

CASE STUDY

Climate control

ebm-papst ventilation systems for commercial vehicles

For many years, renowned bus manufacturers have installed climate control systems with brushless and wear-free centrifugal blowers and axial fans from ebm-papst. These products are also increasingly being used for climate control and ventilation of driver's cabs in trucks, tractors, construction equipment and railcars, as well as transport refrigeration systems.

Before brushless systems became available on the market, brush motors were used in commercial vehicles. In brush motors, the "commutator" performs the task of distributing current to the coils. The commutator consists of copper segments embedded in an insulating compound. Mechanical springs press the integrated carbon brushes onto the commutator. The friction between these two mechanical components is the weak point of conventional DC motors. After an operation time of approximately 5,000 hours, the carbon brushes are used up and the commutator is worn out. As a result, the entire blower needs to be replaced. Furthermore, open-loop speed control is possible only with external electronics. In modern commercial vehicles, constantly increasing expectations for comfort mean that this service life is no longer sufficient.

To reduce service and downtime costs for commercial vehicles, ebm-papst, the market leader in the fan and external rotor motor seg-



ment, has developed new axial and centrifugal fan series for use in commercial vehicles. This represents another successful chapter in the company's growth. During development, the company's tried-and-tested modular and system integration concepts played a critical role. These designs integrate the electronic commutation circuits into the motor housing and optimally adapt them to the contours of the blower. The advantages include a maximum utilization of installation space with simultaneous optimization of the aerodynamic prop-

erties. The unobstructed air inlet areas provide excellent cooling for the electronic components while decreasing noise emissions.



Image 1 Image 2



Image 1 shows a centrifugal blower with electronically commutated motor and **image 2** shows an axial fan in which the motor is located behind the impeller hub.

The new blower series have been developed for applications in vehicles with 24 or 12 V power systems. Thanks to the use of electronically commutated motors, they have significant advantages over products with commutator motors. Since they are not prone to wear like commutator brush systems do, the electronically commutated motors attain a significantly higher service life of over 25,000 hours. The electronic trigger circuit makes it easy to control the commutation times for more torque at higher speeds. For a brush motor, this would correspond to moving the brushes along the circumference, which, of course, is not possible in small motors because the position of the brushes is fixed. Changing the torque characteristics allows the air performance of the blowers to be controlled within a broad range. Improved overall efficiency decreases energy consumption and reduces the environmental impact. The positive effects of this are especially noticeable in applications such as roof-mounted bus climate control systems, which, on average, use 10 fans. Another noteworthy feature is the brushless EC fan's low electromagnetic radiation. The electromagnetic radiation is defined and

constant and conforms to the highest immunity class in terms of conducted susceptibility. The devices comply with European Directive 72/245/EEC and thus bear the e1 symbol. The electromagnetic radiation of brush motors is significantly higher and changes depending on the momentary status of the brush pressure.

In commercial vehicle applications, it is also important that fans withstand constantly fluctuating environmental influences. Standard products would provide less than satisfactory results in these situations. Therefore, ebmpapst automotive products also feature reliable protection against load dump, reverse polarity, shock and vibration as well as damage from moisture and dirt in a wide temperature range. This requires exceptional effort when selecting materials and testing the products. We use extreme tests based on real-world conditions, such as salt spray fog, vibration and temperature change tests, to ensure the performance of the fans.

ebmpapst blowers for commercial vehicles allow precision control of cabin temperature in vehicles. An electrical interface with multiple input and output signals is available for this purpose; the diagnostic output signal keeps the user informed at all times about the operating state of the blower.

The electronics also allow open-loop speed control with multiple input signals used in the commercial vehicle area. Analog signals from 0 to 10 V and 24 to 0 V and digital, pulse width modulated signals from 10 to 30 kHz can be processed. A digital input is also available for lowering the speed to half the maximum speed. Thus all of the control signals that exist in today's buses can be processed.

The electronics are protected from reverse polarity and excess voltage in the case of a load dump. If the operating voltage falls outside the range from 16 to 32 V, they switch off the motor, then restart it automatically. The run-up is always slow, taking up to 5 seconds. This greatly reduces the startup current and avoids the noise caused when all blowers start suddenly.

With the aid of state-of-the-art electronics and the use of a specially designed ASICs, ebm-papst has translated the latest insights and requirements of automotive applications into brushless direct current motors. High integration density and, as a result, visibly fewer components, component tolerances and soldering joints provide added reliability and assure the customer that the products will have an extended service life without faults. The intelligent control of the motor, also made possible by the ASIC, guarantees a reliable start in every situation—even for counterpressure or blower impellers that rotate backwards. A new microcontroller allows the open-loop speed control of the motor to be adjusted via programming to the control signals provided by the user.

Power derating always allows the motor to establish its maximum efficiency without being overloaded, regardless of the operating voltage used by the customer.

Axial fans are available with impeller diameters of 280 and 300 mm. A surrounding ring with inlet radius makes the impeller particularly robust and gives it good aerodynamic properties. Thanks to the use of special impeller materials, very high speeds can now be achieved.

ebm-papst Mulfingen carries centrifugal blower variants with different flange dimensions.

Customer-oriented with support of the latest development methods

The combination of ebm-papst's core competencies in motor technology, electronics and aerodynamics provides the foundation for mastering the complex relationships between



individual components and matching them to each other perfectly. By integrating customers into the process at an early stage, it was possible to define a standardized interface.

Today, the systematic utilization of measures such as FMEA (we use the Matrix FMEA technique) to prevent defects at every system level is a matter of course. Critical characteristics found during this process are automatically incorporated into component drawings and process control plans.

Commonly used simulation and calculation methods are applied in the development phase. Now as before, the objective of all simulations is to provide the most accurate prediction of the desired properties, avoid time-consuming and costly iteration steps and, in general, to provide opportunity for early intervention in all areas of product and process development.

ebm-papst specializes in development support that involves close cooperation with customers, offers a wide range of derived product variants and reacts quickly to changes in the requirements profile. This systematic approach is one of the prerequisites for realizing the design objectives.

For ebm-papst, entering this market segment represents a new, innovative step in its growth. The new products can be installed in new and existing vehicles worldwide. Interchangeability was one of the requirements expressed by our customers. In agricultural and construction equipment, cranes, tractors, buses, coaches and trains, these products provide durable and dependable climate control for driver and passenger compartments.