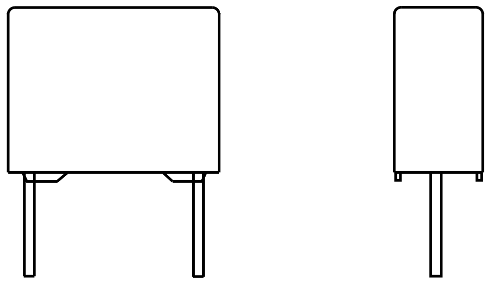
DC Film Capacitors
MKT Radial Potted Type



FEATURES

- 10 mm lead pitch. Supplied loose in box and taped on reel or ammopack
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS COMPLIANT
HALOGEN FREE
GREEN (5-2008)

APPLICATIONS

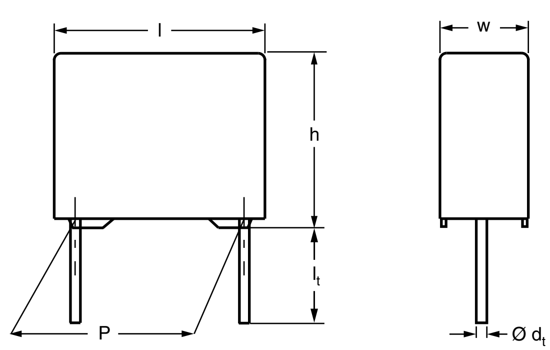
Blocking and coupling, bypass and energy reservoir

QUICK REFERENCE DATA	
Capacitance tolerance	± 10 %, ± 5 %
Capacitance range (E12 series)	0.0047 μF to 0.68 μF
Rated DC voltage	100 V, 250 V, 400 V, 630 V
Rated AC voltage	63 V, 160 V, 220 V, 250 V
Climatic testing class (according to IEC 60068-1)	55/105/56
Rated temperature	85 °C
Maximum application temperature	105 °C
Performance grade	Grade 1 (long life)
Leads	Tinned wire
Reference standards	IEC 60384-2
Dielectric	Polyester film
Electrodes	Metallized
Construction	Mono construction 
Encapsulation	Flame retardant plastic case and epoxy resin (UL-class 94 V-0)
Marking	C-value; tolerance; rated voltage; manufacturer's symbol; year and week of manufacturer; manufacturer's type

Note

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

DIMENSIONS



COMPOSITION OF CATALOG NUMBER

TYPE AND PITCHES	
372	10.00 mm

CAPACITANCE (numerically)

MULTIPLIER (nF)	
0.1	2
1	3
10	4

Example:
104 = 10 x 10 = 100 nF

BFC2	372	XX	YY	Y
2222 (*)	372	XX	YY	Y

(*) Old ordering number

TYPE	PACKAGING	LEAD CONFIGURATION	PREFERRED TYPES				
			C-TOL.	100 V	250 V	400 V	630 V
372	Loose in box	Lead length 4.0 mm + 1.0 mm/- 0.5 mm	± 10 %	21	41	51	61
			± 5 %	22	42	52	62
	Taped on reel (1)	H (1) = 18.5 mm P_0 = 12.7 mm Reel diameter = 356 mm	± 10 %	25	45	55	65
			± 5 %	26	46	56	66
	Ammopack (1)	H (1) = 18.5 mm P_0 = 12.7 mm	± 10 %	28	48	58	68
			± 5 %	29	49	59	69

Note
(1) For detailed tape specifications refer to packaging information: www.vishay.com/doc?28139

SPECIFIC REFERENCE DATA

DESCRIPTION	VALUE		
Tangent of loss angle:	at 1 kHz	at 10 kHz	at 100 kHz
C ≤ 0.1 μF	≤ 75 x 10^{-4}	≤ 130 x 10^{-4}	≤ 250 x 10^{-4}
0.1 μF < C ≤ 0.68 μF	≤ 75 x 10^{-4}	≤ 130 x 10^{-4}	≤ 250 x 10^{-4}

DESCRIPTION	VALUE			
Rated voltage pulse slope $(dU/dt)_R$ at	100 V_{DC}	250 V_{DC}	400 V_{DC}	630 V_{DC}
	34 V/μs	50 V/μs	80 V/μs	120 V/μs
R between leads, for C ≤ 0.33 μF				
at 10 V; 1 min	> 15 000 MΩ			
at 100 V; 1 min		> 15 000 MΩ	> 30 000 MΩ	> 30 000 MΩ
RC between leads, for C > 0.33 μF at 100 V; 1 min	> 5000 s			
R between interconnecting leads and case (foil method)	> 30 000 MΩ			
Withstanding (DC) voltage (cut off current 10 mA) (1); rise time ≤ 1000 V/s	160 V; 1 min	400 V; 1 min	640 V; 1 min	1008 V; 1 min
Withstanding (DC) voltage between leads and case	200 V; 1 min	500 V; 1 min	800 V; 1 min	1260 V; 1 min
Maximum application temperature	105 °C			

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

ELECTRICAL DATA

U_{RDC} (V)	CAP. (µF)	DIMENSIONS w x h x l (mm)	MASS (g) [(3)]	CATALOG NUMBER BFC2 372 XXYYY AND PACKAGING						C-VALUE
				LOOSE IN BOX		REEL [(1)(2)]		AMMOPACK [(2)]		
				l_t = 4.0 mm + 1.0 mm/- 0.5 mm		H = 18.5 mm; P_0 = 12.7 mm		H = 18.5 mm; P_0 = 12.7 mm		
				C-TOL. = ± 10 %	C-TOL. = ± 5 %	C-TOL. = ± 10 %	C-TOL. = ± 5 %	C-TOL. = ± 10 %	C-TOL. = ± 5 %	
				XX (SPQ)	XX (SPQ)	XX (SPQ)	XX (SPQ)	XX (SPQ)	XX (SPQ)	..YYY
	U_{RAC} = 63 V; PITCH = 10.0 mm ± 0.4 mm; d_t = 0.60 mm ± 0.06 mm									
100	0.10 0.12 0.15 0.18 0.22 0.27 0.33	4.0 x 10.0 x 12.5	0.65	**21...** (1000)	**22...** (1000)	**25...** (1400)	**26...** (1400)	**28...** (750)	**29...** (750)	**104 124 154 184 224 274 334**
	0.39 0.47	5.0 x 11.0 x 12.5	0.87	**21...** (1000)	**22...** (1000)	**25...** (1100)	**26...** (1100)	**28...** (600)	**29...** (600)	**394 474**
	0.56 0.68	6.0 x 12.0 x 12.5	1.15	**21...** (750)	**22...** (750)	**25...** (900)	**26...** (900)	**28...** (500)	**29...** (500)	**564 684**
	U_{RAC} = 160 V; PITCH = 10.0 mm ± 0.4 mm; d_t = 0.60 mm ± 0.06 mm									
250	0.047 0.056 0.068 0.082 0.10	4.0 x 10.0 x 12.5	0.65	**41...** (1000)	**42...** (1000)	**45...** (1400)	**46...** (1400)	**48...** (750)	**49...** (750)	**473 563 683 823 104**
	0.12 0.15	5.0 x 11.0 x 12.5	0.87	**41...** (1000)	**42...** (1000)	**45...** (1100)	**46...** (1100)	**48...** (600)	**49...** (600)	**124 154**
	0.18 0.22	6.0 x 12.0 x 12.5	1.15	**41...** (750)	**42...** (750)	**45...** (900)	**46...** (900)	**48...** (500)	**49...** (500)	**184 224**
	U_{RAC} = 220 V; PITCH = 10.0 mm ± 0.4 mm; d_t = 0.60 mm ± 0.06 mm									
400	0.0047 0.0056 0.0068 0.0082 0.010 0.012 0.015 0.018 0.022 0.027 0.033	4.0 x 10.0 x 12.5	0.65	**51...** (1000)	**52...** (1000)	**55...** (1400)	**56...** (1400)	**58...** (750)	**59...** (750)	**472 562 682 822 103 123 153 183 223 273 333**
	0.039 0.047 0.056	5.0 x 11.0 x 12.5	0.87	**51...** (1000)	**52...** (1000)	**55...** (1100)	**56...** (1100)	**58...** (600)	**59...** (600)	**393 473 563**
	0.068 0.082	6.0 x 12.0 x 12.5	1.15	**51...** (750)	**52...** (750)	**55...** (900)	**56...** (900)	**58...** (500)	**59...** (500)	**683 823**
	U_{RAC} = 250 V; PITCH = 10.0 mm ± 0.4 mm; d_t = 0.60 mm ± 0.06 mm									
630	0.010 0.012 0.015 0.018 0.022	4.0 x 10.0 x 12.5	0.65	**61...** (1000)	**62...** (1000)	**65...** (1400)	**66...** (1400)	**68...** (750)	**69...** (750)	**103 123 153 183 223**
	0.027 0.033	5.0 x 11.0 x 12.5	0.87	**61...** (1000)	**62...** (1000)	**65...** (1100)	**66...** (1100)	**68...** (600)	**69...** (600)	**273 333**
	0.039 0.047	6.0 x 12.0 x 12.5	1.15	**61...** (750)	**62...** (750)	**65...** (900)	**66...** (900)	**68...** (500)	**69...** (500)	**393 473**

Notes
- SPQ = Standard Packing Quantity

(1) Reel diameter = 356 mm is available on request
(2) H = in-tape height; P_0 = sprocket hole distance; for detailed specifications refer to packaging information: www.vishay.com/doc?28139
(3) Weight for short lead product only

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

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:

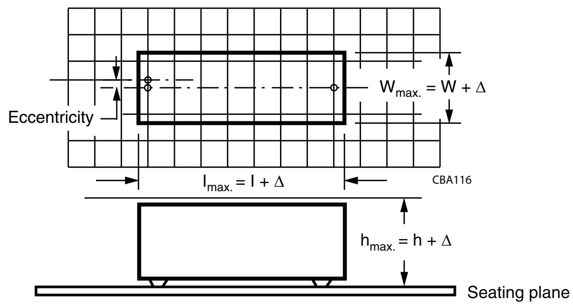
- For pitches ≤ 15 mm capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

Space Requirements 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 drawing:

- 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

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



SOLDERING

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

Storage Temperature

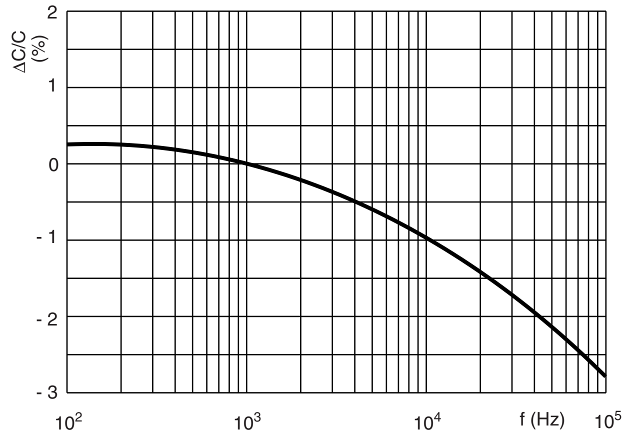
T_{stg} = -25 °C to +35 °C with RH maximum 75 % without condensation

Ratings and Characteristics Reference Conditions

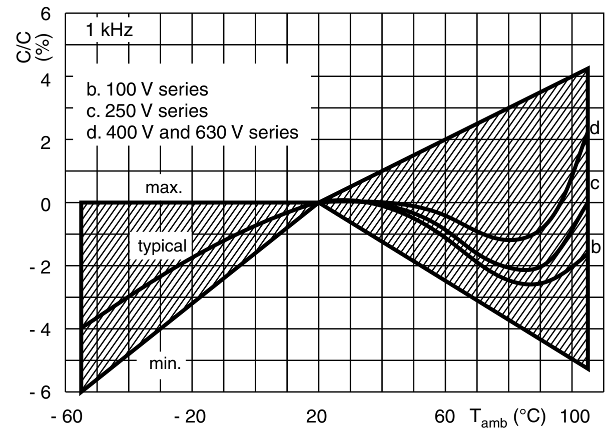
Unless otherwise specified, all electrical values apply to an ambient free air temperature of 23 °C ± 1 °C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

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 %.

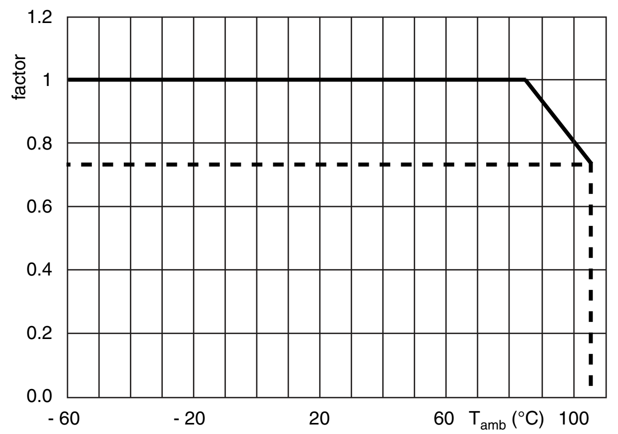
CHARACTERISTICS



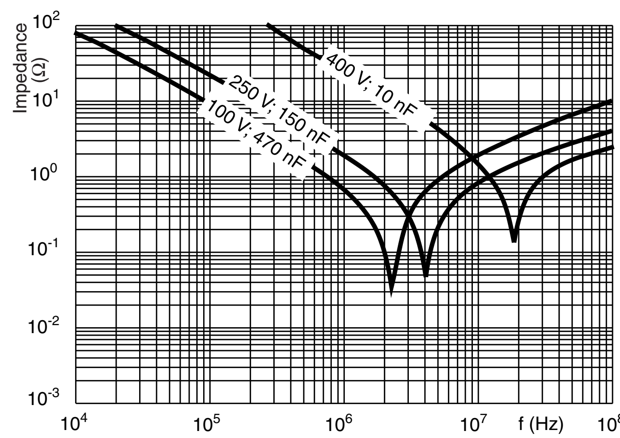
Capacitance as a function of frequency



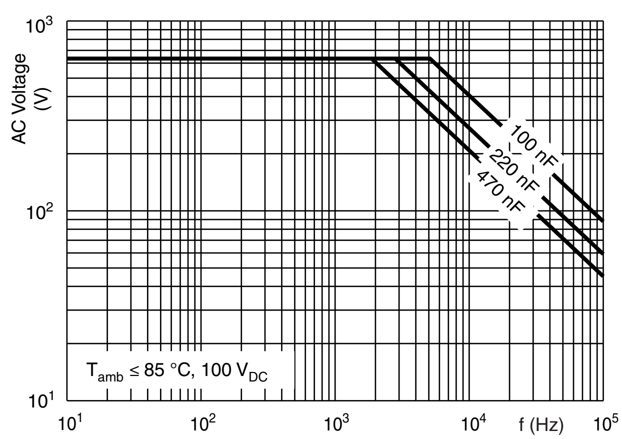
Capacitance as a function of ambient temperature



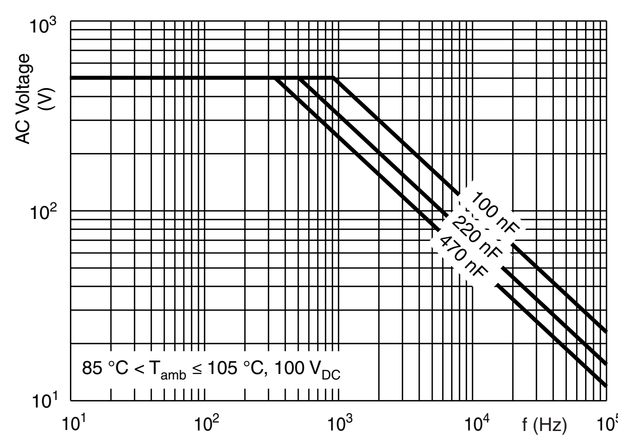
Max. DC and AC voltage as a function of temperature



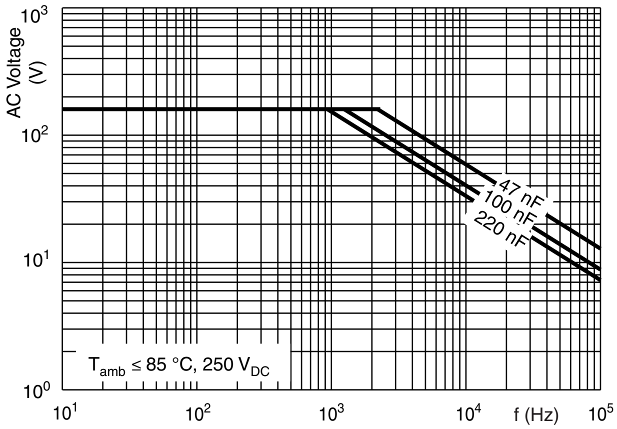
Impedance as a function of frequency



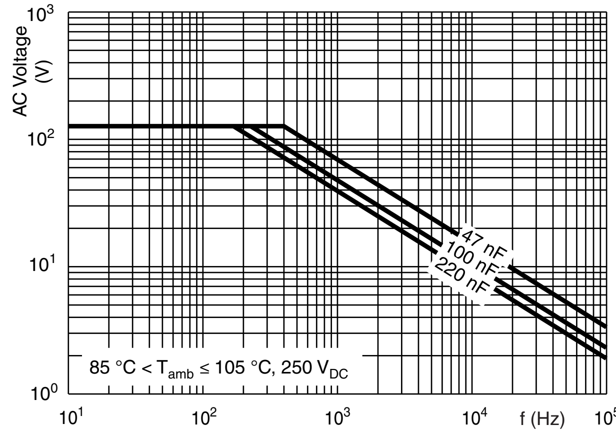
Max. AC voltage as a function of frequency



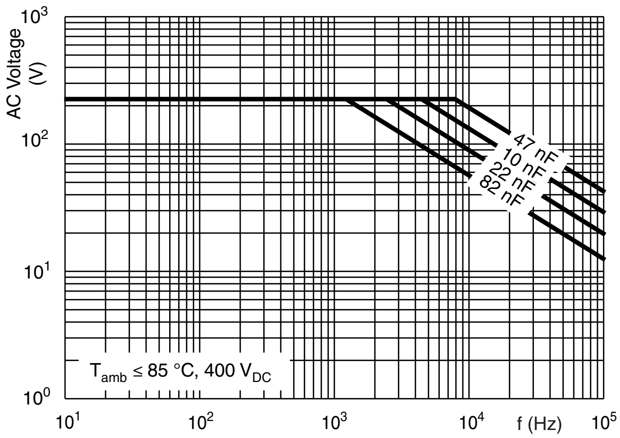
Max. AC voltage as a function of frequency



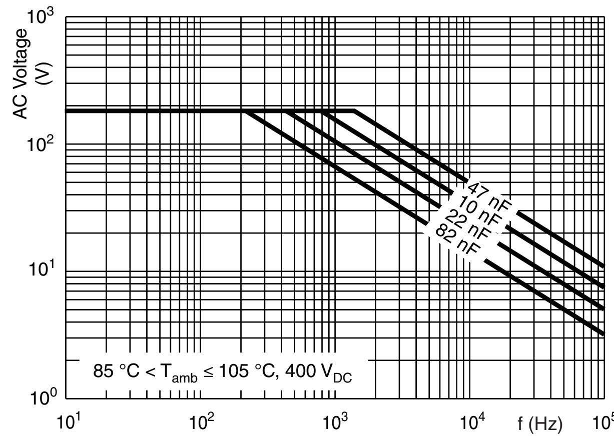
Max. AC voltage as a function of frequency



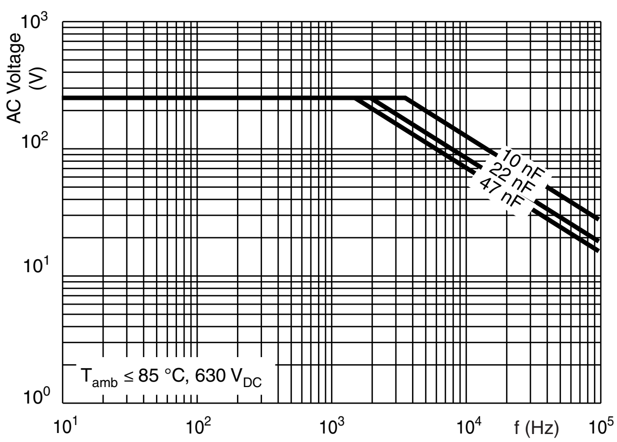
Max. AC voltage as a function of frequency



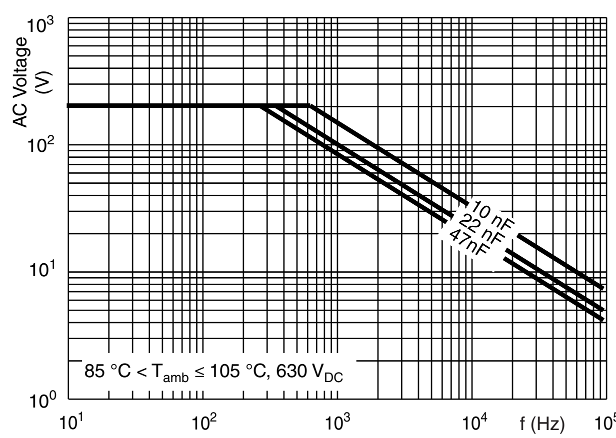
Max. AC voltage as a function of frequency



Max. AC voltage as a function of frequency



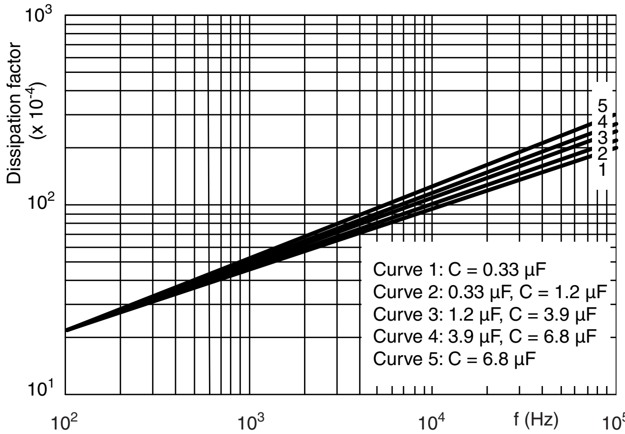
Max. AC voltage as a function of frequency



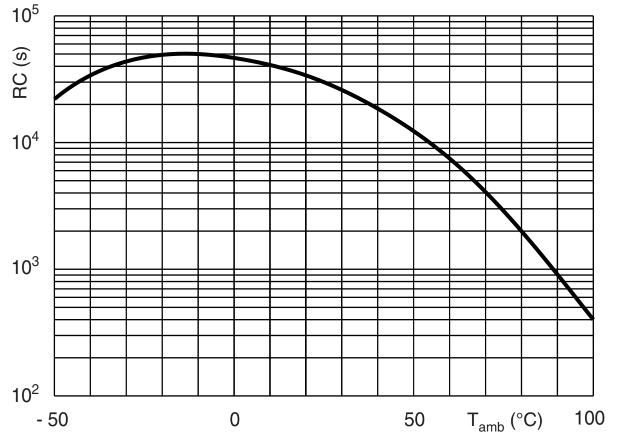
Max. AC voltage as a function of frequency

Maximum RMS current (sinewave) as a function of frequency

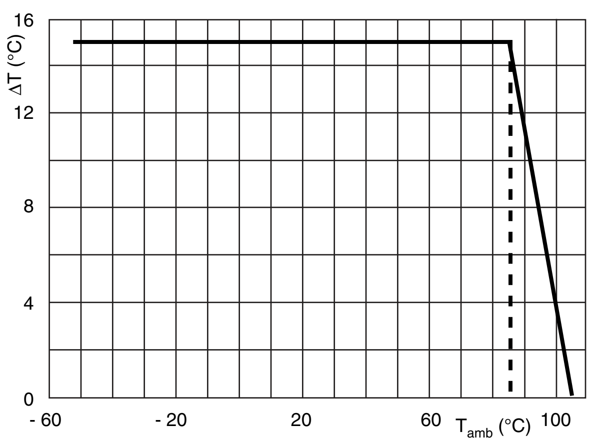
U_{AC} is the maximum AC voltage depending on the ambient temperature in the curves “Max. RMS voltage and AC current as a function of frequency”.



Tangent of loss angle as a function of frequency



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



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

HEAT CONDUCTIVITY (G) AS A FUNCTION OF (ORIGINAL) PITCH AND CAPACITOR BODY THICKNESS IN mW/°C	
$W_{MAX.}$ (mm)	HEAT CONDUCTIVITY (mW/°C)
	PITCH 10.0 mm
4.0	6.0
5.0	7.5
6.0	9.0

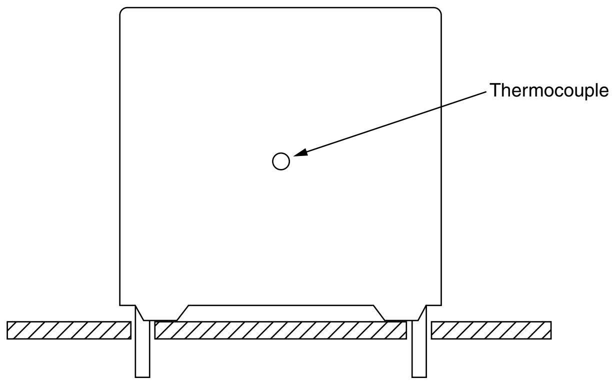
POWER DISSIPATION AND MAXIMUM COMPONENT TEMPERATURE RISE

The power dissipation must be limited in order not to exceed the maximum allowed component temperature rise as a function of the free ambient temperature.
The power dissipation can be calculated according type detail specification “HQN-384-01/101: Technical Information Film Capacitors”.
The component temperature rise (ΔT) can be measured (see section “Measuring the component temperature” for more details) or calculated by $\Delta T = P/G$:

- ΔT = 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.

APPLICATION NOTE AND LIMITING CONDITIONS

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.
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
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 $2\sqrt{2} \times U_{RAC}$ to avoid the ionization inception level
3. The voltage peak 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:
   $$2 \times \int_0^T \left(\frac{dU}{dt}\right)^2 \times \left(dt < U_{RDC} \times \left(\frac{dU}{dt}\right)_{rated}\right)$$
   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}	See "Max. AC voltage as function of temperature" per characteristics
Maximum temperature RMS-overvoltage (< 24 h)	1.25 x U_{RAC}	U_{RAC}
Maximum peak voltage (V_{O-P}) (< 2 s)	1.6 x U_{RDC}	1.3 x U_{RDC}

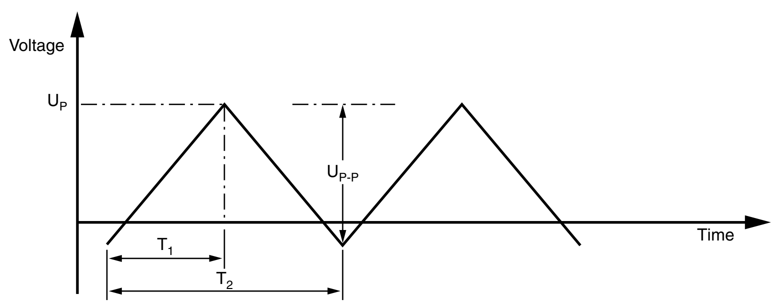
Example

C = 330 nF - 63 V used for the voltage signal shown in next drawing.
U_{P-P} = 40 V; U_P = 35 V; T_1 = 100 µs; T_2 = 200 µs
The ambient temperature is 35 °C

Checking conditions:

1. The peak voltage U_P = 35 V is lower than 63 V_{DC}
2. The peak-to-peak voltage 40 V is lower than 2√2 x 40 V_{AC} = 113 U_{P-P}
3. The voltage pulse slope (dU/dt) = 40 V/100 µs = 0.4 V/µs
   This is lower than 60 V/µs (see specific reference data for each version)
4. The dissipated power is 16.2 mW as calculated with fourier terms
   The temperature rise for $W_{max.}$ = 3.5 mm and pitch = 5 mm will be 16.2 mW/3.0 mW/°C = 5.4 °C
   This is lower than 15 °C temperature rise at 35 °C, according figure "Max. allowed component temperature rise"
5. Not applicable
6. Not applicable

Voltage Signal



INSPECTION REQUIREMENTS

General Notes

Sub-clause numbers of tests and performance requirements refer to the "Sectional Specification, Publication IEC 60384-2 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 Tangent of loss angle: for C ≤ 470 nF at 100 kHz for 470 nF < C ≤ 10 µF at 10 kHz for C > 10 µF at 1 kHz	
4.3 Robustness of terminations	Tensile and bending	No visible damage
4.4 Resistance to soldering heat	Method: 1A Solder bath: 280 °C ± 5 °C Duration: 10 s	

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C1A PART OF SAMPLE OF SUB-GROUP C1		
4.14 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	$\|\Delta C/C\| \leq 2$ % of the value measured initially
	Tangent of loss angle	Increase of tan δ $\leq$ 0.005 for: C $\leq$ 100 nF or $\leq$ 0.010 for: 100 nF < C $\leq$ 220 nF or $\leq$ 0.015 for: 220 nF < C $\leq$ 470 nF and $\leq$ 0.003 for: C > 470 nF Compared to values measured in 4.3.1
SUB-GROUP C1B PART OF SAMPLE OF SUB-GROUP C1		
4.6.1 Initial measurements	Capacitance Tangent of loss angle: for C $\leq$ 470 nF at 100 kHz for 470 nF < C $\leq$ 10 μF at 10 kHz for C > 10 μF at 1 kHz	No visible damage
4.6 Rapid change of temperature	θA = -55 °C θB = +105 °C 5 cycles Duration t = 30 min	
4.7 Vibration	Visual examination 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	No visible damage
SUB-GROUP C1B PART OF SAMPLE OF SUB-GROUP C1		
4.7.2 Final inspection	Visual examination	No visible damage
4.9 Shock	Mounting: see section “Mounting” of this specification Pulse shape: half sine Acceleration: 490 m/s² Duration of pulse: 11 ms	
4.9.3 Final measurements	Visual examination	No visible damage
	Capacitance	$\|\Delta C/C\| \leq 3$ % of the value measured in 4.6.1
	Tangent of loss angle	Increase of tan δ $\leq$ 0.005 for: C $\leq$ 100 nF or $\leq$ 0.010 for: 100 nF < C $\leq$ 220 nF or $\leq$ 0.015 for: 220 nF < C $\leq$ 470 nF and $\leq$ 0.003 for: C > 470 nF Compared to values measured in 4.6.1
	Insulation resistance	As specified in section “Insulation Resistance” of this specification

GROUP C INSPECTION REQUIREMENTS

SUB-CLAUSE NUMBER AND TEST	CONDITIONS	PERFORMANCE REQUIREMENTS
SUB-GROUP C1 COMBINED SAMPLE OF SPECIMENS OF SUB-GROUPS C1A AND C1B		
4.10 Climatic sequence		
4.10.2 Dry heat	Temperature: +105 °C Duration: 16 h	
4.10.3 Damp heat cyclic Test Db, first cycle		
4.10.4 Cold	Temperature: -55 °C Duration: 2 h	
4.10.6 Damp heat cyclic 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 of flash-over
	Visual examination	No visible damage Legible marking
	Capacitance	$\|\Delta C/C\| \leq 3$ % of the value measured in 4.4.2 or 4.9.3
	Tangent of loss angle	Increase of tan δ $\leq$ 0.005 for: C $\leq$ 100 nF or $\leq$ 0.010 for: 100 nF < C $\leq$ 220 nF or $\leq$ 0.015 for: 220 nF < C $\leq$ 470 nF and $\leq$ 0.005 for: C > 470 nF Compared to values measured in 4.3.1 or 4.6.1
	Insulation resistance	$\geq$ 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	
4.11.1 Initial measurements	Capacitance 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 of flash-over
	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 $\delta \leq 0.005$ Compared to values measured in 4.11.1
	Insulation resistance	$\geq$ 50 % of values specified in section "Insulation Resistance" of this specification
SUB GROUP C3		
4.12 Endurance	Duration: 2000 h 1.25 x U_{RDC} at 85 °C 0.8 x 1.25 U_{RDC} at 105 °C	

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB GROUP C3		
4.12.1 Initial measurements	Capacitance Tangent of loss angle: for C ≤ 470 nF at 100 kHz for 470 nF < C ≤ 10 μF at 10 kHz for C > 10 μF at 1 kHz	
4.12.5 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	|ΔC/C| ≤ 5 % compared to values measured in 4.12.1
	Tangent of loss angle	Increase of tan δ ≤ 0.005 for: C ≤ 100 nF or ≤ 0.010 for: 100 nF < C ≤ 220 nF or ≤ 0.015 for: 220 nF < C ≤ 470 nF and ≤ 0.003 for: C > 470 nF Compared to values measured in 4.12.1
	Insulation resistance	≥ 50 % of values specified in section "Insulation Resistance" of this specification
SUB-GROUP C4		
4.13 Charge and discharge	10 000 cycles Charged to U_{RDC} Discharge resistance: $R = \frac{U_R}{C \times 2.5 \times (dU/dt)_R}$	
4.13.1 Initial measurements	Capacitance Tangent of loss angle: for C ≤ 470 nF at 100 kHz for 470 nF < C ≤ 10 μF at 10 kHz for C > 10 μF at 1 kHz	
4.13.3 Final measurements	Capacitance	|ΔC/C| ≤ 3 % compared to values measured in 4.13.1
	Tangent of loss angle	Increase of tan δ ≤ 0.005 for: C ≤ 100 nF or ≤ 0.010 for: 100 nF < C ≤ 220 nF or ≤ 0.015 for: 220 nF < C ≤ 470 nF and ≤ 0.003 for: C > 470 nF 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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