Thermal Management with the PF600-1

In this application note, you will find information on thermal management considerations for the PF600-1.

Thermal Management with the PF600-1
Heatsink and Airflow Calculations

CONSIDERATIONS

For operation at full load, the PF600-1 must be able to dissipate about 100W. It relies on conduction cooling through the baseplate, whereby the copper baseplate of the PF600-1 is thermally coupled to a heatsink or other dissipating surface.

Because of this design criterion, the heat lost directly to the air around the unit is usually negligible. Forced air cooling of the components cannot provide adequate cooling, and may, by causing abnormal temperature gradients, defeat the thermal protection which will otherwise prevent damage to the unit in the event of overheating.

The maximum permitted baseplate temperature is 100ºC, as measured by a thermocouple placed in contact with the center of the baseplate through a small hole in the heatsink. If there is any doubt about the adequacy of cooling in a given installation, this should be checked under worst-case conditions: maximum load, lowest supply voltage, highest ambient temperature, dirtiest air filter, highest altitude, and so on.

The heatsink will typically be an aluminium extrusion, finned on one side, with forced air passing through the fins. Since other components will be used with the PF600-1, the heatsink can usually be larger than the PF600 dimensions, extending over such adjacent components and other modules, even where they also use the heatsink for heat dissipation.

There are then two concerns: to select and install a heatsink with an adequately-low thermal resistance, and to pass enough air through it at a sufficiently low temperature for it to be able to perform its task.

AIR FLOW

The temperature difference (ΔT) between air entering and leaving the heatsink should not be more than about 10°C. Because air has a thermal capacity (C_p) of 1005J/kgK, a mass flow rate (M) of about 0.01kg/s is required to remove power (P) at 100W. In general, $P = C_p \Delta T M$, assuming consistent units.

Air at 50ºC near sea level has a density of about 1.1kg/m³, so this equates to about 0.009m³/s (9L/s). Through a 150mm wide heatsink with fins say 30mm high, the air must move at least at 0.009/(0.03x0.15) = 2m/s, writing all quantities in fundamental units for simplicity. Note that this is an average across the air flow; some regions will be faster while the speed at the edges may be slower.

For other dimensions, or if there are other components dissipating heat to the same heatsink, the calculation must, of course, be adjusted accordingly.

HEATSINK SELECTION

It is then a question of heatsink design to ensure that the temperature difference between the air and mounting surface is sufficiently low. The theory is complex, but usually, a catalogue extrusion or assembly will be selected on the basis of its published characteristics of flow rate, thermal resistance, and mechanical constraints.

If the air flow is along the longer dimension of the heatsink, the effective width is likely to be less than in the above example, and the path through the heatsink longer. This will lead to a high pressure drop and, with its higher temperature rise, perhaps a lower flow rate. In most cases, this orientation is not optimum. The fins should preferably run across the shorter dimension, giving a lower pressure drop and air speed.

Other configurations are available, such as the “pin fin”, where air can move through in any direction. This is usually used with a fan blowing onto the end of the “pins”, as is popular for computer CPUs. The height of such assemblies, though, may make them unattractive here.

The “web”, or solid thickness of the extrusion excluding the fins, should be at least 6mm thick in order to carry the heat from the hot-spots of the module to the fins.

If possible, choose a heatsink with a fin pitch that allows all four mounting screws to sit between fins. This avoids the need to counterbore the mounting holes, saving cost and cut fins.

PF600-1 Thermal Management

Application Note

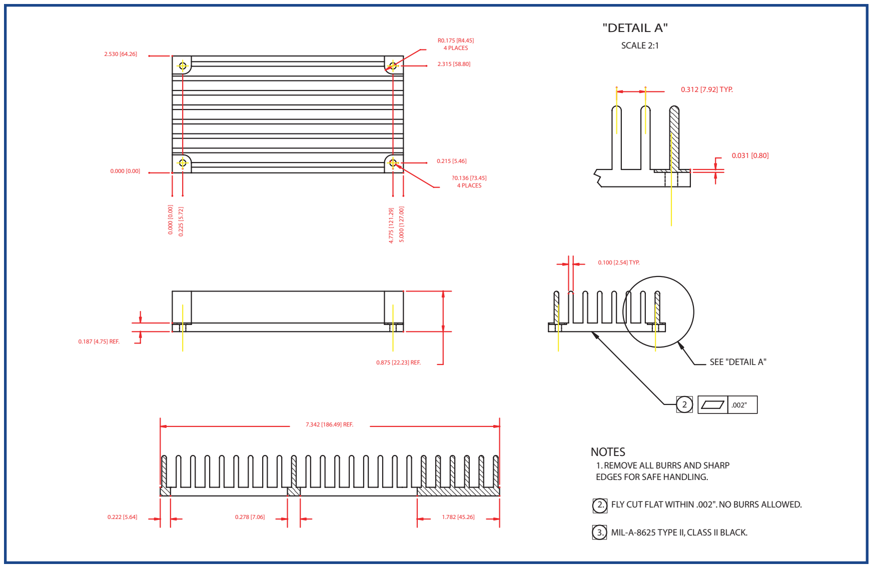
MOUNTING TO THE HEATSINK

The PF600-1 is secured to its heatsink with four M3 screws which engage threaded inserts in the corners of the module. They must penetrate at least 5mm into the module, but may pass all the way through, where they could serve additional securing function on the connection side of the module.

When fitting the module to the heatsink:

1. Ensure that both parts are clean.
2. Apply a bead of thermal compound such as Dow Corning 340 down the center of the baseplate, and additional beads at about 45º from each corner to the centerline.
3. Place the module on the heatsink and fit the screws. DO NOT FULLY TIGHTEN the screws at this stage, as the thermal compound spreads only slowly, and can damage the baseplate.
4. Gently tighten the screws, but only until the gap between the baseplate and heatsink is about 0.5mm near each corner. Ideally, leave the assembly in a warm place for 24 hours before fully tightening. The central area of the baseplate should not be visibly lifted by the thermal compound, and evidence of surplus compound should be present around most of the edge of the module. The baseplate is slightly dished, which helps to achieve good contact across the area.
5. During operation, the compound will continue to spread, filling remaining gaps. Surplus will continue to emerge from the edges, particularly after the first run under load.

LONGITUDINAL



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