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Film Capacitors

Metallized Polypropylene Film Capacitors (MKP)

Series/Type: **B32774P ... B32778P**

Date: February 2017

EPCOS AG is a TDK Group Company.

Typical applications

- Frequency converters
- Industrial and high-end power supplies
- Automotive DC-DC and Compressor

Climatic

- Max. operating temperature: 125 °C (case)
- Climatic category (IEC 60068-1): 40/110/56

Construction

- Dielectric: Polypropylene (MKP)
- Plastic case (UL 94 V-0)
- Epoxy resin sealing (UL 94 V-0)

Features

- Capacitance value up to 50 µF
- Good self-healing properties
- Over-voltage capability
- Low losses with high current capability
- High reliability
- RoHS-compatible

Terminals

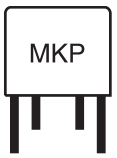
- Parallel wire leads, lead-free tinned
- 2-pin and 4-pin
- Standard lead lengths: 6 –1 mm

Marking

Manufacturer's logo and lot number,
date code, rated capacitance (coded),
capacitance tolerance (code letter),
rated DC voltage

Delivery mode

Bulk (untaped, lead length 6 –1 mm)



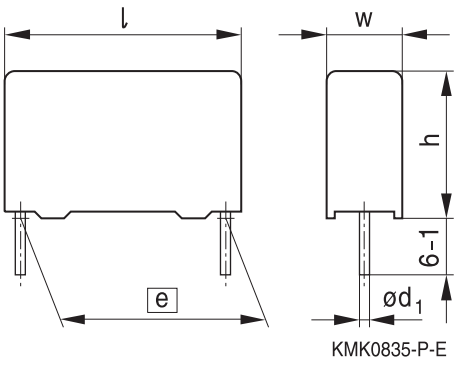
Dimensional drawings

Number of wires	Lead spacing e ±0.4	Lead diameter d_1 ±0.05	Type
2-pin	27.5	1.0[1)]	B32774P
2-pin	37.5	1.0	B32776P
2-pin	37.5	1.0[1)]	B32776P
4-pin	37.5	1.2[1)]	B32776P
4-pin	52.5	1.2[1)]	B32778P

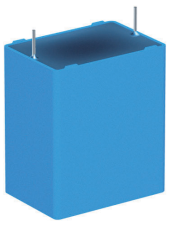
Dimensions in mm

Dimensional drawings 2-pin versions

B32774P, B32776P



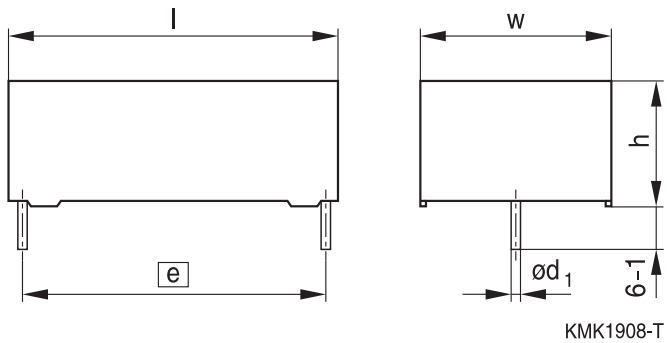
KMK0835-P-E



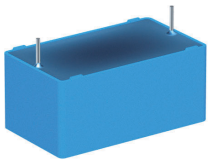
	B32774P	B32776P
Lead spacing e ±0.4:	27.5	37.5
Lead diameter d_1:	1.0[1)]	1.0

Dimensions in mm

B32776P



KMK1908-T



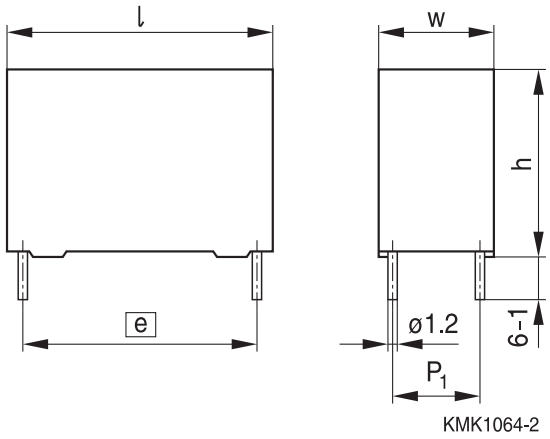
Lead spacing e ±0.4:	37.5
Lead diameter d_1:	1.0[1)]

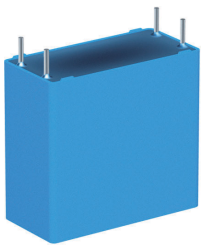
Dimensions in mm

1) Reinforced for vibration

Dimensional drawings 4-pin versions

B32776P, B32778P

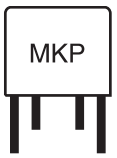




	B32776P	B32778P
Lead spacing e ±0.4:	37.5	52.5
Lead diameter d_1:	1.2[2)]	1.2[2)]

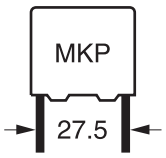
Dimensions in mm

2) Reinforced for vibration



Overview of available types

Lead spacing	27.5 mm			37.5 mm			52.5 mm		
Type	B32774P			B32776P			B32778P		
Page	6			7			8		
V_R (V DC)	630	700	840	630	700	840	630	700	840
C_R (µF)									
1.0			■						
1.5	■	■	■						
2.0		■							
2.2	■								
2.7						■			
3.0	■		■						
3.3		■							
3.5						■			
3.9					■				
4.7	■	■							
5.0			■	■	■				
6.8	■								
7.0		■							
7.5				■					
8.0	■					■			
10				■		■			
12					■	■			
14					■	■			
15				■					
16					■	■			
20				■	■				■
22				■	■				
25				■					
27									■
30				■				■	
35							■		
40								■	
50							■		



B32774P

MKP DC Link – 125 °C series up to 50 µF

Ordering codes and packing units (lead spacing 27.5 mm)

C_R [1]	Max. dimensions w × h × l	P_1	Ordering code (composition see below)	$I_{RMS,max}$ [2] 85 °C 10 kHz	ESR_{typ} 10 kHz	ESL_{typ} [3]	tan δ max. 1 kHz	tan δ max. 10 kHz	MOQ
µF	mm	mm		A	mΩ	nH	10^{-3}	10^{-3}	pcs.
$V_{R,85\,°C}$ = 630 V DC									
1.5	11.0 × 19.0 × 31.5	–	B32774P6155+000	3.5	22.3	13.2	0.5	3.5	1280
2.2	12.5 × 21.5 × 31.5	–	B32774P6225+000	4.7	15.5	14.5	0.5	3.5	1120
3.0	14.0 × 24.5 × 31.5	–	B32774P6305+000	6.0	11.5	16.1	0.5	3.5	1040
4.7	18.0 × 27.5 × 31.5	–	B32774P6475+000	8.2	7.6	18.7	0.5	3.7	800
6.8	21.0 × 31.0 × 31.5	–	B32774P6685+000	10.4	5.4	21.3	0.6	3.9	720
8.0	22.0 × 36.5 × 31.5	–	B32774P6805+000	12.0	4.5	24.0	0.6	4.0	640
$V_{R,85\,°C}$ = 700 V DC									
1.5	11.0 × 19.0 × 31.5	–	B32774P7155+000	3.6	20.3	18.4	0.5	3.2	1280
2.0	12.5 × 21.5 × 31.5	–	B32774P7205+000	4.7	15.3	19.8	0.5	3.2	1120
3.3	18.0 × 27.5 × 31.5	–	B32774P7335+000	7.3	9.6	22.9	0.5	3.3	800
4.7	19.0 × 30.0 × 31.5	–	B32774P7475+000	9.0	6.9	25.8	0.5	3.4	720
7.0	22.0 × 36.5 × 31.5	–	B32774P7705+000	11.8	5.0	31.2	0.5	3.7	640
$V_{R,85\,°C}$ = 840 V DC									
1.0	11.0 × 19.0 × 31.5	–	B32774P8105+000	3.3	25.2	18.3	0.5	2.7	1280
1.5	12.5 × 21.5 × 31.5	–	B32774P8155+000	4.4	17.2	20.2	0.5	2.7	1120
3.0	18.0 × 27.5 × 31.5	–	B32774P8305+000	7.5	9.1	25.6	0.5	2.8	800
5.0	22.0 × 36.5 × 31.5	–	B32774P8505+000	12.5	5.8	31.6	0.5	3.0	640

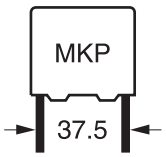
MOQ = Minimum Order Quantity, consisting of 4 packing units.
Intermediate capacitance values are available on request.

Composition of ordering code

+ = Capacitance tolerance code:
K = ±10%
J = ±5%

Packing code:
000 = untaped (lead length 6 – 1 mm)
Other lead lengths available upon request

1) Capacitance value measured at 1 kHz
2) Max. ripple current I_{RMS} at 85 °C at 10 kHz for a $\Delta T \leq 15$ °C when $\Delta ESR_{typ} \leq \pm 5\%$
3) ESL value measured at resonance frequency (see specific graphs of Z vs freq)



Ordering codes and packing units (lead spacing 37.5 mm)

C_R[1] µF	Max. dimensions w × h × l mm	P_1 mm	Ordering code (composition see below)	$I_{RMS,max}$[2] 85 °C 10 kHz A	ESR_{typ} 10 kHz mΩ	ESL_{typ}[3] nH	tan δ max. 1 kHz 10^{-3}	tan δ max. 10 kHz 10^{-3}	MOQ pcs.
$V_{R,85\,°C}$ = 630 V DC									
5.0	24.0 × 15.0 × 42.0	–	B32776P6505+000	6.0	13.4	19.4	0.9	6.9	1040
7.5	24.0 × 19.0 × 42.0	–	B32776P6755K000	7.6	9.5	19.6	0.9	6.9	780
10.0	18.0 × 32.5 × 42.0	–	B32776P6106K000	9.6	7.0	23.4	0.9	7.2	720
15.0	20.0 × 39.5 × 42.0	10.2	B32776P6156K000	13.0	4.8	12.4	0.9	7.1	640
20.0	28.0 × 37.0 × 42.0	10.2	B32776P6206K000	16.0	3.6	11.5	0.9	7.1	440
22.0	28.0 × 42.5 × 42.0	10.2	B32776P6226K000	17.5	3.2	13.2	0.9	7.3	440
25.0	30.0 × 45.0 × 42.0	20.3	B32776P6256+000	19.5	2.9	13.9	0.9	7.4	400
30.0	33.0 × 48.0 × 42.0	20.3	B32776P6306+000	22.5	2.4	15.1	0.9	7.6	180
$V_{R,85\,°C}$ = 700 V DC									
3.9	24.0 × 15.0 × 42.0	–	B32776P7395+000	5.6	15.3	19.2	0.8	6.2	1040
5.0	24.0 × 19.0 × 42.0	–	B32776P7505+000	6.8	12.1	19.1	0.8	6.3	780
12.0	20.0 × 39.5 × 42.0	10.2	B32776P7126K000	12.5	5.3	12.4	0.8	6.4	640
14.0	28.0 × 37.0 × 42.0	10.2	B32776P7146+000	14.5	4.4	11.3	0.8	6.4	440
16.0	28.0 × 42.5 × 42.0	10.2	B32776P7166+000	16.0	3.9	12.5	0.8	6.5	440
20.0	30.0 × 45.0 × 42.0	20.3	B32776P7206+000	19.0	3.2	13.5	0.8	6.6	400
22.0	33.0 × 48.0 × 42.0	20.3	B32776P7226+000	20.5	2.9	14.2	0.9	6.7	180
$V_{R,85\,°C}$ = 840 V DC									
2.7	24.0 × 15.0 × 42.0	–	B32776P8275+000	5.2	18.6	19.2	0.7	5.2	1040
3.5	24.0 × 19.0 × 42.0	–	B32776P8355+000	6.2	14.3	19.2	0.7	5.2	780
8.0	20.0 × 39.5 × 42.0	10.2	B32776P8805+000	11.0	6.3	12.4	0.7	5.3	640
10.0	28.0 × 37.0 × 42.0	10.2	B32776P8106+000	13.5	5.1	11.5	0.7	5.3	440
12.0	28.0 × 42.5 × 42.0	10.2	B32776P8126+000	15.0	4.4	12.8	0.7	5.4	440
14.0	30.0 × 45.0 × 42.0	20.3	B32776P8146+000	17.0	3.8	13.7	0.7	5.5	400
16.0	33.0 × 48.0 × 42.0	20.3	B32776P8166+000	19.0	3.3	14.5	0.7	5.5	180

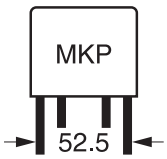
MOQ = Minimum Order Quantity, consisting of 4 packing units.
Intermediate capacitance values are available on request.

Composition of ordering code

+ = Capacitance tolerance code:
K = ±10%
J = ±5%

Packing code:
000 = untaped (lead length 6 – 1 mm)
Other lead lengths available upon request

1) Capacitance value measured at 1 kHz
2) Max. ripple current I_{RMS} at 85 °C at 10 kHz for a $\Delta T \leq 15$ °C when $\Delta ESR_{typ} \leq \pm 5\%$
3) ESL value measured at resonance frequency (see specific graphs of Z vs freq)



B32778P

MKP DC Link – 125 °C series up to 50 µF

Ordering codes and packing units (lead spacing 52.5 mm)

C_R[1]	Max. dimensions w × h × l	P_1	Ordering code (composition see below)	$I_{RMS,max}$[2] 85 °C 10 kHz	ESR_{typ} 10 kHz	ESL_{typ}[3]	tan δ max. 1 kHz	tan δ max. 10 kHz	MOQ
µF	mm	mm		A	mΩ	nH	10^{-3}	10^{-3}	pcs.
$V_{R,85\,°C}$ = 630 V DC									
35.0	30.0 × 45.0 × 57.5	20.3	B32778P6356+000	18.5	4.0	13.9	1.6	14.3	280
50.0	35.0 × 50.0 × 57.5	20.3	B32778P6506K000	23.5	2.9	16.0	1.6	14.8	108
$V_{R,85\,°C}$ = 700 V DC									
30.0	30.0 × 45.0 × 57.5	20.3	B32778P7306+000	18.5	4.2	14.2	1.5	12.9	280
40.0	35.0 × 50.0 × 57.5	20.3	B32778P7406+000	22.5	3.2	15.9	1.5	13.2	108
$V_{R,85\,°C}$ = 840 V DC									
20.0	30.0 × 45.0 × 57.5	20.3	B32778P8206+000	16.5	5.1	14.0	1.2	10.6	280
27.0	35.0 × 50.0 × 57.5	20.3	B32778P8276+000	20.5	3.9	15.7	1.3	10.8	108

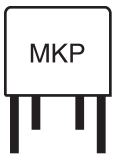
MOQ = Minimum Order Quantity, consisting of 4 packing units.
Intermediate capacitance values are available on request.

Composition of ordering code

+ = Capacitance tolerance code:
K = ±10%
J = ±5%

Packing code:
000 = untaped (lead length 6 – 1 mm)
Other lead lengths available upon request

1) Capacitance value measured at 1 kHz
2) Max. ripple current I_{RMS} at 85 °C at 10 kHz for a $\Delta T \leq 15$ °C when $\Delta ESR_{typ} \leq \pm 5\%$
3) ESL value measured at resonance frequency (see specific graphs of Z vs freq)



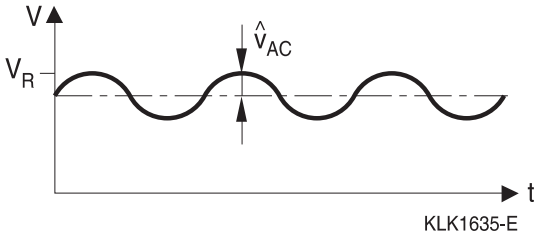
Technical data

Reference standard: IEC 60384-16 and AEC-Q200. All data given at T = 20 °C, unless otherwise specified.

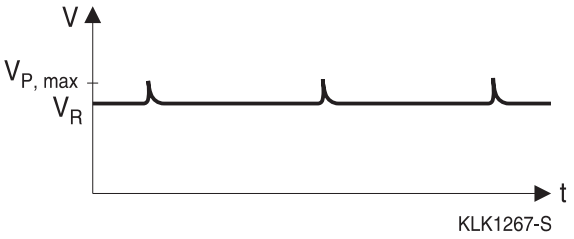
Operating temperature range (case)	Max. operating temperature, $T_{op,max}$ +125 °C[1)] Upper category temperature T_{max} +110 °C Lower category temperature T_{min} −40 °C		
Insulation Resistance R_{ins} given as time constant $\tau = C_R \cdot R_{ins}$, rel. humidity ≤ 65% (minimum as-delivered values)	τ > 10000 s (after 1 min) at 500 V DC		
DC voltage test between terminals (10 s)	1.5 · V_R		
Voltage test terminal to case (10 s)	2110 V AC, 50 Hz		
Peak current I_P (A)	C (µF) · dV/dt		
Reliability: Failure rate λ Service life t_{SL}	5 fit (≤ 1 · 10^{-9} h) at 0.5 · V_R, 40 °C 40 000 h at V_R, 85 °C For conversion to other operating conditions and temperatures, refer to chapter "Quality, 2 Reliability".		
V_R (V DC) at 85 °C[1)]	630	700	840
Continuous operation voltage V_{op} at 105 °C[1)]	540	600	720
Continuous operation voltage V_{op} at 125 °C[1)]	450	500	600
For temperatures between 85 °C and 125 °C[1)]	0.7%/°C of V_{op} de-rating compared to V_{op} at 85 °C		

1) Temperatures given as operating temperature T_{op} (ambient temperature + self-heating), for example when ambient temperature is 125 ºC, selfheating is 0 ºC, or ripple current cannot be permitted.

Typical waveforms



KLK1635-E



KLK1267-S

Restrictions:

V_R: Maximum operating peak voltage of either polarity but of a non-reversing waveform, for which the capacitor has been designed for continuous operation.

$\hat{u}_{AC} \leq 0.2 \cdot V_R$

$V_{p, max}$:

Overvoltage	Maximum duration within one day
1.1 · V_R	30% of on-load duration
1.15 · V_R	30 min.
1.2 · V_R	5 min.
1.3 · V_R	1 min.

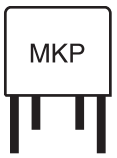
Pulse handling capability

"dV/dt" represents the maximum permissible voltage change per unit of time for non-sinusoidal voltages, expressed in V/µs.

Note:
The values of dV/dt and k_0 provided below must not be exceeded in order to avoid damaging the capacitor. These parameters are given for isolated pulses in such a way that the heat generated by one pulse will be completely dissipated before applying the next pulse. For a train of pulses, please refer to the curves of permissible AC voltage-current versus frequency.

dV/dt values

Lead spacing	27.5 mm			37.5 mm			52.5 mm		
Type	B32774P			B32776P			B32778P		
V_R (V DC)	630	700	840	630	700	840	630	700	840
dV/dt in V/µs	50	75	100	35	54	73	25	35	50

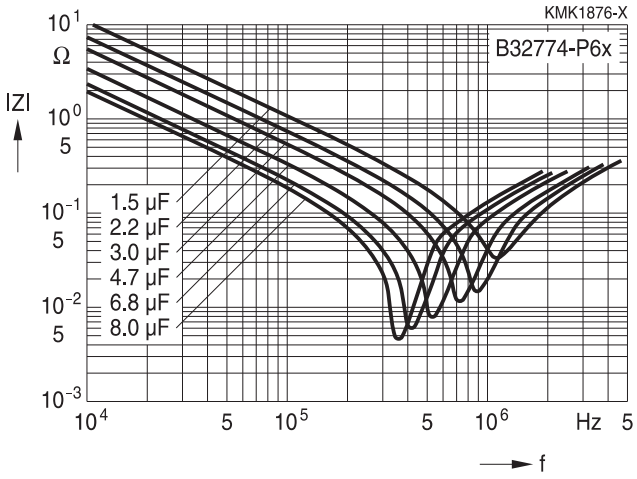


Characteristics curves

Additional technical information can be found under "Design support" on www.epcos.com.

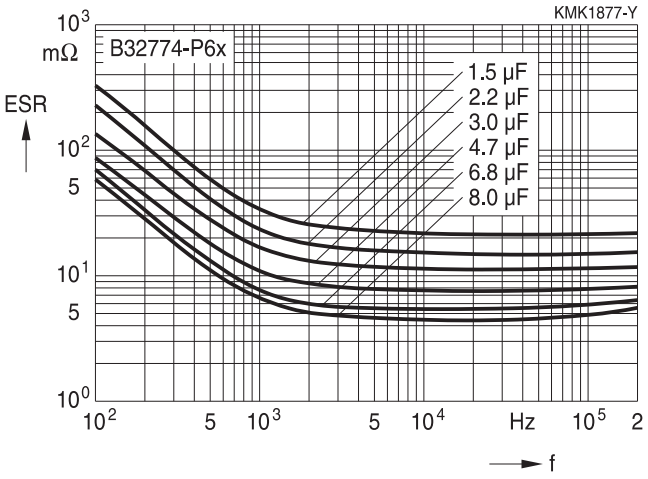
Impedance Z versus frequency f
(typical values)

Lead spacing 27.5 mm
B32774-P6x (2 pins) / 630 V DC



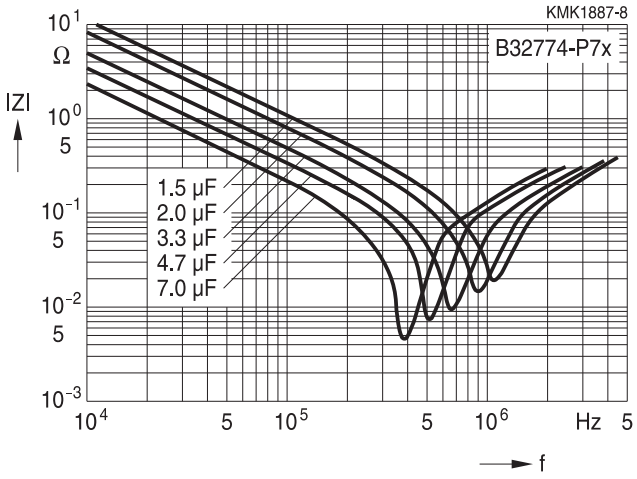
ESR versus frequency f
(typical values)

Lead spacing 27.5 mm
B32774-P6x (2 pins) / 630 V DC



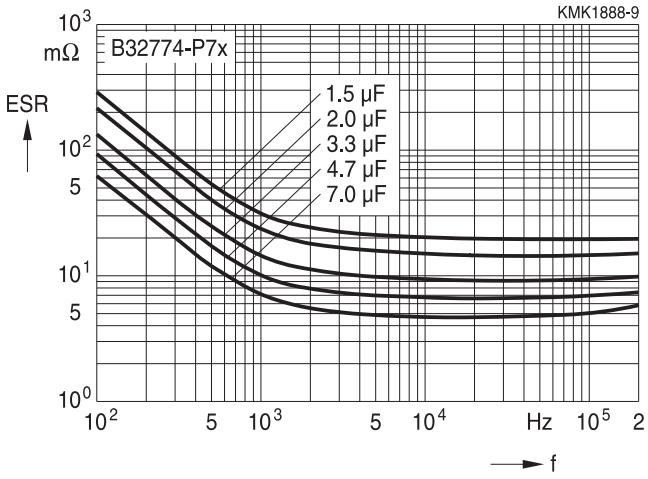
Impedance Z versus frequency f
(typical values)

Lead spacing 27.5 mm
B32774-P7x (2 pins) / 700 V DC



ESR versus frequency f
(typical values)

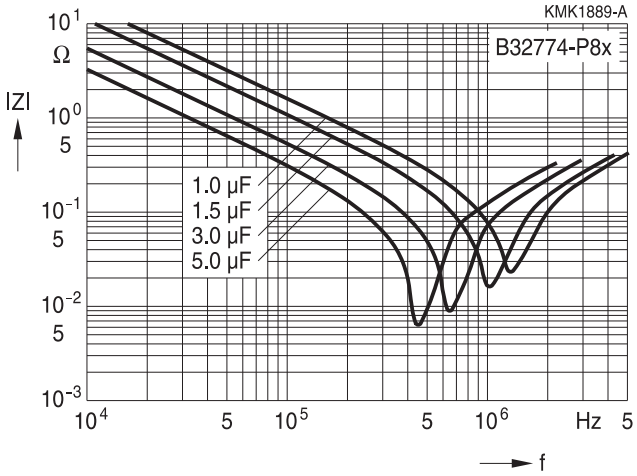
Lead spacing 27.5 mm
B32774-P7x (2 pins) / 700 V DC



Characteristics curves

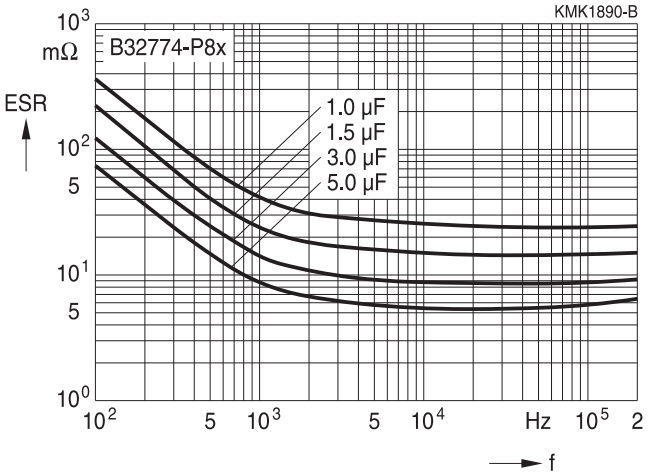
Impedance Z versus frequency f
(typical values)

Lead spacing 27.5 mm
B32774-P8x (2 pins) / 840 V DC



ESR versus frequency f
(typical values)

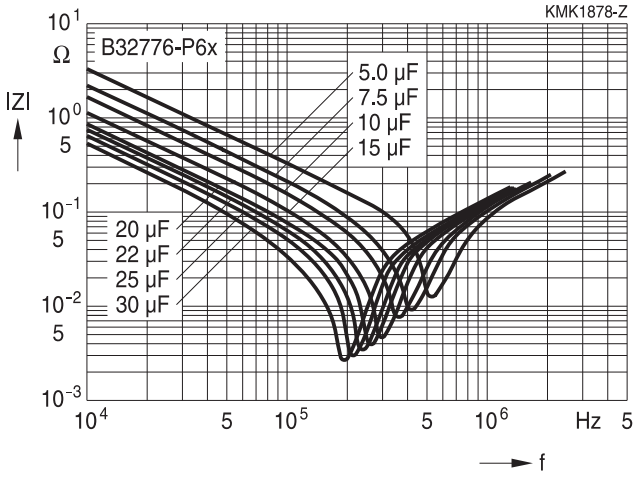
Lead spacing 27.5 mm
B32774-P8x (2 pins) / 840 V DC



Characteristics curves

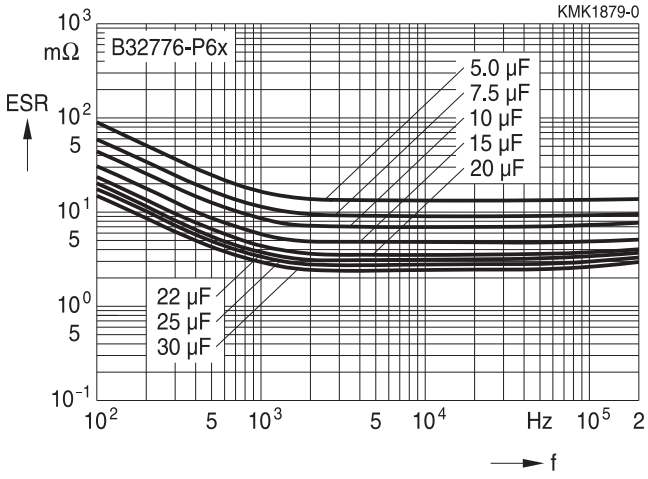
Impedance Z versus frequency f
(typical values)

Lead spacing 37.5 mm
B32776-P6x (2/4 pins) / 630 V DC



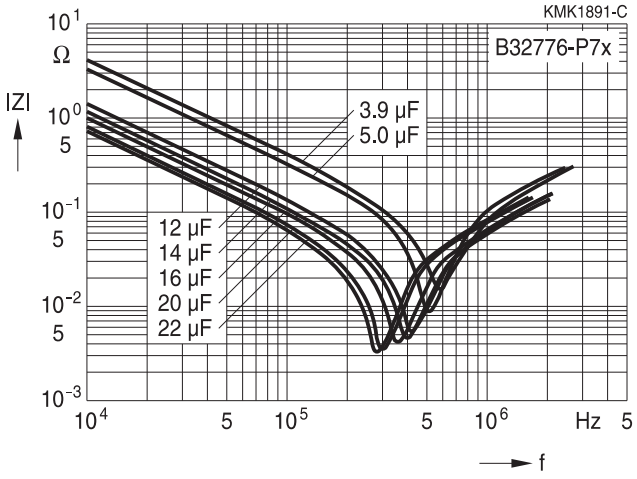
ESR versus frequency f
(typical values)

Lead spacing 37.5 mm
B32776-P6x (2/4 pins) / 630 V DC



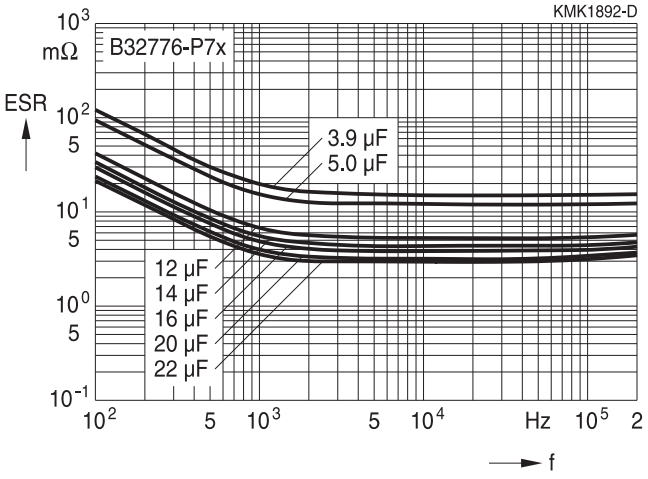
Impedance Z versus frequency f
(typical values)

Lead spacing 37.5 mm
B32776-P7x (2 pins, 4 pins) / 700 V DC



ESR versus frequency f
(typical values)

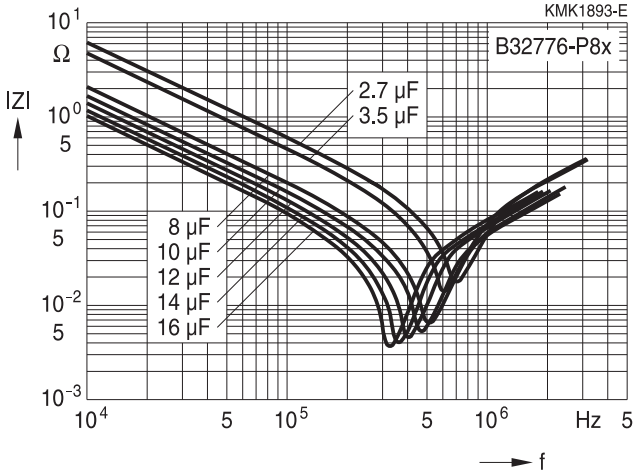
Lead spacing 37.5 mm
B32776-P7x (2 pins, 4 pins) / 700 V DC



Characteristics curves

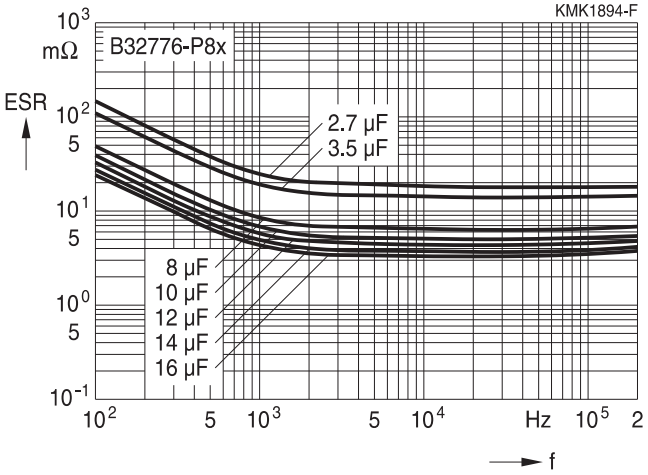
Impedance Z versus frequency f
(typical values)

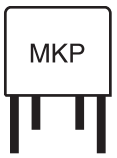
Lead spacing 37.5 mm
B32776-P8x (2 pins, 4 pins) / 840 V DC



ESR versus frequency f
(typical values)

Lead spacing 37.5 mm
B32776-P8x (2 pins, 4 pins) / 840 V DC

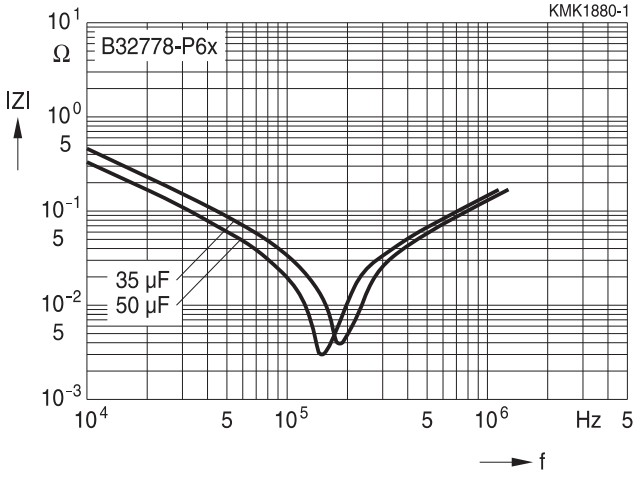




Characteristics curves

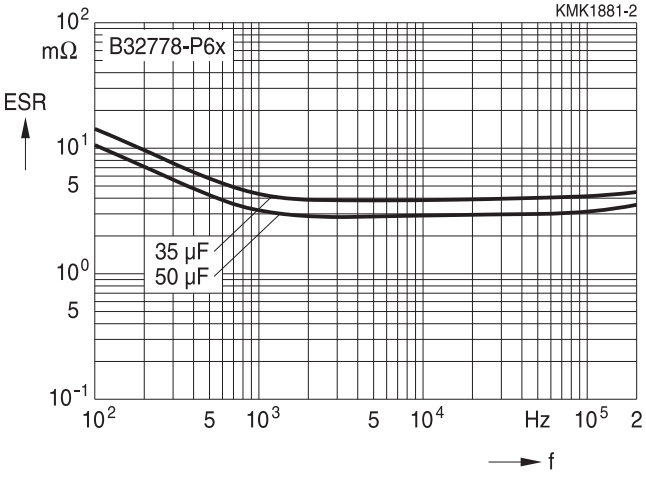
Impedance Z versus frequency f
(typical values)

Lead spacing 52.5 mm
B32778-P6x (4 pins) / 630 V DC



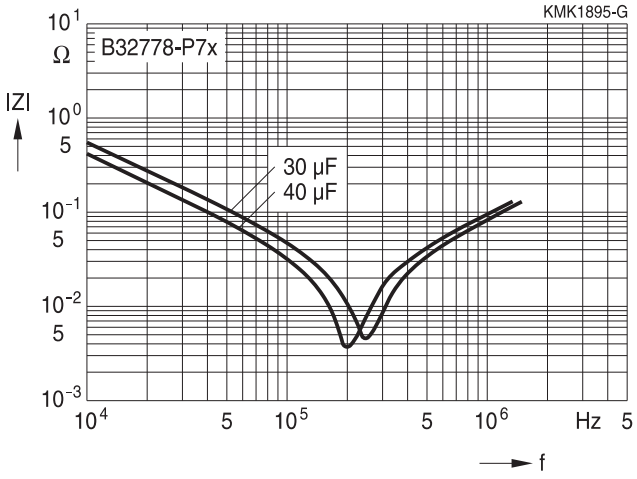
ESR versus frequency f
(typical values)

Lead spacing 52.5 mm
B32778-P6x (4 pins) / 630 V DC



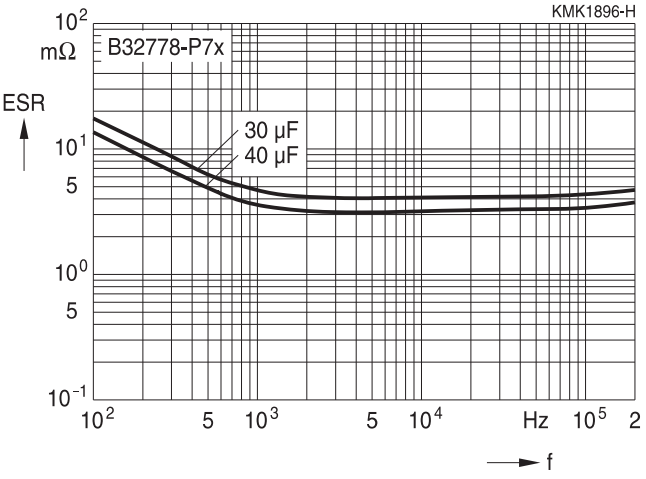
Impedance Z versus frequency f
(typical values)

Lead spacing 52.5 mm
B32778-P7x (4 pins) / 700 V DC



ESR versus frequency f
(typical values)

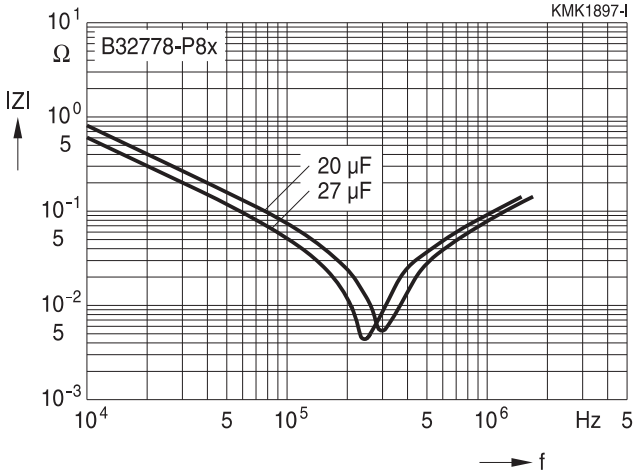
Lead spacing 52.5 mm
B32778-P7x (4 pins) / 700 V DC



Characteristics curves

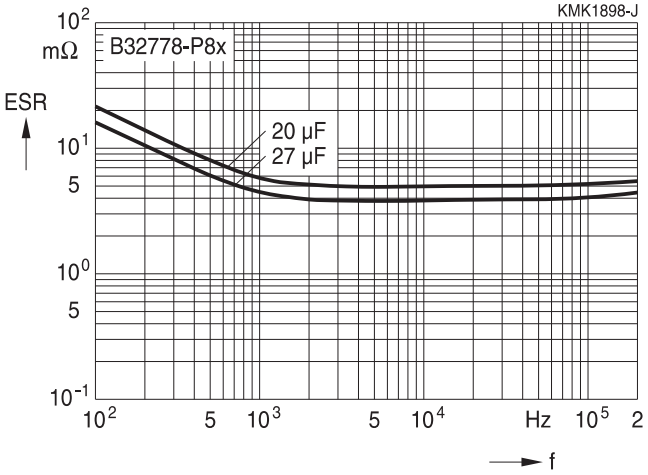
Impedance Z versus frequency f
(typical values)

Lead spacing 52.5 mm
B32778-P8x (4 pins) / 840 V DC



ESR versus frequency f
(typical values)

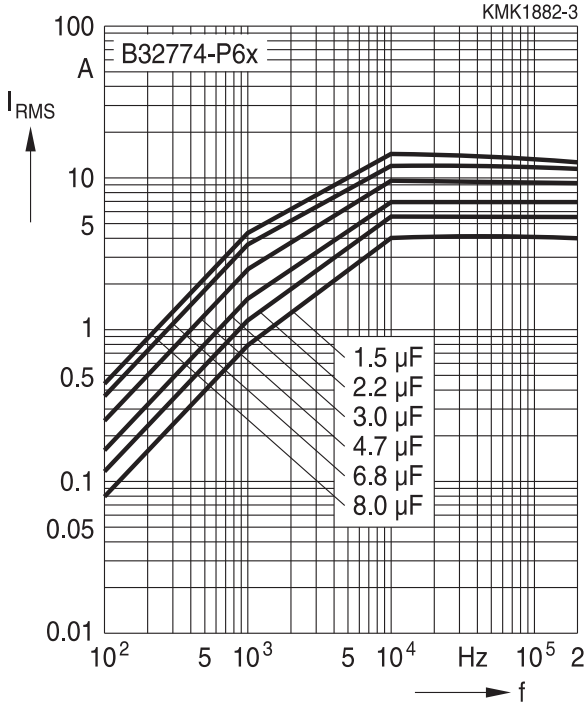
Lead spacing 52.5 mm
B32778-P8x (4 pins) / 840 V DC



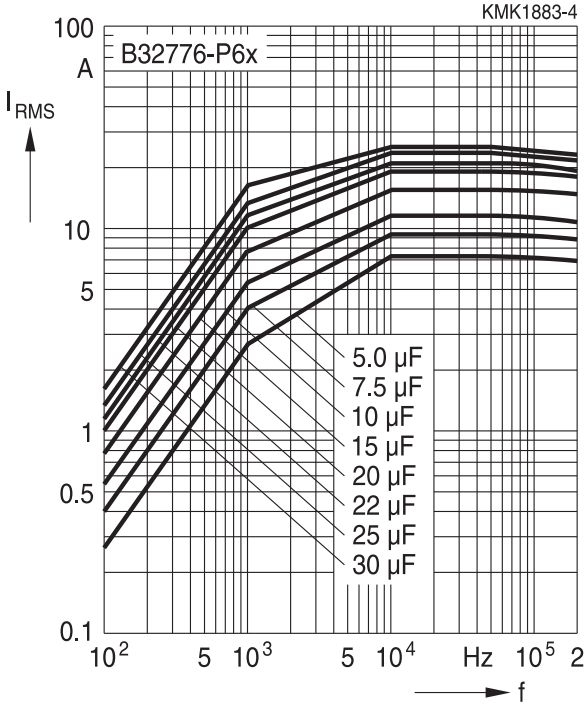
Characteristics curves

Permissible current I_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 85$ ºC)
For $T_A > 85$ ºC, please use derating factor F_T.

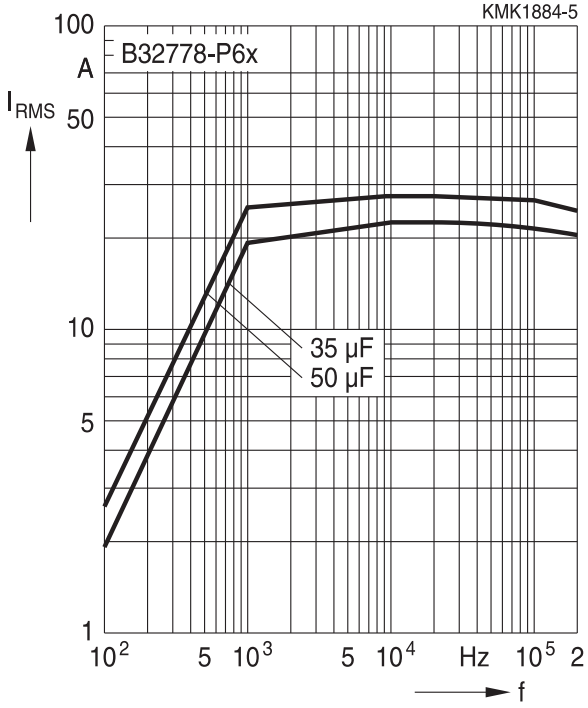
Lead spacing 27.5 mm
B32774-P6x (2 pins) / 630 V DC



Lead spacing 37.5 mm
B32776-P6x (2/4 pins) / 630 V DC



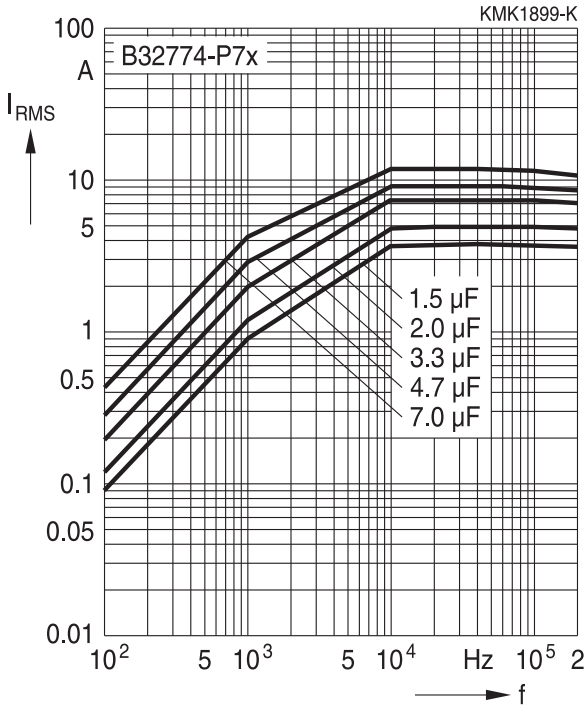
Lead spacing 52.5 mm
B32778-P6x (4 pins) / 630 V DC



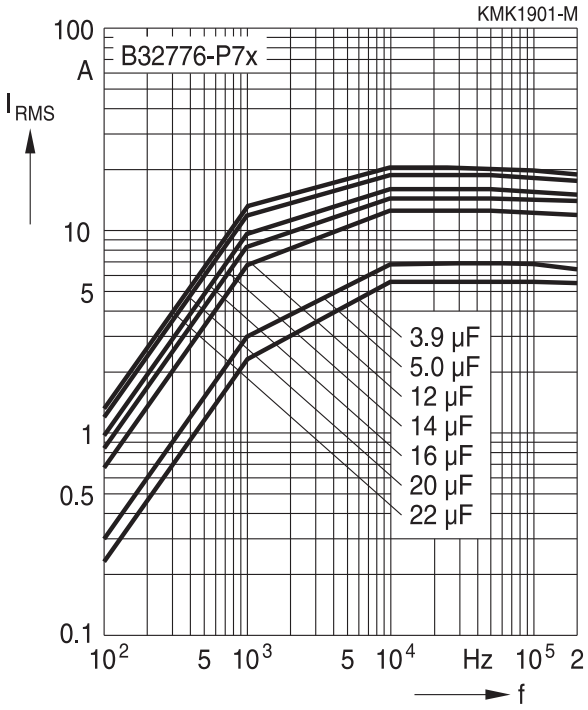
Characteristics curves

Permissible current I_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 85$ ºC)
For $T_A > 85$ ºC, please use derating factor F_T.

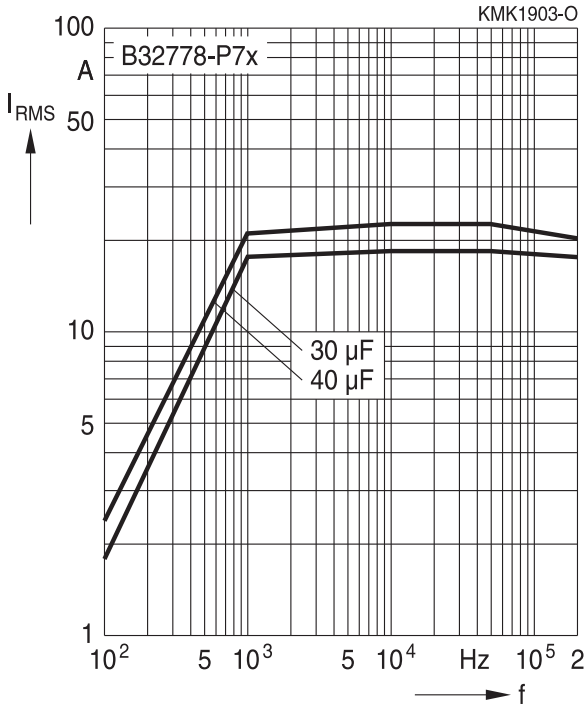
Lead spacing 27.5 mm
B32774-P7x (2 pins) / 700 V DC



Lead spacing 37.5 mm
B32776-P7x (2/4 pins) / 700 V DC



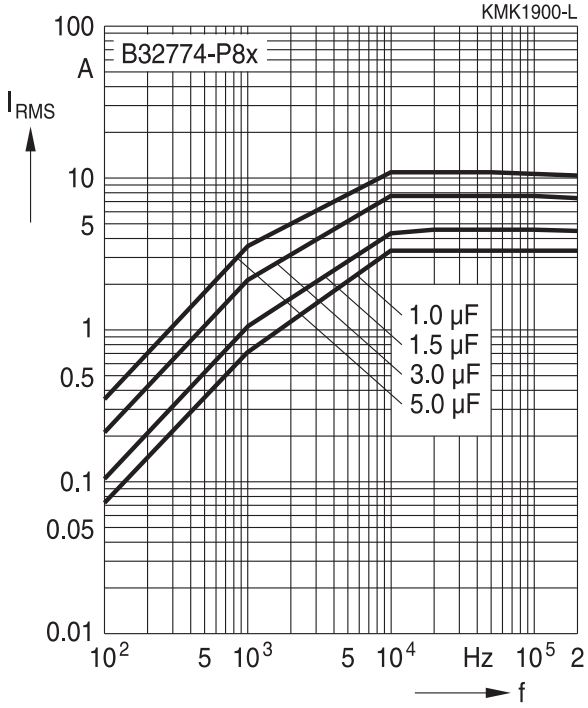
Lead spacing 52.5 mm
B32778-P7x (4 pins) / 700 V DC



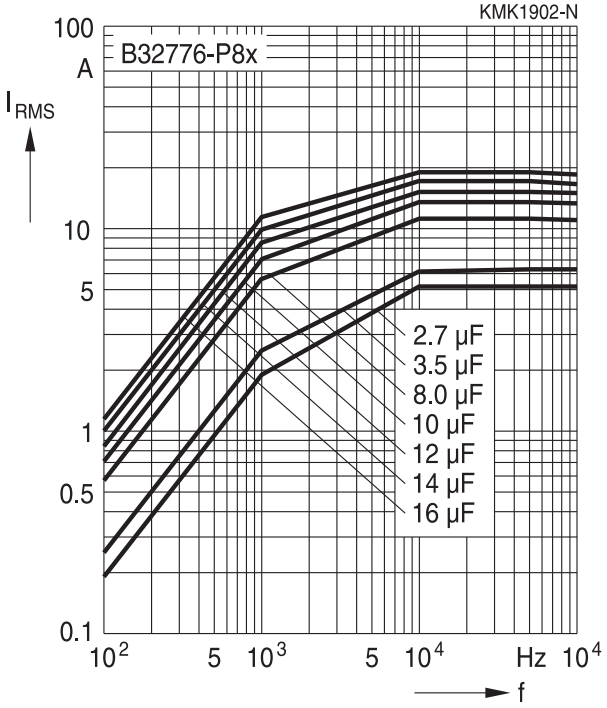
Characteristics curves

Permissible current I_{RMS} versus frequency f (for sinusoidal waveforms, $T_A \leq 85$ ºC)
For $T_A > 85$ ºC, please use derating factor F_T.

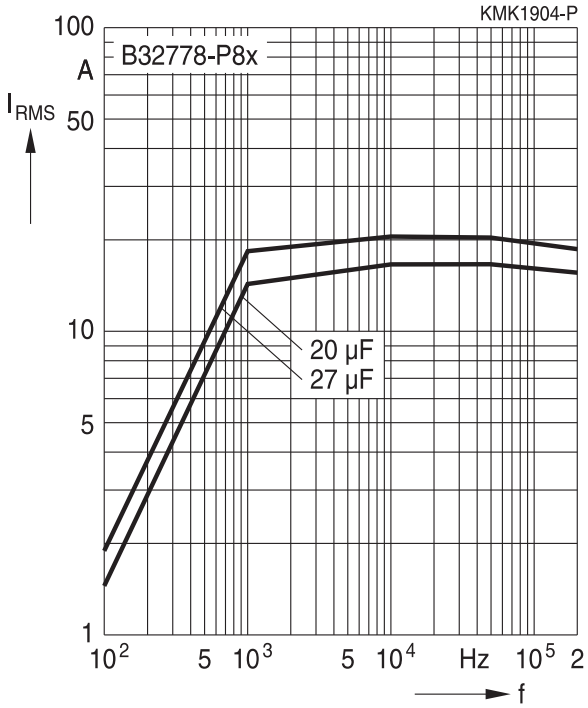
Lead spacing 27.5 mm
B32774-P8x (2 pins) / 840 V DC



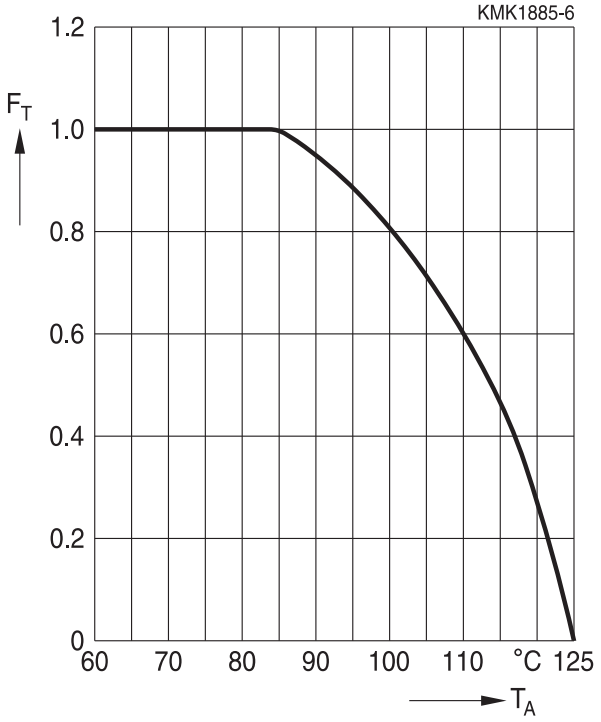
Lead spacing 37.5 mm
B32776-P8x (2/4 pins) / 840 V DC



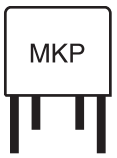
Lead spacing 52.5 mm
B32778-P8x (4 pins) / 840 V DC



Curves Characteristics (I_{RMS} derating vs temperature)



Maximum I_{RMS} current as function of the ambient temperature: I_{RMS} (T_A) = $F_T \times I_{RMS}$ (85 °C)



Heat transference for self heating calculation

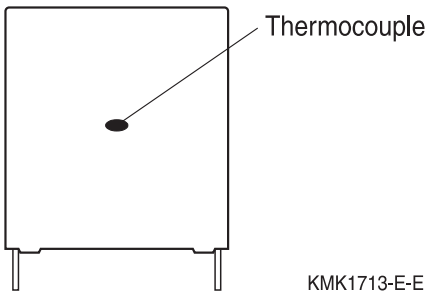


Figure 1

Box dimensions			Equivalent heat coefficient
w (mm)	h (mm)	l (mm)	G (mW/°C)
11.0	19.0	31.5	25
11.0	21.0	31.5	28
12.5	21.5	31.5	30
13.5	23.0	31.5	32
14.0	24.5	31.5	35
15.0	24.5	31.5	36
16.0	32.0	31.5	45
18.0	27.5	31.5	44
18.0	33.0	31.5	48
19.0	30.0	31.5	48
21.0	31.0	31.5	51
22.0	36.5	31.5	58
12.0	22.0	42.0	70
14.0	25.0	42.0	43
16.0	28.5	42.0	50
18.0	32.5	42.0	59
20.0	39.5	42.0	72
24.0	19.0	42.0	50
24.0	15.0	42.0	44
28.0	37.0	42.0	83
28.0	42.5	42.0	90
30.0	45.0	42.0	100
33.0	48.0	42.0	110
30.0	45.0	57.5	125
35.0	50.0	57.5	145

The equivalent heat coefficient **"G (mW/ºC)"** is given for measuring the temperature on the lateral surface of the plastic box as figure1 shows. By using a thermocouple and avoiding effect of radiation and convection the temperature measured during operation conditions should be a result of the dissipated power divided by the equivalent heat coefficient.

Self Heating by power dissipation and equivalent heat coefficient

The I_{RMS} and consequently the power dissipation must be limited during operation in order to not exceed the maximum limit of ΔT allowed for this series. ΔT_{max} given for this series is equal or lower than 15 °C at rated temperature (85 °C), for higher ambient temperatures ΔT_{max} (T) will have the same derating factor than I_{RMS} vs temperature and then an equivalent derating as per:

$$\Delta T_{max}\ (T) = (\text{Factor})^2 \times \Delta T\ (85\ °C).$$

For any particular I_{RMS} the ΔT may be calculated by:

$$\Delta T\ (°C) = P_{dis}\ (mW) / G(mW/°C).$$

Where ΔT (°C) is the difference between the temperature measured on the box (see figure 1) and the ambient temperature when capacitor is working during normal operation;

$$\Delta T\ (°C) = T_{op}(°C) - T_A\ (°C).$$

It represents the increasing of temperature provoked by the I_{RMS} during operation.

G (mW/°C) is the equivalent heat coefficient described above and P_{dis} (mW) is the dissipated power defined by: $P_{dis}\ (mW) = ESR_{typ}\ (m\Omega) \times I_{RMS}^2\ (A_{RMS})$.

Example for thermal calculation:

We will take as reference B32778P6506K (50 µF/630 V DC) type for thermal calculation. Considering the following load and capacitor characteristics:

I_{RMS}: 15 A_{RMS} at 20 kHz
T_A: 100 ºC
35 × 50 × 57.5 box
G (mW/ºC): 145

Then we have to find the ESR_{typ} at 20 kHz what is approximately 2.9 mΩ.

So according to $P_{dis}\ (mW) = ESR_{typ}\ (m\Omega) \times I_{RMS}^2\ (A_{RMS})$

we have the following: $P_{dis}\ (mW) = 2.9\ m\Omega \times 10\ A_{RMS}^2 = 290\ mW.$

And as per $\Delta T\ (°C) = P_{dis}\ (mW) / G\ (mW/°C)$

we have the following: $\Delta T\ (°C) = 290\ (mW) / 145\ (mW/°C) = 4.5\ °C.$

What is below of the $\Delta T_{max}\ (100\ °C) = (\text{Factor})^2 \times \Delta T\ (85\ °C) = (0.80)^2 \times 15\ °C = 9.6\ °C.$

On the other hand we may confirm that max I_{RMS} at 20 kHz at 85 °C = 23.5 A_{RMS}.

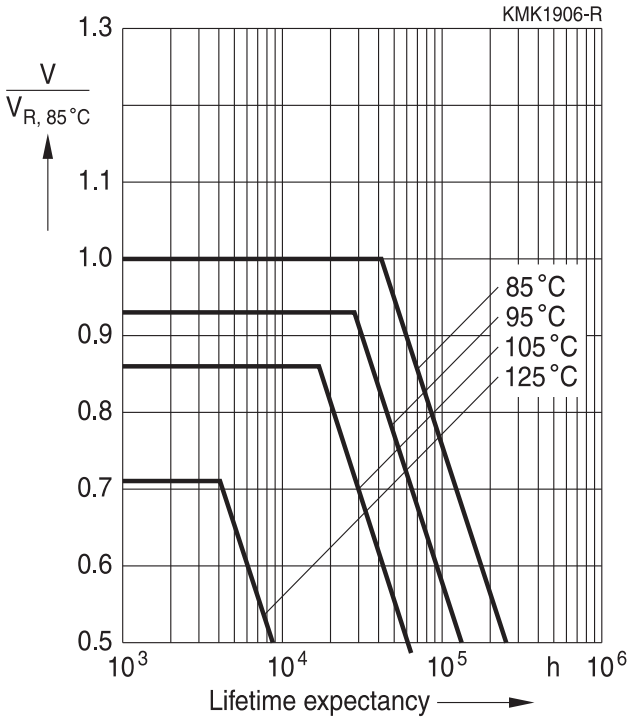
And then max I_{RMS} for 85 °C of ambient temperature is defined as follows:

$$I_{RMS}\ (100\ °C) = \text{Factor} \times I_{RMS}\ (85\ °C) = 0.80 \times 23.5\ A_{RMS} = 18.8\ A_{RMS}.$$

What confirms once again that I_{RMS} (10 A_{RMS} at 20 kHz at 100 °C) is below the max specified for such frequency and ambient temperature.

Service life

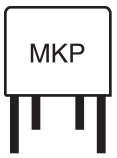
Life time expectancy - typical curve



Note:
(1) Confidence level of 98%
(2) Life expectancy is given as a function of operating temperature (capacitor body temperature).

Testing and Standards

Test	Reference	Conditions of test		Performance requirements
Electrical Parameters (Routine test)	IEC 61071-11	Voltage between terminals, 1.5 V_R, during 10 s Insulation resistance, R_{INS} at 500 V Capacitance, C at 1 kHz (room temperature) Dissipation factor, tan δ at 1/10 kHz (room temperature)		Within specified limits
Robustness of terminations (Type test)	IEC 60068-2-21	Tensile strength (test Ua1)		Capacitance and tan δ within specified limits
		Wire diameter	Tensile force	
		$0.5 < d_1 \leq 0.8$ mm	10 N	
		$0.8 < d_1 \leq 1.25$ mm	20 N	
Resistance to soldering heat (Type test)	IEC 60068-2-20, test Tb, method 1A	Solder bath temperature at 260 ± 5 °C, immersion for 10 seconds		$\lvert\Delta C/C_0\rvert \leq 2\%$ $\lvert\Delta \tan\delta\rvert \leq 0.002$
Bump (Type test)	IEC 60384-16	Test Eb: Total 4000 bumps with 390 m/s² mounted on PCB 6 ms duration		No visible damage $\lvert\Delta C/C_0\rvert \leq 2\%$ $\lvert\Delta \tan\delta\rvert \leq 0.002$ $R_{INS} \geq 50\%$ of initial limit
Climatic sequence (Type test)	IEC 60384-16	Dry heat Tb / 16 h. Damp heat cyclic, 1st cycle + 55 °C / 24h / 95% ... 100% RH Cold Ta / 2h Damp heat cyclic, 5 cycles + 55 °C / 24h / 95% ... 100% RH		No visible damage $\lvert\Delta C/C_0\rvert \leq 3\%$ $\lvert\Delta \tan\delta\rvert \leq 0.001$ $R_{INS} \geq 50\%$ of initial limit
Thermal shock	AEC-Q200	−55 °C ... +85 ºC, 1000 cycles		No visible damage $\lvert\Delta C/C0\rvert \leq 2\%$ $\lvert\Delta \tan\delta\rvert \leq 0.002$ (1kHz) $R_{INS} \geq 50\%$ of initial limit
Vibration	AEC-Q200	5 *g* for 20 minutes, 12 cycles, each of 3 orientations (X, Y, Z axis), 240 min/axis, total 12 hours Test from 10-2000 Hz		No visible damage



Test	Reference	Conditions of test	Performance requirements
High temperature high humidity with load	AEC-Q200	40 °C/93% RH/1000 hours with V_R 60 °C/95% RH/500 hours with V_R	No visible damage $\lvert\Delta C/C_0\rvert \leq 5\%$ $\lvert\Delta \tan\delta/\tan\delta\rvert \leq 400\%$ (1kHz) $R_{INS} \geq 50\%$ of initial limit
		V_R = 630: 85 °C/85% RH/1000 hours with 450 V DC V_R = 700: 85 °C/85% RH/1000 hours with 500 V DC V_R = 840: 85 °C/85% RH/1000 hours with 600 V DC	$\lvert\Delta C/C_0\rvert \leq 5\%$ $\lvert\Delta \tan\delta\rvert \leq 0.005$ (1kHz) $R_{INS} \geq 50\%$ of initial limit
Endurance (Type test)	IEC 60384-16	85 °C/1.25 V_R /1000 hours or 105 °C/1.25 V_{op} /1000 hours or 125 °C/1.25 V_{op} /1000 hours	No visible damage $\lvert\Delta C/C_0\rvert \leq 5\%$ $\lvert\Delta \tan\delta\rvert \leq 0.005$ (1 kHz) $R_{INS} \geq 50\%$ of initial limit

Mounting guidelines

1 Soldering

1.1 Solderability of leads

The solderability of terminal leads is tested to IEC 60068-2-20, test Ta, method 1.

Before a solderability test is carried out, terminals are subjected to accelerated ageing (to IEC 60068-2-2, test Ba: 4 h exposure to dry heat at 155 °C). Since the ageing temperature is far higher than the upper category temperature of the capacitors, the terminal wires should be cut off from the capacitor before the ageing procedure to prevent the solderability being impaired by the products of any capacitor decomposition that might occur.

Solder bath temperature	235 ±5 °C
Soldering time	2.0 ±0.5 s
Immersion depth	2.0 +0/−0.5 mm from capacitor body or seating plane
Evaluation criteria: Visual inspection	 Wetting of wire surface by new solder ≥90%, free-flowing solder