

< High Voltage Insulated Gate Bipolar Transistor : HVIGBT >

# CM600DA-66X

HIGH POWER SWITCHING USE  
INSULATED TYPE

5th-Version HVIGBT (High Voltage Insulated Gate Bipolar Transistor) Modules

## CM600DA-66X



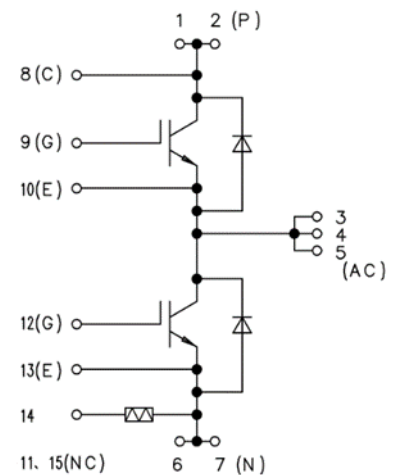
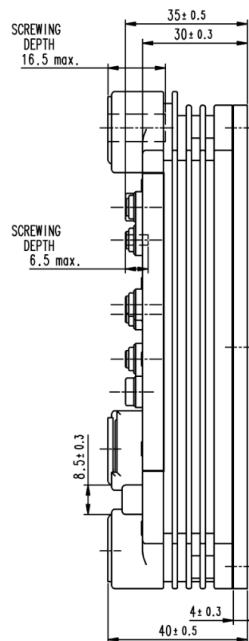
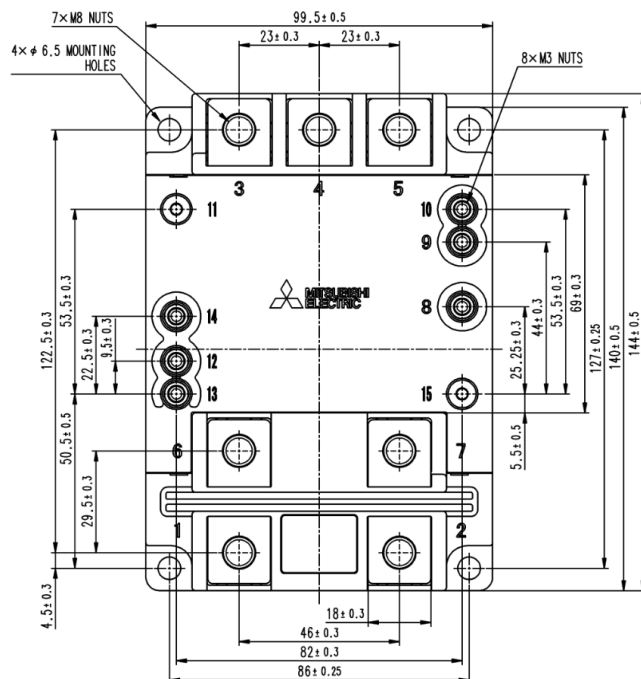
- $I_C$ .....600A
- $V_{CES}$ .....3300V
- 2-elements in a Pack
- Insulated Type
- Al baseplate
- CSTBT™(III) / RFC Diode

## APPLICATION

Traction drives, High Reliability Converters / Inverters, DC choppers

## OUTLINE DRAWING & CIRCUIT DIAGRAM

Dimensions in mm



CIRCUIT DIAGRAM

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**MAXIMUM RATINGS**

Symbol	Item	Conditions	Ratings	Unit
V <sub>CES</sub>	Collector-emitter voltage	V <sub>GE</sub> = 0V, T <sub>j</sub> = -40...+150°C	3300	V
		V <sub>GE</sub> = 0V, T <sub>j</sub> = -50°C	3200	
V <sub>GES</sub>	Gate-emitter voltage	V <sub>CE</sub> = 0V, T <sub>j</sub> = 25°C	± 20	V
I <sub>C</sub>	Collector current	DC, T <sub>c</sub> = 109°C	600	A
I <sub>CRM</sub>		Pulse (Note 1)	1200	A
I <sub>E</sub>	Emitter current (Note 2)	DC, T <sub>c</sub> = 90°C	600	A
I <sub>ERM</sub>		Pulse (Note 1)	1200	A
P <sub>tot</sub>	Maximum power dissipation (Note 3)	T <sub>c</sub> = 25°C, IGBT part	6000	W
V <sub>iso</sub>	Isolation voltage	RMS, sinusoidal, f = 60Hz, t = 1 min., T <sub>c</sub> = 25°C	6000	V
Q <sub>PD</sub>	Partial discharge	Charged part to the baseplate V1 = 3500 Vrms, V2 = 2600 Vrms AC 60 Hz, T <sub>c</sub> = 25 °C (acc. to IEC 61287)	10	pC
V <sub>e</sub>	Partial discharge extinction voltage	RMS, sinusoidal, f = 60Hz, Q <sub>PD</sub> ≤ 10 pC., T <sub>c</sub> = 25°C	2600	V
T <sub>j</sub>	Junction temperature		-50 ~ +150	°C
T <sub>jop</sub>	Operating junction temperature		-50 ~ +150	°C
T <sub>stg</sub>	Storage temperature		-55 ~ +150	°C
t <sub>psc</sub>	Short circuit pulse width	V <sub>CC</sub> = 2400V, V <sub>CE</sub> ≤ V <sub>CES</sub> , V <sub>GE</sub> = 15V, T <sub>j</sub> = 150°C R <sub>g(on)</sub> = 2.2Ω, R <sub>g(off)</sub> = 51Ω, C <sub>GE</sub> = 33nF	10	μs

**ELECTRICAL CHARACTERISTICS**

Symbol	Item	Conditions	Limits			Unit		
			Min	Typ	Max			
I <sub>CES</sub>	Collector cutoff current	V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0V	T <sub>j</sub> = 25°C	—	—	2.0	mA	
			T <sub>j</sub> = 125°C	—	2.0	—		
			T <sub>j</sub> = 150°C	—	20.0	—		
V <sub>GE(th)</sub>	Gate-emitter threshold voltage	V <sub>CE</sub> = 10 V, I <sub>C</sub> = 60 mA, T <sub>j</sub> = 25°C	6.5	7.0	7.5	V		
I <sub>GES</sub>	Gate leakage current	V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0V, T <sub>j</sub> = 25°C	-0.5	—	0.5	μA		
C <sub>ies</sub>	Input capacitance	V <sub>CE</sub> = 10 V, V <sub>GE</sub> = 0 V, f = 100 kHz T <sub>j</sub> = 25°C	—	53.4	—	nF		
C <sub>oes</sub>	Output capacitance		—	3.8	—	nF		
C <sub>res</sub>	Reverse transfer capacitance		—	0.5	—	nF		
Q <sub>G</sub>	Total gate charge	V <sub>CC</sub> = 1800V, I <sub>C</sub> = 600A, V <sub>GE</sub> = ±15V	—	3.6	—	μC		
V <sub>CESat</sub>	Collector-emitter saturation voltage	I <sub>C</sub> = 600 A (Note 4) V <sub>GE</sub> = 15 V	T <sub>j</sub> = 25°C	—	2.30	—	V	
			T <sub>j</sub> = 125°C	—	2.80	3.20		
			T <sub>j</sub> = 150°C	—	2.90	3.30		
t <sub>d(on)</sub>	Turn-on delay time	V <sub>CC</sub> = 1800 V I <sub>C</sub> = 600 A V <sub>GE</sub> = ±15 V R <sub>G(on)</sub> = 2.2 Ω L <sub>s</sub> = 65nH Inductive load	T <sub>j</sub> = 125°C	—	—	1.25	μs	
			T <sub>j</sub> = 150°C	—	—	1.25		
			T <sub>j</sub> = 25°C	—	—	0.50		μs
t <sub>r</sub>	Rise time	V <sub>CC</sub> = 1800 V I <sub>C</sub> = 600 A V <sub>GE</sub> = ±15 V R <sub>G(on)</sub> = 2.2 Ω L <sub>s</sub> = 65nH Inductive load	T <sub>j</sub> = 125°C	—	—	0.50	μs	
			T <sub>j</sub> = 150°C	—	—	0.50		
			T <sub>j</sub> = 25°C	—	0.76	—		J
E <sub>on(10%)</sub>	Turn-on switching energy per pulse (Note 5)	C <sub>GE</sub> = 33 nF	T <sub>j</sub> = 125°C	—	0.92	—	J	
			T <sub>j</sub> = 150°C	—	0.93	—		
			T <sub>j</sub> = 25°C	—	0.82	—		J
E <sub>on</sub>	Turn-on switching energy per pulse (Note 6)	C <sub>GE</sub> = 33 nF	T <sub>j</sub> = 125°C	—	0.99	—	J	
			T <sub>j</sub> = 150°C	—	1.00	—		
			T <sub>j</sub> = 25°C	—	3.40	—		μs
t <sub>d(off)</sub>	Turn-off delay time	V <sub>CC</sub> = 1800 V I <sub>C</sub> = 600 A V <sub>GE</sub> = ±15 V R <sub>G(off)</sub> = 51 Ω L <sub>s</sub> = 65nH Inductive load	T <sub>j</sub> = 125°C	—	3.60	5.00	μs	
			T <sub>j</sub> = 150°C	—	3.65	5.00		
			T <sub>j</sub> = 25°C	—	0.23	—		μs
t <sub>f</sub>	Fall time	V <sub>CC</sub> = 1800 V I <sub>C</sub> = 600 A V <sub>GE</sub> = ±15 V R <sub>G(off)</sub> = 51 Ω L <sub>s</sub> = 65nH Inductive load	T <sub>j</sub> = 125°C	—	0.33	1.00	μs	
			T <sub>j</sub> = 150°C	—	0.35	1.00		
			T <sub>j</sub> = 25°C	—	0.67	—		J
E <sub>off(10%)</sub>	Turn-off switching energy per pulse (Note 5)	C <sub>GE</sub> = 33 nF	T <sub>j</sub> = 125°C	—	0.91	—	J	
			T <sub>j</sub> = 150°C	—	0.92	—		
			T <sub>j</sub> = 25°C	—	0.76	—		J
E <sub>off</sub>	Turn-off switching energy per pulse (Note 6)	C <sub>GE</sub> = 33 nF	T <sub>j</sub> = 125°C	—	1.03	—	J	
			T <sub>j</sub> = 150°C	—	1.04	—		
			T <sub>j</sub> = 25°C	—	1.04	—		

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## ELECTRICAL CHARACTERISTICS (continuation)

Symbol	Item	Conditions	Limits			Unit	
			Min	Typ	Max		
$V_{EC}$	Emitter-collector voltage (Note 2)	$I_E = 600 \text{ A}$ (Note 4) $V_{GE} = 0 \text{ V}$	$T_J = 25^\circ\text{C}$	—	2.10	—	V
			$T_J = 125^\circ\text{C}$	—	2.30	2.80	
			$T_J = 150^\circ\text{C}$	—	2.40	2.90	
$t_{rr}$	Reverse recovery time (Note 2)		$T_J = 25^\circ\text{C}$	—	0.55	—	$\mu\text{s}$
			$T_J = 125^\circ\text{C}$	—	0.65	—	
			$T_J = 150^\circ\text{C}$	—	0.70	—	
$I_{rr}$	Reverse recovery current (Note 2)		$T_J = 25^\circ\text{C}$	—	1170	—	A
			$T_J = 125^\circ\text{C}$	—	1120	—	
			$T_J = 150^\circ\text{C}$	—	1100	—	
$Q_{rr(10\%)}$	Reverse recovery charge (Note 2,7)	$V_{CC} = 1800 \text{ V}$ $I_C = 600 \text{ A}$ $V_{GE} = \pm 15 \text{ V}$ $R_{G(on)} = 2.2 \Omega$ $L_S = 65 \text{ nH}$ Inductive load $C_{GE} = 33 \text{ nF}$	$T_J = 25^\circ\text{C}$	—	620	—	$\mu\text{C}$
			$T_J = 125^\circ\text{C}$	—	740	—	
			$T_J = 150^\circ\text{C}$	—	770	—	
$Q_{rr}$	Reverse recovery charge (Note 2,6)		$T_J = 25^\circ\text{C}$	—	650	—	$\mu\text{C}$
			$T_J = 125^\circ\text{C}$	—	805	—	
			$T_J = 150^\circ\text{C}$	—	845	—	
$E_{rec(10\%)}$	Reverse recovery energy per pulse (Note 2,5)		$T_J = 25^\circ\text{C}$	—	0.66	—	J
			$T_J = 125^\circ\text{C}$	—	0.88	—	
			$T_J = 150^\circ\text{C}$	—	0.91	—	
$E_{rec}$	Reverse recovery energy per pulse (Note 2,6)		$T_J = 25^\circ\text{C}$	—	0.75	—	J
			$T_J = 125^\circ\text{C}$	—	1.01	—	
			$T_J = 150^\circ\text{C}$	—	1.03	—	

## THERMAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
$R_{th(j-c)Q}$	Thermal resistance	Junction to Case, IGBT part, 1/2 module	—	—	20.5	K/kW
$R_{th(j-c)D}$		Junction to Case, FWDi part, per 1/2 module	—	—	34.0	K/kW
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, 1/2 module $\lambda_{grease} = 1\text{W/m}\cdot\text{k}$ , $D_{(c-s)} = 70\mu\text{m}$	—	16.0	—	K/kW

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## NTC THERMISTOR PART

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
R <sub>25</sub>	Zero-power resistance	T <sub>c</sub> =25°C	-	5.00	-	kΩ
B <sub>(25/50)</sub>	B-constant (Note 8)	Approximate by equation	-	3375	-	K

## MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min	Typ	Max	
M <sub>t</sub>	Mounting torque	Main terminals screw M8	7.0	—	14.0	N·m
M <sub>s</sub>		Mounting screw M6	3.0	—	6.0	N·m
M <sub>t</sub>		Auxiliary terminals screw M3	0.4	—	0.8	N·m
m	Mass		—	0.75	—	kg
CTI	Comparative tracking index		600	—	—	—
d <sub>a</sub>	Clearance	Between terminals and baseplate	19.5	—	—	mm
d <sub>s</sub>	Creepage distance	Between terminals and baseplate	32.0	—	—	mm
L <sub>P P-N</sub>	Parasitic stray inductance	Between terminal 1, 2 and terminal 6, 7	—	10.0	—	nH
R <sub>CC+EE'</sub>	Internal lead resistance	T <sub>C</sub> = 25 °C, 1/2 module	—	0.41	—	mΩ
r <sub>g</sub>	Internal gate resistance	T <sub>C</sub> = 25 °C	—	0.83	—	Ω

Note1. Pulse width and repetition rate should be such that junction temperature (T<sub>j</sub>) does not exceed T<sub>jopmax</sub> rating.

- The symbols represent characteristics of the anti-parallel, emitter to collector free-wheel diode (FWD).
- Junction temperature (T<sub>j</sub>) should not exceed T<sub>jmax</sub> rating (150°C).
- Pulse width and repetition rate should be such as to cause negligible temperature rise.
- The integration range of switching energies is from 10%V<sub>CE</sub> to 10%I<sub>C</sub>(10%I<sub>E</sub>).
- Definition of all items is according to IEC 60747, unless otherwise specified.
- The integration range of reverse recovery charge is from I<sub>E</sub> = 0A to 10%I<sub>E</sub>.
- $B_{(25/50)} = \ln \left( \frac{R_{25}}{R_{50}} \right) / \left( \frac{1}{T_{25}} - \frac{1}{T_{50}} \right)$

R<sub>25</sub>: resistance at absolute temperature T<sub>25</sub> [K]; T<sub>25</sub> = 25[°C] + 273.15 = 298.15[K]

R<sub>50</sub>: resistance at absolute temperature T<sub>50</sub> [K]; T<sub>50</sub> = 50[°C] + 273.15 = 323.15[K]

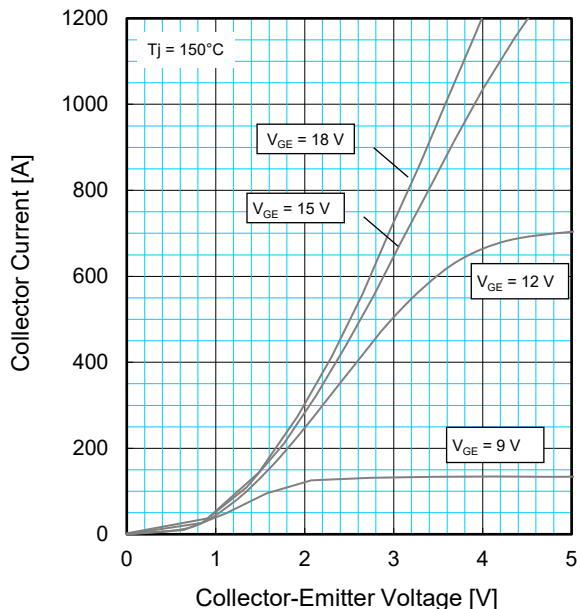
# CM600DA-66X

HIGH POWER SWITCHING USE  
INSULATED TYPE

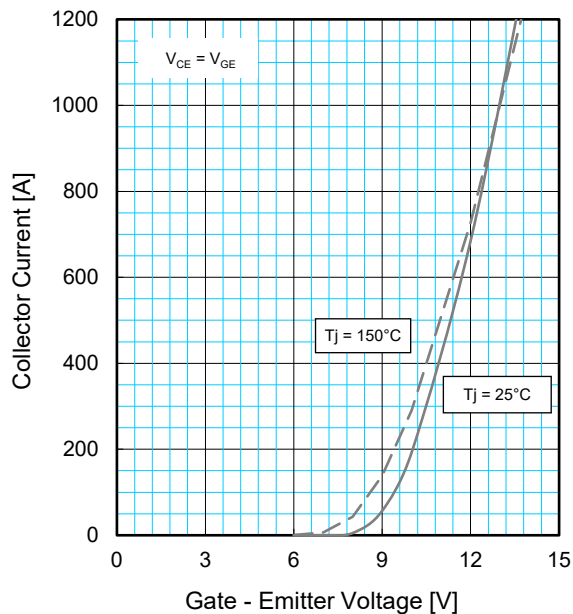
5th-Version HVIGBT (High Voltage Insulated Gate Bipolar Transistor) Modules

## PERFORMANCE CURVES

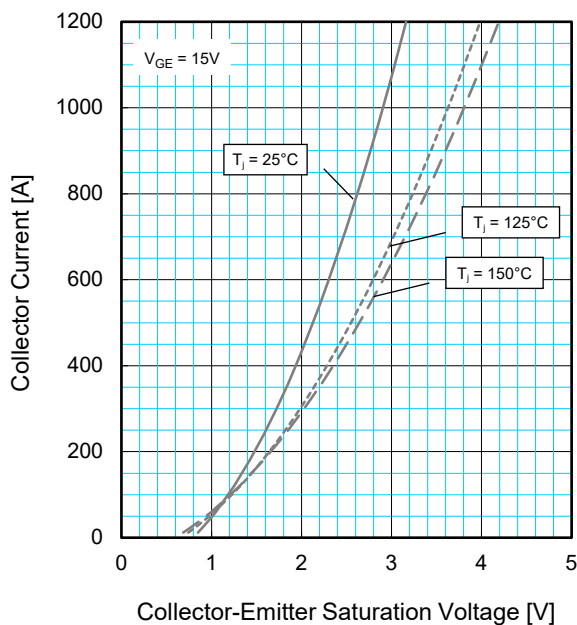
**OUTPUT CHARACTERISTICS (TYPICAL)**



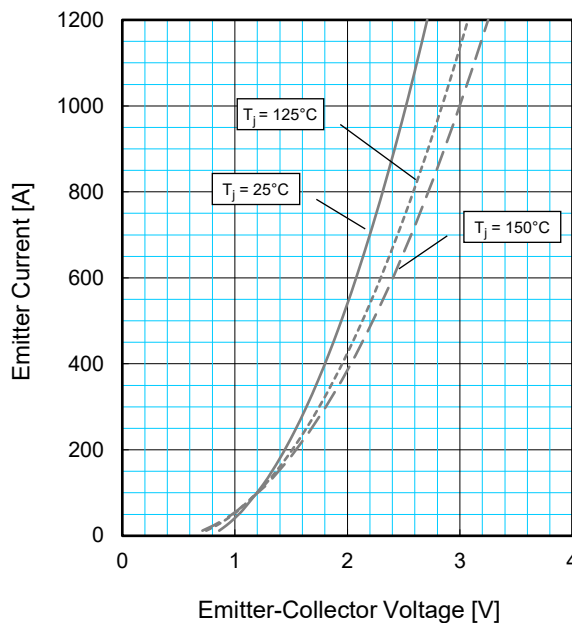
**TRANSFER CHARACTERISTICS (TYPICAL)**



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



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



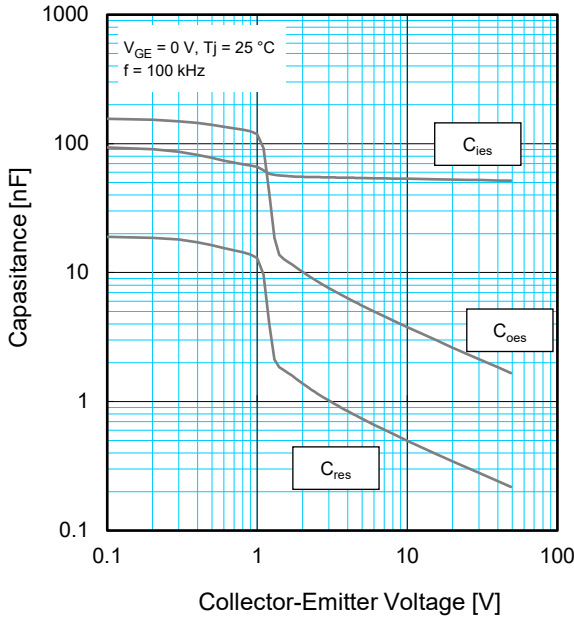
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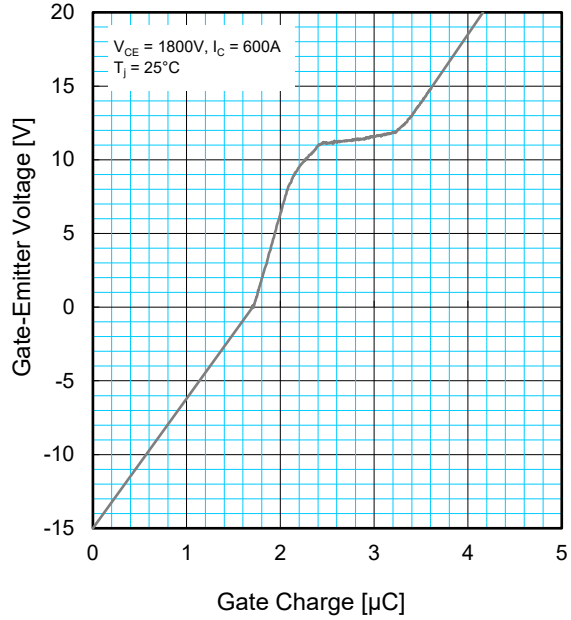
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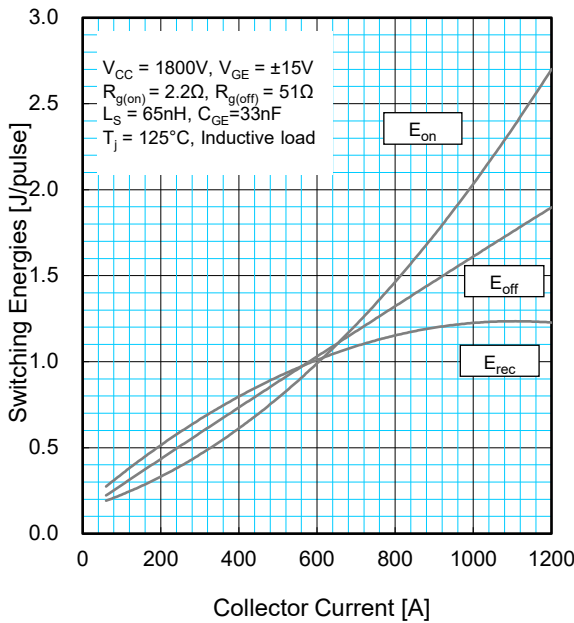
**CAPACITANCE CHARACTERISTICS (TYPICAL)**



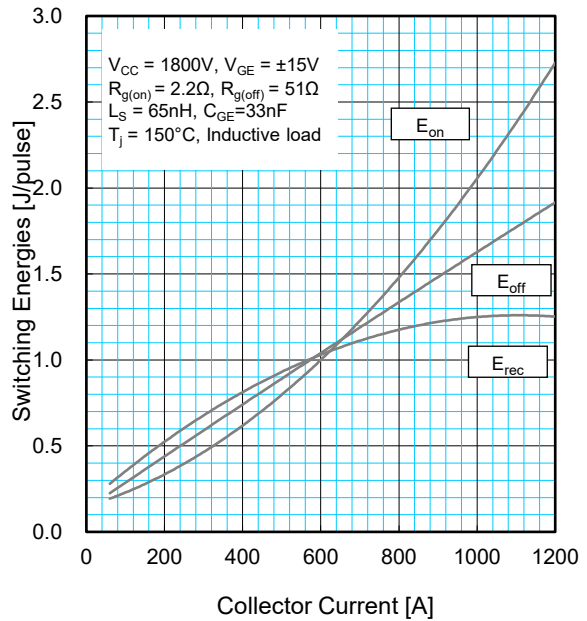
**GATE CHARGE CHARACTERISTICS (TYPICAL)**



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



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



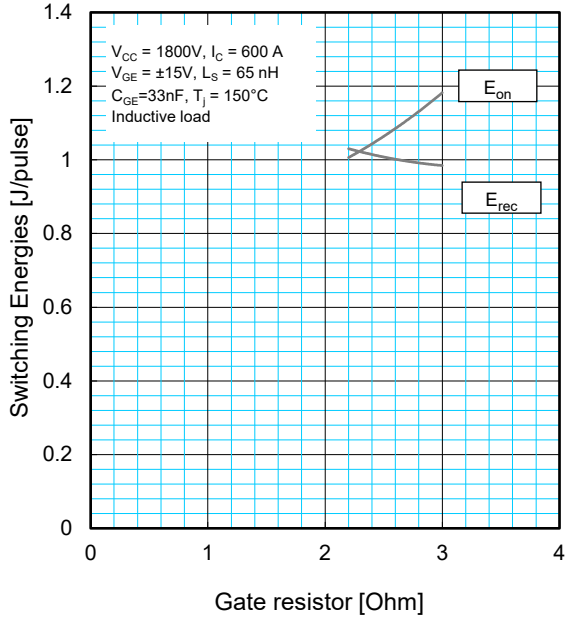
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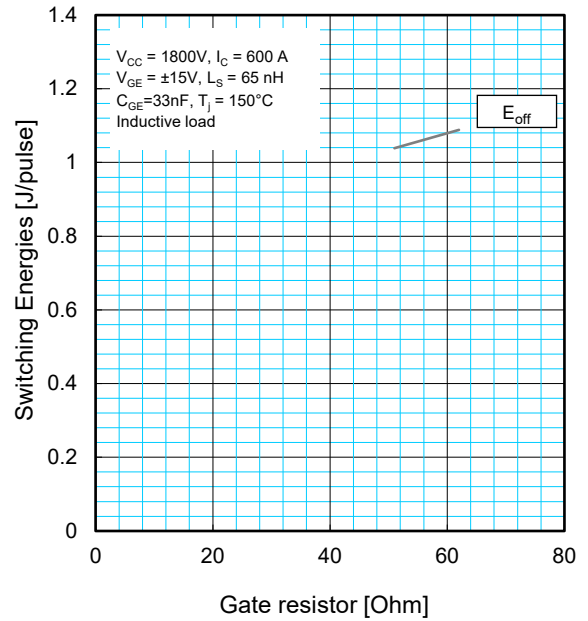
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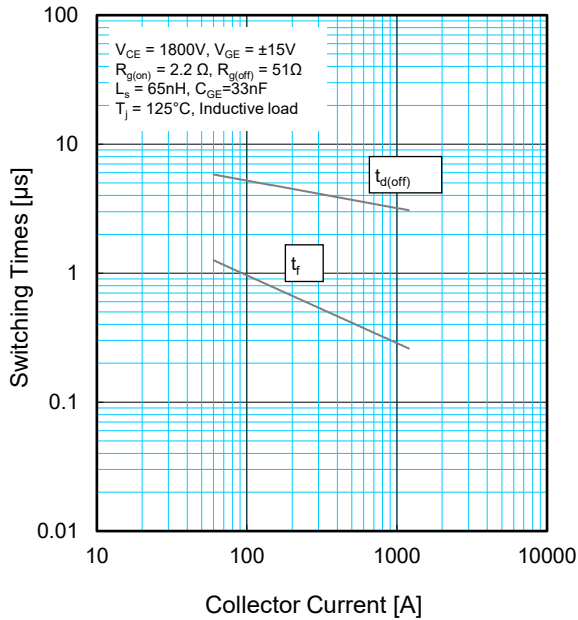
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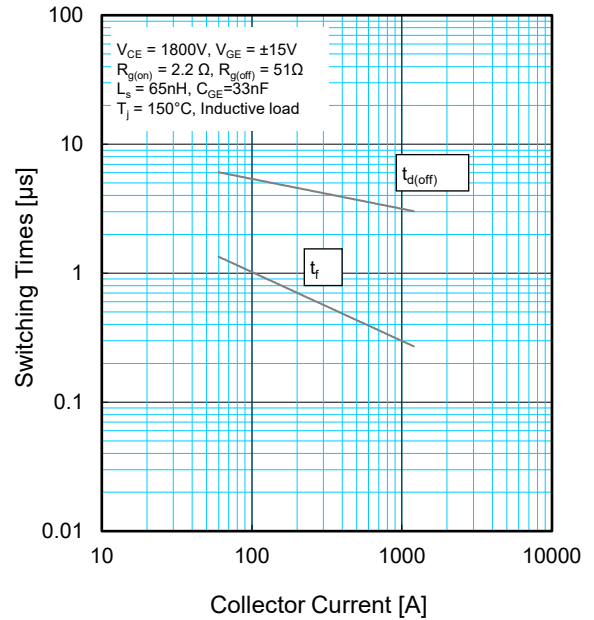
**HALF-BRIDGE SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**



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



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



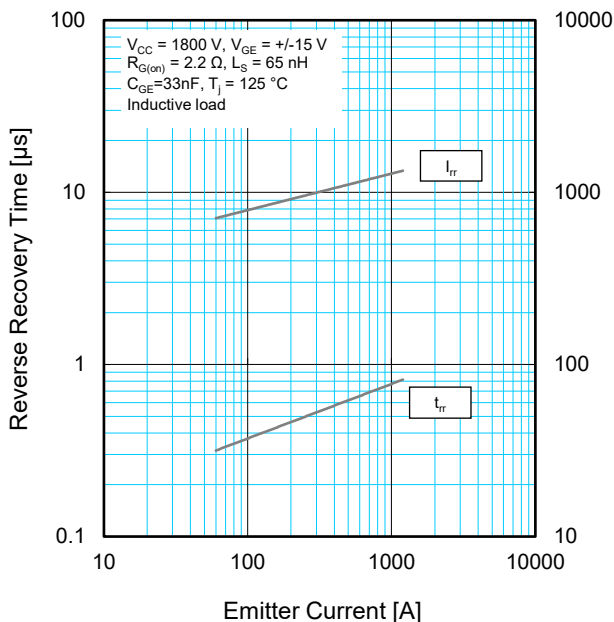
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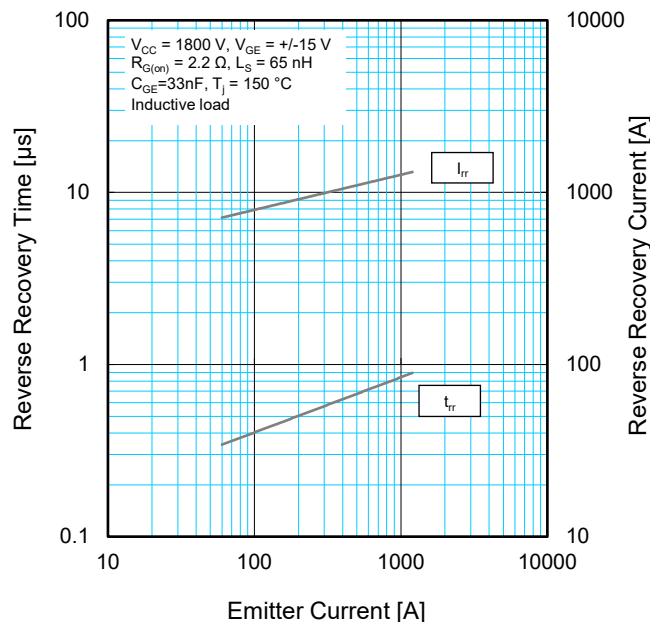
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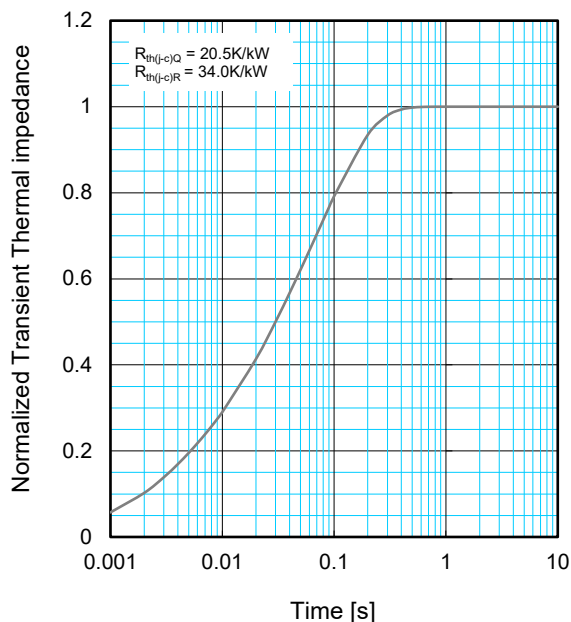
**FREE-WHEEL DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)**



**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
$R_i / R_{th}$ :	0.0292	0.0832	0.2277	0.6599
$\tau_i$ [sec.] :	0.0025	0.0027	0.0155	0.0865



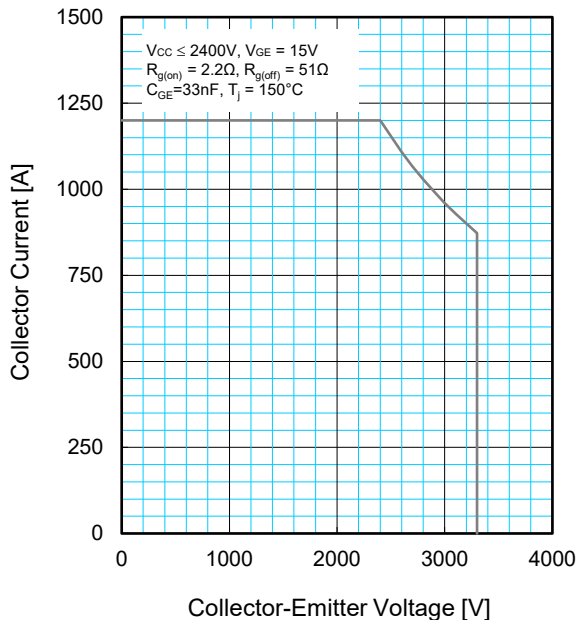
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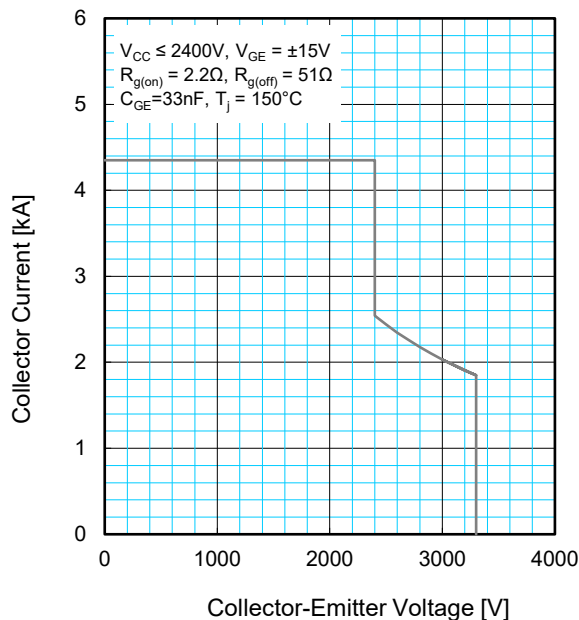
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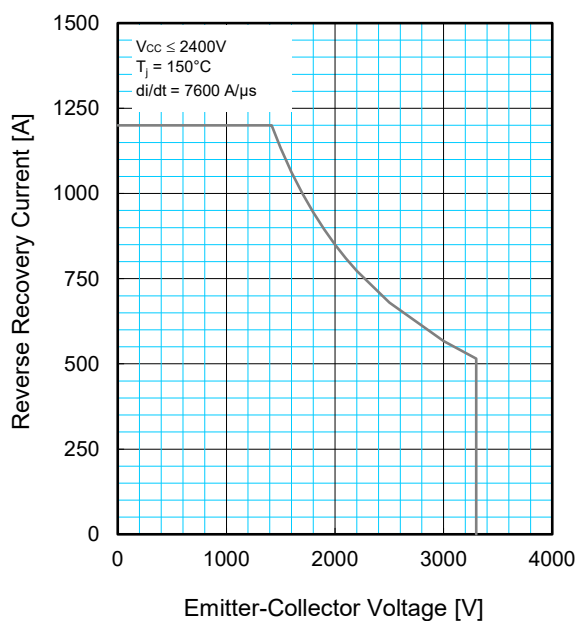
**REVERSE BIAS SAFE OPERATING AREA (RBSOA)**



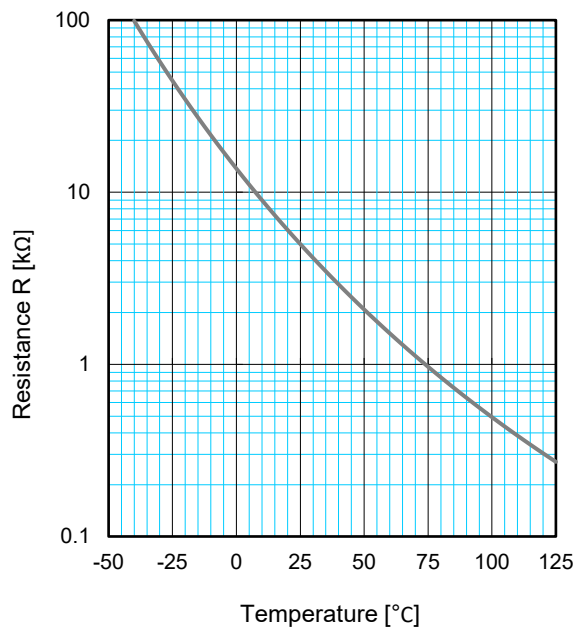
**SHORT CIRCUIT SAFE OPERATING AREA (SCSOA)**



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



**NTC THERMISTOR TEMPERATURE CHARACTERISTICS (TYPICAL)**



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