Kiss your heatsink goodbye: A kilowatt motor inverter based on GaN

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Bodo's Wide Bandgap Event 2024

Making WBG Designs Happen

GaN

60W

65W

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0,2 W/cm³

0,6 W/cm³

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<30 V/ns

>100 V/ns

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What about Motor Control?

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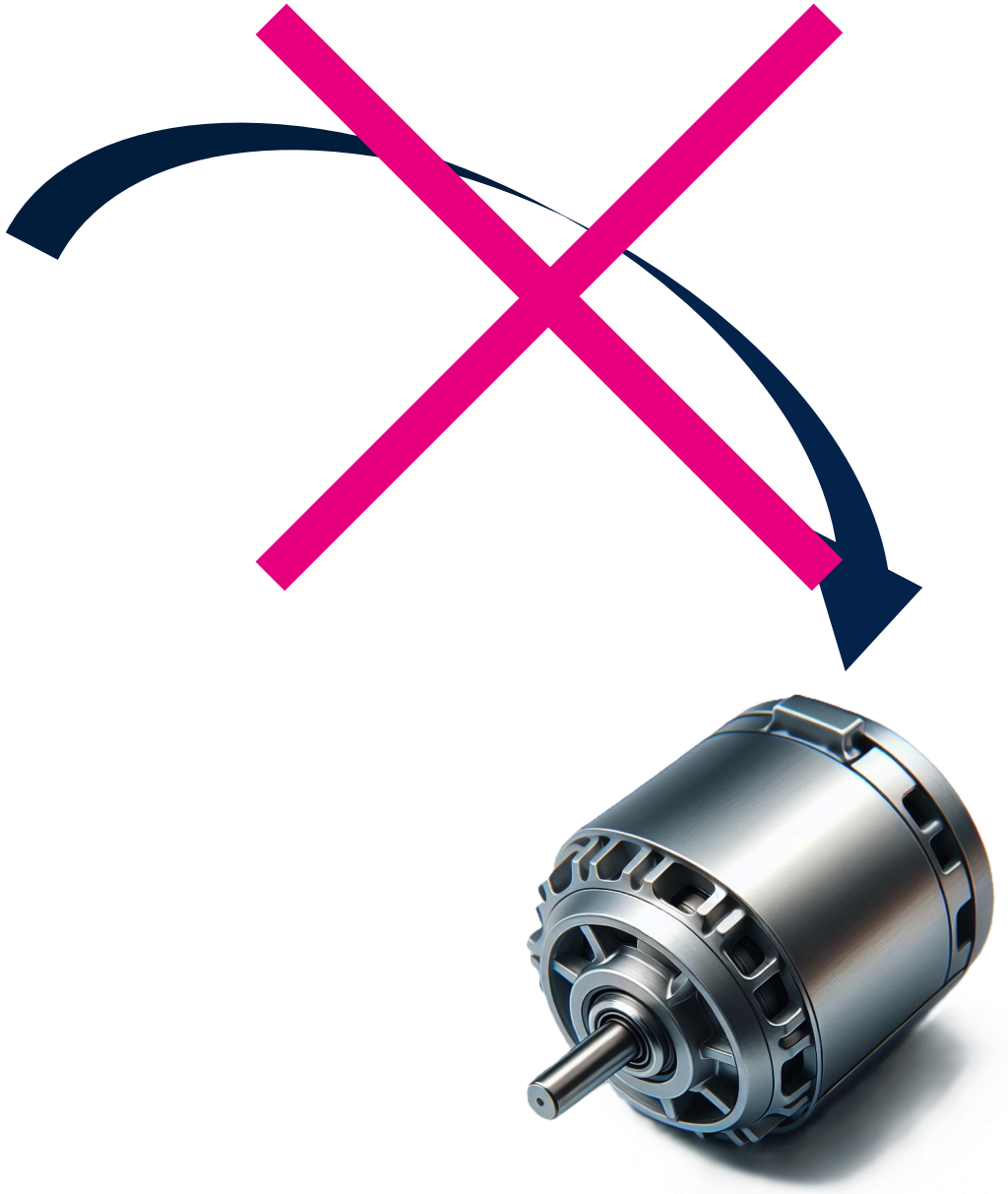

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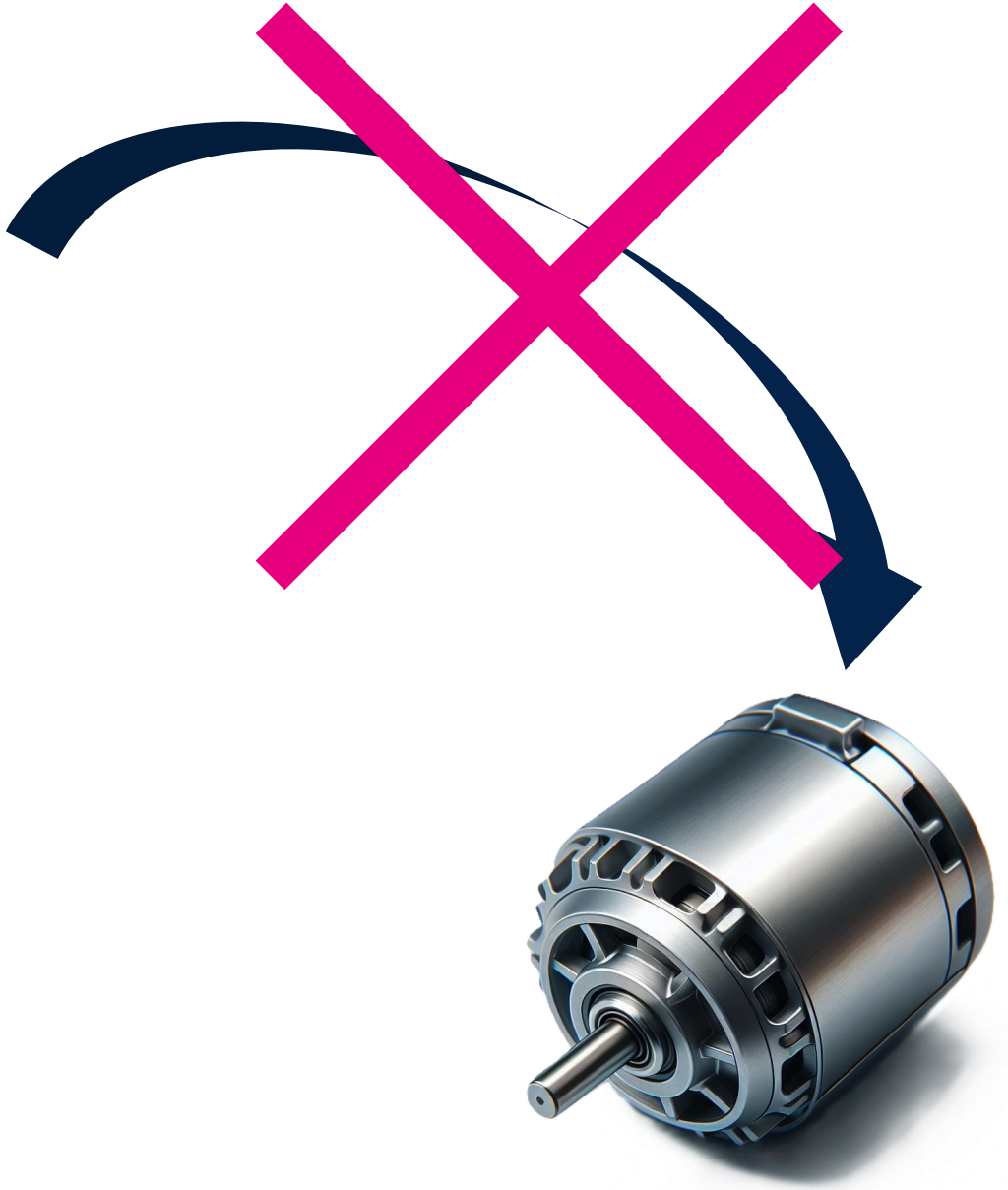

Size of the motor is defining power => we cannot make it smaller

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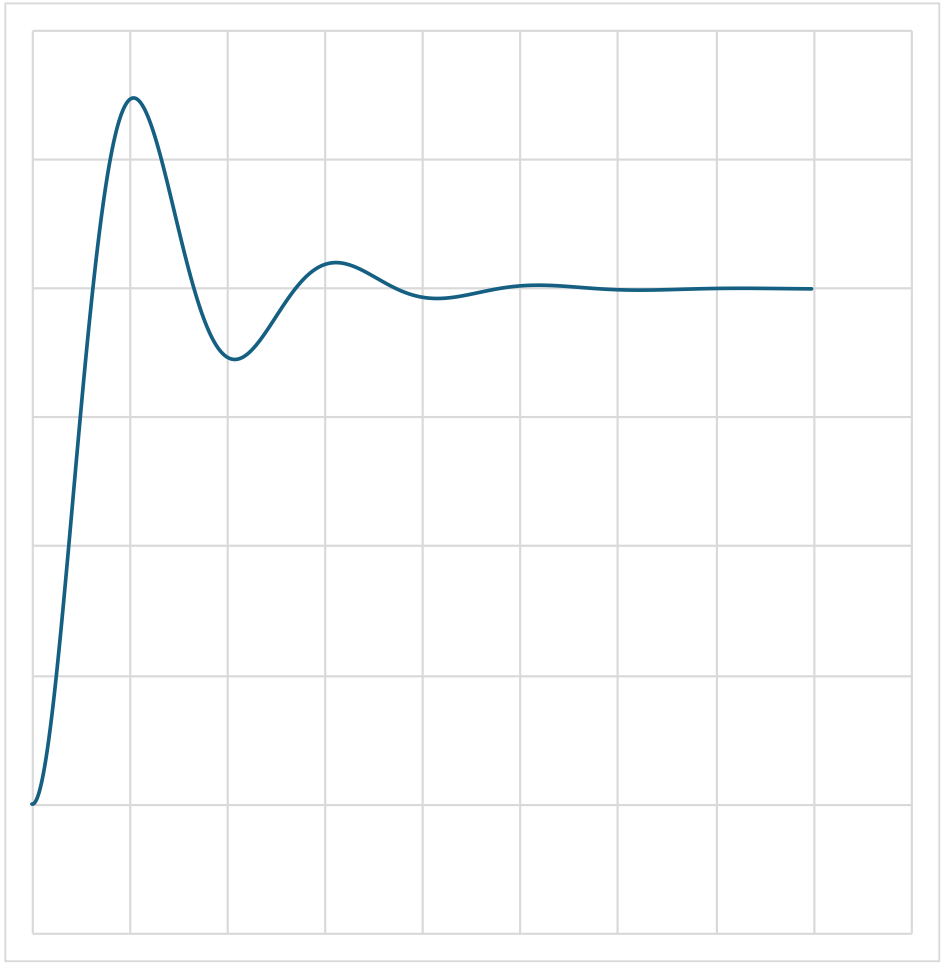
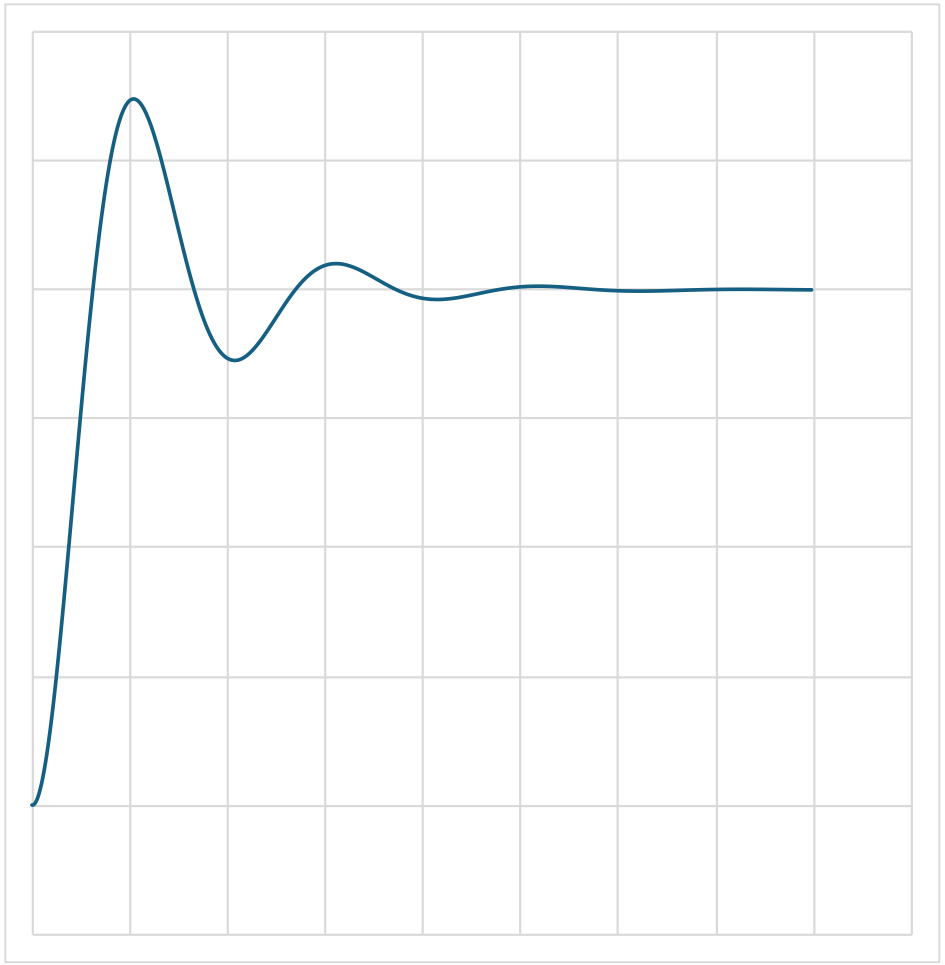
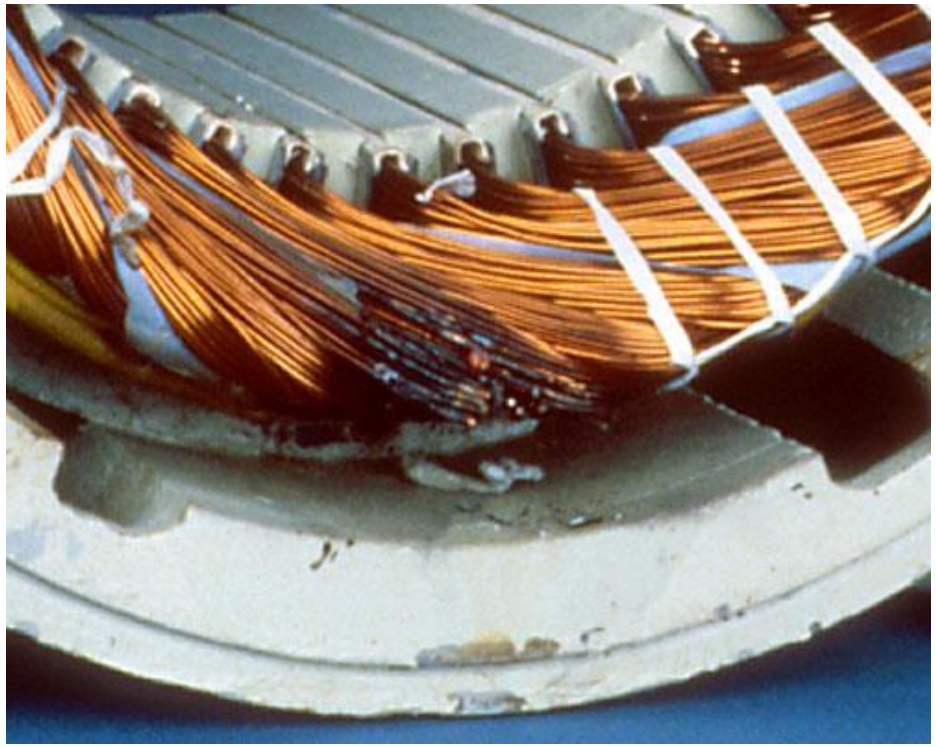


Higher dV/dt is causing voltage overshoots!





This might lead to a partial discharge inside the motor winding

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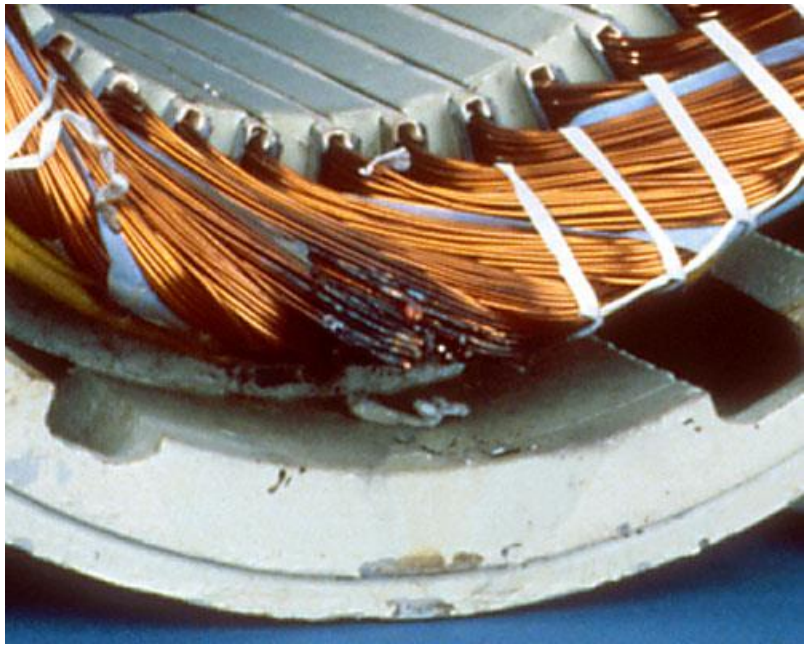
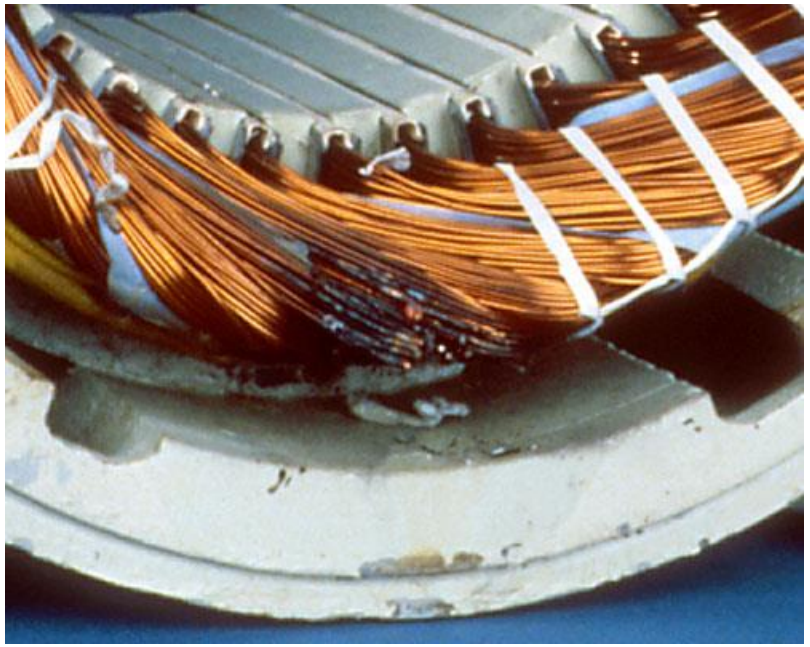


High dV/dt

Smaller motor



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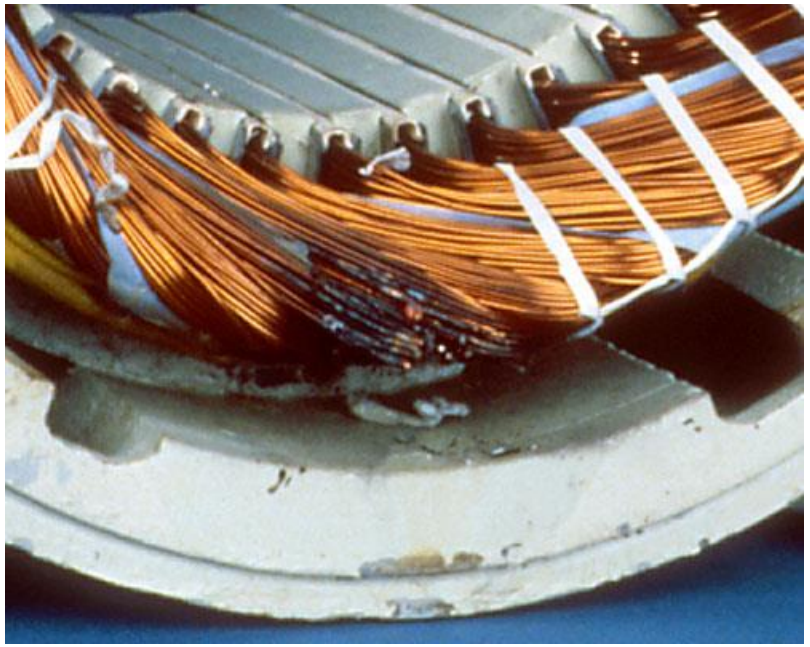

~~High~~ dV/dt

~~Smaller~~ motor

Why to use GaN in Motor Control?

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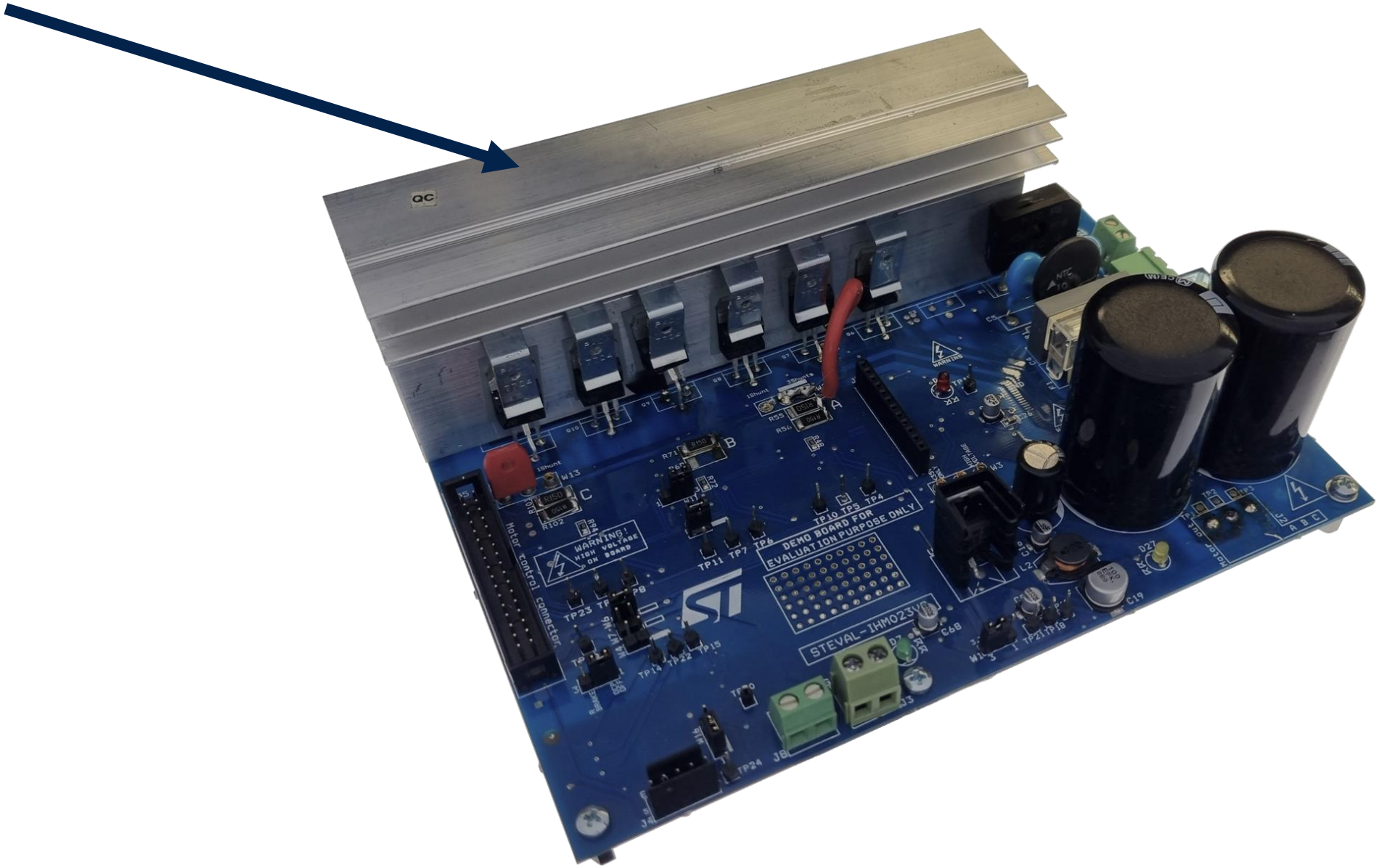
Smaller die area with comparable RDSON

Higher price

Where to focus?



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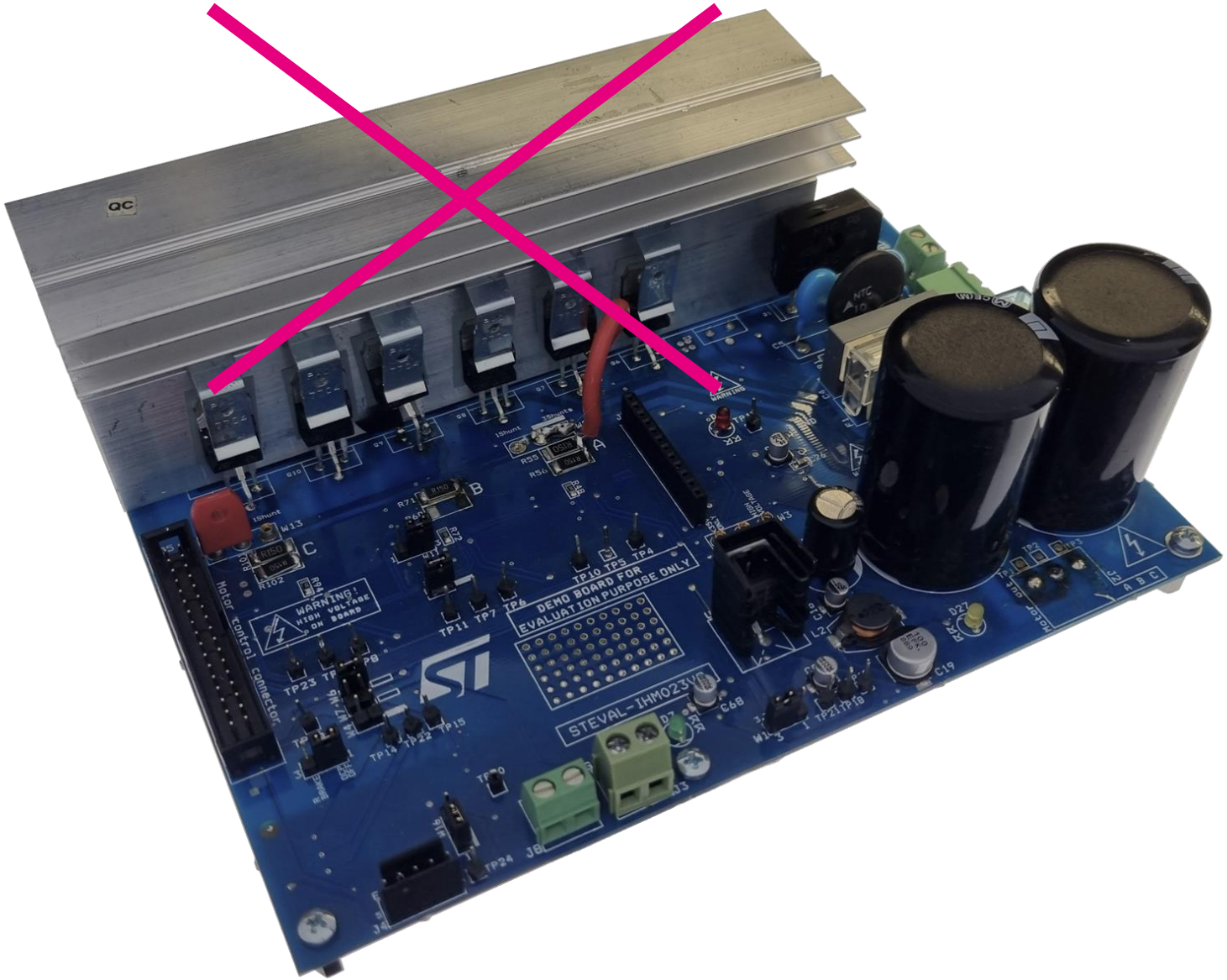

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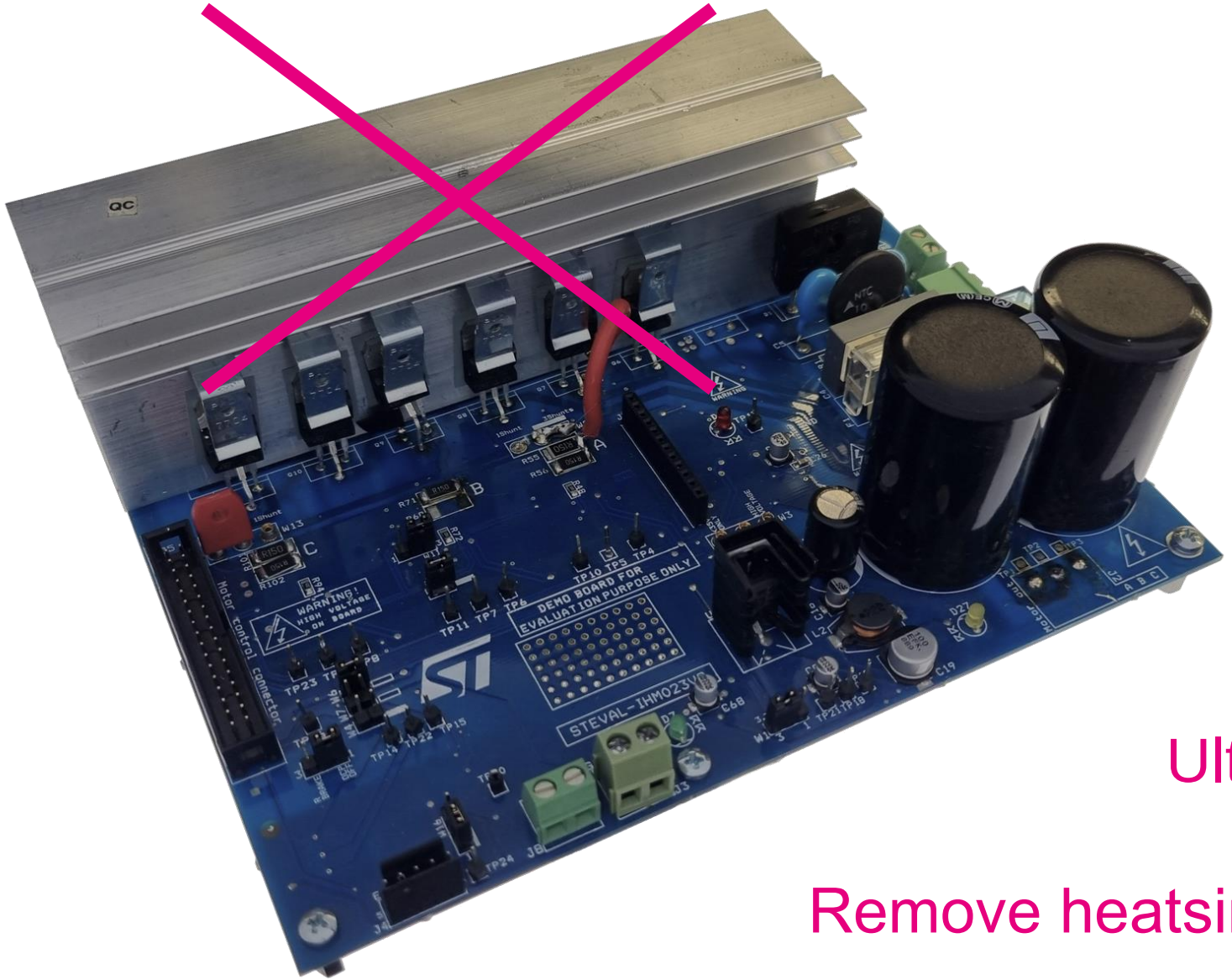

Ultimate goal:

Remove heatsink → lower system cost!

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Is it possible?

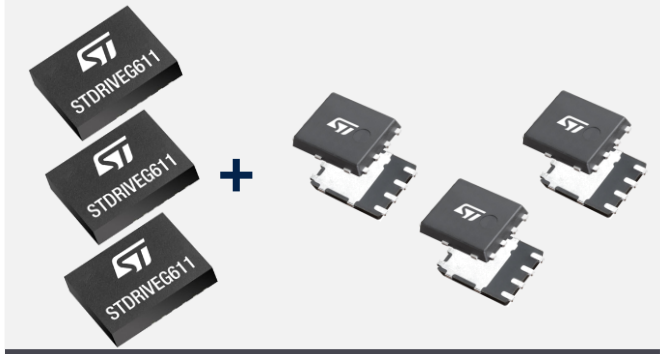
GaN in Motor Control
650V PowerGaN with STDRIVEG611 GaN Driver

Activity details

GaN Transistors under test:

- **120mΩ$_{(MAX)}$** GaN in PowerFLAT 5x6
- **65mΩ$_{(MAX)}$** GaN in PowerFLAT 5x6

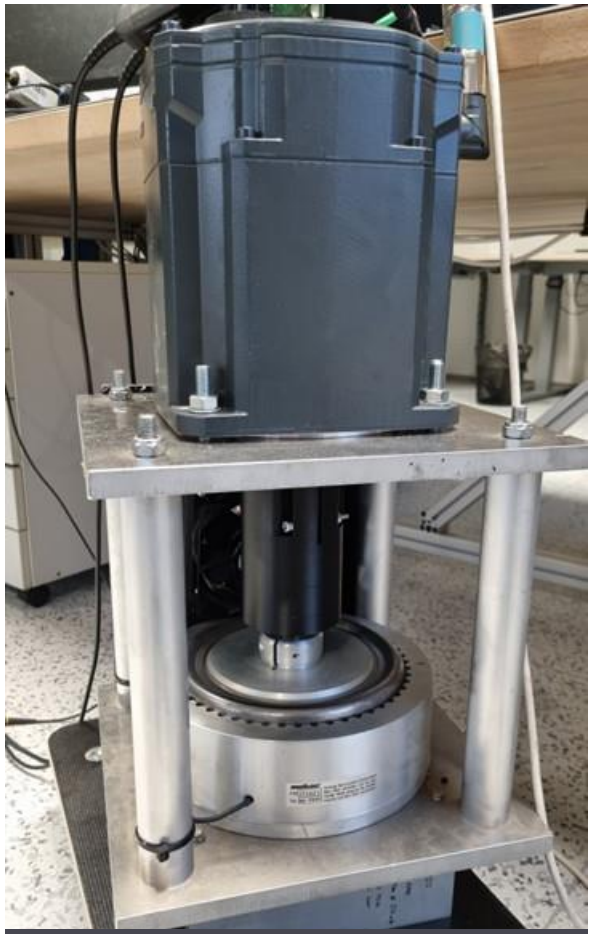
- Validation target: **500W, 800W**



Positioning GaN in Motor Control

1.5 kW motor bench

GaN Inverter with 3x STDRIVEG611



Motor brake joint with 3D printed clutch

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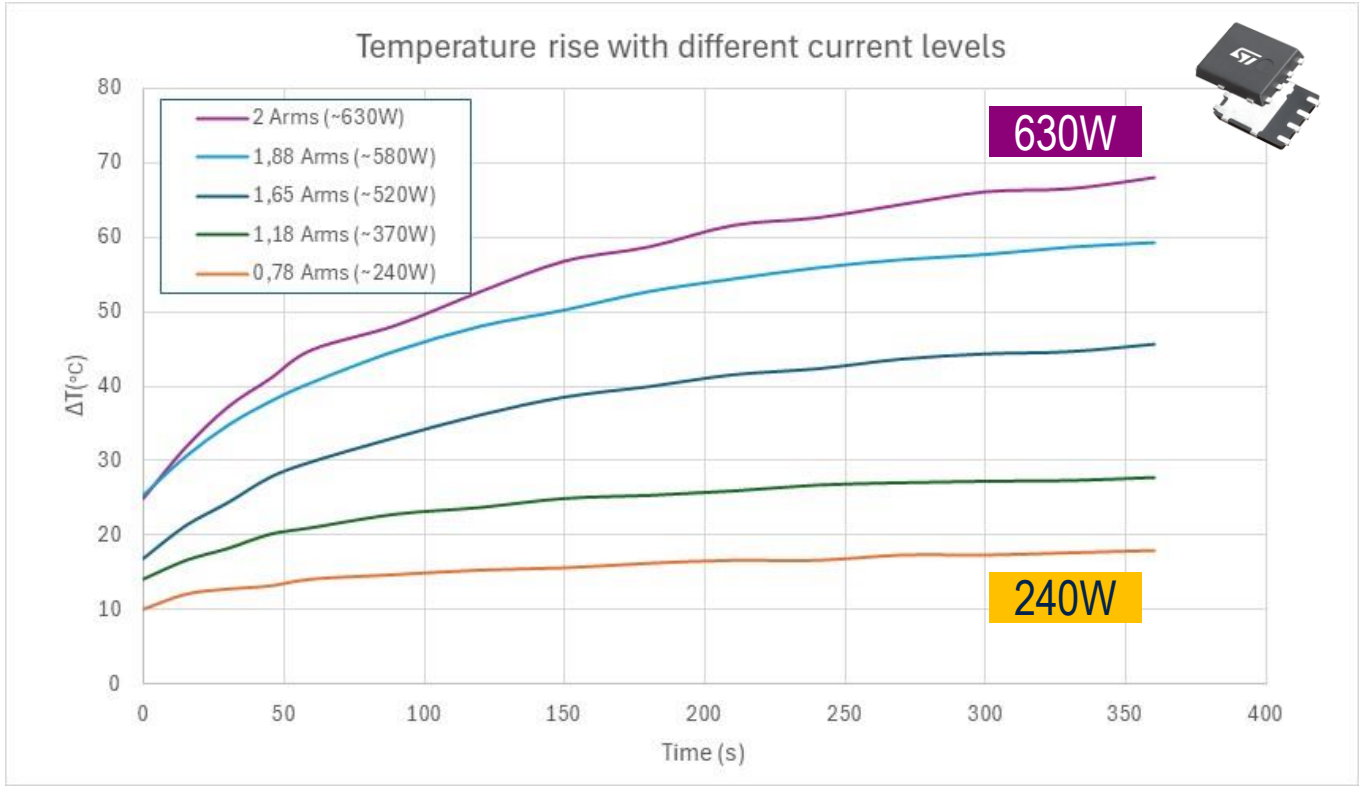
GaN in Motor Control
650V, 120mΩ$_{(MAX)}$ GaN thermal results

SGT120R65AL, thermal performance considerations

- Max input power ~630 W (300 V_{DC}, 2 A_{RMS})
- Turn-on speed set on 10 V/ns
- Switching frequency 16 kHz
- Passive cooling through PCB
- Max case temperature on GaN **92°C**

- Lower power translates into significantly lower temperature



120mΩ GaN seems a good fit for applications around **500W**

SGT120R65AL 75mΩ typ. (120mΩ max), absolute T_{Jmax} 150°C
Typical application starts at T_{amb} 60°C

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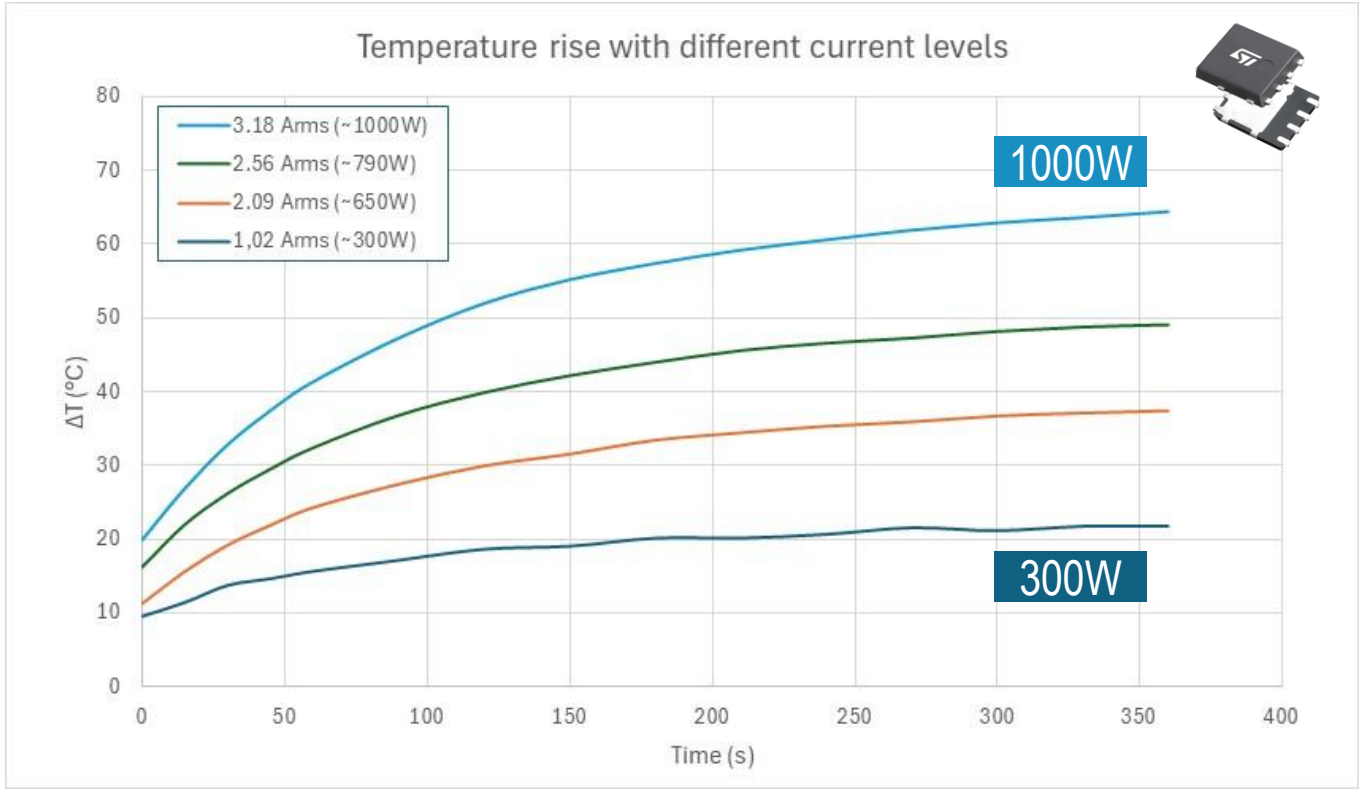
GaN in Motor Control
650V, 65mΩ$_{(MAX)}$ GaN thermal results

SGT65R65AL, thermal performance considerations

- Max input power ~1000 W (300 V_{DC}, 3.2 A_{RMS})
- Turn-on speed set on 10 V/ns
- Switching frequency 16 kHz
- Passive cooling through PCB
- Max case temperature on GaN **91°C**



65mΩ GaN seems a good fit for applications around **800W**

SGT65R65AL 49mΩ typ. (65mΩ max), absolute T_{Jmax} 150°C
Typical application starts at T_{amb} 60°C

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Our technology starts with You

Find out more at st.com/motor-control

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