

# COMFORT WITH CONSERVATION

## Latest reverse conduction IGBT technology for air-conditioning systems

By Thomas Kimmer and Mark Thomas

The demand for energy in our world is increasing dramatically. A large portion of this demand comes from air-conditioning systems that are running over all the different climate zones. Energy saving can be optimized using variable frequency drives with the best cost and performance-optimized power electronics.

### Increasing demand of power electronics for inverter drives

The demand for these systems is increasing resulting in a usage of high efficient systems that can only be realized with the utilization of modern power semiconductor devices. The

increasing demand on power electronics is driven by strong factors that are not only based on end-customer requirements in electricity saving, but also programs of governments emphasize the usage of advanced solutions for the compressor and the fans in air-conditioning-

systems. Power electronics usage is a common trend in washing machines, fridges, freezers and dryers basically effecting a wide range of the so called white-goods applications that are benefiting from the usage of frequency variable drives. Trends are set by the white good producers that implement drives and inverters that can bring their systems energy consumption down to fulfill the requirements set by energy efficiency classes that go beyond the commonly known classes like A++. Differentiation in the market is done with new strategies that quote top-runner models of the year or systems that are 40% more efficient than the A group are

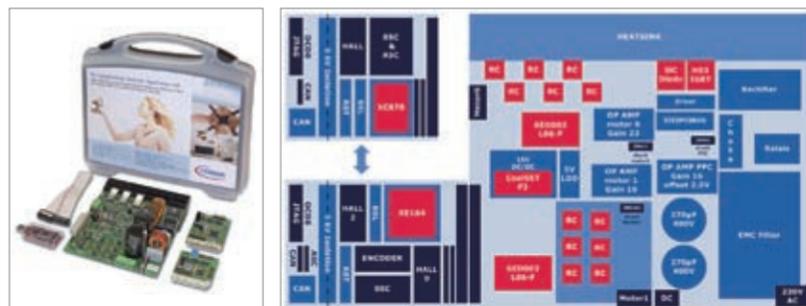


Figure 1: Application reference design for air-conditioning systems.

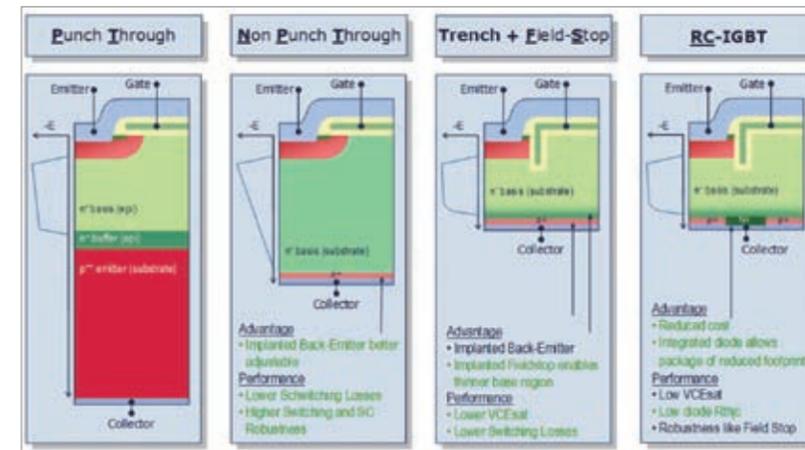


Figure 2: Vertical structure of IGBTs as a generation evolution.

labeled with “A-40 per cent”.

Infineon offers a wide portfolio of energy saving chips for the whole system chain of power electronic devices for air-conditioning systems. To enable engineers a fast entry in the usage of our devices we developed a reference design that controls the compressor and the fan with minimized bill of material to achieve an efficient and powerful control for air-conditioning system shown in Fig. 1. The reference design is split into an inverter section and a control section realized on two separate printed circuit boards. This enables the user to interchange different controllers and adopt existing control solutions.

The reference design uses the industry standard field orientated control with a single-shut solution to lower the energy consumption and increase the comfort functions. In air-conditioning systems the usage of induction machines is quite common, but

they are usually running with a constant speed. Inefficient mechanical switching stages are used since they are simple and easy to implement. The usage of permanent magnet synchronous machines is not only resulting in a size reduction of the system they are also resulting in a silent operation and an increase of efficiency.

### Innovative semiconductors for air-conditioning systems

A recent trend is the application specific usage of power electronic devices in the form of discrete products. In the last years more and more modules where established in the motor-inverters, due to the simplified design in procedure and the production simplification. Due to a multiple sourcing strategy and a flexibility in selection of the different semiconductor sections the trend now goes in the opposite direction enabling cost saving potentials with discrete devices. Microcontrollers, drivers

and power semiconductors can be arranged in the wanted configuration. But not only the selection of the best fitting devices is an issue also the thermal design and the production facilities have to be taken into account. To help our customers with this process the “Air-Conditioning Inverter Kit” was released to guides engineers to realize a price optimized system. On a single PCB a compressor up to 1.2kW and a fan (200W) can be controlled. The board can run on the 110V and the 230V grid and offers with the microcontroller board the two motor-inverter and the PFC.ds with an 8-Bit controller (XC-878) that is capable of controlling PFC and a single motor and the 16-Bit controller (XE-164) for controlling two motors and the PFC.

In air-conditioning inverters a B6-full bridge configuration is used where the IGBT is the most preferred power semiconductor since it has all the preferences on a high power density and a good commutation behavior of the anti-parallel diode. The most recent IGBT TRENCHSTOP™ technology now replaces conventional non-punch trough und punch-trough IGBTs in all frequency classes and offers an extremely performant usage in terms of overall power losses, EMC behavior and cost effectiveness.

Usually the IGBTs used in inverter systems are using a freewheeling diode that is integrated in a duo-pack solution using two dies in a

