

<IGBT Modules>

# CM400DX-12A

HIGH POWER SWITCHING USE  
INSULATED TYPE



dual switch (Half-Bridge)

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

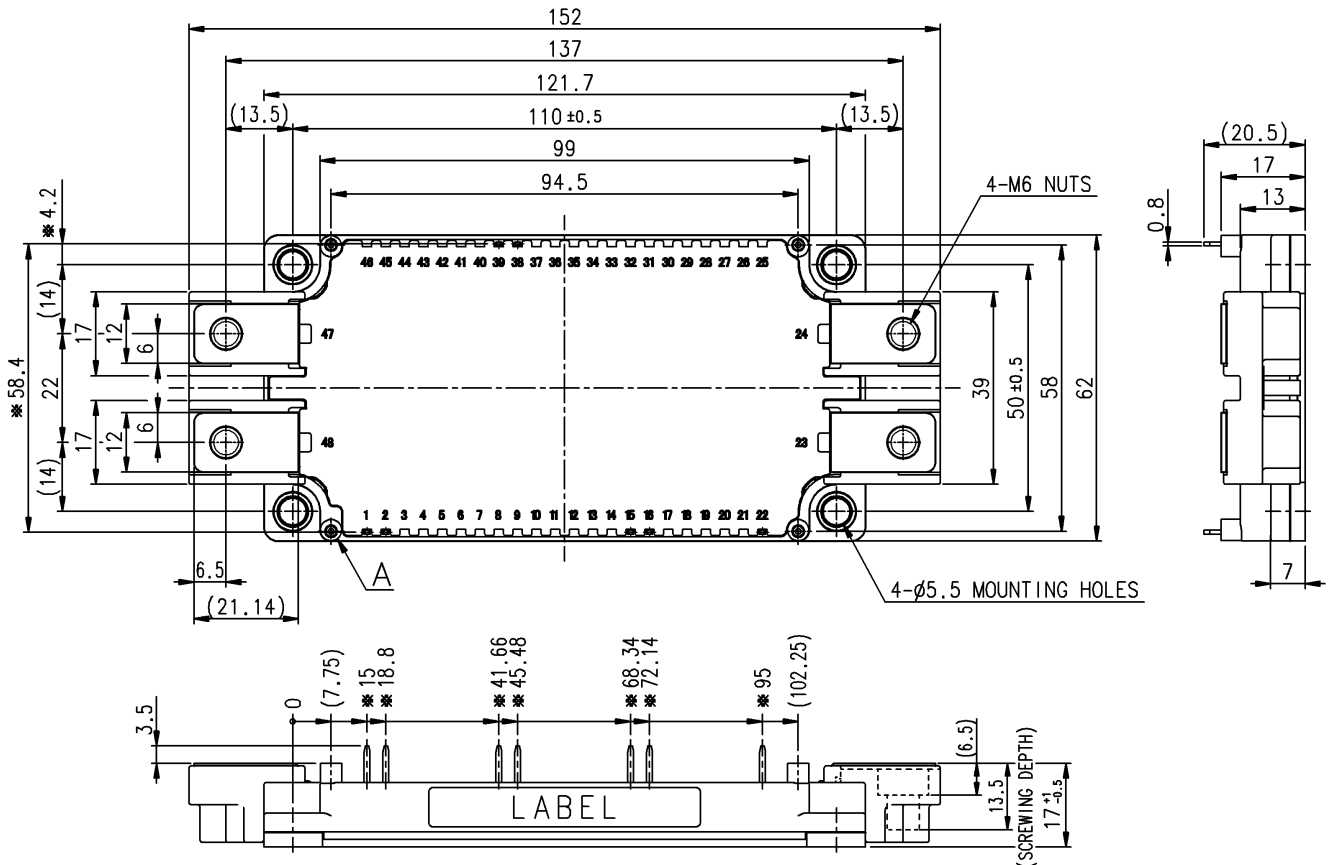
- Flat base Type
- Copper base plate (non-plating)
- RoHS Directive compliant
- Recognized under UL1557, File E323585

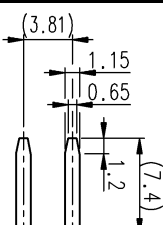
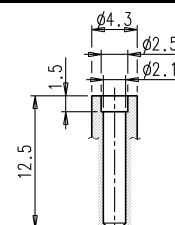
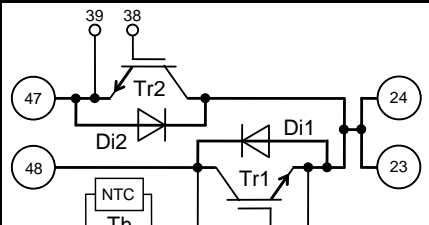
## APPLICATION

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

## OUTLINE DRAWING & INTERNAL CONNECTION

Dimension in mm



TERMINAL $t=0.8$	SECTION A	INTERNAL CONNECTION
		 <p>Terminal code</p> <ul style="list-style-type: none"> <li>1 TH1</li> <li>2 TH2</li> <li>15 G1</li> <li>16 Es1</li> <li>22 Cs1</li> <li>23 C2E1</li> <li>24 C2E1</li> <li>38 G2</li> <li>39 Es2</li> <li>47 E2</li> <li>48 C1</li> </ul>

Tolerance otherwise specified

Division of Dimension	Tolerance
0.5 to 3	$\pm 0.2$
over 3 to 6	$\pm 0.3$
over 6 to 30	$\pm 0.5$
over 30 to 120	$\pm 0.8$
over 120 to 400	$\pm 1.2$

※: Dimensions with a  
Tolerance of  $\pm 0.5$

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MAXIMUM RATINGS ( $T_j=25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

## INVERTER PART IGBT/DIODE

Symbol	Item	Conditions	Rating	Unit
$V_{CES}$	Collector-emitter voltage	G-E short-circuited	600	V
$V_{GES}$	Gate-emitter voltage	C-E short-circuited	$\pm 20$	V
$I_C$	Collector current	DC, $T_C=60\text{ }^{\circ}\text{C}$ (Note2, 4)	400	A
$I_{CRM}$		Pulse, Repetitive (Note3)	800	
$P_{tot}$	Total power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ (Note2, 4)	1340	W
$I_E$ (Note1)	Emitter current	DC (Note2)	400	A
$I_{ERM}$ (Note1)		Pulse, Repetitive (Note3)	800	

## MODULE

Symbol	Item	Conditions	Rating	Unit
$V_{isol}$	Isolation voltage	Terminals to base plate, RMS, $f=60\text{ Hz}$ , AC 1 min	2500	V
$T_j$	Junction temperature	-	$-40 \sim +150$	$^{\circ}\text{C}$
$T_{stg}$	Storage temperature	-	$-40 \sim +125$	

ELECTRICAL CHARACTERISTICS ( $T_j=25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

## INVERTER PART IGBT/DIODE

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$I_{CES}$	Collector-emitter cut-off current	$V_{CE}=V_{CES}$ , G-E short-circuited	-	-	1.0	mA
$I_{GES}$	Gate-emitter leakage current	$V_{GE}=V_{GES}$ , C-E short-circuited	-	-	0.5	$\mu\text{A}$
$V_{GE(th)}$	Gate-emitter threshold voltage	$I_C=40\text{ mA}$ , $V_{CE}=10\text{ V}$	5	6	7	V
$V_{CESat}$	Collector-emitter saturation voltage	$I_C=400\text{ A}$ , $V_{GE}=15\text{ V}$ (Note5) $T_j=25\text{ }^{\circ}\text{C}$	-	1.7	2.1	V
		Refer to the figure of test circuit $T_j=125\text{ }^{\circ}\text{C}$	-	1.9	-	
		$I_C=400\text{ A}$ , $V_{GE}=15\text{ V}$ , chip (Note5)	-	1.6	-	
$C_{ies}$	Input capacitance	$V_{CE}=10\text{ V}$ , G-E short-circuited	-	-	50	nF
$C_{oes}$	Output capacitance		-	-	5.3	
$C_{res}$	Reverse transfer capacitance		-	-	1.6	
$Q_G$	Gate charge	$V_{CC}=300\text{ V}$ , $I_C=400\text{ A}$ , $V_{GE}=15\text{ V}$	-	1100	-	nC
$t_{d(on)}$	Turn-on delay time	$V_{CC}=300\text{ V}$ , $I_C=400\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=3.6\text{ }\Omega$ , Inductive load	-	-	200	ns
$t_r$	Rise time		-	-	200	
$t_{d(off)}$	Turn-off delay time		-	-	400	
$t_f$	Fall time		-	-	600	
$V_{EC}$ (Note1)	Emitter-collector voltage	$I_E=400\text{ A}$ , G-E short-circuited (Note5) $T_j=25\text{ }^{\circ}\text{C}$	-	2.0	2.8	V
		Refer to the figure of test circuit $T_j=125\text{ }^{\circ}\text{C}$	-	1.95	-	
		$I_E=400\text{ A}$ , G-E short-circuited, chip (Note5)	-	1.9	-	
$t_{rr}$ (Note1)	Reverse recovery time	$V_{CC}=300\text{ V}$ , $I_E=400\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=3.6\text{ }\Omega$ , Inductive load	-	-	200	ns
$Q_{rr}$ (Note1)	Reverse recovery charge	$R_G=3.6\text{ }\Omega$ , Inductive load	-	11	-	$\mu\text{C}$
$E_{on}$	Turn-on switching energy per pulse	$V_{CC}=300\text{ V}$ , $I_C=I_E=400\text{ A}$ ,	-	13.5	-	mJ
$E_{off}$	Turn-off switching energy per pulse	$V_{GE}=\pm 15\text{ V}$ , $R_G=3.6\text{ }\Omega$ , $T_j=125\text{ }^{\circ}\text{C}$ ,	-	23	-	
$E_{rr}$ (Note1)	Reverse recovery energy per pulse	Inductive load	-	3.8	-	mJ
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, $T_C=25\text{ }^{\circ}\text{C}$ (Note4)	-	1.1	-	$\text{m}\Omega$
$r_g$	Internal gate resistance	Per switch, $T_C=25\text{ }^{\circ}\text{C}$ (Note4)	-	0	-	$\Omega$

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ELECTRICAL CHARACTERISTICS (cont.;  $T_j=25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

## NTC THERMISTOR PART

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{25}$	Zero-power resistance	$T_C=25\text{ }^{\circ}\text{C}$ (Note4)	4.85	5.00	5.15	k $\Omega$
$\Delta R/R$	Deviation of resistance	$R_{100}=493\text{ }\Omega$ , $T_C=100\text{ }^{\circ}\text{C}$ (Note4)	-7.3	-	+7.8	%
$B_{(25/50)}$	B-constant	Approximate by equation (Note6)	-	3375	-	K
$P_{25}$	Power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ (Note4)	-	-	10	mW

## 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)	-	-	0.093	K/W
$R_{th(j-c)D}$		Junction to case, per Inverter DIODE (Note4)	-	-	0.16	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, per 1 module, Thermal grease applied (Note4, 7)	-	15	-	K/kW

## MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$M_t$	Mounting torque	Main terminals M 6 screw	3.5	4.0	4.5	N·m
$M_s$	Mounting torque	Mounting to heat sink M 5 screw	2.5	3.0	3.5	N·m
$d_s$	Creepage distance	Terminal to terminal	11.55	-	-	mm
		Terminal to base plate	12.32	-	-	
$d_a$	Clearance	Terminal to terminal	10.00	-	-	mm
		Terminal to base plate	10.85	-	-	
$m$	mass	-	-	330	-	g
$e_c$	Flatness of base plate	On the centerline X, Y (Note8)	$\pm 0$	-	+100	$\mu\text{m}$

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

2. Junction temperature ( $T_j$ ) should not increase beyond  $T_{jmax}$  rating.

3. Pulse width and repetition rate should be such that the device junction temperature ( $T_j$ ) does not exceed  $T_{jmax}$  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.

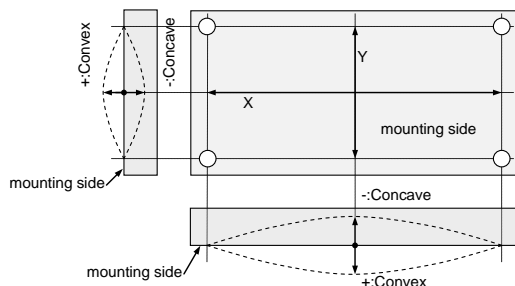
$$6. B_{(25/50)} = \ln\left(\frac{R_{25}}{R_{50}}\right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}}\right),$$

$R_{25}$ : resistance at absolute temperature  $T_{25}$  [K];  $T_{25}=25\text{ }^{\circ}\text{C}+273.15=298.15$  [K]

$R_{50}$ : resistance at absolute temperature  $T_{50}$  [K];  $T_{50}=50\text{ }^{\circ}\text{C}+273.15=323.15$  [K]

7. Typical value is measured by using thermally conductive grease of  $\lambda=0.9\text{ W/(m}\cdot\text{K)}$ .

8. The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



9. Use the following screws when mounting the printed circuit board (PCB) on the standoffs.

" $\phi 2.3 \times 10$  or  $\phi 2.3 \times 12$ , B1 tapping screw"

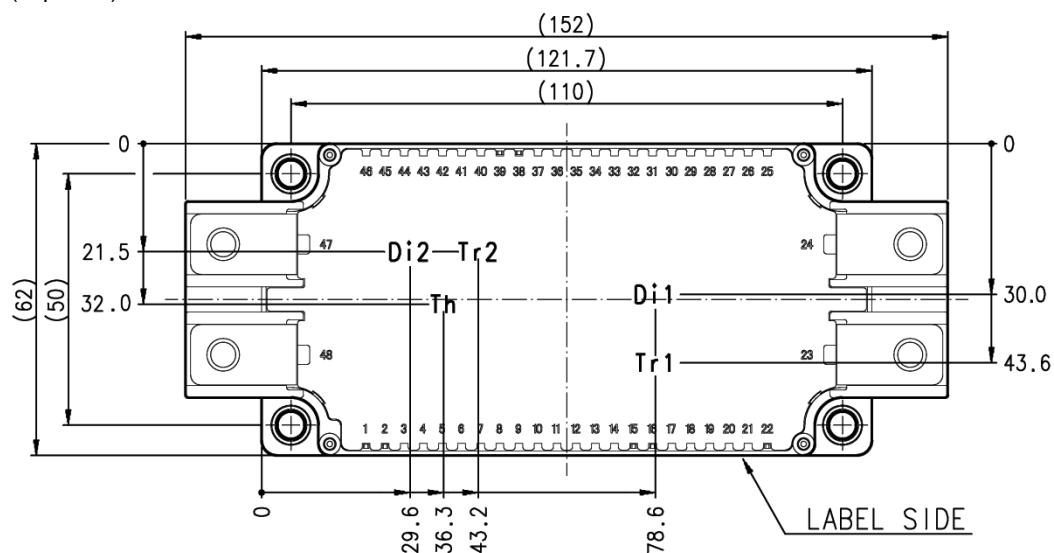
The length of the screw depends on the thickness ( $t1.6\sim t2.0$ ) of the PCB.

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**RECOMMENDED OPERATING CONDITIONS**

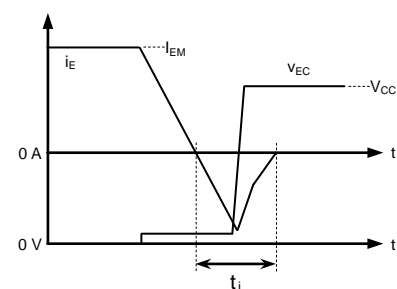
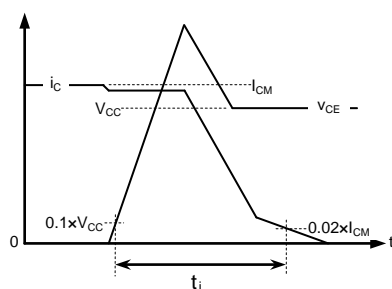
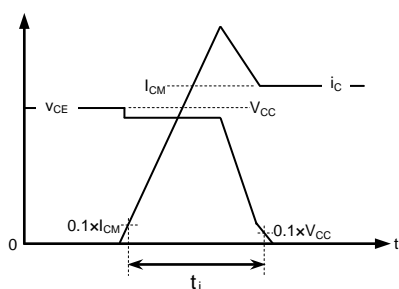
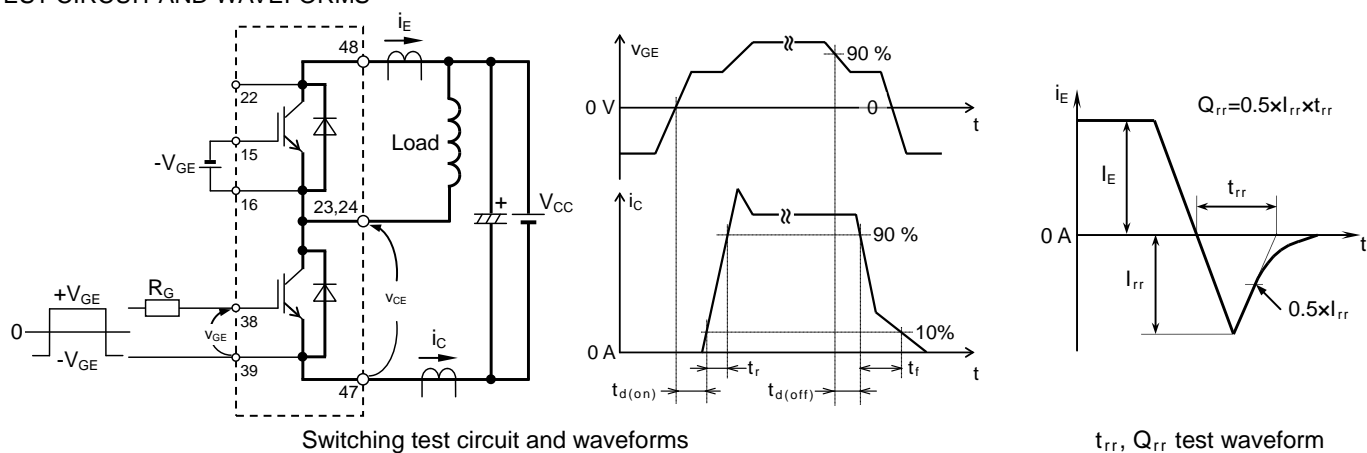
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$V_{CC}$	(DC) Supply voltage	Applied across C1-E2 terminals	-	300	400	V
$V_{GEon}$	Gate (-emitter drive) voltage	Applied across G1-Es1/G2-Es2 terminals	13.5	15.0	16.5	V
$R_G$	External gate resistance	Per switch	1.6	-	16	$\Omega$

**CHIP LOCATION (Top view)**Dimension in mm, tolerance:  $\pm 1$  mm

Tr1/Tr2: IGBT, Di1/Di2: DIODE, Th: NTC thermistor

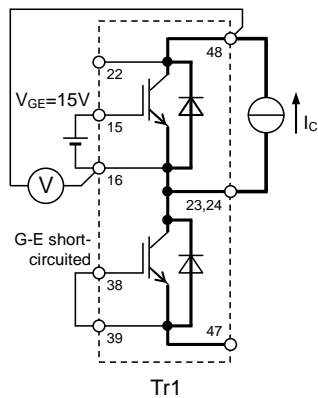
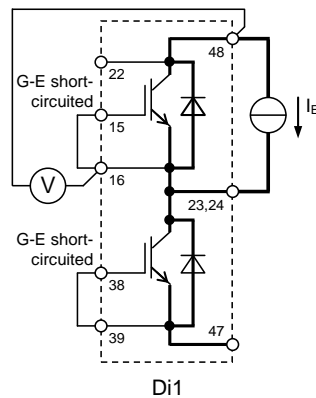
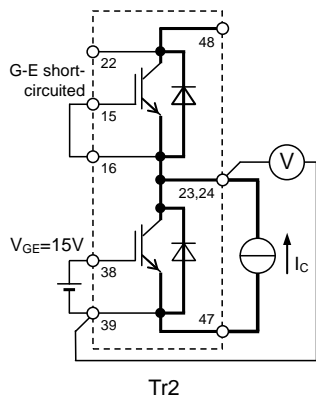
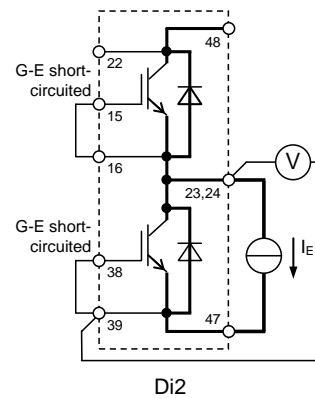
**CM400DX-12A**HIGH POWER SWITCHING USE  
INSULATED TYPE

## TEST CIRCUIT AND WAVEFORMS



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

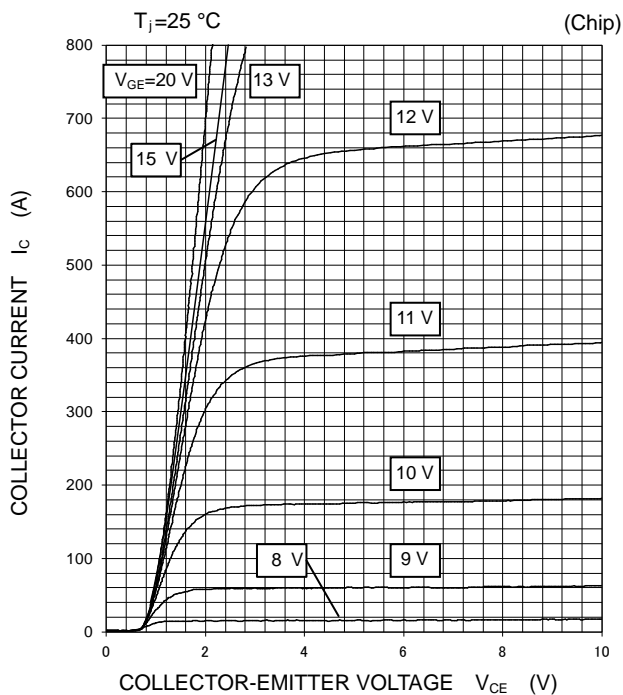
**CM400DX-12A**

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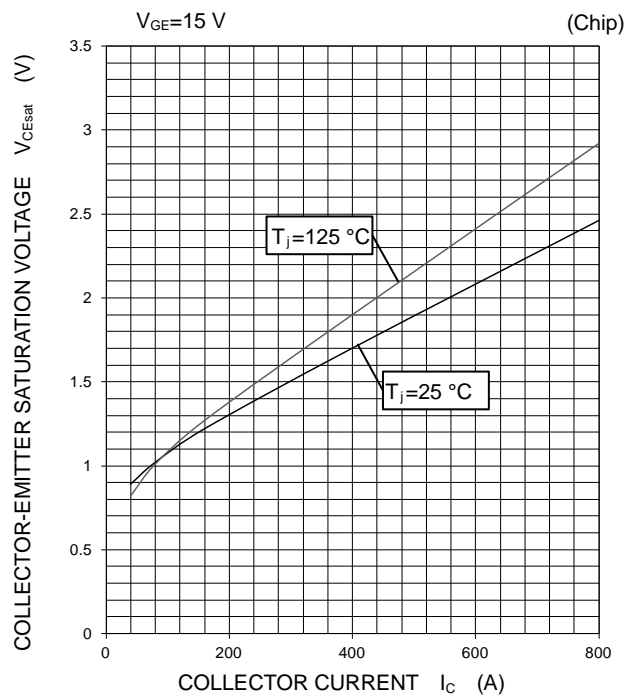
## PERFORMANCE CURVES

## INVERTER PART

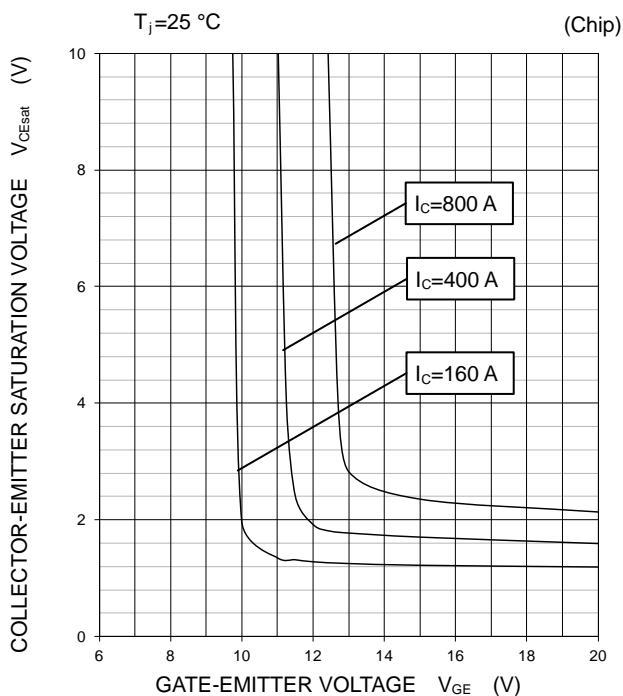
OUTPUT  
CHARACTERISTICS  
(TYPICAL)



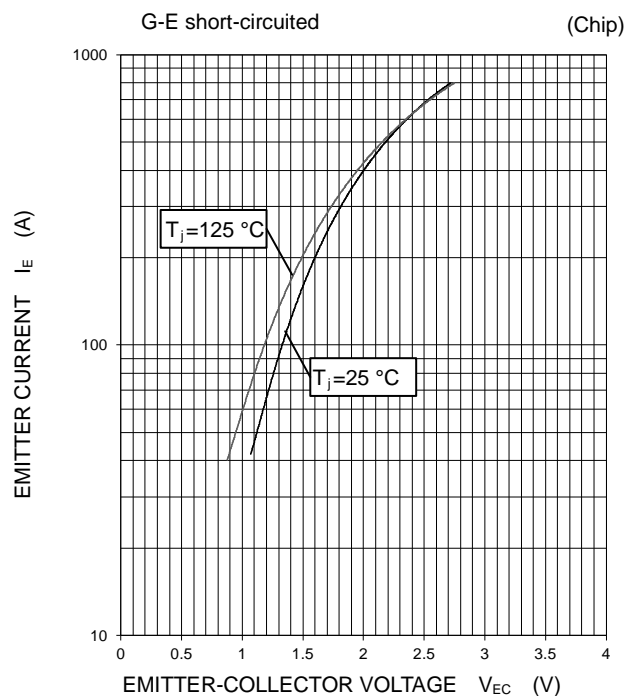
COLLECTOR-EMITTER SATURATION VOLTAGE  
CHARACTERISTICS  
(TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE  
CHARACTERISTICS  
(TYPICAL)



FREE WHEELING DIODE  
FORWARD CHARACTERISTICS  
(TYPICAL)



**CM400DX-12A**

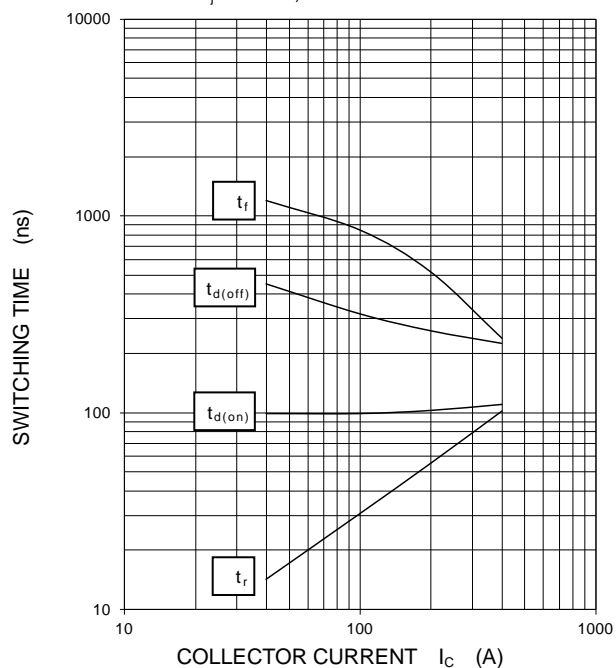
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

## INVERTER PART

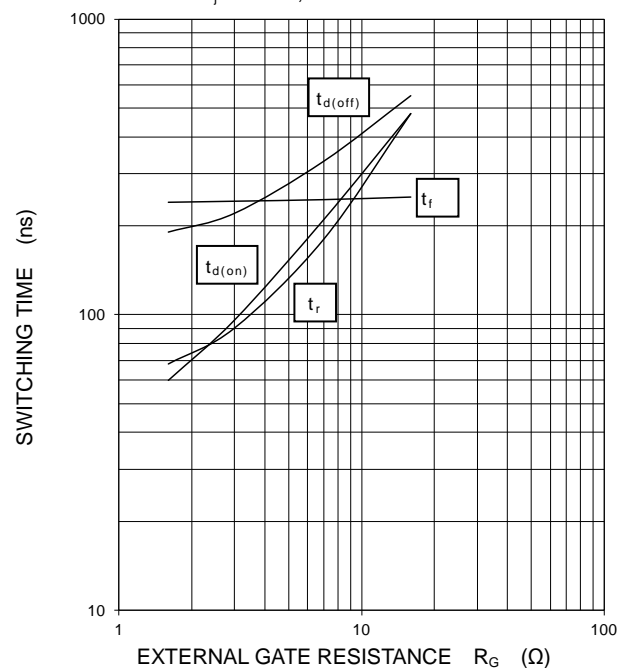
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=300\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=3.6\ \Omega$ ,  
 $T_j=125\text{ }^\circ\text{C}$ , INDUCTIVE LOAD



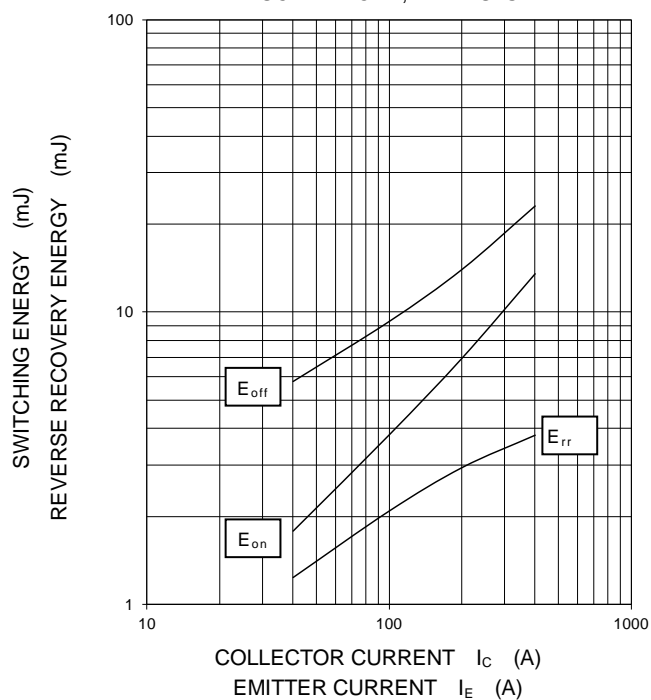
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=300\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C=400\text{ A}$ ,  
 $T_j=125\text{ }^\circ\text{C}$ , INDUCTIVE LOAD



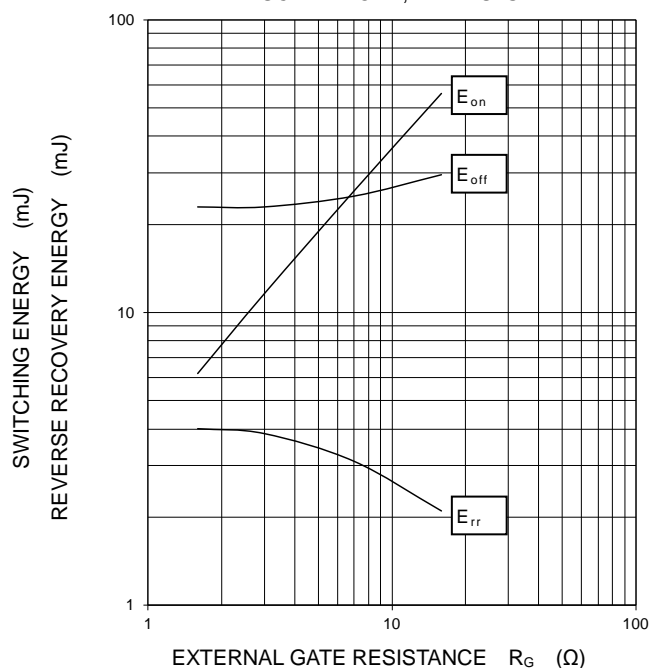
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=300\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=3.6\ \Omega$ ,  $T_j=125\text{ }^\circ\text{C}$   
INDUCTIVE LOAD, PER PULSE



HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=300\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C/I_E=400\text{ A}$ ,  $T_j=125\text{ }^\circ\text{C}$   
INDUCTIVE LOAD, PER PULSE



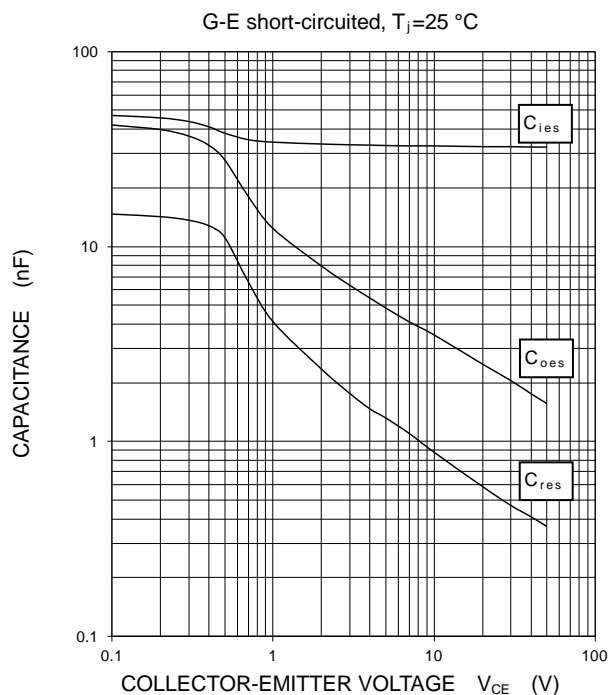
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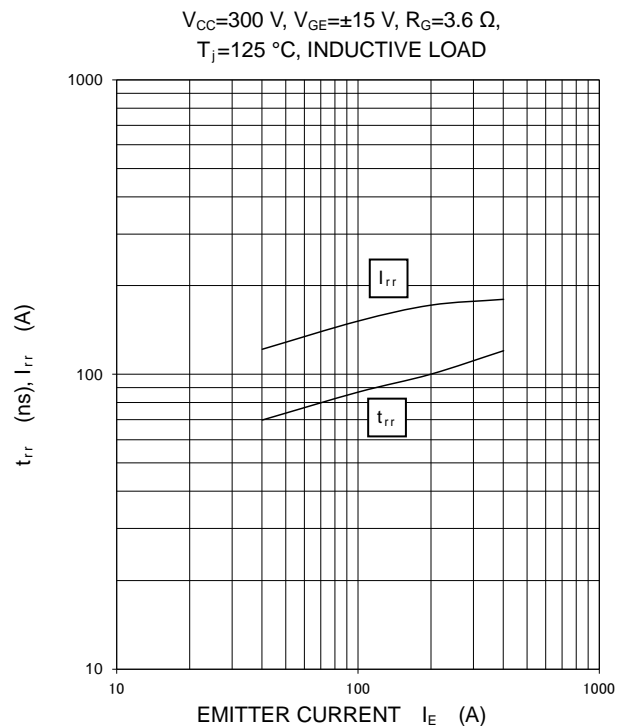
## PERFORMANCE CURVES

## INVERTER PART

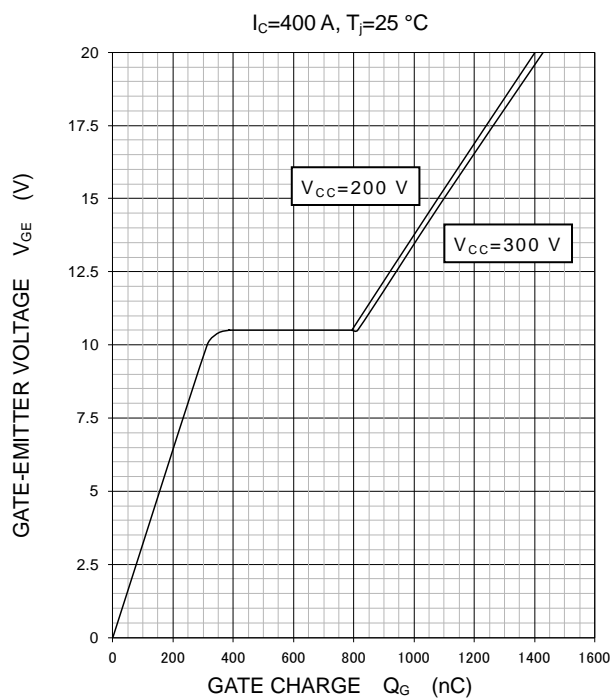
CAPACITANCE  
CHARACTERISTICS  
(TYPICAL)



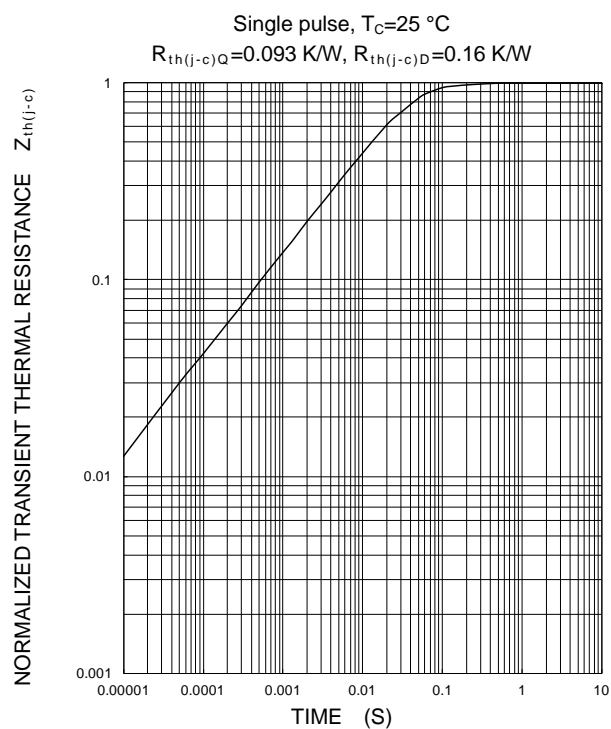
FREE WHEELING DIODE  
REVERSE RECOVERY CHARACTERISTICS  
(TYPICAL)



GATE CHARGE  
CHARACTERISTICS  
(TYPICAL)



TRANSIENT THERMAL IMPEDANCE  
CHARACTERISTICS  
(MAXIMUM)





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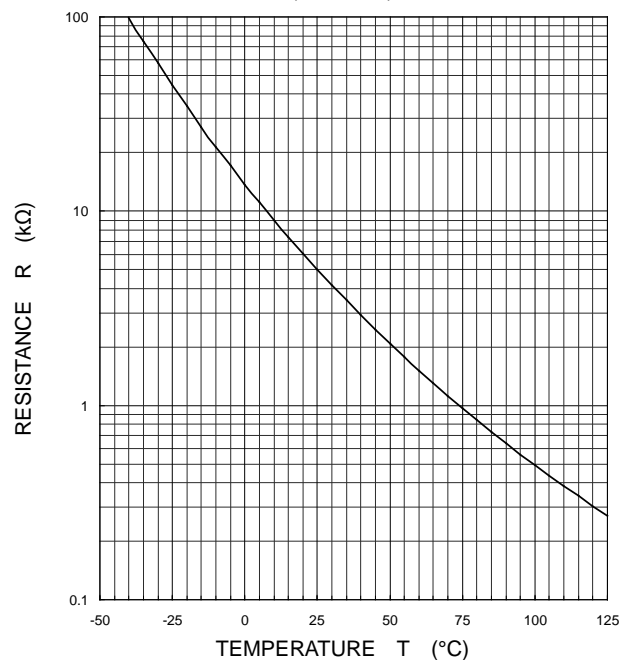
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## PERFORMANCE CURVES

NTC thermistor part

### TEMPERATURE CHARACTERISTICS

(TYPICAL)



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