

## Overview

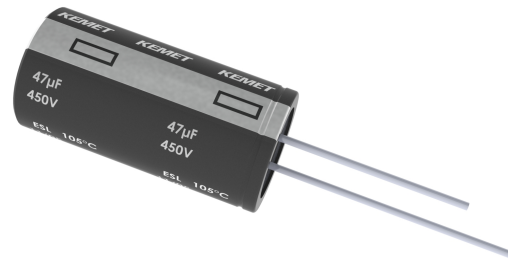
KEMET's ESL aluminum electrolytic single-ended capacitors are designed for high reliability and long life (up to 10,000 hours) applications.

## Applications

Typical applications include LED drive source.

## Benefits

- Long life, up to 10,000 hours
- Operating temperature of up to +105°C
- Safety vent on the capacitor base



## Part Number System

ESL	106	M	016		A	C3	AA
Series	Capacitance Code (pF)	Tolerance	Rated Voltage (VDC)		Electrical Parameters	Size Code	Packaging
Single-ended aluminum electrolytic	First two digits represent significant figures for capacitance values. Last digit specifies the number of zeros to be added.	M = ±20%	016 = 16 025 = 25 035 = 35 050 = 50 063 = 63 100 = 100	160 = 160 200 = 200 250 = 250 350 = 350 400 = 400 450 = 450	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				
10 – 13	Ammo	5 mm lead spacing	$H_0 = 18.5 \pm 0.75$	EA
16 – 18	Ammo	7.5 mm lead spacing	$H_0 = 18.5 \pm 0.75$	EA
Other Packaging Options				
4 – 8	Ammo	Formed to 5 mm	$H_0 = 16 \pm 0.75$	DA
4 – 8	Ammo	Straight	$H_0 = 18.5 \pm 0.75$	EA
4 – 5	Ammo	Formed to 2.5 mm	$H_0 = 16 \pm 0.75$	FA
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.

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

## 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
GM	8	±0.5	11.5	+2.0/-0	3.5	±0.5	0.6	Nominal	20/15	Minimum
G9	8	±0.5	12	+2.0/-0	3.5	±0.5	0.6	Nominal	20/15	Minimum
G8	8	±0.5	16	+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
GG	8	±0.5	50	+2.0/-0	3.5	±0.5	0.6	Nominal	20/15	Minimum
H9	10	±0.5	12.5	+1.5/-0	5	±0.5	0.6	Nominal	20/15	Minimum
H8	10	±0.5	16	+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
HB	10	±0.5	40	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
HE	10	±0.5	50	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
K7	12.5	±0.5	15	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
K5	12.5	±0.5	20	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
K1	12.5	±0.5	25	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
K2	12.5	±0.5	30	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
K3	12.5	±0.5	35	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
K4	12.5	±0.5	40	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
KB	12.5	±0.5	50	+2.0/-0	5	±0.5	0.6	Nominal	20/15	Minimum
M5	16	±0.5	20	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
M7	16	±0.5	25	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
M9	16	±0.5	30	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
MP	16	±0.5	35	+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
N5	18	±0.5	25	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
N8	18	±0.5	30	+2.0/-0	7.5	±0.5	0.8	Nominal	20/15	Minimum
NA	18	±0.5	35	+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	0.47 – 6,800 $\mu$ F	
Capacitance Tolerance	$\pm$ 20% at 120 Hz/20°C	
Rated Voltage	16 – 100 VDC	160 – 450 VDC
Life Test	8,000 – 10,000 hours (see conditions in Test Methods & Performance)	
Operating Temperature	-40°C to +105°C	
Leakage Current	$I \leq 0.01 CV$ or 3 $\mu$ A, whichever is greater	$I \leq 0.02 CV + 10 \mu$ A
	C = rated capacitance ( $\mu$ F), V = rated voltage (VDC). Voltage applied for 2 minutes at 20°C.	

## Impedance Z Characteristics at 120 Hz

Rated Voltage (VDC)	16	25	35	50	63	100	160	200	250	350	400	450
Z (-40°C)/Z (20°C)	8	6	6	6	4	4	6	6	6	7	7	9

## Compensation Factor of Ripple Current (RC) vs. Frequency

Rated Voltage (VDC)	50 Hz	120 Hz	1 kHz	10 kHz	100 kHz
Coefficient	0.40	0.50	0.80	0.90	1.00

## Test Method & Performance

Conditions	Load Life Test		Shelf Life Test
Temperature	105°C		105°C
Test Duration	16 – 100 VDC	Can $\varnothing$ = 5 – 6 mm	1,000 hours
		Can $\varnothing$ $\geq$ 8 mm	
	160 – 450 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
<b>Performance</b>	<b>The following specifications will be satisfied when the capacitor is restored to 20°C:</b>		
Capacitance Change	Within $\pm$ 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-series 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-series aluminum electrolytic capacitors is +5 to +35°C and less than 75% in relative humidity.

KEMET's E-series aluminum electrolytic capacitors should not be stored in damp conditions such as water, saltwater spray or oil spray.

KEMET's E-series 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-series 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**

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)	LC 20°C 2 Minutes (µA)	Part Number
16	20	10	5 x 11	16	150	0.950	3	ESL106M016AC3(1)
16	20	15	5 x 11	16	155	0.950	3	ESL156M016AC3(1)
16	20	22	5 x 11	16	170	0.360	3.52	ESL226M016AC3(1)
16	20	33	5 x 11	16	185	0.360	5.28	ESL336M016AC3(1)
16	20	39	5 x 11	16	225	0.360	6.24	ESL396M016AC3(1)
16	20	47	5 x 11	16	245	0.230	7.52	ESL476M016AC3(1)
16	20	56	5 x 11	16	280	0.230	8.96	ESL566M016AC3(1)
16	20	68	5 x 11	16	305	0.230	10.88	ESL686M016AC3(1)
16	20	100	5 x 11	16	345	0.230	16	ESL107M016AC3(1)
16	20	120	6.3 x 11	16	485	0.098	19.2	ESL127M016AE3(1)
16	20	150	6.3 x 11	16	510	0.098	24	ESL157M016AE3(1)
16	20	180	6.3 x 11	16	525	0.098	28.8	ESL187M016AE3(1)
16	20	220	6.3 x 11	16	555	0.098	35.2	ESL227M016AE3(1)
16	20	270	8 x 11.5	16	870	0.061	43.2	ESL277M016AGM(1)
16	20	330	8 x 11.5	16	920	0.061	52.8	ESL337M016AGM(1)
16	20	390	8 x 11.5	16	940	0.061	62.4	ESL397M016AGM(1)
16	20	470	8 x 11.5	16	960	0.061	75.2	ESL477M016AGM(1)
16	20	560	8 x 16	16	1230	0.049	89.6	ESL567M016AG8(1)
16	20	560	10 x 12.5	16	1340	0.043	89.6	ESL567M016AH9(1)
16	20	680	8 x 16	16	1280	0.049	108.8	ESL687M016AG8(1)
16	20	680	10 x 12.5	16	1340	0.043	108.8	ESL687M016AH9(1)
16	20	820	8 x 20	16	1540	0.031	131.2	ESL827M016AG6(1)
16	20	820	10 x 16	16	1770	0.031	131.2	ESL827M016AH8(1)
16	20	1000	8 x 20	16	1540	0.031	160	ESL108M016AG6(1)
16	20	1000	10 x 16	16	1770	0.031	160	ESL108M016AH8(1)
16	20	1200	10 x 20	16	1970	0.022	192	ESL128M016AH4(1)
16	20	1200	12.5 x 15	16	2340	0.020	192	ESL128M016AK7(1)
16	20	1500	10 x 20	16	1970	0.022	240	ESL158M016AH4(1)
16	20	1500	12.5 x 15	16	2340	0.020	240	ESL158M016AK7(1)
16	20	1800	10 x 25	16	2260	0.020	288	ESL188M016AH5(1)
16	20	1800	12.5 x 20	16	2490	0.019	288	ESL188M016AK5(1)
16	20	2200	12.5 x 20	18	2490	0.019	352	ESL228M016AK5(1)
16	20	2700	12.5 x 25	18	2710	0.017	432	ESL278M016AK1(1)
16	20	3300	12.5 x 30	20	2960	0.014	528	ESL338M016AK2(1)
16	20	3300	16 x 20	20	2960	0.017	528	ESL338M016AM5(1)
16	20	3900	12.5 x 30	20	3060	0.014	624	ESL398M016AK2(1)
16	20	3900	16 x 20	20	3060	0.017	624	ESL398M016AM5(1)
16	20	4700	12.5 x 35	22	3280	0.013	752	ESL478M016AK3(1)
16	20	4700	16 x 25	22	3240	0.014	752	ESL478M016AM7(1)
16	20	5600	16 x 30	24	3700	0.012	896	ESL568M016AM9(1)
16	20	5600	18 x 25	24	3660	0.013	896	ESL568M016AN5(1)
16	20	6800	16 x 30	26	3900	0.012	1088	ESL688M016AM9(1)
16	20	6800	18 x 25	26	3860	0.013	1088	ESL688M016AN5(1)
25	32	10	5 x 11	14	160	0.950	3	ESL106M025AC3(1)
25	32	15	5 x 11	14	170	0.950	3.75	ESL156M025AC3(1)
25	32	22	5 x 11	14	185	0.360	5.5	ESL226M025AC3(1)
25	32	33	5 x 11	14	200	0.360	8.25	ESL336M025AC3(1)
25	32	39	5 x 11	14	225	0.360	9.75	ESL396M025AC3(1)
25	32	47	5 x 11	14	315	0.230	11.75	ESL476M025AC3(1)
25	32	56	5 x 11	14	335	0.230	14	ESL566M025AC3(1)
25	32	68	5 x 11	14	355	0.230	17	ESL686M025AC3(1)
25	32	100	6.3 x 11	14	485	0.098	25	ESL107M025AE3(1)
25	32	120	6.3 x 11	14	525	0.098	30	ESL127M025AE3(1)
25	32	150	6.3 x 11	14	555	0.098	37.5	ESL157M025AE3(1)
25	32	180	8 x 11.5	14	875	0.061	45	ESL187M025AGM(1)
25	32	220	8 x 11.5	14	905	0.061	55	ESL227M025AGM(1)
25	32	270	8 x 11.5	14	965	0.061	67.5	ESL277M025AGM(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)	LC 20°C 2 Minutes (µA)	Part Number
25	32	330	8 x 11.5	14	965	0.061	82.5	ESL337M025AGM(1)
25	32	390	8 x 16	14	1280	0.049	97.5	ESL397M025AG8(1)
25	32	390	10 x 12.5	14	1340	0.043	97.5	ESL397M025AH9(1)
25	32	470	10 x 12.5	14	1325	0.043	117.5	ESL477M025AH9(1)
25	32	560	8 x 20	14	1540	0.031	140	ESL567M025AG6(1)
25	32	560	10 x 16	14	1770	0.031	140	ESL567M025AH8(1)
25	32	680	10 x 16	14	1770	0.031	170	ESL687M025AH8(1)
25	32	820	10 x 20	14	2010	0.020	205	ESL827M025AH4(1)
25	32	820	12.5 x 15	14	2010	0.020	205	ESL827M025AK7(1)
25	32	1000	10 x 25	14	2260	0.020	250	ESL108M025AH5(1)
25	32	1000	12.5 x 20	14	2260	0.019	250	ESL108M025AK5(1)
25	32	1200	12.5 x 20	14	2370	0.019	300	ESL128M025AK5(1)
25	32	1500	12.5 x 20	14	2490	0.019	375	ESL158M025AK5(1)
25	32	1800	12.5 x 25	14	2910	0.017	450	ESL188M025AK1(1)
25	32	2200	12.5 x 30	16	3460	0.014	550	ESL228M025AK2(1)
25	32	2200	16 x 20	16	3260	0.017	550	ESL228M025AM5(1)
25	32	2700	12.5 x 35	16	3580	0.013	675	ESL278M025AK3(1)
25	32	2700	16 x 25	16	3640	0.014	675	ESL278M025AM7(1)
25	32	3300	12.5 x 40	18	3900	0.012	825	ESL338M025AK4(1)
25	32	3300	16 x 25	18	3640	0.014	825	ESL338M025AM7(1)
25	32	3900	16 x 30	18	3900	0.012	975	ESL398M025AM9(1)
25	32	3900	18 x 25	18	3660	0.013	975	ESL398M025AN5(1)
25	32	4700	16 x 35	20	3840	0.011	1175	ESL478M025AMP(1)
25	32	4700	18 x 30	20	4020	0.011	1175	ESL478M025AN8(1)
25	32	5600	18 x 35	22	4090	0.010	1400	ESL568M025ANA(1)
25	32	6800	18 x 40	24	4160	0.010	1700	ESL688M025AN3(1)
35	44	10	5 x 11	12	165	1.350	3.5	ESL106M035AC3(1)
35	44	15	5 x 11	12	175	0.950	5.25	ESL156M035AC3(1)
35	44	22	5 x 11	12	195	0.950	7.7	ESL226M035AC3(1)
35	44	33	5 x 11	12	205	0.360	11.55	ESL336M035AC3(1)
35	44	39	5 x 11	12	245	0.360	13.65	ESL396M035AC3(1)
35	44	47	5 x 11	12	345	0.230	16.45	ESL476M035AC3(1)
35	44	56	6.3 x 11	12	480	0.150	19.6	ESL566M035AE3(1)
35	44	68	6.3 x 11	12	520	0.130	23.8	ESL686M035AE3(1)
35	44	100	6.3 x 11	12	545	0.085	35	ESL107M035AE3(1)
35	44	120	8 x 11.5	12	780	0.078	42	ESL127M035AGM(1)
35	44	150	8 x 11.5	12	840	0.072	52.5	ESL157M035AGM(1)
35	44	180	8 x 11.5	12	965	0.068	63	ESL187M035AGM(1)
35	44	220	8 x 16	12	1020	0.048	77	ESL227M035AG8(1)
35	44	220	10 x 12.5	12	1180	0.043	77	ESL227M035AH9(1)
35	44	270	8 x 16	12	1050	0.048	94.5	ESL277M035AG8(1)
35	44	270	10 x 12.5	12	1210	0.043	94.5	ESL277M035AH9(1)
35	44	330	10 x 12.5	12	1340	0.043	115.5	ESL337M035AH9(1)
35	44	390	8 x 20	12	1520	0.030	136.5	ESL397M035AG6(1)
35	44	390	10 x 16	12	1650	0.030	136.5	ESL397M035AH8(1)
35	44	470	10 x 16	12	1755	0.030	164.5	ESL477M035AH8(1)
35	44	560	10 x 20	12	1970	0.030	196	ESL567M035AH4(1)
35	44	560	12.5 x 15	12	2340	0.025	196	ESL567M035AK7(1)
35	44	680	10 x 25	12	2260	0.024	238	ESL687M035AH5(1)
35	44	680	12.5 x 20	12	2360	0.024	238	ESL687M035AK5(1)
35	44	820	12.5 x 20	12	2490	0.024	287	ESL827M035AK5(1)
35	44	1000	12.5 x 20	12	2490	0.024	350	ESL108M035AK5(1)
35	44	1200	12.5 x 25	12	2910	0.023	420	ESL128M035AK1(1)
35	44	1500	12.5 x 30	12	3460	0.014	525	ESL158M035AK2(1)
35	44	1500	16 x 20	12	3260	0.022	525	ESL158M035AM5(1)
35	44	1800	12.5 x 35	12	3470	0.012	630	ESL188M035AK3(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)	LC 20°C 2 Minutes (µA)	Part Number
35	44	1800	16 x 25	12	3580	0.021	630	ESL188M035AM7(1)
35	44	2200	16 x 25	14	3640	0.020	770	ESL228M035AM7(1)
35	44	2700	16 x 30	14	3540	0.011	945	ESL278M035AM9(1)
35	44	2700	18 x 25	14	3650	0.011	945	ESL278M035AN5(1)
35	44	3300	18 x 35	16	4090	0.010	1155	ESL338M035ANA(1)
35	44	3900	18 x 40	16	4160	0.010	1365	ESL398M035AN3(1)
50	63	10	5 x 11	10	185	1.350	5	ESL106M050AC3(1)
50	63	15	5 x 11	10	195	1.350	7.5	ESL156M050AC3(1)
50	63	22	5 x 11	10	240	0.550	11	ESL226M050AC3(1)
50	63	33	6.3 x 11	10	400	0.320	16.5	ESL336M050AE3(1)
50	63	39	6.3 x 11	10	400	0.230	19.5	ESL396M050AE3(1)
50	63	47	6.3 x 11	10	420	0.230	23.5	ESL476M050AE3(1)
50	63	56	6.3 x 11	10	385	0.120	28	ESL566M050AE3(1)
50	63	68	8 x 11.5	10	640	0.135	34	ESL686M050AGM(1)
50	63	100	8 x 11.5	10	725	0.120	50	ESL107M050AGM(1)
50	63	120	8 x 16	10	975	0.061	60	ESL127M050AG8(1)
50	63	150	8 x 16	10	975	0.061	75	ESL157M050AG8(1)
50	63	180	10 x 16	10	1380	0.046	90	ESL187M050AH8(1)
50	63	220	8 x 20	10	1320	0.041	110	ESL227M050AG6(1)
50	63	220	10 x 16	10	1380	0.042	110	ESL227M050AH8(1)
50	63	270	12.5 x 15	10	1762	0.038	135	ESL277M050AK7(1)
50	63	270	10 x 20	10	1590	0.036	135	ESL277M050AH4(1)
50	63	330	10 x 25	10	1650	0.036	165	ESL337M050AH5(1)
50	63	390	10 x 25	10	1880	0.031	195	ESL397M050AH5(1)
50	63	390	12.5 x 20	10	2060	0.030	195	ESL397M050AK5(1)
50	63	470	12.5 x 20	10	2050	0.030	235	ESL477M050AK5(1)
50	63	560	12.5 x 25	10	2420	0.020	280	ESL567M050AK1(1)
50	63	680	12.5 x 30	10	2860	0.021	340	ESL687M050AK2(1)
50	63	820	12.5 x 30	10	2870	0.022	410	ESL827M050AK2(1)
50	63	1000	12.5 x 35	10	3050	0.018	500	ESL108M050AK3(1)
50	63	1000	16 x 25	10	3010	0.020	500	ESL108M050AM7(1)
50	63	1200	16 x 30	10	3290	0.018	600	ESL128M050AM9(1)
50	63	1200	18 x 25	10	3070	0.025	600	ESL128M050AN5(1)
50	63	1500	16 x 35	10	3050	0.018	750	ESL158M050AMP(1)
50	63	1500	18 x 25	10	3310	0.023	750	ESL158M050AN5(1)
50	63	1800	16 x 40	10	3440	0.016	900	ESL188M050AM4(1)
50	63	1800	18 x 35	10	3520	0.021	900	ESL188M050ANA(1)
50	63	2200	18 x 35	12	3580	0.021	1100	ESL228M050ANA(1)
63	79	0.47	5 x 11	9	80	1.350	3	ESL474M063AC3(1)
63	79	1	5 x 11	9	95	1.350	3	ESL105M063AC3(1)
63	79	1.8	5 x 11	9	95	1.350	3	ESL185M063AC3(1)
63	79	2.2	5 x 11	9	105	1.350	3	ESL225M063AC3(1)
63	79	2.7	5 x 11	9	105	1.350	3	ESL275M063AC3(1)
63	79	3.3	5 x 11	9	115	1.350	3	ESL335M063AC3(1)
63	79	3.9	5 x 11	9	115	1.350	3	ESL395M063AC3(1)
63	79	4.7	5 x 11	9	120	1.350	3	ESL475M063AC3(1)
63	79	5.6	5 x 11	9	135	1.350	3.528	ESL565M063AC3(1)
63	79	6.8	5 x 11	9	135	1.350	4.284	ESL685M063AC3(1)
63	79	8.2	5 x 11	9	145	1.350	5.166	ESL825M063AC3(1)
63	79	10	5 x 11	9	145	1.350	6.3	ESL106M063AC3(1)
63	79	12	5 x 11	9	155	1.350	7.56	ESL126M063AC3(1)
63	79	15	5 x 11	9	165	1.350	9.45	ESL156M063AC3(1)
63	79	18	6.3 x 11	9	265	0.380	11.34	ESL186M063AE3(1)
63	79	22	6.3 x 11	9	295	0.380	13.86	ESL226M063AE3(1)
63	79	27	6.3 x 11	9	305	0.380	17.01	ESL276M063AE3(1)
63	79	33	6.3 x 11	9	335	0.380	20.79	ESL336M063AE3(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)	LC 20°C 2 Minutes (µA)	Part Number
63	79	39	8 x 11.5	9	420	0.230	24.57	ESL396M063AGM(1)
63	79	47	8 x 11.5	9	435	0.230	29.61	ESL476M063AGM(1)
63	79	56	8 x 11.5	9	445	0.230	35.28	ESL566M063AGM(1)
63	79	68	8 x 11.5	9	460	0.230	42.84	ESL686M063AGM(1)
63	79	82	8 x 16	9	560	0.170	51.66	ESL826M063AG8(1)
63	79	100	8 x 16	9	580	0.170	63	ESL107M063AG8(1)
63	79	100	10 x 12.5	9	570	0.170	63	ESL107M063AH9(1)
63	79	120	10 x 12.5	9	580	0.170	75.6	ESL127M063AH9(1)
63	79	150	8 x 20	9	680	0.120	94.5	ESL157M063AG6(1)
63	79	150	10 x 16	9	705	0.190	94.5	ESL157M063AH8(1)
63	79	180	10 x 16	9	725	0.190	113.4	ESL187M063AH8(1)
63	79	220	10 x 20	9	1050	0.086	138.6	ESL227M063AH4(1)
63	79	220	12.5 x 15	9	1020	0.080	138.6	ESL227M063AK7(1)
63	79	270	10 x 20	9	1080	0.086	170.1	ESL277M063AH4(1)
63	79	270	12.5 x 15	9	1045	0.080	170.1	ESL277M063AK7(1)
63	79	330	10 x 25	9	1250	0.076	207.9	ESL337M063AH5(1)
63	79	330	12.5 x 20	9	1320	0.066	207.9	ESL337M063AK5(1)
63	79	390	12.5 x 20	9	1350	0.066	245.7	ESL397M063AK5(1)
63	79	470	12.5 x 25	9	1860	0.047	296.1	ESL477M063AK1(1)
63	79	560	12.5 x 30	9	2050	0.039	352.8	ESL567M063AK2(1)
63	79	560	16 x 20	9	1980	0.047	352.8	ESL567M063AM5(1)
63	79	680	12.5 x 35	9	2250	0.036	428.4	ESL687M063AK3(1)
63	79	680	16 x 25	9	2315	0.035	428.4	ESL687M063AM7(1)
63	79	820	12.5 x 40	9	2430	0.030	516.6	ESL827M063AK4(1)
63	79	820	16 x 25	9	2480	0.035	516.6	ESL827M063AM7(1)
63	79	1000	16 x 30	9	2620	0.026	630	ESL108M063AM9(1)
63	79	1200	16 x 30	9	2650	0.026	756	ESL128M063AM9(1)
63	79	1200	18 x 25	9	2610	0.034	756	ESL128M063AN5(1)
63	79	1500	16 x 35	9	2730	0.023	945	ESL158M063AMP(1)
63	79	1500	18 x 30	9	2780	0.028	945	ESL158M063AN8(1)
63	79	1800	16 x 40	9	3250	0.021	1134	ESL188M063AM4(1)
63	79	2200	18 x 40	11	3430	0.028	1386	ESL228M063AN3(1)
100	125	0.47	5 x 11	9	95	1.850	3	ESL474M100AC3(1)
100	125	1	5 x 11	9	105	1.850	3	ESL105M100AC3(1)
100	125	1.8	5 x 11	9	105	1.800	3	ESL185M100AC3(1)
100	125	2.2	5 x 11	9	115	1.800	3	ESL225M100AC3(1)
100	125	2.7	5 x 11	9	115	1.800	3	ESL275M100AC3(1)
100	125	3.3	5 x 11	9	125	1.800	3.3	ESL335M100AC3(1)
100	125	3.9	5 x 11	9	135	1.800	3.9	ESL395M100AC3(1)
100	125	4.7	5 x 11	9	145	1.800	4.7	ESL475M100AC3(1)
100	125	5.6	6.3 x 11	9	205	1.250	5.6	ESL565M100AE3(1)
100	125	6.8	6.3 x 11	9	235	1.250	6.8	ESL685M100AE3(1)
100	125	8.2	6.3 x 11	9	255	1.050	8.2	ESL825M100AE3(1)
100	125	10	6.3 x 11	9	280	0.680	10	ESL106M100AE3(1)
100	125	12	8 x 11.5	9	320	0.390	12	ESL126M100AGM(1)
100	125	15	8 x 11.5	9	320	0.650	15	ESL156M100AGM(1)
100	125	18	8 x 11.5	9	345	0.600	18	ESL186M100AGM(1)
100	125	22	8 x 11.5	9	365	0.520	22	ESL226M100AGM(1)
100	125	27	8 x 16	9	455	0.550	27	ESL276M100AG8(1)
100	125	27	10 x 12.5	9	460	0.560	27	ESL276M100AH9(1)
100	125	33	8 x 16	9	465	0.460	33	ESL336M100AG8(1)
100	125	33	10 x 12.5	9	475	0.480	33	ESL336M100AH9(1)
100	125	39	10 x 12.5	9	485	0.380	39	ESL396M100AH9(1)
100	125	47	10 x 12.5	9	510	0.320	47	ESL476M100AH9(1)
100	125	56	10 x 12.5	9	540	0.280	56	ESL566M100AH9(1)
100	125	68	8 x 20	9	675	0.280	68	ESL686M100AG6(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)	LC 20°C 2 Minutes (µA)	Part Number
100	125	82	10 x 16	9	785	0.190	82	ESL826M100AH8(1)
100	125	100	10 x 20	9	865	0.130	100	ESL107M100AH4(1)
100	125	100	12.5 x 15	9	845	0.140	100	ESL107M100AK7(1)
100	125	120	10 x 25	9	1050	0.120	120	ESL127M100AH5(1)
100	125	150	12.5 x 20	9	1440	0.085	150	ESL157M100AK5(1)
100	125	180	12.5 x 25	9	1460	0.066	180	ESL187M100AK1(1)
100	125	220	12.5 x 25	9	1630	0.066	220	ESL227M100AK1(1)
100	125	270	12.5 x 30	9	1620	0.056	270	ESL277M100AK2(1)
100	125	270	16 x 20	9	1650	0.064	270	ESL277M100AM5(1)
100	125	330	12.5 x 35	9	1950	0.047	330	ESL337M100AK3(1)
100	125	330	16 x 25	9	1920	0.048	330	ESL337M100AM7(1)
100	125	390	12.5 x 40	9	2050	0.040	390	ESL397M100AK4(1)
100	125	470	16 x 30	9	2010	0.036	470	ESL477M100AM9(1)
100	125	560	16 x 35	9	2430	0.032	560	ESL567M100AMP(1)
100	125	560	18 x 30	9	2480	0.034	560	ESL567M100AN8(1)
100	125	680	16 x 40	9	2680	0.030	680	ESL687M100AM4(1)
100	125	680	18 x 35	9	2870	0.030	680	ESL687M100ANA(1)
100	125	820	18 x 40	9	3250	0.028	820	ESL827M100AN3(1)
160	200	1.8	6.3 x 11	15	65	13.940	15.76	ESL185M160AE3(1)
160	200	2.2	6.3 x 11	15	70	13.940	17.04	ESL225M160AE3(1)
160	200	2.7	6.3 x 11	15	75	13.940	18.64	ESL275M160AE3(1)
160	200	3.3	6.3 x 11	15	80	13.940	20.56	ESL335M160AE3(1)
160	200	3.9	6.3 x 11	15	85	13.940	22.48	ESL395M160AE3(1)
160	200	4.7	8 x 11.5	15	85	11.300	25.04	ESL475M160AGM(1)
160	200	5.6	8 x 11.5	15	100	11.300	27.92	ESL565M160AGM(1)
160	200	6.8	8 x 11.5	15	105	11.300	31.76	ESL685M160AGM(1)
160	200	8.2	8 x 11.5	15	115	11.300	36.24	ESL825M160AGM(1)
160	200	10	8 x 16	15	135	7.500	42	ESL106M160AG8(1)
160	200	12	8 x 16	15	140	7.500	48.4	ESL126M160AG8(1)
160	200	15	8x16	15	285	4.270	58	ESL156M160AG8(1)
160	200	15	10 x 12.5	15	290	4.270	58	ESL156M160AH9(1)
160	200	18	8 x 16	15	310	4.270	67.6	ESL186M160AG8(1)
160	200	22	8 x 20	15	390	2.250	80.4	ESL226M160AG6(1)
160	200	22	10 x 16	15	390	2.250	80.4	ESL226M160AH8(1)
160	200	27	10 x 16	15	410	2.250	96.4	ESL276M160AH8(1)
160	200	33	10 x 20	15	530	1.870	115.6	ESL336M160AH4(1)
160	200	33	12.5 x 15	15	570	1.870	115.6	ESL336M160AK7(1)
160	200	39	10 x 25	15	590	1.870	134.8	ESL396M160AH5(1)
160	200	39	12.5 x 15	15	590	1.870	134.8	ESL396M160AK7(1)
160	200	47	10 x 25	15	610	1.870	160.4	ESL476M160AH5(1)
160	200	47	12.5 x 20	15	630	1.870	160.4	ESL476M160AK5(1)
160	200	56	12.5 x 20	15	740	1.550	189.2	ESL566M160AK5(1)
160	200	56	8 x 50	15	740	1.550	189.2	ESL566M160AGG(1)
160	200	68	12.5 x 20	15	800	1.100	227.6	ESL686M160AK5(1)
160	200	82	12.5 x 25	15	830	1.100	272.4	ESL826M160AK1(1)
160	200	100	16 x 20	15	1120	1.100	330	ESL107M160AM5(1)
160	200	100	10 x 50	15	1210	1.100	330	ESL107M160AHE(1)
160	200	120	16 x 25	15	1240	0.910	394	ESL127M160AM7(1)
160	200	150	16 x 30	15	1280	0.910	490	ESL157M160AM9(1)
160	200	150	12.5 x 50	15	1280	0.910	490	ESL157M160AKB(1)
160	200	180	16 x 30	15	1360	0.810	586	ESL187M160AM9(1)
160	200	220	18 x 30	15	1410	0.810	714	ESL227M160AN8(1)
160	200	270	18 x 35	15	1500	0.670	874	ESL277M160ANA(1)
160	200	330	18 x 40	15	1590	0.670	1066	ESL337M160AN3(1)
200	250	2.2	6.3 x 11	15	75	14.500	18.8	ESL225M200AE3(1)
200	250	2.7	6.3 x 11	15	80	14.500	20.8	ESL275M200AE3(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)	LC 20°C 2 Minutes (µA)	Part Number
200	250	3.3	6.3 x 11	15	95	10.150	23.2	ESL335M200AE3(1)
200	250	3.9	6.3 x 11	15	105	10.150	25.6	ESL395M200AE3(1)
200	250	4.7	8 x 11.5	15	130	10.150	28.8	ESL475M200AGM(1)
200	250	5.6	8 x 11.5	15	135	7.980	32.4	ESL565M200AGM(1)
200	250	6.8	8 x 11.5	15	145	7.980	37.2	ESL685M200AGM(1)
200	250	8.2	8 x 11.5	15	165	7.980	42.8	ESL825M200AGM(1)
200	250	10	8 x 12	15	175	3.650	50	ESL106M200AG9(1)
200	250	12	8 x 16	15	190	3.650	58	ESL126M200AG8(1)
200	250	15	8 x 16	15	360	3.650	70	ESL156M200AG8(1)
200	250	18	10 x 16	15	385	3.240	82	ESL186M200AH8(1)
200	250	22	10 x 16	15	390	3.240	98	ESL226M200AH8(1)
200	250	27	10 x 20	15	410	2.380	118	ESL276M200AH4(1)
200	250	33	10 x 25	15	530	1.650	142	ESL336M200AH5(1)
200	250	39	12.5 x 20	15	620	1.380	166	ESL396M200AK5(1)
200	250	47	12.5 x 20	15	630	1.380	198	ESL476M200AK5(1)
200	250	47	8 x 50	15	650	1.380	198	ESL476M200AGG(1)
200	250	56	12.5 x 25	15	670	1.250	234	ESL566M200AK1(1)
200	250	56	10 x 50	15	670	1.250	234	ESL566M200AHE(1)
200	250	68	12.5 x 30	15	850	1.250	282	ESL686M200AK2(1)
200	250	82	16 x 25	15	860	1.150	338	ESL826M200AM7(1)
200	250	100	16 x 25	15	930	1.150	410	ESL107M200AM7(1)
200	250	120	16 x 30	15	1090	1.030	490	ESL127M200AM9(1)
200	250	150	16 x 35	15	1125	1.030	610	ESL157M200AMP(1)
200	250	180	18 x 30	15	1340	0.800	730	ESL187M200AN8(1)
200	250	220	18 x 35	15	1420	0.740	890	ESL227M200ANA(1)
250	300	2.2	6.3 x 11	15	80	10.150	21	ESL225M250AE3(1)
250	300	2.7	6.3 x 11	15	90	10.150	23.5	ESL275M250AE3(1)
250	300	3.3	6.3 x 11	15	100	10.150	26.5	ESL335M250AE3(1)
250	300	3.9	8 x 11.5	15	110	10.150	29.5	ESL395M250AGM(1)
250	300	4.7	8 x 11.5	15	135	10.150	33.5	ESL475M250AGM(1)
250	300	5.6	8 x 11.5	15	150	9.000	38	ESL565M250AGM(1)
250	300	6.8	8 x 11.5	15	160	6.700	44	ESL685M250AGM(1)
250	300	8.2	8 x 12	15	170	3.650	51	ESL825M250AG9(1)
250	300	10	8 x 16	15	250	3.650	60	ESL106M250AG8(1)
250	300	10	10 x 12.5	15	250	3.650	60	ESL106M250AH9(1)
250	300	15	8 x 20	15	380	3.240	85	ESL156M250AG6(1)
250	300	15	10 x 16	15	390	3.240	85	ESL156M250AH8(1)
250	300	18	10 x 16	15	410	3.240	100	ESL186M250AH8(1)
250	300	22	10 x 20	15	475	3.240	120	ESL226M250AH4(1)
250	300	33	12.5 x 20	15	570	1.380	175	ESL336M250AK5(1)
250	300	33	8 x 50	15	570	1.380	175	ESL336M250AGG(1)
250	300	47	12.5 x 25	15	650	1.380	245	ESL476M250AK1(1)
250	300	56	12.5 x 30	15	750	1.250	290	ESL566M250AK2(1)
250	300	68	12.5 x 30	15	870	1.250	350	ESL686M250AK2(1)
250	300	68	10 x 50	15	870	1.250	350	ESL686M250AHE(1)
250	300	82	16 x 30	15	910	1.150	420	ESL826M250AM9(1)
250	300	100	16 x 30	15	960	1.180	510	ESL107M250AM9(1)
250	300	100	12.5 x 50	15	960	1.180	510	ESL107M250AKB(1)
250	300	120	18 x 30	15	1210	1.020	610	ESL127M250AN8(1)
250	300	150	18 x 30	15	1400	0.980	760	ESL157M250AN8(1)
250	300	180	18 x 35	15	1540	0.740	910	ESL187M250ANA(1)
250	300	220	18 x 40	15	1620	0.610	1110	ESL227M250AN3(1)
350	400	1	6.3 x 11	20	55	21.500	17	ESL105M350AE3(1)
350	400	1.2	6.3 x 11	20	55	21.500	18.4	ESL125M350AE3(1)
350	400	1.5	6.3 x 11	20	60	21.500	20.5	ESL155M350AE3(1)
350	400	1.8	6.3 x 11	20	65	21.500	22.6	ESL185M350AE3(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)	LC 20°C 2 Minutes (µA)	Part Number
350	400	2.2	6.3 x 11	20	70	21.500	25.4	ESL225M350AE3(1)
350	400	2.7	8 x 11.5	20	85	15.710	28.9	ESL275M350AGM(1)
350	400	3.3	8 x 11.5	20	95	15.720	33.1	ESL335M350AGM(1)
350	400	3.9	8 x 11.5	20	100	15.720	37.3	ESL395M350AGM(1)
350	400	4.7	8 x 11.5	20	130	15.720	42.9	ESL475M350AGM(1)
350	400	5.6	8 x 16	20	155	10.510	49.2	ESL565M350AG8(1)
350	400	5.6	10 x 12.5	20	155	10.510	49.2	ESL565M350AH9(1)
350	400	6.8	10 x 12.5	20	170	10.510	57.6	ESL685M350AH9(1)
350	400	8.2	8 x 20	20	240	7.500	67.4	ESL825M350AG6(1)
350	400	8.2	10 x 16	20	240	7.500	67.4	ESL825M350AH8(1)
350	400	10	10 x 16	20	250	7.500	80	ESL106M350AH8(1)
350	400	15	10 x 25	20	340	6.200	115	ESL156M350AH5(1)
350	400	15	12.5 x 15	20	340	6.200	115	ESL156M350AK7(1)
350	400	18	10 x 25	20	430	6.200	136	ESL186M350AH5(1)
350	400	18	12.5 x 20	20	430	3.100	136	ESL186M350AK5(1)
350	400	22	12.5 x 20	20	475	3.100	164	ESL226M350AK5(1)
350	400	22	8 x 50	20	475	3.100	164	ESL226M350AGG(1)
350	400	33	12.5 x 25	20	570	2.250	241	ESL336M350AK1(1)
350	400	33	10 x 50	20	570	2.250	241	ESL336M350AE(1)
350	400	47	16 x 25	20	800	2.250	339	ESL476M350AM7(1)
350	400	56	16 x 30	20	840	2.020	402	ESL566M350AM9(1)
350	400	68	18 x 25	20	880	1.380	486	ESL686M350AN5(1)
350	400	68	12.5 x 50	20	880	1.380	486	ESL686M350AKB(1)
350	400	82	18 x 30	20	940	1.380	584	ESL826M350AN8(1)
350	400	100	18 x 35	20	1120	1.250	710	ESL107M350ANA(1)
350	400	120	18 x 35	20	1200	1.250	850	ESL127M350ANA(1)
400	450	1	6.3 x 11	20	65	25.000	18	ESL105M400AE3(1)
400	450	1.2	6.3 x 11	20	70	25.000	19.6	ESL125M400AE3(1)
400	450	1.5	6.3 x 11	20	75	25.000	22	ESL155M400AE3(1)
400	450	1.8	6.3 x 11	20	85	25.000	24.4	ESL185M400AE3(1)
400	450	2.2	8 x 11.5	20	90	20.000	27.6	ESL225M400AGM(1)
400	450	2.7	8 x 11.5	20	95	15.720	31.6	ESL275M400AGM(1)
400	450	3.3	8 x 11.5	20	100	15.720	36.4	ESL335M400AGM(1)
400	450	3.9	8 x 11.5	20	105	15.720	41.2	ESL395M400AGM(1)
400	450	4.7	8 x 11.5	20	110	12.000	47.6	ESL475M400AGM(1)
400	450	4.7	8 x 16	20	115	12.000	47.6	ESL475M400AG8(1)
400	450	5.6	8 x 16	20	160	10.510	54.8	ESL565M400AG8(1)
400	450	5.6	10 x 12.5	20	180	10.500	54.8	ESL565M400AH9(1)
400	450	6.8	8 x 20	20	180	8.700	64.4	ESL685M400AG6(1)
400	450	6.8	10 x 16	20	220	8.700	64.4	ESL685M400AH8(1)
400	450	8.2	10 x 16	20	252	7.500	75.6	ESL825M400AH8(1)
400	450	10	10 x 20	20	288	4.900	90	ESL106M400AH4(1)
400	450	15	12.5 x 20	20	400	4.200	130	ESL156M400AK5(1)
400	450	18	12.5 x 20	20	470	4.200	154	ESL186M400AK5(1)
400	450	22	12.5 x 25	20	475	2.250	186	ESL226M400AK1(1)
400	450	22	8 x 50	20	475	2.250	186	ESL226M400AGG(1)
400	450	33	16 x 25	20	610	1.700	274	ESL336M400AM7(1)
400	450	33	10 x 50	20	610	1.700	274	ESL336M400AE(1)
400	450	47	18 x 25	20	795	1.700	386	ESL476M400AN5(1)
400	450	56	16 x 30	20	820	1.700	458	ESL566M400AM9(1)
400	450	56	12.5 x 50	20	820	1.700	458	ESL566M400AKB(1)
400	450	68	18 x 30	20	910	1.380	554	ESL686M400AN8(1)
400	450	82	16 x 40	20	980	1.250	666	ESL826M400AM4(1)
400	450	82	18 x 35	20	980	1.250	666	ESL826M400ANA(1)
400	450	100	18 x 40	20	1100	0.970	810	ESL107M400AN3(1)
450	500	1	6.3 x 11	20	50	33.000	19	ESL105M450AE3(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 ( $\mu$ F)	Case Size D x L (mm)	DF 120 Hz 20°C (tan $\delta$ %)*	RC 100 kHz 105°C (mA)	ESR 100 kHz 20°C ( $\Omega$ )	LC 20°C 2 Minutes ( $\mu$ A)	Part Number
450	500	1.2	6.3 x 11	20	55	25.000	20.8	ESL125M450AE3(1)
450	500	1.5	8 x 11.5	20	80	25.000	23.5	ESL155M450AGM(1)
450	500	1.8	8 x 11.5	20	85	20.000	26.2	ESL185M450AGM(1)
450	500	2.2	8 x 16	20	95	15.720	29.8	ESL225M450AG8(1)
450	500	2.7	8 x 16	20	100	15.720	34.3	ESL275M450AG8(1)
450	500	3.3	8 x 16	20	110	15.720	39.7	ESL335M450AG8(1)
450	500	3.9	8 x 16	20	120	15.720	45.1	ESL395M450AG8(1)
450	500	4.7	8 x 20	20	150	10.510	52.3	ESL475M450AG6(1)
450	500	4.7	10 x 16	20	150	10.510	52.3	ESL475M450AH8(1)
450	500	5.6	8 x 20	20	180	7.500	60.4	ESL565M450AG6(1)
450	500	5.6	10 x 16	20	180	7.500	60.4	ESL565M450AH8(1)
450	500	6.8	10 x 16	20	220	7.500	71.2	ESL685M450AH8(1)
450	500	8.2	10 x 20	20	265	6.200	83.8	ESL825M450AH4(1)
450	500	10	10 x 25	20	305	6.200	100	ESL106M450AH5(1)
450	500	10	12.5 x 20	20	305	5.200	100	ESL106M450AK5(1)
450	500	15	12.5 x 20	20	400	5.200	145	ESL156M450AK5(1)
450	500	15	8 x 50	20	400	5.200	145	ESL156M450AGG(1)
450	500	18	12.5 x 25	20	470	3.600	172	ESL186M450AK1(1)
450	500	22	16 x 20	20	550	2.020	208	ESL226M450AM5(1)
450	500	22	10 x 40	20	550	2.020	208	ESL226M450AHB(1)
450	500	33	16 x 25	20	665	1.820	307	ESL336M450AM7(1)
450	500	33	10 x 50	20	665	1.820	307	ESL336M450AHE(1)
450	500	47	16 x 35	20	730	1.380	433	ESL476M450AMP(1)
450	500	47	12.5 x 50	20	730	1.380	433	ESL476M450AKB(1)
450	500	56	16 x 35	20	750	1.380	514	ESL566M450AMP(1)
450	500	68	18 x 35	20	970	1.250	622	ESL686M450ANA(1)
450	500	82	18 x 40	20	1030	0.970	748	ESL826M450AN3(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  $\mu$ F, the DF value (%) is increased by 2% for every additional 1,000  $\mu$ F.

## Mounting Positions (Safety Vent)

In operation, electrolytic capacitors will always conduct a leakage current that 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 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  $V_R \leq 160$  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 and Operation Guidelines

### Electrical Ratings:

#### Capacitance (ESC)



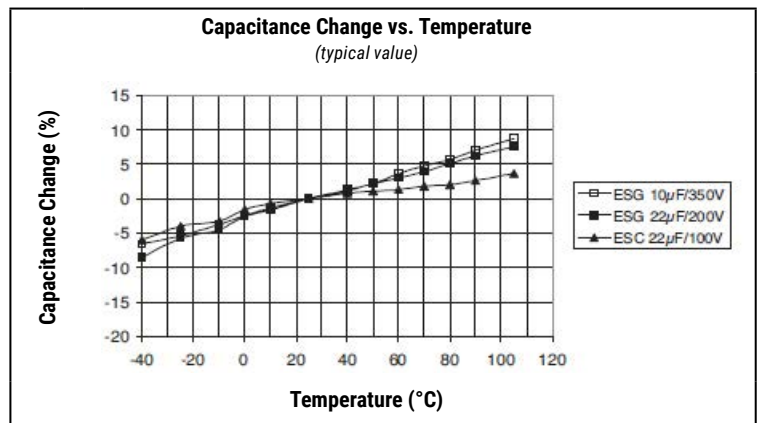
Simplified equivalent circuit diagram of an electrolytic capacitor

The capacitive component of the equivalent series circuit, equivalent series capacitance (ESC), is determined by applying an alternate voltage of  $\leq 0.5$  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.

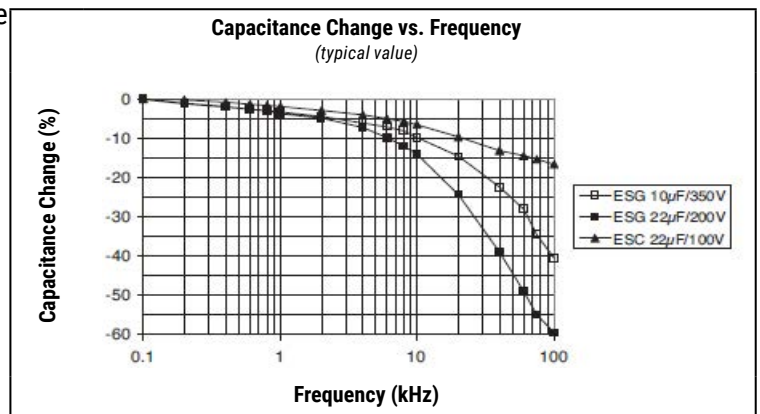


#### Frequency Dependence of the Capacitance

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

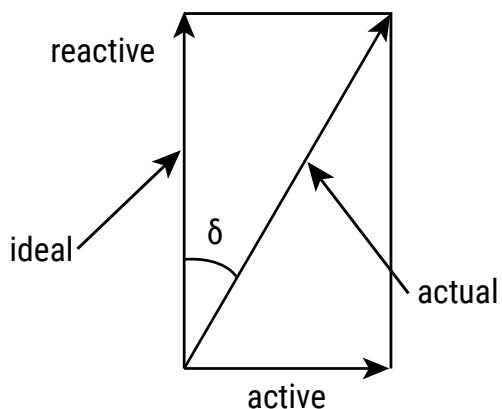
$$C = \frac{1}{2\pi fZ}$$

$C$  = capacitance (F)  
 $f$  = frequency (Hz)  
 $Z$  = impedance ( $\Omega$ )



### Dissipation Factor $\tan \delta$ (DF)

Dissipation Factor  $\tan \delta$  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.

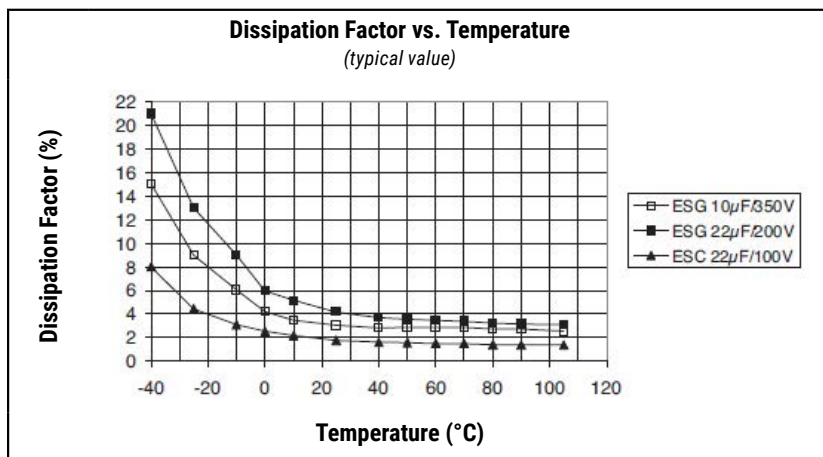
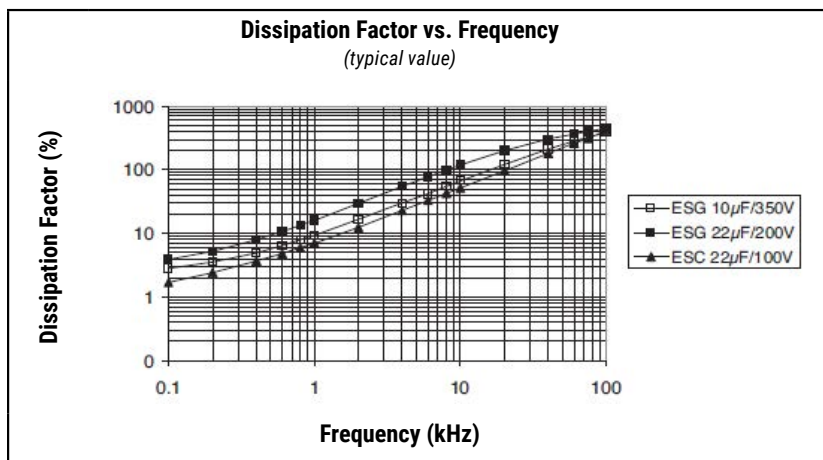


Tan  $\delta$  is measured with the same set-up used for the series capacitance ESC.

Tan  $\delta = \omega \times \text{ESC} \times \text{ESR}$  where:

ESC = equivalent series capacitance

ESR = equivalent series resistance

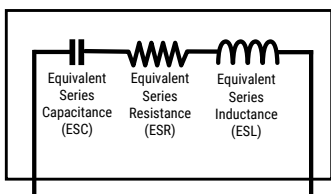




### Equivalent Series Inductance (ESL)

Equivalent series inductance or self-inductance results from the terminal configuration and internal design of the capacitor.

Capacitor Equivalent Internal Circuit



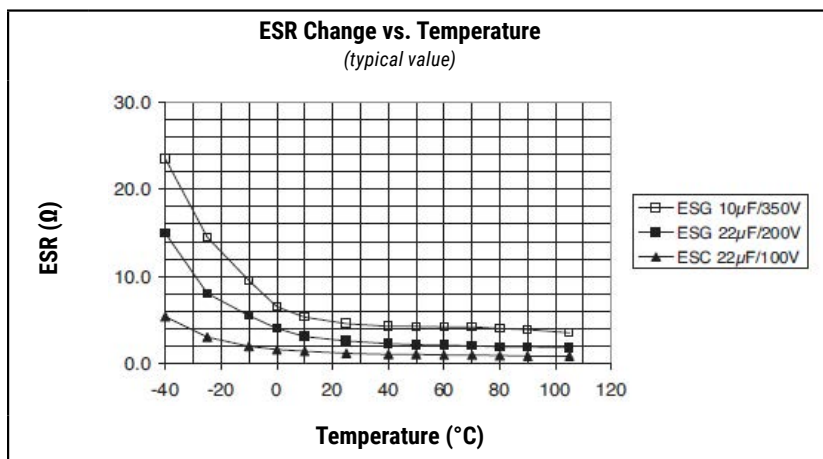
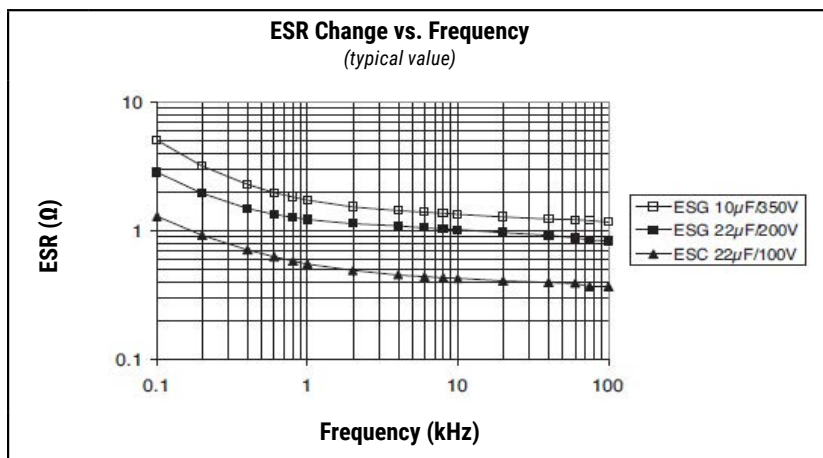
### Equivalent Series Resistance (ESR)

Equivalent series resistance is the resistive component of the equivalent series circuit. ESR value depends on frequency and temperature, and is related to the  $\tan \delta$  by the following equation:

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

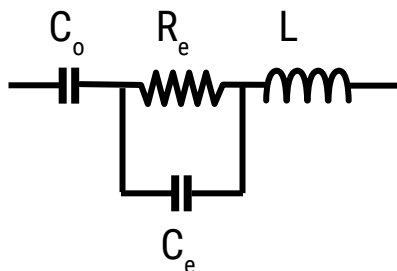
ESR = equivalent series resistance ( $\Omega$ )  
 $\tan \delta$  = dissipation factor  
 ESC = equivalent series capacitance (F)  
 f = frequency (Hz)

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.)

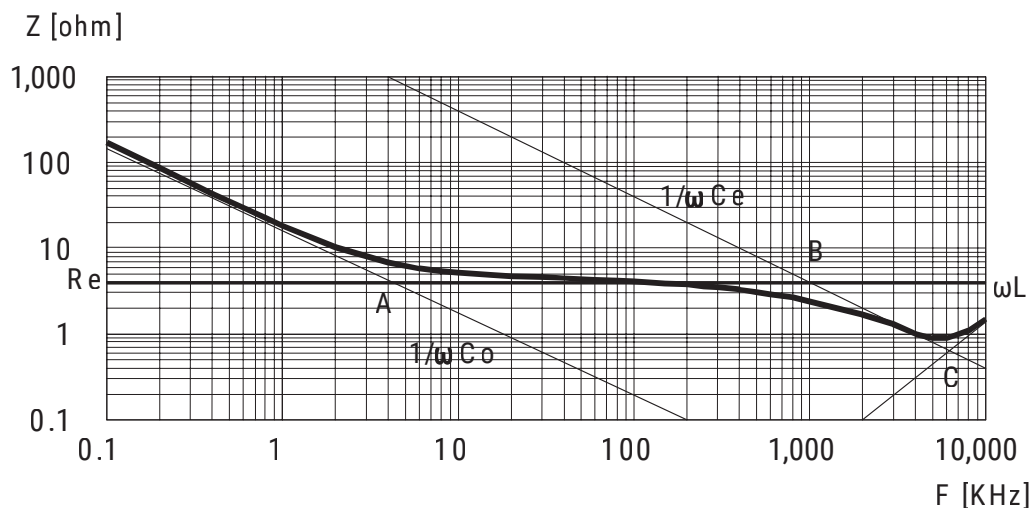
$R_e$  = Resistance of electrolyte and paper mixture (other resistances not depending on the frequency are not considered: tabs, plates, etc.)

$C_e$  = 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:

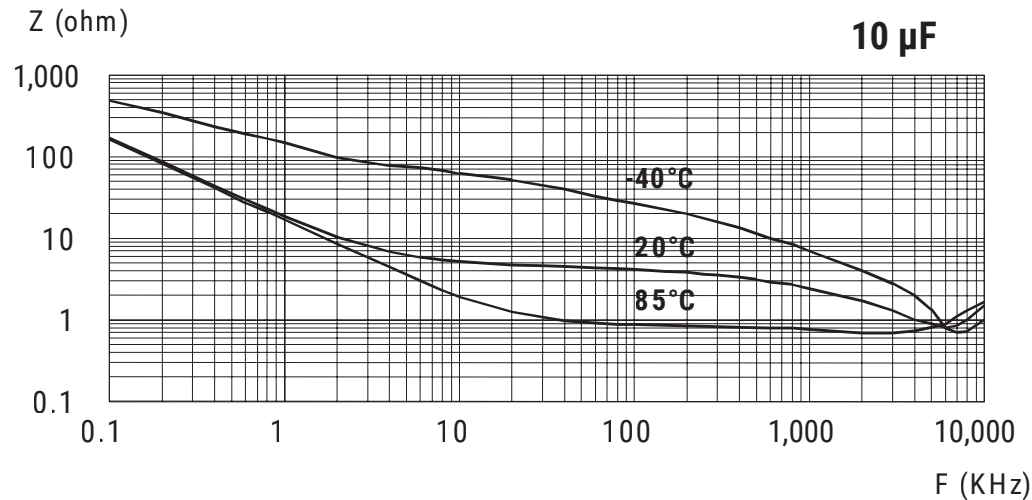


- Capacitive reactance predominates at low frequencies.
- With increasing frequency, capacitive reactance  $X_c = 1/\omega C_o$  decreases until it reaches the order of magnitude of electrolyte resistance  $R_e$  (A).
- At even higher frequencies, resistance of the electrolyte predominates:  $Z = R_e$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

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

### Impedance (Z) cont'd

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.

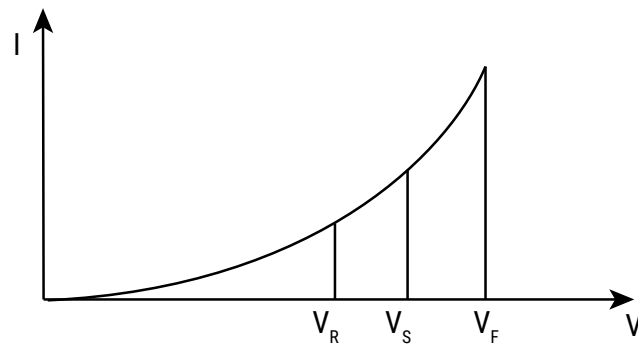
A high leakage current flows after applying voltage to the capacitor then decreases in a few minutes, for example, after prolonged storage without any applied voltage. In the course of continuous operation, the leakage current will decrease and reach an almost constant value.

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.

### Leakage Current (LC) cont'd

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  $\delta$  or ESR
- Frequency

The capacitor's life depends on the thermal stress.

### Frequency Dependence of the Ripple Current

ESR and, thus, the tan  $\delta$  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:  $L = L_o \times 2^{(T_o - T)/10}$

Where:

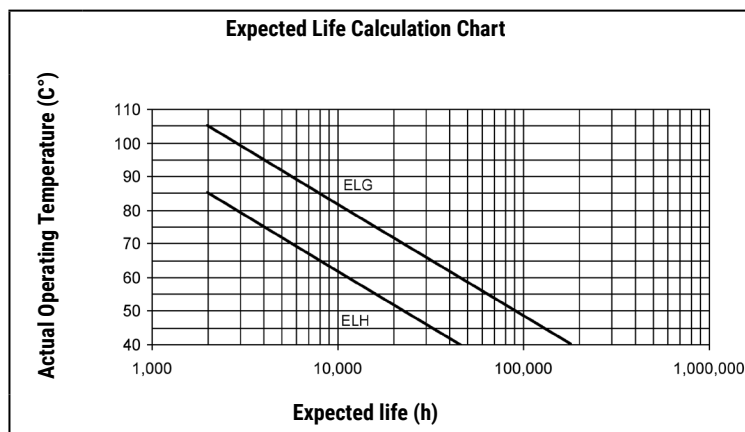
L: Expected life

$L_o$ : Load life at a maximum permissible operating temperature

T: Actual operating temperature

$T_o$ : Maximum permissible operating temperature

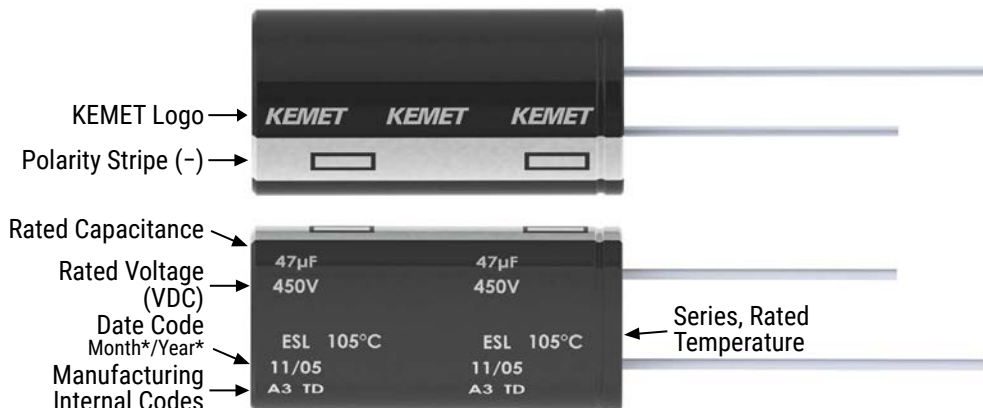
This formula is applicable between 40°C and  $T_o$ .



## Packaging Quantities

Size Code	Diameter (mm)	Length (mm)	Bulk		Auto-insertion	
			Standard Leads	Cut Leads	Ammo	Tape & Reel
C3	5	11	10000	15000	2000	-
E3	6.3	11	10000	15000	2000	-
GM	8	11.5	6000	8000	1000	-
G9	8	12	6000	8000	1000	-
G8	8	16	5000	5000	1000	-
G6	8	20	4000	4000	1000	-
GG	8	50	2400	2400	-	-
H9	10	12.5	4000	4000	700	-
H8	10	16	3000	4000	700	-
H4	10	20	2400	3000	700	-
H5	10	25	2400	2400	500	-
HB	10	40	2100	2100	-	-
HE	10	50	2100	2100	-	-
K7	12.5	15	2000	2000	500	-
K5	12.5	20	2000	2000	500	-
K1	12.5	25	2000	2000	500	-
K2	12.5	30	2000	2000	500	-
K3	12.5	35	2000	2000	500	-
K4	12.5	40	2000	2000	500	-
KB	12.5	50	1200	1200	-	-
M5	16	20	1000	500	300	-
M7	16	25	1000	500	300	-
M9	16	30	800	500	300	-
MP	16	35	600	500	300	-
M4	16	40	600	500	300	-
N5	18	25	800	500	300	-
N8	18	30	800	500	-	-
NA	18	35	500	500	-	-
N3	18	40	500	500	-	-

## Marking



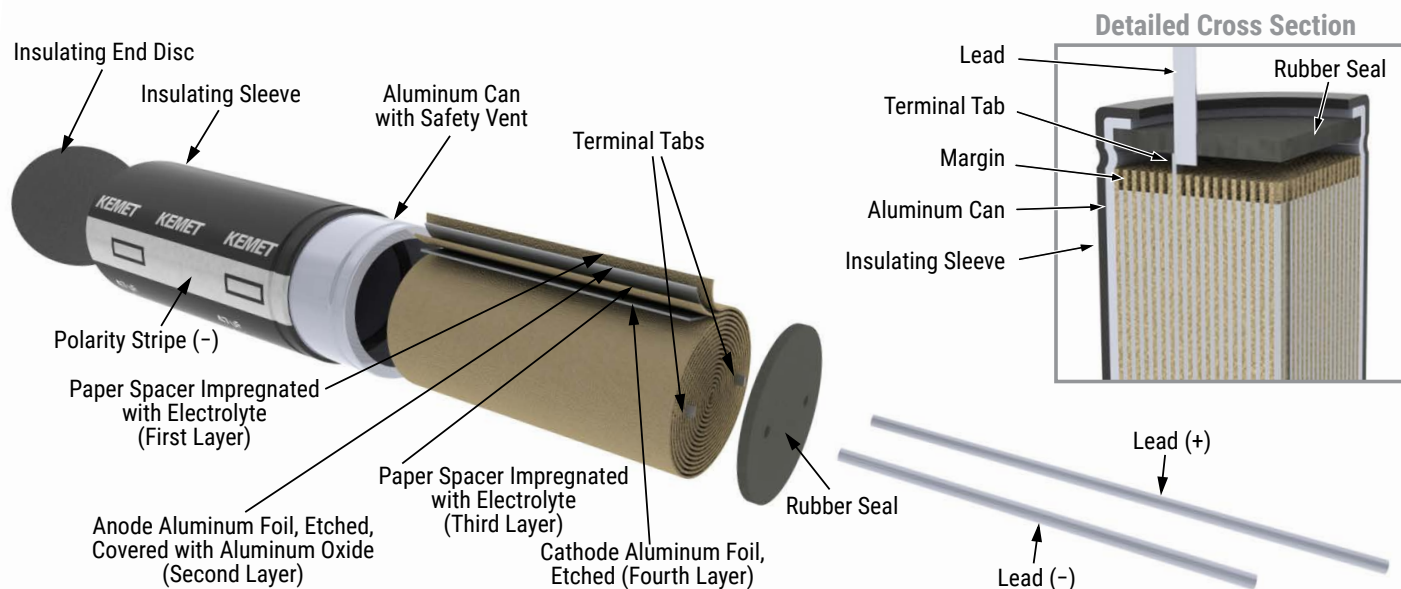
\*Y = Year

Code	01	02	03	04	05	06	07	08	09
Year	2011	2012	2013	2014	2015	2016	2017	2018	2019

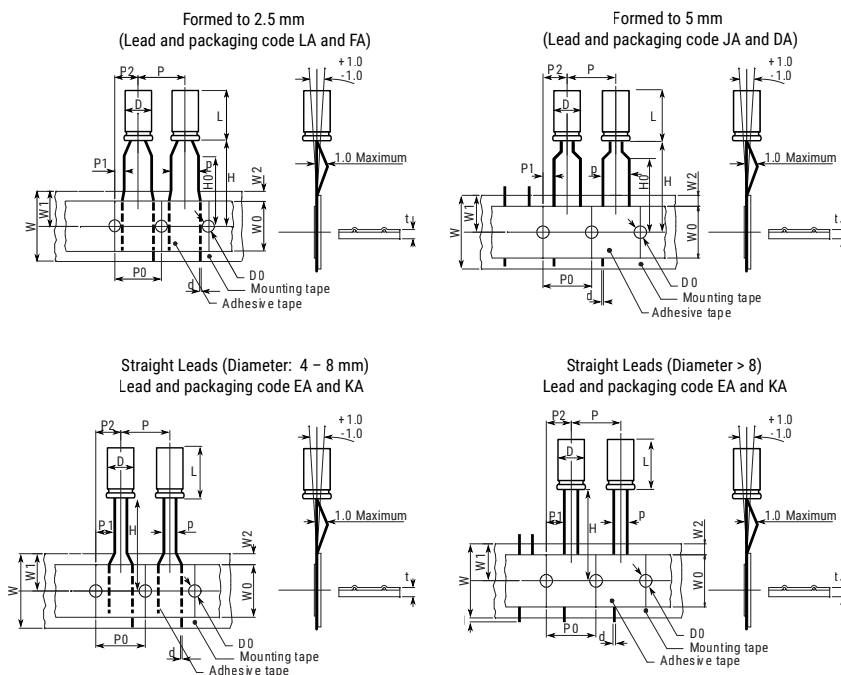
\*M = Month

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

## Construction

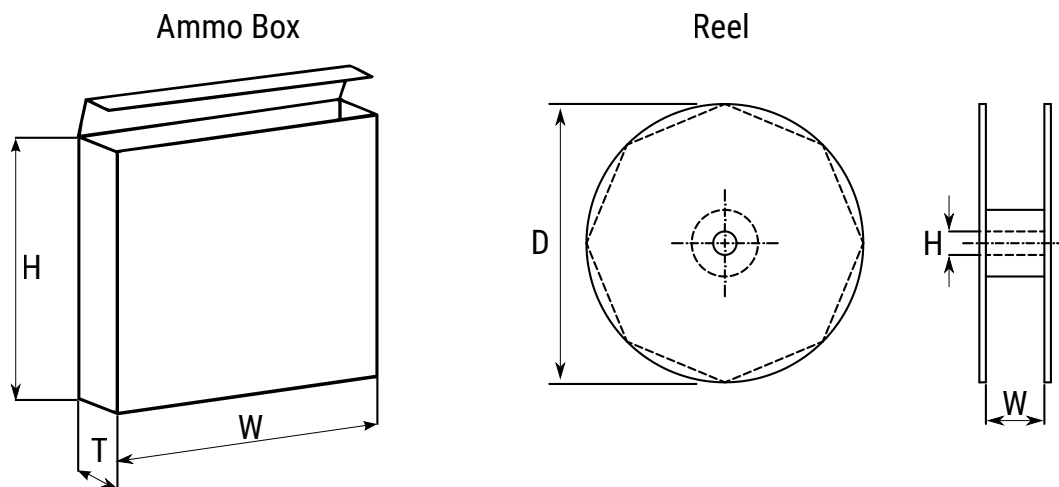


## Taping for Automatic Insertion Machines



Dimensions (mm)	D	L	p	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	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 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.

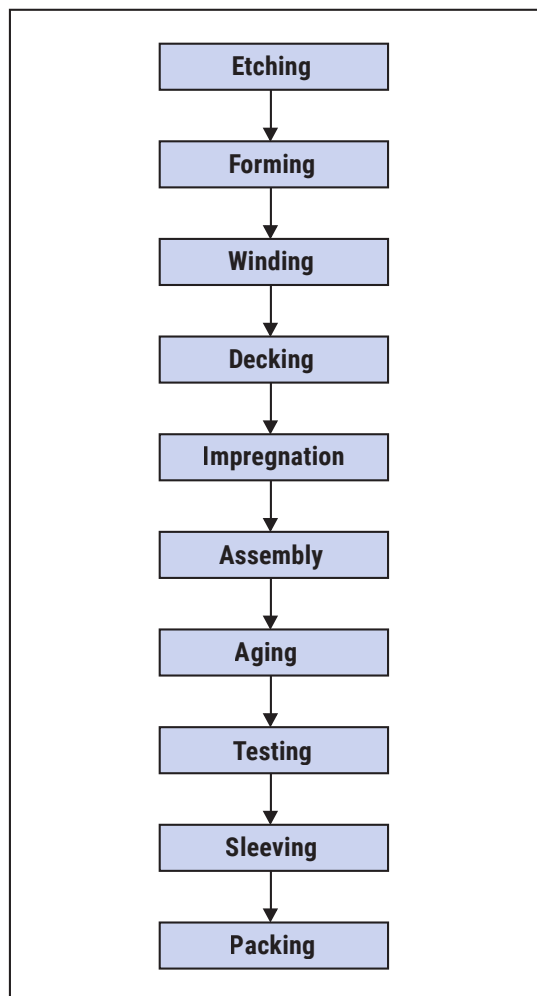
The following tests are applied and may be varied at the request of the customer. In this case the batch, or special procedure, will determine the course of action.

### 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

For a complete list of our global sales offices, please visit [www.kemet.com/sales](http://www.kemet.com/sales).

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