

Overview

KEMET's ESC Series of single-ended aluminum electrolytic capacitors are designed for low impedance and high frequency applications.

Applications

Typical applications include high frequency switch mode circuits.

Benefits

- Low impedance
- 1,000 3,000 hour operating life
- Operating temperature of up to 105°C
- Case with \emptyset D \ge 5 mm
- · Safety vent on the capacitor base



Part Number System

ESC	157	М	6	R3	Α	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%	6R3 = 6.3 010 = 10 016 = 16 025 = 25	035 = 35 050 = 50 063 = 63 100 = 100	A = Standard	See Dimension Table	See Ordering Options Table



Ordering Options Table

Diameter	Packaging Type	Lead Type	Lead Length (mm)	Lead and Packaging Code				
	Sta	andard 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 ±0.75	LA				
6.3	Tape & Reel	2.5 mm Lead Spacing	H ₀ = 18.5 ±0.75	КА				
8	Tape & Reel	Formed to 5 mm	H ₀ = 16 ±0.75	JA				
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 ±0.75	EA				
		Other Packaging Opti	ons					
4 - 8	Ammo	Formed to 5 mm	H ₀ = 16 ±0.75	DA				
4 - 8	Ammo	Straight	H ₀ = 18.5 ±0.75	EA				
4 - 5	4 – 5 Ammo		H ₀ = 16 ±0.75	FA				
4 - 6.3	Tape & Reel	Formed to 5 mm	H ₀ = 16 ±0.75	JA				
4 - 5, 8 - 18	4 – 5, 8 – 18 Tape & Reel		H ₀ = 18.5 ±0.75	KA				
	Contact KEM	ET for other Lead and F	Packaging options					

Environmental Compliance

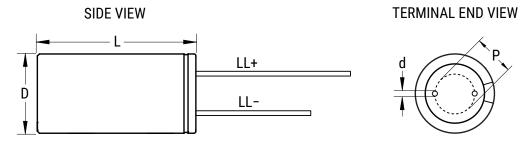
As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of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



Dimensions – Millimeters



Cine O e de	D		I	L		р		d	LL+/LL-	
Size Code	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	2.5	±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
Н9	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
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
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
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	4.7 – 15,000 μF			
Capacitance Tolerance	±20% at 120 Hz / 20°C			
Rated Voltage	6.3 - 100 VDC			
Life Test	2,000 - 3,000 hours (see conditions in Test Method & Performance)			
Operating Temperature	-40°C to +105°C			
Laskana Qumant	I ≤ 0.01 CV or 3 μ A, whichever is greater			
Leakage Current	C = rated capacitance (μ F), 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	35	50	63	100
Z (-25°C)/Z (20°C)	4	3	3	3	3	2	2	2
Z (-40°C)/Z (20°C)	8	6	4	4	4	4	4	4

Compensation Factor of Ripple Current (RC) vs. Frequency

Capacitance Range (µF)	50 Hz	120 Hz	300 Hz	1 kHz	10 kHz	100 kHz
4.7	0.30	0.40	0.50	0.70	0.80	1.00
5.6 - 33	0.40	0.50	0.60	0.80	0.90	1.00
34 - 330	0.60	0.70	0.80	0.90	0.95	1.00
331 - 1,000	0.65	0.90	0.90	0.98	1.00	1.00
1,200 - 15,000	0.85	0.90	0.95	0.98	1.00	1.00



Test Method & Performance

Conditions	Load Li	fe Test	Shelf Life Test			
Temperature	105	105°C				
	Can Ø ≥ 5 x 11, ≤ 10 x 12.5 mm	Can Ø ≥ 5×11 , ≤ 10 x 12.5 mm 2,000 hours				
Test Duration	Can Ø≥10 x 15 mm	3,000 hours	1,000 hours			
	If dimension is down size, endurance will be 1,000 hours less than standard					
Ripple Current	Maximum ripple current s	No ripple current applied				
Voltage	The sum of DC voltage and the p the rated voltage		No voltage applied			
Performance	The following specification	ns 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-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 Vates 120 Hz 20°C (µF) Case Size 0 x L (ma) DF 120 Hz 20°C (har 5%) Z 100 kHZ 20°C (n) RC 100 kHZ 20°C (n) L C 20°C 100 kHZ 20°C (n) Part Number 5.3 8 276 5.3 if 3 5.1 if 3 5.1 if 3 22 6.00 3 230 90 5.2 if 3 5.2 if 3 5.3 if 3 6.3 if 3 6.4 if 3			Deted						
VDC Surge Voltage Capacitance (µF) Case Size D x L (mm) 120 Hz 20°C (as 5x) 100 kHz 20°C (n) 100 kHz 105°C (mA) 2 Minutes (µA) Part Number 6.3 8 138 5x11 22 0.428 288 19 552157M683A53(1) 6.3 8 338 63x11 22 0.288 288 19 55237M683A53(1) 6.3 8 338 63x11 22 0.189 448 50.0 55237M683A53(1) 6.3 8 479 8x11 22 0.190 748 50.0 55237M683A53(1) 6.3 8 479 8x11 22 0.100 788 30.0 552477M683A63(1) 6.3 8 660 8x15 22 0.065 788 62.0 55247M683A63(1) 6.3 8 1000 78.15 22 0.066 69 63.0 55210M687A64(1) 6.3 8 1000 19.25 22 0.0651 69 94.0		VDC	Rated		DF	Z	RC	LC 20°C	
Voltage LP 20 °C VX L (mm) (ma $\delta \approx$) 20°C (0) 105°C (mA) (µA) 6.3 8 20 6.3 *11 22 0.420 286 9.0 ESC15MAGAC(1) 6.3 8 200 6.3 *11 22 0.200 250 17.0 ESC27MAGAES(1) 6.3 8 270 6.3 *11 22 0.200 250 17.0 ESC37MAGAES(1) 6.3 8 339 6.3 *11 22 0.389 448 20.0 ESC37MAGAES(1) 6.3 8 470 *6.3 11 22 0.189 448 20.0 ESC37MAGAES(1) 6.3 8 480 8*15 22 0.005 754 52.0 ESC37MAGAES(1) 6.3 8 1000 8 *15 22 0.065 770 63.0 ESC10MAGAES(1) 6.3 8 1000 8 *15 22 0.065 970 63.0 ESC10MAGAES(1) 6.3 8 100.1	VDC		Capacitance	Case Size					Part Number
Voltage (µF) Vit (m1 0 %) 20°C (U) (US C (mA) (µA) 6.3 8 150 6.3 ± 11 22 0.420 200 1.4 ESC157M68AC(1) 6.3 8 230 6.3 ± 11 22 0.220 250 1.4 ESC27M68AC(1) 6.3 8 330 6.3 ± 11 22 0.230 250 2.10 ESC37M68AC(1) 6.3 8 470 % 5.1 ± 1 22 0.180 440 50.0 ESC37M68AC(1) 6.3 8 470 % 1.1 22 0.140 550 30.0 ESC477M68AC(1) 6.3 8 660 * 1.1 22 0.120 560 4.0 ESC47M68AC(1) 6.3 8 1000 * 1.1 22 0.120 560 4.0 ESC47M68AC(1) 6.3 8 1000 8 × 12 0.065 700 6.0 ESC17M68AC(1) 6.3 8 1000 8 × 12 0.065	VDC	-	120 Hz 20°C	D x L (mm)					Fait Nulliper
6.3 8 150 5 + 11 22 0.400 200 9.0 ESCISYMBRAC(1) 6.3 8 220 6.3 + 11 22 0.220 250 17.0 ESCISYMBRAC(1) 6.3 8 370 6.3 + 11 22 0.220 250 17.0 ESCISYMBRAC(1) 6.3 8 370 6.3 + 11 22 0.180 440 30.0 ESCISYMBRAC(1) 6.3 8 470 *6.1 + 11 22 0.140 550 30.0 ESCISYMBRAC(1) 6.3 8 470 *8.1 + 12 0.140 550 40.0 ESCISTMBRAC(1) 6.3 8 1000 8.1 + 12 0.159 550 63.0 ESCISTMBRAC(1) 6.3 8 1000 8.1 + 12 0.159 550 63.0 ESCIEMBRAC(1) 6.3 8 1000 8.1 + 12 0.065 700 63.0 ESCIEMBRAC(1) 6.3 8 1000 8.1 + 12 <td< th=""><th></th><th>Voltage</th><th>(uF)</th><th>× /</th><th>(tan ô %)'</th><th>20°C (Ω)</th><th>105°C (mA)</th><th>(µA)</th><th></th></td<>		Voltage	(uF)	× /	(tan ô %)'	20°C (Ω)	105°C (mA)	(µA)	
6.3 8 220 6.3 × 11 22 0.320 250 17.0 ESC27M6RAE(3) 6.3 8 336 6.3 × 11 22 0.230 250 21.0 ESC27M6RAE(3) 6.3 8 336 6.3 × 11 22 0.380 440 30.0 ESC37M6RAE(3) 6.3 8 470 * 6.5 × 11 22 0.180 440 30.0 ESC37M6RAE(3) 6.3 8 470 * 6.5 × 11 22 0.120 580 43.0 ESC477M6RAE(3) 6.3 8 660 * 1.5 22 0.010 700 4.30 ESC477M6RAE(3) 6.3 8 1000 * 1.7 2.2 0.045 750 ESC17M6RAE(3) 6.3 8 1000 1.7 1.2 2.0 0.045 900 6.3 ESC17M6RAE(3) 6.3 8 1500 10.1 1.5 2.2 0.045 1000 7.6 ESC17M6RAE(3) 6.3 8	63	8		5 v 11	22	0.420	200	0.0	ESC157M6B3AC3(1)
6.3 8 270 6.3 x 11 22 0.200 250 21.0 ESC27M6RAEX10 6.3 8 330 6.3 x 11 22 0.30 400 21.0 ESC37M6RAEX10 6.3 8 470 *6.4 x 11 22 0.180 440 30.0 ESC477M6RAEX10 6.3 8 470 *6.1 x 11 22 0.140 550 30.0 ESC477M6RAEX10 6.3 8 600 *8.1 1 22 0.105 790 4.2.0 ESC477M6RAEX10 6.3 8 1000 *8.1 1 22 0.105 790 4.2.0 ESC18M6RAEX10 6.3 8 1000 8.1 5 22 0.005 700 6.3.0 ESC18M6RAEX10 6.3 8 1000 10.7 1.2 5 22 0.005 900 94.0 ESC18M6RAEX10 6.3 8 1500 *10.8 16 22 0.051 90.0 94.0 ESC18M6RAEX10 6.3									· · ·
6.3 8 330 6.3 × 11 22 0.180 400 21.0 ESC337M683A821) 6.3 8 470 *6.3 × 11 22 0.180 400 21.0 ESC37M683A821) 6.3 8 470 *8.11 22 0.140 550 30.0 ESC477M683A821) 6.3 8 660 *8.11 22 0.120 580 43.0 ESC47M683A631) 6.3 8 660 *8.15 22 0.010 700 43.0 ESC47M683A641) 6.3 8 1000 *8.20 22 0.026 750 52.0 ESC17M683A641) 6.3 8 1000 *8.21 22 0.046 1000 76.0 ESC12M683A64(1) 6.3 8 1500 19.16 22 0.045 1090 76.0 ESC12M683A64(1) 6.3 8 1500 19.16 22 0.055 1070 94.0 ESC12M683A64(1) 6.3									
6.3 8 470 *6.3 × 11 22 0.140 550 30.0 ESC477M683A82(1) 6.3 8 669 48 × 11 22 0.120 580 43.0 ESC677M683A63(1) 6.3 8 669 8 × 15 22 0.010 700 43.0 ESC677M683A63(1) 6.3 8 1000 8 × 15 22 0.085 750 52.0 ESC277M683A63(1) 6.3 8 1000 8 × 15 22 0.085 700 63.0 ESC199M683A64(1) 6.3 8 1000 10 × 12.5 22 0.064 900 63.0 ESC199M683A64(1) 6.3 8 1500 4 × 15 22 0.065 1000 94.0 ESC159M683A64(1) 6.3 8 1500 1 × 16 22 0.051 1000 94.0 ESC159M683A64(1) 6.3 8 1500 1 × 10 22 0.051 1220 130.0 ESC22M684A14(1)		8							· · ·
6.3 8 470 8 × 11 22 0.140 550 33.0 ESC477M683A62(1) 6.3 8 669 8 × 15 22 0.100 700 43.0 ESC67M683A62(1) 6.3 8 8 × 20 22 0.055 750 52.0 ESC67M683A62(1) 6.3 8 1000 * × 15 22 0.065 700 63.0 ESC109M683A64(1) 6.3 8 1000 8 × 15 22 0.069 800 63.0 ESC109M683A64(1) 6.3 8 1000 18 × 12.5 22 0.069 63.0 ESC109M683A64(1) 6.3 8 1200 11 × 16 22 0.065 980 64.0 ESC128M683A6(1) 6.3 8 1200 10 × 16 22 0.055 800 64.0 ESC128M683A6(1) 6.3 8 1200 10 × 12 22 0.044 130.0 ESC228M683A14(1) 6.3 8 2200 <td< td=""><td>6.3</td><td>8</td><td>330</td><td>8 x 11</td><td>22</td><td>0.180</td><td>400</td><td>21.0</td><td>ESC337M6R3AG3(1)</td></td<>	6.3	8	330	8 x 11	22	0.180	400	21.0	ESC337M6R3AG3(1)
6.3 8 680 8 + 15 22 0.100 700 43.0 ESC627M4R3AG(1) 6.3 8 820 8 × 15 22 0.005 750 52.0 ESC627M4R3AG(1) 6.3 8 1000 8 × 15 22 0.055 750 63.0 ESC128M6R3AG(3) 6.3 8 1000 8 × 15 22 0.069 600 63.0 ESC128M6R3AG(3) 6.3 8 1000 10 × 15 22 0.069 600 63.0 ESC128M6R3AG(4) 6.3 8 1500 4* x 15 22 0.065 960 94.0 ESC128M6R3AG(4) 6.3 8 1500 10 × 10 22 0.051 1070 94.0 ESC128M6R3AG(4) 6.3 8 1200 10 × 10 22 0.051 1270 19.0 ESC128M6R3AG(4) 6.3 8 2200 11 × 23 22 0.051 1270 19.0 ESC128M6R3A(4) 6.		-							ESC477M6R3AE3(1)
6.3 8 620 8 x z0 22 0.100 770 43.0 ESC627MRRA4(1) 6.3 8 1000 ** x11 22 0.150 580 63.0 ESC187MRRA4(1) 6.3 8 1000 8 x15 22 0.669 800 63.0 ESC18MRRA4(1) 6.3 8 1000 10 x15 22 0.669 800 63.0 ESC18MRRA4(1) 6.3 8 1200 10 x15 22 0.644 1000 76.0 ESC18MRRA4(1) 6.3 8 1500 *8 x1 22 0.651 800 94.0 ESC18MRRA4(1) 6.3 8 1500 *10 x16 22 0.044 1250 94.0 ESC18MRRA4(1) 6.3 8 1500 *10 x25 22 0.044 130.0 ESC18MRRA4(3) 6.3 8 200 *10 x25 22 0.043 1400 28.5 ESC18MRRA44(1) 6.3 8									
6.3 6 820 22 0.05 750 52.0 ESCE27MREAGE(1) 6.3 8 1000 8 x15 22 0.055 760 63.0 ESCE37MREAGE(1) 6.3 8 1000 8 x20 22 0.069 600 63.0 ESCE3MREAGE(1) 6.3 8 1000 10 x15.5 22 0.064 600 63.0 ESCE3MREAGE(1) 6.3 8 1500 76 x15 22 0.065 960 94.0 ESCE3MREAGE(1) 6.3 8 1500 10 x10 22 0.051 1200 194.0 ESCE3MREAGE(1) 6.3 8 1500 10 x20 22 0.051 1220 139.0 ESCE3MREAGE(1) 6.3 8 2200 10 x20 22 0.043 1450 139.0 ESCE3MREAGE(1) 6.3 8 2200 13 x25 22 0.043 1450 139.0 ESCE3MREAGE(1) 6.3 8		-							
6.3 8 1000 *8 × 11 22 0.150 580 63.0 ESC108M6R3AG(1) 6.3 8 1000 8 × 15 22 0.065 700 63.0 ESC108M6R3AG(1) 6.3 8 1000 10 × 12 5 22 0.064 1000 76.0 ESC108M6R3AG(1) 6.3 8 1500 *8 × 15 22 0.061 800 94.0 ESC158M6R3AG(1) 6.3 8 1500 *8 × 10 22 0.051 800 94.0 ESC158M6R3AG(1) 6.3 8 1500 *10 × 15 22 0.044 1220 94.0 ESC158M6R3AG(1) 6.3 8 2200 *10 × 25 22 0.043 1450 139.0 ESC228M6R3AH(1) 6.3 8 2300 *10 × 25 22 0.043 1400 208.0 ESC33M6R3AH(1) 6.3 8 3300 *13 × 25 22 0.032 1700 296.0 ESC474M6R63AH(1)									
6.3 8 1000 8 + 15 22 0.05 700 63.0 ESC108M6R3Acf(1) 6.3 8 1000 10 x 12,5 22 0.060 690 63.0 ESC108M6R3Acf(1) 6.3 8 1200 10 x 16 22 0.064 1000 76.0 ESC128M6R3Acf(1) 6.3 8 1500 *8 x 15 22 0.055 1070 94.0 ESC158M6R3Acf(1) 6.3 8 1500 *10 x 16 22 0.051 1270 94.0 ESC158M6R3Acf(1) 6.3 8 2200 *10 x 20 22 0.041 130.0 ESC258M6R3Acf(1) 6.3 8 2200 *10 x 20 22 0.043 1400 130.0 ESC228M6R3Acf(1) 6.3 8 3300 *10 x 25 22 0.043 1400 28.0 ESC338M6R3Acf(1) 6.3 8 3300 *13 x 25 22 0.022 1700 28.0 ESC338M6R3Acf(1) <		-							
6.3 8 1000 8 × 20 22 0.099 800 63.0 ESC108M6R3A6(1) 6.3 8 1200 10 × 16 22 0.064 1000 76.0 ESC108M6R3A48(1) 6.3 8 1500 9 × 15 22 0.061 800 94.0 ESC158M6R3A48(1) 6.3 8 1500 10 × 16 22 0.051 800 94.0 ESC158M6R3A48(1) 6.3 8 1500 10 × 10 22 0.051 1070 94.0 ESC158M6R3A48(1) 6.3 8 2200 110 × 20 22 0.044 1320 139.0 ESC258M6R3A44(1) 6.3 8 2200 110 × 25 22 0.043 1400 208.0 ESC238M6R3A45(1) 6.3 8 2300 113 × 25 22 0.032 1700 26.0 ESC278M6R3A4(1) 6.3 8 2000 13 × 25 22 0.032 1570 26.0 ESC478M6R3A4(1)									· · ·
6.3 8 1000 10 x 12.5 22 0.080 690 6.3.0 ESC10MM63AH9(1) 6.3 8 1500 *x 15 22 0.085 980 94.0 ESC15MM63A4(1) 6.3 8 1500 *x 15 22 0.055 800 94.0 ESC15MM63A4(1) 6.3 8 1500 *10x 16 22 0.055 1070 94.0 ESC15MM63A44(1) 6.3 8 2200 *10x 20 22 0.041 1250 94.0 ESC128M63A41(1) 6.3 8 2200 *10x 25 22 0.043 1450 139.0 ESC228M667A15(1) 6.3 8 2300 13x 25 22 0.043 1460 206.0 ESC33M667A14(1) 6.3 8 3000 13x 25 22 0.032 1750 246.0 ESC47M67A14(1) 6.3 8 4700 *13x 30 22 0.033 1570 246.0 ESC47M67A14(1)									
6.3 8 1200 10x 16 22 0.064 1000 76.0 ESC128M6R3AH(1) 6.3 8 1500 # x 10 22 0.051 800 94.0 ESC158M6R3A6(1) 6.3 8 1500 # 10x 16 22 0.051 800 94.0 ESC158M6R3AH(1) 6.3 8 1500 10x 20 22 0.044 1250 94.0 ESC158M6R3AH(1) 6.3 8 2200 *10x 25 22 0.043 1450 139.0 ESC228M6R3AH(1) 6.3 8 2300 *10x 25 22 0.043 1450 139.0 ESC23M6R3AH(1) 6.3 8 3300 13x 25 22 0.032 1750 246.0 ESC39M6R3AL(1) 6.3 8 3700 13x 25 22 0.032 1750 296.0 ESC479M6R3AL(1) 6.3 8 4700 *13x 25 22 0.032 1570 296.0 ESC479M6R3AL(1)									· · ·
6.3 8 1500 *8 × 15 22 0.085 980 94.0 ESC15MA673.64(1) 6.3 8 1500 *10 × 16 22 0.055 1070 94.0 ESC15MA673.64(1) 6.3 8 1500 *10 × 20 22 0.044 1230 94.0 ESC15MA673.44(1) 6.3 8 2200 *10 × 20 22 0.044 130 139.0 ESC22MA673.44(1) 6.3 8 2200 *10 × 25 22 0.043 1450 139.0 ESC22MA673.44(1) 6.3 8 3300 13 × 25 22 0.043 1450 139.0 ESC23MA673.44(1) 6.3 8 3300 13 × 25 22 0.032 1750 246.0 ESC33MA673.44(1) 6.3 8 4700 *13 × 30 22 0.033 1570 246.0 ESC47MA673.44(1) 6.3 8 6200 16 × 22 20.019 2300 428.0 ESC458MA673.44(2)									
6.3 8 1500 8 × 20 22 0.051 800 94.0 ESC158M6874A6(1) 6.3 8 1500 10 × 20 22 0.041 1250 94.0 ESC158M68744(1) 6.3 8 2200 +10 × 25 22 0.041 1250 94.0 ESC128M68744(1) 6.3 8 2200 13 × 20 22 0.043 1400 208.0 ESC228M687444(1) 6.3 8 3300 13 × 25 22 0.043 1400 208.0 ESC238M68744(1) 6.3 8 3300 13 × 25 22 0.032 1750 226.0 ESC478M6874.4(1) 6.3 8 4700 +13 × 25 22 0.032 1750 296.0 ESC478M6874.4(1) 6.3 8 4700 +13 × 25 22 0.024 2000 428.0 ESC478M6874.4(1) 6.3 8 4700 16 × 25 22 0.026 ESC478M6874.4(1) 6.3		-							· · · ·
6.3 8 1500 *10 x 16 22 0.055 1070 94.0 ESC15MR67AH8(1) 6.3 8 2200 *10 x 20 22 0.051 1220 139.0 ESC15MR67AH4(1) 6.3 8 2200 *10 x 25 22 0.048 1310 139.0 ESC22MR67AL4(1) 6.3 8 2300 *10 x 25 22 0.043 1460 139.0 ESC22MR67AL4(1) 6.3 8 3300 *10 x 25 22 0.043 1400 208.0 ESC23MR67AL4(1) 6.3 8 3900 13 x 25 22 0.032 1750 246.0 ESC47MR67AL4(1) 6.3 8 4700 *13 x 30 22 0.032 1570 296.0 ESC47MR67AL4(1) 6.3 8 4700 *13 x 30 22 0.024 1800 296.0 ESC47MR67AL4(1) 6.3 8 6600 16 x 32 22 0.019 2550 630.0 ESC19MR67AM7(1) <		-							. ,
6.3 8 1500 10 x 20 22 0.044 1250 94.0 ESC158M678144(1) 6.3 8 2200 +10 x 25 22 0.048 1310 139.0 ESC228M678145(1) 6.3 8 2200 13 x 20 22 0.043 1450 139.0 ESC228M678145(1) 6.3 8 3300 13 x 25 22 0.043 1400 208.0 ESC338M67814(1) 6.3 8 3300 13 x 25 22 0.032 1750 246.0 ESC338M67814(1) 6.3 8 4700 +13 x 25 22 0.032 1750 246.0 ESC478M67814(1) 6.3 8 4700 +13 x 25 22 0.022 1520 296.0 ESC478M67814671 6.3 8 4700 16 x 25 22 0.028 1800 296.0 ESC478M67814671 6.3 8 15000 16 x 32 22 0.019 2550 651.0 ESC159M67814471 <									()
6.3 8 2200 *10 x 20 22 0.61 1220 133.0 ESC22MRG3AH(1) 6.3 8 2200 13 x 20 22 0.048 1310 139.0 ESC22MRG3AH(1) 6.3 8 2300 13 x 20 22 0.043 1400 208.0 ESC23MRG3AH(1) 6.3 8 3300 *10 x 25 22 0.035 1700 208.0 ESC33MRG3AH(1) 6.3 8 4700 *13 x 25 22 0.032 1750 246.0 ESC47MRG7AL(1) 6.3 8 4700 *13 x 30 22 0.032 1570 296.0 ESC47MRG7AL(1) 6.3 8 4700 16 x 32 22 0.028 1800 296.0 ESC47MRG7AL(1) 6.3 8 6600 16 x 32 22 0.019 2350 517.0 ESC428MRG7AM(2) 6.3 8 10000 16 x 36 22 0.019 2350 530.0 ESC179MRG7AM(2)		-							
6.3 8 2200 *10 x 25 22 0.043 1310 139.0 ESC22MRGAH5(1) 6.3 8 2200 13 x 25 22 0.043 1400 208.0 ESC23MRGAH5(1) 6.3 8 3300 13 x 25 22 0.043 1400 208.0 ESC23MRGAH5(1) 6.3 8 3300 13 x 25 22 0.032 1770 246.0 ESC33MGRAH5(1) 6.3 8 4700 *13 x 25 22 0.032 1570 296.0 ESC47MGRAH2(1) 6.3 8 4700 16 x 25 22 0.024 2000 428.0 ESC47MGRAH2(1) 6.3 8 10000 16 x 36 22 0.019 2050 517.0 ESC47MGRAH2(1) 6.3 8 10000 16 x 36 22 0.019 2000 428.0 ESC47MGRAH2(1) 6.3 8 10000 16 x 36 22 0.019 2000 ESC47MGRAH2(1) 6.3 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
6.3 8 2200 13 x 20 22 0.043 1450 139.0 ESC22MM6R3A13(1) 6.3 8 3300 *10 x 25 22 0.043 1400 208.0 ESC33M6R3A15(1) 6.3 8 3000 13 x 25 22 0.035 1700 208.0 ESC33M6R3A14(1) 6.3 8 4700 *13 x 35 22 0.032 1750 246.0 ESC37M6R3A14(1) 6.3 8 4700 *13 x 30 22 0.032 1750 296.0 ESC47M6R3A18(1) 6.3 8 4700 *13 x 30 22 0.024 2000 428.0 ESC47M6R3A18(1) 6.3 8 6800 16 x 32 22 0.019 2550 560.0 ESC32M6R3A18(1) 6.3 8 10000 16 x 36 22 0.019 2550 550.0 ESC15M6R3A17(1) 6.3 8 10000 16 x 36 22 0.019 3000 945.0 ESC15M6R3A17(1)		8							(/
6.3 8 3300 13 x 25 22 0.035 1700 208.0 ESC38M6R3AL(1) 6.3 8 4700 *13 x 25 22 0.032 1750 246.0 ESC38M6R3AL(1) 6.3 8 4700 *13 x 25 22 0.032 1520 296.0 ESC478M6R3AL(1) 6.3 8 4700 *13 x 30 22 0.033 1570 296.0 ESC478M6R3AL(1) 6.3 8 4700 16 x 25 22 0.024 2000 428.0 ESC478M6R3AW(1) 6.3 8 6800 16 x 32 22 0.019 2550 630.0 ESC169M6R3AW(1) 6.3 8 10000 16 x 36 22 0.019 2550 630.0 ESC169M6R3AW(1) 6.3 8 10000 5 x 11 19 0.420 150 10.0 ESC169M6R3AW(1) 10 13 120 5 x 11 19 0.320 250 15.0 ESC177M010AG(3) <		8							• •
6.3 8 3900 13 x 25 22 0.032 1750 246.0 ESC398M6R3L4(1) 6.3 8 4700 *13 x 25 22 0.032 1520 296.0 ESC478M6R3AL4(1) 6.3 8 4700 16 x 25 22 0.028 1800 296.0 ESC478M6R3AL4(1) 6.3 8 4700 16 x 25 22 0.024 2000 426.0 ESC688M6R3AW2(1) 6.3 8 6000 16 x 32 22 0.019 2550 630.0 ESC199M6R3AW2(1) 6.3 8 10000 16 x 36 22 0.019 2550 630.0 ESC199M6R3AW2(1) 10 13 100 5 x 11 19 0.420 150 10.0 ESC179M010AC3(1) 10 13 120 5 x 11 19 0.320 250 15.0 ESC179M010AC3(1) 10 13 220 6 3 x 11 19 0.140 550 32.0 ESC37M010AG3(1)	6.3	8	3300	*10 x 25	22	0.043	1400	208.0	ESC338M6R3AH5(1)
6.3 8 4700 *13 x 25 22 0.032 1520 296.0 ESC478M6R3AL4(1) 6.3 8 4700 *13 x 30 22 0.033 1570 296.0 ESC478M6R3AL8(1) 6.3 8 4700 16 x 25 22 0.024 2000 428.0 ESC478M6R3AM2(1) 6.3 8 6800 16 x 32 22 0.019 2350 517.0 ESC88M6R3AM2(1) 6.3 8 10000 16 x 36 22 0.019 2350 630.0 ESC19M6R3AM2(1) 6.3 8 15000 18 x 36 22 0.019 3000 945.0 ESC19M6R3AM2(1) 10 13 100 5 x 11 19 0.320 250 15.0 ESC17M010AC3(1) 10 13 220 6.3 x 11 19 0.220 300 22.0 ESC17M010AC3(1) 10 13 330 8 x 11 19 0.120 ESC477M010AC3(1) ESC17M010AC3(1)	6.3	8	3300	13 x 25	22	0.035	1700	208.0	ESC338M6R3AL4(1)
6.3 8 4700 *13 x 30 22 0.033 1570 296.0 ESC478M6R3AL8(1) 6.3 8 4700 16 x 25 22 0.028 1800 296.0 ESC478M6R3AM2(1) 6.3 8 6800 16 x 32 22 0.024 2000 428.0 ESC688M6R3AM2(1) 6.3 8 8200 16 x 32 22 0.019 2350 517.0 ESC688M6R3AM2(1) 6.3 8 10000 16 x 36 22 0.019 3000 945.0 ESC19M6R3AM2(1) 10 13 100 5 x 11 19 0.320 250 15.0 ESC17M010AC3(1) 10 13 220 6.3 x 11 19 0.220 300 22.0 ESC27M010AC3(1) 10 13 330 8 x 11 19 0.140 550 33.0 ESC477M010AG3(1) 10 13 470 8 x 15 19 0.100 750 47.0 ESC477M010AG3(1) <tr< td=""><td>6.3</td><td>8</td><td>3900</td><td></td><td></td><td>0.032</td><td></td><td>246.0</td><td>ESC398M6R3AL4(1)</td></tr<>	6.3	8	3900			0.032		246.0	ESC398M6R3AL4(1)
6.3 8 4700 16 x 32 22 0.028 1800 296.0 ESC473M673AM(7) 6.3 8 6800 16 x 32 22 0.024 2000 428.0 ESC473M673AM(7) 6.3 8 10000 16 x 32 22 0.019 2350 517.0 ESC22M673AM(1) 6.3 8 10000 16 x 36 22 0.019 2550 630.0 ESC19M673AM2(1) 6.3 8 15000 18 x 36 22 0.019 3000 945.0 ESC19M673AM2(1) 10 13 100 5 x 11 19 0.420 150 10.0 ESC15M673AN2(1) 10 13 130 6.3 x 11 19 0.420 150 12.0 ESC17M010AC3(1) 10 13 330 8 x 11 19 0.140 550 33.0 ESC37M010AC3(1) 10 13 470 8 x 15 19 0.160 74.0 ESC477M010AG3(1) 10	6.3	8	4700	*13 x 25		0.032		296.0	ESC478M6R3AL4(1)
6.3 8 6800 16 x 32 22 0.024 2000 428.0 ESC688M6R3AM2(1) 6.3 8 10000 16 x 32 22 0.019 2350 517.0 ESC288M6R3AM2(1) 6.3 8 10000 16 x 36 22 0.019 2350 63.0 ESC19M6R3AM2(1) 6.3 8 15000 18 x 36 22 0.019 3000 945.0 ESC19M6R3AN2(1) 10 13 100 5 x 11 19 0.420 150 10.0 ESC127M010AC3(1) 10 13 120 5 x 11 19 0.320 250 15.0 ESC127M010AC3(1) 10 13 330 8 x 11 19 0.140 550 33.0 ESC337M010AG3(1) 10 13 470 8 x 11 19 0.100 750 47.0 ESC477M010AG3(1) 10 13 680 10 x 12.5 19 0.005 800 68.0 ESC687M010A(4(1)									ESC478M6R3AL8(1)
6.3 8 8200 16 x 32 22 0.019 2350 517.0 ESC228MR8AM2(1) 6.3 8 10000 16 x 36 22 0.019 2550 630.0 ESC199MR8AM2(1) 10 13 100 5 x 11 19 0.420 150 10.0 ESC159MR8AM2(1) 10 13 120 5 x 11 19 0.370 200 12.0 ESC17M010AC3(1) 10 13 120 5 x 11 19 0.370 200 12.0 ESC17M010AC3(1) 10 13 220 6.3 x 11 19 0.140 550 33.0 ESC37M010AC3(1) 10 13 330 8 x 11 19 0.140 550 33.0 ESC477M010AG3(1) 10 13 470 8 x 15 19 0.100 750 47.0 ESC477M010AG3(1) 10 13 680 10 x 12.5 19 0.085 800 68.0 ESC477M010AG3(1) <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>• • •</td></td<>									• • •
6.3 8 10000 16 x 36 22 0.019 2550 630.0 ESC109M6R3AM3(1) 6.3 8 15000 18 x 36 22 0.019 3000 945.0 ESC159M6R3AN2(1) 10 13 100 5 x 11 19 0.420 150 10.0 ESC179M010AC3(1) 10 13 120 5 x 11 19 0.370 200 12.0 ESC177M010AC3(1) 10 13 120 6.3 x 11 19 0.320 250 15.0 ESC177M010AC3(1) 10 13 330 8 x 11 19 0.140 550 33.0 ESC37M010AC3(1) 10 13 470 8 x 11 19 0.140 550 33.0 ESC477M010AC3(1) 10 13 680 *8 x 11 19 0.100 7.0 ESC477M010AC3(1) 10 13 680 10 x 1.5 19 0.065 1080 68.0 ESC687M010AH3(1) 10									· · /
6.381500018 x 36220.0193000945.0ESC159M6R3AN2(1)10131005 x 11190.42015010.0ESC107M010AC3(1)10131205 x 11190.37020012.0ESC17M010AC3(1)10131506.3 x 11190.32025015.0ESC157M010AC3(1)10132206.3 x 11190.22030022.0ESC27M010AC3(1)10133308 x 11190.14055033.0ESC337M010AG3(1)10134708 x 11190.12055047.0ESC477M010AG3(1)1013680*8 x 11190.10075047.0ESC477M010AG3(1)101368010 x 12.5190.00580068.0ESC687M010AH9(1)101368010 x 16190.064105082.0ESC187M010AH9(1)10131000*10 x 12.5190.075930100.0ESC108M010AH9(1)1013100010 x 16190.0651080100.0ESC108M010AH8(1)1013100010 x 20190.0501100100.0ESC108M010AH8(1)1013100010 x 20190.0501100100.0ESC108M010AH8(1)1013100010 x 20190.0391450150.0ESC18M010AH4(1)		-							
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$									· · ·
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$									
10 13 150 6.3 x 11 19 0.320 250 15.0 ESC157M010AE3(1) 10 13 220 6.3 x 11 19 0.220 300 22.0 ESC157M010AE3(1) 10 13 330 8 x 11 19 0.140 550 33.0 ESC377M010AG3(1) 10 13 470 8 x 11 19 0.140 550 47.0 ESC477M010AG3(1) 10 13 470 8 x 15 19 0.100 750 47.0 ESC477M010AG3(1) 10 13 680 18 x 11 19 0.110 640 68.0 ESC477M010AG4(1) 10 13 680 10 x 12.5 19 0.085 800 68.0 ESC487M010AH8(1) 10 13 820 10 x 16 19 0.065 1080 100.0 ESC108M010AH8(1) 10 13 1000 10 x 12.5 19 0.075 930 100.0 ESC108M010AH8(1)									
10 13 220 6.3 x 11 19 0.220 300 22.0 ESC227M010AE3(1) 10 13 330 8 x 11 19 0.140 550 33.0 ESC337M010A63(1) 10 13 470 8 x 11 19 0.120 550 47.0 ESC477M010A63(1) 10 13 470 8 x 15 19 0.100 750 47.0 ESC477M010A63(1) 10 13 680 *8 x 11 19 0.110 640 68.0 ESC477M010A63(1) 10 13 680 10 x 12.5 19 0.085 800 68.0 ESC687M010A63(1) 10 13 820 10 x 16 19 0.065 1080 100.0 ESC188M010A6(1) 10 13 1000 10 x 12.5 19 0.075 930 100.0 ESC108M010A6(1) 10 13 1000 10 x 12.5 19 0.085 990 100.0 ESC108M010AH4(1)									
10 13 330 8 x 11 19 0.140 550 33.0 ESC337M010AG3(1) 10 13 470 8 x 11 19 0.120 550 47.0 ESC477M010AG3(1) 10 13 470 8 x 15 19 0.100 750 47.0 ESC477M010AG3(1) 10 13 680 *8 x 11 19 0.110 640 68.0 ESC477M010AG3(1) 10 13 680 10 x 12.5 19 0.085 800 68.0 ESC687M010AH9(1) 10 13 820 10 x 16 19 0.065 1080 100.0 ESC188M010AH9(1) 10 13 1000 8 x 20 19 0.075 930 100.0 ESC188M010AH9(1) 10 13 1000 10 x 12.5 19 0.039 1450 ESC188M010AH4(1) 10 13 1000 10 x 20 19 0.039 1450 150.0 ESC188M010AH4(1) 10									· · ·
10 13 470 8 x 11 19 0.120 550 47.0 ESC477M010AG3(1) 10 13 470 8 x 15 19 0.100 750 47.0 ESC477M010AG4(1) 10 13 680 *8 x 11 19 0.110 640 68.0 ESC477M010AG4(1) 10 13 680 10 x 12.5 19 0.085 800 68.0 ESC687M010AH9(1) 10 13 820 10 x 16 19 0.064 1050 82.0 ESC827M010AB(1) 10 13 1000 8 x 20 19 0.065 1080 100.0 ESC108M010AH9(1) 10 13 1000 10 x 12.5 19 0.075 930 100.0 ESC108M010AH9(1) 10 13 1000 10 x 12.5 19 0.050 1100 100.0 ESC108M010AH4(1) 10 13 1000 10 x 20 19 0.044 1250 120.0 ESC128M010AH4(1) <									()
10 13 470 8 x 15 19 0.100 750 47.0 ESC477M010AG4(1) 10 13 680 *8 x 11 19 0.110 640 68.0 ESC687M010AG3(1) 10 13 680 10 x 12.5 19 0.085 800 68.0 ESC687M010AH9(1) 10 13 820 10 x 16 19 0.064 1050 82.0 ESC687M010AH8(1) 10 13 1000 8 x 20 19 0.065 1080 100.0 ESC188M010AH9(1) 10 13 1000 *10 x 12.5 19 0.075 930 100.0 ESC188M010AH9(1) 10 13 1000 10 x 16 19 0.885 990 100.0 ESC188M010AH8(1) 10 13 1000 10 x 20 19 0.050 1100 100.0 ESC188M010AH4(1) 10 13 1200 10 x 20 19 0.039 1450 150.0 ESC188M010AH4(1)									
10 13 680 *8 x 11 19 0.110 640 68.0 ESC687M010AG3(1) 10 13 680 10 x 12.5 19 0.085 800 68.0 ESC687M010AH9(1) 10 13 820 10 x 16 19 0.064 1050 82.0 ESC827M010AH8(1) 10 13 1000 8 x 20 19 0.065 1080 100.0 ESC108M010AH9(1) 10 13 1000 *10 x 12.5 19 0.075 930 100.0 ESC108M010AH9(1) 10 13 1000 10 x 12.5 19 0.085 990 100.0 ESC108M010AH9(1) 10 13 1000 10 x 20 19 0.044 1250 120.0 ESC128M010AH4(1) 10 13 1200 10 x 20 19 0.047 1330 220.0 ESC28M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC28M010AH4(1) <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
10 13 820 10 x 16 19 0.064 1050 82.0 ESC827M010AH8(1) 10 13 1000 8 x 20 19 0.065 1080 100.0 ESC108M010AG6(1) 10 13 1000 *10 x 12.5 19 0.075 930 100.0 ESC108M010AH9(1) 10 13 1000 10 x 16 19 0.085 990 100.0 ESC108M010AH8(1) 10 13 1000 10 x 20 19 0.050 1100 100.0 ESC108M010AH4(1) 10 13 1200 10 x 20 19 0.044 1250 120.0 ESC128M010AH4(1) 10 13 1500 10 x 20 19 0.047 1330 220.0 ESC228M010AH4(1) 10 13 2200 *10 x 20 19 0.039 1450 220.0 ESC28M010AH4(1) 10 13 2200 *10 x 20 19 0.032 20.0 ESC28M010AH4(1)									
10 13 1000 8 x 20 19 0.065 1080 100.0 ESC108M010AG6(1) 10 13 1000 *10 x 12.5 19 0.075 930 100.0 ESC108M010AH9(1) 10 13 1000 10 x 16 19 0.085 990 100.0 ESC108M010AH8(1) 10 13 1000 10 x 20 19 0.050 1100 100.0 ESC108M010AH4(1) 10 13 1200 10 x 20 19 0.044 1250 120.0 ESC128M010AH4(1) 10 13 1500 10 x 20 19 0.039 1450 150.0 ESC128M010AH4(1) 10 13 2200 *10 x 20 19 0.039 1450 220.0 ESC228M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC228M010AH5(1) 10 13 2200 13 x 20 19 0.032 2000 330.0 ESC38M010AH5(1)	10		680	10 x 12.5		0.085	800	68.0	ESC687M010AH9(1)
10 13 1000 *10 x 12.5 19 0.075 930 100.0 ESC108M010AH9(1) 10 13 1000 10 x 16 19 0.085 990 100.0 ESC108M010AH8(1) 10 13 1000 10 x 16 19 0.085 990 100.0 ESC108M010AH8(1) 10 13 1200 10 x 20 19 0.050 1100 100.0 ESC108M010AH4(1) 10 13 1200 10 x 20 19 0.044 1250 120.0 ESC128M010AH4(1) 10 13 2200 *10 x 20 19 0.047 1330 220.0 ESC28M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC28M010AH4(1) 10 13 2200 *10 x 25 19 0.038 1600 220.0 ESC28M010AH5(1) 10 13 3300 *10 x 30 19 0.322 2000 330.0 ESC338M010AL4(1)				10 x 16		0.064		82.0	. ,
10 13 1000 10 x 16 19 0.085 990 100.0 ESC108M010AH8(1) 10 13 1000 10 x 20 19 0.050 1100 100.0 ESC108M010AH4(1) 10 13 1200 10 x 20 19 0.044 1250 120.0 ESC128M010AH4(1) 10 13 1500 10 x 20 19 0.039 1450 150.0 ESC128M010AH4(1) 10 13 2200 *10 x 20 19 0.047 1330 220.0 ESC28M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC28M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC28M010AH4(1) 10 13 2200 13 x 20 19 0.038 1600 220.0 ESC28M010AL3(1) 10 13 3300 *10 x 30 19 0.032 2000 330.0 ESC338M010AL4(1)									
10 13 1000 10 x 20 19 0.050 1100 100.0 ESC108M010AH4(1) 10 13 1200 10 x 20 19 0.044 1250 120.0 ESC128M010AH4(1) 10 13 1500 10 x 20 19 0.039 1450 150.0 ESC128M010AH4(1) 10 13 2200 *10 x 20 19 0.047 1330 220.0 ESC28M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC28M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC28M010AH4(1) 10 13 2200 13 x 20 19 0.038 1600 220.0 ESC28M010AL3(1) 10 13 3300 *10 x 30 19 0.032 2000 330.0 ESC338M010AL4(1) 10 13 3300 13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1)									
10 13 1200 10 x 20 19 0.044 1250 120.0 ESC128M010AH4(1) 10 13 1500 10 x 20 19 0.039 1450 150.0 ESC158M010AH4(1) 10 13 2200 *10 x 20 19 0.039 1450 150.0 ESC128M010AH4(1) 10 13 2200 *10 x 20 19 0.047 1330 220.0 ESC228M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC228M010AH5(1) 10 13 2200 13 x 20 19 0.038 1600 220.0 ESC228M010AL3(1) 10 13 3300 *10 x 30 19 0.032 2000 330.0 ESC338M010AL4(1) 10 13 3300 13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1) 10 13 4700 *13 x 25 19 0.028 1860 470.0 ESC478M010AL4(1) <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
10 13 1500 10 x 20 19 0.039 1450 150.0 ESC158M010AH4(1) 10 13 2200 *10 x 20 19 0.047 1330 220.0 ESC228M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC228M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC228M010AH5(1) 10 13 2200 13 x 20 19 0.038 1600 220.0 ESC28M010AL3(1) 10 13 3300 *10 x 30 19 0.032 2000 330.0 ESC338M010AL4(1) 10 13 3300 13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1) 10 13 4700 *13 x 25 19 0.028 1860 470.0 ESC478M010AL4(1) 10 13 4700 16 x 25 19 0.024 2200 470.0 ESC478M010AM7(1) <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
10 13 2200 *10 x 20 19 0.047 1330 220.0 ESC228M010AH4(1) 10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC228M010AH5(1) 10 13 2200 13 x 20 19 0.039 1450 220.0 ESC228M010AL3(1) 10 13 3300 *10 x 30 19 0.032 2000 330.0 ESC338M010AL4(1) 10 13 3300 13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1) 10 13 4700 *13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1) 10 13 4700 *13 x 25 19 0.028 1860 470.0 ESC478M010AL4(1) 10 13 4700 16 x 25 19 0.024 2200 470.0 ESC478M010AM7(1) 10 13 6800 16 x 36 19 0.019 2550 680.0 ESC688M010AM3(1) <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
10 13 2200 *10 x 25 19 0.039 1450 220.0 ESC228M010AH5(1) 10 13 2200 13 x 20 19 0.038 1600 220.0 ESC228M010AL3(1) 10 13 3300 *10 x 30 19 0.032 2000 330.0 ESC338M010AL4(1) 10 13 3300 13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1) 10 13 4700 *13 x 25 19 0.028 2000 330.0 ESC478M010AL4(1) 10 13 4700 *13 x 25 19 0.024 2200 470.0 ESC478M010AM7(1) 10 13 4700 16 x 25 19 0.019 2550 680.0 ESC478M010AM7(1) 10 13 6800 16 x 36 19 0.019 2550 680.0 ESC688M010AM3(1)									()
10 13 2200 13 x 20 19 0.038 1600 220.0 ESC228M010AL3(1) 10 13 3300 *10 x 30 19 0.032 2000 330.0 ESC338M010AH6(1) 10 13 3300 13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1) 10 13 4700 *13 x 25 19 0.028 1860 470.0 ESC478M010AL4(1) 10 13 4700 16 x 25 19 0.024 2200 470.0 ESC478M010AM7(1) 10 13 6800 16 x 36 19 0.019 2550 680.0 ESC688M010AM3(1)									
10 13 3300 *10 x 30 19 0.032 2000 330.0 ESC338M010AH6(1) 10 13 3300 13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1) 10 13 4700 *13 x 25 19 0.028 1860 470.0 ESC478M010AL4(1) 10 13 4700 16 x 25 19 0.024 2200 470.0 ESC478M010AM7(1) 10 13 6800 16 x 36 19 0.019 2550 680.0 ESC688M010AM3(1)									
10 13 3300 13 x 25 19 0.028 2000 330.0 ESC338M010AL4(1) 10 13 4700 *13 x 25 19 0.028 1860 470.0 ESC478M010AL4(1) 10 13 4700 16 x 25 19 0.024 2200 470.0 ESC478M010AM7(1) 10 13 6800 16 x 36 19 0.019 2550 680.0 ESC688M010AM3(1)									
10 13 4700 *13 x 25 19 0.028 1860 470.0 ESC478M010AL4(1) 10 13 4700 16 x 25 19 0.024 2200 470.0 ESC478M010AL4(1) 10 13 6800 16 x 36 19 0.019 2550 680.0 ESC688M010AM3(1)									· · ·
10 13 4700 16 x 25 19 0.024 2200 470.0 ESC478M010AM7(1) 10 13 6800 16 x 36 19 0.019 2550 680.0 ESC688M010AM3(1)									. ,
10 13 6800 16 x 36 19 0.019 2550 680.0 ESC688M010AM3(1)									· · · ·
VDC VDC Surge Rated Capacitance Case Size DF Z RC LC Part Number									
	VDC	VDC Surge	Rated Capacitance	Case Size	DF	Z	RC	LC	Part Number

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

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



Table 1 - Ratings & Part Number Reference cont'd

VDC 10 16 16 16 16 16	VDC Surge Voltage 13 20 20 20 20 20 20 20 20 20	Rated Capacitance 120 Hz 20°C (μF) 8200 56 68 100	Case Size D x L (mm) 18 x 36 5 x 11	DF 120 Hz 20°C (tan δ %) ¹	Z 100 kHZ 20°C (Ω)	RC 100 kHz	LC 20°C 2 Minutes	Part Number
10 16 16 16 16	Voltage 13 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20	120 Hz 20°C (μF) 8200 56 68	D x L (mm) 18 x 36				2 Minutes	Part Number
16 16 16 16	Voltage 13 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20	(µF) 8200 56 68	18 x 36	(tan δ %) 1	20°C (Ω)			
16 16 16 16	13 20 20 20 20 20 20 20 20	8200 56 68				105°C (mA)	(μA)	
16 16 16 16	20 20 20 20 20 20 20	56 68			()			
16 16 16	20 20 20 20 20 20	68	5 v 11	19	0.019	2800	820.0	ESC828M010AN2(1)
16 16	20 20 20 20			16	0.630	100	11.0	ESC566M016AC3(1)
16	20 20 20	100	5 x 11 5 x 11	16 16	0.420 0.370	150 200	11.0 16.0	ESC686M016AC3(1)
	20 20	120	6.3 x 11	16	0.370	250	19.0	ESC107M016AC3(1) ESC127M016AE3(1)
	20	150	6.3 x 11	16	0.220	300	24.0	ESC157M016AE3(1)
16		220	8 x 11	16	0.140	550	35.0	ESC227M016AG3(1)
16	20	330	8 x 11	16	0.120	550	53.0	ESC337M016AG3(1)
16	20	330	8 x 15	16	0.100	750	53.0	ESC337M016AG4(1)
16	20	330	10 x 12.5	16	0.080	688	53.0	ESC337M016AH9(1)
16	20	470	8 x 15	16	0.093	730	75.0	ESC477M016AG4(1)
16	20	470	10 x 12.5	16	0.085	800	75.0	ESC477M016AH9(1)
16 16	20 20	680 820	10 x 16	16 16	0.064	1050 1100	109.0 131.0	ESC687M016AH8(1)
16	20	820 1000	10 x 20 *10 x 16	16	0.044 0.043	1140	160.0	ESC827M016AH4(1) ESC108M016AH8(1)
16	20	1000	10 x 20	16	0.039	1250	160.0	ESC108M016AH4(1)
16	20	1200	*10 x 25	16	0.042	1310	192.0	ESC128M016AH5(1)
16	20	1200	13 x 20	16	0.038	1450	192.0	ESC128M016AL3(1)
16	20	1500	*10 x 20	16	0.045	1200	240.0	ESC158M016AH4(1)
16	20	1500	13 x 20	16	0.034	1600	240.0	ESC158M016AL3(1)
16	20	2200	*10 x 30	16	0.032	1780	352.0	ESC228M016AH6(1)
16	20	2200	*13 x 20	16	0.033	1720	352.0	ESC228M016AL3(1)
16	20 20	2200 3300	13 x 25	16 16	0.028	2000 2200	352.0 528.0	ESC228M016AL4(1)
16 16	20	3300	*13 x 40 16 x 25	16	0.026 0.024	2200	528.0	ESC338M016AL7(1) ESC338M016AM7(1)
16	20	4700	16 x 36	16	0.019	2550	752.0	ESC478M016AM3(1)
16	20	6800	18 x 36	16	0.019	2800	1088.0	ESC688M016AN2(1)
25	32	10	5 x 11	14	0.550	50	12.0	ESC106M025AC3(1)
25	32	47	5 x 11	14	0.450	150	12.0	ESC476M025AC3(1)
25	32	56	5 x 11	14	0.420	150	17.0	ESC566M025AC3(1)
25	32	68	6.3 x 11	14	0.370	200	17.0	ESC686M025AE3(1)
25	32	100	6.3 x 11	14	0.220	250	25.0	ESC107M025AE3(1)
25 25	32 32	120 150	8 x 11 8 x 11	14 14	0.200 0.140	300 550	30.0 37.0	ESC127M025AG3(1) ESC157M025AG3(1)
25	32	220	8 x 11	14	0.120	550	55.0	ESC227M025AG3(1)
25	32	220	8 x 15	14	0.100	750	55.0	ESC227M025AG4(1)
25	32	330	*8 x 15	14	0.100	660	82.0	ESC337M025AG4(1)
25	32	330	8 x 20	14	0.069	800	82.0	ESC337M025AG6(1)
25	32	330	10 x 16	14	0.086	900	82.0	ESC337M025AH8(1)
25	32	470	8 x 20	14	0.067	800	117.0	ESC477M025AG6(1)
25	32	470	10 x 16	14	0.064	1050	117.0	ESC477M025AH8(1)
25 25	32 32	470 680	10 x 12.5	14 14	0.086 0.039	760 1100	117.0 170.0	ESC477M025AH9(1)
25 25	32 32	820	10 x 20 10 x 20	14	0.039	1250	205.0	ESC687M025AH4(1) ESC827M025AH4(1)
25	32	1000	*10 x 20	14	0.039	1160	250.0	ESC108M025AH4(1)
25	32	1000	*10 x 25	14	0.042	1310	250.0	ESC108M025AH5(1)
25	32	1000	13 x 20	14	0.038	1450	250.0	ESC108M025AL3(1)
25	32	1200	13 x 25	14	0.035	1600	300.0	ESC128M025AL4(1)
25	32	1500	*13 x 30	14	0.032	1750	375.0	ESC158M025AL8(1)
25	32	1500	16 x 25	14	0.028	2000	375.0	ESC158M025AM7(1)
25	32	2200	*13 x 30	14	0.029	1810	550.0	ESC228M025AL8(1)
25 25	32 32	2200 2200	*16 x 25 16 x 32	14 14	0.032 0.024	1660 2200	550.0 550.0	ESC228M025AM7(1) ESC228M025AM2(1)
25 25	32 32	3300	*16 x 32	14	0.024	2200	825.0	ESC338M025AM2(1)
25	32	3300	18 x 36	14	0.019	2550	825.0	ESC338M025AN2(1)
25	32	4700	18 x 36	14	0.019	2800	1175.0	ESC478M025AN2(1)
VDC	VDC Surge	Rated Capacitance	Case Size	DF	Z	RC	LC	Part Number

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

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



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 %) ¹	Z 100 kHZ 20°C (Ω)	RC 100 kHz 105°C (mA)	LC 20°C 2 Minutes (µA)	Part Number
25	32	6800	18 x 36	14	0.019	2800	1175.0	ESC688M025AN2(1)
35	44 44	4.7 6.8	5 x 11 5 x 11	12 12	1.200 1.000	115 120	3.0 3.0	ESC475M035AC3(1)
35 35	44	10	5 x 11	12	0.900	120	3.0	ESC685M035AC3(1) ESC106M035AC3(1)
35	44	15	5 x 11	12	0.690	140	5.0	ESC156M035AC3(1)
35	44	22	5 x 11	12	0.600	190	8.0	ESC226M035AC3(1)
35	44	33	5 x 11	12	0.580	200	11.0	ESC336M035AC3(1)
35	44	47	6.3 x 11	12	0.039	250	16.0	ESC476M035AE3(1)
35	44	68	6.3 x 11	12	0.220	300	24.0	ESC686M035AE3(1)
35	44	100	6.3 x 11	12	0.180	300	35.0	ESC107M035AE3(1)
35	44	100	8 x 11	12	0.140	450	35.0	ESC107M035AG3(1)
35	44	120	8 x 11	12	0.130	550	42.0	ESC127M035AG3(1)
35	44 44	150	8 x 15	12 12	0.100	650 650	52.0 77.0	ESC157M035AG4(1)
35 35	44	220 220	8 x 15 10 x 12.5	12	0.100 0.069	800	77.0	ESC227M035AG4(1) ESC227M035AH9(1)
35	44	330	*10 x 16	12	0.052	900	115.0	ESC337M035AH8(1)
35	44	330	10 x 20	12	0.044	1050	115.0	ESC337M035AH4(1)
35	44	470	10 x 20	12	0.039	1300	164.0	ESC477M035AH4(1)
35	44	680	13 x 20	12	0.038	1400	238.0	ESC687M035AL3(1)
35	44	820	13 x 20	12	0.034	1550	287.0	ESC827M035AL3(1)
35	44	1000	13 x 25	12	0.029	1700	350.0	ESC108M035AL4(1)
35	44	1200	16 x 25	12	0.028	1900	420.0	ESC128M035AM7(1)
35	44	1500	16 x 25	12	0.024	2100	525.0	ESC158M035AM7(1)
35	44	2200	*16 x 32	12	0.021	2300	770.0	ESC228M035AM2(1)
35 35	44 44	2200 3300	16 x 36 18 x 36	12 12	0.019 0.019	2550 2800	770.0 1155.0	ESC228M035AM3(1) ESC338M035AN2(1)
50	63	4.7	5 x 11	12	2.000	115	3.0	ESC475M050AC3(1)
50	63	6.8	5 x 11	10	1.850	120	3.0	ESC685M050AC3(1)
50	63	10	5 x 11	10	1.700	140	5.0	ESC106M050AC3(1)
50	63	15	5 x 11	10	1.200	180	7.0	ESC156M050AC3(1)
50	63	22	5 x 11	10	0.700	200	11.0	ESC226M050AC3(1)
50	63	33	6.3 x 11	10	0.600	250	16.0	ESC336M050AE3(1)
50	63	47	6.3 x 11	10	0.520	300	23.0	ESC476M050AE3(1)
50	63	68	8 x 11	10	0.350	450	34.0	ESC686M050AG3(1)
50 50	63	100	8 x 11	10 10	0.290	450 550	50.0	ESC107M050AG3(1)
50 50	63 63	100 120	8 x 15 8 x 20	10	0.250 0.210	550 650	50.0 60.0	ESC107M050AG4(1) ESC127M050AG6(1)
50	63	150	10 x 12.5	10	0.160	800	75.0	ESC157M050AH9(1)
50	63	220	*10 x 16	10	0.100	1050	110.0	ESC227M050AH8(1)
50	63	220	10 x 25	10	0.068	1050	110.0	ESC227M050AH5(1)
50	63	330	10 x 20	10	0.072	1300	165.0	ESC337M050AH4(1)
50	63	470	*10 x 20	10	0.075	1390	235.0	ESC477M050AH4(1)
50	63	470	13 x 20	10	0.060	1400	235.0	ESC477M050AL3(1)
50	63	680	13 x 25	10	0.050	1550	340.0	ESC687M050AL4(1)
50 50	63	820	16 x 25	10	0.040	1700	410.0	ESC827M050AM7(1)
50 50	63 63	1000 1200	16 x 25 16 x 32	10 10	0.039 0.025	1900 2100	500.0 600.0	ESC108M050AM7(1) ESC128M050AM2(1)
50 50	63	1200	16 x 32 16 x 36	10	0.025	2550	750.0	ESC128M050AM2(1) ESC158M050AM3(1)
50	63	2200	18 x 40	10	0.025	2800	1100.0	ESC228M050AN3(1)
63	79	4.7	5 x 11	9	2.200	115	3.0	ESC475M063AC3(1)
63	79	6.8	5 x 11	9	2.000	120	4.0	ESC685M063AC3(1)
63	79	10	5 x 11	9	1.850	140	6.0	ESC106M063AC3(1)
63	79	15	5 x 11	9	1.700	200	9.0	ESC156M063AC3(1)
63	79	22	6.3 x 11	9	1.200	250	14.0	ESC226M063AE3(1)
63	79	33	6.3 x 11	9	0.900	300	21.0	ESC336M063AE3(1)
63	79	47	8 x 11	9	0.700	450	30.0	ESC476M063AG3(1)
VDC	VDC Surge	Rated Capacitance	Case Size	DF	Z	RC	LC	Part Number

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

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



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 %)1	Z 100 kHZ 20°C (Ω)	RC 100 kHz 105°C (mA)	LC 20°C 2 Minutes (µA)	Part Number
63	79	68	8 x 11	9	0.520	550	43.0	ESC686M063AG3(1)
63	79	100	8 x 20	9	0.350	650	63.0	ESC107M063AG6(1)
63	79	120	10 x 16	9	0.300	800	76.0	ESC127M063AH8(1)
63	79	150	10 x 16	9	0.200	1050	94.0	ESC157M063AH8(1)
63	79	220	10 x 20	9	0.150	1300	139.0	ESC227M063AH4(1)
63	79	330	13 x 20	9	0.100	1400	208.0	ESC337M063AL3(1)
63	79	470	13 x 25	9	0.064	1550	296.0	ESC477M063AL4(1)
63	79	680	16 x 25	9	0.052	1700	428.0	ESC687M063AM7(1)
63	79	820	16 x 32	9	0.048	1900	517.0	ESC827M063AM2(1)
63	79	1000	16 x 32	9	0.042	2100	630.0	ESC108M063AM2(1)
63	79	1200	16 x 36	9	0.036	2550	756.0	ESC128M063AM3(1)
63	79	1500	18 x 36	9	0.033	2800	945.0	ESC158M063AN2(1)
100	125	4.7	5 x 11	8	2.000	120	5.0	ESC475M100AC3(1)
100	125	6.8	5 x 11	8	1.850	140	7.0	ESC685M100AC3(1)
100	125	10	6.3 x 11	8	1.500	200	10.0	ESC106M100AE3(1)
100	125	15	6.3 x 11	8	1.200	250	15.0	ESC156M100AE3(1)
100	125	22	8 x 11	8	0.790	300	22.0	ESC226M100AG3(1)
100	125	33	8 x 15	8	0.590	450	33.0	ESC336M100AG4(1)
100	125	47	10 x 16	8	0.350	550	47.0	ESC476M100AH8(1)
100	125	68	10 x 20	8	0.240	650	68.0	ESC686M100AH4(1)
100	125	100	13 x 20	8	0.180	800	100.0	ESC107M100AL3(1)
100	125	120	13 x 25	8	0.150	1050	120.0	ESC127M100AL4(1)
100	125	150	13 x 25	8	0.110	1300	150.0	ESC157M100AL4(1)
100	125	220	16 x 25	8	0.071	1400	220.0	ESC227M100AM7(1)
100	125	330	16 x 32	8	0.049	1550	330.0	ESC337M100AM2(1)
100	125	470	18 x 36	8	0.038	1700	470.0	ESC477M100AN2(1)
VDC	VDC Surge	Rated Capacitance	Case Size	DF	Z	RC	LC	Part Number

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

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



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 to ≤ 40 mm	> 3 mm			
> 40 mm	> 5 mm			

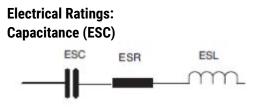
It is recommended that capacitors always be mounted with the safety device uppermost or in the upper part of the capacitor.

- 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 k Ω for capacitors with V_R ≤ 160 V (5 W resistor) and 10 k Ω 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



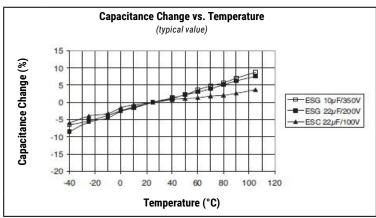
Simplified equivalent circuit diagram of an electrolytic capacitor

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.

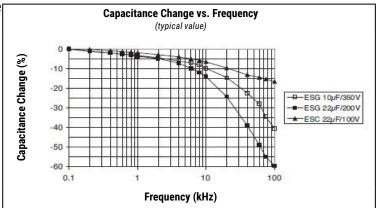
Capacitance will decrease if temperature decreases. Furthermore, temperature drifts cause armature dilatation and, therefore, capacitance changes (up to 20% depending on the series considered, from 0 to 80°C). This phenomenon is more evident for electrolytic capacitors than for other types.



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.

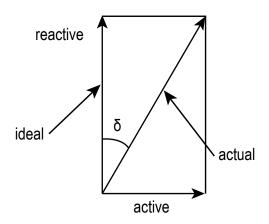
$$C = \frac{1}{2\pi fZ} \begin{cases} C = Capacitance (F) \\ f = Frequency (Hz) \\ Z = Impedance (\Omega) \end{cases}$$





Dissipation Factor tan δ (DF)

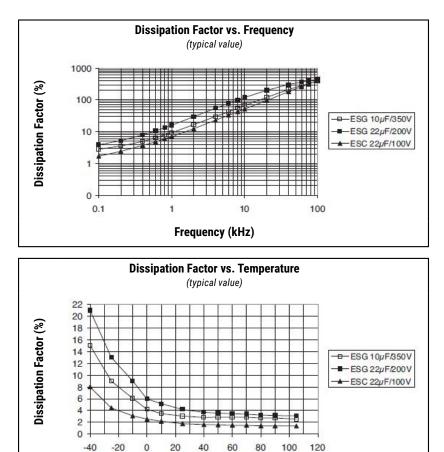
Dissipation Factor tan δ is the ratio between the active and reactive power for a sinusoidal waveform voltage. It can be thought of as a measurement of the gap between an actual and ideal capacitor.



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

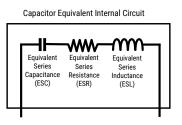


Temperature (°C)



Equivalent Series Inductance (ESL)

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

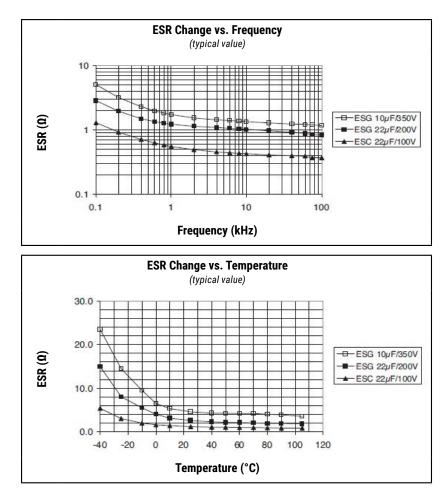


Equivalent Series Resistance (ESR)

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:

 $ESR = \frac{\tan \delta}{2\pi f ESC}$ $ESR = Equivalent Series Resistance (\Omega)$ $\tan \delta = Dissipation Factor$ ESC = Equivalent Series Capacitance (F) f = Frequency (Hz)

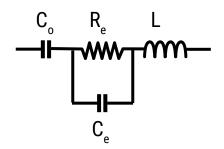
Tolerance limits of the rated capacitance must be taken into account when calculating this value.





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)

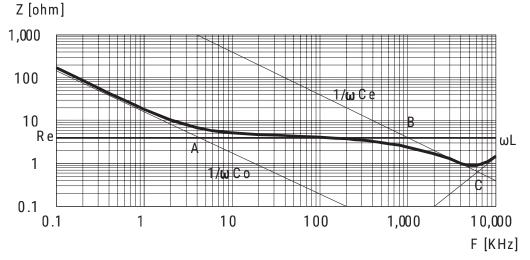
R_e = Resistance of electrolyte and paper mixture (other resistances not depending on the frequency are not considered: tabs, plates, etc.)

C = 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:



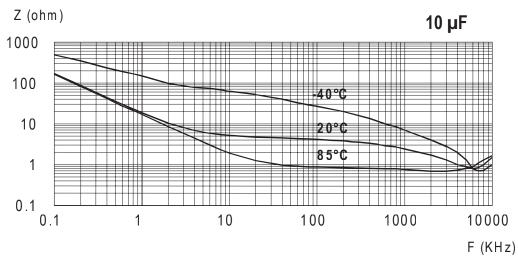
- · Capacitive reactance predominates at low frequencies
- With increasing frequency, capacitive reactance $Xc = 1/\omega C_{o}$ decreases until it reaches the order of magnitude of electrolyte resistance $R_{o}(A)$
- At even higher frequencies, resistance of the electrolyte predominates: Z = R (A B)
- 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 $C_{\rho} \approx 0.01 C_{o}$.



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, 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.



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 δ or ESR
- Frequency

The capacitor's life depends on the thermal stress.

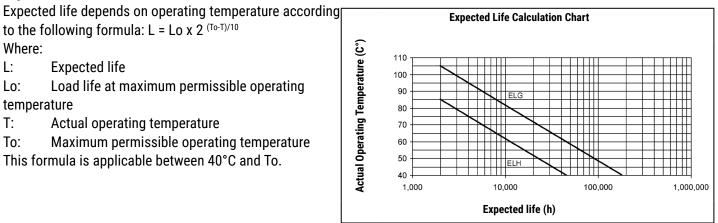
Frequency Dependence of the Ripple Current

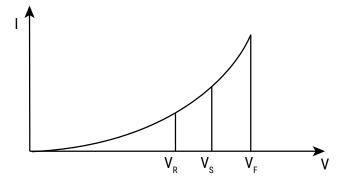
ESR and, thus, the tan δ depend on the frequency of the applied voltage. This indicates that the allowed ripple current is also a function of the frequency.

Temperature Dependence of the Ripple Current

The data sheet specifies maximum ripple current at the upper category temperature for each capacitor.

Expected Life Calculation





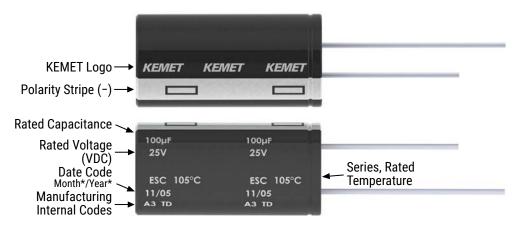


Packaging Quantities

			Βι	ılk	Auto-insertion			
Size Code	Diameter (mm)	Length (mm)	Standard Leads	Cut Leads	Ammo	Tape & Reel		
C3	5	11	10000	15000	2000	2600		
E3	6.3	11	10000	15000	2000	2200		
G3	8	11	6000	8000	1000	1500		
G4	8	15	5000	5000	1000	1500		
G6	8	20	4000	4000	1000	1500		
Н9	10	12.5	4000	4000	700	1200		
H8	10	16	3000	4000	700	1200		
H4	10	20	2400	3000	700	1200		
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	1200	500			
L7	13	40	1000	500	500			
M7	16	25	1000	500	300			
M2	16	32	800	500	300			
M3	16	36	600	500	300			
N2	18	36	500	500				
N3	18	40	500	500				



Marking



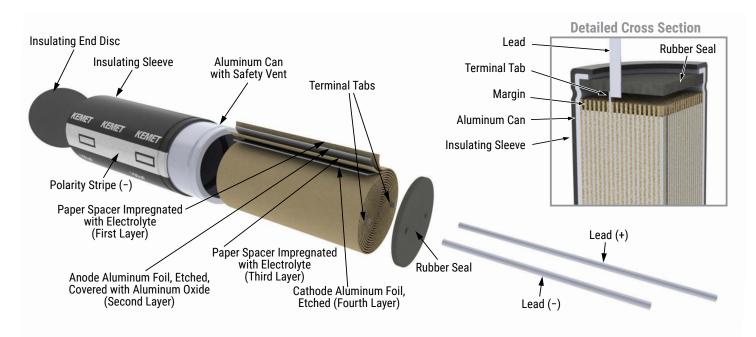
*Y = Year

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

*M = Month

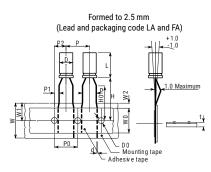
Code	01	02	03	04	05	06	07	08	09	10	11	12
Month	1	2	3	4	5	6	7	8	9	10	11	12

Construction

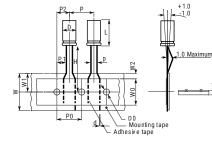


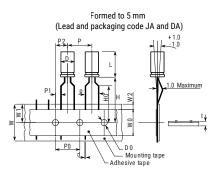


Taping for Automatic Insertion Machines

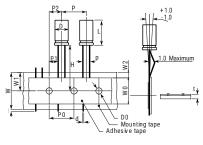


Straight Leads (Diameter: 4 – 8 mm) Lead and packaging code EA and KA





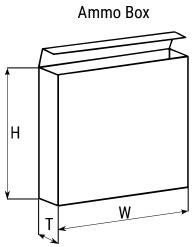
Straight Leads (Diameter > 8) Lead and packaging code EA and KA

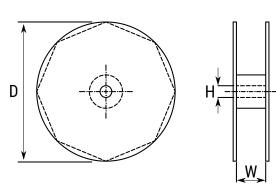


Dimensions (mm)	D	L	р	d	Р	P0	P1	P2	W	WO	W 1	W2	HO	H1	I	DO	t
Tolerance	+0.5		+0.8/-0.2	±0.05	±1 .0	±0.3	±0.7	±1.3	+1/-0.5	±0.5	Maximum	Maximum	±0.75	±0.5	Maximum	±0.2	±0.2
E a mus a d d a	4	5-7	2.5	0.45	12.7	12.7	5.1	6.35	18	12	11	3	16	18.5		4	0.7
Formed to 2.5 mm	5	≤7	2.5	0.45	12.7	12.7	5.1	6.35	18	12	11	3	16	18.5		4	0.7
2.0 mm	J	>7	2.5	0.5	12.7	12.7	5.1	6.35	18	12	11	3	16	18.5		4	0.7
	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
Formedite	5	>7	5	0.5	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
Formed to 5 mm	6	≤7	5	0.5	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
0 1111	0	>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
	0	>7	5	0.5	12.7	12.7	3.85	6.35	18	12	11	3	16	18.5		4	0.7
	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
	5	>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
	0	>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
Straight leads		>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		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
	13	15-25	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





Reel

		Ammo			Reel	
Case Size (mm)	Н	W	Т	D	Н	W
		Maximum	Maximum	±2	±0.5	+1/-0.1
4	230	340	42			
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	250	00	50
8 x 14 - 20	240	340	57	350	30	50
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	1		
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

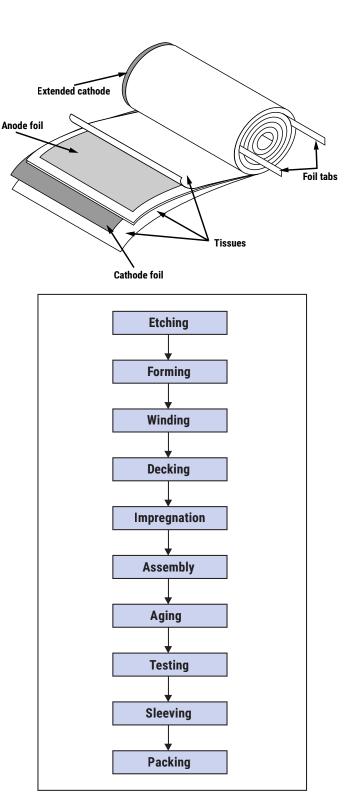
A sample from each batch is taken by the quality department after completion of the production process. This sample size is controlled by the use of recognized sampling tables defined in BS 6001.

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 Electronic Corporation Sales Offices

For a complete list of our global sales offices, please visit www.kemet.com/sales.

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.

KEMET is a registered trademark of KEMET Electronics Corporation.