Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

GENERAL DESCRIPTION

The FFPC series is specifically designed for DC filtering applications such as DC link or resonant filters for voltages up to 3800V.

The safe and reliable ***Controlled Self Healing Technology*** makes this series particularly suitable for power converters in traction, drives and renewable energy areas.

FFPC use a dry solution or a wet solution (without free oil) with polypropylene metallized 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, feel free to contact your local KYOCERA AVX representative.

Rectangular resin filled plastic case (PA66 30% GF) 2 or 4 terminals M12x30mm

STANDARDS

IEC 61071 :	Power electronic capacitors
IEC 61881 :	Railway applications, rolling stock equipment, capacitors for power electronics
IEC 60068-2 :	Environmental testing
UL 94:	Test for Flammability of Plastic Materials for Parts in Devices and Appliances.
EN 45545-2:	Railway applications — Fire protection on railway vehicles Part 2: Requirements for fire behavior of materials and components

HOW TO ORDER

FFPC	2	B	1697	K	°°
Series	**Terminals Numbers** 2 4	**Voltage** B = 800V S = 1900V C = 900V N = 2000V L = 1000V T = 2300V U = 1100V P = 2550V V = 1250V W= 2800V Q = 1350V X = 3000V R = 1500V Y = 3500V M= 1750V Z = 3800V	**Capacitance** EIA code	**Capacitance tolerance** K = ±10%	**Terminal Code** -- = Male Threaded JE = Female Threaded

Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

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 @ 100Hz for continuous operation under natural convection generating 20°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

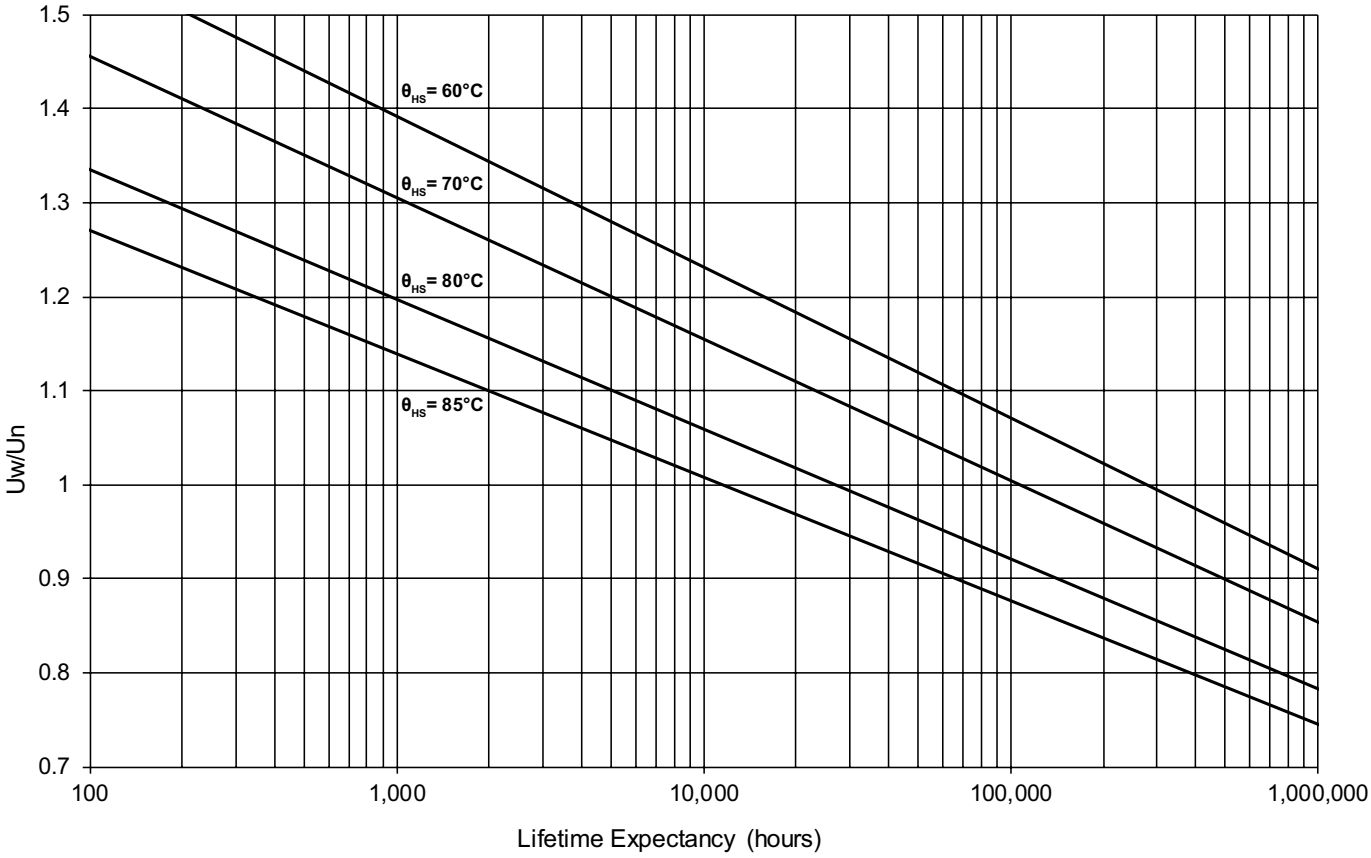
CHARACTERISTICS

Capacitance range C_n	95µF to 5060µF
Tolerance on C_n	±10%
Rated DC voltage U_n	800 to 3800V
Lifetime at Un and 70°C hot-spot temperature and $\Delta C/C<2\%$	100,000h
Typical parasitic inductance L_s	35nH to 85nH
Maximum rms current $I_{rms\,max}$	up to 155A_{rms} for 2 terminals up to 300A_{rms} for 4 terminals
Test voltage between terminals @ 25°C	1.5 x Un for 10s
Test voltage between terminals and Case @ 25°C	9 kV_{rms} @ 50Hz for 10s
Dielectric	polypropylene
Climatic Category	40 / 85 / 56 (IEC 60068)
Working temperature	-40°C / +85°C (according to the power dissipated)
Storage temperature	-40°C / +85°C
Calorific value	40 MJ/kg

Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

LIFETIME EXPECTANCY VS HOT SPOT TEMPERATURES



HOW TO CHOOSE 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 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.

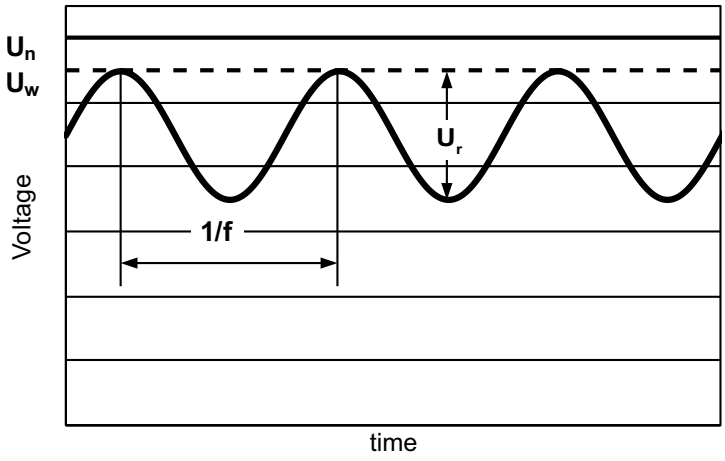
Calculate the maximum ripple voltage allowed for the selected cap : $U_{rmax} = 0{,}2U_n$

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

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

Copy out:

- serial resistance (R_s) : see table of values
- hermal resistance R_{th} : see table of values



Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

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: $P_d = Q \times tg\delta o$ with

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

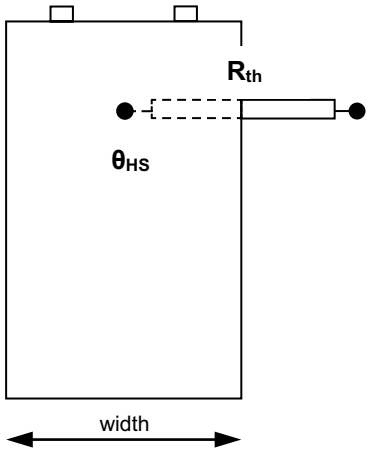
- $tg\delta o = 2 \times 10^{-4}$ (dielectric losses of polypropylene)

Hot spot temperature will be:
$\Theta_{HS} = \Theta_{amb} + (P_j + P_d) \times R_{th}$

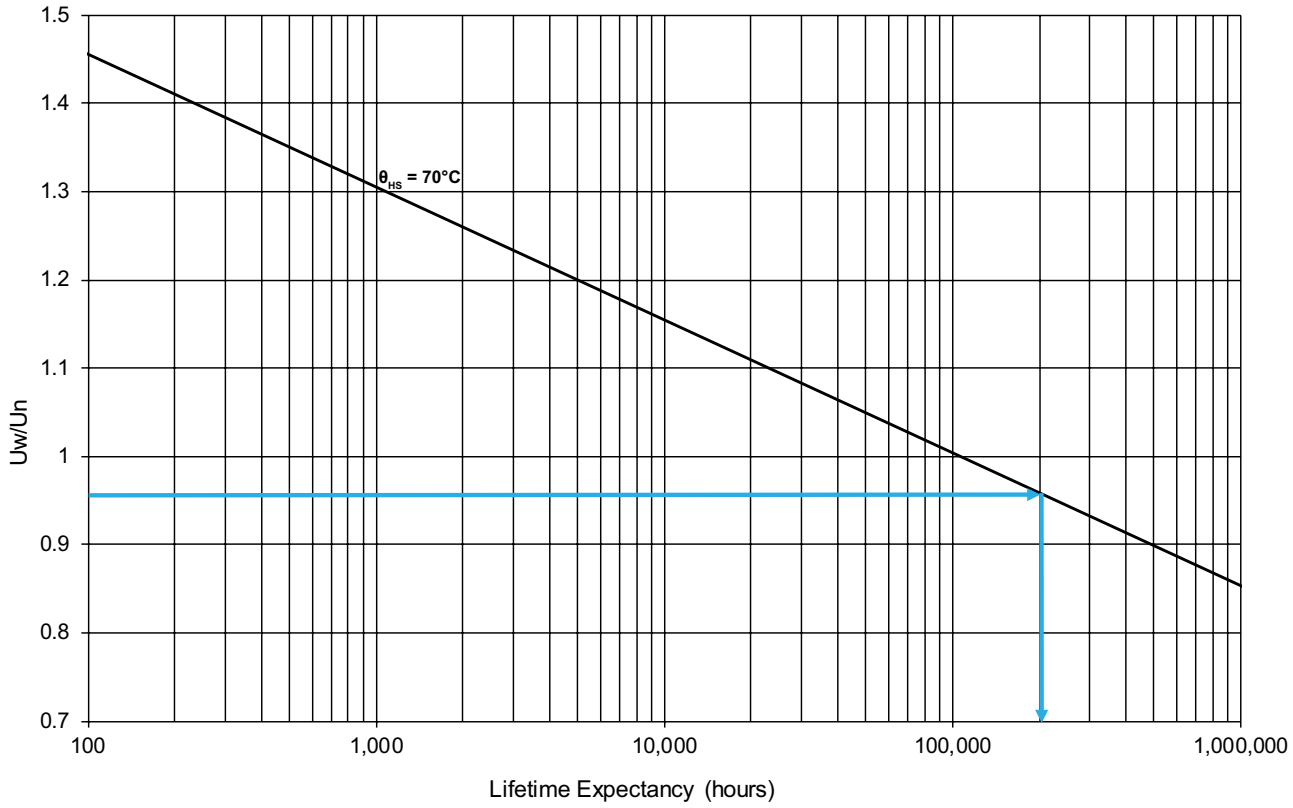
θHS absolute maximum is 85°C

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

R_{th}: thermal resistance between hot spot and ambient air



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



Eg: rated voltage 2000V

working voltage 1900V

$\rho = U_w / U_n = 0{,}95$ lifetime is 200 000hours @ 70°C hot spot temperature

You will find a calculation form at the end of the catalogue

Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

THERMAL RESISTANCE

R_{th} (°C/W): Thermal resistance between hot spot and ambient temperatures (Natural air cooling)

Height (mm)	R_{th} (°C/W)
109	2,9
187	2,2
262,5	1,4

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

PARASITIC INDUCTANCE

Measurement @ 1MHz

Height (mm)	Typical Ls (nH)	
	2 terminals	4 terminals
109	45	35
187	65	55
262,5	85	75

MTBF CALCULATION

The failure rate λ_B depends on hot spot temperature Θ_{HS} and charge ratio ρ.
$\rho = U_w/U_n$

$$\lambda_B \text{ in failures/hour} = 3x10^{2,75(\rho-1)} \times e^{\left(3,2\left(\frac{\theta_{HS}+273}{358}\right)^{30}\right)} x10^{-9}$$

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 π_Q
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 π_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 π_B
Favorable	1
Unfavorable	5

MEAN TIME BETWEEN FAILURE (MTBF)

MTBF = 1/λ hours

SURVIVAL FUNCTION

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

N is the number of pieces sill working after t hours
N_0 is the number of pieces at the origin (t=0)

FAILURE MODE

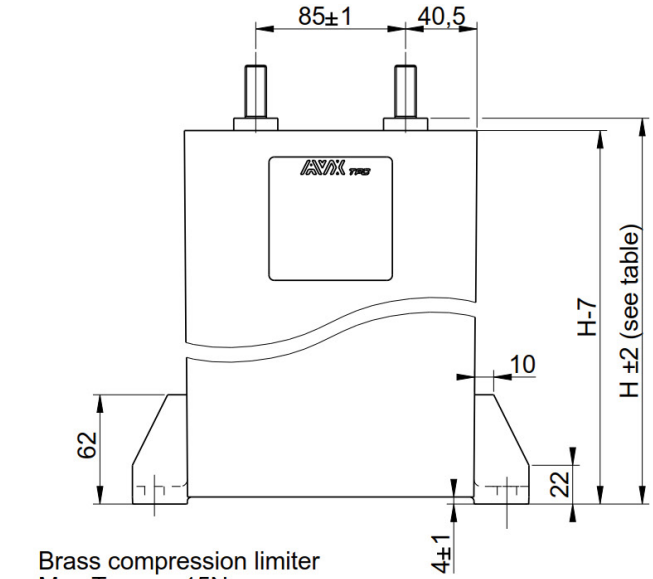
Main failure mode due to KYOCERA AVX's **Controlled Self-Healing Technology** is only losses of capacitance.

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.**

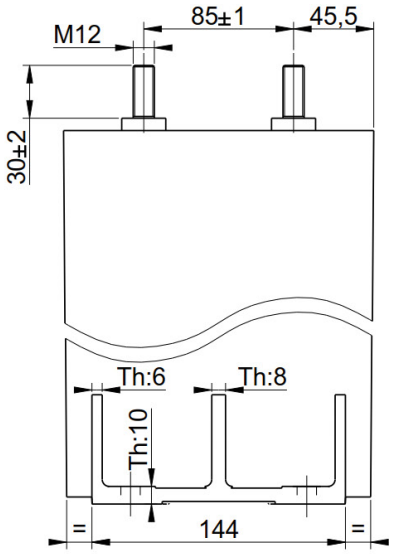
Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

MALE TERMINALS VERSION DIMENSIONS

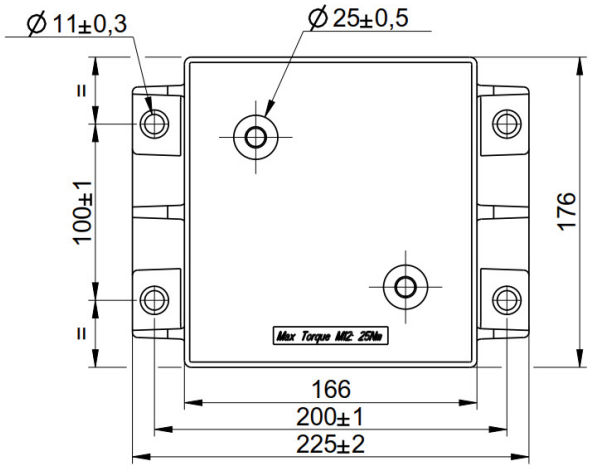


Brass compression limiter
Max Torque: 15Nm



Max Torque M12: 25Nm

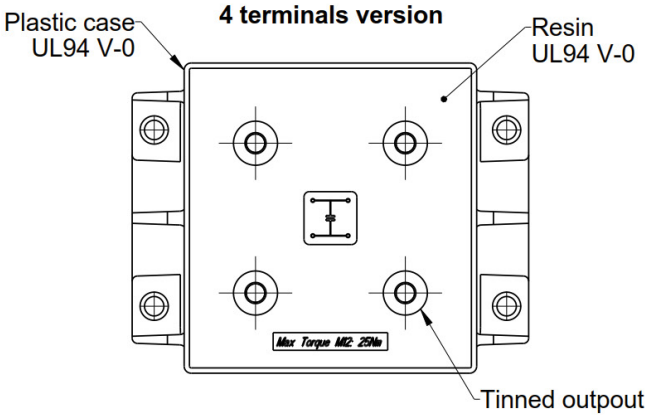
General tolerances: ±3



H (mm)	Weight (Kg)
109	4.2
187	6.8
262.5	9.3

Distance terminals to terminals	
Terminals number	Creepage and clearance (mm)
2	93
4	58

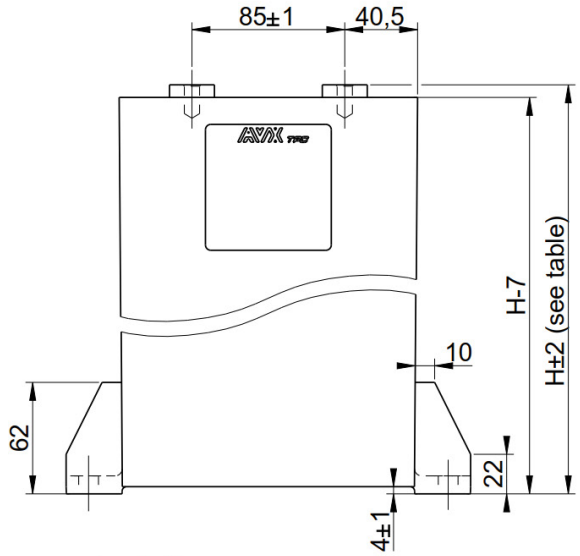
4 terminals version

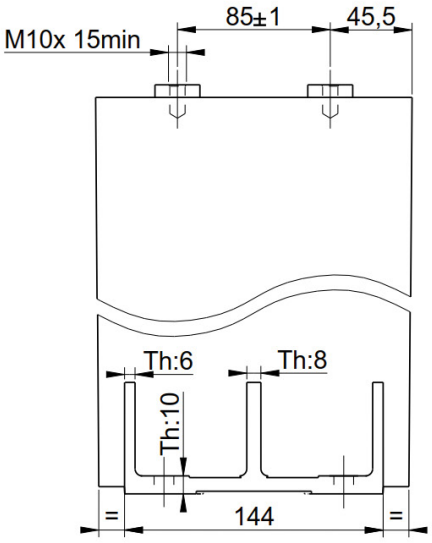


Medium Power Film Capacitors

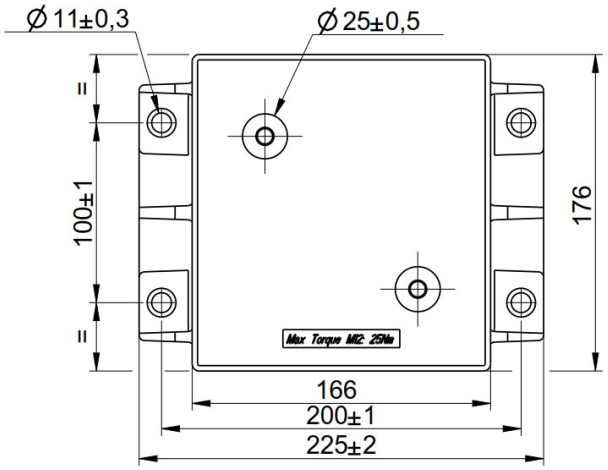
FFPC 800Vdc to 3800Vdc

FEMALE TERMINALS VERSION DIMENSIONS





Brass compression limiter
Max Torque: 15Nm

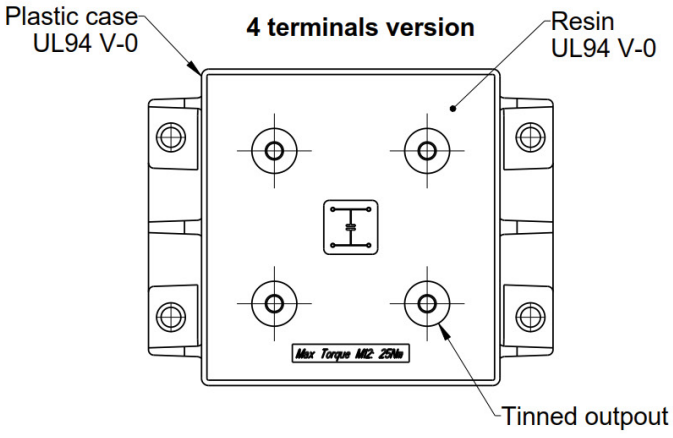


Max Torque M10: 15Nm

General tolerances: ±3

H (mm)	Weight (Kg)
109	4.2
187	6.8
262.5	9.3

Distance terminals to terminals	
Terminals number	Creepage and clearance (mm)
2	93
4	58



Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

TABLE OF VALUES

Part Number	U_n (Vdc)	C (µF)	H (mm)	R_s (mΩ)	I_{rms} (A)
FFPC*B1697K°°	800	1690	109	1,50	65
FFPC*B3377K°°	800	3370	187	0,78	103
FFPC*B5067K°°	800	5060	262,5	0,56	155
FFPC*C1367K°°	900	1360	109	1,67	61
FFPC*C2727K°°	900	2720	187	0,87	97
FFPC*C4087K°°	900	4080	262,5	0,61	146
FFPC*L1127K°°	1000	1120	109	1,83	58
FFPC*L2237K°°	1000	2230	187	0,95	92
FFPC*L3357K°°	1000	3350	262,5	0,67	139
FFPC*U0907K°°	1100	900	109	2,05	54
FFPC*U1797K°°	1100	1790	187	1,06	87
FFPC*U2687K°°	1100	2680	262,5	0,74	131
FFPC*V0697K°°	1250	690	109	2,32	50
FFPC*V1387K°°	1250	1380	187	1,19	81
FFPC*V2067K°°	1250	2060	262,5	0,83	123
FFPC*Q0627K°°	1350	620	109	2,44	49
FFPC*Q1247K°°	1350	1240	187	1,26	78
FFPC*Q1857K°°	1350	1850	262,5	0,87	119
FFPC*R0647K°°	1500	640	109	1,68	57
FFPC*R1287K°°	1500	1280	187	0,88	91
FFPC*R1917K°°	1500	1910	262,5	0,62	137
FFPC*M0477K°°	1750	470	109	1,94	52
FFPC*M0947K°°	1750	940	187	1,01	83
FFPC*M1417K°°	1750	1410	262,5	0,70	126
FFPC*S0417K°°	1900	410	109	2,08	50
FFPC*S0827K°°	1900	820	187	1,08	80
FFPC*S1227K°°	1900	1220	262,5	0,75	121
FFPC*N0367K°°	2000	360	109	2,23	47
FFPC*N0717K°°	2000	710	187	1,15	76
FFPC*N1077K°°	2000	1070	262,5	0,80	116
FFPC*T0287K°°	2300	280	109	2,51	44
FFPC*T0567K°°	2300	560	187	1,29	71
FFPC*T0847K°°	2300	840	262,5	0,89	108
FFPC*P0227K°°	2550	220	109	2,83	40
FFPC*P0437K°°	2550	430	187	1,45	65
FFPC*P0657K°°	2550	650	262,5	1,00	100
FFPC*W0187K°°	2800	180	109	3,12	38
FFPC*W0367K°°	2800	360	187	1,59	61
FFPC*W0537K°°	2800	530	262,5	1,10	93
FFPC*X0157K°°	3000	150	109	3,40	36
FFPC*X0307K°°	3000	300	187	1,74	58
FFPC*X0457K°°	3000	450	262,5	1,19	88
FFPC*Y0117K°°	3500	110	109	1,76	39
FFPC*Y0227K°°	3500	220	187	0,91	63
FFPC*Y0337K°°	3500	330	262,5	0,64	96
FFPC*Z0956K°°	3800	95	109	1,90	37
FFPC*Z0197K°°	3800	190	187	0,98	59
FFPC*Z2856K°°	3800	285	262,5	0,69	91

* Insert terminal number (2 or 4)
°° insert "- -" for male terminals or "JE" for female terminals

Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

CALCULATION FORM

SPECIFICATION

Capacitance	C (µF)	
Working voltage	Uw (V)	
Rms current	Irms (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)	

YOUR CHOICE

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

CALCULATIONS

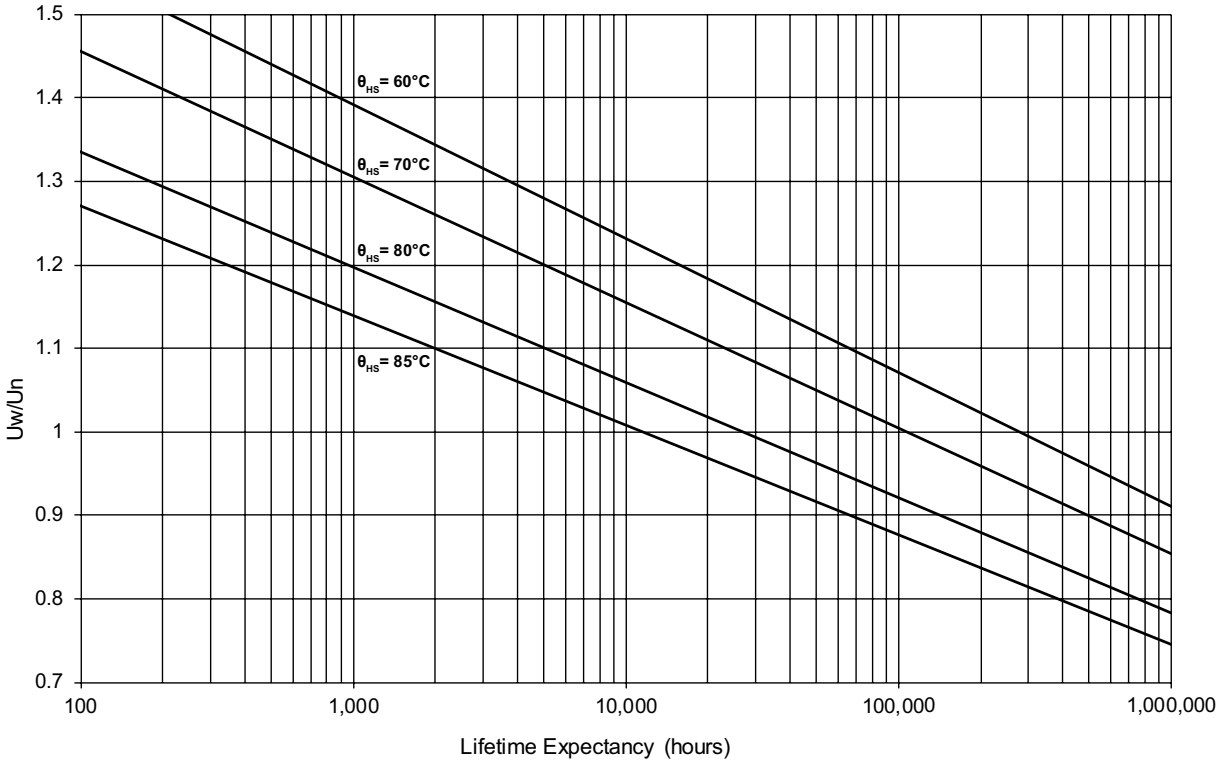
Maximum ripple voltage	$U_{rmax} = 0,2 \times U_n$	Urmax =	V

The maximum ripple voltage of the selected capacitor must be in any case higher than the ripple voltage of your application

Ratio Uw / Un	$\rho = U_w / U_n$	ρ =	
Joule losses	$P_j = R_s \times I_{rms}^2$	P_j =	W
Dielectric losses	$P_d = Q \times tg\delta_0 = Q \times 2.10^{-4}$	P_d =	W
Hot spot temperature	$\Theta HS = \Theta_{amb} + (P_j + P_d) \times R_{th}$	ΘHS =	°C

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

LIFETIME EXPECTANCY VS HOT SPOT TEMPERATURE



Expected lifetime at hot spot calculated and $U=U_w$	

Medium Power Film Capacitors

FFPC 800Vdc to 3800Vdc

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

Company / Name / Email	Project / Quantity

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	/years			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	Terminas	
Section: Height rectangular, cylindrical	vertical, horizontal, inclined, and upside down	Type	Quantity

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

Архангельск (8182)63-90-72
Астана (7172)727-132
Астрахань (8512)99-46-04
Барнаул (3852)73-04-60
Белгород (4722)40-23-64
Брянск (4832)59-03-52
Владивосток (423)249-28-31
Волгоград (844)278-03-48
Вологда (8172)26-41-59
Воронеж (473)204-51-73
Екатеринбург (343)384-55-89
Иваново (4932)77-34-06
Ижевск (3412)26-03-58
Иркутск (395)279-98-46
Казань (843)206-01-48
Калининград (4012)72-03-81
Калуга (4842)92-23-67
Кемерово (3842)65-04-62
Киров (8332)68-02-04
Краснодар (861)203-40-90
Красноярск (391)204-63-61
Курск (4712)77-13-04
Липецк (4742)52-20-81
Киргизия (996)312-96-26-47
Магнитогорск (3519)55-03-13
Москва (495)268-04-70
Мурманск (8152)59-64-93
Набережные Челны (8552)20-53-41
Нижний Новгород (831)429-08-12
Новокузнецк (3843)20-46-81
Новосибирск (383)227-86-73
Омск (3812)21-46-40
Орел (4862)44-53-42
Оренбург (3532)37-68-04
Пенза (8412)22-31-16
Россия (495)268-04-70
Пермь (342)205-81-47
Ростов-на-Дону (863)308-18-15
Рязань (4912)46-61-64
Самара (846)206-03-16
Санкт-Петербург (812)309-46-40
Саратов (845)249-38-78
Севастополь (8692)22-31-93
Симферополь (3652)67-13-56
Смоленск (4812)29-41-54
Сочи (862)225-72-31
Ставрополь (8652)20-65-13
Казахстан (772)734-952-31
Сургут (3462)77-98-35
Тверь (4822)63-31-35
Томск (3822)98-41-53
Тула (4872)74-02-29
Тюмень (3452)66-21-18
Ульяновск (8422)24-23-59
Уфа (347)229-48-12
Хабаровск (4212)92-98-04
Челябинск (351)202-03-61
Череповец (8202)49-02-64
Ярославль (4852)69-52-93