



User Manual

TPLC™ Series

TABLE OF CONTENTS

1. PRODUCT OVERVIEW	3
2. GENERAL DESCRIPTION OF PART TYPES	3
3. SAFETY CONSIDERATIONS AND HANDLING	3
4. ENVIRONMENTAL CONDITIONS AND STORAGE	4
5. DESIGN AND USE	4
6. ROUTINE MAINTENANCE	5
7. TRANSPORTATION	5
8. DISPOSAL AND WARRANTY	5
9. DISCHARGE CURVES	6
10. TEMPERATURE CHARACTERISTICS	9
11. LIFE PERFORMANCE	10
APPENDIX A: HANDLING PRECAUTIONS (INSERT FOR BULK SHIPMENTS)	12
REVISIONS	13

- 1. Product Overview:** The Tecate Group's TPLC™ series is a Hybrid Capacitor (LIC) which combines the high power density of an ultracapacitor and the rich energy density of a lithium battery. The cell is being utilized in expanding applications that require a combination of power and energy. The Hybrid Capacitor has both an anode and cathode electrode with insulating separator material between these two. The positive cathode is manufactured with activated carbon and the negative anode is a carbon formulation which is pre-doped with lithium ions. The entire assembly is inserted in an aluminum can, filled with electrolyte and sealed with a lid. The cells are designed with board-mountable radial through-hole type terminals.

The TPLC™ series has a 3.8 V maximum voltage rating, 500,000 projected cycle life, no thermal runaway and 10 year calendar life. More detailed product specifications can be found on the current data sheet at, www.tecategroup.com.

2. General Specifications TPLC™ Series:

Table 1: Specifications

Item	Performance
Operating temperature	-15°C to +70°C @3.8V -15°C to +85°C @3.5V
Storage temperature	-25°C to +70°C
Capacitance range	10F to 450F
Capacitance tolerance	-20%/+100%
Rated voltage	3.8 VDC / 3.5 VDC
Minimum rated voltage	2.2 VDC
Surge voltage	4.2 VDC
Temperature characteristics	Capacitance change: Within ±50% of initial measured value at +25°C (-15°C to +70°C) Internal resistance: Within ±800% of initial measured value at +25°C (at -15°C)
Endurance (At rated voltage & max. operating temp)	After 1000 hours: Capacitance change: ±30% of initial rated value Internal resistance: Within 2 times of initial specified value
Projected cycle life (From rated voltage to 1/2 rated voltage at 25°C)	After 500,000 cycles: Capacitance change: Within ±30 % of initial rated value Internal resistance: Within 2 times of initial specified value
Shelf life	After 1000 hours storage, at 70°C without load, the capacitor shall meet the specified endurance limits.

- 3. Safety Considerations and Handling:** Our TPLC™ Hybrid Capacitor is charged with voltage before shipment and improper handling or usage may cause an electric shock or personal injury. Please take the time to review this user manual in detail and become knowledgeable of the handling and usage guidelines of this product. You must ensure that the use of this product as well as the operating environment are appropriate and are within the technical parameters as published. Please contact Tecate Engineering (eng@tecategroup.com) directly in the event of any problems or unusual conditions of use and cease operating the Hybrid Capacitor until you do so.

Observe the following precautions when the product is in use:



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

4. Environmental Conditions and Storage: The use and storage of this product should be within the specified environmental conditions as indicated in Table 1. Refer to the TPLC™ series data sheet for Charging or Discharging Current for specific parts.

It is not recommended that the Hybrid Capacitor be stored for a long period of time at voltages that exceed the upper limit of 3.8VDC per cell or below the lower limit of 2.2VDC per cell. Never store the product at high temperatures, near a space heater, direct sunlight or high humidity environments. It is also not recommended to store the product where there is water condensation, ice, snow or freezing conditions. When storing the product for a long period of time care should be taken to use sturdy packaging to prevent damage from stacking and providing appropriate isolation between the individual terminals to prevent any short circuit.

5. Design and Use: Similar best practices of design and care that are employed for energy storage devices should also be used when implementing the TPLC™ series for various applications. As the device is already charged, care should be taken to maintain the integrity of the cell and keeping it within the specified voltages and temperatures. The cell must be used with the proper polarity and the terminals and exterior sleeve clearly indicate the correct polarity of the positive and negative terminals. The Hybrid Capacitor is intended for use in general electronic equipment and associated applications that would benefit from the additional energy that a standard ultracapacitor does not provide. As there is a limited life to the TPLC™ cell it is important that the design and use characteristics are understood for the specific application by the design/power engineer. There is a mechanical pressure release that will actuate if there is an abnormal amount of pressure.

Our recommendations for appropriate cell mounting and spacing are as follows:

Table 2: Vent Clearance

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

Please contact the engineering team at the Tecate Group for more information, (eng@tecatgroup.com) on cell mounting and spacing. Using the Hybrid Capacitor could generate heat and should be used within the currents specified on the data sheets. When an application requires multiple cells in combination, care must be taken to maintain equalized voltages and use of an equalization circuit is recommended. We always recommend that extreme care should be taken when Hybrid Capacitors are used in combination, whether for series or parallel connections as these are already charged cells and ensuring proper voltage integrity is essential. Many applications do require the leads to be cut or bent for assembly onto a PCB. Do exercise caution and cut and/or bend each lead separately to prevent electrical shorts. Do not bend or cut the leads without a proper fixture to eliminate additional stress on the body of the cell or terminals. Specific recommendations for bending or cutting leads may be discussed with Tecate Group engineering (eng@tecatgroup.com).

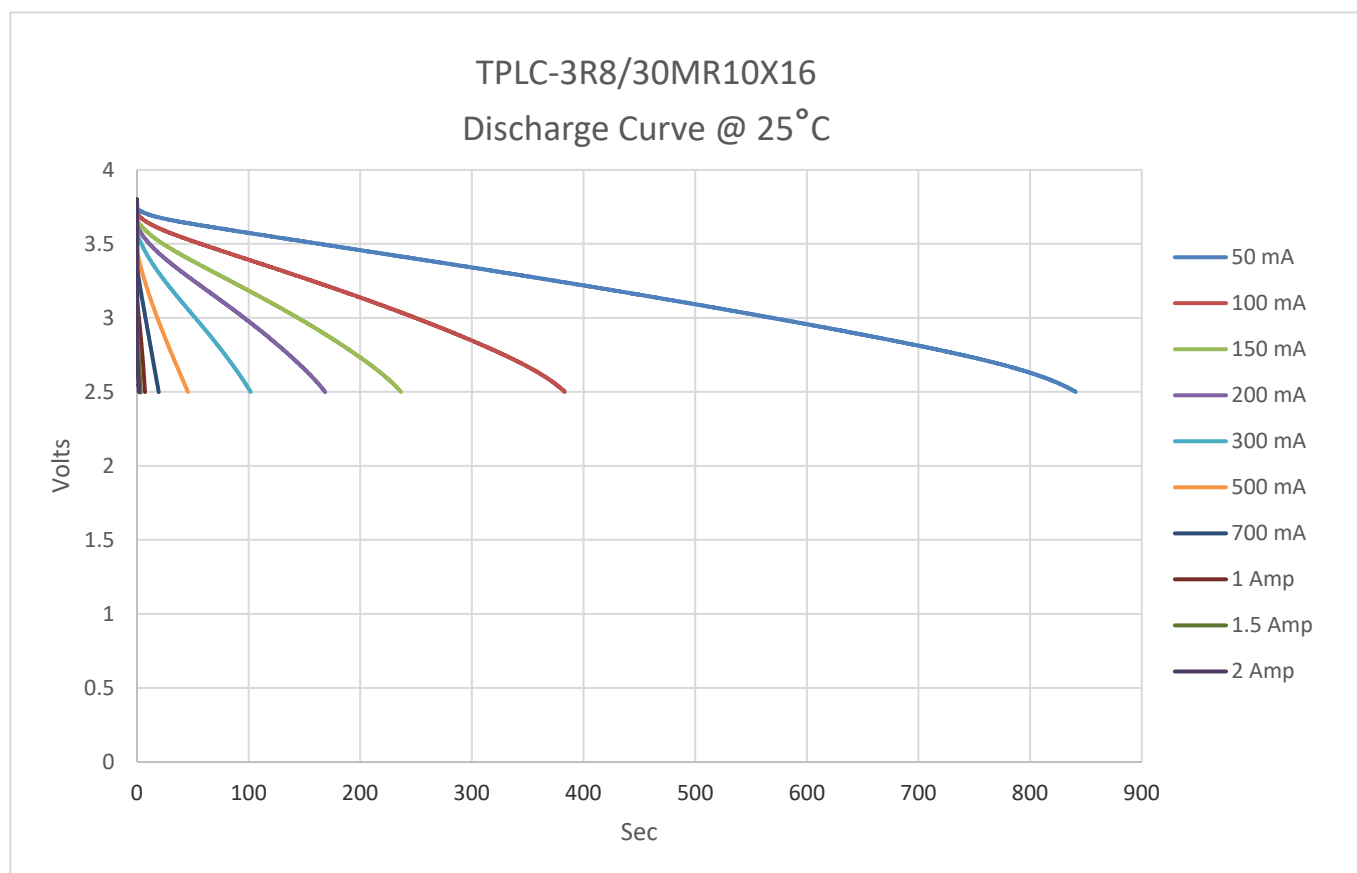
6. Routine Maintenance: It is recommended that the state of charge of cells in storage should take place annually to ensure cell voltage does not dwell below 2.2VDC. per cell while in storage. Any cell found to be below or close to the 2.2VDC threshold should be charged using a power supply to 3.8VDC.

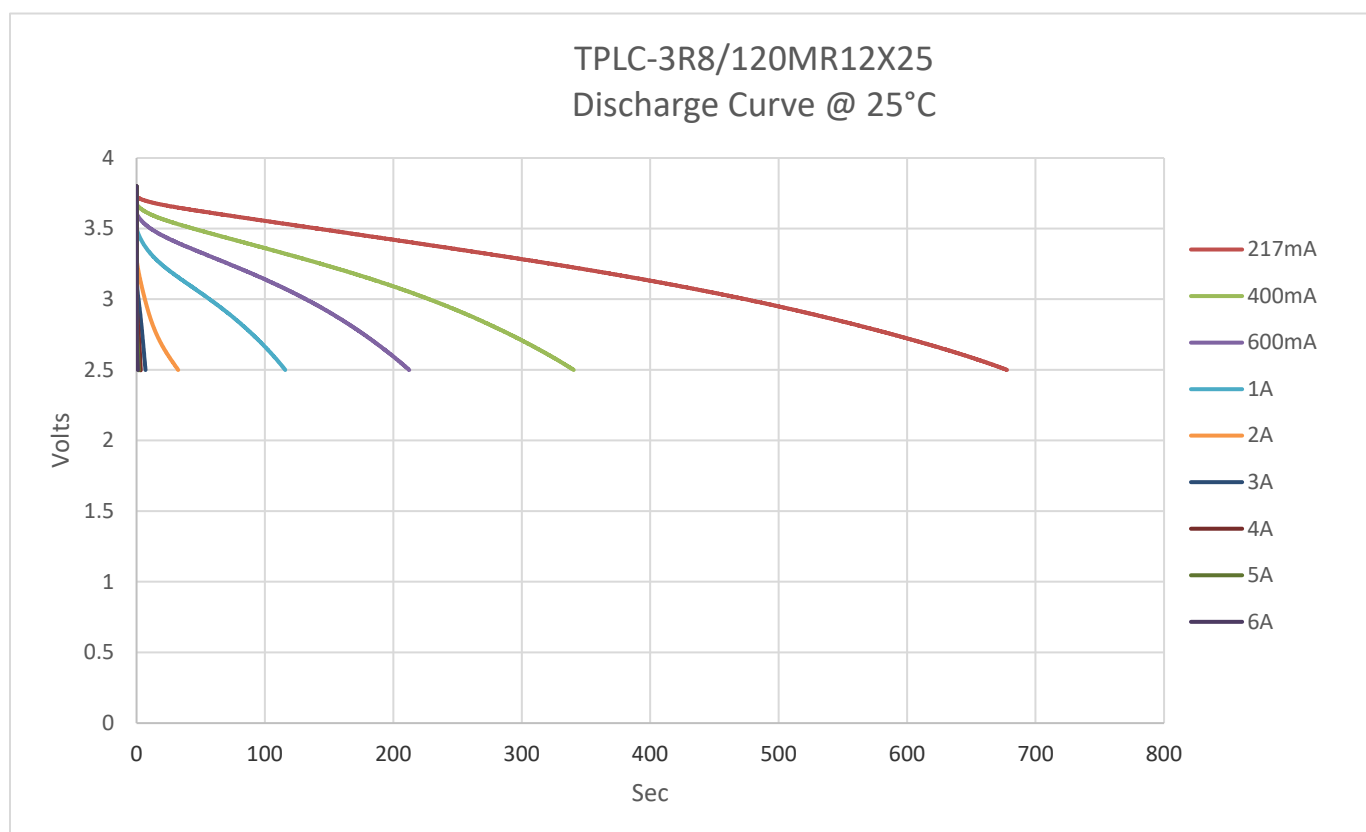
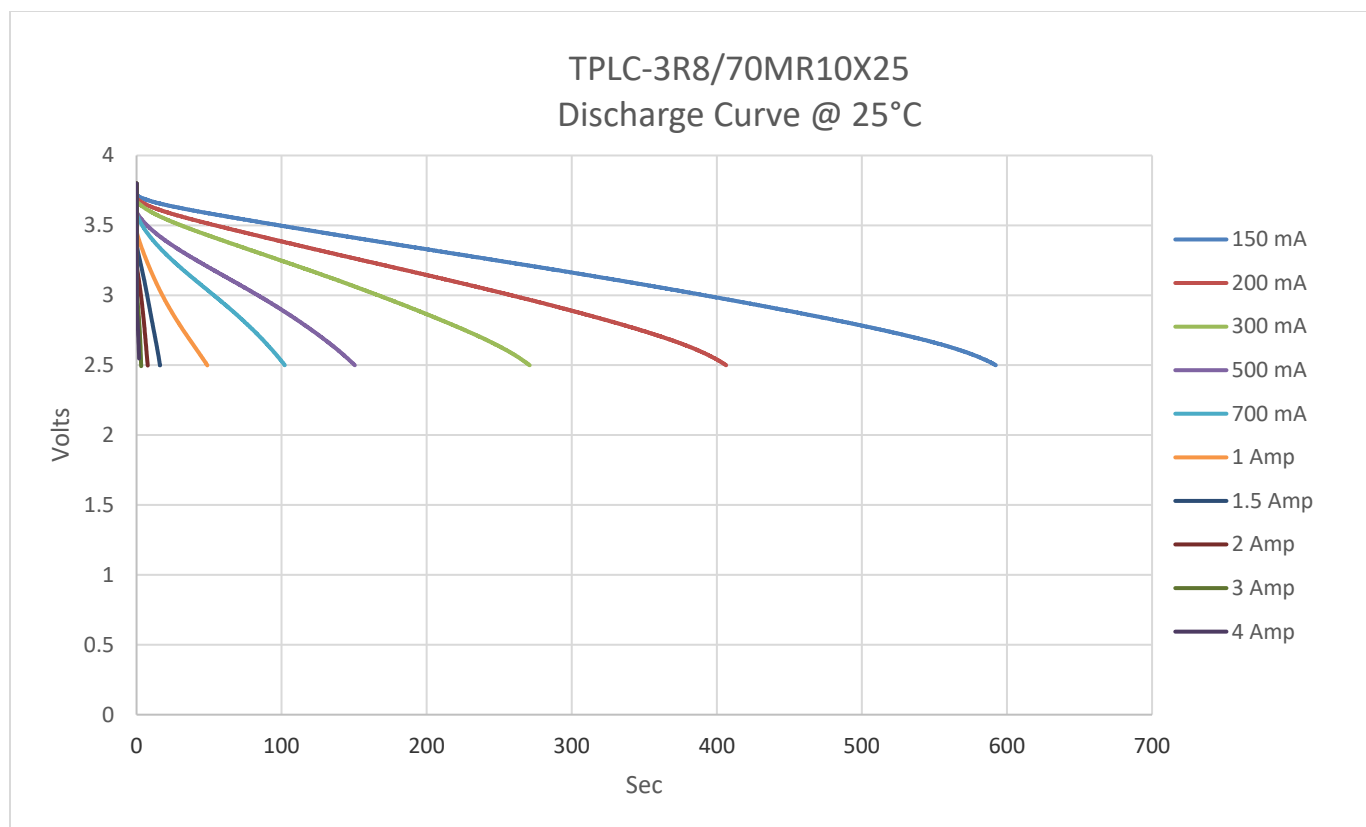
7. Transportation: When transporting the cells be mindful of the following:

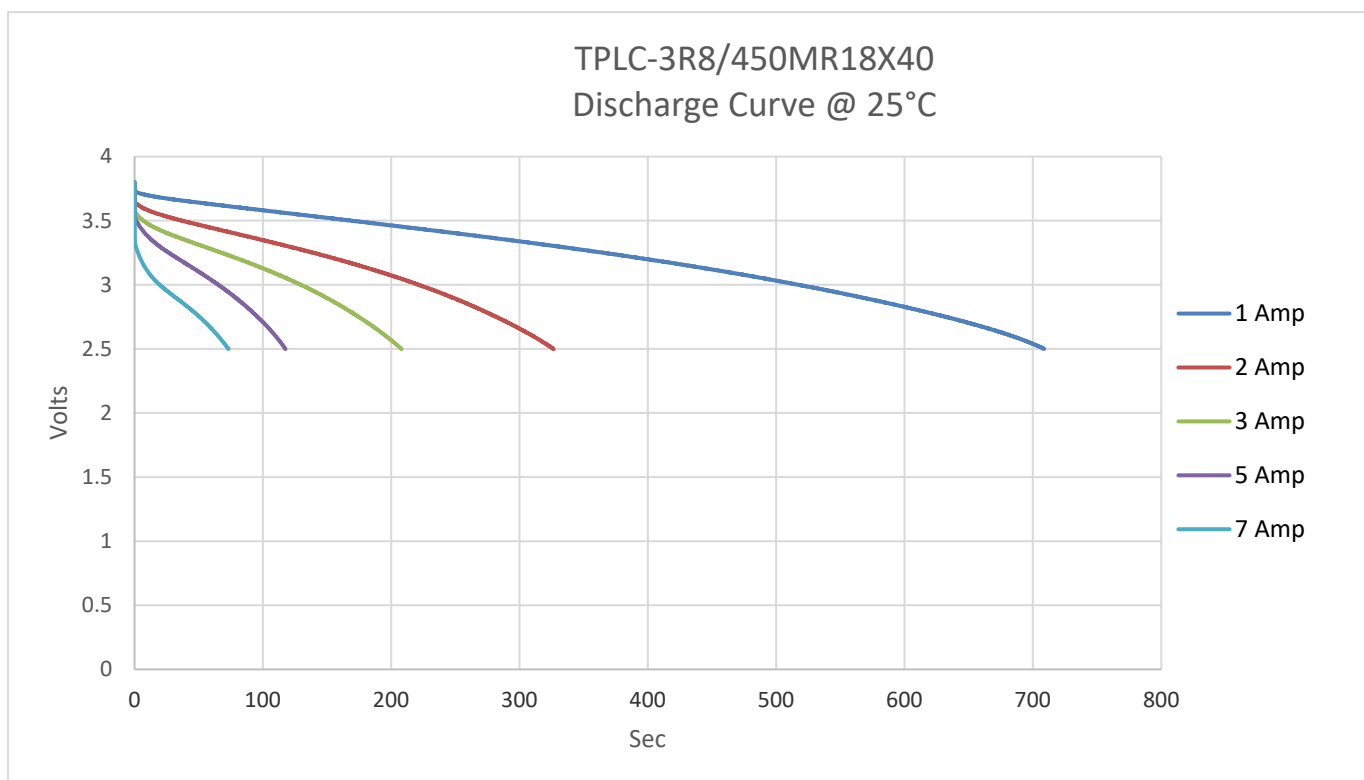
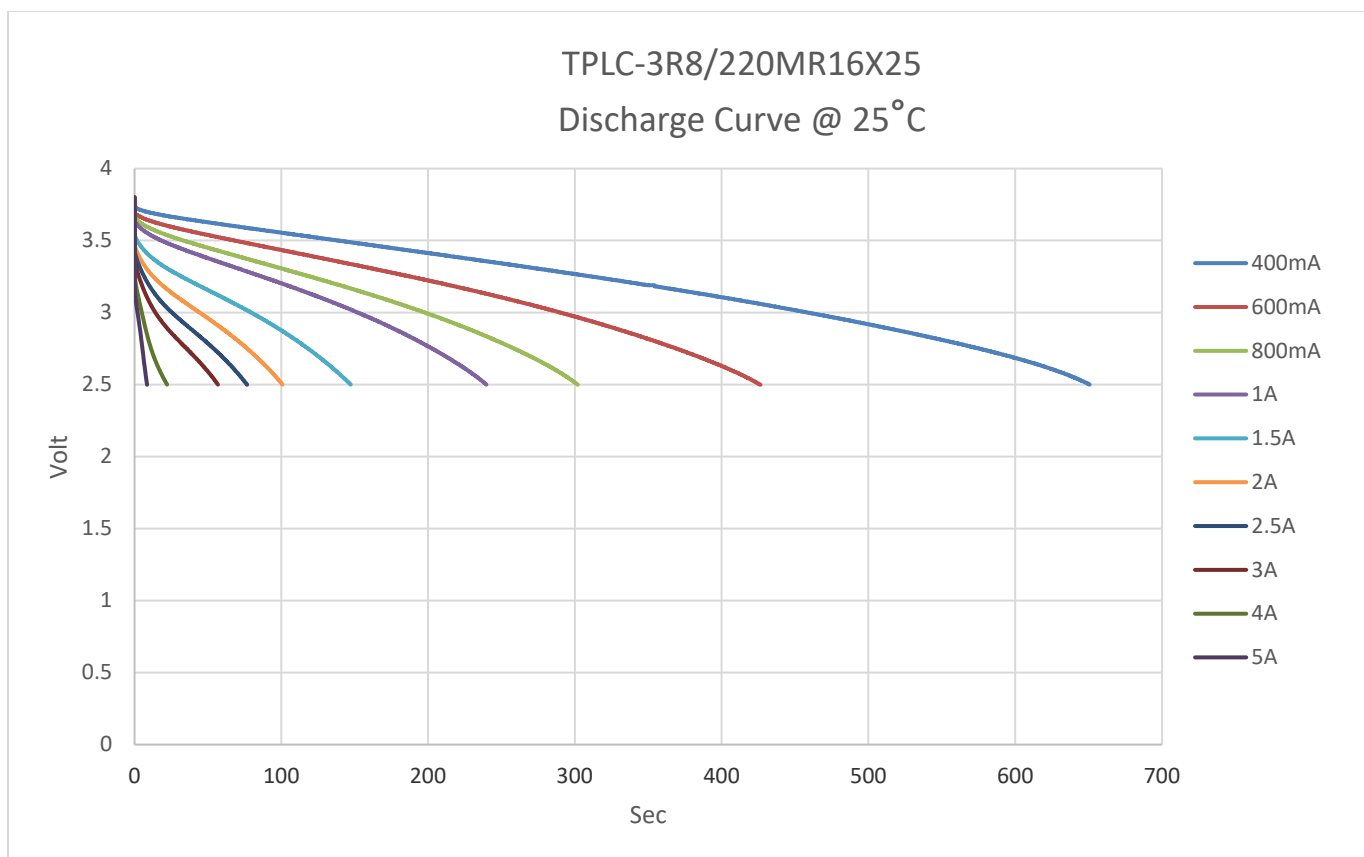
- Avoid excessive shock and vibration
- Sturdy packaging to prevent damage from stacking
- Isolation of the individual terminals to avoid a short circuit
- Do not drop or pierce the packaging
- Ensure the product is dry, free from condensation and excessive humidity
- Voltage should be measured to verify it is within specification before and after shipment

Hybrid Capacitors currently are not restricted as dangerous goods according to IATA Regulations. However, as air transportation regulations may be modified it is best to check local regulations for any changes or updates regarding new mandated shipping requirements. Hybrid Capacitors are regulated for transportation according to UN 3508, we recommend that you consult your local logistics authority for specific requirements.

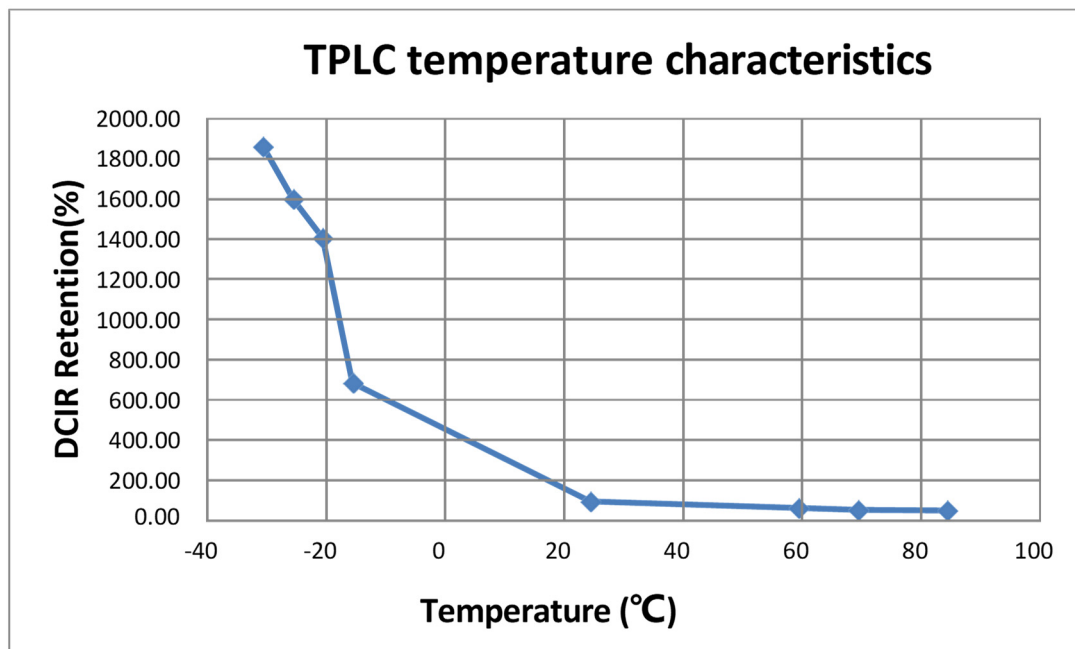
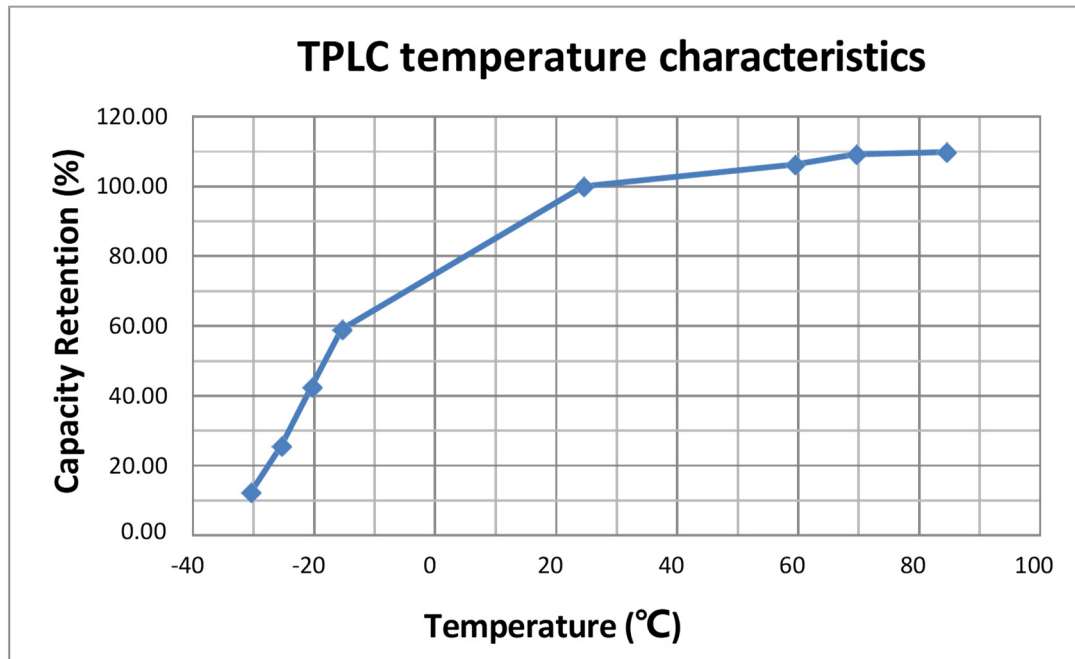
- 8. Disposal and Warranty:**  When disposing of the product comply with all local, regional, federal and national requirements. In most jurisdictions the cell can be disposed of by industrial waste organizations. You will need to insulate the terminals to avoid any short circuit possibility. Our product warranty may be found under our standard Terms and Conditions for sale. This product warranty and is limited to the actual product and does not constitute any liability for damages that may be a direct result from improper use or defects in our products.
- 9. Discharge Curves:** Representative constant current discharge curves for select cells.





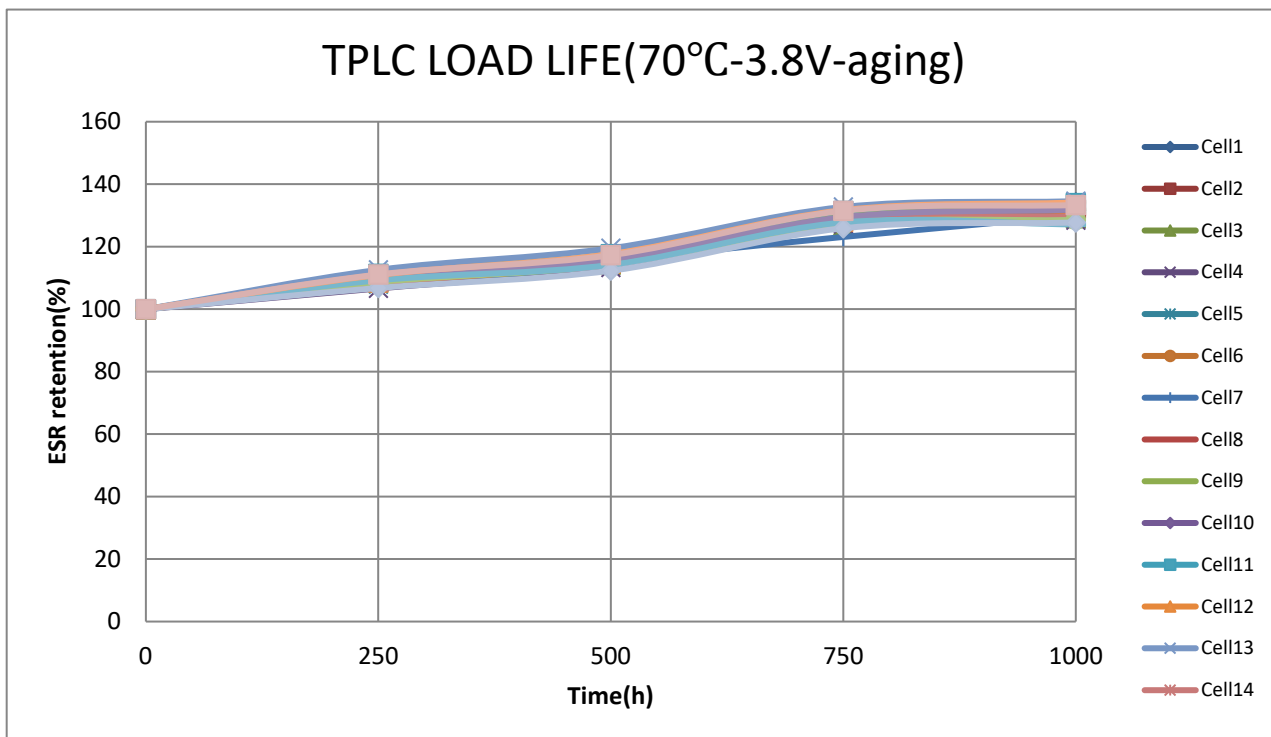
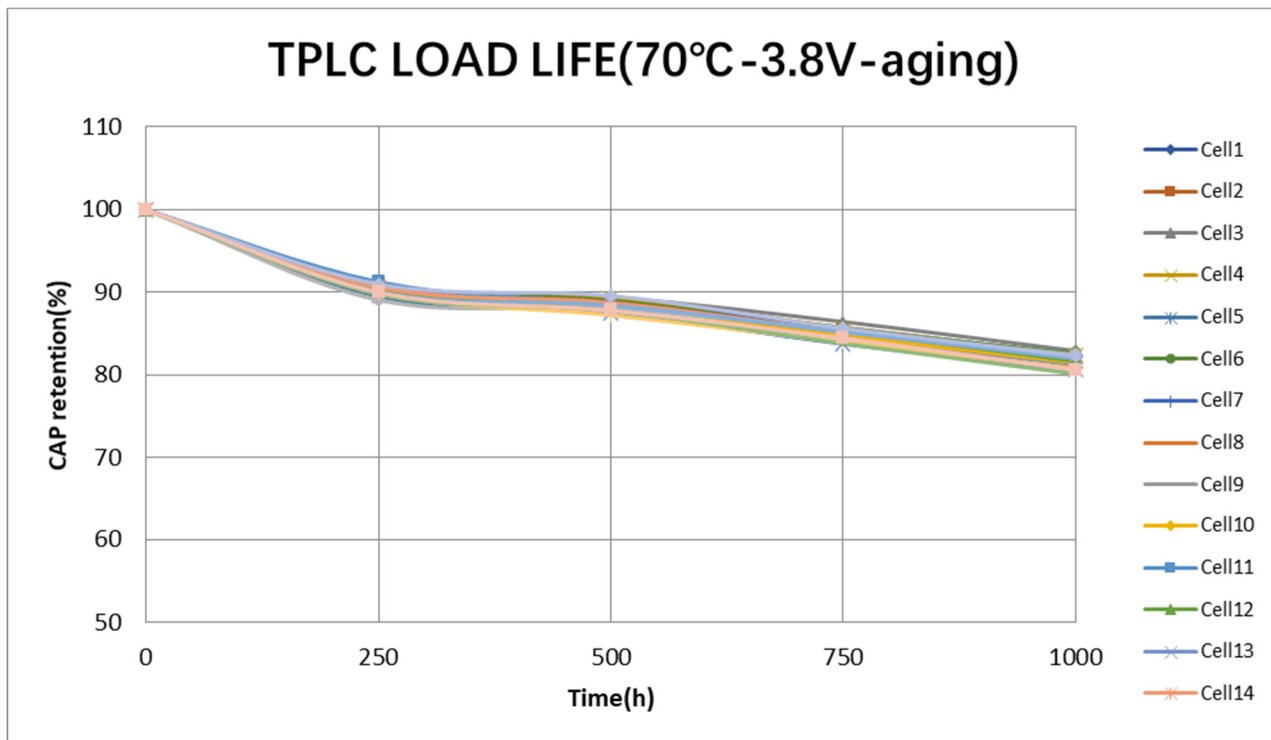


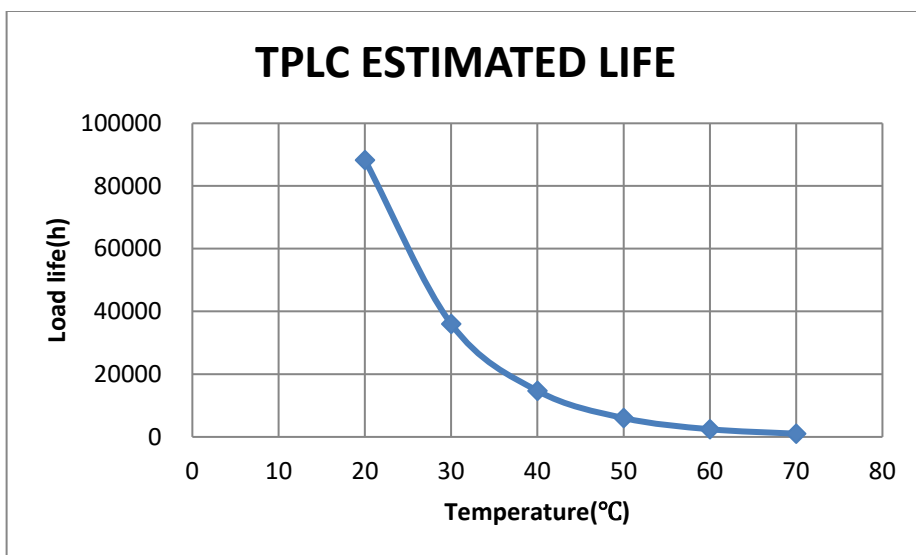
10. Temperature Characteristics: Representative average temperature characteristics for capacitance and ESR.



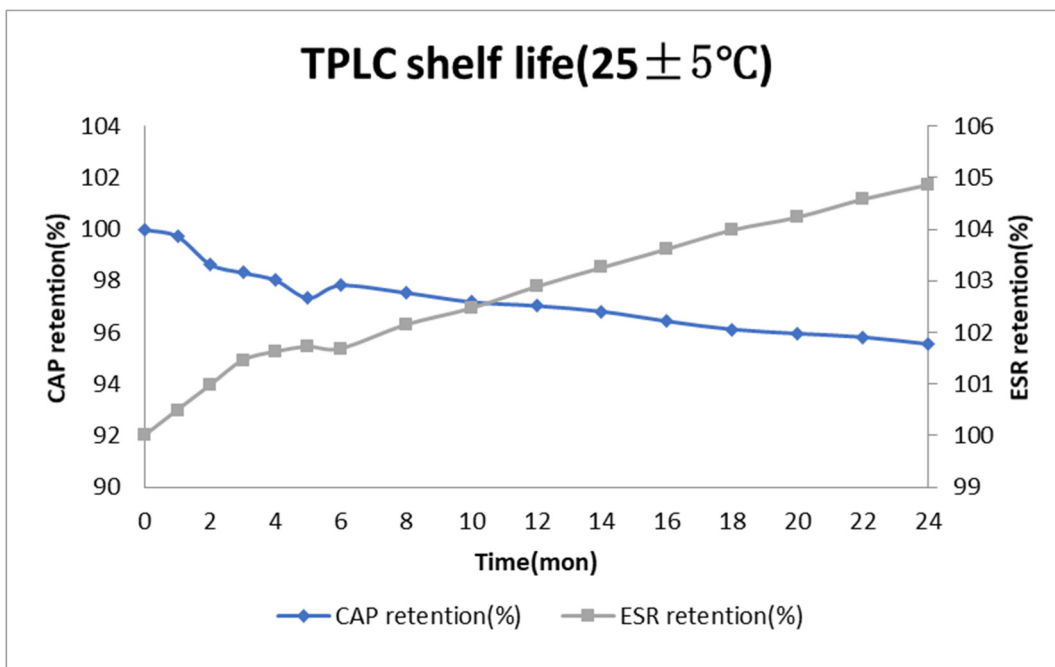
11. Life Performance:

11.1. Life Graph: Typical cell life performance at 70°C @ 3.8V





11.2. **Shelf Life Average:** shelf life at room temperature (25°C)



Handling Precautions for Hybrid Capacitors (LIC)

Tecate Group's Hybrid Capacitors (LIC) are intended for use by personnel that have been trained in the proper handling and use of the product. Tecate Group's TPLC™ cells are transportation compliant for shipment in either cargo or passenger aircraft (ref. UN3508) when packaged in the original packaging. For additional information on handling and usage, consult the Tecate Group Hybrid Capacitor Product Guide or contact Tecate Group Engineering at eng@tecategroup.com.

This product is shipped in a charged state.

1. Do not short the capacitor leads at any time during handling or processing of the cell.
 - a. When using metal tooling, trim and bend leads separately.
 - b. Do not wave solder.
2. Store the cells within the rated storage temperatures and away from heat sources or high humidity.
3. Keep cells dry. During soldering, use only no-clean flux (do not water wash). Consult Tecate Group Engineering for advice on acceptable cleaning agents.
4. Do not hold the terminals when handling the product.
5. Do not charge the cell above the rated maximum voltage. This will drastically reduce the life of the product.
6. Do not discharge the cell below the rated minimum voltage. Discharging the cell below rated voltage will damage the cell which should be immediately removed from service.
7. Do not drop the cell or subject it to excessive shock or vibration.
8. Do not apply force to the positive or negative leads. This may damage the internal construction of the cell.
9. The cells contain toxic and hazardous materials. Do not pierce the cell housing. If the cell is damaged, emits an odor, or leaks electrolyte:
 - a. Handle damaged cells using proper PPE to avoid skin contact and breathing vapors.
 - b. Dispose of the cell in a sealed industrial waste container according to local regulations.
10. Do not burn or incinerate cells.

Circuit Design:

1. Circuit designs should include:
 - a. Overvoltage and undervoltage protection.
 - b. Charge and discharge currents should be controlled within cell ratings.
- c. cell balancing for multi-cell series.
2. Adequate clearance should be provided above the pressure vent to allow it to function properly in the event of a gas buildup.
3. The capacitor casing is an uninsulated live part of the cell and must be appropriately secured, enclosed in the product and provided appropriate spacing to prevent shorts.

Failure to follow these precautions will result in:

1. Electric shock
2. Damage to the cell, including:
 - a. Overheating
 - b. Leakage
 - c. Chemical burns
 - d. Smoke
 - e. Explosion



Waste disposal must be in accordance with appropriate federal, state, and local regulation.

REV	REVISION DESCRIPTION	DATE
A	RELEASED	06/19/20