



A novel SiC JFET technology for Solid State Power Distribution

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Solid State Power Distribution

Why to change a 100-year old, proven electro-mechanical concept



- **Reduction of Fault isolation delay from >10 ms to <5 μ s**
 - Minimal current overshoot
 - Reduced Distortion in the distribution grid
 - Selectivity vs. Electronic Sources
- **Smart Protection Mechanisms**
 - Auto-Retry / Failure Recovery
 - Smart Inrush Handling
 - Self Diagnostic
- **Arc-Free, Wear-free Actuation and Protection**
 - Reduced Maintenance
 - Installation Space (IT environment)
 - Smart Load Control
- **AC and DC compatible**

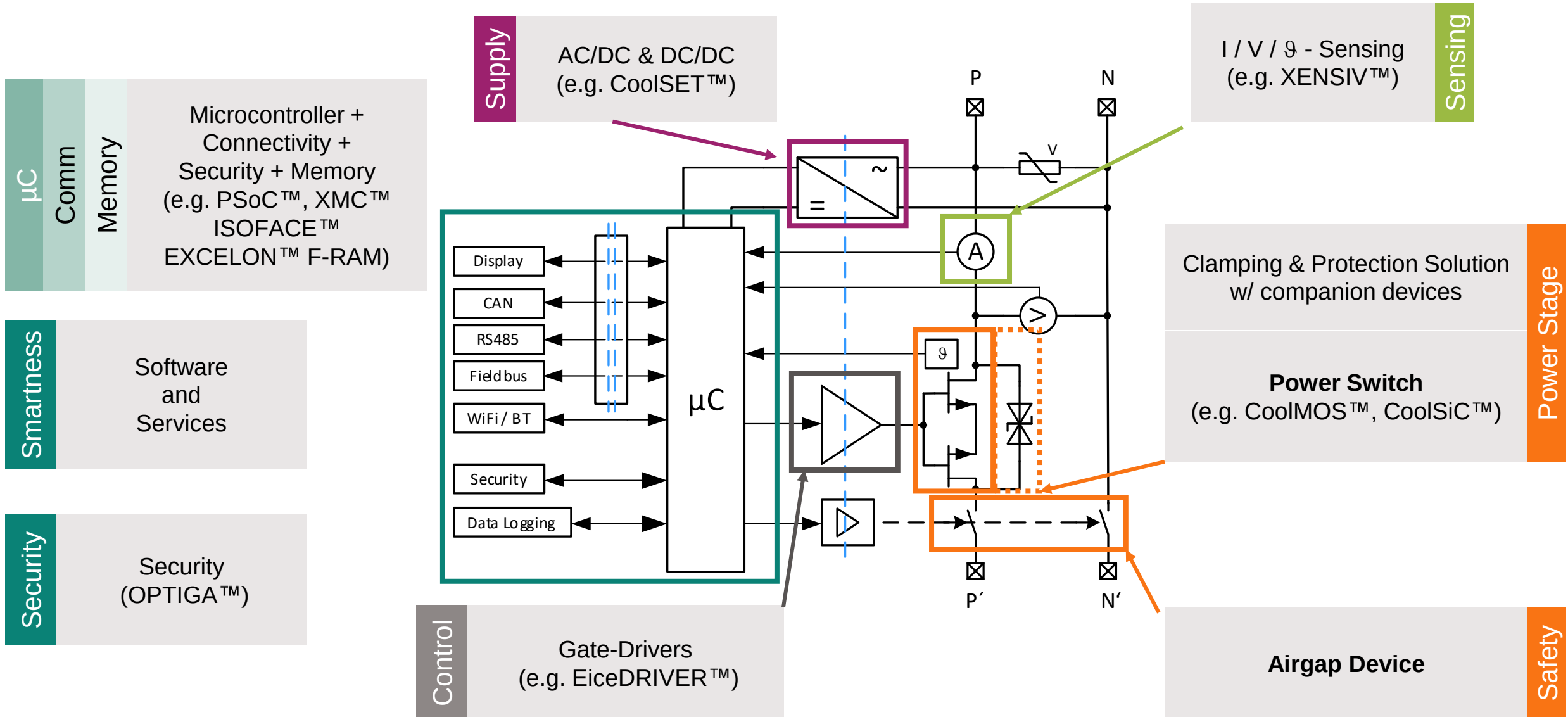
- **Size / Ampacity**
- **Power Dissipation**
- **Cost (CAPEX)**



**Enabled by
Power Semiconductor
Solutions**

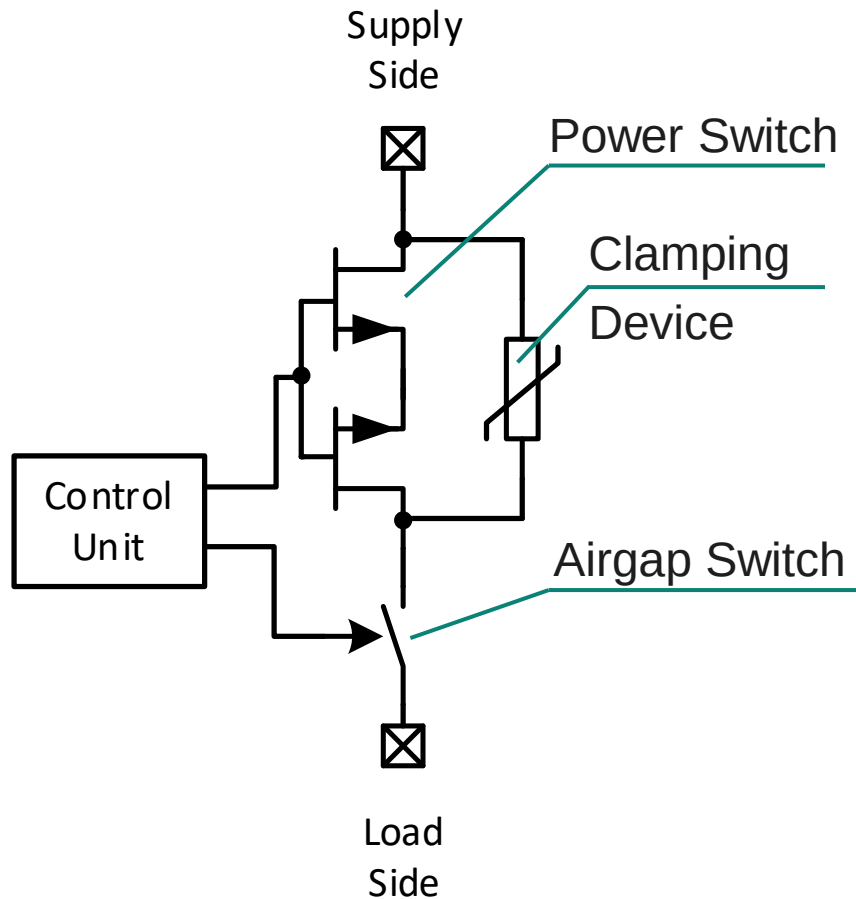
Solid State Circuit Breakers from a System Perspective

Power Stage as critical building block



Power Stage Topologies: EM vs. SSCB

Key semiconductor requirements



SSCB Requirement

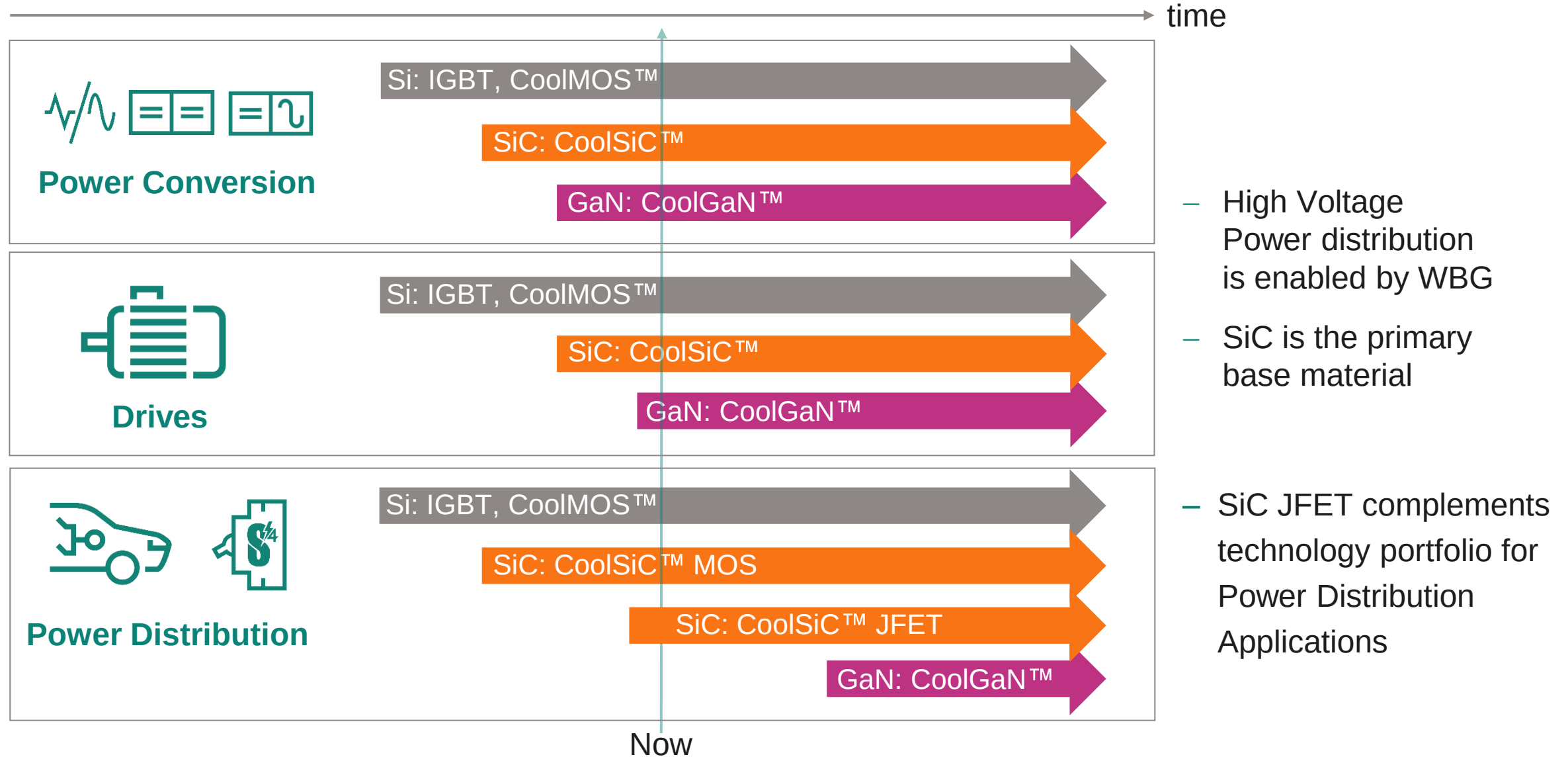
- Very low Voltage drop @ rated current
- Overload Capability
- High Current Switching Capability
- Interplay with Clamping Device
- Overvoltage / Overcurrent Robustness
- Power Temperature Cycle Robustness
- Miniature Solution Size
- Lifetime equivalent to EM solution

Example: 63A/400 Vac

- 150 mV/Pole
- 2.3 mΩ total
- $7 \times I_{\text{nom}} * 3\text{s}$
- $I_{\text{SD}} = 1.1 \text{ kA}$
- MOV or TVS
- OVC III
- 500kc @ 125 °C
- Equivalent to 63A MCB
- >20 years * 24/7

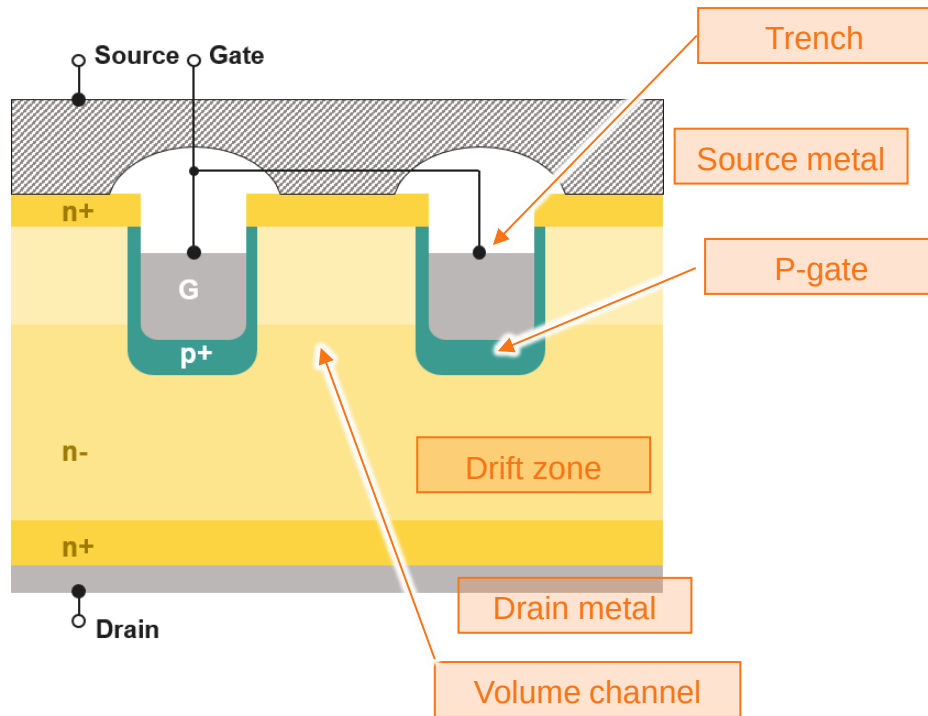
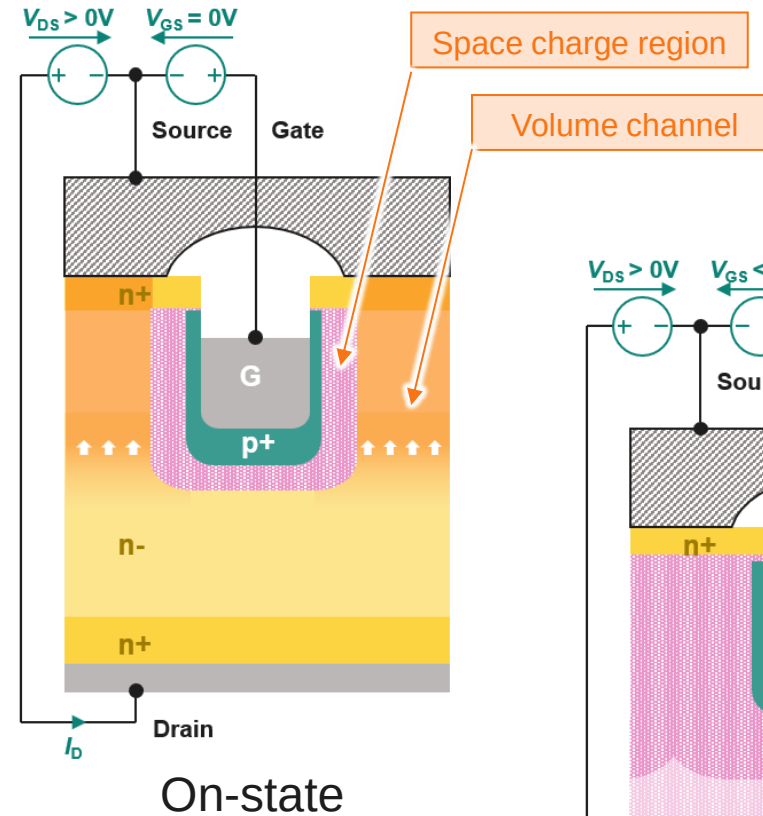
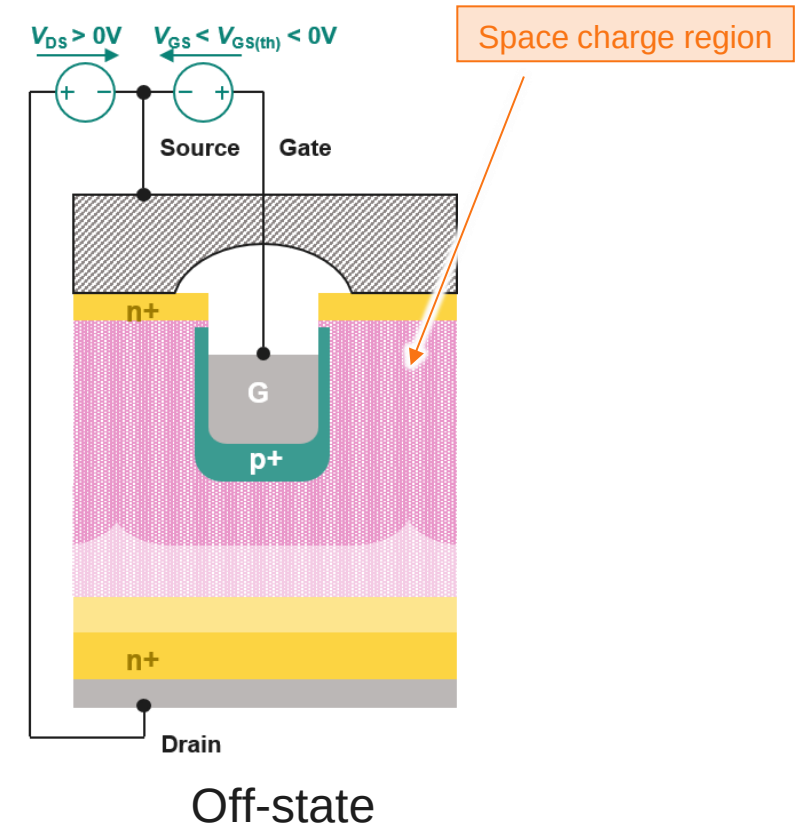
Different Power Technologies for Application Spaces

High Voltage Power Distribution is enabled by WBG technologies



CoolSiC™ JFET

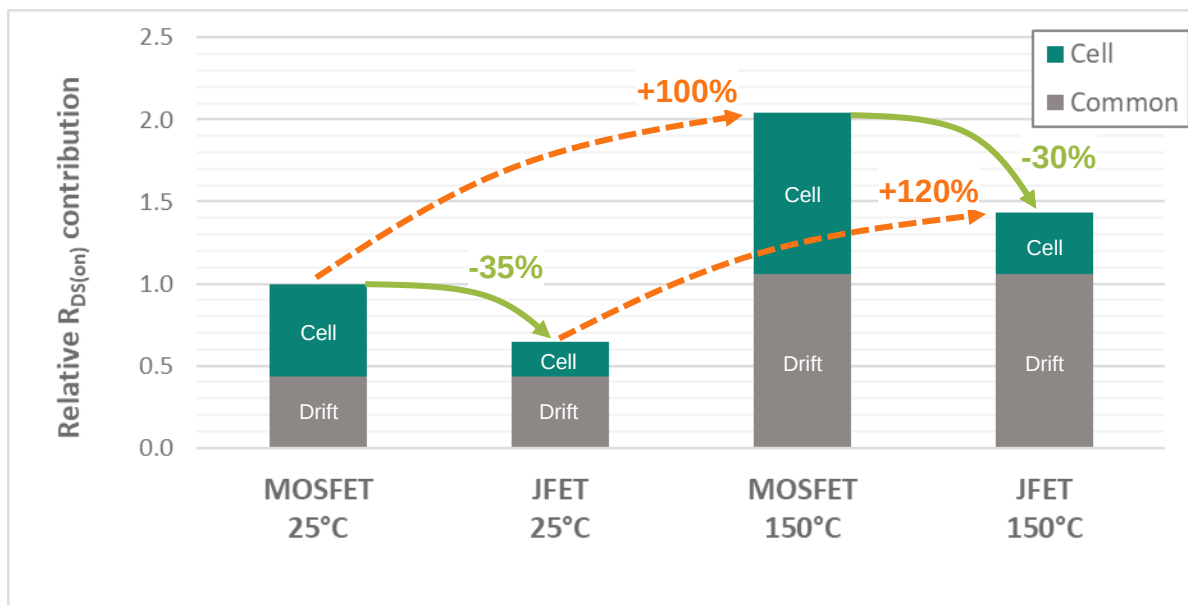
Basic Construction and Operation



- Optimized for $R_{DS(on)} * A$ and robustness
- Thermal Stability over entire SOA
- Active Clamping at high current
- Linear Mode Operation

JFET: Advancements in $R_{on} \cdot A$ and FBSOA

RDson Contribution: 1.2kV CoolSiC™ MOSFET vs. JFET

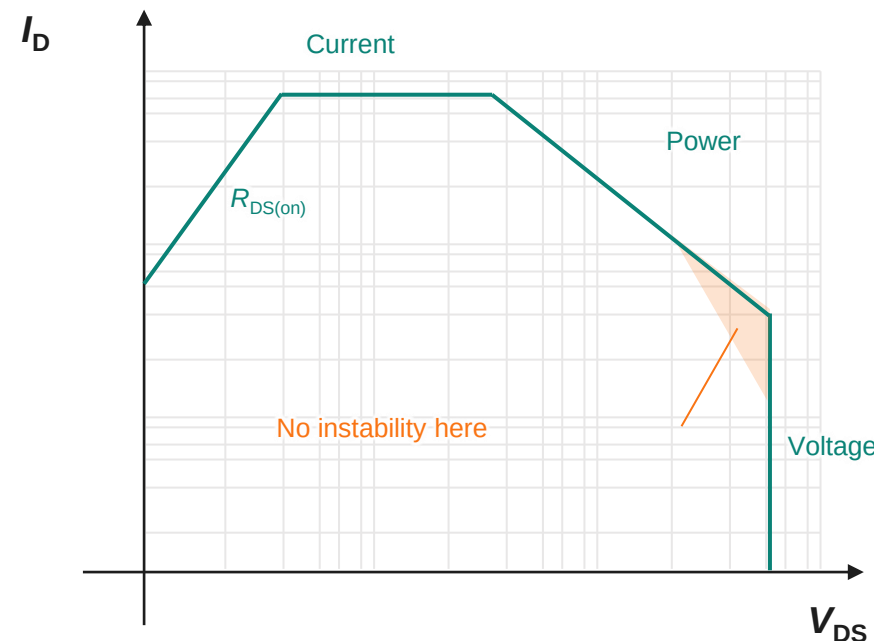


Best-in-Class $R_{DS(on)}$ Ratings:

2.3m Ω @ 1200V V_{BDSS}

1.5m Ω @ 750V V_{BDSS}

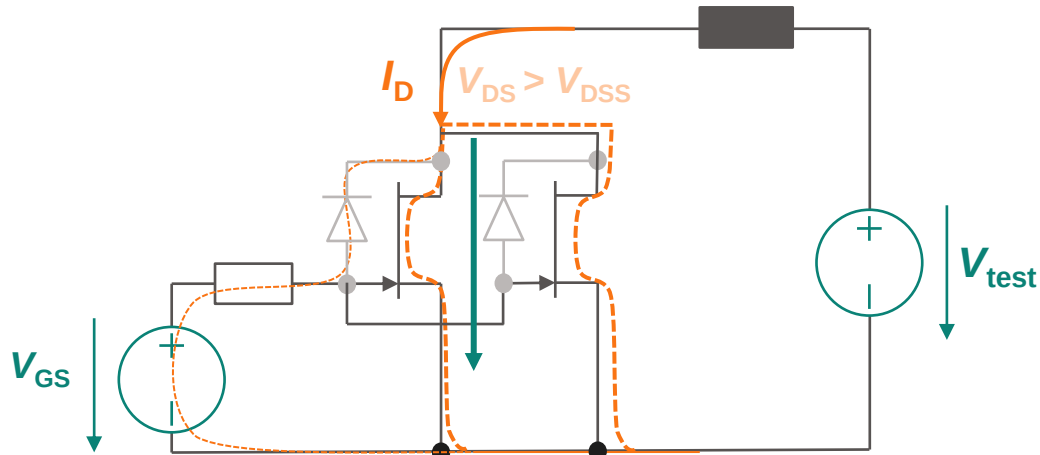
JFET FBSOA: I_D vs. V_{DS}



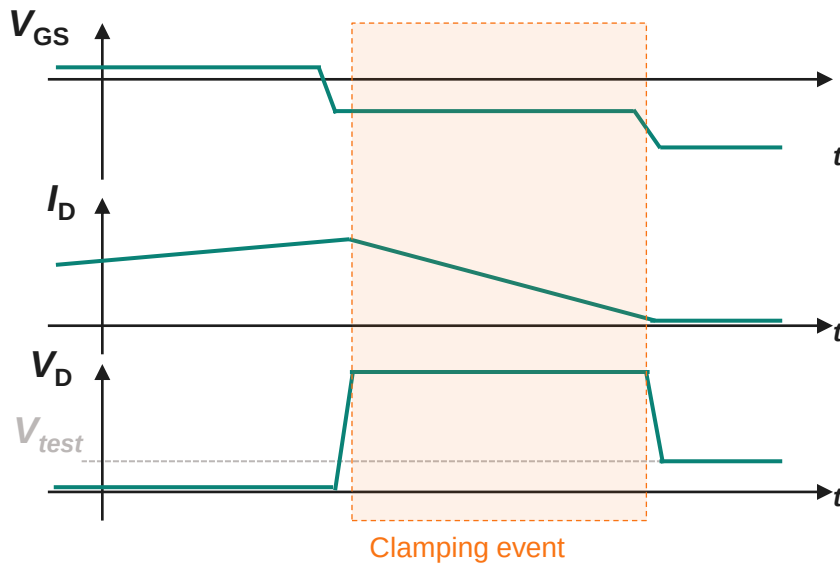
- Thermal Stability under all operating conditions
 - No hot-spotting during overload pulses
 - Linear mode capable
 - Stable operation in “avalanche”

JFET in Overvoltage Clamping Condition

Simplified clamping of overcurrent events



- Stable and reliable handling of high current avalanche
 - Rated and production tested high-power EAS rating
 - Current sharing of paralleled devices



- High avalanche energy rating
- Simplification of clamping design
- Elimination of V_{DSS} voltage margin
- Reduction of turn-off delay / current overshoot

Package Optimization for full application performance

Q-DPAK enables efficient system integration into SSCB assemblies



Large Drain and Source interface area

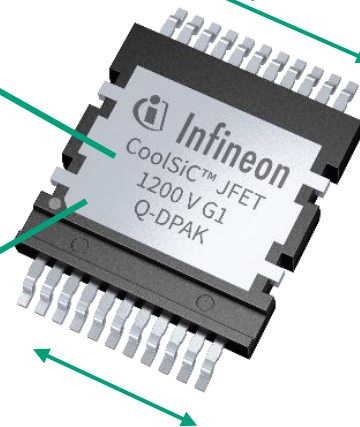
- Minimize Losses
- Reduced current density at the interface

Optimized internal construction

- High current interfaces
- Diffusion soldering
- Large die area & internal paralleling

Top-Side Cooling & large heatslug

- Lowest possible R_{th}
- Directly connected, local C_{th}
- Application-adjustable C_{th}



– Directly attached TSC cooler enables flexibility

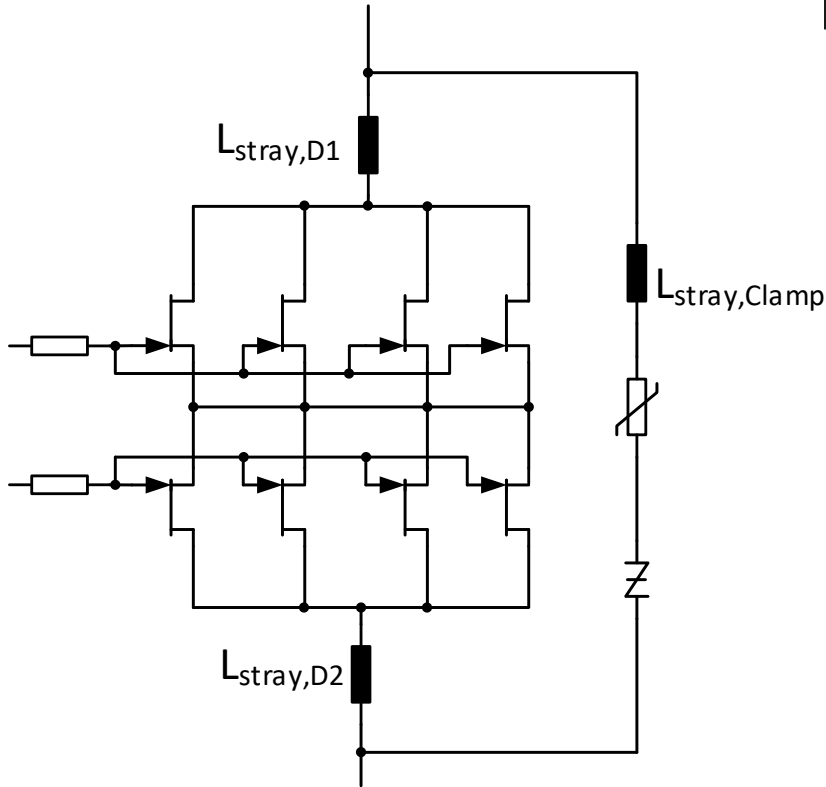
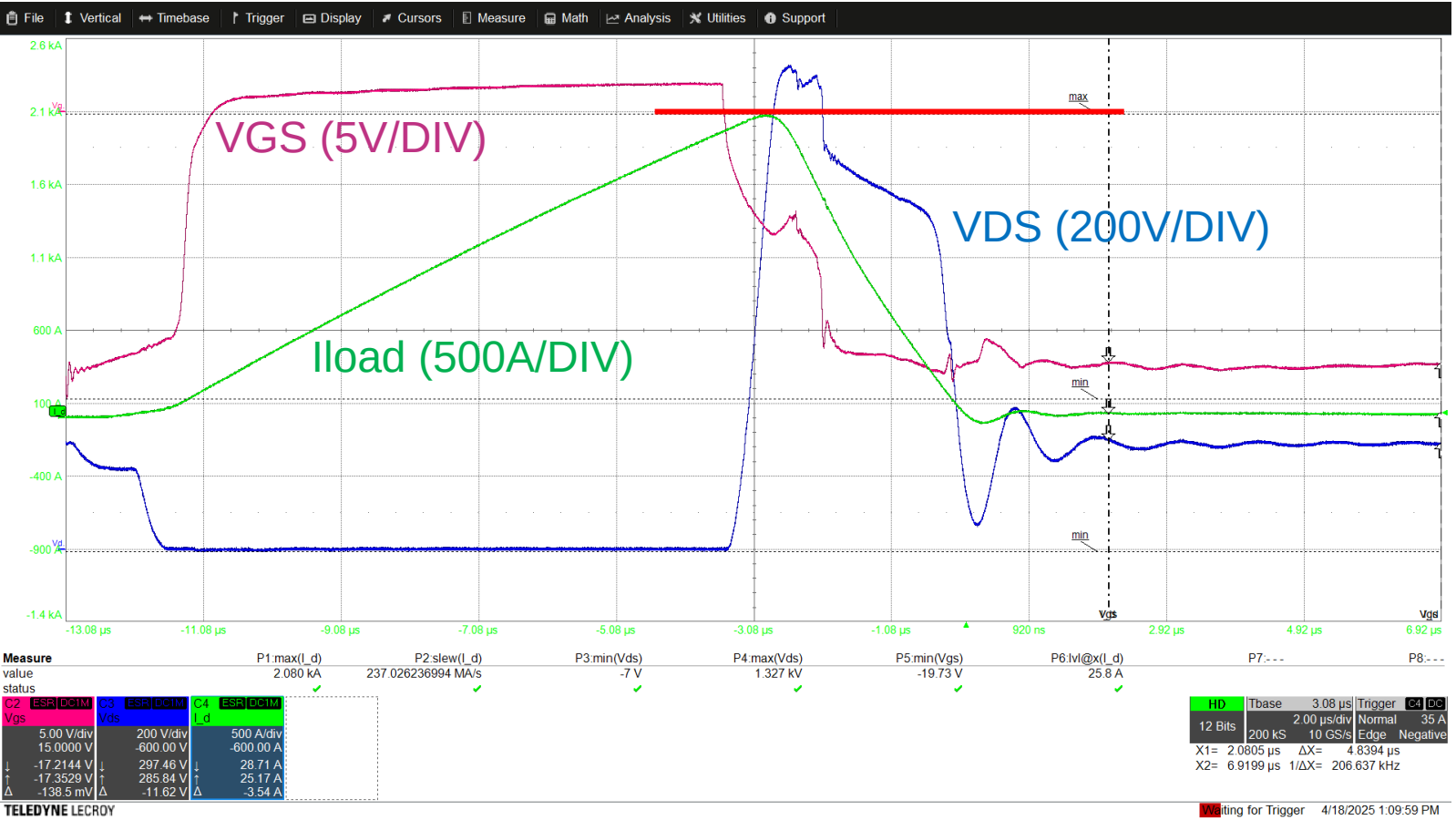
- Adjust i^2t capability via C_{th} extension
- Optimize R_{th}
- Reduce Thermal cycling stress

The importance in SSPD Applications

Example: 800V / 650A SSCB Overcurrent Shutdown



Example: Shutdown of 2kA / 300V



Summary

- Solid-State Power Distribution is a new emerging application field with special requirements to the applied semiconductors
 - Ultra-Low R_{DSon} of HV Power Transistors
 - Robustness and Reliability under heavily exposed conditions
- Infineon is introducing an optimized Silicon-Carbide based trench JFET Technology to ideally address these requirements.
- The CoolSiC JFET enables high performance SSCB designs by
 - Groundbreaking low R_{DSon} values
 - Simplified device paralleling
 - High Current Avalanche Ratings to minimize the effort in clamping solutions
- The Q-DPAK Package is optimally suited for the implementation of high current SSCBs
 - Large routing interface area on both, Drain and Source contacts
 - Large thermal interface area
 - User-extendable thermal capacitance for overload capability.
- For more information, come see us at Hall 7 - Booth 470.

