User Manual

TPLC/TPLCE/PBLC Series

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1. Product Overview

A hybrid capacitor, also known as a lithium-ion capacitor or LIC, is an energy-storage device (like an ultracapacitor) that can store significantly more energy in the same volume of space as an ultracapacitor. The major difference between the two technologies is in the electrode materials. The positive (cathode) electrode material of a hybrid capacitor is activated carbon, which is identical to that of an ultracapacitor. The negative (anode) electrode material is composed of carbon material doped with lithium (Li+) ions, which enables the higher energy density in a lithium-ion capacitor versus an ultracapacitor. This electrode formulation enables the LIC to have similar life and power capabilities to an ultracapacitor with significantly higher energy density and lower self-discharge.

2. Product Specifications

Table 1. Specifications for TPLC/TPLCE/PBLC Series

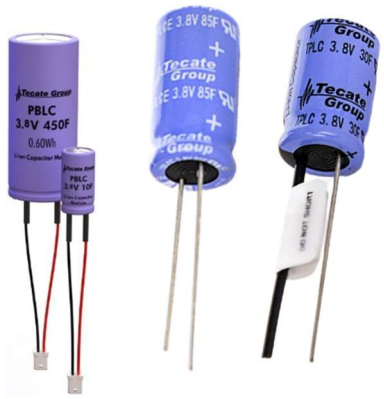
	Performance		
	TPLC	**PBLC**	**TPLCE**
Operating temperature	-15°C to +70°C @3.8V -15°C to +85°C @3.5V		-25°C to +70°C @3.8V -25°C to +85°C @3.5V
Storage temperature	-25°C to +70°C		
Capacitance range	10F to 450F		3F to 1,400F
Capacitance tolerance	+/-20%		
Rated voltage	3.8 VDC / 3.5 VDC		
Min rated voltage	2.2 VDC		
Surge voltage[1]	4.2 VDC		
Temperature characteristics	Capacitance change: Within ±50% of initial measured value at +25°C (across operating temp range) Internal resistance: TPLC/PBLC: Within +600% of initial value at +25°C (at -15°C) Internal resistance: TPLCE: Within +200% of initial value at +25°C (at -25°C)		
Endurance (at rated voltage & max. operating temp)	After 1000 hours: Capacitance change: ±30% of initial rated value Internal resistance: Within two times of initial specified value		
Projected cycle life	TPLC/PBLC: 500,000 cycles TPLCE: 250,000 cycles Number of cycles to reach capacitance decay and internal resistance increase limits defined in endurance test when operated at rated voltage and 25°C.		
Shelf life	Three years at 25°C, or 1000 hours at 70°C		

[1] 3 seconds Max.

3. Safety Considerations and Handling

LIC products are fully charged during production and so require special handling to avoid short circuits or electric shocks, which can damage the product or equipment or cause personal injury. Please take the time to review this user manual in detail and become familiar with the handling and usage guidelines. The LIC must be operated within the specifications identified in the data sheet to ensure safe operation and maximum life. Please contact Tecate's Engineering department with any questions: eng@tecategroup.com. Handling instructions can be found in the following PDF:

https://www.tecategroup.com/downloads/Ultracap_Tech/LIC_handling_instructions.pdf

Observe the following precautions when using the LIC products:	
	• Do not short circuit the terminals. • Do not discharge the product below 2.2V per cell. • Do not charge the cell above 3.8V per cell. • Do not apply reverse voltage. • Do not operate the cell outside of recommended temperature ranges. • Do not drop or subject the cell to excessive shock or vibration. • Do not install or store the cell in hot or humid environments, in direct sunlight, or next to heat-generating components. • Maintain balanced voltages when cells are used in multiple series or parallel connections. • Do not puncture the cell.

4. Environmental Conditions, Voltage, and Storage

Lithium-ion capacitors must be stored and operated within the environmental specifications and voltage limits listed in the data sheet. LICs contain an electrolyte solution that will decompose at temperatures above the specified values, resulting in rapid aging conditions. In cold environments, the electrolyte will solidify and result in a nonfunctional LIC. Operating the LIC above rated voltage or below minimum voltage can result in irreparable damage to the device and should always be avoided. LICs have a very low self-discharge characteristic; however, during extended storage periods (longer than a year), the voltage should be checked to ensure it does not fall below the minimum voltage specification and should be recharged to its rated voltage if it falls below 3V. Do not store the devices in high-temperature and high-humidity locations and avoid direct sunlight.

5. Design and Use

When working with an LIC, it is important to adhere to design guidelines to ensure safety and a maximum useful life. Since LIC products are fully charged during production, care must be taken while handling them to avoid short circuits. Wave soldering is not possible. If the leads need to be trimmed or bent, it is important to use non-conducting tools and fixtures. LICs with the same capacitance rating will have some small capacitance differences between cells, which is normal and expected. For this reason, anytime LIC cells are series connected it is important to use a voltage-management system. Voltage management is necessary to keep the cells at near-equal voltage during operation for reliability and maximum life. It may also be necessary to include temperature and voltage monitors to enhance safety and ensure reliable operation. Thermistors are normally used for temperature monitoring, and there are off-the-shelf integrated circuits that can be implemented for voltage monitoring (under voltage and over voltage). Enclosure designs must take into consideration environmental conditions and have a sufficient IP rating to protect the LICs from water and excessive dust. LIC cells include a safety pressure-relief vent that is located on the top side (opposite the leads). This vent is designed to open and gently release pressure in the event of excessive gas buildup inside the LIC cell. Gas generation can occur if the LIC experiences over-voltage or over-temperature conditions for an extended period. Once a vent opens, the LIC will need to be replaced. The following table includes our recommended clearance on top of the cell to ensure proper vent operation.

Table 2. Vent Clearance

Case Diameter	Clearance Required
6.3 to 16mm	2mm or more
18 to 35mm	3mm or more
40mm+	5mm or more

Please contact Tecate Group's Engineering department with any questions about voltage management, monitoring, lead trimming, lead bending, or enclosure designs. Tecate Group can also design and manufacture a modular solution that includes all of the above. Please visit the Custom Solutions section of our website for more information.

6. Routine Maintenance

For LIC cells in storage, we recommend checking the state of charge annually to ensure cell voltage does not go below 2.2V. Any cell found to be 3V or less must be charged to 3.8V using a power supply.

7. Transportation

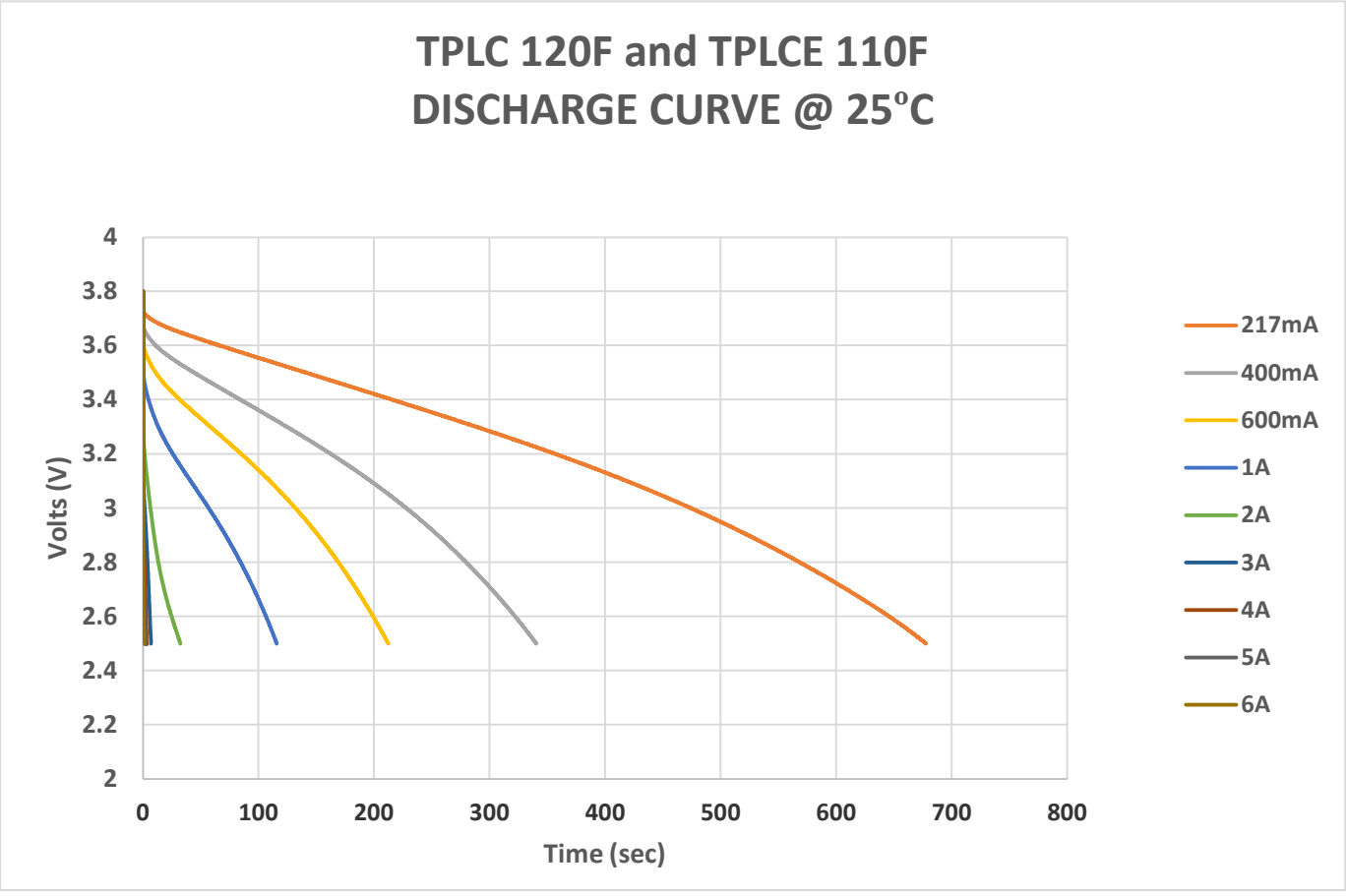
LICs are not restricted as dangerous goods according to IATA or 49 CFR § 172 regulations. LICs are regulated for transportation according to UN 3508. Please consult your local logistics authority for specific requirements and ensure compliance with current regulations.

8. Disposal and Warranty

When disposing of LICs, it is important to comply with all local, regional, and federal requirements. In most jurisdictions, the LIC cells can be disposed of by industrial waste organizations. The LIC product warranty may be found in our Standard Terms and Conditions of Sale, which is available on our website.

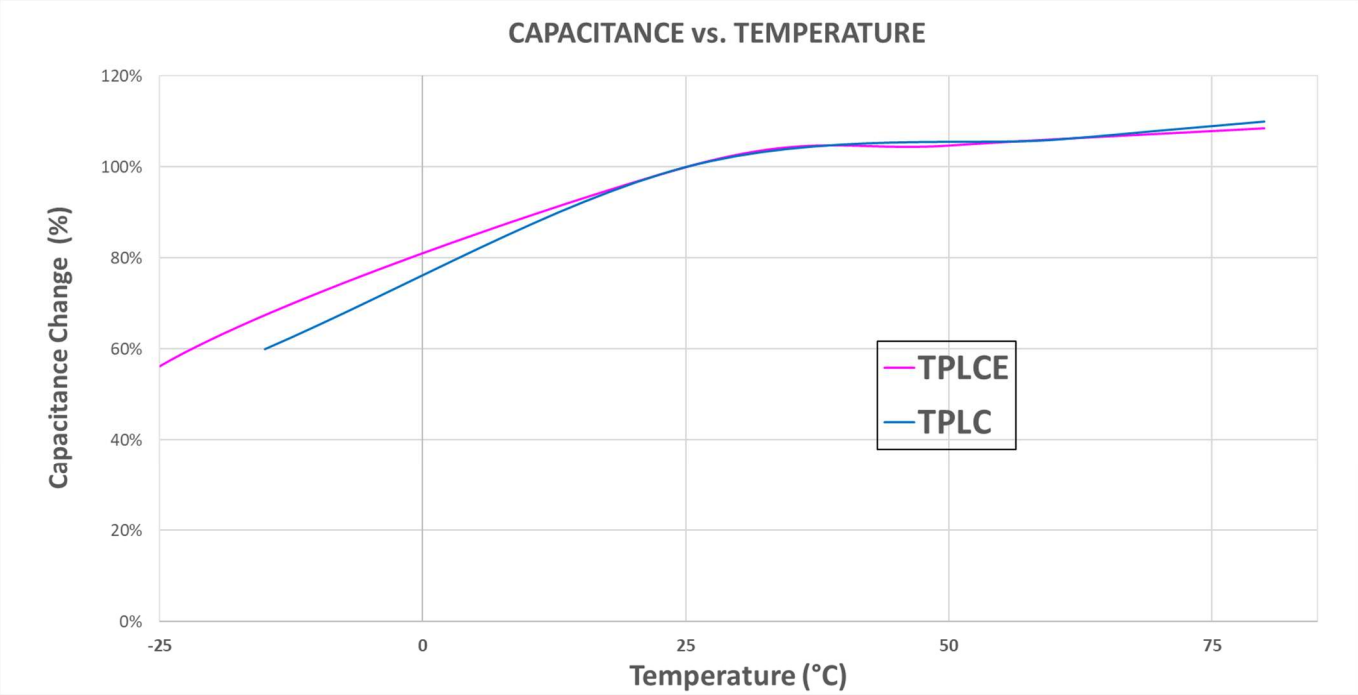
9. Discharge Curves

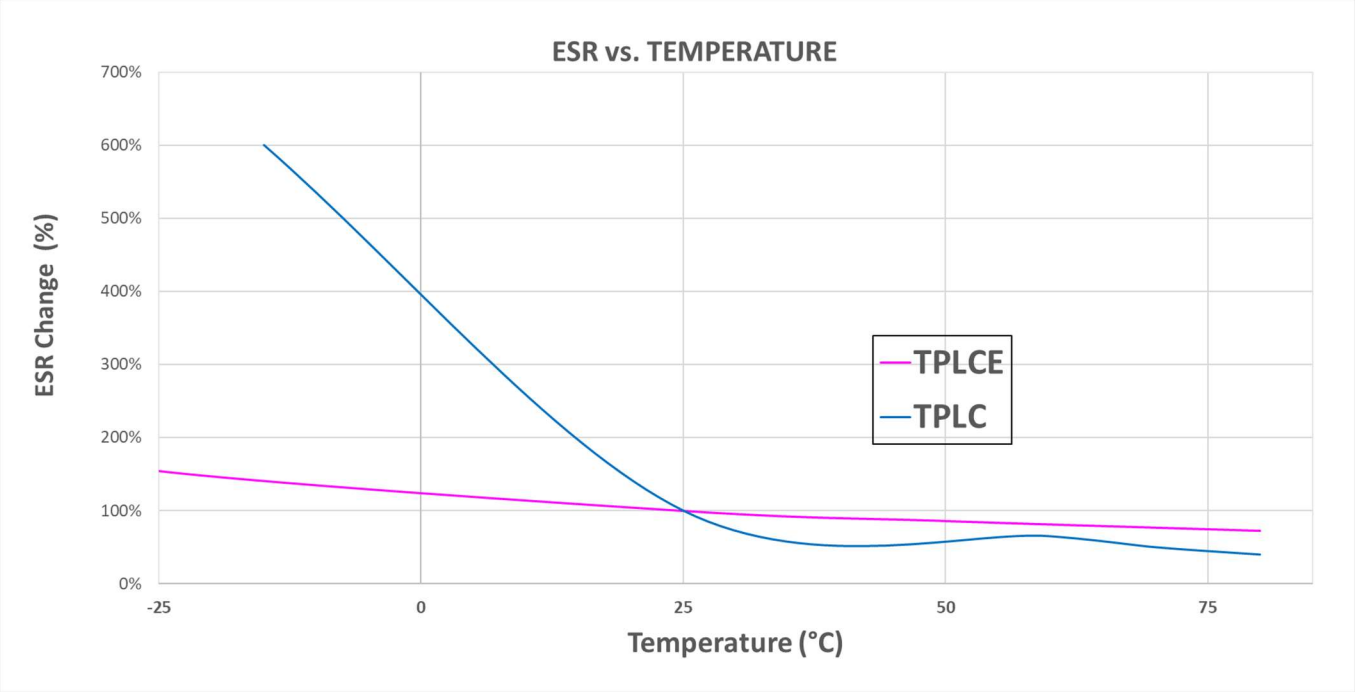
Figure 1. Representative Constant Current Discharge Curves for Similar Capacitance-Sized TPLC and TPLCE Cells



10. Temperature Characteristics

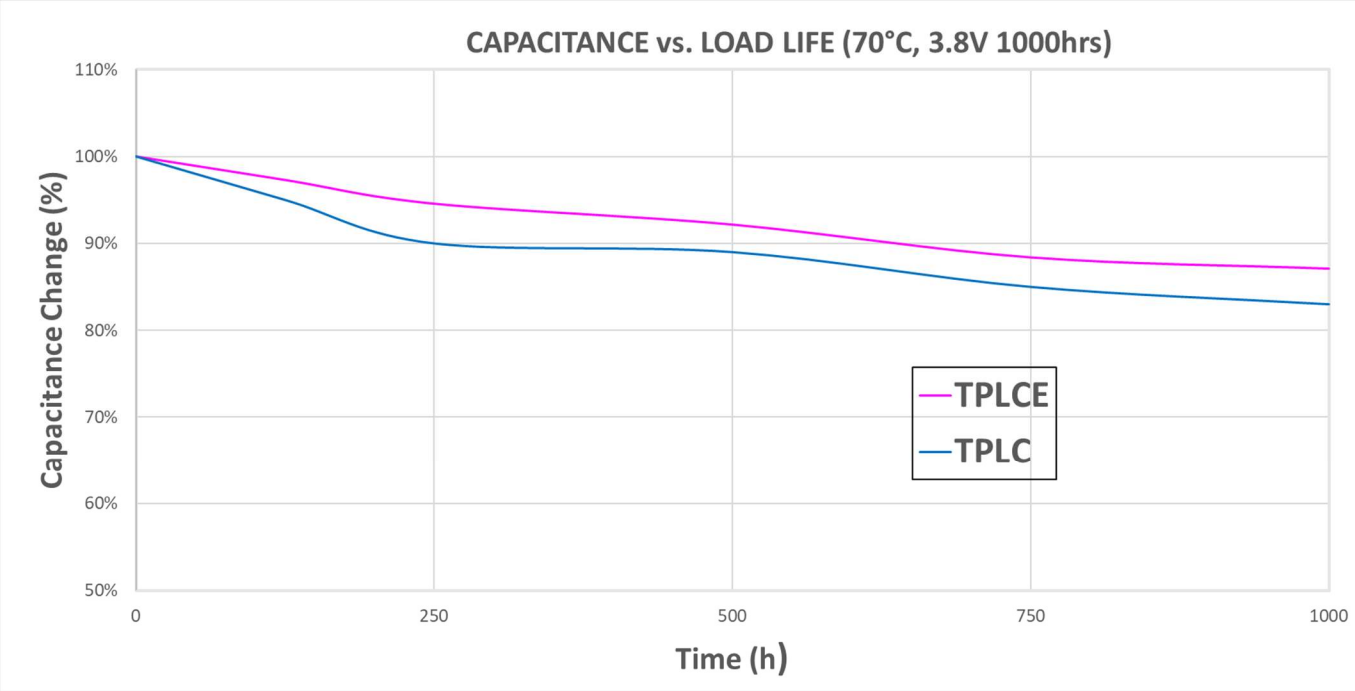
Figure 2. Representative Capacitance and ESR Change From Initial Value at 25°C for Average Temperatures

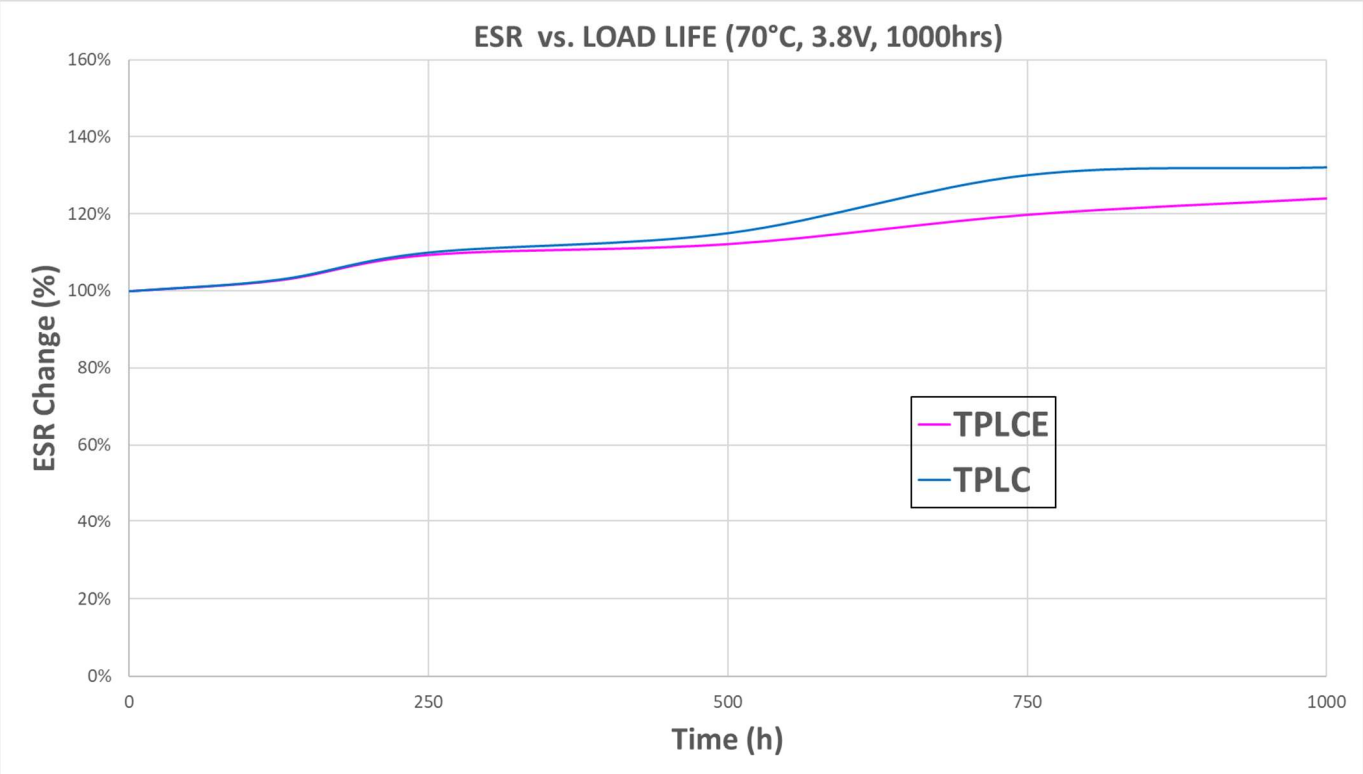




11. Life Performance

Figure 3. Load Life Graph: Typical Cell Life Performance at 70°C, 3.8V for 1000 Hours





12. Soldering

Only manual soldering should be used for TPLC and TPLCE series hybrid capacitors. The soldering iron temperature must not exceed 350°C, and the soldering duration must be limited to a maximum of 5 seconds. Please also keep the following guidelines in mind:

- **Do not reflow solder.** Exposure to infrared or convection reflow temperatures will decrease the electric performance of LICs and may cause the cell to swell, leak, or crack.
- **Do not wave solder.** Wave soldering will cause shorting of the pins and irreparable damage to the cell.
- **Do not wash boards after inclusion of TPLC or TPLCE cells.** Board assembly should be completed with all associated cleaning completed prior to adding the charged cells. A secondary process to solder the TPLC or TPLCE cells should be performed with a no-clean flux; no additional cleaning should be done.

REV	REVISION DESCRIPTION	DATE
A	RELEASED	06/19/20
B	REMOVED APPENDIX AND ADDED RESPECTIVE LINK TO SECTION 3	07/24/20
	ADDED SECTION 12 (SOLDERING)	07/28/20
C	UPDATED TRANSPORTATION DANGEROUS GOODS INFORMATION, REMOVED "." AFTER VOLTAGE	10/09/20
D	ADDED PBLC INFO TO TABLE1, ADDED "PBLC™"	11/11/20
E	REMOVED ALL REFERENCES TO DUAL CELL MODULE	02/08/21
F	ADDED 12.3	04/05/21
G	UPDATED ADDRESS, REMOVED FAX NUMBER	12/12/24
H	UPDATED TO INCLUDE TPLCE SERIES	5/29/25