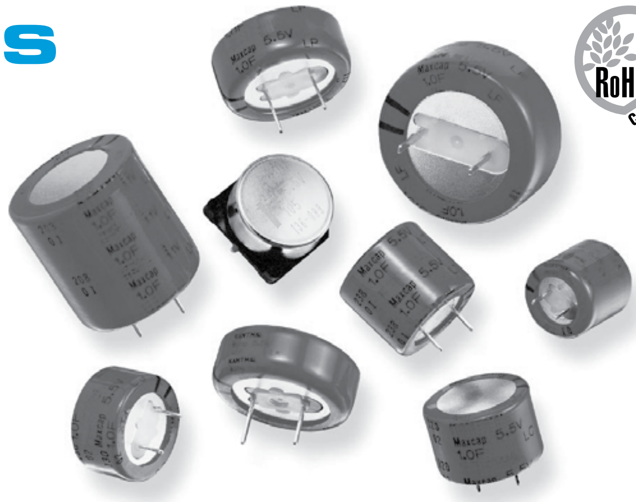
Maxcap Series

Double Layer Capacitors



Maxcap® double layer capacitors are a new electric energy storage device with extremely high volumetric efficiency (over five farads/in3), virtually unlimited service life, fast charge/discharge capability and very low leakage current.

A Maxcap DLC the size of a thimble will support microamp data retention currents of CMOS RAMs for up to several weeks, Microprocessors, small motors and activators having current requirements from one to several hundred milliamps can be supported from several seconds to minutes.

Conventional energy storage devices such as batteries and aluminum electrolytic capacitors often must be replaced during the life of a product. Maxcap DLCs never need replacing because, unlike batteries, they do not undergo life-limiting, irreversible, chemical reactions, and, unlike aluminum electrolytic capacitors, they do not experience dry-up problems.

The high capacitance of Maxcap DLCs results from an electric double layer formed at the interface of high surface area activated carbon and a stable electrolyte. Unit cells are formed by separating two carbon/electrolyte wafers with an ionically conductive porous separator and sandwiching them between two electrically conductive, ionically impermeable membranes. The unit cells are stacked in series to achieve the desired capacitor voltage.

CAUTION: Due to their relatively high internal resistance, Maxcap DLCs should not be subjected to large ripple currents.

FEATURES

- High Energy Density Capacitors for Memory Backup and Data Transmission Power
- New LM Surface Mount Product Series
- Very high capacity in small size: Up to 100 times that of conventional capacitors.
- Useful voltage ratings: 3.5 and 5.5 volt – Ideal for CMOS operating voltage range. 11 volt – LV Series, backup for relays, actuators, small motors.
- Full range of sizes: From 0.01 to 5.6 farads @ 5.5 volts; 0.47, 1.0 and 5.0 farads @ 11 volts.
- Low profile with LP, LJ and LK Series
- Ultra long life: Unlike batteries, Maxcap DLCs have no parasitic chemical reactions. They can be fully charged and discharged indefinitely. There is no “memory” effect.
- One Farad in a 0.65"x 0.75" Package
- Up to 5.6 Farads in a 5.5 Volt Package
- Up to 5.0 Farads in an 11.0 Volt Package

APPLICATIONS

- CMOS; RAMS and microprocessors, Timers for Integrated Cicuits: Home appliances such as TVs, microwave ovens, dishwashers, and refrigerators; utility meters, personal computers, energy management controls, thermostats, point of sale terminals, process controllers, routers.
- Relays, Solenoids: Starters, igniters, actuators
- Small Motors, Alarms: Disc drives, coin metering devices, security systems, toys.
- Data Transmission: Vehicle tracking systems, utility meters.

Maxcap Series

Double Layer Capacitors

SPECIFICATIONS

Part	Capacitance (farads)	Max. ESR (Ω @1kHz)	Typical ESR (Ω @1kHz)	Max. Charge Current after 30 min. (mA)	Weight, typ. (g)	
LP055223A	0.022	60	10–20	0.033	1.6	• Very low ESR: As low as 0.3, typical • As low as 0.3, typical For short time, high current (up to amps) • High energy density: One farad in 1.44" x 0.73" package • Up to 1.5 farads in single package • Typ.** Long Charge Leakage Current: 1–25µa • Operating temp.: -25˚C to +70˚C • Storage temp: -40˚C to +85˚C
LP055473A	0.047	40	7–14	0.071	2.6	
LP055104A	0.1	25	4–10	0.15	4.1	
LP055224A	0.22	25	5–10	0.33	5.3	
LP055474A	0.47	13	2–5	0.71	10	
LP055105A	1.0	7	1–3	1.50	18	
LC055223A	0.022	220	40–80	0.033	1.6	• Reduced diameter, high energy density, low leakage current • Several weeks (microamps) • Small diameter • Very high energy density One farad in 0.85" x 0.63" Up to 2.2 farads in single package • Low self discharge rate • Typ.** Long Charge Leakage Current: 0.1–6µa • Operating temp.: -25°C to +70°C • Storage temp.: -40°C to +85°C
LC055473A	0.047	220	40–80	0.071	1.7	
LC055104A	0.10	100	20–40	0.15	2.4	
LC055224A	0.22	120	20–50	0.33	4.3	
LC055474A	0.47	65	10–25	0.71	6.0	
LC055105A	1.0	35	5–15	1.5	11.0	
LC055145A	1.4	45	5–20	2.1	12.1	
LC055225A	2.2	35	5–15	3.3	23.1	
LK055223A	0.022	200	80-120	0.033	1.5	• Reduced height, high energy density, low leakage current • Several weeks (microamps) • Low profile • Very high energy density One farad in 1.12" x 0.44" package • Low self discharge rate • Typ.** Long Charge Leakage Current: 0.1–4µa • Operating temp.: -25°C to +70°C • Storage temp.: -40°C to +85°C
LK055473A	0.047	100	20-40	0.071	2.1	
LK055104A	0.1	50	10-25	0.15	3.3	
LK055224A	0.22	60	10-25	0.33	3.7	
LK055474A	0.47	35	5-15	0.71	7.1	
LK055105A	1.0	20	2-7	1.50	13.7	
LT055223A	0.022	220	80–120	0.033	2.3	• Expanded temperature range, low leakage current • Several weeks (microamps) • Expanded temperature range (Oper.: -40°C to +85°C; Storage: -40°C to +85°C) • High energy density One farad in 0.85" x 0.87" package • Typ.** Long Charge Leakage Current: 0.1–4µa
LT055473A	0.047	110	20–50	0.071	3.9	
LT055104A	0.1	150	20–50	0.15	4.3	
LT055224A	0.22	180	25–60	0.33	5.3	
LT055474A	0.47	100	10–25	0.71	7.5	
LT055105A	1.0	60	5–15	1.50	13.3	
LF055473A	0.047	14	4-7	0.071	3.8	• Very low ESR • For short time, high current (up to amps) • Very low ESR As low as 0.3, typical • High energy density One farad in 1.44" x 0.73" package Up to 1.5 farads in single package • Typical** Long Charge Leakage Current: 1–25µa • Operating temp.: -25°C to +70°C • Storage temp.: -40°C to +85°C
LF055104A	0.1	6.50	2-4	0.15	4.8	
LF055224A	0.22	3.5	1-3	0.33	9.7	
LF055474A	0.47	1.8	0.5-1.0	0.71	16	
LF055105A	1.0	1.0	0.3-0.6	1.50	38	
LF055155A	1.5	0.6	0.2-0.4	2.3	72	

(continued)

Maxcap Series

Double Layer Capacitors

SPECIFICATIONS

Part	Capacitance (farads)	Max. ESR (Ω @1kHz)	Typical ESR (Ω @1kHz)	Max. Charge Current after 30 min. (mA)	Weight, typ. (g)	
LV110474A	0.47	7	2–5	1.41	23	• Increased voltage capability, low ESR • For short time, high current, high voltage (up to milliamps) • 11 volts rating Up to 5 farads in single package • Low ESR • Typ.** Long Charge Leakage Current: 1–4µa • Operating temp.: -25°C to +70°C • Storage temp.: -40°C to -85°C
LV110105A	1.0	7	1–3	3.0	33	
LV110505A	5.0	4.0	0.8–2	18.0	160	
LX055103A	0.01	300	20-60	0.015	0.9	• Our highest energy density product, low self discharge rate • Several weeks (microamps) • Our Highest Energy Density Product One farad in 0.65" x 0.75" package Up to 4.7 farads in a single package • Small Diameter • Low self discharge rate • Typical** Long Charge Leakage Current: • Operating temp.: -25°C to +70°C • Storage temp.: -40°C to +85°C
LX055223A	0.022	200	10-50	0.033	1.0	
LX055473A	0.047	200	10-50	0.071	1.0	
LX055104A	0.1	100	5-40	0.15	1.3	
LX055224A	0.22	100	4-30	0.33	2.5	
LX055474A	0.47	120	10-50	0.71	5.1	
LX055105A	1	65	3-20	1.5	7.0	
LX055225A	2.2	35	1-10	3.3	12.1	
LX055475A	4.7	35	0.5-8	7.1	27.3	
LJ055104A	0.1	16	5-10	0.15	1.6	• Expanded temperature range • Low ESR • Several weeks (microamps); For short time (milliamps) • Expanded temperature range (Oper.: -40°C to +85°C; Storage: -40°C to +85°C) • Very high energy density with low ESR One farad in 0.85" D x 0.51" H package Up to 5.6 farads in a single package • Low profile • Low self discharge rate • Typ.** Long Charge Leakage Current: 0.7–15µa
LJ055224A	0.22	10	4-8	0.33	4.1	
LJ055474A	0.47	6.5	2-5	0.71	5.3	
LJ055105A	1.0	3.5	1-3	1.5	10.0	
LJ055225A	2.2	1.8	0.5-1	3.3	18.0	
LJ055335A	3.3	1.0	0.3-0.7	5.0	38.0	
LJ055565A	5.6	0.6	0.2-0.4	8.4	72.0	
LM055473A	0.047	50	10-18	0.071	1.0	• Surface mount design, low self discharge • Several weeks (microamps) • Surface Mount Design • One Farad in 0.85" x 0.85" x 0.41" package • Low self discharge rate • 5.5V (LM055) or 3.5V (LM035) • Typ.** Long Charge Leakage Current: 0.5–10µa • Operating temp.: -25°C to +70°C
LM055104A	0.1	25	8-16	0.15	1.0	
LM055224A	0.22	25	6-14	0.33	1.0	
LM055474A	0.47	13	3-8	0.71	3.9	
LM055105A	1.0	7	3-6	1.50	6.8	
LM035104A	0.1	50	10-25	0.090	1.0	
LM035224A	0.22	25	6-14	0.20	1.0	
LM035474A	0.47	25	6-14	0.42	1.0	

* For indication of long term charging current (typical leakage current), see pages XXX.

**Charging current after 72 hours with 1000Ω resistor in series with capacitor at 25°C, see pages XXX.

Maxcap Series

Double Layer Capacitors

CHARACTERISTICS

Radial Lead Products

Item	Test	Specification (see also product tables)
1. Capacitance	See test method, page xxx.	
2. Capacitance Tolerance	-	+80%, –20%
3. DC Maximum Working Voltage	-	5.5 VDC & 11.0 VDC
4. Surge Voltage	Capacitors cycled from 0 to rated surge voltage to 0 volts 1000 times at max. operating temperature	6.3 VDC & 12.6 VDC Capacitance: ≥90%** ESR: ≤120%**
5. Equivalent Series Resistance (ESR)	See test method, page xxx.	
6. Maximum Charging Current	See test method, page xxx.	
7. Operating Temperature	See items 11, 12, and 13 below.	LC, LF, LK, LP, LV, LX Series: -25°C to +70°C LJ & LT Series: –40°C to +85°C
8. Storage Temperature	See item 14 below	–40°C to +85°C
9. Lead Strength	Pull test, 1 kg for 60 seconds	No breaks
10. Solderability	Soldering temperature 230°C ±5°C for 5 ±0.5 seconds	Shall cover more than 75% of lead surface
11. Thermal Stability	Temperature cycling: LC, LF, LK, LP, LV, LX Series:	Cycle / Capacitance / ESR Step 1 (+25°C) / * / * Step 2 (–25°C) / ≥50%*** / ≤+300%*** Step 3 (+25°C) / +20%*** / * Step 4 (+70°C) / ≤+150%*** / * Step 5 (+25°C) / +20%*** / *
	LJ & LT Series:	Step 1 (+25°C) / * / * Step 2 (–40°C) / ≥50%*** / ≤+800%*** Step 3 (+25°C) / +20*** / * Step 4 (+85°C) / ≤+150%*** / * Step 5 (+25°C) / +20%*** / *
12. Thermal Shock	Capacitors cycled 5 times with 30 minute exposure at each temperature with no voltage applied: LC, LF, LK, LP, LV, LX Series: +25°C to –40°C to +25°C to +70°C to +25°C LJ & LT Series: +25°C to 40°C to +25°C to +85°C to +25°C	
13. Life	Capacitors at rated temperature and voltage for 1000 hours: LC, LF, LK, LP, LV, LX Series: Test temperature 70°C; LJ & LT Series: Test temperature 85°C	Capacitance: ≥70%*** ESR: ≥+200%**
14. Storage Life	Capacitors at -40°C and +85°C for 500 hours each with no voltage applied	Capacitance: ≥70%*** ESR: ≥+200%**
15. Humidity	Capacitors at 90 to 95% relative humidity at 40°C for 500 hours with no voltage applied	
16. Resistance to Soldering Heat	Soldering temperature at 260°C ±10°C for 10 ±1 seconds	
17. Vibration	Frequency 10–55 cycles/sec., 1.5 mm amplitude, 3 directions 2 hours each (total 6 hours)	

% of values in product tables *% of initial measured value

Maxcap Series

Double Layer Capacitors

CHARACTERISTICS

LM Surface Mount Products

Item	Test	Specification (see also product tables)
1. Capacitance	Discharge Test Method	
2. Capacitance Tolerance	–	+80%, –20%
3. DC Maximum Working Voltage	–	5.5 VDC & 3.5 VDC
4. Surge Voltage	Capacitors cycled from 0 to rated surge voltage through charge resistor to 0 volts 1000 times at max. operating temperature	6.3 VDC & 4.0 VDC (3.5 V products) Capacitance: ≥90%** ESR: ≤120%**
5. Equivalent Series Resistance (ESR)	See test method, page XXX	
6. Maximum Charging Current	See test method, page XXX.	
7. Operating Temperature	See items 8, 9, and 10 below.	–25°C to +70°C
8. Thermal Stability	Temperature cycling: +25°C to –25°C to +25°C to +70°C to +25°C	
9. Thermal Shock	Capacitors cycled 5 times with 30 minute exposure at each temperature with no voltage applied: +25°C to –40°C to +25°C to +70°C to +25°C	
10. Life	Capacitors at rated temperature and voltage for 1000 hours: Test temperature 70°C	Capacitance : ≥70%*** ESR: ≥+200%**
11. Humidity	Capacitors at 90 to 95% relative humidity at 40°C for 500 hours with no voltage applied	
12. Resistance to Soldering Heat	Temperature at 260°C ±10°C for 10 ±1 seconds*	
13. Vibration	Frequency 10–55 cycles/sec., 1.5 mm amplitude, 3 directions 2 hours each (total 6 hours)	

% of values in product tables *% of initial measured value

LM Surface Mount Solder Reflow Recommendations

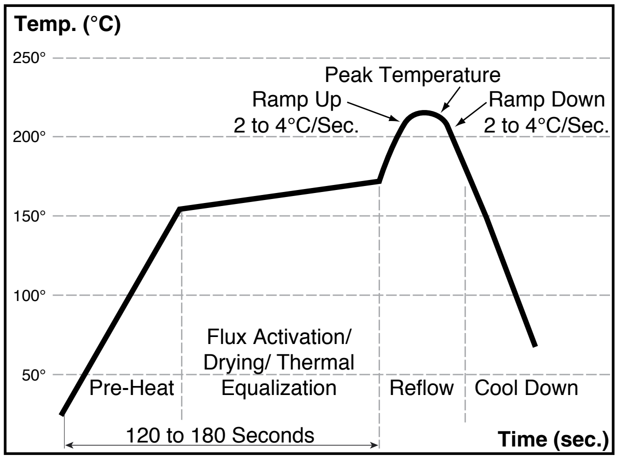
The LM Series capacitor is designed for use in Infrared or Vapor Phase Convection solder reflow processes. The chart at right indicates typical time-temperature conditions for these processes.

Recognizing that a wide range of time and temperature conditions is possible depending on each manufacturer's circumstances, it is recommended that manufacturers adhere to the following general process guideline:

MaxCap DLC peak temperature at the top surface of the capacitor should be limited to 235°C for less than 10 seconds.

Adherence to this guideline should enable successfulprocessing and allow for normal variation in time and temperature for most customer processes. Please consult the factory with questions regarding your specific process conditions.

Typical Solder Reflow Time – Temperature Profile



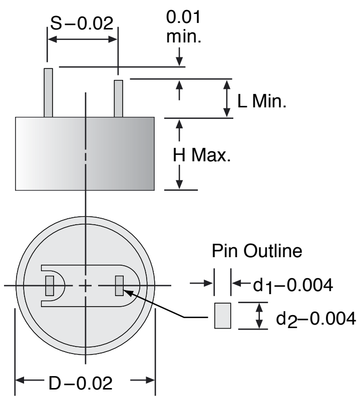
OHMITE
Ceramic Resistor Division

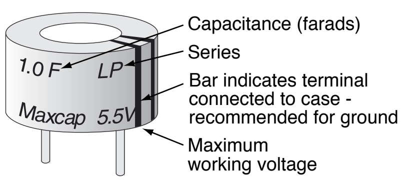
Maxcap Series

Double Layer Capacitors

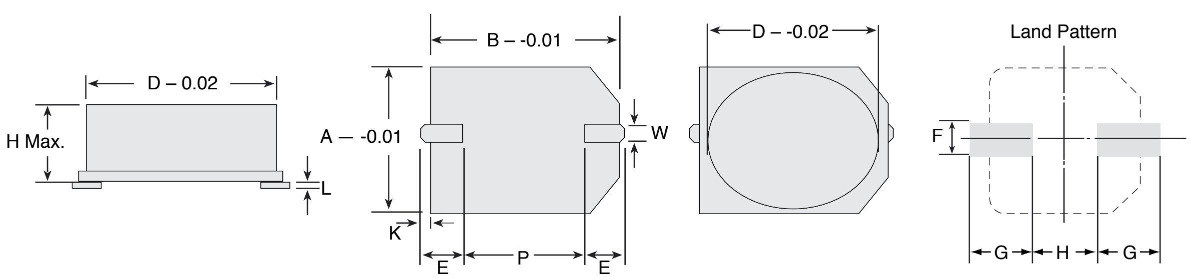
DIMENSIONS

inches (mm)





Part No.	Capacitance (farads)	Diameter D	Max. Height H	Pin Spacing S	Pin Outline d1 x d2	Pin Length L min.
LP055223A	0.022	0.45 (11.5)	0.34 (8.5)	0.2 (5.1)	0.016 x 0.048 (0.4 x 1.2)	0.106 (2.7)
LP055473A	0.047	0.50 (12.5)	0.34 (8.5)	0.2 (5.1)	0.016 x 0.048 (0.4 x 1.2)	0.087 (2.2)
LP055104A	0.1	0.63 (16.0)	0.34 (8.5)	0.2 (5.1)	0.016 x 0.048 (0.4 x 1.2)	0.106 (2.7)
LP055224A	0.22	0.63 (16.0)	0.51 (13.0)	0.2 (5.1)	0.016 x 0.048 (0.4 x 1.2)	0.106 (2.7)
LP055474A	0.47	0.83 (21.0)	0.51 (13.0)	0.3 (7.6)	0.024 x 0.048 (0.6 x 1.2)	0.118 (3.0)
LP055105A	1.0	1.12 (28.5)	0.55 (14.0)	0.4 (10.2)	0.024 x 0.055 (0.6 x 1.2)	0.240 (6.1)
LC055223A	0.022	0.45 (11.5)	0.34 (8.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LC055473A	0.047	0.45 (11.5)	0.34 (8.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LC055104A	0.1	0.51 (13.0)	0.34 (8.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.087 (2.2)
LC055224A	0.22	0.57 (14.5)	0. 59 (15.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.095 (2.4)
LC055474A	0.47	0.65 (16.5)	0.59 (15.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LC055105A	1.0	0.85 (21.5)	0.63 (16.0)	0.3 (7.6)	0.024 x 0.047 (0.6 x 1.2)	0.118 (3.0)
LC055145A	1.4	0.85 (21.5)	0.75 (19.0)	0.3 (7.6)	0.024 x 0.047 (0.6 x 1.2)	0.118 (3.0)
LC055225A	2.2	1.12 (28.5)	0.87 (22.1)	0.4 (10.2)	0.024 x 0.055 (0.6 x 1.4)	0.240 (6.1)
LK055223A	0.022	0.45 (11.5)	0.28 (7.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LK055473A	0.047	0.51 (13.0)	0.28 (7.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.087 (2.2)
LK055104A	0.1	0.65 (16.5)	0.30 (7.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LK055224A	0.22	0.65 (16.5)	0.38 (9.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LK055474A	0.47	0.85 (21.5)	0.40 (10.0)	0.3 (7.6)	0.024 x 0.047 (0.6 x 1.2)	0.118 (3.0)
LK055105A	1.0	1.12 (28.5)	0.44 (11.0)	0.4 (10.2)	0.024 x 0.055 (0.6 x 1.4)	0.240 (6.1)
LT055223A	0.022	0.45 (11.5)	0.55 (14.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LT055473A	0.047	0.57 (14.5)	0.55 (14.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.095 (2.4)
LT055104A	0.1	0.57 (14.5)	0.61 (15.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.095 (2.4)
LT055224A	0.22	0.57 (14.5)	0.83 (21.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.095 (2.4)
LT055474A	0.47	0.65 (16.5)	0.85 (21.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LT055105A	1.0	0.85 (21.5)	0.87 (22.0)	0.3 (7.6)	0.016 x 0.047 (0.4 x 1.2)	0.118 (3.0)
LF055473A	0.047	0.57 (14.5)	0.55 (14.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.087 (2.2)
LF055104A	0.1	0.65 (16.5)	0.55 (14.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LF055224A	0.22	0.85 (21.5)	0.61 (15.5)	0.3 (7.6)	0.024 x 0.047 (0.6 x 1.2)	0.118 (3.0)
LF055474A	0.47	1.12 (28.5)	0.65 (16.5)	0.4 (10.2)	0.024 x 0.055 (0.6 x 1.4)	0.240 (6.1)
LF055105A	1.0	1.44 (36.5)	0.73 (18.5)	0.59 (15.0)	0.024 x 0.067 (0.6 x 1.4)	0.240 (6.1)
LF055155A	1.5	1.75 (44.5)	0.73 (18.5)	0.79 (20.0)	0.039 x 0.055 (1.0 x 1.40	0.240 (6.1)
LV110474A	0.47	1.12 (28.5)	1.00 (25.5)	0.4 (10.2)	0.024 x 0.055 (0.6 x 1.4)	0.240 (6.1)
LV110105A	1.0	1.12 (28.5)	1.24 (31.5)	0.4 (10.2)	0.024 x 0.055 (0.5 x 1.4)	0.240 (6.1)
LV110505A	5.0	1.77 (44.8)	2.36 (60)	0.8 (20.0)	0.040 x 0.055 (1.0 x 1.4)	0.37 (9.5)
LX055103A	0.01	0.43 (11.0)	0.215 (5.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LX055223A	0.022	0.43 (11.0)	0.215 (5.5)	0.2 (5.1)	0.016 x 0.047 (0.4x1.2)	0.106 (2.7)
LX055473A	0.047	0.43 (11.0)	0.215 (5.5)	0.2 (5.1)	0.016 x 0.047 (04x1.2)	0.106 (2.7)
LX055104A	0.1	0.43 (11.0)	0.26 (6.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LX055224A	0.22	0.51 (13.0)	0.36 (9.0)	0.2 (5.1)	0.016 x 0.047 (0.4x1.2)	0.087 (2.2)
LX055474A	0.47	0.57 (14.5)	0.71 (18.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.095 (2.4)
LX055105A	1	0.65 (16.5)	0.75 (19.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LX055225A	2.2	0.85 (21.5)	0.75 (19.0)	0.3 (7.6)	0.024 x 0.047 (0.6 x 1.2)	0.118 (3.0)
LX055475A	4.7	1.12 (28.5)	0.87 (22.0)	0.4 (10.2)	0.024 x 0.047 (0.6 x 1.2)	0.240 (6.1)
LJ055104A	0.1	0.453 (11.5)	0.335 (8.5)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LJ055224A	0.22	0.57 (14.5)	0.47 (12.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.087 (2.2)
LJ055474A	0.47	0.65 (16.5)	0.512 (13.0)	0.2 (5.1)	0.016 x 0.047 (0.4 x 1.2)	0.106 (2.7)
LJ055105A	1.0	0.85 (21.5)	0.512 (13.0)	0.3 (7.6)	0.024 x 0.047 (0.6 x 1.2)	0.118 (3.0)
LJ055225A	2.2	1.12 (28.5)	0.55 (14.0)	0.4 (10.2)	0.024 x 0.055 (0.6 x 1.4)	0.240 (6.1)
LJ055335A	3.3	1.44 (36.5)	0.59 (15.0)	0.6 (15.0)	0.024 x 0.067 (0.6 x 1.7)	0.240 (6.1)
LJ055565A	5.6	1.75 (44.5)	0.67 (17.0)	0.8 (20.0)	0.039 x 0.055 (1.0 x 1.4)	0.240 (6.1)



Part No.	Capacitance (farads)	Diam. D	Max. Height H	A	B	E	W	P	K	L Min.	F	G	H
LM055473A	0.047	0.41 (10.5)	0.22 (5.5)	0.43 (10.8)	0.43 (10.8)	0.14 (3.6)	0.047 (1.2)	0.2 (5.0)	0.028 (0.7)	0.008 (0.2)	0.10 (2.5)	0.18 (4.6)	0.2 (5.0)
LM055104A	0.1	0.41 (10.5)	0.22 (5.5)	0.43 (10.8)	0.43 (10.8)	0.14 (3.6)	0.047 (1.2)	0.2 (5.0)	0.028 (0.7)	0.008 (0.2)	0.10 (2.5)	0.18 (4.6)	0.2 (5.0)
LM055224A	0.22	0.41 (10.5)	0.34 (8.5)	0.43 (10.8)	0.43 (10.8)	0.14 (3.6)	0.047 (1.2)	0.2 (5.0)	0.028 (0.7)	0.008 (0.2)	0.10 (2.5)	0.18 (4.6)	0.2 (5.0)
LM055474A	0.47	0.63 (16.0)	0.37 (9.5)	0.64 (16.3)	0.64 (16.3)	0.27 (6.8)	0.047 (1.2)	0.2 (5.0)	0.047 (1.2)	0.015 (0.38)	0.10 (2.5)	0.39 (10.0)	0.2 (5.0)
LM055105A	1.0	0.83 (21.0)	0.41 (10.5)	0.85 (21.6)	0.85 (21.6)	0.28 (7.0)	0.055 (1.4)	0.39 (10.0)	0.047 (1.2)	0.015 (0.38)	0.14 (3.5)	0.41 (10.5)	0.4 (10.0)
LM035104A	0.1	0.41 (10.5)	0.22 (5.5)	0.43 (10.8)	0.43 (10.8)	0.14 (3.6)	0.047 (1.2)	0.2 (5.0)	0.028 (0.7)	0.008 (0.2)	0.10 (2.5)	0.18 (4.6)	0.2 (5.0)
LM035224A	0.22	0.41 (10.5)	0.22 (5.5)	0.43 (10.8)	0.43 (10.8)	0.14 (3.6)	0.047 (1.2)	0.2 (5.0)	0.028 (0.7)	0.008 (0.2)	0.10 (2.5)	0.18 (4.6)	0.2 (5.0)
LM035474A	0.47	0.41 (10.5)	0.34 (8.5)	0.43 (10.8)	0.43 (10.8)	0.14 (3.6)	0.047 (1.2)	0.2 (5.0)	0.028 (0.7)	0.008 (0.2)	0.10 (2.5)	0.18 (4.6)	0.2 (5.0)

Maxcap Series

Double Layer Capacitors

ELECTRICAL CHARACTERISTIC MEASUREMENT METHODS

1. Capacitance Charge Method

Capacitance in farads can be calculated by using the formula and charging test circuit in the figure:

a. Test temperature – Capacitors to be at +25˚ ±5˚C.

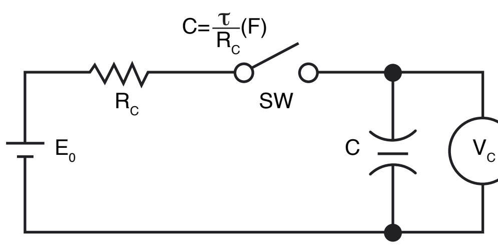
b. Initial capacitor voltage to be less than 0.05V.

c. V_C = Volt meter (DC).

d. E_0 = 5.0 + 0.1V for LC, LF, LK, LP, LT, LX, LJ Series; LV Series: 10.0 + 0.1V for 11 V Rating. 12.0 + 0.1V for 12 V Rating.

e. T = Charging time constant, that is, the time period in seconds from 0 to reach 0.632 x E0 volts.

f. Rc = Charging resistor selected from the table.



	LP	LC	LK	LT	LF	LV	LX	LJ
0.01F	—	—	—	—	—	—	5kΩ	—
0.022F	1kΩ	2kΩ	2kΩ	2kΩ	1kΩ	—	2kΩ	—
0.047F	1kΩ	2kΩ	1kΩ	1kΩ	1kΩ	—	2kΩ	—
0.1F	510Ω	510Ω	1kΩ	1kΩ	510Ω	—	1kΩ	510Ω
0.22F	200Ω	510Ω	510Ω	510Ω	200Ω	—	1kΩ	200Ω
0.47F	100Ω	200Ω	200Ω	200Ω	100Ω	100Ω	1kΩ	100Ω
1.0F	100Ω	100Ω	100Ω	100Ω	100Ω	100Ω	510Ω	100Ω
1.4F	—	200Ω	—	—	—	—	—	—
1.5F	—	—	—	—	51Ω	—	—	—
2.2F	—	100Ω	—	—	—	—	200Ω	51Ω
3.3F	—	—	—	—	—	—	—	51Ω
4.7F	—	—	—	—	—	—	100Ω	—
5.0F	—	—	—	—	—	100Ω	—	—
5.6F	—	—	—	—	—	—	—	20Ω

2. Discharge Method LM Series – 5.5V & 3.5V Products

Capacitance in farads is calculated by using the formula and discharging test circuit in the Figure:

a. Test temperature – Capacitors to be at +25˚ ±5˚C.

b. V_C = Volt meter (DC).

c. E_0 = 5.5V or 3.5V; I = Current (amps);

T = Time (seconds)

d. A_L = Constant Current Load Device

e. Initial capacitor voltage to be less than 0.05V.

f. Begin charging capacitor to rated voltage (5.5V OR 3.5V). When the capacitor terminal voltage reaches the rated voltage, continue charging for another 30 minutes. 1.0F capacitors should be charged for 60 minutes.

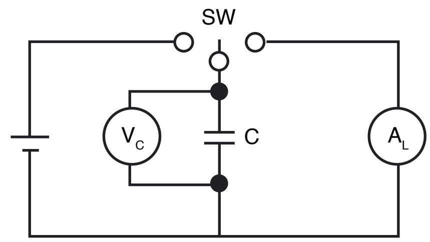
g. Discharge the capacitor with AL (Constant Current Load Device) at a load of 1.0ma per 1.0 Farad. For example, a 0.47F capacitor will be discharged at a current of 0.47ma.

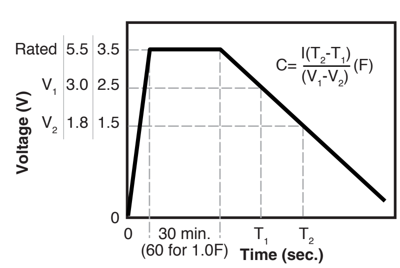
h. Measure the time for the terminal voltage to fall from 3.0V to 2.5V for the 5.5V rated products

and from 1.8V to 1.5V for the 3.5V rated products.

i. Calculate capacitance in farads using the equation

in Figure 3.





Maxcap Series

Double Layer Capacitors

ELECTRICAL CHARACTERISTIC MEASUREMENT METHODS

3. Equivalent Series Resistance (ESR)

ESR in ohms can be measured using the test circuit the figure:

a. Test temperature and tolerance – Capacitor to be at +25˚C ±5˚C.

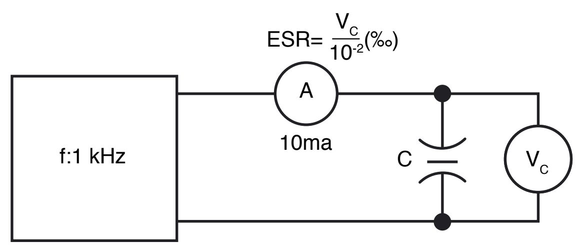
b. Test frequency – 1,000 ±100 Hz.

c. The magnitude of the AC voltage to be limited to 0.5 volt rms maximum.

d. A = Ampere meter (AC).

e. Vc = Volt meter (AC)

Note: Volt meter impedance to be significantly higher than that of the capacitor.



4. DC Leakage Current (Charging Current – 30 Minute)

DC leakage current or charging current is measured using the test circuit and procedure in the figure:

a. Test temperature and tolerance – Capacitors to be at +25˚C ±5˚C.

b. Initial capacitor voltage to be less than 0.05V.

c. Vc – Volt meter (DC).

d. E_0 = Same voltage as used in capacitance

measurement method.

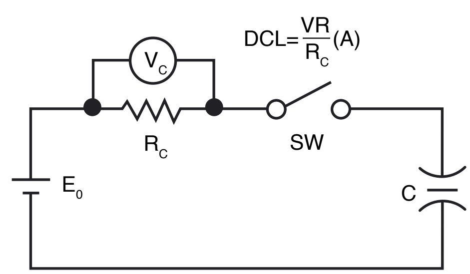
e. VR = Voltage drop by resistance Rc after 30 minutes on charge.

f. Rc = Charging resistors selected from the table below:

0.01 – 0.047F	1000Ω
0.1 – 0.47F	100Ω
1.0 – 5.6F	10Ω

LV Series:

0.47 & 1.0F	100Ω
5.0F	10Ω



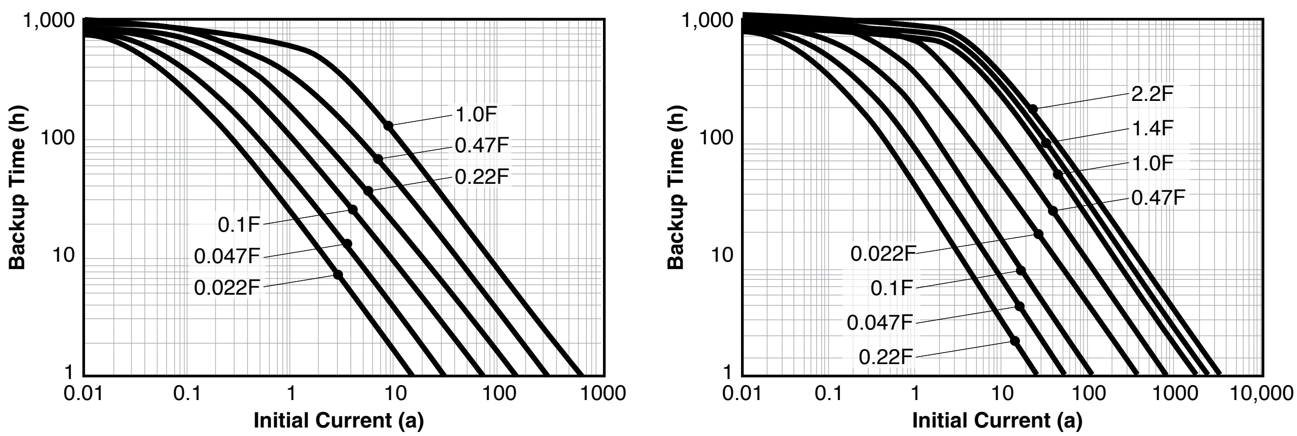
Maxcap Series

Double Layer Capacitors

MINIMUM BACKUP TIME CAPABILITY

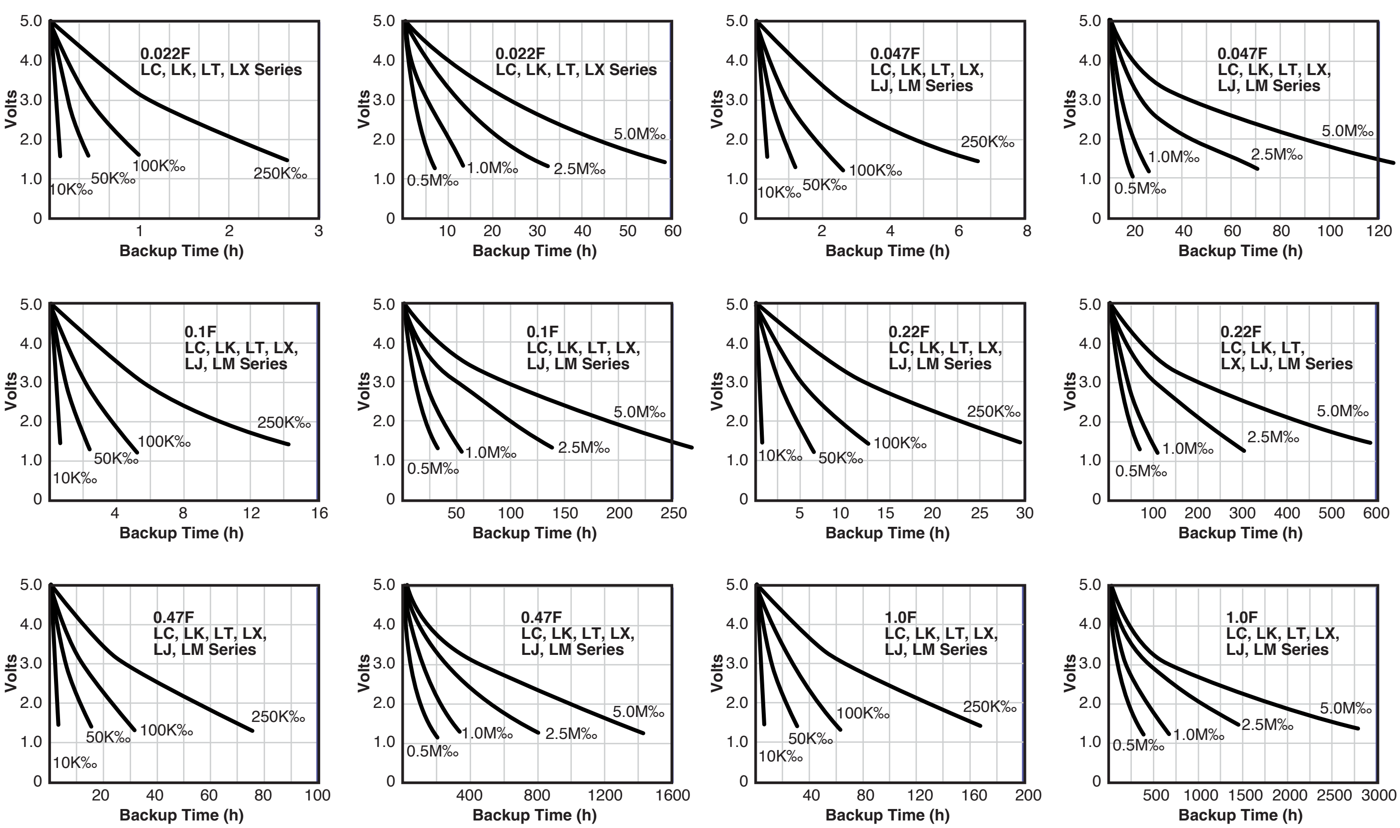
These curves indicate the discharge times for Maxcap DLCs through constant resistance loads after charging for 24 hours at 5.0 volts. They show minimum backup time for a voltage range of from 5 to 2 volts, the typical data retention range for CMOS RAMs.

The actual backup time will be longer than indicated because the current draw of CMOS RAMs over the data retention voltage is somewhat less than that of constant resistance loads even though the initial current is the same.



BACKUP TIMES

Backup times at 25°C for constant resistance loads. Voltage versus backup time for a number of constant resistance loads for LC, LK, LT and LV Series capacitors after charging for 24 hours at 5.0 or 10 volts.



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Maxcap Series

Double Layer Capacitors

BACKUP TIMES

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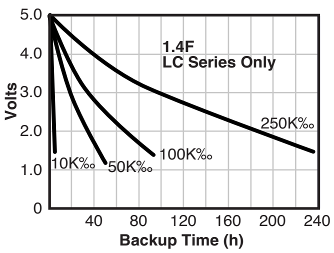
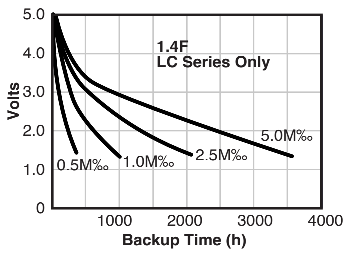
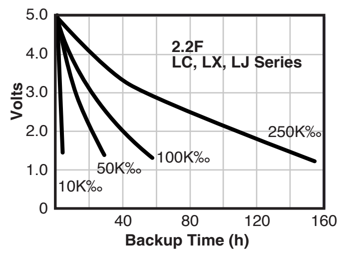
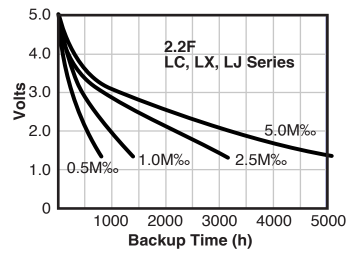
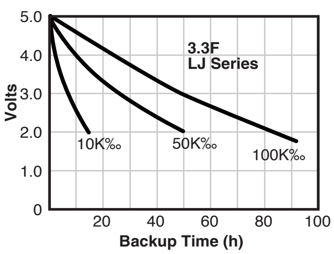
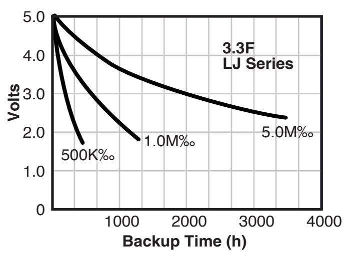


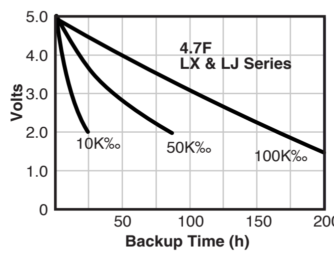


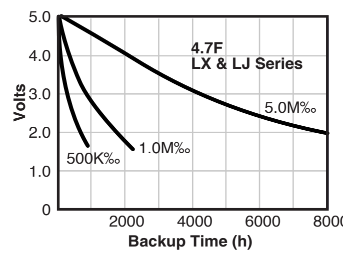


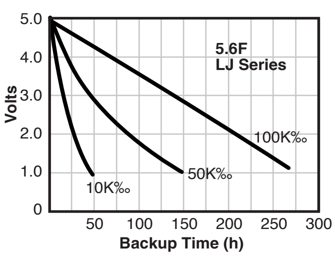


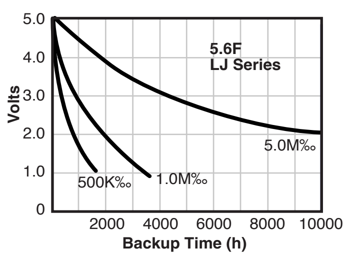


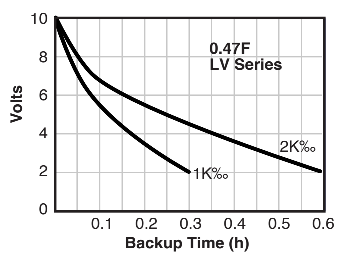


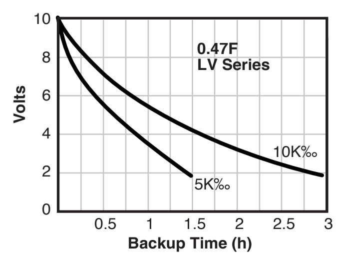


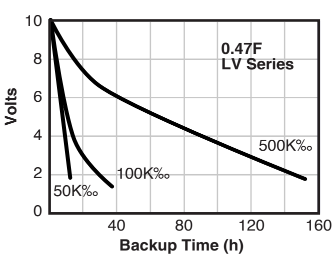


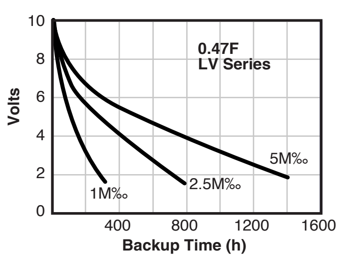


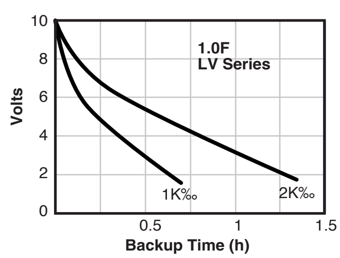


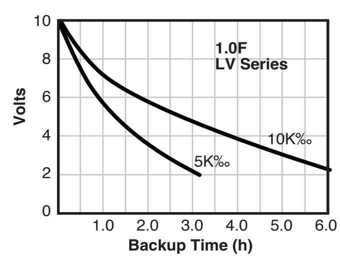


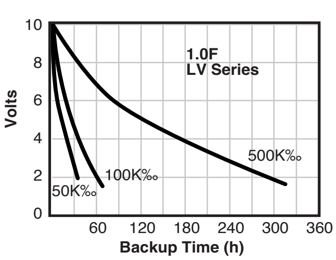


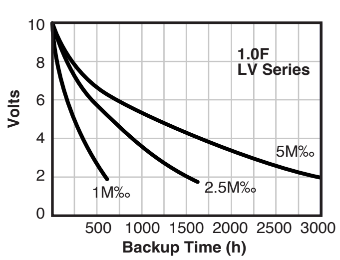


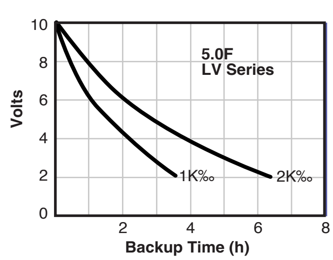


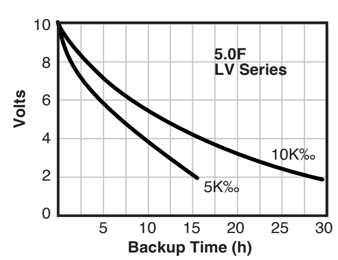


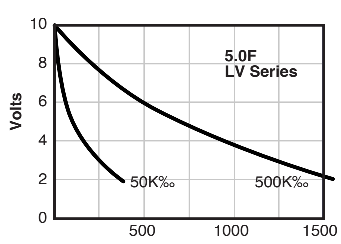


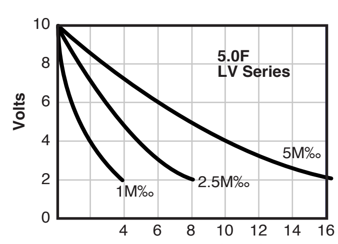










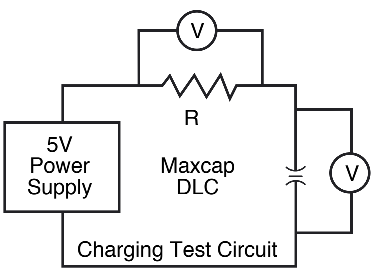


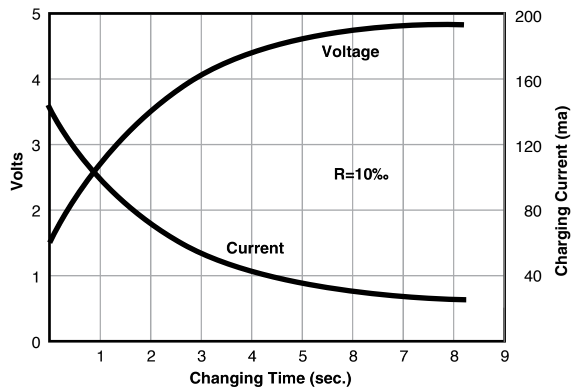
Maxcap Series

Double Layer Capacitors

CHARGING CHARACTERISTICS

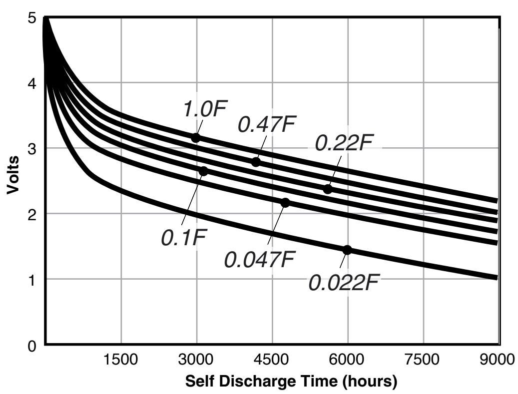
Maxcap DLCs can be charged to their working voltage in a matter of seconds. Typical charge time versus voltage and current curves are given in the graph for Maxcap DLC LP055104A





SELF DISCHARGE CURVES

Graph shows self discharge curves (open circuit) for LC, LK and LT Series capacitors after charging for 24 hours at 5.0 volts.

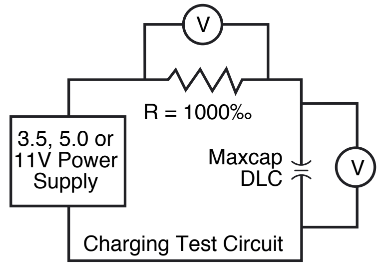


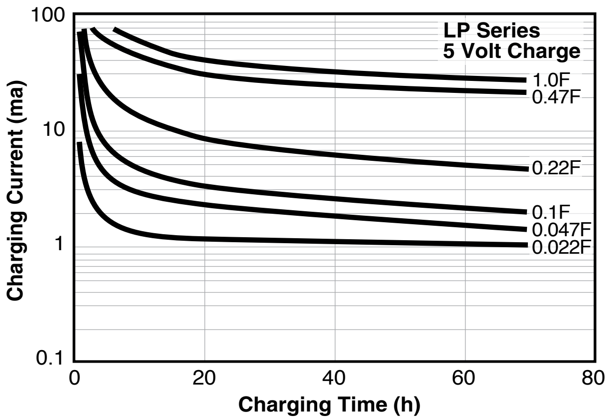
Maxcap Series

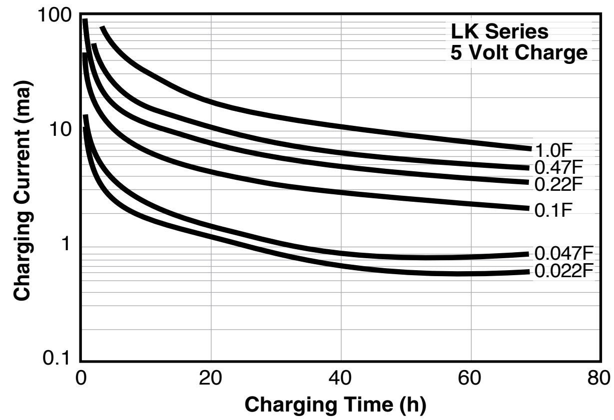
Double Layer Capacitors

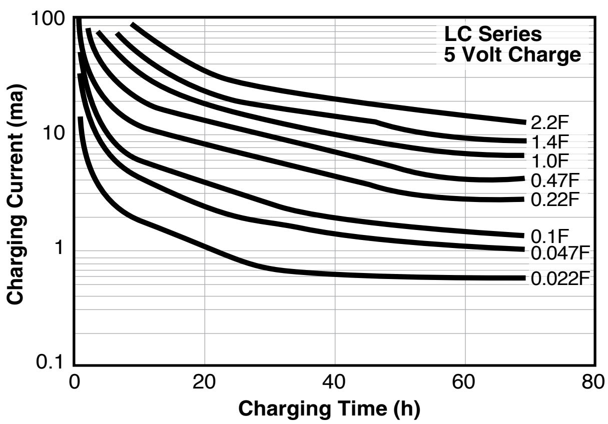
LONG TERM CHARGING CURVES

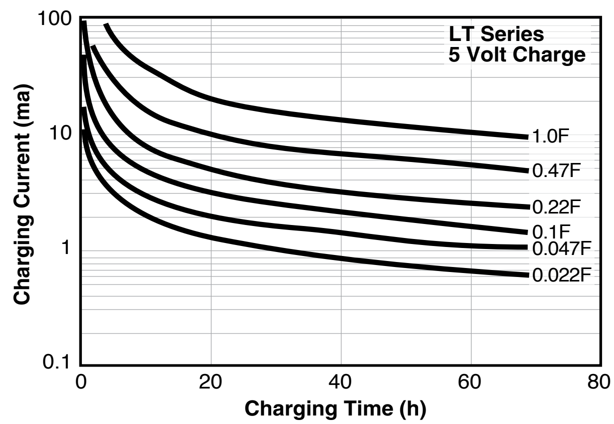
These graphs show typical long term charging curves for each of the Maxcap DLC Capacitor Series using the circuit shown at right.

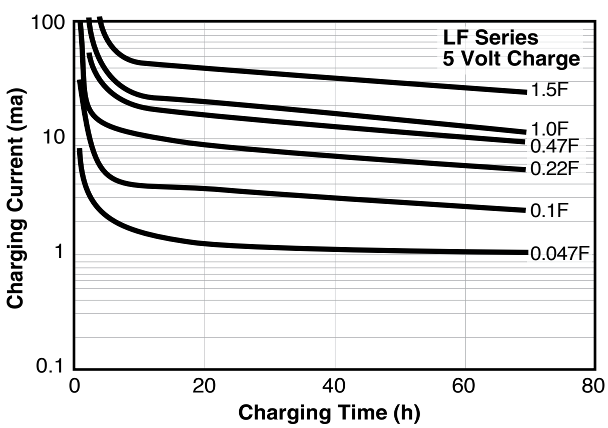


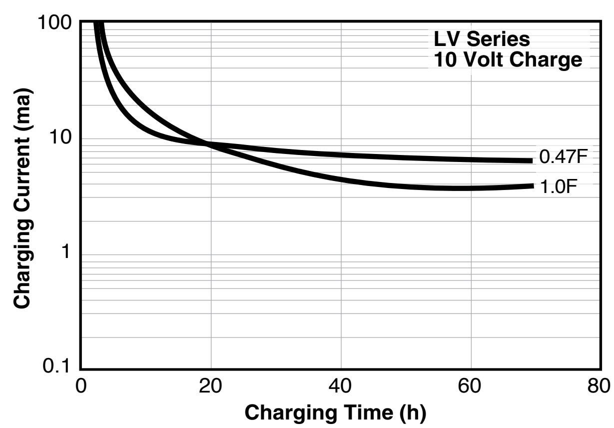












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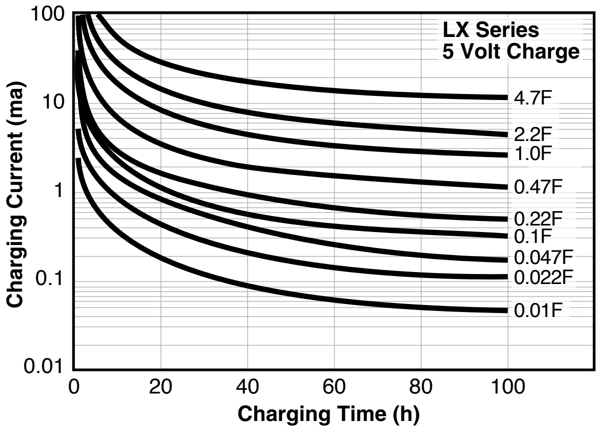
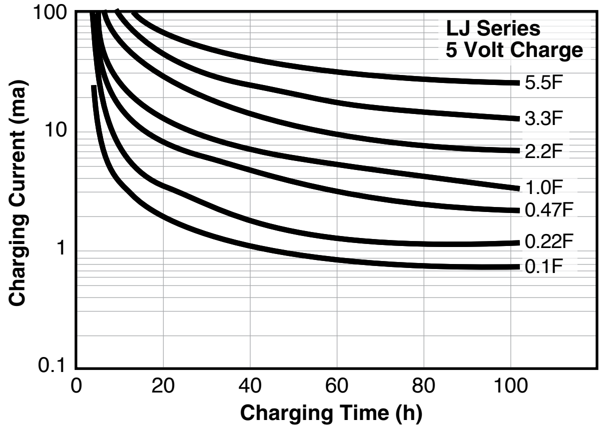
Maxcap Series

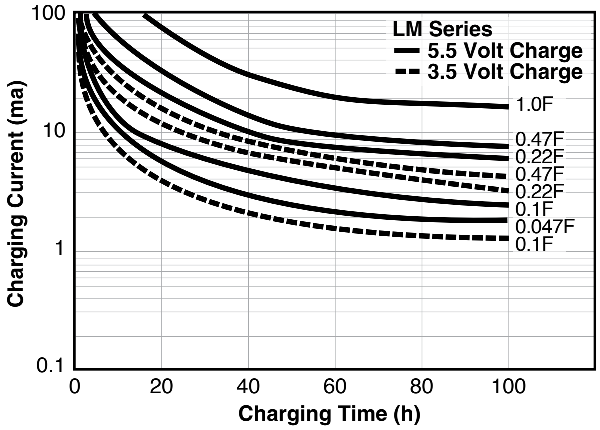
Double Layer Capacitors

LONG TERM CHARGING CURVES

(continued)

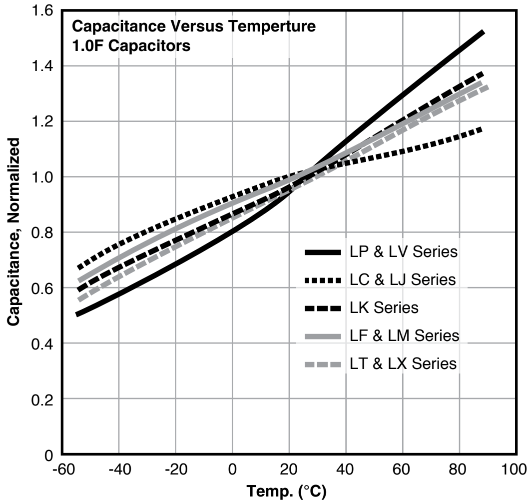


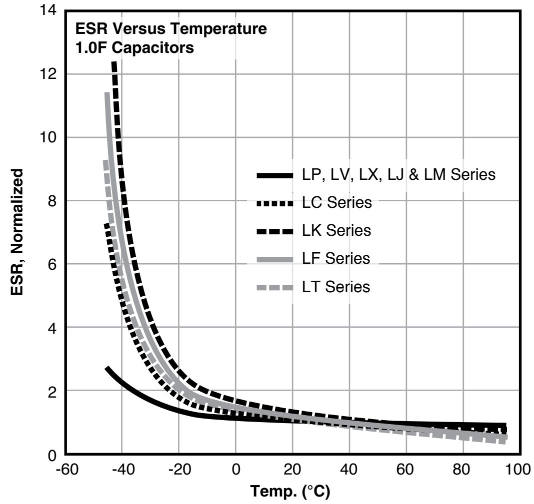




ELECTRICAL CHARACTERISTICS VERSUS TEMPERATURE

Graphs show typical changes in capacitance and ESR over the temperature range from –55 to +85˚C. Note that the rated operating temperature for LP, LV, LC, LK, LX and LF Series capacitors is -25 to +70˚C; LT & LJ- Series, -40 to +85˚C.





Maxcap Series

Double Layer Capacitors

HOW TO ORDER

L P 0 5 5 1 0 4 A E

- **L P** — **Maxcap DLC Product Series**
- **0 5 5** — **Max. Working voltage**: 055 = 5.5VDC
- **1 0 4** — **Capacitance** (µF) First two digits are significant, third digit is number of zeros to follow, e.g., 104 = 100,000
- **A** — **Capacitance tolerance**: +80% -20%
- **E** — **Epoxy End Seal** (non-standard)

rev 2/19-1