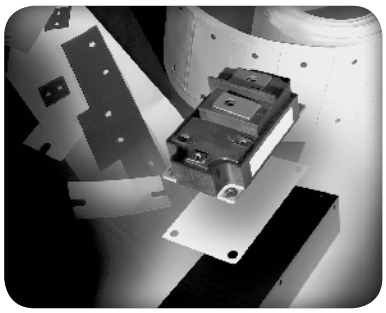
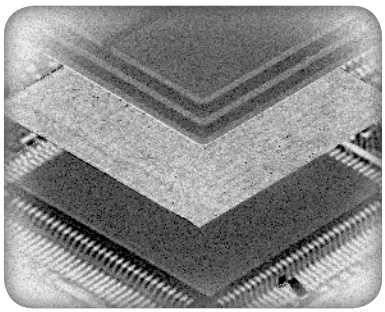
05

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.



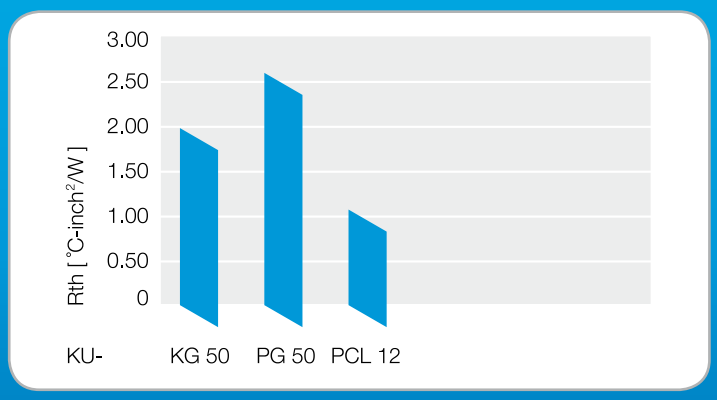


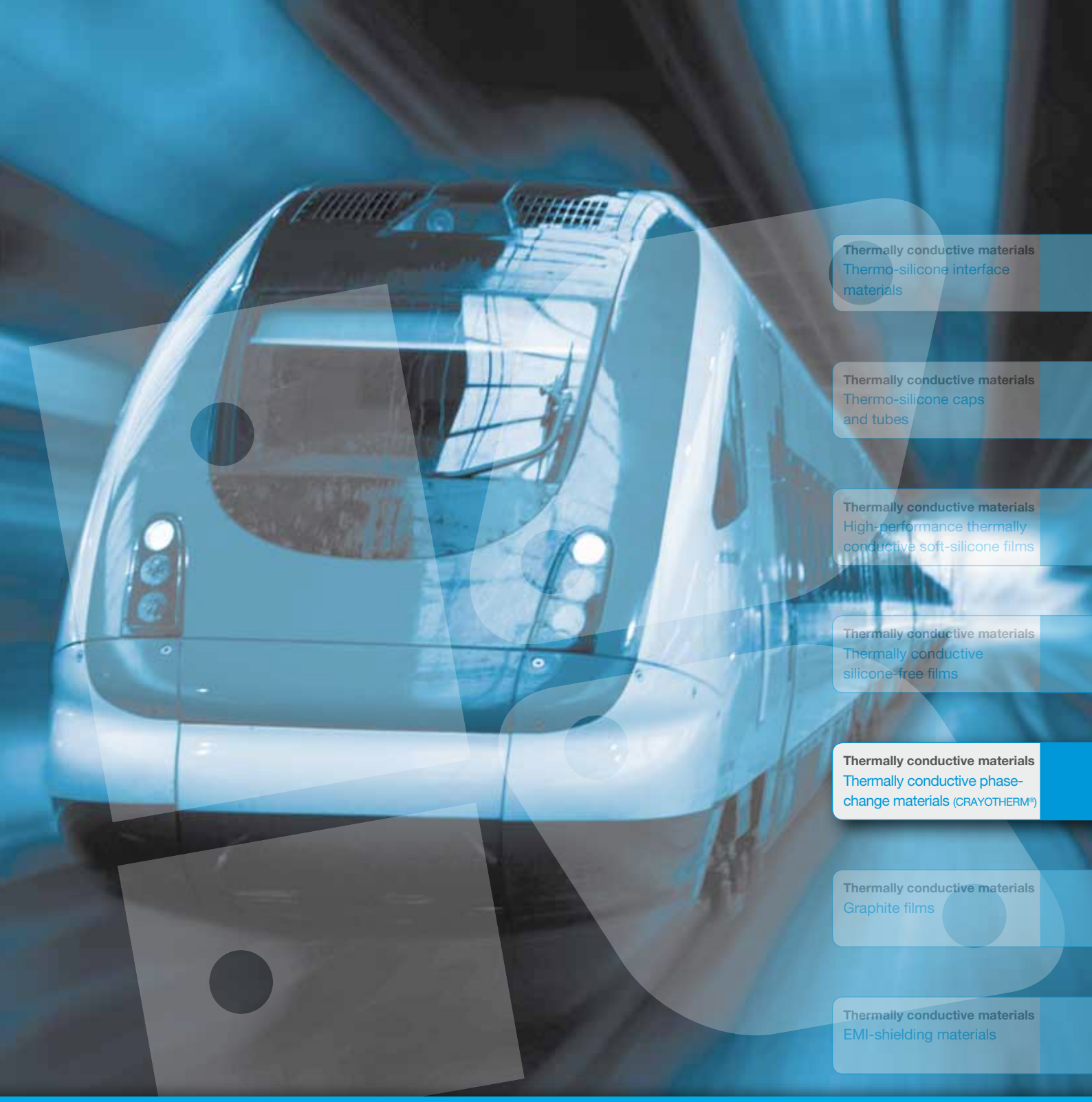
APPLICATION EXAMPLES

Thermal linkage of heat sources and heat sinks in

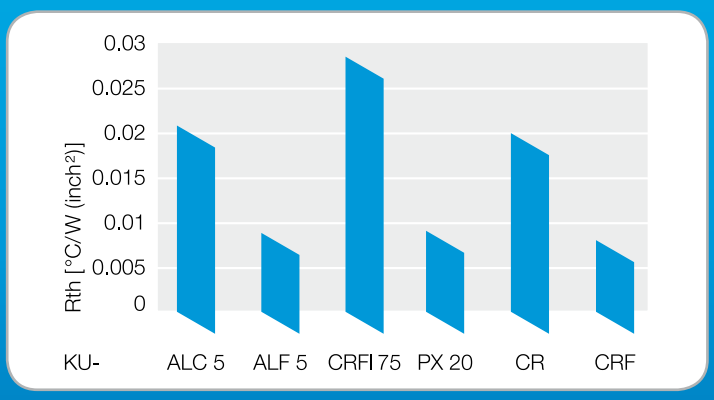
- Active heat sources and heat sinks, replacing thermal grease
- Electrically insulated multichip modules
- Microprocessors, ASICs
- Power modules in power supplies
- UPS
- IGBTs
- CPU modules
- Diodes
- RF components

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

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

We reserve the right to make technical changes without notice.

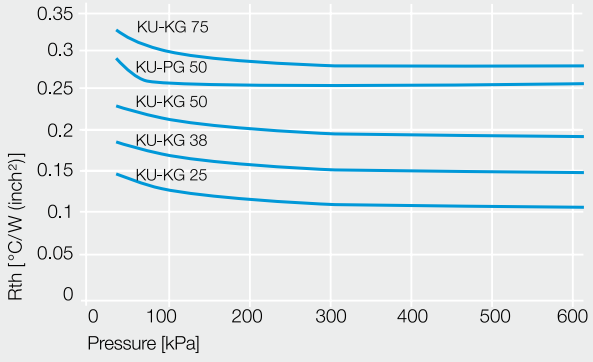
Configurations and dimensions on page 87

PRODUCT AVAILABILITY

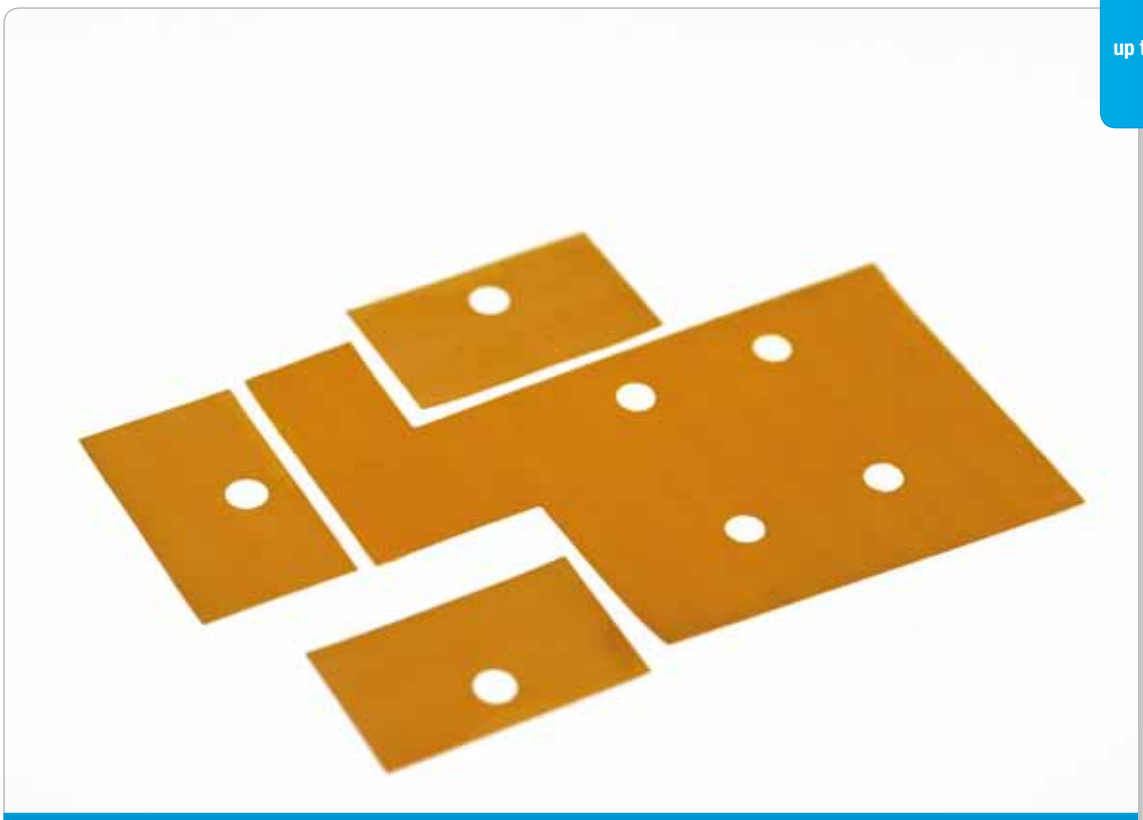
- All standard configurations (see page 87)
- Non-adhesive or adhesive on one side or with adhesive strips on the edges (S)
- In roll form according to customer specifications
- Customer-specific cuts and forms

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.

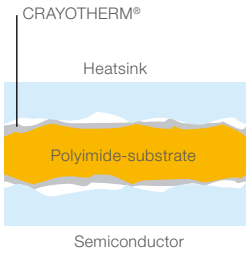
PRODUCT AVAILABILITY

- On rolls or as sheets

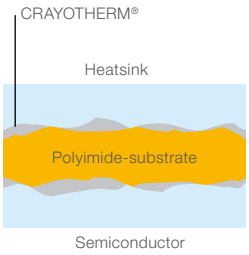
THERMAL CONDUCTIVITY
(W/m·°K)
up to **0.45**
electrically insulating

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

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

We reserve the right to make technical changes without notice.

[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

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

We reserve the right to make technical changes without notice.

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

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

We reserve the right to make technical changes without notice.

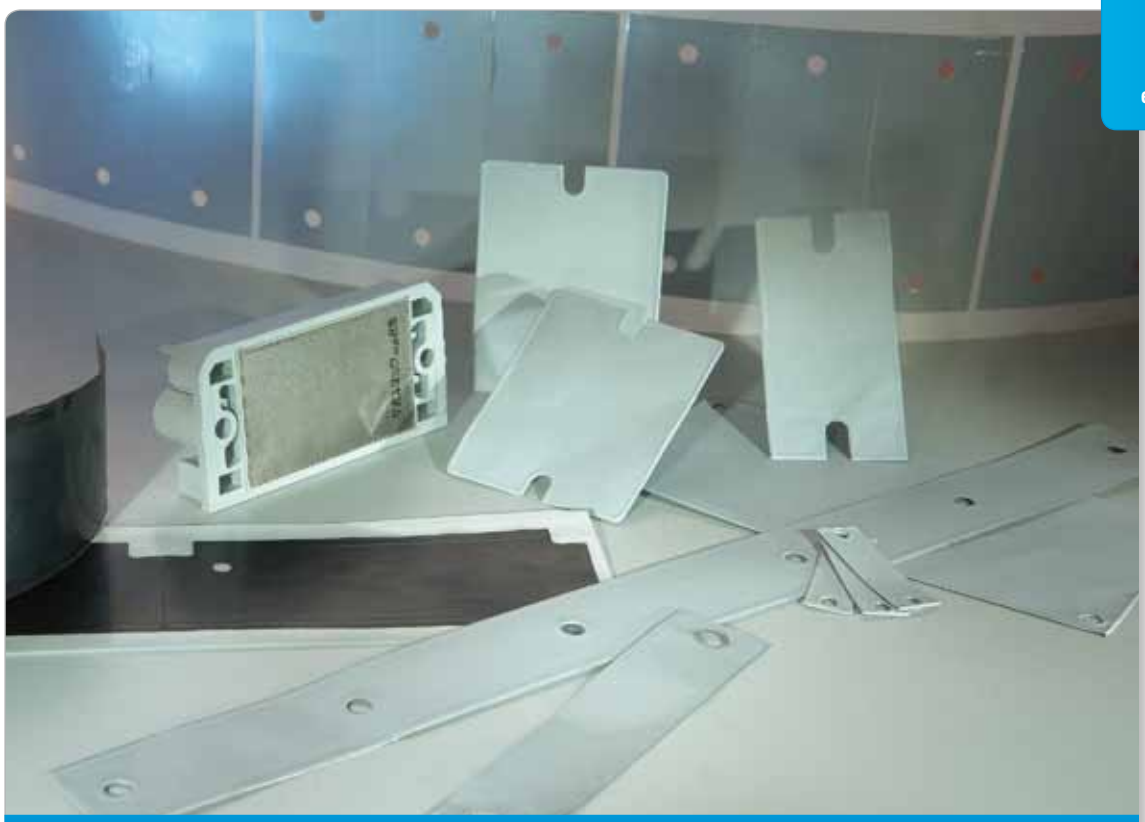
PART	KU-	ALC 5	ALF 5
GENERAL PROPERTIES			
Material	Body	Phase-change – Aluminium – Phase-change	
Phase-change material [1]		CRAYOTHERM®	CRAYOTHERM®/Graphite
Colour		Light grey	Black
Material gauge without coating	µm	51	51
Total gauge	µm	76	76
THERMAL PROPERTIES			
Thermal conductivity (aluminium substrate)	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

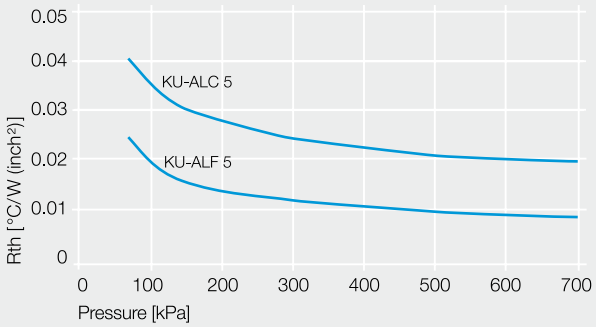
ON REQUEST

- 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

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

We reserve the right to make technical changes without notice.

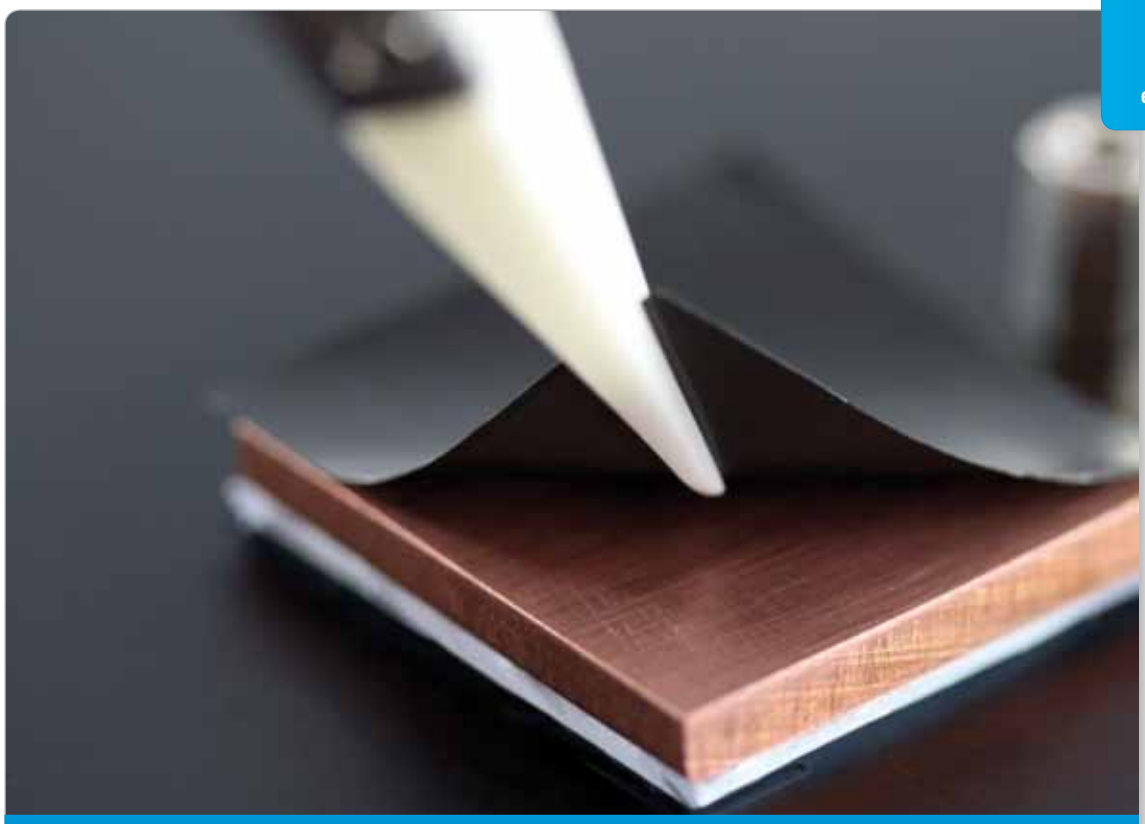
Configurations and dimensions on page 87

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.

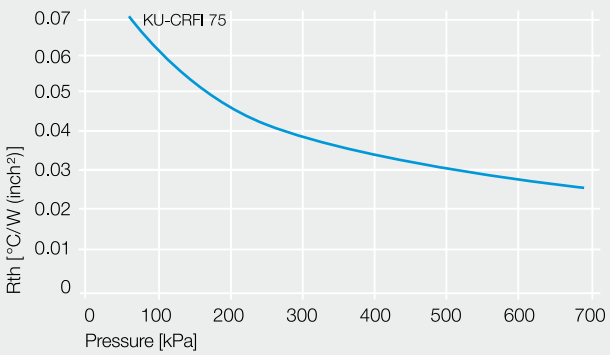
Thermally conductive materials
Thermally conductive phase-change materials (CRAYOTHERM®)

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

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

We reserve the right to make technical changes without notice.

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.

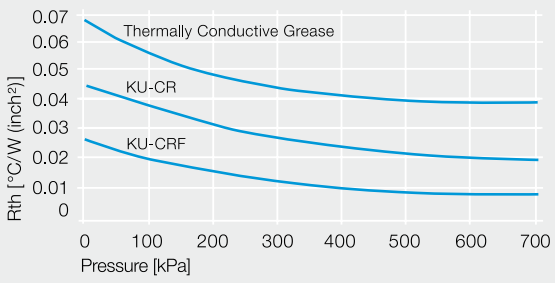
Thermally conductive materials
Thermally conductive phase-change materials (CRAYOTHERM®)

CONFIGURATIONS AND DIMENSIONS

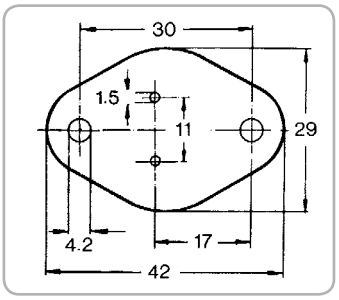
Part	Stick length	Width	Depth	Total Length
KU-CR-MINI	52 mm	10 mm	10 mm	127 mm
KU-CRF-MINI	52 mm	10 mm	10 mm	127 mm
KU-CR-125	46 mm	33 mm	13 mm	103 mm
KU-CRF-125	46 mm	33 mm	13 mm	103 mm

PRESSURE DEPENDENCE

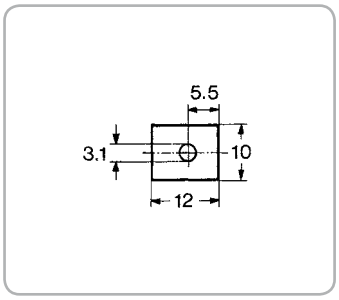
Thermal resistance of CRAYOTHERM® and thermally conductive paste vs. mounting pressure



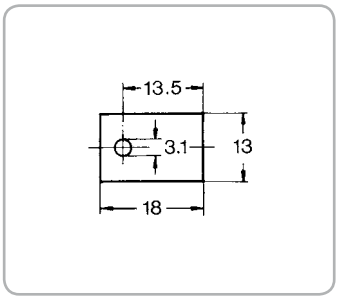
Standard configurations and dimensions: Films



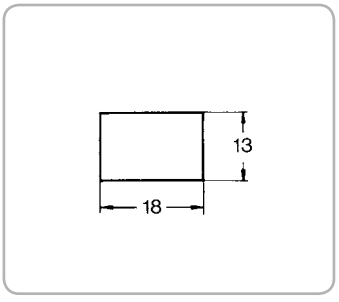
Part-No.: **KU 6-619**
TO-3



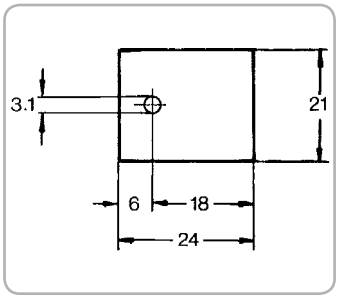
Part-No.: **KU 6-620**
TO-126 · SOT-32



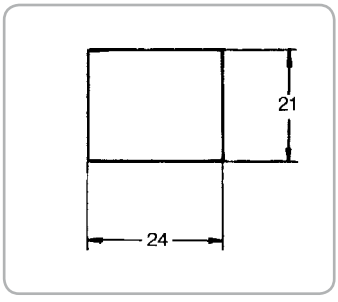
Part-No.: **KU 6-623**
TO-220



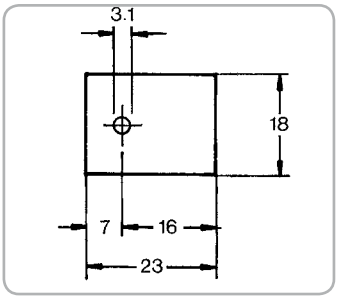
Part-No.: **KU 6-623/0**
TO-220



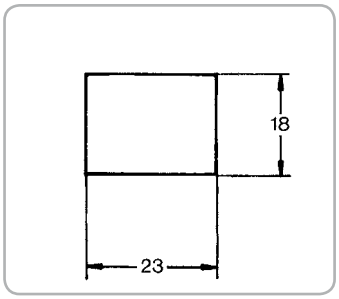
Part-No.: **KU 6-624**
TO-3P · TO-218/247/248 · MT 100



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**
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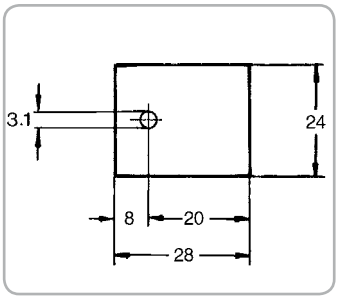
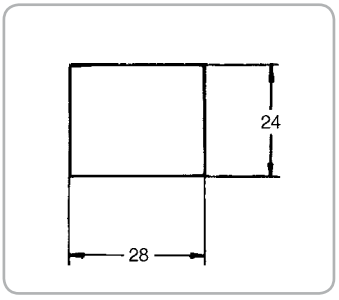
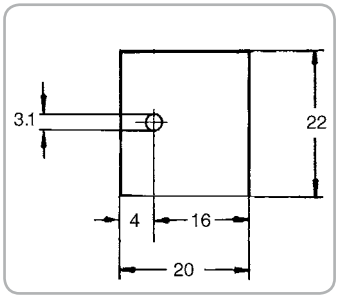


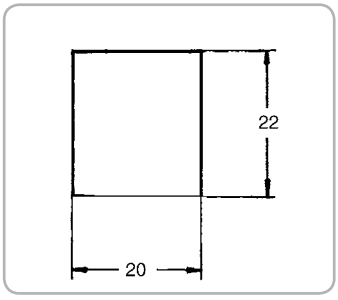
Part-No.: **KU 6-630**
TO-3PL · TO-264



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



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



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

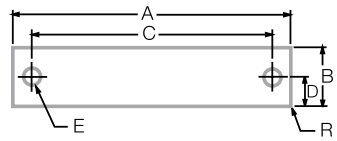
We disclaim all liability for the correctness of the information contained herein.

We reserve the right to make technical changes without notice.

All dimensions in mm.

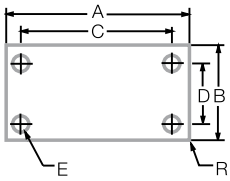
Standard configurations and dimensions: Phase-change materials

Schottky, SCR, Darlington Module



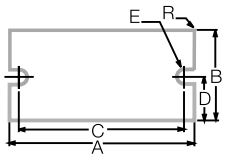
PART-NO.	A	B	C	D	E
KU-ALC 5/244-102	62.0	25.9	52.0	13.0	4.4
KU-ALC 5/354-154	90.0	39.1	76.0	19.5	5.5
KU-ALC 5/364-081	92.5	20.3	80.0	10.2	6.8
KU-ALC 5/370-134	94.0	34.0	80.0	17.0	6.8
KU-ALC 5/425-134	108.0	34.0	93.0	17.0	6.8
KU-ALC 5/480-150	122.0	38.1	110.0	19.0	5.5

SCR, Darlington Module



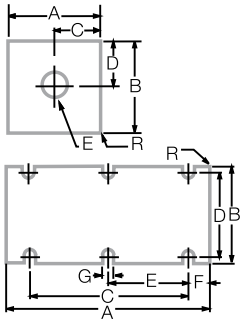
PART-NO.	A	B	C	D	E
KU-ALC 5/366-197	93.0	50.0	80.0	38.1	6.0
KU-ALC 5/370-339	94.0	86.1	80.0	73.9	5.6
KU-ALC 5/374-244	95.0	62.0	80.0	48.0	6.0
KU-ALC 5/386-252	98.0	64.0	63.0	52.1	6.0
KU-ALC 5/402-358	102.1	91.0	80.0	73.9	6.0
KU-ALC 5/425-244	108.0	62.0	93.0	48.0	6.4
KU-ALC 5/445-354	113.0	90.0	93.0	70.1	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



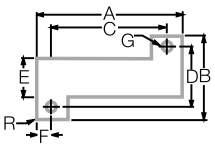
PART-NO.	A	B	C	D	E
KU-ALC 5/220-064	55.9	16.3	48.3	8.1	4.0
KU-ALC 5/225-175	57.2	44.5	47.5	22.3	4.4
KU-ALC 5/250-125	63.5	31.8	48.3	16.0	5.2
KU-ALC 5/276-106	70.1	27.0	60.0	13.5	5.6
KU-ALC 5/315-114	80.0	29.0	68.0	14.5	6.4
KU-ALC 5/315-157	80.0	39.9	66.0	20.1	6.4
KU-ALC 5/346-154	87.9	39.1	76.0	20.0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