

Hybrid Polymer Capacitors

New ZKU Hybrid Capacitors deliver high capacitance in a miniature body



PANASONIC INDUSTRY HYBRID POLYMER CAPACITORS

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PANASONIC INDUSTRY HYBRID POLYMER CAPACITORS

1.0 INTRODUCTION

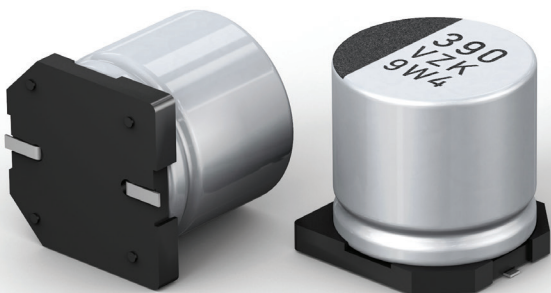
The humble capacitor was one of the first electrical devices to be discovered, tracing its history all the way back to the mid-18th century. Today, there are a huge range of device types, optimized for different applications. Over the past few years, capacitor designs that take advantage of advances in conductive polymers have emerged. These advanced devices sometimes use conductive polymers to form the entire electrolyte. Or the conductive polymers can be used in conjunction with a liquid electrolyte in a design known as a hybrid capacitor. These devices offer a performance edge over conventional electrolytic and ceramic capacitors when it comes to:

- Electrical characteristics
- Stability
- Longevity
- Reliability
- Safety
- Life cycle cost

2.0 HYBRID CAPACITORS: MARKET POSITIONING

Despite their relatively-recent introduction, the high reliability and high performance of Hybrid Capacitors has meant that the devices have been quickly accepted and have been experiencing a fast growth in demand globally. Engineers across different industries employ Hybrid Capacitors due to their high quality, high current and miniature size. Whether in the automotive, renewable energy or industrial sectors, Hybrid Capacitors are able to offer a solution for every application, especially where high power density, active cell balancing and temperature control output are necessary.

The huge uptake in electric vehicles and solar and wind power, and the suitability of Hybrid Capacitors to these burgeoning markets means that developments in this capacitor technology are highly welcomed. Growth data covering the period 2017-2025 is provided [here](#):



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3.0 HYBRID CAPACITOR CONSTRUCTION

As their name suggests, Hybrid Capacitors use a combination of a liquid and conductive polymer to serve as the electrolyte (see Figure 1) and aluminum as the cathode. This approach makes the best of the polymer's high conductivity and low ESR characteristics.

The liquid portion of the electrolyte, meanwhile, can withstand high voltages and provide higher capacitance ratings due to its large effective surface area. Currently available Hybrid Capacitors offer a voltage range from 25 to 80 V and capacitances between 10 and 560 μF .

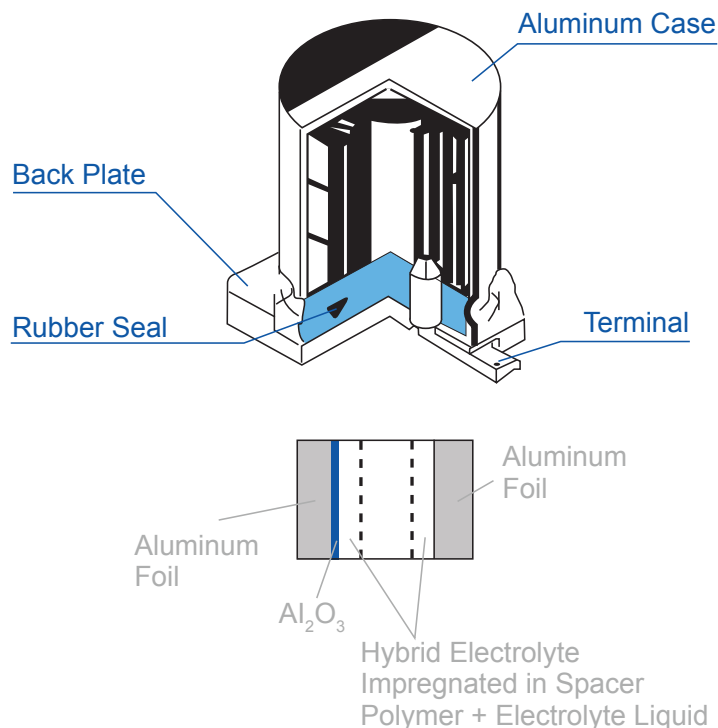


Figure 1 – Polymer Hybrid Aluminum Capacitors

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4.0 BENEFITS OF PANASONIC HYBRID CAPACITOR TECHNOLOGY

Panasonic Industry was one of the pioneers of Hybrid Capacitors and has been producing devices since 2012. Therefore the company can be relied upon to deliver high quality Hybrid Capacitors in production volume quantities.

Panasonic Industry Hybrid Capacitors feature low ESR characteristics at low temperatures (figure 2); stable leakage current for the duration of the product lifetime (figure 3); and long lifetimes (figure 4).

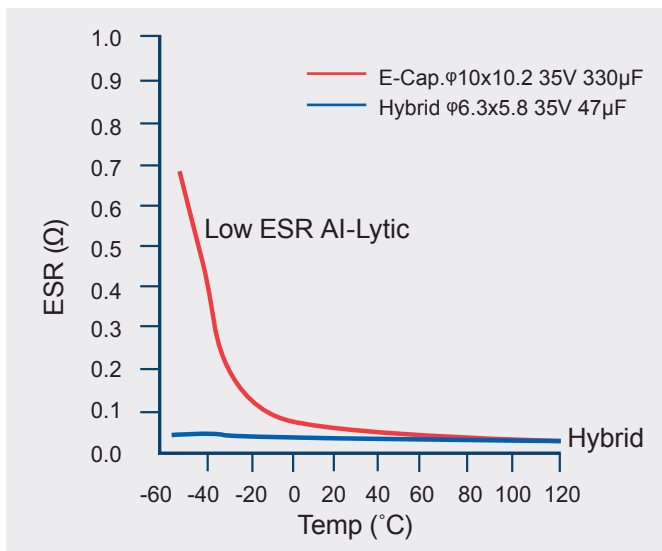


Figure 2 – Hybrid Capacitors exhibit low ESR at low temperature

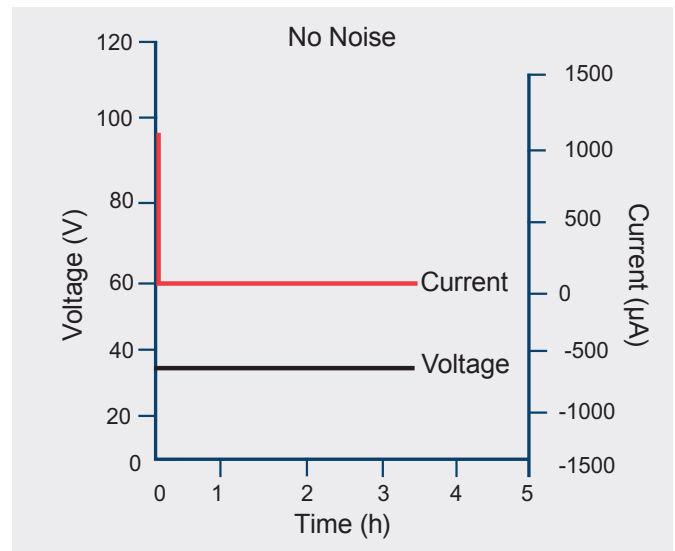
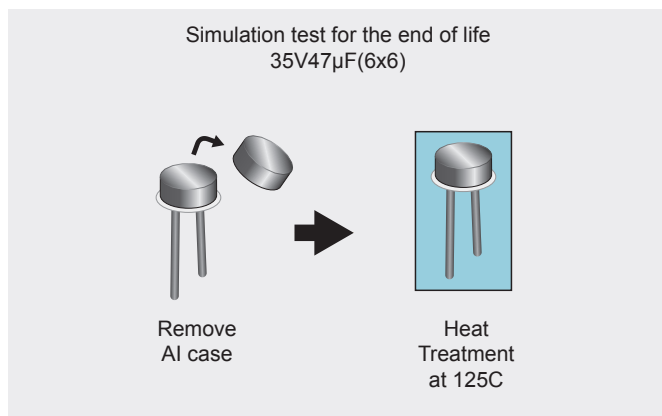


Figure 3 – Showing the stable leakage current across product lifetime



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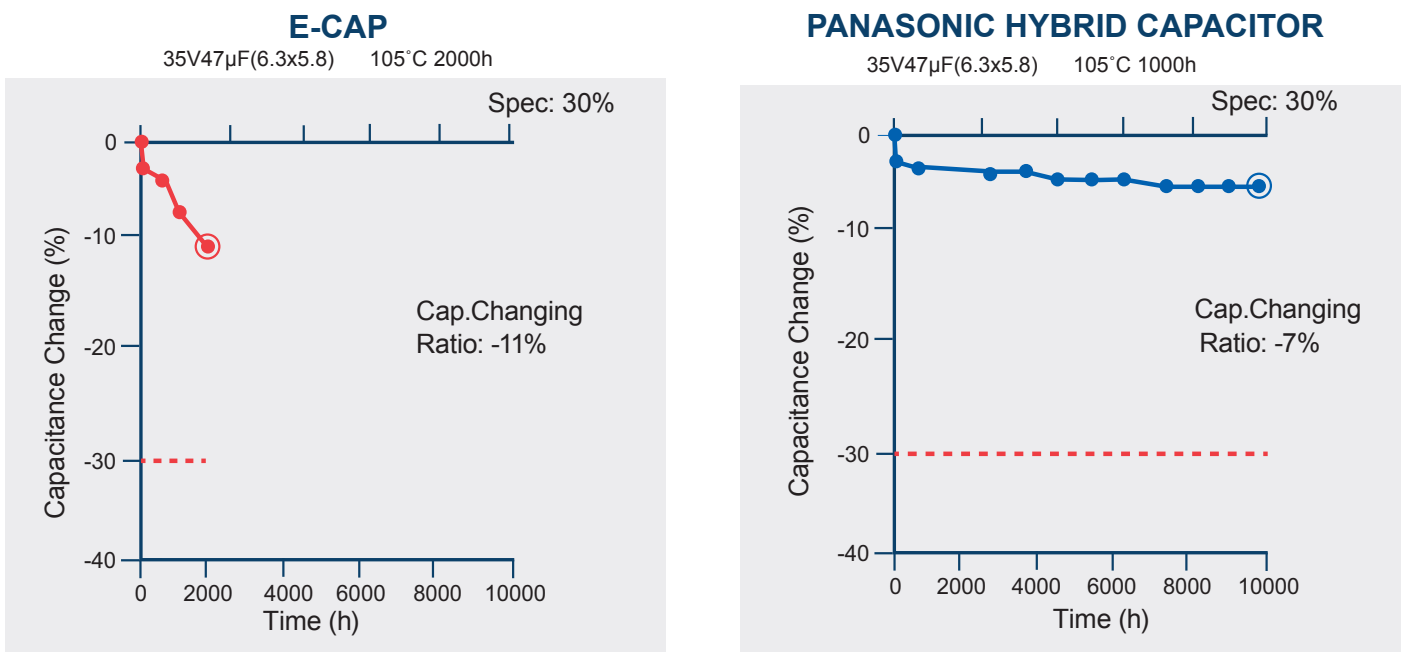


Figure 4 – Hybrid Capacitors have a long, useable lifetime

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5.0 PANASONIC INDUSTRY HYBRID CAPACITOR PORTFOLIO

Panasonic Industry extensive Hybrid Capacitor portfolio is shown in Table 1.

	ZA	ZC	ZK	ZKU	ZS	ZE	ZF
Endurance	105°C 10,000h	125°C 4,000h	125°C 4,000h	125°C 4,000h	125°C 4,000h	145°C 2,000h	150°C 1,000h
Rated Voltage [V DC]	25 – 80	25 – 80	25 – 35	25 – 35	25 – 63	25 – 63	25 – 63
Rated Capacitance [μF]	10 – 330	10 – 330	33 – 470	39 – 560	150 – 560	33 – 330	33 – 270
E S R [mΩ]	20 – 120	20 – 120	20 – 100	20 – 100	11 – 15	20 – 40	20 – 40
Ripple Current [Arms @ Peak Temperature]	0.75 – 2.5	0.5 – 2	0.75 – 2.8	0.75 - 2.8	3.5 – 4	0.6 – 0.9	0.65 – 1
Leakage Current	0.01 CV						
Damp Heat (load)	85°C 85% RH 2,000 h						

Table 1: Panasonic Industry Hybrid Capacitor portfolio

The ZA and ZC series are the initial Hybrid Capacitor product families of Panasonic Industry. Newer ZS series measuring 10mm in diameter and 16.5mm high broke through the market with increased capacitance (100-560 μF) and high ripple current characteristics, especially

suited high power motor application (48V application), E compressor, ISG / BSG applications. Very high temperature 150 °C THT type ZF series devices have also been added. Most recently, the company has introduced its smallest family, the ZKU series.

PANASONIC INDUSTRY HYBRID POLYMER CAPACITORS

6.0 ZKU DESCRIPTION

Featuring a very large capacitance in a small body, ZKU series Hybrid Capacitors enable designers to reduce the number of capacitors on a PCB, saving space and weight. ZKU devices out-perform the industry's standard for achievable capacitance and ripple current performance in certain sizes.

For example, the smallest Panasonic 25 V device in its smallest package – 5mm diameter x 5.8mm high - achieves 56 μF and 850 mA_{rms} , whereas, an industry standard device to meet the same technical specification measures 6.3mm in diameter x 5.8mm high.

ZKU Series	Specification
Temperature range	-55 – 125°C
Rated voltage range	25 – 35V
Capacitance range	39 – 560 μF
Size	$\Phi 5 \times 5.8\text{L}$ – $\Phi 10 \times 10.2\text{L}$
Endurance	125°C 4000h
Humidity	85°C 85% 2000h

Table 2: Main specification of ZKU series

	ZKU series (new product)	ZC series (conventional product)
Temperature range	-55 – 125°C	-55 – 125°C
Rated voltage / Rated Capacitance	25V 560 μF	25V 330 μF
Case size ($\Phi\text{D} \times \text{L}$ mm)	10x10.2	10x10.2
Rated Ripple Current (125°C, 100 kHz)	2800 mA_{rms}	2000 mA_{rms}
ESR (20°C, 100 kHz)	20m Ω	20m Ω

Table 3: Comparison of ZKU specifications and conventional products

Rated Voltage	Size $\Phi\text{D} \times \text{L}$ (mm)	Competition		ZKU Series	
		Capacitance (μF)	Ripple current (mA_{rms}) 100kHz	Capacitance (μF)	Ripple current (mA_{rms}) 100kHz
25V	5x5.8	33	550	56	850
	6.3x5.8	56	900	100	1300
	6.3x7.7	100	1400	180	1800
	8x10.2	220	1600	330	2000
	10x10.2	330	2000	560	2800
35V	5x5.8	22	550	39	750
	6.3x5.8	47	900	68	1200
	6.3x7.7	68	1400	120	1700
	8x10.2	150	1600	220	2000
	10x10.2	270	2000	390	2800

Table 4: Comparison of competitor and ZKU capacitors for the same given capacitance level

PANASONIC INDUSTRY HYBRID POLYMER CAPACITORS

6.1 ZKU APPLICATIONS

Automotive applications demand the very highest levels of reliability. Panasonic Industry Hybrid capacitors are used in ECU control circuits, battery-management systems and ADAS applications (such as cameras, sensors, and other driving aids), see figure 6.

Vehicle electrification demands redundancy in design to

ensure safety and reliability. For example, two identical ECUs are often required. In order to accommodate two units within the same available space, PCB size is at a premium and the reduction in number of capacitors required, as well as the small space and low weight are key factors promoting the use of ZKU capacitors.

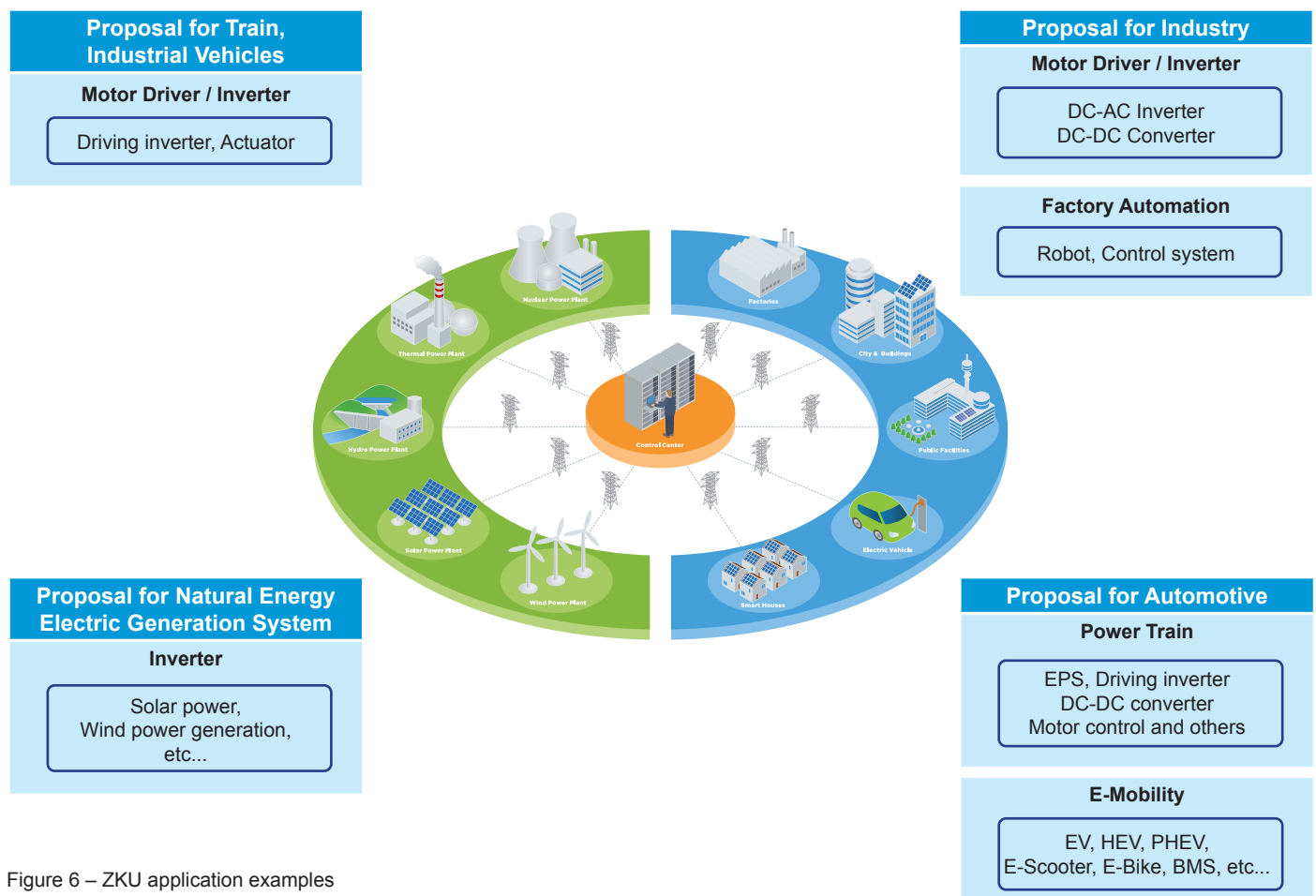


Figure 6 – ZKU application examples

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6.11 ZKU IN AUTOMOTIVE

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Engine ECU

Navigation System

EPS

Transmission ECU

Start & Stop

ABS/ESP

Battery ECU

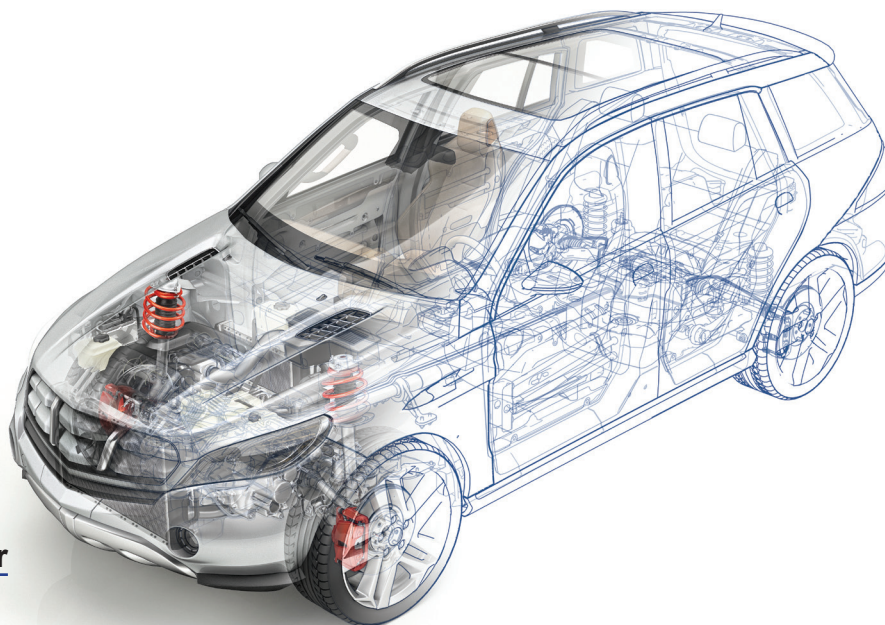
Meter/HUD

Camera

Radar

FPC

Fan Motor Driver



LED Headlamp

Electrically driven EGR

VCT

Seat Controller

Door motor controller

Figure 7 – ZKU Hybrid Capacitors are used widely in automotive applications

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6.12 ZKU IN INDUSTRIAL APPLICATIONS

Many industrial applications benefit from the attributes of ZKU Hybrid Capacitors, including factory automation (Industry 4.0) robotic equipment, inverters and motor drivers for industrial vehicles, and DC/AC inverters and DC/DC converters.



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6.12 ZKU IN RENEWABLE ENERGY GENERATION

Renewable energy is now mainstream, with Germany, for example, committing to shut down its remaining coal-fueled power stations by 2038 and other countries taking similar steps. Instead, they will rely on solar and wind power, and ZKU capacitors are at the heart of many inverter designs for this purpose.



PANASONIC'S HYBRID POLYMER CAPACITORS

7.0 THE FUTURE AND CONCLUSION

It is predicted that by 2025, 25% of newly registered cars will have an electrified powertrain. Approximately, 50% of those will feature 48V technology. More ECUs are being employed in cars due to safety regulations. Therefore the market needs more compact ECUs that can also withstand vibration.

The green energy movement is accelerating as we address climate change concerns. This places great demand on the performance of components selected.

The move towards smart factories is increasing the amount of electronic systems that are used within the manufacturing environment. Devices must be small, reliable and capable of working in harsh environments.

Panasonic's range of Hybrid Capacitors – specifically the market-leading ZKU series devices are engineered to meet these challenges.



Datasheet via QR code



CAD



Simulation Data



Capacitor Selection Tool



Local Technical Support