Prepared by	S. Iura Revision: 1.2
Approved by	H. Yamaguchi : Dec. 2008

PRELIMINARY

CM1000E4C-66R

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

CM1000E4C-66R

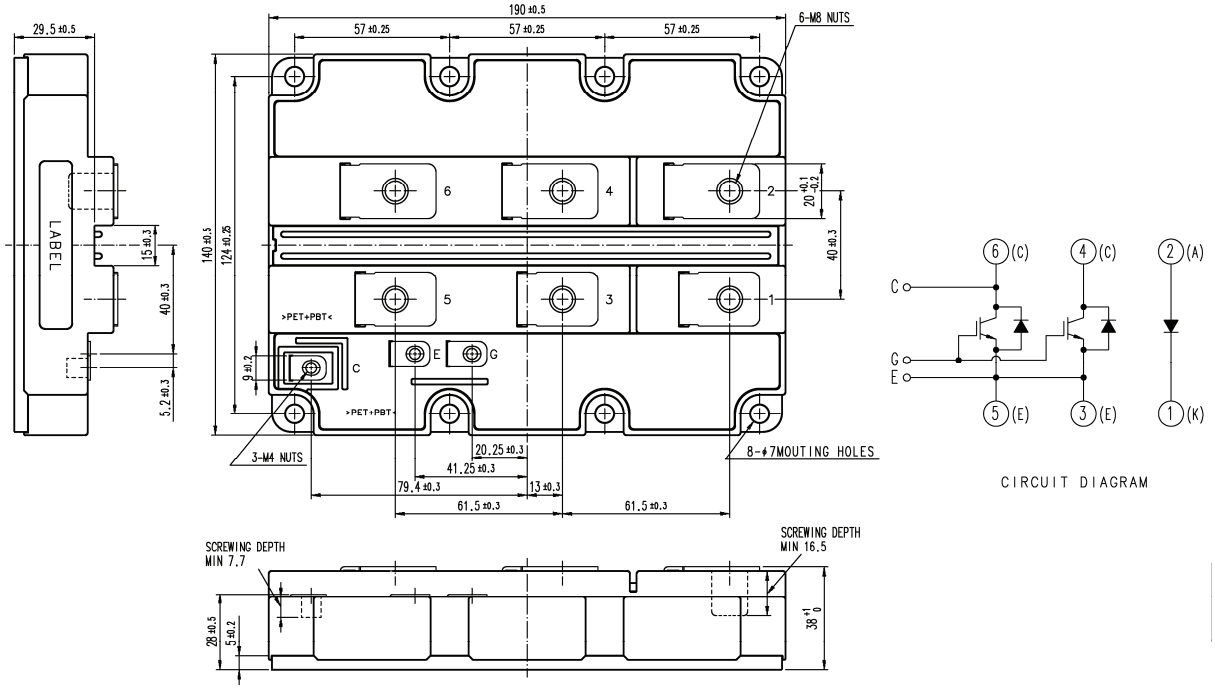
- I_C ..... 1000 A
- V_{CES} ..... 3300 V
- 1-element in a Pack (for brake chopper)
- Insulated Type
- LPT-IGBT / Soft Recovery Diode
- AlSiC Baseplate

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, T_j = −40…+150°C	3300	V
		V_{GE} = 0V, T_j = −50°C	3200	
V_{GES}	Gate-emitter voltage	V_{CE} = 0V, T_j = 25°C	± 20	V
I_C	Collector current	DC, T_c = 95°C	1000	A
I_{CM}		Pulse (Note 1)	3000	A
I_E	Emitter current (Note 2)	DC	1000	A
I_{EM}		Pulse (Note 1)	3000	A
P_c	Maximum power dissipation (Note 3)	T_c = 25°C, IGBT part	10400	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, 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	—	—	4.0	mA
			T_j = 125°C	—	4.0	—	
			T_j = 150°C	—	24.0	—	
$V_{GE(th)}$	Gate-emitter threshold voltage	V_{CE} = 10 V, I_C = 100 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 T_j = 25°C		—	140.0	—	nF
C_{oes}	Output capacitance			—	8.7	—	nF
C_{res}	Reverse transfer capacitance			—	4.0	—	nF
Q_g	Total gate charge	V_{CC} = 1800 V, I_C = 1000 A, V_{GE} = ±15 V		—	10.7	—	μC
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 1000 A (Note 4) 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 I_C = 1000 A V_{GE} = ±15 V $R_{G(on)}$ = 2.4 Ω L_s = 150 nH 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	—	1.65	—	J/P
			T_j = 125°C	—	1.95	—	
			T_j = 150°C	—	2.10	—	
E_{on}	Turn-on switching energy (Note 6)		T_j = 25°C	—	1.80	—	J/P
			T_j = 125°C	—	2.20	—	
			T_j = 150°C	—	2.40	—	

Symbol	Item	Conditions		Limits			Unit
				Min	Typ	Max	
$t_{d(off)}$	Turn-off delay time	V_{CC} = 1800 V I_C = 1000 A V_{GE} = ±15 V $R_{G(off)}$ = 8.4 Ω L_s = 150 nH 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	—	1.35	—	J/P
			T_j = 125°C	—	1.65	—	
			T_j = 150°C	—	1.70	—	
E_{off}	Turn-off switching energy (Note 6)		T_j = 25°C	—	1.50	—	J/P
			T_j = 125°C	—	1.80	—	
			T_j = 150°C	—	1.90	—	
V_{EC}	Emitter-collector voltage (Note 2)	I_E = 1000 A (Note 4) 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	—	
t_{rr}	Reverse recovery time (Note 2)	V_{CC} = 1800 V I_C = 1000 A V_{GE} = ±15 V $R_{G(on)}$ = 2.4 Ω L_s = 150 nH 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	—	850	—	A
			T_j = 125°C	—	1000	—	
			T_j = 150°C	—	1050	—	
Q_{rr}	Reverse recovery charge (Note 2)		T_j = 25°C	—	700	—	μC
			T_j = 125°C	—	1150	—	
			T_j = 150°C	—	1350	—	
$E_{rec(10\%)}$	Reverse recovery energy (Note 2) (Note 5)		T_j = 25°C	—	0.70	—	J/P
			T_j = 125°C	—	1.20	—	
			T_j = 150°C	—	1.35	—	
E_{rec}	Reverse recovery energy (Note 2) (Note 6)		T_j = 25°C	—	0.80	—	J/P
			T_j = 125°C	—	1.35	—	
			T_j = 150°C	—	1.55	—	

THERMAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
$R_{th(j-c)Q}$	Thermal resistance	Junction to Case, IGBT part	—	—	12.0	K/kW
$R_{th(j-c)R}$	Thermal resistance	Junction to Case, FWDi part	—	—	22.5	K/kW
		Junction to Case, Clamp-Di part	—	—	22.5	K/kW
$R_{th(c-f)}$	Contact thermal resistance	Case to Fin, λ_{grease} = 1W/m·K, $D_{(c-f)}$ = 100 µm	—	7.0	—	K/kW

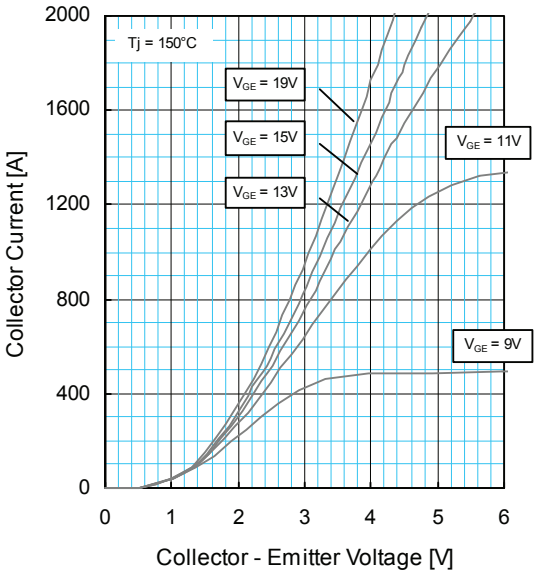
MECHANICAL CHARACTERISTICS

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	Parasitic stray inductance	Collector to Emitter	—	22.0	—	nH
		Anode to Cathode	—	33.0	—	nH
R_L	Internal lead resistance	T_c = 25°C, Collector to Emitter	—	0.24	—	mΩ
		T_c = 25°C, Anode to Cathode	—	0.36	—	mΩ
r_g	Internal gate resistor	T_c = 25°C	—	2.25	—	Ω

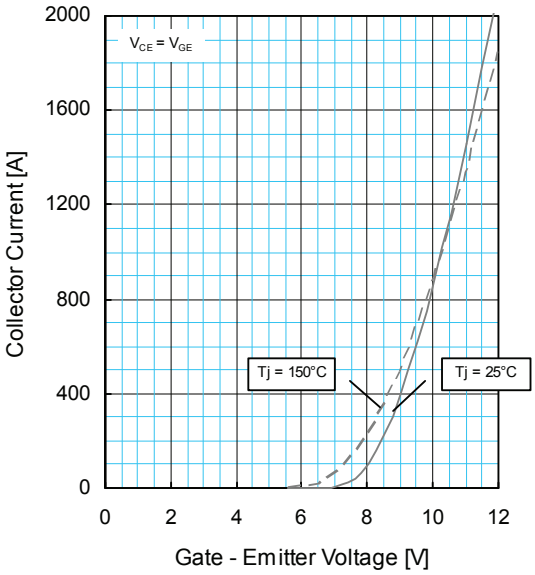
Note 1. Pulse width and repetition rate should be such that junction temperature (T_j) does not exceed T_{opmax} rating (150°C).
Note 2. The symbols represent characteristics of the anti-parallel, emitter to collector free-wheel diode (FWDi) and the brake chopper, anode to cathode clamp diode (Clamp-Di).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

PERFORMANCE CURVES

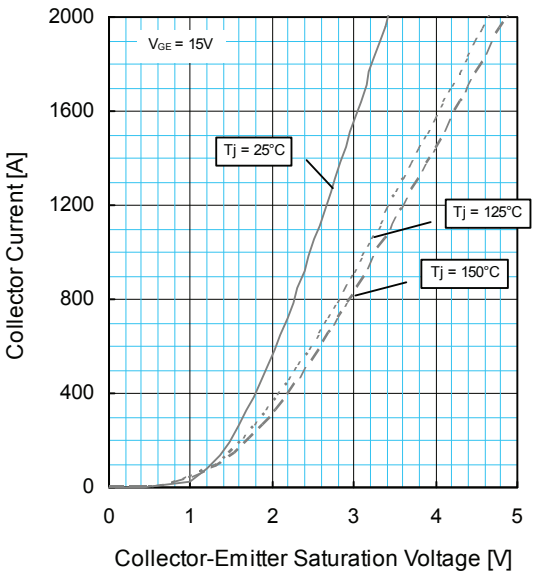
OUTPUT CHARACTERISTICS (TYPICAL)



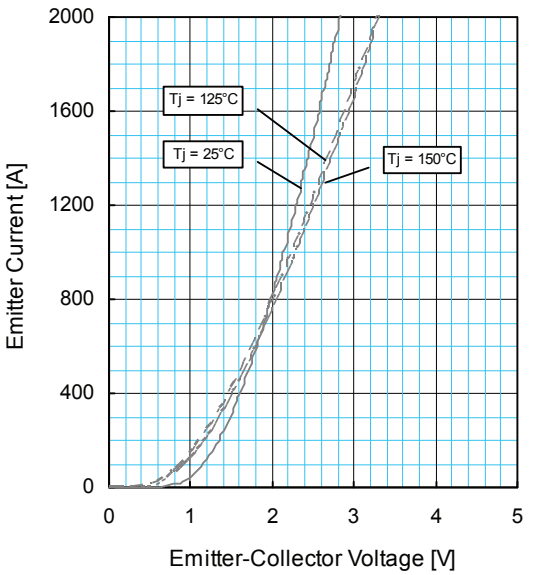
TRANSFER CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)

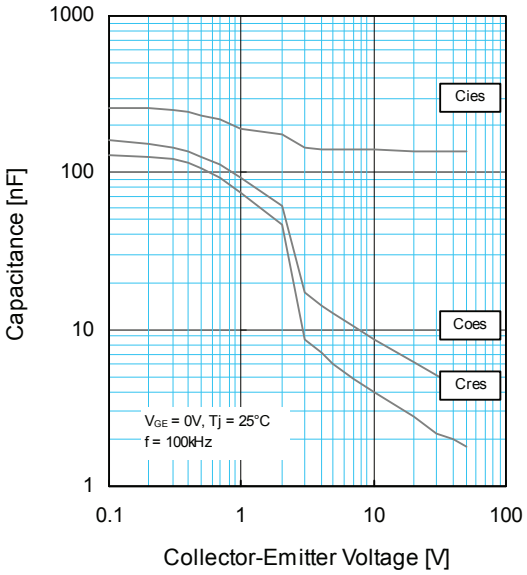


FREE-WHEEL DIODE FORWARD CHARACTERISTICS (TYPICAL)

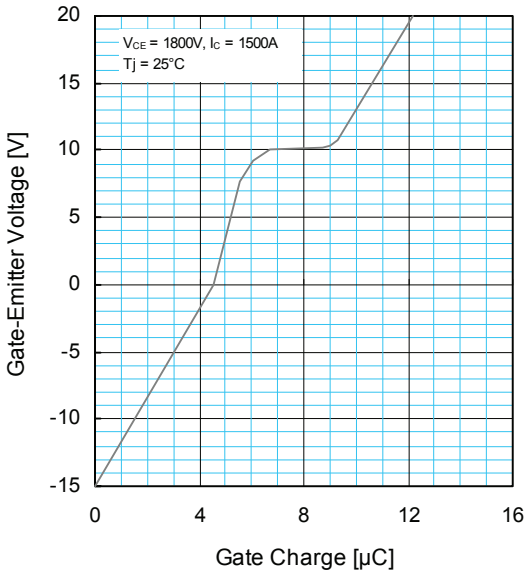


PERFORMANCE CURVES

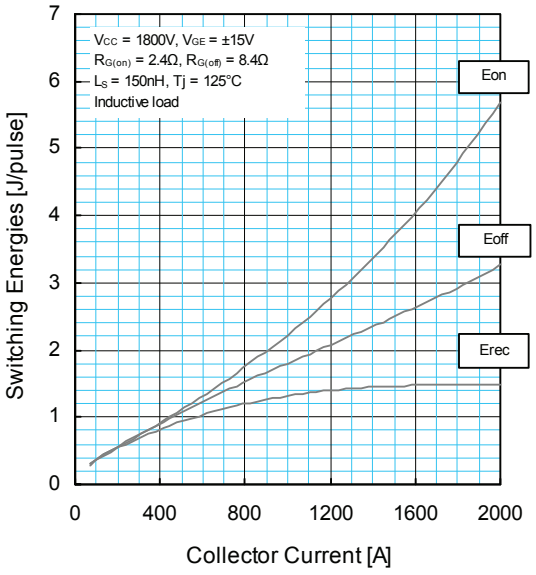
CAPACITANCE CHARACTERISTICS (TYPICAL)



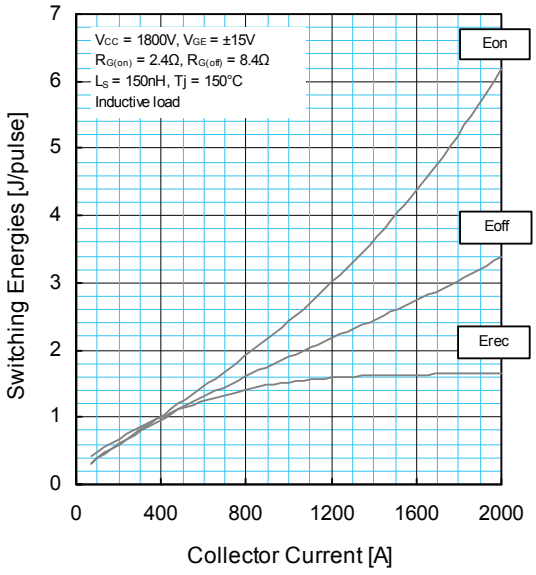
GATE CHARGE CHARACTERISTICS (TYPICAL)



HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

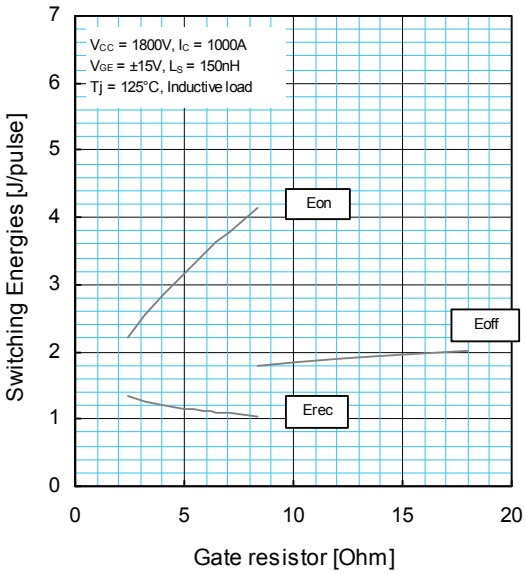


HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)

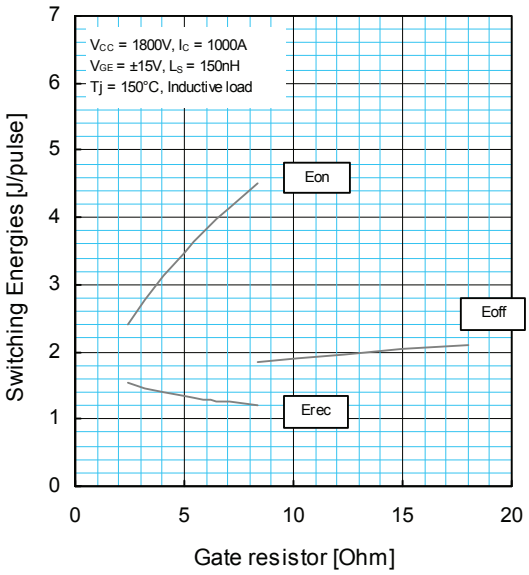


PERFORMANCE CURVES

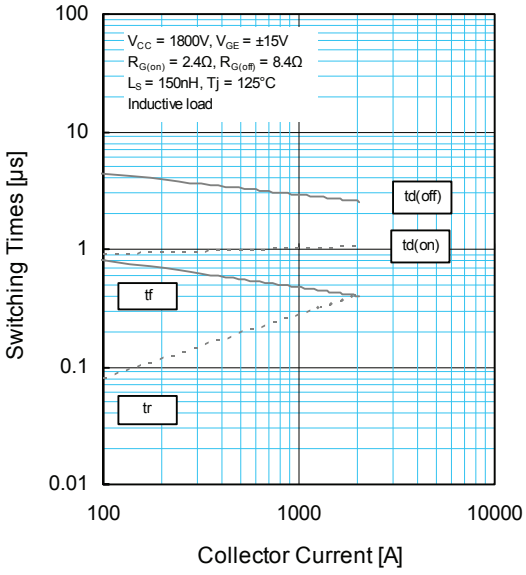
HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



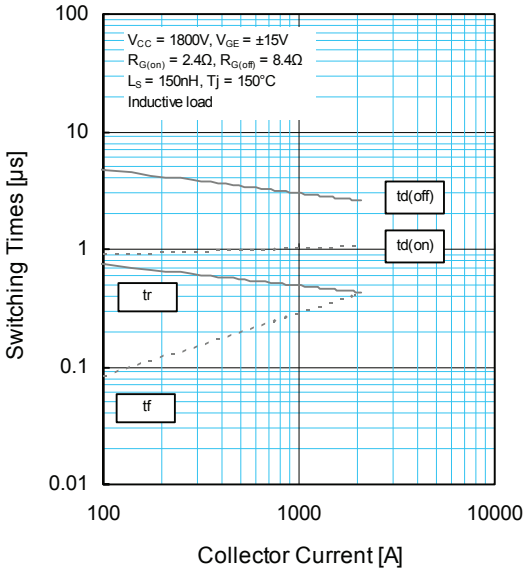
HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)

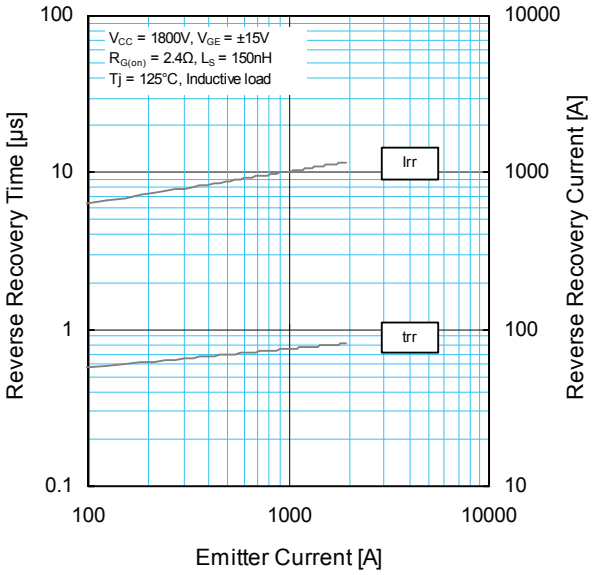


HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)

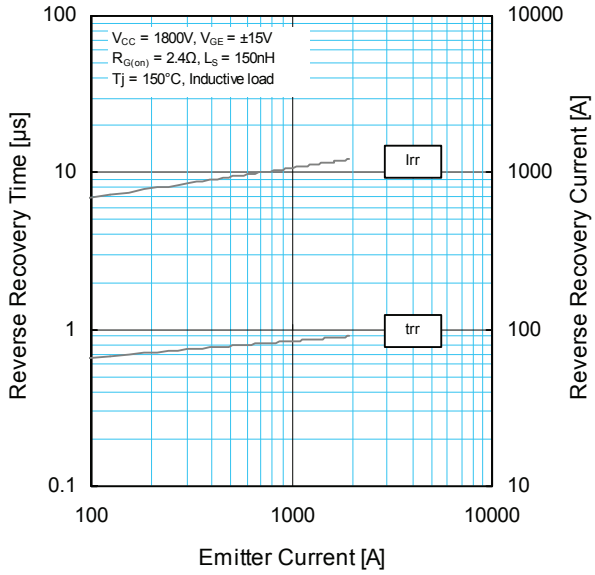


PERFORMANCE CURVES

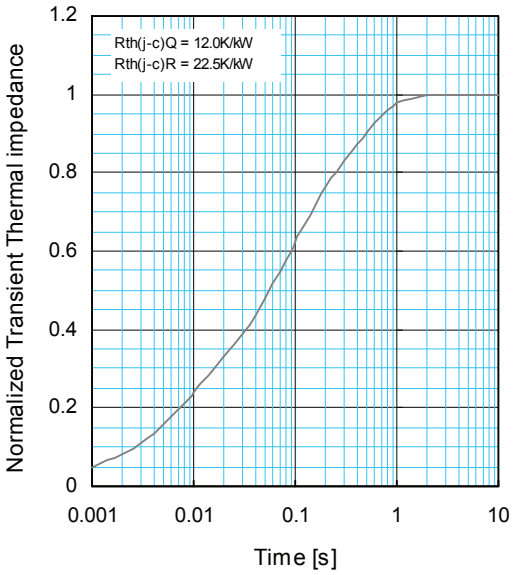
FREE-WHEEL DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



FREE-WHEEL DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS

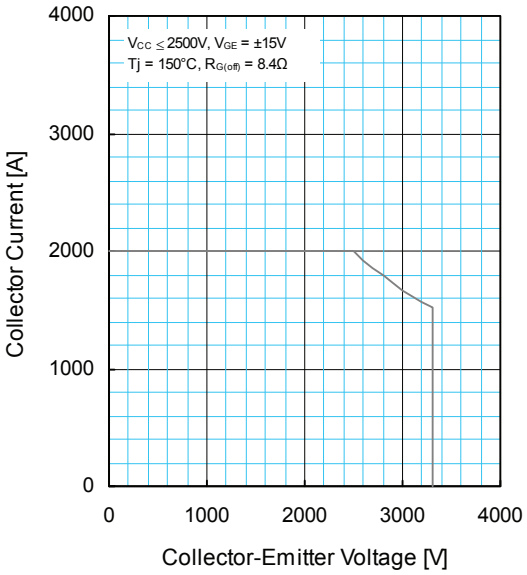


$$Z_{th(j-c)}(t) = \sum_{i=1}^{n} R_i \left\{ 1 - exp\left(-\frac{t}{\tau_i} \right) \right\}$$

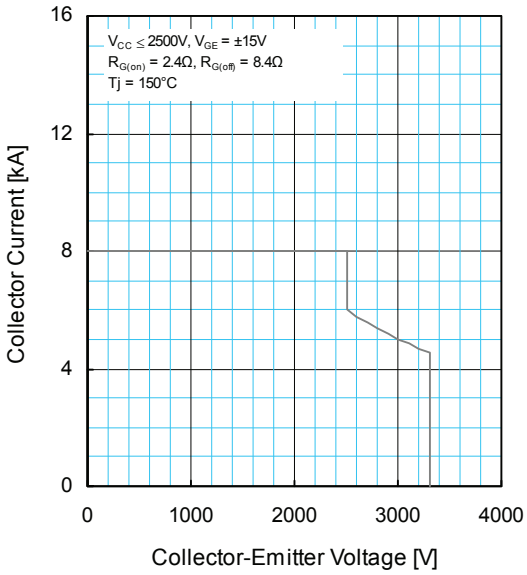
	1	2	3	4
R_i [K/kW] :	0.0096	0.1893	0.4044	0.3967
τ_i [sec] :	0.0001	0.0058	0.0602	0.3512

PERFORMANCE CURVES

REVERSE BIAS SAFE OPERATING AREA (RBSOA)



SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)



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