MITSUBISHI ELECTRIC

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

# CM2400HCB-34X

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

6th-Version HVIGBT (High Voltage Insulated Gate Bipolar Transistor) Modules

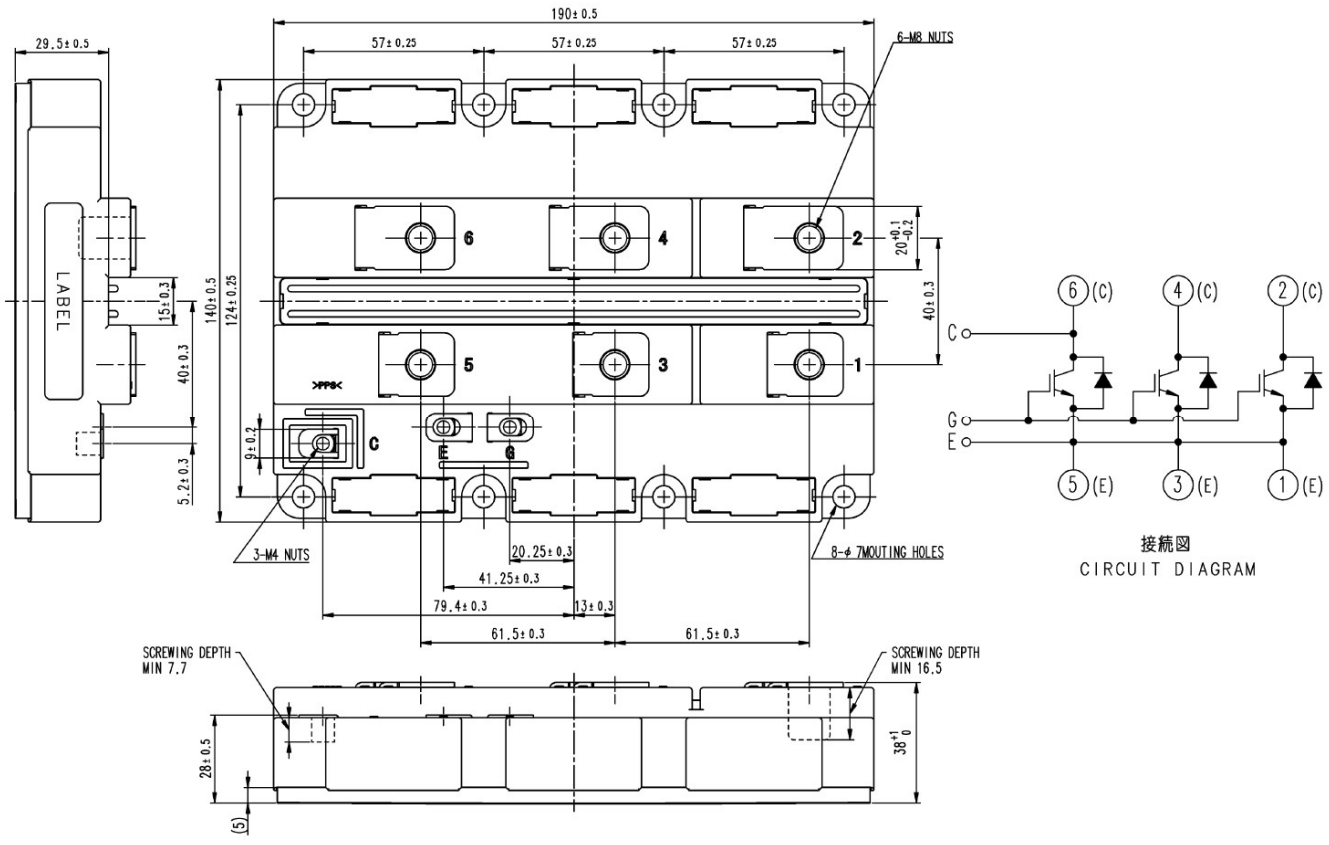
**CM2400HCB-34X**

- $I_C$ ..... 2400A
- $V_{CES}$ ..... 1700V
- 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 | 1700 | V |
| | | $V_{GE}$ = 0V, $T_j$ = -50°C | 1650 | V |
| $V_{GES}$ | Gate-emitter voltage | $V_{CE}$ = 0V, $T_j$ = 25°C | ±20 | V |
| $I_C$ | Collector current | DC, $T_c$ = 95°C | 2400 | A |
| $I_{CRM}$ | | Pulse (Note 1) | 4800 | A |
| $I_E$ | Emitter current (Note 2) | DC, $T_c$ = 75°C | 2400 | A |
| $I_{ERM}$ | | Pulse (Note 1) | 4800 | A |
| $P_{tot}$ | Maximum power dissipation (Note 3) | $T_c$ = 25°C, IGBT part | 13800 | W |
| $V_{iso}$ | Isolation voltage | RMS, sinusoidal, f = 60Hz, t = 1min | 6000 | V |
| $V_e$ | Partial discharge extinction voltage | RMS, sinusoidal, f = 60Hz, $Q_{PD}$ ≤ 10pC | 2600 | 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 | $V_{CC}$ ≤ 1200V, $V_{CE}$ ≤ $V_{CES}$, $V_{GE}$ = 15V, $T_j$ = 150°C | 6.5 | 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 | — | — | 4.0 | mA |
| | | | $T_j$ = 125°C | — | 3.5 | — | |
| | | | $T_j$ = 150°C | — | — | 40.0 | |
| $V_{GE(th)}$ | Gate-emitter threshold voltage | $V_{CE}$ = 10V, $I_C$ = 240mA, $T_j$ = 25°C | | 5.5 | 6.0 | 6.5 | 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 | $V_{CE}$ = 10V, $V_{GE}$ = 0V, f = 100kHz, $T_j$ = 25°C | | — | 817 | — | nF |
| $C_{oes}$ | Output capacitance | | | — | 17.8 | — | |
| $C_{res}$ | Reverse transfer capacitance | | | — | 7.2 | — | |
| $Q_G$ | Total gate charge | $V_{CC}$ = 900V, $I_C$ = 2400A, $V_{GE}$ = ±15V | | — | 51.0 | — | μC |
| $V_{CEsat}$ | Collector-emitter saturation voltage | $I_C$ = 2400A (Note 4), $V_{GE}$ = 15V | $T_j$ = 25°C | — | 1.60 | — | V |
| | | | $T_j$ = 125°C | — | 1.85 | — | |
| | | | $T_j$ = 150°C | — | 1.95 | 2.45 | |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 900V, $I_C$ = 2400A, $V_{GE}$ = ±15V, $R_{G(on)}$ = 0.62Ω, $L_S$ = 75nH, Inductive load | $T_j$ = 150°C | — | — | 1.50 | μs |
| $t_r$ | Rise time | | $T_j$ = 150°C | — | — | 0.50 | μs |
| $E_{on(10\%)}$ | Turn-on switching energy (per pulse) (Note 7) | | $T_j$ = 25°C | — | 0.40 | — | J |
| | | | $T_j$ = 125°C | — | 0.70 | — | |
| | | | $T_j$ = 150°C | — | 0.75 | — | |
| $E_{on}$ | Turn-on switching energy (per pulse) (Note 5) | | $T_j$ = 25°C | — | 0.50 | — | J |
| | | | $T_j$ = 125°C | — | 0.75 | — | |
| | | | $T_j$ = 150°C | — | 0.80 | — | |
| $t_{d(off)}$ | Turn-off delay time | $V_{CC}$ = 900V, $I_C$ = 2400A, $V_{GE}$ = ±15V, $R_{G(off)}$ = 5.6Ω, $L_S$ = 75nH, Inductive load | $T_j$ = 25°C | — | 6.00 | — | μs |
| | | | $T_j$ = 125°C | — | 6.20 | — | |
| | | | $T_j$ = 150°C | — | 6.35 | 10.0 | |
| $t_f$ | Fall time | | $T_j$ = 25°C | — | 0.30 | — | μs |
| | | | $T_j$ = 125°C | — | 0.32 | — | |
| | | | $T_j$ = 150°C | — | 0.34 | 1.00 | |
| $E_{off(10\%)}$ | Turn-off switching energy (per pulse) (Note 7) | | $T_j$ = 25°C | — | 0.95 | — | J |
| | | | $T_j$ = 125°C | — | 1.10 | — | |
| | | | $T_j$ = 150°C | — | 1.20 | — | |
| $E_{off}$ | Turn-off switching energy (per pulse) (Note 5) | | $T_j$ = 25°C | — | 1.00 | — | J |
| | | | $T_j$ = 125°C | — | 1.15 | — | |
| | | | $T_j$ = 150°C | — | 1.25 | — | |

## ELECTRICAL CHARACTERISTICS

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $V_{EC}$ | Emitter-collector voltage (Note 2) | $I_E$ = 2400A (Note 4), $V_{GE}$ = 0V | $T_j$ = 25°C | — | 1.80 | — | V |
| | | | $T_j$ = 125°C | — | 1.95 | — | |
| | | | $T_j$ = 150°C | — | 1.95 | 2.45 | |
| $t_{rr}$ | Reverse recovery time (Note 2) | $V_{CC}$ = 900V, $I_E$ = 2400A, $V_{GE}$ = ±15V, $R_{G(on)}$ = 0.62Ω, $L_S$ = 75nH, Inductive load | $T_j$ = 25°C | — | 0.40 | — | μs |
| | | | $T_j$ = 125°C | — | 0.55 | — | |
| | | | $T_j$ = 150°C | — | 0.60 | — | |
| $I_{rr}$ | Reverse recovery current (Note 2) | | $T_j$ = 25°C | — | 1790 | — | A |
| | | | $T_j$ = 125°C | — | 1930 | — | |
| | | | $T_j$ = 150°C | — | 1980 | — | |
| $Q_{rr(10\%)}$ | Reverse recovery charge (Note 2,6) | | $T_j$ = 25°C | — | 430 | — | μC |
| | | | $T_j$ = 125°C | — | 720 | — | |
| | | | $T_j$ = 150°C | — | 820 | — | |
| $Q_{rr}$ | Reverse recovery charge (Note 2,5) | | $T_j$ = 25°C | — | 480 | — | μC |
| | | | $T_j$ = 125°C | — | 785 | — | |
| | | | $T_j$ = 150°C | — | 890 | — | |
| $E_{rec(10\%)}$ | Reverse recovery energy (per pulse) (Note 2,7) | | $T_j$ = 25°C | — | 0.22 | — | J |
| | | | $T_j$ = 125°C | — | 0.40 | — | |
| | | | $T_j$ = 150°C | — | 0.46 | — | |
| $E_{rec}$ | Reverse recovery energy (per pulse) (Note 2,5) | | $T_j$ = 25°C | — | 0.25 | — | J |
| | | | $T_j$ = 125°C | — | 0.45 | — | |
| | | | $T_j$ = 150°C | — | 0.55 | — | |

## THERMAL CHARACTERISTICS

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $R_{th(j-c)Q}$ | Thermal resistance | Junction to Case, IGBT part | — | — | 9.0 | K/kW |
| $R_{th(j-c)D}$ | | Junction to Case, FWDi part | — | — | 12.5 | K/kW |
| $R_{th(c-s)}$ | Contact thermal resistance | Case to heat sink, $\lambda_{grease}$ = 1W/m·K, $D_{(c-s)}$ = 80μm | — | 5.7 | — | K/kW |

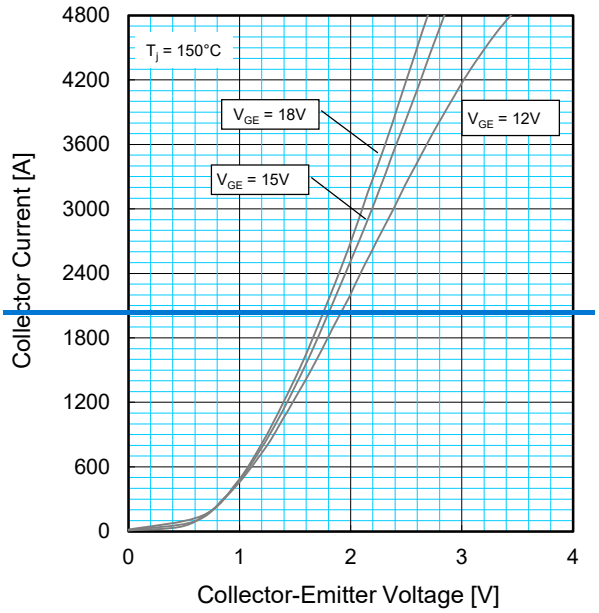
## MECHANICAL CHARACTERISTICS

| 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 (Note 8) | 1.0 | — | 3.0 | N·m |
| m | Mass | | — | 1.2 | — | kg |
| CTI | Comparative tracking index | | 600 | — | — | — |
| $d_a$ | Clearance | | 19.5 | — | — | mm |
| $d_s$ | Creepage distance | | 32.0 | — | — | mm |
| $L_{P\ CE}$ | Parasitic stray inductance | | — | 8.0 | — | nH |
| $R_{CC'+EE'}$ | Internal lead resistance | $T_C$ = 25°C | — | 0.09 | — | mΩ |

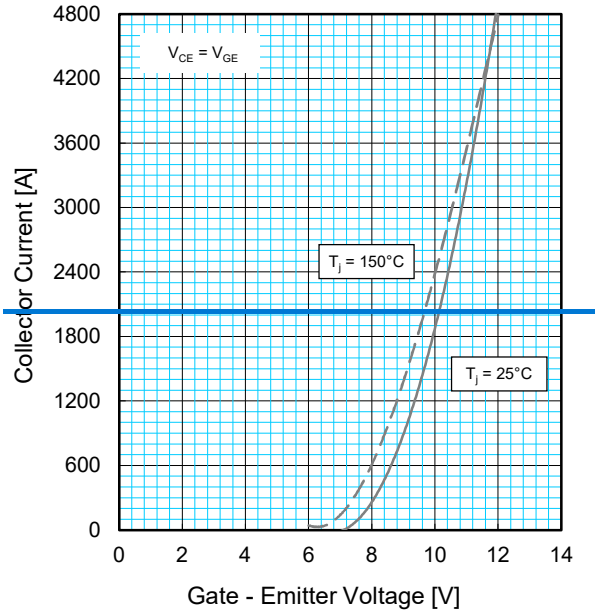
Note1. Pulse width and repetition rate should be such that junction temperature ($T_j$) does not exceed $T_{jopmax}$ rating.
Note2. The symbols represent characteristics of the anti-parallel, emitter to collector free-wheel diode ($FWD_i$).
Note3. Junction temperature ($T_j$) should not exceed $T_{jmax}$ rating (150°C).
Note4. Pulse width and repetition rate should be such as to cause negligible temperature rise.
Note5. Definition of all items is according to IEC 60747, unless otherwise specified.
Note6. The integration range of reverse recovery charge is from $I_E$ = 0A to 10%$I_E$.
Note7. The integration range of switching energies is from 10%$V_{CE}$ to 10%$I_C$(10%$I_E$).
Note8. The maximum specified value is under the condition of using PCB mounted on the power module. In case no PCB is used this maximum torque for M4 screw is 2.0 Nm.

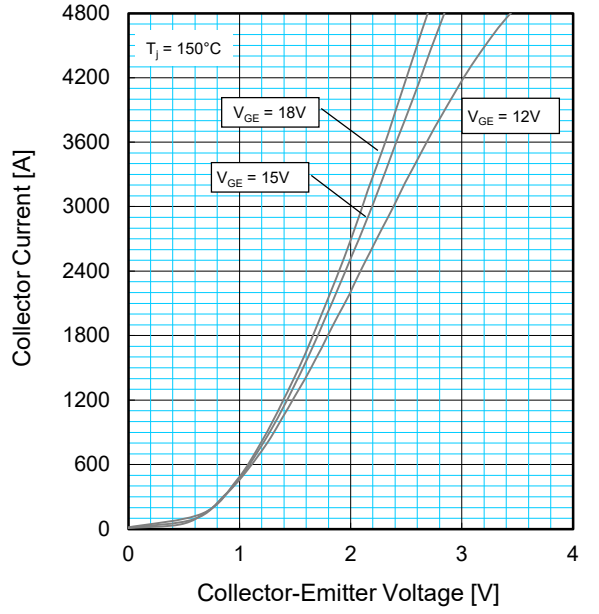
## PERFORMANCE CURVES

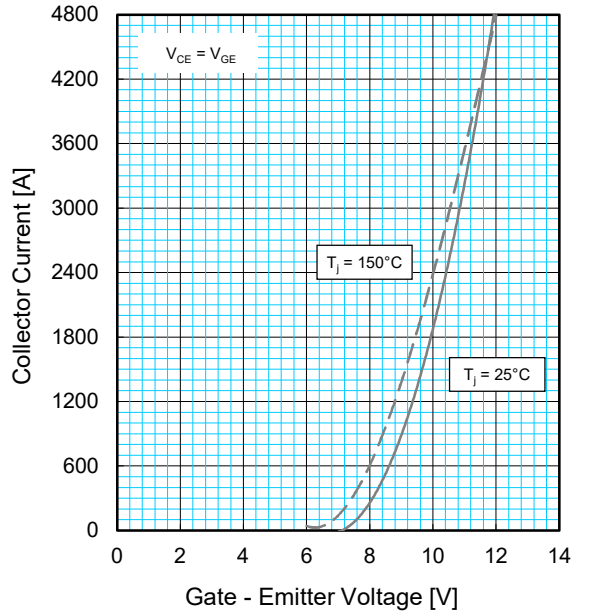
### OUTPUT CHARACTERISTICS (TYPICAL)



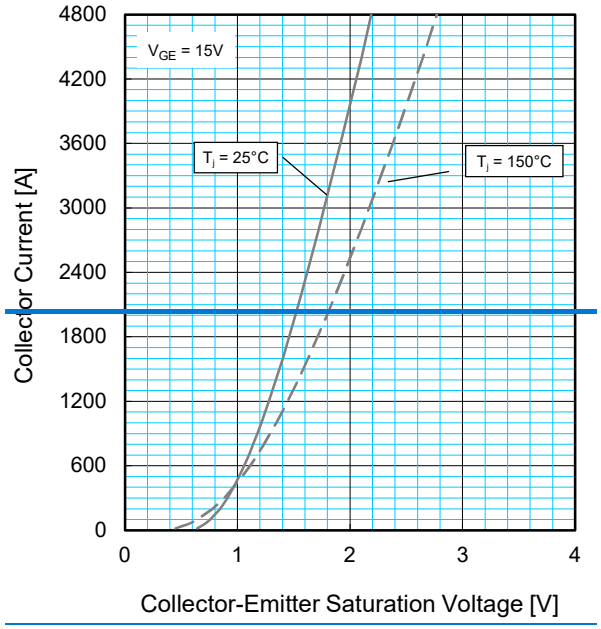

### TRANSFER CHARACTERISTICS (TYPICAL)



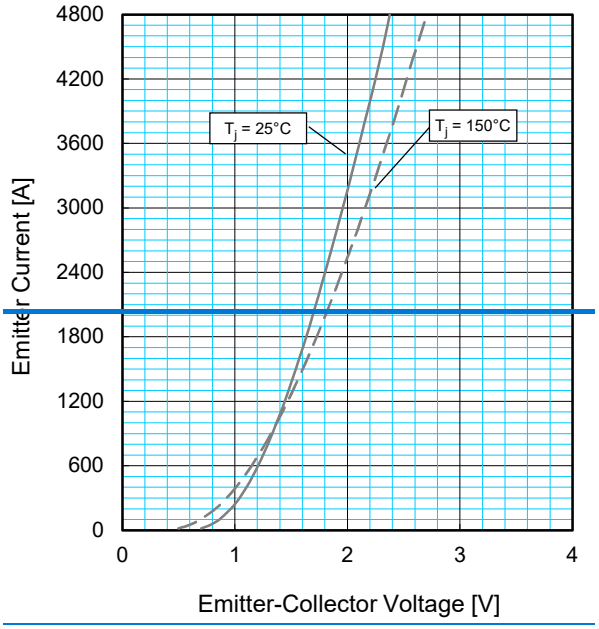



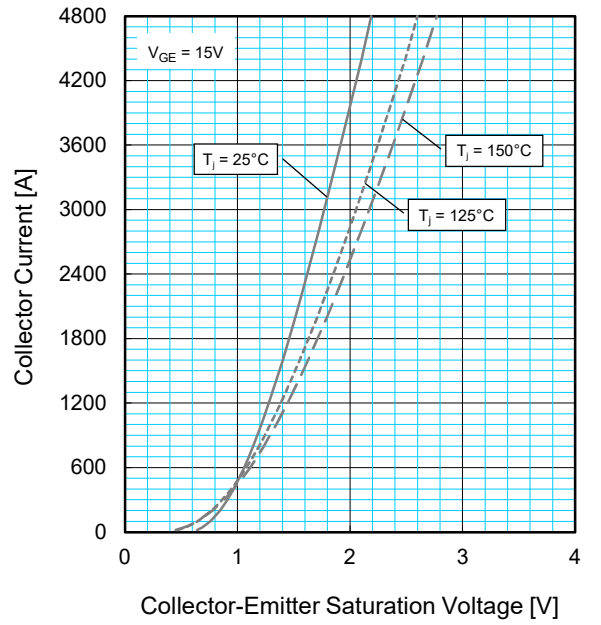



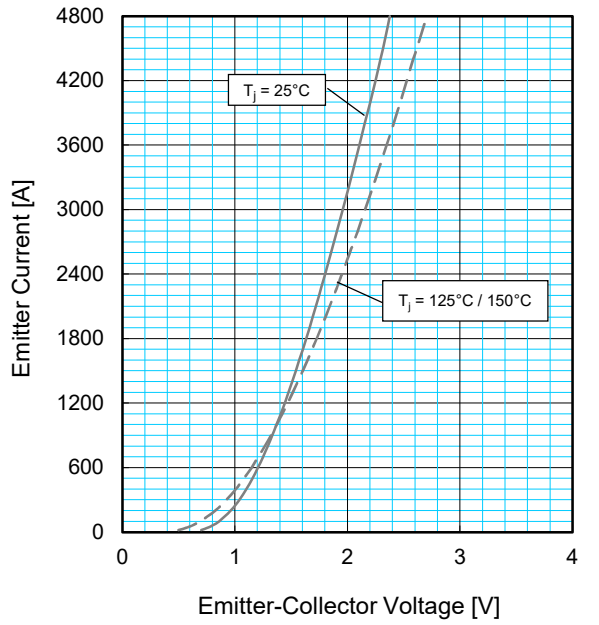
**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)**




**FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)**

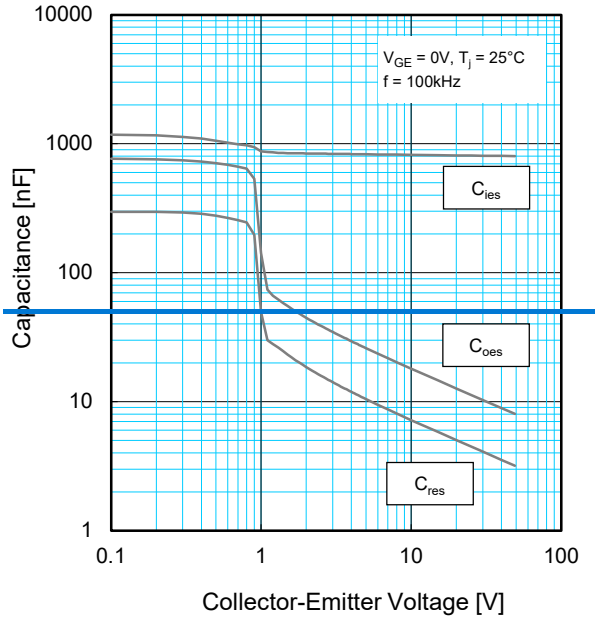


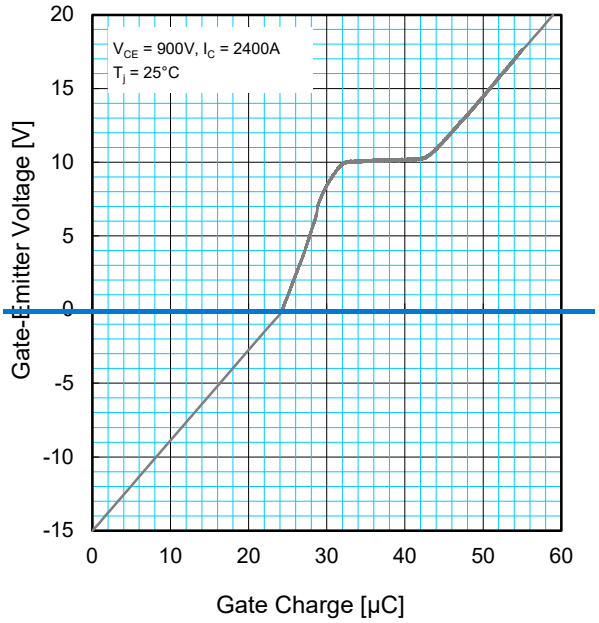



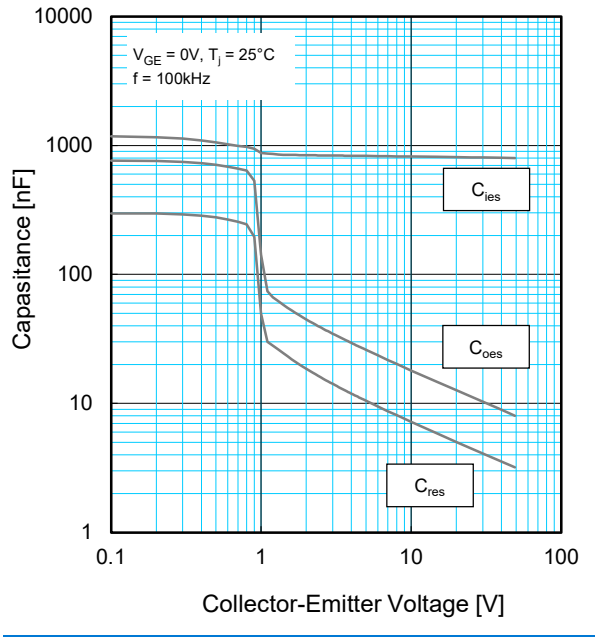
## PERFORMANCE CURVES

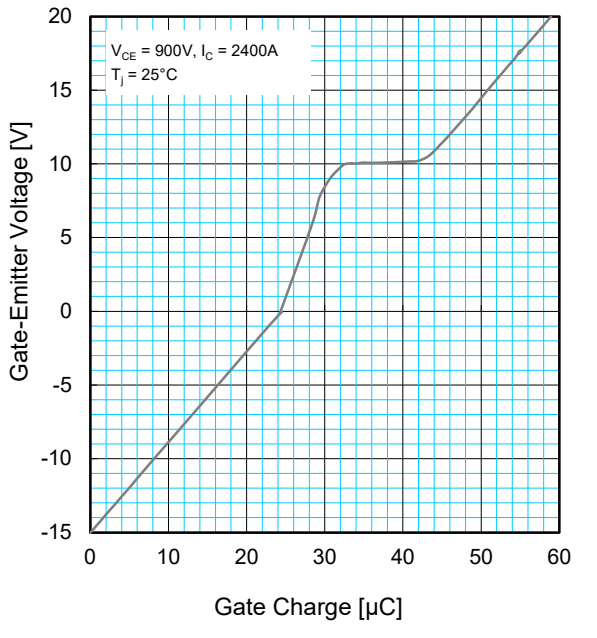
### CAPACITANCE CHARACTERISTICS (TYPICAL)



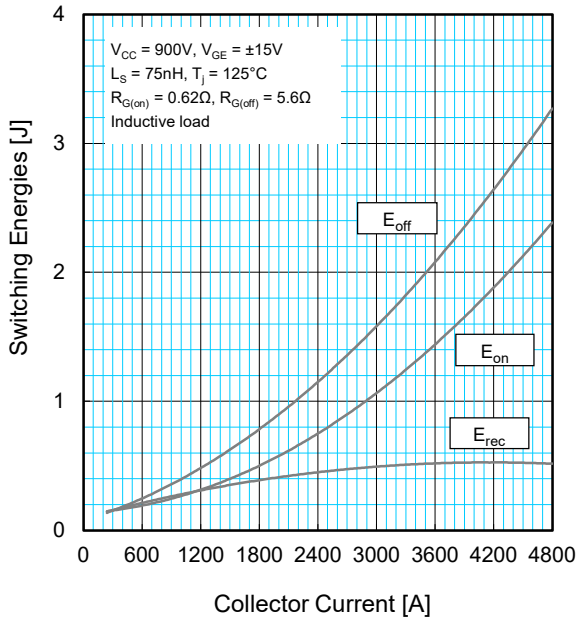

### GATE CHARGE CHARACTERISTICS (TYPICAL)



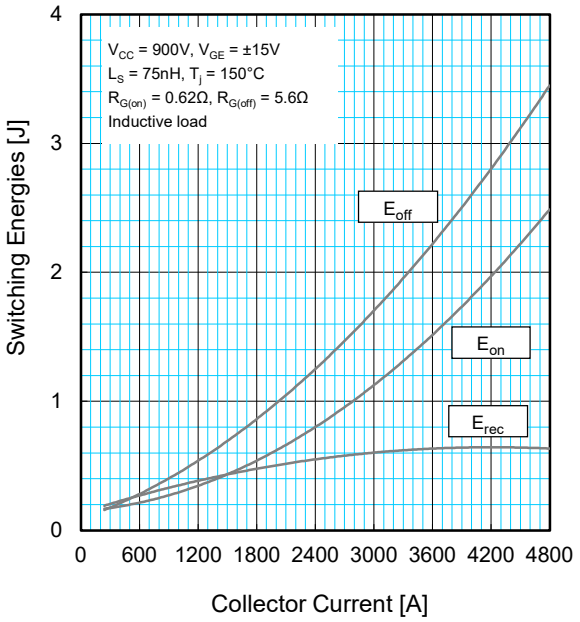



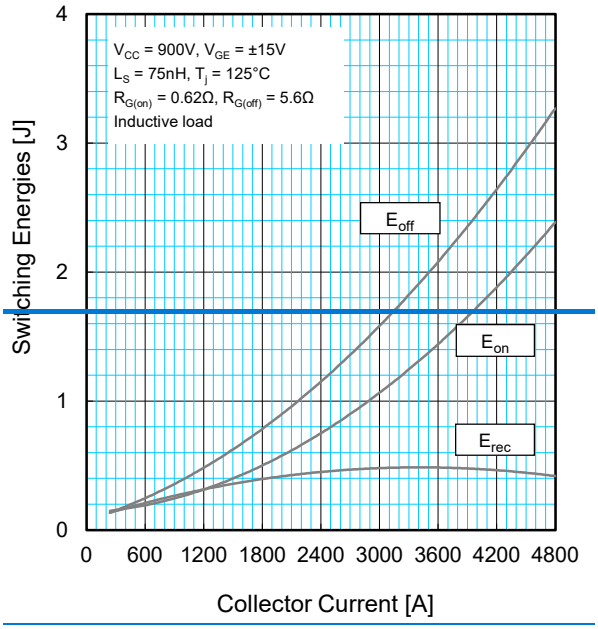



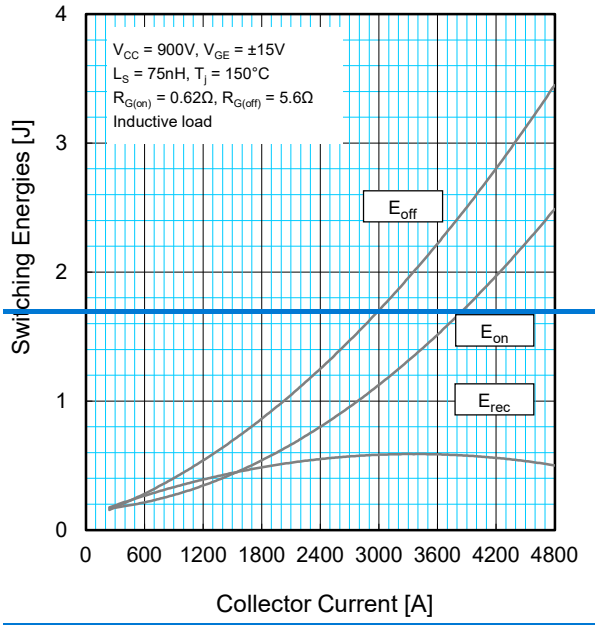
**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**




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

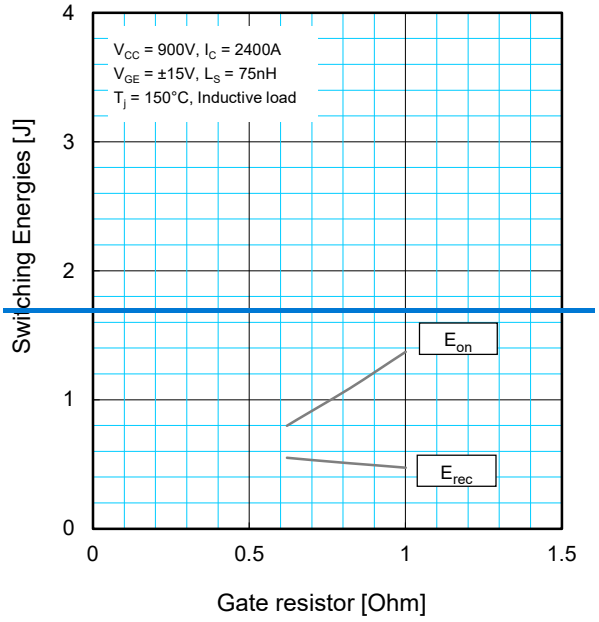


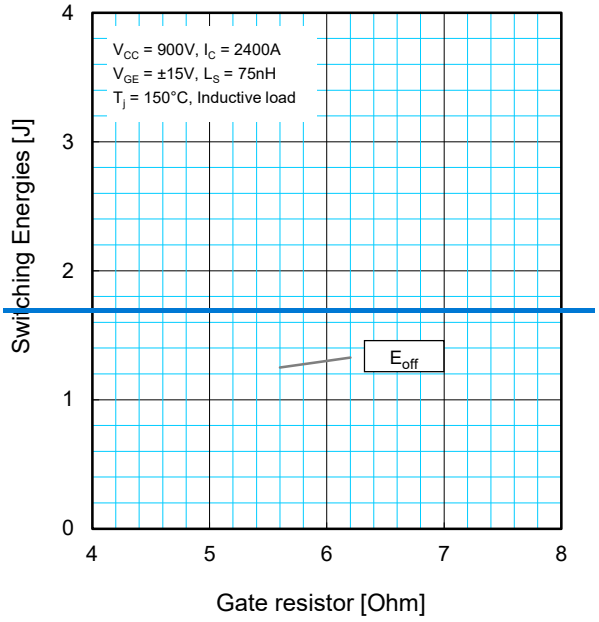



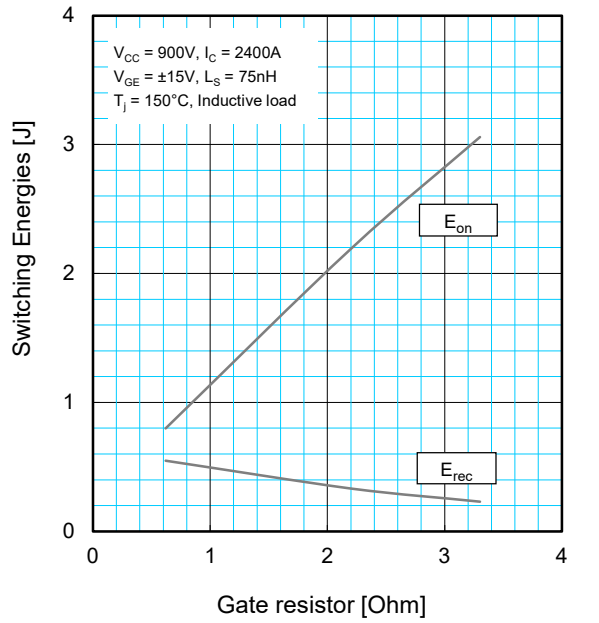
## PERFORMANCE CURVES

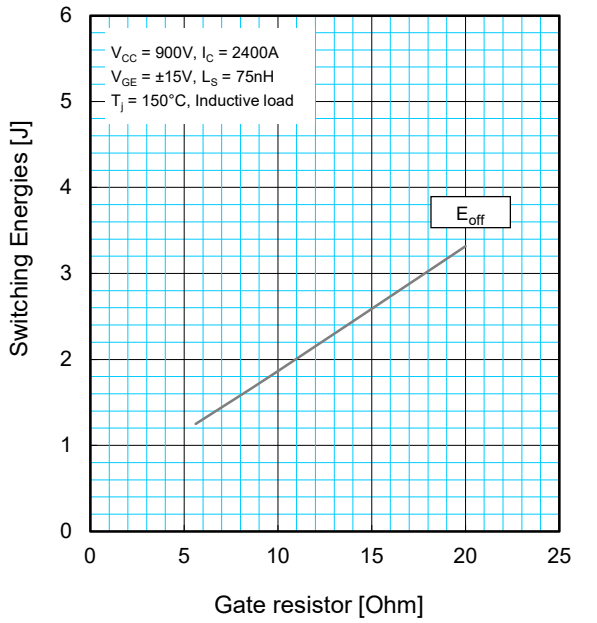
### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



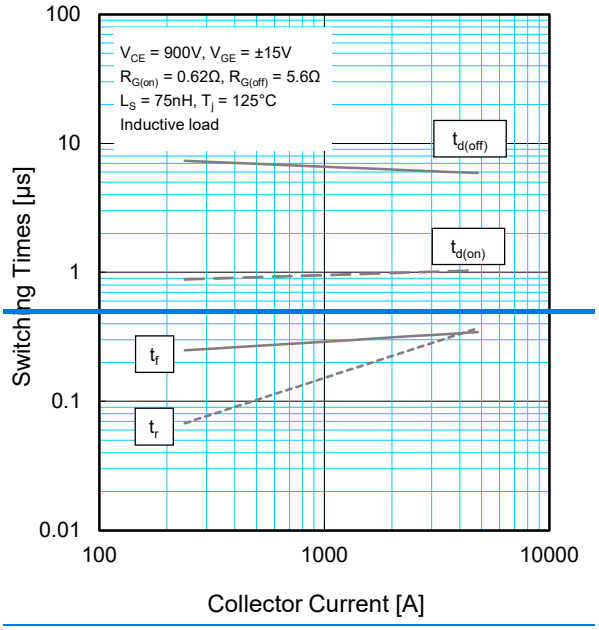

### HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



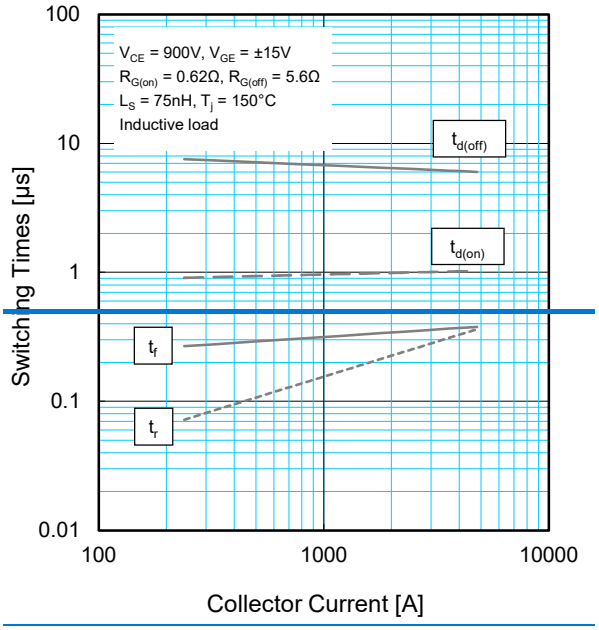



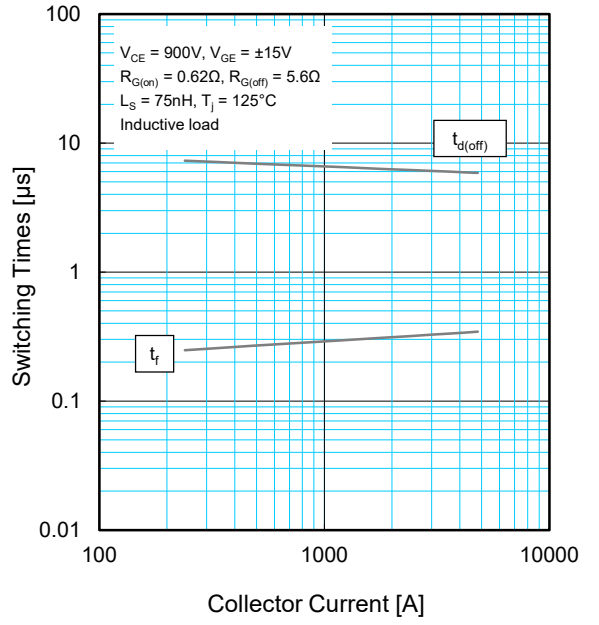



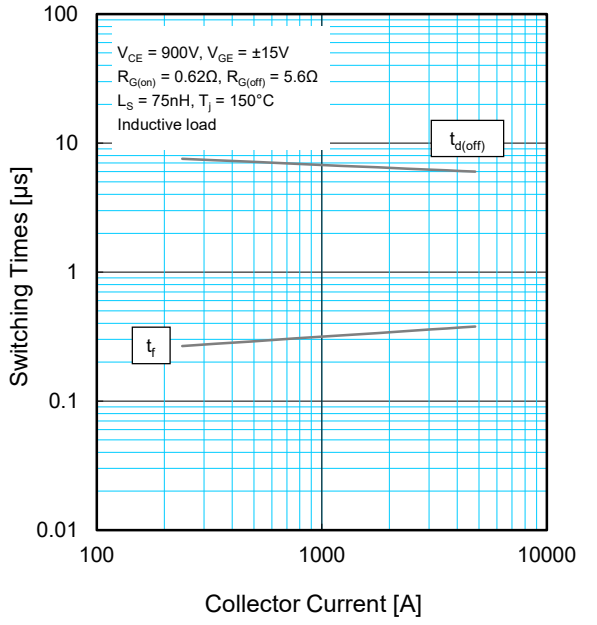
**HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)**




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

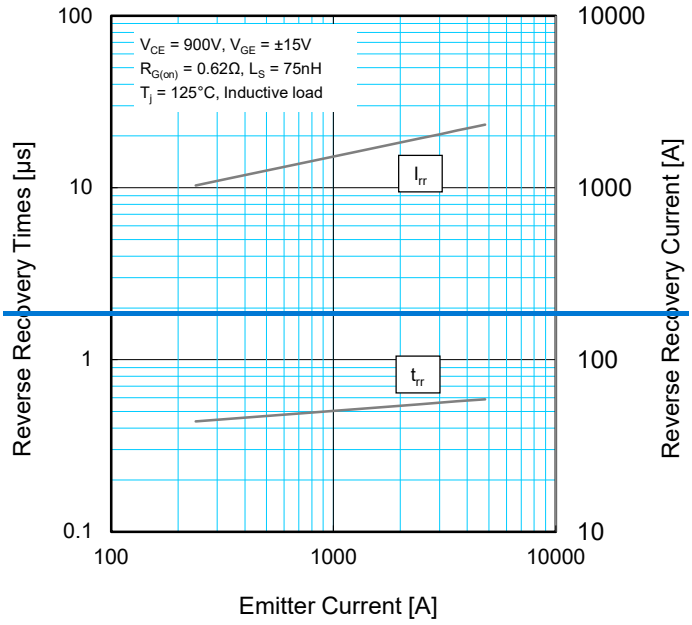


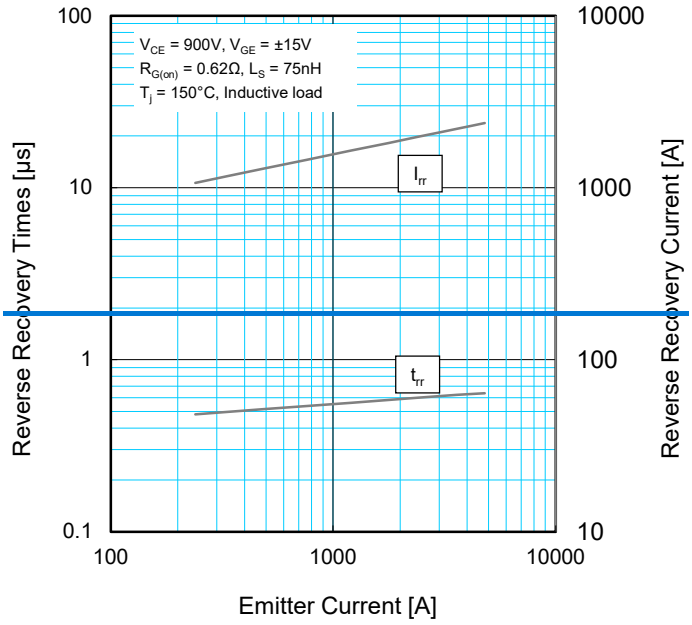



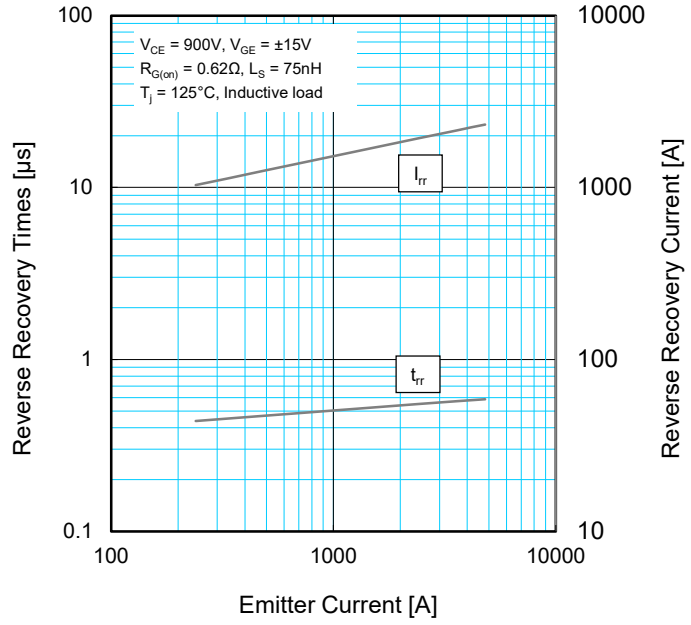
## PERFORMANCE CURVES

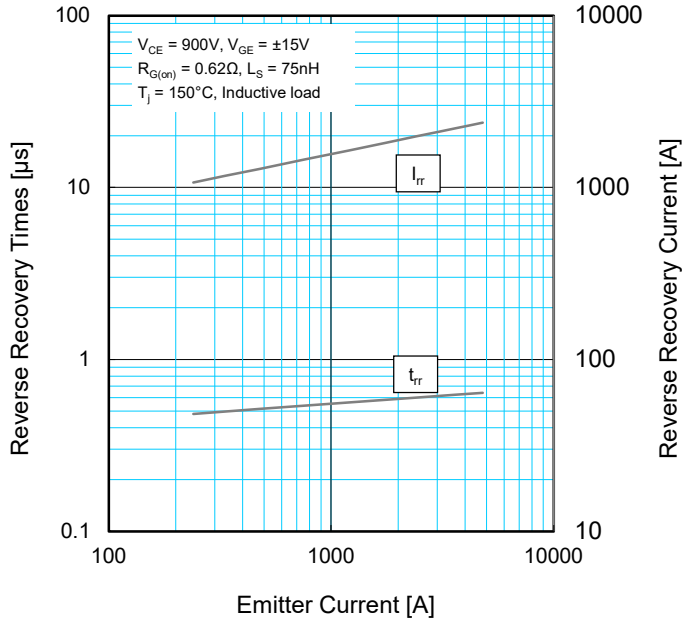
### FREE-WHEEL DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



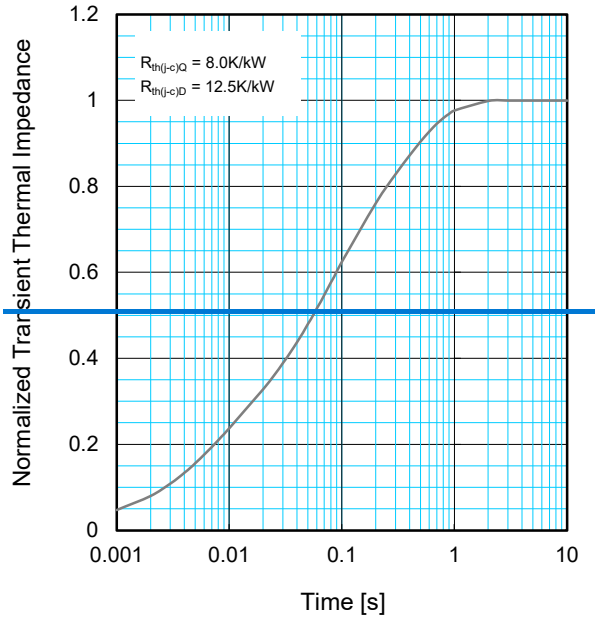

### FREE-WHEEL DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

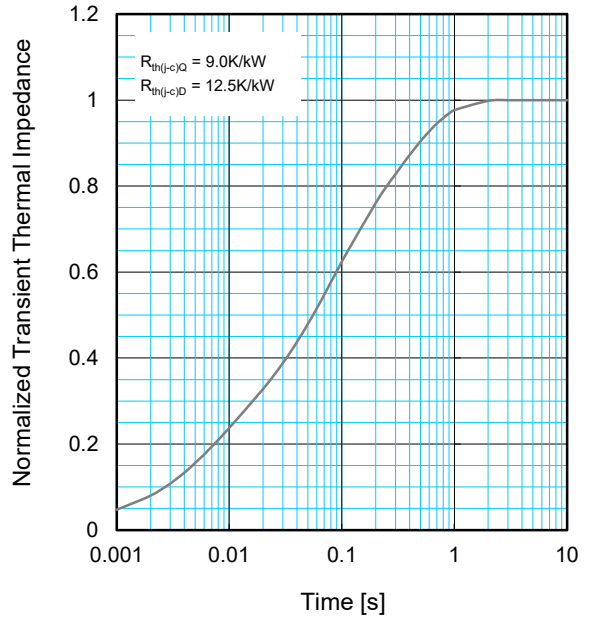


## TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS



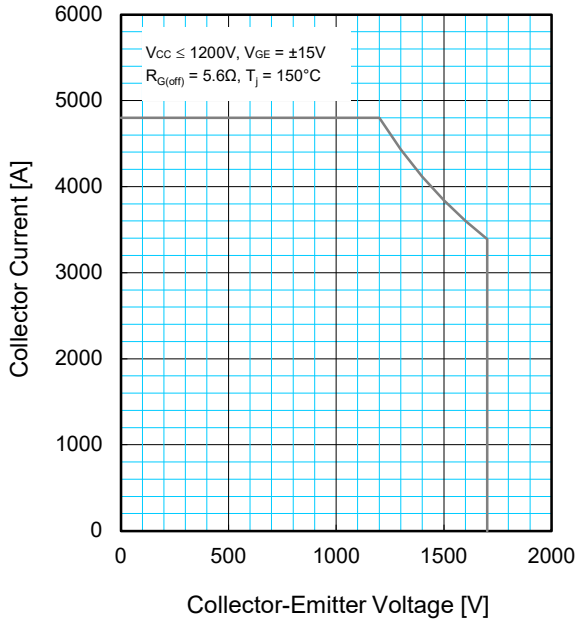




$$Z_{th(j-c)}(t) = \sum_{i=1}^{n} R_i \left\{ 1 - \exp\left( -\frac{t}{\tau_i} \right) \right\}$$

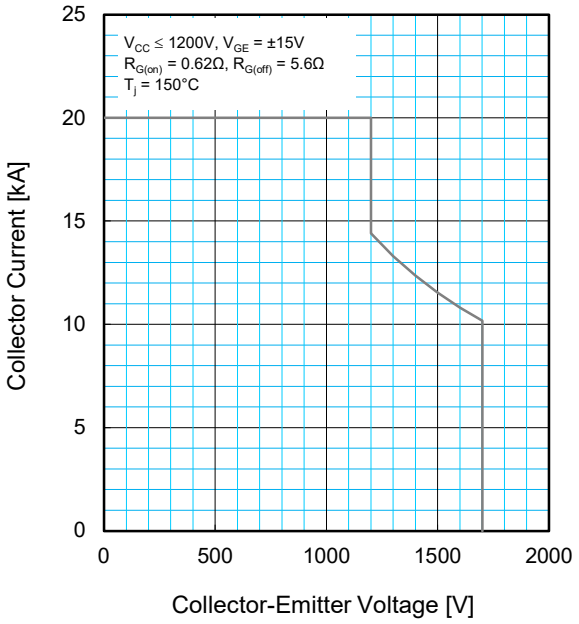
| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $R_i$ / $R_{th(j-c)}$ : | 0.0096 | 0.1893 | 0.4044 | 0.3967 |
| $\tau_i$ [sec] : | 0.0001 | 0.0058 | 0.0602 | 0.3512 |

## PERFORMANCE CURVES

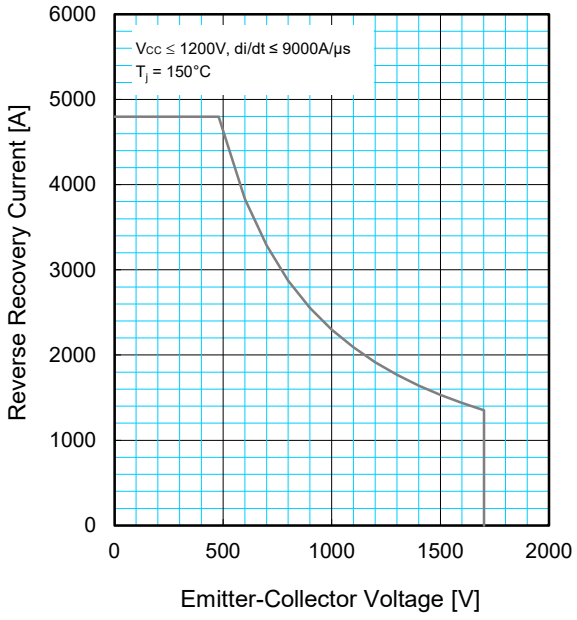
### REVERSE BIAS SAFE OPERATING AREA (RBSOA)




### SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)




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



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