Overview

The KEMET ESH radial aluminum electrolytic capacitors offer high CV and are designed for high quality, high reliability applications requiring a miniature solution.

Applications

Typical applications include general purpose coupling, decoupling, bypass, and filtering.

Benefits

- Suited for high quality, high reliability applications
- High CV
- 2,000 hour operating life
- Operating temperature of up to +105°C
- Case with Ø D ≥ 5 mm
- Safety vent on the capacitor base



Part Number System

ESH	107	M	6R3		A	C3	AA
Series	Capacitance Code (pF)	Tolerance	Rated Voltage (VDC)		Electrical Parameters	Size Code	Packaging
Radial Aluminum Electrolytic	First two digits represent significant figures for capacitance values. Last digit specifies the number of zeros to be added.	M = ±20%	6R3 = 6.3 010 = 10 016 = 16 025 = 25 035 = 35 050 = 50 063 = 63 100 = 100	160 = 160 200 = 200 250 = 250 350 = 350 400 = 400 420 = 420 450 = 450 500 = 500	A = Standard	See Dimension Table	See Ordering Options Table

Ordering Options Table

Diameter	Length	Packaging Type	Lead Type	Lead Length (mm)	Lead and Packaging Code
Standard Bulk Packaging Options					
4 – 22	All	Bulk (bag)	Straight	20/15 Minimum	AA
Tape & Reel					
4 – 5	All	Tape & Reel	Formed to 2.5 mm	H_0 = 16 ±0.75	LA
4 – 8	All	Tape & Reel	2.5 mm lead spacing	H_0 = 18.5 ±0.75	KA
4 – 8	All	Tape & Reel	Formed to 5 mm	H_0 = 16 ±0.75	JA
10	≤ 20	Tape & Reel	Straight	H_0 = 18.5 ±0.75	KA
Ammo Pack					
4 – 8	All	Ammo	Formed to 5 mm	H_0 = 16 ±0.75	DA
4 – 8	All	Ammo	Straight	H_0 = 18.5 ±0.75	EA
4 – 5	All	Ammo	Formed to 2.5 mm	H_0 = 16 ±0.75	FA
10 – 13	All	Ammo	5 mm lead spacing	H_0 = 18.5 ±0.75	EA
16	All	Ammo	7.5 mm lead spacing	H_0 = 18.5 ±0.75	EA
18	≤ 25	Ammo	7.5 mm lead spacing	H_0 = 18.5 ±0.75	EA
Contact KEMET for other lead and packaging options					

Environmental Compliance

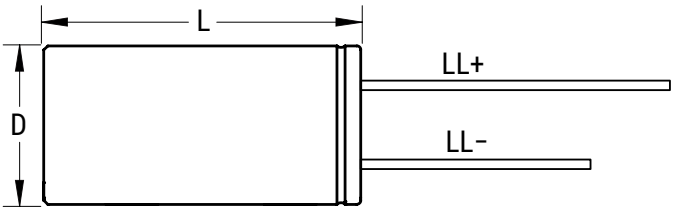
As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of 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 make 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.

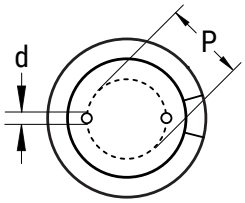
Due to customer requirements, there may appear additional markings such as lead free (LF) or lead-free wires (LFW) on the label.

Dimensions – Millimeters

SIDE VIEW



TERMINAL END VIEW



Size Code	D		L		P		d		LL+/LL-
	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Mininimum
C3	5.0	±0.5	11.0	±1.5	2.0	±0.5	0.5	Nominal	20/15
E3	6.3	±0.5	11.0	±1.5	2.5	±0.5	0.5	Nominal	20/15
G3	8.0	±0.5	11.0	±1.5	3.5	±0.5	0.6	Nominal	20/15
G4	8.0	±0.5	15.0	±2.0	3.5	±0.5	0.6	Nominal	20/15
G8	8.0	±0.5	16.0	±1.5	3.5	±0.5	0.6	Nominal	20/15
H1	10.0	±0.5	12.0	±1.5	5.0	±0.5	0.6	Nominal	20/15
H9	10.0	±0.5	12.5	±1.5	5.0	±0.5	0.6	Nominal	20/15
H2	10.0	±0.5	15.0	±2.0	5.0	±0.5	0.6	Nominal	20/15
H8	10.0	±0.5	16.0	±2.0	5.0	±0.5	0.6	Nominal	20/15
H4	10.0	±0.5	20.0	±2.0	5.0	±0.5	0.6	Nominal	20/15
L3	13.0	±0.5	20.0	±2.0	5.0	±0.5	0.6	Nominal	20/15
L4	13.0	±0.5	25.0	±2.0	5.0	±0.5	0.6	Nominal	20/15
M7	16.0	±0.5	25.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
M2	16.0	±0.5	32.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
M3	16.0	±0.5	36.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
N5	18.0	±0.5	25.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
N8	18.0	±0.5	30.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
N1	18.0	±0.5	32.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
N2	18.0	±0.5	36.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
N3	18.0	±0.5	40.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
N7	18.0	±0.5	45.0	±2.0	7.5	±0.5	0.8	Nominal	20/15
Q4	22.0	±0.5	40.0	±2.0	10.0	±0.5	0.8	Nominal	20/15

Performance Characteristics

Item	Performance Characteristics		
Capacitance Range	1 – 22,000 µF	1 – 470 µF	2.2 – 82 µF
Capacitance Tolerance	±20% at 120 Hz/20°C		
Rated Voltage	6.3 – 100 VDC	160 – 450 VDC	500 VDC
Life Test	2,000 hours (see conditions in Test Methods & Performance)		
Operating Temperature	-40°C to +105°C	-25°C to +105°C	-25°C to +105°C
Leakage Current	I ≤ 0.01 CV (µA) or 3 µA, whichever is greater	I = 0.03 CV (µA) +10 µA	I = 0.04 CV (µA) +100 µA
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 2 minutes at 20°C.		

Impedance Z Characteristics at 120 Hz

Rated Voltage (VDC)	6	10	16	25 – 100	160 – 250	350 – 450	400 – 500	400 – 500
Z (-25°C)/Z (20°C)	4	3	2	2	4	4	6	15
Z (-40°C)/Z (20°C)	8	6	4	3	-	-	-	–

Compensation Factor of Ripple Current (RC) vs. Frequency

Rated Voltage (VDC)	Capacitance Range (µF)	120 Hz	300 Hz	1 kHz	10 kHz
6.3 – 100	1.0 – 68 µF	1.00	1.30	1.57	2.00
6.3 – 100	100 – 470 µF	1.00	1.23	1.34	1.50
6.3 – 100	471 – 22,000 µF	1.00	1.10	1.13	1.15
160 – 450	1.0 – 22,000 µF	1.00	1.25	1.40	1.60
500	1.0 – 22,000 µF	1.00	1.05	1.10	1.15

Test Method & Performance

Conditions	Load Life Test	Shelf Life Test
Temperature	105°C	105°C
Test Duration	2,000 hours	1,000 hours
Ripple Current	Maximum ripple current specified at 120 Hz 105°C	No ripple current applied
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor	No voltage applied
Performance	**The following specifications will be satisfied when the capacitor is restored to 20°C:**	
Capacitance Change	Within ±20% of the initial value	
Dissipation Factor	Does not exceed 200% of the specified value	
Leakage Current	Does not exceed specified value	

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's E aluminum electrolytic capacitors should not be stored in high temperatures or where there is a high level of humidity. The suitable storage condition for KEMET's E aluminum electrolytic capacitors is +5 to +35°C and less than 75% in relative humidity. KEMET's E aluminum electrolytic capacitors should not be stored in damp conditions such as water, saltwater spray or oil spray. KEMET's E aluminum electrolytic capacitors should not be stored in an environment full of hazardous gas (hydrogen sulphide, sulphurous acid gas, nitrous acid, chlorine gas, ammonium, etc.) KEMET's E aluminum electrolytic capacitors should not be stored under exposure to ozone, ultraviolet rays or radiation.

If a capacitor has been stored for more than 18 months under these conditions and it shows increased leakage current, then a treatment by voltage application is recommended.

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.

Table 1 – Ratings & Part Number Reference

Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number
(VDC)	(VDC)	120 Hz 20°C (µF)	D x L (mm)	120 Hz 20°C (tanδ %)*	120 Hz 105°C (mA)	20°C 2 minutes (µA)	( ) Represents Part Number Options
6.3	8	100.0	5 x 11	26	100	6.3	ESH107M6R3AC3(1)
6.3	8	150.0	5 x 11	26	120	9.5	ESH157M6R3AC3(1)
6.3	8	220.0	6.3 x 11	26	165	13.9	ESH227M6R3AE3(1)
6.3	8	330.0	6.3 x 11	26	200	20.8	ESH337M6R3AE3(1)
6.3	8	470.0	6.3 x 11	26	230	29.6	ESH477M6R3AE3(1)
6.3	8	470.0	8 x 11	26	280	29.6	ESH477M6R3AG3(1)
6.3	8	680.0	8 x 11	26	350	42.8	ESH687M6R3AG3(1)
6.3	8	680.0	10 x 12	26	320	42.8	ESH687M6R3AH1(1)
6.3	8	1000.0	8 x 15	26	445	63.0	ESH108M6R3AG4(1)
6.3	8	1000.0	10 x 12	26	470	63.0	ESH108M6R3AH1(1)
6.3	8	1000.0	10 x 12.5	26	470	63.0	ESH108M6R3AH9(1)
6.3	8	1500.0	10 x 15	26	600	94.5	ESH158M6R3AH2(1)
6.3	8	1800.0	10 x 16	26	600	113.4	ESH188M6R3AH2(1)
6.3	8	2200.0	10 x 20	26	800	138.6	ESH228M6R3AH4(1)
6.3	8	2200.0	13 x 20	26	930	138.6	ESH228M6R3AL3(1)
6.3	8	3300.0	13 x 20	26	1100	207.9	ESH338M6R3AL3(1)
6.3	8	4700.0	13 x 20	26	1180	296.1	ESH478M6R3AL3(1)
6.3	8	4700.0	16 x 25	26	1320	296.1	ESH478M6R3AM7(1)
6.3	8	6800.0	16 x 25	26	1490	428.4	ESH688M6R3AM7(1)
6.3	8	10000.0	16 x 32	26	1830	630.0	ESH109M6R3AM2(1)
6.3	8	15000.0	16 x 36	26	2090	945.0	ESH159M6R3AM3(1)
6.3	8	22000.0	18 x 40	26	2350	1386.0	ESH229M6R3AN3(1)
10	13	47.0	5 x 11	22	75	4.7	ESH476M010AC3(1)
10	13	68.0	5 x 11	22	80	6.8	ESH686M010AC3(1)
10	13	100.0	5 x 11	22	110	10.0	ESH107M010AC3(1)
10	13	150.0	5 x 11	22	120	15.0	ESH157M010AC3(1)
10	13	150.0	6 x 11	22	130	15.0	ESH157M010AE3(1)
10	13	220.0	6.3 x 11	22	180	22.0	ESH227M010AE3(1)
10	13	330.0	6.3 x 11	22	235	33.0	ESH337M010AE3(1)
10	13	330.0	8 x 11	22	255	33.0	ESH337M010AG3(1)
10	13	470.0	6.3 x 11	22	250	47.0	ESH477M010AE3(1)
10	13	470.0	8 x 11	22	305	47.0	ESH477M010AG3(1)
10	13	680.0	8 x 11	22	365	68.0	ESH687M010AG3(1)
10	13	680.0	10 x 12	22	420	68.0	ESH687M010AH1(1)
10	13	680.0	10 x 12.5	22	420	68.0	ESH687M010AH9(1)
10	13	1000.0	8 x 15	22	480	100.0	ESH108M010AG4(1)
10	13	1000.0	10 x 16	22	570	100.0	ESH108M010AH2(1)
10	13	1000.0	10 x 12.5	22	540	100.0	ESH108M010AH9(1)
10	13	1500.0	10 x 20	22	800	150.0	ESH158M010AH4(1)
10	13	1800.0	10 x 20	22	800	180.0	ESH188M010AH4(1)
10	13	2200.0	10 x 20	22	870	220.0	ESH228M010AH4(1)
10	13	2200.0	13 x 20	22	1010	220.0	ESH228M010AL3(1)
10	13	3300.0	13 x 20	22	1100	330.0	ESH338M010AL3(1)
10	13	3300.0	13 x 25	22	1220	330.0	ESH338M010AL4(1)
10	13	4700.0	13 x 25	22	1380	470.0	ESH478M010AL4(1)
10	13	4700.0	16 x 25	22	1410	470.0	ESH478M010AM7(1)
10	13	6800.0	16 x 32	22	1610	680.0	ESH688M010AM2(1)
10	13	6800.0	16 x 25	22	1700	680.0	ESH688M010AM7(1)
10	13	10000.0	16 x 36	22	1950	1000.0	ESH109M010AM3(1)
10	13	10000.0	18 x 36	22	1980	1000.0	ESH109M010AN2(1)
10	13	15000.0	18 x 36	22	2180	1500.0	ESH159M010AN2(1)
16	20	33.0	5 x 11	18	70	5.3	ESH336M016AC3(1)
16	20	47.0	5 x 11	18	85	7.5	ESH476M016AC3(1)
16	20	68.0	5 x 11	18	100	10.9	ESH686M016AC3(1)
16	20	100.0	5 x 11	18	130	16.0	ESH107M016AC3(1)
16	20	100.0	6 x 11	18	135	16.0	ESH107M016AE3(1)
16	20	150.0	6.3 x 11	18	175	24.0	ESH157M016AE3(1)
Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number

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

** When capacitance exceeds 1,000 µF, the DF value (%) is increased by 2% for every additional 1,000 µF.*

Table 1 – Ratings & Part Number Reference cont.

Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number
(VDC)	(VDC)	120 Hz 20°C (µF)	D x L (mm)	120 Hz 20°C (tanδ %)*	120 Hz 105°C (mA)	20°C 2 minutes (µA)	( ) Represents Part Number Options
16	20	150.0	8 x 11	18	180	24.0	ESH157M016AG3(1)
16	20	220.0	6.3 x 11	18	220	35.2	ESH227M016AE3(1)
16	20	220.0	8 x 11	18	235	35.2	ESH227M016AG3(1)
16	20	330.0	8 x 11	18	280	52.8	ESH337M016AG3(1)
16	20	330.0	10 x 12	18	285	52.8	ESH337M016AH1(1)
16	20	470.0	8 x 11	18	375	75.2	ESH477M016AG3(1)
16	20	470.0	10 x 12	18	395	75.2	ESH477M016AH1(1)
16	20	680.0	8 x 15	18	450	108.8	ESH687M016AG4(1)
16	20	680.0	10 x 16	18	530	108.8	ESH687M016AH2(1)
16	20	680.0	10 x 12.5	18	480	108.8	ESH687M016AH9(1)
16	20	1000.0	10 x 15	18	640	160.0	ESH108M016AH2(1)
16	20	1500.0	10 x 20	18	830	240.0	ESH158M016AH4(1)
16	20	1500.0	13 x 20	18	860	240.0	ESH158M016AL3(1)
16	20	2200.0	13 x 20	18	1050	352.0	ESH228M016AL3(1)
16	20	3300.0	13 x 25	18	1250	528.0	ESH338M016AL4(1)
16	20	3300.0	16 x 25	18	1350	528.0	ESH338M016AM7(1)
16	20	4700.0	16 x 25	18	1650	752.0	ESH478M016AM7(1)
16	20	6800.0	16 x 32	18	1900	1088.0	ESH688M016AM2(1)
16	20	6800.0	18 x 36	18	1790	1088.0	ESH688M016AN2(1)
16	20	10000.0	18 x 36	18	1900	1600.0	ESH109M016AN2(1)
25	32	22.0	5 x 11	16	60	5.5	ESH226M025AC3(1)
25	32	33.0	5 x 11	16	75	8.3	ESH336M025AC3(1)
25	32	47.0	5 x 11	16	90	11.8	ESH476M025AC3(1)
25	32	68.0	6.3 x 11	16	125	17.0	ESH686M025AE3(1)
25	32	100.0	6.3 x 11	16	145	25.0	ESH107M025AE3(1)
25	32	150.0	8 x 11	16	200	37.5	ESH157M025AG3(1)
25	32	220.0	8 x 11	16	240	55.0	ESH227M025AG3(1)
25	32	220.0	10 x 12	16	250	55.0	ESH227M025AH1(1)
25	32	330.0	8 x 11	16	300	82.5	ESH337M025AG3(1)
25	32	330.0	10 x 12	16	355	82.5	ESH337M025AH1(1)
25	32	330.0	10 x 12.5	16	355	82.5	ESH337M025AH9(1)
25	32	470.0	8 x 15	16	420	117.5	ESH477M025AG4(1)
25	32	470.0	10 x 16	16	470	117.5	ESH477M025AH2(1)
25	32	470.0	10 x 12.5	16	440	117.5	ESH477M025AH9(1)
25	32	680.0	10 x 15	16	560	170.0	ESH687M025AH2(1)
25	32	680.0	10 x 20	16	650	170.0	ESH687M025AH4(1)
25	32	1000.0	10 x 20	16	740	250.0	ESH108M025AH4(1)
25	32	1000.0	13 x 20	16	855	250.0	ESH108M025AL3(1)
25	32	1500.0	13 x 20	16	920	375.0	ESH158M025AL3(1)
25	32	1500.0	13 x 25	16	1020	375.0	ESH158M025AL4(1)
25	32	2200.0	13 x 25	16	1230	550.0	ESH228M025AL4(1)
25	32	2200.0	16 x 25	16	1230	550.0	ESH228M025AM7(1)
25	32	3300.0	16 x 32	16	1450	825.0	ESH338M025AM2(1)
25	32	3300.0	16 x 25	16	1500	825.0	ESH338M025AM7(1)
25	32	4700.0	16 x 32	16	1800	1175.0	ESH478M025AM2(1)
25	32	4700.0	18 x 36	16	1690	1175.0	ESH478M025AN2(1)
25	32	6800.0	18 x 36	16	2050	1700.0	ESH688M025AN2(1)
35	44	10.0	5 x 11	14	44	3.5	ESH106M035AC3(1)
35	44	15.0	5 x 11	14	50	5.3	ESH156M035AC3(1)
35	44	22.0	5 x 11	14	65	7.7	ESH226M035AC3(1)
35	44	33.0	5 x 11	14	85	11.6	ESH336M035AC3(1)
35	44	47.0	5 x 11	14	100	16.5	ESH476M035AC3(1)
35	44	68.0	6.3 x 11	14	130	23.8	ESH686M035AE3(1)
35	44	68.0	8 x 11	14	130	23.8	ESH686M035AG3(1)
35	44	100.0	6.3 x 11	14	170	35.0	ESH107M035AE3(1)
35	44	100.0	8 x 11	14	190	35.0	ESH107M035AG3(1)
35	44	150.0	8 x 11	14	220	52.5	ESH157M035AG3(1)
Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number

(1) Insert packaging code. See Ordering Options Table for available options.
** When capacitance exceeds 1,000 µF, the DF value (%) is increased by 2% for every additional 1,000 µF.*

Table 1 – Ratings & Part Number Reference cont.

Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number
(VDC)	(VDC)	120 Hz 20°C (µF)	D x L (mm)	120 Hz 20°C (tanδ %)*	120 Hz 105°C (mA)	20°C 2 minutes (µA)	( ) Represents Part Number Options
35	44	150.0	10 x 12	14	240	52.5	ESH157M035AH1(1)
35	44	220.0	10 x 12.5	14	315	77.0	ESH227M035AH9(1)
35	44	220.0	8 x 11	14	220	77.0	ESH227M035AG3(1)
35	44	330.0	10 x 16	14	440	115.5	ESH337M035AH2(1)
35	44	330.0	10 x 12.5	14	400	115.5	ESH337M035AH9(1)
35	44	470.0	10 x 15	14	480	164.5	ESH477M035AH2(1)
35	44	470.0	10 x 20	14	580	164.5	ESH477M035AH4(1)
35	44	680.0	10 x 20	14	650	238.0	ESH687M035AH4(1)
35	44	680.0	13 x 20	14	730	238.0	ESH687M035AL3(1)
35	44	1000.0	13 x 20	14	900	350.0	ESH108M035AL3(1)
35	44	1000.0	13 x 25	14	995	350.0	ESH108M035AL4(1)
35	44	1500.0	13 x 25	14	1050	525.0	ESH158M035AL4(1)
35	44	1500.0	16 x 25	14	1110	525.0	ESH158M035AM7(1)
35	44	2200.0	16 x 32	14	1450	770.0	ESH228M035AM2(1)
35	44	2200.0	16 x 25	14	1370	770.0	ESH228M035AM7(1)
35	44	3300.0	16 x 36	14	1680	1155.0	ESH338M035AM3(1)
35	44	3300.0	18 x 36	14	1660	1155.0	ESH338M035AN2(1)
35	44	4700.0	18 x 36	14	1920	1645.0	ESH478M035AN2(1)
50	63	1.0	5 x 11	12	12	3.0	ESH105M050AC3(1)
50	63	2.2	5 x 11	12	18	3.0	ESH225M050AC3(1)
50	63	3.3	5 x 11	12	25	3.0	ESH335M050AC3(1)
50	63	4.7	5 x 11	12	30	3.0	ESH475M050AC3(1)
50	63	6.8	5 x 11	12	30	3.4	ESH685M050AC3(1)
50	63	10.0	5 x 11	12	50	5.0	ESH106M050AC3(1)
50	63	15.0	5 x 11	12	50	7.5	ESH156M050AC3(1)
50	63	22.0	5 x 11	12	75	11.0	ESH226M050AC3(1)
50	63	33.0	5 x 11	12	95	16.5	ESH336M050AC3(1)
50	63	33.0	6 x 11	12	105	16.5	ESH336M050AE3(1)
50	63	47.0	6.3 x 11	12	115	23.5	ESH476M050AE3(1)
50	63	47.0	8 x 11	12	125	23.5	ESH476M050AG3(1)
50	63	68.0	8 x 11	12	159	34.0	ESH686M050AG3(1)
50	63	82.0	8 x 15	12	190	41.0	ESH826M050AG4(1)
50	63	100.0	8 x 11	12	200	50.0	ESH107M050AG3(1)
50	63	150.0	10 x 12	12	289	75.0	ESH157M050AH1(1)
50	63	150.0	10 x 12.5	12	289	75.0	ESH157M050AH9(1)
50	63	220.0	10 x 15	12	415	110.0	ESH227M050AH2(1)
50	63	220.0	10 x 12.5	12	360	110.0	ESH227M050AH9(1)
50	63	330.0	10 x 20	12	535	165.0	ESH337M050AH4(1)
50	63	470.0	10 x 20	12	630	235.0	ESH477M050AH4(1)
50	63	470.0	13 x 20	12	730	235.0	ESH477M050AL3(1)
50	63	680.0	13 x 20	12	800	340.0	ESH687M050AL3(1)
50	63	680.0	13 x 25	12	860	340.0	ESH687M050AL4(1)
50	63	1000.0	13 x 25	12	1060	500.0	ESH108M050AL4(1)
50	63	1000.0	16 x 25	12	1110	500.0	ESH108M050AM7(1)
50	63	1500.0	16 x 32	12	1350	750.0	ESH158M050AM2(1)
50	63	1500.0	16 x 25	12	1300	750.0	ESH158M050AM7(1)
50	63	2200.0	16 x 36	12	1600	1100.0	ESH228M050AM3(1)
50	63	2200.0	18 x 36	12	1530	1100.0	ESH228M050AN2(1)
50	63	3300.0	18 x 36	12	1780	1650.0	ESH338M050AN2(1)
63	79	1.0	5 x 11	10	12	3.0	ESH105M063AC3(1)
63	79	2.2	5 x 11	10	20	3.0	ESH225M063AC3(1)
63	79	3.3	5 x 11	10	27	3.0	ESH335M063AC3(1)
63	79	4.7	5 x 11	10	34	3.0	ESH475M063AC3(1)
63	79	6.8	5 x 11	10	37	4.3	ESH685M063AC3(1)
63	79	10.0	5 x 11	10	55	6.3	ESH106M063AC3(1)
63	79	15.0	5 x 11	10	65	9.5	ESH156M063AC3(1)
63	79	22.0	6.3 x 11	10	90	13.9	ESH226M063AE3(1)
Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number

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

** When capacitance exceeds 1,000 µF, the DF value (%) is increased by 2% for every additional 1,000 µF.*

Table 1 – Ratings & Part Number Reference cont.

Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number
(VDC)	(VDC)	120 Hz 20°C (µF)	D x L (mm)	120 Hz 20°C (tanδ %)*	120 Hz 105°C (mA)	20°C 2 minutes (µA)	( ) Represents Part Number Options
63	79	33.0	6.3 x 11	10	100	20.8	ESH336M063AE3(1)
63	79	33.0	8 x 11	10	110	20.8	ESH336M063AG3(1)
63	79	47.0	8 x 11	10	155	29.6	ESH476M063AG3(1)
63	79	68.0	10 x 12	10	198	42.8	ESH686M063AH1(1)
63	79	68.0	10 x 12.5	10	198	42.8	ESH686M063AH9(1)
63	79	100.0	10 x 12	10	260	63.0	ESH107M063AH1(1)
63	79	100.0	10 x 12.5	10	260	63.0	ESH107M063AH9(1)
63	79	150.0	10 x 15	10	330	94.5	ESH157M063AH2(1)
63	79	220.0	10 x 20	10	465	138.6	ESH227M063AH4(1)
63	79	330.0	13 x 20	10	650	207.9	ESH337M063AL3(1)
63	79	470.0	13 x 20	10	700	296.1	ESH477M063AL3(1)
63	79	470.0	13 x 25	10	800	296.1	ESH477M063AL4(1)
63	79	680.0	16 x 25	10	1000	428.4	ESH687M063AM7(1)
63	79	1000.0	16 x 32	10	1200	630.0	ESH108M063AM2(1)
63	79	1500.0	16 x 36	10	1450	945.0	ESH158M063AM3(1)
63	79	2200.0	18 x 36	10	1650	1386.0	ESH228M063AN2(1)
100	125	1.0	5 x 11	10	15	3.0	ESH105M100AC3(1)
100	125	2.2	5 x 11	10	22	3.0	ESH225M100AC3(1)
100	125	3.3	5 x 11	10	29	3.3	ESH335M100AC3(1)
100	125	4.7	5 x 11	10	37	4.7	ESH475M100AC3(1)
100	125	6.8	5 x 11	10	46	6.8	ESH685M100AC3(1)
100	125	10.0	6.3 x 11	10	65	10.0	ESH106M100AE3(1)
100	125	15.0	6.3 x 11	10	75	15.0	ESH156M100AE3(1)
100	125	15.0	8 x 11	10	82	15.0	ESH156M100AG3(1)
100	125	22.0	8 x 11	10	115	22.0	ESH226M100AG3(1)
100	125	33.0	8 x 11	10	140	33.0	ESH336M100AG3(1)
100	125	33.0	10 x 12	10	160	33.0	ESH336M100AH1(1)
100	125	47.0	10 x 16	10	210	47.0	ESH476M100AH2(1)
100	125	47.0	10 x 12.5	10	185	47.0	ESH476M100AH9(1)
100	125	68.0	10 x 15	10	240	68.0	ESH686M100AH2(1)
100	125	68.0	10 x 20	10	241	68.0	ESH686M100AH4(1)
100	125	100.0	10 x 20	10	305	100.0	ESH107M100AH4(1)
100	125	150.0	13 x 20	10	370	150.0	ESH157M100AL3(1)
100	125	150.0	13 x 25	10	414	150.0	ESH157M100AL4(1)
100	125	220.0	13 x 25	10	520	220.0	ESH227M100AL4(1)
100	125	220.0	16 x 26	10	590	220.0	ESH227M100AM1(1)
100	125	330.0	16 x 25	10	720	330.0	ESH337M100AM7(1)
100	125	470.0	16 x 32	10	875	470.0	ESH477M100AM2(1)
100	125	680.0	16 x 36	10	1200	680.0	ESH687M100AM3(1)
160	200	1.0	5 x 11	15	17	14.8	ESH105M160AC3(1)
160	200	2.2	6.3 x 11	15	25	20.6	ESH225M160AE3(1)
160	200	3.3	6.3 x 11	15	36	25.8	ESH335M160AE3(1)
160	200	4.7	6.3 x 11	15	43	32.6	ESH475M160AE3(1)
160	200	4.7	8 x 11	15	43	32.6	ESH475M160AG3(1)
160	200	6.8	8 x 11	15	54	42.6	ESH685M160AG3(1)
160	200	10.0	8 x 11	15	70	58.0	ESH106M160AG3(1)
160	200	10.0	10 x 12	15	70	58.0	ESH106M160AH1(1)
160	200	15.0	10 x 16	15	90	82.0	ESH156M160AH2(1)
160	200	15.0	10 x 12.5	15	90	82.0	ESH156M160AH9(1)
160	200	22.0	10 x 15	15	115	115.6	ESH226M160AH2(1)
160	200	22.0	10 x 20	15	130	115.6	ESH226M160AH4(1)
160	200	33.0	10 x 20	15	160	168.4	ESH336M160AH4(1)
160	200	33.0	13 x 20	15	180	168.4	ESH336M160AL3(1)
160	200	47.0	10 x 20	15	195	235.6	ESH476M160AH4(1)
160	200	47.0	13 x 25	15	250	235.6	ESH476M160AL4(1)
160	200	68.0	13 x 20	15	255	336.4	ESH686M160AL3(1)
160	200	68.0	13 x 25	15	270	336.4	ESH686M160AL4(1)
Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number

(1) Insert packaging code. See Ordering Options Table for available options.
** When capacitance exceeds 1,000 µF, the DF value (%) is increased by 2% for every additional 1,000 µF.*

Table 1 – Ratings & Part Number Reference cont.

Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number
(VDC)	(VDC)	120 Hz 20°C (µF)	D x L (mm)	120 Hz 20°C (tanδ %)*	120 Hz 105°C (mA)	20°C 2 minutes (µA)	( ) Represents Part Number Options
160	200	100.0	13 x 25	15	350	490.0	ESH107M160AL4(1)
160	200	100.0	16 x 25	15	390	490.0	ESH107M160AM7(1)
160	200	150.0	16 x 32	15	435	730.0	ESH157M160AM2(1)
160	200	150.0	16 x 25	15	435	730.0	ESH157M160AM7(1)
160	200	220.0	16 x 32	15	550	1066.0	ESH227M160AM2(1)
160	200	220.0	16 x 36	15	700	1066.0	ESH227M160AM3(1)
160	200	330.0	18 x 36	15	800	1594.0	ESH337M160AN2(1)
160	200	330.0	18 x 40	15	850	1594.0	ESH337M160AN3(1)
160	200	470.0	18 x 40	15	900	2266.0	ESH477M160AN3(1)
160	200	470.0	22 x 40	15	980	2266.0	ESH477M160AQ4(1)
200	250	1.0	6.3 x 11	15	17	16.0	ESH105M200AE3(1)
200	250	2.2	6.3 x 11	15	25	23.2	ESH225M200AE3(1)
200	250	3.3	6.3 x 11	15	36	29.8	ESH335M200AE3(1)
200	250	4.7	8 x 11	15	50	38.2	ESH475M200AG3(1)
200	250	4.7	10 x 12	15	50	38.2	ESH475M200AH1(1)
200	250	6.8	8 x 11	15	60	50.8	ESH685M200AG3(1)
200	250	10.0	10 x 16	15	80	70.0	ESH106M200AH2(1)
200	250	10.0	10 x 12.5	15	80	70.0	ESH106M200AH9(1)
200	250	15.0	10 x 15	15	110	100.0	ESH156M200AH2(1)
200	250	15.0	10 x 20	15	110	100.0	ESH156M200AH4(1)
200	250	22.0	10 x 20	15	140	142.0	ESH226M200AH4(1)
200	250	33.0	13 x 20	15	200	208.0	ESH336M200AL3(1)
200	250	47.0	13 x 20	15	220	292.0	ESH476M200AL3(1)
200	250	68.0	13 x 25	15	280	418.0	ESH686M200AL4(1)
200	250	68.0	16 x 25	15	280	418.0	ESH686M200AM7(1)
200	250	100.0	16 x 32	15	400	610.0	ESH107M200AM2(1)
200	250	100.0	16 x 25	15	350	610.0	ESH107M200AM7(1)
200	250	150.0	16 x 32	15	480	910.0	ESH157M200AM2(1)
200	250	150.0	16 x 36	15	450	910.0	ESH157M200AM3(1)
200	250	220.0	16 x 36	15	675	1330.0	ESH227M200AM3(1)
200	250	220.0	18 x 32	15	685	1330.0	ESH227M200AN1(1)
200	250	330.0	18 x 36	15	750	1990.0	ESH337M200AN2(1)
200	250	330.0	22 x 40	15	920	1990.0	ESH337M200AQ4(1)
250	300	1.0	6.3 x 11	15	17	17.5	ESH105M250AE3(1)
250	300	2.2	6.3 x 11	15	29	26.5	ESH225M250AE3(1)
250	300	2.2	8 x 11	15	29	26.5	ESH225M250AG3(1)
250	300	3.3	8 x 11	15	42	34.8	ESH335M250AG3(1)
250	300	4.7	8 x 11	15	52	45.3	ESH475M250AG3(1)
250	300	4.7	10 x 12	15	52	45.3	ESH475M250AH1(1)
250	300	6.8	8 x 11	15	62	61.0	ESH685M250AG3(1)
250	300	10.0	10 x 20	15	88	85.0	ESH106M250AH4(1)
250	300	10.0	10 x 12.5	15	80	85.0	ESH106M250AH9(1)
250	300	15.0	10 x 15	15	110	122.5	ESH156M250AH2(1)
250	300	15.0	13 x 20	15	120	122.5	ESH156M250AL3(1)
250	300	22.0	10 x 20	15	140	175.0	ESH226M250AH4(1)
250	300	22.0	13 x 20	15	155	175.0	ESH226M250AL3(1)
250	300	33.0	13 x 20	15	200	257.5	ESH336M250AL3(1)
250	300	33.0	13 x 25	15	200	257.5	ESH336M250AL4(1)
250	300	47.0	13 x 25	15	240	362.5	ESH476M250AL4(1)
250	300	47.0	16 x 25	15	270	362.5	ESH476M250AM7(1)
250	300	68.0	13 x 25	15	290	520.0	ESH686M250AL4(1)
250	300	68.0	16 x 32	15	300	520.0	ESH686M250AM2(1)
250	300	100.0	16 x 25	15	380	760.0	ESH107M250AM7(1)
250	300	100.0	16 x 36	15	440	760.0	ESH107M250AM3(1)
250	300	150.0	16 x 32	15	420	1135.0	ESH157M250AM2(1)
250	300	150.0	18 x 40	15	600	1135.0	ESH157M250AN3(1)
250	300	220.0	18 x 36	15	680	1660.0	ESH227M250AN2(1)
Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number

(1) Insert packaging code. See Ordering Options Table for available options.
** When capacitance exceeds 1,000 µF, the DF value (%) is increased by 2% for every additional 1,000 µF.*

Table 1 – Ratings & Part Number Reference cont.

Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number
(VDC)	(VDC)	120 Hz 20°C (µF)	D x L (mm)	120 Hz 20°C (tanδ %)*	120 Hz 105°C (mA)	20°C 2 minutes (µA)	( ) Represents Part Number Options
250	300	220.0	22 x 40	15	800	1660.0	ESH227M250AQ4(1)
350	400	1.0	6.3 x 11	20	16	20.5	ESH105M350AE3(1)
350	400	2.2	8 x 11	20	31	33.1	ESH225M350AG3(1)
350	400	2.2	10 x 12	20	35	33.1	ESH225M350AH1(1)
350	400	3.3	8 x 11	20	35	44.7	ESH335M350AG3(1)
350	400	4.7	8 x 11	20	45	59.4	ESH475M350AG3(1)
350	400	4.7	10 x 20	20	65	59.4	ESH475M350AH4(1)
350	400	10.0	10 x 15	20	80	115.0	ESH106M350AH2(1)
350	400	10.0	13 x 20	20	95	115.0	ESH106M350AL3(1)
350	400	15.0	13 x 20	20	140	167.5	ESH156M350AL3(1)
350	400	22.0	13 x 20	20	150	241.0	ESH226M350AL3(1)
350	400	22.0	16 x 25	20	165	241.0	ESH226M350AM7(1)
350	400	33.0	13 x 25	20	200	356.5	ESH336M350AL4(1)
350	400	33.0	16 x 32	20	195	356.5	ESH336M350AM2(1)
350	400	47.0	16 x 36	20	210	503.5	ESH476M350AM3(1)
350	400	47.0	16 x 25	20	260	503.5	ESH476M350AM7(1)
350	400	47.0	18 x 36	20	240	503.5	ESH476M350AN2(1)
350	400	68.0	18 x 36	20	320	724.0	ESH686M350AN2(1)
350	400	100.0	18 x 32	20	400	1060.0	ESH107M350AN1(1)
350	400	100.0	18 x 40	20	300	1060.0	ESH107M350AN3(1)
350	400	150.0	22 x 40	20	480	1585.0	ESH157M350AQ4(1)
400	450	1.0	6.3 x 11	20	17	22.0	ESH105M400AE3(1)
400	450	2.2	8 x 11	20	31	36.4	ESH225M400AG3(1)
400	450	3.3	8 x 11	20	35	49.6	ESH335M400AG3(1)
400	450	4.7	8 x 11	20	45	66.4	ESH475M400AG3(1)
400	450	4.7	10 x 15	20	60	66.4	ESH475M400AH2(1)
400	450	4.7	10 x 12.5	20	55	66.4	ESH475M400AH9(1)
400	450	6.8	8 x 15	20	60	91.6	ESH685M400AG4(1)
400	450	6.8	10 x 20	20	67	91.6	ESH685M400AH4(1)
400	450	6.8	10 x 12.5	20	65	91.6	ESH685M400AH9(1)
400	450	10.0	10 x 15	20	80	130.0	ESH106M400AH2(1)
400	450	10.0	10 x 20	20	75	130.0	ESH106M400AH4(1)
400	450	15.0	10 x 20	20	100	190.0	ESH156M400AH4(1)
400	450	15.0	13 x 20	20	120	190.0	ESH156M400AL3(1)
400	450	22.0	13 x 20	20	140	274.0	ESH226M400AL3(1)
400	450	22.0	13 x 25	20	140	274.0	ESH226M400AL4(1)
400	450	33.0	13 x 25	20	200	406.0	ESH336M400AL4(1)
400	450	33.0	16 x 25	20	190	406.0	ESH336M400AM7(1)
400	450	47.0	16 x 25	20	265	574.0	ESH476M400AM7(1)
400	450	68.0	16 x 32	20	410	826.0	ESH686M400AM2(1)
400	450	68.0	18 x 36	20	325	826.0	ESH686M400AN2(1)
400	450	68.0	18 x 25	20	390	826.0	ESH686M400AN5(1)
400	450	100.0	18 x 32	20	500	1210.0	ESH107M400AN1(1)
400	450	100.0	18 x 36	20	290	1210.0	ESH107M400AN2(1)
400	450	100.0	22 x 40	20	365	1,210.0	ESH107M400AQ4(1)
400	450	120.0	18 x 32	20	520	1450.0	ESH127M400AN1(1)
400	450	120.0	18 x 36	20	550	1450.0	ESH127M400AN2(1)
400	450	150.0	18 x 40	20	620	1810.0	ESH157M400AN3(1)
400	450	150.0	18 x 36	20	560	1810.0	ESH157M400AN2(1)
420	470	1.0	6.3 x 11	20	17	22.6	ESH105M420AE3(1)
420	470	2.2	8 x 11	20	29	37.7	ESH225M420AG3(1)
420	470	3.3	8 x 11	20	34	51.6	ESH335M420AG3(1)
420	470	4.7	10 x 12.5	20	55	69.2	ESH475M420AH9(1)
420	470	6.8	10 x 15	20	68	95.7	ESH685M420AH2(1)
420	470	10.0	10 x 20	20	98	136.0	ESH106M420AH4(1)
420	470	15.0	13 x 20	20	130	199.0	ESH156M420AL3(1)
420	470	22.0	13 x 25	20	155	287.2	ESH226M420AL4(1)
Rated Voltage	**Surge Voltage**	**Rated Capacitance**	**Case Size**	**DF**	**RC**	**LC**	**Part Number**

(1) Insert packaging code. See Ordering Options Table for available options.
** When capacitance exceeds 1,000 µF, the DF value (%) is increased by 2% for every additional 1,000 µF.*

Table 1 – Ratings & Part Number Reference cont.

Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number
(VDC)	(VDC)	120 Hz 20°C (µF)	D x L (mm)	120 Hz 20°C (tanδ %)*	120 Hz 105°C (mA)	20°C 2 minutes (µA)	( ) Represents Part Number Options
420	470	33.0	16 x 25	20	205	425.8	ESH336M420AM7(1)
420	470	47.0	16 x 25	20	235	602.2	ESH476M420AM7(1)
420	470	68.0	16 x 32	20	400	866.8	ESH686M420AM2(1)
420	470	68.0	18 x 25	20	380	866.8	ESH686M420AN5(1)
420	470	100.0	18 x 36	20	490	1270.0	ESH107M420AN2(1)
420	470	120.0	18 x 40	20	430	1522.0	ESH127M420AN3(1)
420	470	150.0	18 x 45	20	570	1900.0	ESH157M420AN7(1)
450	500	2.2	8 x 11	20	30	39.7	ESH225M450AG3(1)
450	500	2.2	10 x 12	20	37	39.7	ESH225M450AH1(1)
450	500	2.2	10 x 12.5	20	37	39.7	ESH225M450AH9(1)
450	500	3.3	8 x 15	20	42	54.6	ESH335M450AG4(1)
450	500	3.3	10 x 16	20	51	54.6	ESH335M450AH2(1)
450	500	3.3	10 x 12.5	20	40	54.6	ESH335M450AH9(1)
450	500	4.7	10 x 12.5	20	52	73.5	ESH475M450AH9(1)
450	500	4.7	10 x 20	20	60	73.5	ESH475M450AH4(1)
450	500	6.8	10 x 15	20	62	101.8	ESH685M450AH2(1)
450	500	10.0	10 x 20	20	85	145.0	ESH106M450AH4(1)
450	500	10.0	13 x 25	20	99	145.0	ESH106M450AL4AR
450	500	15.0	13 x 20	20	120	212.5	ESH156M450AL3(1)
450	500	22.0	13 x 25	20	150	307.0	ESH226M450AL4(1)
450	500	22.0	16 x 25	20	145	307.0	ESH226M450AM7(1)
450	500	33.0	16 x 25	20	210	455.5	ESH336M450AM7(1)
450	500	33.0	16 x 32	20	230	455.5	ESH336M450AM2(1)
450	500	47.0	16 x 25	20	260	644.5	ESH476M450AM7(1)
450	500	47.0	18 x 40	20	350	644.5	ESH476M450AN3(1)
450	500	68.0	18 x 32	20	370	928.0	ESH686M450AN1(1)
450	500	68.0	18 x 36	20	380	928.0	ESH686M450AN2(1)
450	500	100.0	18 x 36	20	495	1360.0	ESH107M450AN2(1)
450	500	120.0	18 x 40	20	565	1630.0	ESH127M450AN3(1)
450	500	150.0	18 x 45	20	650	2035.0	ESH157M450AN7(1)
500	550	2.2	8 x 11	25	25	144.0	ESH225M500AG3(1)
500	550	3.3	8 x 16	25	30	166.0	ESH335M500AG8(1)
500	550	4.7	8 x 16	25	34	194.0	ESH475M500AG8(1)
500	550	4.7	10 x 12.5	25	38	194.0	ESH475M500AH9(1)
500	550	6.8	10 x 16	25	50	236.0	ESH685M500AH8(1)
500	550	8.2	10 x 20	25	65	264.0	ESH825M500AH4(1)
500	550	10.0	10 x 20	25	70	300.0	ESH106M500AH4(1)
500	550	10.0	13 x 20	25	85	300.0	ESH106M500AL3(1)
500	550	15.0	13 x 25	25	100	400.0	ESH156M500AL4(1)
500	550	22.0	13 x 25	25	115	540.0	ESH226M500AL4(1)
500	550	22.0	16 x 25	25	130	540.0	ESH226M500AM7(1)
500	550	33.0	18 x 25	25	180	760.0	ESH336M500AN5(1)
500	550	47.0	16 x 32	25	180	1040.0	ESH476M500AM2(1)
500	550	47.0	18 x 30	25	230	1040.0	ESH476M500AN8(1)
500	550	68.0	18 x 32	25	250	1460.0	ESH686M500AN1(1)
500	550	68.0	18 x 36	25	290	1460.0	ESH686M500AN2(1)
500	550	82.0	18 x 40	25	335	1740.0	ESH826M500AN3(1)
Rated Voltage	Surge Voltage	Rated Capacitance	Case Size	DF	RC	LC	Part Number

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

** When capacitance exceeds 1,000 µF, the DF value (%) is increased by 2% for every additional 1,000 µF.*

Mounting Positions (Safety Vent)

In operation, electrolytic capacitors will always conduct a leakage current, which causes electrolysis. The oxygen produced by electrolysis will regenerate the dielectric layer but, at the same time, the hydrogen released may cause the internal pressure of the capacitor to increase. The overpressure vent, or safety vent, ensures that the gas can escape when the pressure reaches a certain value. All mounting positions must allow the safety vent to work properly.

Installing

- As a general principle, lower-use temperatures result in a longer, useful life of the capacitor. For this reason, it should be ensured that electrolytic capacitors are placed away from heat-emitting components. Adequate space should be allowed between components for cooling air to circulate, particularly when high ripple current loads are applied. In any case, the maximum category temperature must not be exceeded.
- Do not deform the case of the capacitors or use capacitors with a deformed case.
- Verify that the connections of the capacitors are able to insert on the board without excessive mechanical force.
- If the capacitors require mounting through additional means, the recommended mounting accessories shall be used.
- Verify the correct polarization of the capacitor on the board.
- Verify that the space around the pressure relief device is according to the following guideline:

Case Diameter	Space Around Safety Vent
≤ 16 mm	> 2 mm
> 16 to ≤ 40 mm	> 3 mm
> 40 mm	> 5 mm

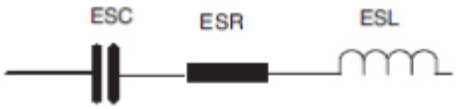
It is recommended that capacitors always be mounted with the safety device uppermost or in the upper part of the capacitor.

- If the capacitors are stored for a long time, the leakage current must be verified. If the leakage current is superior to the value listed in this catalog, the capacitors must be reformed. In this case, they can be reformed by application of the rated voltage through a series resistor approximately 1 kΩ for capacitors with V_R ≤ 160 V (5 W resistor) and 10 kΩ for the other rated voltages.
- In the case of capacitors connected in a series, a suitable voltage sharing must be used.
  In the case of balancing resistors, the approximate resistance value can be calculated as: R = 60/C.

KEMET recommends, nevertheless, to ensure that the voltage across each capacitor does not exceed its rated voltage.

Application & Operation Guidelines

Electrical Ratings:
Capacitance (ESC)



Simplified equivalent circuit diagram of an electrolytic capacitor

The capacitive component of the equivalent series circuit, (equivalent series capacitance - ESC), is determined by applying an alternate voltage of ≤ 0.5 V at a frequency of 120 or 100 Hz and 20°C (IEC 384-1, 384-4).

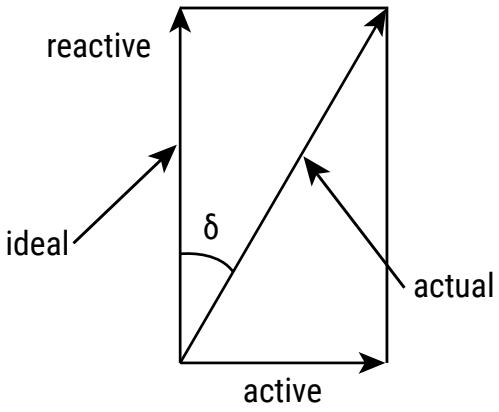
Temperature Dependence of the Capacitance
Capacitance of an electrolytic capacitor depends upon temperature: with decreasing temperature the viscosity of the electrolyte increases, thereby reducing its conductivity.
Capacitance will decrease if temperature decreases. Furthermore, temperature drifts cause armature dilatation and, therefore, capacitance changes (up to 20% depending on the series considered, from 0 to 80°C). This phenomenon is more evident for electrolytic capacitors than for other types.

Frequency Dependence of the Capacitance
Effective capacitance value is derived from the impedance curve, as long as impedance is still in the range where the capacitance component is dominant.

$$C = \frac{1}{2\pi fZ}$$

C = capacitance (F)
f = frequency (Hz)
Z = impedance (Ω)

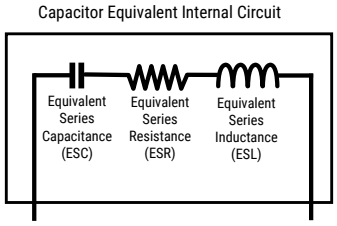
Dissipation Factor tan δ (DF)
Dissipation Factor tan δ is the ratio between the active and reactive power for a sinusoidal waveform voltage. It can be thought of as a measurement of the gap between an actual and ideal capacitor.



Tan δ is measured with the same set-up used for the series capacitance ESC.
Tan δ = ω x ESC x ESR where:
ESC = Equivalent series capacitance
ESR = Equivalent series resistance

Application & Operation Guidelines cont.

Equivalent Series Inductance (ESL)
Equivalent series inductance or self inductance results from the terminal configuration and internal design of the capacitor.



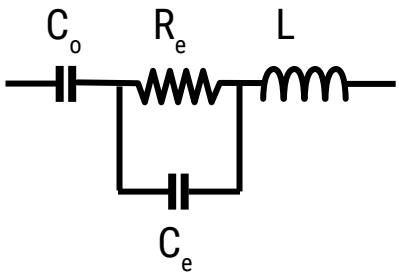
Equivalent Series Resistance (ESR)
Equivalent series resistance is the resistive component of the equivalent series circuit. ESR value depends on frequency and temperature, and is related to the tan δ by the following equation:

$$ESR = \frac{\tan \delta}{2\pi f\, ESC}$$

ESR = Equivalent series resistance (Ω)
tan δ = Dissipation factor
ESC = Equivalent series capacitance (F)
f = Frequency (Hz)

Tolerance limits of the rated capacitance must be taken into account when calculating this value.

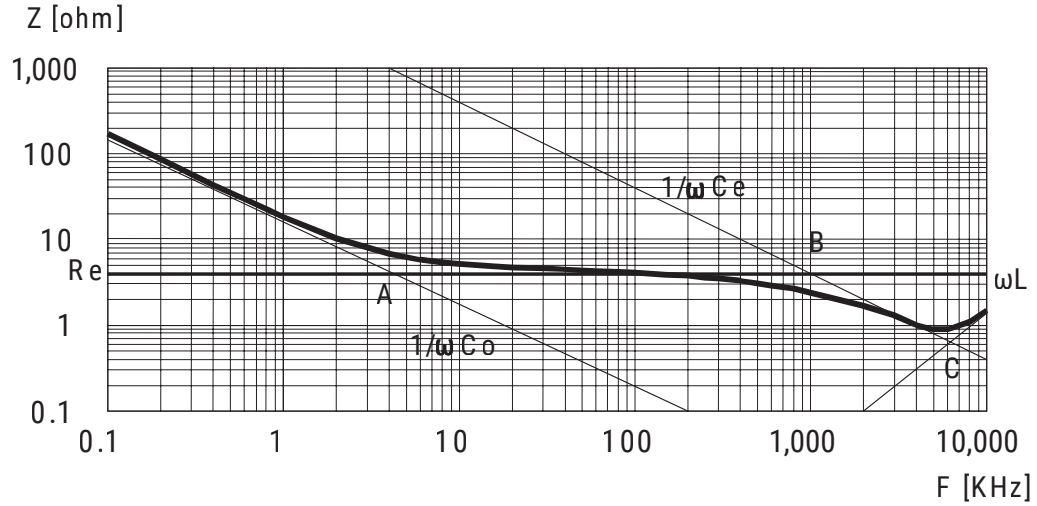
Impedance (Z)
Impedance of an electrolytic capacitor results from a circuit formed by the following individual equivalent series components:



C_o = Aluminum oxide capacitance (surface and thickness of the dielectric.)
R_e = Resistance of electrolyte and paper mixture (other resistances not depending on the frequency are not considered: tabs, plates, etc.)
C_e = Electrolyte soaked paper capacitance.
L = Inductive reactance of the capacitor winding and terminals.
Impedance of an electrolytic capacitor is not a constant quantity that retains its value under all conditions; it changes depending on frequency and temperature.
Impedance as a function of frequency (sinusoidal waveform) for a certain temperature can be represented as follows:

Application & Operation Guidelines cont.

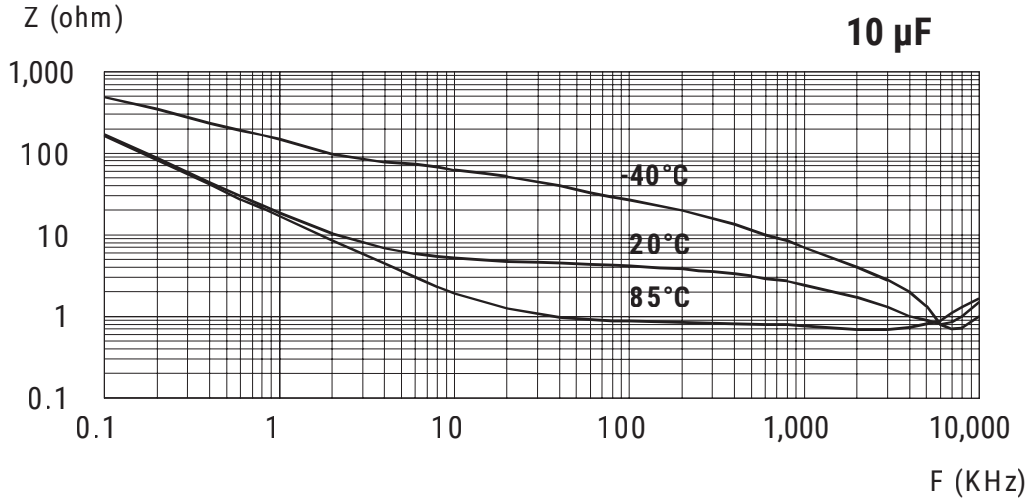
Impedance (Z) cont.



- Capacitive reactance predominates at low frequencies.
- With increasing frequency, capacitive reactance Xc = $1/\omega C_o$ decreases until it reaches the order of magnitude of electrolyte resistance R_e(A)
- At even higher frequencies, resistance of the electrolyte predominates: Z = R_e (A - B)
- When the capacitor's resonance frequency is reached (ω_0), capacitive and inductive reactance mutually cancel each other $1/\omega C_e = \omega L$, $\omega_0 = 1/SQR(LC_e)$
- Above this frequency, inductive reactance of the winding and its terminals (XL = Z = ωL) becomes effective and leads to an increase in impedance

Generally speaking, it can be estimated that $C_e \approx 0.01\ C_o$.

Impedance as a function of frequency (sinusoidal waveform) for different temperature values can be represented as follows (typical values):



R_e is the most temperature-dependent component of an electrolytic capacitor equivalent circuit. Electrolyte resistivity will decrease if temperature rises.
In order to obtain a low impedance value throughout the temperature range, R_e must be as little as possible. However, R_e values that are too low indicate a very aggressive electrolyte, resulting in a shorter life of the electrolytic capacitor at high temperatures. A compromise must be reached.

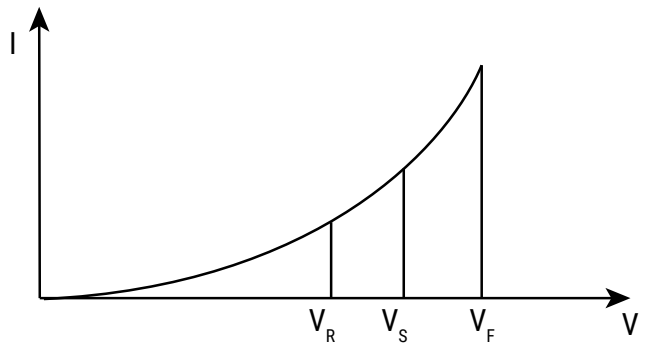
Application & Operation Guidelines cont.

Leakage Current (LC)
Due to the aluminum oxide layer that serves as a dielectric, a small current will continue to flow even after a DC voltage has been applied for long periods. This current is called leakage current.

A high leakage current flows after applying voltage to the capacitor then decreases in a few minutes, for example, after prolonged storage without any applied voltage. In the course of continuous operation, the leakage current will decrease and reach an almost constant value.

After a voltage-free storage the oxide layer may deteriorate, especially at a high temperature. Since there are no leakage currents to transport oxygen ions to the anode, the oxide layer is not regenerated. The result is that a higher than normal leakage current will flow when voltage is applied after prolonged storage.

As the oxide layer is regenerated in use, the leakage current will gradually decrease to its normal level.
The relationship between the leakage current and voltage applied at constant temperature can be shown schematically as follows:



Where:
V_F = Forming voltage
If this level is exceeded, a large quantity of heat and gas will be generated and the capacitor could be damaged.
V_R = Rated voltage
This level represents the top of the linear part of the curve.
V_S = Surge voltage
This lies between V_R and V_F. The capacitor can be subjected to V_S for short periods only.

Electrolytic capacitors are subjected to a reforming process before acceptance testing. The purpose of this preconditioning is to ensure that the same initial conditions are maintained when comparing different products.

Ripple Current (RC)
The maximum ripple current value depends on:
- Ambient temperature
- Surface area of the capacitor (heat dissipation area)
  tan δ or ESR
- Frequency

The capacitor's life depends on the thermal stress.

Application & Operation Guidelines cont.

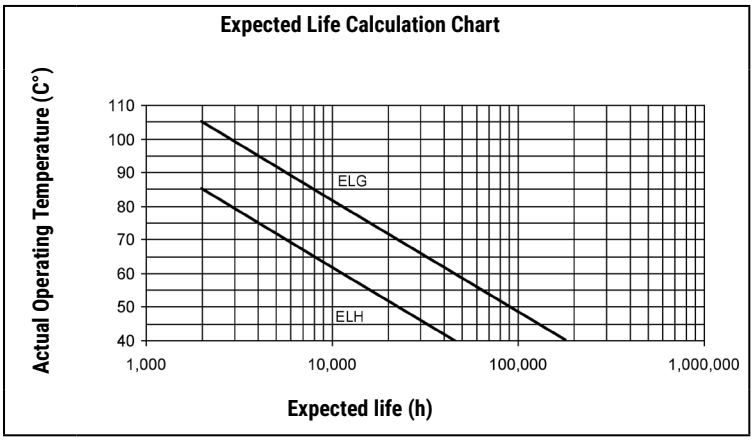
Frequency Dependence of the Ripple Current
ESR and, thus, the tan δ depend on the frequency of the applied voltage. This indicates that the allowed ripple current is also a function of the frequency.

Temperature Dependence of the Ripple Current
The data sheet specifies maximum ripple current at the upper category temperature for each capacitor.

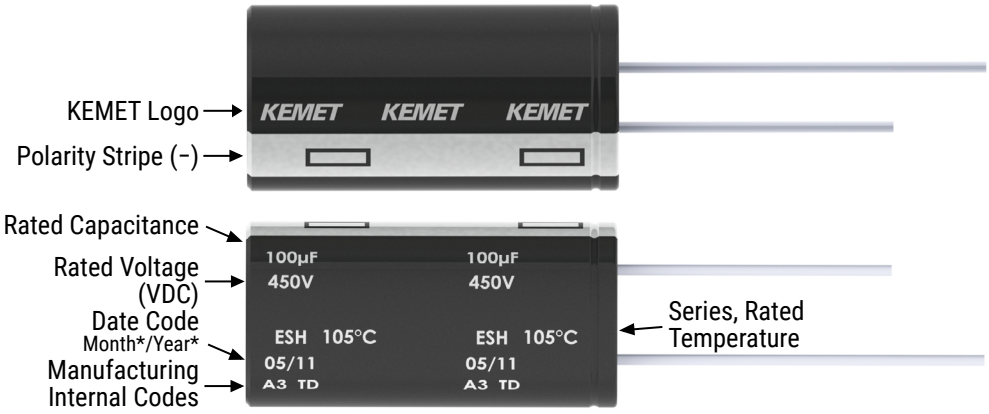
Expected Life Calculation
Expected life depends on operating temperature according to the following formula: $L = Lo \times 2^{(To-T)/10}$
Where:

L: Expected life
Lo: Load life at a maximum permissible operating temperature
T: Actual operating temperature
To: Maximum permissible operating temperature

This formula is applicable between 40°C and To.



Marking



*Y = Year

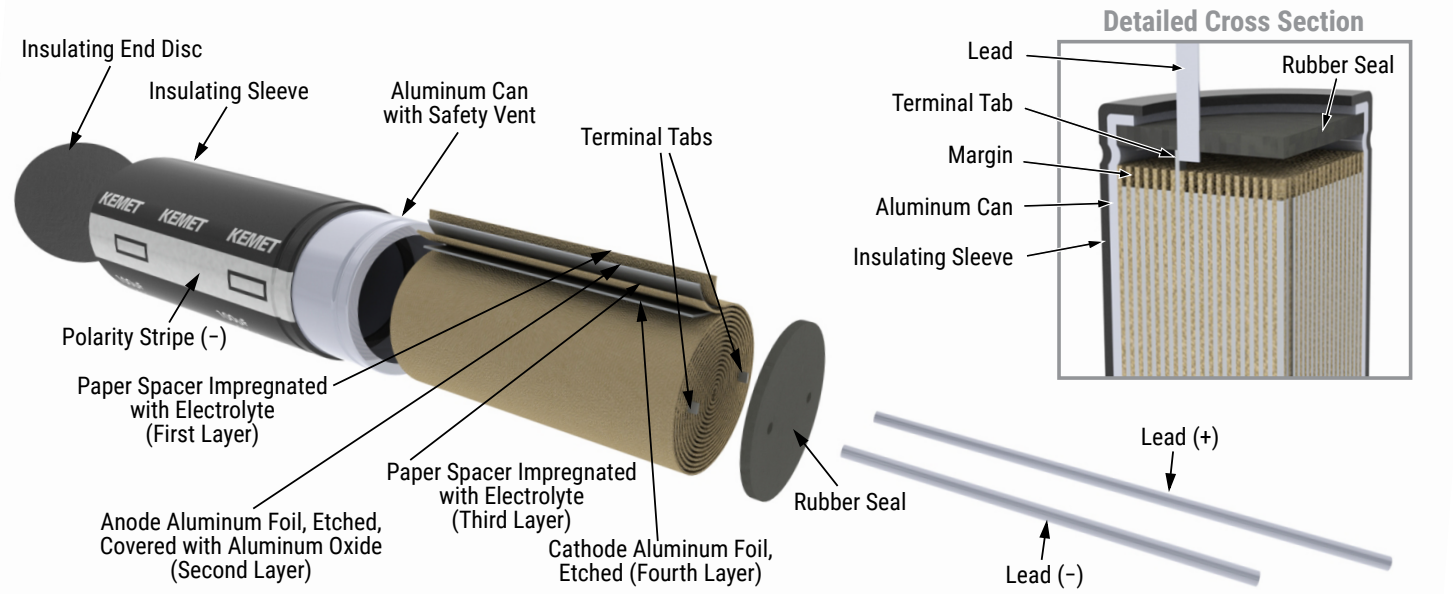
Code	01	02	03	04	05	06	07	08	09	20	21	22	23	24	25
Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025

*M = Month

Code	01	02	03	04	05	06	07	08	09	10	11	12
Month	1	2	3	4	5	6	7	8	9	10	11	12

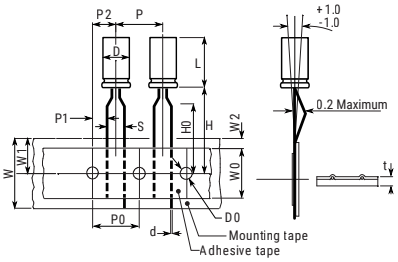
** Image for reference only. A slight change in the layout can occur, not affecting the marking content. This change will not impact the product's form, fit, or function, as the products remain equivalent in physical, mechanical, quality, and reliability characteristics.

Construction

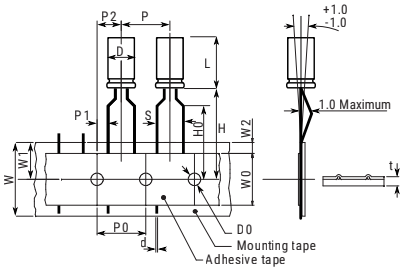


Taping for Automatic Insertion Machines

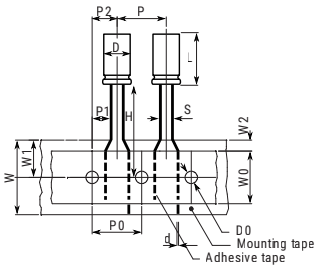
Formed to 2.5 mm
(Lead and packaging code LA and FA)



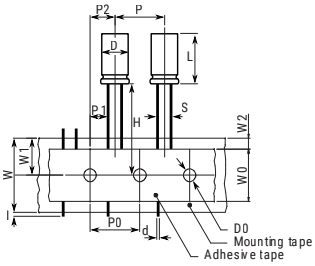
Formed to 5 mm
(Lead and packaging code JA and DA)



Straight Leads (Diameter: 4 – 8 mm)
Lead and packaging code EA and KA



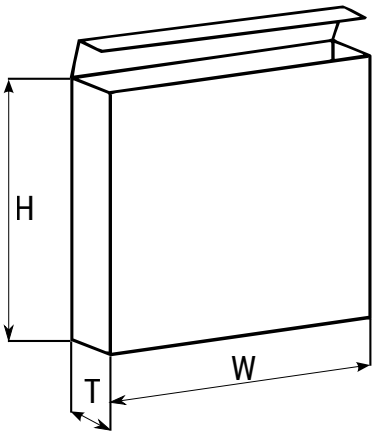
Straight Leads (Diameter > 8)
Lead and packaging code EA and KA



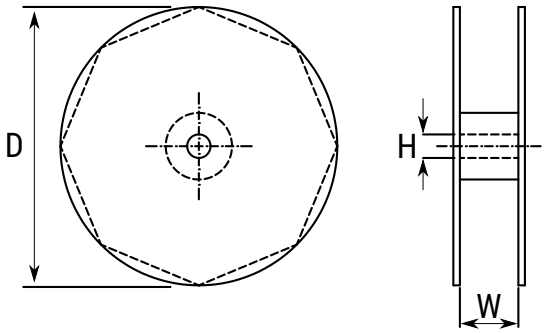
Dimensions (mm)	D	L	S	d	P	P0	P1	P2	W	W0	W1	W2	H0	H1	I	D0	t
Tolerance	+0.5		+0.8/−0.2	±0.05	±1.0	±0.3	±0.7	±1.3	+1/−0.5	±0.5	Maximum	Maximum	±0.75	±0.5	Maximum	±0.2	±0.2
Formed to 2.5 mm	4	5 – 7	2.5	0.45	12.7	12.7	5.1	6.35	18	12	11	3	16.0	18.5		4	0.7
	5	≤ 7	2.5	0.45	12.7	12.7	5.1	6.35	18	12	11	3	16.0	18.5		4	0.7
		> 7	2.5	0.50	12.7	12.7	5.1	6.35	18	12	11	3	16.0	18.5		4	0.7
Formed to 5 mm	4	5 – 7	5.0	0.45	12.7	12.7	3.85	6.35	18	12	11	3	16.0	18.5		4	0.7
	5	≤ 7	5.0	0.45	12.7	12.7	3.85	6.35	18	12	11	3	16.0	18.5		4	0.7
		>7	5.0	0.50	12.7	12.7	3.85	6.35	18	12	11	3	16.0	18.5		4	0.7
	6	≤ 7	5.0	0.50	12.7	12.7	3.85	6.35	18	12	11	3	16.0	18.5		4	0.7
		> 7	5.0	0.50	12.7	12.7	3.85	6.35	18	12	11	3	16.0	18.5		4	0.7
	8	≤ 7	5.0	0.50	12.7	12.7	3.85	6.35	18	12	11	3	16.0	18.5		4	0.7
		> 7	5.0	0.50	12.7	12.7	3.85	6.35	18	12	11	3	16.0	18.5		4	0.7
Straight leads	4	5 – 7	1.5	0.45	12.7	12.7	5.6	6.35	18	12	11	3	18.5			4	0.7
	5	≤ 7	2.0	0.45	12.7	12.7	5.35	6.35	18	12	11	3	18.5			4	0.7
		> 7	2.0	0.50	12.7	12.7	5.35	6.35	18	12	11	3	18.5			4	0.7
	6	≤ 7	2.5	0.50	12.7	12.7	5.1	6.35	18	12	11	3	18.5			4	0.7
		> 7	2.5	0.50	12.7	12.7	5.1	6.35	18	12	11	3	18.5			4	0.7
	8	≤ 7	3.5	0.50	12.7	12.7	4.6	6.35	18	12	11	3	18.5			4	0.7
		> 7	3.5	0.50	12.7	12.7	4.6	6.35	18	12	11	3	18.5			4	0.7
	10	≤ 20	5.0	0.60	12.7	12.7	3.85	6.35	18	12	11	3	18.5		1	4	1.0

Lead Taping & Packaging

Ammo Box



Reel



Diameter	Length	Ammo			Reel		
		H	W	T	D	H	W
			Maximum	Maximum	±2	±0.5	+1/-0.1
4	All	230	340	42	350	30	50
5	≤ 7	230	340	42			
5	11	275	340	42			
6.3	≤ 7	235	340	45			
6.3	11	230	340	48			
8	≤ 7	270	340	48			
8	11	235	340	48			
8	>11 ≤ 20	240	340	57			
10	≤ 13	250	340	52			
10	>13 ≤ 20	256	340	57			
10	>20	250	340	60	NA	NA	NA
12	All	270	340	57			
13	All	285	340	62			
16	All	265	340	62			
18	All	288	340	65			

Construction Data

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. This sample size is controlled by the use of recognized sampling tables defined in BS 6001.

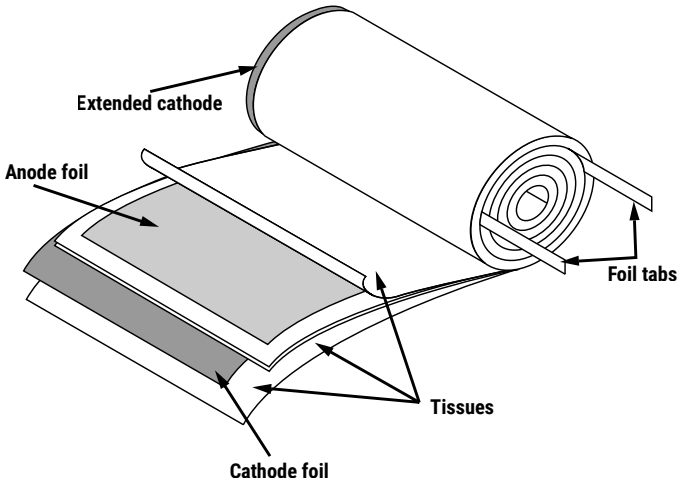
The following tests are applied and may be varied at the request of the customer. In this case the batch, or special procedure, will determine the course of action.

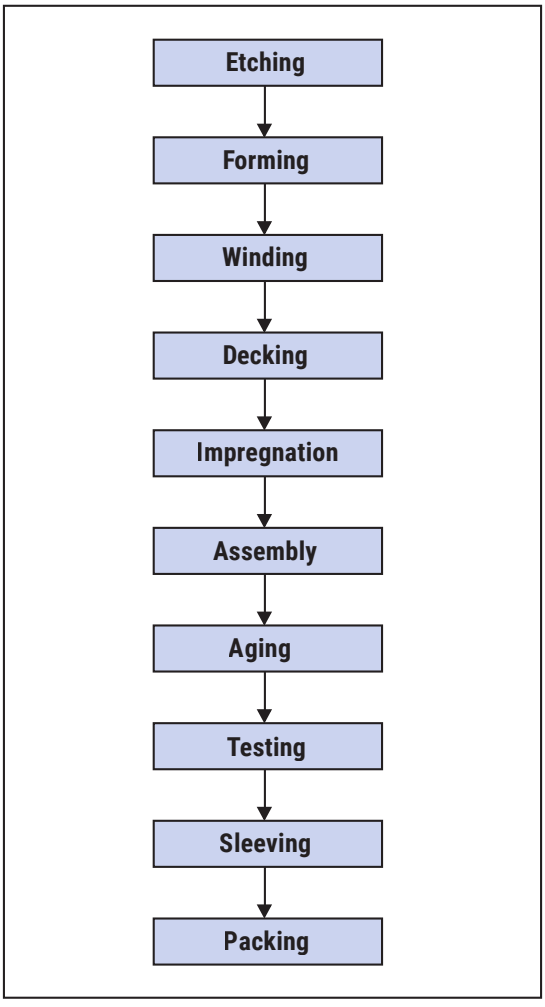
Electrical:

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

Mechanical/Visual:

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





KEMET Electronics Corporation Sales Offices

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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 indicated or that other measures may not be required.

KEMET requires its products to be packaged and shipped on pallets. This is because KEMET's products are specifically designed to be packed onto pallets during shipment. If for any reason, the products are removed from pallets by the shipping party and shipped to the end customer, then additional external protection is required. In this instance, an external box with two carton layers and an upwards orientation sticker must be used by the shipping party, with the empty space filled with filling material, and afterwards sealing the box. If this packing and packaging guideline is not followed by the shipping party, the shipping party, and not KEMET, will be held responsible for any packaging, packing and/or product damages upon delivery of the products to the end customer. KEMET hereby disclaims any liability for damages to the products or otherwise that have been, or threaten to be, inflicted, result from or are in any way related to the packaging, packing or damage by the shipping party in contravention of the packing and packaging guidelines herein.

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