

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 ΔT_j**
- **Thermal Cycling ΔT_c**

Mitigation - Voltage

- **Voltage Margin**
- **Low Inductance Bus**
- **Snubbers**
- **Consider Cosmic Ray Effect**

Mitigation - Current

- **T_j 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

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

Q & A

