

<IGBT Modules>

# CM225DX-24S1

HIGH POWER SWITCHING USE  
INSULATED TYPE



**dual switch (Half-Bridge)**

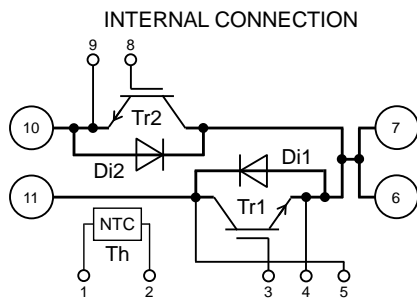
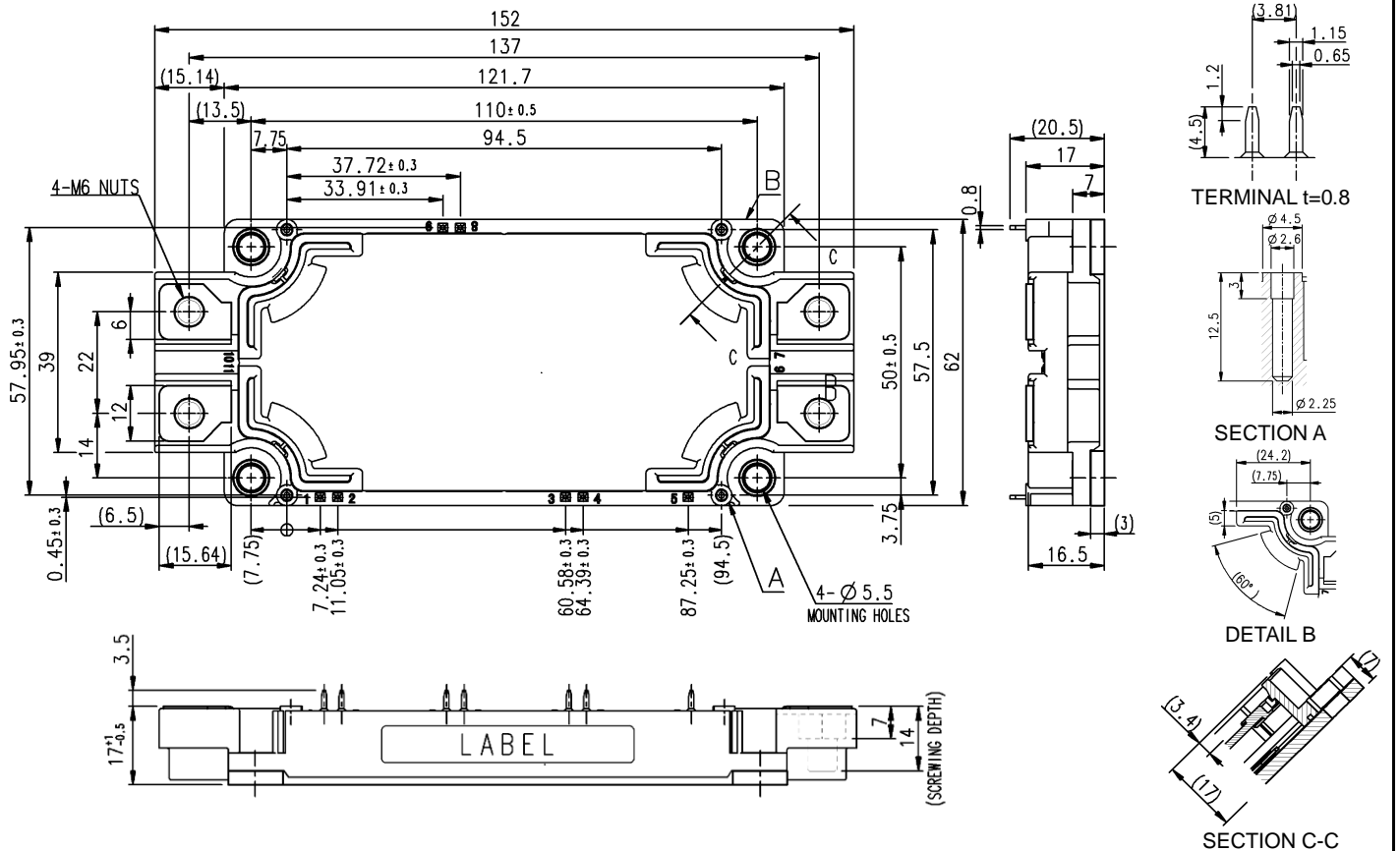
Collector current  $I_C$  ..... 225 A  
 Collector-emitter voltage  $V_{CES}$  ..... 1200 V  
 Maximum junction temperature  $T_{jmax}$  ..... 175 °C

- 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



- 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

## CM225DX-24S1

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	1200	V
$V_{GES}$	Gate-emitter voltage	C-E short-circuited	$\pm 20$	V
$I_C$	Collector current	DC, $T_C=96\text{ }^\circ\text{C}$ (Note2, 4)	225	A
$I_{CRM}$		Pulse, Repetitive, $V_{GE}=15\text{ V}$ (Note3)	450	
$P_{tot}$	Total power dissipation	$T_C=25\text{ }^\circ\text{C}$ (Note2, 4)	1250	W
$I_E$ (Note1)	Emitter current	DC (Note2)	225	A
$I_{ERM}$ (Note1)		Pulse, Repetitive (Note3)	450	

## 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/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	$I_C=22.5\text{ mA}$ , $V_{CE}=10\text{ V}$	5.4	6.0	6.6	V	
$V_{CESat}$ (Terminal)	Collector-emitter saturation voltage	$I_C=225\text{ A}$ , $V_{GE}=15\text{ V}$ , Refer to the figure of test circuit (Note5)	$T_j=25\text{ }^\circ\text{C}$	-	1.90	2.35	V
			$T_j=125\text{ }^\circ\text{C}$	-	2.10	-	
			$T_j=150\text{ }^\circ\text{C}$	-	2.15	-	
$V_{CESat}$ (Chip)		$I_C=225\text{ A}$ , $V_{GE}=15\text{ V}$ , (Note5)	$T_j=25\text{ }^\circ\text{C}$	-	1.80	2.25	V
			$T_j=125\text{ }^\circ\text{C}$	-	2.00	-	
			$T_j=150\text{ }^\circ\text{C}$	-	2.05	-	
$C_{ies}$	Input capacitance	$V_{CE}=10\text{ V}$ , G-E short-circuited	-	-	20	nF	
$C_{oes}$	Output capacitance		-	-	4.0		
$C_{res}$	Reverse transfer capacitance		-	-	0.33		
$Q_G$	Gate charge	$V_{CC}=600\text{ V}$ , $I_C=225\text{ A}$ , $V_{GE}=15\text{ V}$	-	420	-	nC	
$t_{d(on)}$	Turn-on delay time	$V_{CC}=600\text{ V}$ , $I_C=225\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=1.5\text{ }\Omega$ , Inductive load	-	-	800	ns	
$t_r$	Rise time		-	-	200		
$t_{d(off)}$	Turn-off delay time		-	-	600		
$t_f$	Fall time		-	-	300		
$V_{EC}$ (Terminal)	Emitter-collector voltage	$I_E=225\text{ A}$ , G-E short-circuited, Refer to the figure of test circuit (Note5)	$T_j=25\text{ }^\circ\text{C}$	-	2.75	3.55	V
			$T_j=125\text{ }^\circ\text{C}$	-	2.30	-	
			$T_j=150\text{ }^\circ\text{C}$	-	2.20	-	
$V_{EC}$ (Chip)		$I_E=225\text{ A}$ , G-E short-circuited, (Note5)	$T_j=25\text{ }^\circ\text{C}$	-	2.65	3.45	V
			$T_j=125\text{ }^\circ\text{C}$	-	2.20	-	
			$T_j=150\text{ }^\circ\text{C}$	-	2.10	-	
$t_{rr}$ (Note1)	Reverse recovery time	$V_{CC}=600\text{ V}$ , $I_E=225\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ ,	-	-	300	ns	
$Q_{rr}$ (Note1)	Reverse recovery charge	$R_G=1.5\text{ }\Omega$ , Inductive load	-	6.0	-	$\mu\text{C}$	
$E_{on}$	Turn-on switching energy per pulse	$V_{CC}=600\text{ V}$ , $I_C=I_E=225\text{ A}$ ,	-	21.7	-	mJ	
$E_{off}$	Turn-off switching energy per pulse	$V_{GE}=\pm 15\text{ V}$ , $R_G=1.5\text{ }\Omega$ , $T_j=150\text{ }^\circ\text{C}$ ,	-	23.1	-		
$E_{rr}$ (Note1)	Reverse recovery energy per pulse	Inductive load	-	17.1	-	mJ	
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, $T_C=25\text{ }^\circ\text{C}$ (Note4)	-	-	1.0	m $\Omega$	
$r_g$	Internal gate resistance	Per switch	-	3.2	-	$\Omega$	

# CM225DX-24S1

HIGH POWER SWITCHING USE  
INSULATED TYPE

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	$R_{100}=493\ \Omega$ , $T_C=100\text{ }^\circ\text{C}$ (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)	-	-	0.12	K/W
$R_{th(j-c)D}$		Junction to case, per Inverter DIODE (Note4)	-	-	0.18	
$R_{th(c-s)}$	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
$m$	mass	-	-	350	-	g
$d_s$	Creepage distance	Terminal to terminal	17	-	-	mm
		Terminal to base plate	18.5	-	-	
$d_a$	Clearance	Terminal to terminal	10	-	-	mm
		Terminal to base plate	16.3	-	-	
$e_c$	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)

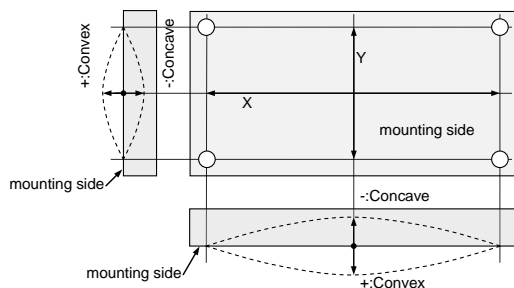
- Junction temperature ( $T_j$ ) should not increase beyond  $T_{jmax}$  rating.
- Pulse width and repetition rate should be such that the device junction temperature ( $T_j$ ) dose not exceed  $T_{jmax}$  rating.
- Case temperature ( $T_C$ ) and heat sink temperature ( $T_s$ ) are defined on the each surface (mounting side) of base plate and heat sink just under the chips. Refer to the figure of chip location.
- 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]

- Typical value is measured by using thermally conductive grease of  $\lambda=0.9\text{ W}/(\text{m}\cdot\text{K})$ .
- 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.  
"φ2.6×10 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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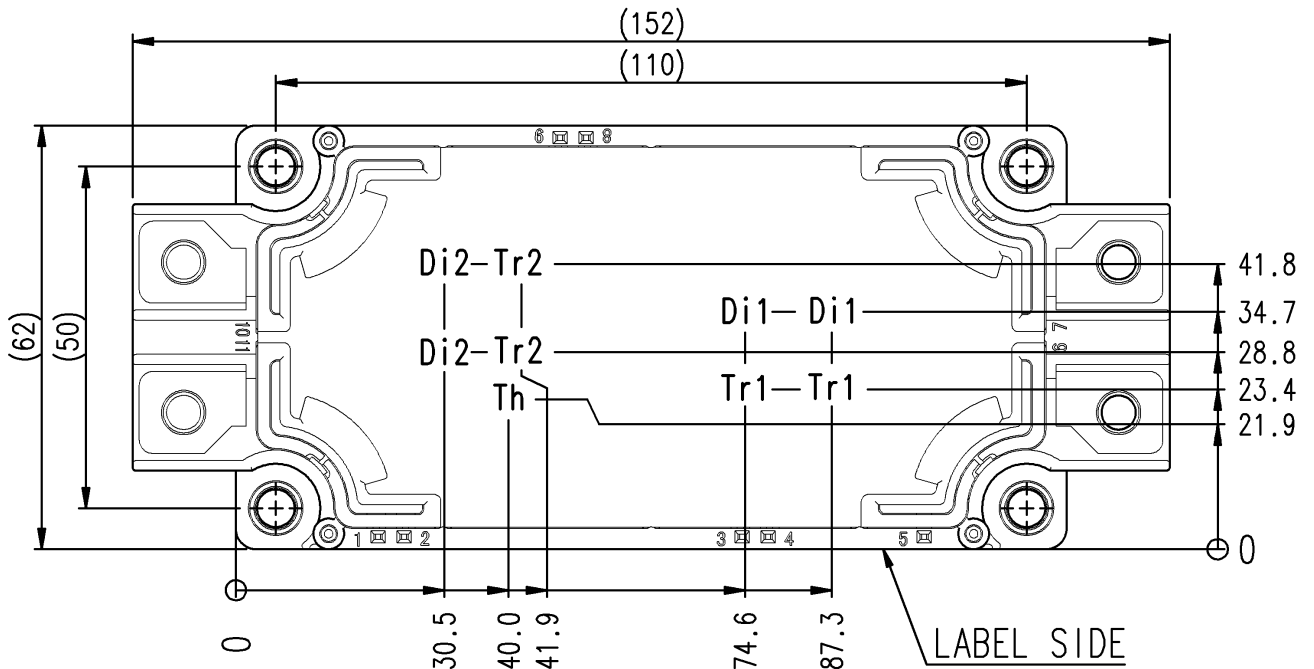
HIGH POWER SWITCHING USE  
INSULATED TYPE

## 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	14.0	15.0	16.5	V
$R_G$	External gate resistance	Per switch	1.5	-	15	$\Omega$

CHIP LOCATION (Top view)

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

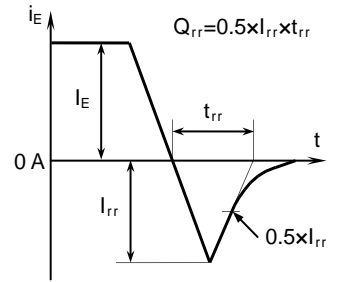
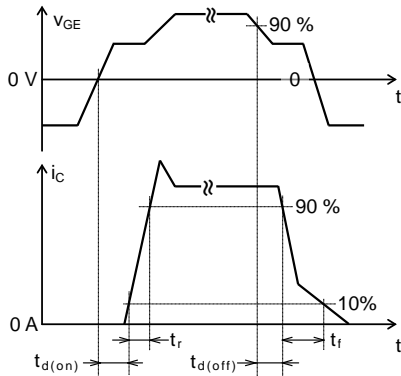
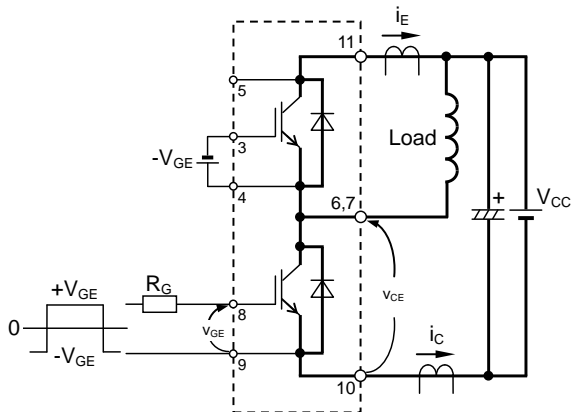


Tr1/Tr2: IGBT, Di1/Di2: DIODE, Th: NTC thermistor

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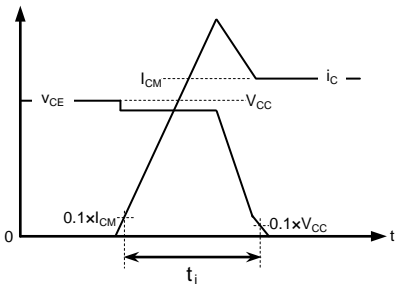
HIGH POWER SWITCHING USE  
INSULATED TYPE

## TEST CIRCUIT AND WAVEFORMS

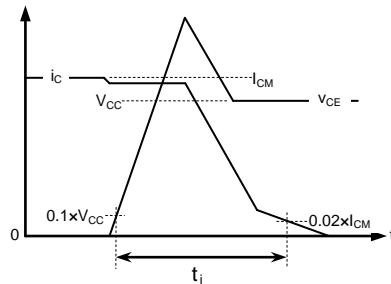


Switching characteristics test circuit and waveforms

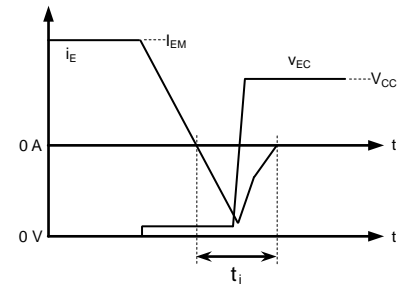
$t_{rr}$ ,  $Q_{rr}$  characteristics test waveform



IGBT Turn-on switching energy



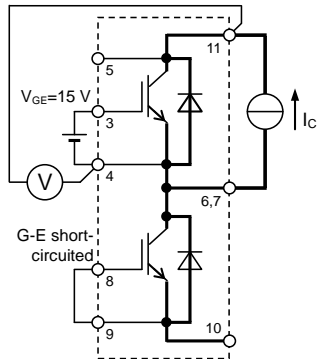
IGBT Turn-off switching energy



DIODE Reverse recovery energy

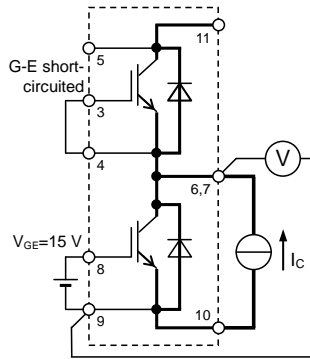
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT

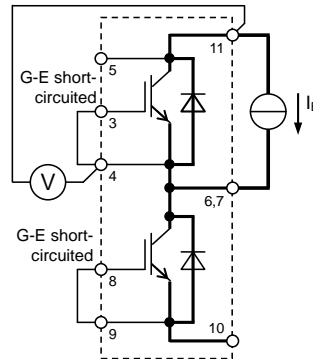


Q1

$V_{CEsat}$  characteristics test circuit

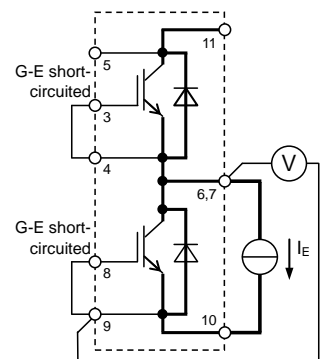


Q2



D1

$V_{EC}$  characteristics test circuit



D2

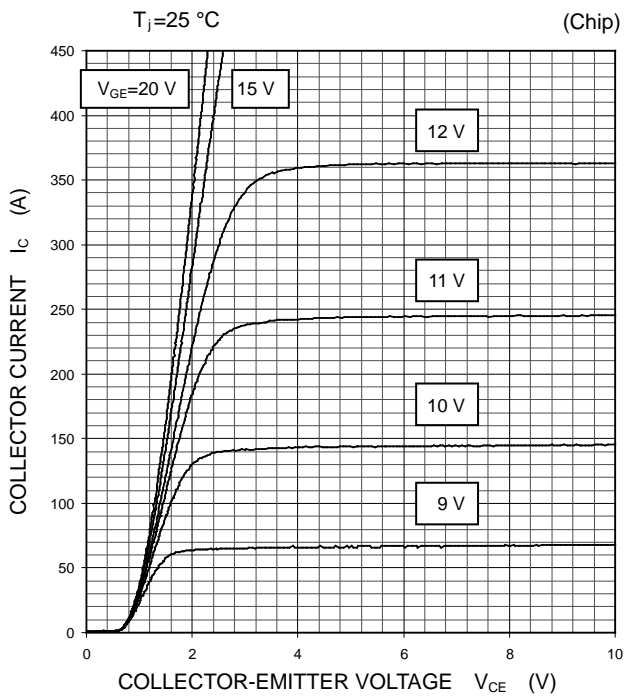
# CM225DX-24S1

HIGH POWER SWITCHING USE  
INSULATED TYPE

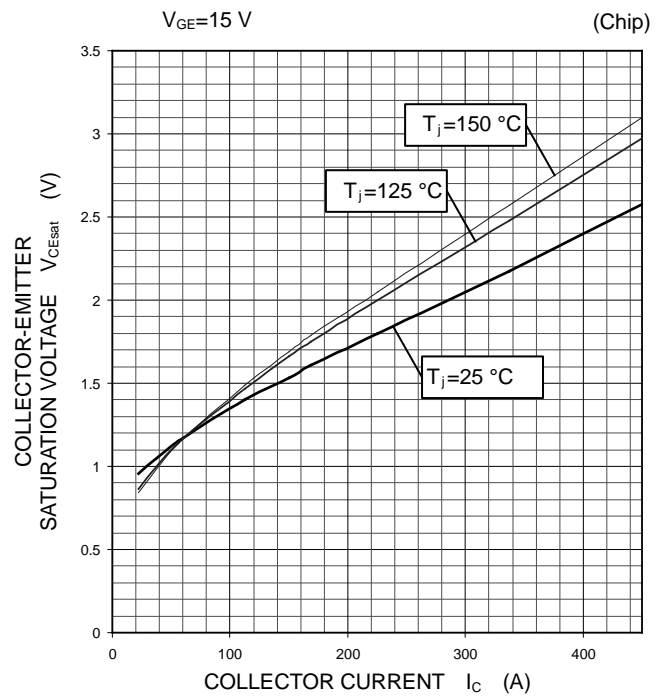
## PERFORMANCE CURVES

### INVERTER PART

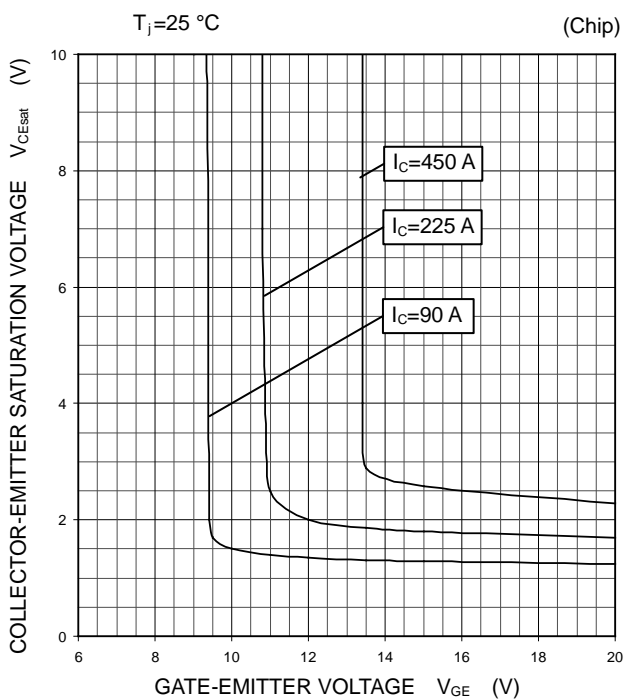
OUTPUT CHARACTERISTICS  
(TYPICAL)



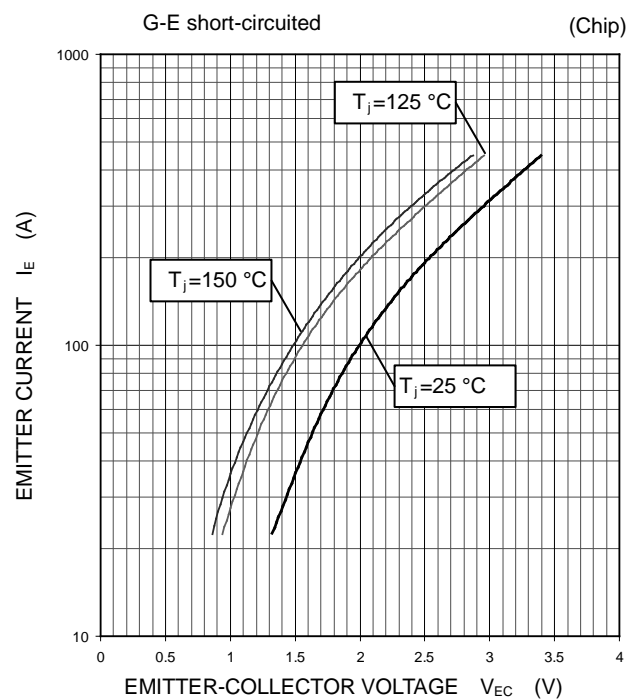
COLLECTOR-EMITTER SATURATION VOLTAGE  
CHARACTERISTICS  
(TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE  
CHARACTERISTICS  
(TYPICAL)



FREE WHEELING DIODE  
FORWARD CHARACTERISTICS  
(TYPICAL)



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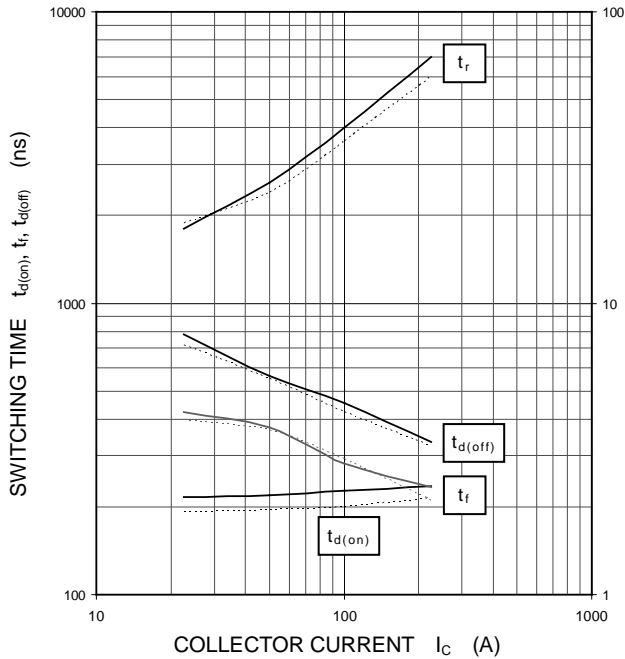
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

### INVERTER PART

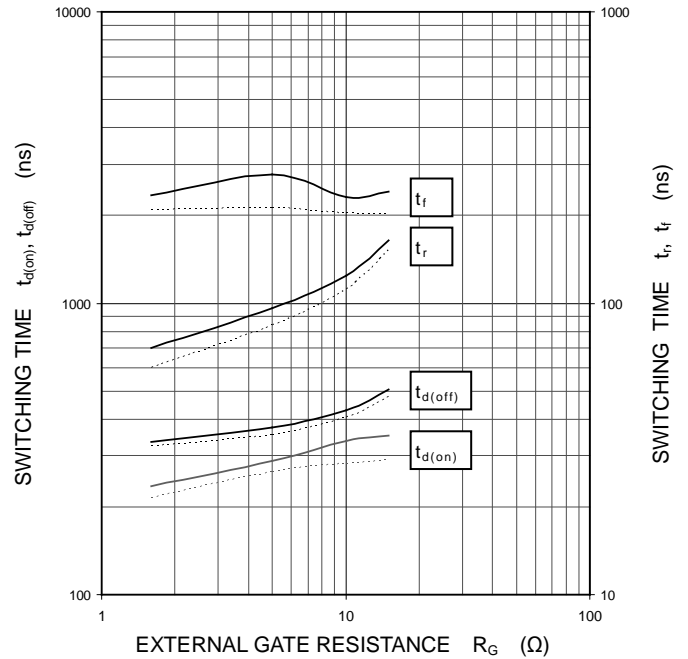
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.6\ \Omega$ , INDUCTIVE LOAD  
——:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



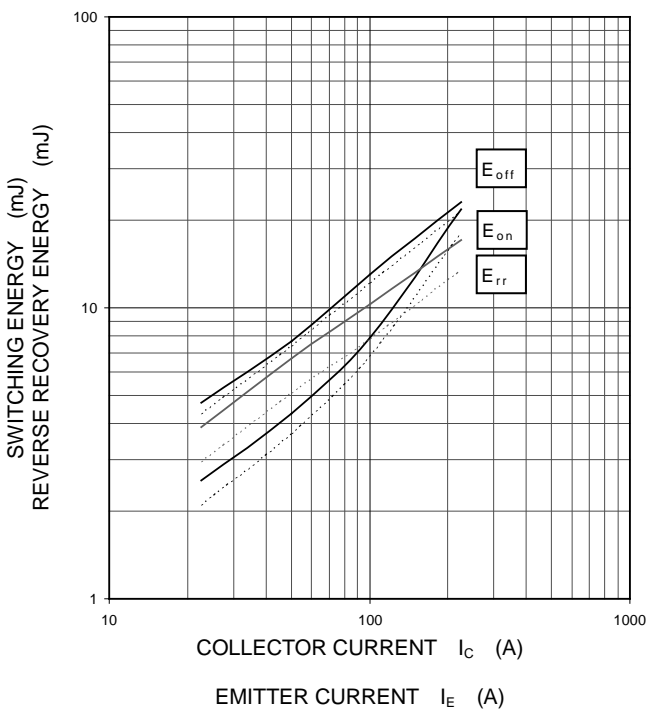
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C=225\text{ A}$ , INDUCTIVE LOAD  
——:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



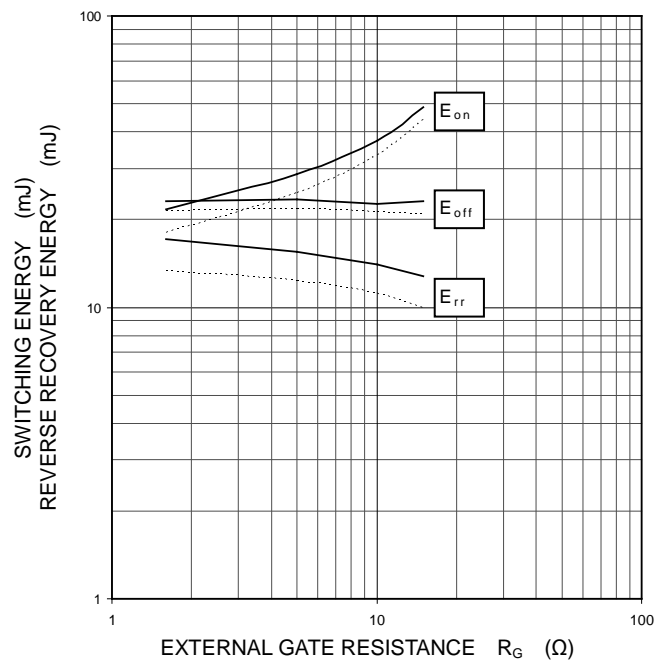
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.6\ \Omega$ ,  
INDUCTIVE LOAD, PER PULSE  
——:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C/I_E=225\text{ A}$ ,  
INDUCTIVE LOAD, PER PULSE  
——:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



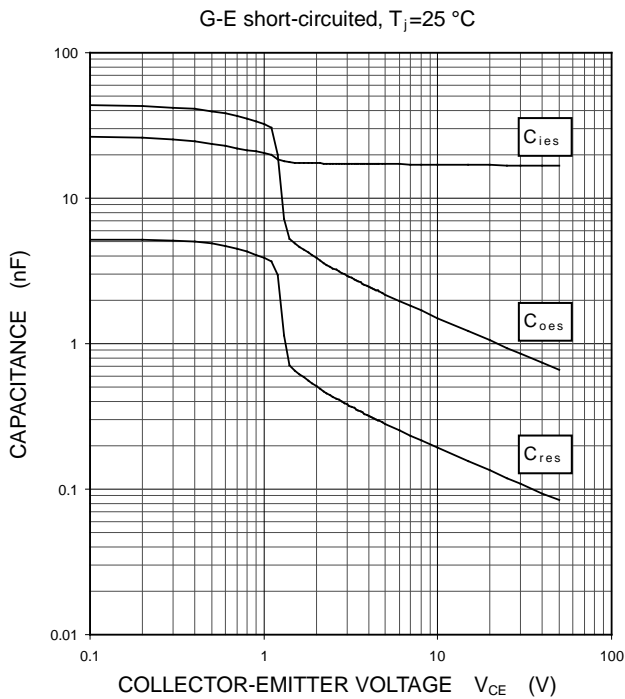
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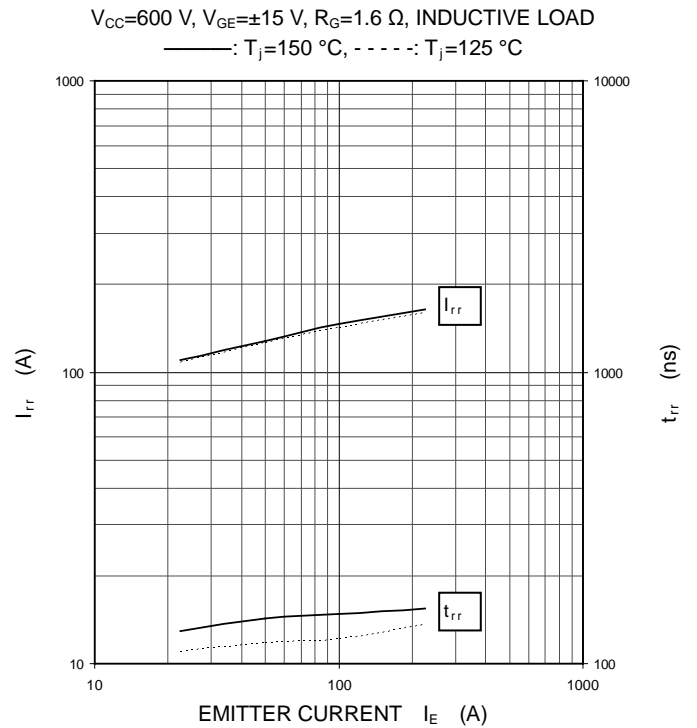
## PERFORMANCE CURVES

### INVERTER PART

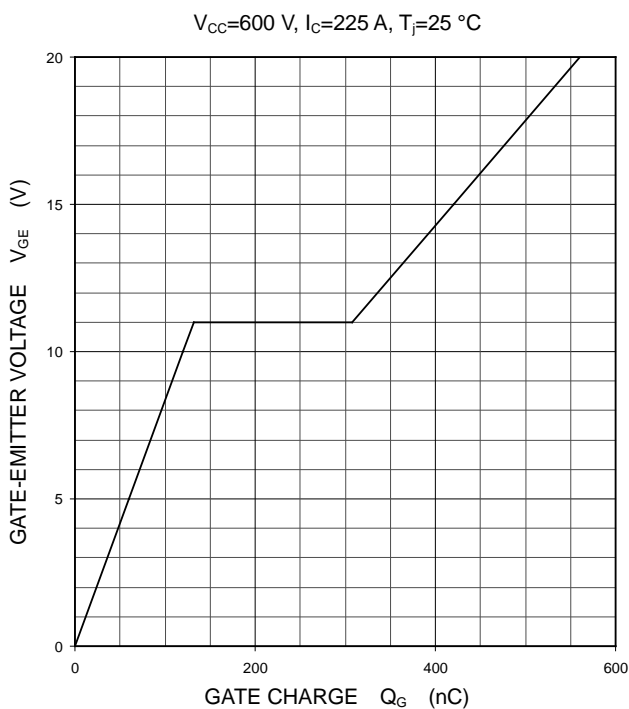
CAPACITANCE CHARACTERISTICS  
(TYPICAL)



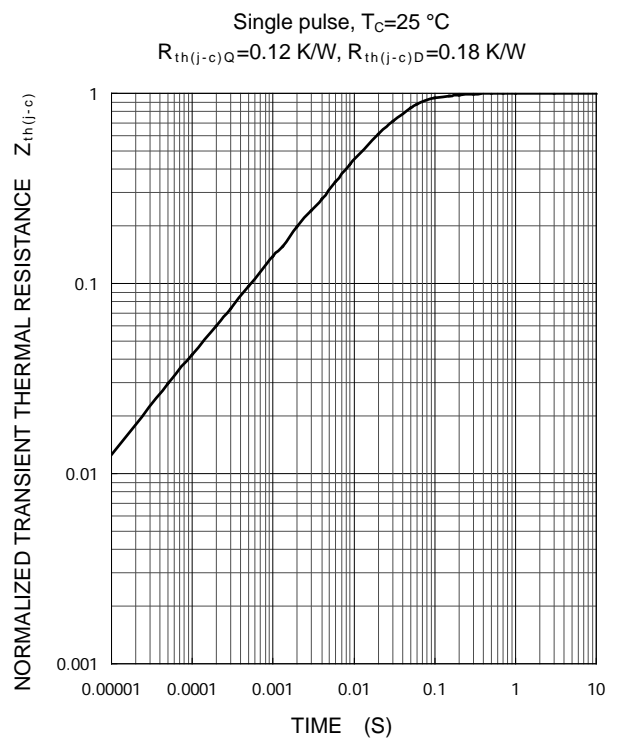
FREE WHEELING DIODE  
REVERSE RECOVERY CHARACTERISTICS  
(TYPICAL)



GATE CHARGE CHARACTERISTICS  
(TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS  
(MAXIMUM)





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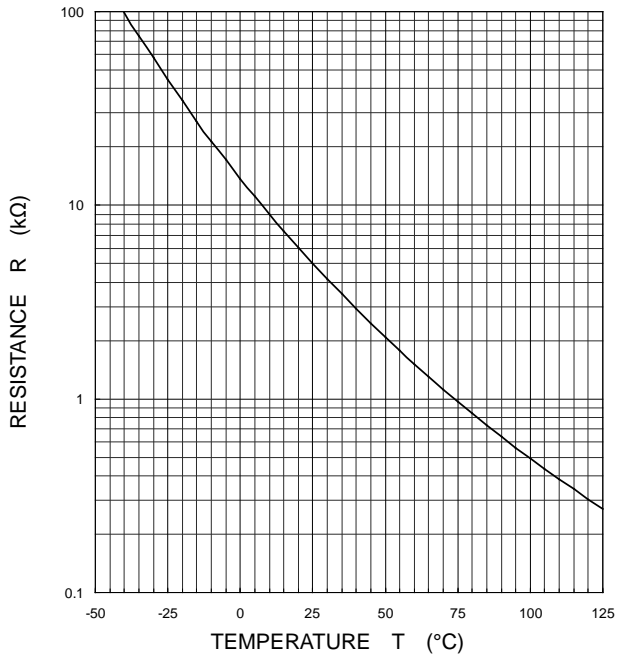
HIGH POWER SWITCHING USE  
INSULATED TYPE

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## PERFORMANCE CURVES

NTC thermistor part

TEMPERATURE CHARACTERISTICS  
(TYPICAL)



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