

< IGBT MODULES >

# CM600DX-24S1

HIGH POWER SWITCHING USE  
INSULATED TYPE



**Dual switch (Half-Bridge)**

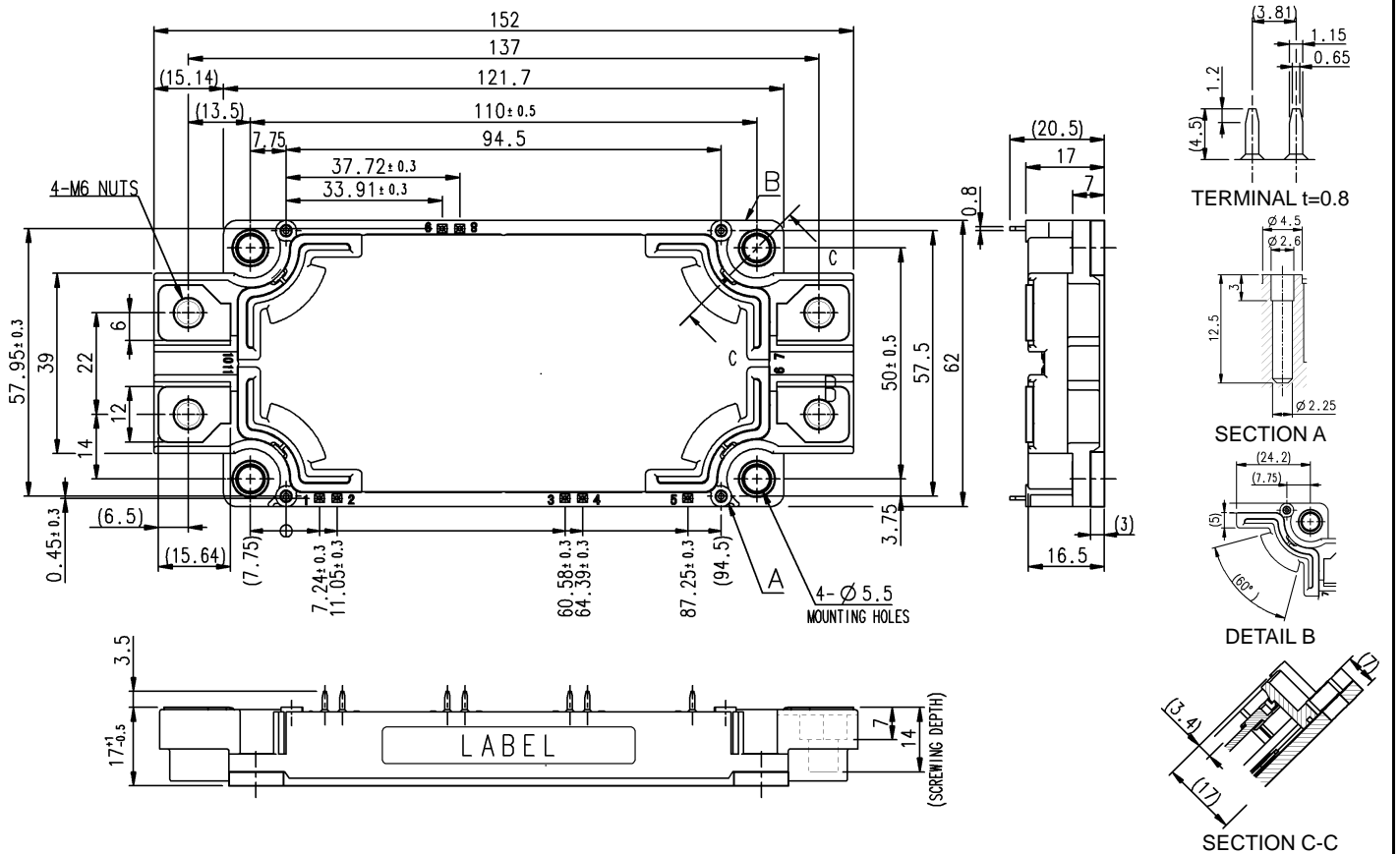
Collector current  $I_C$  ..... **600 A**  
 Collector-emitter voltage  $V_{CES}$  ..... **1200 V**  
 Maximum junction temperature  $T_{jmax}$  ..... **175 °C**

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

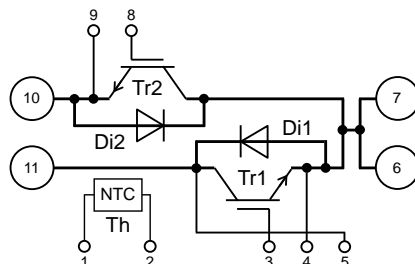
## APPLICATION

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

## OUTLINE DRAWING & INTERNAL CONNECTION



### INTERNAL CONNECTION



### Terminal code

- 1 TH1
- 2 TH2
- 3 G1
- 4 Es1
- 5 Cs1
- 6 C2E1
- 7 C2E1
- 8 G2
- 9 Es2
- 10 E2
- 11 C1

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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MAXIMUM RATINGS (T<sub>j</sub>=25 °C, unless otherwise specified)

INVERTER PART IGBT/DIODE

Symbol	Item	Conditions	Rating	Unit
V <sub>CEs</sub>	Collector-emitter voltage	G-E short-circuited	1200	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> =94 °C (Note2, 4)	600	A
I <sub>CRM</sub>		Pulse, Repetitive, V <sub>GE</sub> =15 V (Note3)	1200	
P <sub>tot</sub>	Total power dissipation	T <sub>C</sub> =25 °C (Note2, 4)	3330	W
I <sub>E</sub> (Note1)	Emitter current	DC (Note2)	600	A
I <sub>ERM</sub> (Note1)		Pulse, Repetitive (Note3)	1200	

MODULE

Symbol	Item	Conditions	Rating	Unit
V <sub>isol</sub>	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	4000	V
T <sub>jmax</sub>	Maximum junction temperature	Instantaneous event (overload)	175	°C
T <sub>Cmax</sub>	Maximum case temperature	(Note4)	125	
T <sub>jop</sub>	Operating junction temperature	Continuous operation (under switching)	-40 ~ +150	°C
T <sub>stg</sub>	Storage temperature	-	-40 ~ +125	

ELECTRICAL CHARACTERISTICS (T<sub>j</sub>=25 °C, unless otherwise specified)

INVERTER PART IGBT/DIODE

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> =60 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> =600 A, V <sub>GE</sub> =15 V, Refer to the figure of test circuit (Note5)	T <sub>j</sub> =25 °C	-	2.00	2.45	V
			T <sub>j</sub> =125 °C	-	2.30	-	
			T <sub>j</sub> =150 °C	-	2.40	-	
V <sub>CEsat</sub> (Chip)	Collector-emitter saturation voltage	I <sub>C</sub> =600 A, V <sub>GE</sub> =15 V, (Note5)	T <sub>j</sub> =25 °C	-	1.85	2.35	V
			T <sub>j</sub> =125 °C	-	2.10	-	
			T <sub>j</sub> =150 °C	-	2.15	-	
C <sub>ies</sub>	Input capacitance	V <sub>CE</sub> =10 V, G-E short-circuited	-	-	50	nF	
C <sub>oes</sub>	Output capacitance		-	-	10		
C <sub>res</sub>	Reverse transfer capacitance		-	-	0.83		
Q <sub>G</sub>	Gate charge	V <sub>CC</sub> =600 V, I <sub>C</sub> =600 A, V <sub>GE</sub> =15 V	-	1050	-	nC	
t <sub>d(on)</sub>	Turn-on delay time	V <sub>CC</sub> =600 V, I <sub>C</sub> =600 A, V <sub>GE</sub> =±15 V, R <sub>G</sub> =0 Ω, Inductive load	-	-	800	ns	
t <sub>r</sub>	Rise time		-	-	200		
t <sub>d(off)</sub>	Turn-off delay time		-	-	600		
t <sub>f</sub>	Fall time		-	-	300		
V <sub>EC</sub> (Note1) (Terminal)	Emitter-collector voltage	I <sub>E</sub> =600 A, G-E short-circuited, Refer to the figure of test circuit (Note5)	T <sub>j</sub> =25 °C	-	2.8	3.60	V
			T <sub>j</sub> =125 °C	-	2.4	-	
			T <sub>j</sub> =150 °C	-	2.3	-	
V <sub>EC</sub> (Note1) (Chip)	Emitter-collector voltage	I <sub>E</sub> =600 A, G-E short-circuited, (Note5)	T <sub>j</sub> =25 °C	-	2.7	3.50	V
			T <sub>j</sub> =125 °C	-	2.3	-	
			T <sub>j</sub> =150 °C	-	2.2	-	
t <sub>rr</sub> (Note1)	Reverse recovery time	V <sub>CC</sub> =600 V, I <sub>E</sub> =600 A, V <sub>GE</sub> =±15 V,	-	-	300	ns	
Q <sub>rr</sub> (Note1)	Reverse recovery charge	R <sub>G</sub> =0 Ω, Inductive load	-	16	-	µC	
E <sub>on</sub>	Turn-on switching energy per pulse	V <sub>CC</sub> =600 V, I <sub>C</sub> =I <sub>E</sub> =600 A,	-	91.5	-	mJ	
E <sub>off</sub>	Turn-off switching energy per pulse	V <sub>GE</sub> =±15 V, R <sub>G</sub> =0 Ω, T <sub>j</sub> =150 °C,	-	63.1	-		
E <sub>rr</sub> (Note1)	Reverse recovery energy per pulse	Inductive load	-	36.1	-	mJ	
R <sub>CC'+EE'</sub>	Internal lead resistance	Main terminals-chip, per switch, T <sub>C</sub> =25 °C (Note4)	-	-	0.4	mΩ	
r <sub>g</sub>	Internal gate resistance	Per switch	-	5.0	-	Ω	

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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 DIODE (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
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	-	-	
m	mass	-	-	350	-	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>) 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.

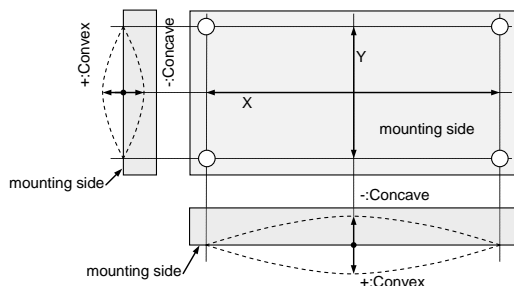
$$6. B_{(25/50)} = \ln\left(\frac{R_{25}}{R_{50}}\right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}}\right),$$

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 as follows of the following figure.



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

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HIGH POWER SWITCHING USE

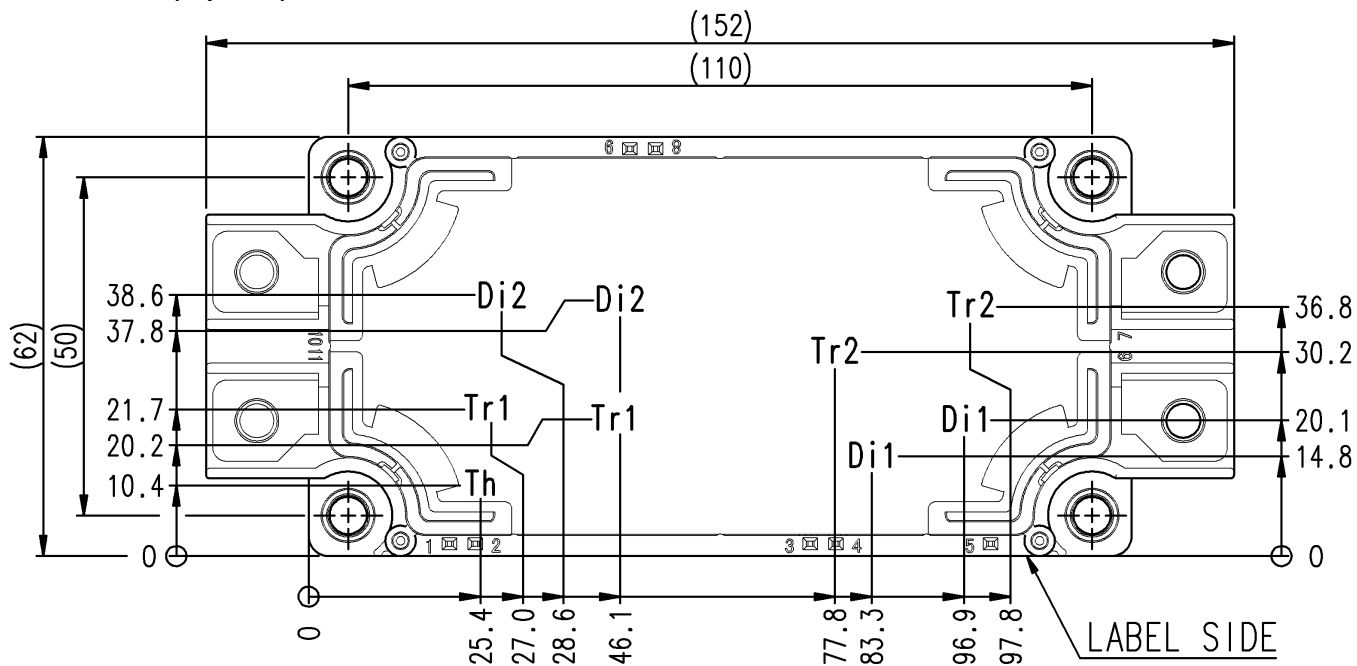
INSULATED TYPE

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$V_{CC}$	(DC) Supply voltage	Applied across C1-E2 terminals	-	600	850	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	0	-	6.8	$\Omega$

CHIP LOCATION (Top view)

Dimension in mm, tolerance:  $\pm 1$  mm



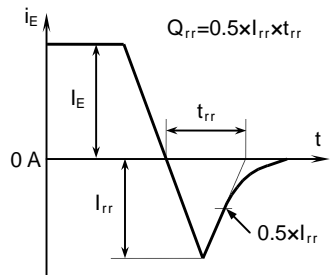
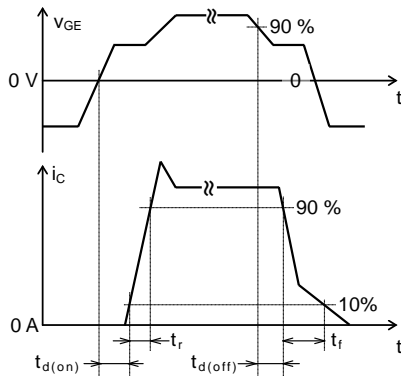
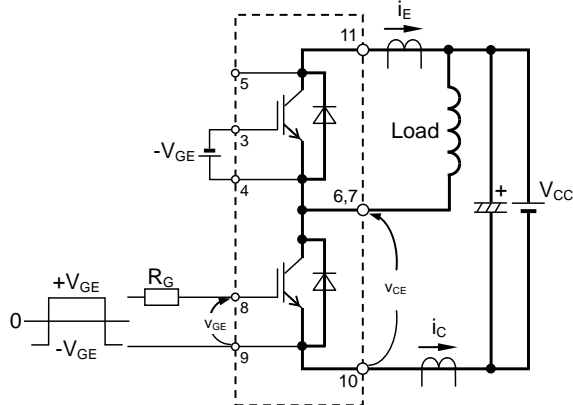
Tr1/Tr2: IGBT, Di1/Di2: DIODE, Th: NTC thermistor

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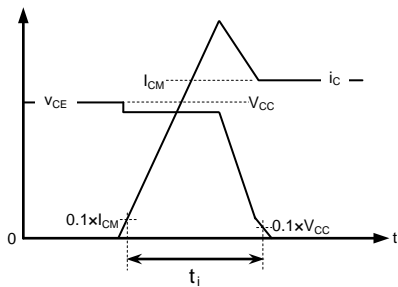
HIGH POWER SWITCHING USE  
INSULATED TYPE

TEST CIRCUIT AND WAVEFORMS

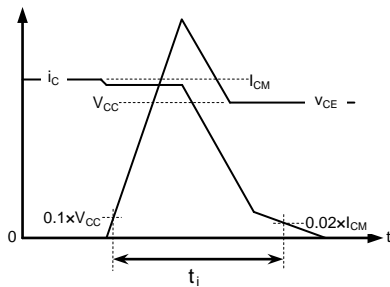


Switching characteristics test circuit and waveforms

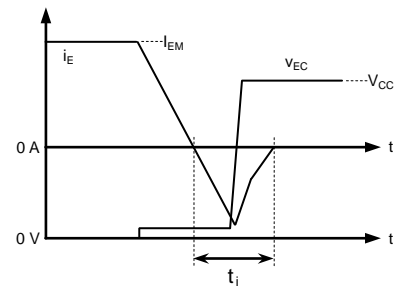
$t_{rr}$ ,  $Q_{rr}$  characteristics test waveform



IGBT Turn-on switching energy



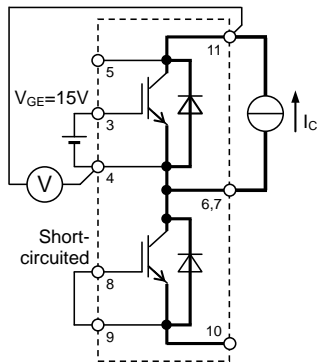
IGBT Turn-off switching energy



DIODE Reverse recovery energy

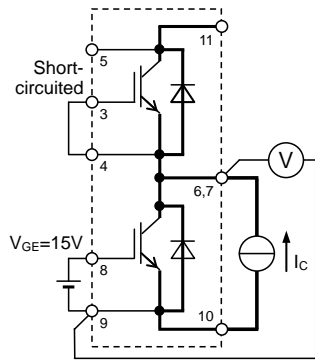
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

TEST CIRCUIT

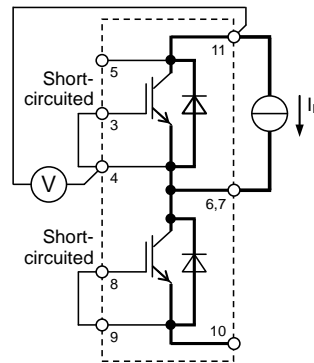


Tr1

$V_{CEsat}$  characteristics test circuit

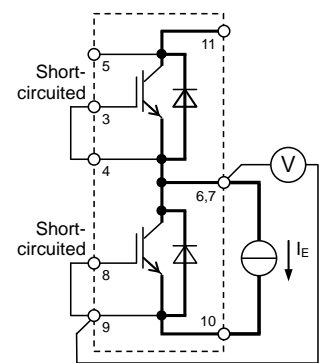


Tr2



Di1

$V_{EC}$  characteristics test circuit



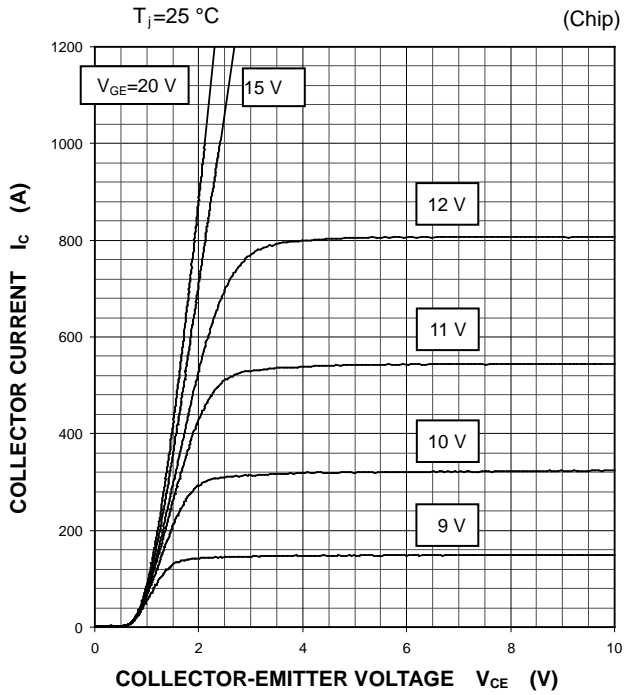
Di2

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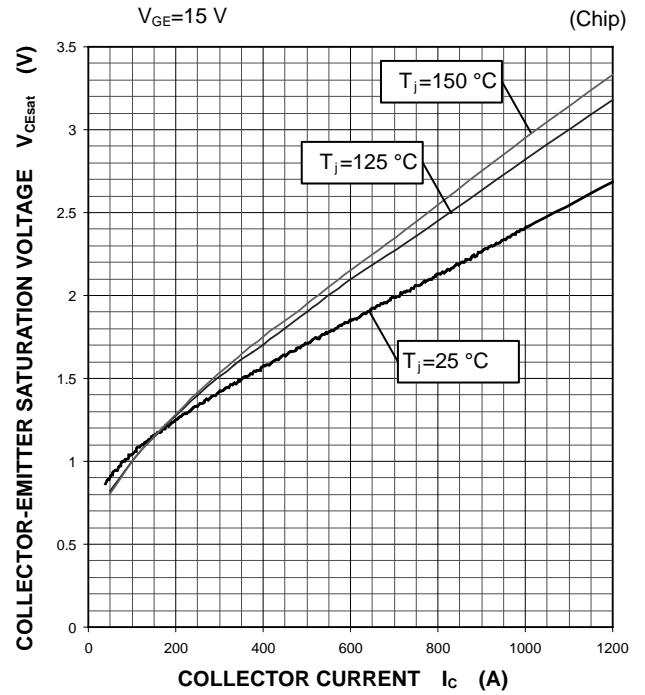
PERFORMANCE CURVES

INVERTER PART

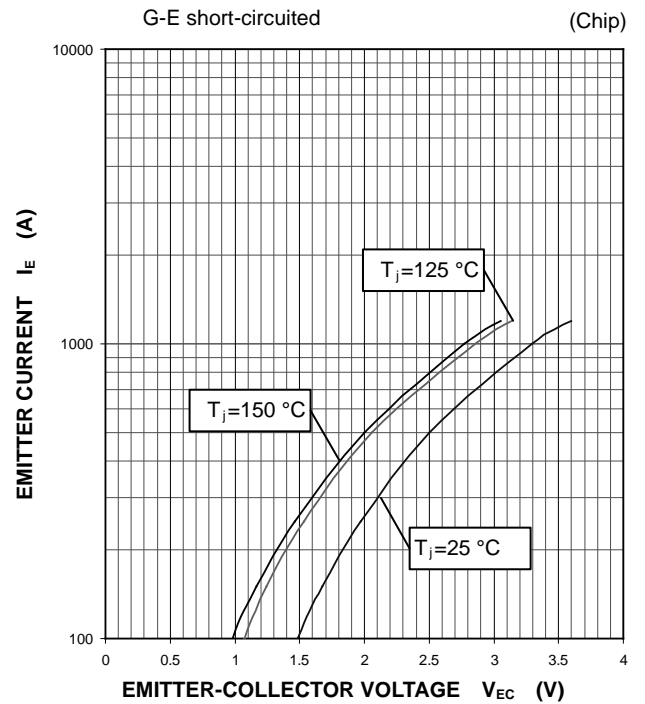
OUTPUT CHARACTERISTICS  
 (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE  
 CHARACTERISTICS  
 (TYPICAL)



FREE WHEELING DIODE  
 FORWARD CHARACTERISTICS  
 (TYPICAL)



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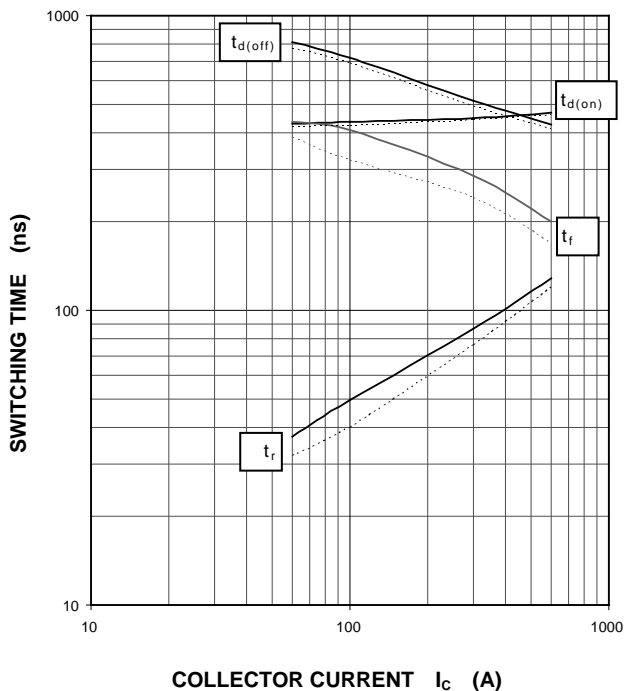
HIGH POWER SWITCHING USE  
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PERFORMANCE CURVES

INVERTER PART

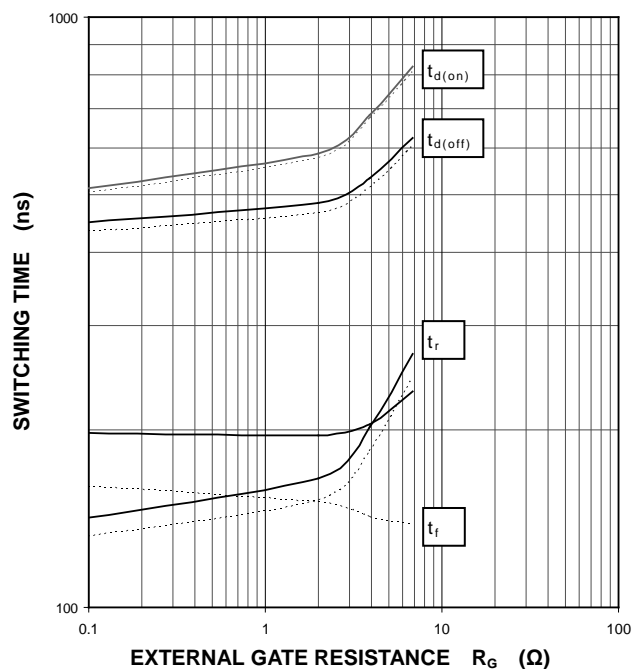
HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)

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



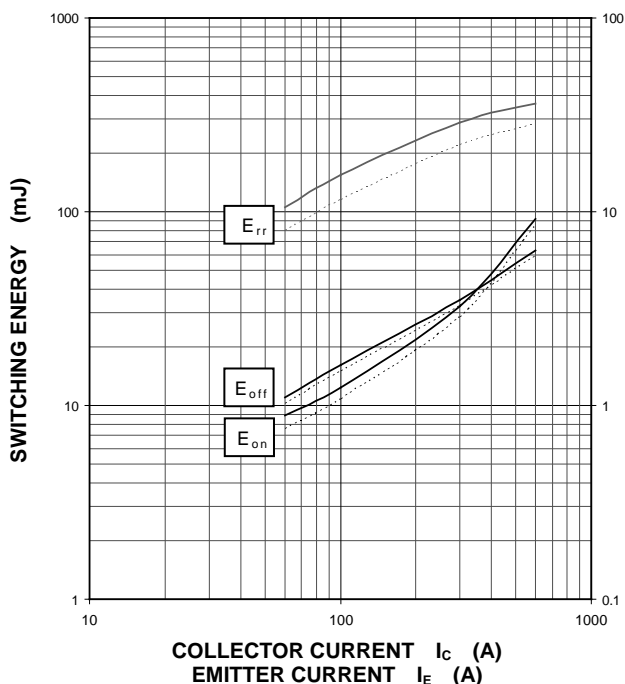
HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)

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



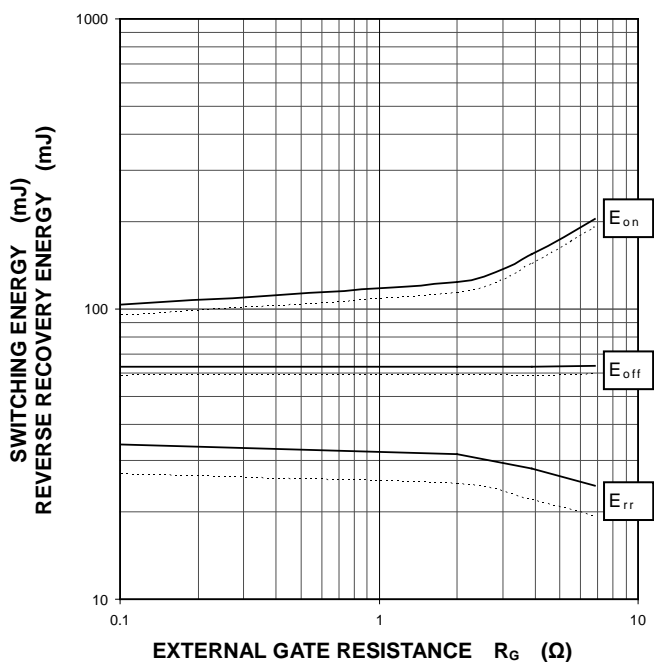
HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)

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



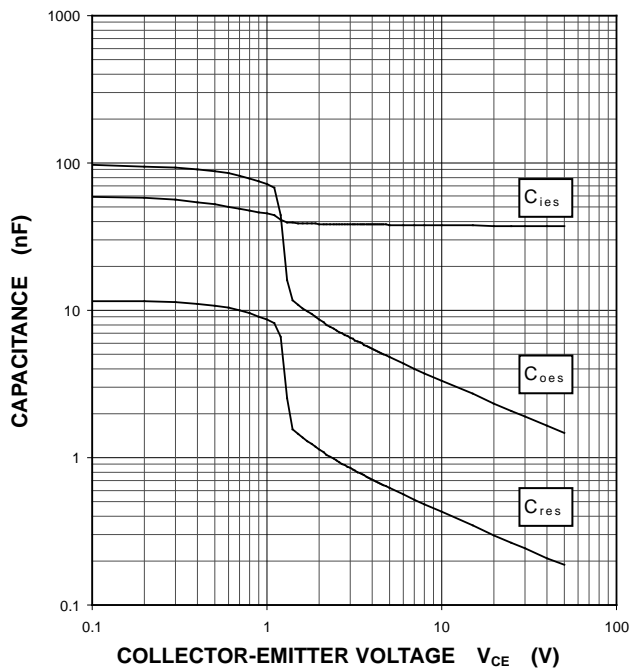
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**PERFORMANCE CURVES**

**INVERTER PART**

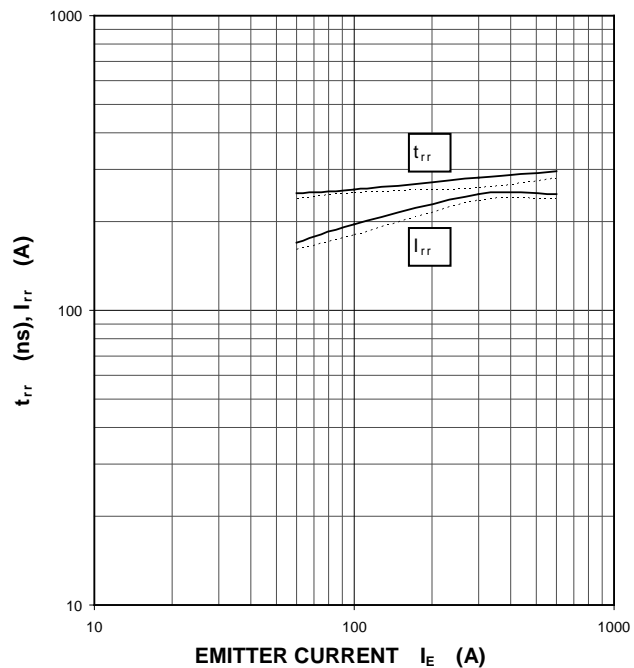
**CAPACITANCE CHARACTERISTICS  
 (TYPICAL)**

G-E short-circuited,  $T_j=25\text{ }^\circ\text{C}$



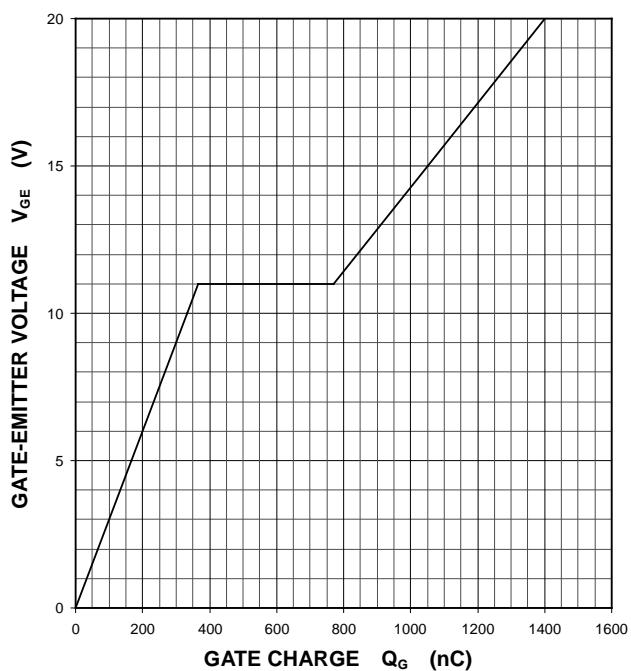
**FREE WHEELING DIODE  
 REVERSE RECOVERY CHARACTERISTICS  
 (TYPICAL)**

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



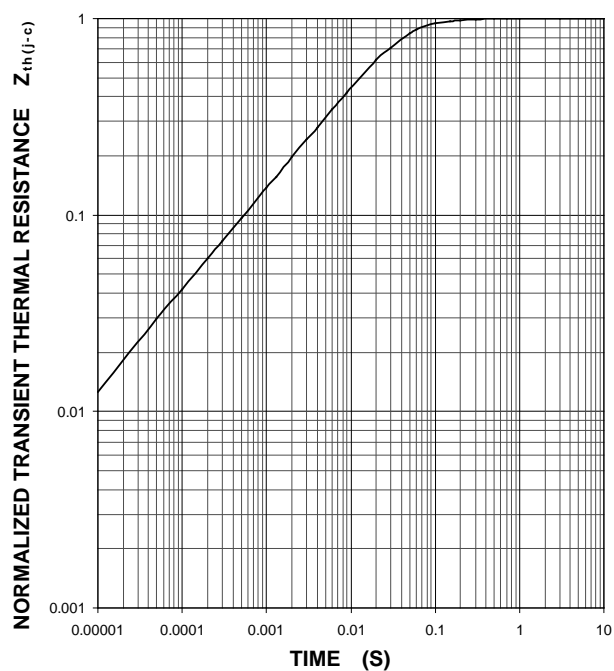
**GATE CHARGE CHARACTERISTICS  
 (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $I_C=600\text{ A}$ ,  $T_j=25\text{ }^\circ\text{C}$



**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS  
 (MAXIMUM)**

Single pulse,  $T_C=25\text{ }^\circ\text{C}$   
 $R_{th(j-c)Q}=45\text{ K/kW}$ ,  $R_{th(j-c)D}=72\text{ K/kW}$





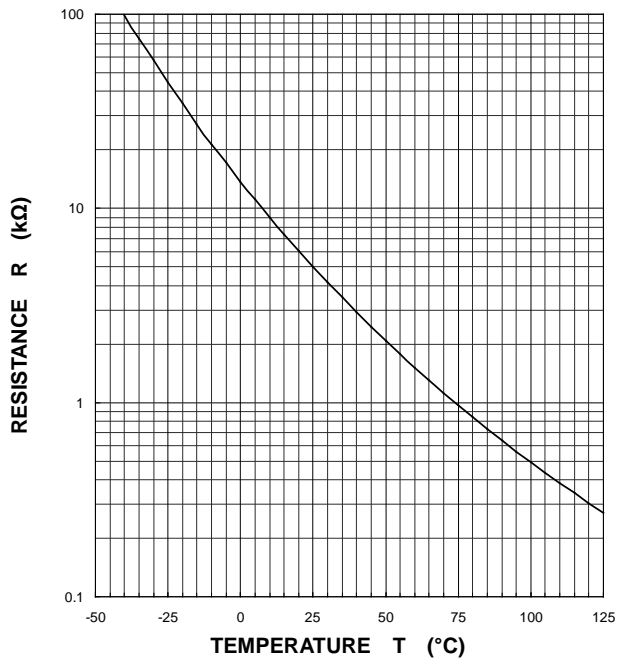
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CM600DX-24S1  
HIGH POWER SWITCHING USE  
INSULATED TYPE

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PERFORMANCE CURVES

NTC thermistor part

TEMPERATURE CHARACTERISTICS  
(TYPICAL)



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

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