IGBT MODULE

MBM450FS33F

Silicon N-channel IGBT 3300V F version

FEATURES
* High current density package
* Low stray inductance & low Rth(j-c)
* Half-bridge (2n1)
* Built in temperature sensor
* Scalable large current easily handled by paralleling
* Equipped with current sensing terminals

ABSOLUTE MAXIMUM RATINGS (Tc=25°C)

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Unit</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector Emitter Voltage</td>
<td>VCES</td>
<td>V</td>
<td>-</td>
<td>0.30</td>
<td>3,300</td>
<td>VCES=3,300V, VGE=0V, Tj=25°C</td>
</tr>
<tr>
<td>Gate Emitter Voltage</td>
<td>VGES</td>
<td>V</td>
<td>±20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector Current</td>
<td>IC</td>
<td>mA</td>
<td>-</td>
<td>15</td>
<td>50</td>
<td>VCE=3,300V, VGE=0V, Tj=150°C</td>
</tr>
<tr>
<td>DC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1ms</td>
<td>IC1m</td>
<td>A</td>
<td>-</td>
<td>900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Current</td>
<td>IF</td>
<td>A</td>
<td>-</td>
<td>450</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1ms</td>
<td>IF1m</td>
<td>A</td>
<td>-</td>
<td>900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>TVJ</td>
<td>°C</td>
<td>-50</td>
<td></td>
<td>150</td>
<td>VCE=10V, VGE=0V</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>TVS</td>
<td>°C</td>
<td>-55</td>
<td></td>
<td>150</td>
<td>VCE=10V, VGE=0V</td>
</tr>
<tr>
<td>Isolation Voltage</td>
<td>VISO</td>
<td></td>
<td>6,000</td>
<td></td>
<td></td>
<td>(AC 1 minute)</td>
</tr>
<tr>
<td>Screw Torque</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.815</td>
<td>M x 0.8 (1)</td>
</tr>
<tr>
<td>Terminals (M3/M8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.0</td>
<td>(1)</td>
</tr>
<tr>
<td>Mounting (M6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: (1) Recommended Value 5.5±0.5N-m

ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Unit</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector Emitter Cut-Off Current</td>
<td>ICES</td>
<td>mA</td>
<td>-</td>
<td>0.0</td>
<td>450</td>
<td>VCE=450A, VGE=15V, TVj=25°C</td>
</tr>
<tr>
<td>Gate Emitter Leakage Current</td>
<td>IGES</td>
<td>nA</td>
<td>-500</td>
<td></td>
<td>+500</td>
<td>VCE=120V, VGE=0V, Tj=25°C</td>
</tr>
<tr>
<td>Collector Emitter Saturation Voltage</td>
<td>VCEsat</td>
<td>V</td>
<td>1.3</td>
<td>1.1</td>
<td>1.0</td>
<td>T=150°C</td>
</tr>
<tr>
<td>Gate Emitter Threshold Voltage</td>
<td>VGE(th)</td>
<td>V</td>
<td>0.48</td>
<td>-</td>
<td>-</td>
<td>IC=0V, T=25°C</td>
</tr>
<tr>
<td>Input Capacitance</td>
<td>C_{G E}</td>
<td>nF</td>
<td>24</td>
<td>-</td>
<td>-</td>
<td>VCE=10V, VGE=0V, f=100kHz, TVj=25°C</td>
</tr>
<tr>
<td>Internal Gate Resistance</td>
<td>R_{G E}</td>
<td>Ω</td>
<td>6.2</td>
<td>-</td>
<td>-</td>
<td>VCE=10V, VGE=0V, f=100kHz, TVj=25°C</td>
</tr>
<tr>
<td>Turn On Delay Time</td>
<td>t_{on}</td>
<td>μs</td>
<td>0.48</td>
<td>-</td>
<td>-</td>
<td>VCE=1800V, IC=450A</td>
</tr>
<tr>
<td>Rise Time</td>
<td>tr</td>
<td>μs</td>
<td>0.12</td>
<td>-</td>
<td>-</td>
<td>Ls=40nH</td>
</tr>
<tr>
<td>Turn Off Delay Time</td>
<td>t_{off}</td>
<td>μs</td>
<td>1.10</td>
<td>-</td>
<td>-</td>
<td>R_{on/off}=6.8Ω/12Ω</td>
</tr>
<tr>
<td>Fall Time</td>
<td>tf</td>
<td>μs</td>
<td>1.30</td>
<td>-</td>
<td>-</td>
<td>VGE=±15V, TVj=150°C</td>
</tr>
<tr>
<td>Forward Voltage Drop</td>
<td>VF</td>
<td>V</td>
<td>2.25</td>
<td>-</td>
<td>-</td>
<td>V=450A, VGE=0V, TVj=25°C</td>
</tr>
<tr>
<td>Reverse Recovery Time</td>
<td>tr</td>
<td>μs</td>
<td>1.10</td>
<td>-</td>
<td>-</td>
<td>VCE=1800V, Iref=450A, Ls=40nH</td>
</tr>
<tr>
<td>Turn-on Loss per Pulse</td>
<td>E_{on}</td>
<td>J/P</td>
<td>0.73</td>
<td>-</td>
<td>-</td>
<td>VCE=1800V, Iref=450A, Ls=40nH</td>
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<tr>
<td>Turn-off Loss per Pulse</td>
<td>E_{off}</td>
<td>J/P</td>
<td>0.63</td>
<td>-</td>
<td>-</td>
<td>R_{on/off}=6.8Ω/12Ω</td>
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<tr>
<td>Reverse Recovery Loss per Pulse</td>
<td>E_{r}</td>
<td>J/P</td>
<td>0.68</td>
<td>-</td>
<td>-</td>
<td>VCE=±15V, TVj=150°C</td>
</tr>
<tr>
<td>Short Circuit Pulse Width</td>
<td>t_{sc}</td>
<td>μs</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>VCE=2200V, Ls=40nH</td>
</tr>
<tr>
<td>Stray Inductance Module</td>
<td>L_{SC}</td>
<td>nH</td>
<td>9</td>
<td>-</td>
<td>-</td>
<td>Between C1(main) and E2(main)</td>
</tr>
<tr>
<td>NTC-Thermistor</td>
<td>R_{TN}</td>
<td>kΩ</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>T=25°C</td>
</tr>
<tr>
<td>B-constant</td>
<td>B_{25(50)}</td>
<td>K</td>
<td>3375</td>
<td>-</td>
<td>-</td>
<td>Between 25°C and 50°C</td>
</tr>
<tr>
<td>Thermal Impedance</td>
<td>R_{th(j-c)}</td>
<td>kW</td>
<td>0.035</td>
<td>-</td>
<td>-</td>
<td>Junction to case</td>
</tr>
<tr>
<td>Contact Thermal Impedance</td>
<td>R_{th(c-j)}</td>
<td>kW</td>
<td>0.02</td>
<td>-</td>
<td>-</td>
<td>Case to fin (per 1 arm)</td>
</tr>
</tbody>
</table>

Notes: (2) R_{th} value is a test condition value for evaluation, not recommended value.
* Please determine the suitable R_{th} value by measuring switching behavior and checking results with the respective SOA.
* Please contact our representatives at order. * For improvement, specifications are subject to change without notice.
* For actual application, please confirm this spec sheet is the newest revision.
* ELECTRICAL CHARACTERISTIC items shown in above table are according to IEC 60747–2 and IEC 60747–9.
OUTLINE DRAWING

Unit in mm

Weight: 770(g)
### Turn-on Loss vs. Collector Current

**Conditions**
- $L_s = 40 \text{nH}$
- $V_{CC} = 1800 \text{V}$
- $R_{G \_on/off} = 6.8 \Omega / 12 \Omega$
- $V_{GE} = \pm 15 \text{V}$

**Equations**
- **$T_v = 25 \text{C}$**
  - $E_{on} = -1.84 \times 10^{-12} x^4 + 3.82 \times 10^{-9} x^3 - 1.88 \times 10^{-6} x^2 + 1.34 \times 10^{-3} x + 2.67 \times 10^{-2}$
- **$T_v = 150 \text{C}$**
  - $E_{on} = -3.62 \times 10^{-12} x^4 + 7.74 \times 10^{-9} x^3 - 3.92 \times 10^{-6} x^2 + 2.06 \times 10^{-3} x + 4.71 \times 10^{-2}$

### Turn-off Loss vs. Collector Current

**Conditions**
- $L_s = 40 \text{nH}$
- $V_{CC} = 1800 \text{V}$
- $R_{G \_on/off} = 6.8 \Omega / 12 \Omega$
- $V_{GE} = \pm 15 \text{V}$

**Equations**
- **$T_v = 25 \text{C}$**
  - $E_{off} = 2.71 \times 10^{-10} x^3 - 4.81 \times 10^{-7} x^2 + 1.45 \times 10^{-3} x + 5.39 \times 10^{-2}$
- **$T_v = 150 \text{C}$**
  - $E_{off} = 1.97 \times 10^{-10} x^3 - 2.94 \times 10^{-7} x^2 + 1.05 \times 10^{-3} x + 3.25 \times 10^{-2}$

### Recovery Loss vs. Forward Current

**Conditions**
- $L_s = 40 \text{nH}$
- $V_{CC} = 1800 \text{V}$
- $R_{G \_on/off} = 6.8 \Omega / 12 \Omega$
- $V_{GE} = \pm 15 \text{V}$

**Equations**
- **$T_v = 25 \text{C}$**
  - $E_{rev} = 4.15 \times 10^{-10} x^3 - 1.05 \times 10^{-6} x^2 + 1.14 \times 10^{-3} x + 5.99 \times 10^{-2}$
- **$T_v = 150 \text{C}$**
  - $E_{rev} = 6.76 \times 10^{-10} x^3 - 1.90 \times 10^{-6} x^2 + 1.89 \times 10^{-3} x + 1.55 \times 10^{-1}$

### Switching time vs. Collector Current

**Conditions**
- $T_v = 150 \text{C}$
- $L_s = 40 \text{nH}$
- $V_{CC} = 1800 \text{V}$
- $R_{G \_on/off} = 6.8 \Omega / 12 \Omega$
- $V_{GE} = \pm 15 \text{V}$

**Equations**
- $t_{on} = 4.58 \times 10^{-3} x + 5.99 \times 10^{-2}$
- $t_{off} = 1.97 \times 10^{-3} x - 2.94 \times 10^{-7} x^2 + 1.05 \times 10^{-3} x + 3.25 \times 10^{-2}$
**MBM450FS33F**

**IGBT MODULE**

**Spec.No.IGBT-SP-14035 R6**

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**Turn-on Loss vs. Gate Resistance**

- **Conditions**
  - $T_{j} = 150^\circ C$
  - $L_{s} = 40nH$
  - $V_{CC} = 1800V$
  - $I_{C} = 450A$
  - $V_{GE} = \pm 15V$

**Typical**

**Turn-off Loss vs. Gate Resistance**

- **Conditions**
  - $T_{j} = 150^\circ C$
  - $L_{s} = 40nH$
  - $V_{CC} = 1800V$
  - $I_{C} = 450A$
  - $V_{GE} = \pm 15V$

**Reverse Recovery Loss vs. Gate Resistance**

- **Conditions**
  - $T_{j} = 150^\circ C$
  - $L_{s} = 40nH$
  - $V_{CC} = 1800V$
  - $I_{C} = 450A$
  - $V_{GE} = \pm 15V$

**Switching time vs. Gate Resistance**

- **Conditions**
  - $T_{j} = 150^\circ C$
  - $L_{s} = 40nH$
  - $V_{CC} = 1800V$
  - $I_{C} = 450A$
  - $V_{GE} = \pm 15V$
**Reverse bias safe operation area (RBSOA)**

- **Conditions**:
  - \( Vcc \leq 2200\text{V} \)
  - \( Ic \leq 900\text{A} \)
  - \( R_{\text{OFF}} \geq 12\Omega \)
  - \( VGE = \pm 15\text{V} \)
  - \( Tvj = 150\text{°C} \)
  - \( Ls \leq 40\text{nH} \)
  - Pulse width \( \geq 10\mu\text{s} \)
  - (Vce spike voltage and Ls are defined at auxiliary terminal)

- **Diagram**:
  - Graph showing IC (to be turned off) vs. VCE (spike Voltage) at auxiliary terminal.
  - Pmax \( \leq 900\text{kw} \)
  - [Definition of Recovery di/dt]
  - \( \frac{di/dt}{\Delta t} = \frac{0.5Irm}{\Delta t} \)
  - \( I_{\text{rm}} \)
  - \( 0.5I_{\text{rm}} \)

**Reverse Recovery SOA**

- **Conditions**:
  - \( Ls \leq 40\text{nH} \)
  - \( Vcc \leq 2200\text{V} \)
  - \( Ic \leq 900\text{A} \)
  - \( R_{\text{OFF}} \geq 12\Omega \)
  - \( VGE = \pm 15\text{V} \)
  - \( Tvj = 150\text{°C} \)
  - Pulse width \( \geq 10\mu\text{s} \)
  - (Vce spike voltage and Ls are defined at auxiliary terminal)

- **Diagram**:
  - Graph showing IR vs. VR at auxiliary terminal.
**IGBT MODULE**

**MBM450FS33F**

**Collector to Emitter Voltage, VCE (V)**

- Conditions:
  - $T_j=25\,^\circ C$
  - $f=100\,kHz$

**Typical**

- Capacitance vs. Collector to Emitter Voltage
  - $C_{ies}$, $C_{oes}$, $C_{res}$

- Transient Thermal Impedance, $Z_{th}(t)$ (K/W)

- Thermistor Resistance vs. Temperature

- Transient Thermal Impedance Curve

- Thermistor Resistance (kΩ)

- Maximum

**Unit**

<table>
<thead>
<tr>
<th>$n$</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tau_{th}[n]$</td>
<td>1.80E-01</td>
<td>2.04E-02</td>
<td>7.46E-04</td>
<td>3.04E-03</td>
</tr>
<tr>
<td>$r_{th}[n,I4D]$</td>
<td>2.52E-02</td>
<td>4.70E-03</td>
<td>7.66E-04</td>
<td>4.38E-03</td>
</tr>
<tr>
<td>$r_{th}[n,Diode]$</td>
<td>4.70E-03</td>
<td>1.02E-02</td>
<td>7.42E-04</td>
<td>6.74E-03</td>
</tr>
</tbody>
</table>

**Case Temperature, $T_c$ (°C)**

- $Z_{th}(t_c)$ (K/W)

- Time, $t$ (s)

- $\Sigma r_{th}[n]*(1-\exp(\frac{-t}{\tau_{th}[n]}))$
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