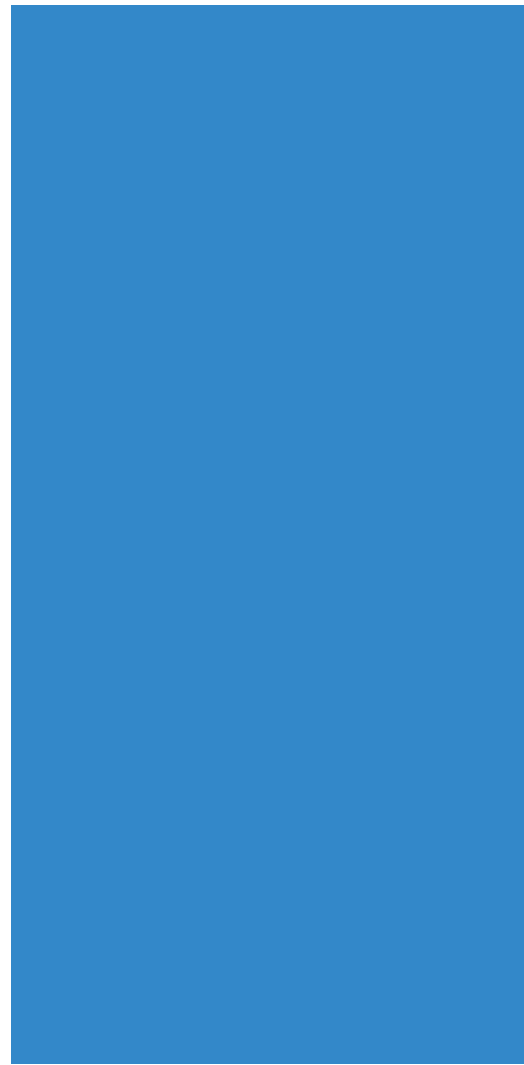


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NEW IDEAS AT A GLANCE



ebmpapst

Editorial

Dear ebm-papst customers, partners and friends,

As I am writing this, the IAA 2005, the international automobile show in Frankfurt/Germany, has just been closing its doors on the last visitors.

For us here at ebm-papst St. Georgen, this show was quite a success! In 1992, we started to do business with partners in the automotive sector, and this business has steadily grown. The cornerstone for our success in the automotive sector was a miniature blower, the so-called sensor blower. These blowers read the cabin temperature and control the air-conditioning of the passenger cabin accordingly. By now, we produce more than 5 million of these sensor blowers each year. But it was not only the quiet, reliable, and proven ebm-papst ventilation technology that made its way into passenger cars to cool electronic components and displays; drive technology as pushed by ebm-papst St. Georgen, with electronically commutated motors, is now used in a wide variety of applications in motor vehicles.

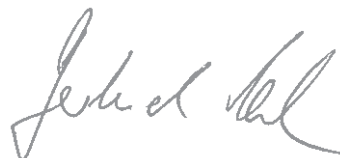
The most sophisticated of these applications is the active steering in the BMW 5 and 3 series, at the heart of which is a motor from ebm-papst St. Georgen. Further

applications in motor vehicles are bound to make use of motors from St. Georgen – more than 130 technicians and engineers are already working on it!

And so, ebm-papst St. Georgen has added a third string to their bow, with applications in the IT/telecommunication field and industrial drive technology already proving the innovative strength of the company. Markets of growth with technical focus can only be developed with highly qualified staff and solid technical know-how and expertise. St. Georgen has this. The segments ventilation and electric drives in motor vehicles correspond to our core expertise and give us a unique selling point. Compared to our competition, we can offer our customers decades of experience in the field. This is what ebm-papst stands for.

Wishing you a great time reading your way through our ebm-papst magazine tech.mag.

Best regards



Dr. Gerhard Lahm
Managing Director
ebm-papst St. Georgen

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The new motor line ECI 42.40 Compact made by ebm-papst St. Georgen

The new motor line ECI 42.40 Compact

With their innovative ECI 42.40 Compact, ebm-papst St. Georgen now has a new and highly dynamic EC motor in size 42 with completely integrated motor and speed control electronics in their product range. It has enabled users such as the conveyor roller manufacturer Interroll in Wermelskirchen to quickly and simply develop a completely new motor roller for conveyor systems on the basis of this plug & play motor technology.

The electronically commutated ECI 42.40 Compact has a nominal torque of more than 100 mNm and its excellent dynamic across the entire speed range as well as its high overload-proof starting-up torque make it a perfect choice. As ideal motor-gear-entity, it is guaranteed to be robust, reliable and extremely quietly in operation. Moreover, the internal-rotor motor is an all-inclusive drive that has the commutation electronics and a highly compact, digital 4-quadrant speed control already integrated, thus saving space.

All-inclusive: Turnkey drive solutions

For the user, this means a minimum of actuation complexity and a maximum of flexibility in operation, and so a large diversity of applications can be served at low development costs. The digital speed control offers just the right excellent features for doing so. Using flash technology, the motor software can be varied with a special programming process during the production stage already.

A cost-efficient and intelligent fine tuning according to customer-specific profiles of requirements, functionalities and setting of parameters such as speed range, overload capacity or control dynamics, is thus accomplished quickly and easily.

And so solution suppliers get a drive system of top quality technology for various fields of application that is completely tested and qualified and offers a high degree of operational safety. Due to the high quantities ebm-papst St. Georgen can manufacture in automated production, a high-quality and efficient production at prices in line with the market is guaranteed.

For Georg Malina, Project Manager RollerDrive, R&D at Interroll in Wermelskirchen, one thing is clear: "The new standard motor gets Interroll RollerDrive the one decisive step ahead. For the first time, we have managed to integrate the necessary control electronics together with the modulator into the drive, and thus into our RollerDrive. Before, they had been housed in a separate and external box." The customer benefit is self-evident: lower installation costs, more direct control, and the chance to realise various conveying speeds with one and the same roller.

Drive motor roller

It is the microprocessor-controlled electronics that is responsible for the manifold tasks involved in motor management. Three Hall sensors provide the micro-controller with the exact rotor position signals to



“State-of-the-art technology: Complex manufacturing of monolithic system”

“The new motor line ECI 42.40 Compact – an ideal motor-gear-entity.”

facilitate the precise commutation of the motor current. The 4-quadrant-modulator integrates an output stage capable of handling over-current, and protective features such as locked-rotor protection and overload protection. A service life exceeding 20,000 hours and the high level of operational safety make this 3-phase motor an industrial standard.

“As one of the leading manufacturers of components for materials handling equipment, Interroll always wanted to have a powerful and quality-oriented development partner at their side.”, says Georg Malina and goes on to explain. “ebm-papst St. Georgen has a good reputation in safety-relevant fields of the automotive industry and thus vouches for an excellent development status and product quality.”

Especially when it comes to material handling equipment, service life and availability of electro-motors play a vital part, as these aspects turn more and more into the crucial criteria when orders are to be placed. “For Interroll, a partner with strengths right in this area is of decisive strategic importance!”, says Malina.

In collaboration with one of their major customer, Interroll carried out extensive tests in different application situations which all had a positive result. This way,

the manufacturer situated in Wermelskirchen was able to bring a big development project to a successful close. At a very early stage of the selection process, Interroll went for ebm-papst St. Georgen, as the company situated in the Black Forest proved to be highly competent and flexible a partner. Georg Malina is full of praise: “The timing allowed us to develop a profound partnership that generated a very good understanding of the application with ebm-papst St. Georgen!”

Specifications that Interroll assigned top priority were:

- Compact power density. Due to the limited mounting space inside a 50 mm pipe, this is a decisive factor.
- High reliability
- Substantial reduction of variants
- Flexible function integration
- Constant conveying speed by using a 4-quadrant controller. This also allows for controlled acceleration and braking across the entire weight range.

Another important point that made Interroll go for ebm-papst St. Georgen was the fact that they know of the good partnership between ebm-papst and the gear manufacturer Zeitlauf Antriebstechnik in Lauf near Nuremberg. After all, this is a guarantee for the manufacturer of conveyor rollers that ebm-papst St. Georgen can supply a drive system consisting of motor, electronics, and gear.

In the Interroll programme, the roller drive based on the ECI 42.40 Compact is the premium product. Apart from this product, the company based in Wermelskirchen offers other 24V roller drives where users have to select the desired conveying speed via one of seven gear speeds. This, however, is a disadvantage, as Interroll has to manage a substantially bigger stock of drives.

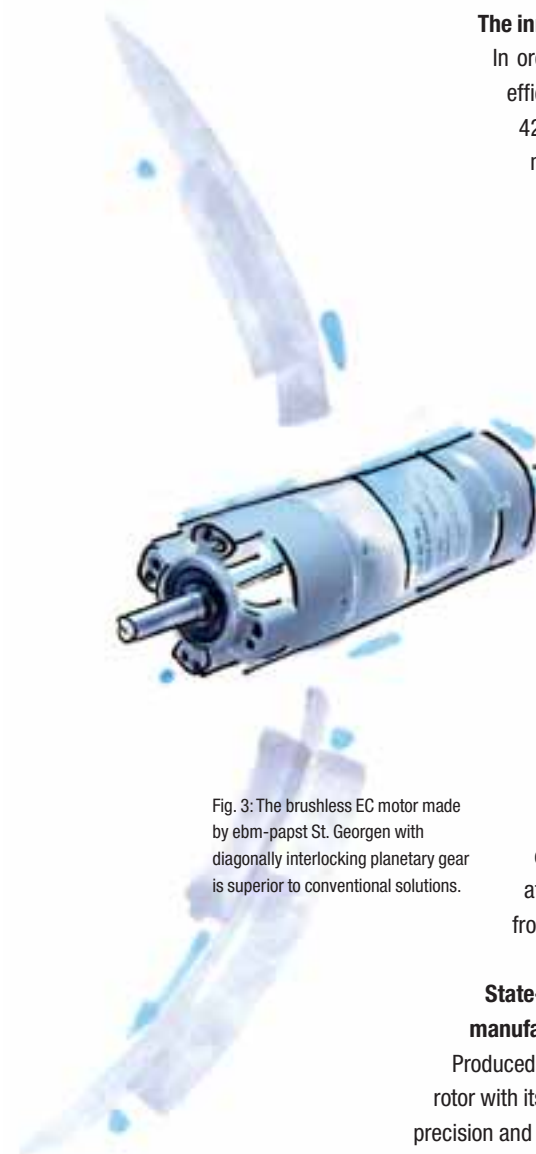


Fig. 3: The brushless EC motor made by ebm-papst St. Georgen with diagonally interlocking planetary gear is superior to conventional solutions.

The innovative rotor concept

In order to get the biggest possible cost efficiency and to be able to offer the ECI 42.40 Compact at attractive and marketable prices, ebm-papst St. Georgen has come up with an optimised motor topology that allows fully-automated and process-monitored motor production. The magnets are no longer glued onto the rotor in ring form, but take the form of cuboid segments that are now inserted into specially designed pockets and then fixed. Compared to a glued rotor with “round” magnet ring, the production of which is complex and expensive, a laminated and electrically insulated rotor stack with integrated magnets results in a substantial reduction of costs. Bandaging is no longer necessary, and the cuboid rare-earth rod magnets are of higher quality and can be procured at a better price than magnet rings from the world markets.

State-of-the-art technology: Complex manufacturing of monolithic system

Produced in a completely automated way, the rotor with its packing of laminations is of highest precision and has only minimal residual imbalance that requires no post-assembly balancing. The special challenge the motor designers were faced with was to retain minimum torque pulsations in on and off

mode as well as a very low level of running noise, high dynamics and power density with compact design.

The solution ebm-papst St. Georgen came up with can be described as synthesis of electro-mechanical and thermal motor development, using appropriate optimisation algorithms and taking account of analytic and numerical calculation programmes. Torque pulsations were optimised down to a minimum using calculations based on the finite element method. Devising a smart rotor topology and using high-quality magnet material guaranteed best torque quality. In addition to all this, the lubrication is specifically adapted to the ball bearing system and the specific application, making the ECI 42.40 Compact extremely quiet: No matter which load is applied, the acoustic performance of the motor (without gear) is always below 48 dB(A).

Stator and wiring PCB

The 6-slot stator has each individual tooth wound very compactly (pin winding), and the insulation displacement contact method is used to terminate all strand ends in a fully automated process. In order to safeguard a highly efficient processing and accuracy, the winding ends are wired up via PCB. In general, all wiring modes such as star or delta connection are possible across a wide voltage and output range. The three phases are conducted onto the electronics PCB and through the back end shield via flat pin connectors. As a next step, the master magnet is then pressed onto the rotor shaft end.

C-flange and electronics

According to the philosophy of ebm-papst St. Georgen, there is a deliberate separation of motor from electronics. After all, the modular design of drives makes for automated line production even with most diverse customer specifications and applications. The PCB with the individually

“The new roller-drives are a major improvement over conventional solutions!”



High conveyance speed, intelligent control electronics, and long service life make the Interroll RollerDrives an ideal drive component. At the heart of this new technology is the brushless roller motor from ebm-papst St. Georgen.

flashed operating software is mounted in the C-flange via a special bracket. This bracket also serves as centring device and insulation for the flat pin connectors. The electrical connection of the motor is effected centrally via plug that is concentrically brought out at the motor cap.

Diagonally interlocking planetary gear

As a standard, the compact motor made by ebm-papst St. Georgen is available with a mounted and optimised planetary gear (either in single stage or multi-stage design), with the large control range of the ECI 42.40 Compact generally making fewer gear variants necessary. The gear reduction ratios that are possible are 3.18:1, 5:1, 21.25:1, 30:1 and 150:1. The planetary gear itself is extremely quiet and designed in a modular way. Compared to other conventional solutions, it has a very high efficiency at shorter overall length: where competitors have to go for a two-stage gear design, this gear can still be of one-step design. For special applications, this one-step range helps to realise 20 different gear reductions, in a two-stage design even up to 240 different ones.

Gear input stage

The gear is optimally adjusted to the high speeds of the first stage. To reduce noise, both the planetary wheels and the internal gear are made of plastic material, with the internal gear being placed in a die-cast zinc housing. Due to their excellent absorption qualities, these materials perfectly minimise the running noise. Moreover, this diagonal interlocking creates far better intervention ratios, and thus higher transmissible loads can be realised, and a smoother and flowing intervention is possible.

Gear output stage

In the output stage, there are mainly lower speeds at higher torques. As this gear step is less critical as to noise, the main emphasis here is on the transmissible torque. Pinions and planetary wheels are therefore made of casehardened steel, and the ball and roller bearing of the planetary wheels is placed on the hardened pins of the pinion cage.

The internal-rotor motor ECI 42.40 made by ebm-papst St. Georgen

With the brushless 24V DC motor from ebm-papst St. Georgen, the new roller-drives are a major improvement over conventional solutions in the field of materials handling. They offer higher conveyance speed at significantly improved performance and reliability, and even heat generation in very limited space represents no problem. The roller-drives have a service life of 20,000 operating hours and are ideally suited for the most diverse applications, for instance in mail distribution centres, in the pharmaceutical and packaging industry, or in picking and logistics plants.

Technical data at a glance

The ECI 42.40 roller-drive motor from ebm-papst St. Georgen has the following technical features:

- High operating safety, foolproofness, and quiet running
- Variable conveyance speed of up to 2 m/sec.
- Up to 33 starts/stops per minute
- Up to 50 kg handling weight
- Long service life (up to 20,000 operating hours)
- Integrated control electronics, thus saving space
- Compatibility with standard controls
- Minimal heat generation due to inverse cooling
- Absolutely maintenance-free operation



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Project Manager RollerDrive, R&D
Interroll in Wermelskirchen

Easy-to-mount fans and blowers for range hoods

With many technical appliances in the home, fans and blowers are an essential part. Wherever there is a demand for cooling down, heating, getting rid of stale air or supplying fresh air, fans and blowers are called for. For the most part, the user may not even register they are there doing their job, as one of the most important specifications for modern blowers is that they run quietly and maintenance-free. One typical example for this are range hoods, the units which make sure you can enjoy a pleasant climate in modern kitchens, without bothersome smells, greasy fumes and troublesome steam. According to a study carried out by the ZVEI, the German central association for the electro-technical and electronics industry, in December 2004, about 66% of all households in Germany have range hoods by now. Together with the filter, their most important components are fans and blowers.



Fig. 2: Blower line in size 140-146, specially developed for range hood applications

Range hoods are available in a broad variety of functional and aesthetic designs. Typical examples are fire-side-shaped chimneys, which can be mounted to the wall or freely in the room hanging from the ceiling above the burner or cooking plates (fig. 1). There are also the flat shield hoods integrated in the kitchen furniture corpus and the almost classic substructure hoods that are favourite designs. All these have by now become important design elements and essential features in modern kitchens. This, of course, had its consequences for their important functional elements, their fans and blowers: Due to the large number of hood variants offered on the markets, they not only have to meet the technical specifications of each specific application, they also have to accommodate the varying installation situations and mounting spaces. One very good example of how versatile and powerful such components can be is provided by ebm-papst Mulfingen with their comprehensive range of products, part of which are a number of blower lines (fig. 2) specifically developed for and adapted to their use in range hoods.

Basic line offering unlimited possibilities: quiet, adaptable and easy to integrate

The first of these blower lines went into serial production back in 1999 and has, to the present day, maintained its top position as quietest blower in this size. The line with type designation D2E146-H... is available in three motor sizes, each one adjusted to the required air performance (fig. 3). The



Fig. 1: Range hoods like this island area chimney are an important design element in modern kitchens. The blowers used do not only have to meet tough technical specifications, they also have to fit the specific installation situation.

“ebm-papst offers customer-oriented solutions for special installation situations!”

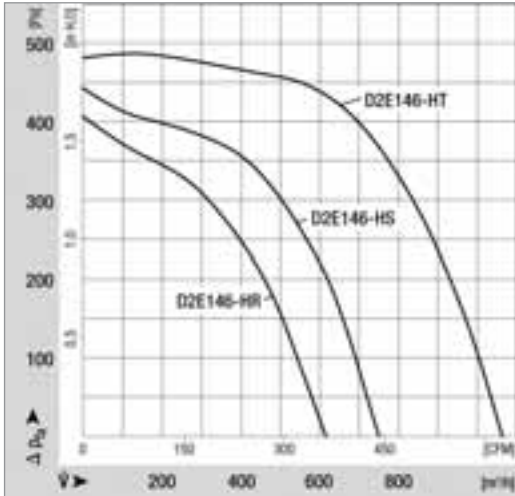


Fig. 3: Air performance curves of different D2E146-H blower designs

blowers are designed in such a way as to allow quick, simple and thus inexpensive integration and mounting in the range hoods (fig. 4).

The aerodynamically optimised blower housing is very compact and can be mounted inside the range hoods via standard sheet metal screws; the corresponding nuts are already pre-assembled. As a standard, an air discharge fitting for pipes with a diameter of 150 mm is already integrated. Connection pieces from angular to round are therefore no longer necessary and do not have to be separately mounted. The air discharge fitting also contains the receptacle for a back draught valve. The terminal box directly mounted to the blower houses the capacitor (P2 category) and a standardised connector system facilitating the post-assembly connection of customer-specific lines. For applications without protection against accidental contact in the end unit, there is a guard grille available as accessory that is simply clipped onto the air intake.

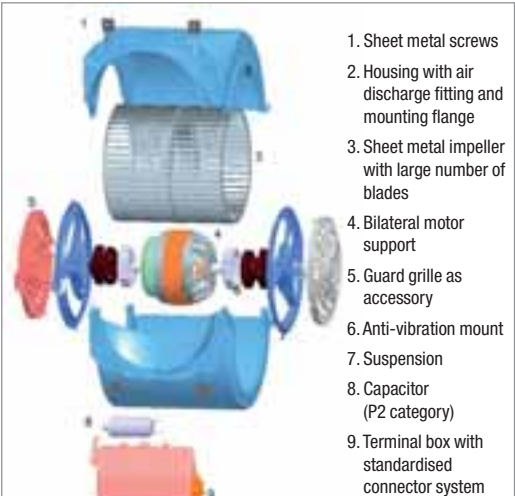
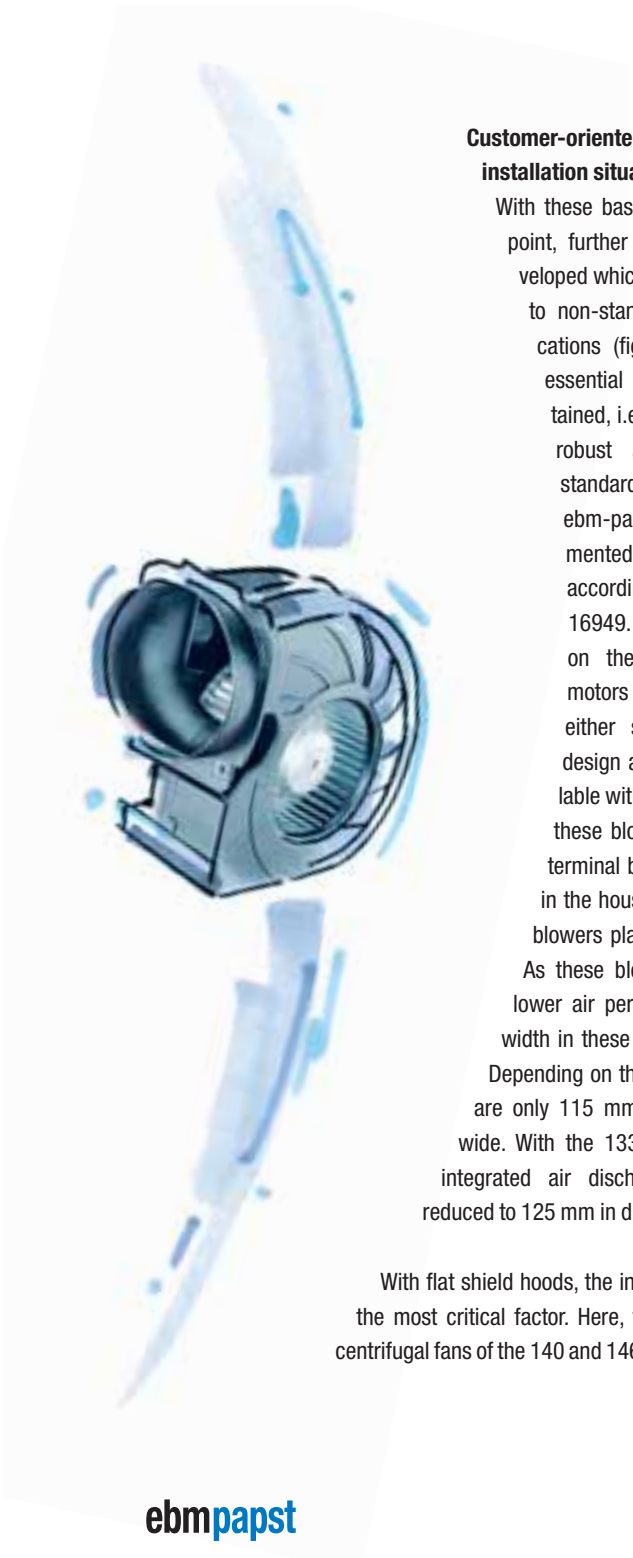


Fig. 4: Many details make integration a lot easier:

In technical respect, too, the blower line has a lot to offer: the robust motors are supported on both sides and are also decoupled from the housing via elastomer elements, guaranteeing maximal running smoothness. Moreover, the single-phase capacitor motors operate extremely efficiently. Optionally, they can also be fitted with a speed graduation; thus, without needing any additional components, different air performances can be set (fig. 5). The blowers already have to prove their robustness at the manufacturer's: permanent tests with more than 20,000 hours in operation and shock tests with accelerations of 30g are convincing proof that the blowers can handle even toughest conditions. For higher operational performance, the blowers can also be fitted with maintenance-free ball bearings.

The blowers are approved according to EN60335-1- and EN60335-2-31, and can also be supplied with UL-conforming materials.



Customer-oriented solutions for special installation situations

With these basic blowers as departing point, further blower lines were developed which were specially tailored to non-standard customer specifications (fig. 6). In doing so, the essential advantages were maintained, i.e. the units are also very robust and meet all quality standards implemented at ebm-papst, which is also documented in the certification according to ISO 9000 and TS 16949. The new lines are based on the proven external-rotor motors in size 68, available in either sleeve or ball bearing design and also optionally available with speed graduation. With these blower lines, however, the terminal box is already integrated in the housing, and in some of the blowers plastic impellers are used. As these blowers are designed for lower air performances, the housing width in these lines could be reduced. Depending on the design, some blowers are only 115 mm, 133 mm or 161 mm wide. With the 133 mm-wide variant, the integrated air discharge fitting was also reduced to 125 mm in diameter.

With flat shield hoods, the installation height is often the most critical factor. Here, the best choice are our centrifugal fans of the 140 and 146 line (fig. 7). The forward

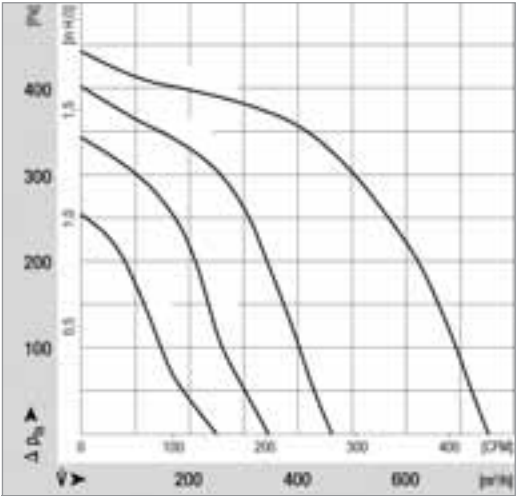


Fig. 5: Air performance curves D2E146-HS... with speed graduation

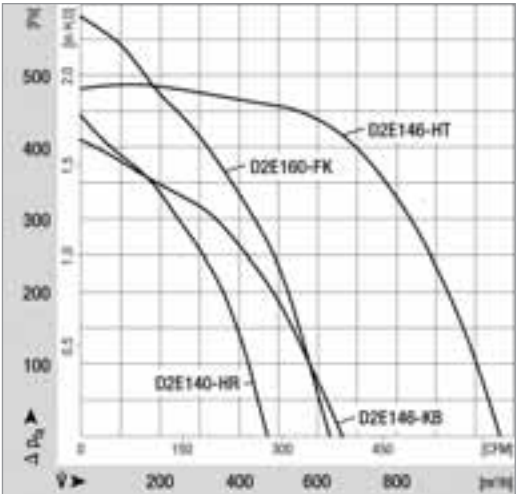


Fig. 6: Air performance curve of dual inlet blowers

curved impellers, available in different widths, are directly pressed onto the rotor of the external-rotor motor. This makes for a very compact built. The centrifugal fans are between 47 and 82 mm in height and can thus easily be

Pleasant indoor climate in the kitchen:
Easy-to-mount fans and blowers for range hoods

High level of integration reduces costs and installation expenditure:

Multifunctional fans for air-conditioning and refrigeration



Fig. 7: Forward curved centrifugal fan
e.g. for use in flat shield hoods

used in very cramped installation situations. They deliver airflows of up to 500 m³/h. In order to increase the airflow or to reduce the generation of noise at identical airflow, two counter-rotating fans can be operated in parallel. When using centrifugal fans with forward curved impellers, it has to be borne in mind though that the range hood will have to accommodate a scroll housing, too. This is not necessary

when using centrifugal fans with backward curved impellers. Such designs (fig. 8) are often used in substructure hoods or in outside wall blowers. They too are comparatively flat and can be easily integrated in the application. They are also very efficient.



Fig. 8: Backward curved centrifugal fans
operate with especially high efficiency

Even though the fans and blowers discussed here were specifically tailored to their use in range hoods, they are also the ideal choice for other applications. They can be practically used wherever there is a pipe system into which air has to be blown, e.g. for cooling servers in switching cabinets and, in general, with applications in air-conditioning. In turn, many fans and blowers from our standard programme are suitable for use in range hoods. This leaves the user with a big choice; there is a “tailored” solution for practically every application.



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“The new multifunctional fans is ideal for the most different applications!”

High labour costs in Europe, and especially in Germany, are forcing the manufacturing industry to look for new ways to allow them to offer their products at a marketable cost/performance ratio and to make sure they can do so in future. This development generates results that the end user profits from the most. One typical example is to be found in air-conditioning and refrigeration. Nowadays, with powerful fan systems normally produced in smaller to medium-sized quantities to customer specifications, using multifunctional fans can reduce the number of required components. At the same time, installation expenditure and the costs for development, logistics and documentation, e.g. with descriptions and operating instructions, are reduced and installation as such is substantially simplified.

Conventional control systems used with condensers in air-conditioning and refrigeration are usually made up of a large number of electrical components. Figure 1 shows the structural principle of such a system. In general, a pressure sensor is needed to measure the pressure in the condenser, plus a closed-loop control and a phase angle control or a frequency inverter for controlling the performance of the asynchronous motors used as fan drives. In some cases, motor circuit switches are also required.

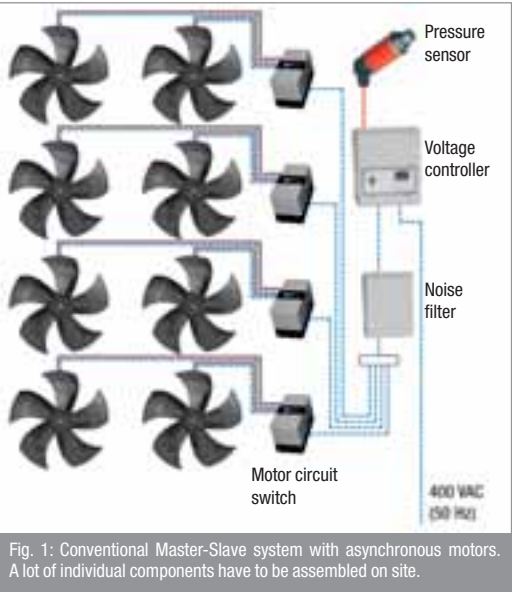


Fig. 1: Conventional Master-Slave system with asynchronous motors. A lot of individual components have to be assembled on site.

EC fan with integrated power electronics reduces energy costs

All these components have to be mounted on or fairly close to the heat exchanger and have to be electrically connected with each other. The expenditure in time and costs thus generated can total up to a substantial level. This is why ebm-papst Mulfingen, as specialist in fans and motors, has decided to take a different approach. The central element of the control system, the fan, comes with additional functions already integrated (figure 2). This reduces the number of required components, and thus the expenditure for the system manufacturer. On top of this, modern, electronically commutated EC motors operating from a three-phase power supply replace the conventionally used asynchronous motors. As the EC motors have significantly higher efficiency, energy costs in operation can be drastically reduced.



Fig. 2: EC motor in size 150 with terminal box

Figure 3 shows how a system for controlling a condenser in refrigeration and air-conditioning is structured: The power electronics are entirely integrated in the motors. They are controlled via the 0...10 V signal of the controller. The fans are then controlled according to the values the sensor has established. Additional motor circuit switches are no longer needed. Safety is provided by the integrated over-temperature protection for motor and electronics, over-voltage cut-off, phase-failure detection, as well as the locked-rotor protection. If needed, the number of components can even be further reduced. The complete closed-loop control may easily be integrated in the EC motors.

Wide input voltage range – reduced number of variants

The EC motors used in these fans also offer further advantages. The integrated power electronics manage all nominal input voltages between 380 and 480 V. Frequencies may vary between 47 and 63 Hz. Air performance remains constant throughout. Compared to asynchronous motors, this special feature drastically reduces the number of variants. The same fan type is ideal for the most different applications. The new multifunctional fans are offered as axial fans with

diameters from 450 to 990 mm, if needed also with guard grille or wall ring. Moreover, centrifugal fans with diameters ranging from 400 to 630 mm. They can also be supplied as modular units.

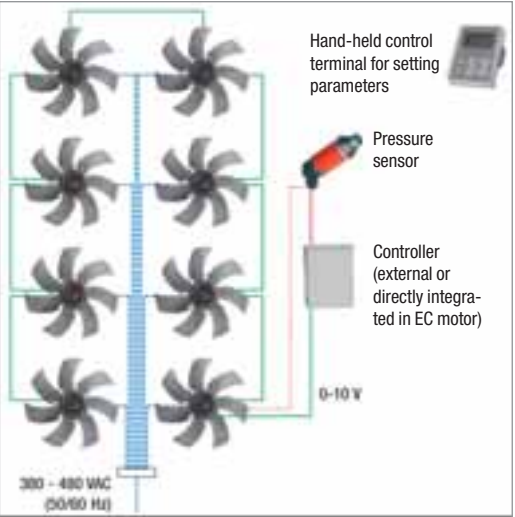


Fig. 3: New Master-Slave system with EC-motors. The power electronics are integrated in the fans.



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Cool air for commercial vehicles

To this day, blowers with mechanically commutated motors, by nature subject to wear-and-tear, are mainly used in passenger cars. While the lifetime of such motors in passenger cars normally corresponds to the utilisation period of the vehicle and is therefore sufficient, things are



Fig. 1: For some years now, the blowers in 24V design have been used to air-condition modern overland busses throughout the world.

different for commercial vehicles, where tougher specifications apply. In order to reduce maintenance costs and down times here, blowers with electronically commutated DC motors are the preferred choice. They are durable and offer better control options due to the integrated electronics, and they can

also be easily fitted due to their compact design. Meanwhile, blowers designed for use in commercial vehicles are not only available in 24V design, but also for 12V battery systems – at identical performance.

Back in 2000, ebm-papst Mulfingen already presented blowers with electronically commutated DC drives for commercial vehicles. Those “aerodynamic power stations” for 24V battery systems have proven their worth in countless applications worldwide by now, e.g. helping to air-condition modern overland busses (fig. 1). However, there

has also been increasing demand for more comfort in smaller commercial vehicles. In vans, tractors and other vehicles used in agriculture, road engineering or forestry, powerful air-conditioning is a comfort that is by now deemed essential. This is anything but luxury – in order to provide a better view and more safety for the driver, the cabins are fully glazed, and this makes temperatures inside the driver go up extremely once the sun comes out. The blowers for such applications have to make do with a 12V battery system, though. If the blowers are to be as powerful as their 24V counterparts, the technology involved needs to be a little more sophisticated:

Same performance at half the voltage

In order to supply the same performance at half the voltage, power input has to be doubled. Naturally enough, this results in an increase of the dissipated energy. At components with resistance, the dissipated energy increases fourfold, as the voltage drop doubles along with the current. For identical ambient temperatures at the site of operation and at identical dimensions, realising such blowers presents a difficulty, especially if the blowers are not only used for cooling but also for heating. Then, they are exposed to ambient temperatures of up to 85 °C. This is why heat dissipation respectively the reduction of lost heat became the main focus in the development of the new 12V blowers (fig. 2).

A typical application for the new and powerful 12V centrifugal blowers is the air-conditioning of driver cabins in modern tractors.



Managing the complex interrelations and adjusting the individual components in such a way as to get the perfect match and solution was based on the core competences that ebm-papst is famous for: engineering expertise in motors and electronics plus aerodynamic engineering, supported by sophisticated computation and calculation approaches and systems. And as the 24V blowers had already proven their worth, they provided vital know-how for the development of the new 12V product.

Technical challenge for our R & D

Due to this expert knowledge, our R & D managed to reduce the losses caused by the current flow, to optimally tie the heat-generating components to the cooling element and to optimise its surface when developing the 12V blower. Power transistors with lower resistance at make and a pioneering current conductance via punched low-resistance power bus lines also helped to reduce the dissipation of energy. Moreover, the power transistors are, just like all the other power-carrying parts, placed close to the cooling webs additionally mounted to the aluminium housing. These cooling webs have a needle-shaped design and are comparatively light despite their large surface (fig. 2).



Fig. 2: Centrifugal blowers and electronically commutated motors for 24V battery systems (left) and 12V battery systems (right)

The high currents at low voltages made it also necessary to develop a new and innovative winding approach for the motors in external-rotor design. The three-phase and delta-connected winding in the stator can now be produced in one step without having to connect individual winding wires afterwards. In order to connect the winding and the punched power line buses to the electronics, state-of-the-art welding and soldering systems are used.

A number of functions of the motor electronics are integrated in an ASIC. Due to the planned assembly variants, the motors can be flexibly adapted to the individual specifications of each application. Thus it is possible to process customer-specific triggering signals, e.g. to influence the air performance curve, without any problem. The electronics are over-temperature protected. To this end, a circuit was integrated limiting the power input as soon as nominal voltage has been surpassed. Fluctuations in operational voltage, which can never really be avoided with battery supply, can therefore cause no damage.

*“12V products:
A technical challenge
for our R & D.”*

*“Your advantage:
A longer service life
and the blowers
operate without
wear-and-tear.”*

Power pack with optimised acoustic performance

In practice, the new 12V blowers score in more than one respect: compared to blowers with mechanically commutated DC motors, the brushless motors have a longer service life, and the blowers practically operate without wear-and-tear. In addition to this, the user also profits from the continuous speed control. It allows comfortable air-conditioning even in working environments with extreme solar radiation. For one thing, the inside temperature can be quickly brought down by going for a correspondingly high air output, and, for another thing, the speed control also makes for an optimal acoustic performance, as the blower output can be individually adjusted to the specific requirements.

The 12V centrifugal blowers are designed for an output of 350W. Their electromagnetic compatibility complies with the toughest interference suppression grades as regards grid-bound and radiated interferences (EN 55025, interference suppression grade 5) as well as the interference immunity classes common in the automotive sector towards outside influences (ISO 7637-2/3; ISO 11452-5; ISO 10605). On top of it all, the new design even offers room for further developments with respect to

higher performance in the 24V design range. So, simply look out for more development news from ebm-papst Mulfingen.



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Intelligent ventilator systems for controlled home ventilation

1. Demands and promotions

Measures aimed at saving energy or at reducing CO₂ emission are in the interest of us all and protect our environment. On February 1, 2002, the energy-saving directive (Energieeinsparverordnung/EnEV) came into effect, containing specifications as to minimum air exchange and minimum heat insulation in buildings. This

EnEV aims at a 25% reduction of the CO₂ emission generated through heating in Germany until 2005. According to the EnEV, the new building standard for new homes should be a 7-litre house. This means, that a maximum of 7 to 8 litres of fuel oil per m² heated area may be consumed per year.

Comparing the demand in fuel oil in litre per m² heated area

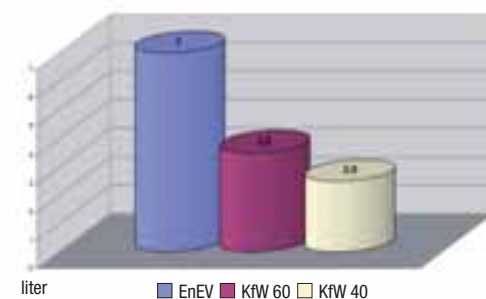


Fig. 1: Comparing the demand in fuel oil in litre per m² heated area

Measures helping to stay below the permissible maximum demand in annual primary energy as set out by the EnEV are to some extent rewarded through certain promotion packages. The credit institute for reconstruction (Kreditanstalt für Wiederaufbau / KfW) offers financial support within the context of their programme to reduce CO₂ emission (programme no. 123). This programme comprises both the financial support for climate protection investments in domestic buildings and for the construction of KfW energy-

saving houses. With energy-saving houses, the KfW distinguishes between the KfW energy-saving house 60, where the annual demand in primary energy may not exceed 60 kWh per m² floor space A_n , and the KfW energy-saving house 40, the annual demand in primary energy of which has to stay below 40 kWh per m² floor space A_n . This annual demand in primary energy takes into account not also the efficiency of the plant technology used, but also the energetic quality of the building shell. The demand in heating energy of the KfW energy-saving house 60 amounts to about 3 to 4 litres, that of the KfW energy-saving house 40 to about 2 to 3 litres fuel oil per m² heated area A_n (see figure 1).

Financial support for the KfW-energy-saving houses takes the form of a low-interest credit from the KfW promotion bank (KfW-Förderbank) amounting to as much as 30,000 € (KfW energy-saving house 60) respectively 50,000 € (KfW energy-saving house 40), with an effective interest rate of 3.83 to 4.27%, depending on the credit period, which can be anything between 10 and 30 years. As for the passive house, which also has an annual demand in primary energy of maximally 40 kWh per m² floor space, there is no additional financial support available. Like the KfW energy-saving house 40, it is supported with a low-interest credit of 50,000 €. (Information as per October 21, 2004)



„Centrifugal fans – for a variety of applications and easy to use!“



A possible measure to comply with the specifications of the KfW energy-saving houses and to reduce the annual demand in primary energy is a home ventilation system with heat recovery plant.

2. Concept of the home ventilation system

In a home ventilation system, two centrifugal blowers are used: one for air supply and one for air discharge. In accordance with DIN 1946, part 10, it has to be safeguarded at all times that the air supply volume equals the air discharge volume. The only deviation permitted is the air discharge volume being bigger by maximally 10% than the air supply volume. Any excess in air supply would inevitably result in a pressure equalisation due to cracks in the walls or any other leaks in the building shell. This means that air escapes through these leaks from inside the building. At first glance, this even makes sense, as cold air cannot seep into the house and as draught is avoided. In winter, however, the warm and perhaps even humid air would start to condensate in the walls when passing out through the leaks. Moisture in the cracks in the walls would then result in building damages and/or mould formation. This is why, if the targeted balance cannot be achieved, it is only per-

missible to have a surplus in discharged air. In order not to distort the energy balance of the building completely, this surplus towards the air supply may not exceed 10%. With open fireplaces in the home, the chimney-sweeping directive applies, and so special measures have to be taken into account.

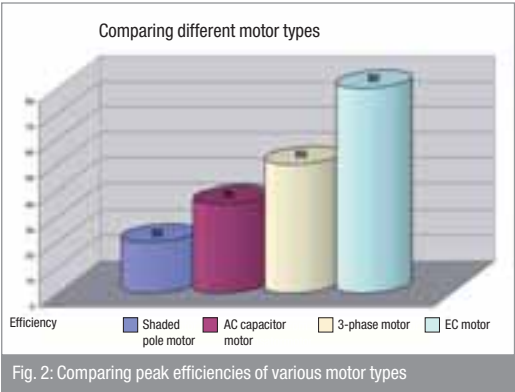
3. AC or EC motors?

As far as motors are concerned, one generally distinguishes between AC motors (alternating current) and EC motors (electronically commutated). AC motors can be directly fed from the AC or 3-phase mains, whereas EC motors still need either DC power supply or integrated motor electronics transforming AC into DC.

Manufacturers of home ventilation systems are faced with the decision which of these motor types to use in their

system. In this task, a comparison of the efficiency of the individual motor types may come in useful.

In this comparison, the EC motor has by far the best results (see Fig. 2). If the home ventilation system is run with AC motors, the power input for two centrifugal blowers



amounts to about 130W¹. At an energy price of 10 cents per kWh, this results in operating costs of 115 € per year. In contrast, ebm-papst EC motors only have a power input of about 25W per EC motor. Two of these EC motors as used in a home ventilation system thus only require about 50W¹. At an energy price of 10 cents per kWh, the annual operating costs amount to about 45 €. Using EC technology and thus saving energy can therefore result in savings amounting to roughly 70 € per year. So it is only a question of (relatively short) time until the – compared to AC motors - slightly higher primary cost of EC motors is amortised via the savings in energy.

4. Forward or backward curved blades?

Centrifugal fans are available in two designs: either with forward curved or with backward curved blades. Backward curved centrifugal fans have a higher efficiency than forward curved ones and, other than the forward curved ones, they offer the advantage of being operated without scroll housing. However, their acoustic performance is worse than that of fans with forward curved blades.

With forward curved centrifugal fans, power input, speed and airflow are almost linearly proportional. This makes it

easy to calculate their airflow via speed and power input. This, in turn, helps to realise a non-sensor airflow control. An external controller with appropriate airflow sensor is thus not required. As this advantage is considered to be a major one, and also due to the more favourable acoustic performance, forward curved centrifugal fans are used in most home ventilation systems.

5. Solutions made by ebm-papst

The proven ebm-papst system includes the switching power supply CNW015AB0213 and two blowers G1G140AW13xx (EC centrifugal fan with forward curved blades inside a housing) and allows for independent control of the two blowers to the set pressure or airflow (Fig. 5). The blowers are very versatile and can be adjusted to customer specifications. Normally, airflow is kept constant. If pressure needs to be constant in exceptional cases, setting a jumper accordingly is all that is required. Moreover, the user can chose between two options of providing the required set value. The required value may be either set via 0 -10V control signal or via 3-step switch. With the latter, it is also possible to go for a variation of four set values via respective DIP-switch settings. Both

Backward curved centrifugal fans		Forward curved centrifugal fans	
+	Efficiency	-	Efficiency
+	More variable, as no housing is needed	-	Scroll housing absolutely necessary
-	Noise generation	+	Noise generation
-	Sensor needed for airflow control	+	Airflow control possible without sensor

Fig. 4: Advantages and disadvantages of both systems



1) Operating point 150 m³/h, 150 Pa

“ebm-papst is committed to make living more comfortable!”



Fig. 6: New blower type G3G140AW0512 with 3-core EC motor

DIP-switch and jumper are not housed in the motor but in the external switch power supply. The logic (card) for airflow control is also part of this external switch power supply.

The non-sensor airflow control as described above makes reduced airflow due to contaminated filters a thing of the past. The system also facilitates adjusting the airflow when putting the system into operation, a cost factor the tradesmen cannot ignore.

Another important factor in home ventilation is noise. As the individual rooms are ventilated and vented via a pipe system laid throughout the house, the vibrations generated by the motor may be perceived as “humming” in other rooms. Not so with the centrifugal fan G1G140AW13xx. Irritating resonance generated by the single-core EC motors used in such systems are, however, not passed on to the pipe system with the G1G140AW13xx, as it features a sophisticated decoupling system for acoustic isolation. This decoupling, however, depends on the mounting position, which is why there are a number of variants.

The second component of the complete system, the switch power supply CNW015AB0213 not only controls the

airflow, but also serves to provide an electrically isolated DC voltage for the two blowers. The switch power supply is fed via the 230V mains and provides a voltage of 48VDC. It is permanently short-circuit proof, open circuit proof and has over-temperature protection.



Fig. 5: ebm-papst EC system

6. New ebm-papst system

Their innovative development approach made the ebm-papst engineers come up with another generation of ebm-papst EC motors. The new 3-core EC motor is combined with proven components - forward curved centrifugal fan impeller and scroll housing – and is available as new blower type G3G140AW0512 (Fig. 6).

In order to be able to offer a compact solution, this pioneering new type has the 230V electronics, so far an external component, integrated in the fan. As this integrated motor electronic contains its own micro-controller, all tasks

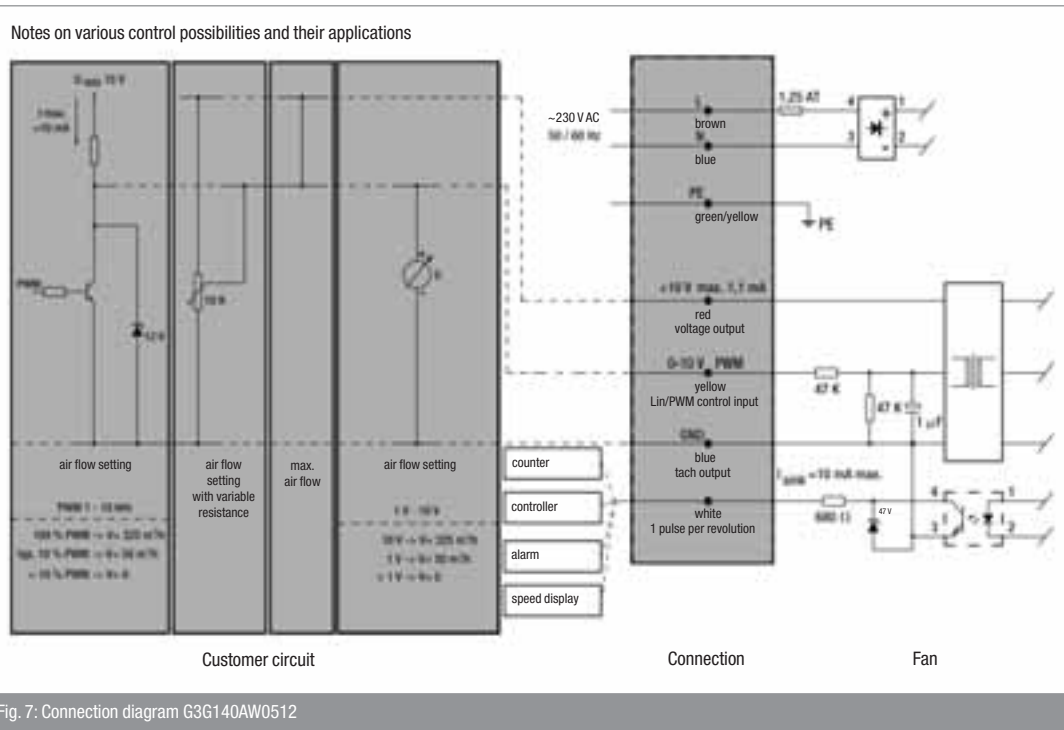


Fig. 7: Connection diagram G3G140AW0512

requiring open and closed loop control can be accomplished. Thus, ebm-papst has managed to realise non-sensor constant airflow without additional electronics. An external switch power supply is no longer needed. The blower G3G140AW0512 can be directly connected to the 230V AC voltage mains with a frequency of 50 or 60Hz.

Like its single-core predecessor, the new type features a control input and a tach output. The customer can set the required airflow either via PWM signal or via adjustable voltage between 1 and 10V or via resistance variation. If maximum airflow is to be used exclusively, the voltage output has to be linked with the control input.

Speed monitoring of blower type G3G140AW0512 generates one pulse per revolution. This output can facilitate a meter, a closed loop control or a speed display (see Fig. 7).

The new EC motor also offers a better IP protection class. The IP 20 realised with the old type has been changed into IP 44. The 3-core design and the new commutation approach also resulted in practically no motor noise being emitted. Thus, the vibration decoupling can be done away with, making it possible to go for any mounting position and to eliminate the number of variants formerly needed.

7. Conclusion

Everything taken together, a home ventilation system with heat recovery unit is absolutely worth its money. However, not only costs and amortisation period should be looked at exclusively. It is the improvement in living quality one should focus on. Fewer allergies, less fatigue due to lack of oxygen, no irritating smells, no mould formation, and constantly fresh air without annoying draughts – nothing more needs to be said.

As leading manufacturer in fans and motors, ebm-papst is committed to make living more comfortable. As far as heat recovery plants are concerned, the world market leader relies on electronically commutated DC motors that achieve efficiencies of at least 70% even when operated at partial load. This is also the case with the new blower generation G3G140AW0512. Here, the user saves energy because of its high efficiency. The compact build and the high integration density substantially reduce installation costs.

Home ventilation systems and heat recovery plants with ebm-papst EC motors – a great leap towards energy saving and improved quality of life.



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