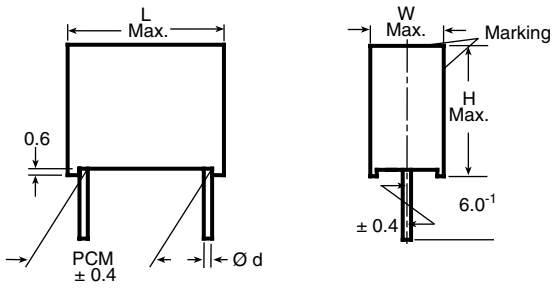
AC and Pulse Double Metallized Polypropylene Film Capacitors
MMKP Radial Potted Type



Dimensions in millimeters

PITCH (mm)	W (mm)	Ø d_t (mm)
7.5 and 10	-	0.6 ± 0.06
15 and 37.5	< 16.0	0.8 ± 0.08
15 and 37.5	≥ 16.0	1.0 ± 0.1

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

REFERENCE STANDARDS
IEC 60384-16

MARKING
C-value; tolerance; rated voltage; manufacturer's type; code for dielectric material; manufacturer location; manufacturer's logo; year and week

DIELECTRIC
Polypropylene film

ELECTRODES
Metallized

CONSTRUCTION
Internal series construction

RATED DC VOLTAGES
250 V, 400 V, 630 V, 1000 V, 1600 V, 2000 V

RATED AC VOLTAGES
160 V, 220 V, 250 V, 400 V, 600 V, 650 V, 700 V

FEATURES
7.5 mm to 37.5 mm lead pitch, supplied loose in box, taped on reel and ammopack.
RoHS compliant

Pb-free

e3

RoHS COMPLIANT

RECOMMENDED SERIES

PITCH	TYPE
7.5	1841
10	1841M
15	see 383
22.5	see 383
27.5	see 383
37.5	1841M

Vdc/Vac	TYPE
630 /400	1841M

ENCAPSULATION
Plastic case, epoxy resin sealed, flame retardant UL-class 94 V-0

CLIMATIC TESTING CLASS ACC. TO EN 60068-1
55/100/56

CAPACITANCE RANGE
470 pF to 4.7 µF

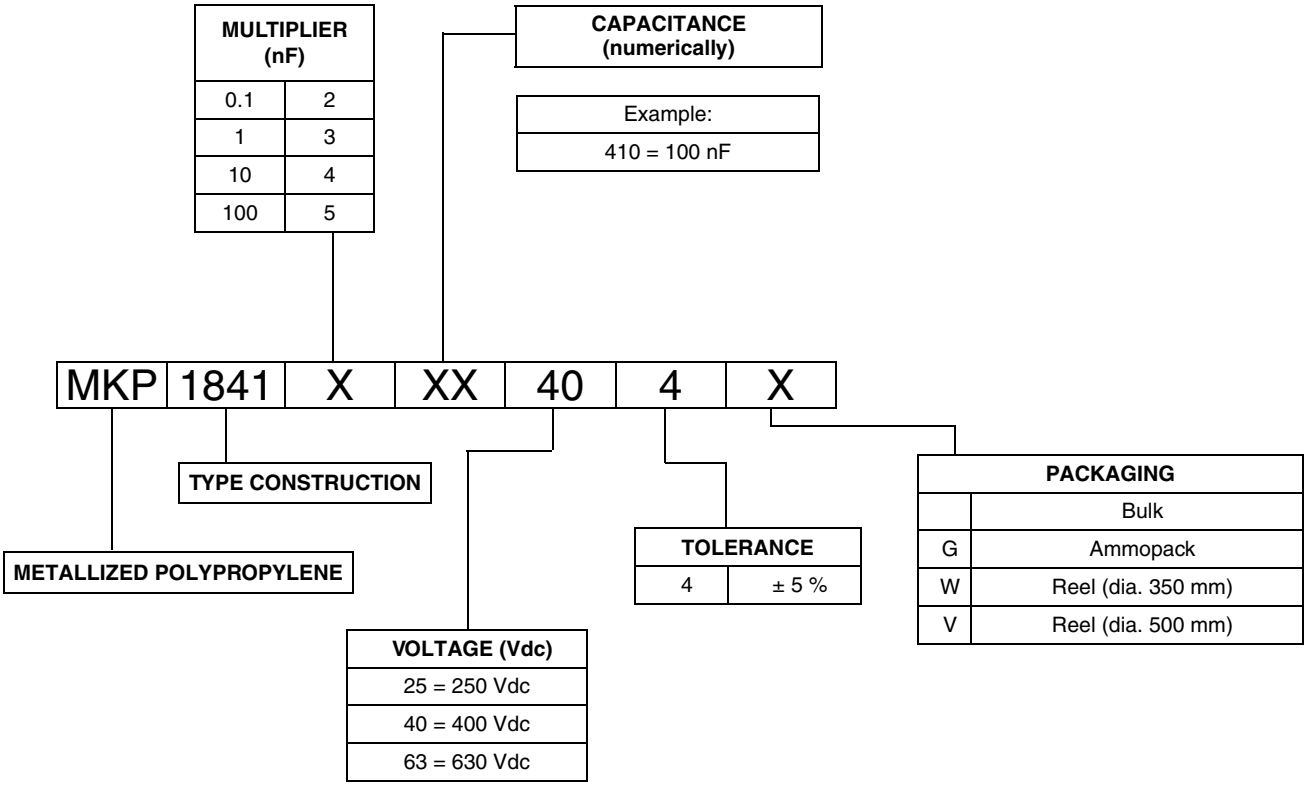
CAPACITANCE TOLERANCE
± 5 %

LEADS
Tinned wire

MAXIMUM APPLICATION TEMPERATURE
100 °C

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

COMPOSITION OF CATALOG NUMBER



Note

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

SPECIFIC REFERENCE DATA: 1841

DESCRIPTION	VALUE		
Tangent of loss angle:	at 1 kHz	at 10 kHz	at 100 kHz
$C \leq 0.1$ µF	3×10^{-4}	4×10^{-4}	15×10^{-4}
0.1 µF < C ≤ 1.0 µF	3×10^{-4}	5×10^{-4}	-
C > 1.0 µF	3×10^{-4}	-	-
Pitch (mm)	Maximum pulse rise time $(dU/dt)_R$ [V/µs]		
	250 Vdc	400 Vdc	630 Vdc/250 Vac
7.5	1800	2200	3600
R between leads, for C ≤ 0.33 µF at 100 V; 1 min			> 100 000 MΩ
R between leads and case; 100 V; 1 min			> 30 000 MΩ
Withstanding (DC) voltage between leads and case			2840 V; 1 min
Maximum application temperature			100 °C

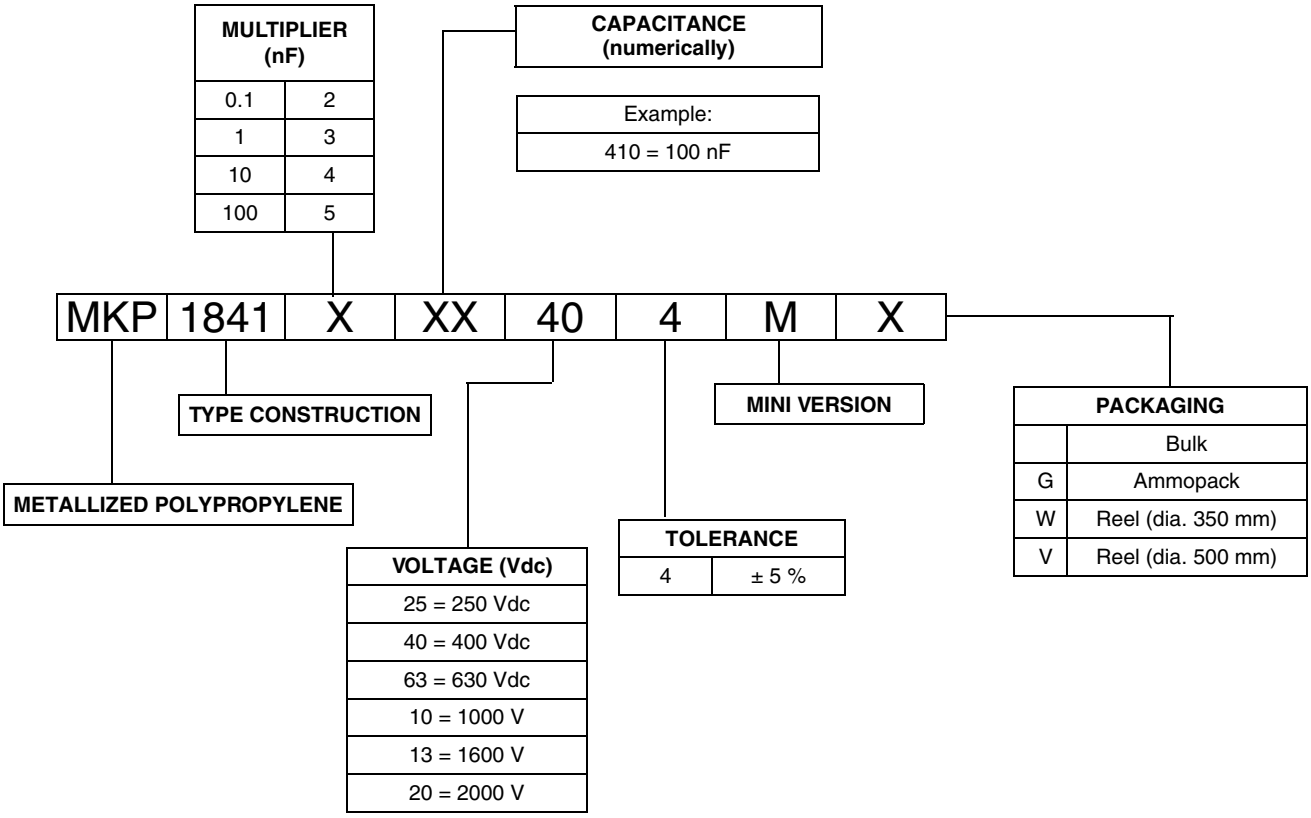
Tables 1841

CAP.	CAP. CODE	VOLTAGE CODE 25 250 Vdc/160 Vac				VOLTAGE CODE 40 400 Vdc/220 Vac				VOLTAGE CODE 63 630 Vdc/250 Vac			
		w (mm)	h (mm)	l (mm)	Pitch (mm)	w (mm)	h (mm)	l (mm)	Pitch (mm)	w (mm)	h (mm)	l (mm)	Pitch (mm)
470 pF	147	-	-	-	-	-	-	-	-	3.0	8.5	10.0	7.5
680 pF	168	-	-	-	-	-	-	-	-	3.0	8.5	10.0	7.5
1000 pF	210	-	-	-	-	-	-	-	-	3.0	8.5	10.0	7.5
1500 pF	215	-	-	-	-	-	-	-	-	3.0	8.5	10.0	7.5
2200 pF	222	-	-	-	-	-	-	-	-	3.0	8.5	10.0	7.5
3300 pF	233	-	-	-	-	-	-	-	-	4.0	9.0	10.0	7.5
4700 pF	247	-	-	-	-	4.5	9.5	10	7.5	-	-	-	-
6800 pF	268	4.0	9.0	10.0	7.5	5.0	10.5	10.3	7.5	-	-	-	-
0.010 µF	310	4.5	9.5	10.0	7.5	-	-	-	-	-	-	-	-
0.015 µF	315	4.5	9.5	10.0	7.5	-	-	-	-	-	-	-	-

RECOMMENDED PACKAGING

LETTER CODE	TYPE OF PACKAGING	HEIGHT (H) (mm)	REEL DIAMETER (mm)	ORDERING CODE EXAMPLES
G	Ammo	18.5	-	MKP 1841-247/404-G
W	Reel	18.5	350	MKP 1841-247/404-W
-	Bulk	-	-	MKP 1841-247/404

COMPOSITION OF CATALOG NUMBER: 1841M



Note

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

SPECIFIC REFERENCE DATA: 1841M

DESCRIPTION					VALUE		
Tangent of loss angle:					at 1 kHz	at 10 kHz	at 100 kHz
C ≤ 0.1 µF					3×10^{-4}	4×10^{-4}	15×10^{-4}
0.1 µF < C ≤ 1.0 µF					3×10^{-4}	5×10^{-4}	-
C > 1.0 µF					3×10^{-4}	-	-
Pitch (mm)	Maximum pulse rise time $(dU/dt)_R$ [V/µs]						
	250 Vdc	400 Vdc	630 Vdc/250 Vac	630 Vdc/400 Vac	1000 Vdc	1600 Vdc	2000 Vdc
10	865	1297	2162	-	-	-	-
15	-	-	-	2703	-	-	-
22.5	-	-	-	1441	-	-	-
27.5	-	-	-	1081	-	-	-
37.5	133	200	-	-	1044	1313	1602
R between leads, for C ≤ 0.33 µF at 100 V; 1 min						> 100 000 MΩ	
RC between leads and case; for C > 0.33 µF at 100 V; 1 min						> 30 000 s	
R between leads and case: 100 V; 1 min						> 30 000 MΩ	
Withstanding (DC) voltage between leads and case						2840 V; 1 min	
Maximum application temperature						100 °C	

Tables 1841

Cap.	Cap. Code	VOLTAGE CODE 25 250 Vdc/160 Vac				VOLTAGE CODE 40 400 Vdc/220 Vac				VOLTAGE CODE 63 630 Vdc/250 Vac				VOLTAGE CODE 63 630 Vdc/400 Vac			
		w (mm)	h (mm)	l (mm)	Pitch (mm)	w (mm)	h (mm)	l (mm)	Pitch (mm)	w (mm)	h (mm)	l (mm)	Pitch (mm)	w (mm)	h (mm)	l (mm)	Pitch (mm)
470 pF	147	-	-	-	-	-	-	-	-	3.5	8.0	13.0	10.0	-	-	-	-
680 pF	168	-	-	-	-	-	-	-	-	3.5	8.0	13.0	10.0	-	-	-	-
1000 pF	210	-	-	-	-	-	-	-	-	3.5	8.0	13.0	10.0	-	-	-	-
1500 pF	215	-	-	-	-	-	-	-	-	3.5	8.0	13.0	10.0	-	-	-	-
2200 pF	222	-	-	-	-	-	-	-	-	3.5	8.0	13.0	10.0	-	-	-	-
3300 pF	233	-	-	-	-	-	-	-	-	3.5	8.0	13.0	10.0	-	-	-	-
4700 pF	247	-	-	-	-	-	-	-	-	4.0	9.0	13.0	10.0	-	-	-	-
6800 pF	268	-	-	-	-	-	-	-	-	4.5	9.5	13.0	10.0	-	-	-	-
0.01 µF	310	-	-	-	-	4.0	9.0	13.0	10.0	5.5	10.5	13.0	10.0	-	-	-	-
0.015 µF	315	-	-	-	-	4.0	9.0	13.0	10.0	6.5	11.5	13.0	10.0	5.5	10.5	18.0	15 (1)
0.022 µF	322	4.0	9.0	13.0	10.0	5.5	10.5	13.0	10.0	9.0	15.5	13.0	10.0	6.5	12.5	18.0	15 (1)
0.033 µF	333	4.5	9.5	13.0	10.0	For remaining information check website MKP 1841M, for new designs select MMKP383				9.0	15.5	13.0	10.0	7.5	13.5	18.0	15 (1)
0.047 µF	347	5.5	10.5	13.0	10.0					10.5	17.5	13.0	10.0	8.5	14.5	18.0	15 (1)
0.068 µF	368	6.5	11.5	13.0	10.0					For remaining information check website MKP 1841M, for new designs select MMKP 383				7.5	15.5	26.5	22.5
0.10 µF	410	For remaining information check website MKP 1841M, for new designs select MMKP 383												8.5	16.5	26.5	22.5
0.15 µF	415													10.5	18.5	26.5	22.5
0.22 µF	422													11.5	20.5	31.5	27.5
0.33 µF	433													13.5	23.5	31.5	27.5
0.47 µF	447													18.0	28.0	31.5	27.5
0.68 µF	468													18.0	33.0	31.5	27.5
1.0 µF	510													-	-	-	-
1.5 µF	515									-	-	-	-	-	-	-	-
2.2 µF	522					16.0	28.5	41.5	37.5	-	-	-	-	-	-	-	-
3.3 µF	533					-	-	-	-	-	-	-	-	-	-	-	-
4.7 µF	547	18.0	32.5	41.5	37.5	-	-	-	-	-	-	-	-	-	-	-	-

Note

(1) Ordering code -2M for pitch 15 (e.g. MKP 1841-322/634-2M)

Cap.	Cap. Code	VOLTAGE CODE 10 1000 Vdc/600 Vac				VOLTAGE CODE 13 1600 Vdc/650 Vac				VOLTAGE CODE 20 2000 Vdc/700 Vac			
		w (mm)	h (mm)	l (mm)	Pitch (mm)	w (mm)	h (mm)	l (mm)	Pitch (mm)	w (mm)	h (mm)	l (mm)	Pitch (mm)
470 pF	147	-	-	-	-	-	-	-	-	For remaining information check website MKP 1841M, for new designs select MMKP 383			
680 pF	168	-	-	-	-	-	-	-	-				
1000 pF	210	-	-	-	-	-	-	-	-				
1500 pF	215	-	-	-	-	-	-	-	-				
2200 pF	222	-	-	-	-	-	-	-	-				
3300 pF	233	-	-	-	-	For remaining information check website MKP 1841M, for new designs select MMKP 383							
4700 pF	247	For remaining information check website MKP 1841M, for new designs select MMK P383											
6800 pF	268												
0.01 µF	310												
0.015 µF	315												
0.022 µF	322												
0.033 µF	333												
0.047 µF	347												
0.068 µF	368												
0.10 µF	410									14.5	24.5	41.5	37.5
0.15 µF	415									16.0	28.5	41.5	37.5
0.22 µF	422					16.0	28.5	41.5	37.5	18.0	32.5	41.5	37.5
0.33 µF	433					-	-	-	-	-	-	-	-
0.47 µF	447	18.0	32.5	41.5	37.5	-	-	-	-	-	-	-	-

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	-	MKP 1841-310/404-MG	X	-	-
W	Reel	18.5	350	MKP 1841-310/404-MW	X	-	-
V	Reel	18.5	500	MKP 1841-410/634-MV	-	X	-
G	Ammo	18.5	-	MKP 1841-410/634-MG	-	X	-
-	Reel	-	-	MKP 1841-410/634-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

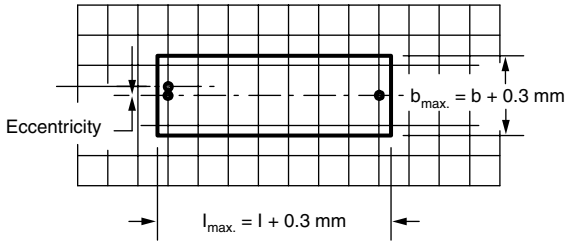
In order to withstand vibration and shock tests, it must be ensure that the stand-off pips are in good contact with the printed-circuit board:

- 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 length and width of film capacitors is shown in the drawing:

- Product height with seating plane as given by “IEC 60717” as reference: $h_{max.} \leq h + 0.3$ mm
- Eccentricity as in drawing. The maximum eccentricity is smaller than or equal to the lead diameter of the product concerned



Storage Temperature

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

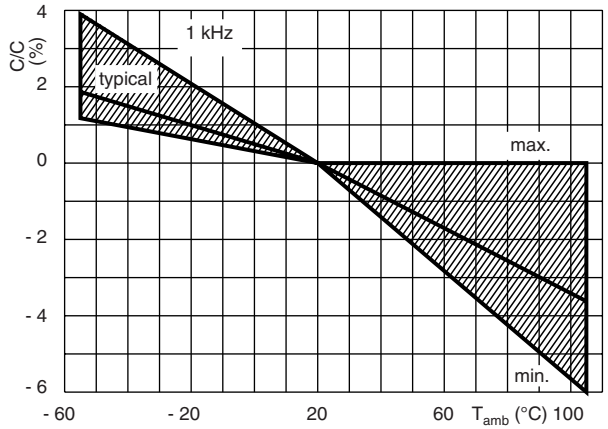
Ratings and Characteristics Reference Conditions

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

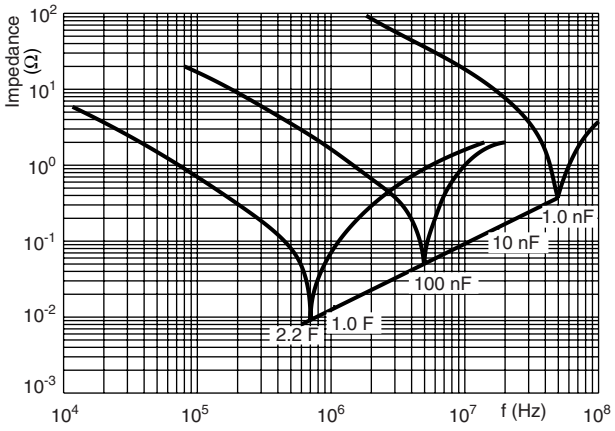
For reference testing, a conditioning period shall be applied over 96 h ± 4 h by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.

CHARACTERISTICS

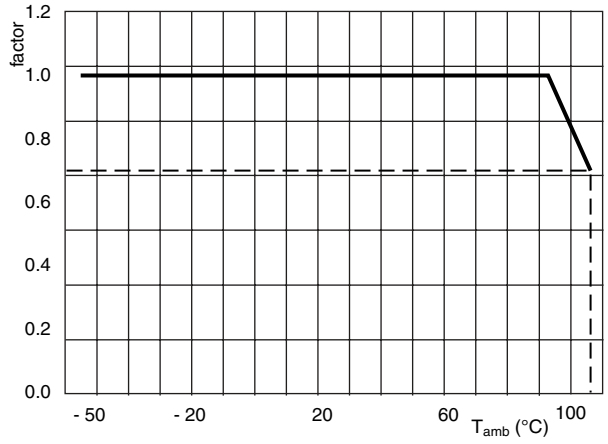
Capacitance as a function of ambient temperature (typical curve)
(1 kHz)



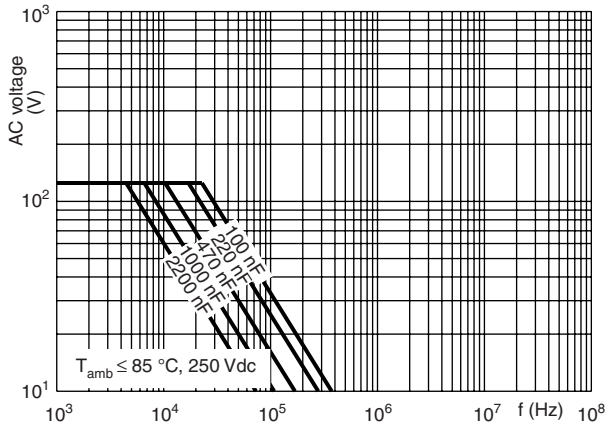
Impedance as a function of frequency (typical curve)



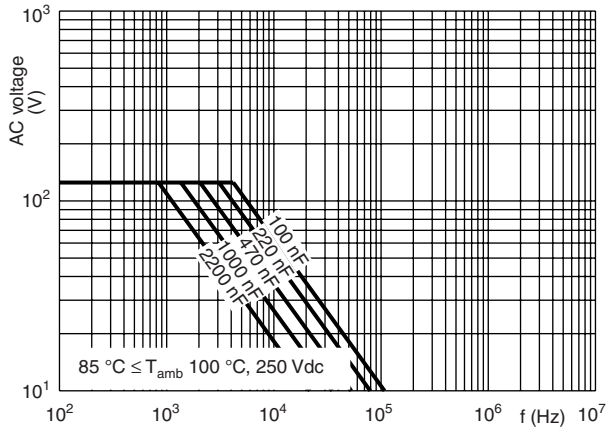
Max. DC and AC voltage as function of temperature



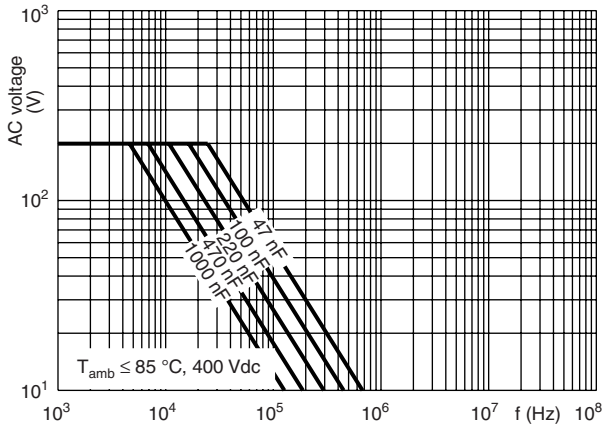
Max. RMS voltage as a function of frequency



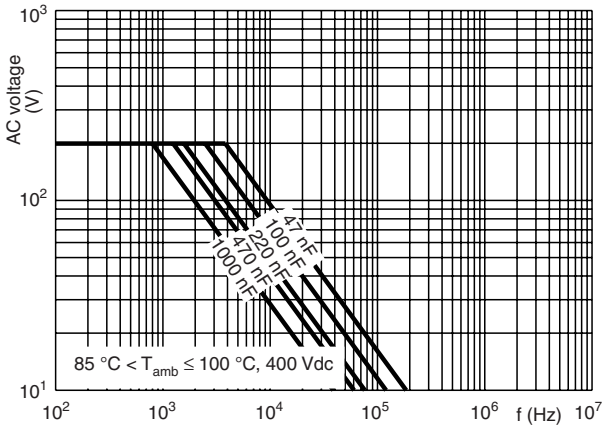
Max. RMS voltage as a function of frequency



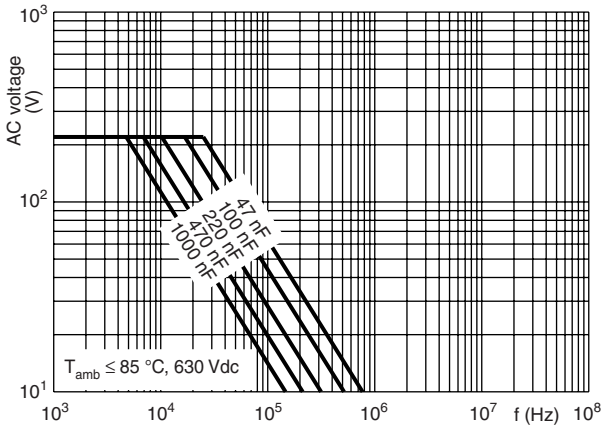
Max. RMS voltage as a function of frequency



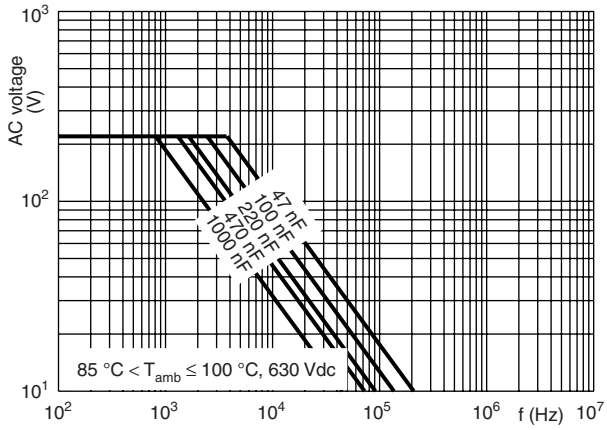
Max. RMS voltage as a function of frequency



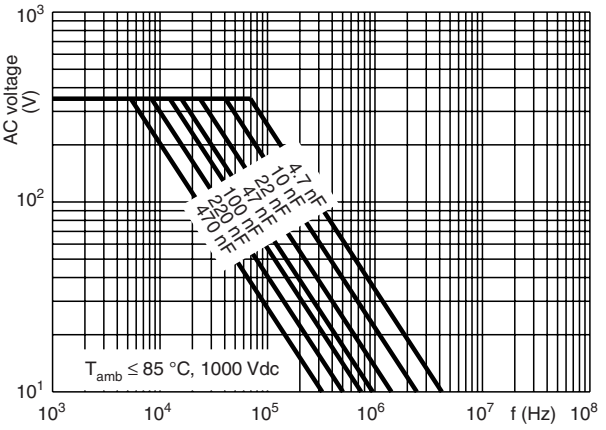
Max. RMS voltage as a function of frequency



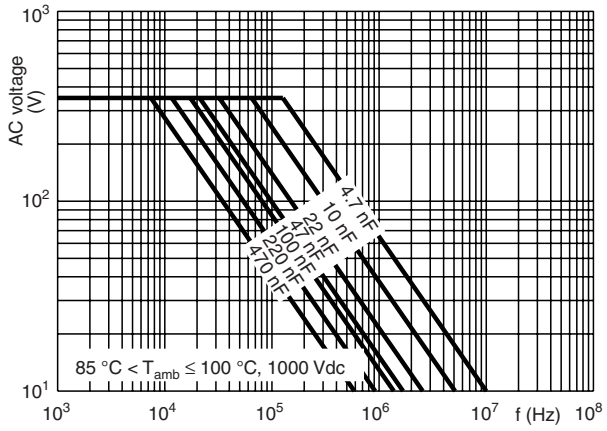
Max. RMS voltage as a function of frequency



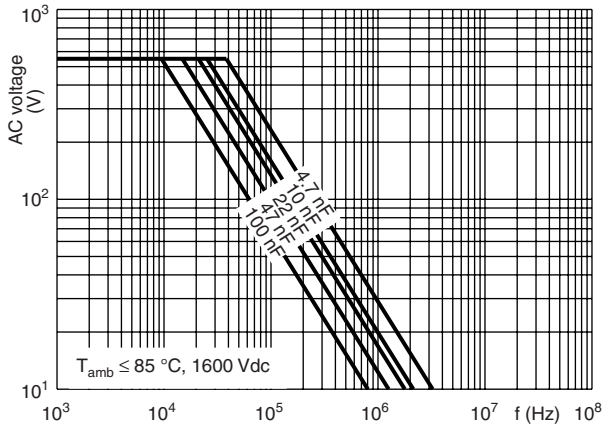
Max. RMS voltage as a function of frequency



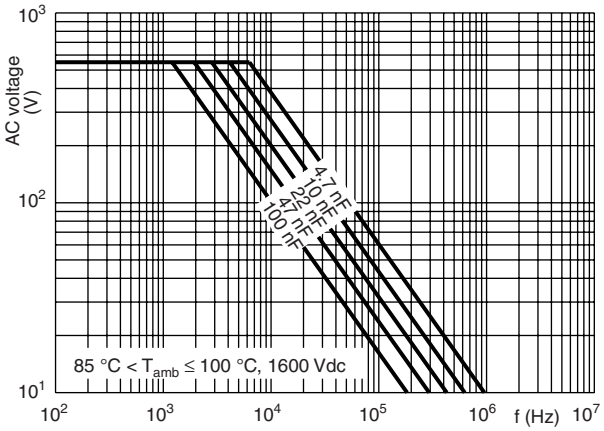
Max. RMS voltage as a function of frequency



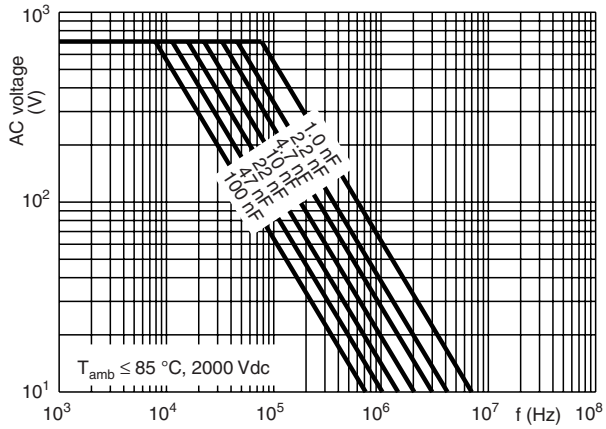
Max. RMS voltage as a function of frequency



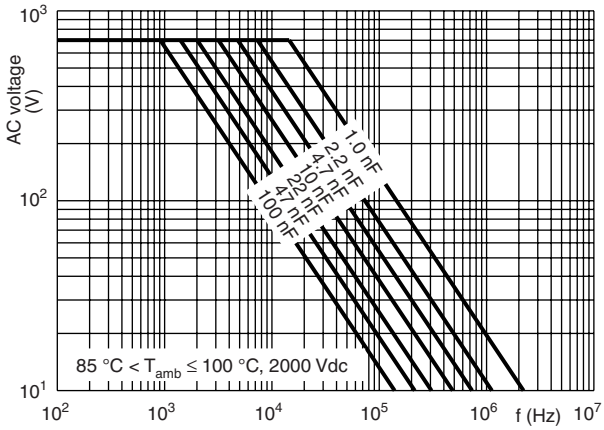
Max. RMS voltage as a function of frequency



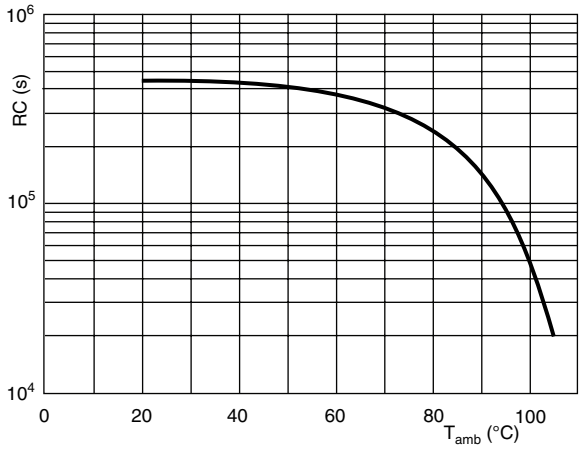
Max. RMS voltage as a function of frequency



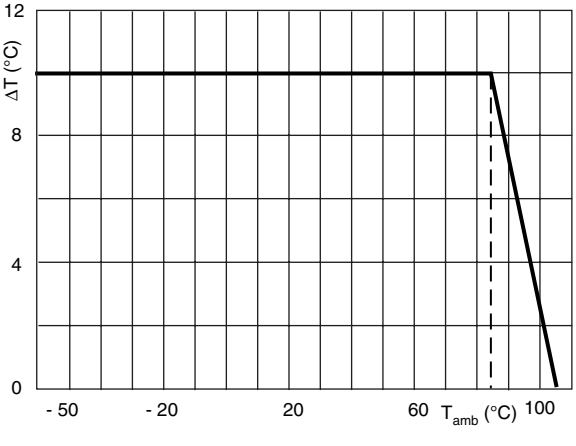
Max. RMS voltage as a function of frequency



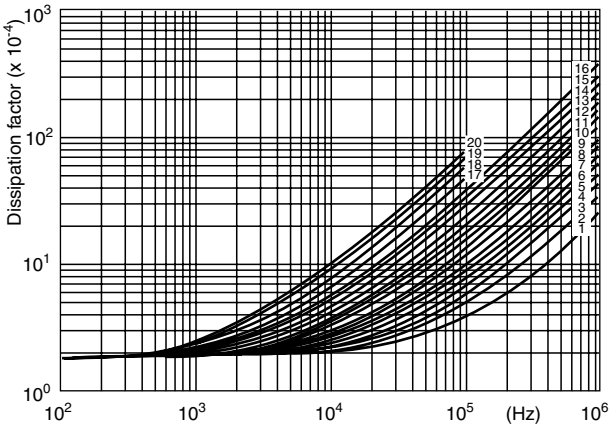
Insulation resistance as a function of ambient temperature



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



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
3.0	4	-	-	-	-	-
4.0	5	6	-	-	-	-
4.5	5	7	-	-	-	-
5.0	6	-	-	-	-	-
5.5	-	8	10	-	-	-
6.5	-	9	13	20	-	-
7.5	-	-	14	22	-	-
8.5	-	-	16	24	-	-
9.0	-	-	-	25	31	-
10.5	-	-	-	29	-	-
11.0	-	-	-	32	-	-
11.5	-	-	-	-	37	-
12.5	-	-	-	-	-	51
13.5	-	-	-	-	44	-
14.5	-	-	-	-	-	59
15.0	-	-	-	-	48	-
16.0	-	-	-	-	-	68
16.5	-	-	-	-	58	-
18.0	-	-	-	-	66	80
20.0	-	-	-	-	73	101

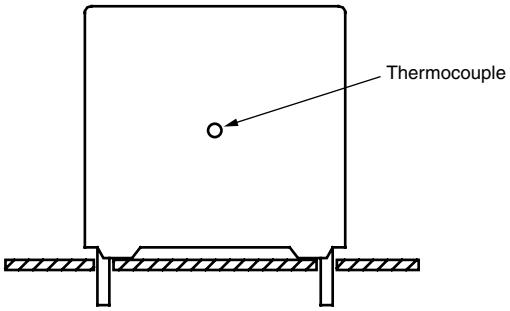
POWER DISSIPATION AND MAXIMUM COMPONENT TEMPERATURE RISE

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 ionisation 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}	1.25 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 at 100 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 at 100 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

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	$\lvert\Delta C/C\rvert \leq 2$ % 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	Visual examination	
	Capacitance	No visible damage Legible marking
	Tangent of loss angle	$\lvert\Delta C/C\rvert \leq 3$ % of the value measured initially 4.11.1
	Insulation resistance	Increase of tan $\delta : \leq 0.003$ Compared to values measured in 4.3.1. or 4.6.1
		≥ 50 % of values specified in section “Insulation Resistance” of this specification
SUB-GROUP C2		
4.11 Damp heat steady state	Capacitance	
4.11.1 Initial measurements	Tangent of loss angle at 1 kHz Visual examination	No visible damage Legible marking
4.11.3 Final measurements	Capacitance	$\lvert\Delta C/C\rvert \leq 3$ % of the value measured in 4.11.1.
	Tangent of loss angle	Increase of tan $\delta: \leq 0.002$ Compared to values measured in 4.11.1
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification

SUB-CLAUSE NUMBER AND TEST	CONDITIONS	PERFORMANCE REQUIREMENTS
SUB-GROUP C3		
4.12 Endurance DC	Duration: 2000 h x U_{Rdc} at 85 °C 0.857 x U_{Rdc} at 100 °C	
4.12.1 Initial measurements	Capacitance Tangent of loss angle at 100 kHz	
4.12.5 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\|\Delta C/C\| \leq 3$ % 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	≥ 50 % of values specified in section “Insulation Resistance” of this specification
SUB-GROUP C4		
4.2.6 Temperature charcteristics Initial measurements Intermediate measurements Final measurements	Capacitance Capacitance atlower category temperature Capacitance at 20 °C Capacitance at upper category temperature Capacitance Insulation resistance	For - 55 °C to + 20 °C: $0 \% \leq \|\Delta C/C\| \leq 2$ % or for 20 °C to 85 °C: $-3 \% \leq \|\Delta C/C\| \leq 0$ % As specified in section “Capacitance” of this specification. 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	$\|\Delta C/C\| \leq 3$ % 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	≥ 50 % of values specified in section “Insulation Resistance” of this specification

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