

< HVIGBT MODULES >

CM1000E4C-66RHIGH POWER SWITCHING USE
INSULATED TYPE

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

MAXIMUM RATINGS

Symbol	Item	Conditions	Ratings	Unit
V_{CES}	Collector-emitter voltage	$V_{GE} = 0V, T_j = -40 \dots +150^\circ C$	3300	V
		$V_{GE} = 0V, T_j = -50^\circ C$	3200	
V_{GES}	Gate-emitter voltage	$V_{CE} = 0V, T_j = 25^\circ C$	± 20	V
I_C	Collector current	DC, $T_c = 95^\circ C$	1000	A
I_{CRM}		Pulse (Note 1)	2000	A
I_E	Emitter current (Note 2)	DC	1000	A
I_{ERM}		Pulse (Note 1)	2000	A
P_{tot}	Maximum power dissipation (Note 3)	$T_c = 25^\circ C$, IGBT part	10400	W
V_{iso}	Isolation voltage	RMS, sinusoidal, $f = 60Hz$, $t = 1 \text{ min.}$	6000	V
V_e	Partial discharge extinction voltage	RMS, sinusoidal, $f = 60Hz$, $Q_{PD} \leq 10 \text{ pC}$	2600	V
T_j	Junction temperature		$-50 \sim +150$	$^\circ C$
T_{jop}	Operating junction temperature		$-50 \sim +150$	$^\circ C$
T_{stg}	Storage temperature		$-55 \sim +150$	$^\circ C$
t_{psc}	Short circuit pulse width	$V_{CC} = 2500V, V_{CE} \leq V_{CES}, V_{GE} = 15V, T_j = 150^\circ C$	10	μs

ELECTRICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
I_{CES}	Collector cutoff current	$V_{CE} = V_{CES}, V_{GE} = 0V$	$T_j = 25^\circ C$	—	4.0	mA
			$T_j = 125^\circ C$	—	4.0	
			$T_j = 150^\circ C$	—	24.0	
$V_{GE(th)}$	Gate-emitter threshold voltage	$V_{CE} = 10V, I_C = 100 \text{ mA}, T_j = 25^\circ C$	5.7	6.2	6.7	V
I_{GES}	Gate leakage current	$V_{GE} = V_{GES}, V_{CE} = 0V, T_j = 25^\circ C$	-0.5	—	0.5	μA
C_{ies}	Input capacitance	$V_{CE} = 10V, V_{GE} = 0V, f = 100 \text{ kHz}$ $T_j = 25^\circ C$	—	140.0	—	nF
C_{oes}	Output capacitance		—	8.7	—	nF
C_{res}	Reverse transfer capacitance		—	4.0	—	nF
Q_G	Total gate charge	$V_{CC} = 1800V, I_C = 1000A, V_{GE} = \pm 15V$	—	10.7	—	μC
V_{CESat}	Collector-emitter saturation voltage	$I_C = 1000A$ (Note 4) $V_{GE} = 15V$	$T_j = 25^\circ C$	—	2.45	V
			$T_j = 125^\circ C$	—	3.10	
			$T_j = 150^\circ C$	—	3.25	
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 1800V$ $I_C = 1000A$ $V_{GE} = \pm 15V$	$T_j = 25^\circ C$	—	1.00	μs
			$T_j = 125^\circ C$	—	0.95	
			$T_j = 150^\circ C$	—	0.95	
t_r	Turn-on rise time	$V_{CC} = 1800V$ $I_C = 1000A$ $V_{GE} = \pm 15V$	$T_j = 25^\circ C$	—	0.28	μs
			$T_j = 125^\circ C$	—	0.30	
			$T_j = 150^\circ C$	—	0.30	
$E_{on(10\%)}$	Turn-on switching energy (Note 5)	$R_{G(on)} = 2.4 \Omega$ $L_s = 150 \text{ nH}$ Inductive load	$T_j = 25^\circ C$	—	1.40	J
			$T_j = 125^\circ C$	—	1.85	
			$T_j = 150^\circ C$	—	2.00	
E_{on}	Turn-on switching energy (Note 6)		$T_j = 25^\circ C$	—	1.50	J
			$T_j = 125^\circ C$	—	1.95	
			$T_j = 150^\circ C$	—	2.15	
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 1800V$ $I_C = 1000A$ $V_{GE} = \pm 15V$	$T_j = 25^\circ C$	—	2.70	μs
			$T_j = 125^\circ C$	—	2.80	
			$T_j = 150^\circ C$	—	2.85	
t_f	Turn-off fall time	$V_{CC} = 1800V$ $I_C = 1000A$ $V_{GE} = \pm 15V$	$T_j = 25^\circ C$	—	0.30	μs
			$T_j = 125^\circ C$	—	0.35	
			$T_j = 150^\circ C$	—	0.40	
$E_{off(10\%)}$	Turn-off switching energy (Note 5)	$R_{G(off)} = 8.4 \Omega$ $L_s = 150 \text{ nH}$ Inductive load	$T_j = 25^\circ C$	—	1.35	J
			$T_j = 125^\circ C$	—	1.65	
			$T_j = 150^\circ C$	—	1.70	
E_{off}	Turn-off switching energy (Note 6)		$T_j = 25^\circ C$	—	1.50	J
			$T_j = 125^\circ C$	—	1.80	
			$T_j = 150^\circ C$	—	1.90	

ELECTRICAL CHARACTERISTICS (continuation)

Symbol	Item	Conditions		Limits			Unit
				Min	Typ	Max	
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
			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
			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
$R_{th(j-c)D}$		Junction to Case, FWDi part	—	—	22.5	K/kW
		Junction to Case, Clamp-Di part	—	—	22.5	K/kW
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, $\lambda_{grease} = 1\text{ W/m}^2\text{K}$, $D_{(c-s)} = 100\mu\text{m}$	—	7.0	—	K/kW

MECHANICAL CHARACTERISTICS

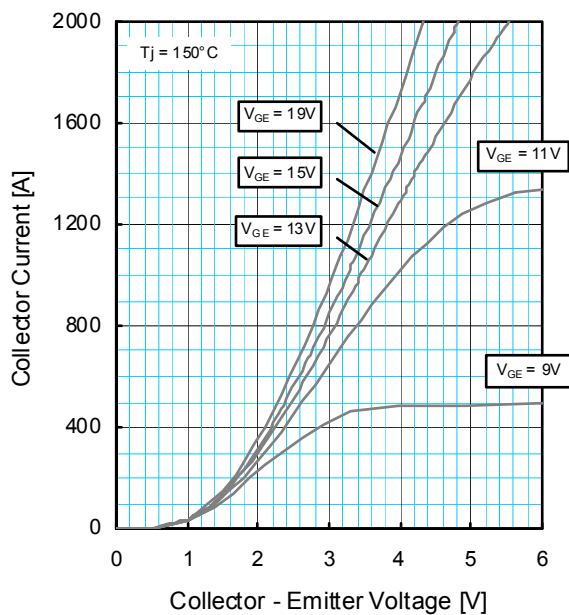
Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
M_t	Mounting torque	M8 : Main terminals screw	7.0	—	22.0	N·m
M_s		M6 : Mounting screw	3.0	—	6.0	N·m
M_t		M4 : Auxiliary terminals screw	1.0	—	3.0	N·m
m	Mass		—	1.2	—	kg
CTI	Comparative tracking index		600	—	—	—
d_a	Clearance		19.5	—	—	mm
d_s	Creepage distance		32.0	—	—	mm
L_{PCE}	Parasitic stray inductance	Collector to Emitter	—	16.5	—	nH
		Anode to Cathode	—	33.0	—	nH
$R_{CC+EE'}$	Internal lead resistance	$T_C = 25^\circ\text{C}$, Collector to Emitter	—	0.18	—	mΩ
$R_{AA+KK'}$	Internal lead resistance	$T_C = 25^\circ\text{C}$, Anode to Cathode	—	0.36	—	mΩ
r_g	Internal gate resistance	$T_C = 25^\circ\text{C}$	—	2.25	—	Ω

Note1. Pulse width and repetition rate should be such that junction temperature (T_J) does not exceed T_{opmax} rating (150°C).

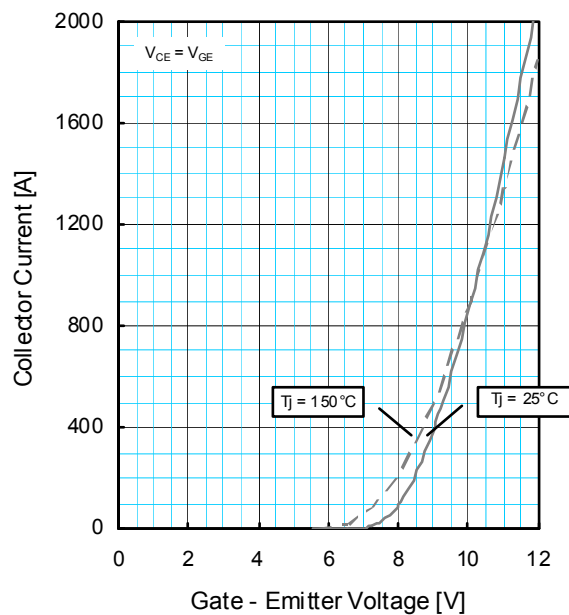
- The symbols represent characteristics of the anti-parallel, emitter to collector free-wheel diode (FWDi) and the brake chopper, anode to cathode clamp diode (Clamp-Di).
- Junction temperature (T_J) should not exceed T_{jmax} rating (150°C).
- Pulse width and repetition rate should be such as to cause negligible temperature rise.
- $E_{on(10\%)}$ / $E_{off(10\%)}$ / $E_{rec(10\%)}$ are the integral of $0.1V_{CE} \times 0.1I_C \times dt$.
- Definition of all items is according to IEC 60747, unless otherwise specified.

PERFORMANCE CURVES

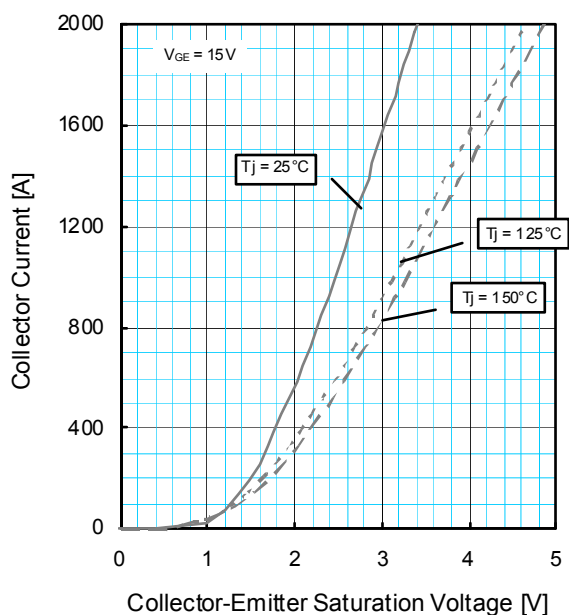
**OUTPUT CHARACTERISTICS
(TYPICAL)**



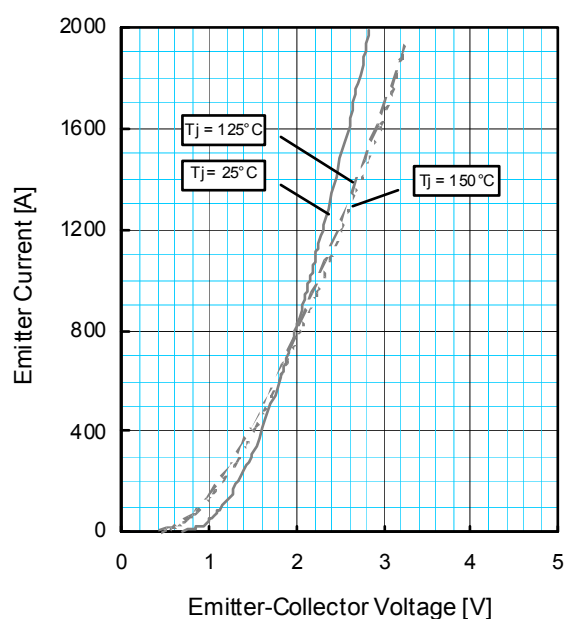
**TRANSFER CHARACTERISTICS
(TYPICAL)**

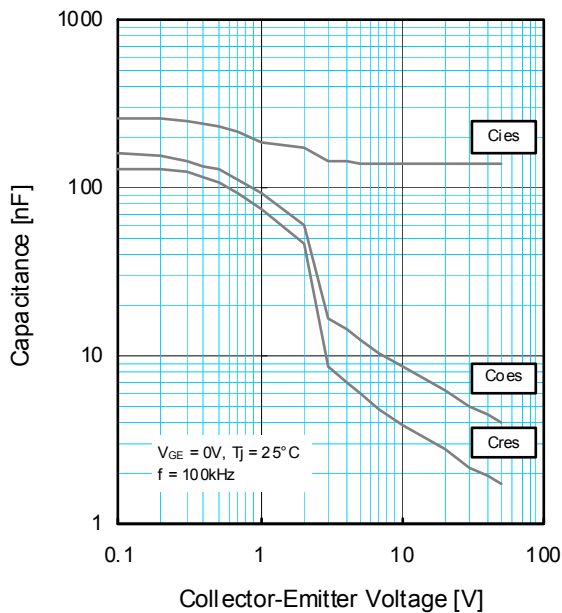
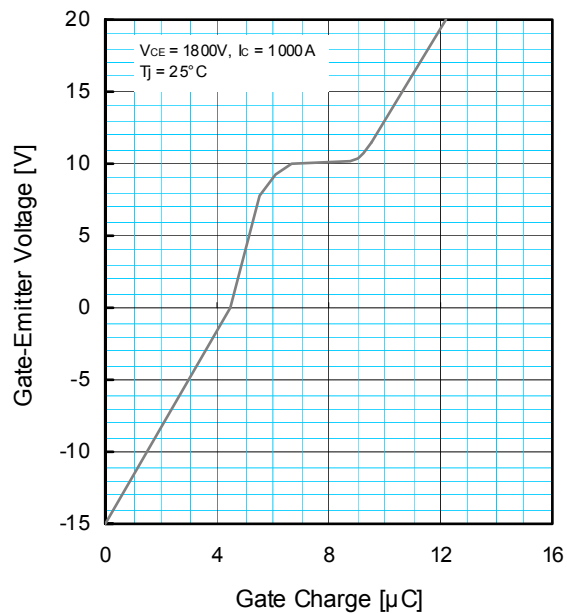
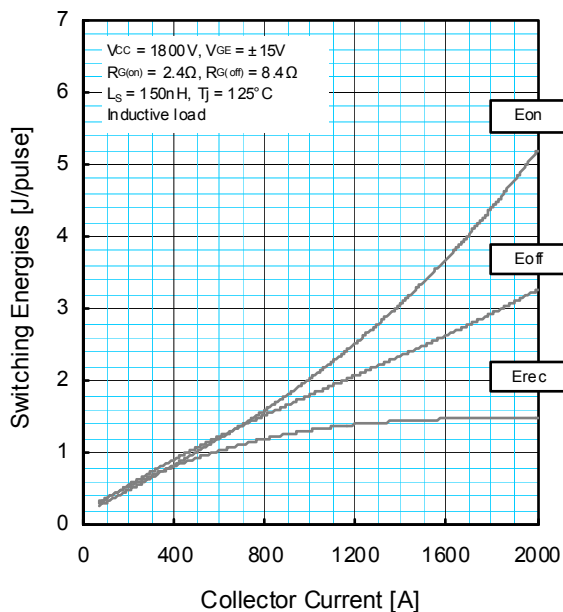
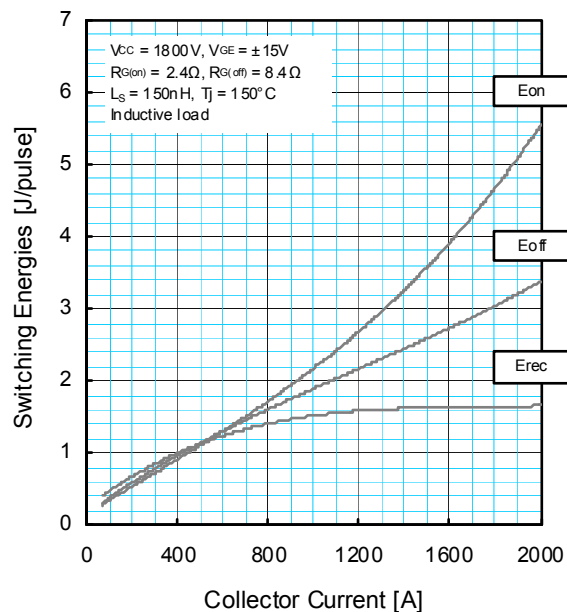


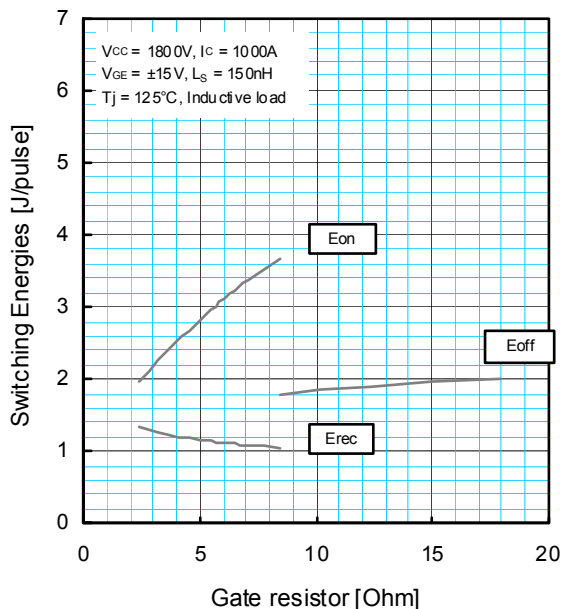
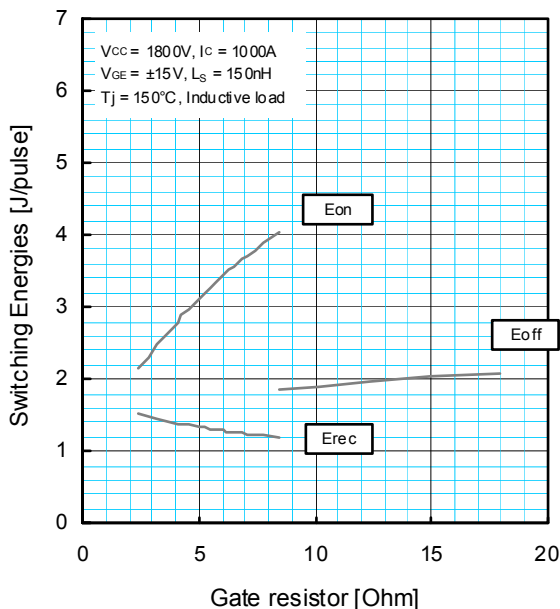
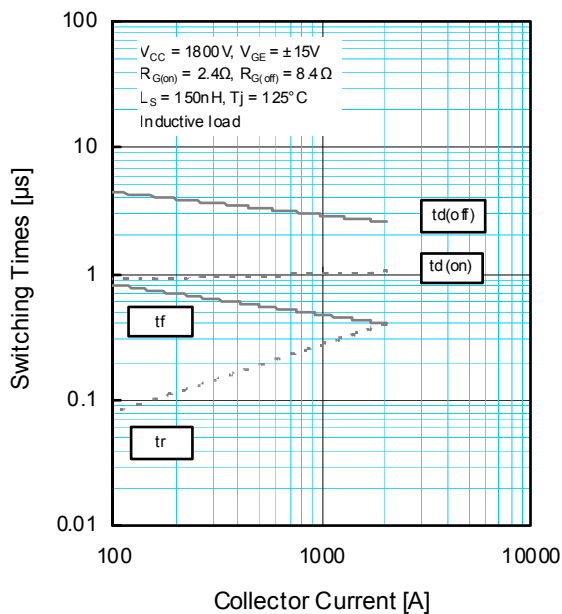
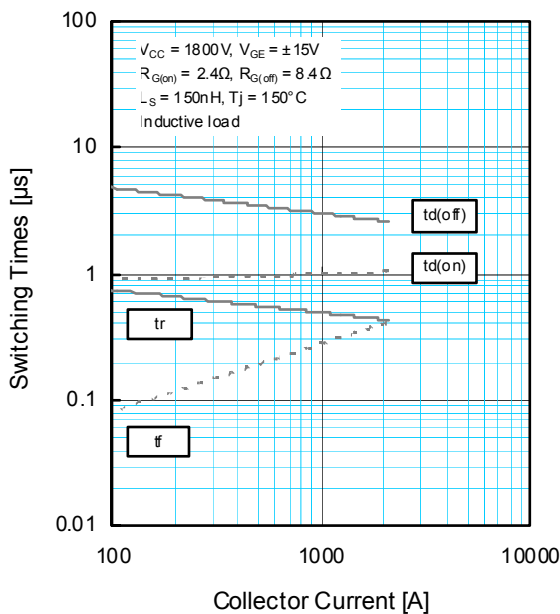
**COLLECTOR-EMITTER SATURATION VOLTAGE
CHARACTERISTICS (TYPICAL)**

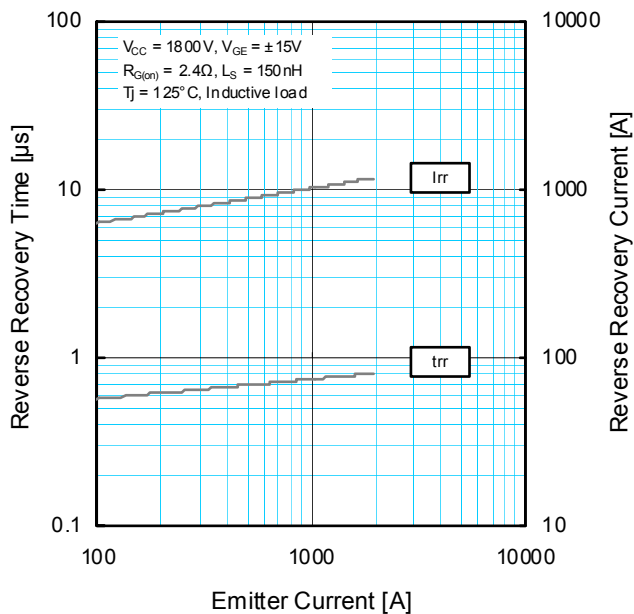
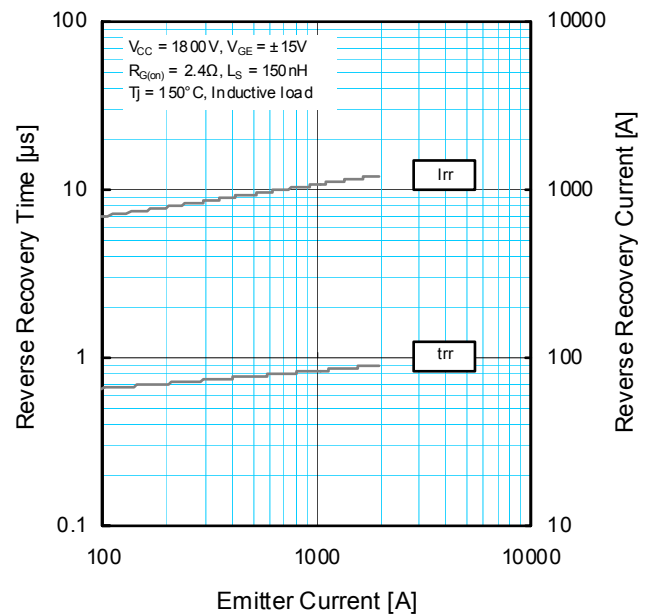
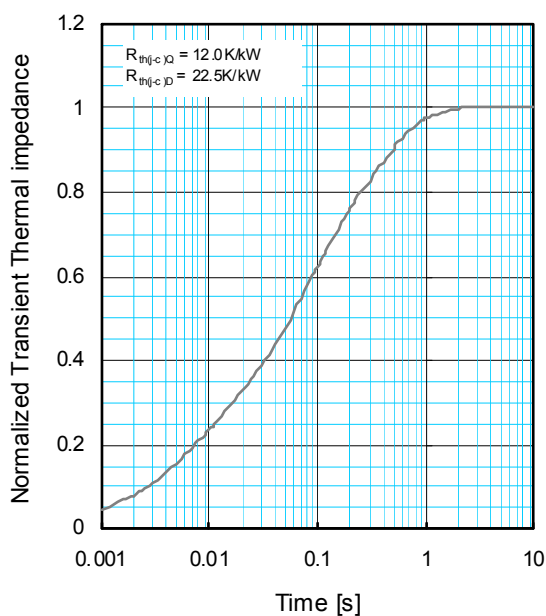


**FREE-WHEEL DIODE FORWARD
CHARACTERISTICS (TYPICAL)**



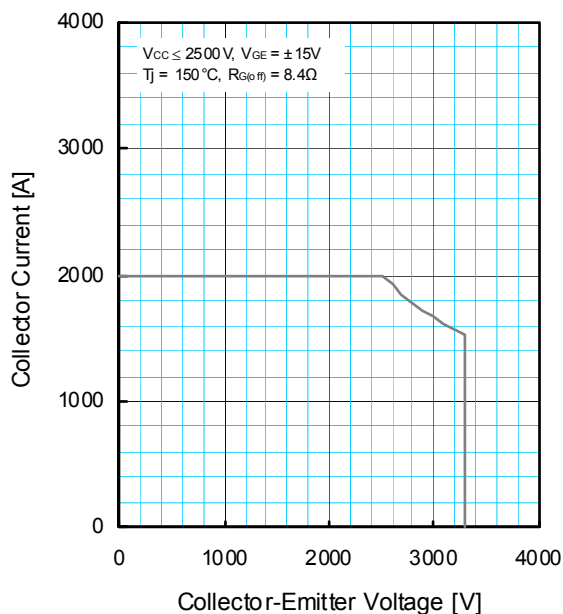
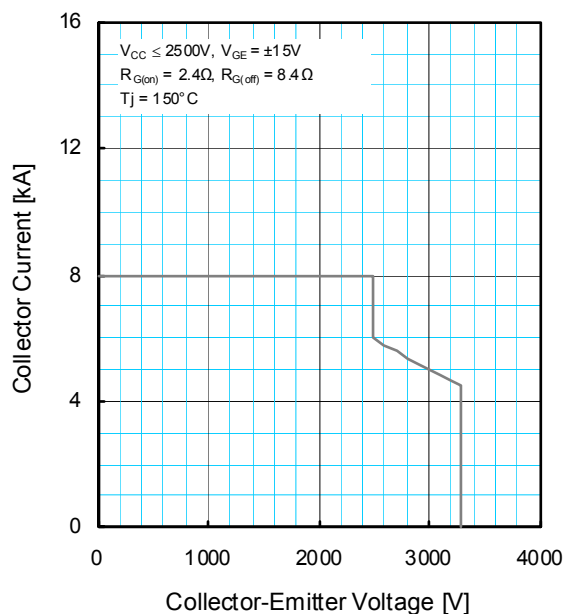
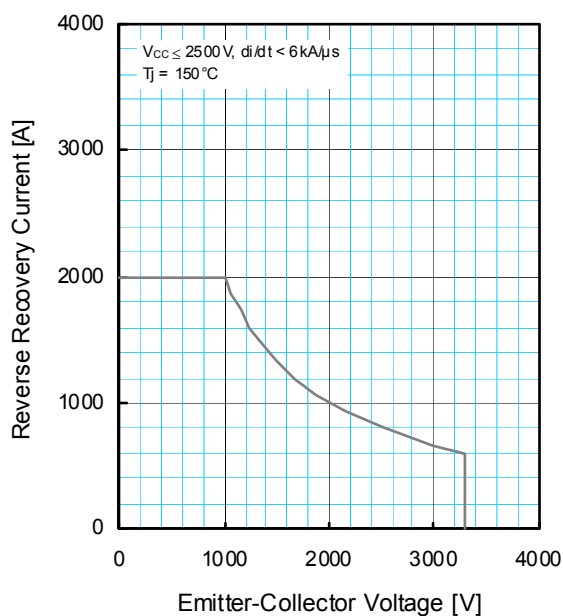
PERFORMANCE CURVES**CAPACITANCE CHARACTERISTICS
(TYPICAL)****GATE CHARGE CHARACTERISTICS
(TYPICAL)****HALF-BRIDGE SWITCHING ENERGY
CHARACTERISTICS (TYPICAL)****HALF-BRIDGE SWITCHING ENERGY
CHARACTERISTICS (TYPICAL)**

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)**

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