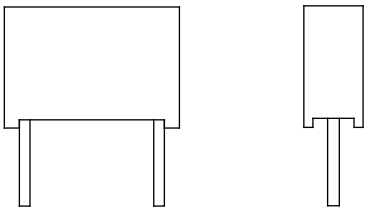
AC and Pulse Metallized Polypropylene Film Capacitors MKP Radial Potted Type



FEATURES

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

APPLICATIONS

High frequency and pulse operations. SMPS, loudspeaker crossover networks, electronic ballast, storage, filter, timing and sample and hold circuits.

Pb-free

e3

RoHS COMPLIANT

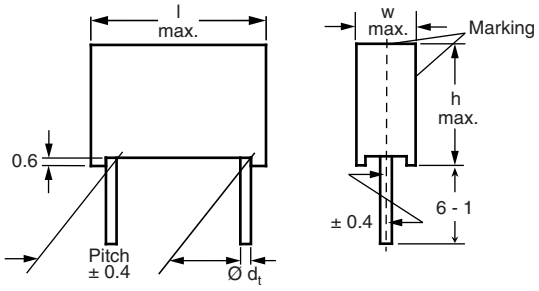
HALOGEN FREE GREEN (5-2008)

QUICK REFERENCE DATA	
Capacitance range	1000 pF to 6.8 µF
Capacitance tolerance	± 5 %, ± 2 %, ± 2.5 % (± 10 % on request)
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	Mono and 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
Rated DC voltages	250 V_{DC}, 400 V_{DC}, 630 V_{DC}, 1000 V_{DC}, 1600 V_{DC}, 2000 V_{DC}
Rated AC voltages	160 V_{AC}, 220 V_{AC}, 250 V_{AC}, 400 V_{AC}, 500 V_{AC}, 600 V_{AC}, 700 V_{AC}

Note

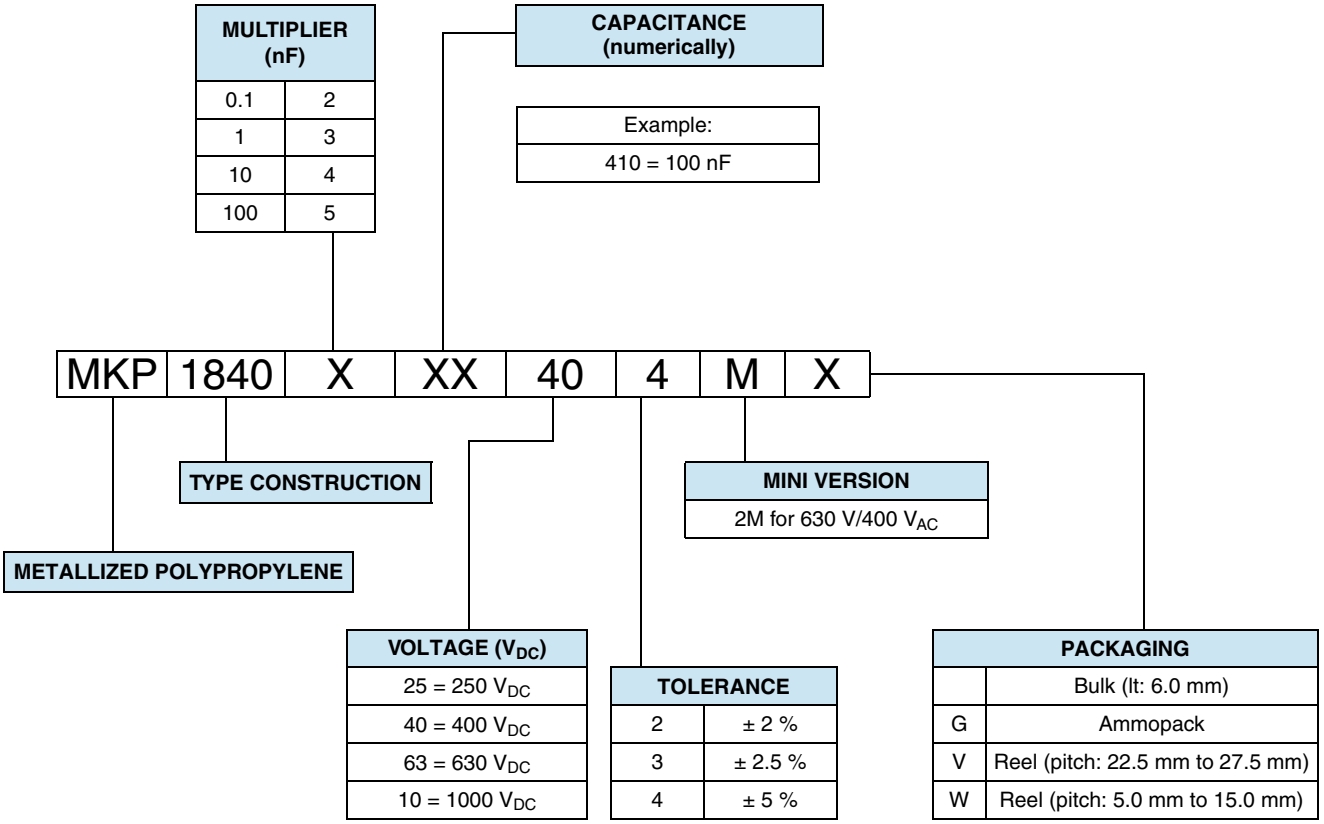
- For more detailed data and test requirements, contact dc-film@vishay.com

DIMENSIONS in millimeters



LEAD DIAMETER d_t	W	PITCH
0.5 ± 0.05	-	5 to 7.5
0.6 ± 0.06	-	10
0.6 ± 0.06	≤ 6	15
0.8 ± 0.08	> 6	15
0.8 ± 0.08	< 16	22.5 to 37.5
1.0 ± 0.1	≥ 16.5	22.5 to 37.5

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

DESCRIPTION	VALUE		
Tangent of loss angle:	at 1 kHz	at 10 kHz	at 100 kHz
C ≤ 0.1 µF	10×10^{-4}	10×10^{-4}	40×10^{-4}
0.1 µF < C ≤ 1.0 µF	10×10^{-4}	10×10^{-4}	-
C > 1.0 µF	10×10^{-4}	-	-

PITCH (mm)	MAXIMUM PULSE RISE TIME $(dU/dt)_R$ [V/µs]					
	250 V_{DC}	400 V_{DC}	630 V_{DC}	1000 V_{DC}	1600 V_{DC}	2000 V_{DC}
5	360	540	1080	-	-	-
7.5	215	325	510	-	-	-
10	150	240	340	1365	4100	-
15	90	135	185	680	1340	3075
22.5	55	80	110	370	620	1365
27.5	40	65	85	285	455	-
37.5	30	45	60	195	300	-

R between leads, for C ≤ 1.0 µF at 100 V, 1 min	> 100 000 MΩ
RC between leads, for C > 1.0 µF at 100 V, 1 min	> 100 000 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	500 V, 1 min
Maximum application temperature	100 °C

Note

(1) See “Voltage Proof Test for Metalized Film Capacitors”: www.vishay.com/doc?28169

METALLIZED POLYPROPYLENE FILM CAPACITOR, MINI VERSION (M)

ELECTRICAL DATA

U_{RDC} (V)	CAP. (µF)	CAPACITANCE CODE	VOLTAGE CODE	V_{AC}	DIMENSIONS [3] w x h x l (mm)	PCM (mm)
250	0.010	-310	25	160	3.5 x 8.5 x 7.5	5.0
	0.015	-315			3.5 x 8.5 x 7.5	5.0
	0.022	-322			3.5 x 8.5 x 7.5	5.0
	0.033	-333			3.5 x 8.5 x 7.5	5.0
	0.047	-347			4.0 x 9.0 x 10.0	7.5
	0.068	-368			4.0 x 9.0 x 10.0	7.5
	0.10	-410			5.0 x 10.5 x 10.0	7.5
	0.15	-415			5.0 x 11.0 x 12.5	10.0
	0.22	-422			6.0 x 12.0 x 12.5	10.0
	0.33	-433			6.0 x 12.0 x 17.5	15.0
	0.47	-447			7.0 x 13.5 x 17.5	15.0
	0.68	-468			8.5 x 15.0 x 17.5	15.0
	1.0	-510			7.0 x 16.5 x 26.0	22.5
	1.5	-515			10.0 x 19.5 x 26.0	22.5
	2.2	-522			12.0 x 22.0 x 26.0	22.5
	3.3	-533			13.0 x 23.0 x 31.0	27.5
	4.7	-547			15.0 x 25.0 x 31.5	27.5
	6.8	-568			14.5 x 24.5 x 41.5	37.5
400	0.0068	-268	40	220 [2]	3.5 x 8.5 x 7.5	5.0
	0.010	-310			3.5 x 8.5 x 7.5	5.0
	0.015	-315			3.0 x 8.0 x 10.0	7.5
	0.022	-322			4.0 x 9.0 x 10.0	7.5
	0.033	-333			4.0 x 9.0 x 10.0	7.5
	0.047	-347			5.0 x 10.5 x 10.0	7.5
	0.068	-368			6.0 x 11.5 x 10.0	7.5
	0.10	-410			5.0 x 11.0 x 17.5	15.0
	0.15	-415			6.0 x 12.0 x 17.5	15.0
	0.22	-422			7.0 x 13.5 x 17.5	15.0
	0.33	-433			8.5 x 15.0 x 17.5	15.0
	0.47	-447			7.0 x 16.5 x 26.0	22.5
	0.68	-468			8.5 x 18.0 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 31.5	27.5
	3.3	-533			18.0 x 28.0 x 31.5	27.5
	4.7	-547			18.0 x 32.5 x 41.0	37.5
	6.8	-568			21.5 x 38.5 x 43.0	37.5
630	0.0010	-210	63	250 [2]	3.5 x 8.5 x 7.5	5.0
	0.0015	-215			3.5 x 8.5 x 7.5	5.0
	0.0022	-222			3.5 x 8.5 x 7.5	5.0
	0.0033	-233			3.0 x 8.0 x 10.0	7.5
	0.0047	-247			3.0 x 8.0 x 10.0	7.5
	0.0068	-268			3.0 x 8.0 x 10.0	7.5
	0.010	-310			3.0 x 8.0 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
	0.033	-333			5.0 x 11.0 x 12.5	10.0
	0.047	-347			6.0 x 12.0 x 12.5	10.0
	0.068	-368			5.0 x 11.0 x 17.5	15.0
	0.10	-410			6.0 x 12.0 x 17.5	15.0
	0.15	-415			8.5 x 15.0 x 17.5	15.0
	0.22	-422			10.0 x 16.5 x 17.5	15.0
	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			18.0 x 28.0 x 31.5	27.5
	2.2	-522			21.0 x 31.0 x 31.0	27.5
	3.3	-533			18.0 x 32.5 x 41.0	37.5
	4.7	-547			21.5 x 38.5 x 43.0	37.5

ELECTRICAL DATA

U_{RDC} (V)	CAP. (µF)	CAPACITANCE CODE	VOLTAGE CODE	V_{AC}	DIMENSIONS [3] w x h x l (mm)	PCM (mm)
630	0.010	-310	63	400 [2]	5.0 x 11.0 x 12.5	10.0 [1]
	0.015	-315			6.0 x 12.0 x 12.5	10.0 [1]
	0.022	-322			9.0 x 15.5 x 13.0	10.0 [1]
	0.033	-333			6.0 x 12.0 x 17.5	15.0 [1]
	0.047	-347			8.5 x 15.0 x 17.5	15.0 [1]
	0.068	-368			10.0 x 16.5 x 17.5	15.0 [1]
	0.10	-410			7.0 x 16.5 x 26.0	22.5 [1]
	0.15	-415			10.0 x 19.5 x 26.0	22.5 [1]
	0.22	-422			12.0 x 22.0 x 26.0	22.5 [1]
	0.33	-433			15.5 x 26.5 x 26.5	22.5 [1]
	0.47	-447			15.0 x 25.0 x 31.5	27.5 [1]
	0.68	-468			18.0 x 28.0 x 31.5	27.5 [1]
	1.0	-510			21.0 x 31.0 x 31.0	27.5 [1]
1000	0.0047	-247	10	500 [2]	4.0 x 10.0 x 12.5	10.0
	0.0068	-268			4.0 x 10.0 x 12.5	10.0
	0.010	-310			5.0 x 11.0 x 12.5	10.0
	0.015	-315			6.0 x 12.0 x 12.5	10.0
	0.022	-322			5.0 x 11.0 x 17.5	15.0
	0.033	-333			6.0 x 12.0 x 17.5	15.0
	0.047	-347			8.5 x 15.0 x 17.5	15.0
	0.068	-368			10.0 x 16.5 x 17.5	15.0
	0.10	-410			7.0 x 16.5 x 26.0	22.5
	0.15	-415			10.0 x 19.5 x 26.0	22.5
	0.22	-422			12.0 x 22.0 x 26.0	22.5
	0.33	-433			13.0 x 23.0 x 31.0	27.5
	0.47	-447			15.0 x 25.0 x 31.5	27.5
	0.68	-468			18.0 x 28.0 x 31.5	27.5
	1.0	-510			20.0 x 35.0 x 31.5	27.5
	1.5	-515			18.0 x 32.5 x 41.5	37.5
1600	0.0068	-268	13	600 [2]	5.0 x 11.0 x 17.5	15.0
	0.010	-310			6.0 x 12.0 x 17.5	15.0
	0.015	-315			7.0 x 13.5 x 17.5	15.0
	0.022	-322			8.5 x 15.0 x 17.5	15.0
	0.033	-333			10.0 x 16.5 x 17.5	15.0
	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			18.0 x 28.0 x 31.5	27.5
	0.33	-433			21.0 x 31.0 x 31.0	27.5
	0.47	-447			20.0 x 35.0 x 31.5	27.5
	0.68	-468			18.5 x 35.5 x 43.0	37.5
2000	0.0010	-210	20	700 [2]	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			5.0 x 11.0 x 17.5	15
	0.0047	-247			5.0 x 11.0 x 17.5	15
	0.0068	-268			6.0 x 12.0 x 17.5	15
	0.010	-310			6.0 x 15.5 x 26.0	22.5
	0.015	-315			6.0 x 15.5 x 26.0	22.5
	0.022	-322			7.0 x 16.5 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

Notes

- Further C-values upon request
- Please refer to X-capacitors in our catalog “RFI Suppression Components”

(1) Ordering code -2M (e.g. MKP1840 410 635-2M)
(2) Not suitable for mains applications
(3) For tolerances see chapter “Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances”

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	S (1)	MKP1840410404MG	x	-	-
W	Reel	18.5	350	MKP1840410404MW	x	-	-
V	Reel	18.5	500	MKP1840510254MV	-	x	-
G	Ammo	18.5	L (2)	MKP1840510254MG	-	x	-
-	Bulk	-	-	MKP1840510254M	x	x	x

Notes
(1) S = box size 55 mm x 210 mm x 340 mm (w x h x l)
(2) L = box size 60 mm x 360 mm x 510 mm (w x h x l)

EXAMPLE OF ORDERING CODE					
TYPE	CAPACITANCE CODE	VOLTAGE CODE	TOLERANCE CODE	MINI	PACKAGING CODE
MKP1840	447	63	4	M	G

Note
- Tolerance codes: **4** = 5 % (J); **3** = 2.5 % (H)

METALLIZED POLYPROPYLENE FILM CAPACITOR, MKP1840 PCM5, MINI VERSION (-5M)

ELECTRICAL DATA							
U_{RDC} (V)	CAP. (µF)	CAPACITANCE CODE	VOLTAGE CODE	V_{AC}	DIMENSIONS (2) w x h x l (mm)	PCM (mm)	d_t ± 0.05 (mm)
250	0.047	-347	25	160	4.5 x 9.0 x 7.2	5.0	0.5
	0.068	-368			6.0 x 11.0 x 7.2		
	0.10	-410			6.0 x 11.0 x 7.2		
400	0.015	-315	40	220 (1)	4.5 x 9.0 x 7.2	5.0	0.5
	0.022	-322			6.0 x 11.0 x 7.2		
	0.033	-333			6.0 x 11.0 x 7.2		
630	0.0033	-233	63	250 (1)	3.5 x 8.0 x 7.2	5.0	0.5
	0.0047	-247			3.5 x 8.0 x 7.2		
	0.0068	-268			3.5 x 8.0 x 7.2		
	0.010	-310			4.5 x 9.0 x 7.2		
	0.015	-315			6.0 x 11.0 x 7.2		

Notes
- Further C-values upon request
(1) Not suitable for mains applications
(2) For tolerances see chapter “Space Requirements for Printed-Circuit Board Applications and Dimension Tolerances”

RECOMMENDED PACKAGING					
LETTER CODE	TYPE OF PACKAGING	HEIGHT (H) (mm)	REEL DIAMETER (mm)	ORDERING CODE EXAMPLES	PITCH 5
G	Ammo	18.5	S (2)	MKP18403104045MG	x
W	Reel	18.5	350	MKP18403104045MW	x
-	Bulk	-	-	MKP18403104045M	x

Note
(1) S = box size 55 mm x 210 mm x 340 mm (w x h x l)

EXAMPLE OF ORDERING CODE					
TYPE	CAPACITANCE CODE	VOLTAGE CODE	TOLERANCE CODE	MINI	PACKAGING CODE
MKP1840	347	25	4	5M	G

Note
- Tolerance codes: **4** = 5 % (J); **3** = 2.5 % (H)

MOUNTING

Normal Use

The capacitors are designed for mounting on printed-circuit boards. The capacitors packed in bandoleers 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 or end of catalog

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:

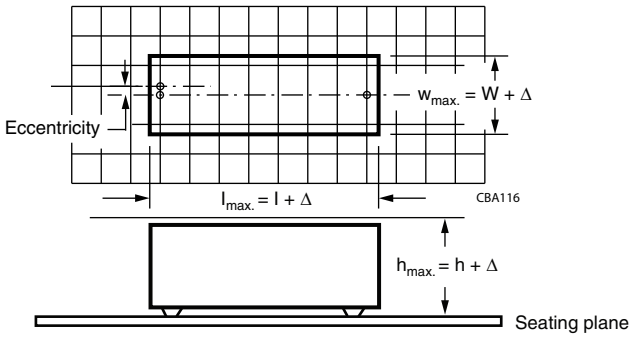
- For pitches ≤ 15 mm capacitors shall be mechanically fixed by the leads
- For larger pitches the capacitors shall be mounted in the same way and the body clamped

Space Requirements for Printed Circuit-Board Applications and Dimension Tolerances

For the maximum product dimensions and maximum space requirements for length ($l_{max.}$), width ($w_{max.}$), and height ($h_{max.}$) following tolerances must be taken in account in the envelopment of the components as shown in the drawings below.

- 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
- For products with pitch = 37.5 mm, $\Delta w = \Delta l = 0.7$ mm; $\Delta h = 0.5$ mm
- For products with pitch = 52.5 mm, $\Delta w = \Delta l = 1.0$ 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.



For the minimum product dimensions for length ($l_{min.}$), width ($w_{min.}$), and height ($h_{min.}$) following tolerances of the components are valid:

$l_{min.} = l - \Delta l$, $w_{min.} = w - \Delta w$, and $h_{min.} = h - \Delta h$ following

- For products with pitch ≤ 10 mm, $\Delta l = 0.3$ mm and $\Delta w = \Delta h = 0.3$ mm
- For products with pitch = 15 mm, $\Delta l = 0.5$ mm and $\Delta w = \Delta h = 0.5$ mm
- For products with 15 mm < pitch ≤ 27.5 mm, $\Delta l = 1.0$ mm and $\Delta w = \Delta h = 0.5$ mm
- For products with pitch = 37.5 mm, $\Delta l = 1.0$ mm and $\Delta w = \Delta h = 1.0$ mm

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

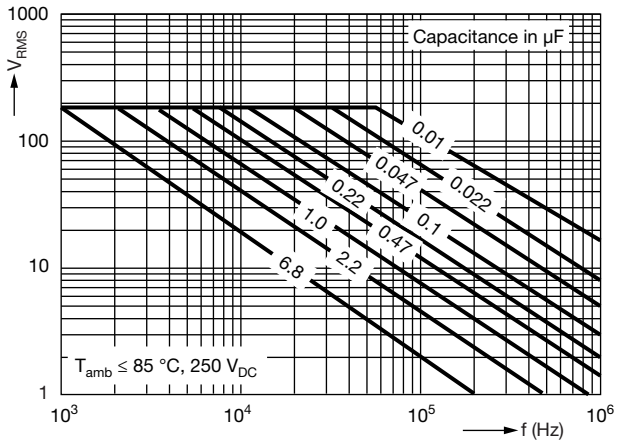
Ratings and Characteristics Reference Conditions

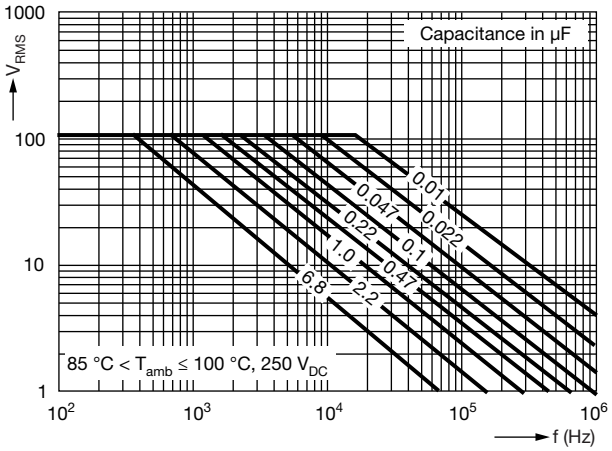
Unless otherwise specified, all electrical values apply to an ambient free temperature of 23 °C ± 1 °C, an atmospheric pressure of 86 kPa to 106 kPa and a relative humidity of 50 % ± 2 %.

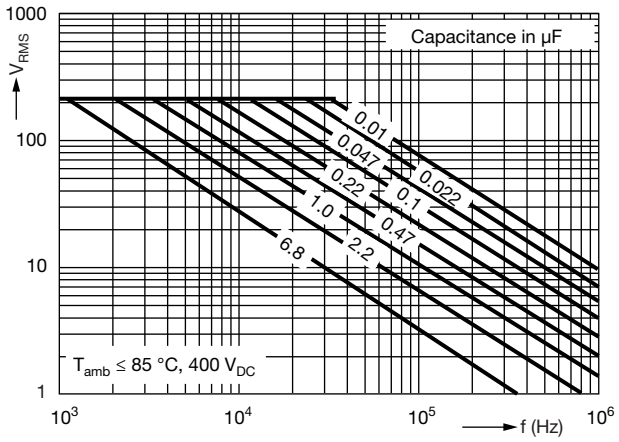
For reference testing, a conditioning period shall be applied over 96 h ± 4 h by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20 %.

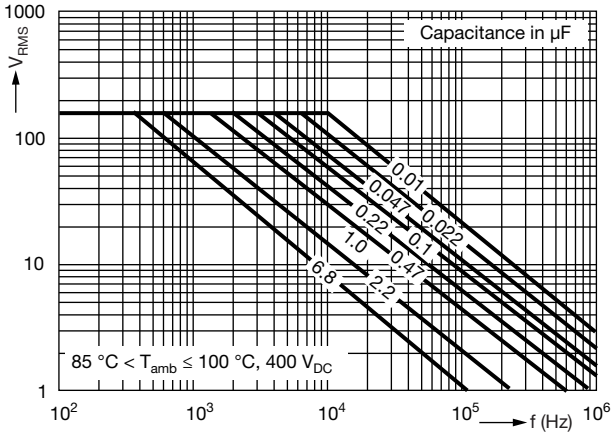
CHARACTERISTICS

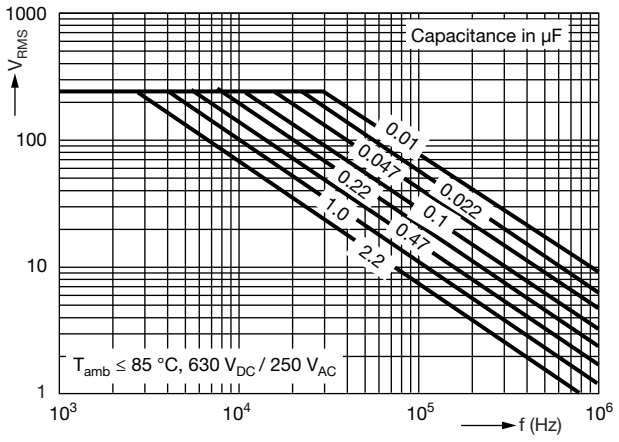
MAX. RMS VOLTAGE AS A FUNCTION OF FREQUENCY

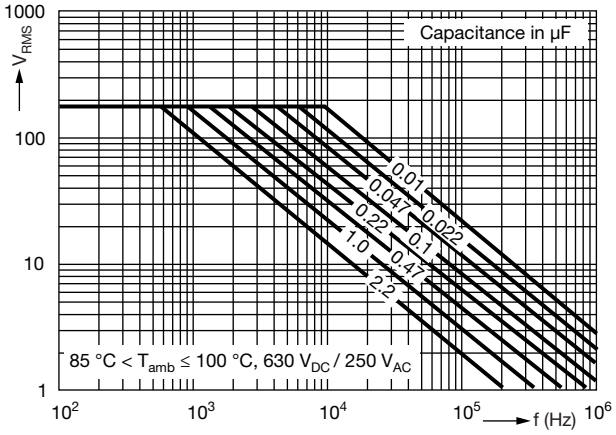






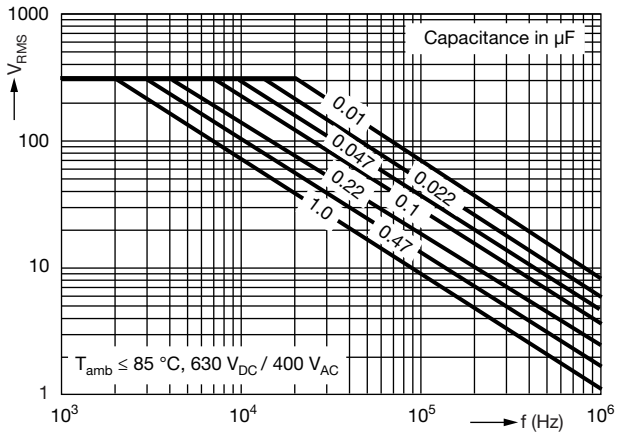


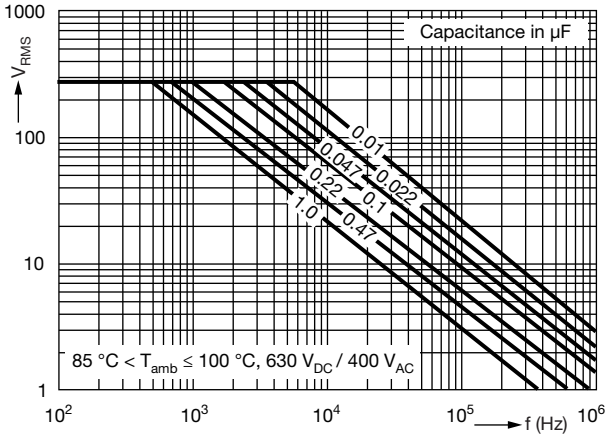


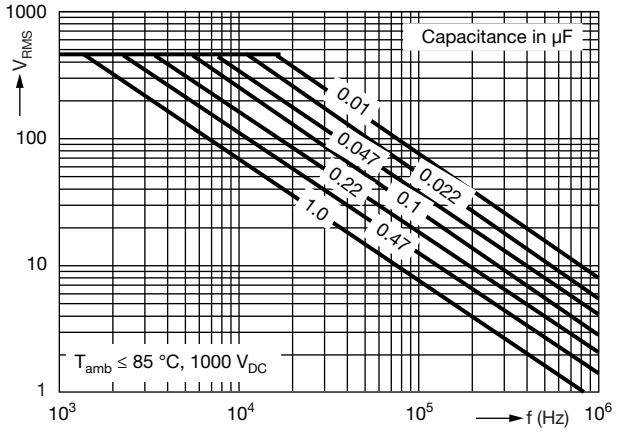


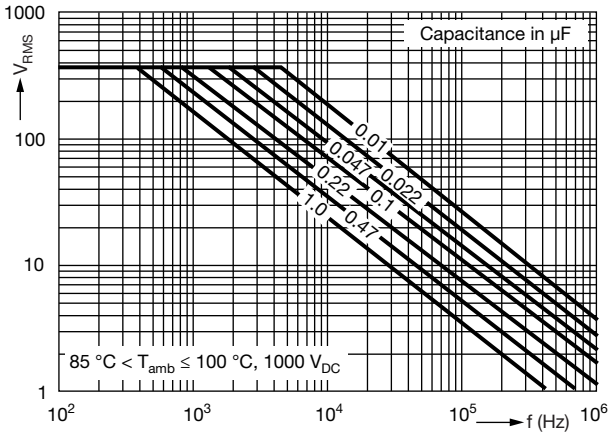
CHARACTERISTICS

MAX. RMS VOLTAGE AS A FUNCTION OF FREQUENCY









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

$W_{max.}$ (mm)	HEAT CONDUCTIVITY (mW/°C)						
	PITCH 5 mm	PITCH 7.5 mm	PITCH 10 mm	PITCH 15 mm	PITCH 22.5 mm	PITCH 27.5 mm	PITCH 37.5 mm
3.0	-	4.0	-	-	-	-	-
3.5	3.5	-	-	-	-	-	-
4.0	-	5.0	6.0	-	-	-	-
4.5	4.5	-	-	-	-	-	-
5.0	5.0	6.5	-	-	-	-	-
6.0	5.5	7.5	9.0	11.5	19.5	-	-
7.0	-	-	-	13.5	22.0	-	-
8.5	-	-	-	15.0	16.5	-	-
9.0	-	-	14.0	-	-	-	-
10.0	-	-	-	19.0	29.0	-	-
11.0	-	-	-	-	-	36.5	-
12.0	-	-	-	-	34.5	-	-
13.0	-	-	-	-	-	42.5	-
15.0	-	-	-	-	-	49.0	-
15.5	-	-	-	-	45.0	-	-
18.0	-	-	-	-	-	57.0	-
18.5	-	-	-	-	-	-	89.0
20.0	-	-	-	-	-	73.0	-
21.0	-	-	-	-	-	68.0	-
21.5	-	-	-	-	-	-	102.0

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 air ambient temperature.

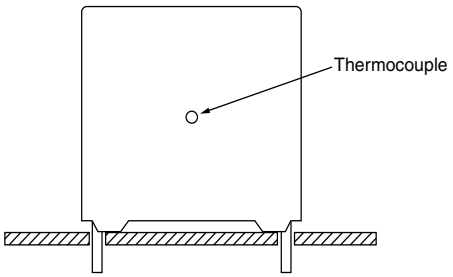
The power dissipation can be calculated according type detail specification “HQN-384-01/101: Technical Information Film Capacitors” with the typical tgd of the curves.

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

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

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 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 60384-2 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 chapter “General Data” of this specification
4.3.1 Initial measurements	Capacitance Tangent of loss angle at $C \leq 1$ µF at 10 kHz $C > 1$ 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: 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 PART OF SAMPLE OF SUB-GROUP C1		
4.6.1 Initial measurements	Capacitance Tangent of loss angle at $C \leq 1$ µF at 10 kHz $C > 1$ µF at 1 kHz	No visible damage
4.15 Solvent resistance of the marking	Isopropylalcohol at room temperature Method: 1 Rubbing material: cotton wool Immersion time: 5 min ± 0.5 min	No visible damage Legible marking
4.6 Rapid change of temperature	θA = lower category temperature θB = upper category temperature 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 Legible marking
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	

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C1B PART OF SAMPLE OF SUB-GROUP C1		
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	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: upper category temperature Duration: 16 h	
4.10.3 Damp heat cyclic Test Db, first cycle		
4.10.4 Cold	Temperature: lower category temperature Duration: 2 h	
4.10.6 Damp heat cyclic Test Db, remaining cycles		
4.10.6.2 Final measurements	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: ≤ 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	Tangent of loss angle at 1 kHz	
4.11.3 Final measurements	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 $\delta \leq 0.002$ Compared to values measured in 4.11.1
	Insulation resistance	≥ 50 % of values specified in section “Insulation Resistance” of this specification

GROUP C INSPECTION REQUIREMENTS		
SUB-CLAUSE NUMBER AND TEST	**CONDITIONS**	**PERFORMANCE REQUIREMENTS**
SUB-GROUP C3		
4.12 Endurance	Duration: 2000 h 1.25 x U_{RDC} at 85 °C 0.875 x U_{RDC} at 100 °C	
4.12.1 Initial measurements	Capacitance Tangent of loss angle at C > 1 µF at 1 kHz C ≤ 1 µF at 10 kHz	
4.12.5 Final measurements	Visual examination	No visible damage Legible marking
	Capacitance	|ΔC/C| ≤ 5 % for C > 10 nF |ΔC/C| ≤ 8 % for C ≤ 10 nF Compared to values measured in 4.12.1
	Tangent of loss angle	Increase of tan δ: ≤ 0.002 C > 1 µF at 1 kHz ≤ 0.004 C ≤ 1 µF at 10 kHz 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 characteristics		
Initial measurements	Capacitance	
Intermediate measurements	Capacitance at lower category temperature Capacitance at 20 °C Capacitance at upper category temperature	For -55 °C to +20 °C: 0 % ≤ |ΔC/C| ≤ 2 % or For 20 °C to 85 °C -3 % ≤ |ΔC/C| ≤ 0 % As specified in section " Capacitance" of this specification
Final measurements	Capacitance Insulation resistance	As 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: $R = \frac{U_R}{1.5 \times C \times (dU/dt)}$	
4.13.1 Initial measurements	Capacitance Tangent of loss angle at C ≤ 1 µF at 10 kHz C > 1 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: ≤ 0.002 C > 1 µF at 1 kHz ≤ 0.005 C ≤ 1 µF at 10 kHz 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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