

Prepared by	K.Kurachi	Revision: B
Date	I.Umezaki	24-Feb.-2009

CM400E2G-130H

HIGH POWER SWITCHING USE
INSULATED TYPE

3rd-Version HVIGBT (High Voltage Insulated Gate Bipolar Transistor) Modules

CM400E2G-130H



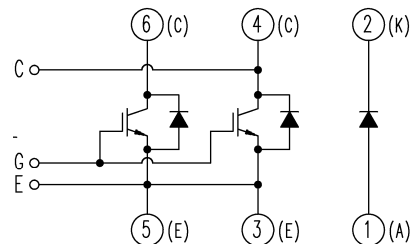
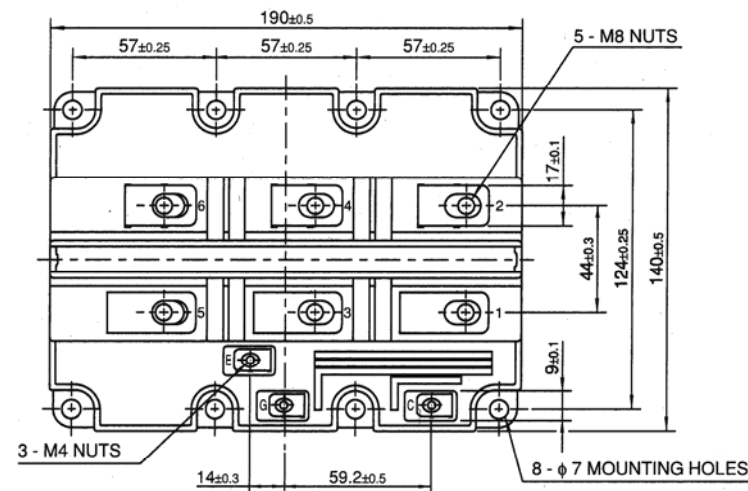
- I_C 400 A
- V_{CES} 6500 V
- 1-element in a Pack (for brake chopper)
- Insulated Type
- AlSiC Baseplate

APPLICATION

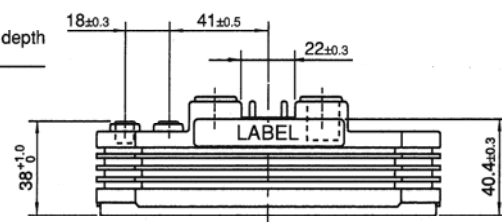
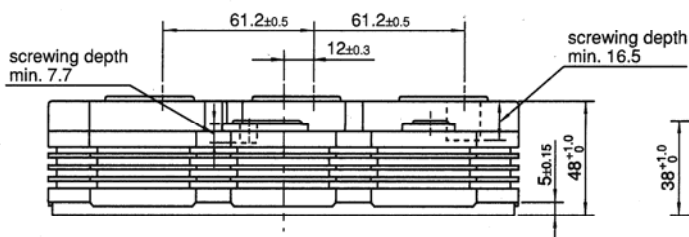
Traction drives, High Reliability Converters / Inverters, DC choppers

OUTLINE DRAWING & CIRCUIT DIAGRAM

Dimensions in mm



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CIRCUIT DIAGRAM



HVIGBT (High Voltage Insulated Gate Bipolar Transistor) MODULES

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MAXIMUM RATINGS

Symbol	Item	Conditions	Ratings	Unit
V_{CES}	Collector-emitter voltage	$V_{GE} = 0 \text{ V}$	$T_j = -40^\circ\text{C}$	V
			$T_j = +25^\circ\text{C}$	
			$T_j = +125^\circ\text{C}$	
V_{GES}	Gate-emitter voltage	$V_{CE} = 0 \text{ V}, T_j = 25^\circ\text{C}$	± 20	V
I_C	Collector current	DC, $T_c = 80^\circ\text{C}$	400	A
I_{CM}		Pulse (Note 1)	800	A
I_E	Emitter current (Note 2)	DC	400	A
I_{EM}		Pulse (Note 1)	800	A
P_c	Maximum power dissipation (Note 3)	$T_c = 25^\circ\text{C}$, IGBT part	5900	W
V_{iso}	Isolation voltage	RMS, sinusoidal, $f = 60\text{Hz}$, $t = 1 \text{ min.}$	10200	V
V_e	Partial discharge extinction voltage	RMS, sinusoidal, $f = 60\text{Hz}$, $Q_{PD} \leq 10 \text{ pC}$	5100	V
T_j	Junction temperature		$-40 \sim +150$	$^\circ\text{C}$
T_{op}	Operating temperature		$-40 \sim +125$	$^\circ\text{C}$
T_{stg}	Storage temperature		$-40 \sim +125$	$^\circ\text{C}$
t_{psc}	Maximum short circuit pulse width	$V_{CC} = 4500 \text{ V}$, $V_{CE} \leq V_{CES}$, $V_{GE} = 15 \text{ V}$, $T_j = 125^\circ\text{C}$	10	μs

ELECTRICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
I_{CES}	Collector cutoff current	$V_{CE} = V_{CES}$, $V_{GE} = 0 \text{ V}$	$T_j = 25^\circ\text{C}$	—	7	mA
			$T_j = 125^\circ\text{C}$	—	60	
$V_{GE(th)}$	Gate-emitter threshold voltage	$V_{CE} = 10 \text{ V}$, $I_C = 40 \text{ mA}$, $T_j = 25^\circ\text{C}$	5.0	6.0	7.0	V
I_{GES}	Gate leakage current	$V_{GE} = V_{GES}$, $V_{CE} = 0 \text{ V}$, $T_j = 25^\circ\text{C}$	-0.5	—	0.5	μA
C_{ies}	Input capacitance	$V_{CE} = 10 \text{ V}$, $V_{GE} = 0 \text{ V}$, $f = 100 \text{ kHz}$ $T_j = 25^\circ\text{C}$	—	82.0	—	nF
C_{oes}	Output capacitance		—	5.0	—	nF
C_{res}	Reverse transfer capacitance		—	1.4	—	nF
Q_g	Total gate charge	$V_{CC} = 3600 \text{ V}$, $I_C = 400 \text{ A}$ $V_{GE} = \pm 15 \text{ V}$, $T_j = 25^\circ\text{C}$	—	6.6	—	μC
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = 400 \text{ A}$ (Note 4) $V_{GE} = 15 \text{ V}$	$T_j = 25^\circ\text{C}$	—	4.5	V
			$T_j = 125^\circ\text{C}$	—	4.6	
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 3600 \text{ V}$, $I_C = 400 \text{ A}$ $V_{GE} = \pm 15 \text{ V}$, $R_{G(on)} = 15 \Omega$ $T_j = 125^\circ\text{C}$, $L_s = 170 \text{ nH}$	—	1.2	—	μs
t_r	Turn-on rise time		—	0.35	—	μs
$E_{on(10\%)}$	Turn-on switching energy (Note 5)		—	3.0	—	J/P
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 3600 \text{ V}$, $I_C = 400 \text{ A}$ $V_{GE} = \pm 15 \text{ V}$, $R_{G(off)} = 50 \Omega$ $T_j = 125^\circ\text{C}$, $L_s = 170 \text{ nH}$	—	8.2	—	μs
t_f	Turn-off fall time		—	0.5	—	μs
t_{f2}	Turn-off fall time		—	3.1	—	μs
$E_{off(10\%)}$	Turn-off switching energy (Note 5)		—	2.7	—	J/P
V_{EC}	Emitter-collector voltage (Note 2)	$I_E = 400 \text{ A}$ (Note 4) $V_{GE} = 0 \text{ V}$	$T_j = 25^\circ\text{C}$	—	4.0	V
			$T_j = 125^\circ\text{C}$	—	3.6	
t_{rr}	Reverse recovery time (Note 2)	$V_{CC} = 3600 \text{ V}$, $I_E = 400 \text{ A}$ $V_{GE} = \pm 15 \text{ V}$, $R_{G(on)} = 15 \Omega$ $T_j = 125^\circ\text{C}$, $L_s = 170 \text{ nH}$	—	1.0	—	μs
t_{rr2}	Reverse recovery time (Note 2)		—	2.4	—	μs
Q_{rr}	Reverse recovery charge (Note 2)		—	740	—	μC
$E_{rec(10\%)}$	Reverse recovery energy (Note 2), (Note 5)		—	1.4	—	J/P

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THERMAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
$R_{th(j-c)Q}$	Thermal resistance	Junction to Case, IGBT part	—	—	21.0	K/kW
$R_{th(j-c)R}$	Thermal resistance	Junction to Case, FWDi part	—	—	33.0	K/kW
		Junction to Case, Clamp-Di part	—	—	33.0	K/kW
$R_{th(c-f)}$	Contact thermal resistance	Case to Fin, $\lambda_{grease} = 1W/m \cdot K$, $D_{(c-f)} = 100 \mu m$	—	9.0	—	K/kW

MECHANICAL CHARACTERISTICS

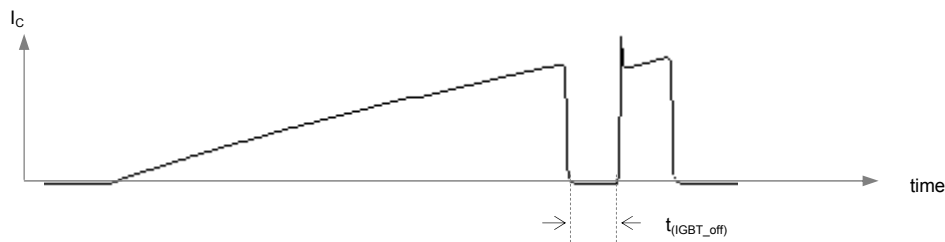
Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
M_t	Mounting torque	M8: Main terminals screw	7.0	—	15.0	N·m
M_s		M6: Mounting screw	3.0	—	6.0	N·m
M_l		M4: Auxiliary terminals screw	1.0	—	3.0	N·m
m	Mass		—	1.35	—	kg
CTI	Comparative tracking index		600	—	—	—
d_a	Clearance		26.0	—	—	mm
d_s	Creepage distance		56.0	—	—	mm
L_{PCE}	Parasitic stray inductance	Collector to Emitter	—	27.0	—	nH
		Anode to Cathode	—	54.0	—	nH
R_{CC+EE}	Internal lead resistance	$T_c = 25^\circ C$, Collector to Emitter	—	0.19	—	mΩ
		$T_c = 25^\circ C$, Anode to Cathode	—	0.38	—	mΩ

Note 1. Pulse width and repetition rate should be such that junction temperature (T_j) does not exceed T_{opmax} rating ($125^\circ C$).

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 ($150^\circ C$).

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. $t_{(IGBT_off)}$ definition is shown as follows.

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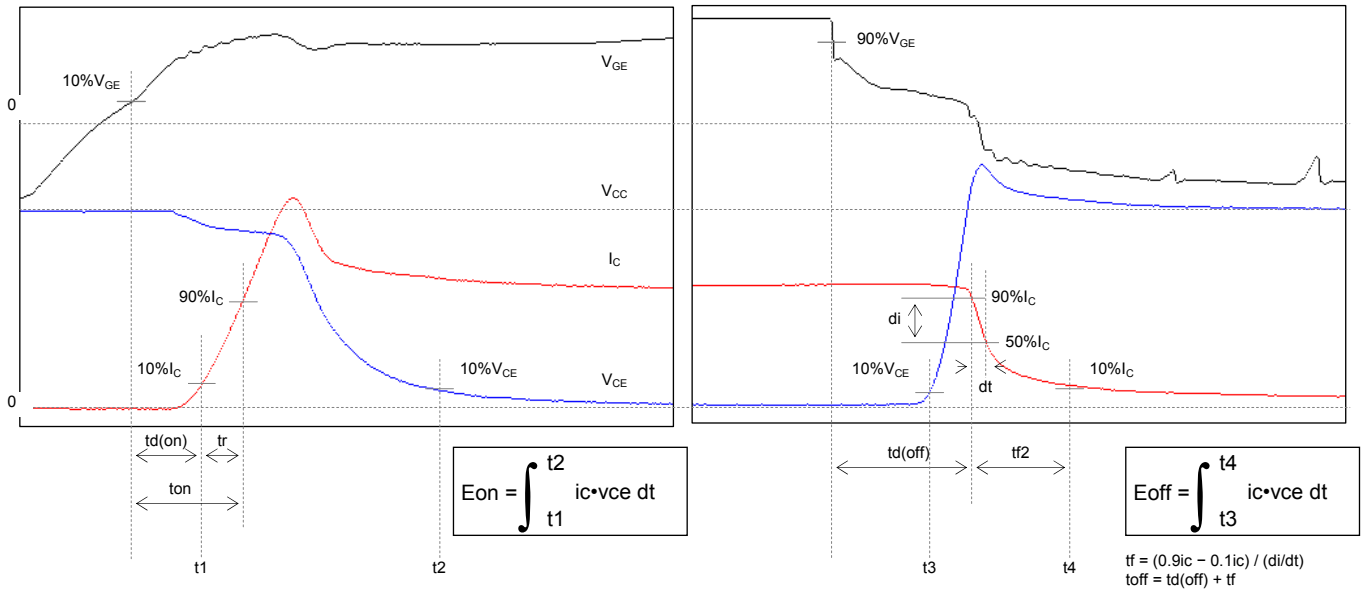


Fig. 2 – Definitions of switching times & energies of IGBT part

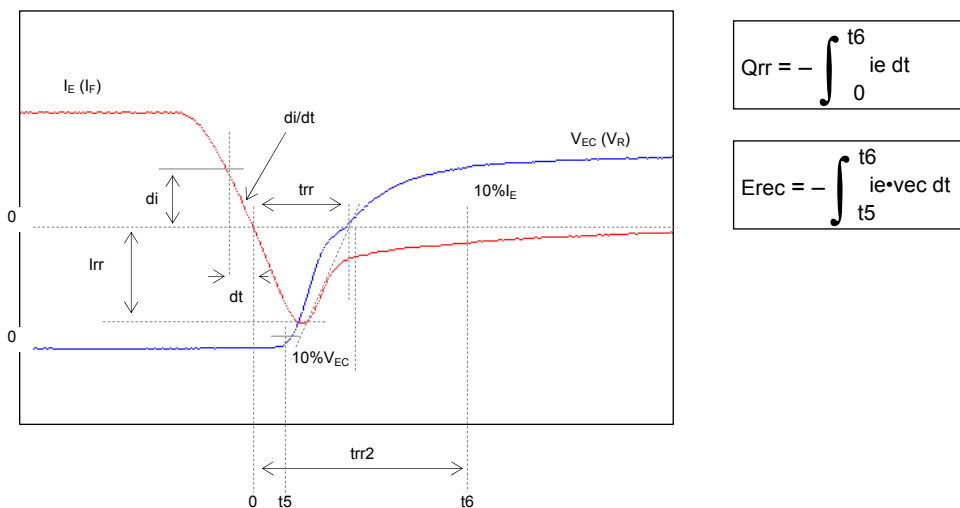


Fig. 3 – Definitions of reverse recovery charge & energy of FWDi part

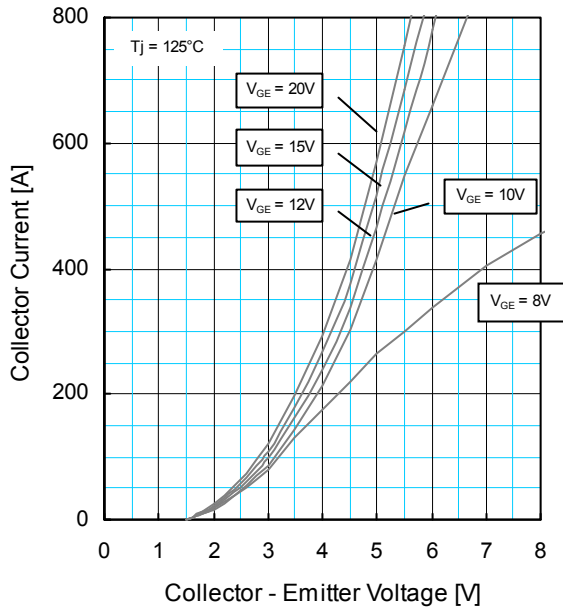
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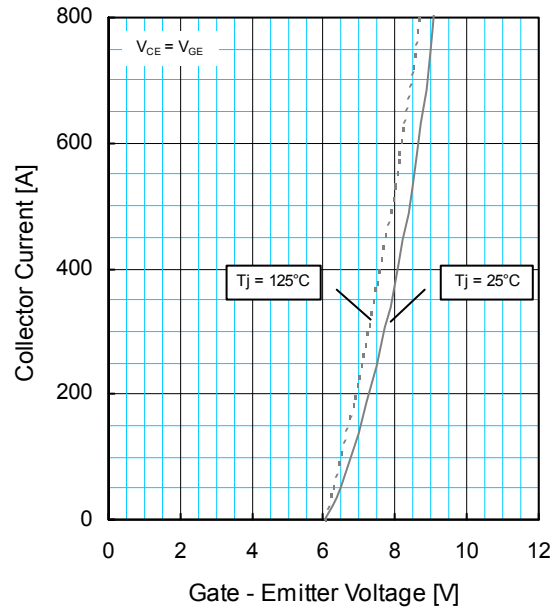
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PERFORMANCE CURVES

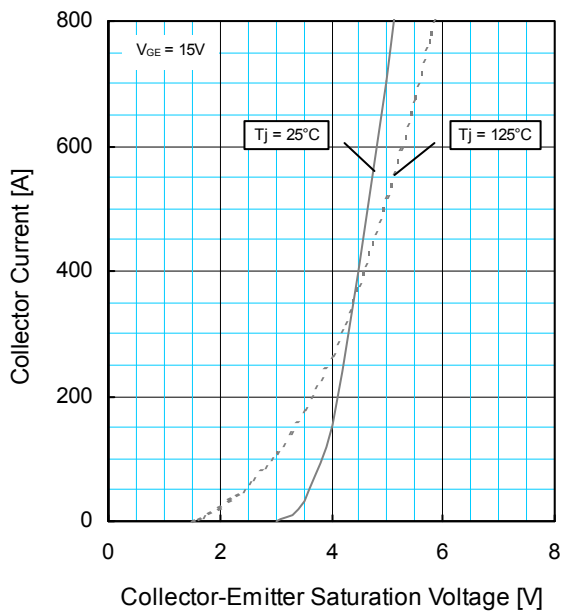
**OUTPUT CHARACTERISTICS
(TYPICAL)**



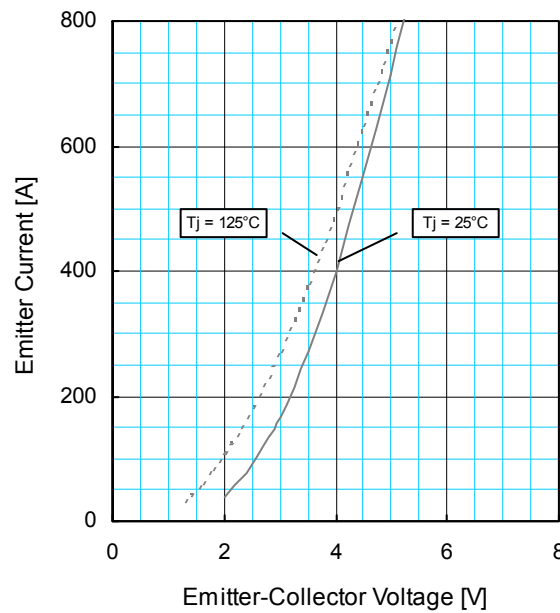
**TRANSFER CHARACTERISTICS
(TYPICAL)**



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



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



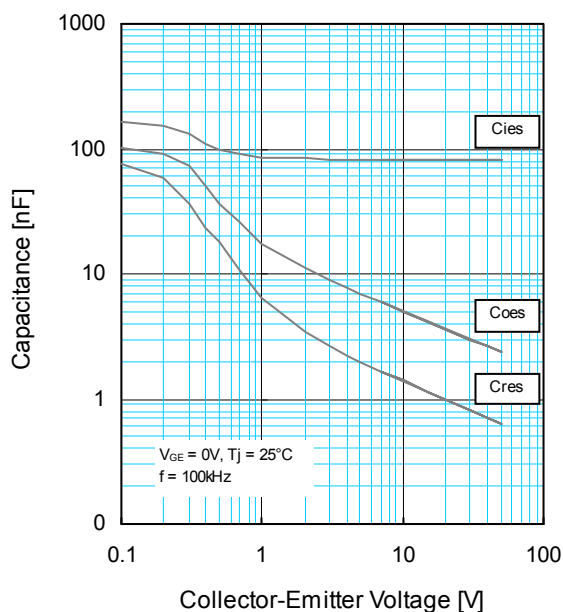
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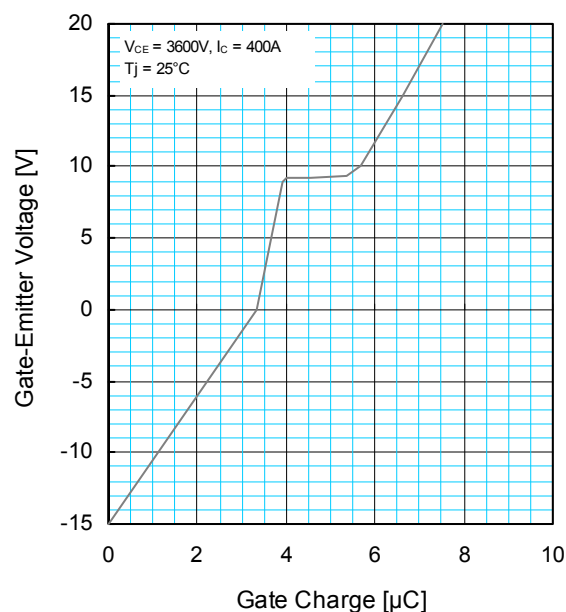
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PERFORMANCE CURVES

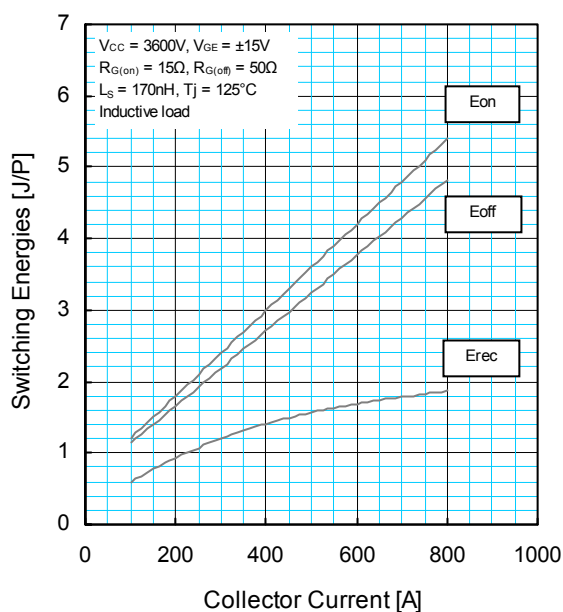
**CAPACITANCE CHARACTERISTICS
(TYPICAL)**



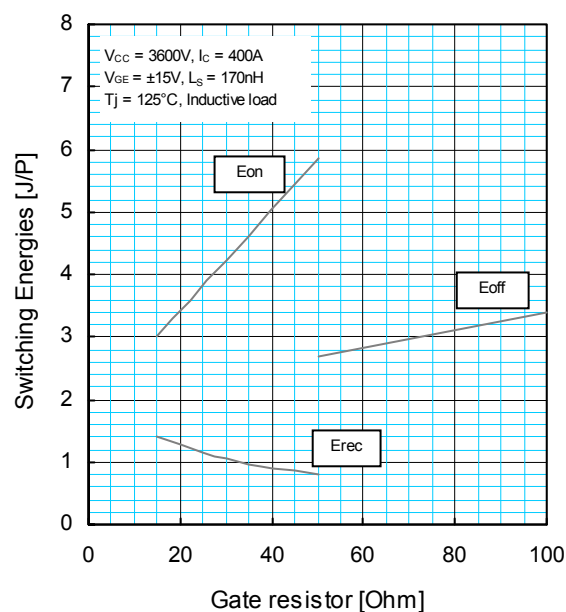
**GATE CHARGE CHARACTERISTICS
(TYPICAL)**



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



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



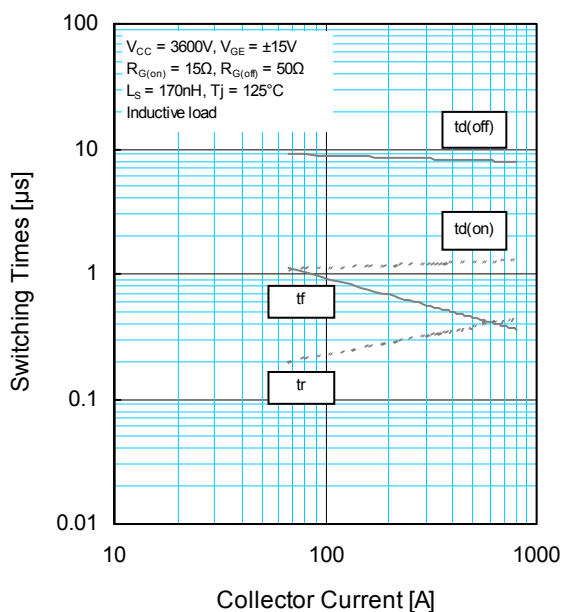
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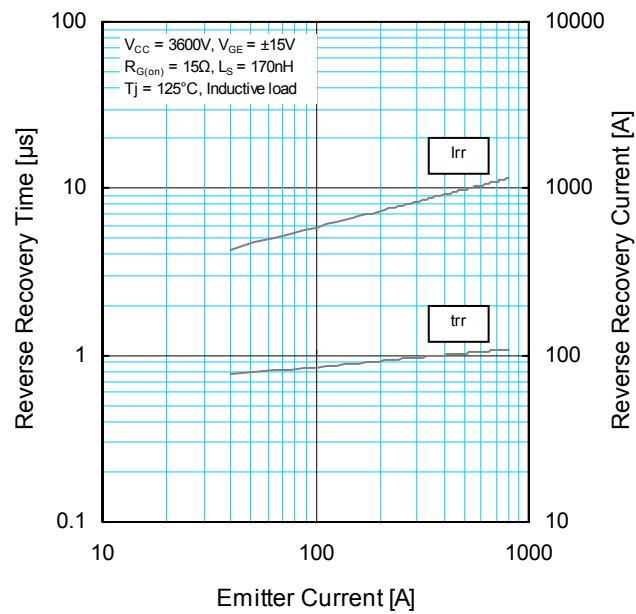
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PERFORMANCE CURVES

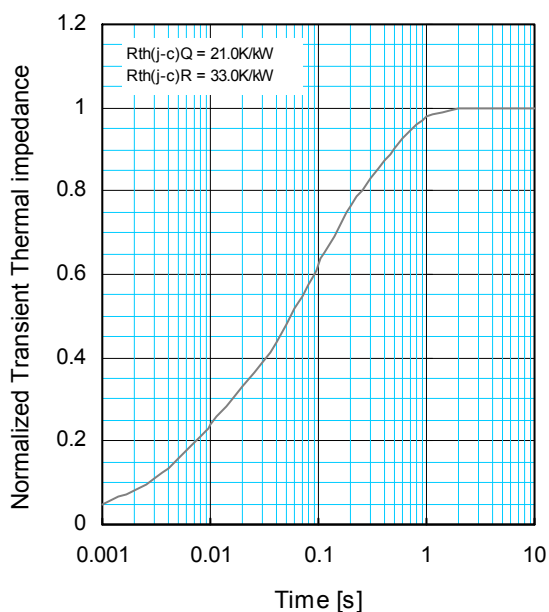
HALF-BRIDGE SWITCHING TIME CHARACTERISTICS (TYPICAL)



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

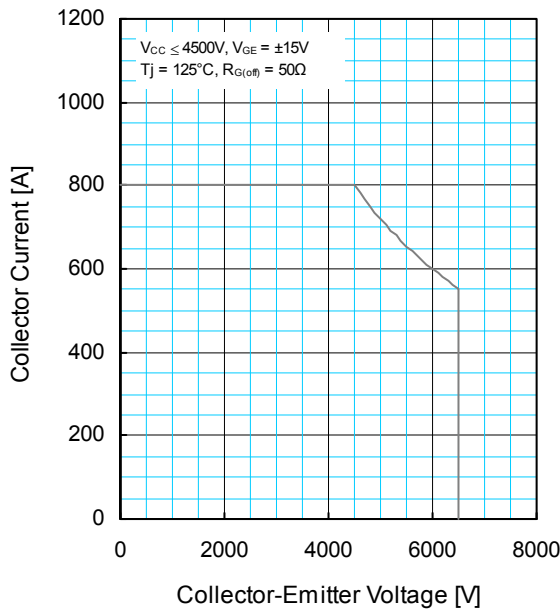
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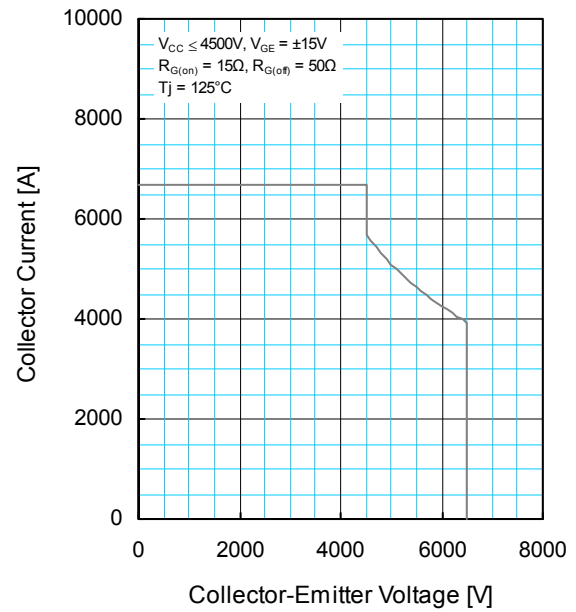
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PERFORMANCE CURVES

REVERSE BIAS SAFE OPERATING AREA (RBSOA)



SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)



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

