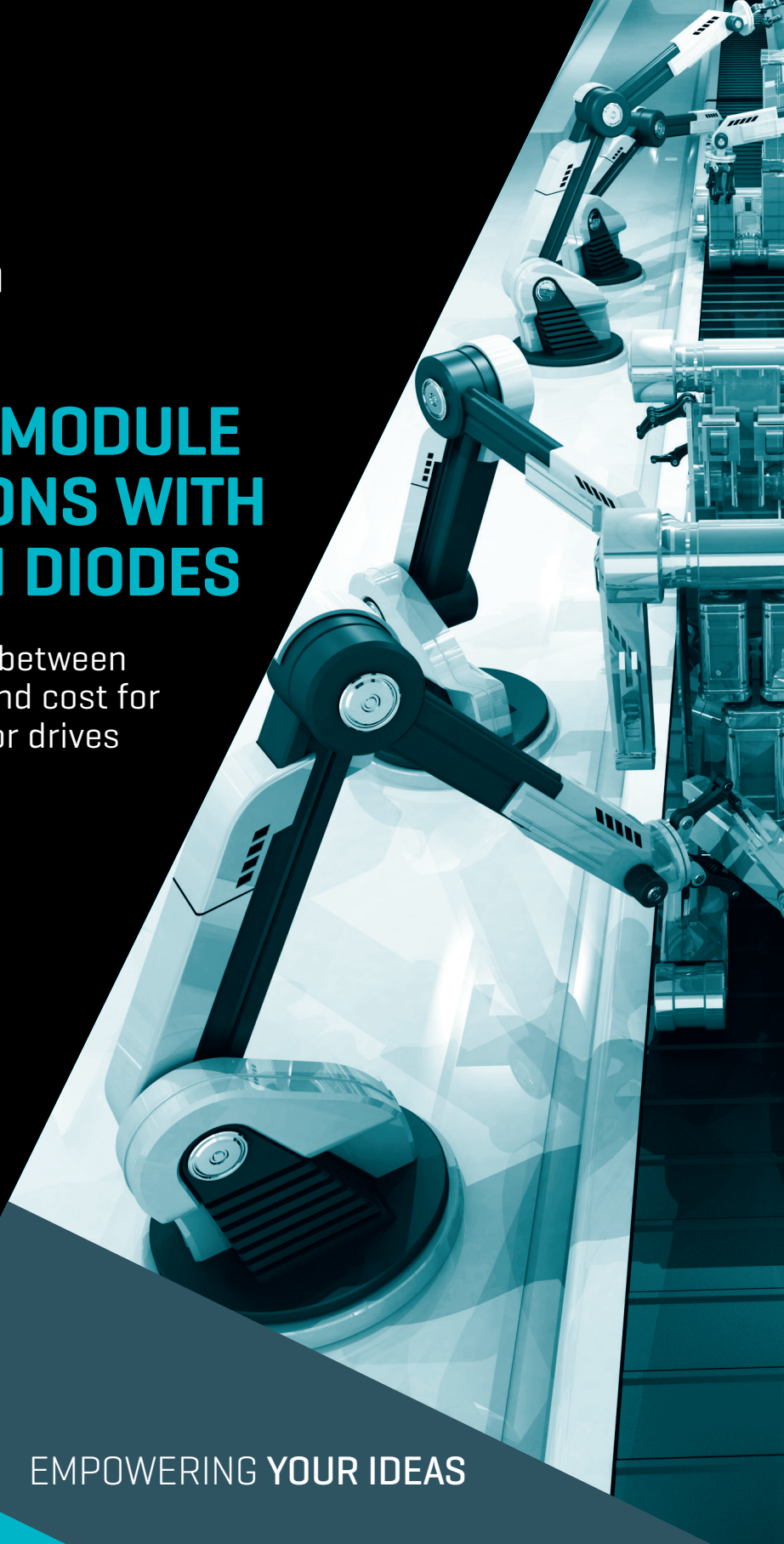
Vincotech

POWER MODULE SOLUTIONS WITH TANDEM DIODES

A compromise between performance and cost for industrial motor drives

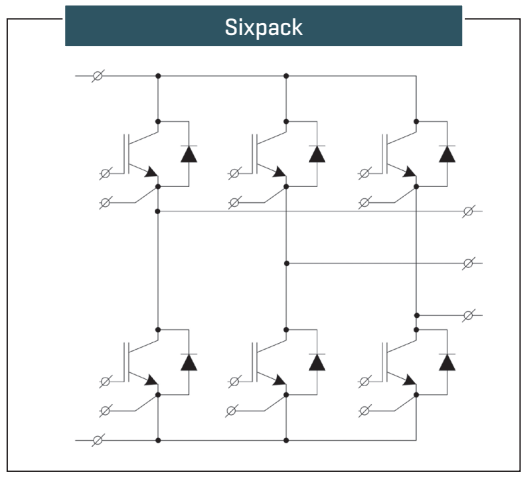


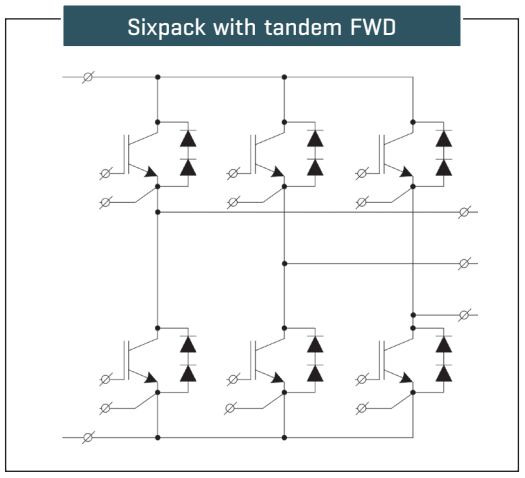
EMPOWERING **YOUR IDEAS**

VINCOTECH HAS 25+ YEARS OF EXPERIENCE IN POWER MODULES, PROVIDING:

- Simple and cost-effective solutions for industry applications
- Wide portfolio covering industrial standard topologies (Sixpack, PIM)
- Multi-source chipset possibilities for a reliable supply chain

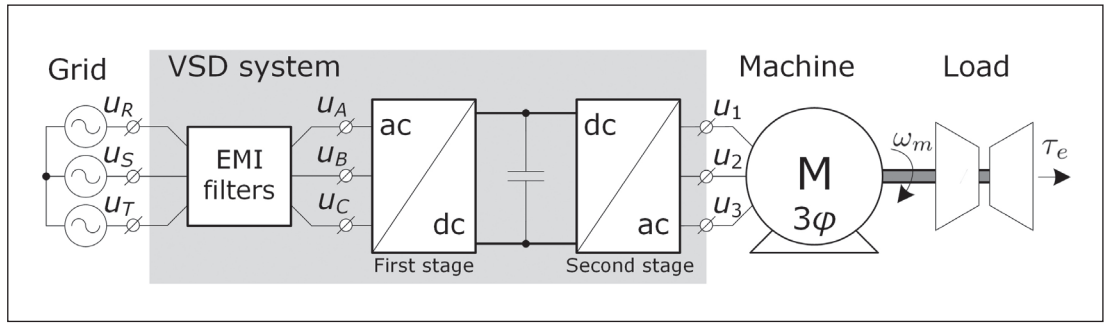
Tandem FWD are **innovative solutions for 1200 V chipset in combinations with IGBT devices** dedicated for motor drives applications.





Tandem diode setup comprised of two snubber-less 650 V devices connected in series outperformed solutions using a single 1200 V FWD in terms of overall semiconductor efficiency losses at high switching frequencies (up to 16 kHz) at a far lower price point than WBG-based FWD solutions.

Standard Motor Drive Application:

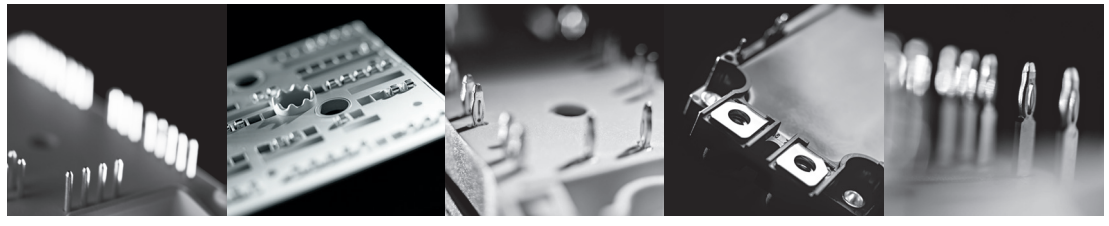


General specifications for motor drive systems:

Switching frequency: 4 kHz < FSW < 16 kHz

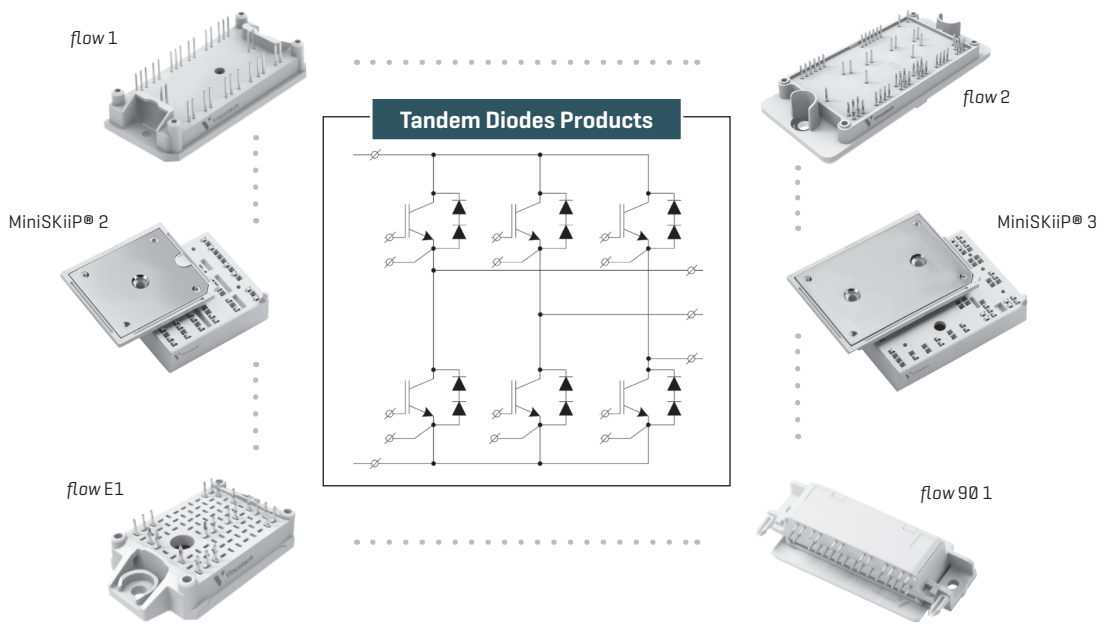
DC-link voltage: 550 V< VDC < 800 V

Voltage slope limit (dv/dt): 3 V/ns up to 6 V/ns



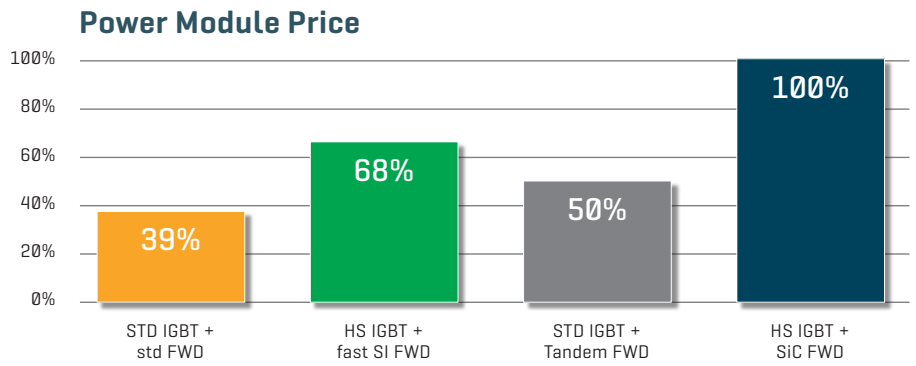
Vincotech **Product Roadmap**

Tandem diodes solutions available for SixPack, Twin SixPack and PIM topologies including custom and industry standard power module housings.



Performance Benchmark

Tandem diode setup in combination with standard IGBT technology provides equilibrated trade-off between cost and performance.



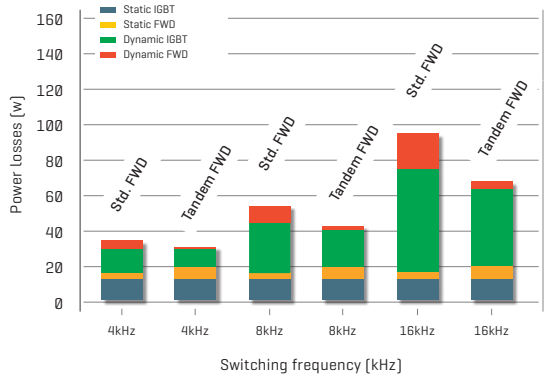
Benchmarking the Sixpack Power Module cost for different chipset realization:

/ Proposed chipset with Std IGBT with Tandem FWD is half of price of HS IGBT with SiC FWD

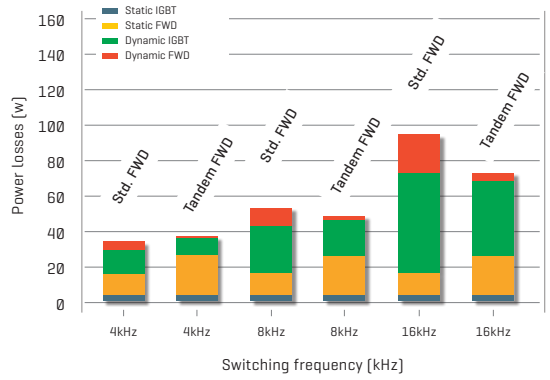
/ Tandem FWD solution is cost saving chipset alternative for high switching frequency comparing other chipset solutions

Power Losses Benchmark

Positive Power Factor (PF=0.8)



Negative Power Factor (PF= -0.8)



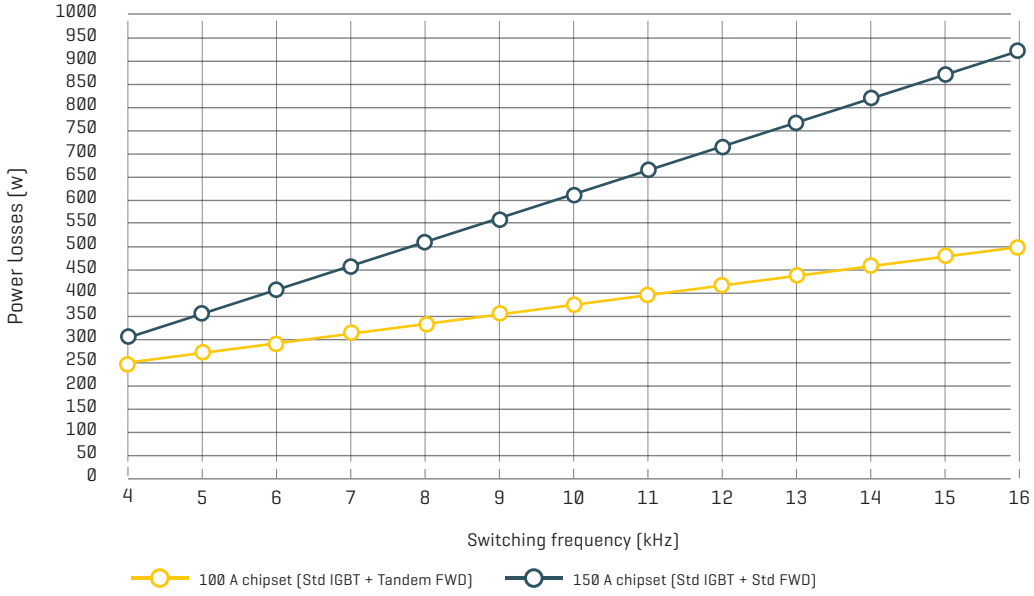
Tandem FWD setup minimizes dynamic losses in overall:

/ Low reverse recovery losses coefficients from diodes setup

/ Low turn-on losses at IGBT;

Semiconductor power losses

150 A (Std IGBT + Std FWD) vs 100 A (Std IGBT + Tandem FWD)



Switching frequency: 4 kHz - 16 kHz; Gate resistor selected for dV/dt = 5 V/ns; DC-link voltage UDC = 800 V; RMS load voltage (line-to-line) UOll,rms = 400 V; RMS load current IOrms = 40 A; Load power factor PF = 0.8; Fundamental frequency synthesized at load FO = 50 Hz

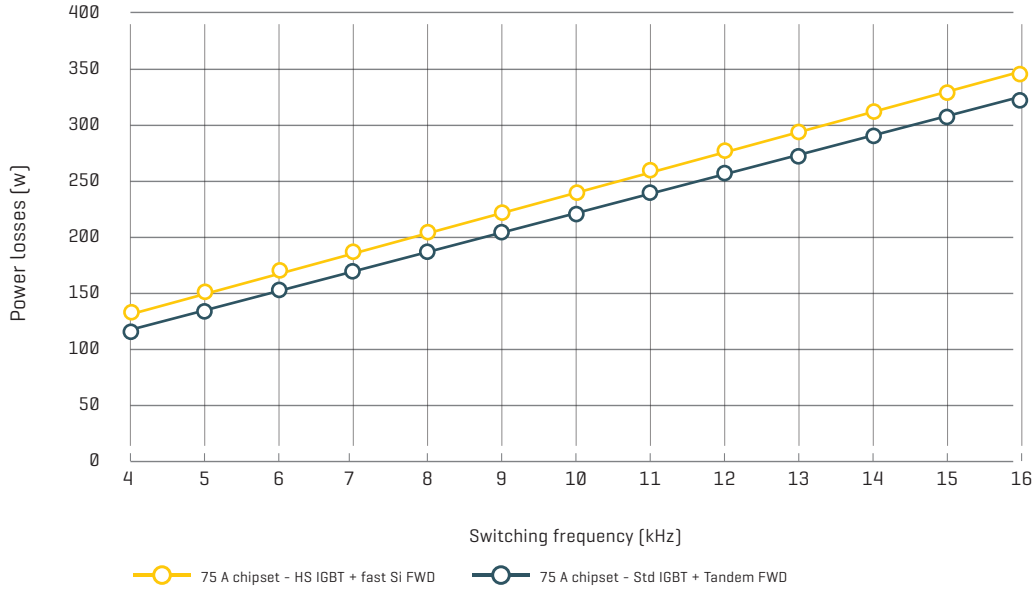
/ Due to low reverse recovery losses from FWD tandem setup – High efficiency is achieved

/ Taking same IGBT technology for both cases. Optimized chipset with smaller IGBT device in combination with tandem FWD that is more efficient than larger IGBT combined with standard FWD device

/ Tandem FWD solution is cost saving chipset alternative for high switching frequency

Semiconductor power losses

75 A (Std IGBT + Tandem FWD) **vs** 75 A (HS IGBT + Fast FWD)



Switching frequency: 4 kHz - 16 kHz; Gate resistor selected for dV/dt = 5 V/ns; DC-link voltage UDC = 800 V; RMS load voltage (line-to-line) UOll,rms = 400 V; RMS load current IOrms = 20 A; Load power factor PF = 0.8; Fundamental frequency synthesized at load FO = 50 Hz.

/ The current is the same for IGBT and FWD devices for both cases

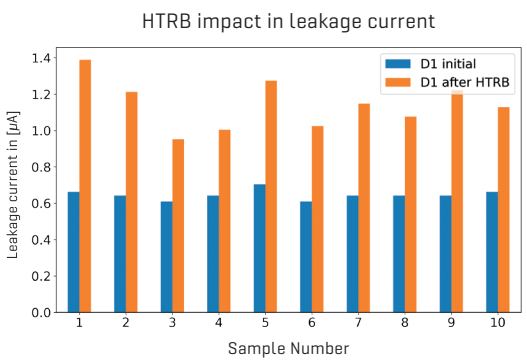
/ Standard IGBT in combination with Tandem FWD chipset has lower losses comparing with High Speed IGBT with fast FWD technology

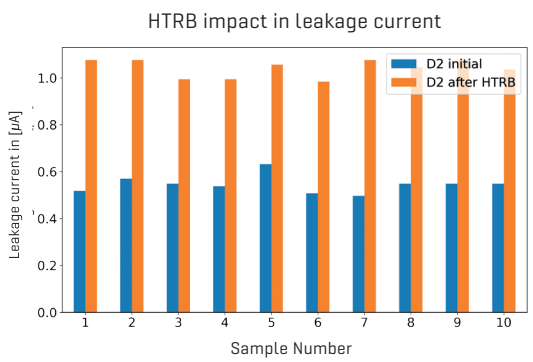
/ Tandem FWD solution is cost saving chipset alternative for high switching frequency

Reliability

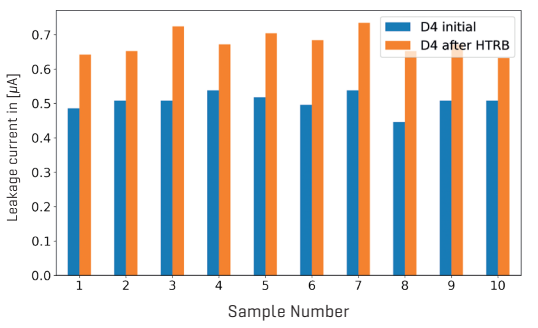
Aging was performed for 1000 hours using the high temperature reverse bias (HTRB) test system (acc. EN60749-23) at a virtual junction temperature, Tvj, of 175 °C and a reverse voltage, Vr, of 1280 V, corresponding to over 15 years in a real-world application.

Diodes measured individually

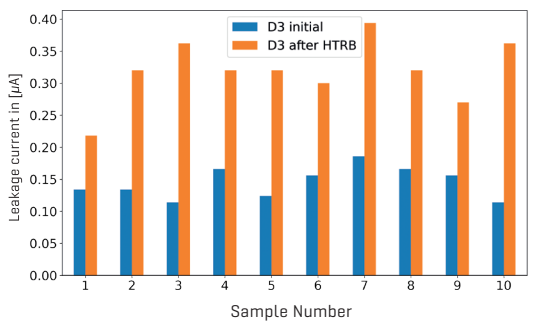




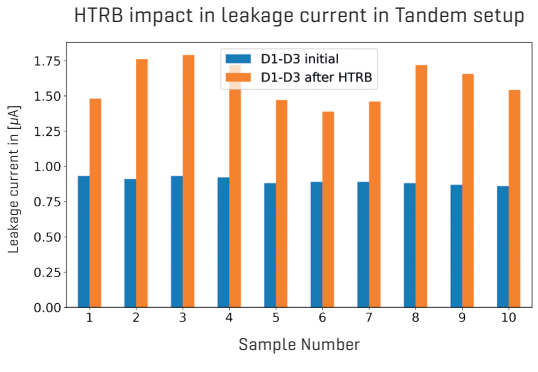
HTRB impact in leakage current in Tandem setup

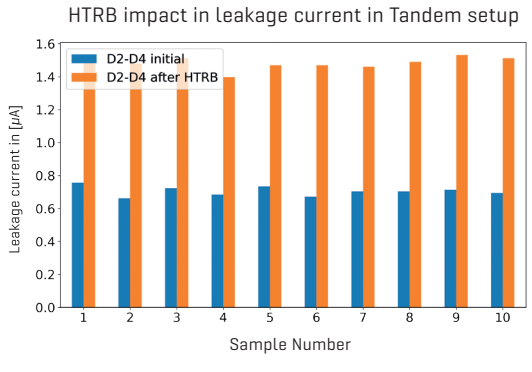


HTRB impact in leakage current

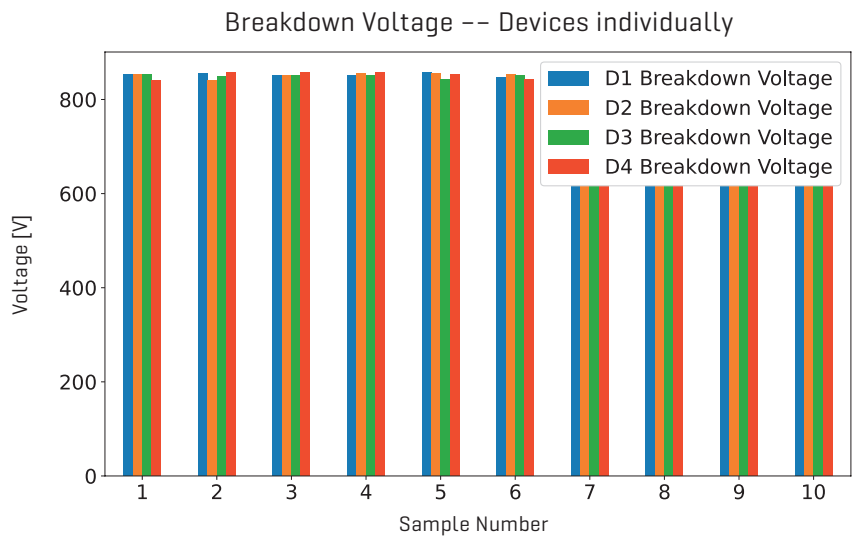


Diodes measured in Tandem setup



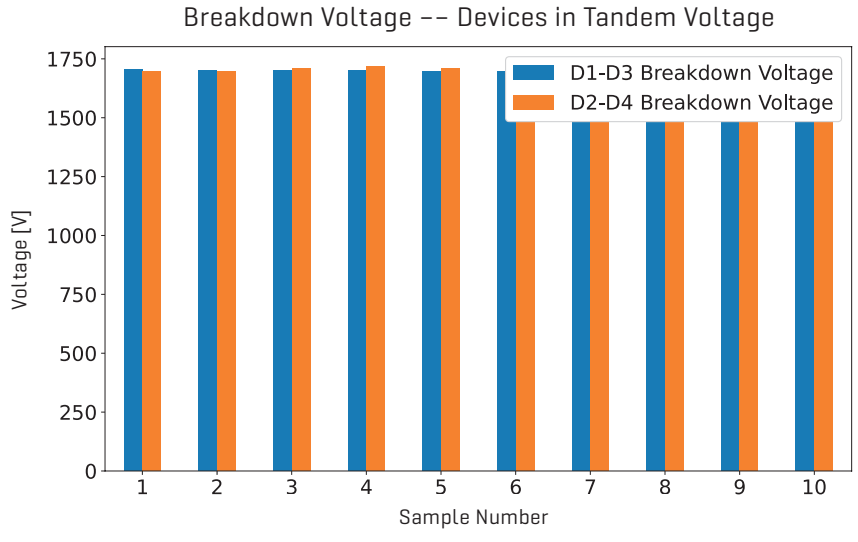


After HTRB tests, the breakdown voltage has been measured individually



Breakdown voltage measured in the range of 840 V up to 856 V

After HTRB tests, the breakdown voltage has been measured in Tandem setup



Breakdown voltage measured in the range of 1692 V up to 1716 V

Symmetrical voltage division is achieved without snubbers components

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