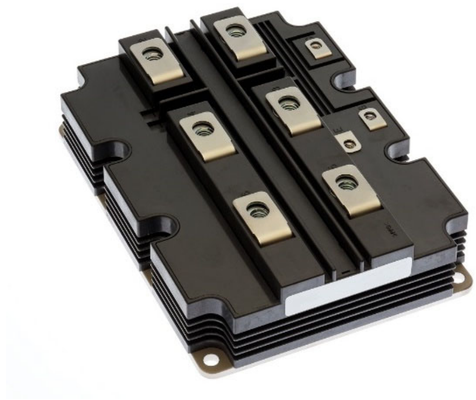
< High Voltage Insulated Gate Bipolar Transistor : HVIGBT >

# CM900E2G-90X

**HIGH POWER SWITHCHING USE**

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

**CM900E2G-90X**

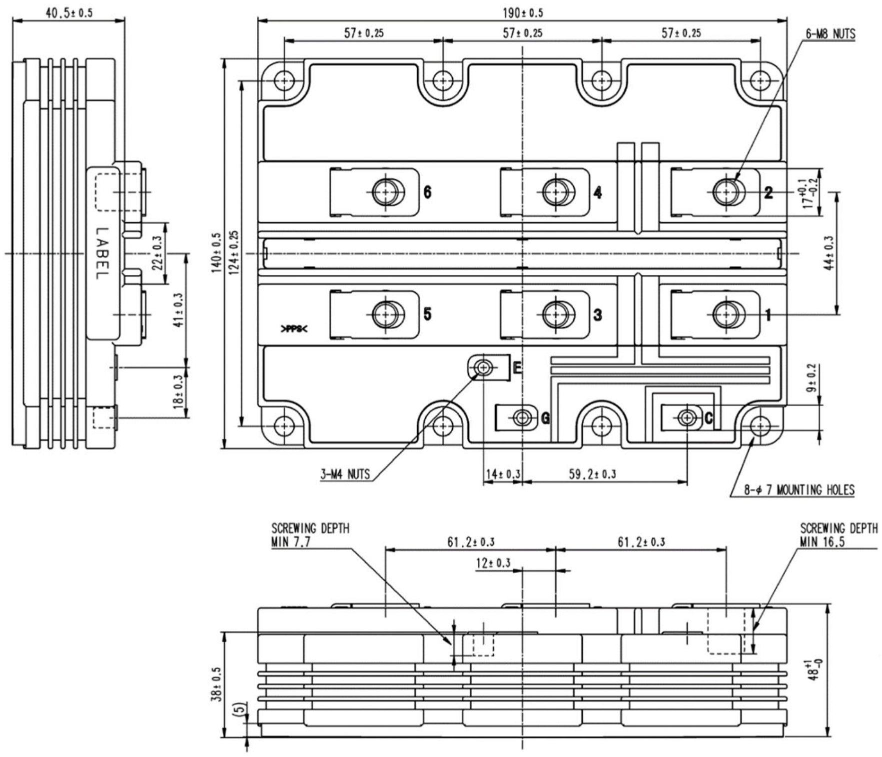


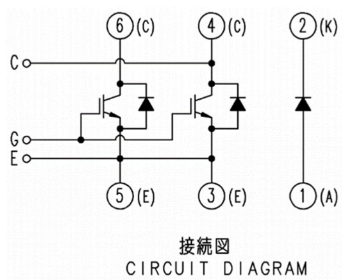
- $I_C$ ........................................ 900 A
- $V_{CES}$ ........................................ 4500 V
- 1-element in pack
- High Insulated type
- CSTBT[TM](III) / RFC Diode
- AlSiC baseplate

## APPLICATION

Brake chopper

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



## MAXIMUM RATINGS

| Symbol | Item | Conditions | Ratings | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage | $V_{GE}$ = 0 V, $T_j$ = -40…+150 °C | 4500 | V |
| | | $V_{GE}$ = 0 V, $T_j$ = −50 °C | 4400 | |
| $V_{RRM}$ | Repetitive peak reverse voltage (Note 3) | $V_{GE}$ = 0 V, $T_j$ = -40…+150 °C | 4500 | V |
| | | $V_{GE}$ = 0 V, $T_j$ = −50 °C | 4400 | |
| $V_{RSM}$ | Non-repetitive peak reverse voltage (Note 3) | $V_{GE}$ = 0 V, $T_j$ = -40…+150 °C | 4500 | V |
| | | $V_{GE}$ = 0 V, $T_j$ = −50 °C | 4400 | |
| $V_{GES}$ | Gate-emitter voltage | $V_{CE}$ = 0 V, $T_j$ = 25 °C | ± 20 | V |
| $I_C$ | Collector current | DC, $T_c$ = 105 °C | 900 | A |
| $I_{CRM}$ | | Pulse (Note 1) | 1800 | |
| $I_E$ | Emitter current (Note 2) | DC, $T_c$ = 90 °C | 900 | A |
| $I_{ERM}$ | | Pulse (Note 1) | 1800 | |
| $I_F$ | Forward current (Note 3) | DC, $T_c$ = 90 °C | 900 | A |
| $I_{FRM}$ | | Pulse (Note 1) | 1800 | |
| $I_{FSM}$ | Surge forward current (Note 3) | $T_{j\_start}$ = 150 °C, $t_p$ = 10ms, $V_R$ = 0 V<br>F(t) = 1 %, Half-sine wave | 8.1 | kA |
| $I^2t$ | Surge current load integral (Note 3) | | 328 | $kA^2s$ |
| $P_{tot}$ | Maximum power dissipation (Note 4) | $T_c$ = 25 °C, IGBT part | 9800 | W |
| $V_{iso}$ | Isolation voltage | RMS, sinusoidal, f = 60 Hz, t = 1 min. | 10200 | V |
| $Q_{PD}$ | Partial discharge | Charged part to the baseplate<br>V1 = 6900 Vrms, V2 = 5100 Vrms<br>AC 60 Hz, $T_c$ = 25 °C (acc. to IEC 61287) | 10 | pC |
| $T_j$ | 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 | $V_{CC}$ = 3400 V, $V_{CE} \leq V_{CES}$, $V_{GE}$ = ±15 V, $T_j$ =150 °C<br>$R_{G(on)}$ = 3.6 Ω, $R_{G(off)}$ = 45 Ω, $L_S \leq$ 225 nH | 10 | μs |

## ELECTRICAL CHARACTERISTICS

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $I_{CES}$ | Collector cutoff current | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0 V | $T_j$ = 25 °C | — | — | 4.0 | mA |
| | | | $T_j$ = 125 °C | — | 4.0 | — | |
| | | | $T_j$ = 150 °C | — | — | 80 | |
| $V_{GE(th)}$ | Gate-emitter threshold voltage | $V_{CE}$ = 10 V, $I_C$ = 90 mA, $T_j$ = 25 °C | | 6.5 | 7.0 | 7.5 | V |
| $I_{GES}$ | Gate leakage current | $V_{CE}$ = 0 V, $V_{GE}$ = $V_{GES}$, $T_j$ = 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 | | — | 115 | — | nF |
| $C_{oes}$ | Output capacitance | | | — | 7.5 | — | nF |
| $C_{res}$ | Reverse transfer capacitance | | | — | 1.0 | — | nF |
| $Q_G$ | Total gate charge | $V_{CC}$ = 2800 V, $I_C$ = 900 A, $V_{GE}$ = ±15 V, $T_j$ = 25 °C | | — | 8.4 | — | μC |
| $V_{CEsat}$ | Collector-emitter saturation voltage | $I_C$ = 900 A (Note 5)<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>$I_C$ = 900 A<br>$V_{GE}$ = ±15 V<br>$R_{G(on)}$ = 3.6 Ω<br>$L_S$ = 225 nH<br>Inductive load | $T_j$ = 150 °C | — | — | 0.90 | μs |
| $t_r$ | Rise time | | $T_j$ = 150 °C | — | — | 0.50 | μs |
| $E_{on(10\%)}$ | Turn-on switching energy (Note 6) per pulse | | $T_j$ = 25 °C | — | 4.10 | — | J |
| | | | $T_j$ = 125 °C | — | 4.40 | — | |
| | | | $T_j$ = 150 °C | — | 4.45 | — | |
| $E_{on}$ | Turn-on switching energy per pulse | | $T_j$ = 25 °C | — | 4.15 | — | J |
| | | | $T_j$ = 125 °C | — | 4.60 | — | |
| | | | $T_j$ = 150 °C | — | 4.65 | — | |

### ELECTRICAL CHARACTERISTICS

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $t_{d(off)}$ | Turn-off delay time | $V_{CC}$ = 2800 V<br>$I_C$ = 900 A<br>$V_{GE}$ = ±15 V<br>$R_{G(off)}$ = 45 Ω<br>$L_S$ = 225 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 (Note 6)<br>per pulse | | $T_j$ = 25 °C | — | 2.60 | — | J |
| | | | $T_j$ = 125 °C | — | 3.55 | — | |
| | | | $T_j$ = 150 °C | — | 3.75 | — | |
| $E_{off}$ | Turn-off switching energy<br>per pulse | | $T_j$ = 25 °C | — | 2.90 | — | J |
| | | | $T_j$ = 125 °C | — | 3.95 | — | |
| | | | $T_j$ = 150 °C | — | 4.15 | — | |
| $V_{EC}$ | Emitter-collector voltage (Note 2) | $I_E$ = 900 A (Note 5)<br>$V_{GE}$ = 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<br>$I_E$ = 900 A<br>$V_{GE}$ = ±15 V<br>$R_{G(on)}$ = 3.6 Ω<br>$L_S$ = 225 nH<br>Inductive load | $T_j$ = 25 °C | — | — | — | μs |
| | | | $T_j$ = 125 °C | — | 1.60 | — | |
| | | | $T_j$ = 150 °C | — | 1.85 | — | |
| $I_{rr}$ | Reverse recovery current (Note 2) | | $T_j$ = 25 °C | — | — | — | A |
| | | | $T_j$ = 125 °C | — | 1300 | — | |
| | | | $T_j$ = 150 °C | — | 1300 | — | |
| $Q_{rr(10\%)}$ | Reverse recovery charge (Note 2.7) | | $T_j$ = 25 °C | — | — | — | μC |
| | | | $T_j$ = 125 °C | — | 1830 | — | |
| | | | $T_j$ = 150 °C | — | 1870 | — | |
| $Q_{rr}$ | Reverse recovery charge (Note 2) | | $T_j$ = 25 °C | — | — | — | μC |
| | | | $T_j$ = 125 °C | — | 1910 | — | |
| | | | $T_j$ = 150 °C | — | 1930 | — | |
| $E_{rec(10\%)}$ | Reverse recovery energy (Note 2,6)<br>per pulse | | $T_j$ = 25 °C | — | 2.30 | — | J |
| | | | $T_j$ = 125 °C | — | 3.00 | — | |
| | | | $T_j$ = 150 °C | — | 3.10 | — | |
| $E_{rec}$ | Reverse recovery energy (Note 2)<br>per pulse | | $T_j$ = 25 °C | — | 2.35 | — | J |
| | | | $T_j$ = 125 °C | — | 3.20 | — | |
| | | | $T_j$ = 150 °C | — | 3.25 | — | |

## ELECTRICAL CHARACTERISTICS

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $I_{RRM}$ | Repetitive reverse current (Note 3) | $V_{AK} = V_{RRM}$ | $T_j$ = 25 °C | — | — | 1.6 | mA |
| | | | $T_j$ = 125 °C | — | 1.6 | — | |
| | | | $T_j$ = 150 °C | — | — | 32 | |
| $V_F$ | Forward voltage (Note 3) | $I_F$ = 900 A (Note 5) | $T_j$ = 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 3) | $V_{CC}$ = 2800 V<br>$I_F$ = 900 A<br>$-di_F/dt$ ≅<br>3000 A/μs @ $T_j$ = 25 °C<br>2800 A/μs @ $T_j$ = 125 °C<br>2700 A/μs @ $T_j$ = 150 °C<br>$L_S$ = 225 nH<br>Inductive load | $T_j$ = 25 °C | — | — | — | μs |
| | | | $T_j$ = 125 °C | — | 1.60 | — | |
| | | | $T_j$ = 150 °C | — | 1.85 | — | |
| $I_{rr}$ | Reverse recovery current (Note 3) | | $T_j$ = 25 °C | — | — | — | A |
| | | | $T_j$ = 125 °C | — | 1300 | — | |
| | | | $T_j$ = 150 °C | — | 1300 | — | |
| $Q_{rr(10\%)}$ | Reverse recovery charge (Note 3,7) | | $T_j$ = 25 °C | — | — | — | μC |
| | | | $T_j$ = 125 °C | — | 1830 | — | |
| | | | $T_j$ = 150 °C | — | 1870 | — | |
| $Q_{rr}$ | Reverse recovery charge (Note 3) | | $T_j$ = 25 °C | — | — | — | μC |
| | | | $T_j$ = 125 °C | — | 1910 | — | |
| | | | $T_j$ = 150 °C | — | 1930 | — | |
| $E_{rec(10\%)}$ | Reverse recovery energy (Note 3,6) per pulse | | $T_j$ = 25 °C | — | 2.30 | — | J |
| | | | $T_j$ = 125 °C | — | 3.00 | — | |
| | | | $T_j$ = 150 °C | — | 3.10 | — | |
| $E_{rec}$ | Reverse recovery energy (Note 3) per pulse | | $T_j$ = 25 °C | — | 2.35 | — | J |
| | | | $T_j$ = 125 °C | — | 3.20 | — | |
| | | | $T_j$ = 150 °C | — | 3.25 | — | |

## THERMAL CHARACTERISTICS

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $R_{th(j-c)Q}$ | Thermal resistance | Junction to Case, IGBT part | — | — | 12.8 | K/kW |
| $R_{th(j-c)D}$ | Thermal resistance (Note 2) | Junction to Case, FWDi part | — | — | 19.5 | K/kW |
| $R_{th(j-c)D}$ | Thermal resistance (Note 3) | Junction to Case, Clamp-Di part | — | — | 19.5 | K/kW |
| $R_{th(c-s)}$ | Contact thermal resistance (Note 2) | Case to heat sink, Switching part<br>$\lambda_{grease}$ = 1W/m·k, $D_{(c-s)}$ = 80 μm | — | 7.5 | — | K/kW |
| $R_{th(c-s)}$ | Contact thermal resistance (Note 3) | Case to heat sink, Clamp-Di part<br>$\lambda_{grease}$ = 1 W/m·K, $D_{(c-s)}$ = 80 μm | — | 15.0 | — | K/kW |

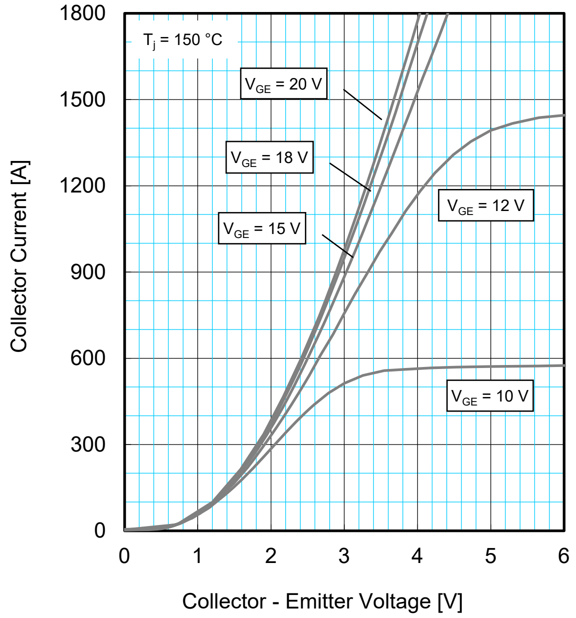
## MECHANICAL CHARACTERISTICS

| 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 |
| $L_{P(C-E)}$ | Internal inductance | Collector to Emitter | — | 20.5 | — | nH |
| $L_{P(A-K)}$ | | Anode to Cathode | — | 41.0 | — | nH |
| $R_{CC'+EE'}$ | Internal lead resistance | $T_C$ = 25 °C, Collector to Emitter | — | 0.18 | — | mΩ |
| $R_{AA'+KK'}$ | | $T_C$ = 25 °C, Anode to Cathode | — | 0.36 | — | mΩ |

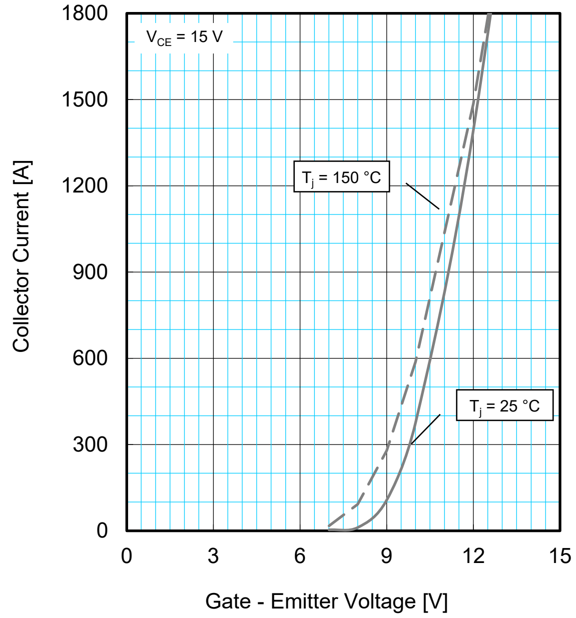
Note 1. Pulse width and repetition rate should be such that junction temperature ($T_j$) does not exceed $T_{jopmax}$ rating.
Note 2. The symbols represent characteristics of the anti-parallel, emitter to collector free-wheel diode ($FWD_i$).
Note 3. The symbols represent characteristics of the clamp diode (Clamp-Di).
Note 4. Junction temperature ($T_j$) should not exceed $T_{jmax}$ rating (150°C).
Note 5. Pulse width and repetition rate should be such as to cause negligible temperature rise.
Note 6. The integration range of switching energies is from 10%$V_{CE}$ to 10%$I_C$(10%$I_E$).
Note 7. The integration range of reverse recovery charge is from $I_E$ = 0A to 10%$I_E$.

## PERFORMANCE CURVES

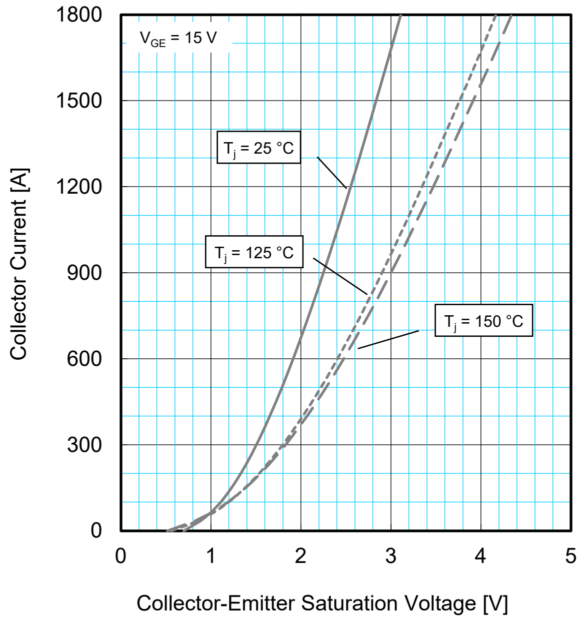
### OUTPUT CHARACTERISTICS (TYPICAL)



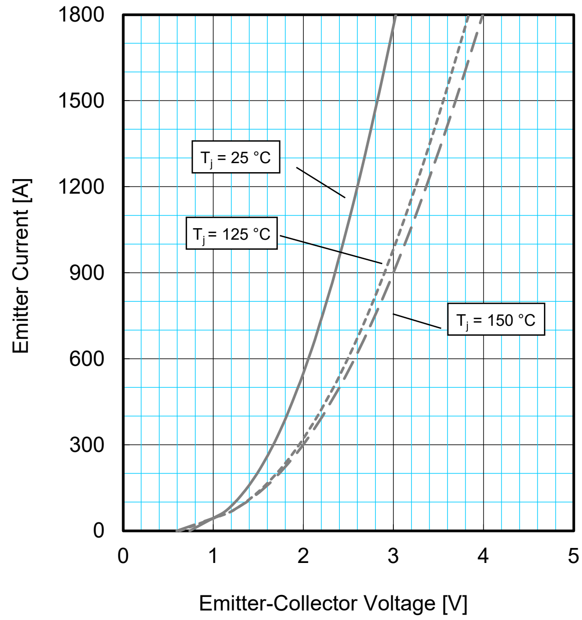

### TRANSFER CHARACTERISTICS (TYPICAL)




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

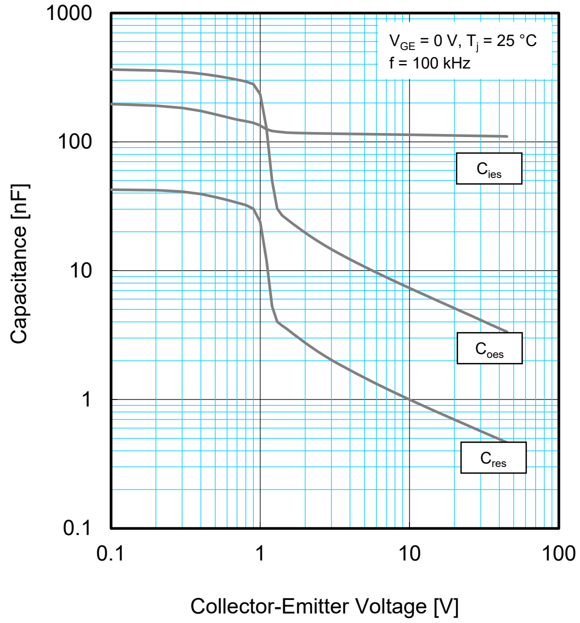



### FREE-WHEEL DIODE / CLAMP DIODE FORWARD CHARACTERISTICS (TYPICAL)

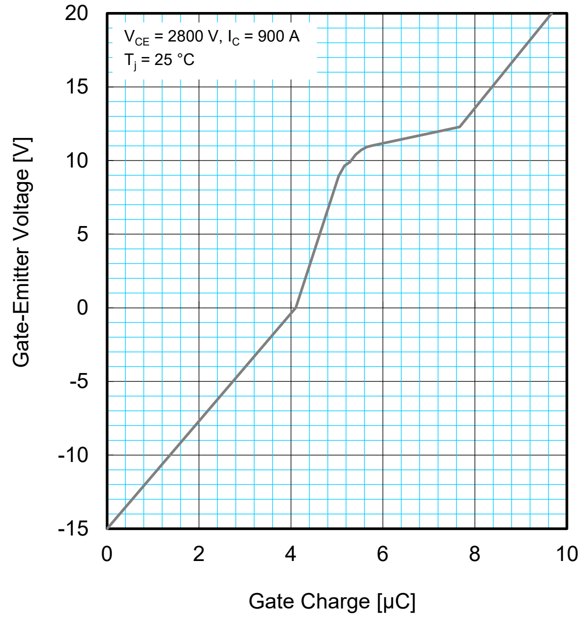


## PERFORMANCE CURVES

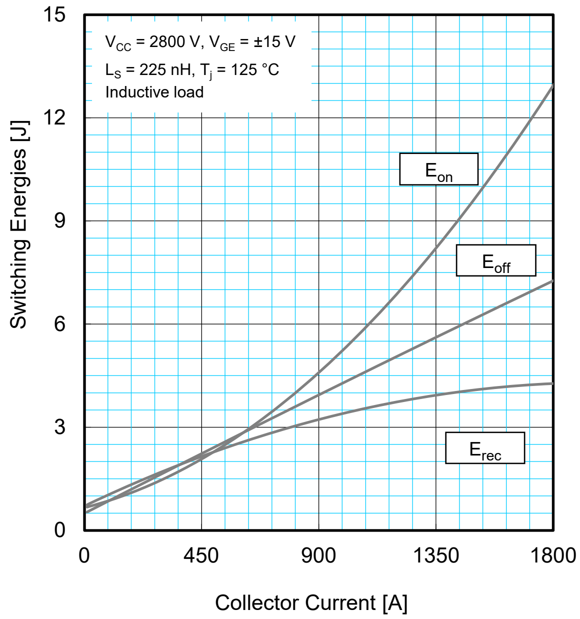
### CAPACITANCE CHARACTERISTICS (TYPICAL)



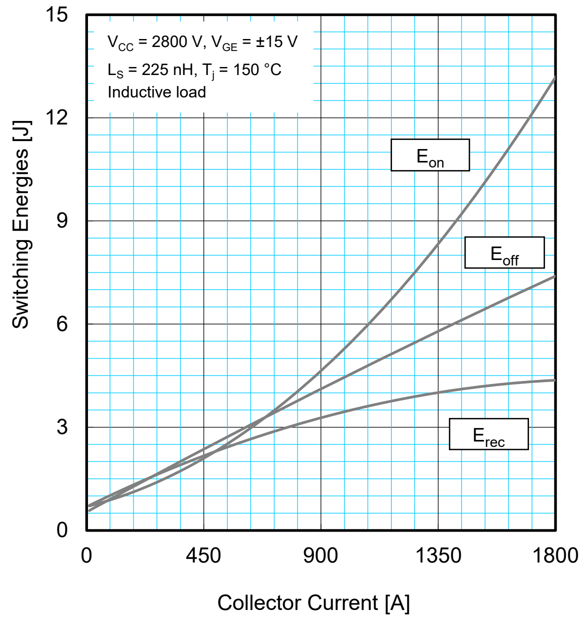

### GATE CHARGE CHARACTERISTICS (TYPICAL)




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

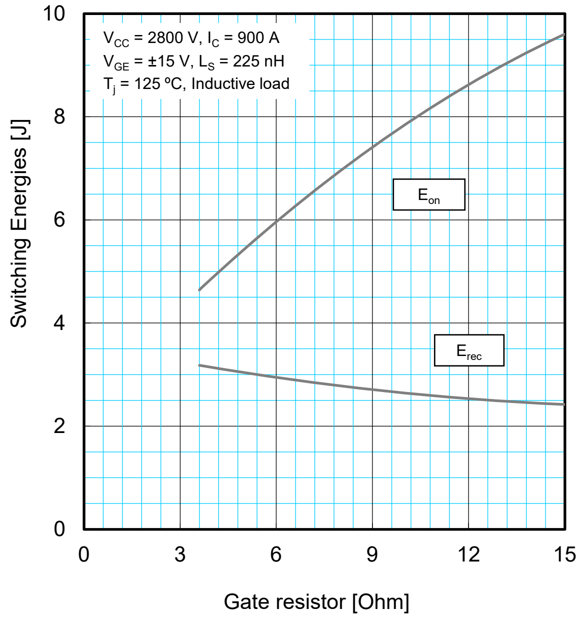



### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

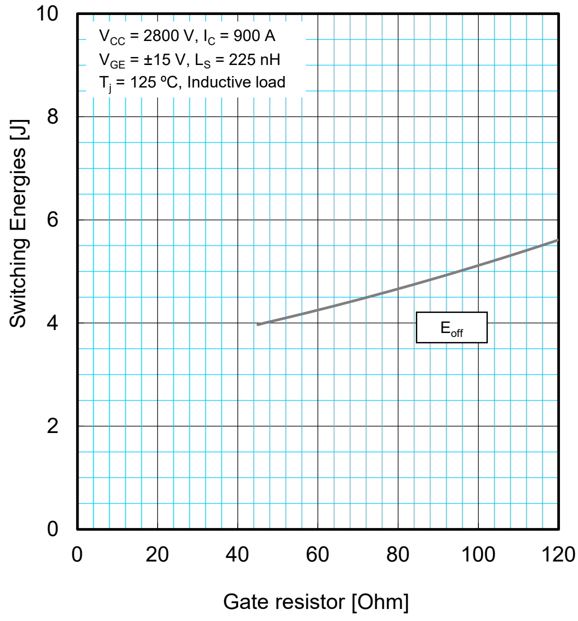


## PERFORMANCE CURVES

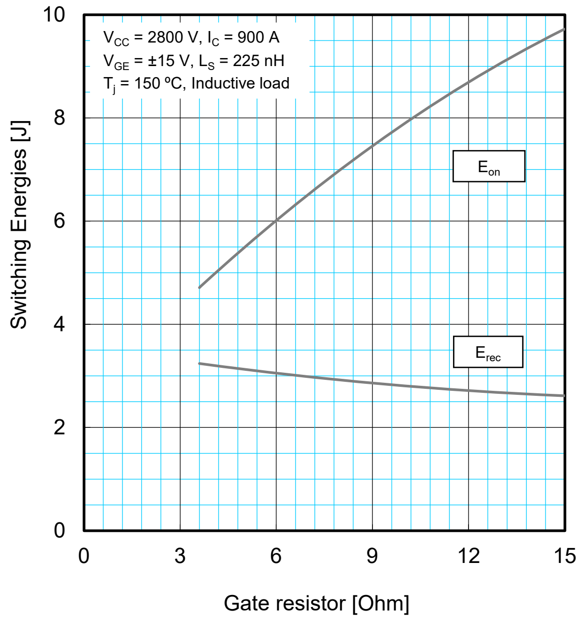
### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



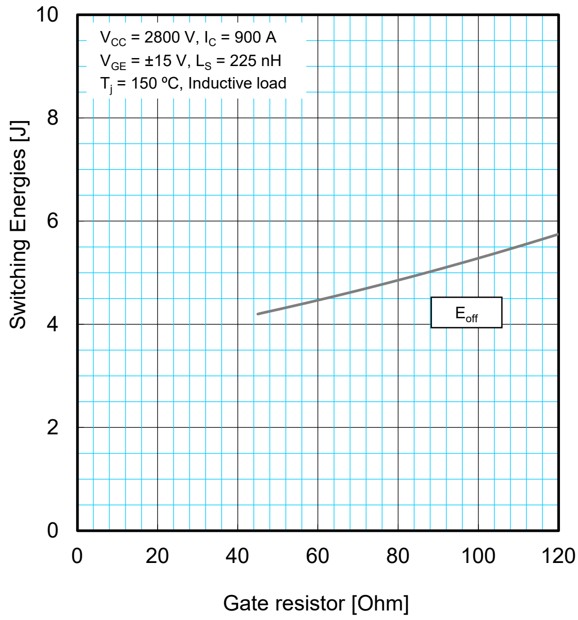

### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)




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

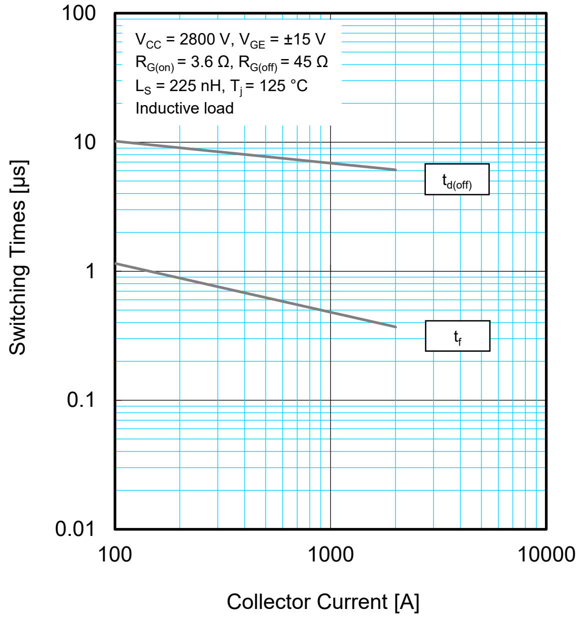



### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

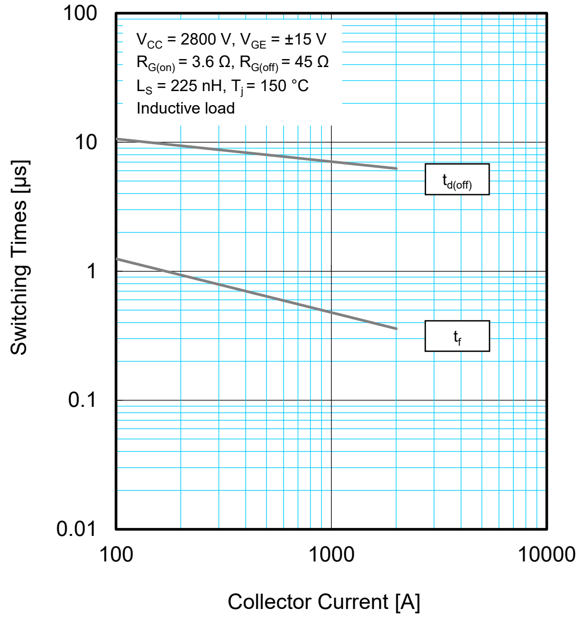


## PERFORMANCE CURVES

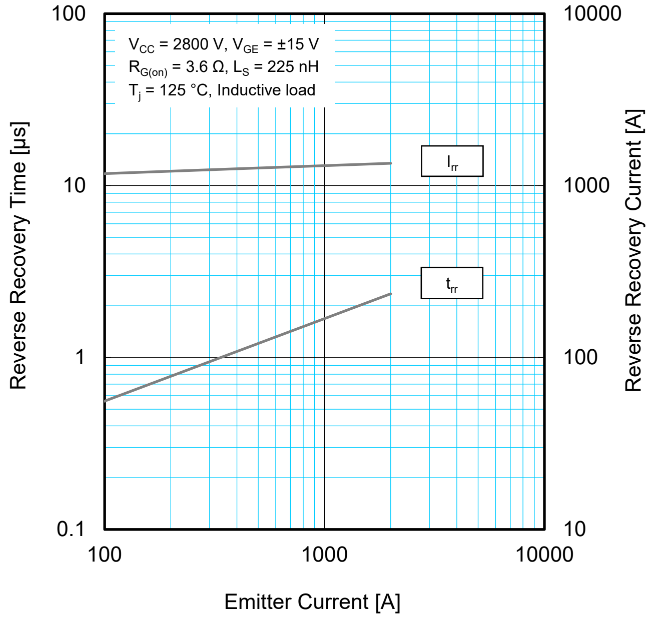
### HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)



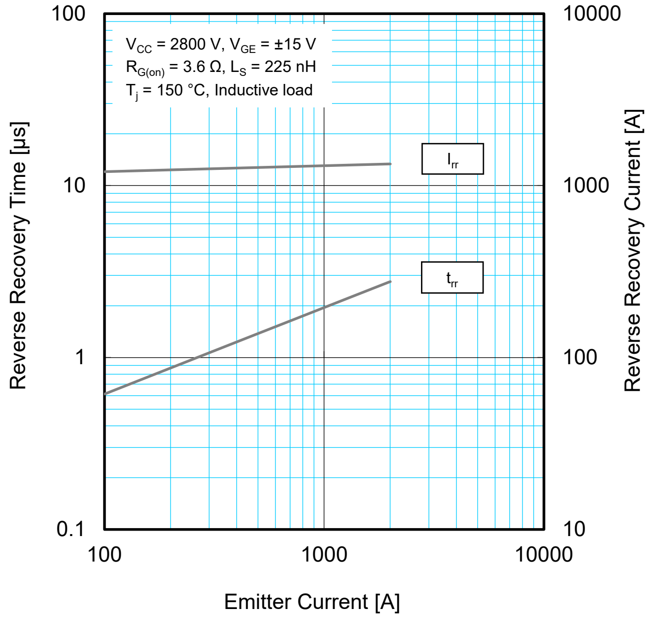

### HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)



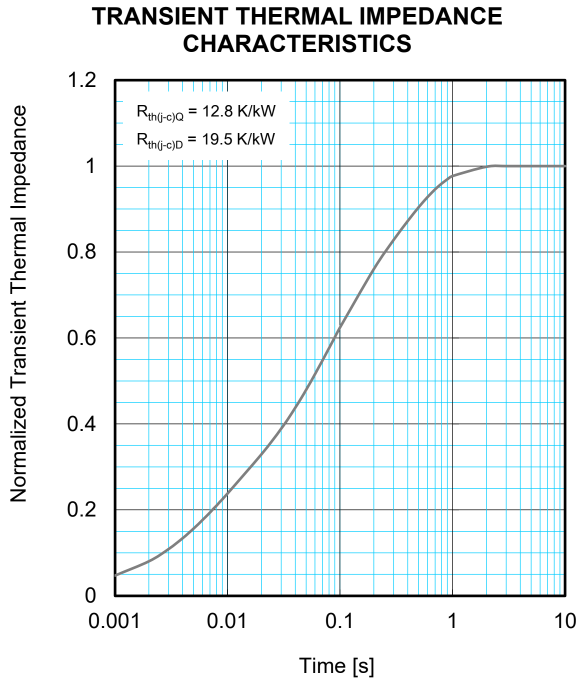

### FREE-WHEEL DIODE / CLAMP DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)




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



## PERFORMANCE CURVES

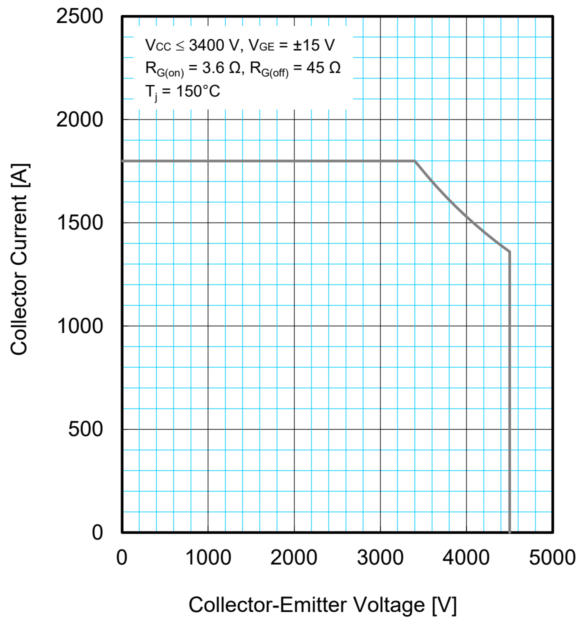



$$Z_{th(j-c)}(t) = \sum_{i=1}^{n} R_i \left\{ 1 - \exp\left( -\frac{t}{\tau_i} \right) \right\}$$

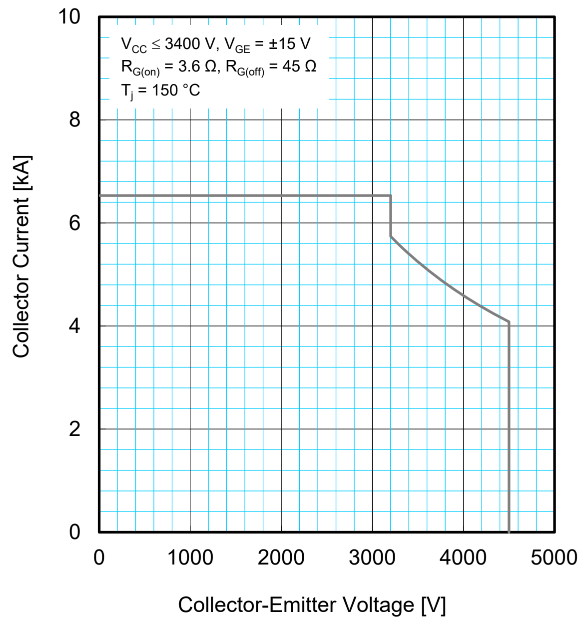
| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $R_i / R_{th}$ : | 0.0096 | 0.1893 | 0.4044 | 0.3967 |
| $\tau_i$ [sec.] : | 0.0001 | 0.0058 | 0.0602 | 0.3512 |

## PERFORMANCE CURVES

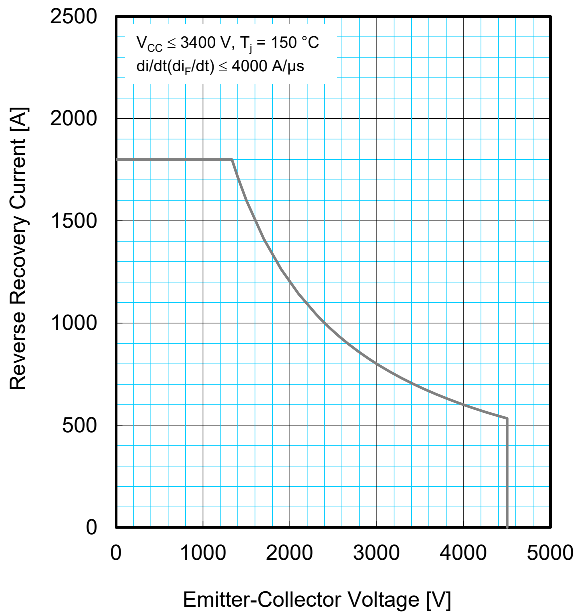
### REVERSE BIAS SAFE OPERATING AREA (RBSOA)




### SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)




### FREE-WHEEL DIODE / CLAMP DIODE REVERSE RECOVERY SAFE OPERATING AREA (RRSOA)



## Important Notice

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