EST Series, +105ºC

Overview

KEMET's EST Series of single-ended aluminum electrolytic capacitors are designed for low impedance and long life (up to 10,000 hours) applications.

Applications

Typical applications include SMPS, power supplies, adaptors, chargers, monitors and computers.

Benefits

- Long life, up to 10,000 hours
- Low impedance
- Operating temperature of up to +105°C
- Case with Ø D ≥ 6.3 mm
- Safety vent on the capacitor base

Part Number System

EST	157	M	6R3	A	C3	AA
Series	Capacitance Code (pF)	Tolerance	Rated Voltage (VDC)	Electrical Parameters	Size Code	Packaging
Single-Ended Aluminum Electrolytic	Digits 4 – 5 represent the first two digits of the capacitance value. The final digit indicates the number of zeros to be added.	M = ±20%	6R3 = 6.3 010 = 10 016 = 16 025 = 25 035 = 35 050 = 50 063 = 63	A = Standard	See Dimension Table	See Ordering Options Table

Ordering Options Table

Diameter	Packaging Type	Lead Type	Lead Length (mm)	Lead and Packaging Code
Standard Bulk Packaging Options				
4 – 22	Bulk (bag)	Straight	20/15 Minimum	AA
Standard Auto-Insertion Packaging Options				
4 – 5	Tape & Reel	Formed to 2.5 mm	H_0 = 16.5 ±0.75	LA
6.3	Tape & Reel	2.5 mm Lead Spacing	H_0 = 18.5 ±0.75	KA
8	Tape & Reel	Formed to 5 mm	H_0 = 16.5 ±0.75	JA
10 – 13	Ammo	5 mm Lead Spacing	H_0 = 18.5 ±0.75	EA
16	Ammo	7.5 mm Lead Spacing	H_0 = 18.5 ±0.75	EA
Other Packaging Options				
4 – 8	Ammo	Formed to 5 mm	H_0 = 16.5 ±0.75	DA
4 – 8	Ammo	Straight	H_0 = 18.5 ±0.75	EA
4 – 5	Ammo	Formed to 2.5 mm	H_0 = 16.5 ±0.75	FA
4 – 6.3	Tape & Reel	Formed to 5 mm	H_0 = 16.5 ±0.75	JA
4 – 5, 8 – 16	Tape & Reel	Straight	H_0 = 18.5 ±0.75	KA
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 makes any necessary changes in its products, whenever needed.

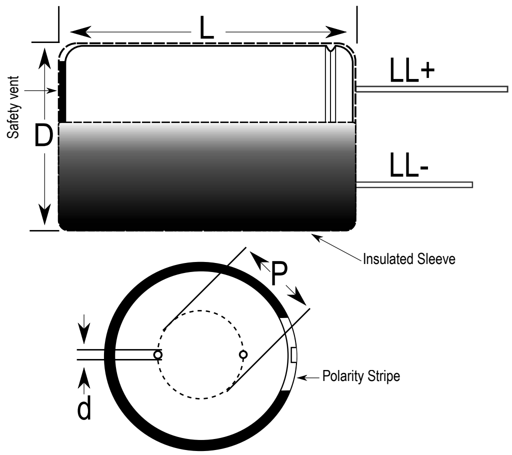
Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

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

Dimensions – Millimeters



Size Code	D		L		p		d		LL+/LL-	
	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance	Nominal	Tolerance
C3	5	±0.5	11	+1.5/-0	2	±0.5	0.5	Nominal	20/15	Minimum
E3	6.3	±0.5	11	+1.5/-0	2.0	±0.5	0.5	Nominal	20/15	Minimum
G3	8	±0.5	11	+1.5/-0	3.5	±0.5	0.6	Nominal	20/15	Minimum
G4	8	±0.5	15	+2.0/-0	3.5	±0.5	0.6	Nominal	20/15	Minimum
G6	8	±0.5	20	+2.0/-0	3.5	±0.5	0.6	Nominal	20/15	Minimum
H1	10	±0.5	12	+1.5/-0	5	±0.5	0.6	Nominal	20/15	Minimum
H2	10	±0.5	15	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
H4	10	±0.5	20	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
H5	10	±0.5	25	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
H6	10	±0.5	30	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
L3	13	±0.5	20	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
L4	13	±0.5	25	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
L8	13	±0.5	30	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
L6	13	±0.5	36	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
L7	13	±0.5	40	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
M7	16	±0.5	25	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
M2	16	±0.5	32	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
M3	16	±0.5	36	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
M4	16	±0.5	40	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
N1	18	±0.5	32	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
N2	18	±0.5	36	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
N3	18	±0.5	40	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum

Performance Characteristics

Item	Performance Characteristics
Capacitance Range	10 – 15,000 µF
Capacitance Tolerance	±20% at 120 Hz / 20°C
Rated Voltage	6.3 – 63 VDC
Life Test	4,000 – 10,000 hours (see conditions in Test Method & Performance)
Operating Temperature	-40°C to +105°C
Leakage Current	I ≤ 0.01 CV or 3 µA, whichever is greater
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 2 minutes at 20°C.

Compensation Factor of Ripple Current (RC) vs. Frequency

Capacitance Range (µF)	120 Hz	1 kHz	10 kHz	100 kHz
6.8 – 180	0.40	0.75	0.90	1.00
220 – 560	0.50	0.85	0.94	1.00
680 – 1,800	0.60	0.87	0.95	1.00
2,200 – 3,900	0.75	0.90	0.95	1.00
≥ 4,700	0.85	0.95	0.98	1.00

Test Method & Performance

Conditions	Load Life Test			Shelf Life Test
Temperature	105°C			105°C
Test Duration	Can Ø ≤ 6.3 mm	V ≤ 10 VDC	4,000 hours	1,000 hours
	Can Ø ≤ 6.3 mm	V ≤ 16 VDC	5,000 hours	
	8.0 ≤ Can Ø ≥ 10.0 mm	V ≤ 10 VDC	6,000 hours	
	8.0 ≤ Can Ø ≥ 10.0 mm	V ≤ 16 VDC	7,000 hours	
	Can Ø ≥ 12.5 mm	V ≤ 10 VDC	8,000 hours	
	Can Ø ≥ 12.5 mm	V ≤ 16 VDC	10,000 hours	
Ripple Current	Maximum ripple current specified at 100 kHz 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 ±25% of the initial value			
Dissipation Factor	Does not exceed 200% of the specified value			
Leakage Current	Does not exceed specified value			

Table 1 – Ratings & Part Number Reference

VDC	VDC Surge Voltage	Rated Capacitance 120 Hz 20°C (µF)	Case Size D x L (mm)	DF 120 Hz 20°C (tan δ %)*	RC 100 kHz 105°C (mA)	ESR 100 kHz 20°C (Ω)	Part Number
6.3	8	150	5x11	22	210	0.72	EST157M6R3AC3(1)
6.3	8	330	6.3x11	22	340	0.38	EST337M6R3AE3(1)
6.3	8	680	8x11	22	640	0.2	EST687M6R3AG3(1)
6.3	8	820	8x15	22	840	0.16	EST827M6R3AG4(1)
6.3	8	1000	10x12	22	865	0.12	EST108M6R3AH1(1)
6.3	8	1500	8x20	22	1050	0.11	EST158M6R3AG6(1)
6.3	8	1500	10x15	22	1210	0.084	EST158M6R3AH2(1)
6.3	8	2200	10x20	22	1400	0.062	EST228M6R3AH4(1)
6.3	8	2700	10x25	22	1650	0.052	EST278M6R3AH5(1)
6.3	8	3300	13x20	22	1900	0.046	EST338M6R3AL3(1)
6.3	8	3900	13x25	22	2230	0.034	EST398M6R3AL4(1)
6.3	8	4700	13x30	22	2650	0.03	EST478M6R3AL8(1)
6.3	8	5600	13x36	22	2880	0.027	EST568M6R3AL6(1)
6.3	8	6800	13x40	22	3350	0.024	EST688M6R3AL7(1)
6.3	8	6800	16x25	22	2930	0.028	EST688M6R3AM7(1)
6.3	8	8200	16x32	22	3450	0.025	EST828M6R3AM2(1)
6.3	8	10000	16x36	22	3610	0.018	EST109M6R3AM3(1)
6.3	8	12000	18x32	22	4170	0.015	EST129M6R3AN1(1)
6.3	8	15000	18x36	22	4220	0.014	EST159M6R3AN2(1)
10	13	100	5x11	19	210	0.72	EST107M010AC3(1)
10	13	220	6.3x11	19	340	0.38	EST227M010AE3(1)
10	13	470	8x11	19	640	0.2	EST477M010AG3(1)
10	13	680	8x15	19	840	0.16	EST687M010AG4(1)
10	13	1000	10x15	19	1210	0.084	EST108M010AH2(1)
10	13	1500	10x20	19	1400	0.062	EST158M010AH4(1)
10	13	220	10x25	19	1650	0.052	EST227M010AH5(1)
10	13	270	13x20	19	1900	0.046	EST277M010AL3(1)
10	13	330	13x25	19	2230	0.034	EST337M010AL4(1)
10	13	390	13x30	19	2650	0.03	EST397M010AL8(1)
10	13	4700	13x36	19	2880	0.027	EST478M010AL6(1)
10	13	4700	13x40	19	3350	0.024	EST478M010AL7(1)
10	13	5600	16x25	19	2930	0.028	EST568M010AM7(1)
10	13	6800	16x32	19	3450	0.025	EST688M010AM2(1)
10	13	8200	16x36	19	3610	0.018	EST828M010AM3(1)
10	13	1000	18x36	19	4220	0.014	EST108M010AN2(1)
16	20	56	5x11	16	210	0.72	EST566M016AC3(1)
16	20	100	6.3x11	16	340	0.38	EST107M016AE3(1)
16	20	220	8x11	16	640	0.2	EST227M016AG3(1)
16	20	330	8x15	16	701	0.16	EST337M016AG4(1)
16	20	470	8x15	16	840	0.16	EST477M016AG4(1)
16	20	680	10x15	16	1210	0.084	EST687M016AH2(1)
16	20	1000	10x20	16	1400	0.062	EST108M016AH4(1)
16	20	4700	10x25	16	1650	0.052	EST478M016AH5(1)
16	20	2200	13x25	16	2230	0.034	EST228M016AL4(1)
16	20	2700	13x30	16	2650	0.03	EST278M016AL8(1)
16	20	3300	13x36	16	2880	0.027	EST338M016AL6(1)
16	20	3900	13x40	16	3350	0.024	EST398M016AL7(1)
16	20	4700	16x32	16	3450	0.028	EST478M016AM2(1)
16	20	5600	16x36	16	3610	0.018	EST568M016AM3(1)
16	20	5600	18x32	16	4170	0.015	EST568M016AN1(1)
16	20	6800	18x36	16	4220	0.014	EST688M016AN2(1)
25	32	47	5x11	14	210	0.72	EST476M025AC3(1)
25	32	100	6.3x11	14	340	0.38	EST107M025AE3(1)
25	32	150	8x11	14	640	0.2	EST157M025AG3(1)
25	32	220	8x11	14	640	0.2	EST227M025AG3(1)
25	32	330	8x15	14	840	0.16	EST337M025AG4(1)
25	32	470	10x15	14	1210	0.084	EST477M025AH2(1)
VDC	**VDC Surge**	**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'd

VDC	VDC Surge Voltage	Rated Capacitance 120 Hz 20°C (µF)	Case Size D x L (mm)	DF 120 Hz 20°C (tan δ %)*	RC 100 kHz 105°C (mA)	ESR 100 kHz 20°C (Ω)	Part Number
25	32	680	10x20	14	1400	0.062	EST687M025AH4(1)
25	32	680	10x25	14	1650	0.052	EST687M025AH5(1)
25	32	1000	13x20	14	1900	0.046	EST108M025AL3(1)
25	32	150	13x25	14	2230	0.034	EST157M025AL4(1)
25	32	220	13x25	14	2880	0.027	EST227M025AL4(1)
25	32	2700	16x25	14	2930	0.028	EST278M025AM7(1)
25	32	3300	16x32	14	3450	0.025	EST338M025AM2(1)
25	32	3900	18x32	14	4170	0.015	EST398M025AN1(1)
25	32	4700	18x36	14	4280	0.014	EST478M025AN2(1)
35	44	33	5x11	12	210	0.72	EST336M035AC3(1)
35	44	47	6.3x11	12	340	0.38	EST476M035AE3(1)
35	44	150	8x11	12	640	0.2	EST157M035AG3(1)
35	44	220	8x15	12	840	0.16	EST227M035AG4(1)
35	44	330	10x20	12	1400	0.062	EST337M035AH4(1)
35	44	470	10x25	12	1650	0.052	EST477M035AH5(1)
35	44	680	10x30	12	1910	0.044	EST687M035AH6(1)
35	44	680	13x20	12	1900	0.046	EST687M035AL3(1)
35	44	820	13x25	12	2230	0.034	EST827M035AL4(1)
35	44	1000	13x25	12	2230	0.034	EST108M035AL4(1)
35	44	1200	13x30	12	2650	0.03	EST128M035AL8(1)
35	44	1500	13x36	12	2880	0.027	EST158M035AL6(1)
35	44	1800	13x40	12	3350	0.024	EST188M035AL7(1)
35	44	2200	16x32	12	3450	0.025	EST228M035AM2(1)
35	44	2700	16x36	12	3610	0.018	EST278M035AM3(1)
35	44	3300	18x36	12	4220	0.014	EST338M035AN2(1)
50	63	10	5x11	10	120	3.5	EST106M050AC3(1)
50	63	22	5x11	10	210	2.3	EST226M050AC3(1)
50	63	33	6.3x11	10	340	1.2	EST336M050AE3(1)
50	63	47	6.3x11	10	340	1.2	EST476M050AE3(1)
50	63	100	8x11	10	555	0.63	EST107M050AG3(1)
50	63	120	8x15	10	730	0.45	EST127M050AG4(1)
50	63	150	8x20	10	910	0.33	EST157M050AG6(1)
50	63	220	10x15	10	1050	0.31	EST227M050AH2(1)
50	63	330	10x20	10	1400	0.21	EST337M050AH4(1)
50	63	470	10x30	10	1690	0.15	EST477M050AH6(1)
50	63	470	13x20	10	1660	0.16	EST477M050AL3(1)
50	63	560	13x25	10	1950	0.12	EST567M050AL4(1)
50	63	680	13x30	10	2310	0.1	EST687M050AL8(1)
50	63	820	13x36	10	2510	0.083	EST827M050AL6(1)
50	63	1000	16x25	10	2555	0.073	EST108M050AM7(1)
50	63	1200	16x32	10	3010	0.054	EST128M050AM2(1)
50	63	1500	16x36	10	3150	0.045	EST158M050AM3(1)
50	63	1800	18x32	10	3635	0.047	EST188M050AN1(1)
50	63	2200	18x36	10	3680	0.04	EST228M050AN2(1)
50	63	2700	18x40	10	3800	0.036	EST278M050AN3(1)
63	79	10	5x11	9	55	2.3	EST106M063AC3(1)
63	79	33	6.3x11	9	115	1.2	EST336M063AE3(1)
63	79	56	8x11	9	232	0.63	EST566M063AG3(1)
63	79	270	10x15	9	357	0.31	EST277M063AH2(1)
63	79	180	10x20	9	466	0.21	EST187M063AH4(1)
63	79	220	10x25	9	531	0.2	EST227M063AH5(1)
63	79	270	10x30	9	663	0.15	EST277M063AH6(1)
63	79	270	13x20	9	690	0.16	EST277M063AL3(1)
63	79	330	13x25	9	784	0.12	EST337M063AL4(1)
63	79	470	13x30	9	905	0.1	EST477M063AL8(1)
63	79	560	13x36	9	1050	0.083	EST567M063AL6(1)
63	79	680	13x40	9	1180	0.071	EST687M063AL7(1)
VDC	**VDC Surge**	**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'd

VDC	VDC Surge Voltage	Rated Capacitance 120 Hz 20°C (µF)	Case Size D x L (mm)	DF 120 Hz 20°C (tan δ %)*	RC 100 kHz 105°C (mA)	ESR 100 kHz 20°C (Ω)	Part Number
63	79	820	16x32	9	1570	0.054	EST827M063AM2(1)
63	79	1000	16x36	9	1790	0.045	EST108M063AM3(1)
63	79	1200	16x40	9	2020	0.04	EST128M063AM4(1)
VDC	**VDC Surge**	**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 (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

- A general principle is that 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 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 mm 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 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 and Operation Guidelines

Electrical Ratings:
Capacitance (ESC)

Capacitance is measured by applying an alternate voltage of ≤ 0.5 V at a frequency of 120 or 100 Hz and 20°C.

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

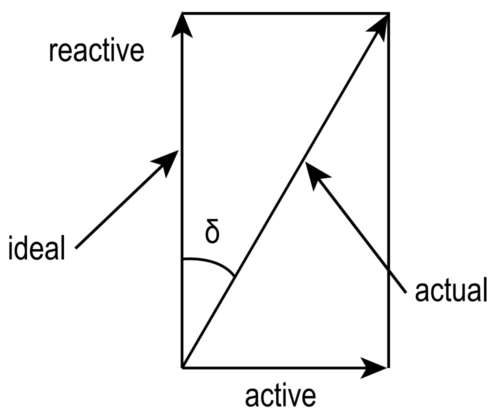
Effective capacitance value is derived from the impedance curve, as long as impedance is still in the range where the capacitance component is dominant.

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

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.



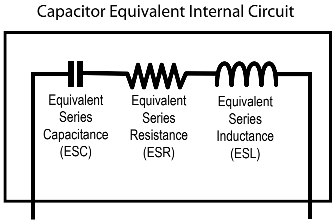
Tan δ is measured with the same set-up used for the series capacitance ESC.
tan δ = ω x ESC x ESR where:

ESC = Equivalent Series Capacitance
ESR = Equivalent Series Resistance

Equivalent Series Inductance (ESL)

Self inductance or Equivalent Series Inductance results from the terminal configuration and internal design of the capacitor.

Capacitor Equivalent Internal Circuit



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:

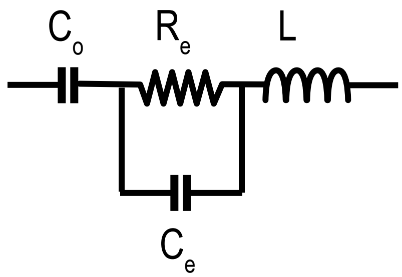
$$ESR = \frac{\tan \delta}{2\pi f \, ESC}$$

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.

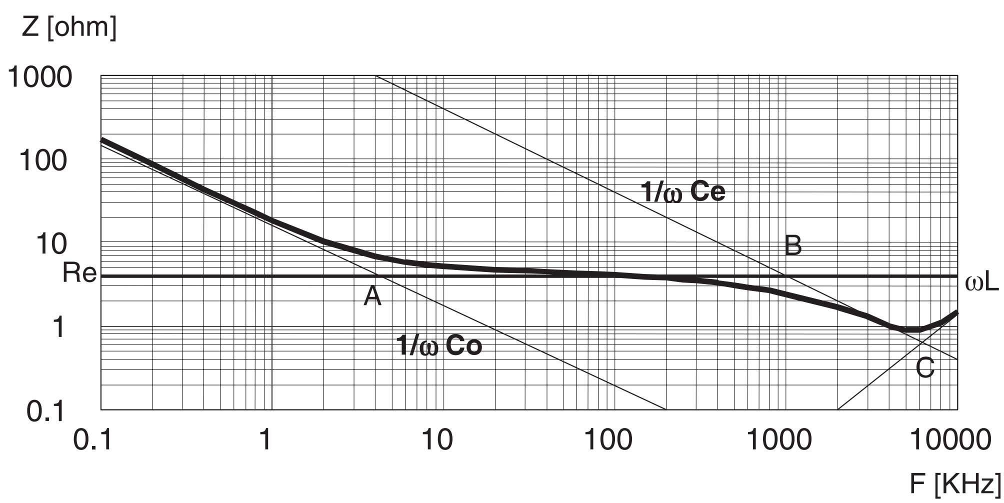
Impedance (Z)

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



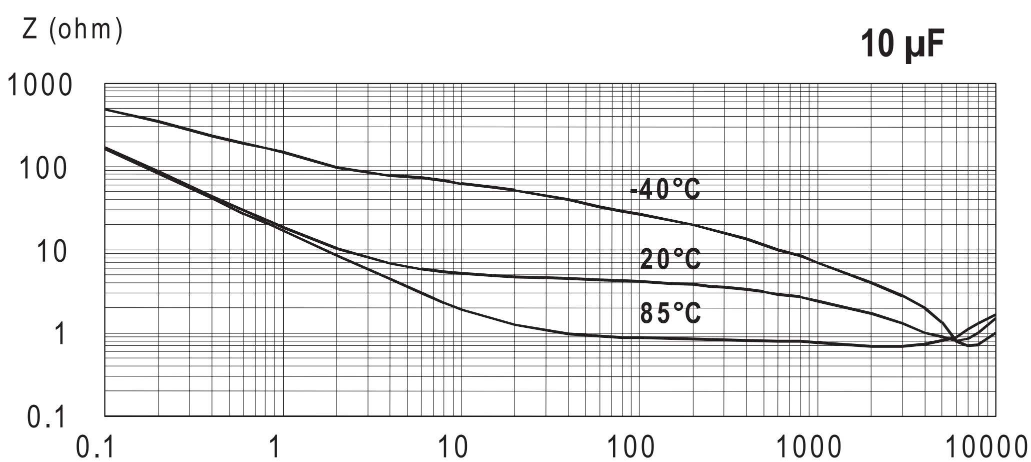
C_o = Aluminum oxide capacitance (surface and thickness of the dielectric)
R_e = Resistance of electrolyte and paper mixture (other resistances not depending on the frequency are not considered: tabs, plates, etc.)
C_e = Electrolyte soaked paper capacitance
L = Inductive reactance of the capacitor winding 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:



- 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 $1/\omega C_e = \omega L$, $\omega_0 = C\sqrt{1/LCe}$
- 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.

Leakage Current (LC)

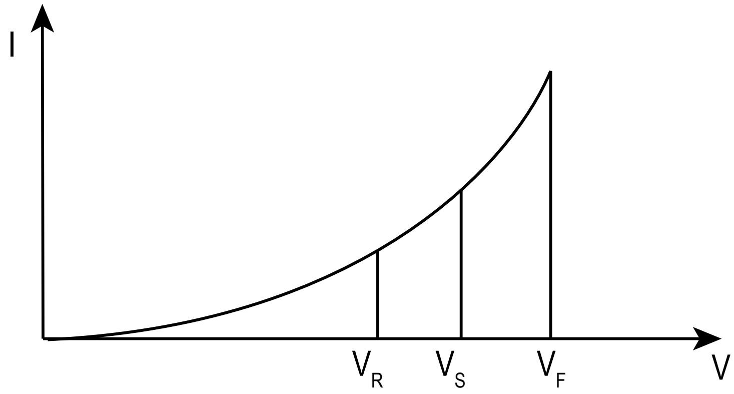
Due to the aluminum oxide layer that serves as a dielectric, a small current will continue to flow even after a DC voltage has been applied for long periods. This current is called leakage current.

A high leakage current flows after applying voltage to the capacitor then decreases in a few minutes, e.g., 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 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.

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 maximum permissible operating temperature
T: Actual operating temperature
To: Maximum permissible operating temperature
This formula is applicable between 40°C and To.

Packaging Quantities

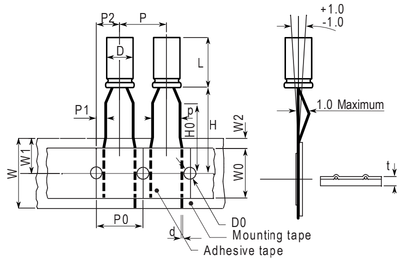
Size Code	Diameter (mm)	Length (mm)	Bulk Standard Leads	Auto-insertion		
				Cut Leads	Ammo	Tape & Reel
C3	5	11	10000	15000	2000	1300
E3	6.3	11	10000	15000	2000	1100
G3	8	11	6000	8000	1000	750
G4	8	15	5000	5000	1000	750
G6	8	20	4000	4000	1000	750
H1	10	12	4000	4000	700	600
H2	10	15	3000	4000	700	600
H4	10	20	2400	3000	700	600
H5	10	25	2400	2400	500	
H6	10	30	2000	2000	500	
L3	13	20	2000	2000	500	
L4	13	25	1600	1600	500	
L8	13	30	1200	2400		
L6	13	36	1000	1200	400	
L7	13	40	1000	500	500	
M7	16	25	1000	500	300	
M2	16	32	800	500		
M3	16	36	600	500		
M4	16	40	600	500		
N1	18	32	500	500		
N2	18	36	500	500		
N3	18	40	500	500		

Standard Marking for Surface Mount Types

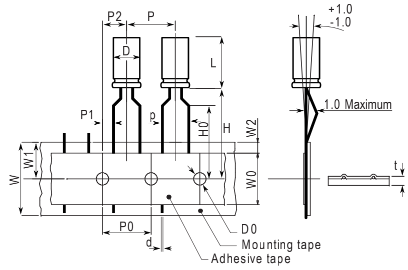
- KEMET logo
- Series
- Operating temperature (°C)
- Rated voltage (VDC)
- Rated capacitance (µF)
- Negative polarity
- Date code

Taping for Automatic Insertion Machines

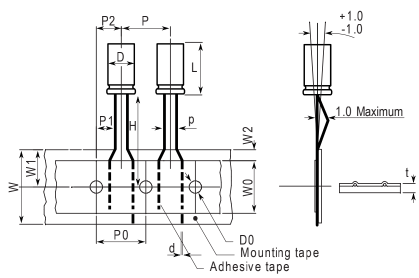
Formed to 2.5 mm
(Lead and packaging code LA and FA)



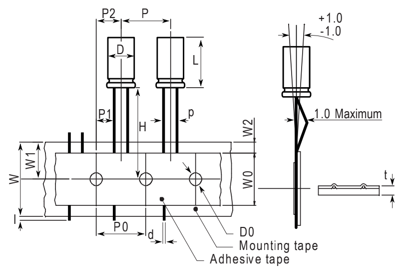
Formed to 5 mm
(Lead and packaging code JA and DA)



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

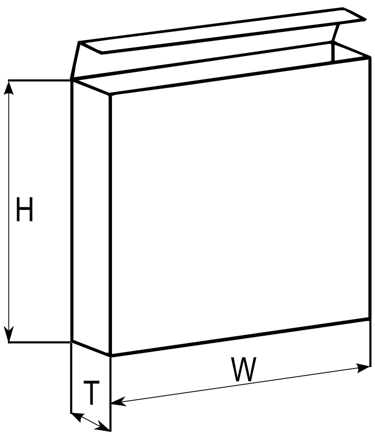


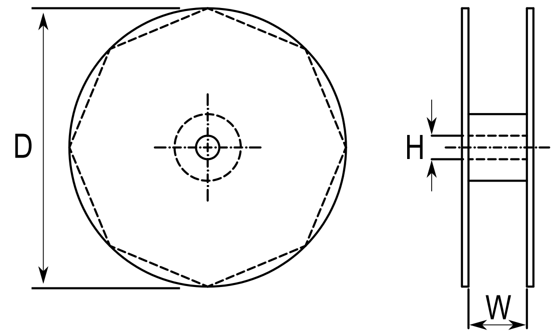
Straight Leads (Diameter > 8)
Lead and packaging code EA and KA



Dimensions (mm)	D	L	p	d	P	P0	P1	P2	W	W0	W1	W2	H0	H1	l	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	18.5		4	0.7
	5	≤7	2.5	0.45	12.7	12.7	5.1	6.35	18	12	11	3	16	18.5		4	0.7
		>7	2.5	0.5	12.7	12.7	5.1	6.35	18	12	11	3	16	18.5		4	0.7
Formed to 5 mm	4	5-7	5	0.45	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
	5	≤7	5	0.45	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
		>7	5	0.5	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
	6	≤7	5	0.5	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
		>7	5	0.5	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
	8	≤7	5	0.5	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
		>7	5	0.5	12.7	12.7	3.85	6.35	18	12	11	3	16	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	0.45	12.7	12.7	5.35	6.35	18	12	11	3	18.5			4	0.7
		>7	2	0.5	12.7	12.7	5.35	6.35	18	12	11	3	18.5			4	0.7
	6	≤7	2.5	0.5	12.7	12.7	5.1	6.35	18	12	11	3	18.5			4	0.7
		>7	2.5	0.5	12.7	12.7	5.1	6.35	18	12	11	3	18.5			4	0.7
	8	≤7	3.5	0.5	12.7	12.7	4.6	6.35	18	12	11	3	18.5			4	0.7
		>7	3.5	0.5	12.7	12.7	4.6	6.35	18	12	11	3	18.5			4	0.7
	10	12-25	5	0.6	12.7	12.7	3.85	6.35	18	12	11	3	18.5		1	4	1
	12	15-25	5	0.6	15	15	3.85	7.5	18	12	11	3	18.5		1	4	1
	13		5	0.6	15	15	3.85	7.5	18	12	11	3	18.5		1	4	1
			5	0.6	15	15	3.85	7.5	18	12	11	3	18.5		1	4	1
	16		7.5	0.8	30	30	3.75	7.5	18	12	11	3	18.5		1	4	1
	18		7.5	0.8	30	30	3.75	7.5	18	12	11	3	18.5		1	4	1

Lead Taping & Packaging

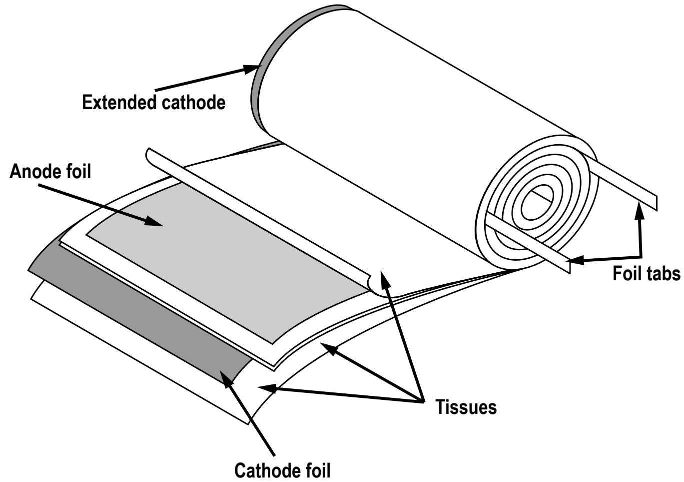




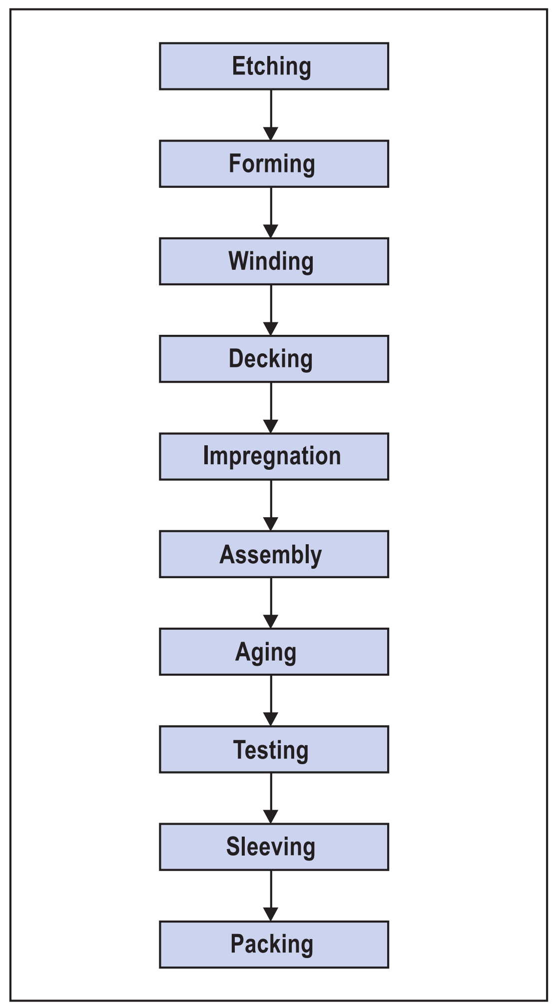
Case Size (mm)	Ammo			Reel		
	H	W	T	D	H	W
		Maximum	Maximum	±2	±0.5	+1/-0.1
4	230	340	42	350	30	50
5 x 5 – 7	230	340	42			
6.3 x 5 – 7	275	340	42			
8 x 5 – 9	235	340	45			
5 x 11	230	340	48			
6.3 x 11	270	340	48			
8 x 11	235	340	48			
8 x 14 – 20	240	340	57			
10 x 12	250	340	52			
10 x 15 – 19	256	340	57			
10 x 22 – 25	250	340	60			
12	270	340	57			
13	285	340	62			
16	265	340	62			

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

KEMET Corporation World Headquarters

2835 KEMET Way
Simpsonville, SC 29681

Mailing Address:
P.O. Box 5928
Greenville, SC 29606

www.kemet.com
Tel: 864-963-6300
Fax: 864-963-6521

Corporate Offices
Fort Lauderdale, FL
Tel: 954-766-2800

North America

Southeast
Lake Mary, FL
Tel: 407-855-8886

Northeast
Wilmington, MA
Tel: 978-658-1663

Central
Novi, MI
Tel: 248-306-9353

West
Milpitas, CA
Tel: 408-433-9950

Mexico
Guadalajara, Jalisco
Tel: 52-33-3123-2141

Europe

Southern Europe
Paris, France
Tel: 33-1-4646-1006

Sasso Marconi, Italy
Tel: 39-051-939111

Central Europe
Landsberg, Germany
Tel: 49-8191-3350800

Kamen, Germany
Tel: 49-2307-438110

Northern Europe
Bishop's Stortford, United Kingdom
Tel: 44-1279-460122

Espoo, Finland
Tel: 358-9-5406-5000

Asia

Northeast Asia
Hong Kong
Tel: 852-2305-1168

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

Note: KEMET reserves the right to modify minor details of internal and external construction at any time in the interest of product improvement. KEMET does not assume any responsibility for infringement that might result from the use of KEMET Capacitors in potential circuit designs. KEMET is a registered trademark of KEMET Electronics Corporation.

Disclaimer

All product specifications, statements, information and data (collectively, the "Information") in this datasheet are subject to change. The customer is responsible for checking and verifying the extent to which the Information contained in this publication is applicable to an order at the time the order is placed.

All Information given herein is believed to be accurate and reliable, but it is presented without guarantee, warranty, or responsibility of any kind, expressed or implied.

Statements of suitability for certain applications are based on KEMET Electronics Corporation's ("KEMET") knowledge of typical operating conditions for such applications, but are not intended to constitute – and KEMET specifically disclaims – any warranty concerning suitability for a specific customer application or use. The Information is intended for use only by customers who have the requisite experience and capability to determine the correct products for their application. Any technical advice inferred from this Information or otherwise provided by KEMET with reference to the use of KEMET's products is given gratis, and KEMET assumes no obligation or liability for the advice given or results obtained.

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.