the difference between

THE DIFFERENCE BETWEEN:

Gearing Options for Small-Frame BLDC Motors

BRUSHLESS DIRECT-CURRENT (BLDC) MOTORS are the go-to motor type for designers looking to move large objects quickly and accurately. Their small frame size combined with high torque and dynamic responsiveness makes BLDCs essential to laboratory equipment, medical devices, precision measurement tools, and more.

In these and other applications, the torque available at a given motor frame size is a designer's limiting factor. Designers can add a gearbox, but the torque gained comes at a cost to footprint compactness, precision, efficiency, and responsiveness.

Recently introduced designs, like those in ElectroCraft's LRPX series, combine specially-designed BLDCs with gearboxes for a streamlined gearmotor design. The integrated design minimizes the number of components for a smaller footprint, greater accuracy, and better dynamic response.

Read on to learn more about the difference between traditional BLDC motor options and integrated BLDC gearmotors.

Motor Design

All BLDC motors have the same basic components: a stator, a rotor, a sensing device, and a means of coupling to a gearbox or object being driven. Standard BLDCs use slotless stators suited to high-speed operation. In integrated gearmotors, encapsulated closed slot stators support higher torque-power ratios and improve heat transfer.

Both standard and integrated gearmotor BLDCs use permanent magnet rotors to create rotary motion. Standard BLDCs feature two or, more commonly, four magnetic poles. Integrated gearmotor designs use eight poles for greater responsiveness and torque at lower speeds.

Once the electromagnetic interaction between the rotor and the stator has started motion, that motion needs to be put to work. For many applications, designers turn to gearboxes to adjust the motor torque and speed to match the torque and speed demands of the application.

Standard BLDC motors require an additional gearbox, along with a coupling to connect the motor shaft to the gearbox, increasing its footprint and sometimes causing compatibility issues. On the other hand, integrated gearmotors contain a planetary gearbox directly coupled to the motor itself. This integration minimizes the flexing of components, ensures efficient operation, and eliminates compatibility problems.

Motor Performance

Designers make choices about motor design with the primary aim of getting the performance they need out of their system. The performance characteristics designers most often consider are motor speed, torque, and power.

BLDC motors are known for their ability to operate at high speeds. Standard BLDCs without added

Integrated gearmotors like those in ElectroCraft's LRPX series are designed with an integrated planetary gearbox to save space over the standard BLDC-plus-gearbox configuration while delivering superior torque and efficiency.

gearboxes can run at speeds as high as 30,000 rpm. However, almost all gearboxes are limited to a top speed of 10,000 rpm or less. Thus, standard BLDCs attached to gearboxes are rated for operating speeds that are much higher than the gearbox maximum input speed. In contrast, the BLDC motor in an integrated gearmotor may have top speeds up to 9,000 rpm, but they are generally rated for 6,000 rpm operating speeds—ideal for a gearmotor application.

Torque, usually measured in ounce-inches or millinewton-meters for BLDC motors, is another important consideration. Many standard BLDC motors have published torque output levels that are only available at speeds above 20,000 rpm and not useable when attached to a gearbox. Useable torque may be significantly reduced at gearbox rated speeds.

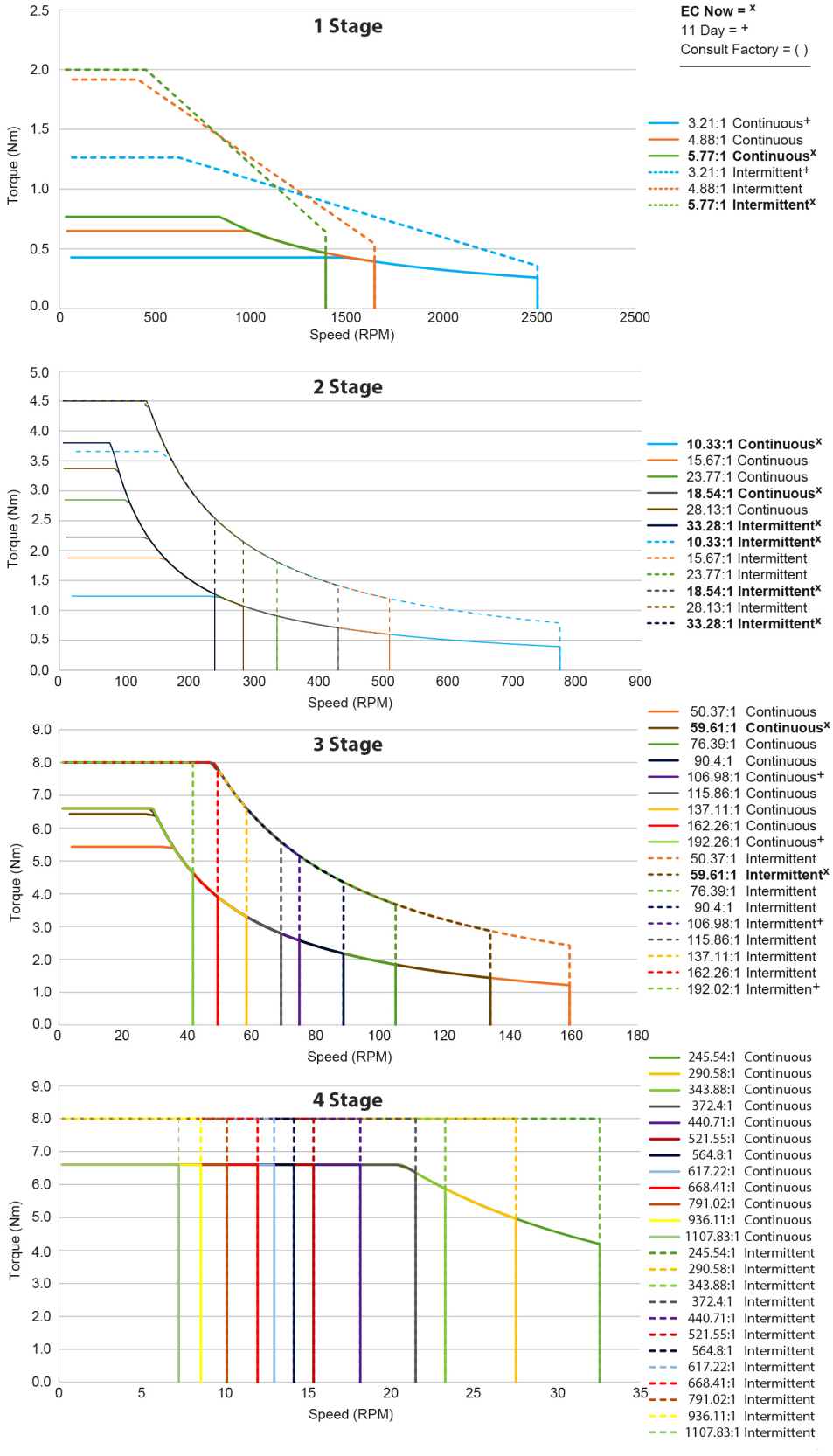
Integrated gearmotors are designed to combine the peak capabilities of both the BLDC motor and the planetary gearing. Integrated planetary gearing can then produce peak torques over 400 oz-in. The high torque density of an integrated gearmotor also enables lower gear ratios in the planetary gearing.

Motor Efficiency

BLDC motors are also known for their efficient conversion of electricity into motion. Maximum operating efficiency occurs near the motor's peak speed. As noted above, the speed of peak efficiency of a standard BLDC

Integrated gearmotors like ElectroCraft's LRPX-32 seamlessly connect an efficient, high-torque BLDC motor with up to four stages of planetary gearing. The combination can supply a variety of speeds and torques as high as 6.6 N-m in continuous operation.

LRPX32 SPEED TORQUE PERFORMANCE



motor coupled with a gearbox, 28,000 rpm, is outside the setup's operating envelope. Standard BLDC motors operating at speeds within the speed range of the gearbox are operating well below their peak efficiency.

On the other hand, integrated gearmotor BLDCs are designed so that the speed of maximum motor efficiency is within the operating speed envelope of the planetary gearing, maximizing overall efficiency.

Gearbox designers seek to minimize gear ratios in order to deliver power most efficiently and use the least energy. For systems like standard BLDCs which have torque under 4 oz-in at gearbox speeds, attached gearboxes need to have much higher gear ratios. This causes energy efficiency, power delivery, and dynamic responsiveness to suffer.

One comparison comes from motors used in peristaltic pumps, such as those in pharmaceutical operations. A large pump delivering 2 Nm of torque would require a BLDC motor attached to a gearbox with a 51:1 ratio. When engineers replaced the standard motor with an ElectroCraft LRPX-32 integrated gearmotor, they were able to use a 33:1 gear ratio and realize a 25% efficiency improvement.

Design Considerations

In the peristaltic pump example above, energy efficiency is not the only benefit. The LRPX-32 also inhabited a 27% smaller footprint than that of a standard BLDC paired with an added gearbox. As designs for devices of all kinds continue to shrink, size efficiency is becoming just as important as energy usage.

Because integrated gearmotors are designed to contain both the motor and planetary gearing, they use space more efficiently. No additional couplings are required to join the motor to a gearbox as in a standard BLDC motor. The integrated design can even accommodate linear motion without the need for a ballscrew or similar device.

Designers of an automated guided vehicle (AGV) saved 54% of the volume of their steering motor by switching to an ElectroCraft LRPX-32. The 1.4 Nm steering setup converted from a 79:1 gear ratio to a 33:1 ratio and cut energy use by a quarter.

Noise is another design consideration in many applications. Noise often comes from the misalignment of system components, a common concern for standard BLDCs coupled to aftermarket gearboxes. Because integrated gearmotors are designed as a unit and aligned at manufacture, they tend to run more quietly.

A final consideration designers often encounter is the motor's ability to resist high humidity, water droplets, dust, debris, and large ranges of temperatures in its operating environment. All BLDC motors use either Hall effect sensors or encoders, so they need greater protection from the elements as compared to mechanically commutated brushed dc motors.

Standard BLDC motors are not encapsulated. Thus, they are able to offer IP40 protection that excludes slim objects like wires and small screws from sensitive electronics but provides no protection against moisture or water.

Integrated gearmotors, on the other hand, have the option of sealed bearings for up to IP65 level protection that excludes all dust and water jets. Integrated gearmotors are also rated for operating temperatures between –42 and 155°C.

Making a Difference with Motors

BLDC motors are a staple for motion needs across a variety of industries. Their energy efficiency, torque capabilities, and speeds make them attractive to designers. However, for standard BLDC motors, these three attributes have not been simultaneously accessible; the gearing needed to attain useful levels of torque precludes the motor reaching peak speed and efficiency.

Integrated gearmotors like those in ElectroCraft's LRPX line combine efficient BLDC motors with an integrated planetary gearbox. This design permits high torque and high power operations while preserving useable speed and energy efficiency. These performance benefits, combined with lower noise and the ability to operate in a variety of environments, make integrated BLDC gearmotors an attractive option for designers who require precise responsive motion in an efficient package. ■