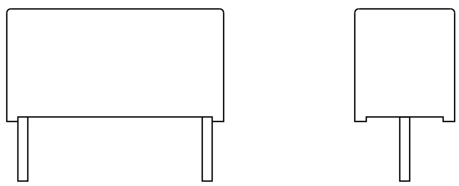
AC and Pulse Double Metallized Polypropylene Film Capacitors MMKP Radial Potted Type



FEATURES

- 7.5 mm to 37.5 mm lead pitch
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT
HALOGEN FREE
GREEN (5-2008)

APPLICATIONS

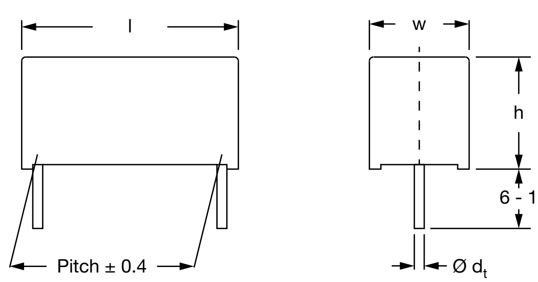
- High voltage, high current and high pulse operations
- Protection circuits in SMPS's, snubber and electronic ballast circuits

QUICK REFERENCE DATA	
Rated DC voltage	250 V_{DC}; 400 V_{DC}; 630 V_{DC}; 1000 V_{DC}; 1600 V_{DC}; 2000 V_{DC}
Rated AC voltage	160 V_{AC}; 220 V_{AC}; 250 V_{AC}; 400 V_{AC}; 600 V_{AC}; 650 V_{AC}; 700 V_{AC}
Capacitance range	470 pF to 4.7 µF
Capacitance tolerance	± 5 %
Climatic testing class according to EN 60068-1	55/100/56
Maximum application temperature	100 °C
Reference standards	IEC 60384-16
Dielectric	Polypropylene film
Electrodes	Metallized
Construction	Internal series construction
Encapsulation	Plastic case, epoxy resin sealed, flame retardant, UL-class 94 V-0
Leads	Tinned wire
Marking	C-value; tolerance; rated voltage; manufacturer's type; code for dielectric material; manufacturer location; manufacturer's logo; year and week

Note

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

DIMENSIONS in millimeters



PITCH	w	Ø d_t
7.5	-	0.5 ± 0.05
10	-	0.6 ± 0.06
15	≤ 6	0.6 ± 0.06
15	> 6	0.8 ± 0.08
22.5 to 27.5	-	0.8 ± 0.08
37.5	< 16.0	0.8 ± 0.08
37.5	≥ 16.0	1.0 ± 0.1

COMPOSITION OF CATALOG NUMBER

MKP	1841	X	XX	40	4	M	X

MKP: METALLIZED POLYPROPYLENE

1841: TYPE CONSTRUCTION

X: MULTIPLIER (nF)

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

XX: CAPACITANCE (numerically)

Example:
410 = 100 nF

40: VOLTAGE (V_{DC})

VOLTAGE (V_{DC})
25 = 250 V_{DC}
40 = 400 V_{DC}
63 = 630 V_{DC}
10 = 1000 V_{DC}
13 = 1600 V_{DC}
20 = 2000 V_{DC}

4: TOLERANCE

TOLERANCE	
4	± 5 %

M: MINI VERSION

X: PACKAGING

PACKAGING	
	Bulk
G	Ammopack
W	Reel (Ø 350 mm)
V	Reel (Ø 500 mm)

Note

- For detailed tape specifications refer to "Packaging Information" www.vishay.com/doc?28139 or end of catalog

SPECIFIC REFERENCE DATA							
DESCRIPTION					**VALUE**		
Tangent of loss angle:					at 1 kHz	at 10 kHz	at 100 kHz
$C \leq 0.1\ \mu F$					$\leq 10 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	$\leq 20 \times 10^{-4}$
$0.1\ \mu F < C \leq 1.0\ \mu F$					$\leq 10 \times 10^{-4}$	$\leq 10 \times 10^{-4}$	-
$C \geq 1.0\ \mu F$					$\leq 10 \times 10^{-4}$	-	-
PITCH (mm)	**MAXIMUM PULSE RISE TIME $(dU/dt)_R$ [V/μs]**						
	250 V_{DC}	**400 V_{DC}**	**630 V_{DC} / 250 V_{AC}**	**630 V_{DC} / 400 V_{AC}**	**1000 V_{DC}**	**1600 V_{DC}**	**2000 V_{DC}**
7.5	1730	-	-	-	-	-	-
10	865	1297	2162	-	-	-	-
15	432	649	-	2703	3784	6683	9610
22.5	247	360	-	1441	2018	2827	3326
27.5	192	282	-	1081	1514	2042	2544
37.5	133	200	-	-	1044	1313	1602
R between leads, for $C \leq 0.33\ \mu F$ at 100 V; 1 min						> 100 000 MΩ	
RC between leads; for $C > 0.33\ \mu F$ at 100 V; 1 min						> 30 000 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						1.6 x U_{RDC}, 1 min	
Withstanding (DC) voltage between leads and case						2840 V; 1 min	
Maximum application temperature						100 °C	

Note

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

ELECTRICAL DATA

U_{RDC} (V)	CAP. (µF)	CAPACITANCE CODE	VOLTAGE CODE	V_{AC}	DIMENSIONS (w x h x l)	PCM
250	0.010	310	25	160	4.0 x 9.0 x 10.0	7.5
	0.015	315			4.0 x 9.0 x 10.0	7.5
	0.022	322			4.0 x 10.0 x 12.5	10
	0.033	333			4.0 x 10.0 x 12.5	10
	0.047	347			5.0 x 11.0 x 12.5	10
	0.068	368			6.0 x 12.0 x 12.5	10
	0.10	410			5.0 x 11.0 x 17.5	15
	0.15	415			6.0 x 12.0 x 17.5	15
	0.22	422			7.0 x 13.5 x 17.5	15
	0.33	433			8.5 x 15.0 x 17.5	15
	0.47	447			8.5 x 18.0 x 26.0	22.5
	0.68	468			10.0 x 19.5 x 26.0	22.5
	1.0	510			10.0 x 19.5 x 26.0	22.5
	1.5	515			13.0 x 23.0 x 31.0	27.5
	2.2	522			15.0 x 25.0 x 31.0	27.5
	3.3	533			21.0 x 31.0 x 31.0	27.5
	4.7	547			18.0 x 32.5 x 41.5	37.5
400	0.010	310	40	220	4.0 x 10.0 x 12.5	10
	0.015	315			4.0 x 10.0 x 12.5	10
	0.022	322			4.0 x 10.0 x 12.5	10
	0.033	333			5.0 x 11.0 x 17.5	15
	0.047	347			5.0 x 11.0 x 17.5	15
	0.068	368			6.0 x 12.0 x 17.5	15
	0.10	410			7.0 x 13.5 x 17.5	15
	0.15	415			8.5 x 15.0 x 17.5	15
	0.22	422			7.0 x 16.5 x 26.0	22.5
	0.33	433			8.5 x 18.0 x 26.0	22.5
	0.47	447			10.0 x 19.5 x 26.0	22.5
	0.68	468			11.0 x 21.0 x 31.0	27.5
	1.0	510			13.0 x 23.0 x 31.0	27.5
	1.5	515			15.0 x 25.0 x 31.0	27.5
	2.2	522			16.0 x 28.5 x 41.5	37.5
630	0.00068	168	63	250	4.0 x 10.0 x 12.5	10
	0.00082	182			4.0 x 10.0 x 12.5	10
	0.0010	210			4.0 x 10.0 x 12.5	10
	0.0015	215			4.0 x 10.0 x 12.5	10
	0.0022	222			4.0 x 10.0 x 12.5	10
	0.0033	233			4.0 x 10.0 x 12.5	10
	0.0047	247			4.0 x 10.0 x 12.5	10
	0.0068	268			4.0 x 10.0 x 12.5	10
	0.010	310			5.0 x 11.0 x 12.5	10
	0.015	315			6.0 x 12.0 x 12.5	10
	0.022	322			6.0 x 12.0 x 12.5	10
630	0.015	315	63	400	5.0 x 11.0 x 17.5	15 (1)
	0.022	322			6.0 x 12.0 x 17.5	15 (1)
	0.033	333			7.0 x 13.5 x 17.5	15 (1)
	0.047	347			8.5 x 15.0 x 17.5	15 (1)
	0.068	368			7.0 x 16.5 x 26.0	22.5
	0.10	410			8.5 x 18.0 x 26.0	22.5
	0.15	415			10.0 x 19.5 x 26.0	22.5
	0.22	422			11.0 x 21.0 x 31.0	27.5
	0.33	433			13.0 x 23.0 x 31.0	27.5
	0.47	447			18.0 x 28.0 x 31.0	27.5
	0.68	468			21.0 x 31.0 x 31.0	27.5

ELECTRICAL DATA						
U_{RDC} (V)	CAP. (µF)	CAPACITANCE CODE	VOLTAGE CODE	V_{AC}	DIMENSIONS (w x h x l)	PCM
1000	0.0047	247	10	600	5.0 x 11.0 x 17.5	15
	0.0068	268			5.0 x 11.0 x 17.5	15
	0.010	310			6.0 x 12.0 x 17.5	15
	0.015	315			7.0 x 13.5 x 17.5	15
	0.022	322			8.5 x 15.0 x 17.5	15
	0.033	333			7.0 x 16.5 x 26.0	22.5
	0.047	347			8.5 x 18.0 x 26.0	22.5
	0.068	368			10.0 x 19.5 x 26.0	22.5
	0.10	410			12.0 x 22.0 x 26.0	22.5
	0.15	415			13.0 x 23.0 x 31.0	27.5
	0.22	422			15.0 x 25.0 x 31.0	27.5
	0.33	433			18.0 x 28.0 x 31.0	27.5
1600	0.0033	233	13	650	5.0 x 11.0 x 17.5	15
	0.0047	247			6.0 x 12.0 x 17.5	15
	0.0068	268			7.0 x 13.5 x 17.5	15
	0.010	310			8.5 x 15.0 x 17.5	15
	0.015	315			10.0 x 16.5 x 17.5	15
	0.022	322			8.5 x 18.0 x 26.0	22.5
	0.033	333			8.5 x 18.0 x 26.0	22.5
	0.047	347			10.0 x 19.5 x 26.0	22.5
	0.068	368			12.5 x 20.0 x 26.5	22.5
	0.10	410			13.0 x 23.0 x 31.0	27.5
	0.15	415			15.0 x 25.0 x 31.0	27.5
	0.22	422			16.0 x 28.5 x 41.5	37.5
2000	0.00047	147	20	700	5.0 x 11.0 x 17.5	15
	0.00068	168			5.0 x 11.0 x 17.5	15
	0.00082	182			5.0 x 11.0 x 17.5	15
	0.0010	210			5.0 x 11.0 x 17.5	15
	0.0015	215			5.0 x 11.0 x 17.5	15
	0.0022	222			5.0 x 11.0 x 17.5	15
	0.0033	233			6.0 x 12.0 x 17.5	15
	0.0047	247			6.0 x 12.0 x 17.5	15
	0.0068	268			6.0 x 15.5 x 26.0	22.5
	0.010	310			6.0 x 15.5 x 26.0	22.5
	0.015	315			7.0 x 16.5 x 26.0	22.5
	0.022	322			8.5 x 18.0 x 26.0	22.5
	0.033	333			9.0 x 19.0 x 31.0	27.5
	0.047	347			11.0 x 21.0 x 31.0	27.5
	0.068	368			13.0 x 23.0 x 31.0	27.5
	0.10	410			14.5 x 24.5 x 41.5	37.5
	0.15	415			16.0 x 28.5 x 41.5	37.5
	0.22	422			18.0 x 32.5 x 41.5	37.5

Note

(1) Ordering code -2M for pitch 15 (e.g. MKP18413226342M)

RECOMMENDED PACKAGING							
LETTER CODE	**TYPE OF PACKAGING**	**HEIGHT (H) (mm)**	**REEL DIAMETER (mm)**	**ORDERING CODE EXAMPLES**	**PITCH ≤ 15**	**PITCH 22.5 TO 27.5**	**PITCH 37.5**
G	Ammo	18.5	-	MKP1841-310/404-MG	X	-	-
W	Reel	18.5	350	MKP1841-310/404-MW	X	-	-
V	Reel	18.5	500	MKP1841-410/634-MV	-	X	-
G	Ammo	18.5	-	MKP1841-410/634-MG	-	X	-
-	Bulk	-	-	MKP1841-410/634-M	X	X	X

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 ensure that the stand-off pips are in good contact with the printed-circuit board:

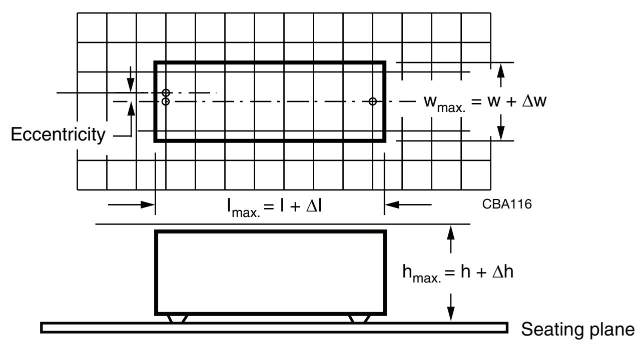
- For pitches = 15 mm capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

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 drawings.

- For products with pitch ≤ 15 mm, $\Delta w = \Delta l = 0.3$ mm; $\Delta h = 0.1$ mm
- For products with 15 mm < pitch ≤ 27.5 mm, $\Delta w = \Delta l = 0.5$ mm; $\Delta h = 0.1$ 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.



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

Storage Temperature

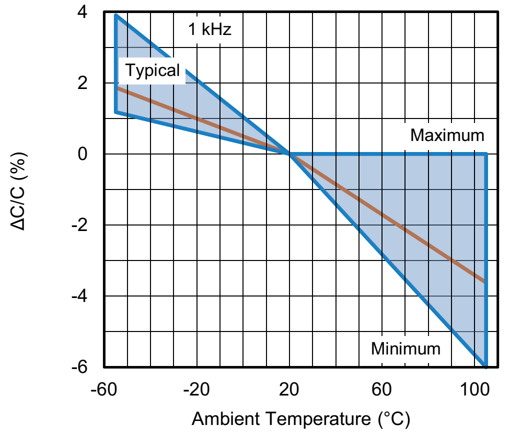
T_{stg} = -25 °C to +35 °C with RH maximum 75 % without condensation

Ratings and Characteristics Reference Conditions

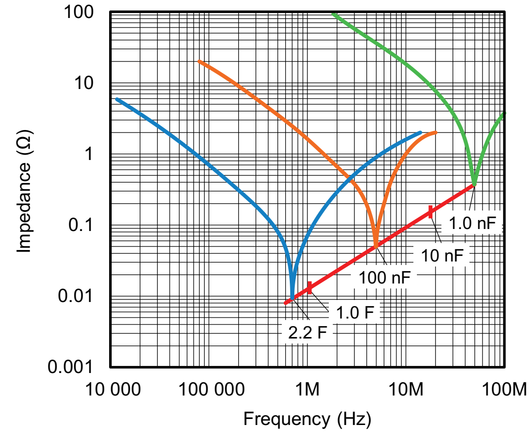
Unless otherwise specified, all electrical values apply to an ambient free temperature of 23 °C ± 1 °C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

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 %.

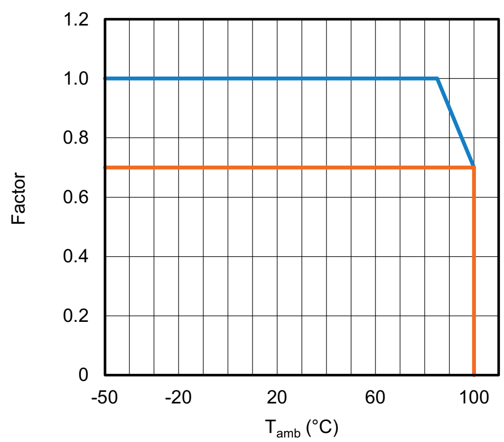
CHARACTERISTICS



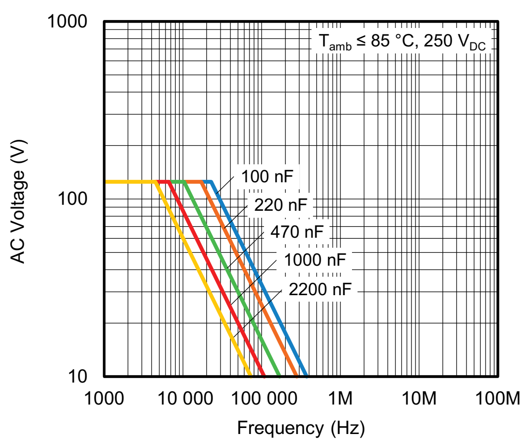
Capacitance as a function of ambient temperature
(typical curve - 1 kHz)



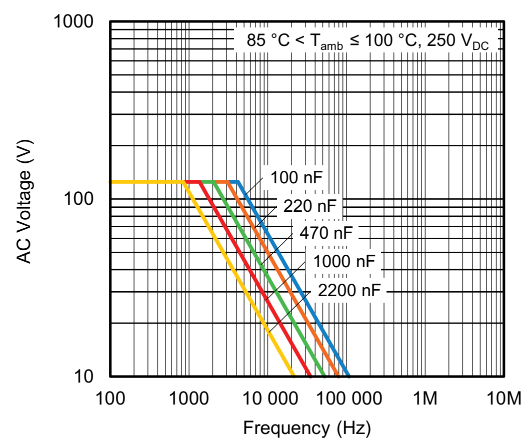
Impedance as a function of frequency
(typical curve)



Max. DC and AC voltage as function of temperature

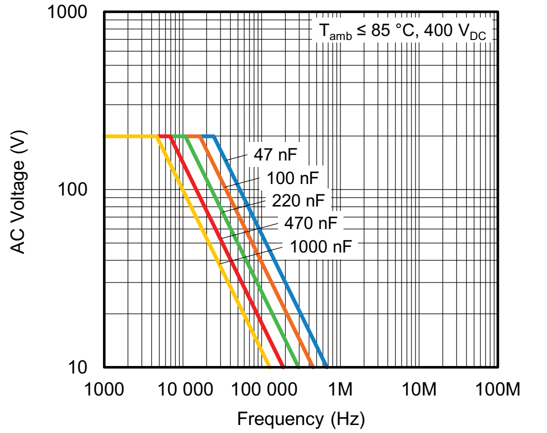


Maximum RMS voltage as a function of frequency

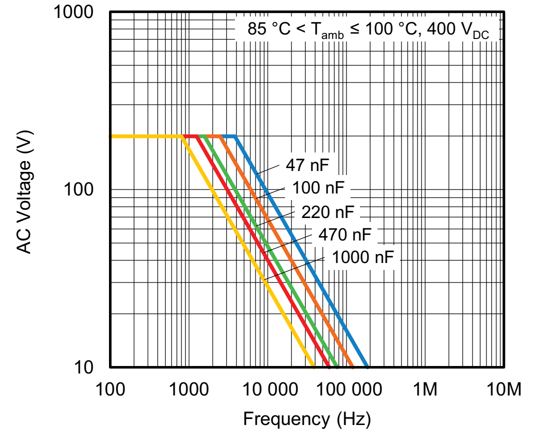


Maximum RMS voltage as a function of frequency

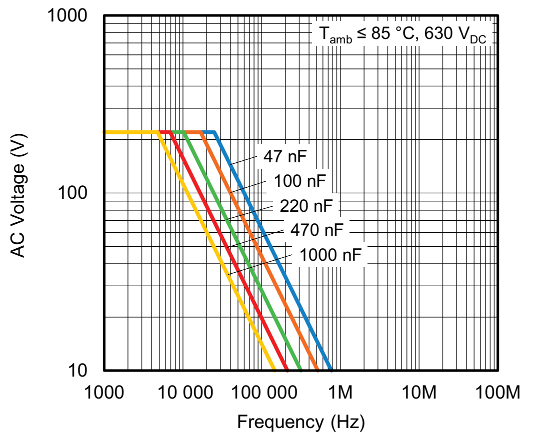
CHARACTERISTICS



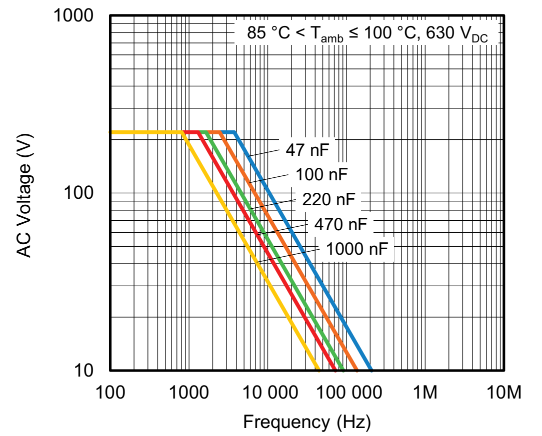
Maximum RMS voltage as a function of frequency



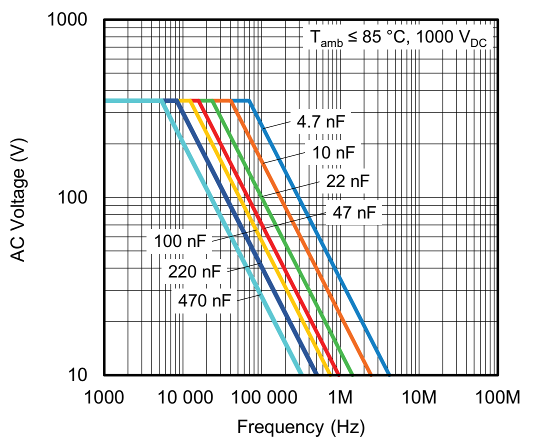
Maximum RMS voltage as a function of frequency



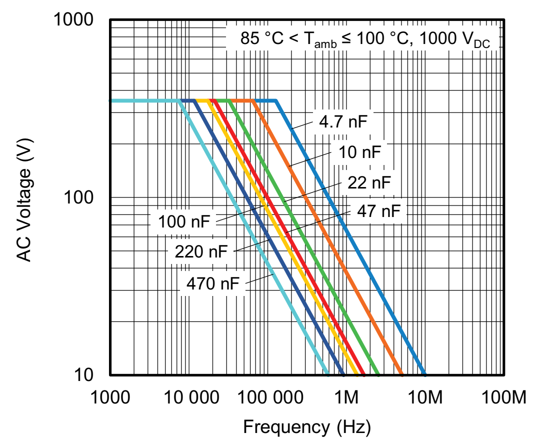
Maximum RMS voltage as a function of frequency



Maximum RMS voltage as a function of frequency

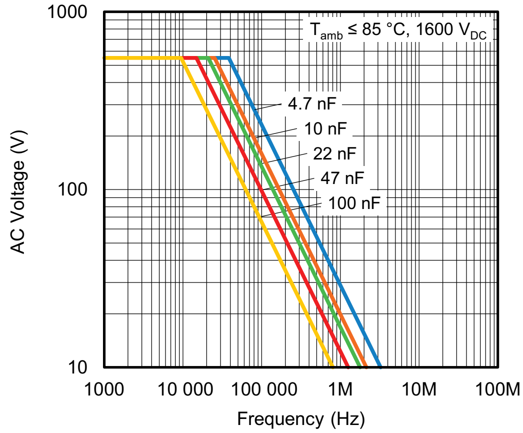


Maximum RMS voltage as a function of frequency

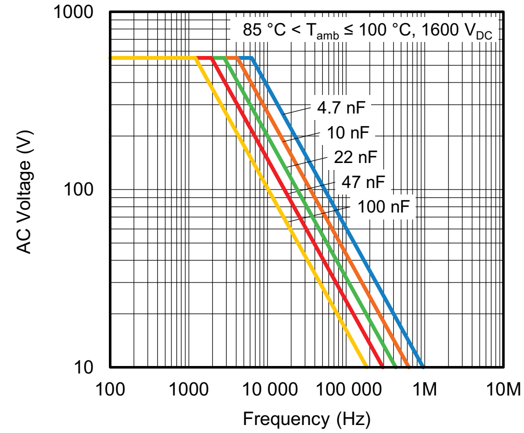


Maximum RMS voltage as a function of frequency

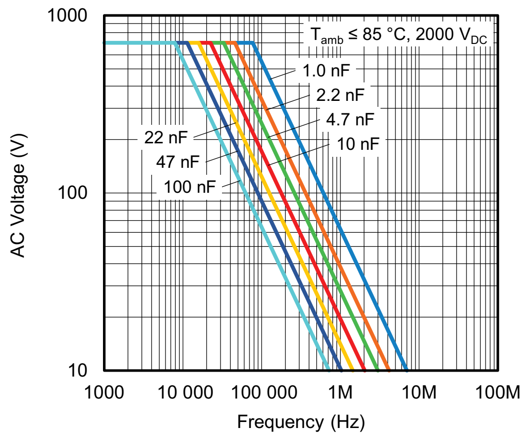
CHARACTERISTICS



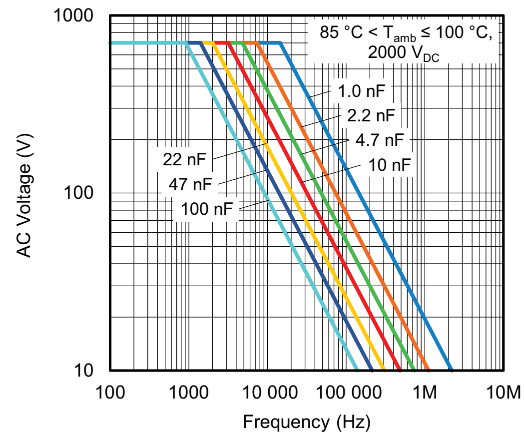
Maximum RMS voltage as a function of frequency



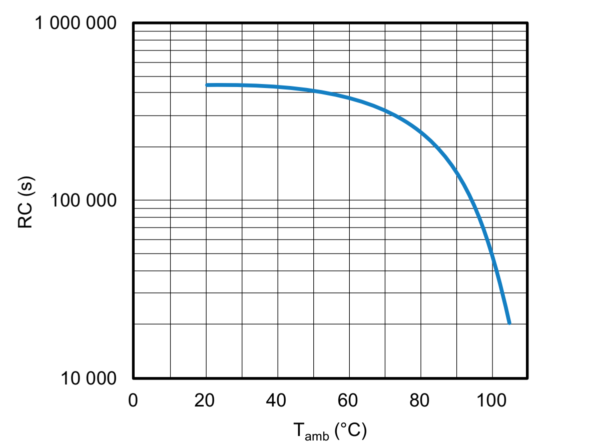
Maximum RMS voltage as a function of frequency



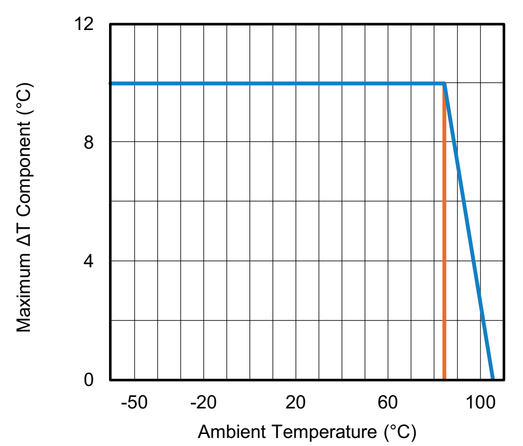
Maximum RMS voltage as a function of frequency



Maximum RMS voltage as a function of frequency

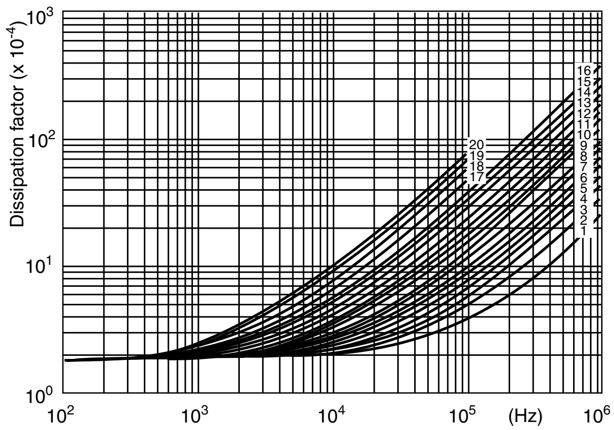


Insulation resistance as a function of ambient temperature



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

CHARACTERISTICS



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

250 V	400 V	630 V	1000 V	1600 V	2000 V
C ≤ 0.091 µF, curve 8	C ≤ 0.047 µF, curve 5	C ≤ 0.033 µF, curve 4	C ≤ 0.01 µF, curve 2	C ≤ 0.0047 µF, curve 3	C ≤ 0.0047 µF, curve 2
C ≤ 0.015 µF, curve 9	C ≤ 0.068 µF, curve 6	C ≤ 0.068 µF, curve 5	C ≤ 0.027 µF, curve 3	C ≤ 0.0091 µF, curve 4	C ≤ 0.033 µF, curve 3
C ≤ 0.022 µF, curve 10	C ≤ 0.1 µF, curve 7	C ≤ 0.1 µF, curve 6	C ≤ 0.047 µF, curve 4	C ≤ 0.068 µF, curve 5	C ≤ 0.1 µF, curve 4
C ≤ 0.027 µF, curve 11	C ≤ 0.2 µF, curve 8	C ≤ 0.15 µF, curve 7	C ≤ 0.062 µF, curve 5	C ≤ 0.01 µF, curve 6	
C ≤ 0.033 µF, curve 12	C ≤ 0.24 µF, curve 12	C ≤ 0.22 µF, curve 11	C ≤ 0.075 µF, curve 6	C ≤ 0.15 µF, curve 7	
C ≤ 0.056 µF, curve 15	C ≤ 0.36 µF, curve 13	C ≤ 0.27 µF, curve 12	C ≤ 0.1 µF, curve 7		
C ≤ 0.082 µF, curve 16	C ≤ 0.47 µF, curve 14	C ≤ 0.47 µF, curve 15	C ≤ 0.15 µF, curve 8		
C ≤ 1.2 µF, curve 18	C ≤ 0.56 µF, curve 16	C ≤ 0.68 µF, curve 16	C ≤ 0.22 µF, curve 9		
C ≤ 1.6 µF, curve 19	C ≤ 1.1 µF, curve 17		C ≤ 0.3 µF, curve 10		
C ≤ 2.2 µF, curve 20			C ≤ 0.39 µF, curve 11		

HEAT CONDUCTIVITY (G) AS A FUNCTION OF (ORIGINAL) PITCH AND CAPACITOR BODY THICKNESS IN mW/°C

$W_{max.}$ (mm)	HEAT CONDUCTIVITY (mW/°C)					
	PITCH 7.5 mm	PITCH 10 mm	PITCH 15 mm	PITCH 22.5 mm	PITCH 27.5 mm	PITCH 37.5 mm
4.0	-	6.5	-	-	-	-
4.5	5	-	-	-	-	-
5.0	-	7.5	10	-	-	-
6.0	-	9.0	11	-	-	-
7.0	-	-	12	21	-	-
8.5	-	-	16	25	-	-
10.0	-	-	18	28	-	-
11.0	-	-	-	-	36	-
12.0	-	-	-	34	-	-
13.0	-	-	-	-	42	-
14.5	-	-	-	-	-	59
15.0		-	-	-	48	-
16.0	-	-	-	-	-	68
18.0	-	-	-	-	57	-
18.5	-	-	-	-	-	89
21.0	-	-	-	-	68	-
30.0	-	-	-	-	-	134

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.

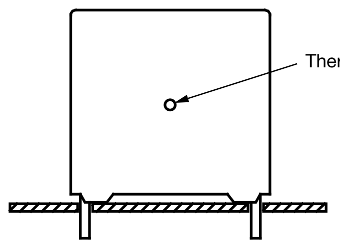
The power dissipation can be calculated according type detail specification "HQN-384-01/101: Technical Information Film Capacitors".

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 ionization inception level
3. The voltage pulse 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 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 < $T_{amb} \leq 100$ °C**
Maximum continuous RMS voltage	U_{RAC}	U_{RAC}
Maximum temperature RMS-overvoltage (< 24 h)	1.25 x U_{RAC}	0.875 x U_{RAC}
Maximum peak voltage (V_{O-P}) (< 2 s)	1.6 x U_{RDC}	1.1 x U_{RDC}

INSPECTION REQUIREMENTS

General Notes

Sub-clause numbers of tests and performance requirements refer to the “Sectional Specification, Publication IEC 60384-16 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 ≤ 0.1 μF at 100 kHz or for C > 0.1 μF at 10 kHz Tensile and bending	
4.3 Robustness of terminations		No visible damage
4.4 Resistance to soldering heat	Method: 1A Solder bath: 280 °C ± 5 °C Duration: 5 s	
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	$\lvert\Delta C/C\rvert \leq 2$ % of the value measured initially
	Tangent of loss angle	Increase of tan δ: ≤ 0.002 Compared to values measured in 4.3.1
SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1		
4.6.1 Initial measurements	Capacitance Tangent of loss angle: for C ≤ 0.1 μF at 100 kHz or for C > 0.1 μF at 10 kHz	
4.15 Solvent resistance of the marking	Isopropylalcohol at room temperature Method: 1 Rubbing material: cotton wool	No visible damage Legible marking
4.6 Rapid change of temperature	Immersion time: 5.0 min ± 0.5 min θA = lower category temperature θB = upper category temperature 5 cycles Duration t = 30 min	
4.7 Vibration	Visual examination Mounting: see section “Mounting” for more information 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

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	
4.9.3 Final measurements	Visual examination	No visible damage
	Capacitance	$|\Delta C/C| \leq 2$ % of the value measured in 4.6.1
	Tangent of loss angle	Increase of tan $\delta \leq 0.002$ Compared to values measured in 4.6.1
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification
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 test chamber	No breakdown or flashover
	Visual examination	No visible damage Legible marking
	Capacitance	$|\Delta C/C| \leq 3$ % of the value measured initially 4.11.1
	Tangent of loss angle	Increase of tan δ: ≤ 0.003 Compared to values measured in 4.3.1. or 4.6.1
	Insulation resistance	≥ 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, no load	
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 test chamber	No breakdown or flashover
	Visual examination	No visible damage Legible marking
	Capacitance	$|\Delta C/C| \leq 3$ % of the value measured in 4.11.1.
	Tangent of loss angle	Increase of tan δ: ≤ 0.002 Compared to values measured in 4.11.1
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C3		
4.12.1 Endurance test at 50 Hz alternating voltage	Duration: 2000 h	
4.12.1.1 Initial measurements	Voltage: 1 x U_{RAC} at 100 °C Capacitance Tangent of loss angle: at 10 kHz	
4.12.1.3 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\lvert\Delta C/C\rvert \leq 5$ % compared to values measured in 4.12.1.1
	Tangent of loss angle	Increase of tan δ: ≤ 0.004 Compared to values measured in 4.12.1
	Insulation resistance	$\geq$ 50 % of values specified in section "Insulation Resistance" of this specification
SUB-GROUP C4		
4.2.6 Temperature characteristics		
Initial measurements	Capacitance	For -55 °C to +20 °C
Intermediate measurements	Capacitance at -55 °C Capacitance at 20 °C Capacitance at 100 °C	+1 % $\leq \lvert\Delta C/C\rvert \leq$ 3.75 % or For 20 °C to 105 °C: -6 % $\leq \lvert\Delta C/C\rvert \leq$ 0 %
Final measurements	Capacitance	As specified in section "Capacitance" of this specification.
	Insulation resistance	As specified in section "Insulation Resistance" of this specification
4.13 Charge and discharge	10 000 cycles Charged to U_{RDC} Discharge resistance: $R = \frac{U_{RDC}}{1.5 \times C(dU/dt)}$	
4.13.1 Initial measurements	Capacitance Tangent of loss angle: for C $\leq$ 1 µF at 100 kHz or for C > 1 µF at 10 kHz	
4.13.3 Final measurements	Capacitance	$\lvert\Delta C/C\rvert \leq 3$ % compared to values measured in 4.13.1
	Tangent of loss angle	Increase of tan δ: ≤ 0.005 compared to values measured in 4.13.1
	Insulation resistance	$\geq$ 50 % of values specified in section "Insulation Resistance" of this specification

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