



THB Interference Suppression Film Capacitors - Class X2 Radial MKP 305 V_{AC} - Across the Line



FEATURES

- AEC-Q200 qualified (rev. D)
- IEC 60384-14: 2013 / AMD1: 2016 grade IIB: 85 °C, 85 % RH, 500 h at U_{RAC}
- Compliant with 85 °C, 85 % RH, 1000 h at 240 V_{AC}
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



RoHS COMPLIANT

APPLICATIONS

For standard across the line X2 applications.
See also application note: www.vishay.com/doc?28153

| QUICK REFERENCE DATA | |
|---------------------------------------|---|
| Rated capacitance range | E12 series 0.1 µF to 4.7 µF (preferred values according to E12) |
| Capacitance tolerance | ± 20 %; ± 10 % |
| Rated voltage range, U _{RAC} | 305 V _{AC} ; 50 Hz to 60 Hz |
| Permissible DC voltage | 630 V _{DC} at 105 °C |
| Climatic testing class | 40 / 105 / 56 / B |
| Rated temperature | 105 °C |
| Reference standards | IEC 60384-14:2013 IEC 60384-14:2013 / AMD1:2016 EN 60384-14 IEC 60065 requires passive flammability class B UL 60384-14 (2 nd edition) CSA-E60384-1:14 (3 rd edition) CQC |
| Dielectric | Polypropylene film |
| Electrodes | Metallized |
| Construction | Mono construction |
| Encapsulation | Plastic case, epoxy resin sealed, flame retardant 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 logo; year and week; safety approvals |

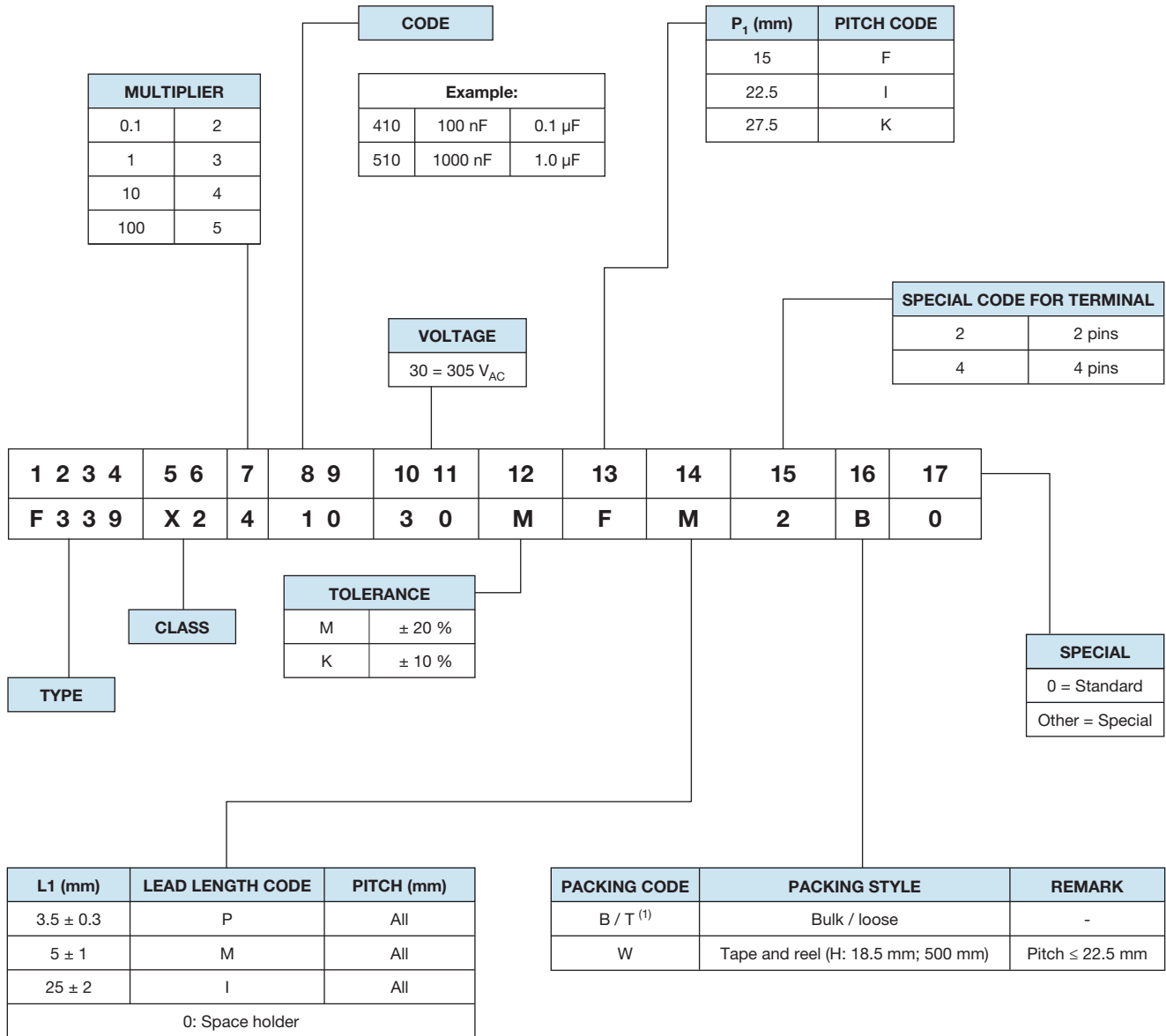
Note

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

| DIMENSIONS in millimeters |
|---------------------------|
| |



COMPOSITION OF CATALOG NUMBER



Notes

- For detailed tape specifications refer to packaging information www.vishay.com/doc?28139
- Taped on reel pitch 27.5 mm is not available
- ⁽¹⁾ Packaging will be bulk for all capacitors with pitch 15 mm. Capacitors with short leads up to 5 mm and pitch > 15 mm will be in tray and asking code will be "T"



| SPECIFIC REFERENCE DATA | | |
|---|--------------------------|--------------------------|
| DESCRIPTION | VALUE | |
| Rated voltage range, U_{RAC} | 305 V _{AC} | |
| Rated voltage range, U_{RDC} | 630 V _{DC} | |
| Tangent of loss angle: | At 1 kHz | At 10 kHz |
| $C < 470$ nF | $\leq 20 \times 10^{-4}$ | $\leq 30 \times 10^{-4}$ |
| 470 nF $\leq C \leq 1$ μ F | $\leq 30 \times 10^{-4}$ | $\leq 80 \times 10^{-4}$ |
| $C > 1$ μ F | $\leq 40 \times 10^{-4}$ | - |
| Rated voltage pulse slope $(dU/dt)_R$ at 430 V _{DC} | | |
| Pitch = 15 mm | 400 V/ μ s | |
| Pitch = 22.5 mm | 150 V/ μ s | |
| Pitch = 27.5 mm | 100 V/ μ s | |
| R between leads, for $C \leq 0.33$ μ F at 100 V; 1 min | $> 15\,000$ M Ω | |
| RC between leads, for $C > 0.33$ μ F at 100 V; 1 min | > 5000 s | |
| R between leads and case; 100 V; 1 min | $> 30\,000$ M Ω | |
| Withstanding (DC) voltage (cut off current 10 mA) ⁽¹⁾ ; rise time ≤ 1000 V/s: | | |
| $C \leq 1$ μ F | 2200 V; 1 min | |
| $C > 1$ μ F | 1800 V; 1 min | |
| Withstanding (AC) voltage between leads and case | 2110 V; 1 min | |

Note

⁽¹⁾ See "Voltage Proof Test for Metalized Film Capacitors": www.vishay.com/doc?28169

| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | | | | |
|---|---|--|----------------------------|--|--------------------------------|-------------|---------------------------------|-------------|--|-----|--|
| U_{RAC} (V) | CAP. (μ F) | DIMENSIONS ⁽³⁾ w x h x l (mm) | MASS (g) ⁽²⁾ | CATALOG NUMBER F339X2... AND PACKAGING | | | | | | | |
| | | | | LOOSE IN BOX | | | | | TAPED REEL (500 mm) ⁽¹⁾ | | |
| | | | | SHORT LEADS | | | LONG LEADS | | | | |
| | | | | $l_t = 3.5$ mm ± 0.3 mm | $l_t = 5.0$ mm ± 1.0 mm | SPQ | $l_t = 25.0$ mm ± 2.0 mm | SPQ | H = 18.5 mm; P ₀ = 12.7 mm | SPQ | |
| PITCH = 15.0 mm \pm 0.4 mm; $d_t = 0.80$ mm \pm 0.08 mm; C-TOL. = \pm 20 % | | | | | | | | | | | |
| 305 | 0.10 | 7.0 x 13.5 x 17.5 | 1.8 | 41030MFP2B0 | 41030MFM2B0 | 750 | 41030MFI2B0 | 500 | 41030MF02W0 | 800 | |
| | 0.15 | 8.5 x 15.0 x 17.5 | 2.4 | 41530MFP2B0 | 41530MFM2B0 | 750 | 41530MFI2B0 | 500 | 41530MF02W0 | 650 | |
| | 0.22 | 10.0 x 16.5 x 17.5 | 3.0 | 42230MFP2B0 | 42230MFM2B0 | 500 | 42230MFI2B0 | 450 | 42230MF02W0 | 600 | |
| | 0.33 | 10.5 x 17.5 x 18.0 | 4.0 | 43330MFP2B0 | 43330MFM2B0 | 225 | 43330MFI2B0 | 400 | 43330MF02W0 | | |
| | 0.47 | 13.5 x 22.5 x 18.0 | 6.5 | 44730MFP2B0 | 44730MFM2B0 | 185 | 44730MFI2B0 | 400 | 44730MF02W0 | 425 | |
| | PITCH = 22.5 mm \pm 0.4 mm; $d_t = 0.80$ mm \pm 0.08 mm; C-TOL. = \pm 20 % | | | | | | | | | | |
| | 0.22 | 7.0 x 16.5 x 26.0 | 2.9 | 42230MIP2T0 | 42230MIM2T0 | 200 | 42230MII2B0 | 250 | 42230MI02W0 | 500 | |
| | 0.33 | 8.5 x 18.0 x 26.0 | 3.8 | 43330MIP2T0 | 43330MIM2T0 | 200 | 43330MII2B0 | 250 | 43330MI02W0 | 450 | |
| | 0.47 | 10.0 x 19.5 x 26.0 | 6.8 | 44730MIP2T0 | 44730MIM2T0 | 200 | 44730MII2B0 | 200 | 44730MI02W0 | 350 | |
| | 0.68 | 12.0 x 22.0 x 26.0 | 7.8 | 46830MIP2T0 | 46830MIM2T0 | 150 | 46830MII2B0 | 200 | 46830MI02W0 | 300 | |
| 1.0 | 12.5 x 22.5 x 26.5 | 10.0 | 51030MIP2T0 | 51030MIM2T0 | 140 | 51030MII2B0 | 400 | 51030MI02W0 | 300 | | |
| PITCH = 27.5 mm \pm 0.4 mm; $d_t = 0.80$ mm \pm 0.08 mm; C-TOL. = \pm 20 % | | | | | | | | | | | |
| 0.47 | 11.0 x 21.0 x 31.0 | 7.4 | 44730MKP2T0 | 44730MKM2T0 | 100 | 44730MKI2B0 | 125 | - | - | | |
| 0.68 | | | 46830MKP2T0 | 46830MKM2T0 | | 46830MKI2B0 | | | | | |
| 1.0 | 13.0 x 23.0 x 31.0 | 9.2 | 51030MKP2T0 | 51030MKM2T0 | 100 | 51030MKI2B0 | 125 | - | - | | |
| 1.5 | 15.0 x 25.0 x 31.5 | 12.3 | 51530MKP2T0 | 51530MKM2T0 | 100 | 51530MKI2B0 | 125 | - | - | | |
| 2.2 | 18.0 x 28.0 x 31.0 | 16.1 | 52230MKP2T0 | 52230MKM2T0 | 100 | 52230MKI2B0 | 100 | - | - | | |
| 3.3 | 21.0 x 31.0 x 31.0 | 20.3 | 53330MKP2T0 | 53330MKM2T0 | 50 | 53330MKI2B0 | 75 | - | - | | |
| 4.7 | 22.0 x 38.0 x 32.0 | 29.3 | 54730MKP2T0 | 54730MKM2T0 | 60 | 54730MKI2B0 | 60 | - | - | | |

Notes

- SPQ = Standard Packing Quantity
- ⁽¹⁾ H = in-tape height; P₀ = sprocket hole distance; for detailed specifications refer to "Packaging Information"
- ⁽²⁾ Weight for short lead product only
- ⁽³⁾ For tolerances see chapter "Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances"






| ELECTRICAL DATA AND ORDERING INFORMATION | | | | | | | | | | | |
|---|---|--|----------------------------|--|-------------------------------------|-------------|--------------------------------------|-------------|--|-------------|-----|
| U _{RAC} (V) | CAP. (μF) | DIMENSIONS ⁽³⁾ w x h x l (mm) | MASS (g) ⁽²⁾ | CATALOG NUMBER F339X2... AND PACKAGING | | | | | | | |
| | | | | LOOSE IN BOX | | | | | TAPED REEL (500 mm) ⁽¹⁾ | | |
| | | | | SHORT LEADS | | | LONG LEADS | | H = 18.5 mm; P ₀ = 12.7 mm | SPQ | |
| | | | | l _t = 3.5 mm ± 0.3 mm | l _t = 5.0 mm ± 1.0 mm | SPQ | l _t = 25.0 mm ± 2.0 mm | SPQ | | | |
| PITCH = 15.0 mm ± 0.4 mm; d _t = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % | | | | | | | | | | | |
| 305 | 0.1 | 7.0 x 13.5 x 17.5 | 1.8 | 41030KFP2B0 | 41030KFM2B0 | 750 | 41030KFI2B0 | 500 | 41030KF02W0 | 800 | |
| | 0.12 | 8.5 x 15.0 x 17.5 | 2.4 | 41230KFP2B0 | 41230KFM2B0 | 750 | 41230KFI2B0 | 500 | 41230KF02W0 | 650 | |
| | 0.15 | | | 41530KFP2B0 | 41530KFM2B0 | | 41530KFI2B0 | | 41530KF02W0 | | |
| | 0.18 | | | 41830KFP2B0 | 41830KFM2B0 | | 41830KFI2B0 | | 41830KF02W0 | | |
| | 0.22 | 10.0 x 16.5 x 17.5 | 3.0 | 42230KFP2B0 | 42230KFM2B0 | 500 | 42230KFI2B0 | 450 | 42230KF02W0 | 600 | |
| | 0.27 | | | 42730KFP2B0 | 42730KFM2B0 | | 42730KFI2B0 | | 42730KF02W0 | | |
| | 0.33 | 10.5 x 17.5 x 18.0 | 3.9 | 43330KFP2B0 | 43330KFM2B0 | 225 | 43330KFI2B0 | 400 | 43330KF02W0 | | |
| | 0.39 | 11.0 x 18.5 x 18 | 4.1 | 43930KFP2B0 | 43930KFM2B0 | 225 | 43930KFI2B0 | 350 | 43930KF02W0 | 550 | |
| | 0.47 | 13.5 x 22.5 x 18.0 | 6.3 | 44730KFP2B0 | 44730KFM2B0 | 185 | 44730KFI2B0 | 400 | 44730KF02W0 | 425 | |
| | PITCH = 22.5 mm ± 0.4 mm; d _t = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % | | | | | | | | | | |
| | 305 | 0.22 | 7.0 x 16.5 x 26.0 | 2.9 | 42230KIP2T0 | 42230KIM2T0 | 200 | 42230KII2B0 | 250 | 42230KI02W0 | 500 |
| | | 0.27 | 8.5 x 18.0 x 26.0 | 3.8 | 42730KIP2T0 | 42730KIM2T0 | 200 | 42730KII2B0 | 250 | 42730KI02W0 | 450 |
| | | 0.33 | | | 43330KIP2T0 | 43330KIM2T0 | | 43330KII2B0 | | 43330KI02W0 | |
| | | 0.39 | | | 43930KIP2T0 | 43930KIM2T0 | | 43930KII2B0 | | 43930KI02W0 | |
| | | 0.47 | 10.0 x 19.5 x 26.0 | 6.8 | 44730KIP2T0 | 44730KIM2T0 | 200 | 44730KII2B0 | 200 | 44730KI02W0 | 350 |
| 0.56 | | 45630KIP2T0 | | | 45630KIM2T0 | 45630KII2B0 | | 45630KI02W0 | | | |
| 0.68 | | 12.0 x 22.0 x 26.0 | 7.8 | 46830KIP2T0 | 46830KIM2T0 | 150 | 46830KII2B0 | 200 | 46830KI02W0 | 300 | |
| 0.82 | | | | 48230KIP2T0 | 48230KIM2T0 | | 48230KII2B0 | | 48230KI02W0 | | |
| 1.0 | | 12.5 x 22.5 x 26.5 | 10.0 | 51030KIP2T0 | 51030KIM2T0 | 140 | 51030KII2B0 | 400 | 51030KI02W0 | 300 | |
| PITCH = 27.5 mm ± 0.4 mm; d _t = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 % | | | | | | | | | | | |
| 305 | 0.47 | 11.0 x 21.0 x 31.0 | 7.4 | 44730KKP2T0 | 44730KKM2T0 | 100 | 44730KKI2B0 | 125 | - | - | |
| | 0.56 | | | 45630KKP2T0 | 45630KKM2T0 | | 45630KKI2B0 | | | | |
| | 0.68 | | | 46830KKP2T0 | 46830KKM2T0 | | 46830KKI2B0 | | | | |
| | 0.82 | 13.0 x 23.0 x 31.0 | 9.2 | 48230KKP2T0 | 48230KKM2T0 | 100 | 48230KKI2B0 | 125 | - | - | |
| | 1.0 | | | 51030KKP2T0 | 51030KKM2T0 | | 51030KKI2B0 | | | | |
| | 1.2 | 15.0 x 25.0 x 31.5 | 12.3 | 51230KKP2T0 | 51230KKM2T0 | 100 | 51230KKI2B0 | 125 | - | - | |
| | 1.5 | | | 51530KKP2T0 | 51530KKM2T0 | | 51530KKI2B0 | | | | |
| | 1.8 | 18.0 x 28.0 x 31.0 | 16.1 | 51830KKP2T0 | 51830KKM2T0 | 100 | 51830KKI2B0 | 100 | - | - | |
| | 2.2 | | | 52230KKP2T0 | 52230KKM2T0 | | 52230KKI2B0 | | | | |
| | 2.7 | | | 52730KKP2T0 | 52730KKM2T0 | | 52730KKI2B0 | | | | |
| | 3.3 | 21.0 x 31.0 x 31.0 | 20.3 | 53330KKP2T0 | 53330KKM2T0 | 50 | 53330KKI2B0 | 75 | - | - | |
| | 3.9 | | | 53930KKP2T0 | 53930KKM2T0 | | 53930KKI2B0 | | | | |
| 4.7 | 22.0 x 38.0 x 32.0 | 29.2 | 54730KKP2T0 | 54730KKM2T0 | 60 | 54730KKI2B0 | 60 | - | - | | |

Notes

- SPQ = Standard Packing Quantity
- (1) H = in-tape height; P₀ = sprocket hole distance; for detailed specifications refer to "Packaging Information"
- (2) Weight for short lead product only
- (3) For tolerances see chapter "Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances"

| APPROVALS | | | | |
|--|---------------------|------------------|-----------------|--|
| SAFETY APPROVALS X2 | VOLTAGE | VALUE | FILE NUMBERS | LINK |
| EN 60384-14 (ENEC) (= IEC 60384-14 ed-4 (2013)) | 305 V _{AC} | 100 nF to 4.7 μF | ENEC/FI 2017049 | www.vishay.com/doc?28243 |
| UL 60384-14 (2 nd edition) | 305 V _{AC} | 100 nF to 4.7 μF | E354331 | www.vishay.com/doc?28242 |
| CSA-E60384-1:14 (3 rd edition) | 305 V _{AC} | 100 nF to 4.7 μF | E354331 | www.vishay.com/doc?28242 |
| CQC | 305 V _{AC} | 100 nF to 4.7 μF | Pending | - |
| CB-test certificate | 305 V _{AC} | 100 nF to 4.7 μF | CB FI-34417 | www.vishay.com/doc?28241 |

The ENEC-approval together with the CB-certificate replace all national marks of the following countries (they have already signed the ENEC-agreement): Austria; Belgium; Czech Republic; Denmark; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Luxembourg; Netherlands; Norway; Portugal; Slovenian; Spain; Sweden, Switzerland, and United Kingdom.

MOUNTING

Normal Use

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

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

Specific Method of Mounting to Withstand Vibration and Shock

The capacitors are designed for mounting on printed-circuit boards. 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. The capacitor shall be mechanically fixed by the leads and the body clamped.

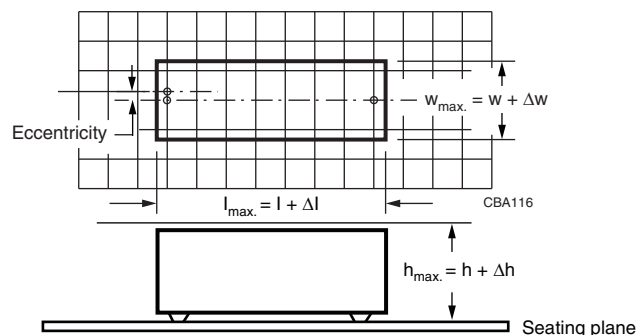
- For pitches ≤ 15 mm capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances

For the maximum product dimensions and maximum space requirements for length ($l_{max.}$), width ($w_{max.}$), and height ($h_{max.}$) following tolerances must be taken in account in the envelopment of the components as shown in the drawings below.

- 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 = 27.5 mm, $\Delta w = \Delta l = \Delta h = 0.7$ mm

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



For the minimum product dimensions for length ($l_{min.}$), width ($w_{min.}$), and height ($h_{min.}$) following tolerances of the components are valid:

$l_{min.} = l - \Delta l$, $w_{min.} = w - \Delta w$, and $h_{min.} = h - \Delta h$ following

- For products with pitch = 15 mm, $\Delta l = 0.5$ mm, and $\Delta w = \Delta h = 0.5$ mm
- For products with 15 mm $<$ pitch < 27.5 mm, $\Delta l = 1.0$ mm, and $\Delta w = \Delta h = 0.5$ mm
- For products with pitch = 27.5 mm, $\Delta w = \Delta l = \Delta h = 1.0$ mm



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

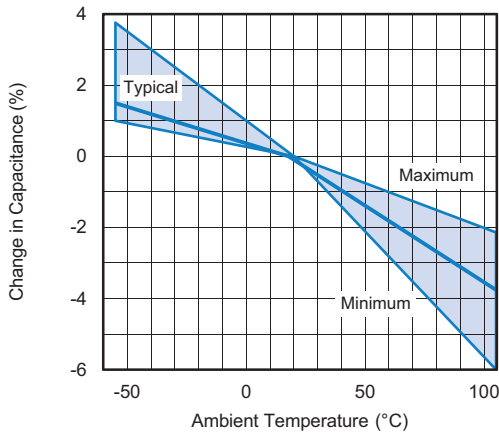
T_{stg} = -25 °C to +35 °C with RH maximum 75 % without condensation

RATINGS AND CHARACTERISTICS REFERENCE CONDITIONS

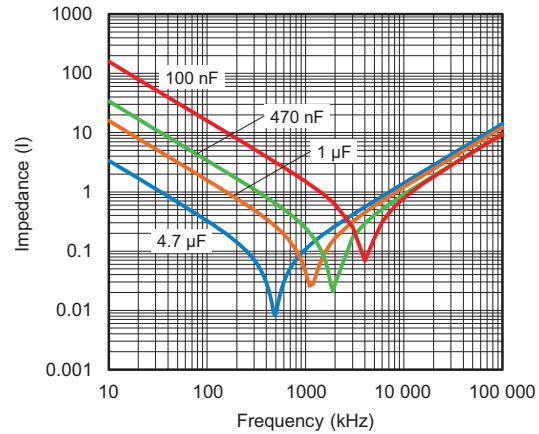
Unless otherwise specified, all electrical values apply to an ambient temperature of 23 °C ± 1°C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

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

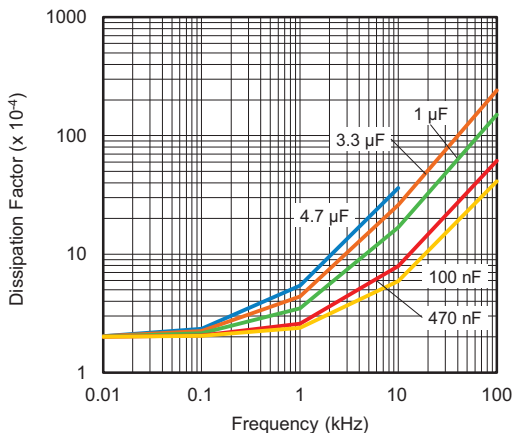
CHARACTERISTICS



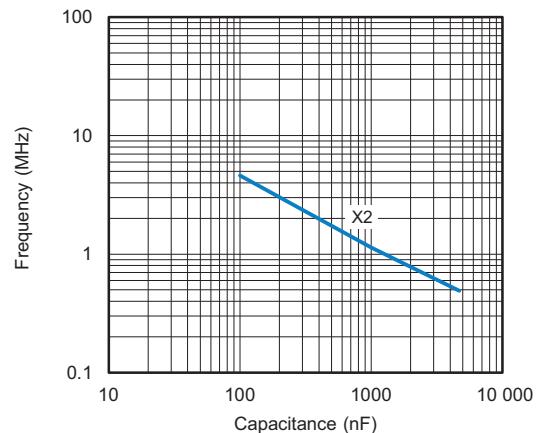
Capacitance as a function of ambient temperature (typical curve)



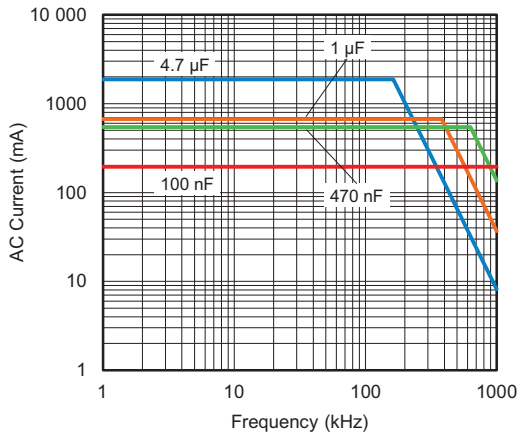
Impedance as a function of frequency (typical curve)



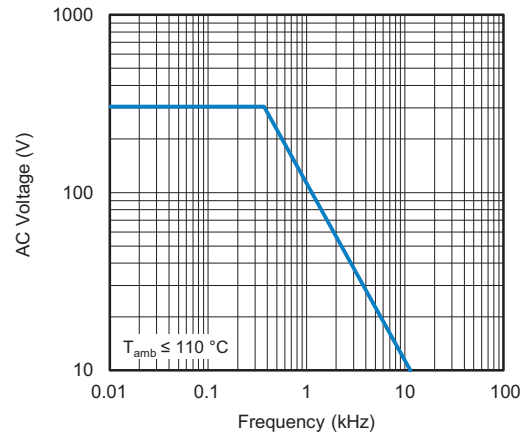
Tangent of loss angle as a function of frequency (typical curve)



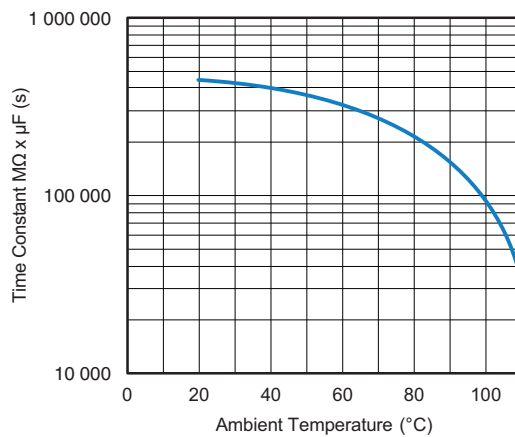
Resonant frequency as a function of capacitance (typical curve)



Max. RMS current as a function of frequency



Max. RMS voltage as a function of frequency



Insulation resistance as a function of ambient temperature (typical curve)

APPLICATION NOTES

- For X2 electromagnetic interference suppression in standard across the line applications (50 Hz / 60 Hz) with a maximum of 305 V_{AC} rated voltage including fluctuation of the mains. It is recommended to use these components in a mains with maximum nominal voltage of 240 V_{AC}. Higher continuous applied voltages will shorten the life time
- For series impedance applications we refer to application note www.vishay.com/doc?28153
- To ensure withstanding high humidity requirements in the application the epoxy adhesion at the leads shall not be damaged. Therefore the leads may not be damaged or not be bent before soldering
- 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: rfi@vishay.com
- These capacitors are not intended for continuous pulse application. For these situations capacitors of the AC and pulse programs must be used.
- The maximum ambient temperature must not exceed 105 °C
- Rated voltage pulse slope:
if the pulse voltage is lower than the rated voltage, the values of the specific reference data can be multiplied by 430 V_{DC} and divided by the applied voltage



INSPECTION REQUIREMENTS

General Notes

Sub-clause numbers of tests and performance requirements refer to the “Sectional Specification, Publication IEC 60384-14 ed-4 (2013) and Specific Reference Data”.

| 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 |
| Initial measurements | Capacitance Tangent of loss angle: for C ≤ 1 μF at 10 kHz for C > 1 μF at 1 kHz | |
| 4.3 Robustness of terminations | Tensile: load 10 N; 10 s Bending: load 5 N; 4 x 90° | No visible damage |
| 4.4 Resistance to soldering heat | No pre-drying Method: 1A Solder bath: 280 °C ± 5 °C Duration: 10 s | |
| 4.19 Component solvent resistance | Isopropylalcohol at room temperature Method: 2 Immersion time: 5 min ± 0.5 min Recovery time: min. 1 h, max. 2 h | |
| 4.4.2 Final measurements | Visual examination | No visible damage Legible marking |
| | Capacitance | ΔC/C ≤ 5 % of the value measured initially |
| | Tangent of loss angle | Increase of tan δ: ≤ 0.008 for: C ≤ 1 μF or ≤ 0.005 for: C > 1 μF Compared to values measured initially |
| | Insulation resistance | As specified in section “Insulation Resistance” of this specification |
| SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1 | | |
| Initial measurements | Capacitance Tangent of loss angle: for C ≤ 1 μF at 10 kHz for C > 1 μF at 1 kHz | |
| 4.20 Solvent resistance of the marking | Isopropyl alcohol at room temperature Method: 1 Rubbing material: cotton wool Immersion time: 5 min ± 0.5 min | No visible damage Legible marking |
| 4.6 Rapid change of temperature | θA = -40 °C θB = +105 °C 5 cycles Duration t = 30 min | |
| 4.6.1 Inspection | Visual examination | No visible damage |
| 4.7 Vibration | Mounting: see section “Mounting” of this specification Procedure B4: Frequency range: 10 Hz to 55 Hz Amplitude: 0.75 mm or Acceleration 98 m/s ² (whichever is less severe) Total duration 6 h | |



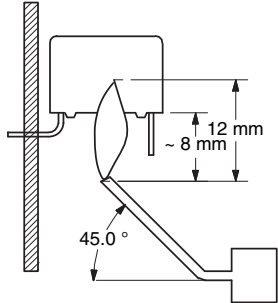
| INSPECTION REQUIREMENTS | | |
|--|---|---|
| SUB-CLAUSE NUMBER AND TEST | CONDITIONS | PERFORMANCE REQUIREMENTS |
| SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1 | | |
| 4.7.2 Final inspection | Visual examination | No visible damage |
| 4.9 Shock | Mounting: see section "Mounting" for more information Pulse shape: half sine Acceleration: 490 m/s ² Duration of pulse: 11 ms | |
| 4.9.2 Final measurements | Visual examination | No visible damage |
| | Capacitance | $ \Delta C/C \leq 5\%$ of the value measured initially |
| | Tangent of loss angle | Increase of tan δ : ≤ 0.008 for: $C \leq 1 \mu F$ or ≤ 0.005 for: $C > 1 \mu F$ Compared to values measured initially |
| | Insulation resistance | As specified in section "Insulation Resistance" of this specification |
| SUB-GROUP C1 COMBINED SAMPLE OF SPECIMENS OF SUB-GROUPS C1A AND C1B | | |
| 4.11 Climatic sequence | | |
| 4.11.1 Initial measurements | Capacitance Measured in 4.4.2 and 4.9.2 | |
| | Tangent of loss angle: measured initially in C1A and C1B | |
| 4.11.2 Dry heat | Temperature: 105 °C | |
| 4.11.3 Damp heat cyclic Test Db First cycle | Duration: 16 h | |
| 4.11.4 Cold | Temperature: -40 °C | |
| 4.11.5 Damp heat cyclic Test Db remaining cycles | Duration: 2 h | |
| 4.11.6 Final measurements | Visual examination | No visible damage Legible marking |
| | Capacitance | $ \Delta C/C \leq 5\%$ of the value measured in 4.11.1. |
| | Tangent of loss angle | Increase of tan δ : ≤ 0.008 for: $C \leq 1 \mu F$ or ≤ 0.005 for: $C > 1 \mu F$ Compared to values measured in 4.11.1 |
| | Voltage proof 1350 V _{DC} ; 1 min between terminations | No permanent breakdown or flash-over |
| | Insulation resistance | $\geq 50\%$ of values specified in section "Insulation Resistance" of this specification |



| INSPECTION REQUIREMENTS | | |
|--|---|---|
| SUB-CLAUSE NUMBER AND TEST | CONDITIONS | PERFORMANCE REQUIREMENTS |
| SUB-GROUP C2 | | |
| 4.12 Damp heat steady state | 56 days, 40 °C, 90 % to 95 % RH, no load | |
| 4.12.1 Initial measurements | Capacitance Tangent of loss angle: for C ≤ 1 µF at 10 kHz for C > 1 µF at 1 kHz | |
| 4.12.3 Final measurements | Visual examination Capacitance Tangent of loss angle Voltage proof 1350 V _{DC} ; 1 min between terminations Insulation resistance | No visible damage Legible marking $ \Delta C/C \leq 5\%$ of the value measured in 4.12.1. Increase of tan δ: ≤ 0.008 for: C ≤ 1 µF or ≤ 0.005 for: C > 1 µF Compared to values measured in 4.12.1. No permanent breakdown or flash-over ≥ 50 % of values specified in section “Insulation Resistance” of this specification |
| SUB-GROUP C2A | | |
| 4.12A Damp heat steady state with load | 85 °C, 85 % RH, load: 305 V _{AC} Duration: 500 h | |
| 4.12.1A Initial measurements | Capacitance Tangent of loss angle: for C ≤ 1 µF at 10 kHz for C > 1 µF at 1 kHz | |
| 4.12.3A Final measurements | Visual examination Capacitance Tangent of loss angle Voltage proof 1350 V _{DC} ; 1 min between terminations Insulation resistance | No visible damage Legible marking $ \Delta C/C \leq 10\%$ of the value measured in 4.12.1. Increase of tan δ: ≤ 0.0240 for: C ≤ 1 µF or ≤ 0.0150 for: C > 1 µF Compared to values measured in 4.12.1. No permanent breakdown or flash-over ≥ 50 % of values specified in section “Insulation Resistance” of this specification |



| INSPECTION REQUIREMENTS | | |
|-----------------------------|--|--|
| SUB-CLAUSE NUMBER AND TEST | CONDITIONS | PERFORMANCE REQUIREMENTS |
| SUB-GROUP C3 | | |
| 4.13.1 Initial measurements | Capacitance Tangent of loss angle: for C ≤ 1 μF at 10 kHz for C > 1 μF at 1 kHz | |
| 4.13 Impulse voltage | 3 successive impulses, full wave, peak voltage: X2: 2.5 kV for C ≤ 1 μF X2: 2.5 kV√C for C > 1 μF Max. 24 pulses | No self healing breakdowns or flash-over |
| 4.14 Endurance | Duration: 1000 h 1.25 x U _{RAC} at 105 °C Once in every hour the voltage is increased to 1000 V _{RMS} for 0.1 s via resistor of 47 Ω ± 5 % | |
| 4.14.7 Final measurements | Visual examination | No visible damage Legible marking |
| | Capacitance | ΔC/C ≤ 10 % compared to values measured in 4.13.1. |
| | Tangent of loss angle | Increase of tan δ: ≤ 0.008 for: C ≤ 1 μF or ≤ 0.005 for: C > 1 μF Compared to values measured in 4.13.1 |
| | Voltage proof 1350 V _{DC} ; 1 min between terminations 2120 V _{AC} ; 1 min between terminations and case | No permanent breakdown or flash-over |
| | Insulation resistance | ≥ 50 % of values specified in section "Insulation Resistance" of this specification |
| SUB-GROUP C4 | | |
| 4.15 Charge and discharge | 10 000 cycles Charged to 430 V _{DC} Discharge resistance: $R = \frac{430 V_{DC}}{1.25 \times C (du/dt)}$ | |
| 4.15.1 Initial measurements | Capacitance Tangent of loss angle: for C ≤ 1 μF at 10 kHz for C > 1 μF at 1 kHz | |
| 4.15.3 Final measurements | Capacitance | ΔC/C ≤ 10 % compared to values measured in 4.15.1. |
| | Tangent of loss angle | Increase of tan δ: ≤ 0.008 for: C ≤ 1 μF or ≤ 0.005 for: C > 1 μF Compared to values measured in 4.15.1 |
| | Insulation resistance | ≥ 50 % of values specified in section "Insulation Resistance" of this specification |

| INSPECTION REQUIREMENTS | | |
|--------------------------------------|---|--|
| SUB-CLAUSE NUMBER AND TEST | CONDITIONS | PERFORMANCE REQUIREMENTS |
| SUB-GROUP C5 | | |
| 4.16 Radio frequency characteristic | Resonance frequency | ≥ 0.9 times the value as specified in section "Resonant Frequency" of this specification |
| SUB-GROUP C6 | | |
| 4.17 Passive flammability Class B | Bore of gas jet: $\varnothing 0.5$ mm Fuel: butane / propane Test duration for actual volume V in mm ³ : Class B V > 1750 60 s One flame application:  | After removing test flame from capacitor, the capacitor must not continue to burn for more than 10 s for V > 1750 mm ³ . No burning particle must drop from the sample. |
| SUB-GROUP C7 | | |
| 4.18 Active flammability | 20 cycles of 2.5 kV discharges on the test capacitor connected to U _{RAC} | The cheese cloth around the capacitors shall not burn with a flame. No electrical measurements are required. |

| AUTOMOTIVE AEC-Q200, REVISION D QUALIFICATION | | | | |
|---|----------|---|-------------|---|
| STRESS | REVISION | CONDITION | SAMPLE SIZE | PERFORMANCE REQUIREMENTS |
| 1. High temperature exposure (storage) | D | Temp.: 105 °C; unpowered 250 h / 500 h / 1000 h | 77 | $ \Delta C/C \leq 5\%$ Increase of tan δ : ≤ 0.008 for C ≤ 1 μ F at 10 kHz Increase of tan δ : ≤ 0.005 for C > 1 μ F at 1 kHz IR > 50 % of initial specified value |
| 2. Temperature cycling | D | Total no. of cycles: 1000 cycles Lower temp.: -40 °C Upper temp.: +105 °C 30 min dwell time at each temperature Transition time < 1 min | 77 | $ \Delta C/C \leq 5\%$ Increase of tan δ : ≤ 0.008 for C ≤ 1 μ F at 10 kHz IR > 50 % of initial specified value |
| 3. Moisture resistance | | No. of cycle: 10 cycles t = 24 h/cycle | 77 | $ \Delta C/C \leq 5\%$ Increase of tan δ : ≤ 0.008 for C ≤ 1 μ F at 10 kHz IR > 50 % of initial specified value |
| 4. Biased humidity AC | D | Temp.: 40 °C; RH: 93 %; U _{RAC} 250 h / 500 h / 1000 h | 77 | $ \Delta C/C \leq 10\%$ Increase of tan δ : ≤ 0.008 for C ≤ 1 μ F at 10 kHz IR > 50 % of initial specified value |
| 5. Operational life AC | D | Temp. = 105 °C; U _{RAC} 1000 h | 77 | $ \Delta C/C \leq 10\%$ Increase of tan δ : ≤ 0.008 for C ≤ 1 μ F at 10 kHz IR > 50 % of initial specified value |
| 6. Terminal strength (lead) | D | Test leaded device lead integrity only. - A (pull-test): 2.27 kg (10 s) - C (wire-lead bend test): 227 g (3 x 3 s) | 30 | No visual damage |



| AUTOMOTIVE AEC-Q200, REVISION D QUALIFICATION | | | | |
|--|-----------------|--|--------------------|--|
| STRESS | REVISION | CONDITION | SAMPLE SIZE | PERFORMANCE REQUIREMENTS |
| 7. Resistance to solvents | D | MIL-STD-202 method 215. - Also aqueous chemical - OKEM clean or equivalent. Do not use banned solvents. | 5 | No visual damage Legible marking |
| 8. Mechanical shock | D | 100 g's ; 6 ms half-sine; 3.75 m/s | 30 | No visual damage |
| 9. Vibration | D | 5 g's for 20 min 12 cycles x 3 directions 10 Hz to 2000 Hz | 30 | No visual damage |
| 10. Resistance to soldering heat | D | Temp.: 280 °C; time: 10 s solder within 1.5 mm of device body | 30 | $ \Delta C/C \leq 5\%$ Increase of $\tan \delta$: ≤ 0.008 for $C \leq 1 \mu F$ at 10 kHz IR > 50 % of initial specified value |
| 11. Solderability | D | Leaded: method A at 235 °C, category 3 (245 °C / 3 s) | 15 | Good tinning as evidence by free flowing of the solder with wetting of terminations > 95 % |
| 12. Electrical characterization | | - | 30 | - |
| 13. Flammability | | One flame application Class B | 15 | V-0 or V-1 are acceptable. Class B or C according IEC is also acceptable |



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- Консультации по применению компонента;
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- Техническая поддержка проекта;
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