# Why Motors Are Smaller, Faster and More Precise With GaN

*With the growing adoption and increasing applications of GaN, Bodo Arlt has taken the opportunity to talk to EPC's CEO and Co-Founder Alex Lidow to discuss what he believes is the next big market for this evolving technology.*

*By Bodo Arlt, Publishing Editor, Bodo's Power Systems*

**EPC has contributed multiple articles to this magazine on the topic of GaN-based motor drives recently. What applications do you see getting the most benefit from motor drives using GaN technology?**
The best fit for our GaN devices is for brushless DC motors where the input voltage is between 24 V and 150 V, typically 48 V and the emerging 96 V. Applications include servo drives, e-bikes and e-scooters, warehouse, autonomous robots, lean production line collaborative robots, medical robotics, and industrial drones.

**e-scooters and e-bikes is a very fast-growing market but seems to be cost-sensitive. Where do you see the fit for GaN in this market?**
The rapid emergence of e-scooters and e-bikes has created a surge in demand for compact, lightweight motor drives. The high frequency capability of GaN allows for the design of much smaller motor drives and this miniaturization enables better esthetic, lighter weight, and lower cost solutions for eMobility. Also, the higher efficiency provided by GaN is critical for longer battery life to achieve increased range between charges.

**I don't typically think of motor drives as needing particularly high frequency. What is the benefit in motor drive designs to increasing the frequency?**
For motor drive applications a GaN inverter can easily operate at 100 kHz PWM frequency thanks to its lower switching dissipation and smoother switching at the allowed dv/dt. An immediate result is that voltage and current ripples at the battery cables are drastically reduced, so there is no need for any LC input filter based on electrolytic capacitors. Ceramic capacitors can replace bulky, temperature sensitive, and lower reliability electrolytic capacitors, thus saving costs, increasing efficiency, reliability, and lifetime. For example, in a 400 W motor drive as would be used in a e-bike, a 330 uF electrolytic capacitor can be replaced with 22 uF of ceramic capacitors. In addition, the input filter inductor can be completely eliminated.

**Is the GaN inverter going to be more efficient than an inverter based on MOSFETs? Is there any effect on the motor due to the use of GaN?**
To answer this question, we need to consider the system made of motor-plus-inverter and not only the inverter alone. Let me explain better: a conventional 20 kHz MOSFET inverter can reach 98% efficiency as well as a GaN inverter can reach 98% when running at 100 kHz. But there is one big difference: the GaN inverter allows very small dead time (tens of ns). Dead time in motor drives is responsible for an even harmonic (the sixth) on the torque that produces only vibration and heat and does not contribute to motion. With a GaN inverter the even harmonic of the torque is completely removed and the motor itself becomes more efficient delivering more torque per ampere. So, the total system becomes more efficient.

**It seems the advantages of compact, lightweight design also benefits many of the other applications you mentioned such as autonomous robots and industrial drones. Are there other advantages to consider?**
Yes, there's quite a large advantage which resulted in some of our earliest motor drive success, and that is precision motion and positioning. Some of the earliest adoption of GaN-based motor drives has been for medical robotics. The weight and size of the motor are also important for these designs but what is perhaps even more crucial is precision. The ability to operate at higher frequencies increases control bandwidth for the motor. This increases the precision at which the motor can be controlled. In addition, the higher frequency reduces, or even eliminates, mechanical vibration which is crucial to being able to take advantage of the higher control precision. Precision can literally save lives in this application!

**What about automotive motors?**
There is an emerging use case for GaN in a myriad of small motors that are inside the vehicle. The value for GaN devices in 48 V automotive motors is that they can reduce the size and weight of the motors, reduce audible noise, get better torque, extend battery life, and provide higher efficiency. EPC has a growing line of AEC-Q101 qualified FETs for automotive applications and will be adding AEC-Q100 qualified GaN ICs to the product portfolio as well.

**If my readers would like further technical information on EPC's GaN solutions for Motor Drive applications, where should they go?**
The motor drive landing page on the EPC website is a great place to start because it has an entire repository of information on GaN in motor drives including applications notes and videos. The landing page is at: https://epc-co.com/epc/Applications/MotorDrive.aspx. In addition, our fantastic team of field applications engineers is always ready to help with everything from product selection to layout reviews and production assistance. The easiest way to reach them, if you don't already have a direct contact, is to submit an inquiry via our Ask a Motor Drive Expert feature.

www.epc-co.com


# Go Farther with GaN for eMobility

## GaN Motors…*Smaller, Lighter, Smoother*

eGaN® FETs and ICs provide motor drive designs the small size, light weight, and high efficiency that enable extended range, smoother rides, and sleeker designs for e-bikes and e-scooters.

**Note:**
Scan QR code to download
GaN for Motor Drives eBook
**bit.ly/GaNMobility**

EFFICIENT POWER CONVERSION

**epc-co.com**