Welcome! In this webinar we will show how GaN-based solutions are improving motor drives by enabling smaller, lighter, more precise systems. We will review some key applications using these systems including e-mobility, cobots and robots, DC servo drives, drones, and automotive.

欢迎大家参加EPC公司的线上研讨会！ 在此研讨会中，我们将展示基于氮化镓器件的解决方案可以实现尺寸更小、重量更轻、更精准的系统，从而提升电机驱动器的性能。

我们将分享使用这些系统的关键应用，包括电动汽车、协作机器人和机器人、直流伺服驱动器、无人机和汽车应用。

议题

- 氮化镓（eGaN）器件于48 V电机驱动器的价值
- 关键应用
- 用于无刷直流电机（BLDC）的EPC产品系列
- EPC公司在意大利设立了FAE实验室，Marco Palma将为我们演示基于氮化镓器件的电机驱动器

First, (build 1) we will explain the value of eGaN devices for 48V motor drives.
首先，我们分享eGaN器件于8 V电机驱动器的价值。

Then (build 2) we will review the key applications.
然后，让我们看看各种关键应用。

Next (build 3) we will review EPC’s product portfolio for motor drives.
接下来，我们将分享面向电机驱动器的EPC产品系列。

And lastly, (build 4) we’ll get a look at our Field Application Engineering lab in Italy where Marco Palma will give us a demonstration of a GaN-based motor drive.
最后，我们在意大利设立了FAE实验室，Marco Palma将为我们演示基于氮化镓器件的电机驱动器。

为什么采用无刷直流电机（BLDC）？

BLDC电机非常受欢迎

- 更高的转矩和功率密度
- 宽泛的速度范围
- 高效
- 无刷式以确保低电磁干扰

应用

- 机器人 – 精确控制
- 无人机 – 重量轻
- 电动自行车 – 体积小、轻巧

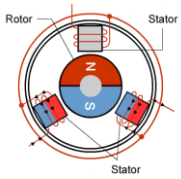


Image courtesy of: Renesas

Image courtesy of: https://electricbikereport.com/

BLDC motors are a class of permanent magnet motor that operate at voltages and currents well aligned to GaN FETs capability. They are popular due to:
BLDC电机是一类永磁电机，其工作电压和电流与GaN FET的性能匹配。 它们之所以受欢迎是因为：

(Build 1)
Their high torque and power density giving them a small size
它具有高转矩和高功率密度，而且尺寸小

(Build 2)
Wide speed range capability
具有宽泛的速度范围

(Build 3)
High efficiency
高效率

(Build 4)

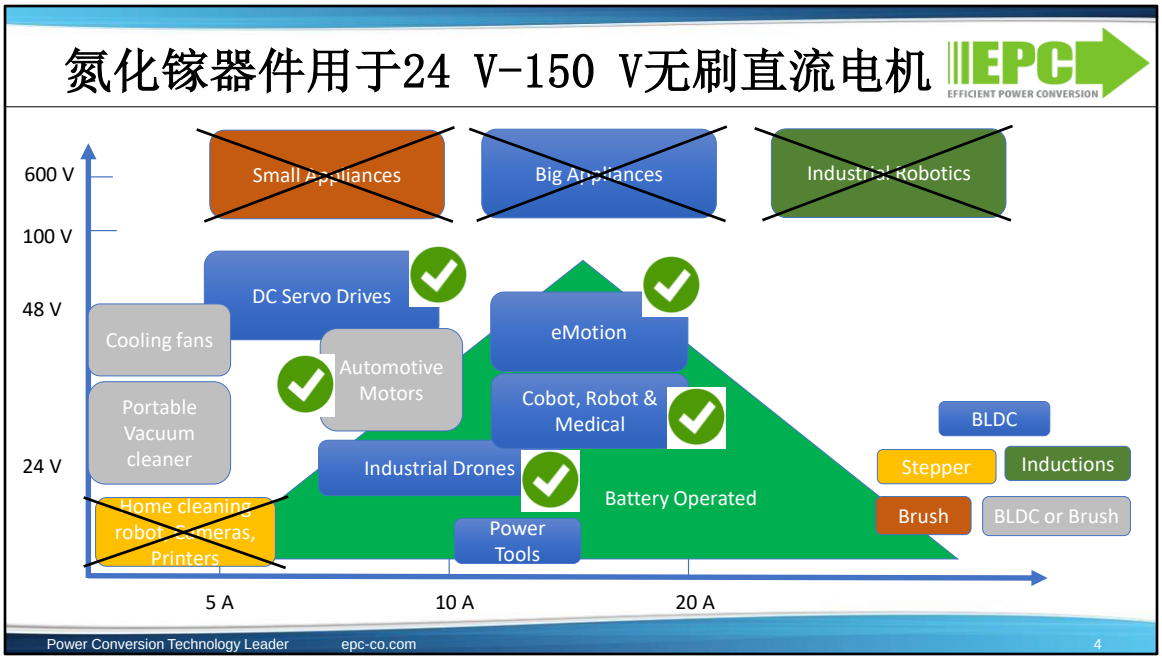
and are brushless thus ensuring low EMI generation.
以及它是无刷式，可确保低电磁干扰。

(Build 5)
BLDC motors are being employed in an increasing number of applications such as:
Robotics for precision control for applications such as medical, manufacturing and warehouse robots
越来越多应用使用无刷直流电机，例如需要精确控制的机器人，包括用于医疗、制造和仓库的机器人。

(Build 6)
Drones that require lightweight solutions
需要轻巧的解决方案的无人机。

(Build 7)
And e-bike traction drives that need to be small and low cost.
以及需要体积小且成本低的解决方案的电动自行车牵引驱动器，

In this webinar, we will show a simple, compact, lightweight approach to motor drives using GaN FETs.
在此研讨会中，我们将展示使用GaN FET可以实现的简单、紧凑且轻巧的电机驱动器。



First, let's look at the many applications for motor drives and discuss where GaN fits and where it does not.
首先，让我们看看电机驱动器的各种应用，并探讨氮化镓器件适用于及不适用于哪些地方。

EPC GaN devices target applications where the input voltage is between 24V and 150V and typically 48V. The key application, as we've said, is brushless DC Motors, or BLDC.
EPC公司的氮化镓器件针对输入电压在24 V~150 V（通常为48 V）的应用。 我们谈过其关键应用，是无刷直流电机（BLDC）。

Typical applications are (build 1) servo drives, (build 2) e-bikes & e-scooters, (build 3) collaborative and low voltage robot and medical robotics, (build 4) industrial drones, and (build 5) automotive motors.
典型的应用包括伺服驱动器、电动自行车、电动踏板车、协作和低压机器人、医用机器人、工业用无人机和汽车电机。

In these applications the motor drive is integrated to the motor and

miniaturization and low weight is a key differentiation for eGaN. Finally, higher battery efficiency is very important for longer battery life.
在这些应用中，电机驱动器与电机集成在一起，采用氮化镓器件(eGaN)的关键优势是实现微型化和轻量化。 最后，更高的电池效率对于延长电池寿命非常重要。

Now let’s look at where we GaN is not necessarily a good fit.
现在让我们看看GaN器件不一定适合使用的地方。

Brushed motors (build 6), they are disappearing, and most are driven with a side chopper that does not need speed. Therefore, these are not a target for GaN.
有刷电机正在消失，而且大多数都由不需要速度的侧切刀驱动。 因此，这些不是GaN器件的目标应用。

As for stepper motor (build 7), typical for small appliances, this is the domain of MOSFETs.
对于通常用于小型家电的步进电机，这是MOSFET的领域。

As for industrial robotics and appliances (build 8), these application are generally higher voltage and higher power. This is the domain of HV IGBT.
对于工业用机器人和设备，这些应用通常具有更高的电压和功率。 这是高压IGBT的领域。

Now you have an idea of what portion of the motor drive market GaN is best suited for - these are the applications where GaN has the most value.
现在，您了解到氮化镓器件最适合用于电机驱动器市场的哪些应用 - 这些就是它最具价值的应用。

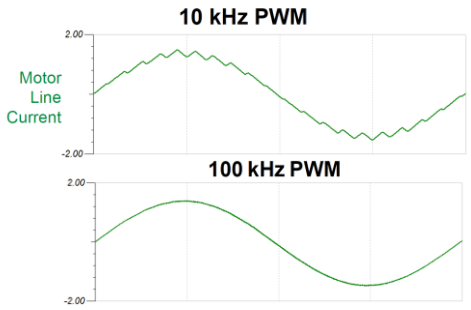
面向电机驱动器氮化镓器件的优势

GaN FETs switch fast with no Q_{RR} = 0

higher switching frequency

lower dead time

- 更低失真 → 更低噪声
- 更低电流脉动 → 减少磁损耗
- 更低转矩脉动 → 更精准
- 更低滤波 → 成本更低、重量更轻 、尺寸更小
- 支持低电感电机



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GaN FETs switch faster and have zero reverse recovery compared to MOSFETs allowing them to operate at higher frequency efficiently and reduce dead time to value not achievable with other technologies. This opens the possibility of higher switching frequency motor drives where 20 – 60 kHz have traditionally been used.
与MOSFET相比，GaN FET的开关速度更快且没有反向恢复，从而使它能够在更高的频率下，高效地工作；而且将死区时间降低至其它技术无法实现的时间，从而有可能实现具有更高的开关频率的电动机驱动器，通常的频率只是20~60 kHz。

Additional benefits of operating at a higher switching frequency include:
以更高的开关频率工作的其它好处包括：

(Build 1)
Lower distortion of the applied voltage waveforms that allows higher speed while keeping acoustic noise low
施加电压波形的失真更低，从而在保持更低的噪声的同时，可以更高速。

(Build 2)

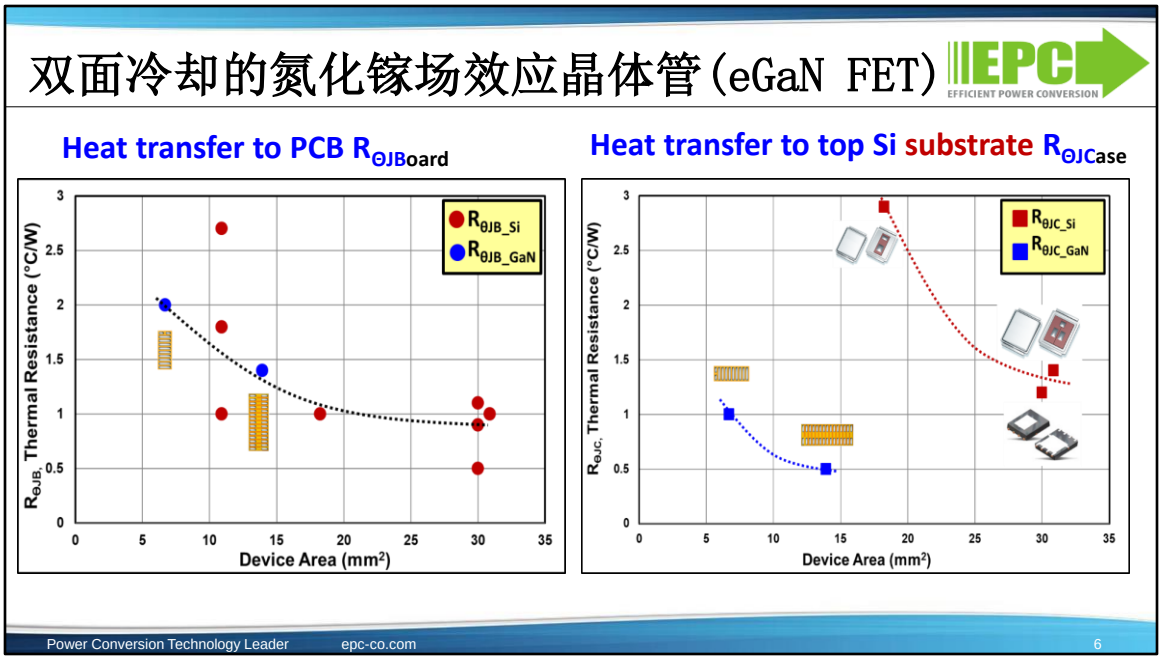
Lower ripple current reduces AC magnetic losses and thus yield higher motor efficiency and lower operating temperature
较低的纹波电流可降低交流磁损耗，从而提高电机效率并降低工作温度。

(Build 3)
Reduced torque ripple that reduces mechanical vibration that is not desired in applications as servo motor or strength amplifiers such as electronic power steering
更低的转矩脉动可减少机械振动，这在伺服电机或强度放大器，如电动助力转向等应用是不理想的。

(Build 4)
Lower filtering requirements thus reducing filter cost, weight and size of the inverter. Electrolytic capacitors may eventually be replaced with ceramic capacitors.
需要更低的滤波，从而降低滤波器的成本、减轻逆变器的重量和缩小它的尺寸。电解电容器最终可以用陶瓷电容器代替。

(Build 5)
And supports newer class of low inductance motors such as slot-less motors
此外，氮化镓器件支持新型的低电感电机，例如无槽电机。

双面冷却的氮化镓场效应晶体管(eGaN FET)

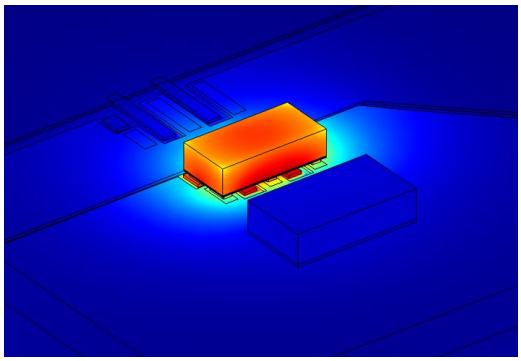


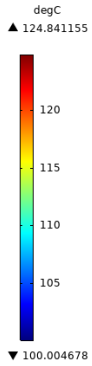
Even though our devices are very small, thermal is not a concern due to the excellent thermal properties of our eGaN dies. On the left you can see that the thermal resistance to pcb is similar to FETs.
即使我们的器件的尺寸小，由于eGaN芯片具有优越的散热性能，散热不是问题。在左图您可以看到，散热至PCB的热阻，与硅基FET相约。

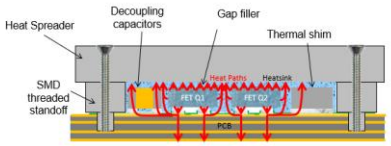
However, on the right we are comparing thermal resistance to case against the absolute best thermal package available for MOSFETs – the Direct FET.
但是，在右图，我们将散热至外壳的热阻与用了最佳散热封装（Direct FET）的MOSFET进行比较。

The eGaN devices are 6 times better than the best-in-class DirectFET because eGaN dies can dissipate heat through the pcb, top, AND the lateral sides.
可以看到，eGaN器件的散热性能要比最佳的DirectFET好6倍，因为eGaN芯片可以通过PCB、顶部和侧面散热。

最佳散热性能 – 4 mm² 、3.9° C/W







- 6 W DC power dissipation in the device
- 125°C average T_J with heat spreader at 100 °C
- 1.5 mm x 3 mm x 0.7 mm thermal shim, 6 W/mK gap filler, 0.2 mm spacing to heat spreader

The lower thermal resistance results in incredible thermal performance. Here you can see that a tiny 4 mm2 die can dissipate 6 W with temperature rise of only 24 degrees, or 4 deg C per Watt.
较低的热阻可以实现难以置信的优越散热性能。 这里您可以看到一个微型4平方毫米的芯片，在上升了摄氏24度（或每瓦摄氏4度）时，耗散了6 W的功率。

A lot of additional information on thermal handling can be found in EPC web, including a complete seminar on thermal designs.
在EPC的网站上，您可以找到更多关于处理散热的其它信息，包括有关散热设计的研讨会等信息。

For motor drives, size and cost dominate, and efficiency is dominated by the motor. Therefore, a key objective for many applications is to drive the most current in as small a volume as possible.
对于电机驱动器，由尺寸和成本主导，而其效率则由电机决定。 因此，许多应用的目标是以尽可能小的体积，来驱动最大的电流。

主要应用

The major value of eGaN devices for cobot and low voltage robot motors is small size and low weight.
用于协作机器人和低压机器人电机的eGaN器件的主要价值在于体积小和重量轻。

Additionally, low switching losses enable an increase in the switching frequency for higher precision.
另外，低开关损耗可提高开关频率，从而实现更高的精度。

While high voltage industrial robots are usually based on AC drives at 380V 3 ph, for these applications a low voltage operation is preferred because humans are near-by in the range of operation.
尽管高压工业用机器人通常基于380 V 3 ph 的交流驱动器，但对于这些应用而言，低压操作是首选，因为人们在操作范围内。

精准稳定的电机:顺滑、精准速度控制

Everest Net 30/80

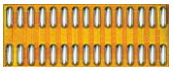
- 微型尺寸，可用于机器人关节
- 具高分辨率的转矩传感器
- 顺滑的转速

Demonstration provided courtesy of

INGENIA

为什么使用氮化镓器件?

- 尺寸小 / 小外形尺寸
- 更低损耗
- 更高效
- 高频



EPC2022
100 V, 3.2 mΩ
6.1 mm x 2.3 mm

Collaborative robot, or cobot, and low voltage industrial robots are a target application for GaN. One customer who has been successful using GaN in this application is the Ingenia Everest that uses EPC2022.
协作机器人（或cobot）和低压工业用机器人是GaN器件的目标应用。 使用EPC2022的Ingenia Everest，是在此应用中成功使用GaN器件的客户。

The eGaN FETs allow a very small size motor drive that delivers very high efficiency
eGaN FET可实现具有很高效率的超小型电机驱动器。

医用电机

- 外科手术机器人需要精确控制，拯救生命！
- 高频且具有低开关损耗的氮化镓器件可实现高分辨率和精准控制
- 体积小、重量轻

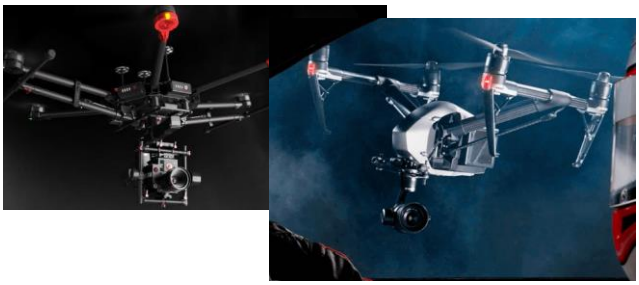
手术机器人

The value of GaN devices for medical is huge….Precision can literally save lives when used for surgical robotics!
GaN器件在医疗领域的应用价值是巨大的 … 其高精确度，可用于外科手术机器人，挽救生命！

Additionally, high frequency operation improves accuracy for diagnostic and display devices.
此外，高频操作提高诊断和显示设备的准确性。

工业用无人机

- 体积更小
- 更轻巧
- 电池效率更高
- 飞得更远



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In drone applications each arm of the drone has a motor and the motor drives need to be very small to be integrated with the motor in the arm.
在无人机的应用中，无人机的每个手臂都有一个电机，而且电机驱动器需要超小型，才能与手臂中的电机集成在一起。

Industrial drones have on average 6 motors per drone. eGaN devices allow smaller and lighter drones that have higher battery efficiency and can fly farther.
工业用无人机平均每架无人机有6台电机。 eGaN器件允许使用更小型化、更轻巧的无人机。这些无人机具有更高的电池效率且可以飞得更远。

面向高端电动自行车和电动踏板车的电机驱动器

- 微型化的氮化镓器件推动电动自行车和踏板车实现美学设计且重量轻

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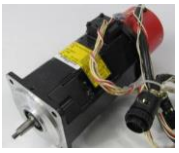
The e-mobility market for bikes and scooters is huge, 40 Mu in 2020. However this is not all addressable with GaN.
自行车和踏板车的电动汽车市场巨大，到2020年将达到4千万台。但氮化镓器件不是可以支持全部的市场。

eGaN devices will be the best solution for the high-end portion of the market (build 1) where it is essential that the motor is very small and very light.
eGaN器件将是面向高端市场的最佳解决方案，因为对于该市场，非常小型和轻巧的电机至为重要。

集成式电机、直流伺服驱动器

eGaN 器件的最佳工作范围：10 V_{DC} - 150 V_{DC} @ 1 - 2 kW

- 体积更小
- 高精度
- 没有EMI电缆线和线圈屏蔽



- 集成式电机
- 机床
- 包装、纺织品

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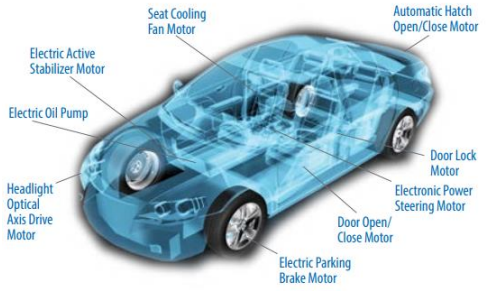
DC Servo Drives are used for machine tools, packaging, and textile. In DC Servo Drives the inverter is integrated to the motor and therefore high precision and miniaturization is key.
直流伺服驱动器用于机床、包装和纺织品。 在直流伺服驱动器中，逆变器与电机集成，因此高精度和微型化至为重要。

Additionally, higher frequency operations achievable with eGaN devices reduces EMI and save equipment costs because EMI cables and winding shields are no longer required.
此外，由于不再需要EMI电缆线和线圈屏蔽，因此eGaN器件可在更高的频率工作、降低EMI并节省设备成本。

The sweet spot for eGaN devices is 10 Vdc to 150 Vdc @ 1-2kW DC input. Outside of this range IGBT solutions are generally used
eGaN器件的最佳工作范围是在1~2kW、 10 VDC~150 VDC。 在此范围之外，通常使用IGBT解决方案。

eGaN器件于车用电机的价值

- 尺寸更小、重量更轻
- 没有噪声
- 转矩更好
- 电池寿命更长
- 效率更高



Automotive Motors

There are, on average, ten electric motors per car for operations such as door locks, trunk latches, retracting roof, gas pumps, ventilation, battery management, heating control, electric steering, just to name a few. BLDC motors are simpler to maintain, more durable, smaller, much more energy efficient, are able to respond faster and at higher operating speeds, and they are considerably lighter. BLDC motors are also less prone to the types of failures experienced by brushed motors, leading to lower warranty costs. As cars migrate to a 48 V-bus architecture, BLDC motors become even more attractive for power levels between 30 W to 1 kW compared with brushed or AC induction motors. The value for eGaN devices in the 48 V automotive motors is that they can reduce the size and weight of the motors, no audible noise, better torque, extended battery life, and higher efficiency.

平均每辆汽车需要十个电机操作各种功能，例如门锁、行李箱闩锁、顶棚、气泵、通风、电池管理、加热控制、电动转向等。

BLDC电机易于维护、耐用、体积更小、能源效率更高、能够更快地响应并具有

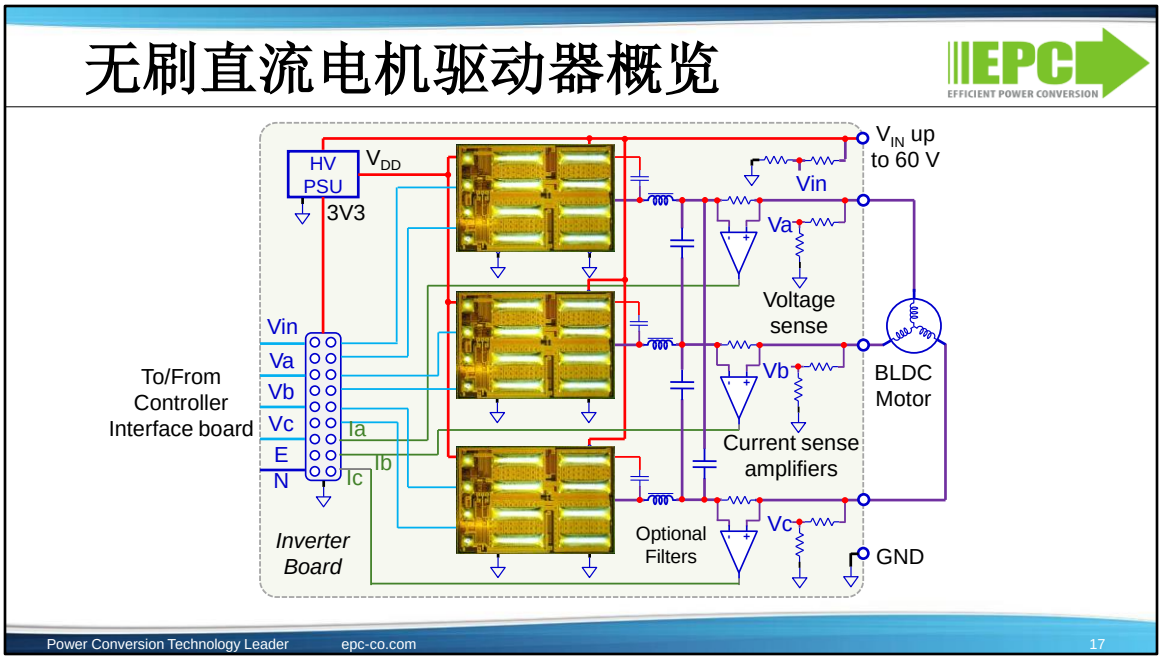
更高的运行速度，而且轻巧很多。

BLDC电动机也不太容易出现有刷电机会发生的故障类型，从而可降低保修成本。随着汽车迁移到48 V总线架构，与有刷或交流感应电机相比，BLDC电机在30 W~1 kW之间的功率级更为优胜。

在48 V汽车电机中，eGaN器件的价值是它可以缩小电机的尺寸和减轻其重量、没有听得到的噪音、更好的转矩、更长的电池寿命和更高的效率。

基于氮化镓器件的
无刷直流电机（BLDC）驱动器

无刷直流电机驱动器概览



A practical high-performance BLDC motor drive requires, the following functional elements:
实用的高性能BLDC电机驱动器需要以下的功能：

(build 1)
Voltage and current sense for each of the phases of the motor. The motor phase currents are measured using shunts where the voltage is amplified using a high-performance shunt amplifier. Voltage measurement is from each phase to ground using a simple voltage divider resistor network. Voltage sense for the DC supply to the drive, using the same techniques as for the motor phase voltage measurement

电机内各相的电压和电流感应/检测 – 使用分流器测量电机中各相的电流，其中使用高性能的分流放大器，从而可以放大电压。

使用简单的分压器电阻网络，测量从每相到接地的电压。

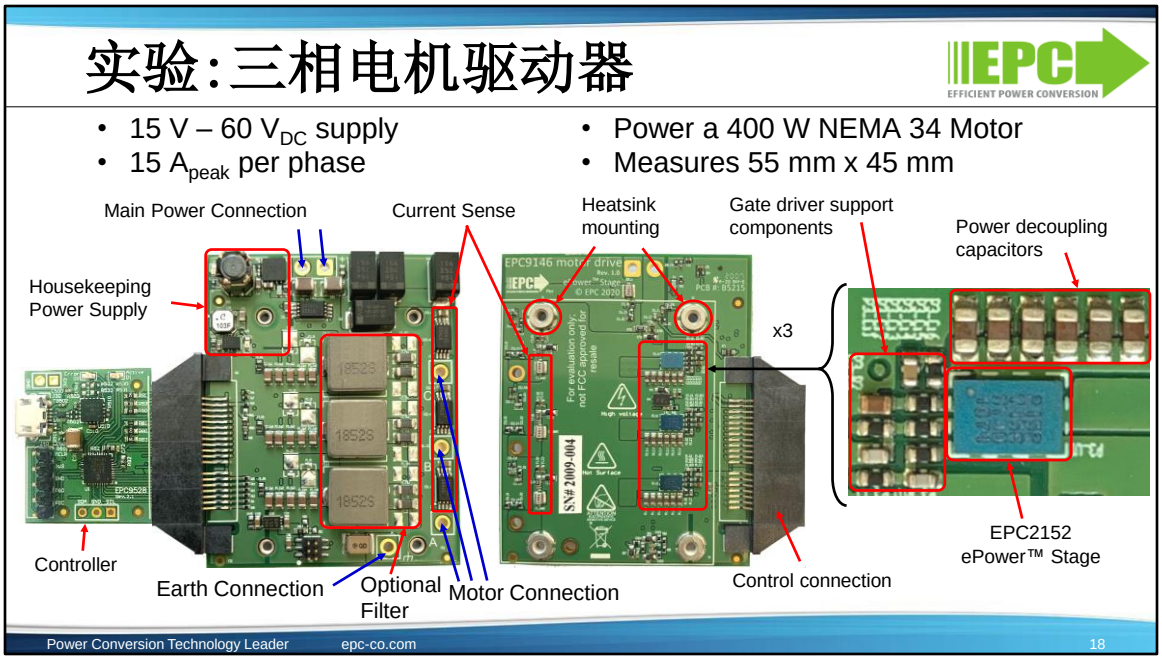
使用电机中各相电压测量的相同技术，对驱动器的直流电源进行电压检测。

(build 2)
A housekeeping power supply for the power stage ICs that required 12 V and controller that requires 3.3 V. And an interface to the motion controller.
用于需要12 V的功率级集成电路，和需要3.3 V的控制器的内部管理电源，以及运动控制器的接口。

(build 3)
An optional filter between the switch-node and the motor connection that can be configured as either a harmonic filter or EMI filter.
开关节点和电机连接之间的可选滤波器，可以配置为谐波滤波器或EMI滤波器。

(build 4)
A 3-phase half-bridge power stage
三相半桥功率级。

(build 5)
Each of the half-bridge power stages use one EPC2152 ePower Stage and requires only a few support capacitors.
每个半桥功率级都使用一个EPC2152 ePower Stage，并且仅需要几个电容器。



An experimental 3-phase BLDC motor drive was designed and built to operate from a 15 V through 60 V main DC supply and deliver a peak current of 15 A into each phase of the motor. The drive can power a 400 W NEMA 34 size BLDC motor and measures just 55 by 45 mm. The drive includes the following features
我们设计并构建一个实验性的三相BLDC电机驱动器，并在15 V~60 V的DC电源下工作，以及将15 A的峰值电流，分配到电机的每相中。

该驱动器可以为400 W、NEMA、尺寸为34的BLDC电机供电，其尺寸仅为55 x 45 mm。 该驱动器包括以下功能：

(Build 1)
A main DC supply connection and a housekeeping power supply that operates off the main supply to provide 12 V for the ePower stage and 3.3 V for the controller
一个主直流电源连接，和一个内部电源，通过主电源供电，为ePower Stage提供12 V电压，以及为控制器提供3.3 V的电压。

(Build 2)

A motor connection including an earth
包含接地的电机连接。

(Build 3)
A current sense for each of the phases
每相的电流传感器。

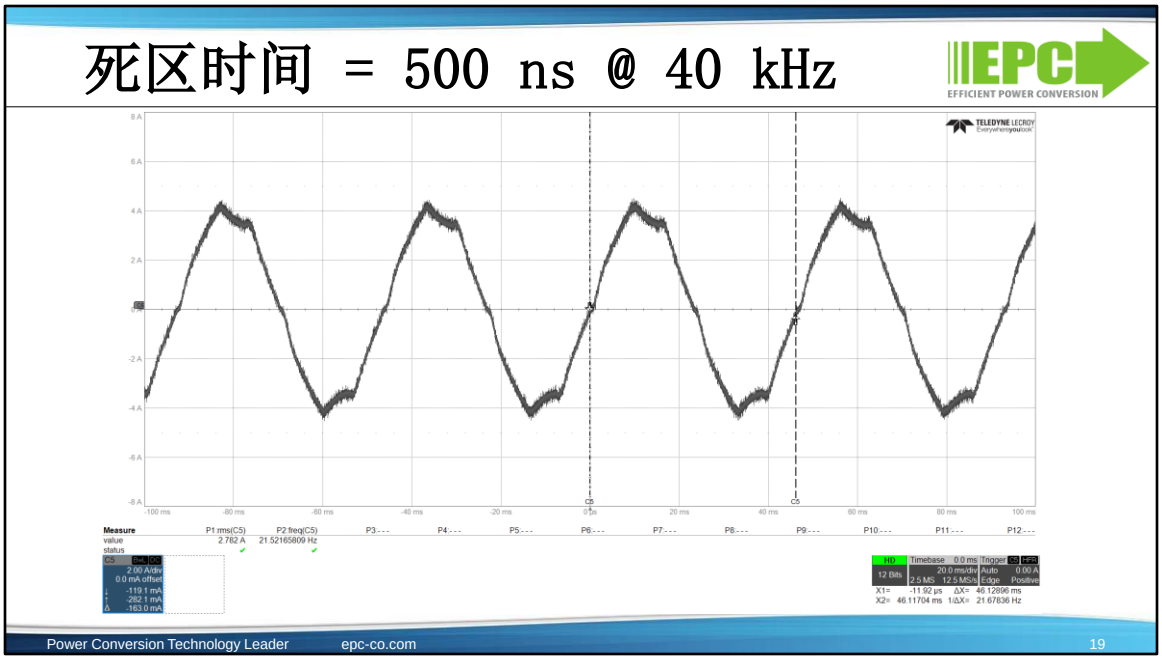
(Build 4)
An optional Filter to reduce dv/dt on the motor windings
可选的滤波器，可降低电机线圈上的dv / dt。

(Build 5）
A heatsink mounting option
散热器安装选项。

(Build 6)
The ePower stages showing the zoomed in portion for one of the phases and The EPC2152 ePower stage that can operate from 20 kHz through 1 MHz switching frequency
ePower Stage显示其中一相的放大部分，EPC2152 ePower Stage可以在20 kHz至1 MHz的开关频率下工作。

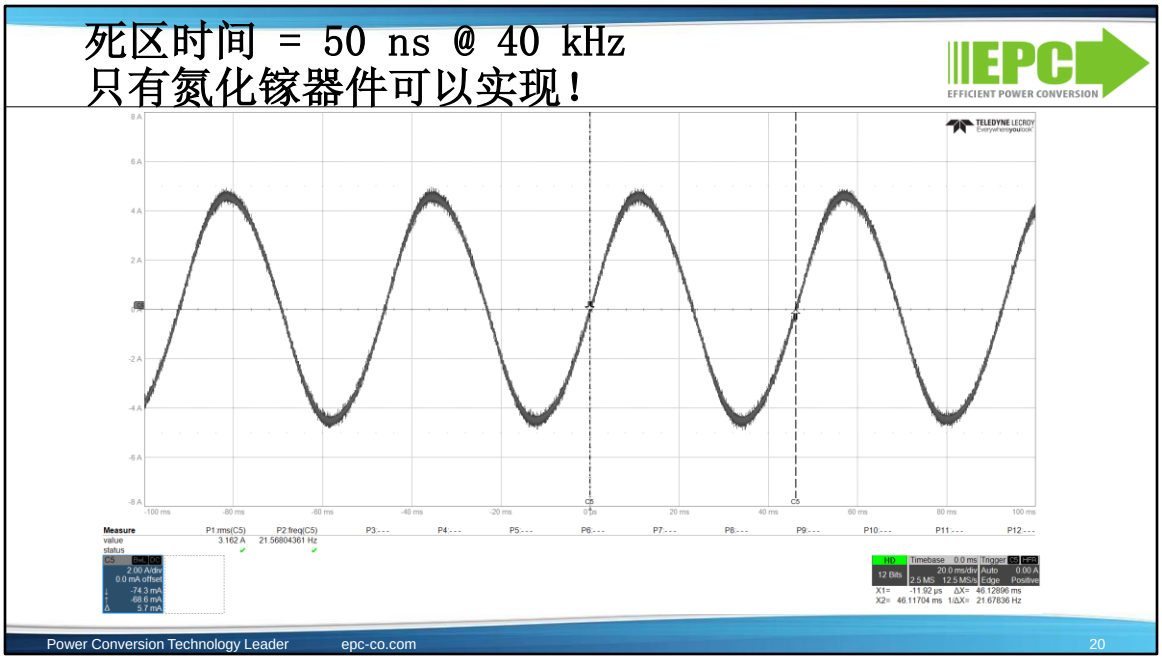
(Build 7)
The power stage decoupling capacitors and the gate driver support components
功率级去耦电容器和栅极驱动器支持元件。

(Build 8)
And finally the controller and controller connection
最后是控制器和控制器的连接。



First, we tested the motor drive operating from a 48 V DC supply voltage delivering up to 3.7 ARMS into each phase of the motor with a Field Oriented Control sensor-less algorithm.
首先，我们使用无传感器磁场定向控制算法，测试了在48 V DC电源电压下，将高达3.7 ARMS传输到电机中的每相。

We used a 40kHz PWM frequency and 500ns deadtime that are typical of MOS based inverters. Using MOS, higher frequency results in higher losses and deadtime cannot be further reduced due to MOS switching behavior. As can be seen in these waveforms, the 500 ns deadtime is significantly distorting the phase current.
我们使用40 kHz PWM频率和500 ns死区时间，这是基于MOS的逆变器的典型频率和死区时间。 使用MOS器件时，较高的频率会导致较高的损耗，并且由于MOS的开关特性，无法进一步减少死区时间。 从这些波形中可以看到，500 ns的死区时间严重影响了相电流。

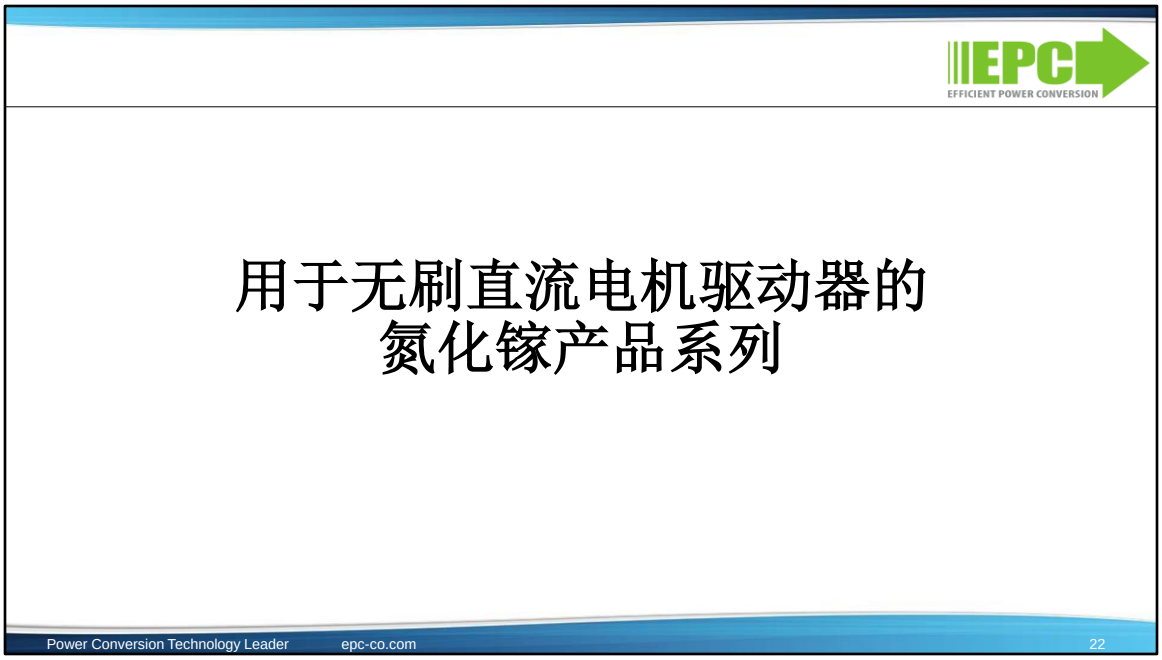


Next, we adjusted the dead time to be 50 ns which is something that can only be achieved with gallium nitride.
接下来，我们将死区时间调整为50 ns，这只能用氮化镓器件实现。

In this example, we are still switching at 40 kHz and delivering 3.7 ARMS into each phase of the motor. Look how much smoother the waveform is with a 50 ns deadtime.
在此范例中，我们仍在40 kHz开关，并将3.7 ARMS传输到电机的每相。 看看死区时间为50 ns时波形有多平滑。

We ran the inverter at 40kHz to directly depict the differences vs. MOS based inverters. As a matter of fact, GaN based inverters can switch at a faster frequency than MOS, bringing more system benefits such as input filter reduction.
我们以40kHz的频率运行逆变器，以直接描述与基于MOS器件的逆变器的不同。实际上，基于氮化镓器件的逆变器可以比基于MOS器件在较高的频率下，实现更快速的开关，从而带来更多的系统优势，例如减少输入滤波。

Now, let’s see some video footage of this demo in action…
现在，让我们看看在意大利FAE Lab的Marco为我们演示关于电机驱动的视频片段。



Thank you to Marco for providing that video of the motor drive demo. Now, we'll take a quick look at which EPC devices allow smaller, lighter and more accurate motor drives.

感谢Marco与我们分享电机驱动的演示。现在，让我们看看哪些EPC器件可以实现更小型化、更轻巧和更精准的电机驱动器。

100 V的产品

Parameter	EPC2051 (@ 5 V_{GS})	EPC2052 (@ 5 V_{GS})	EPC2045 (@ 5 V_{GS})	EPC2204 (@ 5 V_{GS})	EPC2053 (@ 5 V_{GS})	EPC2218 (@ 5 V_{GS})
	1.3 x **0.85** mm	**1.5** x **1.5** mm	**1.5** x **2.5** mm	**1.5** x **2.5** mm	**2** x **3.5** mm	**2** x **3.5** mm
$R_{DS(on)}$ typ	**20 mΩ**	**10 mΩ**	**5.6 mΩ**	**4.5 mΩ**	**3.2 mΩ**	**2.5 mΩ**
$R_{DS(on)}$ max	25 mΩ	12.5 mΩ	7 mΩ	5.6 mΩ	3.8 mΩ	3.2 mΩ
Q_G typ	1.7 nC	3.7 nC	5.9 nC	6.4 nC	12 nC	11.8 nC
Q_{GD} typ (1)	**0.3 nC**	**0.5 nC**	**0.8 nC**	**0.9 nC**	**1.5 nC**	**1.6 nC**
Q_{OSS} typ(1)	7.3 nC	13 nC	25 nC	25 nC	45 nC	46 nC
Qrr typ	0 nC	0 nC	0 nC	0 nC	0 nC	0 nC
Rg typ	0.8 Ω	0.7 Ω	0.6 Ω		0.6 Ω	
Area	**1.11 mm²**	**2.25 mm²**	**3.75 mm²**	**3.75 mm²**	**7 mm²**	**7 mm²**

(1) at V_{DS} = 50 V

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EPC offers a full range of 100 V FETs with RDSon ranging from 20 mOhm to 2.5 mOhm(build 1). Gate charge is very small, (build 2) from 1.7 nC to 11.8 nC, Qgd is also very small, for very low switching losses, and Qrr is 0.
EPC提供100 V FET的整个系列，其导通电阻的范围从20 mOhm到2.5 mOhm。栅极电荷很小，从1.7 nC到11.8 nC，而且Qgd也很小，因此开关损耗很低，以及没有Qrr。

The device area is ultra small (build 3), from 1mm2 to 7mm2. The BGA devices (with the exception of EPC2051) can nest, so that the same layout can accommodate different FETs to allow easy & flexible upgrade for efficiency or load current changes.
器件的面积超小，从1平方毫米到7平方毫米。用BGA封装的器件（EPC2051除外）可以嵌套，因此在相同的布局内容纳不同的FET，从而可以轻松及灵活地随着效率或负载电流的变化，把系统升级。

EPC氮化镓器件与竞争对手的比较

	V_{DS} max [V]	V_{GS} typ [V]	Max $R_{DS(on)}$ [mohm]	Q_G typ [nC]	Q_{GD} typ [nC]	Q_{OSS} typ [nC]	Q_{RR} typ [nC]	Dimensions [mm²]
NTMFS6B03	100	10	4.8	58	17	95 …	120	30
BSC035N10	100	10	3.5	70	14	91	122	30
BSC030N08	80	10	3.0	61	13	73	94	30
EPC2053	100	5	3.8	11.4	1.5	45	0	7
EPC2045	100	5	7	6	0.8	16	0	3.75
EPC2052	100	5	13.5	3.5	0.5	13	0	2.25

于低PWM 频率（20 kHz ~ 40 kHz）
- 与竞争对手相比，面积小30%
- 没有反向恢复
- 实现最小化死区时间

在较高的PWM 频率(40 kHz ~100 kHz），尺寸小很多

EPC的氮化镓器件实现微型化

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Comparing EPC FETs to major competition for motor drives, one can see that EPC devices have the same RDSon in 1/5 of the size. For the same RDSon, they offer lower Qg and Qgd (build 1) for less switching losses, and the huge advantage of no reverse recovery losses.

面向电机驱动器，对EPC 的氮化镓场效应晶体管与主要竞争对手进行比较，可以看到EPC器件以1/5的尺寸就具有相同的导通电阻。

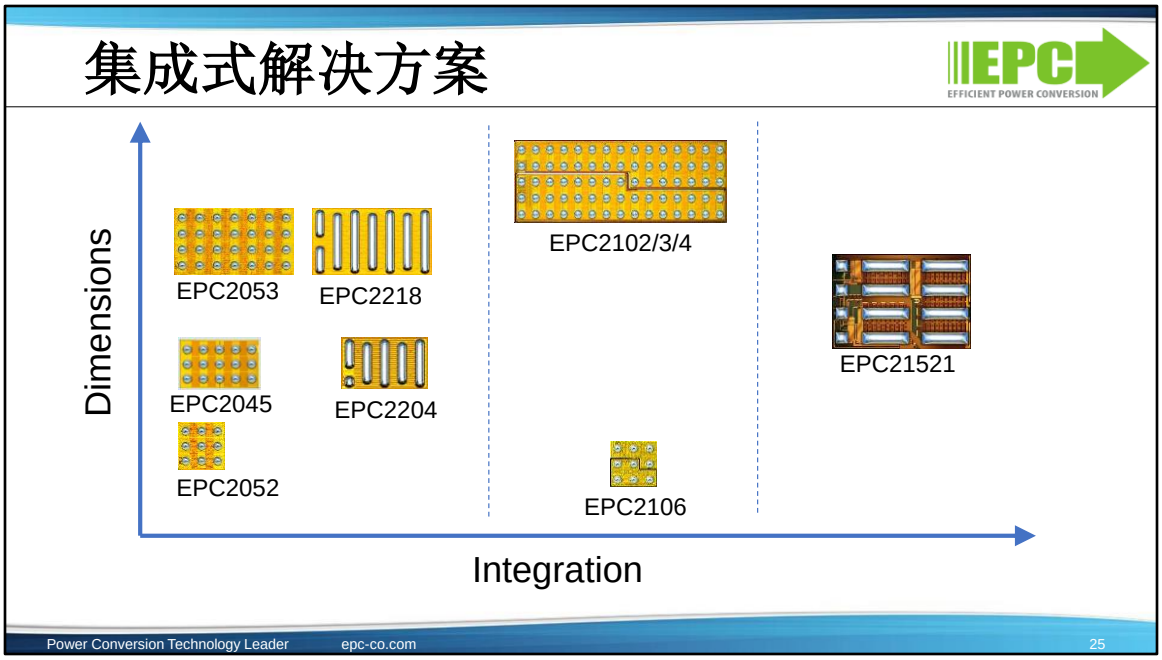
而且在相同的导通电阻下，氮化镓器件提供更低的Qg和Qgd，从而减少开关损耗，并且具有没有反向恢复损耗的巨大优势。

(build 2)At low PWM frequency (i.e. 20kHz -- 40kHz) EPC devices
- occupy 30% of total area vs competitive benchmark
- (build 3) Do not have any reverse recovery
- (buidl 4) And enable minimum dead times

与竞争器件的基准相比，在低PWM频率下，即20 kHz至40 kHz，EPC器件：
- 所占的总面积只有30%
- 没有反向恢复
- 并且可以实现最小化的死区时间

(Build 5) At higher PWM frequency (i.e. 40 kHz – 100kHz) EPC devices can further shrink the dimensions with new Gen5 devices
在更高的PWM频率（即40kHz 至 100kHz）下，EPC的最新第五代器件可以进一步缩小尺寸。

Overall, (build 6) eGaN devices allow miniaturization
总体而言，eGaN器件可实现小型化电机驱动器。



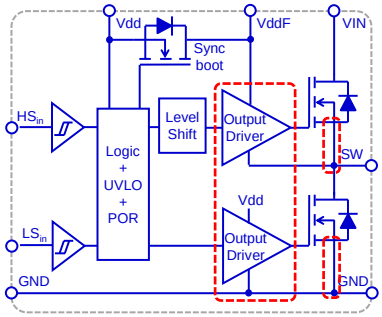
EPC also offers a flexible portfolio for motor drives application. Customers can select (build 1) discrete FETs, (build 2) integrated half bridges, or (build 3) our new integrated power stage. (build 4)

面向电机驱动应用，EPC也有提供灵活的产品组合。 客户可以选择分立式场效应晶体管、集成式半桥器件或最新的集成功率级。

集成功率级（GaN ePower Stage）

EPC21521

80 V_{DSmax}, $R_{DS(on)\_typ}$ = 10 mΩ



- 近乎没有共源电感
- 与场效应晶体管匹配的驱动器
- 散热平衡
- 易于布局

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Introducing the 80 V rated, 10 mOhm, EPC21521 GaN ePower stage that represents the next evolution for GaN FETs; a monolithic integration of the power FETs with complete half bridge gate driver.
氮化镓器件的下一个发展阶段，由额定电压为80 V、10 mOhm的EPC21521 GaN ePower功率级代表，这是集成了功率FET和半桥栅极驱动器的IC。

There are many benefits to monolithic integration of the power stage such as:
单片集成功率级的有很多好处，例如：

(Build 1)
It virtually eliminates common source inductance (CSI), and reduces the power loop and gate loop inductances,
实际上，它消除了共源电感（CSI），并减小了功率环路电感，和栅极环路电感。

(Build 2)
The gate drivers are matched to the FETs and can be designed to optimize switching speed against EMI generation, voltage spikes and efficiency resulting in the shortest practical transition times,

栅极驱动器与各个FET匹配，并且可以设计为在可行的最短转换时间内，优化开关速度以压制EMI， 以及优化电压尖峰和效率。

It improves thermal power dissipation distribution allowing optimized FET scaling that yield higher efficiencies. This feature is more useful for high step-down ratio converters,
它改善了热功耗的分布，并且实现优化的FET缩放，从而取得更高的效率。此功能对于具有高降压比的转换器更为有用。

Integration improves dv/dt immunity that covers all 8 types of switch-node transitions which is important for motor drives,
集成功率级提高dv / dt抗扰度，涵盖所有8种类型的开关节点的转换，这对于电机驱动器而言，非常重要。

(Build 3)
It simplifies PCB layout and reduces assembly component count for the converter solution.
它简化了PCB布局，并减少了转换器解决方案所需的组装部件的数量。

The IC includes 12 V tolerant CMOS and TTL compatible input buffers, a logic interface with Power-On-Reset (POR), Under-Voltage-Lockout (UVLO) functions, a high voltage, high dv/dt capable control signal level-shifter, a synchronous bootstrap supply that ensures proper high side voltage for the high side gate driver and measures just 3.9 by 2.6 mm.
这个IC包括12 V耐压CMOS和TTL兼容输入缓冲器、逻辑接口（具有上电复位（POR）、欠压锁定（UVLO）功能）、具高压和高dv / dt性能的控制信号电平转换器、同步自举电源以确保为高侧栅极驱动器提供合适的高侧电压，而尺寸仅为3.9 x 2.6 mm。

总结

- EPC的氮化镓器件可以实现尺寸更小、重量更轻和更精准的电机驱动器
- 在给定的相同导通电阻（$R_{DS(on)}$）下，EPC氮化镓（eGaN）器件的优势是：
  - 尺寸更小
  - 具有更低的开关损耗
  - 没有反向恢复
- ePower™ Stage系列实现数字输入和功率输出、简化设计和进一步缩小电机驱动器的尺寸

In summary, EPC devices allow smaller, lighter, and more accurate motor drives.
(build 2) Given same Rdson, EPC eGaN devices
(build 3) Are smaller
(build 4) Have lower switching dissipation
(Build 5)Have no reverse recovery compared to silicon MOSFETs
(build 6) The ePower Stage digital In and Power Out family simplifies design and will further reduce size

总而言之，EPC器件可实现尺寸更小、重量更轻、更精准的电机驱动器。

在给定的相同导通电阻下，eGaN器件的尺寸更小、具有更低的开关损耗，而且与硅MOSFET相比，没有反向恢复。

ePower Stage的数字输入和输出功率系列，简化设计，并且进一步缩小电机驱动器的尺寸。

For more detailed information about GaN FETs and ICs in motor drive applications, visit us at epc-co.com and to purchase devices and demo boards visit digikey.com.
有关面向电机驱动器应用的氮化镓场效应晶体管（GaN FET）和集成电路的更多详细信息，请访问epc-co.com.cn.

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