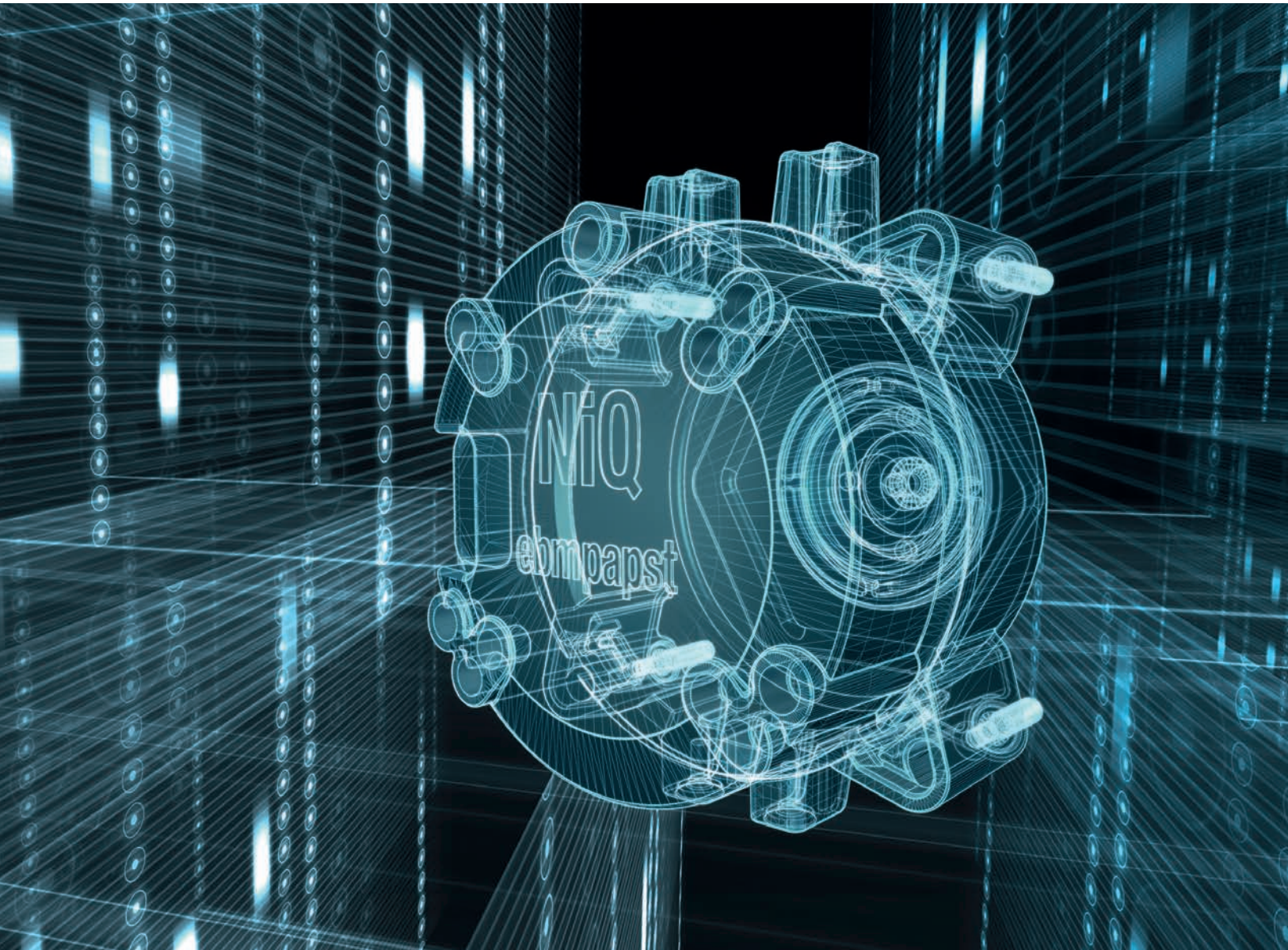
01°2016

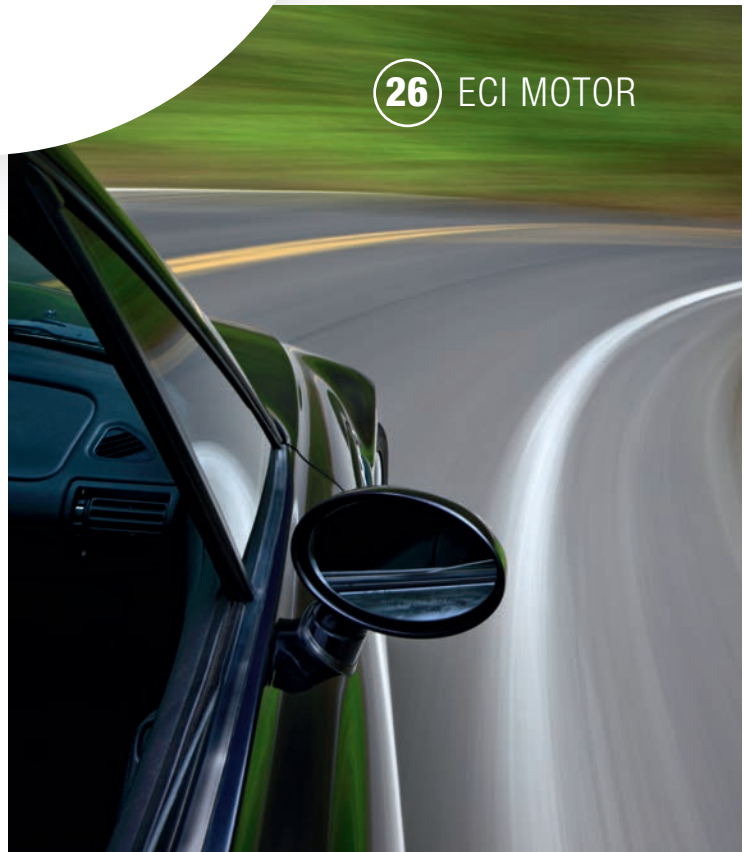
techmag°

Technology by ebm-papst



techmag°

01°2016



“Future proof – Innovative components for a future-proof system”

Dear Customers, Partners and Friends of ebm-papst,

At the 21st UN Climate Change Conference held in Paris in December 2015, the participants set a goal of limiting global warming to well below 2 °C. This will only be possible if all countries adhere to the environmental goals and promises they have made. The world can achieve this goal by significantly reducing CO_2 emissions, but this entails massive energy savings.

ebm-papst and our innovative, energy-saving products can make a contribution to this endeavor. In the second year of ErP2015, we see lots of additional potential for making our products even better, more intelligent and above all, more efficient. At Technical Forum – Refrigeration Engineering 2015 organized by bauverlag, our lecture entitled “Application-oriented fan selection as a prerequisite for optimal system efficiency” (Die applikationsoptimierte Ventilatorauswahl als Voraussetzung für optimale Systemeffizienz) convinced the audience of this potential in detail. Following this motto, we will also be introducing our latest innovations at MCE Mostra Convegno Expocomfort in Milan. The new products on exhibition include the expansion of our AxiCool fan series, which ebm-papst developed especially for application in evaporators and air coolers for industrial and commercial refrigeration. Its clever design features enable this series to provide maximum customer benefits to the companies that use it. The combination of integrated diffuser and discharge vanes teams up with the proven HyBlade® blades and a GreenTech EC motor to deliver an optimally harmonized system that functions at maximum efficiency with a minimum of noise.

Another innovation at this trade show is our NiQ, which ebm-papst is introducing as the next generation of energy-saving motors for refrigeration technology. The compact motor combines the well-known properties of the iQ motor series with a new design – inside and out. The developers have made the “next-generation iQ” even more efficient and above all, more economical. NiQ allows customers to realize additional energy savings in refrigeration technology applications such as refrigerated units and bottle coolers – a step that brings us even closer to the environmental goals.

With a view to the higher ErP limit values the EU has proposed for 2020 and is voting on now, we would like to provide you with security for your planning with these future-proof innovations.

When you read this issue, you will find out how we implement our energy-saving concept in concrete applications – together with our customers. I hope you enjoy your read!

Bernd Kistner, Head of Market Management Refrigeration at ebm-papst Mulfingen

A fresh breeze for the dairy case

Leap from iQ to NiQ: The new generation of energy-saving motors from ebm-papst is more efficient and economical than its predecessors – and is even suitable for use in the food sector.

In refrigerated display cases, dairy cases and bottle coolers in the commercial food sector, fans are in permanent use. This is why they hold great potential for saving energy. The iQ motor – a compact motor for driving axial fans for cool air distribution in evaporators and cooling in condensers – has been available for a long time. It uses proven GreenTech EC technology to achieve high efficiency rates. This is why food retailers and gas stations have successfully relied on iQ motors from ebm-papst for some time.

Now the NiQ, the next generation in the series, is on the market (Figure 1). The latest development from ebm-papst combines the proven properties of the iQ and iQ^2 motors with a new design – both inside and outside. The develop-


Restaurant
BigPizza
TRADIZIONE

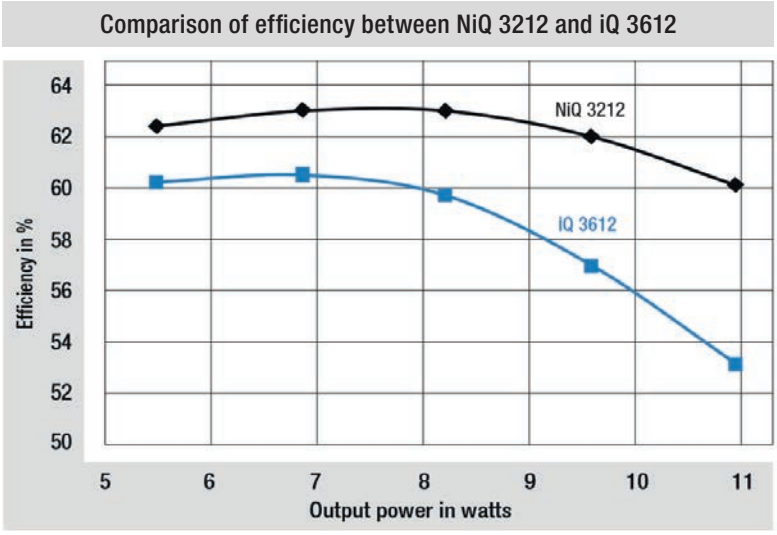


Figure 2: The efficiency of the new NiQ motor has been optimized beyond the level of its predecessors iQ and iQ².

Figure 1: The NiQ – the latest generation of energy-saving motors from ebm-papst.

ers were able to make the "next-generation iQ" more efficient and above all, more economical (Figure 2). And the new motor platform features enhanced functionality for a wider range of applications.

Motor design: optimized for low speeds The NiQ is a completely new motor platform that currently provides three sizes with different levels of power. In accordance with the low speeds the applications typically require, the motor has been optimized to 800 to 2,000 rpm and the corresponding torque. To achieve this, the developers placed the entire motor design on the test stand and changed it at key points. In the NiQ, they replaced the current 4-pole design with a new 6-pole motor concept. The motor with this design functions more closely to the ideal speed, which has a positive impact on its efficiency and smooth operation. Its modified solenoid technology also boosts motor efficiency. The sintered hard ferrite magnets used in the NiQ have a higher magnetic remanence, allowing them to generate a higher motor efficiency level than the plastic-bonded ferrite magnets previously used.

They also added more improvements to the bearing structure. Depending on customer requirements, the NiQ can be delivered with different bearing greases for condensers and evaporators. And the modified motor concept offers one more advantage. Due to the optimized mechanical motor design, the air gap between the rotor and the stator has been significantly reduced. As a result, the torque is now a few percentage points higher.

Overall, the development team at ebm-papst has changed the motor to create the perfect balance between efficiency and costs.

Housing design: innovative retrofitting The first impression reveals that the NiQ is noticeably different from its predecessors. Unlike the iQ with its distinctive aluminum cuboid shape, the NiQ relies on a more organic look (Figure 3).

Figure 3: Thanks to the revised motor concept and the modified housing, the NiQ now has a round design.

A round motor shape has emerged from the 6-pole design. This feature was transferred to the housing. But despite their new concept, the NiQ motors are not ideal for new developments alone. They also make retrofitting easy. They have the same outer dimensions, mounting points and connections as the Q and iQ motors – and the existing accessories are also identical. The advantages of the NiQ can also be used for retrofitting.

Plastic, not aluminum: protection class 2 and FDA-compliant The new material also played a role in shaping the NiQ. The developers replaced the current aluminum housing with plastic. From a manufacturing point of view, the new round design showcases the NiQ's advantages. Manufacturing with plastic is much less energy intensive than aluminum, and the new material easily meets the specifications for degree of protection IP54. The PPC-based material resulted in two fundamental functional innovations. It meets the prerequisites for protection class 2 and the requirements of the US Food and Drug Administration, EU regulation 10/2011/EU, the framework regulation 1935/2004/EC and regulation 2023/2006/EC. The NiQ is not only calibrated for use in harsh environments with a temperature range of -40 °C to +50 °C, but also functions without a protective earth and can be used in indirect contact with food. This is a key advantage for applications in refrigerated display cases for fruit and vegetables, for example. Finding the right plastic was a major development challenge: it had to meet protection class 2 and satisfy the requirements of the regulations.

Wound around the stator The modified design and intelligent material selection were not the only factors contributing to the NiQ's increased economic efficiency; pioneering production changes also played a role. The developers achieved a reduction in the NiQ's total number of parts. And for the motor assembly, threaded fasteners are a thing of the past. Plug-in processes are the only

Plastic easily meets the specifications for degree of protection IP54.

Thanks to the new winding technique the production is more efficient.

ones used. These changes create the conditions for automated production.

But the new winding technique is the most important reason for increased production efficiency. Until now, the stators for EC or DC motors have used the "needle winding technique." Now ebm-papst uses a linear winding process that is perfectly harmonized to the new design. The winding result is more even than with the needle winding technique.

This is not only a matter of aesthetics: the developers selected a more application-friendly certification concept with a special thermal sensor for the NiQ. This innovative concept can only be implemented with an extremely even winding result.

Consistent platform concept Although the NiQ only comes in three sizes, from the technical viewpoint they replace several sizes of the old AC motor technology used in the Q motor. The catalog versions are available as 5 W (NiQ 3208), 12 W (NiQ 3212), and 18 W (NiQ 3224) output power with speeds between 1,300 and 1,550 rpm. And as required, the NiQ provides all the extra functions of the iQ^2 motor: reverse on start, reverse on demand, or two speeds (see box).

The production line also reflects this platform concept. Along most of the line, identical motors are produced and assembled in three sizes. The actual variant is generated only at the end of the production line. This means that the motor obtains the required electronic version in the last step, when the software is loaded onto the printed circuit board.

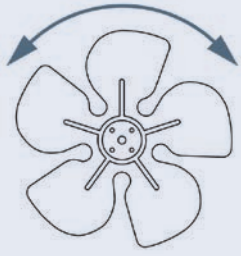
And instead of the former pre-installed cable, a plug-in cable that meets customer requirements is provided separately.

These changes bring customers other advantages in addition to saving costs. The reduction in variants simplifies ordering and warehousing because there are fewer item numbers. ebm-papst is also more flexible in relation to the market: customers receive their products much more quickly. ○

Available functions for the NiQ

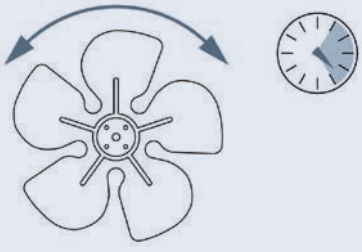
Reverse on start

When starting, the NiQ runs in reverse for a predefined time to blow away the dust collected in the condenser's heat exchanger.



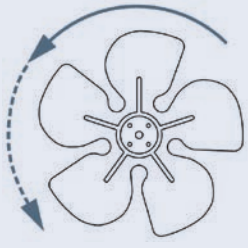
Reverse on demand

Users can determine the time and duration of reverse operation as required, for example when the evaporator defrost cycle is used for the dust removal process.



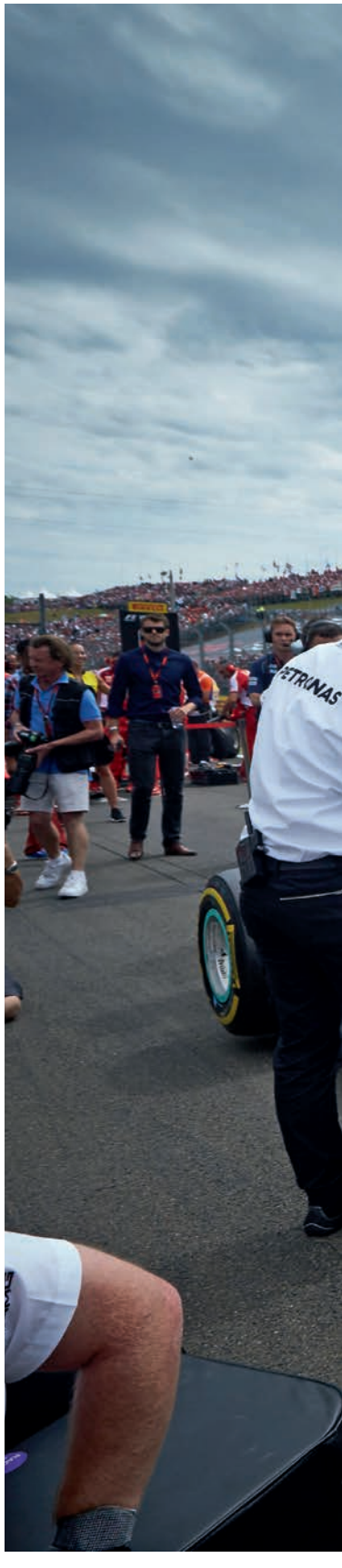
Two speeds

Two speed levels are pre-programmed in the factory. Thus, the application can be run in different day and night modes for even greater energy savings.



The author of this article is Alexander Bleiholder (Dipl.-Ing.), Head of division Household appliances / Diversification at ebm-papst Landshut

You would like more information on this topic? Please address your question to: Alexander.Bleiholder@de.ebmpapst.com



Garage cooling for hot races

EC fans for air conditioning

Formula 1 can be a hot business – for the drivers in their cars, for the spectators in the sun-drenched stands, and also for the engineers who work in the team's garage to prepare the cars for qualifying and racing. At race circuits in particularly hot climates such as Malaysia, temperatures in the garage can reach 40 degrees Celsius and at an almost unbearably high humidity that can exceed 80 percent. An air conditioning system from ebm-papst cools the garage for the MERCEDES AMG PETRONAS Formula OneTM Team at races in especially hot climates. An efficient EC centrifugal fan and a practical system of textile air ducts ensure optimum air flow.

A hot environment makes it more challenging for the team and the drivers to concentrate on their work and aim to perform at the highest level for an entire three-day race weekend, so MERCEDES AMG PETRONAS was fortunate to have ebm-papst, the cooling experts, as a Team Partner. "When we were talking about how to shape our cooperation, garage cooling quickly became one of the top issues on the agenda," says Gareth Jones, Managing Director of ebm-papst Automotive & Drives (UK) Ltd. So ebm-papst took a close look at the problem and worked with a long-standing partner to develop a system for cooling the team's race garages, which are often in hot climates and have no air conditioning.

Flexible system There was a wide range of requirements to be taken into account. The system


PETRONAS
BlackBerry
#KeepFightingMichael
PETRONAS
SYNTIUM

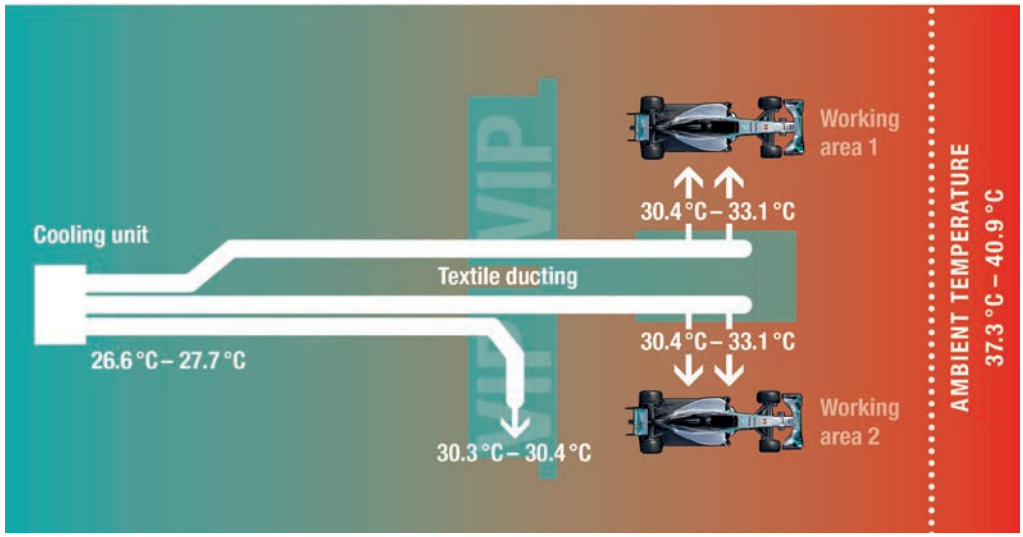


Figure 2: Garage layout for the MERCEDES AMG PETRONAS Formula One™ Team at the 2015 Malaysian PETRONAS Grand Prix. The cooling system transports the air from the rear part of the garage to the VIP visitor area and the cars.

Figure 1: Thanks to water cooling, the air-conditioning unit is only 1.3 by 2.1 by 0.9 meters.

needed to be portable and easy to set up, resistant to high humidity and dust, and – especially important – it had to provide a perceptible cooling effect for the team. First ebm-papst worked with MERCEDES AMG PETRONAS to clarify the question of whether to use an air-cooled or a water-cooled air conditioning system. Once it became clear that running water was available at all potential locations for the system, the engineers chose the water-cooled system. While an air-cooled system would have weighed several thousand kilograms and required a considerable amount of space, the water-cooled unit only weighs 350 kilograms and is very compact: 1.30 meters wide, 2.10 meters high and 90 centimeters deep (Figure 1). The system's small size also helps deal with another challenge: the very different floor plans in the race garages at the venues the team travels to worldwide.

The team from MERCEDES AMG PETRONAS divides a typical garage space into different areas for the car body, transmission, wings, tires, engineering, IT and the work area for the two cars. Two of the system's air outlets cool the work area in the front part of the garage and one outlet ensures pleasant temperatures for VIP guests in the viewing area behind the cars (Figure 2). To avoid taking up too much space, the cooling system is set up in the rear part of the garage. ebm-papst selected textile ducts to conduct air through the garage. The ducts are very light but durable, compact for easy transport, and can be easily adapted to the size and layout of the garage. Depending on the site, the air may be transported over as much as 25 meters from the rear part of the garage to where it is needed. To ensure the desired air flow at the end of the ducts, there is an efficient, high-performance size 500 EC centrifugal fan installed in the cooling unit. Its impeller, motor and electronics are ideally matched, allowing it to achieve an overall efficiency of nearly 60 percent. Thanks to an inlet ring matched to the impeller, the fan also has low noise emissions. It works without problems at ambient temperatures between -25 and +60 °C.

Endurance test in Malaysia The garage cooling system passed its first live test at the Ital-

Figure 3: Without the air conditioner, the air temperature in Malaysia is 39.2 °C (left picture); with the air conditioner the hand thermometer shows 21.8 °C right at the outlet (right picture).

ian Grand Prix in September 2014. “Everything worked as we'd hoped and the system achieved the desired cooling effect without difficulty,” recalls Jones. For the next step, MERCEDES AMG PETRONAS used a garage at the Sepang International Circuit in Malaysia for three days in February 2015. But there the system failed to achieve the desired results. “The temperature in Malaysia was considerably higher than in Italy, so at first we weren't able to generate a perceptibly cool air current where we wanted to. That wasn't because of the cooling system’s performance; the air transport was the problem,” explains Jones. He had parts of the textile air duct system transported to Britain and tailored them for considerably stronger air flow to the crucial parts of the team’s garage. The main challenge was to enlarge the outlets in the textile ducts without fraying. Using special tools, ebm-papst worked against the clock to overcome this challenge. The engineers also changed the orientation of the air outlets. “Instead of trying to cool the air throughout the front part of the garage, we directed the outlets straight toward the places where the team mechanics work so they could feel the cool air current better,” says Jones. Using the modified components, his associates at ebm-papst in Malaysia performed the next test in a factory building. With considerably better results: the cooling system reduced the temperature in the room by nearly 12 degrees Celsius – from hot and sweaty to a pleasant working environment (Figure 3).

A promise kept The system survived its baptism of fire in practical use at the Malaysian Grand Prix in March 2015. “We were really looking forward to using the ebm-papst cooling system that weekend in our garage in Malaysia,” recalls Paddy Lowe, Executive Director (Technical) at MERCEDES AMG PETRONAS. “During the weekend of the race, work is very hectic and it’s really a challenge for the drivers, engineers and mechanics to work at these very high temperatures and in this humidity. Having pleasant temperatures in the garage was a big help for us; that made it possible for the team to perform at its best.” The system fulfilled its requirements

The fan works without problems at ambient temperatures between -25 and +60 °C.

even in the heat of racing operations, cooling the area where the mechanics work on the cars, and the VIP visitor area as well, by as much as 9 degrees C. (Figure 4).

Now the Formula One Team will use the garage cooling system at all racetracks in Asia where temperatures call for it. Next was the Marina Bay Street Circuit in Singapore in September 2015. With its global network of branch offices, ebmpapst deals with the storage and logistics between the races – an additional facet of its partnership with the Formula One Team. Gareth Jones is pleased that he and his colleagues were able to improve working conditions considerably for the engineers at the racetrack. "I always promised the team from MERCEDES AMG PETRONAS: 'We're going to make you the officially coolest team in Formula One'" he says with a laugh.

Figure 4: The pit box cooling system ensures pleasant temperatures for the engineers working on the cars and in the VIP visitor area.

Figure 5: The attachment cooling system for the side pods and the rollover bar is used when the vehicle is in the starting grid or in the box, as here in Hungary in July 2015.

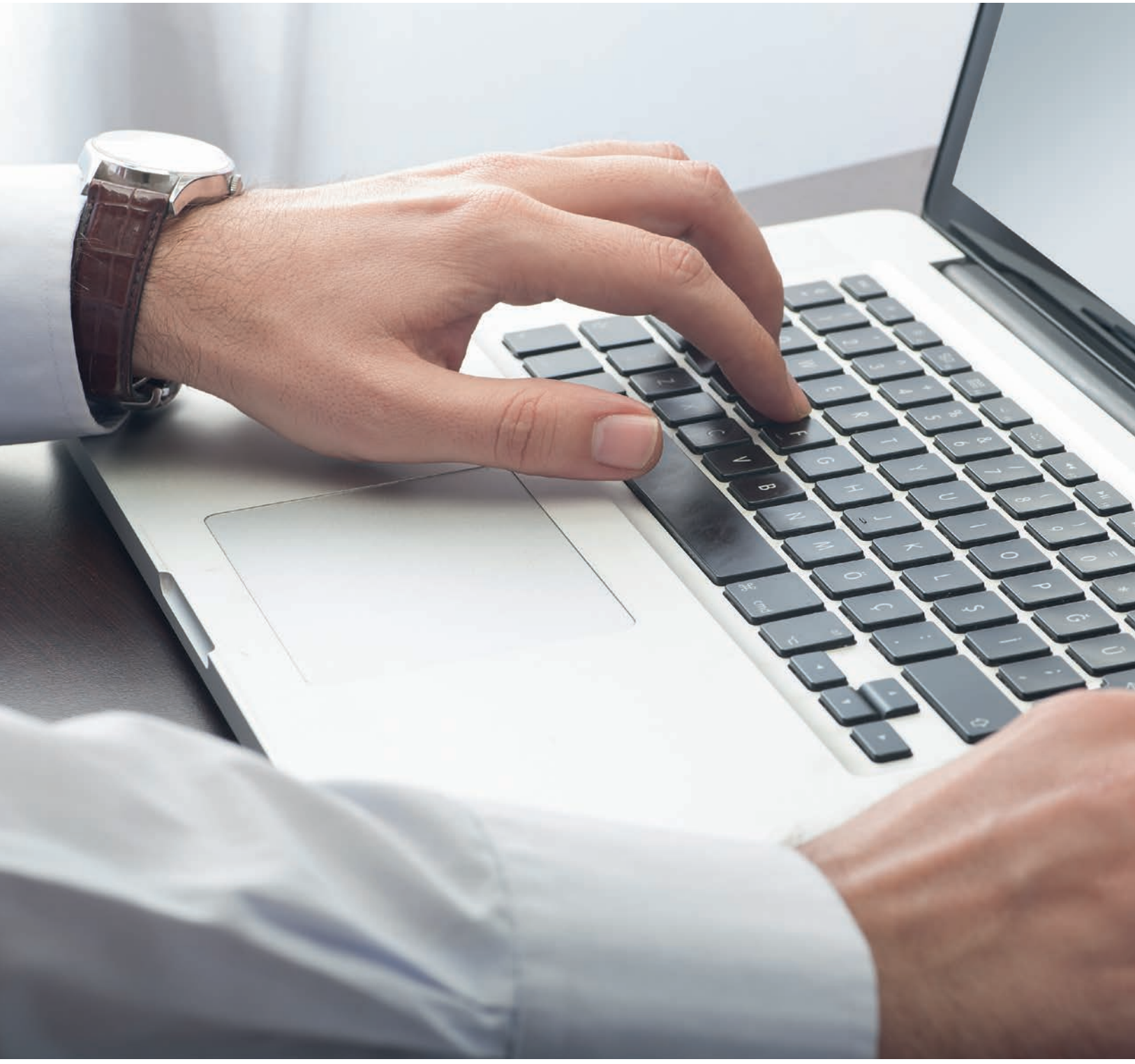
For 2016, ebm-papst remains an Official Team Partner of the 2014 FIA Formula One™ World Constructors' Champions, the MERCEDES AMG PETRONAS Formula One™ Team, offering our support with innovative cooling solutions. Last year, MERCEDES AMG PETRONAS enjoyed its most successful season ever, winning the Constructor's and Drivers' Championships. By joining the team after Formula One™ took a turn towards energy efficiency and hybrid technology with the change in regulations for 2014, ebm-papst became part of this great success.

ebm-papst has developed, in conjunction with the MERCEDES AMG PETRONAS Formula One™ team, a highly specialized off-board cooling solution (Figure 5) optimized for the sidepod radiators and roll-hoop of the F1 W05 race cars which will be deployed when the car is on the grid and in the garage at all Grands Prix and test sessions. In order to achieve the optimal performance for the cars, ebm-papst has used their latest in fan technology. For grid and parc ferme the sidepods and roll-hoop will be cooled with the new 'S Force' axial fans whose performance curve match the high back-pressure characteristics of the Mercedes system and provide a 518% improvement in delivered airflow. This high performance contained within a small packaging size meets the requirements for a small portable powerful system.

When the car is in the garage, the sidepods and roll-hoop will be cooled via a larger low-noise high performance axial solution where the motor and impellor have been integrated into a bespoke designed scroll housing to fit perfectly on to the car for maximum performance and low noise in the garage environment.

The author of this article is Mark Wilson,
Sales Director at ebm-papst Automotive & Drives (UK) Ltd.

You would like more information on this topic?
Please address your question to:
Mark.Wilson@uk.ebmpapst.com



Customizing drives with selected properties

Making the most of EC drive output

The trend in automation has thus far been toward components with maximum flexibility that can be assembled from a set for quick customization. Now miniaturization of the electronics makes it possible to go a step further by "replacing" some hardware functionality with software. Electric drives are an example of this trend: Now a developer no longer needs a number of different electric motors but can use integrated electronics to program modern EC drives for an application's drive profile, e.g. torque-controlled for a thread winder or speed-controlled for pump applications.

Automation increasingly calls for the ability to electronically regulate motors for variable speed or torque or limited output as needed. ebm-papst has been observing this trend for some time and has meanwhile integrated the entire control system and power electronics in the drive unit's K4 module (Figure 1), expand-

Figure 1: Cross-section of drive with K4 electronics module and EtaCrown® angular gear.

The control and power electronics make these modern drives suitable for a wide variety of uses.

ing the range of uses for modern, electronically commutated drives. Whereas conventional DC drives needed to be mechanically designed for certain torque or speed ranges, EC motors are intrinsically able to cover much more extensive ranges. Now an integrated control system makes it possible to fully exploit this potential without compromising on reliability. In addition, programmable drives can be more easily integrated into applications and reduce cabling effort and installation time.

Configurable drives Modern EC drives excel thanks to their rugged construction; their magnetic circuits can easily withstand even the most extreme mechanical and electromagnetic stresses. The result is an enormous potential output at maximum efficiency, though to date the full output range has seldom really been utilized. That will change radically with the new control electronics, designated "K4," which monitor the drives and enable 100% motor output exploitation with the specified parameters for optimum utilization of drive benefits such as full motor torque from zero speed with high short-term overload capacity for applications such as rapid acceleration of heavy loads. With reconfigured parameters, the same motor can also wind even the finest thread at variable speed, or it can be operated like a stepper motor to automatically move to specific positions on command.

Benefits of an integrated control system
A flexible control system makes it possible to tailor a drive to an application's requirements. Three operating modes are possible, with the motor working in speed, positioning or torque mode to reduce the burden on external control systems. The fully integrated control electronics provide several analog and digital inputs and outputs, which can be configured via an RS485 interface. The drive's functionality during operation can also be controlled by monitoring numerous quantities such as voltage, current, speed, tem-

perature, etc., so that users can concentrate on their core expertise – development – and drives operate with optimum values in the permitted range of performance data. In addition, the number of drive variants needed by users with broad requirements profiles is reduced substantially, and subsequent adjustments during operation are also possible. The control and power electronics make these modern drives suitable for a wide variety of uses and can be configured quickly using the powerful "Kickstart" PC configuration tool (Figure 2). An endless variety of applications is conceivable with the concept described here; two practical examples are described below.

Use as a steering motor Precise and reproducible positioning is needed for an active rear axle in transport vehicles, an example of the use of the ECI 63.20-K4 as a steering motor. The vehicle's control system supplies a target angle to the motor, which works in stepper motor mode. The drive then converts this input into a correspond-

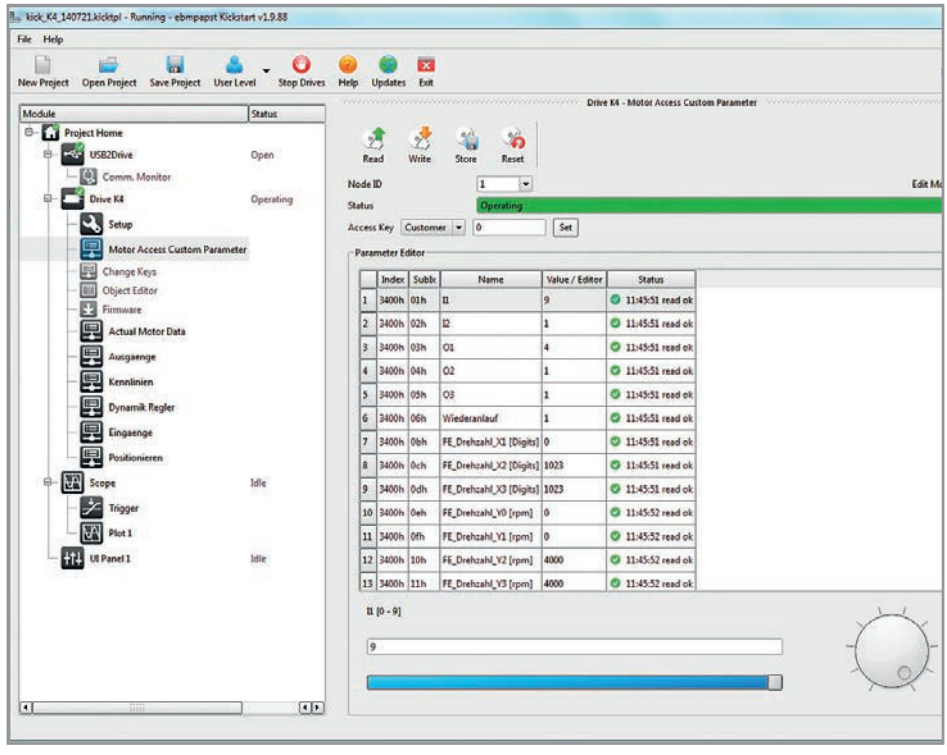


Figure 2: Screenshot of Kickstart tool: the menu enables fast configuration of parameters with the mouse.

Figure 3: ECI series and VDC series.

The customer benefits from both the compact design and the fast configuration of the drives.

ing steering angle automatically. Since the integrated control system preprocesses the steering angle inputs for the motor and passes them on to the power unit, the user need not be concerned with motor control and can concentrate on the core task of correct positioning. In addition, depending on input, the current, voltage, position, speed and other parameters are constantly monitored with a diagnostic tool and alarms are issued when necessary. A configuration tool helps with familiarization, significantly reducing the time needed for development and testing. Only a few mouse clicks are needed to quickly assemble entire functional sequences, which can be activated through two digital inputs. Thanks to the drive's small size and its overload capacity, the steering unit can be built small and light.

Drives for intralogistics With their compact designs and high overload capacity, the drives in the ECI and VDC series lend themselves to applications characterized by confined spaces and dynamic requirements. A good example is a diverter unit used in conveyor systems. In this case, a drive based on the VDC-3-49.15-K4 motor is used. Only 120 mm long and 63 mm in diameter, it contains the motor, the planetary gear and the associated K4 electronics. "Here the customer benefits from both the compact design and the fast configuration of the drives (Figure 3)," says Dominik Häßler, a developer at ebm-papst. "Via the electronics, every motor can be configured to its specific drive task along the conveyor line, which optimizes the system while also lowering costs for spare part inventory. This drastically reduces the number of different drive units."

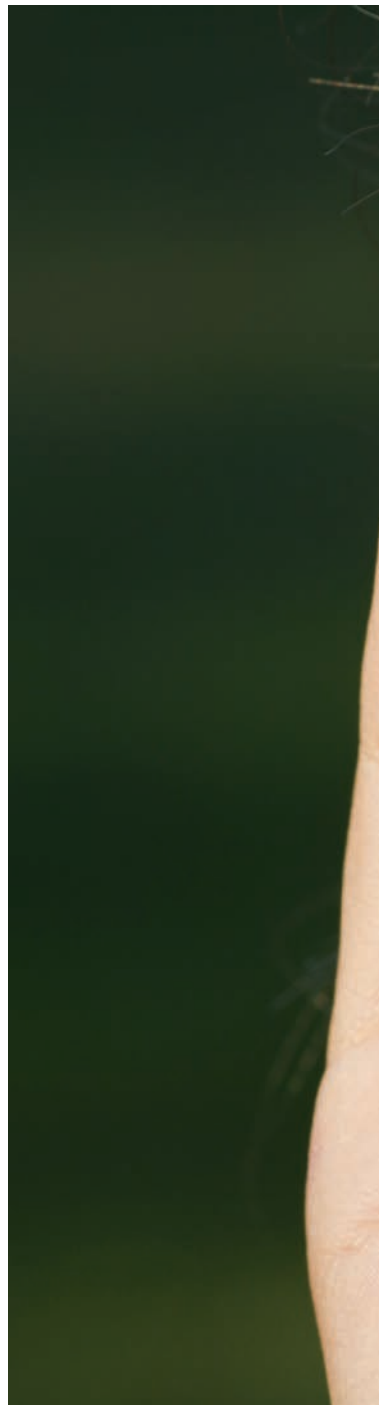
In spite of their compactness, the drives transport packages weighing up to 50 kg at a speed of about 1 m/s. The acceleration needed for distributing or diverting the packages is ap-

proximately 2.5 m/s². The drive benefits here from the high efficiency of the EC motors and their pronounced overload capacity. Low dissipation and compact motor design keep the thermal effects of high transient load peaks manageable.

Modular system plus software Since the electronics can only work within the power range dictated by the motor design, this motor series is also designed as a modular system, with a variety of components such as gearboxes, brakes or electronics modules being combined around a compatible EC drive to match the application. The application bandwidth of a drive configured in this fashion is further expanded by the K4 electronics, which provide especially precise control to unfold the entire capability of each EC motor. Output ranges up to 400 watts for the ECI series of internal rotor motors and 120 watts for the electronically commutated VARIODRIVE Compact external rotor motors. ○

The author of this article is Dominik Häßler (B. Eng.), Project Engineer Application at ebm-papst St. Georgen

You would like more information on this topic? Please address your question to: Dominik.Haessler@de.ebmpapst.com



Focus on psychoacoustics

How is a fan supposed to sound?

Our sense of hearing works constantly and without respite, so our ears receive noises 24 hours a day. About 15,000 hair cells in the inner ear catch the waves from every sound, convert them to signals and relay the signals to the brain, where they are processed. This is the realm of psychoacoustics, a branch of psychophysics. It is concerned with describing personal sound perception in relation to measurable noise levels, i.e. it aims to define why we perceive noises as pleasant or unpleasant. Responsible manufacturers take the results of relevant research into account when developing fans.

When we feel negatively affected by a sound, for example when it disturbs us, we call it noise pollution. Whether this is the case depends on many factors (Figure 1). Among other things, our current situation plays a role, as do the volume and kind of sound. The same is true of fans, which need to fulfill different requirements depending on where they are used. For example, if they are used on a heat exchanger in a cold storage facility where people spend little time, low volume or pleasant sound is not an issue. But ventilation and air conditioning units in living and working areas have to meet much different expectations. However, that does not mean that fans have to work noiselessly. In many applications, their operating noise serves as a functional check; a typical example of this is a kitchen range hood.

Noise spectrum of a fan Noise generation is often a crucial consideration when deciding which fan to purchase. In addition to aerodynamic data (air performance), the sound power level becomes an important property. The noise spectrum of a fan generally includes tonal and broadband components. The ways in which these components arise are completely different. Most tonal components arise from the interaction of the rotating impeller with disturbances in the ad-

Figure 1: Our sense of hearing works constantly and without respite, so our ears receive noises 24 hours a day. About 15,000 hair cells in the inner ear catch the waves from every sound, convert them to signals and relay the signals to the brain, where they are processed.

jacent air flow, which can be caused by struts, guide blades, asymmetric inflow, etc. Their origin thus depends on how the fan impeller is installed. Often, they can be reduced or even prevented by improving the placement of the impeller. In contrast, most broadband noise components are caused by unavoidable turbulence in the inflow and the inherent flow around the blades. The broadband components determine the base level of a fan's noise spectrum. Here manufacturers have made progress and know of many ways to reduce fan noise, including aerodynamically optimized fan impellers, winglets, diffusers and air inlet grilles, with which the sound power and noise level of fans are reduced considerably. Figure 2 shows an example of the substantial noise reduction that can be achieved by using the FlowGrid air inlet grille and the AxiTop diffuser.

A drop of a few decibels in the noise level means that a fan works much more quietly. However, the noise level determined by physical mea-

Figure 4: Searching for pleasant-sounding fans: This is a soundproof room with room for up to eight test subjects who listen to recorded fan sounds in various configurations.

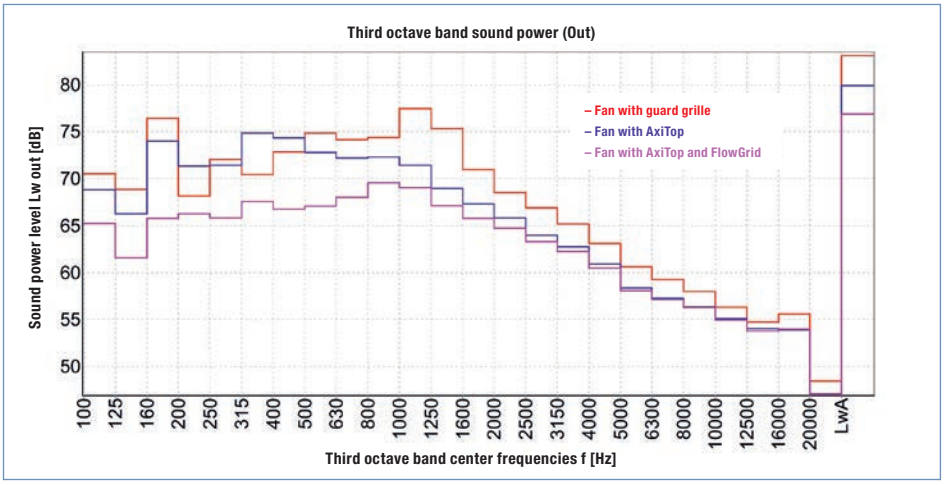


Figure 2: A noticeable reduction in noise can be achieved with the FlowGrid air inlet grille; it can be reduced even more in combination with the AxiTop diffuser.

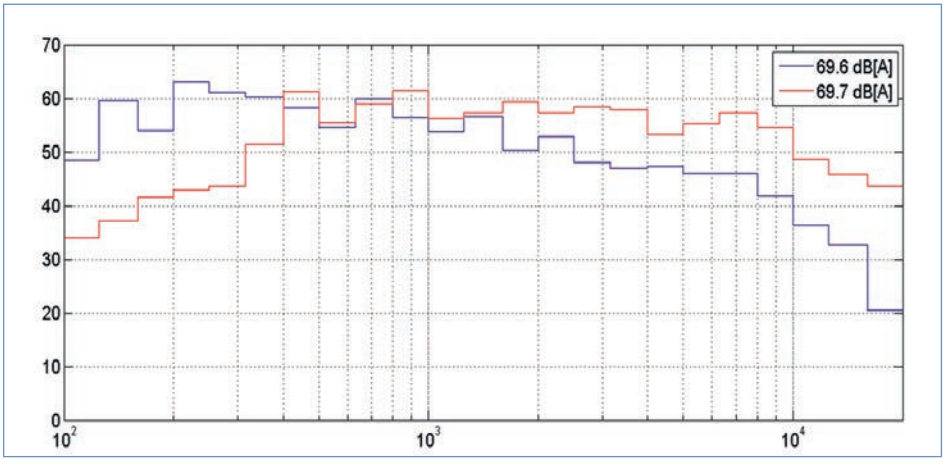


Figure 3: The noise spectra of a piece of music (blue) and a size 250 EC fan (red) are similar but are perceived quite differently.

surements in a test system says nothing about whether we perceive the sound as pleasant or unpleasant. For example, trumpet music and an excavator at a construction site have approximately the same sound power, but our psychoacoustic assessment of them is completely different. Figure 3 shows a further example: In this case, the spectra (the two curves) can be distinguished, but their overall level is (nearly) equal:

69.7 dB(A). What is crucial here is that, based on the spectrum, it is impossible to draw conclusions about whether the sound will be perceived as pleasant or unpleasant. One might assume that the blue spectrum (music!) with its higher proportion of low frequencies would be more unpleasant. But human hearing assesses the sounds quite differently.

Quiet is not enough For subjective judgments, important characteristics include how "rough" or "sharp" a sound is perceived as being. Such perceptions can arise when a signal is given a temporal structure by changes in its frequency or amplitude. Many sounds also include tonal components that can have a strongly irritating effect that differs from person to person, which further complicates their evaluation.

The motor and fan specialists at ebm-papst Mulfingen have addressed this issue, once again taking on a pioneering role. After all, they want

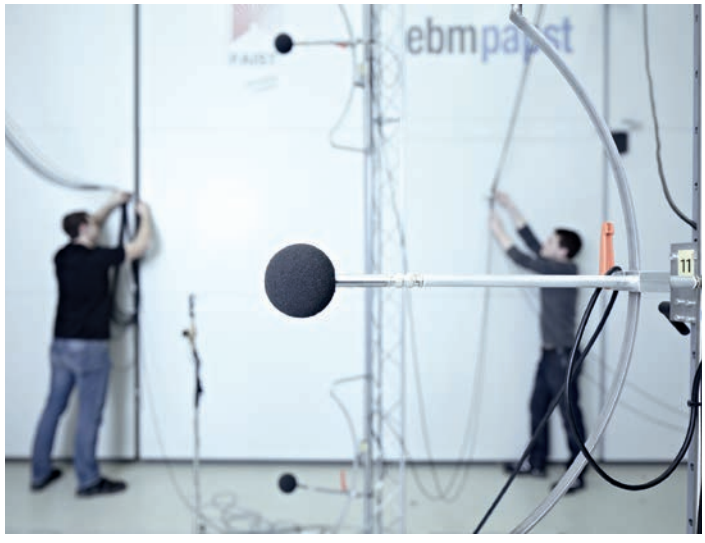


Figure 5: Specially positioned microphones for recording psychoacoustic parameters.

their quiet GreenTech EC motors to have a pleasant sound. For the developers, a worthwhile long-term goal would be a manufacturer-independent standard for noise annoyance similar to the existing regulations for noise protection. For example, even when it satisfies the German Technical Guidelines for noise protection (TA Lärm), an air-heating pump installed outdoors can annoy neighbors with its irritating hum to the extent that harmonious coexistence is no longer possible. In such cases, it is better to work with fans that have been optimized according to psychoacoustic criteria.

Searching for pleasant-sounding fans To conduct tests, ebm-papst has set up a so-called psychoacoustics lab, the "AudiMax" (Figure 4). This is a soundproof room with room for up to eight test subjects who listen to recorded fan sounds in various configurations. 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 (Figure 5) and compared with comments made by the test subjects.

Assessments by the test subjects are analyzed with statistical and psychological methods. The results are used in product development; they make it possible to ascertain which measures are effective at reducing noise annoyance caused by fans and which are not. The ultimate aim is to develop a fan that is perceived as pleasant by as many test subjects as possible. The "AudiMax" thus makes a contribution to the further refinement of GreenTech EC technology. Reducing the annoyance caused by noise is an important development objective from an ecological perspective since noise is a form of pollution. Irritating noise is an impairment to quality of life and, in the worst case, can even lead to illness. ○

The author of this article is Dr. Marc Schneider, Group Leader for Advanced Development of Aerodynamics and Acoustics at ebm-papst Mulfingen

You would like more information on this topic? Please address your question to: Marc.Schneider@de.ebmpapst.com

ECI motors ensure perfect control pressure in transmissions

Electric oil pumps decouple transmissions from drive motors

Greater comfort and better fuel economy are much in demand for today's new vehicles. Automatic start/stop systems and hybrid vehicles are good examples of developments in this direction. But in addition to the engine, it is also necessary to consider components such as the automatic transmission. In conventional vehicles, the internal combustion engine drives an oil pump that in turn builds up the necessary control pressure. When the engine is at rest, this pump also stops and the pressure drops. Newer models therefore have an electrically driven pump in the transmission to continually provide control pressure and make sure that it can change gears immediately at any time – even while the engine is not running. A robust, electronically commutated DC motor that operates reliably in the transmission oil drives this pump.

Modern drive concepts for cars increasingly rely on electrically controlled operation. It allows

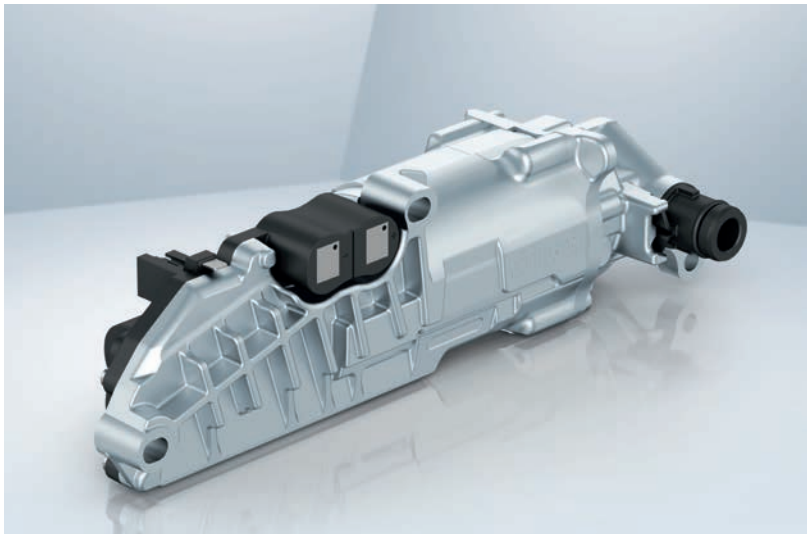


Figure 1: Robust oil pump system with excellent dynamic operation even at high oil temperatures.

The dynamic internal rotor motors work at ambient temperatures from far below 0 °C to over 100 °C.

many drive train parameters to be optimally adjusted to the current driving situation and saves energy in the process – transmissions included. Conventional, purely mechanical systems are difficult to integrate into the new concept, which is why electrically operated actuators are the means of choice. ebm-papst St. Georgen, the specialist for automotive components, now offers a robust DC motor as the hydraulic pump drive for automatic transmissions (Figure 1). It is ready to provide the control pressure required for electronic closed-loop control from a speed of zero, ideally suiting the new control and drive concept.

No more rigid coupling In the past, only mechanically rigid coupling was possible, such as for camshaft drive via chain or gearwheel using the crankshaft. However, this principle always means a fixed ratio of speed to control time. The modern electronics in today's cars have allowed ebm-papst St. Georgen to loosen up this rigid connection, making all the drive train control processes flexible. An advantage here is that classical hydraulic coupling or brake band activation is easy to integrate into modern transmission management via electronically actuated valves.

However, the classical process of pressure generation via pump – which is conventionally located on the input shaft driven by the engine – is a significant disadvantage. Pressure can only be generated when the engine is running, which means minimum delay times that become relevant during startup. And the delivery rate, which increases with pump speed, quickly becomes too

Figure 2: Clean-room production keeps foreign bodies out of the motors.

high. The choke must “dispose of” the excess air flow being delivered. An elegant solution to this problem: an electrically driven auxiliary pump that provides the required pressure immediately after the ignition is turned on.

Sophisticated site of operation The mechanical design of the pump depends on the individual transmission design, and the drive motor parameters must always be adjusted to the transmission. The specialists from the Black Forest solve the problem by using basic components that they select and modify according to the performance specifications. Users must observe this application's special conditions of use: The dynamic internal rotor motors work in transmission oil and must be able to withstand ambient temperatures from far below 0 °C to over 100 °C. The oil contains additives that optimize the friction behavior of couplings, brake bands, etc. but can also have an aggressive impact on non-ferrous metals. Unprotected copper coils or unsuitable insulating enamels would corrode and fail.

Since oil is viscous in cold environments and is difficult to squeeze through cracks and openings, a low air flow is required here. This means speeds must be low and torques high, since relatively high friction must be overcome. When it is warm, oil is more fluid and the pumps must convey higher volumes. In this case, the motor must run at a higher speed and a relatively low torque. This requires a corresponding motor power curve, and here, the good field weakening capability of the drive meets the required performance profile.

Figure 3: The in-house test stand has all the equipment required for testing the motors in detail under real-world conditions.

The motors can be produced in a special clean room to achieve the abcence of dust.

Robust motors On the one hand, different motor powers are required depending on the hydraulic design of the transmission. On the other, the existing installation space often requires extremes: a short motor with a wide diameter or the opposite (an elongated, slim motor). Motors with stack diameters of between 40 and 76 mm and differing lengths are available as basic components. They allow power, torque and design to be adjusted to user requirements. In numbers, this means that the range from 100 mNm to 2000 mNm, or converted, 40 - 500 W output power is seamlessly covered. Especially temperature-resistant high-performance magnets permit operating temperatures of up to 140 °C. Selected materials and varnishes are able to withstand the corrosive additives in the oil. The flexible design of the motors permits sinusoidal or block control. Despite the use of standardized motor components, of course customer-specific electrical contacts or mechanical variants, such as the integration of a pump flange into the motor bearing assembly to reduce the number of interfaces, are possible.

Production know-how An in-house laboratory with a variety of test stands supports the development team (Figure 2). The motors can be examined in detail under the most rigorous conditions. When the development work is completed, the next step is implementation as serial production. For modern automatic transmissions in particular, the closest tolerances between moving components must be maintained. As a result, even the

smallest foreign bodies can produce sensitive disruptions, damage, or even complete failure. Upon customer request, the relevant motors will be produced in a special clean room in order to achieve the required absence of dust (Figure 3). Harmonized process management and a dedicated analysis laboratory monitor production constantly in order to guarantee 100% quality assurance.

The result is modern electric motors that reliably resist the adverse conditions present in the oil baths of automatic transmissions. Optimally designed for the hydraulic issues of the corresponding transmission, they allow for reliable operation and highly responsive gear changes – even when the drive motor speed is zero. This makes them the ideal supplement to modern drive systems. ○

The author of this article is Alexander Hahn, Dipl.-Ing. (FH), Head of Automotive Technology at ebm-papst St. Georgen

You would like more information on this topic? Please address your question to: Alexander.Hahn@de.ebmpapst.com

Imprint

ebm-papst
Mulfingen GmbH & Co. KG
Bachmühle 2
D-74673 Mulfingen
Telefon +49 (0) 7938 81-0
Telefax +49 (0) 7938 81-110
info1@de.ebmpapst.com

ebm-papst
St. Georgen GmbH & Co. KG
Hermann-Papst-Straße 1
D-78112 St. Georgen
Telefon +49 (0) 7724 81-0
Telefax +49 (0) 7724 81-1309
info2@de.ebmpapst.com

ebm-papst
Landshut GmbH
Hofmark-Aich-Straße 25
D-84030 Landshut
Telefon +49 (0) 871 707-0
Telefax +49 (0) 871 707-465
info3@de.ebmpapst.com

www.ebmpapst.com

Responsible for content:
Kai Halter

Editor:
Katrin Lindner

Layout and production:
Scanner GmbH, Künzelsau

Photography:
ebm-papst, fotolia.com (p. 16 © devrim_pinar, p. 23 © Finanzfoto), MERCEDES AMG PETRONAS (p. 11, 14, 15), Getty images (p. 26 © DaveAlan)

Print:
Druckerei Ziegler GmbH + Co. KG

It’s All a Matter of TechNiQ.

NiQ: Our latest generation of energy-saving motors.

New features and design optimization make the NiQ a real winner.

- Outstandingly efficient GreenTech EC motor
- Suitable for use in areas with indirect foodstuffs contact (open vegetable display cases for example)
- Enhanced thermal characteristics thanks to new winding technology
- Long service life thanks to maintenance-free bearing system
- Simple exchange from AC to EC

More information for your application: **www.ebmpapst.com**

ebmpapst

The engineer’s choice

40052-7-8811 PM-EN tech.mag 01/2016 SC-2,5