

## Interference Suppression Film Capacitor - Class X2 Radial MKT 310 V<sub>AC</sub> - High Stability Grade


**FEATURES**

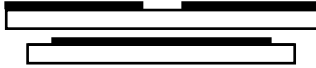
- AEC-Q200 qualified (rev. D) up to 110 °C for  $\leq 470$  nF
- Compliant with IEC 60384-14: AMD1 grade IB - THB: 85 °C / 85 % RH, 168 h at U<sub>RAC</sub>
- THB: 40 °C / 90 % RH for 1000 h at rated voltage, in compliance with AEC-Q200
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

**APPLICATIONS**

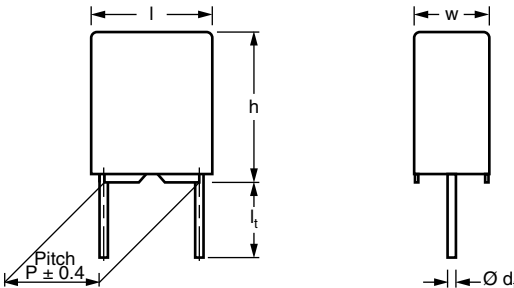
High stability grade for continuous across the line X2 applications.

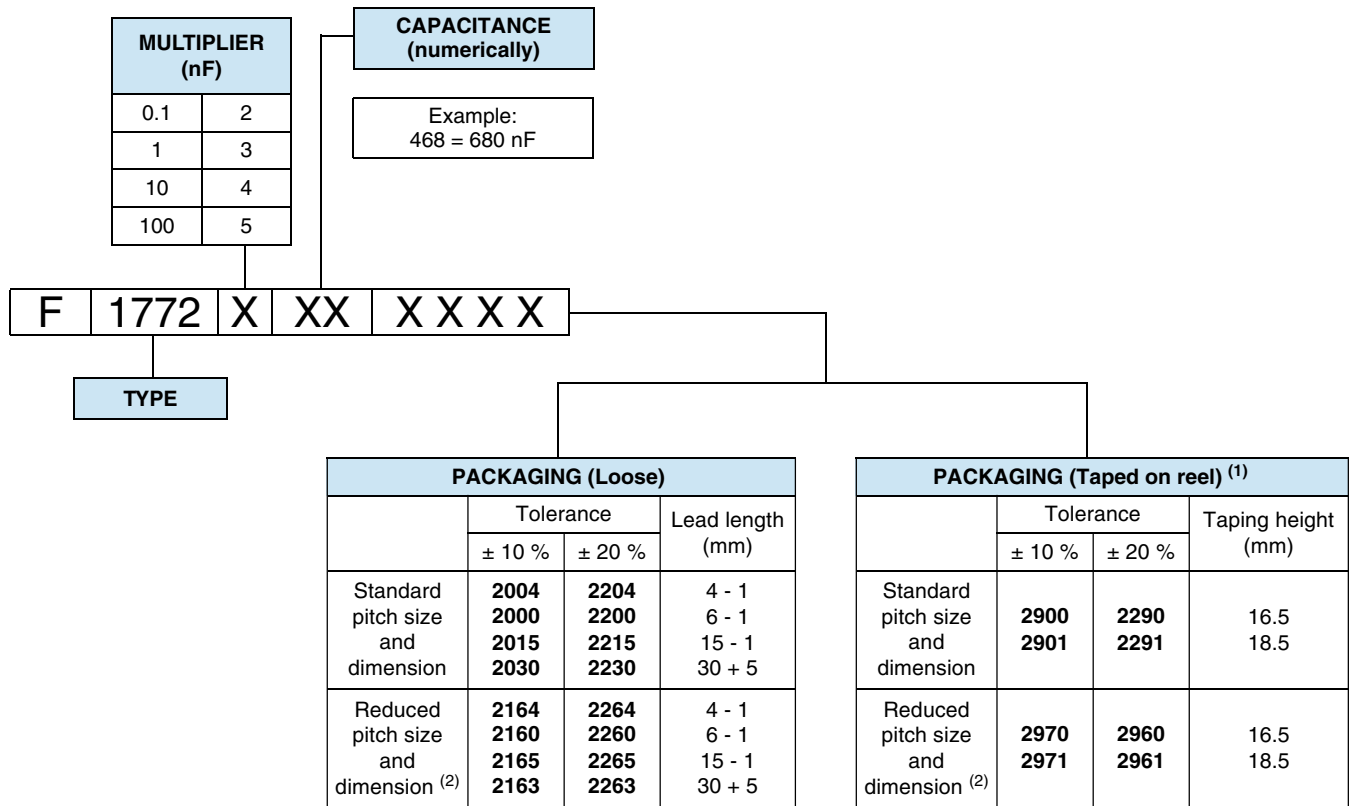
 See also application note: [www.vishay.com/doc?28153](http://www.vishay.com/doc?28153)

QUICK REFERENCE DATA	
Capacitance range (E12 series)	0.01 $\mu$ F to 2.2 $\mu$ F (preferred values acc. to E6)
Capacitance tolerance	$\pm 10$ %, $\pm 20$ % ( $\pm 5$ % on request)
Rated AC voltage	310 V <sub>AC</sub> ; 50 Hz to 60 Hz
Permissible DC voltage	800 V <sub>DC</sub> at 85 °C 630 V <sub>DC</sub> at 110 °C
Climatic testing class according to IEC 60068-1	40/110/56/C for the product volume $\leq 1750$ mm <sup>3</sup> 40/110/56/B for the product volume $\geq 1750$ mm <sup>3</sup>
Maximum application temperature	110 °C
Reference standards	IEC 60384-14 ed-4 and EN 60384-14 IEC 60065 pass. flamm. class C CSA-E384-14 UL 60384-14
Dielectric	Polyester film
Electrodes	Metallized
Construction	Series 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, year and week; manufacturer's logo or name; safety approvals

**Note**

- For more detailed data and test requirements, contact [rfi@vishay.com](mailto:rfi@vishay.com)

DIMENSIONS in millimeters


**COMPOSITION OF CATALOG NUMBER**


Example: F17724152215 means 0.15  $\mu$ F,  $\pm$  20 %; standard pitch 22.5 mm; lead length 15 mm - 1 mm;  
 F17724152265 means 0.15  $\mu$ F,  $\pm$  20 %; reduced pitch 15.0 mm; lead length 15 mm - 1 mm

**Notes**

- For detailed tape specifications refer to packaging information [www.vishay.com/doc?28139](http://www.vishay.com/doc?28139)
- <sup>(1)</sup> Taped on reel pitch  $\geq$  27.5 mm is not available
- <sup>(2)</sup> Same capacitance values  $\geq$  0.15  $\mu$ F are available in two different pitch sizes and dimensions

SPECIFIC REFERENCE DATA	
DESCRIPTION	VALUE
Rated AC voltage ( $U_{RAC}$ )	310 V
Permissible DC voltage ( $U_{RDC}$ )	630 V
Tangent of loss angle	$\leq 100 \times 10^{-4}$ at 1 kHz
Rated voltage pulse slope at $(dU/dt)_R$ 435 $V_{DC}$	100 V/ $\mu$ s
R between leads, for $C \leq 0.33 \mu$ F at 100 V; 1 min	$> 15\,000 \text{ M}\Omega$
RC between leads, $C > 0.33 \mu$ F at 100 V; 1 min	$> 5000 \text{ s}$
R between leads and case; 100 V; 1 min	$> 30\,000 \text{ M}\Omega$
Withstanding (DC) voltage (cut off current 10 mA) <sup>(1)</sup> ; rise time $\leq 1000 \text{ V/s}$	
$C \leq 0.47 \mu$ F	2200 V; for 1 min
$C > 0.47 \mu$ F	2150 V; for 1 min
Withstanding (AC) voltage between leads and case	2120 V; 1 min
Maximum application temperature	110 °C

**Note**

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



<b>ELECTRICAL DATA AND ORDERING INFORMATION</b>						
<b>U<sub>RAC</sub></b> <b>(V)</b>	<b>CAP.</b> <b>(μF)</b>	<b>PITCH</b> <b>(mm)</b>	<b>DIMENSIONS <sup>(4)</sup></b> <b>w x h x l</b> <b>MAX. (mm)</b>	<b>MASS <sup>(3)</sup></b> <b>(g)</b>	<b>SPQ</b> <b>(pieces)</b> <b>SHORT LEAD</b>	<b>ORDERING CODE</b> <b>BULK</b> <b>LEAD LENGTH</b> <b>6 mm - 1 mm <sup>(1)(2)</sup></b>
310	<b>d<sub>t</sub> = 0.60 mm ± 0.06 mm; C-TOL. = ± 10 %</b>					
	0.010	15	5.0 x 11.0 x 17.5	1.4	750	F17723102000
	0.012	15	5.0 x 11.0 x 17.5	1.4	750	F17723122000
	0.015	15	5.0 x 11.0 x 17.5	1.4	750	F17723152000
	0.018	15	5.0 x 11.0 x 17.5	1.4	750	F17723182000
	0.022	15	5.0 x 11.0 x 17.5	1.4	750	F17723222000
	0.027	15	5.0 x 11.0 x 17.5	1.4	750	F17723272000
	0.033	15	5.0 x 11.0 x 17.5	1.4	750	F17723332000
	0.039	15	6.0 x 12.0 x 17.5	2.0	500	F17723392000
	0.047	15	6.0 x 12.0 x 17.5	2.0	500	F17723472000
	0.056	15	6.0 x 12.0 x 17.5	2.0	500	F17723562000
	<b>d<sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 %</b>					
	0.068	15	7.0 x 13.5 x 17.5	2.4	450	F17723682000
	0.082	15	8.5 x 15.0 x 17.5	2.7	300	F17723822000
	0.10	15	8.5 x 15.0 x 17.5	2.7	325	F17724102000
	0.12	15	8.5 x 15.0 x 17.5	2.7	300	F17724122000
	0.15	15	8.5 x 15.0 x 17.5	2.7	300	F17724152160
	0.15	22.5	7.0 x 16.5 x 26.0	4.1	235	F17724152000
	0.18	22.5	7.0 x 16.5 x 26.0	4.1	235	F17724182000
	0.22	15	10.0 x 16.5 x 17.5	3.0	235	F17724222160
	0.22	22.5	8.5 x 16.5 x 26.5	4.6	200	F17724222000
	0.27	22.5	10.0 x 19.5 x 26.0	6.7	170	F17724272000
	0.33	15	13.5 x 22.5 x 18.0	5.5	185	F17724332160
	0.33	22.5	10.0 x 19.5 x 26.0	6.7	170	F17724332000
	0.39	27.5	11.0 x 21.0 x 31.0	9.1	125	F17724392000
	0.47	22.5	12.0 x 22.0 x 26.0	13.0	110	F17724472160
	0.47	27.5	11.0 x 21.0 x 31.0	9.1	125	F17724472000
	0.56	27.5	11.0 x 21.0 x 31.0	9.1	125	F17724562000
	0.68	22.5	15.5 x 26.5 x 26.5	13.5	110	F17724682160
	0.68	27.5	13.0 x 23.0 x 31.0	12.9	110	F17724682000
	0.82	27.5	13.0 x 23.0 x 31.0	12.9	110	F17724822000
	1.0	22.5	15.5 x 26.5 x 26.5	13.5	110	F17725102160
	1.0	27.5	15.0 x 25.0 x 31.5	15.0	100	F17725102000
	1.2	37.5	14.5 x 24.5 x 41.5	18.9	80	F17725122000
	1.5	27.5	18.0 x 28.0 x 31.0	19.0	85	F17725152160
	1.5	37.5	15.5 x 28.5 x 41.5	24.0	70	F17725152000
	1.8	37.5	15.5 x 28.5 x 41.5	24.0	70	F17725182000
	2.2	27.5	21.0 x 31.0 x 31.0	28.0	70	F17725222160
	2.2	37.5	18.0 x 32.5 x 41.5	31.6	60	F17725222000
	<b>d<sub>t</sub> = 0.60 mm ± 0.06 mm; C-TOL. = ± 20 %</b>					
	0.010	15	5.0 x 11.0 x 17.5	1.4	750	F17723102200
	0.015	15	5.0 x 11.0 x 17.5	1.4	750	F17723152200
	0.022	15	5.0 x 11.0 x 17.5	1.4	750	F17723222200
	0.033	15	5.0 x 11.0 x 17.5	1.4	750	F17723332200
	0.047	15	5.0 x 11.0 x 17.5	1.4	750	F17723472200
0.068	15	6.0 x 12.0 x 17.5	2.0	600	F17723682200	
0.10	15	6.0 x 12.0 x 17.5	2.0	600	F17724102200	

<b>ELECTRICAL DATA AND ORDERING INFORMATION</b>						
<b>U<sub>RAC</sub></b> <b>(V)</b>	<b>CAP.</b> <b>(μF)</b>	<b>PITCH</b> <b>(mm)</b>	<b>DIMENSIONS</b> <sup>(4)</sup> <b>w x h x l</b> <b>MAX. (mm)</b>	<b>MASS</b> <sup>(3)</sup> <b>(g)</b>	<b>SPQ</b> <b>(pieces)</b> <b>SHORT LEAD</b>	<b>ORDERING CODE</b> <b>BULK</b> <b>LEAD LENGTH</b> <b>6 mm - 1 mm</b> <sup>(1)(2)</sup>
<b>d<sub>t</sub> = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %</b>						
310	0.15	15	8.5 x 15.0 x 17.5	2.7	325	F17724152260
	0.15	22.5	6.0 x 15.5 x 26.0	3.3	260	F17724152200
	0.22	15	10.0 x 16.5 x 17.5	4.5	300	F17724222260
	0.22	22.5	7.0 x 16.5 x 26.0	4.1	235	F17724222200
	0.33	15	13.5 x 22.5 x 18.0	5.5	185	F17724332260
	0.33	22.5	8.5 x 18.0 x 26.0	5.3	190	F17724332200
	0.47	22.5	10.0 x 19.5 x 26.0	6.7	170	F17724472260
	0.47	27.5	9.0 x 19.0 x 31.5	6.8	160	F17724472200
	0.68	22.5	12.0 x 22.0 x 26.0	13.4	110	F17724682260
	0.68	27.5	11.0 x 21.0 x 31.0	12.9	125	F17724682200
	1.0	22.5	15.5 x 26.5 x 26.5	13.5	110	F17725102260
	1.0	27.5	15.0 x 25.0 x 31.5	15.0	100	F17725102200
	1.5	27.5	18.0 x 28.0 x 31.5	19.0	85	F17725152260
	1.5	37.5	14.5 x 24.5 x 41.5	18.9	80	F17725152200
	2.2	27.5	21.0 x 31.0 x 31.0	28.0	70	F17725222260
2.2	37.5	15.5 x 28.5 x 41.5	24.0	70	F17725222200	

**Notes**

- SPQ = Standard Packing Quantity
- For detailed tape specifications refer to packaging information: [www.vishay.com/doc?28139](http://www.vishay.com/doc?28139)
- (1) For further packaging see table “Composition of Catalog Number”
- (2) Further information about packaging quantities with different lead length and / or taped versions, see document “Packing Quantities” [www.vishay.com/doc?27608](http://www.vishay.com/doc?27608)
- (3) Weight for short lead product only
- (4) For tolerances see chapter “Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances”

<b>APPROVALS</b>				
<b>SAFETY APPROVALS X2</b>	<b>VOLTAGE</b>	<b>VALUE</b>	<b>FILE NUMBERS</b>	<b>LINK</b>
EN 60384-14 (ENEC) (= IEC 60384-14 ed-4)	310 V <sub>AC</sub>	0.01 μF to 2.2 μF X2	40005079	<a href="http://www.vishay.com/doc?28196">www.vishay.com/doc?28196</a>
UL 60384-14	310 V <sub>AC</sub>	0.01 μF to 2.2 μF X2	E354331	<a href="http://www.vishay.com/doc?28191">www.vishay.com/doc?28191</a>
CSA-E 384-14	310 V <sub>AC</sub>	0.01 μF to 2.2 μF X2	E354331	
CB test-certificate	310 V <sub>AC</sub>	0.01 μF to 2.2 μF X2	DE1-58410	<a href="http://www.vishay.com/doc?28226">www.vishay.com/doc?28226</a>
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 capacitors are designed for mounting on printed-circuit boards. 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/doc?28139](http://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 stand-off pips are in good contact with the printed-circuit board:

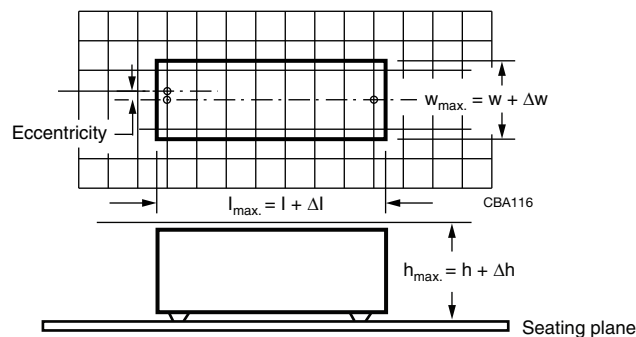
- For pitches  $\leq 15$  mm capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

## 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  $\leq 15$  mm,  $\Delta w = \Delta l = 0.3$  mm, and  $\Delta h = 0.1$  mm
- For products with  $15$  mm  $<$  pitch  $\leq 27.5$  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 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  $\leq 10$  mm,  $\Delta l = 0.3$  mm, and  $\Delta w = \Delta h = 0.3$  mm
- 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  $\leq 27.5$  mm,  $\Delta l = 1.0$  mm and  $\Delta w = \Delta h = 0.5$  mm
- For products with pitch = 37.5 mm,  $\Delta l = 1.0$  mm and  $\Delta w = \Delta h = 1.0$  mm

## SOLDERING CONDITIONS

For general soldering conditions and wave soldering profile, we refer to the application note: "Soldering Guidelines for Film Capacitors": [www.vishay.com/doc?28171](http://www.vishay.com/doc?28171)

### Storage Temperature

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

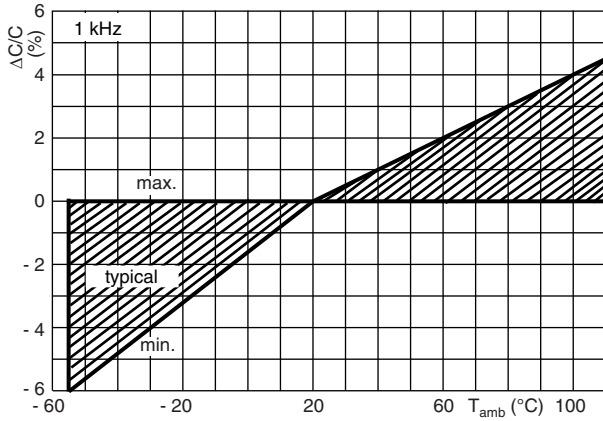
### Ratings and Characteristics Reference Conditions

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

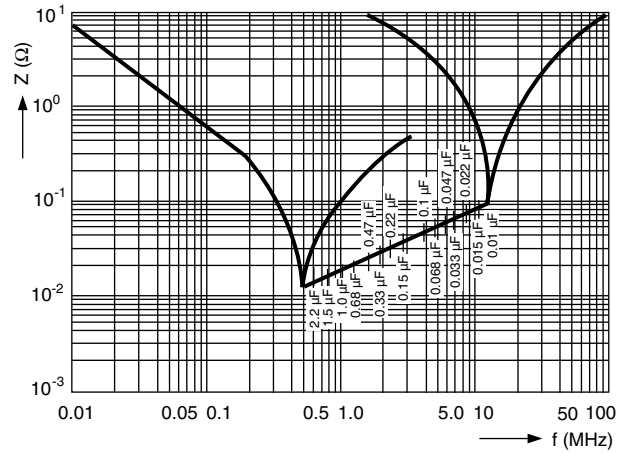
For reference testing, a conditioning period shall be applied over  $96$  h  $\pm 4$  h by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.



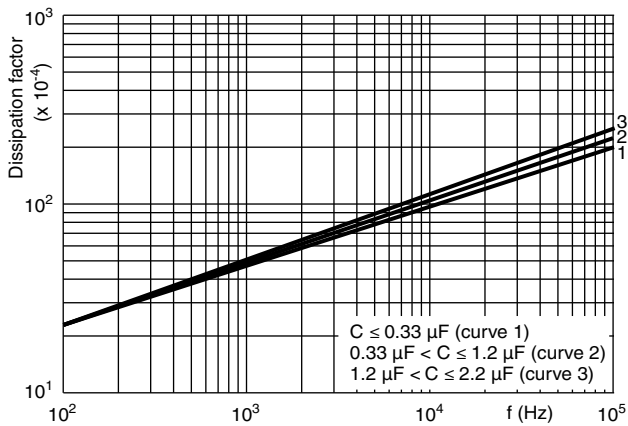
CHARACTERISTICS



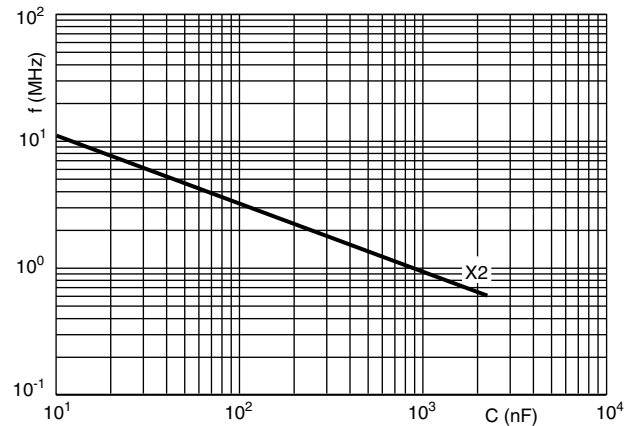
Capacitance as a function of ambient temperature (typical curve)



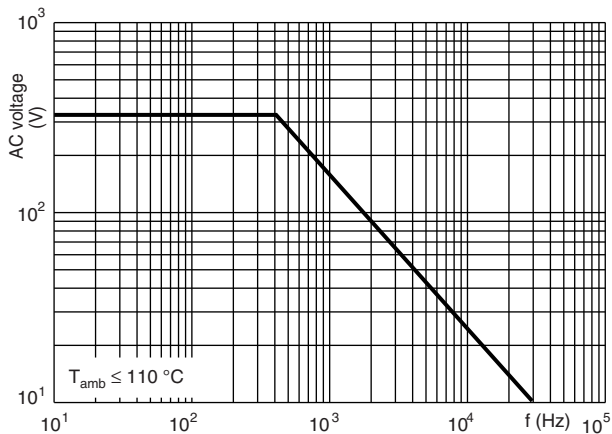
Impedance as a function of frequency (typical curve)



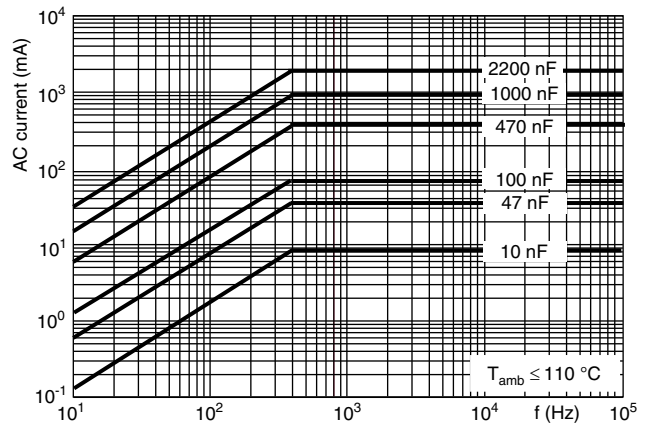
Tangent of loss angle as a function of frequency (typical curve)



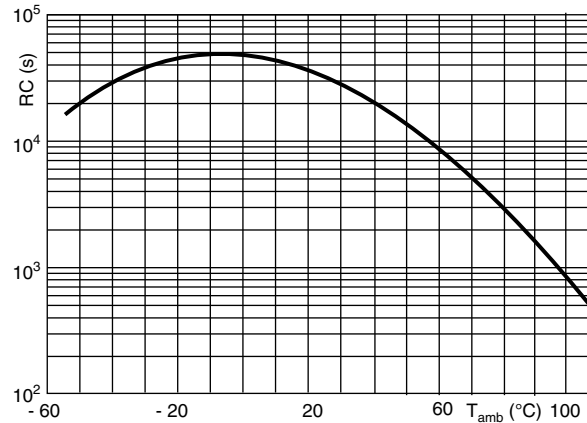
Resonant frequency as a function of capacitance (typical curve)



Max. RMS voltage as a function of frequency



Max. RMS current as a function of frequency



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

### APPLICATION NOTES AND LIMITING CONDITIONS

- For X2 electromagnetic interference suppression where a higher stability grade is needed for **continuous across the line applications** (50 Hz/60 Hz) with a maximum mains voltage of 310 V<sub>AC</sub>.
- These capacitors are not intended for continuous pulse application. For these situations capacitors of the AC and pulse programs must be used.
- For series impedance applications we refer to application note: [www.vishay.com/doc?28153](http://www.vishay.com/doc?28153)
- The maximum ambient temperature must not exceed 110 °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 435 V<sub>DC</sub> 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 3 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 chapter “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	



GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	CONDITIONS	PERFORMANCE REQUIREMENTS
<b>SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1</b>		
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  Capacitance  Tangent of loss angle  Insulation resistance	No visible damage Legible marking  $ \Delta C/C  \leq 5\%$ of the value measured initially  Increase of $\tan \delta$ $\leq 0.008$ for: $C \leq 1 \mu F$ or $\leq 0.005$ for: $C > 1 \mu F$ Compared to values measured initially  As specified in section "Insulation Resistance" of this specification
<b>SUB-GROUP C1B PART OF SAMPLE OF SUB-GROUP C1</b>		
Initial measurements	Capacitance Tangent of loss angle: for $C \leq 1 \mu F$ at 10 kHz for $C > 1 \mu F$ at 1 kHz	
4.20 Solvent resistance of the marking	Isopropylalcohol 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	$\theta A = -40\text{ }^\circ C$ $\theta B = +110\text{ }^\circ C$ 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 $98\text{ m/s}^2$ (whichever is less severe) Total duration 6 h	
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: $490\text{ m/s}^2$ Duration of pulse: 11 ms	
4.9.2 Final measurements	Visual examination  Capacitance  Tangent of loss angle  Insulation resistance	No visible damage  $ \Delta C/C  \leq 5\%$ of the value measured initially  Increase of $\tan \delta$ $\leq 0.008$ for: $C \leq 1 \mu F$ or $\leq 0.005$ for: $C > 1 \mu F$ Compared to values measured initially  As specified in section "Specific Reference" of this specification

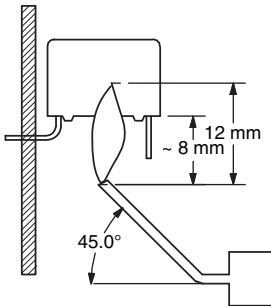




GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	CONDITIONS	PERFORMANCE REQUIREMENTS
<b>SUB-GROUP C1 COMBINED SAMPLE OF SPECIMENS OF SUB-GROUPS C1A AND C1B</b>		
4.11 Climatic sequence	Capacitance	
4.11.1 Initial measurements	Measured in 4.4.2 and 4.9.2 Tangent of loss angle Measured initially in C1A and C1B	
4.11.2 Dry heat	Temperature: 110 °C Duration: 16 h	
4.11.3 Damp heat cyclic Test Db, first cycle		
4.11.4 Cold	Temperature: -40 °C Duration: 2 h	
4.11.5 Damp heat cyclic Test Db, remaining cycles		
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 $\tan \delta$ $\leq 0.008$ for: $C \leq 1 \mu\text{F}$ or $\leq 0.005$ for: $C > 1 \mu\text{F}$ Compared to values measured in 4.11.1
	Voltage proof 1350 V <sub>DC</sub> 1 min between terminations	No permanent breakdown or flash-over
	Insulation resistance	$\geq 50\%$ of values specified in section "Insulation Resistance" of this specification
<b>SUB-GROUP C2</b>		
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: 1 kHz	
4.12.3 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$ \Delta C/C  \leq 5\%$ of the value measured in 4.12.1
	Tangent of loss angle	Increase of $\tan \delta$ $\leq 0.008$ for: $C \leq 1 \mu\text{F}$ or $\leq 0.005$ for: $C > 1 \mu\text{F}$ Compared to values measured in 4.12.1
	Voltage proof 1350 V <sub>DC</sub> ; 1 min between terminations	No permanent breakdown or flash-over
	Insulation resistance	$\geq 50\%$ of values specified in section "Insulation Resistance" of this specification



GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	CONDITIONS	PERFORMANCE REQUIREMENTS
<b>SUB-GROUP C2A</b>		
4.12A Damp heat steady state with load	RH: 85 %; temp.: 85 °C, load: 310 V <sub>AC</sub> Duration: 168 h	
4.12.1A Initial measurements	Capacitance Tangent of loss angle: 1 kHz	
4.12.3A Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$ \Delta C/C  \leq 10\%$ of the value measured in 4.12.1
	Tangent of loss angle	Increase of $\tan \delta$ $\leq 0.024$ for: $C \leq 1 \mu\text{F}$ or $\leq 0.015$ for: $C > 1 \mu\text{F}$ Compared to values measured in 4.12.1
	Insulation resistance	$\geq 50\%$ of values specified in section "Insulation Resistance" of this specification or minimum 200 M $\Omega$ , whichever is higher
<b>SUB-GROUP C3</b>		
4.13.1 Initial measurements	Capacitance Tangent of loss angle: for $C \leq 1 \mu\text{F}$ at 10 kHz for $C > 1 \mu\text{F}$ at 1 kHz	
4.13 Impulse voltage	3 successive impulses, full wave, peak voltage: X2: 2.5 kV for $C \leq 1 \mu\text{F}$ X2: 2.5 kV/ $\sqrt{C}$ for $C > 1 \mu\text{F}$ Max. 24 pulses	No self healing breakdowns or flash-over
4.14 Endurance	Duration: 1000 h 1.25 x U <sub>RAC</sub> at 110 °C Once in every hour the voltage is increased to 1000 V (RMS) for 0.1 s via resistor of 47 $\Omega \pm 5\%$	
4.14.7 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$ \Delta C/C  \leq 5\%$ compared to values measured in 4.13.1
	Tangent of loss angle	Increase of $\tan \delta$ $\leq 0.008$ for: $C \leq 1 \mu\text{F}$ or $\leq 0.005$ for: $C > 1 \mu\text{F}$ Compared to values measured in 4.13.1
	Voltage proof 1350 V <sub>DC</sub> ; 1 min between terminations 2120 V <sub>AC</sub> ; 1 min between terminations and case	No permanent breakdown or flash-over
	Insulation resistance	$\geq 50\%$ of values specified in section "Insulation Resistance" of this specification

<b>GROUP C INSPECTION REQUIREMENTS</b>		
<b>SUB-CLAUSE NUMBER AND TEST</b>	<b>CONDITIONS</b>	<b>PERFORMANCE REQUIREMENTS</b>
<b>SUB-GROUP C4</b>		
4.15 Charge and discharge	10 000 cycles Charged to 435 V <sub>DC</sub> Discharge resistance: $R = \frac{435 V_{DC}}{1.5 \times C(dU/dt)}$	
4.15.1 Initial measurements	Capacitance Tangent of loss angle: for C ≤ 1 μF at 10 kHz for C > 1 μF at 1 kHz	
4.13.3 Final measurements	Capacitance  Tangent of loss angle  Insulation resistance	$ \Delta C/C  \leq 10\%$ compared to values measured in 4.15.1  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  ≥ 50 % of values specified in section "Insulation Resistance" of this specification
<b>SUB-GROUP C5</b>		
4.16 Radio frequency characteristic	Resonance frequency	≥ 0.9 times the value as specified in section "Resonant Frequency" of this specification.
<b>SUB-GROUP C6</b>		
4.17 Passive flammability Class C	Bore of gas jet: Ø 0.5 mm Fuel: butane Test duration for actual volume V in mm <sup>3</sup> : V ≤ 250: 5 s 250 < V ≤ 500: 10 s 500 < V ≤ 1750: 20 s V > 1750: 30 s One flame application 	After removing test flame from capacitor, the capacitor must not continue to burn for more than 30 s. No burning particle must drop from the sample.
<b>SUB-GROUP C7</b>		
4.18 Active flammability	20 cycles of 2.5 kV discharges on the test capacitor connected to U <sub>RAC</sub> .	The cheese cloth around the capacitors shall not burn with a flame. No electrical measurements are required.



TEST CONDITIONS AND REQUIREMENTS ACCORDING AEC-Q200 REVISION D				
NO.	TEST NAME	REFERENCE	TEST CONDITIONS	PERFORMANCE REQUIREMENTS
1	Pre- and post-stress electrical test	Spec.	-	-
3	High temperature exposure (storage)	MIL-STD 202 method 108	110 °C; unpowered 250 h / 500 h / 1000 h	$ \Delta C/C  \leq 5\%$ Increase of $\tan \delta$ $\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or $\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz IR > 50 % of initial specified value
4	Temperature cycling	JESD22 method JA-104	1000 cycles: -40 °C / +110 °C 30 min. dwell time at each temperature extreme Transition time < 1 min.	$ \Delta C/C  \leq 5\%$ Increase of $\tan \delta$ $\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or $\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz IR > 50 % of initial specified value
6	Moisture resistance	MIL-STD 202 method 106	10 cycles at 24 h/cycle unpowered	$ \Delta C/C  \leq 5\%$ Increase of $\tan \delta$ $\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or $\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz IR > 50 % of initial specified value
7	Biased humidity	MIL-STD 202 method 103	40 °C; 93 % RH; $U_{\text{RAC}}$ (310 $V_{\text{AC}}$ ) 250 h / 500 h / 1000 h	$ \Delta C/C  \leq 10\%$ Increase of $\tan \delta$ $\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or $\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz IR > 50 % of initial specified value
8	Operational life	MIL-STD 202 method 108	$T_{\text{amb}} = 110 \text{ °C}$ ; (310 $V_{\text{AC}}$ ) 250 h / 500 h / 1000 h	$ \Delta C/C  \leq 10\%$ Increase of $\tan \delta$ $\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or $\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz IR > 50 % of initial specified value
9	External visual	MIL-STD 883 method 2009	Device construction, marking, and workmanship	Device construction and workmanship; legible marking
10	Physical dimension	JESD22 method JB-100	Spec.	Datasheet
11	Terminal strength (lead)	MIL-STD 202 method 211	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)	No visual damage
12	Resistance to solvents	MIL-STD 202 method 215	- Also aqueous chemical - OKEM clean or equivalent. Do not use banned solvents.	No visual damage Legible marking
13	Mechanical shock	MIL-STD 202 method 213	100 g's; 6 ms half-sine; 3.75 m/s	No visual damage
14	Vibration	MIL-STD 202 method 204	5 g's for 20 min; 12 cycles x 3 directions 10 Hz to 2000 Hz	No visual damage
15	Resistance to soldering heat	MIL-STD 202 method 210	280 °C; 10 s solder within 1.5 mm of device body	$ \Delta C/C  \leq 5\%$ Increase of $\tan \delta$ $\leq 0.008$ for $C \leq 1 \mu\text{F}$ at 10 kHz or $\leq 0.005$ for $C > 1 \mu\text{F}$ at 1 kHz IR > 50 % of initial specified value
17	ESD	-	-	-
18	Solderability	J-STD-002	Leaded: method A, category 3 (245 °C / 3 s)	Good tinning as evidence by free flowing of the solder with wetting of terminations > 95 %
19	Electrical characterization	-	-	-
20	Flammability	UL 94 IEC 60384-1	One flame application Class B	V-0 or V-1 are acceptable. Class B or C acc. IEC is also acceptable



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