DC FILTERING

FFLI 800V to 1400Vdc* RoHS Compliant

KYOCERA
AVX

The FFLI series is specifically designed for DC filtering applications such as DC link. This range offers solutions for voltage from 800V up to 1400V.

The Controlled Self Healing Technology, essential to ensure a safe and reliable behaviour, is achieved using a fully dry solution with polypropylene metallized and segmented film. Standard designs proposed in this catalogue are covering a wide range of voltage and capacitance values.

In case of specific requirements about shape and performances, please feel free to contact your local KYOCERA AVX representative.

STANDARDS

IEC 61071:	Power electronic capacitors
IEC 61881:	Railway applications, rolling stock equipment, capacitors for power electronics
IEC 60068-2:	Environmental testing
IEC 61373:	Shock and vibrations
UL 94:	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

PACKAGING MATERIAL

Aluminium cylindrical case filled with thermosetting resin.

Self extinguishing thermosetting resin (V-0 : in accordance with UL94; certified classifications according to EN 45545-2)

Self extinguishing plastic cover (V-0 : in accordance with UL94; certified classifications according to EN 45545-2)

RoHS components

M6/10 Female connections or M8/20 Male connections

HOW TO ORDER

FFLI	6	L	0337	K	– –	RoHS COMPLIANT
Series	**Dielectric** 6 = Polypropylene	**Voltage Code** B = 800V L = 1000V U = 1150V Q = 1400V	**Capacitance EIA Code**	**Capacitance Tolerances** K = ±10%	**Terminal Code** – – = Male Threaded JE = Female Threaded	

DEFINITIONS

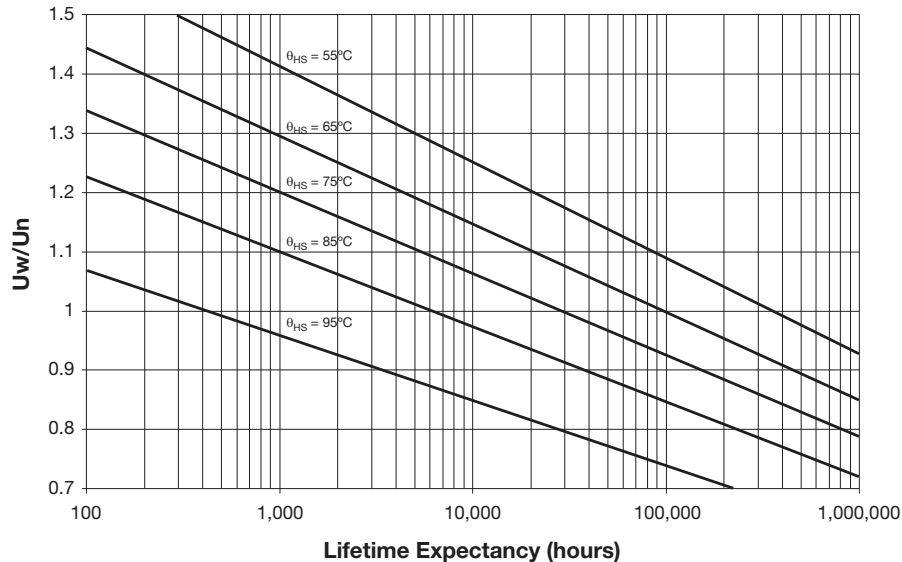| C_n (µF)	capacitance	nominal value of the capacitance measured at θ_{amb} = 25 ± 10°C
U_n (V)	rated DC voltage	maximum operating peak voltage of either polarity (non-reversing type waveform), for which the capacitor has been designed for continuous operation
U_w (V)	working voltage	value of the maximum operating recurrent voltage for a given hot spot temperature and an expected lifetime
U_r (V)	ripple voltage	peak-to-peak alternating component of the unidirectional voltage
L_s (nH)	parasitic inductance	capacitor series self-inductance
R_s (mΩ)	series resistance	capacitor series resistance due to galvanic circuit
I_{rms} (A)	RMS current	RMS current value for continuous operation under natural convection generating 40°C overheating
θ_{amb} (°C)	cooling air temperature	temperature of the cooling air measured at the hottest position of the capacitor, under steady-state conditions, midway between two units NOTE If only one unit is involved, it is the temperature measured at a point approximately 0.1 m away from the capacitor container and at two-thirds of the height from its base
θ_{HS} (°C)	hot spot temperature	highest temperature obtained inside the case of the capacitor in thermal equilibrium
I^2t (A²s)	integral of action	maximum repetitive integral of action that galvanic circuit is able to withstand

CHARACTERISTICS

Capacitance range C_n	105µF to 3000µF
Tolerance on C_n	±10%
Rated DC voltage U_n	800 to 1400V
Lifetime at U_n and 65°C hot-spot temperature and ΔC / C < 2%	100,000h
Parasitic inductance L_s	35 to 60nH
Maximum rms current I_{rms}	up to 112A$_{rms}$
Test voltage between terminals @ 25°C	1.5 x Un for 10s
Test voltage between terminals and Case @ 25°C	4kVrms @ 50Hz for 10s
Dielectric	polypropylene
Climatic Category	40 / 95 / 56 (IEC 60068)
Working temperature	-40°C / +95°C (according to the power dissipated)
Storage temperature	-40°C / +85°C
Calorific value	40 MJ/kg

KYOCERA AVX The Important Information/Disclaimer is incorporated in the catalog where these specifications came from or available online at www.kyocera-avx.com/disclaimer/ by reference and should be reviewed in full before placing any order.

LIFETIME EXPECTANCY VS HOT SPOT TEMPERATURE AND VOLTAGE

Chart: Uw/Un (y-axis, 0.7 to 1.5) vs Lifetime Expectancy (hours) (x-axis, 100 to 1,000,000)
Curves labeled: $\theta_{HS} = 55°C$, $\theta_{HS} = 65°C$, $\theta_{HS} = 75°C$, $\theta_{HS} = 85°C$, $\theta_{HS} = 95°C$

HOW TO CHOSE THE RIGHT CAPACITOR

The capacitor lifetime depends on the working voltage and the hot spot temperature.

Our caps are designed to meet 100000 hours lifetime at rated voltage and 65°C hot spot temperature. In accordance with operating conditions, please calculate the hot spot temperature and deduce from this calculation if the obtained lifetime can suit the application.

1. **From the tables, select a capacitor with required capacitance C_n and voltage U_n.**
Calculate the maximum ripple voltage allowed for the selected cap:
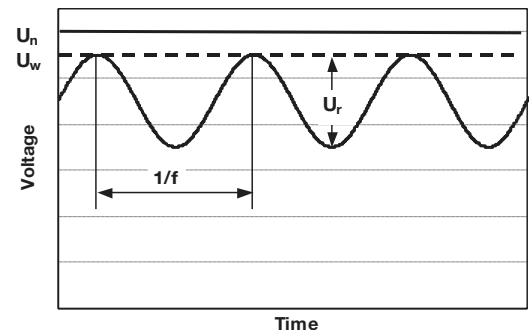$U_{rmax} = 0.2 U_n$

If $U_r > U_{rmax}$, select a capacitor with higher rated voltage

Make sure I_{rms} application < I_{rms} table

Copy out:

- serial resistance (Rs): see table of values
- thermal resistances Rth

2. **Hot spot temperature calculation**
Total losses are calculated as follow: $P_t = P_j + P_d$

Joule losses: $P_j = R_s \times I_{rms^2}$

Dielectric losses: $P_d = Q \times tg\delta_0$ with

- Q(reactive power) $= \dfrac{I_{rms}^2}{C\omega}$ for a sinusoidal waveform

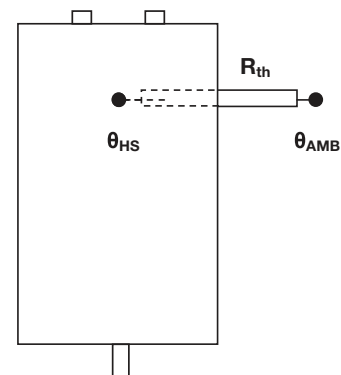- $tg\delta_0 = 2 \times 10^{-4}$ (dielectric losses of polypropylene)

Hot spot temperature will be:

$\theta_{HS} = \theta_{amb} + (P_j + P_d) \times R_{th}$

θ_{HS} *absolute maximum is 95°C*

If temperature is higher than 95°C, come back to #1 and start again with another selection.
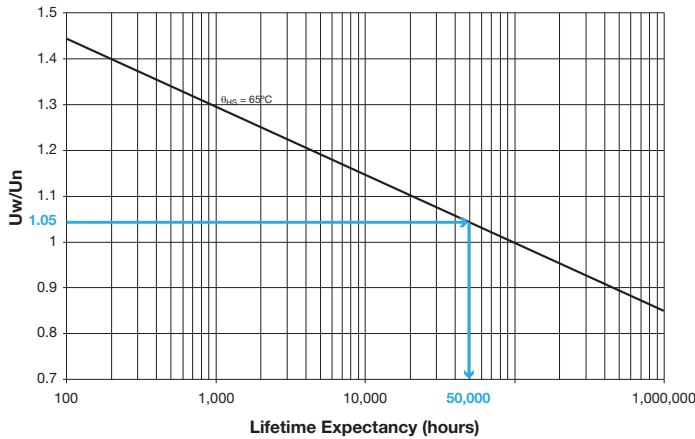
R_{th}: thermal resistance between case and ambient air

3. **Refer to the curve and deduce the lifetime vs U_w/U_n ratio**

eg: rated voltage 1000V
     working voltage 1050V
     ρ = 1.05 $\Rightarrow$ lifetime 50,000 hours
     @ 65°C hot spot temperature

Please, find a calculation form at the end of the catalog

MTBF CALCULATION

Based on Return Of Experience from the field of more than 30 years, we have established the following relation. The failure rate λ_B depends on hot spot temperature θ_{HS} and charge ratio ρ.

$\rho = U_w/U_n$

$$\lambda_B = 3 \times 10^{2,75(\rho-1)} \times e^{\left(3,2\left(\frac{\theta_{HS}+273}{358}\right)^{30}\right)} \times 10^{-9} \quad \text{in failures/hour}$$

GENERAL FAILURE RATE

$\lambda = \lambda_B \times \pi_Q \times \pi_B \times \pi_E$ failures/hour • π_Q, π_B and π_E see following tables

Qualification	Qualification factor πQ
Product qualified on IEC61071 and internal qualification	1
Product qualified on IEC61071	2
Product answering on another norm	5
Product without qualification	15

Environment	Environment factor πE
On ground (good conditions)	1
On ground (fixed materials)	2
On ground (on board)	4
On ship	9
On plane	15

Environment	Environment factor πB
Favorable	1
Unfavourable	5

MEAN TIME BETWEEN FAILURE (MTBF)

MTBF = 1/λ hours

SURVIVAL FUNCTION

N = N_0 x exp (-λt)

N is the number of pieces still working after t hours.

N_0 is the number of pieces at the origin (t = 0)

FAILURE MODE

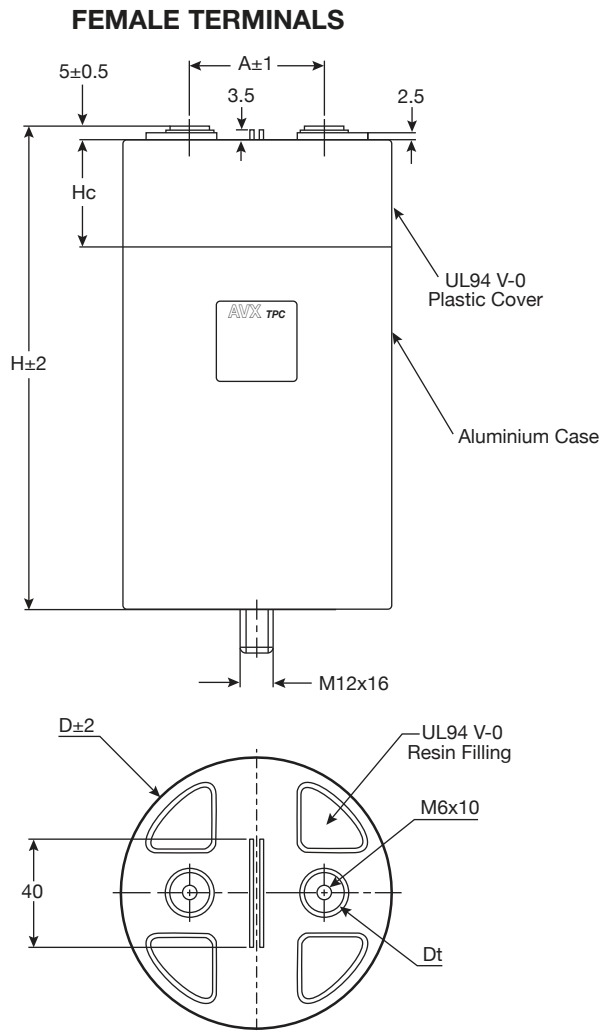Main failure mode due to KYOCERA AVX's **Controlled Self-Healing Technology** is only losses of capacitance. Thanks to **Controlled Self-Healing solution** to interrupt self-healing process in order to prevent avalanche effect due to polypropylene molecular cracking producing gas and potential explosion in confined box for none **Controlled Self-Healing capacitors.**
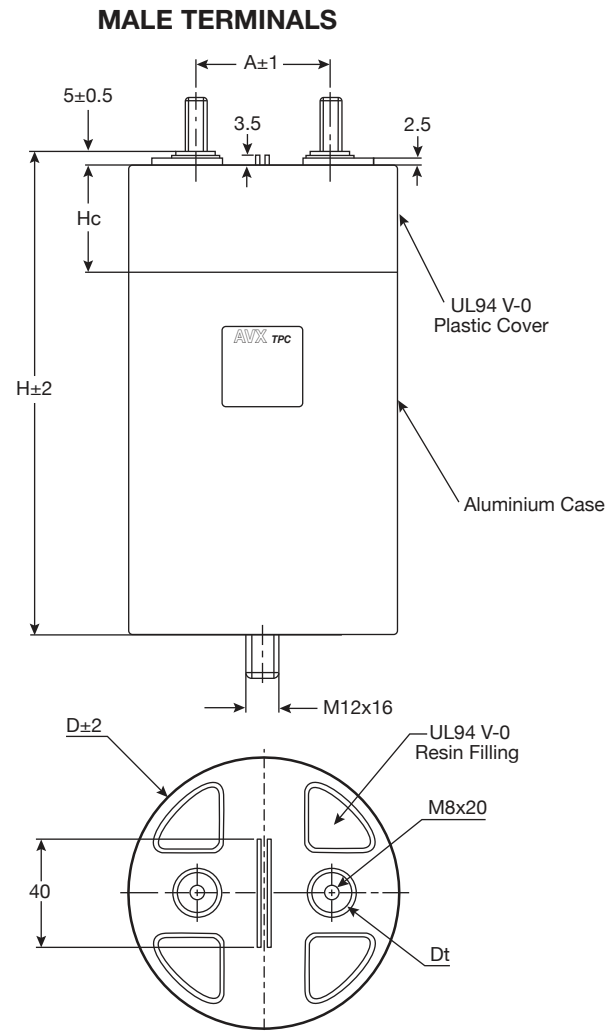
– MEDIUM POWER FILM CAPACITORS –

DIMENSIONS

FEMALE TERMINALS

UL94 V-0 Plastic Cover

Aluminium Case

UL94 V-0 Resin Filling

M6x10

M12x16

D (mm)	75	85	100	116
A (mm)	32	32	50	50
Dt (mm)	12	12	15	15
Hc (mm)	30	30	40	40

MALE TERMINALS

UL94 V-0 Plastic Cover

Aluminium Case

UL94 V-0 Resin Filling

M8x20

M12x16

	Max Torque (Nm)
M6	4.5
M8	8.5
M12	15

D (mm)	Distance terminal to terminal (mm)		Distance terminal to case (mm)	
	creepage	clearance	creepage	clearance
75	40	19	47	45
85	40	19	52	50
100	55	34	59	57
116	55	34	67	65

MECHANICAL MOUNTING

Capacitors enclosure presents a M12 x 16 bolt in order to fix the capacitor. Over height (H) more than 1.5 x D (diameter of tube), we recommend to clamp (constraint < 35daN), just below the plastic cover, the capacitor in order to limit oscillations in case of potential Shock&Vibration stress.

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RATINGS AND PART NUMBER REFERENCE

Part Number	Capacitance (µF)	D	H	I_{rms} (A)	I^2t (A^2s)	Typical L_S (nH)	Typical R_S (mΩ)	R_{th} (°C/W)	Typical Weight (g)
$U_n$dc 800V									
FFLI6B0297K**	290	75	105	54	13	35	3.1	4.5	600
FFLI6B0397K**	390	85	105	66	24	35	2.3	4.0	700
FFLI6B0507K**	500	75	155	49	13	50	4.1	4.0	850
FFLI6B0687K**	680	85	155	59	24	50	3.1	3.7	1100
FFLI6B0817K**	810	85	180	58	24	60	3.5	3.4	1300
FFLI6B1007K**	1000	100	155	73	52	50	2.2	3.4	1500
FFLI6B1207K**	1200	100	180	70	52	60	2.5	3.3	1800
FFLI6B1357K**	1350	116	155	86	95	50	1.7	3.2	2000
FFLI6B1607K**	1600	116	180	80	95	60	2.0	3.1	2400
FFLI6B1907K**	1900	116	240	112	320	40	1.1	2.9	3200
FFLI6B2407K**	2400	116	290	111	320	50	1.2	2.7	3900
FFLI6B3007K**	3000	116	340	109	320	60	1.4	2.4	4500
$U_n$dc 1000V									
FFLI6L0197K**	190	75	105	49	8	35	3.7	4.5	600
FFLI6L0267K**	260	85	105	60	16	35	2.8	4.0	700
FFLI6L0337K**	330	75	155	45	8	50	4.9	4.0	850
FFLI6L0457K**	450	85	155	54	16	50	3.7	3.7	1100
FFLI6L0547K**	540	85	180	53	16	60	4.2	3.4	1300
FFLI6L0657K**	650	100	155	66	33	50	2.7	3.4	1500
FFLI6L0787K**	780	100	180	64	33	60	3.0	3.3	1800
FFLI6L0907K**	900	116	155	79	66	50	2.0	3.2	2000
FFLI6L1107K**	1100	116	180	75	66	60	2.3	3.1	2400
FFLI6L1307K**	1300	116	240	107	210	40	1.2	2.9	3200
FFLI6L1607K**	1600	116	290	103	210	50	1.4	2.7	3900
FFLI6L2007K**	2000	116	340	102	210	60	1.6	2.4	4500
$U_n$dc 1150V									
FFLI6U0157K**	150	75	105	46	7	35	4.2	4.5	600
FFLI6U0207K**	200	85	105	56	12	35	3.2	4.0	700
FFLI6U0267K**	260	75	155	42	7	50	5.6	4.0	850
FFLI6U0357K**	350	85	155	51	12	50	4.2	3.7	1100
FFLI6U0437K**	430	85	180	50	12	60	4.7	3.4	1300
FFLI6U0537K**	530	100	155	64	27	50	2.9	3.4	1500
FFLI6U0637K**	630	100	180	61	27	60	3.3	3.3	1800
FFLI6U0727K**	720	116	155	75	51	50	2.2	3.2	2000
FFLI6U0867K**	860	116	180	72	51	60	2.5	3.1	2400
FFLI6U1007K**	1000	116	240	99	160	40	1.4	2.9	3200
FFLI6U1307K**	1300	116	290	99	160	50	1.5	2.7	3900
FFLI6U1607K**	1600	116	340	99	160	60	1.7	2.4	4500
$U_n$dc 1400V									
FFLI6Q1056K**	105	75	105	43	5	35	4.9	4.5	600
FFLI6Q0147K**	140	85	105	51	9	35	3.8	4.0	700
FFLI6Q1856K**	185	75	155	40	5	50	6.4	4.0	850
FFLI6Q0257K**	250	85	155	47	9	50	4.8	3.7	1100
FFLI6Q0307K**	300	85	180	46	9	60	5.5	3.4	1300
FFLI6Q0367K**	360	100	155	58	19	50	3.5	3.4	1500
FFLI6Q0447K**	440	100	180	56	19	60	3.9	3.3	1800
FFLI6Q0507K**	500	116	155	69	36	50	2.6	3.2	2000
FFLI6Q0607K**	600	116	180	66	36	60	3.0	3.1	2400
FFLI6Q0707K**	700	116	240	96	120	40	1.5	2.9	3200
FFLI6Q0907K**	900	116	290	93	120	50	1.7	2.7	3900
FFLI6Q1107K**	1100	116	340	91	120	60	2.0	2.4	4500

**Insert - - for male terminals or JE for female terminals

051320

— MEDIUM POWER FILM CAPACITORS —

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CALCULATION FORM

SPECIFICATION

Capacitance	C (µF)	
Working voltage	U_w (V)	
Rms current	I_{rms} (A_{rms})	
Frequency	f (Hz)	
Ripple voltage	U_r (V)	
Ambient temperature	θ_{amb} (°C)	
Lifetime @ U_w,I_{rms} and θ_{amb}	hours	
Parasitic inductance	L (nH)	
Cooling conditions		

Your choice

PN		
Capacitance	C (µF)	
Rated voltage	U_n (V)	
Serial resistance	R_s (mΩ)	
between hot spot and case	R_{th} (°C/W)	

CALCULATIONS

Maximum ripple voltage	U_{rmax} = 0.2 U_n	U_{rmax} =	V
The maximum ripple voltage of the selected capacitor must be in any case higher than the ripple voltage of your application			
Ratio U_w/U_n	$\rho = U_w/U_n$	ρ =	
Joule losses	$P_j = R_s \times I_{rms2}$	P_j =	W
Dielectric losses	$P_d = Q \times tg\delta 0 = Q \times 2.10^{-4}$	P_d =	W
Hot spot temperature	$\theta_{HS} = \theta_{amb} + (P_j + P_d) \times R_{th}$	θ_{HS} =	°C
The hot spot temperature must be in any case lower than 95°C			

LIFETIME EXPECTANCY VS HOT SPOT TEMPERATURE AND VOLTAGE
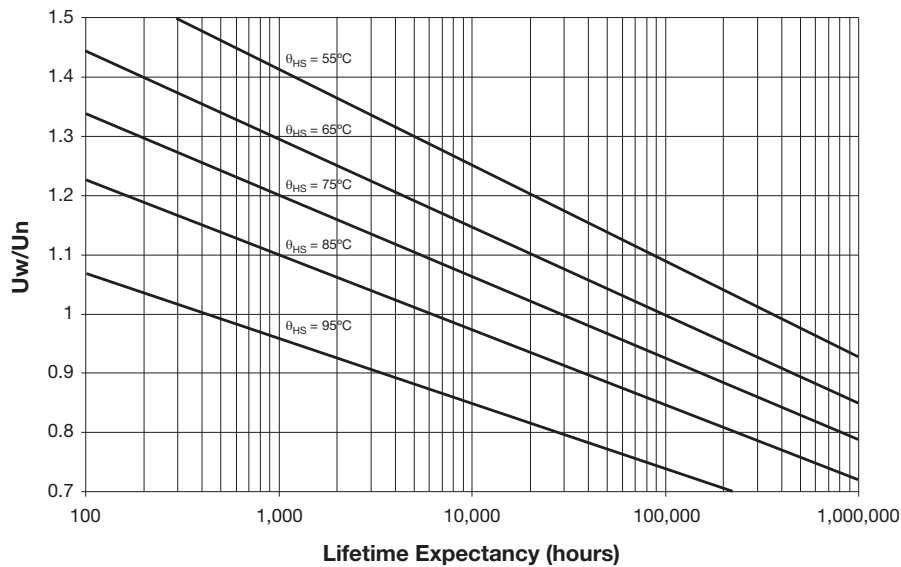
Expected lifetime at hot spot calculated and U = U_w	