CM400DY-34T
HIGH POWER SWITCHING USE
INSULATED TYPE

Collector current \( I_c \) .................................. 4 0 0 A
Collector-emitter voltage \( V_{CES} \) ............ 1 7 0 0 V
Maximum junction temperature \( T_{v,max} \) .......... 1 7 5 °C

- Flat base type
- Copper base plate (Nickel-plating)
- Tin-plating signal terminals
- RoHS Directive compliant
- UL Recognized under UL1557, File No.E323585

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

OPTION (Below options are available.)
- PC-TIM (Phase Change Thermal Interface Material) pre-apply
- \( V_{CEsat} \) selection for parallel connection

OUTLINE DRAWING & INTERNAL CONNECTION

![Diagram]
### MAXIMUM RATINGS (T_{vj}=25 {^\circ}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>1700</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_{c}=125 °C (Note2, 4)</td>
<td>400</td>
<td>A</td>
</tr>
<tr>
<td>I_{c(max)}</td>
<td>Pulse, Repetitive (Note3)</td>
<td></td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>P_{tot}</td>
<td>Total power dissipation</td>
<td>T_{c}=25 °C (Note3)</td>
<td>4345</td>
<td>W</td>
</tr>
<tr>
<td>I_{e}</td>
<td>Emitter current</td>
<td>DC (Note2)</td>
<td>400</td>
<td>A</td>
</tr>
<tr>
<td>I_{PRA} (Note1)</td>
<td>Pulse, Repetitive (Note3)</td>
<td></td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>V_{isol}</td>
<td>Isolation voltage</td>
<td>Terminals to base plate, RMS, f=60 Hz, AC 1 min</td>
<td>4000</td>
<td>V</td>
</tr>
<tr>
<td>T_{max}</td>
<td>Maximum junction temperature</td>
<td>Instantaneous event (overload)</td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>T_{case}</td>
<td>Maximum case temperature</td>
<td></td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>T_{op}</td>
<td>Operating junction temperature</td>
<td>Continuous operation (under switching)</td>
<td>-40 ~ +150</td>
<td>°C</td>
</tr>
<tr>
<td>T_{stg}</td>
<td>Storage temperature</td>
<td></td>
<td>-40 ~ +125</td>
<td></td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS (T_{vj}=25 {^\circ}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_{GCE}=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_{GCE}=V_{GES}, C-E short-circuited</td>
<td>-</td>
<td>μA</td>
</tr>
<tr>
<td>I_{VGE}</td>
<td>Gate-emitter threshold voltage</td>
<td>I_{c}=40 mA, V_{ces}=10 V</td>
<td>5.4</td>
<td>V</td>
</tr>
<tr>
<td>V_{Ces}</td>
<td>Collector-emitter saturation voltage</td>
<td>I_{c}=400 A, V_{ces}=15 V</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>V_{f}</td>
<td>Collector-emitter saturation voltage</td>
<td>Refer to the figure of test circuit (Note5)</td>
<td>2.10</td>
<td></td>
</tr>
<tr>
<td>C_{res}</td>
<td>Input capacitance</td>
<td>V_{GCE}=10 V, G-E short-circuited</td>
<td>-</td>
<td>nF</td>
</tr>
<tr>
<td>C_{ges}</td>
<td>Output capacitance</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>C_{ces}</td>
<td>Reverse transfer capacitance</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Q_{d}</td>
<td>Gate charge</td>
<td>V_{GCE}=1000 V, I_{c}=400 A, V_{ces}=15 V</td>
<td>-</td>
<td>μC</td>
</tr>
<tr>
<td>t_{d(on)}</td>
<td>Turn-on delay time</td>
<td>V_{GCE}=1000 V, I_{c}=400 A, V_{ces}=±15 V</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>I_{r}</td>
<td>Fall time</td>
<td></td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>I_{d(off)}</td>
<td>Turn-off delay time</td>
<td>R_{D}=0 Ω, Inductive load</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>V_{E}</td>
<td>Emitter-collector voltage</td>
<td>I_{c}=400 A, G-E short-circuited, V_{ces}=15 V</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Q_{r}</td>
<td>Reverse recovery time</td>
<td>V_{GCE}=1000 V, I_{c}=400 A, V_{ces}=±15 V</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>E_{on}</td>
<td>Turn-on switching energy per pulse</td>
<td>V_{GCE}=1000 V, I_{c}=I_{c}=400 A</td>
<td>-</td>
<td>mJ</td>
</tr>
<tr>
<td>E_{off}</td>
<td>Turn-off switching energy per pulse</td>
<td>V_{GCE}=±15 V, R_{D}=0 Ω, T_{kJ}=150 °C</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>E_{p}</td>
<td>Reverse recovery energy per pulse</td>
<td></td>
<td>50.6</td>
<td>mJ</td>
</tr>
<tr>
<td>R_{CC,EE}</td>
<td>Internal lead resistance</td>
<td>Main terminals-chip, per switch, T_{c}=25 °C (Note6)</td>
<td>0.3</td>
<td>mΩ</td>
</tr>
<tr>
<td>r_{g}</td>
<td>Internal gate resistance</td>
<td>Per switch</td>
<td>2.0</td>
<td>Ω</td>
</tr>
</tbody>
</table>

(Note1) = Reverse recovery time
(Note2) = Reverse transfer capacitance
(Note3) = Gate charge
(Note4) = Collector-emitter saturation voltage
(Note5) = Collector-emitter saturation voltage
(Note6) = Collector-emitter saturation voltage
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 Inverter IGBT</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
<tr>
<td>$R_{th(j-c)}$</td>
<td></td>
<td>Junction to case, per Inverter FWD</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$R_{th(c-s)}$</td>
<td>Contact thermal resistance</td>
<td>Case to heat sink, per 1 module, Thermal grease applied</td>
<td>-</td>
<td>13.3</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>$M_t$</td>
<td>Mounting torque</td>
<td>Main terminals, M 6 screw</td>
<td>3.5</td>
<td>4.0</td>
</tr>
<tr>
<td>$M_s$</td>
<td>Mounting torque</td>
<td>Mounting to heat sink, M 6 screw</td>
<td>3.5</td>
<td>4.0</td>
</tr>
<tr>
<td>$d_s$</td>
<td>Creepage distance</td>
<td>Terminal to terminal</td>
<td>17.3</td>
<td>-</td>
</tr>
<tr>
<td>$d_a$</td>
<td>Clearances</td>
<td>Terminal to base plate</td>
<td>25.3</td>
<td>-</td>
</tr>
<tr>
<td>$e_c$</td>
<td>Flatness of base plate</td>
<td>On the centerline X, Y</td>
<td>±0</td>
<td>-</td>
</tr>
<tr>
<td>$m$</td>
<td>mass</td>
<td></td>
<td>-</td>
<td>260</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.

1. Represent ratings and characteristics of the anti-parallel, emitter-collector free-wheeling diode (FWD).

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

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

4. Case 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. Typical value is measured by using thermally conductive grease of $\lambda=0.9$ W/(m·K)/D(C-S)=$50$ µm.

7. Typical value is measured by using PC-TIM of $\lambda=3.4$ W/(m·K)/D(C-S)=$50$ µm.

8. The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.
**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 terminals</td>
<td>Min.</td>
<td>Typ.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>$V_{GEon}$</td>
<td>Gate (-emitter drive) voltage</td>
<td>Applied across G1-Es1/G2-Es2 terminals</td>
<td>13.5</td>
<td>15.0</td>
</tr>
<tr>
<td>$R_{g}$</td>
<td>External gate resistance</td>
<td>Per switch</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

**CHIP LOCATION (Top view)**

Dimension in mm, tolerance: ±1 mm

Option: PC-TIM applied baseplate outline

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CMH-11393 Ver.1.0

MITSUBISHI ELECTRIC CORPORATION
<IGBT Modules>
CM400DY-34T
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

FWD Reverse recovery energy

Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

TEST CIRCUIT

V_{CEsat} characteristics test circuit

V_{EC} characteristics test circuit

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MITSUBISHI ELECTRIC CORPORATION
PERFORMANCE CURVES

**OUTPUT CHARACTERISTICS (TYPICAL)**

- Collector current $I_C$ vs. collector-emitter voltage $V_{CE}$
- Various $V_{GE}$ levels:
  - $V_{CE} = 20$ V
  - $V_{CE} = 13.5$ V
  - $V_{CE} = 12$ V

**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)**

- Collector-emitter saturation voltage $V_{CES}$ vs. collector current $I_C$
- Various $V_{GE}$ levels:
  - $V_{GE} = 15$ V

**COLLECTOR-EMITTER VOLTAGE CHARACTERISTIC (TYPICAL)**

- Collector-emitter voltage $V_{CE}$ vs. gate-emitter voltage $V_{GE}$
- Various $I_C$ levels:
  - $I_C = 800$ A
  - $I_C = 400$ A
  - $I_C = 200$ A

**FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)**

- Emitter-current $I_E$ vs. emitter-collector voltage $V_{EC}$
- Various $V_{GE}$ levels:
  - $V_{GE} = 15$ V
  - $V_{GE} = 125$ V
  - $V_{GE} = 25$ V
- $T_{ij} = 25 \, ^\circ C$
- $T_{ij} = 150 \, ^\circ C$
- $T_{ij} = 125 \, ^\circ C$
- $T_{ij} = 25 \, ^\circ C$
- $T_{ij} = 15 \, ^\circ C$
- $T_{ij} = 125 \, ^\circ C$
- $T_{ij} = 25 \, ^\circ C$
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC} = 1000 \text{ V, } V_{GE}=\pm15 \text{ V, } R_G=0 \text{ }\Omega$, INDUCTIVE LOAD

$T_vj=150 ^\circ \text{C} , \cdots \cdots ; T_vj=125 ^\circ \text{C}$

SWITCHING TIME $t_{d(on)}$, $t_{r}$, $t_{f}$ (ns)

COLLECTOR CURRENT $I_c$ (A)

SWITCHING ENERGY (mJ)

REVERSE RECOVERY ENERGY (mJ)

HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC} = 1000 \text{ V, } V_{GE}=\pm15 \text{ V, } I_c=400 \text{ A}$, INDUCTIVE LOAD

$T_vj=150 ^\circ \text{C} , \cdots \cdots ; T_vj=125 ^\circ \text{C}$

EMITTER CURRENT $I_E$ (A)

EXTERNAL GATE RESISTANCE $R_G$ (\$\Omega\$)

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MITSUBISHI ELECTRIC CORPORATION
PERFORMANCE CURVES

CAPACITANCE CHARACTERISTICS  
(TYPICAL)

G-E short-circuited, $T_{\text{j}}=25 \, ^\circ\text{C}$

FREE WHEELING DIODE 
REVERSE RECOVERY CHARACTERISTICS  
(TYPICAL)

$V_{\text{CC}}=1000 \, \text{V}, V_{\text{GE}}=\pm 15 \, \text{V}, R_{G}=0 \, \Omega$, INDUCTIVE LOAD

$--$: $T_{\text{j}}=150 \, ^\circ\text{C}$,  $-\cdots-\cdots$: $T_{\text{j}}=125 \, ^\circ\text{C}$

Note: The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.
**PERFORMANCE CURVES**

**TURN-OFF SWITCHING SAFE OPERATING AREA**
(REVERSE BIAS SAFE OPERATING AREA)

- $V_{CC} \leq 1200 \text{ V}, \ V_{GE} = \pm 15 \text{ V}, \ R_{G} = 0 \sim 30 \ \Omega$

  - $T_{j} = 25 \sim 150 \ ^\circ \text{C}$ (Normal load operations (Continuous))
  - $T_{j} = 175 \ ^\circ \text{C}$ (Unusual load operations (Limited period))

**SHORT-CIRCUIT SAFE OPERATING AREA**
(MAXIMUM)

- $V_{CC} \leq 1200 \text{ V}, \ V_{GE} = \pm 15 \text{ V}, \ R_{G} = 0 \sim 30 \ \Omega$
  - $T_{j} = 25 \sim 150 \ ^\circ \text{C}$, $t_{W} \leq 8 \ \mu\text{s}$, Non-Repetitive

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**NORMALIZED COLLECTOR CURRENT $I_{C}$**

- **COLLECTOR-EMITTER VOLTAGE $V_{CE}$ (V)**

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**NORMALIZED COLLECTOR CURRENT $I_{C}$**

- **COLLECTOR-EMITTER VOLTAGE $V_{CE}$ (V)**
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