



<IGBT Modules>

# CM450DX-24T1/CM450DXP-24T1

**HIGH POWER SWITCHING USE  
INSULATED TYPE**

 <p>DX</p>	<p>Collector current <math>I_C</math> ..... <b>4 5 0 A</b>          Collector-emitter voltage <math>V_{CES}</math> ..... <b>1 2 0 0 V</b>          Maximum junction temperature <math>T_{vjmax}</math> ..... <b>1 7 5 °C</b></p> <ul style="list-style-type: none"> <li>• Flat base type</li> <li>• Copper base plate (Nickel-plating)</li> <li>• RoHS Directive compliant</li> <li>• Tin-plating pin terminals</li> </ul>
 <p>DXP</p>	<p>Collector current <math>I_C</math> ..... <b>4 5 0 A</b>          Collector-emitter voltage <math>V_{CES}</math> ..... <b>1 2 0 0 V</b>          Maximum junction temperature <math>T_{vjmax}</math> ..... <b>1 7 5 °C</b></p> <ul style="list-style-type: none"> <li>• Flat base type</li> <li>• Copper base plate (Nickel-plating)</li> <li>• RoHS Directive compliant</li> <li>• Tin-plating pressfit terminals</li> </ul>
<p>dual switch (half-bridge)</p> <ul style="list-style-type: none"> <li>• UL Recognized under UL1557, File No. E323585</li> </ul>	

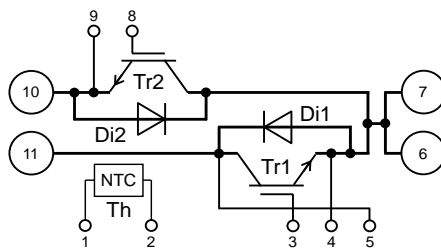
**APPLICATION**

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

**OPTION (Below options are available.)**

- PC-TIM (Phase Change Thermal Interface Material) pre-apply
- $V_{CEsat}$  selection for parallel connection

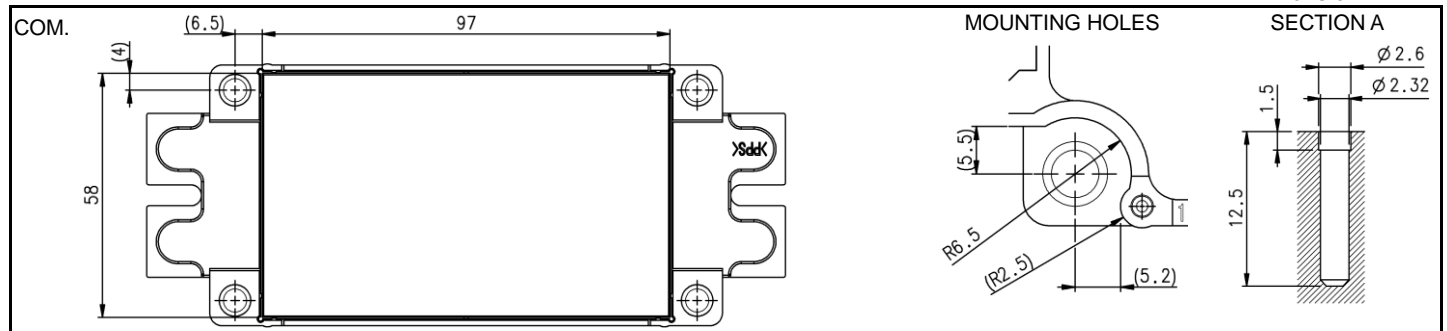
**INTERNAL CONNECTION**



**TERMINAL CODE**

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

**OUTLINE DRAWING**



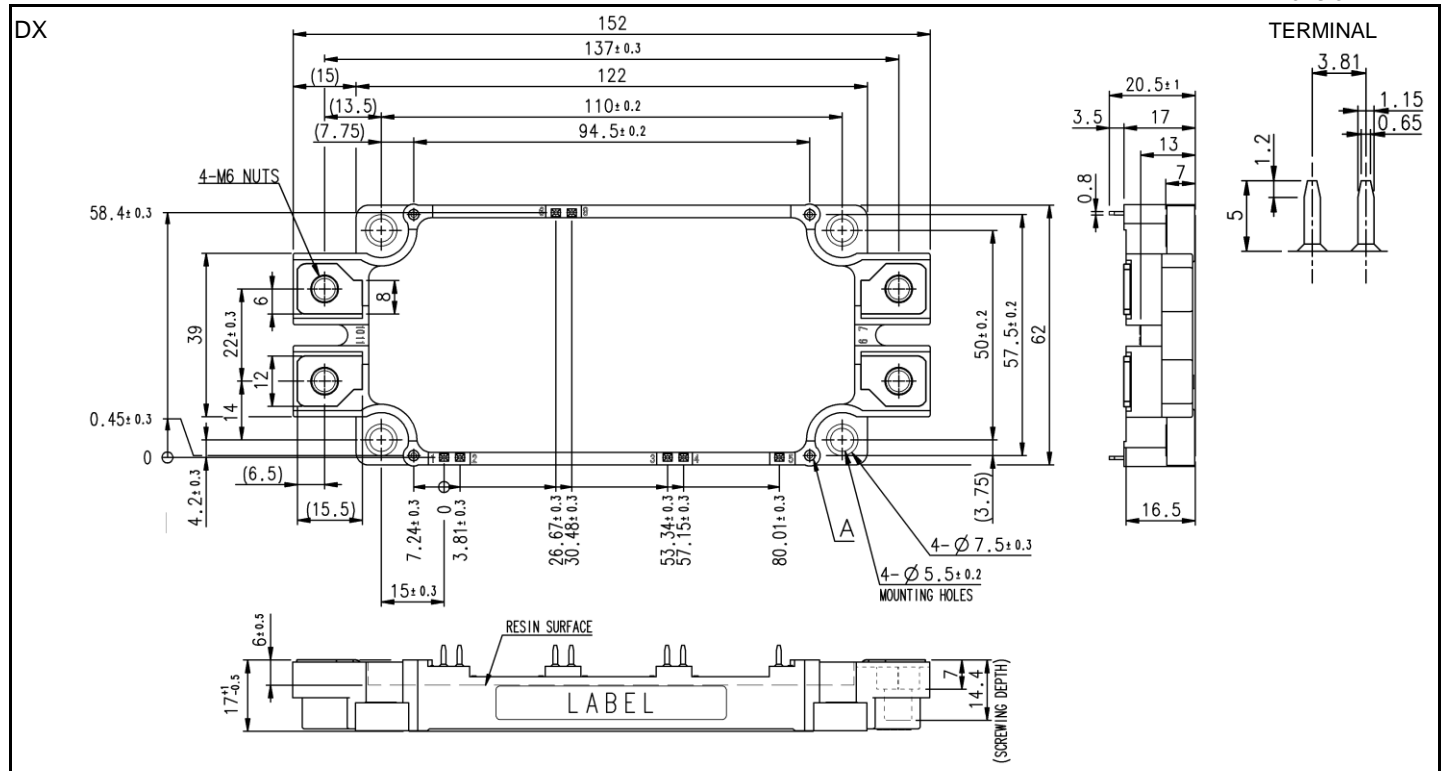
# CM450DX-24T1/CM450DXP-24T1

HIGH POWER SWITCHING USE

INSULATED TYPE

## OUTLINE DRAWING

Dimension in mm



Tolerance otherwise specified

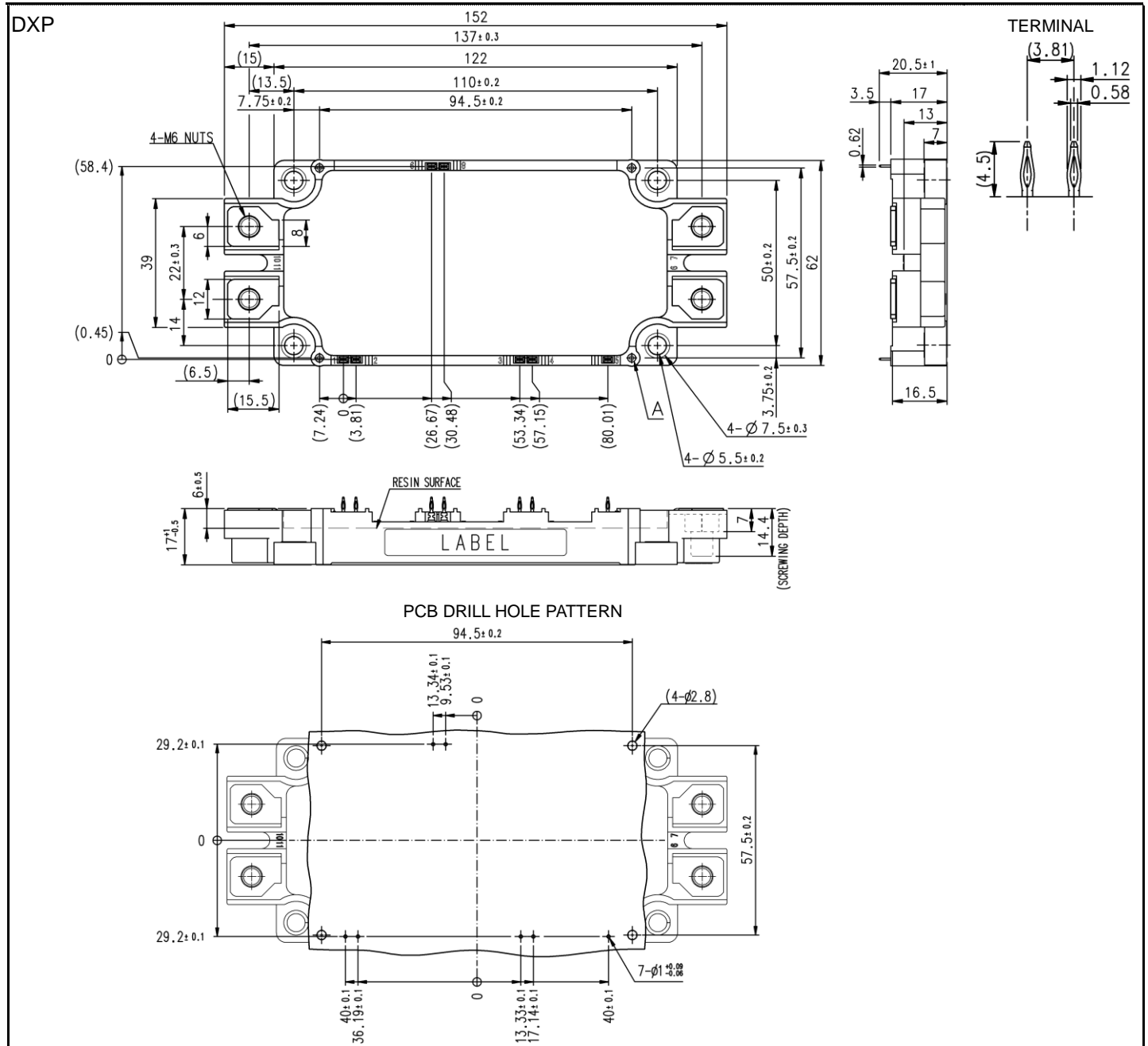
Division of Dimension	Tolerance
0.5 to 3	±0.2
over 3 to 6	±0.3
over 6 to 30	±0.5
over 30 to 120	±0.8
over 120 to 400	±1.2

# CM450DX-24T1/CM450DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPE

## OUTLINE DRAWING

Dimension in mm



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

## CM450DX-24T1/CM450DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPEMAXIMUM RATINGS ( $T_{vj}=25\text{ }^{\circ}\text{C}$ , 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, $T_C=70\text{ }^{\circ}\text{C}$ (Note2, 4)	450	A
$I_{CRM}$		Pulse, Repetitive (Note3)	900	
$P_{tot}$	Total power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ (Note2, 4)	1700	W
$I_E$ (Note1)	Emitter current	DC (Note2)	450	A
$I_{ERM}$ (Note1)		Pulse, Repetitive (Note3)	900	

## MODULE

Symbol	Item	Conditions	Rating	Unit
$V_{isol}$	Isolation voltage	Terminals to base plate, RMS, $f=60\text{ Hz}$ , AC 1 min	2500	V
$T_{vjmax}$	Maximum junction temperature	Instantaneous event (overload)	175	$^{\circ}\text{C}$
$T_{Cmax}$	Maximum case temperature	(Note4)	125	
$T_{vjop}$	Operating junction temperature	Continuous operation (under switching)	-40 ~ +150	$^{\circ}\text{C}$
$T_{stg}$	Storage temperature	-	-40 ~ +125	

ELECTRICAL CHARACTERISTICS ( $T_{vj}=25\text{ }^{\circ}\text{C}$ , 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	$I_C=45\text{ mA}$ , $V_{CE}=10\text{ V}$	5.4	6.0	6.6	V	
$V_{CEsat}$ (Terminal)	Collector-emitter saturation voltage	$I_C=450\text{ A}$ , $V_{GE}=15\text{ V}$ , Refer to the figure of test circuit (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.9	2.3	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	2.2	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	2.3	-	
$V_{CEsat}$ (Chip)		$I_C=450\text{ A}$ , $V_{GE}=15\text{ V}$ , (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.8	2.1	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	2.1	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	2.2	-	
$C_{ies}$	Input capacitance	$V_{CE}=10\text{ V}$ , G-E short-circuited	-	-	72.8	nF	
$C_{oes}$	Output capacitance		-	-	2.1		
$C_{res}$	Reverse transfer capacitance		-	-	0.9		
$Q_G$	Gate charge	$V_{CC}=600\text{ V}$ , $I_C=450\text{ A}$ , $V_{GE}=15\text{ V}$	-	2.26	-	$\mu\text{C}$	
$t_{d(on)}$	Turn-on delay time	$V_{CC}=600\text{ V}$ , $I_C=450\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=1.3\text{ }\Omega$ , Inductive load	-	-	600	ns	
$t_r$	Rise time		-	-	200		
$t_{d(off)}$	Turn-off delay time		-	-	800		
$t_f$	Fall time		-	-	400		
$V_{EC}$ (Note1) (Terminal)	Emitter-collector voltage	$I_E=450\text{ A}$ , G-E short-circuited, Refer to the figure of test circuit (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.90	2.35	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	2.00	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	2.05	-	
$V_{EC}$ (Note1) (Chip)		$I_E=450\text{ A}$ , G-E short-circuited, (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.80	2.15	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	1.85	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	1.85	-	
$t_{rr}$ (Note1)	Reverse recovery time	$V_{CC}=600\text{ V}$ , $I_E=450\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ ,	-	-	400	ns	
$Q_{rr}$ (Note1)	Reverse recovery charge	$R_G=1.3\text{ }\Omega$ , Inductive load	-	35.1	-	$\mu\text{C}$	
$E_{on}$	Turn-on switching energy per pulse	$V_{CC}=600\text{ V}$ , $I_C=I_E=450\text{ A}$ ,	-	56.5	-	mJ	
$E_{off}$	Turn-off switching energy per pulse	$V_{GE}=\pm 15\text{ V}$ , $R_G=1.3\text{ }\Omega$ , $T_{vj}=150\text{ }^{\circ}\text{C}$ ,	-	42.0	-		
$E_{rr}$ (Note1)	Reverse recovery energy per pulse	Inductive load	-	23.0	-	mJ	
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, $T_C=25\text{ }^{\circ}\text{C}$ (Note4)	-	0.88	-	m $\Omega$	
$r_g$	Internal gate resistance	Per switch	-	1.0	-	$\Omega$	

# CM450DX-24T1/CM450DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPE

## ELECTRICAL CHARACTERISTICS (cont.; T<sub>vj</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)	-	-	88	K/kW
R <sub>th(j-c)D</sub>		Junction to case, per Inverter FWD (Note4)	-	-	115	
R <sub>th(c-s)</sub>	Contact thermal resistance	Case to heat sink, Thermal grease applied (Note4, 7)	-	11.5	-	K/kW
		per 1 module, PC-TIM applied (Note4, 8)	-	3.1	-	

## 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	Solder pin type (DX)	Terminal to terminal	17	-	-	mm
			Terminal to base plate	16.4	-	-	
		Pressfit pin type (DXP)	Terminal to terminal	17	-	-	mm
			Terminal to base plate	16.8	-	-	
d <sub>a</sub>	Clearance	Solder pin type (DX)	Terminal to terminal	10	-	-	mm
			Terminal to base plate	16.2	-	-	
		Pressfit pin type (DXP)	Terminal to terminal	10	-	-	mm
			Terminal to base plate	16.2	-	-	
e <sub>c</sub>	Flatness of base plate	On the centerline X, Y (Note9)	±0	-	+200	μm	
m	mass	-	-	300	-	g	

\*: 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).

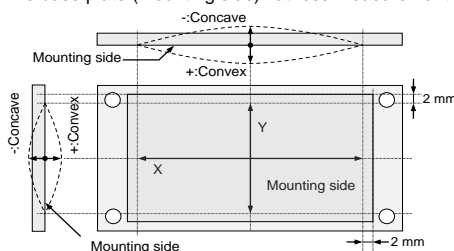
- Junction temperature (T<sub>vj</sub>) should not increase beyond T<sub>vjmax</sub> rating.
- Pulse width and repetition rate should be such that the device junction temperature (T<sub>vj</sub>) dose not exceed T<sub>vjmax</sub> rating.
- Case temperature (T<sub>C</sub>) and heat sink temperature (T<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. Refer to the figure of test circuit.

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

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)/D<sub>(c-s)</sub>=50 μm.
- Typical value is measured by using PC-TIM of λ=3.4 W/(m·K)/D<sub>(c-s)</sub>=50 μm.
- The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.



**CM450DX-24T1/CM450DXP-24T1**

HIGH POWER SWITCHING USE

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Note10. 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 r/min by mechanical screw driver) ~ 600 r/min (by mechanical screw driver)
(2) PT®		K25×10	0.75 ± 0.075 N·m	
(3) DELTA PT®		25×8	0.55 ± 0.055 N·m	
(4) DELTA PT®		25×10	0.75 ± 0.075 N·m	
(5) B1 tapping screw	-	φ2.6×10 φ2.6×12	0.75 ± 0.075 N·m	

**RECOMMENDED OPERATING CONDITIONS**

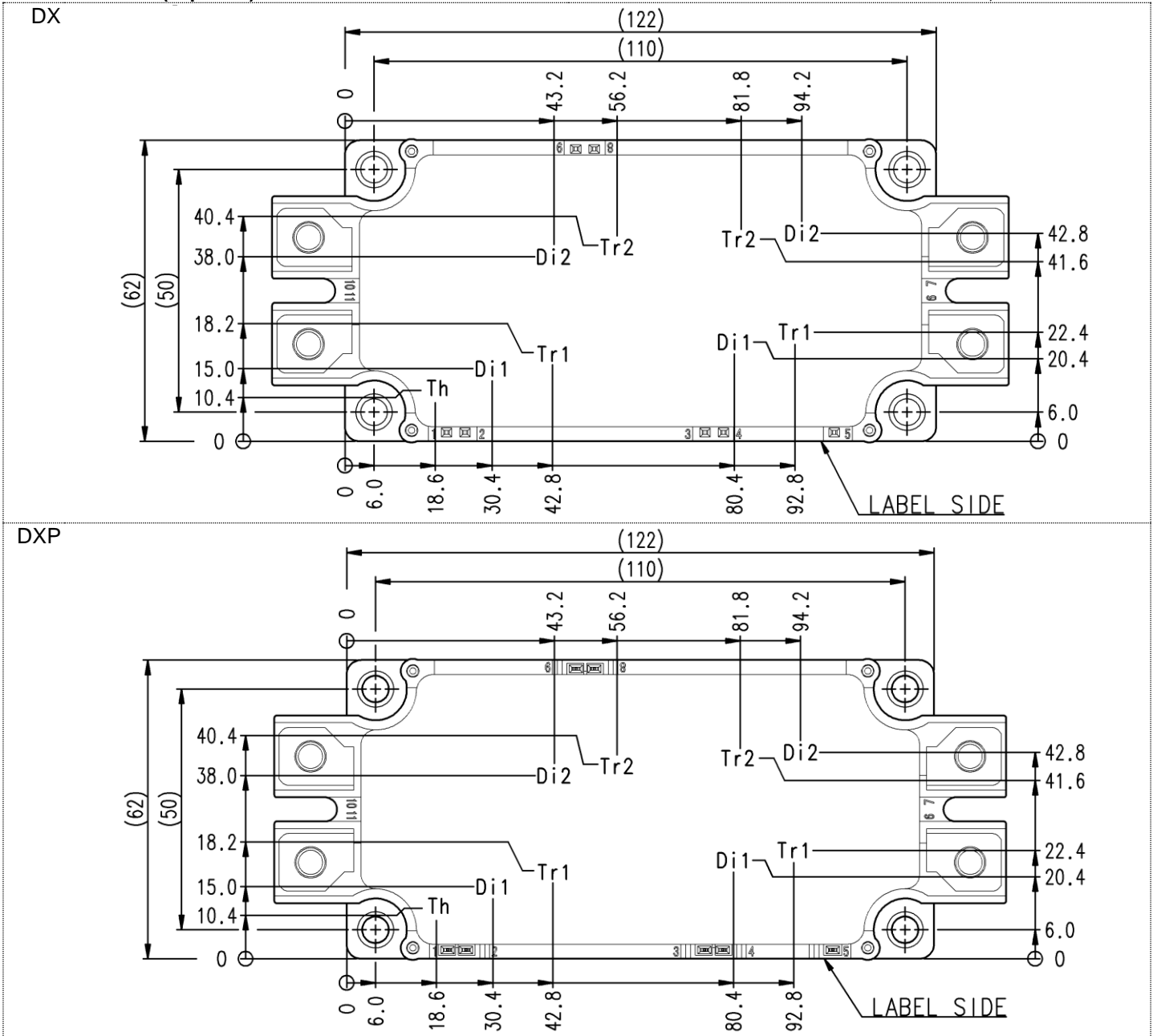
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V <sub>CC</sub>	(DC) Supply voltage	Applied across C1-E2 terminals	-	600	850	V
V <sub>GEon</sub>	Gate (-emitter drive) voltage	Applied across G1-E1s/G2-E2s terminals	13.5	15.0	16.5	V
R <sub>G</sub>	External gate resistance	Per switch	1.3	-	10	Ω

# CM450DX-24T1/CM450DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPE

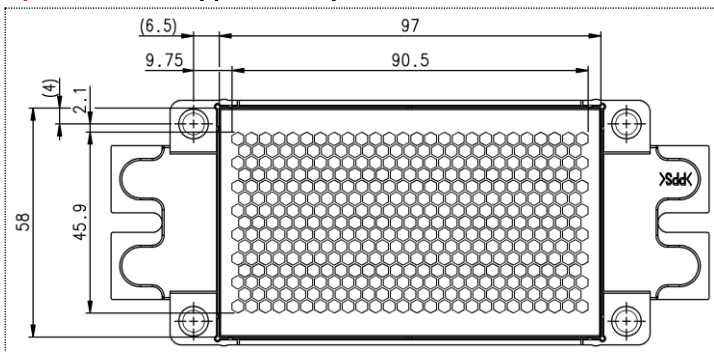
## CHIP LOCATION (Top view)

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



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

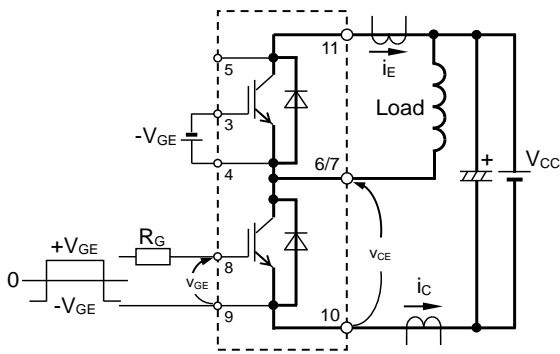
### Option: PC-TIM applied baseplate outline



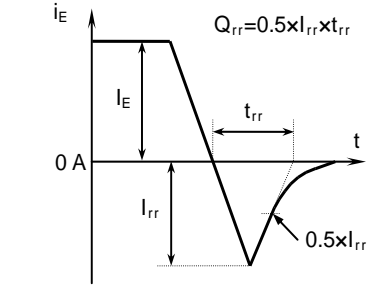
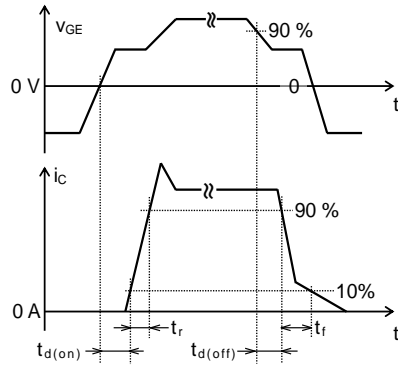
# CM450DX-24T1/CM450DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPE

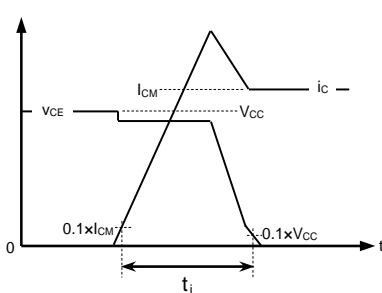
## TEST CIRCUIT AND WAVEFORMS



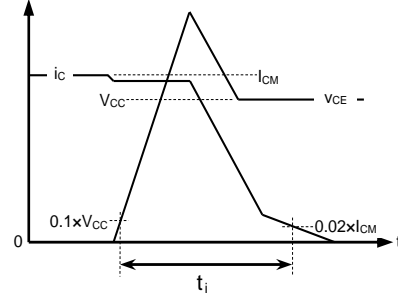
Switching characteristics test circuit and waveforms



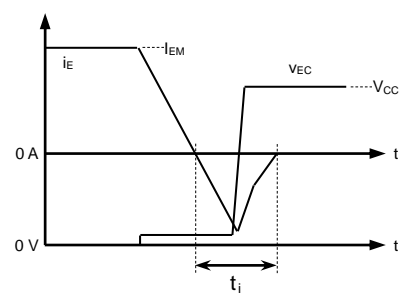
$t_{rr}$ ,  $Q_{rr}$  characteristics test waveform



IGBT Turn-on switching energy



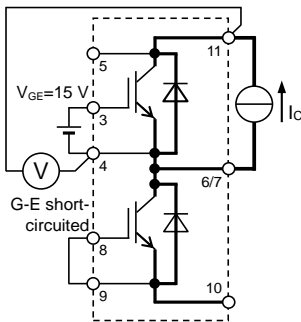
IGBT Turn-off switching energy



FWD Reverse recovery energy

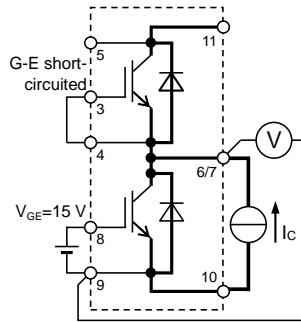
Switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT

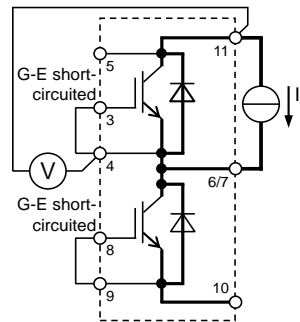


Tr1

$V_{CEsat}$  characteristics test circuit

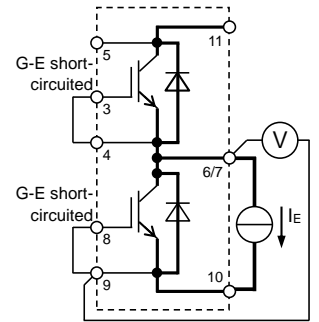


Tr2



Di1

$V_{EC}$  characteristics test circuit



Di2



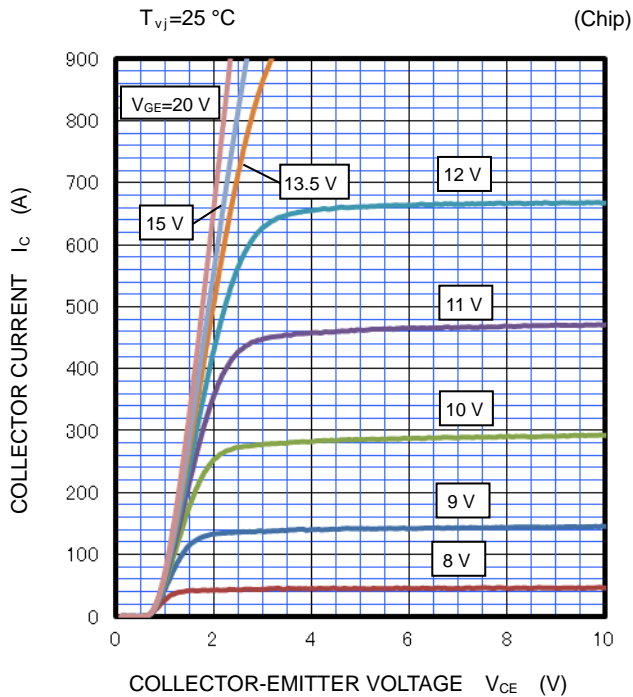
# CM450DX-24T1/CM450DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPE

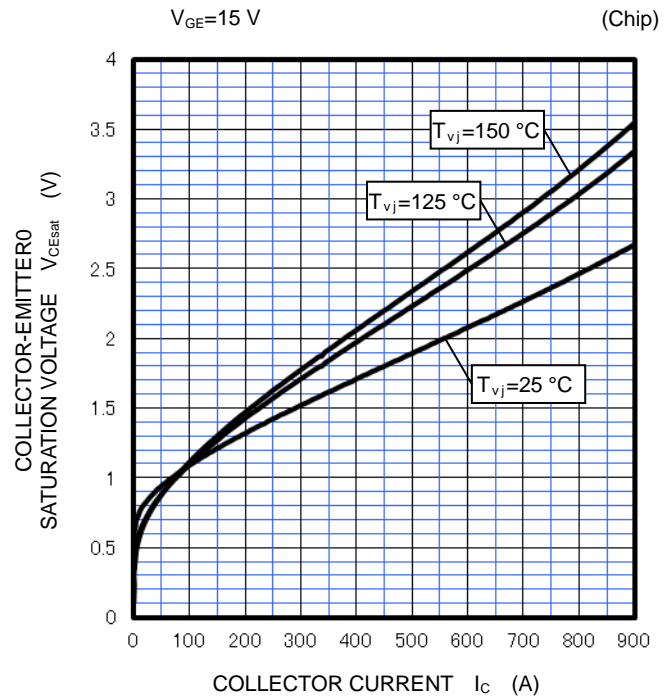
## PERFORMANCE CURVES

### INVERTER PART

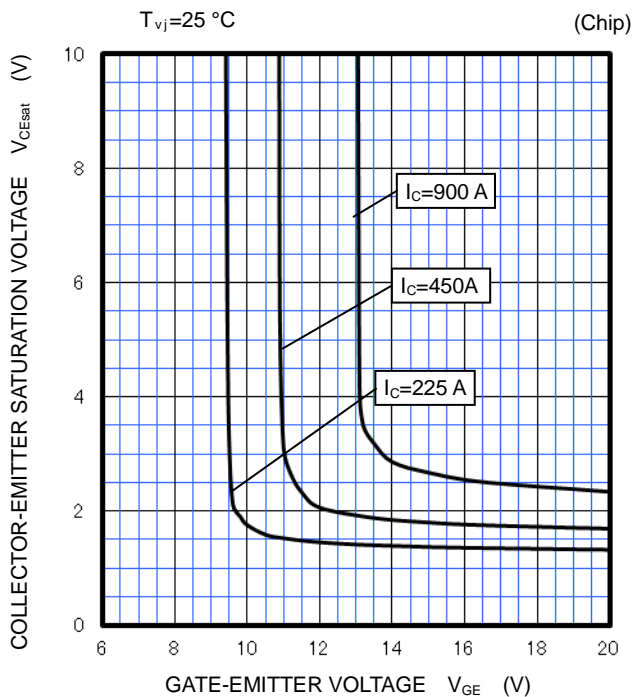
**OUTPUT CHARACTERISTICS**  
(TYPICAL)



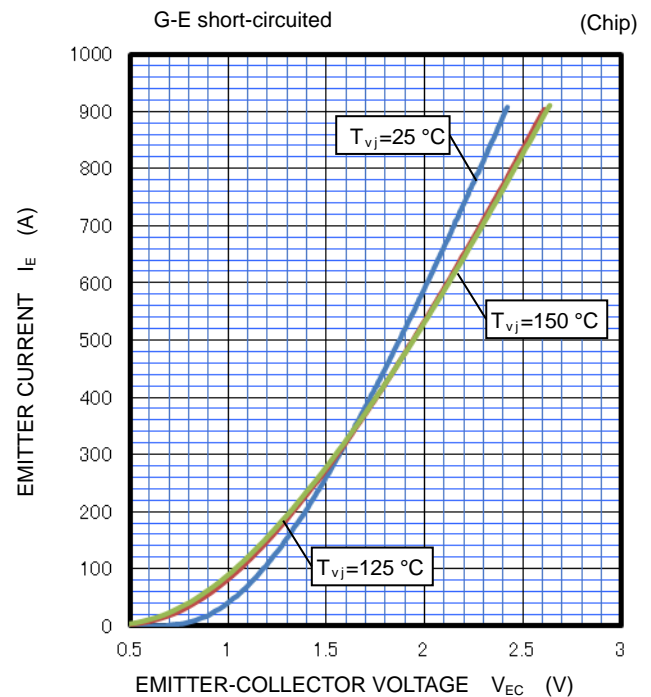
**COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS**  
(TYPICAL)



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



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



# CM450DX-24T1/CM450DXP-24T1

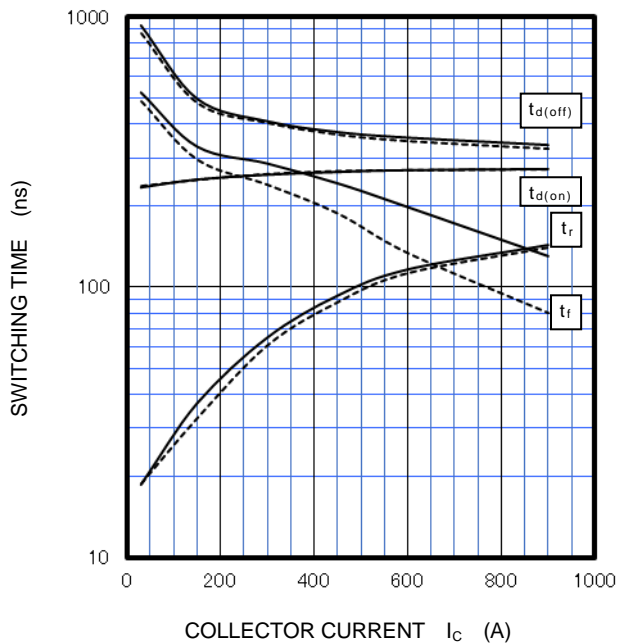
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

### INVERTER PART

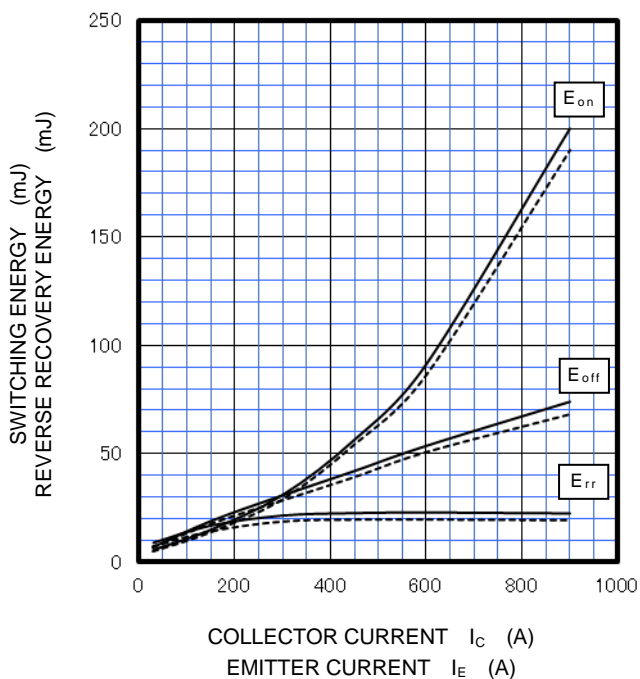
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.3\ \Omega$ , INDUCTIVE LOAD  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



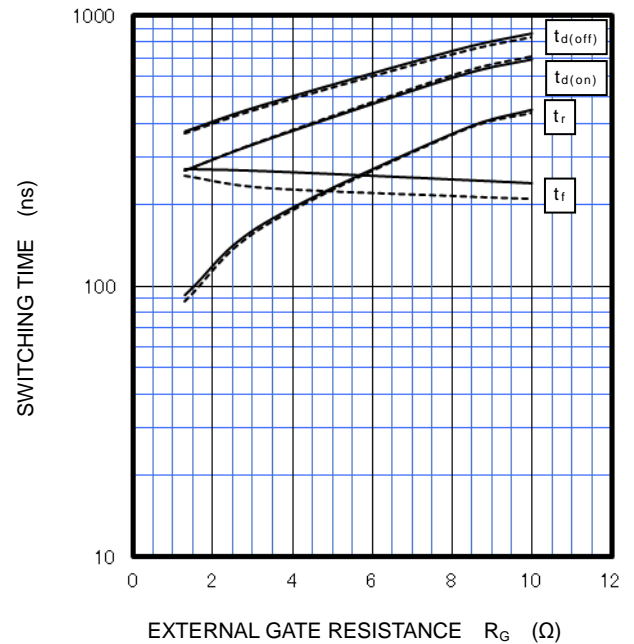
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.3\ \Omega$ ,  
INDUCTIVE LOAD, PER PULSE  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



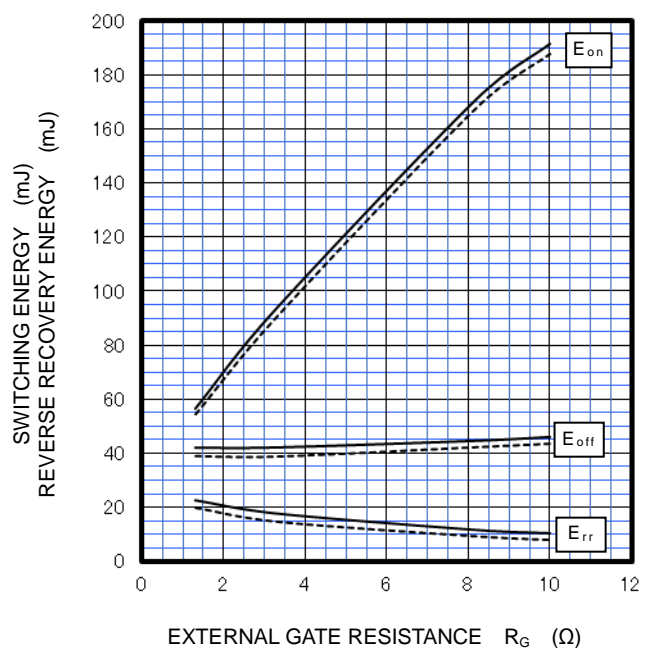
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

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



**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  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



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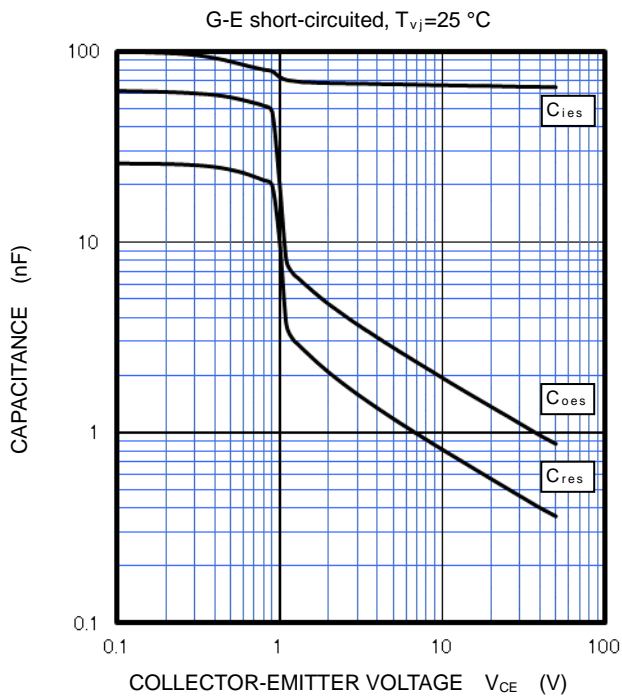
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

### INVERTER PART

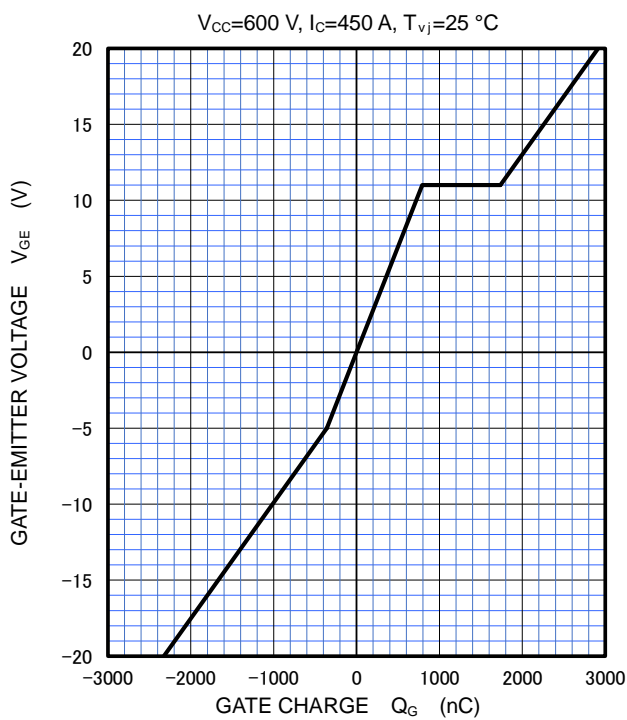
#### CAPACITANCE CHARACTERISTICS

(TYPICAL)



#### GATE CHARGE CHARACTERISTICS

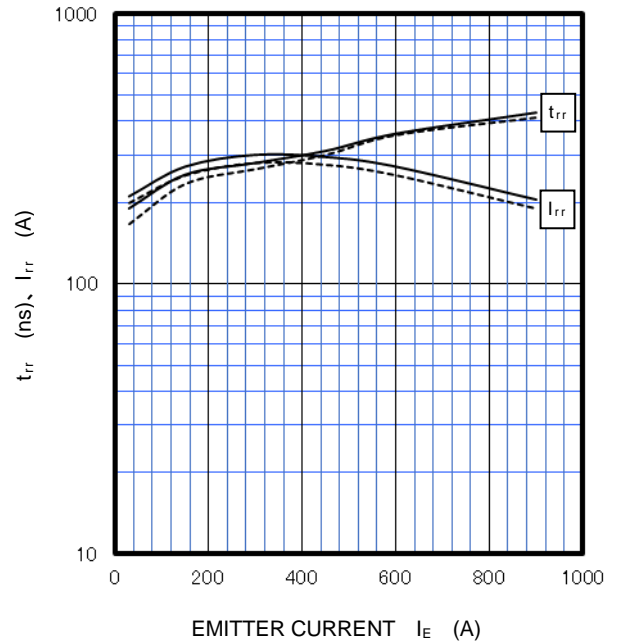
(TYPICAL)



#### FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS

(TYPICAL)

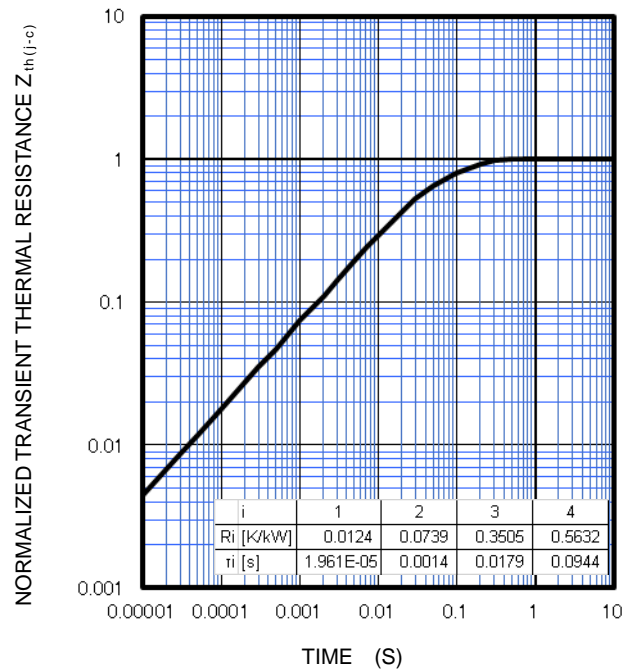
$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.3\ \Omega$ , INDUCTIVE LOAD  
—:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



#### TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS

(MAXIMUM)

Single pulse,  $T_C=25\text{ }^\circ\text{C}$   
 $R_{th(j-c)Q}=88\text{ K/kW}$ ,  $R_{th(j-c)D}=115\text{ K/kW}$



# CM450DX-24T1/CM450DXP-24T1

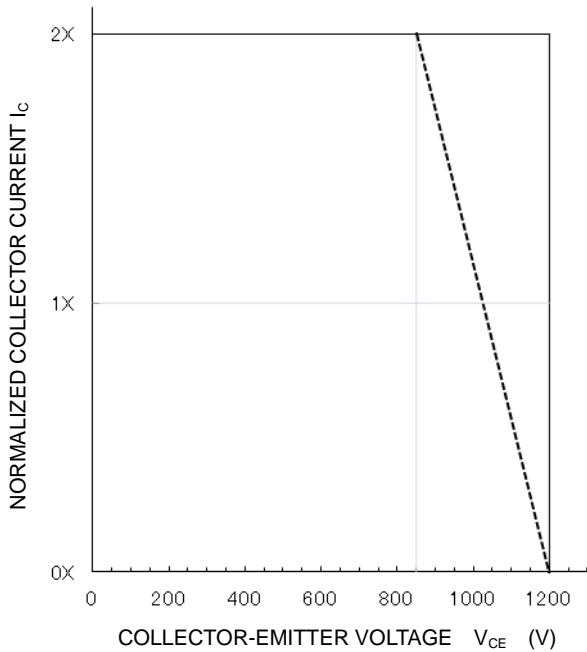
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

### INVERTER PART

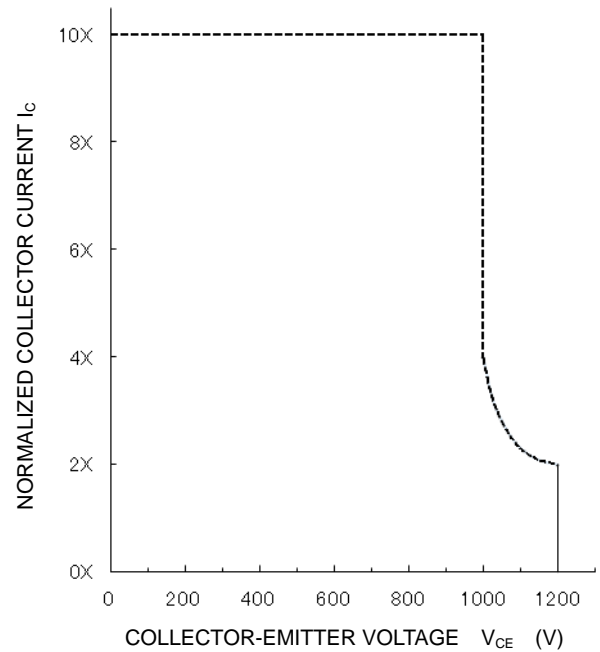
**TURN-OFF SWITCHING SAFE OPERATING AREA  
(REVERSE BIAS SAFE OPERATING AREA)  
(MAXIMUM)**

$V_{CC} \leq 850 \text{ V}$ ,  $R_G = 1.3 \sim 10 \ \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  
 ———:  $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$  (Normal load operations (Continuous))  
 - - - - -:  $T_{vj} = 175 \text{ }^\circ\text{C}$  (Unusual load operations (Limited period))



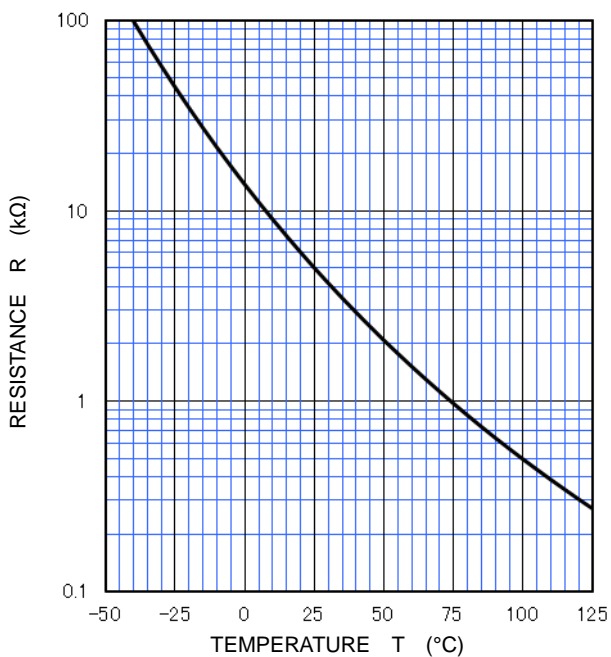
**SHORT-CIRCUIT SAFE OPERATING AREA  
(MAXIMUM)**

$V_{CC} \leq 800 \text{ V}$ ,  $R_G = 1.3 \sim 10 \ \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  
 $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$ ,  $t_W \leq 8 \ \mu\text{s}$ , Non-Repetitive



### NTC thermistor part

**TEMPERATURE CHARACTERISTICS  
(TYPICAL)**



Note: The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

# CM450DX-24T1/CM450DXP-24T1

HIGH POWER SWITCHING USE

INSULATED TYPE

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

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In the customer's research and development, please evaluate it not only with a single semiconductor product but also in the entire system, and judge whether it's applicable. Furthermore, 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 (e.g. appropriate fuse or circuit breaker between a power supply and semiconductor products), (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

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