

**CM400HA-24A**



Single

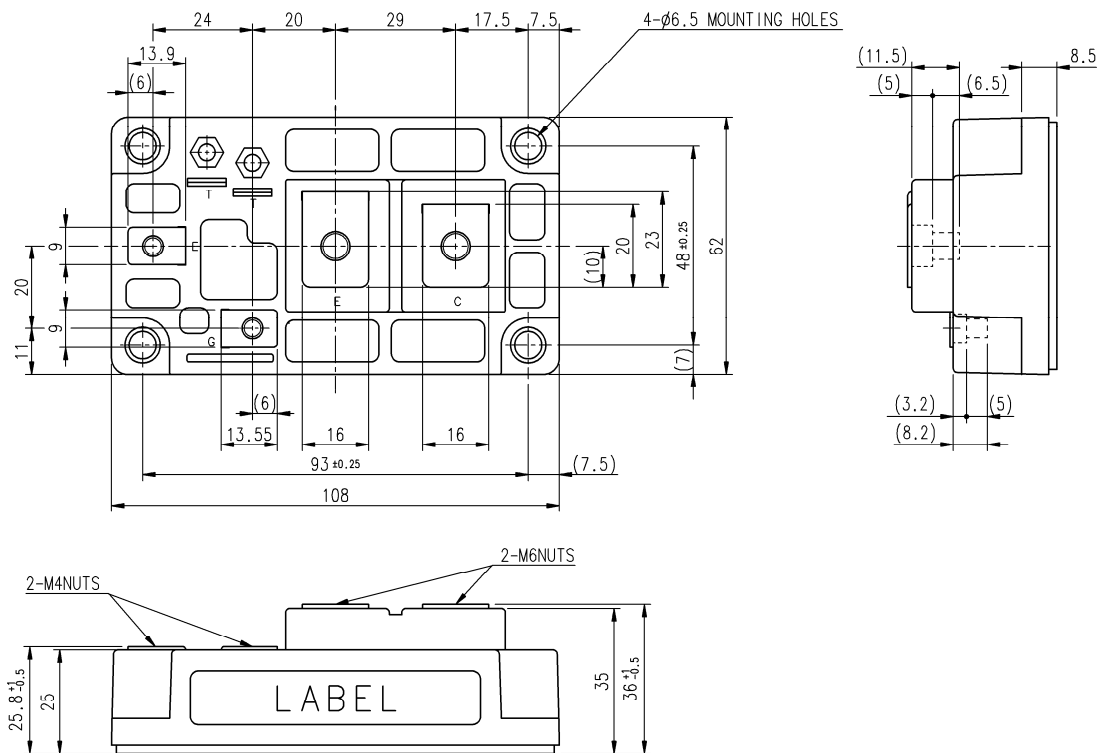
- $I_C$  ..... 400 A
- $V_{CES}$  ..... 1200 V
- Flat base Type  
 Copper (non-plating) base plate  
 No accessory (terminal screw) attach
- RoHS Directive compliant

**APPLICATION**

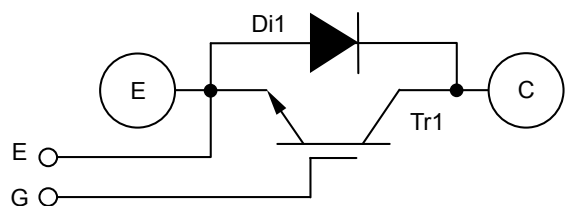
AC Motor Control, Motion/Servo Control, Power supply, etc.

**OUTLINE DRAWING & INTERNAL CONNECTION**

Dimension in mm



**INTERNAL CONNECTION**



| Tolerance otherwise specified |           |
|-------------------------------|-----------|
| Division of Dimension         | Tolerance |
| 0.5 to 3                      | ±0.2      |
| over 3 to 6                   | ±0.3      |
| over 6 to 30                  | ±0.5      |
| over 30 to 120                | ±0.8      |
| over 120 to 400               | ±1.2      |

**ABSOLUTE MAXIMUM RATINGS (T<sub>j</sub>=25 °C, unless otherwise specified)**

| Symbol                    | Item   | Conditions                                      | Rating     | Unit |
|---------------------------|--|---|------------|------|
| V <sub>CES</sub>          | Collector-emitter voltage                                | G-E short-circuited                             | 1200       | V    |
| V <sub>GES</sub>          | Gate-emitter voltage                                     | C-E short-circuited                             | ±20        | V    |
| I <sub>C</sub>            | Collector current  | DC, T <sub>C</sub> =87 °C (Note.2)              | 400        | A    |
| I <sub>CRM</sub>          |  | Pulse, Repetitive (Note.3)                      | 800        |      |
| P <sub>tot</sub>          | Total power dissipation                                  | T <sub>C</sub> =25 °C (Note.2, 4)               | 2350       | W    |
| I <sub>E</sub> (Note.1)   | Emitter current<br>(Free wheeling diode forward current) | T <sub>C</sub> =25 °C (Note.2, 4)               | 400        | A    |
| I <sub>ERM</sub> (Note.1) |  | Pulse, Repetitive (Note.3)                      | 800        |      |
| T <sub>j</sub>            | Junction temperature                                     | -   | -40 ~ +150 | °C   |
| T <sub>stg</sub>          | Storage temperature                                      | -   | -40 ~ +125 |      |
| V <sub>isol</sub>         | Isolation voltage  | Terminals to base plate, RMS, f=60 Hz, AC 1 min | 2500       | V    |

**MECHANICAL CHARACTERISTICS**

| Symbol         | Item                   | Conditions                      | Limits |      |      | Unit |
|----------------|------------------------|---------------------------------|--------|------|------|------|
|                |                        |                                 | Min.   | Typ. | Max. |      |
| M <sub>t</sub> | Mounting torque        | Main terminals M 6 screw        | 1.96   | 2.45 | 2.94 | N·m  |
| M <sub>t</sub> |                        | Auxiliary terminals M 4 screw   | 0.98   | 1.18 | 1.47 |      |
| M <sub>s</sub> |                        | Mounting to heat sink M 6 screw | 1.96   | 2.45 | 2.94 |      |
| m              | Weight                 | -                               | -      | 480  | -    | g    |
| e <sub>c</sub> | Flatness of base plate | On the centerline X, Y (Note.5) | ±0     | -    | +100 | µm   |

**ELECTRICAL CHARACTERISTICS (T<sub>j</sub>=25 °C, unless otherwise specified)**

| Symbol                   | Item                                 | Conditions  | Limits                 |      |      | Unit |
|--------------------------|--------------------------------------|---|------------------------|------|------|------|
|                          |                                      |   | Min.                   | Typ. | Max. |      |
| I <sub>CES</sub>         | Collector-emitter cut-off current    | V <sub>CE</sub> =V <sub>CES</sub> , G-E short-circuited   | -                      | -    | 1    | mA   |
| I <sub>GES</sub>         | Gate-emitter leakage current         | ±V <sub>GE</sub> =V <sub>GES</sub> , C-E short-circuited  | -                      | -    | 1    | µA   |
| V <sub>GE(th)</sub>      | Gate-emitter threshold voltage       | I <sub>C</sub> =40 mA, V <sub>CE</sub> =10 V  | 6                      | 7    | 8    | V    |
| V <sub>CEsat</sub>       | Collector-emitter saturation voltage | I <sub>C</sub> =400 A (Note.6),<br>V <sub>GE</sub> =15 V  | T <sub>j</sub> =25 °C  | 2.1  | 3.0  | V    |
|                          |                                      |   | T <sub>j</sub> =125 °C | 2.4  | -    |      |
| C <sub>ies</sub>         | Input capacitance                    | V <sub>CE</sub> =10 V, G-E short-circuited  | -                      | -    | 70   | nF   |
| C <sub>oes</sub>         | Output capacitance                   |   | -                      | -    | 6.0  |      |
| C <sub>res</sub>         | Reverse transfer capacitance         |   | -                      | -    | 1.4  |      |
| Q <sub>G</sub>           | Gate charge                          | V <sub>CC</sub> =600 V, I <sub>C</sub> =400 A, V <sub>GE</sub> =15 V  | -                      | 2000 | -    | nC   |
| t <sub>d(on)</sub>       | Turn-on delay time                   | V <sub>CC</sub> =600 V, I <sub>C</sub> =400 A, V <sub>GE</sub> =±15 V,<br>R <sub>G</sub> =0.78 Ω, Inductive load  | -                      | -    | 550  | ns   |
| t <sub>r</sub>           | Rise time                            |   | -                      | -    | 180  |      |
| t <sub>d(off)</sub>      | Turn-off delay time                  |   | -                      | -    | 600  |      |
| t <sub>f</sub>           | Fall time                            |   | -                      | -    | 350  |      |
| V <sub>EC</sub> (Note.1) | Emitter-collector voltage            | I <sub>E</sub> =400 A (Note.6), G-E short-circuited   | -                      | 3.0  | 3.8  | V    |
| t <sub>rr</sub> (Note.1) | Reverse recovery time                | V <sub>CC</sub> =600 V, I <sub>E</sub> =400 A, V <sub>GE</sub> =±15 V,<br>R <sub>G</sub> =0.78 Ω, Inductive load  | -                      | -    | 250  | ns   |
| Q <sub>rr</sub> (Note.1) | Reverse recovery charge              | R <sub>G</sub> =0.78 Ω, Inductive load  | -                      | 14.7 | -    | µC   |
| E <sub>on</sub>          | Turn-on switching energy per pulse   | V <sub>CC</sub> =600 V, I <sub>C</sub> =I <sub>E</sub> =400 A,<br>V <sub>GE</sub> =±15 V, R <sub>G</sub> =0.78 Ω, | -                      | 50.4 | -    | mJ   |
| E <sub>off</sub>         | Turn-off switching energy per pulse  | T <sub>j</sub> =125 °C, Inductive load  | -                      | 41.8 | -    |      |
| E <sub>rr</sub> (Note.1) | Reverse recovery energy per pulse    | T <sub>j</sub> =125 °C, Inductive load  | -                      | 20   | -    |      |
| r <sub>g</sub>           | Internal gate resistance             | T <sub>C</sub> =25 °C   | -                      | 1.5  | -    | Ω    |
| R <sub>G</sub>           | External gate resistance             | -   | 0.78                   | -    | 10   | Ω    |

**THERMAL RESISTANCE CHARACTERISTICS**

| Symbol                | Item                                | Conditions  | Limits |      |      | Unit |
|-----------------------|-------------------------------------|---|--------|------|------|------|
|                       |                                     |   | Min.   | Typ. | Max. |      |
| R <sub>th(j-c)Q</sub> | Thermal resistance (Note.2)         | Junction to case, IGBT part                           | -      | -    | 53   | K/kW |
| R <sub>th(j-c)D</sub> |                                     | Junction to case, FWDi part                           | -      | -    | 80   |      |
| R <sub>th(c-s)</sub>  | Contact thermal resistance (Note.2) | Case to heat sink,<br>Thermal grease applied (Note.7) | -      | 20   | -    | K/kW |

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

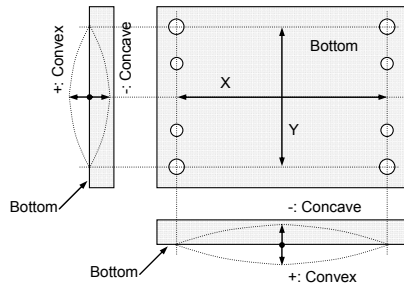
Note.2: Case temperature ( $T_c$ ) and heat sink temperature ( $T_s$ ) are defined on the each surface of base plate and heat sink just under the chips. (Refer to the figure of chip location)

The heat sink thermal resistance  $\{R_{th(s-a)}\}$  should measure just under the chips.

Note.3: Pulse width and repetition rate should be such that the device junction temperature ( $T_j$ ) dose not exceed  $T_{jmax}$  rating.

Note.4: Junction temperature ( $T_j$ ) should not increase beyond  $T_{jmax}$  rating.

Note.5: Base plate flatness measurement point is as in the following figure.



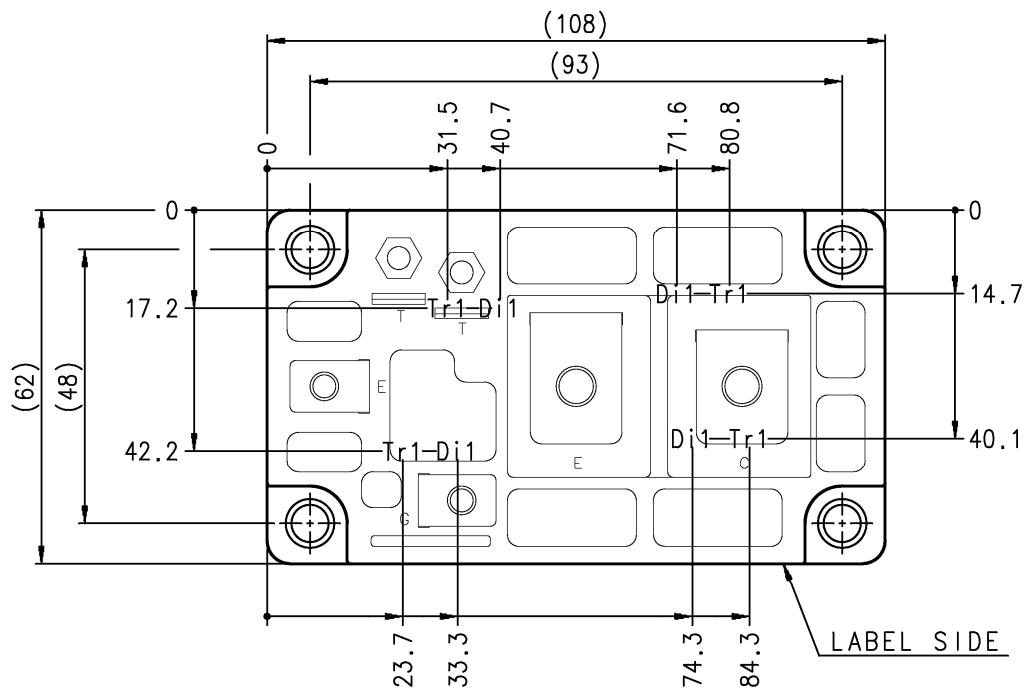
Note.6: Pulse width and repetition rate should be such as to cause negligible temperature rise.

(Refer to the figure of test circuit)

Note.7: Typical value is measured by using thermally conductive grease of  $\lambda=0.9$  W/(m·K).

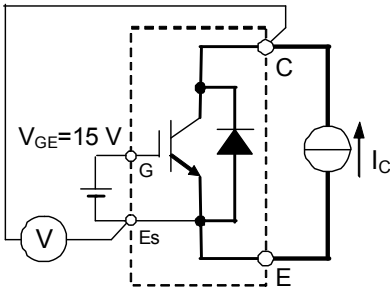
### CHIP LOCATION (Top view)

Dimension in mm, tolerance:  $\pm 1$  mm

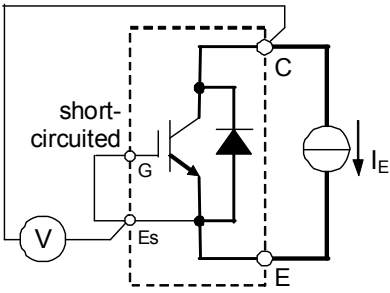


Tr1: IGBT, Di1: FWDi. Each mark points the center position of each chip.

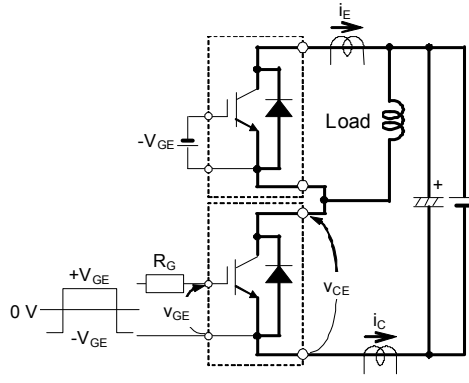
**TEST CIRCUIT AND WAVEFORMS**



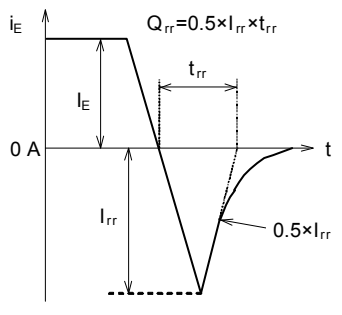
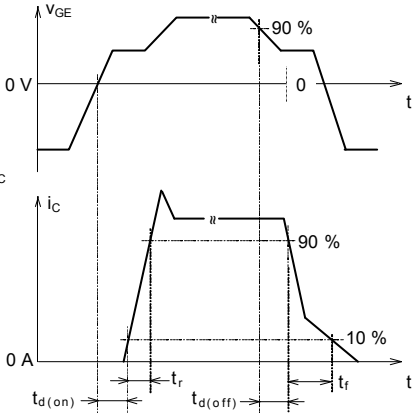
$V_{CEsat}$  test circuit



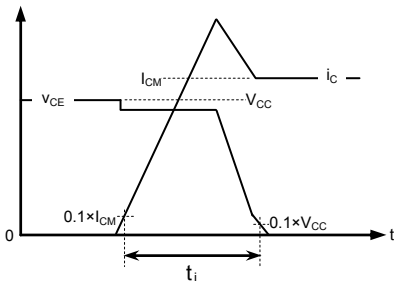
$V_{EC}$  test circuit



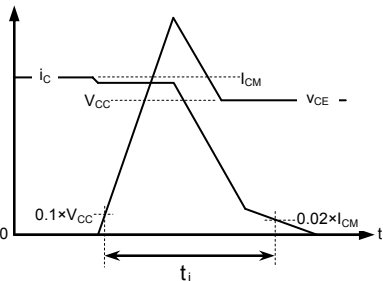
Switching characteristics test circuit and waveforms



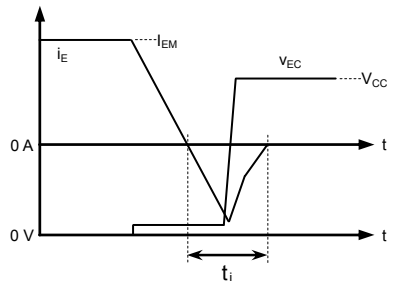
$t_{rr}$ ,  $Q_{rr}$  test waveform



IGBT Turn-on switching energy



IGBT Turn-off switching energy

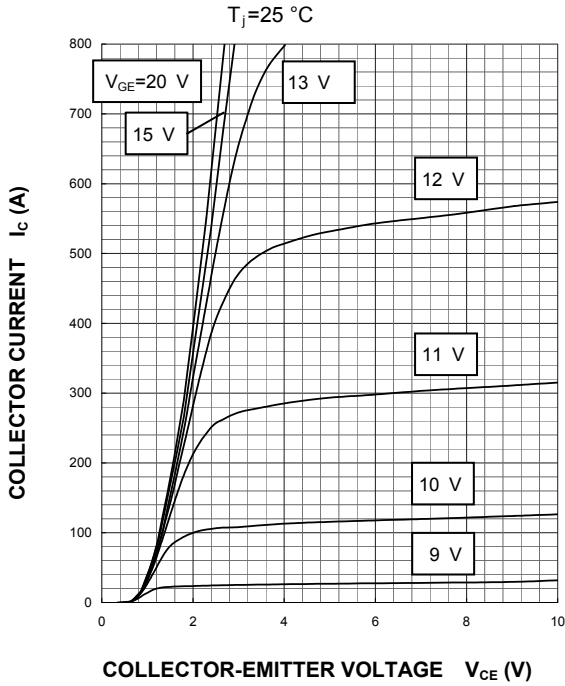


FWDi Reverse recovery energy

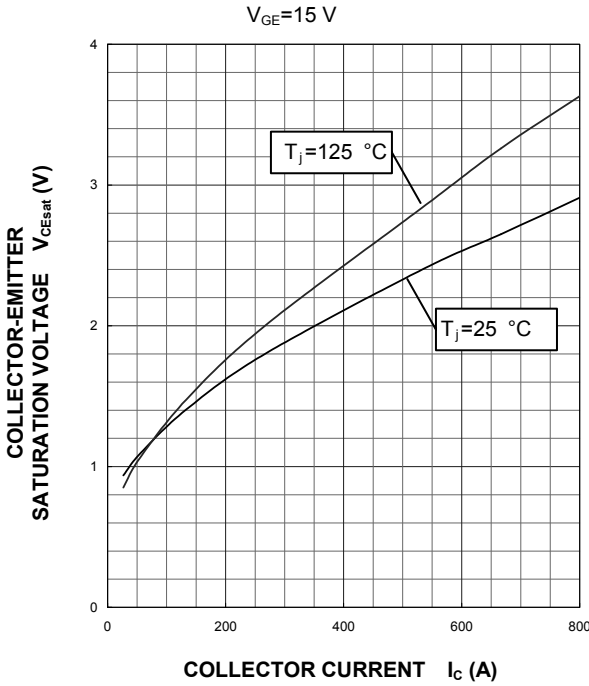
Turn-on, Turn-off switching and Reverse recovery energy test waveforms (integral range)

PERFORMANCE CURVES

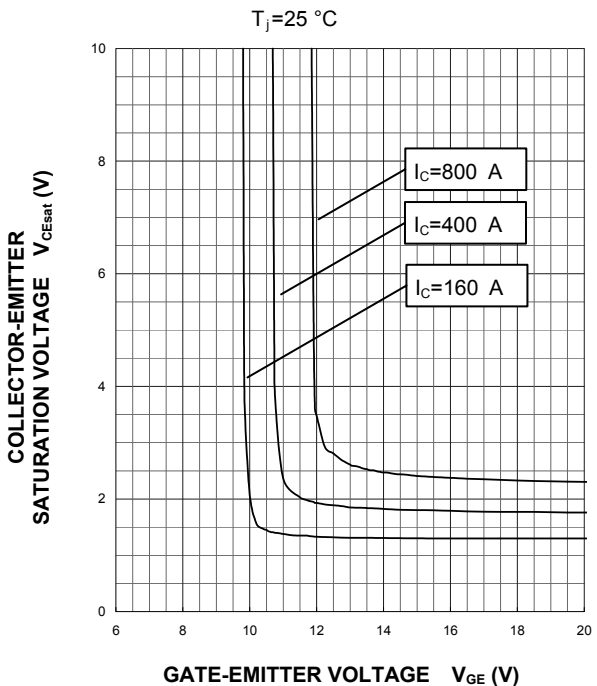
OUTPUT CHARACTERISTICS  
 (TYPICAL)



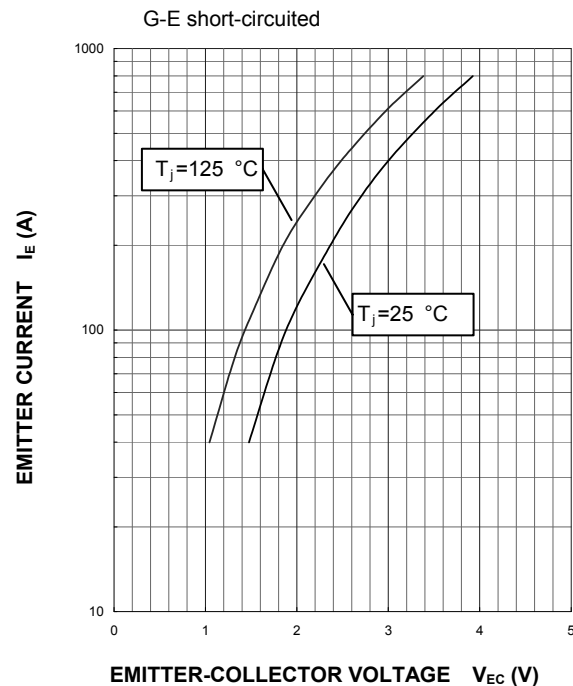
COLLECTOR-EMITTER SATURATION  
 VOLTAGE CHARACTERISTICS  
 (TYPICAL)



COLLECTOR-EMITTER SATURATION  
 VOLTAGE CHARACTERISTICS  
 (TYPICAL)

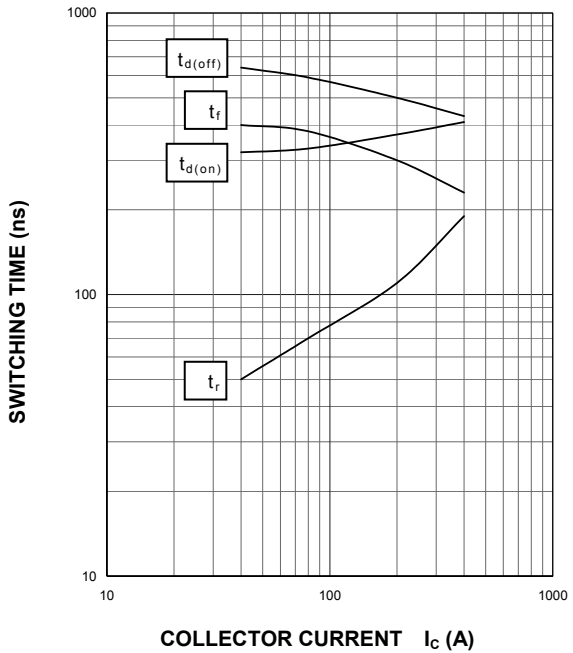


FREE WHEELING DIODE  
 FORWARD CHARACTERISTICS  
 (TYPICAL)



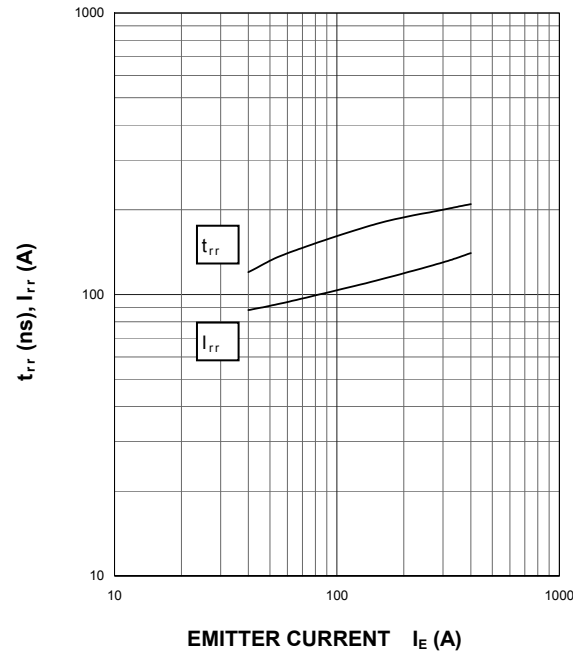
**HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0.78\ \Omega$ ,  $T_j=125\text{ }^\circ\text{C}$   
 INDUCTIVE LOAD



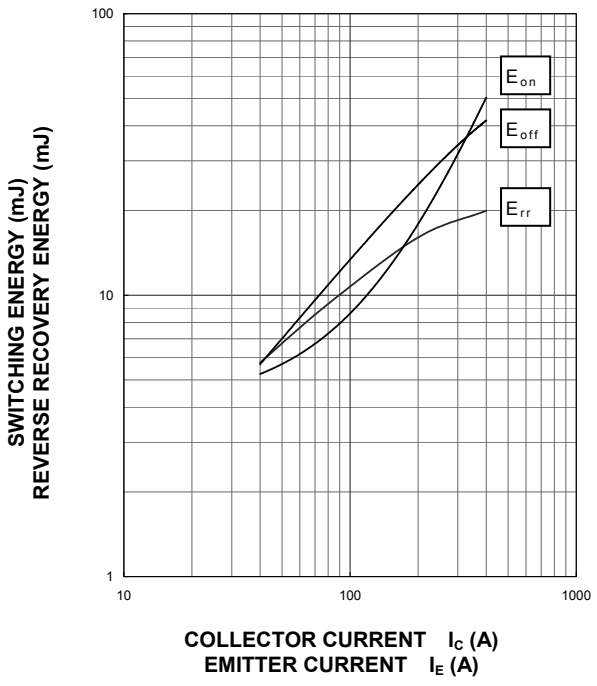
**FREE WHEELING DIODE  
 REVERSE RECOVERY CHARACTERISTICS  
 (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0.78\ \Omega$ ,  $T_j=125\text{ }^\circ\text{C}$   
 INDUCTIVE LOAD



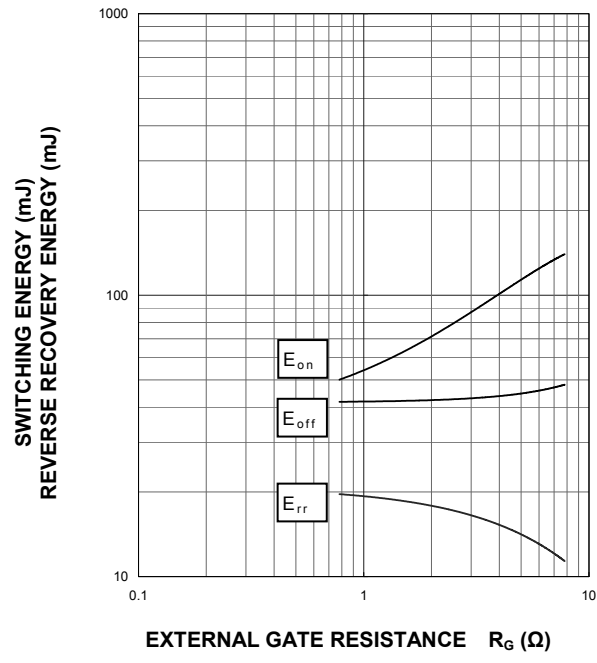
**HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0.78\ \Omega$ ,  $T_j=125\text{ }^\circ\text{C}$   
 INDUCTIVE LOAD, PER PULSE

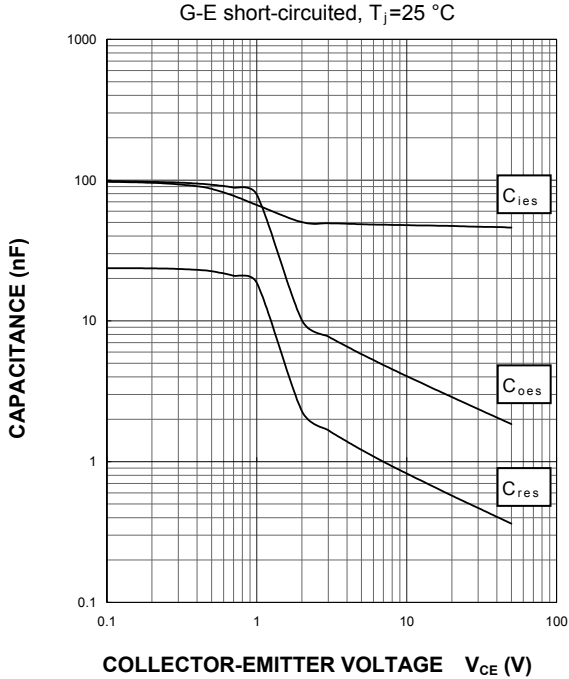


**HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)**

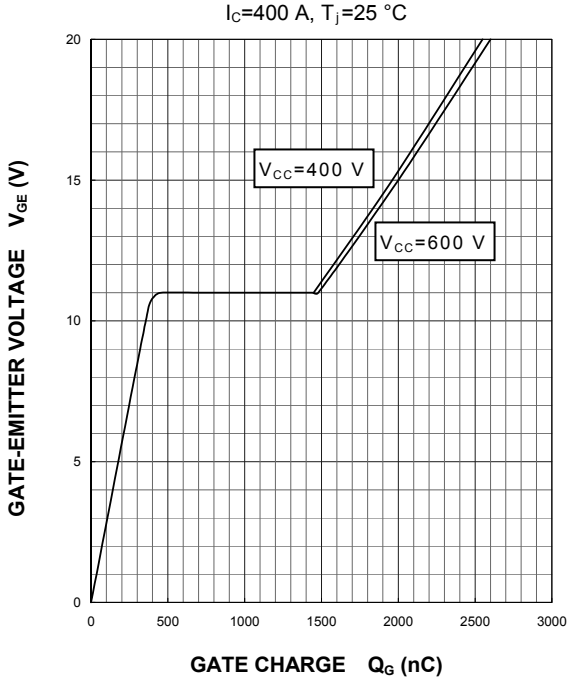
$V_{CC}=600\text{ V}$ ,  $I_C/I_E=400\text{ A}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $T_j=125\text{ }^\circ\text{C}$   
 INDUCTIVE LOAD, PER PULSE



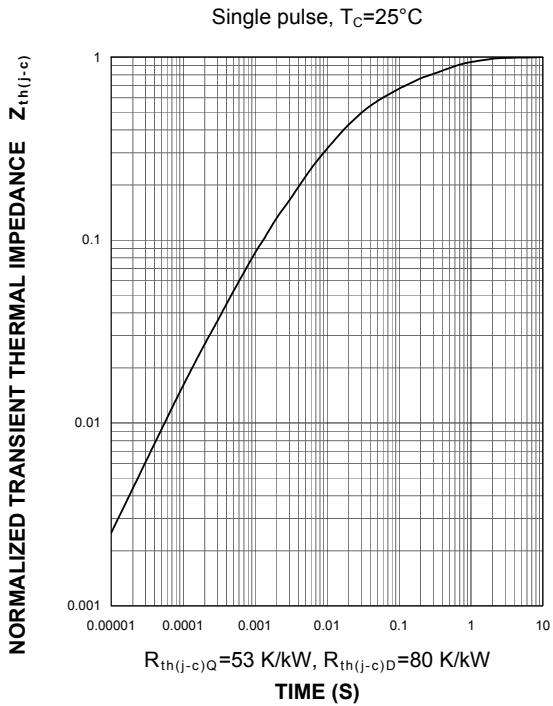
**CAPACITANCE CHARACTERISTICS  
 (TYPICAL)**



**GATE CHARGE CHARACTERISTICS  
 (TYPICAL)**



**TRANSIENT THERMAL IMPEDANCE  
 CHARACTERISTICS  
 (MAXIMUM)**



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