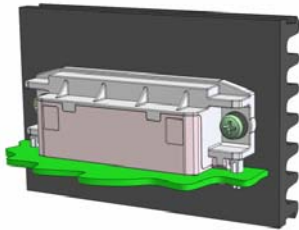


flow90PIM1 - Tyco Electronics introduces an innovative Power Module with 90° mounting angle

Michael Schulz, Tyco Electronics Sep. 2005

Tyco Electronics' flow90PIM power module (rectifier + BRC + inverter) can reduce soldering effort and preclude the need for specially constructed heat sinks. To this end, the module features a special design similar to that of discrete power components, enabling it to be mounted to the PCB at a 90° angle. This is a great advantage, particularly for narrow-chassis frequency inverters, for example, as utilized in control cabinets.



Yesterday

Power modules' design dictates the way they must be mounted. The module is mounted horizontally on the PCB. This can be done on the component side with other through-hole components or on the solder side. Both mounting options have specific advantages and disadvantages. For the former, the module can be soldered in a single pass together with the other through-hole components as depicted in Fig. 1a and thereby cut assembly costs. This mounting option's disadvantage is that it requires the use of special recessed heat sinks. The module cannot be soldered with other components if it is mounted on the flip side as shown as in Fig. 1b. It must either be soldered manually or by special soldering robots in a separate process. This entails higher manufacturing costs, and the risk of malfunctions usually increases with these soldered connections. In addition, some applications require that cooling is performed on the rear of the housing, that is, at a 90° to the PCB. For example, this is the case with devices designed for use in control cabinets, such as so called bookshelf inverters. This type of application mandates the use of heat sinks that first conduct heat to the rear of the housing as shown in Fig. 2. Next to entailing relatively high costs for the heat sink, this also appreciably diminishes thermal properties.

For these and other applications, Tyco Electronics has developed a new family of modules called *flow90PIM*. What sets this module apart from conventional power modules is its 90° package. It enables the implementation of a mechanical connection between the heat sink

and PCB at an angle of 90° within the device (see Fig. 2), without requiring additional mechanical components or special heat sinks.

Fig. 1a:

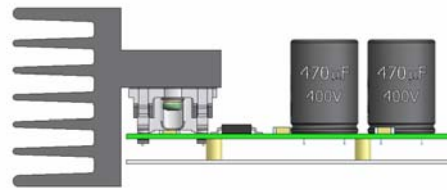
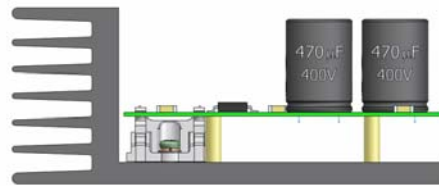
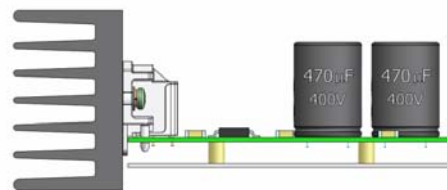


Fig. 1b:



Today

Fig. 2:

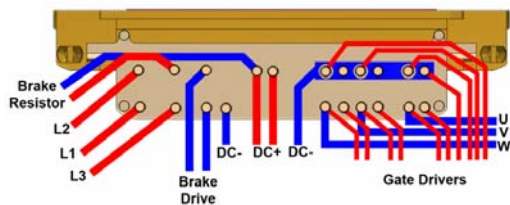


The power module is installed vertically on the same side as all other components rather than horizontally as it has been to date. In contrast to Fig. 1, the components are mounted on one rather than two sides, thereby eliminating an additional soldering operation. What's more, specially designed heat sinks are no longer required. This simplifies the manufacturing process and reduces operating costs. In addition, flow90PIM allows end devices such as frequency inverters to be built in a more compact format. This method of mounting modules is especially well-suited for power components in narrow control cabinets where cooling is performed at the back of the cabinet, as well as for all other applications requiring the heat sink and PCB to be arrayed at a 90° angle.

Two plastic clips that engage in the PCB serve to attach the module to the board. The heat sink may be affixed conventionally using screws or with the aid of two clips. The clips screw onto the heat sink or wedge into a groove. Clip fastening can prove very useful in instances where it is difficult or impossible to screw the module on because larger components such as capacitors stand in the way. *flow90PIM*'s housing is designed to preclude the need for additional mounting brackets near the module between the PCB and heat sink. This also cuts the costs of assembly material and mounting. In addition, it prevents potential tolerance differences when additional spacers or brackets are employed.

As the product designator "flow" indicates, Tyco Electronics develops all modules to ensure utmost simplicity in the wiring of circuits on the PCB and low-inductive internal and external circuit tracks. This applies especially to *flow90PIM*, wherein longer circuits were used for the less critical network interface and motor connections, and shorter and consequently low-inductive circuits were used to implement the critical link to the intermediate circuit capacity. The possibility of wiring with a low-cost, two-layer PCB was decisive to this end (see Fig. 3).

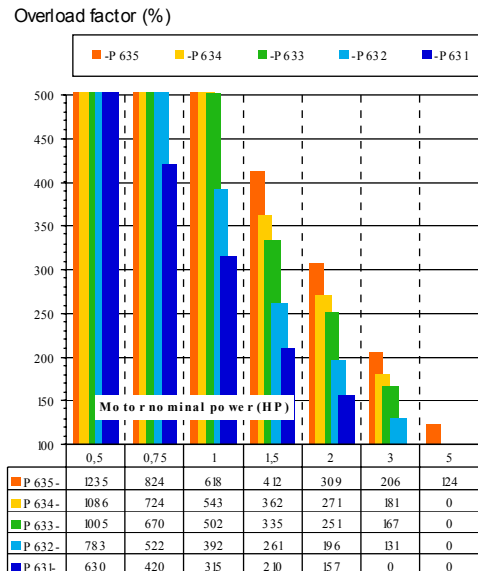
Fig. 3:



The "90" stands for the mounting angle between the module and PCB, which can now be implemented far more easily. PIM (Power Integrated Module) designates the topology of the integrated circuit, an input rectifier, a brake IGBT with recovery diodes, and six inverter IGBTs and their recovery diodes. The module is available in 600-V and 1200-V versions, whereby the design of the module and the circuit array comply with air and creepage clearances according to UL. A plastic apron was integrated specifically for the heat sink; it extends beyond the PCB so that circuits may be routed between the connectors and the heat sink in compliance with air and creepage clearances. If the module is not sited at the edge of the PCB, the perforated plastic shield can be removed by simply snapping it off.

Selecting modules

flow90PIM 1 is available with different currents - 600-V and 1200-V (6, 10, 15, 20, 30 A at 600 V and 8, 15 A at 1200 V). With dimensions of 83.5 x 37 x 20 mm, it is extremely compact and leaves a very small footprint on the PCB. A selection guide is provided to help select the right module for the given application and motor power. It indicates peak motor power according to the selected module, switching frequency, heat sink temperature and overload factor. Fig. 4 is an excerpt from the selection guide that provides a view of the modules' output power. The various modules are represented in the diagram by bars of different colors. Motor output power is indicated on the X axis and the overload factor on the Y axis at 16 kHz switching frequency, 85°C heat sink temperature and 125°C chip temperature. Fig. 4:



The blue module, that is, the V23990-P631-A, satisfies the requirements of a frequency inverter with a 2-HP motor and a desired overload factor of 150%. Applications demanding a higher overload factor or a larger motor require a more powerful module, for example, the V23990-P632-A. Once a suitable module has been pre-selected with help of the selection guide, the module can be sized precisely using the data sheet and the available application note (see: <http://www.flowpim.com>).

Trench Field Stop technology

Trench-field-stop IGBTs are used in *flow90PIM 1*. This technology serves to attain lower collector-emitter saturation voltages and consequently lower forward resistance, while fast switching performance is ensured. This is achieved using an additional layer between n⁻ substrates and the collector, the so-called field stop, as well as a vertically arrayed gate called a trench gate. The field-stop technology's addi-

tional layer enables the overall gauge of the wafer to be reduced, thereby reducing forward resistance as well as the tail current during switch-off. The vertically arrayed gate also improves forward resistance while the IGBTs' short-circuit stability is ensured, a property that is very important for motor drives. The trench-field-stop IGBT is thus particularly well-suited for applications with switching frequencies up to 20 kHz. Faster IGBT variants or MOSFETs are also used.

Summary

Equipped with an integrated input rectifier, brake and motor inverter, *flow90PIM* combines the advantages of a power module - for example isolation, good thermal coupling with the heat sink and enhanced reliability - with the advantages of the 90° mounting option customarily used for discrete components. When mounted vertically on the board, the module can be installed on the same side as other through-hole components, and wave-soldered along with these other components in one pass. The heat sink is mounted at a 90° angle to the board, thereby eliminating the need for special housings as depicted in Figure 1. Available in 600-V and 1200-V versions rated for 6 to 30 A currents, *flow90PIM 1* covers a wide range of power applications.

Tyco Electronics provides a special selection guide (see Fig. 4) to help users choose the suitable module for the given application, while taking the frequency, temperature and overload factor into account. With this guide, the right module can be determined very quickly for the desired motor power.