TRANSFORMING THE WORLD
WITH SMALLER, LOWER COST, MORE EFFICIENT POWER ELECTRONICS
CUSTOMERS LEVERAGING THE GaN ADVANTAGE
APEC 2019
FAST GROWING CUSTOMER BASE IN ALL MARKETS

**Computer charger**
- 4x smaller
- 3x lighter
- 40 W/in$^3$

**EV inverter**
- 5x smaller
- 3x lighter
- 50% lower $P_{\text{loss}}$

**Solar ESS**
- 2x smaller
- 3x lighter
- Eliminated fan

**Datacenter server power supply**
- 50% higher power density
- 20% lower $P_{\text{loss}}$
Market leader for GaN power transistors

- GaN-on-Silicon transistors for the power conversion market
- Industry’s most extensive & highest-performance products
  - Enhancement mode devices
  - 100V & 650V devices; industry-best performance

Global company with decades of experience in GaN

- Parts shipping overnight from Mouser since 2014
- World-class fabless manufacturing and advanced packaging
- HQ and R&D in Ottawa, Canada
- Sales & App. Eng. in Germany, Japan, China, Taiwan, Korea, USA
GLOBAL ELECTRICITY DEMAND
A DRAMATIC INCREASE

25,000 TWh
2018

38,000 TWh
2050

52% PROJECTED INCREASE

Bloomberg, 2018  TWh = 1 Million MWh
The Challenge
Build systems that use less materials & waste less energy ... so all 7B people can use

The Solution
Better power electronics by using better power transistors
GaN REDUCES LOSSES AT EVERY POWER CONVERSION STAGE

- Energy
- EV charging
- EV
- Data Center

*PV panel*
- AC/DC
- DC/DC
- Battery

*OBC*
- AC/DC
- DC/DC
- Battery

*Motor*
- DC/AC
- DC/DC
- Audio, wipers, heater, etc.

*GaN Power Electronics*
*GaN Systems*

*Power grid*

*UPS*
- PFC
- DC/DC
- DC/DC
- PoL
GaN SYSTEMS TODAY

#1 in GaN
- Highest current; broadest voltages
- Best electrical performance
- Best die & best package
- Most widely used by customers

Shipping since 2014
- Offices in 7 countries
- Worldwide distribution & direct sales

Customer Successes
- Solar Inverter and ESS
- Motor Drives
- Wireless Power and Charging
- AC Adapters
- Data Center Server and Rack Power
- Automotive OBC and Traction Inverter
Applied GaN: Innovations in Energy Management Systems

Carlos Restrepo
VP Technology | Sonnen Inc.
March 2019
Renewable Energy Management

Energy Storage Systems enable renewable energy by adding an extra degree of freedom

• Net Metering are challenging original ROI calculation
  • Lower Feed-In Rates
  • Zero-Export Regulation

• Energy Independence
  • Solar production only works when grid-tied
  • More demand on weaker grids
  • Use it when you need it

• Grid Resiliency
  • Enhance grid-edge by deploying virtual power plants
  • Allow end-nodes to remain operational during outages
Energy Storage Systems Status Quo

Renewable energy know-how comes from the learnings and teachings derived from PV and Wind

• Monodirectional designs have been adapted to operate in bi-directional configurations
  • Uneven efficiencies

• High Power is the best power
  • Targeting better efficiencies at nominal power
  • ESS benefits from high power charging and low power discharging

• Integrated solutions are hard to come by
  • Each component is sold separately
  • Sophisticated Installers required
Advantage with GaN Systems

Integrated solutions can help us achieve a new product offering that centers not only on power harvesting but properly manage energy as individual unit or a collective virtual power plant

• Leveraging GaN Systems’ technology gives us improved design freedom
  • Higher Efficiencies: *4% round-trip efficiency increase*
  • Normalized Efficiencies: *at low and high power*
  • Reduction in Material Cost: *8% BoM cost savings*
  • Reduction in Size: *30% smaller*

• GaN Systems allow us to pack an improved value-stack at a competitive cost position
  • Extending the value of the battery usable capacity by improving directional efficiencies
  • Allow us to design more integrated solutions
GaN Application Expected in Automotive Electronics

Shinya Fukuda
DENSO INTERNATIONAL AMERICA, INC.
Once-in-a-Century Shift

Paradigm Shift

PHEV/EV components are important to make a paradigm shift.
Expected GaN Application in PHEV/EV

GaN is expected to be applied to the Power Supply.
## Automotive Power Supply Trends

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<tbody>
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<td><strong>Mobility Trends</strong></td>
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<td>Electric: High Power</td>
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<td>Autonomous: Redundancy</td>
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### Higher power density & Higher efficiency

- Mobility Trends: Autonomous: Redundancy, Electric: High Power
- Output Power: UP
- Volume & Mass: Down
- Efficiency: UP
# Investigation Case

<table>
<thead>
<tr>
<th>Power Conversion Unit of DC/DC Converter</th>
<th>Si</th>
<th>GaN</th>
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<tr>
<td></td>
<td>Transformer SubAssy</td>
<td>Choke Core</td>
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<tr>
<td></td>
<td>Choke SubAssy</td>
<td>Transformer Core</td>
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<tr>
<td># of SubAssy</td>
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<td>Volume</td>
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- **Primary Si-Module**
- **Secondary Si-Module**
- **Bus Bar**
- **Secondary GaN**
- **Primary GaN**
- **PCB**
Reducing Total Cost to the Environment (TCE)

Shawn Gao
Total Cost of Ownership (TCO) has been a measure of data center operational efficiency.

Supermicro challenges IT leaders to look more broadly at the Total Cost to the Environment (TCE).

Two ways to improve TCE:
1) Increase data center power efficiency
2) Drive towards elimination of e-waste
Improved data center power efficiency

- Supermicro high-density, high-efficiency cost effective solutions save space, money and reduce our imprint on the environment.

- GaN-based power supplies provide the next leap in efficiency and power density.
• The trend for more data and more power continues to grow

• We must prioritize both TCO and TCE

• GaN power devices are a critical technology to support these initiatives

We Keep IT Green®
Evolving to a Sustainable Ecosystem

Challenge
• More connected people and devices
• More vehicle electrification
• More renewable energy
• Exponential Data and Power growth

Solution
• Better power electronics by using better power transistors → GaN
GaN IS KEEPING ITS PROMISE

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