CAP-XX

Powering next generation products

Product Bulletin

LY13R8 RADIAL LEAD LITHIUM-ION CAPACITOR datasheet

Revision 1.3, Apr 2023

Electrical Specifications

The LY13R8 radial lead Lithium-ion capacitors are 3.8V rated cylindrical cells offering excellent value, providing an order of magnitude higher capacitance for the same size compared to our standard GY/HY cells.

Part numbering code

L	Y	N	vvv	dd	mmm	S	ccc	R	-V
Model Li-ion Cap	**Cylind-rical**	**no of cells** 1	**Voltage** 3R8 = 3.8V	**Diameter** 08 = 8.0 10 = 10 1B = 12.5 16 = 16 18 = 18	**Length (mm)** 012 = 12 068 = 68 120 = 120	**Tolerance** M ± 20% S +30% /-10% V +25% / -5%	**µF** Two digits + number of zeros. 106 = 10000000µF = 10F	**Lead format** R = Radial lead	**Variant** -L = Low temperature variant -H = Standard variant

Low temperature variant:

Rated voltage range:	2.5V ~ 3.8V (DO NOT discharge below 2.5V)
Surge voltage:	4.2V
Temperature Range:	-25°C to +70°C
Cycle life:	250,000 cycles between 2.5V ~ 3.8V @ 25˚C, with < 200% initial ESR and > 70% initial C.

CAP-XX Part no.	Cap (F)	AC ESR Max @1kHz (mΩ)	DC ESR (mΩ)	Diameter (mm)	Length (mm)	IL max @ 120Hrs (µA)	Test Current (A)* [1]	Pulse Current (A)* [2]	Mass (g)
LY13R808014M106R-L	10	270	800	8	14	3	0.05	1.4	1.3
LY13R808020M256R-L	25	175	370	8	20	3.3	0.125	3.2	1.9
LY13R808025M306R-L	30	125	350	8	25	4	0.15	3.4	2.3
LY13R810016M306R-L	30	125	280	10	16	4	0.15	4.1	2.4
LY13R810020M506R-L	50	95	220	10	20	6	0.25	5.4	3.1
LY13R810025M706R-L	70	65	165	10	25	8	0.35	7.3	3.7
LY13R810030M117R-L	110	50	125	10	30	10	0.55	9.7	4.7
LY13R81B025M127R-L	120	50	125	12.5	25	20	0.6	9.8	5.5
LY13R816025M227R-L	220	40	70	16	25	40	1.1	17.4	9.7

High temperature variant:

Rated voltage range: 2.5V ~ 3.8V (DO NOT discharge below 2.5V)
Surge voltage: 4.2V
Temperature Range: -15°C to +70°C (85°C @ 3.5V)
Cycle life: 500,000 cycles between 2.5V ~ 3.8V @ 25˚C, with < 200% initial ESR and > 70% initial C.

CAP-XX Part no.	Cap (F)	AC ESR Max @1kHz (mΩ)	DC ESR (mΩ)	Diameter (mm)	Length (mm)	IL max @ 120Hrs (µA)	Test Current (A)* [1]	Pulse Current (A)* [2]	Mass (g)
LY13R808014M106R-H	10	500	1500	8	14	2	0.05	0.8	1.4
LY13R808020M256R-H	25	300	650	8	20	2.5	0.125	1.9	2
LY13R808025M306R-H	30	250	700	8	25	3	0.15	1.8	2.4
LY13R810016M306R-H	30	250	550	10	16	3	0.15	2.2	2.5
LY13R810020M506R-H	50	200	450	10	20	4.5	0.25	2.8	3.2
LY13R810025M706R-H	70	100	250	10	25	5	0.35	4.9	3.9
LY13R810030M117R-H	110	90	220	10	30	6.5	0.55	5.7	4.8
LY13R81B025M127R-H	120	80	200	12.5	25	20	0.6	6.2	5.7
LY13R816025M227R-H	220	60	100	16	25	40	1.1	12.4	9.7

Notes:

1. Current used to test DC ESR and Capacitance in production
2. 1 sec pulse current to discharge a LIC from 3.8V to 2.5V: $\frac{V_{rated}-V_{\min}}{1+DC\ ESR\times C}\times C\ (Amp)$

Features:

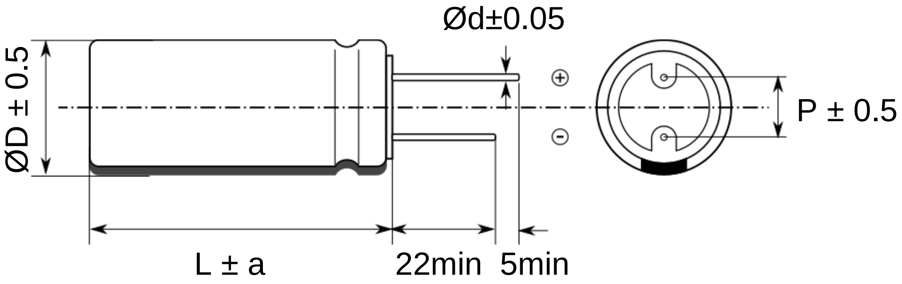
- Very high energy density
- Extremely long cycle life, up to 500,000 cycles
- Very low leakage current
- Wide temperature range

Applications:

- Powering wireless sensors from small energy harvesters
- Replacing small batteries
- Power backup

Mechanical drawing:

ΦD	P	Φd	a
8	3.5	0.6	1.5
10	5	0.6	2.0
12.5	5	0.6	2.0
16	7.5	0.8	2.0



Measurement of capacitance

Capacitance is measured at 25°C using the method shown in Fig 1. This measures DC capacitance. The capacitor is charged to rated voltage, V_R, at constant current, held at rated voltage for at least 30 minutes and then discharged at constant current. The time taken to discharge from 3.5V to 2.5V is measured to calculate capacitance as:

$$C = I \times (T_1 - T_2)/(V_1 - V_2)$$

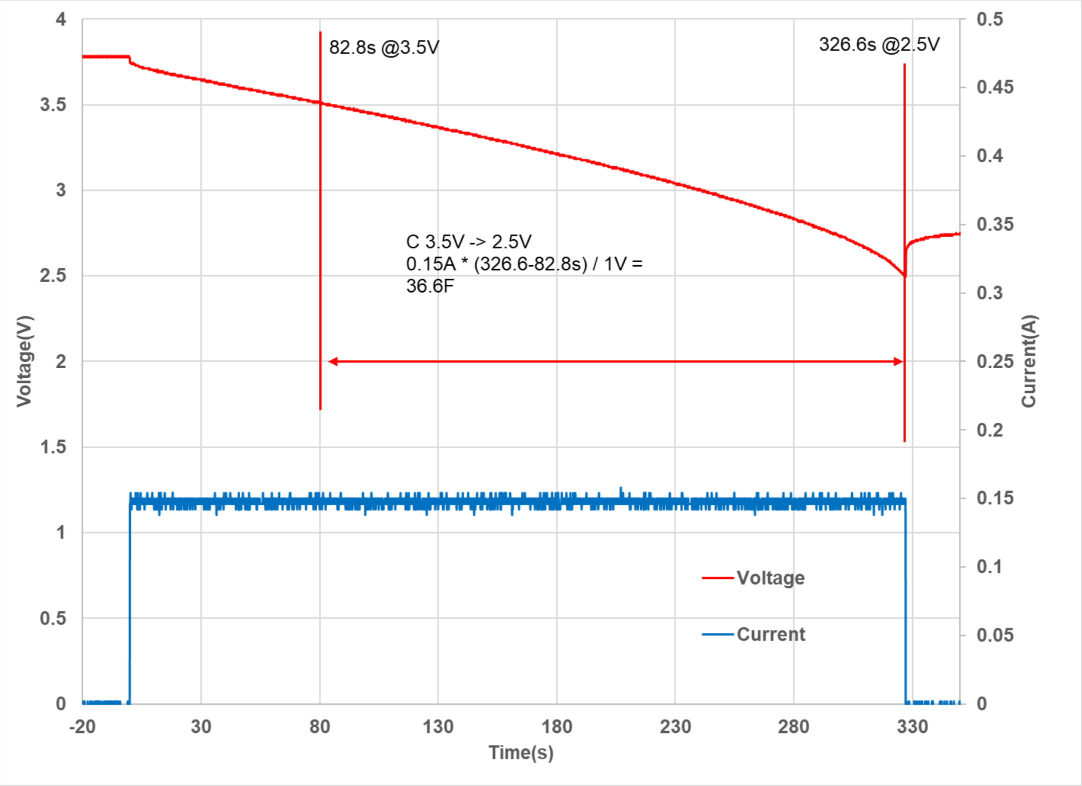


Fig 1: LY13R810016V306R-L Capacitance measurement

In this case, C = 0.15A x (326.6 - 82.8)s /(3.5 - 2.5)V = 36.6F, which is well within the 30F +30% / -10% tolerance for a LY13R810016V306R-L cell.

Measurement of ESR

DC Equivalent Series Resistance (DC ESR) is measured at 25°C by applying a step load current to the supercapacitor and measuring the resulting voltage drop. CAP-XX waits for a delay of 2ms after the step current is applied to ensure the voltage and current have settled. In this case, for a LY13R810016V306R-L the ESR is measured as 31mV/0.15A = 206.7mΩ.

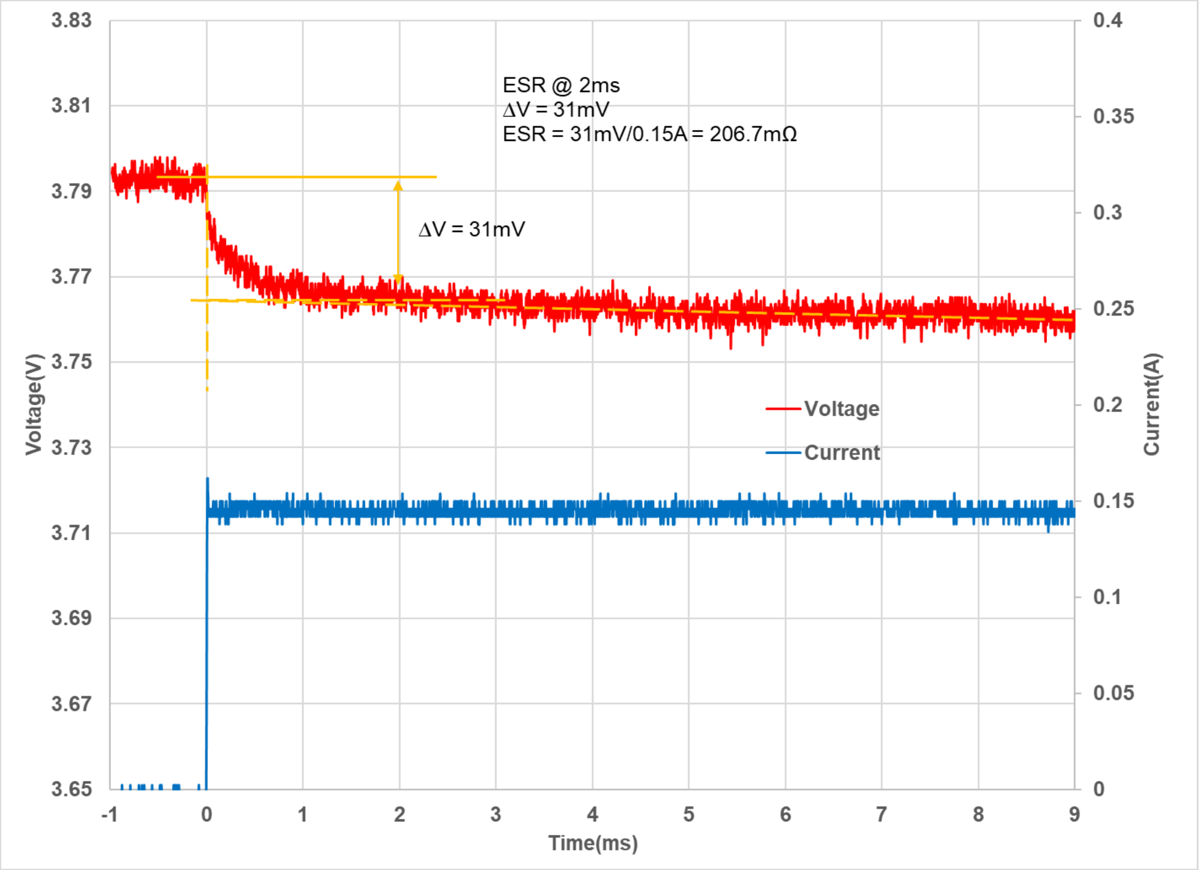


Fig 2: LY13R810016V306R-L ESR Measurement

Measurement of Leakage Current

Leakage current is measured by holding the supercapacitor at rated voltage at 25°C and charging it through a low value current limit resistor, in this case, 28Ω. After the current through the 28Ω resistor has decayed the supercapacitor is then held on charge with a higher value sense resistor, typically 1KΩ or 2.2KΩ, and measuring the voltage across this resistor to determine leakage current. The leakage current decays over time as shown in Fig 3. Leakage current at 120hrs for an LIC is less than 1/10th of an equivalent EDLC supercapacitor.

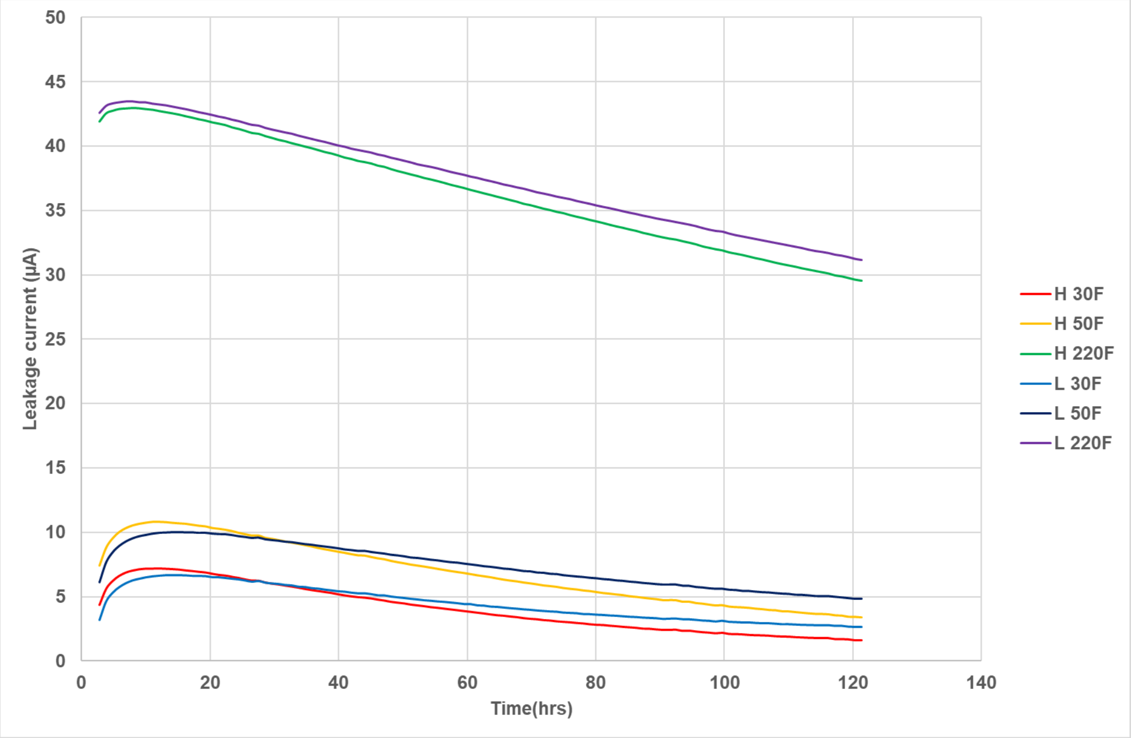


Fig 3: Leakage current measurement

Variation in DC Capacitance and ESR with temperature

Figure 4 shows the typical DC capacitance variation across the operating temperature range of -25°C to +70°C (low temp variant) or -15°C to +85°C (high temp variant). Discharge current used is set to the 5C rate = $5 * C * \frac{3.8-2.5}{3600}$ (Amp). Cap > 50% of C value at 20˚C over the temperature range.

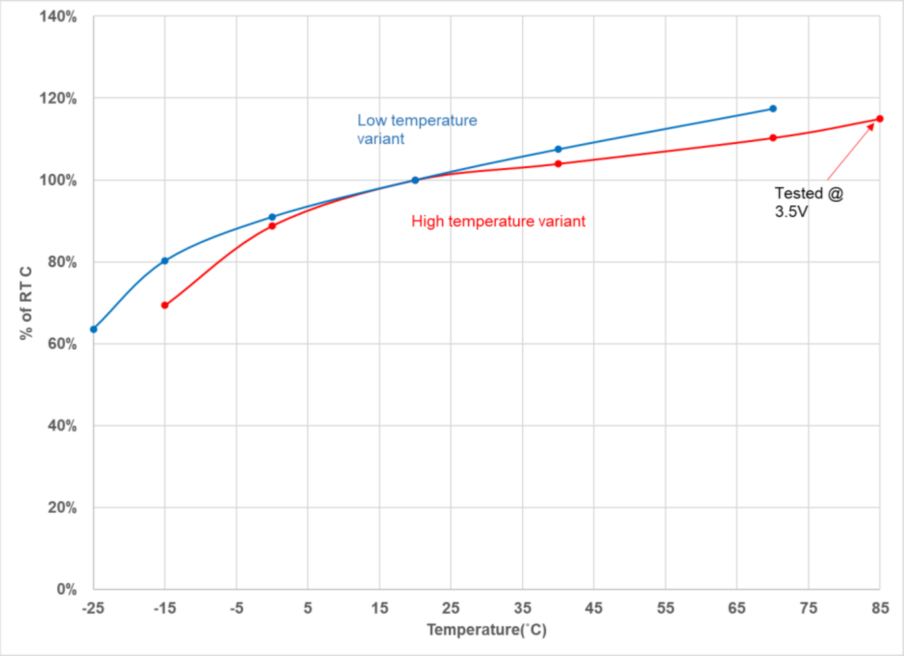


Fig 4: Typical variation in Capacitance over the operating temperature range

Figure 5 shows variation in DC ESR over the operating temperature range. DC ESR < 1000% of 20˚C value over the temperature range.

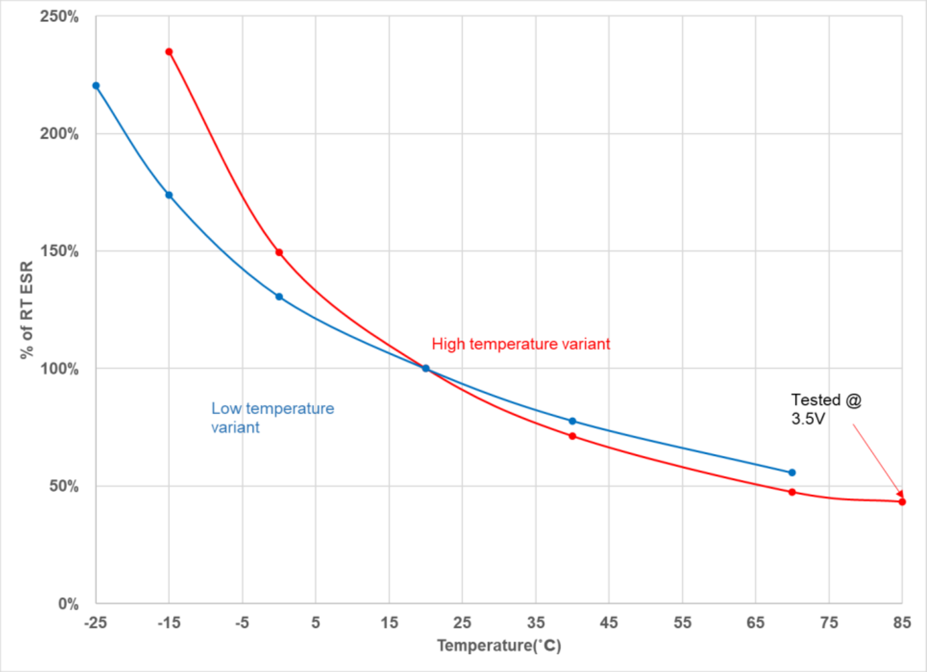


Fig 5: Typical variation in DC ESR over the operating temperature range

The variation in ESR with temperature is due to the change in the mobility of ions in solution in the electrolyte and the characteristics of the activated carbon used in that part.

Effective capacitance (Ceff)

Effective capacitance is the capacitance seen for short pulse widths. Due to the LiC's frequency response, for shorter pulse widths there will be less capacitance available than the DC capacitance. In Fig 6, consider the voltage drop due to capacitance after 100ms = 3.3V – 3.13V = 170mV. Therefore Ceff(100ms) = Discharge_Current x 100ms/Voltage drop(100ms) = 1.8A x 0.1s/0.17V = 1.06F. The voltage drop due to capacitance after 1s = 3.3V – 3.03V = 270mV, hence Ceff(1s) = 1.8A x 1s/0.27V = 6.7F. Fig 7 shows a typical Ceff as a % of DC capacitance for the LY13R8 series of Lithium-ion capacitors.

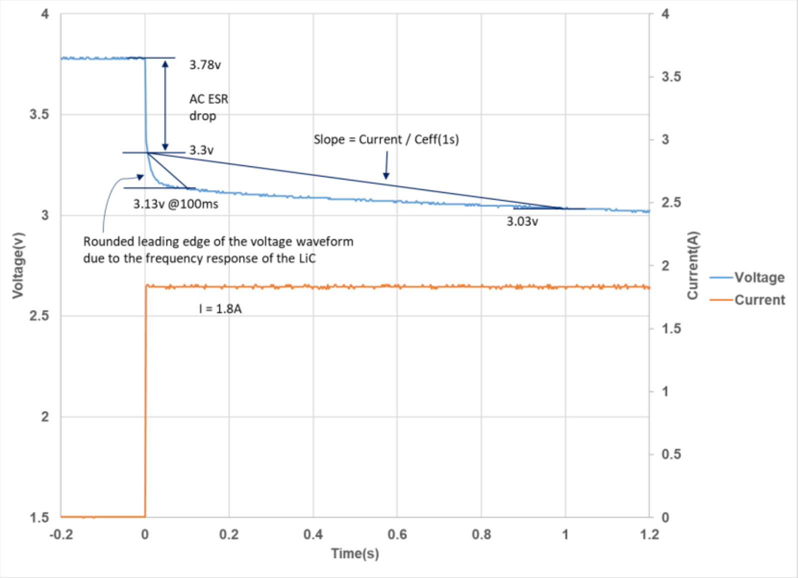


Fig 6: Discharge pulse illustrating the concept of Ceff

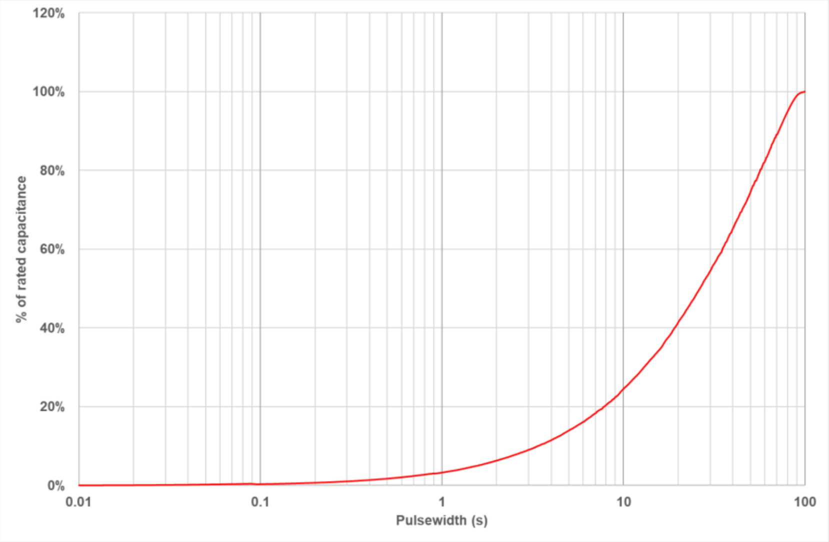


Fig 7: Typical effective capacitance range for LY13R8 series LiC

For any given pulse width, T, with a constant discharge current I_{DISCH}, the voltage drop is given by:

Vdrop = I_{DISCH} x AC ESR + I_{DISCH} x T/Ceff(T)

Where Ceff(T) = DC capacitance x % at time T read from Fig 8.

Shorter pulses need less capacitance to support them, so the supercapacitors can support short pulses despite their slow frequency response.

Storage

CAP-XX recommends storing supercapacitors and Lithium-Ion capacitors in their original packaging in an air conditioned room, preferably at < 30°C and < 50% relative humidity. CAP-XX supercapacitors can be stored at any temperature not exceeding their maximum operating temperature but storage at continuous high temperature and humidity is not recommended and will cause premature ageing.

DO NOT store Lithium-Ion capacitors or supercapacitors in the following environments:

- High temperature / high humidity
- Direct sunlight
- In direct contact with water, salt, oil or other chemicals
- In direct contact with corrosive materials, acids, alkalis or toxic gases
- Dusty environment
- In environments subjected to shock and vibration

LIC self-discharges overtime, after long term storage please check the cell voltage is >2.5V.

Soldering

When soldering it is important to not over-heat the Lithium-Ion capacitor or supercapacitor to not adversely affect its performance. CAP-XX recommends that only the leads come in contact with solder and not the supercapacitor body.

Hand Soldering

Be sure the PCBA being soldered is electrically floating.

DO NOT short circuit the Lithium-Ion capacitor’s pins when soldering.

Heat transfers from the leads into to the supercapacitor body, so the soldering iron temperature should be < 350°C soldering time should be kept to the minimum possible and be less than 4 seconds.

Wave Soldering

DO NOT wave solder. Wave soldering will short circuit the cell.

Reflow Soldering

DO NOT reflow solder.