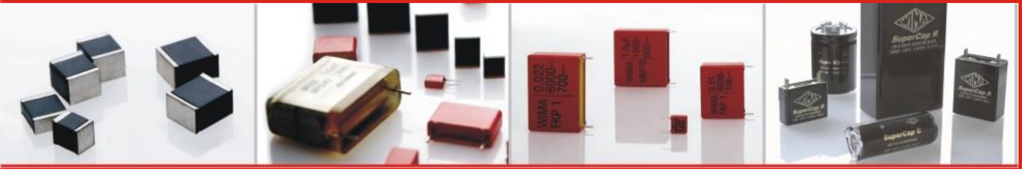
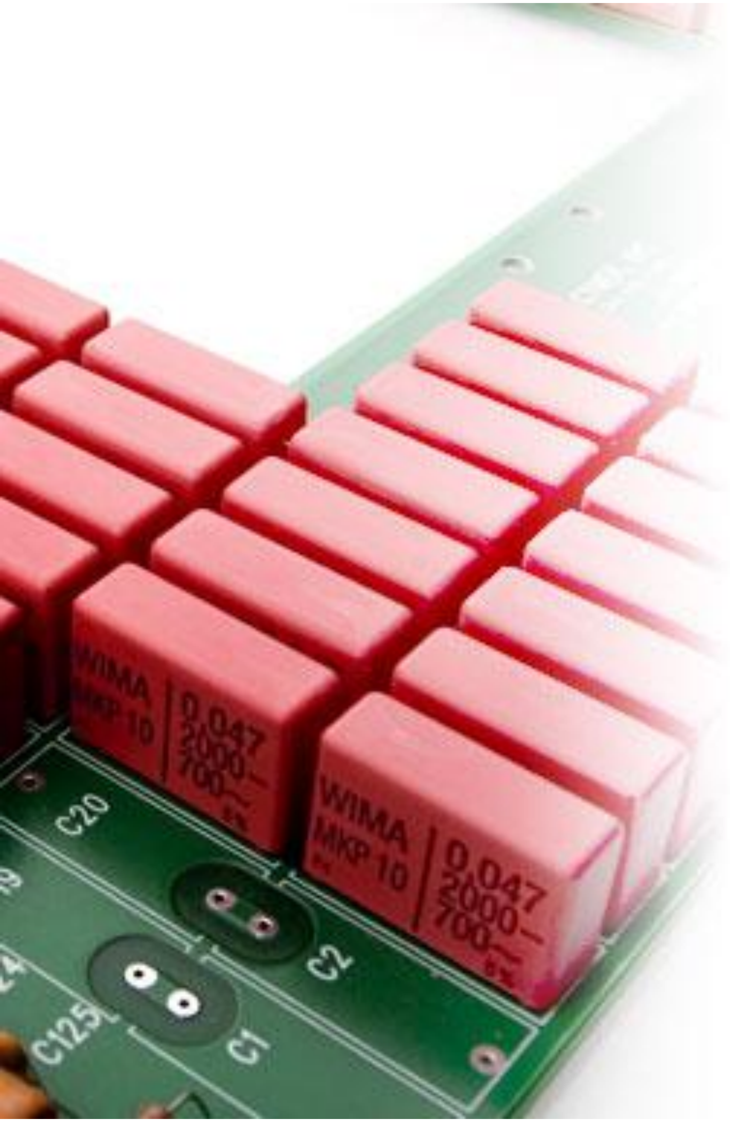
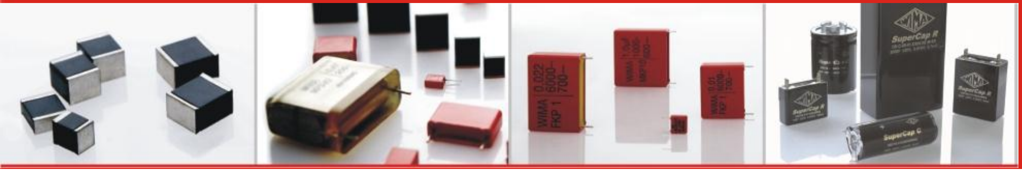


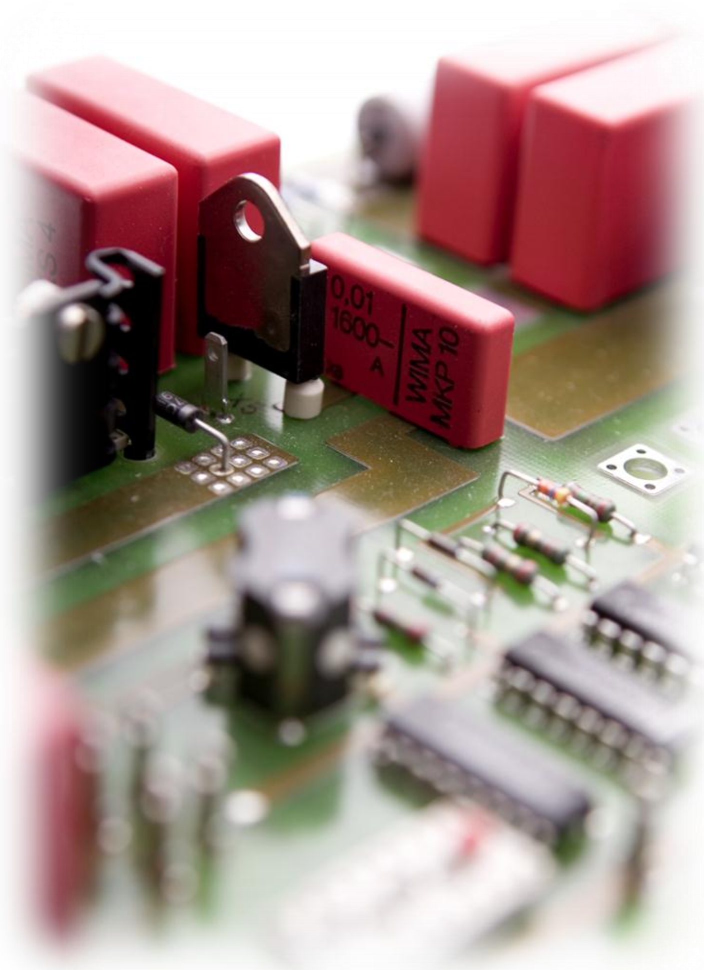


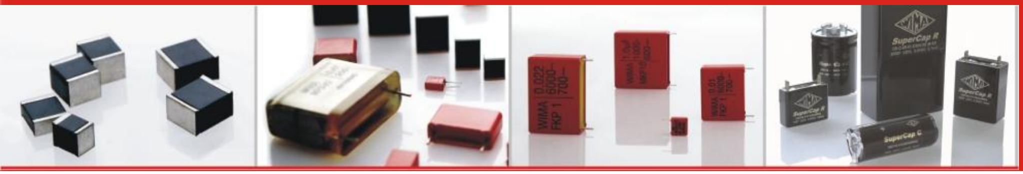
WIMA Pulse Capacitors



Outline

- Characteristics of the Polypropylene Film
- Pulse Capability of different Construction Principles
- Self-healing Capability of Pulse Capacitors
- Application Examples of Pulse Capacitors
- Selection of Capacitors for Pulse Applications





BEST CAPACITORS
MADE IN GERMANY

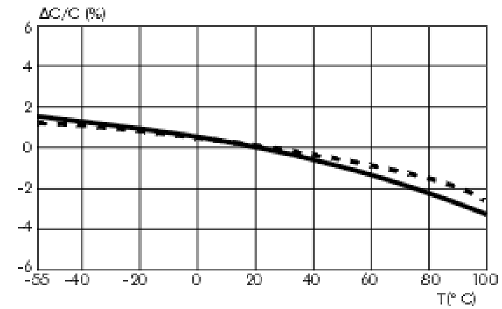
Polypropylene (PP) Film

Typical Applications

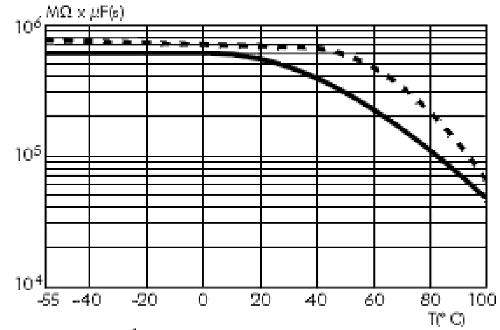
- Energy storing
- Oscillating
- Resonating
- Smoothing
- A/D conversion
- Snubbing
- Temperature compensation
- RFI suppression
- Sample and hold circuits etc.

Film Properties

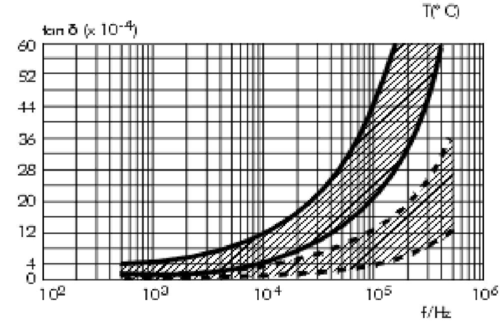
- Max. operating temperature: +100°C
- Film thickness: > 4 µm
- Lowest dissipation factor
- Constantly negative TKc
- Tight tolerances



Capacitance change versus temperature (f = 1 kHz) (general guide)



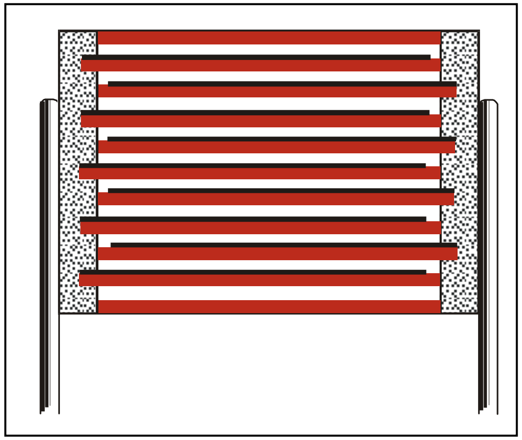
Insulation resistance change versus temperature (general guide)



Dissipation factor change versus frequency (general guide)

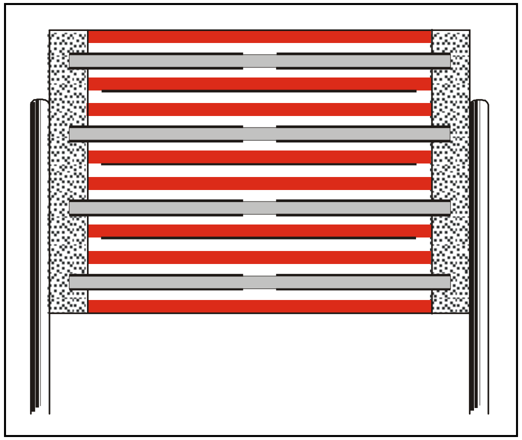
Pulse Capability

WIMA MKP 4
single metallized plastic film



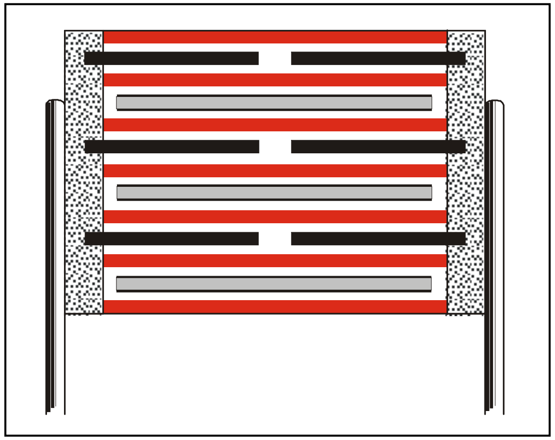
Capacitance µF	max. pulse rise time V/µs at $T_A < 40°C$		
	400 VDC	630 VDC	1000 VDC
0.01 ...0.022	450	500	550
0.033...0.068	300	350	400
0.1 ...0.22	200	250	300

WIMA MKP 10
double sided metallized plastic film



Capacitance µF	max. pulse rise time V/µs at $T_A < 40°$ C		
	400 VDC	630 VDC	1000 VDC
0.01 ...0.022	1200	1800	2100
0.033...0.068	900	1800	2100
0.1 ...0.22	500	900	1400

WIMA FKP 1
aluminium foil and double sided metallized plastic film



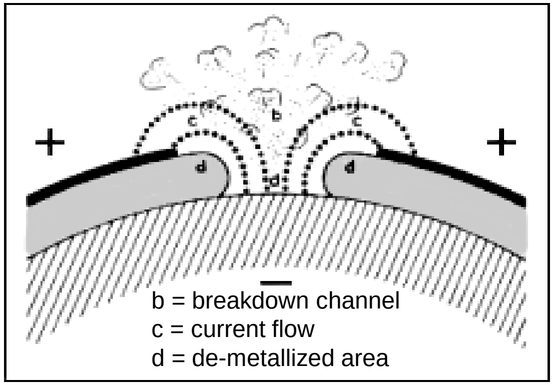
Capacitance µF	max. rulse rise time V/µs at $T_A < 40°$ C		
	400 VDC	630 VDC	1000 VDC
0.01 ...0.022	9000	11000	11000
0.033...0.068	9000	11000	11000
0.1 ...0.22	7000	11000	11000

Self-healing Process

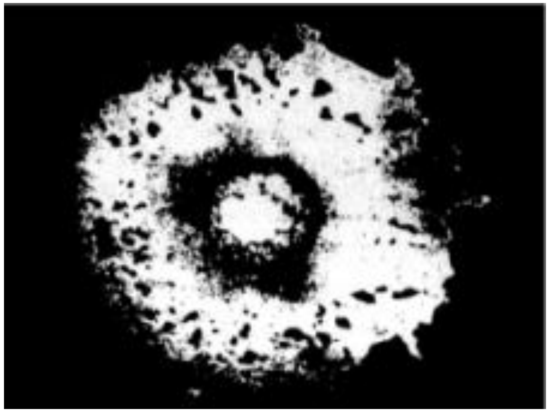
The physical process which leads to self-healing of a metallized film capacitor is basically as follows:

- during operation e.g. voltage spikes and/or high temperature may impact the capacitor
- as a result there is an electrical breakdown at the weakest point of the dielectric causing temperatures occurring in its surrounding of several thousand °C
- as a consequence the metallization evaporates in the area of the break-through channel
- a metal-free zone is created around the affected spot isolating the area electrically. The capacitor has regenerated (self-healed) completely.

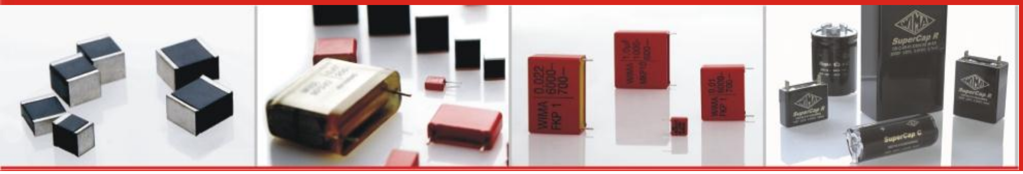
Only metallized film and paper capacitors exhibit the self-healing property. Ceramic, tantalum or electrolytic capacitors regularly fail after a breakdown.



Schematic depiction of the self-healing process



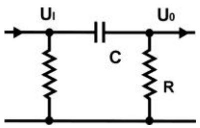
Isolated area after the self-healing process



BEST CAPACITORS
MADE IN GERMANY

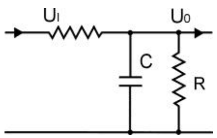
Industrial Electronics · Power Supplies/UPS/SMPS · AC/DC Converters · Measuring and Control Equipment

Coupling/ Blocking



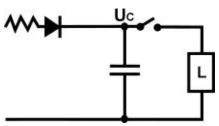
SMD	MKS 2
MKS 02	MKS 4

Decoupling/ Bypassing



SMD	MKS 2
MKS 02	FKS 3
FKS 2	MKS 4

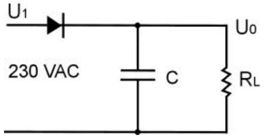
Energy Storing



MKP 2 *	FKP 1
MKP 10	Snubber
FKP 4	GTO

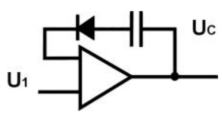
* ≥ 250VDC

Smoothing



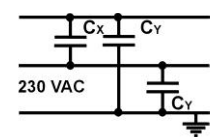
SMD	MKS 4
MKS 02	MKP 4
MKS 2	MKP 10

A/D Conversion



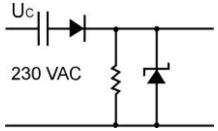
FKP 02	FKP 3
FKP 2	MKP 4
MKP 2	

RFI - Suppression



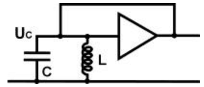
MKP-X2	MP3-X1
MKP-Y2	MP3-Y2
MP3-X2	MP3R-Y2

Voltage Dropper



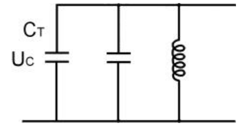
MP3-X2	MKS 4 *
MP 3-X2	* ≥ 630VDC ≥ PCM 10

Oscillating



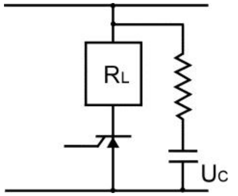
SMD-PPS	MKP 4
FKP 02	MKP 10
FKP 2	FKP 4
MKP 2 *	FKP 1
FKP 3	* ≥ 250VDC

Temperature Compensating



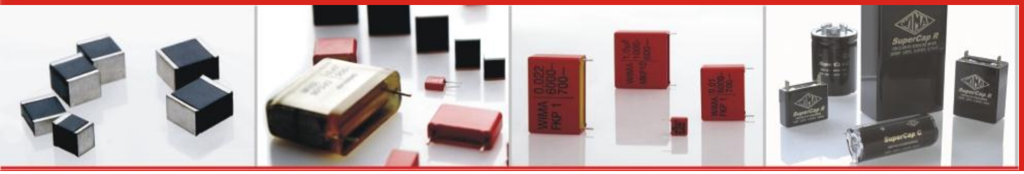
FKP 02/2	FKP 3
MKP 2	MKP4

Snubbing



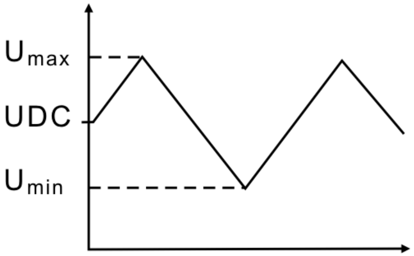
FKP 02/2	FKP 4
MKP 2 *	FKP 1
FKP 3	Snubber
MKP 10	GTO

* ≥ 250VDC



Selection of Capacitors for Pulse Application

Determination of DC and AC Voltage



$$U_{pp} = \left| U_{max} - U_{min} \right|$$

$$\left| U_{min} \right| \leqslant \left| U_{max} \right|$$

$$U_r \geqslant \frac{1}{k} \times U_{pp} + \left| U_{min} \right|$$

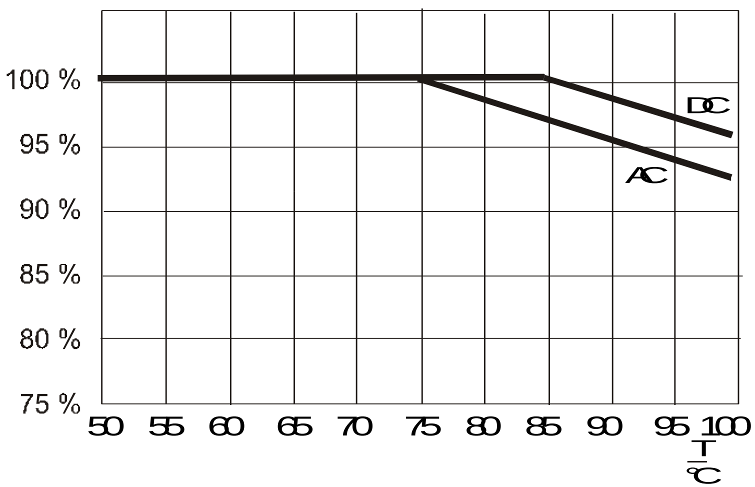
The voltage amplitude must not exceed the nominal DC voltage of the capacitor.

The r.m.s. voltage derived from the peak to peak voltage must not exceed the nominal AC voltage rating of the capacitor (ionization inception level).

Selection of Capacitors for Pulse Application

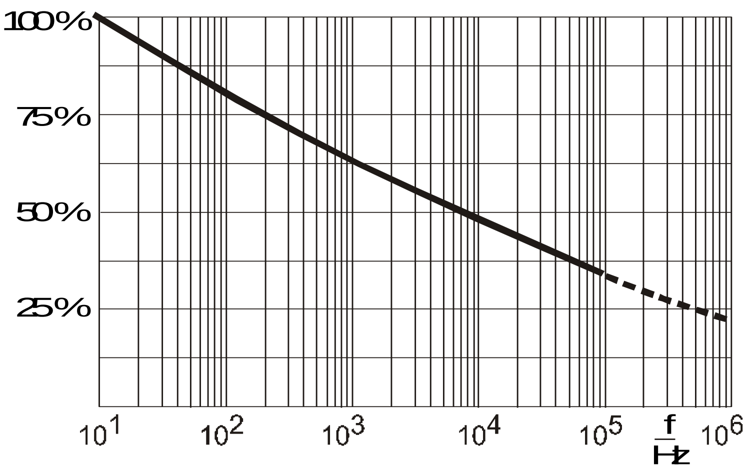
Voltage Derating

Temperature

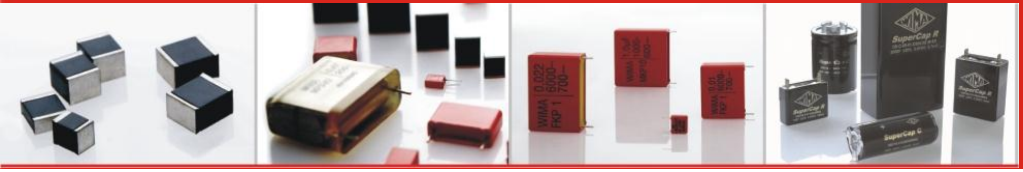


For Polypropylene film a voltage derating factor of 1.35% per K must be applied as of +85° C for DC voltage and as of +75° C for AC voltage.

Frequency



Dielectric strength of Polypropylene film as a factor of frequency (general guide)



Selection of Capacitors for Pulse Application

Determining the Permissible AC Voltage

To determine the permissible AC voltage (sinusoidal) for applications in a higher frequency spectrum, graphs showing AC voltage derating with frequency are available for the respective WIMA series.

The diagrams refer to a permissible self-heating of:
$\Delta\vartheta \leq 10$ K.

For the WIMA MKP 10 / 0.01 µF / 630 VDC/400 VAC, for example, this shows - when f = 50 kHz - a permissible AC voltage of U_{rms} = 280 V

The AC voltage given in the diagrams can also be used to determine the maximum effective current

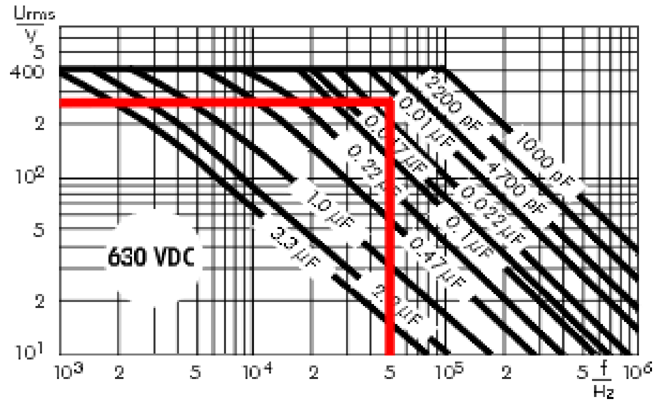
$$X_c = \frac{1}{\omega \times C} = \frac{1}{2\pi \times 50\ \text{kHz} \times 0.01\ \mu\text{F}}$$ Xc = 318 Ohm

$$I_c = \frac{U_c}{X_c} = \frac{280\ \text{V}}{318\ \Omega}$$ Ic = 0.88 A

The calculated maximum value of the effective current

$$I_p = I_c \times \sqrt{2} = 0.88\ \text{A} \times \sqrt{2}$$ Ip = 1.24 A

must not exceed the maximum pulse rise time calculation.



Permissible AC voltage in relation to frequency at 10° C internal temperature rise (general guide)

Selection of Capacitors for Pulse Application

Calculation for Pulse Capability

$$\frac{I}{C\ (\mu F)} = \frac{U}{t\ (\mu sec)}$$

$$Fmax = \frac{Ur}{Upp} \times Fr$$

1. Example: Calculation of Fmax

Given: Ip = 200 A, C = 1 μF

$$Fmax = \frac{200\ A}{1\ \mu F} = \frac{200\ V}{\mu sec}$$

2. Example: Calculation of Ip

Given: Fr = 100 V/μsec, C = 1 μF

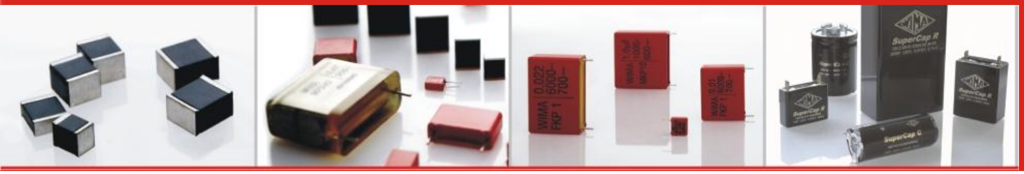
$$100\ \frac{V}{\mu sec} \times 1\ \mu F = 100\ A$$

3: Example: Calculation of Fmax

WIMA MKP 10 1μF/1000 VDC
Fr = 200 V/μsec (see WIMA main catalogue)
Upp = 500 V

$$Fmax = 200\ \frac{V}{\mu sec} \times \frac{1000\ V}{500\ V} = 400\ \frac{V}{\mu sec}$$

Ip = Peak Current [A]
Upp = Peak to Peak Voltage [V]
Fmax = Max. Pulse Rise Time [V/sec]



Selection of Capacitors for Pulse Application

Dissipation (heat losses):

The heat dissipated by a capacitor when stressed by non-sinusoidal voltages or when under pulse conditions can be approximately determined from the following formula:

$$Pd = U_{rms}^2 \ \text{x} \ \omega C \ \text{x} \ \tan\delta$$

where

Pd = dissipation in Watts.

U_{rms} = root mean square value of the AC voltage share

ω = 2π x f (f is the repetition frequency of the pulse waveform)
C = capacitance in Farad.

tan δ = dissipation factor corresponding to the frequency of the steepest part of the pulse.

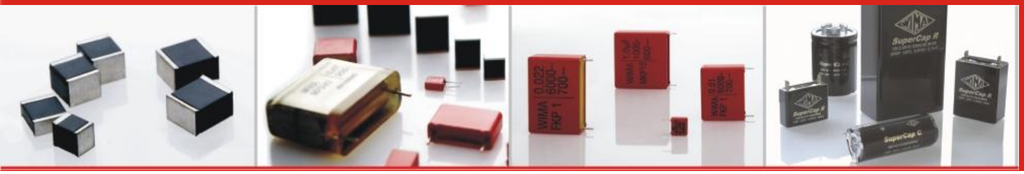
$$\text{Max.Temperature Rise} = \frac{Pd}{Pspec} < 10K$$

Printed circuit module PCM (in mm)	Specific dissipation in Watts per K above the ambient temperature
2.5	0.0025
5	0.004
7.5	0.006
10	0.0075
15	0.012
22.5	0.015
27.5	0.025
37.5	0.03

Example: WIMA MKP 10 1μF/1000 VDC PCM 37.5 mm

Given: U_{rms} (354)² x ωC (2π x 1 x 10^{-6}) x tan δ (3 x 10^{-4}) = Pd = 0.236W

$$\text{Max.Temperature Rise} = \frac{0.236}{0.03} = 7.9\ K \quad < 10K$$

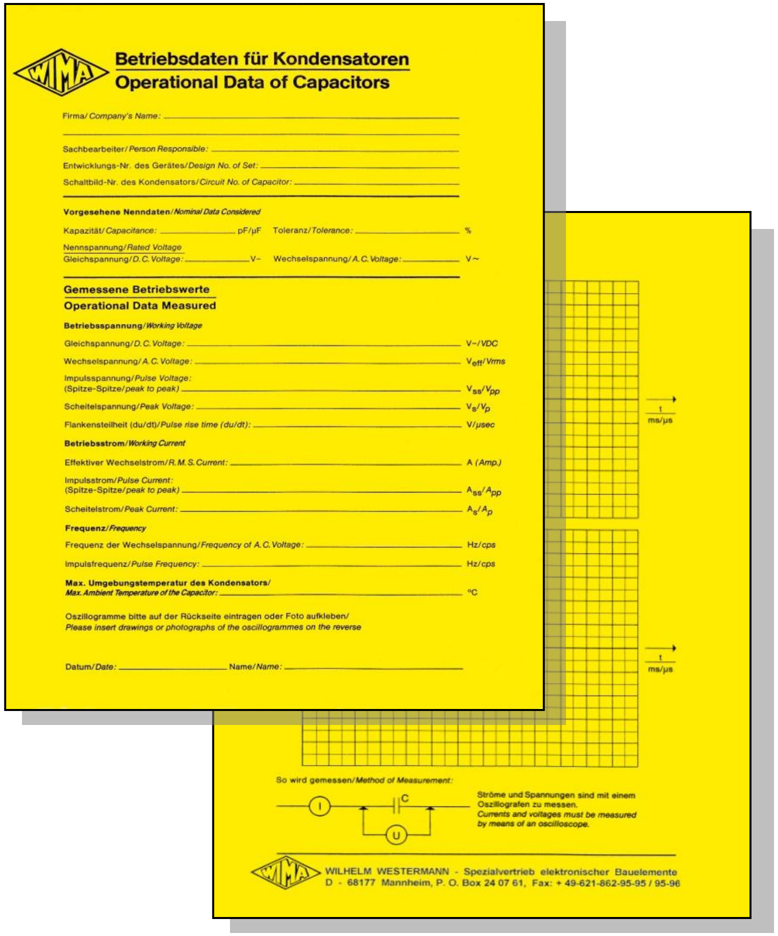


Selection of Capacitors for Customized Applications

Operational Data Required for Capacitor Calculation

- **Electrical data of the capacitor**
  - Capacitance
  - Voltage (DC / AC)
  - Tolerance*
  - Dimensions* / PCM*
- **Electrical data of the application**
  - Voltage
  - Current
  - Pulse frequency / Repetition frequency
  - Time axis
  - Pulse rise time*
- **Application data**
  - Ambient temperature
  - Kind of application*
- **Oscillogramme (voltage and current) appreciated**

***optional**



Betriebsdaten für Kondensatoren
Operational Data of Capacitors

Firma/ *Company's Name:* ____

Sachbearbeiter/ *Person Responsible:* ____
Entwicklungs-Nr. des Gerätes/ *Design No. of Set:* ____
Schaltbild-Nr. des Kondensators/ *Circuit No. of Capacitor:* ____

Vorgesehene Nenndaten/ *Nominal Data Considered*

Kapazität/ *Capacitance:* ____ pF/µF Toleranz/ *Tolerance:* ____ %
Nennspannung/ *Rated Voltage*
Gleichspannung/ *D. C. Voltage:* ____ V– Wechselspannung/ *A. C. Voltage:* ____ V~

Gemessene Betriebswerte
Operational Data Measured

Betriebsspannung/ *Working Voltage*
Gleichspannung/ *D. C. Voltage:* ____ V–/ VDC
Wechselspannung/ *A. C. Voltage:* ____ V_{eff}/ Vrms
Impulsspannung/ *Pulse Voltage:*
(Spitze-Spitze/ *peak to peak)* ____ V_{ss}/V_{pp}
Scheitelspannung/ *Peak Voltage:* ____ V_s/V_p
Flankensteilheit (du/dt)/ *Pulse rise time (du/dt):* ____ V/µsec

Betriebsstrom/ *Working Current*
Effektiver Wechselstrom/ *R. M. S. Current:* ____ A (Amp.)
Impulsstrom/ *Pulse Current:*
(Spitze-Spitze/ *peak to peak)* ____ A_{ss}/A_{pp}
Scheitelstrom/ *Peak Current:* ____ A_s/A_p

Frequenz/ *Frequency*
Frequenz der Wechselspannung/ *Frequency of A. C. Voltage:* ____ Hz/cps
Impulsfrequenz/ *Pulse Frequency:* ____ Hz/cps

Max. Umgebungstemperatur des Kondensators/
Max. Ambient Temperature of the Capacitor: ____ °C

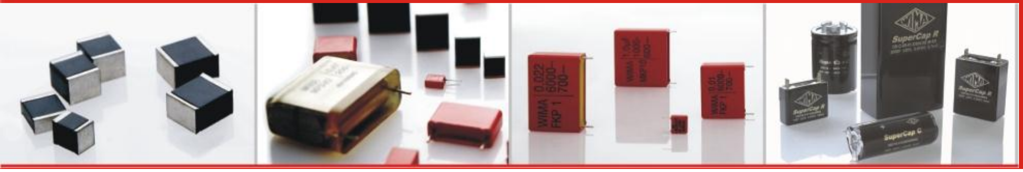
Oszillogramme bitte auf der Rückseite eintragen oder Foto aufkleben/
Please insert drawings or photographs of the oscillogrammes on the reverse

Datum/ *Date:* ____ Name/ *Name:* ____

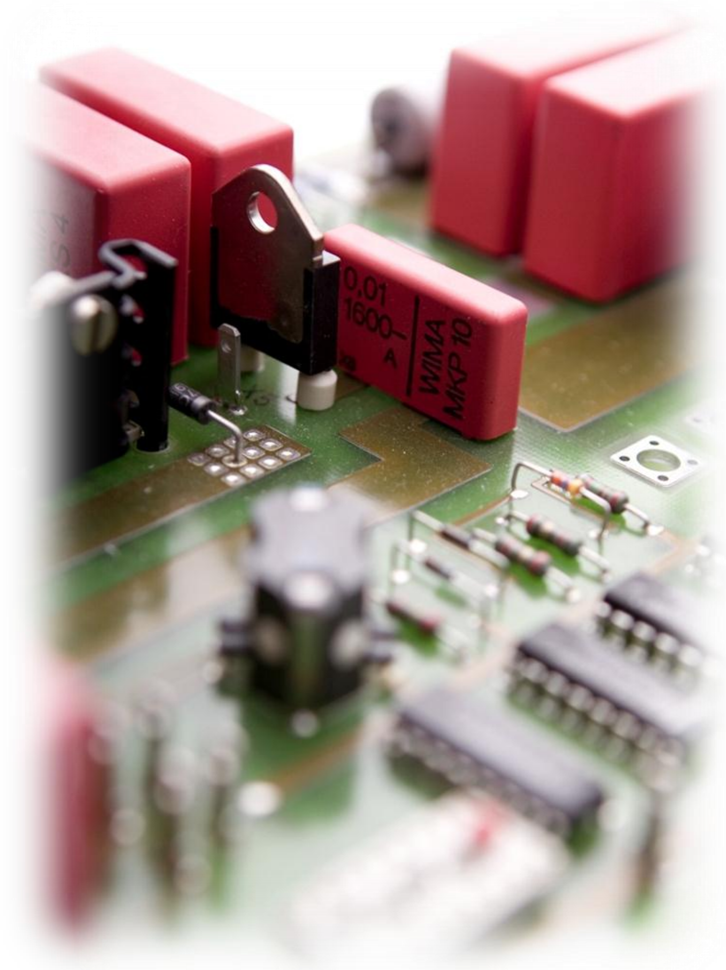
So wird gemessen/ *Method of Measurement:*

Ströme und Spannungen sind mit einem Oszillografen zu messen.
Currents and voltages must be measured by means of an oscilloscope.

WILHELM WESTERMANN - Spezialvertrieb elektronischer Bauelemente
D - 68177 Mannheim, P. O. Box 24 07 61, Fax: + 49-621-862-95-95 / 95-96



Thank you!



PT ELECTRONICS
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