



<IGBT Modules>

# CM600DX-24T1/CM600DXP-24T1

**HIGH POWER SWITCHING USE  
INSULATED TYPE**

 <p>DX</p>	<p>Collector current <math>I_C</math> ..... <b>600 A</b>            Collector-emitter voltage <math>V_{CES}</math> ..... <b>1200 V</b>            Maximum junction temperature <math>T_{vjmax}</math> ..... <b>175 °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>600 A</b>            Collector-emitter voltage <math>V_{CES}</math> ..... <b>1200 V</b>            Maximum junction temperature <math>T_{vjmax}</math> ..... <b>175 °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>	

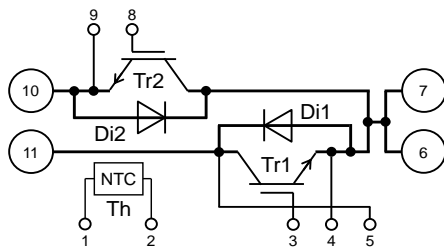
**APPLICATION**

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

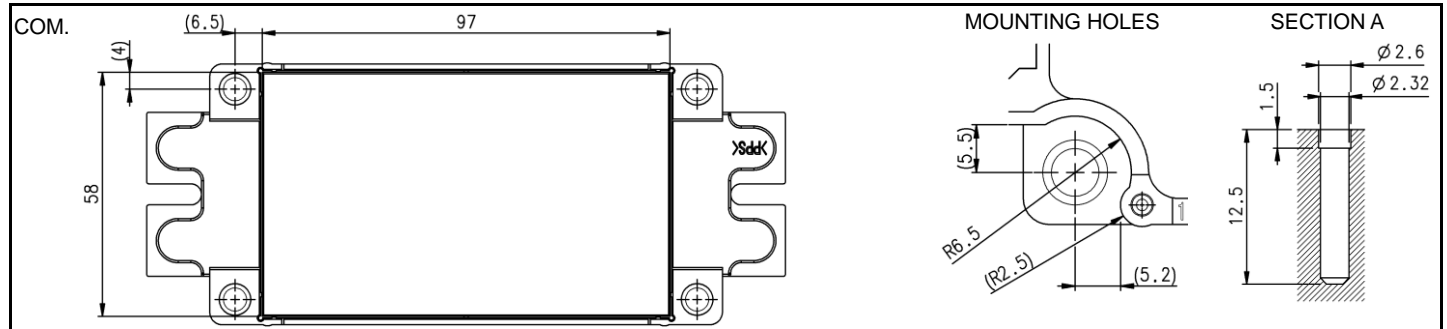
**INTERNAL CONNECTION**



**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**

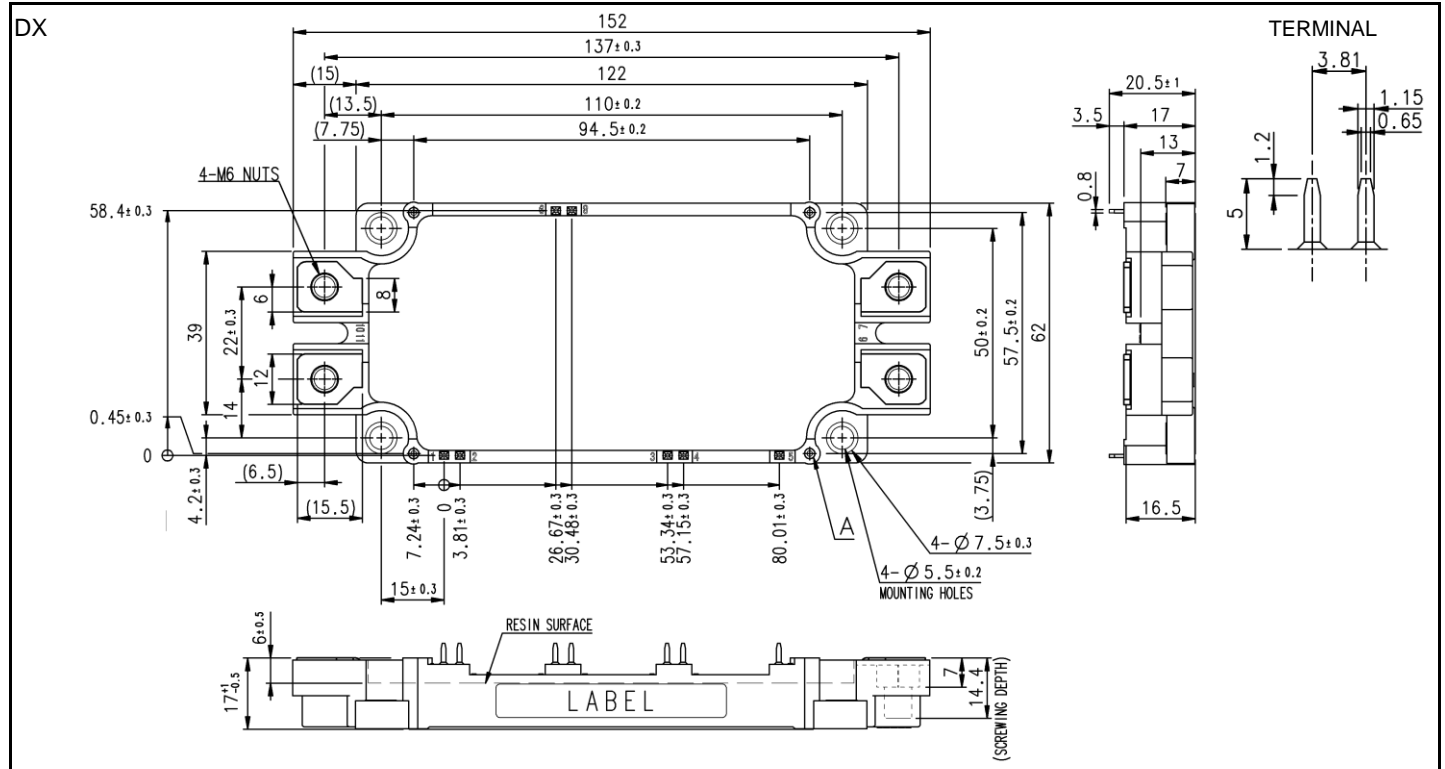


# CM600DX-24T1/CM600DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPE

## OUTLINE DRAWING

Dimension in mm



Tolerance otherwise specified

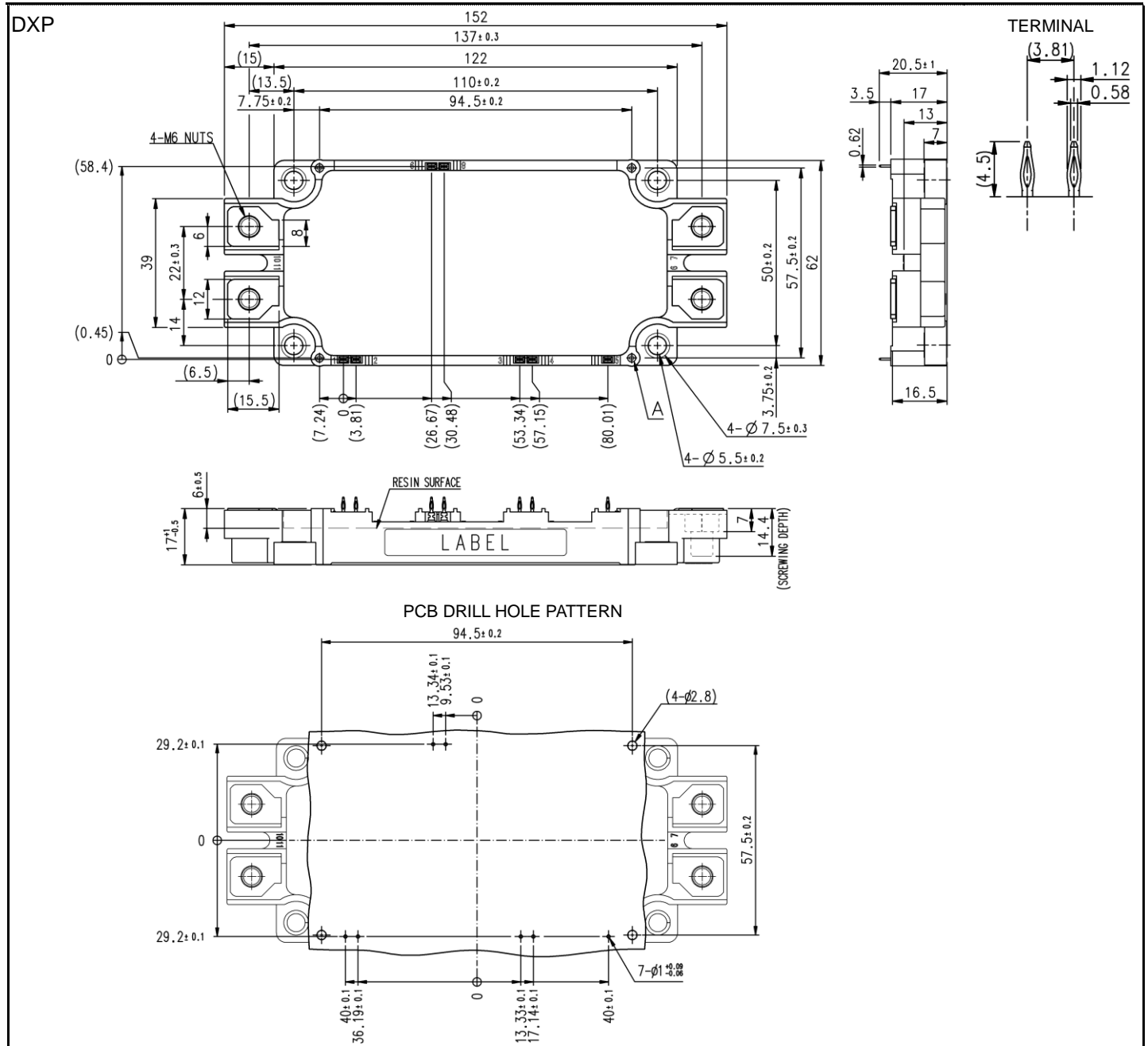
Division of Dimension	Tolerance
0.5 to 3	±0.2
over 3 to 6	±0.3
over 6 to 30	±0.5
over 30 to 120	±0.8
over 120 to 400	±1.2

# CM600DX-24T1/CM600DXP-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

## CM600DX-24T1/CM600DXP-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, $T_C=86\text{ }^{\circ}\text{C}$ (Note2, 4)	600	A
$I_{CRM}$		Pulse, Repetitive (Note3)	1200	
$P_{tot}$	Total power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ (Note2, 4)	2500	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	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	$I_C=60\text{ mA}$ , $V_{CE}=10\text{ V}$	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)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.90	2.25	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	2.15	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	2.25	-	
$V_{CEsat}$ (Chip)		$I_C=600\text{ A}$ , $V_{GE}=15\text{ V}$ , (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.70	2.00	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	1.95	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	2.05	-	
$C_{ies}$	Input capacitance	$V_{CE}=10\text{ V}$ , G-E short-circuited	-	-	109.1	nF	
$C_{oes}$	Output capacitance		-	-	3.1		
$C_{res}$	Reverse transfer capacitance		-	-	1.4		
$Q_G$	Gate charge	$V_{CC}=600\text{ V}$ , $I_C=600\text{ A}$ , $V_{GE}=15\text{ V}$	-	3.4	-	$\mu\text{C}$	
$t_{d(on)}$	Turn-on delay time	$V_{CC}=600\text{ V}$ , $I_C=600\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=1.0\text{ }\Omega$ , Inductive load	-	-	600	ns	
$t_r$	Rise time		-	-	300		
$t_{d(off)}$	Turn-off delay time		-	-	800		
$t_f$	Fall time		-	-	400		
$V_{EC}$ (Note1) (Terminal)	Emitter-collector voltage	$I_E=600\text{ A}$ , G-E short-circuited, Refer to the figure of test circuit (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.90	2.35	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	1.95	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	2.00	-	
$V_{EC}$ (Note1) (Chip)		$I_E=600\text{ A}$ , G-E short-circuited, (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.75	2.10	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	1.80	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	1.80	-	
$t_{rr}$ (Note1)	Reverse recovery time	$V_{CC}=600\text{ V}$ , $I_E=600\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ ,	-	-	400	ns	
$Q_{rr}$ (Note1)	Reverse recovery charge	$R_G=1.0\text{ }\Omega$ , Inductive load	-	46.8	-	$\mu\text{C}$	
$E_{on}$	Turn-on switching energy per pulse	$V_{CC}=600\text{ V}$ , $I_C=I_E=600\text{ A}$ ,	-	53.0	-	mJ	
$E_{off}$	Turn-off switching energy per pulse	$V_{GE}=\pm 15\text{ V}$ , $R_G=1.0\text{ }\Omega$ , $T_{vj}=150\text{ }^{\circ}\text{C}$ ,	-	56.0	-		
$E_{rr}$ (Note1)	Reverse recovery energy per pulse	Inductive load	-	40.0	-	mJ	
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, $T_C=25\text{ }^{\circ}\text{C}$ (Note4)	-	0.75	-	m $\Omega$	
$r_g$	Internal gate resistance	Per switch	-	0.67	-	$\Omega$	

# CM600DX-24T1/CM600DXP-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)	-	-	60	K/kW
R <sub>th(j-c)D</sub>		Junction to case, per Inverter FWD (Note4)	-	-	87	
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).

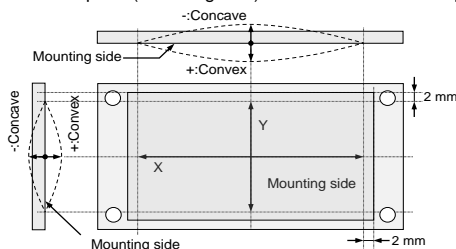
- Junction temperature (T<sub>vj</sub>) should not increase beyond T<sub>vjmax</sub> rating.
- Pulse width and repetition rate should be such that the device junction temperature (T<sub>vj</sub>) dose not exceed T<sub>vjmax</sub> rating.
- Case temperature (T<sub>C</sub>) and heat sink temperature (T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

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

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.



**CM600DX-24T1/CM600DXP-24T1**

HIGH POWER SWITCHING USE

INSULATED TYPE

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**

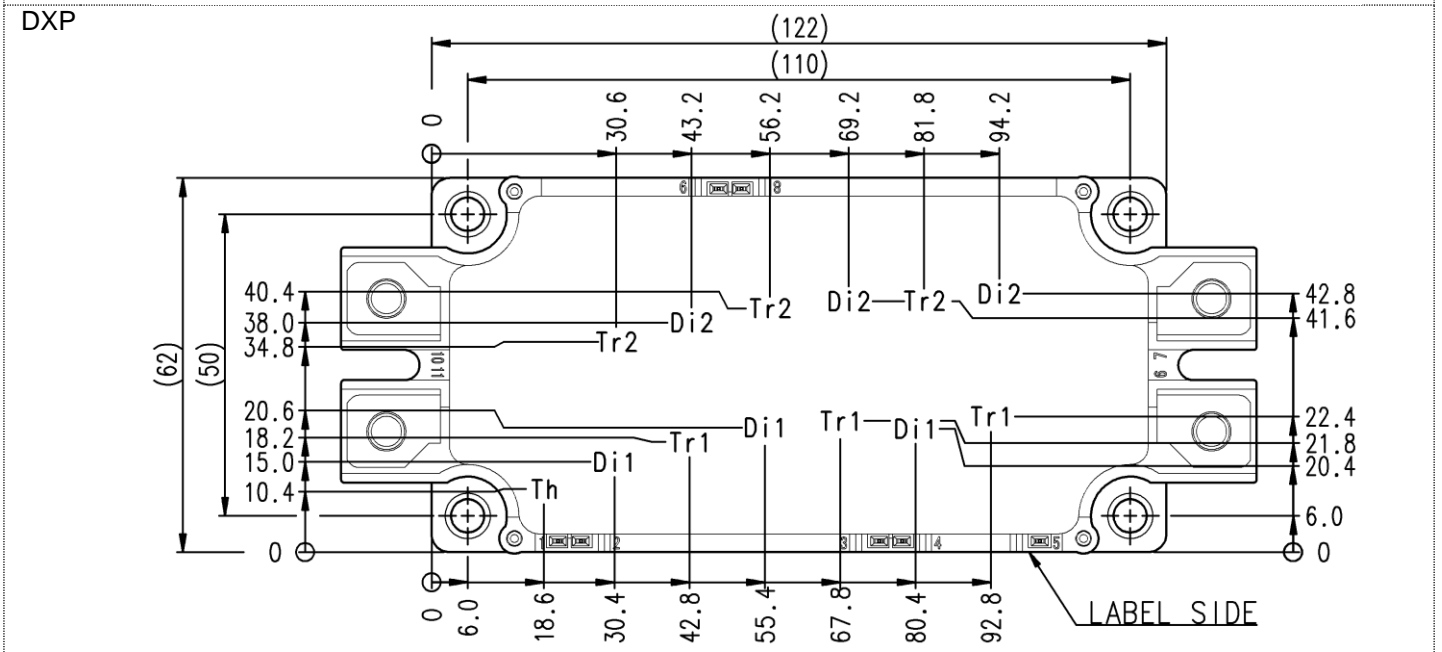
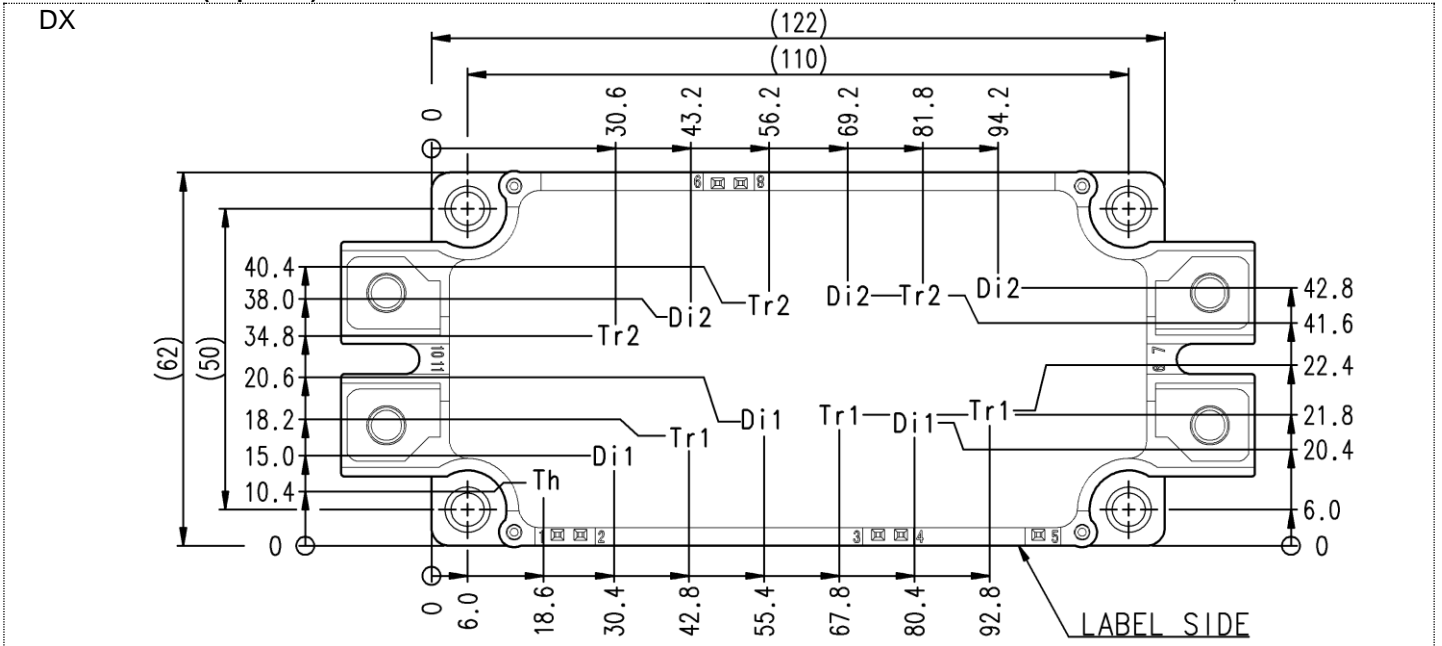
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$V_{CC}$	(DC) Supply voltage	Applied across C1-E2 terminals	-	600	850	V
$V_{GEon}$	Gate (-emitter drive) voltage	Applied across G1-E1s/G2-E2s terminals	13.5	15.0	16.5	V
$R_G$	External gate resistance	Per switch	1.0	-	6.8	Ω

# CM600DX-24T1/CM600DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPE

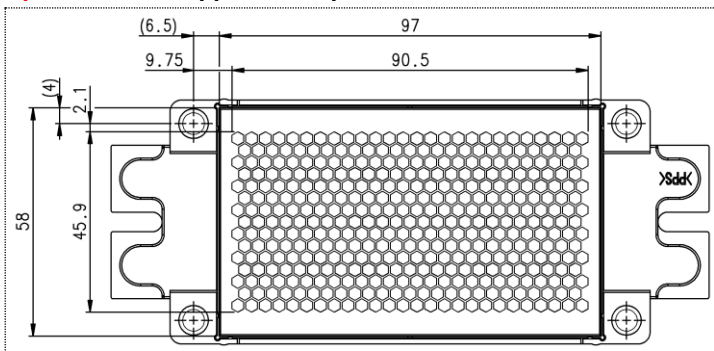
## CHIP LOCATION (Top view)

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



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

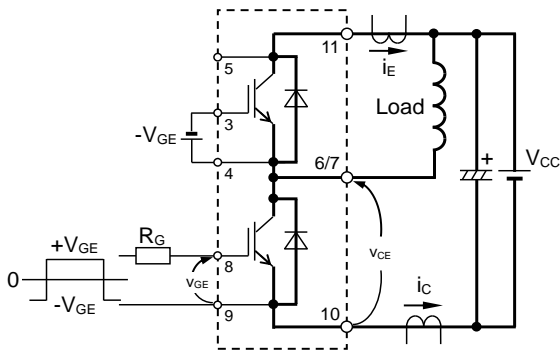
**Option: PC-TIM applied baseplate outline**



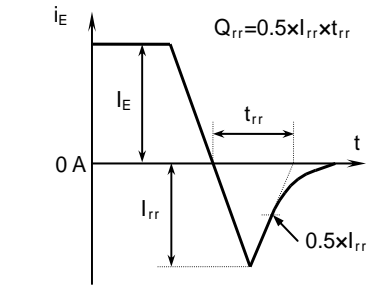
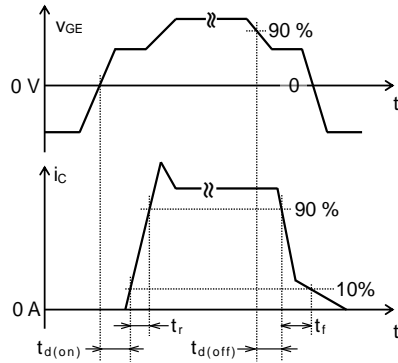
# CM600DX-24T1/CM600DXP-24T1

HIGH POWER SWITCHING USE  
INSULATED TYPE

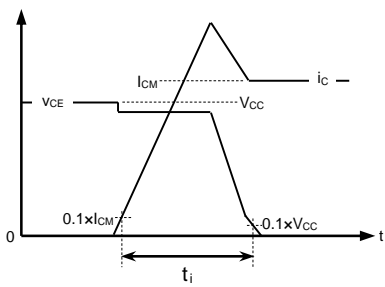
## TEST CIRCUIT AND WAVEFORMS



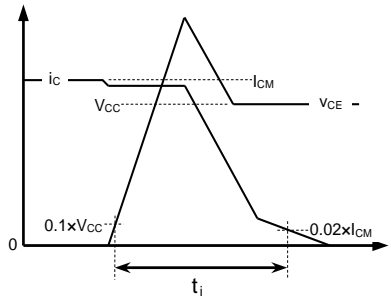
Switching characteristics test circuit and waveforms



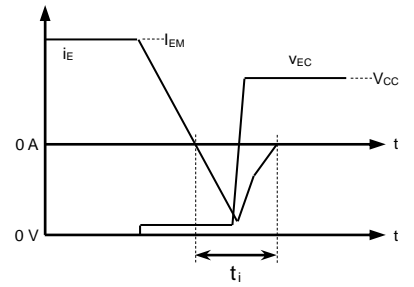
$t_{rr}$ ,  $Q_{rr}$  characteristics test waveform



IGBT Turn-on switching energy



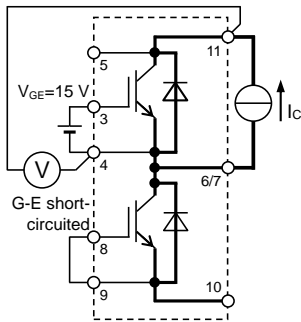
IGBT Turn-off switching energy



FWD Reverse recovery energy

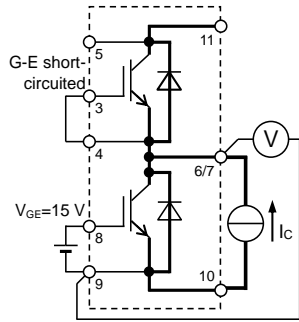
Switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT

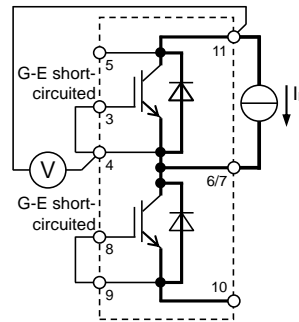


Tr1

$V_{CEsat}$  characteristics test circuit

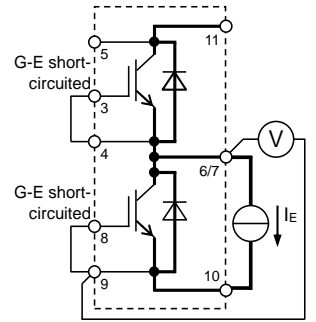


Tr2



Di1

$V_{EC}$  characteristics test circuit



Di2



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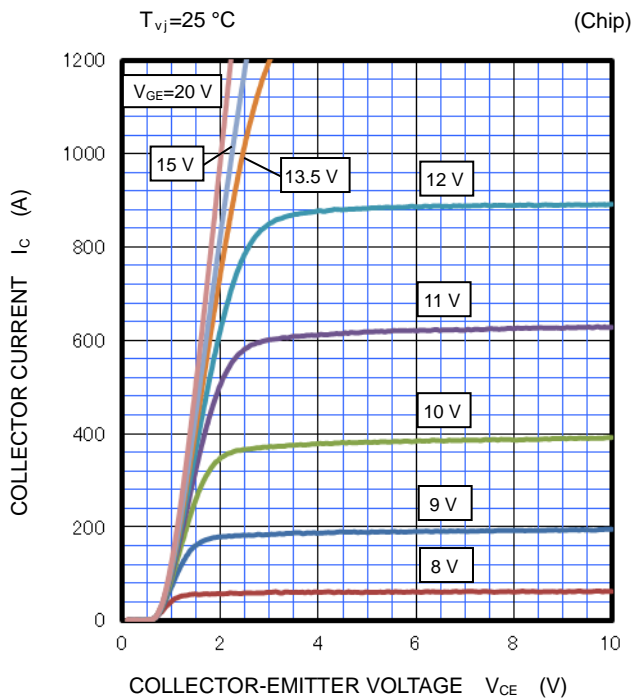
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

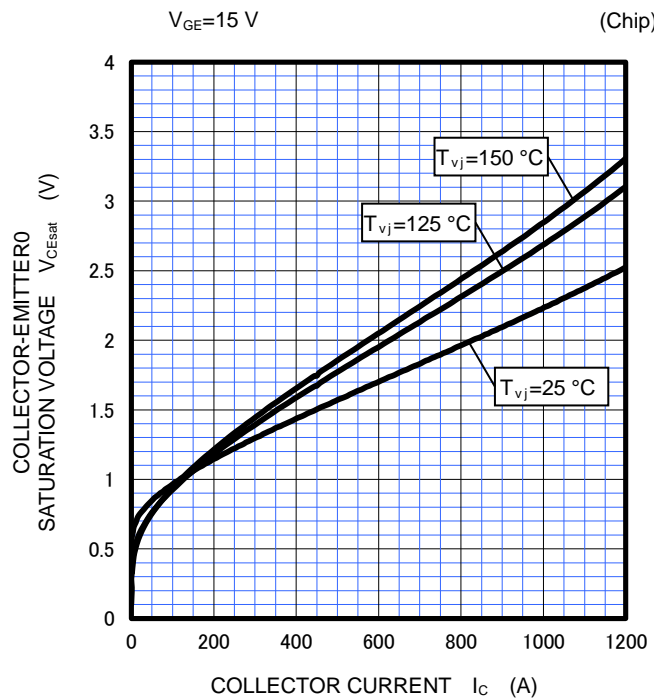
### INVERTER PART

OUTPUT CHARACTERISTICS

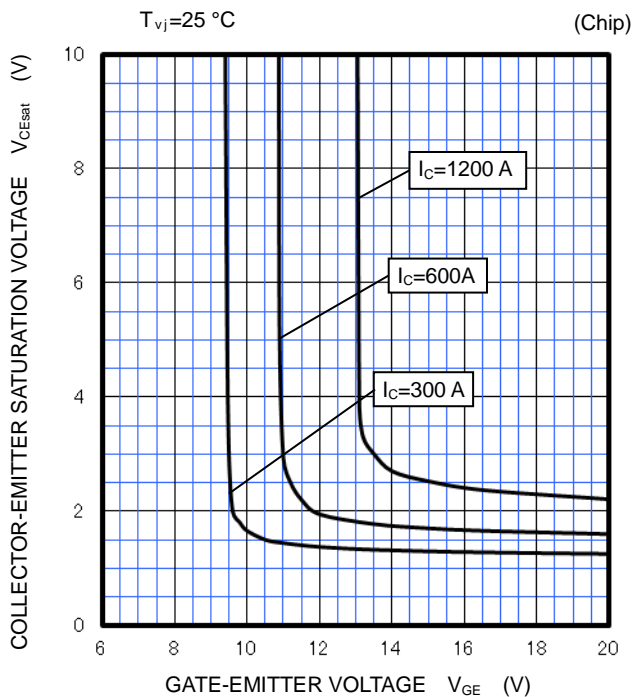
(TYPICAL)



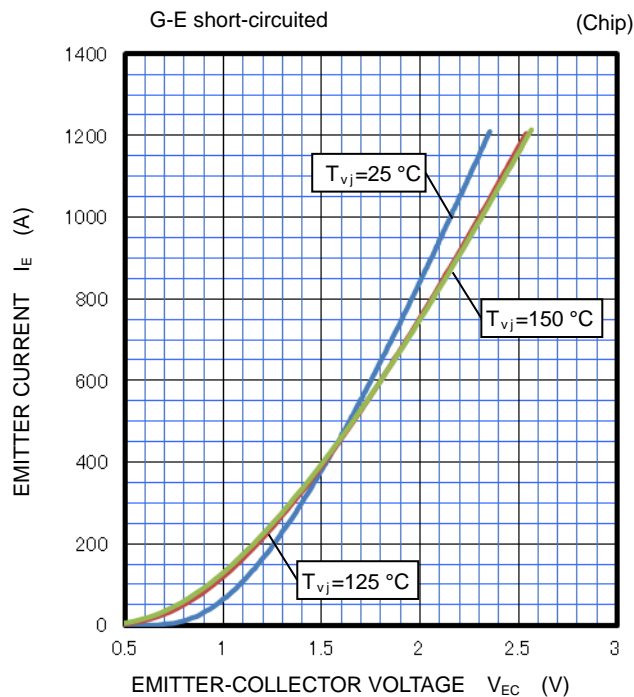
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



# CM600DX-24T1/CM600DXP-24T1

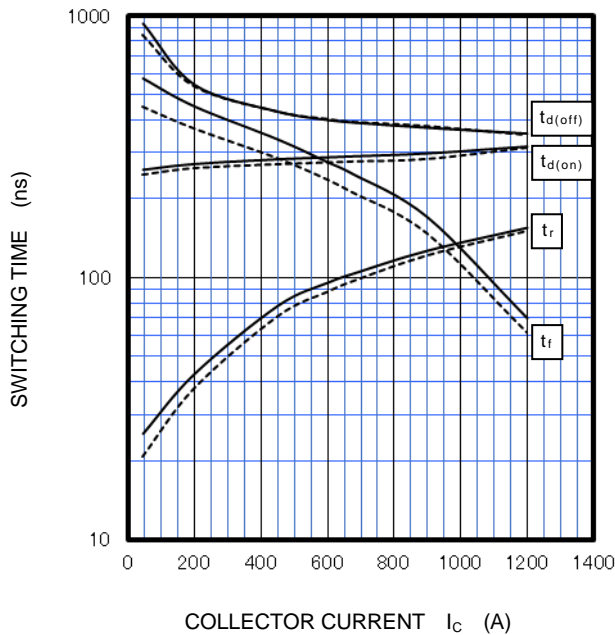
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

### INVERTER PART

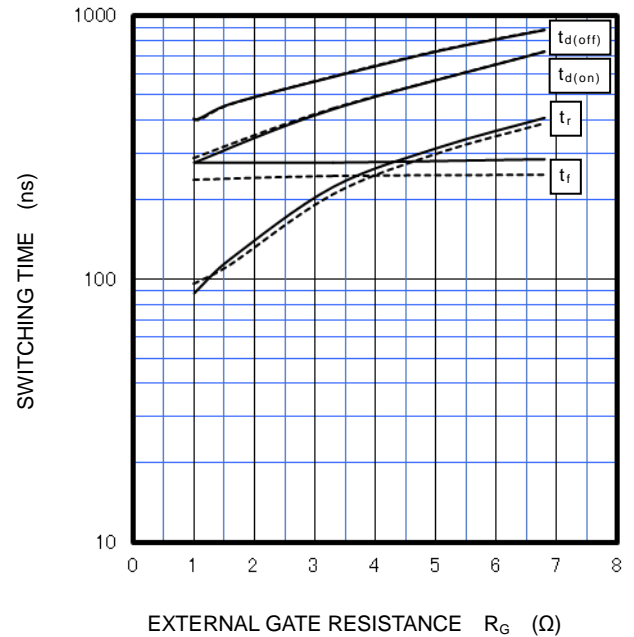
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.0\ \Omega$ , INDUCTIVE LOAD  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



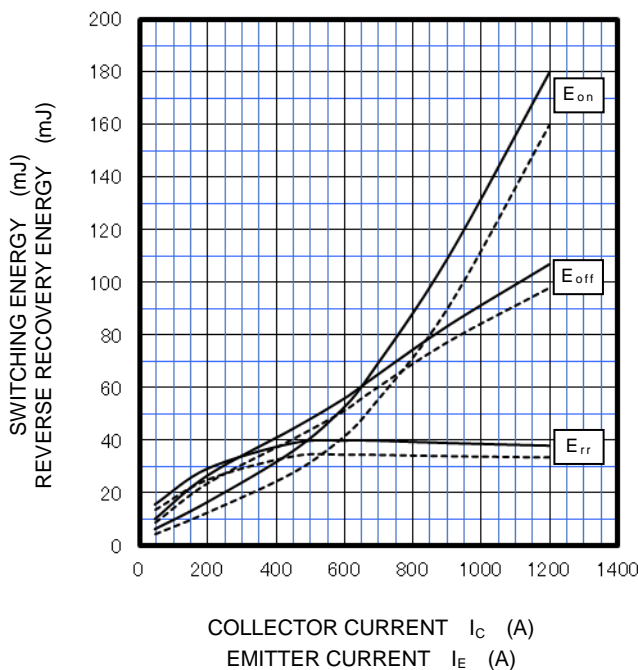
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

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



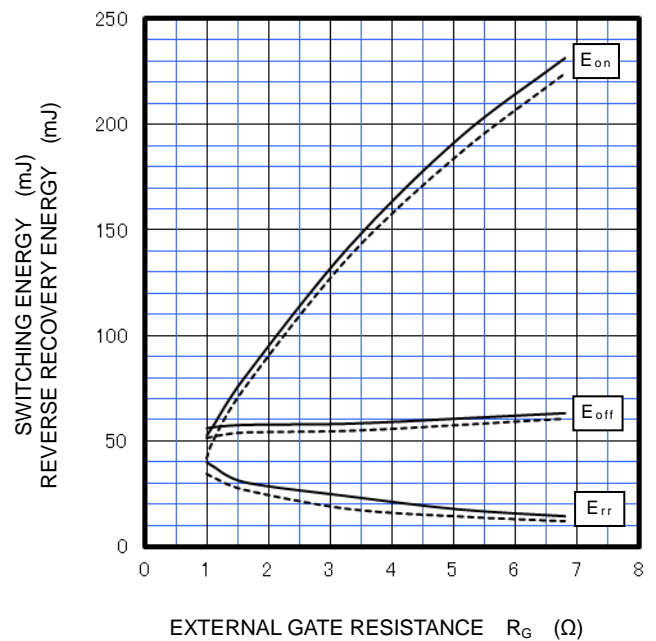
**HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)**

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.0\ \Omega$ ,  
INDUCTIVE LOAD, PER PULSE  
 —:  $T_{vj}=150\text{ }^\circ\text{C}$ , - - - -:  $T_{vj}=125\text{ }^\circ\text{C}$



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

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



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INSULATED TYPE

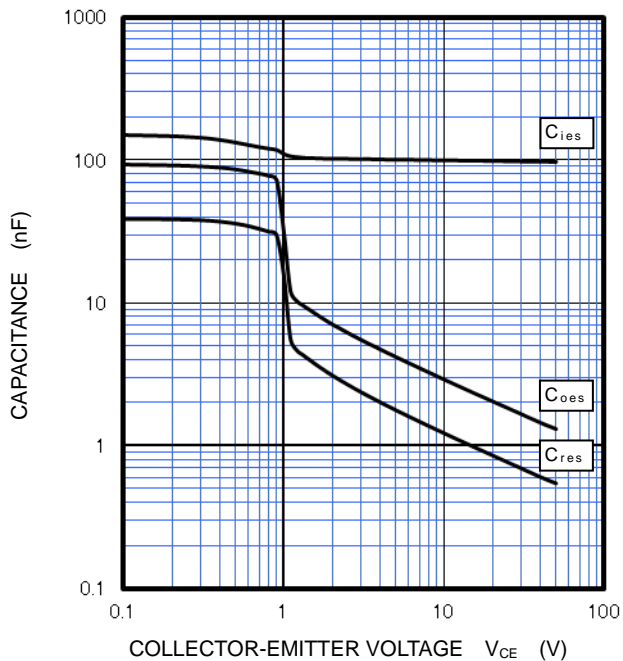
## PERFORMANCE CURVES

### INVERTER PART

#### CAPACITANCE CHARACTERISTICS

(TYPICAL)

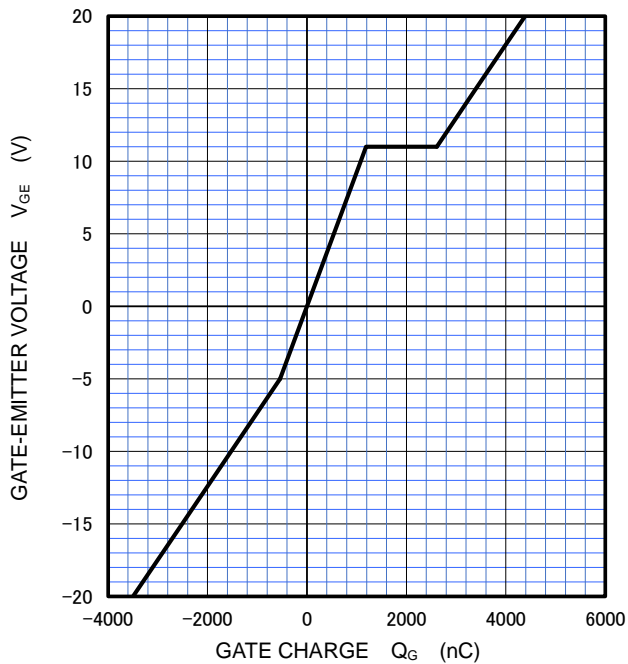
G-E short-circuited,  $T_{vj}=25\text{ }^{\circ}\text{C}$



#### GATE CHARGE CHARACTERISTICS

(TYPICAL)

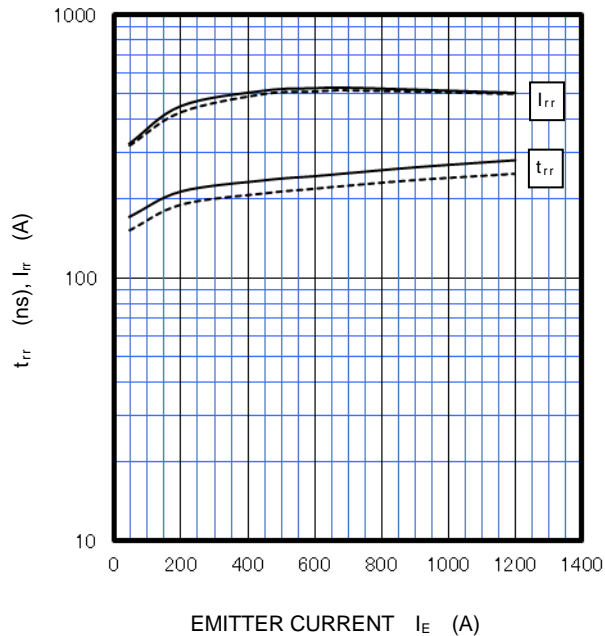
$V_{CC}=600\text{ V}$ ,  $I_C=600\text{ A}$ ,  $T_{vj}=25\text{ }^{\circ}\text{C}$



#### FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS

(TYPICAL)

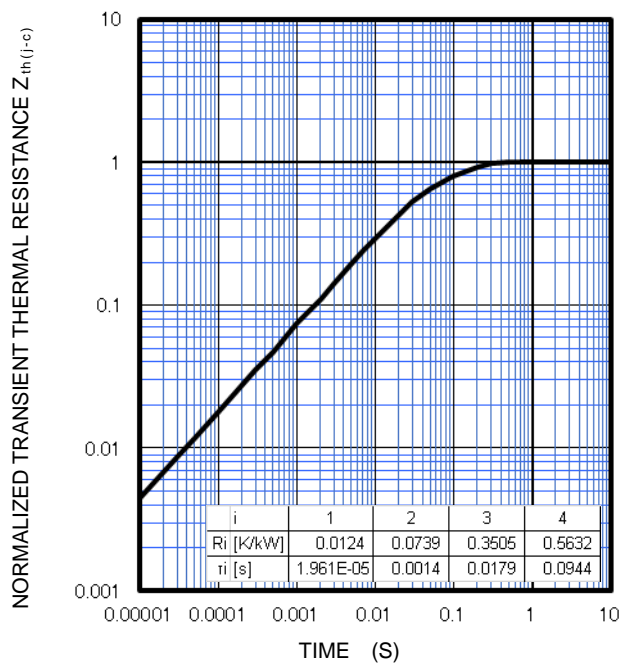
$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=1.0\text{ }\Omega$ , INDUCTIVE LOAD  
—:  $T_{vj}=150\text{ }^{\circ}\text{C}$ , - - - -:  $T_{vj}=125\text{ }^{\circ}\text{C}$



#### TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS

(MAXIMUM)

Single pulse,  $T_C=25\text{ }^{\circ}\text{C}$   
 $R_{th(j-c)Q}=60\text{ K/kW}$ ,  $R_{th(j-c)D}=87\text{ K/kW}$



# CM600DX-24T1/CM600DXP-24T1

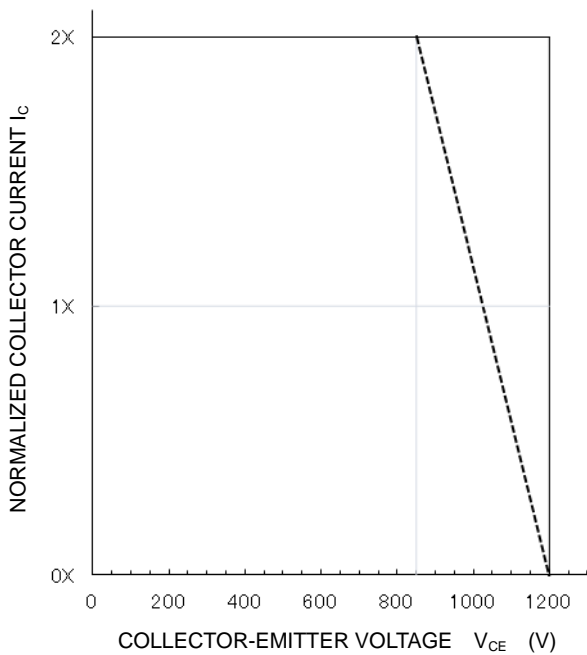
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

### INVERTER PART

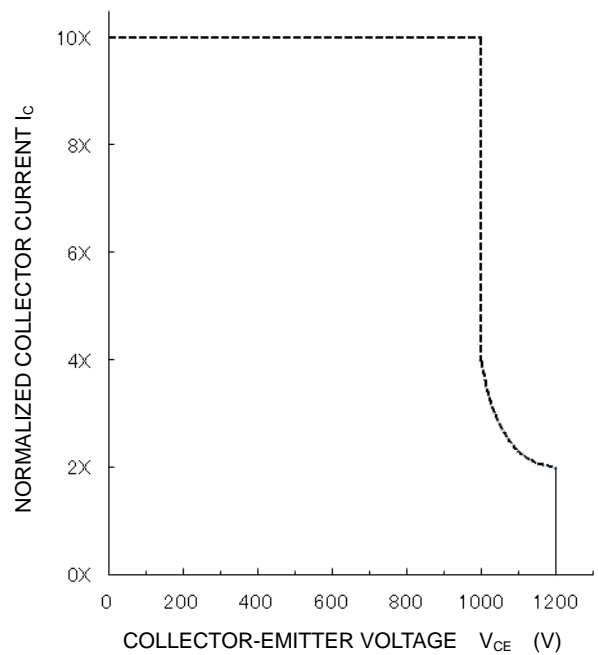
**TURN-OFF SWITCHING SAFE OPERATING AREA  
(REVERSE BIAS SAFE OPERATING AREA)  
(MAXIMUM)**

$V_{CC} \leq 850 \text{ V}$ ,  $R_G = 1.0 \sim 6.8 \ \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  
 ———:  $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$  (Normal load operations (Continuous))  
 - - - - -:  $T_{vj} = 175 \text{ }^\circ\text{C}$  (Unusual load operations (Limited period))



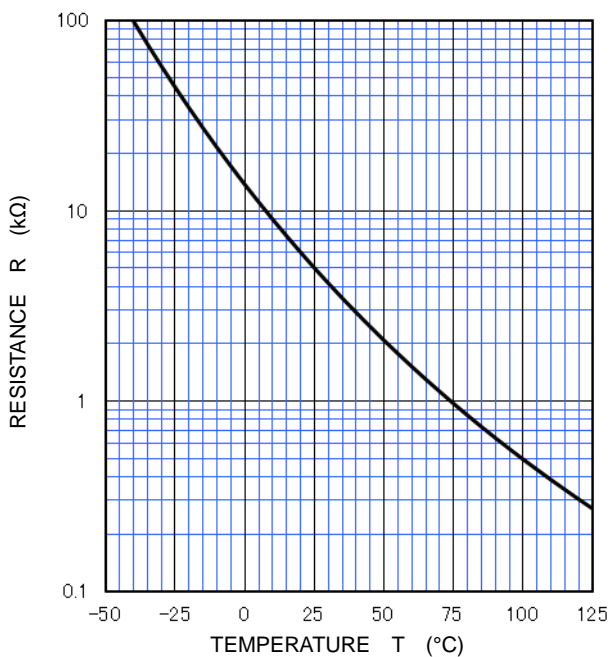
**SHORT-CIRCUIT SAFE OPERATING AREA  
(MAXIMUM)**

$V_{CC} \leq 800 \text{ V}$ ,  $R_G = 1.0 \sim 6.8 \ \Omega$ ,  $V_{GE} = \pm 15 \text{ V}$ ,  
 $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$ ,  $t_W \leq 8 \ \mu\text{s}$ , 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.

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

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