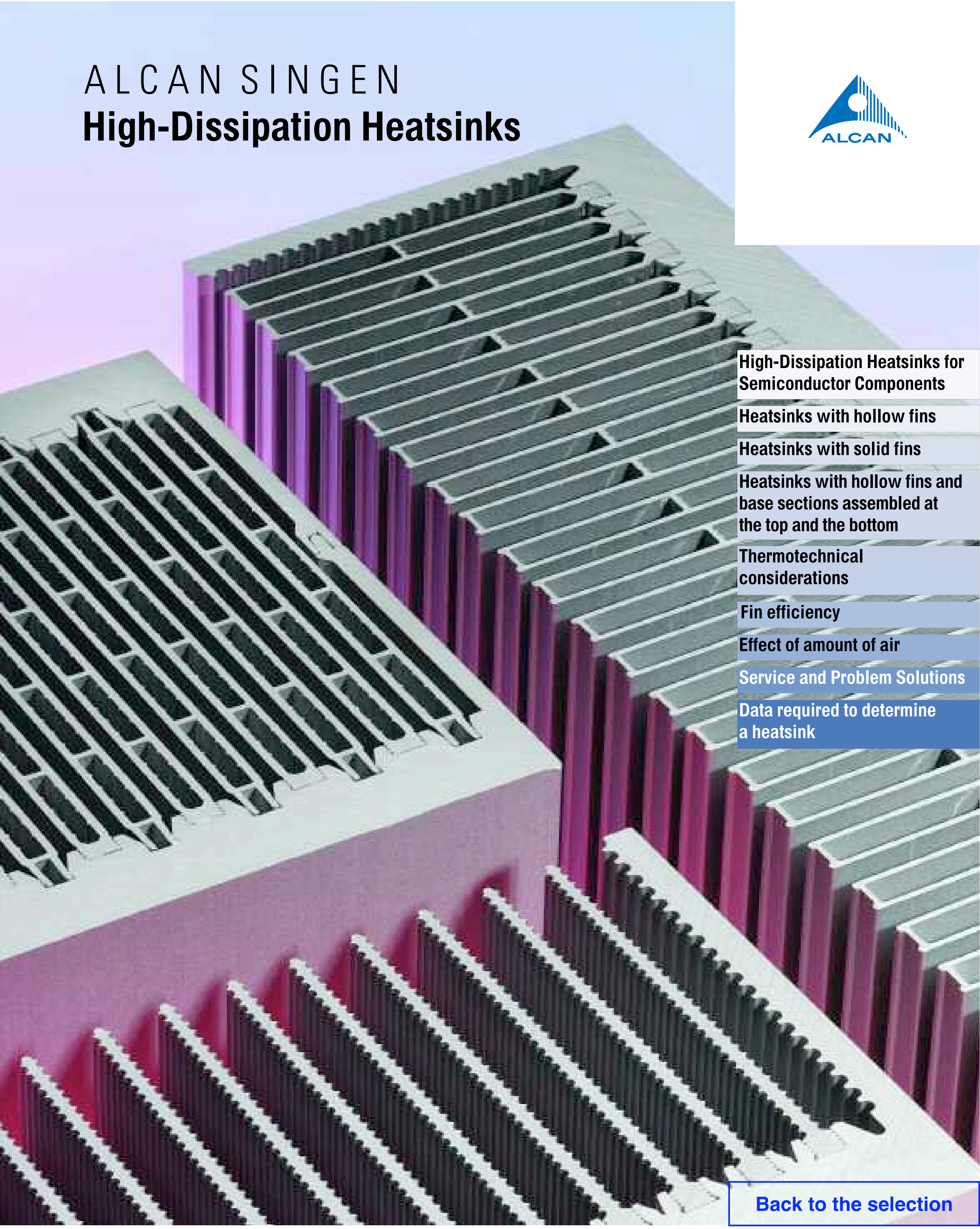
ALCAN SINGEN

High-Dissipation Heatsinks

ALCAN



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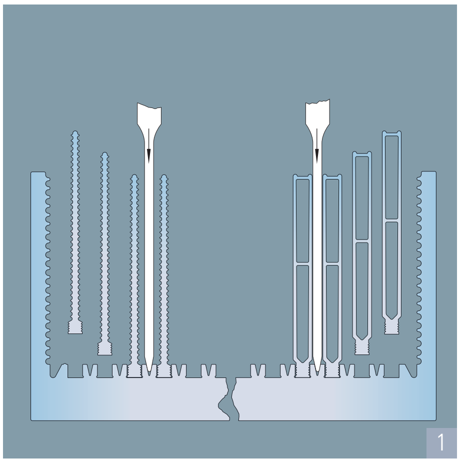
High-Dissipation Heatsinks for Semiconductor Components

There is probably no need to mention that the efficiency of semiconductor components has drastically increased, particularly over the last decade. The result of this rapid development is a large quantity of thermal loss to be dissipated from a semiconductor module or its baseplate, that is smaller in size. The resulting energy density may be as high as 10 Ws/cm^2 even exceeding the energy density of a hot plate on a cooker. This has of course an influence on the configuration of the heatsink or the positioning of the semiconductors.

The efficiency of a heatsink is largely determined by its surface area so that a great number of fins with small spacing is desirable. Conventionally extruded heatsinks are inadequate to meet this requirement. Alcan Singen has therefore developed various patented shapes and manufacturing techniques for heatsinks over the past 20 years that fulfill the demand of a maximum surface area.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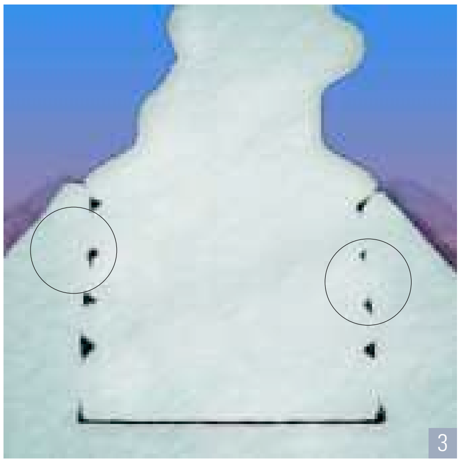
Characteristic Features

The distinctive feature of Alcan Singen's high-dissipation heatsinks is that the baseplate and the fins are extruded separately and then assembled mechanically by means of a special tool (Fig 1 and 2).

Using a modified technology that allows for a clear fin spacing of 2.5 mm, partial cold pressure welding joints are achieved in addition to the mechanical bond (Fig 3).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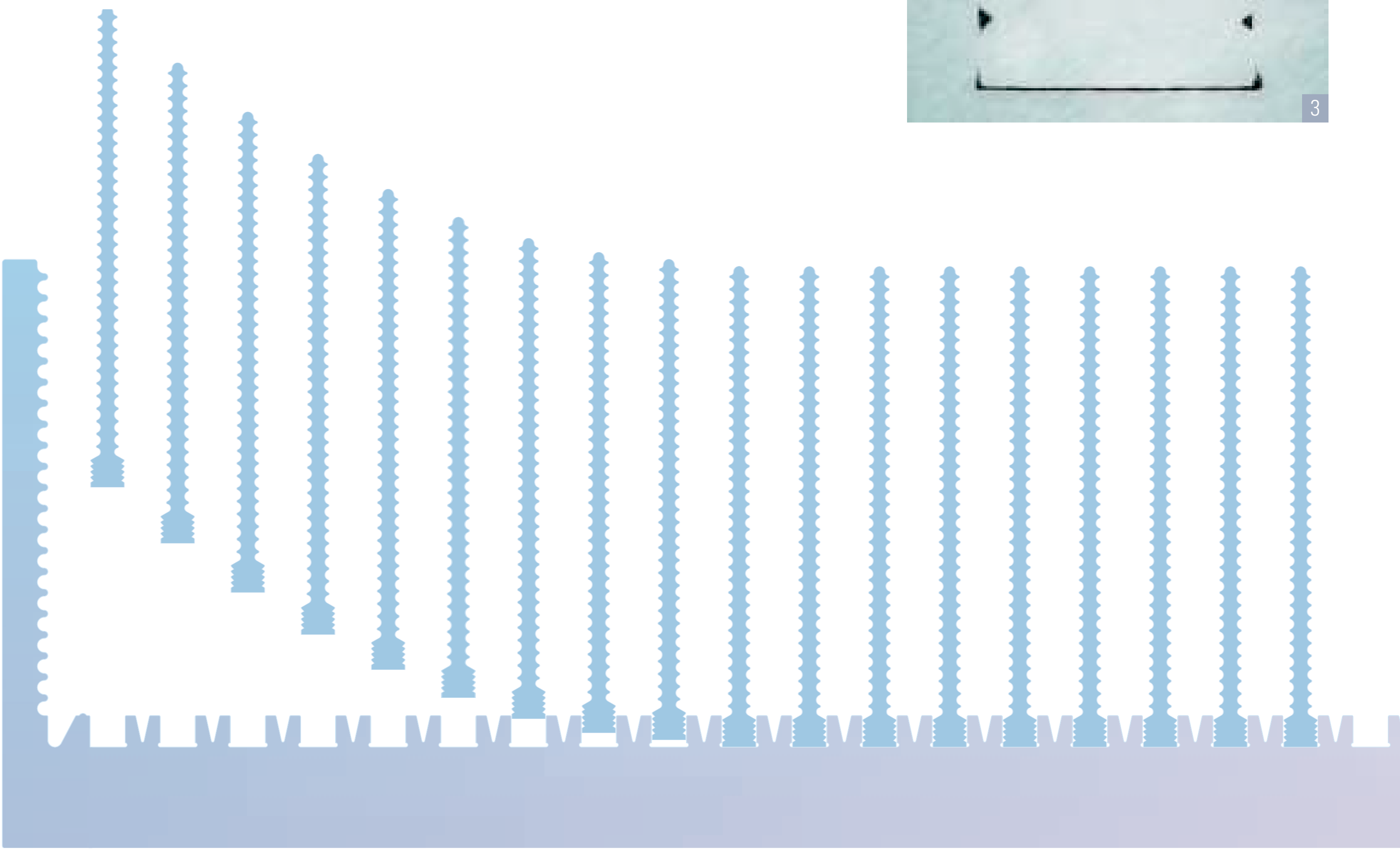


Alcan Singen's high-dissipation heatsinks manufactured to the new technology, offer substantial technical and economic advantages as a result of the following features:

- High cooling performance due to the very large surface area of the fins and small spacing between the fins
- Favourable weight/performance ratio
- Low die costs
- Numerous possibilities to adapt the system to each use
- Many variations can be achieved by combining different base and fin sections.
- Partial assembly of base section is possible across the width and the length

In addition to the standard program, Alcan Singen high-dissipation heatsinks can be manufactured on the existing equipment within the following range of dimensions:

Height of heatsink:	max.	180 mm
Height of fin:	max.	150 mm
Base section:		
width including outer fins	max.	750 mm
width excluding outer fins	max.	800 mm
thickness of baseplate	min.	8 mm
	max.	40 mm

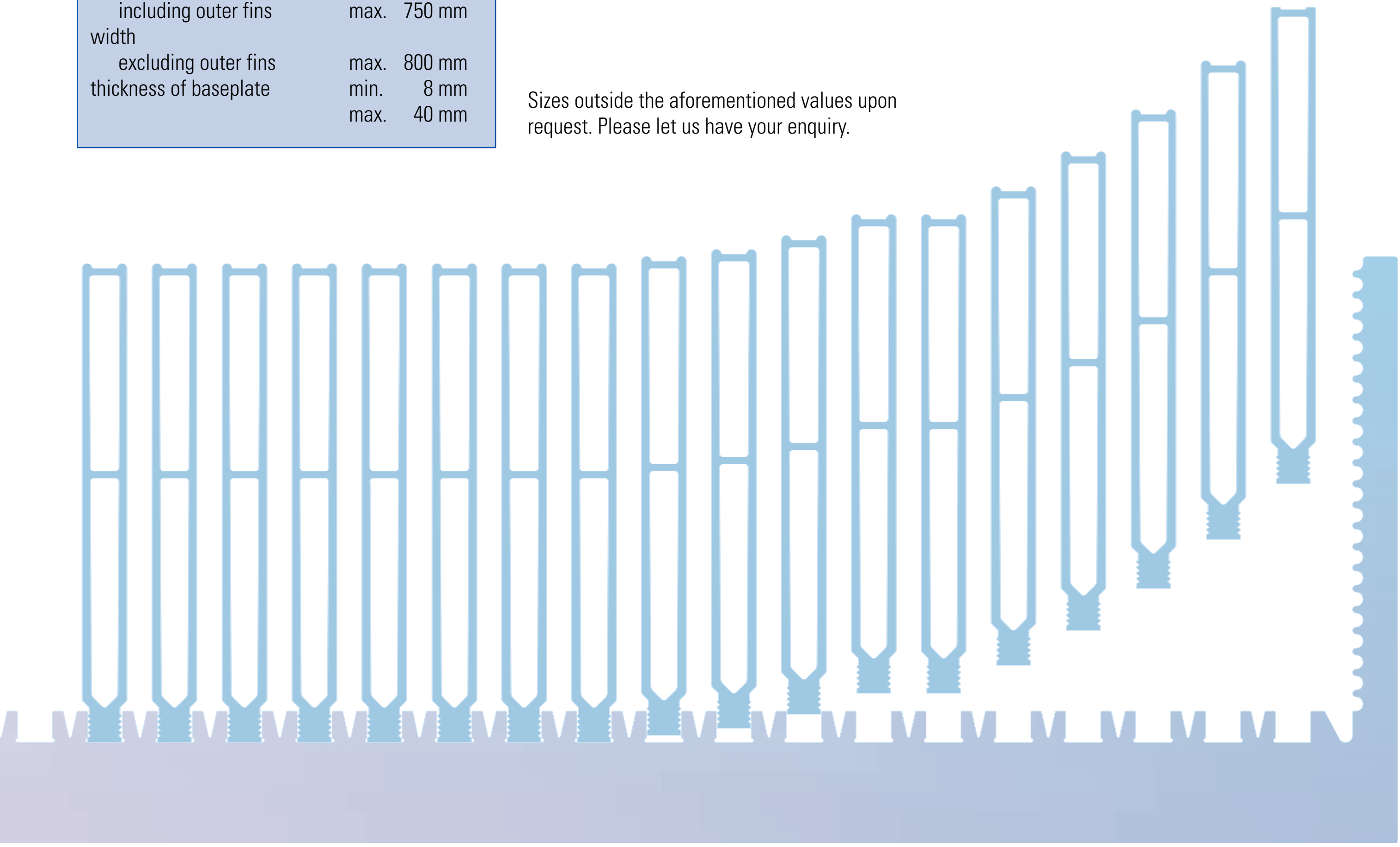
Alloys

ANTICORODAL-045-* temper: 61 (heat-treated)
Pure aluminium 99.5 E*

Properties			**Anticorodal-045**	**Pure aluminium 99.5E**
Tensile strength	R_m	min.	200 N/mm^2	65 N/mm^2
0,2-Proof stress	$Rp_{0,2}$	min.	150 N/mm^2	25 N/mm^2
Elongation	A_5	min.	12%	25%
Brinell hardness	HB		75 (standard value)	20 (standard value)
Module of elasticity	E		70 kN/mm^2	65 kN/mm^2
Elektrical conductivity at 20°C		min.	30 m/ mm^2	35.4 m/ mm^2
Thermal conductivity		min.	2 W/cmK	2.3 W/cmK
Coefficient of linear thermal expansation			0.0000234 1/K	0.0000235 1/K
Designation according to EN 573-3			EN AW-6101B	EN AW-1050A
Designation according to DIN 1712-3 resp. DIN 1725-1			E-AlMgSi0.5	Al99.5

*) E-AlMgSi0.5 or. E-Al99.5 resp. to DIN 40501

Sizes outside the aforementioned values upon request. Please let us have your enquiry.



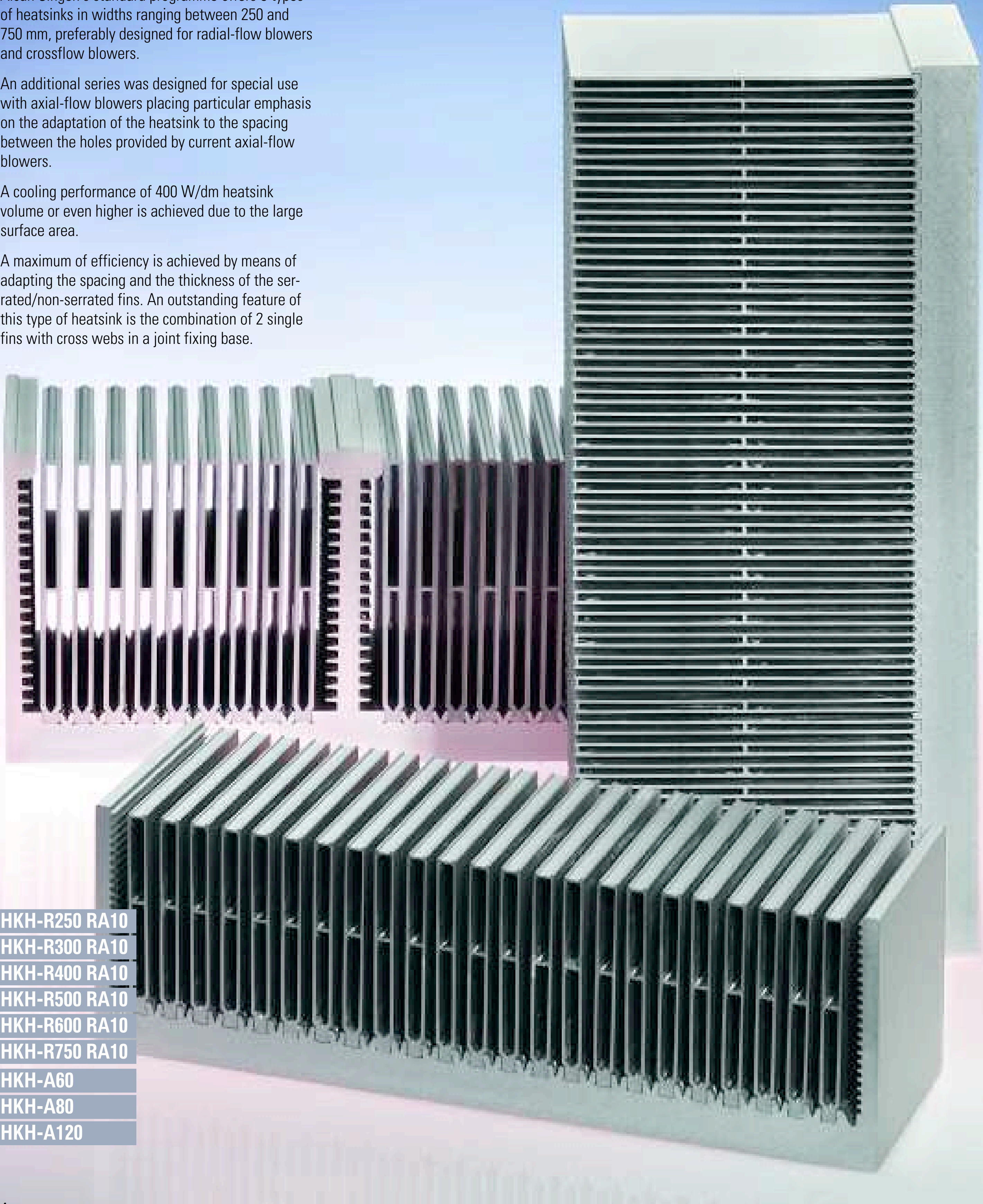
Heatsinks with hollow fins

Alcan Singen's standard programme offers 6 types of heatsinks in widths ranging between 250 and 750 mm, preferably designed for radial-flow blowers and crossflow blowers.

An additional series was designed for special use with axial-flow blowers placing particular emphasis on the adaptation of the heatsink to the spacing between the holes provided by current axial-flow blowers.

A cooling performance of 400 W/dm heatsink volume or even higher is achieved due to the large surface area.

A maximum of efficiency is achieved by means of adapting the spacing and the thickness of the serrated/non-serrated fins. An outstanding feature of this type of heatsink is the combination of 2 single fins with cross webs in a joint fixing base.



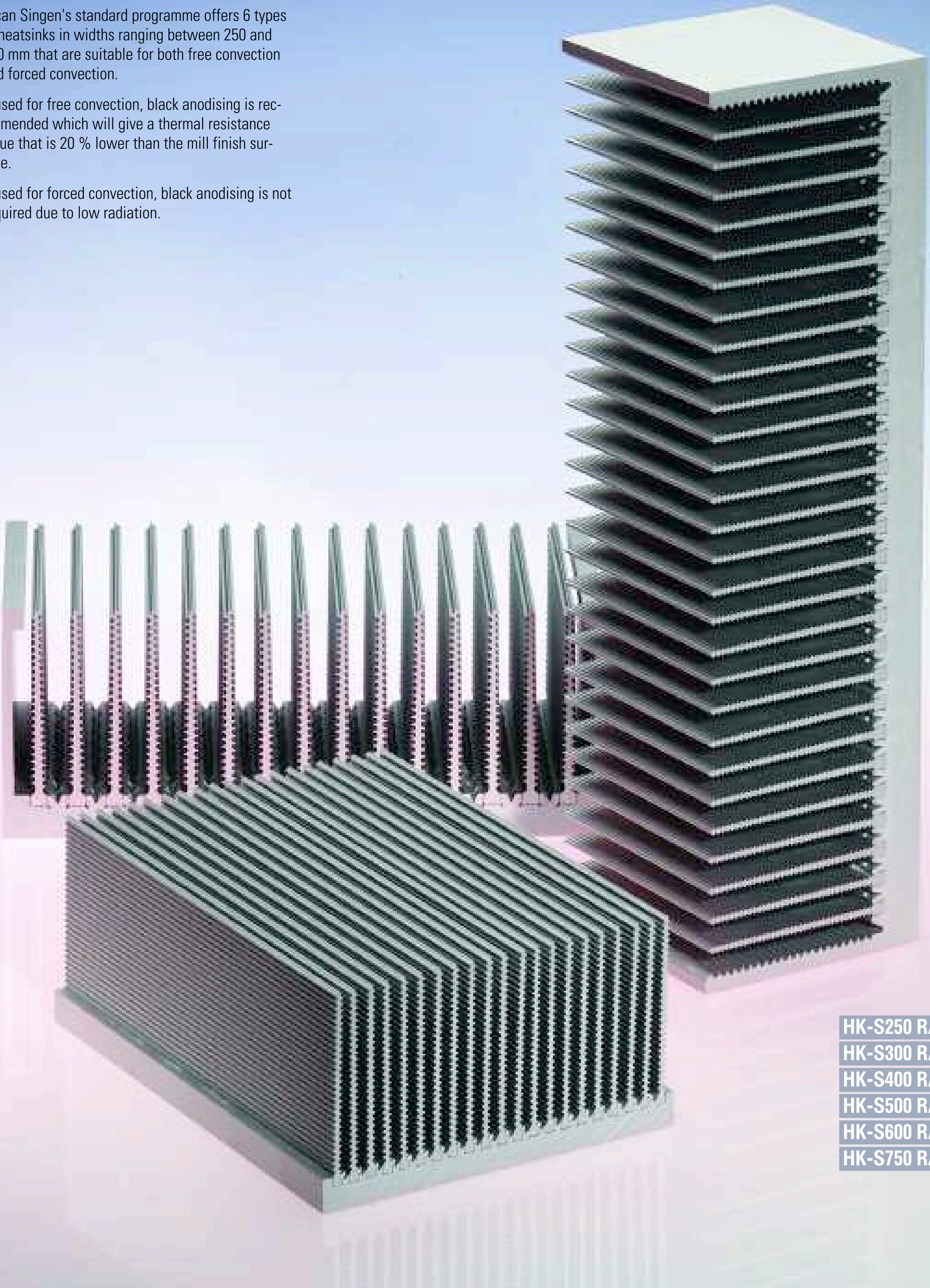
HKH-R250 RA10
HKH-R300 RA10
HKH-R400 RA10
HKH-R500 RA10
HKH-R600 RA10
HKH-R750 RA10
HKH-A60
HKH-A80
HKH-A120

Heatsinks with solid fins

Alcan Singen's standard programme offers 6 types of heatsinks in widths ranging between 250 and 750 mm that are suitable for both free convection and forced convection.

If used for free convection, black anodising is recommended which will give a thermal resistance value that is 20 % lower than the mill finish surface.

If used for forced convection, black anodising is not required due to low radiation.



HK-S250 RA10
HK-S300 RA10
HK-S400 RA10
HK-S500 RA10
HK-S600 RA10
HK-S750 RA10

Heatsinks with hollow fins and base sections assembled at the top and the bottom

To increase the specific performance, i.e. the dissipated performance per unit of volume, a new heatsink with hollow fins and base sections assembled at the top and bottom was developed. The heat is directed into the heat transferring fins from both sides and thus results in a markedly improved fin efficiency.

A typical application is the column construction in combination with GTO-semiconductor components

HKH-D 92/1
HKH-D 92/2
HKH-D 120/1
HKH-D 120/2
HKH-D 155

Thermotechnical considerations

First, one has to distinguish between the two types of cooling, i.e. free convection and forced convection, which require a different geometry of heatsink. For forced convection a clear spacing between fins of 3 mm or even less is desirable, whereas such a small spacing would be detrimental to free convection. This means that for free convection the spacing between fins has to be larger depending on the length of the heatsink.

It is important to remember that the thermal resistance of a heatsink is composed of the heat resistance junction-to-case (resistance resulting from thermal conductivity of heatsink material) and the heat resistance case-to-ambient (depending on surface, heat transmission coefficient, and amount of air).

The heat resistance junction-to-base has again to be divided into that of the fins and that of the baseplate, so one could talk about baseplate efficiency and fin efficiency. The efficiency of the baseplate is not only determined by its geometry and specific thermal conductivity but also by the size and positioning of the semiconductor components.

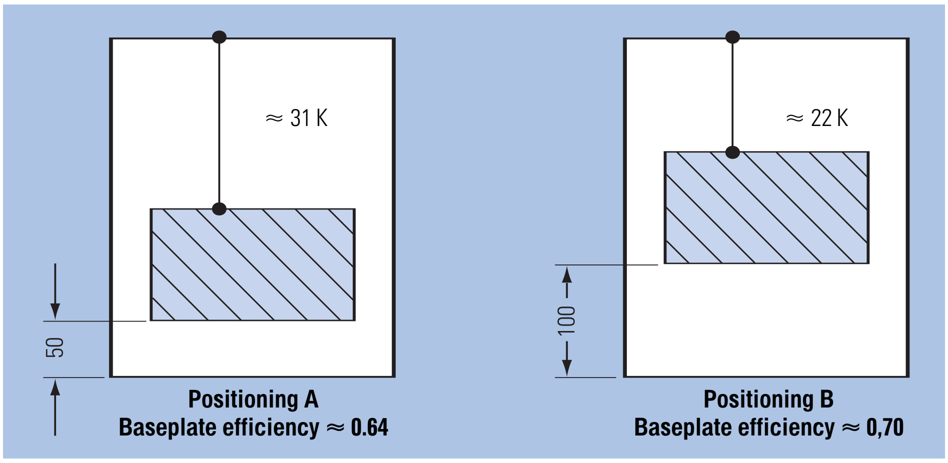
Today, a relatively large surface per unit of volume is achieved due to the feasibility of small spacings between fins. In conjunction with a large amount of air a heat resistance case-to-ambient is achieved that is clearly below the heat resistance junction-to-case. A heat resistance junction-to-case/case-to-ambient ratio of 2:1 is quite realistic.

However, this does not apply to free convection because of the very low heat transmission coefficient.

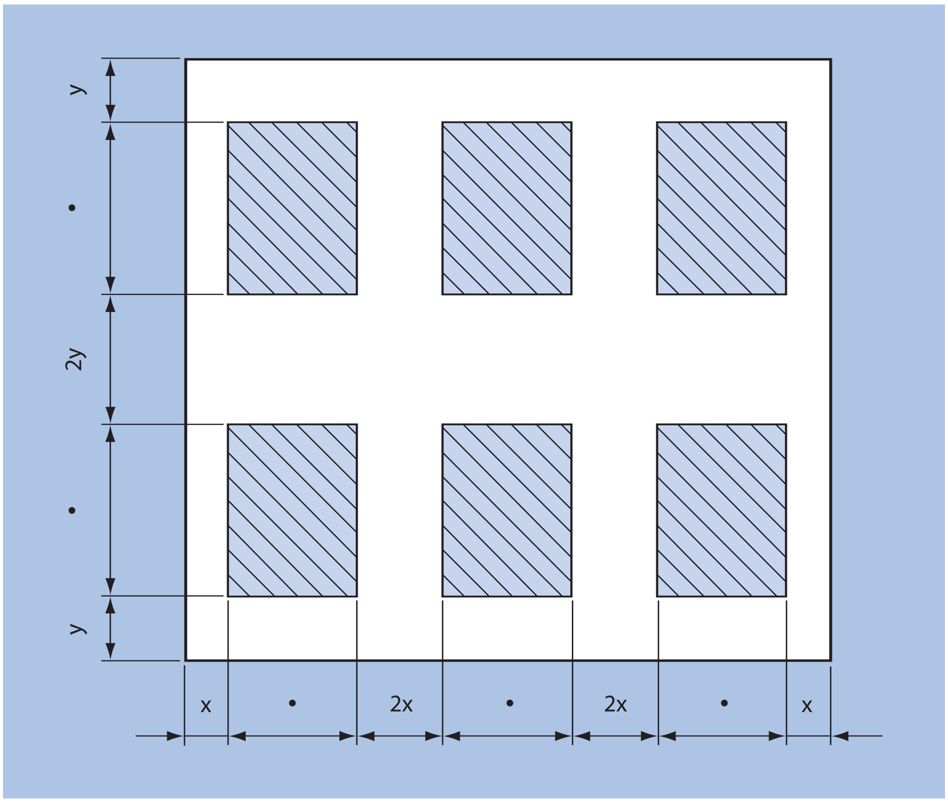
Baseplate efficiency as a parameter depending on the positioning of semiconductors

Below is a simplified example:

Base area of semiconductor:	180 x 100 mm
Heatsink lengthxwidthxheight:	300 x 250 x 100 mm
Thickness of baseplate:	20 mm
Total perimeter of fins:	7.2 m
Heat transmission coefficient :	50 W/m²K
Efficiency of fin:	0.6



The aforementioned example leads to the optimum layout opposite for a number of modules of the same kind.



Fin efficiency

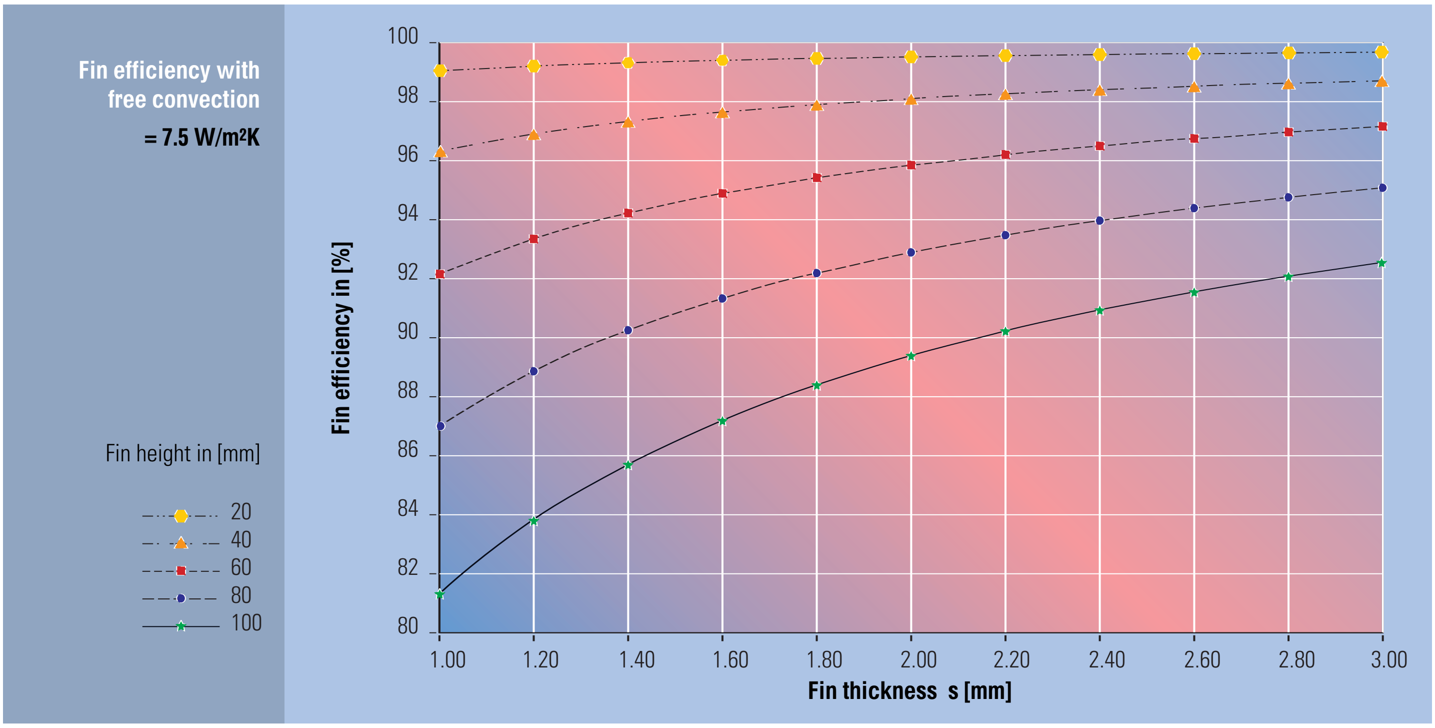
Fin efficiency is determined by the following parameters:
the fin geometry, i.e. height and thickness of fins, the specific resistance as a matter constant, and the heat transmission coefficient.

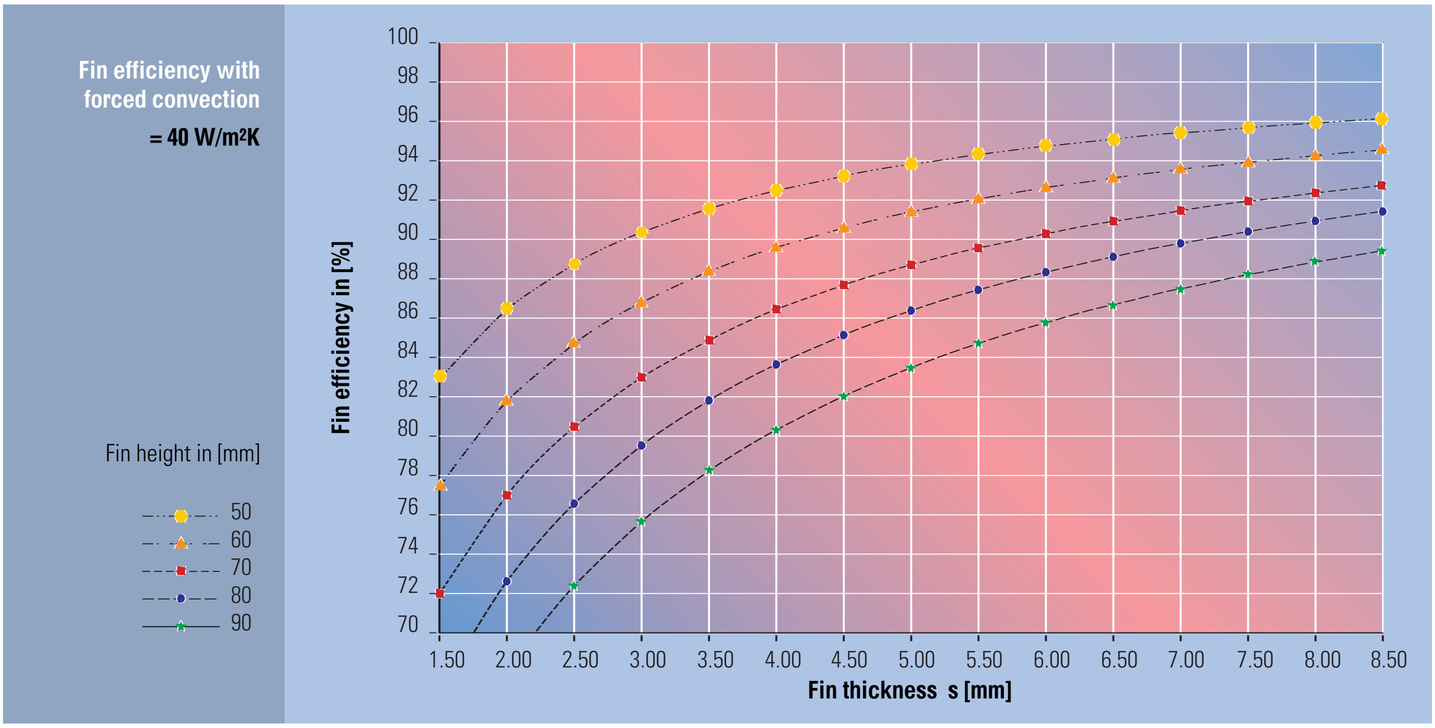
The comparison between the two diagrams below –

a. free convection with a low heat transmission coefficient of 7.5 W/m²K and

b. forced convection with a heat transmission coefficient of 40 W/m²K

– clearly shows the impact of the heat transmission coefficient .



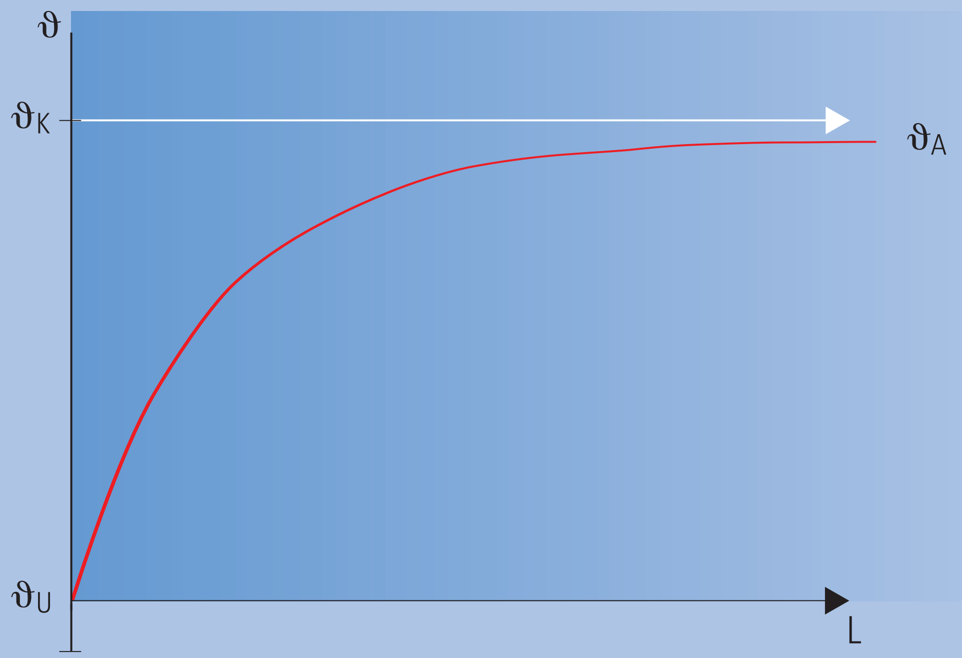


Effect of amount of air

The impact of the amount of air on forced convection systems is often underestimated. In extreme cases and with heatsinks of great length, the output air temperature may almost reach the temperature of the heatsink. This means that the volume of power to be dissipated is rather low at the output air side.

It is necessary for an adequate evaluation to make a theoretical determination of the output air temperature. The temperature rise of the air is determined by the following formula:

$$\Delta\vartheta = \frac{P}{Q \times \rho \times c_p}$$



$\Delta\vartheta$ = output air temperature – input air temperature K

P = total power dissipation Watt

Q = air volume m^3/sec

ρ = specific gravity (temperature dependent) kg/m^3

c_p = specific heat capacity J/kg x K

ϑ_U = ambient temperature = input air temperature

ϑ_K = heatsink temperature

ϑ_A = output air temperature

L = length of heatsink

The volume of dissipated power depends on the average temperature difference between heatsink and cooling air.

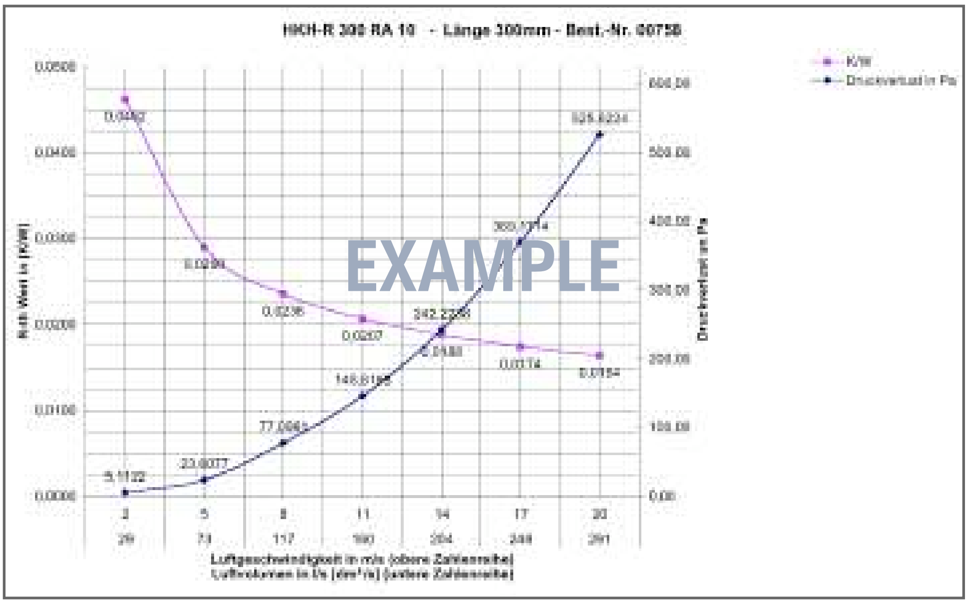
In the ideal case – which is never given in practice –, the output air temperature is equivalent to the input air temperature resulting in the maximum temperature difference between heatsink and cooling air. In this particular case the efficiency could be set at 1. In practice, however, the efficiency is clearly below 1 due to the air volume with higher output temperature and the average temperature difference, the efficiency may be clearly below 1. Suitable data is given in the table below where the degree of efficiency is assigned to the percentage of temperature rise of the escaping air (= difference between heatsink temperature and ambient temperature).

Temperature rise %	Efficiency ε
10	0.95
20	0.90
30	0.84
40	0.78
50	0.72
60	0.65
70	0.58
80	0.50
90	0.39

Service and Problem Solutions

Details about our standard range of heatsinks are available on our current CD-Rom "High-dissipation Heatsinks" which also provides information about dimensions and thermal resistance.

Despite the wide range and versatility of Alcan Singen's extruded heatsink profiles it may not offer the exact cross section required.



Besides its main function, i.e. the optimum dissipation of heat, a heatsink must often serve additional purposes such as combining the functions of a heatsink with those of a housing.

On the other hand those additional functions may be an essential feature of an efficient and economic end-product. For this particular reason it is recommended to get in touch with Alcan Singen "Application Engineering" at an early stage of planning.

Together we will design the optimum high-dissipation heatsink for your requirements making full use of the possibilities given by the extrusion technology.

Please fill in the following form and return it to us so that we can calculate the heatsink parameters that meet best your special requirements.

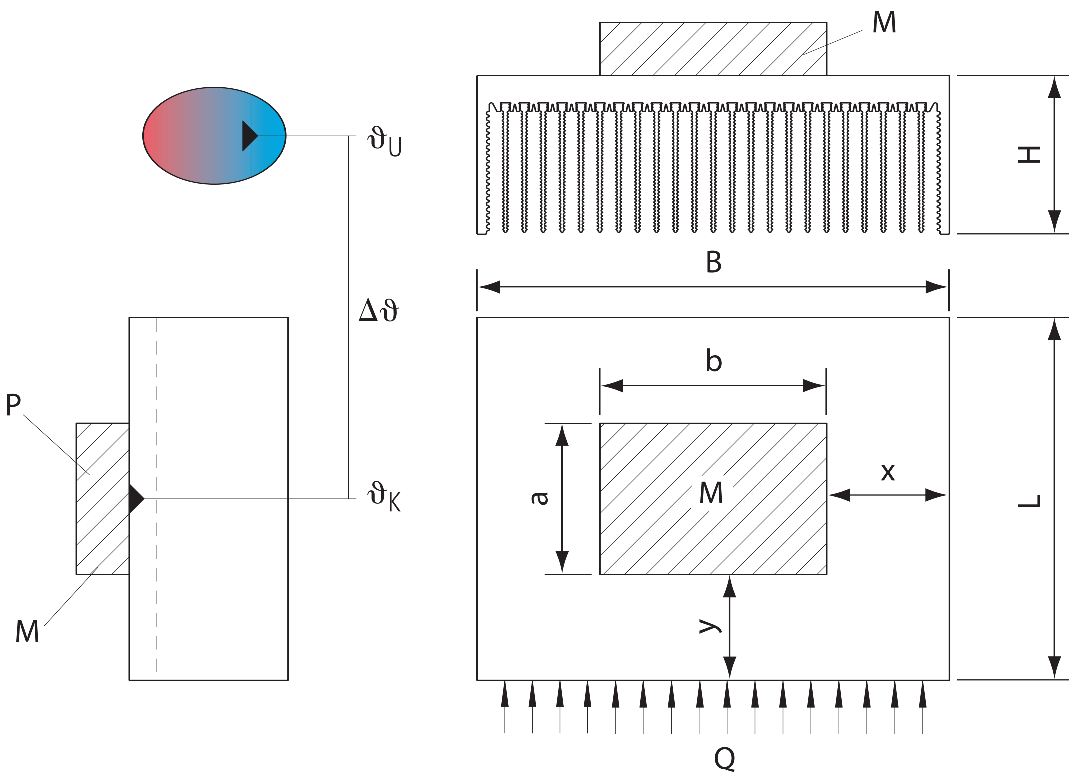
Data required to determine a heatsink

Please fill in below the required data enabling us to carry out a heatsink calculation for you and return the completed page by fax to our fax No. +49(0)7731/80-2669.

Fax: +49(0)7731/80-2669

Your address:

M	semiconductor module	=
Q	air volume or type of fan (diagram, characteristic curve)	=
P	power dissipation of semiconductor module(s)	=
$_K$	maximum permissible heatsink temperature	=
$_U$	maximum ambient temperature	=
	temperature difference heatsink - ambience	=
B		=
L	maximum possible heatsink dimension length x width x height	=
H		=
a	heat-transferring surface of semiconductor module(s)	=
b		=
x	position of semiconductor module(s) on the baseplate	=
y		=



Alcan Singen manufacturing unit for high-dissipation heatsinks with mechanically assembled fins

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