Econo Modules: Mechanical Attributes

1. Shape and tolerance

1.1 Flatness and cavity of base plate

Econo modules have special requirements in the shape of the base plate due to the high power integration. The base plate flatness used to be tested by measuring one point in the middle of the module. Further investigations with key customers have helped to optimize this test procedure.

The highest concentration of losses, which has to be dissipated directly to the heat-sink, is found under the IGBT area. Due to the form tolerances of both, base plate and heat-sink surface, cavities form when the module is mounted. The new standard testing procedure measures these cavities directly under the IGBT positions for every module. Table 1 shows the allowed cavities and bows.

	Cavity	Bow
Econo II	max. 50 µm	0 .. 190 µm
Econo III	max. 70 µm	-20 .. 200 µm

Table 1 : Permitted cavities and bows

These specified values are valid for the final testing. Minor changes can occur due to relaxation of the base plate during storage or different measuring methods. The above described test is performed on 100% of Econo II and III modules.

As a result the thermal resistance between base plate and heat-sink has improved making Econo modules better and safer to use. All data is collected and evaluated in Statistical Process Control (SPC) and used in the continuous improvement process. In addition, the bow measurements are used to monitor the production process.

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1.2 Requirements on base plate and heat-sink

The quality of the heat-sink surface in combination with the base plate characteristic is essential for the thermal dissipation of the whole system.

The flatness should not exceed the following values on that part of the heat-sink surface where the module will be mounted.

	Flatness	Roughness R_Z
Econo II	≤ 25 µm at 100 mm	≤ 10 µm
Econo III	≤ 25 µm at 100 mm	≤ 10 µm

Table 2 : Permitted flatness and roughness

Point-shaped and line-shaped scrapings exceeding the values specified in table 2 are permitted to cover up to 2% of the total surface. Disruptions in the galvanic surface between base plate and heat-sink do not have a negative impact on functionality. Spike-like protrusions, however, lead to improper thermal coupling and should therefore be removed before mounting.

The same is true for PIM modules with similar dimensions.

1.3 Module height

The module has a mounting height of 17 mm with a tolerance of +/- 0,5 mm.

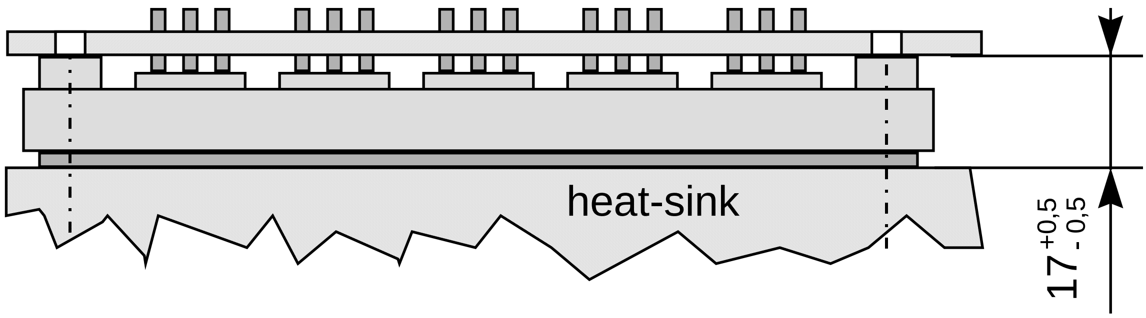

Figure 1: Mounting height and tolerances

Where more than one module is mounted on a PCB it is necessary to assure that the various base plates are on one level otherwise there will be mechanical tensions in the PCB which can destroy the construction.

1.4 Pin positions

The outlines of the Econo modules are shown in the corresponding data sheet. The center position of the pin can deviate form the ideal position by a diameter of 400µm as shown in figure 2.

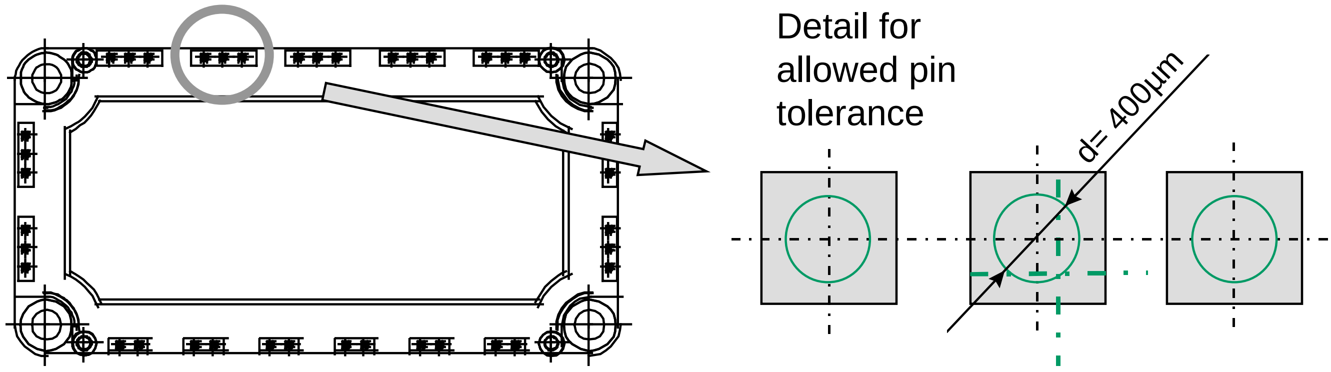

Figure 2: Tolerance of pin center position

2. Mounting

2.1 Dimensioning of copper layer on PCB

The PCB traces should be dimensioned so that at maximum current no excessive heating occurs. The conditions can be improved with forced air cooling. Usually a trace thickness of 105µm is used. The width of the trace depends on the current level.

A local reduction of the copper cross section should be avoided because it would cause a rise in temperature at this point. It is recommended to simulate worst case conditions on a prototype.

2.2 Inserting of module to PCB

Econo modules can be fastened to the PCB either by notch nails according to DIN 1476 or screws according to DIN 7513 BM3xL with a torque of 1 Nm (figure 3 and table 3).

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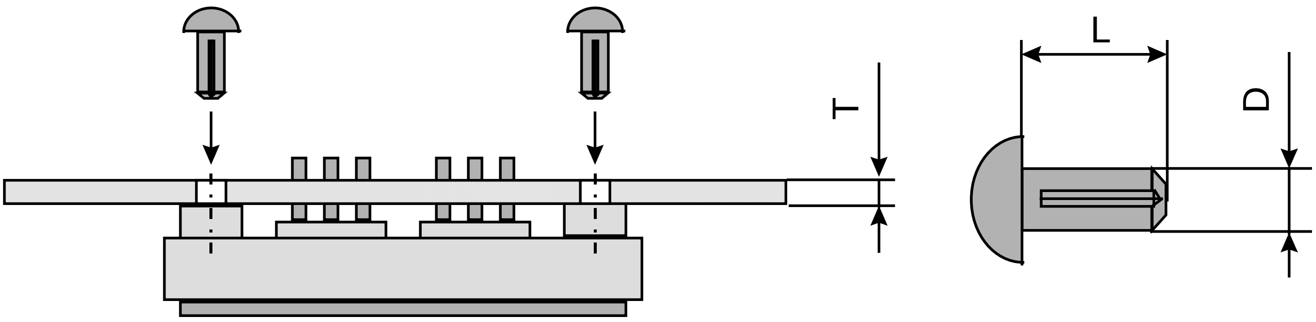

Figure 3: Mounting to PCB

The following notch nails are recommended (D= 2,5mm):

PCB <T>	0,5 mm	1,0 mm	1,5 mm	2,0 mm	3,0 mm
nail <L>	5,0 mm	5,0 mm	6,0 mm	6,0 mm	8,0 mm

Table 3: Length of notch nails

2.3 Soldering

A good solder joint with low transfer resistance is necessary for proper thermal dissipation and conduction from pin to PCB trace. For efficient production a wave soldering process can be used. Of course, the thermal limits for all devices should not be exceeded. A visual quality control of the soldering is usually sufficient. A well-balanced layer of solder should be surrounding every pin.

2.4 Mounting to heat-sink

A thermal grease with permanent elastic properties should be selected for a lifelong constant thermal resistance between base plate and heat-sink. Low viscosity at mounting conditions is required to prevent mechanical stress to the base plate. Low thermal resistance is necessary for a proper power dissipation.

A layer of 100 µm to 200 µm thermal grease is to be distributed evenly on the base plate. The thickness of the layer is appropriate if a small amount of thermal grease shows all around the edge of the module after screwing it down.

The entire arrangement of PCB and Econo modules is placed on the heat-sink. First, all mounting screws have to be tightened by hand. Then they are fixed with half torque followed by nomi-

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nal torque criss-crossed. (torque values: see data sheet). It might be necessary to repeat the last step after three hours.

The allowed torque for the screws depends on the heat-sink material. Formula 1 shows the dependency of torque and friction coefficient μ to the resulting force.

$$F = \frac{2 \circ M}{d} \circ \frac{1 - \mu \circ \tan\alpha}{\mu + \tan\alpha}, \text{ with } \tan\alpha = \frac{h}{d \circ \pi} \qquad \text{Formula 1}$$

An example is shown for steel and aluminium with M6 thread (d=5,35 mm, h=1 mm):

material	μ	F(M=3 Nm)	F(M=6 Nm)
steel	0,15	5,3 kN	10,6 kN
aluminium	0,25 .. 0,30	3,0 .. 3,6 kN	6,2 .. 7,1 kN

Table 4: Resulting force for given torque's and different materials

The result depends strictly on the mounting conditions. The torque has to be adjusted accordingly.

2.5 Dismantling

The screws for the connection of module and heat-sink have to be removed. The heat-sink has to be removed to the side. Pulling could disconnect the base plate from the housing due to the adhesive force of the thermal grease.

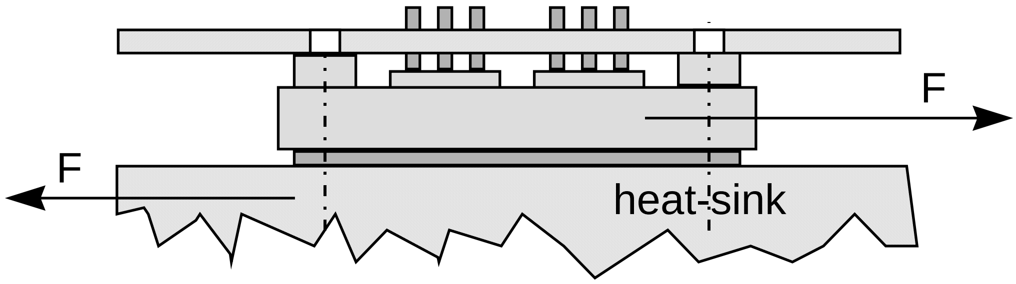

Figure 4: Dismantling of Econo module

The solder connections have to be dismantled using appropriate techniques.

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