temperature/performance endurance.

Designed to operate in extreme environments with excellent low temperature characteristics.

Double Ripple Current operational testing can be provided upon request.[1]

Specifications:

Rated Voltage [V]	Capacitance [μF]	Size (mm) D x L	E. S.R.[mΩ] /100kHz, 20°C	Rated Ripple Current [mA] /100kHz,125°C
25	220	8 x 9	27	1600
	330	10 x 9	20	2000
	470[1]	10x11	14	2600
	820[2]	10x20	12	3000
35	150	8 x 9	27	1600
	270	10 x 9	20	2000
	330[1]	10x11	14	2600
	680[2]	10x20	12	3000
50	68	8 x 9	30	1250
	100	10 x 9	28	1600
	150[1]	10x11	22	2000
	220[2]	10x20	16	2500
63	33	8 x 9	40	1100
	56	10 x 9	30	1400
	68[1]	10x11	24	1800
	150[2]	10x20	18	2200

65+ YEARS Rubycon CAPACITORS

Under Development (Tentative Spec)
[1],[2] SOP/Sample Schedule
See Product Master

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• Quality • Reliability • Precision

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hYBRID ARS II™ technology

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

125°C

AEC-Q200

PZ-CAP™

NEW

TEMPERATURE RANGE	-55°C to +125°C
LIFE (ENDURANCE)- HRS	4,000 @ 125°C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/°C)

pzj Series pjv Series

PZJ

RADIAL

PJV

SMD

Options:
- 25-35 VDC
- 180-560 µFd
- 8-10 mm Dia
- 14-25 mΩ

Applications:
- POWER
- AUTOMOTIVE
- INDUSTRIAL

Rated Voltage [V]	Capacitance [µF]	Size (mm) D x L PJV	Size (mm) D x L PZJ	E. S.R. [mΩ] 100kHz 20°C	Rated RC [mA] 100kHz 125°C
25	68[1]	6.3x6.1	-	50	1080
	150[1]	6.3x8	-	30	1680
	270	8x10.5	8X9	25	1920
	470	10x10.5	10X9	20	2800
	560[2]	10x12.5	10X11	14	3200
35	56[1]	6.3x6.1	-	50	1080
	100[1]	6.3x8	-	30	1680
	180	8x10.5	8X9	25	1920
	330	10x10.5	10X9	20	2800
	390[2]	10X12.5	10X11	14	3200
63	47[3]	8x10.5		35	1550
	82[3]	10x10.5		28	2300
	100[3]	10x12.5		22	3000

Under Development (Tentative Spec)
[1],[2],[3] SOP/Sample Schedule
See Product Master

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65+ YEARS Rubycon CAPACITORS

• Quality • Reliability • Precision

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hYBRID ARS II™ technology

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PZH Series

NEW

PZ-CAP™

featuring: ARS II™ technology

- AECQ-200
- AUTOMOTIVE GRADE
- HIGH VIBRATION
- LONG LIFE
- REVERSE BATTERY
- LOAD DUMP
- DOUBLE RIPPLE OPERATION³

options:

- 25-63 VDC
- 150-820 µFd
- 10x20 mm Size
- 12-18 mΩ

applications:

- POWER
- AUTOMOTIVE
- INDUSTRIAL

150◦C ,300 Hours

135°C

AEC-Q200

specifications:

TEMPERATURE RANGE	-55◦C to +135◦C
LIFE (ENDURANCE)- HRS	4,000 @ 135◦C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/◦C)

Rubycon's PZH series conductive polymer (hybrid) capacitors are designed for applications requiring ultra miniaturization with high temperature/performance endurance.

Designed to operate in extreme environments with excellent low temperature characteristics.

Double Ripple Current operational testing can be provided upon request. ³

Rated Voltage [V]	Capacitance [µF]	Size (mm) D x L	ESR [mΩ] 100kHz 20°C	Rated Ripple Current [mA] 100kHz 125°C 4,000 Hours	Rated Ripple Current [mA] 100kHz 135°C 4,000 Hours
25	820	10x20	12	5400	3000
35	680	10x20	12	5400	3000
50	220	10x20	16	4500	2500
63	150	10x20	18	4000	2200

SOP/Sample Schedule
See Product Master

CLICK FOR PRODUCT MASTER

65+ YEARS Rubycon CAPACITORS

• Quality • Reliability • Precision

INTERNAL ONLY

Rubycon

hYBRID ARS II™ technology

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PeV Series

PZ-CAP™

105°C

AEC-Q200

featuring:

- AECQ-200
- AUTOMOTIVE GRADE
- HIGH VIBRATION
- LONG LIFE
- REVERSE BATTERY
- LOAD DUMP
- DOUBLE RIPPLE OPERATION[1]

options:

- 25-63 VDC
- 33-330 µFd
- 8-10 mm Dia
- 20-40 mΩ

applications:

- POWER
- AUTOMOTIVE
- INDUSTRIAL

specifications:

TEMPERATURE RANGE	-55°C to +105°C
LIFE (ENDURANCE)- HRS	10,000 @ 105°C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/°C)

Rubycon's PeV series conductive polymer (hybrid) capacitors are designed for applications requiring ultra miniaturization with high temperature/performance endurance.

Designed to operate in extreme environments with excellent low temperature characteristics.

Double Ripple Current operational testing can be provided upon request.[1]

Volt [V]	Cap. [µF]	Size ϕD × L [mm]	ESR [mΩ] 100KHz 20°C	ESR [mΩ] 100KHz -40°C	Ripple [mA] 105°C
25	56	6.3 x 6.1	50	75	1300
	100	6.3 x 8	30	45	2000
	220	8 x 10.5	27	41	2300
	330	10 x 10.5	20	30	2500
35	47	6.3 x 6.1	60	90	1300
	68	6.3 x 8	35	53	2000
	150	8 x 10.5	27	41	2300
	270	10 x 10.5	20	30	2500

Volt [V]	Cap. [µF]	Size ϕD × L [mm]	ESR [mΩ] 100KHz 20°C	ESR [mΩ] 100KHz -40°C	Ripple [mA] 105°C
50	22	6.3 x 6.1	80	120	1100
	33	6.3 x 8	40	60	1600
	68	8 x 10.5	30	45	1800
	100	10 x 10.5	28	42	2000
63	10	6.3 x 6.1	120	180	1000
	22	6.3 x 8	80	120	1500
	33	8 x 10.5	40	60	1700
	56	10 x 10.5	30	45	1800

DESIGNED FOR RELIABILITY… SINCE 1952 THE EXPERTS IN CAPACITORS

CLICK FOR PRODUCT MASTER

6.3 SIZE NEW

65 YEARS Rubycon CAPACITORS

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HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

AEC-Q200

PZ-CAP™

CLICK FOR PRODUCT MASTER

pfv Series

125°C

featuring:

- AECQ-200
- AUTOMOTIVE GRADE
- HIGH VIBRATION
- LONG LIFE
- REVERSE BATTERY
- LOAD DUMP
- DOUBLE RIPPLE OPERATION[1]

options:

- 25-80* VDC
- 10-470 µFd
- 6.3-10 mm DIA
- 14-120 mΩ

Rubycon's PFV series conductive polymer (hybrid) capacitors are designed for applications requiring ultra miniaturization with high temperature/performance endurance. Designed to operate in extreme environments with excellent low temperature characteristics.

applications:

- POWER
- AUTOMOTIVE
- INDUSTRIAL

TEMPERATURE RANGE	-55°C to +125°C
LIFE (ENDURANCE)- HRS	4,000 @ 125°C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/°C)

ARS II™ technology

65 YEARS Rubycon CAPACITORS

Leakage Current
RUBYCON 4.4µA
HXA: 9.5µA

ESR
RUBYCON 10.9mΩ[1]
ZC 18.7mΩ[1] Measured

Rated Voltage [V]	Capacitance [µF]	Size (mm) D x L	E. S.R.[mΩ] /100kHz, 20°C	Rated Ripple Current [mA] /100kHz,125°C [1]
25	56	6.3x6.1	50	900
	100	6.3x8	30	1400
	220	8 x 10.5	27	1600
	330	10 x 10.5	20	2000
	470*	10x12.5	14	2600
35	47	6.3x6.1	60	900
	68	6.3x8	35	1400
	150	8 x 10.5	27	1600
	270	10 x 10.5	20	2000
	330*	10x12.5	14	2600
50	22	6.3x6.1	80	750
	33	6.3x8	40	1100
	68	8 x 10.5	30	1250
	100	10 x 10.5	28	1600
	150*	10X12.5	22	2000
63	10	6.3x6.1	120	700
	22	6.3x8	80	900
	33	8 x 10.5	40	1100
	56	10 x 10.5	30	1400
	68*	10X12.5	24	1800
80	22*	8x10.5	45	1100
	39*	10x10.5	35	1200

• Quality • Reliability • Precision

INTERNAL ONLY

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hYBRID ARS II™ technology

HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

125°C

PZ-CAP™

pzj Series pjv Series

NEW

AEC-Q200

TEMPERATURE RANGE	-55°C to +125°C
LIFE (ENDURANCE)- HRS	4,000 @ 125°C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/°C)

PZJ RADIAL PJV SMD

Options:

- 25-35 VDC
- 180-560 µFd
- 8-10 mm Dia
- 14-25 mΩ

Applications:

- POWER
- AUTOMOTIVE
- INDUSTRIAL

Rated Voltage [V]	Capacitance [µF]	Size (mm) D x L PJV	Size (mm) D x L PZJ	E. S.R. [mΩ] 100kHz 20°C	Rated RC [mA] 100kHz 125°C
25	68[1]	6.3x6.1	-	50	1080
	150[1]	6.3x8	-	30	1680
	270	8x10.5	8X9	25	1920
	470	10x10.5	10X9	20	2800
	560[2]	10x12.5	10X11	14	3200
35	56[1]	6.3x6.1	-	50	1080
	100[1]	6.3x8	-	30	1680
	180	8x10.5	8X9	25	1920
	330	10x10.5	10X9	20	2800
	390[2]	10X12.5	10X11	14	3200

Under Development (Tentative Spec)
[1,2] SOP/Sample Schedule
See Product Master

CLICK FOR PRODUCT MASTER

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HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

NEW phv Series

PZ-CAP™

featuring: ARS II™ technology

- AECQ-200
- AUTOMOTIVE GRADE
- HIGH VIBRATION
- LONG LIFE
- REVERSE BATTERY
- LOAD DUMP
- DOUBLE RIPPLE OPERATION[3]

options:

- 25-63 VDC
- 33-470 µFd
- 6-10 mm Dia
- 14-60 mΩ

applications:

- POWER
- AUTOMOTIVE
- INDUSTRIAL

150◦C ,300 Hours

135°C

AEC-Q200

specifications:

TEMPERATURE RANGE	-55◦C to +135◦C
LIFE (ENDURANCE)- HRS	4,000 @ 135◦C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/◦C)

Rubycon's PHV series conductive polymer (hybrid) capacitors are designed for applications requiring ultra miniaturization with high temperature/performance endurance.

Designed to operate in extreme environments with excellent low temperature characteristics.

Double Ripple Current operational testing can be provided upon request.[3]

Rated Voltage [V]	Capacitance [µF]	Size (mm) D x L	ESR [mΩ] 100kHz 20°C	ESR [mΩ] 100kHz -40°C	Rated Ripple Current [mA] 100kHz 125°C 4,000 Hours	Rated Ripple Current [mA] 100kHz 135°C 4,000 Hours
25	56	6.3x6.1	50		1400	900
	100	6.3x8	30		2200	1400
	220	8 x 10.5	22	33	2900	1600
	330	10 x 10.5	20	30	3600	2000
	470[1]	10x12.5	14		2300	4100
35	47	6.3x6.1	60		1400	900
	68	6.3x8	35		2200	1400
	150	8 x 10.5	22	33	2900	1600
	270	10 x 10.5	20	30	3600	2000
	330[1]	10x12.5	14		4100	2300
50	68[2]	8x10.5	30		2300	1250
	100[2]	10x10.5	28		2900	1600
63	33[2]	8x10.5	40		2100	1100
	56[2]	10x10.5	30		2600	1400

Under Development (Tentative Spec)
[1,2] SOP/Sample Schedule
See Product Master

CLICK FOR PRODUCT MASTER

• Quality • Reliability • Precision

SLIDE NAVIGATION

INTERNAL ONLY

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HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PLV Series

PZ-CAP™

featuring:

- AECQ-200
- AUTOMOTIVE GRADE
- HIGH VIBRATION
- LONG LIFE
- REVERSE BATTERY
- LOAD DUMP
- DOUBLE RIPPLE OPERATION[1]

options:

- 25-63 VDC
- 33-270 µFd
- 8-10 mm Dia
- 20-40 mΩ

applications:

- POWER
- AUTOMOTIVE
- INDUSTRIAL

AEC-Q200

150°C

ARS II™ technology

TEMPERATURE RANGE	-55◦C to +150◦C
LIFE (ENDURANCE)- HRS	1,000 @ 150◦C
BIASED HUMIDITY- HRS	2,000 @ 85/85 (%RH/◦C)

Rubycon's PLV series conductive polymer (hybrid) capacitors are designed for applications requiring ultra miniaturization with high temperature/performance endurance.

Designed to operate in extreme environments with excellent low temperature characteristics.

Double Ripple Current operational testing can be provided upon request.[1]

specifications:

Rated Voltage [V]	Capacitance [µF]	Size (mm) D x L	E. S.R.[mΩ] /100kHz, 20°C	Rated Ripple Current [mA] /100kHz,150°C
25	150	8 x 10.5	27	1400
	270	10 x 10.5	20	1800
35	100	8 x 10.5	27	1400
	150	10 x 10.5	20	1800
50	56	8 x 10.5	35	1000
	100	10 x 10.5	28	1300
63	33	8 x 10.5	40	900
	56	10 x 10.5	30	1100

Under Development (Tentative Spec)
SOP/Sample Schedule
See Product Master

CLICK FOR PRODUCT MASTER

65 YEARS+ Rubycon CAPACITORS

• Quality • Reliability • Precision

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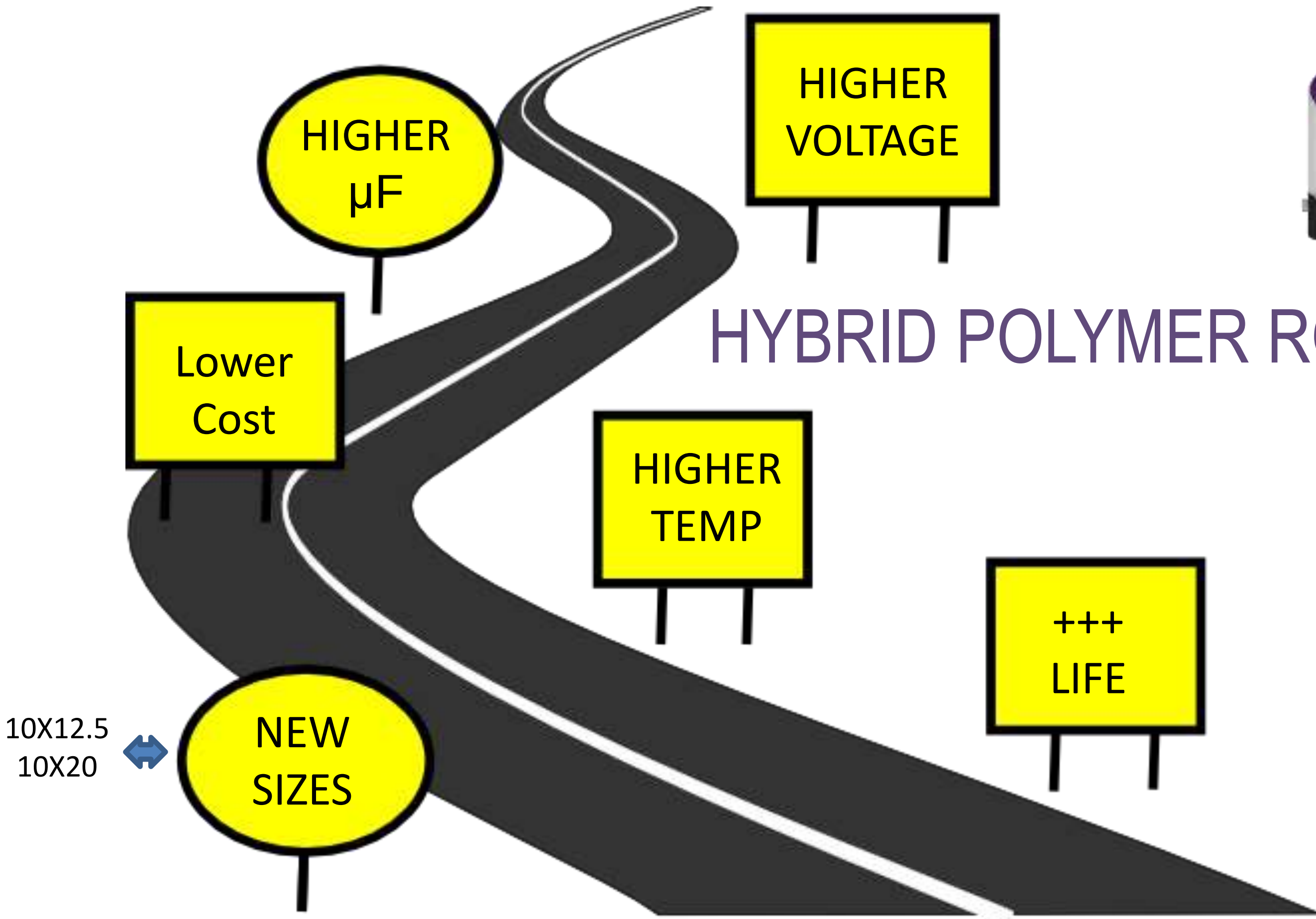
HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PZ-CAP™

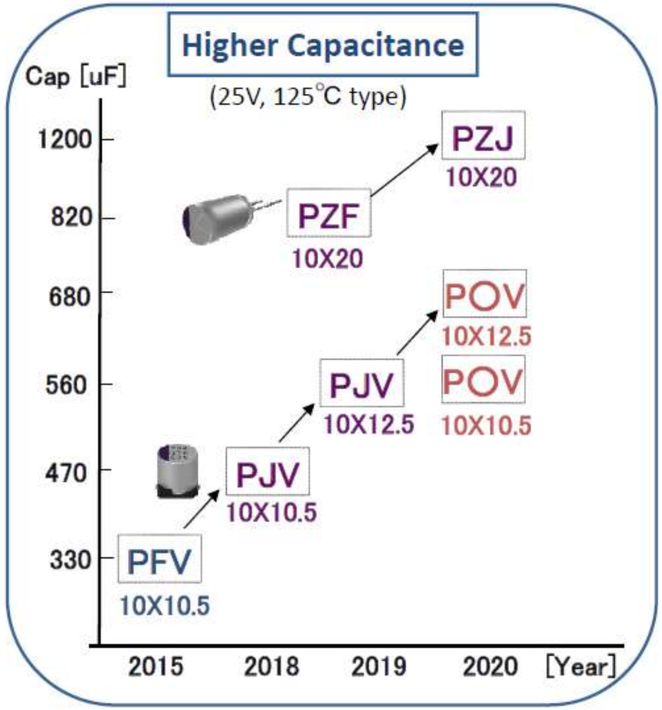
HYBRID POLYMER ROADMAP

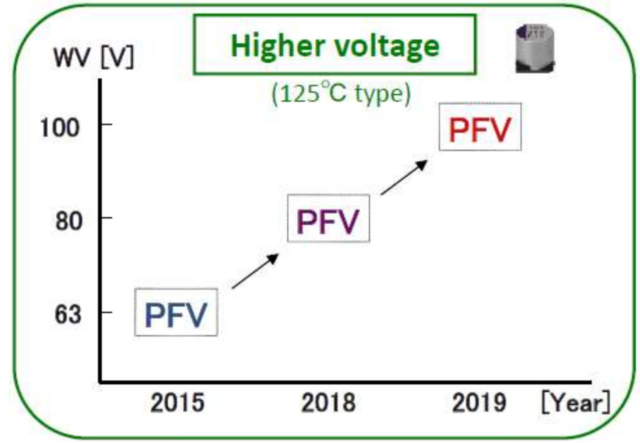


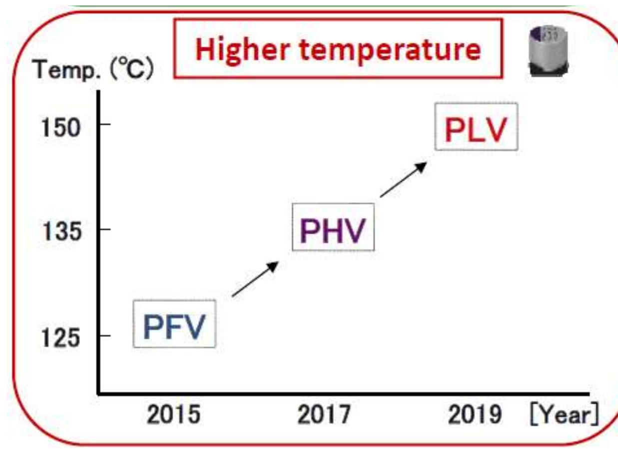
HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

HYBRID POLYMER ROADMAP







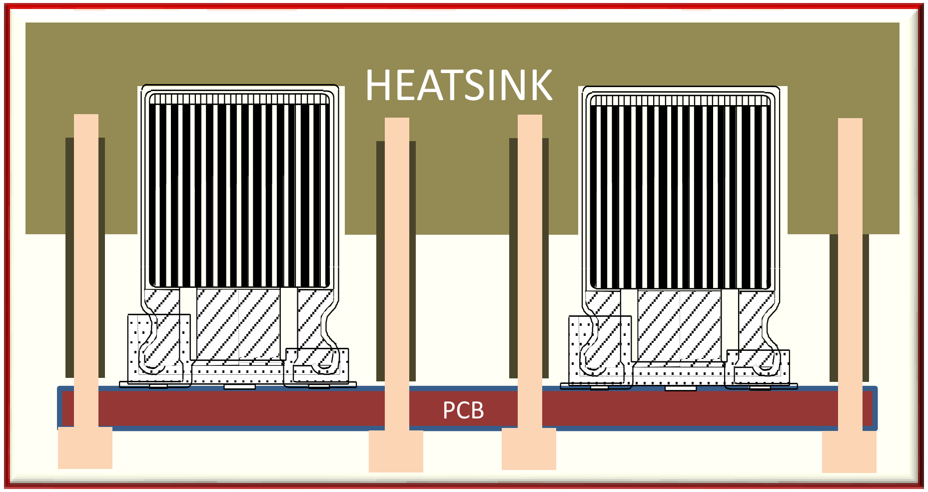
LINK TO DATA SHEETS

Radial		SMD
PZE SERIES	105°C	PEV SERIES
PZF SERIES	125°C	PFV SERIES
PZJ SERIES	125°C	PJV SERIES
PZH SERIES	135°C	PHV SERIES
	150°C	PLV SERIES

• Quality • Reliability • Precision

PERFORMANCE

THRESHOLD TESTING



PURPOSE: EXTENDED TESTING AT VARIABLE LOAD CONDITIONS TO TEST FOR HIGH RIPPLE CURRENT DURABILITY

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Conductive Polymer Aluminum Solid Hybrid Capacitors

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TEST SETUP

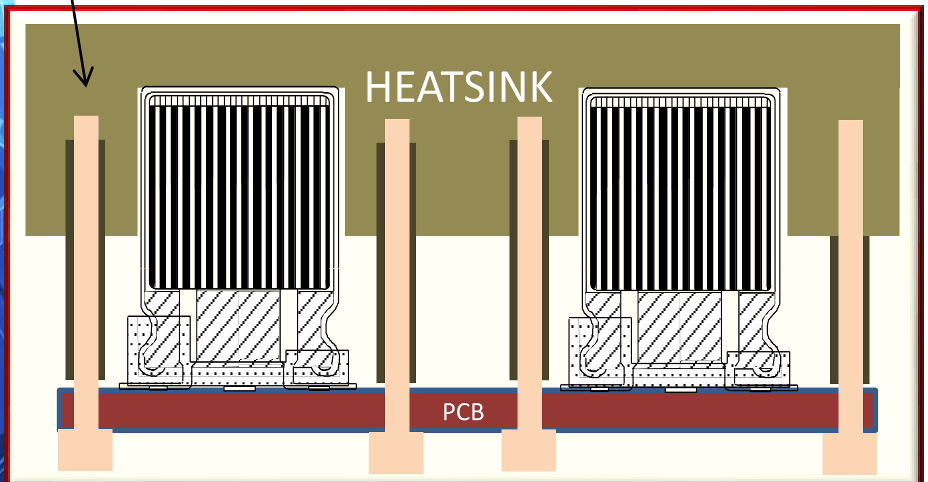
CATALOG SPECIFICATION

ESR: 20mΩ @ 20◦C, 100KHz

RIPPLE CURRENT: 2Arms/125◦C, 100KHz

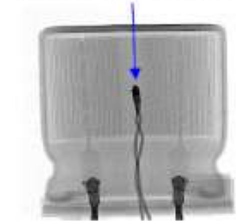
25PFV330M10X10.5

Thermal Interface (1 Watt/Meter ºK)

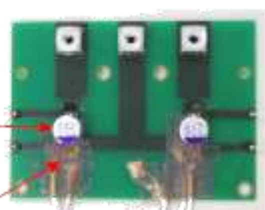


0.65M/Sec

Thermocouple



Tested capacitor



Thermocouple

Test PCB

Thermal Gap Filler

Test Fixture

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$$\text{*1: Estimated } T_j = T_{ambient} + \text{Estimated } \Delta T_j$$
$$= T_{ambient} + 2.3 {*} \Delta T_c \quad (\text{Ratio } \Delta T_j/\Delta T_c\text{: } 2.3)$$
$$= T_{ambient} + 2.3 {*} (T_{case} - T_{ambient})$$
$$= 120 + 2.3\,(125-120) = 131.5$$

Forced Convection Temperature Chamber

TEST RIPPLE/TEMPERATURE/VOLTAGE- CONDITIONS

PARAMETER	Low ripple	Middle ripple	High Ripple
DC Voltage (V)	14	14	14
Ripple Current (100kHz)	6.5Arms	9Arms	14Arms
ΔTcase (K)	5	10	20
Estimated ΔTj (K)	12	23	46
Ambient Temp. (◦C)	120	115	105
Tcase (◦C)	125	125	125
Estimated Tj (◦C) *1	132	138	151

Case Temperature Held Constant

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HIGH RIPPLE TESTING- 6.5Amp > 3x Rated Ripple Current

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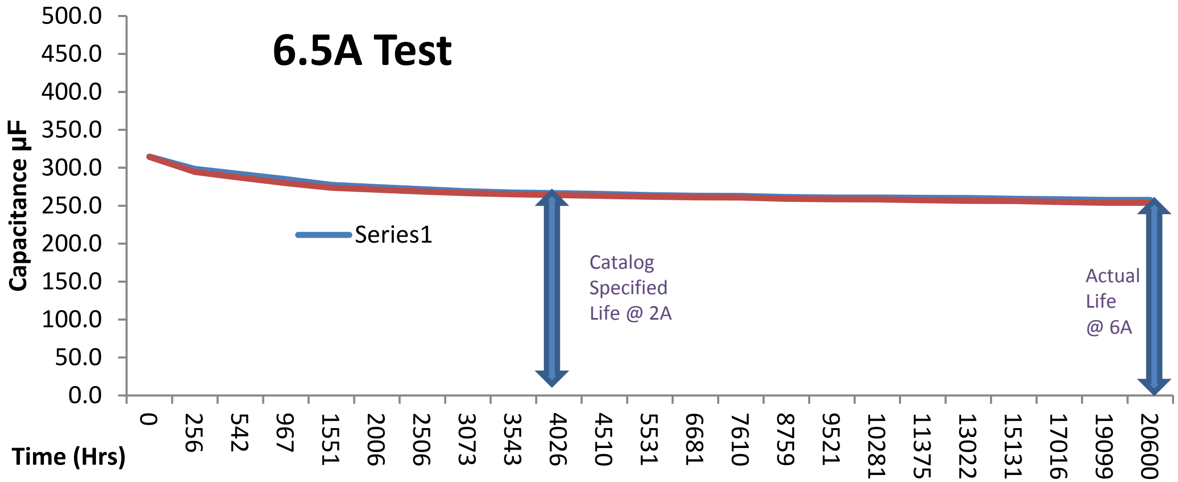

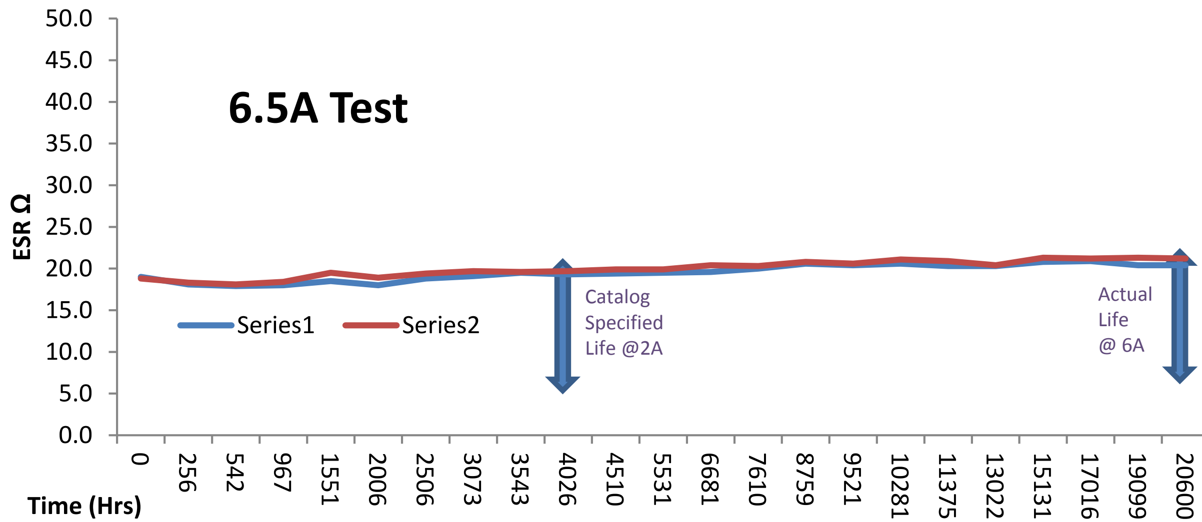

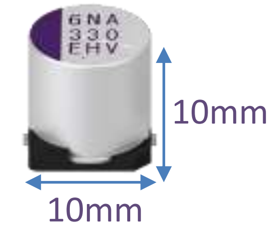

TEST ITEM

25PFV330M10X10.5

CATALOG SPECIFICATION
ESR: 20mΩ @ 20°C, 100KHz
RC: 2Arms/125°C, 100KHz
4000 Hours @ 125°c

TEST CONDITIONS

Ambient temp: 120°C
Surface temp: 125°C
Core temp: 132°C
Oper voltage: 14 VDC
Load current: 6.5 Amps

TEST RESULT

> 20,000 Hours- No Failure

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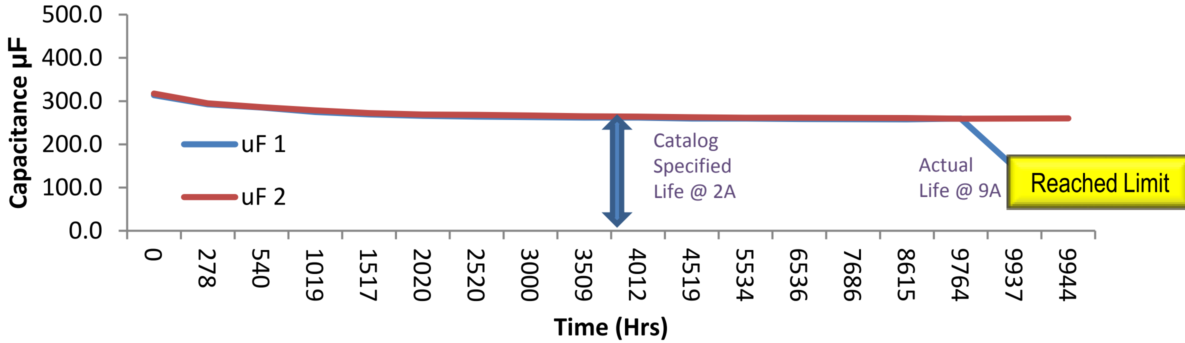
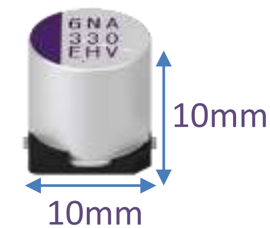
Conductive Polymer Aluminum Solid Hybrid Capacitors

HIGH RIPPLE TESTING- 9Amp
4.5x Rated Ripple Current

PZ-CAP™





TEST ITEM

25PFV330M10X10.5

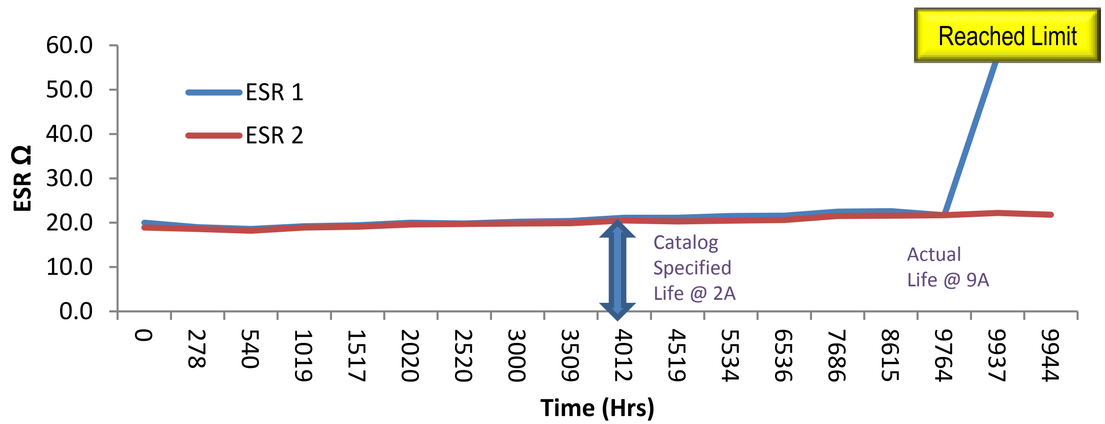
CATALOG SPECIFICATION
ESR: 20mΩ @ 20◦C, 100KHz
RC: 2Arms/125◦C, 100KHz

TEST CONDITIONS

Ambient temp: 115°C
Surface temp: 125°C
Core temp: 135°C
Oper voltage: 14 VDC
Load current: 9 Amps

TEST RESULT

9,937 Hours- 1ST Failure



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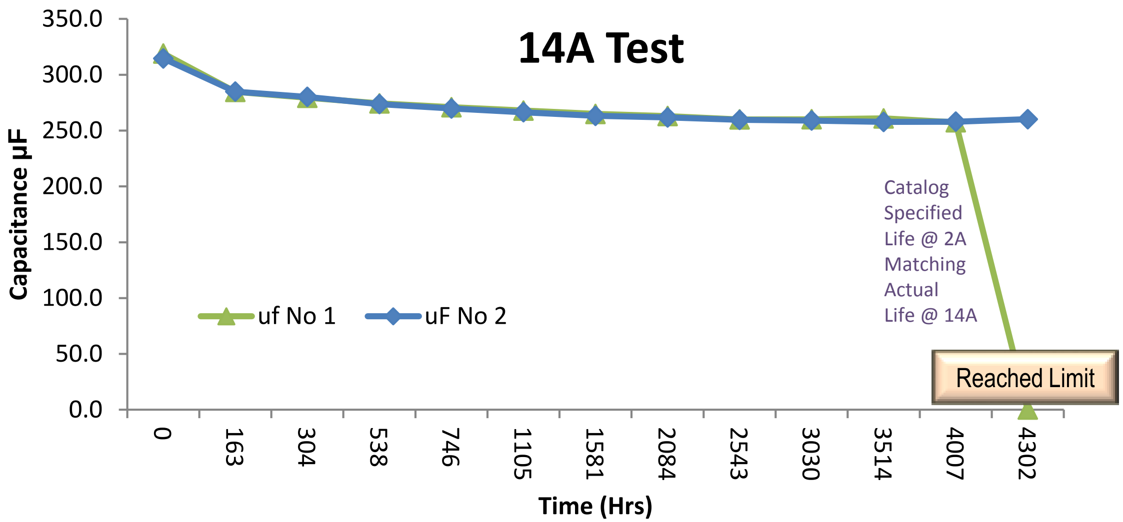
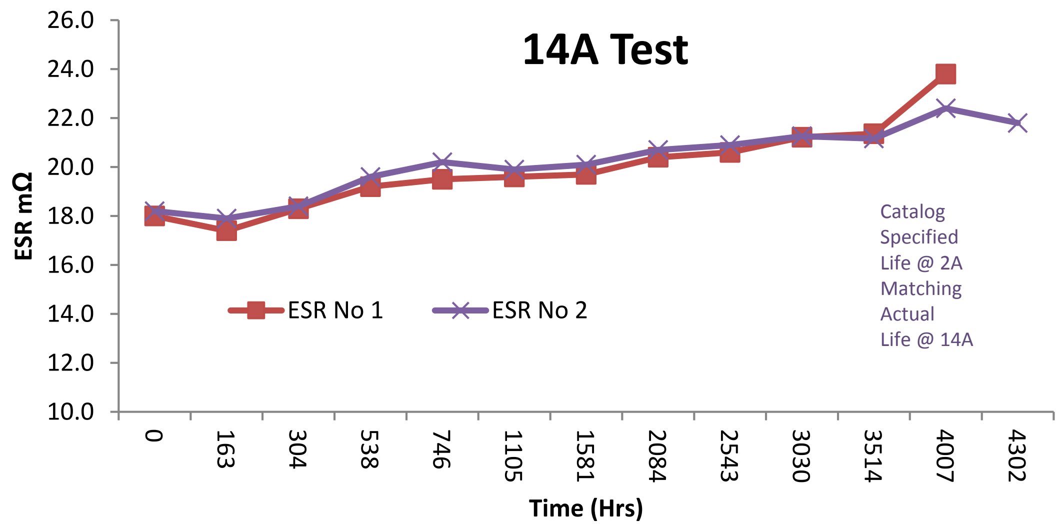
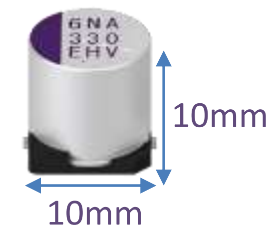
Conductive Polymer Aluminum Solid Hybrid Capacitors

HIGH RIPPLE TESTING- 14Amp
7x Rated Ripple Current

PZ-CAP™







TEST ITEM

25PFV330M10X10.5

CATALOG SPECIFICATION
ESR: 20mΩ @ 20°C, 100KHz
RC: 2Arms/125°C, 100KHz

TEST CONDITIONS

Ambient temp: 105°C
Surface temp: 125°C
Core temp: 151°C
Oper voltage: 14 VDC
Load current: 14 Amps

TEST RESULT

>4,000 Hours- 1ST Failure

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Conductive Polymer Aluminum Solid Hybrid Capacitors

Log Data

PZ-CAP™

RC (Amps)	Time [hrs]	Capacitance [uF]		ESR [mΩ]		RC (Amps)	Time [hrs]	Capacitance [uF]		ESR [mΩ]		RC (Amps)	Time [hrs]	Capacitance [uF]		ESR [mΩ]	
		No.1	No.2	No.1	No.2			No.1	No.2	No.1	No.2			No.1	No.2	No.1	No.2
6.5	0	314.7	314.3	19.0	18.8	9	0	313.9	317.3	20.0	18.9	14	0	319.0	314.6	18.0	18.2
6.5	256	298.6	294.5	18.1	18.3	9	278	292.5	295.0	19.0	18.6	14	163	284.7	284.9	17.4	17.9
6.5	542	291.8	287.0	17.9	18.1	9	540	285.1	286.1	18.6	18.2	14	304	279.4	280.2	18.3	18.4
6.5	967	285.0	279.8	18.0	18.4	9	1019	274.9	278.7	19.2	18.9	14	538	274.4	273.7	19.2	19.6
6.5	1551	277.4	273.6	18.5	19.5	9	1517	269.4	272.3	19.4	19.1	14	746	270.9	269.8	19.5	20.2
6.5	2006	274.4	271.1	18.0	18.9	9	2020	266.2	269.0	20.0	19.6	14	1105	267.9	266.4	19.6	19.9
6.5	2506	271.7	268.5	18.8	19.4	9	2520	264.2	268.2	19.8	19.7	14	1581	264.9	263.2	19.7	20.1
6.5	3073	269.1	266.4	19.1	19.7	9	3000	263.0	266.9	20.2	19.8	14	2084	263.0	261.8	20.4	20.7
6.5	3543	267.3	265.0	19.5	19.6	9	3509	261.8	264.9	20.4	19.9	14	2543	260.0	259.6	20.6	20.9
6.5	4026	266.4	263.9	19.3	19.7	9	4012	261.8	264.2	21.1	20.5	14	3030	260.1	259.0	21.2	21.3
6.5	4510	265.4	263.0	19.4	19.9	9	4519	259.9	262.6	21.1	20.3	14	3514	260.9	257.8	21.4	21.2
6.5	5531	264.0	261.8	19.5	19.9	9	5534	259.6	261.5	21.5	20.5	14	4007	257.4	258.0	23.8	22.4
6.5	6681	263.2	261.1	19.6	20.4	9	6536	258.6	261.5	21.6	20.6	14	4302	0.2	260.2		21.8
6.5	7610	263.0	260.8	20.0	20.3	9	7686	258.1	261.4	22.5	21.5						
6.5	8759	261.5	259.1	20.6	20.8	9	8615	257.9	260.9	22.6	21.6						
6.5	9521	260.9	258.5	20.4	20.6	9	9764	259.7	259.2	21.7	21.7						
6.5	10281	260.9	258.3	20.6	21.1	9	9937	147.4	259.6	57.6	22.2						
6.5	11375	260.4	257.2	20.3	20.9	9	9944		260.2		21.8						
6.5	13022	260.1	256.4	20.3	20.4												
6.5	15131	259.2	256.2	20.8	21.3												
6.5	17016	258.5	254.9	20.9	21.2												
6.5	19099	257.7	253.8	20.4	21.3												
6.5	20600	257.6	253.9	20.4	21.2												

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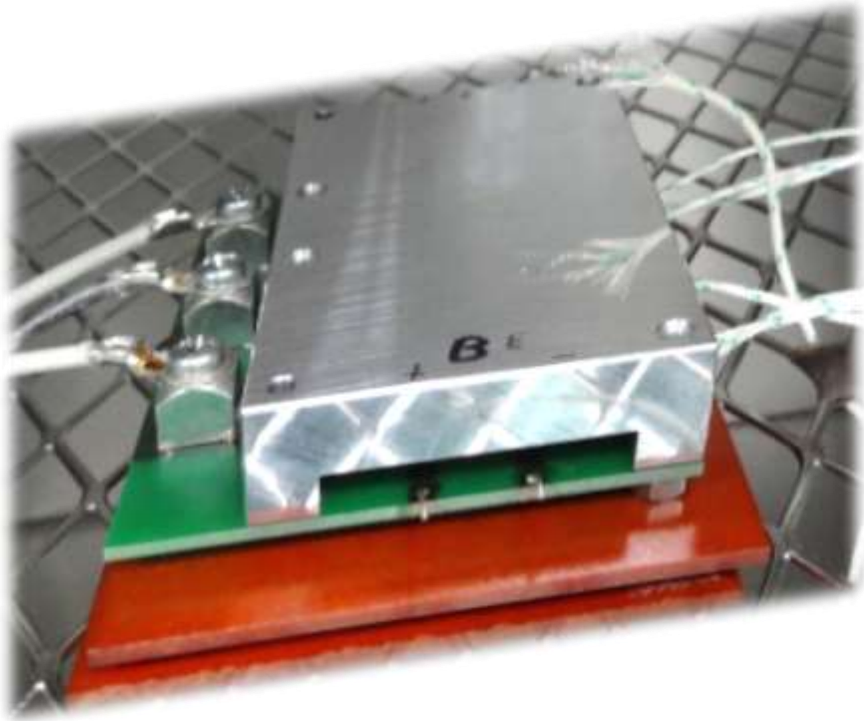
Conductive Polymer Aluminum Solid Hybrid Capacitors

PZ-CAP™

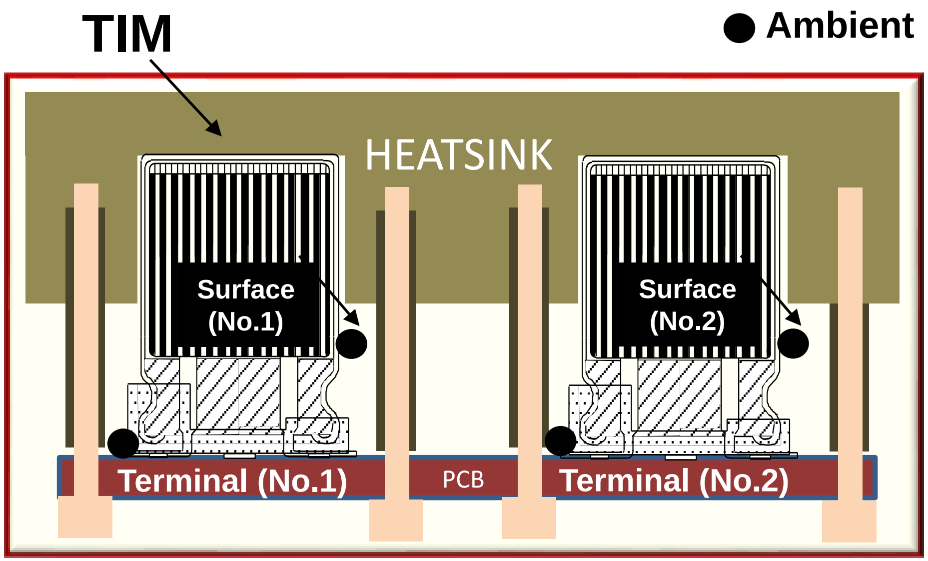
FAILURE ANALYSIS – TEST REPORT 9/14 AMP LOAD



TEST REPORT – 14 AMP TEST

Temperature monitoring over ripple current load life test

TEMPERATURE MEASUREMENT POINTS



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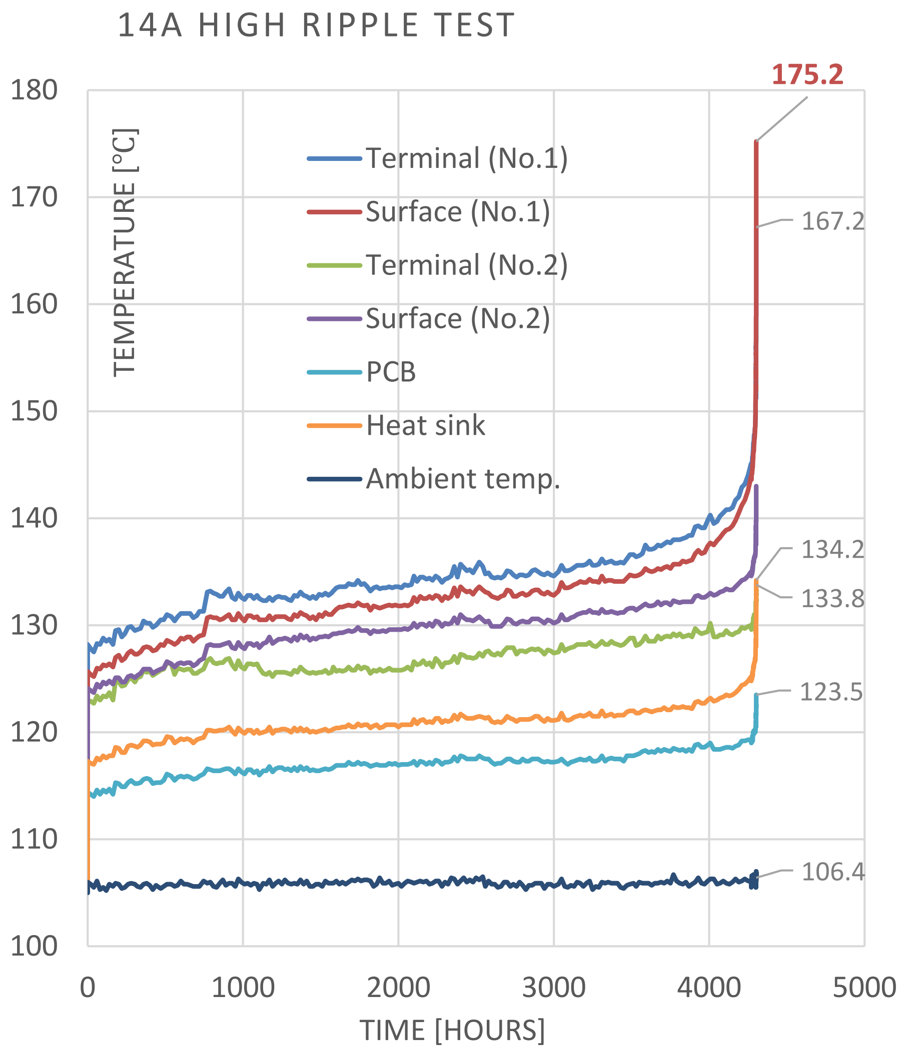
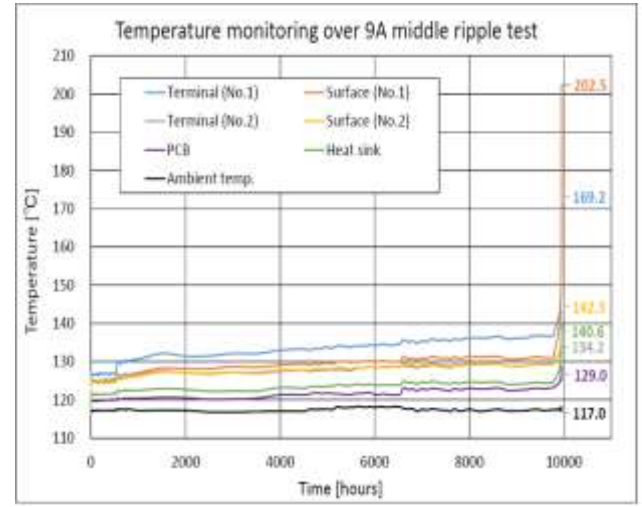
Conductive Polymer Aluminum Solid Hybrid Capacitors

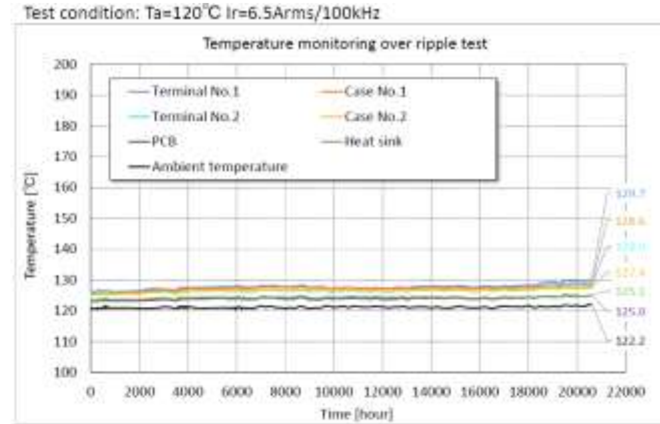
TEMP. MONITORING

PZ-CAP™





Test condition: Ta=120°C Ir=6.5Arms/100kHz



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SLIDE NAVIGATION

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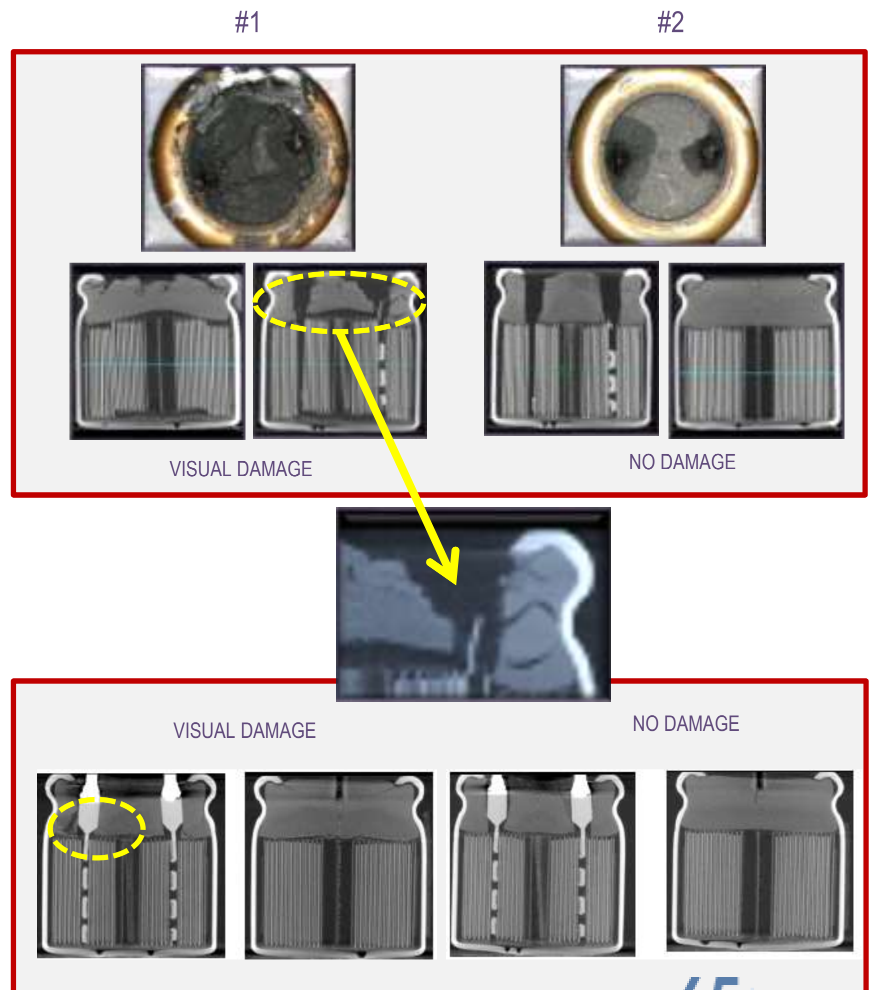
ELECTRICAL & XRAY ANALYSIS

PZ-CAP™

HIGH RIPPLE- TEAR DOWN ANALYSIS -14A

Characteristic	No.1	No. 2
Capacitance (120Hz)	0uF (-100%)	253uF (-19.4%)
tanδ (120Hz)	2.74	0.026
ESR (100kHz)	370,716 mΩ	2.9mΩ
L.C. (14V 1min)	22.2uA	4.0uA
Comments	Open Mode	Functional



HIGH RIPPLE- TEAR DOWN ANALYSIS -9A

Characteristic	No.1	No. 2
Capacitance (120Hz)	0uF (-100%)	260.2uF (-18%)
tanδ (120Hz)	3.27	0.033
ESR (100kHz)	303 Ω	21.8mΩ
L.C. (14V 1min)	3.2uA	4.0uA
Comments	Open Mode	Functional

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Conductive Polymer Aluminum Solid Hybrid Capacitors

PZ-CAP™

KEY TAKE A WAY POINTS

- SAFE – OPEN CIRCUIT FAILURE MODE
- POLYMER MATERIALS CONTINUE TO FUNCTION UNDER EXTREME CONDITIONS
- 7X RATED RIPPLE CURRENT APPLIED AND SUSTAINED LIFE FOR OVER 4,000 HOURS (WHICH IS THE GUARANTEED RATING AT LOWER CURRENT)
- ESR IS EXTREMELY STABLE- EVEN UNDER HIGH STRESS CONDITIONS
- LOW TEMPERATURE PERFORMANCE OUTPERFORMS CONVENTIONAL WET TYPE HYBRIDS
- CAPACITANCE STABLE AFTER INITIAL BREAK IN PERIOD
- EXCELLENT SIZE/PERFORMANCE RATIO – REDUCED SIZE AND IMPROVED VIBRATION PERFORMANCE
- LIFE LIMITING FACTOR SEEMS TO BE RUBBER BUNG

Extended Rubber Seal Testing- Next

65+ YEARS Rubycon CAPACITORS

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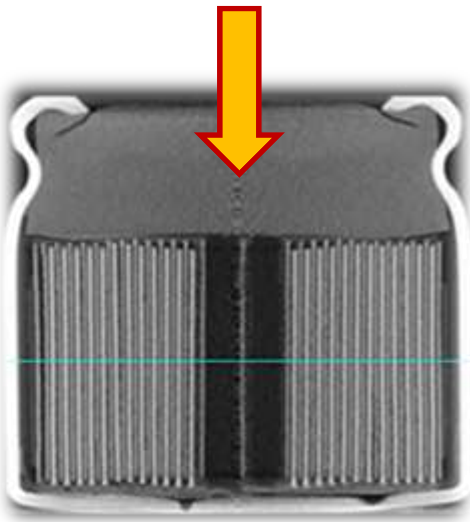
RUBBER BUNG TESTING



TEMPERATURES TESTED

105°C, 125°C, 135°C, 150°C, 166°C

KEY CHARACTERISTIC CHECKED

RUBBER HARDNESS

HIGH TEMPERATURE CAPACITOR SEAL TESTING

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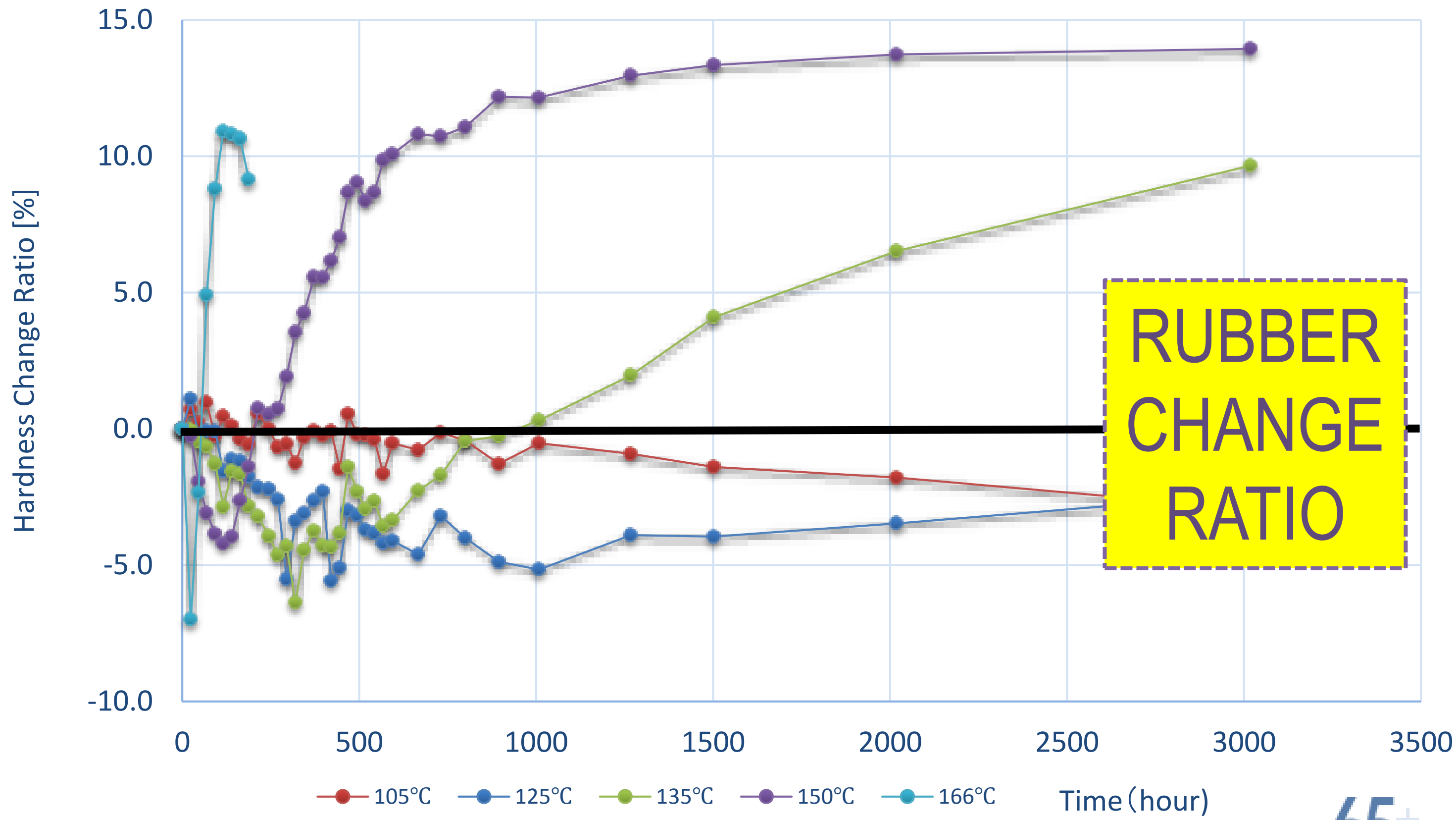
HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PZ-CAP™

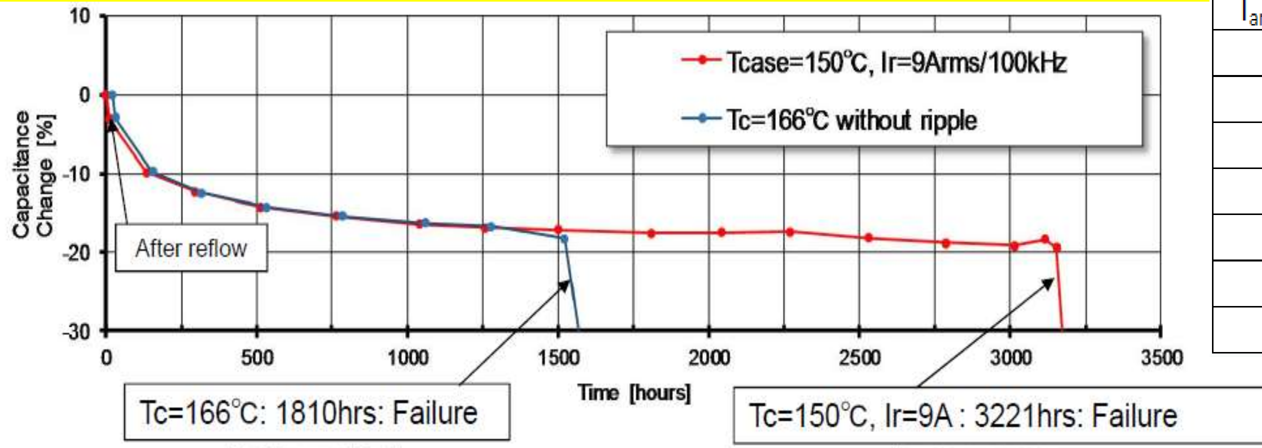
RUBBER BUNG HARDNESS TEMP TEST

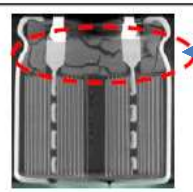


65+ YEARS Rubycon CAPACITORS

• Quality • Reliability • Precision

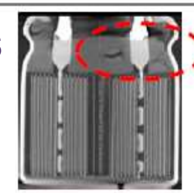
RUBBER BUNG- TENTATIVE LIFE SPEC 2,000 HRS @ 150◦C





MORE RUBBER FRACTURES

HIGHER EFFECT
FROM PURE TEMP.
VS APPLIED LOAD



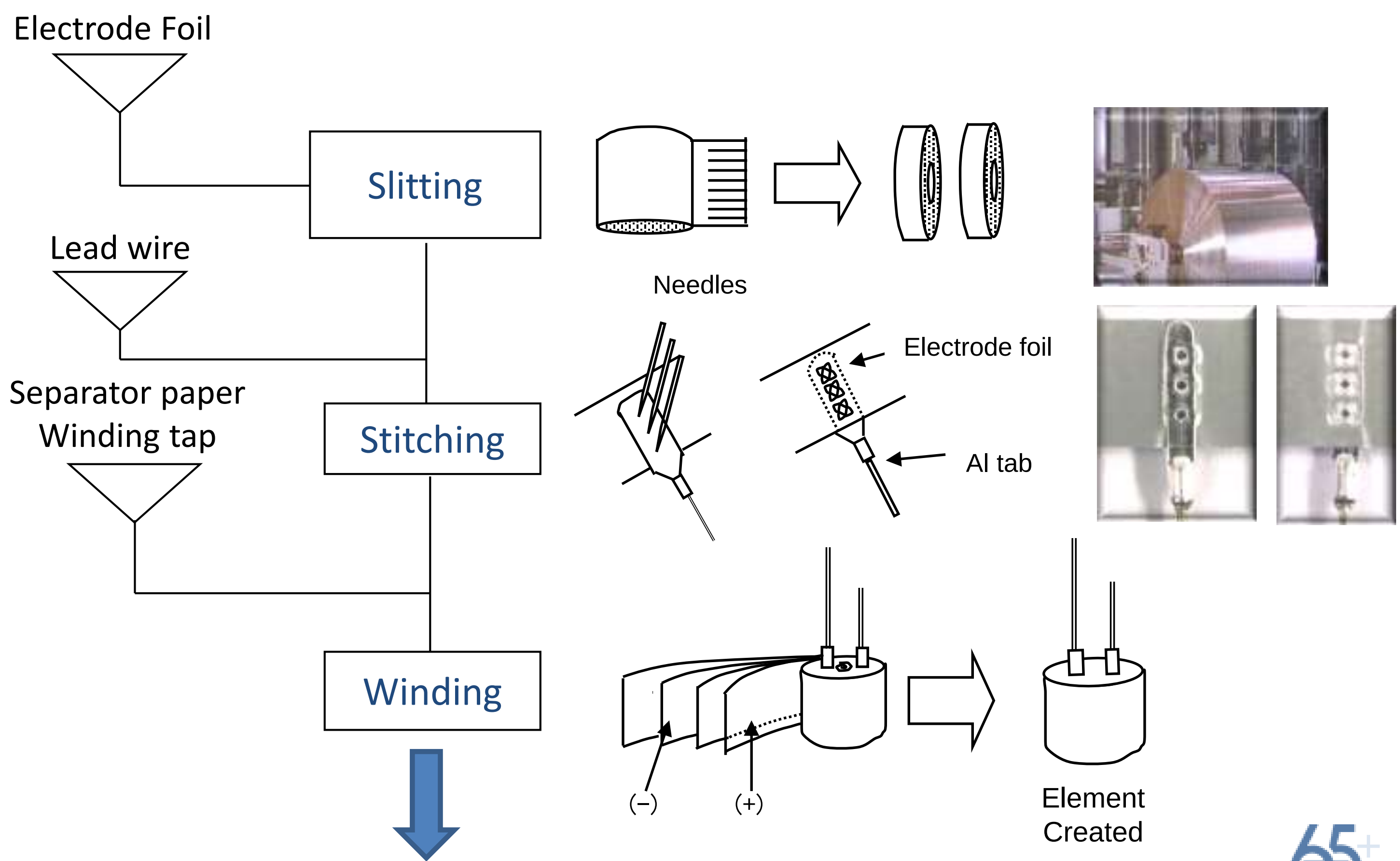
LIFE CHART RUBBER BUNG

T_{amb} [°C]	$L_{rub.op}$ [hrs]
150	2,000
145	3,362
140	5,651
135	9,500
125	26,844
115	75,855
105	214,344

APPLY 166◦C WITHOUT LOAD

APPLY 9A TO GENERATE 166◦C AT SEAL (CASE TEMP 150◦C)

HYBRID POLYMER- MANUFACTURING PROCESS CONTROL



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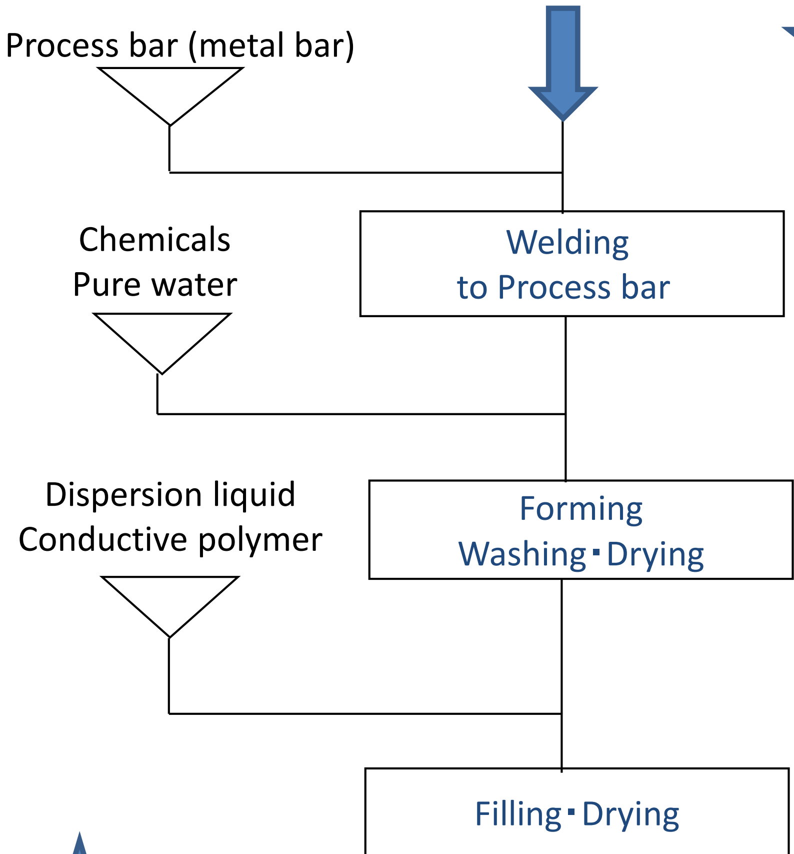
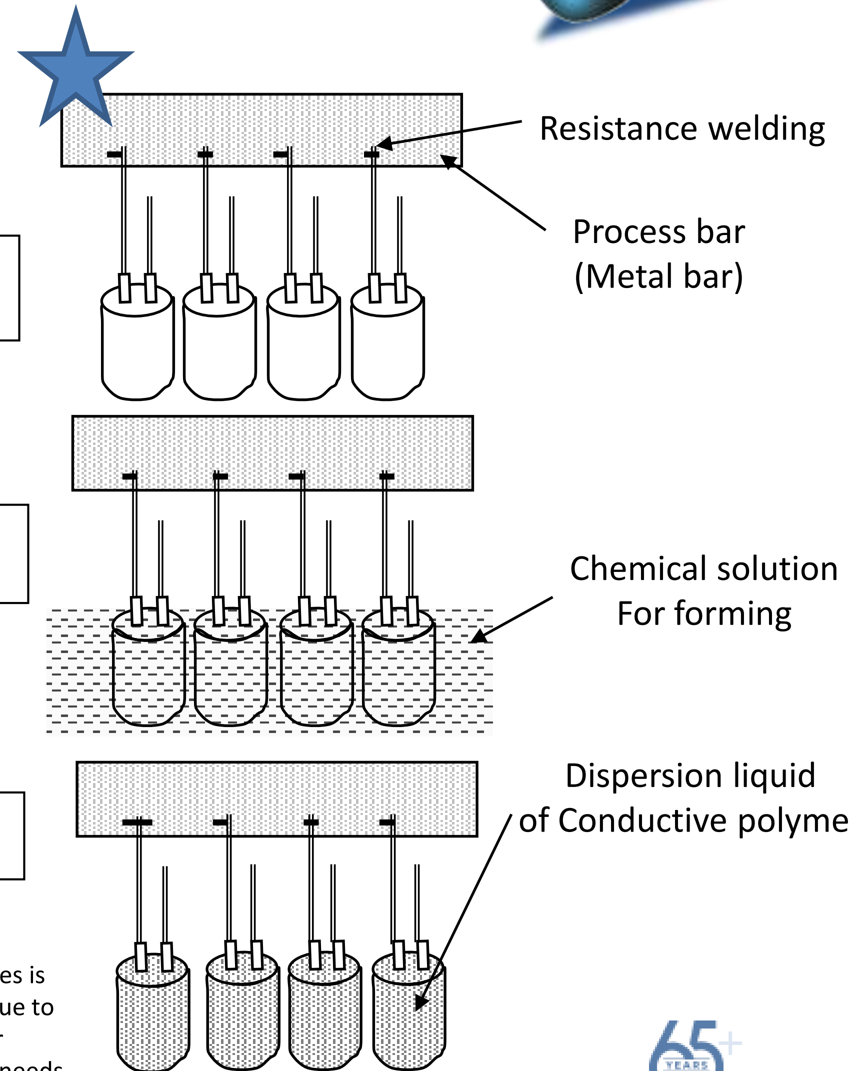
Conductive Polymer Aluminum Solid Hybrid Capacitors





For aluminum electrolytic capacitors, reforming of foil edges is performed during the aging process which is easily done due to electrolyte conductivity. In the case of hybrid polymer our functional liquid is not conductive so an alternate process needs to take place.

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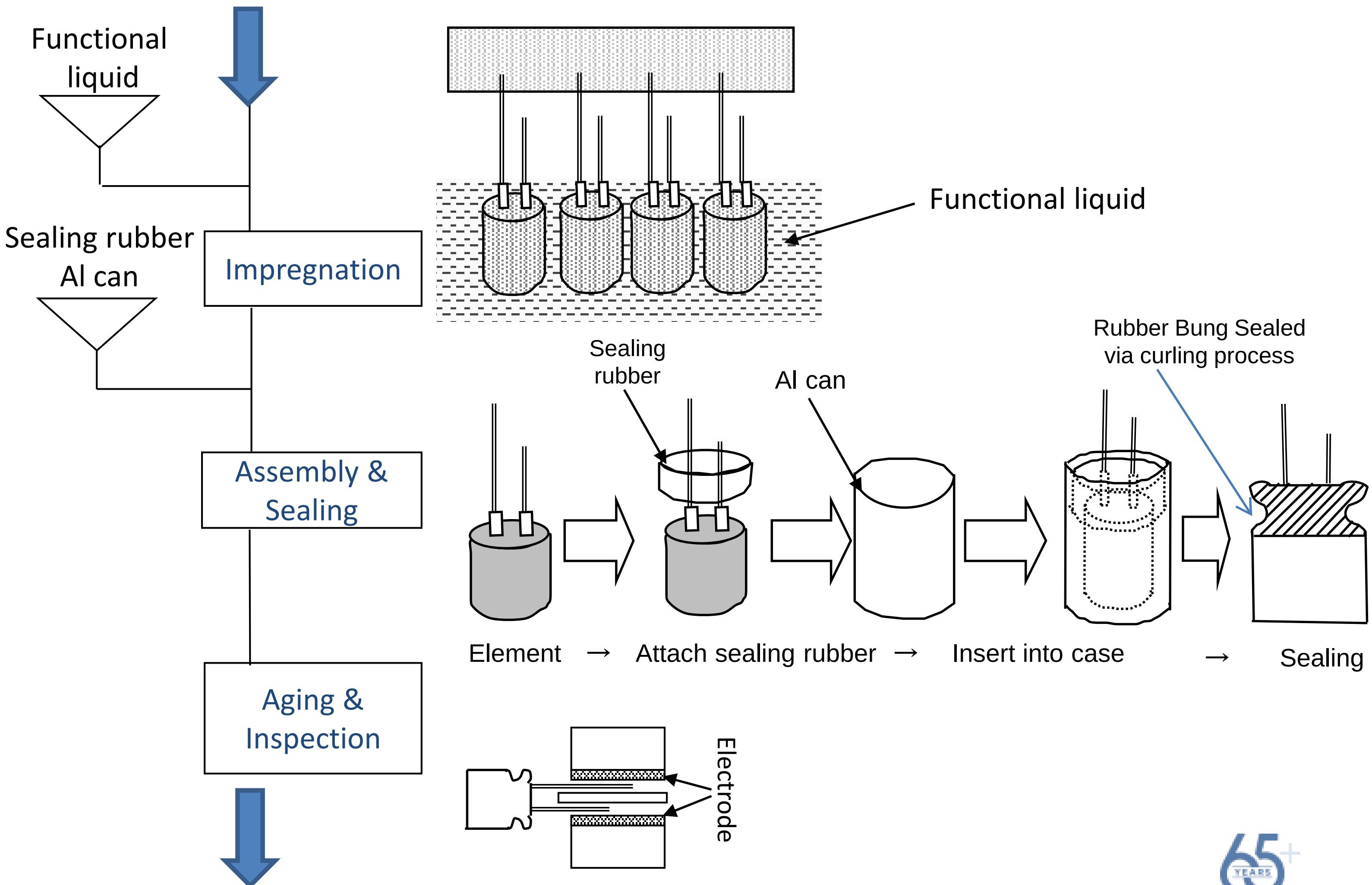

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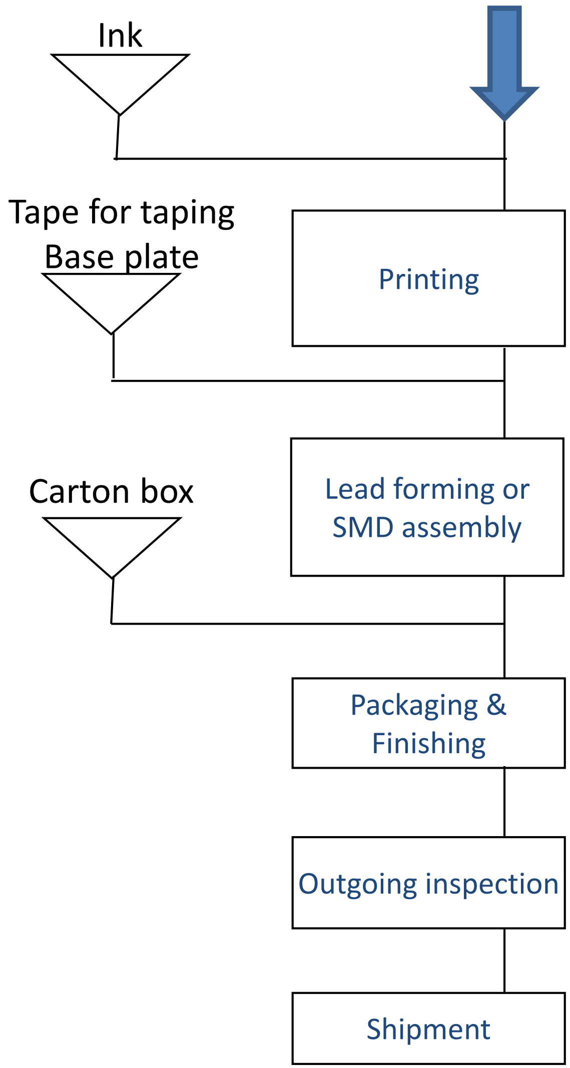
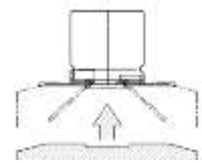
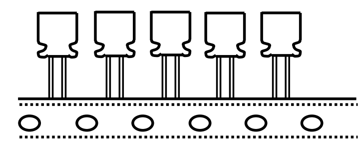
HYBRID TECHNOLOGY

Conductive Polymer Aluminum Solid Hybrid Capacitors

PZ-CAP™







65 YEARS+ Rubycon CAPACITORS

• Quality • Reliability • Precision

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THANK YOU!

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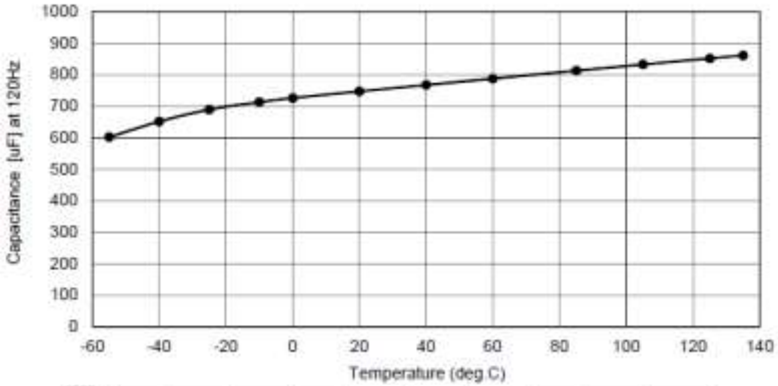
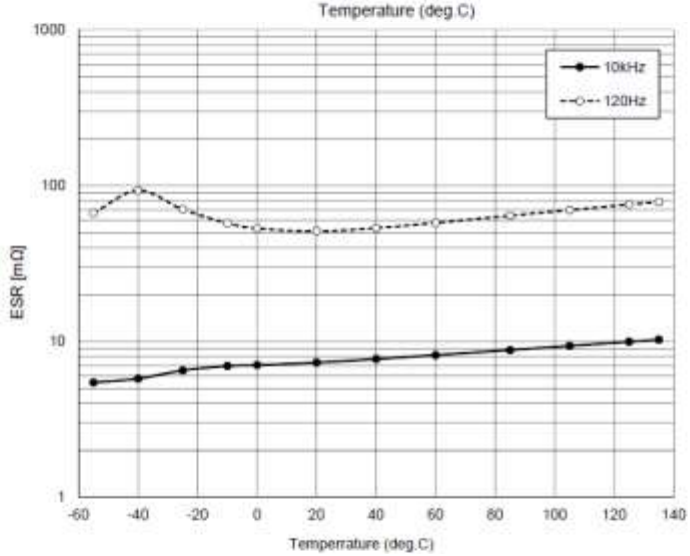
Conductive Polymer Aluminum Solid Hybrid Capacitors

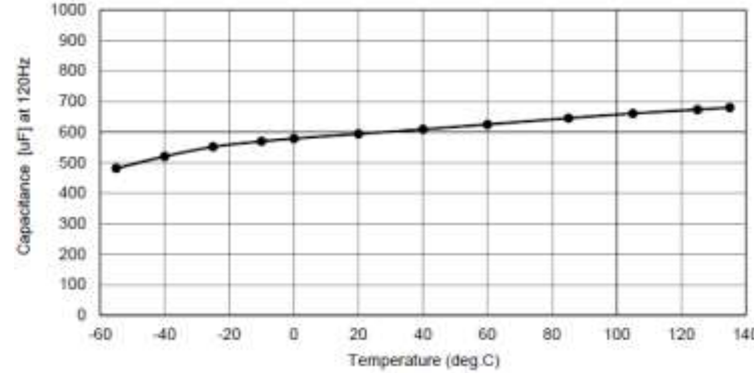
PZ-CAP™

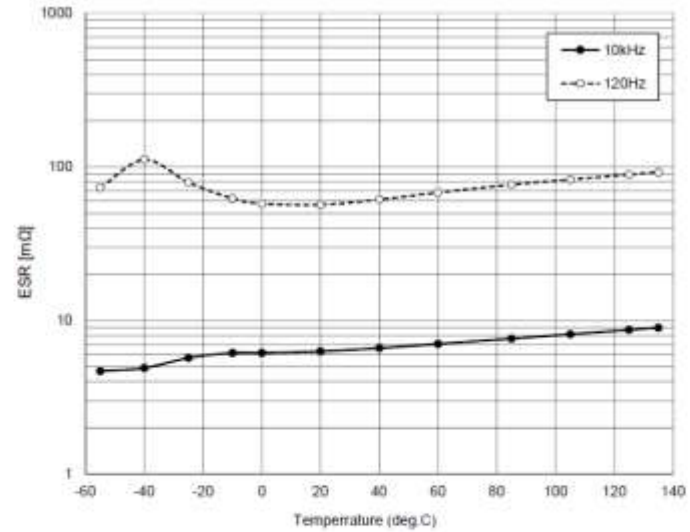
25 PZH 820 M 10X20
(PZH series 25V 820uF size 10X20)





35 PZH 680 M 10X20
(PZH series 35V 680uF size 10X20)





• Quality • Reliability • Precision

65+ YEARS Rubycon CAPACITORS

50 PFV 33 M 6.3X8
Lifetime 125degC/4000h

Typical value(100kHz)

	Temperature	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	125
Reference	ESR (Ohm) beginning of lifetime	0.013	0.013	0.013	0.014	0.014	0.015	0.015	0.016	0.016	0.017	0.017	0.017	0.018	0.018	0.019	0.019	0.021
Reference	ESR (Ohm) end of lifetime	0.016	0.016	0.016	0.017	0.017	0.017	0.018	0.018	0.019	0.019	0.020	0.020	0.021	0.021	0.022	0.022	0.024

MAX value(100kHz)

	Temperature	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	125
Reference	ESR (Ohm) beginning of lifetime	0.032	0.033	0.034	0.035	0.037	0.038	0.039	0.040	0.041	0.042	0.043	0.044	0.046	0.047	0.048	0.049	0.053
Reference	ESR (Ohm) end of lifetime	0.040	0.040	0.041	0.042	0.042	0.044	0.045	0.046	0.047	0.048	0.050	0.050	0.052	0.054	0.055	0.056	0.061

25 PHV 330 M THY 10X10.5
Lifetime 125degC/4000h

Typical value(100kHz)

	Temperature	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	125	150
Reference	ESR (Ohm) beginning of lifetime	0.007	0.008	0.008	0.009	0.009	0.009	0.010	0.010	0.011	0.011	0.011	0.012	0.012	0.012	0.013	0.013	0.014	0.015
Reference	ESR (Ohm) end of lifetime	0.009	0.009	0.010	0.010	0.010	0.011	0.011	0.012	0.012	0.013	0.013	0.013	0.014	0.014	0.015	0.015	0.016	0.017

MAX value(100kHz)

	Temperature	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	125	150
Reference	ESR (Ohm) beginning of lifetime	0.015	0.015	0.016	0.017	0.018	0.019	0.019	0.020	0.021	0.021	0.022	0.023	0.024	0.024	0.025	0.026	0.028	0.030
Reference	ESR (Ohm) end of lifetime	0.018	0.018	0.019	0.020	0.020	0.021	0.022	0.023	0.024	0.025	0.025	0.026	0.027	0.028	0.029	0.030	0.032	0.034

Typical value(10kHz)

	Temperature	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	125	150
Reference	ESR (Ohm) beginning of lifetime	0.011	0.011	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.014	0.015	0.015	0.015	0.016	0.017	0.017
Reference	ESR (Ohm) end of lifetime	0.014	0.013	0.014	0.014	0.015	0.015	0.015	0.015	0.015	0.015	0.016	0.016	0.017	0.017	0.018	0.018	0.019	0.020

MAX value(10kHz)

	Temperature	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	125	150
Reference	ESR (Ohm) beginning of lifetime	0.022	0.022	0.023	0.024	0.025	0.026	0.026	0.026	0.027	0.027	0.028	0.028	0.029	0.030	0.031	0.031	0.033	0.035
Reference	ESR (Ohm) end of lifetime	0.027	0.026	0.028	0.028	0.029	0.029	0.030	0.030	0.031	0.031	0.032	0.033	0.034	0.035	0.035	0.036	0.039	0.040