Axial and Radial Aluminum Electrolytic Capacitors

Up to 150°C for Demanding Vehicular, Lighting and Other Long-Life Applications

One world. One KEMET.

Electronic Components
KEMET
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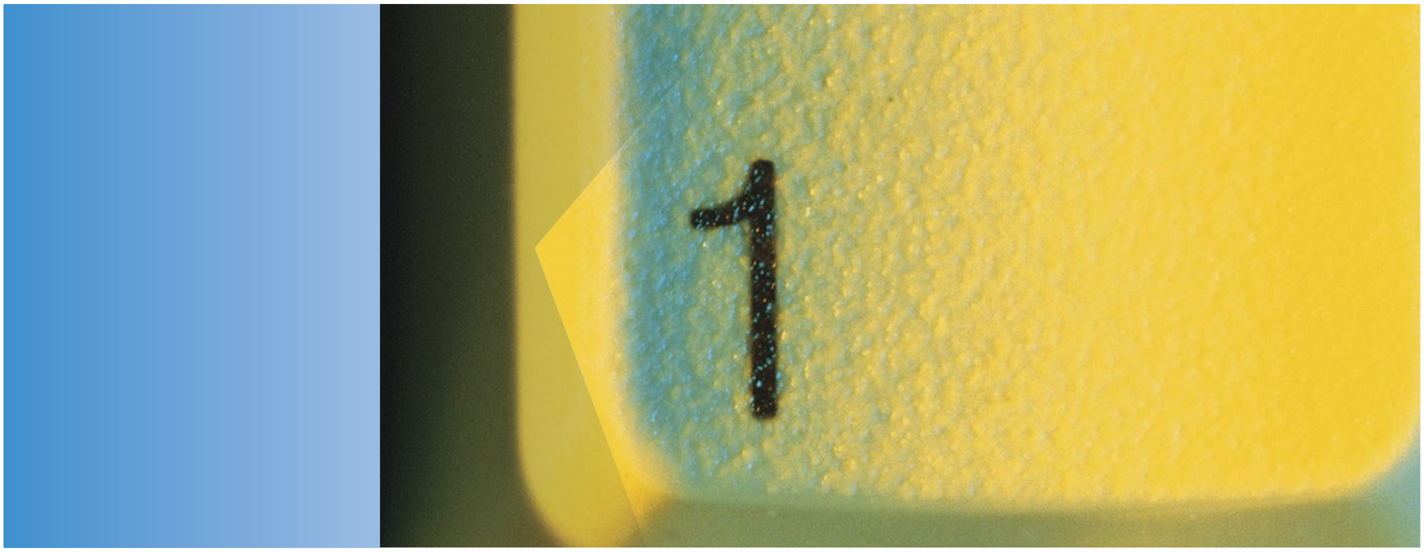


One world. One source. One KEMET.

When you partner with KEMET, our entire global organization provides you with the coordinated service you need. No bouncing from supplier to supplier. No endless phone calls and web browsing. We're your single, integrated source for electronic component solutions worldwide.

Less hassles. More solutions.

Our commitment to product quality and on-time delivery has helped customers succeed for over 90 years. There's a reason KEMET components can be found in defense and aerospace equipment. Our reputation is built on a history of consistency, reliability and service.

The "Easy-to-Buy-From" company.

KEMET offers a level of responsiveness that far surpasses any other supplier. Our passion for customer service is evident throughout our global sales organization, which offers localized support bolstered by our worldwide logistics capabilities. Whether you need rush samples, technical assistance, in-person consultation, accelerated custom design, design collaboration or prototype services, we have a solution.

Made for you.

When you need custom products delivered on a tight schedule, you can trust KEMET. Get direct design consultation from global experts, who help you get the job done on time and within budget.

Working for a better world.

KEMET is dedicated to economically, environmentally and socially sustainable development. We've adopted the Electronic Industry Code of Conduct (EICC) to address all aspects of corporate responsibility. Our manufacturing facilities have won numerous environmental excellence awards and recognitions, and our supply chain is certified. We believe doing the right thing is in everyone's interest.

About KEMET.

KEMET Corporation is a leading global supplier of electronic components. We offer our customers the broadest selection of capacitor technologies in the industry across multiple dielectrics, along with an expanding range of electromechanical devices, and electromagnetic compatibility solutions. Our vision is to be the preferred supplier of electronic component solutions for customers demanding the highest standards of quality, delivery and service.

Axial Aluminum Electrolytic Capacitors

PEG124 Series, +105ºC and +125ºC

Overview

KEMET's PEG124 is an electrolytic capacitor with very long-life and outstanding electrical performance. The device has a polarized all-welded design, tinned copper wire leads, a negative pole connected to the case, and plastic insulation. long-life and very high reliability are achieved by dimensioning of the capacitor, careful selection of materials/methods and discipline in quality control allowing operation up to +125°C/+105°C.

The PEG124 winding is housed in a cylindrical aluminum can with a high purity aluminum lid and high quality rubber gasket. The sealing system is designed for electrolyte leakage-free operation and a very low gas-diffusion rate of electrolyte. Low ESR is the result of a low resistive electrolyte/paper system and an all-welded design. Thanks to its mechanical robustness, the PEG124 is also suitable for use in mobile and aircraft installations.

Benefits

- Operating temperature of +125°C and +105°C
- Long life, up to 27,500 hours at +105°C
- Low ESR
- Low ESL

Applications

KEMET's PEG124 is a high performance axial electrolytic capacitor. Typical applications include smoothing, coupling/decoupling and energy storage in telecommunication, power supply system, data processing, process control and measuring where long life and high reliability are of paramount importance.

Part Number System

PEG124	E		F	410	0	Q	T1
Series	Voltage (VDC)		Size Code	Capacitance Code (µF)	Version	Capacitance Tolerance	Packaging
Axial Aluminum Electrolytic	E= 10 G = 16 H = 25 K = 40 M = 63	P = 100 R = 200 U = 350 V = 400 Y = 450	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	0 = Standard A-Z = High Performance	Q = -10 +30% M = ±20%	See Ordering Options Table

Performance Characteristics

Item	Performance Characteristics	
Capacitance Range	1 – 4,700 µF	1 – 470 µF
Rated Voltage	10 – 63 VDC	100 – 450 VDC
Operating Temperature	-40 to +125°C	-40 to +105°C
Capacitance Tolerance	-10/+30%, (-10/+50%, ±20% select values) at 100 Hz/+20°C	
Operational Lifetime	27,500 hours at +105°C (hours, D = 20 mm)	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC +40°C 10 years O VDC	
Leakage Current	I = 0.01 CV (µA, CV ≤ 1,000) I = 0.003 CV + 4000 (µA, CV > 1,000)	I = 0.006 CV + 4,000 (µA)
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	0.75 mm displacement amplitude or 10 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 500 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56	

Compensation Factor of Ripple Current (RC) vs. Frequency

Frequency	300 Hz	1 kHz	5 kHz	100 kHz
Coefficient	0.57	0.80	1.00	1.04

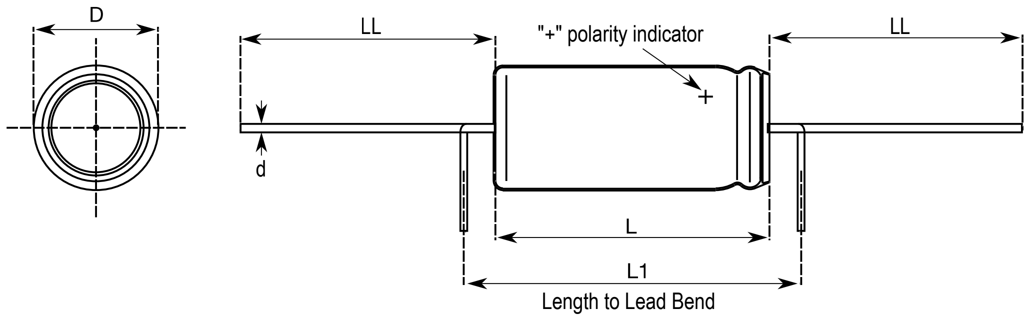
Test Method & Performance

Endurance Life Test		
Conditions	Performance	
Temperature	+125°C	+105°C (≥100 V)
Test Duration	2,000 hours	5,000 hours
Ripple Current	Maximum ripple current specified in table	
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor	
Performance	**The following specifications will be satisfied when the capacitor is tested at +20°C:**	
Capacitance Change	< 160 V	Within 15% of the initial value
	≥ 160 V	Within 10% of the initial value
Equivalent Series Resistance	Does not exceed 200% of the initial value	
Leakage Current	Does not exceed leakage current limit	

Ordering Options Table

Case Size	Packaging Kind	Lead Length (mm)	Lead and Packaging Code
Standard Bulk Packaging Options			
	Bulk (bag)	42 +3/-2	L1
≤ 13 x 37	Tape & Reel	See Dimension Table	T1

Dimensions – Millimeters



Size Code	Dimensions in mm				Bulk	Taped
	D	L	L1	d	LL	LL
	±0.5	±1	Minimum	±0.03	+3/-2	+3/-2
A	10	20.0	26.0	0.8		31
B	10	29.0	35.0	0.8		27
C	13	20.0	26.0	0.8		31
D	13	29.0	35.0	0.8		27
E	13	37.0	43.0	0.8	42	24
F	16	29.0	35.0	0.8	42	
G	16	37.0	43.0	0.8	42	
H	20	29.0	35.0	0.8	42	
J	20	37.0	43.0	0.8	42	
L	20	46.0	52.0	0.8	42	

Shelf Life

The capacitance, ESR and impedance of a capacitor will not change significantly after extended storage periods, however the leakage current will very slowly increase. KEMET products are particularly stable and allow a shelf life in excess of three years at 40°C. See sectional specification under each product series for specific data.

Re-age (Reforming) Procedure

Apply the rated voltage to the capacitor at room temperature for a period of one hour, or until the leakage current has fallen to a steady value below the specified limit. During re-aging a maximum charging current of twice the specified leakage current or 5 mA (whichever is greater) is suggested.

Reliability

The reliability of a component can be defined as the probability that it will perform satisfactorily under a given set of conditions for a given length of time.

In practice, it is impossible to predict with absolute certainty how any individual component will perform; thus, we must utilize probability theory. It is also necessary to clearly define the level of stress involved (e.g. operating voltage, ripple current, temperature and time). Finally, the meaning of satisfactory performance must be defined by specifying a set of conditions which determine the end of life of the component.

Reliability as a function of time, R(t), is normally expressed as: $R(t)=e^{-\lambda t}$
where R(t) is the probability that the component will perform satisfactorily for time t, and λ is the failure rate.

Failure Rate

The failure rate is the number of components failing per unit time. The failure rate of most electronic components follows the characteristic pattern:

- Early failures are removed during the manufacturing process.
- The operational life is characterized by a constant failure rate.
- The wear out period is characterized by a rapidly increasing failure rate.

The failures in time (FIT) are given with a 60% confidence level for the various type codes. By convention, FIT is expressed as 1×10^{-9} failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.
e.g., 100FIT = 1×10^{-7} failures per hour = 0.01%/1,000 hours

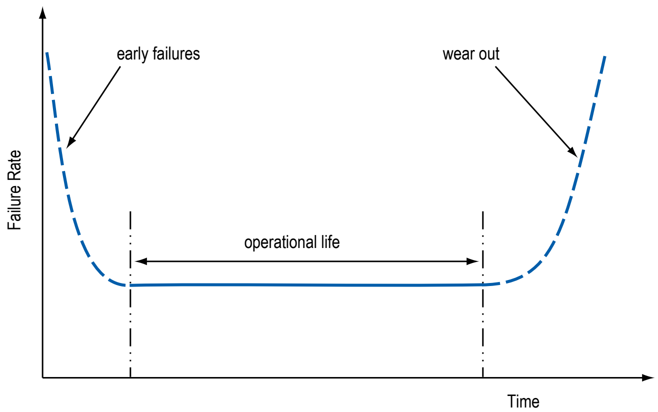
End of Life Definition
Catastrophic Failure: short circuit, open circuit or safety vent operation
Parametric Failure:

- Change in capacitance > ±10%
- Leakage current > specified limit
- ESR > 2 x initial ESR value

Failure Rate cont'd

MTBF

The mean time between failures (MTBF) is simply the inverse of the failure rate.
MTBF= 1/λ



Estimated field failure rate: ≤ 1.0 ppm (Failures per year/produced number of capacitors per year)
The expected failure rate for this capacitor range is based on field experience for capacitors with structural similarity.

Environmental Compliance

As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of some hazardous materials, such as lead (Pb), in electronic equipment. All products in this catalog are produced to help our customers' obligations to guarantee their products and fulfill these legislative requirements. The only material of concern in our products has been lead (Pb), which has been removed from all designs to fulfill the requirement of containing less than 0.1% of lead in any homogeneous material. KEMET will closely follow any changes in legislation world wide and makes any necessary changes in its products, whenever needed.

Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.

RoHS Compliant

Table 1A – Ratings & Part Number Reference

125°C										
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current			ESR		L_{ESL}	Part Number
				Maximum	Rated		Maximum		Approximate	
	100 Hz 20°C (µF)		D x L (mm)	100 Hz 125°C (A)	≥ 5 kHz 60°C (A)	≥ 5 kHz 125°C (A)	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	(nH)	
10	1000	F	16 x 29	1.035	4.6	1.7	200	140	10	PEG124EF4100Q(1)
10	1500	G	16 x 37	1.276	5.6	2.1	140	100	12	PEG124EG4150Q(1)
10	2200	J	20 x 37	1.804	8	2.9	90	60	15	PEG124EJ4220Q(1)
10	3300	L	20 x 46	2.088	8.8	3.2	70	50	17	PEG124EL4330Q(1)
16	68	A	10 x 20	0.13	0.95	0.36	2400	1600	5	PEG124GA2680Q(1)
16	100	A	10 x 20	0.191	1.2	0.45	1700	1100	5	PEG124GA3100Q(1)
16	150	B	10 x 29	0.287	1.5	0.61	1100	710	6	PEG124GB3150Q(1)
16	220	B	10 x 29	0.315	1.5	0.7	800	540	6	PEG124GB3220Q(1)
16	220	C	13 x 20	0.422	3.9	1.4	390	140	6	PEG124GC322AQ(1)
16	330	D	13 x 29	0.515	2.6	1.1	500	330	8	PEG124GD3330Q(1)
16	470	C	13 x 20	0.645	3.9	1.5	250	120	6	PEG124GC347AQ(1)
16	470	D	13 x 29	0.632	3.1	1.1	370	250	8	PEG124GD3470Q(1)
16	680	E	13 x 37	0.851	4.6	1.7	200	120	10	PEG124GE3680Q(1)
16	680	F	16 x 29	0.85	4	1.5	260	180	10	PEG124GF3680Q(1)
16	680	F	16 x 29	1.005	7.6	2.7	130	50	10	PEG124GF368AQ(1)
16	1000	F	16 x 29	1.166	7.6	2.8	110	50	10	PEG124GF410AQ(1)
16	1000	G	16 x 37	1.031	4.8	1.8	190	130	12	PEG124GG4100Q(1)
16	1500	G	16 x 37	1.49	9.3	3.4	70	40	12	PEG124GG415AQ(1)
16	1500	J	20 x 37	1.372	6	2.2	140	100	15	PEG124GJ4150Q(1)
16	2200	G	16 x 37	1.72	9.3	3.4	60	40	12	PEG124GG422AQ(1)
16	2200	L	20 x 46	1.782	8	2.9	90	60	17	PEG124GL4220Q(1)
16	3300	J	20 x 37	2.251	11.8	4.1	40	20	15	PEG124GJ433AQ(1)
16	4700	J	20 x 37	2.685	12.7	5	40	20	15	PEG124GJ447AQ(1)
25	47	A	10 x 20	0.141	1.1	0.44	2400	1300	5	PEG124HA2470Q(1)
25	100	B	10 x 29	0.255	1.5	0.56	1200	670	6	PEG124HB3100Q(1)
25	220	C	13 x 20	0.452	3.1	1.2	460	200	6	PEG124HC322AQ(1)
25	220	D	13 x 29	0.448	2.6	0.96	590	320	8	PEG124HD3220Q(1)
25	330	C	13 x 20	0.525	3.1	1.2	370	200	6	PEG124HC333AQ(1)
25	330	E	13 x 37	0.57	3.4	1.2	360	200	10	PEG124HE3330Q(1)
25	470	F	16 x 29	0.806	4.7	1.7	250	140	10	PEG124HF3470Q(1)
25	470	F	16 x 29	0.827	6.1	2.1	200	80	10	PEG124HF347AQ(1)
25	680	F	16 x 29	0.946	6	2.1	170	80	10	PEG124HF368AQ(1)
25	680	G	16 x 37	0.96	5.3	1.9	190	110	12	PEG124HG3680Q(1)
25	1000	G	16 x 37	1.248	7.8	2.8	110	50	12	PEG124HG410AQ(1)
25	1000	J	20 x 37	1.323	7.4	2.6	120	70	15	PEG124HJ4100Q(1)
25	1500	G	16 x 37	1.437	7.8	2.8	90	60	12	PEG124HG415AQ(1)
25	1500	L	20 x 46	1.659	8.9	3.2	90	50	17	PEG124HL4150Q(1)
25	2200	J	20 x 37	1.803	9.5	3.2	60	40	15	PEG124HJ422BQ(1)
25	3300	J	20 x 37	2.067	9.5	3.3	60	40	15	PEG124HJ433BQ(1)
25	4000	L	20 x 46	2.454	12.3	4.2	40	20	17	PEG124HL440BM(1)
40	33	A	10 x 20	0.153	1.1	0.39	2900	1300	5	PEG124KA2330Q(1)
40	68	B	10 x 29	0.221	1.5	0.56	1400	650	6	PEG124KB2680Q(1)
40	150	C	13 x 20	0.381	3.1	1.2	580	200	6	PEG124KC315AQ(1)
40	150	D	13 x 29	0.416	2.8	1	620	290	8	PEG124KD3150Q(1)
40	220	C	13 x 20	0.452	3.1	1.2	440	200	6	PEG124KC322AQ(1)
40	220	E	13 x 37	0.487	3.5	1.3	440	190	10	PEG124KE3220Q(1)
40	220	F	16 x 29	0.575	3.9	2	410	190	10	PEG124KF3220Q(1)
40	330	F	16 x 29	0.739	6.1	2.1	240	80	10	PEG124KF333AQ(1)
40	330	G	16 x 37	0.692	4.8	1.7	290	130	12	PEG124KG3330Q(1)
40	470	F	16 x 29	0.827	6.1	2.1	200	80	10	PEG124KF347CQ(1)
40	470	J	20 x 37	0.898	6	2.1	220	100	15	PEG124KJ3470Q(1)
40	680	G	16 x 37	1.048	7.7	2.7	130	50	12	PEG124KG368AQ(1)
40	680	J	20 x 37	1.132	7.3	2.6	150	70	15	PEG124KJ3680Q(1)
40	1000	G	16 x 37	1.242	7.8	2.8	110	50	12	PEG124KG410AQ(1)
40	1000	L	20 x 46	1.414	8.8	3.2	100	50	17	PEG124KL4100Q(1)
40	1500	J	20 x 37	1.598	9.5	3.3	70	40	15	PEG124KJ415AQ(1)
40	2200	J	20 x 37	1.9	9.6	3.5	60	40	15	PEG124KJ422AQ(1)
63	10	A	10 x 20	0.076	0.9	0.35	5900	1600	5	PEG124MA2100Q(1)
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current			ESR		L_{ESL}	Part Number

(1) Insert packaging code. See Ordering Options Table for available options.

Roll Over for Order Info.

Table 1A – Ratings & Part Number Reference cont'd

125°C										
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current			ESR		L_{ESL}	Part Number
				Maximum	Rated		Maximum		Approximate	
	100 Hz 20°C (µF)		D x L (mm)	100 Hz 125°C (A)	≥ 5 kHz 60°C (A)	≥ 5 kHz 125°C (A)	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	(nH)	
63	15	A	10 x 20	0.113	1	0.39	4300	1400	5	PEG124MA2150Q(1)
63	22	A	10 x 20	0.134	1.1	0.43	3400	1200	5	PEG124MA2220Q(1)
63	33	B	10 x 29	0.158	1.4	0.53	2200	780	6	PEG124MB2330Q(1)
63	47	B	10 x 29	0.19	1.6	0.57	1600	550	6	PEG124MB2470Q(1)
63	68	D	13 x 29	0.274	2.3	0.89	1100	400	8	PEG124MD2680Q(1)
63	100	D	13 x 29	0.355	3	1	740	260	8	PEG124MD3100Q(1)
63	100	C	13 x 20	0.328	3.1	1	730	220	6	PEG124MC310AQ(1)
63	150	F	16 x 29	0.491	4	1.4	500	180	10	PEG124MF3150Q(1)
63	150	D	13 x 29	0.455	3.6	1.4	460	150	8	PEG124MD315AQ(1)
63	220	F	16 x 29	0.647	6.1	2.1	290	80	10	PEG124MF322AQ(1)
63	220	G	16 x 37	0.61	5	1.8	340	120	12	PEG124MG3220Q(1)
63	330	F	16 x 29	0.737	6.1	2.1	240	80	10	PEG124MF333AQ(1)
63	330	J	20 x 37	0.845	6.8	2.3	220	80	15	PEG124MJ3330Q(1)
63	470	G	16 x 37	0.927	7.5	2.6	170	60	12	PEG124MG347AQ(1)
63	470	L	20 x 46	1.018	7.9	2.9	160	60	17	PEG124ML3470Q(1)
63	680	G	16 x 37	1.09	7.5	2.6	140	60	12	PEG124MG368AQ(1)
63	1000	J	20 x 37	1.399	9.2	3.1	90	40	15	PEG124MJ410AQ(1)
63	1500	L	20 x 46	1.715	10.2	3.5	70	40	17	PEG124ML415AQ(1)
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current			ESR		L_{ESL}	Part Number

(1) Insert packaging code. See Ordering Options Table for available options.

Roll Over for Order Info.

Table 1B – Ratings & Part Number Reference

105°C										
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current			ESR		L_{ESL}	Part Number
				Maximum	Rated		Maximum		Approximate	
	120 Hz 20°C (µF)		D x L (mm)	100 Hz 125°C (A)	≥ 5 kHz 60°C (A)	≥ 5 kHz 125°C (A)	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	(nH)	
100	4.7	A	10 x 20	0.05	0.65	0.20	16000	2800	5	PEG124PA147CQ(1)
100	22	B	10 x 29	0.122	1.24	0.37	3000	1100	6	PEG124PB222VQ(1)
100	47	D	13 x 29	0.206	1.90	0.58	1500	540	8	PEG124PD247VQ(1)
100	47	E	13 x 37	0.192	1.50	0.45	1800	920	10	PEG124PE247CQ(1)
100	100	F	16 x 29	0.354	3.20	0.98	700	260	10	PEG124PF310VQ(1)
100	220	G	16 x 37	0.536	3.60	1.10	500	300	12	PEG124PG322CQ(1)
100	470	L	20 x 46	0.904	6.30	1.90	210	120	17	PEG124PL347VQ(1)
200	5.6	A	10 x 20	0.049	0.38	0.11	20000	10000	5	PEG124RA156BM(1)
200	10	B	10 x 29	0.065	0.47	0.17	10000	4200	6	PEG124RB2100Q(1)
200	15	D	13 x 29	0.096	0.74	0.26	6300	2400	8	PEG124RD2150Q(1)
200	22	D	13 x 29	0.12	0.86	0.31	4600	1900	8	PEG124RD2220Q(1)
200	33	F	16 x 29	0.167	1.20	0.42	3100	1300	10	PEG124RF2330Q(1)
200	47	F	16 x 29	0.21	1.50	0.53	2200	920	10	PEG124RF2470Q(1)
200	68	H	20 x 29	0.294	2.00	0.71	1500	660	12	PEG124RH2680Q(1)
200	100	J	20 x 37	0.353	2.40	0.88	1000	440	15	PEG124RJ3100Q(1)
200	150	L	20 x 46	0.446	3.10	1.10	690	300	17	PEG124RL3150Q(1)
350	4.7	B	10 x 29	0.055	0.37	0.14	17000	7500	6	PEG124UB1470Q(1)
350	6.8	D	13 x 29	0.092	0.59	0.22	9000	4200	8	PEG124UD1680Q(1)
350	10	D	13 x 29	0.102	0.65	0.24	7600	3600	8	PEG124UD2100Q(1)
350	22	F	16 x 29	0.184	1.20	0.44	3300	1500	10	PEG124UF2220Q(1)
350	33	H	20 x 29	0.248	1.60	0.56	2300	1100	12	PEG124UH2330Q(1)
350	47	J	20 x 37	0.328	2.10	0.77	1500	660	15	PEG124UJ2470Q(1)
350	68	L	20 x 46	0.389	2.50	0.91	1100	500	17	PEG124UL2680Q(1)
400	2.2	B	10 x 29	0.042	0.27	0.11	25000	12000	6	PEG124VB1220Q(1)
400	4.7	D	13 x 29	0.078	0.52	0.21	11000	5100	8	PEG124VD1470Q(1)
400	10	E	13 x 37	0.116	0.70	0.26	5900	3000	10	PEG124VE2100Q(1)
400	22	G	16 x 37	0.209	1.40	0.50	2700	1200	12	PEG124VG2220Q(1)
400	33	J	20 x 37	0.304	1.90	0.71	1600	760	15	PEG124VJ2330Q(1)
400	47	L	20 x 46	0.377	2.40	0.89	1200	530	17	PEG124VL2470Q(1)
450	1.0	A	10 x 20	0.03	0.21	0.08	49000	20000	5	PEG124YA1100Q(1)
450	2.2	B	10 x 29	0.043	0.29	0.11	24000	11000	6	PEG124YB1220Q(1)
450	3.3	B	10 x 29	0.055	0.38	0.14	17000	7300	6	PEG124YB1330Q(1)
450	4.7	D	13 x 29	0.079	0.54	0.20	11000	4800	8	PEG124YD1470Q(1)
450	6.8	D	13 x 29	0.097	0.61	0.22	8300	4000	8	PEG124YD1680Q(1)
450	10	F	16 x 29	0.133	0.82	0.40	5700	2800	10	PEG124YF2100Q(1)
450	10	F	16 x 29	0.141	1.40	0.30	4600	1700	10	PEG124YF210AT(1)
450	15	G	16 x 37	0.171	1.10	0.41	3600	1700	12	PEG124YG2150Q(1)
450	15	H	20 x 29	0.185	1.60	0.49	3300	1400	12	PEG124YH215AQ(1)
450	22	H	20 x 29	0.24	1.60	0.56	2400	1100	12	PEG124YH2220Q(1)
450	22	J	20 x 37	0.242	2.30	0.67	2100	800	15	PEG124YJ222AT(1)
450	33	J	20 x 37	0.306	2.00	0.72	1600	740	15	PEG124YJ2330Q(1)
450	47	L	20 x 46	0.377	2.40	0.89	1200	530	17	PEG124YL2470Q(1)
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current			ESR		L_{ESL}	Part Number

(1) Insert packaging code. See Ordering Options Table for available options.

Roll Over for Order Info.

Operational Life PEG124 (+125°C)

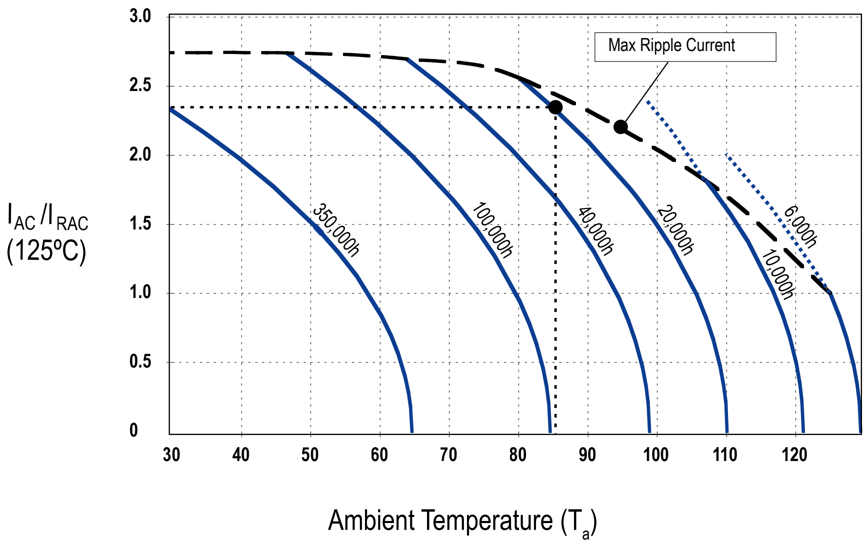
Operational life (L_{op}) at ambient temperature T_a and ripple current I_{AC}.

Diagram valid for 20 mm case size.
Operational life,
- 16 mm case size: 0.67 x diagram value
- 13 mm case size: 0.44 x diagram value
- 10 mm case size: 0.37 x diagram value

Example:
Article: PEG124MG368AQ (16 x 37 mm)
Ambient temperature (T_a): +85°C
Ripple current at 10 kHz (I_{AC}): 6.2 A

I_{RAC} (+125°C, ≥ 5 kHz) = 2.7 A (from data table)
→ I_{AC}/ I_{RAC} (+125°C) = 2.3

Operational life: Interpolation between the
L_{op}-curves → L_{op} ~20 kh x 0.67 = 13 kh (blue curves)



Operational Life PEG124 (+105°C)

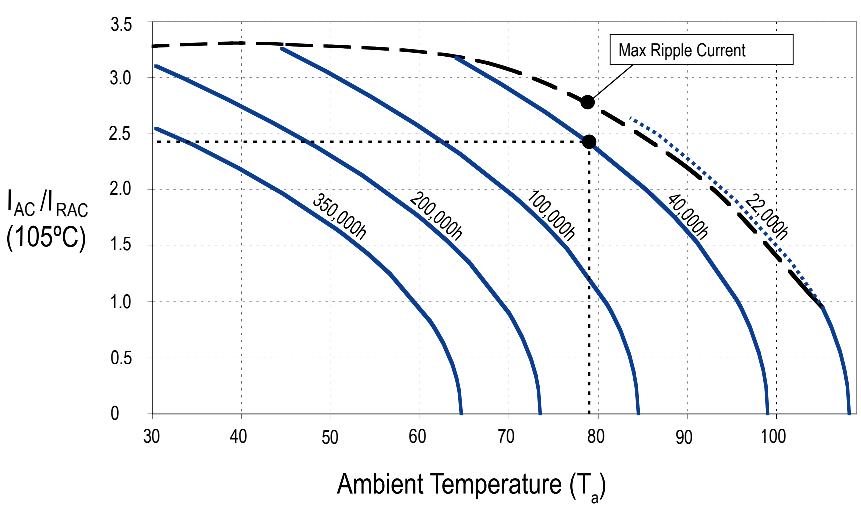
Operational life (L_{op}) at ambient temperature T_a and ripple current I_{AC}.

Diagram valid for 20 mm case size.
Operational life,
- 16 mm case size: 0.67 x diagram value
- 13 mm case size: 0.44 x diagram value
- 10 mm case size: 0.37 x diagram value

Example:
Article: PEG124RL3150Q (20 x 46 mm)
Ambient temperature (T_a): +79°C
Ripple current, at 10 kHz (I_{AC}): 2.7 A

I_{RAC}(105°C, ≥ 5 kHz)= 1.10 A (from data table)
→ I_{AC}/ I_{RAC}(+105°C) = 2.45

Operational life: Interpolation between the
L_{op}-curves → L_{op} ~ 40 kh (blue curves)



Packaging Quantities

Size Code	Packaging Quantities	
	Tape & Reel	Bulk
A	500	250
B	500	200
C	400	250
D	400	200
E	400	150
F		125
G		100
H		150
J		125
L		100

Print Detail

Standard Marking for PEG and PEH types

- KEMET Logo
- Rated capacitance
- Capacitance tolerance
- Rated voltage
- Date code
- Polarity indication
- Article code

PEG126 Series, +150ºC

Overview

KEMET's PEG126 is an electrolytic capacitor with outstanding electrical performance. The device has a polarized all-welded design, tinned copper wire leads, a negative pole connected to the case, and plastic insulation. The PEG126 winding is housed in a cylindrical aluminum can with a high purity aluminum lid and high quality rubber gasket. Low ESR is the result of a low resistive electrolyte/paper system and an all-welded design. Thanks to its mechanical robustness, the PEG126 is suitable for use in mobile and aircraft installations with operation up to +150°C.

Applications

KEMET's PEG126 is a high performance axial electrolytic capacitor. It is designed for automotive applications with high demands on resistance to vibrations and high ambient temperature.

Benefits

- 1,500 hours at +150°C
- Resistance to vibrations
- Low ESR
- High ripple capability

Part Number System

PEG126	H	F	368	E	Q	E1
Series	Voltage (VDC)	Size Code	Capacitance Code (µF)	Version	Capacitance Tolerance	Packaging
Axial Aluminum Electrolytic	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	E = Standard	Q = -10 +30% M = ±20%	E1 = Bulk

Performance Characteristics

Item	Performance Characteristics	
Capacitance Range	250 – 4,000 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +150°C	
Capacitance Tolerance	-10/+30%, (±20% select values) at 100 Hz/+20°C	
Operational Lifetime	D (mm)	+125°C (hours)
	16	6,500
	20	8,500
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56, AEC-Q200	

Compensation Factor of Ripple Current (RC) vs. Frequency

Frequency	300 Hz	1 kHz	5 kHz	100 kHz
Coefficient	0.57	0.80	1.00	1.04

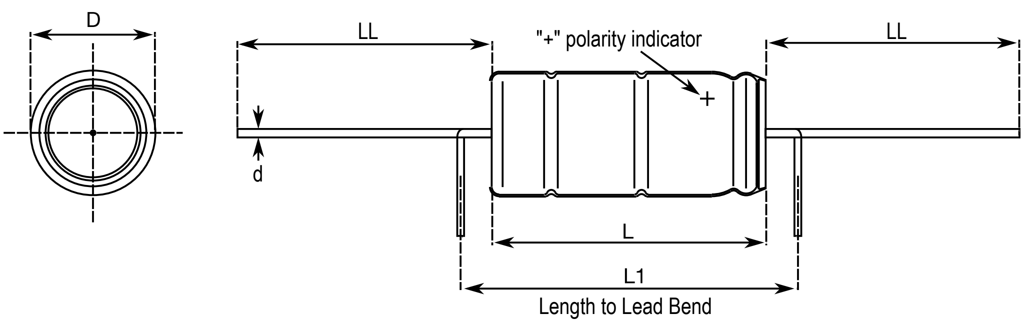
Test Method & Performance

Endurance Life Test	
Conditions	Performance
Temperature	+150°C
Test Duration	1,500 hours (D = 16 mm)
	2,000 hours (D = 20 mm)
Ripple Current	Maximum ripple current specified in table
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor
Performance	**The following specifications will be satisfied when the capacitor is tested at +20°C:**
Capacitance Change	Within 15% of the initial value
Equivalent Series Resistance	Does not exceed 200% of the initial value
Leakage Current	Does not exceed leakage current limit

Ordering Options Table

Packaging Kind	Lead Length (mm)	Lead and Packaging Code
Standard Packaging Option		
Bulk (bag)	42 +3/-2	E1

Dimensions – Millimeters



Size Code	Dimensions in mm				
	D	L	L1	d	LL
	±0.5	±1	Minimum	±0.03	+3/-2
F	16	29.0	35.0	1.0	42
G	16	37.0	43.0	1.0	42
H	20	29.0	35.0	1.0	42
J	20	37.0	43.0	1.0	42
L	20	46.0	52.0	1.0	42

Shelf Life

The capacitance, ESR and impedance of a capacitor will not change significantly after extended storage periods, however the leakage current will very slowly increase. KEMET products are particularly stable and allow a shelf life in excess of three years at 40°C. See sectional specification under each product series for specific data.

Re-age (Reforming) Procedure

Apply the rated voltage to the capacitor at room temperature for a period of one hour, or until the leakage current has fallen to a steady value below the specified limit. During re-aging a maximum charging current of twice the specified leakage current or 5 mA (whichever is greater) is suggested.

Reliability

The reliability of a component can be defined as the probability that it will perform satisfactorily under a given set of conditions for a given length of time.

In practice, it is impossible to predict with absolute certainty how any individual component will perform; thus, we must utilize probability theory. It is also necessary to clearly define the level of stress involved (e.g. operating voltage, ripple current, temperature and time). Finally, the meaning of satisfactory performance must be defined by specifying a set of conditions which determine the end of life of the component.

Reliability as a function of time, R(t), is normally expressed as: $R(t)=e^{-\lambda t}$
where R(t) is the probability that the component will perform satisfactorily for time t, and λ is the failure rate.

Failure Rate

The failure rate is the number of components failing per unit time. The failure rate of most electronic components follows the characteristic pattern:

- Early failures are removed during the manufacturing process.
- The operational life is characterized by a constant failure rate.
- The wear out period is characterized by a rapidly increasing failure rate.

The failures in time (FIT) are given with a 60% confidence level for the various type codes. By convention, FIT is expressed as 1×10^{-9} failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.
e.g., 100FIT = 1×10^{-7} failures per hour = 0.01%/1,000 hours

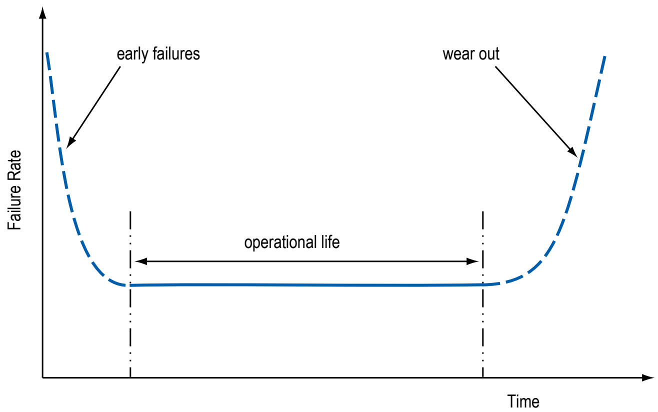
End of Life Definition
Catastrophic Failure: short circuit, open circuit or safety vent operation
Parametric Failure:

- Change in capacitance > ±10%
- Leakage current > specified limit
- ESR > 2 x initial ESR value

Failure Rate cont'd

MTBF

The mean time between failures (MTBF) is simply the inverse of the failure rate.
MTBF= 1/λ



Estimated field failure rate: ≤ 0.15 ppm (failures per year/produced number of capacitors per year)
The expected failure rate for this capacitor range is based on field experience for capacitors with structural similarity.

Environmental Compliance

As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of some hazardous materials, such as lead (Pb), in electronic equipment. All products in this catalog are produced to help our customers' obligations to guarantee their products and fulfill these legislative requirements. The only material of concern in our products has been lead (Pb), which has been removed from all designs to fulfill the requirement of containing less than 0.1% of lead in any homogeneous material. KEMET will closely follow any changes in legislation world wide and makes any necessary changes in its products, whenever needed.

Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.

Pb

RoHS Compliant

Table 1 – Ratings & Part Number Reference

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current Maximum				ESR Maximum		L_{ESL}	Part Number
	100 Hz 20°C (µF)		D x L (mm)	100 Hz 125°C (A)	≥ 5 kHz 105°C (A)	≥ 5 kHz 125°C (A)	≥ 5 kHz 150°C (A)	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	Approximate (nH)	
25	680	F	16 x 29	1.4	6.9	4.1	1.6	120	43	10	PEG126HF368EQE1
25	1000	G	16 x 37	1.7	8.8	5.2	2.0	80	28	12	PEG126HG410EQE1
25	1500	G	16 x 37	2.1	9.2	5.4	2.1	63	26	12	PEG126HG415EQE1
25	2200	H	20 x 29	2.5	9.4	5.5	2.1	51	25	12	PEG126HH422EQE1
25	3300	J	20 x 37	3.2	11.7	6.9	2.6	34	17	15	PEG126HJ433EQE1
25	4000	L	20 x 46	3.7	13.1	7.7	2.9	29	14	17	PEG126HL440EME1
40	470	F	16 x 29	1.1	5.9	3.5	1.3	150	45	10	PEG126KF347EQE1
40	600	G	16 x 37	1.4	8.3	4.9	1.9	120	30	12	PEG126KG360EQE1
40	1000	H	20 x 29	1.9	9.4	5.5	2.1	75	23	12	PEG126KH410EQE1
40	1200	H	20 x 29	2.0	9.0	5.3	2.0	71	26	12	PEG126KH412EQE1
40	1500	H	20 x 29	2.2	9.7	5.7	2.2	58	22	12	PEG126KH415EQE1
40	2200	J	20 x 37	2.8	11.4	6.7	2.6	43	18	15	PEG126KJ422EQE1
40	2700	L	20 x 46	3.1	12.1	7.1	2.7	37	17	17	PEG126KL427EQE1
63	250	F	16 x 29	0.9	5.3	3.1	1.2	240	53	10	PEG126MF325EQE1
63	370	G	16 x 37	1.2	6.7	3.9	1.5	160	37	12	PEG126MG337EQE1
63	470	H	20 x 29	1.4	7.3	4.3	1.6	130	32	12	PEG126MH347EQE1
63	680	J	20 x 37	1.7	9.0	5.3	2.0	90	23	15	PEG126MJ368EQE1
63	900	L	20 x 46	2.1	10.5	6.1	2.3	69	18	17	PEG126ML390EQE1
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current				ESR		L_{ESL}	Part Number

Operational Life

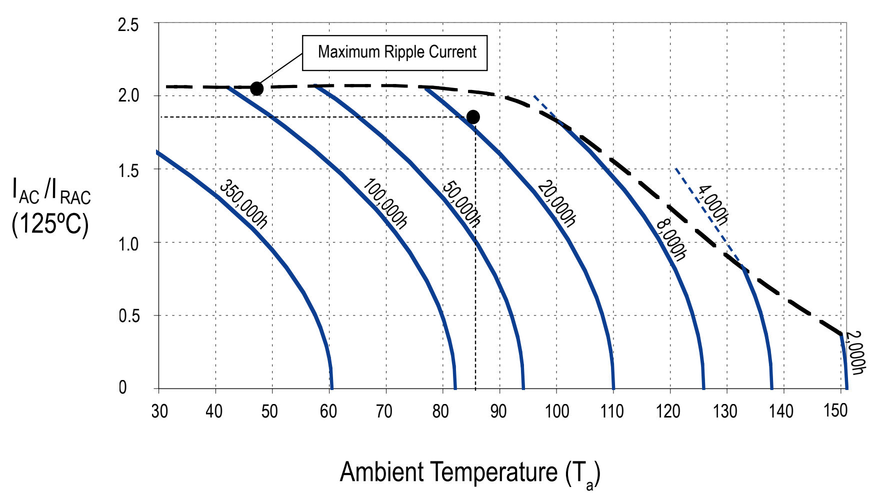
Operational life (L_{op}) at ambient temperature T_a and ripple current I_{AC}.

Diagram valid for 20 mm case size.
Operational life,
16 mm case size: 0.75 x diagram value

Example:
Article: PEG126KJ422EQ (20 x 37 mm)
Ambient temperature (T_a): +85°C
Ripple current, at 10 kHz (I_{AC}): 12.6 A

I_{RAC}(+125°C, ≥ 5 kHz)= 7A (from data table)
→ I_{AC}/ I_{RAC}(+125°C)= 12.6/7= 1.8

Operational life: Interpolation between the L_{op}-curves → L_{op} ~18kh (blue curves)



Roll Over for Order Info.

Packaging Quantities

Size Code	Packaging Quantities
	Bulk
F	125
G	100
H	150
J	125
L	100

Print Detail

Standard Marking for PEG and PEH types

- KEMET Logo
- Rated capacitance
- Capacitance tolerance
- Rated voltage
- Date code
- Polarity indication
- Article code

PEG127 Series, +150ºC

Overview

KEMET's PEG127 is an electrolytic capacitor with outstanding electrical performance. The device has a polarized all-welded design, tinned copper wire leads, a negative pole connected to the case, and plastic insulation. The PEG127 winding is housed in a cylindrical aluminum can with a high purity aluminum lid and high quality rubber gasket, as well as high temperature capability in small case sizes. The PEG127 has 1,600 hours operational life at +150°C for all case sizes.

Applications

KEMET's PEG127 is a high performance axial electrolytic capacitor. It is designed for automotive applications with high demands on resistance to vibrations and high ambient temperature.

Benefits

- 1,600 hours at +150°C
- High ripple capability

Part Number System

PEG127	H	A	318	0	Q	T1
Series	Voltage (VDC)	Size Code	Capacitance Code (μF)	Version	Capacitance Tolerance	Packaging
Axial Aluminum Electrolytic	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	0 = Standard	Q = -10 +30%	See Ordering Options Table

Performance Characteristics

Item	Performance Characteristics	
Capacitance Range	33 – 1,300 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +150°C	
Capacitance Tolerance	-10/+30% at 100 Hz/+20°C	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and $\tan \delta$ from initial measurements must not exceed: $\Delta C/C < 5\%$
Standards	IEC 60384–4 long life grade 40/125/56, AEC–Q200	

Compensation Factor of Ripple Current (RC) vs. Frequency

Frequency	100 Hz	300 Hz	1 kHz	5 kHz	100 kHz
Coefficient	0.35	0.57	0.80	1.00	1.04

Compensation Factor of ESR (5 kHz,+125 °C) vs. Frequency

Frequency	300 Hz	1 kHz	5 kHz	100 kHz
Coefficient	8.00	3.00	1.5	1

Compensation Factor of ESR (5 kHz,+125 °C) vs. Temperature

Frequency	-10°C	60°C	105°C	125°C
Coefficient	5.00	1.50	1.1	1

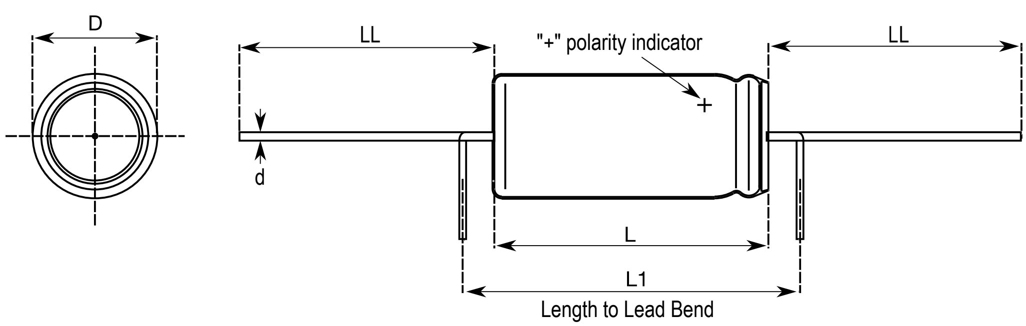
Test Method & Performance

Endurance Life Test	
Conditions	Performance
Temperature	+150°C
Test Duration	1,600 hours
Ripple Current	Maximum ripple current specified in table
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor
Performance	**The following specifications will be satisfied when the capacitor is tested at +20°C:**
Capacitance Change	Within 15% of the initial value
Equivalent Series Resistance	Does not exceed 200% of the initial value
Leakage Current	Does not exceed leakage current limit

Ordering Options Table

Packaging Kind	Lead Length (mm)	Lead and Packaging Code
Standard Packaging Options		
Bulk (bag)	42 +3/-2	(Blank)
Tape & Reel	See Dimension Table	T1

Dimensions – Millimeters



Size Code	Dimensions in mm				Bulk	Taped
	D	L	L1	d	LL	LL
	±0.5	±1	Minimum	±0.03	+3/-2	+3/-2
A	10	20.0	26.0	0.8	42	31
B	10	29.0	35.0	0.8	42	27
C	13	20.0	26.0	0.8	42	31
D	13	29.0	35.0	0.8	42	27
E	13	37.0	43.0	0.8	42	24

Shelf Life

The capacitance, ESR and impedance of a capacitor will not change significantly after extended storage periods, however the leakage current will very slowly increase. KEMET products are particularly stable and allow a shelf life in excess of three years at 40°C. See sectional specification under each product series for specific data.

Re-age (Reforming) Procedure

Apply the rated voltage to the capacitor at room temperature for a period of one hour, or until the leakage current has fallen to a steady value below the specified limit. During re-aging a maximum charging current of twice the specified leakage current or 5 mA (whichever is greater) is suggested.

Reliability

The reliability of a component can be defined as the probability that it will perform satisfactorily under a given set of conditions for a given length of time.

In practice, it is impossible to predict with absolute certainty how any individual component will perform; thus, we must utilize probability theory. It is also necessary to clearly define the level of stress involved (e.g. operating voltage, ripple current, temperature and time). Finally, the meaning of satisfactory performance must be defined by specifying a set of conditions which determine the end of life of the component.

Reliability as a function of time, R(t), is normally expressed as: $R(t)=e^{-\lambda t}$
where R(t) is the probability that the component will perform satisfactorily for time t, and λ is the failure rate.

Failure Rate

The failure rate is the number of components failing per unit time. The failure rate of most electronic components follows the characteristic pattern:

- Early failures are removed during the manufacturing process.
- The operational life is characterized by a constant failure rate.
- The wear out period is characterized by a rapidly increasing failure rate.

The failures in time (FIT) are given with a 60% confidence level for the various type codes. By convention, FIT is expressed as 1×10^{-9} failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.
e.g., 100FIT = 1×10^{-7} failures per hour = 0.01%/1,000 hours

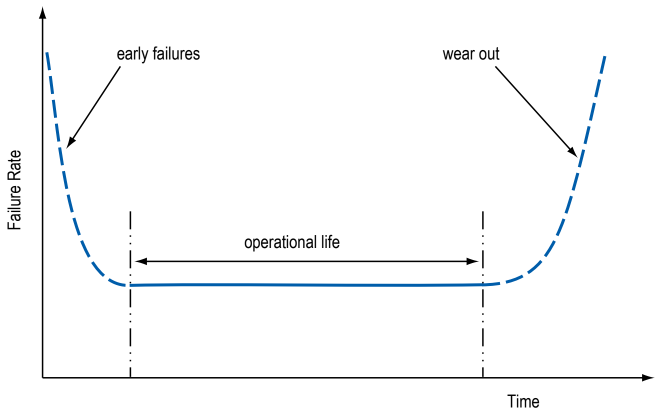
End of Life Definition
Catastrophic Failure: short circuit, open circuit or safety vent operation
Parametric Failure:

- Change in capacitance > ±10%
- Leakage current > specified limit
- ESR > 2 x initial ESR value

Failure Rate cont'd

MTBF

The mean time between failures (MTBF) is simply the inverse of the failure rate.
MTBF= 1/λ



Estimated field failure rate: ≤ 0.15 ppm (failures per year/produced number of capacitors per year)
The expected failure rate for this capacitor range is based on field experience for capacitors with structural similarity.

Environmental Compliance

As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of some hazardous materials, such as lead (Pb), in electronic equipment. All products in this catalog are produced to help our customers' obligations to guarantee their products and fulfill these legislative requirements. The only material of concern in our products has been lead (Pb), which has been removed from all designs to fulfill the requirement of containing less than 0.1% of lead in any homogeneous material. KEMET will closely follow any changes in legislation world wide and makes any necessary changes in its products, whenever needed.

Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.

RoHS Compliant

Table 1 – Ratings & Part Number Reference

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current Maximum				ESR Maximum			Part Number
	100 Hz 20°C (µF)		D x L (mm)	≥ 5 kHz 100°C (A)	≥ 5 kHz 125°C (A)	≥ 5 kHz 140°C (A)	≥ 5 kHz 150°C (A)	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	5 – 100 kHz 125 – 150°C (mΩ)	
25	180	A	10 x 20	2.4	1.7	1.1	0.49	560	255	80	PEG127HA3180Q(1)
25	360	B	10 x 29	3.5	2.5	1.6	0.71	281	130	43	PEG127HB3360Q(1)
25	470	C	13 x 20	3.8	2.8	1.8	0.79	226	110	40	PEG127HC3470Q(1)
25	900	D	13 x 29	5.6	4.0	2.6	1.15	118	58	23	PEG127HD3900Q(1)
25	1300	E	13 x 37	6.6	4.8	3.0	1.35	85	42	18	PEG127HE4130Q(1)
40	110	A	10 x 20	2.3	1.7	1.1	0.48	710	240	82	PEG127KA3110Q(1)
40	220	B	10 x 29	3.4	2.5	1.6	0.70	360	125	45	PEG127KB3220Q(1)
40	270	C	13 x 20	3.7	2.7	1.7	0.77	301	110	42	PEG127KC3270Q(1)
40	520	D	13 x 29	5.4	3.9	2.5	1.11	157	58	24	PEG127KD3520Q(1)
40	750	E	13 x 37	6.5	4.7	3.0	1.32	110	42	19	PEG127KE3750Q(1)
63	33	A	10 x 20	1.6	1.1	0.7	0.32	1700	370	181	PEG127MA2330Q(1)
63	68	B	10 x 29	2.4	1.7	1.1	0.49	825	185	92	PEG127MB2680Q(1)
63	80	C	13 x 20	2.7	1.9	1.2	0.55	704	160	82	PEG127MC2800Q(1)
63	160	D	13 x 29	4.0	2.9	1.8	0.83	354	82	44	PEG127MD3160Q(1)
63	230	E	13 x 37	4.9	3.5	2.2	1.00	250	59	32	PEG127ME3230Q(1)
VDC	**Rated Capacitance**	**Size Code**	**Case Size**	**Ripple Current**				**ESR**			**Part Number**

(1) Insert packaging code. See Ordering Options Table for available options.

Packaging Quantities

Size Code	Packaging Quantities	
	Tape and Reel	Bulk
A	500	250
B	500	200
C	400	250
D	400	200
E	400	150

Print Detail

Standard Marking for PEG and PEH types

- KEMET Logo
- Rated capacitance
- Capacitance tolerance
- Rated voltage
- Date code
- Polarity indication
- Article code

Overview

KEMET's PEG220 is an electrolytic capacitor with outstanding electrical performance. The device has a polarized all-welded design, tinned copper wire leads, and a negative pole connected to the case. The PEG220 winding is housed in a cylindrical aluminum can with a high purity aluminum lid and high quality rubber gasket. Low ESR is the result of a low resistive electrolyte/paper system and an all-welded design. Thanks to its mechanical robustness, the PEG220 is suitable for use in mobile and aircraft installations with operation up to +150°C.

Applications

KEMET's PEG220 is a new generation of high performance axial electrolytic capacitors. It is designed for automotive applications with extremely high demands.

Benefits

- 4,000 hours at +150°C
- Very high ripple current
- Up to 21A ripple, RMS, continuous load
- High vibration resistance

Part Number System

PEG220	H	F	415	0	Q
Series	Voltage (VDC)	Size Code	Capacitance Code (μF)	Version	Capacitance Tolerance
Axial Aluminum Electrolytic	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	0 = Standard	Q = -10 +30% M = ±20%

Performance Characteristics

Item	Performance Characteristics	
Capacitance Range	250 – 4,700 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +150°C	
Capacitance Tolerance	-10/+30%, (±20% select values) sat 100 Hz/+20°C	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56, AEC–Q200	

Compensation Factor of Ripple Current (RC) vs. Frequency

Frequency	100 Hz	300 Hz	1 kHz	5 kHz	100 kHz
Coefficient	0.35	0.57	0.80	1.00	1.04

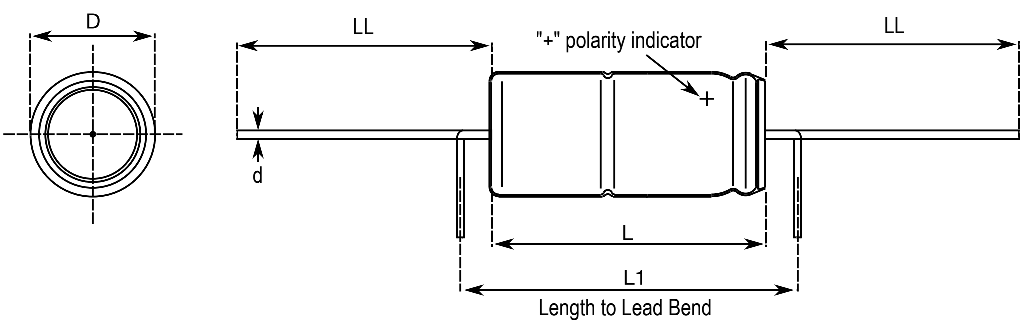
Test Method & Performance

Endurance Life Test	
Conditions	Performance
Temperature	+150°C
Test Duration	1,500 hours (D = 16 mm)
	2,000 hours (D = 20 mm)
Ripple Current	Maximum ripple current specified in table
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor
Performance	**The following specifications will be satisfied when the capacitor is tested at +20°C:**
Capacitance Change	Within 15% of the initial value
Equivalent Series Resistance	Does not exceed 200% of the initial value
Leakage Current	Does not exceed leakage current limit

Ordering Options Table

Packaging Kind	Lead Length (mm)	Lead and Packaging Code
Standard Packaging Option		
Bulk (bag)	40 ±2	(Blank)

Dimensions – Millimeters



Size Code	Dimensions in mm				
	D	L	L1	d	LL
	±0.5	±1	Minimum	±0.03	±2
F	16	26.5	33	1.0	40
G	16	34.5	41	1.0	40
H	20	26.5	33	1.0	40
J	20	34.5	41	1.0	40
L	20	42.5	49	1.0	40

Shelf Life

The capacitance, ESR and impedance of a capacitor will not change significantly after extended storage periods, however the leakage current will very slowly increase. KEMET products are particularly stable and allow a shelf life in excess of three years at 40°C. See sectional specification under each product series for specific data.

Re-age (Reforming) Procedure

Apply the rated voltage to the capacitor at room temperature for a period of one hour, or until the leakage current has fallen to a steady value below the specified limit. During re-aging a maximum charging current of twice the specified leakage current or 5 mA (whichever is greater) is suggested.

Reliability

The reliability of a component can be defined as the probability that it will perform satisfactorily under a given set of conditions for a given length of time.

In practice, it is impossible to predict with absolute certainty how any individual component will perform; thus, we must utilize probability theory. It is also necessary to clearly define the level of stress involved (e.g. operating voltage, ripple current, temperature and time). Finally, the meaning of satisfactory performance must be defined by specifying a set of conditions which determine the end of life of the component.

Reliability as a function of time, R(t), is normally expressed as: $R(t)=e^{-\lambda t}$
where R(t) is the probability that the component will perform satisfactorily for time t, and λ is the failure rate.

Failure Rate

The failure rate is the number of components failing per unit time. The failure rate of most electronic components follows the characteristic pattern:

- Early failures are removed during the manufacturing process.
- The operational life is characterized by a constant failure rate.
- The wear out period is characterized by a rapidly increasing failure rate.

The failures in time (FIT) are given with a 60% confidence level for the various type codes. By convention, FIT is expressed as 1×10^{-9} failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.
e.g., 100FIT = 1×10^{-7} failures per hour = 0.01%/1,000 hours

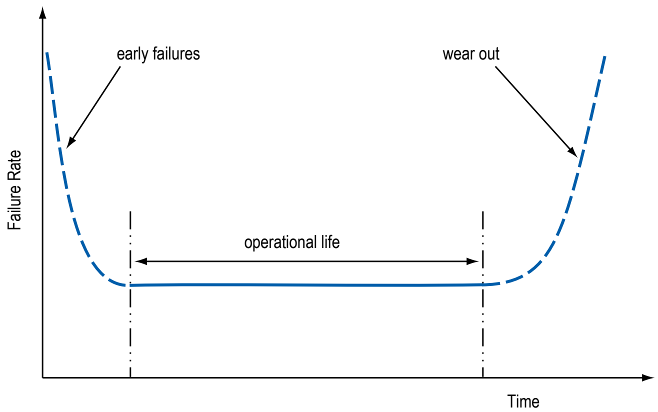
End of Life Definition
Catastrophic Failure: short circuit, open circuit or safety vent operation
Parametric Failure:

- Change in capacitance > ±10%
- Leakage current > specified limit
- ESR > 2 x initial ESR value

Failure Rate cont'd

MTBF

The mean time between failures (MTBF) is simply the inverse of the failure rate.
MTBF= 1/λ



Estimated field failure rate: ≤ 0.15 ppm (failures per year/produced number of capacitors per year)
The expected failure rate for this capacitor range is based on field experience for capacitors with structural similarity.

Environmental Compliance

As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of some hazardous materials, such as lead (Pb), in electronic equipment. All products in this catalog are produced to help our customers' obligations to guarantee their products and fulfill these legislative requirements. The only material of concern in our products has been lead (Pb), which has been removed from all designs to fulfill the requirement of containing less than 0.1% of lead in any homogeneous material. KEMET will closely follow any changes in legislation world wide and makes any necessary changes in its products, whenever needed.

Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.

RoHS Compliant

Table 1 – Ratings & Part Number Reference

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR Maximum			Part Number
				Maximum			Rated	Maximum				
	100 Hz 20°C (µF)		D x L (mm)	≥ 5 kHz 125°C (A)[1]	≥ 5 kHz 140°C (A)[1]	≥ 5 kHz 150°C (A)[1]	≥ 5 kHz 125°C (A)[2]	≥ 5 kHz 125°C (A)[3]	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	5 – 100 kHz 125 – 150°C (mΩ)	
25	1500	F	16 x 27	13.9	8.8	3.9	4.8	6.1	78	42	18.4	PEG220HF4150M
25	2200	G	16 x 35	15.8	10.0	4.5	5.8	7.4	56	31	14.3	PEG220HG4220M
25	2200	H	20 x 27	16.6	10.5	4.7	5.2	6.6	61	36	19	PEG220HH4220Q
25	3300	J	20 x 35	19.1	12.1	5.4	6.4	8.1	43	26	14.3	PEG220HJ4330Q
25	4700	L	20 x 43	21.0	13.3	5.9	7.4	9.3	32	20	11.8	PEG220HL4470Q
40	800	F	16 x 27	13.6	8.6	3.9	4.7	5.9	108	43	19.2	PEG220KF3800Q
40	1200	G	16 x 35	15.5	9.8	4.4	5.7	7.2	74	31	14.8	PEG220KG4120Q
40	1500	H	20 x 27	17.1	10.8	4.8	5.4	6.8	68	33	17.8	PEG220KH4150Q
40	2200	J	20 x 35	19.4	12.2	5.5	6.5	8.2	49	25	13.9	PEG220KJ4220Q
40	2700	L	20 x 43	20.7	13.1	5.9	7.3	9.2	39	20	12.1	PEG220KL4270Q
63	250	F	16 x 27	10.5	6.6	3.0	3.6	4.5	233	59	32.4	PEG220MF3250Q
63	370	G	16 x 35	12.2	7.7	3.5	4.5	5.7	160	42	23.9	PEG220MG3370Q
63	470	H	20 x 27	14.2	9.0	4.0	4.5	5.7	134	41	25.9	PEG220MH3470Q
63	680	J	20 x 35	16.3	10.3	4.6	5.6	7.0	94	30	19.7	PEG220MJ3680Q
63	900	L	20 x 43	17.7	11.2	5.0	6.3	7.9	74	25	16.6	PEG220ML3900Q
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR			Part Number

[1] *Capacitor mounted with low thermal resistance path (heat-sink)*

[2] *Continuous operation at natural convection (D=20, 4000h; D=16, 3000h)*

[3] *Reduced life (D=20, 2000h; D=16, 1500h)*

Packaging Quantities

Size Code	Packaging Quantities
	Bulk
F	125
G	100
H	150
J	125
L	100

Print Detail

Standard Marking for PEG and PEH types

- KEMET Logo
- Rated capacitance
- Capacitance tolerance
- Rated voltage
- Date code
- Polarity indication
- Article code

PEG225 Series, +125ºC and +150ºC

Electronic Components KEMET CHARGED®

Overview

KEMET's PEG225 is an electrolytic capacitor with outstanding electrical performance. The device has a polarized all-welded design, tinned copper wire leads, and a negative pole connected to the case. The PEG225 winding is housed in a cylindrical aluminum can with a high purity aluminum lid and high quality rubber gasket. Low ESR is the result of a low resistive electrolyte/paper system and an all-welded design. Thanks to its mechanical robustness, the PEG225 is suitable for use in mobile and aircraft installations with operation up to +150°C.

Applications

KEMET's PEG225 is a new generation of high performance axial electrolytic capacitors. It is designed for automotive applications with extremely high demands.

Benefits

- 4,000 hours at +150°C
- High CV
- Extremely high ripple current
- Up to 28 A ripple, RMS, continuous load
- High vibration resistance

Part Number System

PEG225	H	F	422	0	M
Series	Voltage (VDC)	Size Code	Capacitance Code (µF)	Version	Capacitance Tolerance
Axial Aluminum Electrolytic	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	0 = Standard	Q = -10 +30% M = ±20%

Performance Characteristics

Item	Performance Characteristics	
Capacitance Range	470 – 6,300 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +125°C (-40 to +150°C at derated voltage)	
Capacitance Tolerance	-10/+30%, (±20% select values) at 100 Hz/+20°C	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56, AEC–Q200	

Compensation Factor of Ripple Current (RC) vs. Frequency

Frequency	100 Hz	300 Hz	1 kHz	5 kHz	100 kHz
Coefficient	0.35	0.57	0.80	1.00	1.04

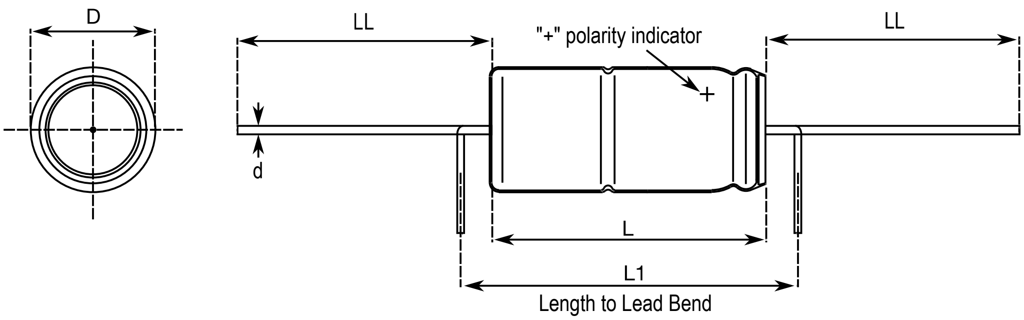
Test Method & Performance

Endurance Life Test	
Conditions	Performance
Temperature	+150°C
Test Duration	1,500 hours (D = 16 mm)
	2,000 hours (D = 20 mm)
Ripple Current	Maximum ripple current specified in table
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor
Performance	**The following specifications will be satisfied when the capacitor is tested at +20°C:**
Capacitance Change	Within 15% of the initial value
Equivalent Series Resistance	Does not exceed 200% of the initial value
Leakage Current	Does not exceed leakage current limit

Ordering Options Table

Packaging Kind	Lead Length (mm)	Lead and Packaging Code
Standard Packaging Option		
Bulk (bag)	40 ±2	(Blank)

Dimensions – Millimeters



Size Code	Dimensions in mm				
	D	L	L1	d	LL
	±0.5	±1	Minimum	±0.03	±2
F	16	26.5	33	1.0	40
G	16	34.5	41	1.0	40
H	20	26.5	33	1.0	40
J	20	34.5	41	1.0	40
L	20	42.5	49	1.0	40

Shelf Life

The capacitance, ESR and impedance of a capacitor will not change significantly after extended storage periods, however the leakage current will very slowly increase. KEMET products are particularly stable and allow a shelf life in excess of three years at 40°C. See sectional specification under each product series for specific data.

Re-age (Reforming) Procedure

Apply the rated voltage to the capacitor at room temperature for a period of one hour, or until the leakage current has fallen to a steady value below the specified limit. During re-aging a maximum charging current of twice the specified leakage current or 5 mA (whichever is greater) is suggested.

Reliability

The reliability of a component can be defined as the probability that it will perform satisfactorily under a given set of conditions for a given length of time.

In practice, it is impossible to predict with absolute certainty how any individual component will perform; thus, we must utilize probability theory. It is also necessary to clearly define the level of stress involved (e.g. operating voltage, ripple current, temperature and time). Finally, the meaning of satisfactory performance must be defined by specifying a set of conditions which determine the end of life of the component.

Reliability as a function of time, R(t), is normally expressed as: $R(t)=e^{-\lambda t}$
where R(t) is the probability that the component will perform satisfactorily for time t, and λ is the failure rate.

Failure Rate

The failure rate is the number of components failing per unit time. The failure rate of most electronic components follows the characteristic pattern:

- Early failures are removed during the manufacturing process.
- The operational life is characterized by a constant failure rate.
- The wear out period is characterized by a rapidly increasing failure rate.

The failures in time (FIT) are given with a 60% confidence level for the various type codes. By convention, FIT is expressed as 1×10^{-9} failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.
e.g., 100FIT = 1×10^{-7} failures per hour = 0.01%/1,000 hours

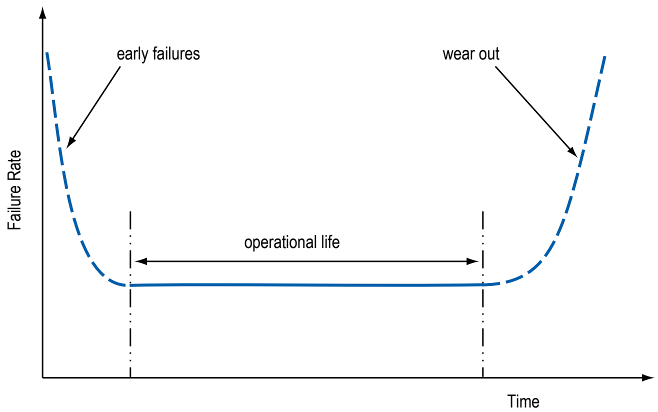
End of Life Definition
Catastrophic Failure: short circuit, open circuit or safety vent operation
Parametric Failure:

- Change in capacitance > ±10%
- Leakage current > specified limit
- ESR > 2 x initial ESR value

Failure Rate cont'd

MTBF

The mean time between failures (MTBF) is simply the inverse of the failure rate.
MTBF= 1/λ



Estimated field failure rate: ≤ 0.15 ppm (failures per year/produced number of capacitors per year)
The expected failure rate for this capacitor range is based on field experience for capacitors with structural similarity.

Environmental Compliance

As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of some hazardous materials, such as lead (Pb), in electronic equipment. All products in this catalog are produced to help our customers' obligations to guarantee their products and fulfill these legislative requirements. The only material of concern in our products has been lead (Pb), which has been removed from all designs to fulfill the requirement of containing less than 0.1% of lead in any homogeneous material. KEMET will closely follow any changes in legislation world wide and makes any necessary changes in its products, whenever needed.

Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.

RoHS Compliant

Table 1 – Ratings & Part Number Reference

VDC	VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR Maximum			Part Number
					Maximum			Rated	Maximum (Reduced Voltage)				
	(150°C)	100 Hz 20°C (µF)		D x L (mm)	≥ 5 kHz 125°C (A)[1]	≥ 5 kHz 140°C (A)[2]	≥ 5 kHz 150°C (A)[3]	≥ 5 kHz 125°C (A)[4]	≥ 5 kHz 125°C (A)[4]	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	5 – 100 kHz 125 – 150°C (mΩ)	
25	18	2200	F	16 x 27	17.3	11.0	4.9	6.1	7.7	60	34	11.9	PEG225HF4220M
25	18	3000	G	16 x 35	19.7	12.5	5.6	7.4	9.4	44	25	9.2	PEG225HG4300M
25	18	3600	H	20 x 27	23.5	14.9	6.7	7.6	9.6	38	22	9.4	PEG225HH4360Q
25	18	4800	J	20 x 35	26.7	16.9	7.6	9.2	11.7	28	16	7.3	PEG225HJ4480Q
25	18	6300	L	20 x 43	28.3	17.9	8.0	10.2	12.9	24	14	6.5	PEG225HL4630Q
40	32	1200	F	16 x 27	16.6	10.5	4.7	5.8	7.4	80	36	13	PEG225KF4120M
40	32	1800	G	16 x 35	19.3	12.2	5.5	7.2	9.2	55	25	9.6	PEG225KG4180M
40	32	2000	H	20 x 27	22.8	14.4	6.5	7.3	9.3	50	23	10	PEG225KH4200Q
40	32	3000	J	20 x 35	25.8	16.3	7.3	8.9	11.3	35	17	7.8	PEG225KJ4300Q
40	32	3900	L	20 x 43	27.7	17.5	7.8	10.0	12.7	28	14	6.8	PEG225KL4390Q
63	54	470	F	16 x 27	12.1	7.7	3.4	4.2	5.3	156	52	24.3	PEG225MF3470Q
63	54	680	G	16 x 35	13.8	8.7	3.9	5.3	6.7	109	37	18.7	PEG225MG3680Q
63	54	900	H	20 x 27	18.0	11.4	5.1	5.8	7.3	86	31	16.1	PEG225MH3900Q
63	54	1400	J	20 x 35	20.9	13.2	5.9	7.3	9.2	57	22	11.9	PEG225MJ4140Q
63	54	1800	L	20 x 43	22.8	14.4	6.5	8.3	10.5	45	18	10	PEG225ML4180Q
VDC	VDC (150°C)	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR			Part Number

[1] Capacitor-mounted with low thermal resistance path (heat-sink).
[2] Valid for capacitor supplied with reduced DC voltage, capacitor-mounted with low thermal resistance path.
[3] Continuous operation at natural convection (D=20, 4,000h; D=16 3,000h).
[4] Reduced Life (D=20, 2000h; D=16, 1500h).

Packaging Quantities

Size Code	Packaging Quantities
	Bulk
F	125
G	100
H	150
J	125
L	100

Print Detail

Standard Marking for PEG and PEH types

- KEMET Logo
- Rated capacitance
- Capacitance tolerance
- Rated voltage
- Date code
- Polarity indication
- Article code

PEG226 Series, +150ºC

Overview

KEMET's PEG226 is an electrolytic capacitor with outstanding electrical performance. The device has a polarized all-welded design, tinned copper wire leads, and a negative pole connected to the case. The PEG226 winding is housed in a cylindrical aluminum can with a high purity aluminum lid and high quality rubber gasket. Low ESR is the result of a low resistive electrolyte/paper system and an all-welded design. Thanks to its mechanical robustness, the PEG226 is suitable for use in mobile and aircraft installations with operation up to +150°C.

Applications

KEMET's PEG226 is a new generation of high performance axial electrolytic capacitors. It is designed for automotive applications with extremely high demands.

Benefits

- 4,000 hours at +150°C
- Extremely high ripple current
- Up to 28 A ripple, RMS, continuous load
- High vibration resistance

Part Number System

PEG226	H	F	415	0	M
Series	Voltage (VDC)	Size Code	Capacitance Code (µF)	Version	Capacitance Tolerance
Axial Aluminum Electrolytic	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	0 = Standard	Q = -10 + 30% M = ±20%

Performance Characteristics

Item	Performance Characteristics	
Capacitance Range	250 – 4,700 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +150°C	
Capacitance Tolerance	-10/+30%, (±20% select values) at 100 Hz / +20°C	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56, AEC–Q200	

Compensation Factor of Ripple Current (RC) vs. Frequency

Frequency	100 Hz	300 Hz	1 kHz	5 kHz	100 kHz
Coefficient	0.35	0.57	0.80	1.00	1.04

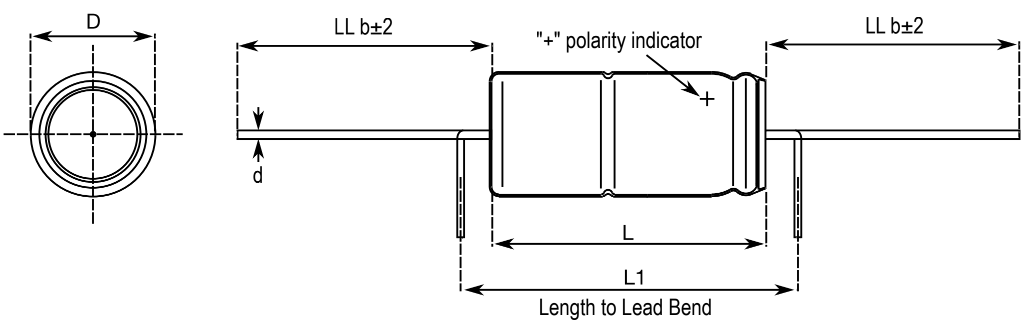
Test Method & Performance

Endurance Life Test	
Conditions	Performance
Temperature	+150°C
Test Duration	1,500 hours (D = 16 mm)
	2,000 hours (D = 20 mm)
Ripple Current	Maximum ripple current specified in table
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor
Performance	**The following specifications will be satisfied when the capacitor is tested at +20°C:**
Capacitance Change	Within 15% of the initial value
Equivalent Series Resistance	Does not exceed 200% of the initial value
Leakage Current	Does not exceed leakage current limit

Ordering Options Table

Packaging Kind	Lead Length (mm)	Lead and Packaging Code
Standard Packaging Option		
Bulk (bag)	40 ±2	(Blank)

Dimensions – Millimeters



Size Code	Dimensions in mm				
	D	L	L1	d	LL
	±0.5	±1	Minimum	±0.03	b±2 Box
F	16	26.5	33	1.0	40
G	16	34.5	41	1.0	40
H	20	26.5	33	1.0	40
J	20	34.5	41	1.0	40
L	20	42.5	49	1.0	40

Shelf Life

The capacitance, ESR and impedance of a capacitor will not change significantly after extended storage periods, however the leakage current will very slowly increase. KEMET products are particularly stable and allow a shelf life in excess of three years at 40°C. See sectional specification under each product series for specific data.

Re-age (Reforming) Procedure

Apply the rated voltage to the capacitor at room temperature for a period of one hour, or until the leakage current has fallen to a steady value below the specified limit. During re-aging a maximum charging current of twice the specified leakage current or 5 mA (whichever is greater) is suggested.

Reliability

The reliability of a component can be defined as the probability that it will perform satisfactorily under a given set of conditions for a given length of time.

In practice, it is impossible to predict with absolute certainty how any individual component will perform; thus, we must utilize probability theory. It is also necessary to clearly define the level of stress involved (e.g. operating voltage, ripple current, temperature and time). Finally, the meaning of satisfactory performance must be defined by specifying a set of conditions which determine the end of life of the component.

Reliability as a function of time, R(t), is normally expressed as: $R(t)=e^{-\lambda t}$
where R(t) is the probability that the component will perform satisfactorily for time t, and λ is the failure rate.

Failure Rate

The failure rate is the number of components failing per unit time. The failure rate of most electronic components follows the characteristic pattern:

- Early failures are removed during the manufacturing process.
- The operational life is characterized by a constant failure rate.
- The wear out period is characterized by a rapidly increasing failure rate.

The failures in time (FIT) are given with a 60% confidence level for the various type codes. By convention, FIT is expressed as 1×10^{-9} failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.
e.g., 100FIT = 1×10^{-7} failures per hour = 0.01%/1,000 hours

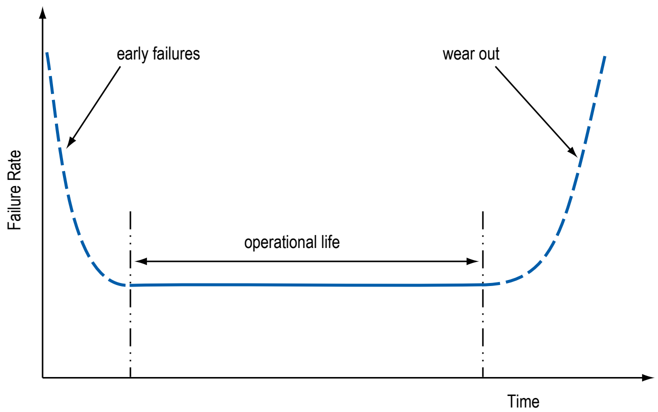
End of Life Definition
Catastrophic Failure: short circuit, open circuit or safety vent operation
Parametric Failure:

- Change in capacitance > ±10%
- Leakage current > specified limit
- ESR > 2 x initial ESR value

Failure Rate cont'd

MTBF

The mean time between failures (MTBF) is simply the inverse of the failure rate.
MTBF= 1/λ



Estimated field failure rate: ≤ 0.15 ppm (failures per year/produced number of capacitors per year)
The expected failure rate for this capacitor range is based on field experience for capacitors with structural similarity.

Environmental Compliance

As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of some hazardous materials, such as lead (Pb), in electronic equipment. All products in this catalog are produced to help our customers' obligations to guarantee their products and fulfill these legislative requirements. The only material of concern in our products has been lead (Pb), which has been removed from all designs to fulfill the requirement of containing less than 0.1% of lead in any homogeneous material. KEMET will closely follow any changes in legislation world wide and makes any necessary changes in its products, whenever needed.

Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.

RoHS Compliant

Table 1 – Ratings & Part Number Reference

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR Maximum			Part Number
				Maximum			Rated	Maximum				
	100 Hz 20°C (µF)		D x L (mm)	≥ 5 kHz 125°C (A)[1]	≥ 5 kHz 140°C (A)[1]	≥ 5 kHz 150°C (A)[1]	≥ 5 kHz 125°C (A)[2]	≥ 5 kHz 125°C (A)[3]	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	5 – 100 kHz 125 – 150°C (mΩ)	
25	1500	F	16 x 27	16.8	10.6	4.7	5.9	7.4	72	36	12.7	PEG226HF4150M
25	2200	G	16 x 35	19.2	12.1	5.4	7.2	9.1	51	26	9.7	PEG226HG4220M
25	2200	H	20 x 27	22.2	14.0	6.3	7.1	9.1	50	25	10.6	PEG226HH4220Q
25	3300	J	20 x 35	25.8	16.3	7.3	8.9	11.3	34	17	7.8	PEG226HJ4330Q
25	4700	L	20 x 43	28.5	18.0	8.1	10.3	13.1	25	13	6.4	PEG226HL4470Q
40	800	F	16 x 27	16.2	10.2	4.6	5.6	7.2	100	36	13.6	PEG226KF3800Q
40	1200	G	16 x 35	18.6	11.8	5.3	7.0	8.8	69	26	10.3	PEG226KG4120Q
40	1500	H	20 x 27	22.8	14.4	6.5	7.3	9.3	57	22	10	PEG226KH4150Q
40	2200	J	20 x 35	25.7	16.2	7.3	8.9	11.2	41	17	7.9	PEG226KJ4220Q
40	2700	L	20 x 43	27.9	17.6	7.9	10.1	12.8	32	13	6.7	PEG226KL4270Q
63	250	F	16 x 27	11.5	7.3	3.3	4.0	5.1	227	53	26.9	PEG226MF3250Q
63	370	G	16 x 35	13.6	8.6	3.9	5.1	6.4	155	37	19.2	PEG226MG3370Q
63	470	H	20 x 27	17.3	10.9	4.9	5.5	7.0	125	32	17.5	PEG226MH3470Q
63	680	J	20 x 35	20.0	12.7	5.7	6.9	8.7	87	23	13	PEG226MJ3680Q
63	900	L	20 x 43	22.2	14.0	6.3	8.1	10.2	67	18	10.6	PEG226ML3900Q
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR			Part Number

[1] *Capacitor-mounted with low thermal resistance path (heat-sink).*
[2] *Continuous operation at natural convection (D=20, 4,000h; D=16, 3,000h).*
[3] *Reduced Life (D=20, 2,000h; D=16, 1,500h).*

Packaging Quantities

Size Code	Packaging Quantities
	Bulk
F	125
G	100
H	150
J	125
L	100

Print Detail

Standard Marking for PEG and PEH types

- KEMET Logo
- Rated capacitance
- Capacitance tolerance
- Rated voltage
- Date code
- Polarity indication
- Article code

Roll Over for Order Info.

PEH126, +150°C, PEH220, +150°C, PEH225, +125ºC and +150ºC, and PEH226, +150ºC

Overview

These electrolytic capacitors contain a radial crown which allows them to be mounted in a standing position. They feature outstanding electrical performance, a polarized, all-welded design, tinned copper wire leads, a negative pole connected to the case, and plastic insulation. The winding is housed in a cylindrical aluminium can with a high purity aluminium lid and a high quality rubber gasket. Low ESR is a result of a low resistive electrolyte/paper system and an all-welded design. Thanks to its mechanical robustness these capacitors are suitable for use in mobile and aircraft installations with operation up to +150°C.

Applications

KEMET's PEH126, PEH220, PEH225, and PEH226 are a high performance electrolytic capacitor. It is designed for automotive applications with high demands on resistance to vibrations and high ambient temperature.

Benefits

- High performance
- 4,000 hours at +150°C
- High ripple current
- Low ESR
- 16 mm diameter axial can sizes F and G

Part Number System

PEH126	H	F	368	E	Q	E1
Series	Voltage (VDC)	Size Code	Capacitance Code (pF)	Version	Capacitance Tolerance	Packaging
Aluminum Electrolytic with Soldering Star Termination	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	E = Standard	Q = -10 +30%	E1 = Bulk

Part Number System cont'd

PEH220	H	F	415	0	M
Series	Voltage (VDC)	Size Code	Capacitance Code (pF)	Version	Capacitance Tolerance
Aluminum Electrolytic with Soldering Star Termination	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	0 = Standard	Q = -10 +30% M = ±20%

PEH225	H	F	422	0	M
Series	Voltage (VDC)	Size Code	Capacitance Code (pF)	Version	Capacitance Tolerance
Aluminum Electrolytic with Soldering Star Termination	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	0 = Standard	Q = -10 +30% M = ±20%

PEH226	H	F	415	0	M
Series	Voltage (VDC)	Size Code	Capacitance Code (pF)	Version	Capacitance Tolerance
Aluminum Electrolytic with Soldering Star Termination	H = 25 K = 40 M = 63	See Dimension Table	The second two digits indicate the two most significant digits of the capacitance value. The first digit indicates the total number digits.	0 = Standard	Q = -10 +30% M = ±20%

Performance Characteristics PEH126

Item	Performance Characteristics	
Series	PEH126	
Capacitance Range	250 – 1,500 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +150°C	
Capacitance Tolerance	-10/+30%, (±20% select values) at 100 Hz/+20°C	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56, AEC–Q200	

Performance Characteristics PEH220

Item	Performance Characteristics	
Series	PEH220	
Capacitance Range	250 – 2,200 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +150°C	
Capacitance Tolerance	-10/+30%, (±20% select values) at 100 Hz/+20°C	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56, AEC–Q200	

Performance Characteristics PEH225

Item	Performance Characteristics	
Series	PEH225	
Capacitance Range	470 – 3,000 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +125°C (-40 to +150°C at derated voltage)	
Capacitance Tolerance	-10/+30%, (±20% select values) at 100 Hz/+20°C	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56, AEC–Q200	

Performance Characteristics PEH226

Item	Performance Characteristics	
Series	PEH226	
Capacitance Range	250 – 2,200 µF	
Rated Voltage	25 – 63 VDC	
Temperature Range	-40 to +150°C	
Capacitance Tolerance	-10/+30%, (±20% select values) at 100 Hz/+20°C	
Shelf Life	5,000 hours at +105°C or 10 years at +40°C 0 VDC	
Leakage Current	I = 0.003 CV + 4,000 (µA)	
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.	
Vibration Test Specifications	Procedure	Requirements
	1.5 mm displacement amplitude or 20 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 2,000 Hz (capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tan δ from initial measurements must not exceed: Δ C/C < 5%
Standards	IEC 60384–4 long life grade 40/125/56, AEC–Q200	

Compensation Factor of Ripple Current (RC) vs. Frequency

Frequency	100 Hz	300 Hz	1 kHz	5 kHz	100 kHz
Coefficient	0.35	0.57	0.80	1.00	1.04

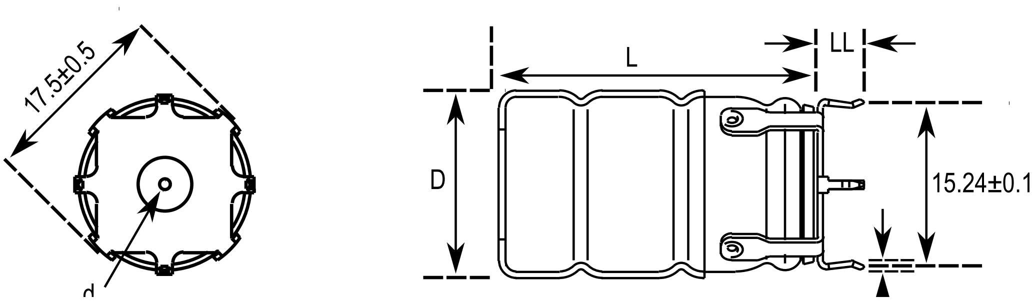
Test Method & Performance

Endurance Life Test	
Conditions	Performance
Temperature	+150°C
Test Duration	1,500 hours
Ripple Current	Maximum ripple current specified in table
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor
Performance	**The following specifications will be satisfied when the capacitor is tested at +20°C:**
Capacitance Change	Within 15% of the initial value
Equivalent Series Resistance	Does not exceed 200% of the initial value
Leakage Current	Does not exceed leakage current limit

Ordering Options Table

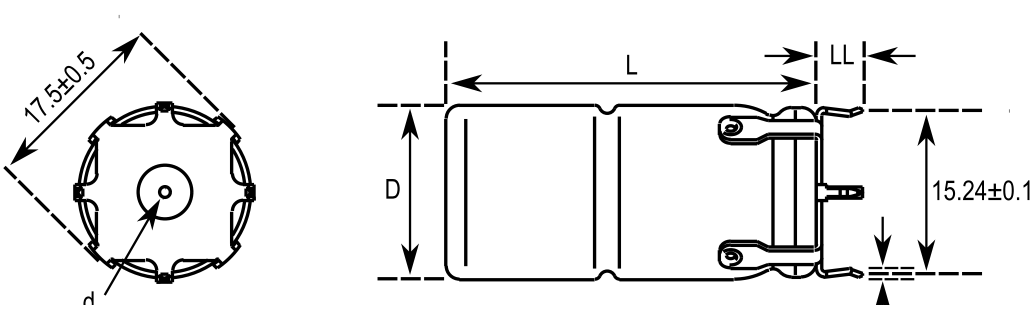
Packaging Kind	Lead Length (mm)	Lead and Packaging Code
Standard Packaging Option		
Bulk (bag)	3.3 ±0.5	E1

Dimensions – Millimeters PEH126



Size Code	Dimensions in mm			
	D	L	d	LL
	±0.5	±1	±0.03	±0.5
F	16.5	31	1.0	3.3
G	16.5	39	1.0	3.3

Dimensions – Millimeters PEH220 – 226



Size Code	Dimensions in mm			
	D	L	d	LL
	±0.5	±1	±0.03	±0.5
F	16.0	27.5	1.0	3.3
G	16.0	35.5	1.0	3.3

Shelf Life

The capacitance, ESR and impedance of a capacitor will not change significantly after extended storage periods, however the leakage current will very slowly increase. KEMET products are particularly stable and allow a shelf life in excess of three years at 40°C. See sectional specification under each product series for specific data.

Re-age (Reforming) Procedure

Apply the rated voltage to the capacitor at room temperature for a period of one hour, or until the leakage current has fallen to a steady value below the specified limit. During re-aging a maximum charging current of twice the specified leakage current or 5 mA (whichever is greater) is suggested.

Reliability

The reliability of a component can be defined as the probability that it will perform satisfactorily under a given set of conditions for a given length of time.

In practice, it is impossible to predict with absolute certainty how any individual component will perform; thus, we must utilize probability theory. It is also necessary to clearly define the level of stress involved (e.g. operating voltage, ripple current, temperature and time). Finally, the meaning of satisfactory performance must be defined by specifying a set of conditions which determine the end of life of the component.

Reliability as a function of time, R(t), is normally expressed as: $R(t)=e^{-\lambda t}$
where R(t) is the probability that the component will perform satisfactorily for time t, and λ is the failure rate.

Failure Rate

The failure rate is the number of components failing per unit time. The failure rate of most electronic components follows the characteristic pattern:

- Early failures are removed during the manufacturing process.
- The operational life is characterized by a constant failure rate.
- The wear out period is characterized by a rapidly increasing failure rate.

The failures in time (FIT) are given with a 60% confidence level for the various type codes. By convention, FIT is expressed as 1×10^{-9} failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.
e.g., 100FIT = 1×10^{-7} failures per hour = 0.01%/1,000 hours

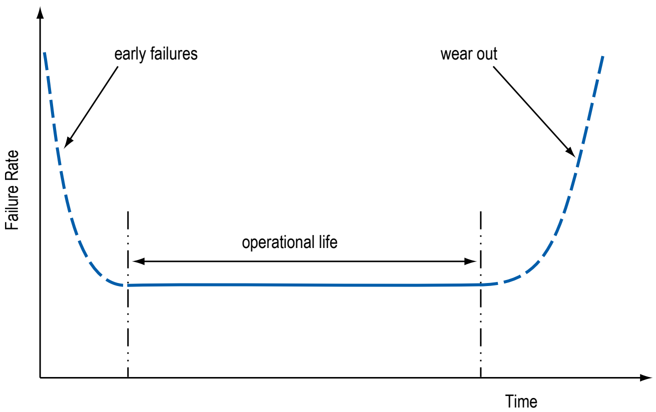
End of Life Definition
Catastrophic Failure: short circuit, open circuit or safety vent operation
Parametric Failure:

- Change in capacitance > ±10%
- Leakage current > specified limit
- ESR > 2 x initial ESR value

Failure Rate cont'd

MTBF

The mean time between failures (MTBF) is simply the inverse of the failure rate.
MTBF= 1/λ



Estimated field failure rate: ≤ 0.15 ppm (failures per year/produced number of capacitors per year)
The expected failure rate for this capacitor range is based on field experience for capacitors with structural similarity.

Environmental Compliance

As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of some hazardous materials, such as lead (Pb), in electronic equipment. All products in this catalog are produced to help our customers' obligations to guarantee their products and fulfill these legislative requirements. The only material of concern in our products has been lead (Pb), which has been removed from all designs to fulfill the requirement of containing less than 0.1% of lead in any homogeneous material. KEMET will closely follow any changes in legislation world wide and makes any necessary changes in its products, whenever needed.

Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.

RoHS Compliant

Table 1A – PEH126, Ratings & Part Number Reference

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current Maximum				ESR Maximum		L_{ESL}	Part Number
	100 Hz 20°C (µF)		D x L (mm)	100 Hz 125°C (A)	≥ 5 kHz 105°C (A)	≥ 5 kHz 125°C (A)	≥ 5 kHz 150°C (A)	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	Approximate (nH)	
25	680	F	16.5 x 29	1.4	6.9	4.1	1.6	120	43	10	PEH126HF368EQE1
25	1000	G	16.5 x 37	1.7	8.8	5.2	2.0	80	28	12	PEH126HG410EQE1
25	1500	G	16.5 x 37	2.1	9.2	5.4	2.1	63	26	12	PEH126HG415EQE1
40	470	F	16.5 x 29	1.1	5.9	3.5	1.3	150	45	10	PEH126KF347EQE1
40	600	G	16.5 x 37	1.4	8.3	4.9	1.9	120	30	12	PEH126KG360EQE1
63	250	F	16.5 x 29	0.9	5.3	3.1	1.2	240	53	10	PEH126MF325EQE1
63	370	G	16.5 x 37	1.2	6.7	3.9	1.5	160	37	12	PEH126MG337EQE1
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current				ESR		L_{ESL}	Part Number

Table 1B – PEH220, Ratings & Part Number Reference

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR Maximum			Part Number
				Maximum			Rated	Maximum				
	100 Hz 20°C (µF)		D x L (mm)	≥ 5 kHz 125°C (A)[1]	≥ 5 kHz 140°C (A)[1]	≥ 5 kHz 150°C (A)[1]	≥ 5 kHz 125°C (A)[2]	≥ 5 kHz 125°C (A)[3]	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	5 – 100 kHz 1 25 – 150°C (mΩ)	
25	1500	F	16 x 27	13.9	8.8	3.9	4.8	6.1	78	42	18.4	PEH220HF4150M
25	2200	G	16 x 35	15.8	10.0	4.5	5.8	7.4	56	31	14.3	PEH220HG4220M
40	800	F	16 x 27	13.6	8.6	3.9	4.7	5.9	108	43	19.2	PEH220KF3800Q
40	1200	G	16 x 35	15.5	9.8	4.4	5.7	7.2	74	31	14.8	PEH220KG4120Q
63	250	F	16 x 27	10.5	6.6	3.0	3.6	4.5	233	59	32.4	PEH220MF3250Q
63	370	G	16 x 35	12.2	7.7	3.5	4.5	5.7	160	42	23.9	PEH220MG3370Q
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR			Part Number

[1] *Capacitor mounted with low thermal resistance path (heat-sink)*
[2] *Continuous operation at natural convection (D=20, 4000h; D=16, 3000h)*
[3] *Reduced life (D=20, 2000h; D=16, 1500h)*

Table 1C – PEH225, Ratings & Part Number Reference

VDC	VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR Maximum			Part Number
					Maximum			Rated	Maximum (Reduced Voltage)				
	(150°C)	100 Hz 20°C (µF)		D x L (mm)	≥ 5 kHz 125°C (A)[1]	≥ 5 kHz 140°C (A)[2]	≥ 5 kHz 150°C (A)[3]	≥ 5 kHz 125°C (A)[4]	≥ 5 kHz 125°C (A)[4]	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	5 – 100 kHz 125 – 150°C (mΩ)	
25	18	2200	F	16 x 27	17.3	11.0	4.9	6.1	7.7	60	34	11.9	PEH225HF4220M
25	18	3000	G	16 x 35	19.7	12.5	5.6	7.4	9.4	44	25	9.2	PEH225HG4300M
40	32	1200	F	16 x 27	16.6	10.5	4.7	5.8	7.4	80	36	13	PEH225KF4120M
40	32	1800	G	16 x 35	19.3	12.2	5.5	7.2	9.2	55	25	9.6	PEH225KG4180M
63	54	470	F	16 x 27	12.1	7.7	3.4	4.2	5.3	156	52	24.3	PEH225MF3470Q
63	54	680	G	16 x 35	13.8	8.7	3.9	5.3	6.7	109	37	18.7	PEH225MG3680Q
VDC	VDC (150°C)	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR			Part Number

[1] *Capacitor-mounted with low thermal resistance path (heat-sink).*
[2] *Valid for capacitor supplied with reduced DC voltage, capacitor-mounted with low thermal resistance path.*
[3] *Continuous operation at natural convection (D=20, 4,000h; D=16 3,000h).*
[4] *Reduced Life (D=20, 2000h; D=16, 1500h).*

Table 1B – PEH226, Ratings & Part Number Reference

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR Maximum			Part Number
				Maximum			Rated	Maximum				
	100 Hz 20°C (µF)		D x L (mm)	≥ 5 kHz 125°C (A)[1]	≥ 5 kHz 140°C (A)[1]	≥ 5 kHz 150°C (A)[1]	≥ 5 kHz 125°C (A)[2]	≥ 5 kHz 125°C (A)[3]	100 Hz 20°C (mΩ)	100 kHz 20°C (mΩ)	5 – 100 kHz 1 25 – 150°C (mΩ)	
25	1500	F	16 x 27	16.8	10.6	4.7	5.9	7.4	72	36	12.7	PEH226HF4150M
25	2200	G	16 x 35	19.2	12.1	5.4	7.2	9.1	51	26	9.7	PEH226HG4220M
40	800	F	16 x 27	16.2	10.2	4.6	5.6	7.2	100	36	13.6	PEH226KF3800Q
40	1200	G	16 x 35	18.6	11.8	5.3	7.0	8.8	69	26	10.3	PEH226KG4120Q
63	250	F	16 x 27	11.5	7.3	3.3	4.0	5.1	227	53	26.9	PEH226MF3250Q
63	370	G	16 x 35	13.6	8.6	3.9	5.1	6.4	155	37	19.2	PEH226MG3370Q
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current					ESR			Part Number

[1] *Capacitor mounted with low thermal resistance path (heat-sink)*
[2] *Continuous operation at natural convection (D=20, 4000h; D=16, 3000h)*
[3] *Reduced life (D=20, 2000h; D=16, 1500h)*

Packaging Quantities

Size Code	Packaging Quantities
	Bulk
F	100
G	100

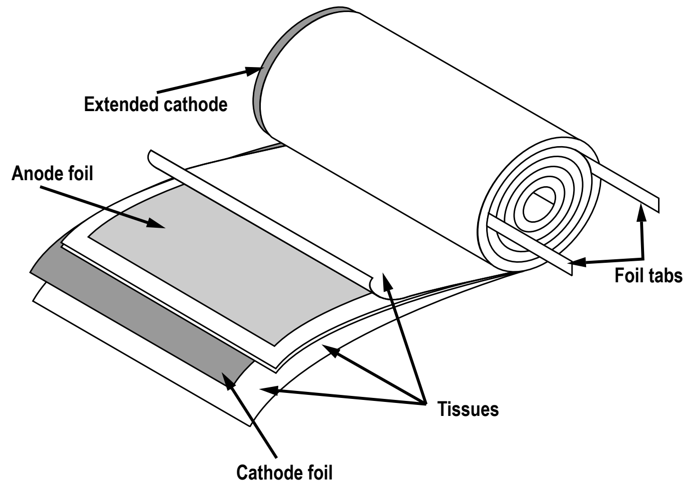
Print Detail

Standard Marking for PEG and PEH types

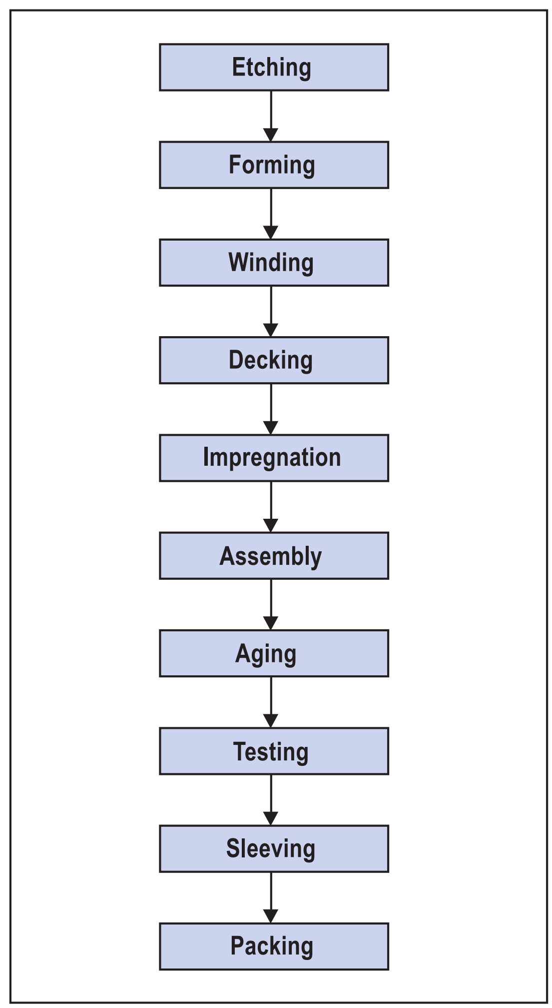
- KEMET Logo
- Rated capacitance
- Capacitance tolerance
- Rated voltage
- Date code
- Polarity indication
- Article code

Construction

The manufacturing process begins with the anode foil being electrochemically etched to increase the surface area and then “formed” to produce the aluminum oxide layer. Both the anode and cathode foils are then interleaved with absorbent paper and wound into a cylinder. During the winding process, aluminum tabs are attached to each foil to provide the electrical contact.



The deck, complete with terminals, is attached to the tabs and then folded down to rest on top of the winding. The complete winding is impregnated with electrolyte before being housed in a suitable container, usually an aluminum can, and sealed. Throughout the process, all materials inside the housing must be maintained at the highest purity and be compatible with the electrolyte.



Each capacitor is aged and tested before being sleeved and packed. The purpose of aging is to repair any damage in the oxide layer and thus reduce the leakage current to a very low level. Aging is normally carried out at the rated temperature of the capacitor and is accomplished by applying voltage to the device while carefully controlling the supply current. The process may take several hours to complete.

Damage to the oxide layer can occur due to variety of reasons:

- Slitting of the anode foil after forming
- Attaching the tabs to the anode foil
- Minor mechanical damage caused during winding

A sample from each batch is taken by the quality department after completion of the production process.

The following tests are applied and may be varied at the request of the customer. In this case the batch, or special procedure, will determine the course of action.

Electrical:

- Leakage current
- Capacitance
- ESR
- Impedance
- Tan Delta

Mechanical/Visual:

- Overall dimensions
- Torque test of mounting stud
- Print detail
- Box labels
- Packaging, including packed quantity

IEC Qualifications

This is the summary of test methods and requirements from IEC Publication 60384–4: Aluminum Electrolytic Capacitors with Non-Solid Electrolyte. Reference to relevant test methods is given below:

Test	IEC Publication	Procedure	Requirements
Mechanical Test Robustness of Terminations:	60068–2–21		No leakage of electrolyte or other visible damage. Deviations in capacitance, and tanδ from initial measurements must not exceed: Δ C/C < 5% tanδ ≤ 1.2 x initial value
Test Ua: Tensile		Loading force 10 N (0.5 < d ≤ 0.8) 20 N (0.8 < d ≤ 1.25)	
Test Ub: Bending		Loading force 5 N, two bends	
Test Uc: Torsion, Severity 2		Two successive rotations of 180° during 10 – 15 seconds, 2.0 Nm for M 5 mm thread	
Test Ud: Torque, Severity 1		2.5 Nm for M 6 mm thread	
Resistance to Soldering Heat Test T	60068–2–20	Solder bath method 260°C 10 seconds	
Solderability Test T	60068–2–20	Solder bath method 235 ±5°C/2±0.2 seconds for SnPb solder 245 ±5°C/3±0.3 seconds for SnAgCu solder 250 ±5°C/3±0.3 seconds for SnCu solder	Good tinning
Rapid Change of Temperature Test Na	60068–2–14	5 cycles Duration of exposure: 3 hours Recovery period: 16 hours	No leakage of electrolyte or other visible damage. Deviations in capacitance and tanδ from initial measurements must not exceed: Δ C/C < 5%.
Vibration Test Fc	60068–2–6	Procedure B4 **PEH169 and PEH200:** Frequency range: 10 – 500 Hz Amplitude: 0.75 mm or acceleration 10 g Time: 3 x 2 hours Big cans Ø 65, 75 and 90 mm Frequency range: 10 – 55 Hz Amplitude: 0.75 mm or acceleration 10 g Time: 3 x 2 hours **ALS 30/31/32/36/37/40/41/42/43:** Frequency range: 10 – 55 Hz Amplitude: 0.75 mm or acceleration 10 g Time: 3 x 2 hours except 220 mm long cans 10 – 55 Hz at 0.35 mm or 5 g for 3 x 0.5 hours **PEG124:** Frequency range: 10 – 500 Hz Amplitude 0.75 mm or acceleration 10 g Time 3 x 2 hours Ø 16 – 20 mm to be clamped by their body **PEG126 and PEH526:** Clamped body Frequency range: 10 – 2,000 Hz Amplitude: 1.5 mm or acceleration 20 . Time: 3 x 2 hours	No leakage of electrolyte or other visible damage. Deviations in capacitance and tanδ from initial measurements must not exceed: Δ C/C < 5%.

IEC Qualifications cont'd

Test	IEC Publication	Procedure	Requirements
Vibration Test Fc	60068–2–6	**PEG220, PEG225, PEG 226:** Clamped body Frequency range: 10 – 2,000 Hz Amplitude: 1.5 mm or acceleration 20 g Time 3 x 22 hours **PEH506/532/534/536** **ALC 10/12/40/42:** Clamped body Frequency range: 10 – 500 Hz Amplitude: 0.75 mm or acceleration 10 g Time: 3 x 2 hours, except ø 45, ø 50 mm: 10 – 55 Hz at 0.35 mm or 5 g for 3 x 0.5 hours	No leakage of electrolyte or other visible damage. Deviations in capacitance and tanδ from initial measurements must not exceed: Δ C/C < 5%.
Shock Test Ea	60068-2-27	Degree of severity Acceleration: 490 m/s^2 Duration of pulse: 11 ms Capacitors shall be mounted using clamps supplied by KEMET or shall be mounted by their stud, reinforced with clamps supplied by KEMET.	No leakage of electrolyte or other visible damage. Deviations in capacitance from initial measurements must not exceed: ΔC/C < 5%.
Climatic Test Climatic Sequency Test 4.21	60384–1		
1. Dry Heat Test Ba	60068–2–2	Temperature = upper category temperature Duration 16 hours	
2. Damp Heat, Cyclic Test Db	60068–2–30	Upper temperature 55°C 1 cycle of 24 hours at 55 ±2°C RH 95 to 100%, no voltage applied	
3. Cold Test Aa	60068–2–1	Temperature = lower category temperature Duration: 16 hours	
4. Low Air Pressure Test M	60068–2–13	Pressure 44 mbar (4.4 kPa) Temperature 15 – 35°C Duration: 5 minutes During the last minute the rated voltage (V_R) to be applied	
5. Damp Heat, Cyclic	60068–2–30	Remaining 5 cycles Upper temperature +55°C	No leakage of electrolyte or other damage. The marking to be legible. The difference in capacitance from the initial measurement must not exceed 10%.
Damp Heat Steady State Test Ca	60068–2–3	Duration: 56 days	No leakage of electrolyte or other visible damage. The marking to be legible. No breakdown or flashover.
		After the test a voltage test is performed between terminations connected to case and a metal foil wrapped around the insulation, V-block as an alt. 1,000 VDC, 60 seconds. Insulation resistance measurement. 100 VDC, 60 seconds	Insulation resistance ≥100 MΩ.

IEC Qualifications cont'd

Test	IEC Publication	Procedure	Requirements
Life Test Endurance Test 4.13 Long Life Types	60384–4	(1) 2,000 hours at upper category temperature The ripple current given in the part number to be superimposed. PEG124 125°C PEG126 150°C PEG220/22/226 150°C PEH169 105°C PEH200/PEH506 85°C PEH532/534/536 105°C PEH526 125°C ALC12 85°C ALS40/ALS/42/ALC42 105°C (2) 5,000 hours at upper category temperature The ripple current given in the part number to be superimposed. PEH169 85°C PEG124, ALC40 105°C ALS 30/31/32/33 85°C ALS 36/37 ALC10 85°C ALP/T/N 20/22 85°C	No leakage of electrolyte or other visible damage. The marking to be legible. Δ C/C +15/-30% $V_R \leq 6.3$ VDC Δ C/C ±15% $6.3 \leq V_R \leq 160$ VDC Δ C/C ±10% for $V_R > 160$ VDC Leakage current ≤ the limit in the article list ESR ≤ 2 x initial value PEH500 range ESR ≤ 3 x initial specified limit No flashover or breakdowns in voltage proof at 1,000 VDC
Surge Voltage Test 4.14	60384–4	The capacitor to be subjected to 1,000 cycles of charge to voltage 0.5 minute load period followed by a no load period of 5 minute 30 seconds. Temperature = upper category temperature Applied voltage: 1.15 x rated voltage for $V_R \leq$ 315 V. 1.10 x rated voltage for $V_R > 315$ V. Time constant for charge 0.1 ± 0.05 seconds Duration: 30 seconds Recovery: 1–2 hours	No leakage of electrolyte or other visible damage. Δ C/C ≤ 15% Leakage current and tangent of the loss angle not to exceed the values given in the article list.
Pressure Relief Test 4.16	60384–4	A DC voltage is applied in the reverse direction to give a current of 1 to 10A	The pressure relief is to open in such away that any danger of explosion or fire is eliminated.
Storage at High Temperature Test Ba	60068–2–2	96 ± 4 at upper category temperature. Recovery: minimum 16 hours	No leakage of electrolyte or other visible damage. Leakage current ≤ 2 x the maximum value in the part number. Δ C/C – 10%
Storage at Low Temperature Test Aa	60068–2–1	72 hours lower category temperature acc. to table below. Category Temperature °C 25/-/- –40 40/-/- –55 55/-/- –65 Recovery: minimum 16 hours	No leakage of electrolyte or other visible damage. The marking to be legible. Δ C/C ≤ 10%. The leakage current and tangent loss angle to be lower or equal to the values given in the article list.

IEC Qualifications cont'd

Test	IEC Publication	Procedure	Requirements
Characteristics at High and Low Temperature Test 4.19	60068–2	Test Aa of 60068-2-1 followed by Test Ba of 60068–2–2 Temperature lower respectively upper category temperature. The impedance to be measured at lower category temperature. Leakage current, tanδ and capacitance to be measured at upper category temperature.	The ratio of the impedance measured at lower category temperature and initially must not exceed the values listed below. Rated Voltage VDC — Ratio of Impedance $V_R \le 6.3$ — 5 $6.3 < V_R < 16$ — 4 $16 < V_R \le 160$ — 3 $V_R > 160$ — 6
Charge and Discharge Test 4.20	60384–4	Number of cycles: 10^6 Temperature: 20°C Charge applied voltage: V_R Duration: 0.5 second Time constant: 0.1 second Discharge The discharge resistor to give a time constant = 0.1 second	No leakage of electrolyte or other visible damage. Δ C/C ≤ 10%
Fire Hazard Testing	60695–2–2	Needle-flame test. Duration of test flame: 30 seconds	Maximum burning time after removal of test flame: 30 seconds

Product Safety

THESE NOTES SHOULD BE READ IN CONJUNCTION WITH THE PRODUCT DATA SHEET. FAILURE TO OBSERVE THE RATINGS AND THE INFORMATION ON THIS SHEET MAY RESULT IN A SAFETY HAZARD.

Warning

When potentially lethal voltages e.g. 30V a.c. (r.m.s) or 60V d.c. are applied to the terminals of this product, the use of a hazard warning label is recommended. In the case of motor start capacitors they meet the requirements of British Standard Specifications BS.5267: 1976 and reference should be made to Appendix C -Guide for installation and operation.

1. Electrolyte

Aluminum electrolytic capacitors contain liquids (electrolytes) which can be hazardous. The electrolytes are conducting solutions of organic and/or boric acid, neutralized with amines or ammonia, in a variety of solvents. The major solvents are butyrolactone and ethylene glycol. Co-solvents e.g. N-methyl pyrolidone may be present. Inorganic or organo-phosphates are present in low concentration. The physical, chemical and toxicological properties of the electrolytes are largely determined by the solvents, as summarized below:

Physical Properties

1. Low viscosity–typically 5 – 50 cp at 25°C
2. Combustible–flash points 95 – 120°C
3. Low vapor pressure– < 20 mm Hg at 25°C

Chemical properties

1. Non-corrosive
2. Can be aggressive to many plastics, lacquers and resins
3. Totally soluble in hot water

Toxicology

The electrolytes are moderately toxic, with LD50 values in the range 1.5 – 2 g/Kg. Skin exposure can cause drying and defatting. Severe irritation may be caused to the mucous membranes, particularly the eyes, where conjunctivitis may result.

Safety Precautions

In the event of electrolyte escape, wash the affected area with hot water. Use rubber gloves to avoid skin contact. Any contact with the eyes should be liberally irrigated with water and medical advice sought.

Note: The electrolyte systems do not contain materials currently listed as carcinogenic, mutagenic or teratogenic, e.g., polychlorinated biphenyls (PCBs), dimethylformamide (DMF) or dimethylacetamide (DMA).

2. Intrinsic Properties

Operating

DC capacitors are polar devices and will operate safely only if correctly connected. Reversing the connections will result in high leakage currents which could subsequently cause short circuit failure, rupture of the safety vent, and possibly explosion and fire. Correctly polarized operation may result in the above failure modes if:

- The surge voltage is exceeded
- The ambient temperature is too high
- Excessive ripple currents are applied

AC types are non-polar. Catastrophic failure may be caused by:

- Abnormal duty cycles
- Voltage in excess of rated value
- Ambient temperature too high

Non-Operating

Aluminum electrolytic capacitors contain liquids which can leak out (see material content).

Damage to the encapsulation may cause leakage of the electrolyte. Excessive torque or soldering heat may affect the performance of the capacitor or damage the sealing. Electric shock may result if capacitors are not discharged.

3. Disposal

Aluminum electrolytic capacitors are consignable waste under the Special Waste Regulations 1996 (Statutory Instrument 1996 No 972), which complies with the EC Hazardous Waste Directive – Directive 91/689/EEC. The electrolyte should therefore be treated as a hazardous waste and advice should be sought from the local office of the Environmental Agency regarding its disposal.

Due to the construction of an aluminum electrolytic capacitor, high temperature incineration may cause the component to explode due to build-up of internal pressure. In addition, incineration may also cause the emission of noxious fumes. If it is decided that this is the best practicable option then it must be carried out under controlled conditions and at a minimum temperature of 1200°C. It should also be confirmed that the incinerator is authorized under parts A or B of the Environmental Protection Act.

The alternative is to dispose of them in an engineered lined landfill site that is licensed to take materials identified on the safety sheet. It should be stressed that these capacitors are not to be disposed of in a landfill site set aside for domestic waste.

KEMET strongly recommends that if there are any doubts regarding the disposal of aluminum electrolytic capacitors, that advice be sought from the local regulating authority.

In addition, KEMET would like to request that users of aluminum electrolytic capacitors respect the needs of the environment and, wherever possible, recover as much of the materials as possible, i.e. aluminum.

4. Unsafe Use

Most failures are of a passive nature and do not represent a safety hazard. A hazard may, however, arise if this failure causes a dangerous malfunction of the equipment in which the capacitor is employed. Circuits should be designed to fail safe under the normal modes of failure.

The usual failure mode is an increase in leakage current or short circuit. Other possible modes are decrease of capacitance, increase in dissipation factor (and impedance) or an open circuit.

Capacitors should be used in a well-ventilated enclosure or cabinet.

5. Mounting

Care should be taken when mounting by clamp, that any safety vent in the can is not covered.

6. Fumigation

In many countries throughout the world it is now common practice to fumigate shipments of products in order to control insect infestation, particularly when wooden packaging is used. Currently, methyl bromide is widely used as a fumigant, which can penetrate cardboard packing and polymer bags and, therefore, come into direct contact with equipment or components contained within.

If aluminum electrolytic capacitors become exposed to methyl bromide then corrosion may occur, depending upon the concentration and exposure time to the chemical.

This failure mode can affect all types of KEMET aluminum electrolytic capacitors. Methyl bromide can penetrate the seals of aluminum electrolytic capacitors and cause internal corrosion of the anode connection, resulting in the component becoming open circuit. The rate of corrosion will depend upon the level of exposure to methyl bromide as well as the subsequent operating conditions, such as voltage and temperature. It may take months or, in some cases, several years before the component becomes open circuit.

7. Dielectric Absorption

A phenomenon known as dielectric absorption can cause aluminum electrolytic capacitors to recharge themselves. The phenomenon is well known but impossible to predict with any great accuracy, so potentially any electrolytic product could be affected. Thus, a capacitor that has been charged and then completely discharged will appear to recharge itself if left open circuit; this will manifest itself as a small voltage across the terminals of the capacitor. Generally, the voltages seen are less than 20 VDC. However, higher voltages have on occasion been reported.

In order to avoid any problems caused by this voltage, KEMET recommends that capacitors be discharged before connecting to the terminals.

8. Flammability

Most plastics and elastomers are combustible (e.g., will ignite if an ignition source is applied under suitable conditions of temperature and oxygen level). For most published data, the UL 94 Horizontal or Vertical Burning System has been applied. Although useful for comparative values, this test is not practicable, as the ignition characteristics are strongly influenced by the material dimensions and other materials with which they may be in intimate contact. KEMET has completed a series of flammability tests based on a Needle Flame Test, as specified in IEC 60695–2–2. Details of the tests undertaken on both the external components and internal wind elements can be found in a full technical article, TD005, Flammability Characteristics contained within KEMET Aluminum Electrolytic Capacitors – Application Notes.

Fire Classification of Materials			
		Oxygen Index	Corresponding UL Standard
PEG124, PEG126, PEG127, PEG220-226	Tape (polyester)	20	UL 94 HB
PEH169 – PEH200 Series	Cover (phenolic - vyncolite)	35	UL 94 V-0
	Insulating cup (polypropylene)	17	UL 94 HB
ALS Series	Cover (phenolic - plenco)	30	UL 94 HB
ALS/C/P/T/N Series	Insulating sleeve (PVC)	35	UL 224 VW-1
	End disc (polypropylene)	17	UL 94 HB
ALS (on request)	Insulating sleeve (polyolefin)	34	UL94 V-2
PEH500 Series	Sleeve (PVC)	60	UL 94 V-0
ALC/P/T/N Series	Cover (phenolic - laminate)	51.3	NO DATA
MS/MD Series	Plastic case (noryl)	32	UL 94 V-1
Accessories	PYB mounting nut (polyamid)	26	UL 94 V-2

Application and Operation Guidelines

Selection of an electrolytic capacitor for reliable operation in a particular application should be based on a complete working condition specification.

An electrolytic capacitor used for smoothing, energy storage or filtering of a rectified AC voltage will be loaded with an AC ripple current causing a power loss and heating of the capacitor. The temperature in the hottest part inside the capacitor, the hot spot, is the major factor influencing operational life. The hot spot temperature is dependent upon several factors:

- Power loss caused by AC current
- Thermal resistance between the hot spot and the ambient
- Ambient temperature and capacitor cooling condition

KEMET's electrolytic can types and axial's are designed for operation under severe climatic conditions and for heavy ripple current load. This requires low internal losses and an efficient heat transfer between the capacitor hot spot and the ambient. The internal thermal design and the method of mounting the capacitor are therefore of equal importance for reliability and operational life, together with the capacitor's electrical design. Long term high parameter stability is the key to long life, as well as the ability to withstand high temperature and high ripple current. The power loss P in the capacitor can be calculated from:

$P = R_{ESR} \text{ x } I_{AC}^2$

R_{ESR} is dependent on the frequency f, and winding temperature. With complex current waveform it is therefore necessary to calculate the contribution from each harmonic frequency to the power loss.

$P = R_{ESR} (f_1) x I_{AC}^2 (f_1) + R_{ESR} (f_2) x I_{AC}^2 (f_2) (W)$

The thermal resistance R_{th}, (°C/W) of a capacitor is defined from the power loss P and the temperature difference, ΔT between the hot spot temperature, T_h and the ambient temperature, T_a in the thermal equilibrium.

$\Delta T = P \text{ x } R_{th}$

$Th = \Delta T + T_a$

The power P is assumed to be generated in the hot spot.

R_{th} (total thermal resistance) can be divided in two parts. R_{thhc} is the inner thermal resistance between the hot spot and the case. R_{thca} is the outer thermal resistance between the case and the ambient.

$\Delta T = P \text{ x } (R_{thhc} + R_{thca})$

R_{thhc} is dependent on the capacitor design; R_{thca} is dependent on cooling conditions. In electrolytic capacitors, heat generated in the winding is easily transferred in the axial direction. With this design a very low R_{thhc} is achieved and, thus, a very low temperature difference between the hot spot and the case. The operational life of long life electrolytic capacitors is dependent upon the evaporation of electrolyte through the seal.

At voltages up to rated voltage and at high temperatures there are practically no other factors that influence the life of the capacitors. Sealing materials are selected for minimum of diffusion losses.

Even if the Hot Spot temperature, T_h determines service life, the case temperature, T_c is better suited as a reference temperature for the calculation of service life. T_c is the temperature of a well defined surface area (the bottom of the case beneath the insulation). It is easily measured when e.g. effect of forced cooling is determined. For a certain power loss P the temperature difference between T_h and T_c is a constant.

$T_h = T_c + P \text{ x } R_{thhc}$

Parallel and Series Operation

Special considerations arise when electrolytic capacitors are used in series or parallel banks.

In series operation, matching of capacitance values may be necessary to avoid imbalance during charging and discharging mode. Steps must be taken to ensure adequate DC voltage distribution while biased, either by providing shunt resistors to compensate for inequalities in capacitor DC leakage currents, or some other means.

There are two major configurations to consider when constructing a series/parallel bank of capacitors - individual balancing resistors and common center connection. Individual balancing resistors afford greater protection for the capacitors if one becomes short circuited, but is more complex to construct and expensive. Common center connections give improved balancing during steady state and transient conditions, but offer the possibility of exposing one half of the bank to full voltage should one capacitor short circuit.

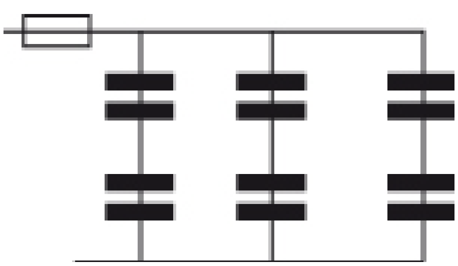
Full details on the section and use of shunt resistors can be found in the separate application notes produced by KEMET.

In parallel operation, particularly large, high voltage banks, the possibility of capacitors discharging into each other may entail special precautions in certain applications.

Series/Parallel Bank Protection

There are three major configurations to consider in protecting a series/parallel bank of capacitors. The advantages and disadvantages of each are outlined below but the final choice must be made by the equipment designer.

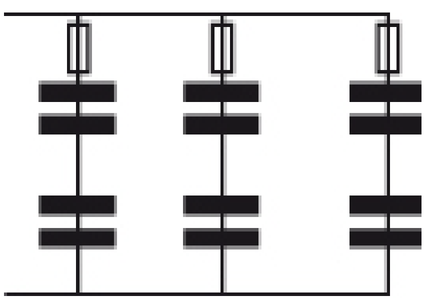
Option 1 – Fusing for Whole Bank



Advantages
- Simple construction
- Inexpensive

Disadvantages
- Only offers basic protection
- Cannot protect against internal discharges within bank

Option 2 – Individual capacitor fuses



Advantages
- Removes faulty capacitor from circuit

Disadvantages
- Expensive
- Complex assembly (busbars and fuses)

Option 3 – Electronic monitoring

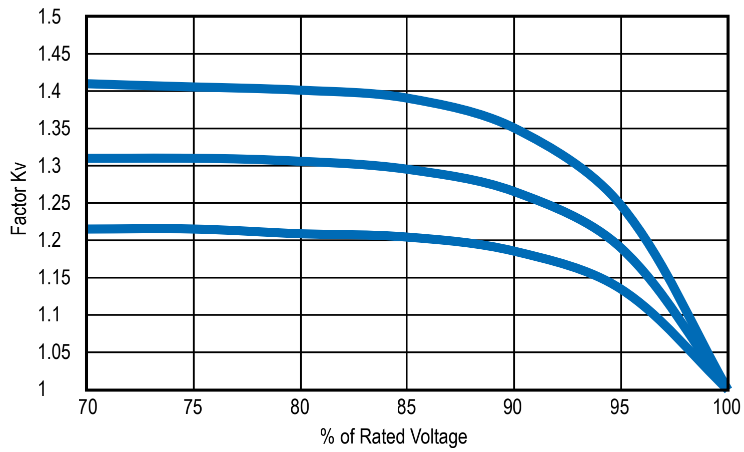
Advantages
- May prevent serious failure by early shutdown of equipment
- Optional bank discharge mechanism to prevent capacitors dumping charge into failed capacitor

Disadvantages
- Must be designed into control circuitry
- Complex and expensive

Voltage Derating

If capacitors are operated at a voltage below their rated value then the reduced stress and lower leakage current will give an improvement in the life expectancy.

Since leakage current increases with temperature, the benefit of a reduced operating voltage is more pronounced at higher temperatures. The graph below shows the voltage derating factor (Kv) for products with a rated temperature of 85°C and core temperatures (T_c) of 45°C, 65°C and 85°C.



The life expectancy of a capacitor at full rated voltage is multiplied by the voltage derating factor to obtain the new life expectancy at the lower operating voltage:

$Le_{(Vop)} = Le(V_R) \times Kv$

$Le_{(Vop)}$ - Life expectancy at operating voltage

$Le(V_R)$ - Life expectancy at rated voltage

Kv - Voltage derating factor

Polarity and Reversed Voltage

Aluminum electrolytic capacitors manufactured for use in DC applications contain an anode foil and a cathode foil. As such, they are polarized devices and must be connected with the +ve to the anode foil and the -ve to the cathode foil. If this were to be reversed then the electrolytic process that took place in forming the oxide layer on the anode would be recreated in trying to form an oxide layer on the cathode. In forming the cathode foil in this way heat would be generated and gas given off within the capacitor, usually leading to catastrophic failure.

The cathode foil already possesses a thin stabilized oxide layer. This thin oxide layer is equivalent to a forming voltage of approximately 2V. As a result, the capacitor can withstand a voltage reversal of up to 2V for short periods. Above this voltage the formation process will commence.

Aluminum electrolytic capacitors can also be manufactured for use in intermittent AC applications by using two anode foils in place of one anode and one cathode.

Case Polarity

Due to the presence of electrolyte in the capacitor, the aluminum can, stud mounting and any dummy pins will essentially be at the same potential as the negative terminal. It is therefore recommended that they are either:
- Left unconnected
- Connected to the same potential as the negative terminal
- Insulated

Mounting

All aluminum electrolytic capacitors incorporate a safety vent in order to relieve build up of internal pressure due to overstress or catastrophic failure. For the smaller ranges, such as snap-in or solder pin types, this takes the form of a weakened area in the side or base of the can. For the larger screw terminal types, the vent is incorporated in the deck.

In all cases consideration must be given, when mounting the capacitor, to the operation of the vent under failure conditions. It is recommended that capacitors are always mounted with the safety vent uppermost, or in the upper part of the device. Should the vent operate, the least amount of electrolyte will then be expelled.

It is worth noting that screw terminal capacitors may be mounted in any position so long as the vent can operate safely. The operational and parametric performance is totally unaffected by the physical orientation, but should the vent operate with the capacitor mounted upside down then a few drops of electrolyte may be expelled.

Board mounting types are designed to be mounted by their terminals alone. Larger types may have dummy pins for extra rigidity. Screw terminal and tag ended types may be fixed with a base stud or suitable mounting clamp. Adequate space should be allowed between components for cooling air to circulate, particularly when high ripple currents are being applied.

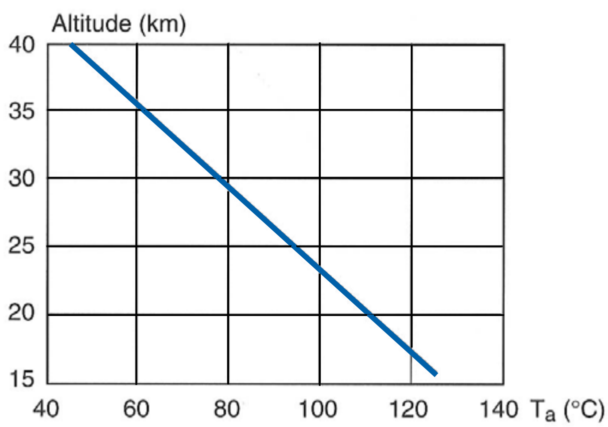
Altitude and Low Air Pressure

If a capacitor is operated at altitude, the life will be affected slightly for two reasons:

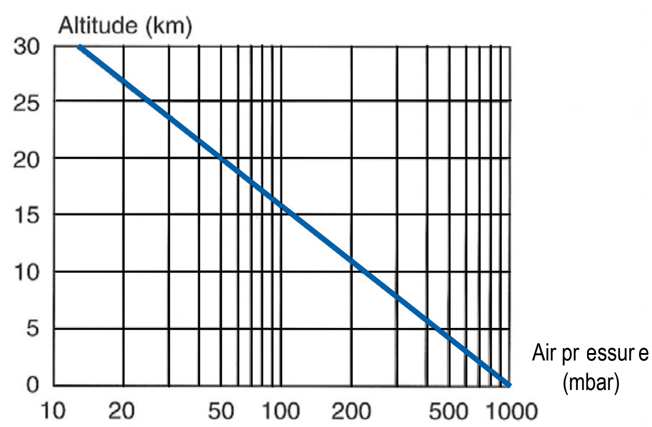
1. Convected heat loss will be reduced as the air density falls, resulting in the capacitor running hotter with a consequent reduction in life.

2. As the air pressure drops the differential between the internal case pressure and external pressure increases. A complete vacuum would cause the internal pressure to rise by approximately 15 psi. If maintained this would lead to increased electrolyte vapor loss and give a slight reduction in life expectancy.

Maximum altitude as a function of the ambient temperature (T_a)



Air pressure as a function of the altitude.



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Shenzhen, China
Tel: 86-755-2518-1306

Beijing, China
Tel: 86-10-5829-1711

Shanghai, China
Tel: 86-21-6447-0707

Taipei, Taiwan
Tel: 886-2-27528585

Southeast Asia
Singapore
Tel: 65-6586-1900

Penang, Malaysia
Tel: 60-4-6430200

Bangalore, India
Tel: 91-806-53-76817

Other KEMET Resources

Tools	
Resource	Location
Configure A Part: CapEdge	http://capacitoredge.kemet.com
SPICE & FIT Software	http://www.kemet.com/spice
Search Our FAQs: KnowledgeEdge	http://www.kemet.com/keask
Electrolytic LifeCalculator	http://www.kemet.com:8080/elc

Product Information	
Resource	Location
Products	http://www.kemet.com/products
Technical Resources (Including Soldering Techniques)	http://www.kemet.com/technicalpapers
RoHS Statement	http://www.kemet.com/rohs
Quality Documents	http://www.kemet.com/qualitydocuments

Product Request	
Resource	Location
Sample Request	http://www.kemet.com/sample
Engineering Kit Request	http://www.kemet.com/kits

Contact	
Resource	Location
Website	www.kemet.com
Contact Us	http://www.kemet.com/contact
Investor Relations	http://www.kemet.com/ir
Call Us	1-877-MyKEMET
Twitter	http://twitter.com/kemetcapacitors

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Although KEMET designs and manufactures its products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product–related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicted or that other measures may not be required.

Digitally signed by Jeannette Calvo
DN: c=US, st=FL, l=Fort Lauderdale, o=KEMET Corp., ou=Marketing Communications, cn=Jeannette Calvo, email=jeannettecalvo@kemet.com
Date: 2013.08.05 12:49:02 -04'00'

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Quality

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People: Leadership
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KEMET Production System

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