THB Grade IIIB Class X1 Interference Suppression Film Capacitor Radial MKP 480 V_{AC} - Three Phase Across the Line



FEATURES

- IEC 60384-14: 2013 / AMD1: 2016 grade IIIB: 85 °C, 85 % RH, 1000 h at U_{RAC} certified
- AEC-Q200 qualified
- Maximum permissible AC voltage up to 530 V
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

APPLICATIONS

For standard across the line X1 and series impedance applications.

See also application note: www.vishay.com/doc?28153

LINKS TO ADDITIONAL RESOURCES

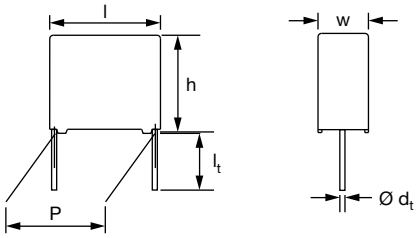
3D Models

QUICK REFERENCE DATA	
Rated capacitance range	220 nF to 8.2 µF (preferred values according to E12)
Capacitance tolerance	± 20 %; ± 10 %
Rated voltage range, U_{RAC}	480 V_{AC}
Permissible DC voltage	800 V_{DC} at 105 °C
Climatic testing class	40 / 105 / 56 / B
Maximum application 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 (2nd edition) CSA-E60384-1:14 (3rd edition) CQC
Dielectric	Polypropylene 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, manufacturer's logo; year and week; safety approvals

Note

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

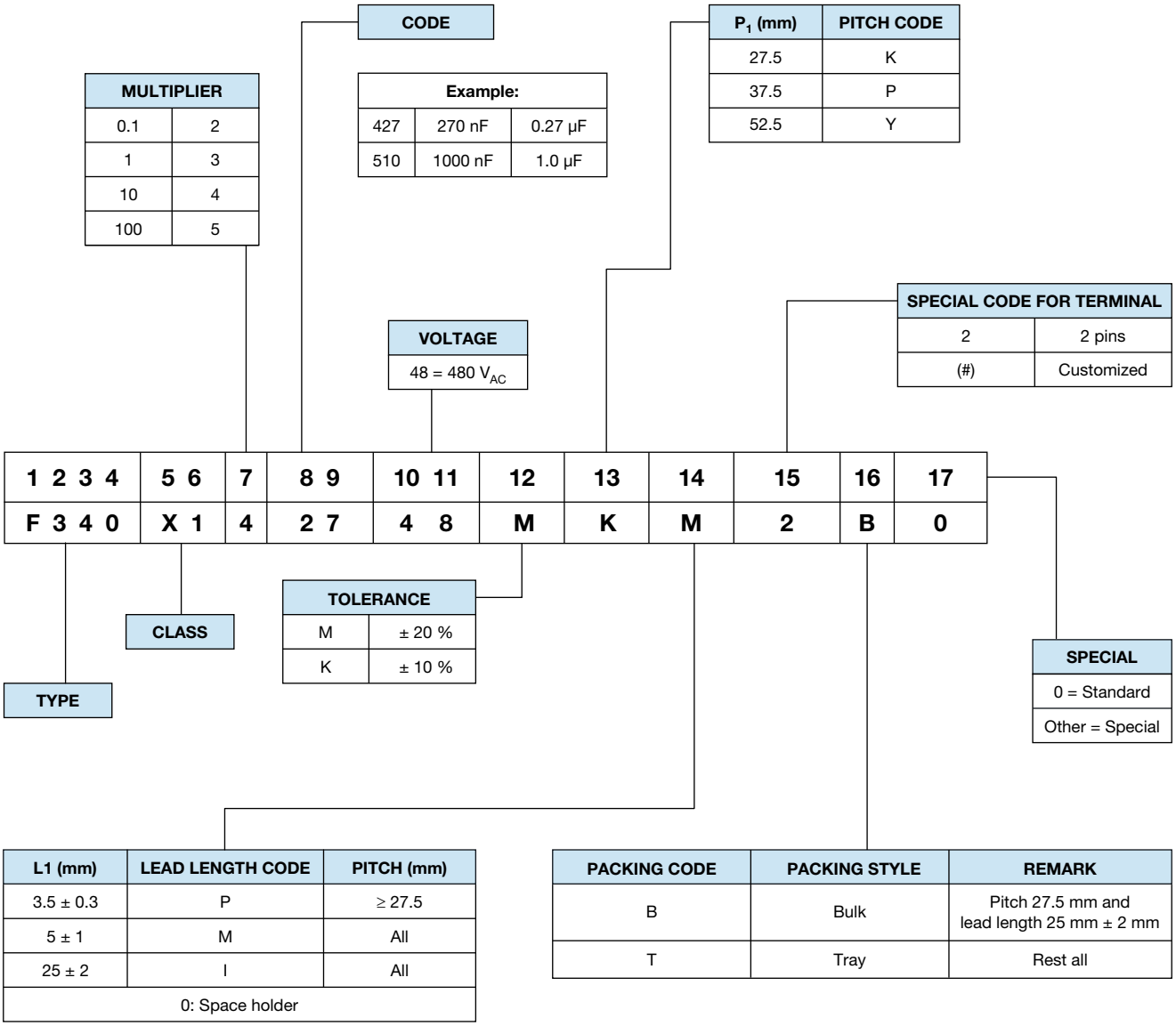
DIMENSIONS in millimeters



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COMPOSITION OF CATALOG NUMBER



Note

- Taped on reel not available

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SPECIFIC REFERENCE DATA

DESCRIPTION	VALUE	
Rated voltage range, U_{RAC}	480 V_{AC}	
Maximum permissible AC voltage	530 V	
Rated voltage range, U_{RDC}	800 V_{DC}	
Tangent of loss angle:	At 1 kHz	At 10 kHz
C ≤ 1.5 µF	≤ 20 x 10^{-4}	≤ 30 x 10^{-4}
1.5 µF< C ≤ 3.9 µF	≤ 30 x 10^{-4}	≤ 50 x 10^{-4}
C > 3.9 µF	≤ 40 x 10^{-4}	≤ 80 x 10^{-4}
Rated voltage pulse slope $(du/dt)_R$ at 670 V_{DC}		
Pitch = 27.5 mm	100 V/µs	
Pitch = 37.5 mm	80 V/µs	
Pitch = 52.5 mm	35 V/µs	
R between leads, for C ≤ 0.33 µF at 100 V; 1 min	> 15 000 MΩ	
RC between leads, for C > 0.33 µF at 100 V; 1 min	> 5000 s	
R between leads and case; 100 V; 1 min	> 30 000 MΩ	
Withstanding (DC) voltage (cut off current 10 mA) (1); rise time ≤ 1000 V/s:		
C ≤ 1 µF	3400 V; 1 min	
C > 1 µF	2500 V; 1 min	
Withstanding (AC) voltage between leads and case	2460 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. (µF)	DIMENSIONS (2) w x h x l (mm)	MASS (g) (1)	CATALOG NUMBER F340X1... AND PACKAGING				
				LOOSE IN BOX				
				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
480	PITCH = 27.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 20 %							
	0.22	13.0 x 23.0 x 32.0	9.2	42248MKP2T0	42248MKM2T0	115	42248MKI2B0	115
	0.33			43348MKP2T0	43348MKM2T0		43348MKI2B0	
	0.47	15.0 x 25.0 x 32.0	12.3	44748MKP2T0	44748MKM2T0	95	44748MKI2B0	95
	0.68	18.0 x 28.0 x 32.0	16.1	46848MKP2T0	46848MKM2T0	80	46848MKI2B0	80
	1.0	21.0 x 31.0 x 32.0	20.3	51048MKP2T0	51048MKM2T0	65	51048MKI2B0	65
	1.5	22.0 x 38.0 x 32.0	42.5	51548MKP2T0	51548MKM2T0	60	51548MKI2B0	65
	PITCH = 37.5 mm ± 0.4 mm; d_t = 1.00 mm ± 0.1 mm; C-TOL. = ± 20 %							
	2.2	21.5 x 38.5 x 42.0	61	52248MPP2T0	52248MPM2T0	84	52248MPI2T0	84
	3.3	30.0 x 45.0 x 42.0	94.5	53348MPP2T0	53348MPM2T0	63	53348MPI2T0	63
	PITCH = 52.5 mm ± 0.4 mm; d_t = 1.20 mm ± 0.12 mm; C-TOL. = ± 20 %							
	4.7	30.0 x 45.0 x 57.5	138.5	54748MYP2T0	54748MYM2T0	45	54748MYI2T0	45
	6.8		135	56848MYP2T0	56848MYM2T0		56848MYI2T0	

Notes
- SPQ = Standard Packing Quantity

(1) Weight for short lead product only
(2) For tolerances see chapter “Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances”

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ELECTRICAL DATA AND ORDERING INFORMATION

U_{RAC} (V)	CAP. (µF)	DIMENSIONS (2) w x h x l (mm)	MASS (g) (1)	CATALOG NUMBER F340X1... AND PACKAGING				
				LOOSE IN BOX				
				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
480	PITCH = 27.5 mm ± 0.4 mm; d_t = 0.80 mm ± 0.08 mm; C-TOL. = ± 10 %							
	0.22	13.0 x 23.0 x 32.0	9.2	42248KKP2T0	42248KKM2T0	115	42248KKI2B0	115
	0.27			42748KKP2T0	42748KKM2T0		42748KKI2B0	
	0.33			43348KKP2T0	43348KKM2T0		43348KKI2B0	
	0.39	15.0 x 25.0 x 32.0	12.3	43948KKP2T0	43948KKM2T0	95	43948KKI2B0	95
	0.47			44748KKP2T0	44748KKM2T0		44748KKI2B0	
	0.56	18.0 x 28.0 x 32.0	16.1	45648KKP2T0	45648KKM2T0	80	45648KKI2B0	80
	0.68			46848KKP2T0	46848KKM2T0		46848KKI2B0	
	0.82	21.0 x 31.0 x 32.0	20.3	48248KKP2T0	48248KKM2T0	65	48248KKI2B0	65
	1.0			51048KKP2T0	51048KKM2T0		51048KKI2B0	
	1.2	22.0 x 38.0 x 32.0	22.5	51245KKP2T0	51245KKM2T0	60	51245KKI2B0	65
	PITCH = 37.5 mm ± 0.4 mm; d_t = 1.00 mm ± 0.1 mm; C-TOL. = ± 10 %							
	1.5	21.5 x 38.5 x 42.0	61.5	51548KPP2T0	51548KPM2T0	84	51548KPI2T0	84
	1.8		61	51848KPP2T0	51848KPM2T0		51848KPI2T0	
	2.2		60	52248KPP2T0	52248KPM2T0		52248KPI2T0	
	2.7	30.0 x 45.0 x 42.0	95.5	52748KPP2T0	52748KPM2T0	63	52748KPI2T0	63
	3.3		92.5	53348KPP2T0	53348KPM2T0		53348KPI2T0	
	3.9		88.5	53948KPP2T0	53948KPM2T0		53948KPI2T0	
	PITCH = 52.5 mm ± 0.4 mm; d_t = 1.20 mm ± 0.12 mm; C-TOL. = ± 10 %							
	4.7	30.0 x 45.0 x 57.5	137.5	54748KYP2T0	54748KYM2T0	45	54748KYI2T0	45
	5.6		136	55648KYP2T0	55648KYM2T0		55648KYI2T0	
	6.8	35.0 x 50.0 x 57.5	171	56848KYP2T0	56848KYM2T0	40	56848KYI2T0	40
	8.2		165.5	58248KYP2T0	58248KYM2T0		58248KYI2T0	

Notes

- SPQ = Standard Packing Quantity

(1) Weight for short lead product only

(2) For tolerances see chapter “Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances”

APPROVALS

SAFETY APPROVALS X1	VOLTAGE	VALUE	FILE NUMBERS	LINK
EN 60384-14 (ENEC) (= IEC 60384-14 ed-4 (2013))	480 V_{AC}	220 nF to 8.2 µF	ENEC16/FI/19/10008	www.vishay.com/doc?28247
UL 60384-14	480 V_{AC}	220 nF to 8.2 µF	E354331	www.vishay.com/doc?28249
CSA-E384-14	480 V_{AC}	220 nF to 8.2 µF	E354331	www.vishay.com/doc?28249
CQC	480 V_{AC}	220 nF to 8.2 µF	L-18001205119	www.vishay.com/doc?28248
			F-18001207457	www.vishay.com/doc?28250
CB-test certificate	480 V_{AC}	220 nF to 8.2 µF	FI-39834	www.vishay.com/doc?28246

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.

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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 in printed-circuit boards by means of automatic insertion machines.

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 pitches ≥ 27.5 mm the capacitors shall be mechanically fixed by the leads and the body clamped

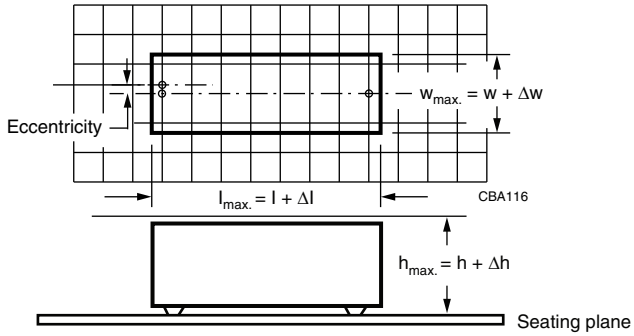
Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances

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.

$l_{max.} = l + \Delta l$, $w_{max.} = w + \Delta w$, and $h_{max.} = h + \Delta h$

- For products with pitch = 27.5 mm, $\Delta w = \Delta l = \Delta h = 0.7$ mm
- For products with pitch = 37.5 mm, $\Delta w = \Delta l = \Delta h = 0.7$ mm
- For products with pitch = 52.5 mm, $\Delta w = \Delta l = \Delta h = 1.0$ 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 $h_{min.} = h - \Delta h$

- For products with pitch = 27.5 mm, $\Delta w = \Delta l = \Delta h = 1.0$ mm
- For products with pitch = 37.5 mm, $\Delta w = \Delta l = \Delta h = 1.0$ mm
- For products with pitch = 52.5 mm, $\Delta w = \Delta l = \Delta h = 1.5$ 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.

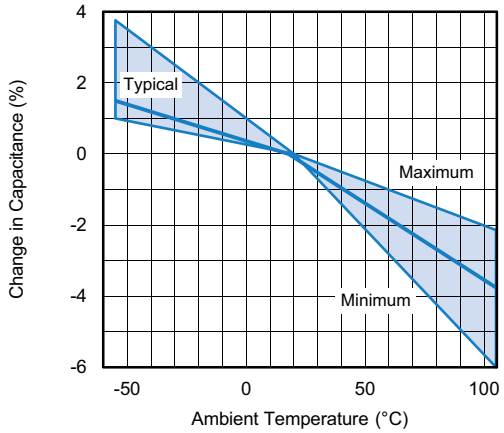
RATINGS AND CHARACTERISTICS REFERENCE CONDITIONS

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 %.

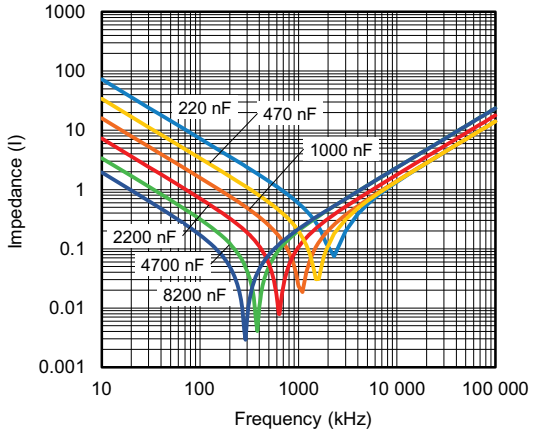
For reference testing. a conditioning period shall be applied over 96 hours ± 4 hours by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.

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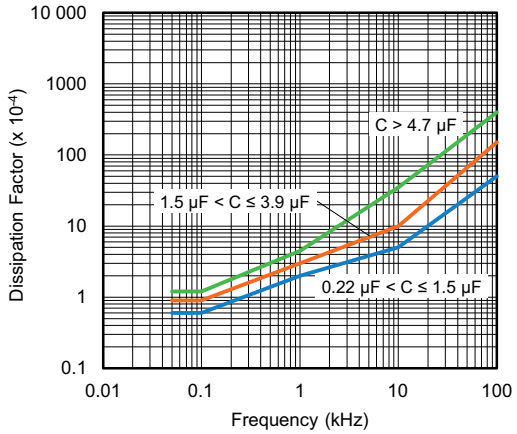
CHARACTERISTICS



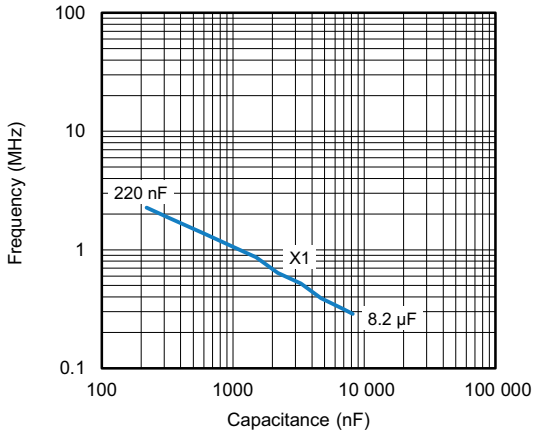
Capacitance as a function of ambient temperature (typical curve)



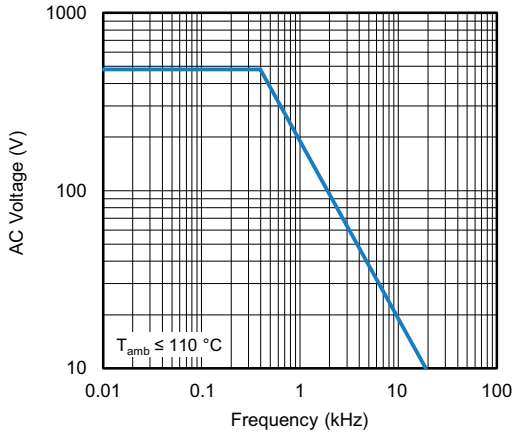
Impedance as a function of frequency (typical curve)



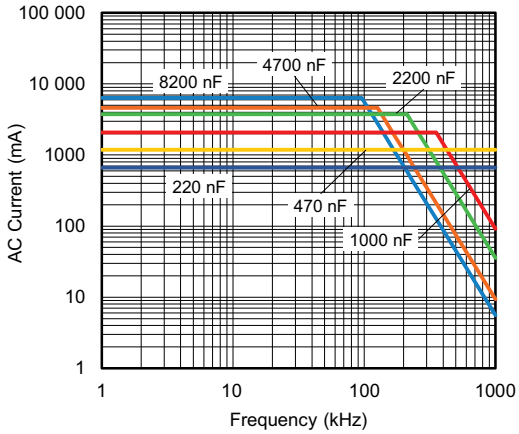
Tangent of loss angle as a function of frequency (typical curve)



Resonant frequency as a function of capacitance (typical curve)

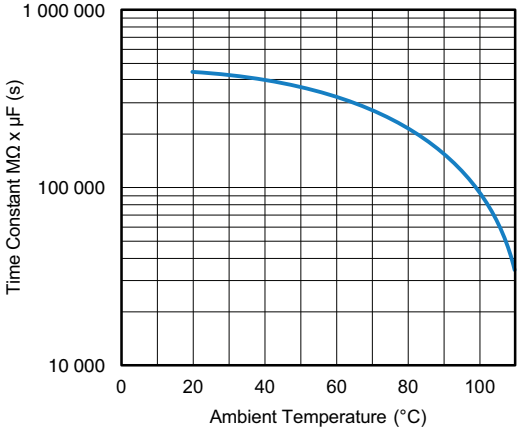


Max. RMS voltage as a function of frequency



Max. RMS current as a function of frequency

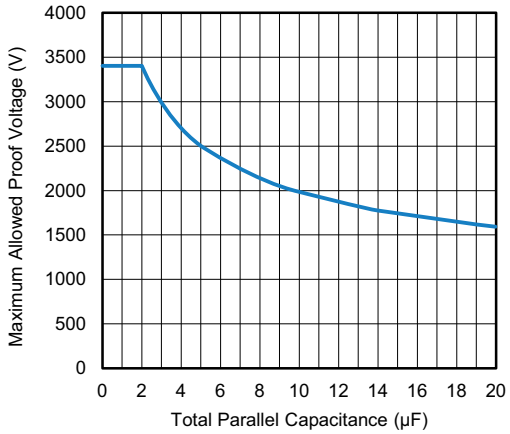
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Insulation resistance as a function of ambient temperature
(typical curve)

APPLICATION NOTES

- For X1 electromagnetic interference suppression in standard across the line applications (50 Hz / 60 Hz) with a maximum of 480 V_{AC} rated voltage including fluctuation of the mains. It is recommended to use these components in a mains with maximum nominal voltage of 400 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 must be reduced in function of the total parallel capacitance value, see graph.



Proof voltage as function of total parallel capacitance

- These capacitors are not intended for continuous pulse applications. 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 670 V_{DC} and divided by the applied voltage

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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".

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
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	$\|\Delta C/C\| \leq 5$ % of the value measured initially
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: C ≤ 1 µF ≤ 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/s² (whichever is less severe) Total duration 6 h	

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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		
4.7.2 Final inspection	Visual examination	No visible damage
4.9 Shock	Mounting: see section “Mounting” for more information Pulse shape: half sine Acceleration: 490 m/s² Duration of pulse: 11 ms	
4.9.2 Final measurements	Visual examination	No visible damage
	Capacitance	$\lvert\Delta C/C\rvert \leq 5$ % of the value measured initially
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: $C \leq 1$ µF ≤ 0.005 for: $C > 1$ µF 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	$\lvert\Delta C/C\rvert \leq 5$ % of the value measured in 4.11.1.
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: $C \leq 1$ µF ≤ 0.005 for: $C > 1$ µF Compared to values measured in 4.11.1.
	Voltage proof 1900 V_{DC}; 1 min between terminations	No permanent breakdown or flash-over
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification

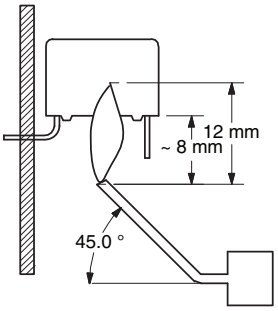
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GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C2		
4.12 Damp heat steady state	56 days, 40 °C, 90 % to 95 % RH, no load	
4.12.1 Initial measurements	Capacitance Tangent of loss angle: for C ≤ 1 µF at 10 kHz for C > 1 µF at 1 kHz	
4.12.3 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 5$ % of the value measured in 4.12.1.
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: C ≤ 1 µF ≤ 0.005 for: C > 1 µF Compared to values measured in 4.12.1.
	Voltage proof 1900 V_{DC}; 1 min between terminations	No permanent breakdown or flash-over
	Insulation resistance	≥ 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: 480 V_{AC} Duration: 1000 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	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 10$ % of the value measured in 4.12.1A.
	Tangent of loss angle	Increase of tan δ: ≤ 0.0240 for: C ≤ 1 µF at 10 kHz ≤ 0.0150 for: C > 1 µF at 1 kHz Compared to values measured in 4.12.1A.
	Voltage proof 1900 V_{DC}; 1 min between terminations	No permanent breakdown or flash-over
	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 C3		
4.13.1 Initial measurements	Capacitance Tangent of loss angle: for $C \leq 1$ µF at 10 kHz for $C > 1$ µF at 1 kHz	
4.13 Impulse voltage	3 successive impulses, full wave, peak voltage: X1: 4 kV for $C \leq 1$ µF 4 kV$\sqrt{C}$ 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	$\lvert\Delta C/C\rvert \leq 10$ % compared to values measured in 4.13.1.
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: $C \leq 1$ µF or ≤ 0.005 for: $C > 1$ µF Compared to values measured in 4.13.1
	Voltage proof 1900 V_{DC}; 1 min between terminations 2380 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 670 V_{DC} Discharge resistance: $R = \frac{670\ V_{DC}}{1.5 \times C\ (du/dt)}$	
4.15.1 Initial measurements	Capacitance Tangent of loss angle: for $C \leq 1$ µF at 10 kHz for $C > 1$ µF at 1 kHz	
4.15.3 Final measurements	Capacitance	$\lvert\Delta C/C\rvert \leq 10$ % compared to values measured in 4.15.1.
	Tangent of loss angle	Increase of tan δ: ≤ 0.008 for: $C \leq 1$ µF ≤ 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

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GROUP C 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: Ø 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. No burning particle must drop from the sample.
SUB-GROUP C7		
4.18 Active flammability	20 cycles of 4 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.

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