

< IGBT MODULES >

# CM450DX-24S1

HIGH POWER SWITCHING USE  
INSULATED TYPE



**Dual switch (Half-Bridge)**

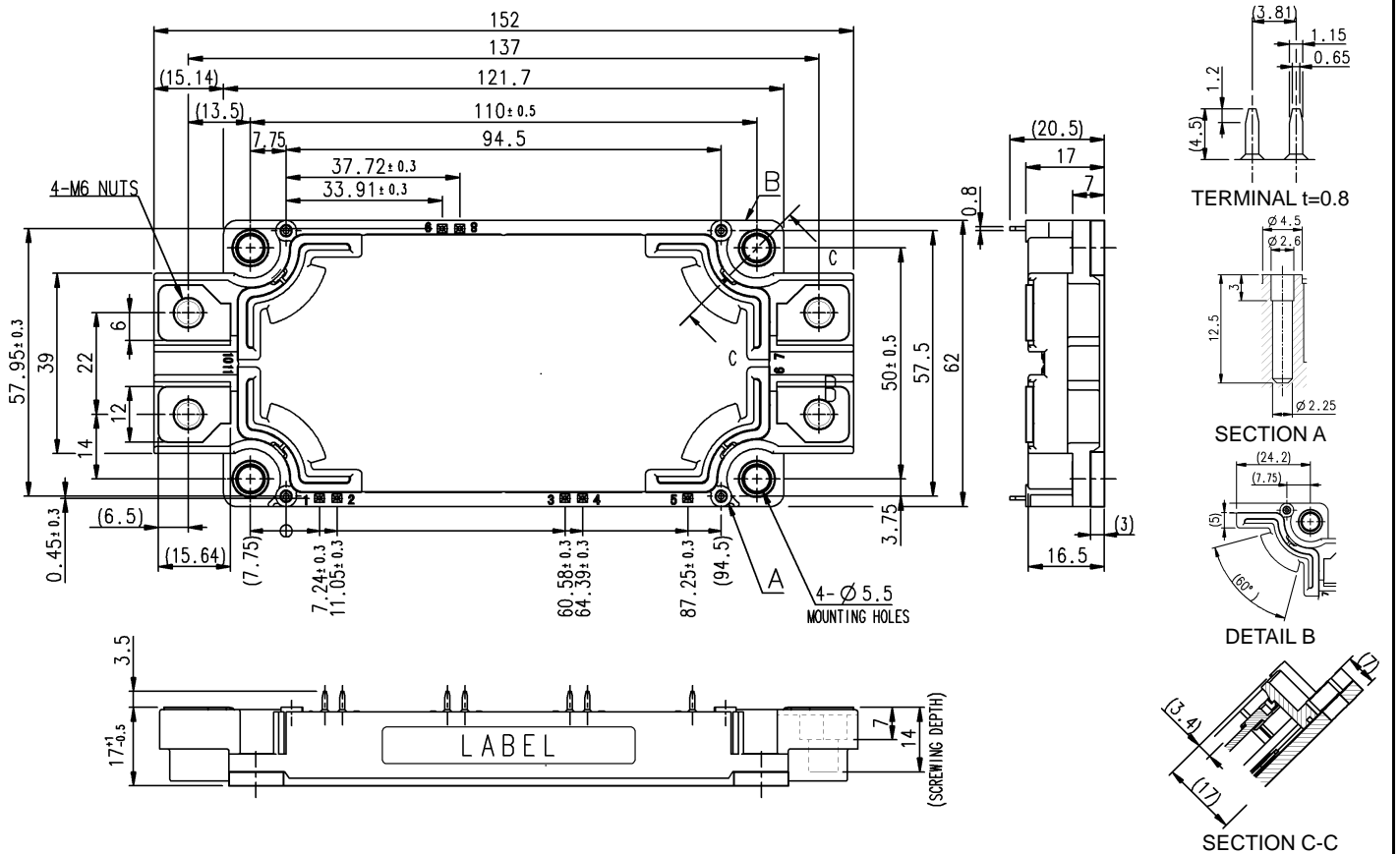
Collector current  $I_C$  ..... **450 A**  
 Collector-emitter voltage  $V_{CES}$  ..... **1200 V**  
 Maximum junction temperature  $T_{jmax}$  ..... **175 °C**

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

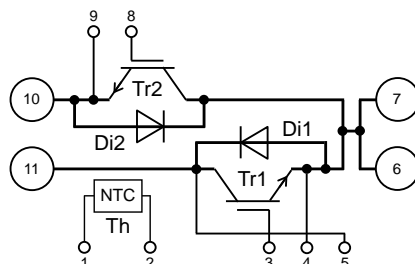
## APPLICATION

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> =107 °C (Note2, 4)	450	A
I <sub>CRM</sub>		Pulse, Repetitive (Note3)	900	
P <sub>tot</sub>	Total power dissipation	T <sub>C</sub> =25 °C (Note2, 4)	2775	W
I <sub>E</sub> (Note1)	Emitter current	DC (Note2)	450	A
I <sub>ERM</sub> (Note1)		Pulse, Repetitive (Note3)	900	

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> =45 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> =450 A, V <sub>GE</sub> =15 V, Refer to the figure of test circuit (Note5)	T <sub>j</sub> =25 °C	-	1.80	2.25	V
			T <sub>j</sub> =125 °C	-	2.00	-	
			T <sub>j</sub> =150 °C	-	2.05	-	
V <sub>CEsat</sub> (Chip)	Collector-emitter saturation voltage	I <sub>C</sub> =450 A, V <sub>GE</sub> =15 V, (Note5)	T <sub>j</sub> =25 °C	-	1.70	2.15	V
			T <sub>j</sub> =125 °C	-	1.90	-	
			T <sub>j</sub> =150 °C	-	1.95	-	
C <sub>ies</sub>	Input capacitance	V <sub>CE</sub> =10 V, G-E short-circuited	-	-	45	nF	
C <sub>oes</sub>	Output capacitance		-	-	9.0		
C <sub>res</sub>	Reverse transfer capacitance		-	-	0.75		
Q <sub>G</sub>	Gate charge	V <sub>CC</sub> =600 V, I <sub>C</sub> =450 A, V <sub>GE</sub> =15 V	-	945	-	nC	
t <sub>d(on)</sub>	Turn-on delay time	V <sub>CC</sub> =600 V, I <sub>C</sub> =450 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> =450 A, G-E short-circuited, Refer to the figure of test circuit (Note5)	T <sub>j</sub> =25 °C	-	2.60	3.40	V
			T <sub>j</sub> =125 °C	-	2.16	-	
			T <sub>j</sub> =150 °C	-	2.10	-	
V <sub>EC</sub> (Note1) (Chip)	Emitter-collector voltage	I <sub>E</sub> =450 A, G-E short-circuited, (Note5)	T <sub>j</sub> =25 °C	-	2.50	3.30	V
			T <sub>j</sub> =125 °C	-	2.06	-	
			T <sub>j</sub> =150 °C	-	2.00	-	
t <sub>rr</sub> (Note1)	Reverse recovery time	V <sub>CC</sub> =600 V, I <sub>E</sub> =450 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	-	12	-		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> =450 A,	-	35.8	-	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,	-	52.4	-		
E <sub>rr</sub> (Note1)	Reverse recovery energy per pulse	Inductive load	-	27.9	-	mJ	
R <sub>CC'+EE'</sub>	Internal lead resistance	Main terminals-chip, per switch, T <sub>C</sub> =25 °C (Note2)	-	-	0.7	mΩ	
r <sub>g</sub>	Internal gate resistance	Per switch	-	4.3	-	Ω	

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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)	-	-	54	K/kW
R <sub>th(j-c)D</sub>		Junction to case, per Inverter DIODE (Note4)	-	-	86	
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

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.

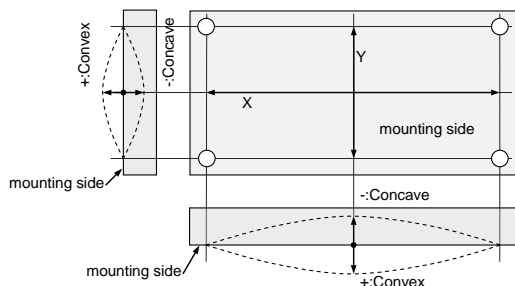
$$6. B_{(25/50)} = \ln\left(\frac{R_{25}}{R_{50}}\right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}}\right),$$

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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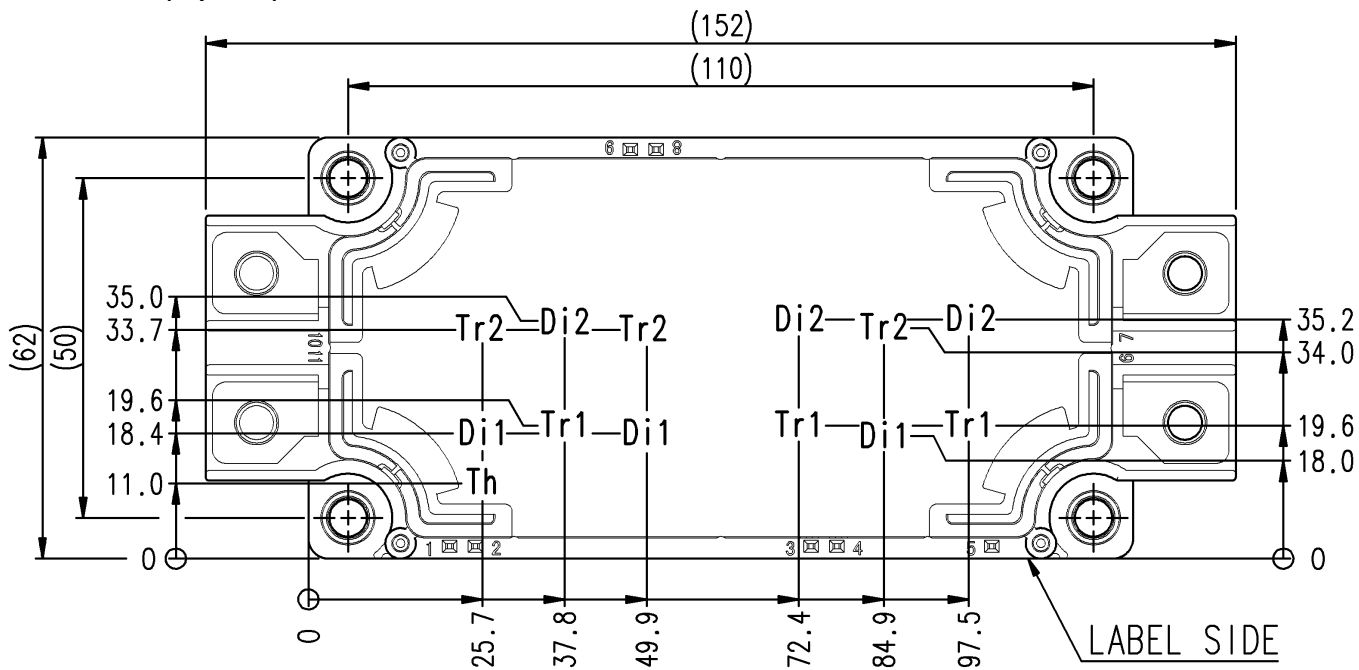
HIGH POWER SWITCHING USE  
INSULATED TYPE

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	-	10	$\Omega$

CHIP LOCATION (Top view)

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

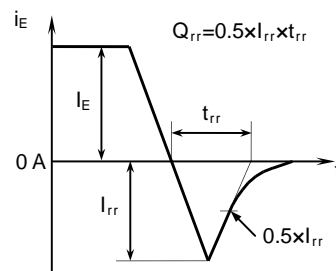
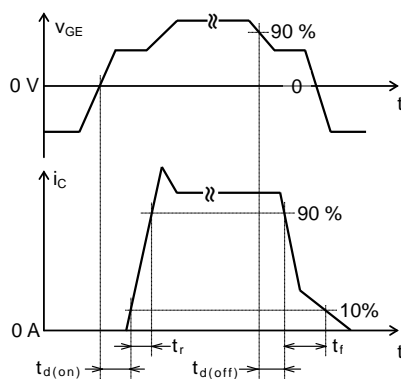
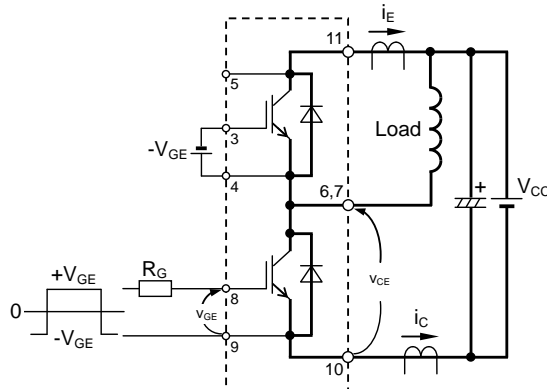


Tr1/Tr2: IGBT, Di1/Di2: DIODE, Th: NTC thermistor

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**CM450DX-24S1**

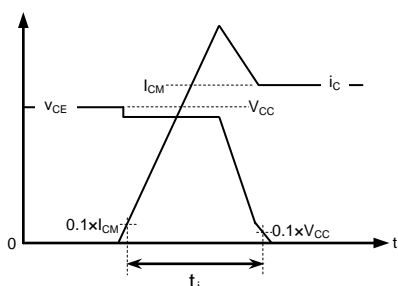
**HIGH POWER SWITCHING USE**  
**INSULATED TYPE**

**TEST CIRCUIT AND WAVEFORMS**

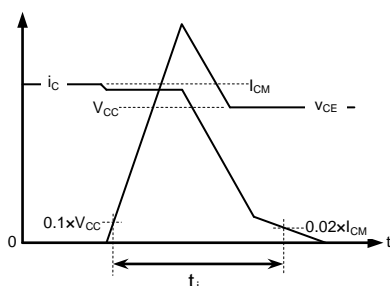


**Switching characteristics test circuit and waveforms**

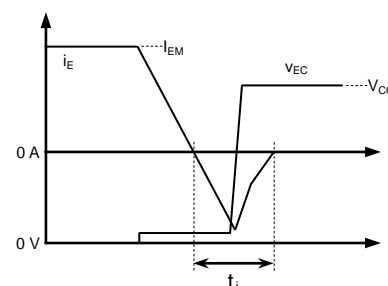
**$t_{rr}$ ,  $Q_{rr}$  characteristics test waveform**



**IGBT Turn-on switching energy**



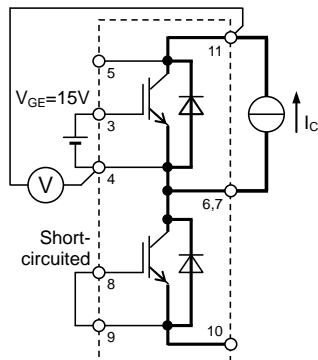
**IGBT Turn-off switching energy**



**DIODE Reverse recovery energy**

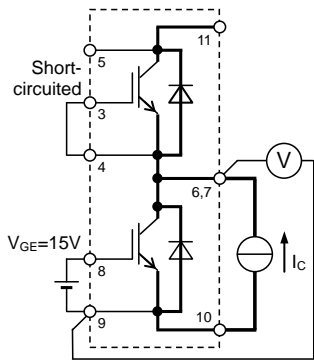
**Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)**

**TEST CIRCUIT**

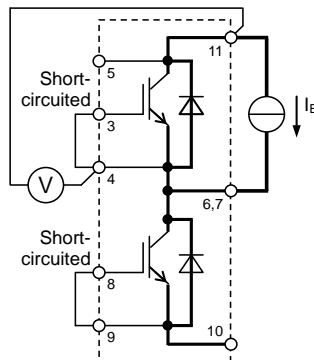


**Tr1**

**$V_{CEsat}$  characteristics test circuit**

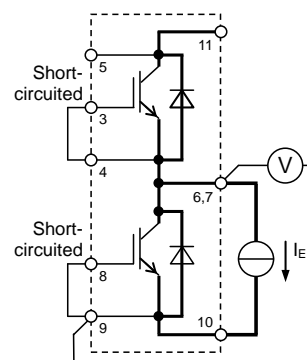


**Tr2**



**Di1**

**$V_{EC}$  characteristics test circuit**



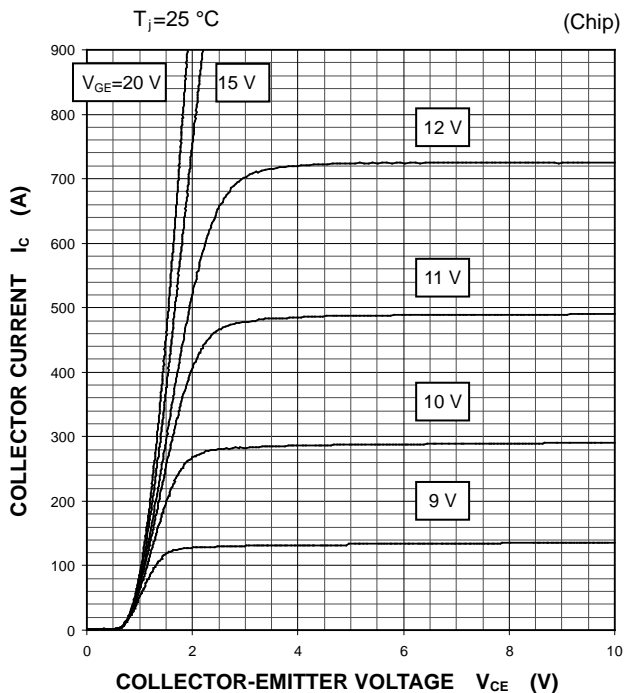
**Di2**

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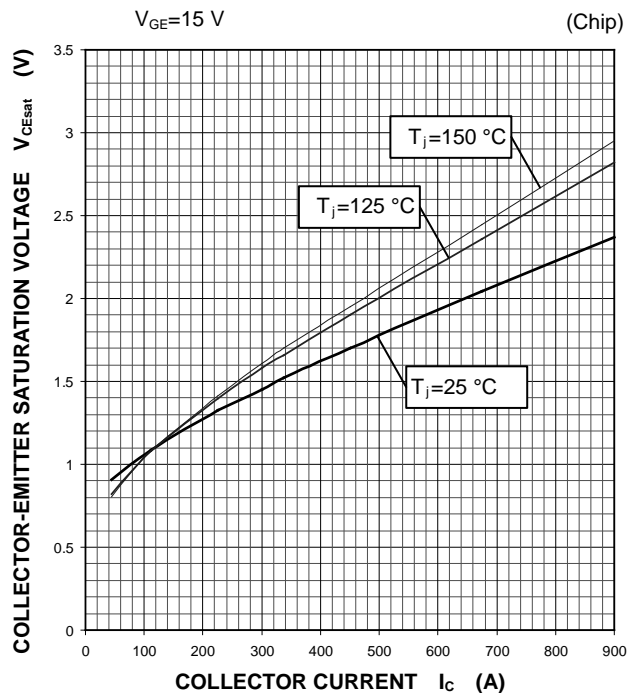
PERFORMANCE CURVES

INVERTER PART

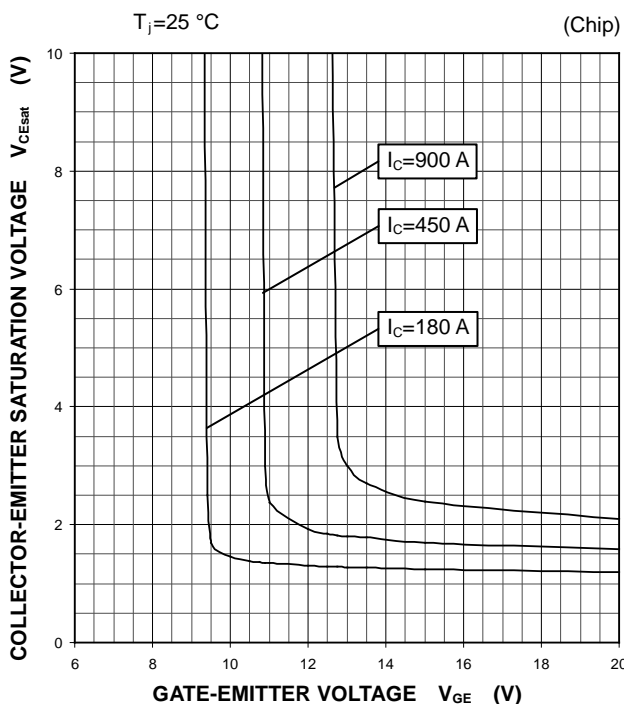
OUTPUT CHARACTERISTICS  
 (TYPICAL)



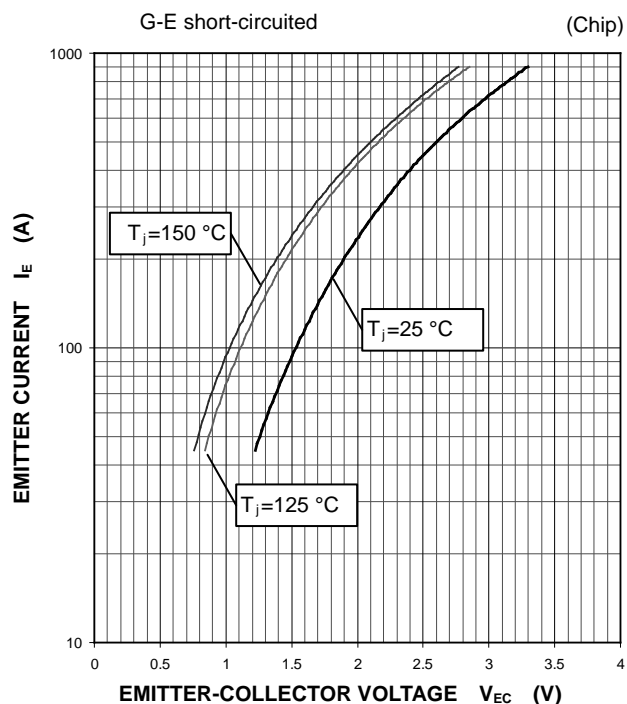
COLLECTOR-EMITTER SATURATION VOLTAGE  
 CHARACTERISTICS  
 (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE  
 CHARACTERISTICS  
 (TYPICAL)



FREE WHEELING DIODE  
 FORWARD CHARACTERISTICS  
 (TYPICAL)



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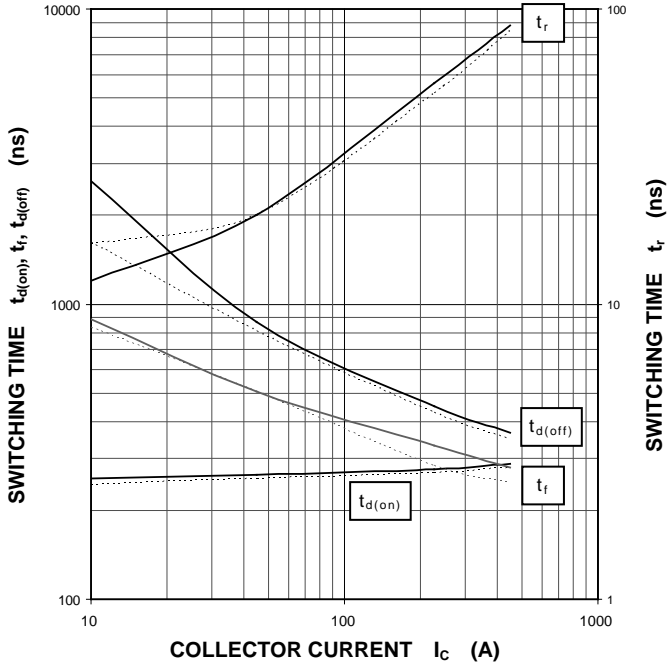
**HIGH POWER SWITCHING USE  
 INSULATED TYPE**

**PERFORMANCE CURVES**

**INVERTER PART**

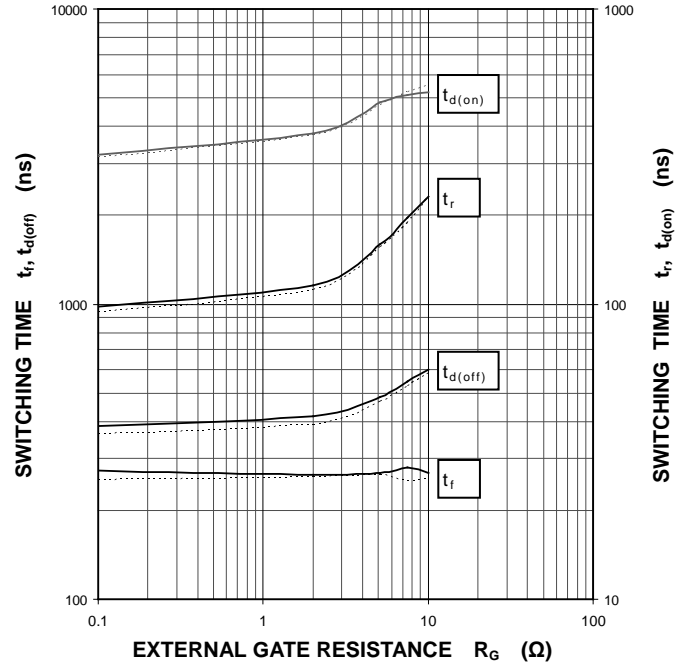
**HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)**

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



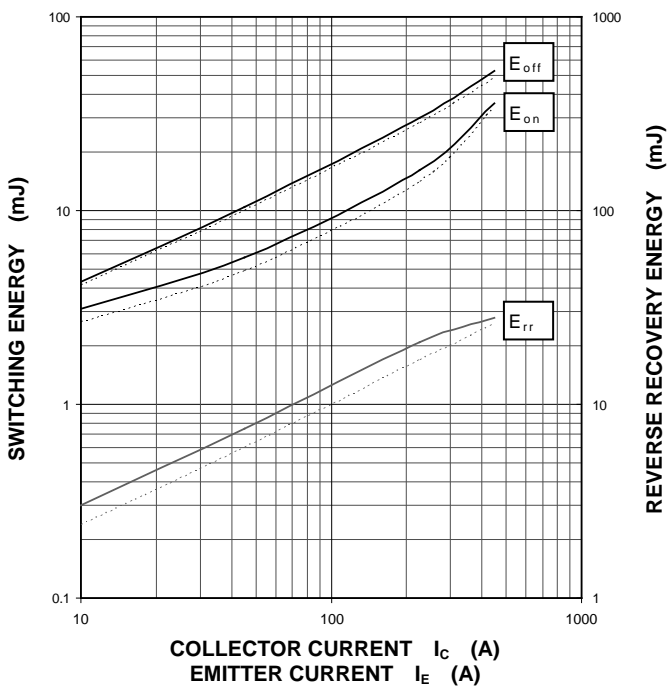
**HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C=450\text{ A}$ , INDUCTIVE LOAD  
 —:  $T_j=150\text{ }^\circ\text{C}$ , - - - - -:  $T_j=125\text{ }^\circ\text{C}$



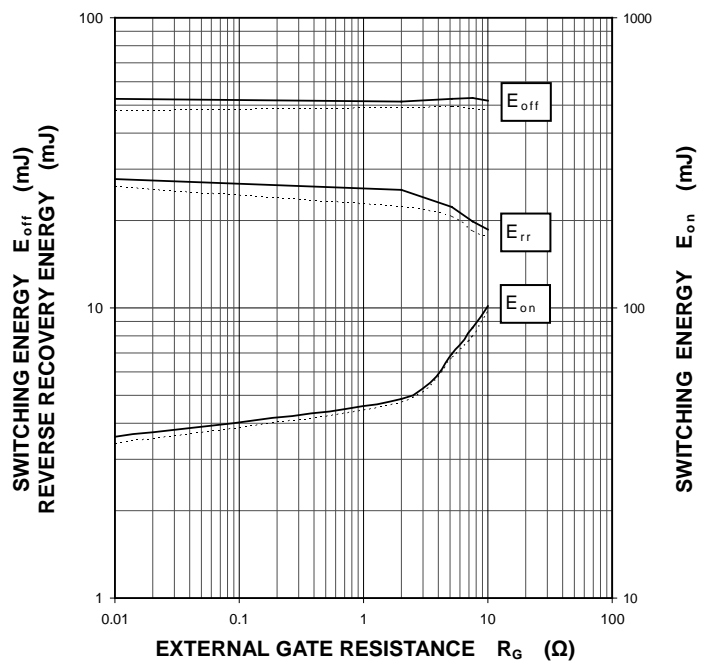
**HALF-BRIDGE  
 SWITCHING CHARACTERISTICS  
 (TYPICAL)**

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



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

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C/I_E=450\text{ A}$ ,  
 INDUCTIVE LOAD, PER PULSE  
 —:  $T_j=150\text{ }^\circ\text{C}$ , - - - - -:  $T_j=125\text{ }^\circ\text{C}$

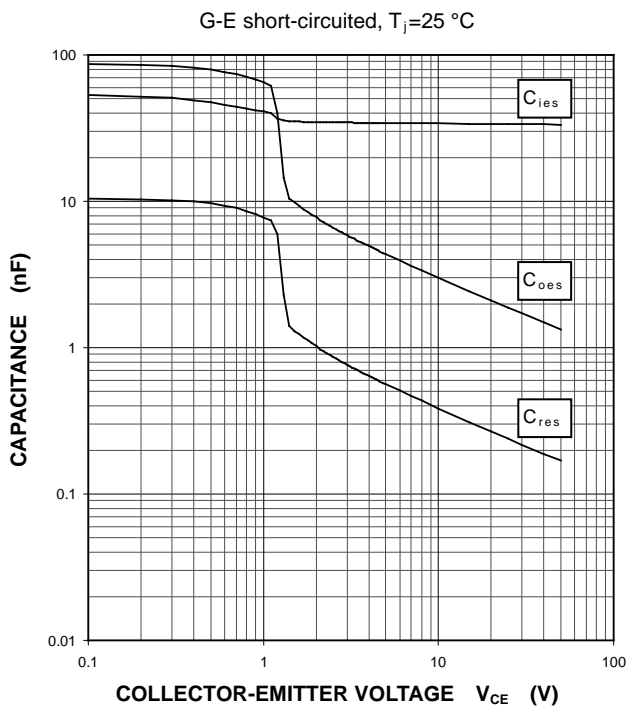


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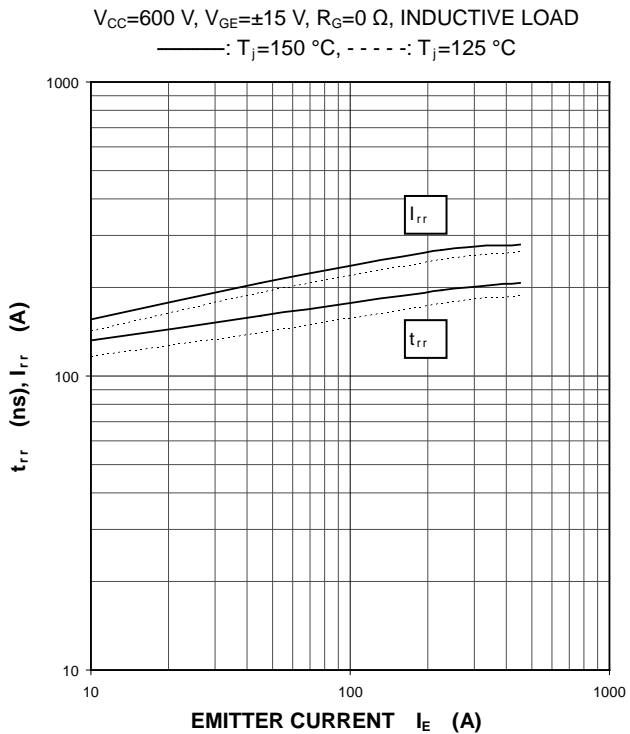
PERFORMANCE CURVES

INVERTER PART

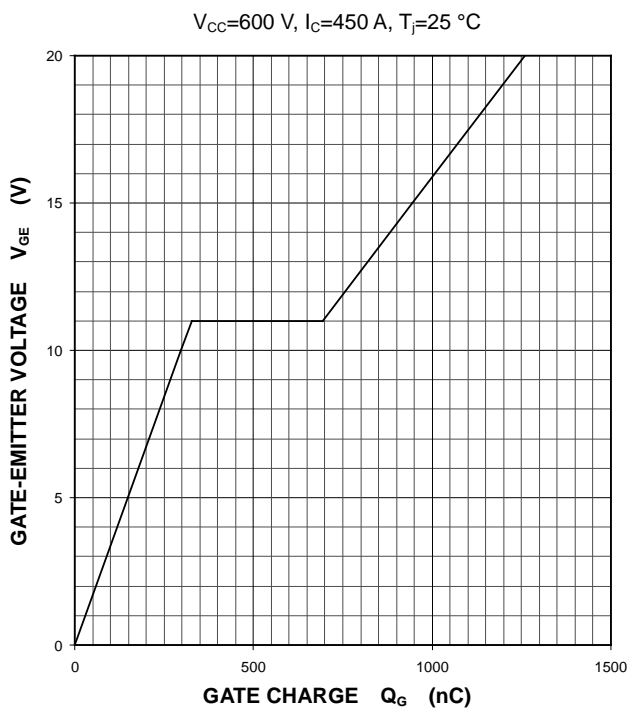
**CAPACITANCE CHARACTERISTICS (TYPICAL)**



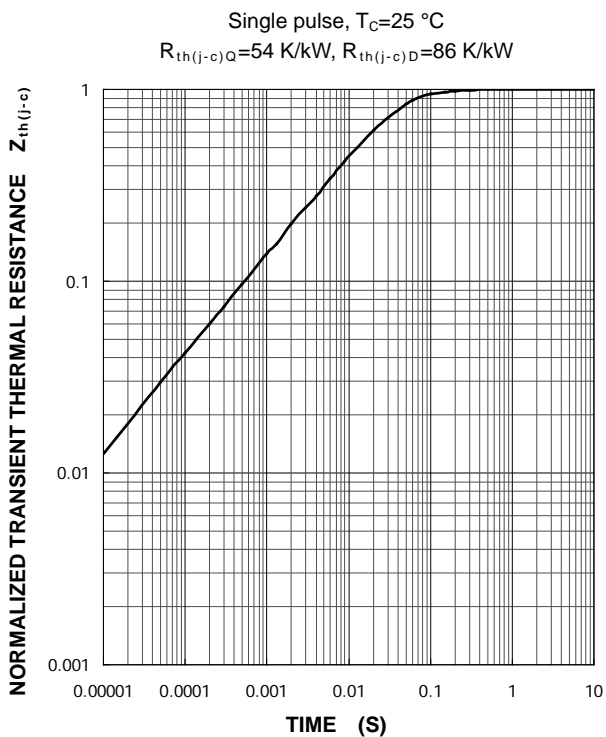
**FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)**



**GATE CHARGE CHARACTERISTICS (TYPICAL)**



**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)**





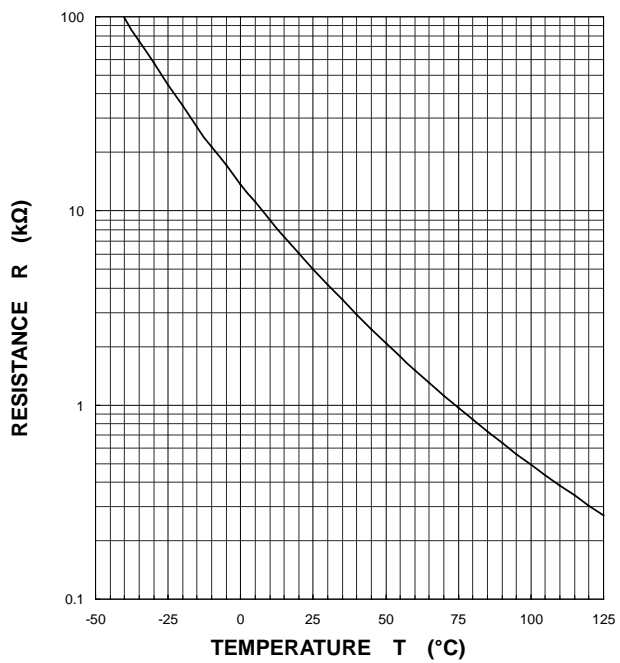
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CM450DX-24S1  
HIGH POWER SWITCHING USE  
INSULATED TYPE

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PERFORMANCE CURVES

NTC thermistor part

TEMPERATURE CHARACTERISTICS  
(TYPICAL)



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

Mitsubishi Electric Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

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