Hidden pits of SiC MOSFET benchmarking and evaluation

Aleš Loidl, *STMicroelectronics*

Bodo's Wide Bandgap Event 2024

Making WBG Designs Happen

SiC

ST silicon carbide business

Business Development

~85 customers, ~**130** programs awarded

$1.14B revenues in 2023 (+60% vs. 2022)

$5B+ revenue opportunity by 2030

>40% market share in SiC MOSFETs and power modules

Source: Omdia

Portfolio & technology

Portfolio of SiC MOSFETs & diodes

- **650V to 1700V SiC MOSFET product range**
- **3rd generation MOSFETs in high-volume production**
- **Flexible** approach **covering discrete packages, modules, dice**

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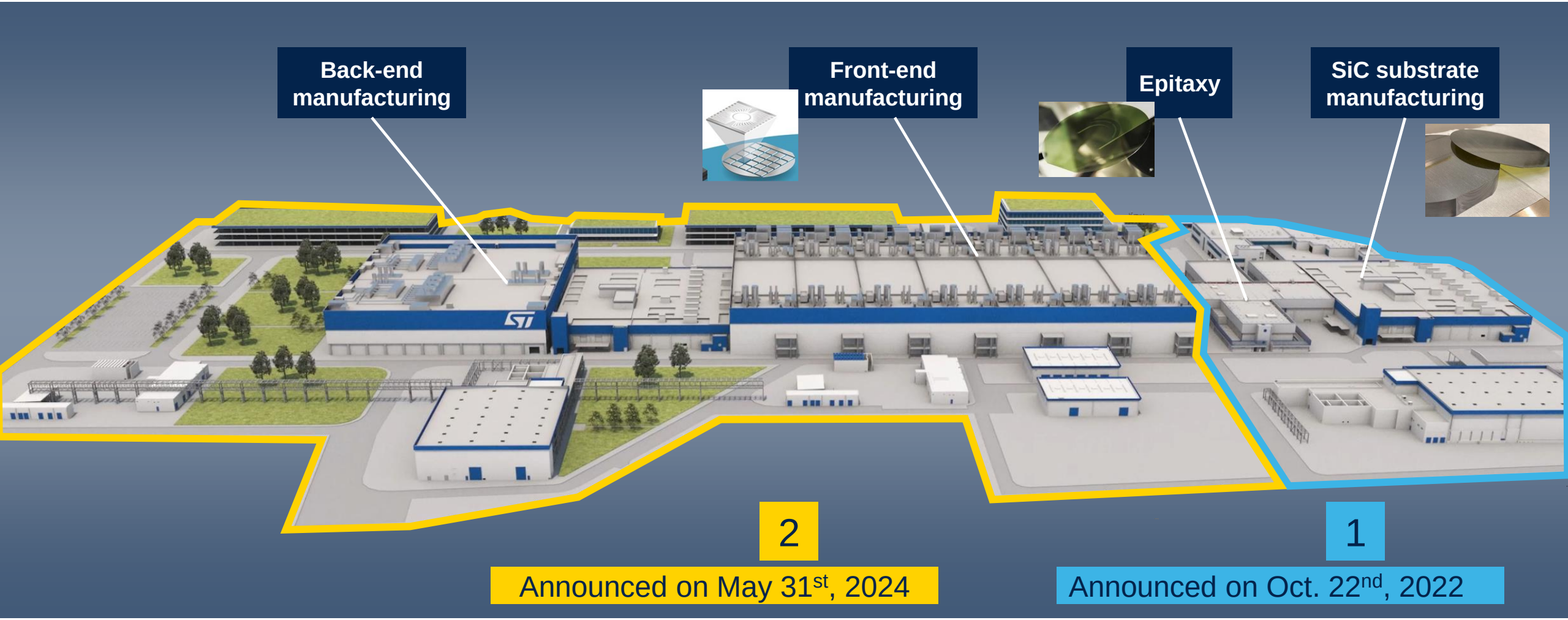
ST silicon carbide campus in Catania
Vertically integrated silicon carbide facility



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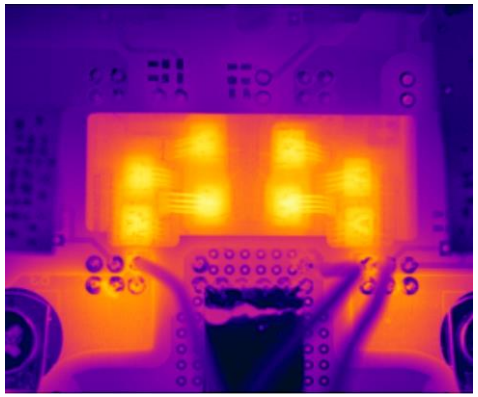
SiC MOSFET Benchmarking

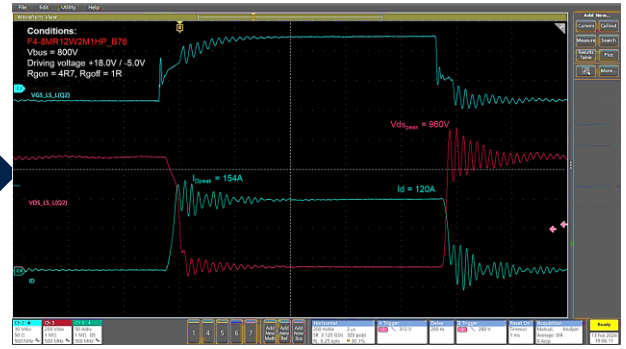
Efficiency Benchmarking of the devices

SiC Efficiency benchmarking



Thermal behaviour

Electrical losses



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Efficiency Benchmarking of the devices

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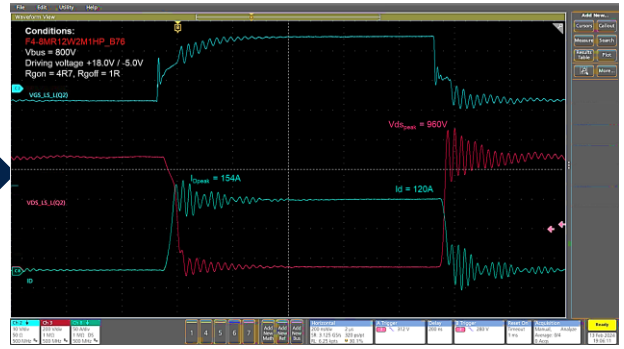

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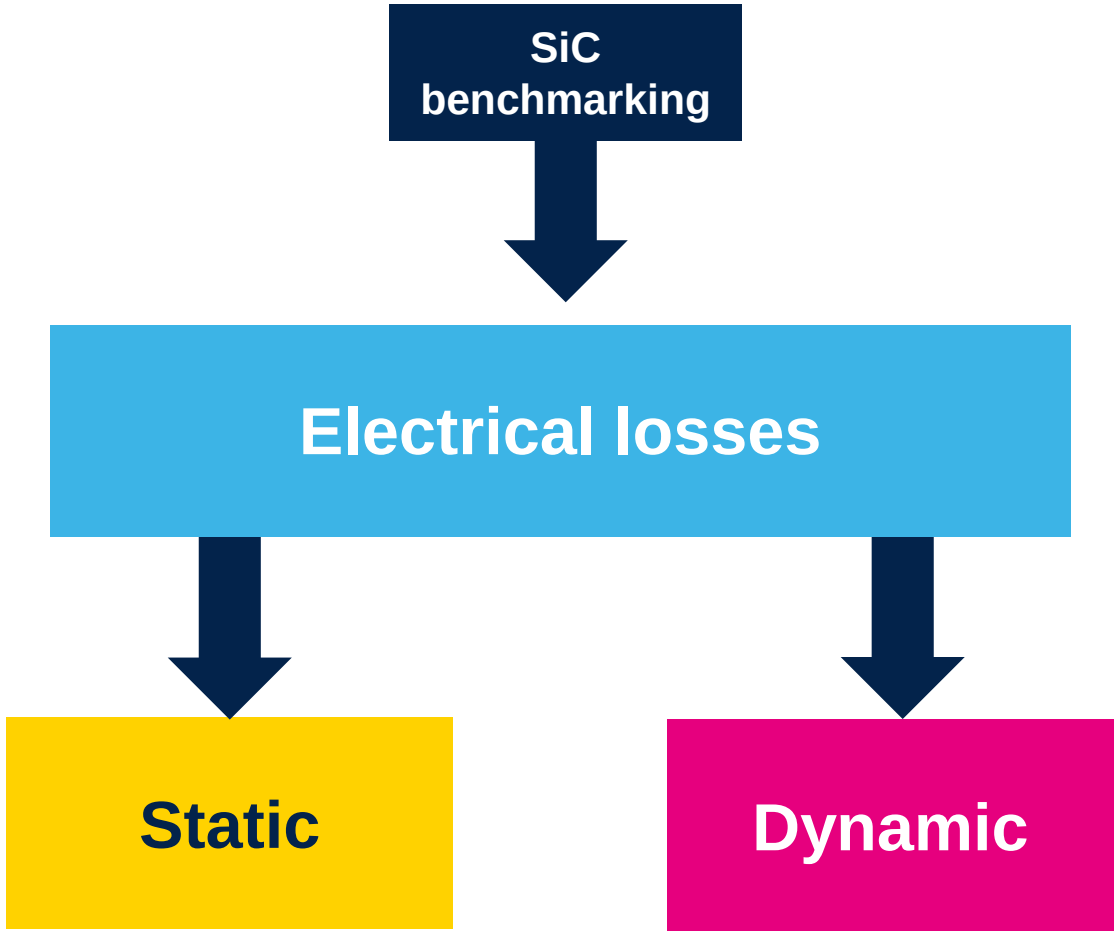
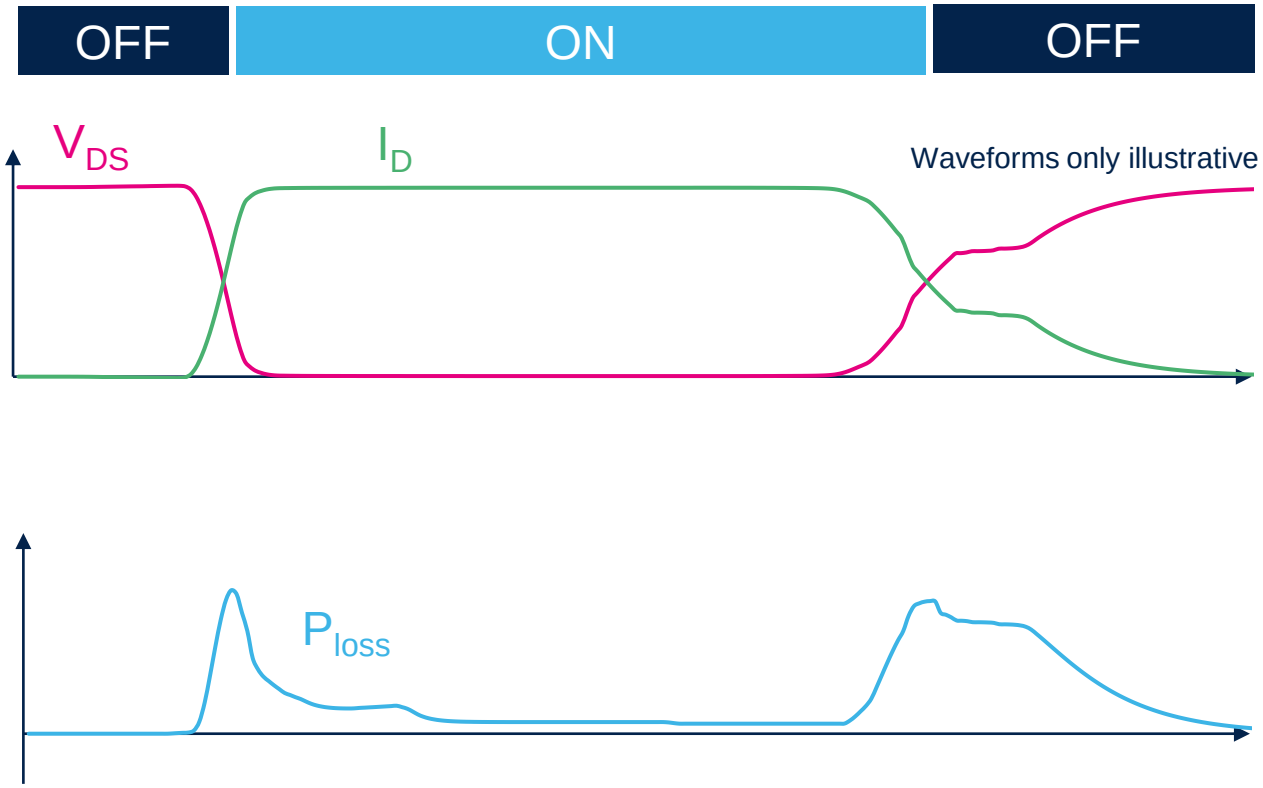
Benchmarking of the devices
electrical behavior





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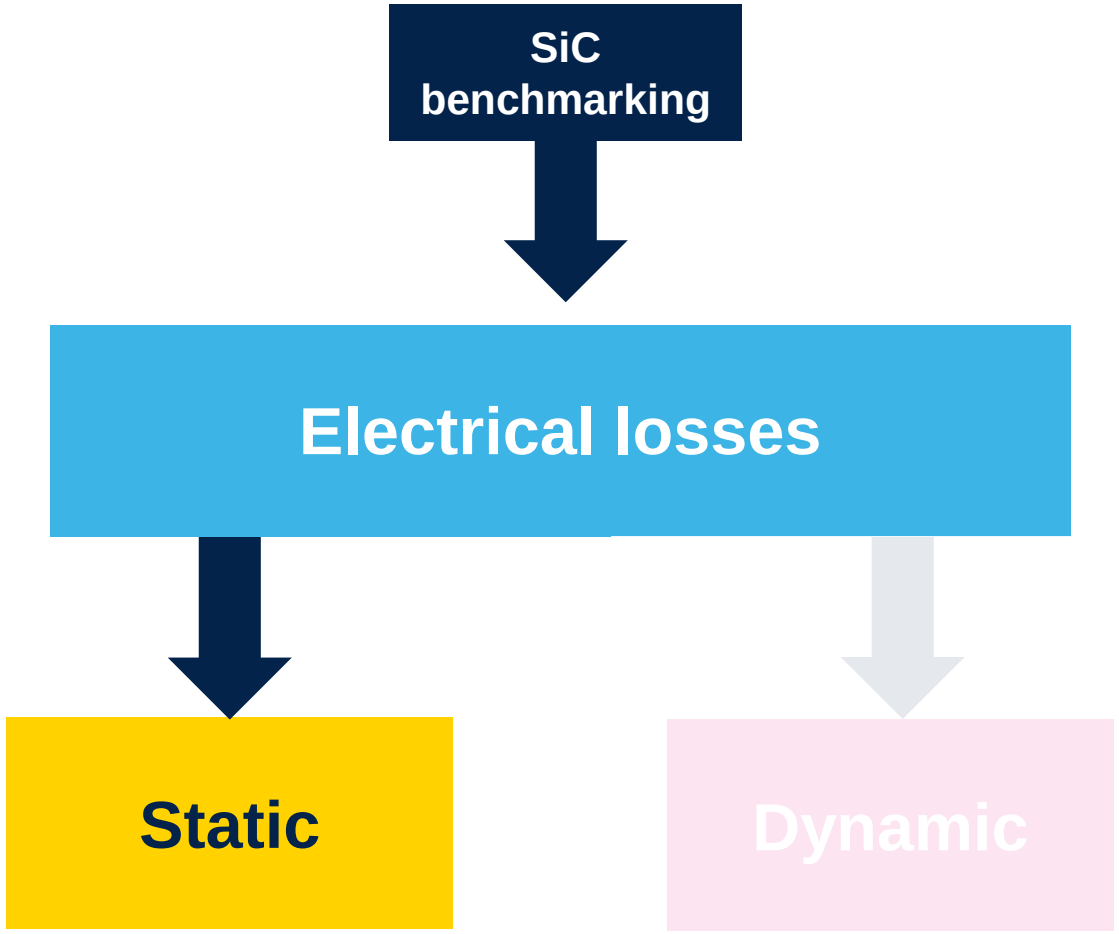
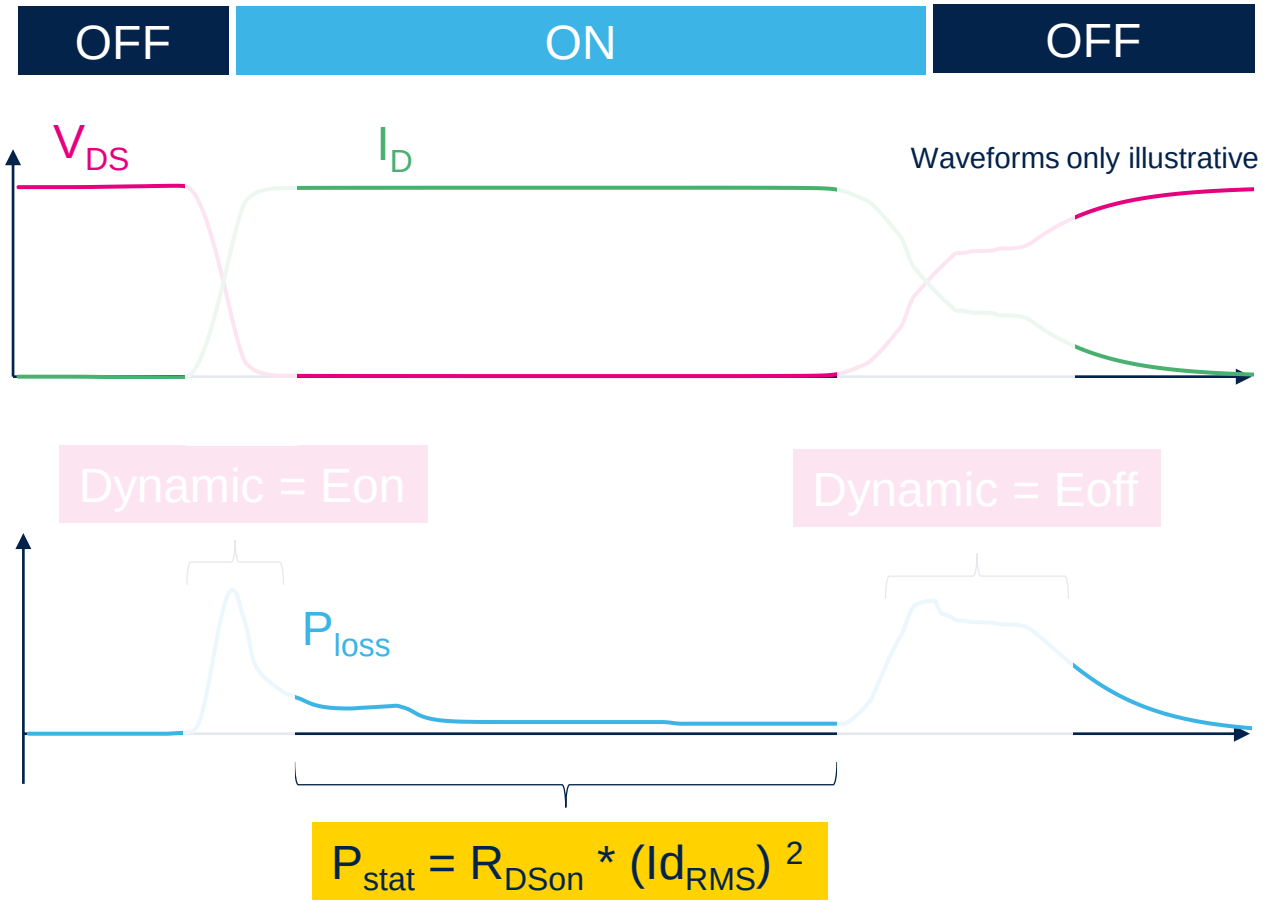
Benchmarking of the devices
electrical behavior





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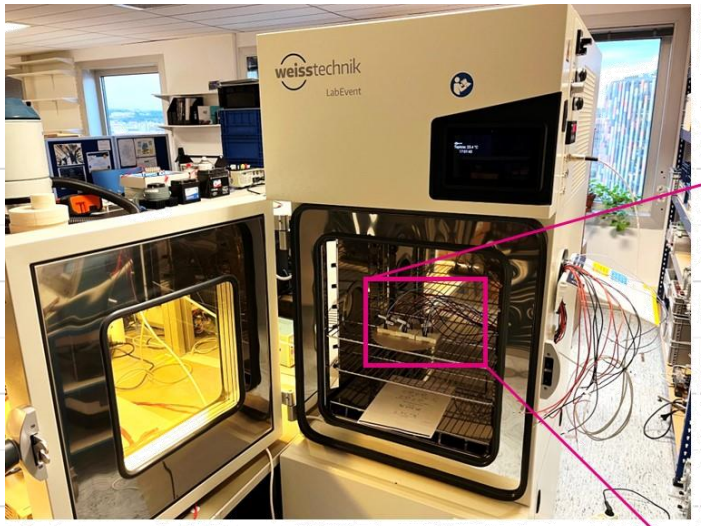
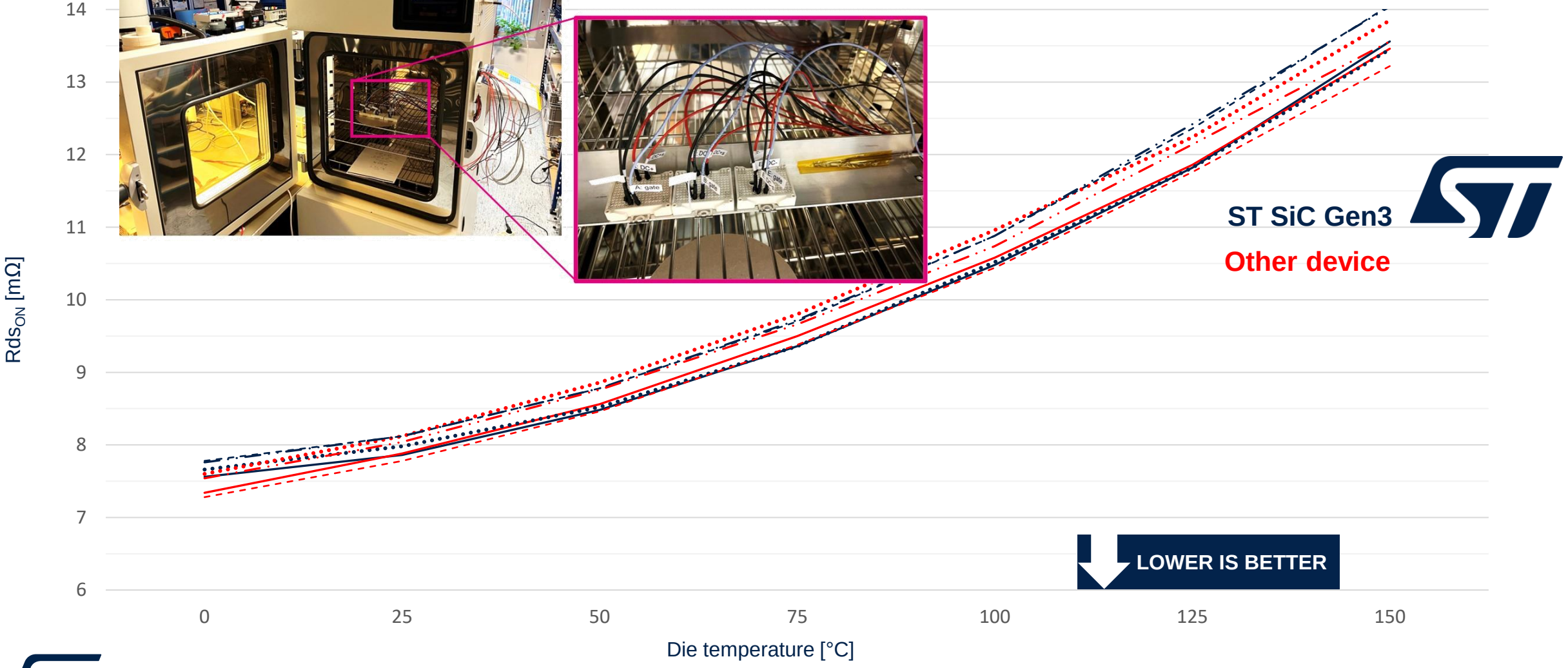
Static losses
Rdson benchmarked





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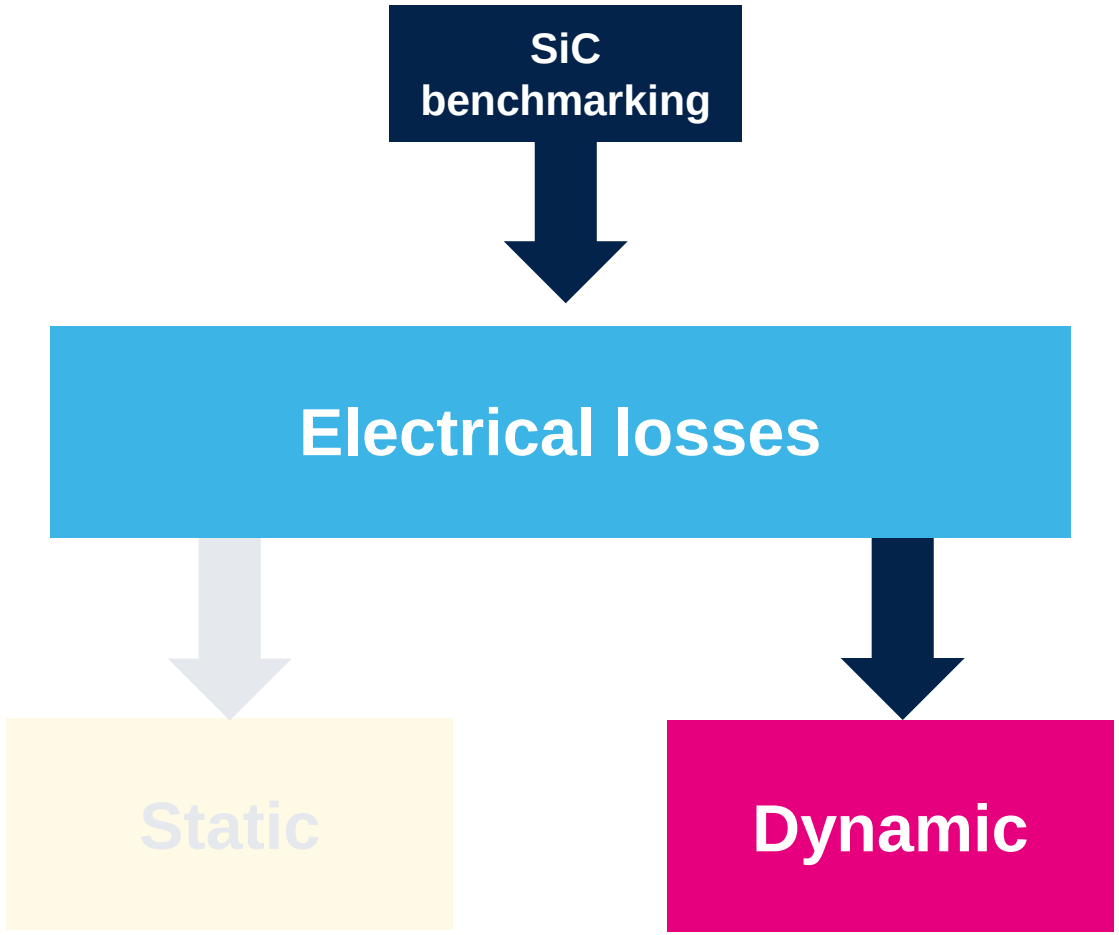
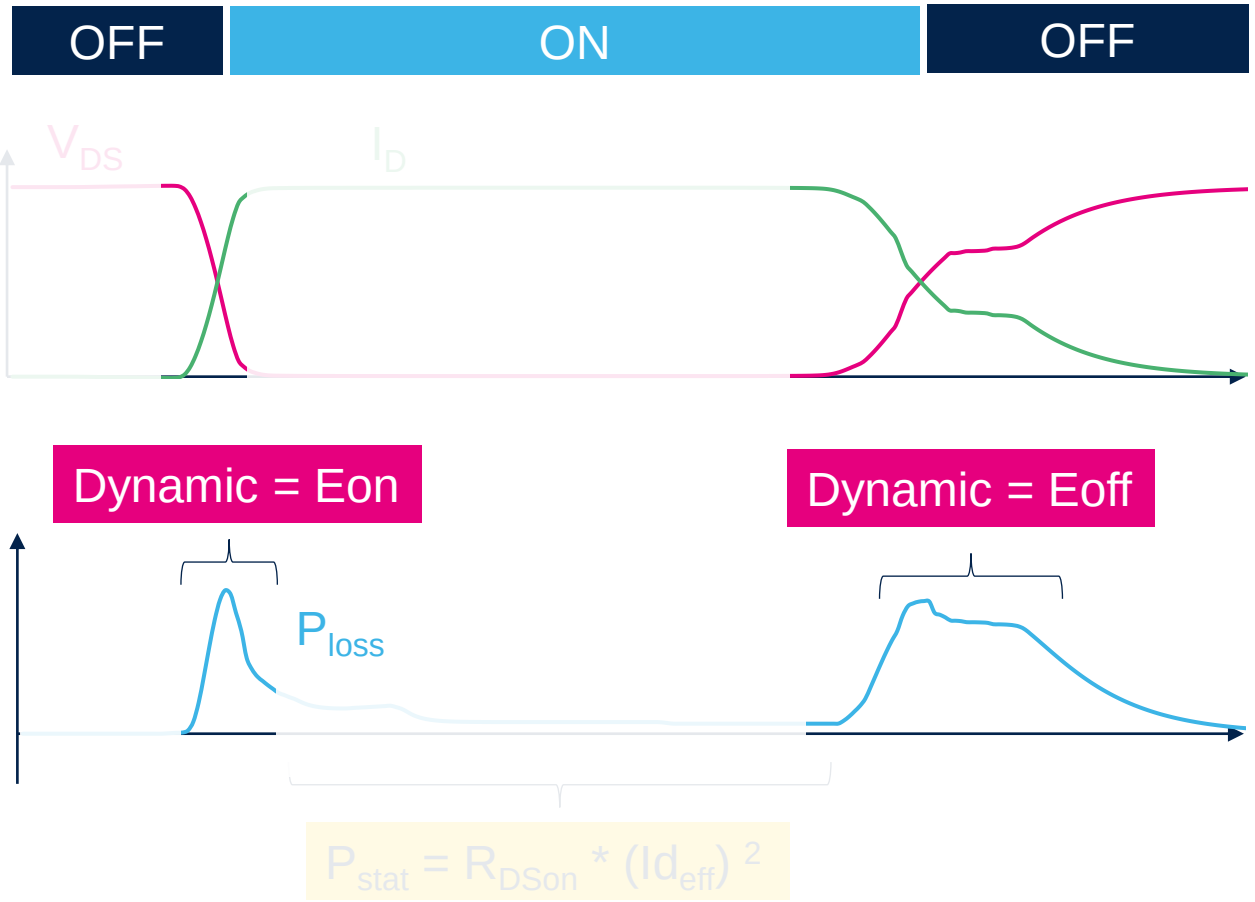
Benchmarking of the devices
electrical behavior





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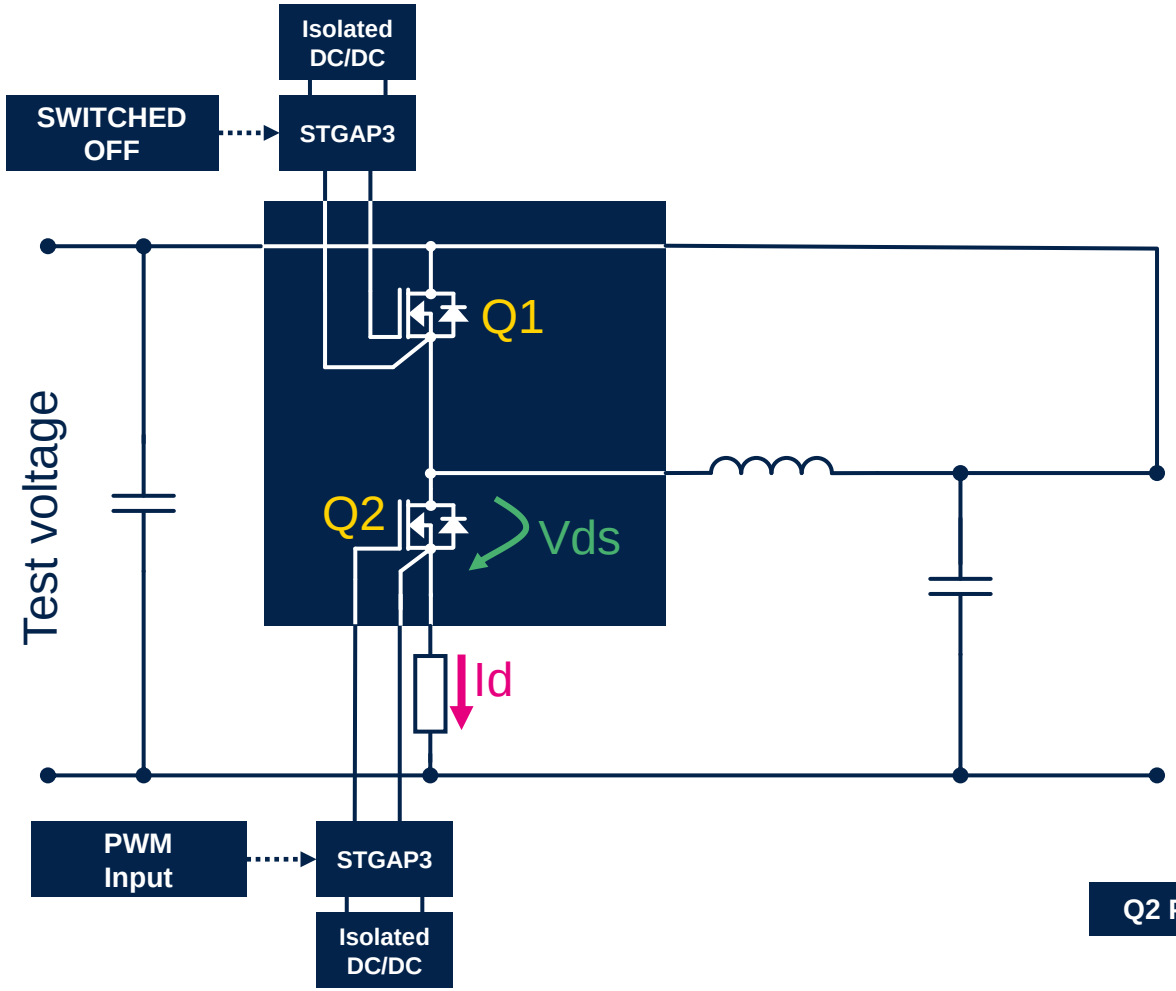
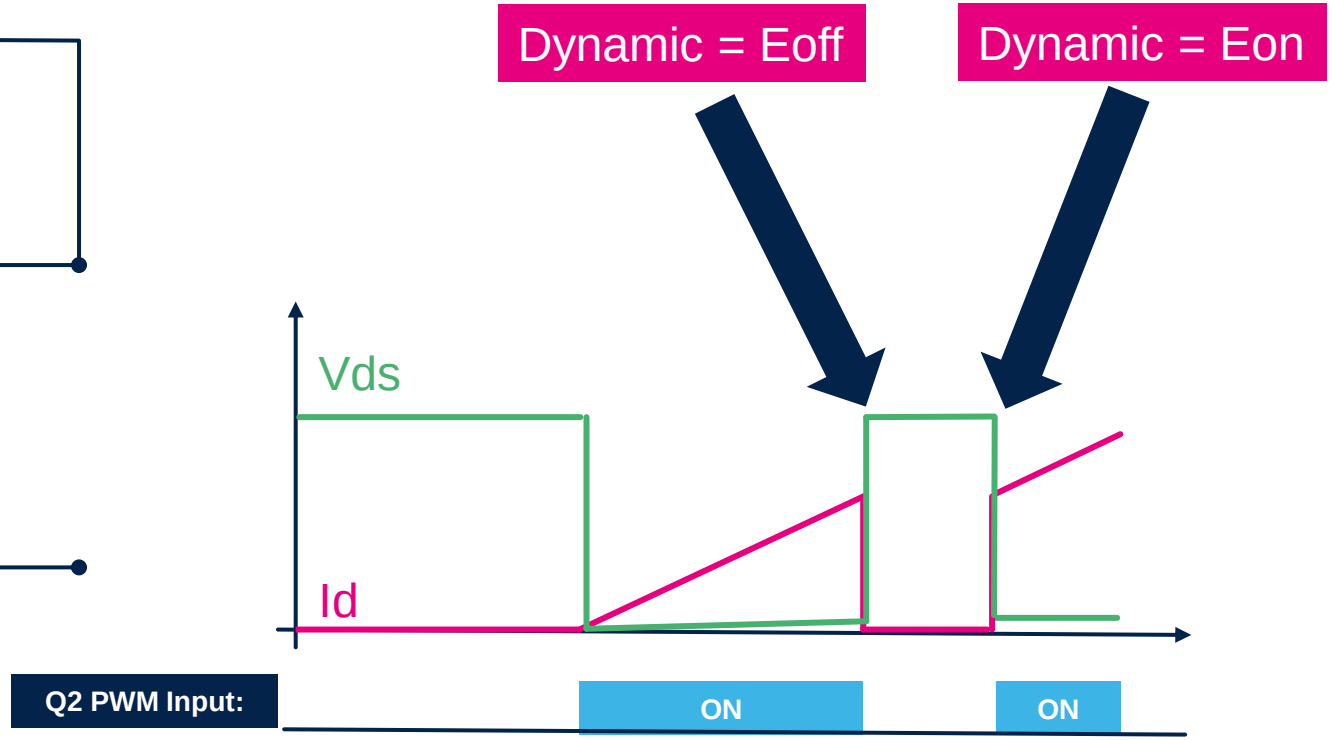
Double pulse test setup





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Hidden pits
Measurement tools

Voltage measurement:

- HV passive probe 100:1 - 250MHz
- HV passive probe 100:1 - 400MHz
- Differential Probe IsoVu 500V 1GHz
- Differential Probe BumbleBee 1000V 400MHz
- ….

Current measurement:

- Coaxial shunt 50mΩ
- Rogowski coil 20MHz
- ….

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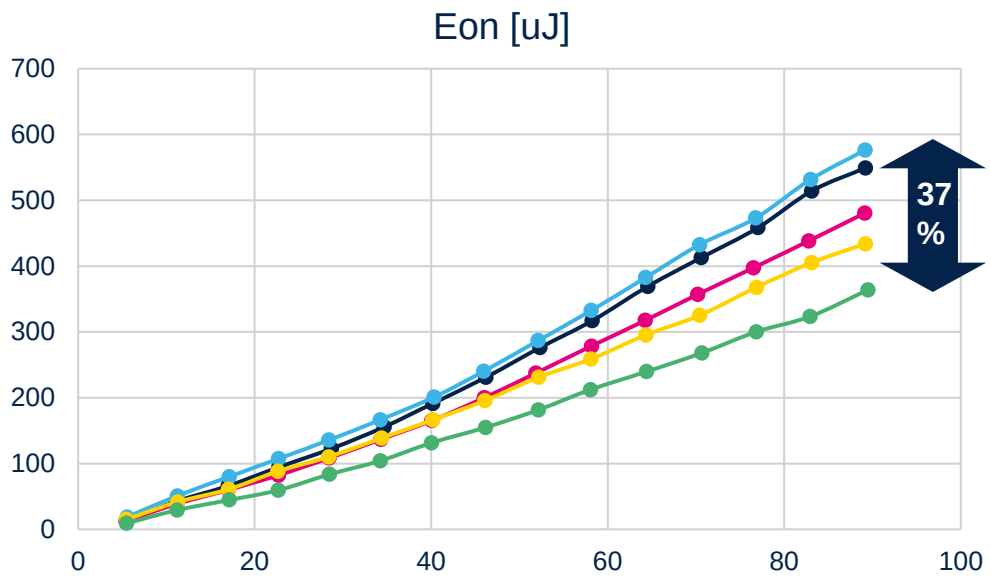
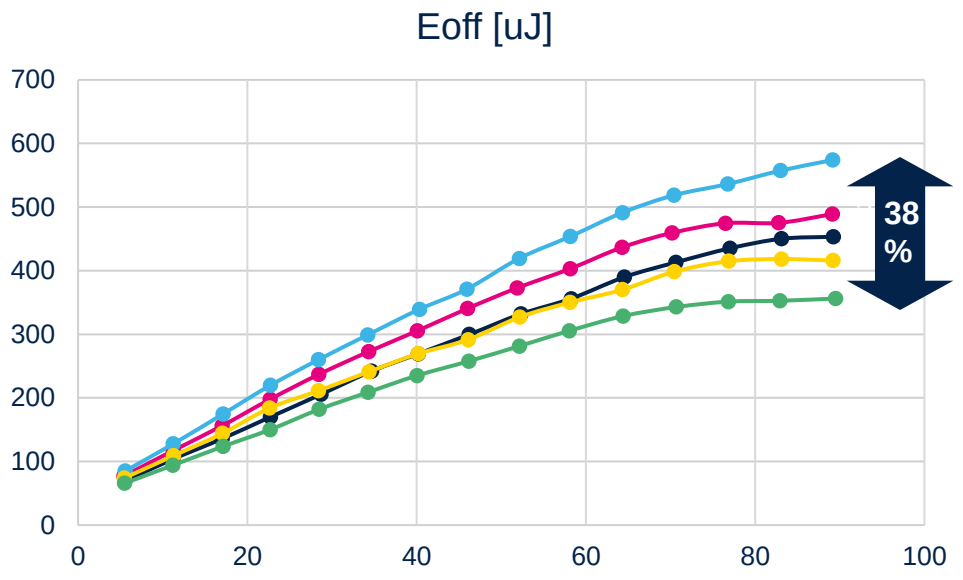
Hidden pits

Double pulse testing - Effect of different voltage probes





- HV passive probe 100:1 - 250MHz
- HV passive probe 100:1 - 400MHz
- IsoVu 500V 1GHz
- IsoVu 500V 1GHz with offset comp.
- IsoVu 500V 1GHz after new self calib.

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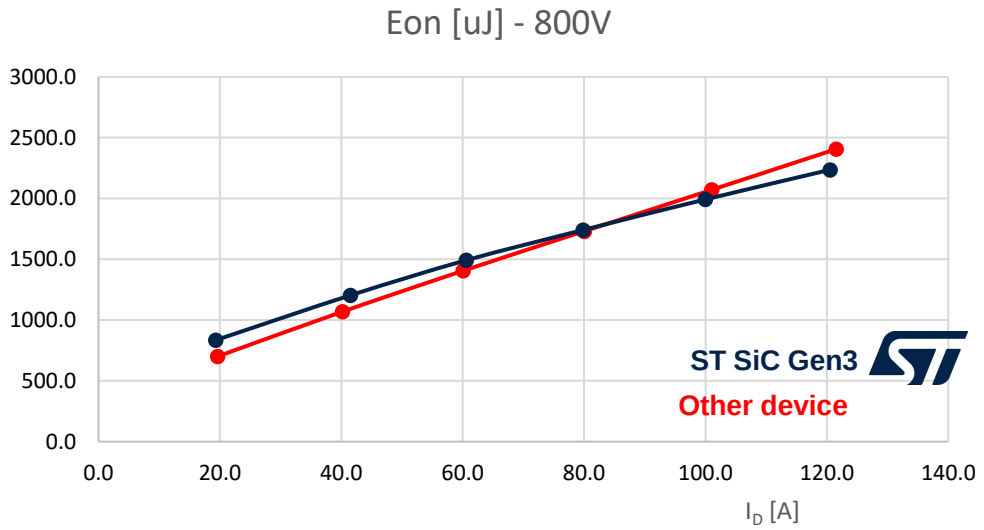
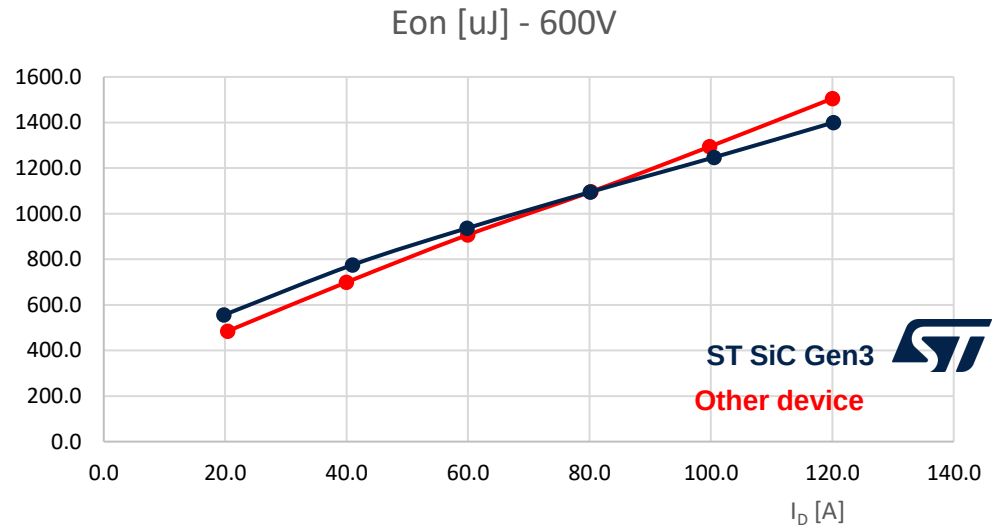
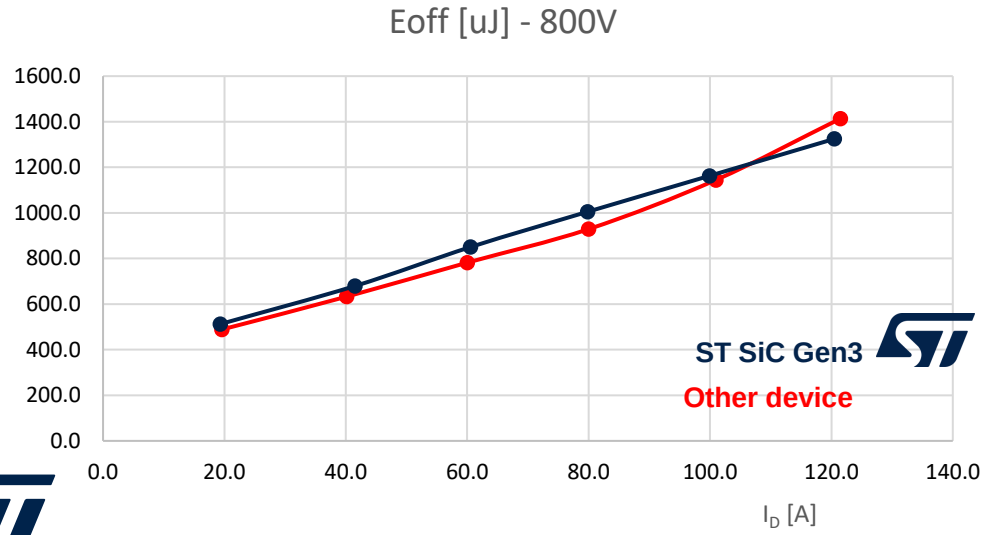
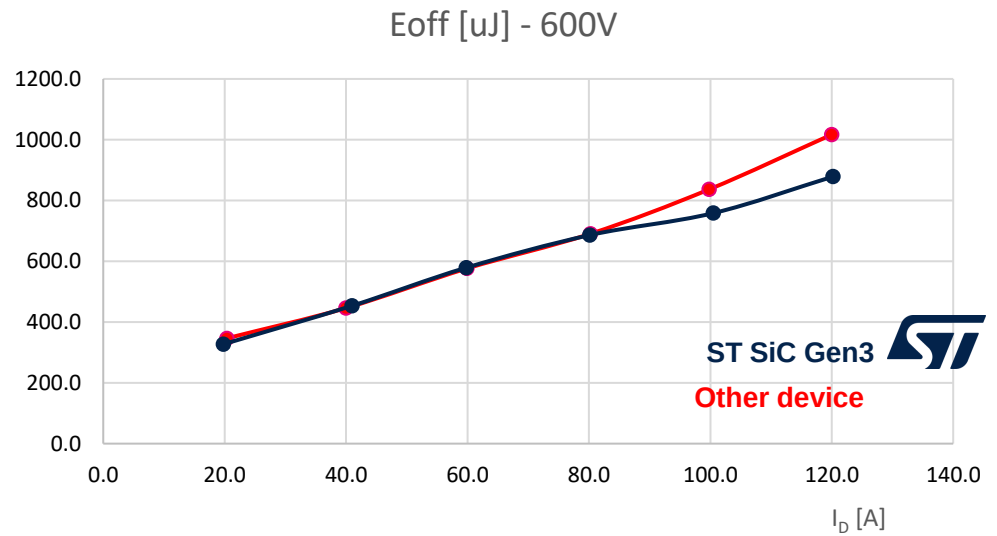
Dynamic Losses
Eon – Eoff Comparison/benchmark









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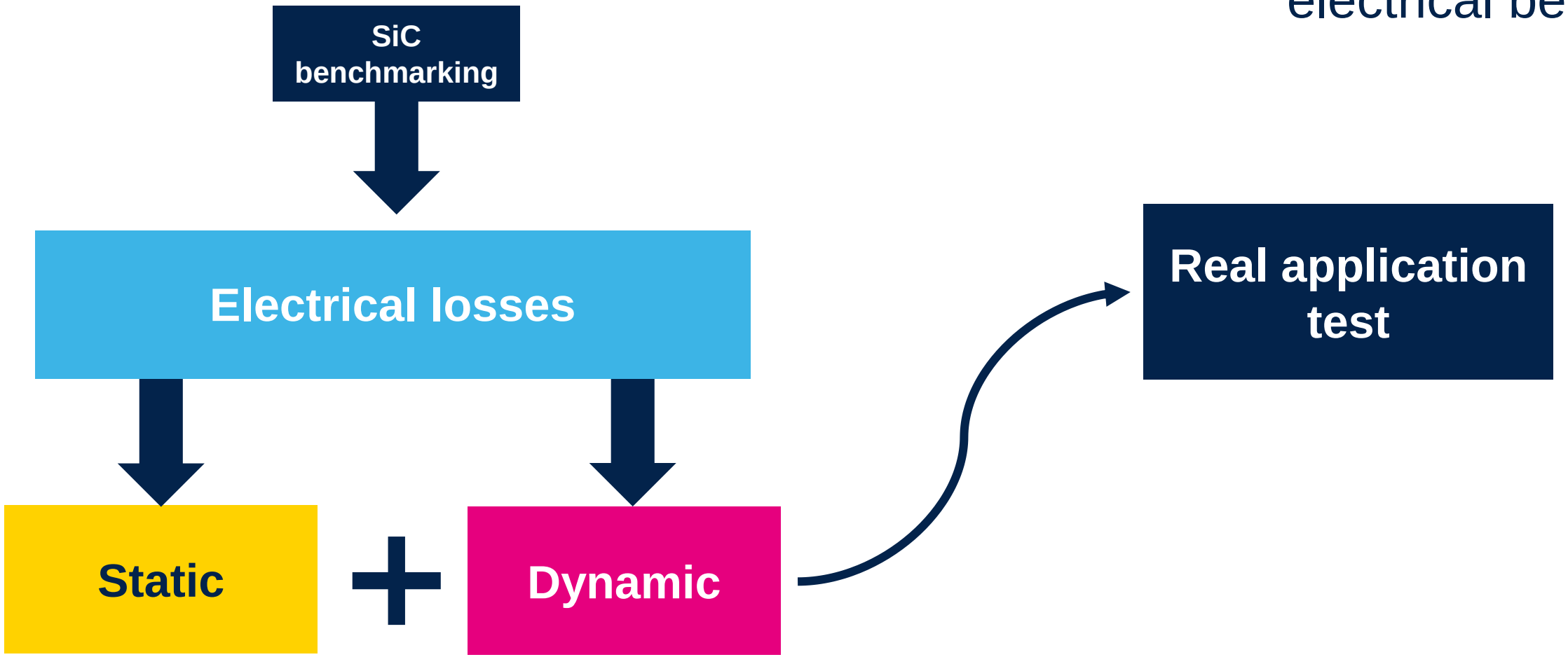
Full application tests

Benchmarking of the devices
electrical behavior



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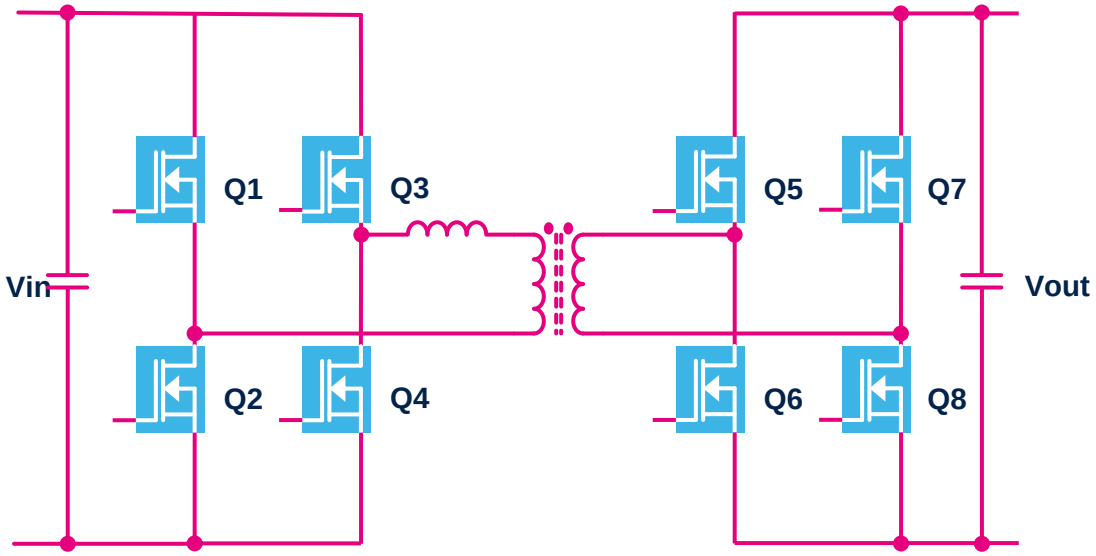
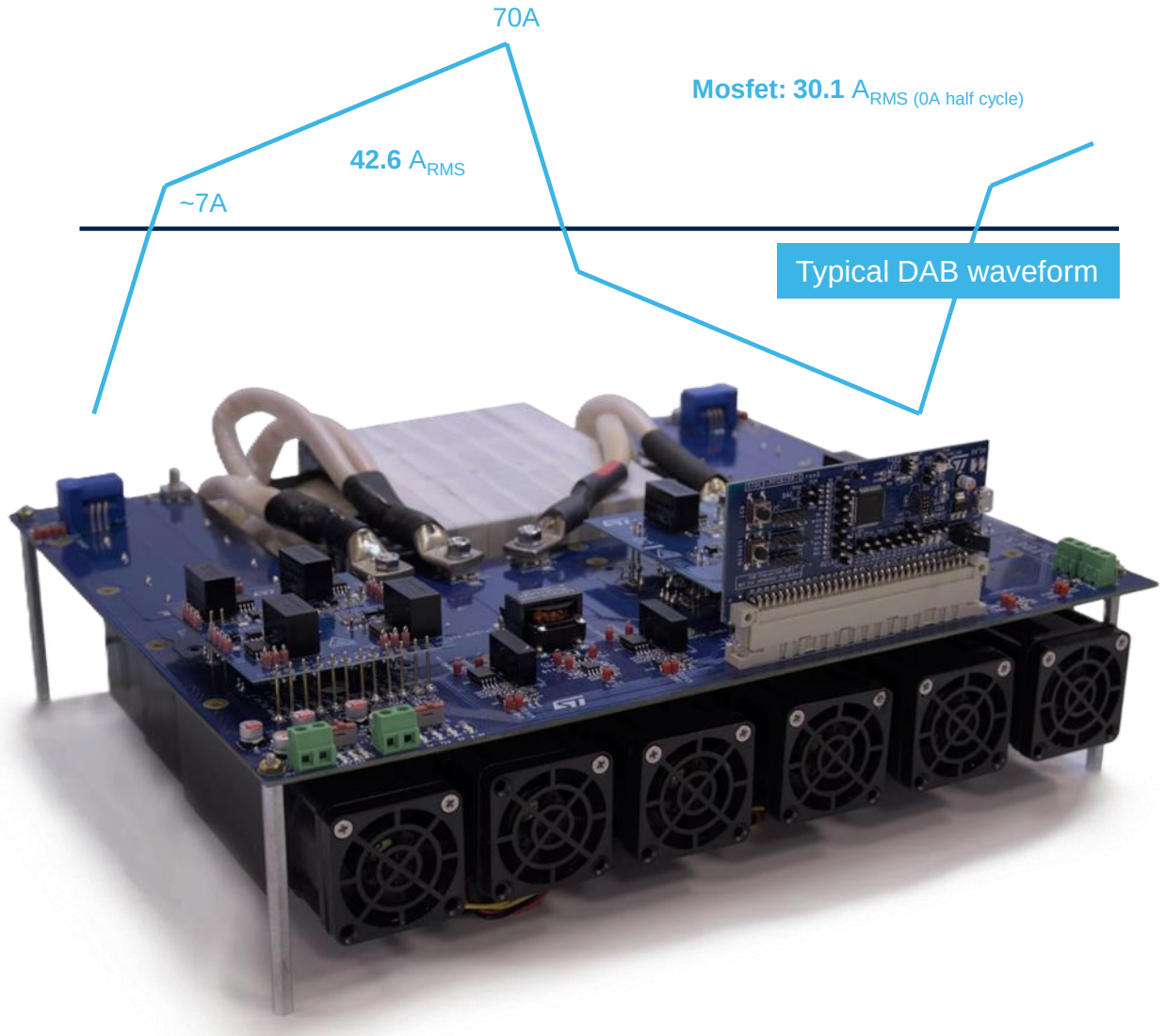
Dual Active Bridge Structure & waveform example

- DAB real block scheme



The best, but too complex



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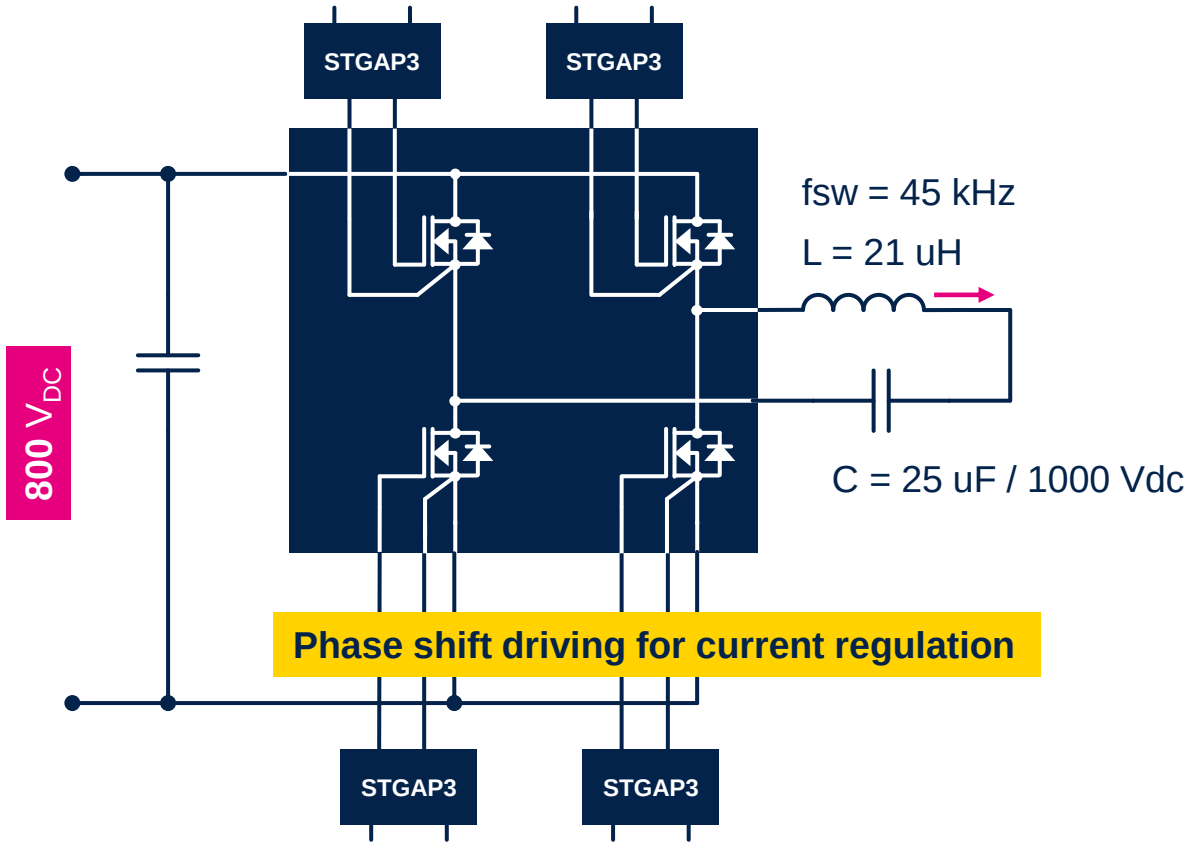
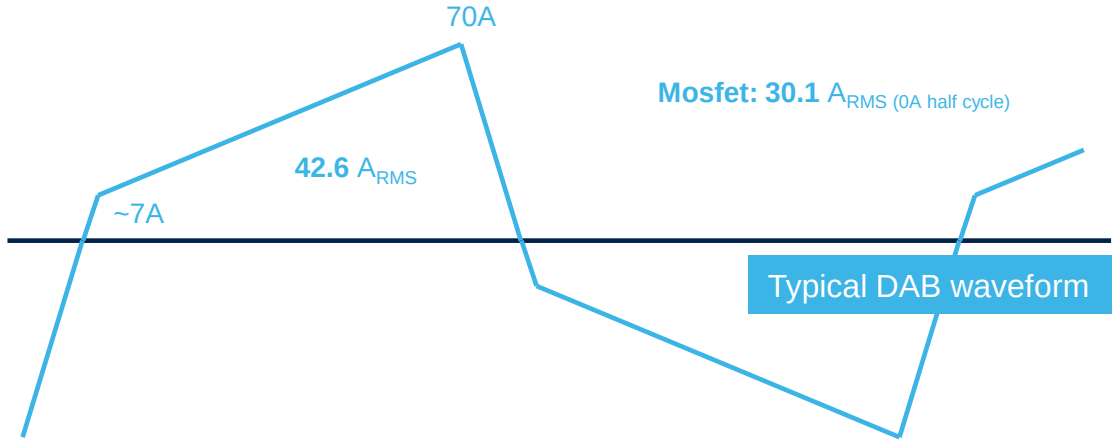
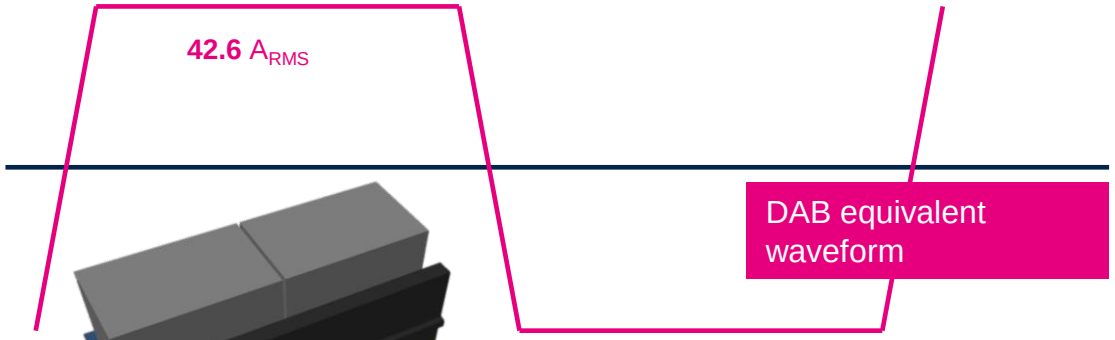
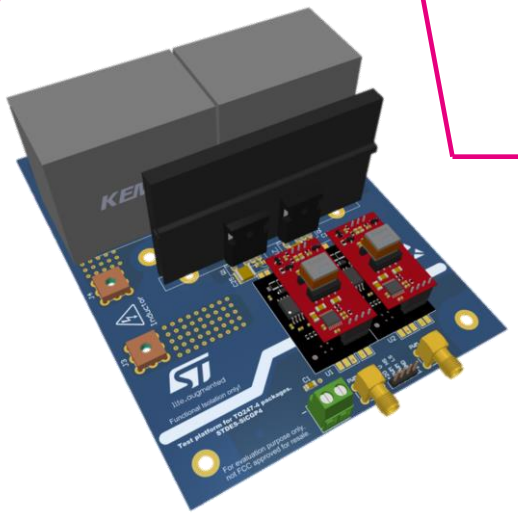
Simplified converter with same device's stress









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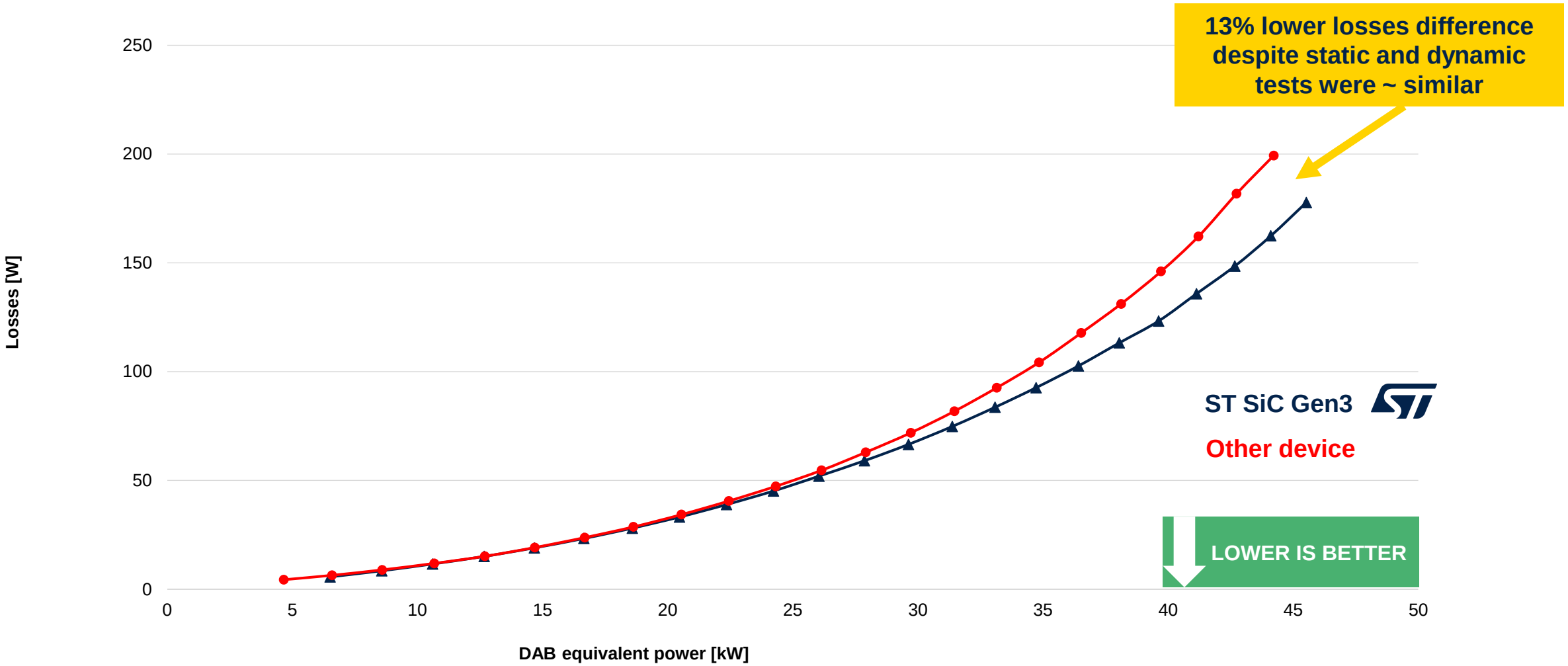
DAB testing method
Efficiency Result



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Bonus slide

Hidden pits

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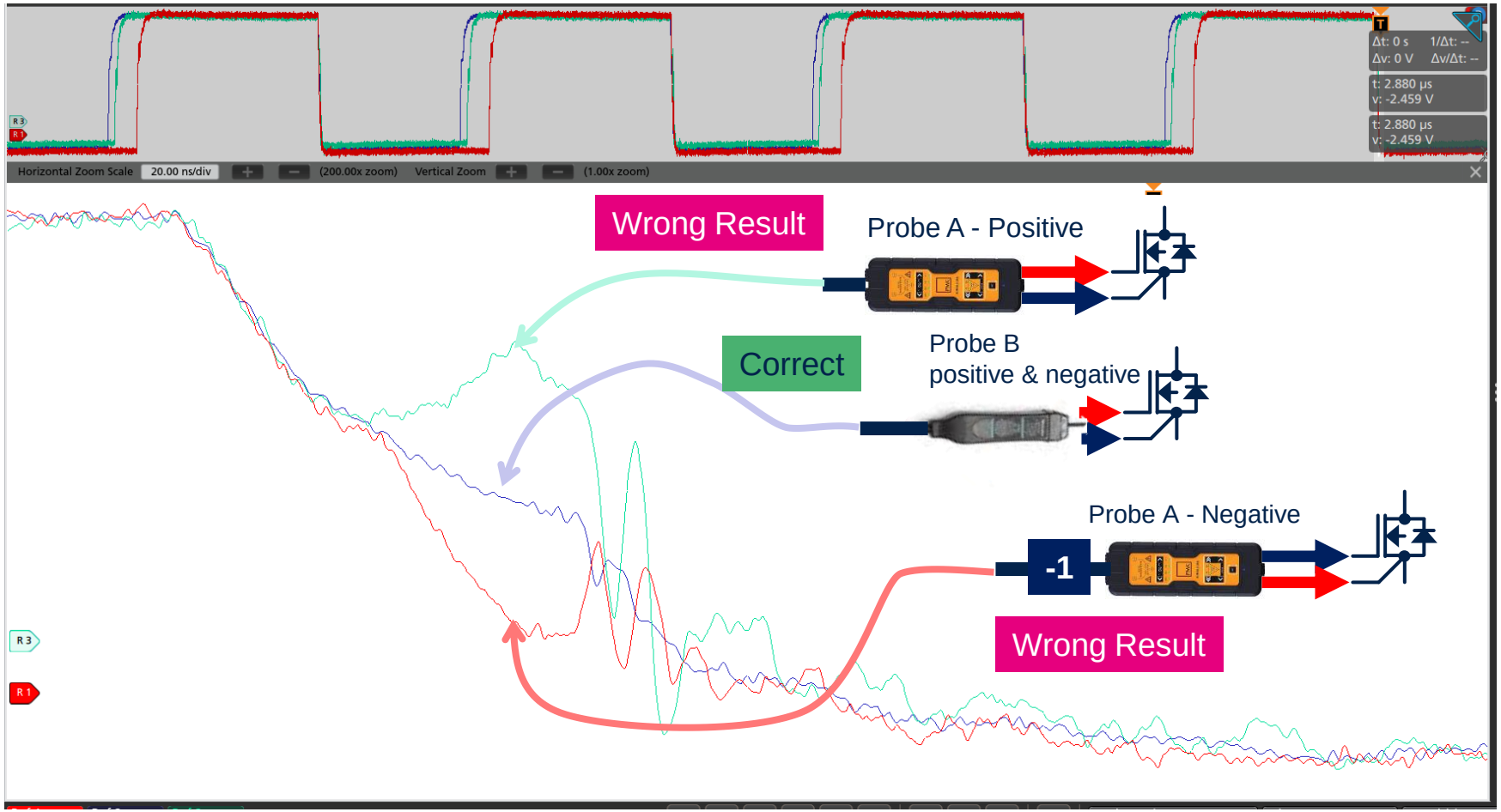
Hidden pits
Application Measurement example

- Positive oscillations seen by probe A
- **Application was running perfectly**

- Negative oscillations seen by probe A with switched connectors
- Oscillations not seen by probe type B



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