**2MBI1000XRNE120-50**

**IGBT Modules**

**Power Module (X series)**
1200V / 1000A / 2-in-1 package

■ **Features**
- Low $V_{CE(sat)}$
- Low Inductance Module structure
- Solder pin terminals

■ **Applications**
- Inverter for Motor Drives, AC and DC Servo Drives
- Uninterruptible Power Supply Systems, Wind Turbines, PV Power Conditioning Systems

■ **Outline drawing (Unit: mm)**

![Outline drawing](image)

■ **Equivalent Circuit**

![Equivalent Circuit](image)
### Absolute Maximum Ratings (at $T_C = 25°C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Items</th>
<th>Symbols</th>
<th>Conditions</th>
<th>Maximum Ratings</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-emitter voltage, gate-emitter short-circuited</td>
<td>$V_{GES}$</td>
<td></td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>Gate-emitter voltage, collector-emitter short-circuited</td>
<td>$V_{GES}$</td>
<td></td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Collector current</td>
<td>$I_C$</td>
<td>Continuous</td>
<td>$T_C=100°C$</td>
<td>1000 A</td>
</tr>
<tr>
<td>Repetitive peak collector current</td>
<td>$I_{CRM}$</td>
<td>1ms</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>Reverse-conducting current</td>
<td>$I_{RC}$</td>
<td></td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak reverse-conducting current</td>
<td>$I_{RCRM}$</td>
<td>1ms</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$</td>
<td>1 device</td>
<td>8330</td>
<td>W</td>
</tr>
<tr>
<td>Virtual junction temperature</td>
<td>$T_{vj}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>Operating virtual junction temperature (under switching conditions)</td>
<td>$T_{v_{opp}}$</td>
<td></td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>Case temperature</td>
<td>$T_c$</td>
<td></td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td></td>
<td>-40 ~ 150</td>
<td></td>
</tr>
<tr>
<td>Isolation voltage between terminals and copper base (*1)</td>
<td>$V_{isol}$</td>
<td>AC: 1min.</td>
<td>4000</td>
<td>Vrms</td>
</tr>
<tr>
<td>Isolation voltage between thermistor and others (*2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting torque for screws to heatsink (*3)</td>
<td>$M_s$</td>
<td>M5</td>
<td>6.0</td>
<td>N·m</td>
</tr>
<tr>
<td>Mounting torque for terminal screws (*3)</td>
<td>$M_t$</td>
<td>M6</td>
<td>6.0</td>
<td>N·m</td>
</tr>
</tbody>
</table>

(*1) All terminals should be connected together during the test.

(*2) Two thermistor terminals should be connected together, other terminals should be connected together

(*3) Recommendable Value: Mounting torque of screws to heatsink 2.5 ~ 6.0 N·m (M5)
Recommendable Value: Mounting torque of screws to terminals 3.5 ~ 6.0 N·m (M6)
## Electrical characteristics (at $T_{vj}=25°C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Items</th>
<th>Symbols</th>
<th>Conditions</th>
<th>Characteristics</th>
<th>Units</th>
</tr>
</thead>
</table>
| Collector-emitter cut-off current, Collector current | $I_{CES}$ | $V_{GE} = 0V$  
$V_{CE} = 1200V$ | min. | -  
max. | 200 μA |
| Gate leakage current, collector-emitter short-circuited | $I_{GES}$ | $V_{GE}=0V$, $V_{GE}=±20V$ | -  | -  
max. | 400 nA |
| Gate-emitter threshold voltage        | $V_{GE(th)}$ | $V_{CE} = 20V$  
$I_{C} = 1000mA$ | min. | 5.8  
typ. | 6.4  
max. | 7.0  |
| Collector-emitter saturation voltage  | $V_{CE(sat)}$ | $V_{CE(sat)}(terminal)$  
$V_{CE(sat)}(chip)$  
$I_{C}= 15V$  
$I_{C}= 1000A$ | $T_{vj}=25°C$ | -  
$T_{vj}=125°C$ | -  
max. | 3.30 |
| Internal gate resistance              | $r_{g}$       | -                               | - | 0.95  
max. | -  |
| Input capacitance                    | $C_{ies}$     | $V_{CE}=10V$, $V_{GE}=0V$, $f=1MHz$ | - | 126  
max. | -  |
| Output capacitance                   | $C_{res}$     | -                               | - | 5.3  
max. | -  |
| Reverse transfer capacitance         | $C_{res}$     | -                               | - | 1.19  
max. | -  |
| Gate charge                           | $Q_G$         | $V_{CC} = 600V$, $I_{C} = 1000A$  
$V_{GE} = -15 \rightarrow +15V$ | - | 7.8  
max. | -  |
| Reverse-conducting voltage           | $V_{RC}$      | $V_{RC}(terminal)$  
$V_{RC}(chip)$  
$I_{RC} = 1000A$  
$I_{RC} = 0V$ | $T_{vj}=25°C$ | -  
$T_{vj}=125°C$ | -  
$T_{vj}=150°C$ | -  
$T_{vj}=175°C$ | -  
max. | 3.30 |
| Turn-on delay time (*1)               | $t_{d(on)}$   | $V_{CC} = 600V$  
$I_{C}, I_F = 1000A$  
$V_{GE} = +15V / -15V$  
$R_G = 0.5Ω$  
$L_g = 35 nF$ | $T_{vj}=25°C$ | -  
$T_{vj}=125°C$ | -  
$max. | 0.42  |
| Rise time                             | $t_r$         | -                               | - | 0.11  
max. | -  |
| Turn-off delay time (*2)              | $t_{d(off)}$  | -                               | - | 0.12  
max. | -  |
| Fall time                             | $t_f$         | -                               | - | 0.12  
max. | -  |
| Forward recovery time                 | $t_f$         | -                               | - | 0.12  
max. | -  |

(*) Turn on time ($t_{on}$) = $t_{d(on)} + t_r$

(‡) Turn off time ($t_{off}$) = $t_{d(off)} + t_f$
## Electrical characteristics (at $T_{vj}=25^\circ C$ unless otherwise specified)

<table>
<thead>
<tr>
<th>Items</th>
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<th>Conditions</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter</td>
<td>$E_{on}$</td>
<td>$V_{DC} = 600V$</td>
<td>$T_{vj}=25^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_C, I_F = 1000A$</td>
<td>$T_{vj}=125^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GE} = +15V / -15V$</td>
<td>$T_{vj}=150^\circ C$</td>
</tr>
<tr>
<td>turn-on energy (per pulse)</td>
<td></td>
<td>$R_G = 0.5\Omega$</td>
<td>$T_{vj}=175^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$L_S = 35,nH$</td>
<td>$T_{vj}=25^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$T_{vj}=125^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$T_{vj}=150^\circ C$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$T_{vj}=175^\circ C$</td>
</tr>
<tr>
<td>Turn-off energy (per pulse)</td>
<td>$E_{off}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward recovery energy (per pulse)</td>
<td>$E_{fr}$</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermistor</td>
<td>$R$</td>
<td>$T = 25^\circ C$</td>
<td>5000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T = 100^\circ C$</td>
<td>465</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>495</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>520</td>
</tr>
<tr>
<td>Resistance</td>
<td>$B$</td>
<td>$T = 25/ 50^\circ C$</td>
<td>3305</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3375</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3450</td>
</tr>
</tbody>
</table>

**NOTICE:**
The external gate resistance ($R_G$) shown above is one of our recommended value for the purpose of minimum switching loss. However the optimum $R_G$ depends on circuit configuration and/or environment. We recommend that the $R_G$ has to be carefully chosen based on consideration if IGBT module matches design criteria, for example, switching loss, EMC/EMI, spike voltage, surge current and no unexpected oscillation and so on.

## Thermal resistance characteristics

<table>
<thead>
<tr>
<th>Items</th>
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<th>Conditions</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance junction to case(1 device)</td>
<td>$R_{th(j-c)}$</td>
<td>Inverter IGBT</td>
<td>0.018</td>
</tr>
<tr>
<td>Thermal resistance case to heatsink(1 IGBT+1 FWD)(**1)</td>
<td>$R_{th(c-s)}$</td>
<td>with 1 W/(m·K) thermal grease</td>
<td>0.0125</td>
</tr>
</tbody>
</table>

(**1) This is the value which is defined mounting on the additional heatsink with thermal grease.
**IGBT Modules**

- **$E_{on}$ vs. Collector current (typ.)**
  - $V_{CC} = 600V$, $V_{GE} = +15V / -15V$, $R_G = 0.5\Omega$
  - [Graph showing $E_{on}$ vs. $I_C$ for different temperatures: 25°C, 125°C, 150°C, 175°C]

- **$E_{off}$ vs. Collector current (typ.)**
  - $V_{CC} = 600V$, $V_{GE} = +15V / -15V$, $R_G = 0.5\Omega$
  - [Graph showing $E_{off}$ vs. $I_C$ for different temperatures: 25°C, 125°C, 150°C, 175°C]

- **$E_{fr}$ vs. Gate resistance (typ.)**
  - $V_{CC} = 600V$, $V_{GE} = +15V / -15V$, $I_C = 1000A$
  - [Graph showing $E_{fr}$ vs. $R_G$ for different temperatures: 25°C, 125°C, 150°C, 175°C]

- **$E_{fr}$ vs. Reverse-conducting current (typ.)**
  - $V_{CC} = 600V$, $V_{GE} = +15V / -15V$, $R_G = 0.5\Omega$
  - [Graph showing $E_{fr}$ vs. $I_{RC}$ for different temperatures: 25°C, 125°C, 150°C, 175°C]
Switching time vs. Collector current (typ.)

Switching time vs. Gate resistance (typ.)

Reverse bias safe operating area (max.)

Notice) Switching characteristics of $V_{CE}$ is defined between Sense C and Sense E1 for Upper arm and Sense E1 and Sense E2 for Lower arm.
2MBI1000XRNE120-50

IGBT Modules

Reverse-conducting current vs. Reverse-conducting voltage (typ.)

Collector-emitter voltage: \( V_{CE} \) [V]

Forward recovery current:

\[ I_{Fr} \] [A]

Forward recovery time:

\[ t_{fr} \] [nsec]

FWD safe operation area (max.)

\( T_{vj} = 175^\circ \text{C} \)

\( P_{max} = 600kW \)

Transient thermal impedance junction to case

\[ Z_{th(j-c)} \] [K/W]

(1) \[ Z_{th(j-c)} = \sum_{n=1}^{4} r_n \left( 1 - e^{-\frac{1}{\tau_n}} \right) \]

Reverse-conducting voltage:

\( V_{RC} \) [V]

Forward recovery current:

\[ I_{Fr} \] [A]

Reverse-conducting current:

\[ I_{RC} \] [A]

Thermistor

Temperature characteristic (typ.)

Resistance: \( R \) [kΩ]

Notice:

Switching characteristics of \( V_{CE} \) is defined between Sense C and Sense E1 for Upper arm and Sense E1 and Sense E2 for Lower arm.

Inverter

Forward recovery characteristics (typ.)

\( V_{CC} = 600V, \ V_{GE} = +15V / -15V, \ R_{o} = 0.5\Omega \)

Reverse-conducting voltage:

\( V_{RC} \) [V]

Forward recovery current:

\[ I_{Fr} \] [A]

Reverse-conducting current:

\[ I_{RC} \] [A]

[Thermistor]

Temperature characteristic (typ.)

Resistance: \( R \) [kΩ]

Transistor

Pulse width:

\[ t_w \] [sec]

\[ T^C \] [°C]

\[ Z_{th(j-c)} \] [K/W]

\( t_{Fr} \) [sec]
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- Machine tools
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- Electrical home appliances
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- Traffic-signal control equipment
- Gas leakage detectors with an auto-shut-off feature
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- Safety devices
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IGBT Modules

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<table>
<thead>
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<th><a href="http://www.fujielectric.co.jp/products/semiconductor/">www.fujielectric.co.jp/products/semiconductor/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td><a href="http://www.fujielectric.com/products/semiconductor/">www.fujielectric.com/products/semiconductor/</a></td>
</tr>
<tr>
<td>中国</td>
<td><a href="http://www.fujielectric.com.cn/products/semiconductor/">www.fujielectric.com.cn/products/semiconductor/</a></td>
</tr>
<tr>
<td>Europe</td>
<td><a href="http://www.fujielectric-europe.com/en/power_semiconductor/">www.fujielectric-europe.com/en/power_semiconductor/</a></td>
</tr>
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<td>North America</td>
<td><a href="http://www.americas.fujielectric.com/products/semiconductors/">www.americas.fujielectric.com/products/semiconductors/</a></td>
</tr>
</tbody>
</table>

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