

A New 6 Inch IGCT Platform for up to 8.5 kV with Outstanding Current Capability

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01 INTRODUCTION

- Power semiconductors: key components in highest power application like HVDC transmission, MV drives, offshore wind turbines, railway interties
- Trend toward higher power → devices with increased voltage and current ratings
- New 6 Inch IGCT platform: up to 8.5 kV, excellent thermal and dynamic performance
- Monolithic Si chip in a hermetic press-pack → high reliability and robustness
- Best reliability: Design for reliability, monitoring of the population in the field and post-field failure analysis.

02 POWER HANDLING CAPABILITY

- IGCT: established where highest availability, efficiency and scalable power are required
- New platform: 138 mm pole piece, blocking capability 6.5 kV and 8.5 kV
- High voltage → fewer series-connected cells in multilevel converters (MMC) → lower system complexity and cost

Table 1 RMS and turn-off current capability, 138 mm platform.

Pole piece diam. (mm)	Blocking / DC link (kV)	Status	Type	$I_{T(RMS)}$ * (A)	Turn-off cap. (A)
138	6.5 / 4.0	prototype	RC	3700	8 000
138	6.5 / 4.0	prototype	AS	6300	12 000
138	8.5 / 5.0	prototype	RC	3000	5 500
138	8.5 / 5.0	prototype	AS	4550	10 000

* IT(RMS): RMS on-state current, half sine wave, case temperature 85 °C.

03 6 INCH IGCT DESIGN

- Three integrated parts: semiconductor + housing + gate unit
- Single IGCT on a 6Inch wafer → ≈ 150 cm² active cooled area
- RC: active area shared between GCT switch and free-wheeling diode
- 6Inch design: updated GCT segment layout, diode with segmented cathode, high-voltage vertical design [1]–[8]
- Housing height 26 mm or 35 mm, depending on voltage rating
- AS: improved gate circuit concept investigated to extend the maximum controllable current.

RC IGCT

- Turn-off at 125 °C: 10 kA @ 4.0 kV, 8 kA @ 5.3 kV
- Frequency operation: 8 kA @ 4.0 kV

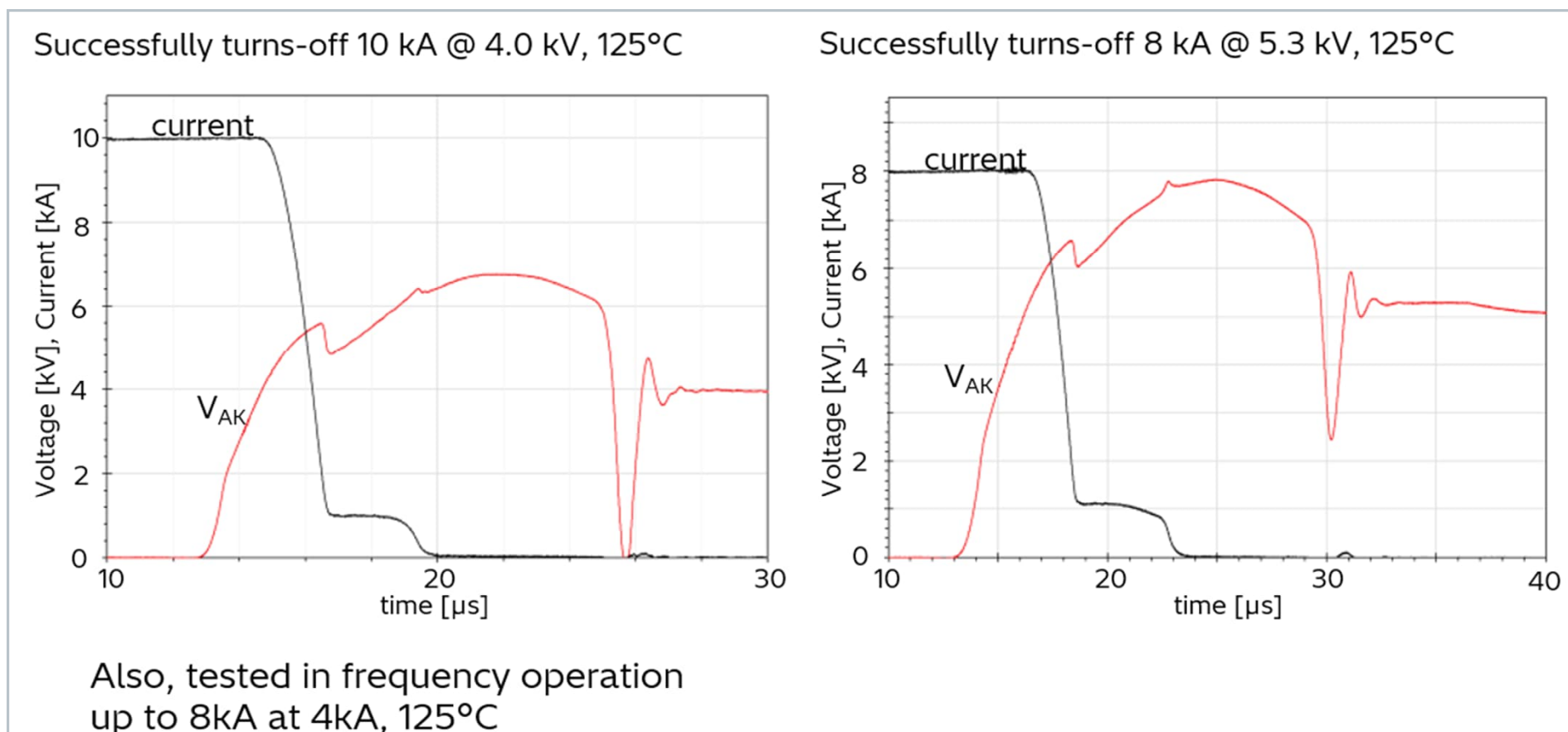


Fig. 1 RC-IGCT turn-off, both voltage classes — above the anticipated MCC ratings.

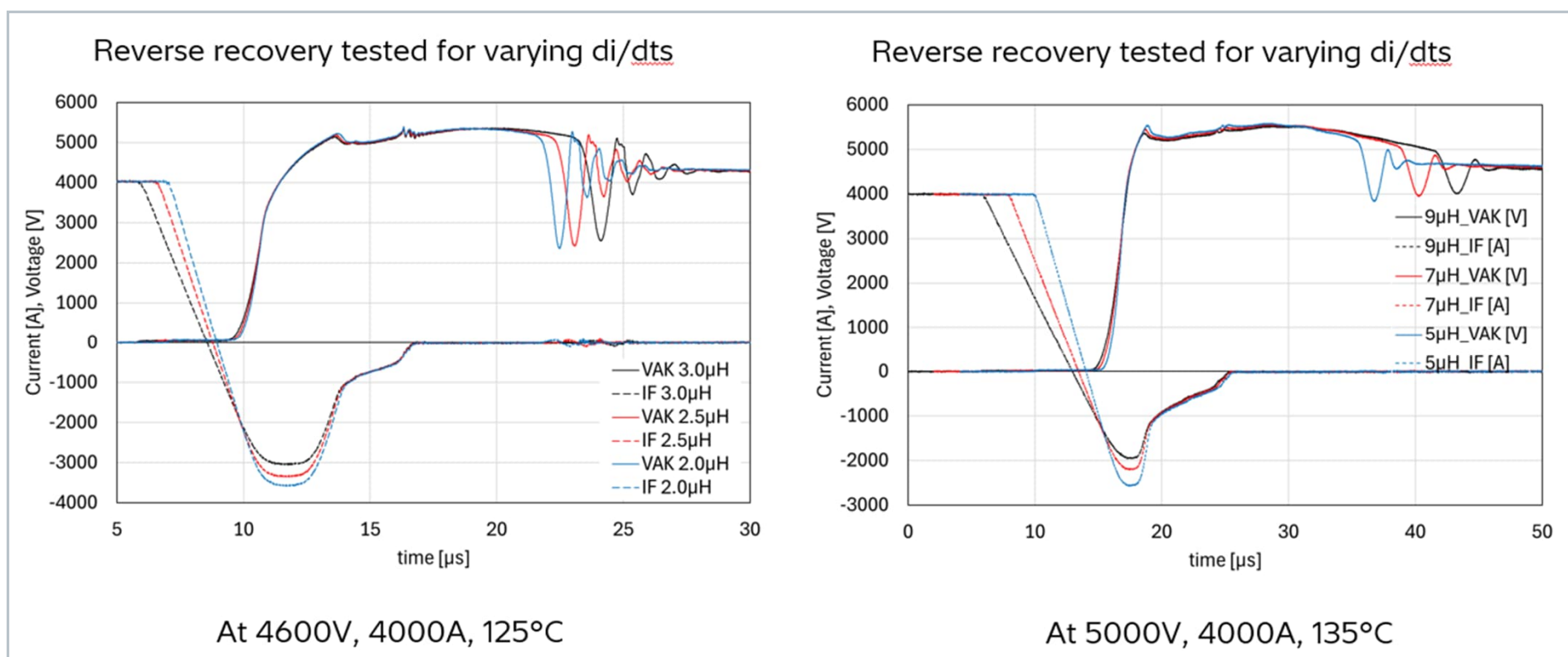


Fig. 2 Diode reverse recovery for varying di/dt — 4600 V / 4000 A / 125 °C (left), 5000 V / 4000 A / 135 °C (right).

AS IGCT

- Prototypes: up to 6.5 kV.
- Target > 12 kA for the AS-IGCT

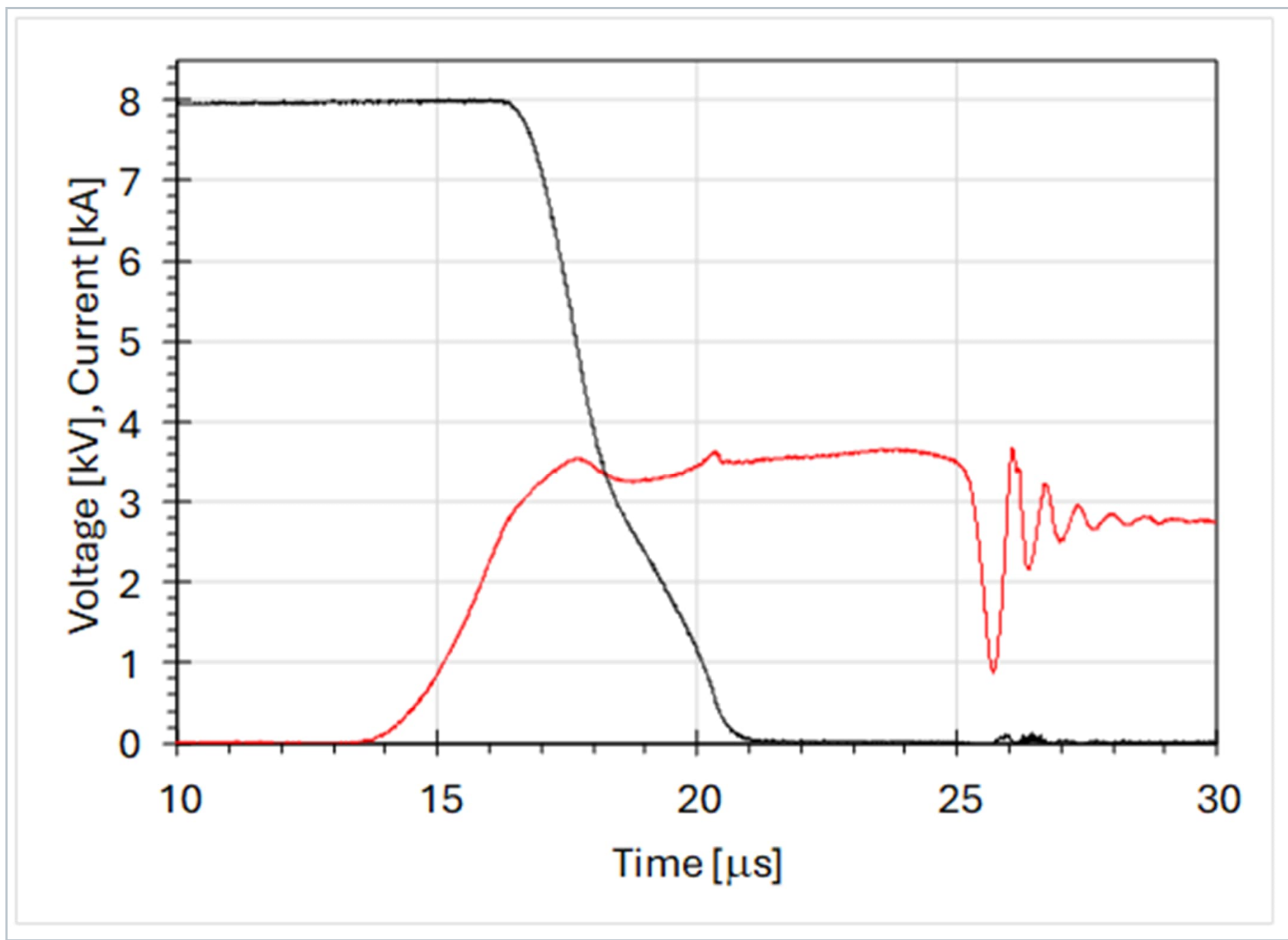
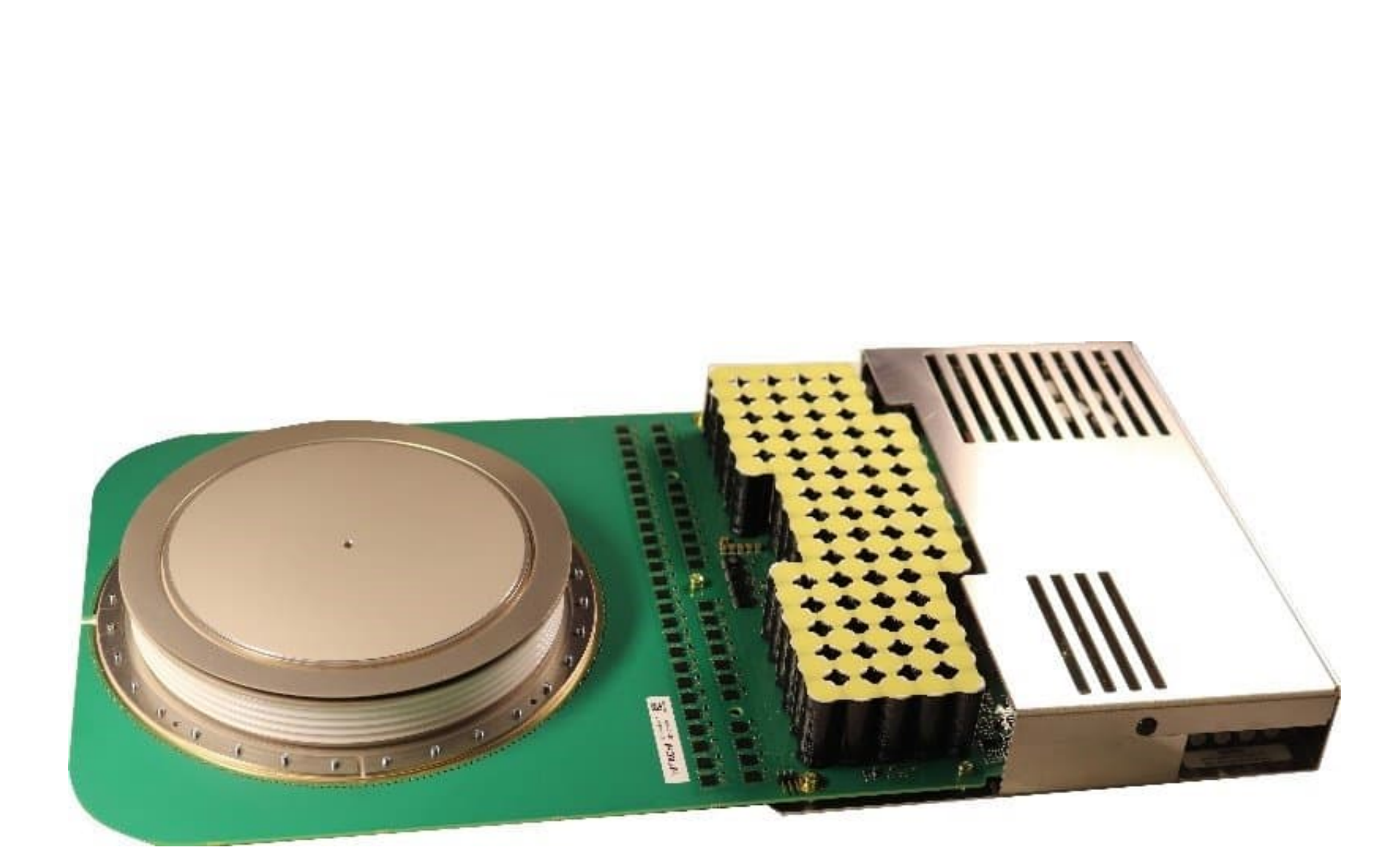


Fig. 3 Sample turn-off waveform, AS-IGCT prototype.



04 HIGH-POWER APPLICATION

- Thyristor structure → on-state losses well below comparable IGBTs → ideal for application with low switching frequency e.g. MMC topology.
- Choke + clamp circuit: di/dt control at turn-on, lower turn-on losses associated with device.
- Reactor limits fault currents from stored system energy → lower risk of housing rupture and collateral damage
- With the high SCFM capability of the package, device provides significant advantages when employed in MMC applications subject to non-explosive failure requirements.

Black-start capability

- Powered gate unit: displacement current out via the low-inductance gate path → no latch-up, even at dV/dt > 10 kV/μs
- Startup, unpowered: displacement current via anode shorts → lower, but sufficient dV/dt capability

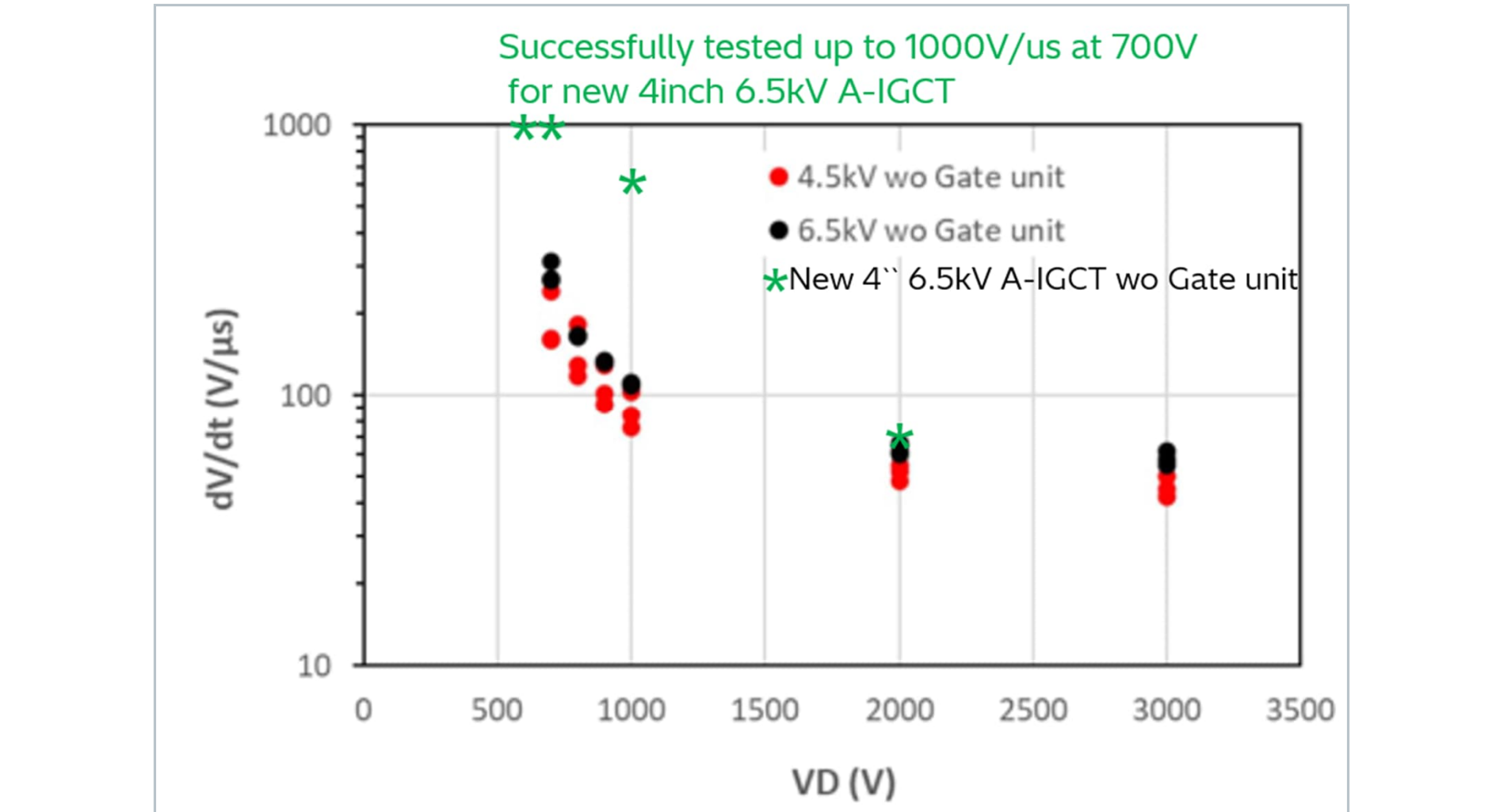


Fig. 4 dV/dt capability of 4.5 kV and 6.5 kV IGCTs without gate unit. New 4 Inch 6.5 kV A-IGCT: dV/dt testing and qualification passed.

Reliability

- Hermetic ceramic press-pack → no humidity-related degradation of blocking capability
- High power cycling capability; stable SCFM: no VT degradation beyond 4000 h [11]
- No major failure traced to the high-current path: neither MOSFET nor electrolytic capacitor in field return [12]

05 CONCLUSION

- 6 Inch IGCT platform demonstrated up to 8.5 kV blocking capability
- Unprecedented thermal and dynamic performance across voltage classes
- Inherently safe: stable SCFM and fault-current limiting → non-explosive failure behaviour
- Made for mission-critical high-power applications: MMC, e.g. in HVDC

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