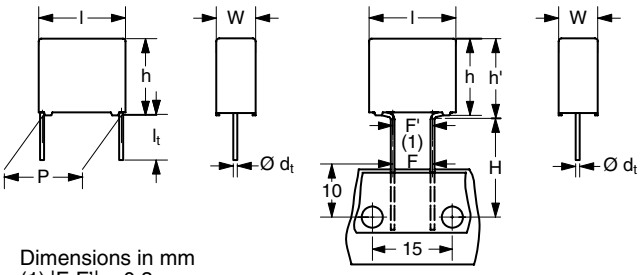
Metallized Polypropylene Film AC and Pulse Capacitors MKP Radial Potted Type



Dimensions in mm
(1) |F-F'| < 0.3 mm
F = 7.5 + 0.6/- 0.1 mm

APPLICATIONS

Where steep pulses occur e.g. SMPS (switch mode power supplies). Electronic lighting e.g. ballast. Motor control circuits.

MARKING

C-value; tolerance; rated voltage; code for dielectric material; code for factory of origin; manufacturer's type designation; manufacturer; year and week of manufacture

DIELECTRIC

Polypropylene film

ELECTRODES

Metallized film

ENCAPSULATION

Flame retardant plastic case and epoxy resin (UL-class 94 V-0)

CONSTRUCTION

Internal serial construction

LEADS

Tinned wire

CAPACITANCE RANGE (E24 SERIES)

0.001 to 0.033 µF

CAPACITANCE TOLERANCE

± 5 %

RATED (DC) VOLTAGE

1600 V; 2000 V

FEATURES

7.5 mm bent back pitch, 10 and 15 mm lead pitch. Low contact resistance. Low loss dielectric. Small dimensions for high density packaging. Supplied loose in box and taped on reel.

RoHS compliant product.

Pb-free

e3

RoHS COMPLIANT

RATED (AC) VOLTAGE

550 V; 700 V

RATED PEAK-TO-PEAK VOLTAGE

1600 V; 2000 V

CLIMATIC CATEGORY

55/110/56

RATED TEMPERATURE (DC)

85 °C

RATED TEMPERATURE (AC)

85 °C

MAXIMUM APPLICATION TEMPERATURE

110 °C

MAXIMUM OPERATING TEMPERATURE FOR LIMITED TIME

125 °C

REFERENCE SPECIFICATIONS

IEC 60384-17

PERFORMANCE GRADE

Grade 1 (long life)

STABILITY GRADE

Grade 2

DETAIL INSPECTION AND TEST REQUIREMENTS

See Technical Product Documentation sheet 191

DETAIL SPECIFICATION

For more detailed data and test requirements contact: filmcaps.roeselare@vishay.com

Metallized Polypropylene Film
AC and Pulse Capacitors
MKP Radial Potted Type

COMPOSITION OF CATALOG NUMBER

TYPE AND PITCHES	
385	10.0/7.5 mm
	15.0/7.5 mm
	10.0 mm
	15.0 mm

CAPACITANCE (numerically)

MULTIPLIER (nF)	
0.1	2
1	3
10	4
100	5

Example:
104 = 10 x 10 = 100 nF

2222	385	XX	XX	X
BFC2*	385	XX	XX	X

* Use this partnumber for those with access to the Vishay's SAP system and Partners website within the Americas

TYPE	PACKAGING	LEAD CONFIGURATION	PREFERRED TYPES		
			C-TOL	1600 V	2000 V
385	Loose in box	lead length 3.5 + 1/- 0.5 mm or 3.5 ± 0.3 mm	± 5 %	50	60
	Taped on reel	H = 18.5 mm; P_0 = 12.7 mm reel diameter = 500 mm	± 5 %	52	62
	Taped on reel (bent back to 7.5 mm)	H = 16.0 mm; P_0 = 15.0 mm reel diameter = 500 mm	± 5 %	53	63
	Ammopack	H = 18.5 mm; P_0 = 12.7 mm	± 5 %	56	66
	Ammopack (bent back to 7.5 mm)	H = 16.0 mm; P_0 = 15.0 mm	± 5 %	58	68
				ON REQUEST	
385	Loose in box	lead length 5.0 ± 1.0 mm	± 5 %	51	61
	Loose in box	lead length 25.0 ± 2.0 mm	± 5 %	54	64
	Taped on reel (bent back to 7.5 mm)	H = 16.0 mm; P_0 = 15.0 mm reel diameter = 356 mm	± 5 %	55	65
	Loose in box	lead length 3.2 + 0.3/- 0.6 mm	± 5 %	57	67

SPECIFIC REFERENCE DATA

DESCRIPTION	VALUE	
Tangent of loss angle:	at 10 kHz	at 100 kHz
	$\leq 5 \times 10^{-4}$	$\leq 15 \times 10^{-4}$
Rated voltage pulse slope $(dU/dt)_R$		
P = 10 mm and 10 mm bent back to 7.5 mm	> 4000 V/µs	
P = 15 mm and 15 mm bent back to 7.5 mm	> 2000 V/µs	
R between leads, for C ≤ 1 µF at 500 V; 1 minute	> 100000 MΩ	
R between leads and case; 500 V; 1 minute	> 30000 MΩ	
	at 1600 VDC	at 2000 VDC
Ionization (AC) voltage (typical value) at 20 pC peak discharge	> 600 V	> 750 V
Withstanding (DC) voltage (cut off current 10 mA); rise time 100 V/s	2560 V; 1 minute	3200 V; 1 minute
Withstanding (DC) voltage between leads and case	2840 V; 1 minute	2840 V; 1 minute

U_{Rdc} = 1600 V; U_{Rac} = 550 V; U_{p-p} = 1600 V

C (µF)	DIMENSIONS w × h (h') × l (mm)	MASS (g)*	CATALOG NUMBER 2222 385 ..... AND PACKAGING							
			C-TOL = ± 5 %							
			LOOSE IN BOX			REEL			AMMOPACK	
			I_T = 3.5 + 1/- 0.5 MM(1)	Short Leads	Long Leads	Original Pitch	Pitch = 7.5 mm (Bent Back)		Original Pitch	Bent Back
							Ø 500 mm	Ø 365 mm		
			Last 5 Digits	SPQ	SPQ	SPQ	SPQ	SPQ	SPQ	SPQ
Pitch = 10 ± 0.4 mm; d_t = 0.60 ± 0.06 mm						**Pitch = 10.0 mm**	**Pitch = 7.5 mm (Bent Back)**		**Pitch = 10.0 mm**	**Pitch = 7.5 mm**
0.002	4.0 × 10.0 (12.0) × 12.5	0.66	50202	1000	1250	1400	2000		950	1300
0.0022			50222							
0.0024			50242							
0.0027			50272							
0.003			50302							
0.0033	5.0 × 11.0 (13.0) × 12.5	0.90	50332	1000	1000	1100	1900		750	1000
0.0036			50362							
0.0039			50392							
0.0043			50432							
0.0047	6.0 × 12.0 (14.0) × 12.5	1.1	50472	750	750	900	1500		600	850
0.0051			50512							
0.0056			50562							
0.0062			50622							
0.0068			50682							
Pitch = 15 ± 0.4 mm; d_t = 0.60 ± 0.06 mm						**Pitch = 15.0 mm**	**Pitch = 7.5 mm (Bent Back)**			
0.0075	5.0 × 11.0 (13.0) × 17.5	1.1	50752	1250	1000	1100	950	550		
0.0082			50822							
0.0091	6.0 × 12.0 (14.0) × 17.5	1.4	50912	1000	1000	900	800	450		
0.010			50103							
0.011			50113							
0.012			50123							
Pitch = 15 ± 0.4 mm; d_t = 0.80 ± 0.08 mm						**Pitch = 15.0 mm**	**Pitch = 7.5 mm (Bent Back)**			
0.013	7.0 × 13.5 (15.5) × 17.5	2.0	50133	1000	500	800	700	400		
0.015			50153							
0.016			50163							
0.018	8.5 × 15.0 (17.0) × 17.5	2.5	50183	1000	500	650	550	300		
0.020			50203							
0.022			50223							
0.024			50243							
0.027	10.0 × 16.5 (18.5) × 17.5	3.3	50273	500	500	600	500	250		
0.030			50303							
0.033			50333							

Note

1. l_t = 3.5 ± 0.3 mm for pitch = 15 mm

* net weight for short lead component

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U_{Rdc} = 2000 V; U_{Rac} = 700 V; U_{p-p} = 2000 V

C (µF)	DIMENSIONS w × h (h') × l (mm)	MASS (g)*	CATALOG NUMBER 2222 385 ..... AND PACKAGING							
			C-TOL = ± 5 %							
			LOOSE IN BOX			REEL			AMMOPACK	
			l_t = 3.5 + 1/- 0.5 mm(1)	Short Leads	Long Leads	Original Pitch	Pitch = 7.5 mm (Bent Back)		Original Pitch	Bent Back
							Ø 500 mm	Ø 365 mm		
			Last 5 Digits	SPQ	SPQ	SPQ	SPQ	SPQ	SPQ	SPQ
Pitch = 10 ± 0.4 mm; d_t = 0.60 ± 0.06 mm						**Pitch = 10.0 mm**	**Pitch = 7.5 mm (Bent Back)**		**Pitch = 10.0 mm**	**Pitch = 7.5 mm**
0.001 0.0011 0.0012 0.0013 0.0015 0.0016	4.0 × 10.0 (12.0) × 12.5	0.66	60102 60112 60122 60132 60152 60162	1000	1250	1400	2000		950	1300
0.0018 0.002 0.0022 0.0024	5.0 × 11.0 (13.0) × 12.5	0.90	60182 60202 60222 60242	1000	1000	1100	1900		750	1000
0.0027 0.003 0.0033 0.0036	6.0 × 12.0 (14.0) × 12.5	1.1	60272 60302 60332 60362	750	750	900	1500		600	850
Pitch = 15 ± 0.4 mm; d_t = 0.60 ± 0.06 mm						**Pitch = 15.0 mm**	**Pitch = 7.5 mm (Bent Back)**			
0.0039 0.0043 0.0047	5.0 × 11.0 (13.0) × 17.5	1.1	60392 60432 60472	1250	1000	1100	950	550		
0.0051 0.0056 0.0062 0.0068	6.0 × 12.0 (14.0) × 17.5	1.4	60512 60562 60622 60682	1000	1000	900	800	450		
Pitch = 15 ± 0.4 mm; d_t = 0.80 ± 0.08 mm						**Pitch = 15.0 mm**	**Pitch = 7.5 mm (Bent Back)**			
0.0075 0.0082 0.0091 0.010	7.0 × 13.5 (15.5) × 17.5	2.0	60752 60822 60912 60103	1000	500	800	700	400		
0.011 0.012 0.013	8.5 × 15.0 (17.0) × 17.5	2.5	60113 60123 60133	1000	500	650	550	300		
0.015 0.016 0.018 0.020	10.0 × 16.5 (18.5) × 17.5	3.3	60153 60163 60183 60203	500	500	600	500	250		

Note

1. l_t = 3.5 ± 0.3 mm for pitch = 15 mm

* net weight for short lead component

MOUNTING

NORMAL USE

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

For detailed tape specifications refer to Type detail specification "HQN-384-01/102, Packaging information".

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. The capacitors shall be mechanically fixed by the leads.

SPACE REQUIREMENTS ON PRINTED-CIRCUIT BOARD

The maximum length and width of film capacitors is shown in the figure:

- Eccentricity as in figure. The maximum eccentricity is smaller than or equal to the lead diameter of the product concerned.
- Product height with seating plane as given by "IEC 60717" as reference: hmax ≤ h + 0.3 mm.

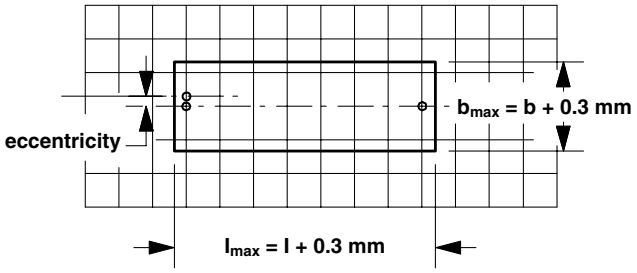
STORAGE TEMPERATURE

- Storage temperature: T_{stg} = - 25 to + 40 °C with RH maximum 80 % without condensation

RATINGS AND CHARACTERISTICS REFERENCE CONDITIONS

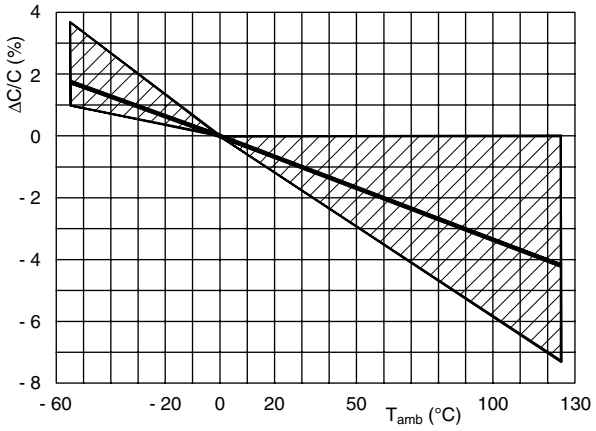
Unless otherwise specified, all electrical values apply to an ambient free temperature of 23 ± 1 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 50 ± 2 %.

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

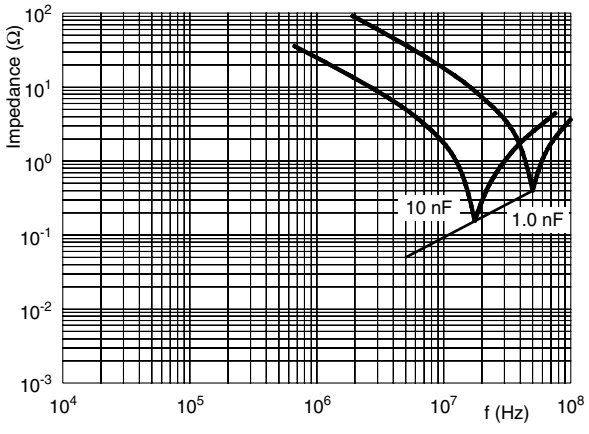


CHARACTERISTICS

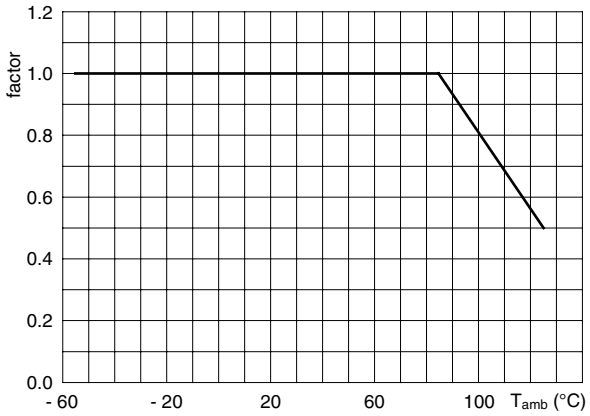
Capacitance (1 kHz)



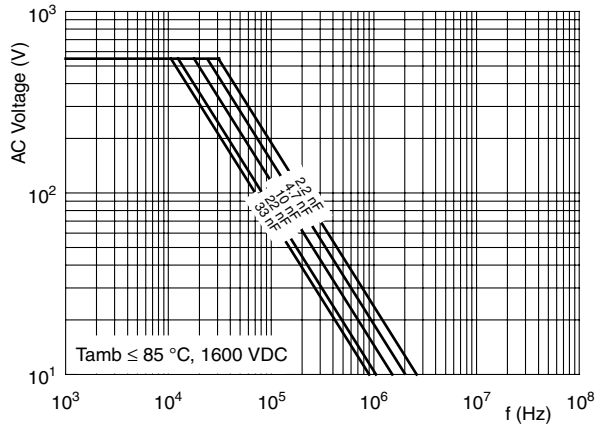
IMPEDANCE

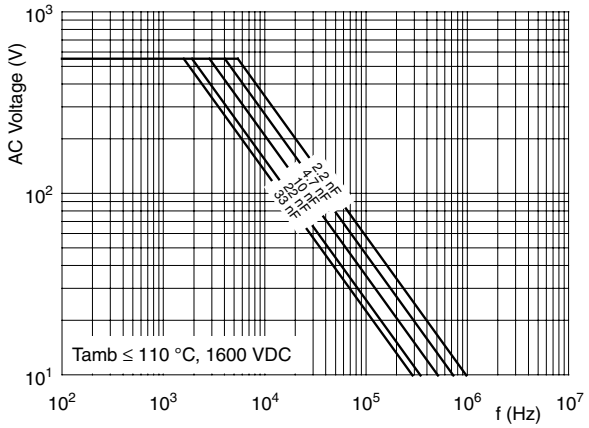


MAX DC AND AC VOLTAGE AS FUNCTION OF TEMPERATURE

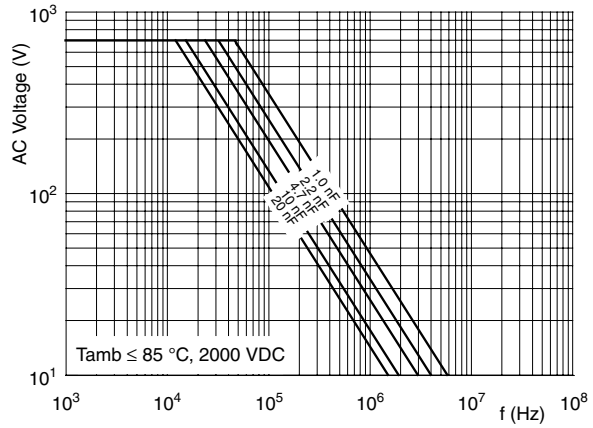


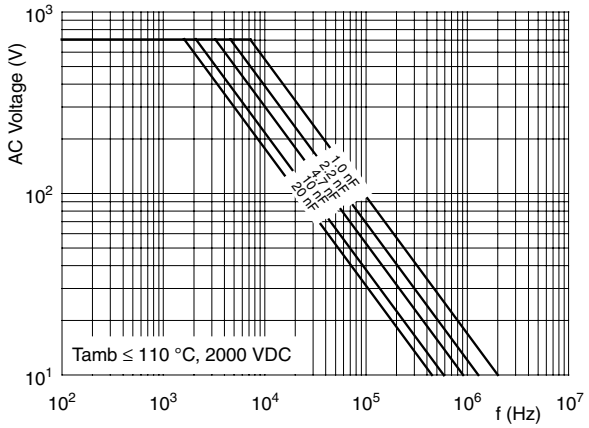
MAX RMS VOLTAGE AS A FUNCTION OF FREQUENCY



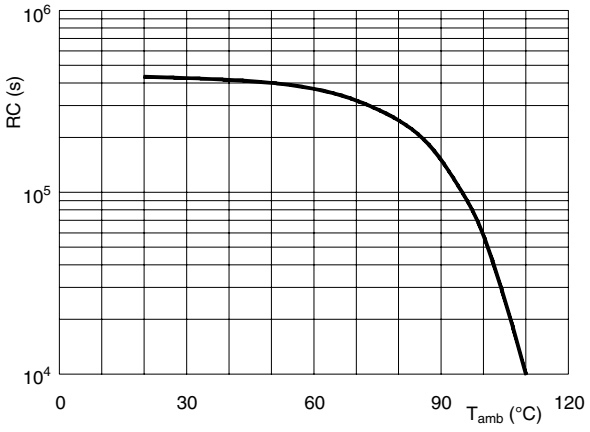


MAX RMS VOLTAGE AS A FUNCTION OF FREQUENCY

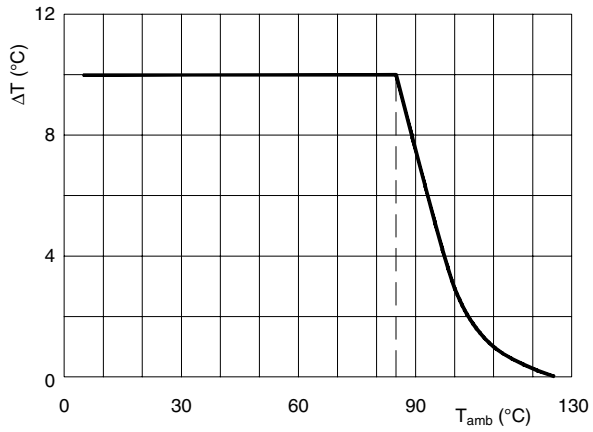




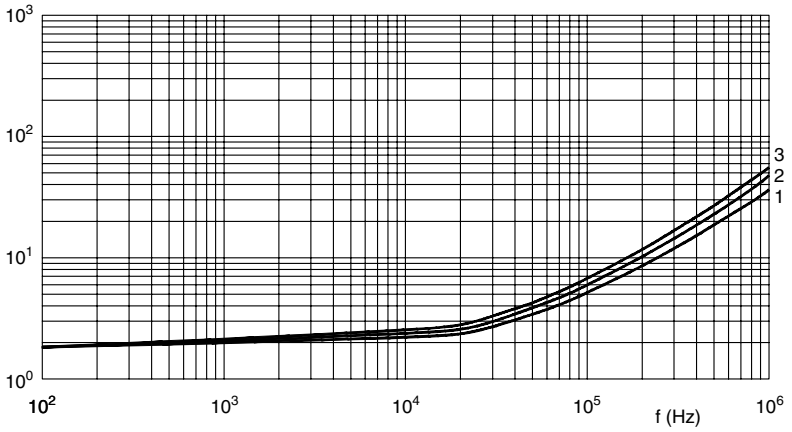
INSULATION RESISTANCE



MAXIMUM ALLOWED COMPONENT TEMPERATURE RISE (∆T) AS A FUNCTION OF THE AMBIENT TEMPERATURE (T_{amb})



TANGET OF LOSS ANGLE



1600 V:
C ≤ 0.0068 µF : curve 2
C ≤ 0.033 µF : curve 3

2000 V:
C ≤ 0.0036 µF : curve 1
C ≤ 0.020 µF : curve 2

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 mm	PITCH 15 mm
4.0	6.5	-
5.0	7.5	10
6.0	9.0	11
7.0	-	12
8.5	-	16
10.0	-	18

POWER DISSIPATION AND MAXIMUM COMPONENT TEMPERATURE RISE

The power dissipation must be limited in order not to exceed the maximum allowed component temperature rise as a function of the free air ambient temperature.

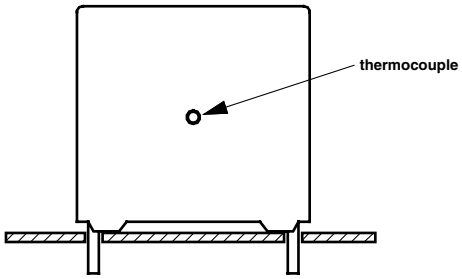
The power dissipation can be calculated according Type detail specification "HQN-384-01/101: Technical information film capacitors" with the typical tgd of the curves.

The component temperature rise (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.

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

1. The peak voltage (U_p) shall not be greater than the rated DC voltage (U_{Rdc})
2. The peak-to-peak voltage (U_{p-p}) shall not be greater than the maximum (U_{p-p}) to avoid the ionisation 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:

   $$2 \times \int_0^T \left(\frac{dU}{dt}\right)^2 \times dt < U_{Rdc} \times \left(\frac{dU}{dt}\right)_{rated}$$

   T is the pulse duration
4. The maximum component surface temperature rise must be lower than the limits (see figure max allowed component temp 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 < $T_{amb} \leq 110$ °C	110 °C < $T_{amb} \leq 125$ °C
Maximum continuous RMS voltage	U_{Rac}	U_{Rac}	U_{Rac}
Maximum temporary RMS-overvoltage (< 24 hours)	1.25 x U_{Rac}	0.875 x U_{Rac}	0.625 x U_{Rac}
Maximum peak voltage (V_{o-p}) (< 2 s)	1.6 x U_{Rdc}	1.1 x U_{Rdc}	0.8 x U_{Rdc}

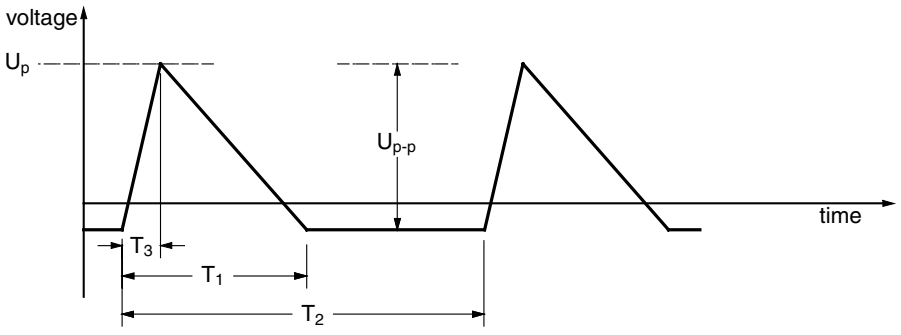
EXAMPLE

C = 4n7 1600 V used for the voltage signal shown in next figure.
U_{p-p} = 1000 V; U_p = 900 V; T1 = 12 µs; T2 = 64 µs; T3 = 4 µs
The ambient temperature is 80 °C. In case of failure, the oscillation is blocked.

Checking the conditions:

1. The peak voltage U_p = 900 V is lower than 1600 V (DC)
2. The peak-to-peak voltage 1000 V is lower than $2\sqrt{2 \times 550 \text{ V (AC)}} = 1600\ U_{p-p}$
3. The voltage pulse slope dU/dt = 1000 V/4µs = 250 V/µs. This is lower than 4000 V/µs (see specific reference data for each version)
4. The dissipated power is 35 mW as calculated with Fourier terms and typical tgd.
   The temperature rise for w_{max} = 6.0 and pitch = 10 mm will be 35 mW / 9 mW/°C = 3.9 °C
   This is lower than 10 °C temperature rise at 80 °C, acc figure.
5. Oscillation is blocked
6. Not applicable

Voltage signal:



QUICK REFERENCE TEST REQUIREMENTS

TEST	PROCEDURE (quick reference)	REQUIREMENTS
Robustness of leads		
Tensile strength: *"IEC 60068-2-21"*	Load 10 N; 10 s	No visible change Ligible marking
Bending: *"IEC 60068-2-21"*	Load 5 N; 4 x 90°	$\|\Delta C/C\| \leq 1$ %
Resistance to soldering heat: *"IEC 60068-2-20"*	Solder bath: 260 °C; 10 s	$\Delta\tan\delta \leq 5 \times 10^{-4}$
Component solvent Resistance	Isopropyl alcohol; 23 °C; 5 minutes	
Robustness of component		
Vibration: *"IEC 60068-2-6"*	10 to 55 Hz; amplitude 0.75 mm or acceleration 98 m/s^2; 6 hours	$\|\Delta C/C\| \leq 1$ %
Shock: *"IEC 60068-2-27"*	Half sinewave; 490 m/s^2; 11 ms	$\Delta\tan\delta \leq 5 \times 10^{-4}$
Climatic sequence		
Dry heat: *"IEC 60068-2-2"*	16 hours; 110 °C	$\|\Delta C/C\| \leq 2$ % $\Delta\tan\delta \leq 5 \times 10^{-4}$ $R_{ins} \geq 50$ % of specified value
Damp heat, cyclic,test Db, first cycle, *"IEC 60068-2-30"*		
Cold: *"IEC 60068-2-1"*	2 hours; - 55 °C	
Damp heat, cyclic,test Db; Remaining cycles: *"IEC 60068-2-30"*		
Other applicable tests		
Damp heat, steady state: *"IEC 60068-2-3"*	56 days; 40 °C; 90 to 95 % RH	$\|\Delta C/C\| \leq 2$ % $\Delta\tan\delta \leq 5 \times 10^{-4}$ $R_{ins} \geq 50$ % of specified value
Endurance (AC): *"IEC 60384-17"*	2000 hours: 1.25 x U_{Rac}; (RMS); 50 Hz; 85 °C 0.875 x U_{Rac}; (RMS); 50 Hz; 110 °C	$\|\Delta C/C\| \leq 5$ % $\Delta\tan\delta \leq 5 \times 10^{-4}$ $R_{ins} \geq 50$ % of specified value
Endurance (AC):	500 hours : 0.625 x U_{Rac}; (RMS); 50 Hz; 125 °C	$\|\Delta C/C\| \leq 10$ % + 100 pF $\Delta\tan\delta \leq 5 \times 10^{-4}$ $R_{ins} \geq 50$ % of specified value
Heat storage: *"IEC 60384-17"*	2000 hours; 110 °C	$\|\Delta C/C\| \leq 3$ % $\Delta\tan\delta \leq 5 \times 10^{-4}$
Resistance to soldering heat with preheating: *"IEC 60384-17"*	Body temperature: 105 °C Bath temperature: 260°C; Dwell time 10 s	$\|\Delta C/C\| \leq 3$ % $\Delta\tan\delta \leq 5 \times 10^{-4}$
Passive flammability: *"IEC 60384-1"*	Class B	No burning
Endurance (DC) *"IEC 60384-17"*	2000 hours: 1.25 x U_{Rdc}; 85 °C 0.875 x U_{Rdc}; 110 °C	$\|\Delta C/C\| \leq 3$ % $\Delta\tan\delta \leq 5 \times 10^{-4}$ $R_{ins} \geq 50$ % of specified value
Endurance (DC)	500 hours: 0.625 x U_{Rdc}; 125 °C	$\|\Delta C/C\| \leq 6$ % $\Delta\tan\delta \leq 5 \times 10^{-4}$ $R_{ins} \geq 50$ % of specified value
Ignition of lamp application test: 1600 V types: 2000 V types:	60 kHz 85 °C 10000 cycles : 1 s ON 29 s OFF 2800 V_{pp} 3000 V_{pp}	$\|\Delta C/C\| \leq 5$ % $\Delta\tan\delta \leq 5 \times 10^{-4}$ $R_{ins} \geq 50$ % of specified value

Disclaimer

All product specifications and data are subject to change without notice.

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