

# FILFIM PRODUCTS

6500Vdc to 56000Vdc



## GENERAL DESCRIPTION

The FILFIM series is specifically designed for DC filtering applications for voltages up to 56000V.

Large case sizes up to 100 liters and high specific energy up to 250J/l together with safe and reliable **Controlled Self Healing Technology** make this series particularly suitable for power converters in energy and power transmission areas, active correction and high power DC supply.

The **Controlled Self Healing Technology** is based on a high temperature grade metallized film impregnated with vegetable oil allowing operating temperature up to 85°C.

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, feel free to contact your local KYOCERA AVX representative.

## PACKAGING MATERIAL

- non-painted
- with or without fixing brackets
- grounding via a nut on the top of the case
- 3 terminal sizes vs voltage
- 1 or 2 terminals

## STANDARDS

- IEC 61071: Power electronic capacitors
- IEC 60068-2: Environmental testing

## HOW TO ORDER

<b>DL</b>	<b>IFM</b>	<b>1</b>	<b>B</b>	<b>M</b>	<b>B</b>	<b>0306</b>
Series	Section and Option	Terminals Type	Fixing	Voltage	Capacitance EIA code	
	1 = 350x185 1 terminal 2 = 350x185 2 terminals 3 = 520x185 1 terminal 4 = 520x185 2 terminals 5 = 695x185 1 terminal 6 = 695x185 2 terminals	A, B or C See drawings	W = without M = brackets	A = 6500V B = 7900V C = 9000V D = 10500V E = 12000V F = 14500V G = 15800V H = 18000V I = 22000V J = 26000V K = 28000V L = 32000V M = 36000V N = 42000V O = 56000V		

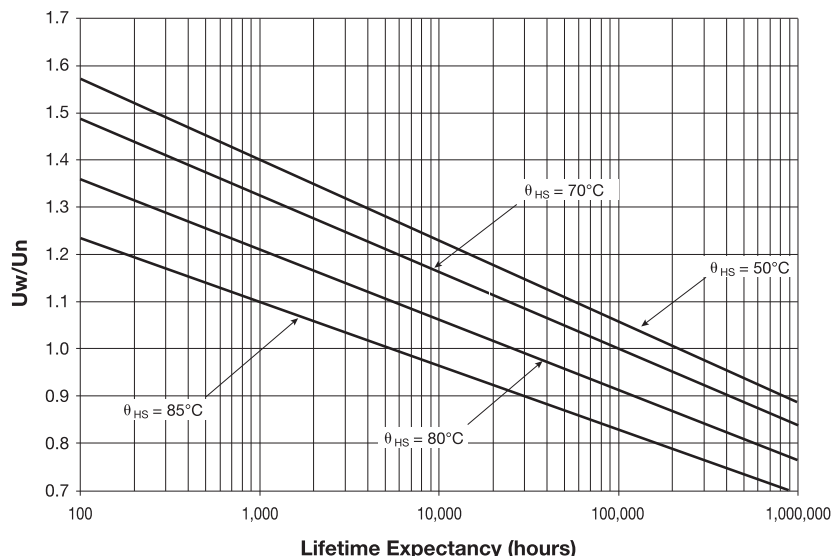
### DEFINITIONS

$C_n$ ( $\mu\text{F}$ )	capacitance	nominal value of the capacitance measured at $\theta_{\text{amb}} = 25^\circ\text{C} \pm 10^\circ\text{C}$
$U_n$ (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
$R_s$ (m $\Omega$ )	series resistance	capacitor series resistance due to galvanic circuit
$I_{\text{rms}}$ (A) <b>max</b> (A)	RMS current	Maximum rms current value @ 100Hz for continuous operation
$\theta_{\text{amb}}$ ( $^\circ\text{C}$ )	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
$\theta_{\text{HS}}$ ( $^\circ\text{C}$ )	hot spot temperature	highest temperature obtained inside the case of the capacitor in thermal equilibrium

### CHARACTERISTICS

Capacitance range $C_n$	2.6 $\mu\text{F}$ to 612 $\mu\text{F}$
Tolerance on $C_n$	$\pm 10\%$
Rated DC voltage $U_n$	6500 to 56000V (100kV on specific design)
Lifetime at $U_n$ and 80 $^\circ\text{C}$ hot-spot temperature and $\Delta C / C < 2\%$	100,000h
Parasitic inductance $L_s$	250nH to 830nH
Maximum rms current $I_{\text{rms}}$	up to 120A <sub>rms</sub>
Test voltage between terminals @ 25 $^\circ\text{C}$	1.5 x $U_n$ for 10s
Test voltage between terminals and Case @ 25 $^\circ\text{C}$	1.5 x $U_n$ for 10s
Dielectric	Polypropylene
Climatic Category	55 / 85 / 56 (IEC 60068)
Working temperature	-55 $^\circ\text{C}$ / +85 $^\circ\text{C}$ (according to the power dissipated)
Storage temperature	-55 $^\circ\text{C}$ / +85 $^\circ\text{C}$
Calorific value	30 MJ/kg

### LIFETIME EXPECTANCY VS HOT SPOT TEMPERATURE AND VOLTAGE



### 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 100,000 hours lifetime at rated voltage and 70°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:

$$U_{rmax} = 0.2U_n$$

If  $U_r > U_{rmax}$ , select a capacitor with higher rated voltage or contact your local sales representative

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

Copy out:

- serial resistance ( $R_s$ ): see table of values
- thermal resistances  $R_{th1}$  and  $R_{th2}$

#### 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:  $P_d = Q \times \text{tg}\delta_0$  with

- $Q$  (reactive power) =  $\frac{I_{rms}^2}{C}$  for a sinusoidal waveform
- $\text{tg}\delta_0 = 3 \times 10^{-4}$  (dielectric losses of polypropylene + oil)

Hot spot temperature will be:

$$\theta_{HS} = \theta_{amb} + (P_j + P_d) \times (R_{th1} + R_{th2})$$

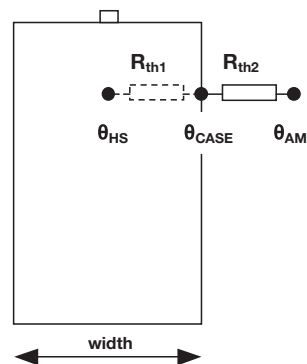
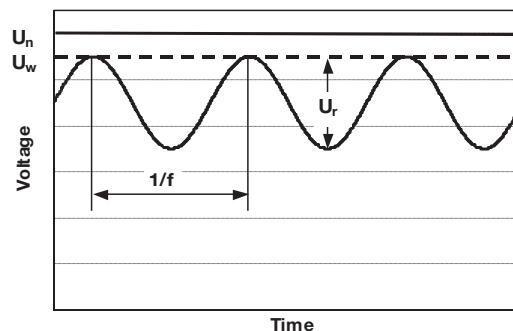
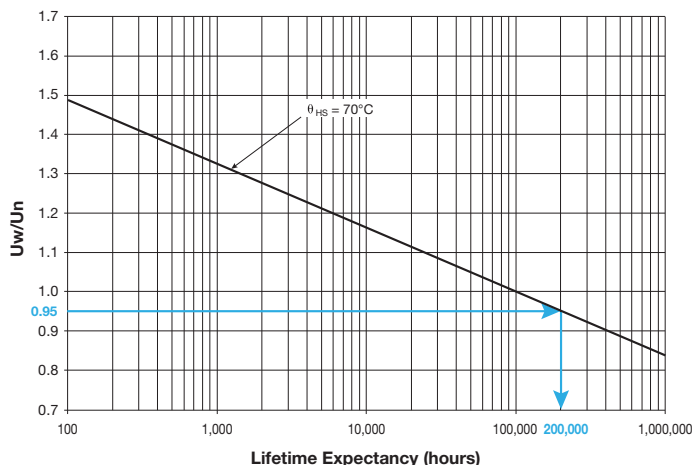
$\theta_{HS}$  **absolute maximum is 85°C**

If temperature is higher than 85°C, come back to #1 and start again with another selection.

$R_{th1}$ : thermal resistance between hot spot and case

$R_{th2}$ : 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 12000V  
 working voltage 11400V  
 $\rho = 0.95 \Rightarrow$  lifetime 200,000 hours  
 @ 70°C hot spot temperature  
 Please, find a calculation form at the end of the catalog

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## THERMAL RESISTANCES

$R_{th1}$  (°C/W): Thermal resistance between hot spot and case

$R_{th2}$  (°C/W): Thermal resistance between case and ambient air under natural convection and forced air

Height (mm)	$R_{th1}$ (°C/W)			$R_{th2}$ (°C/W)		
	Section (LxW)			Section (LxW)		
	350x185	520x185	695x185	350x185	520x185	695x185
315	0.2	0.15	0.115	0.2	0.15	0.115
410	0.16	0.12	0.095	0.16	0.12	0.095
500	0.14	0.1	0.08	0.14	0.1	0.08
595	0.12	0.085	0.07	0.12	0.085	0.07
685	0.1	0.075	0.06	0.1	0.075	0.06
770	0.09	0.07	0.055	0.09	0.07	0.055



For confined area, capacitor working in a closed cabinet, a thermal test under real conditions is necessary to evaluate the thermal resistance.

## PARASITIC INDUCTANCE VS SIZE

Discharge method measurement

$L_s (nH) = 0.332 \times \text{Height (mm)} + L_{\text{terminal}} \times \text{terminal qty}$

## WEIGHT VS SIZE

Height (mm)	Weight (kg)		
	Section 350x185	Section 520x185	Section 695x185
315	29	41	54
410	36	52	68
500	43	62	81
595	50	72	95
685	57	82	108
770	63	91	119

# FILFIM PRODUCTS

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## MTBF CALCULATION

The failure rate  $\lambda_B$  depends on hot spot temperature  $\theta_{HS}$  and charge ratio  $\rho$ .

$$\rho = U_w/U_n$$

$$\lambda_B = 3 \times 10^{5,738(\rho-1)} \times e^{\left(3,933 \left(\frac{\theta_{HS}+273}{368}\right)^{27,75}\right)} \times 10^{-9} \text{ in failures/hour}$$

## GENERAL FAILURE RATE

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

Qualification	Qualification factor $\pi_Q$
Product qualified on IEC61071 or IEC61881 and internal qualification	1
Product qualified on IEC61071 or IEC61881	2
Product answering on another norm	5
Product without qualification	15

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

Environment	Environment factor $\pi_B$
Favorable	1
Unfavourable	5

## MEAN TIME BETWEEN FAILURE (MTBF)

$$MTBF = 1/\lambda \text{ hours}$$

## SURVIVAL FUNCTION

$$N = N_0 \times \exp(-\lambda t)$$

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

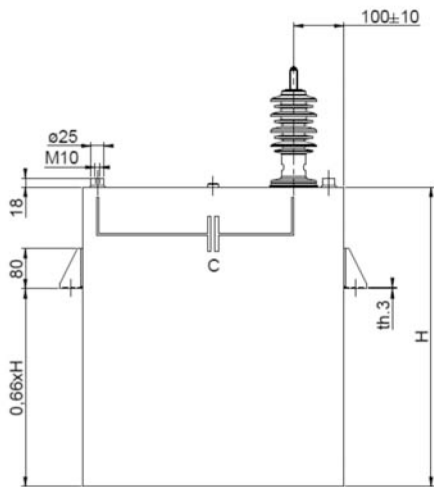
Main failure mode due to KYOCERA AVX's Controlled Self-Healing Technology is only losses of capacitance. Thanks to the Controlled Self-Healing Technology, the efficient solution to interrupt the self-healing process and prevent the avalanche effect leading to the worse sequence of events for non-controlled self-healing capacitors: polypropylene molecular cracking, gas emission and potential explosion in confined box.

# FILFIM PRODUCTS

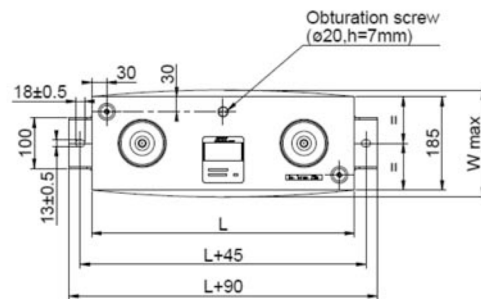
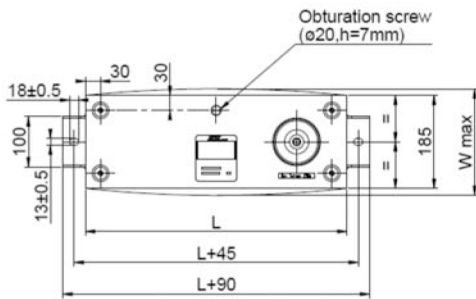
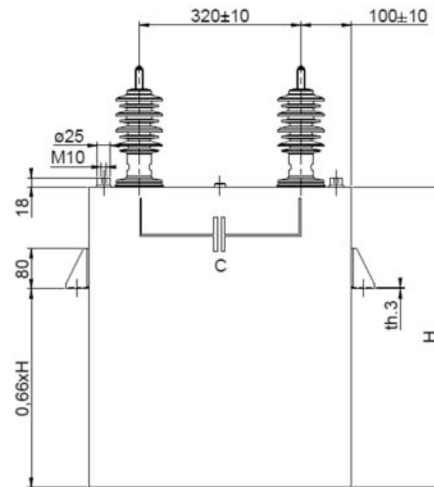
6500Vdc to 56000Vdc

## DIMENSIONS

1 TERMINAL



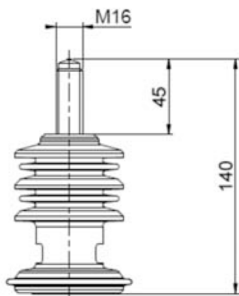
2 TERMINALS



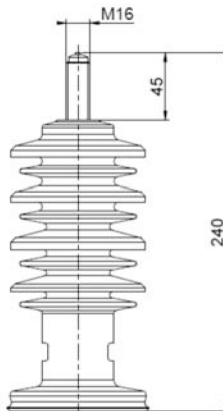
L	≥520mm	<520mm
Wmax	215mm	205mm

## TERMINALS

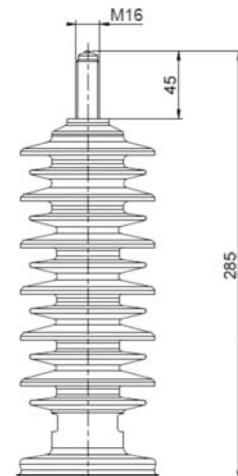
**Type A**  $U_n \leq 16kV$   
 $L=140nH$   
 max torque 25Nm



**Type B**  $16kV < U_n \leq 32kV$   
 $L=240nH$   
 max torque 25Nm



**Type C**  $32kV < U_n \leq 56kV$   
 $L=285nH$   
 max torque 25Nm



# FILFIM PRODUCTS

6500Vdc to 56000Vdc



## RATINGS AND PART NUMBER REFERENCE

Part Number	Capacitance (μF)	Height (mm)	R <sub>s</sub> (mΩ)	I <sub>rms</sub> max (A)
<b>Un = 6500Vdc Terminal type A Section 350x185 (LxW)</b>				
DLIFM*A#A1886	188	315	3.4	90
DLIFM*A#A2756	275	410	3.3	110
DLIFM*A#A3626	362	500	3.2	120
DLIFM*A#A0457	450	595	3.2	120
DLIFM*A#A5376	537	685	3.1	120
DLIFM*A#A6126	612	770	3.1	120
<b>Un = 7900Vdc Terminal type A Section 350x185 (LxW)</b>				
DLIFM*A#B1266	126	315	3.6	81
DLIFM*A#B1846	184	410	3.4	100
DLIFM*A#B2426	242	500	3.3	115
DLIFM*A#B0307	300	595	3.2	120
DLIFM*A#B3596	359	685	3.2	120
DLIFM*A#B0417	410	770	3.2	120
<b>Un = 9000Vdc Terminal type A Section 350x185 (LxW)</b>				
DLIFM*A#C0956	95	315	3.7	72
DLIFM*A#C1386	138	410	3.4	95
DLIFM*A#C1816	181	500	3.3	110
DLIFM*A#C2256	225	595	3.3	120
DLIFM*A#C2696	269	685	3.2	120
DLIFM*A#C3076	307	770	3.2	120
<b>Un = 10500Vdc Terminal type A Section 350x185 (LxW)</b>				
DLIFM*A#D0736	73	315	5.8	63
DLIFM*A#D1076	107	410	5	80
DLIFM*A#D0147	140	500	4.6	96
DLIFM*A#D1746	174	595	4.4	110
DLIFM*A#D2086	208	685	4.3	120
DLIFM*A#D2376	237	770	4.3	120
<b>Un = 12000Vdc Terminal type A Section 350x185 (LxW)</b>				
DLIFM*A#E0556	55	315	6.2	56
DLIFM*A#E0806	80	410	5.3	74
DLIFM*A#E1056	105	500	4.9	88
DLIFM*A#E0137	130	595	4.6	102
DLIFM*A#E1556	155	685	4.5	114
DLIFM*A#E1776	177	770	4.4	120
<b>Un = 14500Vdc Terminal type A Section 350x185 (LxW)</b>				
DLIFM*A#F3755	37.5	315	5.6	45
DLIFM*A#F0556	55	410	4.9	67
DLIFM*A#F0726	72	500	4.6	81
DLIFM*A#F0896	89	595	4.4	94
DLIFM*A#F1066	106	685	4.3	106
DLIFM*A#F1216	121	770	4.2	115
<b>Un = 15800Vdc Terminal type A Section 350x185 (LxW)</b>				
DLIFM*A#G3155	31.5	315	5.9	41
DLIFM*A#G0466	46	410	5.1	61
DLIFM*A#G6055	60.5	500	4.7	76
DLIFM*A#G0756	75	595	4.5	89
DLIFM*A#G0896	89	685	4.4	100
DLIFM*A#G1026	102	770	4.3	110
<b>Un = 18000Vdc Terminal type B Section 350x185 (LxW)</b>				
DLIFM*B#H1955	19.5	315	7.8	29
DLIFM*B#H0306	30	410	6.5	45
DLIFM*B#H0456	45	500	5.9	67
DLIFM*B#H0516	51	595	5.6	76
DLIFM*B#H0626	62	685	5.4	86
DLIFM*B#H0726	72	770	5.3	96

Part Number	Capacitance (μF)	Height (mm)	R <sub>s</sub> (mΩ)	I <sub>rms</sub> max (A)
<b>Un = 22000Vdc Terminal type B Section 520x185 (LxW)</b>				
DLIFM*B#I0206	20	315	8.9	36
DLIFM*B#I3155	31.5	410	7.2	52
DLIFM*B#I4255	42.5	500	6.6	64
DLIFM*B#I0546	54	595	6.2	76
DLIFM*B#I0656	65	685	6	86
DLIFM*B#I0756	75	770	5.9	94
<b>Un = 26000Vdc Terminal type B Section 520x185 (LxW)</b>				
DLIFM*B#J1425	14.2	315	9.8	30
DLIFM*B#J2255	22.5	410	7.8	46
DLIFM*B#J0306	30	500	7	57
DLIFM*B#J0386	38	595	6.6	67
DLIFM*B#J0466	46	685	6.3	77
DLIFM*B#J0536	53	770	6.2	85
<b>Un = 28000Vdc Terminal type B Section 350x185 (LxW)</b>				
DLIFM*B#K0585	5.8	315	6.8	14
DLIFM*B#K0905	9	410	5.9	22
DLIFM*B#K0126	12	500	5.5	30
DLIFM*B#K1555	15.5	595	5.2	39
DLIFM*B#K1835	18.3	685	5.1	46
DLIFM*B#K2155	21.5	770	5.1	54
<b>Un = 32000Vdc Terminal type B Section 695x185 (LxW)</b>				
DLIFM*B#L1285	12.8	315	11.2	32
DLIFM*B#L0206	20	410	8.8	43
DLIFM*B#L0276	27	500	7.9	54
DLIFM*B#L0346	34	595	7.4	63
DLIFM*B#L0416	41	685	7.1	73
DLIFM*B#L0476	47	770	6.9	80
<b>Un = 36000Vdc Terminal type C Section 695x185 (LxW)</b>				
DLIFM*C#M0905	9	315	13.5	27
DLIFM*C#M1425	14.2	410	10.5	37
DLIFM*C#M1935	19.3	500	9.3	46
DLIFM*C#M2485	24.8	595	8.6	56
DLIFM*C#M0306	30	685	8.2	64
DLIFM*C#IM3555	35.5	770	7.9	72
<b>Un = 42000Vdc Terminal type C Section 520x185 (LxW)</b>				
DLIFM*C#N0355	3.5	315	10	13
DLIFM*C#N0565	5.6	410	8	21
DLIFM*C#N0775	7.7	500	7.2	29
DLIFM*C#N0985	9.8	595	6.9	37
DLIFM*C#N0126	12	685	6.7	45
DLIFM*C#N0146	14	770	6.6	52
<b>Un = 56000Vdc Terminal type C Section 695x185 (LxW)</b>				
DLIFM*C#O0265	2.6	315	11.6	13
DLIFM*C#O0425	4.2	410	9.2	21
DLIFM*C#O0575	5.7	500	8.3	28
DLIFM*C#O0735	7.3	595	7.8	34
DLIFM*C#O0885	8.8	685	7.5	40
DLIFM*C#O1035	10.3	770	7.4	45

\* Section 350x185: Insert section and option (1 or 2)  
 \* Section 520x185: Insert section and option (3 or 4)  
 \* Section 695x185: Insert section and option (5 or 6)  
 # Insert **W** (without) or **M** (brackets) for fixing

# FILFIM PRODUCTS

## FILFIM 6500Vdc to 56000Vdc



### CALCULATION FORM

#### Specification

Capacitance	C (μF)	
Working voltage	U <sub>w</sub> (V)	
Rms current	I <sub>rms</sub> (A <sub>rms</sub> )	
Frequency	f (Hz)	
Ripple voltage	U <sub>r</sub> (V)	
Ambient temperature	θ <sub>amb</sub> (°C)	
Lifetime @ V <sub>w</sub> , I <sub>rms</sub> and θ <sub>amb</sub>	hours	
Parasitic inductance	L (nH)	
Cooling conditions		

#### Your Choice

PN		
Capacitance	C (μF)	
Rated voltage	U <sub>n</sub> (V)	
Serial resistance	R <sub>s</sub> (mΩ)	
Thermal resistance between hot spot and case	R <sub>th1</sub> (°C/W)	
Thermal resistance between case and ambient air	R <sub>th2</sub> (°C/W)	

#### Calculations

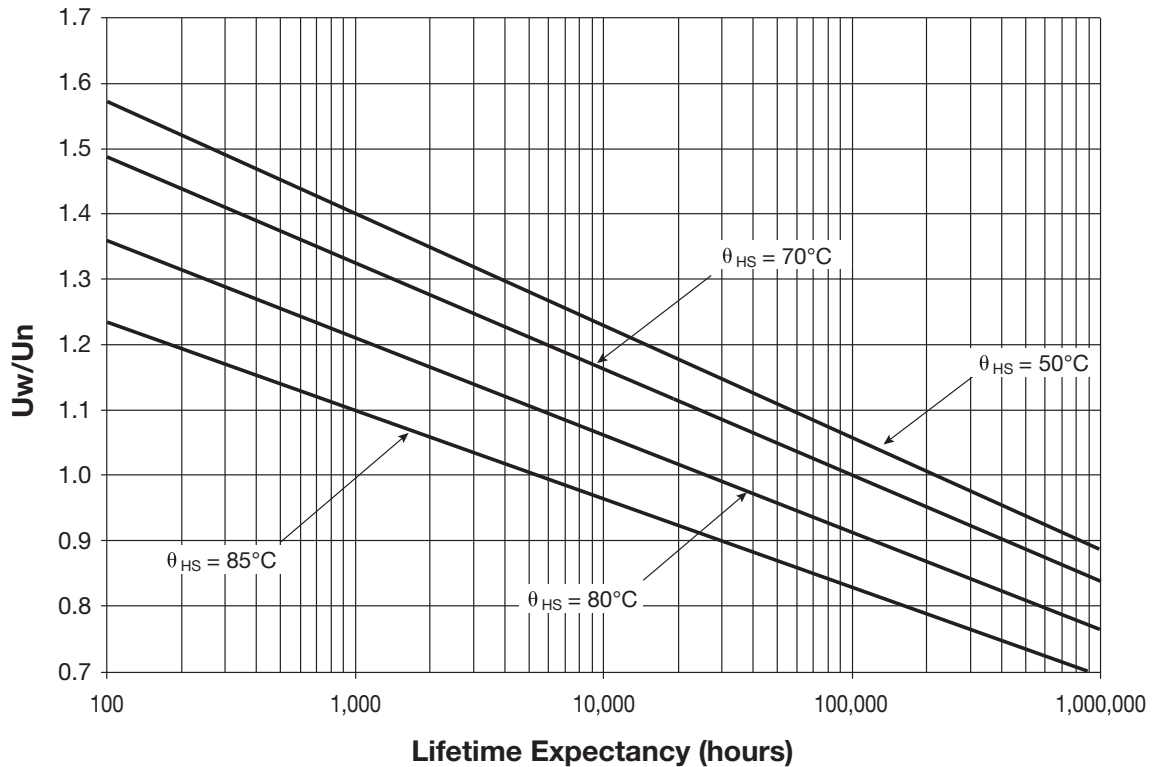
Maximum ripple voltage	U <sub>rmax</sub> = 0.45U <sub>n</sub>	U <sub>rmax</sub> =	V
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The maximum ripple voltage of the selected capacitor must be in any case higher than the ripple voltage of your application

Ratio U <sub>w</sub> /U <sub>n</sub>	ρ = U <sub>w</sub> /U <sub>n</sub>	ρ =	
Joule losses	P <sub>j</sub> = R <sub>s</sub> × I <sub>rms</sub> <sup>2</sup>	P <sub>j</sub> =	W
Dielectric losses	P <sub>d</sub> = Q × tgδ <sub>n</sub> = Q × 3.10 <sup>-4</sup>	P <sub>d</sub> =	W
Hot spot temperature	θ <sub>HS</sub> = θ <sub>amb</sub> + (P <sub>j</sub> + P <sub>d</sub> ) × (R <sub>th1</sub> + R <sub>th2</sub> )	θ <sub>HS</sub> =	°C

The hot spot temperature must be in any case lower than 85°C

### LIFETIME EXPECTANCY VS HOT SPOT TEMPERATURE AND VOLTAGE



Expected lifetime at hot spot calculated and U = U<sub>w</sub>



# FILFIM PRODUCTS

## FILFIM 6500Vdc to 56000Vdc



This questionnaire lists the information we require to prepare an offer according to your exact requirements

Company / Name / Email	Project / Quantity
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Applications	DC Filtering		Discharge*		Protection*		Tuning
Capacitance (µF)							
Tolerance (%)							
Operating Voltage	Vpeak		Vch		Vpeak	Vdc	Vrms
Ripple Voltage (peak to peak)	V						
Working Frequency (Hz)							
Operating Current	Arms		Apeak		Arms		Arms
Maximum Current/Duration	Arms	s			Apeak		
Discharge			Aperiodic	Oscillatory			
Pulse Duration (5% Ipeak)							
Time to Ipeak (µs)							
Ringing Frequency (Hz)							
Reversal Voltage (%)							
Repetition Rate			shots/min/hour/day		Hz		
Hold Time @ Full Voltage (s)							
Fault Peak Current / nb shots	Apeak	shots	Apeak	shots			
Fault Reversal Voltage (%)							
Lifetime Expectancy	hours		shots		hours		hours
Maximum Inductance (nH)							
Test Voltage between Terminals (V)							
Test Voltage between Shorted Terminals and Case (V)							
Maximum Surge Voltage (MSV)							
MSV Duration / Frequency	s	/year			s	/year	

\*Due to the particularities of varying waveforms in such application, more information on the exact nature of waveform is generally required for a full analysis.

Description			
Dimensions (mm) / Shape		Operating Position	Terminals
Section:	Height:	vertical, horizontal inclined, upside down	type
rectangular, cylindrical			quantity

Thermal Characteristics				
Storage Temperature (°C)		Operating Temperature (°C)		Cooling Method
min.		min.		Natural Convection
average		average		Forced Air (m/s)
max.		max.		Water

Remarks
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