# EC Technology is Robust, Quiet and Efficient

WITH COMMUNITY ENVIRONMENT IN MIND

# COOLING POWER TRANSFORMERS

Photo: ebmpapst Inc.

**Power transformers are essential in power networks. They convert AC voltage between different voltage levels, and thus play an important role in power plants, industrial operations, and electrical substations. As a result of urbanization, a lot of towns are growing closer and closer to transformer stations that once stood on open greenfield land sites. This poses new challenges in terms of noise emissions. It is not just the transformer that has to be quiet, but it's the cooling system as well. That is why manufacturers need to rely on efficient and quiet fans from ebm-papst.**

During the voltage conversion process, a great amount of waste heat is generated – which heats up the oil inside the transformer. In order for the cooling process to work, cooling fins are attached to the transformer, through which the oil circulates. In the case of smaller transformers, the cooling ambient air is enough to prevent the oil temperature from reaching a critical level. However, in the case of larger transformers, additional measures need to be put in place for the cooling process. A simple and efficient solution is to use highly efficient fans – attached to either the sides or below the cooling fins (Figure 1).

*Figure 1. EC fans built by ebm-papst can be attached either to the side of or below the cooling fins.*

## Focus on: Noise and Efficiency

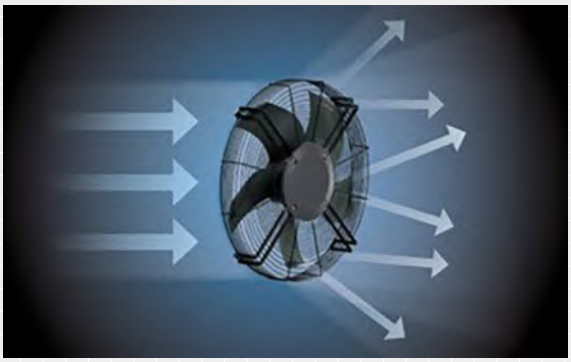
Transformer manufacturers have been in the business for decades and are constantly expanding their portfolios – to include larger and more complex transformers (Figure 2). Manufacturers should have high requirements in terms of the fans used for the cooling process, with a focus on low noise emissions. Due to the fact that towns are continually expanding, a lot of transformers that not long ago stood on open and empty greenfield sites are now situated near new housing developments. Residents and strict legal provisions demand a quiet cooling process and community friendly noise emissions. As most power transformers are positioned in the open air, they also have to be wind-proof and weather-resistant, including being able to function under hot, extremely cold, humid, and salt-spray conditions. On top of everything, fans built into transformers have to comply with specific regulations (for example: EU's Energy-Related Products Directive), which is why the efficiency level of the fans is also becoming more and more important.

*Figure 2. The complexity of cooling transformers has increased over recent decades resulting in higher efficiency and less noise emissions.*

ebm-papst's fans satisfy all the DIN requirements for the sophisticated cooling of large transformers (EN 50216-12 "Power transformer and reactor fittings – Part 12: Fans"; and come in sizes 500 mm to 1,250 mm with air performance of up to 27,500 cfm. Their development is based on decades of experience and intense research supported by extensive simulations and tests. The range also has a long service life and resistance to salt spray (corrosion protection class C5M as per DIN EN ISO 12944 / UL) – the fan is therefore also suitable for use in coastal areas.

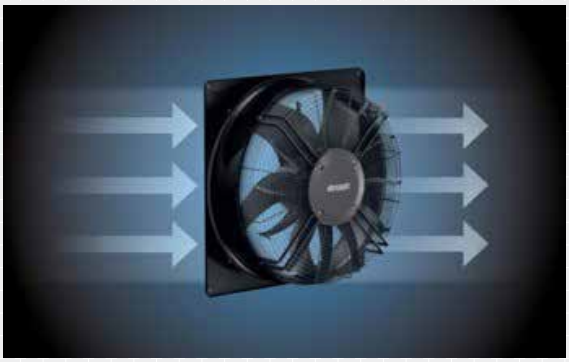
## Perfectly Matched Components

All the components of the plug-&-play-compatible modules – the fan housing, HyBlade® impeller, EC motor with integrated electronics and intake-side guard grill (OSHA-compliant) – are perfectly matched. For example, aerodynamic optimization reduces air turbulence and operating noise. The impeller has an aerodynamically ideal shape based on combining an aluminum frame with a covering of glass-fiber reinforced plastic. Compared with traditional blades, this significantly reduces noise and improves efficiency and, at the same time, reduces overall weight. This is good news for the transformer operators, who thus can comply with strict legal provisions, and also for the people who live near the transformer stations. All of the motor types meet the requirements of the current Ecodesign Directive and, thanks to their integrated electronics, also reduce the wiring work and number of components needed compared to conventional systems with AC fans.



### Old technology without wall ring / venturi

- **Erratic air flow**
- **Turbulences creating noise**
- **Very low aerodynamic efficiency**



### State of the Art Technology

- **Reduction in power consumption**
- **Best aerodynamic efficiency**
- **Maximum reduced turbulences lead to low noise level**
- **Housing significantly increases the air performance**

As per IEEE Std. C57.120-2017, there are auxiliary losses (AL) on power transformers, which account for the watts used when auxiliary cooling equipment (fans and/or pumps) is applied. Auxiliary losses are dependent on hours of operation and the power consumed during operation of these devices.

EC fans result in a better option in terms of better efficiency and lower losses since AL must be considered in the transformer Total Owning Cost (TOC), especially if two or more separate cooling stages are used; these stages should be expressed in separate parts because the individual stages will be used at full speed for different amounts of time. When a cooling stage start to cool the transformer, it typically does not need full speed to begin the cooling process. With EC fans, stage can begin cooling at a reduced speed that could be further reduced or increased depending on the rate of increase of the transformer temperature. With this method, reduction of the number of cooling stages or cooling fans may be considered, or the kVA rating may be increased.

Photo: ebm-papst Inc.

The motor mount of the fans is positioned on the intake side and provides protection against accidental contact. On the outlet side, guard grills are available as an accessory. Both the guard grills and the fan housing are made of hot-dip galvanized sheet steel with an extra coating for additional protection. The outlet side also has an integrated circumferential flange for direct attachment to the radiator. Especially when the fans function with free air (as is usual in the case of oil-cooled transformers), the positive effect of this type of fan housing is excellent (see above characteristics showing benefits of using a fan housing). It significantly reduces air turbulence, increases the airflow rate and, ultimately, the efficiency of the fan.

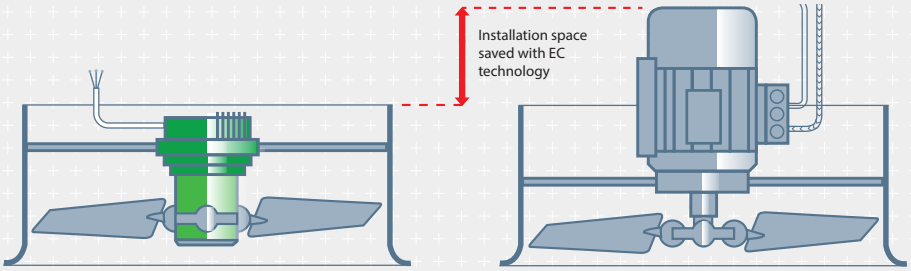



*Figure 3. Low profile EC motor design vs. conventional AC motor design*

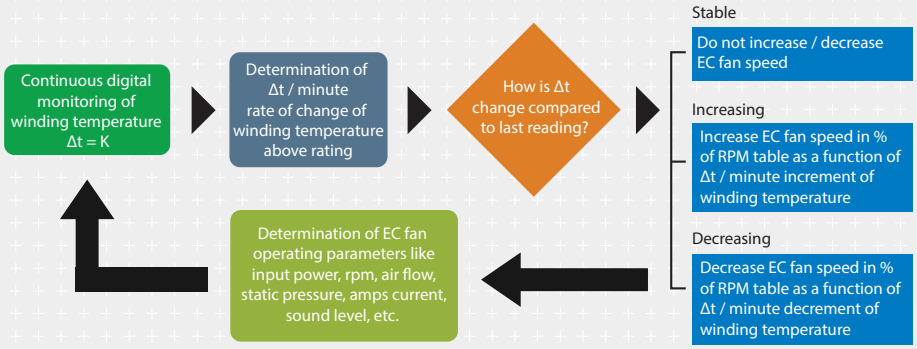



*Figure 4. This algorithm is only possible using EC fans to reduce the range of variation of the winding temperature for more efficient cooling. It shows how a large transformer cooling can be digitally controlled.*

## EC Technology in Transformer Cooling

Our EC products (Electronically Commutated motor) use an external rotor motor with integrated electronics which can be connected directly to an AC mains supply, and will operate at 50 and 60Hz without any change in performance. In addition to performing the commutation, the electronics convert AC to DC and control the fan speed by regulating the power of the motor.

According to IEEE Std. C57.136-2000, a practical technique for sound level abatement is installing low-sound fans, where EC motor plays a significant role, especially if the user specifies a sound level below the value in the NEMA TR1 sound level table.

This means you get high performance, silent speed controllability, and long-life expectancy, all in a compact package that is proven to be more efficient, quieter, and overtime, less costly than the AC products it replaces (user no longer needs to incorporate a VFD, filtering, and extensive labor in order to speed control their conventional AC product), see Figure 5.

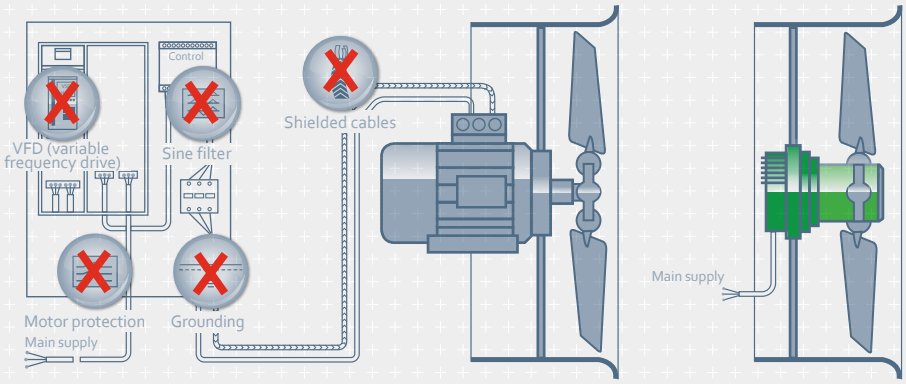



*Figure 5. EC technology with unsurpassed compactness*

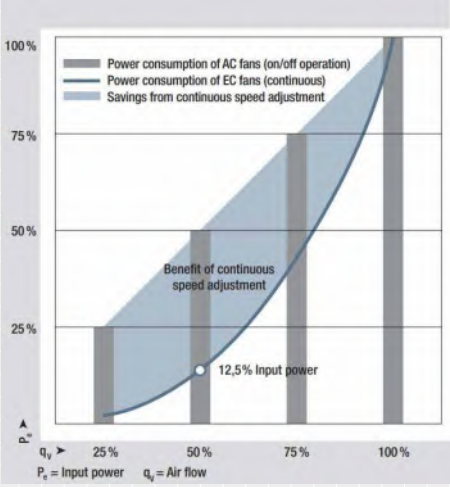
## Reliable All Over the World

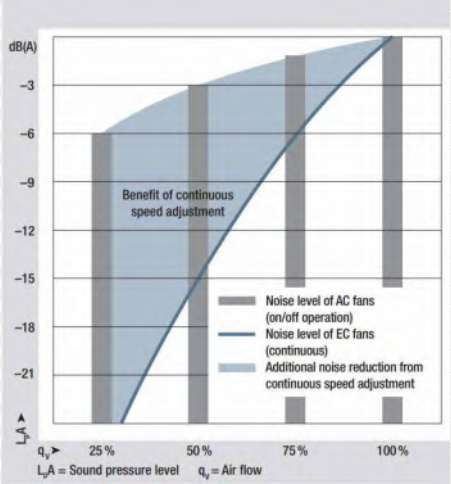
The continuous control characteristics of the EC fans is another significant advantage. They enable the fans to adapt to the load and climatic conditions, which helps them to work in an energy-efficient manner. They can be used with a range of power supplies – between 200-240 V and 380-480 V (in 50 or 60 Hz operation) – and fulfill all of the relevant standards (CE, UL, CSA, EAC, CCC). Due to their practical design, the transformer fans are also easy to put into operation. For example, it is possible to install and mount the fan directly on the transformer with a horizontal or vertical installation position as required. The motor terminal box for the supply connection and control is easily accessible and isolated from the motor electronics. Great value was placed on the quality of the terminals.

*Figure 6. Transformer fans from ebm-papst stand out from the competition in particular through their energy efficiency, low noise emissions, and robustness.*

*Photo: ebm-papst Inc.*

*Figure 7. Possible energy savings and noise reduction with continuous speed adjustment in part load operation*




**Reduced energy consumption**
The bars show the power consumption of fans that are switched on stepwise as needed. Air performance is reduced by 50% when half of the fans are switched off. The blue line shows the power consumption of all fans with smooth speed adjustment at the required air flow (50% air flow = only 12.5 % input power).

**Lower noise generation**
While switching off half the fans (50% decrease in air flow) only reduces noise generation by approx. 3 dB, a speed reduction resulting in 50% less air flow achieves an improvement of 15 dB.

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**ABOUT EBM PAPST INC.**
ebm-papst is an innovator and market leader in ventilation and drive engineering technology. Our core competencies in motor technology, aerodynamics, and electronics make ebm-papst a much sought-after engineering partner in many industries. With around 20,000 products, we provide solutions to a wide range of markets including Air-conditioning and Ventilation, Appliance, Automotive, Commercial Refrigeration, Heating, Industrial, IT/Telecom, Lighting, Medical, Transportation and more. We have placed the highest emphasis on economy and ecology for many years. We believe the consistent further development of our highly-efficient GreenTech EC technology provides our customers with the best opportunities for the future in industrial digitization. With GreenIntelligence, ebm-papst already offers intelligent networked complete solutions that are unique anywhere in the world today and that secure our customers a decisive advantage.

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**ABOUT H-J**
We have combined ebm-papst's knowledge and technology about fans with The H-J Family of Companies technical and commercial experience in the specific market of power and distribution transformers. This partnership brings this technology's benefits even closer to the manufacturers and end-users of transformers through personalized technical support in North America, Central America and the Caribbean, and South America.