Kunze®

The Heatmanagement Company

▶ PRODUCT CATALOGUE

Table of Content

We ensure quality and process reliability in your power electronics …

History

Two years after the conclusion of his studies of electrotechnology in Munich, Dipl.-Ing. Burkhard Kunze founded his own engineering firm. A one-man business in the beginning, Kunze Folien GmbH was officially launched in 1985.

Mr. Kunze soon recognized the future significance of power electronics and the necessity for heat loss dissipation. At that time, the combination of mica with thermally conductive paste was beginning to be replaced by the new technology of thermo-silicone films. That technology became the focus of the young company‘s operations.

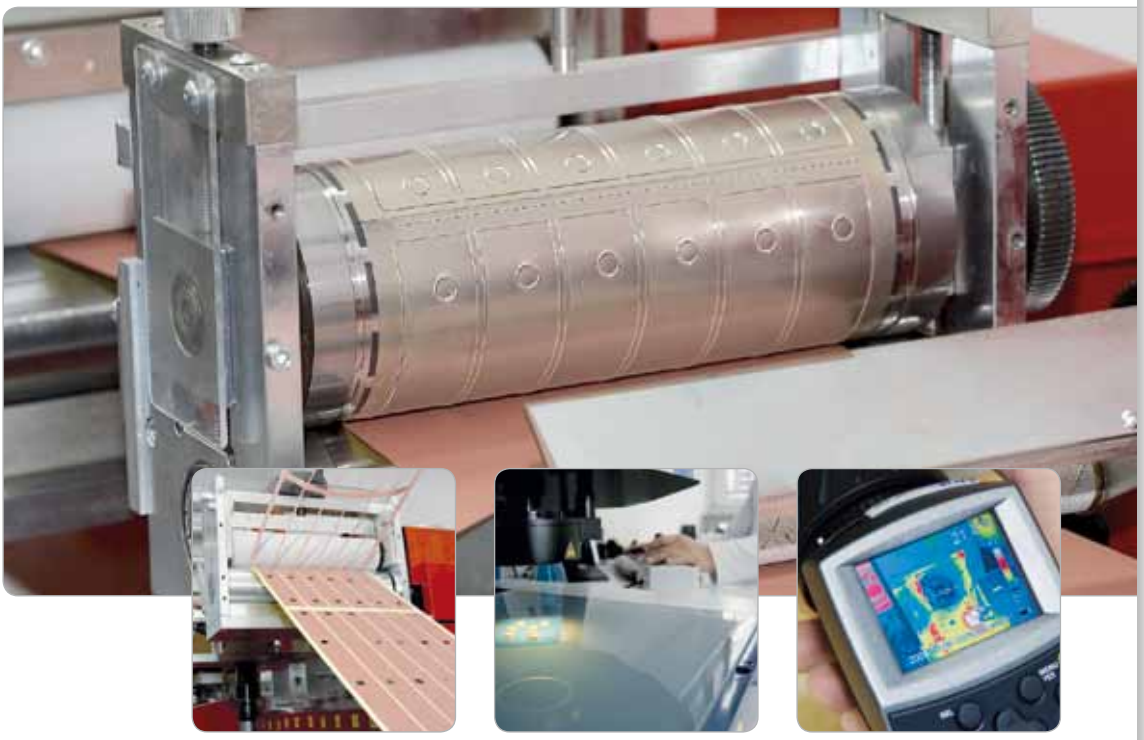
The company‘s continuous and lasting success has confirmed that decision since. Semiconductor cooling will always be a decisive factor in the development of power electronics – we at Kunze Folien face that challenge with innovative materials, processes and techniques.

Company philosophy

Kunze Folien is a leading supplier of customized heat management solutions and an important business partner for customers all over the world. The cornerstone of our success lies in the long-standing competence and commitment of our international staff. Individual responsibility in an open-minded, teamwork-oriented company culture is our maxim: it is the pre-condition for technical knowledge, management competence, know-how and innovation to effectively contribute to maximum customer benefit.

As our customers‘ applications and our products evolve continuously, we take great care to provide regular training and specialized skill enhancement to our staff.

In order to stay at the top, we maintain a constant dialogue with international research institutes and development departments. This allows for our staff to be always one step ahead of things, earning our customers‘ trust and certainty to be working with a reliable and trustworthy partner.



Product variety

We provide complete heat management solutions, specializing primarily in the integrated application of thermally conductive films, heat sinks and transistor clips in power electronics. Our product portfolio is enhanced by the possibility to laminate such films and foils. It additionally includes heat management-related services, e.g. measuring of thermal conductivity, IR analysis, and in-design simulations. Always in close collaboration with our customers, we analyze specific application requirements in order to develop optimal, integral and cost-effective solutions.

Customers and partners

Requirements regarding process reliability and flexibility have been increasing continuously. Owing to our expertise and the largeness of our portfolio, our customers are used to expecting complete one-stop heat management solutions – from the first idea to design, construction and application in the final product. We accompany customer applications from the beginning, in order to guarantee maximum satisfaction. Many of our clients are business companies of international renown who demand quick and reliable fulfilment of their heat management needs – highest quality standards and fair prices provided.

… in the quickest way possible.

Definition of goals

With our technical know-how, staff competence, long-standing expertise and potential for innovation, we strive to continuously improve the relationship with our customers and to make use of our potential world-wide. We view customer-oriented service, in combination with our open company culture, as the indispensable foundation for sustainable, organic growth and increase of our company value.

Kunze Folien GmbH stands for competence, innovation, speedy delivery and highest quality standards.

Our customized solutions ensure the quality, reliability and success of renowned brands all over the world. Their manufacturers appreciate our products‘ superior thermal performance in the fields of automotive technology, aero- and astronautics, IT and controlling technology, environmental engineering and green energy production, as well as medical engineering with integrated appliances for optimum waste heat dissipation.

By implementing state-of-the-art computer-controlled machines and specially developed production techniques, we have been widening our range of products and services constantly. As an „all-in-one“ supplier, we support our customers in their development processes from beginning to end.

Beside the wide range of products and production potential, we offer our customers a variegated spectrum of services. This includes, for example, the manufacturing of accurate, design-specific pilot samples at low cost and at an early stage in the development process.

Own manufacturing facilities at Oberhaching near Munich

Our long-standing competence, technical know-how and innovation derived from many years' experience in manufacturing allow for quick and precise production of all customized forms. Our portfolio includes a wide range of stamping and cutting techniques as well as state-of-the-art laser technology. By implementing high-end computer-controlled machines, custom-made software and specially developed stamping and cutting techniques, as well as novel processes for single-film lamination, we have been able to greatly enlarge our range of services.

Faster is more efficient

24H DESIGN-IN SERVICE

We at Kunze offer our customers an innovative and unique service:

You send us your CAD data for prototypes and samples, and we manufacture precision heat management products in exact compliance with your specifications at shortest possible notice. This service allows for fast, individual and solution-oriented processes, affording a decisive advantage in product development.

ENVIRONMENT AND SUSTAINABILITY

- Our environmental management system has been certfied according to DIN ISO 14001 since 2006.
- Since 2009, we have been a member of Umweltpakt Bayern – a campaign of the Bavarian Ministry of Health and Environmental Affairs.
- We buy our environmentally friendly electricity (from 100% renewable sources) from Greenpeace Energy.

In order to keep our consumption of resources and environmental impact as low as possible, we have been implementing a series of measures:

- Use of environmentally friendly, recyclable packaging materials made from renewable resources
- Acquisition of energy-saving machines when possible
- Exclusive use of chlorine-free reprographic paper (TCF)
- Efficient state-of-the-art inverter air conditioning instead of conventional A/C
- Substitution of conventional lamps by more efficient lighting systems (electronic control gear, LEDs)
- Electronic heating control with night setback for reduced heat loss

We take care to keep our IT environmentally friendly as well:

- PVC-free network cables (LSOH sheathed)
- Highly efficient PC and server systems with power supply units certified 80 PLUS-Gold or better
- Preference for LED-illuminated monitors and PVC/bromide-free casings
- Use of virtualization technology

Disused but functioning PCs are re-conditioned and donated to educational or other community institutions.

RoHS-COMPLIANCE

Additionally, all Kunze heat management products comply with EC directive 2002/95/EG (RoHS) – proof of our commitment to environmental and consumer protection which we see as integral part of our business policy.

Our future is in quality …

... and that‘s why it has such high priority in our company policy. We have been certified according to DIN EN ISO 9001 since 1995. To ensure zero-defect quality and absolute precision, we employ innovative technology and qualified partners for quality and reliability in all aspects of our operation.

Kunze offers products and services which meet the highest possible standards, all over the globe. Our distributors and representatives keep us close by our customers worldwide.

For us, it is not good enough to merely abide by technical standards. To constantly improve our product and service quality, we work in close collaboration with our customers and business partners, as we see quality as a continuous process.

Our philosophy with regards to quality is for our products and services to meet our customers‘ high expectations at all times. Quality results from the sum of all our employees‘ and collaborators‘ efforts, relying on customer exigencies and company standards. Our highly qualified staff in all fields constantly receive further training to ensure high quality products and continuous improvement.

To provide quality assurance, we employ state-of-the-art measuring systems. Parts to be produced are measured, e.g., by means of non-contact measuring equipment, and results are automatically documented.

Underwriter Laboratories – UL certification

Product liability legislation is far stricter in Canada and the US than in Europe. Whoever wishes to export their products to North America should therefore have them UL certified, especially when electric appliances are concerned.

For this reason, the use of UL certified materials and parts is increasingly decisive in the development of electronic appliances and components.

We have taken all the necessary measures for our products to comply with UL safety standards.

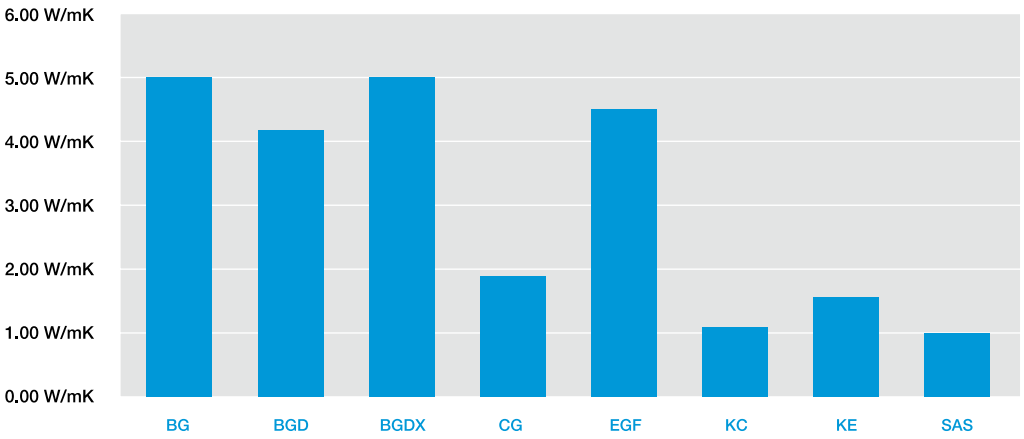
Kunze Folien GmbH is an accredited and certified repackager for all UL listed materials.

- UL-File No.: E339639

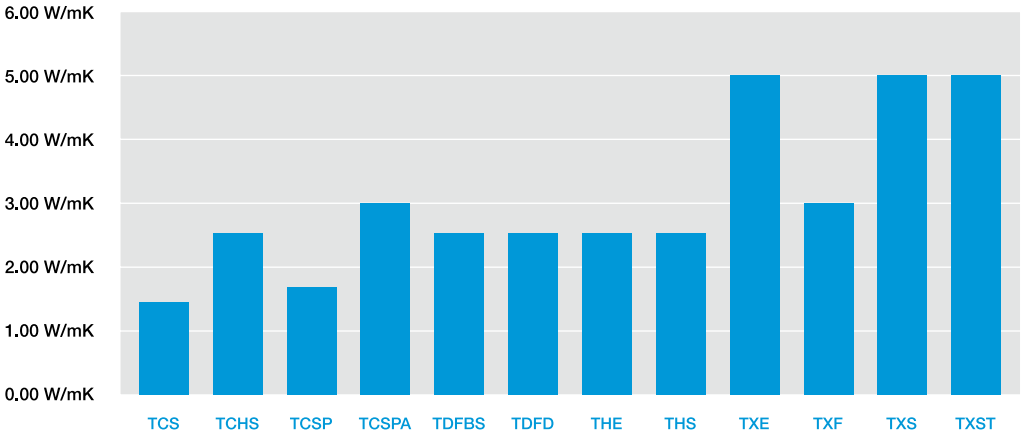
Additionally, our product portfolio contains a large number of UL certified materials and component parts.

- UL-File No.: E337894

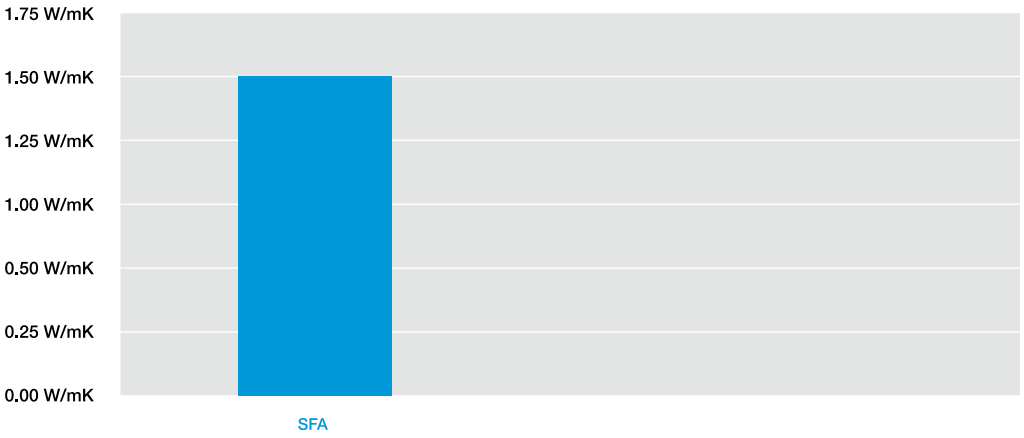
Overview:
Thermal properties



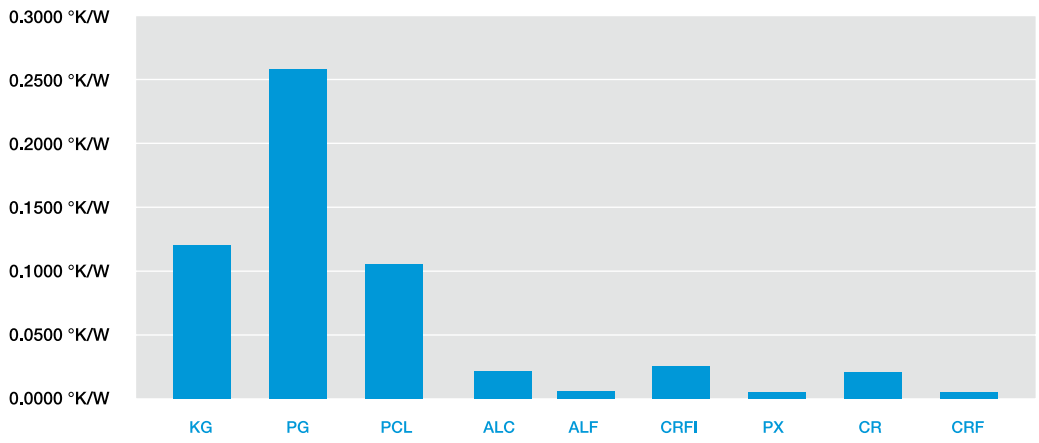
Thermo-silicone interface materials



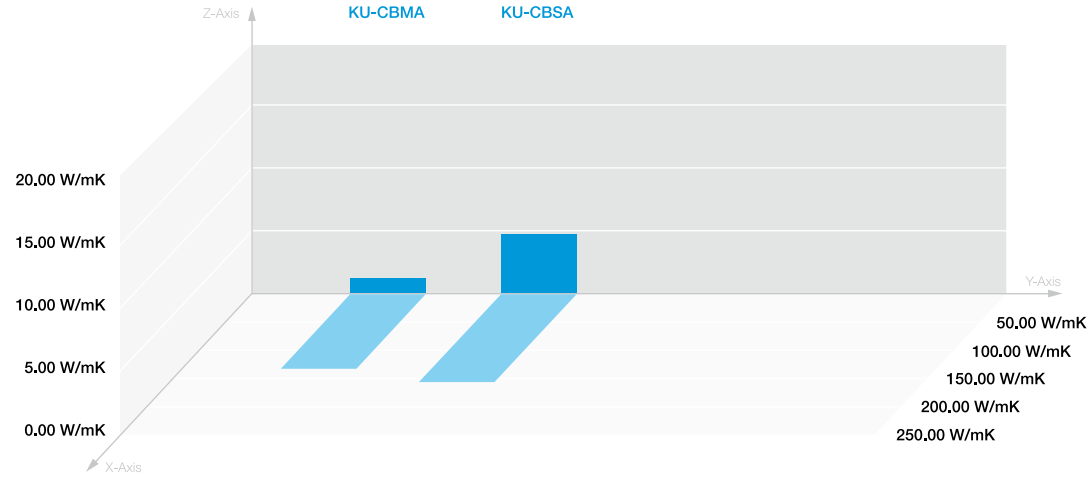
High-performance thermally conductive soft-silicone films



Thermally conductive silicone-free films



Thermally conductive phase-change materials



Graphite films

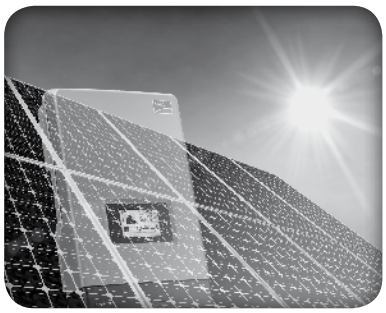
01

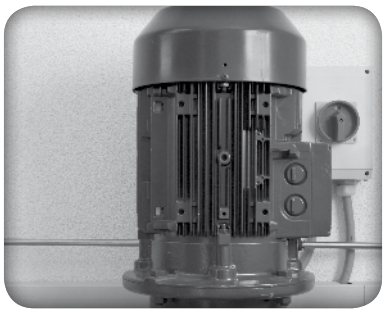
Thermo-silicone interface materials

Kunze HEATPAD® silicone films are the ideal and user-friendly alternative to mica in combination with thermal paste for heat dissipation and electrical insulation. The main disadvantage of the conventional mica/thermal paste combination is its lack of reproducibility, a critical factor when superior process reliability is required.

With the use of thermo-silicone foils, there is no such problem. Additionally, thermo-silicone boasts excellent temperature resistance and chemical stability as well as high dielectric strength.

Thermal conductivity of silicone is enhanced by the insertion of highly thermally conductive ceramics like boron nitride, aluminium oxide, or aluminium nitride into the polymeric structure of the elastomer. When pressure is applied, the material's softness allows it to actively cover contact surfaces, expelling air pockets and minimizing thermal contact resistance (and consequently, total thermal transfer resistance). For mechanical stability, the interface material is reinforced with fiberglass or polyimide.





APPLICATION EXAMPLES

Thermal linkage and electric insulation of heat sources and heat sinks in:

- Power modules
- Power supplies
- Electric drives
- Telecommunication modules
- Engine control
- Frequency converters
- UPS
- Optical applications (LEDs)
- Automotive (lithium-ion technology)
- Photovoltaics

THERMAL RESISTANCE OVERVIEW

THERMAL CONDUCTIVITY
(W/m·°K)

5.0

electrically insulating

Thermo-silicone interface material KU-BG

HEATPAD® KU-BG is a high-performance thermally conductive silicone film, filled with boron nitride and reinforced with fiberglass. Its very soft surface adapts to the contact surfaces so that thermal resistance is reduced to a minimum. It meets the highest technical requirements in interface materials.

PROPERTIES

- Outstanding thermal conductivity
- Minimal thermal resistance
- Very flexible
- Fiberglass reinforced
- Clean and easy mounting, high process reliability
- No thermal paste required
- UL flammability rating: UL 94 V0

PART	KU-	BG 20	BG 30	BG 45	BG 80
GENERAL PROPERTIES					
Material		Fiberglass reinforced silicone			
Filler		Thermally conductive ceramic (Boron Nitride)			
Colour		White			
Gauge	mm	0.2 +0.05 to -0.05	0.3 +0.1 to 0	0.45 +0.05 to -0.05	0.8 +0.1 to 0
Outgassing (LMW Siloxane)	ppm	∑ D3 - D10 = < 10			
MECHANICAL PROPERTIES					
Tensile strength	Mpa	51.0	50.0	49.0	14.0
Tear strength	kN/m	197	223	209	54
Hardness (Shore A)		85	85	85	85
ELECTRICAL PROPERTIES					
Breakdown voltage (Voltage ramp)[1]	V (AC)	7000	12000	16000	21000
Breakdown voltage (Voltage steps)[2]	V (AC)	2000	5000	7000	12000
Volume resistivity	Ωm	8.0×10^{12}	10.0×10^{12}	9.0×10^{12}	11.0×10^{12}
Dielectric constant (1 kHz)		3.0	3.1	2.9	2.9
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	5.0	5.0	5.0	5.0
Thermal resistance[3] (inch²)	°C/W	0.19	0.25	0.35	0.63
Operating temperature	°C	-60 to +200	-60 to +200	-60 to +200	-60 to +200

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

[3] Increase of thermal resistance through adhesive by about 0,1 °C/W

Thermo-silicone interface material KU-BG

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard configurations (see page 86)
- Non-adhesive or adhesive on one side
- Stamped and cut according to customer specifications
- In sheet form:

BG 20	320 mm x 440 mm
BG 30	210 mm x 270 mm
BG 45	320 mm x 440 mm
Adhesive on one side	200 mm x 260 mm

THERMAL CONDUCTIVITY
(W/m·°K)

4.1

electrically insulating

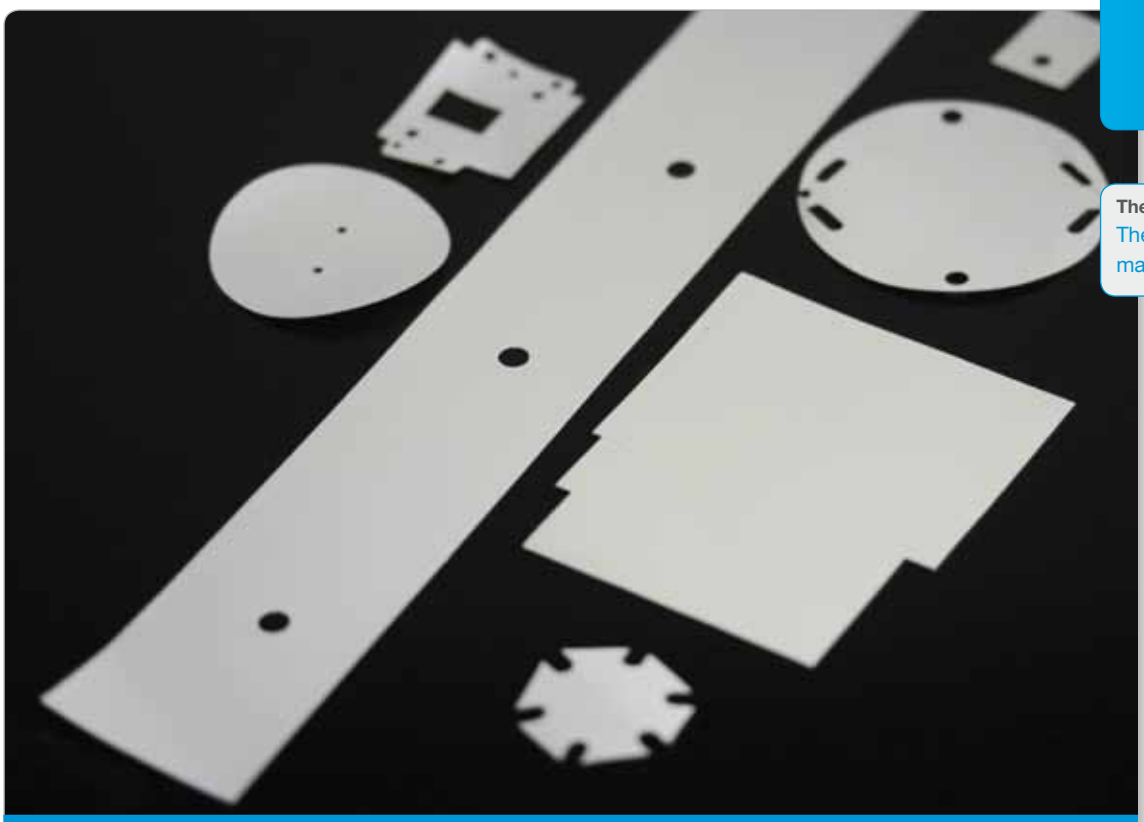
Thermo-silicone interface material KU-BGD

HEATPAD® KU-BGD is a silicone foil filled with boron nitride for excellent thermal conductivity, and reinforced with fiberglass. Its very soft texture adapts superbly to the contact surfaces so that thermal contact resistance and total thermal transfer resistance are reduced to a minimum. It meets the highest technical standards for interface materials.

PROPERTIES

- Extremely high thermal conductivity
- Minimal thermal resistance
- Fiberglass reinforced for mechanical stability
- Very flexible
- Quick and clean handling, superior process reliability
- No thermal paste required
- UL flammability rating: UL 94 V0

PART	KU-	BGD 20	BGD 30	BGD 45	BGD 80
GENERAL PROPERTIES					
Material		Fiberglass reinforced silicone			
Filler		Thermally conductive ceramic (Boron Nitride)			
Colour		Light green	White		
Gauge	mm	0.2 +0.05 to -0.05	0.3 +0.05 to -0.05	0.45 +0.05 to -0.05	0.8 +0.2 to -0.05
Density	g/cm³	1.7	1.7	1.7	1.7
Outgassing (LMW Siloxane)	ppm	∑ D3 - D10 = < 5			
MECHANICAL PROPERTIES					
Tensile strength (JIS K6301)	Mpa	25	20	14	9
Tear strength (JIS K6301)	kN/m	117	88	59	39
Hardness (Shore A)		88	88	88	88
ELECTRICAL PROPERTIES					
Breakdown voltage (JIS C2110)	kV (AC)	3	6.5	9	> 10
Volume resistivity	Ωcm	1.9×10^{15}	2.4×10^{15}	3.3×10^{15}	4.1×10^{15}
Dielectric constant (1 MHz)		3.6	3.6	3.6	3.6
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	4.1	4.1	4.1	4.1
Thermal resistance ($inch^2$)	°C/W	0.23	0.26	0.32	0.48



Thermo-silicone interface material KU-BGD

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard configurations (see page 86)
- Non-adhesive or adhesive on one side
- Stamped and cut according to customer specifications
- In sheet form 440 mm x 500 mm

THERMAL CONDUCTIVITY
(W/m·°K)

5.0

electrically insulating

Thermo-silicone interface material KU-BGDX

HEATPAD® KU-BGDX is a silicone foil filled with boron nitride for excellent thermal conductivity, and reinforced with fiberglass. Its very soft texture adapts superbly to the contact surfaces so that thermal contact resistance and total thermal transfer resistance are reduced to a minimum.

It meets the highest technical standards for interface materials.

PROPERTIES

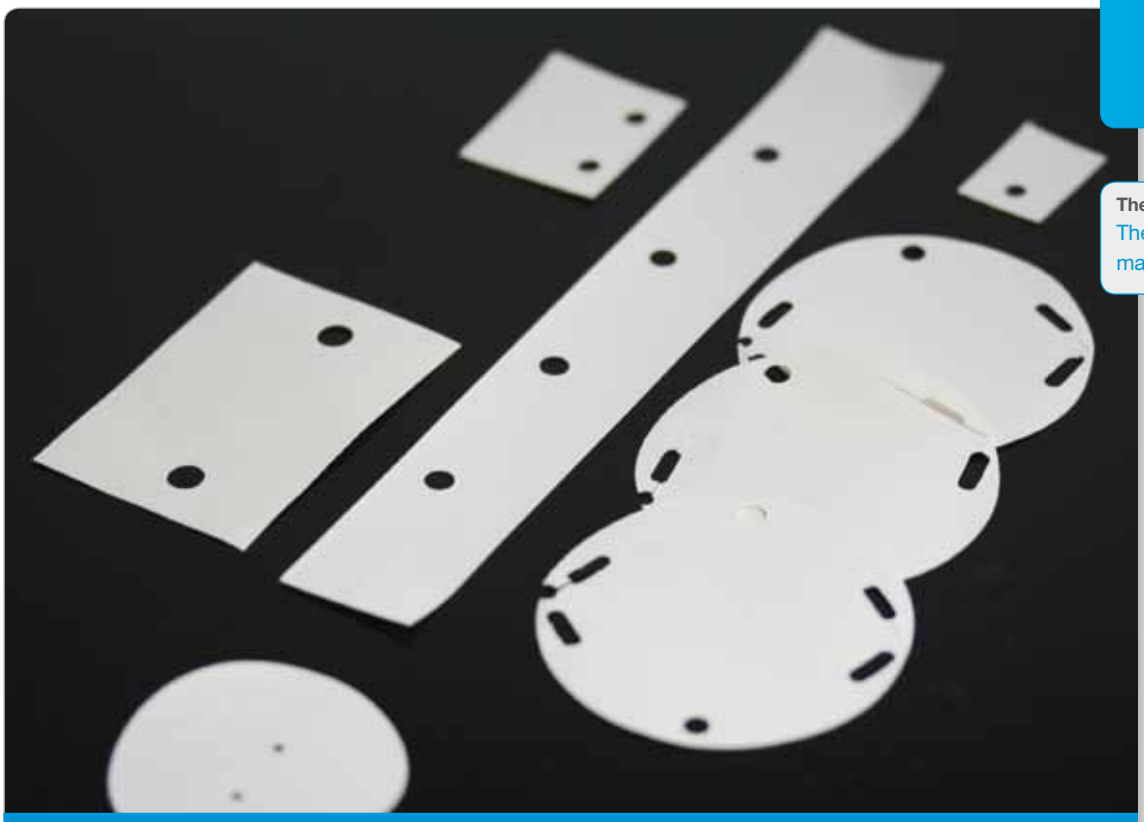
- Extremely high thermal conductivity
- Minimal thermal resistance
- Fiberglass reinforced for mechanical stability
- Very flexible
- Quick and clean handling, superior process reliability
- No thermal paste required
- UL flammability rating: UL 94 V0

PART	KU-	BGDX 08	BGDX 20	BGDX 30	BGDX 80
GENERAL PROPERTIES					
Material		Fiberglass reinforced silicone			
Filler		Thermally conductive ceramic (Boron Nitride)			
Colour		White			
Gauge	mm	0.08 $^{+0.05 \text{ to } -0.05}$	0.2 $^{+0.05 \text{ to } -0.05}$	0.3 $^{+0.05 \text{ to } -0.05}$	0.8 $^{+0.2 \text{ to } -0.05}$
Outgassing (LMW Siloxane)	ppm	$\sum$ D3 - D10 = < 14			
MECHANICAL PROPERTIES					
Tensile strength (JIS K6251)	Mpa	8	9	8	4
Tear strength (JIS K6252)	kN/m	38	41	37	18
Hardness (Shore A) (JIS K6253)		90	90	90	88
ELECTRICAL PROPERTIES					
Breakdown voltage (JIS C2110)	kV (AC)	1.0	3	6.0	> 10
Volume resistivity	Ωcm	2.2×10^{14}	1.7×10^{15}	7.9×10^{15}	8.9×10^{15}
Dielectric constant (1 MHz)		3.3	3.3	3.3	3.3
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	5.0	5.0	5.0	5.0
Thermal resistance ($inch^2$)	°C/W	0.06	0.18	0.19	0.41

THERMAL CONDUCTIVITY
(W/m·°K)

5.0

electrically insulating



Thermo-silicone interface material KU-BGDX

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard configurations (see page 86)
- Stamped and cut according to customer specifications
- In sheet form:
  KU-BGDX08 440 mm x 510 mm
  all other 440 mm x 500 mm
  and to customer specifications

THERMAL CONDUCTIVITY
(W/m·°K)

1.9

electrically insulating

Thermo-silicone interface material KU-CG

HEATPAD® KU-CG is a silicone film filled with thermal conductive ceramics for superior thermal conductivity, and reinforced with fiberglass. By implementing it, a very low total thermal resistance can be achieved. Its performance and flexibility make it the ideal interface material for most applications.

PROPERTIES

- High thermal conductivity
- Very low thermal resistance
- Very flexible
- Fiberglass reinforced
- Clean and easy mounting, high process reliability
- No thermal paste required
- UL flammability rating: UL 94 V0

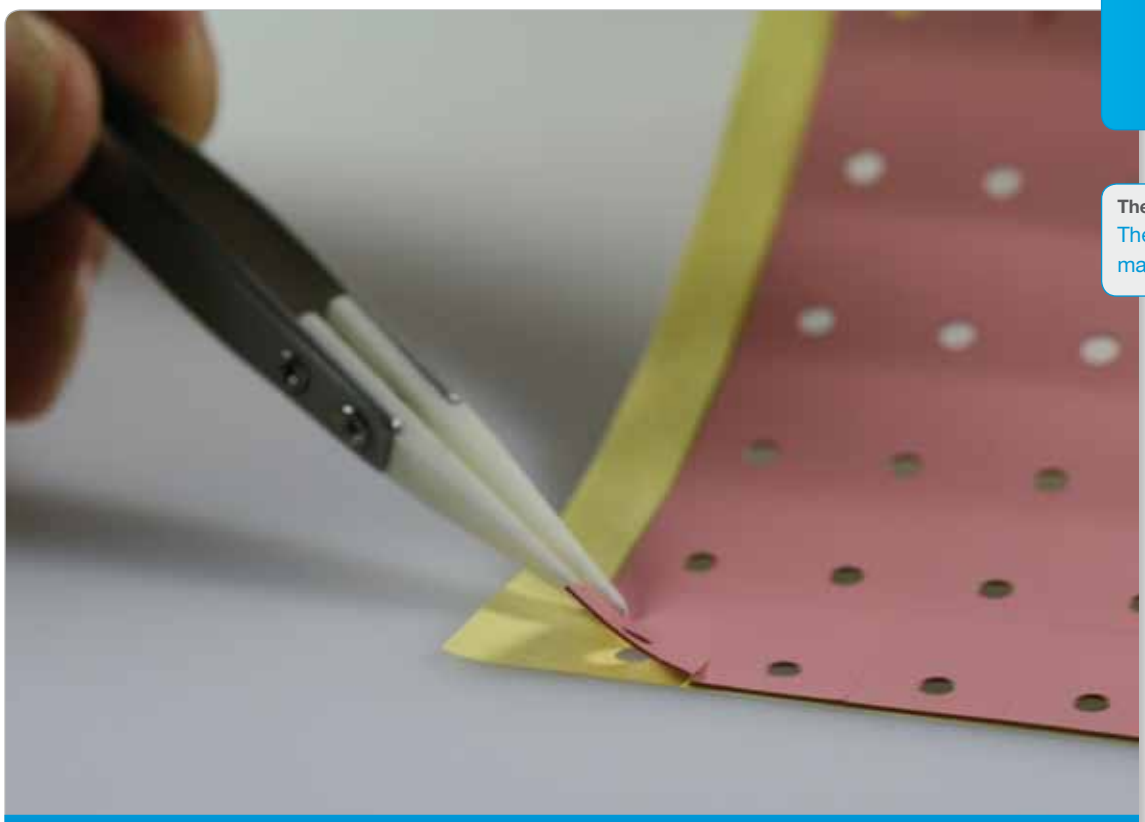
PART	KU-	CG 20	CG 30	CG 45	CG 80
GENERAL PROPERTIES					
Material		Fiberglass reinforced silicone			
Filler		Thermally conductive ceramic			
Colour		Salmon			
Gauge	mm	0.2 +0.05 to -0.05	0.3 +0.1 to 0	0.45 +0.05 to -0.05	0.8 +0.1 to 0
Outgassing (LMW Siloxane)	ppm	∑ D3 - D10 = < 10			
MECHANICAL PROPERTIES					
Tensile strength	Mpa	25.9	24.1	20.4	9.3
Tear strength	kN/m	70	69	68	24
Hardness (Shore A)		92	92	92	92
ELECTRICAL PROPERTIES					
Breakdown voltage (Voltage ramp)[1]	V (AC)	5000	7000	10000	19999
Breakdown voltage (Voltage steps)[2]	V (AC)	2000	3000	5000	10000
Volume resistivity	Ωm	1.8×10^{12}	1.8×10^{12}	1.2×10^{12}	1.0×10^{12}
Dielectric constant (1 kHz)		3.8	4.2	4.3	4.3
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	1.9	1.9	1.9	1.9
Thermal resistance[3] (inch²)	°C/W	0.30	0.45	0.65	1.05
Operating temperature	°C	-60 to +200	-60 to +200	-60 to +200	-60 to +200

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

[3] Increase of thermal resistance through adhesive by about 0,1 °C/W



Thermo-silicone interface material KU-CG

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard configurations (see page 86)
- Non-adhesive or adhesive on one side
- In roll form up to 50 m (except KU-CG 80) according to customer specifications
- Stamped and cut according to customer specifications
- In sheet form:

CG 20	320 mm x 1000 mm
CG 30	320 mm x 1000 mm
CG 45	320 mm x 1000 mm
CG 80	300 mm x 1000 mm
Adhesive on one side	320 mm x 1000 mm

THERMAL CONDUCTIVITY
(W/m·°K)

4.5

electrically insulating

Thermo-silicone interface material KU-EGF

HEATPAD® KU-EGF is a silicone film filled with highly thermally conductive ceramics and reinforced with fiberglass. By implementing it, an extremely low total thermal resistance can be achieved. It is ideal for applications involving critical temperatures.

PROPERTIES

- Very high thermal conductivity
- Extremely low thermal resistance
- Very flexible
- Fiberglass reinforced
- Clean and easy mounting, high process reliability
- No thermal paste required
- UL flammability rating: UL 94 V0

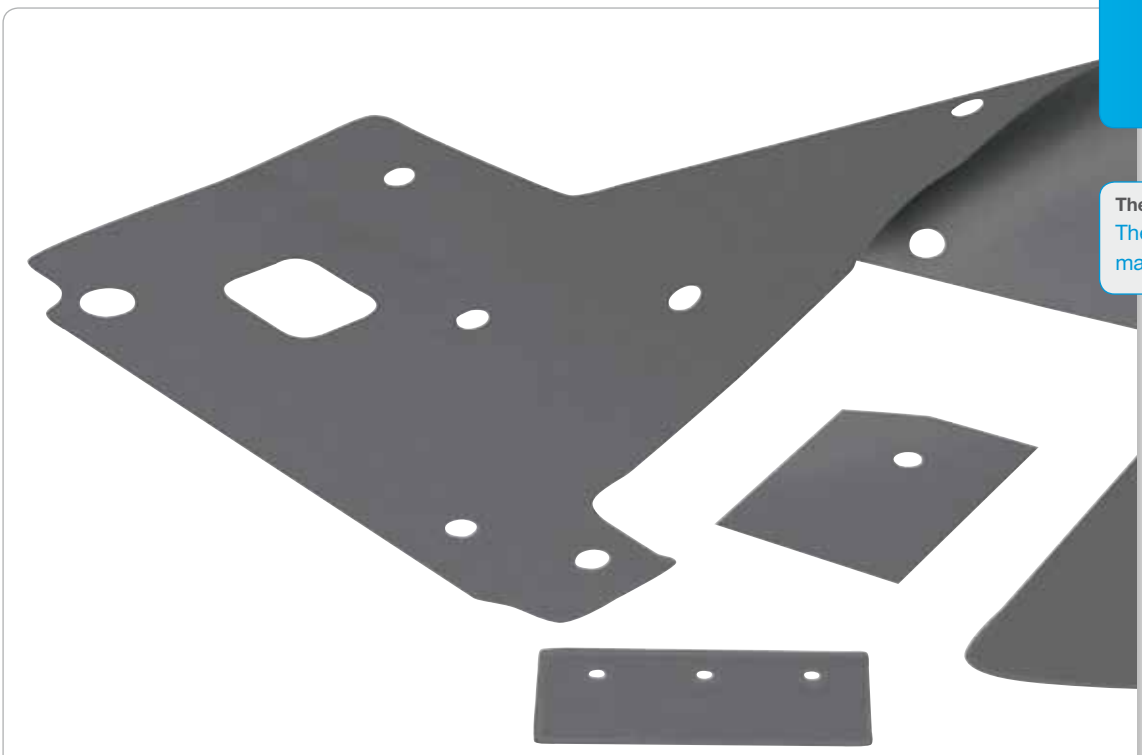
PART	KU-	EGF 20	EGF 30	EGF 45
GENERAL PROPERTIES				
Material		Fiberglass reinforced silicone		
Filler		Thermally conductive ceramic		
Colour		Blue-grey		
Gauge	mm	0.2 +0.05 to -0.05	0.3 +0.05 to -0.05	0.45 +0.05 to -0.05
Outgassing (LMW Siloxane)	ppm	∑ D3 - D10 = < 10		
MECHANICAL PROPERTIES				
Tensile strength	Mpa	18.0	17.0	15.0
Tear strength	kN/m	70	50	55
Hardness (Shore A)		91	91	91
ELECTRICAL PROPERTIES				
Breakdown voltage (Voltage ramp)[1]	V (AC)	4000	7000	8000
Breakdown voltage (Voltage steps)[2]	V (AC)	2000	5000	6000
Volume resistivity	Ωm	25.0 x 10^{12}	22.0 x 10^{12}	19.0 x 10^{12}
Dielectric constant (1 kHz)		6.5	6.5	6.5
THERMAL PROPERTIES				
Thermal conductivity	W/mK	4.5	4.5	4.5
Thermal resistance[3] (inch²)	°C/W	0.22	0.30	0.44
Operating temperature	°C	-60 to +200	-60 to +200	-60 to +200

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

[3] Increase of thermal resistance through adhesive by about 0,1 °C/W



Thermo-silicone interface material KU-EGF

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard configurations (see page 86)
- Non-adhesive or adhesive on one side
- In roll form up to 50 m according to customer specifications
- Stamped and cut according to customer specifications
- In sheet form:

EGF 20	330 mm x 1000 mm
EGF 30	330 mm x 1000 mm
EGF 45	330 mm x 1000 mm
Adhesive on one side	320 mm x 1000 mm

THERMAL CONDUCTIVITY
(W/m·°K)

1.05

electrically insulating

Thermally conductive silicone film with polyimide substrate KU-KC15

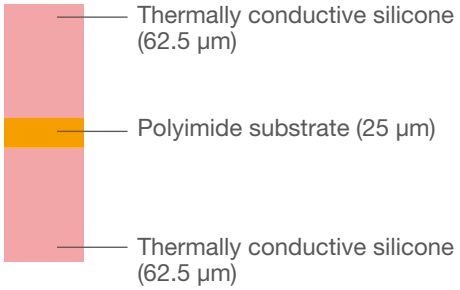
HEATPAD® KU-KC is a high-performance thermally conductive film based on a polyimide substrate and coated on both sides with the thermally conductive silicone film KU-C (same as KU-CG but without fiberglass reinforcement).

It possesses the extraordinary dielectric and mechanical properties of polyimide, combined with the excellent thermal properties of silicone. Due to its softness and with pressure applied, the material adapts well to the contact surfaces, reducing total thermal resistance. It is the process-reliable substitute for the brittle combination of mica and thermal paste.

PROPERTIES

- Minimal thermal contact resistance combined with electrical insulation
- Very flexible and mechanically stable
- Guaranteed layer thickness
- Low starting torque required
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0 (non-adhesive) (FileNr: E337894)

CONSTRUCTION



PART	KU-	KC15
GENERAL PROPERTIES		
Material		Silicone – Polyimide – Silicone
Filler		Thermally conductive ceramic
Colour		Salmon
Material gauge	mm	0.15
Substrate thickness	mm	0.025
Density	g/cm³	2.18
Outgassing (LMW Siloxane)	ppm	∑ D3 - D10 = < 10
MECHANICAL PROPERTIES		
Tensile strength	MPa	46
Tear strength	kN/m	60
Hardness (Shore A)		95
ELECTRICAL PROPERTIES		
Breakdown voltage (Voltage ramp)[1]	V (AC)	12500
Breakdown voltage (Voltage steps)[2]	V (AC)	9500
THERMAL PROPERTIES		
Thermal conductivity	W/mK	1.05
Thermal resistance[3] (inch²)	°C/W	0.36
Operating temperature	°C	-60 to +200

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

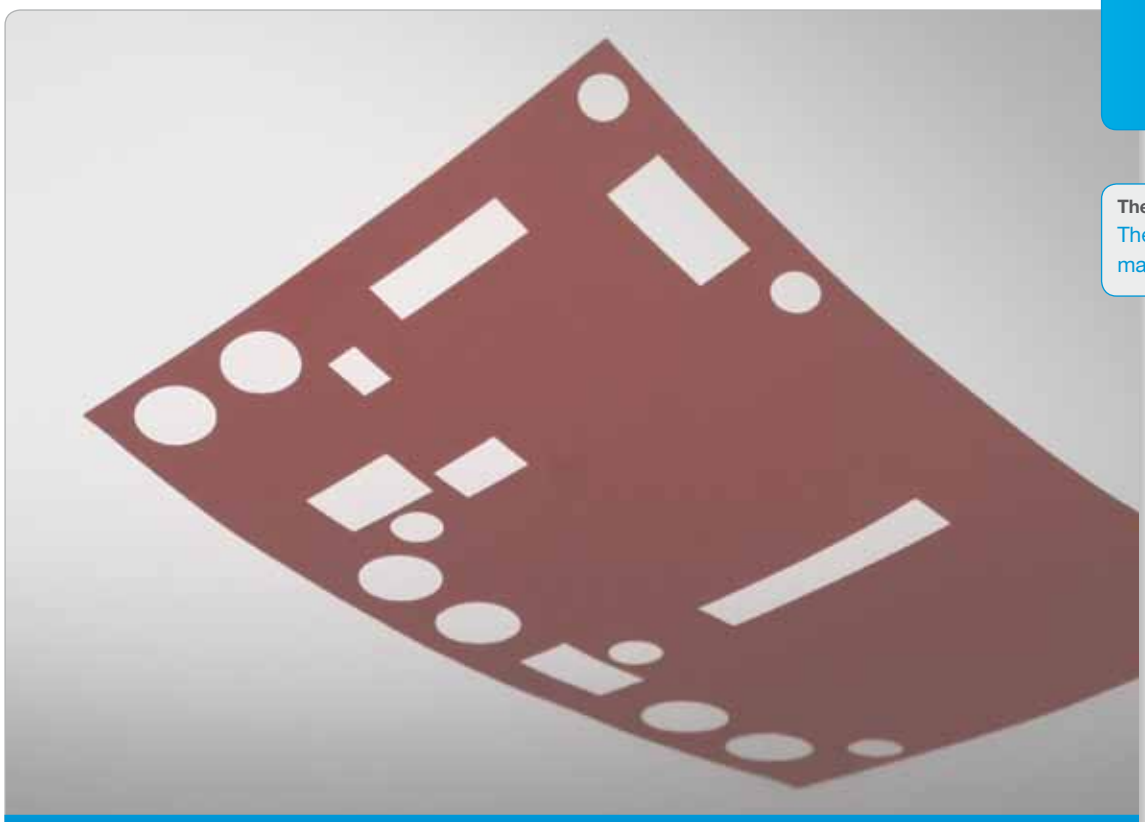
[2] Step-by-step voltage increments until dielectric breakdown

[3] Increase of thermal resistance through adhesive by about 0,1 °C/W

THERMAL CONDUCTIVITY
(W/m·°K)

1.05

electrically insulating



Thermally conductive silicone film with polyimide substrate KU-KC15

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard configurations (see page 86)
- Non-adhesive or adhesive on one side
- In roll form according to customer specifications, max. length 50 m
- In sheet form: 300 mm x 1000 mm

THERMAL CONDUCTIVITY
(W/m·°K)

1.6

electrically insulating

Thermally conductive silicone film with polyimide substrate KU-KE11

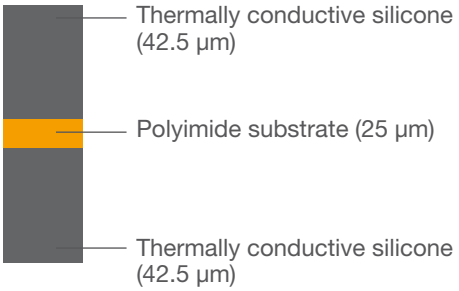
HEATPAD® KU-KE11 is a highly thermally conductive film with a polyimide substrate, coated on both sides with the thermally conductive silicone film KU-E (same as KU-EG but without fiberglass reinforcement).

It possesses the extraordinary dielectric and mechanical properties of polyimide, combined with the excellent thermal properties of silicone. Due to its softness and with pressure applied, it adapts well to contact surface irregularities, minimizing total thermal resistance. It is a process-reliable substitute for the brittle combination of mica and thermal paste.

PROPERTIES

- Minimal thermal resistance combined with very high dielectric strength
- Very stable and flexible
- Guaranteed layer thickness
- Low starting torque required
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

CONSTRUCTION



PART	KU-	KE11
GENERAL PROPERTIES		
Material		Silicone – Polyimide – Silicone
Filler		Thermally conductive ceramic
Colour		Grey
Substrate gauge	µm	25
Material gauge with coating	µm	110
MECHANICAL PROPERTIES		
Tensile strength	Mpa	40
Tear strength	kN/m	80
Hardness (Shore A)		95
ELECTRICAL PROPERTIES		
Breakdown voltage[1] (JIS K6249)	V (AC)	10000
Flammability rating		Equivalent to UL 94 V0
THERMAL PROPERTIES		
Thermal conductivity (Calculated value)	W/mK	1.6
Thermal resistance (inch²)	°C/W	0.35
Operating temperature	°C	-60 to +200

[1] Voltage ramp 1000 V/s

Thermally conductive silicone film with polyimide substrate KU-KE11

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard configurations (see page 86)
- In roll form according to customer specifications, max. length 50 m
- In sheet form: 300 mm x 1000 mm

THERMAL CONDUCTIVITY
(W/m·°K)

1.0

electrically insulating

Thermo-silicone interface material KU-SAS

HEATPAD® KU-SAS is a double-sided adhesive tape with outstanding thermal interface properties and very high adhesion.

PROPERTIES

- Easy to apply, even on large surfaces
- Wide temperature range
- Very flexible
- Easy to remove
- Clean and easy handling, superior process reliability
- UL flammability rating: UL 94 V0

TYPICAL APPLICATIONS:

- **Thermal connection of:**
  LEDs, carriers and casings
- **Thermal connection of:**
  Power semiconductors and heat sinks, as well as the junction of cooling elements, semiconductors and other electronic component parts

For explanatory notes regarding voltage ramp/step, see page 152

PART	KU-	SAS10	SAS20
GENERAL PROPERTIES			
Material		Silicone	
Colour		White	
Thickness	µm	100 +15 to -15	200 +15 to -15
Outgassing (LMW Siloxane, Generating Gas Analysis)	ppm	∑ D3 - D10 = 1	∑ D3 - D10 = 1
MECHANICAL AND ELECTRICAL PROPERTIES			
Peeling strength [1]	N/cm	6	6.4
Breakdown voltage (Voltage ramp) [2]	kV	3.2	6.5
Breakdown voltage (Voltage steps) [3]	kV	2.0	5.0 at 25°C / 4.5 at 80°C
Flammability rating		UL 94 V0	UL 94 V0
THERMAL PROPERTIES			
Thermal conductivity (ISO 22007-2)	W/mK	1.0	1.0
Thermal resistance (inch²) (according to an ISO 22007-2)	K/W	0.16	0.48
Operating temperature	C°	-40 to +150	-40 to +150

[1] 180° Peeling strength with Al plate, at 23°C, peeling speed: 300 mm/min, sample was boned using a 2 kg roller, measurement follows after 10 min.

[2] Voltage ramp 1000 V/s

[3] Step-by-step voltage increments until dielectric breakdown

Thermo-silicone interface material KU-SAS

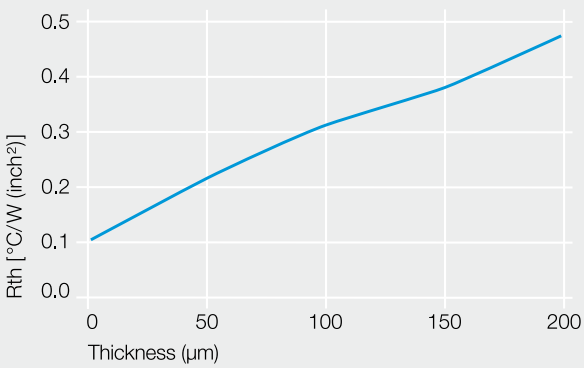
Image may differ from the original product.

PRODUCT AVAILABILITY

- In roll form
- In sheet form
- Cut and stamped to customer specifications

THICKNESS DEPENDENCE

Thickness dependence of total thermal transfer resistance

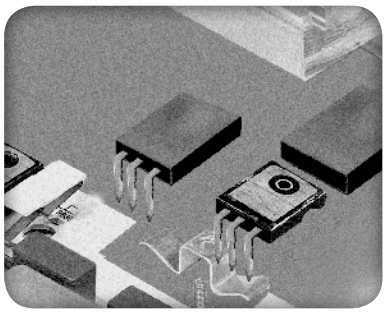


02 Thermo-silicone caps and tubes

Thermo-silicone caps of the S, C and A series and thermo-silicone tubes of the A series are made of silicone filled with highly thermally conductive ceramics.

All-round electric insulation of the component ensures optimal protection (depending on material gauges) against electrical breakdown, while reducing total thermal resistance to the cooling device (heat sink or chassis).

Thermo-silicone caps are available in different sizes to fit standards TO 220, TO 3P and TO 247. Thermo-silicone tubes are available in different diameters. Caps and tubes are ideal for use with Kunze POWER-CLIPS®.

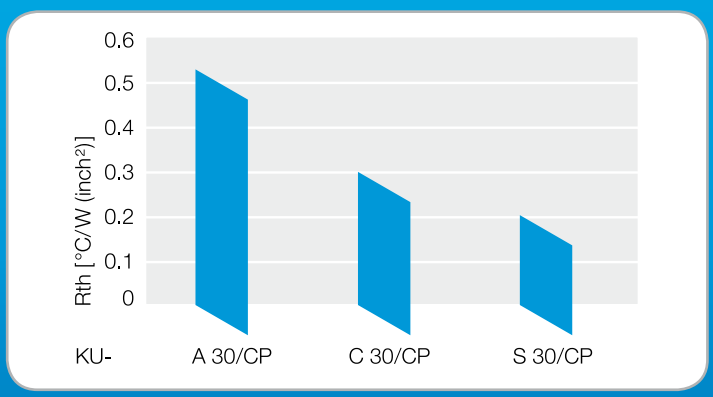


APPLICATION EXAMPLES

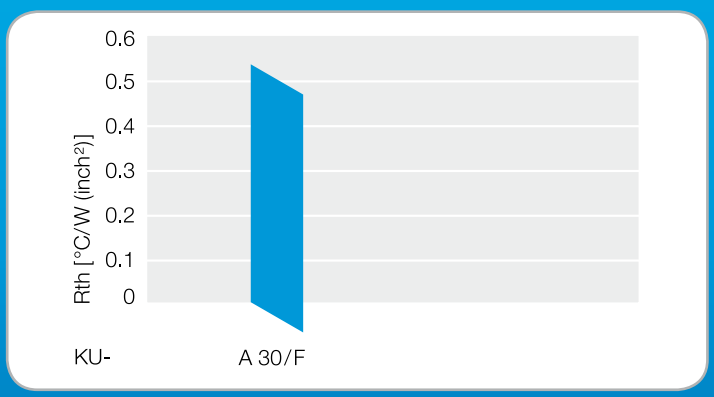
Thermal linkage and electric insulation of heat sources and heat sinks in:

- Power modules
- Power supplies
- Electric drives
- Telecommunication modules
- Engine control
- Frequency converters
- UPS

THERMAL RESISTANCE OVERVIEW CAPS



THERMAL RESISTANCE OVERVIEW TUBES



THERMAL CONDUCTIVITY
(W/m·°K)

1.1

electrically insulating

Thermo-silicone caps
A series

Kunze thermo-silicone caps of the A type are made of silicone filled with thermally conductive ceramics. Their implementation allows for low thermal resistance. Owing to their high dielectric strength, thermo-silicone caps of the A type are used in applications with high requirements regarding electrical insulation. Ideal for use with Kunze POWERCLIPS®.

PROPERTIES

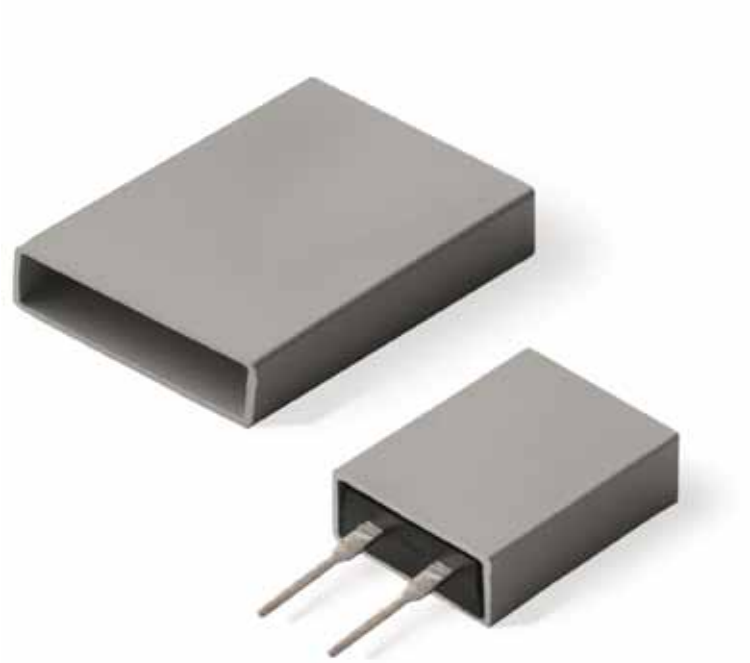
- Good thermal conductivity
- Low thermal resistance
- Very flexible
- Reliable all-round insulation
- Very high dielectric strength
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

PART	KU-	A 30	A 45	A 80
GENERAL PROPERTIES				
Material		Silicone		
Filler		Thermally conductive ceramic		
Colour		Grey		
Gauge	mm	0.3 +0.15 to 0	0.45 +0.1 to -0.05	0.8 +0.15 to 0
MECHANICAL PROPERTIES				
Tensile strength	MPa	5.7	5.7	5.7
Tear strength	kN/m	8.0	8.0	8.0
ELECTRICAL PROPERTIES				
Breakdown voltage (Voltage ramp)[1]	V (AC)	12000	15000	20000
Breakdown voltage (Voltage steps)[2]	V (AC)	7000	9000	13000
Volume resistivity	Ωm	1.0×10^{12}	1.0×10^{12}	1.0×10^{12}
Dielectric constant (1 kHz)		4.8	4.8	4.8
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES				
Thermal conductivity	W/mK	1.1	1.1	1.1
Thermal resistance (inch²)	°C/W	0.53	0.74	1.14
Operating temperature	°C	-60 to +200	-60 to +200	-60 to +200

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

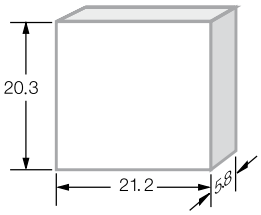


Thermo-silicone caps A series

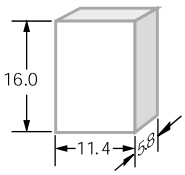
Image may differ from the original product.

AVAILABLE CAP CONFIGURATIONS AND DIMENSIONS (External dimensions)

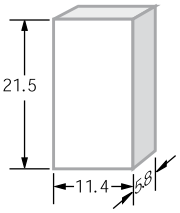
All dimensions in mm.



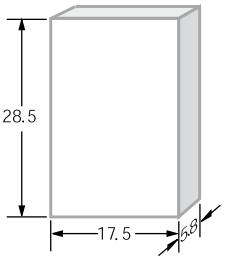
Part-No.
KU 7-700/AXX/CP



Part-No.
KU 7-723/16/AXX/CP
TO-220



Part-No.
KU 7-723/AXX/CP
TO-220



Part-No.
KU 7-724/AXX/CP
TO-3P/TO-247

ON REQUEST

- Other dimensions

THERMAL CONDUCTIVITY
(W/m·°K)

1.5

electrically insulating

Thermo-silicone caps
C series

Kunze thermo-silicone caps of the C type are made of silicone filled with highly thermally conductive ceramics.

Their excellent thermal properties and high dielectric strength make them perfect for most applications. Ideal for use with Kunze POWERCLIPS®.

PROPERTIES

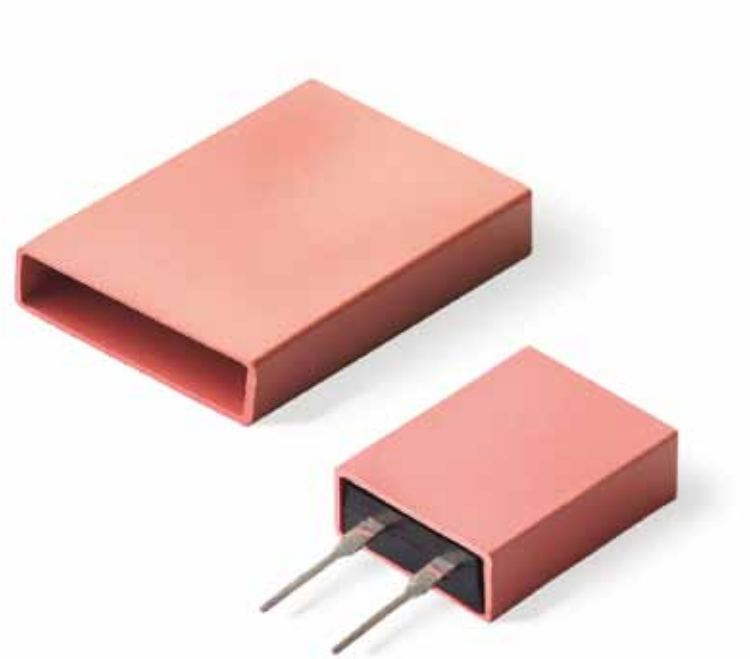
- High thermal conductivity
- Very low thermal resistance
- Very flexible
- Reliable all-round insulation
- High dielectric strength
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

PART	KU-	C 30	C 45	C 80
GENERAL PROPERTIES				
Material		Silicone		
Filler		Thermally conductive ceramic		
Colour		Salmon		
Gauge	mm	0.3 +0.15 to 0	0.45 +0.1 to -0.05	0.8 +0.15 to 0
MECHANICAL PROPERTIES				
Tensile strength	MPa	3.2	3.2	3.2
Tear strength	kN/m	10.0	10.0	10.0
ELECTRICAL PROPERTIES				
Breakdown voltage (Voltage ramp)[1]	V (AC)	10000	12000	18000
Breakdown voltage (Voltage steps)[2]	V (AC)	8000	10000	14000
Volume resistivity	Ωm	3.2×10^{12}	3.2×10^{12}	3.2×10^{12}
Dielectric constant (1 kHz)		6.0	6.0	6.0
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES				
Thermal conductivity	W/mK	1.5	1.5	1.5
Thermal resistance (inch²)	°C/W	0.30	0.42	0.70
Operating temperature	°C	-60 to +200	-60 to +200	-60 to +200

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

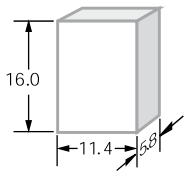


Thermo-silicone caps C series

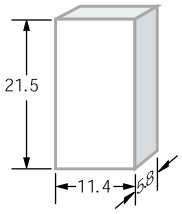
Image may differ from the original product.

AVAILABLE CAP CONFIGURATIONS AND DIMENSIONS (External dimensions)

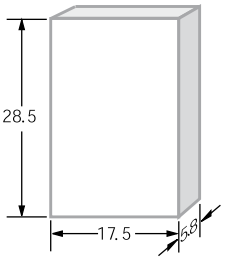
All dimensions in mm.



Part-No.
KU 7-723/16/CXX/CP
TO-220



Part-No.
KU 7-723/CXX/CP
TO-220



Part-No.
KU 7-724/CXX/CP
TO-3P/TO-247

ON REQUEST

- Other dimensions

THERMAL CONDUCTIVITY
(W/m·°K)

2.0

electrically insulating

Thermo-silicone caps
S series

Kunze thermo-silicone caps of the S series are made of silicone filled with high-performance thermally conductive ceramics. Total thermal resistance is minimized due to the material's flexibility and its adaptability to contact surfaces.

Owing to their very high thermal conductivity and very low thermal resistance, thermo-silicone caps of the S type are employed in applications with the highest technical requirements. Ideal for use with Kunze POWERCLIPS®.

PROPERTIES

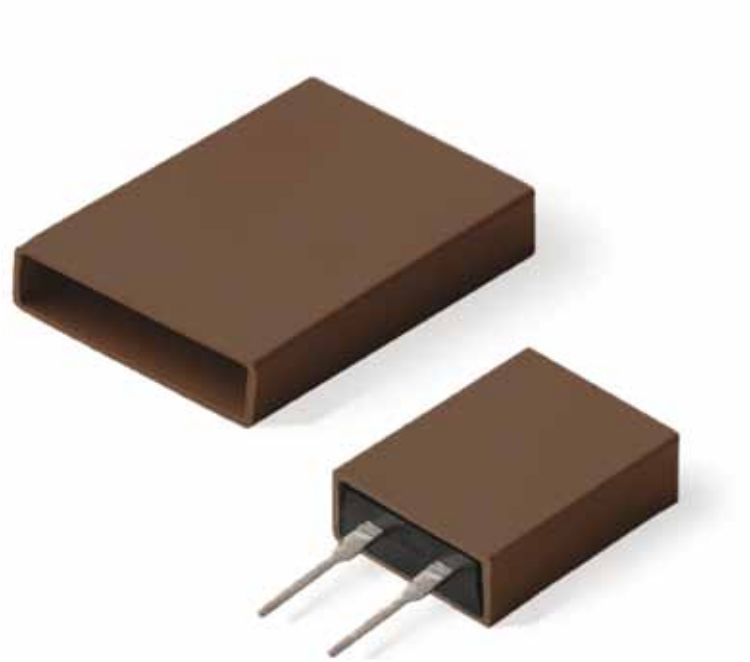
- Excellent thermal conductivity
- Minimal thermal resistance
- Very flexible
- Reliable all-round insulation
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

PART	KU-	S 30	S 45	S 80
GENERAL PROPERTIES				
Material		Silicone		
Filler		Thermally conductive ceramic		
Colour		Brown		
Gauge	mm	0.3 +0.15 to 0	0.45 +0.1 to -0.05	0.8 +0.15 to 0
MECHANICAL PROPERTIES				
Tensile strength	MPa	3.0	3.0	3.0
Tear strength	kN/m	6.0	6.0	6.0
ELECTRICAL PROPERTIES				
Breakdown voltage (Voltage ramp)[1]	V (AC)	6000	9000	14000
Breakdown voltage (Voltage steps)[2]	V (AC)	4000	7000	12000
Volume resistivity	Ωm	3.5×10^{13}	3.5×10^{13}	3.5×10^{13}
Dielectric constant (1 kHz)		6.3	6.3	6.3
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES				
Thermal conductivity	W/mK	2.0	2.0	2.0
Thermal resistance (inch²)	°C/W	0.2	0.26	0.48
Operating temperature	°C	-60 to +200	-60 to +200	-60 to +200

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

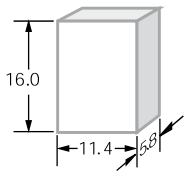


Thermo-silicone caps S series

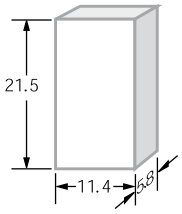
Image may differ from the original product.

AVAILABLE CAP CONFIGURATIONS AND DIMENSIONS (External dimensions)

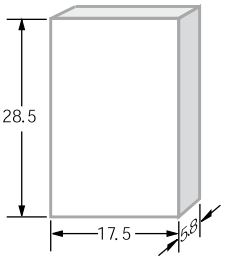
All dimensions in mm.



Part-No.
KU 7-723/16/SXX/CP
TO-220



Part-No.
KU 7-723/SXX/CP
TO-220



Part-No.
KU 7-724/SXX/CP
TO-3P/TO-247

ON REQUEST

- Other dimensions

THERMAL CONDUCTIVITY
(W/m·°K)

1.1

electrically insulating

Thermo-silicone tubes
A series

Kunze thermo-silicone tubes of the A type are made of silicone, filled with thermally conductive ceramics. Their implementation allows for low total thermal resistance.

Owing to their very high dielectric strength, thermo-silicone tubes of the A type are used in applications with high requirements regarding electrical insulation. Ideal for use with Kunze POWERCLIPS®.

PROPERTIES

- Good thermal conductivity
- Low thermal resistance
- Reliable all-round insulation
- Very high dielectric strength
- Very flexible
- Clean and easy mounting
- UL flammability rating: UL 94 V0

For explanatory notes regarding voltage ramp/step, see page 152

PART	KU-	A 30	A 45	A 80
GENERAL PROPERTIES				
Material		Silicone		
Filler		Thermally conductive ceramic		
Colour		Grey		
Gauge	mm	0.3 +0.10 to 0	0.45 +0.05 to -0.05	0.8 +0.10 to 0
MECHANICAL PROPERTIES				
Tensile strength	MPa	5.7	5.7	5.7
Tear strength	kN/m	8.0	8.0	8.0
ELECTRICAL PROPERTIES				
Breakdown voltage (Voltage ramp)[1]	V (AC)	12000	15000	20000
Breakdown voltage (Voltage steps)[2]	V (AC)	7000	9000	13000
Volume resistivity	Ωm	1.0×10^{12}	1.0×10^{12}	1.0×10^{12}
Dielectric constant (1 kHz)		4.8	4.8	4.8
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES				
Thermal conductivity	W/mK	1.1	1.1	1.1
Thermal resistance (inch²)	°C/W	0.53	0.74	1.14
Operating temperature	°C	-60 to +200	-60 to +200	-60 to +200

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

Thermo-silicone tubes A series

Image may differ from the original product.

AVAILABLE FORMS

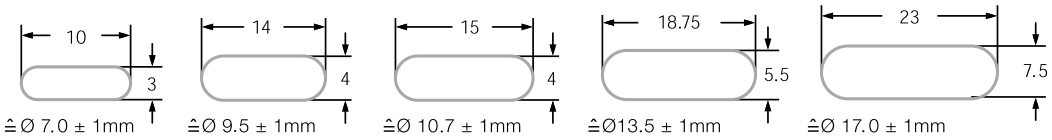
- By the metre
- Cut to customer specifications

ON REQUEST

- Other dimensions

AVAILABLE TUBE DIAMETERS

All dimensions in mm.



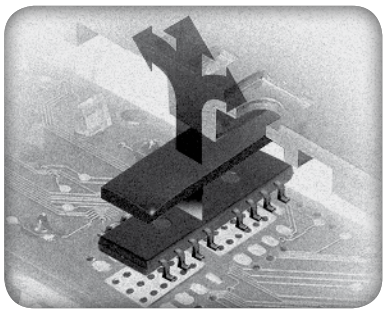
03

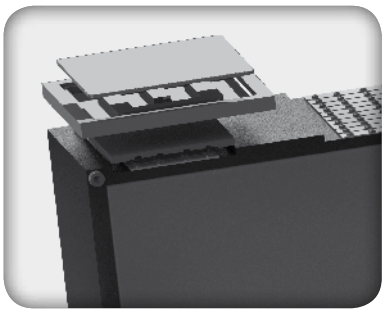
Thermally conductive soft-silicone films

Kunze HEATPAD® soft-silicone foils are soft and highly thermally conductive silicone interface materials filled with thermally conductive ceramics. They are especially suitable for applications in which the heat needs to be conducted longer distances from source to heat sink or chassis (due to component height difference or different tolerances and surface ruggedness, for instance). Additionally, the advantages of silicone as basic material are its resistance to high temperatures and many chemicals, as well as its high dielectric strength.

The high compressibility of these materials allows for heat sources and heat sinks to be optimally thermally linked in spite of surfaces ruggedness, different tolerances, etc. Chassis and casings can then be used as heat sinks, saving space within the application itself. Due to the material's flexibility, junction to the sides of the electronic components is reached, enlarging contact surfaces and therefore improving thermal transfer. The pressure necessary is very low, preventing components, conductor plates and casings from damage.

The high elasticity also provides good mechanical cushioning within the application. Due to their mechanical and thermal properties, soft-silicone interface materials are the ideal thermal solution for applications mounted on SMD boards. HEATPAD® soft-silicone films are optionally available laminated with HEATPAD® thermo-silicone. Lamination increases mechanical stability and, in combination with the material's self-adhesion on one side, makes it ideal for automated mounting.

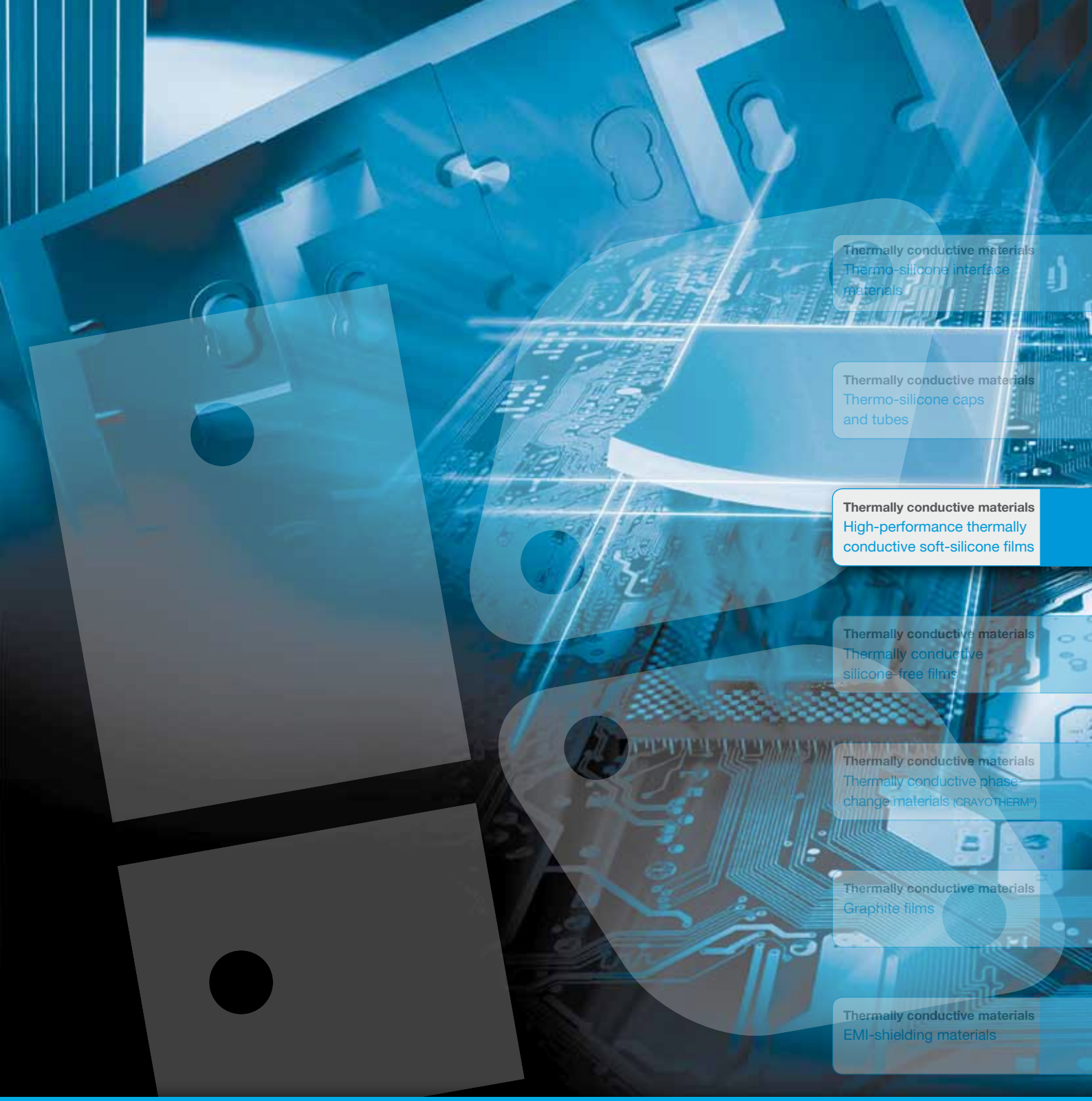




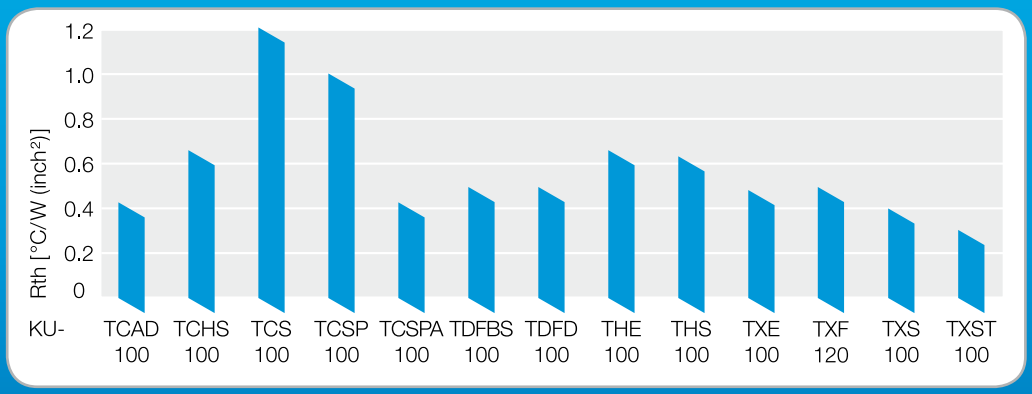
APPLICATION EXAMPLES

Thermal linkage and electric insulation of heat sources and heat sinks to bridge larger air gaps in:

- SMD-power modules
- Engine control and cooling units
- Vias and heat sinks or housings
- Electrolytic capacitors
- Thermosensors
- High-power diodes
- Heatpipes
- CD-ROM and DVD-ROM housings
- CPU modules
- Battery chargers
- UPS
- SMPS



THERMAL RESISTANCE OVERVIEW



THERMAL CONDUCTIVITY
(W/m·°K)

3.2

electrically insulating

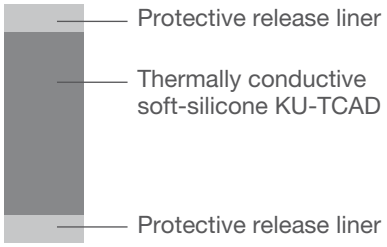
Thermally conductive soft-silicone film KU-TCAD

HEATPAD® KU-TCAD is a soft silicone film filled with thermally conductive ceramic for excellent thermal conductivity, superior elasticity and high dielectric strength. KU-TCAD meets the highest requirements regarding thermal transfer. Total thermal transfer resistance is minimized by this material. It is self-adhesive on both sides.

PROPERTIES

- Good thermal conductivity
- Very high dielectric strength
- Very soft and flexible
- Self-adhesive on both sides
- Gauges from 0.5 to 5 mm
- Gauges >1 mm: 12.6 Shore A / 60 Shore 00
- Quick and easy handling, superior process reliability
- UL flammability rating: UL 94 V0

CONSTRUCTION



PART	KU-	TCAD100
GENERAL PROPERTIES		
Material		Soft silicone
Filler		Thermally conductive ceramic
Colour		Grey
Gauge	mm	1
Density	g/cm³	3
Outgassing (LMW Siloxane)	ppm	∑ D3 - D10 = 180
MECHANICAL PROPERTIES		
Hardness (Shore A)		24
Hardness (Shore 00)		77
Resilience (Charge/discharge per 30 sec)	%	90
ELECTRICAL PROPERTIES		
Dielectric strength	kV/mm	15
Flammability rating		UL 94 V0
THERMAL PROPERTIES		
Thermal conductivity	W/mK	3.2
Thermal resistance (inch²)	°C/W	0.43
Operating temperature	°C	-40 to +180

THERMAL CONDUCTIVITY
(W/m·°K)

3.2

electrically insulating

Thermally conductive soft-silicone film KU-TCAD

Image may differ from the original product.

PRODUCT AVAILABILITY

- Customer-specific cuts and forms
- As sheets (300 mm x 400 mm)

THERMAL CONDUCTIVITY
(W/m·°K)

1.4

electrically insulating

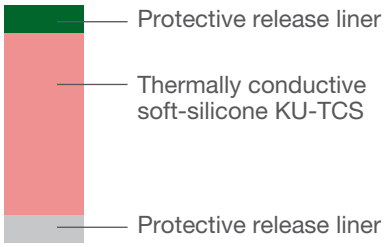
Thermally conductive soft-silicone KU-TCS

HEATPAD® KU-TCS is a soft-silicone interface material filled with thermally conductive ceramics for superior thermal conductivity and very high dielectric strength. KU-TCS considerably reduces total thermal resistance. The material is available in numerous gauges, covering a wide range of applications. KU-TCS is available self-adhesive on one or on both sides.

PROPERTIES

- Good thermal conductivity
- Very high dielectric strength
- Self-adhesive on both sides
- Clean and easy mounting, high process reliability
- Gauges from 0.5 mm to 10 mm
- UL flammability rating: UL 94 V1 for gauges < 3.0 mm
- UL flammability rating: UL 94 V0 for gauges > 3.0 mm

CONSTRUCTION



PART	KU-	TCS 50	TCS 100	TCS 200	TCS 300	TCS 400	TCS 500
GENERAL PROPERTIES							
Material		Soft silicone					
Filler		Thermally conductive ceramic					
Colour		Salmon					
Gauge	mm	0.5	1.0	2.0	3.0	4.0	5.0
Outgassing (LMW Siloxane)	ppm	∑ D3-10 = 260					
MECHANICAL PROPERTIES							
Tensile strength	MPa	0.35	0.35	0.35	0.35	0.35	0.35
Hardness (Shore A)		13	13	13	13	13	13
Hardness (Shore 00)		68	68	68	68	68	68
ELECTRICAL PROPERTIES							
Breakdown voltage (Voltage ramp)[1]	V (AC)	11000	22000	> 40000	> 40000	> 40000	> 40000
Breakdown voltage (Voltage steps)[2]	V (AC)	9000	18000	> 30000	> 30000	> 30000	> 30000
Volume resistivity	Ωm	$1.4x10^{12}$	$1.4x10^{12}$	$1.4x10^{12}$	$1.4x10^{12}$	$1.4x10^{12}$	$1.4x10^{12}$
Flammability rating		UL 94 V1	UL 94 V1	UL 94 V1	UL 94 V1	UL 94 V0	UL 94 V0
THERMAL PROPERTIES							
Thermal conductivity	W/mK	1.40	1.40	1.40	1.40	1.40	1.40
Thermal resistance (inch²)	°C/W	0.75	1.20	1.75	2.46	2.92	3.35
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180	-60 to +180	-60 to +180	-60 to +180

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

THERMAL CONDUCTIVITY
(W/m·°K)

1.4

electrically insulating

Thermally conductive soft-silicone KU-TCS

Image may differ from the original product.

PRODUCT AVAILABILITY

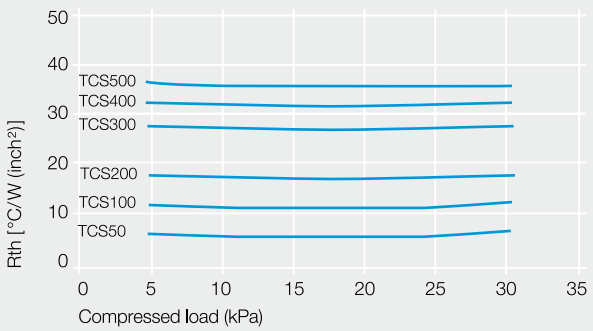
- Self-adhesive on one side (not UL listed) or on both sides
- Stamped and cut to customer specifications
- In sheet form 300 mm x 400 mm

ON REQUEST

- Other material gauges
- Intermediate gauges

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

1.7

electrically insulating

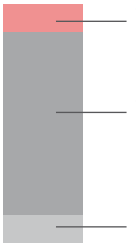
Thermally conductive soft-silicone KU-TCSP

HEATPAD® KU-TCSP is a soft-silicone interface material, laminated with fiberglass-reinforced KU-C on one side and filled with thermally conductive ceramics. It possesses outstanding elasticity, good thermal conductivity and very high dielectric strength. KU-TCSP is coated with fiberglass-reinforced silicone KU-CG on one side for improved stability. KU-TCSP considerably reduces total thermal resistance. The material is available in numerous gauges, covering a wide range of applications.

PROPERTIES

- Good thermal conductivity
- Very high dielectric strength
- Self-adhesive on one side
- Clean and easy mounting, high process reliability
- Wide range of material gauges in stock
- UL flammability rating: UL 94 V0

CONSTRUCTION

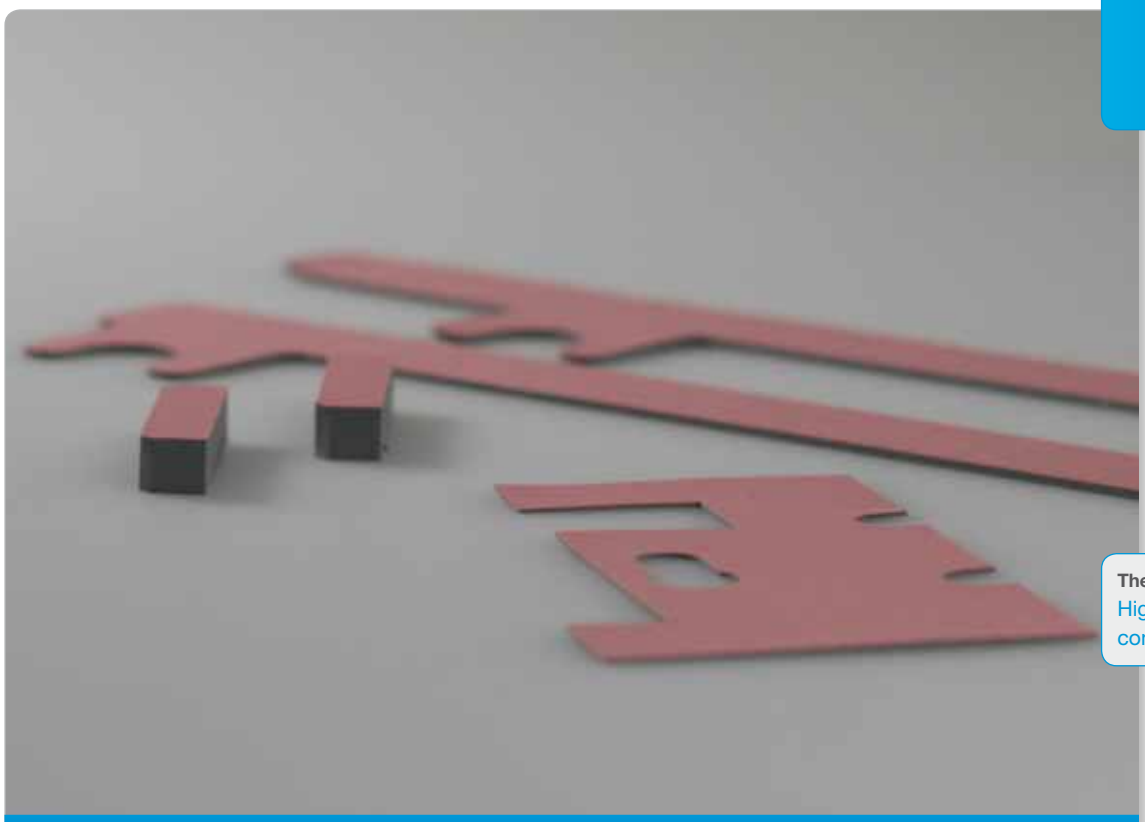


PART	KU-	TCSP 50	TCSP 100	TCSP 200	TCSP 300	TCSP 400	TCSP 500
GENERAL PROPERTIES							
Material		Soft silicone coated with KU-CG					
Filler		Thermally conductive ceramic					
Colour		Grey / salmon					
Gauge	mm	0.5	1.0	2.0	3.0	4.0	5.0
Outgassing (LMW Siloxane)	ppm	∑ D3-10 = 200 / ∑ D11-20 = 540					
MECHANICAL PROPERTIES							
Tensile strength	MPa	0.4	0.4	0.4	0.4	0.4	0.4
Hardness (Shore A)		44	44	44	44	44	44
Hardness (Shore 00)		44	44	44	44	44	44
ELECTRICAL PROPERTIES							
Breakdown voltage (Voltage ramp)[1]	V (AC)	10000	20000	> 30000	> 30000	> 30000	> 30000
Breakdown voltage (Voltage steps)[2]	V (AC)	8000	16000	> 25000	> 25000	> 25000	> 25000
Volume resistivity	Ωm	$1.0x10^{12}$	$1.0x10^{12}$	$1.0x10^{12}$	$1.0x10^{12}$	$1.0x10^{12}$	$1.0x10^{12}$
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES							
Thermal conductivity	W / mK	1.7	1.7	1.7	1.7	1.7	1.7
Thermal resistance (inch²)	°C / W	0.57	1.0	1.55	2.10	2.61	2.72
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180	-60 to +180	-60 to +180	-60 to +180

For explanatory notes regarding voltage ramp / step, see page 152

[1] Voltage ramp 1000 V / s

[2] Step-by-step voltage increments until dielectric breakdown



Thermally conductive soft-silicone KU-TCSP

Image may differ from the original product.

PRODUCT AVAILABILITY

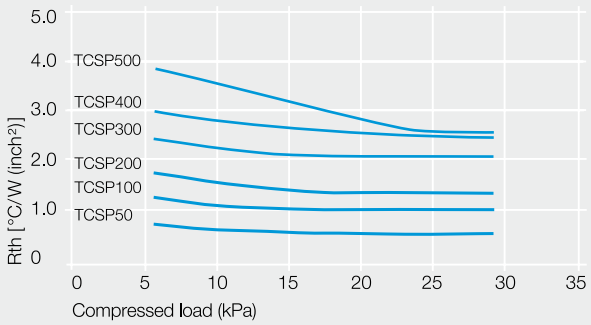
- Stamped and cut to customer specifications
- In sheet form 300 x 400 mm

ON REQUEST

- Intermediate gauges

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

3.0

electrically insulating

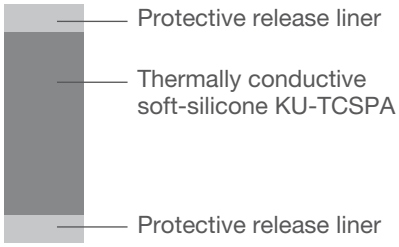
Thermally conductive soft-silicone KU-TCSPA

HEATPAD® KU-TCSPA is a soft-silicone interface material filled with thermally conductive ceramics. It possesses extraordinary elasticity and good thermal conductivity. KU-TCSPA considerably reduces total thermal resistance. It is available in numerous gauges, covering a wide range of applications.

PROPERTIES

- Good thermal conductivity
- Self-adhesive
- Wide range of material gauges in stock
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

CONSTRUCTION



PART	KU-	TCSPA 50	TCSPA 100	TCSPA 150	TCSPA 200	TCSPA 250	TCSPA 300
GENERAL PROPERTIES							
Material		Soft silicone					
Filler		Thermally conductive ceramic					
Colour		Grey					
Gauge	mm	0.5	1.0	1.5	2.0	2.5	3.0
Outgassing (LMW Siloxane)	ppm	∑ D3 - D10 = 200					
MECHANICAL PROPERTIES							
Hardness (VLRH according to DIN ISO 27588)		7.1	7.1	7.1	7.1	7.1	7.1
Hardness (Shore 00)		42	42	42	42	42	42
Resilience	%	32.3	32.3	32.3	32.3	32.3	32.3
ELECTRICAL PROPERTIES							
Breakdown voltage (Voltage ramp)[1]	V (AC)	*	240	*	*	*	*
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES							
Thermal conductivity	W/mK	3.0	3.0	3.0	3.0	3.0	3.0
Thermal resistance (inch²)	°C/W	*	0.42	*	*	*	*
Operating temperature	°C	-40 to +180	-40 to +180	-40 to +180	-40 to +180	-40 to +180	-40 to +180

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

* Not yet determined

THERMAL CONDUCTIVITY
(W/m·°K)

3.0

electrically insulating

Thermally conductive soft-silicone KU-TCSPA

Image may differ from the original product.

PRODUCT AVAILABILITY

- Stamped and cut to customer specifications
- In sheet form 300 mm x 400 mm

THERMAL CONDUCTIVITY
(W/m·°K)

2.5

electrically insulating

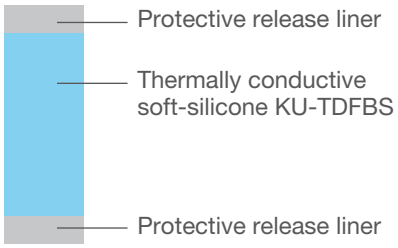
Thermally conductive soft-silicone KU-TDFBS

HEATPAD® KU-TDFBS is an ultra-soft silicone interface material filled with thermally conductive ceramics. It possesses high thermal conductivity and dielectric strength plus excellent surface adaptability. KU-TDFBS considerably reduces total thermal resistance. It boasts an outstanding combination of mechanical and thermal qualities at a competitive price to cover a wide range of applications. KU-TDFBS is available self-adhesive on one or on both sides.

PROPERTIES

- High thermal conductivity
- High dielectric strength
- Ultra soft, highly malleable, flexible
- Superior mechanical absorption
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

CONSTRUCTION



PART	KU-	TDFBS100	TDFBS200	TDFBS300
GENERAL PROPERTIES				
Material		Soft silicone		
Filler		Thermally conductive ceramic		
Colour		Light blue		
Gauge	mm	1.0	2.0	3.0
Density	g/cm³	2.8	2.8	2.8
Outgassing (LMW Siloxane)	ppm	∑ D11 - 20 = 27		
MECHANICAL PROPERTIES				
Hardness (VLRH according to DIN ISO 27588)		45	45	45
Hardness (Shore 00)		30	30	30
ELECTRICAL PROPERTIES				
Breakdown voltage	V (AC)/mm	10000	10000	10000
Volume resistivity	Ωcm	1.0 x 10^{13}	1.0 x 10^{13}	1.0 x 10^{13}
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES				
Thermal conductivity	W/mK	2.5	2.5	2.5
Thermal resistance (inch²)	°C/W	0.49	0.89	1.2
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180

THERMAL CONDUCTIVITY
(W/m·°K)

2.5

electrically insulating

Thermally conductive soft-silicone KU-TDFBS

Image may differ from the original product.

PRODUCT AVAILABILITY

- Self-adhesive on one or on both sides
- Stamped and cut to customer specifications
- In sheet form:

TDFBS 100 and 150	460 mm x 480 mm
TDFBS 200	460 mm x 460 mm
TDFBS 250 and 300	450 mm x 460 mm

THERMAL CONDUCTIVITY
(W/m·°K)

2.5

electrically insulating

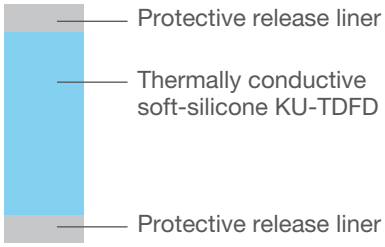
Thermally conductive soft-silicone KU-TDFD

HEATPAD® KU-TDFD is an ultra-soft silicone interface material filled with thermally conductive ceramics. It possesses high thermal conductivity and dielectric strength as well as extraordinary surface adaptability. KU-TDFD reduces total thermal resistance considerably. It boasts an outstanding combination of mechanical and thermal qualities at a competitive price to cover a wide range of applications. KU-TDFD is available self-adhesive on one or on both sides.

PROPERTIES

- High thermal conductivity
- High dielectric strength
- Ultra soft, highly malleable, flexible
- Excellent mechanical absorption
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

CONSTRUCTION

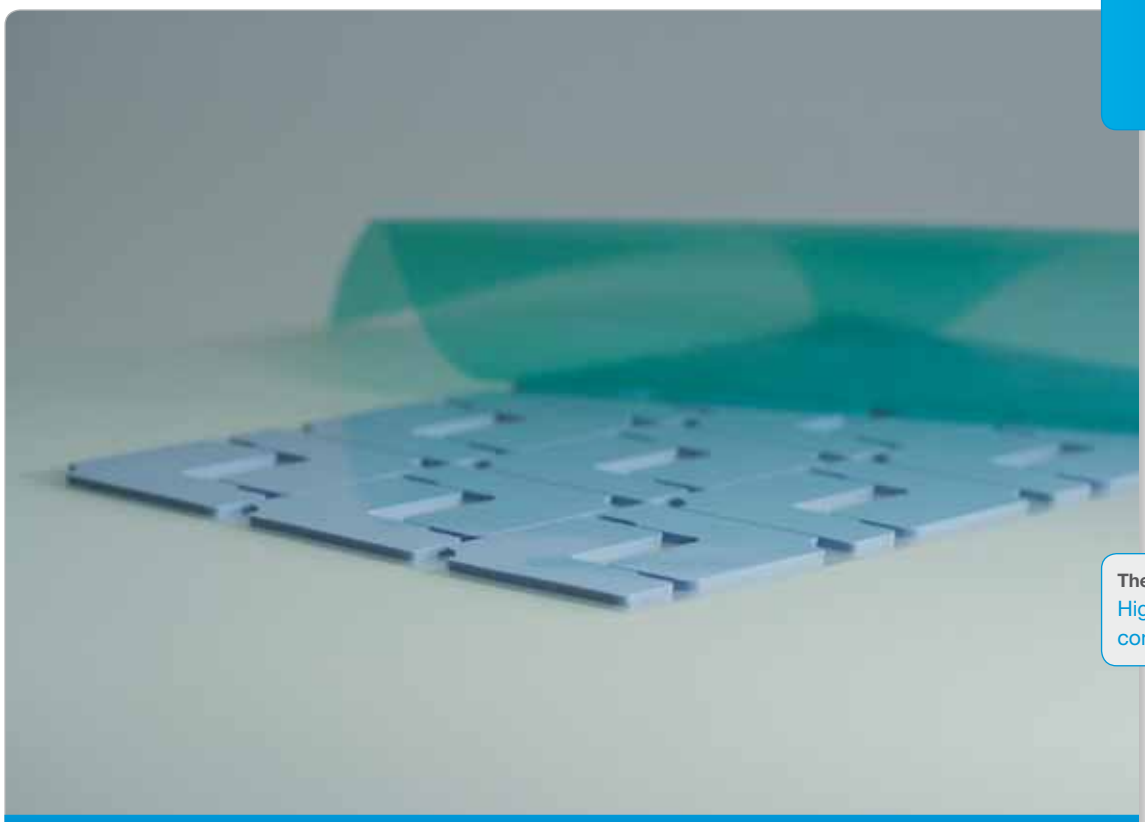


PART	KU-	TDFD 50	TDFD 100	TDFD 200	TDFD 300
GENERAL PROPERTIES					
Material		Soft silicone			
Filler		Thermally conductive ceramic			
Colour		Light blue			
Gauge	mm	0.5	1.0	2.0	3.0
Outgassing (LMW Siloxane)	ppm	∑ D3-10 = 2 / ∑ D11-20 = 8			
MECHANICAL PROPERTIES					
Tensile strength	MPa	0.15	0.15	0.15	0.15
Hardness (Shore A)		8.5	8.5	8.5	8.5
Hardness (Shore 00)		73	73	73	73
ELECTRICAL PROPERTIES					
Breakdown voltage	V (AC)	5000	10000	20000	30000
Volume resistivity	Ωcm	1.0×10^{13}	1.0×10^{13}	1.0×10^{13}	1.0×10^{13}
Dielectric constant (1 kHz)		5.2	5.2	5.2	5.2
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	2.5	2.5	2.5	2.5
Thermal resistance ($inch^2$)	°C/W	0.28	0.49	0.89	1.2
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180	-60 to +180

THERMAL CONDUCTIVITY
(W/m·°K)

2.5

electrically insulating



Thermally conductive soft-silicone KU-TDFD

Image may differ from the original product.

PRODUCT AVAILABILITY

- Self-adhesive on one or on both sides
- Stamped and cut to customer specifications
- In sheet form on request

THERMAL CONDUCTIVITY
(W/m·°K)

2.5

electrically insulating

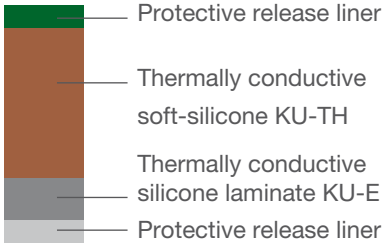
Thermally conductive soft-silicone KU-THE

HEATPAD® KU-THE is a soft-silicone interface material filled with thermally conductive ceramics for high thermal conductivity, dielectric strength and elasticity. KU-THE significantly reduces total thermal resistance. It is laminated with KU-E on one side (non-fiberglass reinforced version of KU-EGF) for mechanical stability. It is self-adhesive on the unlaminated side.

PROPERTIES

- High thermal conductivity
- High dielectric strength
- Very soft and flexible
- Self-adhesive on one side
- Clean and easy mounting, high process reliability
- KU-E laminate reinforced
- UL flammability rating: UL 94 V0

CONSTRUCTION

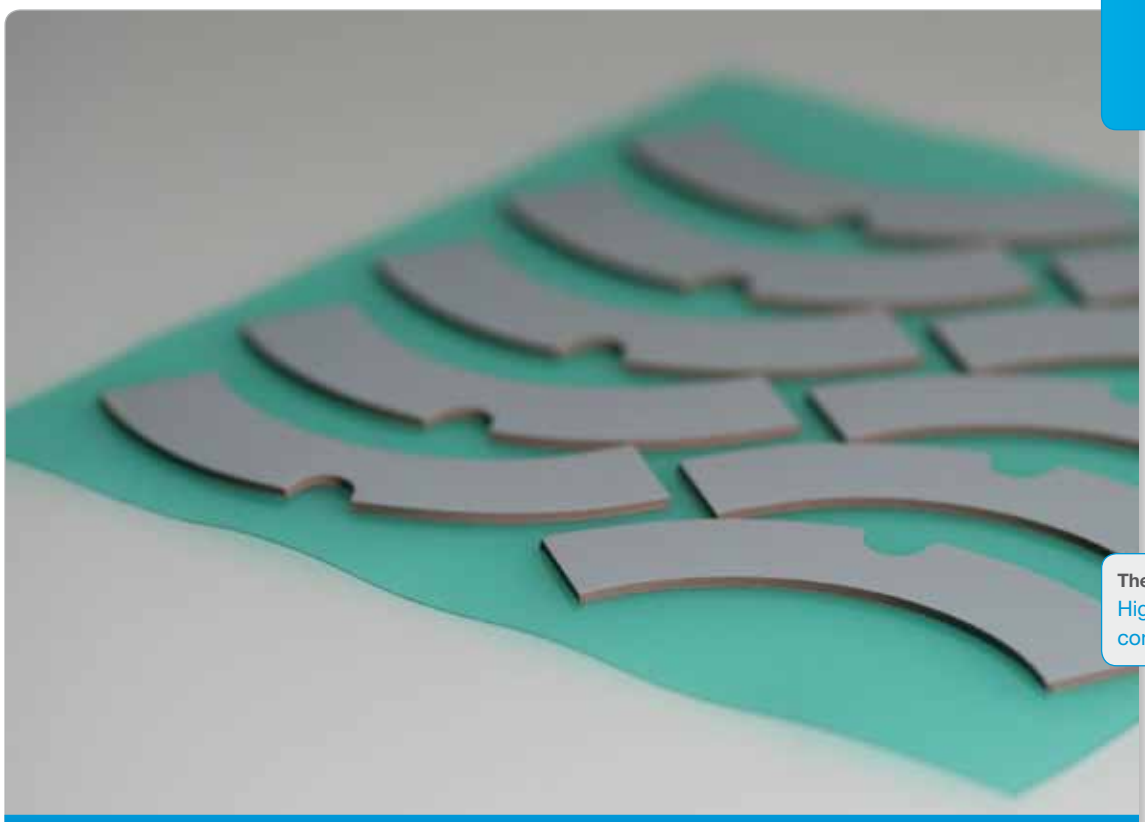


PART	KU-	THE 50	THE 100	THE 200	THE 300
GENERAL PROPERTIES					
Material		Soft silicone with KU-E laminate reinforcement			
Filler		Thermally conductive ceramic			
Colour (Soft silicone / Laminate)		Brown / light grey			
Gauge	mm	0.5	1.0	2.0	3.0
Outgassing (LMW Siloxane)	ppm	∑ D3-10 = 660 / ∑ D11-20 = 2400			
MECHANICAL PROPERTIES					
Tensile strength	MPa	0.55	0.40	0.30	0.29
Hardness (Shore A)		29	29	29	29
Hardness (Shore 00)		68	68	68	68
ELECTRICAL PROPERTIES					
Breakdown voltage (Voltage ramp)[1]	V (AC)	6000	12000	17000	> 17000
Breakdown voltage (Voltage steps)[2]	V (AC)	3000	8000	15000	> 15000
Volume resistivity	Ωm	0.80×10^{11}	0.58×10^{11}	0.42×10^{11}	0.38×10^{11}
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	2.5	2.5	2.5	2.5
Thermal resistance (inch²)	°C/W	0.37	0.66	0.93	1.30
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180	-60 to +180

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown



Thermally conductive soft-silicone KU-THE

Image may differ from the original product.

PRODUCT AVAILABILITY

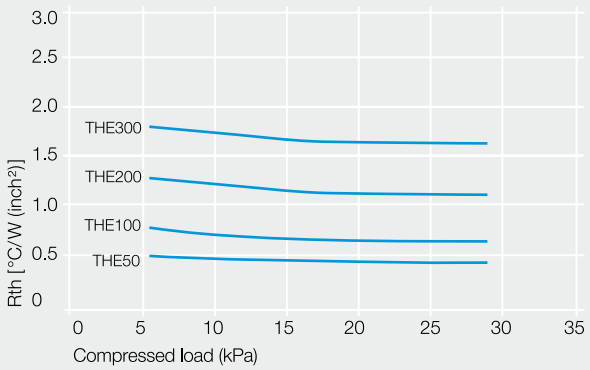
- Stamped and cut to customer specifications
- In sheet form 300 mm x 400 mm

ON REQUEST

- Intermediate gauges

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

2.5

electrically insulating

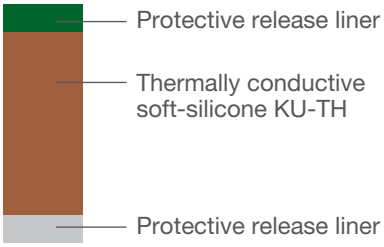
Thermally conductive soft-silicone KU-THS

HEATPAD® KU-THS is a soft-silicone interface material filled with thermally conductive ceramics for high thermal conductivity, dielectric strength and elasticity. KU-THS significantly reduces total thermal resistance. KU-THS is self-adhesive on both sides.

PROPERTIES

- High thermal conductivity
- High dielectric strength
- Very soft and flexible
- Self-adhesive on both sides
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

CONSTRUCTION



PART	KU-	THS 50	THS 100	THS 200	THS 300
GENERAL PROPERTIES					
Material		Soft silicone			
Filler		Thermally conductive ceramic			
Colour		Brown			
Gauge	mm	0.5	1.0	2.0	3.0
Outgassing (LMW Siloxane)	ppm	∑ D3-10 = 660 / ∑ D11-20 = 2400			
MECHANICAL PROPERTIES					
Tensile strength	MPa	0.28	0.28	0.28	0.28
Hardness (Shore A)		30	30	30	30
Hardness (Shore 00)		68	68	68	68
ELECTRICAL PROPERTIES					
Breakdown voltage (Voltage ramp)[1]	V (AC)	4000	11000	> 15000	> 15000
Breakdown voltage (Voltage steps)[2]	V (AC)	2000	8000	> 15000	> 15000
Volume resistivity	Ωm	0.35 x 10^{11}	0.35 x 10^{11}	0.35 x 10^{11}	0.35 x 10^{11}
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	2.5	2.5	2.5	2.5
Thermal resistance (inch²)	°C/W	0.35	0.63	0.88	1.25
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180	-60 to +180

For explanatory notes regarding voltage ramp/step, see page 152

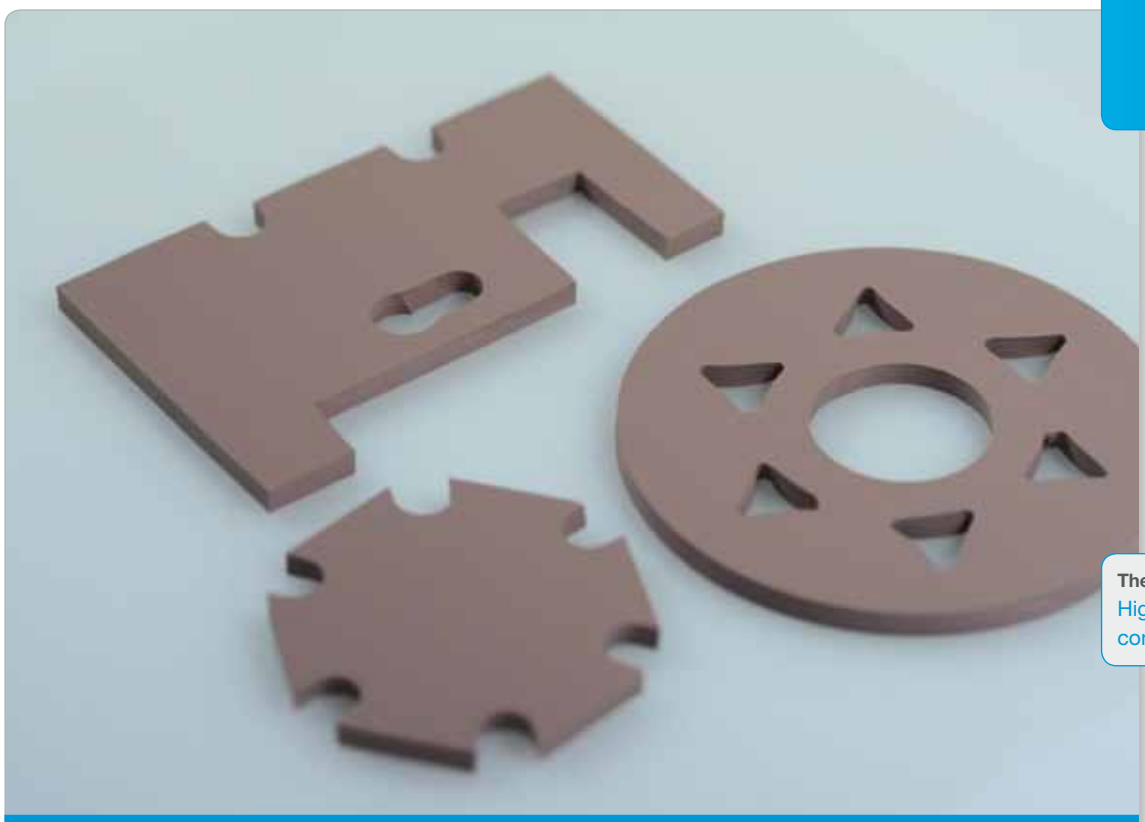
[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

THERMAL CONDUCTIVITY
(W/m·°K)

2.5

electrically insulating



Thermally conductive soft-silicone KU-THS

Image may differ from the original product.

PRODUCT AVAILABILITY

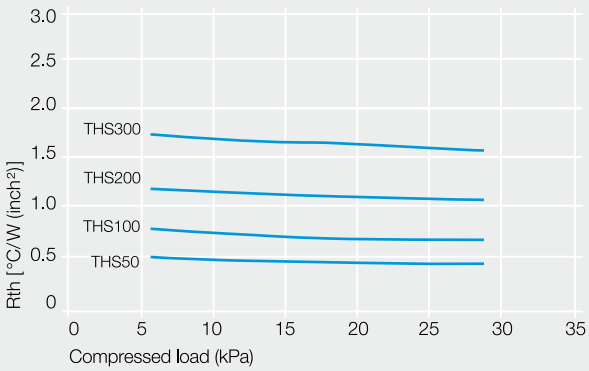
- Stamped and cut to customer specifications
- In sheet form 300 mm x 400 mm

ON REQUEST

- Intermediate gauges

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

5.0

electrically insulating

Thermally conductive soft-silicone KU-TXE

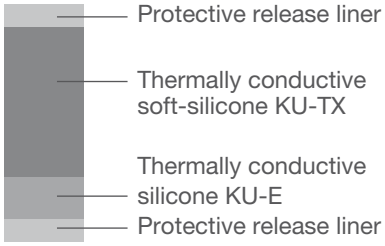
HEATPAD® KU-TXE is a soft-silicone interface material filled with thermally conductive ceramics for excellent thermal conductivity, dielectric strength and elasticity. KU-TXE meets the highest requirements regarding heat dissipation. Total thermal resistance is minimized by its application.

KU-TXE is laminated with KU-E material on one side (non-fiberglass reinforced version of KU-EGF) for mechanical stability and is self-adhesive on the other side.

PROPERTIES

- Superior thermal conductivity
- Very high dielectric strength
- Very soft and flexible
- Self-adhesive on one side
- Clean and easy mounting, high process reliability
- KU-E laminate reinforced
- UL flammability rating: UL 94 V0

CONSTRUCTION



PART	KU-	TXE 50	TXE 100	TXE 200	TXE 300
GENERAL PROPERTIES					
Material		Soft silicone with KU-E laminate reinforcement			
Filler		Thermally conductive ceramic			
Colour (Soft silicone / Laminate)		Grey / light grey			
Gauge	mm	0.5	1.0	2.0	3.0
Outgassing (LMW Siloxane)	ppm	∑ D3-10 = 240 / ∑ D11-20 = 450			
MECHANICAL PROPERTIES					
Tensile strength	MPa	0.80	0.50	0.46	0.44
Hardness (Shore A)		29	29	29	29
Hardness (Shore 00)		74	74	74	74
ELECTRICAL PROPERTIES					
Breakdown voltage (Voltage ramp)[1]	V (AC)	11000	21000	> 21000	> 21000
Breakdown voltage (Voltage steps)[2]	V (AC)	8000	20000	> 20000	> 20000
Volume resistivity	Ωm	2.3×10^{10}	5.1×10^{10}	1.2×10^{10}	1.1×10^{10}
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	5.0	5.0	5.0	5.0
Thermal resistance (inch²)	°C/W	0.27	0.48	0.90	1.32
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180	-60 to +180

For explanatory notes regarding voltage ramp / step, see page 152

[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

Thermally conductive soft-silicone KU-TXE

Image may differ from the original product.

PRODUCT AVAILABILITY

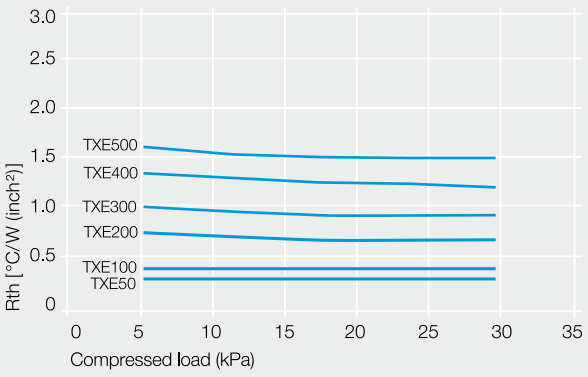
- Stamped and cut to customer specifications
- In sheet form 300 mm x 400 mm

ON REQUEST

- Other material gauges
- Intermediate gauges

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

3.0

electrically insulating

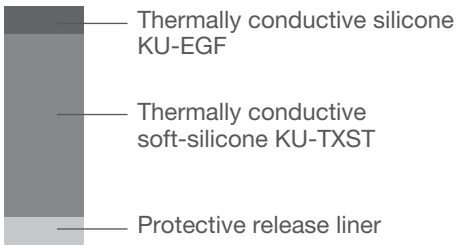
High-performance thermally conductive soft-silicone film KU-TXF

HEATPAD® KU-TXF is a soft silicone film (KU-TXST100) filled with thermally conductive ceramic for superior thermal conductivity, very high dielectric strength, and high elasticity. For increased mechanical stability and twofold electric insulation, it is laminated with fiberglass-reinforced silicone film (KU-EGF20). KU-TXF meets the highest requirements regarding thermal transfer. Total thermal transfer resistance is minimized by this interface material. KU-TXF is self-adhesive on one side.

PROPERTIES

- Very high thermal conductivity
- Very high dielectric strength
- Twofold electric insulation
- Very soft and flexible
- Self-adhesive on one side
- Quick and easy handling, superior process reliability
- Component flammability rating: UL 94 V0 (FileNr: E337894)
- Laminate flammability rating equivalent to UL 94 V0

CONSTRUCTION



PART	KU-	TXF120
GENERAL PROPERTIES		
Material		Soft silicone (KU-TXST100) – Thermally conductive silicone (KU-EGF20)
Filler		Thermally conductive ceramic
Colour		Grey
Gauge	mm	1.2
Density	g/cm³	3.1
Outgassing (LMW Siloxane)	ppm	KU-TXST: ∑ D3 - D10 = 600 / ∑ D11 - D20 = 740 KU-EGF: ∑ D3 -10 = < 10
MECHANICAL PROPERTIES		
Hardness Soft-silicone (Shore 00)		68
Hardness Soft-silicone (Supersoft)		74
ELECTRICAL PROPERTIES		
Breakdown voltage (Voltage ramp)[1]	V (AC)	> 22000
THERMAL PROPERTIES		
Thermal conductivity (ISO 22007-2)	W/mK	3.0 (rounded from 2.97)
Thermal resistance (inch²) (ISO 22007-2)	°C/W	0.47
Operating temperature	°C	-60 to +180

[1] Voltage ramp 1000 V/s

For explanatory notes regarding voltage ramp/step, see page 152

THERMAL CONDUCTIVITY
(W/m·°K)

3.0

electrically insulating

Thermally conductive soft-silicone KU-TXF

Image may differ from the original product.

PRODUCT AVAILABILITY

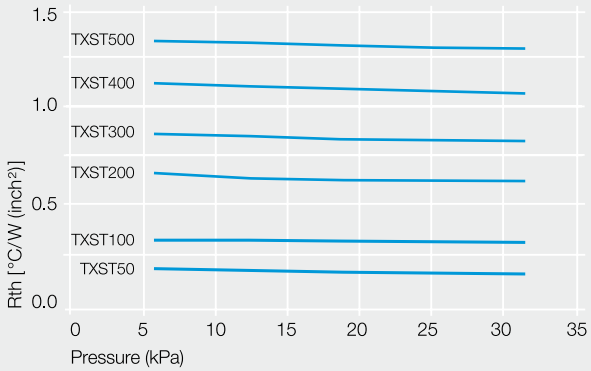
- Self-adhesive on one side
- Stamped and cut to customer specifications
- In sheet form on request

ON REQUEST

- Other material gauges

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

5.0

electrically insulating

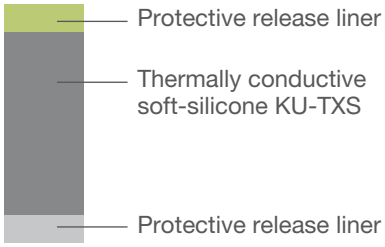
Thermally conductive soft-silicone KU-TXS

HEATPAD® KU-TXS is a soft-silicone interface material filled with thermally conductive ceramics for superior thermal conductivity, dielectric strength and elasticity. KU-TXS meets the highest requirements regarding heat dissipation. Total thermal resistance is minimized by its application. KU-TXS is self-adhesive on both sides.

PROPERTIES

- Superior thermal conductivity
- Very high dielectric strength
- Very soft and flexible
- Self-adhesive on both sides
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

CONSTRUCTION



PART	KU-	TXS 50	TXS 100	TXS 200	TXS 300
GENERAL PROPERTIES					
Material		Soft silicone			
Filler		Thermally conductive ceramic			
Colour		Grey			
Gauge	mm	0.5	1.0	2.0	3.0
Outgassing (LMW Siloxane)	ppm	∑ D3-10 = 240 / ∑ D11-20 = 450			
MECHANICAL PROPERTIES					
Tensile strength	MPa	0.35	0.35	0.35	0.35
Hardness (Shore A)		32	32	32	32
Hardness (Shore 00)		80	80	80	80
ELECTRICAL PROPERTIES					
Breakdown voltage (Voltage ramp)[1]	V (AC)	8000	> 15000	> 15000	> 15000
Breakdown voltage (Voltage steps)[2]	V (AC)	6000	> 15000	> 15000	> 15000
Volume resistivity	Ωm	1.0×10^{10}	1.0×10^{10}	1.0×10^{10}	1.0×10^{10}
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	5.0	5.0	5.0	5.0
Thermal resistance (inch²)	°C/W	0.25	0.40	0.80	1.20
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180	-60 to +180

For explanatory notes regarding voltage ramp/step, see page 152

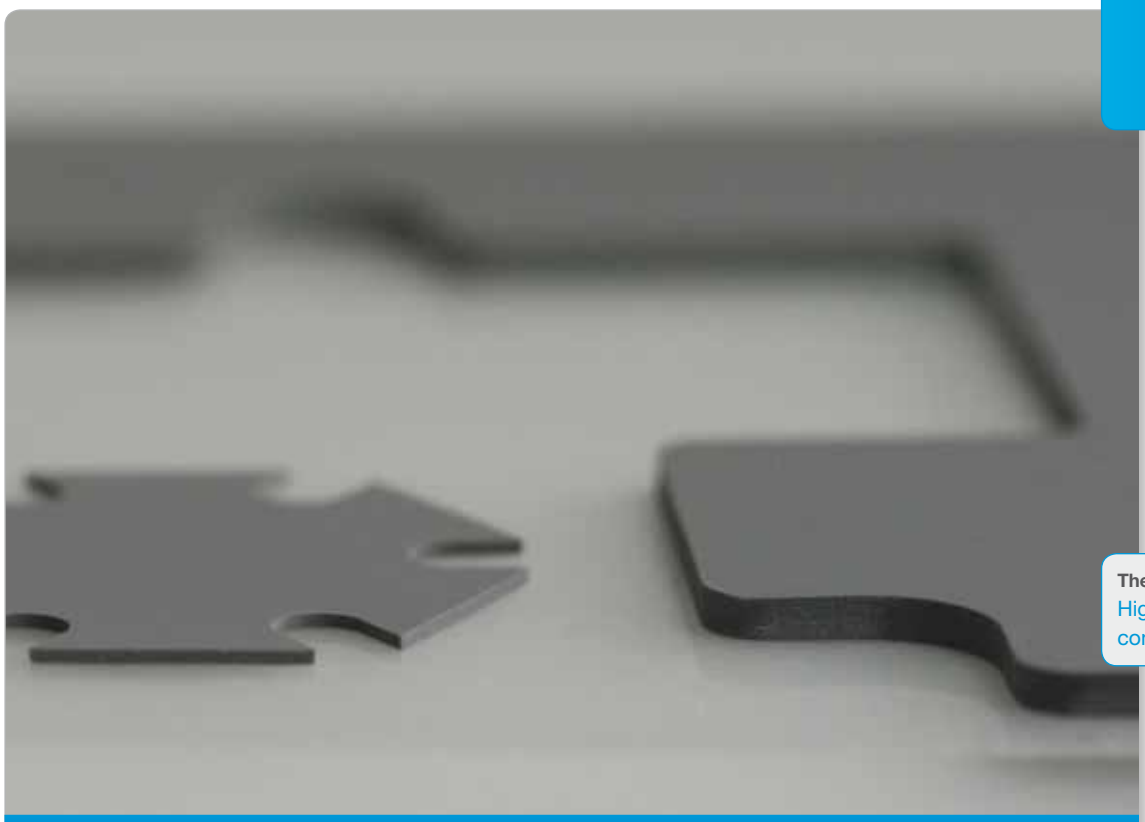
[1] Voltage ramp 1000 V/s

[2] Step-by-step voltage increments until dielectric breakdown

THERMAL CONDUCTIVITY
(W/m·°K)

5.0

electrically insulating



Thermally conductive soft-silicone KU-TXS

Image may differ from the original product.

PRODUCT AVAILABILITY

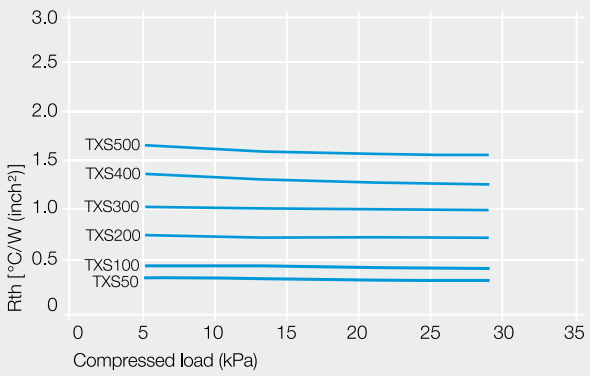
- Stamped and cut to customer specifications
- In sheet form 300 mm x 400 mm

ON REQUEST

- Other material gauges
- Intermediate gauges

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

5.0

electrically insulating

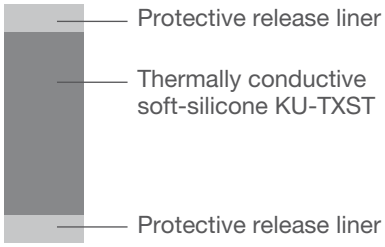
Thermally conductive soft-silicone KU-TXST

HEATPAD® KU-TXST is a soft-silicone interface material filled with thermally conductive ceramics for superior thermal conductivity, dielectric strength and elasticity. KU-TXST meets the highest requirements regarding heat dissipation, minimizing total thermal resistance. KU-TXST is self-adhesive on both sides.

PROPERTIES

- Superior thermal conductivity
- Very high dielectric strength
- Very soft and flexible
- Self-adhesive on both sides
- Gauges from 0,5 mm to 5mm
- Clean and easy mounting, high process reliability
- UL flammability rating: UL 94 V0

CONSTRUCTION



PART	KU-	TXST50	TXST 100	TXST 200	TXST 300
GENERAL PROPERTIES					
Material		Soft silicone			
Filler		Thermally conductive ceramic			
Colour		Grey			
Gauge	mm	0.5	1.0	2.0	3.0
Density	g/cm³	3.1	3.1	3.1	3.1
Outgassing (LMW Siloxane)	ppm	∑ D3 - D10 = 600 / ∑ D11 - 20 = 740			
MECHANICAL PROPERTIES					
Tensile strength	Mpa	0.35	0.35	0.35	0.35
Hardness (VLRH according to DIN ISO 27588)		74	74	74	74
ELECTRICAL PROPERTIES					
Breakdown voltage (Voltage ramp)[1]	V (AC)	–	21000	–	–
Volume resistivity	Ωm	–	1.4 x 10[11]	–	–
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	5.0	5.0	5.0	5.0
Thermal resistance (inch²)	°C/W	0.18	0.35	0.64	0.85
Operating temperature	°C	-60 to +180	-60 to +180	-60 to +180	-60 to +180

For explanatory notes regarding voltage ramp/step, see page 152

[1] Voltage ramp 1000 V/s

THERMAL CONDUCTIVITY
(W/m·°K)

5.0

electrically insulating

Thermally conductive soft-silicone KU-TXST

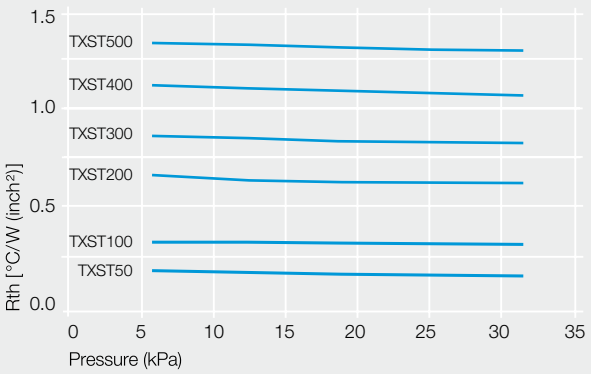
Image may differ from the original product.

PRODUCT AVAILABILITY

- Stamped and cut to customer specifications
- In sheet form 300 mm x 400 mm

PRESSURE DEPENDENCE

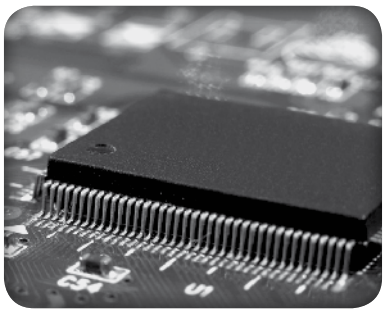
Thermal resistance vs. mounting pressure



04

Thermally conductive silicone-free films

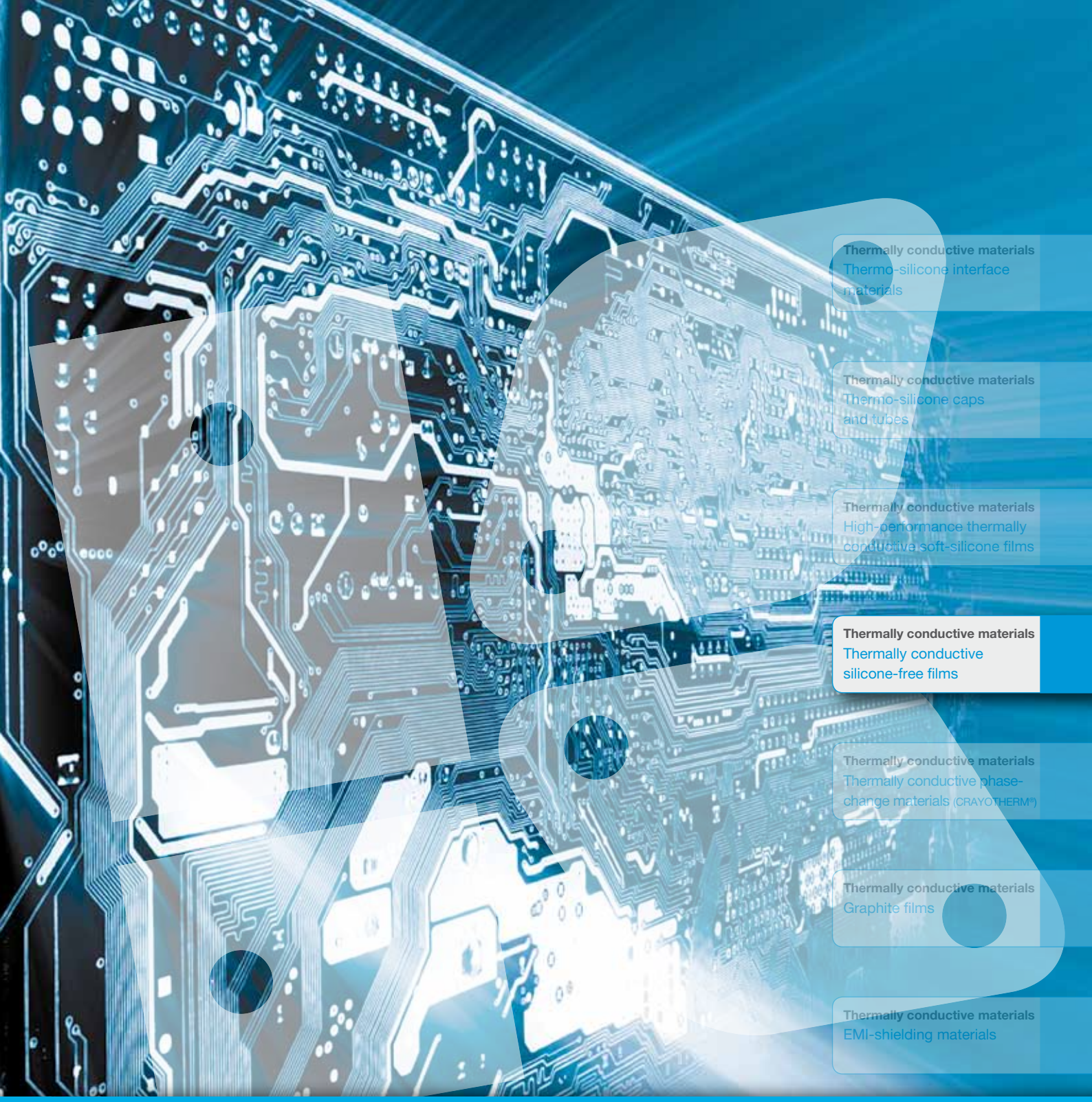
Kunze silicone-free films are perfect for applications which, due to chemical requirements, exclude the use of silicone. For mechanical stability, these films are optionally available with fiberglass reinforcement.



APPLICATION EXAMPLES

Thermal linkage and electric insulation of heat sources and heat sinks in:

- Power modules
- Power supplies
- Electric drives
- Telecommunication modules
- Engine control
- Frequency converters
- Thermosensors
- CPU modules
- Optical applications (LEDs)
- Automotive (lithium-ion technology)



THERMAL CONDUCTIVITY
(W/m·°K)

1.5

electrically insulating

Thermally conductive silicone-free film KU-SFA

Kunze HEATPAD® KU-SFA is a silicone-free, thermally conductive film on a TPR basis. It is adhesive on both sides and compensates surface irregularities in an optimal way due to its softness and flexibility. Its use reduces thermal transfer resistance considerably.

PROPERTIES

- Silicone free
- Good thermal conductivity
- Clean and easy mounting with high process reliability
- Very flexible
- Good electrical insulation
- UL flammability rating: UL 94 V0

PART	KU-	SFA200
GENERAL PROPERTIES		
Material		TPR
Gauge	mm	2
Colour		Dark grey
Flammability rating		UL 94-V0
MECHANICAL PROPERTIES		
Hardness (Shore A)		14
Hardness (Shore 00)		68
ELECTRICAL PROPERTIES		
Volume resistivity	Ωcm	1.00×10^{14}
Breakdown voltage	kV/mm	12
THERMAL PROPERTIES		
Thermal resistance (inch²)	°C/W	2
Thermal conductivity	W/mK	1.5

THERMAL CONDUCTIVITY
(W/m·°K)

1.5

electrically insulating

Thermally conductive silicone-free film KU-SFA

Image may differ from the original product.

PRODUCT AVAILABILITY

- One or both side adhesive
- Cut according to customer specifications
- Sheets 150 mm x 235 mm

ON REQUEST

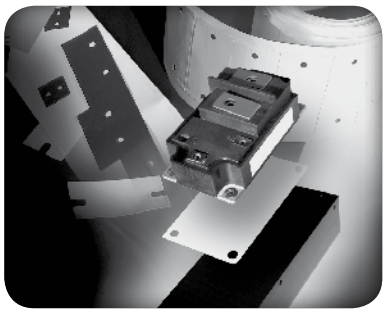
- Other material gauges

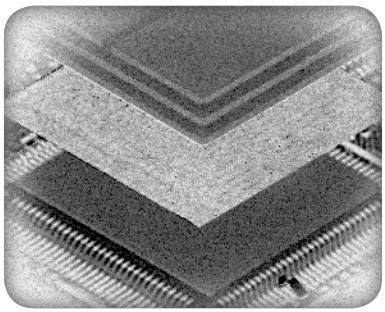
05

Thermally conductive phase-change materials

Kunze phase-change interface materials are characterized by the material's change from solid to soft aggregate state at a pre-defined temperature – the so-called phase-change temperature.

Phase-change materials turn soft at first exceeding phase-change temperature, actively wetting out the contact surfaces and expelling air pockets from their micropores. When pressure is applied, layer thickness of the soft material becomes minimal. As a result, thermal contact resistance is minimized also, henceforward remaining very low at all temperatures, even below phase-change temperature.



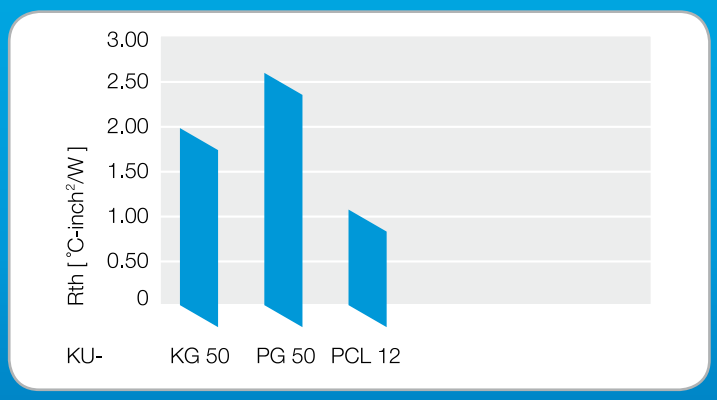


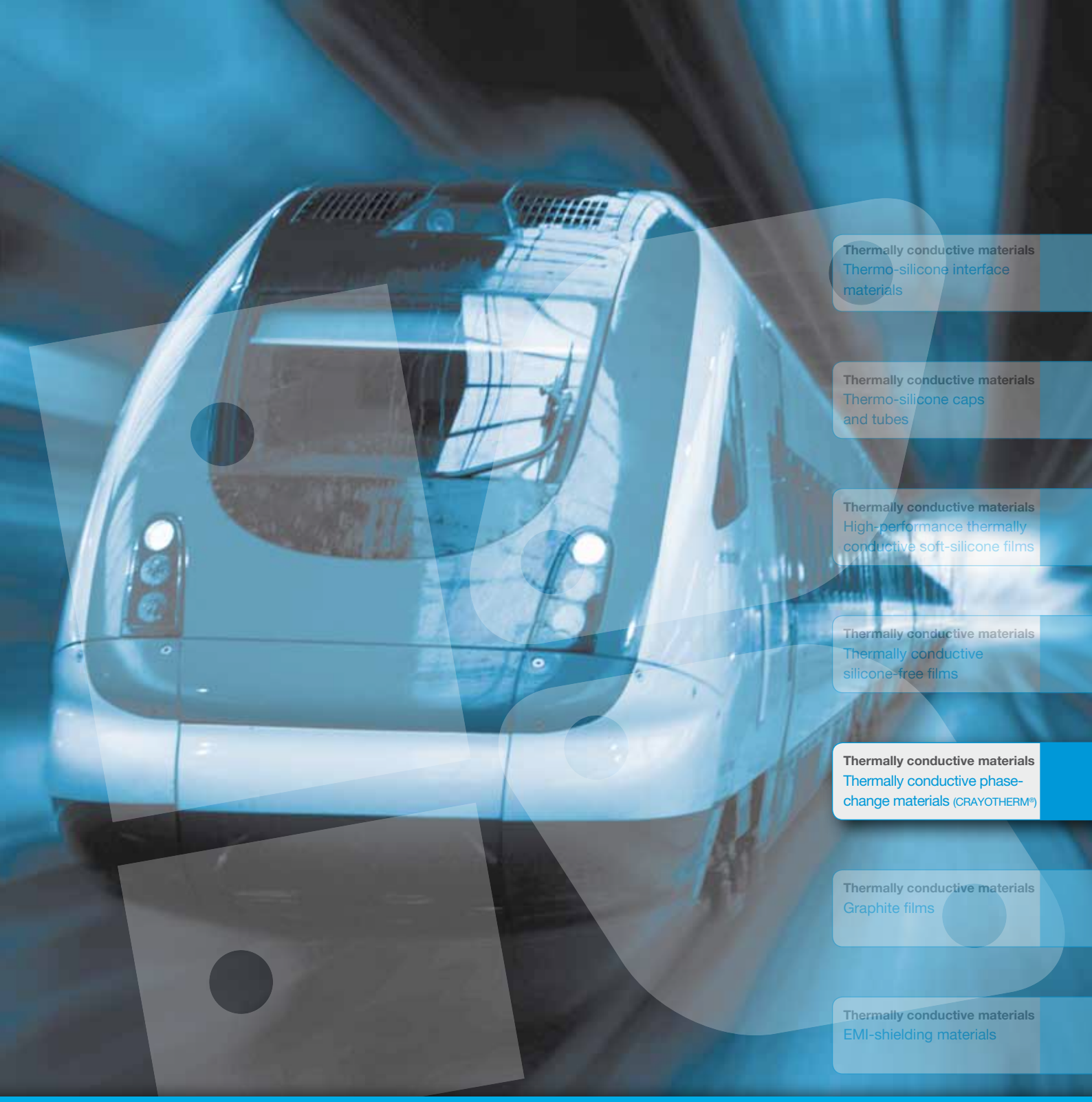
APPLICATION EXAMPLES

Thermal linkage of heat sources and heat sinks in

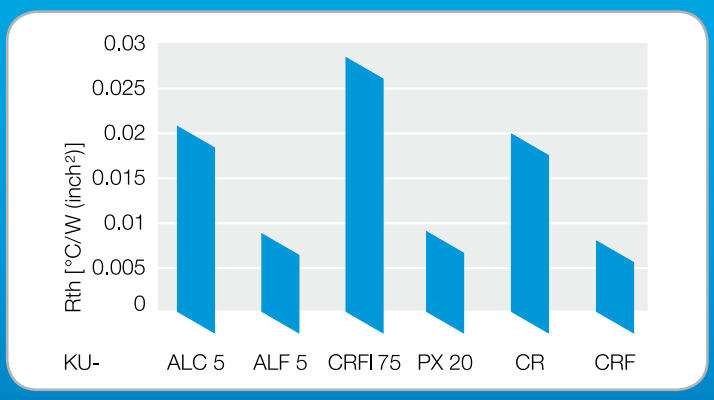
- Active heat sources and heat sinks, replacing thermal grease
- Electrically insulated multichip modules
- Microprocessors, ASICs
- Power modules in power supplies
- UPS
- IGBTs
- CPU modules
- Diodes
- RF components

THERMAL RESISTANCE OVERVIEW





THERMAL RESISTANCE OVERVIEW



THERMAL CONDUCTIVITY
(W/m·°K)

up to **0.45**

electrically insulating

Polyimide film with phase-change coating KU-KG and KU-PG

HEATPAD® KU-KG and KU-PG are high-performance thermoconducting films, consisting of a polyimide carrier film filled with thermally conductive ceramic, and a silicone-free CRAYOTHERM® coating on both sides. They combine the outstanding dielectric and mechanical properties of a polyimide with the thermal properties of CRAYOTHERM®. The CRAYOTHERM® coating changes its aggregate state when heated to ca. 60°C, turning soft. Due to its expansion in volume (by 15 to 20 per cent) and the subsequent active covering of the contact surfaces, it compensates for next to all flaws in these surfaces, minimizing thermal transfer resistance. Once the phase-change temperature is first exceeded, the material's optimal thermal performance is sustained at all times, below and above that temperature.

KU-KG is ideal for high-performance applications.

KU-PG is ideal for high-volume applications.

PROPERTIES

- Minimal thermal contact resistance combined with outstanding electrical insulation
- Silicone-free
- Active covering of contact surfaces through expansion by 15 to 20 per cent
- Very flexible and mechanically stable
- Guaranteed layer thickness
- Low tightening torque required
- Quick and clean handling, high process reliability
- Replaceable without surface treatment
- Cleaning with isopropyl alcohol

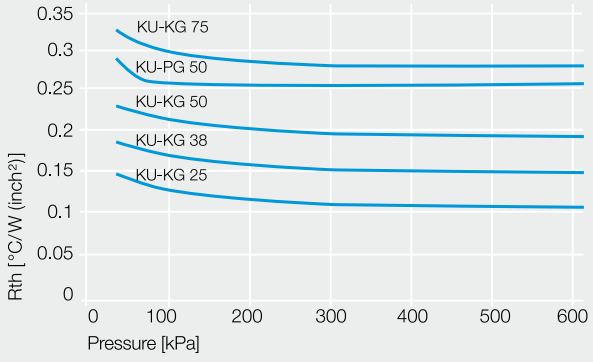
PRODUCT AVAILABILITY

- All standard configurations (see page 87)
- Non-adhesive or adhesive on one side or with adhesive strips on the edges (S)
- In roll form according to customer specifications
- Customer-specific cuts and forms

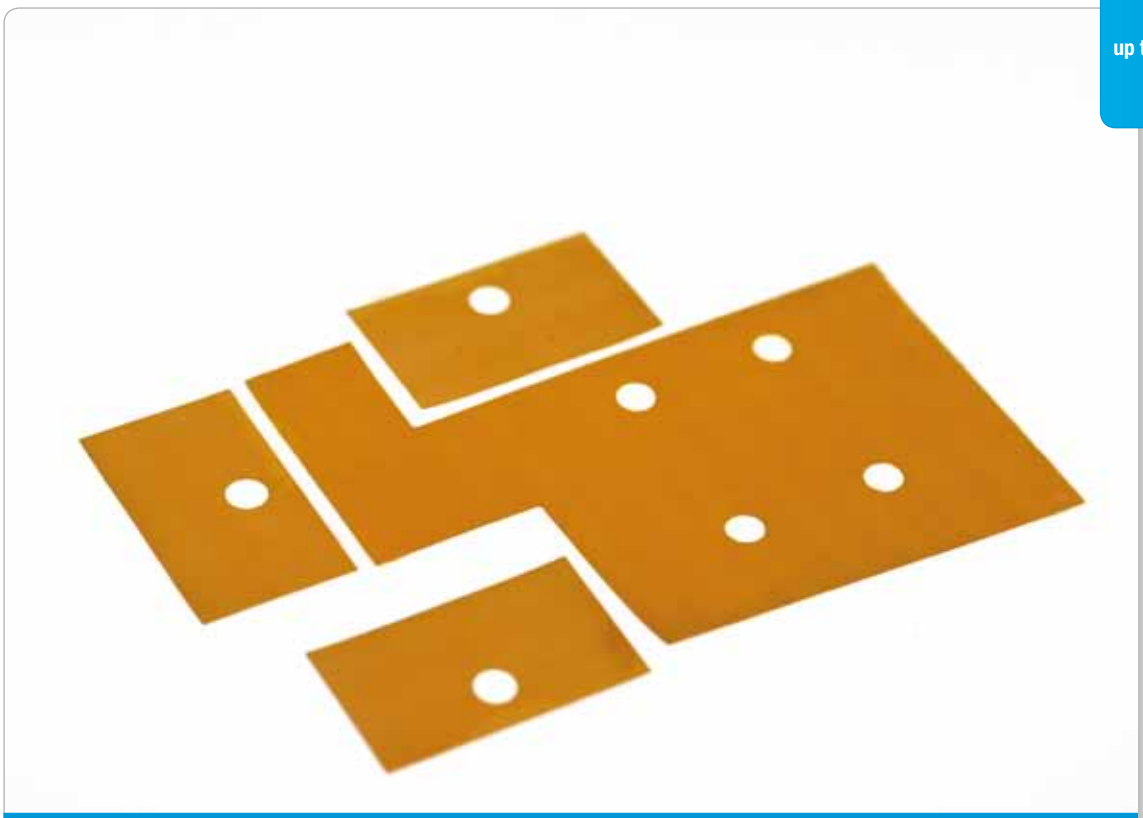
Configurations and dimensions on page 87

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)
up to **0.45**
electrically insulating



Polyimide film with phase-change coating KU-KG

Image may differ from the original product.

HEATPAD® KU-KG/S and KU-PG/S – with adhesive strips on the sides

HEATPAD® KU-KG/S and KU-PG/S are polyimide films filled with ceramics, coated on both sides with CRAYOTHERM® and with adhesive strips (5 mm) on the sides for easy mounting. These do not affect the material's outstanding thermal properties.

PRODUCT AVAILABILITY

- Available only in roll form for technical reasons

HEATPAD® KU-KG – adhesive on one side

HEATPAD® KU-KG is a polyimide film filled with ceramics, coated on one side with CRAYOTHERM® and adhesive on the other to facilitate mounting.

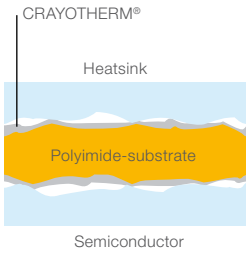
PRODUCT AVAILABILITY

- On rolls or as sheets

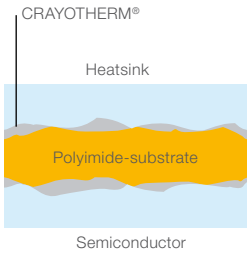
THERMAL CONDUCTIVITY
(W/m·°K)
up to **0.45**
electrically insulating

Polyimide film with phase-change coating KU-KG and KU-PG

MODE OF ACTION KU-KG AND KU-PG



Before first operation, unheated



In operation, after first phase-change

KU-KG is ideal for high-performance applications.

KU-PG is ideal for high-volume applications.

PART	KU-	KG 25	KG 38	KG 50	KG 75
GENERAL PROPERTIES					
Material	Body	CRAYOTHERM® – Polyimide – CRAYOTHERM®			
Phase-change material [1]		CRAYOTHERM®			
Colour		Dull orange			
Material thickness without coating	µm	25	38	51	76
Total thickness	µm	50	63	76	101
MECHANICAL PROPERTIES					
Tensile strength	MPa	124	124	124	124
Tear strength	kN/m	300	300	300	300
ELECTRICAL PROPERTIES					
Breakdown voltage	V (AC)	4200	6000	7700	11000
Volume resistivity	Ωm	1.0×10^{12}	1.0×10^{12}	1.0×10^{12}	1.0×10^{12}
Flammability rating		–	UL 94 V0*	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal conductivity	W/mK	0.45	0.45	0.45	0.45
Thermal resistance [2] (inch²)	°C/W	0.12	0.16	0.20	0.29
Phase-change temperature CRAYOTHERM®	°C	60	60	60	60
Operating temperature	°C	-60 to +150	-60 to +150	-60 to +150	-60 to +150
Storage temperature	°C	max. 40	max. 40	max. 40	max. 40

[1] Coating thickness approx. 12 µm per side

[2] Increase of thermal resistance through acrylic adhesive by about 0.05 °C/W

* Without glue

THERMAL CONDUCTIVITY
(W/m·°K)
up to **0.45**
electrically insulating

Polyimide film with phase-change coating KU-PG

Image may differ from the original product.

PART	KU-	PG50
GENERAL PROPERTIES		
Material	Body	CRAYOTHERM® – Polyimide – CRAYO-THERM®
Phase-change material [1]		CRAYOTHERM®
Material thickness without coating	µm	51
Total thickness	µm	76
ELECTRICAL PROPERTIES		
Breakdown voltage ASTM D-149-91	V (AC)	4500
Volume resistivity	Ωm	1.0 x 10^{10}
Dielectric constant (1 kHz)		3-4
Flammability rating		–
THERMAL PROPERTIES		
Thermal conductivity	W/mK	0.40
Thermal resistance (inch²)	°C/W	0.262
Phase-change temperature CRAYOTHERM®	°C	60
Operating temperature	°C	-60 to +150
Storage temperature	°C	max. 40

Thermally conductive materials
Thermally conductive phase-change materials (CRAYOTHERM®)

[1] Coating thickness approx. 12 µm per side

THERMAL CONDUCTIVITY
(W/m·°K)

3.0

electrically non-insulating

Thermally conductive silicone film with phase-change coating KU-PCL

KU-PCL is a phase-change silicone interface material. It is ideally suited to minimize thermal contact resistance in CPUs and power modules which require no special electric insulation. Optimal thermal contact resistance is reached immediately after the component group first reaches the phase-change temperature of ca. 50°C, and is then maintained at all temperatures above and below that point. The material is easy to apply and can be removed just as easily without residues.

PROPERTIES

- Minimal thermal contact and transfer resistance
- No material deterioration through ageing
- Guaranteed layer thickness
- Low tightening torque required
- Quick and clean handling, superior process reliability

PART	KU-	PCL12
GENERAL PROPERTIES		
Material		Phase-change
Colour		Grey
Gauge	µm	120
THERMAL PROPERTIES		
Thermal conductivity	W/mK	3.0
Thermal resistance (inch²)	°C/W	0.11
Phase-change temperature	°C	ca. 50

THERMAL CONDUCTIVITY
(W/m·°K)

3.0

electrically non-insulating

Thermally conductive silicone film with phase-change coating KU-PCL

Image may differ from the original product.

PRODUCT AVAILABILITY

- Easy-strip on plastic carrier sheet
- In cuts and shapes to customer specifications

MOUNTING

- Double-sided adhesion
- No leakage after phase change
- Easy removal without residues

THERMAL CONDUCTIVITY
(W/m·°K)

220

electrically non-insulating

Aluminium foil with phase-change coating KU-ALC and KU-ALF

HEATPAD® KU-ALC and KU-ALF are very thin aluminium foils, coated on both sides with the silicone-free, thermally conductive polymer CRAYOTHERM®. This coating changes its aggregate state at about 60°C for KU-ALC and 51°C for KU-ALF, turning soft. CRAYOTHERM® expands in volume by about 15 to 20 per cent once past the phase-change temperature, achieving complete wet-out of the contact surfaces without outflow.

After the first phase-change has taken place and the material has expanded, it irreversibly remains in that condition through all following temperature cycles. Minimum total thermal resistance is therefore permanently assured.

The fact that CRAYOTHERM® is mixed with highly thermally conductive graphite in the KU-ALF version additionally enhances its thermal qualities.

KU-ALC/S and KU-ALF/S possess narrow lateral acrylic adhesive strips, allowing for easier mounting and high process reliability without impairing either thermal flow effected by CRAYOTHERM® or total thermal resistance.

PROPERTIES

- Minimum thermal resistance through active covering of the contact surfaces by volumetric expansion of CRAYOTHERM® by about 15-20 % without outflow
- Silicone-free
- Guaranteed layer thickness
- Low starting torque required
- Clean and easy pre-mounting, high process reliability due to adhesive strips (ALC/S, ALF/S)
- Mechanically stable through aluminium substrate
- Replaceability of the material without surface treatment
- Cleaning with isopropyl alcohol

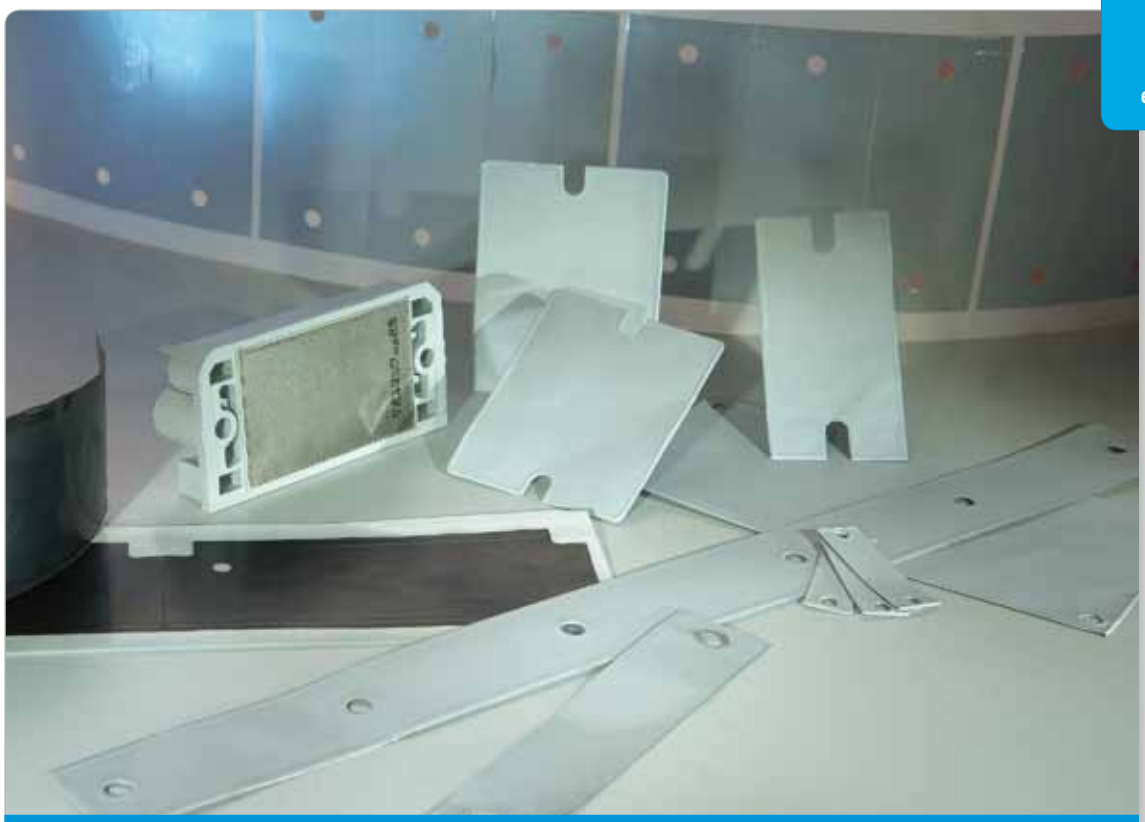
PART	KU-	ALC 5	ALF 5
GENERAL PROPERTIES			
Material	Body	Phase-change – Aluminium – Phase-change	
Phase-change material [1]		CRAYOTHERM®	CRAYOTHERM®/Graphite
Colour		Light grey	Black
Material gauge without coating	µm	51	51
Total gauge	µm	76	76
THERMAL PROPERTIES			
Thermal conductivity (aluminium substrate)	W/mK	220	220
Thermal resistance (inch²)	°C/W	0.021	0.009
Phase-change temperature CRAYOTHERM®	°C	60	51
Operating temperature	°C	-60 to +150	-60 to +150
Storage temperature	°C	max. 40	max. 40

[1] Coating thickness approx. 12 µm per side

THERMAL CONDUCTIVITY
(W/m·°K)

220

electrically non-insulating



Aluminium foil with phase-change coating KU-ALC and KU-ALF

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard IGBT and microprocessor configurations
- Non-adhesive or with lateral adhesive strips (S)
- In roll form according to customer specifications
- Stamped and cut according to customer specifications

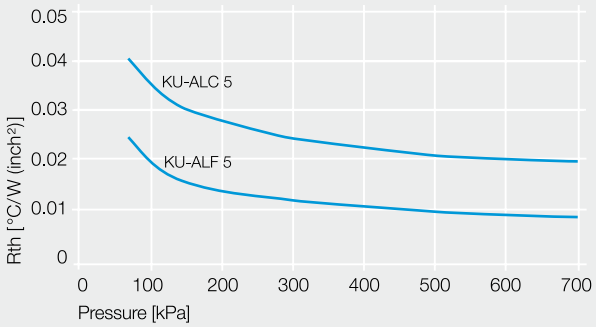
ON REQUEST

- Other coating thicknesses

Thermally conductive materials
Thermally conductive phase-change materials (CRAYOTHERM®)

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

3.0

electrically non-insulating

Phase-change film KU-CRFI and KU-PX

HEATPAD® KU-CRFI and KU-PX 20 are homogeneous films made from pure silicone-free thermally conductive polymer CRAYOTHERM®. This wax changes its aggregate state at about 51°C and turns soft. It expands in volume by about 15 to 20 per cent once past the phase-change temperature, and complete wet-out of the contact surfaces takes place without outflow. After the first phase change, it irreversibly remains in this condition through all future temperature cycles.

Minimal total thermal resistance is permanently assured.

This material replaces conventional thermal paste used to reduce thermal contact resistance in applications where no electrical insulation is needed. It is ideal for applications with uneven contact surfaces (concave, convex or corrugated), such as power module carrier plates.

PROPERTIES

- Minimum thermal resistance through active wet-out of the interfaces by volumetric expansion of CRAYOTHERM® by about 15-20 % without outflow
- Silicone-free
- Guaranteed layer thickness
- Low starting torque required
- Clean and easy mounting, high process reliability
- Replaceable without surface treatment
- Cleaning with isopropyl alcohol

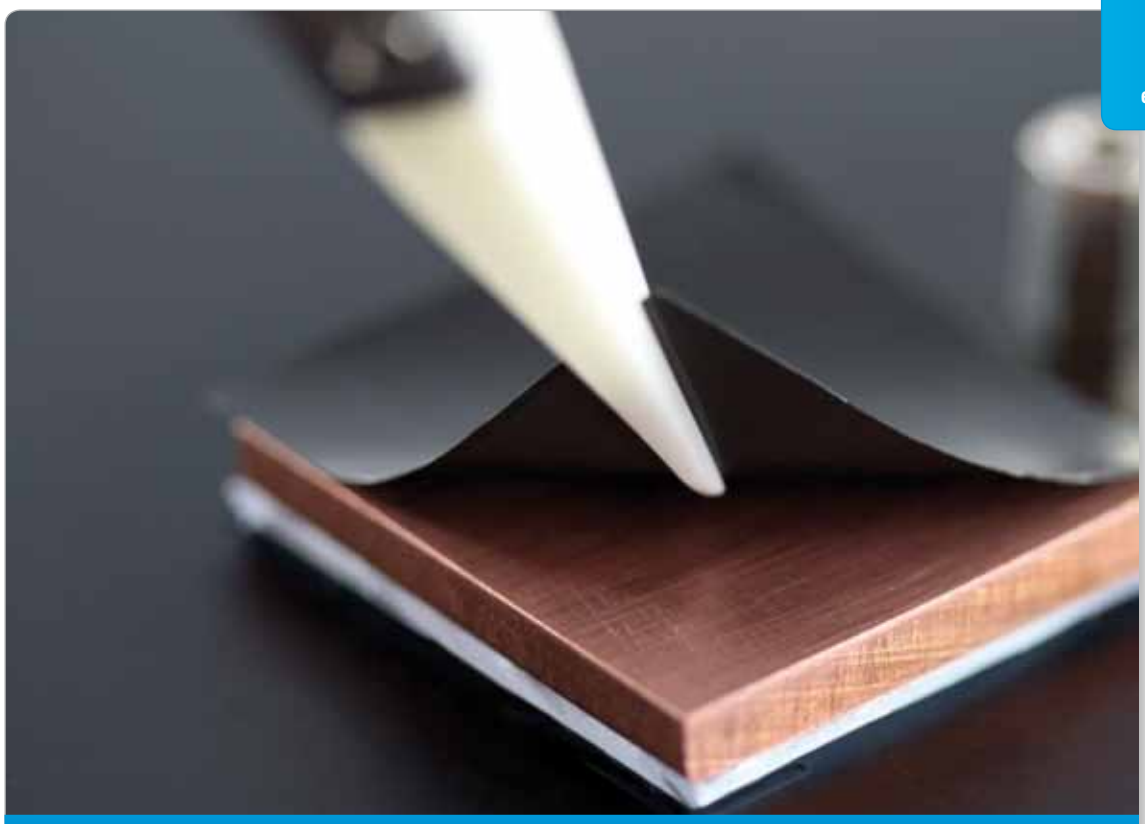
Configurations and dimensions on page 87

PART	KU-	CRFI 75	PX 20
GENERAL PROPERTIES			
Material		CRAYOTHERM®	
Colour		Black	
Gauge	µm	75	200
THERMAL PROPERTIES			
Thermal conductivity	W/mK	3.0	3.0
Thermal resistance (inch²)	°C/W	0.028	0.009
Phase-change temperature CRAYOTHERM®	°C	51	45
Operating temperature	°C	-60 to +150	-60 to +150
Storage temperature	°C	max. 27	max. 27

THERMAL CONDUCTIVITY
(W/m·°K)

3.0

electrically non-insulating



Phase-change film KU-CRFI and KU-PX

Image may differ from the original product.

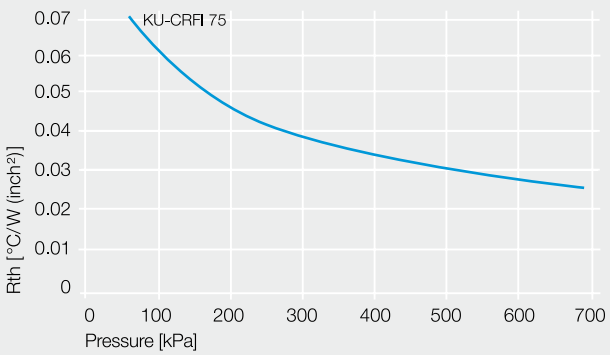
Thermally conductive materials
Thermally conductive phase-change materials (CRAYOTHERM®)

PRODUCT AVAILABILITY

- All standard configurations
- In roll form according to customer specifications
- Stamped or cut to customer specifications

PRESSURE DEPENDENCE

Thermal resistance vs. mounting pressure



THERMAL CONDUCTIVITY
(W/m·°K)

0.47

(KU-CR)

3.0

(KU-CRF)

electrically non-insulating

Phase-change compound KU-CR and KU-CRF

CRAYOTHERM® KU-CR and KU-CRF are silicone-free polymer compounds in bloc form with exceptional thermal conductivity. They allow for easy, quick and clean application, eliminating the disadvantages of thermal paste. These materials change their aggregate state from solid to soft once their phase-change temperature (of approx. 60°C for KU-CR and approx. 51°C for KU-CRF) is reached.

CRAYOTHERM® expands in volume by 15 to 20 per cent once past the phase-change temperature, and complete wet-out of the contact surfaces takes place without outflow. After the initial phase change has taken place and the material has expanded, it irreversibly remains in this condition through all future temperature cycles. Minimal total thermal resistance is permanently assured. In the KU-CRF version, CRAYOTHERM® is mixed with highly thermally conductive graphite for additionally enhanced thermal performance. It is ideal for applications with uneven contact surfaces (concave, convex or corrugated) such as power module carrier plates.

PROPERTIES

- Minimum thermal resistance through active wet-out of the contact surfaces by volumetric expansion of CRAYOTHERM® by about 15-20% without outflow
- Solid, dry to the touch
- Silicone-free, thermally conductive compound
- No hardening
- Easy to use hand-held bloc applicator
- Replaceable without surface treatment
- Cleaning with isopropyl alcohol

PRODUCT AVAILABILITY

- In stick form

PART	KU-	CR	CRF
GENERAL PROPERTIES			
Material		CRAYOTHERM®	CRAYOTHERM®/Graphite
Colour		White	Black
THERMAL PROPERTIES			
Thermal conductivity	W/mK	0.47	3.00
Thermal resistance (inch²)	°C/W	0.020	0.008
Phase-change temperature CRAYOTHERM®	°C	60	51
Operating temperature	°C	-60 to +150	-60 to +150
Storage temperature	°C	max. 40	max. 40

THERMAL CONDUCTIVITY
(W/m·°K)

0.47
(KU-CR)

3.0
(KU-CRF)

electrically non-insulating

Phase-change compound KU-CR and KU-CRF

Image may differ from the original product.

APPLICATION

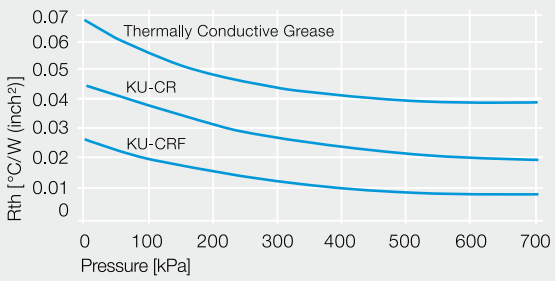
Push the stick approx. 5 to 10 mm out of its container and pull it across the surface of heat-sink and semiconductor at a 45° angle, applying gentle pressure. When heated to phase-change temperature, optimal heat transfer is achieved between the joint surfaces.

CONFIGURATIONS AND DIMENSIONS

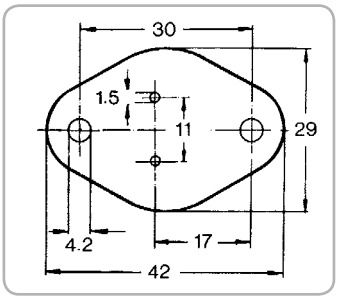
Part	Stick length	Width	Depth	Total Length
KU-CR-MINI	52 mm	10 mm	10 mm	127 mm
KU-CRF-MINI	52 mm	10 mm	10 mm	127 mm
KU-CR-125	46 mm	33 mm	13 mm	103 mm
KU-CRF-125	46 mm	33 mm	13 mm	103 mm

PRESSURE DEPENDENCE

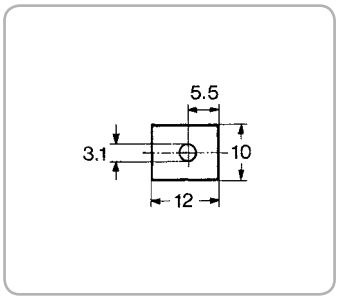
Thermal resistance of CRAYOTHERM® and thermally conductive paste vs. mounting pressure



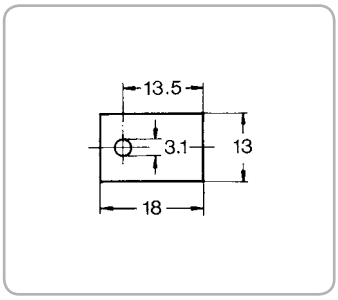
Standard configurations and dimensions: Films



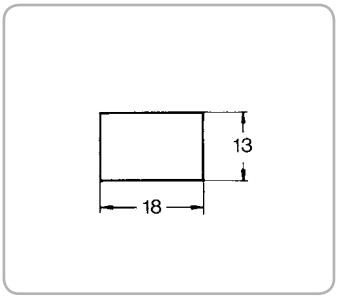
Part-No.: **KU 6-619**
TO-3



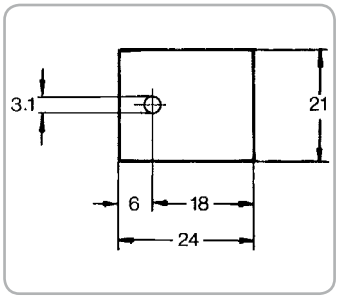
Part-No.: **KU 6-620**
TO-126 · SOT-32



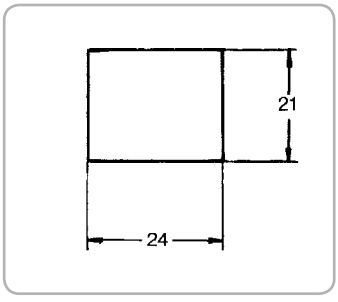
Part-No.: **KU 6-623**
TO-220



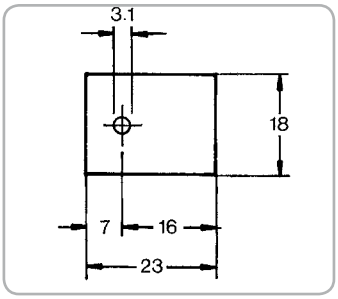
Part-No.: **KU 6-623/0**
TO-220



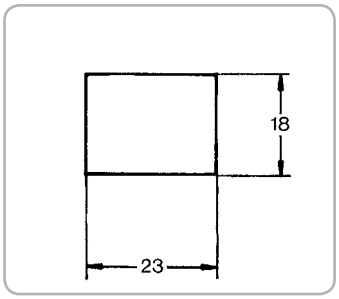
Part-No.: **KU 6-624**
TO-3P · TO-218/247/248 · MT 100



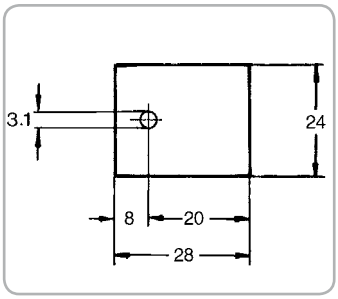
Part-No.: **KU 6-624/0**
TO-3P · TO-218/247/248 · MT 100



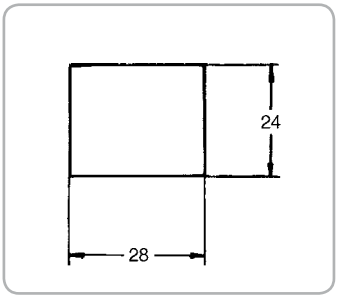
Part-No.: **KU 6-628**
TO-220



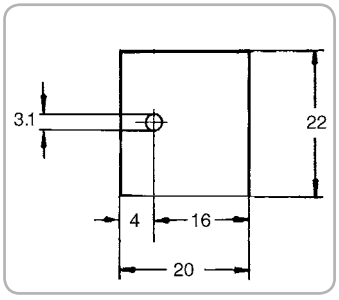
Part-No.: **KU 6-628/0**
TO-220



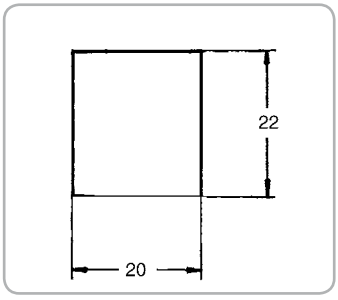
Part-No.: **KU 6-630**
TO-3PL · TO-264



Part-No.: **KU 6-630/0**
TO-3PL · TO-264



Part-No.: **KU 6-631**
Multiwatt

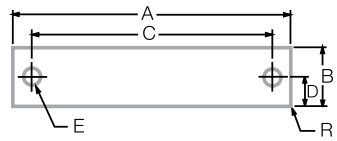


Part-No.: **KU 6-631/0**
Multiwatt

All dimensions in mm.

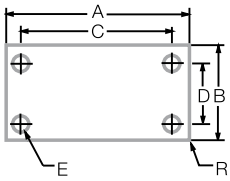
Standard configurations and dimensions: Phase-change materials

Schottky, SCR, Darlington Module



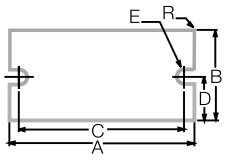
PART-NO.	A	B	C	D	E
KU-ALC 5/244-102	62.0	25.9	52.0	13.0	4.4
KU-ALC 5/354-154	90.0	39.1	76.0	19.5	5.5
KU-ALC 5/364-081	92.5	20.3	80.0	10.2	6.8
KU-ALC 5/370-134	94.0	34.0	80.0	17.0	6.8
KU-ALC 5/425-134	108.0	34.0	93.0	17.0	6.8
KU-ALC 5/480-150	122.0	38.1	110.0	19.0	5.5

SCR, Darlington Module



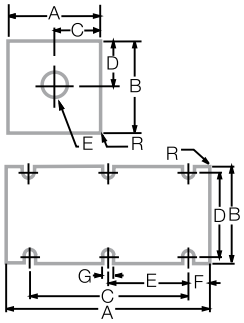
PART-NO.	A	B	C	D	E
KU-ALC 5/366-197	93.0	50.0	80.0	38.1	6.0
KU-ALC 5/370-339	94.0	86.1	80.0	73.9	5.6
KU-ALC 5/374-244	95.0	62.0	80.0	48.0	6.0
KU-ALC 5/386-252	98.0	64.0	63.0	52.1	6.0
KU-ALC 5/402-358	102.1	91.0	80.0	73.9	6.0
KU-ALC 5/425-244	108.0	62.0	93.0	48.0	6.4
KU-ALC 5/445-354	113.0	90.0	93.0	70.1	6.4
KU-ALC 5/449-449	114.0	114.0	93.0	93.0	6.4
KU-ALC 5/550-370	139.7	94.0	80.0	80.0	8.3
KU-ALC 5/630-302	160.0	76.7	80.0	62.7	6.8
KU-ALC 5/750-370	190.5	94.0	80.0	80.0	6.8

Relays



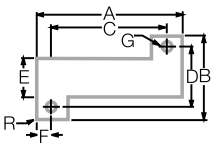
PART-NO.	A	B	C	D	E
KU-ALC 5/220-064	55.9	16.3	48.3	8.1	4.0
KU-ALC 5/225-175	57.2	44.5	47.5	22.3	4.4
KU-ALC 5/250-125	63.5	31.8	48.3	16.0	5.2
KU-ALC 5/276-106	70.1	27.0	60.0	13.5	5.6
KU-ALC 5/315-114	80.0	29.0	68.0	14.5	6.4
KU-ALC 5/315-157	80.0	39.9	66.0	20.1	6.4
KU-ALC 5/346-154	87.9	39.1	76.0	20.0	5.2

Rectifier bridges



PART-NO.	A	B	C	D	E	F	G
KU-ALC 5/100-100	25.4	25.4	12.7	12.7	4.8	–	–
KU-ALC 5/112-112	28.5	28.5	14.2	14.2	5.2	–	–
KU-ALC 5/125-125	31.8	31.8	15.9	15.9	3.6	–	–
KU-ALC 5/206-206	52.3	52.3	26.2	26.2	9.5	–	–
KU-ALC 5/241-229	58.2	61.2	33.0	53.3	16.5	12.6	3.8
KU-ALC 5/456-236	115.8	60.0	91.5	53.3	45.7	12.2	4.1
KU-ALC 5/460-230	116.8	58.5	101.6	43.2	47.0	–	7.6

Resistor



PART-NO.	A	B	C	D	E	F	G
KU-ALC 5/075-080	19.0	20.3	14.3	15.9	10.8	2.4	2.4
KU-ALC 5/106-108	27.0	27.4	18.3	19.8	14.0	4.4	3.2
KU-ALC 5/197-114	50.0	29.0	39.6	21.3	16.0	5.1	3.2
KU-ALC 5/350-281	88.9	71.4	69.9	57.1	46.0	9.7	4.8

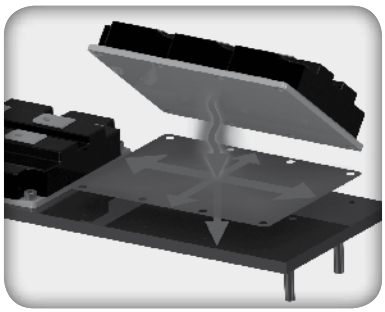
06

Graphite films

Kunze graphite interface materials KU-CB are made from pure graphite and are not electrically insulating. They combine high thermal conductivity with very low thermal contact resistance. The graphite structure‘s thermal conductivity in the X-Y direction (in-plane direction) and Z direction (through direction) is anisotropic.

These interface materials are ideal for heat dissipation away from hot spots. Due to their natural softness, they adapt perfectly to the contact surfaces even under little pressure, expelling air pockets and greatly reducing thermal contact resistance (and consequently, total thermal transfer resistance).

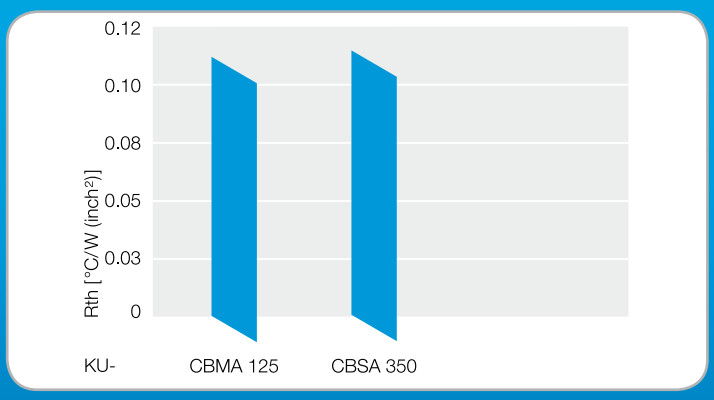
Graphite interface materials effectively replace thermal pastes. They are ideal for use in applications in which phase-change temperatures cannot be reached and therefore phase-change materials cannot be implemented. Owing to their high resistance to heat, graphite materials can also be used in applications at temperatures beyond 200°C. Their excellent electrical properties allow for Kunze graphite foils to be used for EMI shielding up to the GHz range, with superior attenuation.



APPLICATION EXAMPLES
Thermal linkage of heat sources and heat sinks in:

- CPU modules and microprocessors
- DC/DC converters
- Power modules
- Power units in automotive applications
- Active components in notebooks
- Telecommunication modules

THERMAL RESISTANCE OVERVIEW



THERMAL CONDUCTIVITY
(W/m·°K)

x-y-direction (in-plane)

134

z-direction (through-plane)

6.0

electrically non-insulating

Graphite interface material
KU-CBMA

HEATPAD® KU-CBMA pure graphite interface material possesses very high thermal conductivity along length and width (x-y-direction) and good thermal conductivity through the thickness (z-direction).

PROPERTIES

- Anisotropic thermal conductivity: very high thermal conductivity along length and width (x-y-direction), good thermal conductivity through the thickness (z-direction)
- Silicone-free
- Low thermal resistance
- Soft and flexible
- High temperature resistance
- No hardening
- Guaranteed layer thickness
- No ageing
- Low starting torque required
- Clean and easy mounting, high process reliability

PART	KU-	CBMA125	CBMA250
GENERAL PROPERTIES			
Material		Graphite	
Colour		Dark grey	
Gauge	µm	125	250
Density	g/cm³	1.35	1.35
Purity of material (Graphite)	%	> 98	> 98
ELECTRICAL PROPERTIES			
Volume resistivity in x-y-direction (in-plane)	Ωm	2×10^{-6}	1.5×10^{-6}
Volume resistivity in z-direction (through-plane)	Ωm	2×10^{-6}	1.5×10^{-6}
THERMAL PROPERTIES			
Thermal conductivity in x-y-direction (in-plane) (ISO 22007-2)	W/mK	134	134
Thermal conductivity in z-direction (through-plane) (ISO 22007-2)	W/mK	6.0	6.0
Thermal resistance	°C/W	0.032	0.064
Operating temperature	°C	-250 to +400	-250 to +400

THERMAL CONDUCTIVITY
(W/m·°K)

x-y-direction (in-plane)

134

z-direction (through-plane)

6.0

electrically non-insulating

Graphite film KU-CBMA

Image may differ from the original product.

PRODUCT AVAILABILITY

- All standard IGBT and microprocessor configurations
- In roll form according to customer specifications
- Stamped and cut to customer specifications

THERMAL CONDUCTIVITY
(W/m·°K)

x-y-direction (in-plane)

155

z-direction (through-plane)

4.8

electrically non-insulating

Graphite film
KU-CBSA

HEATPAD® KU-CBSA pure graphite interface material possesses very high thermal conductivity along length and width (x-y-direction) and high thermal conductivity through the thickness (z-direction).

PROPERTIES

- Anisotropic thermal conductivity: very high thermal conductivity along length and width (x-y-direction), high thermal conductivity through the thickness (z-direction)
- Silicone-free
- Soft and flexible
- Very high temperature resistance
- No hardening
- Guaranteed layer thickness
- No ageing
- Low starting torque required
- Clean and easy mounting, high process reliability

PART	KU-	CBSA 350
GENERAL PROPERTIES		
Material		Graphite
Colour		Dark grey
Gauge	µm	150-1500
Density	g/cm³	0.7-1.3 (depending on gauge)
Purity of material (Graphite)	%	99.85
MECHANICAL PROPERTIES		
Tensile strength	N/mm²	≥ 4
ELECTRICAL PROPERTIES		
Volume resistivity in x-y-direction (in-plane)	Ωµm	9
Volume resistivity in z-direction (through-plane)	Ωµm	≥ 650
THERMAL PROPERTIES		
Thermal conductivity in x-y-direction (in-plane)	W/mK	155
Thermal conductivity in z-direction (through-plane)	W/mK	4.8
Thermal resistance	°C/W	0.113
Operating temperature	°C	-250 to ca. +500

THERMAL CONDUCTIVITY
(W/m·°K)

x-y-direction (in-plane)

155

z-direction (through-plane)

4.8

electrically non-insulating

Graphite film KU-CBSA

Image may differ from the original product.

PRODUCT AVAILABILITY

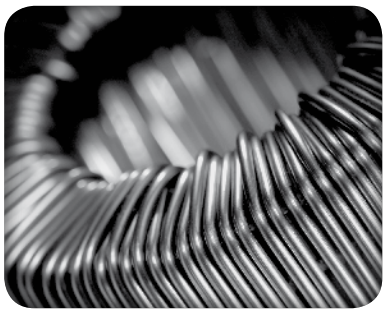
- All standard IGBT and microprocessor configurations
- In roll form according to customer specifications
- Stamped and cut to customer specifications
- Adhesive on one side (up to 1 mm gauge)

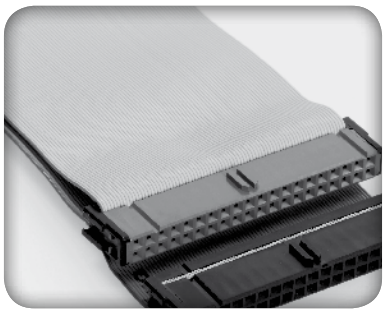
07

EMI-shielding materials

High-frequency switching operations in electronics require the suppression of electromagnetic interference over a wide range of frequencies. In power electronics, these interferences are primarily caused by undesired but inevitable harmonic waves, or by high-frequency power modules. In the same way, electronic power components cause high-frequency EMI in computers.

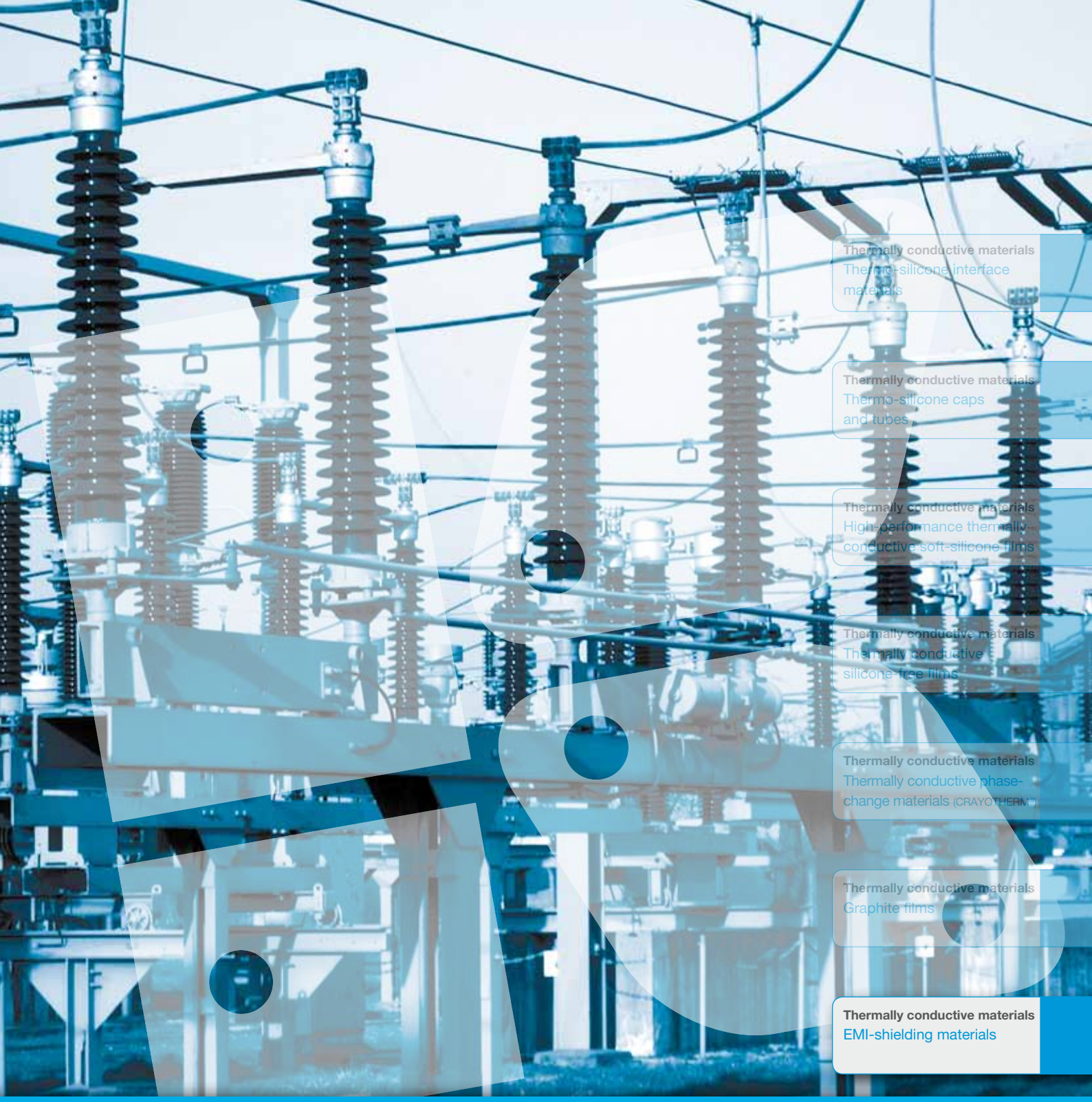
Kunze shielding foils meet the highest demands regarding shielding from these interferences by deflecting, and thus reducing, EMI. As they are also thermally conductive, thermal transfer resistance is reduced, and hazardous overheating avoided.





APPLICATION EXAMPLES
Suppression of electromagnetic interferences in

- SMPS
- Between PCBs and housings
- Between LSI and heat sinks
- Transformers
- Flat cables
- PCBs
- Telecommunication modules
- Operational amplifiers



THERMAL CONDUCTIVITY
(W/m·°K)

0.5

electrically insulating

EMI-conducting interface material KU-K/CU/K

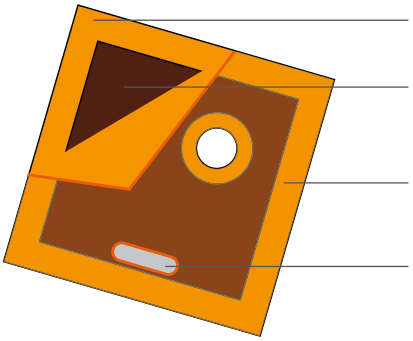
HEATPAD® KU-K/CU/K is a very thin copper foil electrically insulated by a thin polyimide coating on both sides. The copper foil has a soldering point that can be grounded to dissipate EMI. The thinness and good thermal conductivity of the material make for low total thermal resistance. By its use, components can be prevented both from dangerous overheating and electromagnetic interferences. KU-K/CU/K is most commonly applied in high-frequency SMPS for its excellent thermally conductive electric insulation combined with superior shielding properties.

All parts have a tinned soldering point.

PROPERTIES

- Superior shielding
- Good thermal conductivity
- Very flexible
- Clean and easy mounting, high process reliability

CONSTRUCTION



PART	KU-	K/CU/K
GENERAL PROPERTIES		
Material construction (sealed)		Polyimide – Copper – Polyimide
Gauge copper substrate	µm	35
Total gauge	µm	135
MECHANICAL PROPERTIES		
Tensile strength	N/m²	124
ELECTRICAL PROPERTIES		
Breakdown voltage	V	4000
Specific volume resistivity	Ωm	1.2 x 10^{12}
Dielectric constant		4.5
THERMAL PROPERTIES		
Thermal conductivity	W/mK	0.5
Thermal resistance (inch²)	°C/W	0.5
Operating temperature	°C	-60 to +200

THERMAL CONDUCTIVITY
(W/m·°K)

0.5

electrically insulating

EMI-conducting interface material KU-K/CU/K

Image may differ from the original product.

PRODUCT AVAILABILITY

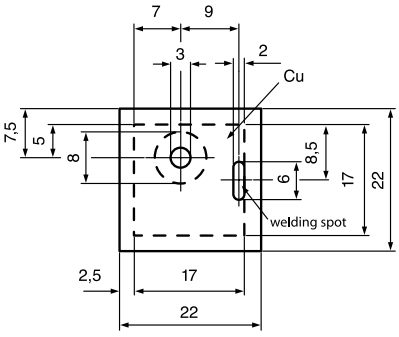
- Standard semiconductor types TO 220 and TO 247/248 also without notch for clip mounting

ON REQUEST

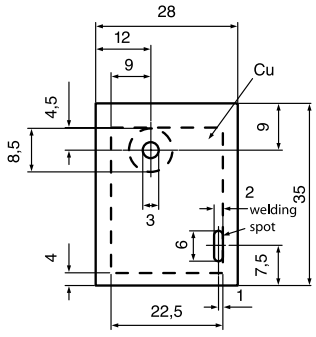
- Special shapes according to customer specifications

AVAILABLE CONFIGURATIONS AND DIMENSIONS

All dimensions in mm.



Part-No.
KU 6-623/K/CU/K
TO-220

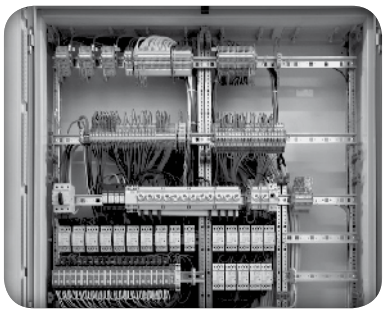


Part-No.
KU 6-624/K/CU/K
TO-247/248

08 Other products

Electrically insulating special films, injection-molded parts and technical ceramics complete our product portfolio.

We offer several solutions for each of a wide range of applications, such as polyimide or polycarbonate films, or thermally conductive ceramics made from aluminium oxide or aluminium nitride. For the insulation of fixing screws, Kunze insulating bushings are ideally suited.



THERMAL CONDUCTIVITY
(W/m·°K)

25

(KU-ALO)

150

(KU-ALN)

electrically insulating

Thermally conductive ceramics KU-ALN and KU-ALO

The ceramic plates made from aluminium nitride and aluminium oxide possess extremely high thermal conductivity, dielectric strength, and mechanical stability. They meet the highest requirements regarding operating temperatures.

Ceramic plates can typically be implemented in gauges between 0.5 and 3 or 5 mm (or more), depending on specifications.

For compensation of ruggedness or unevenness of the contact surfaces, a malleable interface material is required.

The ceramic plates made from aluminium nitride and aluminium oxide possess extremely high thermal conductivity, dielectric strength, and mechanical stability. They meet the highest requirements regarding operating temperatures.

PROPERTIES

- Extremely high thermal conductivity
- High dielectric strength
- Very high temperature resistance
- Very stable

Configurations and dimensions on page 107

PART	KU-	ALN	ALO
GENERAL PROPERTIES			
Material		Aluminium-nitride	Aluminium-oxide
Colour		Light grey	White
Purity of material	%		96.00%
MECHANICAL PROPERTIES			
Flexural strength	N/mm^2	350	380
Compressive strength	kN/mm^2	2.1	3.0
Roughness, unfinished	µm	~ 0.6	0.9 - ~ 1.3
Smoothness, unpolished, 25 mm flatness	mm	0.025	0.15
ELECTRICAL PROPERTIES			
Volume resistivity	Ωm	1.0×10^{10}	1.0×10^{12}
Dielectric constant (1 kHz)		8.6	9.6
Breakdown voltage	kV/mm	25	10
THERMAL PROPERTIES			
Thermal conductivity	W/mK	150	25
Operating temperature	°C	-65 to +850	-65 to +850

THERMAL CONDUCTIVITY
(W/m·°K)

25

(KU-ALO)

150

(KU-ALN)

electrically insulating

Thermally conductive ceramics KU-ALN and KU-ALO

Image may differ from the original product.

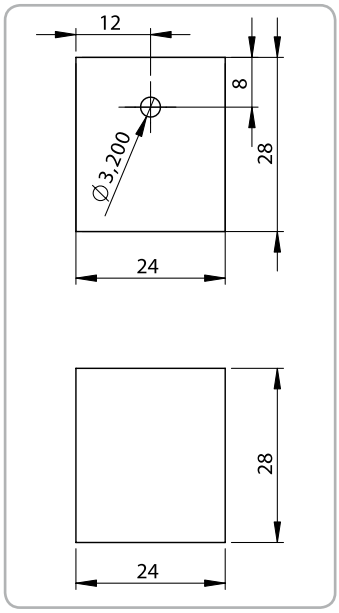
PRODUCT AVAILABILITY

- Standard shapes and sizes
- Customer-specific dimensions

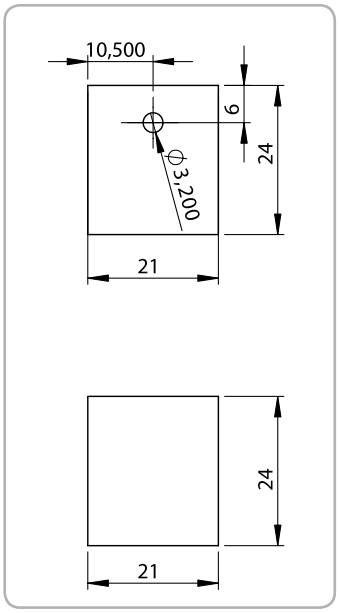
ON REQUEST

- Ceramic plates with other material gauges

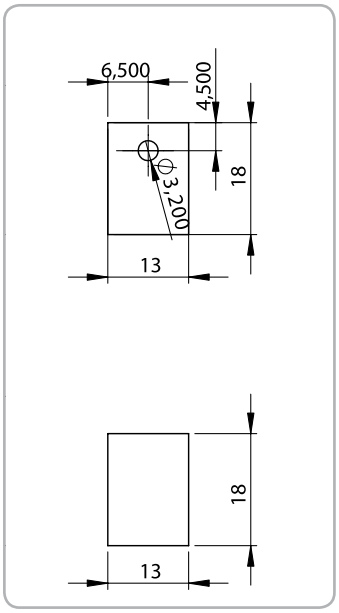
Standard configurations and dimensions: Ceramics



Part-No.: **6-630**, TO-264



Part-No.: **6-624**, TO-247



Part-No.: **6-623**, TO-220

Thermally conductive materials
Other products

Insulating films

Kunze insulating films are user-friendly and ensure electric insulation between electric/electronic component parts and their surroundings (e.g. casings etc.).

They combine very high dielectric strength with mechanical toughness and flexibility. Despite their relatively low thermal conductivity, their low thermal transfer resistance allows for them to be utilized as heat conducting material if the material gauge is between 25 and 125 µm. Superior contact surface finishing is paramount, nevertheless, as the firm structure of the plastics does not allow them to adapt to surface irregularities and air pockets.

Insulating films

KUNZE INSULATING FILMS CONSIST OF (AMONG OTHERS):

- Aramide paper
- Polycarbonate
- Polyester
- Polyimide
- Polypropylene

Other materials available on request. All films can be coated with acrylate glue for easy handling. If required, they can be pre-bent to enable form-fit mounting. Our films are made and tested at our state-of-the-art facilities in complete concordance with customers‘ designs.

Insulating film aramide paper

KU-NOMA is a very thin aramide paper with high dielectric strength and superior thermal stability.

PROPERTIES

- High dielectric strength
- Flexible and robust
- Suitable for applications in a wide temperature range
- UL flammability range: UL 94 V0

PRODUCT AVAILABILITY

- Customer-specific cuts and forms

ON REQUEST

- Other material gauges

Insulating film aramide paper

PART	KU-	NOMA
GENERAL PROPERTIES		
Material	Body	Aramide paper
Gauge	µm	NOMA0.25 = 236 - 284 NOMA0.38 = 348 - 429 NOMA0.51 = 474 - 563
Density	g/cm³	0.72 - 1.1 (Depends on thickness)
MECHANICAL PROPERTIES		
Tear strength	N/cm	285
ELECTRICAL PROPERTIES		
Breakdown voltage (ASTM D-149)	kV/mm	32
Dielectric constant (60Hz - ASTM D-150)		2.8
Flammability rating		UL 94 V0
THERMAL PROPERTIES		
Operating temperature	°C	max. 300

Thermally conductive materials
Other products

Insulating film polycarbonate

This material is a very thin polycarbonate film. It possesses high dielectric strength and retains its good thermal and mechanical properties at a wide range of temperatures.

Insulating film polycarbonate

PROPERTIES

- High dielectric strength
- Very flexible and mechanically stable
- Suitable for application in a wide temperature range

PRODUCT AVAILABILITY

- Cuts and forms according to customer specifications

ON REQUEST

- Other material gauges

KU-LEXA and **KU-LEXB** are very thin polycarbonate films, polished on on side and matt finish on the other. They possess superior dielectric strength.

KU-LEXC is a transparent, thin polycarbonate film with polished surface finish and outstanding dielectric strength.

PART	KU-	LEXA0.25	LEXB0.25	LEXC0.25
GENERAL PROPERTIES				
Material	Body	Polycarbonate (Black)	Polycarbonate (Milky transparent)	Polycarbonate (Transparent)
Gauge	µm	250	250	250
Density	g/cm³	1.32	1.32	1.2
MECHANICAL PROPERTIES				
Tensile strength	Mpa	70	70	70
Tear strength	kN/m	298	298	245
ELECTRICAL PROPERTIES				
Breakdown voltage (IEC 60243)	kV/mm	68	59	67
Volume resistivity (IEC 60093)	Ωcm	1.0×10^{17}	1.0×10^{17}	1.0×10^{14}
Dielectric constant (1 Mhz – IEC 60250)		2.8	2.8	–
Flammability rating		UL 94 V0	UL 94 V0	–
THERMAL PROPERTIES				
Operating temperature	°C	to 130	to 130	to 150

KU-MFDEA is a polycarbonate film with excellent dielectric strength. It retains its superior mechanical and thermal qualities at a wide range of temperatures (-70°C to +130°C).

PART	KU-	MFDEA
GENERAL PROPERTIES		
Material		Polycarbonate
Colour		Milky white
Gauge	µm	125 - 750
Density	g/cm³	1.2
MECHANICAL PROPERTIES		
Tear strength	Mpa	70
ELECTRICAL PROPERTIES		
Breakdown voltage	kV/mm	60
Flammability rating		UL 94 VTM-2
THERMAL PROPERTIES		
Operating temperature	°C	-70 to +130

Insulating film polyester

KU-MYA is a polyester film with excellent dielectric properties. It retains its superior mechanical and thermal qualities at a wide range of temperatures (-70°C to +150°C); in extreme cases it is even suitable for applications at temperatures ranging from -200°C to +250°C, if physical stress is moderate. KU-MYA is resistant to many common chemicals.

Insulating film polyester

PROPERTIES

- High dielectric strength
- Very flexible and mechanically stable
- Good chemical stability
- Suited for application in a wide temperature range

PRODUCT AVAILABILITY

- Cuts and forms according to customer specifications
- Gauges: 0.05 / 0.10 / 0.19 / 0.25 / 0.35 / 0.50 mm

PART	KU-	MYA
GENERAL PROPERTIES		
Material		Polyester
Colour		Milky white
Gauge	µm	50/100/190/250/350/500
Density	g/cm³	1.39
MECHANICAL PROPERTIES		
Tensile strength	Mpa	200
ELECTRICAL PROPERTIES		
Breakdown voltage (ASTM D149 and D2305)	VAC/µm	280
Volume resistivity (ASTM D257 and D2305)	Ωcm	1.0×10^{18}
Dielectric constant (1 Mhz – ASTM D150)		3.0
Dielectric strength	V/µ	157
Flammability rating		UL 94 VTM-2
THERMAL PROPERTIES		
Operating temperature	°C	-250 to +200

Insulating film polyimide

These pure polyimide-films possess good to excellent thermal conductivity and outstanding dielectric and mechanical qualities.

PROPERTIES

- Excellent electrical insulation
- Silicone-free
- Very flexible and mechanically stable
- Quick and clean handling, superior process reliability through adhesive coating or lateral adhesive strips
- Very wide temperature range
- UL flammability rating: UL 94 VO

Insulating film polyimide

PRODUCT AVAILABILITY

- Cuts and forms according to customer specifications
- As sheets
- In roll form

HEATPAD® KU-KAHN is a polyimide-based film with good thermal conductivity and excellent dielectric and mechancial properties.

PART	KU-	KAHN25	KAHN50	KAHN75	KAHN125
GENERAL PROPERTIES					
Material	Body	Polyimide			
Gauge	µm	25	50	75	125
MECHANICAL PROPERTIES					
Tensile strength	Mpa	33.5	33.5	33.5	33.5
ELECTRICAL PROPERTIES					
Breakdown voltage	kV/mm	303	240	205	154
Volume resistivity	Ωm	1.5×10^{17}	1.5×10^{17}	1.4×10^{17}	1.0×10^{17}
Dielectric constant (1 kHz)		3.4	3.4	3.5	3.5
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Operating temperature	°C	-269 to +230 (temporarily +400)			

HEATPAD® KU-KAMT is a polyimide-based, thermally conductive film with excellent dielectric and mechanical qualities.

PART	KU-	KAMT25	KAMT38	KAMT50	KAMT75
GENERAL PROPERTIES					
Material	Body	Polyimide			
Gauge	µm	25	38	50	75
MECHANICAL PROPERTIES					
Tensile strength	Mpa	186	186	186	186
ELECTRICAL PROPERTIES					
Breakdown voltage	V µm	212	212	212	212
Volume resistivity	Ωm	1.0×10^{14}	1.0×10^{14}	1.0×10^{14}	1.0×10^{14}
Dielectric constant (1 kHz)		4.2	4.2	4.2	4.2
Flammability rating		UL 94 V0	UL 94 V0	UL 94 V0	UL 94 V0
THERMAL PROPERTIES					
Thermal resistance ($inch^2$)	°C/W	0.12	0.16	0.21	0.31
Operating temperature	°C	-269 to +230 (temporary up to +400)			

Insulating film polypropylene

KU-FORA and **KU-FORB** are flame-retarding polypropylene films, characterized by their superior mechanical stability, flexibility and dielectric strength.

PROPERTIES

- High dielectric strength
- Flexible and mechanically stable

PRODUCT AVAILABILITY

- Customized cuts and forms
- Colours: black (FORA) or white (FORB)

ON REQUEST

- Other material gauges

Insulating film polypropylene

PART	KU-	FORA / FORB
GENERAL PROPERTIES		
Material	Body	Polypropylene
Gauge	µm	250 - 760
ELECTRICAL PROPERTIES		
Breakdown voltage (ASTM D-149)	kV	22 - 32.4
Dielectric constant (ASTM D-150)		2.3
Flammability rating		UL 94 VTM-0 resp. UL 94 V0*
THERMAL PROPERTIES		
Operating temperature	°C	to 115

* Depending on material gauge

Thermally conductive materials
Other products

Insulating bushings to 200°C

Insulating bushings to 200°C

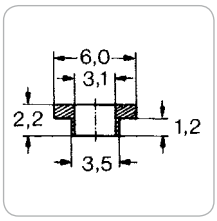
MATERIAL

- High-performance heat resistant plastic SR
- Resistant to permanent temperatures of approx. 200°C, excellent shape retention

ON REQUEST

- Bushings in other dimensions

CONFIGURATIONS AND DIMENSIONS



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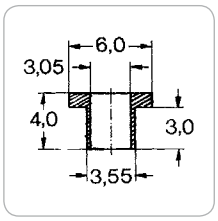

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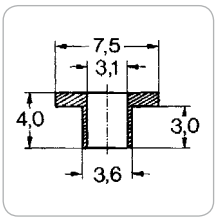

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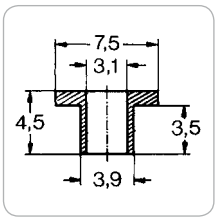

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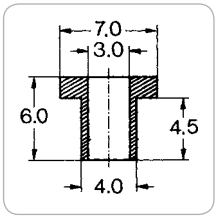

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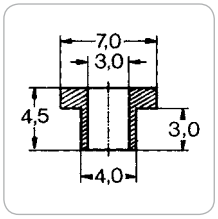

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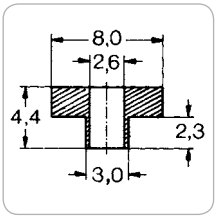

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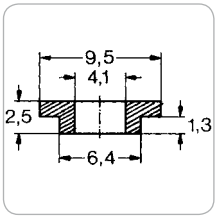


Part-No.: **KU 6-658**/SR

We disclaim all liability for the correctness of the information contained herein.

We reserve the right to make technical changes without notice.

All dimensions in mm.

INSULATING BUSHINGS		up to approx. 200°C
GENERAL PROPERTIES		
Colour		Grey
MECHANICAL PROPERTIES		
Density	g/cm³	1.4
Tensile strength	N/mm²	80
Modulus in tension	N/mm²	2400
Impact resistance as per DIN 52423	KJ/m²	No breakage
ELECTRICAL PROPERTIES		
Volume resistivity	Ωm	1.0×10^{15}
Breakdown voltage	kV/mm	40

Insulating bushings to 140°C

MATERIAL

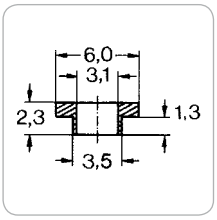
- Polyamide GV
- This material possesses superior heat resistivity (permanent temperatures to 140 °C) and high shape retention due to the addition of heat stabilizers, fiberglass reinforcement and polymers

ON REQUEST

- Bushings in other dimensions

Insulating bushings to 140°C

CONFIGURATIONS AND DIMENSIONS



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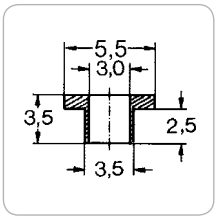

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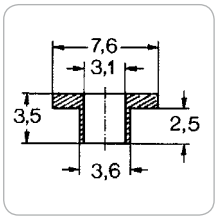

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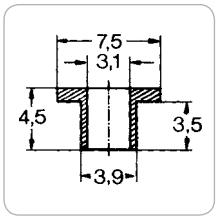

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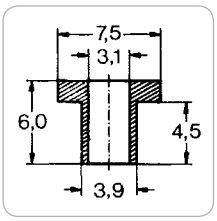
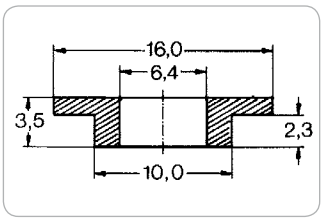


Part-No.: **KU 6-655**/PA



Part-No.: **KU 6-665**/PA

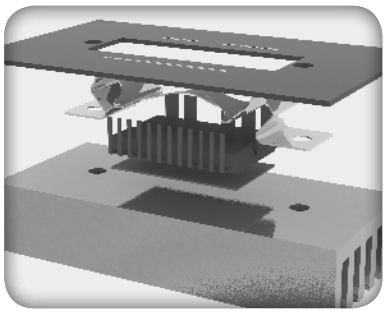
INSULATING BUSHINGS		up to approx. 140°C
GENERAL PROPERTIES		
Colour		Black
Proportion of fiberglass reinforcement	%	25
MECHANICAL PROPERTIES		
Density	g/cm³	1.3
Tensile strength	N/mm²	110
Modulus in tension	N/mm²	6000
Impact resistance	KJ/m²	30 (at +23 °C), 25 (at -40 °C)
ELECTRICAL PROPERTIES		
Volume resistivity	Ωm	1.0 x 10¹⁰
Breakdown voltage	kV/mm	40

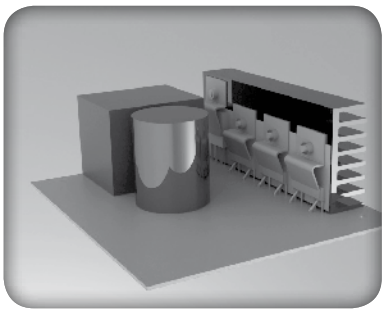
Thermally conductive materials
Other products

08 POWERCLIPS®

Kunze POWERCLIPS® are ideal components for integrated heat management solutions:

- Optimum interaction of transistor clips, interface materials and heat sinks through intelligent clip design
- Perfect application-specific implementation based on force-distance measurement
- Over 30 types of POWERCLIPS® constantly in stock
- Customized CAD-design and development of POWERCLIPS® on request
- Corrosion resistant steel CrNi 1.4310
- Quick prototype development
- All clips optionally available with insulation

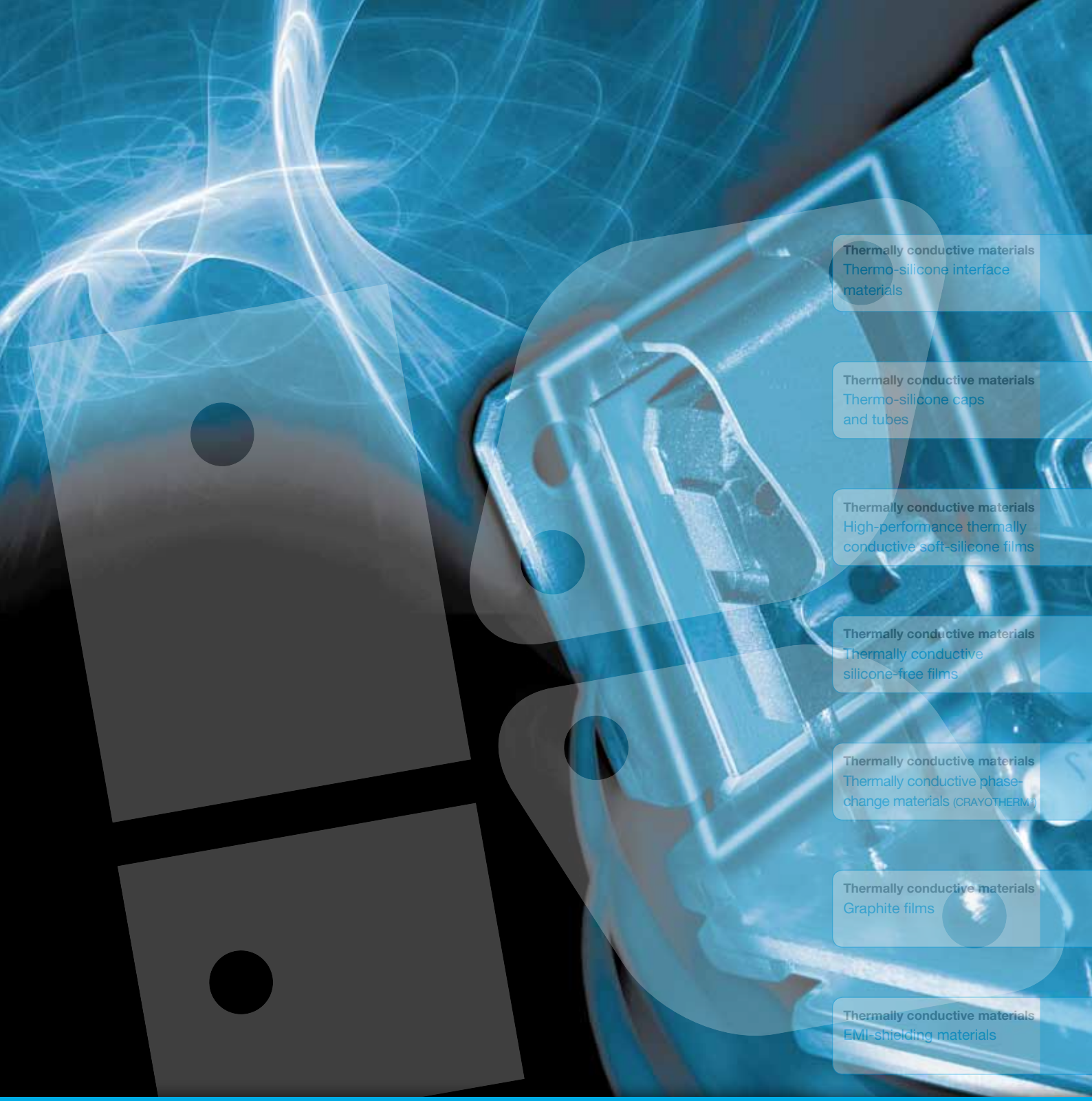




APPLICATION EXAMPLES

Process-reliable, mechanical connection of heat source (power semiconductors etc.) to heat sink.

- Power supplies
- UPS
- Battery chargers
- Frequency converters

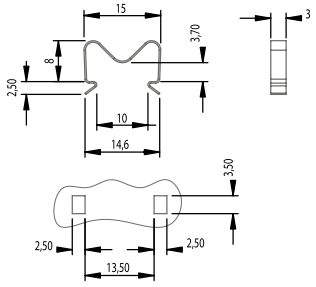


TECHNICAL DATA

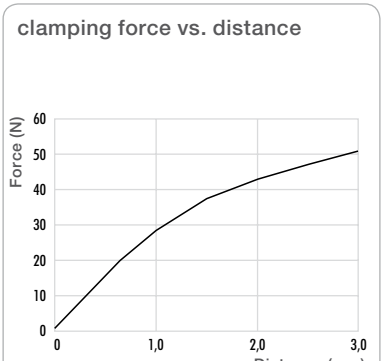
Part	POWERCLIPS®	
General Properties		
Material	Corrosion resistant steel CrNi 1.4310	
Mechanical Properties		
Tensile strength	N/mm²	1300 - 1500
Elongation	%	> 40
Young modulus	kN/mm²	190

POWERCLIPS®
Finger Clips

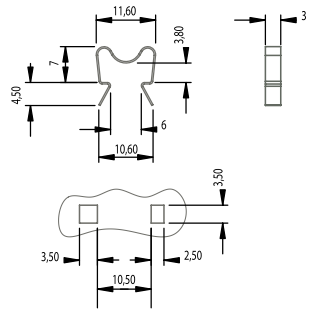
Part-No. KU 3-381
TO-220



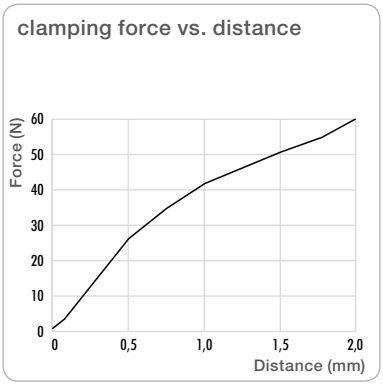
Mat. 0.3 mm, for sheet gauge 1.5-2.0 mm



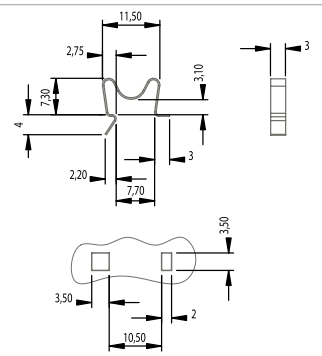
Part-No. KU 3-383
TO-126



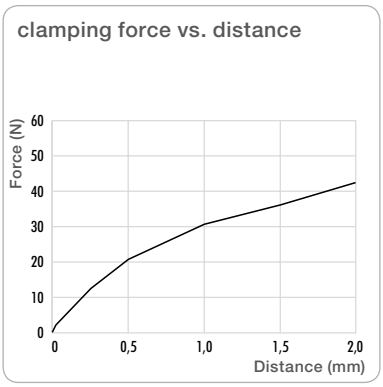
Mat. 0.3 mm, for sheet gauge 2.0 mm



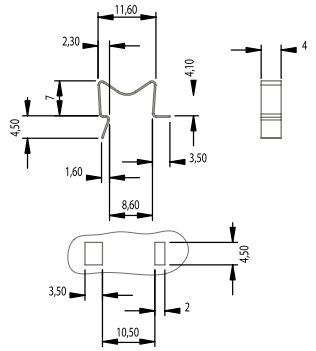
Part-No. KU 3-384
TO-126



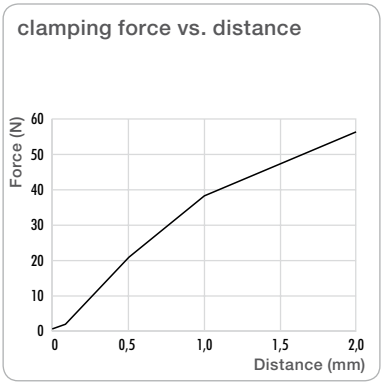
Mat. 0.3 mm, for sheet gauge 2.0 mm



Part-No. KU 3-385
TO-126

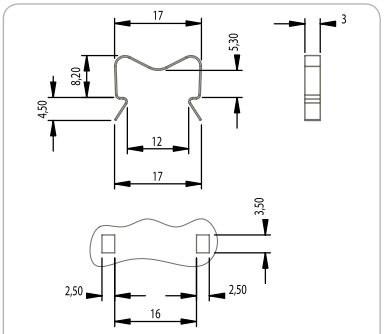


Mat. 0.3 mm, for sheet gauge 2.0 mm

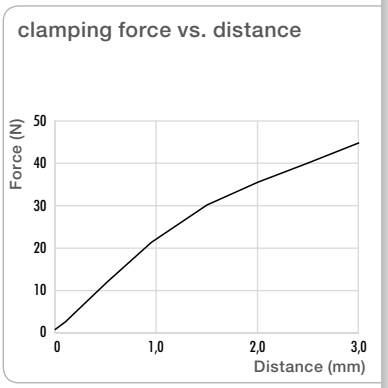


All dimensions in mm.

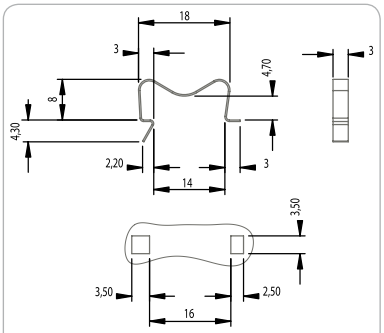
Part-No. KU 3-386
TO-220



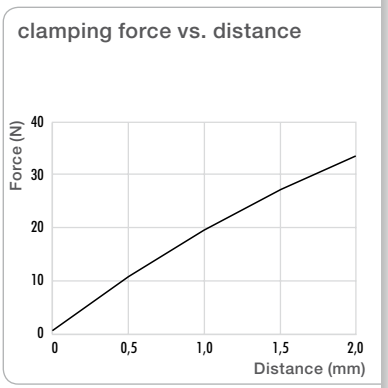
Mat. 0.3 mm, for sheet gauge 1.5-2.0 mm



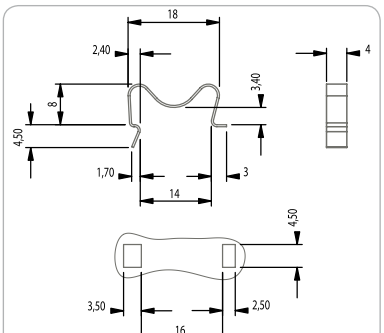
Part-No. KU 3-387
TO-220



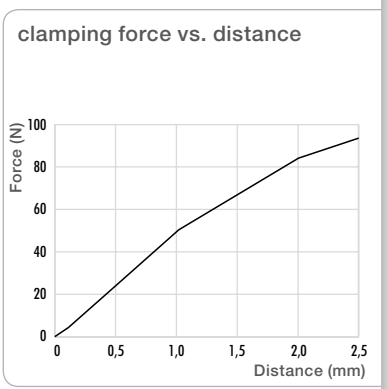
Mat. 0.3 mm, for sheet gauge 1.5-2.0 mm



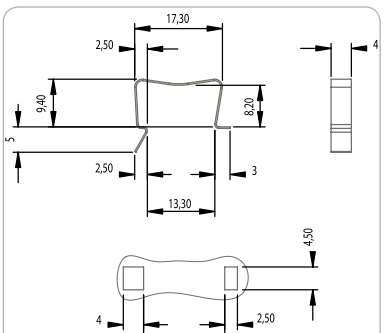
Part-No. KU 3-388
TO-220



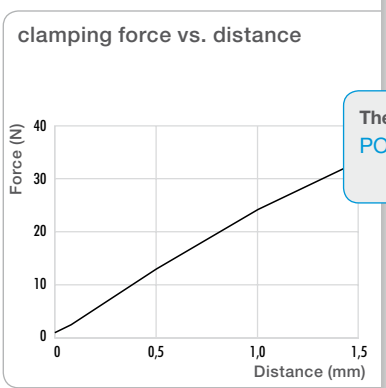
Mat. 0.4 mm, for sheet gauge 1.5-2.0 mm



Part-No. KU 3-389
TO-220

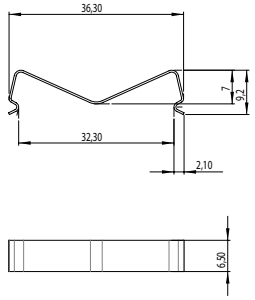


Mat. 0.3 mm, for sheet gauge 4.0 mm

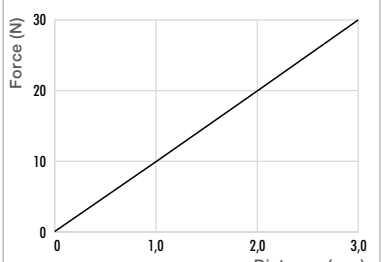


POWERCLIPS®
Finger Clips

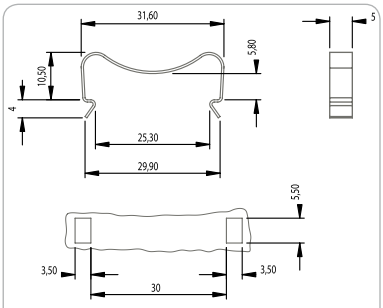
Part-No. KU 3-391
TO-126



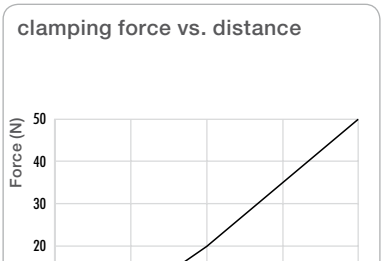
Mat. 0.4 mm, for sheet gauge 4.0 mm



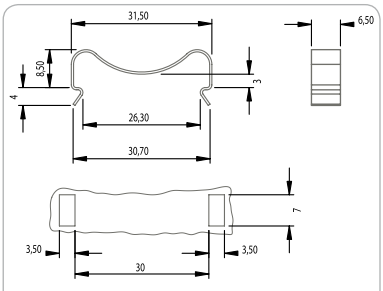
Part-No. KU 3-392
TO-3P · TO-247/248



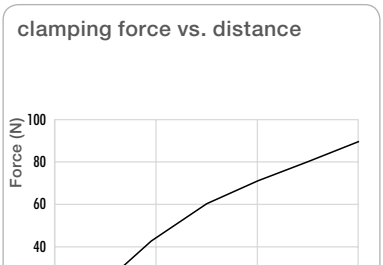
Mat. 0.5 mm, for sheet gauge 2.0 mm



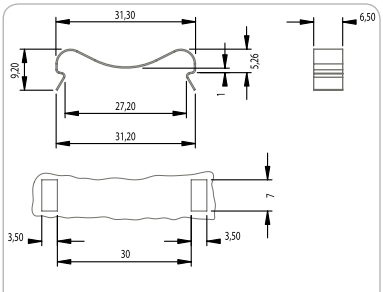
Part-No. KU 3-393
Low-profile bridge rectifier



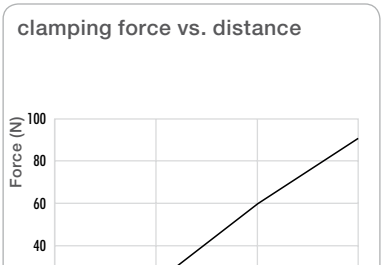
Mat. 0.5 mm, for sheet gauge 1.5 mm



Part-No. KU 3-394
Multiwatt

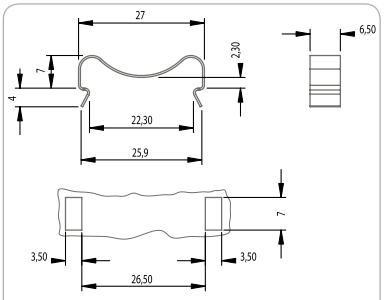


Mat. 0.3 mm, for sheet gauge 1.5-2.0 mm

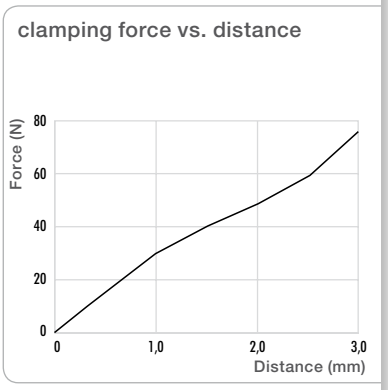


All dimensions in mm.

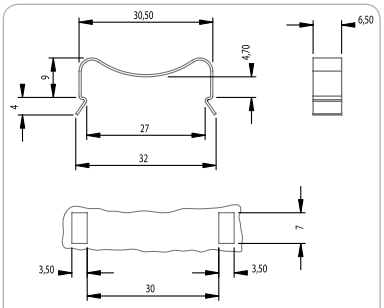
Part-No. KU 3-395
TO-3P



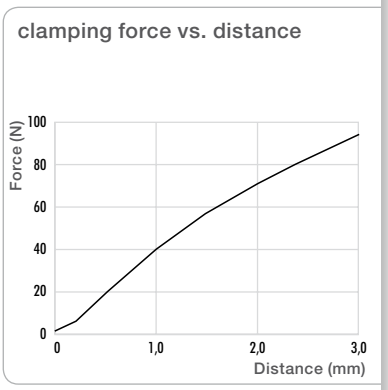
Mat. 0.4 mm, for sheet gauge 1.0-2.0 mm



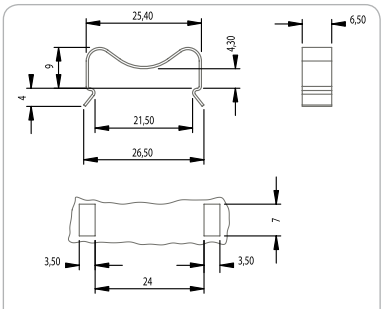
Part-No. KU 3-396
TO-3P · TO-247/248



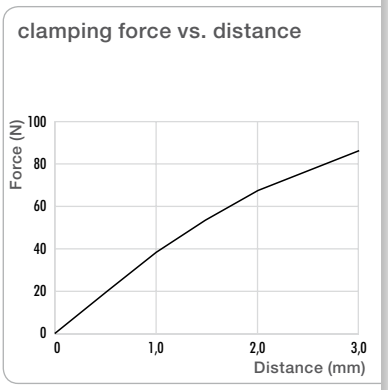
Mat. 0.5 mm, for sheet gauge 2.0 mm



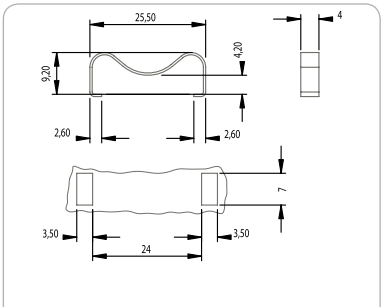
Part-No. KU 3-396/24
TO-3P



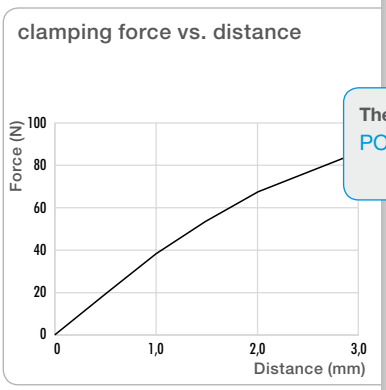
Mat. 0.5 mm, for sheet gauge 2.0 mm



Part-No. KU 3-396/24/4
TO-3P

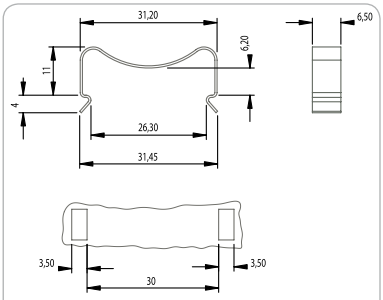


Mat. 0.5 mm, for sheet gauge 2.0 mm

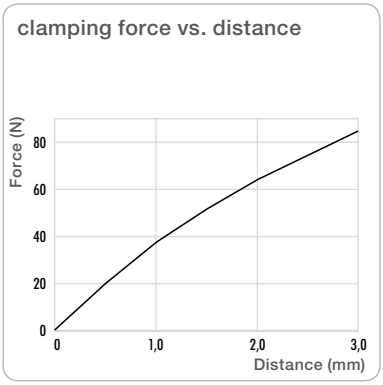


POWERCLIPS®
Finger Clips

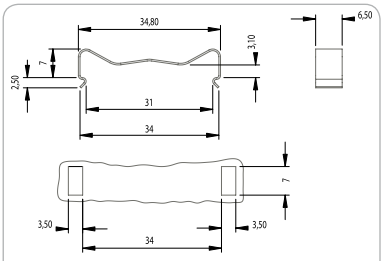
Part-No. KU 3-397
TO-3P · TO-247 / 248



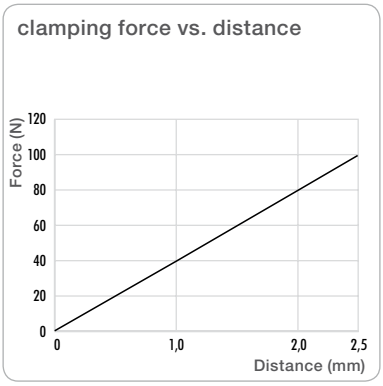
Mat. 0.5 mm, for sheet gauge 4.0 mm



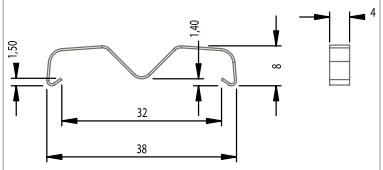
Part-No. KU 3-398
2 x TO-220



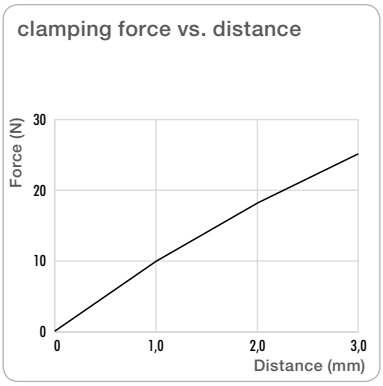
Mat. 0.4 mm, for sheet gauge 1.0-1.5 mm



Part-No. KU 3-399
TO-220 / TO-3P

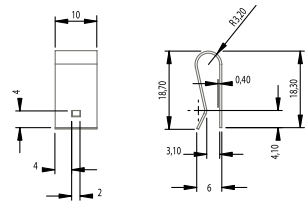


Mat. 0.4 mm



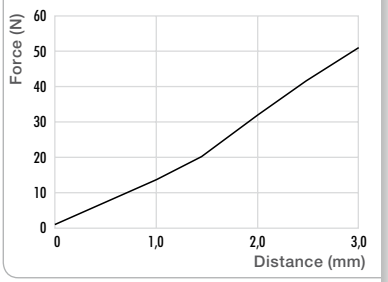
All dimensions in mm.

Part-No. KU 4-440/3.1
TO-220 / TO-3P

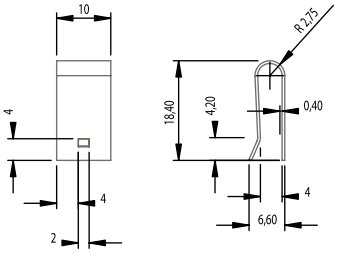


Mat. 0.5 mm, hardened spring steel

clamping force vs. distance

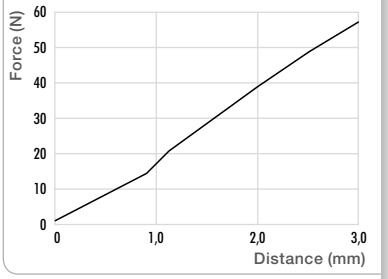


Part-No. KU 4-440/4.0
TO-220 / TO-3P

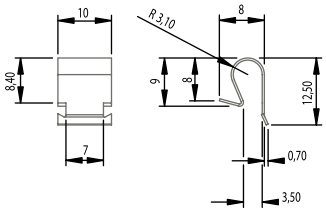


Mat. 0.5 mm, hardened spring steel

clamping force vs. distance

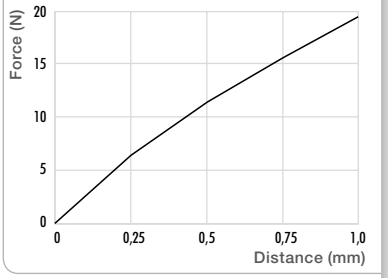


Part-No. KU 4-441
TO-220 / TO-3P

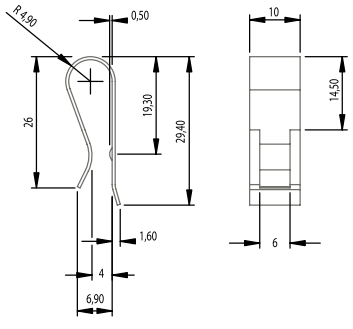


Mat. 0.4 mm

clamping force vs. distance

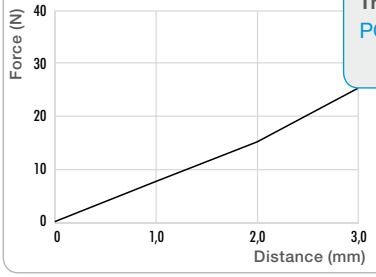


Part-No. KU 4-443
TO-220 / TO-3P



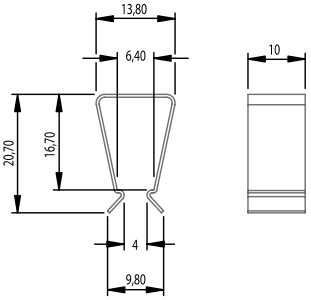
Mat. 0.6 mm, hardened spring steel

clamping force vs. distance

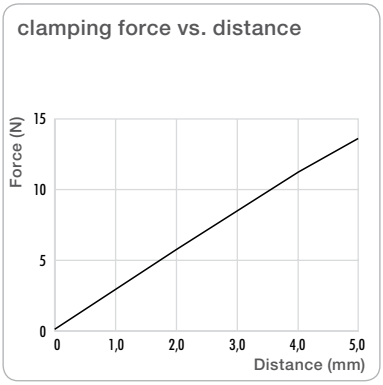


POWERCLIPS®
Finger Clips

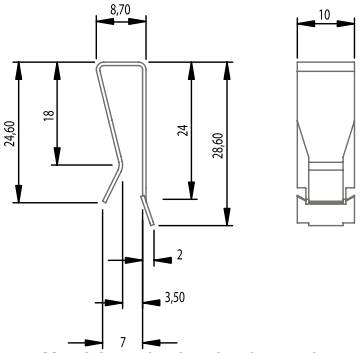
Part-No. KU 4-445
TO-220 / TO-3P



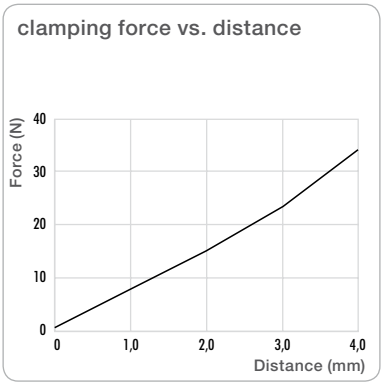
Mat. 0.5 mm



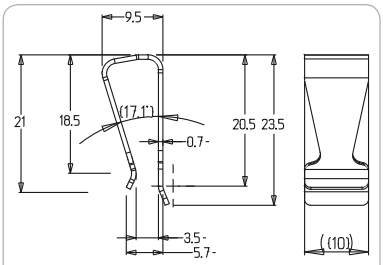
Part-No. KU 4-450
TO-220 / TO-3P



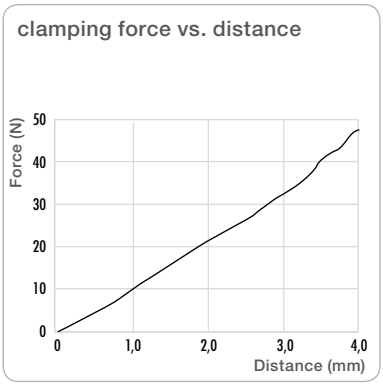
Mat. 0.6 mm, hardened spring steel



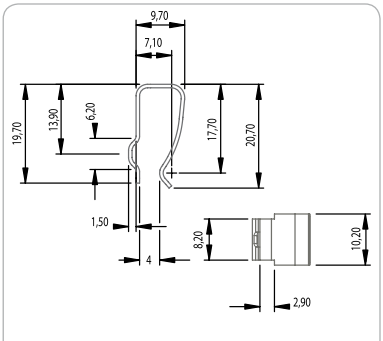
Part-No. KU 4-451



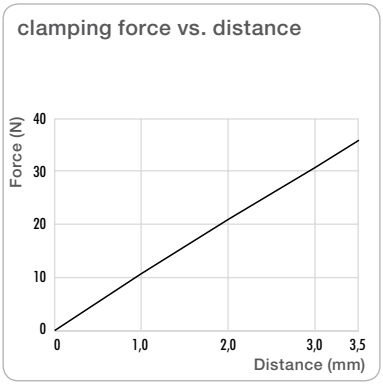
Mat. 0.7 mm



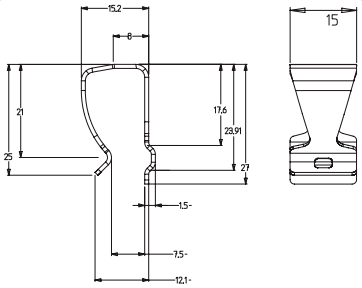
Part-No. KU 4-453
TO-220 / TO-3P



Mat. 0.7 mm

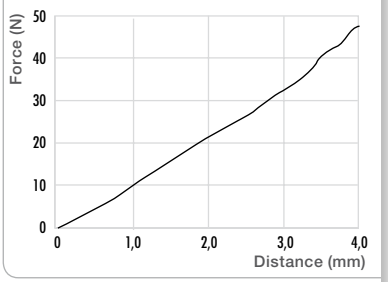


Part-No. KU 4-461

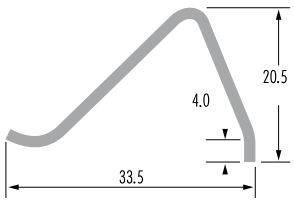


Mat. 0.9 mm

clamping force vs. distance



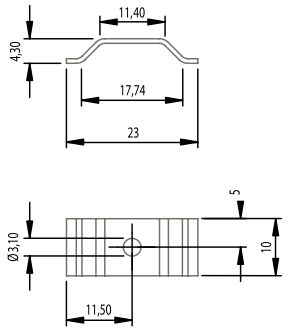
Part-No. KU 4-490
TO-220 / TO-3P



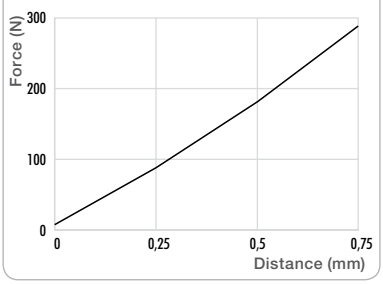
POWERCLIPS®

Gull wing clips and multiple transistor clips

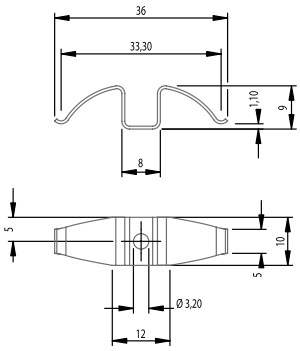
Part-No. KU 4-430



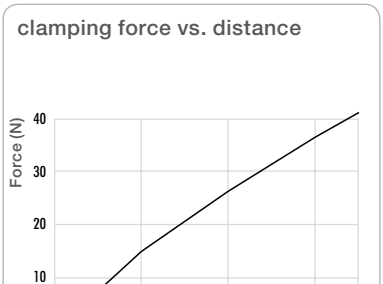
Mat. 0.8 mm



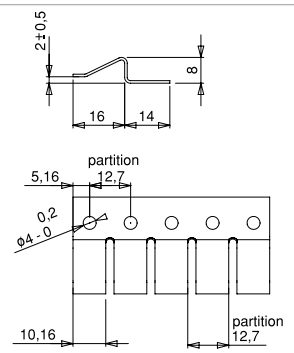
Gull Wing Clip
Part-No. KU 4-495



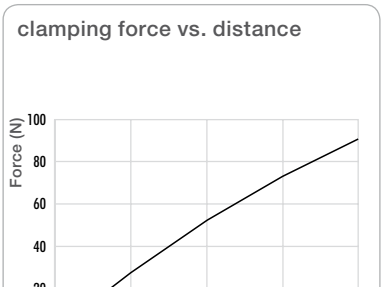
Mat. 0.6 mm



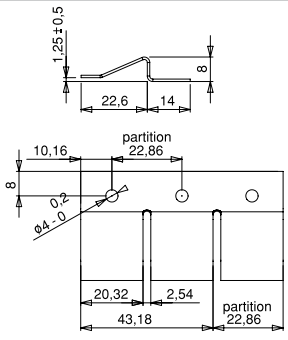
Multiple Transistor Clip
Part-No. KU 4-498/X
TO-220
(X = Number of fingers)



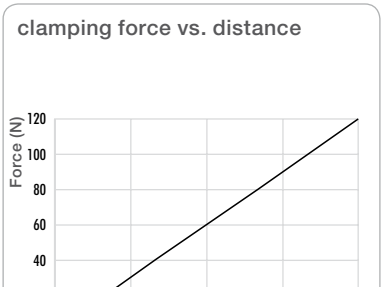
Mat. 0.8 mm, holes 4.0 mm ø



Multiple Transistor Clip
Part-No. KU 4-499/X
TO-247 / TO-264
(X = Number of fingers)



Mat. 0.8 mm, holes 4.0 mm ø

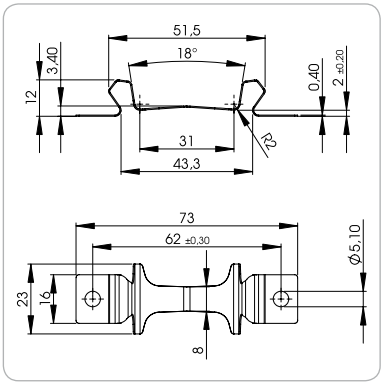


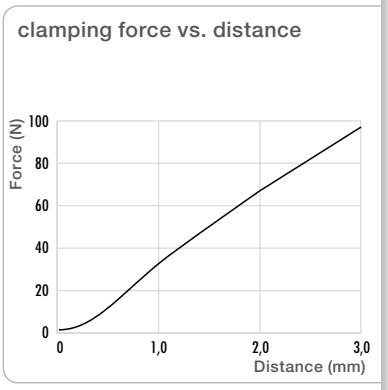
We disclaim all liability for the correctness of the information contained herein.

We reserve the right to make technical changes without notice.

All dimensions in mm.

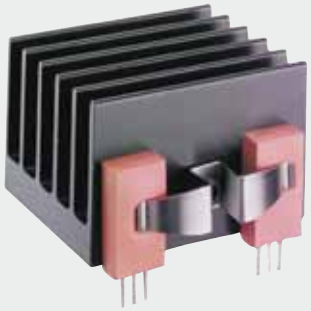
Part-No. KU 4-501
ISOPLUS





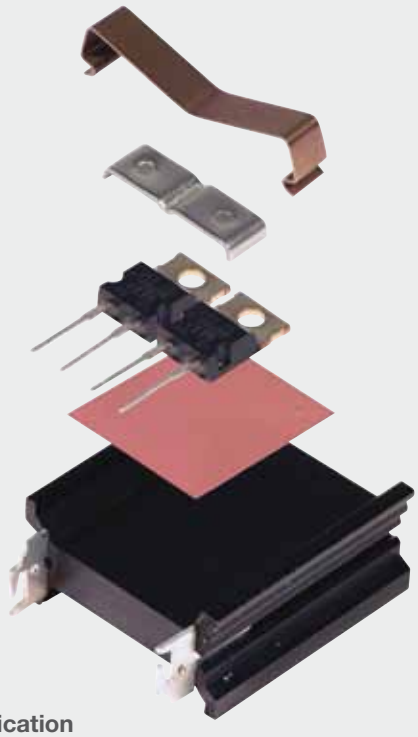
APPLICATIONS

Application with KU 4-501



Application with Gull Wing Clips

Application with Multiple Transistor Clips

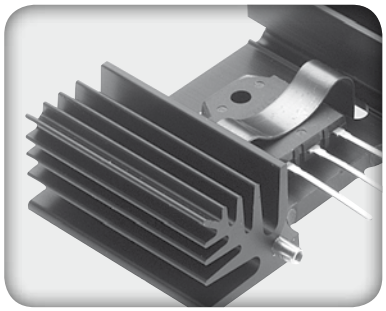


Application

Heat sink:	KU 1-070
POWERCLIP®:	KU 3-391
Centering element:	KU 2-ZUB01-567
Mounting element:	KU 2-ZUB 38-1

10 Heat sinks

Kunze heat sinks are made from high quality materials, using different production methods. A wide range of stamped heat sinks is available for standard semiconductor casings. For high-performance applications, we offer a variety of standard profiles produced and finished with state-of-the-art technology (CNC machines, vibratory barrel finishing, etc.). Alternatively, cooling plates and special heat sinks can be manufactured for the most diverse kinds of application. On request, all cooling devices can be made to customer specifications.



PROFILE HEAT SINKS

STAMPED HEAT SINKS

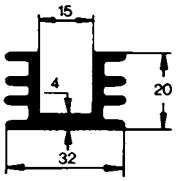
COOLING PLATES

SPECIAL HEAT SINKS

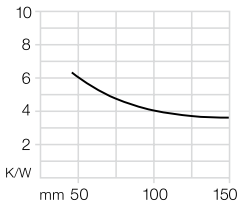
APPLICATION EXAMPLES
Cooling of power semiconductors, CPU modules, high-performance LEDs etc.

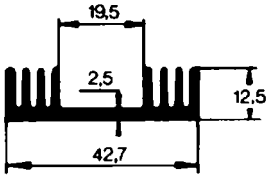
- Power supplies
- Battery chargers
- PCs and notebooks
- Consumer electronics
- Lighting

Profile heat sink

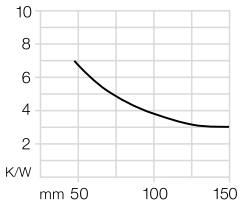


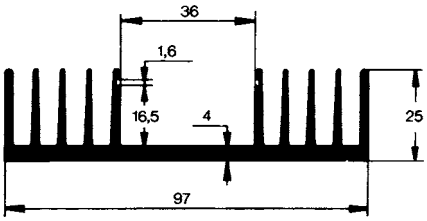
Part-No. KU 1-016



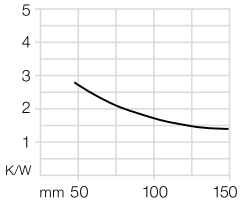


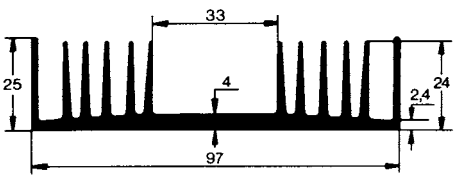
Part-No. KU 1-019



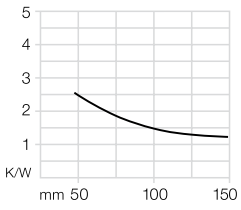


Part-No. KU 1-050





Part-No. KU 1-051



We disclaim all liability for the correctness of the information contained herein.

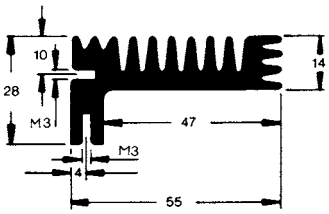
We reserve the right to make technical changes without notice.

All dimensions in mm.

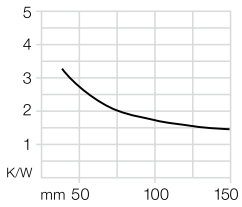
With regards to profile tolerances, we abide by DIN EN 755-9 resp. DIN EN 12020-2.

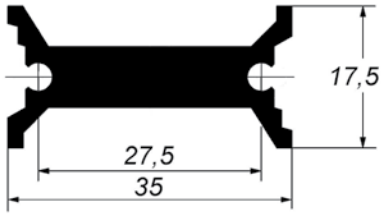
Customer-specific manufacturing according to DIN ISO 2768-mK.

Lower tolerances on request.

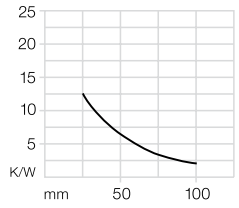


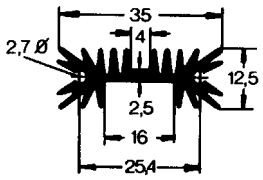
Part-No. KU 1-065



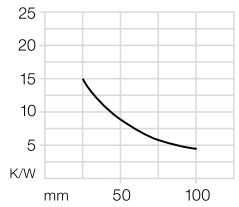


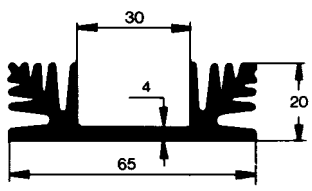
Part-No. KU 1-070



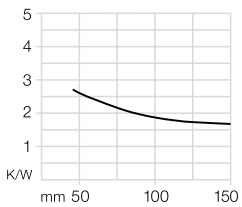


Part-No. KU 1-072

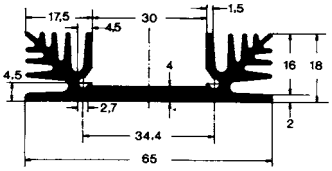




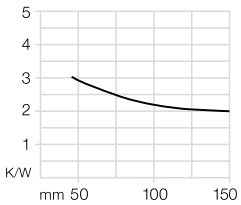
Part-No. KU 1-086



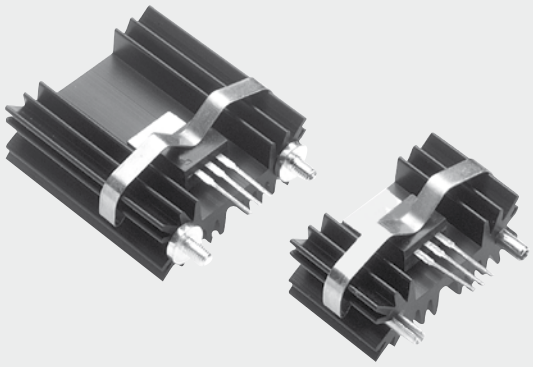
Profile heat sink



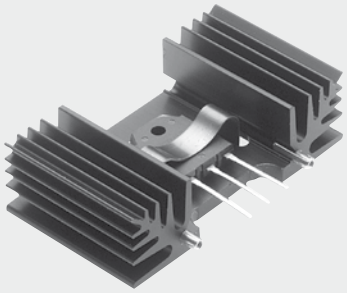
Part-No. KU 1-086/1



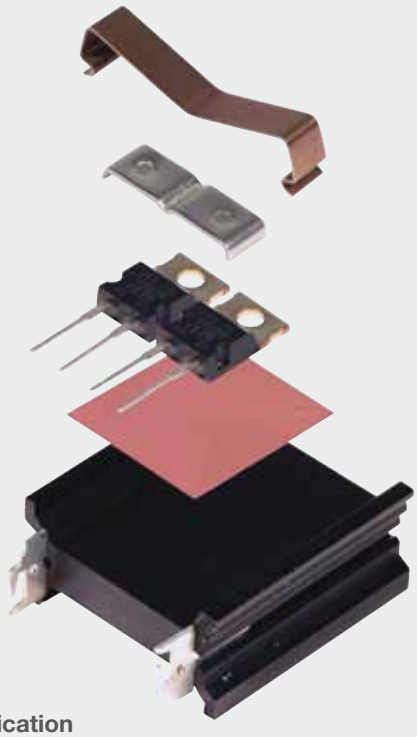
APPLICATIONS



Application with KU 1-072

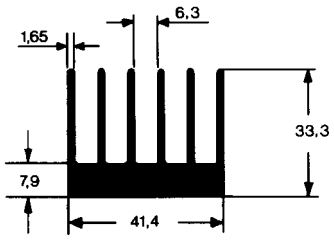


Application with KU 1-086/1

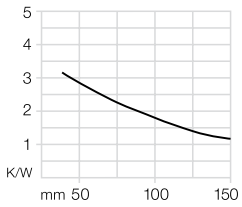


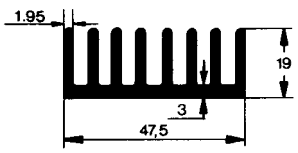
Application

Heat sink:	KU 1-070
POWERCLIP®:	KU 3-391
Centering element:	KU 2-ZUB01-567
Mounting element:	KU 2-ZUB 38-1

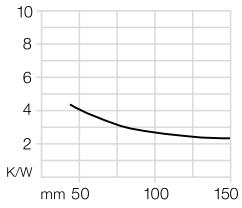


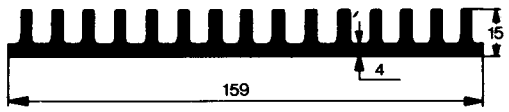
Part-No. KU 1-159



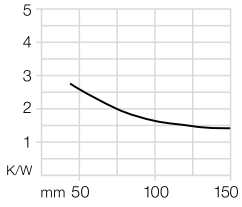


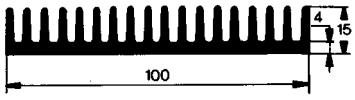
Part-No. KU 1-160



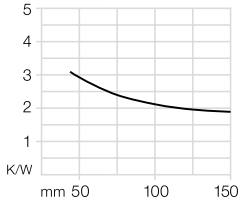


Part-No. KU 1-163

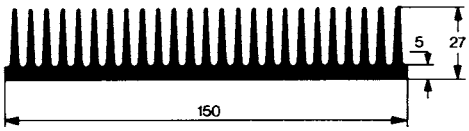




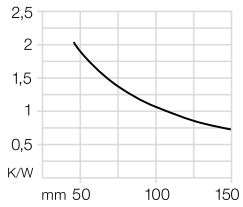
Part-No. KU 1-166

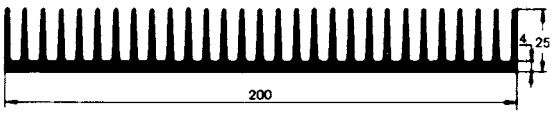


Profile heat sink



Part-No. KU 1-169





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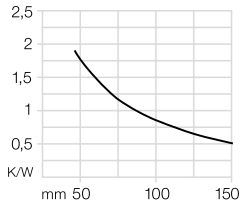
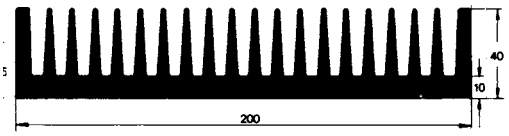
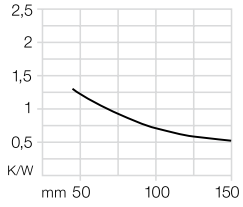
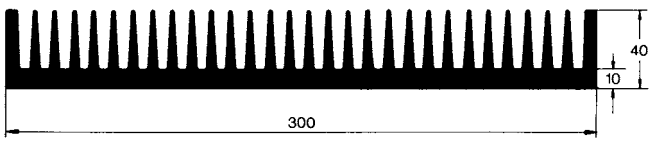


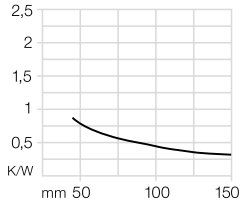


Part-No. KU 1-180





Part-No. KU 1-182



Other profiles available on request.

We disclaim all liability for the correctness of the information contained herein.

We reserve the right to make technical changes without notice.

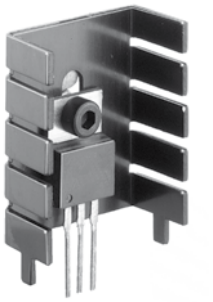
All dimensions in mm.

With regards to profile tolerances, we abide by DIN EN 755-9 resp. DIN EN 12020-2.

Customer-specific manufacturing according to DIN ISO 2768-mK.

Lower tolerances on request.

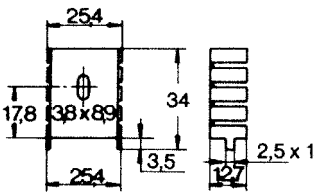
Stamped heat sinks



Thermal Resistance: 20 K/W

· SE (black anodized)
· VE (nickel-plated solderable)
· VZ (tin-plated solderable)

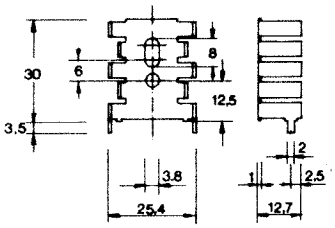
Part-No. KU 3-300
for Package TO 126 (SOT 32) · TO 220 · TO 218 (TO 3 P)

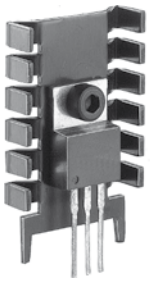


Thermal Resistance: 15 K/W

· SE (black anodized)
· VE (nickel-plated solderable)
· VZ (tin-plated solderable)

Part-No. KU 3-303
for Package TO 126 (SOT 32) · TO 220 · TO 218 (TO 3 P)

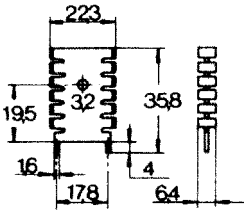




Thermal Resistance: 25 K/W

· SE (black anodized)
· VE (nickel-plated solderable)
· VZ (tin-plated solderable)

Part-No. KU 3-310
for Package TO 220

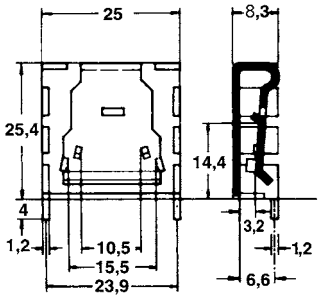


Thermal Resistance: 18 K/W

· SE (black anodized)
· VE (nickel-plated solderable)
· VZ (tin-plated solderable)

Material: Al Mg 3

Part-No. KU 3-333
for Package TO 220 · TO 218 (TO 3 P)

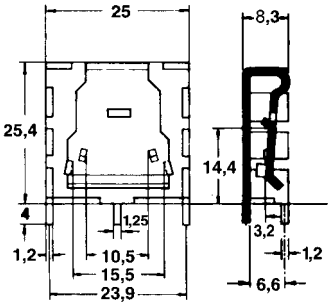


Thermal Resistance: 18 K/W

· SE (black anodized)
· VE (nickel-plated solderable)
· VZ (tin-plated solderable)

Material: Al Mg 3

Part-No. KU 3-333/3
for Package TO 220 · TO 218 (TO 3 P)

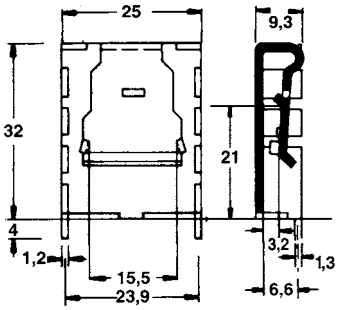


Thermal Resistance: 16 K/W

· SE (black anodized)
· VE (nickel-plated solderable)
· VZ (tin-plated solderable)

Material: Al Mg 3

Part-No. KU 3-334
for Package TO 220 · TO 218 (TO 3 P)

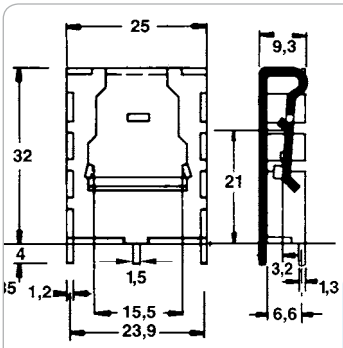


Thermal Resistance: 16 K/W

· SE (black anodized)
· VE (nickel-plated solderable)
· VZ (tin-plated solderable)

Material: Al Mg 3

Part-No. KU 3-334/3
for Package TO 218 (TO 3 P)

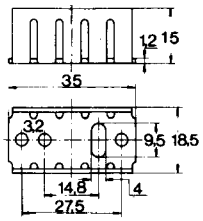


All heat sinks on this page also available with stop.

Composition of product code:
KU type/no. of legs/stop/surface
(e.g. KU 3-333/3/1/VE)

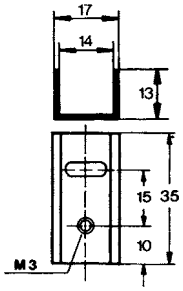
Stamped heat sinks

Thermal Resistance: 20 K/W
SE Black Anodized



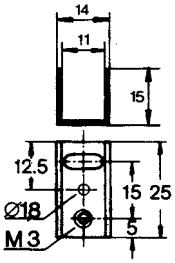
Part-No. KU 3-325
for Package TO 220 · TO 218 (TO 3 P)

Thermal Resistance: 25 K/W
SE Black Anodized



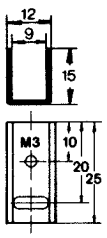
Part-No. KU 3-339
for Package TO 220

Thermal Resistance: 29 K/W
SE Black Anodized



Part-No. KU 3-340
for Package TO 220

Thermal Resistance: 30 K/W
SE Black Anodized

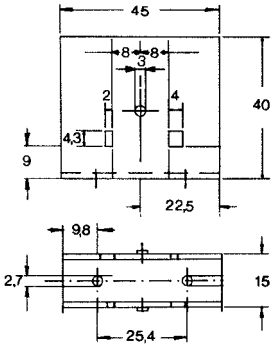


Part-No. KU 3-360
for Package TO 202 · SOT 32

Thermal Resistance: 6 K/W
SE Black Anodized

Part-No. KU 3-368
for Package TO 220

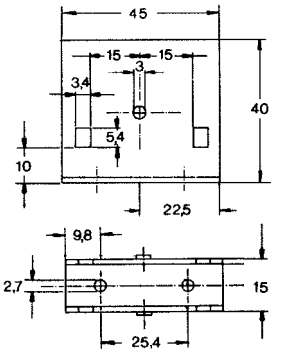
On request: with clip KU 3-388
with solder/screw pin KU-380/382



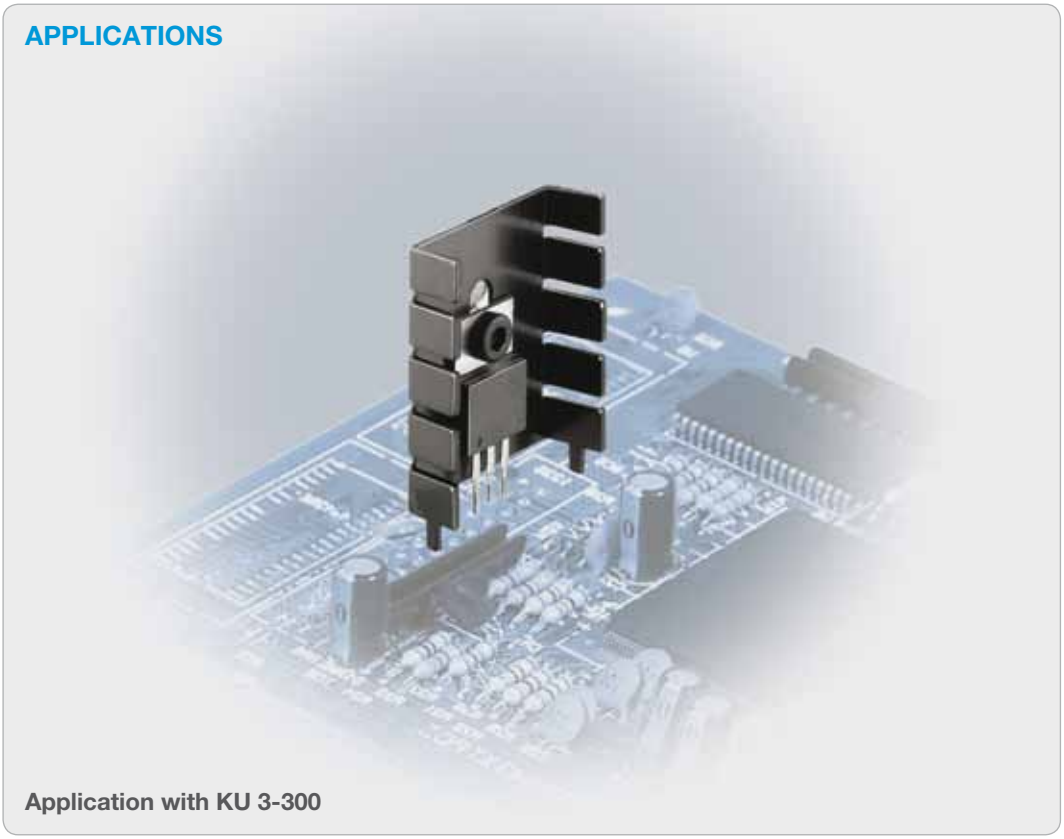
Thermal Resistance: 6 K/W
SE Black Anodized

Part-No. KU 3-369
for Package TO 218 (TO 3 P)

On request: with clip KU 3-392
with solder/screw pin KU-380/382



APPLICATIONS



Application with KU 3-300

Cooling plates

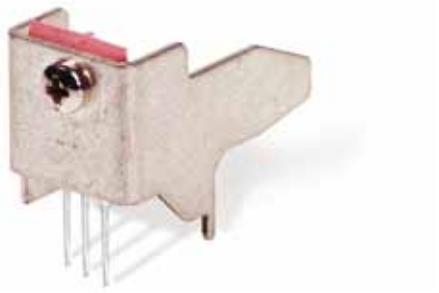
We at Kunze Folien produce a wide range of customized cooling plates and angled cooling plates, already with openings for mounting with our semiconductor clips / POWERCLIPS®, if required. AlMg3 is the most common material for these component parts, but copper, brass, etc. may also be used. Material gauges can be varied from 0.1 to several mm.

All technically possible surface finishes, e.g. anodized colours, are available on request.

Special cooling plates can be made on request (tool costs will be charged separately). Custom production is cost-efficient from quantities as low as 15,000 pieces.

We provide customer-specific, integrated solutions consisting of cooling plate, thermally conductive materials and semiconductor clip. Pre-assembly can also be carried out by us, if requested.

In case no standard transistor clip suits customer demands, special clips can be made in line with the specifications of the cooling plate.



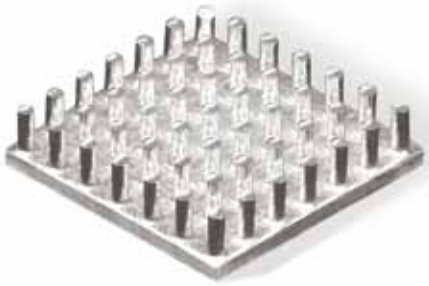
All dimensions in mm.

Special heat sinks

We make and tool a wide variety of cooling elements according to your specifications. All special heat sinks are available with preproduction and tool costs charged serarately. Custom production is cost-efficient at relatively small order volumes.

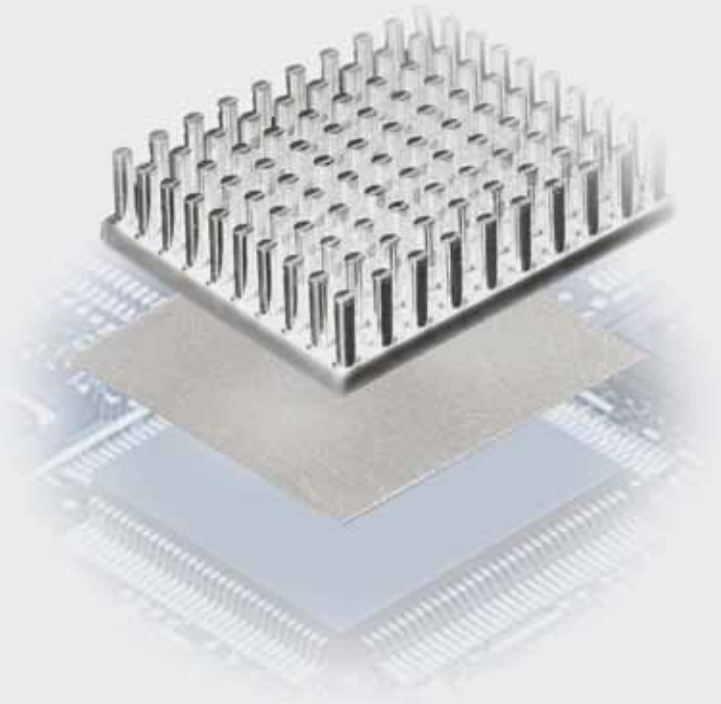
All technically possible surface finishes, e.g. anodized colours, are available on request.

We provide customer-specific, integrated solutions consisting of cooling plate, thermally conductive materials and semiconductor clip. Pre-assembly can also be carried out by us, if requested.



All dimensions in mm.

APPLICATIONS



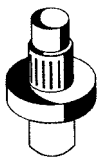
Application with special heat sink

Mounting examples
see page 146-147

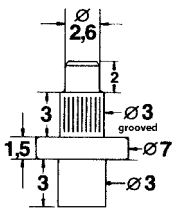
Fitting accessories

Kunze fitting accessories are the ideal complement to our heat sinks. The different products (among others) serve the purpose of firmly joining aluminium heat sinks to the conductor plate, be it by screw connection, soldering or clamping.

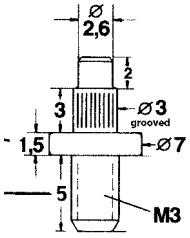
The fitting accessories are made from high quality materials such as brass, for example, and can be made with solderable surface finishes on request.



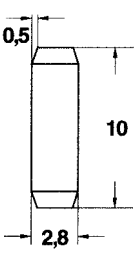
Part-No. KU 3-380/LP

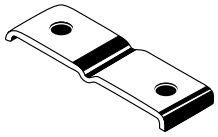


Part-No. KU 3-380/M3

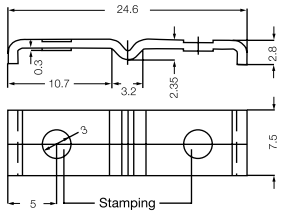


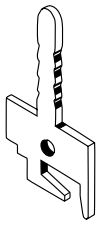
Part-No. KU 3-382



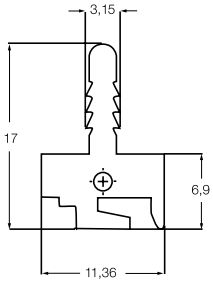


Part-No. KU 2-ZUB01-567
Centering element

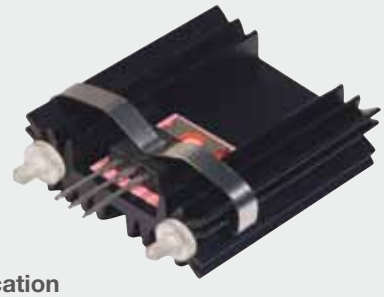




Part-No. KU 2-ZUB 38-1



APPLICATIONS

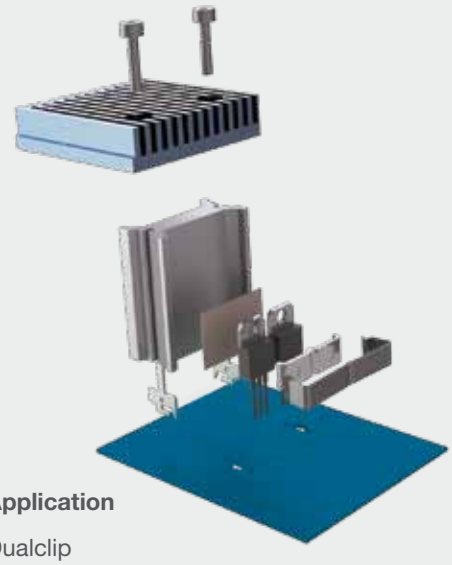


Application

Heat sink: KU 1-072

POWERCLIP®: KU 3-399

Mounting element: KU 3-380/LP



Application

Dualclip

Technical Information

OPTIMAL THERMAL MANAGEMENT OF POWER SEMICONDUCTORS

Increased power density and high quality standards call for optimal and process-reliable cooling solutions in power semiconductor modules. This article provides a practical overview of the options and possibilities regarding thermal management.

Waste heat is a crucial factor in power electronics. If it is not dissipated adequately, high temperatures lead to reduced component durability, or even to complete destruction of the module. In addition, every change in temperature causes mechanical strain in the component, especially where soldering or bonding connections are concerned.

Therefore, highly integrated power modules, which rapidly heat up during operation, need to be thermally linked to heat sinks for dissipation. Depending on application and power density, aluminium heat sinks, component casings, die-cast housings or copper sheets may be used to this end. Owing to their large surface, these cooling elements quickly spread waste heat and dissipate it by means of natural convection. This effect can be enhanced by the use of fan units, which may prove essential if space is limited. In this case, the fan‘s lifespan must, of course, be taken into consideration. In special high-performance applications, heat pipes or liquid coolers are employed despite the relatively high costs involved. In order to achieve maximum efficiency, however, all of the above options require optimal thermal linkage of semiconductor and heat sink.

There are three decisive factors opposed to optimal heat dissipation:

1. surface ruggedness
2. contact surface convexity/concavity
3. electric insulation (prerequisite in most applications)

Basics

Heat transfer away from the source (semiconductor junctions, for example) passes through several layers, consisting of different materials, before the heat is finally dissipated to the ambient air by means of natural or forced convection. Heat flow H (heat quantity Q transported per time unit) through any given layer at thermal equilibrium is commonly stated as the following equation:

A being the contact surface area, **dT/dx** the gradient of temperature over layer thickness, and **k** the specific thermal conductivity of the interface material.

$$H = \frac{dQ}{dt} = -kA \times \frac{dT}{dx}$$

In the case of a homogeneous material of constant gauge at thermal equilibrium, the equation may be simplified to:

$$H = kA \times \frac{T2 - T1}{d}$$

where temperature **T2** is greater than **T1**, and **d** is the layer thickness.

Specific thermal conductivity k is a material constant.

The higher the value of **k** at otherwise equivalent geometry, the better is thermal transfer.

Analogous to the formula for electric currents,

Copper:	390 W/mK
Aluminium (99%):	220 W/mK
Graphite:	169 W/mK
Steel:	45 W/mK
Air:	0,0026 W/mK

the above equation may alternatively be stated as:

R_{th} being thermal resistance. In relation to the

$$H = \frac{\Delta T}{R_{th}} \qquad H \times R_{th} = \Delta T$$

above equation, R_{th} can be expressed as:

$$R_{th} = \frac{d}{k \times A}$$

R_{th} is usually given in **°C/W**. Thermal resistance is thus dependent both on the material's measurements and its thermal conductivity. It is inversely proportional to contact surface area and thermal conductivity, and proportional to layer thickness. It is, therefore, alternatively stated as $R_{th\ material}$.

An additional influential factor in the thermal transfer between two contact surfaces is the thermal contact resistance $R_{th\ contact}$. In reality, surfaces are always rugged to some extent. The larger the surface, the more irregularities (convex, concave, or undulating) diminish the area of contact. In the case of small surfaces – e.g. TO-220 housings –, of course, this problem can be neglected.

As the thermal conductivity of air is very low (0.0026 W/mK), air gaps impair thermal transfer. The heat path is thus limited to actual points of contact between the contact surfaces.

In short, thermal contact resistance depends on surface area, surface quality, evenness, the adaptability of the interface material, and the pressure applied.

Conclusion:
Total thermal transfer resistance is, therefore, the sum of the thermal resistance of the interface materials and thermal contact resistance.

In practice, contact surface area is determined by the dimensions of the component casings.

$$R_{th\ total} = R_{th\ material} + R_{th\ contact}$$

If an application requires electric insulation, the thermally conductive layer must be of a certain minimum thickness. If this is not provided, the layer will be unable to compensate surface irregularities or burrs.

The larger the surfaces involved, the more their convexity / concavity must be taken into account. Both cause the formation of more or less large air gaps which lead to considerably increased thermal transfer resistance. This, in turn, leads to inferior heat dissipation, overheating and, potentially, to complete failure of the component.

MEASURES TO REDUCE THERMAL TRANSFER RESISTANCE

If larger surfaces are concerned, as in the case of IGBTs (**I**nsulated **G**ate **B**ipolar **T**ransistor), contact surfaces are polished to compensate for convexity / concavity and to allow for optimal contact to the heat sink, as the conventional methods of dissipation cannot bridge major gaps without increasing costs.

In the past, thermally conductive paste was the most common option for cooling power semiconductors, combined with mica to provide electric insulation. If no electric insulation is required, making the mica unnecessary, and proper application provided, this solution makes for good thermal linkage. Even today, thermally conductive pastes are in use, despite the obvious disadvantages:

- difficult and time-consuming application
- low process reliability, depending on application method
- thermally conductive pastes can leak or dry out
- if all production factors are considered, pastes are often more expensive than modern alternatives
- limited storage due to temperature sensitivity and finite lifespan

A solution to these problems was brought about by the invention of so-called phase-change materials, which allow for thermal linkage of surfaces equivalent or superior to the results achieved with pastes – without the disadvantages of these (as mentioned above).

Technical Information

Phase-change materials Crayotherm®

These materials consist of a special, thermally conductive wax mixture which changes its state at 50°-60°C from solid to soft. In doing so, it expands by ca. 15-20 per cent, wetting out all inevitable surface irregularities and expelling undesired pockets of air. This makes for excellent thermal linkage. When temperatures fall below phase-change, the material returns to its solid state, but thermal contact remains the same. This technology, as a rule, allows for lowest possible thermal transfer resistances.

For mechanical stabilization, phase-change materials may be applied onto electrically insulating substrate carriers, e.g. polyimides or other plastics, depending on specifications. If no electric insulation is required, metal foils (e.g. aluminium) can be used to the same end.

Phase-change materials guarantee constant layer thickness, quick and clean handling, and superior process reliability.

Elastomers

In the 1980s, thermally conductive **Elastomers** were introduced as an alternative to the paste/mica combination. The most common elastomer is silicone rubber. Beside high dielectric strength and good chemical stability, this material possesses high temperature resistance.

For thermal conductivity (combined with the material's naturally high dielectric strength), a variety of ceramics may be added to the silicone, such as silica, Al_2O_3, aluminium- or boron nitride. A high percentage of ceramics added leads to better thermal conductivity of the material – but also increases its hardness.

Silicone is highly electrically insulating, resistant to ageing, very soft and malleable. It has a tendency to slight outgassing which is undesireable in some applications. Owing to its softness, it is relatively easy to process, allowing for the manufacturing even of complex geometries.
The range of these films possesses a maximum thermal conductivity from 1 to 6 W/mK. They are available in gauges from 0.1 up to 10 mm.
For increased mechanical stability, they can be applied onto fiberglass mats or other substrate carriers. To facilitate handling, these materials are also available adhesive on one or on both sides. Materials thicker than 0.5 mm are mostly used as gap fillers, as their soft texture makes for excellent compensation of tolerances and surface irregularities. Their compression rate, depending on material hardness and filling ratio, is 40 per cent at most. The right choice of contact pressure, therefore, will result in minimum thermal transfer resistance.

Thermally conductive silicone may be applied as a one- or two-component plastic compound. This requires adequate devices for application to ensure constant, process-reliable layer thickness for electric insulation. Thermally conductive silicone is also available in the form of caps and tubes.

Silicone-free thermally conductive materials

In applications which exclude the use of silicone (e.g. certain optical applications), silicone-free acrylic films are employed. The thermal conductivity obtainable by their use is around 1.5 W/mK at most. Acrylic possesses high dielectric strength and is temperature resistant up to 120°C.

With regards to processing, acrylic films are as versatile as silicone.

Technical ceramics

Ceramic insulating discs are usually made from aluminium oxide or aluminium nitride. Their thermal conductivity and dielectric strength are outstanding. Typically, they come in gauges ranging from 0.5 mm to several millimetres. They boast excellent temperature resistance. These discs, however, need to be coated with thermally conductive wax or paste, as their hard and rugged surface alone allows but for poor heat flow. They are also relatively brittle, their hardness making them susceptible to breaking.

Pure ceramics up to ca. 3 mm can be processed with cutting machines. Thicker layers are more difficult to process as they require the implementation of costly special tools, which only makes sense for large quantities.

Graphite materials

Pure **Graphite** possesses outstanding thermal conductivity and high temperature resistance up to 450°C, or even 650°C in the case of high-performance carbon.

Graphite films are ideal for dissipation at hot spots because their thermal conductivity is anisotropic. In-plane (x-y-direction), it is up to 170 W/mK; through-plane (z-direction) up to 12 W/mK.

Superior surface quality is prerequisite for optimal heat flow. For quick and simple handling, carbon films are available with one-sided adhesive coating. This coating, however, raises thermal transfer resistance. Graphite is not electrically insulating. It is available in a variety of gauges – all forms and shapes technically possible can be manufactured at low cost.

Plastic films

Polyimide, polyester, polycarbonate, polypropylene, aramide paper etc. are preferably used for electric insulation in component parts. They boast outstanding dielectric strength and very low to zero flammability*. These materials are both mechanically tough and flexible.

Polyimide films can also be used as interface materials. Despite their relatively low thermal conductivity, they provide good heat flow if applied in thin layers of 25-125 µm. In this case, however, excellent surface finish is essential as the firm structure of the film does not allow it to compensate any irregularities. Their stability makes them ideal substrate carriers for coating with thermally conductive silicone or phase-change wax.

Concluding remarks

Choosing the ideal interface material can be facilitated by in-advance calculation and thermal simulation. Through these, costs can be reduced in the development of power electronics, and thermal problems solved far more efficiently. However, calculations and simulations are only able to provide general directions; by no means they are a substitute for final testing of the application in practice (in which an IR camera may be helpful).

* Flammability rating:
UL 94 VO / UL 94 VTM
Underwriter Labatories

THERMAL MANAGEMENT: AN IMPORTANT ISSUE NOW AND IN THE FUTURE

Thermal management will continue to play an important role in power electronics. Especially many cutting-edge technologies make high demands with regards to component cooling. Growing power density and, simultaneously, ever smaller dimensions of the applications call for increasingly specific thermal solutions.

In a wide range of technologies, e.g. photovoltaics, fuel cells, high power LEDs, electric vehicles, ultracaps and power control units, thermally conductive materials are essential. Other areas of application are to come.

Technical Information

Conversion table

	SI unit	Industry unit	Physical unit	British unit
THERMAL CONDUCTIVITY	**W/m°K**	**kcal/mh°C**	**cal/cm · s°C**	**BTU/ft · h · °F**
SI unit	1	0.85985	0.00239	0.5778
Industry unit	1.163	1	0.00278	0.672
Physical unit	4.1686	360	1	241.9
British unit	1.73070	1.48810	0.00413	1
THERMAL RESISTANCE	**°C/W**	**°Ch/kcal**	**°Cs/cal**	**°F · h/BTU**
SI unit	1	1.163	4.1868	0.293
Industry unit	0.85985	1	3.6	0.252
Physical unit	0.23885	0.27778	1	0.0633
British unit	3.4129	3.96825	14.30615	1

Manufacturing tolerances

All products are manufactured in compliance with DIN ISO 2768-mK regulations. We reserve the right to make changes with regards to material and/or processing.

Determination of electrical, thermal and mechanical properties

Electric insulation provided by the interface materials depends on their dielectric strength. The higher the breakdown voltage, the better the material's insulating qualities.

Determination of dielectric breakdown strength

Voltage ramp:

A test sample is inserted between two electrodes (25 mm diameter) and immersed in insulating oil. An alternating current is applied (beginning at 1000 V), and the voltage is steadily increased at a rate of 1 kV/sec. The minimum voltage required to cause dielectric breakdown is measured, and this is considered the dielectric breakdown voltage. The dielectric breakdown voltage of a test sample sheet (thickness: 1.0 $^{+0.2 \text{ to } -0.1}$ mm) was measured, and this value divided by the thickness of the sample is considered the dielectric breakdown strength.
Measured in accordance with JIS K 6249.

Voltage step:

A test sample is inserted between two electrodes (25 mm diameter) and immersed in insulating oil. A alternating current is applied with constant 1000 V for 20 seconds to test dielectric breakdown of the test sample. Voltage is increased in stages of 1 kV/sec., and the maximum voltage before dielectric breakdown is measured. This value is considered the dielectric strength.
Measured in accordance with JIS C 2110.

Determination of electrical properties is undertaken in compliance with international standards (DIN, IEC, ASTM, etc.)

Determination of thermal properties is carried out according to ISO 22007-2.

Our measuring system for thermal conductivity has been developed and built in close collaboration with the manufacturer to suit the specific

demands and requirements of thermal interface materials. It is able to measure the thermal conductivity of a wide range of materials (solids, pastes, foils and films from 10 to 2000 µm). The different measuring modules determine through-plane conductivity, in-plane conductivity (anisotropic), or the combination of both. In addition, the measuring system is able to evaluate the specific thermal capacity of the materials to be measured.

Measurements can be carried out under pressure of up to 1kN. Measurements of phase-change materials are carried out at phase-change temperature (up to 70°C).

State-of-the-art equipment and measuring devices – such as **hardness testing devices** and **force-distance measuring tools** – enable us to determine elasticity, tensile strength, resilience, hardness and stress.

Hardness testing devices are used for measuring soft plastics and elastomers, in accordance with norms DIN 53505, ASTM-D2240 and ISO 27588 (Shore A, Shore 00 and VLRH [**V**ery **L**ow **R**ubber **H**ardness] for extremely soft materials), and for determining resilience (hysteresis) in soft plastics.

Force-distance measuring equipment is employed to evaluate bending force and tensile strength of transistor clips and spring elements, as well as the puncture strength of a wide range of materials.

Compressive strength, tensile and tear strength measurements are also carried out and their results analyzed with regards to their force-distance ratio.

This equipment, in combination with mechanical simulation, e.g. allows for the precise design of spring elements.

Forms of delivery

Our products are available in a variety of forms for standard semiconductor builds. Additionally, most products can be manufactured according to customer specifications, using state-of-the-art production methods and technologies, and delivered as stamped, cut or folded parts.

Available
- in roll form
- in sheet form / mats
- as bulk goods
- customized cuts and special shapes

Storage conditions

All our products without adhesive coating can be stored for an indefinite period of time, adequate storage in the original package and under normal conditions (room temperature 18 - 22°C, relative humidity 50 - 70%, no direct exposure to sunlight) provided.

Limited durability applies for adhesive tapes and films with adhesive coating.

PICTURE CREDITS

Image “Solar inverter” (page 12 left): SMA Solar Technology AG

Notes

This catalogue has been presented to you by:

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