transphorm

Highest Performance, Highest Reliability GaN

SNAPSHOT

- Revenue ramping in 2018; growing backlog with well-known end customers
- First publicly recorded high voltage GaN customers in production
- Proven highest quality, highest reliability high voltage GaN available
- Vertically integrated technology development (design, EPI, process, apps)
- Ability to scale to high volume quickly and easily
- Industry' s strongest GaN power patent portfolio
- More than 300 years of combined GaN experience

bel power solutions · CORSAIR · DELTA · Seasonic · YASKAWA

Founded in 2007, Transphorm is the market and technology leader in the development of gallium nitride (GaN) products for high-voltage power conversion applications. The Company delivers the highest performance, highest reliability GaN devices while providing best-in-class application design support to a growing customer base.

The Company' s technology is built on an incomparable IP portfolio of more than 1,000 patents/applications. addressing each core area of the GaN process, end to end. The Company also integrates leading-edge R&D platforms with a world-class engineering team comprising 300 plus years of GaN expertise. Transphorm' s technology and team proficiency enable it to create innovations that move beyond silicon' s limitations to eliminate more of today' s energy losses and capture market share.

Transphorm' s products switch 4x faster than silicon and increase a system' s power density—producing greater efficiency while enabling system size reduction. Further, the Company' s products are especially optiized within a bridgeless totem-pole PFC design, which reduces overall system cost by eliminating need for bridge rectifiers as well as other passive components.

GaN Value Proposition

Need for Speed
GaN operates at higher frequencies with up to 4x faster switching, lower crossover losses, and increased system efficiency

Feel the Power
GaN in a totem-pole configuration lowers component count and EMI filter size to deliver the same power in a smaller footprint

Smaller, Lighter, Cooler
Higher efficiency and increased power density means lower overall system cost

While silicon is reaching its technological limits, GaN has significant potential for performance and efficiency improvements within various practical applications. These factors drive the projected significant growth of the GaN product market. And, Transphorm is optimally positioned to support this growth.

Relying on a world-class manufacturing process capable of scaling to mass production, Transphorm ships device orders within 20 weeks. Customers use these devices to produce end products with unprecedented performance. CORSAIR' s Gaming PC power supply—dubbed the Emperor of Efficiency—puts out 100 W more power in a 12.5% smaller enclosure for 6.5% less in system cost (in comparison to Silicon). Yaskawa' s first integrated servo motor uses GaN to cut circuit losses by 66%, shrink the PCB, and reduce ambient noise. These examples demonstrate what' s possible with Transphorm' s GaN and will be followed by others. Welcome to the GaN Revolution.

Transphorm Value Proposition

1st AEC Qualified GaN · Golden Mousetrap Awards 2018 Winner · 1st JEDEC Qualified GaN

In production with Tier 1 customers with ramping volumes
- Adoption in high-voltage consumer; computing (Gaming, Crypto-mining, AI); and, infrastructure and IT segments

Best-in-class quality and reliability
- Only JEDEC and AEC-Q101 qualified 650V device(s) available on the market

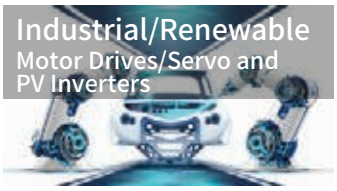
Comprehensive product portfolio
- 3rd generation of products now in the market and ramping

Manufacturing structure in place to support long-term demand
- Fujitsu foundry relationship for high volume and quality production

Long-term product, package, and automotive roadmap in place

4x revenue growth · >500m sales pipeline · 50+ design wins · AEC-Q101 + JEDEC qualified

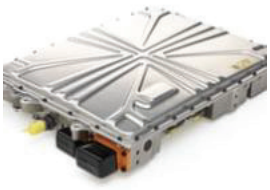
GaN Value in Target Applications



Ability to double available power in standardized server and telecom form factors.

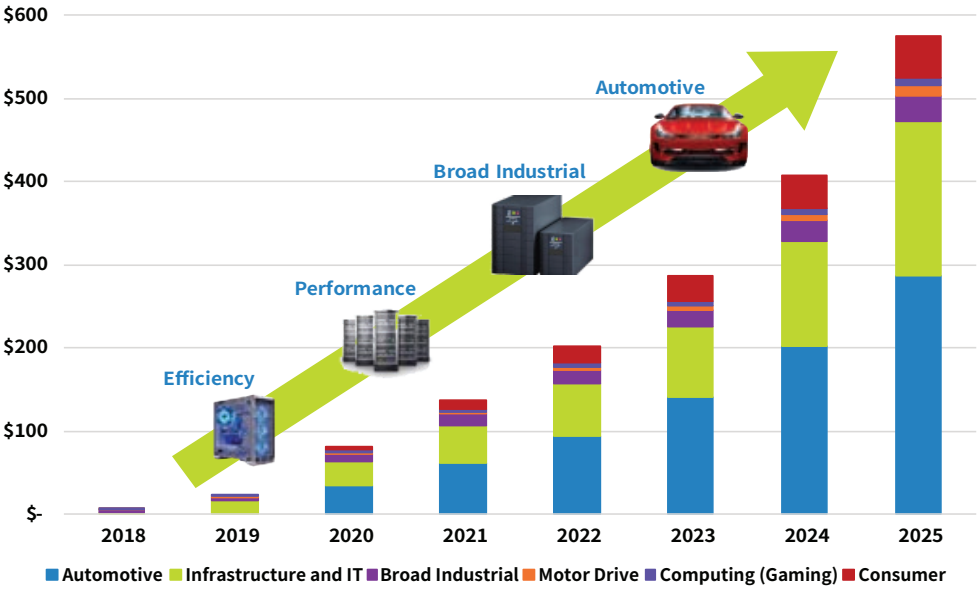
Improved efficiencies result in lower thermals, improved power density and lower system cost.

Reduces size, cable complexity and cost in servo motors and makes PV inverters significantly smaller and lighter.



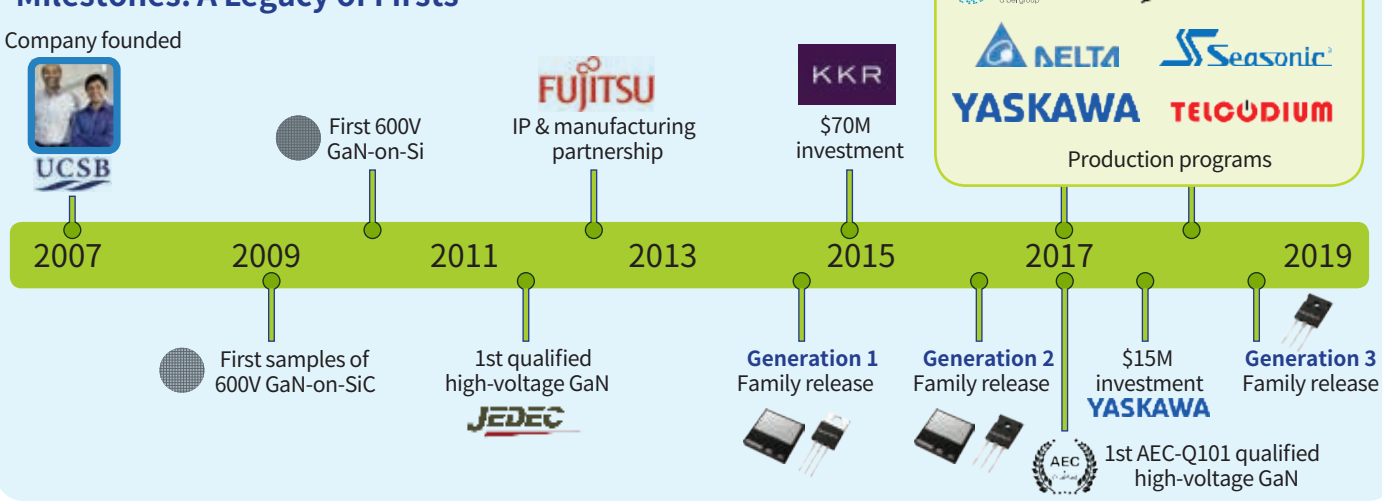
Size & weight reduction translates to longer distance per charge and lower system cost.

GaN Market Evolution



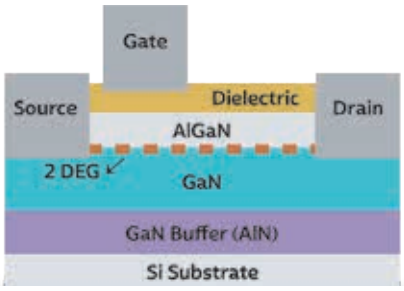
- **Early adoption**
  - High performance
  - High efficiency
  - Smaller markets
- **Industrial applications have slow ramp but long life cycles**
- **Market growth inflection point in CY19**
- **Automotive applications drive growth beyond 2021**

Milestones: A Legacy of Firsts

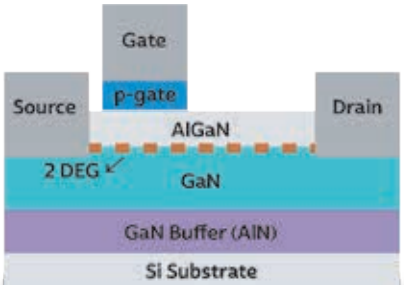


Transphorm GaN vs. Market e-mode GaN

氮化镓 (GaN)的设计可不一定相同，
Transphorm的氮化镓FET效应管公认为质量和可靠性比市场上的增长型氮化镓更高



Transphorm GaN



Market e-mode GaN

Attribute	Cascode (Transphorm)*	e-mode (market)*
质量、可靠性、工作寿命	通过JEDEC、AECQ101验证	验证中
崩溃电压(T_J=150°C)	650V(JEDEC认证标准), 1200V(内部测量)	500V及600V(内部测量)
最高瞬间电压	800V	750V
栅极电压工作范围(R_{ON}~V_{GS})	10V	1V
栅极门限电压	4.0V(典型值)	1.7V(典型值)
栅极负电压	不需要	需要
开通速率控制(Slew Rate)	有	有
反向体二极管导通压降(V_{SD})	2.2V至2.6V	6V－9V(由删极驱动决定)
最大饱和正向电流(T_J = 150°C)	比相同Rds(on)的E-mode 大三倍	随结温升高而递减
并联	可两管并联	稍好但可靠性成疑
FOM (R_{ON} * Q_{OSS})	为同业的标准	Q＋R比Cascode稍低
芯片面积(同Rds(on))	业界标准	比Cascode稍小
温升(72mohm)	50°C~1500 W 83°C~2526 W	80°C~1500 W

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*除非另有说明，否则数据基于50mΩ的器件

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SNAPSHOT

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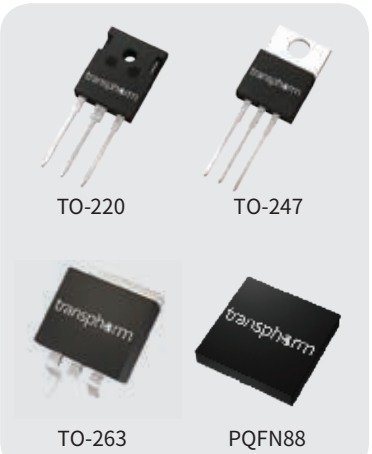
Released

Part Number	Vds (V) min	Rds(on)eff (mΩ) typ	effRds(on) (mΩ) max	Id (25°C) (A) max	Package	Package Variation
TP65H035WS	650	35	41	46.5	TO-247	Source
TP65H035WSQA	650	35	41	47	TO-247	Source
TP65H050WS	650	49	60	34	TO-247	Source
TPH3205WSBQA	650	49	62	35	TO-247	Source
TPH3212PS	650	72	85	26	TO-220	Source
TPH3208PS	650	110	130	20	TO-220	Source
TPH3206PSB	650	150	180	16	TO-220	Source
TP90H180PS	900	170	205	15	TO-220	Source

Sampling

TP65H050BS*	650	50	60	34	TO-263	Source
TP65H070LSG**	650	72	85	25	PQFN88	Source
TP65H070LDG**	650	72	85	25	PQFN88	Drain
TP65H150LSG***	650	150	180	15	PQFN88	Source



** Release (TBD)*
*** Release April 2019*
**** Release September 2019*

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www.transphormusa.com www.transphormchina.com

650 V GaN in PC Gaming Power Supplies

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2018年初, 电竞类个人电脑周边配件生产商CORSAIR发布全新1.6KW电源AX1600i。

此钛金节能标准(80Plus@PSU)的电源采用了Transphorm公司的高压GaN TPH3205WS于无桥交错图腾柱PFC线路, 得使Transphorm的GaN FET特性和优点发挥得淋漓尽致。

虽然Corsair公司上一代同类电源AX1500i已经获奖无数, AX1600i仍具有众多优势，从高效率到高功率输出，基于相同的价格水位。并且，产品评论员已注意到：

“Corsair 再次令电源界噪动。(此电源可以说是电源中的法拉利)。以其高输出效率及各方面的高性能令业界震惊。”

TECHPOWERUP

“Corsair AX1600i 是当今及近期可买到的最佳电源。”

tom's HARDWARE
THE AUTHORITY ON TECH

“如果读者相信高性能电源能提升电脑系统的表现，Corsair AX1600i肯定是同级产品的佼佼者。又或读者还要比好更好的选择，它将会是不二之选。”

KITGURU

The AX1600i PSU

CORSAIR

使用Transphorm GaN的好处：

- AC-DC(PFC)效率提高1.2%(>99%)
- 最大输出功率增加100W (1.5KW→1.6KW)
- 生产成本降低了6.3% (USD0.3/W→0.28/W)
- 外壳体积缩小12.5%(体长减少25mm)
- 外壳最大温升与上代相约
- 厂家提供十年保修期

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1st AEC Qualified GaN

650 V GaN in Broad Industrial Power Systems

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TDK-Lambda新推出的504 W AC DC PFH500F-28是该公司在新的PFH功率模块系列的第一个产品及其首款基于GaN的器件。该模块设计用于恶劣环境应用，这些应用需要高质量，高可靠性的电源系统，并且可以实现最大功率输出。Transphorm的GaN FET被选用来实现这些目标。

TDK-Lambda重新设计的标准功率模块采用无桥图腾柱功率因数校正拓扑，最佳化Transphorm封装于PQFN 8x8的TPH3206LDG FET。 而且，与之前的PFE电源模块系列相比，PFH500F-28具有多样采用GaN带来的优势 。

The PFH500F-28 Power Module

TDK

使用Transphorm GaN带来的优点:

- 坚固耐用，适用于恶劣环境
- 提高5%效率
- 增加30%功率密度(100 W / in^3)
- 减少38%的热能

650 V GaN in Electric Scooter Battery Charging

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电源业界一直在研究高压氮化镓（GaN) 的使用，GaN于电池驱动的电动运输工具(BEV)，以替代硅组件。由于GaN拥有高性能，高效率及长期可靠性的优点，因此被广泛使用于电动汽车中的AC-DC PFC 车载充电器，DC-AC 辅助电源逆变器，以及DC-DC降压电源及驱动车内操作系统如空调，动力辅助转向及电子悬挂系统等。

最近Gogoro选用了Transphorm GaN开发产品，作为一家以突破性创新科技著名的电动摩托车制造商，Gogoro成功地示范了如何运用GaN在BEV的充电设备上，发挥出色的功效。

Gogoro 公司利用Transphorm的GaN管TP65H050WS (Gen III)， 应用在不断扩展的智能电池充电置换装置Go Stations。这个电池交换站网络系统，使用了数字控制无桥图腾柱PFC拓扑，最佳化GaN器件的典型性能。因此用户不单能使用同一系统作充电及放电用途，同时亦能提升系统的功率密度。

Electric Scooter Chargers

gogoro

其他使用Transphorm具体的优势，包括：

- 提升4% AC DC效率; PFC >99%
- 提高散热性能
- 降低整体系统成本

650 V GaN in Common Redundant Power Supplies

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GaN可以在不同的拓扑应用中体现出不同的优点，而在无桥图腾柱PFC应用中，GaN的优点绝对发挥得淋漓尽致。透过使用GaN可达到提升效率，增加功率密度，并且降低成本。更重要的是，GaN在某些应用中，能提升产品某方面的特性，从而使产品得到创新性的改进。

原创设计制造商台达电子公司(Delta Electronics)将Transphorm第二代GaN FET应用在数据中心的电源上，使该电源提升了升压管理的功能。虽然该电源上使用的PFC 电路只是传统CCM线路，台达电子
(Delta) 仍可在这800 Watts的电源上改善了以下范畴：

800 W Server Power Supply

DELTA

Transphorm GaN带来的优点:

- PFC线路体积减少25%
- 工作频率增加54%
- 可在原有大小电源内置备用锂电池
- 获得白金牌效率标签
- 达到标准CRPS 1U 尺寸

transphorm

氮化镓 MOSFET

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