CapXon Professional

ELECTROLYTIC

CAPACITORS

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CapXon White Papers

Technology of
Conductive Polymer Capacitors
Conductive Hybrid Capacitors

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All kind of electronic devices have become an integral part of our daily life and have a significant influence on professional and private needs. Consumers are demanding robust, durable products that are environmentally friendly, low in energy consumption and, in addition, smaller, lighter as well more cost effective.

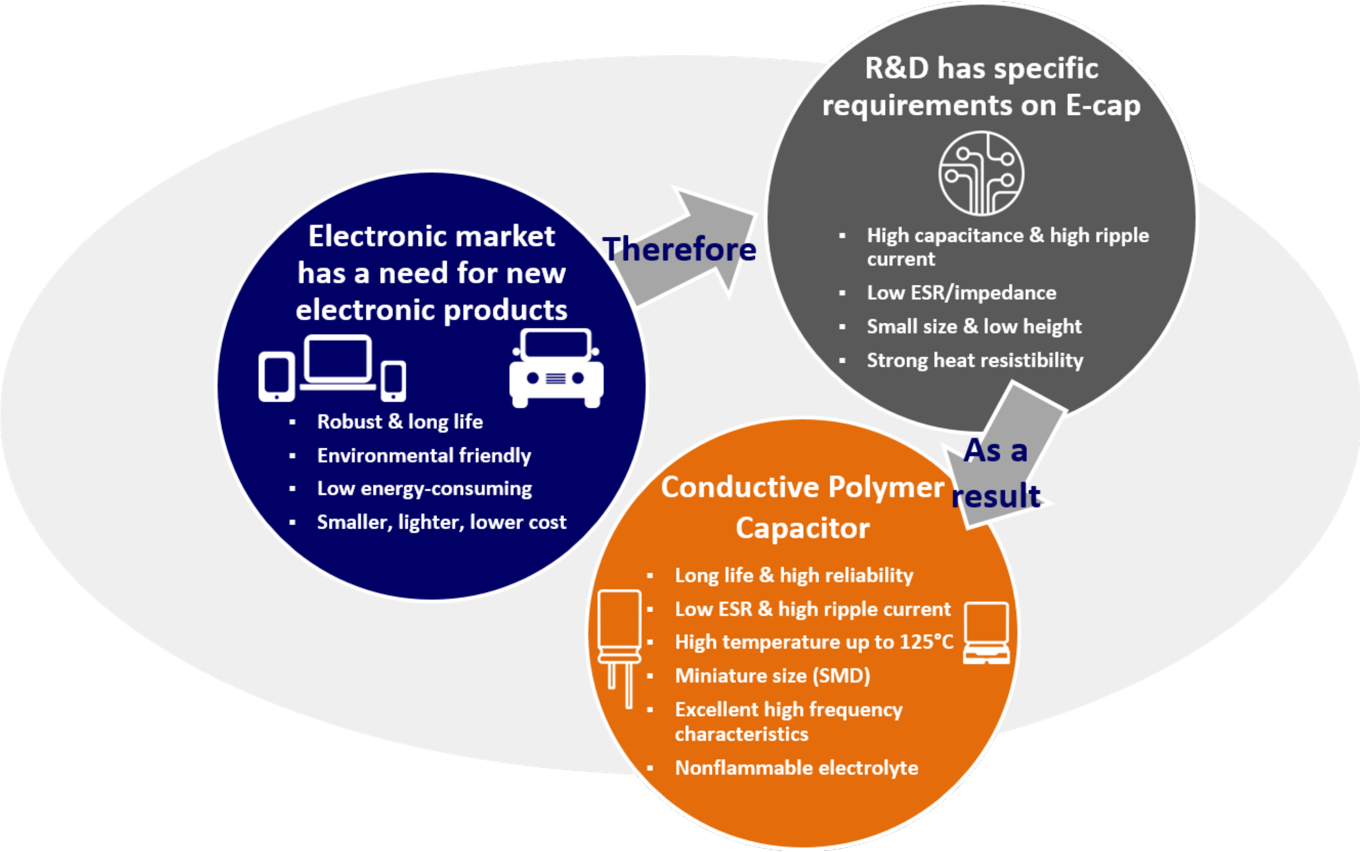


Fig. 1: Polymer capacitors for the requirements of today and tomorrow

Future-oriented electronic components are gaining ground to meet these demands and will increasingly outstrip existing technologies.

Passive devices - inductors, capacitors, or resistors - are often overshadowed by their active counterparts, discrete semiconductors, or integrated circuits, and are often viewed as easy-to-use components. The significantly lower purchase prices for passive components compared to active components do the rest to underestimate these difficult and complex to understand components.

The choice of capacitors with a variety of dielectrics make the developer of choice. Which capacitor for which application? In addition, the development of electronic components with new materials is progressing steadily, so that only a close examination and careful consideration of the respective design-specific advantages and disadvantages can lead to the desired success.

The demand for

- higher capacities and currents
- lower equivalent series resistance (ESR) or impedances
- Resistance even under high operating temperatures
- reduced dimensions and weight

keeps asking for new capacitor designs. Polymer or hybrid polymer capacitors use the properties of conductive plastic, the polymer. Simply put, this solid polymer replaces the liquid electrolyte, comparing this technology to that of conventional electrolytic capacitors. Particularly noteworthy is the high conductivity of the used polymer.

It is distinguished between pure polymer and the so-called hybrid polymer capacitors. Where in polymer capacitors only solid polymer is used as electrolyte and in hybrid polymer capacitors a combination of solid polymer with liquid electrolyte.

Both polymer and hybrid polymer designs offer many advantages over the widely used liquid electrolytic, tantalum, and ceramic capacitors when higher demands

- Long lifetimes
- Safety even in the event of a fault
- Stable electrical parameters over a long service life, temperature and frequency
- Reliability even under extreme operating conditions
- Consideration of the total costs

are made.

POLYMER CPACITORS FROM CAPXON

CapXon develops and manufactures both technologies of polymer capacitors. Due to the different properties due to the design, these can be used for a wide variety of applications.

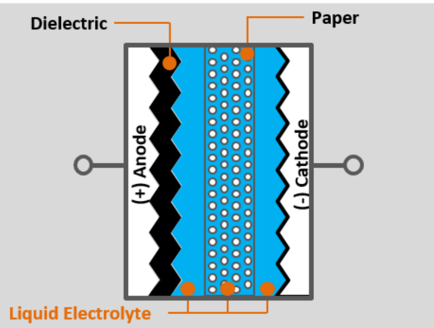
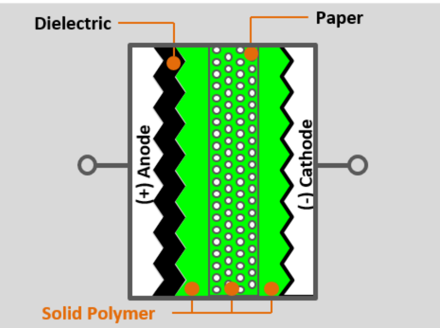
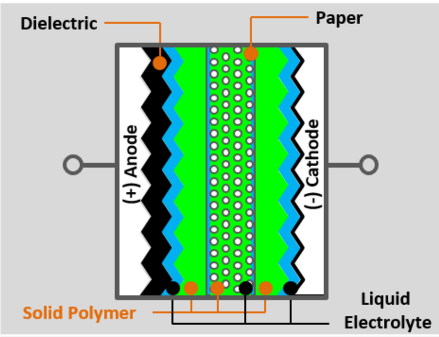
Liquid Electrolyt	Conductive Polymer	Hybrid Polymer
		
4 to 650 V	2.5 to 400 V	16 to 100 V
Lowest cost	Highest ripple current	Similar ESR as conductive polymer capacitor
Reduced performance at low temperature	Stable for high and low temperature	More stable than liquid type
Limited life@high temperature	Very stable life	Lower leakage current than conductive polymer capacitor

Fig. 2: Principle structure of aluminum capacitors with different electrolytes

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In **polymer electrolytic capacitors**, a solid, conductive polymer is used as the electrolyte. Together with the aluminum power supply foil, it forms the cathode of the capacitor. The anode is also designed as an aluminum current supply foil. Both foils are structured by etching and thus achieve a larger surface area and thus a higher capacitance in the capacitor. On the anode side, the dielectric is formed by a wafer-thin aluminum oxide layer (Al_2O_3) on the etched surface. The construction of film, paper and electrolyte is carried out as a capacitor winding and assembled in a radial variant for through-hole technology (THT) or surface mountable in SMD. Depending on size and series, these capacitors provide capacities between 4.7-3900µF and are available in a voltage range of 2.5-400V. The key feature of our polymer capacitors is their ultra-low equivalent series resistance (ESR) of 7mΩ, measured at 100kHz and allowed ripple currents of 7.1A in can sizes 8x11.5mm and 10x12.5mm.

Polymer hybrid capacitors use a combination of liquid and solid electrolyte. So, the properties of liquid electrolytic capacitors are combined with those of solid polymer capacitors and this combination offers the best technical compromise from the two electrolytes.

Since the conductivity of polymer materials is several thousand times better than that of liquid electrolytes, this results in low ESR.

The liquid electrolyte film additionally contained in the hybrids combines optimally between the open-pored structure of the dielectric located on the aluminum foil and the polymer electrolyte. This results in a larger effective capacitor surface than in the solid polymer types. They are available in the capacitance range from 10 to 560µF and voltages between 16 to 100V. Due to the lower conductivity of the electrolyte film, their ESR values are a little higher compared to those of their "solid" polymer brothers with 14 to 120mΩ compared to conventional liquid electrolytic capacitors (80 to 440mΩ for comparable dimensions), but very low. This is particularly noticeable in applications with high output power.

Technology	Conductive Polymer	Hybrid Polymer
Capacitance	4.7µF – 3900µF	10µF – 560µF
Rated voltage	2.5V – 400V	16V – 100V
Max. temperatur	105°C / 125°C	105°C / 125°C
ESR	7mΩ - 120mΩ	14mΩ - 120mΩ

Table 1: Value ranges of electrolytic capacitors with solid polymer and hybrid capacitors

WHY USE POLYMER CAPACITORS?

The very low ESR values have already been mentioned several times, so that we now want to pay more attention to this as well as the other positive electrical properties.

STABILITY OF THE ELECTRICAL PARAMETERS OVER A LONG PERIOD OF USE

If you compare the polymer or polymer hybrid technology with other capacitors designs, the advantages become clear.

The capacitance of **ceramic capacitors** reduces for high capacitance types with the applied voltage.

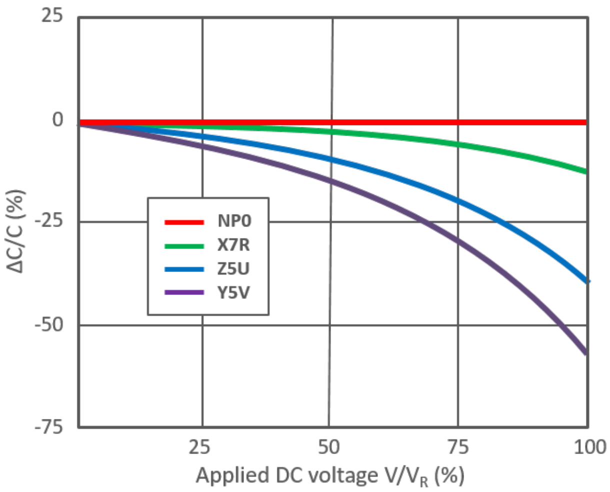

Fig. 3: Change in capacitance of different ceramics as a function of applied voltage for a 25V capacitor

Ceramics of class 2, such as X5R, X7R, Y4T or Z5U, are used as the starting material for the dielectric, since, in contrast to class 1, ceramics such as NPO (COG) have a significantly higher relative permittivity ε_r and thereby make higher capacitance values possible.

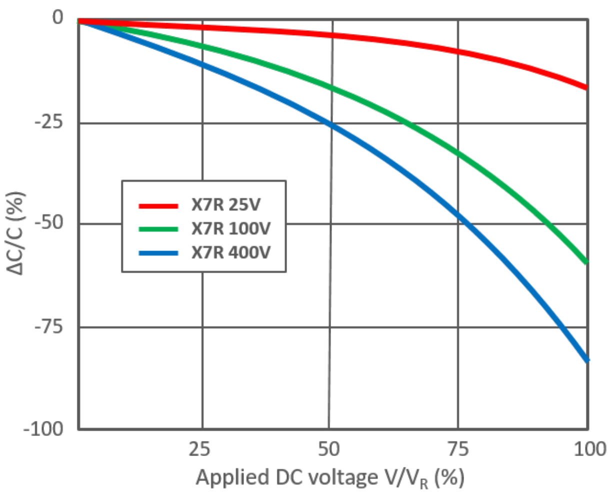

Fig. 4: Change in capacitance for X7R ceramics at different rated voltages

The other side of the coin, however, is that class 2 ceramics are ferroelectric materials, the higher the voltage applied, the lower the permittivity. The capacitance measured or applied at higher voltage may drop to -80% of the value measured with the standardized measurement voltage of 0.5 or 1.0V. What that means for the circuit in filters or memory applications need not be further elaborated here. This is the reason for harmonic distortions in audio applications.

In addition to the voltage dependence, the large temperature coefficient and thus the temperature dependence of class 2 ceramics add to the difficulty. Depending on the used material, the capacitance can drift by -80% over the entire temperature range, e.g. from -40 °C to + 85 °C!

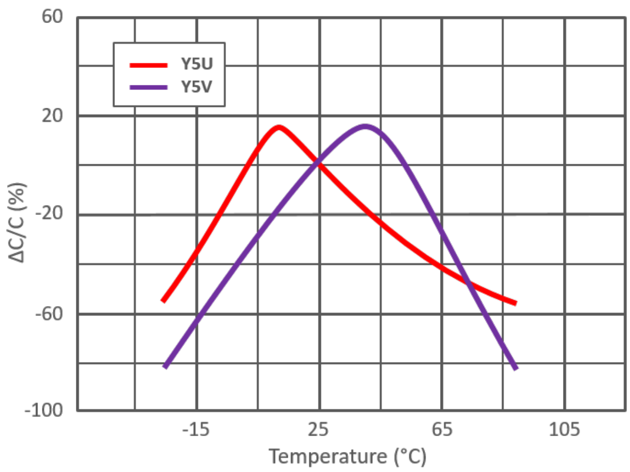

Fig. 5: Change in the capacity of different ceramics as a function of the applied temperature

Another point is aging, so the decrease in capacity over time. For Class 2 ferroelectric ceramic capacitors, this behavior is called "aging". It occurs in ferroelectric dielectrics where domains of polarization in the dielectric contribute to the overall polarization. Their degradation in the dielectric reduces the relative permittivity ε_r over time, so that the capacitance of ceramic capacitors of class 2 decreases.

Polymer capacitors do not exhibit such behavior and behave stably over temperature, time, and applied voltage (see Figures 6 and 7).

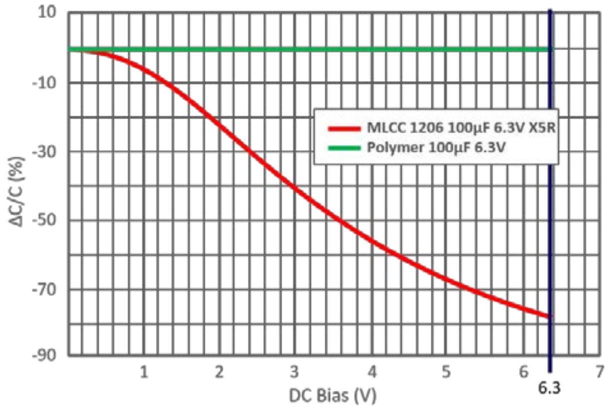

Fig. 6: Change in capacitance as a function of the applied voltage for an MLCC and a polymer capacitor

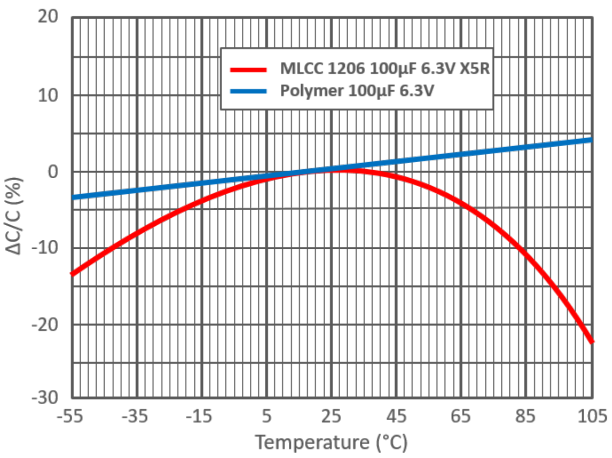

Fig. 7: Change in capacitance as a function of temperature for a MLCC and a polymer capacitor

Applications in the automotive or industrial environment such as electric drives, regenerative energy production (solar, wind, etc.), the devices and thus the electronic components are often exposed to adverse environmental conditions and large temperature fluctuations. If the capacitance values fall very sharply as described in the previous chapter, this can lead to malfunctions during operation or in the worst case to field failures, which is why ceramic capacitors are only of limited suitability for such purposes.

	Worst case	Al Polymer 100 µF 6.3V ±20%	MLCC 100 µF 6.3V ±20% X5R
Nominal Wert		100 µF	100 µF
Nominal Tolerance	Polymer: -20% MLCC: -20%	80 µF	80 µF
ΔC/C (DC Bias) at 6.3V	Polymer: 0 MLCC: -75%	80 µF	20 µF
ΔC/C (Temp.) at 85°C	Polymer: +5% MLCC: -15%	84 µF	17 µF
Result		**84 µF**	**17 µF**

Table 2: Worst case consideration of the capacity decrease of MLCC compared to aluminum polymer capacitors

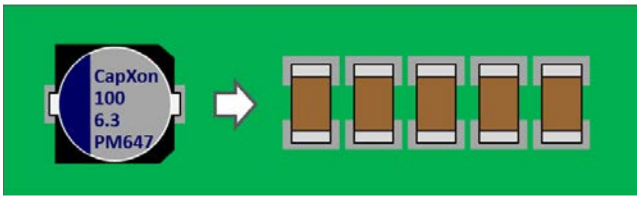

Fig. 8: A polymer capacitor replaces five high-capacity MLCCs

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HOW IS IT WITH LIQUID ELECTROLYTIC CAPACITORS?

Even aluminum capacitors with liquid electrolyte are always a compromise for such applications, because of their high-volume capacity often their design-related disadvantages are overlooked. Due to the liquid electrolyte, the capacitor properties are very dependent on the temperature, since the movement of the charge carriers is directly dependent on the viscosity of the electrolyte.

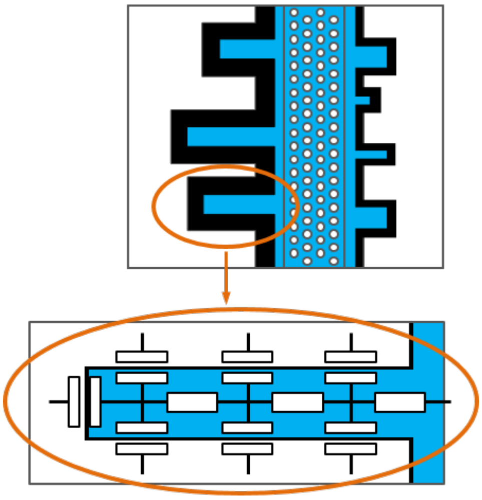

Fig. 9: Tunnelling capacity of liquid electrolyte capacitors

In addition, the electrolyte resistance with the tunnel capacitances etched into the aluminum foil forms an RC network. At high frequencies, the tunnel capacity no longer contributes to total capacity and thus ensures a strong capacity reduction over frequency.

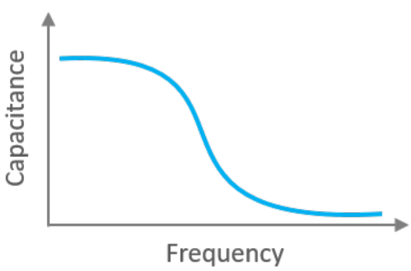

Fig. 10: Capacity reduction over frequency for liquid electrolytic capacitors

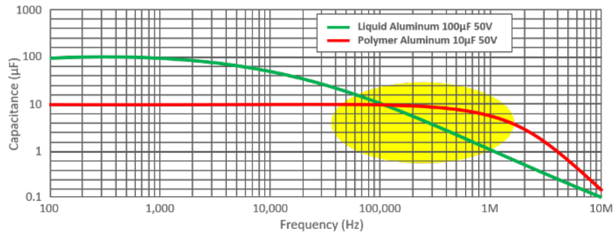

Fig. 11: Dependence of the capacity on the frequency for liquid electrolyte and polymer capacitors

A typical capacity curve over frequency shows figure 11. The capacity of the liquid electrolyte capacitor degrades strongly at higher frequencies. At 100kHz, only 10µF of the 100µF nominal capacity is left. Especially in the yellow area, therefore between 100kHz to the MHz range, such capacitors are only conditionally suitable while polymer capacitors retain their capacity.

AND WHAT'S WITH TANTAL CAPACITORS?

Tantalum capacitors with MnO_2 manganese dioxide electrolytes must be operated at a reduced voltage of 50% of their rated voltage, to ensure safe use. This means a maximum DC voltage of 25V, for a 50V component, which should not be overlaid with additional voltage ripple, otherwise the capacitors will fail early. Such a decrease of the threshold voltage means an increase in the case size and raises the cost of the component.

	Output filter	Input filter
Capacitor rated voltage	Maximum permissible operating voltage	Maximum permissible operating voltage
4.0 V	2.5 V	2.5 V
6.3 V	3.6 V	3.3 V
10 V	6.0 V	5.0 V
16 V	10 V	6.0 V
20 V	12 V	10 V
25 V	15 V	12 V
35 V	24 V	15 V
50 V	28 V	24 V
63 V	36 V	31 V

Table 3: Recommended voltage reduction for tantalum capacitors at operating temperatures below 85°C

In addition to the reduced threshold voltage, the high-frequency characteristics of tantalum capacitors must also be considered, for example when used as a smoothing capacitor in high-speed DC / DC converters. Their capacity drift is very much frequency-dependent, which must be taken into account in the circuit dimensioning.

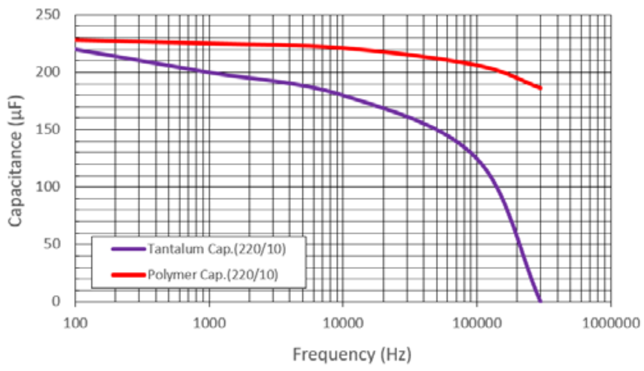

Fig. 12: Capacity dependence of frequency for tantalum and aluminum polymer capacitors

A high capacity drift over frequency necessitates a higher nominal capacity, which has a negative effect on the costs and the space aspect. With a required capacity of 1500µF and 100kHz switching frequency 12 pieces of tantalum capacitors but only 8 pieces of aluminum polymer capacitors must be used in the above example.

Capacitor	Tantalum 220 µF 10 V	Conductive Polymer 220 µF 10 V
Capacitance at 100 kHz	125 µF	206 µF
Required capacitance at 100kHz	1500 µF	1500 µF
Required quantity	**12 pcs**	**8 pcs**

Table 4: Number of required capacitors for the required total capacity of 1500µF at a frequency of 100kHz

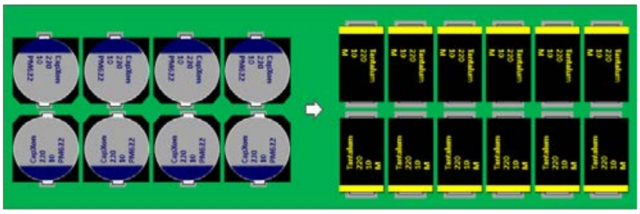

Fig. 13: Size comparison of polymer to tantalum capacitors

Due to their design, polymer or polymer hybrid capacitors make a significant contribution to guaranteeing the required capacity over a wide temperature range, at high frequencies and at the nominal voltages specified for them.

EXTREMELY LONG LIFE

In order to achieve a high capacity in the smallest space at the same time acceptable costs remained so far only the way to use aluminum capacitors with liquid electrolyte.

Apart from the temperature and frequency-related disadvantages, the lifetime of these capacitors must always be considered. Where heat generated by ohmic losses is immaterial-for example, in timer circuits is possible to make a lifetime consideration using Arrhenius's rule of thumb. That a doubling of the service life is achieved with 10°C temperature reduction of the electrolytic capacitor. This simplified consideration is not possible for a capacitor in a power supply, since the temperature rise due to ohmic losses during charging and discharging can't be neglected. The relevant influence of the alternating current must be taken into account.

The use of a liquid electrolyte results in changes in electrical properties over time.

Even at room temperature it comes to outgassing of parts of the electrolyte, which diffuses despite the sealed housing through the seal rubber.

As a result, an aluminum electrolytic capacitor slowly but constantly loses electrolyte during the time - the component is drying out. The lower the temperature of the capacitor, the slower the desiccation process, hence a longer life.

The ambient temperature and the heat development due to resistive losses during current flow determine the temperature of the electrolytic capacitor and thus the desiccation process. By decreasing the amount of liquid electrolyte in the capacitors, Ohmic Losses (ESR) increase because there is less electrolyte that handles charge carrier transport to and from the anode. At the same time, the capacity decreases because the electrolyte is no longer in contact with all the pores of the entire surface on the etched anode.

With **polymer capacitors**, the solid electrolyte can’t dry out, either by the ambient temperature or the temperature rise in the capacitor. Only the influence of materials due to the temperature in the component and the conversion of the conductivity limit the service life. The Arrhenius rule, also applies to polymer capacitors their application. The lifetime increases **ten-times** when the temperature of the capacitor is reduced by 20° C.

Liquid E-Cap	Hybrid Conductive Polymer	Conductive Polymer
$L_x = L_0 \cdot 2^{\frac{T_0 + \Delta T_0 - T_x - \Delta T_x}{10K}}$	$L_x = L_0 \cdot 2^{\frac{T_0 + \Delta T_0 - T_x - \Delta T_x}{10K}}$	$L_x = L_0 \cdot 10^{\frac{T_0 + \Delta T_0 - T_x - \Delta T_x}{20K}}$
10°C lower temperature = double lifetime	**10°C lower temperature = double lifetime**	**20°C lower temperature = 10 x lifetime**
2000 hrs @ 105°C, guaranteed At 65°C lifetime: 32000 hrs or 3.7 years	**2000 hrs @ 105°C, guaranteed At 65°C lifetime: 32000 hrs or 3.7 years**	**2000 hrs @ 105°C, guaranteed At 65°C lifetime: 200000 hrs or 22.8 years**

Fig. 14: Comparison of the lifetimes of electrolytic capacitors with liquid and solid, conductive polymers, considering the ambient temperature and the additional heating of the application current.

L_x : Expected life period (hrs) at actual application temperature

L_0 : Specified life period (hrs) at maximum allowed capacitor temperature, ripple current and voltage **(datasheet)**

T_0 : Maximum allowed capacitor temperature (°C) **(datasheet)**

T_x : Actual application temperature (°C)

ΔT_0: Core temperature increase (°C) by internal heating due to rated maximum permissible ripple current

ΔT_x: Core temperature increase (°C) by internal heating due to actual operating ripple current

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SAFETY ISSUES

In the case of ordinary aluminum capacitors with liquid electrolytes, damage to the oxide layer may occur due to mechanical or electrical overstress. Vibrations due to shock or mechanical stress on the one hand, stress levels above the specified rated voltage, or excessive AC load on the other, can, in the worst case, cause the capacitor to short circuit and possibly result in failure of the complete device.

Even ceramic SMD multilayer capacitors (MLCC) are only partially immune to mechanical stress. Due to their wafer-thin ceramic layers in high-capacitive types, about 200 to 300 layers with a thickness of a few microns, it may be due to excessive PCB bends for touching the electrodes and ultimately to short circuit. **The capacitor ignites and burns like a match.**

Solid-conductive polymer capacitors provide extremely **high levels of safety** in the event of a fault, such as the breakthrough of the alumina dielectric.

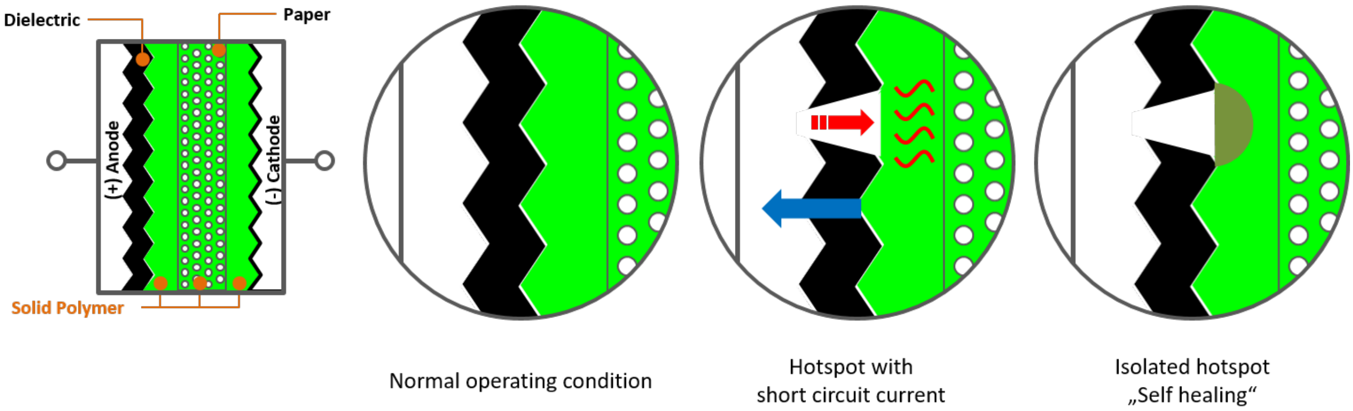


Fig. 15: Self-healing properties of polymer capacitors

At the point of breakdown there is an increased flow of residual current and a local hotspot of the damaged area. The polymer heats up so much that it becomes highly resistive and evaporates. The breakdown is thus isolated and decoupled from the rest of the material. Like film capacitors is spoken by **"SELF-HEALING"**. However, it should not be concealed that the healed place is no longer available for the capacity of the capacitor.

Hybrid polymer capacitors contain in addition to the conductive plastic still a small proportion of a liquid electrolyte. This effect a current flow at the disruptive discharge point, which in turn causes an oxidation of the dielectric and the formerly damaged spot makes electrically usable again.

	Liquid E-Cap	Polymer E-Cap	Hybrid E-Cap
Cap. Recovery @ high frequency	×	◎	○
ESR@ high frequency	×	◎	○
Leakage current	◎	△	◎
High ripple current	×	◎	△
High rated voltage	◎	△	△
Temperature characteristics	×	◎	○
Low temperarture characteristics	×	◎	○
Life time	△	◎	○
Failure mode	Open	Short	Open

Excellent > inferior ◎ > ○ > △ > ×

Table 5: Comparison of liquid electrolyte, hybrid polymer and polymer capacitors

APPLICATIONS

The technical advantages of polymer and hybrid polymer capacitors have been explained above. In the above statements. In the following sections, we will look at the versatile fields of application of polymer technology and their benefits in applications.

DECOUPLING

Digital ICs require pulsed high currents during their operation, which contain harmonics, so that in some circumstances the supply voltage breaks down. This would have serious consequences for the other circuit parts. The decoupling capacitor stores energy and must be able to deliver it very quickly. So, it buffers and keeps the voltage stable for the circuit. In addition, he has the task for the harmonics to form a short loop to prevent backflow via the supply line. If it is not present or not able to dissipate the harmonics, a large harmonic current loop is created from the IC to the supply line and the resulting antennas produce very high emission noise. A good decoupling capacitor must have a sufficiently large capacitance and a very low impedance. It effectively prevents the AC component produced by the IC from flowing into the source.

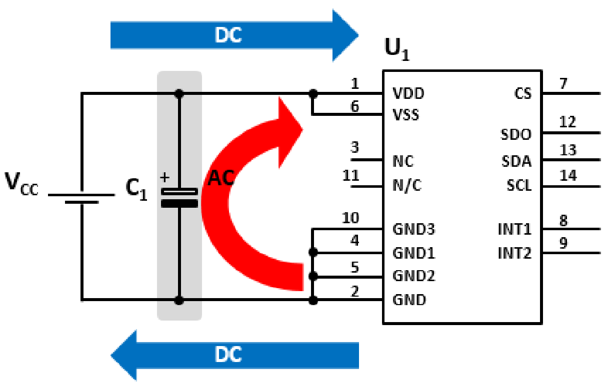
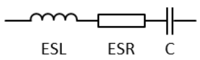


Fig. 16: Function of a decoupling capacitor

The impedance Z of a real capacitor is composed of the capacitive (XC), resistive (ESR) and inductive (XL) reactance. It is calculated using the following equation and displayed using the simplified equivalent circuit diagram.



$$Z = \sqrt{\left(\frac{1}{\omega \cdot C} - \omega \cdot L\right)^2 + ESR^2}$$

Fig. 17: Simplified equivalent circuit diagram and impedance equation of a real capacitor

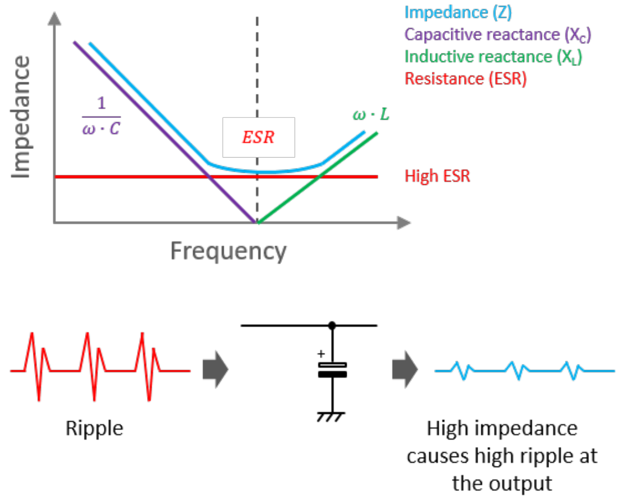


Fig. 18: Impedance curve of a liquid electrolytic capacitor and effect on AC ripple

The impedance curve of polymer capacitors is like that of an ideal capacitor. Due to the extremely low impedance near the resonance frequency (dashed grey line), caused by the significantly lower ESR, this technology is ideally suited as a decoupling to filter harmonics in digital, static and audio applications. The AC ripple is many times lower compared to tantalum capacitors or liquid electrolytic capacitors.

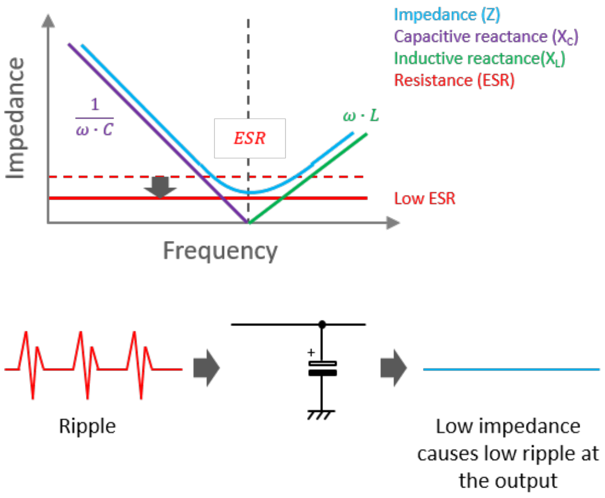


Fig. 19: Impedance curve of a polymer capacitor and effect on AC ripple

BACK UP CIRCUITS

Liquid aluminum E-caps, even low ESR types, can't respond to high-speed load changes at high currents due to the ESR. The high ESR prevents fast electrical charge and discharge of the capacitance. Polymer capacitors with their extremely low ESR of up to 7mΩ can respond to high power requirements and to compensate for load changes quickly. The polymer material supports the stable operation of the load. Typical applications are back-up circuits of microprocessors, CPUs or FPGAs where the power requirement between 5A and 100A can be in microseconds.

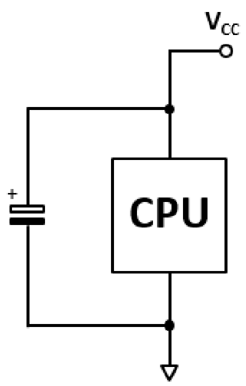


Fig. 20: Typical back-up circuit of a central processor unit (CPU)

- Low ESR allows fast loading and unloading
- Able to respond to high current transitions at high speed
- Polymer supports the stable operation of the charge

SMOOTHING

Electronic assemblies for industrial applications such as renewable energy inverters (solar / wind), motor drives or switch mode power supplies are predestined for polymer capacitors due to their harsh environmental conditions and requirements. The ESR is not temperature dependent, allowing safe operation within the temperature range specified for the capacitor.

Industrial devices, unlike consumer products, are designed for a long-term period. A good example are solar inverters which should work safely and reliably for up to 20 years. The power electronics contained therein, consisting of a DC / DC converter, DC link and AC / DC converter, are controlled by means of control units via digital signal processors (DSP). For the supply of the control units, corresponding DC / DC converters are required, which are made of high voltage sources, e.g. generate 15V voltage.

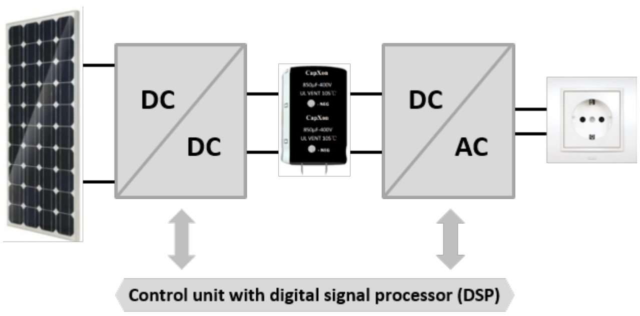


Fig. 21: Block diagram of a solar inverter

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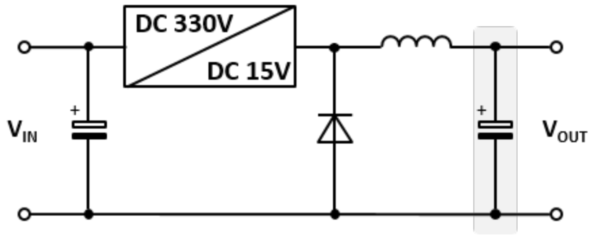

Fig. 22: Power supply of the DSP

Typically, ceramic capacitors MLCC or liquid aluminum E-caps are used as the output capacitor for the control unit of a power supply (15V DC side).

However, in MLCC, their capacity dependency on temperature and applied voltage negatively affects the ambient conditions. Liquid aluminum e-caps are to design very accurate into the application due to their limited lifetime.

The capacity of the polymer capacitors does not decrease by the applied voltage or the ambient temperature. At the same time, they offer a 10-time lifetime increase when reducing their ambient temperature by 20°C.

Polymer offers:

- Stable electrical properties over years
- No capacity drift over temperature or applied voltage
- Can be used even at very low temperatures

Polymer E-Cap	Liquid E-Cap
105 °C → 2,000 h	105 °C → 2,000 h
95 °C → 6,300 h	95 °C → 4,000 h
85 °C → 20,000 h	85 °C → 8,000 h
75 °C → 63,000 h	75 °C → 16,000 h

Table 6: Arrhenius rule of thumb for polymer and liquid electrolytic capacitors

FILTER CIRCUITS

Filters are necessary wherever sensitive circuit parts are protected against interference or the negative effects are to be reduced. For example, in DC / DC converters such as up and down topologies, the input as well as the output side have interference frequencies. On the one hand, the switching regulator IC generates the disturbances due to the switching frequency as well as through switching transitions. On the other hand, there are versatile couplings via the printed circuit board which can cause massive disturbances. The filters used are series circuits consisting of inductors and capacitors (LC, π or T filters) which form a low-pass filter. The low pass lets almost all signal amplitudes below its cut off frequency while effectively attenuating the signal amplitudes above this frequency.

Very often aluminum capacitors are used with liquid electrolyte because of their high capacity to increase the efficiency in the filters. However, their ESR is many times higher than that of polymer capacitors, which is particularly palpable in filters for high frequencies due to a noticeable noise. Now, using capacitors with conductive polymers and very small ESRs, the gain of the filter is increased and, ultimately, the noise is significantly suppressed. For example, under certain circumstances, the number of components can be reduced in the case of π filters, which leads to a reduction in costs and at the same time a reduction in the space requirement on the printed circuit board.

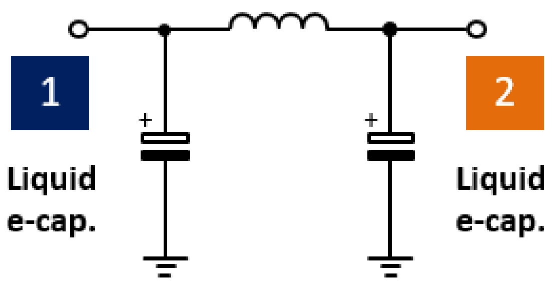

Fig. 23: π filter with liquid aluminum electrolytic capacitors and filter inductance

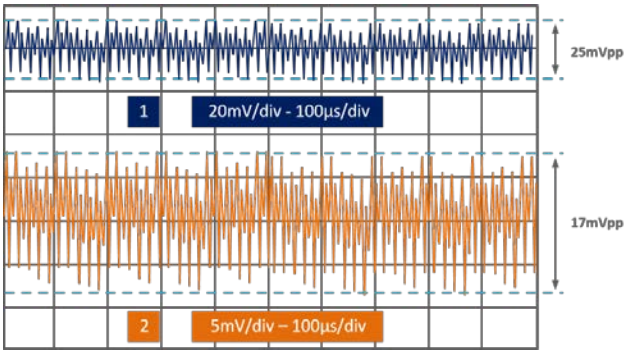

Fig. 24: Strong noise caused by the high ESR of the liquid-aluminum electrolytic capacitors

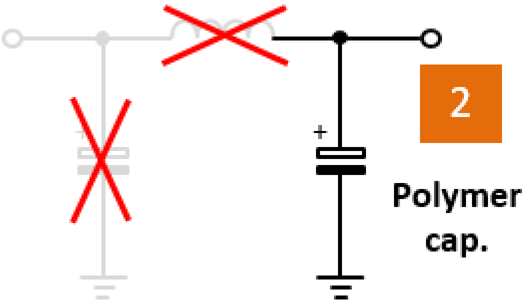

Fig. 25: π filter with polymer capacitor instead of liquid electrolyte and filter inductance

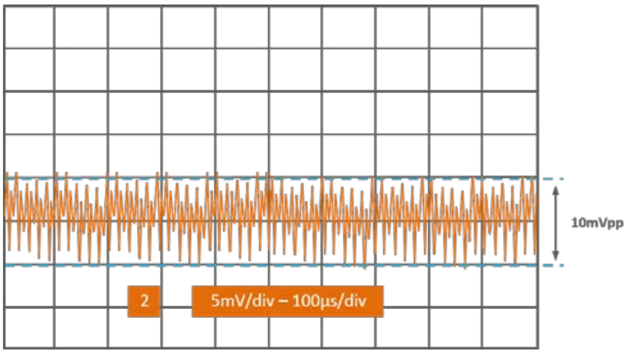

Fig. 26: Significantly improved performance and low noise due to the polymer capacitor and its very low ESR

AUTOMOTIVE APPLICATIONS

All series meet the quality requirements in automotive applications:

- Production Approval Process "PPAP level 3" - Sampling of all production and spare parts for the automotive industry
- Testing of polymer and hybrid polymer capacitors according to standard AEC-Q200
- Production in our IATF 16949 certified manufacturing in Shenzhen

Fig. 27: Certification according to IATF 16949

AVAILABLE PRODUCTS

The following overviews illustrate all series available at CapXon and their key parameters for polymer and hybrid capacitors. The portfolio is constantly being expanded and the previously achievable limits shifted upwards. Our development works permanent on:

- Miniaturization
- Higher voltages (polymer up to 400V and hybrid polymer up to 100V)

For technical questions please contact sales@capxon-europe.com

- Lower ESR
- Higher capacitance
- Longer lifetimes at high temperature

In this way, polymer and hybrid capacitors with all the mentioned technical advantages become more and more interesting for more and more applications and penetrate application fields which were previously reserved for other capacitor technologies.

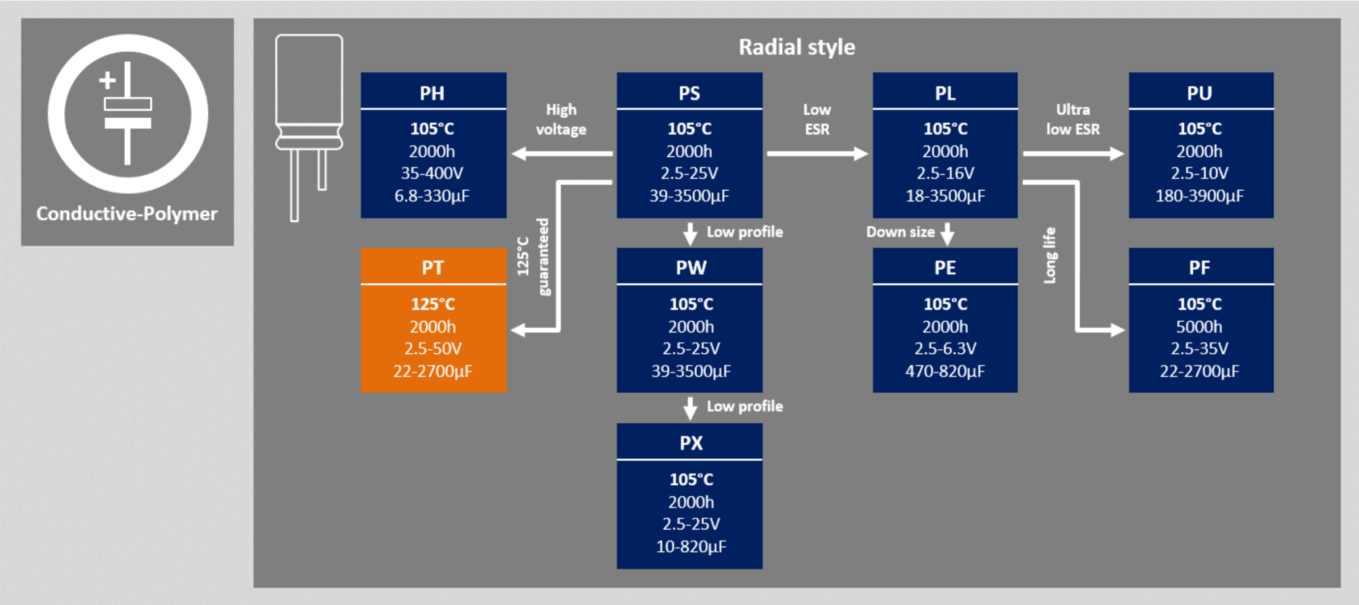

Fig. 28: Overview of radial aluminum polymer capacitors

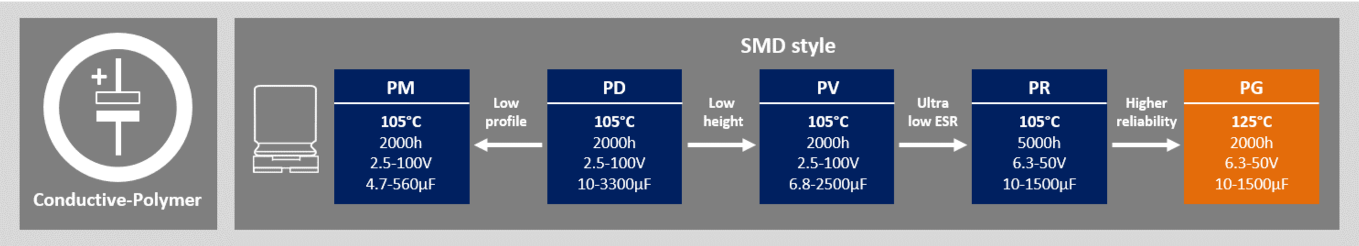

Fig.29: Overview SMD aluminum polymer capacitors

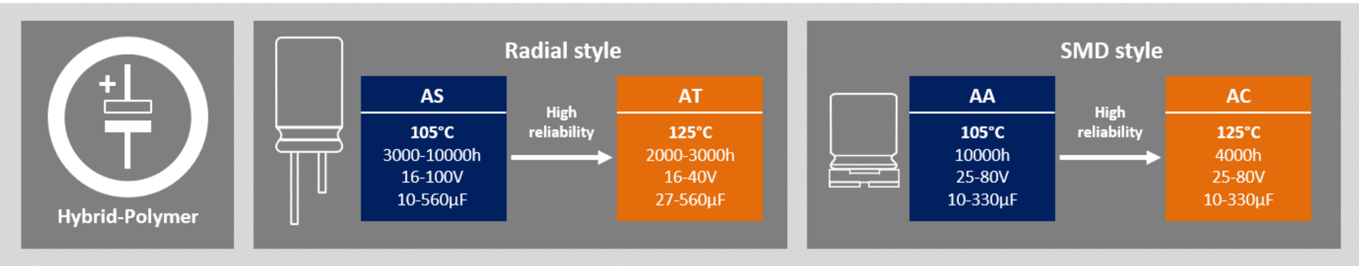

Fig. 30: Overview of radial and SMD hybrid polymer capacitors

For further information visit our homepage http://www.capxongroup.com/en/

1. Specification and description for the component(s) are subject to change without notice

1. 零件的規格和說明如有更改，恕不另行通知。

2. Operation conditions (ambient temperature, ripple current, thermal resistance, etc.) may affect the lifetime of a capacitor, please consult CapXon for life time calculation in your application.

2. 操作條件（環境溫度, 紋波電流, 熱阻等）可能會影響電容器的壽命， 您應用的壽命計算請諮詢Capxon。

3. For aerospace or military application and for life-saving or life-sustaining applications please consult us before design-in in your application.

3. 對於航太或軍事應用以及安全維持生命的應用， 在 您導入設計應用之前請向本公司諮詢。

4. Under no circumstance, CapXon warrants that any CapXon product is suitable for the purposes intended for your application, even CapXon knows the application. It is buyer's duty and obligation to check and make sure that CapXon's products are suitable for the purposes intended and select the correct and proper CapXon product.

4. 在任何情況下， Capxon不保證任何Capxon產品符 合您應用之預期目的， 即使Capxon知悉該應用。檢 查並確保Capxon產品符合預期目的以及選擇正確和 適當的Capxon產品是買方的義務。

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Contact us for any question on usage of our products inside your application, like safety, lifetime, reliability or assembling and mounting. Please refer to the guidelines inside the catalogue and the disclaimer.

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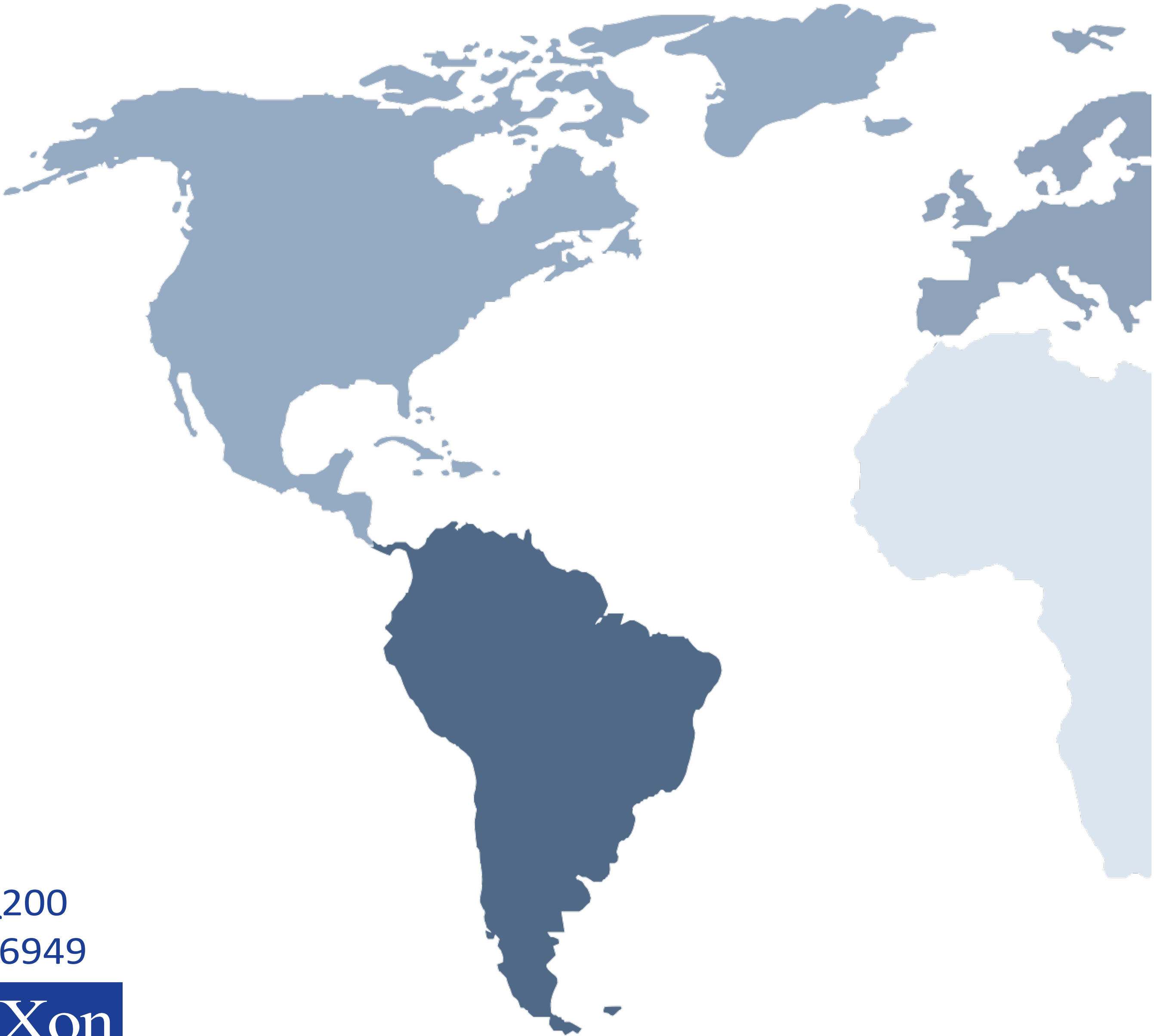

AEC-Q200
IATF 16949

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