

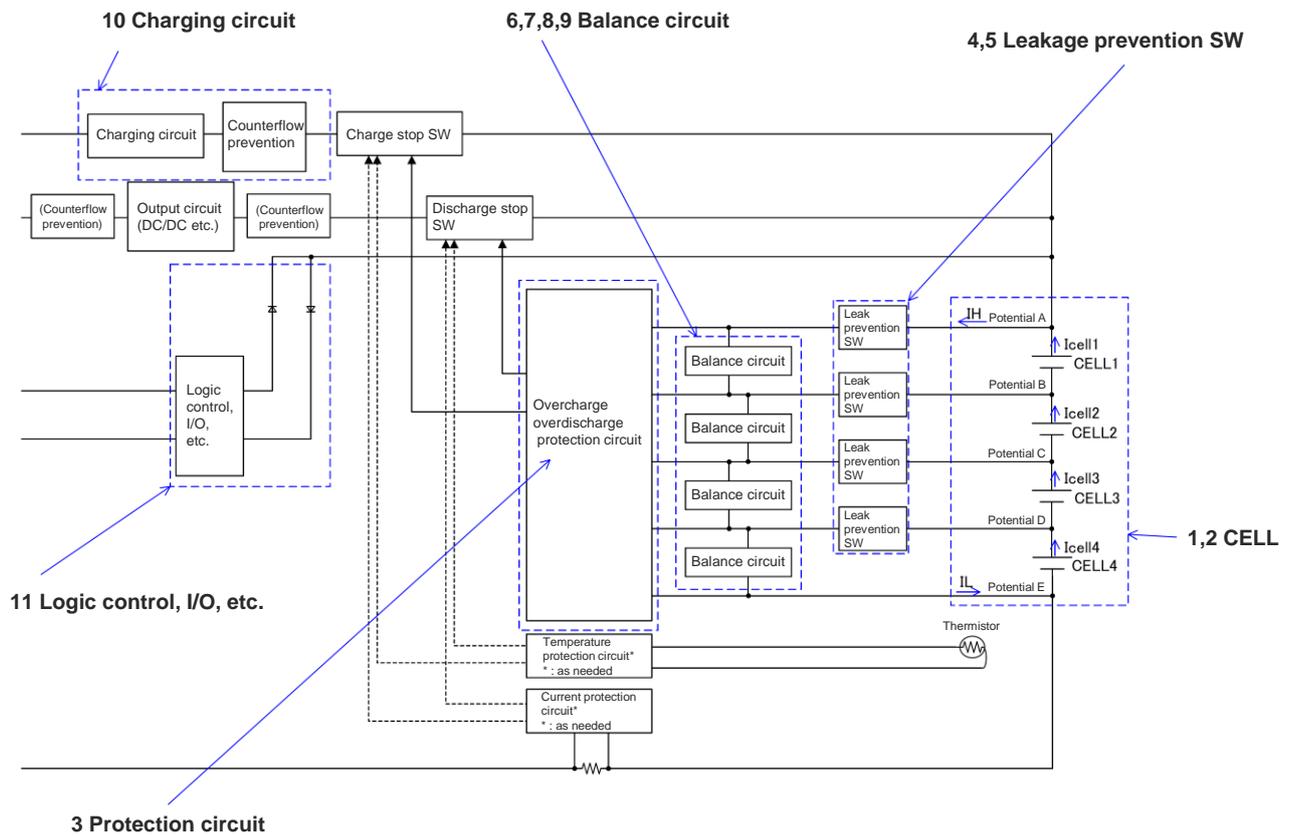
# Notes on circuit design for Lithium Ion Capacitor

This document provides a reference material for the use of our products (cylinder type lithium ion capacitor) for the developers of circuits and systems. Use it during design and evaluation.

Also, in addition to the precautions shown here, please read the product specifications and observe the details.

Reference block diagram and precautions at each part are shown below.

## ○ Block diagram



○ **Precautions at each site**

No.	Site	Contents	For a single series connection	For multiple series connection	Charging and discharging	Standby	Storage and maintenance
1	CELL	<ul style="list-style-type: none"> <li>If the voltage of the capacitor exceeds the upper limit voltage or lower than the lower limit voltage, the capacitor will be permanently damaged. Therefore, please avoid overcharge or overdischarge. Never use the capacitor after overcharge or overdischarge.</li> </ul>	○	○	○	○	○
2	CELL	<ul style="list-style-type: none"> <li>Please design so that the current consumption of each capacitor is uniform. Specifically, the current of B, C, and D at the midpoint is almost 0 A by designing as follows. (* Except when controlling voltage balance.)  <math>I_H = I_L</math>  <math>I_{cell1} = I_{cell2} = I_{cell3} = I_{cell4}</math></li> <li>When current is supplied from the intermediate potential B, C and D to GND(≠potential E), the discharge of the lowest capacitor(=CELL4) becomes faster, and the voltage of each capacitor becomes unbalanced.</li> <li>The voltage of each capacitor becomes unbalanced when the resistance connection is to GND or when the power is generated from the intermediate potential.</li> <li>When testing, monitor the voltage of the capacitor with a voltmeter and make sure not unbalanced. When conducting a long-term test, consider the leakage current to the measuring instrument.</li> </ul>		○		○	○
3	Protection circuit	<ul style="list-style-type: none"> <li>Do not use again when overcharging or overdischarging by monitoring that each capacitor is within the upper and lower limit voltage.</li> <li>Not only the protection circuit section, please devise as a system such as the charging circuit side, the discharge circuit side, etc.</li> </ul>	○	○	○	○	○
4	Leakage prevention SW	<ul style="list-style-type: none"> <li>The capacitor may be discharged below the lower limit voltage due to the consumption current of the protective circuit. Calculate the time required to discharge the capacitor to the lower limit voltage due to current consumption, and add the switch to prevent leakage current if necessary.</li> <li>For example, calculate the discharge time t (s) with the following formula and set the time until the capacitor is recharged so that it does not go below the lower limit voltage.  <math>t = C \times (V_s - V_{under}) / I</math></li> </ul> <div style="border-left: 1px solid black; padding-left: 5px; margin-left: 20px;"> <ul style="list-style-type: none"> <li>Discharge starting voltage : <math>V_s</math> [V]</li> <li>Lower limit voltage: <math>V_{under}</math> [V]</li> <li>Circuit consumption current: <math>I</math> [A]</li> <li>Total capacitance*: <math>C</math> [F]</li> <li>* When connected in series, divide the capacitance of one capacitor by the number of series connections..</li> <li>* When connecting in parallel, add the capacitance of each capacitor.</li> </ul> </div>	○	○		○	○
5	Leakage prevention SW	<ul style="list-style-type: none"> <li>If the capacitor may not be used for a long period of time after incorporating the capacitor into the substrate or set, design the circuit so that the capacitor does not overdischarge as with No.4.</li> </ul>	○	○		○	○
6	Balance circuit	<ul style="list-style-type: none"> <li>There are various types of balance circuits, but avoid the connection of the capacitor which is constantly discharging the capacitor, such as connecting the simple resistor, because it may cause overdischarge.</li> </ul>		○			○
7	Balance circuit	<ul style="list-style-type: none"> <li>If a voltage is continuously applied to a capacitor through a charging circuit, it may be unbalanced due to individual differences in each capacitor at the end of the charging period. Therefore, when the voltage is applied to the capacitor, the function of the balance circuit should not be turned OFF.</li> </ul>		○	○		
8	Balance circuit	<ul style="list-style-type: none"> <li>When the voltage of the capacitor is unbalanced, the protection circuit of the overcharge protection voltage and overdischarge protection voltage is detected earlier than expected. For example, if there is a difference of 0.2 V between the capacitors in two series, and the overcharge protection voltage is 3.8 V and the overdischarge protection voltage is limited to 2.2 V, the allowable voltage range is 7.4 V to 4.6 V.(7.4 V = 3.8 V + 3.6 V, 4.6 V = 2.4 V + 2.2 V. If the voltage of the capacitor in 2 series is the same, the allowable voltage range is 7.6 V to 4.4 V.)</li> </ul>			○	○	
9	Balance circuit	<ul style="list-style-type: none"> <li>When repeatedly charging and discharging with a large current, the balance circuit does not work effectively, so that the voltage of the capacitor should be balanced at the timing close to the full charge with less charging current.</li> </ul>			○	○	
10	Charging circuit	<ul style="list-style-type: none"> <li>If there is no input voltage etc. in the charging circuit, the energy of the capacitor is discharged to the charging circuit side and the capacitor may fall below the lower limit voltage. Please give consideration to the circuit.</li> </ul>	○	○	○	○	
11	Logic Control · I/O etc.	<ul style="list-style-type: none"> <li>If the power of capacitors is used for control or I / O signals, check that the capacitor is not charged or discharged by an unintended route. For example, if the IR of a diode is large, the capacitor may be charged and discharged unintentionally. As a result, the voltage of the capacitor may exceed the upper or lower limit voltage.</li> <li>Charging and discharging in a route that does not pass the switch of charge stop or discharge stop are very dangerous because the protection function does not work and the capacitor continues to charge and discharge.</li> </ul>	○	○	○	○	

# Cylinder Type Lithium Ion Capacitors

## Product Usage Guide (User Manual)

**Lithium ion capacitors are shipped in a charged state.  
It is dangerous if a short circuit forms between the terminals because  
they already have stored energy by the time they are shipped.  
Please read this user manual carefully and handle the products with the  
utmost caution.**

TAIYO YUDEN CO., LTD.

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to non-authorized persons is prohibited.**

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## Precautions for Use

### 1. Safety Symbols Used in This Manual

This manual uses symbols to highlight danger and sources of hazards that may cause personal injury or damage to property. Users of cylinder-type lithium ion capacitors (hereinafter, "lithium ion capacitors") should pay special attention to these safety symbols.

Please read the sections in which the symbols are displayed and familiarize yourself with them before using the product.

● To ensure safe use of the product, the following warning symbols are used with explanations in this manual.

 <b>Danger</b>	This symbol indicates actions that <b>present imminent danger of serious personal injury</b> if the product is handled improperly.
 <b>Warning</b>	This symbol indicates actions that <b>present the possibility of serious personal injury</b> if the product is handled improperly.
 <b>Caution</b>	This symbol indicates actions that <b>present the possibility of personal injury or property damage</b> if the product is handled improperly.

● The following warning symbols are used to categorize and explain matters to be observed in handling the product.

	This symbol indicates an action that is <b>prohibited</b> .
	This symbol indicates instructions that <b>must be followed without fail</b> .
	This symbol indicates a general <b>caution</b> .

#### Note on this product usage guide (user manual)

1. No part of this document may be reprinted or copied without permission.
2. The content of this document may be changed in the future without prior notification.
3. Although we make every effort to ensure that the content of this document is accurate, please let us know if you find any errors or omissions.
4. TAIYO YUDEN assumes no responsibility for the results of any actions that go against the instructions given in this user manual.

○ Lithium ion capacitors are suitable for use in a wide range of business fields because of not only their high operating voltage and high energy density, but also their long cycle life and quick charging and discharging capabilities.

## 2. For Your Safety

- This product has been charged to a certain voltage before shipment, and therefore improper handling or usage may cause an electric shock or personal injury.
- Read this document carefully and familiarize yourself with the handling and usage before using the product.
- Make sure that the purpose of use, place, and environment are appropriate. In the event of abnormal conditions or if you find a problem, stop using the product and contact us immediately.

### <Dangers>

- For your safety, please observe the following when using the product.

 <b>Danger</b>	
	<p><b>Do not throw the product into the fire or heat it to temperatures exceeding the upper limit temperature specified in the specifications. Do not use the product near flames.</b></p> <ul style="list-style-type: none"> <li>●It may start to smoke, explode, or burst into flames.</li> </ul>
	<p><b>Do not throw the product into water.</b></p> <ul style="list-style-type: none"> <li>●It may start to smoke, explode, or burst into flames.</li> </ul>
	<p><b>Do not disassemble or alter the product or damage it with a sharp object such as a knife or nail.</b></p> <ul style="list-style-type: none"> <li>●It may cause an electric shock or personal injury. Damage to the main body may cause it to heat up, and it may start to leak or smoke.</li> </ul>
	<p><b>Do not short-circuit or inversely connect the positive and negative electrode terminals.</b></p> <ul style="list-style-type: none"> <li>●It may start to heat up, leak, or smoke.</li> </ul>
	<p><b>Do not hit the product with a hammer or a similar object or step on it.</b></p> <ul style="list-style-type: none"> <li>●It may start to heat up, leak, or smoke.</li> </ul>
	<p><b>Do not place the product on an electromagnetic cooker or in a microwave oven, a high-pressure vessel, or a vacuum vessel.</b></p> <ul style="list-style-type: none"> <li>●It may start to heat up, leak, or smoke.</li> </ul>
	<p><b>Do not store or install the product in places exposed to high temperatures, such as a vehicle cab under the direct sunlight.</b></p> <ul style="list-style-type: none"> <li>●It may start to heat up, leak, or smoke.</li> </ul>
	<p><b>Wear personal protective equipment such as insulating gloves</b> when touching conductive parts such as terminals.</p> <ul style="list-style-type: none"> <li>●Failure to wear personal protective equipment may result in an electric shock, burns, or personal injury.</li> </ul>
	<p>Before storing the product, <b>insulate the positive and negative electrode terminals.</b></p> <ul style="list-style-type: none"> <li>●Failure to insulate the terminals may result in an electric shock, burns, or personal injury, and the product may start to heat up, leak, or smoke.</li> </ul>

## <Warnings>

- For your safety, please observe the following warnings when using the product.

 <b>Warning</b>	
	<p><b>Do not use the product at voltages outside the operating range.</b></p> <ul style="list-style-type: none"><li>● Improper use at voltages outside the operating range not only will shorten the product's life, but may also cause it to heat up, leak, or smoke.</li></ul>
	<p><b>Do not use the product at temperatures outside the operating range.</b></p> <ul style="list-style-type: none"><li>● Improper use at temperatures outside the operating range not only will shorten the life, but may also cause it to heat up, leak, or smoke.</li></ul>
	<p><b>Keep the voltages balanced when multiple products are used in series or parallel connection.</b></p> <ul style="list-style-type: none"><li>● It may cause an internal short circuit, leakage, or a fault.</li></ul>
	<p><b>Do not hold the terminals when carrying the product.</b></p> <ul style="list-style-type: none"><li>● It may cause an electric shock, an internal short circuit, leakage, or a fault.</li></ul>
	<p><b>Do not drop or subject the product to excessive shock or vibration.</b></p> <ul style="list-style-type: none"><li>● It may cause an internal short circuit, leakage, heat generation, or a fault.</li></ul>
	<p><b>Make sure that the product is not installed near heat generating parts of the equipment.</b></p> <ul style="list-style-type: none"><li>● It may cause leakage, heat generation, or a fault.</li></ul>
	<p><b>Do not install or store the product in hot and humid places or places exposed to direct sunlight for a long period of time.</b></p> <ul style="list-style-type: none"><li>● It may cause leakage, heat generation, or a fault.</li></ul>
	<p>In general, electronic components all have a definite failure rate. <b>In view of the fact that the product will fail at some time, design for safety including built-in redundancy, measures to prevent the spread of fire, and fail-safe design to prevent accidents that can result in personal injury, fire, or negative social impact.</b></p>
	<p><b>Use a protection circuit such as a voltage equalization circuit</b> to balance voltages between cells.</p> <ul style="list-style-type: none"><li>● Failure to balance voltages between cells may cause leakage or a fault.</li></ul>
	<p><b>Wear personal protective equipment such as insulating gloves</b> when touching conductive parts such as terminals.</p> <ul style="list-style-type: none"><li>● Failure to wear personal protective equipment may result in an electric shock, burns, or personal injury.</li></ul>
	<p><b>Please contact TAIYO YUDEN for advice first</b> if there is a problem with the conditions of use, operating voltage range, or other matters, as well as when the product is used in combination with other batteries.</p> <ul style="list-style-type: none"><li>● TAIYO YUDEN assumes no responsibility for problems resulting from failure to seek prior advice.</li></ul>
	<p>In the event of abnormal conditions, such as leaks, emission of a strange smell, smoke, or heat, <b>stop using the product and contact us or the distributor immediately.</b></p> <ul style="list-style-type: none"><li>● Failure to balance voltages may cause leakage or a fault.</li></ul>
	<p>If leaking electrolyte comes into contact with the skin or eyes, <b>do not rub them. Flush the area thoroughly with running tap water.</b> If electrolyte gets into the mouth, <b>rinse your mouth with running tap water. Consult a doctor immediately in both cases.</b></p>

## <Cautions>

For your safety, please observe the following cautions when using the product.

 <b>Caution</b>	
	The terminals of the product have a (positive or negative) polarity. <b>Use them with the correct polarities.</b> <ul style="list-style-type: none"><li>● Use with the wrong polarities may cause it to heat up, leak, or smoke.</li></ul>
	<b>Observe the precautions for electrical handling</b> when connecting a connector or electrical wire to the terminals. <ul style="list-style-type: none"><li>● Failure to do so may cause it to heat up, leak, or smoke.</li></ul>
	<b>Select</b> connectors and electrical wires to be connected <b>with the correct ratings for the electrical currents used.</b> <ul style="list-style-type: none"><li>● Use of a connector or an electric wire with the wrong rating for the electric current used may cause it to heat up or leak.</li></ul>
	When returning the product, <b>wrap the terminal in insulating tape to avoid short-circuiting the terminals and then return it using TAIYO YUDEN's original packaging (or similar packaging).</b> <ul style="list-style-type: none"><li>● Failure to do this may cause it to heat up or burst into flames.</li></ul>
	Please note that if the voltage of the connected equipment is lower than the hold voltage of the product, <b>an excessive current may flow from the cell to the connected equipment</b> on turning on the power.
	If the electrolyte leaks out onto your clothing, <b>wash it out immediately with running tap water.</b>
	When you receive the product, <b>check that there are no abnormalities, such as deformation, leaking electrolyte, strange smell, or heat.</b> If you find anything unusual on receiving the product, <b>do not use it and contact us or the distributor immediately.</b>

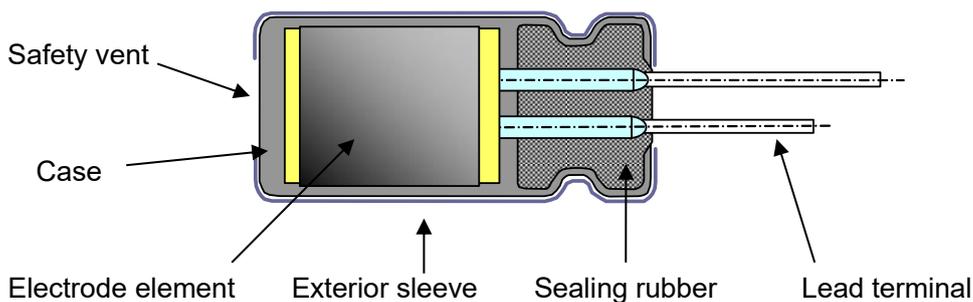
### 3. Product Overview

A lithium ion capacitor is a hybrid type of capacitor, in which activated carbon is used as the positive electrode and lithium-occluded carbon is used as the negative electrode. It is a promising new type of storage device that combines the high power density of an electric double layer capacitor and the high energy density of a lithium ion battery.

Use the product in accordance with the application and the conditions of use.

### 4. Appearance and Names of Parts

- Cell components



### 5. Environmental Conditions and Storage Locations

- Use and store the product under the following environmental conditions specified for individual products.

TAIYO YUDEN's product number	LIC1030RS3R8206, LIC1235RS3R8406 LIC1840RS3R8107, LIC2540RS3R8277
① Operating temperature range	-30°C to 70°C (over 70°C to 85°C)*
② Operating voltage range	2.2 V to 3.8 V (2.5V to 3.5V)*
③ Storage temperature range	5°C to 35°C
④ Long-term storage temperature (Recommended maximum duration is one year.)	10°C to 35°C
⑤ Storage humidity range	80% RH or less (non-condensing)
⑥ Long-term storage humidity (Recommended maximum duration is one year.)	65% RH or less (non-condensing)

\*: Please note that the Operating voltage range differs when used at temperatures higher than 70°C.

	<b>Do not store the product for a long period of time at voltages above the upper limit voltage (3.8 V) or below the lower limit voltage (2.2 V).</b>
	<b>Do not use or store the product at high temperatures, in direct sunlight, near a space heater or other heat sources, at high humidity, or in locations where there is water condensation, ice and snow, or freezing conditions. In addition, do not store the product in the following environments:</b>

	<ol style="list-style-type: none"> <li>1. Environments exposed to liquids such as solvents or oil</li> <li>2. Environments filled with gaseous oily constituents</li> <li>3. Environments exposed to salt water or salt-laden air</li> <li>4. Environments exposed to acid or alkaline solutions</li> <li>5. Environments filled with a caustic gas (e.g., hydrogen sulfide, sulfur dioxide, chlorine, and bromine)</li> <li>6. Environments that may subject the product to vibrations or impacts</li> </ol>
	<p>When storing the product for a long period of time, <b>pack it in materials strong enough to prevent damage from stacking, taking care to preserve the isolation between individual terminals</b> to prevent a short circuit between them.</p>

## 6. Precautions in Handling

- Observe the following precautions when using the product.

	<p><b>Do not damage the main body with a knife, nail, or other sharp object.</b></p> <ul style="list-style-type: none"> <li>● It may cause an electric shock, personal injuries, or burns. Damage to the main body cause it to heat up, leak, or smoke.</li> </ul>
	<p><b>Do not short-circuit the positive and negative electrode terminals.</b></p> <ul style="list-style-type: none"> <li>● <b>This product is designed to have a certain voltage at the time of shipment. More specifically, energy corresponding to the voltage has been prestored in the product. Therefore, never short-circuit the positive electrode terminal with the negative electrode terminal.</b></li> <li>● It may cause an electric shock, burns, or personal injury, resulting in a fault causing it to leak, heat up, or smoke.</li> <li>● Especially when using a metal tool, use it taking care not to short-circuit the terminals. (Examples of dangerous operations: cutting two lead terminals at the same time with nippers; measuring the pitch of the lead terminals with metal vernier calipers)</li> </ul>
	<p><b>Do not discharge the product to voltages less than the lower limit voltage (2.2 V).</b></p> <ul style="list-style-type: none"> <li>● Discharging the product to voltages less than the lower limit voltage will drastically shorten the life, which may result in a deterioration of the electrical characteristics, a short circuit, an open circuit, or leaking electrolyte.</li> <li>● <b>Products whose voltage falls below the lower limit voltage cannot return to the initial normal state even when they are recharged one more time. Please take special care with storage and handling, and design circuits so that the voltage never falls below the lower limit voltage.</b></li> </ul>
	<p><b>Do not charge the product to voltages greater than the upper limit voltage (3.8 V).</b></p> <ul style="list-style-type: none"> <li>● Charging the product to voltages greater than the upper limit voltage will drastically shorten the life, which may result in a deterioration of the electrical characteristics, a short circuit, an open circuit, or leaking electrolyte.</li> </ul>
	<p><b>Do not apply a reverse voltage.</b></p> <ul style="list-style-type: none"> <li>● It may deteriorate the electrical characteristics, and result in leakages, or a short circuit.</li> </ul>
	<p><b>Do not use products that have been dropped.</b></p> <ul style="list-style-type: none"> <li>● Use of a dropped product may result in a short circuit or leakages.</li> </ul>

	<p>Do not apply excessive heat stress to the main body, positive electrode terminal, or negative electrode terminal. This will deteriorate the electrical characteristics, and result in leakages, a short circuit, or an abnormal appearance because of increased internal pressure from generated gases.</p>
	<p>Do not apply force to the positive and negative electrode terminals as this may bend or break off the terminal, resulting in breach of the airtightness, leaking electrolyte or a short circuit caused by generated gases and resultant increased internal pressure, or abnormal appearance.</p>
	<p>Do not apply excessive external force with a sharp object as this may pierce the product, resulting in breach of the airtightness, leaking electrolyte or a short circuit caused by generated gases and resultant increased internal pressure, or abnormal appearance.</p>

## **7. Precautions for Devices Using Lithium Ion Capacitors**

### **7.1 Operating voltage range and operating temperature range**

- Use the product within the operating voltage range and the operating temperature range

	<p><b>Do not use the product at voltages above the upper limit voltage (3.8 V) or below the lower limit voltage (2.2 V), or at temperatures outside the operating temperature range (-30°C to 85°C).</b></p> <ul style="list-style-type: none"> <li>● It may generate gas, causing it to leak, heat up, or smoke.</li> </ul>
	<p><b>Do not use the product at voltages below the lower limit voltage (2.2 V).</b></p> <ul style="list-style-type: none"> <li>● It may generate gas, causing it to leak, heat up, or smoke.</li> </ul> <p><b>Take due care when designing circuits so that the voltage never falls below the lower limit voltage.</b></p>
	<p><b>Do not use the product at voltages greater than the upper limit voltage (3.8 V).</b></p> <ul style="list-style-type: none"> <li>● It may generate gas, causing it to leak, heat up, or smoke.</li> </ul> <p><b>Take due care when designing circuits so that the voltage never exceeds the upper limit voltage.</b></p>
	<p><b>Install a switch that can interrupt the equalization circuit or an anti-overdischarge function</b> that prevents, in particular, overdischarge states at a voltage below the lower limit voltage (2.2 V). <b>It is recommended that an anti-overdischarge function be implemented to deal with human error such as forgetting to turn off switches.</b></p>
	<p><b>Design the heat dissipation performance with care.</b></p> <p>Depending on the use conditions (e.g., ambient temperature, charging/discharging currents, charging/discharging frequency), the temperature inside the cell can exceed the operating temperature range. When there is concern over a rise in temperature, design the heat dissipation performance not to allow the internal temperature to exceed the operating temperature range by ensuring there is sufficient dissipation space, implementing a dissipation board, or other appropriate methods. In addition, concurrent use of a forced cooler such as a cooling fan is recommended.</p>

## 7.2 Use with the proper polarity

- The terminals of the product have a (positive or negative) polarity.



**Do not connect the terminals the wrong way round.**

- It may generate gas, causing it to leak, heat up, or smoke.



To identify the terminals, **the polarities are displayed on the exterior sleeve and the terminal lengths are different.** To avoid connecting the terminals the wrong way round, **check the exterior sleeve and terminal lengths before connecting the terminals.**

## 7.3 Use in particularly safety-conscious applications

- In general, all electronic components have failure rate. Although TAIYO YUDEN makes every effort to improve the product quality, it is not possible for us to make the failure rate zero. In some cases, generation of gases may occur, caused by leaking electrolyte or an internal short circuit, resulting in expansion or deformation. It is strongly recommended that the housing structure should be designed to reduce deformation of the cell.



**Do not incorporate our products into any equipment requiring high levels of safety and/or reliability (e.g., aerospace equipment, aviation equipment\*, medical equipment classified as Class IV by IMDRF, nuclear control equipment, undersea equipment, military equipment).**

- It may cause an accident resulting in personal injury or negative social impact.



Our products are intended for use in general electronic equipment (e.g., AV equipment, OA equipment, home electric appliances, office equipment, information and communication equipment including, without limitation, mobile phone, and PC) and medical equipment classified as Class I or II by IMDRF. **Please be sure to contact TAIYO YUDEN for further information before using the products for any equipment which may directly cause loss of human life or bodily injury (e.g., transportation equipment including, without limitation, automotive powertrain control system, train control system, and ship control system, traffic signal equipment, disaster prevention equipment, medical equipment classified as Class III by IMDRF, highly public information network equipment including, without limitation, telephone exchange, and base station).**



To minimize the result of a product failure in the application for which it is used, **design for safety including built-in redundancy, measures to prevent the spread of fire, and fail-safe design to prevent accidents that can result in personal injury, fire, or negative social impact.**

- It may cause an accident resulting in personal injury, a fire, or negative social impact.



When our products are used even for high safety and/or reliability-required devices or circuits of general electronic equipment, please perform a thorough safety evaluation prior to use of our products. In addition, please take care of a fail-safe design with a protection circuit or a redundant design that does not become an unsafe event with a single failure, and ensure sufficient safety. **Please contact TAIYO YUDEN or the distributor for advice beforehand** for details of the application the product is used in.

#### 7.4 Use conditions and life

- Lithium ion capacitor products have a limited life.



The life of the product varies depending on the use conditions. **Design the equipment to cope with changes in the characteristics over a long period of time to ensure the safety of the equipment.**

#### 7.5 Ensuring safety

- Lithium ion capacitors are equipped with a safety vent.



If the pressure inside the main body increases abnormally, this safety vent ruptures to release the gas inside. **Mount the product allowing a set space (2 mm or more for products with a diameter less than  $\phi 18$  mm; 3 mm or more for products with a diameter equal to or greater than  $\phi 18$  mm) above the safety vent** so that the safety vent can work effectively. Do not place any wires or patterns above the safety vent because a jet of hot gas is emitted when the safety vent is activated. In addition, products with an open safety vent cannot be used.

#### 7.6 Using with large currents

- Lithium ion capacitors used with large currents will generate heat.



**Do not use the product at currents exceeding the maximum charging/discharging current.**

The allowable current for controlling the voltage is specified, even when the product is controlled within the predetermined voltage range. Please ensure that the product charges or discharges within the prescribed current range.

- It may generate heat, start to smoke, expand, deform, or start to leak electrolyte.
- The following are the maximum charging/discharging currents (at RT) that TAIYO YUDEN evaluated the reliability.

TAIYO YUDEN's product number	Charging	Discharging
LIC1030RS3R8206	0.75 A	1.00 A
LIC1235RS3R8406	1.00 A	2.00 A
LIC1840RS3R8107	1.50 A	5.00 A
LIC2540RS3R8277	2.00 A	10.0 A

- Please contact TAIYO YUDEN for advice before using** product at currents exceeding the maximum charging/discharging current. TAIYO YUDEN assumes no responsibility for problems resulting from failure to consult us.



Use of the product at the maximum charging/discharging current generates a large amount of heat in a short period of time. **Do not use the product continuously at the maximum charging/discharging current.**



**Design the heat dissipation performance and the connection method** to avoid allowing the surface temperature of the cell to exceed the operating temperature range.

At low temperatures, it is recommended to charge below the following value.



TAIYO YUDEN's product number	Charging		
	under 0°C	0~10°C	over 10°C
LIC1030RS3R8206	Not recommended	0.40 A	0.75 A
LIC1235RS3R8406		0.50 A	1.00 A
LIC1840RS3R8107		0.75 A	1.50 A
LIC2540RS3R8277		1.00 A	2.00 A

●Please contact TAIYO YUDEN for advice before using product at currents exceeding the maximum charging current. TAIYO YUDEN assumes no responsibility for problems resulting from failure to consult us.

### 7.7 Using multiple capacitors in combination

●Observe the following precautions when multiple capacitors are used in combination.



**Do not mix this product with other storage devices such as other types of capacitors or different types of lithium ion capacitors.**



When multiple lithium ion capacitors of the same type are used in combination, **equalize the voltages before using them.**



When multiple capacitors are connected in series, **the balance of the applied voltage may be lost, and some capacitors may be overcharged or overdischarged. Make sure that the voltage of each lithium ion capacitor is within the operating voltage range. Use of a voltage equalization circuit is recommended.**



When multiple capacitors are connected in parallel, **pay attention to the balance of charge / discharge current of each lithium ion capacitor.**



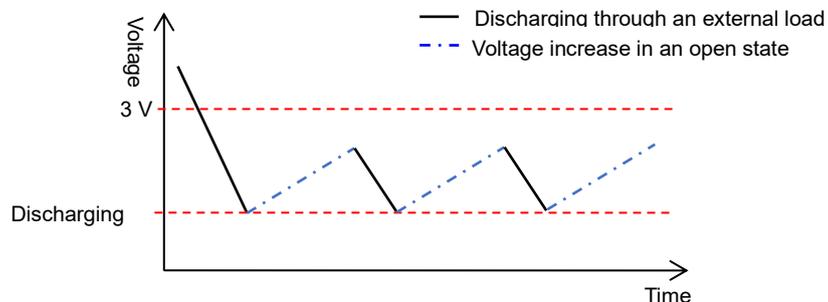
The voltage is "equal to or greater than 3.0 V" when the product is shipped. However, when using multiple cells that have not been used for a long time in combination, **equalize the voltages of the cells before using them.**

### 7.8 Discharging at low voltages

●A lithium ion capacitor has a slowly increasing voltage characteristic when it is open-circuited at a voltage equal to or less than 3 V.

Repeated discharging following a voltage increase as a result of an open circuit at a voltage equal to or less than 3 V (refer to the following chart) may deteriorate the characteristics of the cell.

**Avoid starting to discharge when the voltage of the product is less than 3 V.**



To avoid using the product as described above, **charge it to a voltage equal to or greater than 3 V before starting to discharge.**

### 7.9 Bending or cutting lead terminals

- Observe the following precaution when bending or cutting lead terminals.



**Do not bend or cut leads without tools for fixing cell.**

Provide a fixed part between the stress application point at the time of bending and the product body so that stress is not applied to the product body when bending or cutting the lead terminal.



**Do not bend or cut from the base of the lead terminal.**

Please set a certain distance (as a standard, more than twice the lead wire diameter) from the main body of the product and perform bending of the lead. As stress is applied to the inside of the product, it may cause troubles such as internal short circuit.

### 8. Maintenance and Checks

- It is recommended that equipment in use should be checked periodically.



**Equipment in which lithium ion capacitors are used should be checked periodically for the following items.**

- (1) Appearance: Presence or absence of any marked abnormalities, such as deformation, expansion, or electrolyte leakage.
- (2) Electrical characteristics: Items specified in the catalogue or the delivery specification document.

●**In the event that you find anything unusual from the above checks, stop using the product and take appropriate measures or replace it.**

### 9. Transportation

- Keep in mind the following points when transporting the product.



**Do not apply excessive vibration or shocks when transporting the product.**



**Prevent the packaging from being dropped during transportation or being stabbed by lifts, etc. during freight handling.**



**Package the product in materials strong enough to prevent damage from stacking.**



**Package the product with individual terminals isolated to prevent short circuits between them.**



**Do not allow the product to get wet from, for example, rainwater, seawater, ice and snow, dew condensation, or freezing during transportation.**



**Confirm that the voltage of the cell is not out of the range of the specifications before and after transportation.**

### **[Air transportation regulations]**

Lithium ion capacitor falls under UN Recommendation UN3508 (capacitor, asymmetric (with an energy storage capacity greater than 0.3Wh)), and only LIC2540RS3R8277 (270F, 0.36Wh) is applicable because of its energy content.

IATA : UN3508 Class9, A196

IMDG Code : UN3508 Class9 372\*

\*A196 and 372 have the same content.

As LIC2540RS3R8277 meets the following requirements, it is not subject to any provisions other than A196.



- The energy storage capacity is greater than 0.3Wh and less than 20Wh.
- It is no danger of short-circuiting due to special trays and packaging partitioned individually.
- It has a safety vent to safely release the pressure accumulated during use.
- There is a notation of Wh on the side of product.
- It can withstand 95 kPa differential pressure test.
- There is no loss of contents even if it is dropped from 1.2 m on a flat surface without packing it.
- For products other than LIC2540RS3R8277 (20F to 100F), UN3508 is not applicable because there are less than 0.3 Wh.
- Be sure to check the latest shipping regulations for details.

## **10. In Case of Emergency**

- Take the following measures in the event of any abnormalities in use.



If the cell becomes deformed or damaged, **stop using it and replace or collect it immediately.**



If the cell starts leaking electrolyte or gives out a strange smell, **stop using it and move it away from naked flames immediately.**

- The leaked electrolyte may catch fire.

## **11. Disposal**

- Observe the following precaution when disposing of cells.



**To insulate a positive lead terminal (+) and a negative lead terminal (-) by covering such as a tape to avoid short circuit and dispose in accordance with local and country rules and regulations.**

## **12. Warranty and Reliability**

- Before you export or take TAIYO YUDEN's cell products and/or their technical information outside Japan and provide it to a third party, you must fulfill the conditions of the Foreign Exchange and Foreign Trade Control Law, Export Administration Regulations (EAR) in the U.S. as well as related ordinances, laws, and regulations and follow the procedures prescribed by them.  
TAIYO YUDEN assumes no responsibility for problems caused by failure to follow the necessary procedures.
- The technical information described in the delivery specification document is not intended to permit or guarantee the implementation or use of intellectual property or other rights of TAIYO YUDEN or third parties. Consequently, TAIYO YUDEN assumes no responsibility for uses that violate third party rights.
- No part of this document may be reprinted or copied without permission.
- TAIYO YUDEN assumes no responsibility for trouble caused by misuse, improper use, or use deviating from the operating range described in this document.
- TAIYO YUDEN assumes no responsibility for trouble caused by a change in the design (including application and use conditions) specified by your company.
- Although TAIYO YUDEN makes every effort to improve the quality and reliability, all products have a failure rate and will fail at some time. In preparation for the unlikely event of a fault, design the equipment/system safely so that it does not endanger human life directly or cause harm to people or property.
- The TAIYO YUDEN product specifications (example) shown in Section 13 of this document represent typical values. Before using the product, please ask for the delivery specification document specific to TAIYO YUDEN's cell products to confirm specific details.
- The content of this document may be changed in the future without prior notification. You are advised to contact us before starting design for mass production.

### 13. Product Specifications (Example)

- The following are (example) lithium ion capacitor product specifications (electrical characteristics) by product number.

Product number	Nominal capacitance	Initial specification value	
		Capacitance (Cap.)	Internal resistance (DCR)
LIC1030RS3R8206	20 F	17 to 23 F	250 mΩ or less
LIC1235RS3R8406	40 F	34 to 46 F	125 mΩ or less
LIC1840RS3R8107	100 F	85 to 115 F	60 mΩ or less
LIC2540RS3R8277	270 F	230 to 310 F	60 mΩ or less

#### Performance and specifications

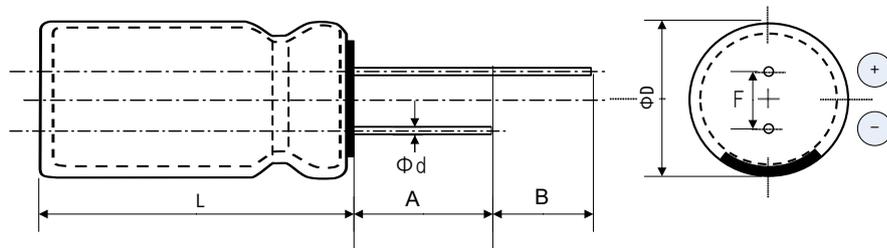
Item	Specification				Condition			
	LIC1030RS 3R8206	LIC1235RS 3R8406	LIC1840RS 3R8107	LIC2540RS 3R8277				
1	Operating temperature range (°C)				-30 to +85*1	—		
2	Maximum operating voltage (V)				3.8	Within the operating temperature range *1: 3.5 V at temperatures exceeding 70°C		
3	Minimum operating voltage (V) (This product has a lower voltage limit.)				2.2	Within the operating temperature range *1: 2.5 V at temperatures exceeding 70°C		
4	Temperature characteristics	-30°C	Cap.	Over 10.2F	Over 20F	Over 51F	Over 115F	Measured after standing at the temperature on the left for two hours or more. *2: +85°C: The charging voltage during the measurement of capacitance is 3.5 V.
			DCR	4Ω or less	2Ω or less	1Ω or less	1Ω or less	
	+70°C	Cap.	To satisfy the initial specification value					
		DCR	To satisfy the initial specification value					
+85°C*2	Cap.	To satisfy the initial specification value						
	DCR	To satisfy the initial specification value						
5	High temperature load characteristics -1	Cap.	Over 13.6F	Over 27F	Over 68F	Over 184F	Ambient temperature : 70±2°C	
		DCR	375mΩ or less	190mΩ or less	90mΩ or less	90mΩ or less	Voltage : 3.8V Test period : 1,000 hours	
6	High temperature load characteristics -2	Cap.	Over 13.6F	Over 27F	Over 68F	Over 184F	Ambient temperature : 85±2°C	
		DCR	375mΩ or less	190mΩ or less	90mΩ or less	90mΩ or less	Voltage : 3.5 V Test period : 1,000 hours	

Note: Unless otherwise specified, all the tests are conducted at room temperature (25±5°C) and room humidity (60±20%RH) set as default.

	The product specifications (example) represent typical values. <b>Before using the product, please ask TAIYO YUDEN for the delivery specification document specific to the product to confirm specific details.</b>
	<b>Please ask TAIYO YUDEN</b> for details of the test conditions in the product specifications.
	The product specifications may be changed without prior notification. <b>Contact us before using the product.</b>

#### 14. Rough External Dimensions (Reference Values)

- The outline drawing and rough dimensions (reference values) by product number of our lithium ion capacitor products are as follows.



Product number	Product dimensions (mm)					
	$\phi D$	L	A	B	F	$\phi d$
LIC1030RS3R8206	$\phi 10.0 \pm 0.5$	$30 \pm 2$	15 min.	3 min.	$5.0 \pm 0.5$	$\phi 0.6 \pm 0.05$
LIC1235RS3R8406	$\phi 12.5 \pm 0.5$	$35 \pm 2$	15 min.	3 min.	$5.0 \pm 0.5$	$\phi 0.8 \pm 0.05$
LIC1840RS3R8107	$\phi 18.0 \pm 0.5$	$40 \pm 2$	15 min.	3 min.	$7.5 \pm 0.5$	$\phi 0.8 \pm 0.05$
LIC2540RS3R8277	$\phi 25.0 \pm 0.5$	$40 \pm 2$	15 min.	3 min.	$12.5 \pm 0.5$	$\phi 1.0 \pm 0.05$

\*These products are equipped with a safety vent. Mount the product with a set space (2 mm or more for products with a diameter less than  $\phi 18$  mm; 3 mm or more for products with a diameter equal to or greater than  $\phi 18$  mm) above the safety vent so that the safety vent can work effectively.

	The rough external dimensions represent reference values. <b>Before using the product, please ask TAIYO YUDEN for the delivery specification document specific to the product to confirm specific details.</b>
	The rough external dimensions may be changed without prior notification. <b>Contact us before using the product.</b>

## [Reference]

### **Laws and Regulations and Guidelines for Lithium Ion Capacitors**

The following are the related laws and regulations as of 2019.



**Consult the latest laws and regulations before using the product.**

No.	Laws and regulations	Storage	Transportation	Disposal	Safety
1	Fire Service Law	√	√	—	—
2	IATA Dangerous Goods Regulations	—	√	—	—
3	IMDG code	—	√	—	—
4	Regulations for the Carriage and Storage of Dangerous Goods By Ships	√	√	—	—
5	Ship Safety Act	—	√	—	—
6	Civil Aeronautics Act	—	√	—	—
7	Waste Management and Public Cleansing Act	—	—	√	—
8	Safety Application Guide	—	—	—	√
9	Transportation guide	—	√	—	—

#### **1. Fire Service Law (June 27, 2018, Act No. 66) / fire prevention ordinances (established by individual municipalities)**

These are regulations for the storage and domestic transportation of electrolyte solutions used in lithium ion capacitors. The Fire Service Law stipulates the specified numbers and fire prevention ordinances stipulate the standard transaction volumes. Lithium ion capacitors (cells/modules) use Class III and IV petroleum, water-soluble liquid, danger rating III (specified volume in the Fire Service Law: 4,000 liters) as their electrolyte solutions. Contact our sales representatives for the amount of electrolyte used in each product.

The law also stipulates that storage or handling of this dangerous material must be conducted in a permitted facility in accordance with the technical standards stipulated in the government ordinance. Refer to the Fire Service Law and fire prevention ordinances established by individual municipalities for details.

#### **2. IATA Dangerous Goods Regulations (60th edition, January 2019)**

UN3508 Class9, Special provisions A196

Note: Only LIC2540RS3R8277 (270F, 0.36Wh) is applied.

#### **3. IMDG Code (VOLUME2, 2018)**

UN3508 Class9, Special provisions 372

Note: Only LIC2540RS3R8277 (270F, 0.36Wh) is applied.

#### **4. Regulations for the Carriage and Storage of Dangerous Goods by Ships (December 26, 2018, the Ministry of Land, Infrastructure and Transport ordinance No. 90)**

Transportation and storage of dangerous goods by vessels must be pursuant to the Regulations for the Carriage and Storage of Dangerous Goods by Ships.

**5. Ship Safety Act (May 31, 2017, Act No. 41)**

The electrolyte solution used is classified as a flammable liquid. Observe the regulations in the Ship Safety Act.

**6. Civil Aeronautics Act (June 2, 2017, Act No. 45)**

The aviation regulations during transportation must be pursuant to the regulations in the Civil Aeronautics Act.

**7. Waste Management and Public Cleansing Act (abbreviated name: Waste Management Law, June 16, 2017 No. 61)**

To insulate a positive lead terminal (+) and a negative lead terminal (-) by covering such as a tape to avoid short circuit and dispose in accordance with local and country rules and regulations.

**8. JEITA RCR-2377 Safety Application Guide for Lithium Ion Capacitors (Established in November 2013, Japanese only)**

**9. JEITA Transportation guide for Lithium Ion Capacitors (Published in May 2014, Japanese only)**