ESH Series, +105°C



Overview

KEMET's ESH Series of single-ended aluminum electrolytic capacitors offer high CV and are designed for high quality, high reliability applications requiring a miniature solution.

Applications

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

Benefits

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



Part Number System

| ESH | 107 | M | 6R3 | | A | C3 | AA |
|--|--|-----------|--|--|--------------------------|------------------------|-------------------------------|
| Series | Capacitance Code (pF) | Tolerance | Rated Voltage (VDC) | | Electrical Parameters | Size Code | Packaging |
| 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 | 160 = 160 200 = 200 250 = 250 350 = 350 400 = 400 420 = 420 450 = 450 500 = 500 | A = Standard | See Dimension Table | See Ordering Options Table |



Ordering Options Table

| Diameter | 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 ±0.75 | LA | | | | | | | |
| 6.3 | Tape & Reel | 2.5 mm Lead Spacing | $H_0 = 18.5 \pm 0.75$ | KA | | | | | | | |
| 8 | Tape & Reel | Formed to 5 mm | $H_0 = 16 \pm 0.75$ | JA | | | | | | | |
| 10 - 13 | Ammo | 5 mm Lead Spacing | $H_0 = 18.5 \pm 0.75$ | EA | | | | | | | |
| 16 – 18 | Ammo | 7.5 mm Lead Spacing | $H_0 = 18.5 \pm 0.75$ | 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 | Ammo | Formed to 2.5 mm | H ₀ = 16 ±0.75 | FA | | | | | | | |
| 4 - 6.3 | Tape & Reel | Formed to 5 mm | $H_0 = 16 \pm 0.75$ | JA | | | | | | | |
| 4 - 5, 8 - 18 | Tape & Reel | Straight | $H_0 = 18.5 \pm 0.75$ | KA | | | | | | | |
| | Contact KEM | ET for other Lead and F | Packaging options | | | | | | | | |

Environmental Compliance

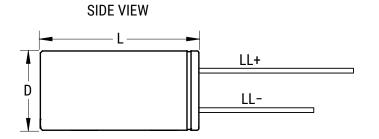
As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of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

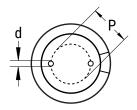
Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.



Dimensions - Millimeters



TERMINAL END VIEW



| Ci O-d- | | D | L | | | p | 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 |
| G8 | 8 | ±0.5 | 16 | +1.5/-0 | 3.5 | ±0.5 | 0.6 | Nominal | 20/15 | Minimum |
| H9 | 10 | ±0.5 | 12.5 | +1.5/-0 | 5 | ±0.5 | 0.6 | Nominal | 20/15 | Minimum |
| H2 | 10 | ±0.5 | 15 | +2.0/-0 | 5 | ±0.5 | 0.6 | Nominal | 20/15 | Minimum |
| Н8 | 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 |
| М3 | 16 | ±0.5 | 36 | +2.0/-0 | 7.5 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |
| N5 | 18 | ±0.5 | 25 | +2.0/-0 | 7.5 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |
| N8 | 18 | ±0.5 | 30 | +2.0/-0 | 7.5 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |
| 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 |
| N7 | 18 | ±0.5 | 45 | +2.0/-0 | 7.5 | ±0.5 | 0.8 | Nominal | 20/15 | Minimum |



Performance Characteristics

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

Impedance Z Characteristics at 120 Hz

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

Compensation Factor of Ripple Current (RC) vs. Frequency

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



Test Method & Performance

| Conditions | Load Life Test | Shelf Life Test | | | | |
|--------------------|--|--|--|--|--|--|
| Temperature | 105°C | 105°C | | | | |
| Test Duration | 2,000 hours | 1,000 hours | | | | |
| Ripple Current | Maximum ripple current specified at 120 Hz 105°C | No ripple current applied | | | | |
| Voltage | The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor | No voltage applied | | | | |
| Performance | The following specifications will be satisfi | ed 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

| | | | | DF | RC | | |
|------------|-----------|--------------------|----------------------|------------|--------------|----------------|--------------------------------------|
| | VDC Surge | Rated | Case Size | 120 Hz | 120 Hz | LC | |
| VDC | - | Capacitance | | | | 20°C 2 | Part Number |
| | Voltage | 120 Hz 20°C (μF) | D x L (mm) | 25°C | 105°C | minutes (µA) | |
| | | 120 112 20 0 (μ1) | | (tan δ %)* | (mA) | miliates (pri) | |
| 6.3 | 8 | 100 | 5 x 11 | 26 | 100 | 6.3 | ESH107M6R3AC3(1) |
| 6.3 | 8 | 150 | 5 x 11 | 26 | 120 | 9.5 | ESH157M6R3AC3(1) |
| 6.3 6.3 | 8 8 | 220 330 | 6.3 x 11 6.3 x 11 | 26 26 | 165 200 | 13.9 20.8 | ESH227M6R3AE3(1) ESH337M6R3AE3(1) |
| 6.3 | 8 | 470 | 6.3 x 11 | 26 | 230 | 29.6 | ESH477M6R3AE3(1) |
| 6.3 | 8 | 680 | 8 x 11 | 26 | 350 | 42.8 | ESH687M6R3AG3(1) |
| 6.3 | 8 | 1000 | 8 x 15 | 26 | 445 | 63.0 | ESH108M6R3AG4(1) |
| 6.3 | 8 | 1000 | 10 x 12.5 | 26 | 470 | 63.0 | ESH108M6R3AH9(1) |
| 6.3 | 8 | 1500 | 10 x 15 | 26 | 600 | 94.5 | ESH158M6R3AH2(1) |
| 6.3 | 8 | 2200 | 10 x 20 | 26 | 800 | 138.6 | ESH228M6R3AH4(1) |
| 6.3 6.3 | 8 8 | 3300 | 13 x 20 | 26 26 | 1100 | 207.9 | ESH338M6R3AL3(1) |
| 6.3 | 8 | 4700 6800 | 13 x 20 16 x 25 | 26 26 | 1180 1490 | 296.1 428.4 | ESH478M6R3AL3(1) ESH688M6R3AM7(1) |
| 6.3 | 8 | 10000 | 16 x 32 | 26 | 1830 | 630.0 | ESH109M6R3AM2(1) |
| 6.3 | 8 | 15000 | 16 x 36 | 26 | 2090 | 945.0 | ESH159M6R3AM3(1) |
| 6.3 | 8 | 22000 | 18 x 40 | 26 | 2350 | 1386.0 | ESH229M6R3AN3(1) |
| 10 | 13 | 47 | 5 x 11 | 22 | 75 | 4.7 | ESH476M010AC3(1) |
| 10 | 13 | 68 | 5 x 11 | 22 | 80 | 6.8 | ESH686M010AC3(1) |
| 10 | 13 | 100 | 5 x 11 | 22 | 110 | 10.0 | ESH107M010AC3(1) |
| 10 | 13 | 150 | 5 x 11 | 22 | 120 | 15.0 | ESH157M010AC3(1) |
| 10 10 | 13 | 220 | 6.3 x 11 | 22 22 | 180 235 | 22.0 | ESH227M010AE3(1) |
| 10 | 13 13 | 330 330 | 6.3 x 11 8 x 11 | 22 | 255 | 33.0 33.0 | ESH337M010AE3(1) ESH337M010AG3(1) |
| 10 | 13 | 470 | 6.3 x 11 | 22 | 250 | 47.0 | ESH477M010AE3(1) |
| 10 | 13 | 470 | 8 x 11 | 22 | 305 | 47.0 | ESH477M010AG3(1) |
| 10 | 13 | 680 | 8 x 11 | 22 | 365 | 68.0 | ESH687M010AG3(1) |
| 10 | 13 | 680 | 10 x 12.5 | 22 | 420 | 68.0 | ESH687M010AH9(1) |
| 10 | 13 | 1000 | 8 x 15 | 22 | 480 | 100.0 | ESH108M010AG4(1) |
| 10 | 13 | 1000 | 10 x 12.5 | 22 | 540 | 100.0 | ESH108M010AH9(1) |
| 10 | 13 | 1500 2200 | 10 x 20 | 22 22 | 800 | 150.0 | ESH158M010AH4(1) |
| 10 10 | 13 13 | 3300 | 10 x 20 13 x 20 | 22 | 870 1100 | 220.0 330.0 | ESH228M010AH4(1) ESH338M010AL3(1) |
| 10 | 13 | 4700 | 13 x 25 | 22 | 1380 | 470.0 | ESH478M010AL4(1) |
| 10 | 13 | 6800 | 16 x 25 | 22 | 1700 | 680.0 | ESH688M010AM7(1) |
| 10 | 13 | 10000 | 16 x 36 | 22 | 1950 | 1000.0 | ESH109M010AM3(1) |
| 10 | 13 | 15000 | 18 x 36 | 22 | 2180 | 1500.0 | ESH159M010AN2(1) |
| 16 | 20 | 33 | 5 x 11 | 18 | 70 | 5.3 | ESH336M016AC3(1) |
| 16 | 20 | 47 | 5 x 11 | 18 | 85 | 7.5 | ESH476M016AC3(1) |
| 16 16 | 20 20 | 68 | 5 x 11 | 18 18 | 100 | 10.9 | ESH686M016AC3(1) |
| 16 | 20 | 100 150 | 5 x 11 6.3 x 11 | 18 | 130 175 | 16.0 24.0 | ESH107M016AC3(1) ESH157M016AE3(1) |
| 16 | 20 | 220 | 6.3 x 11 | 18 | 220 | 35.2 | ESH227M016AE3(1) |
| 16 | 20 | 330 | 8 x 11 | 18 | 280 | 52.8 | ESH337M016AG3(1) |
| 16 | 20 | 470 | 8 x 11 | 18 | 375 | 75.2 | ESH477M016AG3(1) |
| 16 | 20 | 680 | 8 x 15 | 18 | 450 | 108.8 | ESH687M016AG4(1) |
| 16 | 20 | 680 | 10 x 12.5 | 18 | 480 | 108.8 | ESH687M016AH9(1) |
| 16 | 20 | 1000 | 10 x 15 | 18 | 640 | 160.0 | ESH108M016AH2(1) |
| 16 | 20 | 1500 | 10 x 20 | 18 10 | 830 | 240.0 | ESH158M016AH4(1) |
| 16 16 | 20 20 | 2200 3300 | 13 x 20 13 x 25 | 18 18 | 1050 1250 | 352.0 528.0 | ESH228M016AL3(1) ESH338M016AL4(1) |
| 16 | 20 | 4700 | 16 x 25 | 18 | 1650 | 752.0 | ESH478M016AM7(1) |
| 16 | 20 | 6800 | 16 x 32 | 18 | 1900 | 1088.0 | ESH688M016AM2(1) |
| 16 | 20 | 10000 | 18 x 36 | 18 | 1900 | 1600.0 | ESH109M016AN2(1) |
| 25 | 32 | 22 | 5 x 11 | 16 | 60 | 5.5 | ESH226M025AC3(1) |
| 25 | 32 | 33 | 5 x 11 | 16 | 75 | 8.3 | ESH336M025AC3(1) |
| 25 | 32 | 47 | 5 x 11 | 16 | 90 | 11.8 | ESH476M025AC3(1) |
| 25 | 32 32 | 68 | 6.3 x 11 | 16 | 125 | 17.0 | ESH686M025AE3(1) |
| 25 VD0 | | 100 | 6.3 x 11 | 16 | 145 | 25.0 | ESH107M025AE3(1) |
| VDC | VDC Surge | Rated Capacitance | Case Size | DF | RC | LC | Part Number |

 $^{(1) \} Insert \ packaging \ code. \ See \ Ordering \ Options \ Table \ for \ available \ options.$

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



Table 1 - Ratings & Part Number Reference cont'd

| | VDO Commo | Rated | 0 0: | DF 100 H- | RC | LC | |
|----------|-----------|--------------------|----------------------|--------------|------------|-----------------|--------------------------------------|
| VDC | VDC Surge | Capacitance | Case Size | 120 Hz | 120 Hz | 20°C 2 | Part Number |
| | Voltage | 120 Hz 20°C (μF) | D x L (mm) | 25°C | 105°C | minutes (µA) | |
| | | 120 112 20 € (μ1) | | (tan δ %)* | (mA) | illiliates (µA) | |
| 25 | 32 | 150 | 8 x 11 | 16 | 200 | 37.5 | ESH157M025AG3(1) |
| 25 | 32 | 220 | 8 x 11 | 16 | 240 | 55.0 | ESH227M025AG3(1) |
| 25 25 | 32 32 | 330 330 | 8 x 11 10 x 12.5 | 16 16 | 300 355 | 82.5 82.5 | ESH337M025AG3(1) ESH337M025AH9(1) |
| 25 | 32 | 470 | 8 x 15 | 16 | 420 | 117.5 | ESH477M025AG4(1) |
| 25 | 32 | 470 | 10 x 12.5 | 16 | 440 | 117.5 | ESH477M025AH9(1) |
| 25 | 32 | 680 | 10 x 15 | 16 | 560 | 170.0 | ESH687M025AH2(1) |
| 25 | 32 | 1000 | 10 x 20 | 16 | 740 | 250.0 | ESH108M025AH4(1) |
| 25 | 32 | 1500 | 13 x 20 | 16 | 920 | 375.0 | ESH158M025AL3(1) |
| 25 | 32 | 2200 | 13 x 25 | 16 | 1230 | 550.0 | ESH228M025AL4(1) |
| 25 | 32 | 3300 | 16 x 25 | 16 | 1500 | 825.0 | ESH338M025AM7(1) |
| 25 | 32 | 4700 | 16 x 32 | 16 | 1800 | 1175.0 | ESH478M025AM2(1) |
| 25 35 | 32 44 | 6800 10 | 18 x 36 5 x 11 | 16 14 | 2050 44 | 1700.0 3.5 | ESH688M025AN2(1) ESH106M035AC3(1) |
| 35 | 44 | 15 | 5 x 11 | 14 | 50 | 5.3 | ESH156M035AC3(1) |
| 35 | 44 | 22 | 5 x 11 | 14 | 65 | 7.7 | ESH226M035AC3(1) |
| 35 | 44 | 33 | 5 x 11 | 14 | 85 | 11.6 | ESH336M035AC3(1) |
| 35 | 44 | 47 | 5 x 11 | 14 | 100 | 16.5 | ESH476M035AC3(1) |
| 35 | 44 | 68 | 6.3 x 11 | 14 | 130 | 23.8 | ESH686M035AE3(1) |
| 35 | 44 | 100 | 6.3 x 11 | 14 | 170 | 35.0 | ESH107M035AE3(1) |
| 35 | 44 | 150 | 8 x 11 | 14 | 220 | 52.5 | ESH157M035AG3(1) |
| 35 | 44 | 220 | 10 x 12.5 | 14 | 315 | 77.0 | ESH227M035AH9(1) |
| 35 35 | 44 44 | 330 | 10 x 12.5 | 14 | 400 | 115.5 164.5 | ESH337M035AH9(1) |
| 35 | 44 | 470 680 | 10 x 15 10 x 20 | 14 14 | 480 650 | 238.0 | ESH477M035AH2(1) ESH687M035AH4(1) |
| 35 | 44 | 1000 | 13 x 20 | 14 | 900 | 350.0 | ESH108M035AL3(1) |
| 35 | 44 | 1500 | 13 x 25 | 14 | 1050 | 525.0 | ESH158M035AL4(1) |
| 35 | 44 | 2200 | 16 x 25 | 14 | 1370 | 770.0 | ESH228M035AM7(1) |
| 35 | 44 | 3300 | 16 x 36 | 14 | 1680 | 1155.0 | ESH338M035AM3(1) |
| 35 | 44 | 4700 | 18 x 36 | 14 | 1920 | 1645.0 | ESH478M035AN2(1) |
| 50 | 63 | 1.0 | 5 x 11 | 12 | 12 | 3.0 | ESH105M050AC3(1) |
| 50 | 63 | 2.2 | 5 x 11 | 12 | 18 | 3.0 | ESH225M050AC3(1) |
| 50 50 | 63 | 3.3 | 5 x 11 | 12 12 | 25 | 3.0 3.0 | ESH335M050AC3(1) |
| 50 | 63 63 | 4.7 6.8 | 5 x 11 5 x 11 | 12 | 30 30 | 3.4 | ESH475M050AC3(1) ESH685M050AC3(1) |
| 50 | 63 | 10 | 5 x 11 | 12 | 50 | 5.0 | ESH106M050AC3(1) |
| 50 | 63 | 15 | 5 x 11 | 12 | 50 | 7.5 | ESH156M050AC3(1) |
| 50 | 63 | 22 | 5 x 11 | 12 | 75 | 11.0 | ESH226M050AC3(1) |
| 50 | 63 | 33 | 5 x 11 | 12 | 95 | 16.5 | ESH336M050AC3(1) |
| 50 | 63 | 47 | 6.3 x 11 | 12 | 115 | 23.5 | ESH476M050AE3(1) |
| 50 | 63 | 68 | 8 x 11 | 12 | 159 | 34.0 | ESH686M050AG3(1) |
| 50 | 63 | 100 | 8 x 11 | 12 | 200 | 50.0 | ESH107M050AG3(1) |
| 50 50 | 63 | 150 | 10 x 12.5 | 12 12 | 289 | 75.0 110.0 | ESH157M050AH9(1) |
| 50 50 | 63 63 | 220 220 | 10 x 12.5 10 x 15 | 12 12 | 360 415 | 110.0 | ESH227M050AH9(1) ESH227M050AH2(1) |
| 50 | 63 | 330 | 10 x 15 | 12 | 535 | 110.0 165.0 | ESH227M050AH2(1) ESH337M050AH4(1) |
| 50 | 63 | 470 | 10 x 20 | 12 | 630 | 235.0 | ESH477M050AH4(1) |
| 50 | 63 | 470 | 13 x 20 | 12 | 730 | 235.0 | ESH477M050AL3(1) |
| 50 | 63 | 680 | 13 x 20 | 12 | 800 | 340.0 | ESH687M050AL3(1) |
| 50 | 63 | 1000 | 13 x 25 | 12 | 1060 | 500.0 | ESH108M050AL4(1) |
| 50 | 63 | 1500 | 16 x 25 | 12 | 1300 | 750.0 | ESH158M050AM7(1) |
| 50 | 63 | 2200 | 16 x 36 | 12 | 1600 | 1100.0 | ESH228M050AM3(1) |
| 50 | 63 | 3300 | 18 x 36 | 12 | 1780 | 1650.0 | ESH338M050AN2(1) |
| 63 | 79 79 | 1.0 2.2 | 5 x 11 | 10 10 | 12 20 | 3.0 | ESH105M063AC3(1) ESH225M063AC3(1) |
| 63 63 | 79 79 | 3.3 | 5 x 11 5 x 11 | 10 | 20 27 | 3.0 3.0 | ESH335M063AC3(1) |
| 63 | 79 | 4.7 | 5 x 11 | 10 | 34 | 3.0 | ESH475M063AC3(1) |
| VDC | VDC Surge | Rated Capacitance | Case Size | DF | RC | LC | Part Number |

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

^{*} When capacitance exceeds 1,000 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 | Case Size D x L (mm) | DF 120 Hz 25°C | RC 120 Hz 105°C | LC 20°C 2 | Part Number |
|------------|----------------------|-------------------|------------------------|----------------------|-----------------------|--------------|--------------------------------------|
| | . . | 120 Hz 20°C (μF) | , | (tan δ %)* | (mA) | minutes (μA) | |
| 63 | 79 | 6.8 | 5 x 11 | 10 | 37 | 4.3 | ESH685M063AC3(1) |
| 63 | 79 | 10 | 5 x 11 | 10 | 55 | 6.3 | ESH106M063AC3(1) |
| 63 | 79 | 15 | 5 x 11 | 10 | 65 | 9.5 | ESH156M063AC3(1) |
| 63 | 79 | 22 | 6.3 x 11 | 10 | 90 | 13.9 | ESH226M063AE3(1) |
| 63 | 79 | 33 | 6.3 x 11 | 10 | 100 | 20.8 | ESH336M063AE3(1) |
| 63 | 79 70 | 47 | 8 x 11 | 10 | 155 | 29.6 | ESH476M063AG3(1) |
| 63 63 | 79 79 | 68 100 | 10 x 12.5 10 x 12.5 | 10 10 | 198 260 | 42.8 63.0 | ESH686M063AH9(1) |
| 63 | 79 | 150 | 10 x 12.5 | 10 | 330 | 94.5 | ESH107M063AH9(1) ESH157M063AH2(1) |
| 63 | 79 | 220 | 10 x 13 | 10 | 465 | 138.6 | ESH227M063AH2(1) |
| 63 | 79 | 330 | 13 x 20 | 10 | 650 | 207.9 | ESH337M063AL3(1) |
| 63 | 79 | 470 | 13 x 20 | 10 | 700 | 296.1 | ESH477M063AL3(1) |
| 63 | 79 | 680 | 16 x 25 | 10 | 1000 | 428.4 | ESH687M063AM7(1) |
| 63 | 79 | 1000 | 16 x 32 | 10 | 1200 | 630.0 | ESH108M063AM2(1) |
| 63 | 79 | 1500 | 16 x 36 | 10 | 1450 | 945.0 | ESH158M063AM3(1) |
| 63 | 79 | 2200 | 18 x 36 | 10 | 1650 | 1386.0 | ESH228M063AN2(1) |
| 100 | 125 | 1.0 | 5 x 11 | 10 | 15 | 3.0 | ESH105M100AC3(1) |
| 100 | 125 | 2.2 | 5 x 11 | 10 | 22 | 3.0 | ESH225M100AC3(1) |
| 100 | 125 | 3.3 | 5 x 11 | 10 | 29 | 3.3 | ESH335M100AC3(1) |
| 100 | 125 | 4.7 | 5 x 11 | 10 | 37 | 4.7 | ESH475M100AC3(1) |
| 100 | 125 | 6.8 | 5 x 11 | 10 | 46 | 6.8 | ESH685M100AC3(1) |
| 100 | 125 | 10 | 6.3 x 11 | 10 | 65 75 | 10.0 | ESH106M100AE3(1) |
| 100 100 | 125 125 | 15 22 | 6.3 x 11 | 10 10 | 75 115 | 15.0 22.0 | ESH156M100AE3(1) |
| 100 | 125 | 33 | 8 x 11 8 x 11 | 10 | 140 | 33.0 | ESH226M100AG3(1) ESH336M100AG3(1) |
| 100 | 125 | 47 | 10 x 12.5 | 10 | 185 | 47.0 | ESH476M100AH9(1) |
| 100 | 125 | 68 | 10 x 12.5 | 10 | 240 | 68.0 | ESH686M100AH2(1) |
| 100 | 125 | 100 | 10 x 20 | 10 | 305 | 100.0 | ESH107M100AH4(1) |
| 100 | 125 | 150 | 13 x 20 | 10 | 370 | 150.0 | ESH157M100AL3(1) |
| 100 | 125 | 220 | 13 x 25 | 10 | 520 | 220.0 | ESH227M100AL4(1) |
| 100 | 125 | 330 | 16 x 25 | 10 | 720 | 330.0 | ESH337M100AM7(1) |
| 100 | 125 | 470 | 16 x 32 | 10 | 875 | 470.0 | ESH477M100AM2(1) |
| 100 | 125 | 680 | 16 x 36 | 10 | 1200 | 680.0 | ESH687M100AM3(1) |
| 160 | 200 | 1.0 | 5 x 11 | 15 | 17 | 14.8 | ESH105M160AC3(1) |
| 160 | 200 | 2.2 | 6.3 x 11 | 15 | 25 | 20.6 | ESH225M160AE3(1) |
| 160 160 | 200 | 3.3 | 6.3 x 11 | 15 15 | 36 42 | 25.8 32.6 | ESH335M160AE3(1) |
| 160 | 200 200 | 4.7 6.8 | 6.3 x 11 8 x 11 | 15 | 43 54 | 32.6 42.6 | ESH475M160AE3(1) ESH685M160AG3(1) |
| 160 | 200 | 10 | 8 x 11 | 15 | 70 | 58.0 | ESH106M160AG3(1) |
| 160 | 200 | 15 | 10 x 12.5 | 15 | 90 | 82.0 | ESH156M160AH9(1) |
| 160 | 200 | 22 | 10 x 15 | 15 | 115 | 115.6 | ESH226M160AH2(1) |
| 160 | 200 | 33 | 10 x 20 | 15 | 160 | 168.4 | ESH336M160AH4(1) |
| 160 | 200 | 47 | 10 x 20 | 15 | 195 | 235.6 | ESH476M160AH4(1) |
| 160 | 200 | 68 | 13 x 20 | 15 | 255 | 336.4 | ESH686M160AL3(1) |
| 160 | 200 | 100 | 13 x 25 | 15 | 350 | 490.0 | ESH107M160AL4(1) |
| 160 | 200 | 150 | 16 x 25 | 15 | 435 | 730.0 | ESH157M160AM7(1) |
| 160 | 200 | 220 | 16 x 32 | 15 | 550 | 1066.0 | ESH227M160AM2(1) |
| 160 | 200 | 330 | 18 x 36 | 15 | 800 | 1594.0 | ESH337M160AN2(1) |
| 160 | 200 | 470 | 18 x 40 | 15 15 | 900 | 2266.0 | ESH477M160AN3(1) |
| 200 | 250 250 | 1.0 2.2 | 6.3 x 11 | 15 15 | 17 25 | 16.0 | ESH105M200AE3(1) |
| 200 200 | 250 250 | 3.3 | 6.3 x 11 6.3 x 11 | 15 | 25 36 | 23.2 29.8 | ESH225M200AE3(1) ESH335M200AE3(1) |
| 200 | 250 | 4.7 | 8 x 11 | 15 | 50 | 38.2 | ESH475M200AE3(1) |
| 200 | 250 | 6.8 | 8 x 11 | 15 | 60 | 50.8 | ESH685M200AG3(1) |
| 200 | 250 | 10 | 10 x 12.5 | 15 | 80 | 70.0 | ESH106M200AH9(1) |
| 200 | 250 | 15 | 10 x 15 | 15 | 110 | 100.0 | ESH156M200AH2(1) |
| 200 | 250 | 22 | 10 x 20 | 15 | 140 | 142.0 | ESH226M200AH4(1) |
| VDC | VDC Surge | Rated Capacitance | Case Size | DF | RC | LC | Part Number |

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

^{*} When capacitance exceeds 1,000 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 Capacitance 120 Hz 20°C (µF) L (mm) 120 Hz 25°C (mA) 15 C 20°C 2 minutes (µA) Part Number 200 250 33 13 z 20 15 200 250 ESH39M200ALS(II) 200 250 47 13 z 20 15 220 220.0 ESH49M200ALS(II) 200 250 47 13 z 20 15 20 220.0 ESH49M200ALS(II) 200 250 220 16 x 36 15 480 448.8 ESH49M200ALS(II) 200 250 220 16 x 36 15 75 133.0 ESH27ZV20DANAR(I) 200 250 330 10 x 36 15 750 1990.0 ESH27ZV20DANAR(I) 250 330 10 x 32 8 x 11 18 17 17.5 ESH27ZV20DANAR(I) 250 300 47 8 x 11 15 52 45 B ESH15ZV2DANAR(I) 250 300 10 10 x 12 S 16 80 8.0 | | | Rated | | DF | RC | LC | |
|--|----------|---------|------------------|------------|------------|-------|--------------|------------------|
| Voltage 120 Hz 20°C (μF) UX L (mm) (tan δ ξ) | VDC | | | | | | | Part Number |
| | V DO | Voltage | - | D x L (mm) | 25°C | 105°C | | i dit itullibei |
| 200 | | | 120 HZ 20°C (µF) | | (tan δ %)* | (mA) | minutes (µA) | |
| 200 250 68 13 x 25 15 280 418.0 ESHGGMZQDAL4(1) 200 250 150 16 x 32 15 480 910.0 ESHITSMZQDAMZ(1) 200 250 220 16 x 36 15 655 1330.0 ESHITSMZQDAMZ(1) 200 250 220 18 x 32 13 665 1330.0 ESHITSMZQDAMZ(1) 200 250 220 18 x 32 13 665 1330.0 ESHITSMZQDAMZ(1) 200 250 220 18 x 32 13 665 1330.0 ESHITSMZQDAMZ(1) 200 250 220 18 x 32 13 665 1330.0 ESHITSMZQDAMZ(1) 250 200 22 22 23 24 24 24 24 25 25 25 25 | 200 | 250 | 33 | 13 x 20 | 15 | 200 | 208.0 | ESH336M200AL3(1) |
| 200 | 200 | 250 | 47 | 13 x 20 | 15 | 220 | 292.0 | ESH476M200AL3(1) |
| 200 | 200 | | 68 | 13 x 25 | | | | ESH686M200AL4(1) |
| 200 | | | | | | | | ` ' |
| 200 | | | | | | | | ` ' |
| 250 330 | | | | | | | | ` ' |
| 250 300 1.0 6.3 x 11 15 17 17.5 ESH105M320AE3(1) 250 300 3.3 8 x 11 15 29 2.6.5 ESH25M320AE3(2) 250 300 3.3 8 x 11 15 52 4.5 34.8 ESH335M320AG3(1) 250 300 6.8 8 x 11 15 52 4.5 S ESH35M320AG3(1) 250 300 10 10 10 x 12.5 15 80 8.5 0 ESH66M320AG3(1) 250 300 15 10 x 15 15 10 10 12.5 55 30 300 15 10 x 15 15 10 10 12.5 55 30 300 15 10 x 20 15 140 175.0 ESH25M320AH2(1) 250 300 333 13 x 20 15 200 237.5 ESH35M320AL3(1) 250 300 33 13 x 20 15 200 237.5 ESH35M320AL3(1) 250 300 68 13 x 25 15 240 36.2 ESH476M320AL4(1) 250 300 68 13 x 25 15 240 36.2 ESH476M320AL4(1) 250 300 150 16 x 32 15 400 ESH66M320AH2(1) 250 300 150 16 x 32 15 680 160.0 ESH27M320AM2(1) 250 300 150 16 x 32 15 680 160.0 ESH27M320AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 5 380 70.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 5 380 70.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 5 380 70.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 5 380 70.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 5 380 70.0 ESH157M320AM2(1) 250 300 150 16 x 32 15 5 5 60 60 ESH35M30AM3(1) 250 400 1.0 63 x 11 20 16 20.5 ESH157M350AM2(1) 250 300 150 16 x 32 15 5 60 60 ESH35M30AM3(1) 250 400 1.0 63 x 11 20 16 20.5 ESH157M350AM2(1) 250 300 150 16 x 32 20 150 150 20 0 115 15 ESH156M30AM3(1) 250 400 3.3 8 x 11 20 31 33 1 ESH25M350AM3(1) 250 400 10 10 10 10 10 10 10 10 10 10 10 10 1 | | | | | | | | . , |
| 250 300 2.2 6.3 x 11 15 29 26.5 ESH22SM250AE2(1) 250 300 4.7 8 x 11 15 42 34.8 ESH33SM250AE2(1) 250 300 4.7 8 x 11 15 62 45.3 ESH475M250A3(1) 250 300 10 10 x 12.5 15 10 10 ESH65M250A3(1) 250 300 15 10 x 12.5 15 110 12.2 5 ESH166M250AH2(1) 250 300 22 10 x 20 15 140 175.0 ESH22SM250AH2(1) 250 300 22 10 x 20 15 200 257.5 ESH32SM250AH2(1) 250 300 47 13 x 25 15 200 257.5 ESH32SM250AH2(1) 250 300 47 13 x 25 15 200 257.5 ESH36M250AH2(1) 250 300 100 10 16 x 25 15 240 362.5 ESH475M250AH2(1) 250 300 150 16 x 32 15 200 ESH66M250AH2(1) 250 300 100 16 x 25 15 240 362.5 ESH475M250AH2(1) 250 300 100 16 x 25 15 200 ESH66M250AH2(1) 250 300 150 16 x 32 15 200 ESH66M250AH2(1) 250 300 150 16 x 32 15 420 1135.0 ESH57M250AH2(1) 250 300 150 16 x 32 15 420 1135.0 ESH57M250AH2(1) 250 300 220 18 x 36 15 680 1660.0 ESH27M250AH2(1) 250 300 120 18 x 36 15 680 1660.0 ESH27M250AH2(1) 350 400 2.2 8 x 11 20 16 20.5 ESH105M250AH2(1) 350 400 4.7 8 x 11 20 35 447 ESH35M350AG3(1) 350 400 4.7 8 x 11 20 35 447 ESH35M350AG3(1) 350 400 4.7 8 x 11 20 35 447 ESH35M350AG3(1) 350 400 4.7 8 x 11 20 35 447 ESH35M350AG3(1) 350 400 4.7 8 x 11 20 35 44.7 ESH35M350AG3(1) 350 400 4.7 8 x 11 20 35 54.4 ESH475M350AG3(1) 350 400 4.7 8 x 11 20 35 54.4 ESH475M350AG3(1) 350 400 47 16 x 25 20 20 150 241.0 ESH22SM350AG3(1) 350 400 47 16 x 25 20 20 150 241.0 ESH22SM350AG3(1) 350 400 47 16 x 25 20 20 150 241.0 ESH22SM350AG3(1) 400 450 4.7 10 x 15 20 80 115.0 ESH160M350AH2(1) 400 450 4.7 10 x 12.5 20 45 6.4 ESH475M30AG3(1) 400 450 4.7 10 x 12.5 20 80 130.0 ESH160M350AH2(1) 400 450 4.7 10 x 12.5 20 55 66.4 ESH475M30AG3(1) 400 450 4.7 10 x 12.5 20 55 66.4 ESH475M30AGA(1) 400 450 4.7 10 x 12.5 20 55 66.4 ESH475M30AGA(1) 400 450 4.7 10 x 12.5 20 55 66.4 ESH475M30AGA(1) 400 450 450 4.7 10 x 12.5 20 55 66.4 ESH475M30AGA(1) 400 450 450 47 10 x 12.5 20 50 50 66.4 ESH475M30AGA(1) 400 450 450 47 10 x 12.5 20 50 50 66.4 ESH475M30AGA(1) 400 450 68 18 x 22 20 400 100 ESH166M30AGA(1) 400 450 68 18 x 22 20 400 60 68 19 x 22 ESH160M30AGA(1) 400 450 68 18 x 22 20 500 120 ESH160M30AGA(1) 40 | | | | | | | | . , |
| 250 300 3.3 8 x 11 15 42 34.8 ESH335M250A32(1) 250 300 6.8 8 x 11 15 52 45.3 ESH35M250A32(1) 250 300 10 10 10 x 12.5 15 80 85.0 ESH65M250A32(1) 250 300 15 10 x 15 15 10 10 12.5 55 250 300 15 10 x 15 15 110 12.5 ESH55M250A32(1) 250 300 30 33 13 x 20 15 200 257.5 ESH350M250A12(1) 250 300 33 13 x 20 15 200 257.5 ESH350M250A12(1) 250 300 47 13 x 25 15 200 257.5 ESH350M250A12(1) 250 300 68 13 x 25 15 200 52.0 ESH65M250A12(1) 250 300 160 16 x 25 15 380 70.0 ESH65M250A12(1) 250 300 150 16 x 25 15 380 70.0 ESH65M250A12(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M250AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M250AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M250AM2(1) 250 300 100 16 x 25 15 420 1135.0 ESH157M250AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M250AM2(1) 250 300 100 10 16 x 20 15 5 40 1135.0 ESH157M250AM2(1) 250 300 150 16 x 32 15 420 1135.0 ESH157M250AM2(1) 250 300 100 10 16 x 20 15 5 50 50 50 50 50 50 50 50 50 50 50 50 | | | | | | | | |
| 250 300 4.7 8 x 11 15 52 45.3 ESH-75M250AS3(1) 250 300 10 10 10 x 12.5 15 80 85.0 ESH16M250AH9(1) 250 300 15 10 10 x 15 15 110 122.5 ESH156M250AH9(1) 250 300 22 10 x 20 15 140 175.0 ESH26M250AH9(1) 250 300 33 13 x 20 15 200 257.5 ESH256M250AH2(1) 250 300 47 13 x 25 15 200 257.5 ESH256M250AH3(1) 250 300 47 13 x 25 15 240 362.5 ESH36M250AL3(1) 250 300 100 16 x 25 15 240 362.5 ESH36M250AL4(1) 250 300 100 16 x 25 15 380 760.0 ESH167M250AL4(1) 250 300 150 16 x 25 15 380 760.0 ESH167M250AL4(1) 250 300 220 18 x 36 15 680 1660.0 ESH177M250AM2(1) 250 300 220 18 x 36 15 680 1660.0 ESH27M250AL2(1) 250 300 400 1.0 6.3 x 11 20 16 20.5 ESH36M250AS(1) 350 400 2.2 8 x 11 20 31 33.1 ESH252M350AS(1) 350 400 4.7 8 x 11 20 35 4.4 7 ESH35M350AS(1) 350 400 4.7 8 x 11 20 35 4.4 7 ESH35M350AS(1) 350 400 4.7 8 x 11 20 35 4.4 7 ESH35M350AS(1) 350 400 4.7 8 x 11 20 35 5.4 7 ESH35M350AS(1) 350 400 10 10 10 x 15 20 80 115.0 ESH16M350AS(1) 350 400 22 13 x 20 20 150 241.0 ESH26M350AS(1) 350 400 47 16 x 25 20 20 150 241.0 ESH26M350AL(1) 350 400 47 16 x 25 20 20 56 50.5 ESH26M350AS(1) 350 400 47 16 x 25 20 20 66 503.5 ESH36M350A(1) 350 400 47 16 x 25 20 20 66 503.5 ESH36M350A(1) 350 400 47 16 x 25 20 20 66 503.5 ESH36M350A(1) 350 400 47 16 x 25 20 20 66 503.5 ESH36M350A(1) 350 400 450 1.0 6.3 x 11 20 17 22.0 ESH105M30A(1) 400 450 1.0 6.3 x 11 20 17 22.0 ESH105M30A(1) 400 450 4.7 8 x 11 20 35 4.6 ESH25M30A(1) 400 450 4.7 10 x 12.5 20 55 66.4 ESH35M30A(1) 400 450 4.7 10 x 12.5 20 55 66.4 ESH35M30A(1) 400 450 4.7 10 x 12.5 20 55 66.4 ESH35M40A(3(1) 400 450 4.7 10 x 12.5 20 50 50 66 ESH375M40OA(1) 400 450 6.8 18 x 11 20 31 31 30.0 ESH106M30A(1) 400 450 6.8 18 x 11 20 35 54.0 ESH36M40A(1) 400 450 6.8 18 x 11 20 35 66.4 ESH375M40OA(1) 400 450 6.8 18 x 11 20 35 66.4 ESH375M40OA(1) 400 450 6.8 18 x 12 20 30 66 50 51.6 ESH36M40OA(1) 400 450 6.8 18 x 12 20 30 60 66.4 ESH375M40OA(1) 400 450 6.8 18 x 25 20 30 60 ESH36M40OA(1) 400 450 6.8 18 x 25 20 30 60 ESH36M40OA(1) 400 450 6.8 18 x 25 20 30 60 ESH36M40OA(1) 400 450 6.8 18 x 25 20 30 60 ESH36M40OA(1) 40 | | | | | | | | . , |
| 250 300 6.8 8 x 11 15 62 61.0 EBH6SM250A32(1) 250 300 10 10 10 x 12.5 15 80 85.0 EBH6SM250A32(1) 250 300 15 10 x 12.5 15 110 122.5 EBH156M250AH2(1) 250 300 322 10 x 20 15 140 175.0 EBH56M250AH2(1) 250 300 33 31 3 x 20 15 200 257.5 EBH36M250AH2(1) 250 300 47 13 x 25 15 240 362.5 EBH36M250AH2(1) 250 300 68 13 x 25 15 240 362.5 EBH36M250AH2(1) 250 300 100 10 10 x 25 15 380 76.0 EBH66M250AH2(1) 250 300 150 16 x 25 15 380 76.0 EBH167M250AM2(1) 250 300 150 16 x 22 15 420 113.5 EBH157M250AM2(1) 250 300 150 16 x 22 15 420 113.5 EBH157M250AM2(1) 250 300 10 0 10 6.8 x 11 20 16 20.5 EBH167M250AM2(1) 350 400 1.0 6.8 x 11 20 16 20.5 EBH167M250AM2(1) 350 400 3.3 8 x 11 20 35 47 EBH25M250AG2(1) 350 400 10 10 10 10 x 15 20 35 44 7 EBH35M250AG2(1) 350 400 10 10 10 10 x 15 20 80 115.0 EBH167M250AG2(1) 350 400 10 10 10 x 15 20 80 115.0 EBH6M350AH2(1) 350 400 10 10 10 x 15 20 80 115.0 EBH6M350AH2(1) 350 400 10 10 10 x 15 20 80 115.0 EBH6M350AH2(1) 350 400 10 10 10 x 15 20 80 115.0 EBH6M350AH2(1) 350 400 10 10 10 x 15 20 80 115.0 EBH6M350AH2(1) 350 400 33 13 x 25 20 200 355.5 EBH36M350A(1) 350 400 33 3 13 x 25 20 200 355.5 EBH36M350AH2(1) 350 400 33 3 13 x 25 20 200 355.5 EBH36M350AH2(1) 350 400 450 47 10 x 15 20 80 115.0 EBH6M350AH2(1) 350 400 100 18 x 32 20 400 166.0 EBH707M350AM1(1) 400 450 47 10 x 12.5 20 80 15.0 EBH6M350AH2(1) 400 450 47 10 x 12.5 20 80 EBH6M36M36AH2(1) 400 450 47 10 x 12.5 20 80 EBH6M36M36AH2(1) 400 450 47 10 x 12.5 20 80 EBH6M36M36AH2(1) 400 450 68 10 x 22 20 10 10 10 10 10 10 x 15 20 80 EBH6M36M36AH2(1) 400 450 68 10 x 22 20 10 10 10 10 10 10 x 15 20 80 EBH6M36M36AH2(1) 400 450 68 10 x 22 20 30 40 EBH35M40AAH2(1) 400 450 68 10 x 22 20 30 45 5 5 64 EBH35M40AAH2(1) 400 450 68 10 x 22 20 30 45 5 5 5 64 EBH35M40AAH2(1) 400 450 68 10 x 22 20 30 45 5 5 5 69 2 EBH6SM40AAH2(1) 400 450 68 10 x 22 20 30 30 5 5 5 69 2 EBH6SM40AAH2(1) 400 450 68 10 x 22 30 30 30 5 5 5 69 2 EBH6SM40AAH2(1) 400 450 68 10 x 22 30 30 30 5 5 5 69 2 EBH6SM40AAH2(1) 400 450 68 10 x 22 30 30 30 5 5 5 69 2 EBH6SM40AAH2(1) 400 450 10 10 10 x 20 | | | | | | | | . , |
| 250 300 10 10 10 x 12.5 15 80 85.0 ESHIGMESOAH9(1) 250 300 15 10 x 15 15 110 122.5 ESHISSMESOAH9(1) 250 300 22 10 x 20 15 140 175.0 ESH2SMESOAH9(1) 250 300 33 3 x 20 15 200 257.5 ESH2SMESOAH4(1) 250 300 300 47 13 x 25 15 200 362.5 ESH3SMESOAH4(1) 250 300 100 16 x 25 15 240 362.5 ESH3SMESOAH4(1) 250 300 100 16 x 25 15 380 760.0 ESH1SMESOAH4(1) 250 300 100 16 x 25 15 380 760.0 ESH1SMESOAH4(1) 250 300 100 15 10 x 25 15 420 1135.0 ESH1SMESOAH4(1) 250 300 150 16 x 32 15 420 1135.0 ESH1SMESOAH4(1) 250 300 150 16 x 32 15 420 1135.0 ESH1SMESOAH4(1) 250 300 120 18 x 36 15 680 1660.0 ESH2ZMESOAH2(1) 250 300 120 18 x 36 15 680 1660.0 ESH2ZMESOAH2(1) 350 400 3.3 8 x 11 20 35 44.7 ESH3SMESOAH3(1) 350 400 3.3 8 x 11 20 35 44.7 ESH3SMESOAH3(1) 350 400 10 10 10 x 15 20 80 115.0 ESH1SMESOAH3(1) 350 400 10 10 10 x 15 20 80 115.0 ESH1SMESOAH2(1) 350 400 33 3 18 x 11 20 35 44.7 ESH3SMESOAH2(1) 350 400 10 10 x 10 x 15 20 80 115.0 ESH1SMESOAH2(1) 350 400 33 3 18 x 25 20 20 80 115.0 ESH1SMESOAH2(1) 350 400 10 10 x 10 x 15 20 80 115.0 ESH1SMESOAH2(1) 350 400 10 10 x 10 x 15 20 80 115.0 ESH1SMESOAH2(1) 350 400 10 10 x 10 x 15 20 80 115.0 ESH1SMESOAH2(1) 350 400 33 3 18 x 25 20 20 00 356.5 ESH3SMESOAH2(1) 350 400 100 18 x 32 20 400 1660.0 ESH1OTMSSOAH2(1) 400 450 4.7 8 x 11 20 35 40 40 ESH1OTMSSOAH(1) 400 450 4.7 10 x 15 20 45 66.4 ESH3SMMSOAH4(1) 400 450 4.7 10 x 15 20 55 66.4 ESH3SMMSOAH4(1) 400 450 4.7 10 x 15 20 80 130 ESH1OTMSSOAH(1) 400 450 4.7 10 x 15 20 60 66.4 ESH3TMMOOAH(1) 400 450 4.7 10 x 15 20 60 66.4 ESH3TMMOOAH(1) 400 450 4.7 10 x 15 20 60 66.4 ESH3TMMOOAH(1) 400 450 4.7 10 x 15 20 55 66.4 ESH3TMMOOAH(1) 400 450 4.7 10 x 15 20 50 60 66.4 ESH3TMMOOAH(1) 400 450 4.7 10 x 15 20 60 66.4 ESH3TMMOOAH(1) 400 450 4.7 10 x 15 20 60 66.4 ESH3TMMOOAH(1) 400 450 6.8 8 x 11 20 35 40 6 ESH3SMMOOAH(1) 400 450 6.8 8 x 11 20 35 56 60 ESH3SMMOOAH(1) 400 450 6.8 8 x 11 20 35 56 60 ESH3SMMOOAH(1) 400 450 6.8 8 x 11 20 35 56 60 ESH3SMMOOAH(1) 400 450 6.8 8 x 15 20 60 66 60 ESH3SMMOOAH(1) 400 450 6.8 8 x 15 20 60 66 60 ESH3SMMOOAH(1) 400 450 6 | | | | | | | | ` ' |
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| 400 450 68 16 x 32 20 410 826.0 ESH686M400AM2(1) 400 450 68 18 x 25 20 390 826.0 ESH686M400AN5(1) 400 450 100 18 x 32 20 500 1210.0 ESH107M400AN1(1) 400 450 120 18 x 32 20 520 1450.0 ESH127M400AN1(1) 400 450 120 18 x 36 20 550 1450.0 ESH127M400AN2(1) 400 450 150 18 x 40 20 620 1810.0 ESH157M400AN3(1) 420 470 1.0 6.3 x 11 20 17 22.6 ESH105M420AE3(1) 420 470 2.2 8 x 11 20 29 37.7 ESH25EM420AG3(1) 420 470 3.3 8 x 11 20 34 51.6 ESH335M420AG3(1) 420 470 4.7 10 x 12.5 20 55 69.2 ESH475M420AH9(1) | | | | | | | | |
| 400 450 68 18 x 25 20 390 826.0 ESH686M400AN5(1) 400 450 100 18 x 32 20 500 1210.0 ESH107M400AN1(1) 400 450 120 18 x 32 20 520 1450.0 ESH127M400AN1(1) 400 450 120 18 x 36 20 550 1450.0 ESH127M400AN2(1) 400 450 150 18 x 40 20 620 1810.0 ESH157M400AN3(1) 420 470 1.0 6.3 x 11 20 17 22.6 ESH105M420AE3(1) 420 470 2.2 8 x 11 20 29 37.7 ESH225M420AG3(1) 420 470 3.3 8 x 11 20 34 51.6 ESH335M420AG3(1) 420 470 4.7 10 x 12.5 20 55 69.2 ESH475M420AH9(1) 420 470 6.8 10 x 15 20 68 95.7 ESH685M420AH2(1) | | | | | | | | |
| 400 450 100 18 x 32 20 500 1210.0 ESH107M400AN1(1) 400 450 120 18 x 32 20 520 1450.0 ESH127M400AN1(1) 400 450 120 18 x 36 20 550 1450.0 ESH127M400AN2(1) 400 450 150 18 x 40 20 620 1810.0 ESH157M400AN3(1) 420 470 1.0 6.3 x 11 20 17 22.6 ESH105M420AE3(1) 420 470 2.2 8 x 11 20 29 37.7 ESH225M420AG3(1) 420 470 3.3 8 x 11 20 34 51.6 ESH335M420AG3(1) 420 470 4.7 10 x 12.5 20 55 69.2 ESH475M420AH9(1) 420 470 6.8 10 x 15 20 68 95.7 ESH685M420AH2(1) 420 470 10 10 x 20 20 98 136.0 ESH106M420AH4(1) | 400 | | | 18 x 25 | | 390 | | ESH686M400AN5(1) |
| 400 450 120 18 x 36 20 550 1450.0 ESH127M400AN2(1) 400 450 150 18 x 40 20 620 1810.0 ESH157M400AN3(1) 420 470 1.0 6.3 x 11 20 17 22.6 ESH105M420AE3(1) 420 470 2.2 8 x 11 20 29 37.7 ESH225M420AG3(1) 420 470 3.3 8 x 11 20 34 51.6 ESH335M420AG3(1) 420 470 4.7 10 x 12.5 20 55 69.2 ESH475M420AH9(1) 420 470 6.8 10 x 15 20 68 95.7 ESH685M420AH2(1) 420 470 10 10 x 20 20 98 136.0 ESH106M420AH4(1) 420 470 15 13 x 20 20 130 199.0 ESH156M420AL3(1) | | | | | 20 | | | |
| 400 450 150 18 x 40 20 620 1810.0 ESH157M400AN3(1) 420 470 1.0 6.3 x 11 20 17 22.6 ESH105M420AE3(1) 420 470 2.2 8 x 11 20 29 37.7 ESH225M420AG3(1) 420 470 3.3 8 x 11 20 34 51.6 ESH335M420AG3(1) 420 470 4.7 10 x 12.5 20 55 69.2 ESH475M420AH9(1) 420 470 6.8 10 x 15 20 68 95.7 ESH685M420AH2(1) 420 470 10 10 x 20 20 98 136.0 ESH106M420AH4(1) 420 470 15 13 x 20 20 130 199.0 ESH156M420AL3(1) | | | | | | | | ` , |
| 420 470 1.0 6.3 x 11 20 17 22.6 ESH105M420AE3(1) 420 470 2.2 8 x 11 20 29 37.7 ESH225M420AG3(1) 420 470 3.3 8 x 11 20 34 51.6 ESH335M420AG3(1) 420 470 4.7 10 x 12.5 20 55 69.2 ESH475M420AH9(1) 420 470 6.8 10 x 15 20 68 95.7 ESH685M420AH2(1) 420 470 10 10 x 20 20 98 136.0 ESH106M420AH4(1) 420 470 15 13 x 20 20 130 199.0 ESH156M420AL3(1) | | | | | | | | |
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| 420 470 4.7 10 x 12.5 20 55 69.2 ESH475M420AH9(1) 420 470 6.8 10 x 15 20 68 95.7 ESH685M420AH2(1) 420 470 10 10 x 20 20 98 136.0 ESH106M420AH4(1) 420 470 15 13 x 20 20 130 199.0 ESH156M420AL3(1) | | | | | | | | |
| 420 470 6.8 10 x 15 20 68 95.7 ESH685M420AH2(1) 420 470 10 10 x 20 20 98 136.0 ESH106M420AH4(1) 420 470 15 13 x 20 20 130 199.0 ESH156M420AL3(1) | | | | | | | | ` , |
| 420 470 10 10 x 20 20 98 136.0 ESH106M420AH4(1) 420 470 15 13 x 20 20 130 199.0 ESH156M420AL3(1) | | | | | | | | () |
| 420 470 15 13 x 20 20 130 199.0 ESH156M420AL3(1) | | | | | | | | ` ' |
| | | | | | | | | |
| | — | | | | | | | |

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

^{*} 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 25°C (tan δ %)* | RC 120 Hz 105°C (mA) | LC 20°C 2 minutes (µA) | Part Number |
|-----|----------------------|--|-------------------------|------------------------------------|-------------------------------|------------------------------|------------------|
| 420 | 470 | 22 | 13 x 25 | 20 | 155 | 287.2 | ESH226M420AL4(1) |
| 420 | 470 | 33 | 16 x 25 | 20 | 205 | 425.8 | ESH336M420AM7(1) |
| 420 | 470 | 47 | 16 x 25 | 20 | 235 | 602.2 | ESH476M420AM7(1) |
| 420 | 470 | 68 | 16 x 32 | 20 | 400 | 866.8 | ESH686M420AM2(1) |
| 420 | 470 | 68 | 18 x 25 | 20 | 380 | 866.8 | ESH686M420AN5(1) |
| 420 | 470 | 100 | 18 x 36 | 20 | 490 | 1270.0 | ESH107M420AN2(1) |
| 420 | 470 | 120 | 18 x 40 | 20 | 430 | 1522.0 | ESH127M420AN3(1) |
| 420 | 470 | 150 | 18 x 45 | 20 | 570 | 1900.0 | ESH157M420AN7(1) |
| 450 | 500 | 1.0 | 6.3 x 11 | 20 | 18 | 23.5 | ESH105M450AE3(1) |
| 450 | 500 | 1.0 | 8 x 11 | 20 | 22 | 23.5 | ESH105M450AG3(1) |
| 450 | 500 | 2.2 | 8 x 11 | 20 | 30 | 39.7 | ESH225M450AG3(1) |
| 450 | 500 | 2.2 | 10 x 12.5 | 20 | 37 | 39.7 | ESH225M450AH9(1) |
| 450 | 500 | 3.3 | 8 x 15 | 20 | 42 | 54.6 | ESH335M450AG4(1) |
| 450 | 500 | 3.3 | 10 x 12.5 | 20 | 40 | 54.6 | ESH335M450AH9(1) |
| 450 | 500 | 4.7 | 10 x 12.5 | 20 | 52 | 73.5 | ESH475M450AH9(1) |
| 450 | 500 | 6.8 | 10 x 15 | 20 | 62 | 101.8 | ESH685M450AH2(1) |
| 450 | 500 | 10 | 10 x 20 | 20 | 85 | 145.0 | ESH106M450AH4(1) |
| 450 | 500 | 15 | 13 x 20 | 20 | 120 | 212.5 | ESH156M450AL3(1) |
| 450 | 500 | 22 | 13 x 25 | 20 | 150 | 307.0 | ESH226M450AL4(1) |
| 450 | 500 | 33 | 16 x 25 | 20 | 210 | 455.5 | ESH336M450AM7(1) |
| 450 | 500 | 47 | 16 x 25 | 20 | 260 | 644.5 | ESH476M450AM7(1) |
| 450 | 500 | 68 | 18 x 32 | 20 | 370 | 928.0 | ESH686M450AN1(1) |
| 450 | 500 | 100 | 18 x 36 | 20 | 495 | 1360.0 | ESH107M450AN2(1) |
| 450 | 500 | 120 | 18 x 40 | 20 | 565 | 1630.0 | ESH127M450AN3(1) |
| 450 | 500 | 150 | 18 x 45 | 20 | 650 | 2035.0 | ESH157M450AN7(1) |
| 500 | 550 | 2.2 | 8 x 11 | 25 | 25 | 144.0 | ESH225M500AG3(1) |
| 500 | 550 | 3.3 | 8 x 16 | 25 | 30 | 166.0 | ESH335M500AG8(1) |
| 500 | 550 | 4.7 | 8 x 16 | 25 | 34 | 194.0 | ESH475M500AG8(1) |
| 500 | 550 | 4.7 | 10 x 12.5 | 25 | 38 | 194.0 | ESH475M500AH9(1) |
| 500 | 550 | 6.8 | 10 x 16 | 25 | 50 | 236.0 | ESH685M500AH8(1) |
| 500 | 550 | 8.2 | 10 x 20 | 25 | 65 | 264.0 | ESH825M500AH4(1) |
| 500 | 550 | 10 | 10 x 20 | 25 | 70 | 300.0 | ESH106M500AH4(1) |
| 500 | 550 | 10 | 13 x 20 | 25 | 85 | 300.0 | ESH106M500AL3(1) |
| 500 | 550 | 15 | 13 x 25 | 25 | 100 | 400.0 | ESH156M500AL4(1) |
| 500 | 550 | 22 | 13 x 25 | 25 | 115 | 540.0 | ESH226M500AL4(1) |
| 500 | 550 | 22 | 16 x 25 | 25 | 130 | 540.0 | ESH226M500AM7(1) |
| 500 | 550 | 33 | 18 x 25 | 25 | 180 | 760.0 | ESH336M500AN5(1) |
| 500 | 550 | 47 | 16 x 32 | 25 | 180 | 1040.0 | ESH476M500AM2(1) |
| 500 | 550 | 47 | 18 x 30 | 25 | 230 | 1040.0 | ESH476M500AN8(1) |
| 500 | 550 | 68 | 18 x 32 | 25 | 250 | 1460.0 | ESH686M500AN1(1) |
| 500 | 550 | 68 | 18 x 36 | 25 | 290 | 1460.0 | ESH686M500AN2(1) |
| 500 | 550 | 82 | 18 x 40 | 25 | 335 | 1740.0 | ESH826M500AN3(1) |
| VDC | VDC Surge | Rated Capacitance | Case Size | DF | RC | LC | Part Number |

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

^{*} When capacitance exceeds 1,000 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 $V_p \le 160$ 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

Electrical Ratings: Capacitance (ESC)



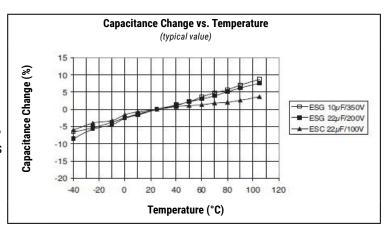
Simplified equivalent circuit diagram of an electrolytic capacitor

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

Temperature Dependence of the Capacitance

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

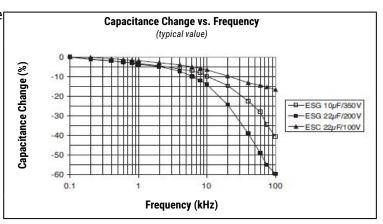
Capacitance will decrease if temperature decreases. Furthermore, temperature drifts cause armature dilatation and, therefore, capacitance changes (up to 20% depending on the series considered, from 0 to 80°C). This phenomenon is more evident for electrolytic capacitors than for other types.



Frequency Dependence of the Capacitance

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

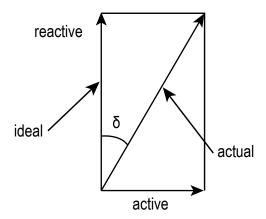
$$C = \frac{1}{2\pi \text{ fZ}} \frac{\text{C = Capacitance (F)}}{\text{f = Frequency (Hz)}}$$
$$Z = \text{Impedance (Ω)}$$





Dissipation Factor tan δ (DF)

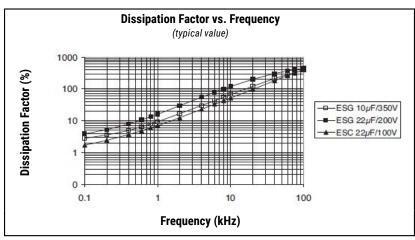
Dissipation Factor $\tan \delta$ is the ratio between the active and reactive power for a sinusoidal waveform voltage. It can be thought of as a measurement of the gap between an actual and ideal capacitor.

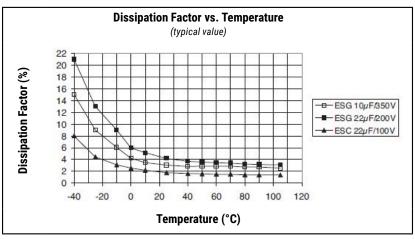


Tan δ is measured with the same set-up used for the series capacitance ESC. tan δ = ω x ESC x ESR where:

ESC = Equivalent Series Capacitance

ESR = Equivalent Series Resistance



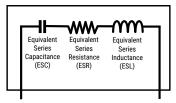




Equivalent Series Inductance (ESL)

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



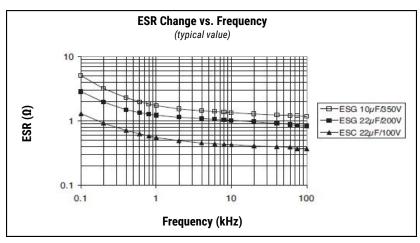


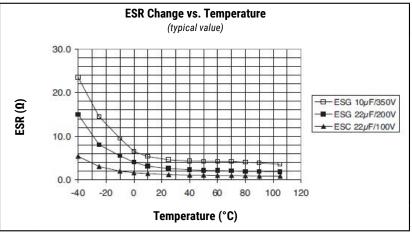
Equivalent Series Resistance (ESR)

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:

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

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

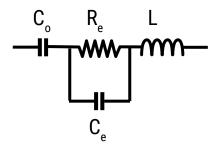






Impedance (Z)

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



 $C_{_{\alpha}}$ = Aluminum oxide capacitance (surface and thickness of the dielectric)

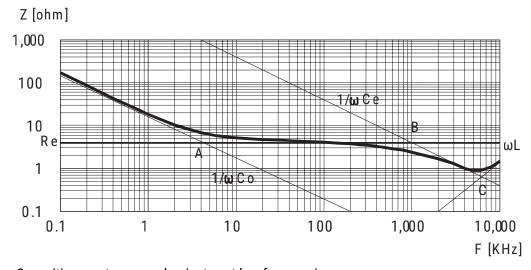
 R_{e} = Resistance of electrolyte and paper mixture (other resistances not depending on the frequency are not considered: tabs, plates, etc.)

C_a = Electrolyte soaked paper capacitance

L = Inductive reactance of the capacitor winding and terminals

Impedance of an electrolytic capacitor is not a constant quantity that retains its value under all conditions; it changes depending on frequency and temperature.

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



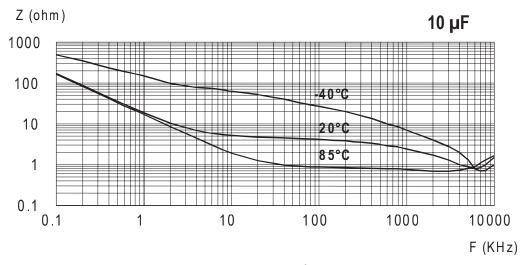
- Capacitive reactance predominates at low frequencies
- With increasing frequency, capacitive reactance $Xc = 1/\omega C_o$ decreases until it reaches the order of magnitude of electrolyte resistance $R_e(A)$
- At even higher frequencies, resistance of the electrolyte predominates: Z = R_a (A B)
- When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

Generally speaking, it can be estimated that $C_p \approx 0.01 C_0$.



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:



٧, = Forming voltage

If this level is exceeded, a large quantity of heat and gas will be generated and the capacitor could be damaged.

V_D = Rated Voltage

This level represents the top of the linear part of the curve.

V_s = Surge voltage

This lies between V_R and V_F . The capacitor can be subjected to V_S for short periods only.

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

Ripple Current (RC)

The maximum ripple current value depends on:

- Ambient temperature
- Surface area of the capacitor (heat dissipation area)

tan δ or ESR

Frequency

The capacitor's life depends on the thermal stress.

Frequency Dependence of the Ripple Current

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

Temperature Dependence of the Ripple Current

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

Expected Life Calculation

Expected life depends on operating temperature according

to the following formula: $L = Lo \times 2^{(To-T)/10}$

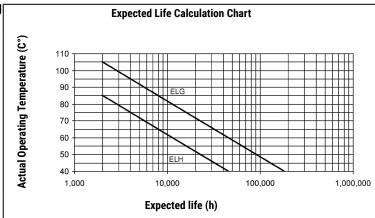
Where:

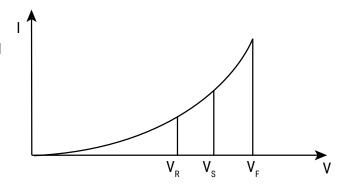
L: Expected life

Lo: Load life at maximum permissible operating temperature

T: Actual operating temperature

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





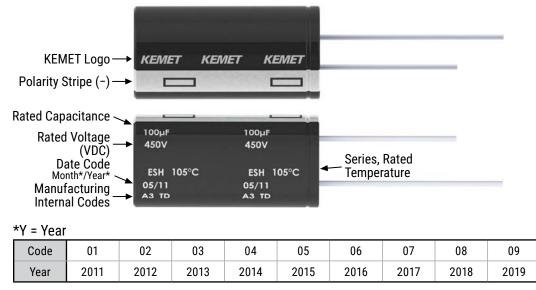


Packaging Quantities

| | | | Вι | 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 | | |
| G8 | 8 | 16 | 5000 | 5000 | 1000 | 1500 | | |
| Н9 | 10 | 12.5 | 4000 | 4000 | 700 | 1200 | | |
| H2 | 10 | 15 | 3000 | 4000 | 700 | 1200 | | |
| Н8 | 10 | 16 | 3000 | 4000 | 700 | 1200 | | |
| H4 | 10 | 20 | 2400 | 3000 | 700 | 1200 | | |
| L3 | 13 | 20 | 2000 | 2000 | 500 | | | |
| L4 | 13 | 25 | 1600 | 1600 | 500 | | | |
| М7 | 16 | 25 | 1000 | 500 | 300 | | | |
| M2 | 16 | 32 | 800 | 500 | 300 | | | |
| М3 | 16 | 36 | 600 | 500 | 300 | | | |
| N5 | 18 | 25 | 800 | 500 | 300 | | | |
| N8 | 18 | 30 | 800 | 500 | | | | |
| N1 | 18 | 32 | 500 | 500 | | | | |
| N2 | 18 | 36 | 500 | 500 | | | | |
| N3 | 18 | 40 | 500 | 500 | | | | |
| N7 | 18 | 45 | 500 | 500 | | | | |

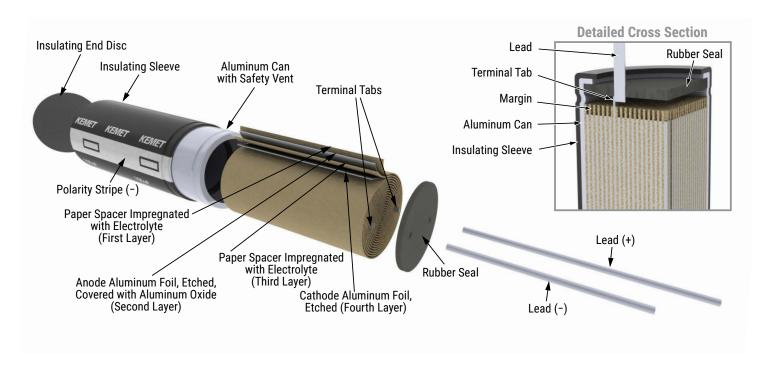


Marking



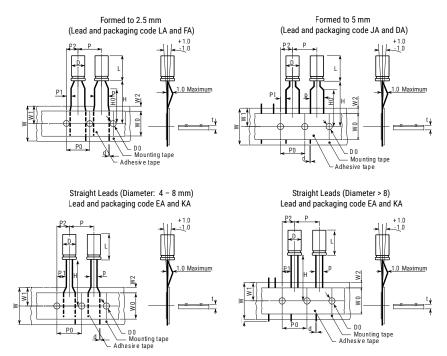
| - | | | | | | | | | | | | | |
|---|-------|----|----|----|----|----|----|----|----|----|----|----|----|
| | Code | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
| | Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |

Construction





Taping for Automatic Insertion Machines

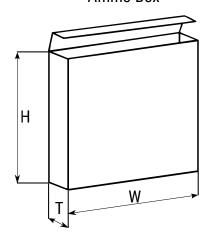


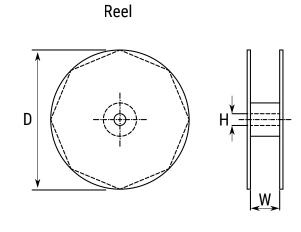
| Dimensions (mm) | D | L | р | d | P | P0 | P1 | P2 | W | W0 | W 1 | W2 | НО | H1 | I | D0 | t |
|---------------------|------|-------|-----------|-------|-------|------|-------|-------|---------|------|------------|---------|-------|------|---------|------|------|
| Tolerance | +0.5 | | +0.8/-0.2 | ±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 |
| F 1. 0.5 | 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 |
| | Э | >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 |
| | 3 | >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 |
| | U | >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 |
| | 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 |
| 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 |
| | 10 | 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 | 8.0 | 30 | 30 | 3.75 | 7.5 | 18 | 12 | 11 | 3 | 18.5 | | 1 | 4 | 1 |



Lead Taping & Packaging

Ammo Box





| | | 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 | 20 | Ε0 | | | |
| 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 | 1 | | | | | |



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.

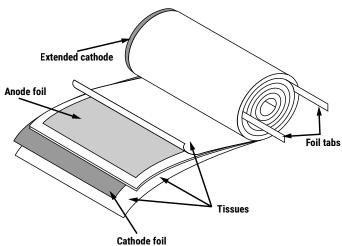
The following tests are applied and may be varied at the request of the customer. In this case the batch, or special procedure, will determine the course of action.

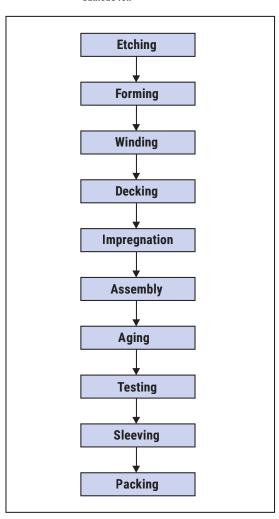
Electrical:

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

Mechanical/Visual:

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







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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.

Mouser Electronics

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| ESH107M016AE3AA | ESH107M025AE3AA | ESH107M035AE3AA | ESH107M035AG3AA | ESH107M050AG3AA |
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| ESH227M035AH1AA | ESH227M050AH1AA | ESH227M050AH2AA | ESH228M025AM7AA | ESH228M035AM7AA |
| ESH335M050AC3AA | ESH336M035AC3AA | ESH336M050AE3AA | ESH337M050AH4AA | ESH475M050AC3AA |
| ESH476M016AC3AA | ESH476M025AC3AA | ESH476M063AE3AA | ESH477M025AH1AA | ESH477M025AH2AA |
| ESH477M035AH3AA | ESH477M035AL3AA | ESH477M050AL3AA | ESH478M035AN2AA | ESH476M100AH2AA |
| ESH227M010AE3AA | ESH227M016AE3AA | ESH107M025AE3DA | ESH108M035AL4AA | ESH338M010AL3AA |
| ESH477M010AE3AA | ESH108M010AH1AA | ESH107M200AM7AA | ESH337M025AG3AA | ESH108M050AL4AA |
| ESH226M016AC3DA | ESH336M050AC3AA | ESH226M035AC3AA | ESH107M100AL3AA | ESH225M450AH1AA |
| ESH106M400AH4AA | | | | |