Radial Aluminum Electrolytic Capacitors

# ESK Series, +85ºC

Electronic Components

KEMET CHARGED.

## Overview

KEMET's ESK Series of aluminum electrolytic radial capacitors are designed for high-density printed circuit boards.

## Applications

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

## Benefits

- Operating temperature of up to 85°C
- 2,000 hour operating life
- Case diameters 5 – 22 mm
- Safety vent on the capacitor base




## Part Number System

| ESK | 226 | M | 6R3 | | A | C3 | AA |
|---|---|---|---|---|---|---|---|
| Series | Capacitance Code (pF) | Tolerance | Rated Voltage (VDC) | | Electrical Parameters | Size Code | Packaging |
| Radial Leaded Aluminum Electrolytic | Digits 4 – 5 represent the first two digits of the capacitance value. The final digit indicates the number of zeros to be added. | M = ±20% | 6R3 = 6.3<br>010 = 10<br>016 = 16<br>025 = 25<br>035 = 35<br>050 = 50<br>063 = 63 | 100 = 100<br>160 = 160<br>200 = 200<br>250 = 250<br>350 = 350<br>400 = 400<br>450 = 450<br>500 = 500 | A = Standard | See Dimension Table | See Ordering Options Table |



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## Ordering Options Table

| Diameter | Packaging Type | Lead Type | Lead Length (mm) | Lead and Packaging Code |
|---|---|---|---|---|
| Standard Bulk Packaging Options | | | | |
| 4 – 22 | Bulk (bag) | Straight | 20/15 Minimum | AA |
| Standard Auto-Insertion Packaging Options | | | | |
| 4 – 5 | Tape & Reel | Formed to 2.5 mm | $H_0$ = 16.5 ±0.75 | LA |
| 6.3 | Tape & Reel | 2.5 mm Lead Spacing | $H_0$ = 18.5 ±0.75 | KA |
| 8 | Tape & Reel | Formed to 5 mm | $H_0$ = 16.5 ±0.75 | JA |
| 10 – 13 | Ammo | 5 mm Lead Spacing | $H_0$ = 18.5 ±0.75 | EA |
| 16 | Ammo | 7.5 mm Lead Spacing | $H_0$ = 18.5 ±0.75 | EA |
| Other Packaging Options | | | | |
| 4 – 8 | Ammo | Formed to 5 mm | $H_0$ = 16.5 ±0.75 | DA |
| 10 | Ammo | 5 mm Lead Spacing | $H_0$ = 16.5 ±0.75 | DA |
| 4 – 8 | Ammo | Straight | $H_0$ = 18.5 ±0.75 | EA |
| 4 – 5 | Ammo | Formed to 2.5 mm | $H_0$ = 16.5 ±0.75 | FA |
| 4 – 6.3 | Tape & Reel | Formed to 5 mm | $H_0$ = 16.5 ±0.75 | JA |
| 4 – 5, 8 – 16 | Tape & Reel | Straight | $H_0$ = 18.5 ±0.75 | KA |
| Contact KEMET for other Lead and Packaging options | | | | |

## Environmental Compliance

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

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

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

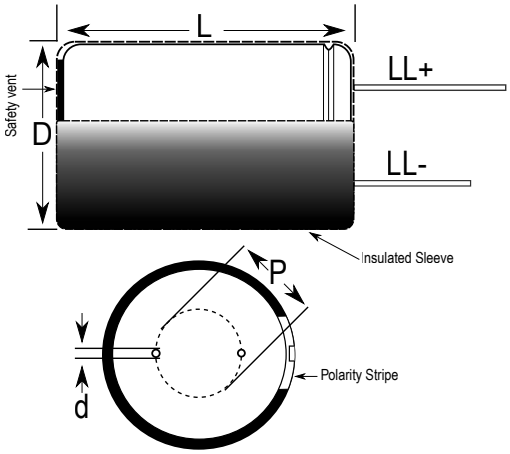



RoHS Compliant



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## 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 | 2.5 | ±0.5 | 0.5 | Nominal | 20/15 | Minimum |
| G3 | 8 | ±0.5 | 11 | +1.5/-0 | 3.5 | ±0.5 | 0.5 | Nominal | 20/15 | Minimum |
| G4 | 8 | ±0.5 | 15 | +2.0/-0 | 3.5 | ±0.5 | 0.5 | Nominal | 20/15 | Minimum |
| H1 | 10 | ±0.5 | 12 | +1.5/-0 | 5 | ±0.5 | 0.6 | Nominal | 20/15 | Minimum |
| H2 | 10 | ±0.5 | 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 |
| 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 |
| 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 |
| N4 | 18 | ±0.5 | 20 | +2.0/-0 | 7.5 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |
| N1 | 18 | ±0.5 | 32 | +2.0/-0 | 7.5 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |
| N2 | 18 | ±0.5 | 36 | +2.0/-0 | 7.5 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |
| N3 | 18 | ±0.5 | 40 | +2.0/-0 | 7.5 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |
| Q3 | 22 | ±0.5 | 35 | +2.0/-0 | 10 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |
| Q4 | 22 | ±0.5 | 40 | +2.0/-0 | 10 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |



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## Performance Characteristics

| Item | Performance Characteristics | |
|---|---|---|
| Capacitance Range | 1 – 22,000 µF | 0.47 – 470 µF |
| Capacitance Tolerance | ±20% at 120 Hz / 20°C | |
| Rated Voltage | 6.3 – 100 VDC | 160 – 450 VDC |
| Life Test | 2,000 hours (see conditions in Test Methods & Performance) | |
| Operating Temperature | -40°C to +85°C | -25°C to +85°C |
| Leakage Current | I ≤ 0.01 CV (µA) or 3 µA, whichever is greater | I = 0.03 CV (µA) + 10 µA |
| | C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 2 minutes at 20°C. | |

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

| Rated Voltage (VDC) | Capacitance Range (µF) | 50 Hz | 120 Hz | 300 Hz | 1 kHz | 10 to 100 kHz |
|---|---|---|---|---|---|---|
| 6.3 – 100 | 0.1 – 68 | 0.75 | 1.00 | 1.20 | 1.30 | 1.45 |
| 6.3 – 100 | 100 – 680 | 0.75 | 1.00 | 1.10 | 1.15 | 1.25 |
| 6.3 – 100 | 1,000 – 22,000 | 0.75 | 1.00 | 1.05 | 1.10 | 1.15 |
| 160 – 450 | 0.47 – 220 | 0.80 | 1.00 | 1.25 | 1.40 | 1.40 |
| 160 – 450 | 330 – 470 | 0.80 | 1.00 | 1.10 | 1.13 | 1.15 |

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

| Temperature | 50°C | 70°C | 85°C |
|---|---|---|---|
| Coefficient | 1.30 | 1.15 | 1.00 |

## Test Method & Performance

| Conditions | Load Life Test | Shelf Life Test |
|---|---|---|
| Temperature | 85°C | 85°C |
| Test Duration | 2,000 hours | 1,000 hours |
| Ripple Current | Maximum ripple current specified at 120 Hz 85°C | No ripple current applied |
| Voltage | The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor. | No voltage applied |
| **Performance** | **The following specifications will be satisfied when the capacitor is restored to 20°C:** | |
| Capacitance Change | Within ±20% of the initial value | |
| Dissipation Factor | Does not exceed 200% of the specified value | |
| Leakage Current | Does not exceed specified value | |



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## 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 25°C (tan δ %)* | RC 120 Hz 85°C (mA) | Part Number |
|---|---|---|---|---|---|---|
| 6.3 | 8 | 22 | 5 x 11 | 22 | 35 | ESK226M6R3AC3(1) |
| 6.3 | 8 | 33 | 5 x 11 | 22 | 55 | ESK336M6R3AC3(1) |
| 6.3 | 8 | 47 | 5 x 11 | 22 | 75 | ESK476M6R3AC3(1) |
| 6.3 | 8 | 100 | 5 x 11 | 22 | 130 | ESK107M6R3AC3(1) |
| 6.3 | 8 | 220 | 5 x 11 | 22 | 200 | ESK227M6R3AC3(1) |
| 6.3 | 8 | 220 | 6 x 11 | 22 | 240 | ESK227M6R3AE3(1) |
| 6.3 | 8 | 330 | 6 x 11 | 22 | 260 | ESK337M6R3AE3(1) |
| 6.3 | 8 | 330 | 8 x 11 | 22 | 300 | ESK337M6R3AG3(1) |
| 6.3 | 8 | 470 | 6 x 11 | 22 | 330 | ESK477M6R3AE3(1) |
| 6.3 | 8 | 470 | 8 x 11 | 22 | 380 | ESK477M6R3AG3(1) |
| 6.3 | 8 | 1000 | 8 x 11 | 22 | 460 | ESK108M6R3AG3(1) |
| 6.3 | 8 | 1000 | 10 x 12 | 22 | 580 | ESK108M6R3AH1(1) |
| 6.3 | 8 | 2200 | 10 x 20 | 22 | 840 | ESK228M6R3AH4(1) |
| 6.3 | 8 | 2200 | 13 x 20 | 22 | 1050 | ESK228M6R3AL3(1) |
| 6.3 | 8 | 3300 | 10 x 20 | 22 | 1000 | ESK338M6R3AH4(1) |
| 6.3 | 8 | 3300 | 13 x 20 | 22 | 1250 | ESK338M6R3AL3(1) |
| 6.3 | 8 | 4700 | 13 x 20 | 22 | 1300 | ESK478M6R3AL3(1) |
| 6.3 | 8 | 4700 | 16 x 25 | 22 | 1700 | ESK478M6R3AM7(1) |
| 6.3 | 8 | 6800 | 16 x 25 | 22 | 1900 | ESK688M6R3AM7(1) |
| 6.3 | 8 | 10000 | 16 x 25 | 22 | 1900 | ESK109M6R3AM7(1) |
| 6.3 | 8 | 10000 | 16 x 32 | 22 | 2250 | ESK109M6R3AM2(1) |
| 6.3 | 8 | 15000 | 16 x 36 | 22 | 2500 | ESK159M6R3AM3(1) |
| 6.3 | 8 | 15000 | 18 x 36 | 22 | 2880 | ESK159M6R3AN2(1) |
| 6.3 | 8 | 22000 | 18 x 40 | 22 | 3650 | ESK229M6R3AN3(1) |
| 10 | 13 | 4.7 | 5 x 11 | 19 | 20 | ESK475M010AC3(1) |
| 10 | 13 | 10 | 5 x 11 | 19 | 35 | ESK106M010AC3(1) |
| 10 | 13 | 22 | 5 x 11 | 19 | 55 | ESK226M010AC3(1) |
| 10 | 13 | 33 | 5 x 11 | 19 | 80 | ESK336M010AC3(1) |
| 10 | 13 | 47 | 5 x 11 | 19 | 95 | ESK476M010AC3(1) |
| 10 | 13 | 100 | 5 x 11 | 19 | 180 | ESK107M010AC3(1) |
| 10 | 13 | 220 | 5 x 11 | 19 | 230 | ESK227M010AC3(1) |
| 10 | 13 | 220 | 6 x 11 | 19 | 250 | ESK227M010AE3(1) |
| 10 | 13 | 330 | 8 x 11 | 19 | 330 | ESK337M010AG3(1) |
| 10 | 13 | 470 | 6 x 11 | 19 | 360 | ESK477M010AE3(1) |
| 10 | 13 | 470 | 8 x 11 | 19 | 400 | ESK477M010AG3(1) |
| 10 | 13 | 680 | 8 x 15 | 19 | 430 | ESK687M010AG4(1) |
| 10 | 13 | 680 | 10 x 16 | 19 | 460 | ESK687M010AH2(1) |
| 10 | 13 | 1000 | 10 x 12 | 19 | 580 | ESK108M010AH1(1) |
| 10 | 13 | 1000 | 10 x 16 | 19 | 630 | ESK108M010AH2(1) |
| 10 | 13 | 2200 | 10 x 20 | 19 | 880 | ESK228M010AH4(1) |
| 10 | 13 | 2200 | 13 x 20 | 19 | 1100 | ESK228M010AL3(1) |
| 10 | 13 | 3300 | 13 x 20 | 19 | 1250 | ESK338M010AL3(1) |
| 10 | 13 | 3300 | 13 x 25 | 19 | 1400 | ESK338M010AL4(1) |
| 10 | 13 | 4700 | 13 x 25 | 19 | 1500 | ESK478M010AL4(1) |
| 10 | 13 | 4700 | 16 x 25 | 19 | 1800 | ESK478M010AM7(1) |
| 10 | 13 | 6800 | 16 x 25 | 19 | 1900 | ESK688M010AM7(1) |
| 10 | 13 | 6800 | 16 x 32 | 19 | 2150 | ESK688M010AM2(1) |
| 10 | 13 | 10000 | 16 x 36 | 19 | 2500 | ESK109M010AM3(1) |
| 10 | 13 | 10000 | 18 x 36 | 19 | 2500 | ESK109M010AN2(1) |
| 10 | 13 | 15000 | 18 x 36 | 19 | 2950 | ESK159M010AN2(1) |
| 10 | 13 | 22000 | 22 x 40 | 19 | 3700 | ESK229M010AQ4(1) |
| 16 | 20 | 1.0 | 5 x 11 | 16 | 9.3 | ESK105M016AC3(1) |
| 16 | 20 | 4.7 | 5 x 11 | 16 | 25 | ESK475M016AC3(1) |
| 16 | 20 | 10 | 5 x 11 | 16 | 40 | ESK106M016AC3(1) |
| 16 | 20 | 22 | 5 x 11 | 16 | 75 | ESK226M016AC3(1) |
| 16 | 20 | 33 | 5 x 11 | 16 | 110 | ESK336M016AC3(1) |
| 16 | 20 | 47 | 5 x 11 | 16 | 130 | ESK476M016AC3(1) |
| 16 | 20 | 100 | 5 x 11 | 16 | 185 | ESK107M016AC3(1) |
| 16 | 20 | 100 | 6 x 11 | 16 | 185 | ESK107M016AE3(1) |
| 16 | 20 | 220 | 6 x 11 | 16 | 320 | ESK227M016AE3(1) |
| **VDC** | **VDC Surge** | **Rated Capacitance** | **Case Size** | **DF** | **RC** | **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.*



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## 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 25°C (tan δ %)* | RC 120 Hz 85°C (mA) | Part Number |
|---|---|---|---|---|---|---|
| 16 | 20 | 220 | 8 x 11 | 16 | 320 | ESK227M016AG3(1) |
| 16 | 20 | 330 | 8 x 11 | 16 | 360 | ESK337M016AG3(1) |
| 16 | 20 | 470 | 8 x 11 | 16 | 400 | ESK477M016AG3(1) |
| 16 | 20 | 470 | 10 x 12 | 16 | 470 | ESK477M016AH1(1) |
| 16 | 20 | 680 | 10 x 16 | 16 | 560 | ESK687M016AH2(1) |
| 16 | 20 | 1000 | 10 x 16 | 16 | 630 | ESK108M016AH2(1) |
| 16 | 20 | 1000 | 10 x 20 | 16 | 790 | ESK108M016AH4(1) |
| 16 | 20 | 2200 | 13 x 20 | 16 | 1100 | ESK228M016AL3(1) |
| 16 | 20 | 2200 | 13 x 25 | 16 | 1350 | ESK228M016AL4(1) |
| 16 | 20 | 3300 | 13 x 25 | 16 | 1400 | ESK338M016AL4(1) |
| 16 | 20 | 3300 | 16 x 25 | 16 | 1700 | ESK338M016AM7(1) |
| 16 | 20 | 4700 | 16 x 25 | 16 | 1800 | ESK478M016AM7(1) |
| 16 | 20 | 4700 | 16 x 32 | 16 | 2100 | ESK478M016AM2(1) |
| 16 | 20 | 6800 | 16 x 36 | 16 | 2200 | ESK688M016AM3(1) |
| 16 | 20 | 6800 | 18 x 36 | 16 | 2500 | ESK688M016AN2(1) |
| 16 | 20 | 10000 | 18 x 36 | 16 | 2700 | ESK109M016AN2(1) |
| 16 | 20 | 15000 | 22 x 40 | 16 | 3150 | ESK159M016AQ4(1) |
| 16 | 20 | 22000 | 22 x 40 | 16 | 3800 | ESK229M016AQ4(1) |
| 25 | 32 | 4.7 | 5 x 11 | 14 | 30 | ESK475M025AC3(1) |
| 25 | 32 | 10 | 5 x 11 | 14 | 50 | ESK106M025AC3(1) |
| 25 | 32 | 22 | 5 x 11 | 14 | 90 | ESK226M025AC3(1) |
| 25 | 32 | 33 | 5 x 11 | 14 | 115 | ESK336M025AC3(1) |
| 25 | 32 | 47 | 5 x 11 | 14 | 135 | ESK476M025AC3(1) |
| 25 | 32 | 100 | 6 x 11 | 14 | 200 | ESK107M025AE3(1) |
| 25 | 32 | 220 | 8 x 11 | 14 | 290 | ESK227M025AG3(1) |
| 25 | 32 | 220 | 10 x 12 | 14 | 340 | ESK227M025AH1(1) |
| 25 | 32 | 330 | 8 x 15 | 14 | 380 | ESK337M025AG4(1) |
| 25 | 32 | 330 | 10 x 12 | 14 | 420 | ESK337M025AH1(1) |
| 25 | 32 | 330 | 10 x 16 | 14 | 420 | ESK337M025AH2(1) |
| 25 | 32 | 470 | 10 x 12 | 14 | 460 | ESK477M025AH1(1) |
| 25 | 32 | 470 | 10 x 16 | 14 | 540 | ESK477M025AH2(1) |
| 25 | 32 | 1000 | 10 x 20 | 14 | 760 | ESK108M025AH4(1) |
| 25 | 32 | 1000 | 13 x 20 | 14 | 950 | ESK108M025AL3(1) |
| 25 | 32 | 2200 | 13 x 25 | 14 | 1300 | ESK228M025AL4(1) |
| 25 | 32 | 2200 | 16 x 25 | 14 | 1550 | ESK228M025AM7(1) |
| 25 | 32 | 3300 | 16 x 25 | 14 | 1660 | ESK338M025AM7(1) |
| 25 | 32 | 3300 | 16 x 32 | 14 | 1950 | ESK338M025AM2(1) |
| 25 | 32 | 4700 | 16 x 32 | 14 | 1950 | ESK478M025AM2(1) |
| 25 | 32 | 4700 | 18 x 36 | 14 | 2360 | ESK478M025AN2(1) |
| 25 | 32 | 6800 | 18 x 36 | 14 | 2550 | ESK688M025AN2(1) |
| 25 | 32 | 10000 | 22 x 40 | 14 | 2800 | ESK109M025AQ4(1) |
| 25 | 32 | 15000 | 22 x 40 | 14 | 3200 | ESK159M025AQ4(1) |
| 35 | 44 | 4.7 | 5 x 11 | 12 | 35 | ESK475M035AC3(1) |
| 35 | 44 | 10 | 5 x 11 | 12 | 60 | ESK106M035AC3(1) |
| 35 | 44 | 22 | 5 x 11 | 12 | 95 | ESK226M035AC3(1) |
| 35 | 44 | 33 | 5 x 11 | 12 | 120 | ESK336M035AC3(1) |
| 35 | 44 | 47 | 5 x 11 | 12 | 120 | ESK476M035AC3(1) |
| 35 | 44 | 47 | 6 x 11 | 12 | 140 | ESK476M035AE3(1) |
| 35 | 44 | 100 | 6 x 11 | 12 | 200 | ESK107M035AE3(1) |
| 35 | 44 | 100 | 8 x 11 | 12 | 230 | ESK107M035AG3(1) |
| 35 | 44 | 220 | 8 x 11 | 12 | 290 | ESK227M035AG3(1) |
| 35 | 44 | 220 | 10 x 12 | 12 | 370 | ESK227M035AH1(1) |
| 35 | 44 | 330 | 10 x 12 | 12 | 420 | ESK337M035AH1(1) |
| 35 | 44 | 330 | 10 x 16 | 12 | 490 | ESK337M035AH2(1) |
| 35 | 44 | 470 | 10 x 16 | 12 | 480 | ESK477M035AH2(1) |
| 35 | 44 | 470 | 10 x 20 | 12 | 510 | ESK477M035AH4(1) |
| 35 | 44 | 470 | 13 x 20 | 12 | 640 | ESK477M035AL3(1) |
| 35 | 44 | 1000 | 13 x 20 | 12 | 950 | ESK108M035AL3(1) |
| 35 | 44 | 1000 | 13 x 25 | 12 | 1100 | ESK108M035AL4(1) |
| 35 | 44 | 2200 | 16 x 25 | 12 | 1600 | ESK228M035AM7(1) |
| **VDC** | **VDC Surge** | **Rated Capacitance** | **Case Size** | **DF** | **RC** | **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.*



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## 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 25°C (tan δ %)* | RC 120 Hz 85°C (mA) | Part Number |
|---|---|---|---|---|---|---|
| 35 | 44 | 2200 | 16 x 32 | 12 | 1800 | ESK228M035AM2(1) |
| 35 | 44 | 3300 | 16 x 36 | 12 | 1970 | ESK338M035AM3(1) |
| 35 | 44 | 3300 | 18 x 36 | 12 | 2220 | ESK338M035AN2(1) |
| 35 | 44 | 4700 | 18 x 36 | 12 | 2400 | ESK478M035AN2(1) |
| 35 | 44 | 6800 | 22 x 40 | 12 | 2600 | ESK688M035AQ4(1) |
| 50 | 63 | 0.1 | 5 x 11 | 10 | 1 | ESK104M050AC3(1) |
| 50 | 63 | 0.22 | 5 x 11 | 10 | 2 | ESK224M050AC3(1) |
| 50 | 63 | 0.33 | 5 x 11 | 10 | 3 | ESK334M050AC3(1) |
| 50 | 63 | 0.47 | 5 x 11 | 10 | 5 | ESK474M050AC3(1) |
| 50 | 63 | 1 | 5 x 11 | 10 | 10 | ESK105M050AC3(1) |
| 50 | 63 | 2.2 | 5 x 11 | 10 | 23 | ESK225M050AC3(1) |
| 50 | 63 | 3.3 | 5 x 11 | 10 | 35 | ESK335M050AC3(1) |
| 50 | 63 | 4.7 | 5 x 11 | 10 | 40 | ESK475M050AC3(1) |
| 50 | 63 | 10 | 5 x 11 | 10 | 65 | ESK106M050AC3(1) |
| 50 | 63 | 22 | 5 x 11 | 10 | 100 | ESK226M050AC3(1) |
| 50 | 63 | 33 | 6 x 11 | 10 | 125 | ESK336M050AE3(1) |
| 50 | 63 | 47 | 6 x 11 | 10 | 140 | ESK476M050AE3(1) |
| 50 | 63 | 47 | 8 x 11 | 10 | 150 | ESK476M050AG3(1) |
| 50 | 63 | 100 | 8 x 11 | 10 | 230 | ESK107M050AG3(1) |
| 50 | 63 | 100 | 10 x 12 | 10 | 250 | ESK107M050AH1(1) |
| 50 | 63 | 220 | 10 x 12 | 10 | 360 | ESK227M050AH1(1) |
| 50 | 63 | 220 | 10 x 16 | 10 | 440 | ESK227M050AH2(1) |
| 50 | 63 | 330 | 10 x 16 | 10 | 490 | ESK337M050AH2(1) |
| 50 | 63 | 330 | 10 x 20 | 10 | 580 | ESK337M050AH4(1) |
| 50 | 63 | 470 | 10 x 20 | 10 | 610 | ESK477M050AH4(1) |
| 50 | 63 | 470 | 13 x 20 | 10 | 760 | ESK477M050AL3(1) |
| 50 | 63 | 1000 | 13 x 25 | 10 | 1100 | ESK108M050AL4(1) |
| 50 | 63 | 1000 | 16 x 25 | 10 | 1350 | ESK108M050AM7(1) |
| 50 | 63 | 2200 | 16 x 36 | 10 | 1850 | ESK228M050AM3(1) |
| 50 | 63 | 2200 | 18 x 36 | 10 | 2090 | ESK228M050AN2(1) |
| 50 | 63 | 3300 | 18 x 36 | 10 | 2170 | ESK338M050AN2(1) |
| 50 | 63 | 3300 | 18 x 40 | 10 | 2400 | ESK338M050AN3(1) |
| 50 | 63 | 4700 | 22 x 35 | 10 | 2500 | ESK478M050AQ3(1) |
| 50 | 63 | 4700 | 22 x 40 | 10 | 2500 | ESK478M050AQ4(1) |
| 63 | 79 | 0.47 | 5 x 11 | 9 | 5 | ESK474M063AC3(1) |
| 63 | 79 | 1.0 | 5 x 11 | 9 | 10 | ESK105M063AC3(1) |
| 63 | 79 | 2.2 | 5 x 11 | 9 | 29 | ESK225M063AC3(1) |
| 63 | 79 | 3.3 | 5 x 11 | 9 | 40 | ESK335M063AC3(1) |
| 63 | 79 | 4.7 | 5 x 11 | 9 | 45 | ESK475M063AC3(1) |
| 63 | 79 | 10 | 5 x 11 | 9 | 70 | ESK106M063AC3(1) |
| 63 | 79 | 22 | 6 x 11 | 9 | 115 | ESK226M063AE3(1) |
| 63 | 79 | 33 | 6 x 11 | 9 | 130 | ESK336M063AE3(1) |
| 63 | 79 | 33 | 8 x 11 | 9 | 140 | ESK336M063AG3(1) |
| 63 | 79 | 47 | 6 x 11 | 9 | 190 | ESK476M063AE3(1) |
| 63 | 79 | 47 | 8 x 11 | 9 | 190 | ESK476M063AG3(1) |
| 63 | 79 | 100 | 10 x 12 | 9 | 300 | ESK107M063AH1(1) |
| 63 | 79 | 220 | 10 x 16 | 9 | 410 | ESK227M063AH2(1) |
| 63 | 79 | 220 | 10 x 20 | 9 | 490 | ESK227M063AH4(1) |
| 63 | 79 | 330 | 10 x 20 | 9 | 540 | ESK337M063AH4(1) |
| 63 | 79 | 330 | 13 x 20 | 9 | 680 | ESK337M063AL3(1) |
| 63 | 79 | 470 | 13 x 25 | 9 | 880 | ESK477M063AL4(1) |
| 63 | 79 | 1000 | 16 x 25 | 9 | 1310 | ESK108M063AM7(1) |
| 63 | 79 | 1000 | 16 x 32 | 9 | 1550 | ESK108M063AM2(1) |
| 63 | 79 | 2200 | 18 x 40 | 9 | 2200 | ESK228M063AN3(1) |
| 63 | 79 | 3300 | 22 x 40 | 9 | 2500 | ESK338M063AQ4(1) |
| 100 | 125 | 1.0 | 5 x 11 | 8 | 21 | ESK105M100AC3(1) |
| 100 | 125 | 2.2 | 5 x 11 | 8 | 30 | ESK225M100AC3(1) |
| 100 | 125 | 3.3 | 5 x 11 | 8 | 45 | ESK335M100AC3(1) |
| 100 | 125 | 4.7 | 5 x 11 | 8 | 50 | ESK475M100AC3(1) |
| 100 | 125 | 10 | 6 x 11 | 8 | 75 | ESK106M100AE3(1) |
| **VDC** | **VDC Surge** | **Rated Capacitance** | **Case Size** | **DF** | **RC** | **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.*



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## 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 25°C (tan δ %)* | RC 120 Hz 85°C (mA) | Part Number |
|---|---|---|---|---|---|---|
| 100 | 125 | 22 | 8 x 11 | 8 | 130 | ESK226M100AG3(1) |
| 100 | 125 | 33 | 8 x 11 | 8 | 140 | ESK336M100AG3(1) |
| 100 | 125 | 33 | 10 x 12 | 8 | 170 | ESK336M100AH1(1) |
| 100 | 125 | 47 | 10 x 12 | 8 | 190 | ESK476M100AH1(1) |
| 100 | 125 | 47 | 10 x 16 | 8 | 230 | ESK476M100AH2(1) |
| 100 | 125 | 100 | 10 x 20 | 8 | 400 | ESK107M100AH4(1) |
| 100 | 125 | 220 | 13 x 25 | 8 | 710 | ESK227M100AL4(1) |
| 100 | 125 | 330 | 13 x 25 | 8 | 720 | ESK337M100AL4(1) |
| 100 | 125 | 330 | 16 x 25 | 8 | 860 | ESK337M100AM7(1) |
| 100 | 125 | 470 | 16 x 25 | 8 | 1100 | ESK477M100AM7(1) |
| 100 | 125 | 1000 | 16 x 32 | 8 | 1350 | ESK108M100AM2(1) |
| 100 | 125 | 1000 | 18 x 40 | 8 | 1680 | ESK108M100AN3(1) |
| 100 | 125 | 2200 | 22 x 40 | 8 | 2300 | ESK228M100AQ4(1) |
| 160 | 200 | 0.47 | 5 x 11 | 15 | 12 | ESK474M160AC3(1) |
| 160 | 200 | 1.0 | 5 x 11 | 15 | 17 | ESK105M160AC3(1) |
| 160 | 200 | 2.2 | 6 x 11 | 15 | 26 | ESK225M160AE3(1) |
| 160 | 200 | 3.3 | 6 x 11 | 15 | 30 | ESK335M160AE3(1) |
| 160 | 200 | 3.3 | 8 x 11 | 15 | 35 | ESK335M160AG3(1) |
| 160 | 200 | 4.7 | 6 x 11 | 15 | 32 | ESK475M160AE3(1) |
| 160 | 200 | 4.7 | 8 x 11 | 15 | 40 | ESK475M160AG3(1) |
| 160 | 200 | 10 | 8 x 11 | 15 | 50 | ESK106M160AG3(1) |
| 160 | 200 | 10 | 10 x 12 | 15 | 65 | ESK106M160AH1(1) |
| 160 | 200 | 22 | 10 x 16 | 15 | 110 | ESK226M160AH2(1) |
| 160 | 200 | 33 | 10 x 20 | 15 | 150 | ESK336M160AH4(1) |
| 160 | 200 | 47 | 13 x 20 | 15 | 180 | ESK476M160AL3(1) |
| 160 | 200 | 100 | 13 x 25 | 15 | 250 | ESK107M160AL4(1) |
| 160 | 200 | 100 | 16 x 25 | 15 | 300 | ESK107M160AM7(1) |
| 160 | 200 | 220 | 16 x 32 | 15 | 450 | ESK227M160AM2(1) |
| 160 | 200 | 220 | 16 x 36 | 15 | 510 | ESK227M160AM3(1) |
| 160 | 200 | 330 | 18 x 36 | 15 | 540 | ESK337M160AN2(1) |
| 160 | 200 | 330 | 18 x 40 | 15 | 600 | ESK337M160AN3(1) |
| 160 | 200 | 470 | 22 x 40 | 15 | 900 | ESK477M160AQ4(1) |
| 200 | 250 | 0.47 | 5 x 11 | 15 | 14 | ESK474M200AC3(1) |
| 200 | 250 | 1.0 | 5 x 11 | 15 | 19 | ESK105M200AC3(1) |
| 200 | 250 | 2.2 | 6 x 11 | 15 | 22 | ESK225M200AE3(1) |
| 200 | 250 | 2.2 | 8 x 11 | 15 | 27 | ESK225M200AG3(1) |
| 200 | 250 | 3.3 | 6 x 11 | 15 | 30 | ESK335M200AE3(1) |
| 200 | 250 | 3.3 | 8 x 11 | 15 | 37 | ESK335M200AG3(1) |
| 200 | 250 | 4.7 | 8 x 11 | 15 | 36 | ESK475M200AG3(1) |
| 200 | 250 | 4.7 | 10 x 12 | 15 | 45 | ESK475M200AH1(1) |
| 200 | 250 | 10 | 10 x 12 | 15 | 57 | ESK106M200AH1(1) |
| 200 | 250 | 10 | 10 x 16 | 15 | 70 | ESK106M200AH2(1) |
| 200 | 250 | 22 | 10 x 16 | 15 | 120 | ESK226M200AH2(1) |
| 200 | 250 | 33 | 10 x 20 | 15 | 160 | ESK336M200AH4(1) |
| 200 | 250 | 47 | 13 x 20 | 15 | 160 | ESK476M200AL3(1) |
| 200 | 250 | 47 | 13 x 25 | 15 | 190 | ESK476M200AL4(1) |
| 200 | 250 | 100 | 16 x 25 | 15 | 330 | ESK107M200AM7(1) |
| 200 | 250 | 220 | 18 x 32 | 15 | 600 | ESK227M200AN1(1) |
| 200 | 250 | 220 | 18 x 36 | 15 | 600 | ESK227M200AN2(1) |
| 200 | 250 | 330 | 18 x 36 | 15 | 800 | ESK337M200AN2(1) |
| 200 | 250 | 330 | 18 x 40 | 15 | 800 | ESK337M200AN3(1) |
| 200 | 250 | 470 | 18 x 40 | 15 | 1000 | ESK477M200AN3(1) |
| 250 | 300 | 0.47 | 5 x 11 | 15 | 14 | ESK474M250AC3(1) |
| 250 | 300 | 1.0 | 6 x 11 | 15 | 19 | ESK105M250AE3(1) |
| 250 | 300 | 2.2 | 6 x 11 | 15 | 24 | ESK225M250AE3(1) |
| 250 | 300 | 2.2 | 8 x 11 | 15 | 30 | ESK225M250AG3(1) |
| 250 | 300 | 3.3 | 8 x 11 | 15 | 30 | ESK335M250AG3(1) |
| 250 | 300 | 3.3 | 10 x 12 | 15 | 38 | ESK335M250AH1(1) |
| 250 | 300 | 4.7 | 8 x 11 | 15 | 36 | ESK475M250AG3(1) |
| 250 | 300 | 4.7 | 10 x 12 | 15 | 45 | ESK475M250AH1(1) |
| **VDC** | **VDC Surge** | **Rated Capacitance** | **Case Size** | **DF** | **RC** | **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.*



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## 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 25°C (tan δ %)* | RC 120 Hz 85°C (mA) | Part Number |
|---|---|---|---|---|---|---|
| 250 | 300 | 10 | 10 x 12 | 15 | 70 | ESK106M250AH1(1) |
| 250 | 300 | 10 | 10 x 16 | 15 | 70 | ESK106M250AH2(1) |
| 250 | 300 | 22 | 10 x 20 | 15 | 130 | ESK226M250AH4(1) |
| 250 | 300 | 33 | 13 x 20 | 15 | 140 | ESK336M250AL3(1) |
| 250 | 300 | 33 | 13 x 25 | 15 | 160 | ESK336M250AL4(1) |
| 250 | 300 | 47 | 13 x 25 | 15 | 210 | ESK476M250AL4(1) |
| 250 | 300 | 100 | 16 x 32 | 15 | 310 | ESK107M250AM2(1) |
| 250 | 300 | 220 | 18 x 40 | 15 | 600 | ESK227M250AN3(1) |
| 350 | 400 | 0.47 | 5 x 11 | 20 | 14 | ESK474M350AC3(1) |
| 350 | 400 | 1.0 | 6 x 11 | 20 | 19 | ESK105M350AE3(1) |
| 350 | 400 | 2.2 | 8 x 11 | 20 | 33 | ESK225M350AG3(1) |
| 350 | 400 | 3.3 | 8 x 11 | 20 | 33 | ESK335M350AG3(1) |
| 350 | 400 | 3.3 | 10 x 12 | 20 | 39 | ESK335M350AH1(1) |
| 350 | 400 | 4.7 | 10 x 12 | 20 | 39 | ESK475M350AH1(1) |
| 350 | 400 | 4.7 | 10 x 16 | 20 | 45 | ESK475M350AH2(1) |
| 350 | 400 | 10 | 10 x 16 | 20 | 70 | ESK106M350AH2(1) |
| 350 | 400 | 22 | 13 x 20 | 20 | 130 | ESK226M350AL3(1) |
| 350 | 400 | 33 | 13 x 25 | 20 | 170 | ESK336M350AL4(1) |
| 350 | 400 | 47 | 16 x 25 | 20 | 220 | ESK476M350AM7(1) |
| 350 | 400 | 100 | 18 x 36 | 20 | 360 | ESK107M350AN2(1) |
| 400 | 450 | 0.47 | 6 x 11 | 20 | 14 | ESK474M400AE3(1) |
| 400 | 450 | 1.0 | 6 x 11 | 20 | 19 | ESK105M400AE3(1) |
| 400 | 450 | 1.0 | 8 x 11 | 20 | 19 | ESK105M400AG3(1) |
| 400 | 450 | 2.2 | 8 x 11 | 20 | 26 | ESK225M400AG3(1) |
| 400 | 450 | 2.2 | 10 x 12 | 20 | 33 | ESK225M400AH1(1) |
| 400 | 450 | 3.3 | 10 x 12 | 20 | 40 | ESK335M400AH1(1) |
| 400 | 450 | 4.7 | 10 x 16 | 20 | 45 | ESK475M400AH2(1) |
| 400 | 450 | 10 | 10 x 20 | 20 | 56 | ESK106M400AH4(1) |
| 400 | 450 | 10 | 13 x 20 | 20 | 70 | ESK106M400AL3(1) |
| 400 | 450 | 22 | 13 x 25 | 20 | 110 | ESK226M400AL4(1) |
| 400 | 450 | 22 | 16 x 25 | 20 | 130 | ESK226M400AM7(1) |
| 400 | 450 | 33 | 16 x 25 | 20 | 170 | ESK336M400AM7(1) |
| 400 | 450 | 33 | 18 x 20 | 20 | 130 | ESK336M400AN4(1) |
| 400 | 450 | 47 | 16 x 25 | 20 | 180 | ESK476M400AM7(1) |
| 400 | 450 | 47 | 16 x 32 | 20 | 220 | ESK476M400AM2(1) |
| 400 | 450 | 100 | 18 x 36 | 20 | 360 | ESK107M400AN2(1) |
| 450 | 500 | 0.47 | 6 x 11 | 20 | 14 | ESK474M450AE3(1) |
| 450 | 500 | 1.0 | 8 x 11 | 20 | 19 | ESK105M450AG3(1) |
| 450 | 500 | 2.2 | 10 x 12 | 20 | 33 | ESK225M450AH1(1) |
| 450 | 500 | 3.3 | 10 x 16 | 20 | 42 | ESK335M450AH2(1) |
| 450 | 500 | 4.7 | 10 x 16 | 20 | 50 | ESK475M450AH2(1) |
| 450 | 500 | 10 | 13 x 20 | 20 | 60 | ESK106M450AL3(1) |
| 450 | 500 | 10 | 13 x 25 | 20 | 75 | ESK106M450AL4(1) |
| 450 | 500 | 22 | 16 x 25 | 20 | 130 | ESK226M450AM7(1) |
| 450 | 500 | 33 | 16 x 32 | 20 | 160 | ESK336M450AM2(1) |
| 450 | 500 | 33 | 16 x 36 | 20 | 180 | ESK336M450AM3(1) |
| 450 | 500 | 47 | 18 x 40 | 20 | 230 | ESK476M450AN3(1) |
| 450 | 500 | 47 | 18 x 36 | 20 | 200 | ESK476M450AN2(1) |
| 450 | 500 | 100 | 22 x 40 | 20 | 370 | ESK107M450AQ4(1) |
| **VDC** | **VDC Surge** | **Rated Capacitance** | **Case Size** | **DF** | **RC** | **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.*



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## 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.
- Verify the correct polarization of the capacitor on the board.
- Verify that the space around the pressure relief device is according to the following guideline:

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

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

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

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

## Application and Operation Guidelines

**Electrical Ratings:**
**Capacitance (ESC)**

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

**Temperature Dependence of the Capacitance**

Capacitance of an electrolytic capacitor depends upon temperature: with decreasing temperature the viscosity of the electrolyte increases, thereby reducing its conductivity.



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

### Frequency Dependence of the Capacitance

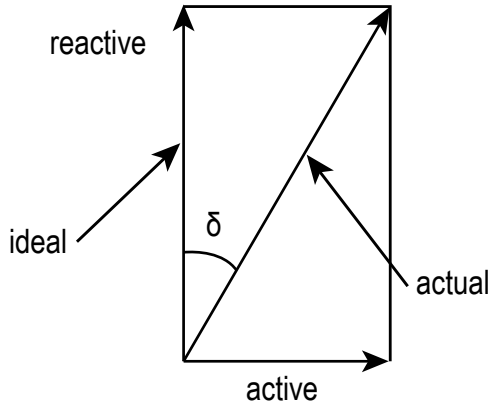
Effective capacitance value is derived from the impedance curve, as long as impedance is still in the range where the capacitance component is dominant.

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

C = Capacitance (F)
f = Frequency (Hz)
Z = Impedance (Ω)

### Dissipation Factor tan δ (DF)

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

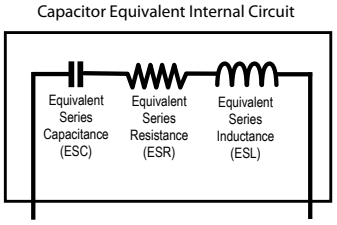



Tan δ is measured with the same set-up used for the series capacitance ESC.
tan δ = ω x ESC x ESR where:

ESC = Equivalent Series Capacitance
ESR = Equivalent Series Resistance

### Equivalent Series Inductance (ESL)

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






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## Equivalent Series Resistance (ESR)

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

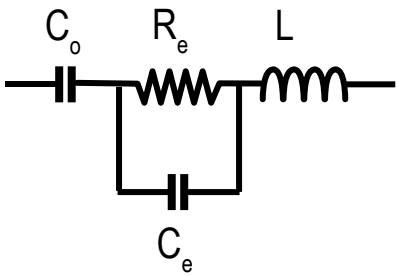
$$ESR = \frac{\tan \delta}{2\pi f \, ESC}$$

ESR = Equivalent Series Resistance (Ω)
tan δ = Dissipation Factor
ESC = Equivalent Series Capacitance (F)
f = Frequency (Hz)

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

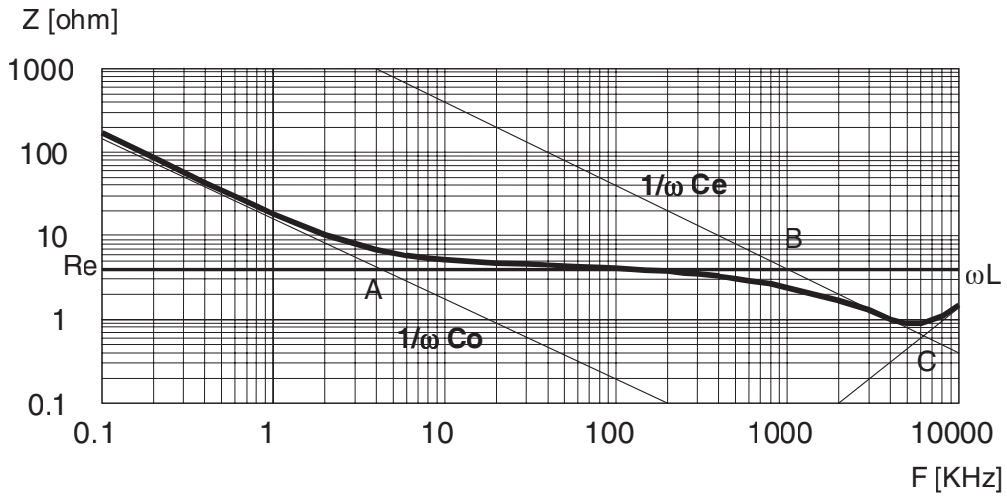
## Impedance (Z)

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




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

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

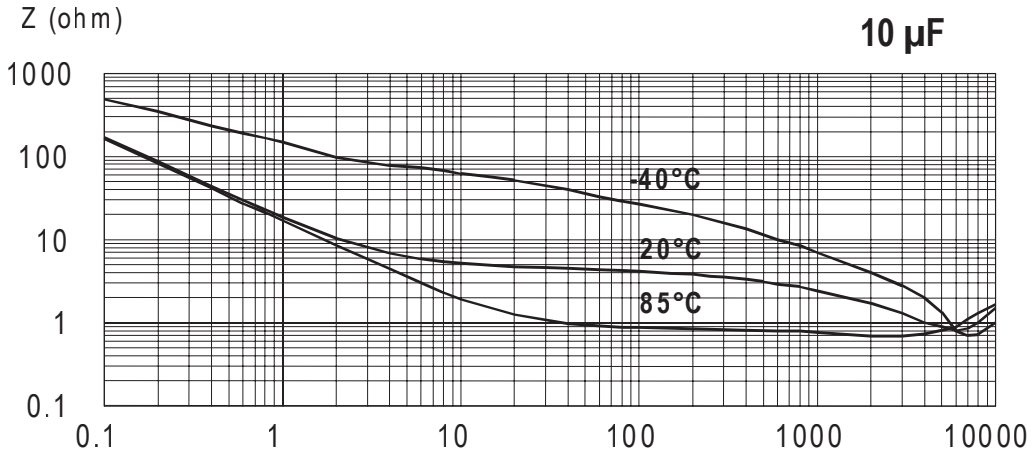





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- Capacitive reactance predominates at low frequencies
- With increasing frequency, capacitive reactance Xc = $1/\omega C_o$ decreases until it reaches the order of magnitude of electrolyte resistance $R_e$(A)
- At even higher frequencies, resistance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

Generally speaking, it can be estimated that $C_e \approx 0.01\ C_o$.
Impedance as a function of frequency (sinusoidal waveform) for different temperature values can be represented as follows (typical values):




$R_e$ is the most temperature-dependent component of an electrolytic capacitor equivalent circuit. Electrolyte resistivity will decrease if temperature rises.

In order to obtain a low impedance value throughout the temperature range, $R_e$ must be as little as possible. However, $R_e$ values that are too low indicate a very aggressive electrolyte, resulting in a shorter life of the electrolytic capacitor at high temperatures. A compromise must be reached.

**Leakage Current (LC)**

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

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

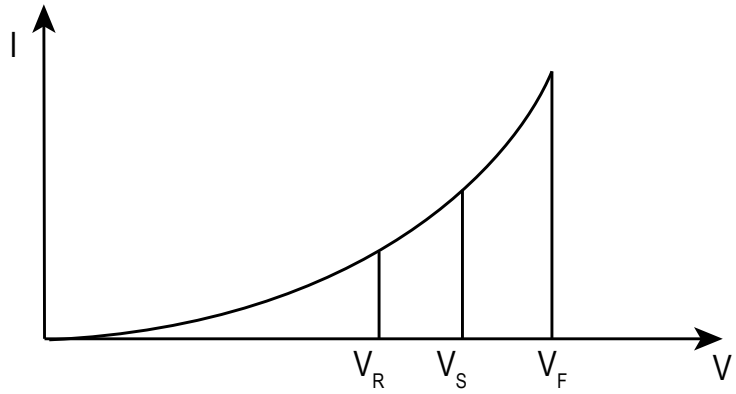
After a voltage-free storage the oxide layer may deteriorate, especially at high temperature. Since there are no leakage currents to transport oxygen ions to the anode, the oxide layer is not regenerated. The result is that a higher than normal leakage current will flow when voltage is applied after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

As the oxide layer is regenerated in use, the leakage current will gradually decrease to its normal level.



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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.



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### Expected Life Calculation

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

Where:

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

This formula is applicable between 40°C and To.

## Packaging Quantities

| Size Code | Diameter (mm) | Length (mm) | Bulk Standard Leads | Cut Leads | Auto-insertion | |
|---|---|---|---|---|---|---|
| | | | | | Ammo | Tape & Reel |
| C3 | 5 | 11 | 10000 | 15000 | 2000 | 1300 |
| E3 | 6.3 | 11 | 10000 | 15000 | 2000 | 1100 |
| G3 | 8 | 11 | 6000 | 8000 | 1000 | 750 |
| G4 | 8 | 15 | 5000 | 5000 | 1000 | 750 |
| H1 | 10 | 12 | 4000 | 4000 | 700 | 600 |
| H2 | 10 | 16 | 3000 | 4000 | 700 | 600 |
| H4 | 10 | 20 | 2400 | 3000 | 700 | 600 |
| L3 | 13 | 20 | 2000 | 2000 | 500 | |
| L4 | 13 | 25 | 1600 | 1600 | 500 | |
| M7 | 16 | 25 | 1000 | 500 | 300 | |
| M2 | 16 | 32 | 800 | 500 | | |
| M3 | 16 | 36 | 600 | 500 | | |
| N4 | 18 | 20 | 800 | 1000 | | |
| N1 | 18 | 32 | 500 | 500 | | |
| N2 | 18 | 36 | 500 | 500 | | |
| N3 | 18 | 40 | 500 | 500 | | |
| Q3 | 22 | 35 | 400 | | | |
| Q4 | 22 | 40 | 300 | 400 | | |

## Standard Marking for Radial Types

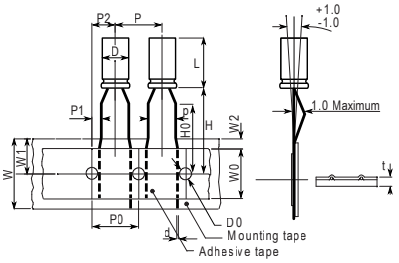
- KEMET logo
- Series
- Operating temperature (°C)
- Rated capacitance (µF)
- Rated voltage (VDC)
- Negative polarity: white line
- Date code



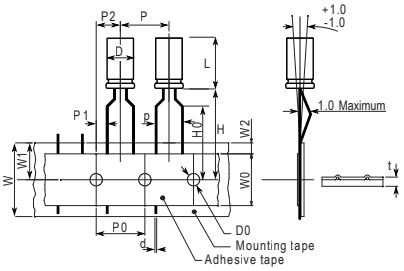
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# Taping for Automatic Insertion Machines

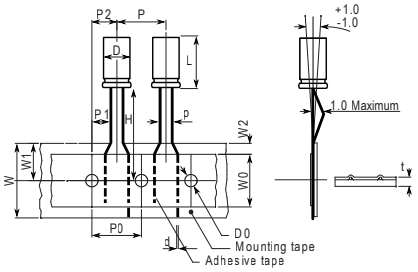
Formed to 2.5 mm
(Lead and packaging code LA and FA)



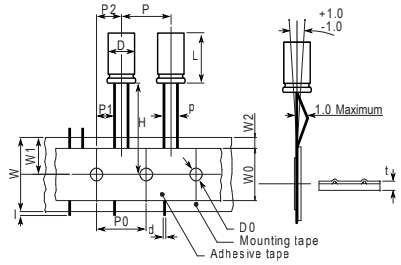

Formed to 5 mm
(Lead and packaging code JA and DA)




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




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



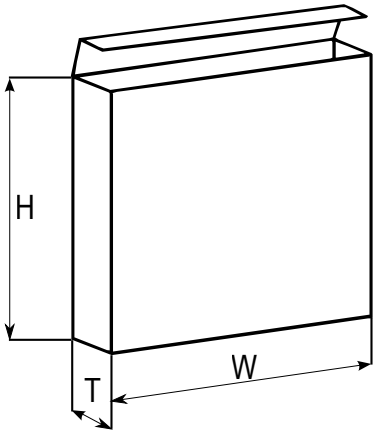

| Dimensions (mm) | D | L | p | d | P | P0 | P1 | P2 | W | W0 | W1 | W2 | H0 | H1 | I | D0 | t |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tolerance | +0.5 | | +0.8/-0.2 | ±0.05 | ±1 .0 | ±0 .3 | ±0 .7 | ±1 .3 | +1/-0.5 | ±0.5 | Maximum | Maximum | ±0.75 | ±0.5 | Maximum | ±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 |



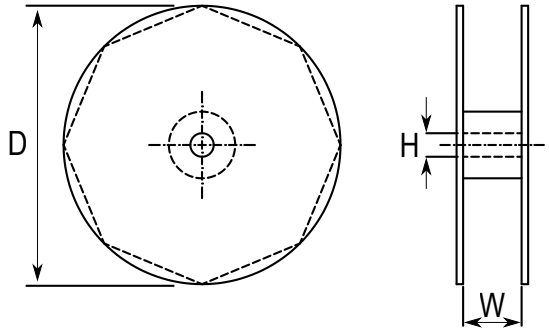
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## Lead Taping & Packaging

Ammo Box




Reel



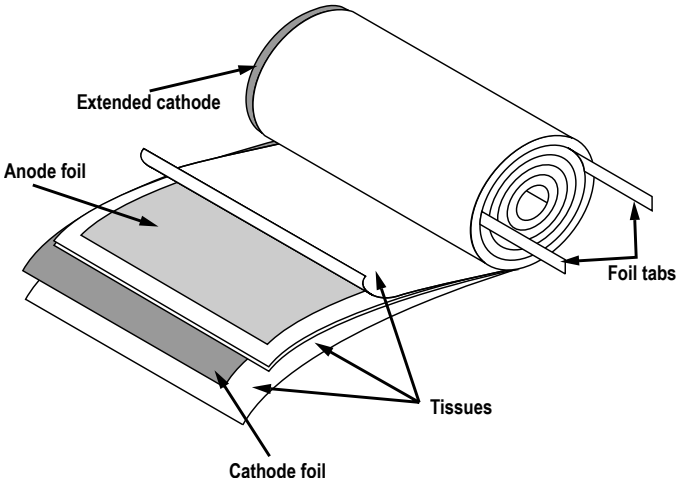

| Case Size (mm) | Ammo | | | Reel | | |
|---|---|---|---|---|---|---|
| | H | W | T | D | H | W |
| | | Maximum | Maximum | ±2 | ±0.5 | +1/-0.1 |
| 4 | 230 | 340 | 42 | 350 | 30 | 50 |
| 5 x 5 – 7 | 230 | 340 | 42 | | | |
| 6 x 5 – 7 | 275 | 340 | 42 | | | |
| 8 x 5 – 9 | 235 | 340 | 45 | | | |
| 5 x 11 | 230 | 340 | 48 | | | |
| 6 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 | | | |



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## Construction

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




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

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

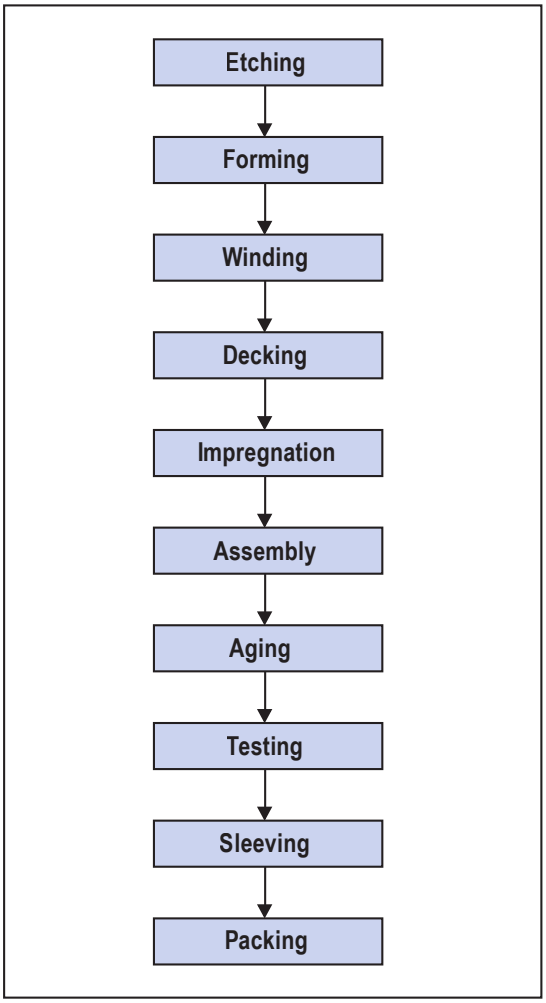
Damage to the oxide layer can occur due to variety of reasons:
- Slitting of the anode foil after forming
- Attaching the tabs to the anode foil
- Minor mechanical damage caused during winding

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

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

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

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






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