

<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
- Copper base plate (Nickel-plating)
- Nickel-plating tab terminals
- RoHS Directive compliant
- UL Recognized under UL1557, File No.E323585

**APPLICATION**

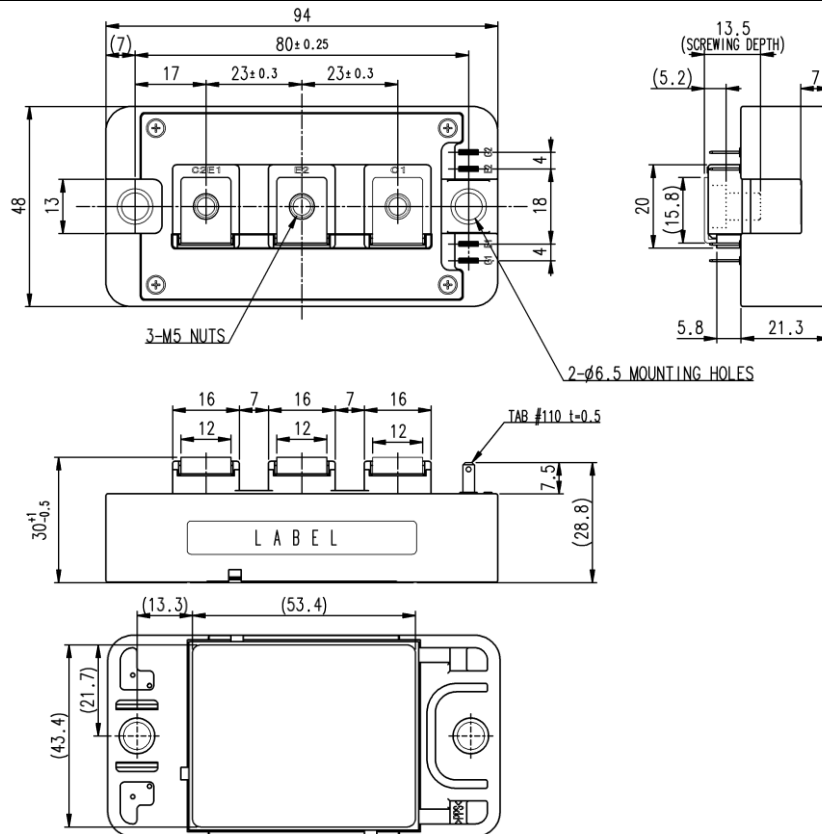
AC Motor Control, Motion/Servo Control, Power supply, etc.

**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)	175	°C
T <sub>Cmax</sub>	Maximum case temperature	(Note4)	150*	
T <sub>vjop</sub>	Operating junction temperature	Continuous operation (under switching)	-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)	Collector-emitter saturation voltage	I <sub>C</sub> =400 A, V <sub>GE</sub> =15 V, (Note5)	T <sub>vj</sub> =25 °C	-	1.30	1.55	V
V <sub>CEsat</sub> (Chip)			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)	Emitter-collector voltage	I <sub>E</sub> =400 A, G-E short-circuited, (Note5)	T <sub>vj</sub> =25 °C	-	1.90	2.65	V
V <sub>EC</sub> (Note.1) (Chip)			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,	-	-	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,	-	4.5	-	mJ	
E <sub>off</sub>	Turn-off switching energy per pulse	V <sub>GE</sub> =±15 V, R <sub>G</sub> =1.6 Ω, T <sub>vj</sub> =150 °C,	-	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.

# CM400DY-13T

HIGH POWER SWITCHING USE  
INSULATED TYPE

## 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)	-	24	-	K/kW

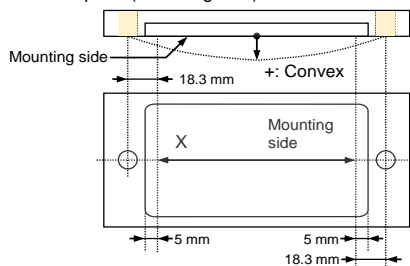
## MECHANICAL CHARACTERISTICS

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.

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.



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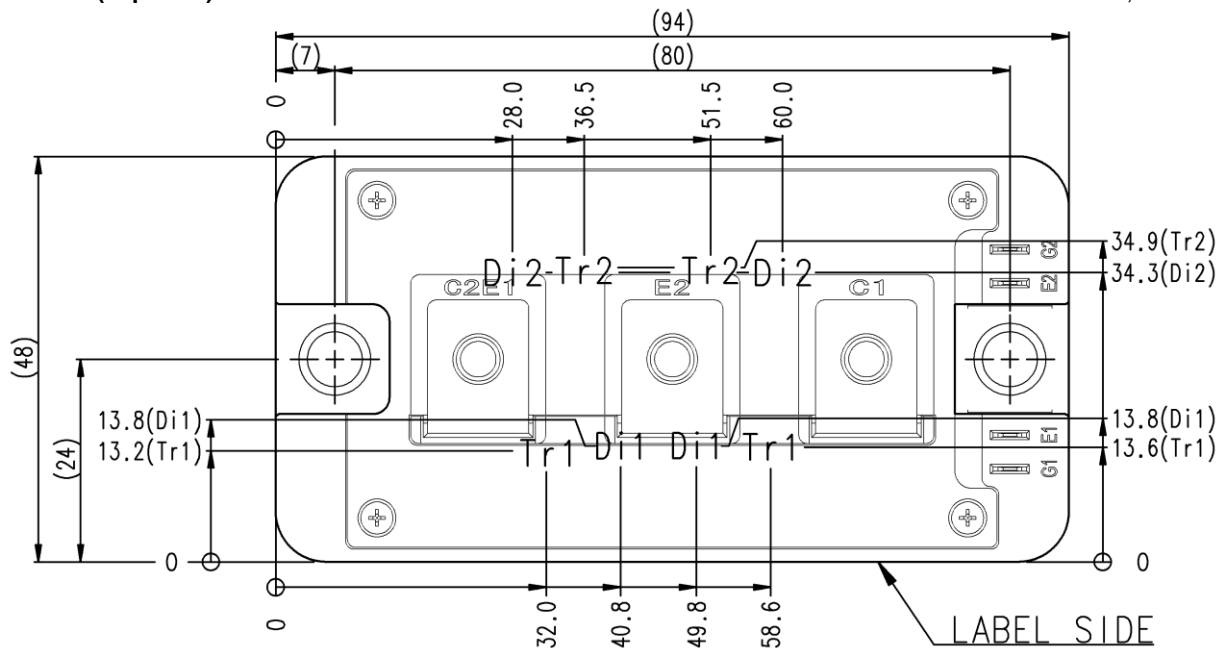
HIGH POWER SWITCHING USE  
INSULATED TYPE

## 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

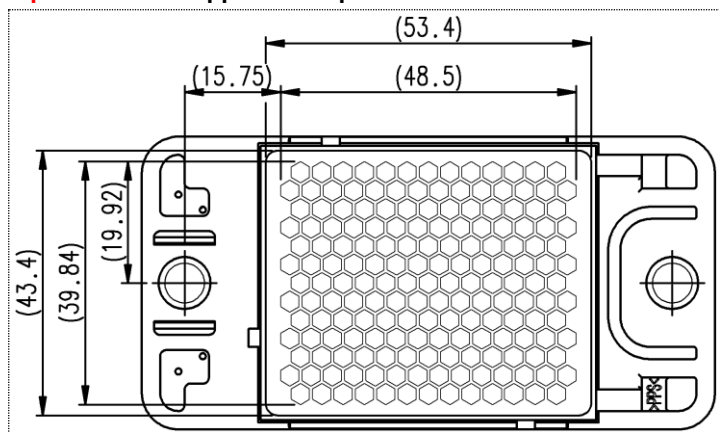
### CHIP LOCATION (Top view)

Dimension in mm, tolerance: ±1 mm



Tr1/Tr2: IGBT, Di1/Di2: FWD

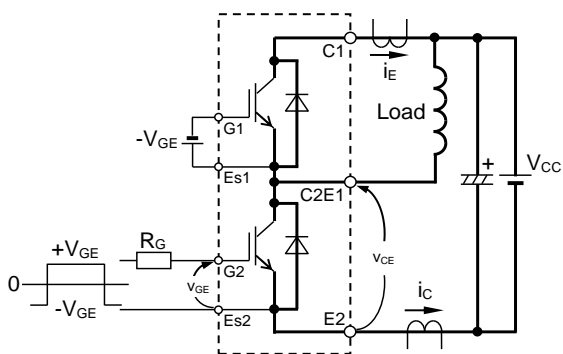
### Option: PC-TIM applied baseplate outline



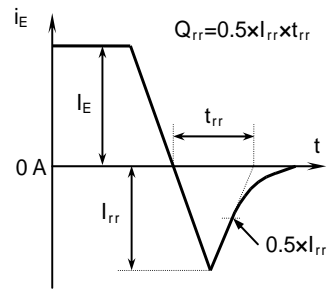
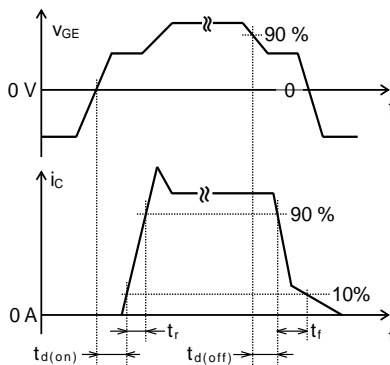
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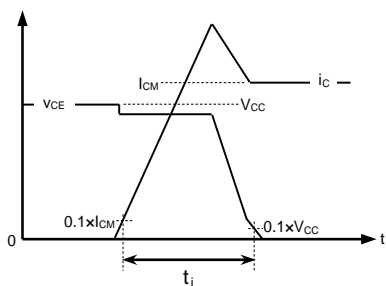
## TEST CIRCUIT AND WAVEFORMS



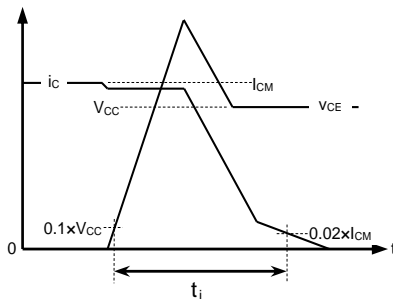
Switching characteristics test circuit and waveforms



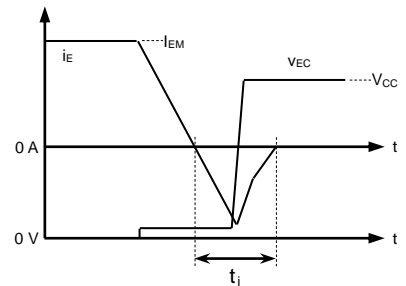
$t_{rr}$ ,  $Q_{rr}$  characteristics test waveform



IGBT Turn-on switching energy



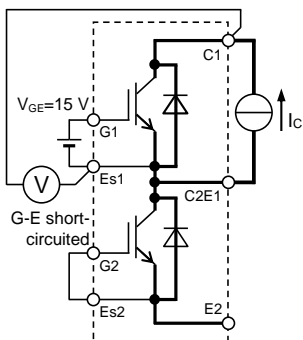
IGBT Turn-off switching energy



FWD Reverse recovery energy

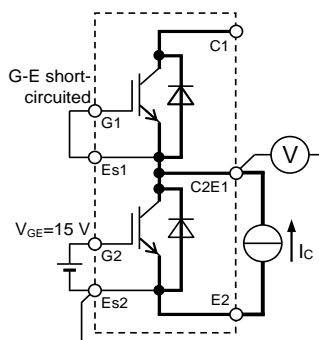
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT

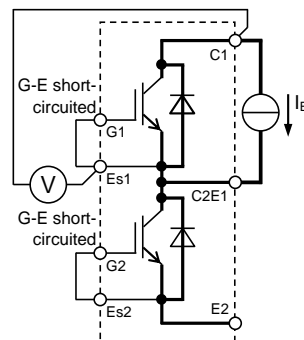


Tr1

$V_{CEsat}$  characteristics test circuit

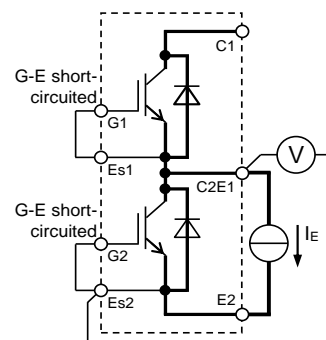


Tr2



Di1

$V_{EC}$  characteristics test circuit



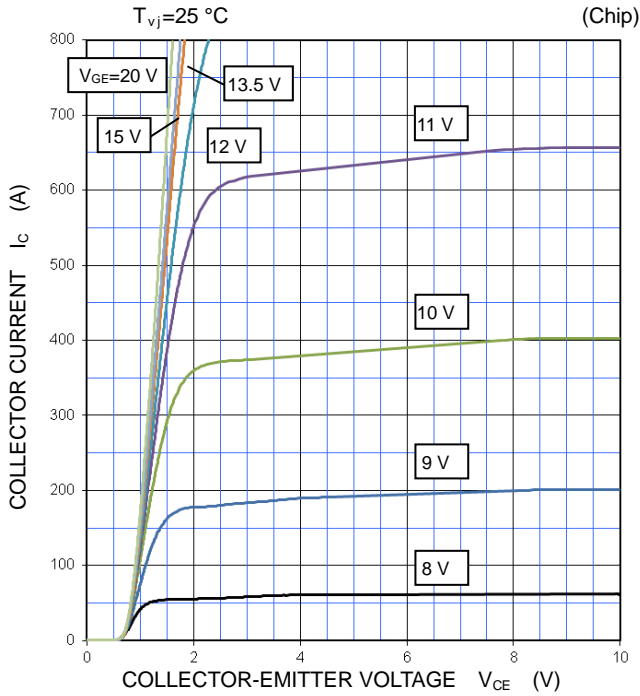
Di2

# CM400DY-13T

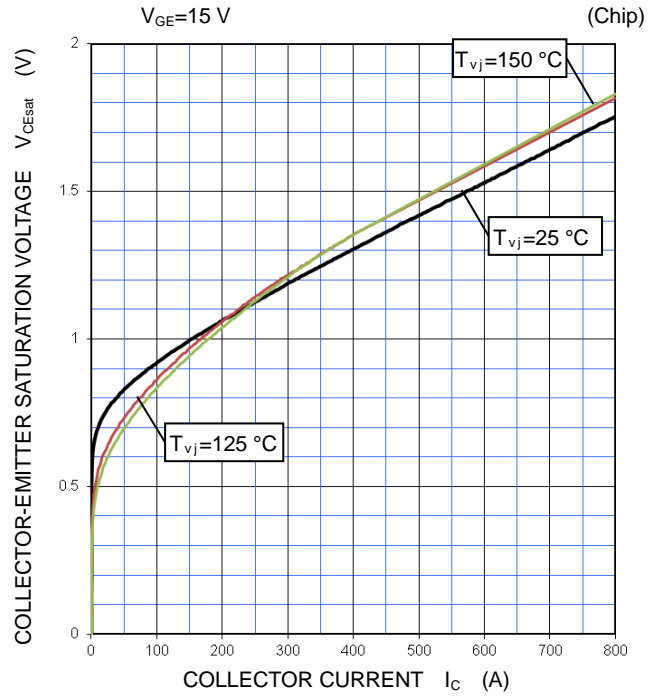
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

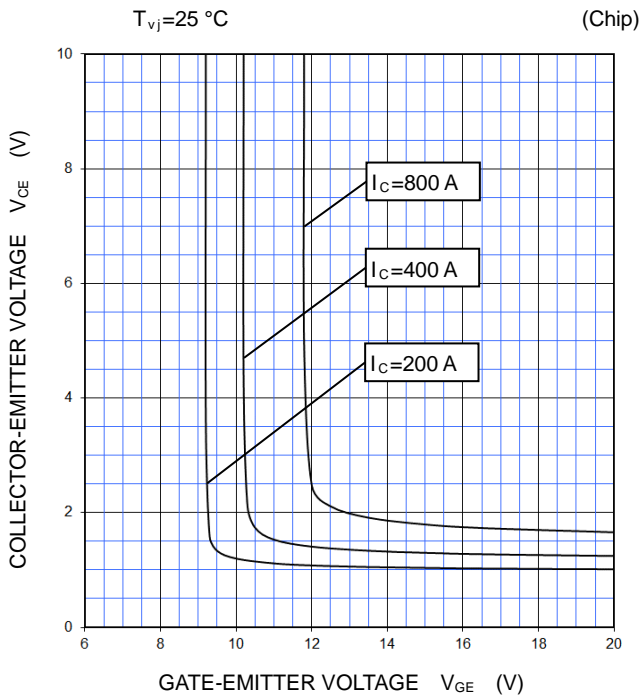
**OUTPUT CHARACTERISTICS  
(TYPICAL)**



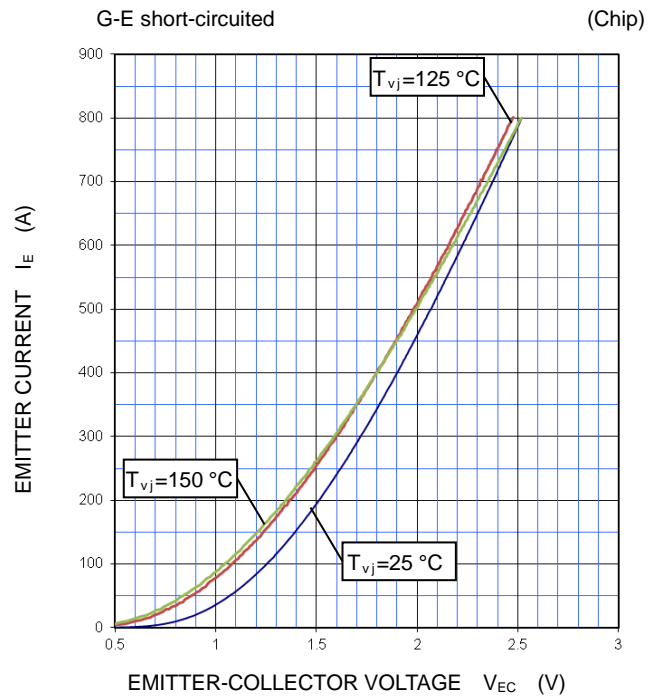
**COLLECTOR-EMITTER SATURATION VOLTAGE  
CHARACTERISTICS  
(TYPICAL)**



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



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



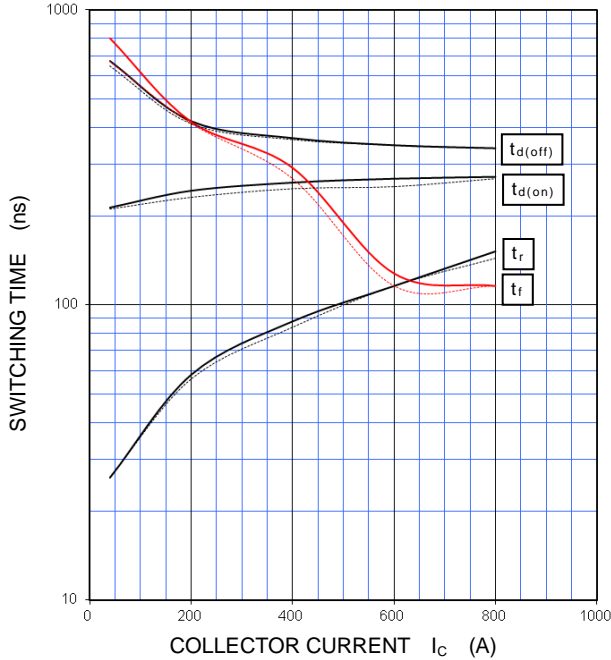
# CM400DY-13T

HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

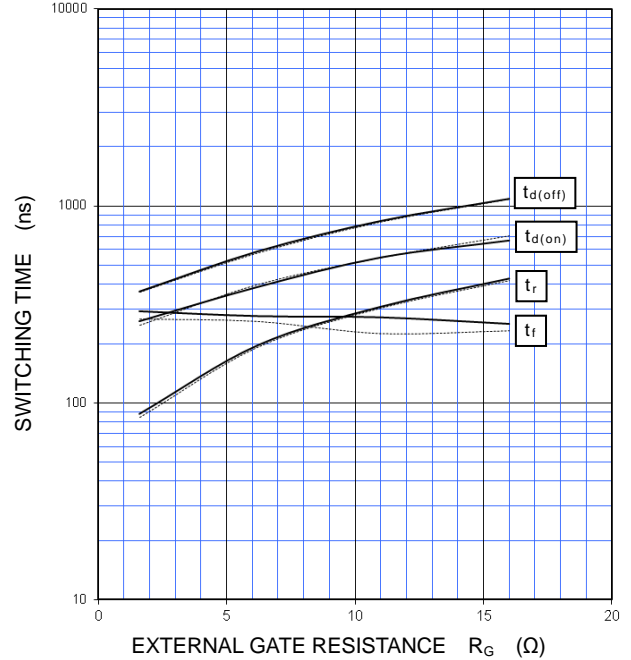
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

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



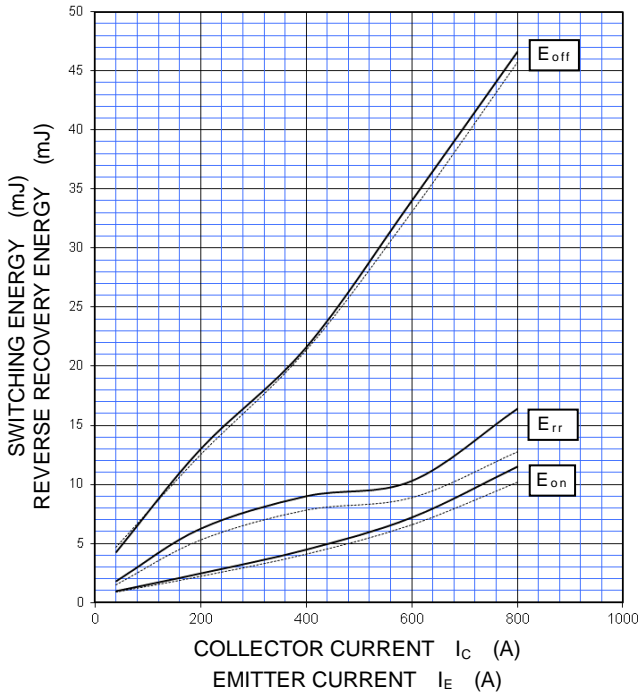
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

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



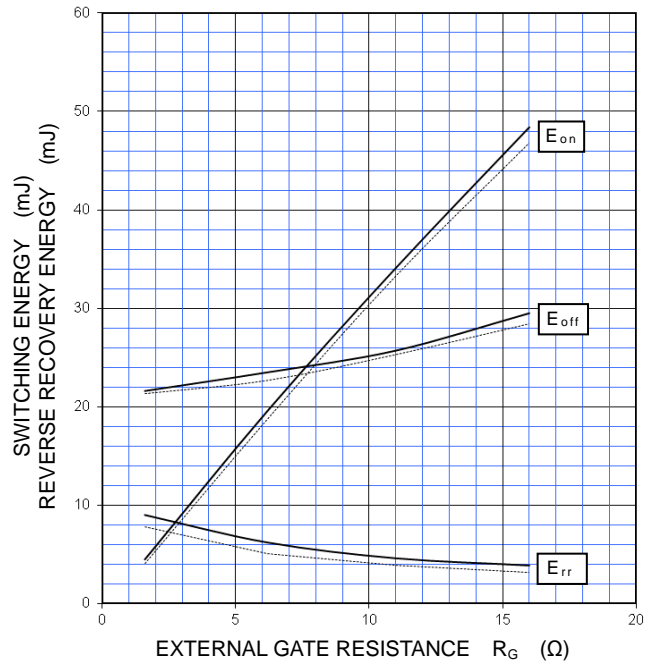
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

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

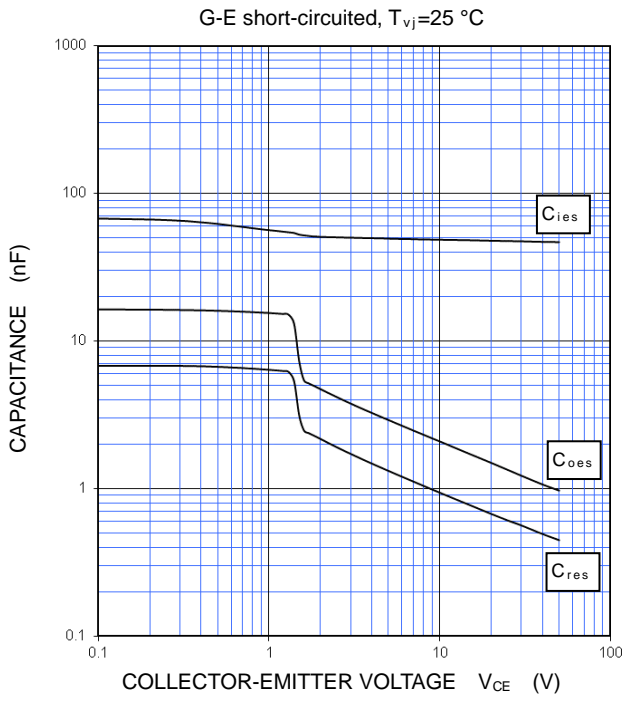


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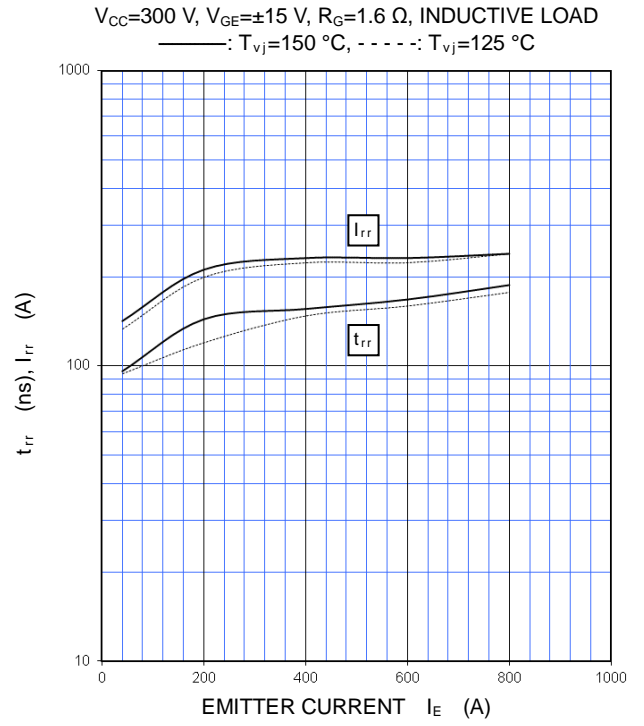
HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

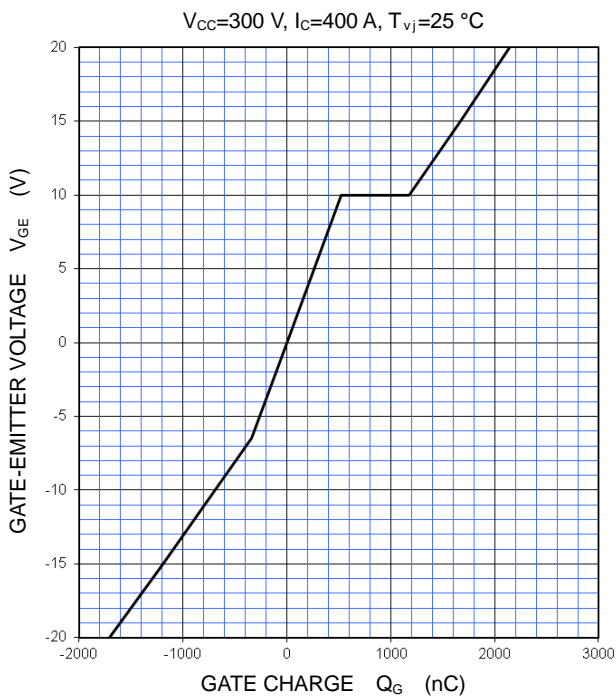
**CAPACITANCE CHARACTERISTICS  
(TYPICAL)**



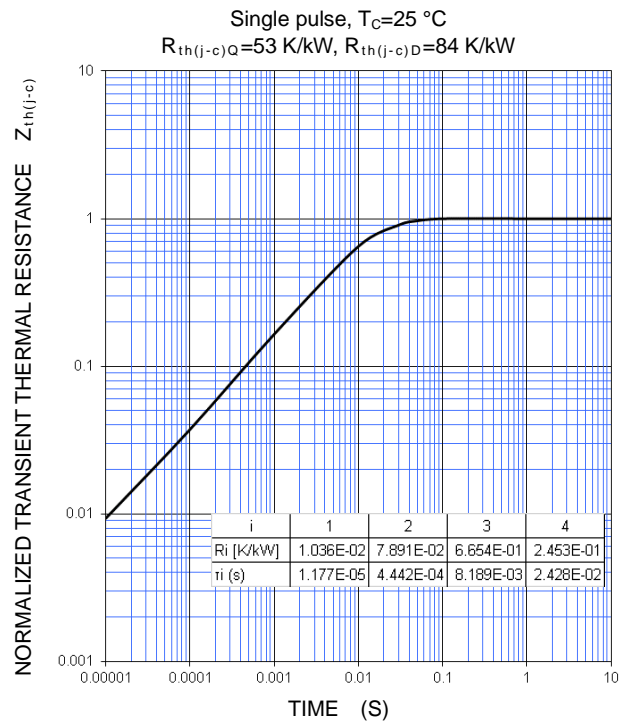
**FREE WHEELING DIODE  
REVERSE RECOVERY CHARACTERISTICS  
(TYPICAL)**



**GATE CHARGE CHARACTERISTICS  
(TYPICAL)**



**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS  
(MAXIMUM)**





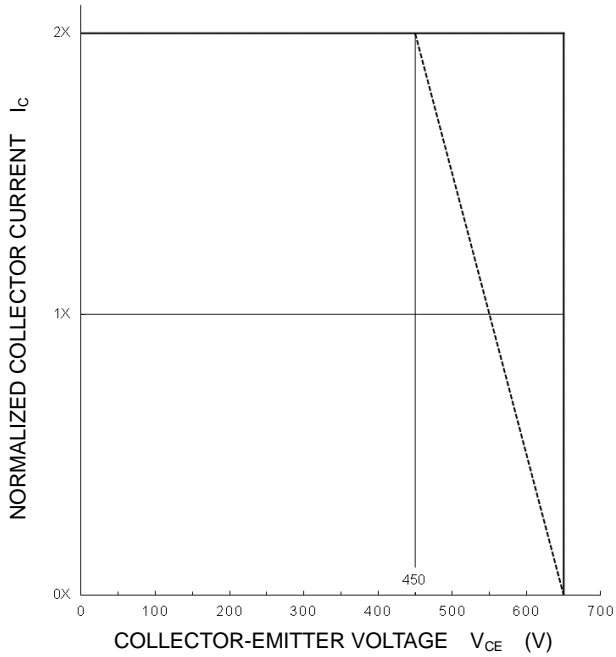
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HIGH POWER SWITCHING USE  
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## PERFORMANCE CURVES

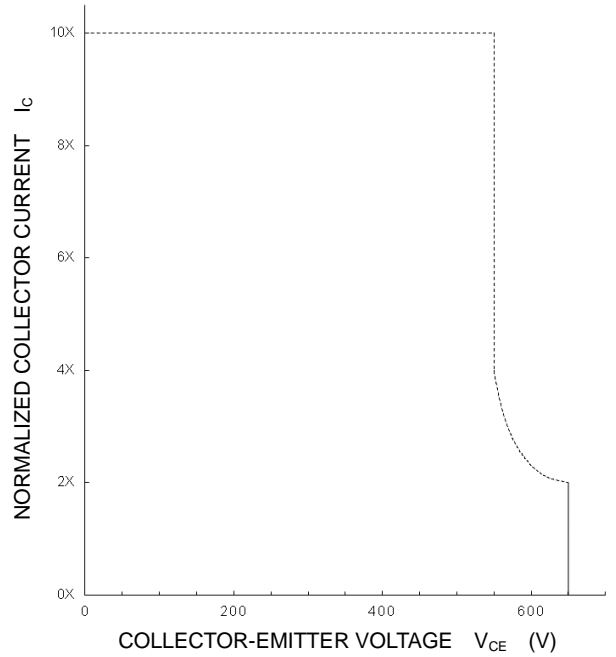
**TURN-OFF SWITCHING SAFE OPERATING AREA  
(REVERSE BIAS SAFE OPERATING AREA)  
(MAXIMUM)**

$V_{CC} \leq 450 \text{ V}$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  $R_G = 1.6 \sim 16 \Omega$ ,  
——:  $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$  (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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