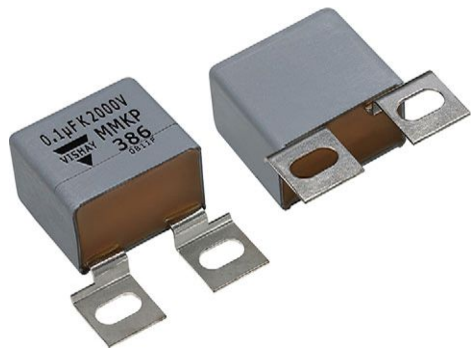
Double Metallized Polypropylene Film Capacitor Radial Snubber Type



FEATURES

- Low inductive construction
- Low loss dielectric
- Double sided metallized for high pulse ratings
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

e3

RoHS COMPLIANT

APPLICATIONS

Industrial motor control circuits, mounted directly on the IGBT or GTO.

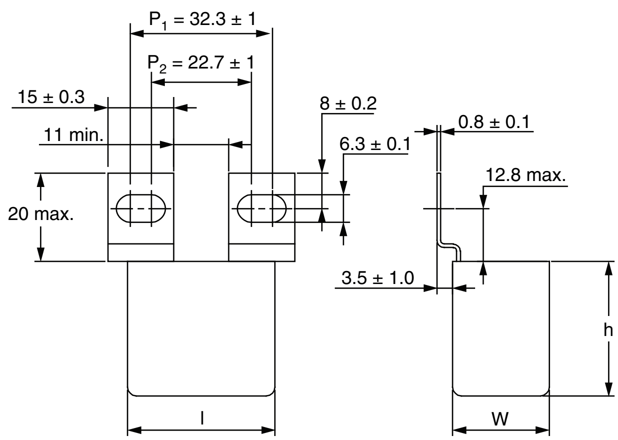
QUICK REFERENCE DATA	
Capacitance range (E12 series)	0.1 µF to 4.7 µF
Capacitance tolerance	± 5 %; ± 10 %
Rated (DC) voltage	630 V, 850 V, 1000 V, 1250 V, 1400 V, 1600 V, 2000 V, 2500 V
Climatic testing class acc. to IEC 60068-1	55/085/56
Rated (DC) temperature	85 °C
Rated (AC) temperature	85 °C
Maximum application temperature	85 °C
Rated (AC) voltage	220 V, 300 V, 350 V, 425 V, 500 V, 550 V, 700 V, 900 V
Rated peak-to-peak voltage	630 V, 850 V, 1000 V, 1250 V, 1400 V, 1600 V, 2000 V, 2500 V
Reference standards	IEC 60384-17
Dielectric	Polypropylene film
Electrodes	Double metallized
Construction	Mono construction for 630 V version Internal serial construction from 850 V_{DC} on
Encapsulation	Flame retardant plastic case (UL-class 94 V-0) and epoxy resin
Tabs	Tinned coated copper
Performance grade	Grade 1 (long life)
Stability grade	Grade 2
Marking	C-value, tolerance; rated voltage; code for dielectric material; code for factory of origin; manufacturer's type; manufacturer; year and week of manufacture

Note

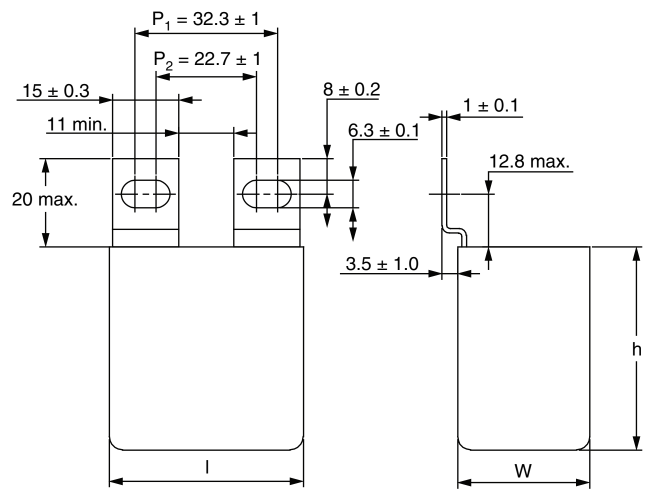
- For more detailed data and test requirements contact dc-film@vishay.com

DIMENSIONS in millimeters

HORIZONTALLY MOUNTED

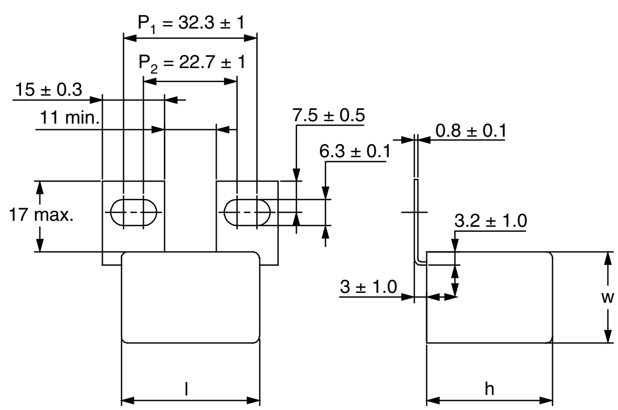


Drawing A

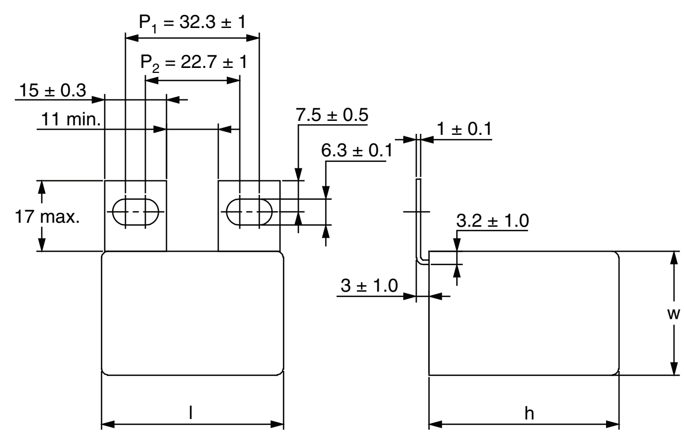


Drawing B

VERTICALLY MOUNTED



Drawing A



Drawing B

Note

P_1 = Pitch 1

P_2 = Pitch 2

COMPOSITION OF CATALOG NUMBER

TYPE
386

CAPACITANCE (numerically)

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

Example:
104 = 10 x 10 = 100 nF

BFC2	386	XX	XX	X
2222 (1)	386	XX	XX	X

(1) Old ordering code

TYPE	PACKAGING	MOUNTING CONFIGURATION	PREFERRED TYPES								
			C-TOL.	630 V	850 V	1000 V	1250 V	1400 V	1600 V	2000 V	2500 V
386	Loose in box	Horizontally mounted	± 10 %	20	00	30	80	40	50	60	70
		Vertically mounted	± 10 %	22	02	32	82	42	52	62	72
			ON REQUEST								
386	Loose in box	Horizontally mounted	± 5 %	21	01	31	81	41	51	61	71
		Vertically mounted	± 5 %	23	03	33	83	43	53	63	73

SPECIFIC REFERENCE DATA

DESCRIPTION	VALUE							
	630 V	850 V	1000 V	1250 V	1400 V	1600 V	2000 V	2500 V
Capacitance range	0.33 µF to 4.7 µF	0.22 µF to 2.7 µF	0.33 µF to 1.8 µF	0.15 µF to 0.82 µF	0.1 µF to 0.68 µF	0.1 µF to 0.56 µF	0.1 µF to 0.47 µF	0.1 µF to 0.27 µF
Maximum operating DC voltage	630 V	850 V	1000 V	1250 V	1400 V	1600 V	2000 V	2500 V
Maximum operating AC voltage	220 V	300 V	350 V	425 V	500 V	550 V	700 V	900 V
Tangent of loss angle	≤ 0.47 µF			0.56 µF ≤ C ≤ 1.0 µF			C > 1.0 F	
at 1 kHz	< 5 x 10^{-4}			< 5 x 10^{-4}			< 10 x 10^{-4}	
at 10 kHz	< 10 x 10^{-4}			< 10 x 10^{-4}			< 20 x 10^{-4}	
at 100 kHz	< 12 x 10^{-4}			< 25 x 10^{-4}				
R between terminals at 500 V; 1 min	> 5000 MΩ							
R between terminals and case; 500 V; 1 min	> 30 000 MΩ							
Withstanding (DC) voltage (cut off current 10 mA); rise time 100 V/s	1000 V; 1 min	1360 V; 1 min	1600 V; 1 min	2000 V; 1 min	2240 V; 1 min	2560 V; 1 min	3200 V; 1 min	4000 V; 1 min
Withstanding (DC) voltage between terminals and case	2840 V; 1 min							
Maximum dU/dt (V/µs)	630 V	850 V	1000 V	1250 V	1400 V	1600 V	2000 V	2500 V
w x h x l = 22.0 x 30.5 x 33.5	250	650	1000	1500	2000	2400	2500	5500
w x h x l = 22.0 x 38.0 x 44.0	100	350	500	750	900	1000	1000	2000
w x h x l = 30.0 x 46.0 x 44.0	75	260	350	550	650	750	750	1500
ESR at 100 kHz	6 mΩ							
ESL	Typical 15 nH							
Temperature range	- 55 °C to + 85 °C							

ELECTRICAL DATA AND ORDERING INFORMATION

U_{RDC} (V)	CAP. (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOG NUMBER BFC2 386 XXXXX AND PACKAGING — TRAY PACKAGING — C-TOL. = ± 10 %	SPQ
630	**DRAWING A**				
	0.33	22.0 x 30.5 x 33.5	39	20334	56
	0.39		38	20394	
	0.47		38	20474	
	0.56		37	20564	
	0.68		37	20684	
	0.82		36	20824	
	1.0		35	20105	
	1.2		35	20125	
	DRAWING B				
	1.5	22.0 x 38.0 x 44.0	60	20155	42
	1.8		58	20185	
	2.2		56	20225	
	2.7		54	20275	
	3.3	30.0 x 46.0 x 44.0	86	20335	36
	3.9		83	20395	
	4.7		80	20475	
850	**DRAWING A**				
	0.22	22.0 x 30.5 x 33.5	39	00224	56
	0.27		39	00274	
	0.33		38	00334	
	0.39		38	00394	
	0.47		37	00474	
	0.56		37	00564	
	0.68		36	00684	
	0.82		35	00824	
	DRAWING B				
	1.0	22.0 x 38.0 x 44.0	61	00105	42
	1.2		59	00125	
	1.5		58	00155	
	1.8	30.0 x 46.0 x 44.0	91	00185	36
	2.2		88	00225	
	2.7		85	00275	
1000	**DRAWING A**				
	0.33	22.0 x 30.5 x 33.5	36	30334	56
	0.39		35	30394	
	0.47		34	30474	
	DRAWING B				
	0.56	22.0 x 38.0 x 44.0	60	30564	42
	0.68		59	30684	
	0.82		57	30824	
	1.0		55	30105	
	1.2	30.0 x 46.0 x 44.0	88	30125	36
	1.5		84	30155	
	1.8		80	30185	
1250	**DRAWING A**				
	0.15	22.0 x 30.5 x 33.5	37	80154	56
	0.18		35	80184	
	0.22		34	80224	
	0.27		33	80274	
	DRAWING B				
	0.33	22.0 x 38.0 x 44.0	59	80334	42
	0.39		58	80394	
	0.47		57	80474	
	0.56	30.0 x 46.0 x 44.0	89	80564	36
	0.68		85	80684	
	0.82		82	80824	

ELECTRICAL DATA AND ORDERING INFORMATION

U_{RDC} (V)	CAP. (µF)	DIMENSIONS w x h x l (mm)	MASS (g)	CATALOG NUMBER BFC2 386 XXXXX AND PACKAGING TRAY PACKAGING C-TOL. = ± 10 %	SPQ
1400	**DRAWING A**				
	0.10	22.0 x 30.5 x 33.5	37	40104	56
	0.12		36	40124	
	0.15		35	40154	
	DRAWING B				
	0.18	22.0 x 38.0 x 44.0	61	40184	42
	0.22		59	40224	
	0.27		57	40274	
	0.33		56	40334	
	0.39	30.0 x 46.0 x 44.0	89	40394	36
	0.47		85	40474	
	0.56		82	40564	
	0.68		79	40684	
1600	**DRAWING A**				
	0.10	22.0 x 30.5 x 33.5	37	50104	56
	0.12		36	50124	
	0.15		35	50154	
	DRAWING B				
	0.18	22.0 x 38.0 x 44.0	61	50184	42
	0.22		59	50224	
	0.27		58	50274	
	0.33		57	50334	
	0.39	30.0 x 46.0 x 44.0	90	50394	36
	0.47		87	50474	
	0.56		84	50564	
2000	**DRAWING A**				
	0.10	22.0 x 30.5 x 33.5	36	60104	56
	0.12		35	60124	
	DRAWING B				
	0.15	22.0 x 38.0 x 44.0	61	60154	42
	0.18		59	60184	
	0.22		58	60224	
	0.27		57	60274	
	0.33	30.0 x 46.0 x 44.0	89	60334	36
	0.39		86	60394	
	0.47		84	60474	
2500	**DRAWING B**				
	0.10	22.0 x 38.0 x 44.0	60	70104	42
	0.12		59	70124	
	0.15		57	70154	
	0.18		55	70184	
	0.22	30.0 x 46.0 x 44.0	87	70224	36
	0.27		83	70274	

Note

- SPQ = Standard Packaging Quantity

MOUNTING

Normal Use

The capacitors are designed for direct mounting on IGBT or GTO.

Specific Method of Mounting to Withstand Vibration and Shock

In order to withstand vibration and shock tests, it must be ensured that the tabs are screwed tightly on the test board.

Storage Temperature

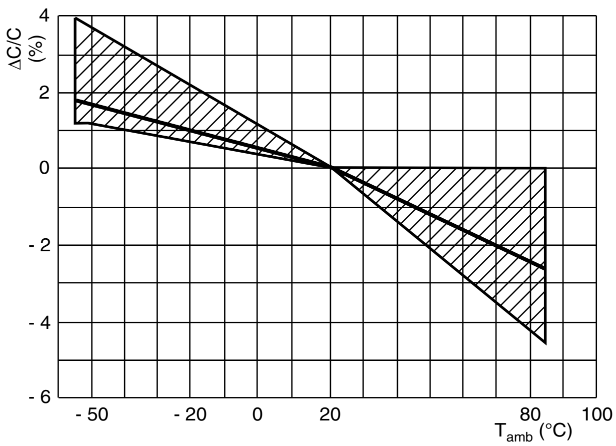
T_{stg} = - 25 °C to + 35 °C with RH maximum 75 % without condensation.

Ratings and Characteristics Reference Conditions

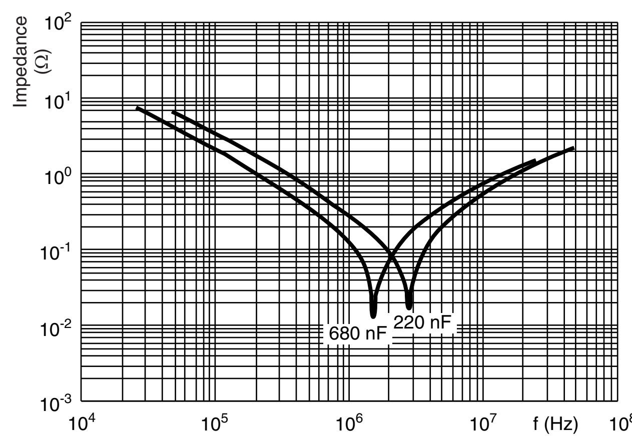
Unless otherwise specified, all electrical values apply to an ambient temperature of 23 °C ± 1 °C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

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

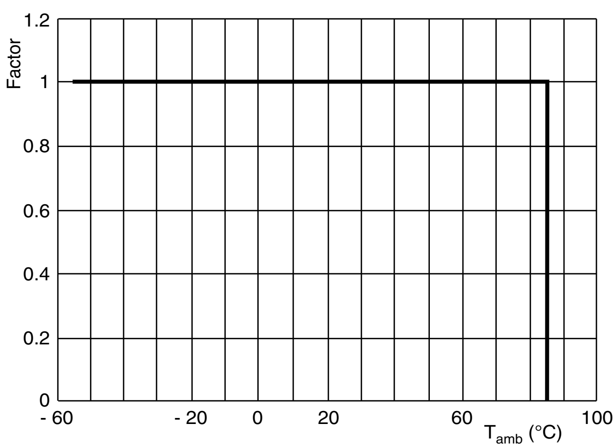
CHARACTERISTICS



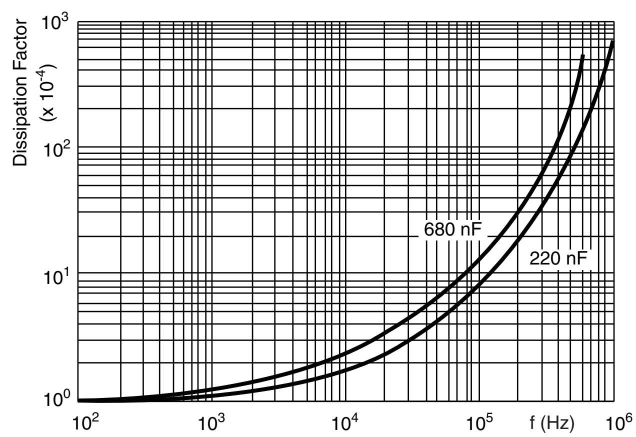
Capacitance as a function of ambient temperature (typical curve)



Impedance as a function of frequency (typical curve)

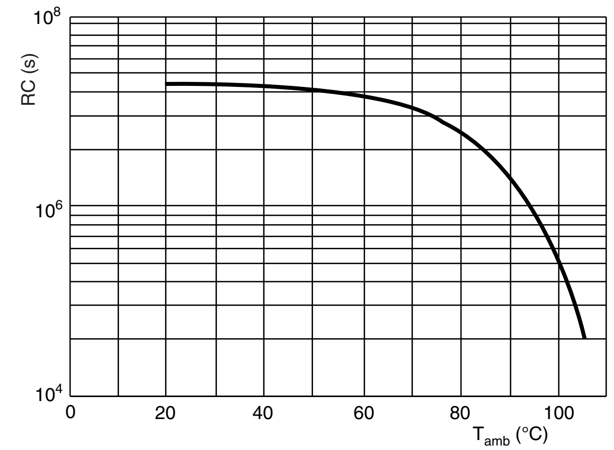


Max. DC and AC voltage as function of temperature

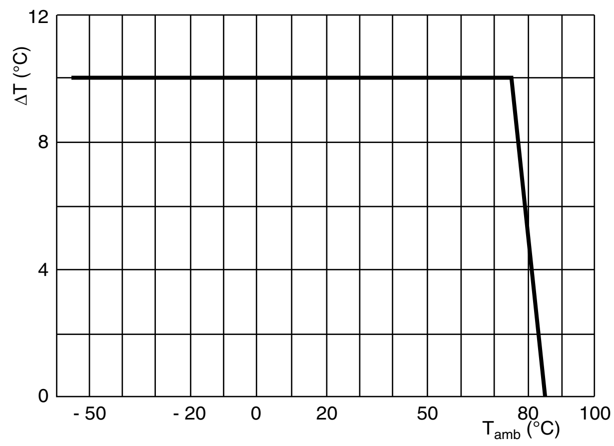


Tangent of loss angle as a function of frequency (typical curve)

CHARACTERISTICS

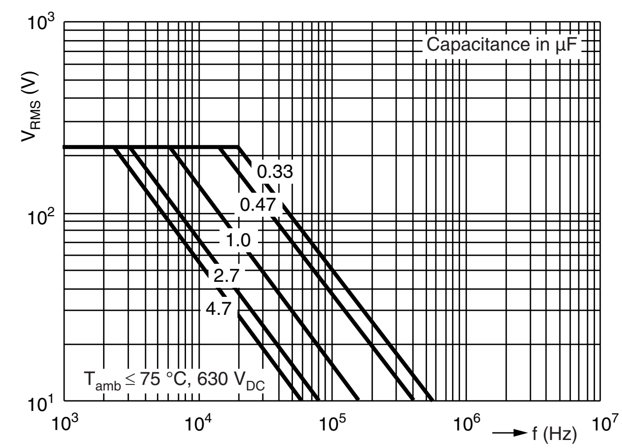


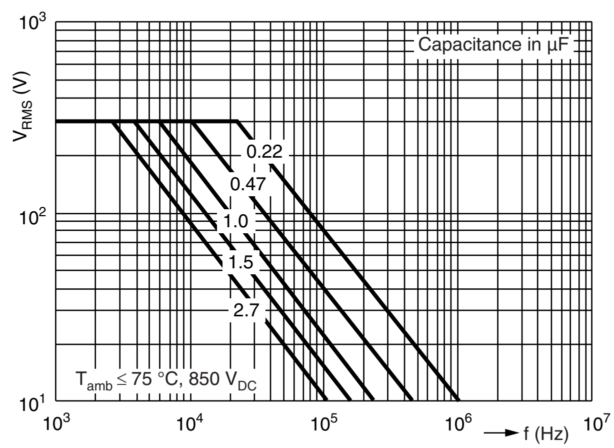
Insulation resistance as a function of ambient temperature (typical curve)

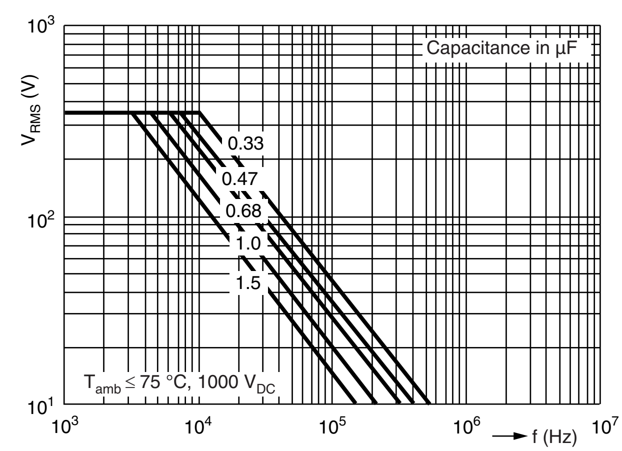


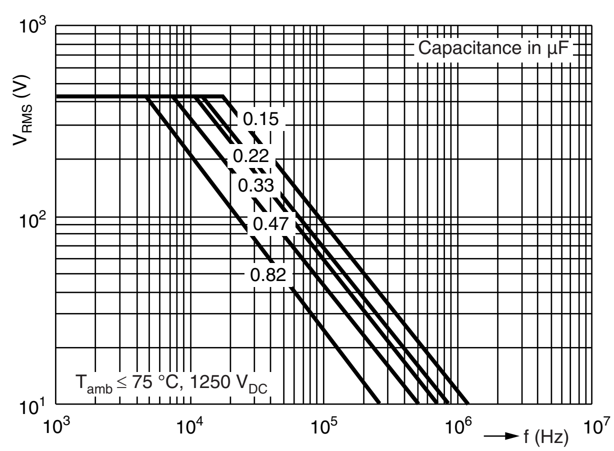
Max. allowed component temperature as a function of ambient temperature

MAXIMUM AC VOLTAGE AS A FUNCTION OF FREQUENCY

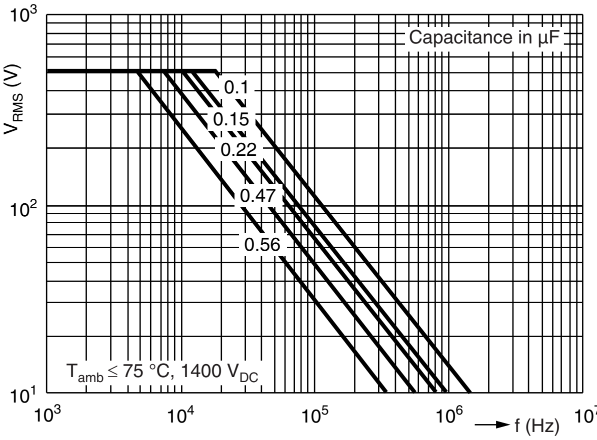


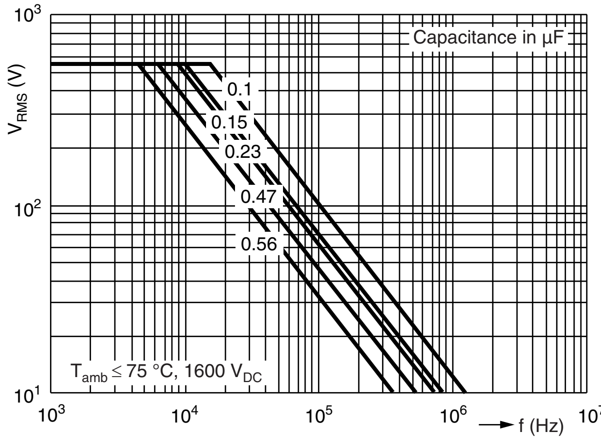


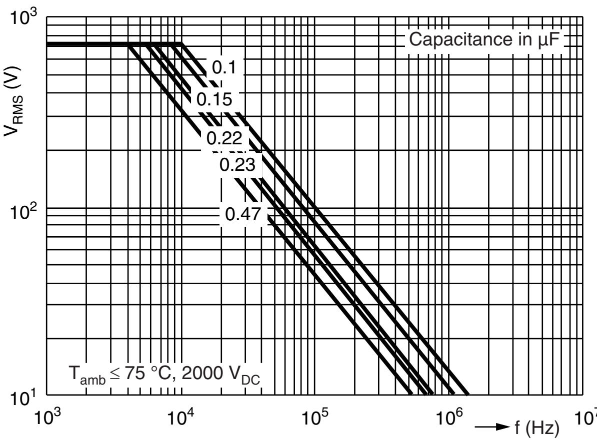


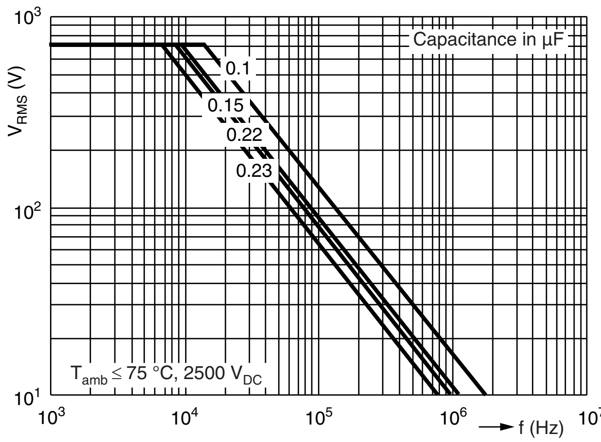


MAXIMUM AC VOLTAGE AS A FUNCTION OF FREQUENCY









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

$W_{max.}$ (mm)	HEAT CONDUCTIVITY (mW/°C)	
	BOX LENGTH 33.5 mm	BOX LENGTH 44.0 mm
22.0	75	100
30.0	-	140

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.

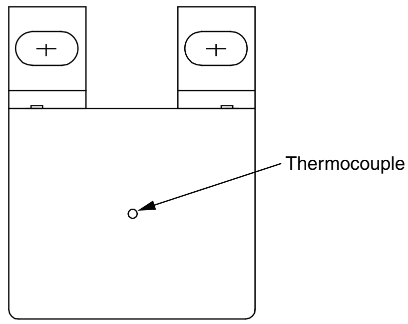
The power dissipation can be calculated according type detail specification "HQN-384-0/101: Technical Information Film Capacitors".

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.
   The rated voltage pulse slope is valid for ambient temperatures up to 85 °C.
4. The maximum component surface temperature rise must be lower than the limits (see figure).
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”

VOLTAGE CONDITIONS	
ALLOWED VOLTAGES	**$T_{amb} \leq 85$ °C**
Maximum continuous RMS voltage	U_{RAC}
Maximum temperature RMS-overvoltage (< 24 h)	1.25 x U_{RAC}
Maximum peak voltage (V_{O-P}) (< 2 s)	1.6 x U_{RDC}

INSPECTION REQUIREMENTS

General Notes

Sub-clause numbers of tests and performance requirements refer to the “Sectional Specification, Publication IEC 60384-17 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	
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	$\lvert\Delta C/C\rvert \leq 1$ % of the value measured initially
	Tangent of loss angle	Increase of tan δ ≤ 0.001 for: 100 nF < C $\leq$ 470 nF or ≤ 0.0015 for: C > 470 nF 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 Immersion time: 5.0 min. ± 0.5 min	No visible damage Legible marking
4.6 Rapid change of temperature	θA = - 55 °C θB = + 85 °C 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/s^2 (whichever is less severe) Total duration 6 h	No visible damage
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/s^2 Duration of pulse: 11 ms	

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C1B OTHER PART OF SAMPLE OF SUB-GROUP C1		
4.9.3 Final measurements	Visual examination	No visible damage
	Capacitance	$\vert\Delta C/C\vert \leq 1$ % of the value measured in 4.6.1
	Tangent of loss angle	Increase of tan δ ≤ 0.001 for: 100 nF < C $\leq$ 470 nF or ≤ 0.0015 for: C > 470 nF Compared to values measured in 4.6.1
	Insulation resistance	As specified in section “Insulation Resistance” of this specification
SUB-GROUP C1 COMBINED SAMPLE OF SPECIMENS OF SUB-GROUPS C1A AND C1B		
4.10 Climatic sequence		
4.10.2 Dry heat	Temperature: + 85 °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 flashover
	Visual examination	No visible damage Legible marking
	Capacitance	$\vert\Delta C/C\vert \leq 2$ % of the value measured in 4.4.2 or 4.9.3
	Tangent of loss angle	Increase of tan δ ≤ 0.001 for: 100 nF < C $\leq$ 470 nF or ≤ 0.0015 for: C > 470 nF 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	

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C2		
4.11.3 Final measurements	Voltage proof = U_{RDC} for 1 min within 15 min after removal from testchamber	No breakdown of flashover
	Visual examination	No visible damage Legible marking
	Capacitance	$\|\Delta C/C\| \leq 1$ % of the value measured in 4.11.1.
	Tangent of loss angle	Increase of tan δ $\leq$ 0.001 for: 100 nF < C $\leq$ 470 nF or $\leq$ 0.0015 for: C $\leq$ 470 nF Compared to values measured in 4.11.1
	Insulation resistance	$\geq$ 50 % of values specified in section “Insulation Resistance” of this specification
SUB-GROUP C3A		
4.12.1 Endurance test at 50 Hz alternating voltage	Duration: 2000 h Voltage: 1.25 x U_{RAC} at 85 °C	
4.12.1.1 Initial measurements	Capacitance Tangent of loss angle at 100 kHz	
4.12.1.3 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	$\|\Delta C/C\| \leq 5$ % compared to values measured in 4.12.1.1
	Tangent of loss angle	Increase of tan δ $\leq$ 0.001 for: 100 nF < C $\leq$ 470 nF or $\leq$ 0.0015 for: C > 470 nF Compared to values measured in 4.12.1.1
	Insulation resistance	$\geq$ 50 % of values specified in section “Insulation Resistance” of this specification
SUB-GROUP C4		
4.2.6 Temperature characteristics Initial measurements Intermediate measurements Final measurements	Capacitance Capacitance at - 55 °C Capacitance at 20 °C Capacitance at + 85 °C Capacitance	For - 55 °C to + 20 °C: + 1 % $\leq \|\Delta C/C\| \leq$ 3.75 % or for 20 °C to 105 °C: - 6 % $\leq \|\Delta C/C\| \leq$ 0 % 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: $R = \frac{U_{RDC}}{5 \times C\ (dU/dt)}$	
4.13.1 Initial measurements	Capacitance Tangent of loss angle at 100 kHz	
4.13.3 Final measurements	Capacitance	$\|\Delta C/C\| \leq 1$ % compared to values measured in 4.13.1
	Tangent of loss angle	Increase of tan δ $\leq$ 0.001 for: 100 nF < C $\leq$ 470 nF or $\leq$ 0.0015 for: C > 470 nF 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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