

<IGBT Modules>

# CM400DY-13T

**HIGH POWER SWITCHING USE  
INSULATED TYPE**



**dual switch (half-bridge)**

Collector current  $I_C$  ..... **4 0 0 A**  
 Collector-emitter voltage  $V_{CES}$  ..... **6 5 0 V**  
 Maximum junction temperature  $T_{vjmax}$  ..... **1 7 5 °C**

- Flat base type
- Nickel-plating tab terminals
- RoHS Directive compliant
- UL Recognized under UL1557, File No.E323585

**APPLICATION**

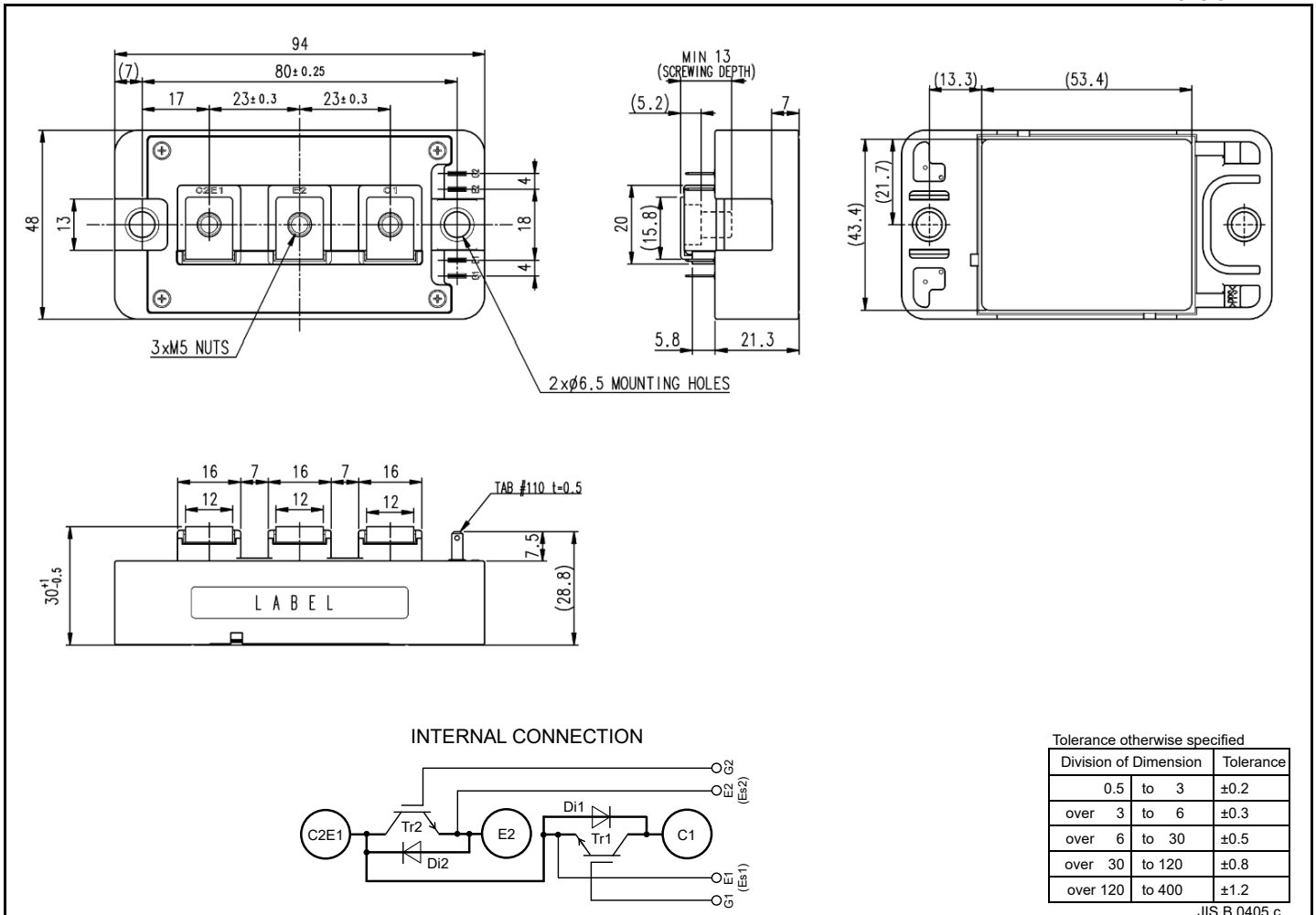
AC Motor Control, Motion/Servo Control, Power supply, etc.

**OPTION** (Below options are available.)

- PC-TIM (Phase Change Thermal Interface Material) pre-apply
- $V_{CESat}$  selection for parallel connection

**OUTLINE DRAWING & INTERNAL CONNECTION**

Dimension in mm



Tolerance otherwise specified		
Division of Dimension		Tolerance
0.5	to 3	±0.2
over 3	to 6	±0.3
over 6	to 30	±0.5
over 30	to 120	±0.8
over 120	to 400	±1.2

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**CM400DY-13T**HIGH POWER SWITCHING USE  
INSULATED TYPE**MAXIMUM RATINGS (T<sub>vj</sub>=25 °C, unless otherwise specified)**

Symbol	Item	Conditions	Rating	Unit
V <sub>CES</sub>	Collector-emitter voltage	G-E short-circuited	650	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> =140 °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)	2830	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	4000	V
T <sub>vjmax</sub>	Maximum junction temperature	Instantaneous event (overload) (Note8)	175	°C
T <sub>Cmax</sub>	Maximum case temperature	(Note4,8)	150*	
T <sub>vjop</sub>	Operating junction temperature	Continuous operation (under switching) (Note8)	-40 ~ +150	°C
T <sub>stg</sub>	Storage temperature	-	-40 ~ +150*	

**ELECTRICAL CHARACTERISTICS (T<sub>vj</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	-	-	0.5	μA	
V <sub>GE(th)</sub>	Gate-emitter threshold voltage	I <sub>C</sub> =40 mA, V <sub>CE</sub> =10 V	5.4	6.0	6.6	V	
V <sub>CEsat</sub> (Terminal)	Collector-emitter saturation voltage	I <sub>C</sub> =400 A, V <sub>GE</sub> =15 V, Refer to the figure of test circuit (Note5)	T <sub>vj</sub> =25 °C	-	1.45	1.75	V
V <sub>CEsat</sub> (Chip)			T <sub>vj</sub> =125 °C	-	1.55	-	
			T <sub>vj</sub> =150 °C	-	1.60	-	
	V <sub>CEsat</sub> (Chip)	I <sub>C</sub> =400 A, V <sub>GE</sub> =15 V, (Note5)	T <sub>vj</sub> =25 °C	-	1.30	1.55	V
T <sub>vj</sub> =125 °C			-	1.35	-		
T <sub>vj</sub> =150 °C			-	1.35	-		
C <sub>ies</sub>	Input capacitance	V <sub>CE</sub> =10 V, G-E short-circuited	-	-	53.5	nF	
C <sub>oes</sub>	Output capacitance		-	-	2.6		
C <sub>res</sub>	Reverse transfer capacitance		-	-	1.0		
Q <sub>G</sub>	Gate charge	V <sub>CC</sub> =300 V, I <sub>C</sub> =400 A, V <sub>GE</sub> =15 V	-	1.65	-	μC	
t <sub>d(on)</sub>	Turn-on delay time	V <sub>CC</sub> =300 V, I <sub>C</sub> =400 A, V <sub>GE</sub> =±15 V, R <sub>G</sub> =1.6 Ω, Inductive load	-	-	400	ns	
t <sub>r</sub>	Rise time		-	-	200		
t <sub>d(off)</sub>	Turn-off delay time		-	-	400		
t <sub>f</sub>	Fall time		-	-	400		
V <sub>EC</sub> (Note.1) (Terminal)	Emitter-collector voltage	I <sub>E</sub> =400 A, G-E short-circuited, Refer to the figure of test circuit (Note5)	T <sub>vj</sub> =25 °C	-	2.10	2.90	V
V <sub>EC</sub> (Note.1) (Chip)			T <sub>vj</sub> =125 °C	-	2.05	-	
			T <sub>vj</sub> =150 °C	-	2.05	-	
	V <sub>EC</sub> (Note.1) (Chip)	I <sub>E</sub> =400 A, G-E short-circuited, (Note5)	T <sub>vj</sub> =25 °C	-	1.90	2.65	V
T <sub>vj</sub> =125 °C			-	1.80	-		
T <sub>vj</sub> =150 °C			-	1.80	-		
t <sub>rr</sub> (Note1)	Reverse recovery time	V <sub>CC</sub> =300 V, I <sub>E</sub> =400 A, V <sub>GE</sub> =±15 V, R <sub>G</sub> =1.6 Ω, Inductive load	-	-	200	ns	
Q <sub>rr</sub> (Note1)	Reverse recovery charge	R <sub>G</sub> =1.6 Ω, Inductive load	-	14	-	μC	
E <sub>on</sub>	Turn-on switching energy per pulse	V <sub>CC</sub> =300 V, I <sub>C</sub> =I <sub>E</sub> =400 A, V <sub>GE</sub> =±15 V, R <sub>G</sub> =1.6 Ω, T <sub>vj</sub> =150 °C,	-	4.5	-	mJ	
E <sub>off</sub>	Turn-off switching energy per pulse	Inductive load	-	21.6	-		
E <sub>rr</sub> (Note1)	Reverse recovery energy per pulse	Inductive load	-	9.0	-	mJ	
R <sub>CC'+EE'</sub>	Internal lead resistance	Main terminals-chip, per switch, T <sub>C</sub> =25 °C (Note4)	-	0.3	-	mΩ	
r <sub>g</sub>	Internal gate resistance	Per switch	-	1.5	-	Ω	

\*: The value of PC-TIM applied module is limited by the heat resistant temperature of PC-TIM.

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HIGH POWER SWITCHING USE  
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## THERMAL RESISTANCE CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance	Junction to case, per Inverter IGBT (Note4)	-	-	53	K/kW
$R_{th(j-c)D}$		Junction to case, per Inverter FWD (Note4)	-	-	84	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, per 1 module Thermal grease applied (Note4,6,8)	-	24	-	K/kW

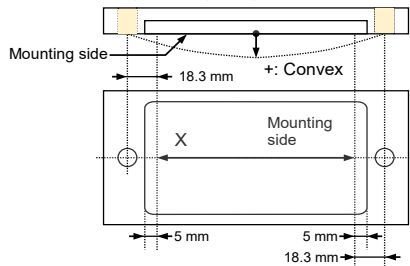
## MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$M_t$	Mounting torque	Main terminals M 5 screw	2.5	3.0	3.5	N·m
$M_s$	Mounting torque	Mounting to heat sink M 6 screw	3.5	4.0	4.5	N·m
$d_s$	Creepage distance	Terminal to terminal	18	-	-	mm
		Terminal to base plate	21.1	-	-	
$d_a$	Clearance	Terminal to terminal	9.6	-	-	mm
		Terminal to base plate	16.7	-	-	
$e_c$	Flatness of base plate	On the centerline (Note7)	$\pm 0$	-	+200	$\mu\text{m}$
$m$	mass	-	-	155	-	g

\*. This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU and (EU) 2015/863.

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

- Junction temperature ( $T_{vj}$ ) should not increase beyond  $T_{vjmax}$  rating.
- Pulse width and repetition rate should be such that the device junction temperature ( $T_{vj}$ ) does not exceed  $T_{vjmax}$  rating.
- 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.
- Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.
- Typical value is measured by using thermally conductive grease of  $\lambda=3.0 \text{ W}/(\text{m}\cdot\text{K})/D_{(c-s)}=50 \mu\text{m}$ .
- The base plate (mounting side) flatness measurement points (X) are shown in the following figure.



- Long term performance related to thermal conductive grease and (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under your specific application conditions. Each temperature condition ( $T_{vjmax}$ ,  $T_{vjop}$ ,  $T_{cmax}$ ) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

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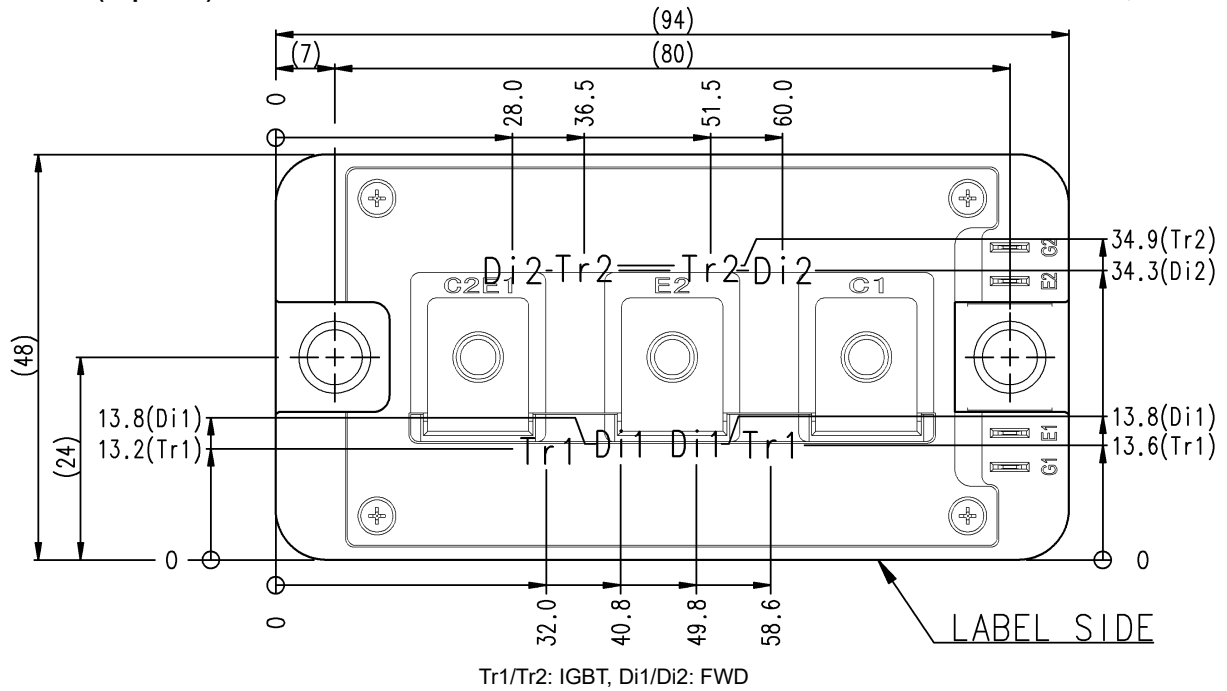
HIGH POWER SWITCHING USE  
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## RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V <sub>CC</sub>	(DC) Supply voltage	Applied across C1-E2 terminals	-	300	450	V
V <sub>GEon</sub>	Gate (-emitter drive) voltage	Applied across G1-Es1/G2-Es2 terminals	13.5	15.0	16.5	V
R <sub>G</sub>	External gate resistance	Per switch	1.6	-	16	Ω

## CHIP LOCATION (Top view)

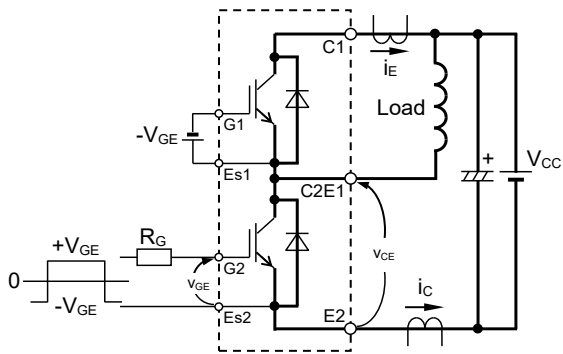
Dimension in mm, tolerance: ±1 mm



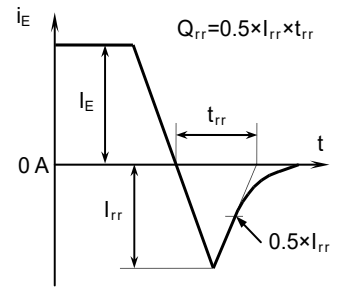
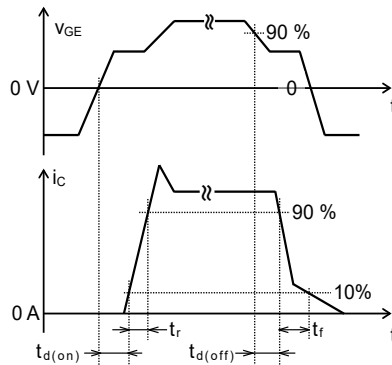
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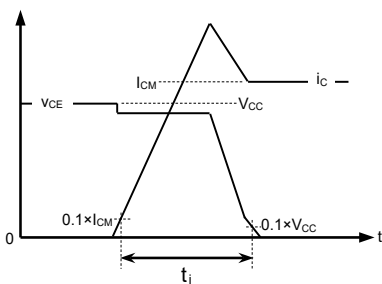
## TEST CIRCUIT AND WAVEFORMS



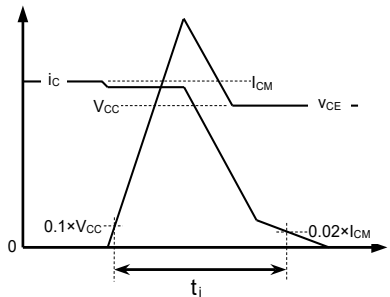
Switching characteristics test circuit and waveforms



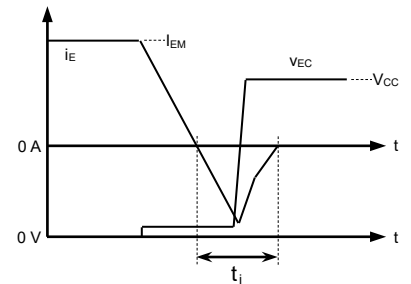
$t_{rr}$ ,  $Q_{rr}$  characteristics test waveform



IGBT Turn-on switching energy



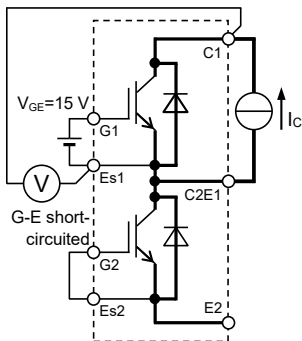
IGBT Turn-off switching energy



FWD Reverse recovery energy

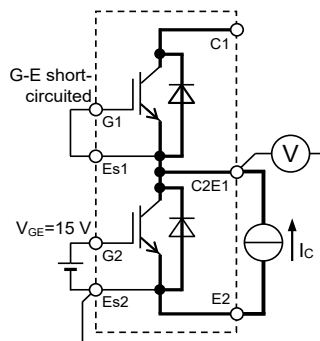
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT

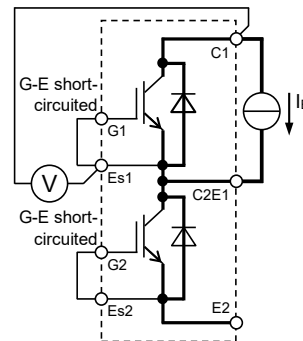


Tr1

$V_{CEsat}$  characteristics test circuit

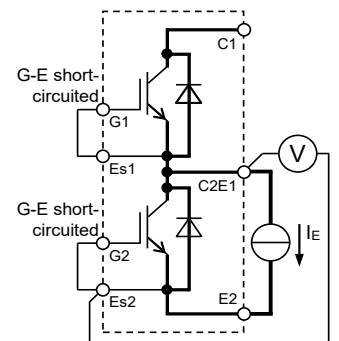


Tr2



Di1

$V_{EC}$  characteristics test circuit



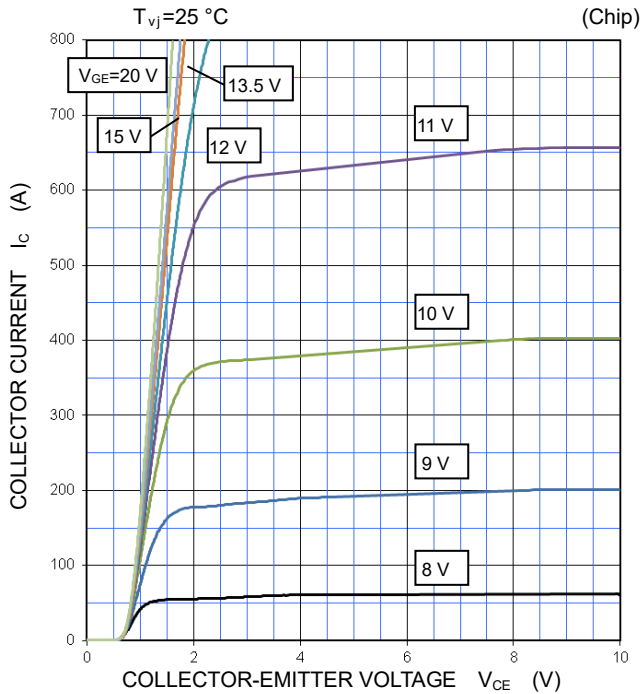
Di2

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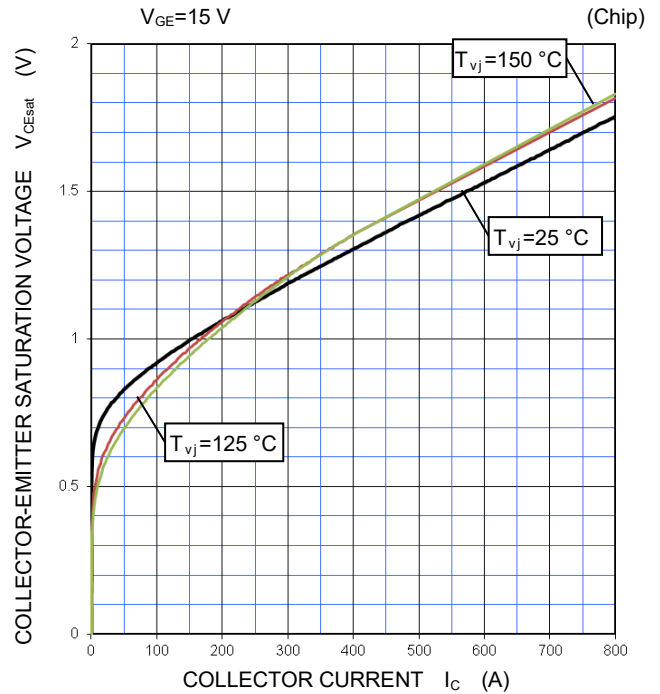
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

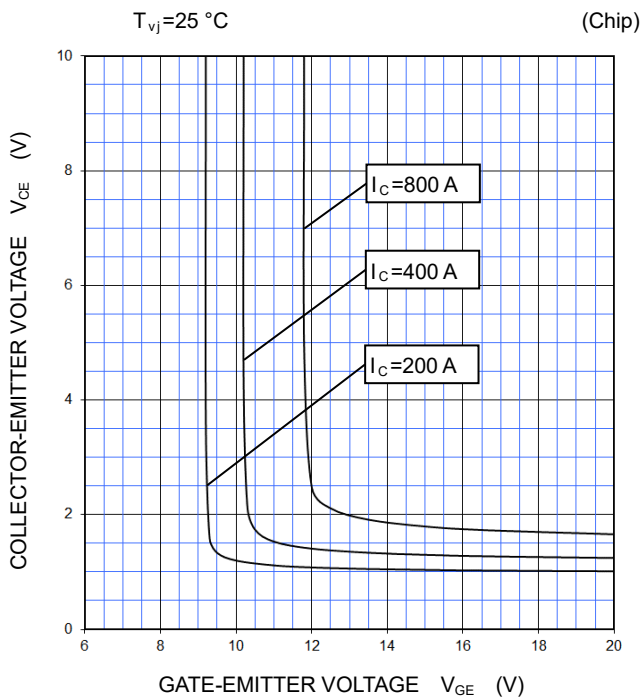
**OUTPUT CHARACTERISTICS (TYPICAL)**



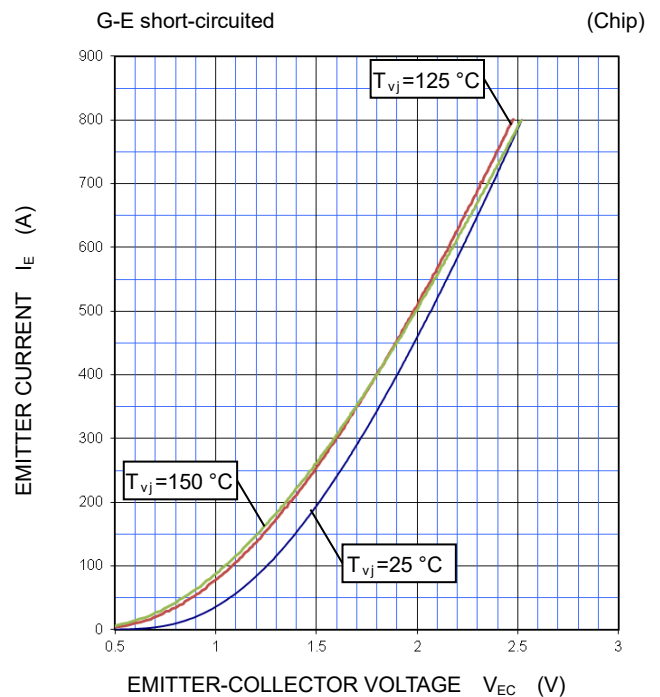
**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)**



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



**FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)**



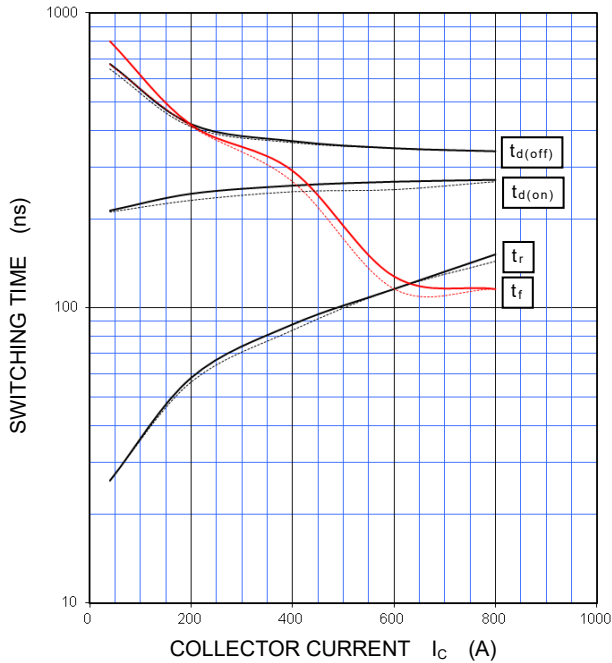
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HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

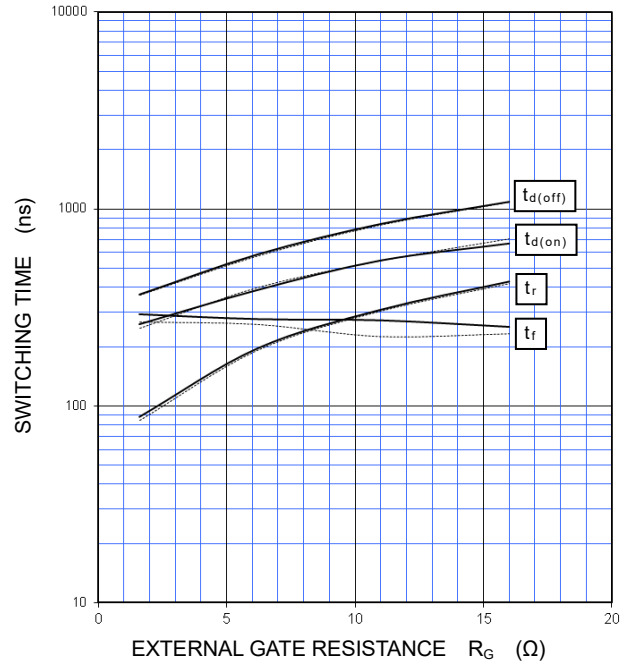
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=300\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.6\ \Omega$ , INDUCTIVE LOAD  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



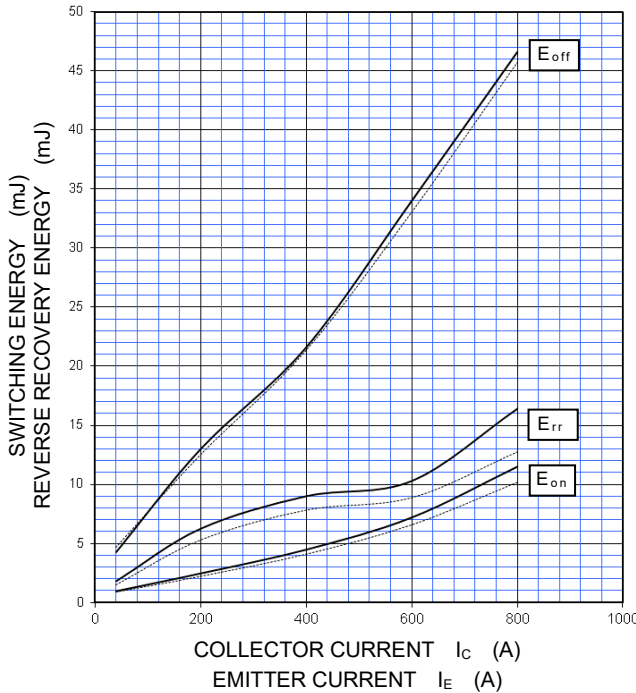
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=300\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C=400\text{ A}$ , INDUCTIVE LOAD  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



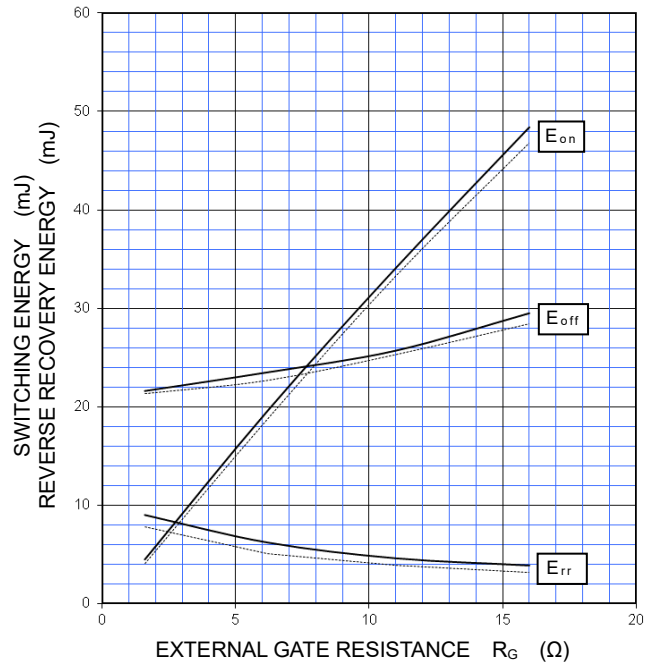
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=300\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.6\ \Omega$ ,  
INDUCTIVE LOAD, PER PULSE  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



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

$V_{CC}=300\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C/I_E=400\text{ A}$ ,  
INDUCTIVE LOAD, PER PULSE  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$

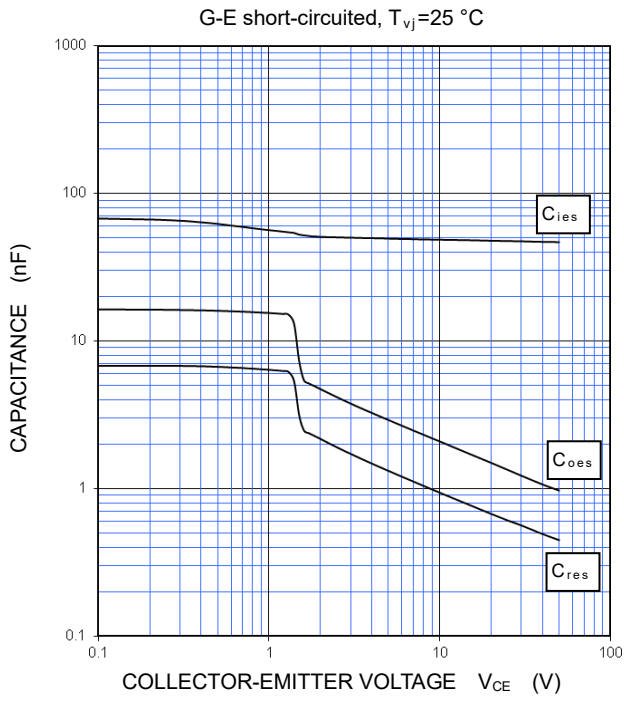


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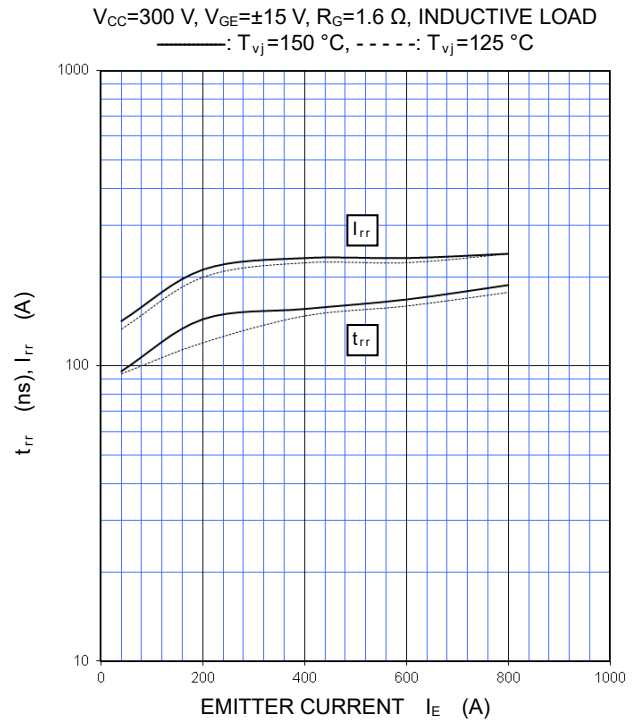
HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

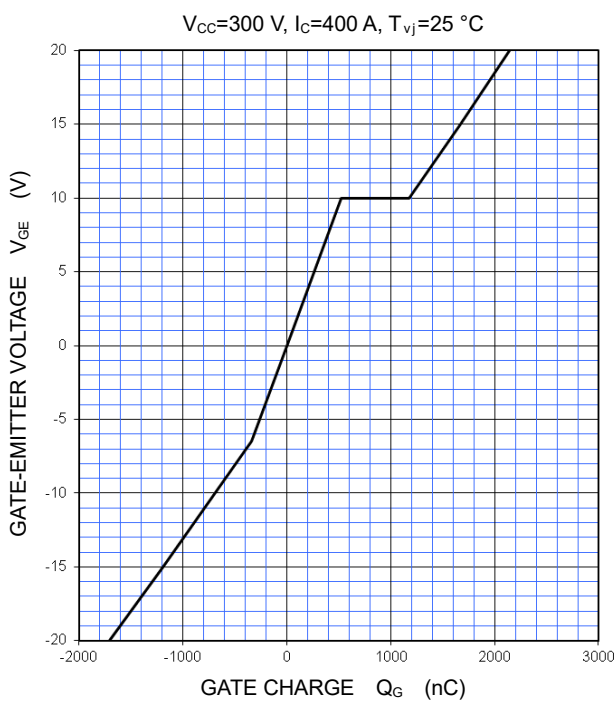
**CAPACITANCE CHARACTERISTICS  
(TYPICAL)**



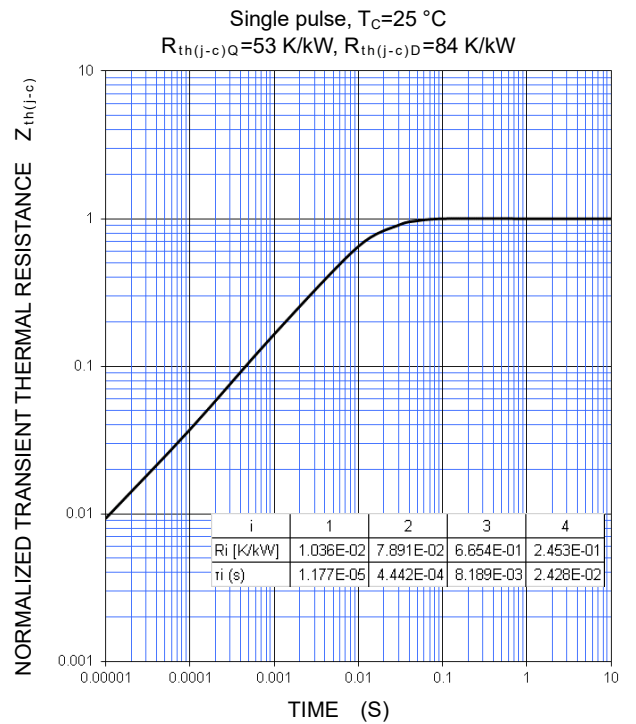
**FREE WHEELING DIODE  
REVERSE RECOVERY CHARACTERISTICS  
(TYPICAL)**



**GATE CHARGE CHARACTERISTICS  
(TYPICAL)**



**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS  
(MAXIMUM)**





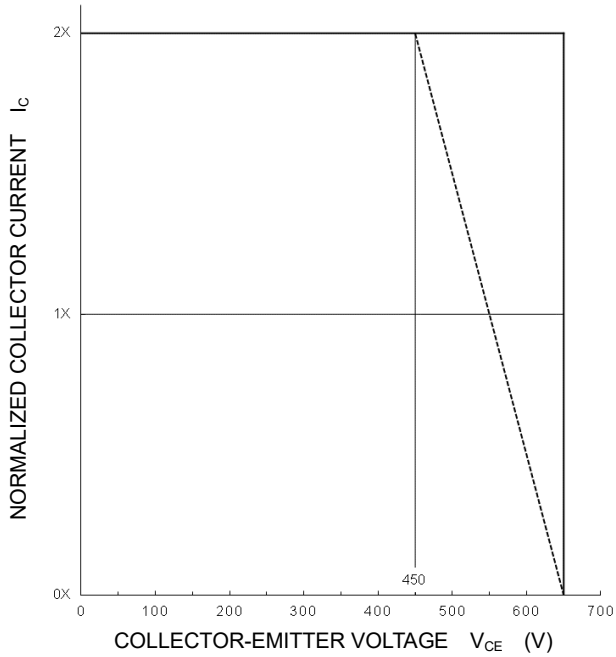
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## PERFORMANCE CURVES

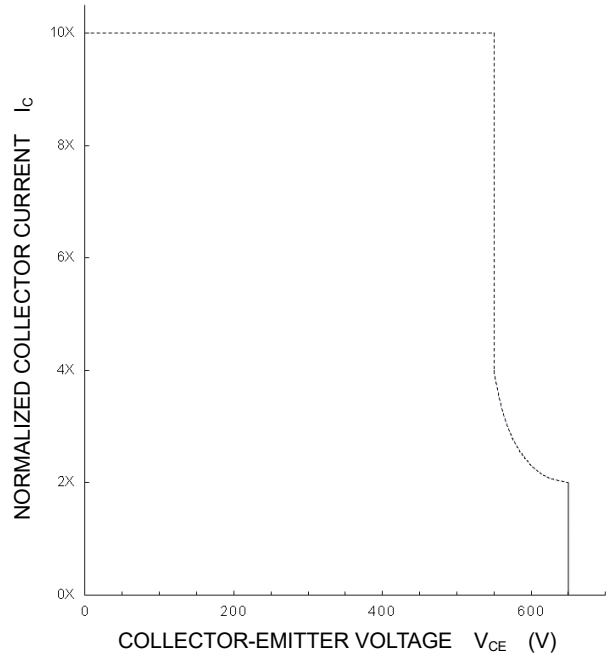
**TURN-OFF SWITCHING SAFE OPERATING AREA  
(REVERSE BIAS SAFE OPERATING AREA)  
(MAXIMUM)**

$V_{CC} \leq 450 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $R_G = 1.6 \sim 16 \ \Omega$ ,  
——:  $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$  (Normal load operations (Continuous))  
- - - -:  $T_{vj} = 175 \text{ }^\circ\text{C}$  (Unusual load operations (Limited period))



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

$V_{CC} \leq 400 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $R_G = 1.6 \sim 16 \ \Omega$ ,  
 $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$ ,  $t_W \leq 8 \ \mu\text{s}$ , Non-Repetitive



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

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