Mounting Instructions for SP6-P (12mm) Power Modules

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Introduction:
This application note gives the main recommendations to appropriately connect the SP6-P power module onto the heat sink, and the PCB (Printed Circuit Board) to the power module. It is very important to follow the mounting instructions to limit both the thermal and mechanical stresses.

1. Power module mounting onto heatsink.

Proper mounting of the module base plate onto the heat sink is essential to guarantee good heat transfer. The heat sink and the power module contact surface must be flat (recommended flatness <50µm for 100mm continuous, recommended roughness Rz 10) and clean (no dirt, no corrosion, no damage) in order to avoid mechanical stress when the power module is mounted, and to avoid an increase in thermal resistance.

1.1 Thermal grease application

To achieve the lowest case to heat sink thermal resistance, a thin layer of thermal grease must be applied between the power module and the heat sink.
If the grease is applied onto the module base plate, a minimum thickness of 100µm (3.9 mils) of grease should be applied with a roller or a spatula.

If the grease is applied onto the heat sink, it is recommended to use screen printing technique to ensure a uniform deposition of a minimum thickness of 100µm (3.9 mils). In any case, the module bottom surface must be wetted completely with thermal grease.

2. Mounting the PCB onto the power module with spacers outside the power module.

2.1 Mounting the power module onto the heat sink.

Place the power module above heat sink holes, and apply a small pressure to it. Insert the M6 screw with lock and flat washers in each mounting hole (a #12 screw can be used instead of M6). The screw length must be at least 16 mm (0.6”).

First lightly tighten the four mounting screws. Tighten alternatively the screws until their final torque value is reached (between 3 and 5 N.m, or 2.21 and 3.69 lbf·ft).
It is recommended to use a screwdriver with controlled torque for this operation.
If possible, screws can be tightened again after three hours.

The quantity of thermal grease is correct when a small amount of grease appears around the power module once it is bolted down onto the heat sink with the appropriate mounting torque (see figure 3, screws are tightened with a mounting torque of 4 N.m, or 2.95 lbf·ft). Figure 4 shows the thermal grease on the SP6-P module base plate when removed from the heat sink. Screws are tightened with a mounting torque of 4 N.m.

2.2 Mounting the PCB onto the power module.

First, place spacers on the heat sink, close to the power module (see figure 1). The spacers must have $12^{\pm 0.2}$mm height. The PCB must be mounted onto the power module and screwed onto the spacers. A mounting torque of 0.6N.m (5 lbf·in) is recommended.

The second step consists of soldering all signal terminals of the power module to the PCB.
Manual soldering process is recommended to solder the terminals to the PCB.
No-clean solder flux is required to attach the PCB onto the module since aqueous module cleaning is not allowed.

Do not reverse these two steps, because if all pins are soldered first to the PCB, screwing the PCB onto the spacers will create a deformation of the PCB, leading to some mechanical stress that can damage the traces or break the components on the PCB.

If a long and large PCB is used, others additional spacers between the PCB and the heat sink are necessary. It is recommended to keep a distance of at least 5 cm between each spacer.

Note 1: The SP6-P plastic frame height is the same height as an Isotop® (SOT-227). On the same PCB, if an Isotop® and an SP6-P power module are used and if the distance between the two power modules does not exceed 5 cm, it is not necessary to install the spacer.

Note 2: To reduce switching over-voltages, decoupling capacitors must be placed as close as possible of the V_{BUS} and $0/V_{BUS}$ terminals (See figure 5).

Note 3: For efficient production, a wave soldering process can be used to solder the terminals to the PCB. Each application, heat sink and PCB can be different; wave soldering must be evaluated on a case-by-case basis. In any case, a well-balanced layer of solder should surround each pin.

Note 4: Holes in the PCB are necessary to insert and tighten the mounting screws that bolt down the power module to the heat sink. These access holes must be large enough for the screw head and washers to pass through freely, allowing for normal tolerance in PCB hole location.

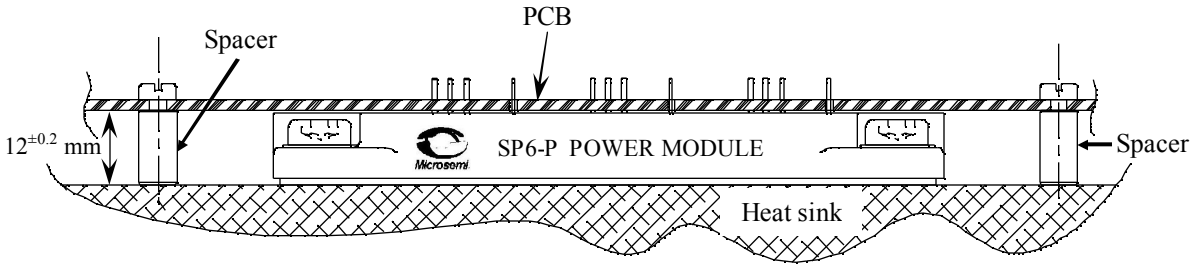


fig 1: PCB screwed onto the spacer.

3. Mounting the PCB onto the power module with spacers onto the mounting holes.

3.1 Mounting the power module and the PCB onto the heat sink.

First, follow paragraph 1 & 1.1 on page 1 for grease application onto heat sink.

Place the power module above heat sink holes, and apply a small pressure to it. Insert the spacers on each mounting hole and then the PCB must be mounted onto the power module.
The spacers must have $5.5^{\pm 0.1}$mm height.

Insert the M5 screw with lock and flat washers in each mounting hole, through the PCB and the spacers (see figure 2). The screw length must be at least 23 mm (0.9"). #10 screws can be used instead of M5.

Lightly tighten the four mounting screws. Tighten alternatively the screws until their final torque value is reached (between 3 and 5 N.m, or 2.21 and 3.69 lbf·ft).
It is recommended to use a screwdriver with controlled torque for this operation.
If possible, screws can be tightened again after three hours.

The quantity of thermal grease is correct when a small amount of grease appears around the power module once it is bolted down onto the heat sink with the appropriate mounting torque (see figure 3, screws are tightened with a mounting torque of 4 N.m, or 2.95 lbf·ft). Figure 4 shows the thermal grease on the SP6-P module base plate when removed from the heat sink.
Screws are tightened with a mounting torque of 4 N.m.

The next step consists of soldering all signal terminals of the power module to the PCB.
Manual soldering process is recommended to solder the terminals to the PCB.
No-clean solder flux is required to attach the PCB onto the module since aqueous module cleaning is not allowed.

If a long and large PCB is used, other additional spacers between the PCB and the heat sink are necessary. A mounting torque of 0.6N.m (5 lbf·in) is recommended. It is recommended to keep a distance of at least 5 cm between each spacer. The spacers must have the same height ($12^{\pm 0.2}$ mm).

Note 1: If all pins are soldered first to the PCB, screwing the PCB onto the power module will create a deformation of the PCB, leading to some mechanical stress that can damage the tracks or break the components on the PCB.

Note 2: The SP6-P plastic frame height is the same height as an Isotop® (SOT-227). On the same PCB, if an Isotop® and an SP6-P power module are used and if the distance between the two power modules does not exceed 5 cm, it is not necessary to install the spacer.

Note 3: To reduce switching over-voltages, decoupling capacitors must be placed as close as possible of the V_{BUS} and $0/V_{BUS}$ terminals (See figure 5).

Note 4: For efficient production, a wave soldering process can be used to solder the terminals to the PCB. Each application, heat sink and PCB can be different; wave soldering must be evaluated on a case-by-case basis. In any case, a well-balanced layer of solder should surround each pin.

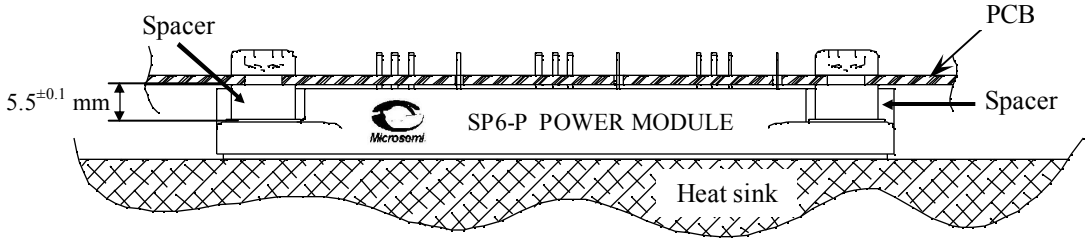


Fig 2: PCB screwed onto the mounting holes.

3. Thermal grease application

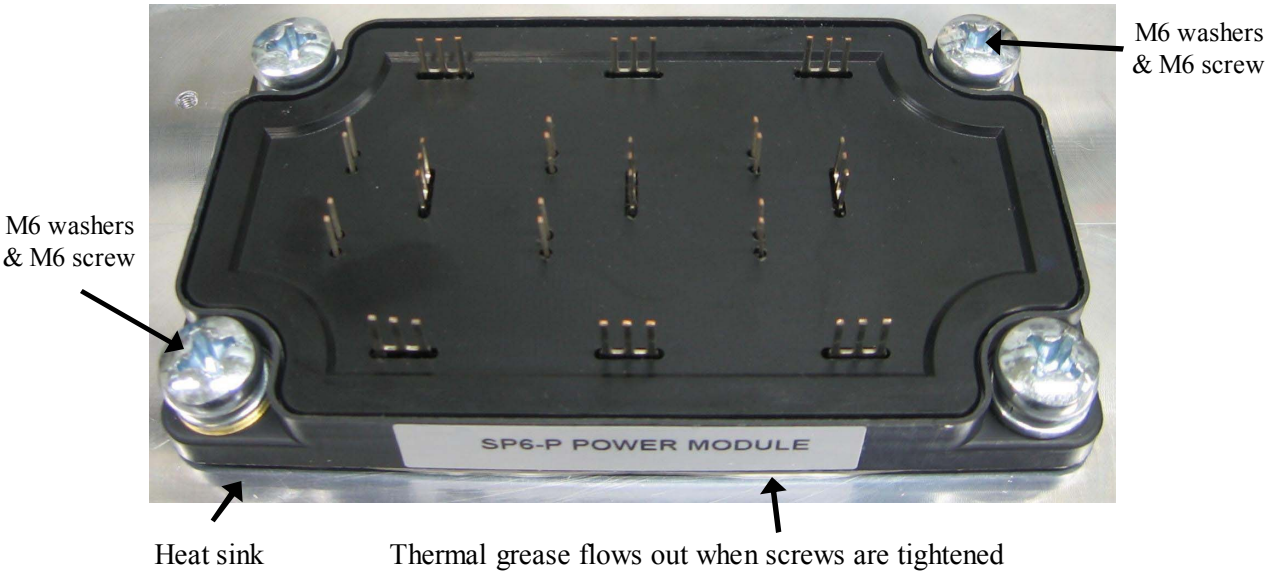
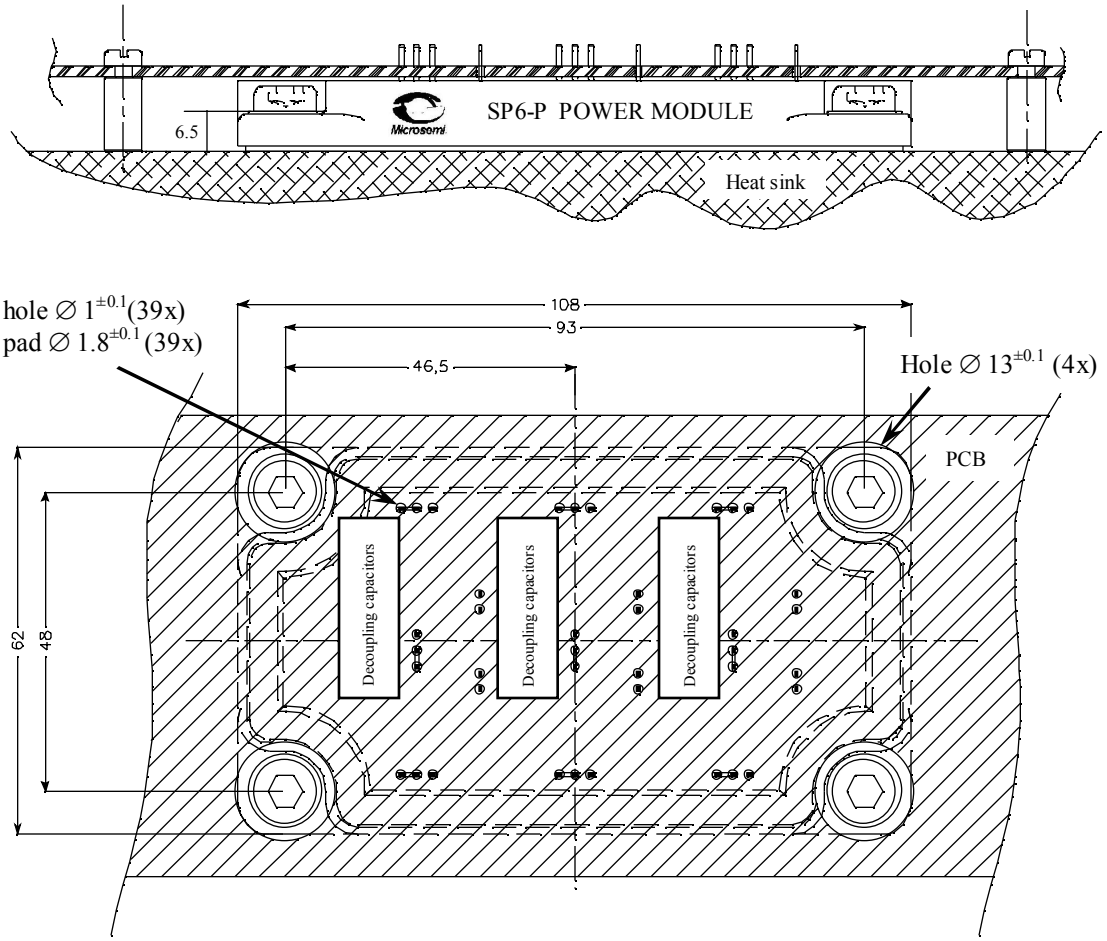


Fig 3: Proper application of thermal grease to the power module.

Fig 4: SP6-P base plate with properly applied thermal grease after removal from heat sink.

4. Holes diameters in the PCB.



* For spacers placed onto the mounting holes, hole diameter must be $6.8^{\pm 0.1}$ (4x)

Fig 5: Pad and hole diameters (in millimeters) for a 3 phase leg configuration.

Example of PCB specification:
Material Epoxy FR4 ; Type double side
Metallized holes ; Plating: tinning or gold
Conductor layers thicknesses in accordance with the current capability.

5. Connection push - pull forces.

When the PCB is mounted onto the power module and the terminals soldered to it, some mechanical forces may be applied to the terminals. Such push or pull forces must not exceed 10N (2.25lbf) maximum per individual connector. This acceptable maximum value of push-pull force may vary depending on the mounting and operating conditions.

Conclusion:

This application note gives the main recommendations regarding the mounting of SP6-P modules. Applying these instructions will help decreasing the mechanical stress both on PCB and power module and therefore will ensure long term operation of the system. Mounting instructions to the heat sink must also be followed to achieve the lowest thermal resistance from the power chips down to the cooler. All these operations are essential to guarantee the best system reliability and achieve the highest possible MTBF (Mean Time Between Failure).