MITSUBISHI ELECTRIC

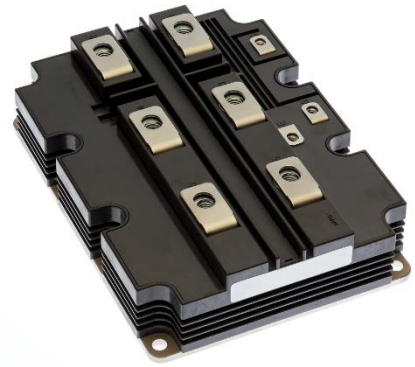
**< High Voltage Insulated Gate Bipolar Transistor : HVIGBT >**

# CM1350HG-90X

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

5th-Version HVIGBT (High Voltage Insulated Gate Bipolar Transistor) Modules

**CM1350HG-90X**

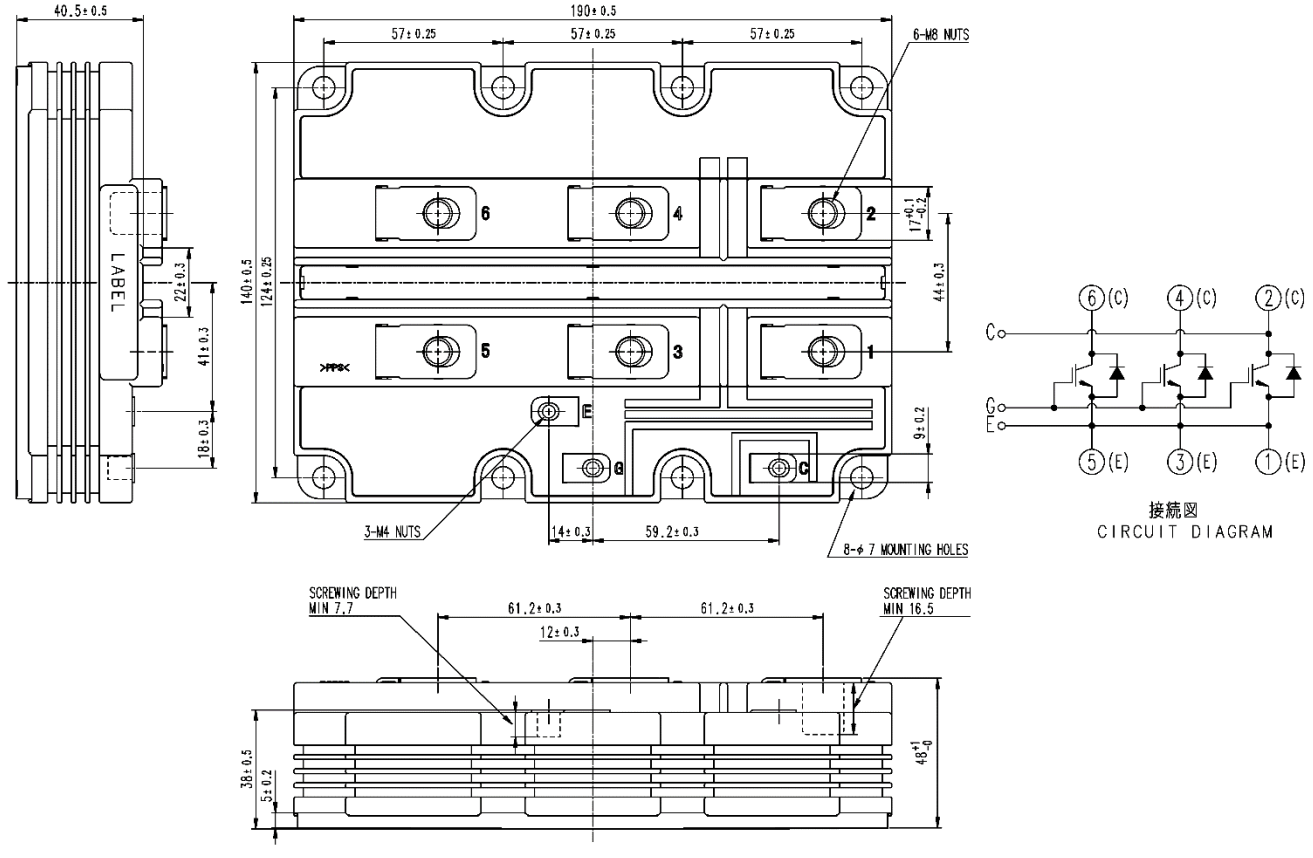


- $I_C$ ..... 1350A
- $V_{CES}$ ..... 4500V
- 1-element in a Pack
- Insulated Type
- CSTBT™(III) / RFC Diode
- AlSiC Baseplate
- UL recognized under UL1557

## APPLICATION

Traction drives, High Reliability Converters / Inverters, DC choppers

**OUTLINE DRAWING & CIRCUIT DIAGRAM** **Dimensions in mm**



## MAXIMUM RATINGS

| Symbol | Item | Conditions | Ratings | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage | $V_{GE}$ = 0V, $T_j$ = -40…+150°C | 4500 | V |
| | | $V_{GE}$ = 0V, $T_j$ = −50°C | 4400 | |
| $V_{GES}$ | Gate-emitter voltage | $V_{CE}$ = 0V, $T_j$ = 25°C | ± 20 | V |
| $I_C$ | Collector current | DC, $T_C$ = 105°C | 1350 | A |
| $I_{CRM}$ | | Pulse (Note 1) | 2700 | A |
| $I_E$ | Emitter current (Note 2) | DC | 1350 | A |
| $I_{ERM}$ | | Pulse (Note 1) | 2700 | A |
| $P_{tot}$ | Maximum power dissipation (Note 3) | $T_C$ = 25°C, IGBT part | 14700 | W |
| $V_{iso}$ | Isolation voltage | RMS, sinusoidal, f = 60Hz, t = 1 min. | 10200 | V |
| $V_e$ | Partial discharge extinction voltage | RMS, sinusoidal, f = 60Hz, $Q_{PD}$ ≤ 10 pC | 5100 | V |
| $T_j$ | Junction temperature | | −50 ~ +150 | °C |
| $T_{jop}$ | Operating junction temperature | | −50 ~ +150 | °C |
| $T_{stg}$ | Storage temperature | | −55 ~ +150 | °C |
| $t_{psc}$ | Short circuit pulse width | $V_{CC}$ = 3400V, $V_{CE}$ ≤ $V_{CES}$, $V_{GE}$ =15V, $T_j$ =150°C | 10 | µs |

## ELECTRICAL CHARACTERISTICS

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $I_{CES}$ | Collector cutoff current | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V | $T_j$ = 25°C | — | — | 10.0 | mA |
| | | | $T_j$ = 125°C | — | 10.0 | — | |
| | | | $T_j$ = 150°C | — | 60.0 | — | |
| $V_{GE(th)}$ | Gate-emitter threshold voltage | $V_{CE}$ = 10 V, $I_C$ = 135 mA, $T_j$ = 25°C | | 6.5 | 7.0 | 7.5 | V |
| $I_{GES}$ | Gate leakage current | $V_{GE}$ = $V_{GES}$, $V_{CE}$ = 0V, $T_j$ = 25°C | | −0.5 | — | 0.5 | µA |
| $C_{ies}$ | Input capacitance | $V_{CE}$ = 10 V, $V_{GE}$ = 0 V, f = 100 kHz<br>$T_j$ = 25°C | | — | 170 | — | nF |
| $C_{oes}$ | Output capacitance | | | — | 11.0 | — | nF |
| $C_{res}$ | Reverse transfer capacitance | | | — | 1.5 | — | nF |
| $Q_G$ | Total gate charge | $V_{CC}$ = 2800V, $I_C$ = 1350A, $V_{GE}$ = ±15V | | — | 12.6 | — | µC |
| $V_{CEsat}$ | Collector-emitter saturation voltage | $I_C$ = 1350 A (Note 4)<br>$V_{GE}$ = 15 V | $T_j$ = 25°C | — | 2.25 | — | V |
| | | | $T_j$ = 125°C | — | 2.90 | — | |
| | | | $T_j$ = 150°C | — | 3.00 | 3.50 | |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 2800 V<br>$I_C$ = 1350 A<br>$V_{GE}$ = ±15 V<br>$R_{G(on)}$ =2.4 Ω<br>$L_s$ = 150 nH<br>Inductive load | $T_j$ = 25°C | — | — | — | µs |
| | | | $T_j$ = 125°C | — | 0.55 | — | |
| | | | $T_j$ = 150°C | — | 0.55 | 1.00 | |
| $t_r$ | Rise time | | $T_j$ = 25°C | — | — | — | µs |
| | | | $T_j$ = 125°C | — | 0.25 | — | |
| | | | $T_j$ = 150°C | — | 0.25 | 0.50 | |
| $E_{on(10\%)}$ | Turn-on switching energy per pulse (Note 5) | | $T_j$ = 25°C | — | 5.85 | — | J |
| | | | $T_j$ = 125°C | — | 6.25 | — | |
| | | | $T_j$ = 150°C | — | 6.30 | — | |
| $E_{on}$ | Turn-on switching energy per pulse (Note 6) | | $T_j$ = 25°C | — | 5.95 | — | J |
| | | | $T_j$ = 125°C | — | 6.60 | — | |
| | | | $T_j$ = 150°C | — | 6.65 | — | |
| $t_{d(off)}$ | Turn-off delay time | $V_{CC}$ = 2800 V<br>$I_C$ = 1350 A<br>$V_{GE}$ = ±15 V<br>$R_{G(off)}$ = 30 Ω<br>$L_s$ = 150 nH<br>Inductive load | $T_j$ = 25°C | — | — | — | µs |
| | | | $T_j$ = 125°C | — | 7.00 | — | |
| | | | $T_j$ = 150°C | — | 7.20 | 10.0 | |
| $t_f$ | Fall time | | $T_j$ = 25°C | — | — | — | µs |
| | | | $T_j$ = 125°C | — | 0.50 | — | |
| | | | $T_j$ = 150°C | — | 0.50 | 1.20 | |
| $E_{off(10\%)}$ | Turn-off switching energy per pulse (Note 5) | | $T_j$ = 25°C | — | 3.90 | — | J |
| | | | $T_j$ = 125°C | — | 5.30 | — | |
| | | | $T_j$ = 150°C | — | 5.60 | — | |
| $E_{off}$ | Turn-off switching energy per pulse (Note 6) | | $T_j$ = 25°C | — | 4.35 | — | J |
| | | | $T_j$ = 125°C | — | 5.95 | — | |
| | | | $T_j$ = 150°C | — | 6.25 | — | |

**ELECTRICAL CHARACTERISTICS (continuation)**

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $V_{EC}$ | Emitter-collector voltage (Note 2) | $I_E$ = 1350 A (Note 4), $V_{GE}$ = 0 V | $T_j$ = 25°C | — | 2.35 | — | V |
| | | | $T_j$ = 125°C | — | 2.90 | — | |
| | | | $T_j$ = 150°C | — | 3.00 | 3.50 | |
| $t_{rr}$ | Reverse recovery time (Note 2) | $V_{CC}$ = 2800 V, $I_C$ = 1350 A, $V_{GE}$ = ±15 V, $R_{G(on)}$ = 2.4 Ω, $L_s$ = 150 nH, Inductive load | $T_j$ = 25°C | — | — | — | µs |
| | | | $T_j$ = 125°C | — | 1.45 | — | |
| | | | $T_j$ = 150°C | — | 1.70 | — | |
| $I_{rr}$ | Reverse recovery current (Note 2) | | $T_j$ = 25°C | — | — | — | A |
| | | | $T_j$ = 125°C | — | 1900 | — | |
| | | | $T_j$ = 150°C | — | 1900 | — | |
| $Q_{rr(10\%)}$ | Reverse recovery charge (Note 2,7) | | $T_j$ = 25°C | — | — | — | µC |
| | | | $T_j$ = 125°C | — | 2450 | — | |
| | | | $T_j$ = 150°C | — | 2500 | — | |
| $Q_{rr}$ | Reverse recovery charge (Note 2,6) | | $T_j$ = 25°C | — | — | — | µC |
| | | | $T_j$ = 125°C | — | 2560 | — | |
| | | | $T_j$ = 150°C | — | 2600 | — | |
| $E_{rec(10\%)}$ | Reverse recovery energy per pulse (Note 2,5) | | $T_j$ = 25°C | — | 3.05 | — | J |
| | | | $T_j$ = 125°C | — | 3.90 | — | |
| | | | $T_j$ = 150°C | — | 4.00 | — | |
| $E_{rec}$ | Reverse recovery energy per pulse (Note 2,6) | | $T_j$ = 25°C | — | 3.10 | — | J |
| | | | $T_j$ = 125°C | — | 4.20 | — | |
| | | | $T_j$ = 150°C | — | 4.30 | — | |

**THERMAL CHARACTERISTICS**

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $R_{th(j-c)Q}$ | Thermal resistance | Junction to Case, IGBT part | — | — | 8.5 | K/kW |
| $R_{th(j-c)D}$ | | Junction to Case, FWDi part | — | — | 13.0 | K/kW |
| $R_{th(c-s)}$ | Contact thermal resistance | Case to heat sink, $\lambda_{grease}$ = 1W/m·k, $D_{(c-s)}$ = 80µm | — | 5.0 | — | K/kW |

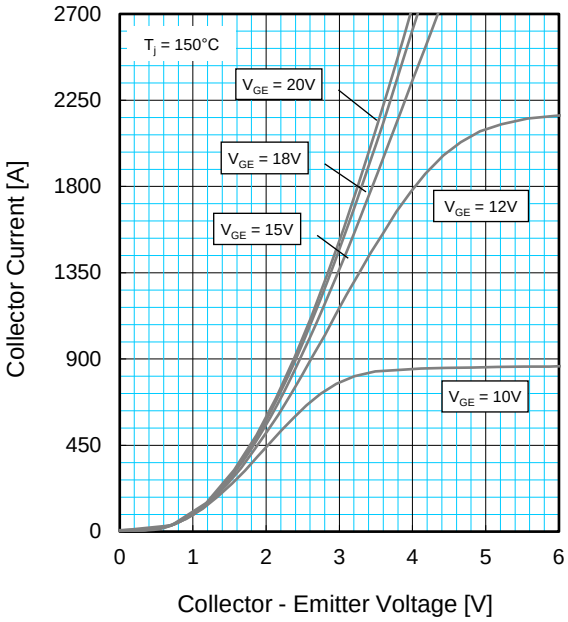
**MECHANICAL CHARACTERISTICS**

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $M_t$ | Mounting torque | M8 : Main terminals screw | 7.0 | — | 19.0 | N·m |
| $M_s$ | | M6 : Mounting screw | 3.0 | — | 6.0 | N·m |
| $M_t$ | | M4 : Auxiliary terminals screw | 1.0 | — | 3.0 | N·m |
| m | Mass | | — | 1.5 | — | kg |
| CTI | Comparative tracking index | | 600 | — | — | — |
| $d_a$ | Clearance | | 26.0 | — | — | mm |
| $d_s$ | Creepage distance | | 56.0 | — | — | mm |
| $L_{P\ CE}$ | Parasitic stray inductance | | — | 13.5 | — | nH |
| $R_{CC'+EE'}$ | Internal lead resistance | $T_C$ = 25 °C | — | 0.12 | — | mΩ |

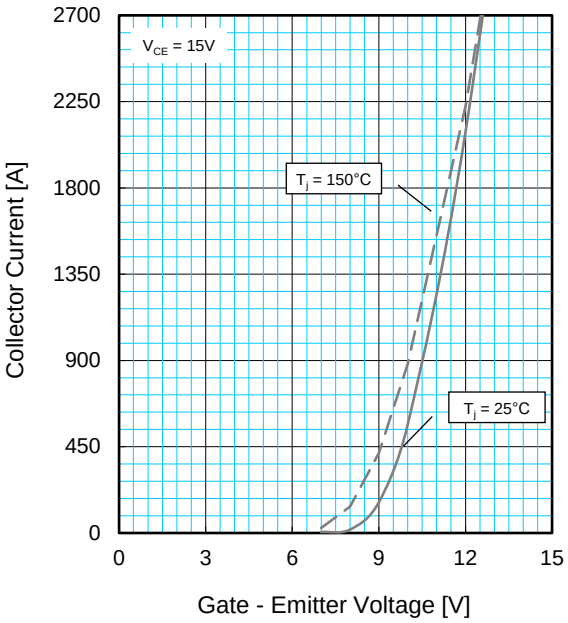
Note1. Pulse width and repetition rate should be such that junction temperature ($T_j$) does not exceed $T_{jopmax}$ rating.
Note2. The symbols represent characteristics of the anti-parallel, emitter to collector free-wheel diode ($FWD_i$).
Note3. Junction temperature ($T_j$) should not exceed $T_{jmax}$ rating (150°C).
Note4. Pulse width and repetition rate should be such as to cause negligible temperature rise.
Note5. The integration range of switching energies is from 10%$V_{CE}$ to 10%$I_C$(10%$I_E$).
Note6. Definition of all items is according to IEC 60747, unless otherwise specified.
Note7. The integration range of reverse recovery charge is from $I_E$ = 0A to 10%$I_E$.

**PERFORMANCE CURVES**

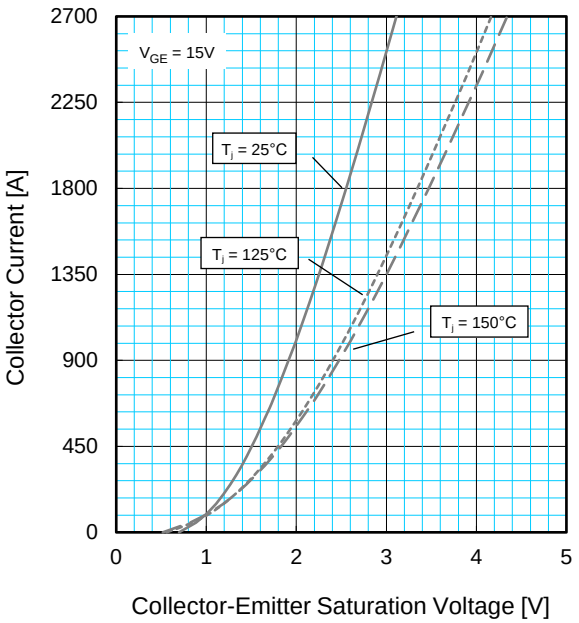
## OUTPUT CHARACTERISTICS (TYPICAL)



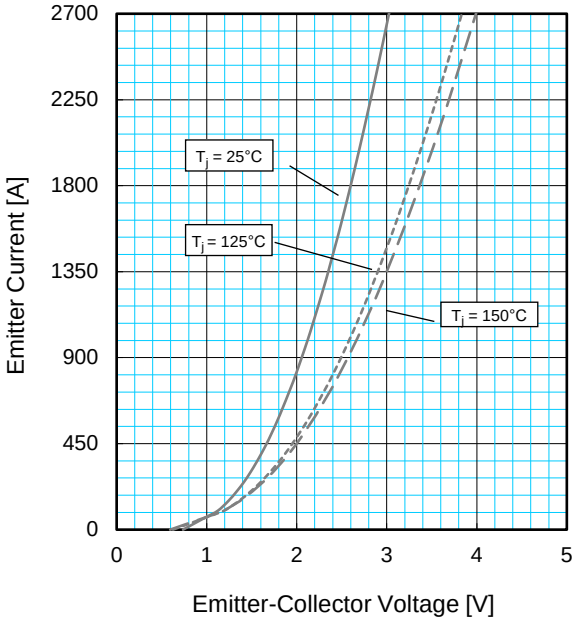

## TRANSFER CHARACTERISTICS (TYPICAL)




## COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)

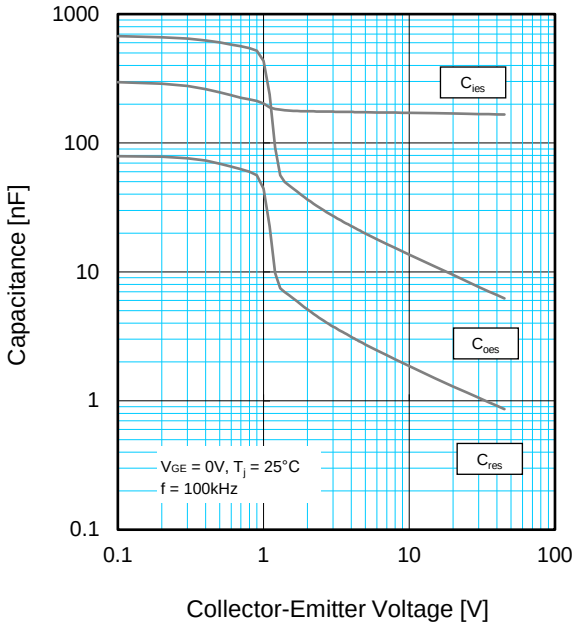



## FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)

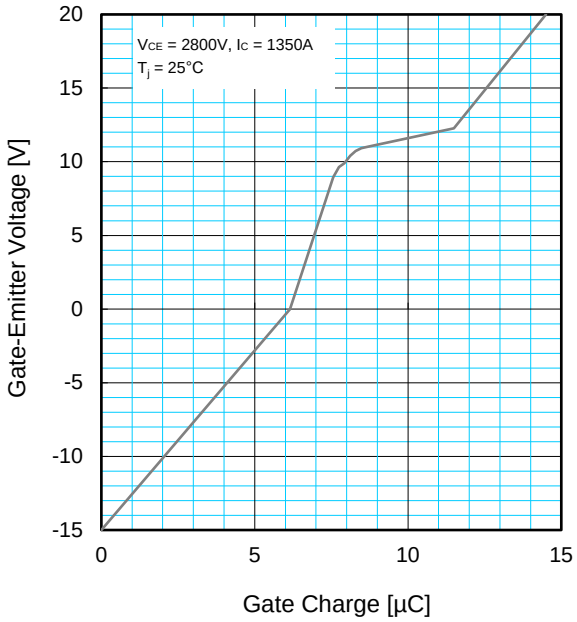


**PERFORMANCE CURVES**

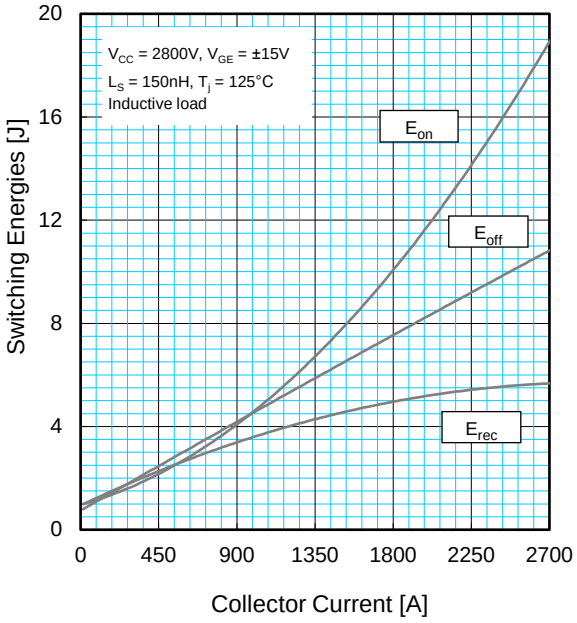
### CAPACITANCE CHARACTERISTICS (TYPICAL)




### GATE CHARGE CHARACTERISTICS (TYPICAL)




### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

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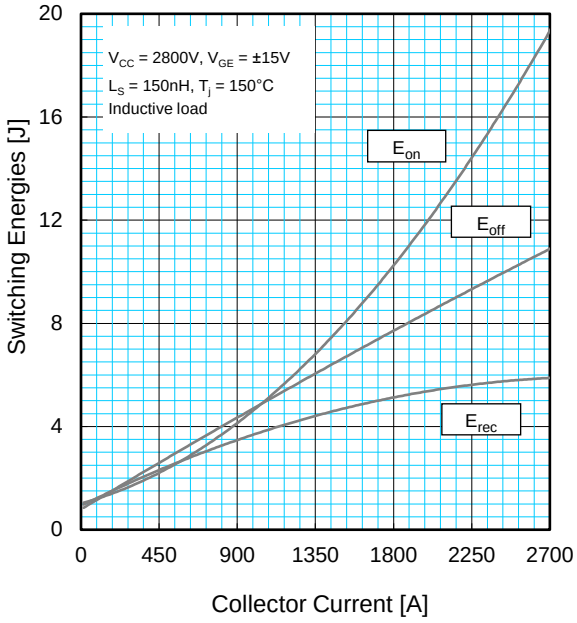

**PERFORMANCE CURVES**

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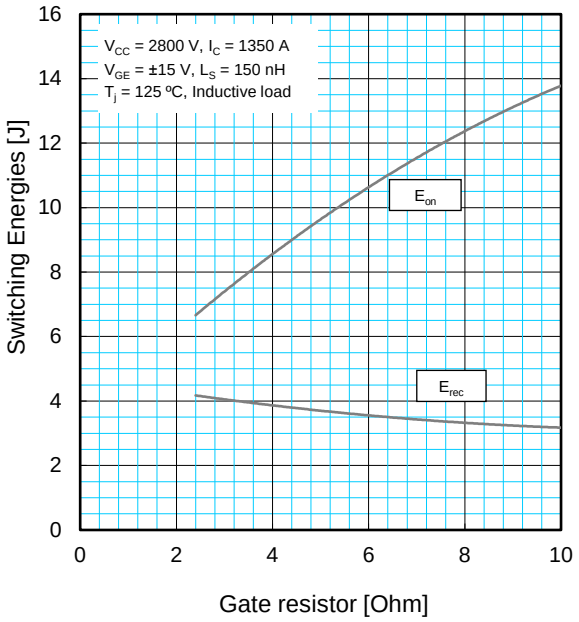


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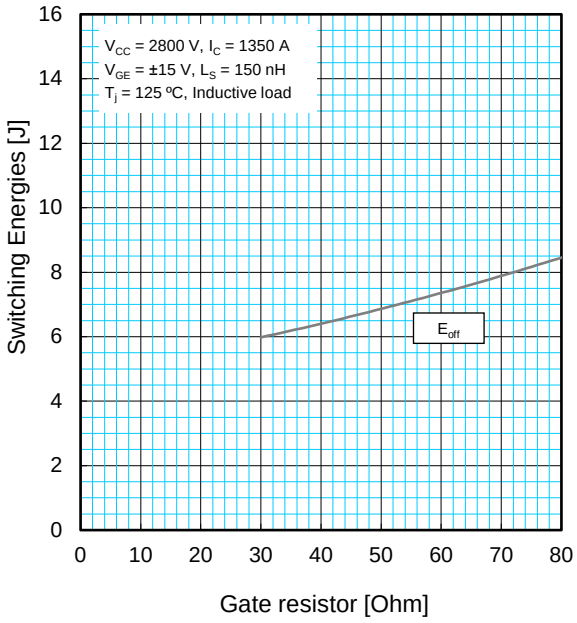
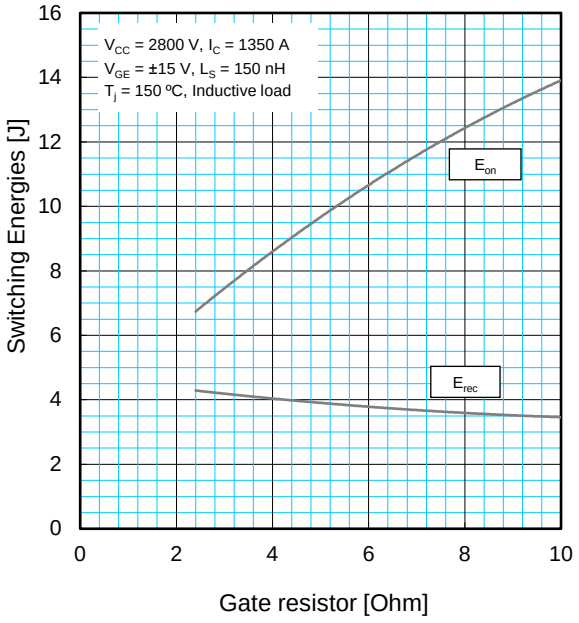
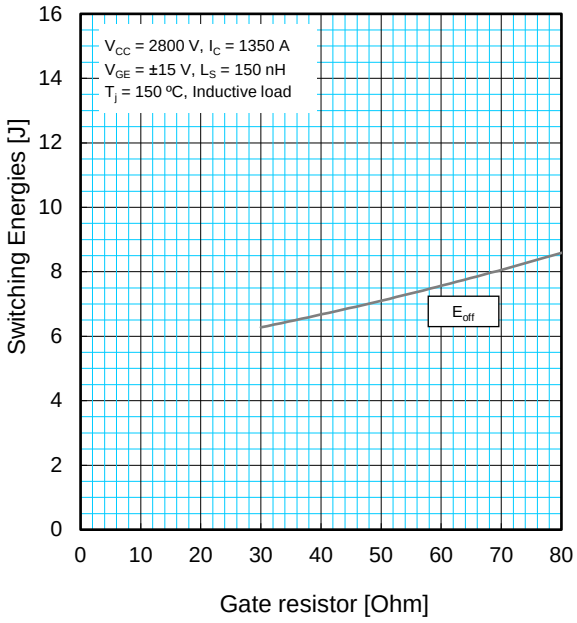



### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

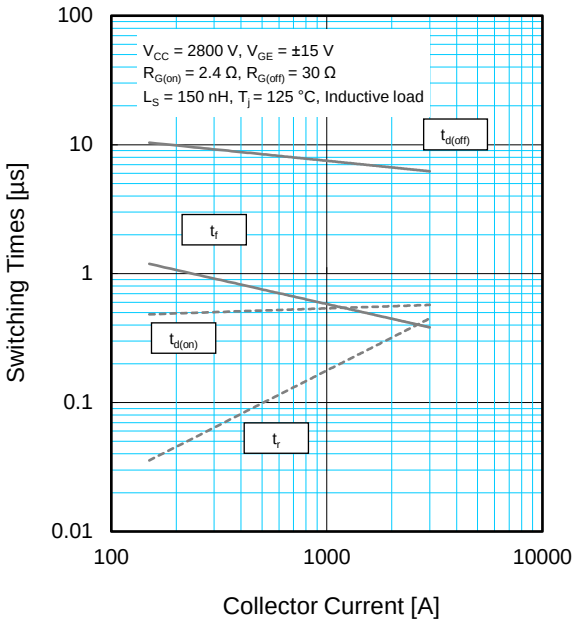



### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

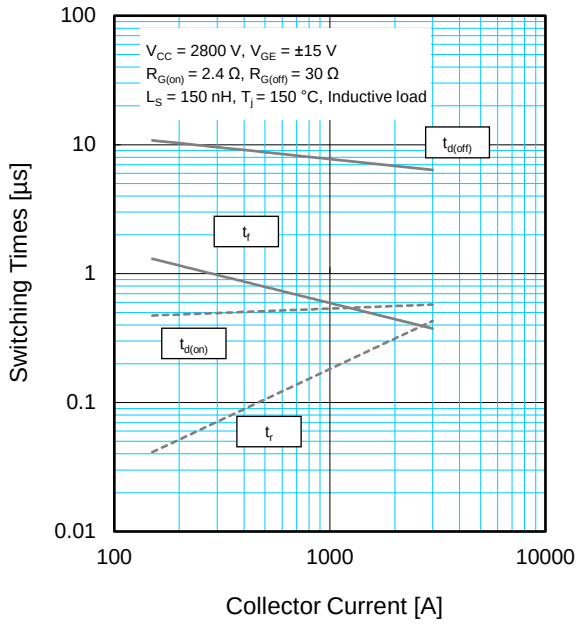


## PERFORMANCE CURVES

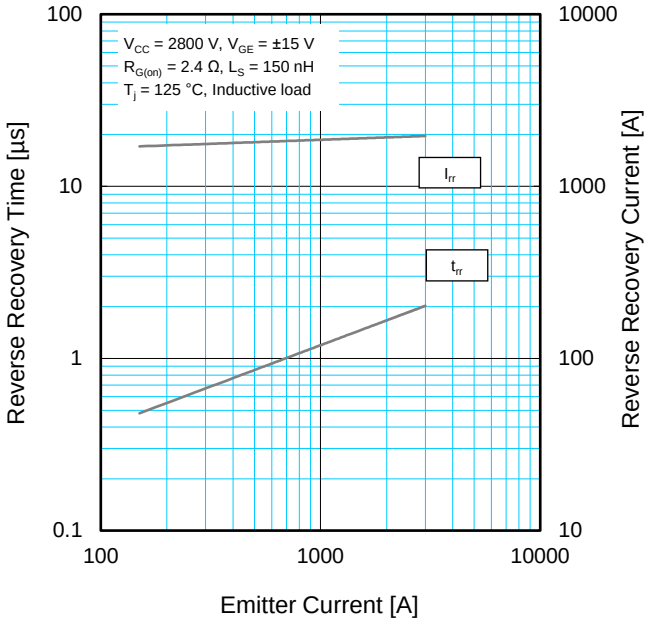
### HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)




### HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)




### FREE-WHEEL DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

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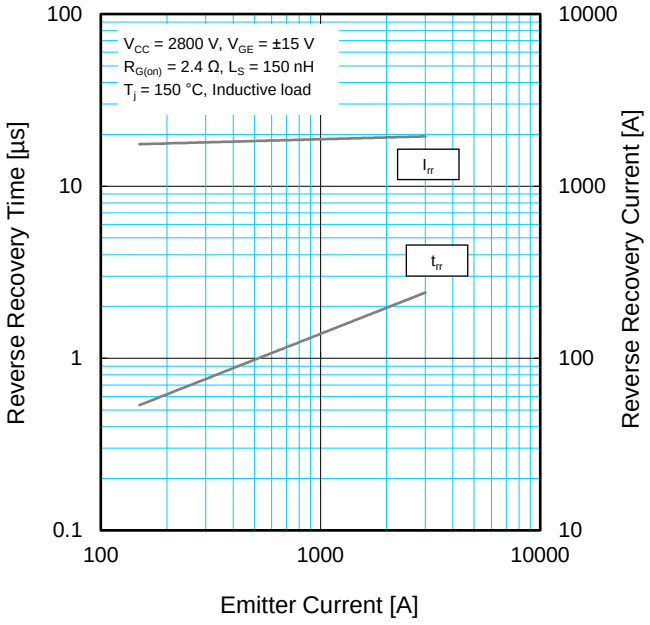
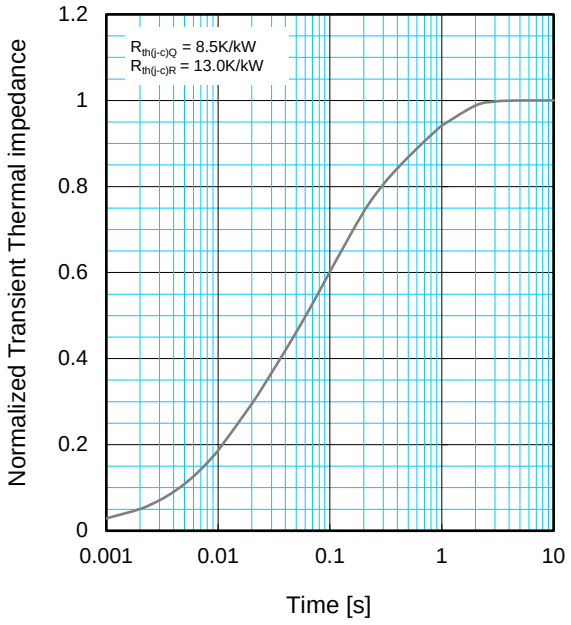


**PERFORMANCE CURVES**

## TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS

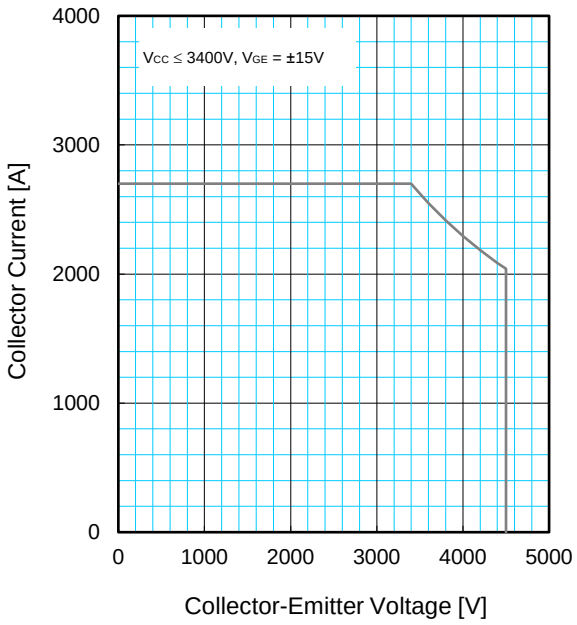



$$Z_{th(j-c)}(t) = \sum_{i=1}^{n} R_i \left\{ 1 - \exp\left( -\frac{t}{\tau_i} \right) \right\}$$

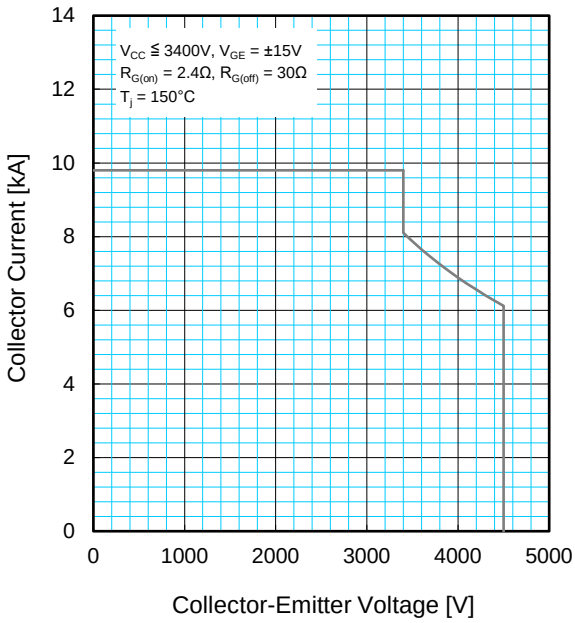
| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $R_i$ / $R_{th(j-c)}$ : | 0.0096 | 0.1893 | 0.4044 | 0.3967 |
| $\tau_i$ [sec] : | 0.0001 | 0.0058 | 0.0602 | 0.3512 |

**PERFORMANCE CURVES**

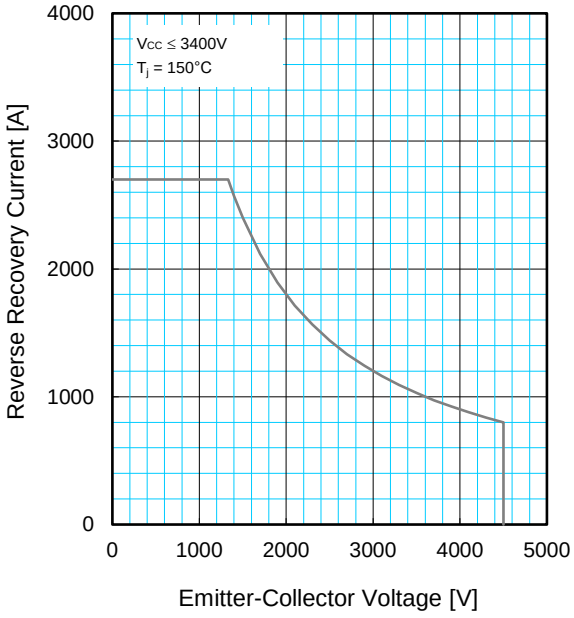
**REVERSE BIAS SAFE OPERATING AREA (RBSOA)**




**SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)**




**FREE-WHEEL DIODE REVERSE RECOVERY SAFE OPERATING AREA (RRSOA)**



## Keep safety first in your circuit designs!

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