

# “Cool” Solutions for Hot Applications

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## 1 Abstract

*Vincotech’s PIM with integrated Power Factor Correction (PFC) circuit is a unique and innovative topology for power modules featuring a high level of integration. It represents the best compromise between cost and performance for applications requiring high power density.*

## 2 Market trend for Renewable energy

Societies around the world are on the verge of a profound and urgently necessary transformation with the way they produce and use energy. This shift is moving the world away from the consumption of fossil fuels towards cleaner, renewable forms of energy. The rapid deployment of renewable energy has been driven mainly by a wide range of drivers, which include advancing economic development, improving energy security, enhancing energy access and mitigating climate change.

Among the others, heat pump systems offer economical alternatives of recovering heat from different sources to be used in various industrial, commercial and residential applications. As the cost of energy continues to rise, it becomes imperative to save energy and improve overall energy efficiency. In this light, the heat pump becomes a key component in an energy recovery system with great potential for energy saving.

In addition, the growth in the construction industry and the stringent regulations, introduced by governments in developing nations for promoting renewable energy globally, will stimulate the growth of the global heat pump market.

High safety, less maintenance, and low operational costs are some of the key underlying features complimenting the market demand of these units when compared to the combustion-based heating systems.



### 3 Vincotech's product portfolio for heat pumps

Increasing the power density is one of the main goals in the design of heat pump and HVAC systems. This goal can be achieved by:

- a) moving towards more compact designs
- b) increasing the efficiency of the energy conversion
- c) integrating more cost-effective solutions

Vincotech's PIM with interleaved Power Factor Correction (PFC) circuit is a unique and innovative topology for power modules featuring a high level of integration as well as improved energy conversion efficiency. Interleaved configuration offers several benefits including:

- ease of PCB design
- higher efficiency of the energy conversion
- better heating distribution
- smaller components on the PCB
- easier design of EMI filtering
- reduced output RMS current

Vincotech's new 600V *flowPIM* + PFC family is composed of three different sub-families featuring two-leg interleaved PFC circuit with and without an integrated input rectifier, and three-leg interleaved PFC without an input rectifier, respectively (see Figure 1). All of them are equipped with both a three-phase motor inverter and a temperature sensor.

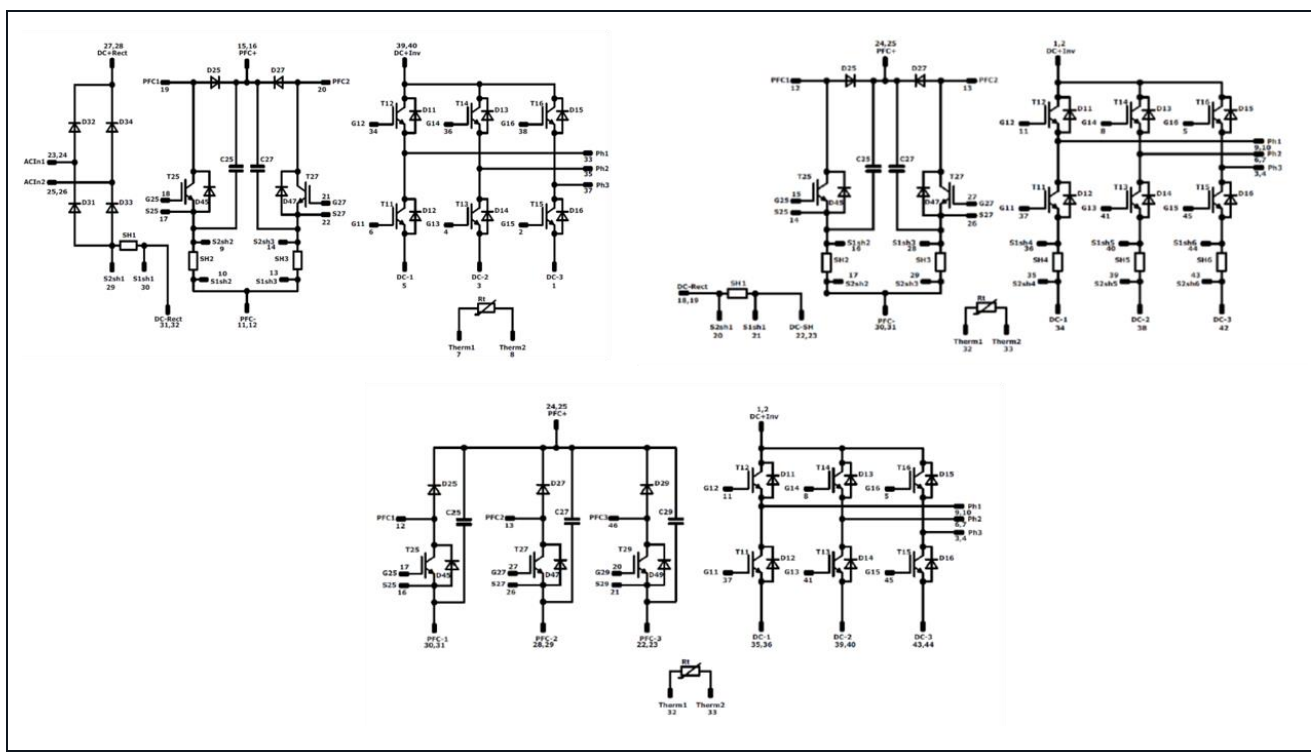


Figure 1: Streamlined schematics of the 600V PIM with interleaved PFC

Products with two-leg interleaved PFC feature also shunt resistors in the motor inverter as well as PFC circuit. The common and leg shunts in the PFC allow a perfect balancing of the current in the PFC circuit that leads to an increased lifetime of the chipset. The integrated shunt resistors in each leg of the inverter result in vastly improved motor control. Furthermore, the DC-link voltage overshoot is dramatically reduced thanks to the on-board capacitors (see Figure 2).

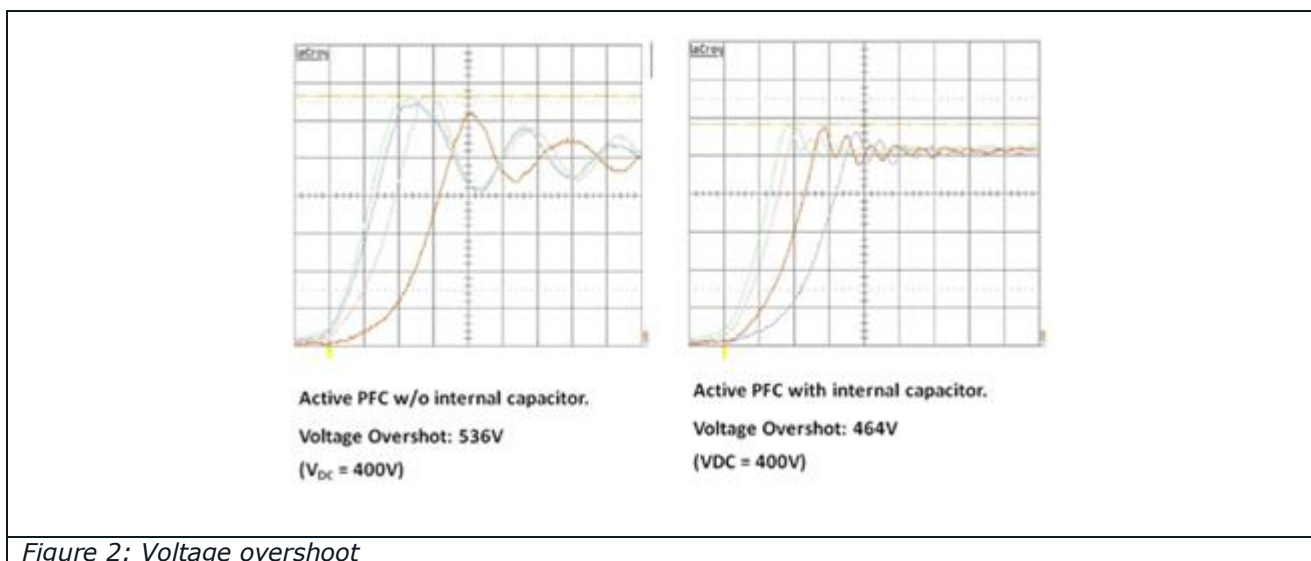


Figure 2: Voltage overshoot



Special care is paid to the layout of the products in order to offer the best compromise between cost and performance. The power pins on the edge of the power modules result in a simplified and a more cost-effective PCB design. The thermal design is also optimized thanks to the separation of inverter and PFC parts.

Vincotech's 600V *flowPIM* + PFC comes in a compact *flow 1* housing equipped with Press-fit pins (see *Figure 3*). Press-fit technology reduces PCB assembly time and effort considerably by eliminating the need for soldering. This cuts process time and costs and boosts production output.



*Figure 3: Press-fit pins for solder-less mounting*

The module's creepage and clearance distances fulfill the applicable industrial standards. There are no special requirements regarding the shape of the heat sink. The thermal interconnection between the 600V *flowPIM* + PFC and the heat sink is vastly improved by pre-applying phase-change material.

Vincotech's in-house screen-printing process deposits the material with great precision, achieving the proper thickness. The material can be optimized for maximum heat transfer capability.

## **4 Conclusion**

Fueled by the rising preference of consumers toward more energy efficient and environment friendly products, heat pumps are predicted to gain more demand in the coming years.



Increasing the power density and the efficiency are some of the main goals in the design of such kind of systems.

Vincotech's PIM with integrated Power Factor Correction (PFC) circuit is a unique and innovative topology for power modules featuring a high level of integration as well as improved efficiency. It represents the best compromise between cost and performance for power systems based on renewable energy requiring higher power density and energy conversion efficiency.