

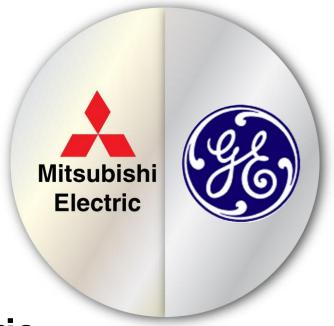
IGBT Reliability Issues and Needs

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Powerex The Most Powerful Alliance in the Power-Electronics Field



General Electric Mitsubishi Electric



- Corporate offices in Youngwood, PA
- 280 employees
- 120,000 square feet of facilities
- Design & manufacture
 - Rectifiers and Thyristors
 - Custom Modules
 - Integrated POW-R-PAKs
- Sales & Marketing, Engineering, & Logistics for Mitsubishi in the Americas
 - IGBTs, IPMs, & MOSFET Modules





Topics

- Failure Modes
- Mitigation
- Industry perspective
- Future Advances
- Predictive Data
- Switching scheme robustness



Failure Modes

- Voltage
- Current
- SwSOA
- Temperature
- Mechanical (cycling/fatigue)



Voltage

IGBTs have very limited avalanche capability so the rated voltage must never be exceeded...

Not even for a nano-second!!



Voltage

- Over Voltage
- Cosmic Ray Effect



Current

Tj Max



SwSOA

- Voltage
- Current
- Desaturation linear operation



Temperature

• Tj Max



Cycling/Fatigue

- Power Cycling ΔTj
- Thermal Cycling ΔTc



Mitigation - Voltage

- Voltage Margin
- Low Inductance Bus
- Snubbers

Consider Cosmic Ray Effect



Mitigation - Current

Tj max Margin



Mitigation - SwSOA

- Voltage/Current Limits
- Gate Drive Design



Mitigation - Temperature

- Design Margin
- Know Your Customer/Application



Mitigation – Cycling/Fatigue

- Understand and Consider Up Front
- Limit ΔT



Industry Perspective

- IGBT Modules are Reliable
- IGBT is an Innocent Victim
- 30-50 FIT → < 1 FIT



Future Advances

- Lower Loss Chips
- Innovative Packaging



Predictive Data

• ?

Proprietary



Switching Scheme Robustness

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- Margin
- Limit Aggressiveness
- Know Your Application and Customer
- Field Test



