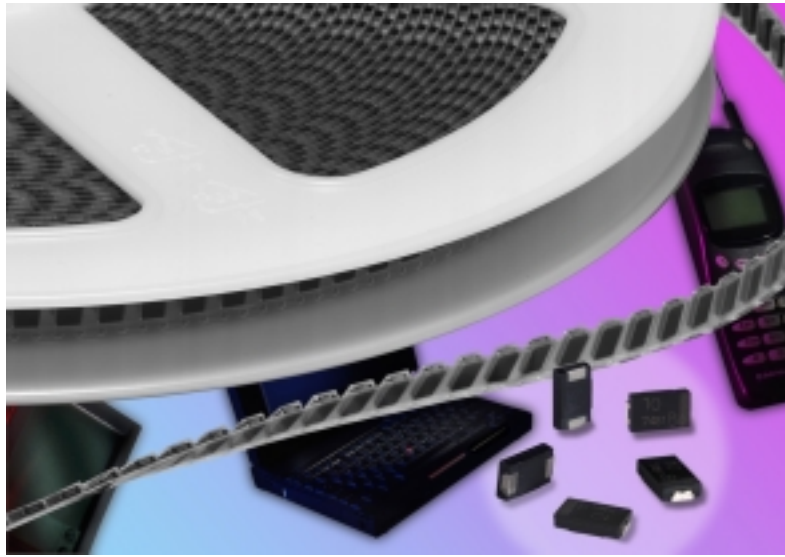


CORNELL DUBILIER SPA Capacitors

Solid Polymer Aluminum Surface Mount Capacitors



Highlights

- **Capacitance Range: 2.2 μF to 390 μF**
- **Ripple current ratings up to 3.5 Arms at 100 kHz and 105°C**
- **Low Impedance**
- **Ultra-Low E.S.R.; 10 $\text{m}\Omega$ @ 100 kHz**
- **-55° to 105°C operating temperature**
- **Voltage Range: 2.0 Vdc to 16 Vdc**
- **Solid electrolyte for extended life**
- **Footprint Compatible with “D” and “E” Case Tantalum**
- **Flat Z and E.S.R. vs. temperature**
- **Ignition free**

Filtering power of 3 or more tantalum chips and 50 year life —

Solid polymer aluminum capacitors combine the high capacitance capability of an electrolytic component with the high frequency performance of film capacitors. When the need for low impedance at high frequency is critical for your design, one SPA chip is capable of replacing several liquid electrolyte aluminum or tantalum capacitors connected in parallel. This is due to the ultra-low e.s.r. which results in significantly lower impedance than either aluminum or tantalum capacitors at frequencies of 100 kHz and above. There is no longer a need to stack capacitors to lower the impedance at high frequency. The low e.s.r. and high

capacitance make them ideal for bypassing high frequency noise, and for switching frequency filtering in DC/DC conversion. SPA capacitors are packaged in a molded resin case with the same footprint (7.3x4.3 mm) as the industry standard tantalum “D” and “E” case sizes. The solid electrolyte results in a capacitor with stable impedance and equivalent series resistance over the entire operating temperature range and they have more than twice the ripple current handling capability of tantalum capacitors. In addition, the solid electrolyte delivers a typical expected operating life of more than 50 years, and it is ignition free.

CDE SPA Type	ESRE	ESRD	ESRD	ESRL
Dimensions (mm)	7.3x4.3x4.1	7.3x4.3x2.8	7.3x4.3x1.8	7.3x4.3x1.1
Capacitance Range (μF)	100 - 390	68 - 270	2.2 - 120	15 - 68
Max. ESR at 100 kHz (Ω)	0.010 & 0.015	0.012 & 0.018	.015 - .110	.035 & .040
Max. Ripple Current at 100 kHz (Arms)	3.5	3.3	1.0 - 2.7	1.4 & 1.6

SPA Capacitors

Solid Polymer Aluminum Capacitors

Applications

Motherboard By-Pass

Switching Supply Input/Output Filters

Power Supply Decoupling

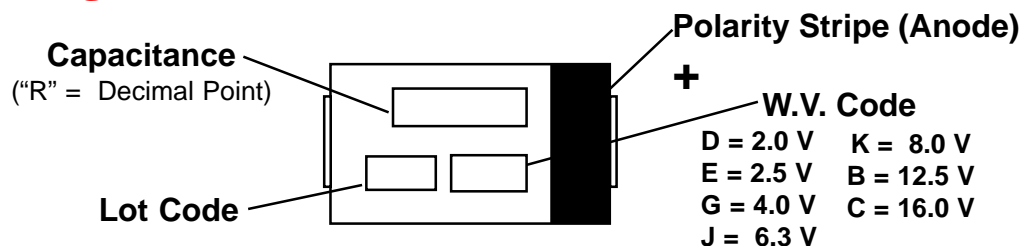
High Frequency Noise Reduction

Laptop LCD Displays

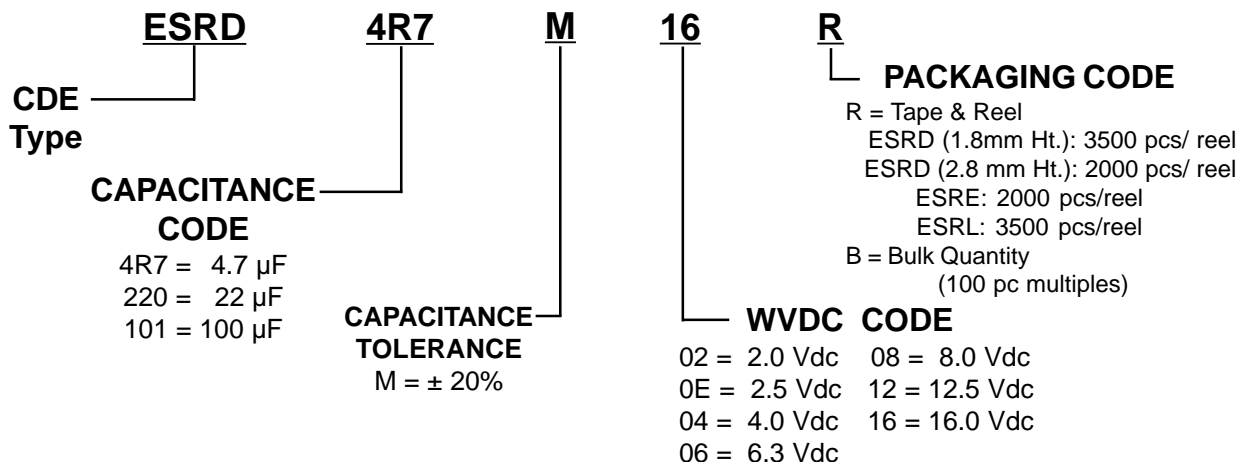
Automotive Digital Equipment

Portable Electronic Equipment

Markings



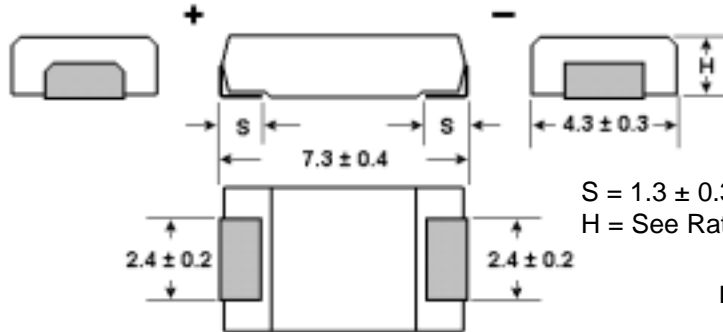
Ordering Information



SPA Capacitors

Solid Polymer Aluminum Capacitors

ESRD Surface Mount Outline Drawing



S = 1.3 ± 0.3
H = See Ratings Table

Dimensions in mm

Ratings

Capacitance (μ F)	Part Number (Tape & Reel)	Maximum E.S.R 100kHz/20°C (Ω)	Maximum ¹ Ripple Current 100kHz/105°C (Amps)	Case Height H (± 0.1 mm)
2.0 Vdc				
100	ESRD101M02R	0.025	1.8	1.8
120	ESRD121M02XR	0.015	2.7	1.8
180	ESRD181M02R	0.018	2.2	2.8 ± 0.2
220	ESRD221M02R	0.018	2.2	2.8 ± 0.2
270	ESRD271M02XR	0.012	3.3	2.8 ± 0.2
2.5 Vdc				
82	ESRD820M0ER	0.025	1.8	1.8
100	ESRD101M0EXR	0.015	2.7	1.8
150	ESRD151M0ER	0.018	2.2	2.8 ± 0.2
180	ESRD181M0ER	0.018	2.2	2.8 ± 0.2
220	ESRD221M0EXR	0.012	3.3	2.8 ± 0.2
4.0 Vdc				
56	ESRD560M04R	0.025	1.8	1.8
82	ESRD820M04XR	0.015	2.7	1.8
120	ESRD121M04R	0.018	2.2	2.8 ± 0.2
150	ESRD151M04XR	0.012	3.3	2.8 ± 0.2
6.3 Vdc				
10	ESRD100M06R	0.060	1.0	1.8
22	ESRD220M06R	0.045	1.3	1.8
33	ESRD330M06R	0.035	1.6	1.8
47	ESRD470M06R	0.025	1.8	1.8
68	ESRD680M06XR	0.015	2.7	1.8
100	ESRD101M06R	0.018	2.2	2.8 ± 0.2
120	ESRD121M06XR	0.012	3.3	2.8 ± 0.2
8.0 Vdc				
8.2	ESRD8R2M08R	0.060	1.0	1.8
15	ESRD150M08R	0.045	1.3	1.8
22	ESRD220M08R	0.035	1.6	1.8
33	ESRD330M08R	0.025	1.8	1.8
68	ESRD680M08R	0.018	2.2	2.8 ± 0.2
12.5 Vdc				
4.7	ESRD4R7M12R	0.080	1.0	1.8
10	ESRD100M12R	0.060	1.0	1.8
15	ESRD150M12R	0.050	1.3	1.8
22	ESRD220M12R	0.040	1.3	1.8
16.0 Vdc				
2.2	ESRD2R2M16R	0.110	1.0	1.8
4.7	ESRD4R7M16R	0.080	1.0	1.8
6.8	ESRD6R8M16R	0.070	1.0	1.8
8.2	ESRD8R2M16R	0.060	1.0	1.8

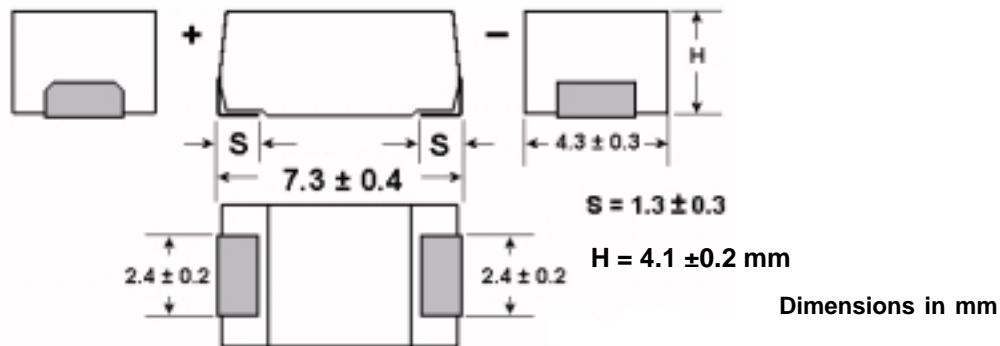
¹ For other frequencies use the ripple current frequency multipliers.

SPA Capacitors

Solid Polymer Aluminum Capacitors

ESRE Surface Mount, High Capacitance

Outline Drawing



Ratings

Capacitance (μF)	Part Number (Tape & Reel)	Maximum E.S.R. 100kHz/20°C (Ω)	Maximum ¹ Ripple Current 100kHz/105°C (Amps)
2.0 Vdc			
270	ESRE271M02R	0.015	3.0
330	ESRE331M02R	0.015	3.0
390	ESRE391M02XR	0.010	3.5
2.5 Vdc			
220	ESRE221M0ER	0.015	3.0
270	ESRE271M0ER	0.015	3.0
330	ESRE331M0EXR	0.010	3.5
4.0 Vdc			
180	ESRE181M04R	0.015	3.0
220	ESRE221M04XR	0.010	3.5
6.3 Vdc			
150	ESRE151M06R	0.015	3.0
180	ESRE181M06XR	0.010	3.5
8.0 Vdc			
100	ESRE101M08R	0.015	3.0

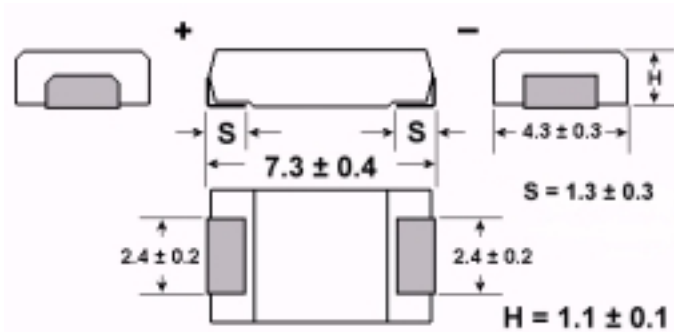
¹ For other frequencies use the ripple current frequency multipliers.

SPA Capacitors

Solid Polymer Aluminum Capacitors

ESRL Surface Mount, Very Low Profile (1.1mm High)

Outline Drawing



Dimensions in mm

Ratings

Capacitance (μF)	Part Number (Tape & Reel)	Maximum E.S.R. 100kHz/20°C (Ω)	Maximum ¹ Ripple Current 100kHz/105°C (Amps)
2.0 Vdc			
68	ESRL680M02R	0.035	1.6
2.5 Vdc			
56	ESRL560M0ER	0.035	1.6
4.0 Vdc			
47	ESRL470M04R	0.035	1.6
39	ESRL390M04R	0.035	1.6
6.3 Vdc			
33	ESRL330M06R	0.035	1.6
8.0 Vdc			
22	ESRL220M08R	0.035	1.6
12.5 Vdc			
15	ESRL150M12R	0.040	1.4

¹ For other frequencies use the ripple current frequency multipliers.

SPA Capacitors

Solid Polymer Aluminum Capacitors

Specifications

Operating Temperature Range;

-55°C to +105°C, at 100% rated voltage

Surge Voltage;

125% of the rated working Vdc

Capacitance Range;

2.2 μ F to 390 μ F

Capacitance Tolerance;

\pm 20% at 120 Hz and +20°C

DC Leakage Current (DCL);

After a two minute application of the rated working voltage at +20°C:

2V - 4V: $I \leq 0.06CV$

6.3V - 16V: $I \leq 0.04CV$ or $3\mu A$

(whichever greater)

Dissipation Factor (DF);

The ratio of the capacitor's equivalent series resistance to its reactance at 120Hz and +20°C.

ESRL & ESRD (1.8 mm ht.): D.F. is .06 Max.

ESRE & ESRD (2.8 mm ht.): D.F. is .10 Max.

Resistance to Soldering Heat;

Heat the capacitors at 235°C in an oven for 200 seconds. The capacitors will meet the following limits after stabilizing at 20°C:

$\Delta C = \pm 10\%$ of the initial measured value

$DF \leq$ the initial specified value

$DCL \leq$ the initial specified value

Vibration;

No abnormal change shall occur to capacitors that have been soldered (and attached) to a board when subjected to a vibration of 1.5 mm amplitude that is varied from 10 Hz to 2000 Hz in 20 min. cycles. The test duration is 2 hours for each right angle direction (total 6 hours). Capacitance is monitored during the last cycle of the test for stability.

Moisture Resistance;

After 500 hours storage at +60°C and 90 to 95% R.H. without load, the capacitor will meet the following limits:

$\Delta C = +70\%/-20\%$ of the initial measured value (2.0 Vdc, 2.5 Vdc),
 $+60\%/-20\%$ of the initial measured value (4.0 Vdc),
 $+50\%/-20\%$ of the initial measured value (6.3 Vdc),
 $+40\%/-20\%$ of the initial measured value (all other voltages)

$DF \leq$ two times the initial specified value

$DCL \leq$ the initial specified value

Life Test;

Apply rated DC working voltage at 105°C for 1000 hours, and then stabilize them to +20°C. Capacitors will meet the following limits:

$\Delta C = \pm 10\%$ of the initial measured value

$DF \leq$ the initial specified value

$DCL \leq$ the initial specified value

Shelf Life Test;

Shelf life is typically 5 to 10 years. Accelerated test: after 500 hours at 105°C, capacitors will meet the following limits after stabilization at 20°C:

$\Delta C = \pm 10\%$ of the initial measured value

$DF \leq$ the initial specified value

$DCL \leq$ the initial specified value

Shear Test;

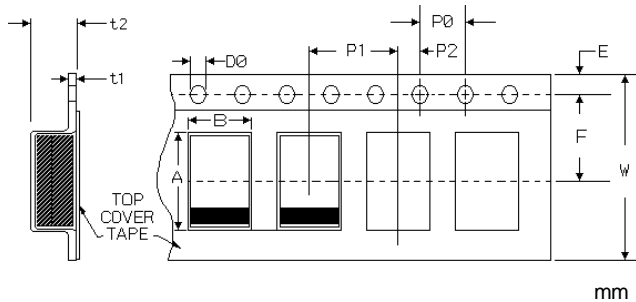
No damage shall be visible after subjecting a mounted capacitor to a side force of 5 N for 10 seconds

SPA Capacitors

Solid Polymer Aluminum Capacitors

Tape Specifications

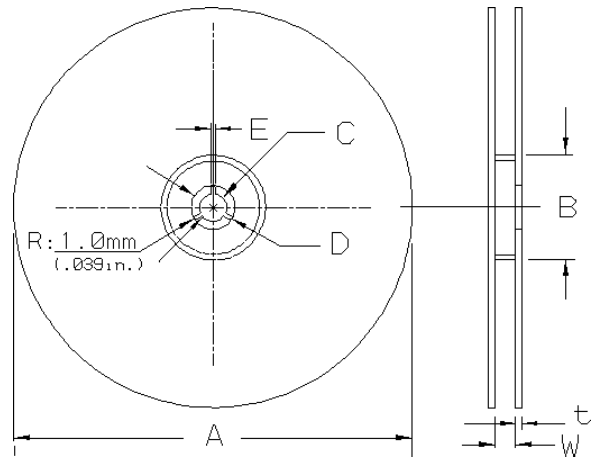
Reel Specifications



SPA Type	ESRL	ESRD (1.8 mm Ht.)	ESRD (2.8 mm Ht.)	ESRE
t ₂	1.4 ± 0.2	2.1 ± 0.2	3.4 ± 0.2	4.5 ± 0.2

W ± 0.3	E	F	Dø + 0.1/- 0.0	Pø	P ₁ ± 0.2	P ₂	A ± 0.2	B ± 0.2	t ₁
12	1.75	5.5	1.5	4	8	2	7.7	4.6	0.4

Tol.: ± 0.1 mm unless otherwise specified

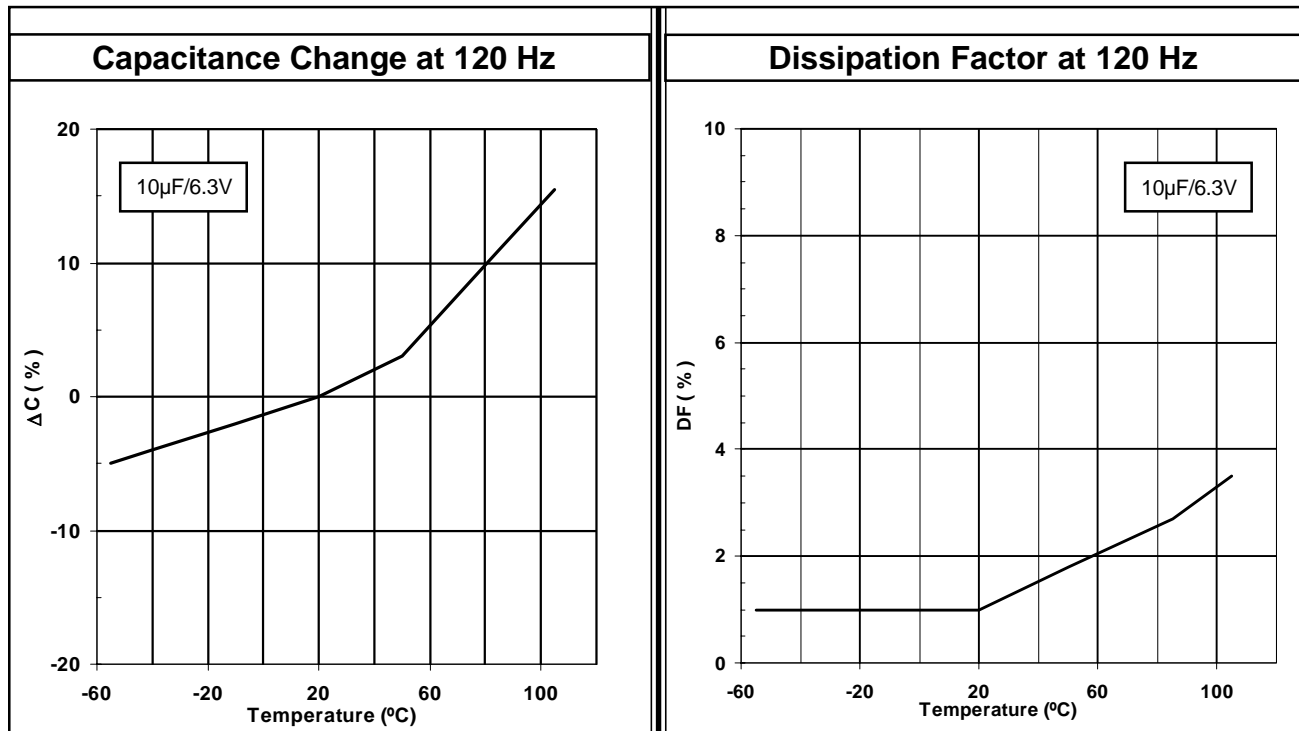


A ± 2	B min.	C ± 0.5	D ± 0.8	E ± 0.5	W ± 1	t
330	50	13.0	21.0	2.0	14	3

Design Kits

Design kits containing various ratings are available through the CDE Web site.

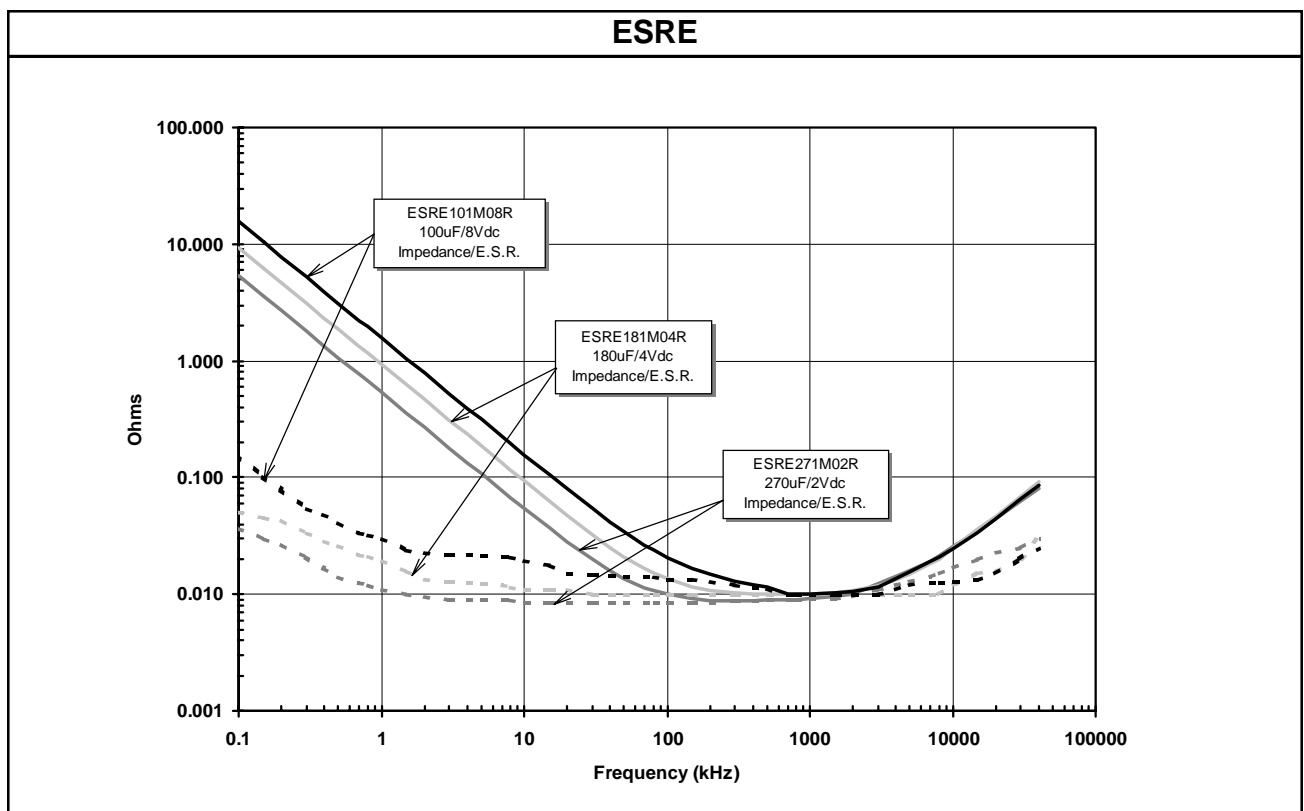
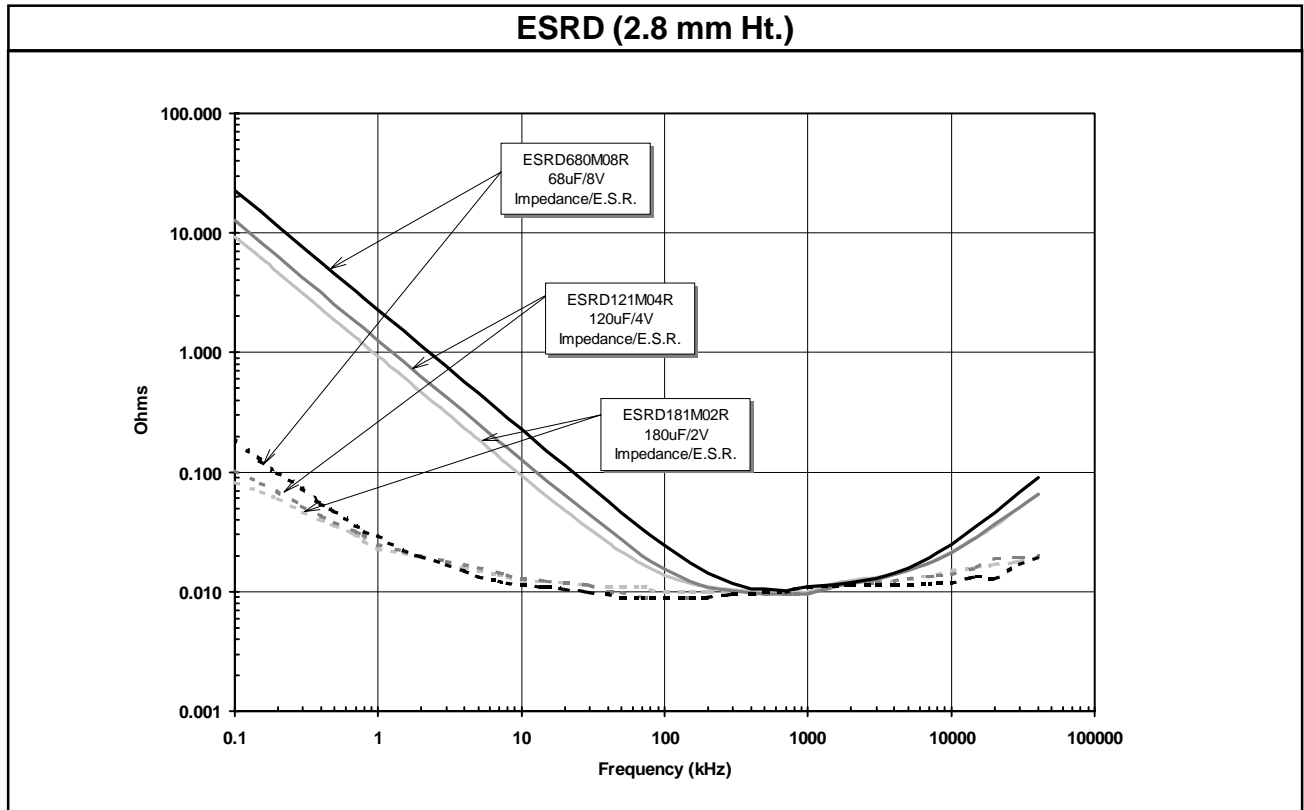
Typical Temperature Characteristics



SPA Capacitors

Solid Polymer Aluminum Capacitors

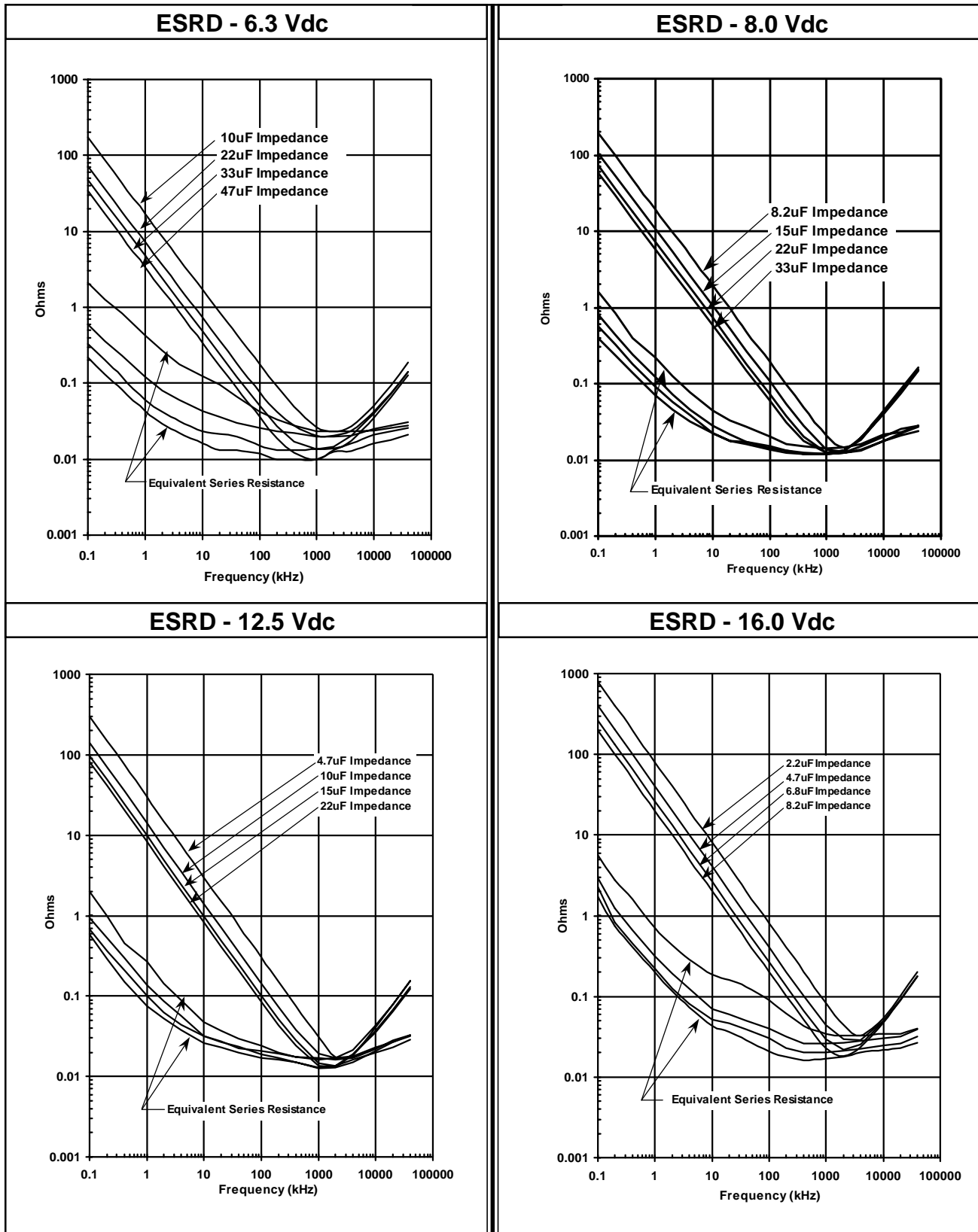
Typical Impedance and Equivalent Series Resistance



SPA Capacitors

Solid Polymer Aluminum Capacitors

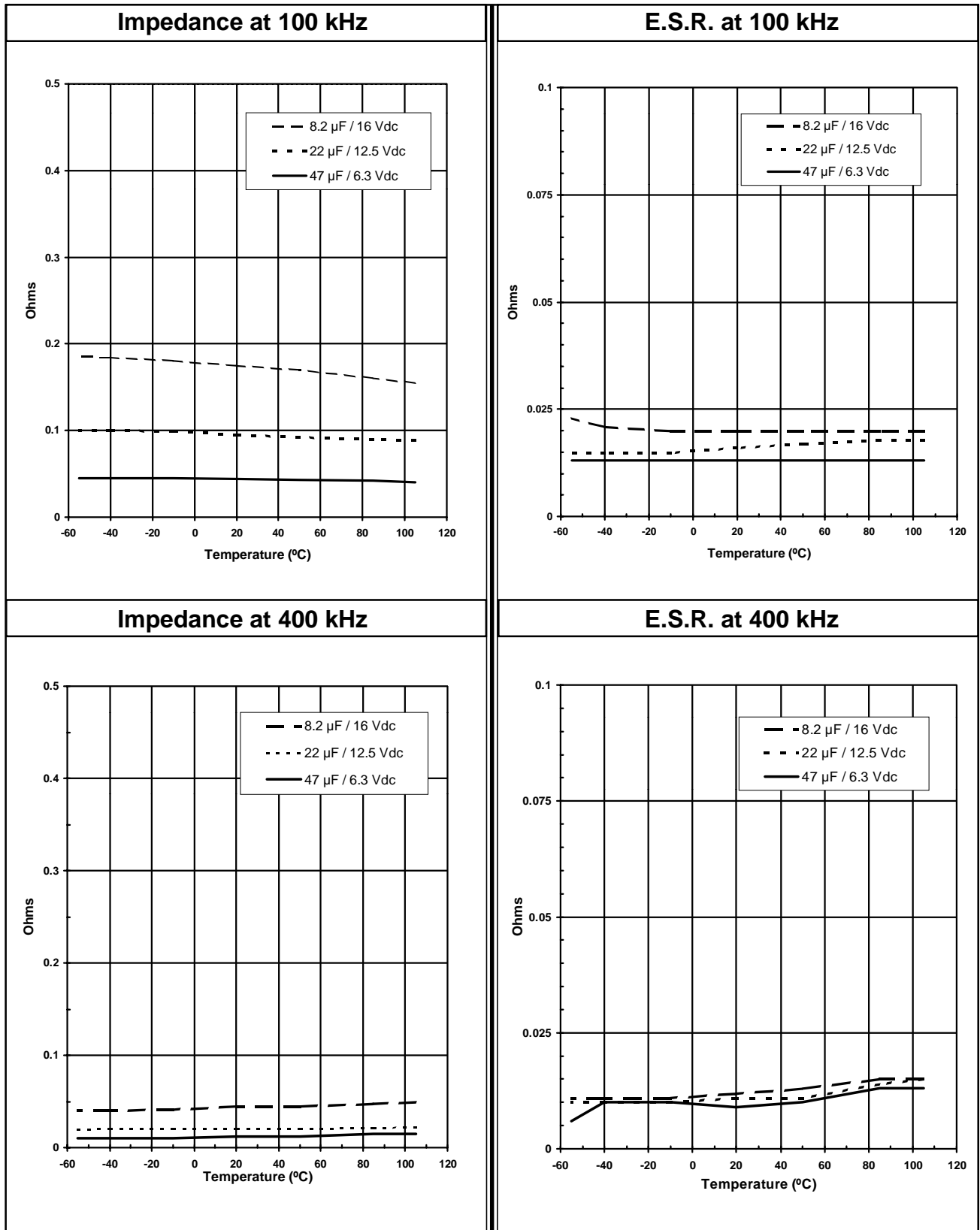
Typical Impedance and Equivalent Series Resistance



SPA Capacitors

Solid Polymer Aluminum Capacitors

Typical Temperature Characteristics

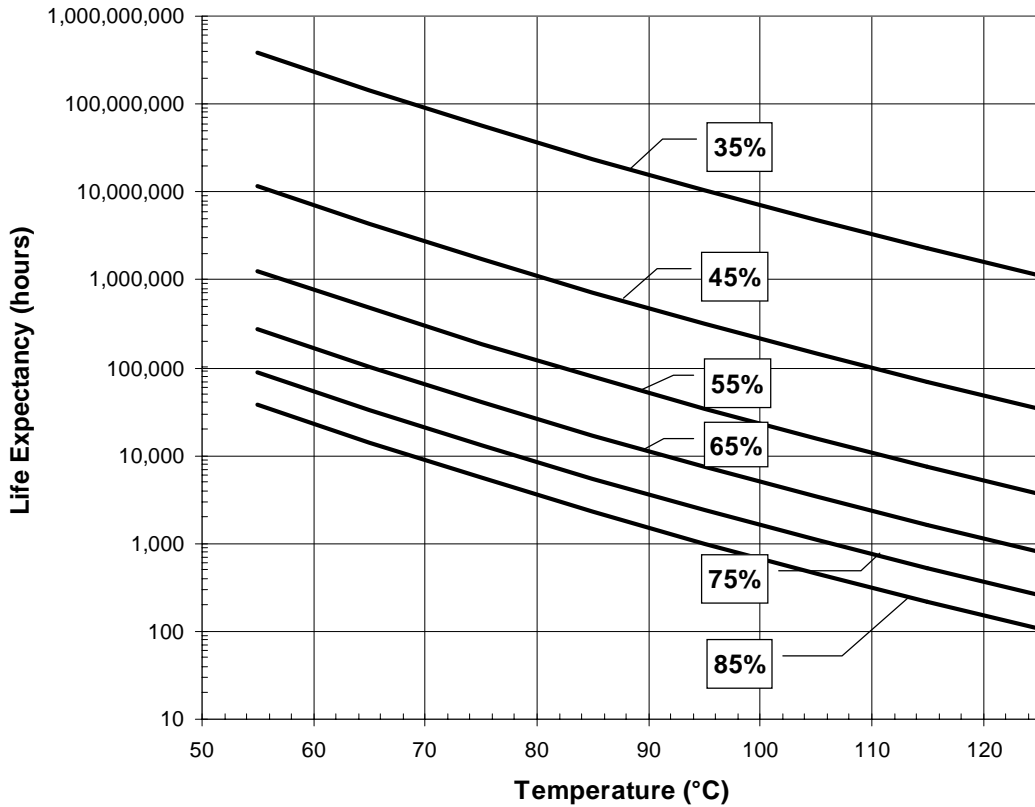


SPA Capacitors

Solid Polymer Aluminum Capacitors

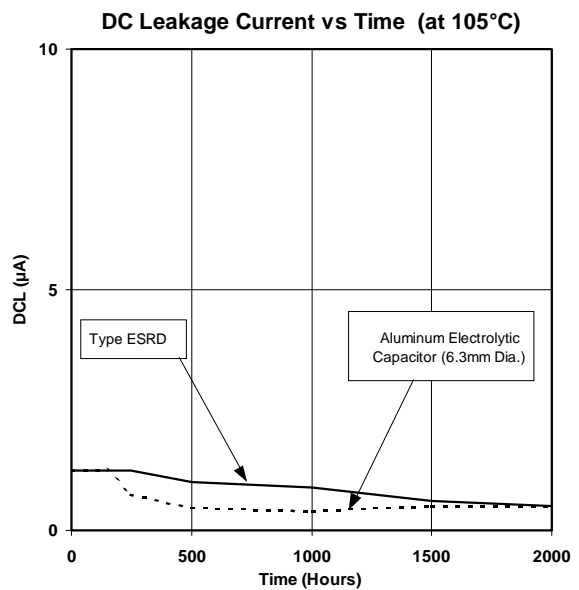
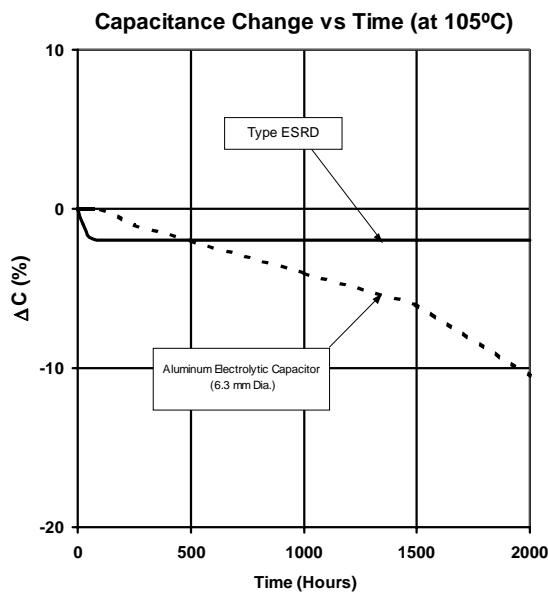
Life Expectancy

Life Expectancy vs Temperature and Relative Humidity



Note: Failure limit is 100% impedance increase at 400 kHz.

Endurance Test Data



SPA Capacitors

Solid Polymer Aluminum Capacitors

Application Notes

Rated Voltage

This is the maximum voltage that the capacitor has been designed to withstand continuously at rated temperature.

Solid polymer aluminum capacitors are quite rugged and may be operated continuously at rated voltage. Voltage derating does not significantly increase the life expectancy of the capacitor. At voltage levels equal to or less than rated voltage, the capacitor will not short circuit (even at end of life). In fact it can self heal. A polymer aluminum capacitor can be operated over a lifetime at full rated voltage without worry of short circuiting. However, if subjected to sufficient over voltage or reverse voltage, a SPA capacitor can fail short circuit.

Ripple Current/Ripple Voltage

AC voltage as part of the capacitor's DC bias voltage will cause current to flow through the capacitor. This ripple current flows through the capacitor's equivalent series resistance generating heat. The heat increases the capacitor's internal

temperature. Exceeding the specified maximum ripple current will overheat and damage the capacitor. The maximum ripple current ratings are given in the ratings tables.

Peaks of the AC ripple voltage should not exceed the rated voltage or cause voltage reversal.

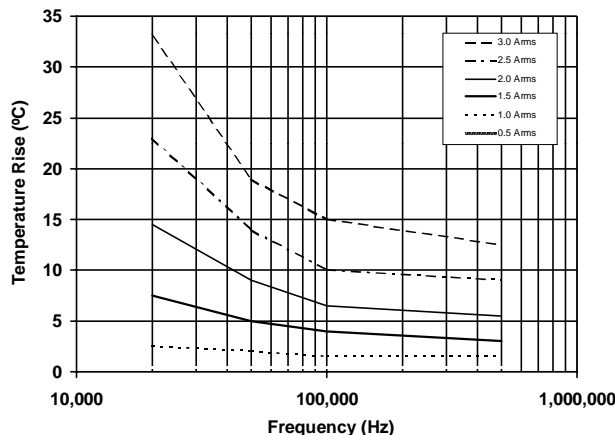
Reverse Voltage

SPA capacitors are polarized and are not intended to be used with reversed voltage. They can withstand reverse voltage pulses or transients up to 20% of the rated voltage, and they are capable of operating with up to 10% of the rated voltage when reverse voltage is applied continuously.

Shelf Life

When stored at room temperature, in low humidity, and out of direct sunlight, SPA capacitors have a storage life of 5 to 10 years. Storage at high humidity over long periods of time can cause the DC leakage current to increase. However, the application of rated voltage will reduce the DC leakage current to normal limits.

Temperature Rise from Ripple Current
(47 μ F/6.3Vdc)

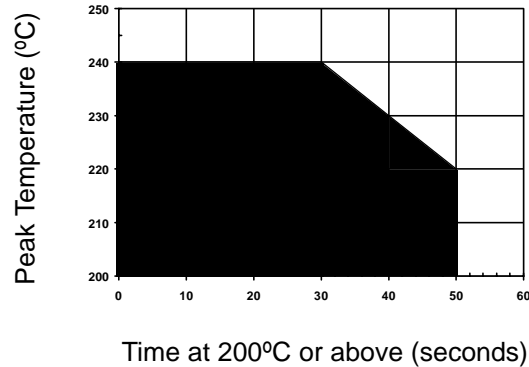
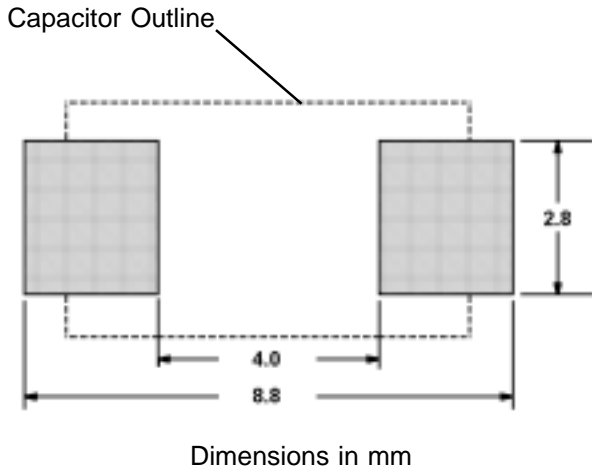


Ripple Current Frequency Multipliers							
Frequency (kHz)	10	20	50	100	250	500	1,000
Frequency Multipliers for Sine Wave Current +20 to +105°C	0.6	0.7	0.8	1.0	1.1	1.2	1.3

SPA Capacitors

Solid Polymer Aluminum Capacitors

Recommended Circuit Board Mounting Pads

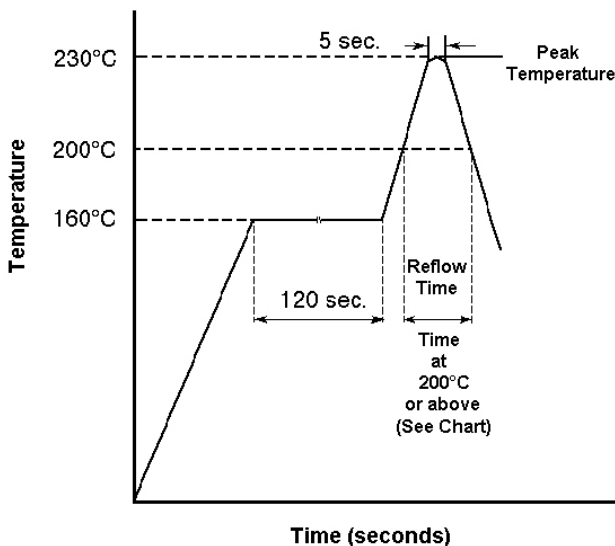


Reclamation

The resin case of a capacitor can be damaged by the heat stress of soldering if it has absorbed excessive moisture. Capacitors suspected of having been exposed to high humidity can be reclaimed by placing them in an oven at 50°C for 100 Hours.

Reflow Soldering

The following graph gives the maximum recommended capacitor surface temperature during reflow soldering.



Heat Stress while Soldering

DC leakage current can increase after soldering, but it will return to the initial level after applying voltage.

When using a soldering iron to mount the capacitor, the iron should have a maximum temperature of 350°C and soldering should not exceed 10 seconds.

Cleaning

The capacitors can withstand for 5 minutes at 60°C the following cleaning solvents by dipping or ultrasonic methods:

- Pine Alpha ST-100S
- Sunelec B-12
- DK Be-Clear CW-5790
- Aqua Cleaner 210SEP
- Cold Cleaner P3-375
- Telpen Cleaner EC-7R
- Clean-Thru 750H, 750L, and 710M
- Techno-Cleaner 219
- Techno-Care FRW-1, FRW-17, & FRV-1

After cleaning, wash the circuit board with water for about 3 minutes, and dry at 100°C for 20 minutes.

SPA Capacitors

Solid Polymer Aluminum Capacitors

Up to 50 Years Life

SPA SMT capacitors are polarized, aluminum capacitors which use a highly conductive solid polymer as the electrolyte. They have reliability advantages over both aluminum and solid tantalum electrolytic capacitors. Unlike aluminum capacitors, there is no liquid electrolyte that can evaporate and cause a failure. Unlike solid tantalum which can

fail short and burn, SPA capacitors gradually become open circuits after 25 to 50 years operation.

Life expectancy curves show 200,000 hours expected life at full rated voltage and normal ambient conditions.

Ultra Low E.S.R. and High Ripple Current Capability

The equivalent series resistance (e.s.r.) of solid polymer aluminum capacitors is much lower than the e.s.r. of solid tantalum capacitors. This results in a much higher ripple current handling capability. The e.s.r. is even lower than the new tantalum-polymer hybrid capacitors. SPA's ultra-low resistance magic is in the solid conductive polymer.

The series resistance of electrolytic capacitors is largely determined by the resistivity of the electrolyte. Because the resistivity of SPA's polymer electrolyte is several orders of magnitude less than that of other electrolytes, the equivalent series resistance is almost zero.

Construction

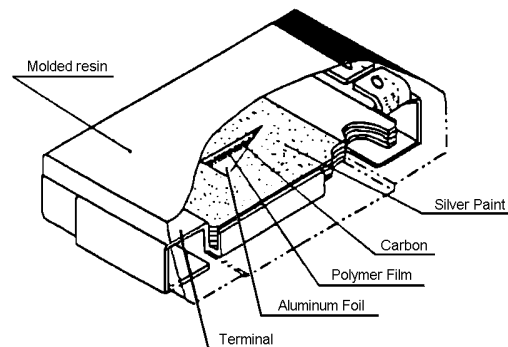
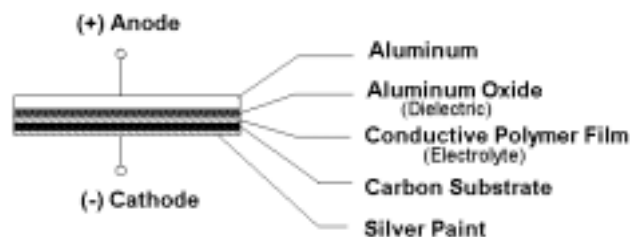
Construction is a unique combination of the elements of aluminum electrolytic and solid tantalum capacitors.

Like conventional aluminum electrolytic capacitors, the anode in SPA capacitors is an aluminum plate on which an aluminum oxide layer has been built up by an electrolysis process. The aluminum oxide serves as the dielectric in both SPA and conventional aluminum electrolytics.

The dielectric in solid tantalum capacitors is tantalum pentoxide which is built upon a tantalum pellet anode.

A highly conductive polymer electrolyte film is deposited over the aluminum oxide dielectric in SPA capacitors. Carbon and silver paint are used to finish the capacitor's cathode. This is similar to what is used in solid tantalum capacitors, where manganese dioxide is used as the electrolyte.

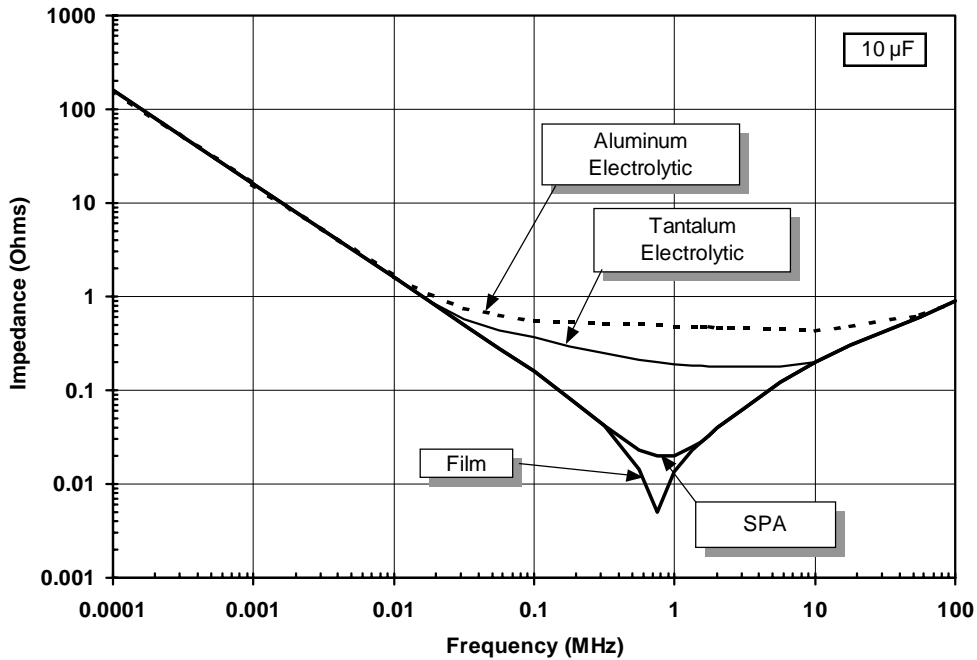
The capacitor element is encased in a molded resin that is capable of meeting the UL-94, V0 flammability rating. The terminals are solder coated copper clad steel.



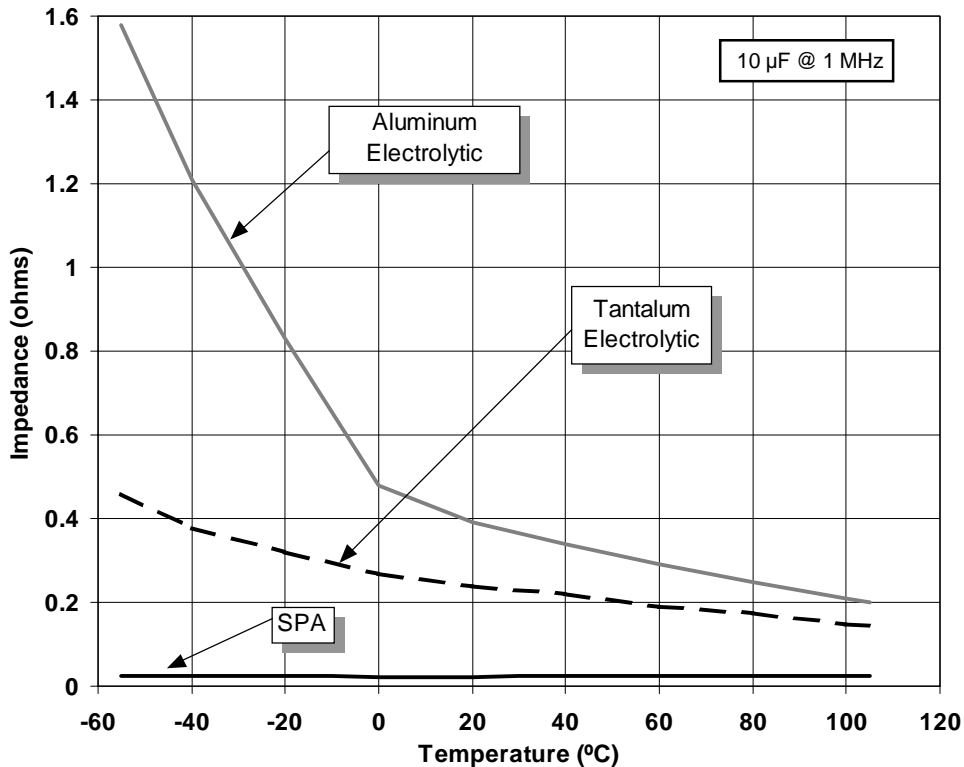
SPA Capacitors

Solid Polymer Aluminum Capacitors

SPA Compared to Other Electrolytics



SPA capacitors have lower impedance at high frequencies than the same values of wet electrolyte aluminum capacitors and solid tantalum capacitors.

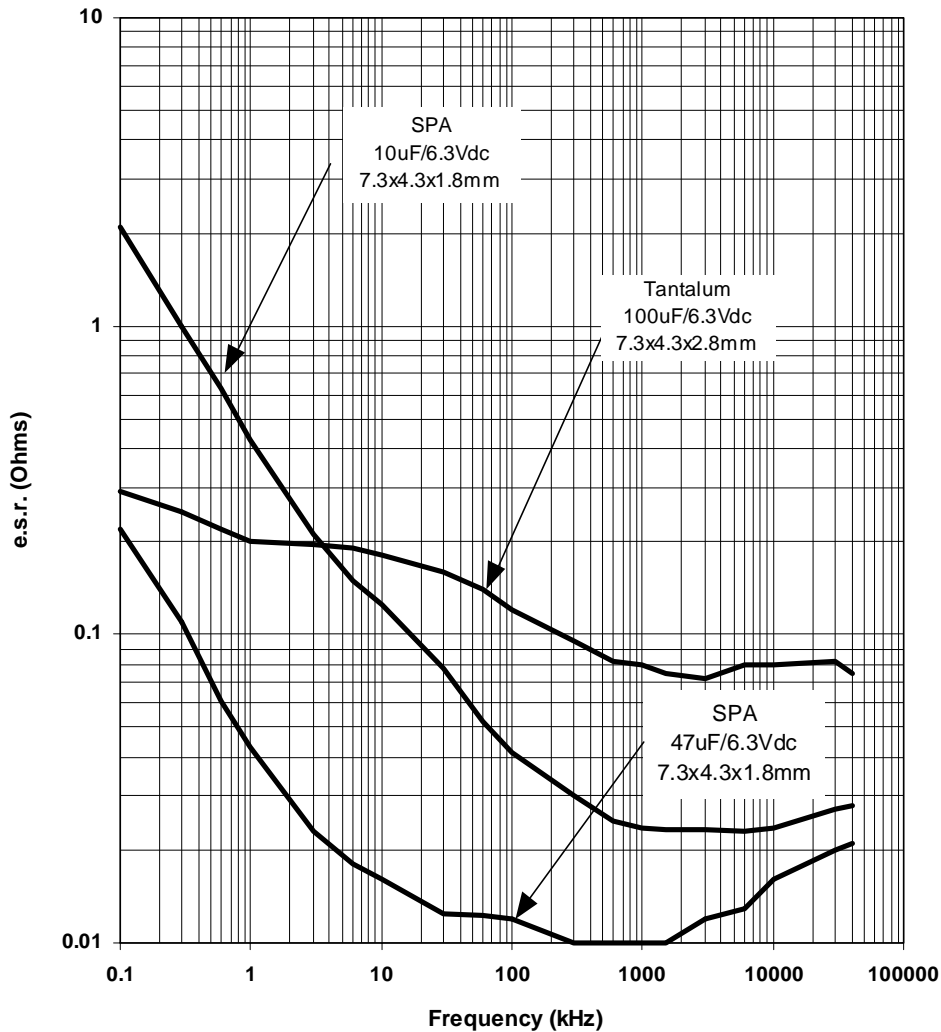


SPA capacitors have stable impedance over the entire temperature range.

SPA Capacitors

Solid Polymer Aluminum Capacitors

SPA vs Solid Tantalum



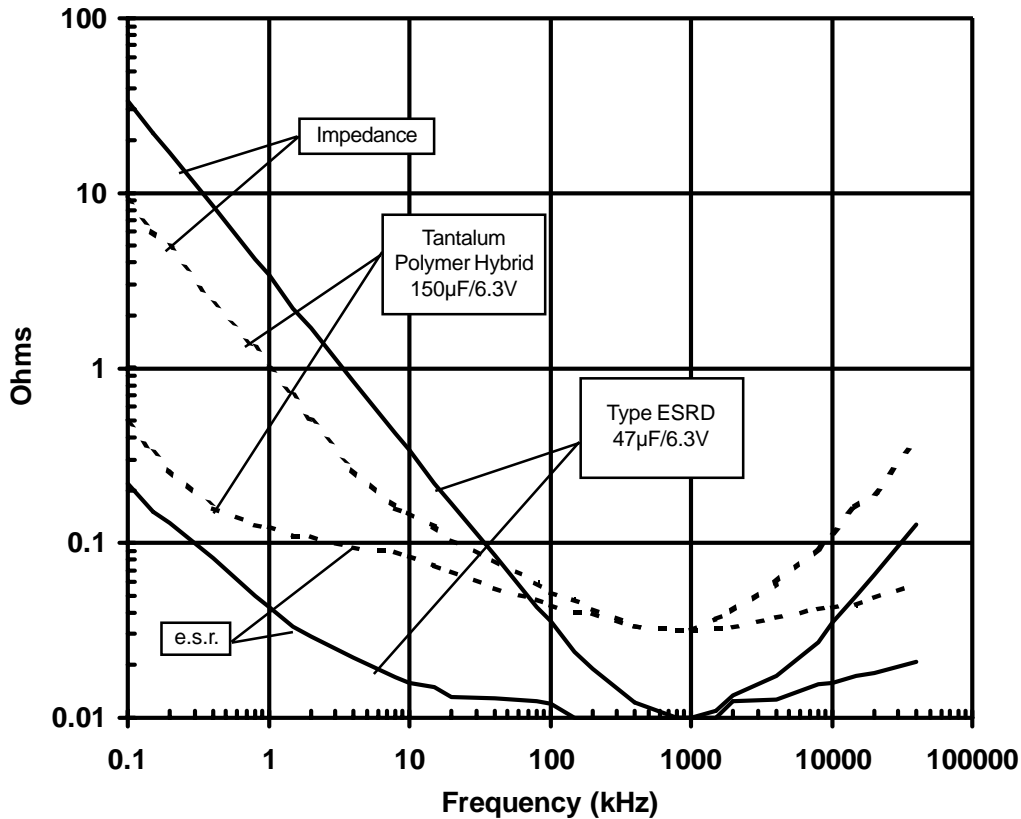
	100µF Tantalum Capacitor		47µF Solid Polymer Aluminum Electrolytic Capacitor	
Frequency	Equivalent series resistance (ohm)	Impedance Magnitude Z (ohm)	Equivalent series resistance (ohm)	Impedance Magnitude Z (ohm)
100kHz	0.12	0.12	0.012	0.035
1.0MHz	0.08	0.08	0.010	0.010
10MHz	0.08	0.19	0.016	0.035

At 1 MHz the Solid Polymer Aluminum capacitor will provide almost 8 times more ripple and noise attenuation (.08/.01) as compared to the tantalum capacitor.

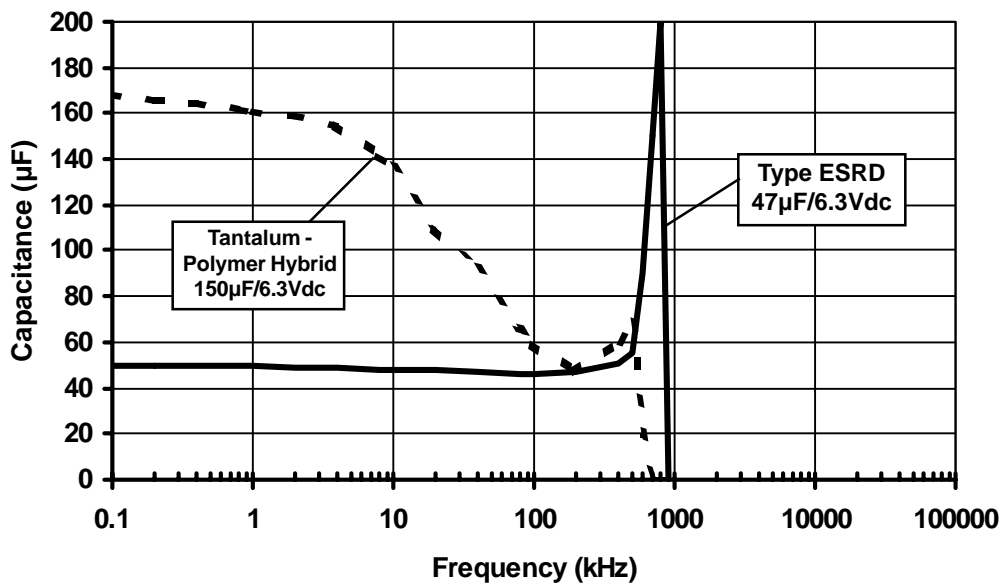
SPA Capacitors

Solid Polymer Aluminum Capacitors

SPA vs Tantalum-Polymer Hybrid



Type ESRD's impedance and equivalent series resistance are lower at high frequencies than that of tantalum-polymer hybrid type capacitors.



Note the capacitance roll off of the tantalum-polymer capacitor at high frequencies. The tantalum-polymer capacitor loses approximately 2/3 of its capacitance at 100kHz.