Operational life time section

LIFE TIME CALCULATION OF RIFA ELECTROLYTIC CAPACITORS

P_{LOSS} = I_{RMS}^2 x ESR
P_{LOSS} = Power losses in the capacitor
I_{RMS} = Ripple current

ESR = Equivalent serie resistance
T_h = T_a + P_{LOSS} x R_{th}
T_h = Hot spot temperature

T_a = Ambient temperature
R_{th} = Thermal resistance
A = Expected life time at 85°C hotspot temperature (hours)

$$L_{OP} = \text{Expected life time} = A \times 2^{\frac{85-T_h}{C}} \text{ hours}$$

Capacitor	Diameter	A	C
PEG124	10	36000	11
	13	43000	11
	16	65000	11
	20	97000	11
PEG 126	16	64000	12
	20	85000	12
PEG 220, PEG 225, PEG 226	16	64000	12
	20	85000	12
PEH 532	22-40	6500	12
PEH 534	22-40	13000	12
PEH 536	22-40	19500	12
PEH 506	22-40	6000	12
PEH 526	25-35	63000*	12
PEH 169	35	29000	12
	50	35000	12
	65	44000	12
	75	58000	12
	90	78000	12
PEH 200	35	20000	12
	50	24000	12
	65	30000	12
	75	40000	12
	90	60000	12

* = L_{OP} (125°C) limited to 4000h

Capacitor		Max T_a	Max T_h at Max T_a
PEG 124	125°C	125°C	129°C
	105°C	105°C	108°C
PEG 126	150°C	150°C	151°C
PEG 220, PEG 225, PEG 226	150°C	150°C	151°C
PEH 532	105°C	105°C	110°C
PEH 534	105°C	105°C	110°C
PEH 536	105°C	105°C	110°C
PEH 506	85°C	85°C	97°C
PEH 526	125°C	125°C	129°C
PEH 169	85°C	85°C	100°C ($U_R \leq$ 420 VCD)
	85°C	85°C	95°C (U_R = 450 VDC)
	105°C	105°C	112°C
PEH 200	85°C	85°C	100°C
	105°C	105°C	110°C

Note: Operational life time for BHC types can be found in separate application notes, TD003

CALCULATION EXAMPLE, PEH 200

Article No: PEH200OO427AMB2

Input: Ambient temperature = 70°C
Ripple current = 30A (10kHz)
ESR (85°C, 10 kHz) = 5.8 mΩ
Thermal resistance R_{th} = 2.6°C/W

Calculation: $P_{LOSS} = I_{RMS}^2 \times ESR = 30^2 \times 5.8 \times 10^{-3} = 5.3$ W
Hot spot temp. $T_h = T_a + R_{th} \times P_{LOSS} = 70 + 2.6 \times 5.3 = 84$°C
The assumption of hot-spot temp 85°C when we get ESR was OK!

Output: Expected Life time $L_{OP} = 30000 \times 2^{\frac{85-84}{12}} = 31$k hours

Remark! ESR (T_h, f) values, of a given article number, is available upon request. Please contact customer support.

Equivalent series resistance factor k as a function of frequency and winding hot-spot temperature.
k=ESR (T_{hs},f)/ESR(20°C, 100Hz) ESR(20°C, 100Hz) = 26 mΩ (Maximum value)
18 mΩ (Typical value)

Freq. f	Hot-spot temperature T_h (°C)													
kHz	-40	-30	-20	-10	0	10	20	30	40	50	60	70	85	100
0.050	13.0	7.9	4.9	3.1	2.2	1.7	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.7
0.100	12.5	7.4	4.4	2.6	1.7	1.2	1.0	0.93	0.89	0.88	0.88	0.88	0.91	0.95
0.200	12.2	7.2	4.1	2.4	1.4	0.96	0.75	0.66	0.61	0.58	0.56	0.56	0.56	0.58
0.300	12.2	7.1	4.0	2.3	1.3	0.88	0.66	0.57	0.52	0.48	0.46	0.45	0.45	0.45
0.400	12.1	7.1	4.0	2.2	1.3	0.84	0.62	0.52	0.47	0.43	0.41	0.39	0.39	0.39
0.500	12.1	7.0	4.0	2.2	1.3	0.81	0.60	0.50	0.44	0.40	0.38	0.36	0.35	0.36
0.600	12.1	7.0	3.9	2.2	1.3	0.80	0.58	0.48	0.42	0.38	0.35	0.34	0.33	0.33
0.800	12.1	7.0	3.9	2.2	1.2	0.78	0.56	0.46	0.40	0.36	0.33	0.31	0.30	0.30
1.000	12.0	7.0	3.9	2.2	1.2	0.76	0.55	0.44	0.39	0.34	0.31	0.29	0.28	0.28
2.000	12.0	7.0	3.9	2.1	1.2	0.74	0.52	0.42	0.36	0.31	0.28	0.26	0.25	0.24
5.000	12.0	6.9	3.9	2.1	1.2	0.72	0.51	0.40	0.34	0.30	0.26	0.24	0.23	0.22
10.000	12.0	6.9	3.9	2.1	1.2	0.72	0.50	0.40	0.34	0.29	0.26	0.23	0.22	0.21
20.000	12.0	6.9	3.9	2.1	1.2	0.71	0.50	0.39	0.33	0.29	0.25	0.23	0.22	0.21
50.000	12.0	6.9	3.9	2.1	1.2	0.71	0.50	0.39	0.33	0.29	0.25	0.23	0.21	0.21
100.000	12.0	6.9	3.9	2.1	1.2	0.71	0.50	0.39	0.33	0.29	0.25	0.23	0.21	0.21

CALCULATION EXAMPLE, PEG 22X (PEG 220, PEG 225, PEG 226)

Article No: PEG 226KL4270Q

Input data: Capacitor case temperature T_c = 125°C
Ripple current = 27.9 A (≥ 5 kHz)
ESR (125°C, 5 kHz) = 6.7 mΩ
(see catalogue sheet)
Thermal resistance R_{thhc} = 2.4°C/W
(Hot-spot to case, see table)

Calculation: $P_{LOSS} = I_{RMS}^2 \times ESR = 27.9^2 \times 6.7 \times 10^{-3} = 5.2$ W
Hot spot temp. $T_h = T_a + R_{thhc} \times P_{LOSS} =$
$125 + 2.4 \times 5.2 = 137.5$°C

Output: Expected Life time, $L_{OP} = 85$ kh $\times 2^{\frac{85-137.5}{12}} =$
4.1 k hours

See table on page 148 (parameter "A")

Max allowed hot-spot temperature, continuous operation:
$T_{h\,max} = 0.5 \times T_C + 75$[°C] (heat-sinked)
$T_h - T_C$ = max 15 °C
$T_{h\,max} = 0.5 \times T_a + 75$[°C] (**not** heat-sinked)
$T_h - T_a$ = max 40 °C

Thermal parameters , PEG220, PEG225 and PEG226:

Article	C_{thw} (J/°C)	C_{thc} (J/°C)	C_{thtot} (J/°C)	Internal Thermal Res. R_{thhc} (C/W)	Typ Natural Conv. R_{thca} (C/W)	Typ. Heat Heat Sinked R_{thcc} (C/W)
PEG 22X F-Case	5.8	2.2	8.0	3.5	26	2.0
PEG 22X G-Case	8.0	2.5	10.4	3.5	21	2.0
PEG 22X H-Case	10.0	3.4	13.4	2.4	21	1.5
PEG 22X J-Case	14.0	4.1	18.2	2.4	18	1.5
PEG 22X L-Case	18.4	4.6	23.0	2.4	16	1.5

ESR correction factor, vs. frequency [ESR / ESR (5kHz, 125°C)]

	Frequency			
	100 Hz	300 Hz	1 kHz	≥5 kHz
Correction factor (Corr)	8.0	3.0	1.5	1.0

ESR correction factor, vs. temperature [ESR / ESR (5kHz, 125°C)]

	Temperature			
	-10°C	60°C	105°C	125°C
Correction factor (Corr)	4.4	1.3	1.1	1.0