PG - 6DI -40°C +85°C

Specifications

- **Voltage range :** 50 VDC to 550 VDC
- **Can size :** 35ϕ x 62mm to 90ϕ x 240mm
- **Operating Temperature range :** -40°C to + 85°C
- **Capacitance :** 330 MFD to 470000 MFD
  Tolerance ± 20%
- **Leakage current:** The max. leakage current (IL) is given by the formula:
  IL = 0.003 CV (microamps)
  C = capacitance in microfarads
  V = DC rated voltage
  Pre-conditioning of the capacitors prior to testing for leakage current is essential.
- **Ripple Current:** All capacitors withstand rms ripple current at 100 Hz at 85°C. When capacitors operate at temperatures other than 85°C, the permissible rms ripple current at 85°C should be multiplied by the factors given below :

+40°C	+45°C	+50°C	+65°C
2.2	2.1	1.9	1.6

Where capacitors are required to operate at frequencies other than 100 Hz, the multiplying factors given below, may be used to determine the ripple current capacity, at that frequency.

Frequency Hz	100	120	250	500	1k to10k	>10K
Multiplying Factor	1.0	1.02	1.05	1.20	1.32	1.35

- **Notes :**

1. Can is negative, However, it is isolated with a PVC insulating sleeve and polypropylene end-disc.
2. The base stud is also negative and can be insulated with a nylon nut. Please see the page regarding mounting accessories for details.
3. Maximum ripple current for each capacitor diameter .

Capacitor Diameter (mm)	35	50	63	76	90
Max. Ripple Current (Amps)	20	20	40	40	72

Application

Filter, energy storage, UPS, General Purpose Power Supplies.

Capacitor mounting

Capacitors are available in screw terminals in three mounting styles

AEST - Screw terminals with plain insulated base. *see page 9,10*

AEST-D - Screw terminals with stud mounting. *see page 9,10*

AEST-AL - Capacitor with aluminium bottom disc. *see page 11*

Capacitor Terminal Style

Capacitors are available in two different terminal style, round and across flat. Below table summarizes the available terminal styles in different capacitors diameter

Capacitors Diameter (mm)	35	50	63	76	90
Terminal Style - Round	○	○	○	○	○
Terminal Style - Across Flat		○	○	○	○

For details see pages 9, 10, 11

Marking on capacitors

Each capacitor will have the following information printed on it, sequentally:

- The Company's symbol followed by the words ALCON ELECTRONICS
- The capacitor grade viz. PG-6DI
- The capacitance value __ MFD, rated voltage __VDC
- The surge voltage
- Capacity tolerance
- Climatic category
- Part number on non-standard capacitors
- CE marking
- Batch Code

PG - 6DI -40°C +85°C

Useful life

Useful life is a period of time which the capacitor takes to reach "end of life".

For PG-6DI capacitors the useful life is estimated as 12000 hours at maximum rated temperature, ripple current and voltages.

End of the defined as follows :

1. Catastrophic failure : capacitor short or open circuit
2. Mechanical failure : operation of safety vent or sleeve damage
3. Parametric failure :
   a. Capacitance change ±30%
   b. ESR exceed three times specified value
   c. Leakage current exceed specified value

The useful life for a known ripple current load and ambient temperature (Ta) °C is determined on the basis of the " Life graph" shown below.

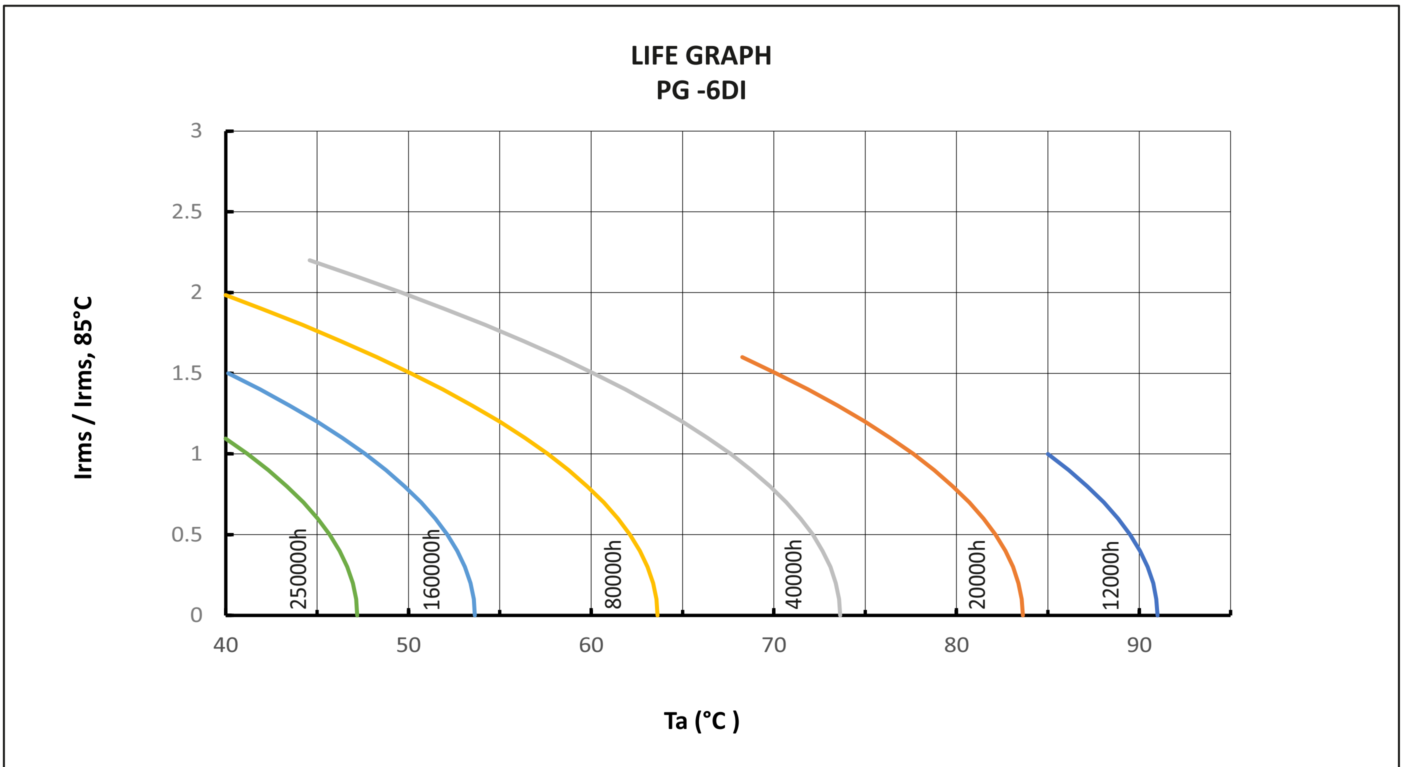
Manufacturing Date Code Chart

The manufacturing code shall consists of four digits (alphanumeric). The first two shall denote the date (numeric). The third stands for the month (alpha-numeric). The fourth stands for the year (alphabet)

First two spaces	Third space	Fourth space	
DATE	MONTH	YEAR	
01	1 = JANUARY	A = 2012	N = 2024
02	2 = FEBRUARY	B = 2013	P = 2025
03	3 = MARCH	C = 2014	R = 2026
.	4 = APRIL	D = 2015	S = 2027
.	5 = MAY	E = 2016	T = 2028
.	6 = JUNE	F = 2017	U = 2029
10	7 = JULY	G = 2018	V = 2030
11	8 = AUGUST	H = 2019	W = 2031
.	9 = SEPTEMBER	J = 2020	X = 2032
.	X = OCTOBER	K = 2021	Y = 2033
.	Y = NOVEMBER	L = 2022	Z = 2034
31	Z = DECEMBER	M = 2023	A = 2035

For example :

1. Manufacturing code 023A will mean 2nd March, 2012
2. Manufacturing code 10XA will mean 10th October, 2012



PG - 6DI -40°C +85°C

Standard Capacitor Values

Rated Voltage (VDC)	Surge Voltage (VDC)	Capacitance Nominal (MFD)	MAX ESR at 100 Hz, 25°C (miliohm)	Ripple Current (Irms) at 100 Hz, 85°C (Amps)	Can size Nominal D x L mm	Case code	Ordering code
50	60	4700	70.8	4.29	35x62	025	SA047000050AA025_ _ _ _M01
		5600	61.6	4.60	35x62	025	SA056000050AA025_ _ _ _M01
		6800	59.6	4.68	35x62	025	SA068000050AA025_ _ _ _M01
		10000	44.6	6.05	35x80	012	SA100000050AA012_ _ _ _M01
		10000	46.1	7.26	50x80	020	SA100000050AA020_ _ _ _M01
		15000	22.2	9.70	35x105	013	SA150000050AA013_ _ _ _M01
		22000	17.9	11.66	50x80	020	SA220000050AA020_ _ _ _M01
		27000	14.1	13.11	50x80	020	SA270000050AA020_ _ _ _M01
		33000	11.7	16.24	50x105	022	SA330000050AA022_ _ _ _ M01
		47000	10.3	19.67	63x105	026	SA470000050AA026_ _ _ _M01
		68000	10.8	21.45	76x105	028	SA680000050AA028_ _ _ _M01
		82000	10.9	22.55	76x120	041	SA820000050AA041_ _ _ _M01
		100000	9.7	23.96	76x120	041	SA1000H0050AA041_ _ _ _M01
		150000	8.9	27.12	76x146	081	SA1500H0050AA081_ _ _ _M01
		180000	8.0	27.50	90x105	093	SA1800H0050AA093_ _ _ _M01
		220000	6.6	32.00	90X120	097	SA2200H0050AA097_ _ _ _M01
		270000	6.5	35.00	90X146	095	SA2700H0050AA095_ _ _ _M01
		330000	5.7	42.50	76x240	091	SA3300H0050AA091_ _ _ _M01
		390000	4.9	48.50	90x220	094	SA3900H0050AA094_ _ _ _M01
		470000	4.1	55.00	90x240	098	SA4700H0050AA098_ _ _ _M01
63	75	4700	55.6	4.84	35x62	025	SA047000063AA025_ _ _ _M01
		5600	43.1	5.50	35x62	025	SA056000063AA025_ _ _ _M01
		6800	37.5	6.60	35x80	012	SA068000063AA012_ _ _ _M01
		10000	27.5	7.70	35x80	012	SA100000063AA012_ _ _ _M01
		10000	24.6	9.94	50x80	020	SA100000063AA020_ _ _ _M01
		15000	21.6	10.60	50x80	020	SA150000063AA020_ _ _ _M01
		22000	17.6	13.26	50x105	022	SA220000063AA022_ _ _ _M01
		27000	15.1	14.30	50x105	022	SA270000063AA022_ _ _ _M01
		33000	14.7	16.50	63x105	026	SA330000063AA026_ _ _ _M01
		47000	12.6	19.81	76x105	028	SA470000063AA028_ _ _ _M01
		68000	11.2	22.31	76x120	041	SA680000063AA041_ _ _ _M01
		82000	10.4	23.10	76x120	041	SA820000063AA041_ _ _ _M01
		82000	10.4	24.10	90X105	093	SA820000063AA093_ _ _ _M01
		100000	9.6	26.05	76x146	081	SA1000H0063AA081_ _ _ _M01
		150000	8.2	28.60	90X120	097	SA1500H0063AA097_ _ _ _M01
		180000	7.8	35.00	76x220	092	SA1800H0063AA092_ _ _ _M01
		180000	7.7	32.00	90X146	095	SA1800H0063AA095_ _ _ _M01
		220000	7.0	38.50	76x240	091	SA2200H0063AA091_ _ _ _M01
		270000	6.7	41.50	90x220	094	SA2700H0063AA094_ _ _ _M01
		330000	6.3	44.50	90x240	098	SA3300H0063AA098_ _ _ _M01

Custom designed capacitors available

PG - 6DI

-40°C +85°C

Standard Capacitor Values

Rated Voltage (VDC)	Surge Voltage (VDC)	Capacitance Nominal (MFD)	MAX ESR at 100 Hz, 25°C (miliohm)	Ripple Current (Irms) at 100 Hz, 85°C (Amps)	Can size Nominal D x L mm	Case code	Ordering code
75	90	4700	40.7	6.34	35x80	012	SA047000075AA012_ _ _ _M01
		5600	33.3	7.00	35x80	012	SA056000075AA012_ _ _ _M01
		6800	25.4	9.09	35x105	013	SA068000075AA013_ _ _ _M01
		10000	20.9	10.79	50x80	020	SA100000075AA020_ _ _ _M01
		10000	20.7	12.20	50x105	022	SA100000075AA022_ _ _ _M01
		15000	17.6	13.26	50x105	022	SA150000075AA022_ _ _ _M01
		22000	14.8	16.46	63x105	026	SA220000075AA026_ _ _ _M01
		27000	13.8	17.05	63x105	026	SA270000075AA026_ _ _ _M01
		33000	12.6	19.80	76x105	028	SA330000075AA028_ _ _ _M01
		47000	11.9	21.60	76x120	041	SA470000075AA041_ _ _ _M01
		68000	10.5	25.00	76x146	081	SA680000075AA081_ _ _ _M01
		68000	10.5	24.00	90X105	093	SA680000075AA093_ _ _ _M01
		82000	9.2	27.00	90X120	097	SA820000075AA097_ _ _ _M01
		100000	8.8	33.00	76x220	092	SA1000H0075AA092_ _ _ _M01
		120000	8.5	30.50	90X146	095	SA1200H0075AA095_ _ _ _M01
		150000	8.2	35.60	76x240	091	SA1500H0075AA091_ _ _ _M01
		180000	7.3	39.50	90x220	094	SA1800H0075AA094_ _ _ _M01
		220000	6.2	44.60	90x240	098	SA2200H0075AA098_ _ _ _M01
100	115	2200	87.9	3.85	35x62	025	SA022000100AA025_ _ _ _M01
		2700	77.2	4.60	35x80	012	SA027000100AA012_ _ _ _M01
		3300	65.3	5.00	35x80	012	SA033000100AA012_ _ _ _M01
		4700	34.0	6.93	35x80	012	SA047000100AA012_ _ _ _M01
		5600	30.0	9.00	50x80	020	SA056000100AA020_ _ _ _M01
		6800	24.6	9.94	50x80	020	SA068000100AA020_ _ _ _M01
		10000	17.6	13.26	50x105	022	SA100000100AA022_ _ _ _M01
		15000	14.8	16.45	63x105	026	SA150000100AA026_ _ _ _M01
		22000	11.1	21.09	76x105	028	SA220000100AA028_ _ _ _M01
		27000	10.2	22.00	76x105	028	SA270000100AA028_ _ _ _M01
		33000	8.9	24.94	76x120	041	SA330000100AA041_ _ _ _M01
		33000	8.3	27.00	90X105	093	SA330000100AA093_ _ _ _M01
		47000	8.2	28.31	76x146	081	SA470000100AA081_ _ _ _M01
		47000	7.5	30.00	90X120	097	SA470000100AA097_ _ _ _M01
		56000	7.3	33.00	90X146	095	SA560000100AA095_ _ _ _M01
		68000	7.1	36.70	76x220	092	SA680000100AA092_ _ _ _M01
		82000	6.8	39.00	76x240	091	SA820000100AA091_ _ _ _M01
		100000	6.5	42.00	90x220	094	SA1000H0100AA094_ _ _ _M01
		120000	5.4	48.00	90x240	098	SA1200H0100AA098_ _ _ _M01

Custom designed capacitors available

PG - 6DI -40°C +85°C

Standard Capacitor Values

Rated Voltage (VDC)	Surge Voltage (VDC)	Capacitance Nominal (MFD)	MAX ESR at 100 Hz, 25°C (miliohm)	Ripple Current (Irms) at 100 Hz, 85°C (Amps)	Can size Nominal D x L mm	Case code	Ordering code
150	172	1000	205.7	3.19	35x105	013	SA010000150AA013_ _ _ _M01
		2000	66.5	6.05	50x80	020	SA020000150AA020_ _ _ _M01
		2200	63.4	6.19	50x80	020	SA022000150AA020_ _ _ _M01
		2500	59.3	7.22	50x105	022	SA025000150AA022_ _ _ _M01
		3300	49.5	8.99	63x105	026	SA033000150AA026_ _ _ _M01
		4700	36.5	9.2	50x105	022	SA047000150AA022 _ _ _ _M01
		4700	36.2	10.52	63x105	026	SA047000150AA026 _ _ _ _M01
		5600	33.1	11.00	63x105	026	SA056000150AA026 _ _ _ _M01
		6800	27.3	12.10	63x105	026	SA068000150AA026_ _ _ _M01
		10000	19.6	14.3	63x105	026	SA100000150AA026_ _ _ _M01
		10000	19.6	16.50	63x146	035	SA100000150AA035_ _ _ _M01
		12000	15.8	20.34	76x146	081	SA120000150AA081_ _ _ _M01
		15000	14.1	19.4	63x145	035	SA150000150AA035_ _ _ _M01
		15000	14.1	21.54	76x146	081	SA150000150AA081_ _ _ _M01
		22000	13.6	26.50	76x220	092	SA220000150AA092_ _ _ _M01
		22000	13.6	21.10	90X105	093	SA220000150AA093_ _ _ _M01
		27000	11.9	28.40	76x220	092	SA270000150AA092_ _ _ _M01
		27000	11.9	23.80	90X120	097	SA270000150AA097_ _ _ _M01
		33000	9.4	32.00	76x220	092	SA330000150AA092_ _ _ _M01
		33000	9.4	29.00	90X146	095	SA330000150AA095_ _ _ _M01
		39000	8.7	34.50	76x240	091	SA390000150AA091_ _ _ _M01
		47000	7.7	38.50	90x220	094	SA470000150AA094_ _ _ _M01
		56000	7.3	41.20	90x240	098	SA270000150AA098_ _ _ _M01
200	230	1000	150.0	3.30	35x80	012	SA010000200AA012_ _ _ _M01
		1500	141.2	3.85	35x105	013	SA015000200AA013_ _ _ _M01
		2200	85.8	6.00	50x105	022	SA022000200AA022_ _ _ _ M01
		3300	62.5	8.00	63x105	026	SA033000200AA026_ _ _ _M01
		4700	45.9	8.2	50x105	022	SA047000200AA022_ _ _ _M01
		4700	45.0	10.00	63x120	039	SA047000200AA039_ _ _ _M01
		5600	28.1	12.65	63x120	039	SA056000200AA039_ _ _ _M01
		6800	23.7	13.0	63x105	026	SA068000200AA026_ _ _ _M01
		6800	23.1	15.51	76x120	041	SA068000200AA041_ _ _ _M01
		8200	21.6	16.04	76x120	041	SA082000200AA041_ _ _ _M01
		10000	18.4	16.4	76x105	028	SA100000200AA028_ _ _ _M01
		10000	18.1	19.00	76x146	081	SA100000200AA081_ _ _ _M01
		10000	18.1	18.25	90X105	093	SA100000200AA093_ _ _ _M01
		12000	16.4	20.00	76x146	081	SA120000200AA081_ _ _ _M01
		15000	14.7	25.51	76x220	092	SA150000200AA092_ _ _ _M01
		15000	14.7	21.40	90X120	097	SA150000200AA097_ _ _ _M01
		22000	11.8	28.50	76x220	092	SA220000200AA092_ _ _ _M01
		22000	11.8	25.90	90X146	095	SA220000200AA095_ _ _ _M01
		27000	10.3	31.70	76x240	091	SA270000200AA091_ _ _ _M01
		33000	9.6	34.50	90x220	094	SA330000200AA094_ _ _ _M01
		39000	8.4	38.50	90x240	098	SA390000200AA098_ _ _ _M01

Custom designed capacitors available

PG - 6DI

-40°C +85°C

Standard Capacitor Values

Rated Voltage (VDC)	Surge Voltage (VDC)	Capacitance Nominal (MFD)	MAX ESR at 100 Hz, 25°C (miliohm)	Ripple Current (Irms) at 100 Hz, 85°C (Amps)	Can size Nominal D x L mm	Case code	Ordering code
250	288	470	280.2	2.16	35x62	025	SA004700250AA025_ _ _ _M01
		680	184.7	3.37	35x105	013	SA006800250AA013_ _ _ _M01
		1000	119.6	4.51	50x80	020	SA010000250AA020_ _ _ _M01
		2000	62.3	7.04	50x105	022	SA020000250AA022_ _ _ _M01
		2200	55.7	7.45	50x105	022	SA022000250AA022_ _ _ _M01
		2500	45.1	9.42	63x105	026	SA025000250AA026_ _ _ _M01
		3300	43.6	9.58	63x105	026	SA033000250AA026_ _ _ _M01
		4700	37.3	10.4	63x105	026	SA047000250AA026_ _ _ _M01
		4700	37.2	11.00	63x120	039	SA047000250AA039_ _ _ _M01
		5600	28.1	12.65	63x120	039	SA056000250AA039_ _ _ _M01
		6800	17.8	16.7	76x105	028	SA068000250AA028_ _ _ _M01
		6800	17.8	19.16	76x146	081	SA068000250AA081_ _ _ _M01
		8200	16.7	19.80	76x146	081	SA082000250AA081_ _ _ _M01
		8200	15.1	20.00	90X105	093	SA082000250AA093_ _ _ _M01
		10000	14.2	18.7	76x105	028	SA100000250AA028_ _ _ _M01
		10000	14.1	21.54	76x146	081	SA100000250AA081_ _ _ _M01
		10000	14.1	21.85	90X120	097	SA100000250AA097_ _ _ _M01
		12000	13.5	22.00	76x146	081	SA120000250AA081_ _ _ _M01
		15000	12.9	27.20	76x220	092	SA150000250AA092_ _ _ _M01
		18000	10.8	31.00	76x240	091	SA180000250AA091_ _ _ _M01
		18000	10.9	27.00	90X146	095	SA180000250AA095_ _ _ _M01
		22000	10.0	33.80	90x220	094	SA220000250AA094_ _ _ _M01
		27000	7.7	38.50	90x220	094	SA270000250AA094_ _ _ _M01
315	362	2200	55.8	8.5	63x105	026	SA022000315AA026_ _ _ _M01
		3300	59.3	9.7	76x120	041	SA033000315AA041_ _ _ _M01
		4700	37.9	12.1	76x120	041	SA047000315AA041_ _ _ _M01
		5600	36.9	13.3	76x146	081	SA056000315AA081_ _ _ _M01
		6800	22.8	16.9	76x146	081	SA068000315AA081_ _ _ _M01
		6800	22.7	16.3	90X105	093	SA068000315AA093_ _ _ _M01
		8200	22.8	20.5	76x220	092	SA082000315AA092_ _ _ _M01
		8200	22.8	17.2	90X120	097	SA082000315AA097_ _ _ _M01
		10000	16.3	24.2	76x220	092	SA100000315AA092_ _ _ _M01
		12000	13.3	26.8	76x220	092	SA120000315AA092_ _ _ _M01
		12000	13.3	24.4	90X146	095	SA120000315AA095_ _ _ _M01
		15000	12.2	29.1	76x240	091	SA150000315AA091_ _ _ _M01
		15000	12.2	30.7	90x220	094	SA150000315AA094_ _ _ _M01

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Standard Capacitor Values

Rated Voltage (VDC)	Surge Voltage (VDC)	Capacitance Nominal (MFD)	MAX ESR at 100 Hz, 25°C (miliohm)	Ripple Current (Irms) at 100 Hz, 85°C (Amps)	Can size Nominal D x L mm	Case code	Ordering code
350	385	330	386.0	2.06	35x80	012	SA003300350AA012_ _ _ _M01
		1000	116.5	5.15	50x105	022	SA010000350AA022_ _ _ _M01
		1500	94.6	6.50	63x105	026	SA015000350AA026_ _ _ _M01
		2200	51.4	7.8	50x105	022	SA022000350AA022_ _ _ _M01
		2200	51.2	9.37	63x120	039	SA022000350AA039_ _ _ _M01
		3300	37.7	10.3	63x105	026	SA033000350AA026_ _ _ _M01
		3300	37.9	10.89	63x120	039	SA033000350AA039_ _ _ _M01
		3300	42.4	11.44	76x120	041	SA033000350AA041_ _ _ _M01
		4700	33.6	12.2	76x105	028	SA047000350AA028_ _ _ _M01
		4700	33.6	13.95	76x146	081	SA047000350AA081_ _ _ _M01
		5600	25.7	15.95	76x146	081	SA056000350AA081_ _ _ _M01
		6800	22.0	15.9	76x120	041	SA068000350AA041_ _ _ _M01
		6800	22.0	17.25	76x146	081	SA068000350AA081_ _ _ _M01
		8200	20.7	21.50	76x220	092	SA082000350AA092_ _ _ _M01
		8200	20.8	18.00	90X120	097	SA082000350AA097_ _ _ _M01
		10000	15.0	20.9	76x146	081	SA100000350AA081_ _ _ _M01
		10000	15.0	25.30	76x220	092	SA100000350AA092_ _ _ _M01
		12000	12.7	28.50	76x240	091	SA120000350AA091_ _ _ _M01
		12000	12.7	25.00	90X146	095	SA120000350AA095_ _ _ _M01
		15000	11.2	32.00	90x220	094	SA150000350AA094_ _ _ _M01
400	440	680	203.8	3.46	50x80	020	SA006800400AA020_ _ _ _M01
		1000	107.6	5.36	50x105	022	SA010000400AA022_ _ _ _ M01
		1000	107.5	6.10	63x105	026	SA010000400AA026_ _ _ _M01
		1500	100.3	6.32	63x105	026	SA015000400AA026_ _ _ _M01
		2200	62.5	8.49	63x120	039	SA022000400AA039_ _ _ _M01
		3300	51.5	10.39	76x120	041	SA033000400AA041_ _ _ _M01
		4700	40.3	12.74	76x146	081	SA047000400AA081_ _ _ _M01
		5600	36.6	13.37	76x146	081	SA056000400AA081_ _ _ _M01
		6800	38.2	15.84	76x220	092	SA068000400AA092_ _ _ _M01
		6800	38.2	12.58	90X105	093	SA068000400AA093_ _ _ _M01
		8200	31.9	17.33	76x220	092	SA082000400AA092_ _ _ _M01
		8200	31.8	14.55	90X120	097	SA082000400AA097_ _ _ _M01
		10000	26.5	17.30	90X146	095	SA100000350AA095_ _ _ _M01
		12000	22.4	22.60	90x220	094	SA120000350AA094_ _ _ _M01
		12000	22.4	21.50	76x240	091	SA120000350AA091_ _ _ _M01
		15000	20.2	23.85	90x220	094	SA150000400AA094_ _ _ _M01

Custom designed capacitors available

PG - 6DI

-40°C +85°C

Standard Capacitor Values

Rated Voltage (VDC)	Surge Voltage (VDC)	Capacitance Nominal (MFD)	MAX ESR at 100 Hz, 25°C (miliohm)	Ripple Current (Irms) at 100 Hz, 85°C (Amps)	Can size Nominal D x L mm	Case code	Ordering code
450	495	470	279.9	2.95	50x80	020	SA004700450AA020_ _ _ _M01
		680	121.9	5.03	50x105	022	SA006800450AA022_ _ _ _M01
		1000	107.6	6.10	63x105	026	SA010000450AA026_ _ _ _M01
		1500	96.6	6.82	63x120	039	SA015000450AA039 _ _ _ _M01
		2200	72.8	7.4	63x105	026	SA022000450AA026_ _ _ _M01
		2200	72.7	7.87	63x120	039	SA022000450AA039_ _ _ _M01
		3300	52.2	9.8	76x105	028	SA033000450AA028_ _ _ _M01
		3300	52.1	11.20	76x146	081	SA033000450AA081_ _ _ _M01
		4700	33.8	13.92	76x146	081	SA047000450AA081_ _ _ _M01
		4700	33.8	13.36	90X105	093	SA047000450AA093_ _ _ _M01
		5600	28.6	15.35	90X120	097	SA056000450AA097_ _ _ _M01
		6800	25.1	16.50	90X146	095	SA068000450AA095_ _ _ _M01
		8200	20.2	21.78	76x220	092	SA082000450AA092_ _ _ _M01
		8200	20.2	19.80	90X146	095	SA082000450AA095_ _ _ _M01
		10000	18.5	23.65	76x240	091	SA100000450AA091_ _ _ _M01
		12000	17.2	25.85	90x220	094	SA120000450AA094_ _ _ _M01
		15000	15.1	27.00	90X240	098	SA150000450AA098_ _ _ _M01
500	550	820	154.0	4.95	50x105	022	SA008200500AA022_ _ _ _M01
		1000	138.2	5.23	50x105	022	SA010000500AA022_ _ _ _M01
		1500	99.3	7.02	63x105	026	SA015000500AA026_ _ _ _M01
		2200	67.9	9.0	63x120	039	SA022000500AA039_ _ _ _M01
		2200	68.0	9.44	76x105	028	SA022000500AA028_ _ _ _M01
		3300	54.8	10.9	63x146	035	SA033000500AA035_ _ _ _M01
		3300	54.6	12.10	76x146	081	SA033000500AA081_ _ _ _M01
		4700	41.4	13.9	76x146	081	SA047000500AA081_ _ _ _M01
		4700	41.7	13.30	90X105	093	SA047000500AA093_ _ _ _M01
		5600	39.7	14.40	90X120	097	SA056000500AA097_ _ _ _M01
		6800	33.5	17.00	90X146	095	SA068000500AA095_ _ _ _M01
		8200	27.1	21.60	76x240	091	SA082000500AA091_ _ _ _M01
		8200	27.1	22.75	90x220	094	SA082000500AA094_ _ _ _M01
		10000	21.7	22.9	90x175	096	SA100000500AA096_ _ _ _M01
		10000	21.7	25.40	90x220	094	SA100000500AA094_ _ _ _M01

Custom designed capacitors available

PG - 6DI

-40°C +85°C

Standard Capacitor Values

Rated Voltage (VDC)	Surge Voltage (VDC)	Capacitance Nominal (MFD)	MAX ESR at 100 Hz, 25°C (miliohm)	Ripple Current (Irms) at 100 Hz, 85°C (Amps)	Can size Nominal D x L mm	Case code	Ordering code
550	600	560	223.4	3.30	50x80	020	SA005600550AA020_ _ _ _M01
		680	213.8	3.80	50x105	022	SA006800550AA022_ _ _ _M01
		820	167.0	4.30	50x105	022	SA008200550AA022_ _ _ _M01
		1000	152.5	4.50	50x105	022	SA010000550AA022_ _ _ _M01
		1000	152.6	5.12	63x105	026	SA010000550AA026_ _ _ _M01
		1200	132.2	5.50	63x105	026	SA012000550AA026_ _ _ _M01
		1500	113.4	6.30	63x120	026	SA015000550AA026_ _ _ _M01
		1800	110.6	6.94	63x146	035	SA018000550AA035_ _ _ _M01
		1800	110.5	6.70	76x105	028	SA018000550AA028_ _ _ _M01
		2200	83.6	7.98	63x146	035	SA022000550AA035_ _ _ _M01
		2200	83.6	8.15	76x120	041	SA022000550AA041_ _ _ _M01
		2200	83.6	8.50	90X105	093	SA022000550AA093_ _ _ _M01
		2700	80.8	9.00	76x146	081	SA027000550AA081_ _ _ _M01
		3300	59.4	10.50	76x146	081	SA033000550AA081_ _ _ _M01
		4700	52.5	13.50	76x220	092	SA047000550AA092_ _ _ _M01
		5600	50.6	14.30	76x240	091	SA056000550AA091_ _ _ _M01
		5600	50.7	12.50	90X146	095	SA056000550AA095_ _ _ _M01
		8200	44.8	16.00	90x220	094	SA082000550AA094_ _ _ _M01
		10000	38.3	18.00	90x240	098	SA100000550AA098_ _ _ _M01

Custom designed capacitors available

Technical Information

Construction

An aluminum electrolytic capacitor consists of two electrically conductive aluminum layers, separated by a dielectric layer. One of the electrodes (the aluminum foil called anode) undergoes a Process called 'forming', by which a dielectric layer of aluminum oxide (Al_2O_3) is electrochemically coated on it. The other electrode is a conductive liquid, called the electrolyte. The second aluminum foil, the cathode, acts as a large surfaced contact area for passing current to the electrolyte. The basic principle of the capacitor is to store electrical charge and is defined as:

Q = CV

Q = charge in Coulombs

C = capacitance, in Farads (between the plates)

V = potential difference between the plates

Based on the formula given above, it can be said that the unit of capacitance, the Farad, is the capacitance between the plates, across which appears a potential difference of 1 Volt when it is charged by 1 Coulomb of electricity. The value of capacitance in a capacitor is directly proportional to the area of the plates and is inversely proportional to the distance between them. Hence capacitance is expressed by the equation:

$$C = \frac{A}{d} \varepsilon_o \varepsilon_r$$

A = surface area of the plates in m^2

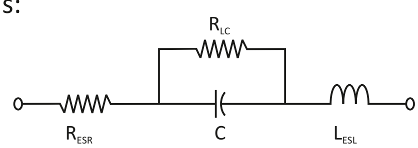
d = distance between the plates (or dielectric thickness) in metres

$E_{o.}$ = permittivity of free space = 8.885×10^{-12} F/m

$E_{r.}$ = relative permittivity of the dielectric (9.5 for Al_2O_3)

The surface area of the anode is enlarged (up to 200 times) by an electrochemical etching process. Similarly the cathode is also etched to increase the surface area. The thickness of the dielectric layer is very small (in microns) and increases in proportion to the forming voltage (approximately 1.2nm/v), making the distance between the two plates very small. This construction of aluminum electrolytic capacitors allows for very high capacitance per unit area in comparison with capacitors which use other dielectric materials.

An equivalent circuit of an aluminum electrolytic capacitor is:



R_{ESR} = equivalent series resistance (ESR)

C = capacitance

R_{LC} = resistance due to leakage current

L_{ESL} = equivalent series inductance (ESL)

The capacitance of the anode foil will depend on the etching pattern and the forming voltage. The cathode foil is etched and has a thin oxide layer on it, which is caused due to atmospheric oxidation.

Manufacturing Process

The main stages of the manufacturing process are:

Anode foil : Etching → Forming → Slitting → Winding

Cathode foil : Etching → Slitting → Winding

Capacitor paper : Slitting → Winding

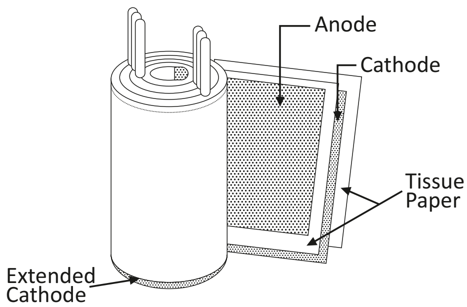
Winding ↓

Ageing ← Assembly2 ← Impregnation ← Assembly 1

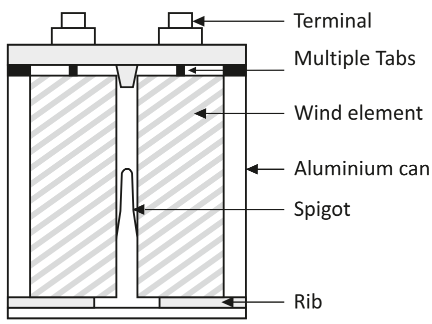
Ageing ↓

Sleeving → Testing → Packing

Super pure aluminium foil is etched to increase the surface area. The anode foil undergoes an electrochemical process called forming by which a dielectric layer is 'formed' on it. The anode and cathode are interleaved with different densities and thickness papers and wound into a cylinder as shown in the fig. below. During winding, aluminum tabs are attached to the foil for electrical contacts by a cold welding process.



The capacitor element is impregnated with an electrolyte, under vacuum. In the assembly process, terminals are riveted and/or welded to the tabs and housed in an aluminium can without anchoring material, as shown:



Technical Information

Capacitors are then sealed and aged. The aging process repairs any damage to the oxide layer that may have been caused during the process of assembling the capacitor into the aluminium can. A thorough test is carried out for seepage by placing the capacitors in an oven. A visual check is carried out on each capacitor for any sign of electrolyte leakage.

Next, capacitors are tested for the following electrical parameters.

I) Capacitance ii) ESR
iii) Leakage current iv) Tan δ

The capacitors are then sleeved and packed. After completion of the production process, the company's Q.A. Personnel carry out a sample test.

Electrical Characteristics

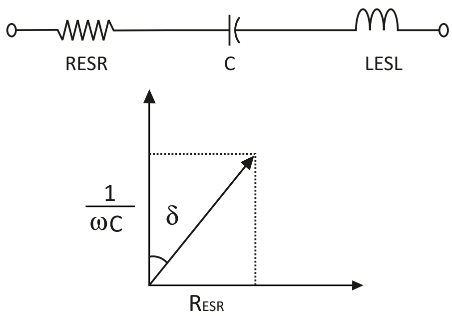
- **Rated voltage:** The rated voltage is the DC voltage for which the capacitor has been designed. The capacitors can be operated continuously at the full rated voltage within the operating temperature range.
- **Surge voltage:** The surge voltage is the maximum DC voltage that a capacitor can be subjected to, for a very short duration, not exceeding 30 seconds. This includes transients and peak ripple at highest line voltage.
  Capacitors are designed to withstand 6 such surge in an hour, at a minimum interval of 10 minutes. The capacitor will withstand the following surge test: The capacitor is connected in series with a current limiting resistor.
  The rated surge voltage is applied at room temperature for a period not exceeding 30 seconds. The capacitor is then discharged through a suitable resistor. This cycle (charge discharged) may be repeated for a maximum of 6 cycles in one hour, each being at an interval of 10 minutes.
- **Ripple voltage:** The ripple voltage is the superimposed AC voltage that may be applied to the capacitor provided that:
  i) the sum of DC voltage and superimposed AC Voltage dose not exceed the rated voltage.
  ii) rated ripple current is not exceeded.
- **Reverse voltage:** Aluminium electrolytic capacitors are polar capacitors. Reverse voltage $\leq$ 1.5V can be applied for a duration of less than 1 second, but not continuously or repeatedly. The reverse voltage of 1.5 V is the voltage at which the breakdown of the oxide layers on the cathode takes place. Where necessary a diode may be connected to prevent any reverse voltage from appearing on the capacitor.
- **Selection of current limiting resistor:**
  A current limiting resistor, which is to be connected in series with the capacitor, may be chosen as follows:
  a) for capacitors of rating up to 2500µF, the limiting resistor will be of 1000 ohms.
  b) for capacitors of rating higher than 2500µF, the value of current limiting resistor will be determined on the formula:

  $$R = \frac{2.5 \times 10^6}{C}$$

  C = capacitance in µF
  R = resistor value in Ohms
- **Capacitance:** Capacitance can be measured by:
  i) measuring its AC impedance after taking into account amplitude and phase
  ii) measuring the charge it will hold when DC voltage is applied DC capacitance is approximately equal to 1.1 to 1.5 times AC capacitance

Notes: Measurement of capacitance is made at frequency of 100 Hz and ambient temperature of 25°C. The value is in microfarads (µF or MFD) and is indicated on the capacitor. Capacitance increases with temperature and decreases with increases in frequency.

- **Dissipation factor (Tan δ):** This is the ratio of ESR to capacitive reactance in the equivalent series circuit. Alternatively, it could be defined as the ratio of effective power (dissipated power) to the reactive power for a sinusoidal voltage:



$$\text{Tan } \delta = R_{ESR} \div \frac{1}{\omega C} = \omega C R_{ESR}$$

- **Equivalent series resistance (ESR):** The equivalent series resistance is the resistive component of equivalent series circuit. it is related to dissipation factor by the formula:

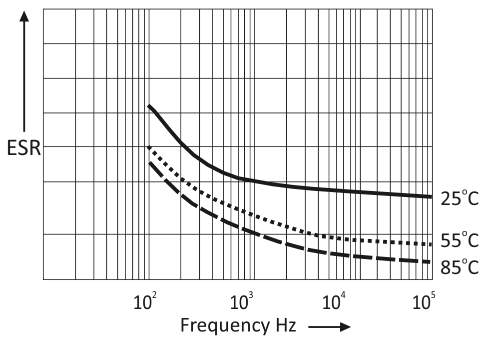
  $$\mathbf{RESR} = \frac{\text{Tan } \delta}{\omega \text{ Cs}}$$

  RESR = equivalent series resistance in Ω
  Tanδ = dissipation factor
  Cs = series capacitance in Farads
  ω = 2πf (f=frequency)

  ESR values are measured by the bridge method (to eliminate the resistance of lead wires) at a frequency of 100Hz and ambient temperature of 25°C. ESR

Technical Information

values decrease with increase in temperature and frequency:



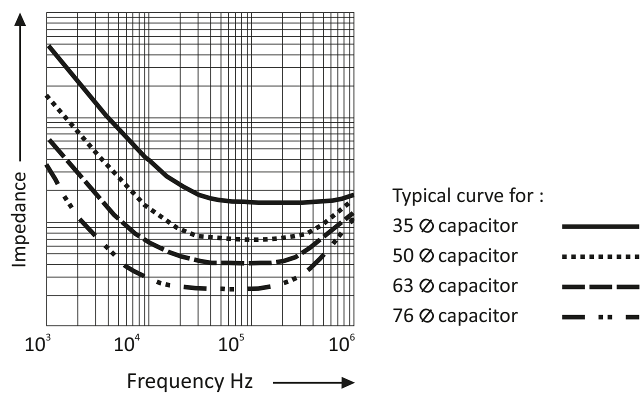
- **Impedance:** Impedance is given by the formula:

Z = $\sqrt{ESR^2 + (X_L - X_c)^2}$
Z = impedance in Ohms
ESR = equivalent series resistance (Ω)
X_L = $2\pi f L$
X_c = $\frac{1}{2\pi f C}$

Impedance is dominated by capacitive reactance (Xc) at lower frequencies and by inductive reactance (XL) at higher frequencies. Resonance occurs when:

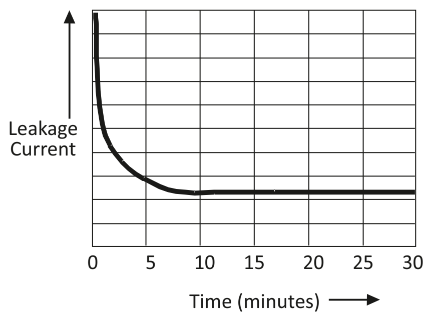
X_L = X_c at which Z = ESR

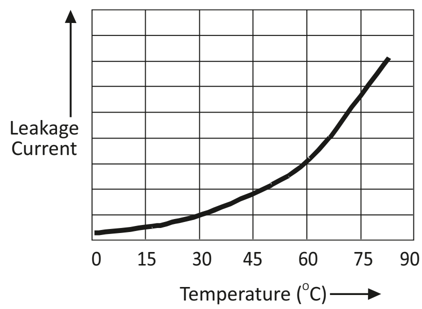
Impedance below resonance decreases with increase in temperature and frequency. However, impedance above resonance, decreases with temperature but increases as frequency increases.



- **Leakage current:** Leakage current is the residual current which continues to flow through the capacitor even after the capacitor has been charged to the set voltage or rated voltage. After the capacitor has been fully charged to the set voltage, the leakage current will continue to fall with time until a steady state has been reached. Leakage current is a measure of the quality of the dielectric layer and is dependent on capacitance voltage and temperature. Measurement of leakage current is made at the rated DC voltage of the capacitor, which is applied from a steady source like a regulated power supply. A current limiting resistor must be connected in series with the capacitor under test.

Measurement is carried out at an ambient temperature of 25° C ± 3°C. The rated voltage is applied for 5 minutes before the leakage current measurement are taken:





- **Ripple current:** The ripple current rating of a capacitor is the rms value of AC current that flows through a capacitor due to the presence of ripple voltage. Ripple current generates heat inside the capacitor which is:

P = I_r^2xESR
p = power loss in watts
Ir = rms value or ripple current in Amperes
ESR = equivalent series resistance in Ohms

The maximum ripple current that a capacitor can handle depends on :
i) the winding design
ii) aluminium can design
iii) surface area of the can
iv) ESR

Since ripple current increases the temperature of the capacitor, it has a significant effect on the operational life of the capacitor. Ripple current handling capacity is dependent on frequency and temperature. Heat sinking and forced air cooling will aid heat transfer and allow higher ripple currents to be applied.

- **Shelf life:** Shelf life is defined as the times for which a capacitor can be stored without voltage being applied.

Normally the capacitance, ESR and impedance of a capacitor do not change significantly after extended storage period. However, the leakage current can slowly increase. The shelf life versus storage

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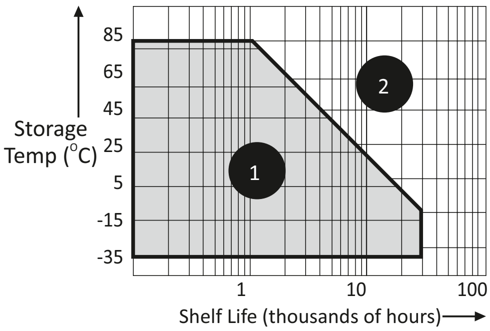
temperature graph is shown below:

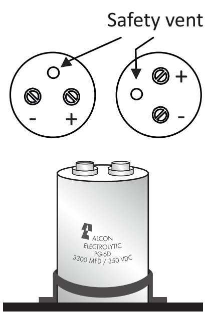


Region ❶ Leakage current remains unchanged
Region ❷ Leakage current increases
In both cases capacitance, ESR and impedance do not change significantly. If the capacitors are in region ❷, capacitors should be preconditioned prior to use. The procedure follows under, "preconditioning":

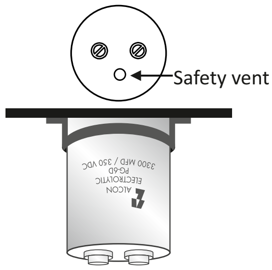
- **Preconditioning**: preconditioning is carried out by applying the rated working voltage across the capacitor. The power source should be a regulated power supply. A suitable current limiting resistor should be connected in series with the capacitor. The voltage should be maintained for one hour after its value has becomes equal to the rated working voltage applied ±3%. After this, the capacitor should be discharge through a resistor of suitable value. The capacitor can now be stored idle for 12 to 24 hours. After this period, the capacitor can be tested for any of the specified parameters.

Application Notes

- **Mounting positions:** During operating, the leakage current of the capacitor will cause electrolysis of the electrolyte. The oxygen produced during electrolysis, helps in 'Self Healing' of the dielectric layer. The minute quantity of hydrogen released at this time, may increase the internal pressure in the capacitor over an extended period of time**.** All capacitors are provided with a safety vent, which punctures when the pressure inside the capacitor increase beyond the safe limit of 80 psi. Therefore, it is recommended that the capacitors be mounted upright or horizontal, with the vent on top, as shown:

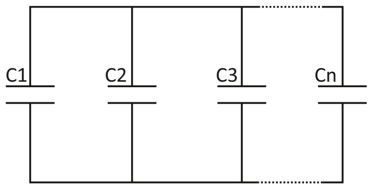


If capacitors are mounted with the safety vent at the lowest Position (shown below), a small pool of electrolyte may form near the safety vent. When the vent punctures, the electrolyte may spray out, on to other components, causing damage. Alternatively, the electrolyte may dry and crystallize inside the safety vent, over a period of time, making it non-functional.



- **Capacitor bank design**: capacitor may require parallel or series connections or both. This depends on the application.

Parallel connection

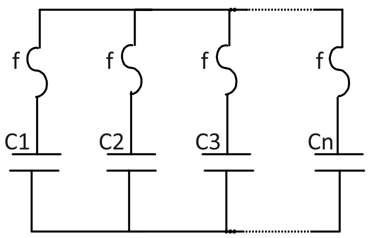


In a bank of 'n' capacitors connected in parallel, each with capacitance rating of C_1 C_2.........C_n and voltage rating V_1, V_2 ,....V_n, respectively, the effective capacitance and voltage of the bank will be:

C bank = $\mathbf{C_1 + C_2 + \ldots + C_n}$
V bank = **minimum voltage rating of any capacitor in the bank**.

It is advisable to use capacitors of the same nominal capacitance value and voltage rating to avoid excessive stress on any one capacitor in the bank. In this circuit, if any capacitor in the bank fails due to an internal short circuit, then all the other capacitors in the bank will discharge through this particular capacitor, leading to an extremely abrupt and severe discharge phenomenon.

Hence it is advisable to connect these capacitors through a fuse:



f = fuse

For impulse discharge circuit, where it may not be feasible to use the fuses, the capacitors can be

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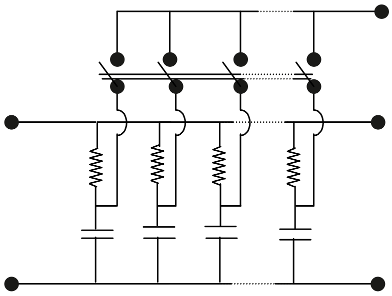
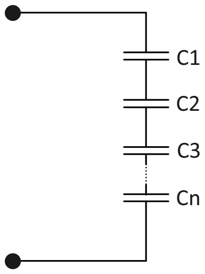
protected during charging by means of a suitable current limiting resistor and then connected in parallel at the time of discharge:



Series Connection

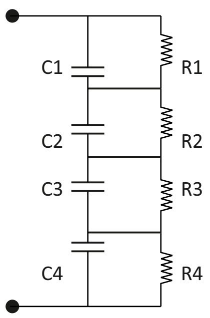


In the bank of 'n' capacitors connected in series, each with capacitance rating of C_1 C_2 ...... C_n and voltage rating V_1, V_2,.....V_n , respectively, the effective capacitance and voltage of the bank will be:

$$\frac{1}{C\ bank} = \frac{1}{C_1} + \frac{1}{C_2} + \dots\dots\dots + \frac{1}{C_2}$$

$$V\ bank = V_1 + V_2 + \dots\dots\dots + \dots V_n$$

It is advisable to use capacitors of the same nominal capacitance value and voltage rating to avoid excessive stress on any one capacitor in the bank. When capacitors are connected in series, the voltage of any individual capacitor should not exceed the maximum permissible voltage. The total DC voltage applied is divided among individual capacitors in proportion to their insulation resistance value (leakage current). Hence to avoid any imbalance during charging of the bank, it is recommended that a shunt resistor be connected with each capacitor:



The value of the shunt resistance can be computed as follows:

A) $$R = \frac{nVr - Vb}{L.C.max\ \{(Vb / Vr) - ((n+9)/10)\}}$$

R	:	Shunt resistance value (minimum) in ohms
Vr	:	Rated voltage of each capacitor
n	:	Number of capacitors in($n \geq 2$)
Vb	:	Bank voltage
L. C. max	:	Maximum leakage current of one capacitor (in amp.)

B) Suggested wattage of resistor V^2r / R

Combined series-parallel connections Capacitors may be connected as follows:

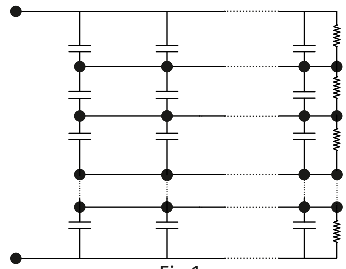


Fig 1

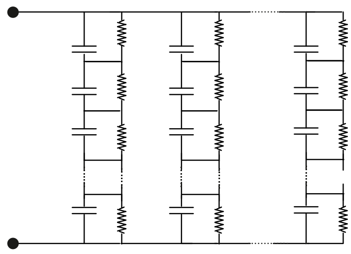


Fig 2

If one capacitor in the series bank (Fig.1) fails due to a short circuit, the other capacitors will be subjected to the total voltage. This may lead to an excess voltage on the other capacitors, causing all capacitors in the bank to fail. Hence it is recommended that capacitors are connected as shown in Fig 2, where only one "series bank" suffers the risk of failure, in the event of a short circuit of one capacitor.

- **Life Expectancy** : During the working life of capacitors, certain physical and parametric changes occur. These changes eventually make the capacitor unusable, either due to "thermal runaway" leading to catastrophic failure or an excessive parametric drift. At a higher temperature, degradation of the material, used to manufacture the capacitor, accelerates these effects. There are many reasons for these changes. Some performance aspects of the capacitors cannot be predicted. Hence evaluation of the capacitor's long term behavior must be determined by 'endurance' tests.
  Useful life (service life or operational life) is the life

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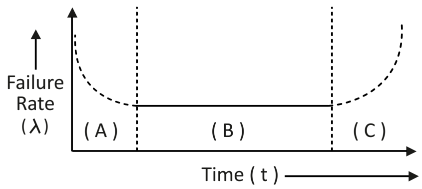
achieved by the capacitor without exceeding a specified failure rate. Useful life can be prolonged by operating the capacitors at load factors below the rated values specified, like lower operating voltage, ripple current and ambient temperature, Capacitor life can also be prolonged by appropriate cooling methods.

Failure percentage is the ratio of number of failures to total number of inspected capacitors. Failure rate(or long term failure)is the number of components failing per unit time. The characteristic curve is as follows:



Region A is the early failure period (or infant mortality), this can be decreased by improvement in the manufacturing process Region B is the useful life (operational life or service life) where failure rate is nearly constant Region C is the 'wear-out' period. This occurs due to the end of life of the capacitors and occurs when capacitor properties deteriorate. End of life of can be due to:

i) Catastrophic failure like short circuit, open circuit or operation of the safety vent

ii) Parametric failure like
   - ESR increases to more than thrice the initial specified limit
   - leakage current greater than specified maximum limit
   - capacitance changes of more than ±30%
   - a combination of these

Reliability is the probability that the capacitor will perform satisfactorily under given set of conditions for a given length of time. For calculation of useful life the components are taken from a normally manufactured batch. The components are tested under controlled conditions and the data for long term reliability is based on a confidence level of 60% . The figure can be taken only as a guide for reliability since actual working conditions are likely to deviate significantly from those used in routine testing. Meantime between failure (MTBF) is the inverse of failure rate

$$\mathbf{MTBF} = \frac{1}{\lambda}$$

e.g. For given set of conditions

No. of components used in the field

N = 12,000

No. of operating hours to = 10.000 hrs

No. of failures n = 12

$$\text{Failures\%} = \frac{n}{N} = \frac{12}{12,000} = 0.1\% = F(\%)$$

$$\text{Failures rate } \lambda = \frac{F(\%)}{to} = \frac{0.1\%}{10,000} = 0.01\% /1000\text{hours}$$

Forced Air Cooling

All capacitors are designed to ensure that heat from the core is transferred quickly and efficiently to the outer aluminium can. It is recommended that efficient air flow is created to enable the capacitor bank to remain at the lowest possible temperatures. This would increase the life expectancy of the capacitor. From the table given below it will be seen that the ripple current carrying capacity can be enhanced by increasing the air flow rate.

Ripple Current Multiplier
Air Flow Rate, metres per second (m/s)

Can Size (DxL) mm	< 1.0 m/s Free Convection	1.0 m/s Forced air cooling	2.5 m/s Forced air cooling	5.0 m/s Forced air cooling
35X62	1.00	1.15	1.37	1.54
35X80	1.00	1.15	1.18	1.51
35X105	1.00	1.14	1.33	1.46
50X80	1.00	1.15	1.37	1.55
50X105	1.00	1.14	1.34	1.49
50X120	1.00	1.14	1.33	1.47
63X105	1.00	1.15	1.35	1.51
63x120	1.00	1.14	1.33	1.47
63X145	1.00	1.13	1.32	1.45
76X105	1.00	1.15	1.36	1.52
76X120	1.00	1.15	1.36	1.52
76X145	1.00	1.14	1.32	1.46
76X177	1.00	1.08	1.32	1.37
76X220	1.00	1.12	1.27	1.38
90X105	1.00	1.15	1.37	1.54
90X120	1.00	1.15	1.35	1.51
90X145	1.00	1.14	1.33	1.47
90X220	1.00	1.12	1.27	1.38

Note : Above Ripple Current Multipliers are for Clamp Mounted Capacitors

Technical Information

Precautions

- **Polarity:** Aluminium electrolytic capacitor are polar. Therefore, the capacitors should be connected accordingly. If the polarity of a capacitors is reversed, the capacitor will heat up and normally the safety vent will operate. In extreme cases there is possibility of an explosion and fire.
- **Mechanical stress:** During installation capacitors should not be mechanically damaged.
  - i) Capacitors have been designed with the can being negative. Hence damage to the insulation sleeve may causes a short circuit.
  - ii) The terminals of screw terminal type capacitors (AEST) are made of highly pure aluminium, the screw are made of brass or stainless steel which are a hard material. Hence mismatch of the threads during fitment can cause damage to the threads of the aluminium terminals. Also while connecting the screw terminals, the tightening torque

    For M5 threading : Maximum 2.5Nm (thread depth $\geq$ 8mm)

    For M6 threading : Maximum 4Nm (thread depth $\geq$ 9.5mm)
  - iii) Vibration resistance test :
    To IEC 60068-2-6, test Fc : Displacement amplitude 0-75 mm, frequency range 10... 55Hz, acceleration max. 10 g, duration 3 x 2 h. Capacitor mounted by its body which is rigidly clamped to the work surface.
- **Cleaning agents:** Halogenated hydrocarbons, if in contact with capacitor, may cause serious damage. These solvents may decompose the insulation sleeve and reduce insulating properties below permissible levels. Moreover, these may penetrate the capacitor through the capacitor seal leading to premature failure. Commonly used halogeneted hydrocarbons and other solvent which should not be used are freon, trichloroethylene, methylchloride, carbon tetrachloride, acetone, methyl ethyl ketone. Cleaning agents which normally do not have any detrimental effects are methanol, ethanol, propanol and isopropanol.
- **Operating conditions:** During operating, capacitors may fail due to the following:
  - i) Operating in very high ambient conditions.
  - ii) Surge voltage exceeds or surge voltage is applied for longer periods than specified.
  - iii) Voltage on the capacitor exceeds rated voltage
  - iv) Ripple current exceeds the specified values.
  - v) Reverse polarity.

  These can lead to catastrophic failure, with the possibility of an explosion and fire. Hence care should be taken during use. Also capacitors should be used in a well ventilated enclosure.
- **Exposure to electrolyte:** When an electrolyte comes in contact with skin, wash throughly with water. If electrolyte comes in contact with eyes, wash throughly with water and immediately seek medical advice.
- **Storage:** The following conditions for storage are recommended:
  - i) When not in use capacitors should be kept in their original packing.
  - ii) Capacitors should be stored indoors, away from direct sunlight, at a temperature of 5 to 35°C and a humidity level of less than 70%RH.
  - iii) Capacitors should be stored in an environment free from water, oil, salt water and gases like hydrogen sulphied. Keep away from other chemicals like sulfuric acid, hydrochloric acid, chlorine, ammonia or any corrosive environment.
  - iv) On storage, capacitors should not be subjected to severe mechanical shock or vibration, beyond specified limits.
- **Safety:** Due to the characteristics of electrolytic capacitor there can be a “rebound” voltage of up to of 40 to 50v even after the capacitor is discharged for a brief period. Therefore, it is necessary to ensure that the capacitor is totally discharge before using them, so that other sensitive components will not be affected.