

<IGBT Modules>

# CM600DX-24S1

HIGH POWER SWITCHING USE  
INSULATED TYPE



dual switch (Half-Bridge)

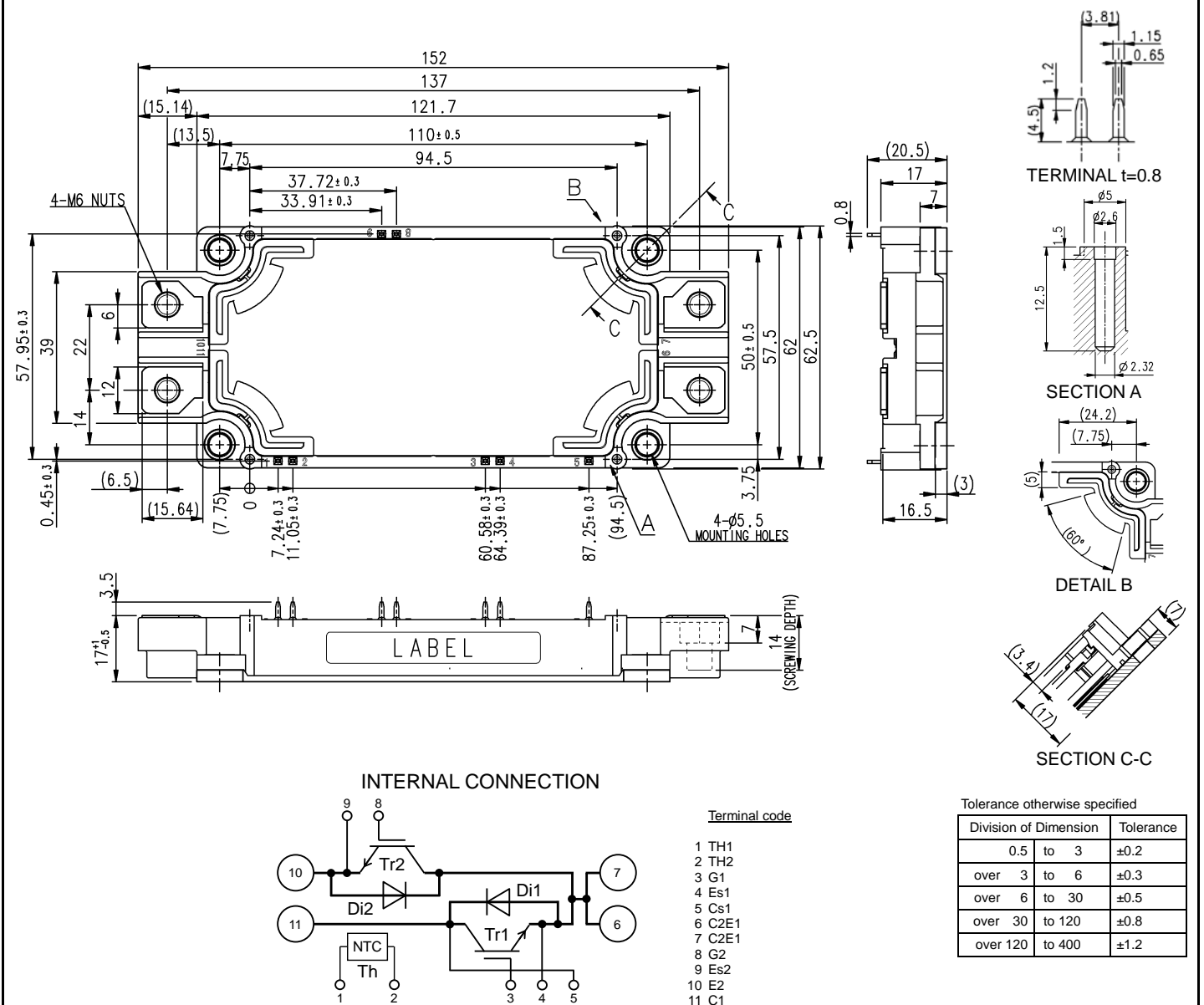
Collector current  $I_c$  ..... 600 A  
 Collector-emitter voltage  $V_{CES}$  ..... 1200 V  
 Maximum junction temperature  $T_{jmax}$  ..... 175 °C

- Flat base Type
- Copper base plate (non-plating)
- Tin plating pin terminals
- RoHS Directive compliant
- UL Recognized under UL1557, File No. E323585

## APPLICATION

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

## OUTLINE DRAWING & INTERNAL CONNECTION



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

## INVERTER PART IGBT/FWD

Symbol	Item	Conditions	Rating	Unit
$V_{CES}$	Collector-emitter voltage	G-E short-circuited	1200	V
$V_{GES}$	Gate-emitter voltage	C-E short-circuited	$\pm 20$	V
$I_C$	Collector current	DC, $T_C=94\text{ }^\circ\text{C}$ (Note2, 4)	600	A
$I_{CRM}$		Pulse, Repetitive, $V_{GE}=15\text{ V}$ (Note3)	1200	
$P_{tot}$	Total power dissipation	$T_C=25\text{ }^\circ\text{C}$ (Note2, 4)	3330	W
$I_E$ (Note1)	Emitter current	DC (Note2)	600	A
$I_{ERM}$ (Note1)		Pulse, Repetitive (Note3)	1200	

## MODULE

Symbol	Item	Conditions	Rating	Unit
$V_{isol}$	Isolation voltage	Terminals to base plate, RMS, $f=60\text{ Hz}$ , AC 1 min	4000	V
$T_{jmax}$	Maximum junction temperature	Instantaneous event (overload)	175	$^\circ\text{C}$
$T_{Cmax}$	Maximum case temperature	(Note4)	125	
$T_{jop}$	Operating junction temperature	Continuous operation (under switching)	-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/FWD

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	$I_C=60\text{ mA}$ , $V_{CE}=10\text{ V}$	5.4	6.0	6.6	V	
$V_{CESat}$ (Terminal)	Collector-emitter saturation voltage	$I_C=600\text{ A}$ , $V_{GE}=15\text{ V}$ , Refer to the figure of test circuit (Note5)	$T_j=25\text{ }^\circ\text{C}$	-	2.00	2.45	V
			$T_j=125\text{ }^\circ\text{C}$	-	2.30	-	
			$T_j=150\text{ }^\circ\text{C}$	-	2.40	-	
$V_{CESat}$ (Chip)		$I_C=600\text{ A}$ , $V_{GE}=15\text{ V}$ , (Note5)	$T_j=25\text{ }^\circ\text{C}$	-	1.85	2.35	V
			$T_j=125\text{ }^\circ\text{C}$	-	2.10	-	
			$T_j=150\text{ }^\circ\text{C}$	-	2.15	-	
$C_{ies}$	Input capacitance	$V_{CE}=10\text{ V}$ , G-E short-circuited	-	-	50	nF	
$C_{oes}$	Output capacitance		-	-	10		
$C_{res}$	Reverse transfer capacitance		-	-	0.83		
$Q_G$	Gate charge	$V_{CC}=600\text{ V}$ , $I_C=600\text{ A}$ , $V_{GE}=15\text{ V}$	-	1050	-	nC	
$t_{d(on)}$	Turn-on delay time	$V_{CC}=600\text{ V}$ , $I_C=600\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=0\text{ }\Omega$ , Inductive load	-	-	800	ns	
$t_r$	Rise time		-	-	200		
$t_{d(off)}$	Turn-off delay time		-	-	600		
$t_f$	Fall time		-	-	300		
$V_{EC}$ (Note1) (Terminal)	Emitter-collector voltage	$I_E=600\text{ A}$ , G-E short-circuited, Refer to the figure of test circuit (Note5)	$T_j=25\text{ }^\circ\text{C}$	-	2.8	3.60	V
			$T_j=125\text{ }^\circ\text{C}$	-	2.4	-	
			$T_j=150\text{ }^\circ\text{C}$	-	2.3	-	
$V_{EC}$ (Note1) (Chip)		$I_E=600\text{ A}$ , G-E short-circuited, (Note5)	$T_j=25\text{ }^\circ\text{C}$	-	2.7	3.50	V
			$T_j=125\text{ }^\circ\text{C}$	-	2.3	-	
			$T_j=150\text{ }^\circ\text{C}$	-	2.2	-	
$t_{rr}$ (Note1)	Reverse recovery time	$V_{CC}=600\text{ V}$ , $I_E=600\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=0\text{ }\Omega$ , Inductive load	-	-	300	ns	
$Q_{rr}$ (Note1)	Reverse recovery charge	$R_G=0\text{ }\Omega$ , Inductive load	-	16	-	$\mu\text{C}$	
$E_{on}$	Turn-on switching energy per pulse	$V_{CC}=600\text{ V}$ , $I_C=I_E=600\text{ A}$ ,	-	91.5	-	mJ	
$E_{off}$	Turn-off switching energy per pulse	$V_{GE}=\pm 15\text{ V}$ , $R_G=0\text{ }\Omega$ , $T_j=150\text{ }^\circ\text{C}$ ,	-	63.1	-		
$E_{rr}$ (Note1)	Reverse recovery energy per pulse	Inductive load	-	36.1	-	mJ	
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, $T_C=25\text{ }^\circ\text{C}$ (Note4)	-	-	0.4	m $\Omega$	
$r_g$	Internal gate resistance	Per switch	-	5.0	-	$\Omega$	

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HIGH POWER SWITCHING USE  
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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)	-	-	45	K/kW
R <sub>th(j-c)D</sub>		Junction to case, per Inverter FWD (Note4)	-	-	72	
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
m	mass	-	-	350	-	g
d <sub>s</sub>	Creepage distance	Terminal to terminal	17	-	-	mm
		Terminal to base plate	18.5	-	-	
d <sub>a</sub>	Clearance	Terminal to terminal	10	-	-	mm
		Terminal to base plate	16.3	-	-	
e <sub>c</sub>	Flatness of base plate	On the centerline X, Y (Note8)	±0	-	+100	μm

\*. 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<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>) dose 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.

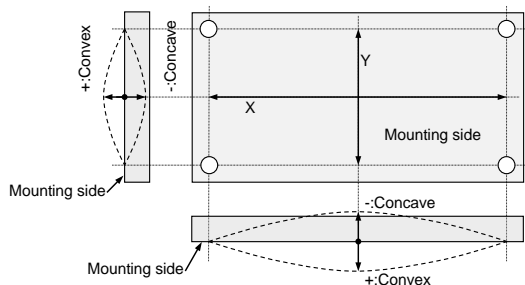
$$6. B_{(25/50)} = \ln\left(\frac{R_{25}}{R_{50}}\right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}}\right)$$

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]

7. Typical value is measured by using thermally conductive grease of λ=0.9 W/(m·K).

8. The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.



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Note9 Use the following screws when mounting the printed circuit board (PCB) on the standoffs.

PCB thickness : t=1.6

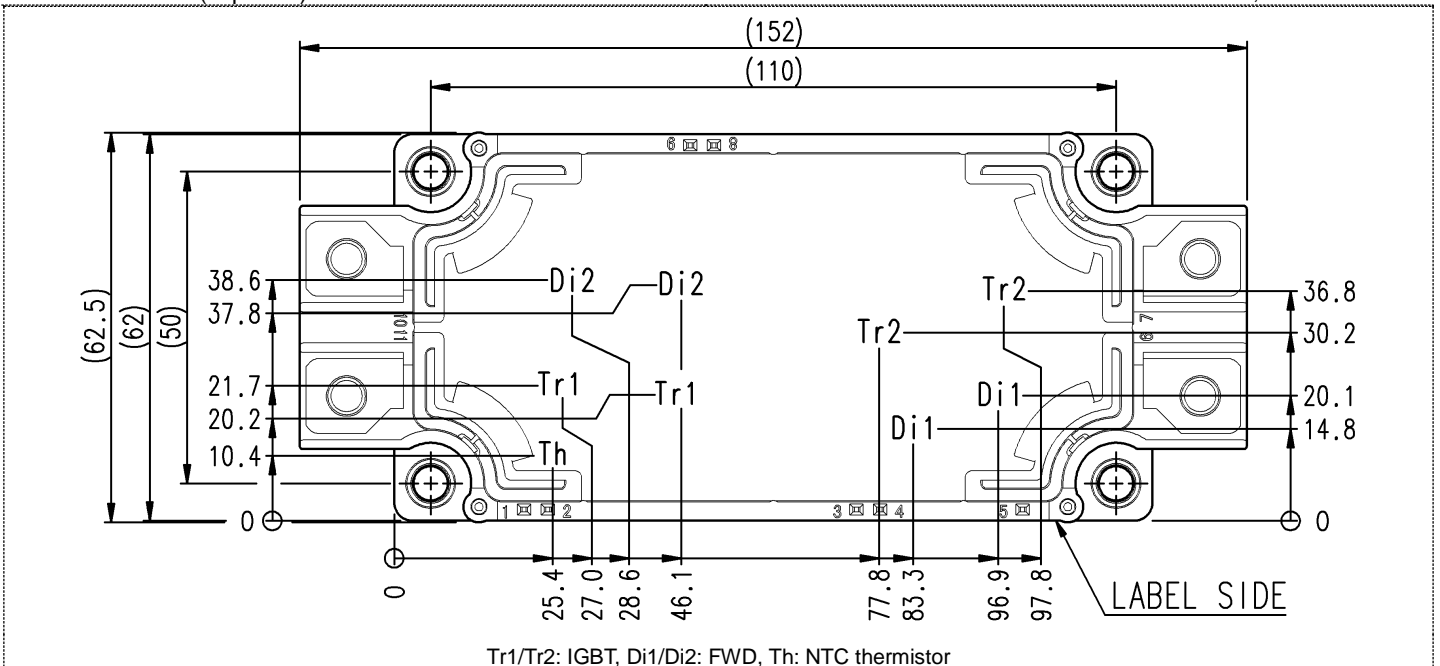
Type	Manufacturer	Size	Tightening torque (N·m)	Recommended tightening method
(1) PT®	EJOT	K25×8	0.55 ± 0.055	by handwork (equivalent to 30 rpm by mechanical screw driver) ~ 600 rpm (by mechanical screw driver)
(2) PT®		K25×10	0.75 ± 0.075	
(3) DELTA PT®		25×8	0.55 ± 0.055	
(4) DELTA PT®		25×10	0.75 ± 0.075	
(5) B1 tapping screw	-	φ2.6×10	0.75 ± 0.075	
		φ2.6×12		

## RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V <sub>CC</sub>	(DC) Supply voltage	Applied across C1-E2 terminals	-	600	850	V
V <sub>GEon</sub>	Gate (-emitter drive) voltage	Applied across G1-Es1/G2-Es2 terminals	14.0	15.0	16.5	V
R <sub>G</sub>	External gate resistance	Per switch	0	-	6.8	Ω

## CHIP LOCATION (Top view)

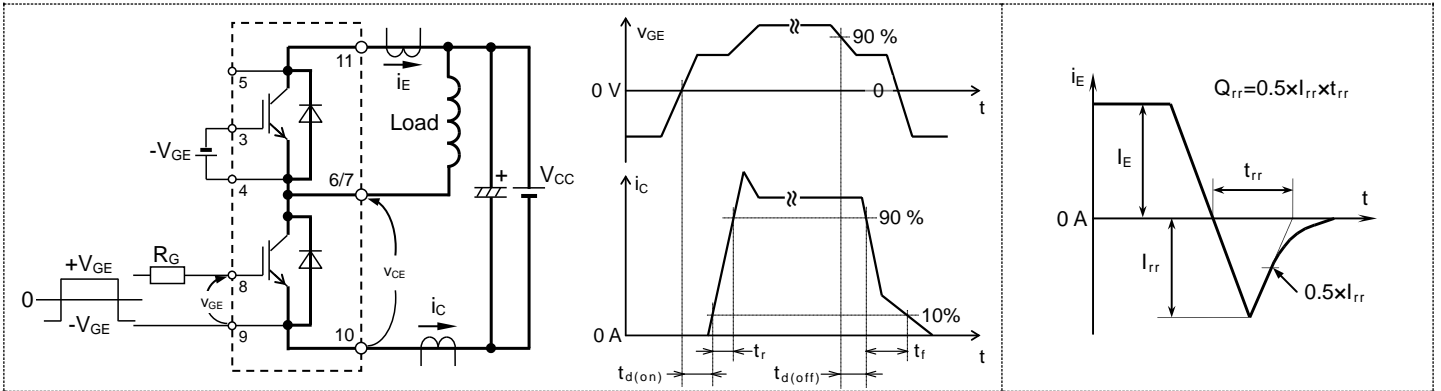
Dimension in mm, tolerance: ±1 mm



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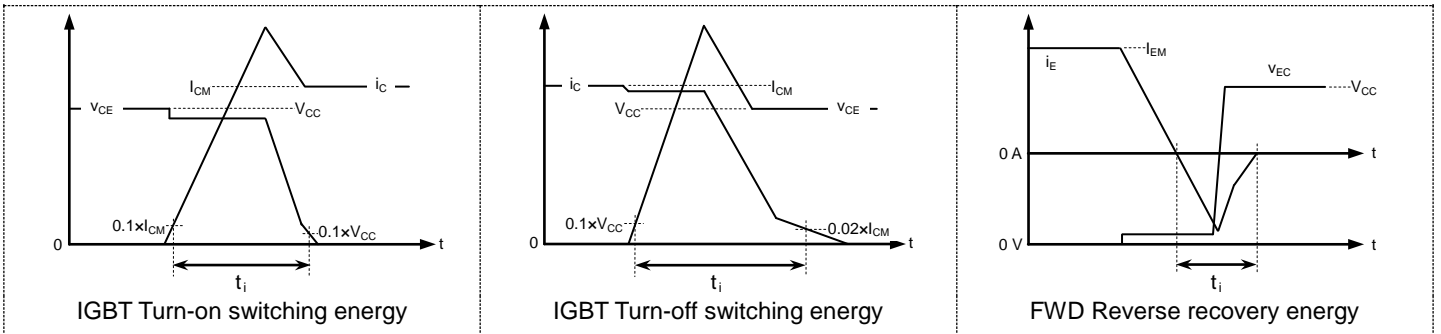
HIGH POWER SWITCHING USE  
INSULATED TYPE

## TEST CIRCUIT AND WAVEFORMS



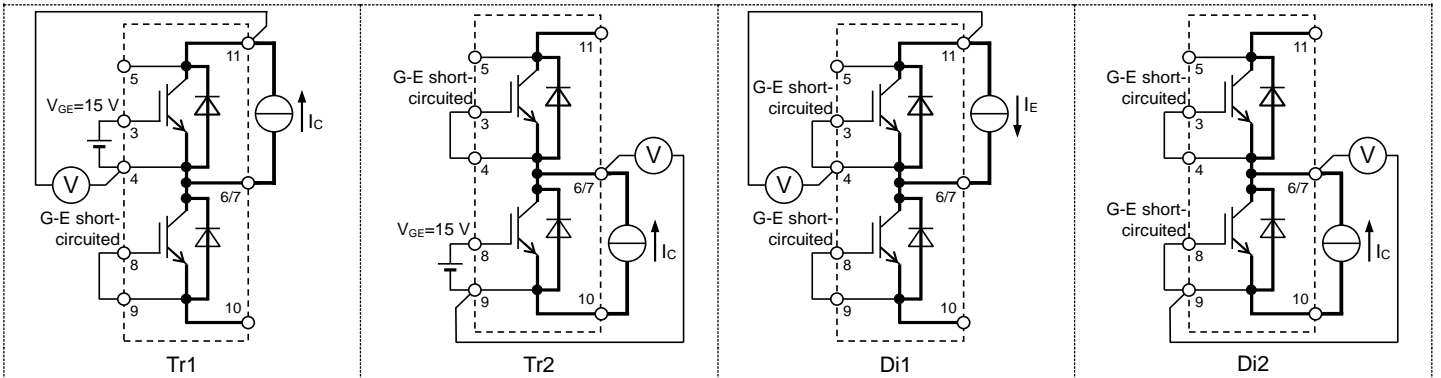
Switching characteristics test circuit and waveforms

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



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

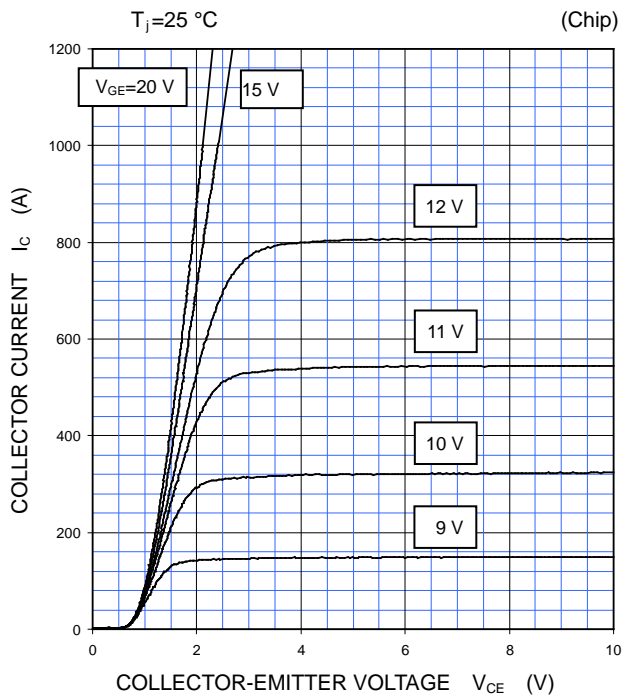
# CM600DX-24S1

HIGH POWER SWITCHING USE  
INSULATED TYPE

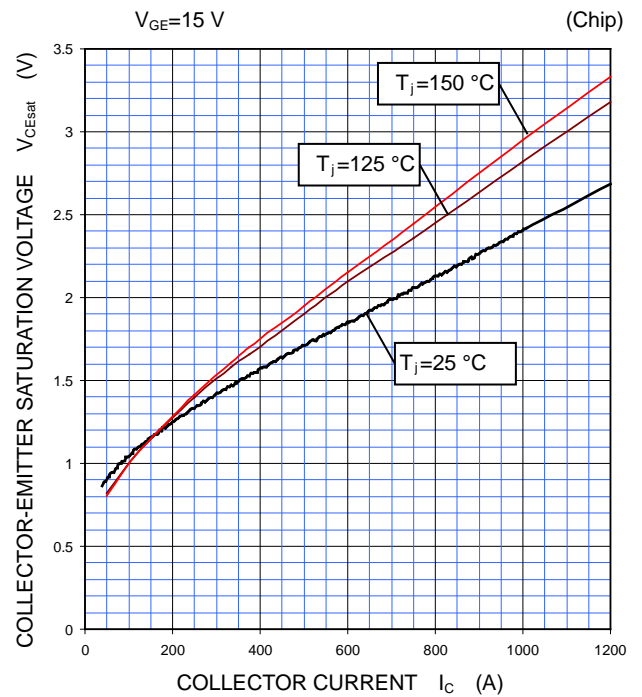
## PERFORMANCE CURVES

### INVERTER PART

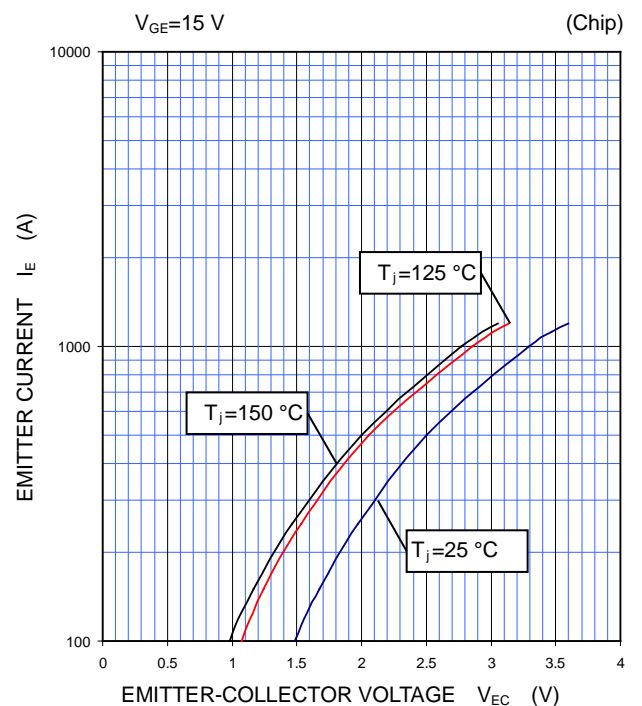
#### OUTPUT CHARACTERISTICS (TYPICAL)



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



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



# CM600DX-24S1

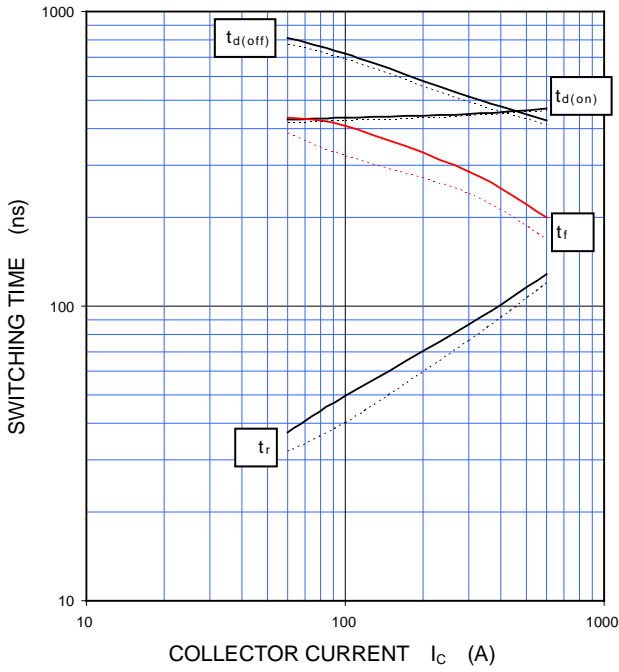
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

### INVERTER PART

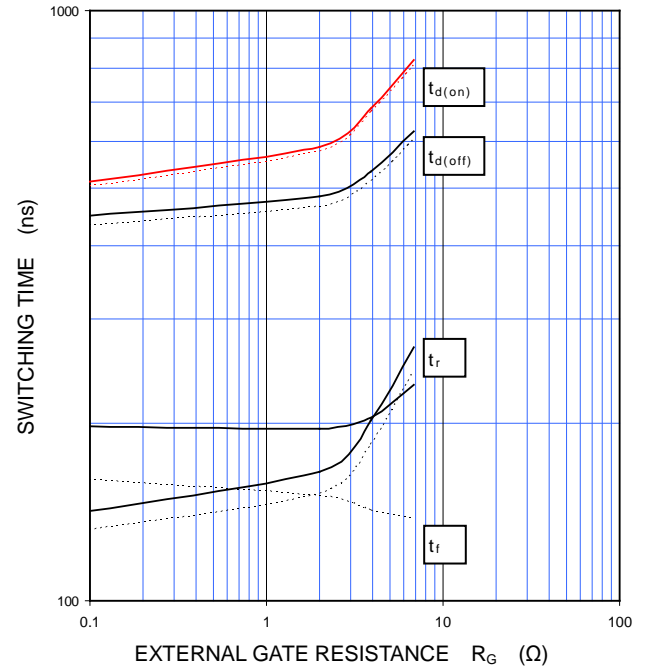
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0\ \Omega$ , INDUCTIVE LOAD  
 —:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



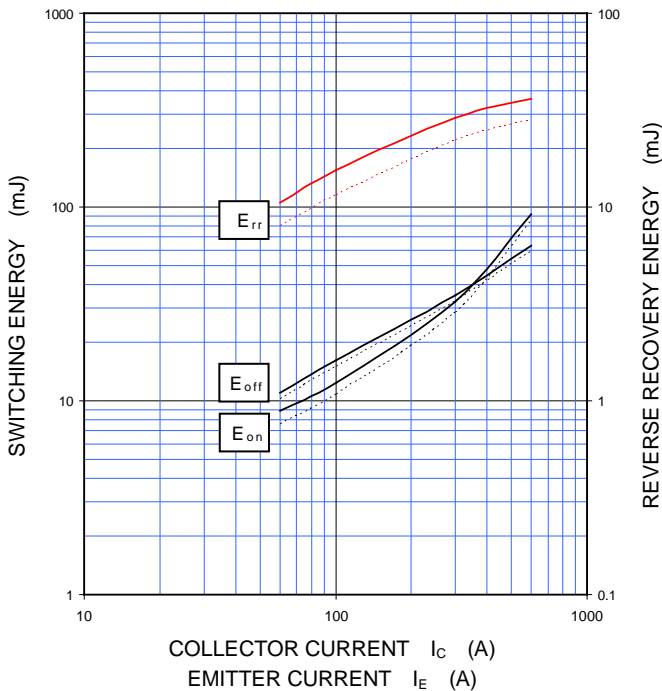
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C=600\text{ A}$ , INDUCTIVE LOAD  
 —:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



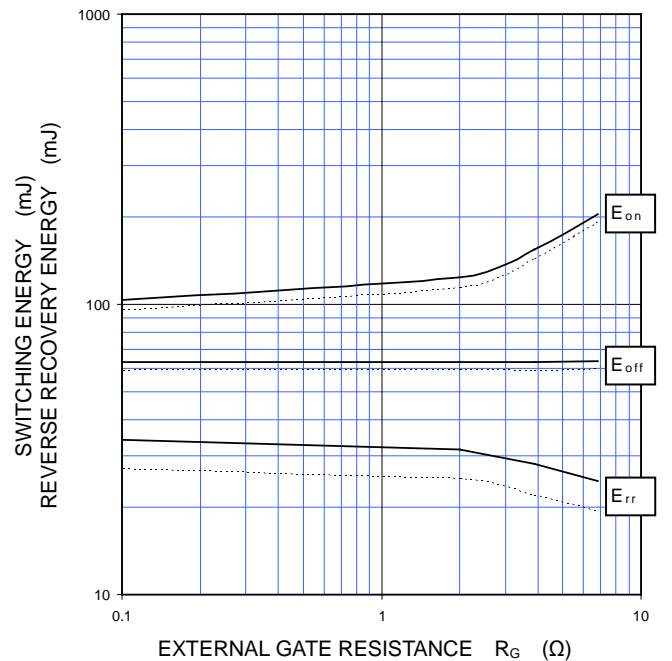
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0\ \Omega$ ,  
INDUCTIVE LOAD, PER PULSE  
 —:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C/I_E=600\text{ A}$ ,  
INDUCTIVE LOAD, PER PULSE  
 —:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



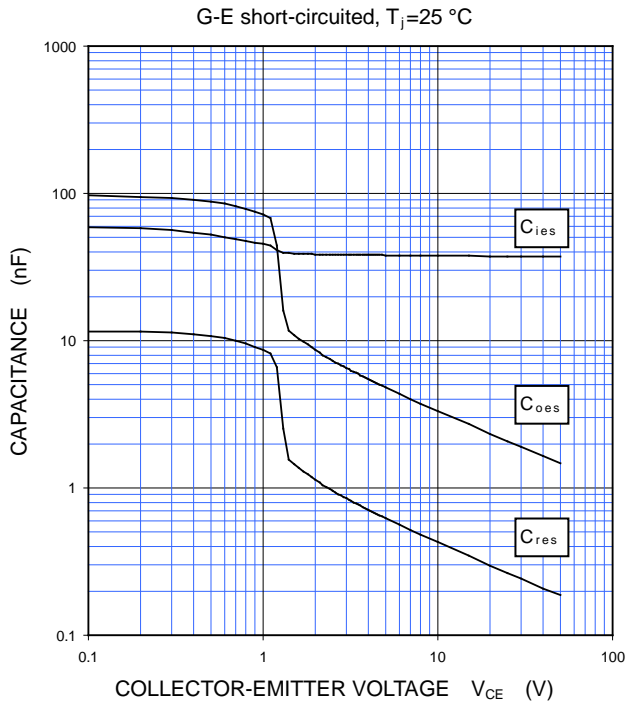
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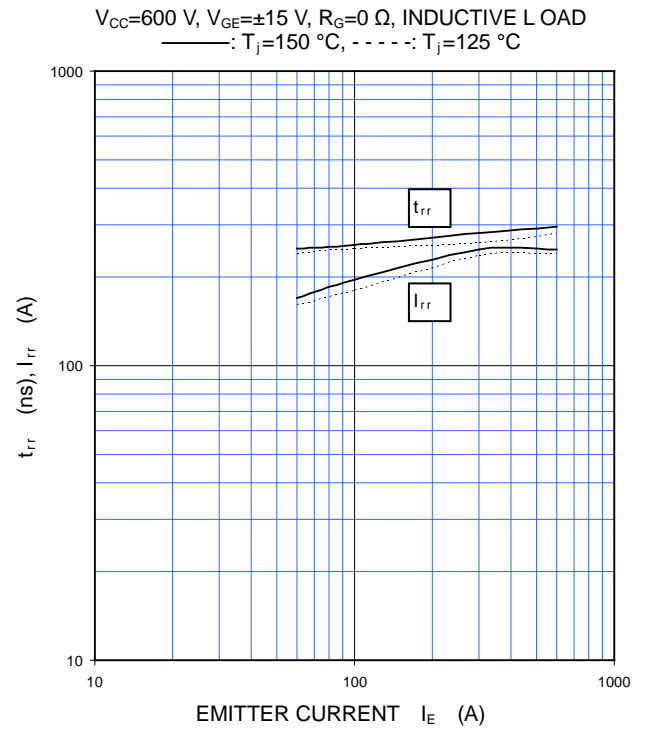
## PERFORMANCE CURVES

### INVERTER PART

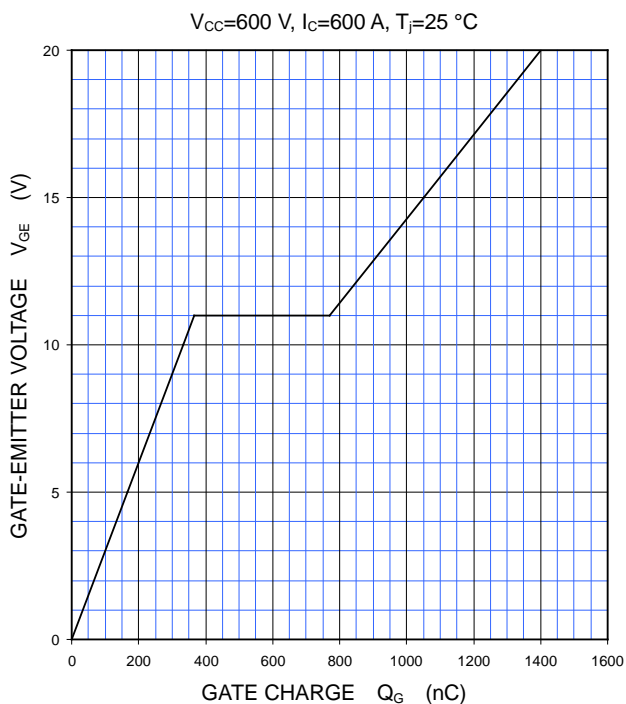
CAPACITANCE CHARACTERISTICS  
(TYPICAL)



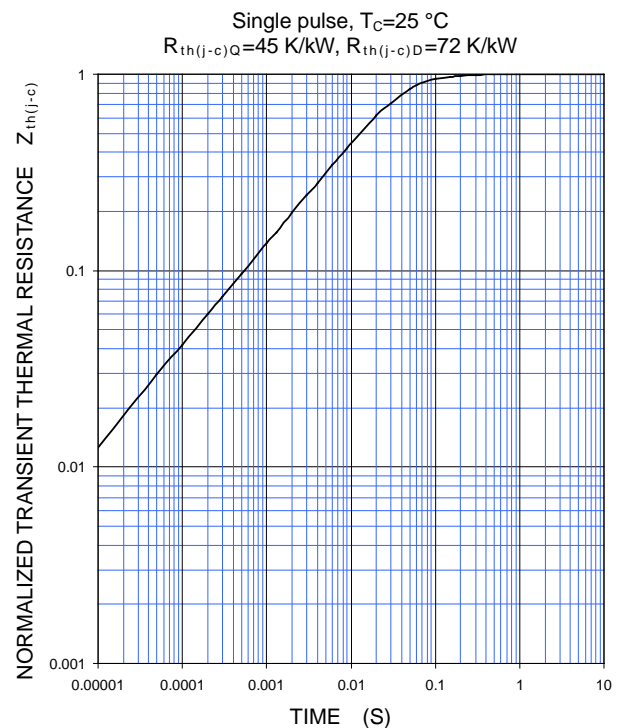
FREE WHEELING DIODE  
REVERSE RECOVERY CHARACTERISTICS  
(TYPICAL)



GATE CHARGE CHARACTERISTICS  
(TYPICAL)



TRANSIENT THERMAL IMPEDANCE  
CHARACTERISTICS  
(MAXIMUM)





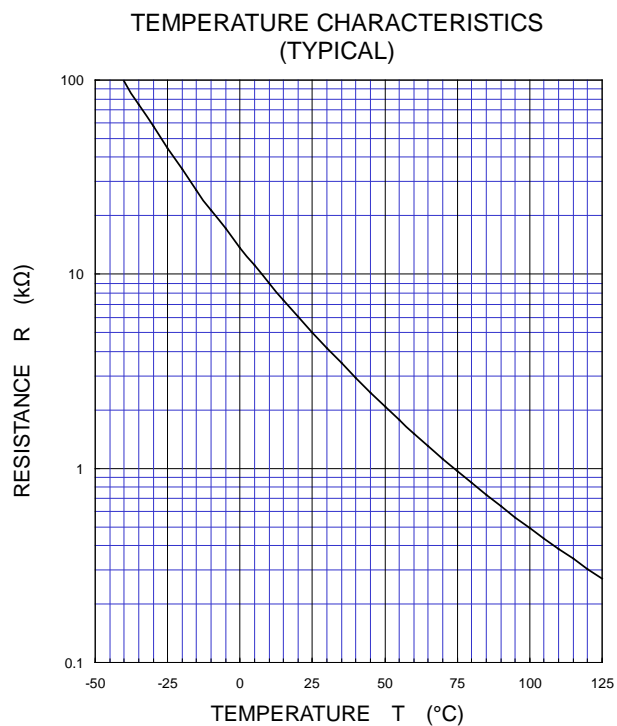
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HIGH POWER SWITCHING USE

INSULATED TYPE

## PERFORMANCE CURVES

NTC thermistor part



### **Keep safety first in your circuit designs!**

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