



# WHITE PAPER

## New RadiPac – *for greater power and efficiency*

Better and quieter thanks to  
new impeller geometry, air guide module  
and high-performance electronics

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**ebmpapst**

engineering a better life

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## 1. Increased requirements in ventilation and air conditioning technology

Ventilation and air conditioning fans are constantly being developed, as user demands for control options and energy efficiency in particular are increasing rapidly. Legal requirements, increasing environmental awareness, and potential savings on operating costs are all playing a role in this trend. Centrifugal fans from ebm-papst are setting new standards here: Thanks to aerodynamic optimizations, innovative materials, sophisticated design details, and highly efficient EC motors with intelligent control electronics, they not only deliver significantly more air performance than before, but they are also particularly quiet and efficient. This is advantageous for both ventilation and air-conditioning technology, as well as industrial applications.

## 2. More air flow and pressure

For some time now, motor and fan specialist ebm-papst has been employing a continuous improvement process in fan technology. In recent years, the centrifugal fans in the RadiPac series, specially designed for use in air conditioning and ventilation units, have been constantly optimized, with particular emphasis on energy efficiency, noise reduction, intelligent functions like automatic resonance detection, networking options and handling. With the RadiPac C comes another decisive improvement in this successful series. These centrifugal fans in sizes 280 to 630 mm operate at higher efficiency levels (Fig. 1). Higher speeds ensure a greater air flow and higher pressures, meaning that even applications with over 2000Pa in static pressure increase can be covered (Fig. 2). In addition, noise generation has decreased further; depending on the operating point, the noise level is reduced by between 3 and 7 dB(A) compared to the predecessor series.

In recent years, the centrifugal fans in the RadiPac series have been constantly optimized. Especially in terms of energy efficiency, noise reduction, and handling.

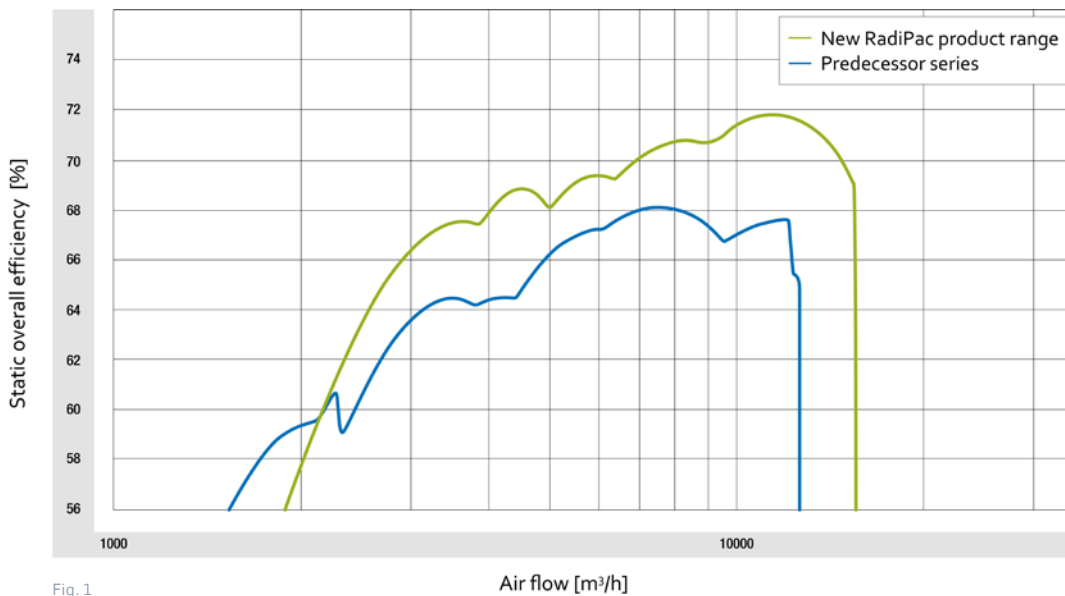


Fig. 1

Fig 1: The new generation of centrifugal fans offers higher efficiency; this results in significantly lower operating costs.

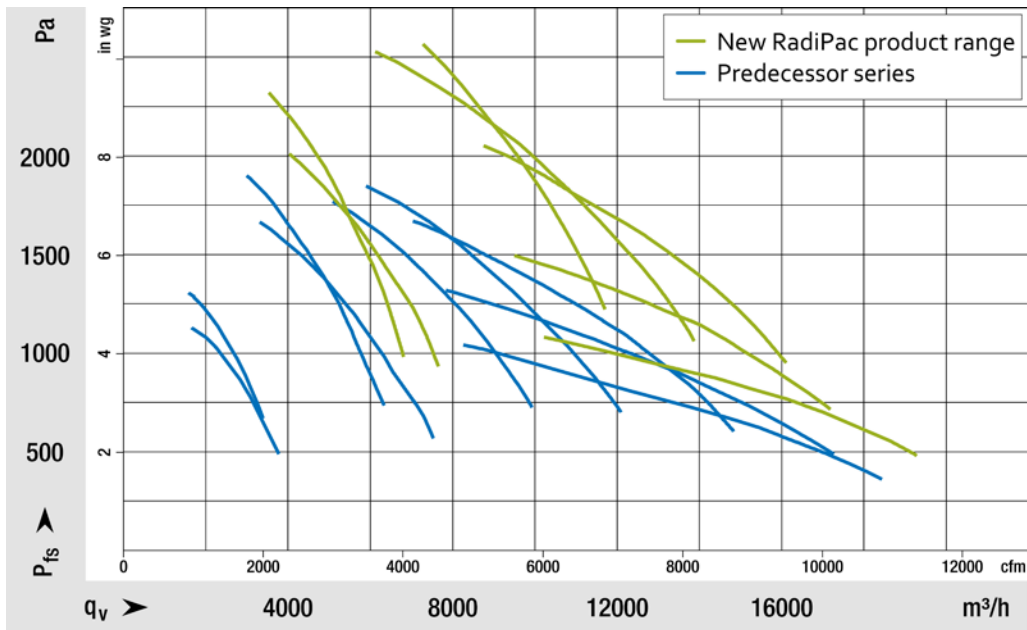


Fig. 2

Fig. 2: Increase in power density compared to the predecessor series.

2.1. High-strength composite material plus innovative impeller geometry

To bring about this optimization, the impeller plays an important role. It has been developed according to the latest aerodynamic findings with its five geometrically sophisticated impeller blades (Fig. 3): A high-strength, glass-fiber reinforced composite material is used here. The complex shape is made possible by the injection molding process used. This blade geometry drastically reduces flow losses. The rounded flow contour at the blade inlet and the blade trailing edge, which tapers toward the back, contribute toward this. A wavy cover plate ensures the best possible air flow rate through the impeller. The inlet ring is also made of composite material and is designed for perfect interaction with the new impeller.

The sophisticated impeller geometry not only reduces flow losses, but also noise generation. When it comes to its strength, the mechanical design of the impeller also impresses. The edges on the intake and outlet sides are counter-curved, which increases the impeller's stability. High pe-



Fig. 3

Fig. 3: The material used is a high-strength, glass fiber-reinforced composite material. The injection molding process enables a complex shape.

Five geometrically sophisticated impeller blades.

This blade geometry drastically reduces flow losses and noise generation.

ripheral speeds are therefore easily possible and, depending on the impeller diameter, they result in correspondingly high speeds. This has been proven under harsh conditions in extensive stress and long-term tests. They can be operated at maximum speed in a temperature range from -25°C to +40°C. Here, the tried-and-tested industrial composite material meets all the relevant standards, and UL approval is also available if required.

2.2. Numerous flexible options

To meet the requirements of different installation situations, the centrifugal fans are available in a standard and short version (Fig. 4). For the most powerful standard types, the impeller is attached to the motor in such a way that it has no negative influence on aerodynamic efficiency. In the short version, the motor is immersed in the impeller. These fans are more compact yet they are much more efficient than comparable predecessor models in spite of the slightly shorter axial installation dimensions in comparison to the standard version. Both RadiPac versions are available as a motor-impeller combination or as a ready-to-in-

stall plug & play solution in a compact support bracket for easy wall mounting (Fig. 5). The support plates have been dimensioned to make the best possible use of space on a Euro pallet, saving on transport costs and improving the carbon footprint. The completely enclosed FlowGrid air inlet grill is also available as an option. This acts as a kind of rectifier that reduces noise-generating turbulence in the inflow without impacting the air performance and power consumption. It also serves as a guard grill for the intake side. The fans are then even quieter, which benefits ventilation applications as well as many others.

A standard and a short version.

Much more efficient than comparable predecessor models.

A completely enclosed FlowGrid air inlet grill is also available as an option.

Fig. 4: In the standard types (left), the powerful motor is completely pulled out of the flow area. In the short version (right), the motor is immersed in the impeller.

Fig. 5: The RadiPac as a ready-to-install plug & play solution in a compact support bracket for simple wall mounting.



### 2.3 Air guide module reduces outlet losses

Special air guide modules increase the efficiency by up to 5 percentage points once again. This is achieved by reducing the outlet losses. For this purpose, ebm-papst has developed a housing for the RadiPac, consisting of four segments. The module segments are made of galvanized sheet steel and have an aerodynamic shape. This special shape slows down the flow, which reduces the dynamic pressure component and increases the usable static pressure component (Fig. 6). In addition, the new flange plate was turned by 15 degrees and provided with recesses at the flow outlet. This also contributes to reducing outlet losses. At the same operating point, for example, the fans can run at a lower speed, which in turn means that less energy is required (Fig. 7).



Fig. 6

**Fig. 6:** In the RadiPac C Perform centrifugal fan, the four-part air guide module reduces outlet losses, increasing the efficiency by up to 5 percentage points. This enabled the proven support bracket to be retained.

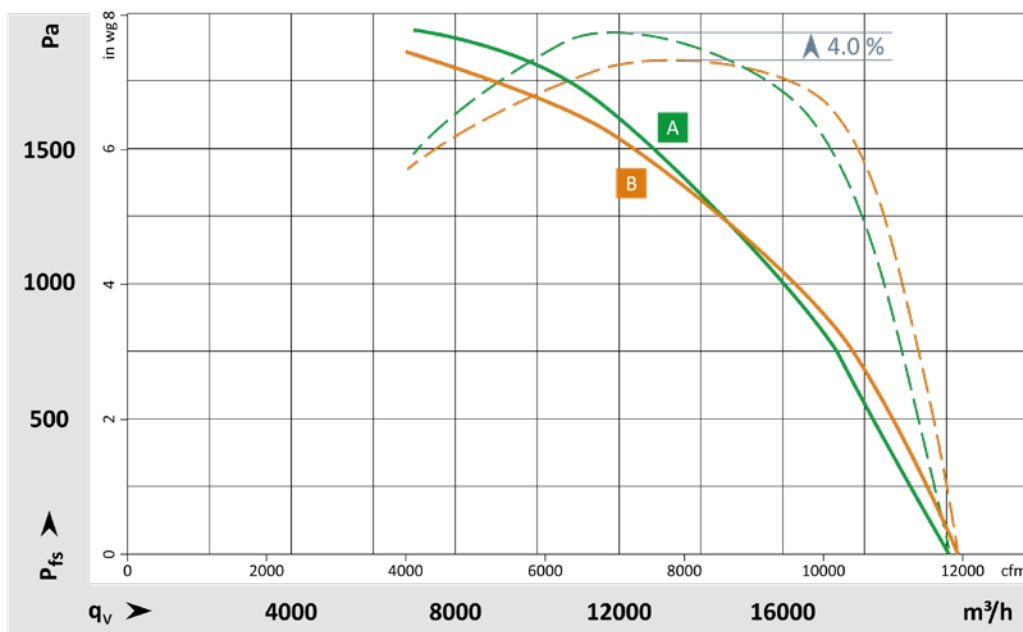


Fig. 7

**Fig. 7:** At the same operating point, size 560 fans can run at a lower speed, which in turn lowers the energy requirements (characteristic curve A green: RadiPac C Perform compared to characteristic curve B orange: RadiPac C).

The support bracket is retained. This means that the mounting dimensions and mounting hole patterns remain identical, so practically no design changes are necessary in the application to benefit from the higher efficiency levels and lower current consumption.

Which RadiPac version users choose depends on a variety of factors, such as usage type and duration, the required air performance, the desired speed

range and the pressure conditions of the application. The FanScout web-based selection program from ebm-papst makes it easy to select the right one. It helps planners and manufacturers find the ideal product for their application in just a few steps. Users get precise and reliable data based on measurements of the fan as an integrated system, consisting of fan impeller, EC drive motor and integrated control electronics. Life cycle costs and sustainability aspects are also taken into account.

**2.4. EC motors: more powerful, more flexible and even more compact**

In all models, high-efficiency EC motors in the power range from 500 W to 8 kW are the driving force behind RadiPac centrifugal fans. The integrated EC motors with external rotor design achieve efficiency levels in accordance with the requirements for efficiency class IE5 set out in IEC/TS 60034-30-2. For reasons of system efficiency, the drive system consisting of motor and integrated power electronics is individually adapted on each fan, and is optimized for the re-

spective operating range. The newly developed 8 kW drive sets high standards. The performance of the integrated electronics has been increased again, even with its more compact dimensions. This makes the drive the most powerful in its class at present. Design and functionality have also been updated to the latest generation, and upgraded to include a configurable interface – including the MODBUS-RTU interface and integrated resonance sensor.

**2.5. Operational reliability thanks to resonance detection**

Centrifugal fans are used in various ventilation units and air conditioners. Depending on the installation situation, previously unforeseeable speed ranges may result in increased vibration levels in the resonant range. There are many reasons for this: a high residual imbalance (e.g. caused by transport and handling), changes in vibration behavior after installation in the customer's unit, and dirt adhering to the impeller. If the fan is operated frequently at excessive vibration levels, the bearings may get damaged and premature failures may occur. Although these vibrations can be measured when commissioning the system, they cannot simply be eliminated.

ebm-papst has solved this problem in its RadiPac centrifugal fans by using an automatic resonance detection function that minimizes the impact of vibrations (Fig. 8). A test start-up is carried out during commissioning in which the vibration levels over the entire speed curve are recorded and analyzed. If excessive vibration velocities are detected in specific ranges, the control software automatically sets itself to „fast-forward“ through these speed ranges in future. In this way EC centrifugal fans can be operated without risk of damage. Operators can manually edit the software settings at any time, so always have full control.

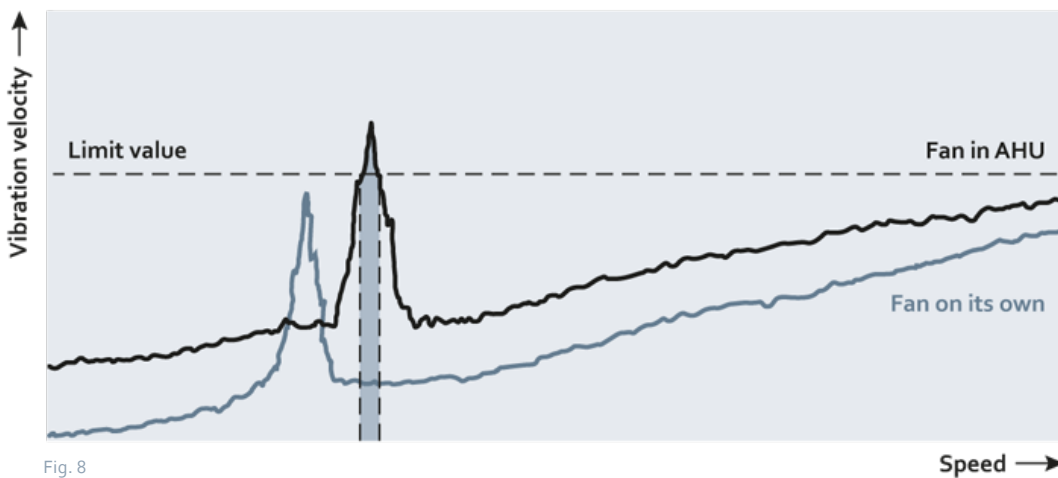


Fig. 8

**High-efficiency EC motors** in the power range from 500 W to 8 kW.

With **configurable interface** – including the **MODBUS-RTU** interface and integrated resonance sensor.

Depending on the installation situation, **previously unforeseeable speed ranges** may result in **increased vibration levels** in the entire range.

If the fan is operated frequently at excessive vibration levels, **the bearings can be damaged and premature failures occur.**

ebm-papst solves the effects of vibrations with an **automatic resonance detection function.**

Operators can **manually edit the software settings** at any time.

**Fig 8:** If standard resonance detection is activated, ranges with excessive vibration velocities are detected and „overrun“.



## 2.6. Fitting dimensions – suitable for a retrofit

Once a ventilation system is around 15 years old, or greater demands start being placed on it, there are two options: The operator can either replace the entire ventilation system with a new one, or upgrade the ventilation units with more powerful and more efficient fans. In many cases, a lack of space means it is not possible to replace the entire ventilation system. It can also be very time-consuming and expensive to do so. This is where retrofits come into play. Switching to new fans not only saves a lot of energy, it also makes existing systems more durable and quieter. If several small fans are installed in parallel in a space-saving fan wall (FanGrid), they will be easier to install and maintain. This configuration also protects the system against failures because if there are problems with one fan, the others compensate for its power. With the new RadiPac fans, retrofitting is usually possible in the application without any design changes, as these fans are geometrically smaller despite the higher power in the same size.

## 3. FanGrid solution

In the next step, there will also be FanGrid variants in the series. In FanGrids, multiple small fans operate in parallel, rather than having one large fan. The RadiPac modules for FanGrids can be individually assembled according to the modular principle. They are available as finished cubes or as a kit. The following applies when operating several fans in parallel: the sum of the air flows from the individual fans equals the total air flow desired. This provides redundancy, increasing the operational reliability. In addition, several adjustable fans can be better adapted to the actual air performance required. With this development, ebm-papst is showing that there are always new approaches to significantly improving energy efficiency, air performance, and noise generation.

If several small fans are installed in parallel in a space-saving fan wall, known as a FanGrid, they will be easier to install and maintain.

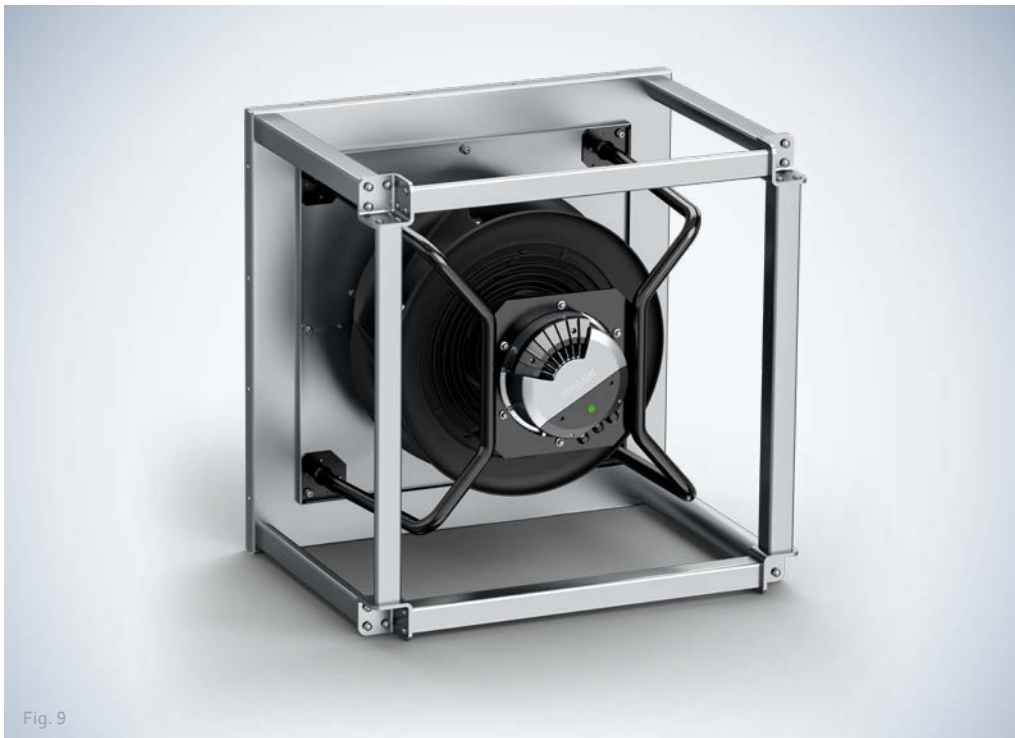


Fig. 9:  
RadiPac in cube design for  
FanGrid solutions

Fig. 9



#### 4. Side note: psychoacoustics – how is a fan supposed to sound?

If ventilation and air conditioners are used in an environment in which there are always people, it is very important that they operate with little noise, as permanent stress due to background noise can make people ill. Psychoacoustics is concerned with describing personal sound perception in relation to measurable noise levels, i.e. it aims to explain why we perceive noises as pleasant or unpleasant. Unfortunately, this is something that physical measurements of sound levels in test rigs are unable to address. Trumpet music and a construction-site excavator have approximately the same sound power but are perceived psychoacoustically in completely different ways. ebm-papst has addressed this matter by setting up a special psychoacoustic laboratory in which

noise from fans in various configurations is played back for eight test subjects. Employees question the subjects afterwards to build up a scientifically founded database based on the following psychoacoustic parameters: loudness (unit: sone), sharpness (unit: acum), pitch (unit: mel), roughness (unit: asper) and fluctuation strength (unit: vacil). Other important quantities are tonality and impulsiveness. They can be measured with microphones and compared with comments made by the test subjects. Assessments by the test subjects are analyzed using statistical and psychological methods. The results are used for product development. The ultimate aim is to develop a fan whose operating noise is perceived as pleasant by as many test subjects as possible.

#### About ebm-papst

The ebm-papst Group, a family-run company headquartered in Mulfingen, Germany, is the world's leading manufacturer of fans and motors. Since it was founded in 1963, the technological leader has set international industry standards with its core competencies in motor technology, electronics, digitalization, and aerodynamics. ebm-papst offers sustainable, intelligent, and tailor-made solutions for virtually every requirement in ventilation and heating technology.

In the 2022/23 financial year, the Group generated turnover of EUR 2.540 billion. It employs just under 15,000 people at 30 production sites (including in Germany, China, and the U.S.) and in 50 sales offices worldwide. ebm-papst sets the benchmark in almost all sectors, such as ventilation, air conditioning and refrigeration technology, heating technology, information technology, mechanical engineering, intralogistics, and medical technology.