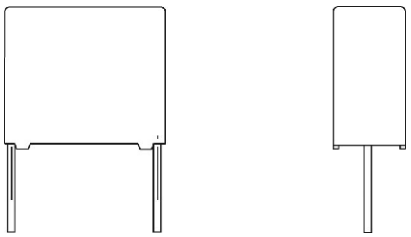
# AC and Pulse Double Metallized Polypropylene Film Capacitors MMKP Radial Potted Type



## FEATURES

- 7.5 mm to 37.5 mm lead pitch; 7.5 mm bent back pitch
- Low contact resistance
- Low loss dielectric
- Small dimensions for high density packaging
- Supplied loose in box and taped on reel or ammopack
- Mounting: radial
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

## APPLICATIONS

- Where steep pulses occur e.g. SMPS (switch mode power supplies)
- Electronic lighting e.g. ballast
- Motor control circuits
- S-correction
- For flyback applications please use 1400 V series

| QUICK REFERENCE DATA | |
|---|---|
| Capacitance range (E24 series) | 0.00047 µF to 4.7 µF |
| Capacitance tolerance | ± 5 % |
| Climatic testing class according to IEC 60068-1 | 55/105/56 |
| Rated DC temperature | 85 °C |
| Rated AC temperature | 105 °C |
| Maximum application temperature | 105 °C |
| Reference specifications | IEC 60384-17 |
| Dielectric | Polypropylene film |
| Electrodes | Metallized |
| Construction | Mono and internal serial construction |
| Encapsulation | Flame retardant plastic case and epoxy resin UL-class 94 V-0 |
| Leads | Tinned wire |
| Marking | C-value; tolerance; rated voltage; sub-class; manufacturer's type; code for dielectric material; manufacturer location; manufacturer's logo; year and week |

**Note**

- For more detailed data and test requirements, contact dc-film@vishay.com

| VOLTAGE RATINGS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Rated DC voltage | 250 | 400 | 630 | 1000 | 1400 | 1600 | 2000 | 2500 |
| Rated AC voltage | 125 | 200 | 220 | 350 | 500 | 550 | 700 | 900 |
| Rated peak to peak voltage | 350 | 560 | 630 | 1000 | 1400 | 1600 | 2000 | 2500 |



For technical questions, contact: dc-film@vishay.com

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## COMPOSITION OF CATALOG NUMBER

| Example | | |
|---|---|---|
| 147 | 470 pF | 0.00047 µF |
| 210 | 1 nF | 0.001 µF |
| 310 | 10 nF | 0.01 µF |
| 410 | 100 nF | 0.1 µF |
| 510 | 1000 nF | 1.0 µF |
| 610 | 10 000 nF | 10.0 µF |

| Voltage ($V_{DC}$) |
|---|
| 025 = 250 |
| 040 = 400 |
| 063 = 630 |
| 100 = 1000 |
| 140 = 1400 |
| 160 = 1600 |
| 200 = 2000 |
| 250 = 2500 |

| $P_1$ (mm) | Pitch Code |
|---|---|
| 5 | B |
| 7.5 | C |
| 10 | D |
| 15 | F |
| 22.5 | I |
| 27.5 | K |
| 37.5 | P |

| Multiplier (nF) | |
|---|---|
| 0.01 | 1 |
| 0.1 | 2 |
| 1 | 3 |
| 10 | 4 |
| 100 | 5 |
| 1000 | 6 |

**Capacitance Code (numerically)**

| Special Code for Terminal | |
|---|---|
| 2 | 2 pins |
| 4 | 4 pins $P_2$ = 10.2 mm |
| 5 | 4 pins $P_2$ = 20.3 mm |
| (#) | Customized |

| 1 2 3 4 5 6 | 7 | 8 9 | 10 11 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|
| MKP383 | 1 | 47 | 2 5 0 | J | I | P | 2 | T | 0 |

**Type**

**Tolerance**

| | |
|---|---|
| J | ± 5 % |
| A | Special tolerance |

**Special**

| |
|---|
| 0 = Standard |
| Other = Special |

| It (mm) | Lead Length Code | Pitch (mm) |
|---|---|---|
| 3.5 + 1.0/- 0.5 | A | ≤ 10 |
| 3.5 ± 0.3 | P | ≥ 15 |
| 5 ± 1 | M | All |
| 25 ± 2 | I | All |
| 0: Space holder | | |

| Packing Code | Packing Style | Remark |
|---|---|---|
| B/T | Bulk/loose (1) | Excluding bent back |
| R | Tape and reel; (H: 16.0 mm; 500 mm) | For bent back only |
| Z | Tape and reel; (H: 16.0 mm; 356 mm) | For bent back only |
| H | Ammo (H: 16.0 mm) | For bent back only |
| W | Tape and reel (H: 18.5 mm; 500 mm) | Pitch 5 mm to 22.5 mm |
| G | Ammo (H: 18.5 mm) | Pitch ≤ 10 mm |

**Notes**

- For detailed tape specifications refer to packaging information www.vishay.com/doc?28139

(1) Packaging will be bulk for all capacitors with pitch ≤ 15 mm and such with long leads (> 5 mm).
Capacitors with short leads up to 5 mm and pitch > 15 mm will be in tray and asking code will be “T”.

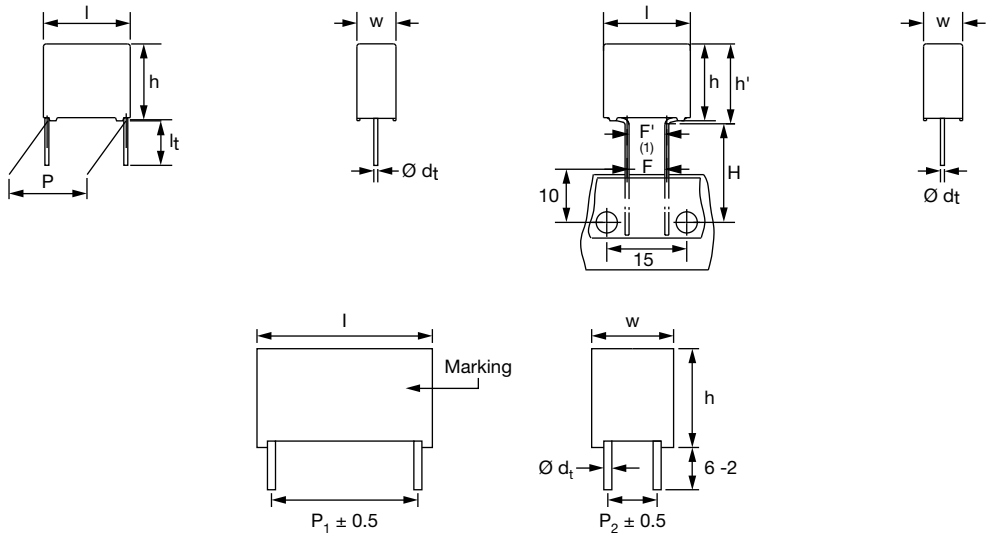


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| **ELECTRICAL DATA** (For Detailed Ratings go to www.vishay.com/doc?28183) | |
|---|---|
| **$U_{RDC}$ (V)** | **CAP. (µF)** |
| 250 | 0.0068 min. |
| | 2.7 max. |
| 400 | 0.0047 min. |
| | 1.5 max. |
| 630 | 0.00047 min. |
| | 4.7 max. |
| 1000 | 0.0043 min. |
| | 1.8 max. |
| 1400 | 0.0022 min. |
| | 0.68 max. |
| 1600 | 0.0027 min. |
| | 0.56 max. |
| 2000 | 0.0010 min. |
| | 0.56 max. |
| 2500 | 0.0010 min. |
| | 0.3 max. |

## **DIMENSIONS** in millimeters




**Note**

(1) | F-F' | < 0.3 mm
F = 7.5 mm + 0.6 mm / - 0.1 mm
Ø dt ± 10 % of standard diameter specified



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## MOUNTING

### Normal Use

The capacitors are designed for mounting on printed-circuit boards. The capacitors packed in bandoliers are designed for mounting on printed-circuit boards by means of automatic insertion machines.

For detailed tape specifications refer to packaging information www.vishay.com/doc?28139

### Specific Method of Mounting to Withstand Vibration and Shock

In order to withstand vibration and shock tests, it must be ensured that the stand-off pips are in good contact with the printed-circuit board:

- For original pitch = 15 mm the capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

### Space Requirements on Printed-Circuit Board

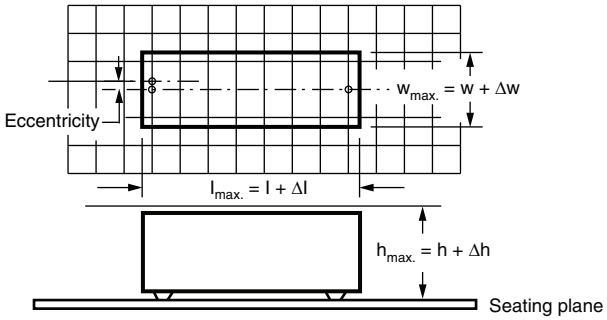
The maximum space for length ($l_{max.}$), width ($w_{max.}$) and height ($h_{max.}$) of film capacitors to take in account on the printed circuit board is shown in the drawings.

For products with pitch ≤ 15 mm, $\Delta w = \Delta l = 0.3$ mm and $\Delta h = 0.1$ mm

For products with 15 mm < pitch ≤ 27.5 mm, $\Delta w = \Delta l = 0.5$ mm and $\Delta h = 0.1$ mm

For products with pitch = 37.5 mm, $\Delta w = \Delta l = 0.7$ mm and $\Delta h = 0.5$ mm

Eccentricity as in drawing. The maximum eccentricity is smaller than or equal to the lead diameter of the product concerned.




## SOLDERING CONDITIONS

For general soldering conditions and wave soldering profile we refer to the document “Soldering Guidelines for Film Capacitors”: www.vishay.com/doc?28171

## STORAGE TEMPERATURE

$T_{stg}$ = -25 °C to +35 °C with RH maximum 75 % without condensation

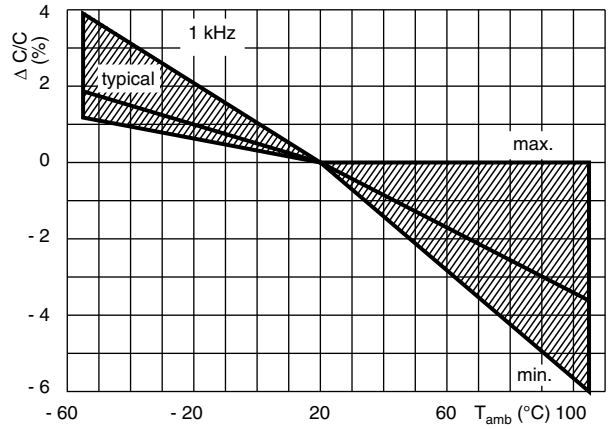
## RATINGS AND CHARACTERISTICS REFERENCE CONDITIONS

Unless otherwise specified, all electrical values apply to an ambient free temperature of 23 °C ± 1 °C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

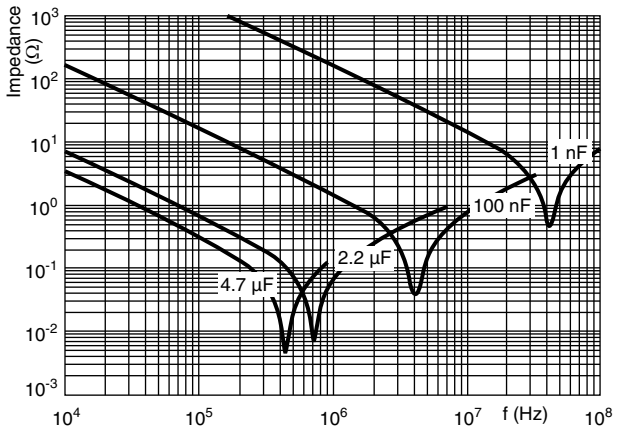
For reference testing, a conditioning period shall be applied over 96 h ± 4 h by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.


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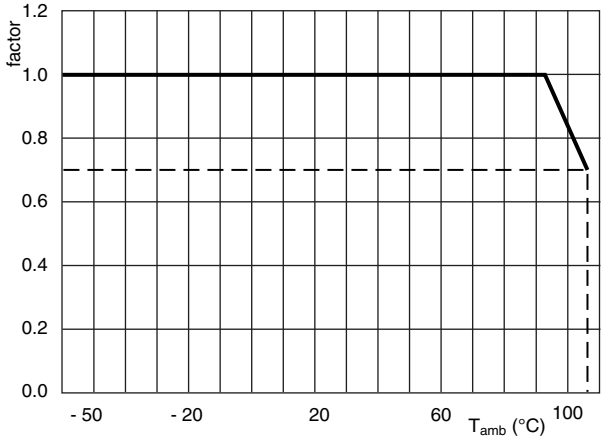
## CHARACTERISTICS



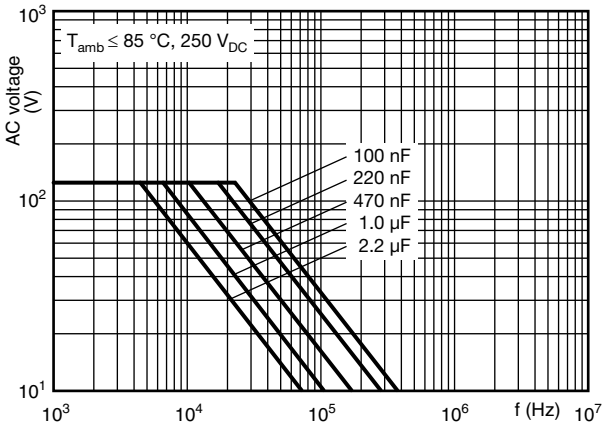

Capacitance as a function of ambient temperature (typical curve) (1 kHz)



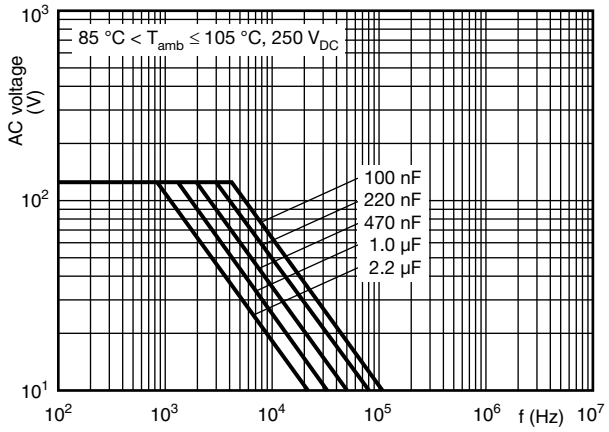

Impedance as a function of frequency (typical curve)




Max. DC and AC voltage as a function of temperature




Max. RMS voltage as a function of frequency

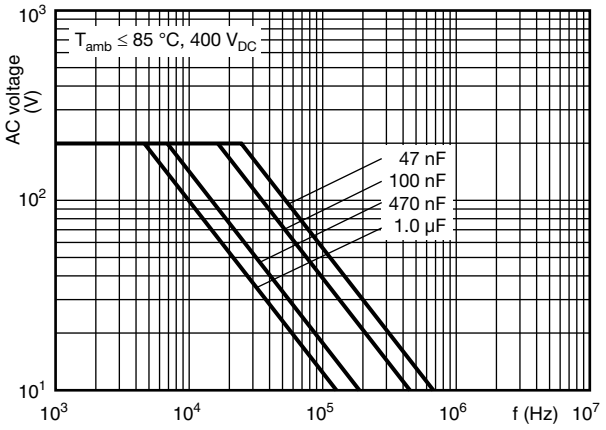



Max. RMS voltage as a function of frequency

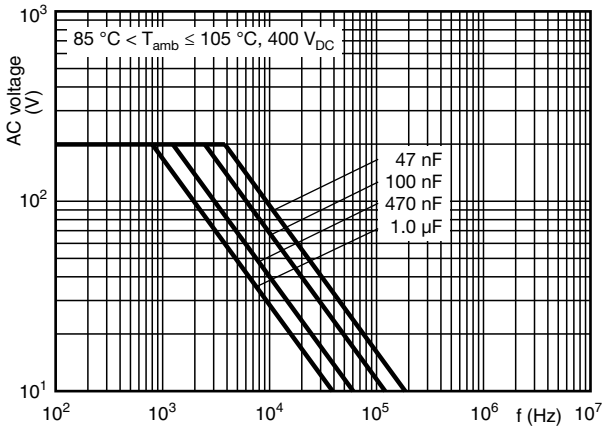


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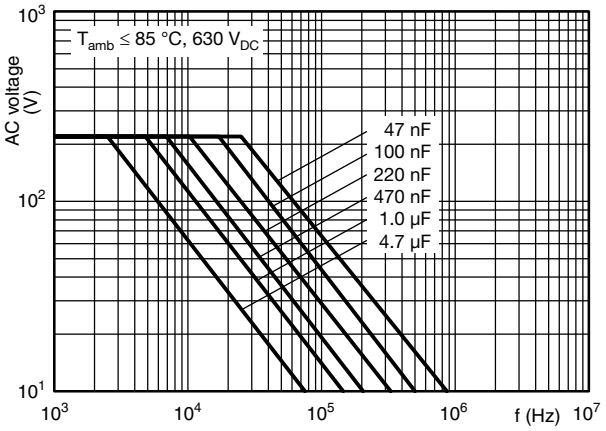
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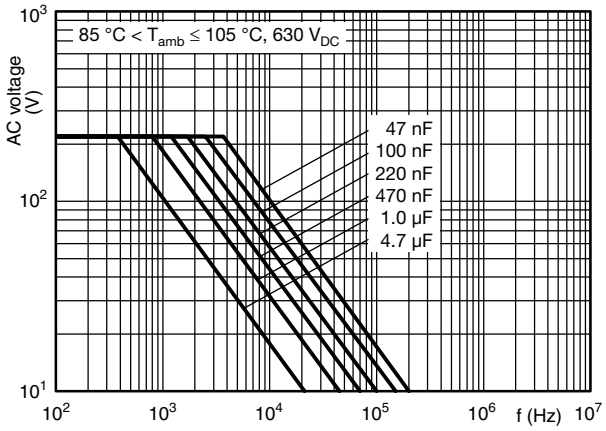

Max. RMS voltage as a function of frequency



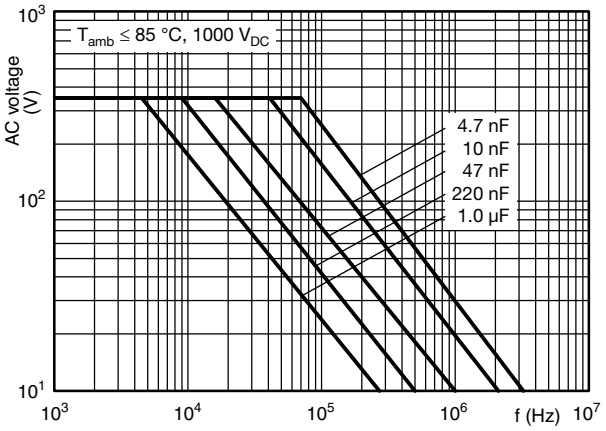

Max. RMS voltage as a function of frequency



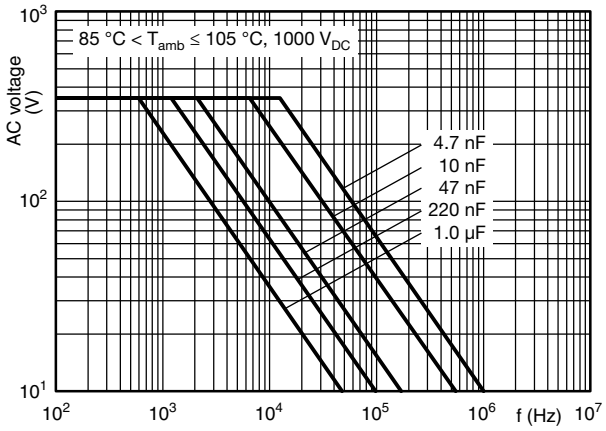

Max. RMS voltage as a function of frequency




Max. RMS voltage as a function of frequency




Max. RMS voltage as a function of frequency

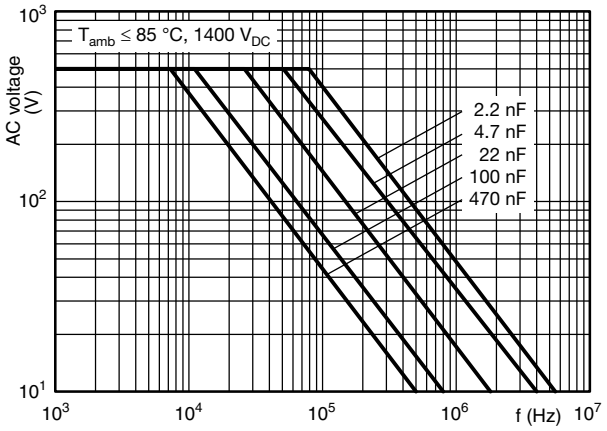



Max. RMS voltage as a function of frequency

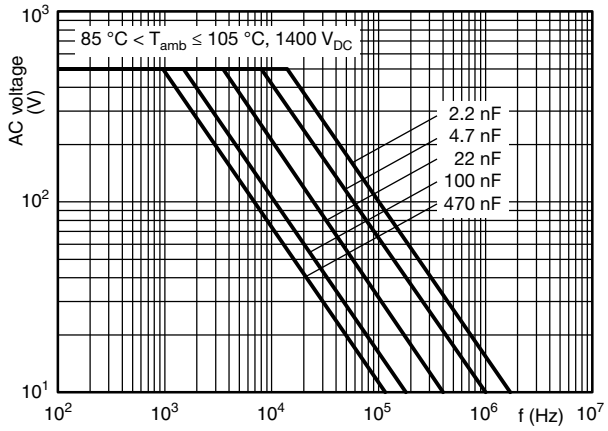


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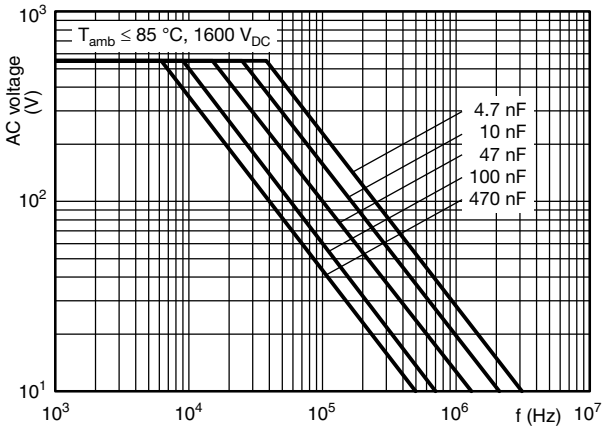
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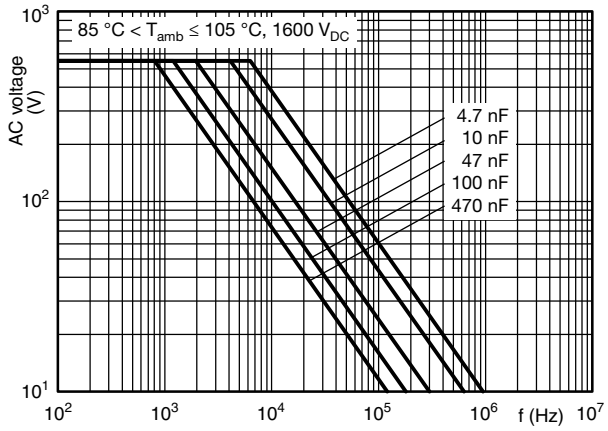

Max. RMS voltage as a function of frequency



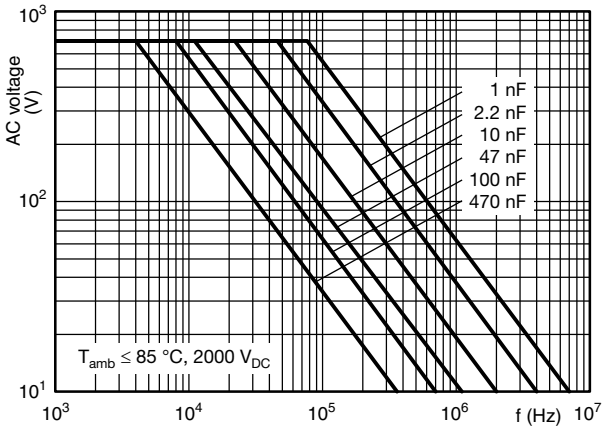

Max. RMS voltage as a function of frequency



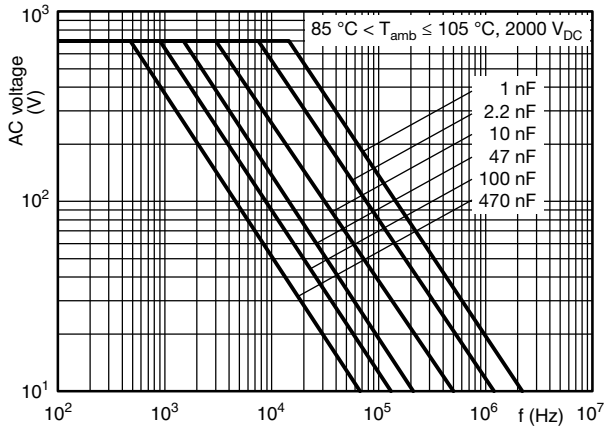

Max. RMS voltage as a function of frequency




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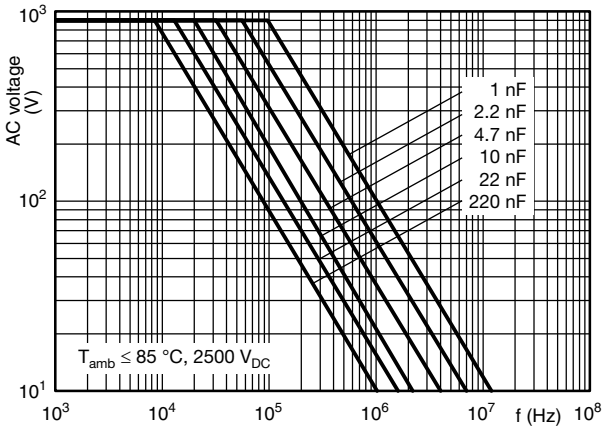



Max. RMS voltage as a function of frequency

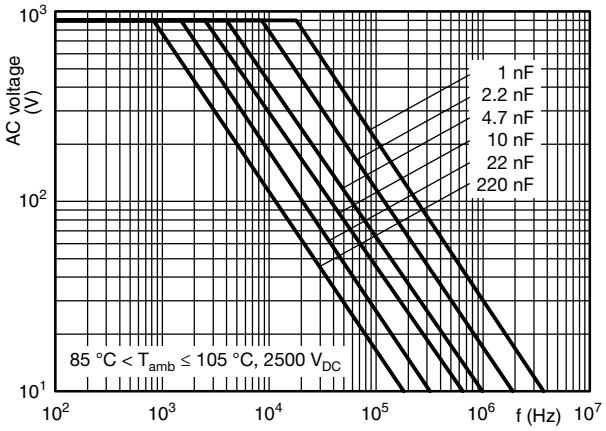



Max. RMS voltage as a function of frequency

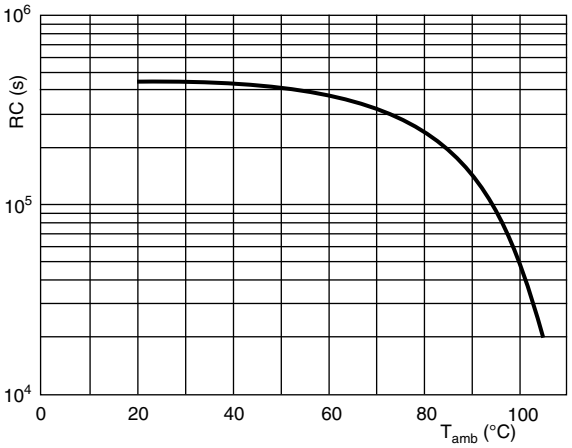

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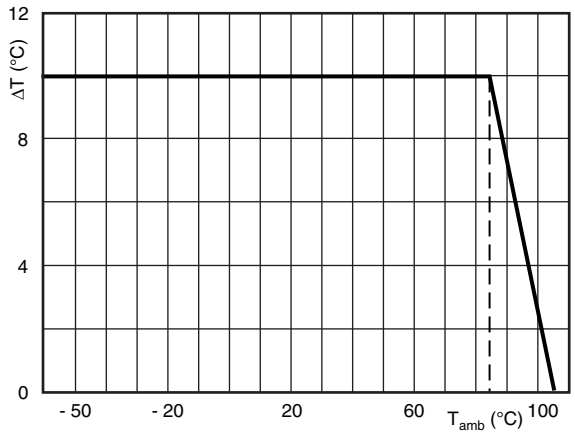

Max. RMS voltage as a function of frequency




Max. RMS voltage as a function of frequency

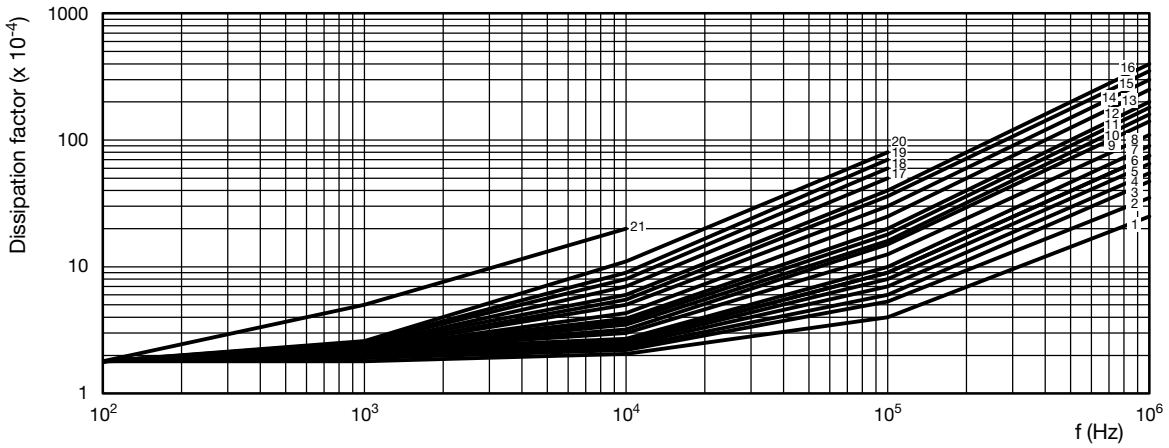



Insulation resistance as a function of the ambient temperature




Maximum allowed component temperature rise (ΔT)
as a function of the ambient temperature ($T_{amb}$)


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Tangent of loss angle as a function of frequency (typical curve)

| | | | |
|---|---|---|---|
| **250 V:**<br>0.0068 ≤ C ≤ 0.091 µF, curve 8<br>0.1 < C ≤ 0.15 µF, curve 9<br>0.15 < C ≤ 0.22 µF, curve 10<br>0.22 < C ≤ 0.27 µF, curve 11<br>0.27 < C ≤ 0.33 µF, curve 12<br>0.33 < C ≤ 0.56 µF, curve 15<br>0.56 < C ≤ 0.82 µF, curve 16<br>0.82 < C ≤ 1.2 µF, curve 18<br>1.2 < C ≤ 1.6 µF, curve 19<br>1.6 < C ≤ 2.7 µF, curve 20 | **400 V:**<br>0.0047 < C ≤ 0.047 µF, curve 5<br>0.047 < C ≤ 0.068 µF, curve 6<br>0.068 < C ≤ 0.1 µF, curve 7<br>0.1 < C ≤ 0.2 µF, curve 8<br>0.2 < C ≤ 0.24 µF, curve 12<br>0.24 < C ≤ 0.36 µF, curve 13<br>0.36 < C ≤ 0.43 µF, curve 14<br>0.43 < C ≤ 0.56 µF, curve 16<br>0.56 < C ≤ 1.1 µF, curve 17<br>1.1 < C ≤ 1.5 µF, curve 18 | **630 V:**<br>0.00047 < C ≤ 0.033 µF, curve 4<br>0.033 < C ≤ 0.068 µF, curve 5<br>0.068 < C ≤ 0.1 µF, curve 6<br>0.1 < C ≤ 0.15 µF, curve 7<br>0.15 < C ≤ 0.22 µF, curve 11<br>0.22 < C ≤ 0.27 µF, curve 12<br>0.27 < C ≤ 0.33 µF, curve 15<br>0.33 < C ≤ 0.82 µF, curve 16<br>0.82 < C ≤ 1 µF, curve 18<br>1 < C ≤ 4.7 µF, curve 21 | **1000 V:**<br>C ≤ 0.01 µF, curve 2<br>0.011 < C ≤ 0.027 µF, curve 3<br>0.027 < C ≤ 0.047 µF, curve 4<br>0.047 < C ≤ 0.062 µF, curve 5<br>0.062 < C ≤ 0.075 µF, curve 6<br>0.075 < C ≤ 0.1 µF, curve 7<br>0.1 < C ≤ 0.15 µF, curve 8<br>0.15 < C ≤ 0.22 µF, curve 9<br>0.22 < C ≤ 0.3 µF, curve 10<br>0.3 < C ≤ 1 µF, curve 16<br>1 < C ≤ 1.8 µF, curve 19 |
| **1400 V:**<br>C ≤ 0.0047 µF, curve 1<br>0.0051 < C ≤ 0.016 µF, curve 2<br>0.016 < C ≤ 0.033 µF, curve 3<br>0.033 < C ≤ 0.051 µF, curve 4<br>0.051 < C ≤ 0.068 µF, curve 5<br>0.068 < C ≤ 0.082 µF, curve 6<br>0.082 < C ≤ 0.2 µF, curve 7<br>0.2 < C ≤ 0.68 µF, curve 14 | **1600 V:**<br>C ≤ 0.0047 µF, curve 3<br>0.0051 < C ≤ 0.0091 µF, curve 4<br>0.0091 < C ≤ 0.068 µF, curve 5<br>0.068 < C ≤ 0.01 µF, curve 6<br>0.01 < C ≤ 0.16 µF, curve 7<br>0.16 < C ≤ 0.56 µF, curve 14 | **2000 V:**<br>C ≤ 0.0047 µF, curve 2<br>0.0051 < C ≤ 0.033 µF, curve 3<br>0.033 < C ≤ 0.091 µF, curve 4<br>0.091 < C ≤ 0.56 µF, curve 14 | **2500 V:**<br>C ≤ 0.0047 µF, curve 1<br>0.0051 < C ≤ 0.015 µF, curve 2<br>0.015 < C ≤ 0.091 µF, curve 3<br>0.091 < C ≤ 0.33 µF, curve 12 |


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| HEAT CONDUCTIVITY (G) AS A FUNCTION OF (ORIGINAL) PITCH AND CAPACITOR BODY THICKNESS IN mW/°C | | | | | | |
|---|---|---|---|---|---|---|
| $W_{max.}$ (mm) | HEAT CONDUCTIVITY (mW/°C) | | | | | |
| | PITCH 7.5 mm | PITCH 10 mm | PITCH 15 mm | PITCH 22.5 mm | PITCH 27.5 mm | PITCH 37.5 mm |
| 3.0 | 4 | - | - | - | - | - |
| 4.0 | 5 | 6.5 | - | - | - | - |
| 4.5 | 5 | - | - | - | | - |
| 5.0 | 6 | 7.5 | 10 | - | - | - |
| 6.0 | - | 9.0 | 11 | 19 | - | - |
| 7.0 | - | - | 12 | 21 | - | - |
| 8.5 | - | - | 16 | 25 | - | - |
| 9.0 | - | - | - | - | 31 | - |
| 10.0 | - | - | 18 | 28 | - | - |
| 11.0 | - | - | - | - | 36 | - |
| 13.0 | - | - | - | - | 42 | - |
| 15.0 | - | - | - | - | 48 | - |
| 18.0 | - | - | - | - | 57 | - |
| 18.5 | - | - | - | - | - | 89 |
| 21.0 | - | - | - | - | 68 | - |
| 21.5 | - | - | - | - | - | 102 |
| 24.0 | - | - | - | - | - | 116 |
| 30.0 | - | - | - | - | - | 134 |

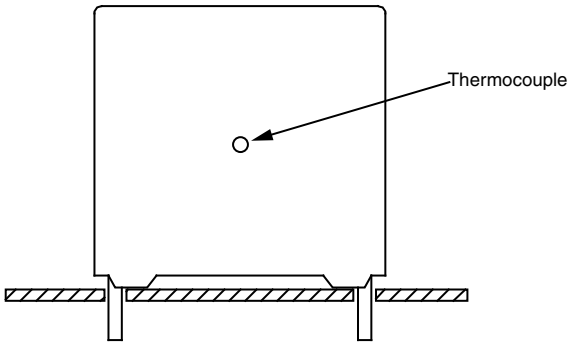
## POWER DISSIPATION AND MAXIMUM COMPONENT TEMPERATURE RISE

The power dissipation must be limited in order not to exceed the maximum allowed component temperature rise as a function of the free air ambient temperature.
The power dissipation can be calculated according type detail specification "*HQN-384-01/101: Technical information film capacitors* with the typical tgd of the curves.".
The component temperature rise ($\Delta T$) can be measured (see section "Measuring the component temperature" for more details) or calculated by $\Delta T = P/G$:

- $\Delta T$ = component temperature rise (°C)
- P = power dissipation of the component (mW)
- G = heat conductivity of the component (mW/°C)

## MEASURING THE COMPONENT TEMPERATURE

A thermocouple must be attached to the capacitor body as in:




The temperature is measured in unloaded ($T_{amb}$) and maximum loaded condition ($T_c$).
The temperature rise is given by $\Delta T = T_c - T_{amb}$.
To avoid radiation or convection, the capacitor should be tested in a wind-free box.


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## APPLICATION NOTE AND LIMITING CONDITIONS

For capacitors connected in parallel, normally the proof voltage and possibly the rated voltage must be reduced. For information depending of the capacitance value and the number of parallel connections contact: dc-film@vishay.com

These capacitors are not suitable for mains applications as across-the-line capacitors without additional protection, as described hereunder. These mains applications are strictly regulated in safety standards and therefore electromagnetic interference suppression capacitors conforming the standards must be used.

To select the capacitor for a certain application, the following conditions must be checked:

1. The peak voltage ($U_p$) shall not be greater than the rated DC voltage ($U_{RDC}$)
2. The peak-to-peak voltage ($U_{p-p}$) shall not be greater than the maximum ($U_{p-p}$) to avoid the ionization inception level
3. The voltage pulse slope (dU/dt) shall not exceed the rated voltage pulse slope in an RC-circuit at rated voltage and without ringing. If the pulse voltage is lower than the rated DC voltage, the rated voltage pulse slope may be multiplied by $U_{RDC}$ and divided by the applied voltage.
   For all other pulses following equation must be fulfilled:
   $$2 \times \int_0^T \left(\frac{dU}{dt}\right)^2 \times dt < U_{RDC} \times \left(\frac{dU}{dt}\right)_{rated}$$
   T is the pulse duration
4. The maximum component surface temperature rise must be lower than the limits (see graph max. allowed component temperature rise).
5. Since in circuits used at voltages over 280 V peak-to-peak the risk for an intrinsically active flammability after a capacitor breakdown (short circuit) increases, it is recommended that the power to the component is limited to 100 times the values mentioned in the table: “Heat Conductivity”
6. When using these capacitors as across-the-line capacitor in the input filter for mains applications or as series connected with an impedance to the mains the applicant must guarantee that the following conditions are fulfilled in any case (spikes and surge voltages from the mains included).

| VOLTAGE CONDITIONS FOR 6 ABOVE | | |
|---|---|---|
| **ALLOWED VOLTAGES** | **$T_{amb} \leq 85$ °C** | **85 °C < $T_{amb} \leq 105$ °C** |
| Maximum continuous RMS voltage | $U_{RAC}$ | $U_{RAC}$ |
| Maximum temperature RMS-over voltage (< 24 h) | 1.25 x $U_{RAC}$ | 1.25 x $U_{RAC}$ |
| Maximum peak voltage ($V_{o-p}$) (< 2 s) | 1.6 x $U_{RDC}$ | 1.1 x $U_{RDC}$ |

## EXAMPLE

C = 4n7 - 1600 V used for the voltage signal shown in next drawing.

$U_{p-p}$ = 1000 V; $U_p$ = 900 V; $T_1$ = 12 µs; $T_2$ = 64 µs; $T_3$ = 4 µs

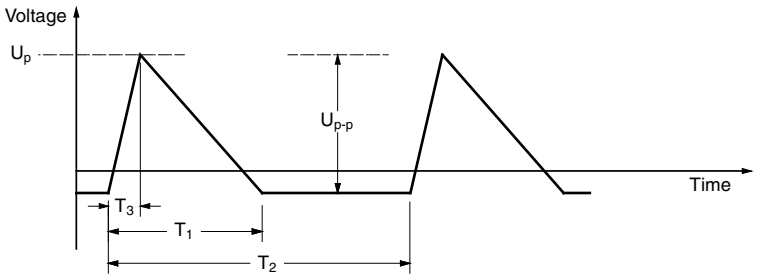
The ambient temperature is 80 °C. In case of failure, the oscillation is blocked.

Checking conditions:

1. The peak voltage $U_p$ = 900 V is lower than 1600 $V_{DC}$
2. The peak-to-peak voltage 1000 V is lower than $2\sqrt{2} \times 550\ V_{AC} = 1600\ U_{p-p}$
3. The voltage pulse slope (dU/dt) = 1000 V/4 µs = 250 V/µs. This is lower than 8000 V/µs (see specific reference data for each version).
4. The dissipated power is 35 mW as calculated with fourier terms and typical tgd.
   The temperature rise for $w_{max.}$ = 6.0 mm and pitch = 15 mm will be 35 mW / 11 mW/°C = 3.2 °C
   This is lower than 10 °C temperature rise at 80 °C, according graph.
5. Oscillation is blocked
6. Not applicable


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## VOLTAGE SIGNAL




## INSPECTION REQUIREMENTS

**General Notes**

Sub-clause numbers of tests and performance requirements refer to the “Sectional Specification, Publication IEC 60384-17 and Specific Reference Data”.

| GROUP C INSPECTION REQUIREMENTS | | | |
|---|---|---|---|
| **SUB-CLAUSE NUMBER AND TEST** | | **CONDITIONS** | **PERFORMANCE REQUIREMENTS** |
| **SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1** | | | |
| 4.1 | Dimensions (detail) | | As specified in chapters “General Data” of this specification |
| 4.3.1 | Initial measurements | Capacitance<br>Tangent of loss angle:<br>for C ≤ 1 µF at 100 kHz or<br>for C > 1 µF at 10 kHz | |
| 4.3 | Robustness of terminations | Tensile: load 10 N; 10 s<br>Bending: load 5 N; 4 x 90° | No visible damage |
| 4.4 | Resistance to soldering heat | Method: 1A<br>Solder bath: 280 °C ± 5 °C<br>Duration: 10 s | |
| 4.14 | Component solvent resistance | Isopropylalcohol at room temperature<br>Method: 2<br>Immersion time: 5 min ± 0.5 min<br>Recovery time: min. 1 h, max. 2 h | |
| 4.4.2 | Final measurements | Visual examination | No visible damage<br>Legible marking |
| | | Capacitance | $\lvert\Delta C/C\rvert \leq 1$ % of the value measured initially |
| | | Tangent of loss angle | Increase of tan $\delta$:<br>≤ 0.0005 for: C ≤ 100 nF or<br>≤ 0.001 for: 100 nF < C ≤ 470 nF or<br>≤ 0.0015 for: C > 470 nF<br>Compared to values measured in 4.3.1 |


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| GROUP C INSPECTION REQUIREMENTS | | |
|---|---|---|
| **SUB-CLAUSE NUMBER AND TEST** | **CONDITIONS** | **PERFORMANCE REQUIREMENTS** |
| **SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1** | | |
| 4.6.1 Initial measurements | Capacitance<br>Tangent of loss angle:<br>for C ≤ 1 µF at 100 kHz or<br>for C > 1 µF at 10 kHz | |
| 4.15 Solvent resistance of the marking | Isopropylalcohol at room temperature<br>Method: 1<br>Rubbing material: cotton wool<br>Immersion time: 5.0 min ± 0.5 min | No visible damage<br>Legible marking |
| 4.6 Rapid change of temperature | θA = -55 °C<br>θB = +105 °C<br>5 cycles<br>Duration t = 30 min | |
| 4.7 Vibration | Visual examination<br>Mounting: see section “Mounting” for more information<br>Procedure B4<br>Frequency range: 10 Hz to 55 Hz<br>Amplitude: 0.75 mm or<br>Acceleration 98 m/s²<br>(whichever is less severe)<br>Total duration 6 h | No visible damage |
| 4.7.2 Final inspection | Visual examination | No visible damage |
| 4.9 Shock | Mounting: see section “Mounting” for more information<br>Pulse shape: half sine<br>Acceleration: 490 m/s²<br>Duration of pulse: 11 ms | |
| 4.9.3 Final measurements | Visual examination | No visible damage |
| | Capacitance | \|ΔC/C\| ≤ 2 % for pitch < 10 mm<br>\|ΔC/C\| ≤ 1 % for pitch > 10 mm of the value measured in 4.6.1 |
| | Tangent of loss angle | Increase of tan δ:<br>≤ 0.0005 for: C ≤ 100 nF or<br>≤ 0.001 for: 100 nF < C ≤ 470 nF or<br>≤ 0.0015 for: C > 470 nF<br>Compared to values measured in 4.6.1 |
| | Insulation resistance | As specified in section “Insulation Resistance” of this specification |


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| GROUP C INSPECTION REQUIREMENTS | | |
|---|---|---|
| **SUB-CLAUSE NUMBER AND TEST** | **CONDITIONS** | **PERFORMANCE REQUIREMENTS** |
| **SUB-GROUP C1<br>COMBINED SAMPLE OF SPECIMENS OF SUB-GROUPS C1A and C1B** | | |
| 4.10 Climatic sequence | | |
| 4.10.2 Dry heat | Temperature: +105 °C<br>Duration: 16 h | |
| 4.10.3 Damp heat cyclic<br>Test Db, first cycle | | |
| 4.10.4 Cold | Temperature: -55 °C<br>Duration: 2 h | |
| 4.10.6 Damp heat cyclic<br>Test Db, remaining cycles | | |
| 4.10.6.2 Final measurements | Voltage proof = $U_{RDC}$ for 1 min within 15 min after removal from testchamber | No breakdown or flash-over |
| | Visual examination | No visible damage<br>Legible marking |
| | Capacitance | For original pitch = 22.5 mm and 37.5 mm:<br>$\lvert\Delta C/C\rvert \leq 2$ % or<br>for original pitch ≤ 15 mm:<br>$\lvert\Delta C/C\rvert \leq 3$ % of the value measured in 4.4.2 or 4.9.3 |
| | Tangent of loss angle | Increase of tan δ:<br>≤ 0.0005 for: C ≤ 100 nF or<br>≤ 0.001 for: 100 nF < C ≤ 470 nF or<br>≤ 0.0015 for: C > 470 nF<br>Compared to values measured in 4.3.1 or 4.6.1 |
| | Insulation resistance | ≥ 50 % of values specified in section "Insulation Resistance" of this specification |
| **SUB-GROUP C2** | | |
| 4.11 Damp heat steady state | 56 days, 40 °C, 90 % to 95 % RH<br>no load | |
| 4.11.1 Initial measurements | Capacitance<br>Tangent of loss angle at 1 kHz | |
| 4.11.3 Final measurements | Voltage proof = $U_{RDC}$ for 1 min within 15 min after removal from testchamber | No breakdown or flash-over |
| | Visual examination | No visible damage<br>Legible marking |
| | Capacitance | $\lvert\Delta C/C\rvert \leq 1$ % of the value measured in 4.11.1 |
| | Tangent of loss angle | Increase of tan δ:<br>≤ 0.0005 for: C ≤ 100 nF or<br>≤ 0.001 for: 100 nF < C ≤ 470 nF or<br>≤ 0.0015 for: C > 470 nF<br>Compared to values measured in 4.11.1 |
| | Insulation resistance | ≥ 50 % of values specified in section "Insulation Resistance" of this specification |


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| GROUP C INSPECTION REQUIREMENTS | | |
|---|---|---|
| **SUB-CLAUSE NUMBER AND TEST** | **CONDITIONS** | **PERFORMANCE REQUIREMENTS** |
| **SUB-GROUP C3A** | | |
| 4.12.1 Endurance test at 50 Hz alternating voltage | Duration: 2000 h | |
| 4.12.1.1 Initial measurements | Voltage:<br>1.25 x $U_{RAC}$ at 105 °C<br>Capacitance<br>Tangent of loss angle:<br>for C ≤ 1 µF at 100 kHz or<br>for C > 1 µF at 10 kHz | |
| 4.12.1.3 Final measurements | Visual examination | No visible damage<br>Legible marking |
| | Capacitance | \|ΔC/C\| ≤ 5 % compared to values measured in 4.12.1.1 |
| | Tangent of loss angle | Increase of tan δ:<br>≤ 0.0005 for: C ≤ 100 nF or<br>≤ 0.001 for: 100 nF < C ≤ 470 nF or<br>≤ 0.0015 for: C > 470 nF<br>Compared to values measured in 4.12.1.1 |
| | Insulation resistance | ≥ 50 % of values specified in section "Insulation Resistance" of this specification |
| **SUB-GROUP C4** | | |
| 4.2.6 Temperature charcteristics<br>Initial measurements<br>Intermediate measurements | Capacitance<br>Capacitance at -55 °C<br>Capacitance at +20 °C<br>Capacitance at +105 °C | For -55 °C to +20 °C:<br>+1 % ≤ \|ΔC/C\| ≤ 3.75 % or<br>for 20 °C to 105 °C:<br>-6 % ≤ \|ΔC/C\| ≤ 0 % |
| Final measurements | Capacitance | As specified in section "Capacitance" of this specification. |
| | Insulation resistance | As specified in section "Insulation Resistance" of this specification |
| 4.13 Charge and discharge | 10 000 cycles<br>Charged to $U_{RDC}$<br>Discharge resistance:<br>$R = \frac{U_{RDC}}{5 \times C \times (dU/dt)}$ | |
| 4.13.1 Initial measurements | Capacitance<br>Tangent of loss angle:<br>for C ≤ 1 µF at 100 kHz or<br>for C > 1 µF at 10 kHz | |
| 4.13.3 Final measurements | Capacitance | \|ΔC/C\| ≤ 1 % compared to values measured in 4.13.1 |
| | Tangent of loss angle | Increase of tan δ:<br>≤ 0.0005 for: C ≤ 100 nF or<br>≤ 0.001 for: 100 nF < C ≤ 470 nF or<br>≤ 0.0015 for: C > 470 nF<br>Compared to values measured in 4.13.1 |
| | Insulation resistance | ≥ 50 % of values specified in section "Insulation Resistance" of this specification |


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