

<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

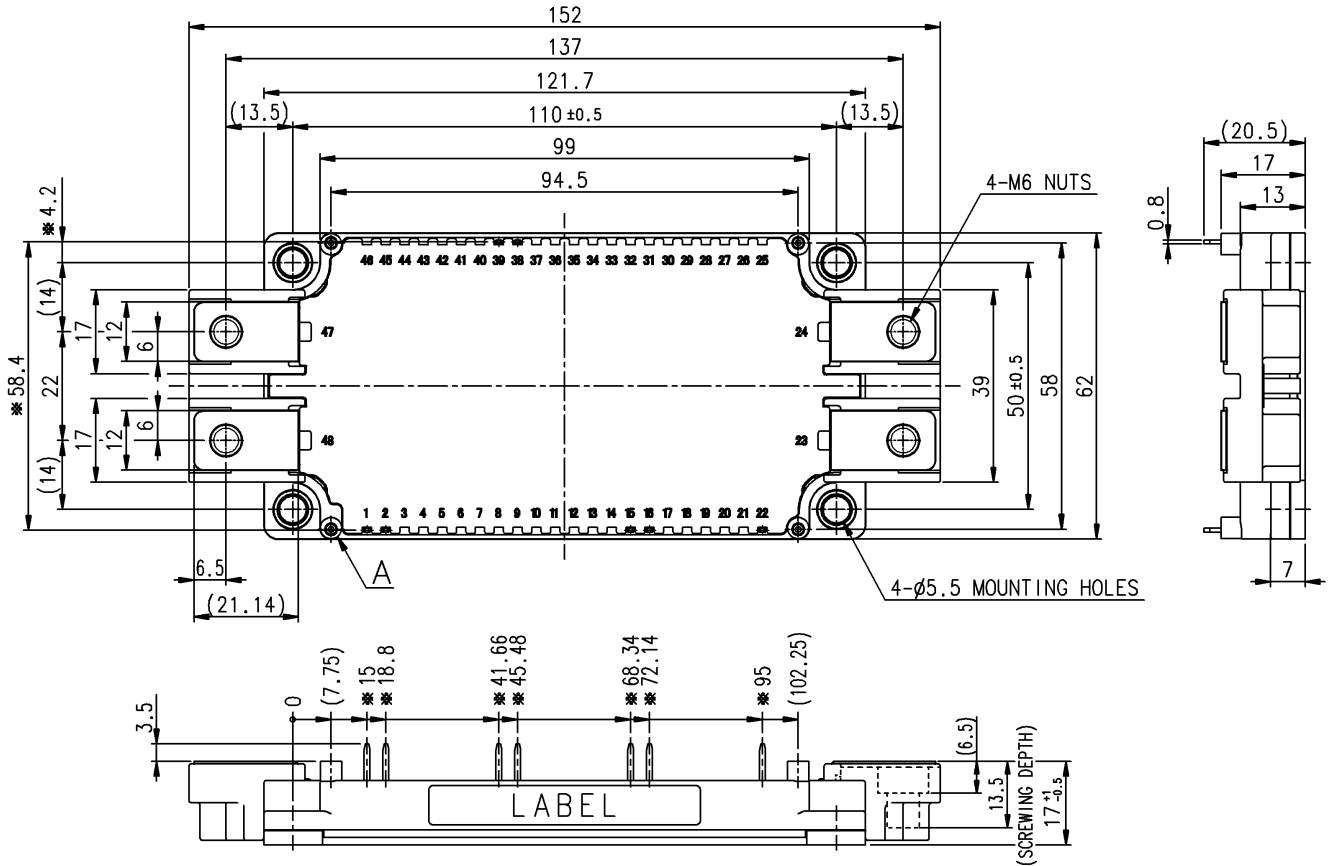
- Flat base Type
- Copper base plate (non-plating)
- RoHS Directive compliant
- Recognized under UL1557, File E323585

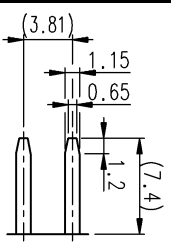
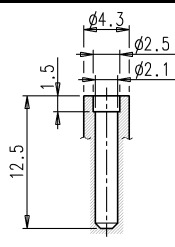
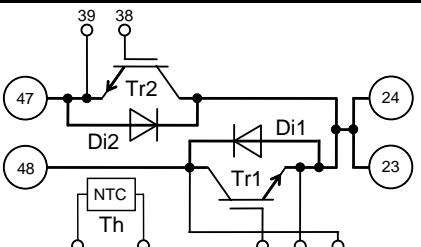
## APPLICATION

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	±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

※: Dimensions with a  
Tolerance of  $\begin{matrix} \square \\ \oplus \end{matrix} \phi 0.5$

## CM400DX-12A

HIGH POWER SWITCHING USE  
INSULATED TYPEMAXIMUM 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 ~ +150	$^\circ\text{C}$
$T_{stg}$	Storage temperature	-	-40 ~ +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	-	$\Omega$	

# CM400DX-12A

HIGH POWER SWITCHING USE  
INSULATED TYPE

ELECTRICAL CHARACTERISTICS (cont.; T<sub>j</sub>=25 °C, unless otherwise specified)  
NTC THERMISTOR PART

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R <sub>25</sub>	Zero-power resistance	T <sub>C</sub> =25 °C (Note4)	4.85	5.00	5.15	kΩ
ΔR/R	Deviation of resistance	R <sub>100</sub> =493 Ω, T <sub>C</sub> =100 °C (Note4)	-7.3	-	+7.8	%
B <sub>(25/50)</sub>	B-constant	Approximate by equation (Note6)	-	3375	-	K
P <sub>25</sub>	Power dissipation	T <sub>C</sub> =25 °C (Note4)	-	-	10	mW

THERMAL RESISTANCE CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R <sub>th(j-c)Q</sub>	Thermal resistance	Junction to case, per Inverter IGBT (Note4)	-	-	0.093	K/W
R <sub>th(j-c)D</sub>		Junction to case, per Inverter DIODE (Note4)	-	-	0.16	
R <sub>th(c-s)</sub>	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 <sub>t</sub>	Mounting torque	Main terminals M 6 screw	3.5	4.0	4.5	N·m
M <sub>s</sub>	Mounting torque	Mounting to heat sink M 5 screw	2.5	3.0	3.5	N·m
d <sub>s</sub>	Creepage distance	Terminal to terminal	11.55	-	-	mm
		Terminal to base plate	12.32	-	-	
d <sub>a</sub>	Clearance	Terminal to terminal	10.00	-	-	mm
		Terminal to base plate	10.85	-	-	
m	mass	-	-	330	-	g
e <sub>c</sub>	Flatness of base plate	On the centerline X, Y (Note8)	±0	-	+100	μm

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

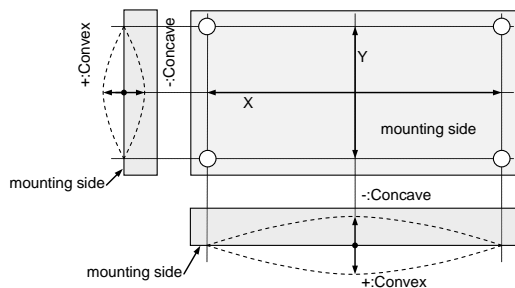
- Junction temperature (T<sub>j</sub>) should not increase beyond T<sub>jmax</sub> rating.
- Pulse width and repetition rate should be such that the device junction temperature (T<sub>j</sub>) does not exceed T<sub>jmax</sub> rating.
- Case temperature (T<sub>C</sub>) and heat sink temperature (T<sub>s</sub>) 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.

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

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]

- Typical value is measured by using thermally conductive grease of λ=0.9 W/(m·K).
- The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



- Use the following screws when mounting the printed circuit board (PCB) on the standoffs.  
"φ2.3×10 or φ2.3×12, B1 tapping screw"  
The length of the screw depends on the thickness (t1.6~t2.0) of the PCB.

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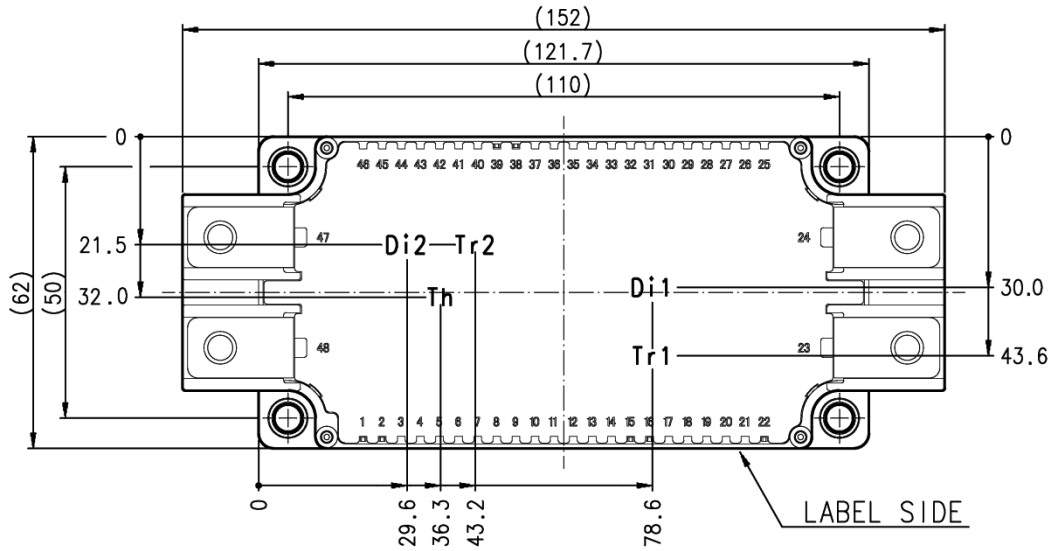
HIGH POWER SWITCHING USE  
INSULATED TYPE

## 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

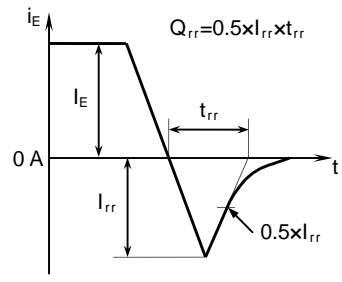
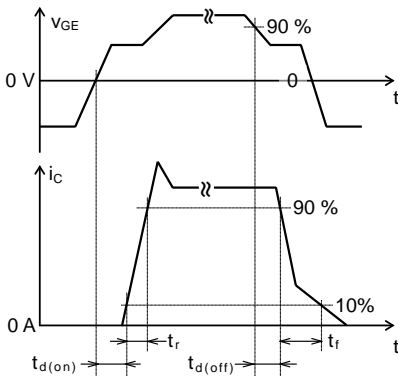
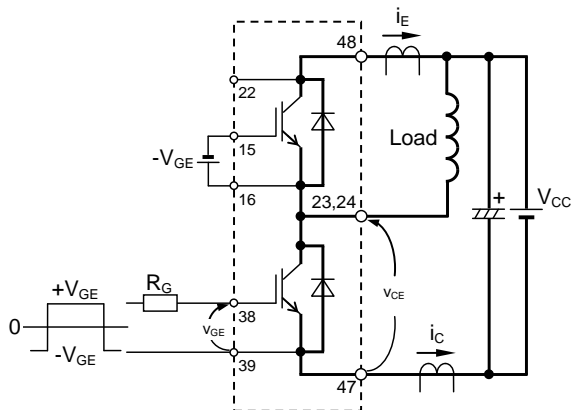


Tr1/Tr2: IGBT, Di1/Di2: DIODE, Th: NTC thermistor

# CM400DX-12A

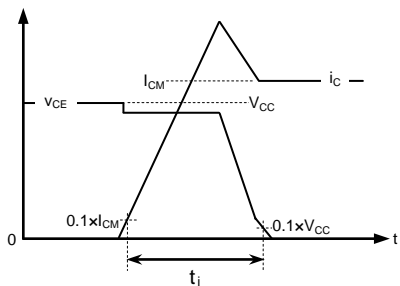
HIGH POWER SWITCHING USE  
INSULATED TYPE

## TEST CIRCUIT AND WAVEFORMS

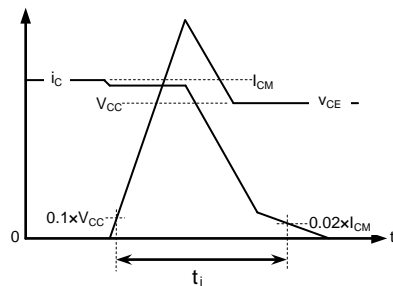


Switching test circuit and waveforms

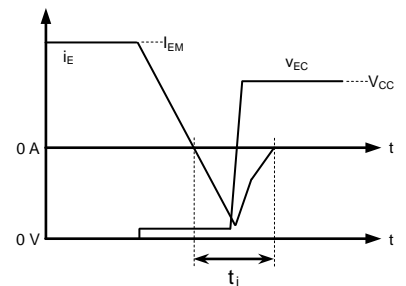
$t_{rr}$ ,  $Q_{rr}$  test waveform



IGBT Turn-on switching energy



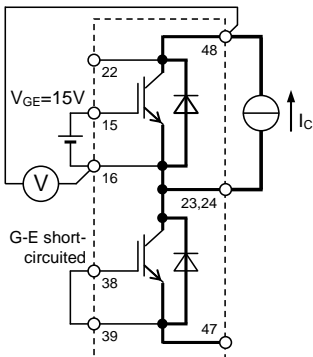
IGBT Turn-off switching energy



DIODE Reverse recovery energy

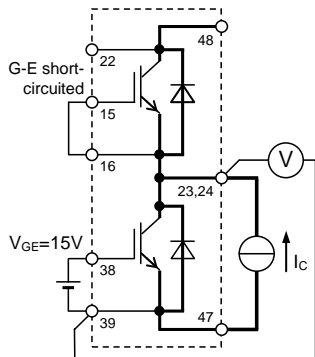
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT

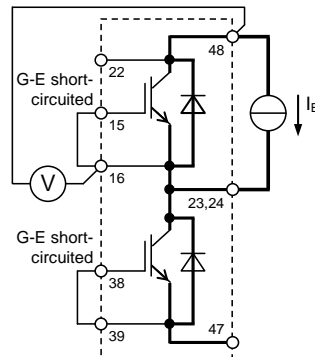


Tr1

$V_{CEsat}$  characteristics test circuit

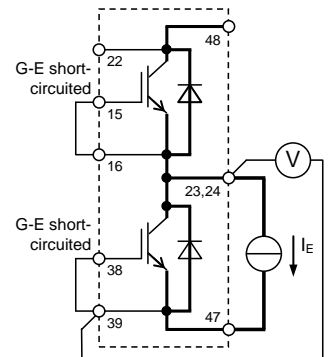


Tr2



Di1

$V_{EC}$  characteristics test circuit



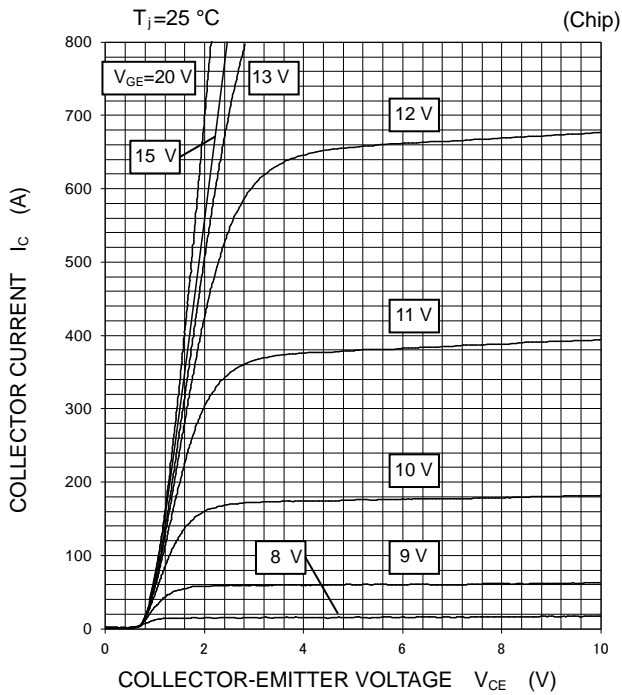
Di2

# CM400DX-12A

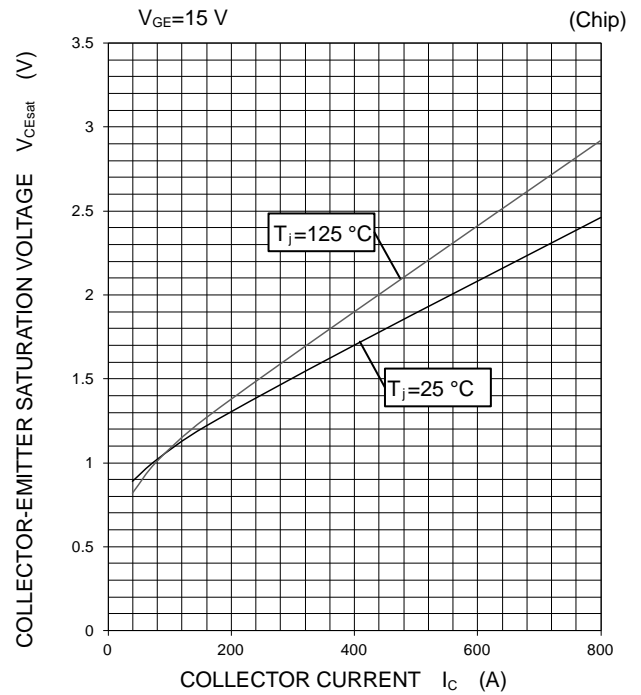
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES INVERTER PART

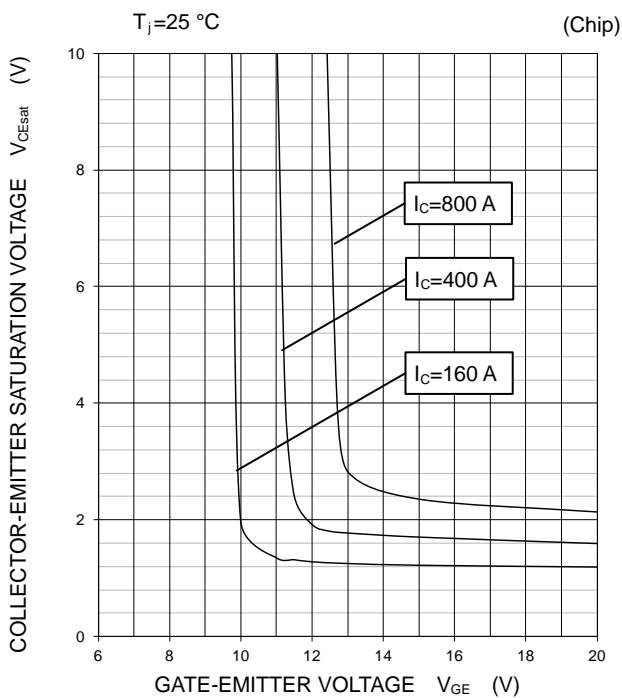
OUTPUT CHARACTERISTICS (TYPICAL)



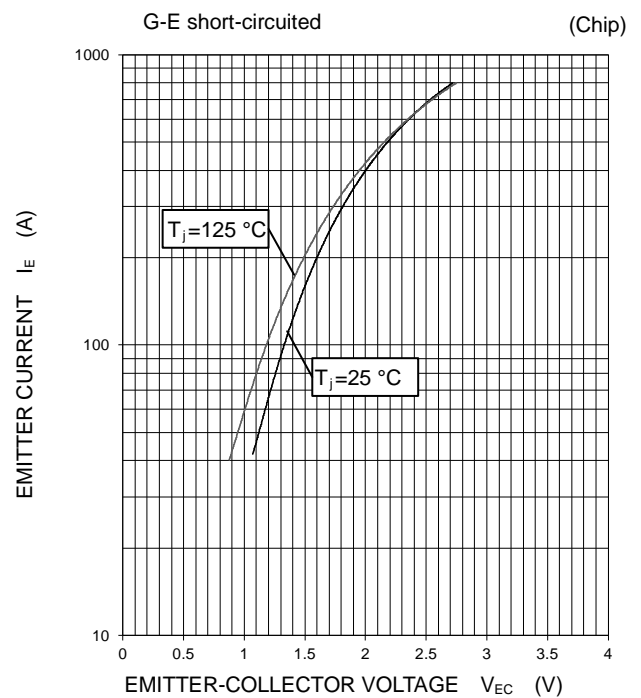
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



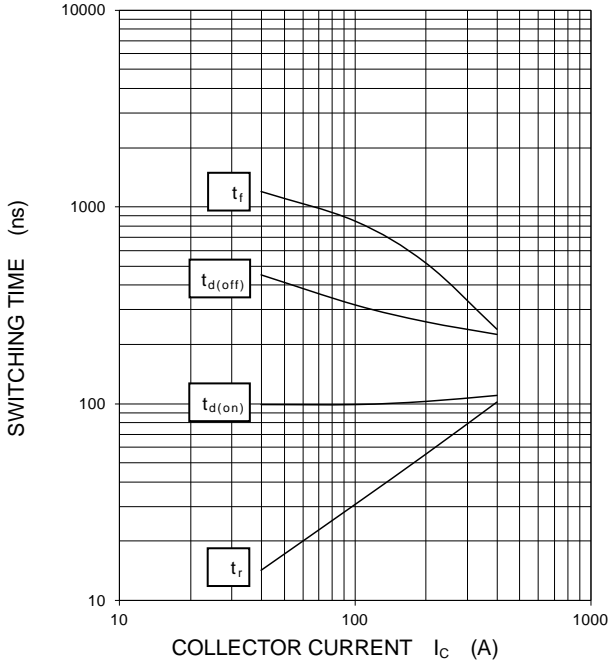
# CM400DX-12A

HIGH POWER SWITCHING USE  
INSULATED TYPE

PERFORMANCE CURVES  
INVERTER PART

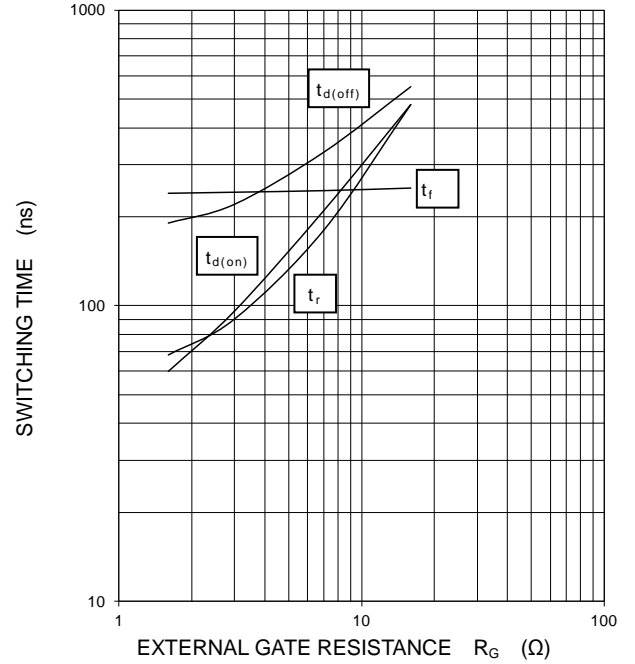
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

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



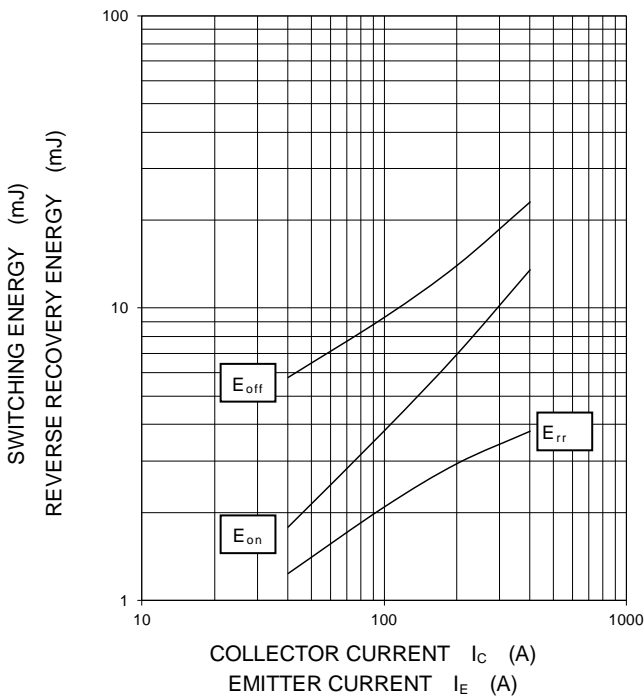
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

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



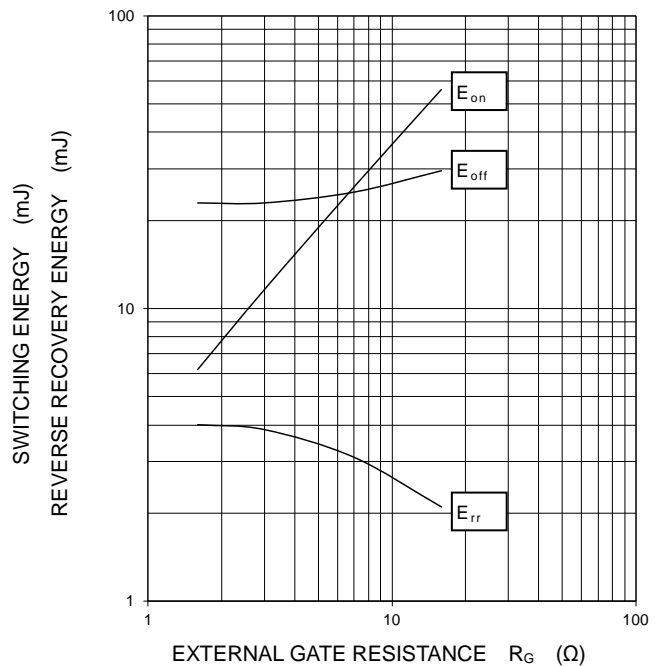
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

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

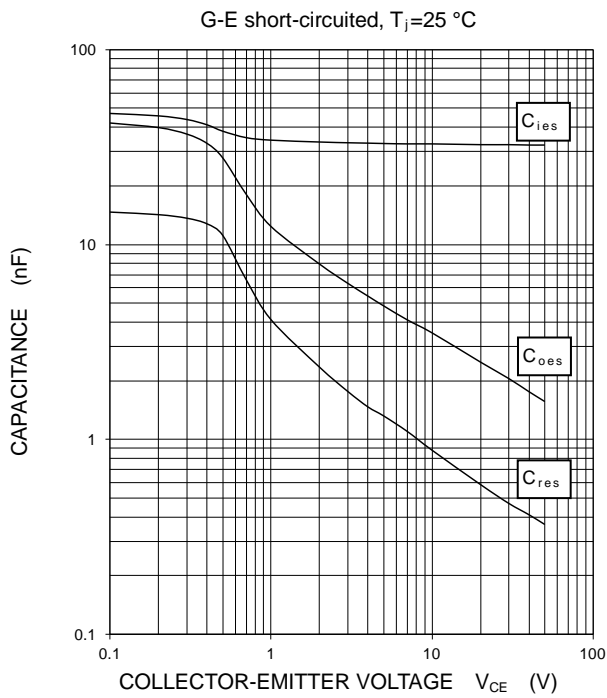


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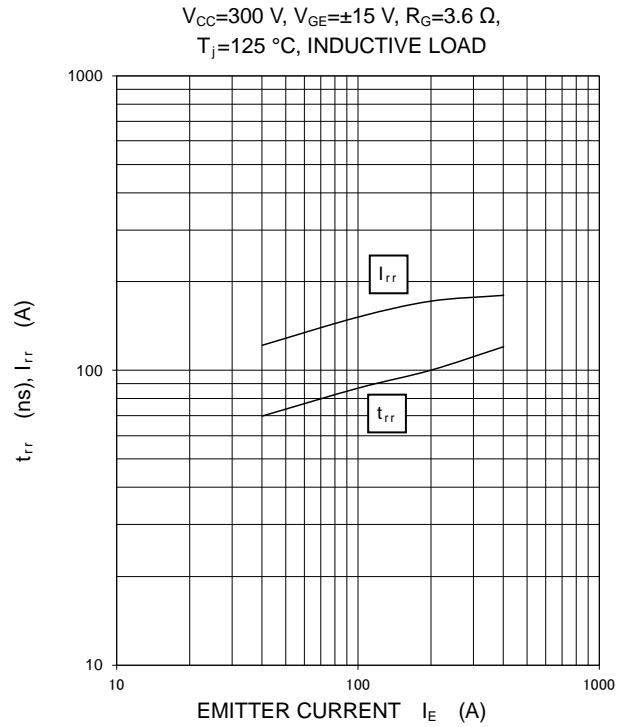
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES INVERTER PART

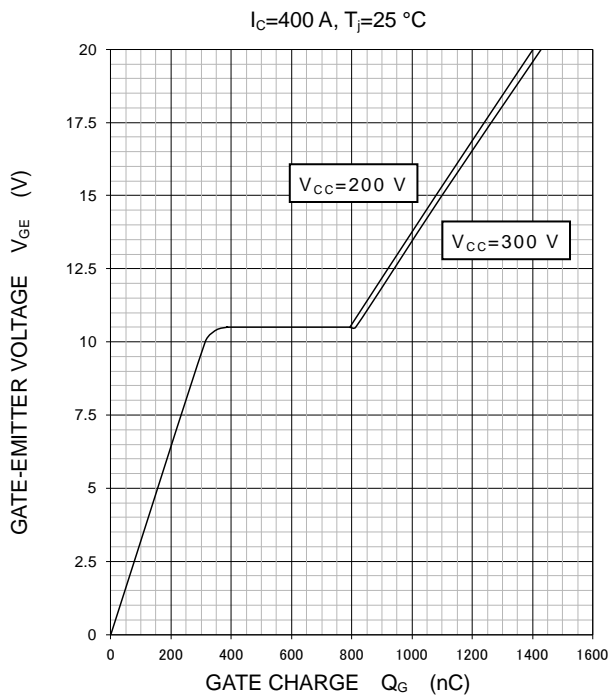
CAPACITANCE CHARACTERISTICS (TYPICAL)



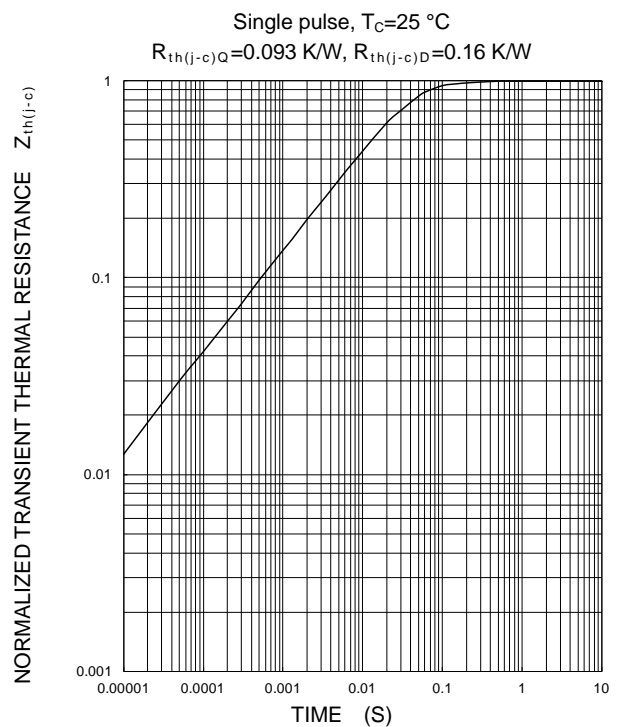
FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



GATE CHARGE CHARACTERISTICS (TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)





# CM400DX-12A

HIGH POWER SWITCHING USE  
INSULATED TYPE

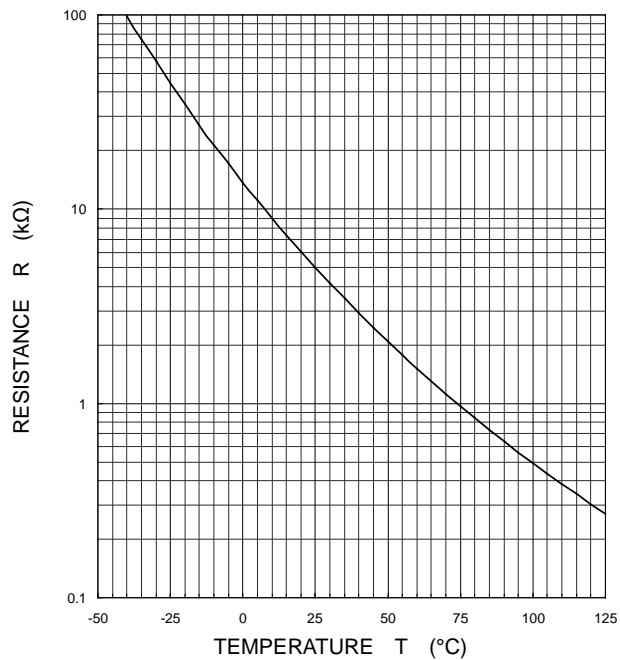
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## PERFORMANCE CURVES

NTC thermistor part

### TEMPERATURE CHARACTERISTICS

(TYPICAL)



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