

<IGBT Modules>

# CM400HA-24A

**HIGH POWER SWITCHING USE  
INSULATED TYPE**



single switch

Collector current  $I_C$  ..... **4 0 0 A**  
 Collector-emitter voltage  $V_{CES}$  ..... **1 2 0 0 V**  
 Maximum junction temperature  $T_{jmax}$  ..... **1 5 0 °C**

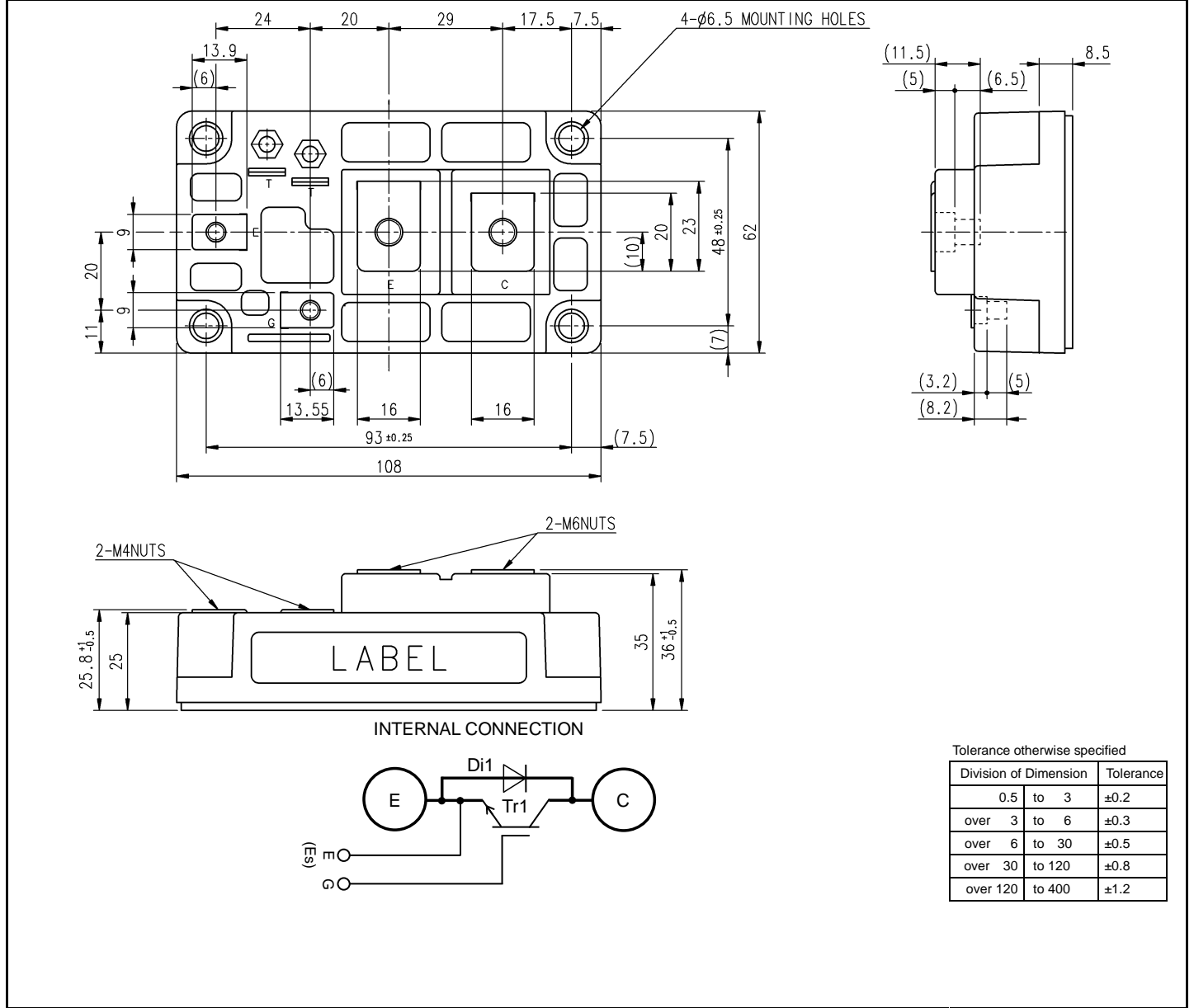
- Flatbase type
- Copper base plate (non-plating)
- Main terminal screws are not attached.
- RoHS Directive compliant
- Recognized under UL1557, File E323585

**APPLICATION**

AC Motor Control, Motion/Servo Control, Power supply, etc.

**OUTLINE DRAWING & INTERNAL CONNECTION**

Dimension in mm



**CM400HA-24A**HIGH POWER SWITCHING USE  
INSULATED TYPE**MAXIMUM RATINGS (T<sub>j</sub>=25 °C, unless otherwise specified)**

Symbol	Item	Conditions	Rating	Unit
V <sub>CES</sub>	Collector-emitter voltage	G-E short-circuited	1200	V
V <sub>GES</sub>	Gate-emitter voltage	C-E short-circuited	± 20	V
I <sub>C</sub>	Collector current	DC, T <sub>C</sub> =87 °C (Note2, 4)	400	A
I <sub>CRM</sub>		Pulse, Repetitive (Note3)	800	
P <sub>tot</sub>	Total power dissipation	T <sub>C</sub> =25 °C (Note2, 4)	2350	W
I <sub>E</sub> (Note1)	Emitter current	DC (Note2)	400	A
I <sub>ERM</sub> (Note1)		Pulse, Repetitive (Note3)	800	
V <sub>isol</sub>	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	2500	V
T <sub>j</sub>	Operating junction temperature	-	-40 ~ +150	°C
T <sub>stg</sub>	Storage temperature	-	-40 ~ +125	

**ELECTRICAL CHARACTERISTICS (T<sub>j</sub>=25 °C, unless otherwise specified)**

Symbol	Item	Conditions	Limits			Unit	
			Min.	Typ.	Max.		
I <sub>CES</sub>	Collector-emitter cut-off current	V <sub>CE</sub> =V <sub>CES</sub> , G-E short-circuited	-	-	1.0	mA	
I <sub>GES</sub>	Gate-emitter leakage current	V <sub>GE</sub> =V <sub>GES</sub> , C-E short-circuited	-	-	1.0	μA	
V <sub>GE(th)</sub>	Gate-emitter threshold voltage	I <sub>C</sub> =40 mA, V <sub>CE</sub> =10 V	6	7	8	V	
V <sub>CEsat</sub>	Collector-emitter saturation voltage	I <sub>C</sub> =400 A, V <sub>GE</sub> =15 V (Note5) Refer to the figure of test circuit	T <sub>j</sub> =25 °C	-	2.1	3.0	V
			T <sub>j</sub> =125 °C	-	2.4	-	
C <sub>ies</sub>	Input capacitance	V <sub>CE</sub> =10 V, G-E short-circuited	-	-	70	nF	
C <sub>oes</sub>	Output capacitance		-	-	6.0		
C <sub>res</sub>	Reverse transfer capacitance		-	-	1.4		
Q <sub>G</sub>	Gate charge	V <sub>CC</sub> =600 V, I <sub>C</sub> =400 A, V <sub>GE</sub> =15 V	-	2.0	-	μC	
t <sub>d(on)</sub>	Turn-on delay time	V <sub>CC</sub> =600 V, I <sub>C</sub> =400 A, V <sub>GE</sub> =±15 V, R <sub>G</sub> =0.78 Ω, Inductive load	-	-	550	ns	
t <sub>r</sub>	Rise time		-	-	180		
t <sub>d(off)</sub>	Turn-off delay time		-	-	600		
t <sub>f</sub>	Fall time		-	-	350		
V <sub>EC</sub> (Note1)	Emitter-collector voltage	I <sub>E</sub> =400 A, G-E short-circuited (Note5) Refer to the figure of test circuit	-	3.0	3.8	V	
t <sub>rr</sub> (Note1)	Reverse recovery time	V <sub>CC</sub> =600 V, I <sub>E</sub> =400 A, V <sub>GE</sub> =±15 V,	-	-	250	ns	
Q <sub>rr</sub> (Note1)	Reverse recovery charge	R <sub>G</sub> =0.78 Ω, Inductive load	-	14.7	-	μC	
E <sub>on</sub>	Turn-on switching energy per pulse	V <sub>CC</sub> =600 V, I <sub>C</sub> =I <sub>E</sub> =400 A,	-	50.4	-	mJ	
E <sub>off</sub>	Turn-off switching energy per pulse	V <sub>GE</sub> =±15 V, R <sub>G</sub> =0.78 Ω, T <sub>j</sub> =125 °C,	-	41.8	-		
E <sub>rr</sub> (Note1)	Reverse recovery energy per pulse	Inductive load	-	20	-	mJ	
r <sub>g</sub>	Internal gate resistance	T <sub>C</sub> =25 °C (Note4)	-	1.5	-	Ω	

**THERMAL RESISTANCE CHARACTERISTICS**

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R <sub>th(j-c)Q</sub>	Thermal resistance	Junction to case, per IGBT (Note4)	-	-	53	K/kW
R <sub>th(j-c)D</sub>		Junction to case, per FWD (Note4)	-	-	80	
R <sub>th(c-s)</sub>	Contact thermal resistance	Case to heat sink, Thermal grease applied (Note4, 6)	-	20	-	K/kW

**MECHANICAL CHARACTERISTICS**

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
M <sub>t</sub>	Mounting torque	Main terminals M 6 screw	1.96	2.45	2.94	N·m
		G/E auxiliary terminals M 4 screw	0.98	1.18	1.47	
M <sub>s</sub>	Mounting torque	Mounting to heat sink M 6 screw	1.96	2.45	2.94	N·m
m	mass	-	-	480	-	g
e <sub>c</sub>	Flatness of base plate	On the centerline X, Y (Note7)	±0	-	+100	μm

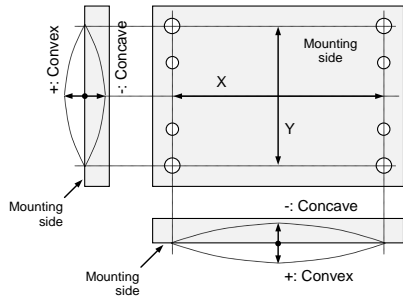
# CM400HA-24A

HIGH POWER SWITCHING USE  
INSULATED TYPE

\*: This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU.

Note1. Represent ratings and characteristics of the anti-parallel, emitter-collector free-wheeling diode (FWD).

2. Junction temperature ( $T_{vj}$ ) should not increase beyond  $T_{vjmax}$  rating.
3. Pulse width and repetition rate should be such that the device junction temperature ( $T_{vj}$ ) dose not exceed  $T_{vjmax}$  rating.
4. Case temperature ( $T_c$ ) and heat sink temperature ( $T_s$ ) are defined on the each surface (mounting side) of base plate and heat sink just under the chips.  
Refer to the figure of chip location.
5. Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.
6. Typical value is measured by using thermally conductive grease of  $\lambda=0.9\text{ W/(m}\cdot\text{K)}$
7. The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.

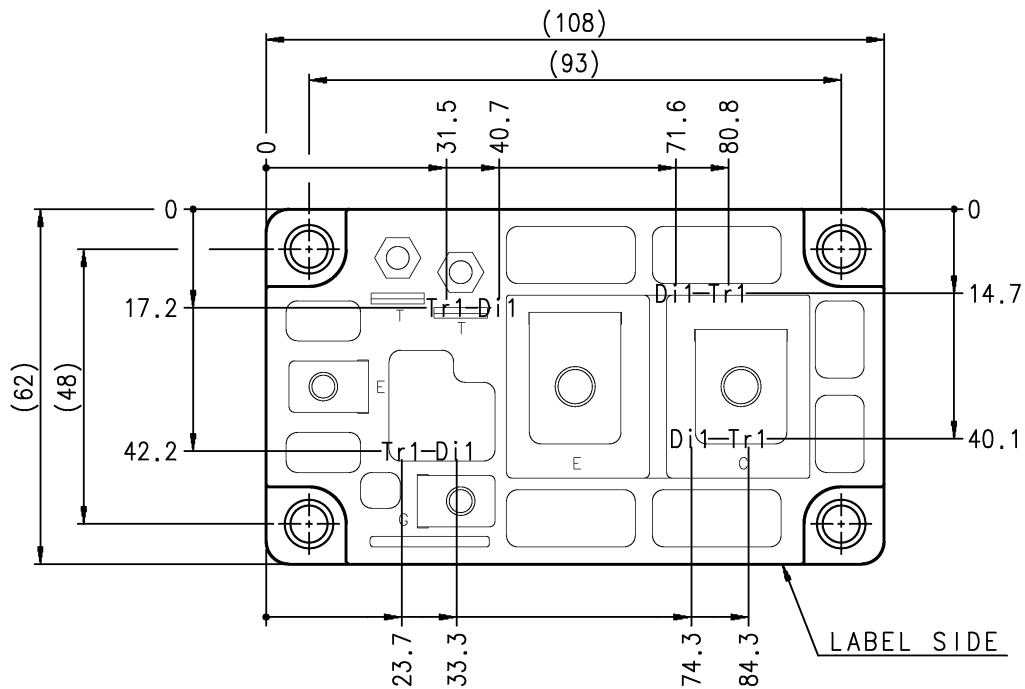


## RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$V_{CC}$	(DC) Supply voltage	Applied across C-E terminals	-	600	800	V
$V_{GEon}$	Gate (-emitter drive) voltage	Applied across G-Es terminals	13.5	15.0	16.5	V
$R_G$	External gate resistance	Per switch	0.78	-	10	$\Omega$

## CHIP LOCATION (Top view)

Dimension in mm, tolerance:  $\pm 1\text{ mm}$

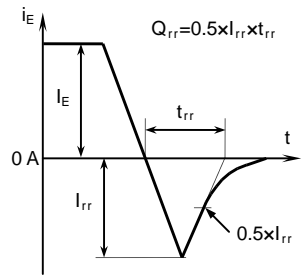
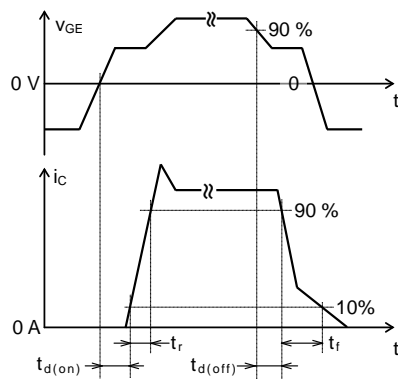
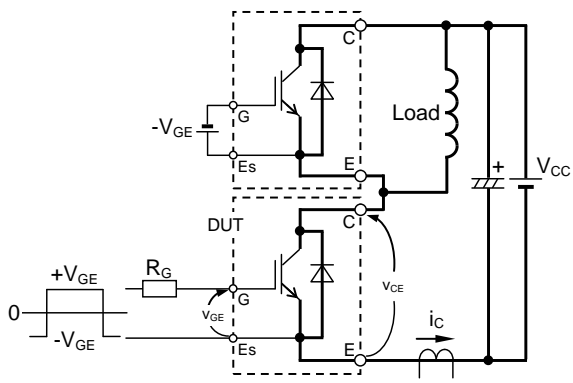


Tr1/Tr2: IGBT, Di1/Di2: FWD

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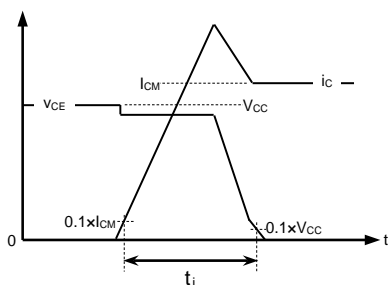
HIGH POWER SWITCHING USE  
INSULATED TYPE

## TEST CIRCUIT AND WAVEFORMS

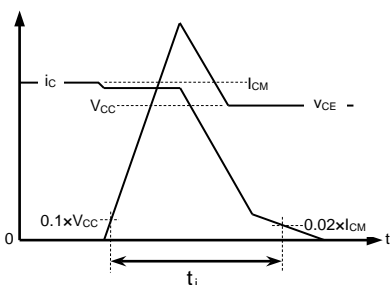


Switching characteristics test circuit and waveforms

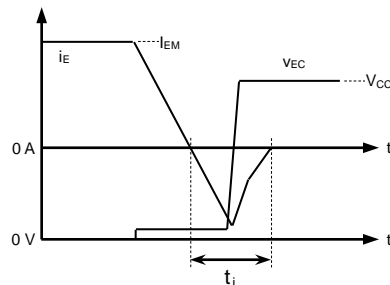
$t_{rr}$ ,  $Q_{rr}$  characteristics test waveform



IGBT Turn-on switching energy



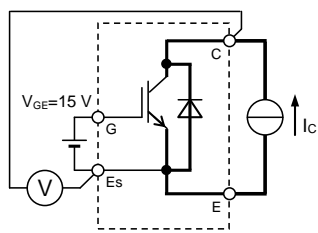
IGBT Turn-off switching energy



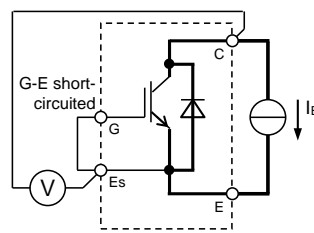
FWD Reverse recovery energy

Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT



$V_{CEsat}$  characteristics test circuit



$V_{EC}$  characteristics test circuit

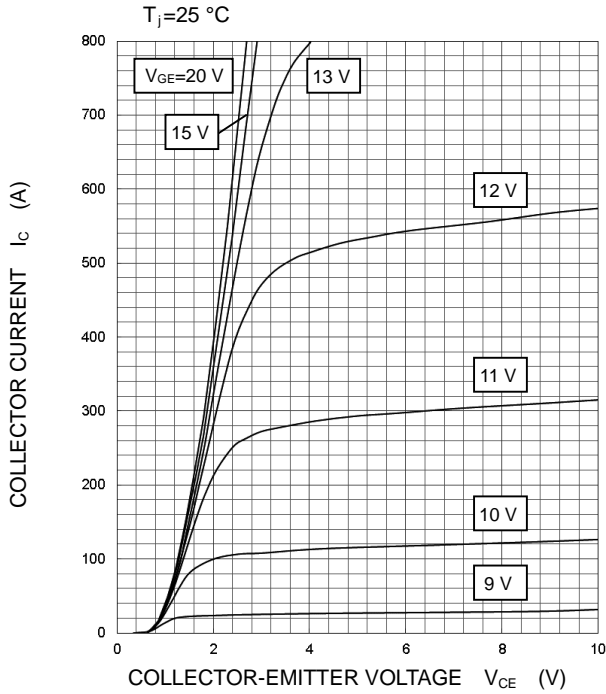
# CM400HA-24A

HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

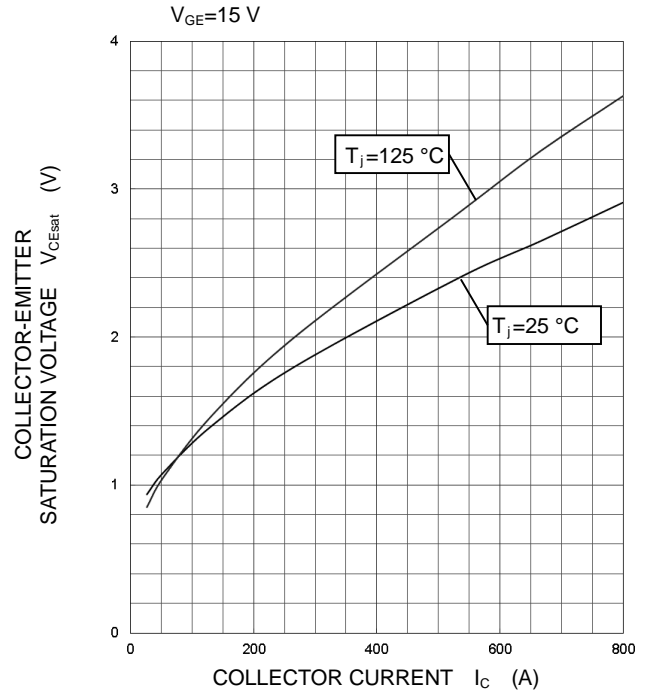
**OUTPUT CHARACTERISTICS**

(TYPICAL)



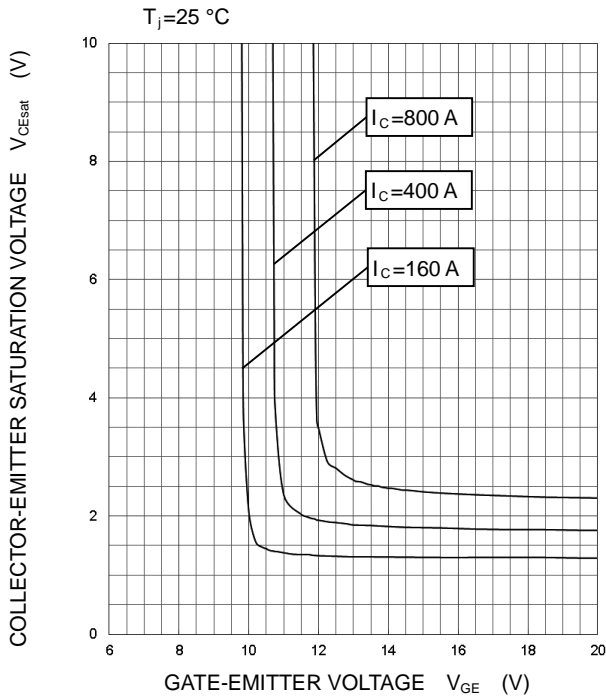
**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS**

(TYPICAL)



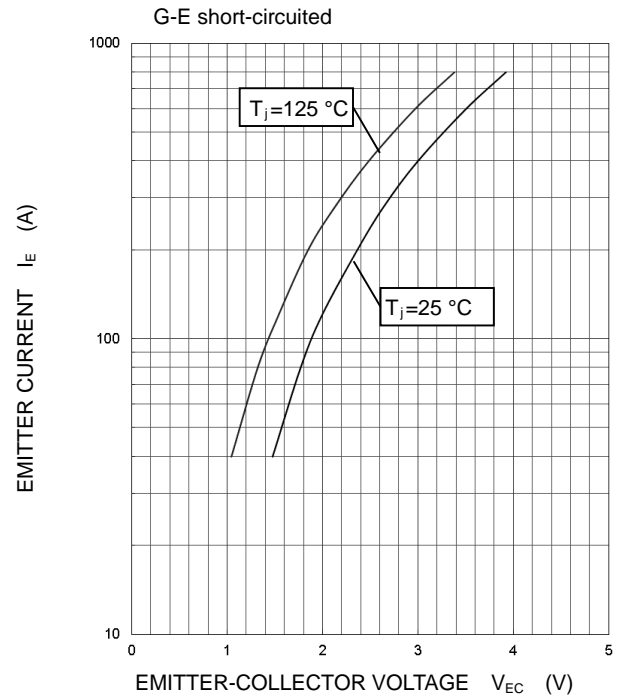
**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS**

(TYPICAL)



**FREE WHEELING DIODE FORWARD CHARACTERISTICS**

(TYPICAL)



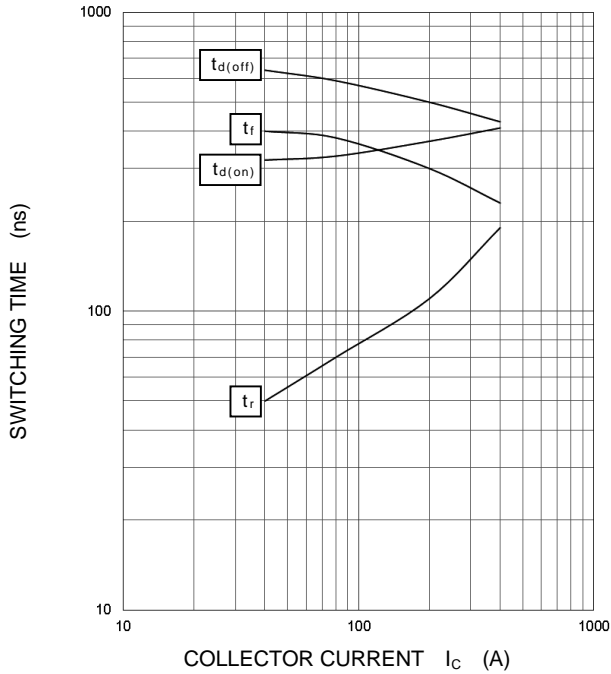
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HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

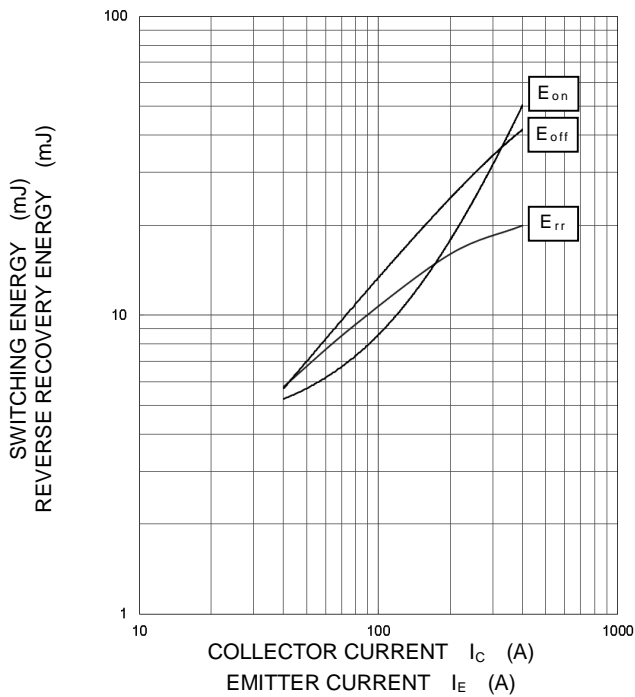
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0.78\ \Omega$ ,  
 $T_j=125\text{ }^\circ\text{C}$ , INDUCTIVE LOAD



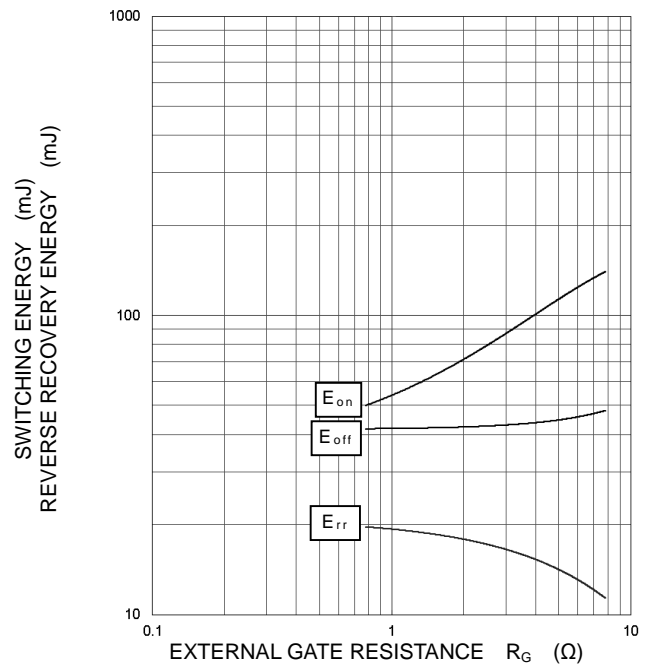
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0.78\ \Omega$ ,  $T_j=125\text{ }^\circ\text{C}$   
INDUCTIVE LOAD, PER PULSE



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

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C/I_E=400\text{ A}$ ,  $T_j=125\text{ }^\circ\text{C}$   
INDUCTIVE LOAD, PER PULSE



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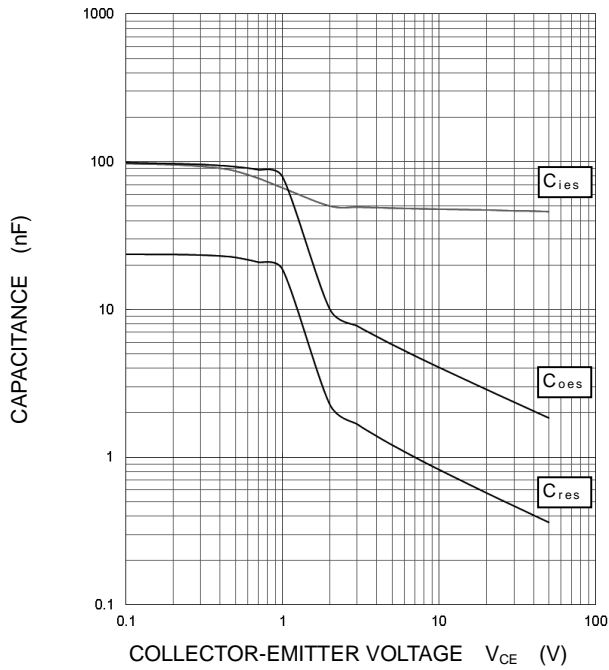
HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

### CAPACITANCE CHARACTERISTICS

(TYPICAL)

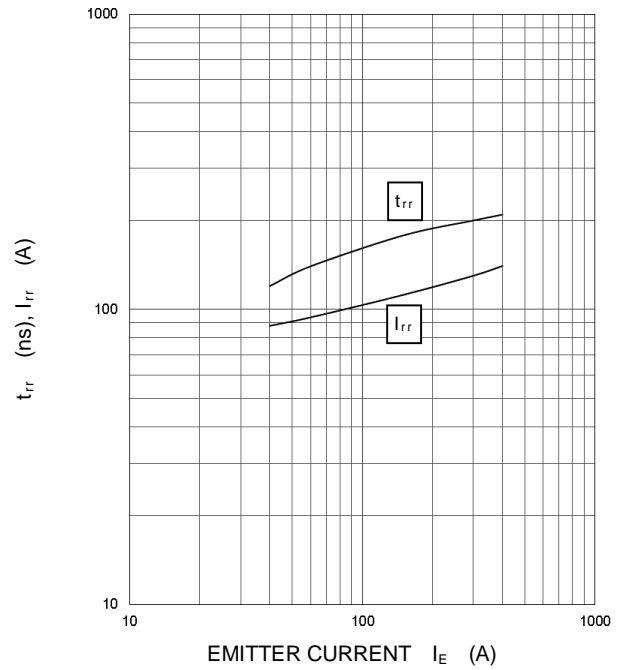
G-E short-circuited,  $T_j=25\text{ }^\circ\text{C}$



### FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS

(TYPICAL)

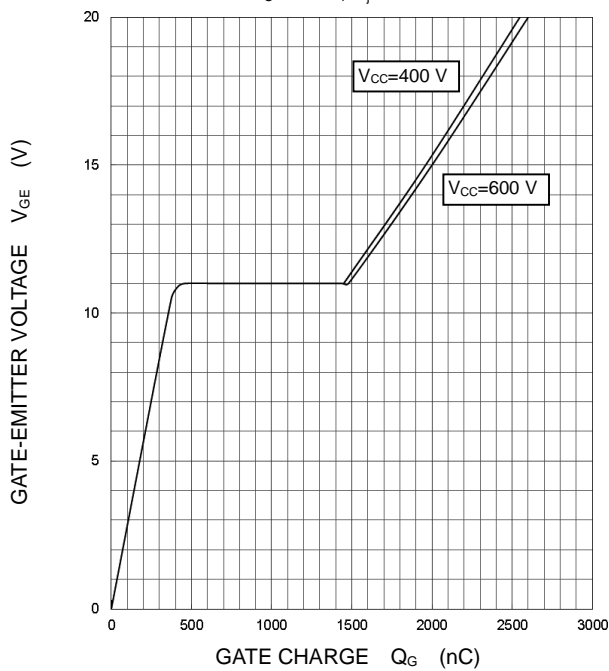
$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0.78\ \Omega$ ,  
 $T_{vj}=125\text{ }^\circ\text{C}$ . INDUCTIVE LOAD



### GATE CHARGE CHARACTERISTICS

(TYPICAL)

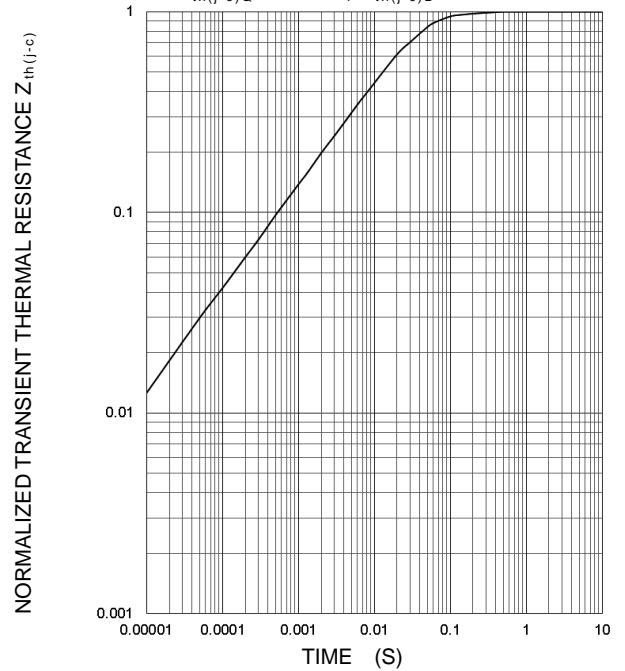
$I_C=400\text{ A}$ ,  $T_j=25\text{ }^\circ\text{C}$



### TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS

(MAXIMUM)

Single pulse,  $T_C=25\text{ }^\circ\text{C}$   
 $R_{th(j-c)Q}=53\text{ K/kW}$ ,  $R_{th(j-c)D}=80\text{ K/kW}$



Note: The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

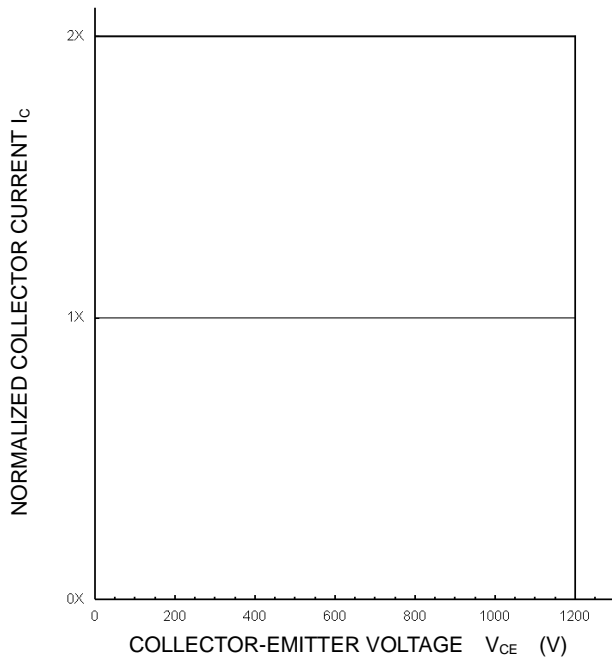
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## PERFORMANCE CURVES

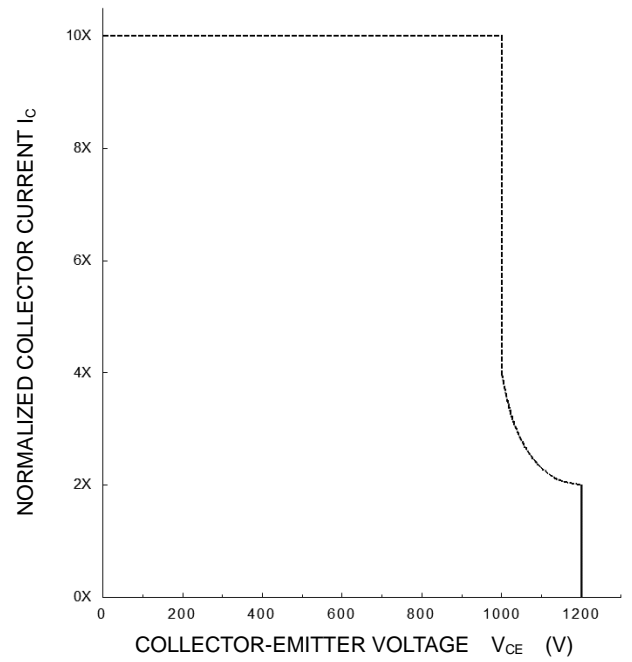
**TURN-OFF SWITCHING SAFE OPERATING AREA  
(REVERSE BIAS SAFE OPERATING AREA)  
(MAXIMUM)**

$V_{CC} \leq 800 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $R_G = 0.78 \sim 10 \ \Omega$ ,  $T_j = 25 \sim 125 \text{ }^\circ\text{C}$



**SHORT-CIRCUIT SAFE OPERATING AREA  
(MAXIMUM)**

$V_{CC} \leq 800 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $R_G = 0.78 \sim 10 \ \Omega$ ,  
 $T_j = 25 \sim 125 \text{ }^\circ\text{C}$ ,  $t_w \leq 10 \ \mu\text{s}$ , Non-Repetitive





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