Technical introduction

1. General points

In order to provide optimum performance of semi-conducting devices it is essential not to exceed the maximum junction temperature indicated by the manufacturer.

Generally this maximum junction temperature can only be maintained without exceeding it by running the device concerned at lower power outputs.

At outputs approaching the maximum ratings semi-conductor devices have to be cooled by so called heatsinks, sometimes called dissipators.

The thermal performance of these heatsinks primarily depends on the thermal conductivity of the material from which they are made, size of surface area and mass.

In addition, surface colour, mounting position,temperature, ambient air velocity and mounting place all have varying influence on the final performance of the heatsink from one application to another..

However, a figure for thermal resistance can be experimentally determined in a reliable manner and used in the equations that follow in part 2.

There are no agreed international standard methods for testing electronic cooling systems or for the determination of the thermal resistance.

Therefore the diagrams and values given in our catalogue have been determined under practical operating conditions and therefore allow the most suitable heatsink from the range to be selected.

We expressly point out that all information and data is given to the best of our knowledge and belief. The user is solely responsible for the proper use of our products and he should check their suitability for the intended application.

Fischer Elektronik do not assume any warranty, whether expressed or implied, for the suitability, function or merchantibility of their products in specific or general applications, and they cannot be held liable for accidental or consequential damage due to non-observance of the above.

Furthermore Fischer Elektronik reserve the right to carry out technical modifications to their products at any time.
All orders are subject to the General Sales Conditions of Fischer Elektronik.

2. The determination of thermal resistance

The thermal resistance is the parameter that is the most important in cooler selection, apart from mechanical considerations.

For determination of the thermal resistance the following equation applies:

Equation 1:

$$R_{thK} = \frac{\vartheta_i - \vartheta_u}{P} - (R_{thG} + R_{thM}) = \frac{\Delta\vartheta}{P} - R_{thGM}$$

In case of an application where the maximum junction temperature is not exceeded the temperature has to be verified.
When the case temperature has been measured the use of the following equation will enable the maximum junction temperature to be calculated:

Equation 2:

$$\vartheta_i = \vartheta_G + P \times R_{thG}$$

The meaning of the determinants:

ϑ_i = maximum junction temperature in °C of the device as indicated by manufacturer.
As a »safety factor« this should be reduced by 20-30 °C.

ϑ_u = ambient temperature in °C.
The rise in temperature caused by radiant heat of the heatsink should be increased by a margin of 10-30 °C.

$\Delta\vartheta$ = difference between maximum junction temperature and ambient temperature.

ϑ_G = measured temperature of device case (equation 2).

P = maximum power rating of device in watts

R_{th} = thermal resistance in K/W

R_{thG} = internal thermal resistance of semiconductor device (as indicated by manufacturer)

R_{thM} = thermal resistance of mounting surface. For TO 3 cases the following approximate values apply:

1. dry, without insulatar	0.05 - 0.20 K/W
2. with thermal compound/without insulator	0.005 - 0.10 K/W
3. Aluminium oxide wafer with thermal compound	0.20 - 0.60 K/W
4. Mica wafer (0.05 mm thick) with thermal compound	0.40 - 0.90 K/W

R_{thK} = thermal resistance of heatsink, which can be directly taken from the diagrams

R_{thGM} = sum of R_{thG} and R_{thM}. For parallel connections of several transistors the value R_{thGM} can be determined by the following equation:

Equation 3:

$$\frac{1}{R_{thGM\ ges.}} = \frac{1}{R_{thG1} + R_{thM1}} + \frac{1}{R_{thG2} + R_{thM2}} + \cdots + \frac{1}{R_{thGn} + R_{thMn}}$$

The result can be substituted into equation 1.

K = Kelvin, which is the standard measure of temperature differences, measured in °C, therefore 1°C = 1 K.

K/W = Kelvin per watt, the unit of thermal resistance.

Calculation examples:

1. A TO 3 power transistor with 60 watt rating has a maximum junction temperature of 180 °C and an internal resistance of 0.6 K/W at an ambient of 40 °C with aluminium oxide wafers.

What thermal resistance is required for the heatsink?

given:

P = 60 W
ϑ_i = 180 °C - 20 °C =160 °C (for safety margin)
ϑ_u = 40 °C
R_{thG} = 0.6 K/W
R_{thM} = 0.4 K/W (average value)

find: R_{thK} using equation 1

$$R_{thK} = \frac{\vartheta_i - \vartheta_u}{P} - (R_{thG} + R_{thM}) = \frac{160\ °C - 40\ °C}{60\ W} - (0.6\ K/W + 0.4\ K/W) = \underline{1{,}0\ K/W}$$

2. Same conditions as above but for three devices with equally distributed power ratings.

solution use equation 1 and equation 3

$$\frac{1}{R_{thGM\ ges.}} = \frac{1}{0.6 + 0.4\ K/W} + \frac{1}{0.6 + 0.4\ K/W} + \frac{1}{0.6 + 0.4\ K/W} = \frac{3}{1}\ W/K$$

$$R_{thGM\ ges.} = \frac{1}{3}\ K/W = \underline{0.33\ K/W}$$

substitute into Equation 1 gives:

$$R_{thK} = \frac{160\ °C - 40\ °C}{60\ W} - 0.33\ K/W = \underline{1.67\ K/W}$$

With these values determined, the tabulation on page A 13 - 17 can be used to give a choice of possible heatsink profiles. Then by examination of the drawings and curves the final choice can be made.

3. A transistor with power rating of 50 W and internal thermal resistance of 0.5 K/W has a case temperature of 40 °C.

What is the actual value of junction temperature?

given:

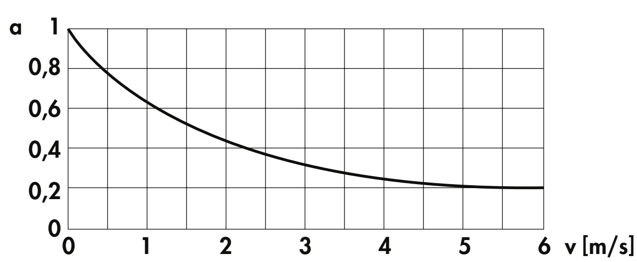
P = 50 W R_{thG} = 0.5 K/W ϑ_G = 40 °C

find: ϑ_i using equation 2

$$\vartheta_i = \vartheta_G + (P \bullet R_{thG}) \qquad \vartheta_i = 40\ °C + (50\ W \bullet 0.5\ K/W) = \underline{65\ °C}$$

Thermal resistances of any profiles with forced convection

R_{thKf} ≈ $a \bullet R_{thK}$
R_{thKf} = thermal resistance with forced convection
R_{thK} = thermal resistance with natural convection
a = factor of proportion



Standard aluminium profiles → A 135 - 136
Extruded heatsinks → A 22 - 83
Lamella heatsinks → A 129 - 130
Fluid coolers → A 131 - 133
Thermal conductive material → E 2 - 24
Hole pattern → A 21
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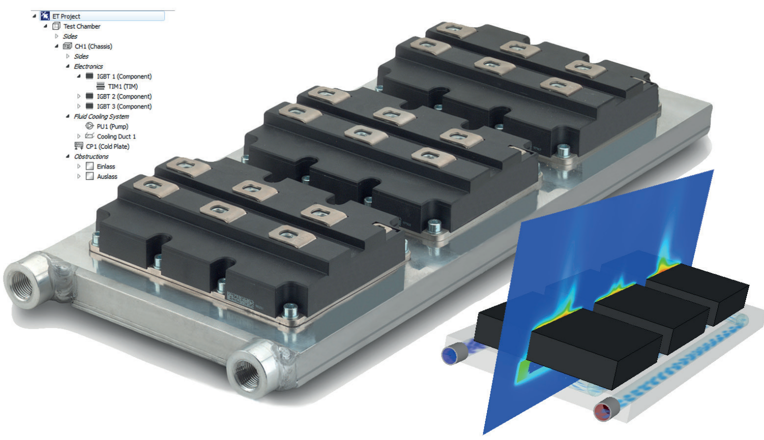
Computer based thermal simulation for optimal cooling concepts

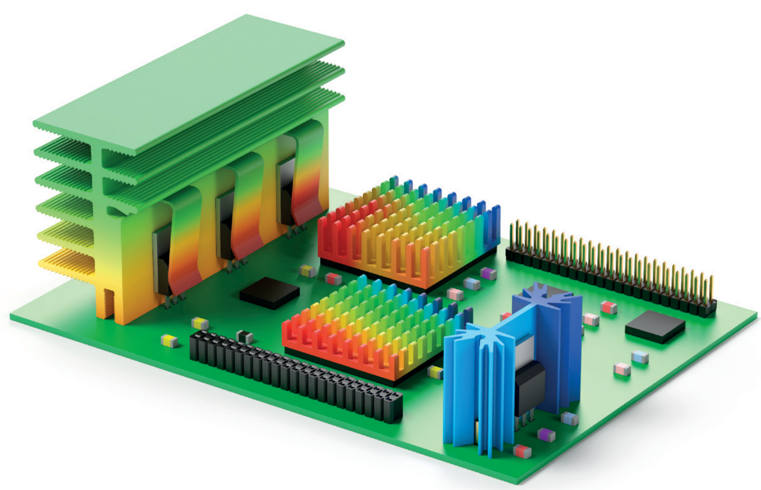
Performance, service life and reliability of electronic semiconductor devices are significantly determined by the thermal load to which the devices are exposed. An exceeding of the maximum operating temperature leads to malfunctions. An exceeding of the permissible junction temperature leads to a destruction of the semiconductor. To make it worse there is an advancing trend in the semiconductor industry for continuous increasing integration- and power densities of electronic devices. For the solution of thermal problems the first question is which kind of heat dissipation has to be considered. For this there are different processes available: by means of free convection (passive) with different heatsink solutions, by means of forced convection (active with help of fans, cooling aggregates) or by means of fluid media (fluid cooling).

However, electronic devices and systems have many different boundary and installation conditions. Therefore the choice of the optimum thermal management is often difficult. There are surely possibilities to find the right heat dissipation concept by using the thermal resistance for calculations or by testing and verifying prototypes directly in the application, but nowadays customer specified mechanical adjustments are requested and demanded more than ever. Small mechanical post-machinings, such as additional integrated threads or drilling can be considered in the calculation with safety reserves in the temperature of the thermal resistance, but extensive modifications demand a repeated inspection of the thermal circumstances.



To facilitate the determination of passive heat dissipation concepts Fischer Elektronik offers a computer based thermal simulation as a kind of service.

Considered factors in the thermal simulation



With help of the computer based thermal simulation the necessary characteristics of the cooling concept can be determined exactly. Based on physical concepts such as mass, energy and impulse the software especially considers the thermal requirements for free or forced convection. Simultaneously the system is aligned to thermal dissipation by means of fluid. Moreover the thermal simulation calculates physical effects such as thermal radiation and turbulences. The emission factor of the different surfaces also plays its role. As a result the simulation software delivers a precise cooling solution for the application and is a big help for the decision-making and interpretation of the electronic design.

Advantages of a computer based simulation

The computer based thermal simulation is already used for the prototype development. Herewith the development cycles of heat dissipation concepts is reduced considerably. Unsuitable concepts can be discarded quickly and without big costs of material. A lot of features and options of the simulation system also reduce the temporary and apparatuses efforts compared to a conventional simulation in the measurement chamber.

We will be happy to advise you in detail about the theme thermal simulation.

Technical introduction

Remarks:

1. The values indicated in the diagrams apply only for heatsinks with black anodised surface, mounted vertically and natural convection.

Correction factors: natural surface: +10 to 15 % for horizontal mounting: +15 to 20 %

2. Heatsink profiles are extruded to European standard DIN EN 12020 (former DIN 17615).
   For profiles exceeding a circumscribed circle of 350 mm, the tolerances to DIN EN 755 (former DIN 1748) apply.

Important note:
Manufacturers of certain electronic components, especially modules with a large surface area, IGBT etc., specify installation surfaces for heatsinks etc. with an flatness, which is beyond standard tolerances. Such perfect flatness can only be achieved by milling the installation surface. Furthermore, it should be noted that threaded wire inserts may be required in order to reach higher tightening torques in aluminium (e.g. Heli-Coil or similar.). Please observe the semiconductor manufacturers' information.

3. The mentioned heatsink profiles in our catalogue contain so called extrusion marks between the fins for a profile identification. To avoid misuse the operator has to check the size and position for the mechanical treatment or placement of the components.

4. Profile extruded threaded channels are no threads conforming to standards, as they have no thread pitch. The thread pitch is imitated by staggered webs (ribs). The customer is responsible for appropriate use.

5. Machining of our extruded and non extruded profiles conforms to requirements of DIN ISO 2768 m - unless otherwise stated. For all ICK S types DIN ISO 2768c is valid.

6. The lengths of extruded profiles [|↔|] and the pin layouts [✥] indicate only the standard range. We offer every profile cut to customer's exact length and machining requirement made to drawing or sample. We bore, countersink, mill, saw, grind and cut threads into your heat sink to meet your specific requirements. With our modern machine tools including CNC machining centres, multispindled drills (up to 26 drillings/threads at the same time) and digital milling and stamping tools plus our own "in house" tool room we are able to manufacture competetively priced prototypes as well as batch and mass produced parts with short lead times.

7. The standard material of our heatsinks is warm age-hardened aluminium alloy according to EN AW 6060 – T66 (former AlMgSi05 – F22 acc. to DIN 1748). Our standard surface treatments are raw degreased aluminium (Al) and black anodised (SA). On request, we anodise clear natural (ME) or decorative in any colour that is technically possible.

8. If you cannot find a suitable profile within our range of approx. 400 profiles, 13 small heatsinks and 50 finger shaped heatsinks, we can design and produce to your requirements. Please contact us at the start of your next project so that we can work together, either directly or through our representatives. Remember that we have the ability to find the solution for "your" cooling problem.

9. Note on tolerances

All dimensions given in this cataloque for products, items and machined parts are acc. to DIN ISO 2768 m if not otherwise stated. Not included are items like extruded profiles, diecasts, handles, vibration dumpers etc. for which different standards apply.

Update - August 2014

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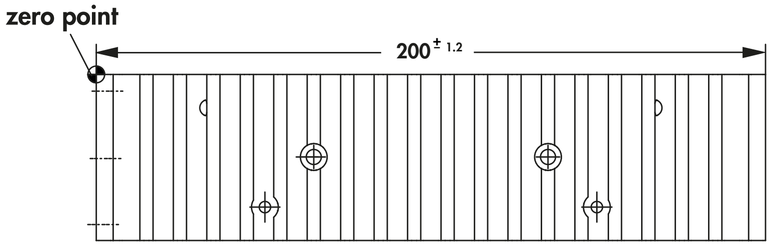
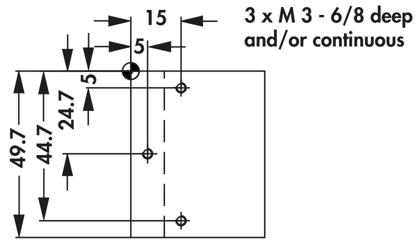
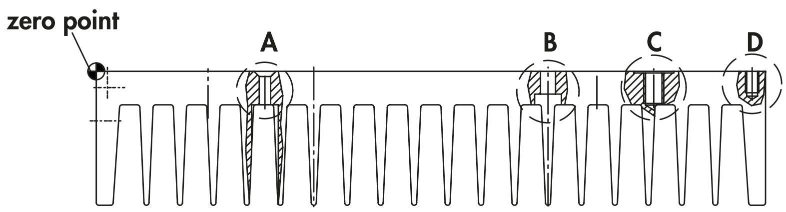
General information

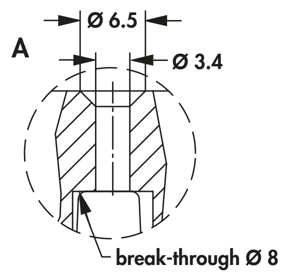
Blind holes are produced after anodising. Through holes are produced before anodising. With completely visual parts, additional painting is recommended. The sections are extruded according to DIN EN 12020. For sections that exceed a circumscribed circle of 300 mm, DIN EN 755 apply. The machining tolerances are specified according to DIN ISO 2768 m.

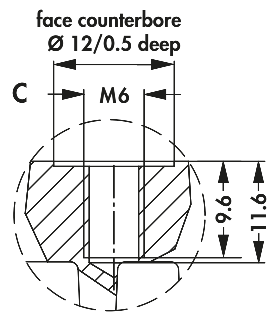
Visual parts: Please indicate at which place **clamp points** are allowed! We recommend e.g. supplementary laquering.

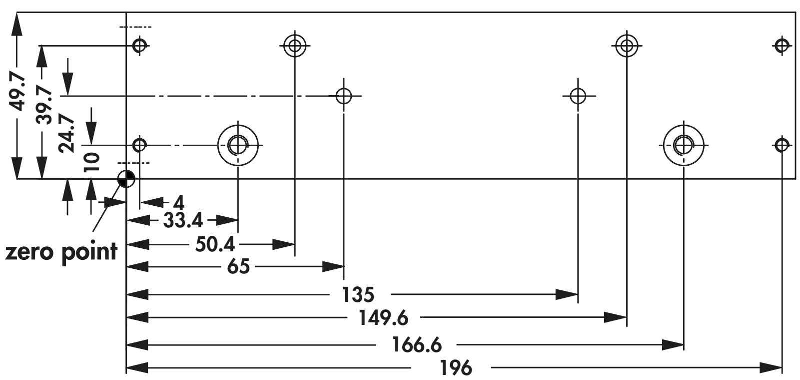


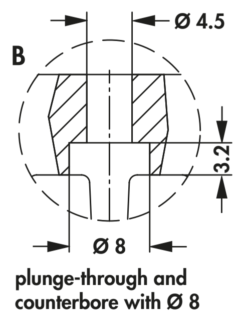


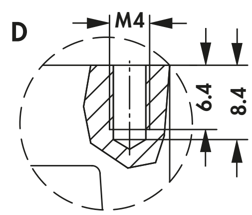












A B C D E F G H I K L M N

Information for dimensioning, shown on SK 47 general:

The deflection can be up to 0.8 mm concave, 0.2 mm convex. If a certain flatness of the bottom surface is required the bottom thickness can be decreased by a maximum of approx. 0.8 mm by means of face-milling. This situation must be taken into consideration with the bore hole depths for blind holes.
Counterbores and bore hole diameters are to be produced according to DIN 74, if not explicitly stated otherwise.
The depth of thread should be calculated as follows.

Example M 5:
thread: <M> 5 x 1.6 mm = 8 mm   core bore: 8 mm + 2 mm = 10 mm

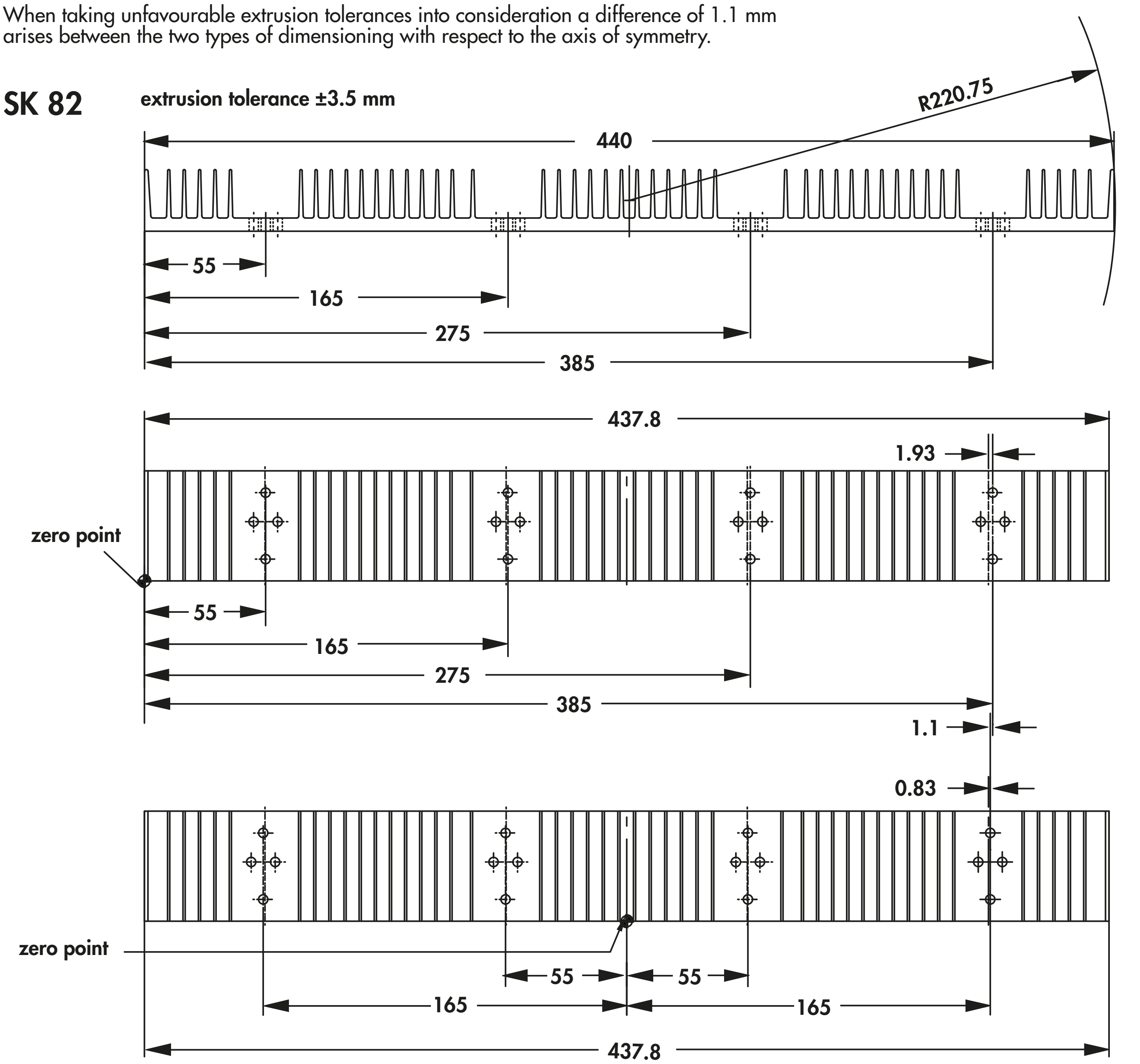
Examples:
cutout A: Through-hole according to DIN 74 A m 3, counterbore bottom side, undercut of the fins.
cutout B: Through hole with break-through of the fins according to DIN 74 H m 4, counterbore on fin side.
cutout C: Thread M 6. Depth of thread 1.6 x 6 mm = 9.6 mm, bore depth 9.6 mm + 2 mm = 11.6 mm.
Bore hole on fin base is plunged through. Face counterbore dia. 12 x 0.5 on bottom side.
cutout D: Blind thread M 4. Depth of thread 1.6 x 4 mm = 6.4 mm, bore depth 6.4 mm + 2 mm = 8.4 mm.

Extrusion tolerances – production tolerances

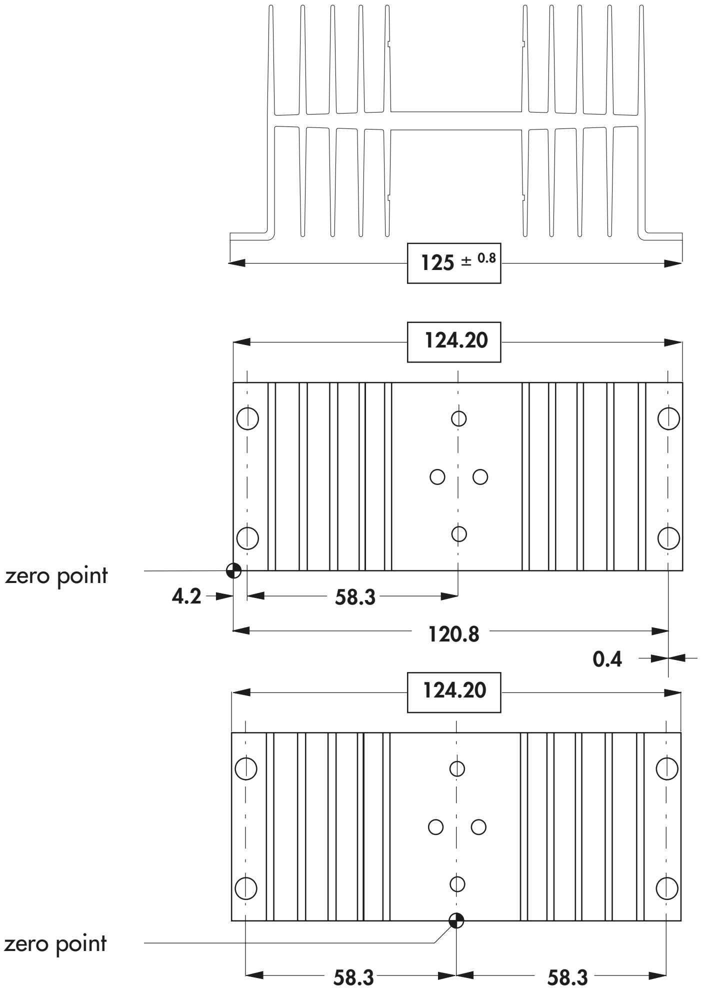
There is often the problem, that the production tolerances cannot be adhered to, due to the extrusion tolerances. The two examples show how the production tolerances can be cut in half by means of suitable dimensioning (here: extension of the zero point from the outer edge to the center of the section).

When taking unfavourable extrusion tolerances into consideration a difference of 1.1 mm arises between the two types of dimensioning with respect to the axis of symmetry.

SK 82 **extrusion tolerance ±3.5 mm**



SK 34



extrusion tolerance ± 0.8 mm

dimensioning set to the outer edges

dimensioning set to the center

When taking unfavourable extrusion tolerances into consideration, a difference of 0.4 mm arises between the two types of dimensioning with respect to the axis of symmetry.

Milling

If, when milling heatsinks, cooling aggregates, etc., the milling tool diameter is smaller than the area being milled for production reasons, so called „milling grooves" with steps or edges are produced (see sketch). Even if the roughness depth value for the surface is observed, it is a good idea to specify the area of the component in which no milling edges are allowed.