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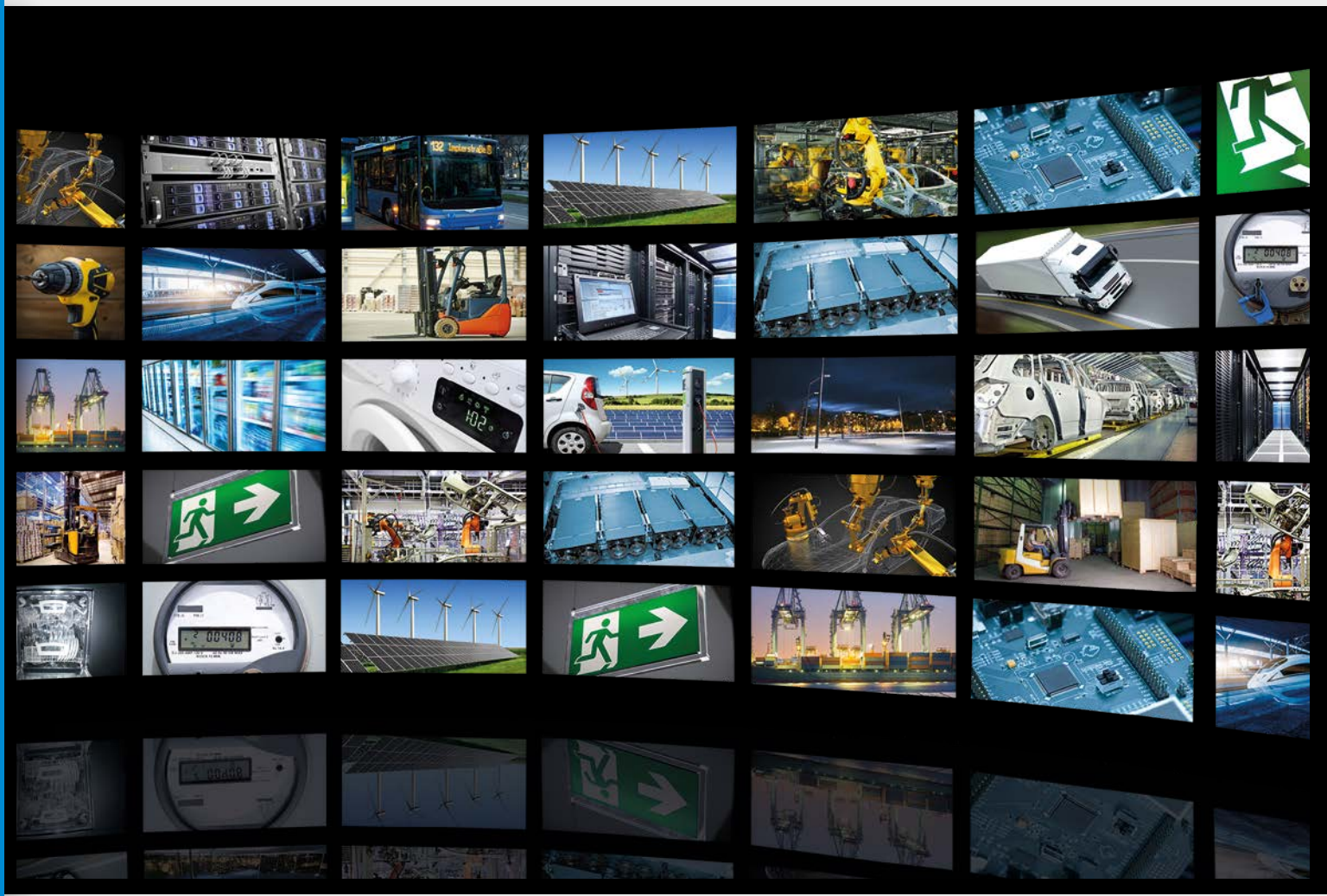
ELECTRONICS WORLDWIDE

Electric Double Layer Capacitors



V3.0

Rutronik presents key facts, benefits and innovations in the supercap market in cooperation with valued partners

Content

Our Product Portfolio

- Semiconductors
- Passive Components
- Electromechanical Components
- Displays & Monitors
- Boards & Systems
- Storage Technologies
- Wireless Technologies

Our Initiatives

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Committed to Excellence

Consult – Know-how. Built-in.

The Technical Competence from RUTRONIK

Worldwide and individual consulting on the spot: by competent sales staff, application engineers and product specialists.

Components – Variety. Built-in.

The Product Portfolio from RUTRONIK

Wide product range of semiconductors, passive and electro-mechanical components, displays & monitors, boards & systems, storage and wireless technologies for optimum coverage of your needs.

Logistics – Reliability. Built-in.

The Delivery Service from RUTRONIK

Innovative and flexible solutions: from supply chain management to individual logistics systems.

Quality – Security. Built-in.

Quality Management without Compromise

The integrated management system (IMS) encompasses quality control, information security, environmental protection, occupational health and safety.

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Electric Double Layer Capacitors (EDLC)

Benefits of a strong partner

We are the only top broadliner in Europe who generates one third of its turnover from passive components. Furthermore, we buy more passive components in Europe than any other distributor.

Our focus is to provide a comprehensive product portfolio combined with high quality and technical standards.

Electric Double Layer Capacitors – the intelligent, cost saving and green solution

The EDLC technology was developed a long time ago but is still quite new. There are daily new applications arising for those products based on new requirements from the market.

They offer the highest energy density of all capacitors and close the gap between common capacitors and batteries. Especially for safety relevant applications or in harsh environments, this technology could be a clever and a cheaper solution over a couple of operation years compared to batteries.

On the other hand there are a lot of applications where batteries and EDLCs work together effectively.

We offer you

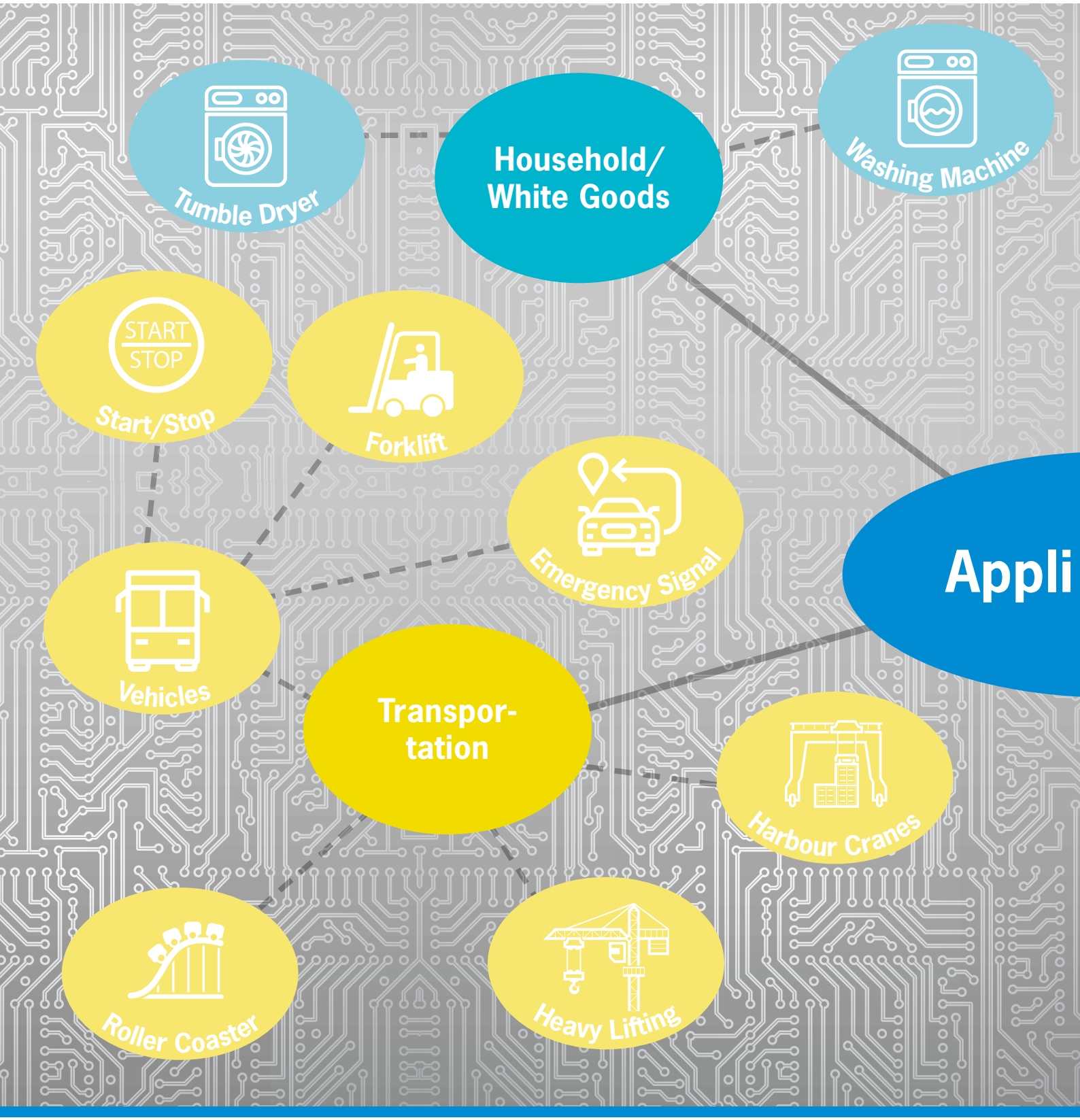
- Worldwide franchises with major manufacturers and world market leaders for Electric Double Layer Capacitors like AVX, Eaton, Maxwell and SECH
- High reliability due to our second source principle – different sources for the same type of product
- Competitive products, consulting and technical support based on exceptional expertise from product specialists with great market experience

Our key customers are leading companies in the following sectors:

- Industrial
- Automotive
- Consumer
- Telecommunications
- Information
- Medical

AVX · EATON Powering Business Worldwide · KORCHIP Energy Storage Innovator · Maxwell Technologies Enabling Energy's Future · Panasonic · SAMWHA · sech · VISHAY

You think these applications are familiar?
Your product portfolio can be found here?



Then you should seriously consider using the ultracapacitor technology.

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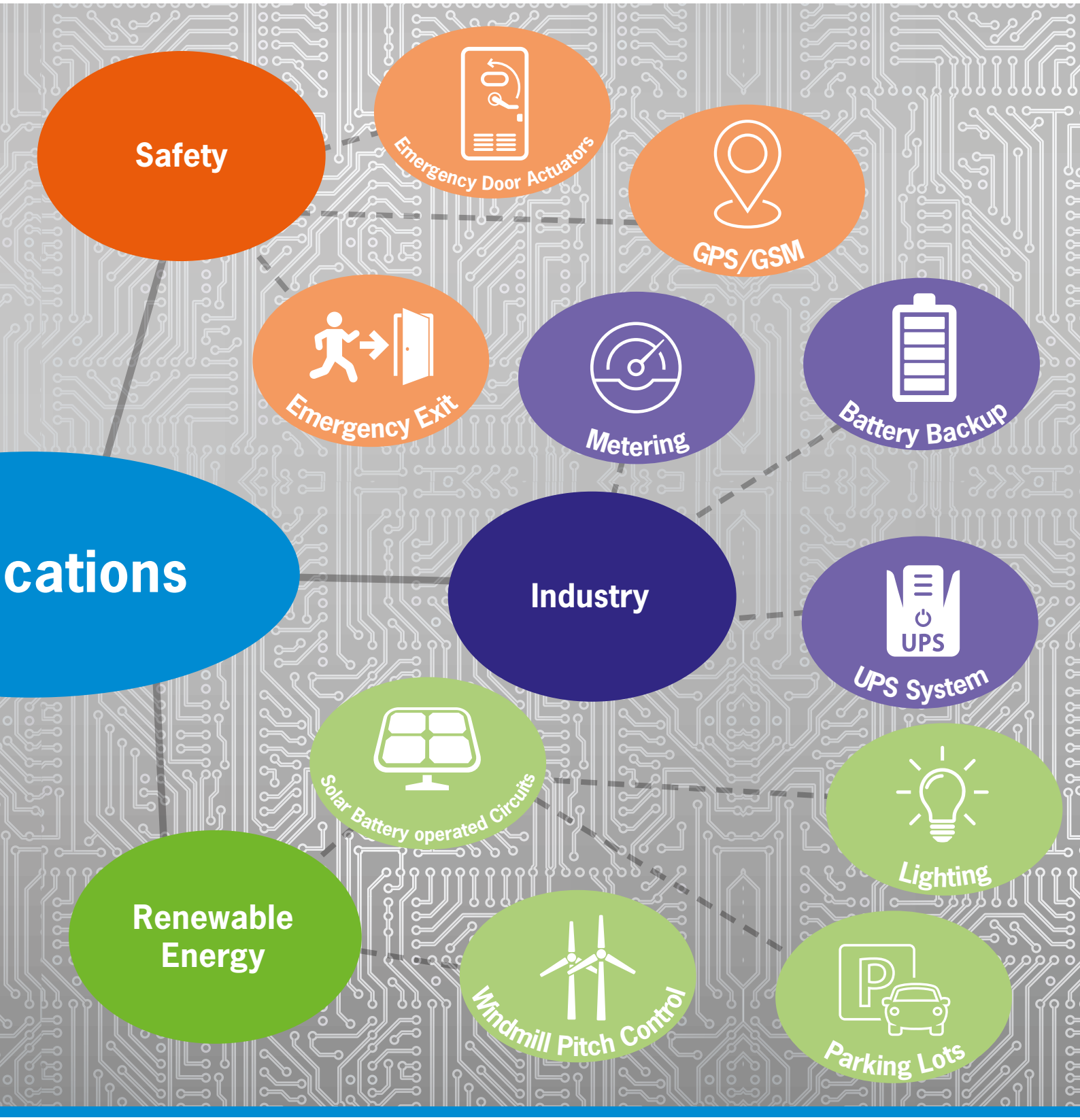


The best technical support for choosing the right product and the best fitting design concerning your requirements you get exclusively from the leading distributor of passive components in Europe: **RUTRONIK**!

Key Facts & Benefits

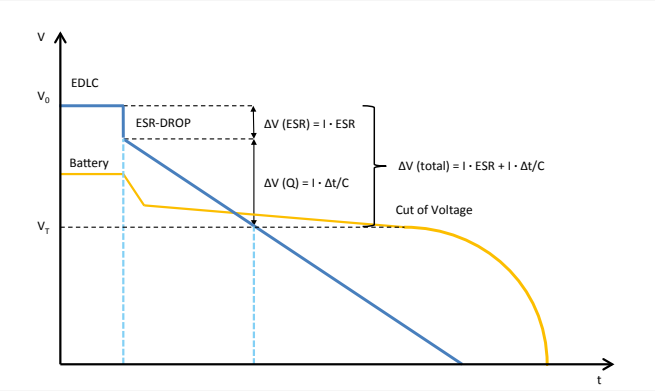
Basically, there are two different types of constructions: On the one hand the **stacked** and on the other hand the **wound construction forms**. The stacked types called "**Coin**", generally offer a capacitor voltage of **5.5V** (integrating cells in a row). Available with capacities of up to **1.5F**, these cells are used especially in RTC (Real Time Clock) applications. The construction of the wound types is similar to the construction of ordinary radial electrolytic capacitors. Available with a maximum cell voltage between **2.1V and 3V**, capacities of up to **3400F** can be reached with these cells. Due to an increasing demand and new applications, the focus of this brochure is related to **wound construction forms**.

Benefits

- Fast charge/discharge cycles (only a few seconds)
- High charge/discharge currents (up to hundreds of A)
- Long lifetime (up to over one million cycles)
- Very long operating lifetime (up to 10 years and even more)
- No memory effect
- Reliable operation in harsh environments
- Wide operating temperature range (-40 °C up to +85 °C)
- Virtually maintenance free
- Higher energy vs. electrolytic
- Higher power vs. batteries
- Series- and parallel-connection possible

Type	Batteries	EDLC	Conv. Capacitors
			
Time of charge	1 to 5 hours	0.3 to 30 s	10^{-3} to 10^{-6}
Time of discharge	0.3 to 3 h	0.3 to 30 s	10^{-3} to 10^{-6}
Spec. energy [Wh/kg]	20 to > 100	< 10	< 0.1
Lifetime [cycles]	1.000	up to 1 Mio.	> 500.000
Spec. power [W/kg]	< 1.000	> 10.000	> 100.000
Efficiency	0.7 to 0.85	0.9 to 0.98	> 0.95

Comparison to Batteries



The ESR-Drop (DIR) shown on the graph above is a voltage drop caused by the ultracapacitor's Equivalent Series Resistance (ESR) and is directly proportional to the capacitor´s ESR. Especially in cases of high discharge currents the voltage drop can be important and thus should be calculated.
Related to the continuous voltage drop the cut off voltage of customers' applications has to be considered to ensure to reach the required back-up time.

Lifetime advantage over batteries

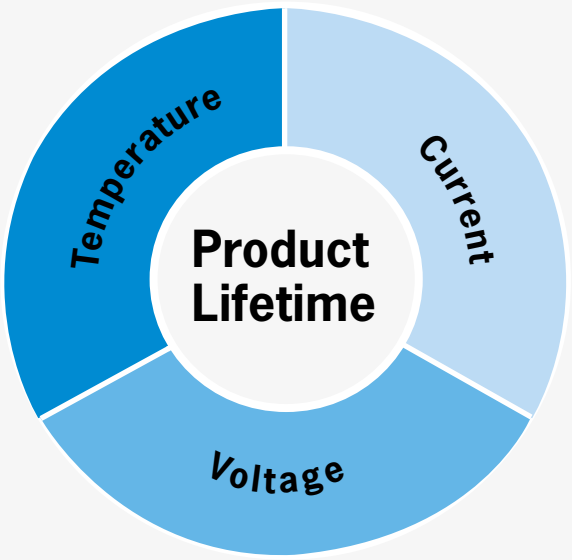
The lifetime of an double layer capacitor is significantly affected by three factors: v**oltage, temperature and current.**

Electric double layer capacitors operate at very **low voltages** of 2.3V - 3V. Since overvoltage can decompose the electrolyte and thus **irreversibly damage** the capacitor, the EDLC should be operated only **within** its **specifications**. In order to obtain a positive influence on the service life over the voltage, it is recommended to operate the capacitor **below its rated voltage.**

Another critical factor related to the lifetime is the **temperature** - the ambient temperature and the resulting **self-heating**. The self-heating depends largely on the strength of the currents and the cycle frequency (charging and discharging).

High temperatures lead to a **decrease in capacity** and an **increase of the ESR** over time. The higher the temperature (ambient temperature + self-heating), the faster the aging process progresses and the faster the so-called **end-of-life criteria** (i.e. 20% loss of capacity, 200% of the ESR) are achieved. It is important to know that the **EDLC is functional** even after reaching the end-of-life criteria.

Compared to batteries, the technology of the supercaps **has a higher current carrying capacity** as well as a **higher cycle stability**, which allow a significantly longer life of up to 10 years compared to batteries.



EDLC Technologies – Portfolio

Technology	Flatpacks / Pouch Cells	SMD	Coin	Radial / Leaded	Snap-In	Screw/Weldable	Module
							
AVX							
Eaton							
Korchip							
Maxwell							
SECH							
Panasonic							
Samwha							
Vishay							
Application Examples	Barcode scanner, Metering, Personal locators (GPS/GSM), Wireless modems	Subsidiary power supply, Memory backup during battery exchange, RTC, Bike light	Backup of CMOS micro-computers, Memory backup, RTC, Metering	UPS, Garden light, Toys, Solar battery operated circuits, Metering, Emergency light	UPS, Windmill, Electric car, Electric scooter, Power tools	UPS, Windmill, Electric car, Electric scooter, Power Tools	UPS, Windmill, Electric car, Electric scooter
Capacitance	0.0068F– 600F	0.033F – 0.47F	0.022F – 1.5F	1F – 100F	100F – 400F	650F – 3400F	variable
Temperature	-20/-25 – 70/75°C	-10-25 – 60/70°C	-25/-40 – 70/85°C	-25/-40 – 60/65/70°C	-25/-40 – 60/65/70°C	-25/-40 – 60/65°C	-40 – 60/65°C
Operating currents	mA / A	µA	µA / mA	mA / A	A	A	A

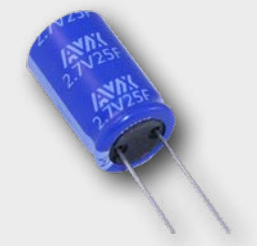
Focus supplier 2nd source On demand

AVX EATON Powering Business Worldwide KORCHIP Energy Storage Innovator Maxwell Technologies Enabling Energy's Future Panasonic SAMWHA sech

AVX Technologies

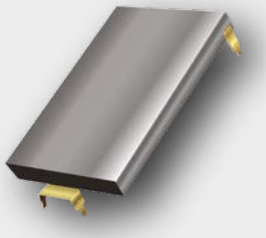
SCC Series

The SCC Series capacitors are cylindrically wound EDLC supercapacitors. The SCC Series provides the highest energy density characteristics available at AVX. Used by themselves or in conjunction with primary or secondary batteries, they provide extended back-up time, longer battery life, and provide instantaneous power pulses as needed. This series is best used in applications requiring pulse power handling, energy storage, and energy/power hold-up.



BestCap® - BZ Series & BW Series

In the BestCap®, a unique proton polymer membrane is used – charge transfer by protons is close to the transfer rate for electrons and orders of magnitude greater than organic molecules. BestCap® is a low ESR pulse supercapacitor based on the non-hazardous proton activated polymer system. It competes directly with devices made with organic electrolytes, but has a far wider voltage range, from 3.6V to 20V (organics are typically limited up to 5V). BestCap® has a temperature range of -20°C to +70°C, which is wider than for batteries, and also offers select values available between -40°C to +75°C. BestCap® has the most "capacitor-like" frequency response of all supercaps and has low ESR and low profile characteristics.



PrizmaCap™ - SCP Series (under development)

PrizmaCap™ uses has a propylene carbonate (PC)-based electrolyte technology. The PrizmaCap™ current collector is made of a special low ESR type aluminum. The PrizmaCap™ features cell voltage of ~2.1V/cell and 1.1V to 2.4V rated voltage. Capacitance values are 1F to 500F. The PrizmaCap™ offers a low profile design at 0.5mm thickness. with high energy, low ESR and LC, and high-temperature capabilities with an oper-ating temperature of -55°C to +90°C. The sizes start from 29x27mm to 155x85mm.

Ultracapacitor Single Cells Technologies

Type	BestCap®	Cylindrical (SCC & SCM)	PrizmaCap™
Current Collector	Proprietary - Non-metal	Aluminum - Standard low cost type	Aluminum - Special low ESR type $$
Carbon Electrode	Activated carbon	Activated carbon	Activated carbon
Electrolyte	H2O based	Acetonitrile (ACN) or Propylene Carbonate (PC) based	Propylene Carbonate (PC) based
Separator	Proprietary - PVC	Paper	Paper
Packaging	Stainless steel - Prismatic	Aluminum cylindrical can	Flexible Tri-Ply Aluminum - Prismatic
Leads	SMT or Leaded	Leaded	SMT
Voltage per Cell	~0.6V / Cell	~2.7V / Cell (ACN) ~2.1V / Cell (PC)	~2.1V / Cell
Multiple Cells in Series	Yes to 20V	No	No
Rated Voltage	2.0V to 20V	2.3V to 2.7V	1.1V to 2.4V
Cap Values	4.7mF to 1F	1F to 3,500F	1F to 500F
Operating Temp.	-40°C to +75°C	-40°C to +85°C	-55°C to +90°C
Storage Temp.	-20°C to +70°C	-40°C to +70°C	-55°C to +105°C
Minimum Height	2.1mm	6.3mm (on side)	0.5mm
Lowest ESR	25mΩ	< 1mΩ	< 1mΩ
Lowest LC	< 1µA	2µA	5µA
Current Capacity	30,000 / day	90,000+ / day	3,000 / day
RoHS Compliant	Yes	Yes	Yes
Reach Compliant	No	Yes	Yes
Key Benefits	Low profile High voltage Low ESR Low LC	Low cost High energy Low ESR Low LC	Low profile High energy, Low ESR & LC, High temperature

Ultracapacitors

High Power Energy Storage for Your Industrial Applications

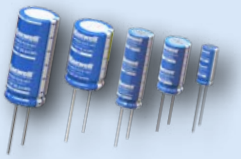
Maxwell TECHNOLOGIES
Enabling Energy's Future™

Robotics? Smart Meter? AGV? Heavy-duty industrial equipment? We' ve got you covered.

Maxwell's high power, fast-response ultracapacitor energy storage technology bolsters efficiency in your operations by providing:

- Long life
- High duty cycles
- Resiliency in demanding environmental conditions

Maxwell ultracapacitors are available in a wide range of size, capacitance and modular configurations

Type	Standard Cells	XP™	DuraBlue®	Modules
				
Designed for	Optimized for size and power in industrial, electronics and consumer applications	Time-proven performance for high heat and humidity environments	Premium energy storage for high shock and vibration environments	Industry-leading modules designed to provide energy storage and power delivery for a wide range of applications
Capacitance	1 – 2000F	3 – 50F	3000 – 3400F	5.8 – 500F

XP™-Series XTRA Performance

XP™ products are engineered specifically for applications that operate over long durations in environments with high temperature and humidity. Proprietary product and manufacturing enhancements, designed into XP™, significantly reduce the likelihood of long term reliability issues resulting from prolonged operation in adverse environmental conditions. Under biased test conditions (2.7V, 90% relative humidity, 60°C), XP™ products deliver a 3 times improvement compared to benchmarked industry-standard cells.

High-perfomance Ultracapacitors

SECH with its high-performance and ultra-low internal resistance ultracapacitor designs, develops and supplies customized energy storage and power delivery solutions for various applications and markets. Our single cell ultracapacitors, the standard modules and customized systems are characterized by high-energy and very high-power density.

Key Features

- State of the art single cell voltage of 3V
- Laser welded connections for highest quality and robustness
- Ultra-low ESR
- Optimal thermal behaviour, idea for heavy duty cycling
- Hermetically sealed cells for longest life

Swiss engineered Products – Solutions – Simplicity

Ultracapacitor single cells
3V – 330F up to 3200F

Standard modules
18V up to 144V
in various capacitance

Customized systems & solutions
up to 12MW

Ultracapacitor Single Cells – Selection of our high-performance types

Cell Diameter	35 mm		46 mm			60 mm
Type	**C35S-3R0-0330**	**C35S-3R0-0390**	**C46W-3R0-0600**	**C46W-3R0-0800**	**C46W-3R0-1200**	**SC-003R0-3200**
Rated voltage V_R	3.00V	3.00V	3.00V	3.00V	3.00V	3.00V
Rated capacitance C *	330F	390F	600F	800F	1200F	3200F
DC ESR *	<1.2 mΩ	<2 mΩ	<0.7 mΩ	<0.8 mΩ	<0.55 mΩ	<0.30 mΩ
Leakage current I_L *	<0.45 mA	<0.45 mA	<1.5 mA	<1.9 mA	<2.7 mA	<5.3 mA
Self-discharge rate *	<20%	<20%	<20%	<20%	<20%	<20%
Max constant working current IMCC? ΔT=15°C? *	33A	25A	83A	74A	90A	131A
Energy storage E *	0.4 Wh	0.5 Wh	0.75 Wh	1.0 Wh	1.5 Wh	4.00 Wh
Energy density E_d *	5.9 Wh/kg	6.8 Wh/kg	5.6 Wh/kg	5.6 Wh/kg	5.4 Wh/kg	7.57 Wh/kg

*) details see datasheet

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