

High power density, high functionality and constant performance

Multi-pole external rotor motor with compact electronics

Beate Fehrenbach
Anprechpartner für Redaktion
Telefon +49 7724 81-1342
Telefax +49 7724 81-1459
beate.fehrenbach@de.ebmpapst.com

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Short version:

Outstanding power density and more compact dimensions than internal rotor motors coupled with unexpectedly excellent dynamic characteristics are the outstanding features of a new generation of external rotor motors manufactured by ebm-papst St. Georgen. A high torque, wide speed range and a high overload capability together with a high breakaway torque distinguish it from other motors. A high operating efficiency, control of speed 0 with safety torque, torque control and optional position control complement the extensive range of functions that are available. Thanks to the robust mechanics and compliance with protection Class IP54, integration into machines and systems does not present a problem.

The output data of both current motor versions speak for themselves: Nominal voltage 48 and 24 VDC, operating voltage range 18 to 55 V and 18 to 30 V. The nominal speed is 4000 rpm, the nominal torque 250 mNm and 150 mNm. The starting torque is 100 % higher. With 2.9 A (48 V) and 3.5 A (24 V) current consumption, the drives have a continuous power output of 105 and 63 watt. With dimensions of only 63 x 52 mm (diameter x length) the motors are extremely compact (Fig. 1). They thus achieve top ratings with regard to nominal rated power per construction volume and mass. A bearing system that is specially designed to meet the requirements of the drive motors has a service life of up to 40.000 h even under difficult conditions.

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Long version:

Many applications require smaller, reliable drive units. Unfortunately, compact internal rotor motors have small dimensions, in other words short but highly dynamic and with high speed stability. For many drive tasks therefore, they require a multi-stage reduction gear unit. This motor/gear unit is large by comparison. Compacter dimensions and unexpected high dynamics can be found in the new generation of external rotor motors. A high, constant torque over a wide speed range avoids the use of gears or allows one-stage reduction. The unit is more compact and is easier to integrate into the application. Thanks to inexpensive production methods, the price of the „power package“ is definitely competitive.

Modern electronics focus on distributed, decentralized intelligence, a trend that applies increasingly to smaller drive units where a compact drive is required. A power output of around 100 watt suffices for many areas of application whereby dynamic control behaviour and a highly adaptable speed range are required. In order to fulfil these requirements ebm-papst, the specialist for small external rotor motors from St. Georgen in the Black Forest, developed a new motor generation. Motor components and production methods based on new technologies enable favourably priced, high performance motors to be manufactured in this category.

Tailor-made

For the Black Forest specialist, external rotor motors have long been a state-of-the-art feature of small fans and drives. The further development of drives for this purpose is based on long years of experience. Contrary to „Fan motors“ a drive motor suitable for universal use requires a completely different motor configuration. A high torque over a wide speed range or high overload capability combined with a high breakaway torque are important factors. On the other hand, a high efficiency coefficient, reliable control of minimum speeds, controlled safety torque at 0 speed as well as quiet running and easy integration in the unit are also required. To solve these basic demands, the engineers based their developments on the principle of a multi-pole external rotor motor (Fig. 1).

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An arrangement of a multi-pole magnet in the rotor housing and a corresponding number of poles at the stator winding simply mean a higher coverage of magnet and stator pole at all times and thus a multiple torque – remotely comparable to a higher number of cylinders in a combustion motor (Fig. 2a,b). The motor provides a substantial torque even at lower speeds, so that the numbers of stages of the gearbox can often be reduced by one. Despite the many poles, the stator poles of the external rotor motor are open to the outside and it is easier to wind than comparable stators of internal rotor motor. Using modern NeFeB or plastic-bonded magnets specific performance values can be achieved. Nevertheless, the ripple in both versions is less than 1% of the nominal torque. As the iron bell supports the magnets against the centrifugal forces on the outside, the motor remains absolutely stable at high speeds. Integrated electronics that operate with field-oriented control (FOC), supply the stator winding in the star winding configuration with voltage required for sinus commutation (Fig. 3). This has the advantage that the winding is optimally used and enhances the quiet running. Even the operating efficiency increases with this type of commutation. Mounted on a 6-layer HDI PCB, the powerful electronics improve the efficiency of the motor. Variable current limitation per analogue nominal value as well as varying additional input and outputs enable extensive drive functionality. Using different types of software, numerous motor characteristics can be parameterized depending on the application. Further options, e.g. position controller, single turn absolute encoders or an RS-485 interface can be provided on request. Two analogue, four digital inputs and three digital outputs can now be used for integrating in the unit. An optional BUS connection is also available for changing parameters during operation or for receiving current motor data for further processing. All components of the SMD-loaded PCB are AOI tested. Both PCB and motor fulfil all requirements relating to EMC and creepage paths that are necessary for e.g. medical applications. The specially developed, fully sealed cable connection is screwed as a separate module to the motor and enables further flexibility in the designing of interfaces and functionality (Fig. 4a,b).

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Top performance data

The performance data of the two current motor versions speak for themselves: Nominal voltage 48 /24 VDC, operating voltage range 18 to 55 V and 18 to 30 V. The nominal speed is 4000 rpm, the nominal torque 250 mNm and 150 mNm. The starting torque is up to 100 % higher. The drives have a 105 and 63 watt continuous power output at 2.9 A (48 V) and 3.5 A (24 V) current consumption. With dimensions of only 63 x 52 mm (diameter x length) the motors are extremely compact. They thus achieve top ratings with regard to nominal rated power per construction volume and mass. A bearing system that is specially designed to meet the requirements of the drive motors has a service life of up to 40.000 h even under difficult conditions. The motors can thus be used over the entire speed range from 0 to 5000 rpm and are maintenance-free. In addition to the powerful versions with NeFeB magnets, a less powerful model is also available with a rubber magnet. This reaches its maximum operating efficiency of over 80% at small torques whereas the more powerful version has a wide torque range with virtually optimum operating efficiency and thus has high power reserves.

The solid flange of the motor with three tapped holes is designed for direct mounting and is suitable for different gears. Spur and planetary gears are adapted exactly to the motor characteristics, so that optimum combinations can be realized, e.g. to produce quiet running or maximum torque.

Universal use

The compact drives are suitable for many technology sectors, not only in peristaltic pumps for dialysis purposes but also in limited drives of rehabilitation equipment. With an integrated bus system, the motors can be used in industrial automation for adjustment and feed drives, e.g. for replacing a handwheel. In the packaging and textile industry, the sensitive speed control in conjunction with the adjustable torque limitation enables optimum adaptation to the materials used, e.g. for coil and winding drives. Thanks also to its 4-Q controller, the high overload capability of $2 \times M_{nom}$ and the digital fault output, the bus drive is optimally equipped for electronic gears as used in letter sorting systems.

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The new multi-pole external rotor motor drives are both powerful and compact. The wide speed range and corresponding torque enhance the dynamic values of the motors which together with the external moments of inertia approximately reach those of internal rotor motor drives. All motor functions are optimally controlled via integrated electronics and relevant operating data and error messages can be transmitted to external terminals if required. A special, application-specific motor configuration is thus possible by simply programming the control electronics. This saves costs in development, production and storage.

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Fig. 1 Compact design, high power density and sturdy mechanical structure

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Fig. 2a,b The multi-pole structure of the stator ensures high power density and an efficient production concept

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EPS_09-001_fig3.jpg

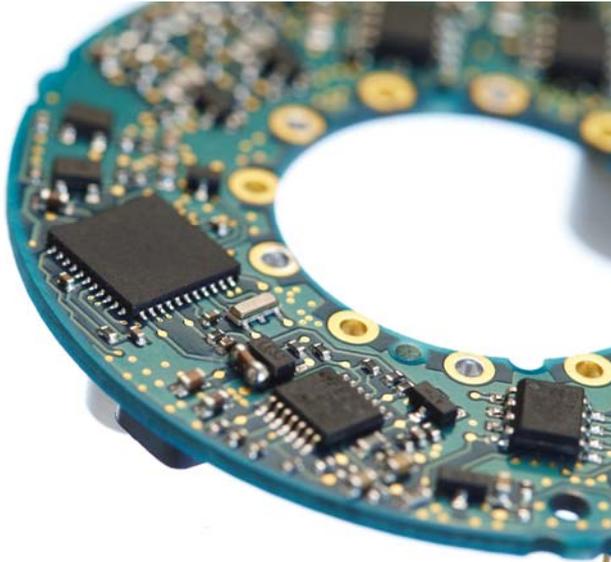


Fig. 3 Compact electronics in multi-layer technology combine logic and power electronics

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Fig. 4a,b Newly developed connector system with extensive interface for maximum functionality and tight fit