

A new IGBT family optimized for high switching speed

Holger Hüsken¹⁾, Davide Chiola²⁾, Thomas Kimmer²⁾

¹⁾ Infineon Technologies, Am Campeon 1-12, 85579 Neubiberg, Germany

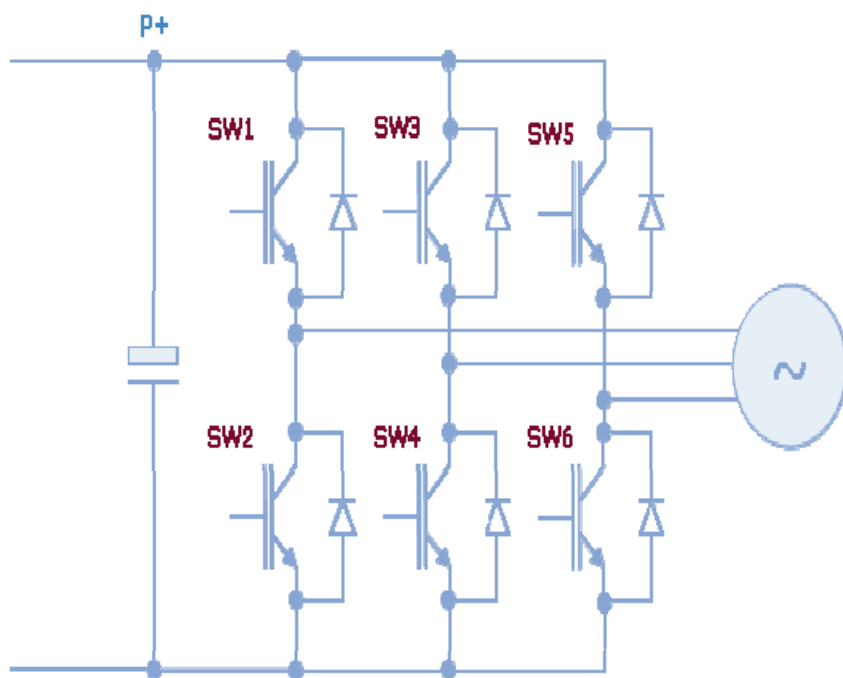
²⁾ Infineon Technologies Austria, Siemensstr. 2, 9500 Villach, Austria



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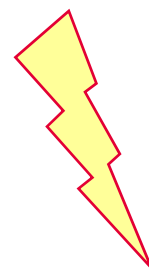
- Motivation
- Technological background: IGBT
- Technological background: diode
- Product spectrum
- Application study: inverter
- Application study: boost stage
- Conclusion

Motivation



Drive:

- Frequency range 8-20kHz
- ‚motoring‘ and ‚braking‘ mode:
Power factor ranging from 0.8 to -0.8
- High ruggedness (SC, PC, ...)



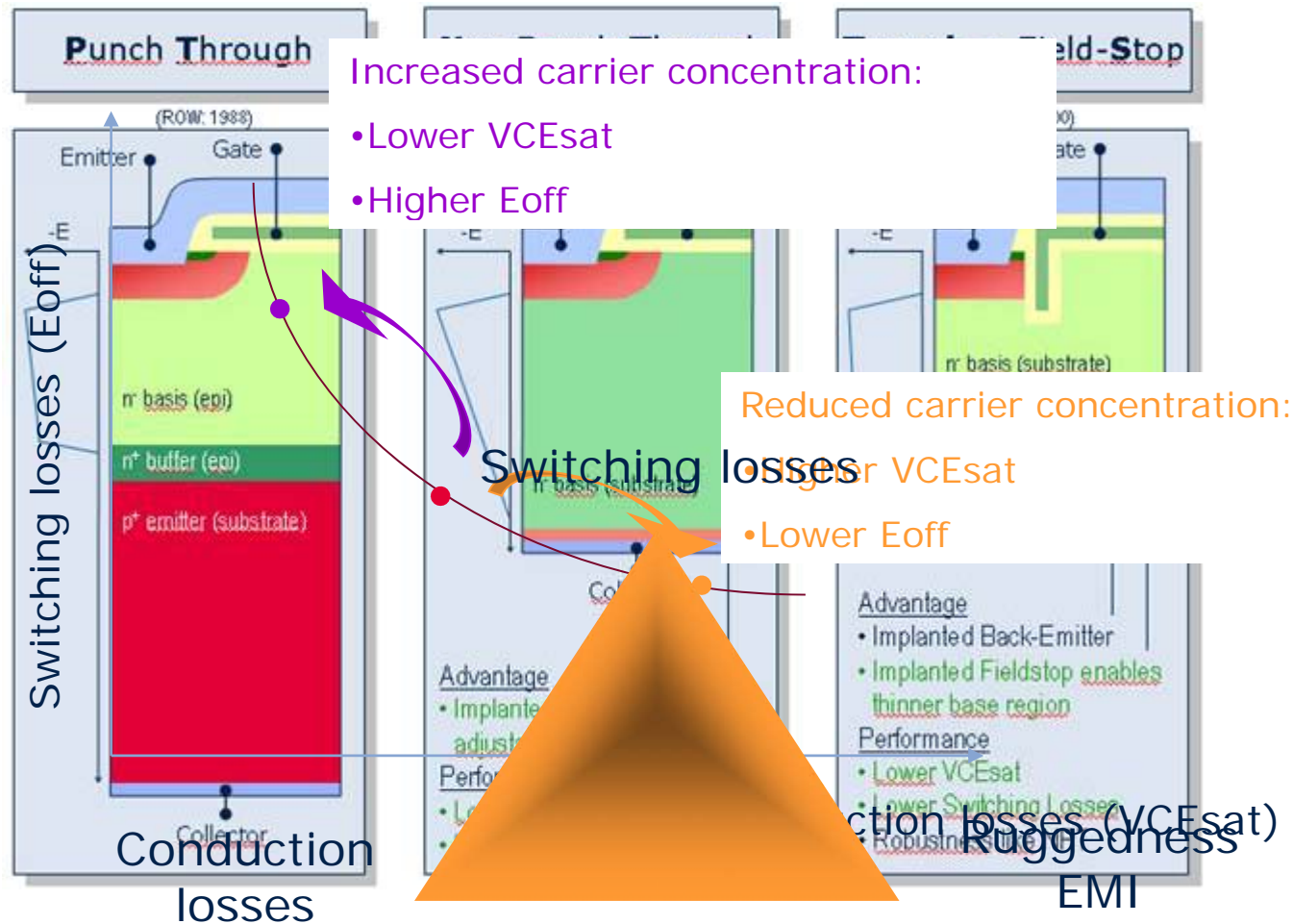
Diverging requirements ->
different product optimisations

UPS & solar:

- Frequency range 16kHz and above
- Power factor close to 1
- Low EMC, high efficiency

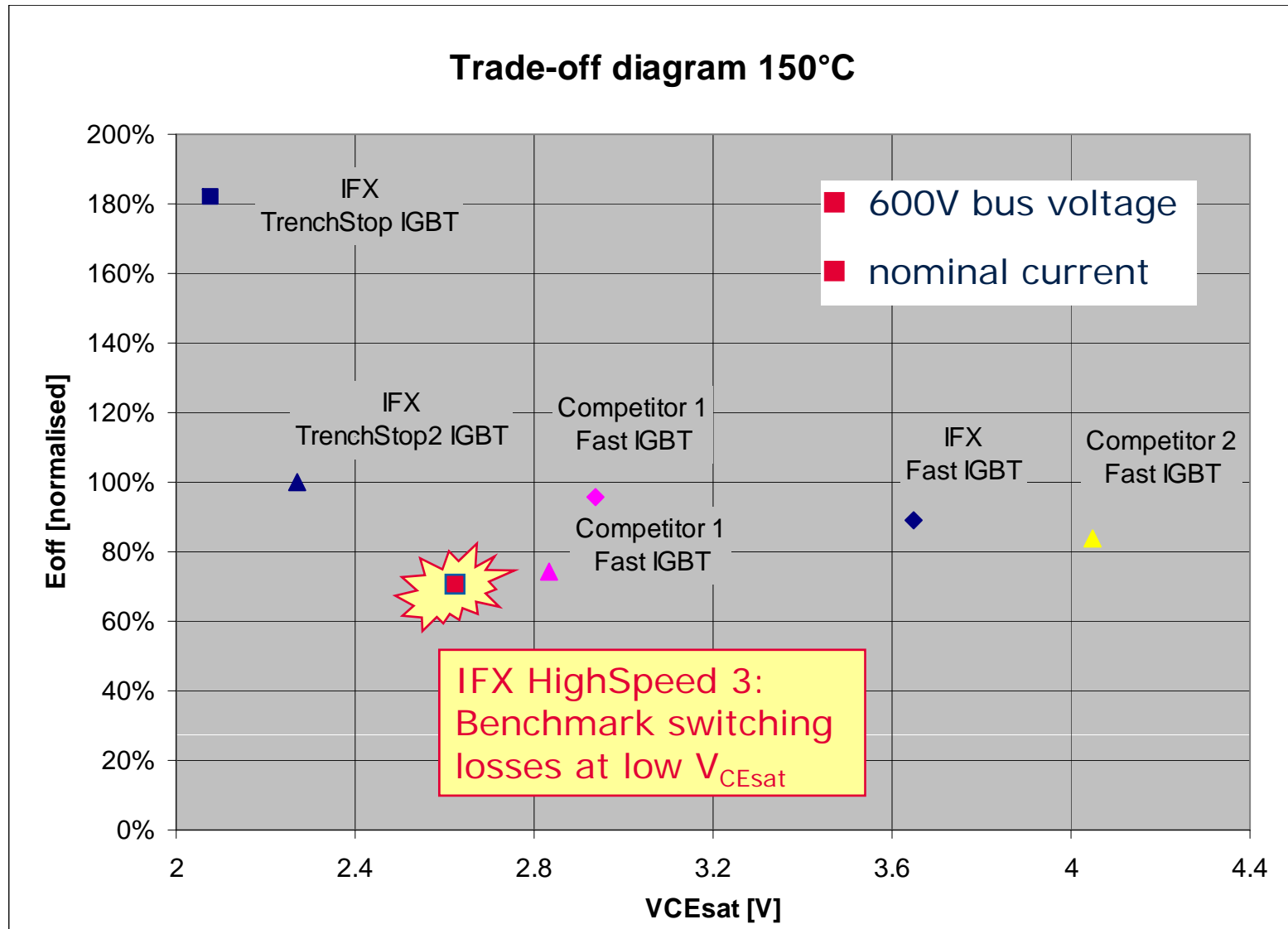
Technological background IGBT: Tuning performance

- The key to IGBT performance is the carrier profile engineering



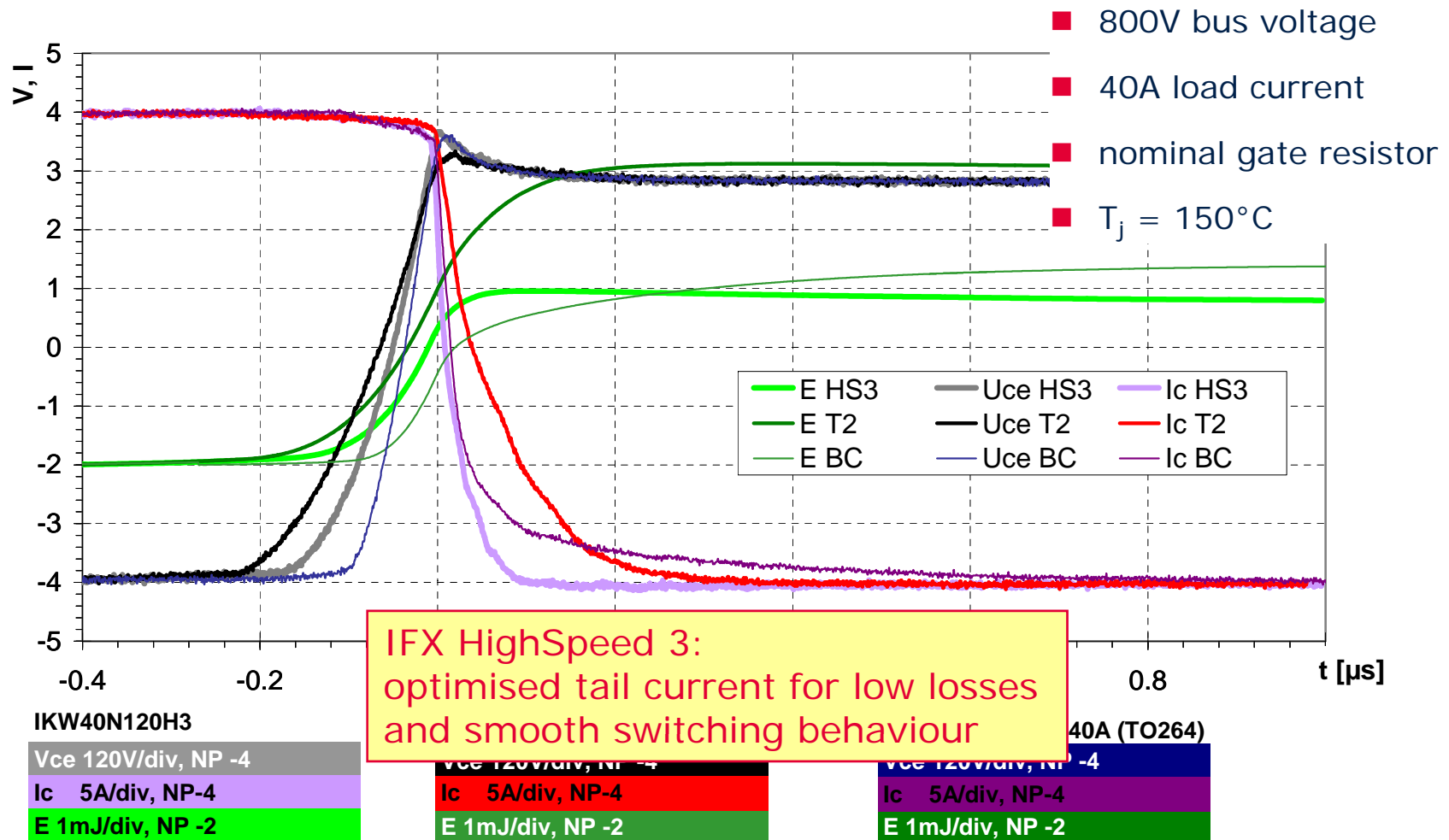
Technological background: IGBT

Trade-off curve

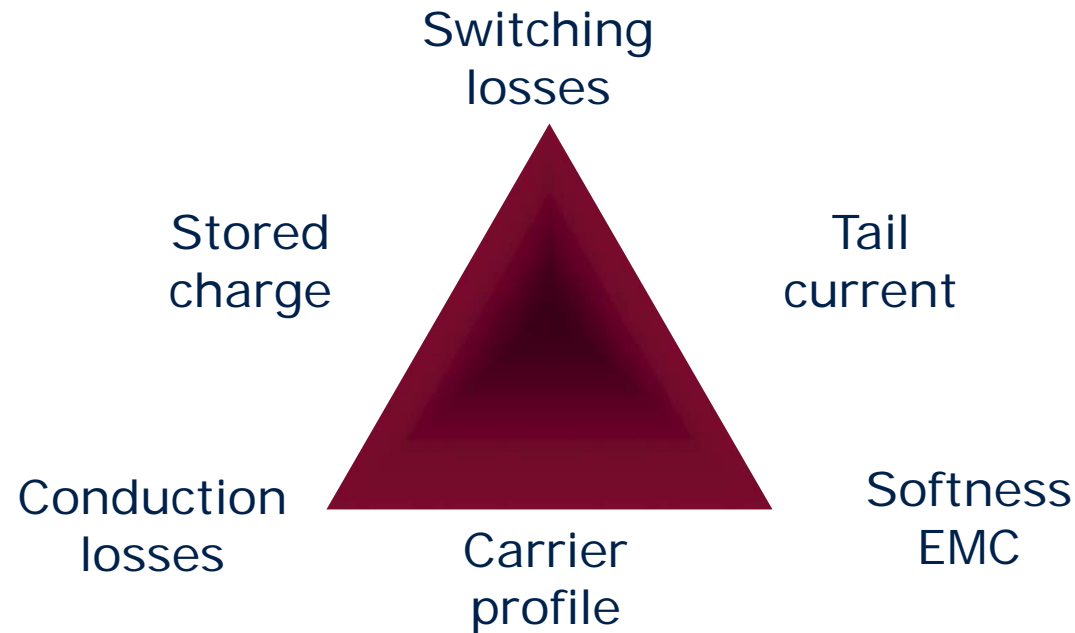


Technology background: IGBT

Switching behaviour



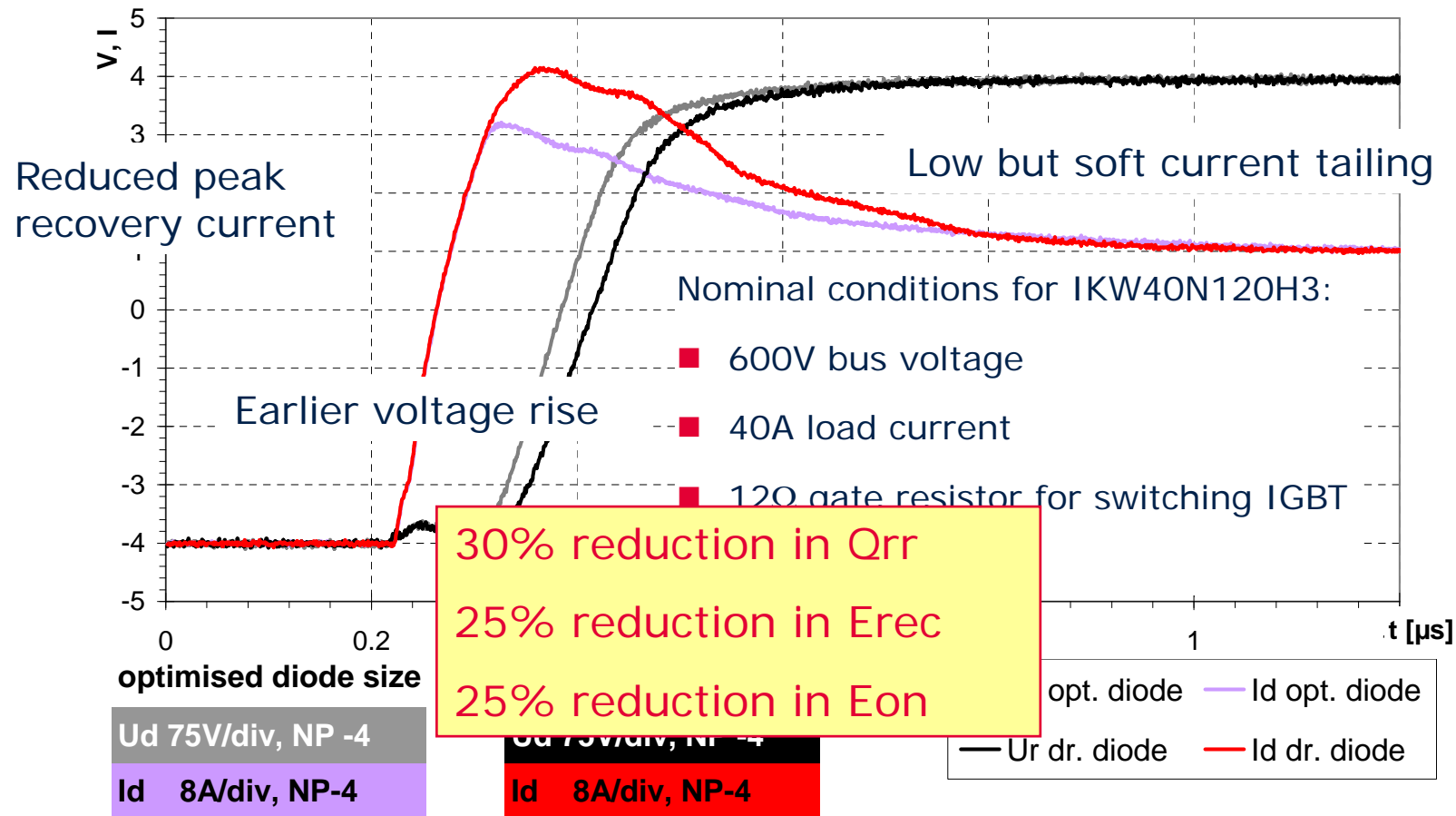
Technology background: Diode Tuning performance



- 4th generation of Emitter controlled diode technology features
 - optimised chip thickness -> reduced losses
 - optimised carrier lifetime control-> reduced switching losses
 - novel and unique fieldstop -> improved softness

Technology background: Diode

Effect of optimised diode size



Technology background: Diode

Ruggedness of optimised diode size

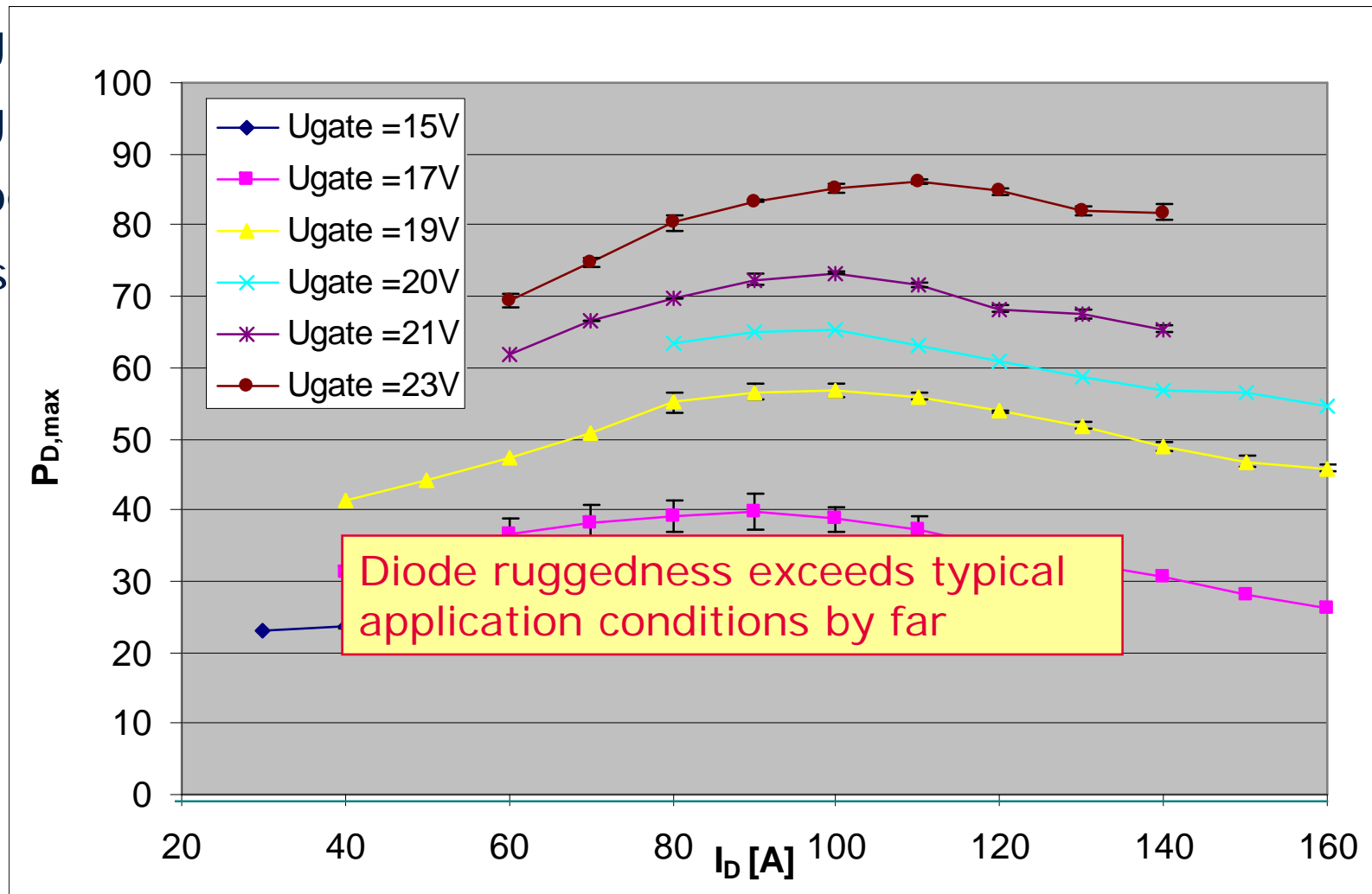


Testing for the limits of the diode:

■ Hig
■ Hig
■ Dio
■ Fas

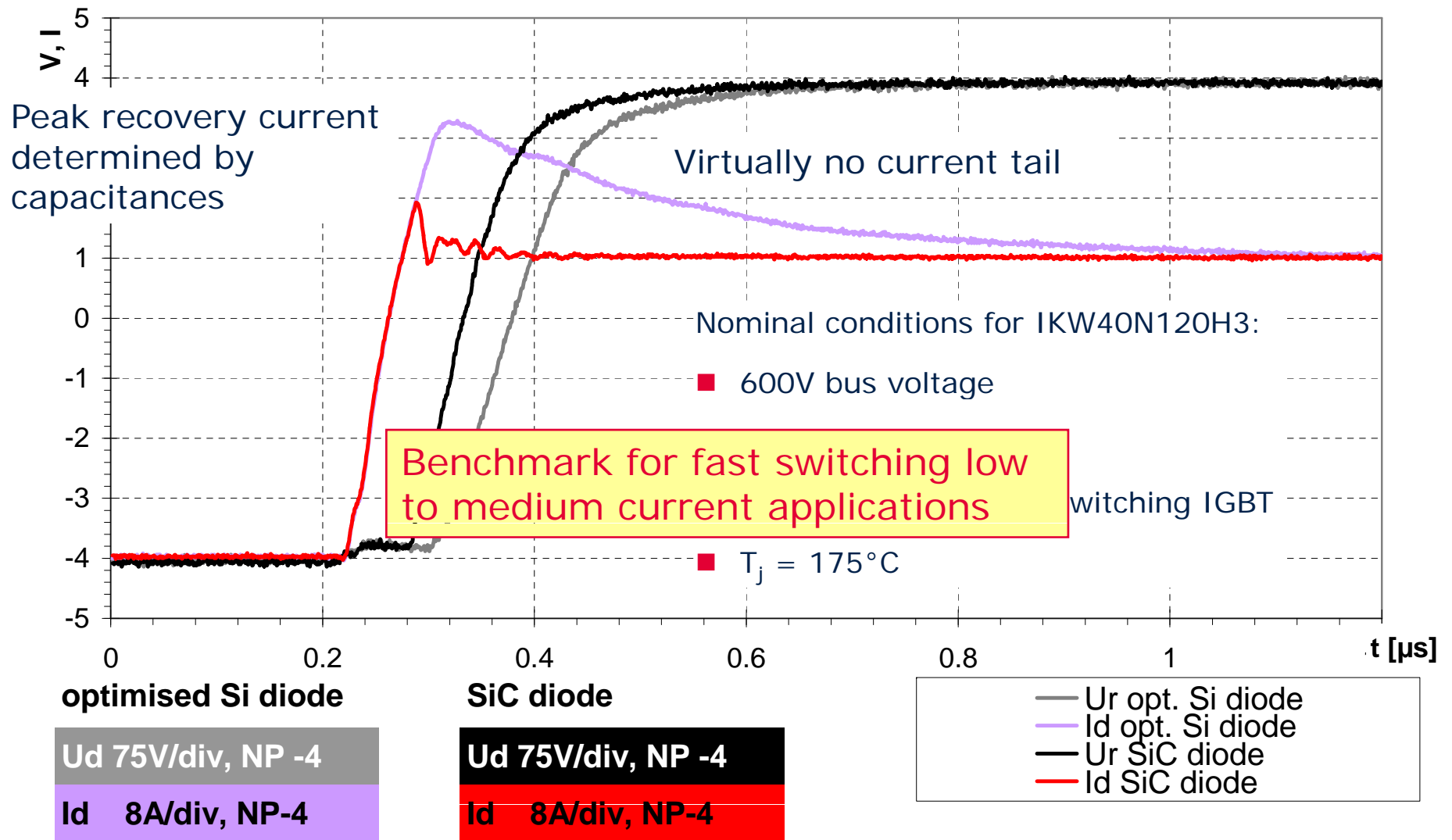


Diode

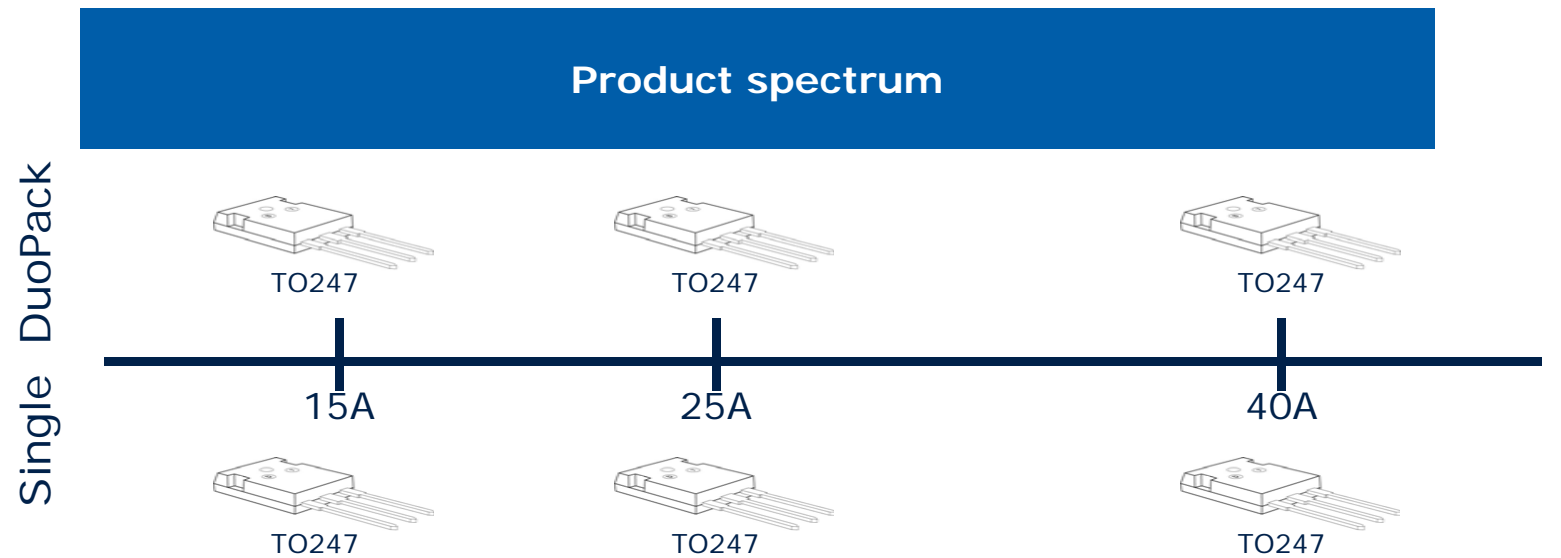


Technological background: Diode

Benefit of SiC diode



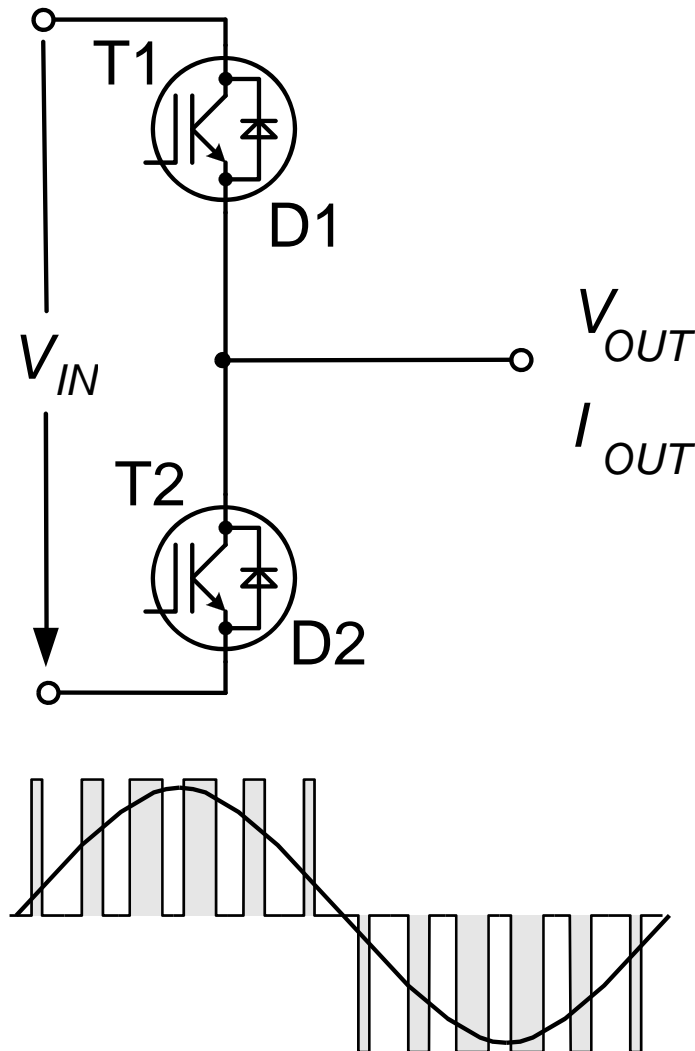
Product Spectrum



	V_{CEsat}	V_F	E_{off}	E_{on}
25°C	2.05V	2.4V	30μJ/A	80μJ/A
175°C	2.7V	2.6V	65μJ/A	110μJ/A

Values taken from IKW40N120H3 datasheet

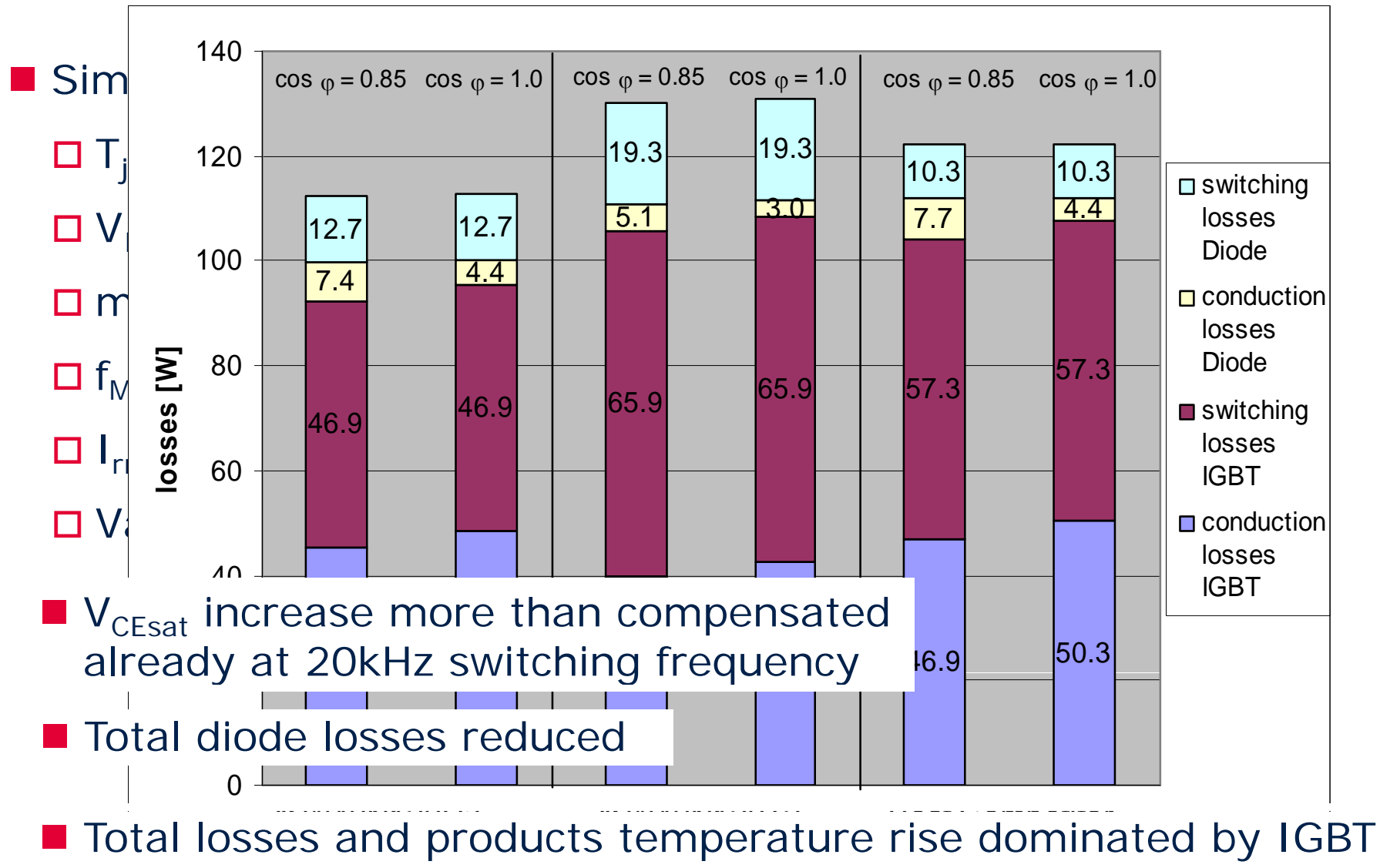
Application study: Inverter Topology and simulation inputs



- Half-bridge as building block of many applications generating output sine wave from DC bus voltage
- Easy loss calculations as a function of
 - V_{IN}
 - V_{OUT} / modulation factor m
 - $f_{\text{Modulation}} (\gg f_{\text{out}})$
 - $I_{\text{rms,out}}$
 - Power Factor ($\cos \varphi$)

For a detailed description see e.g. "Dimensioning program IPOSIM for loss and thermal calculation of Infineon IGBT modules", Infineon Technologies, 2006 and references therein

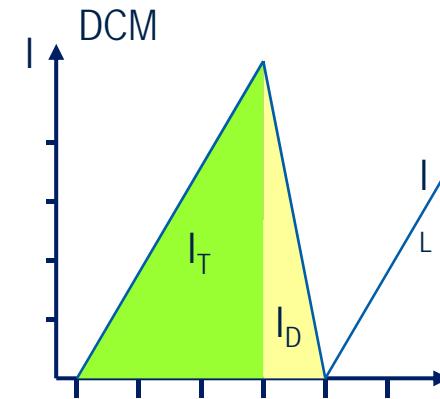
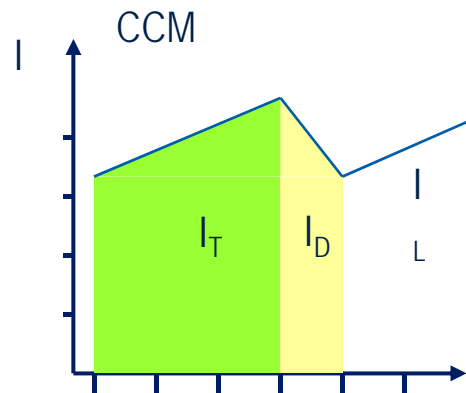
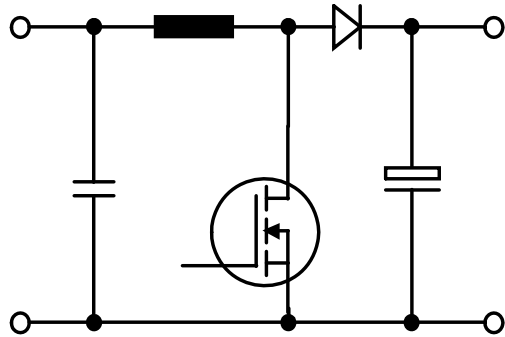
Application study: Inverter Loss calculation



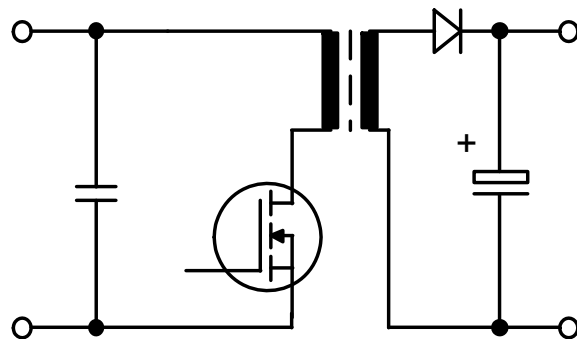
Application study: Boost stage

Topology and simulation inputs

Boost Converter



Flyback Converter



■ Easy loss calculations as a function of

□ V_{OUT}

□ Switch duty cycle d

□ $f_{Modulation}$

□ I_{peak}

Application study: Boost stage

Loss calculation CCM



■ Loss simulation input:

□ $T_{\text{junc}} = 150^{\circ}\text{C}$

□ $V_{\text{Off}} = 800\text{V}$

□ duty cycle

□ $I_{\text{peak}} = 12\text{A}$

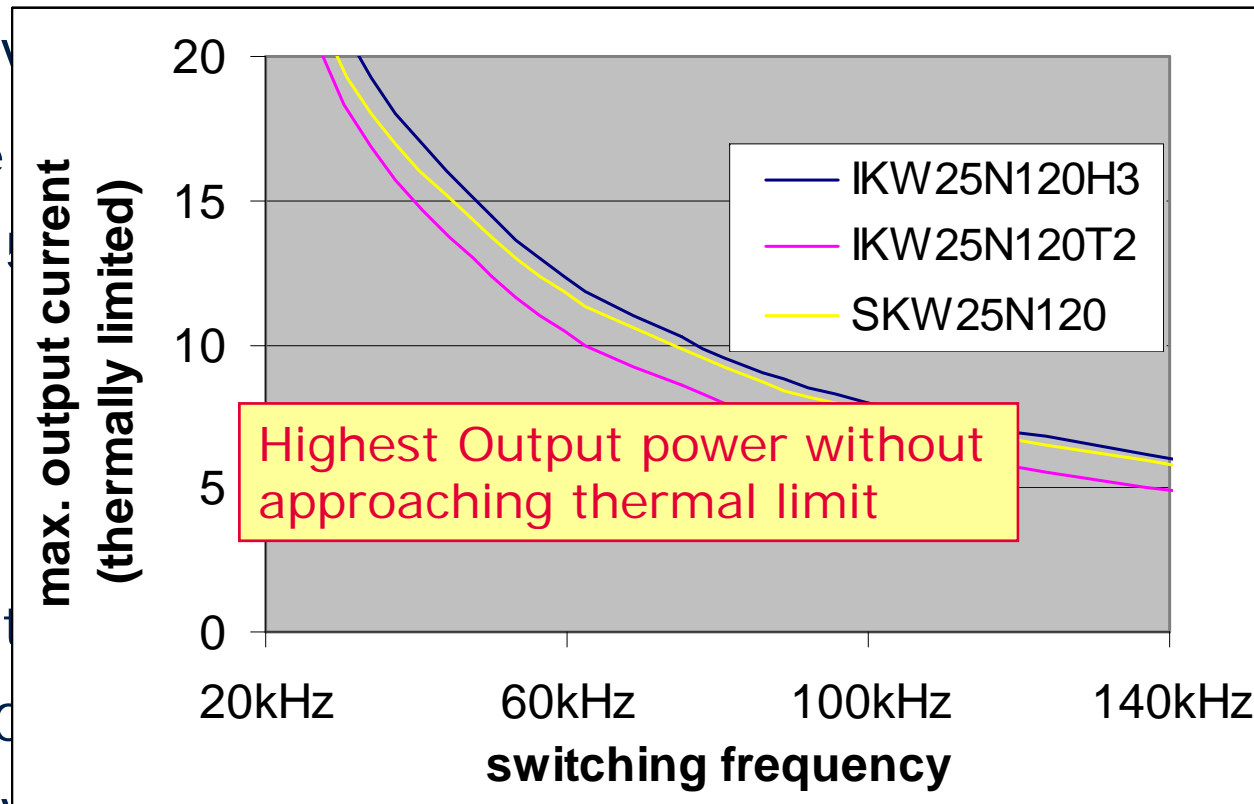
□ $I_{\text{low}} = 50\%$

■ Limit simulation

□ $T_{\text{junc}} = 150^{\circ}\text{C}$

□ $V_{\text{Off}} = 800\text{V}$

□ duty cycle $d=0.5$



Boost stage diode: SiC IDH15S120

Application study: Boost stage

Loss calculation DCM



■ Loss simulation input:

□ $T_{\text{junc}} = 150^{\circ}\text{C}$

□ $V_{\text{Off}} = 800\text{V}$

□ duty cycle

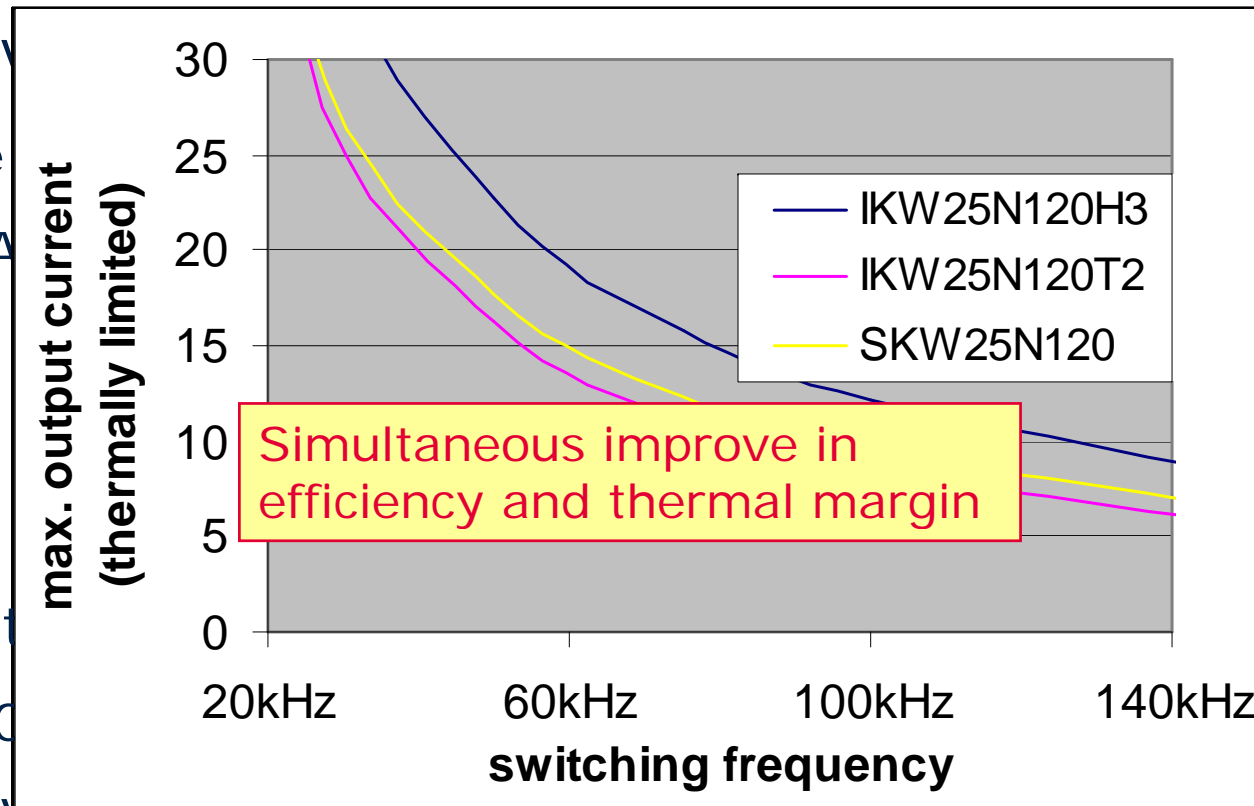
□ $I_{\text{peak}} = 25\text{A}$

■ Limit simulation

□ $T_{\text{junc}} = 150^{\circ}\text{C}$

□ $V_{\text{Off}} = 800\text{V}$

□ duty cycle $d=0.3$



Boost stage diode: SiC IDH15S120

Highspeed 3rd generation offers

- Up to 25% lower turn-off losses
- optimised diode for lower diode and IGBT losses
- Low EMI for less filtering effort
- Easy paralleling for higher power levels
- Benchmark performance in for switching frequencies above 20kHz



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