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

- $T_j$ Max
Cycling/Fatigue

- Power Cycling $\Delta T_j$
- Thermal Cycling $\Delta T_c$
Mitigation - Voltage

• Voltage Margin

• Low Inductance Bus

• Snubbers

• Consider Cosmic Ray Effect
Mitigation - Current

- $T_j \max \text{ Margin}$
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 $\Delta T$
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

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