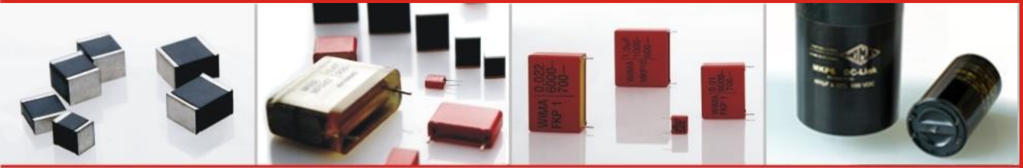
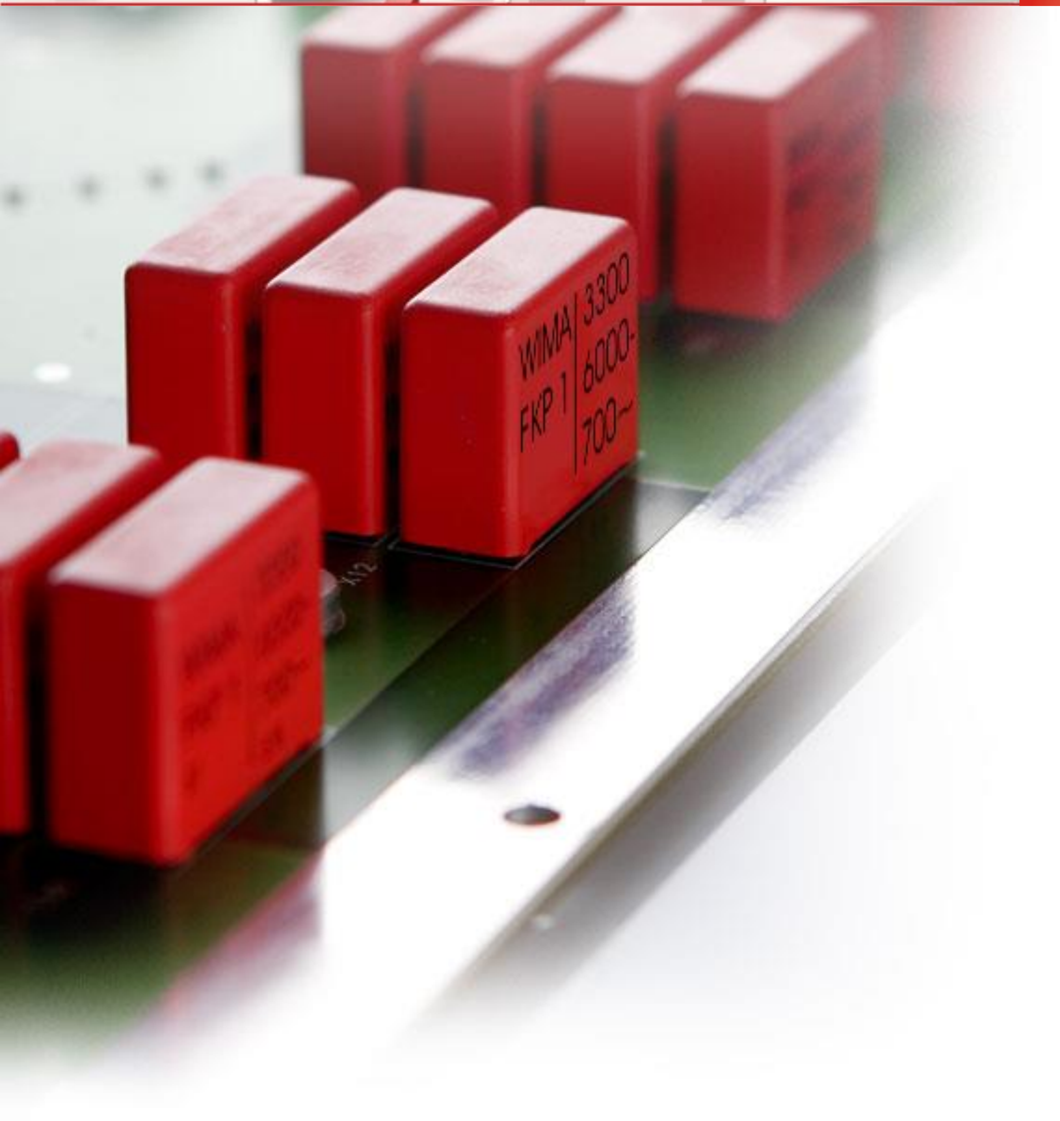
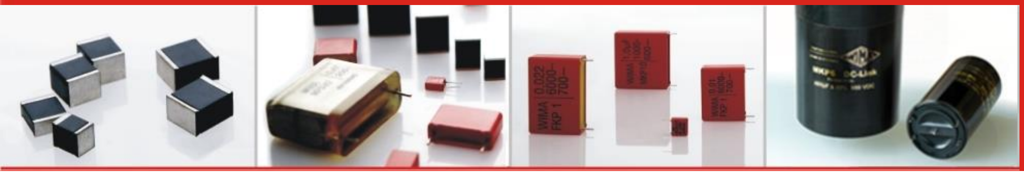




WIMA technical training

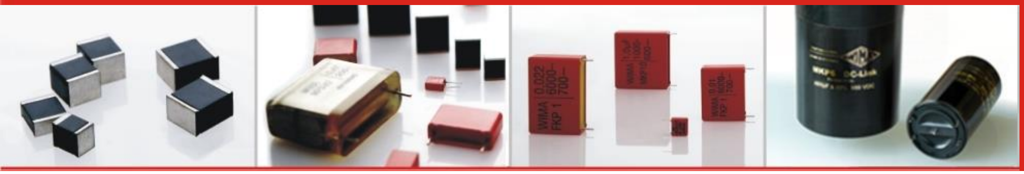
27.05.2015

Maritex



Outline

- **WIMA facts**
  - Product range
  - Application guide
- Film capacitors
  - Construction principles and technology
  - SMD capacitors
  - RFI capacitors
  - GTO / Snubber capacitors
  - DC-Link capacitors
  - Pulse capacitors



WIMA Facts

- **Foundation:** 1948 by Wilhelm Westermann
- **Fields of Activities:** Manufacture and sale of:
  - SMD film capacitors
  - through hole plastic film capacitors
  - metallized paper capacitors
  - DC-Link power capacitors
- **Ownership:** 100 % privately owned
  Wilhelm Westermann: 1948 - 1980
  Wolfgang Westermann: 1981 - today
- **Production Capacity:** 3 million pieces/day
- **Sites:** Administration and production in Germany only
- **Distribution:** Worldwide

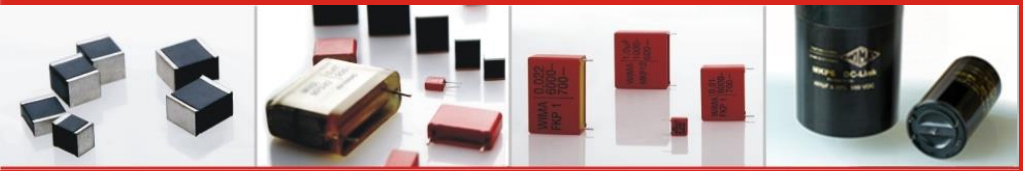
WIMA Locations and Products

Production

R & D / Special Capacitors

Production

Sales Department



WIMA Quality

All WIMA factories are approved to
ISO 9001:2008
as well as to
ISO 14001:2004
Furtmermore all WIMA series will be approved in accordance to **AEC-Q200** by end of 2016.

All WIMA products are manufactured in accordance with **IEC** specifications.

All WIMA products are in accordance with RoHS 2011/65/EC

All WIMA plants are subject to **WPCS** (WIMA Process Control System) to optimize quality.
WPCS is a quality surveillance and optimization system developed by WIMA being a major part of our quality-orientated production.

WPCS

System 1

Inspection by parameters and/or identity checks per production stage (QCG - Quality Control Gates)

Detection and elimination of deviations from the parameters as the basis of the quality assurance of the respective production stage

- Surveillance: Determination good/bad
- Immediate elimination of non-conformity

System 2

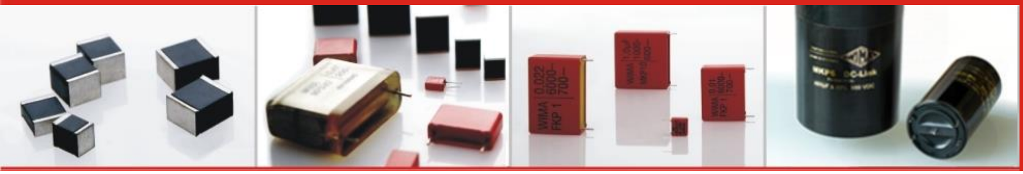
SPC (Statistical Process Control)

- Continuous control of quality level within defined limits
- Continuous optimization of process parameters
- Reconstruction of process data

Consistent Quality Status

Issues of WPCS during production process:

1. Incoming material inspection
2. Film metallization
3. Film inspection
4. Schoopage
5. Pre-healing
6. Pin attachment
7. Cast resin preparation/ encapsulation
8. 100% final inspection
9. Testing as per customer requirements



WIMA Philosophy

Overall goal of the WIMA Group is **highest quality and total customer satisfaction** by a performance covering:

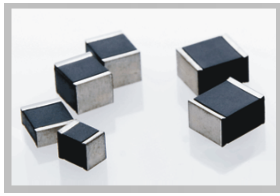
- **Quality**
- **Innovation**
- **Delivery Reliability**
- **Cost Effectiveness**

As a **capacitor specialist** with headquarter and production in Germany the competitiveness against multinational conglomerates can only be sustained through a combination of:

- a lean and flexible organisation and
- excellence in technical innovation, productivity and customer orientation.

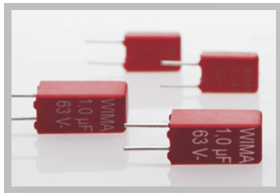
The increasing tendency away from the pure “low-price-philosophy” is primarily due to the customer’s desire for further improvement of his own product quality.

WIMA Product Range



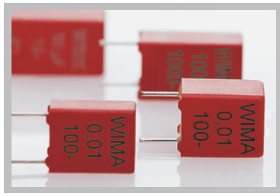
- **SMD Plastic Film Capacitors**

  0.01 µF - 6.8 µF
  63 VDC - 1000 VDC



- **PCM 2.5 mm Capacitors**

  100 pF - 1 µF
  50 VDC - 400 VDC

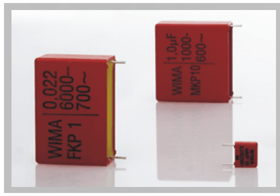


- **PCM 5 mm Capacitors**

  27 pF - 10 µF
  50 VDC - 1000 VDC

- **Capacitors for stringent requirements**

  100 pF - 220 µF
  50 VDC - 2000 VDC

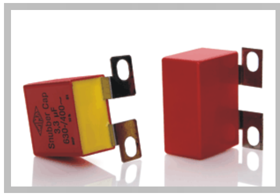


- **Capacitors for high current ratings**

  100 pF - 47 µF
  100 VDC - 6000 VDC

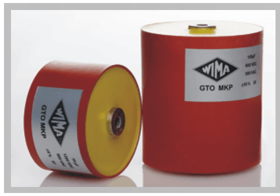
- **RFI Capacitors Class X1, X2, Y2**

  1000 pF – 10 µF
  250 VAC - 500 VAC



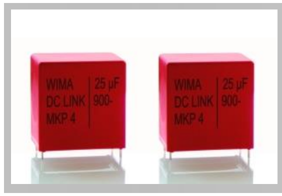
- **Snubber Capacitors**

  0.01 µF - 25 µF
  250 VDC - 4000 VDC



- **GTO Capacitors**

  1 µF - 100 µF
  400 VDC - 2000 VDC

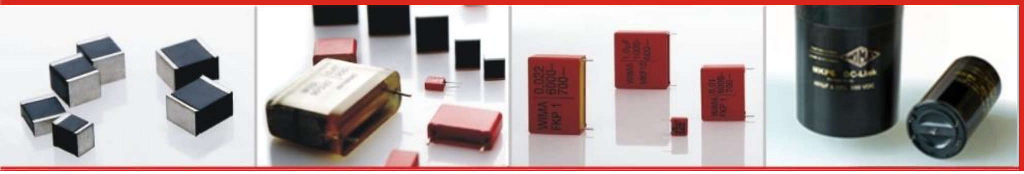


- **DC-LINK Capacitors**

  0.47 µF - 150 µF
  450 VDC - 1300 VDC

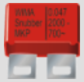
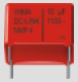
- **DC-LINK Capacitors**

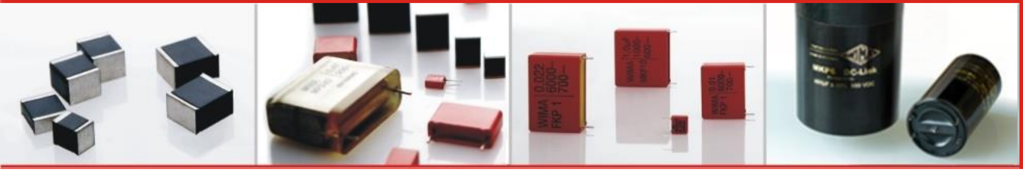
  16 µF - 4920 µF
  400 VDC - 1600 VDC



WIMA Application Guide:

Overview

			Fields of Application						
			Automotive	Power	Lighting	Medical	Consumer	Telecom/Data	New Energy
Product Family	Range Description	Picture							
SMD Capacitors	**Size Codes 1812-6054** SMD-PET/-PPS		✓	✓		✓	✓	✓	
Film Capacitors	**PCM 2.5 - 52.5 mm** MKS, MKP, FKS, FKP		✓	✓	✓	✓	✓	✓	✓
Pulse Duty Capacitors	**PCM 7.5 - 52.5 mm** MKP 10, FKP 4, FKP 1		✓	✓	✓	✓	✓	✓	✓
EMI Suppression Capacitors	**PCM 7.5 - 27.5 mm** MKP-X2/-Y2 MP 3-X2/-X1/-Y2/R-Y2			✓	✓	✓	✓	✓	✓
Snubber Capacitors	**Variable terminations** Snubber MKP/FKP		✓	✓		✓			✓
GTO Capacitors	**Axial screw connection** GTO MKP			✓					✓
DC-LINK Capacitors	**Variable contacts** DC-LINK MKP 3/4/4S/5/6 HC/HY		✓	✓					✓



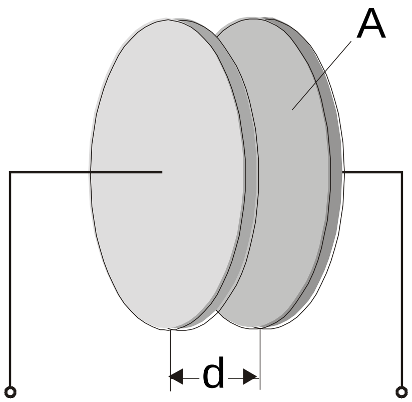
Outline

- WIMA facts
  - Product range
  - Application guide
- **Film / foil capacitors**
  - Construction principles and technology
  - SMD capacitors
  - RFI capacitors
  - GTO / Snubber capacitors
  - DC-Link capacitors
  - Pulse capacitors

The Plate Capacitor

Definition:
A capacitor is measured by the size of its capacitance. A capacitance is the electric capacity of a capacitor, i.e. the amount of electrically charged carriers it can store.

Symbol: C
Measurement Unit: F = Farad (nF, pF, µF)



$$C = \varepsilon_0 \times \varepsilon_r \times \frac{A}{d}$$

A = One plate surface in cm²
(in this case a metal plate as the electrode)

d = Distance between the plates in cm
(in this case air as a dielectric)

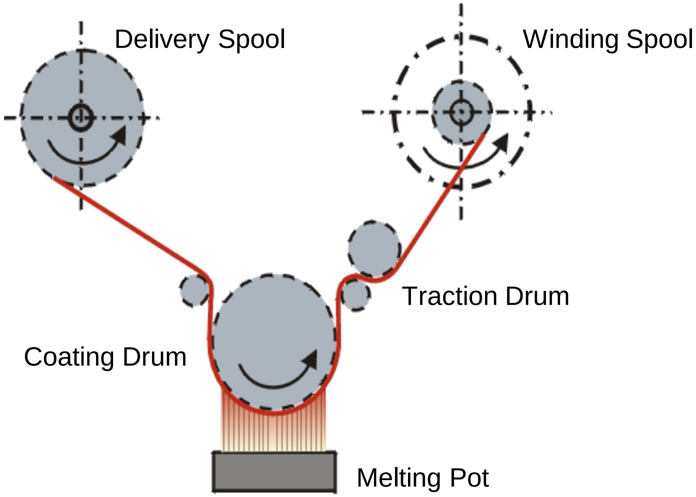
<u>Basic parameters of a capacitor</u>

-Capacitance
-Capacitance tolerance (nominal = 20% / down to 1%)
- Voltage DC/AC
- Mechanical dimesion / PCM

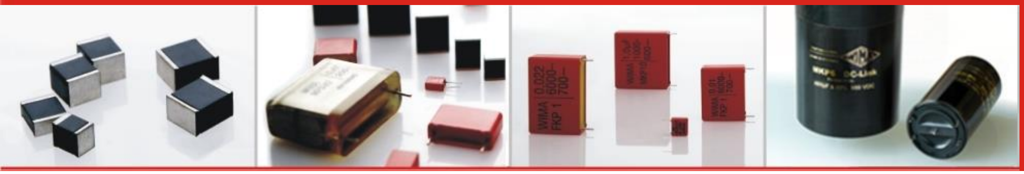
Film Technology

Metallization of Plastic Film

- Aluminium is heated up to approx. 1400° C.
- The evaporated aluminium precipitates on the plastic film.
- In order not to damage the ultra-thin plastic film the coating drum has to be cooled down to approx. - 50°C.

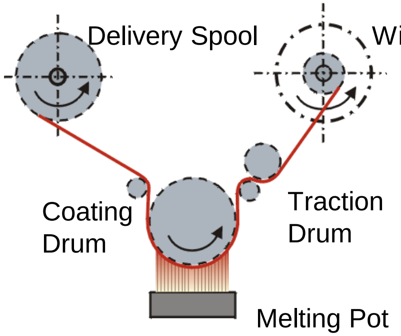


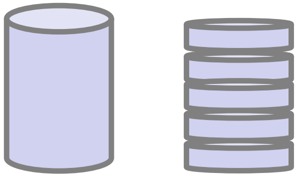
Metallization of films used for production of WIMA capacitors are made by WIMA using special equipment.

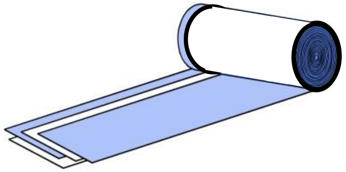


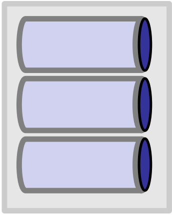
WIMA Manufacturing Process of Plastic Film Capacitors

Metallization → **Cutting** → **Winding** → **Schoopage**



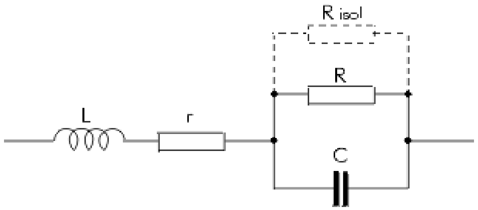






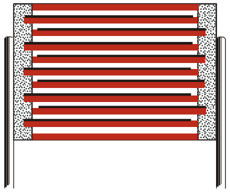
Schoopage of Front surface

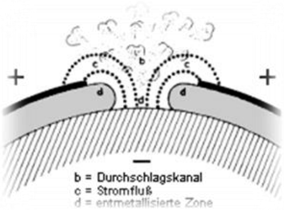
100% Final Inspection ← **Encapsulation** ← **Lead attachment** ← **Pre-healing**



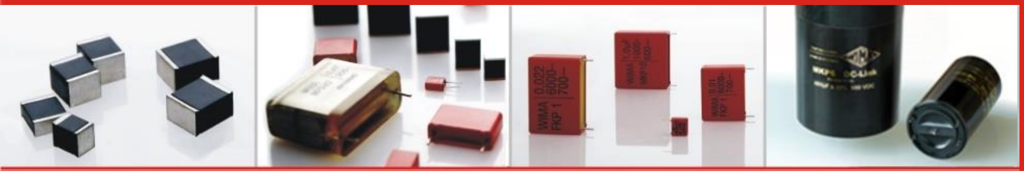
<u>100% final inspection:</u>
-Capacitance tolerance
-Insulation resistance
-Dissipation factor

Separate cast resin preparation





Pre-Healing in incremental steps



Definition of technical terms regarding plastic film capacitors

Dissipation factor and ESR

The dissipation factor tanδ is a measure of loss-rate of energy of a mode of oscillation.
Electrical potential energy is dissipated in all dielectric materials, usually in the form of heat. In a capacitor made of a dielectric placed between conductors, the typical lumped element model includes a lossless ideal capacitor in series with a resistor termed the equivalent series resistance (= ESR) The ESR represents losses in the capacitor.
In a good capacitor the ESR is very small, and in a poor capacitor the ESR is high.

Insulation resistance/Time Constant

The resistance to the flow of current through an insulating material resulting from an impressed direct voltage; usually expressed in ohms.
The time constant defines the time in seconds, in which the voltage across the capcitor self-discharges to 37% of the fully charged state.
In a good capacitor the Insulation resistance (Ris) is very high, and in a poor capacitor the Ris is low.

Dielectric strength

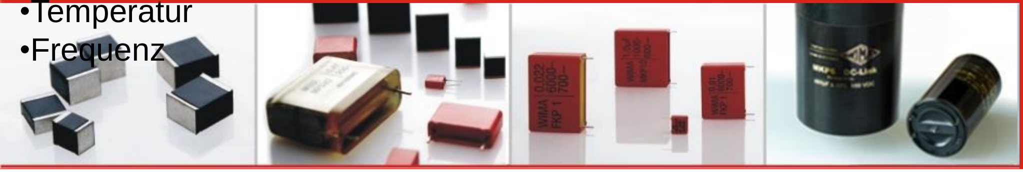
With regards to an insulating material: the maximum electric field that a pure material can withstand under ideal conditions without breaking down. A good capacitor has a high dielectric strength, and a poor capacitor has a low dielectric strength.

Dielectric absorption

Dielectric absorption is the name given to the effect by which a capacitor, that has been charged for a long time, discharges only incompletely when briefly discharged. Although an ideal capacitor would remain at zero volts after being discharged, real capacitors will develop a small voltage from time-delayed dipole discharging, a phenomenon that is also called dielectric relaxation.
A good capacitor has a low dielectric absorption, and a poor capacitor has a high dielectric absorption.

Maximum current / Pulse rise time (in V/μsec)

The interval of time required for the leading edge of a pulse to rise from 10% to 90% of the peak pulse amplitude. The rise time of the pulse is taken as the reference point when calculating the maximum current rating to the end contacts.
A good capacitor shows a high pulse rise time, and a poor capacitor shows a low pulse rise time.



Definition of technical terms regarding plastic film capacitors

Self-Inductance

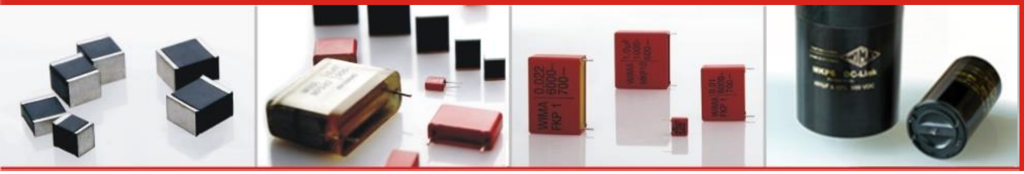
The capacitor winding element creates a more or less distinctive magnetic field which can be measured as inductance L.
In a good capacitor the Self-Inductance is very low, and in a poor capacitor the Self-Inductance is high.

Temperature coefficient of capacitance

The temperature coefficient shows the change of capacitance with temperature.
A good capacitor has a low temperature coefficient, and a poor capacitor has a high temperature coefficient.

Stress factors for capacitors

- Current
- Voltage
- temperature
- frequency



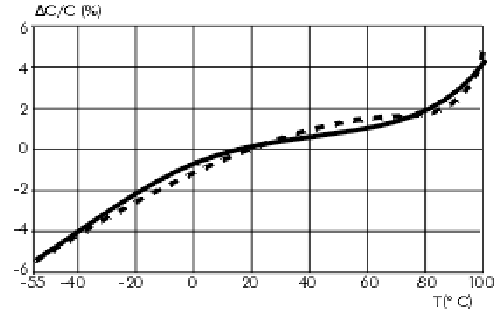
Polyester (PET) Film

Typical Applications

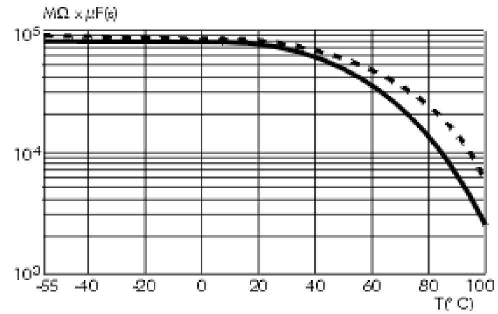
- Decoupling/Bypassing
- Coupling/Blocking
- Smoothing etc.

Film Properties

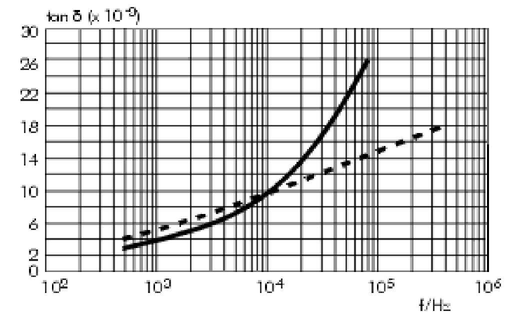
- Max. operating temperature: +100°C
- Film thickness: > 0.5 µm
- Advantageous price/performance ratio
- Advantageous capacitance/volume ratio
- Substitution of ceramic, electrolytic and tantalum capacitors



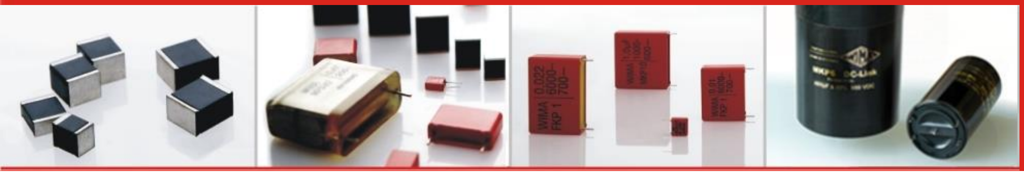
Capacitance change versus temperature (f = 1 kHz) (general guide)



Insulation resistance change versus temperature (general guide)



Dissipation factor change versus frequency (general guide)



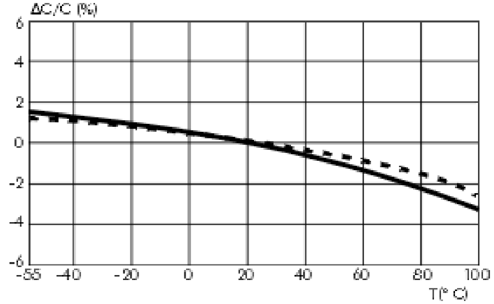
Polypropylene (PP) Film

Typical Applications

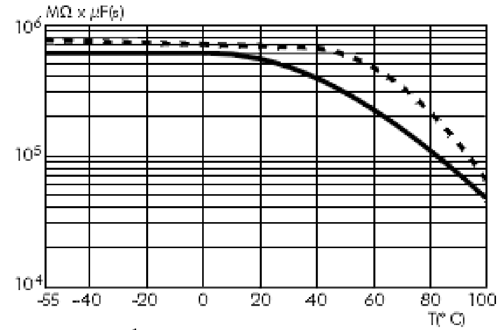
- Energy storing
- Oscillating
- Resonating
- Smoothing
- A/D conversion
- Snubbing
- Temperature compensation
- RFI suppression
- Sample and hold circuits etc.

Film Properties

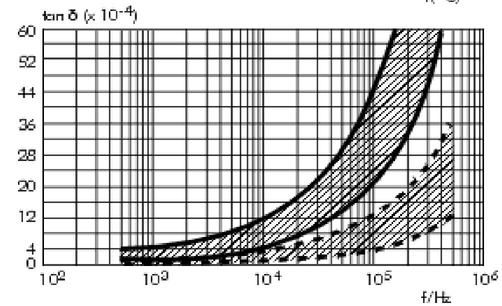
- Max. operating temperature: +100°C
- Film thickness: > 4 µm
- Lowest dissipation factor
- Constantly negative TKc
- Tight tolerances



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



Insulation resistance change versus temperature (general guide)



Dissipation factor change versus frequency (general guide)

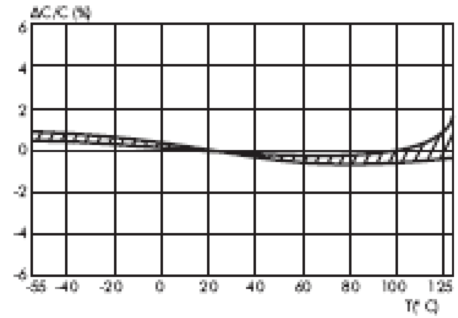
Polyphenylene-sulphide (PPS) Film

Typical Applications

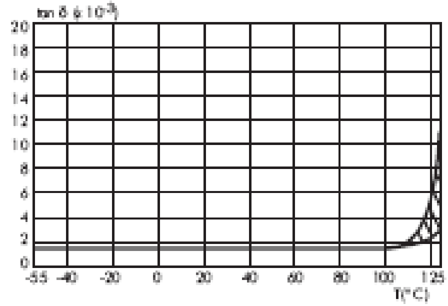
- Filtering
- Oscillating
- Resonating

Film Properties

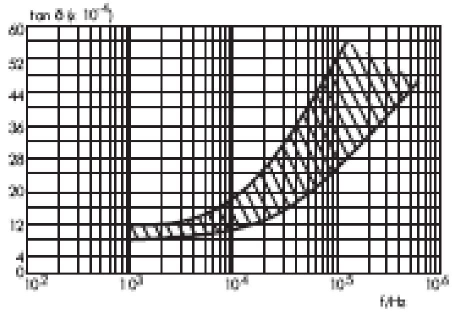
- Max. operating temperature: +140°C
- Advantageous capacitance/volume ratio
- Low dissipation factor
- Quite constant TKc



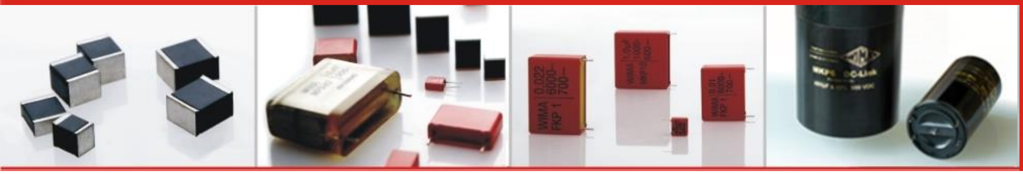
Capacitance change versus temperature (f = 1 kHz) (general guide)



Dissipation factor change versus temperature (f = 1 kHz) (general guide)

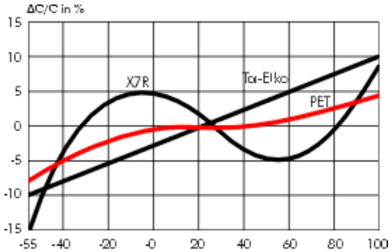


Dissipation factor change versus frequency (general guide)

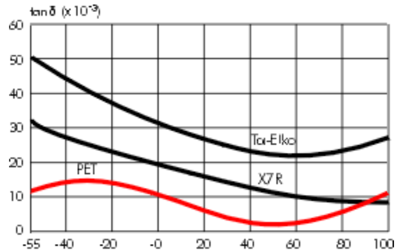


Comparison of Dielectrics

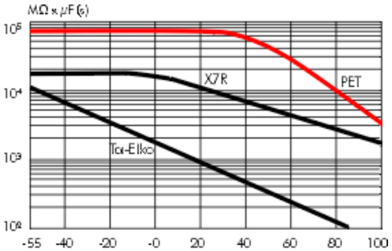
	PET	PP	PPS	NPO	X7R	Tantalum
Dielectric constant 1kHz/23°C	3.3 (positive with temperature rise)	2.2 (negative as temperature rise)	3.0 (very constant versus temperature)	12...40	700-2000	26
ΔC/C with temperature(%)	+/-5	+/-2.5	+/-1.5	+/-0.3	+/-15	+/-10
DC Voltage coefficient (%)	negligible	negligible	negligible	negligible	-20	negligible
ΔC Aging rate (%/h dec.)	negligible	negligible	negligible	negligible	2	n.a.
Dissipation factor (%) 1 kHz 10 kHz 100 kHz	 0.8 1.5 3.0	 0.05 0.08 0.25	 0.2 0.25 0.5	 0.10 0.10 0.10	2.5	8
Self-healing	yes	yes	yes	no	no	no
Dielectric absorption (%)	0.5	0.05...0.10	0.05	0.6	2.5	n.a.



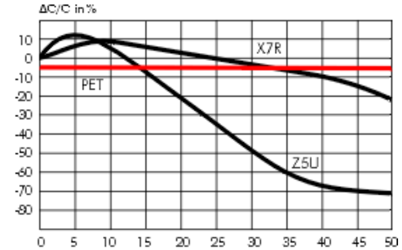
Capacitance change with temperature (f = 1 kHz)



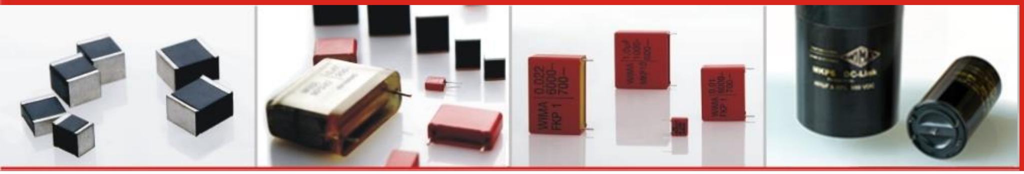
Dissipation factor change with temperature (f = 1 kHz)



Insulation resistance change with temperature



Capacitance change with voltage (f = 1 kHz)



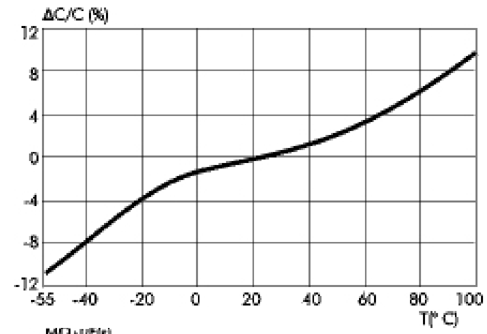
Paper (MP) Dielectric

Typical Applications

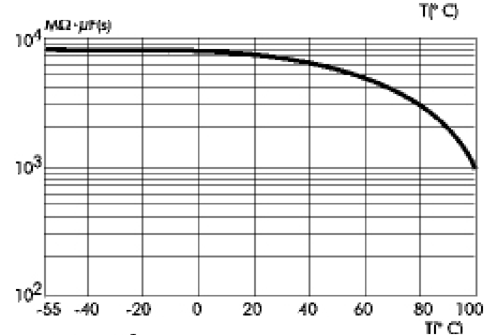
- RFI circuits (class X and Y)
- Across the line applications
- Phase to earth applications

Film Properties

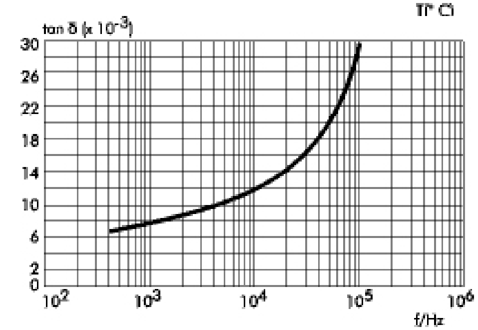
- Temperature range up to +110° C
- Excellent self-healing property (oxidation ratio)
- High reliability against active and passive flammability
- Recommended for across the line applications also during stand-by mode



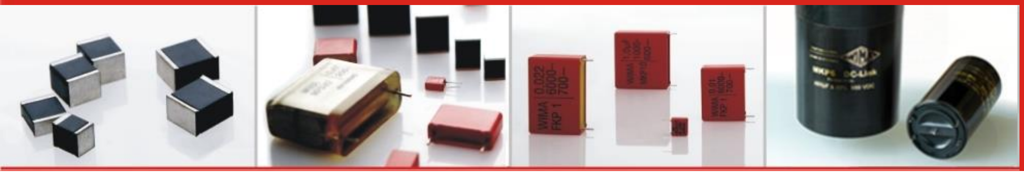
Capacitance change versus temperature
(f = 1 kHz)
(general guide)



Insulation resistance change versus temperature
(general guide)



Dissipation factor change versus frequency
(general guide)

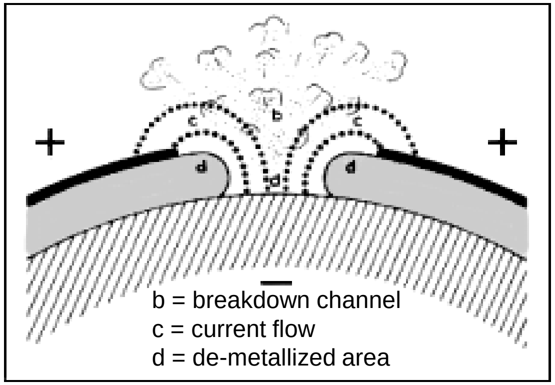


Self-healing Process

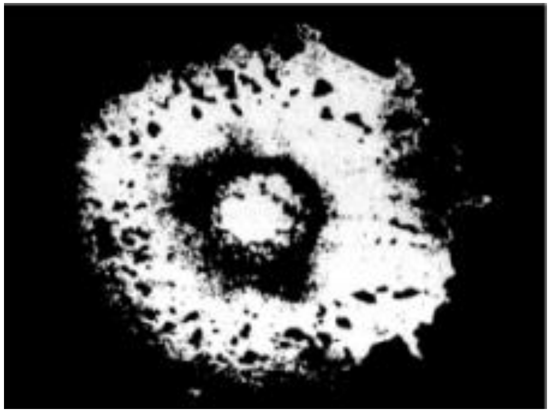
The physical process which leads to self-healing of a metallized film capacitor is basically as follows:

- 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.

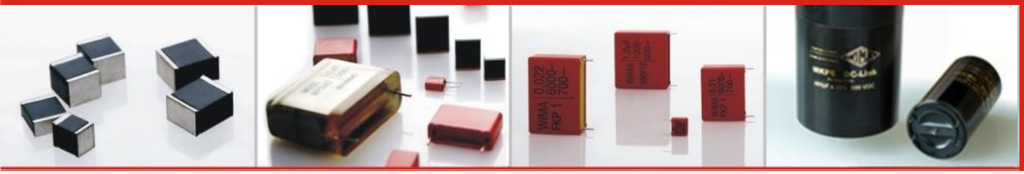
Only metallized film and paper capacitors exhibit the self-healing property. Ceramic, tantalum or electrolytic capacitors regularly fail after a breakdown.



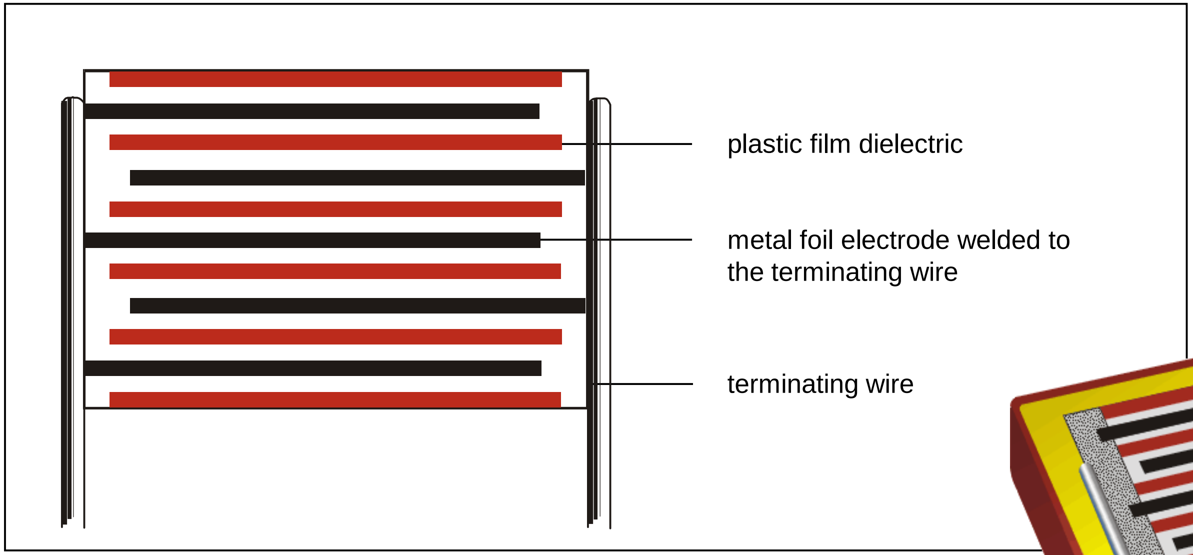
Schematic depiction of the self-healing process

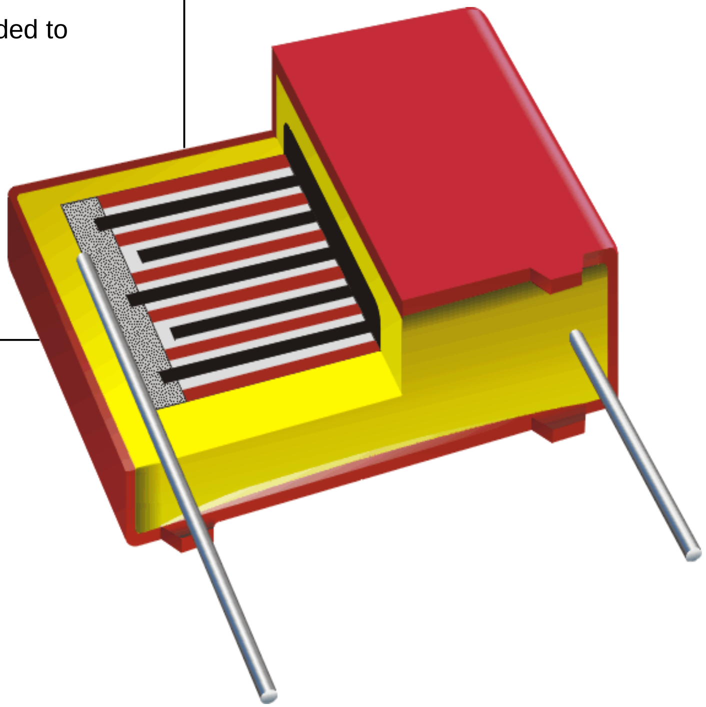


Isolated area after the self-healing process



Film/Foil Construction

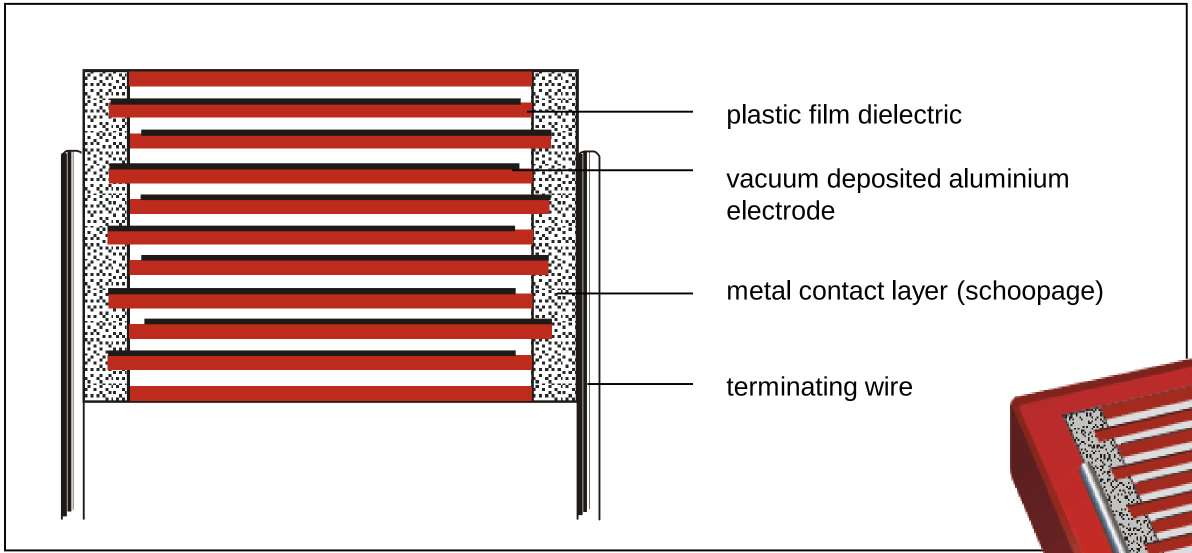


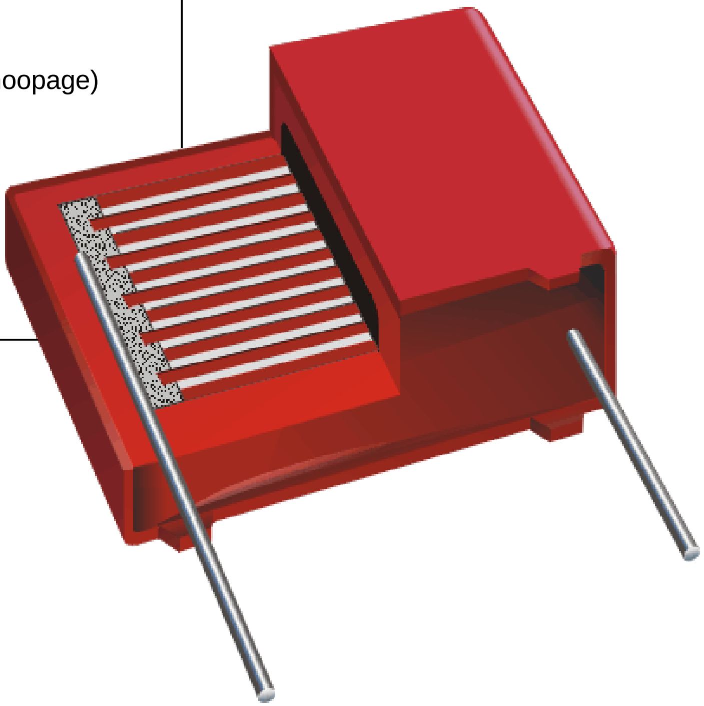


With film/foil capacitors the electrode being a metal foil is wound together with the dielectric film.

Due to their low series resistance, components of this construction type exhibit **excellent pulse and current carrying capabilities** as well as a **very high insulation resistance**.

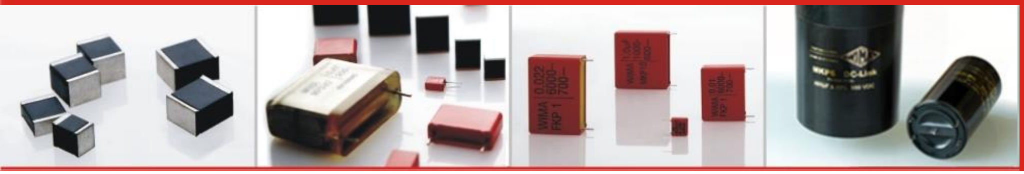
Metallized Construction



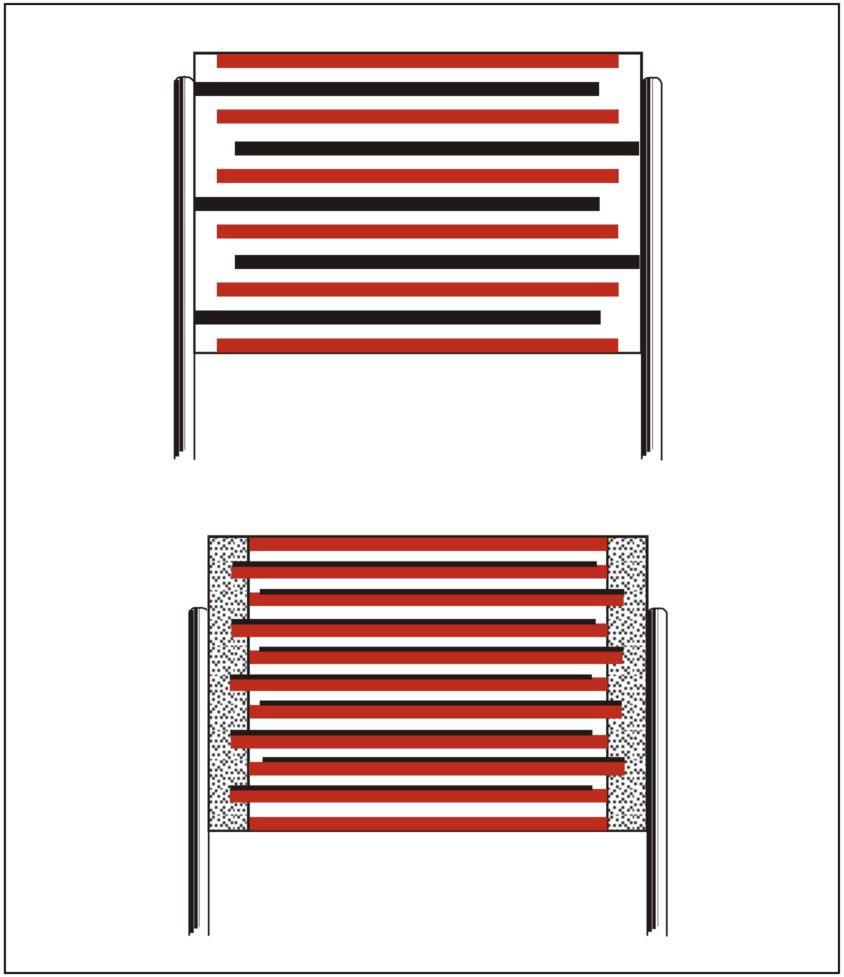


With metallized capacitors the dielectric film is metallized with aluminium serving as an electrode resulting in a **favourable capacitance / volume** ratio.

Another specific characteristic is the **excellent self-healing ability** ensuring an almost **unlimited life expectancy** of the capacitors.



Construction Principles



Film/Foil Construction

Advantages

- Excellent pulse and current carrying capability
- High insulation resistance
- Close tolerances up to ± 1%
- Voltage ranges up to 1000 VDC in PCM 5 mm.

Disadvantages

- Irreversible short circuit in case of breakdown

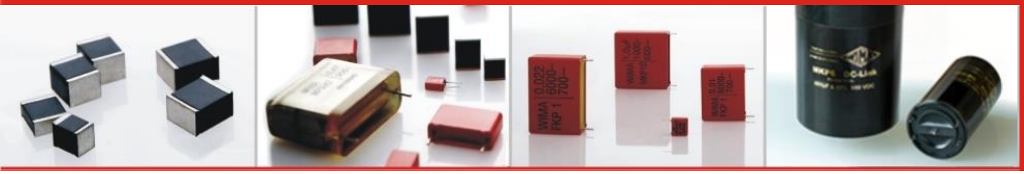
Metallized Construction

Advantages

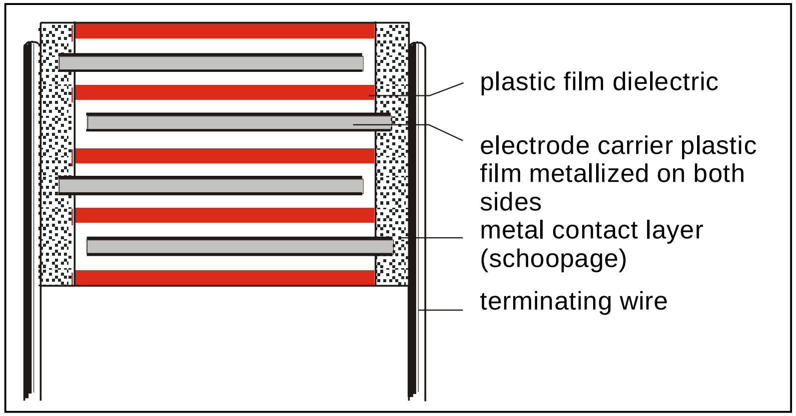
- Small size
- Excellent self-healing properties
- Cost effectiveness

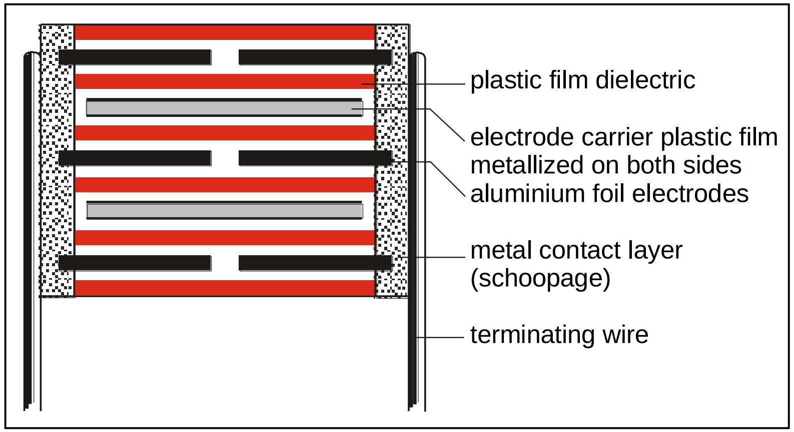
Disadvantages

- Low pulse resistance



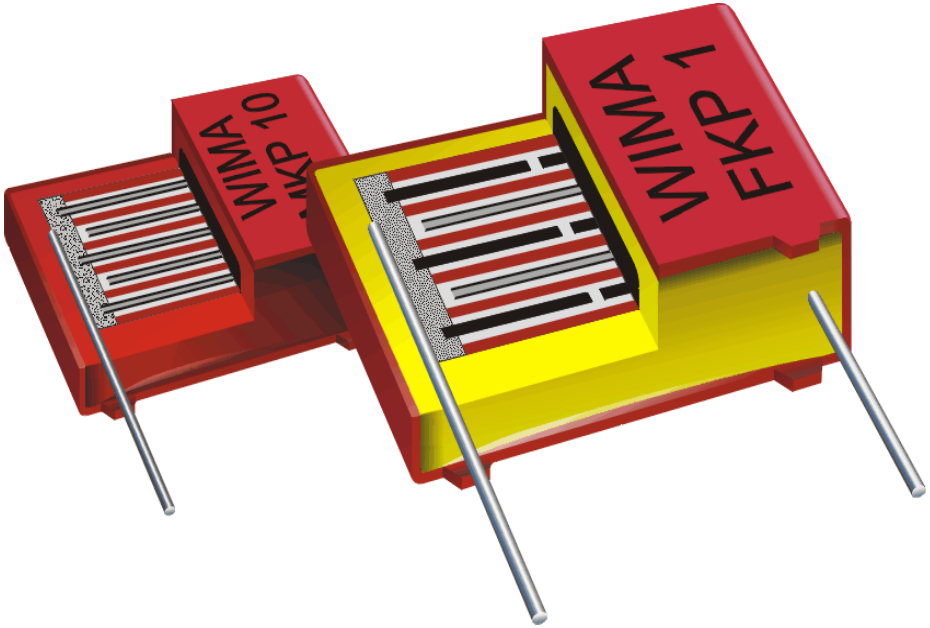
WIMA Constructions for Pulse Applications





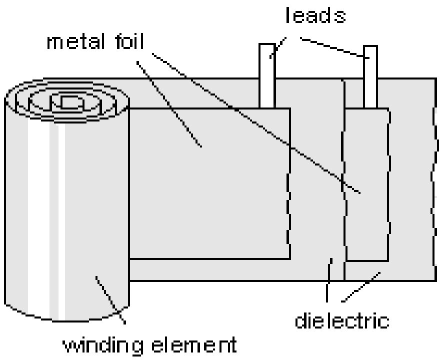
WIMA MKP 10 exhibit a non-metallized dielectric and a carrier film electrode metallized on both sides.

WIMA FKP 1 / FKP 4 have an internal series connection, the metal foil electrodes being combined with a floating metallized electrode. Due to their special construction they combine the properties of metallized and film/foil capacitors as there are **excellent pulse and current carrying capability** as well as **very good self-healing properties**.



Self-Inductance Depends on Construction Principle

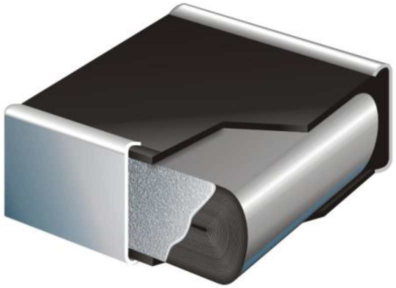
Antiquated construction with high self-inductance



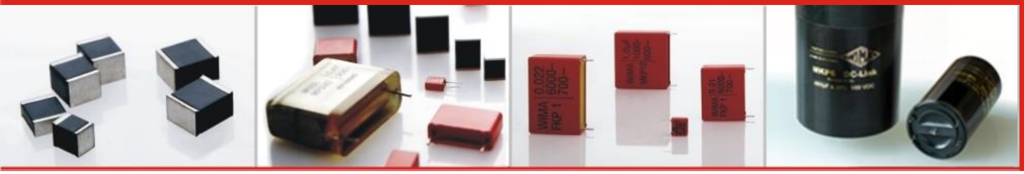
The tape length of the winding element determines the amount of the self-inductance

WIMA MKS 02
PCM 2.5 mm
Self-inductance L< 8nH

WIMA SMD 1812
Self-inductance L< 4nH



The self-inductance is determined only by the PCM and the remaining length of the terminating wires (for SMD capacitors the distance between the soldering tabs is relevant).



BEST CAPACITORS
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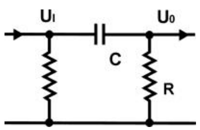
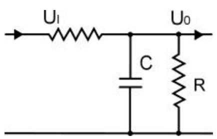
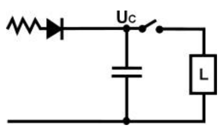
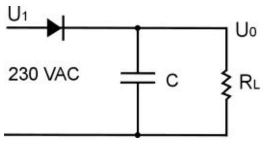
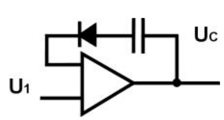
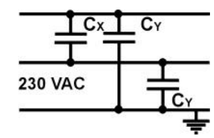
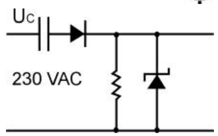
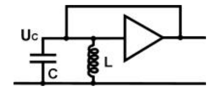
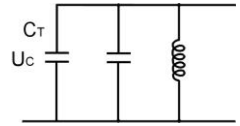
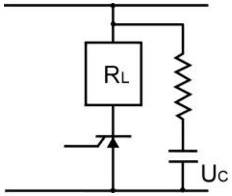
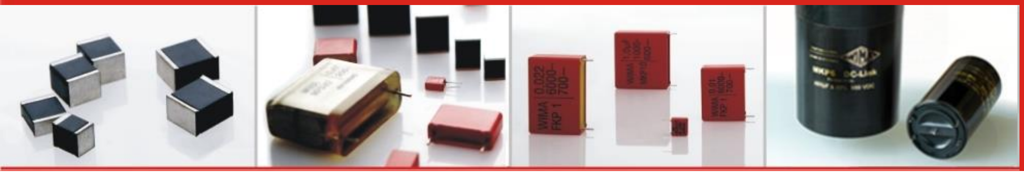
Application	Circuit	WIMA Series
Coupling/ Blocking		SMD, MKS 2, MKS 02, MKS 4
Decoupling/ Bypassing		SMD, MKS 2, MKS 02, FKS 3, FKS 2, MKS 4
Energy Storing		MKP 2 *, FKP 1, MKP 10, Snubber, FKP 4, GTO * ≥ 250VDC
Smoothing		SMD, MKS 4, MKS 02, MKP 4, MKS 2, MKP 10
A/D Conversion		FKP 02, FKP 3, FKP 2, MKP 4, MKP 2
RFI - Suppression		MKP-X1R, MP3R-Y2, MKP-X2, MP3-X1, MKP-Y2, MP3-Y2, MP3-X2
Voltage Dropper		MP3-X2, MKS 4 *, MP3-X2R * ≥ 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



Outline

- WIMA facts
  - Product range
  - Application guide
- Film / foil capacitors
  - Construction principles and technology
  - ➢ **SMD capacitors**
  - RFI capacitors
  - GTO / Snubber capacitors
  - DC-Link capacitors
  - Pulse capacitors

SMD Plastic Film Capacitors

Capacitances:

0.01 µF – 6.8 µF

Voltages:

63 VDC – 1000 VDC

Size Codes:

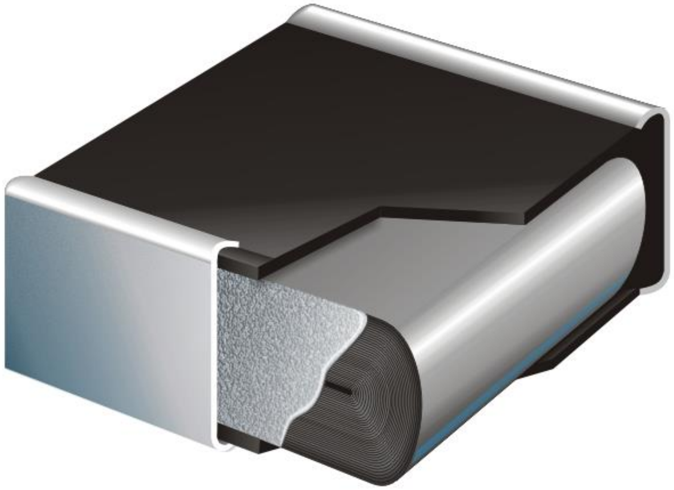
1812 – 6054

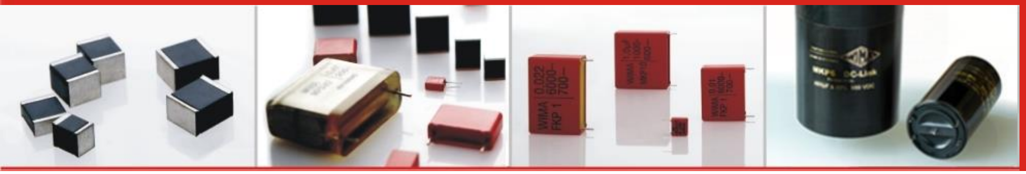
Dielectrics:

PET, PPS

WIMA SMD capacitors are produced with the proven box technology offering many advantages in comparison with non-encapsulated or moulded capacitor versions:

- Safe protection of the capacitor element against mechanical and thermal stress during processing and operation.
- No risk of internal cracks or impact on the contacts due to construction-inherent elasticity.
- No risk of delamination due to solder plates covering the capacitor‘s entire end surfaces
- Solvent-resistant, flame-retardent plastic case in accordance with UL 94 V-0.

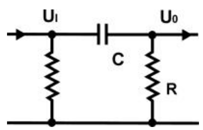




BEST CAPACITORS
MADE IN GERMANY

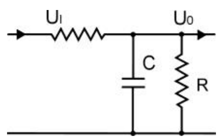
Industrial Electronics · Power Supplies/UPS/SMPS · AC/DC Converters · Measuring and Control Equipment

Coupling/ Blocking



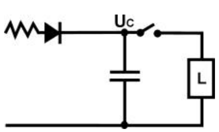
SMD | MKS 2 | MKS 02 | MKS 4

Decoupling/ Bypassing



SMD | MKS 2 | MKS 02 | FKS 3 | FKS 2 | MKS 4

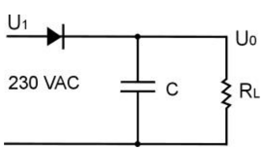
Energy Storing



MKP 2 * | FKP 1 | MKP 10 | Snubber | FKP 4 | GTO

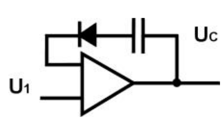
* ≥ 250VDC

Smoothing



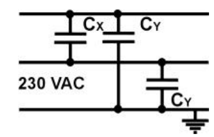
SMD | MKS 4 | MKS 02 | MKP 4 | MKS 2 | MKP 10

A/D Conversion



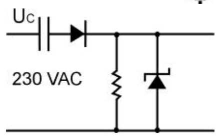
FKP 02 | FKP 3 | FKP 2 | MKP 4 | MKP 2

RFI - Suppression



MKP-X1R | MP3R-Y2 | MKP-X2 | MP3-X1 | MKP-Y2 | MP3-Y2 | MP3-X2

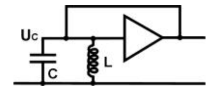
Voltage Dropper



MP3-X2 | MKS 4 * | MP3-X2R

* ≥ 630VDC
≥ PCM 10

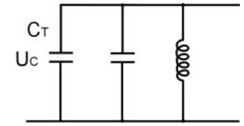
Oscillating



SMD-PPS | MKP 4 | FKP 02 | MKP 10 | FKP 2 | FKP 4 | MKP 2* | FKP 1 | FKP 3

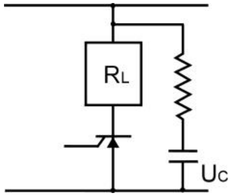
* ≥ 250VDC

Temperature Compensating



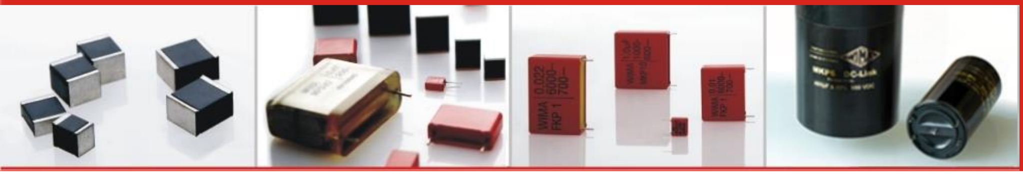
FKP 02/2 | FKP 3 | MKP 2 | MKP4

Snubbing



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

* ≥ 250VDC



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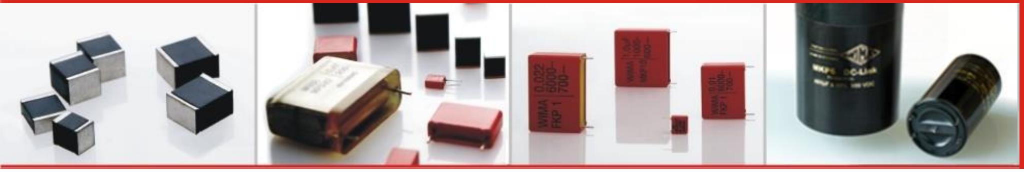
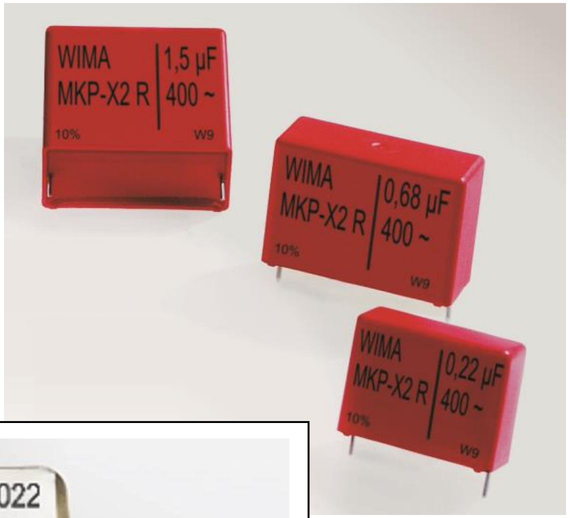


Radio Interference Suppression

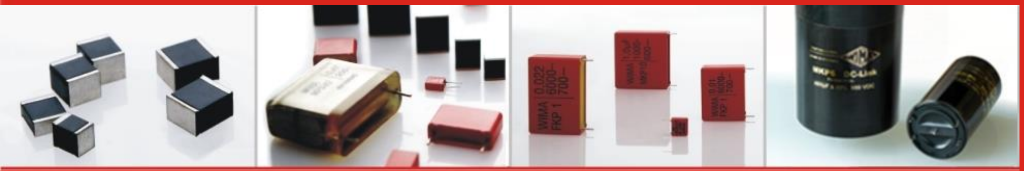


Features of WIMA RFI Capacitors:

Capacitances: 1000pF -10 µF
Voltage ranges: 250 VAC – 500 VAC
Dielectrics: Polypropylene film (PP) or Paper (MP)
Operating temperature: -55° C to +110°C

Characteristics:

-Particularly high reliability against active and passive flammability
-High degree of interference suppression
-Excellent self-healing properties
-Almost unlimited life expectancy



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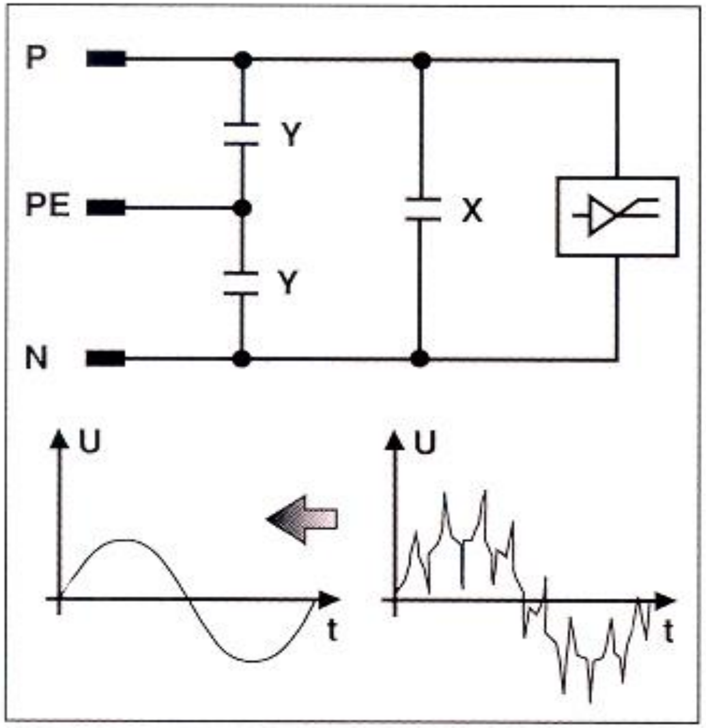
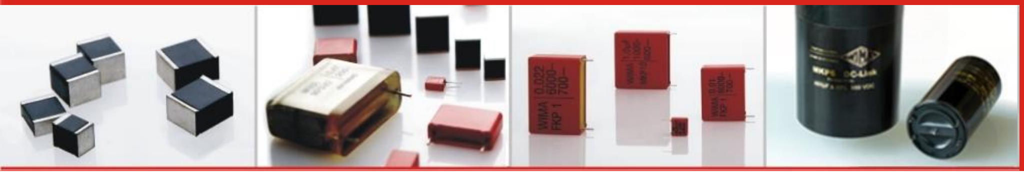
Radio Interference Suppression

Application of X and Y Class Capacitors:

Interference suppression capacitors suppress high-frequency disturbances of electrical equipment on the mains.

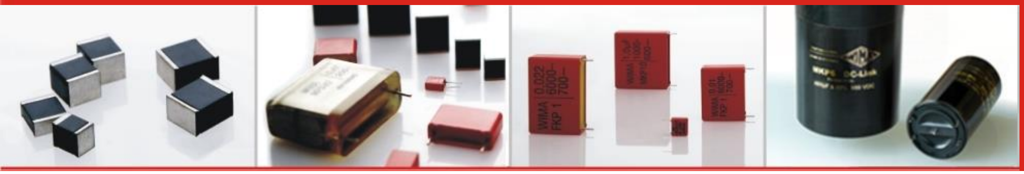
Sub-class	Type of application	Range of rated voltages	Peak pulse voltage endurance test
X1	Class X capacitors are connected between phase and neutral or phase and phase conductors.	≤ 760 V	4 kV
X2		≤ 760 V	2.5 kV
Y1	Class Y capacitors are connected between phase conductors and earthed casing and thus by-pass operating insulation.	≤ 500 V	8 kV
Y2		≤ 300 V	5 kV





Radio Interference Suppression

WIMA Type	MKP-X2	MKP-X2 R	MKP-X1R	MKP-Y2	MP 3-X2	MP 3-X1	MP 3-Y2	MP 3R-Y2
Dielectric	Metallized Polypropylene	Metallized Polypropylene	Metallized Polypropylene	Metallized Polypropylene	Metallized Paper	Metallized Paper	Metallized Paper	Metallized Paper
Capacitance range	1000pF - 10µF	0.033µF - 10µF	1000pF – 2.2µF	1000pF-1µF	1000pF - 1.0µF	1000pF-0.22µF	1000pF - 0.022µF	1000pF-0.1µF
Nominal voltages	275 VAC 305 VAC	400 VAC	440 VAC	300 VAC	250 VAC 275 VAC	300 VAC 440 VAC 500 VAV	250 VAC	300 VAC
Test category in accordance with IEC	55/105/56/B	55/105/56/C	55/105/56/C	55/105/56/C	40/110/56/C	40/110/56/C	40/110/56/C	40/110/56/B
Approvals	250~ 305~	under preparation		250~	EN 132 400	EN 132 400	EN 132 400	



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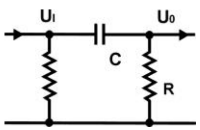
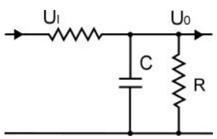
Coupling/ Blocking



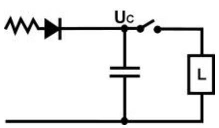
SMD · MKS 2 · MKS 02 · MKS 4

Decoupling/ Bypassing



SMD · MKS 2 · MKS 02 · FKS 3 · FKS 2 · MKS 4

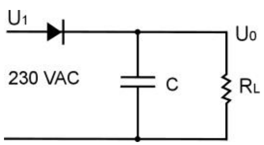
Energy Storing



MKP 2 * · FKP 1 · MKP 10 · Snubber · FKP 4 · GTO

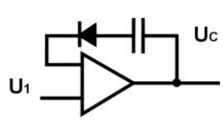
* ≥ 250VDC

Smoothing



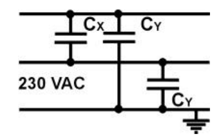
SMD · MKS 4 · MKS 02 · MKP 4 · MKS 2 · MKP 10

A/D Conversion



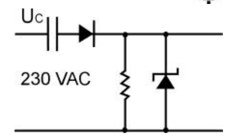
FKP 02 · FKP 3 · FKP 2 · MKP 4 · MKP 2

RFI - Suppression



MKP-X1R · MP3R-Y2 · MKP-X2 · MP3-X1 · MKP-Y2 · MP3-Y2 · MP3-X2

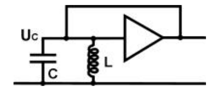
Voltage Dropper



MP3-X2 · MKS 4 * · MP3-X2R

* ≥ 630VDC
≥ PCM 10

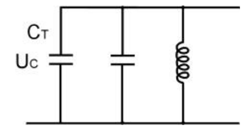
Oscillating



SMD-PPS · MKP 4 · FKP 02 · MKP 10 · FKP 2 · FKP 4 · MKP 2 * · FKP 1 · FKP 3

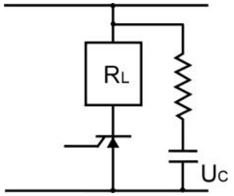
* ≥ 250VDC

Temperature Compensating



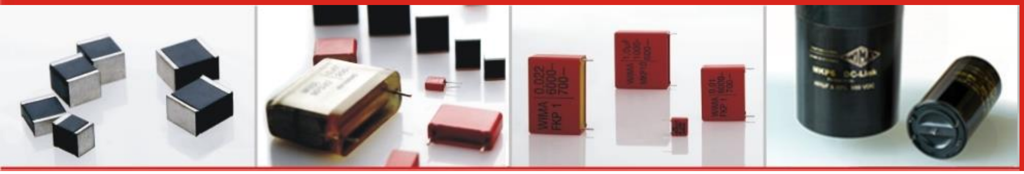
FKP 02/2 · FKP 3 · MKP 2 · MKP4

Snubbing



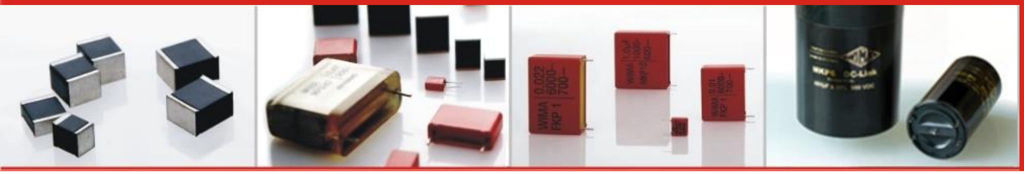
FKP 02/2 · FKP 4 · MKP 2 * · FKP 1 · FKP 3 · Snubber · MKP 10 · GTO

* ≥ 250VDC



Outline

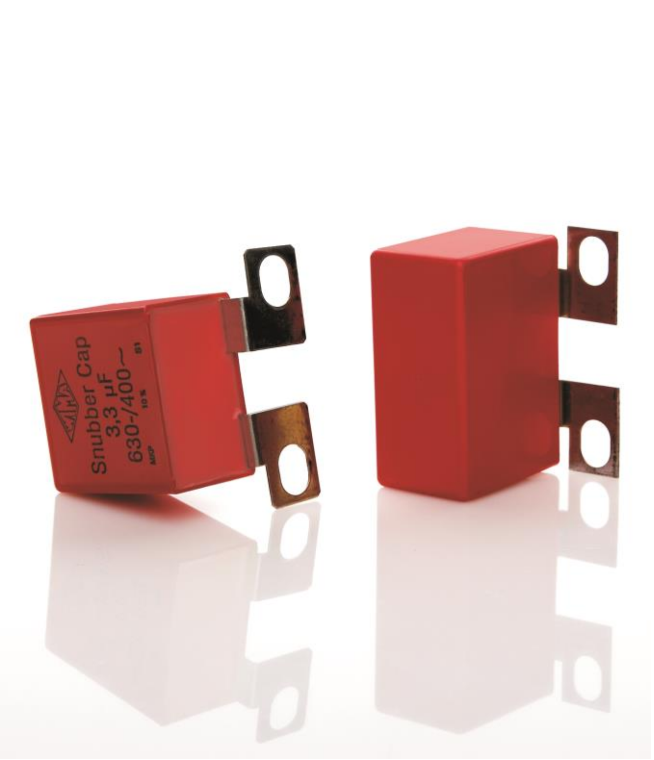
- WIMA facts
  - Product range
  - Application guide
- Film / foil capacitors
  - Construction principles and technology
  - SMD capacitors
  - RFI capacitors
  - ➢ **GTO / Snubber capacitors**
  - DC-Link capacitors
  - Pulse capacitors



Snubber Capacitors
for High Power Conversion

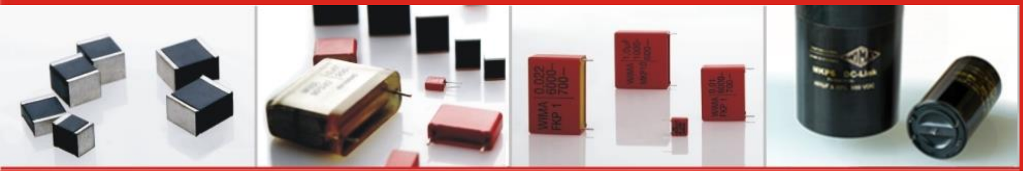
Features of WIMA Snubber Capacitors

Capacitances: 0.01 µF - 25 µF
Voltages: 250 VDC - 4000 VDC
Dielectric: Polypropylene (PP) film
Properties:
- Plates soldered directly to the schoopage for safe contacts at high rms currents
- Low inductance construction achieved by end-surface contacts
- High pulse reliability due to double-sided metallization and/or film/foil construction
- High voltage/overvoltage strength by internal series connection with self-healing metallized floating electrode
- Available in various contact configurations
- Flame retardent plastic case in accordance with UL 94 V-0



Fields of Application

- IGBT applications subject to high pulse and high frequency requiring extremely reliable contacts

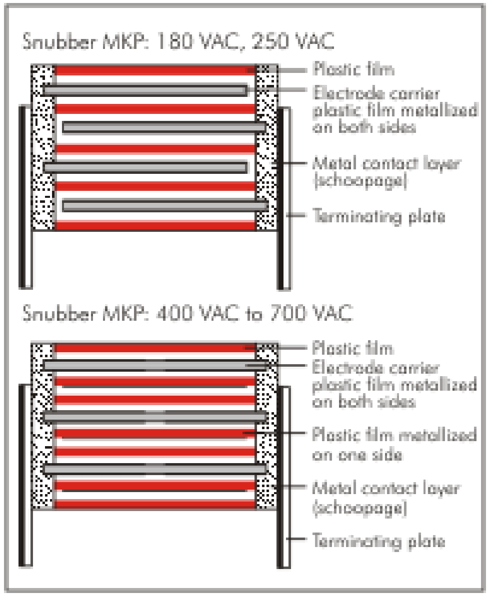


WIMA Snubber Capacitors

WIMA Snubber MKP

Capacitance range:	0.047 µF - 25 µF
Rated voltages:	250 VDC - 3000 VDC
Dielectric:	Polypropylene (PP) film
Climatic test category:	55/100/56 according to IEC
Reliability:	Operational life > 300 000 hours Failure rate < 1 fit (0.5 x Ur / 40°C)

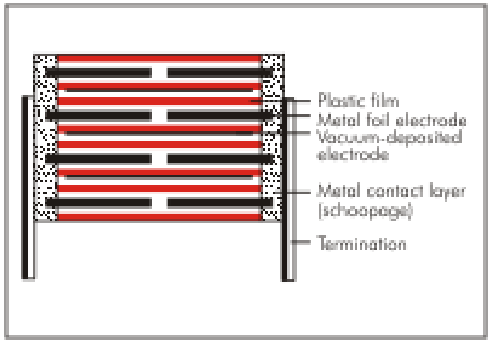
Internal construction:

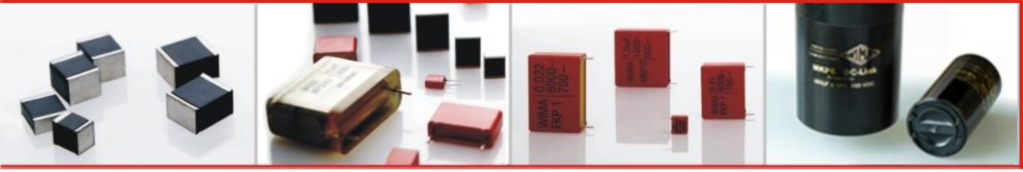


WIMA Snubber FKP

Capacitance range:	0.01 µF - 2.2 µF
Rated voltages:	630 VDC - 4000 VDC
Dielectric:	Polypropylene (PP) film
Climatic test category:	55/100/56 according to IEC
Reliability:	Operational life > 300 000 hours Failure rate < 1 fit (0.5 x Ur / 40°C)

Internal construction:





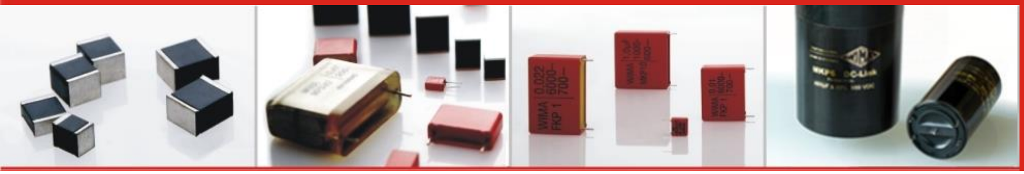
GTO (Gate-Turn-Off) Capacitors with Screw Connection

Features of WIMA GTO Capacitors

Capacitances: 1.0 µF -100 µF
Voltages: 400 VDC - 2000 VDC
Dielectric: Polypropylene (PP) film
Properties:
- Very low self-inductance
- High pulse capability
- High rms current carrying capability
- Excellent self-healing property
- High shock and vibration resistance
- Outstanding mechanical stability
- Almost unlimited life expectancy

Fields of Application

GTO applications subject to high current and voltage, e.g.
- converter equipment in power generation or in traction technology for train drives, hoists, crane drives etc.

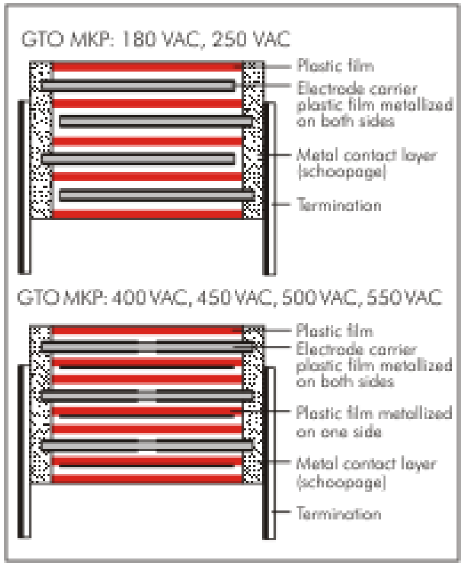


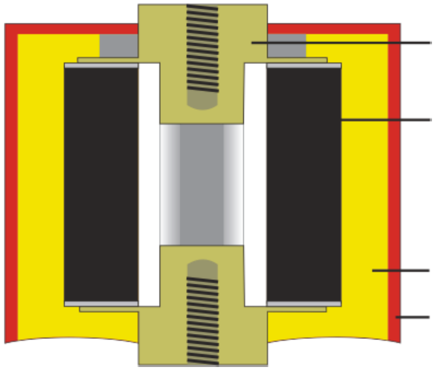
WIMA GTO Capacitors

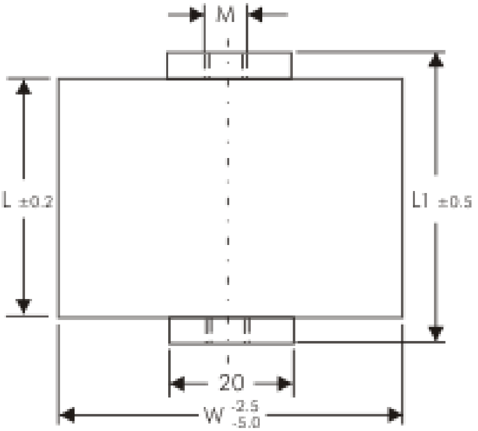
WIMA GTO MKP

Climatic test category: 55/085/56 according to IEC
Reliability: Operational life > 300 000 hours
Failure rate < 1 fit (0.5 x Ur / 40°C)
Terminations: Axial screw connection M6 or M8

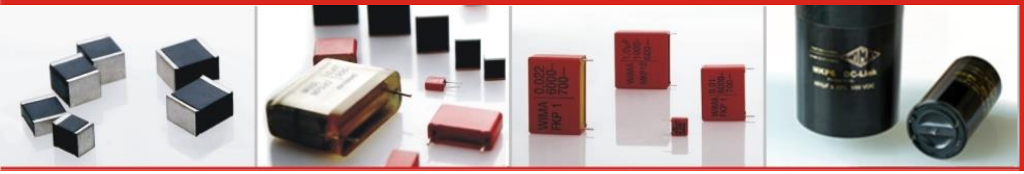
Internal construction:





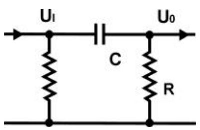


W	L	L1	M
60	49	55	M6
70	49	55	M6
80	49	55	M8
90	49	55	M8
90	58	64	M8
90	97	103	M8



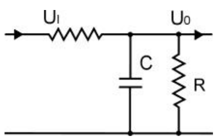
Industrial Electronics · Power Supplies/UPS/SMPS · AC/DC Converters · Measuring and Control Equipment

Coupling/ Blocking



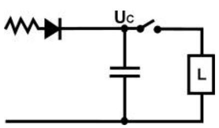
SMD, MKS 2, MKS 02, MKS 4

Decoupling/ Bypassing



SMD, MKS 2, MKS 02, FKS 3, FKS 2, MKS 4

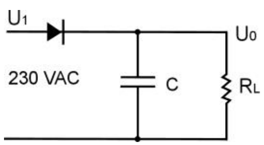
Energy Storing



MKP 2 *, FKP 1, MKP 10, Snubber, FKP 4, GTO

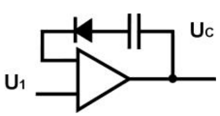
* ≥ 250VDC

Smoothing



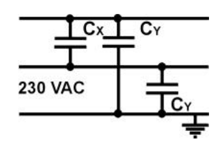
SMD, MKS 4, MKS 02, MKP 4, MKS 2, MKP 10

A/D Conversion



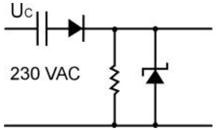
FKP 02, FKP 3, FKP 2, MKP 4, MKP 2

RFI - Suppression



MKP-X1R, MP3R-Y2, MKP-X2, MP3-X1, MKP-Y2, MP3-Y2, MP3-X2

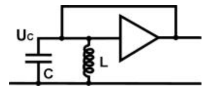
Voltage Dropper



MP3-X2, MKS 4 *, MP3-X2R

* ≥ 630VDC
≥ PCM 10

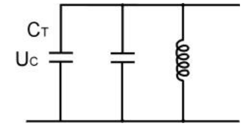
Oscillating



SMD-PPS, MKP 4, FKP 02, MKP 10, FKP 2, FKP 4, MKP 2 *, FKP 1, FKP 3

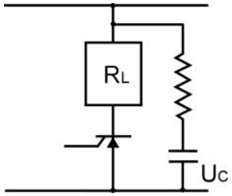
* ≥ 250VDC

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

Inhaltsübersicht

- WIMA facts
  - Product range
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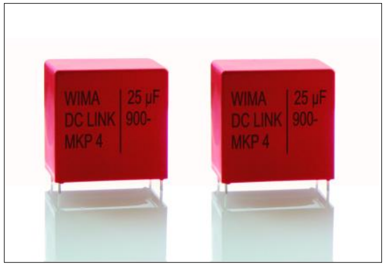
  - GTO / Snubber capacitors
  - ➢ **DC-Link capacitors**
  - Pulse capacitors

DC-Link Capacitors

Intermediate circuit capacitors



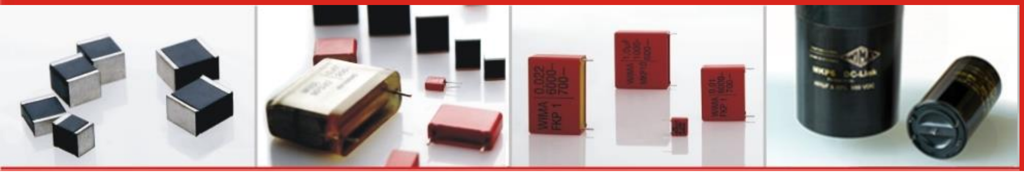
Features of WIMA DC-Link Capacitors

Capacitances: 0.47 µF - 8250 µF
Voltages: 450 VDC - 1500 VDC
Dielectric: Polypropylene (PP) film
Properties:

- very high capacitance/volume ratio
- high voltage rating per component
- very low dissipation factor (ESR)
- very high insulation resistance
- excellent self-healing properties
- long life expectancy
- non-polar construction
- particularly reliable contact configuration
- high shock and vibration resistance
- outstanding mechanical stability
- Solvent-resistant, flame retardant plastic case (in accordance with UL 94 V-0)

Fields of Application

- capacitors for high power applications
- converter

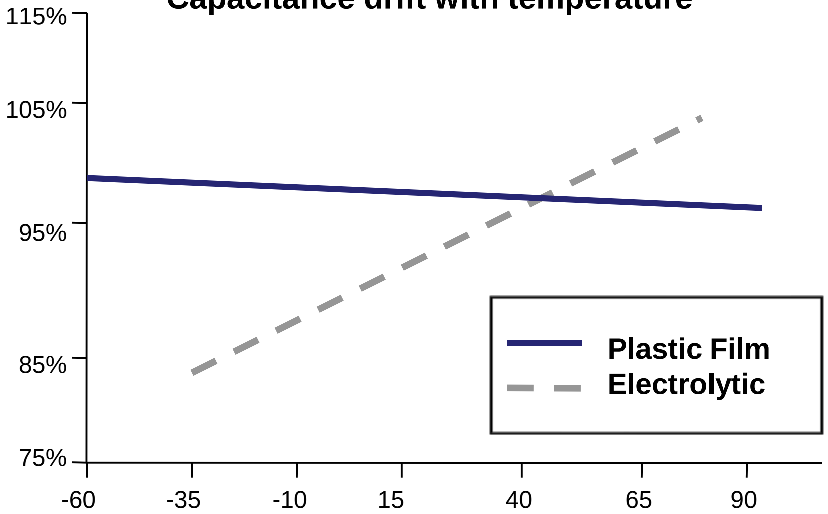


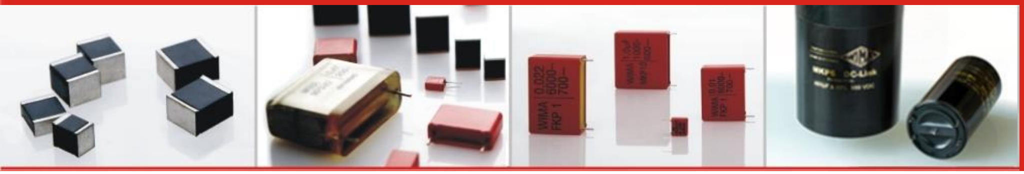
Comparison of DC-Link Capacitor Technologies: Film Cap vs. Electrolytics

Technical characteristics

Technology	Capacitance per Volume	ESR	Irms	Stability / Reliability
Plastic Film	Improving	Low	High	High
Electrolytic	High	High	Medium	Medium

Capacitance drift with temperature

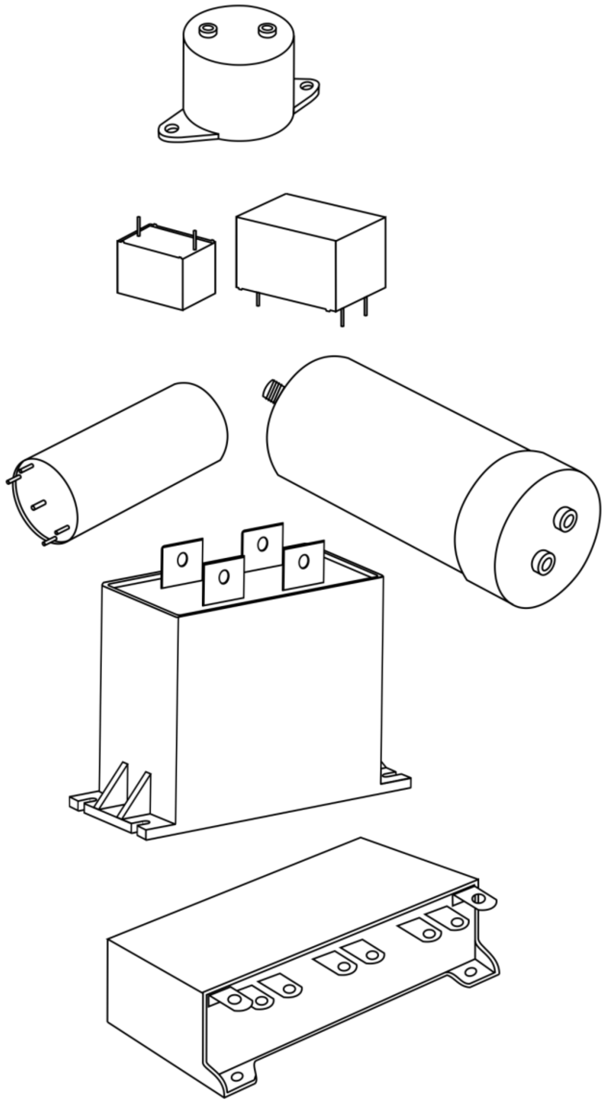


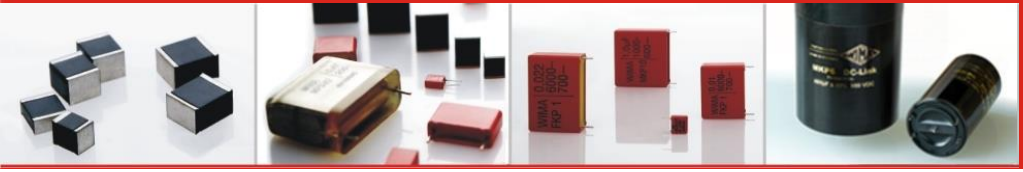


Terminal Configurations

DC-Link Termination Options:

- Cylindrical plastic case with screw fixing and male or female connections
  → **DC-LINK MKP 3**
- 2-pin and 4-pin versions (screwable plate versions on request)
  → **DC-LINK MKP 4 / DC-LINK MKP 4S**
- Cylindrical capacitor body with pin connections for PCB mounting
  → **DC-LINK MKP 5**
- Cylindrical capacitor body with male or female connections for bus bar mounting
  → **DC-LINK MKP 6**
- Versatile and safe contact configurations by screwable plates
  → **DC-LINK HC / DC-LINK HY**





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  - Product range
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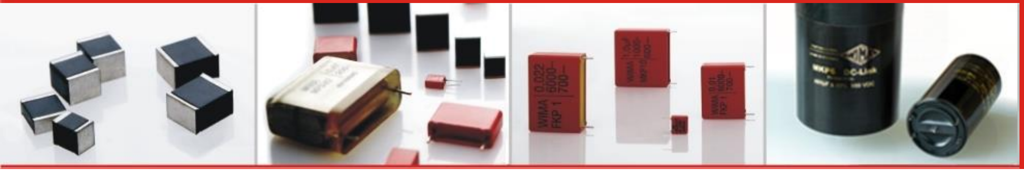
  - GTO / Snubber capacitors
  - DC-Link capacitors
  - ➢ **Pulse capacitors**



Pulse Capacitors

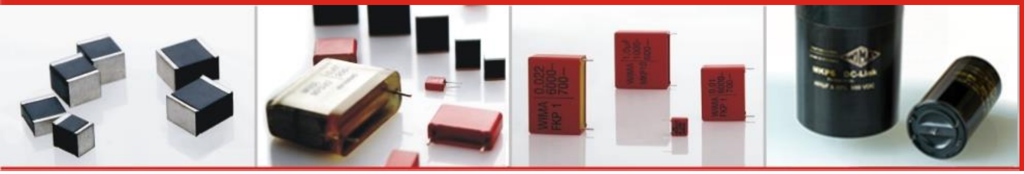
Features of WIMA pulse capacitors

Capacitances: 0.1nF - 47 µF
Voltages: 100 VDC - 6000 VDC
Dielectric: Polypropylene (PP) film
Properties:

- Pulse duty construction
- Self-healing
- very low dissipation factor (ESR)
- negative capacitance change vs. temperature
- Solvent-resistant, flame retardant plastic case (in accordance with UL 94 V-0)

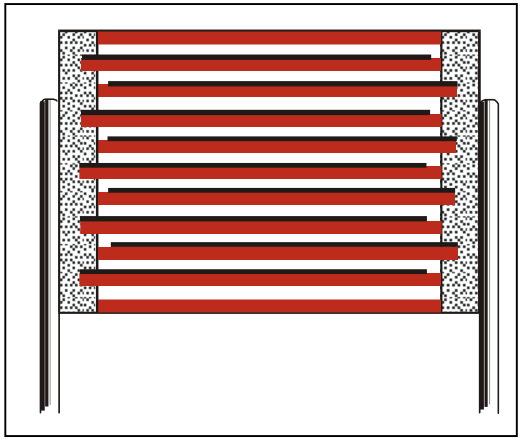
Fields of Application

- capacitors for pulse applications
- Switch mode power supplies
- Lighting
- Audio/video equipment
- Converter
- Electronic ballasts



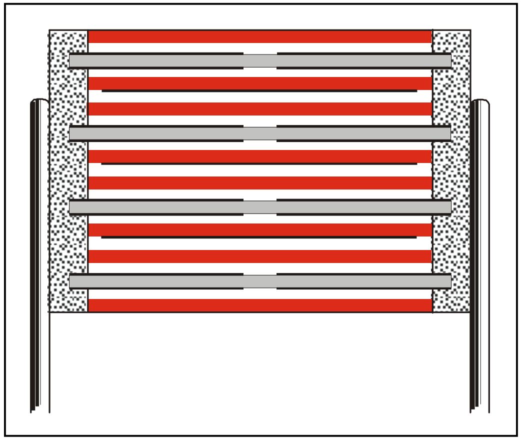
Pulse Capability

WIMA MKP 4
single metallized plastic film



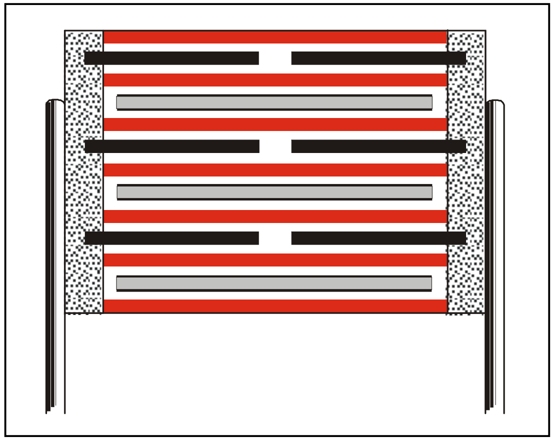
Capacitance µF	max. pulse rise time V/µs at TA < 40°C		
	400 VDC	630 VDC	1000 VDC
0.01 ...0.022	450	500	550
0.033...0.068	300	350	400
0.1 ...0.22	200	250	300

WIMA MKP 10
double sided metallized plastic film

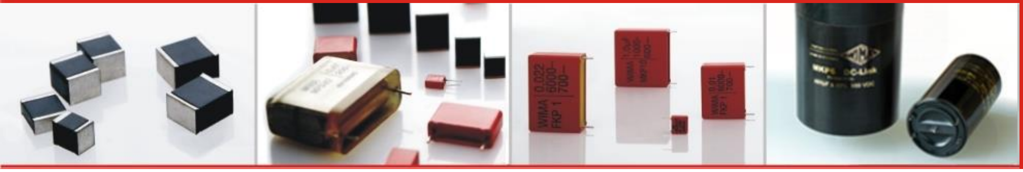


Capacitance µF	max. pulse rise time V/µs at TA < 40° C		
	400 VDC	630 VDC	1000 VDC
0.01 ...0.022	1200	1800	2100
0.033...0.068	900	1800	2100
0.1 ...0.22	500	900	1400

WIMA FKP 1
aluminium foil and double sided metallized plastic film

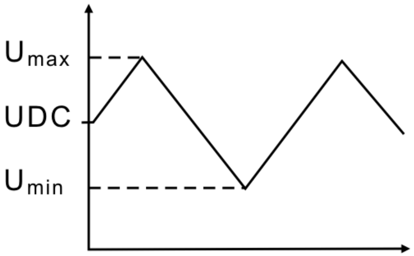


Capacitance µF	max. rulse rise time V/µs at TA < 40° C		
	400 VDC	630 VDC	1000 VDC
0.01 ...0.022	9000	11000	11000
0.033...0.068	9000	11000	11000
0.1 ...0.22	7000	11000	11000



Selection of Capacitors for Pulse Application

Determination of DC and AC Voltage



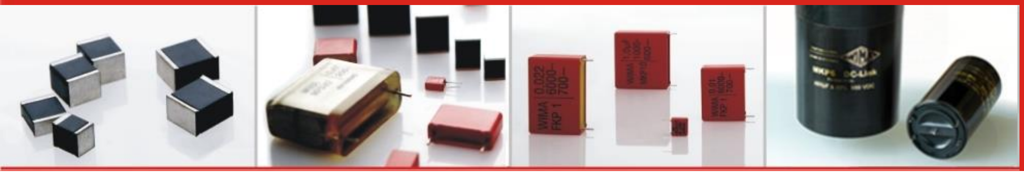
$$U_{pp} = \left| U_{max} - U_{min} \right|$$

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

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

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).



BEST CAPACITORS
MADE IN GERMANY

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

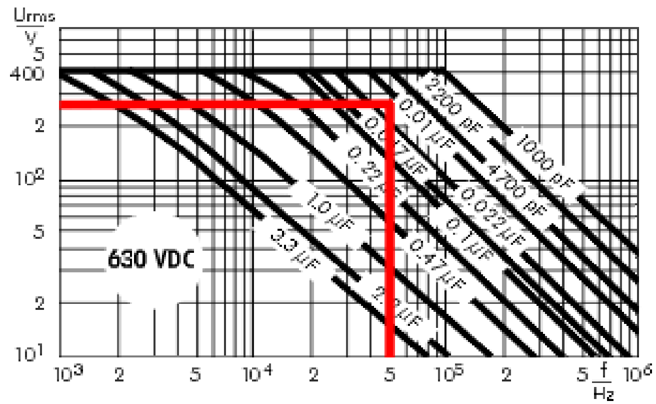
$$X_c = \frac{1}{\omega \times C} = \frac{1}{2\pi \times 50\ \text{kHz} \times 0.01\ \mu\text{F}}$$ Xc = 318 Ohm

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

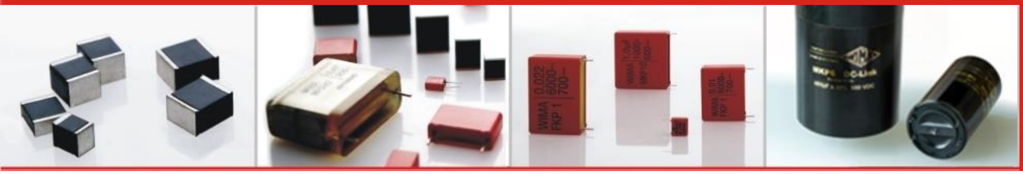
The calculated maximum value of the effective current

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

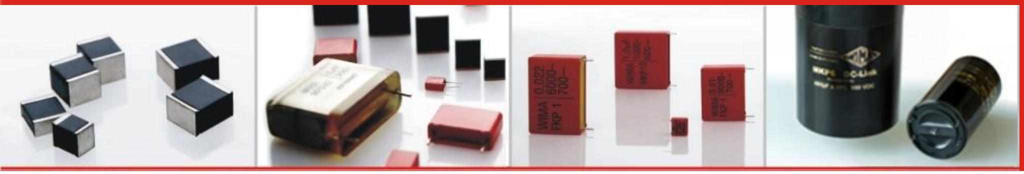
$$100\ \frac{V}{\mu sec} \times 1\ \mu F = 100\ A$$

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:

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

where

Pd = dissipation in Watts.

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

$\omega = 2\pi \times f$ (f is the repetition frequency of the pulse waveform)
C = capacitance in Farad.

$\tan\delta$ = dissipation factor corresponding to the frequency of the steepest part of the pulse.

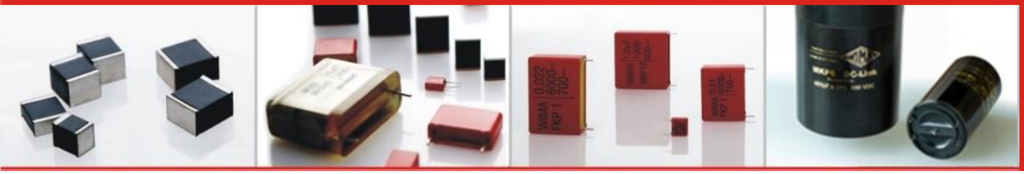
$$\text{Max.Temperature Rise} = \frac{Pd}{Pspec} < 10K$$

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

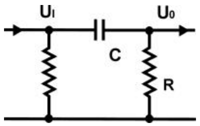
Given: U_{rms} $(354)^2 \times \omega C\ (2\pi \times 1 \times 10^{-6}) \times \tan\delta\ (3 \times 10^{-4}) = Pd = 0.236W$

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



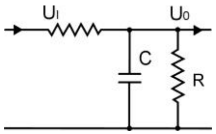
Industrial Electronics · Power Supplies/UPS/SMPS · AC/DC Converters · Measuring and Control Equipment

Coupling/ Blocking



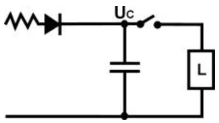
SMD · MKS 2 · MKS 02 · MKS 4

Decoupling/ Bypassing



SMD · MKS 2 · MKS 02 · FKS 3 · FKS 2 · MKS 4

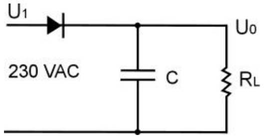
Energy Storing



MKP 2 * · FKP 1 · MKP 10 · Snubber · FKP 4 · GTO

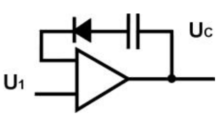
* ≥ 250VDC

Smoothing



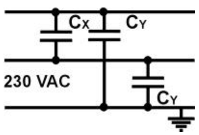
SMD · MKS 4 · MKS 02 · MKP 4 · MKS 2 · MKP 10

A/D Conversion



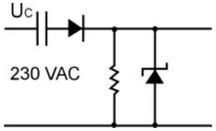
FKP 02 · FKP 3 · FKP 2 · MKP 4 · MKP 2

RFI - Suppression



MKP-X1R · MP3R-Y2 · MKP-X2 · MP3-X1 · MKP-Y2 · MP3-Y2 · MP3-X2

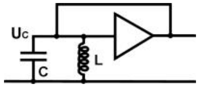
Voltage Dropper



MP3-X2 · MKS 4 * · MP3-X2R

* ≥ 630VDC
≥ PCM 10

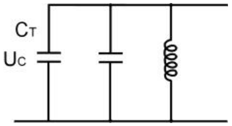
Oscillating



SMD-PPS · MKP 4 · FKP 02 · MKP 10 · FKP 2 · FKP 4 · MKP 2 * · FKP 1 · FKP 3

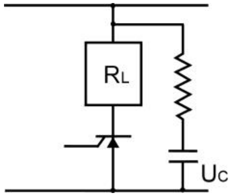
* ≥ 250VDC

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

You need for your application a partner offering plastic film capacitors in

- **Highest Quality**
- **Highest Reliability**
- **Longest Life Time**

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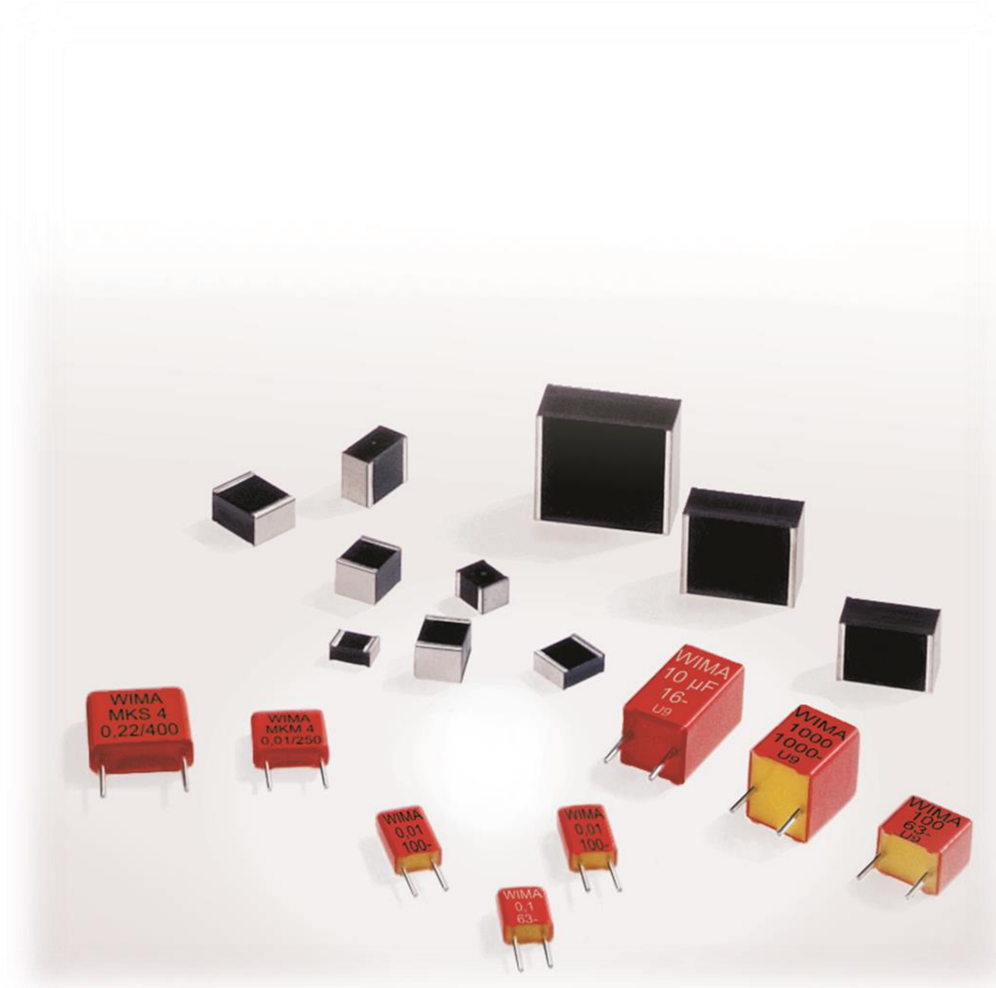

Thank you!

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