Scaling up energy efficiency with EC drives based on intelligent power modules

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Energy efficiency figures prominently in recent product designs. For good reason: The potential for energy savings is great, especially in pumps, fans, and others devices that run around the clock. Electronic commutated (EC) motor drives can be up to 90% more energy efficient than conventional motor drives. Manufacturers who aim to tap this rich potential need compact and reliable power electronics. And if they opt for highly integrated power electronics such as IPMs, they can also benefit from vastly accelerated time to market.

Manufacturers are compelled to do their part to achieve lofty climate protection goals and contain rising energy costs. This is why many engineers seeking to develop innovative new products are focusing first on reducing energy consumption. Fans, pumps, compressors, air-conditioning units, and the like run continuously, so their potential for energy savings is considerable. The motors in these applications often operate at partial load. Unfortunately, the classic motor drive performs efficiently only when running at full load. The answer would seem to be intelligent motor drive electronics. However, limited space, environments lacking air circulation, and demanding EMC specifications pose daunting challenges for such power electronics.

EC drives for utmost efficiency

An electronic commutated (EC) motor drive is the best means of maximizing the efficiency of such applications. It drives the motor coils always with optimum power, also when running on a partial load. This increases overall energy efficiency enormously. However, it does take several power electronic components to implement an EC motor drive. For one, AC line power has to be rectified to DC voltage. A PFC circuit may be used to reduce reactive power and enable remarkably variable input voltages, for example, ranging from 90 to 230 VAC. The next stage, the inverter, generates the voltage necessary to drive the EC motor.

Such a system requires at least a dozen power semiconductors. Conduction and switching losses dictate that they must be cooled by a heat sink. Map the circuitry of and assemble so many discrete power semiconductors are a very difficult tasks, especially when dealing with applications where space is a concern.

There is an elegant way to resolve this issue – by using power modules. They provide all the necessary power semiconductors in one integrated package that mounts directly to the heat sink. Different models are available for rectifier, inverter, and PFC circuits. All components within the module feature low inductive connections to improve performance and tackle EMC problems. One example of a power module equipped with all the aforementioned components is Vincotech's *flow*PIM 0 +P for up to 2.2 kW output power.

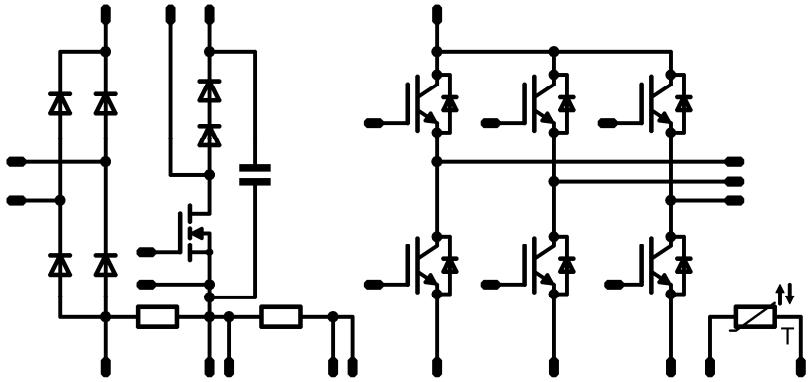

Figure 1: Schematic of *flow*PIM 0 +P

So power modules resolve the main issues associated with electronic motor drives. However, the engineer still needs to design the driver circuit, which can prove to be a very tricky task and may send him back to the layout several times. Enter the intelligent power module (IPM): They integrate power semiconductors, including driver circuit components, which takes care of the driver circuit design problem. In the outcome the power semiconductors are switched with logic-level input voltages.

Ultra compact design with an IPM solution

There is just one IPM solution available now that integrates the rectifier, PFC, and inverter in a single package - *flow*IPM 1B from Vincotech. This 72x36 mm² module also contains the entire driver circuit (including bootstrap diodes and capacitors), shunt resistors for the PFC and inverter, an NTC, and a small DC link capacitor (see Figure 2). All these components sit right on a ceramic substrate. Featuring very good thermal conductivity, this ceramic can be mounted directly to the heat sink to ensure all components are cooled to maximum effect. This is a tremendous advantage because power semiconductors' performance, efficiency, and lifespan depend very much on good cooling. The same goes for components such as driver circuits and shunt resistors, especially in hermetic environments lacking air circulation.

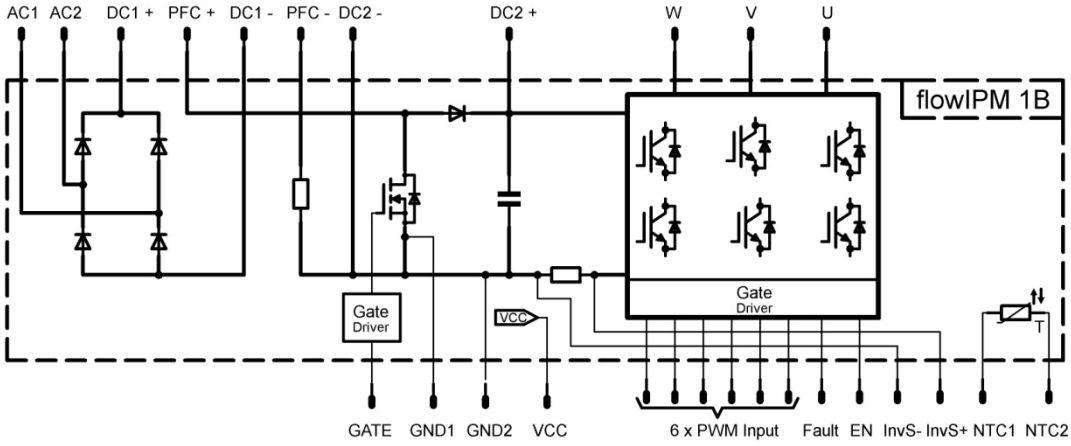

Figure 2: Schematic of flowIPM 1B

The *flow*IPM contains all power semiconductors and most peripherals required for an EC motor drive application. Only the large passive components and control logic have to be

mounted separately. Pins are arrayed in two separate lines, one providing power connections and the other routing control signals. This array prevents any crossings of power inputs and outputs (see Figure 3). Equipped with logic-level inputs, the driver circuit may be connected directly to a microcontroller or the like. The module is available in versions with 1 and 2 kW maximum output power.

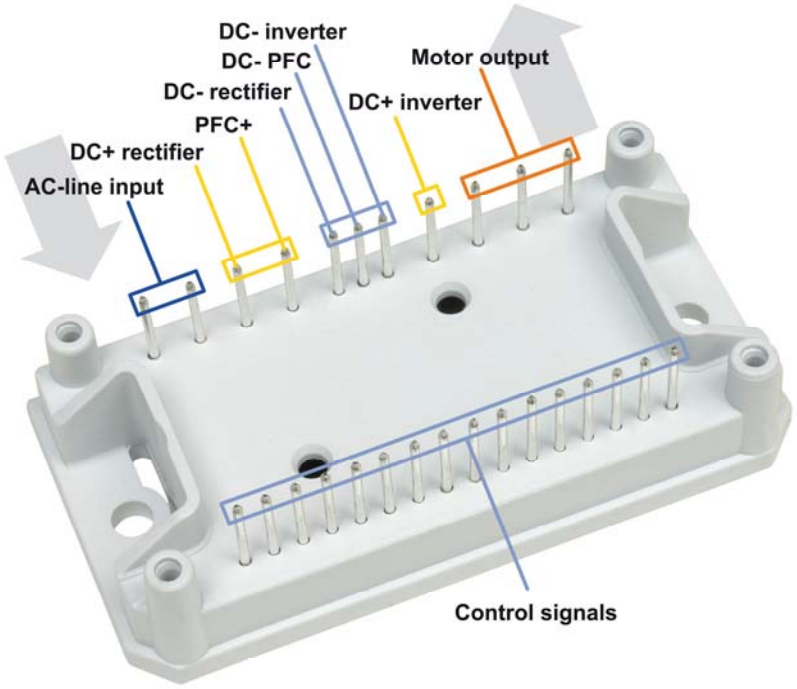

Figure 3: Arrayed in- and ouputs of flowIPM 1B

The ultra compact design of the *flow*IPM 1B is more than merely a space-saving feature. A combination of closely connected components and an integrated capacitor for the DC link prevents HF loops. Parasitic inductivities are limited to reduce voltage overshoots during switching operations. All this adds up to very good EMC performance.

The benefits of easy assembly

The *flow*IPM also comes with a host of unique features engineered to expedite assembly. Equipped with optionally available Press-fit pins, the module is mounted to the PCB without any soldering. This is a big plus during manufacturing, especially when the module is mounted from the bottom. An optional pre-applied phase change material can provide a very good and reliable thermal interconnection between the module and heat-sink. The module is also protected against humidity and harmful gases. Its creepage and clearance distances are in line the applicable industrial standards

Figure 4: flowIPM 1B with phase-change material

Seeking to provide optimum design-in support and help accelerate time to market, Vincotech offers a complete evaluation board for the *flow*IPM 1B (see Figure 5). It provides a complete 1 kW PFC stage, including all passive components and the PFC controller. All the engineer has to do is connect it to a motor control board, and then a complete motor drive may be created in just a few steps. Microcontroller vendors furnish motor control boards to help manufacturers assess their products' motor drive capabilities.

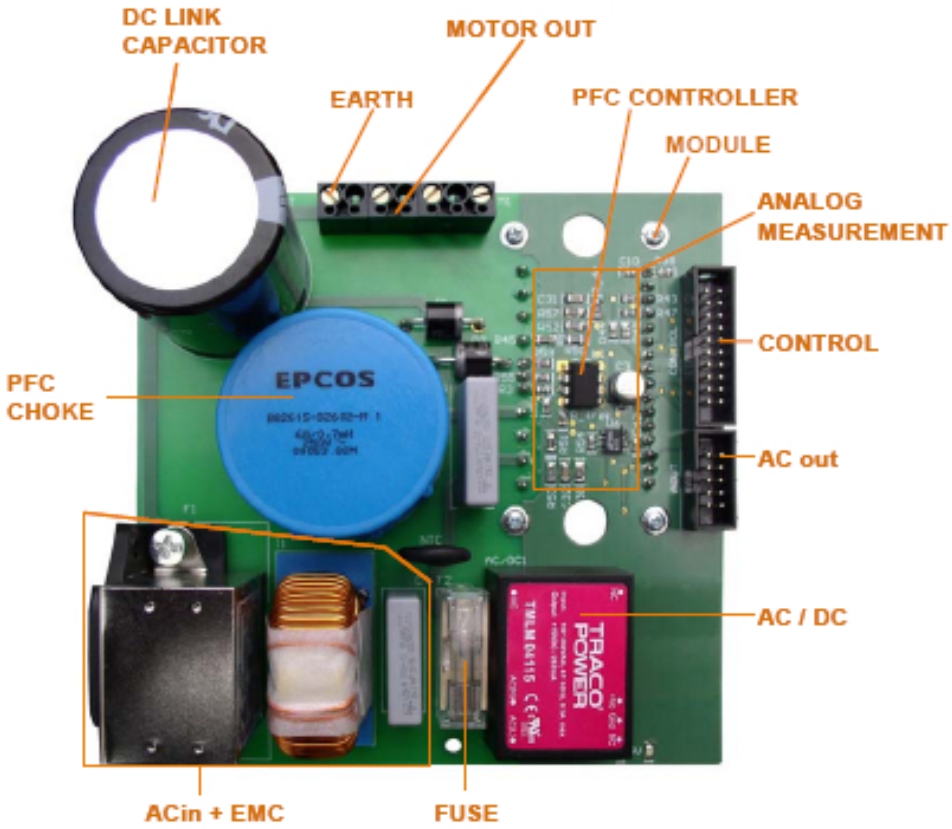

Figure 5: Bird's-eye view of a *flow*IPM 1B evaluation board

Conclusion

EC motor drives are the best solution for applications where energy efficiency matters. However, they require power electronics that are not easily implemented where space is limited, air flow is lacking, and EMC specifications are demanding. This makes integrated power electronics such IPMs the solution of choice. And the state-of-the-art, easy-to-use Vincotech *flow*IPM 1B is the most complete power electronics solution available for embedded motor drive applications.