

Fast Switching for Welding Equipment

Satisfying demands in power, size and price

In recent years, welding equipment has become increasingly lighter and physically smaller. In the case of welders of higher power, size is becoming increasingly important as a cost factor, e.g. in determining the total surface of a production line. For handheld equipment, size and weight are critical. In both cases, the price pressure is high.

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The fastPACK 0 H 2nd gen and fastPHASE 0 families of power modules are Vincotech’s answer to these requirements. The portfolio of CoolMOS and fast IGBT full-bridges and half-bridges, along with optional AlN substrate and/or integrated capacitors, enable the fast switching required to reduce the size of the transformer. Featuring chips of various sizes, these modules cater for almost every need in welding for up to approximately 30kW as single modules. The compact flow0 housing and efficient layout design, lead to a high power per area rating, thus satisfying the demands for both small size and low price.

Overview of fastPACK 0 H 2nd gen and fastPHASE 0 modules

An overview of the modules in question can be seen in Table 1.

- The technologies used are
- 600 V: CoolMOS and High Speed IGBT2
 - 1200 V: Fast IGBT2
 - Optionally available is an AlN substrate instead of the standard Al₂O₃ substrate for better thermal performance. The P72x modules feature the same layout and components as the P62x family and additionally feature internal DC link capacitors for reduction of E_{off} losses.

The simulation results shown throughout this document were generated using a linear interpolation model,

600V	1200V
U _{out} = U _{dc} = 320V R _{gon} = 4 Ohm R _{goff} = 2 Ohm	U _{out} = U _{dc} = 600V R _{gon} = 6 Ohm R _{goff} = 6 Ohm
T _j = 125 °C I _{outpeak} /I _{out} = 1,3 T _{sink} = 60 °C to 100 °C in steps of 10 °C ZVS DC output	

Table 2: Parameters for application examples.

based on actual measurements. This tool allows the comparison of two modules under the same conditions.

Part	Configuration	Voltage	Current	Technology	Substrate
P622-F64*	H	600 V	30 A	CoolMOS	Al ₂ O ₃
P622-F74*	H	600 V	30 A	CoolMOS	AlN
P623-F04*	H	600 V	60 A	High Speed IGBT2	Al ₂ O ₃
P623-F14*	H	600 V	60 A	High Speed IGBT2	AlN
P569-F40	Half bridge	1200 V	100 A	Fast IGBT2	Al ₂ O ₃
P569-F50	Half bridge	1200 V	100 A	Fast IGBT2	AlN

*optionally available with internal DC link capacitors (P72x family)

Table 1: Overview of fastPACK 0 H 2nd gen & fastPHASE 0 modules for welding.

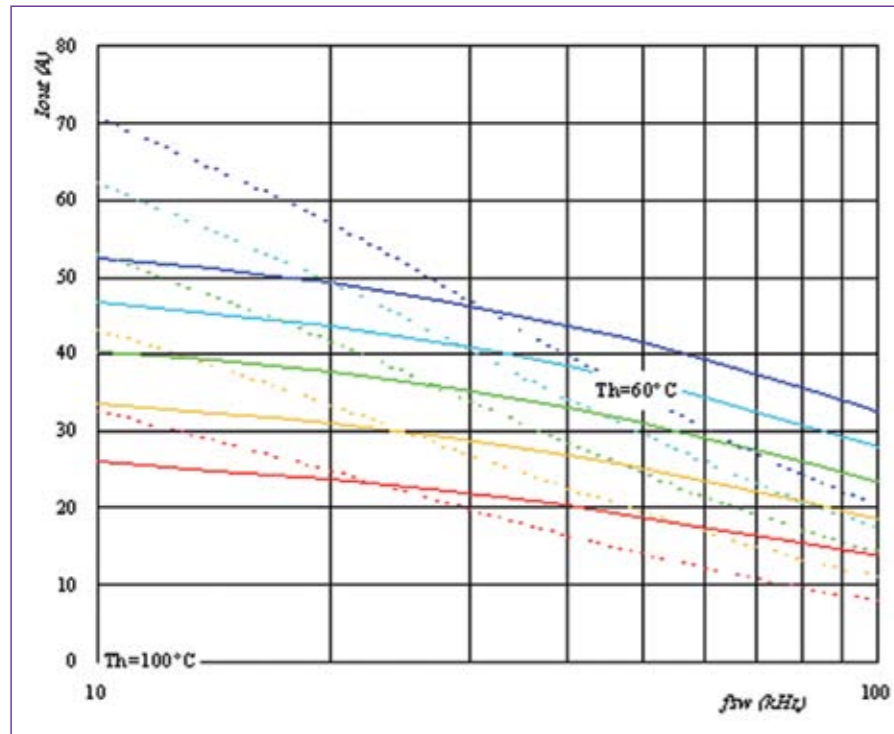


Figure 1: 600V High Speed IGBT2 vs std IGBT3
Typical available current at $T_j = 125^\circ\text{C}$ as function of frequency (parameter: heatsink temperature)
• continuous lines: P623-F04 (60 A rating, High Speed IGBT2)
• dashed lines: P625-F24 (75A rating, std IGBT3)

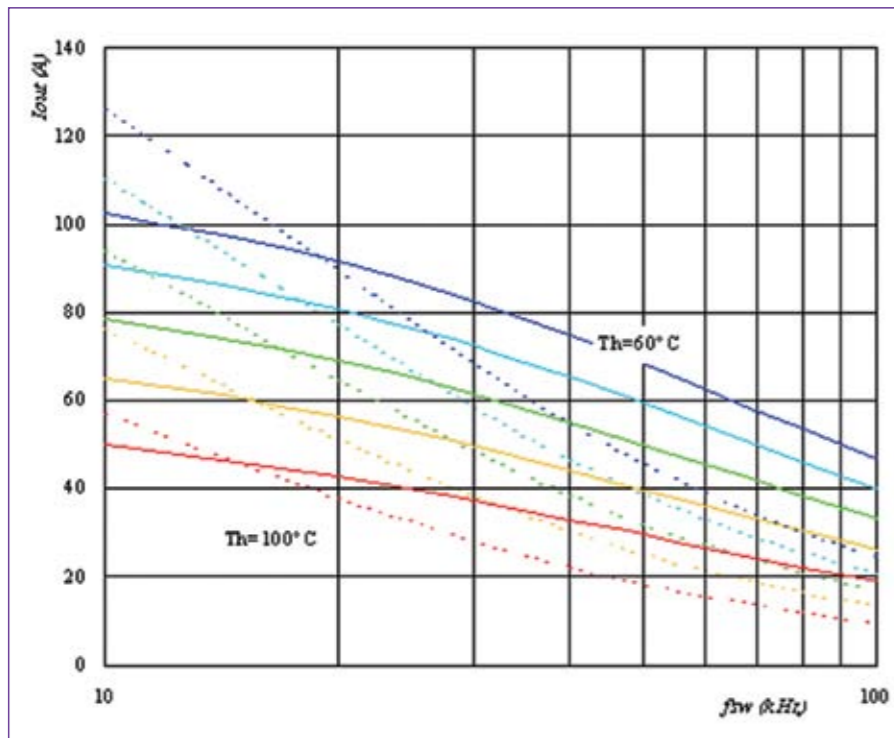


Figure 2: 1200V fast IGBT2 vs std IGBT3
Typical available current at $T_j = 125^\circ\text{C}$ as function of frequency (parameter: heatsink temperature)
• continuous lines: P569-F50 (100A rating, Fast IGBT2)
• dashed lines: P569-F30 (100 rating, std IGBT3)

The cases simulated are for DC to DC conversion using Zero Voltage Switching, which is typical for welding. A more detailed simulation tool is flowSIM, the power module simulation tool by Vincotech.

Component Technology

At 600V, CoolMOS is used for the P622 and P722 modules. It is ideal for applications requiring extremely fast switching without short circuit capability. High Speed IGBT2 at 600V and Fast IGBT2 at 1200V are IGBT platforms designed for extremely fast switching. A comparison between the different technologies based on an application example can be seen in Figure 1 (600 V) and Figure 2 (1200 V). The conditions chosen are typical for welding and can be found in Table 2 below.

As can be seen in Figure 1, for any frequency above 13 kHz to 18 kHz (depending on the heatsink temperature), the High Speed IGBT2 module P623-F04 provides a clear advantage over the even higher rated IGBT3 module P624-F24. At 1200V, the Fast IGBT2 module P569-F50 performs better than the equally rated standard IGBT3 module P569-F10 for any switching frequency above 10 kHz (Figure 2).

DC link capacitors

The internal DC link capacitors of the P72x family aim at reducing the parasitic inductance and the E_{off} losses during switching. The great advantage of capacitors inside the package is the extremely short current path. As can be seen in Figure 3, the switch-off overvoltage peak in a module with capacitors reaches 120% of the nominal DC voltage, as opposed to 138% in a module without capacitors. This 15% reduction in the turn-off voltage peak extends the lifetime of the module and increases its reliability. In some cases, it even makes the use of lower rated components possible.

The conditions used for the example above were:

- U_{ce} (100%) = 400 V
- U_{ge} (100%) = 15 V
- I_c (100%) = 60 A
- R_{gon} = 4 Ohm
- R_{goff} = 2 Ohm

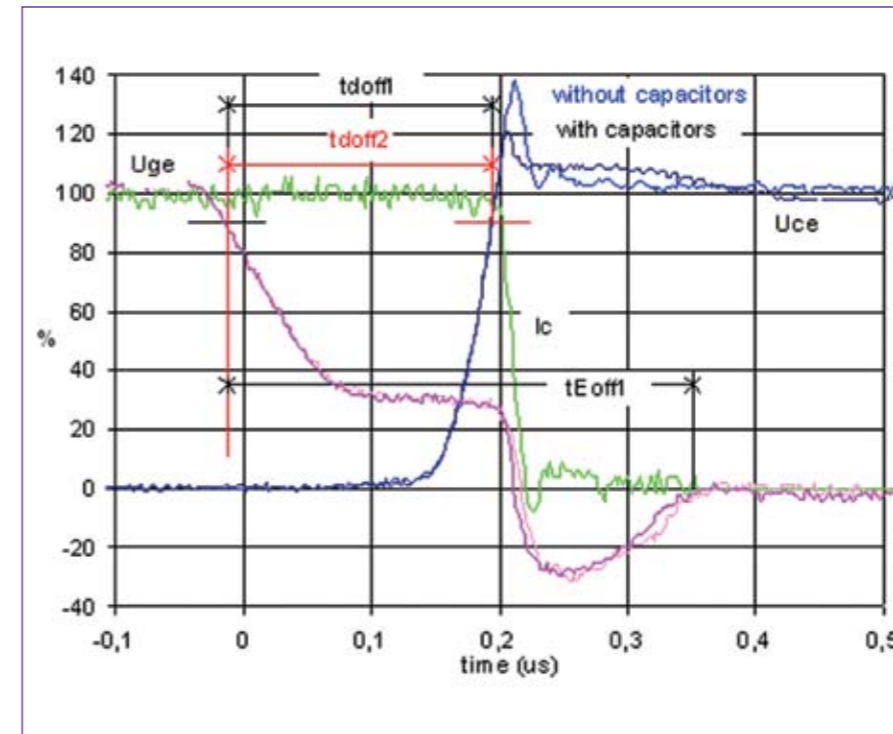


Figure 3: Turn-off characteristics w/o internal capacitors
• light coloured lines: P623-F10 (no capacitors)
• dark coloured lines: P723-F10 (with internal capacitors)

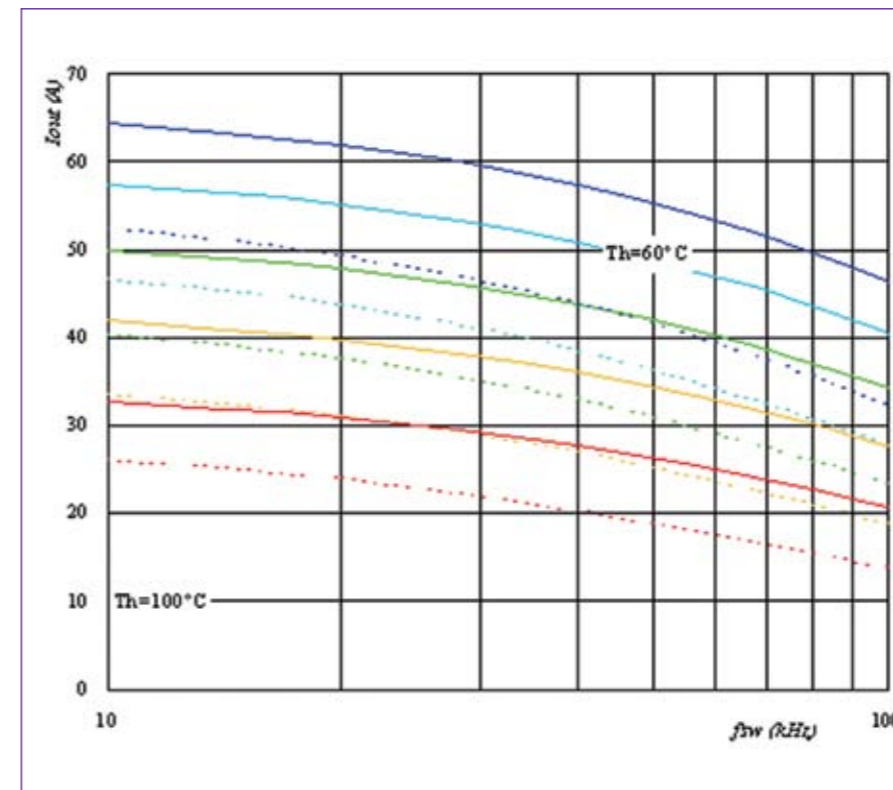


Figure 4: AIN vs Al_2O_3 substrate
Typical available current at $T_j = 125^\circ\text{C}$ as function of frequency (parameter: heatsink temperature)
• continuous lines: P623-F10 (AIN substrate)
• dashed lines: P623-F04 (Al_2O_3 substrate)

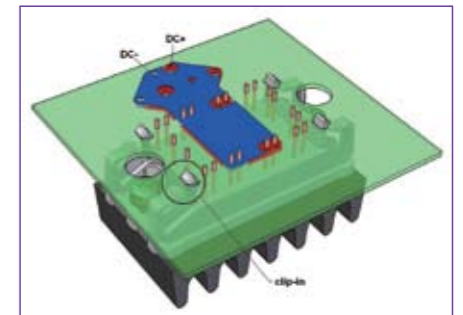


Figure 5: P62x family with DC+ & DC- side by side in flow0 housing with easy clip-in mechanism.

AIN substrate

The AIN substrate reduces the thermal resistance of the module by approximately 30% compared to a module with an Al_2O_3 substrate. The lower temperature rise means that smaller chips and potentially smaller modules can be used, or that a higher switching frequency can be used, leading to an advantage in size and price. Figure 4 illustrates the advantage of a module with AIN (conditions in Table 2). The two modules used are identical, apart from the substrate.

flow0 housing

The flow0 housing features a number of advantages: it is compact (66 mm x 13 mm x 17 mm), flexible in pin position and therefore with optimized DCB layout and pinout (DC+ and DC- side by side for low inductive supply) and easy to mount onto the PCB (via clip-in mechanism). For details see Figure 5.

Conclusion

The fastPACK 0 H 2nd gen and fastPHASE 0 families are designed to meet the requirements of today's welding manufacturers: fast switching in a compact design. Single modules cover up to 30 kW; due to the positive thermal coefficient of the IGBTs, chips can also be paralleled in order to achieve higher power. Vincotech also offers the corresponding input rectifier stages in the flowCON 0 family (P590 and P600), as well as PFC stages (P80x family).

For more information please visit: www.flowpim.com, or contact Vincotech directly.

www.vincotech.com