ENERGY CAPACITORS

Engineered Solutions

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JIANGHAI EUROPE
Electronic Components GmbH

Was sind Energie-Kondensatoren?

What are Energy Capacitors?

In Zeiten von E-Mobility und ganz allgemein bei Speicherung von Energie sind oft die Energiespeicher die einschränkende Komponente in einer Applikation. Gute Ideen werden verworfen und Potenzial verschenkt, wenn die benötigte Energie nicht bereitgestellt werden kann. Genau hier kommen **Energie-Kondensatoren** zum Einsatz. Das Konzept teilt sich in zwei Schlüsseltechnologien mit individuellen Eigenschaften auf.

In times of e-mobility and generally when storing energy, often the energy storage devices are the limiting components in an application. Good ideas are rejected and potential is given away if the required energy can not be provided. This is exactly where **energy capacitors** *are used. The concept is divided into two key technologies with completely individual characteristics.*

EDLC

Die Basistechnologie ist der klassische Electric-Double-Layer-Kondensator (u.a. auch bekannt als Super- oder Ultracap). Diese Technologie basiert auf der Speicherung von Ladung in der namensgebenden Doppelschicht. Zum Einsatz kommen zwei symmetrisch angeordnete Aktivkohle-Elektroden, die optimal dazu geeignet sind, eine Doppelschicht zu bilden.

The basic technology is the classic Electric Double Layer capacitor (also known as Supercap or Ultracap). This technology is based on the storage of charge in the characteristic double layer. Two symmetrically arranged activated carbon electrodes are used, which are optimally suited to form a double layer.

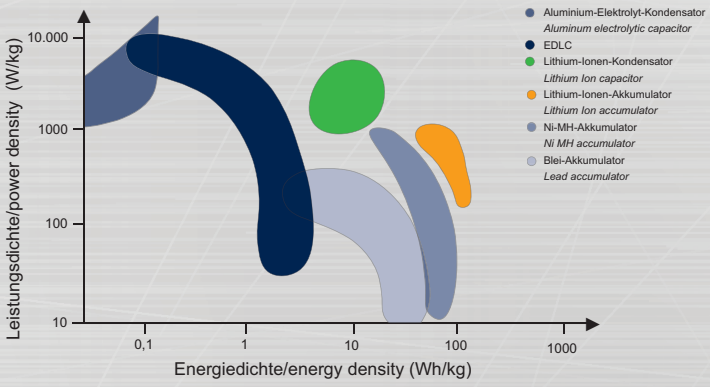
LiC

Lithium-Kondensatoren sind eine Weiterentwicklung der EDLCs. Hier wird die Kathoden-Elektrode gegen eine Lithiumionen dotierte Graphit-Elektrode ausgetauscht, ähnlich der einer Lithiumionen-Batterie. Der gezielt asymmetrische Aufbau optimiert die Kapazitätsbildung der Elektroden. Damit lassen sich weitaus höhere Kapazitäten erreichen als es bisher mit der EDLC Technologie möglich war. So schließt sich die Lücke zwischen Kondensator und Batterie.

Lithium capacitors are a further development of the EDLCs. Here, the cathode electrode is replaced by a lithium ion doped graphite electrode, similar to a lithium ion battery. The asymmetric design optimizes the capacitance formation of the electrodes. This allows much higher capacitance value than previously possible with EDLC technology. This closes the gap between capacitor and battery.

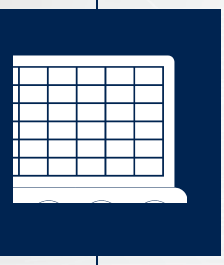
Das folgende Ragone-Diagramm setzt beide Technologien ins Verhältnis:

The following Ragone diagram compares both technologies:



ANWENDUNGSBEREICHE
FIELDS OF APPLICATION

AGF & FLURFÖRDER-FAHRZEUGE
AGV & INDUSTRIAL TRUCKS

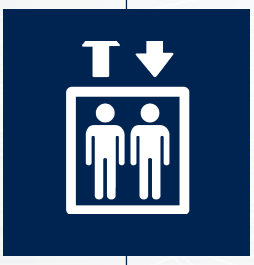


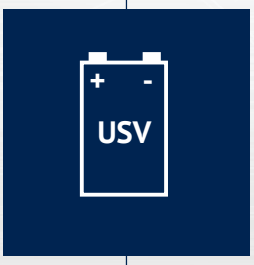
24/7-BETRIEB
24/7 OPERATION

"CHARGE-AND-GO"

GERINGES GEWICHT
LOW WEIGHT

ENERGIESPEICHERUNG & BACKUP
ENERGY STORAGE & BACKUP

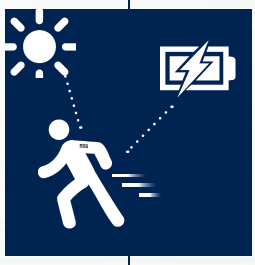




VIELE ZYKLEN
MANY CICLES

HOHE STRÖME
HIGH CURRENTS

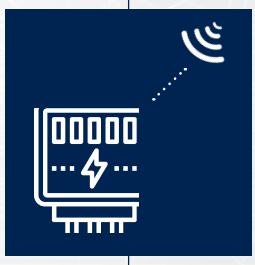
ENERGIEGEWINNUNG
ENERGY HARVESTING

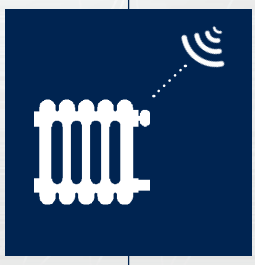


GERINGER LECKSTROM
LOW LEAKAGE CURRENT

HOHE SICHERHEIT
HIGH SAFETY

SMART METER & POWER TOOLS





HOHER PULSSTROM
HIGH PULSE CURRENT

GERINGE SELBST-ENTLADUNG
LOW SELF-DISCHARGE

LANGE LEBENSDAUER
LONG LIFETIME

E-MOBILITÄT
E-MOBILITY

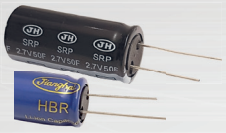
GERINGES GEWICHT
LOW WEIGHT

GERINGES VOLUMEN
LOW VOLUME

HOHE ENERGIEDICHTE
HIGH ENERGY DENSITY

HOHE LEISTUNGSDICHTE
HIGH POWER DENSITY

RADIAL



Radial – *die* Bauform für ein platzsparendes Design. Sowohl die EDLC als auch die LiC Technologie der Energie-Kondensatoren finden Anwendung in dieser Bauform. Mit den Individuellen Eigenschaften beider Technologien können viele unterschiedliche Anforderungen erfüllt werden.

Radial - the first choice for a space-saving design! Both the EDLC and the LiC technology of the energy capacitors are used in this design. With the individual characteristics of both technologies many different requirements can be met.

EDLC

BEZEICHNUNG DESIGNATION	WERT VALUE
Spannungsbereich voltage range	0V-3V (Surge 3,2V)
Temperaturbereich temperature range	-40°C-65°C (85°C UR-0,5V)
Energiedichte energy density	1-5 Wh/kg
Kapazitätsbereich capacitance range	1F-100F
Leistungsdichte power density (W/kg)	5-10kW/kg
Lade-/Entladestrom charge/discharge	max. 48A
Zyklenfestigkeit cycle stability	>500.000
Baugröße size	8x14-18x60 (mm)

LiC

BEZEICHNUNG DESIGNATION	WERT VALUE
Spannungsbereich voltage range	2,5V-3,8V (Surge 4,2V)
Temperaturbereich temperature range	-25°C-60°C / -15°C-70°C
Energiedichte energy density	10-25 Wh/kg
Kapazitätsbereich capacitance range	30F-220F
Leistungsdichte power density (W/kg)	2,5-3,8kW/kg
Lade-/Entladestrom charge/discharge	max. 8A
Zyklenfestigkeit cycle stability	>500.000
Baugröße size	10x16-16x25 (mm)

SNAP-IN

Für den größeren Anspruch ist die Snap-In Bauform die optimale Wahl. Große Leistungsaufnahme ist kein Problem, und mit passender Verschaltung entsteht ein wahres Energiepaket!

For larger requirements, the snap-in design is the optimal choice. Great power consumption is not a problem, and proper interconnection creates a true energy beast!

BEZEICHNUNG DESIGNATION	WERT VALUE
Spannungsbereich voltage range	0V-3V (Surge 3,2V)
Temperaturbereich temperature range	-40°C-65°C (85°C UR-0,5V)
Energiedichte energy density	5-7 Wh/kg
Kapazitätsbereich capacitance range	100F-470F
Leistungsdichte power density (W/kg)	6-10 kW/kg
Lade-/Entladestrom charge/discharge	max. 260A
Zyklenfestigkeit cycle stability	>500.000
Baugröße size	22x45 - 35x60 (mm)

BEZEICHNUNG DESIGNATION	WERT VALUE
Spannungsbereich voltage range	2,5V-4V (Surge 4,35V)
Temperaturbereich temperature range	-30°C-60°C
Energiedichte energy density	10-50Wh/kg
Kapazitätsbereich capacitance range	1000F-16000F
Leistungsdichte power density (W/kg)	2-8,5kW/kg
Lade-/Entladestrom charge/discharge	bis zu 200A
Zyklenfestigkeit cycle stability	50.000-500.000
Baugröße size	100x71x3 - 295x123x8 (LxWxT in mm)

PRISMATISCH / PRISMATIC

Nicht allein optisch ähnelt die prismatische Energie-C Zelle der einer Akkumulator Zelle, sondern auch das Einsatzgebiet schneidet sich.

Not only optically resembles the prismatic energy-C cell of an accumulator cell, but also the field of application cuts.

BEZEICHNUNG DESIGNATION	WERT VALUE
Spannungsbereich voltage range	**z.B.** 12V-600V
Temperaturbereich temperature range	-25°C-70°C
Energiedichte energy density	40-50Wh/kg
Kapazitätsbereich capacitance range	**z.B.** 47F-7500F
Lesitungsdichte power density (W/kg)	6-10kW/kg
Lade-/Entladestrom charge/discharge	**z.B.** 50A-300A
Zyklenfestigkeit cycle stability	50.000-200.000
Baugröße size	individuell/individual

MODULE / MODULES

Die Module bilden die Königsklasse dieser Kondensatoren! Anpassungsfähig und maßgeschneidert werden Lösungen für jede Anforderung gefunden. Ob schon bestehende Applikation oder eine erste Idee, Energie-Kondensatoren liefern die Energie!

The modules form the premier class of these capacitors! Adaptable and tailor-made solutions are found for every requirement. Whether already existing application or first idea, energy capacitors deliver the energy!

Alle Vorteile auf einen Blick

All advantages at a glance

HOHE ENERGIEDICHTE
HIGH ENERGY DENSITY

HOHE LEISTUNGSDICHTE
HIGH POWER DENSITY

GROSSER SPANNUNGSBEREICH
WIDE VOLTAGE RANGE

VIELE LADE-/ ENTLADEZYKLEN
MANY CHARGE/ DISCHARGE CYCLES

GERINGER LECKSTROM
LOW LEAKAGE CURRENT

SICHER! KEIN EXPLODIEREN ODER BRENNEN!
HIGH SAFETY! NO EXPLODING OR BURNING!

Need Assistance?

Die meisten Module sind kundenspezifisch und auf eine bestimmte Applikation zugeschnitten. Damit wir den passenden Energiespeicher für Sie finden und herstellen können, benötigen wir Ihre Anforderungen. Unten stehende Fragen sollen Ihnen helfen, alle Infos zusammenzustellen.

Most of the modules are customized and tailored to a specific application. We need your requirements so that we can find and build the right energy storage for you. The questions below should help you to gather all the information together.

Welche maximale Spannung benötigen Sie, und bis zu welcher Spannung arbeitet Ihre Schaltung?

Which maximum voltage do you need and up to which voltage does your circuit work?

Spannungsbereich / voltage range:

Wie viel Energie benötigen Sie, und wie lange wird diese Energie benötigt?

How much energy do you need and how long is this energy needed?

Kapazität bzw. Energie/Capacitance or energy:

Zeit/Time:

In welchem Temperaturbereich muss das Modul arbeiten?

In what temperature range does the module have to work?

Temperaturbereich/Temperature range:

Für welche Lebensdauer und/oder Zyklenzahl soll der Energiespeicher Energie bereitstellen?

Which lifespan and / or no. of cycles should the energy storage, provide energy?

Lebensdauer/Lifetime:

Zyklenzahl/Number of cycles:

Wie viel Platz steht zur Verfügung?

How much space is available?

Abmessungen/Dimensions:

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Warning: JIANGHAI is not liable for any extent of possible injuries or damages to persons or things, of any kind, caused by the improper application of and/or operating conditions harmful to Energy-Capacitors. Misapplications which may cause failures include, but are not limited to: operating current or peak current or voltage outside the specified range, operating voltage above surge voltage specified, temperature exposure outside of the specified operating temperature range. Examples of harmful operating conditions comprise, but are not limited to: unusual storage or transport temperatures, excessive and/or rapid changes of ambient temperature or humidity, heavy mechanical shock or vibration, corrosive and abrasive particles in the ambient (cooling) air, conducting dust in the ambient (cooling) air, oil or water vapor or corrosive substances, explosive gas or dust, operation under extremely high or low ambient pressure conditions (below or above sea level), superimposed radio frequency voltages, radioactivity. In case of doubt about the impact of operating conditions on capacitor performance, please contact JIANGHAI.

Personal safety: Electrical or mechanical misapplication of Energy-Capacitors may be hazardous. Personal injury or property damage may result from explosion of a capacitor or from the expulsion of electrolyte due to mechanical disruption or the release of a safety vent of a capacitor. In case of injury or skin or eye exposure to electrolyte, immediately seek professional medical advice. Before using Energy-Capacitors in any application, please read these Handling Precautions, familiarizing thoroughly with the information contained herein. Please check before using any of our Energy-Capacitors if these components fulfill the requirements of your application and that warnings and instructions for use are followed.

Warranty: The information contained in this datasheet does neither form part of any quotation nor of a contract, it is believed to be accurate, reliable and up to date. Quality data are based on the statistical evaluations of a large quantity of parts and do not constitute a guarantee in a legal sense. However, agreement on these specifications does mean that the customer may claim for replacement of individual defective capacitors within the terms of delivery. We cannot assume any liability beyond the replacement of defective components. This applies in particular to any further consequences of component failure. Furthermore it must be taken into consideration that the figures stated for lifetime, failure rates and outlier percentages refer to the average production status and are therefore to be understood as mean values (statistical expectations) for a large number of delivery lots of identical capacitors. These figures are based on application experience and data obtained from preceding tests under normal conditions, or – for purpose of accelerated aging – more severe conditions. JIANGHAI reserves the right to change these specifications without prior notice. Any application information given is advisory and does not form part of any specification. The products are not primarily designed for use in life supporting applications, devices or systems where malfunction of these products can reasonably be expected to result in personal injury. JIANGHAI customers using or selling these products for use in such applications without prior written consent of JIANGHAI do so at their own risk and agree fully to indemnify JIANGHAI for any damage resulting from such improper use or sale. This version of the datasheet supersedes all previous versions.

Handling Guidelines:
(1) Energy-Capacitors must not be used in AC and filtering circuits.
(2) The actual operating voltage must not exceed the max. specified operating voltage and it must not fall below the min. specified operating voltage.
(3) Please check the polarity before using. If operated under reverse polarity conditions, the capacitors will not only suffer from a shortened life time, but they may even swell, and electrolyte leakage or other malfunctions may result.
(4) Environment: The operating temperature has an influence on the life time of the capacitors, and the maximum specified operating temperature must never be exceeded.
(5) Current drain during discharge needs to be controlled to avoid a voltage drop below the min. voltage of the capacitor. The permissible current drain IR is usually specified in the datasheet.
(6) Capacitors in series connection: when capacitors are connected in series connection it must be ensured that the operating voltage of any single capacitor does not exceed to the limit of the max. and min. operating voltages. Systems for balancing and monitoring as well as modules are available on request. Please contact the JIANGHAI EUROPE Sales office for further Information.
(7) Energy-Capacitors must not be short-circuited. Discharge below the minimum voltage will destroy the capacitor.

Precautions:
(1) Prohibition of disassembly
Any attempt to disassemble the capacitor may result in short circuits to the capacitor, which may generate gas, and may cause electrolyte leakage, explosion or other problems.
(2) Prohibition of dumping capacitors into fire to avoid potential risk of explosion.
(3) Prohibition of immersing capacitors into water or seawater or any similar liquid.
(4) Prohibition of using damaged capacitors: If any abnormal features of the capacitors are found (especially such as damages of the package, electrolyte leakage or others) the capacitor cannot be used anymore and must be stored away from open flames.
(5) Prohibition of short-circuit or use outside the specified operating voltage range.
(6) Prohibition of reverse voltage.
Precautions for devices using Energy-Capacitors: The operating conditions for modules, devices or application using Energy-Capacitors must follow the detailed operating condition of the individual cell.

Operating voltage (U_R): Energy-Capacitors are specified with a maximum operating voltage $U_{max} = U_R$ and a minimum operating voltage U_{min}. For a safe operation, these limits must be strictly adhered to.

Surge voltage: Maximum voltage, which may be applied to the capacitor for a short period of maximum 5 seconds within the complete lifetime.

Effect of current flow: Energy-Capacitor used with large currents will generate heat. Do not apply currents exceeding the maximum charge/discharge current. It may generate heat, deform, explode or lose electrolyte. Comply with the maximum specified charge/discharge currents in the datasheet.

Operating current (I_R): The rated charge/discharge current is the current which can be used to charge and discharge the capacitor repeatedly without any pause.

Max. constant current (I_{max}): The maximum constant charge/discharge current is specified with a minimum pause between charging cycles of 15 seconds.

Surge current: The surge current is the maximum charge/discharge current and it is limited (see datasheet).

Self-discharge current: The self-discharge current is specified after 3 months at ambient temperature of 25°C, relative humidity between 25% to 85% and without further voltage applied with t in seconds.

$$I = \frac{C^* (U_R - U_3)}{t}$$

Self-discharge voltage: The self-discharge voltage is specified at ambient temperature 25±2 °C. The following procedure must be followed to determine the self-discharge voltage drop:
(a) the capacitor is charged to rated voltage with constant current (operating current, see datasheet);
(b) the capacitor is kept at the rated voltage for 30 minutes;
(c) open the circuit and store the capacitor for 72 hours at an ambient temperature of 25±2 °C;
(d) measure the self-discharge voltage between the capacitor terminals with a high ohmic voltmeter.

Leakage current: The leakage current is specified at ambient temperature 25±2°C. The following procedure must be followed to determine the leakage current:
(a) the capacitor is charged to rated voltage with constant current (operating current, see datasheet);
(b) the capacitor is kept at the rated voltage for 72 hours, during which the leakage current declines to a steady-state value;
(d) measure the leakage current between the capacitor terminals for the characteristic leakage current.

Polarity: The terminals of the product have a (positive or negative) polarity marks. Please check the polarity before using. Never apply any reverse voltage.

Lifetime: There are many different lifetime definitions known without any true standard definition. Take special care when capacitors of different manufacturers or technologies are compared. In the case of lifetime tests, please consider the rated operating voltage and rated operating temperature. Do not exceed the rated operating current.

Load Life: Period of time, during which the technical parameters of all capacitors stay within the given limits. JIANGHAI does not allow for outliers.

High Temperature storage time: Period of time, during which the technical parameters of all capacitors stay within the given limits. JIANGHAI does not allow for outliers.

Cycle Life: Number of charge and discharge cycles at ambient temperature 25°C during which the technical parameters of all capacitors stay within the given current limits and voltage range. JIANGHAI defines this without allowing for outliers.

Temperature Characteristics: The parameters of the capacitor are dependent of the temperature. Please check the datasheet or ask for assistance to define the temperature dependencies.

AC internal resistance(ESR_{AC}): Please note that the capacitor must not be connected to alternating voltage during regular operation. The only exemption is the determination of the ESR_{AC}, by a test procedure devised to determine the ESR without charging the component. At ambient temperature 25±2 °C the capacitor is discharged to U_{min} with constant current I_R before testing. A sinusoidal alternating current signal with an amplitude of maximum 5 mA and a frequency of 1kHz is applied, then the decreasing alternating voltage at the capacitor is detected. The AC internal resistance of the capacitor is calculated according to the following formula: $ESR_{AC}=V_{AC} / I_{AC}$

DC internal resistance(ESR_{DC}): At ambient temperature 25±2 °C, the DC internal resistance of a capacitor is evaluated by following these steps:
(a) the capacitor is charged to the rated voltage U_R with constant current I_R;
(b) the capacitor is kept at the rated voltage U_R for 30 minutes;
(c) the capacitor is discharged to the minimum operating voltage U_{min} with a constant current I_R, measure the voltage U_i after 30ms discharge;
(d) repeat the steps for three times from (a) to (c);
(e) calculate the DC internal resistance of capacitor (R_{DC}) within the third cycle according to the following formula: $R_{DC} =(U_R-U_i)/I$

Vibration and mechanical stress: Capacitors are sensitive to vibration and mechanical forces applied on the leads. Do not use capacitors, which have been dropped onto a rigid surface.

Insulation: If any defect of the sleeve is visible, the component should not be used – the same holds for any kind of visible damage. A capacitor should be electrically isolated from the following parts: aluminum case, cathode lead wire, anode lead wire and circuit pattern, and auxiliary terminal of snap-in type. The sleeve of the capacitor is not an insulator and therefore the standard capacitor should not be used in a place where insulation function is needed. Please contact JIANGHAI if a higher grade of insulation is required.

Electrolyte and separator paper: Electrolyte and separator paper used in Energy-Capacitors may be flammable. Also, electrolyte is electrically conductive. Therefore, in case electrolyte gets in contact with PC board it may cause corrosion of circuit pattern or cause short circuit between patterns, and may lead to smoke generation or ignition in worst case.

Caution during use of capacitors: Do not touch the terminals of capacitors. Keep the capacitor free from conductive solution, such as acids, alkali and so on. Ensure that the operating environment of the equipment into which the capacitor has been built is within the specified conditions mentioned in the catalogue or specification sheets.

Safety Vent (Radial and Snap-In): The safety vend needs some free space to open properly. Allow free headroom of at least 2mm for diameter ≤16mm, more than 3mm for diameter 18 - 35mm. Do not place any wires or PCB tracks above the valve.

Soldering: Please only use manual soldering. Don't use reflow soldering or wave-soldering or infrared heating or air heating. Heat shock will decrease the electric performance of capacitors or cause malfunction.
(1) Soldering temperature for radial and snap-in types should not exceed 260°C and soldering time not exceed 5s.
(2) Soldering temperature for pouch bag types should not exceed 420°C and soldering time not exceed 10s.
Take measure at prevent Energy-Capacitors becoming short-circuited during the soldering process.

Glueing, cleaning and coating: Do not use fixing agents or cleaning substances containing halogens. Do not use coating and moulding components that completely seal the capacitors from the environment. Also, never use solvents containing: Halogenated hydrocarbons, alkali, petroleum, trichloroethylene/-ethane, xylene, acetones, trichloro trifluoroethane, tetrachloroethylene, methylene chloride, chloroform, acetates, ketones, esters, chlorides and bromides.

Mounting: Other devices, which are mounted near the capacitor, should not touch the capacitor. Heat transferred from other components to the capacitor may reduce the lifetime of the capacitor. Do never bend or twist the capacitor after soldering to avoid stress on the leads. Radial capacitors are not protected against mechanical forces on the leads. Forces on the pins might damage the capacitor. No printed circuit board tracks are allowed between the lead pads of the capacitor.

Transportation:
(1) Do not apply excessive vibration or shock when transporting the product.
(2) Prevent the packaging from being dropped during transportation or being stabbed by fork, lift forks etc. during freight handling.
(3) Package the product with individual terminals isolated to prevent short-circuits between them.
(4) Do not allow the product to get wet from, for example, rainwater, seawater, ice and snow, dew condensation, or freezing during transportation.
(5) Package the product in materials strong enough to prevent damage from stacking.
(6) Avoid fumigation and spraying insecticides (especially with bromides) in the import or export procedures which can cause corrosion. This applies also to the finished devices.

Storage conditions for Lithium-Ion-Capacitors: When storing the product for a long period of time, pack it in a way that stacking does not damage the product, taking care to preserve the isolation between individual terminals to prevent a short circuit between them.
(1) Temperature 0°C to 35°C and relative humidity below 65%.
(2) Storage voltage 3,4V to 3,7V.
(3) Storage time above 1 year should be avoided.

Storage conditions of Electrolytic-Double-Layer-Capacitors: When storing the product for a long period of time, pack it in a way that stacking does not damage the product, taking care to preserve the isolation between individual terminals to prevent a short circuit between them.
(1) Temperature 15°C to 35°C and relative humidity below 65%.
(2) Uncharged state (Voltage: 0~0.3V).
(3) Storage time above 4 year should be avoided.

Maintenance
Periodical inspection should be carried out for the capacitor: visual inspection to check pressure relief open or leakage of electrolyte, electrical characteristic as self-discharge current and capacitance.

Air transportation regulations
Currently, Energy-Capacitors are not considered as dangerous goods in 2015IATA Regulations (status as of January 1st, 2019). However, as air transportation regulations may change, it is recommended that you should check the regulations each time you are transporting Lithium-Ion Capacitors and use an appropriate transportation method.

In case of emergency
(1) If the capacitor becomes deformed or damaged, stop using it and replace it immediately.
(2) If the cell starts leaking electrolyte or released gas and smoke, stop using it and replace it immediately. Keep away from open flames or sources of ignition. Leaked electrolyte might cause short circuits on the PCB.

Emergency actions: When the pressure relief vent is open and some gas blows out from the capacitor, please turn the main switch of the equipment off or pull out the plug from the power outlet immediately. During safety vent operation, extremely hot gas (>100°C) may blow out of the capacitors. Do not stand close to the capacitors. In case of eye contact, rinse the open eye(s) with clean water immediately. In case of ingestion, gargle with water immediately, do not swallow. In the case of innervation please exposed to fresh air. Do not touch electrolyte but wash skin with soap and water in case of skin contact. In the case of an accident with electrolyte, please consult a doctor.

Disposal: Following the rules of WEEE, Energy-Capacitors must be collected separately as electronic waste.

Jianghai Europe Electronic Components GmbH
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