pcim ASIA *Hybrid Platform*

SiC Power Device Hammer and Burn-In System

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Contents

- SiC technology milestone overview
- SiC qualification and reliability tests
- Hammer and Burn-In system introduction and applications
- Summary

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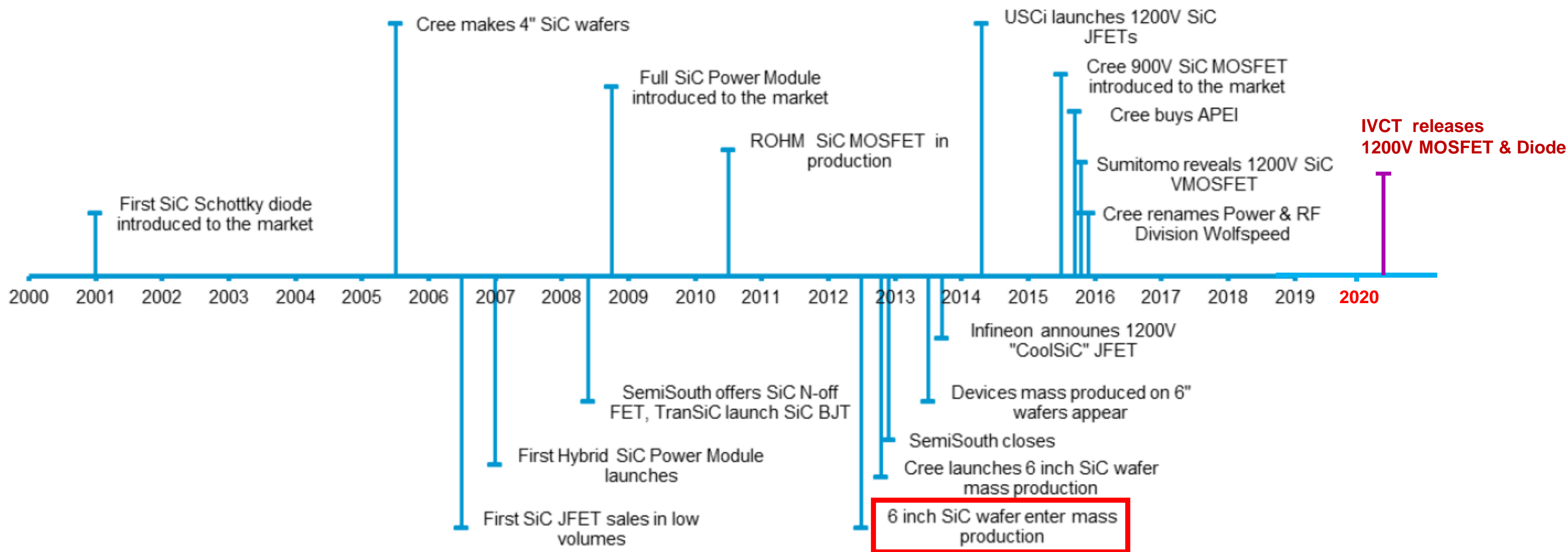
SiC Technology Milestones



In Sept. 2012, Cree's announcement of 6" SiC mass production is the turning point of the technology's consumerization.

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SiC MOSFET/Diode Qualification and Reliability

JEDEC Standard for SiC devices (JC-70.2 , Not ready yet)
High temperature reverse bias (HTRB)
High temperature fate bias (HTGB)

Chip level test

High temperature, high humidity and high reverse bias (H3TRB)
HV-H3TRB
HASS (High Temp, High Humility, High Air Pressure)
Thermal cycling (TC)
Power cycling/Intermittent Operation Life (IOL)
Unclamped inductive switching (UIS)/ Avalanche
Short circuit tests (SC)
Cosmic rays
Vibration
Mechanical shock

Package level test

Hammer tests
Application soft switching and hard switching tests

System level test

SiC Industrial-Grade Qualification beyond Si JEDEC Limits

Test	Si Conditions	SiC Conditions
HTRB	JEDEC 150°C	JEDEC 150°C /175°C
HV-H3TRB	JEDEC 100V	JEDEC 80% Vds rating
HTGB	JEDEC	JEDEC
IOL	Not required	AEC-Q101/MIL-STD-750
TC	JEDEC -55°C-150°C	JEDEC -55°C-150°C /175°C
HAST	JEDEC	JEDEC

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Qualification vs Reliability

- Qualification analysis is based on accelerated test models
- Pass-fail outcome reflects whether the product exceeds a minimum acceptable key indicator
- Qual Pass ≠ reliable in the lifetime
- Qualification is a “gate”, while Reliability is a “marathon”

Qualification Test

Extended tests with data collection

Highly accelerated tests

End Products

Problem Solution

Reliability Issues

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Hammer and Burn-In Test Purposes

Switching Devices should be tested in switching mode!

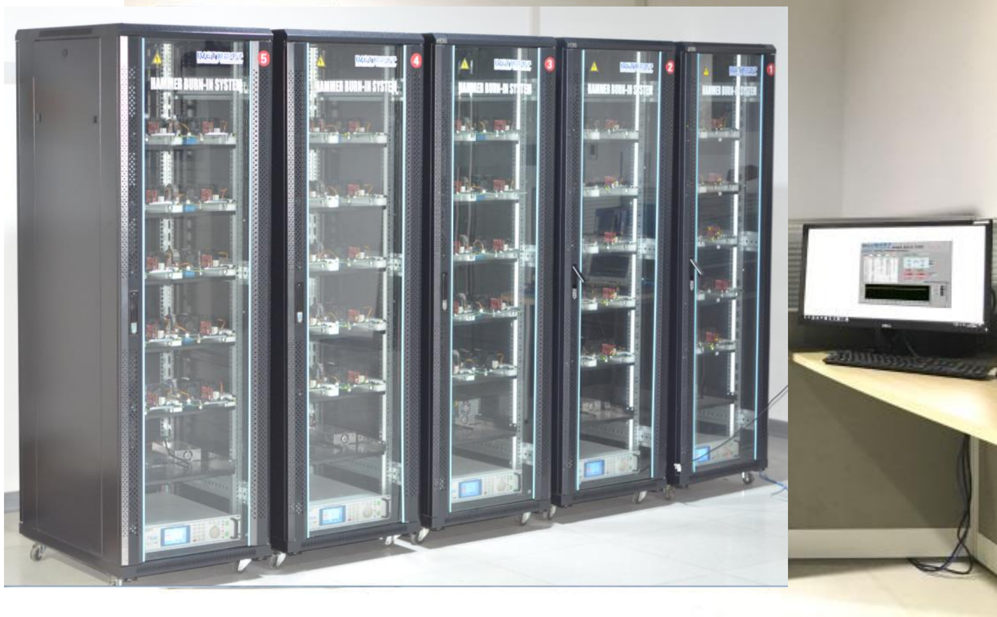
- Stress power devices with any combination of Vds bias, gate voltage, dv/dt, di/dt and elevated temperature
- Mimic real applications
- Find device weakness
- Find early failure or duplicate application failure mode for device problem debugging
- Collect quantitative reliability data (device-hours)
- Predict devices' real application lifetime
- Product screen

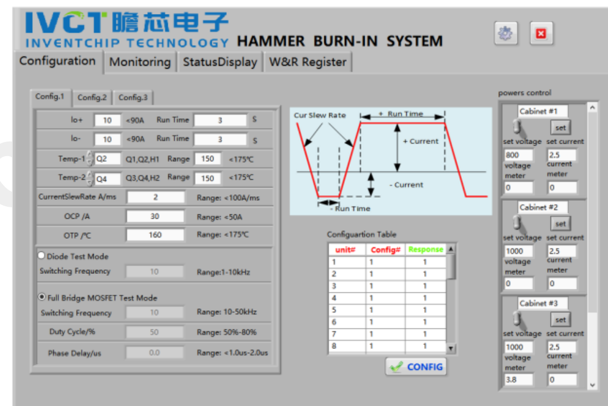
IVCT Hammer and Burn-In System

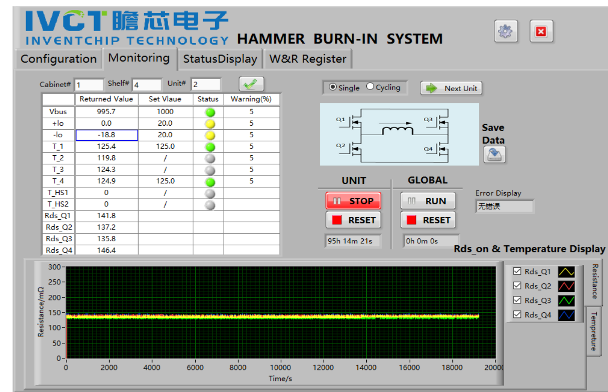
Emulate real applications-模拟真实应用

Collect Device-Hour reliability data-收集长时可靠性数据

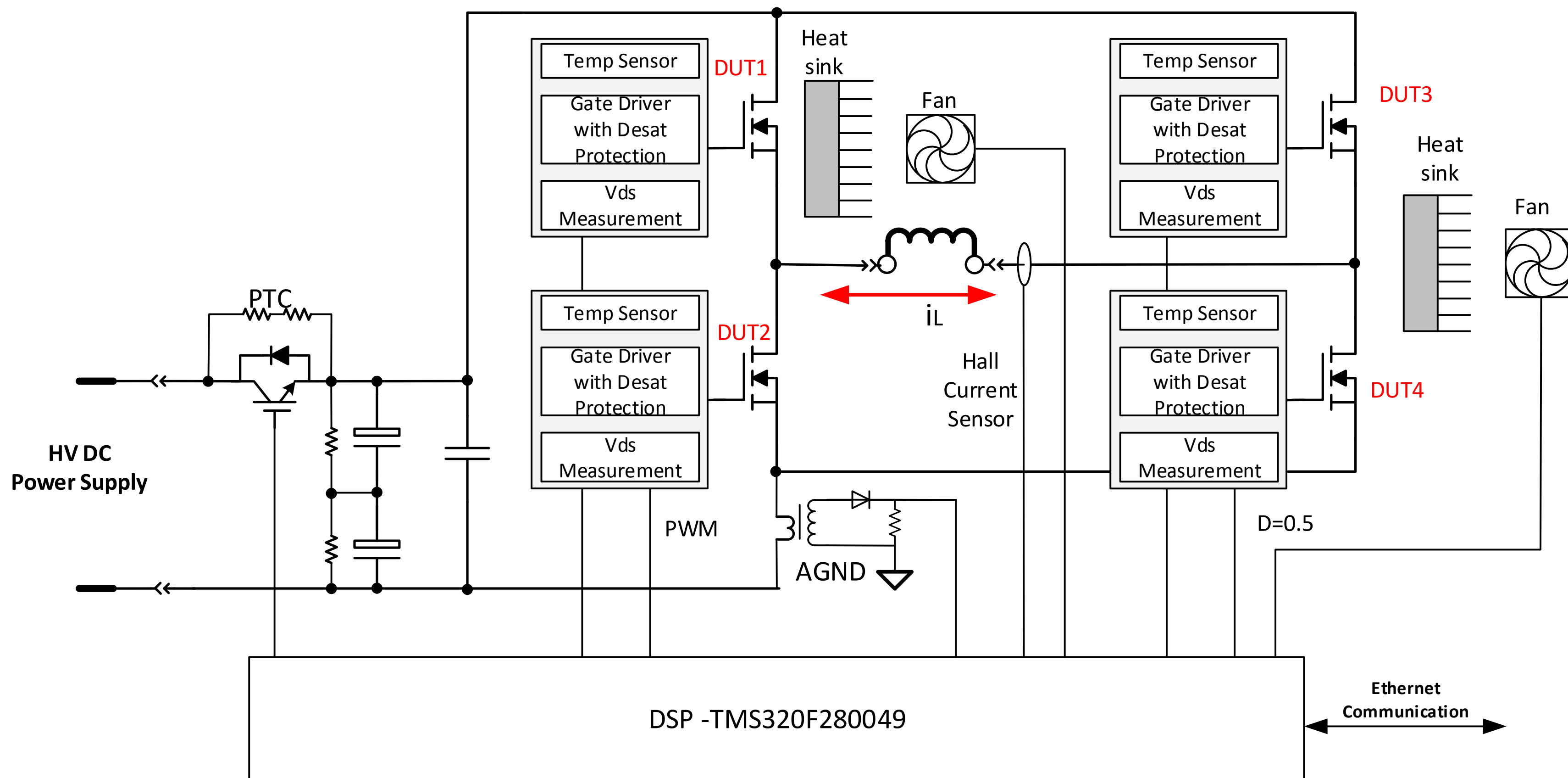
高温高压大电流老化系统



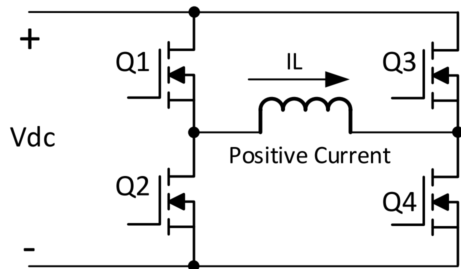




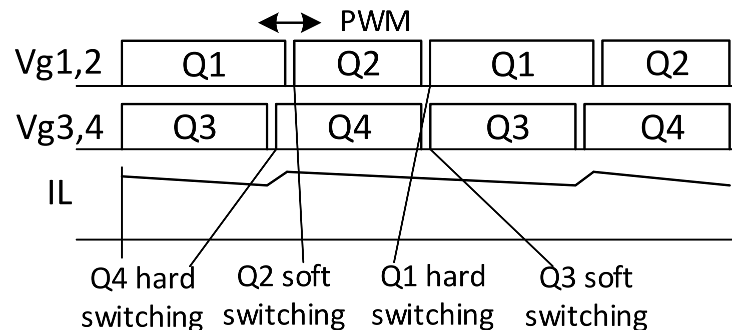
IVCT Hammer and Burn-In System



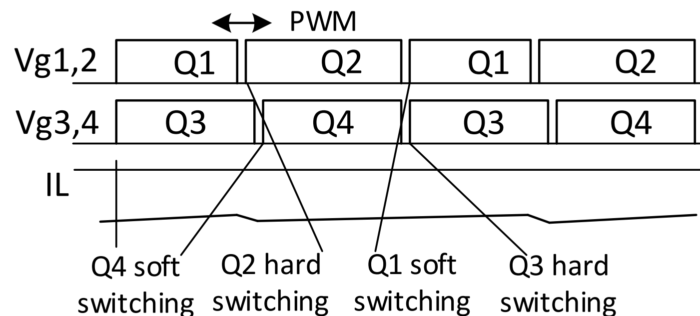
Soft-Switching and Hard-Switching Operations



Positive Current Operation

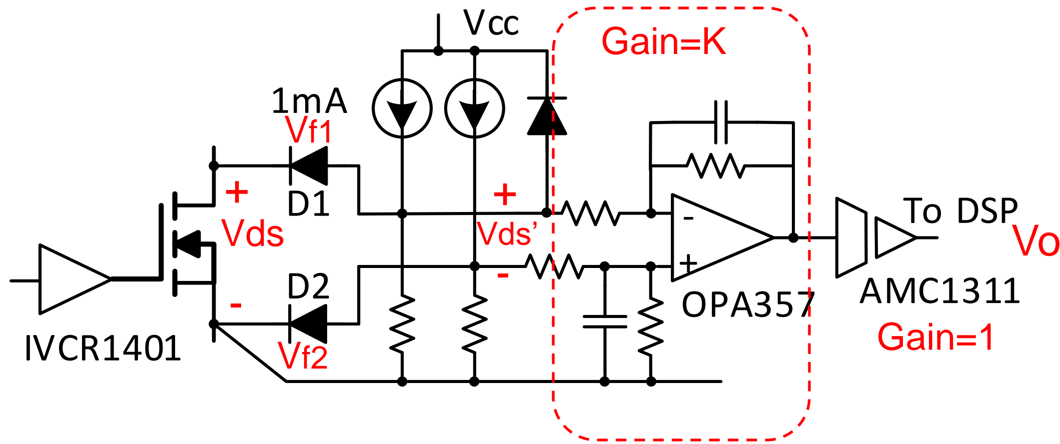


Negative Current Operation



Energy can be recycled efficiently.
System consumes no power except the device losses.

Real-time Dynamic Rds_on Sensing



D1 and D2 are well matched high voltage isolation diodes => $Vf1 = Vf2$

$$Vds' = Vds + Vf1 - Vf2 = Vds$$

$$Vo = K \cdot Vds$$

Vo and the inductor current are sensed simultaneously for Rds_on calculation

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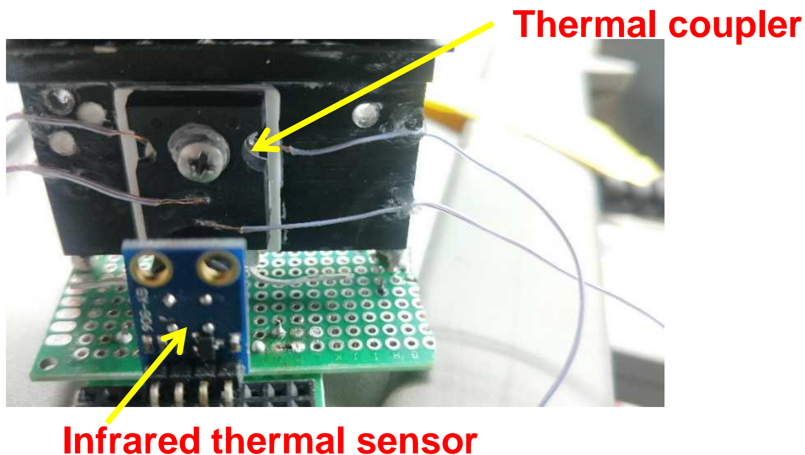
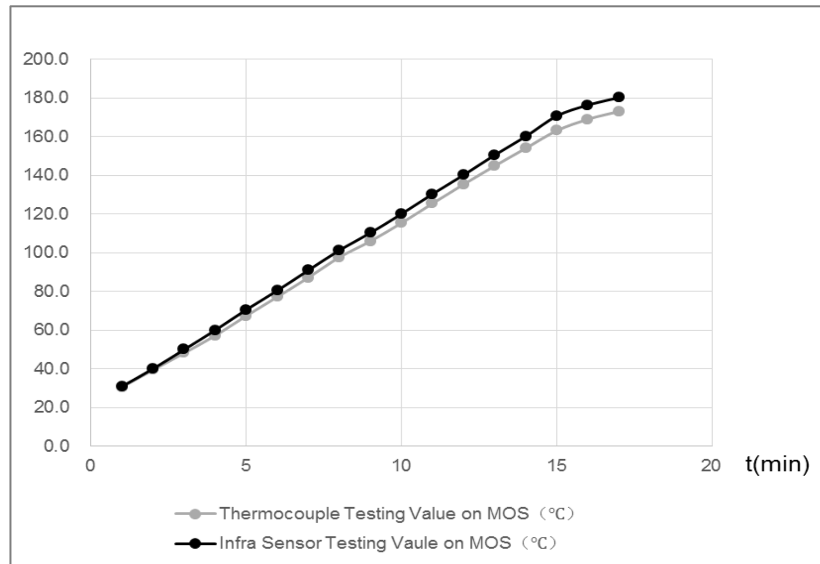
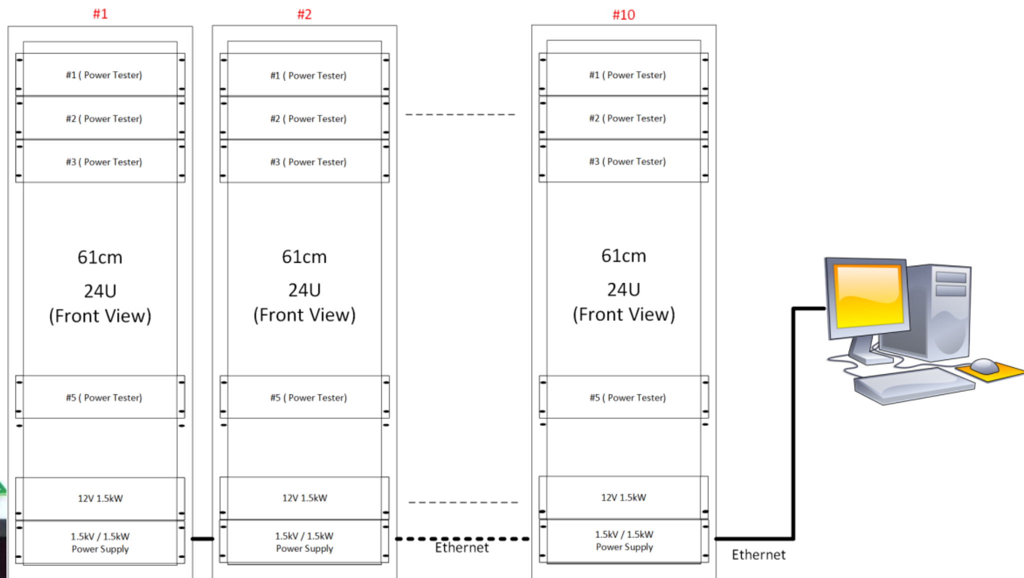
Real-time Device Temperature Measurement





- Infrared sensor remotely senses temperature, more suitable for device test
- Infrared sensor can achieve more accurate device temperature sensing

IVCT SiC Device Hammer Burn-In System

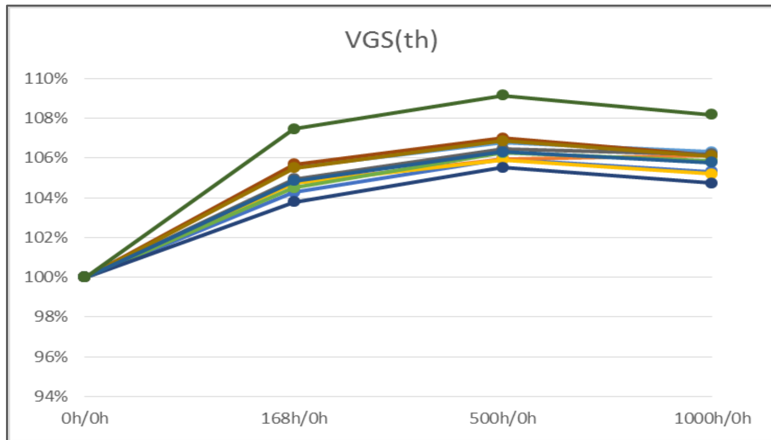


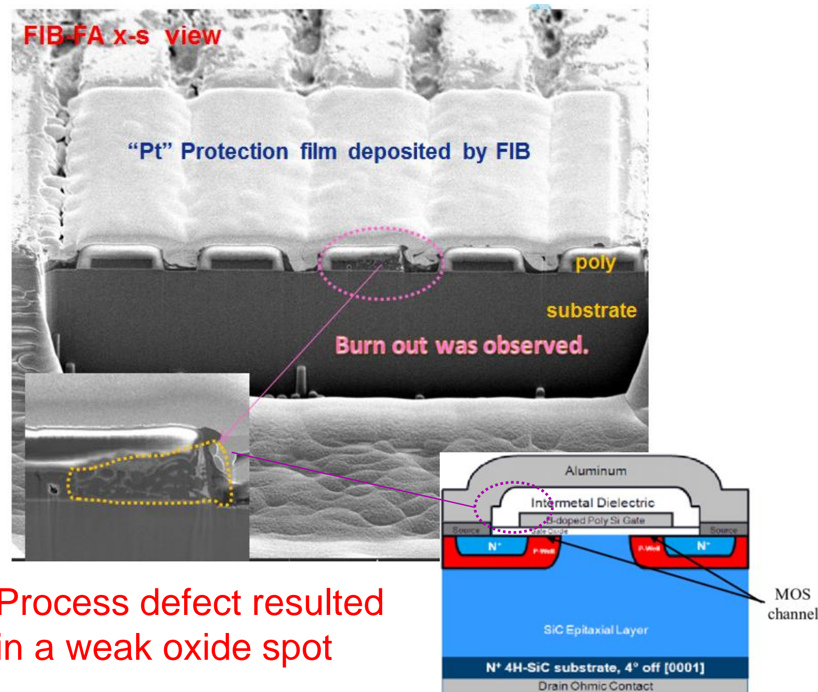
Test Configuration and Data logging

- Flexible test settings
- Settable warning and protection thresholds
- Selectable MOSFET and Diode test
- Suitable for TO-247-2L/3L/4L and TO-220

- Real-time Rds_on and device temperature monitoring
- Selectable static or alternating unit monitoring
- Auto data logging

Device Analysis Examples After Hammer Tests





Process defect resulted in a weak oxide spot

- How stable device's parameters can be
- Help to find out design problems, material defect and process issues in the early development phase
- Test to device limitation and find out weakness in real application modes

Summary

- A hammer and burn-in system is introduced. It is a powerful supplemental SiC device test equipment
- Application-oriented test is a necessary step to ensure product reliability
- The system is able to accelerate product development
- Able to collect quantitative device-hours of real operation before product release
- The system is energy efficient, it consumes only device power losses.

临港滴水湖

谢谢！

Thank You！