< IGBT MODULES >

# CM400C1Y-24S

**HIGH POWER SWITCHING USE**
**INSULATED TYPE**

**Dual (AC switch)**

| | |
|---|---|
| Collector current $I_C$ ........................................ | 350 A* |
| Collector-emitter voltage $V_{CES}$ ........................ | 1200 V |
| Maximum junction temperature $T_{jmax}$ ............. | 175 °C |

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

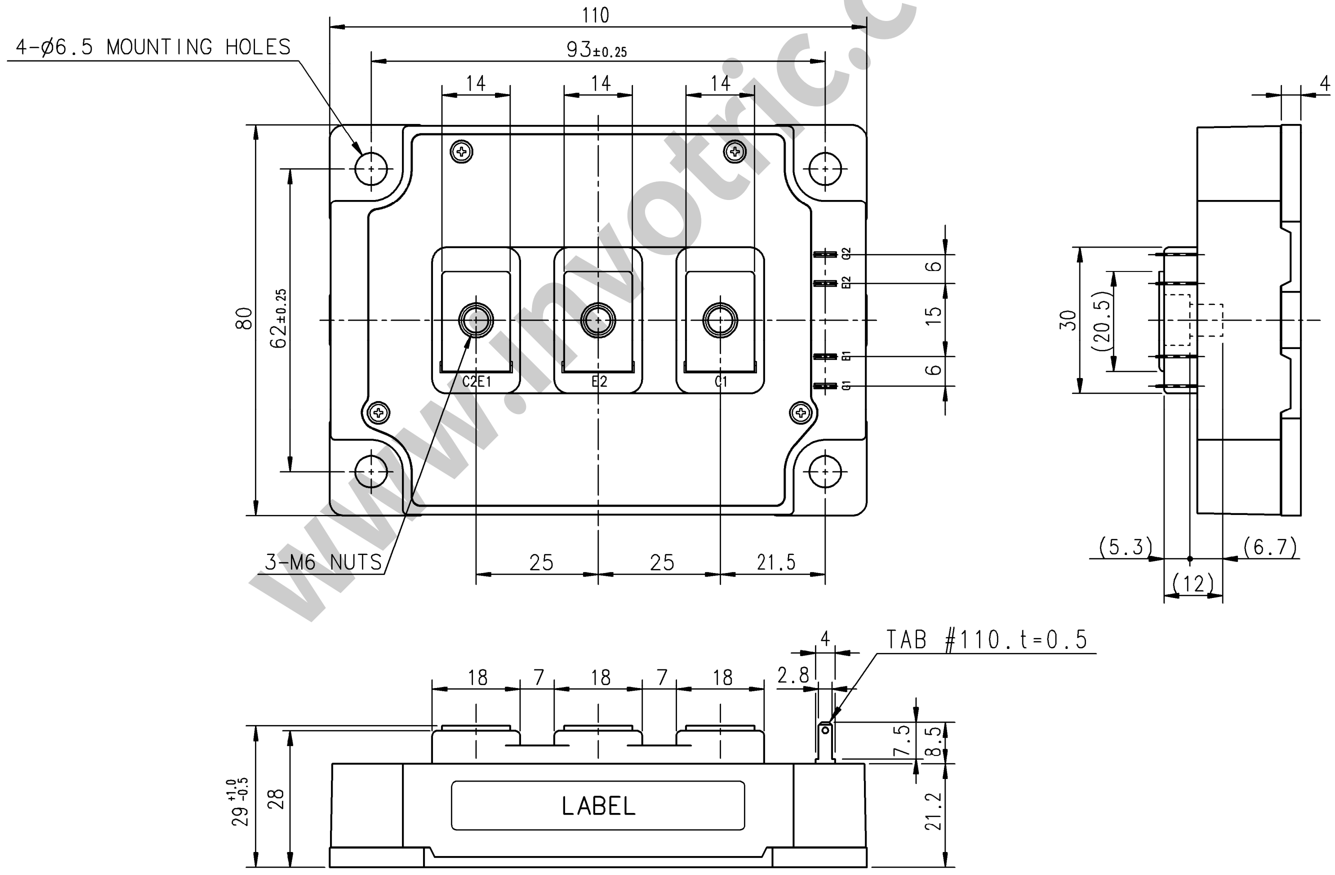
*. DC current rating is limited by power terminals.

## APPLICATION

AC Power Switch for NPC

## OUTLINE DRAWING & INTERNAL CONNECTION

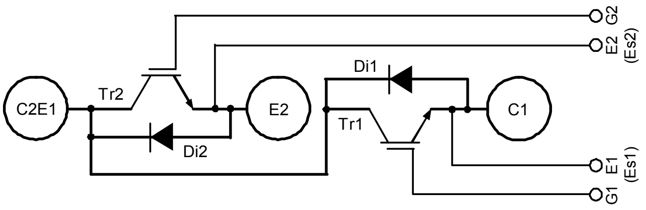
Dimension in mm



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 |

**INTERNAL CONNECTION**



### ABSOLUTE MAXIMUM RATINGS ($T_j$=25 °C, unless otherwise specified)

| Symbol | Item | Conditions | Rating | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage | G-E short-circuited | 1200 | V |
| $V_{GES}$ | Gate-emitter voltage | C-E short-circuited | ±20 | V |
| $I_C$ | Collector current | DC, $T_C$=124 °C (Note.2, 4) | 350 * | A |
| $I_{CRM}$ |  | Pulse, Repetitive (Note.3) | 800 |  |
| $P_{tot}$ | Total power dissipation | $T_C$=25 °C (Note.2, 4) | 2670 | W |
| $I_E$ (Note.1) | Emitter current | $T_C$=25 °C (Note.2, 4) | 350 * | A |
| $I_{ERM}$ (Note.1) |  | Pulse, Repetitive (Note.3) | 800 |  |
| $V_{isol}$ | Isolation voltage | Terminals to base plate, RMS, f=60 Hz, AC 1 min | 2500 | V |
| $T_{jmax}$ | Maximum junction temperature | - | 175 | °C |
| $T_{cmax}$ | Maximum case temperature | (Note.2) | 125 |  |
| $T_{jopr}$ | Operating junction temperature | - | -40 ~ +150 | °C |
| $T_{stg}$ | Storage temperature | - | -40 ~ +125 |  |

### ELECTRICAL CHARACTERISTICS ($T_j$=25 °C, unless otherwise specified)

| Symbol | Item | Conditions |  | Limits |  |  | Unit |
|---|---|---|---|---|---|---|---|
|  |  |  |  | Min. | Typ. | Max. |  |
| $I_{CES}$ | Collector-emitter cut-off current | $V_{CE}$=$V_{CES}$, G-E short-circuited |  | - | - | 1.0 | mA |
| $I_{GES}$ | Gate-emitter leakage current | $V_{GE}$=$V_{GES}$, C-E short-circuited |  | - | - | 0.5 | μA |
| $V_{GE(th)}$ | Gate-emitter threshold voltage | $I_C$=40 mA, $V_{CE}$=10 V |  | 5.4 | 6.0 | 6.6 | V |
| $V_{CEsat}$ | Collector-emitter saturation voltage | $I_C$=400 A (Note.5), | $T_j$=25 °C | - | 1.85 | 2.30 | V |
|  |  | $V_{GE}$=15 V, | $T_j$=125 °C | - | 2.05 | - |  |
|  |  | Terminal | $T_j$=150 °C | - | 2.10 | - |  |
|  |  | $I_C$=400 A (Note.5), | $T_j$=25 °C | - | 1.70 | 2.15 | V |
|  |  | $V_{GE}$=15 V, | $T_j$=125 °C | - | 1.90 | - |  |
|  |  | Chip | $T_j$=150 °C | - | 1.95 | - |  |
| $C_{ies}$ | Input capacitance | $V_{CE}$=10 V, G-E short-circuited |  | - | - | 40 | nF |
| $C_{oes}$ | Output capacitance |  |  | - | - | 8.0 |  |
| $C_{res}$ | Reverse transfer capacitance |  |  | - | - | 0.66 |  |
| $Q_G$ | Gate charge | $V_{CC}$=600 V, $I_C$=400 A, $V_{GE}$=15 V |  | - | 934 | - | nC |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$=600 V, $I_C$=400 A, $V_{GE}$=±15 V,<br>$R_G$=0 Ω, Inductive load |  | - | - | 800 | ns |
| $t_r$ | Rise time |  |  | - | - | 200 |  |
| $t_{d(off)}$ | Turn-off delay time |  |  | - | - | 600 |  |
| $t_f$ | Fall time |  |  | - | - | 300 |  |
| $V_{EC}$ (Note.1) | Emitter-collector voltage | $I_E$=400 A (Note.5), | $T_j$=25 °C | - | 1.85 | 2.30 | V |
|  |  | G-E short-circuited, | $T_j$=125 °C | - | 1.85 | - |  |
|  |  | Terminal | $T_j$=150 °C | - | 1.85 | - |  |
|  |  | $I_E$=400 A (Note.5), | $T_j$=25 °C | - | 1.70 | 2.15 | V |
|  |  | G-E short-circuited, | $T_j$=125 °C | - | 1.70 | - |  |
|  |  | Chip | $T_j$=150 °C | - | 1.70 | - |  |
| $t_{rr}$ (Note.1) | Reverse recovery time | $V_{CC}$=600 V, $I_E$=400 A, $V_{GE}$=±15 V,<br>$R_G$=0 Ω, Inductive load |  | - | - | 300 | ns |
| $Q_{rr}$ (Note.1) | Reverse recovery charge |  |  | - | 21.4 | - | μC |
| $E_{on}$ | Turn-on switching energy per pulse | $V_{CC}$=600 V, $I_C$=$I_E$=400 A,<br>$V_{GE}$=±15 V, $R_G$=0 Ω,<br>$T_j$=150 °C, Inductive load |  | - | 39.8 | - | mJ |
| $E_{off}$ | Turn-off switching energy per pulse |  |  | - | 44.9 | - |  |
| $E_{rr}$ (Note.1) | Reverse recovery energy per pulse |  |  | - | 35.2 | - | mJ |
| $r_g$ | Internal gate resistance | Per switch |  | - | 4.9 | - | Ω |

## THERMAL RESISTANCE CHARACTERISTICS

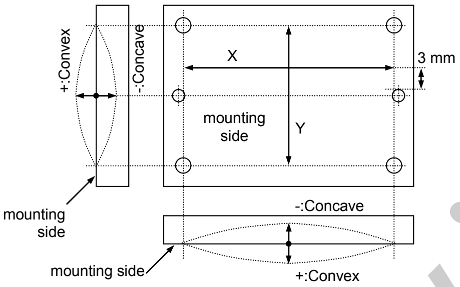
| Symbol | Item | Conditions | Limits |  |  | Unit |
|---|---|---|---|---|---|---|
|  |  |  | Min. | Typ. | Max. |  |
| $R_{th(j-c)Q}$ | Thermal resistance (Note.2) | Junction to case, per IGBT | - | - | 56 | K/kW |
| $R_{th(j-c)D}$ |  | Junction to case, per FWDi | - | - | 95 | K/kW |
| $R_{th(c-s)}$ | Contact thermal resistance (Note.2) | Case to heat sink, per 1/2 module,<br>Thermal grease applied (Note.6) | - | 18 | - | K/kW |

## MECHANICAL CHARACTERISTICS

| Symbol | Item | Conditions |  | Limits |  |  | Unit |
|---|---|---|---|---|---|---|---|
|  |  |  |  | Min. | Typ. | Max. |  |
| $M_t$ | Mounting torque | Main terminals | M 6 screw | 3.5 | 4.0 | 4.5 | N·m |
| $M_s$ |  | Mounting to heat sink | M 6 screw | 3.5 | 4.0 | 4.5 | N·m |
| m | Weight | - |  | - | 580 | - | g |
| $e_c$ | Flatness of base plate | On the centerline X, Y (Note.7) |  | -100 | - | +100 | μm |

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

2. Case temperature ($T_C$) and heat sink temperature ($T_s$) are defined on the each surface (mounting side) of base plate and heat sink just under the chips. Refer to the figure of chip location.
The heat sink thermal resistance should measure just under the chips.
3. Pulse width and repetition rate should be such that the device junction temperature ($T_j$) dose not exceed $T_{jmax}$ rating.
4. Junction temperature ($T_j$) should not increase beyond $T_{jmax}$ rating.
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 λ=0.9 W/(m K).
7. Base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



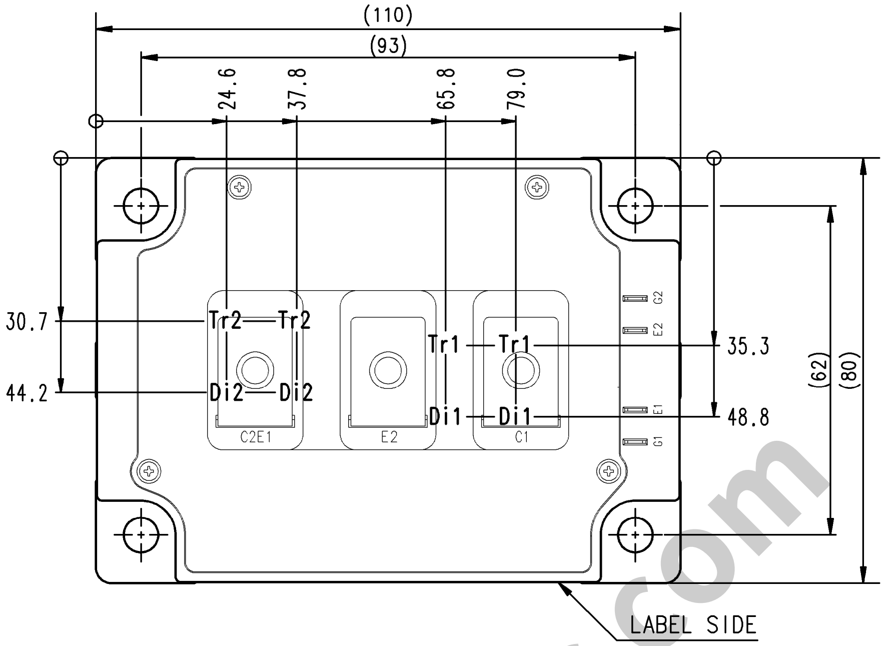
*. DC current rating is limited by power terminals.

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Item | Conditions | Limits |  |  | Unit |
|---|---|---|---|---|---|---|
|  |  |  | Min. | Typ. | Max. |  |
| $V_{CC}$ | (DC) Supply voltage | Applied across C1-E2 | - | 600 | 850 | V |
| $V_{GEon}$ | Gate (-emitter drive) voltage | Applied across G1-Es1/G2-Es2 | 13.5 | 15.0 | 16.5 | V |
| $R_G$ | External gate resistance | Per switch | 0 | - | 10 | Ω |

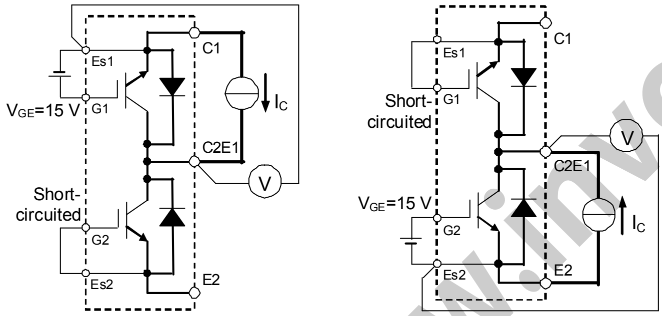
**CHIP LOCATION (Top view)**

Dimension in mm, tolerance: ±1 mm



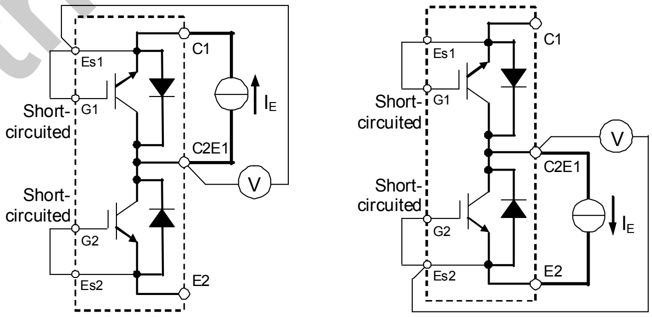
Tr1/Tr2: IGBT, Di1/Di2: FWDi

## TEST CIRCUIT



**Tr1**  **Tr2**

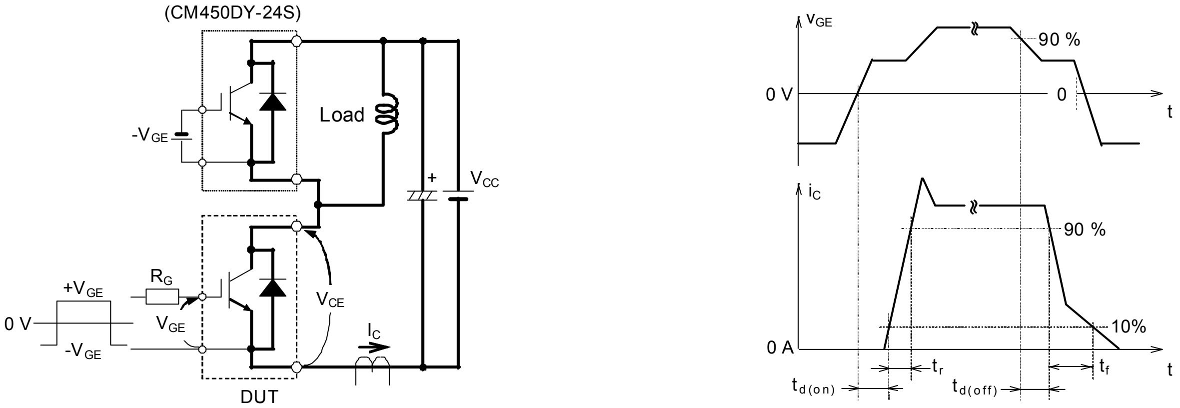
**$V_{CEsat}$ test circuit**



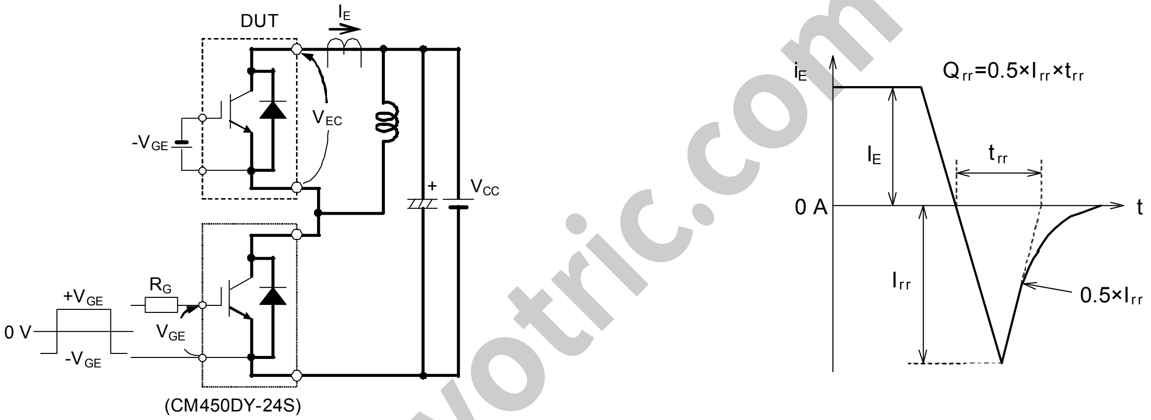
**Di1**  **Di2**

**$V_{EC}$ test circuit**

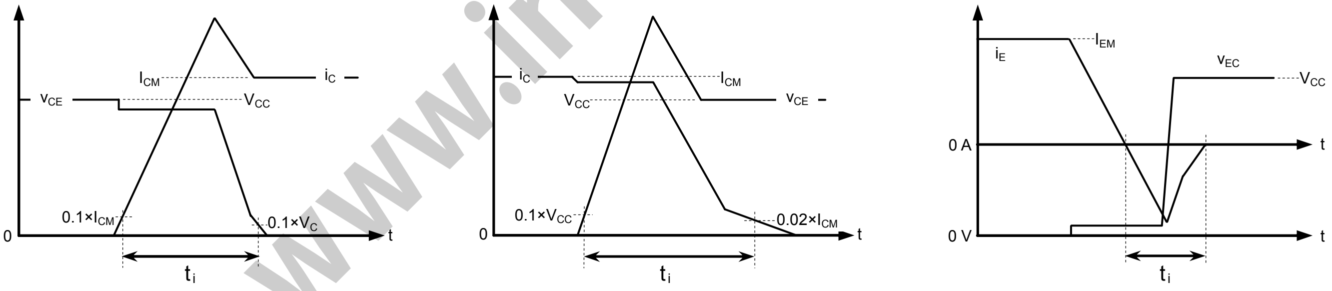
## TEST CIRCUIT AND WAVEFORMS



**Switching characteristics test circuit and waveform**



**Reverse recovery characteristics ($t_{rr}$, $Q_{rr}$) test circuit**

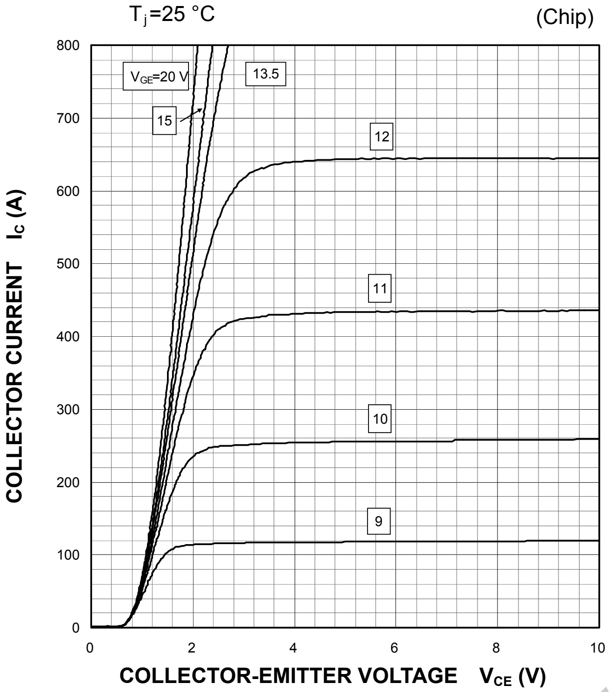


**IGBT Turn-on switching energy** **IGBT Turn-off switching energy** **FWDi Reverse recovery energy**

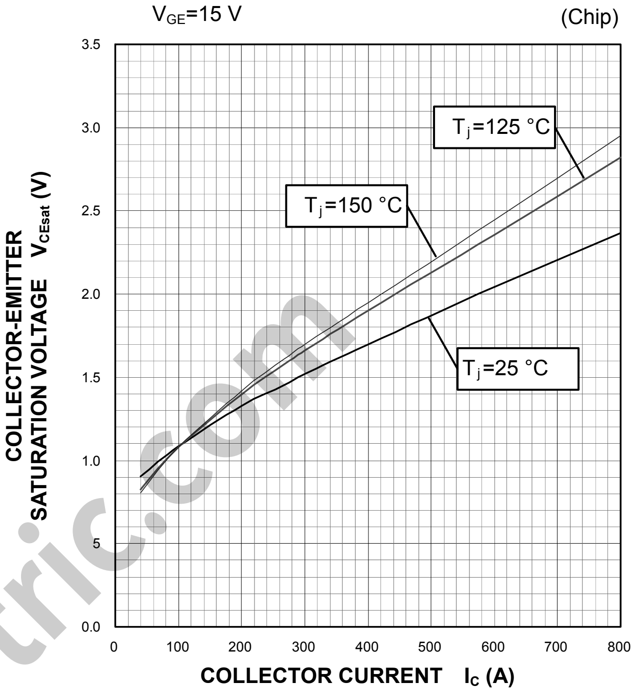
**Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)**

## PERFORMANCE CURVES

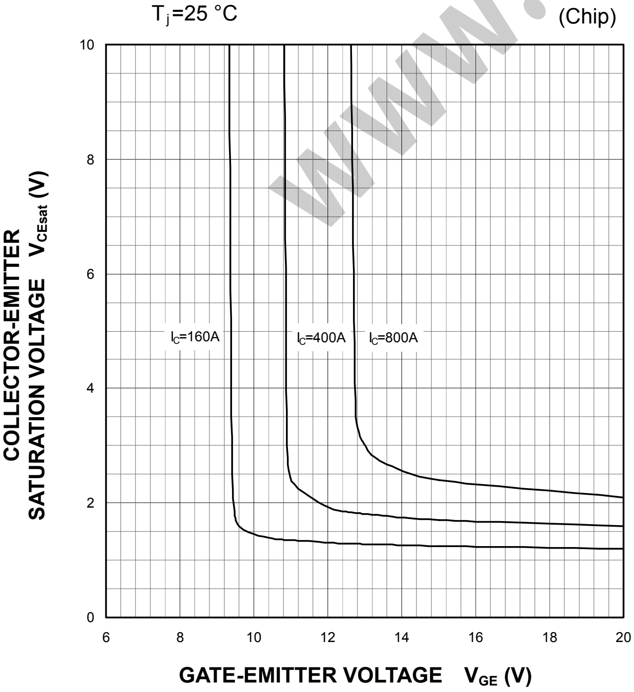
### OUTPUT CHARACTERISTICS (TYPICAL)



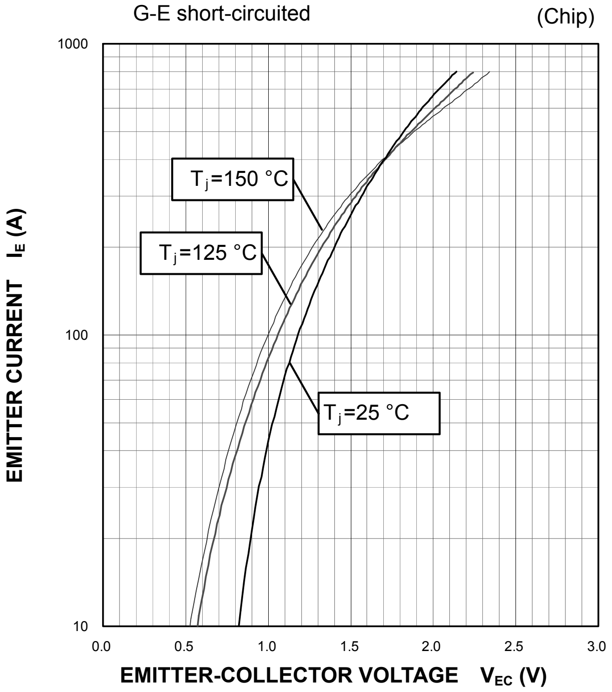
### COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



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



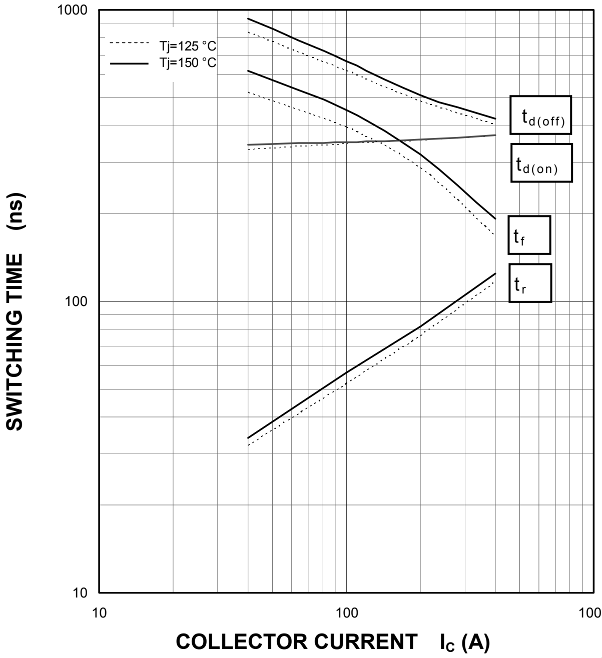
### FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



## PERFORMANCE CURVES

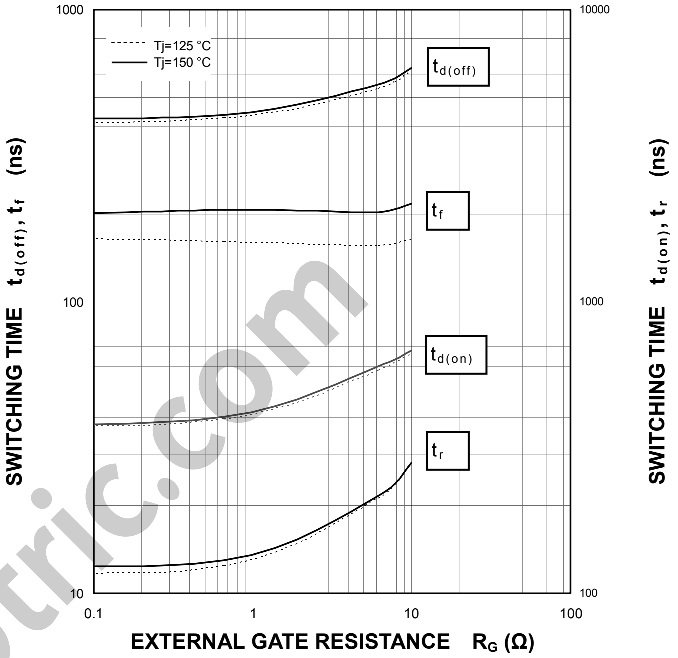
### HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=0 Ω,
INDUCTIVE LOAD



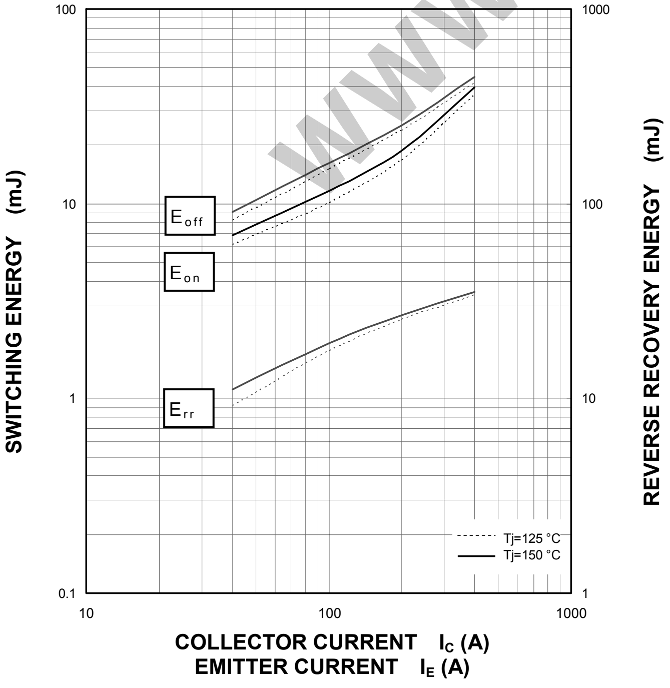
### HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $I_C$=400 A, $V_{GE}$=±15 V,
INDUCTIVE LOAD



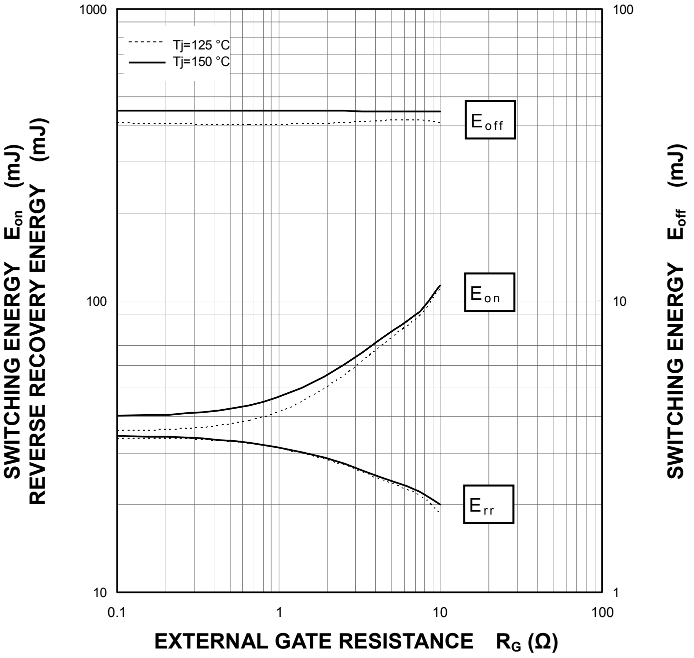
### HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=0 Ω
INDUCTIVE LOAD, PER PULSE



### HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

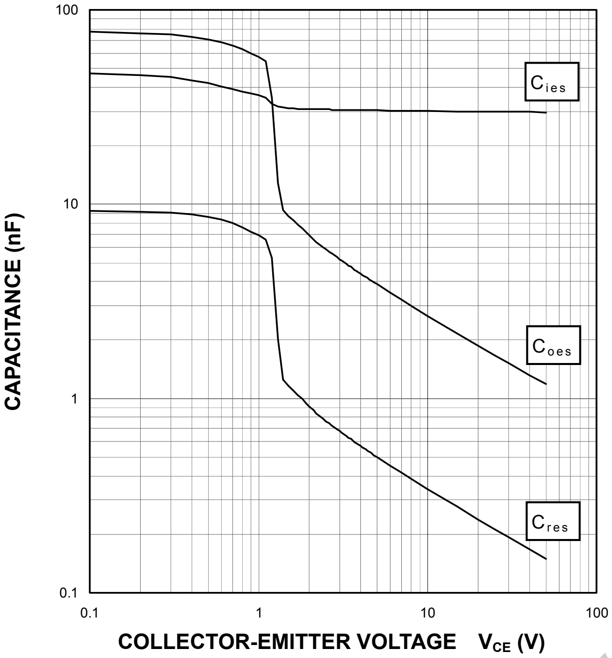
$V_{CC}$=600 V, $I_C/I_E$=400 A, $V_{GE}$=±15 V,
INDUCTIVE LOAD, PER PULSE



## PERFORMANCE CURVES

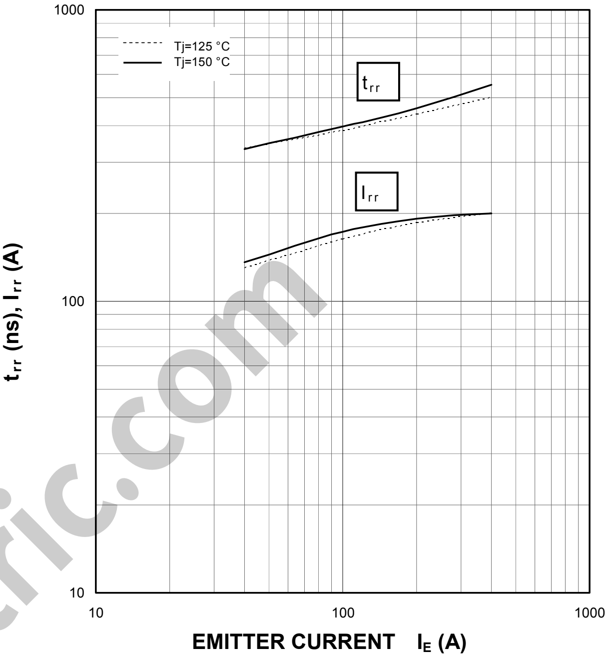
### CAPACITANCE CHARACTERISTICS (TYPICAL)

G-E short-circuited, $T_j$=25 °C



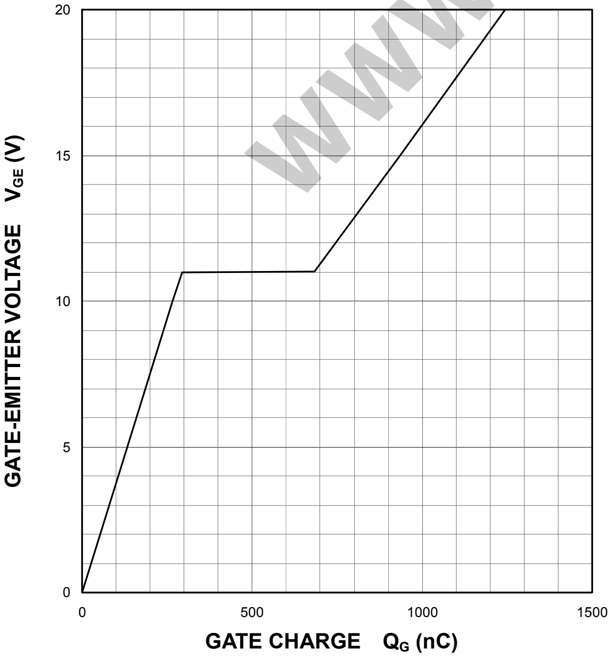
### FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $V_{GE}$=±15 V, $R_G$=0 Ω,
INDUCTIVE LOAD



### GATE CHARGE CHARACTERISTICS (TYPICAL)

$V_{CC}$=600 V, $I_C$=400 A, $T_j$=25 °C



### TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, $T_C$=25°C
$R_{th(j-c)Q}$=56 K/kW, $R_{th(j-c)D}$=95 K/kW