# CM1500HC-66R

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

4th-Version HVIGBT (High Voltage Insulated Gate Bipolar Transistor) Modules

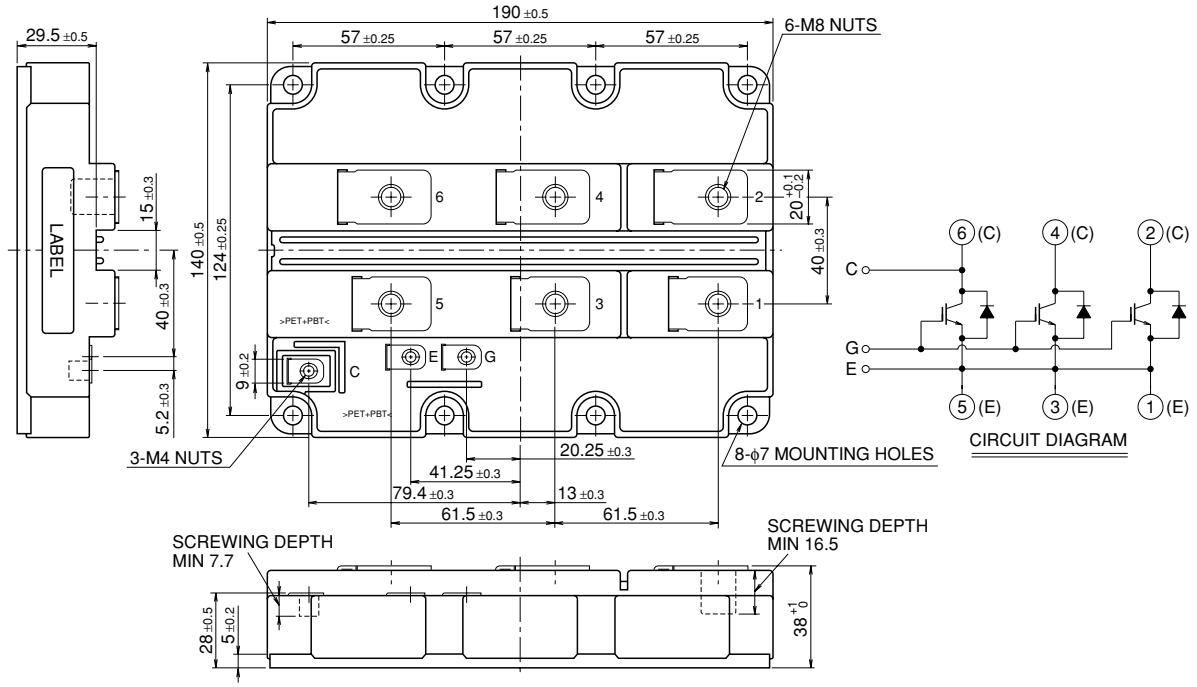
**CM1500HC-66R**

- $I_C$ ..... 1500 A
- $V_{CES}$ ..... 3300V
- 1-element in a Pack
- Insulated Type
- LPT-IGBT / Soft Recovery Diode
- AlSiC Baseplate

## 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, Tj = –40…+150°C | 3300 | V |
| | | $V_{GE}$ = 0V, Tj = –50°C | 3200 | |
| $V_{GES}$ | Gate-emitter voltage | $V_{CE}$ = 0V, Tj = 25°C | ± 20 | V |
| $I_C$ | Collector current | DC, $T_c$ = 95°C | 1500 | A |
| $I_{CM}$ | | Pulse (Note 1) | 3000 | A |
| $I_E$ | Emitter current (Note 2) | DC | 1500 | A |
| $I_{EM}$ | | Pulse (Note 1) | 3000 | A |
| $P_C$ | Maximum power dissipation(Note 3) | Tc = 25°C, IGBT part | 15600 | W |
| $V_{iso}$ | Isolation voltage | RMS, sinusoidal, f = 60Hz, t = 1 min. | 6000 | V |
| $V_e$ | Partial discharge extinction voltage | RMS, sinusoidal, f = 60Hz, $Q_{PD}$ ≤ 10 pC | 2600 | V |
| $T_j$ | Junction temperature | | –50 ~ +150 | °C |
| $T_{op}$ | Operating temperature | | –50 ~ +150 | °C |
| $T_{stg}$ | Storage temperature | | –55 ~ +150 | °C |
| $t_{psc}$ | Maximum short circuit pulse width | $V_{CC}$ =2500V, $V_{CE}$ ≤ $V_{CES}$, $V_{GE}$ =15V, Tj =150°C | 10 | µs |

## ELECTRICAL CHARACTERISTICS

| Symbol | Item | Conditions | | Limits Min | Limits Typ | Limits Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{CES}$ | Collector cutoff current | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V | $T_j$ = 25°C | — | — | 6.0 | mA |
| | | | $T_j$ = 125°C | — | 6.0 | — | |
| | | | $T_j$ = 150°C | — | 36.0 | — | |
| $V_{GE(th)}$ | Gate-emitter threshold voltage | $V_{CE}$ = 10 V, $I_C$ = 150 mA, $T_j$ = 25°C | | 5.7 | 6.2 | 6.7 | 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 | | — | 210.0 | — | nF |
| $C_{oes}$ | Output capacitance | | | — | 13.0 | — | nF |
| $C_{res}$ | Reverse transfer capacitance | | | — | 6.0 | — | nF |
| $Q_g$ | Total gate charge | $V_{CC}$ = 1800 V, $I_C$ = 1500 A, $V_{GE}$ = ±15 V | | — | 16.0 | — | µC |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $I_C$ = 1500 A (Note 4)<br>$V_{GE}$ = 15 V | $T_j$ = 25°C | — | 2.45 | — | V |
| | | | $T_j$ = 125°C | — | 3.10 | 3.70 | |
| | | | $T_j$ = 150°C | — | 3.25 | — | |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 1800 V<br>$I_C$ = 1500 A<br>$V_{GE}$ = ±15 V<br>$R_{G(on)}$ = 1.6Ω<br>$L_S$ = 100 nH<br>Inductive load | $T_j$ = 25°C | — | 1.00 | — | µs |
| | | | $T_j$ = 125°C | — | 0.95 | 1.25 | |
| | | | $T_j$ = 150°C | — | 0.95 | 1.25 | |
| $t_r$ | Turn-on rise time | | $T_j$ = 25°C | — | 0.28 | — | µs |
| | | | $T_j$ = 125°C | — | 0.30 | 0.50 | |
| | | | $T_j$ = 150°C | — | 0.30 | 0.50 | |
| $E_{on(10\%)}$ | Turn-on switching energy (Note 5) | | $T_j$ = 25°C | — | 2.45 | — | J/P |
| | | | $T_j$ = 125°C | — | 2.90 | — | |
| | | | $T_j$ = 150°C | — | 3.10 | — | |
| $E_{on}$ | Turn-on switching energy (Note 6) | | $T_j$ = 25°C | — | 2.70 | — | J/P |
| | | | $T_j$ = 125°C | — | 3.30 | — | |
| | | | $T_j$ = 150°C | — | 3.60 | — | |
| $t_{d(off)}$ | Turn-off delay time | $V_{CC}$ = 1800 V<br>$I_C$ = 1500 A<br>$V_{GE}$ = ±15 V<br>$R_{G(off)}$ = 5.6Ω<br>$L_S$ = 100 nH<br>Inductive load | $T_j$ = 25°C | — | 2.70 | — | µs |
| | | | $T_j$ = 125°C | — | 2.80 | 3.30 | |
| | | | $T_j$ = 150°C | — | 2.85 | 3.30 | |
| $t_f$ | Turn-off fall time | | $T_j$ = 25°C | — | 0.30 | — | µs |
| | | | $T_j$ = 125°C | — | 0.35 | 1.00 | |
| | | | $T_j$ = 150°C | — | 0.40 | 1.00 | |
| $E_{off(10\%)}$ | Turn-off switching energy (Note 5) | | $T_j$ = 25°C | — | 2.00 | — | J/P |
| | | | $T_j$ = 125°C | — | 2.45 | — | |
| | | | $T_j$ = 150°C | — | 2.50 | — | |
| $E_{off}$ | Turn-off switching energy (Note 6) | | $T_j$ = 25°C | — | 2.20 | — | J/P |
| | | | $T_j$ = 125°C | — | 2.70 | — | |
| | | | $T_j$ = 150°C | — | 2.80 | — | |
| $V_{EC}$ | Emitter-collector voltage (Note 2) | $I_E$ = 1500 A (Note 4)<br>$V_{GE}$ = 0 V | $T_j$ = 25°C | — | 2.15 | — | V |
| | | | $T_j$ = 125°C | — | 2.30 | 2.80 | |
| | | | $T_j$ = 150°C | — | 2.25 | — | |

**ELECTRICAL CHARACTERISTICS (continuation)**

| Symbol | Item | Conditions | | Limits | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| $t_{rr}$ | Reverse recovery time (Note 2) | $V_{CC}$ = 1800 V<br>$I_C$ = 1500 A<br>$V_{GE}$ = ±15 V<br>$R_{G(on)}$ = 1.6 Ω<br>$L_S$ = 100 nH<br>Inductive load | $T_j$ = 25°C | — | 0.50 | — | μs |
| | | | $T_j$ = 125°C | — | 0.70 | — | |
| | | | $T_j$ = 150°C | — | 0.80 | — | |
| $I_{rr}$ | Reverse recovery current (Note 2) | | $T_j$ = 25°C | — | 1250 | — | A |
| | | | $T_j$ = 125°C | — | 1500 | — | |
| | | | $T_j$ = 150°C | — | 1550 | — | |
| $Q_{rr}$ | Reverse recovery charge (Note 2) | | $T_j$ = 25°C | — | 1050 | — | μC |
| | | | $T_j$ = 125°C | — | 1700 | — | |
| | | | $T_j$ = 150°C | — | 2000 | — | |
| $E_{rec(10\%)}$ | Reverse recovery energy (Note 2)(Note 5) | | $T_j$ = 25°C | — | 1.05 | — | J/P |
| | | | $T_j$ = 125°C | — | 1.75 | — | |
| | | | $T_j$ = 150°C | — | 2.00 | — | |
| $E_{rec}$ | Reverse recovery energy (Note 2)(Note 6) | | $T_j$ = 25°C | — | 1.20 | — | J/P |
| | | | $T_j$ = 125°C | — | 2.00 | — | |
| | | | $T_j$ = 150°C | — | 2.30 | — | |

**THERMAL CHARACTERISTICS**

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $R_{th(j-c)Q}$ | Thermal resistance | Junction to Case, IGBT part | — | — | 8.0 | K/kW |
| $R_{th(j-c)R}$ | | Junction to Case, FWDi part | — | — | 15.0 | K/kW |
| $R_{th(c-f)}$ | Contact thermal resistance | Case to Fin, $\lambda_{grease}$ = 1W/m·K ,D(c-f) = 100 μm | — | 6.0 | — | K/kW |

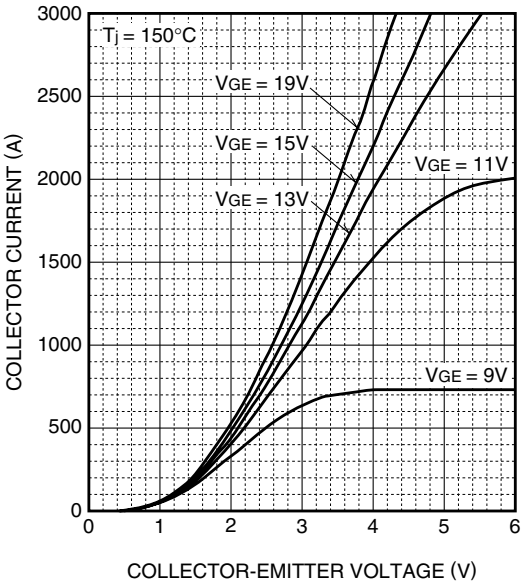
**MECHANICAL CHARACTERISTICS**

| Symbol | Item | Conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $M_t$ | Mounting torque | M8: Main terminals screw | 7.0 | — | 22.0 | 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 | | — | 1.2 | — | 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 | | — | 11.0 | — | nH |
| $R_{CC'+EE'}$ | Internal lead resistance | Tc = 25°C | — | 0.12 | — | mΩ |
| $r_g$ | Internal gate resistor | Tc = 25°C | — | 1.5 | — | Ω |

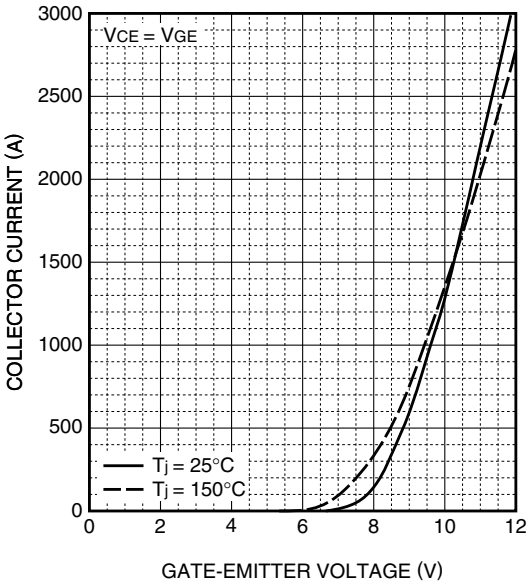
Note 1. Pulse width and repetition rate should be such that junction temperature ($T_j$) does not exceed $T_{opmax}$ rating (150°C).
2. The symbols represent characteristics of the anti-parallel, emitter to collector free-wheel diode (FWDi).
3. Junction temperature ($T_j$) should not exceed $T_{jmax}$ rating (150°C).
4. Pulse width and repetition rate should be such as to cause negligible temperature rise.
5. $E_{on(10\%)}$ / $E_{off(10\%)}$ / $E_{rec(10\%)}$ are the integral of $0.1V_{CE} \times 0.1I_C \times dt$.
6. The integration range of $E_{on}$ / $E_{off}$ / $E_{rec}$ according to IEC 60747.

**PERFORMANCE CURVES**

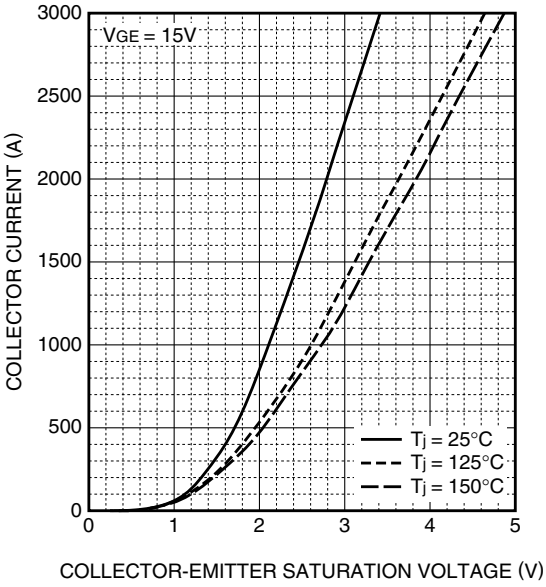
**OUTPUT CHARACTERISTICS (TYPICAL)**



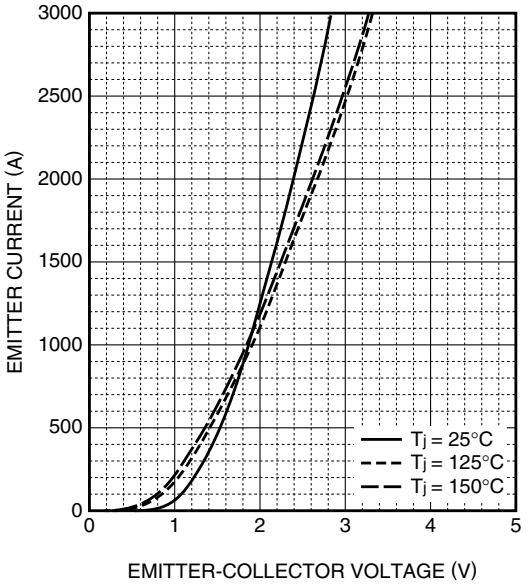

**TRANSFER CHARACTERISTICS (TYPICAL)**



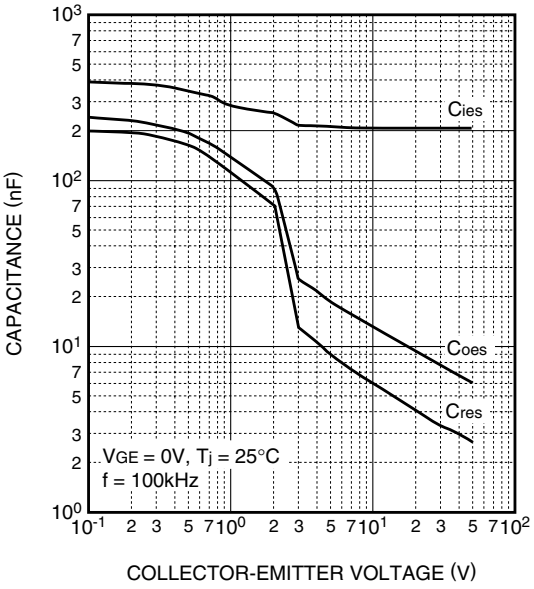

**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)**



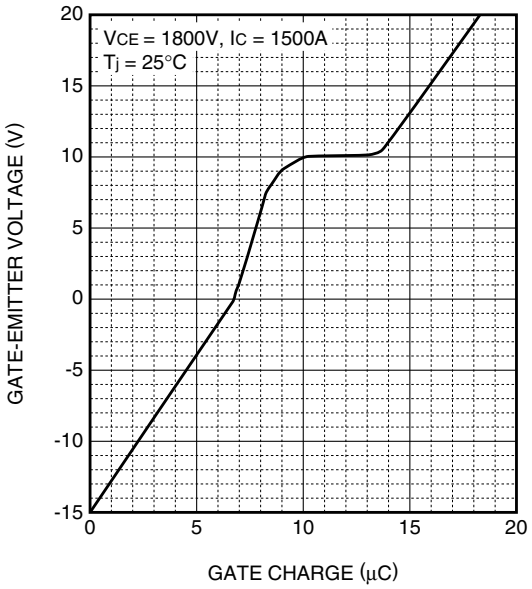

**FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)**



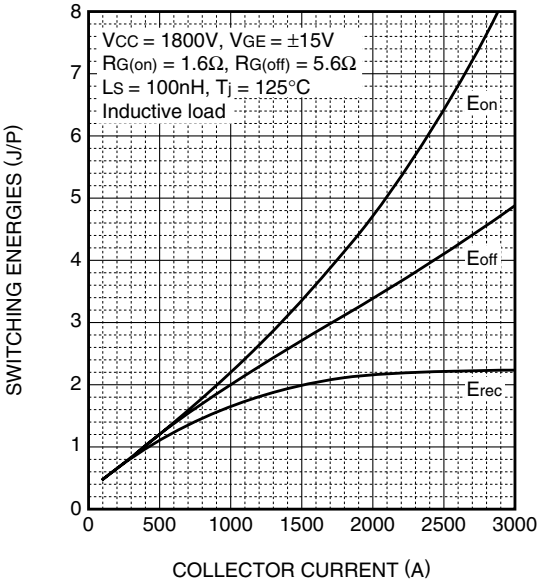
**CAPACITANCE CHARACTERISTICS (TYPICAL)**



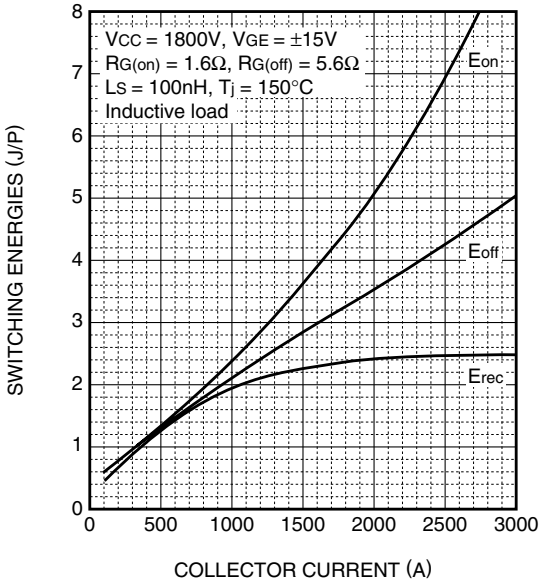

**GATE CHARGE CHARACTERISTICS (TYPICAL)**



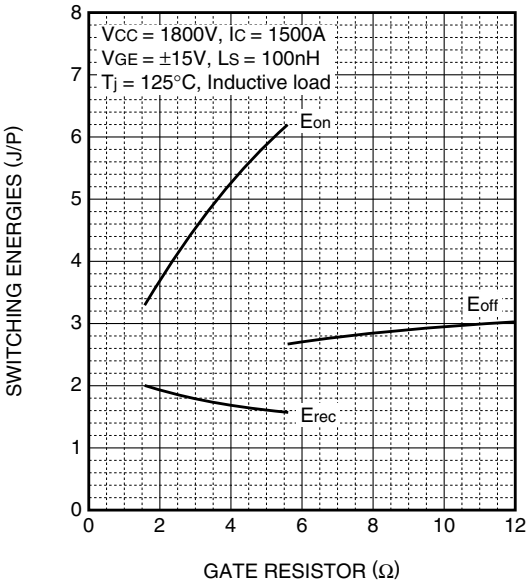

**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**



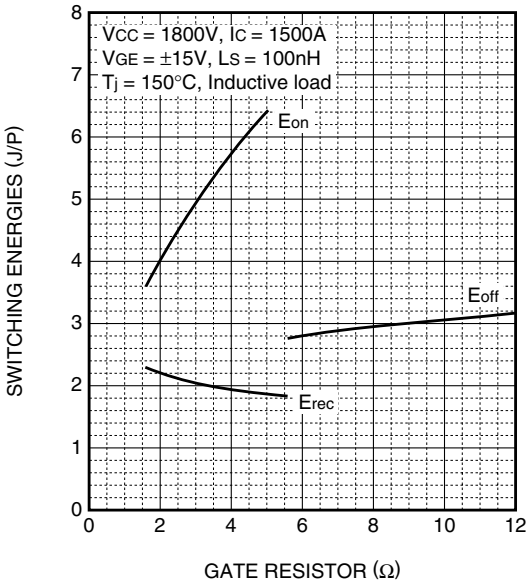

**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**



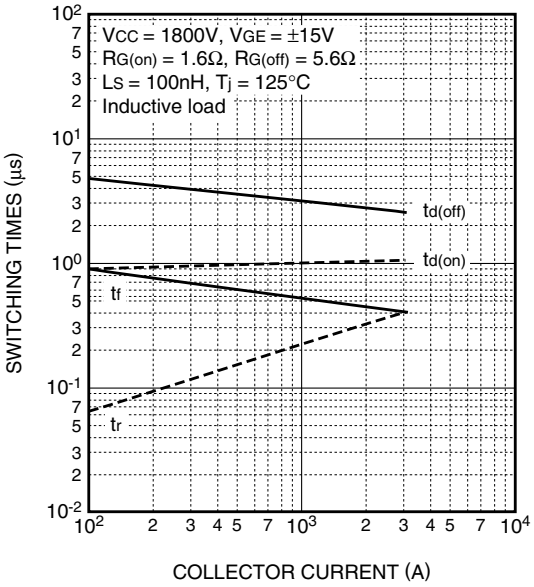
**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**



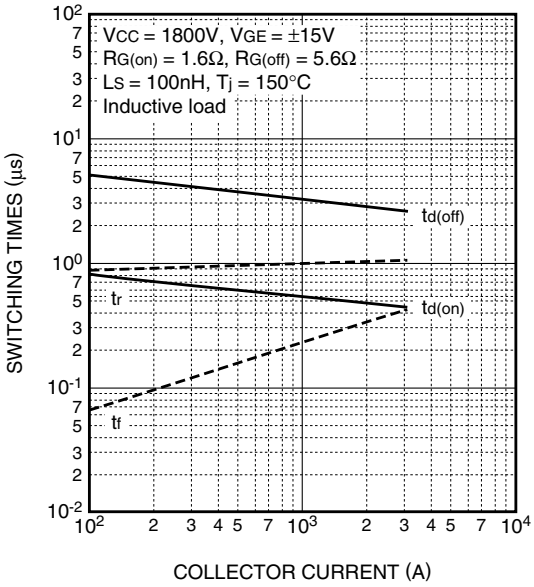

**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**



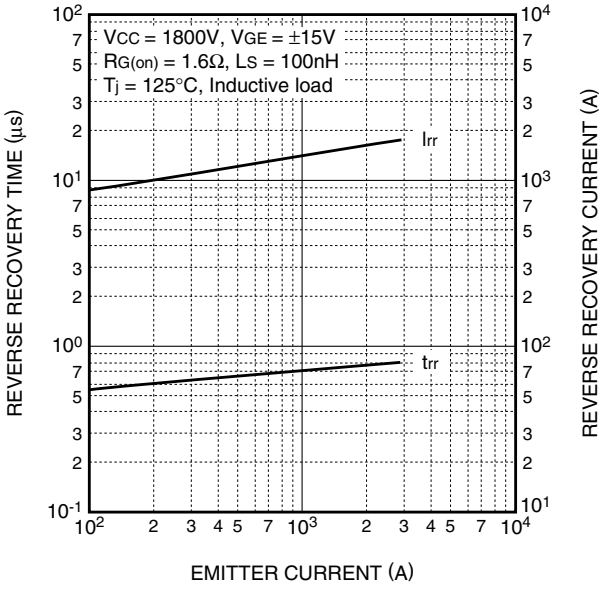

**HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)**



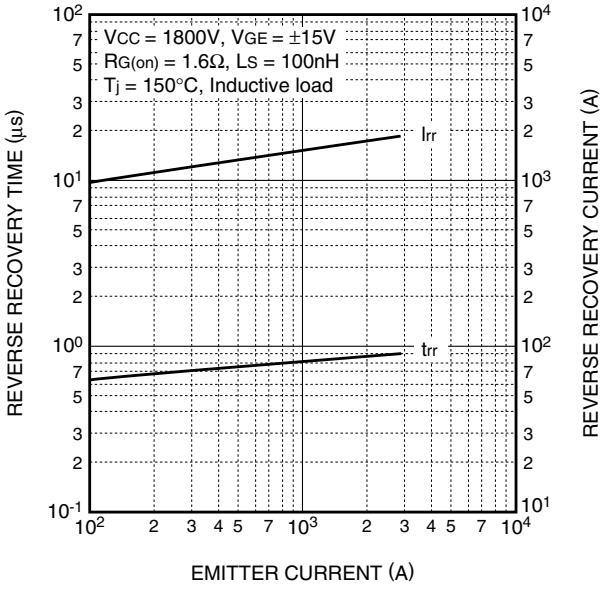

**HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)**



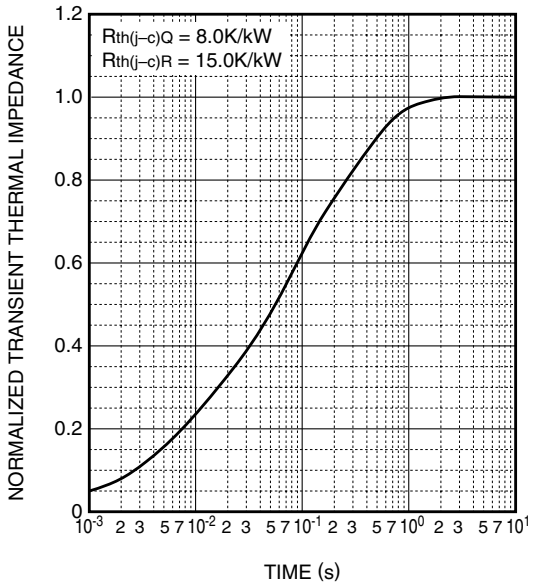
**FREE-WHEEL DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)**




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



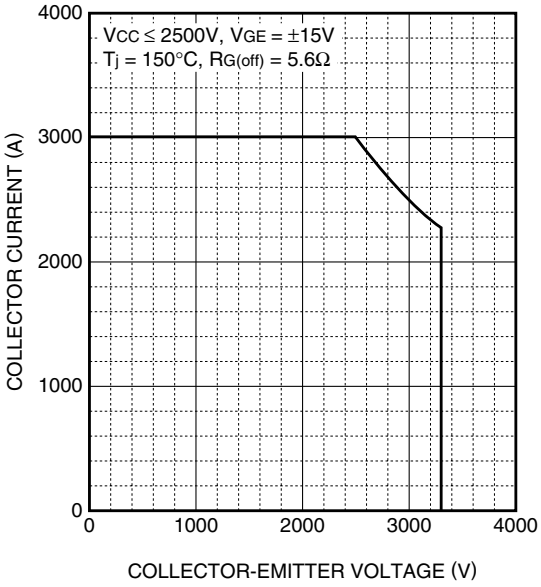

**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS**



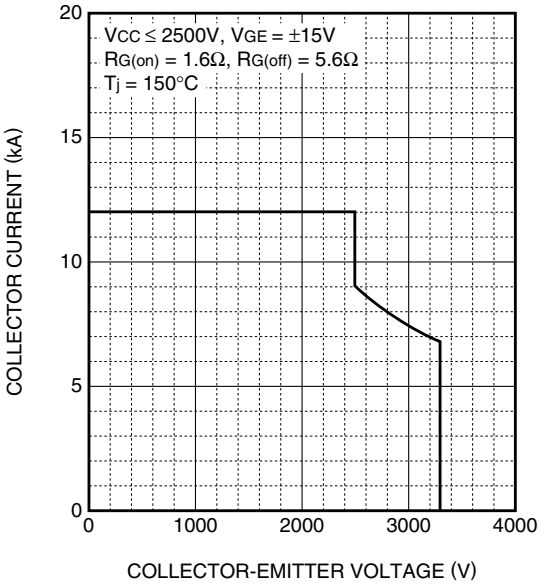

$$Z_{th(j-c)}(t) = \sum_{i=1}^{n} R_i \left\{ 1 - exp\left(-\frac{t}{\tau_i}\right) \right\}$$

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $R_i$ [K/kW] : | 0.0096 | 0.1893 | 0.4044 | 0.3967 |
| $\tau_i$ [sec] : | 0.0001 | 0.0058 | 0.0602 | 0.3512 |

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




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




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