

Application-specific dissipation of waste heat required

## Frequency inverter cooling calls for properly matched fans

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*High-performance semiconductors can switch enormous energy fluxes in a minimal construction volume. However, even with very good efficiency, the power losses add up to considerable amounts. In each operating state, reliable dissipation of this waste heat is required. As it is available always and everywhere, air is the cooling medium of choice in most cases. To make controlled and targeted use of the air flow, various fan concepts and design versions have proven useful. The dream of "one for all" will always remain unfulfilled – rather, it is important to filter out the best options for the specific application from the wide variety of options. In doing so, many years of experience and a wide product range help to present fast solutions.*

Frequency inverters, which distribute the current flow from the power line to consumers as required, enable energy-saving operation of motors. However, frequency inverters are also used in applications other than drive engineering. For inductive loads such as welding transformers, for example, they enable drastic savings in weight and a higher output with a smaller construction volume. As power loss also occurs in frequency inverters, reliable dissipation is required for this as well. Fan specialist ebm-papst from Germany's Black Forest region offers a wide variety of different fan solutions for the area of frequency inverter cooling. These range from the reliable standard model to customer-specific solutions. By request, the customer units are measured in our own test lab with regard to operating point, noise and air performance to attain optimum cooling.

### Powerful basic version

For state-of-the-art compact fans from current production, certain characteristics are always required, regardless of the model and application. For example, the energy consumption is to be as low as possible. Good closed-loop speed control that allows the fan to be adapted to various operating states or customer requests is just as important as a long, reliable service life. Therefore, the fan specialists from Germany's Black Forest region use state-of-the-art EC drives with additional options in their fans. Depending on the design, these electronically commutated motors are equipped with more or less extensive internal electronics and thus enable maximum efficiency in all operating states. As there are no more wear parts except for the rotor bearing, the service life for these drives is far greater than 100,000 hours. Optimised aerodynamics not only ensure higher air performance, they also decrease the operating noise level drastically; this is an important benefit in many applications. To adapt the drives to extreme ambient conditions, detail solutions can be used, such as encapsulated stainless steel bearings, water vapour-resistant, thick-film plastic insulation for the electronics board or, for the most stringent

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requirements, with PU plastic in vacuum potted windings (Figure 1). Therefore, the fans can withstand temperature fluctuations, moisture, splash water, dust, oil or salt loads, such as those encountered in coastal applications.

### Requirements according to the specific application

Simultaneously, however, various frequency inverters also place individual requirements on the fans used. These can be classified roughly according to their application areas. For example, frequency inverters for general drive engineering, servo drives and solar inverters each impose different requirements on the thermal management than do welding inverters or particularly robust devices for rail technology. Depending on the application category, the cooling air devices must fulfil certain main requirements:

In solar technology: long service life, even for outdoor installation with large fluctuations of temperature and humidity. For installation within a protective housing, even high operating temperatures (intake air as hot as 120° C is currently possible) must not impair the function (Figure 2). High efficiency of the system is likewise important.

In drive engineering and for welding converters: long service life, high air performance, compact design. Depending on where it is used, temperature fluctuations, dust, oil, and abrasive materials must not impair the function, even after years of operation.

Rail technology imposes additional requirements for environmental resistance in addition to stringent demands for vibration and shock resistance.

### Customer-specific solutions

Many special requirements for state-of-the-art fans can be met with minor modifications from the extensive range of products of the cooling experts from the Black Forest region. However, there are also some exceptions. In these cases, the company's long-time expertise in the area of fan development shows its full potential. In individual cases, special measures can protect the drive motor from materials such as water, oil and salt. If the conditions involve a large amount of suspended matter or dust and moisture, a dirt resistant surface coating with lotus effect can help (Figure 3). Then, malfunctions due to clinging dust or oil deposits are a thing of the past. If the application imposes special demands for installation, familiar fan concepts can be integrated into custom-designed housings.

Though even standard EC fans offer a wide variety of different configuration options and monitoring functions, bus-controlled drive motors are also available for special cases (Figure 4).

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In many cases, intelligent designs can react automatically to environmental triggers via connected sensors for temperature, humidity, light/darkness detection etc. and thus relieve the burden on a higher-level control system.

As varied as the requirements of different frequency inverters are, off-the-shelf solutions already exist for many applications. With minor modifications, these models can be used for additional, more advanced applications. For the toughest requirements, customised solutions are available. If the user takes advantage of the fan specialists' expertise from the beginning of development, the most efficient cooling methods can be implemented.

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**Figure 1: Vacuum potted windings withstand even the toughest ambient conditions**

**Figure 2: Efficient compact fans for ambient temperatures up to 120 °C**

**Figure 3: Model 4400 with dirt-resistant coating reduces deposits significantly**

**Figure 4: The S-Force centrifugal family for high pressure build-up with very good motor efficiency (up to 89%) and high power density**