Electric motors benefit from GaNFast™
Older motors are being replaced with BLDC* motors and inverters

- BLDC* motors are more efficient (80%+) versus older AC motors (60%), smaller and lighter
- However, BLDC motors need an inverter to operate → additional system complexity
- The inverter allows for torque and speed control

→ Efficiency gain and added features are the key reasons for the trend to BLDC

* BLDC = brushless (or electronically commutated) DC motor
GaN switches for Motor Inverters
Full system solution

• Motor inverter: GaNFast™ halfbridges for compact and highly efficient power stage, with significantly reduced cooling efforts
• PFC in totem-pole or boost converter configuration with highest efficiency and smallest passive components
• Ultracompact, efficient aux supply (QR/ACF) with copackaged controller
Total cost of ownership (TCO) for motor inverters

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Raw materials</th>
<th>Component cost</th>
<th>Assembly</th>
<th>Design effort</th>
<th>Transportation</th>
<th>Usage</th>
<th>Recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical drivers</strong></td>
<td>Copper, Aluminum</td>
<td>Power switches, rectifiers</td>
<td>Microcontrollers, digital signal processors</td>
<td>EMI filters, heatsinks, inductors</td>
<td>Manual assembly, thermals</td>
<td>R&amp;D bandwidth for control loop, gate drive</td>
<td>Size and weight</td>
</tr>
<tr>
<td><strong>GaNFast™ advantage</strong></td>
<td>Reduced materials consumption through lower losses</td>
<td>Reduced component cost through higher integration (less external components)</td>
<td>Easier control circuit through GaNSense™ Higher control loop bandwidth possible</td>
<td>Lower losses enable reduced heatsink, lower emissions for smaller EMI filter</td>
<td>Reduced assembly cost with smaller / no heatsink</td>
<td>Ease of use through high integration levels of GaNFast™</td>
<td>Smaller heatsink, motors for reduced weight and size</td>
</tr>
</tbody>
</table>

- Biggest cost impact through reduced heatsink size and electricity consumption
- Additionally, better performance and protections
Total loss comparison of Silicon IGBT, silicon MOSFET and GaN FET

Application case:
- Bus voltage 400V
- Current 7A RMS
- Motor power 2kW
- Switching 6V/ns
- GaN and MOSFET same conduction losses

Using GaN FETs, the inverter efficiency increases by 2.5% (96% → 98.5%) and total losses are halved (15W → 6.8W)

➡ Significant reduction in cost, weight and size of thermal mgmt (like heatsink, fans, other thermal components)
➡ Benefit even larger at higher switching frequency
Key benefits of GaNFast™ and GaNSense™

Enabling motor-integrated inverters

- **High, stable and repeatable performance** → design margins can be reduced
  - Very low prop delay for best control loop performance
- Controlled gate drive conditions enable **outstanding reliability**
- **Much reduced component count** → system size and cost reduced, enabling motor-integrated inverters
- Easy to use → **fast time to market**
- Lossless current sensing **removes shunt resistors** → cost, size, reliability and performance improvement
- Fast and precise overcurrent protection → improved **system robustness**
- On-chip temperature sensing for better thermal design margin
- Precise overtemperature turn-off → improved **system robustness**

GaNFast™ and GaNSense™ offer highest performance, integration, robustness
Motor inverter using three halfbridges

Enable thermal spreading on the PCB

- Scalable solution for motor power 40…300W without heatsink*
- Very few external components for compact design
- Good thermal spreading through separation of the power stages

(* Motor power estimated and depending on application conditions, in particular thermal design)
Reference design

300W motor integrated inverter / power stage

Board diameter 56mm

Thermal scan @ 300W, 20kHz
Peak temperatures are ~52°C
Reference design

300W motor integrated inverter

Inverter efficiency for different switching speeds (20V/ns, 50V/ns)
Using GaNFast™ and GaNSense™ for Motor Inverters

• Trends in electric motor drive applications:
  • Improved energy efficiency
  • System cost and TCO reduction
  • Size and weight reduction
  • Improved performance
  • New / different motors

• Challenge to reduce design time / effort and improve end customer experience

GaNFast™ and GaNSense™ offer convincing solutions for motor drive trends and challenges – the next level of performance and integration
Thank you!