<IGBT Modules>

CM450DY-24S
HIGH POWER SWITCHING USE
INSULATED TYPE

Collector current $I_C$ ........................................ 4 1 0 A *
Collector-emitter voltage $V_{CES}$ ................................ 1 2 0 0 V
Maximum junction temperature $T_{j,max}$ ........... 1 7 5 °C

- Flat base Type
- Copper base plate
- RoHS Directive compliant
- UL Recognized under UL1557, File E323585

* DC current rating is limited by power terminals.

APPLICATION

AC Motor Control, Motion/Servo Control, Power supply, etc.

OUTLINE DRAWING & INTERNAL CONNECTION

<table>
<thead>
<tr>
<th>Division of Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 to 3</td>
<td>±0.2</td>
</tr>
<tr>
<td>over 3 to 6</td>
<td>±0.3</td>
</tr>
<tr>
<td>over 6 to 30</td>
<td>±0.5</td>
</tr>
<tr>
<td>over 30 to 120</td>
<td>±0.8</td>
</tr>
<tr>
<td>over 120 to 400</td>
<td>±1.2</td>
</tr>
</tbody>
</table>

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### MAXIMUM RATINGS (T_{j}=25 °C, unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CES}</td>
<td>Collector-emitter voltage</td>
<td>G-E short-circuited</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>V_{GES}</td>
<td>Gate-emitter voltage</td>
<td>C-E short-circuited</td>
<td>± 20</td>
<td>V</td>
</tr>
<tr>
<td>I_{C}</td>
<td>Collector current</td>
<td>DC, T_{j}=125 °C (Note2, 4)</td>
<td>410 *</td>
<td>A</td>
</tr>
<tr>
<td>I_{CM}</td>
<td></td>
<td>(Note2)</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>I_{CRM}</td>
<td>Pulse, Repetitive (Note3)</td>
<td></td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total power dissipation</td>
<td>T_{j}=25 °C (Note2, 4)</td>
<td>3330</td>
<td>W</td>
</tr>
<tr>
<td>I_{E}</td>
<td>Emitter current</td>
<td>DC (Note2)</td>
<td>410 *</td>
<td>A</td>
</tr>
<tr>
<td>I_{EM}</td>
<td></td>
<td>(Note2)</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>I_{ER}</td>
<td>Pulse, Repetitive (Note3)</td>
<td></td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>V_{ISO}</td>
<td>Isolation voltage</td>
<td>Terminals to base plate, RMS, f=60 Hz, AC 1 min</td>
<td>2500</td>
<td>V</td>
</tr>
<tr>
<td>T_{jmax}</td>
<td>Maximum junction temperature</td>
<td>Instantaneous event (overload)</td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>T_{Cmax}</td>
<td>Maximum case temperature</td>
<td>(Note4)</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>T_{jop}</td>
<td>Operating junction temperature</td>
<td>Continuous operation (under switching)</td>
<td>-40 ~ +150</td>
<td>°C</td>
</tr>
<tr>
<td>T_{sig}</td>
<td>Storage temperature</td>
<td>-</td>
<td>-40 ~ +150</td>
<td></td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS (T_{j}=25 °C, unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CES}</td>
<td>Collector-emitter cut-off current</td>
<td>V_{GE}=V_{CES}, G-E short-circuited</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>I_{GES}</td>
<td>Gate-emitter leakage current</td>
<td>V_{GE}=V_{GES}, C-E short-circuited</td>
<td>-</td>
<td>μA</td>
</tr>
<tr>
<td>V_{GE(th)}</td>
<td>Gate-emitter threshold voltage</td>
<td>I_{C}=45 mA, V_{GE}=10 V</td>
<td>5.4</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEsat}</td>
<td>Collector-emitter saturation voltage</td>
<td>I_{C}=450 A, V_{GE}=15 V, Refer to figure of test circuit (Note6)</td>
<td>T_{j}=25 °C</td>
<td>1.80</td>
</tr>
<tr>
<td>V_{CEsat}</td>
<td></td>
<td>(Note5)</td>
<td>T_{j}=125 °C</td>
<td>2.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T_{j}=150 °C</td>
<td>2.10</td>
</tr>
<tr>
<td>C_{ies}</td>
<td>Input capacitance</td>
<td>V_{GE}=10 V, G-E short-circuited</td>
<td>-</td>
<td>nF</td>
</tr>
<tr>
<td>C_{oies}</td>
<td>Output capacitance</td>
<td>V_{CE}=15 V, G-E short-circuited</td>
<td>-</td>
<td>9.0</td>
</tr>
<tr>
<td>Q_{g}</td>
<td>Gate charge</td>
<td>V_{CC}=600 V, V_{CE}=450 A, V_{GE}=15 V</td>
<td>-</td>
<td>1050</td>
</tr>
<tr>
<td>t_{on}</td>
<td>Turn-on delay time</td>
<td>V_{CC}=600 V, I_{C}=450 A, V_{GE}=±15 V,</td>
<td>-</td>
<td>800</td>
</tr>
<tr>
<td>t_{r}</td>
<td>Rise time</td>
<td>V_{CC}=600 V, I_{C}=450 A, V_{GE}=±15 V,</td>
<td>-</td>
<td>200</td>
</tr>
<tr>
<td>t_{off}</td>
<td>Turn-off delay time</td>
<td>R_{0}=0 Ω, Inductive load</td>
<td>-</td>
<td>600</td>
</tr>
<tr>
<td>t_{f}</td>
<td>Fall time</td>
<td></td>
<td>-</td>
<td>300</td>
</tr>
<tr>
<td>V_{EC}</td>
<td>Emitter-collector voltage</td>
<td>I_{C}=450 A, G-E short-circuited, Refer to figure of test circuit (Note7)</td>
<td>T_{j}=25 °C</td>
<td>1.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Note6)</td>
<td>T_{j}=125 °C</td>
<td>1.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>T_{j}=150 °C</td>
<td>1.85</td>
</tr>
<tr>
<td>t_{rr}</td>
<td>Reverse recovery time</td>
<td>V_{CC}=600 V, I_{C}=450 A, V_{GE}=±15 V,</td>
<td>-</td>
<td>300</td>
</tr>
<tr>
<td>Q_{rr}</td>
<td>Reverse recovery charge</td>
<td>R_{0}=0 Ω, Inductive load</td>
<td>-</td>
<td>24</td>
</tr>
<tr>
<td>E_{on}</td>
<td>Turn-on switching energy per pulse</td>
<td>V_{CC}=600 V, I_{C}=450 A,</td>
<td>-</td>
<td>54.9</td>
</tr>
<tr>
<td>E_{off}</td>
<td>Turn-off switching energy per pulse</td>
<td>V_{GE}=±15 V, R_{0}=0 Ω,</td>
<td>-</td>
<td>48</td>
</tr>
<tr>
<td>E_{rf}</td>
<td>Reverse recovery energy per pulse</td>
<td>T_{j}=150 °C, Inductive load</td>
<td>-</td>
<td>32.4</td>
</tr>
<tr>
<td>R_{CC}+E_{E}</td>
<td>Internal lead resistance</td>
<td>Main terminals - chip, per switch, T_{j}=25 °C</td>
<td>-</td>
<td>0.7</td>
</tr>
<tr>
<td>r_{a}</td>
<td>Internal gate resistance</td>
<td>Per switch</td>
<td>-</td>
<td>4.3</td>
</tr>
</tbody>
</table>
**THERMAL RESISTANCE CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th(j-c)}$</td>
<td>Thermal resistance</td>
<td>Junction to case, per IGBT&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
<tr>
<td>$R_{th(c- s )}$</td>
<td>Contact thermal resistance</td>
<td>Case to heat sink, per 1/2 module, Thermal grease applied&lt;sup&gt;4, 6&lt;/sup&gt;</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
</tbody>
</table>

MECHANICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_r$</td>
<td>Mounting torque</td>
<td>Main terminals, M6 screw</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
<tr>
<td>$m$</td>
<td>Mass</td>
<td>Mounting to heat sink, M6 screw</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
<tr>
<td>$e_c$</td>
<td>Flatness of base plate</td>
<td>On the centerline X, Y&lt;sup&gt;7&lt;/sup&gt;</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
</tbody>
</table>

This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU.

**Note1.** Represent ratings and characteristics of the anti-parallel, emitter-collector free wheeling diode (DIODE).

2. Junction temperature ($T_j$) should not increase beyond $T_{j\text{max}}$ rating.

3. Pulse width and repetition rate should be such that the device junction temperature ($T_j$) does not exceed $T_{j\text{max}}$ rating.

4. Temperature ($T_c$) and heat sink temperature ($T_s$) are defined on each surface (mounting side) of base plate and heat sink just under the chips. Refer to the figure of chip location.

5. Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.

6. Base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.

7. Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.

This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU.

**RECOMMENDED OPERATING CONDITIONS**

<table>
<thead>
<tr>
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<th>Item</th>
<th>Conditions</th>
<th>Limits</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$</td>
<td>(DC) Supply voltage</td>
<td>Applied across C1-E2</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
<tr>
<td>$V_{G\text{on}}$</td>
<td>Gate (-emitter drive) voltage</td>
<td>Applied across G1-Es1/G2-Es2</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
<tr>
<td>$R_0$</td>
<td>External gate resistance</td>
<td>Per switch</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
</tbody>
</table>
<IGBT Modules>
CM450DY-24S
HIGH POWER SWITCHING USE
INSULATED TYPE

TEST CIRCUIT AND WAVEFORMS

Switching characteristics test circuit and waveforms

IGBT Turn-on switching energy
IGBT Turn-off switching energy
DIODE Reverse recovery energy

Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)
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CM450DY-24S
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

OUTPUT CHARACTERISTICS
(TYPICAL)

COLLECTOR-EMITTER SATURATION
VOLTAGE CHARACTERISTICS
(TYPICAL)

COLLECTOR-EMITTER SATURATION
VOLTAGE CHARACTERISTICS
(TYPICAL)

FREE WHEELING DIODE
FORWARD CHARACTERISTICS
(TYPICAL)

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CM450DY-24S
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

\[ V_{CC}=600 \, \text{V}, \, V_{GE}=\pm15 \, \text{V}, \, R_{G}=0 \, \Omega, \, \text{INDUCTIVE LOAD} \]

- \( T_{j}=150 \, ^{\circ} \text{C} \), - - - - , \( T_{j}=125 \, ^{\circ} \text{C} \)

SWITCHING TIME \( t_{d(on)} \)

COLLECTOR CURRENT \( I_{C} \) (A)

1000
100
10

10

SWITCHING TIME

10000
1000
100
10

HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

\[ V_{CC}=600 \, \text{V}, \, I_{C}=450 \, \text{A}, \, V_{GE}=\pm15 \, \text{V}, \, \text{INDUCTIVE LOAD, PER PULSE} \]

- \( T_{j}=150 \, ^{\circ} \text{C} \), - - - - , \( T_{j}=125 \, ^{\circ} \text{C} \)

SWITCHING TIME \( t_{d(on)}, t_{r} \)

EXTERNAL GATE RESISTANCE \( R_{G} \) (\( \Omega \))

1000
100
10

10

SWITCHING TIME

10000
1000
100
10

HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

\[ V_{CC}=600 \, \text{V}, \, V_{GE}=\pm15 \, \text{V}, \, R_{G}=0 \, \Omega, \, \text{INDUCTIVE LOAD, PER PULSE} \]

- \( T_{j}=150 \, ^{\circ} \text{C} \), - - - - , \( T_{j}=125 \, ^{\circ} \text{C} \)

SWITCHING ENERGY \( E_{on} \) (mJ)

COLLECTOR CURRENT \( I_{C} \) (A)

1000
100
10

10

SWITCHING ENERGY

10000
1000
100
10

HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

\[ V_{CC}=600 \, \text{V}, \, I_{C}=450 \, \text{A}, \, V_{GE}=\pm15 \, \text{V}, \, \text{INDUCTIVE LOAD, PER PULSE} \]

- \( T_{j}=150 \, ^{\circ} \text{C} \), - - - - , \( T_{j}=125 \, ^{\circ} \text{C} \)

SWITCHING ENERGY \( E_{off} \) (mJ)

EXTERNAL GATE RESISTANCE \( R_{G} \) (\( \Omega \))

1000
100
10

10

SWITCHING ENERGY

10000
1000
100
10

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MITSUBISHI ELECTRIC CORPORATION
CM450DY-24S
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

CAPACITANCE CHARACTERISTICS
(TYPICAL)

FREE WHEELING DIODE
REVERSE RECOVERY CHARACTERISTICS
(TYPICAL)

G-E short-circuited, $T_i = 25 \, {^\circ}C$

$V_{CC}=600 \, V$, $V_{CE}=\pm 15 \, V$, $R_d=0 \, \Omega$, INDUCTIVE LOAD

$T_i=150 \, {^\circ}C$, $T_i=125 \, {^\circ}C$

$V_{CC}=600 \, V$, $I_C=450 \, A$, $T_i=25 \, {^\circ}C$

$Z_{th(j-c)}=45 \, K/\,KW$, $R_{th(j-c)}=68 \, K/\,KW$

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