

&lt;IGBT Modules&gt;

# CM450DX-34T/CM450DXP-34T

HIGH POWER SWITCHING USE

INSULATED TYPE

DX



DXP



dual switch (half-bridge)

 Collector current  $I_C$  ..... 450 A

 Collector-emitter voltage  $V_{CES}$  ..... 1700 V

 Maximum junction temperature  $T_{vjmax}$  ..... 175 °C

- Flat base type
- Copper base plate (Nickel-plating)
- RoHS Directive compliant
- Tin-plating pin terminals

 Collector current  $I_C$  ..... 450 A

 Collector-emitter voltage  $V_{CES}$  ..... 1700 V

 Maximum junction temperature  $T_{vjmax}$  ..... 175 °C

- Flat base type
- Copper base plate (Nickel-plating)
- RoHS Directive compliant
- Tin-plating pressfit terminals

• UL Recognized under UL1557, File No. E323585

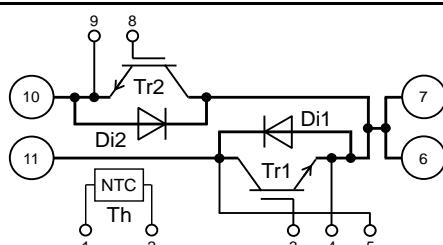
## APPLICATION

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

## OPTION (Below options are available.)

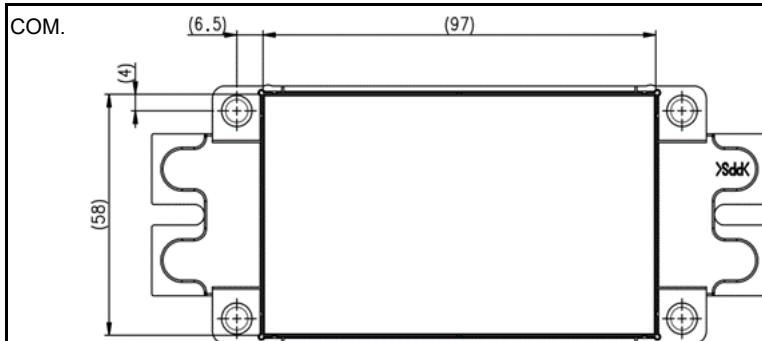
- PC-TIM (Phase Change Thermal Interface Material) pre-apply
- $V_{CEsat}$  selection for parallel connection

## INTERNAL CONNECTION

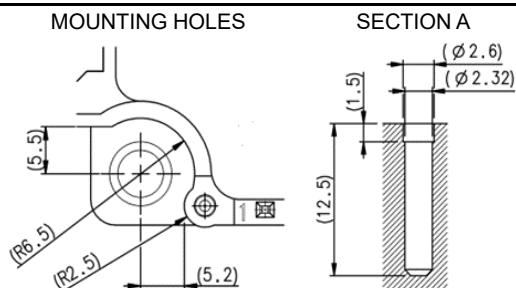


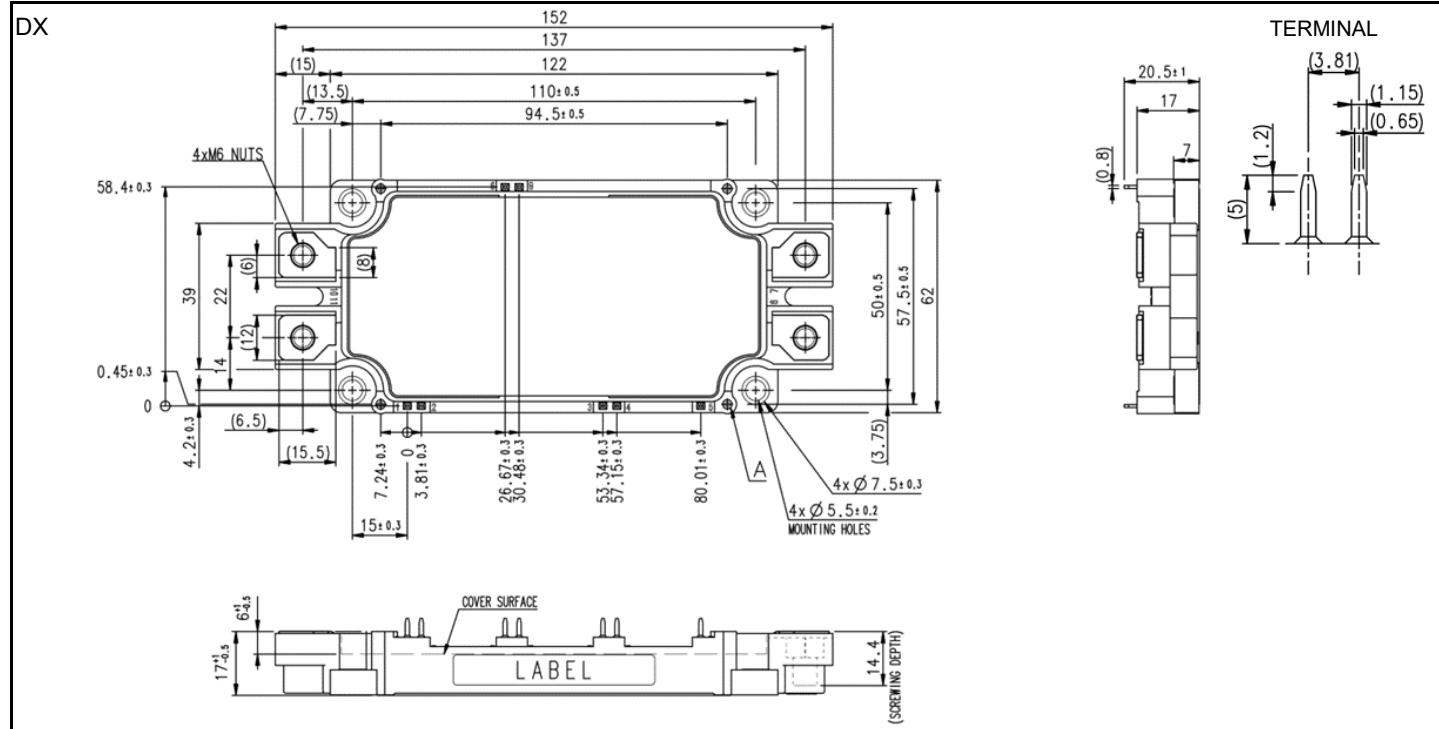
## TERMINAL CODE

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



## MOUNTING HOLES

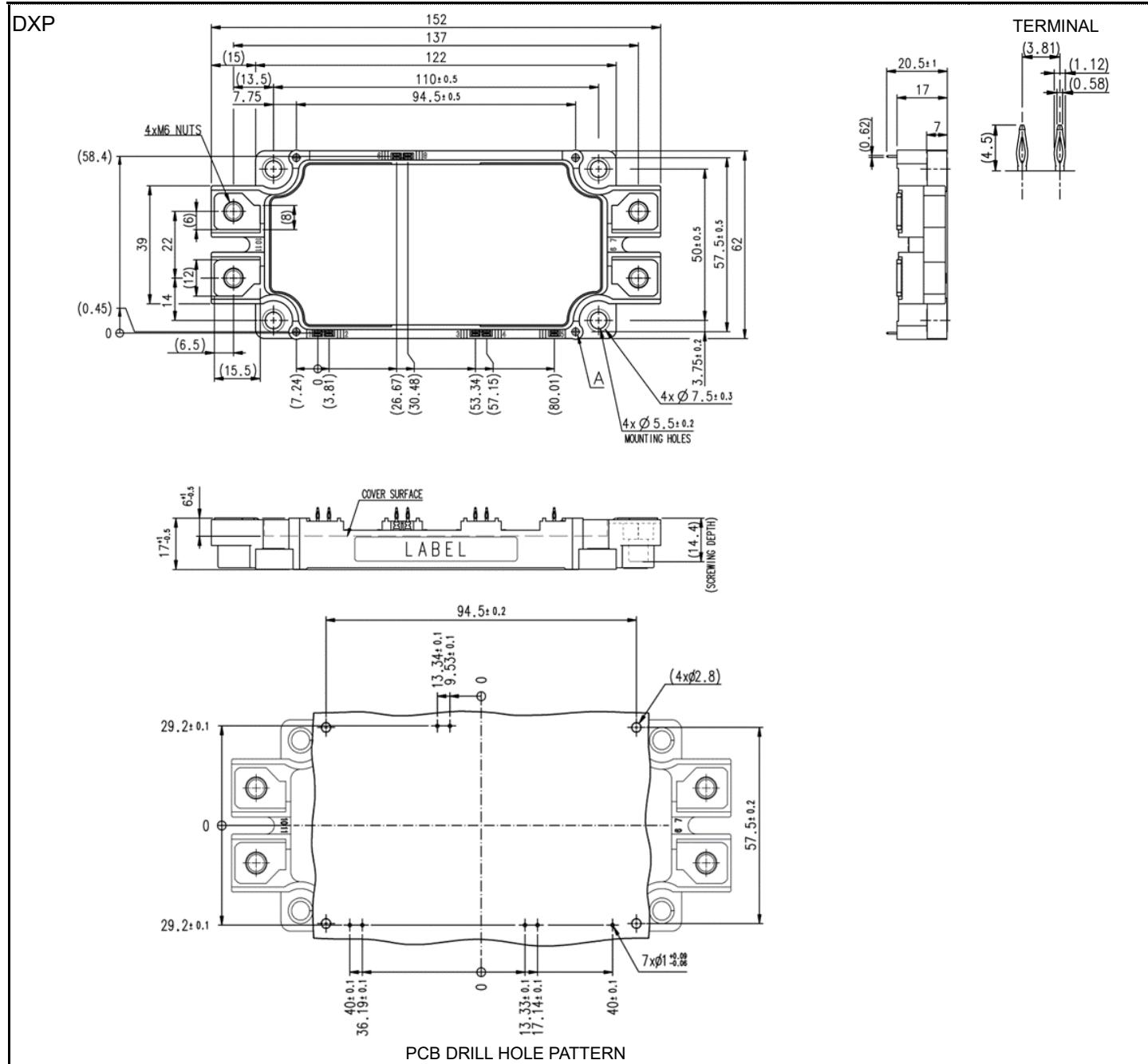


**OUTLINE DRAWING**

Tolerance otherwise specified

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

## OUTLINE DRAWING



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-34T/CM450DXP-34T**

HIGH POWER SWITCHING USE

INSULATED TYPE

**MAXIMUM RATINGS (T<sub>vj</sub>=25 °C, unless otherwise specified)****INVERTER PART IGBT/FWD**

Symbol	Item	Conditions	Rating	Unit
V <sub>CES</sub>	Collector-emitter voltage	G-E short-circuited	1700	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> =84 °C (Note2, 4)	450	A
		Pulse, Repetitive (Note3)	900	
P <sub>tot</sub>	Total power dissipation	T <sub>C</sub> =25 °C (Note2, 4)	2235	W
I <sub>E</sub> (Note1)	Emitter current	DC (Note2)	450	A
		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>vjmax</sub>	Maximum junction temperature	Instantaneous event (overload) (Note9)	175	°C
T <sub>Cmax</sub>	Maximum case temperature	(Note4, 9)	125	
T <sub>vjop</sub>	Operating junction temperature	Continuous operation (under switching) (Note9)	-40 ~ +150	°C
T <sub>stg</sub>	Storage temperature	-	-40 ~ +125	

**ELECTRICAL CHARACTERISTICS (T<sub>vj</sub>=25 °C, unless otherwise specified)****INVERTER PART IGBT/FWD**

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>vj</sub> =25 °C	-	2.05	2.45
			T <sub>vj</sub> =125 °C	-	2.45	-
			T <sub>vj</sub> =150 °C	-	2.55	-
V <sub>CEsat</sub> (Chip)		I <sub>C</sub> =450 A, V <sub>GE</sub> =15 V, (Note5)	T <sub>vj</sub> =25 °C	-	1.95	2.35
			T <sub>vj</sub> =125 °C	-	2.35	-
			T <sub>vj</sub> =150 °C	-	2.45	-
C <sub>ies</sub>	Input capacitance	V <sub>CE</sub> =10 V, G-E short-circuited	-	-	120	nF
C <sub>oes</sub>	Output capacitance		-	-	3.3	
C <sub>res</sub>	Reverse transfer capacitance		-	-	1.1	
Q <sub>G</sub>	Gate charge	V <sub>CC</sub> =1000 V, I <sub>C</sub> =450 A, V <sub>GE</sub> =15 V	-	3.53	-	µC
t <sub>d(on)</sub>	Turn-on delay time	V <sub>CC</sub> =1000 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		-	-	800	
t <sub>f</sub>	Fall time		-	-	600	
V <sub>EC</sub> (Terminal)	Emitter-collector voltage	I <sub>E</sub> =450 A, G-E short-circuited, Refer to the figure of test circuit (Note5)	T <sub>vj</sub> =25 °C	-	2.75	3.35
			T <sub>vj</sub> =125 °C	-	2.95	-
			T <sub>vj</sub> =150 °C	-	2.95	-
V <sub>EC</sub> (Chip)		I <sub>E</sub> =450 A, G-E short-circuited, (Note5)	T <sub>vj</sub> =25 °C	-	2.65	3.25
			T <sub>vj</sub> =125 °C	-	2.75	-
			T <sub>vj</sub> =150 °C	-	2.75	-
t <sub>rr</sub> (Note1)	Reverse recovery time	V <sub>CC</sub> =1000 V, I <sub>E</sub> =450 A, V <sub>GE</sub> =±15 V, R <sub>G</sub> =0 Ω, Inductive load	-	-	300	ns
Q <sub>rr</sub> (Note1)	Reverse recovery charge		-	21.5	-	µC
E <sub>on</sub>	Turn-on switching energy per pulse	V <sub>CC</sub> =1000 V, I <sub>C</sub> =I <sub>E</sub> =450 A, V <sub>GE</sub> =±15 V, R <sub>G</sub> =0 Ω, T <sub>vj</sub> =150 °C, Inductive load	-	113.4	-	mJ
E <sub>off</sub>	Turn-off switching energy per pulse		-	116.4	-	
E <sub>rr</sub> (Note1)	Reverse recovery energy per pulse		-	56.3	-	
R <sub>CC'EE'</sub>	Internal lead resistance	Main terminals-chip, per switch, T <sub>C</sub> =25 °C (Note4)	-	0.75	-	mΩ
r <sub>g</sub>	Internal gate resistance	Per switch	-	1.7	-	Ω

**CM450DX-34T/CM450DXP-34T**HIGH POWER SWITCHING USE  
INSULATED TYPE**ELECTRICAL CHARACTERISTICS (cont.;  $T_{VJ}=25^{\circ}\text{C}$ , unless otherwise specified)****NTC THERMISTOR PART**

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{25}$	Zero-power resistance	$T_C=25^{\circ}\text{C}$ (Note4)	4.85	5.00	5.15	$\text{k}\Omega$
$\Delta R/R$	Deviation of resistance	$R_{100}=493\ \Omega$ , $T_C=100^{\circ}\text{C}$ (Note4)	-7.3	-	+7.8	%
$B_{(25/50)}$	B-constant	Approximate by equation (Note6)	-	3375	-	K
$P_{25}$	Power dissipation	$T_C=25^{\circ}\text{C}$ (Note4)	-	-	10	$\text{mW}$

**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)	-	-	67	$\text{K}/\text{kW}$
$R_{th(j-c)D}$		Junction to case, per Inverter FWD (Note4)	-	-	101	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, per 1 module Thermal grease applied (Note4, 7,9)	-	11.5	-	$\text{K}/\text{kW}$

**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	$\text{N}\cdot\text{m}$
$M_s$	Mounting torque	Mounting to heat sink	M 5 screw	2.5	3.0	3.5	$\text{N}\cdot\text{m}$
$d_s$	Creepage distance	Solder pin type (DX)	Terminal to terminal	17	-	-	mm
			Terminal to base plate	18.1	-	-	
		Pressfit pin type (DXP)	Terminal to terminal	17	-	-	mm
			Terminal to base plate	18.6	-	-	
$d_a$	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	-	-	
$e_c$	Flatness of base plate	On the centerline X, Y (Note8)	$\pm 0$	-	+200	$\mu\text{m}$	
$m$	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 and (EU) 2015/863.

Note1. Represent ratings and characteristics of the anti-parallel, emitter-collector free-wheeling diode (FWD).

2. Junction temperature ( $T_{VJ}$ ) should not increase beyond  $T_{VJ\max}$  rating.

3. Pulse width and repetition rate should be such that the device junction temperature ( $T_{VJ}$ ) dose not exceed  $T_{VJ\max}$  rating.

4. 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.

5. Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.

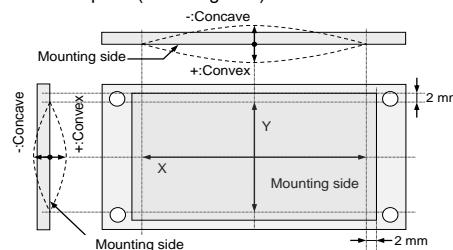
$$6. B_{(25/50)} = \ln\left(\frac{R_{25}}{R_{50}}\right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}}\right)$$

$R_{25}$ : resistance at absolute temperature  $T_{25}$  [K];  $T_{25}=25^{\circ}\text{C}+273.15=298.15$  [K]

$R_{50}$ : resistance at absolute temperature  $T_{50}$  [K];  $T_{50}=50^{\circ}\text{C}+273.15=323.15$  [K]

7. Typical value is measured by using thermally conductive grease of  $\lambda=0.9\ \text{W}/(\text{m}\cdot\text{K})/D_{(C-S)}=50\ \mu\text{m}$ .

8. The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.



9. Long term performance related to thermal conductive grease (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under user's specific application conditions. Each temperature condition ( $T_{VJ\max}$ ,  $T_{VJ\text{op}}$ ,  $T_C\max$ ) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

**CM450DX-34T/CM450DXP-34T**

HIGH POWER SWITCHING USE

INSULATED TYPE

Note10. Use the following screws when mounting the printed circuit board (PCB) on the standoffs.

PCB thickness : t1.6

Type	Manufacturer	Size	Tightening torque (N·m)	Recommended tightening method
(1) PT®	EJOT	K25×8	0.55 ± 0.055	by handwork (equivalent to 30 rpm by mechanical screw driver) ~ 600 rpm (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	0.75 ± 0.075 N·m	
		φ2.6×12		

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$V_{CC}$	(DC) Supply voltage	Applied across C1-E2 terminals	-	1000	1200	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	-	16	$\Omega$

## CM450DX-34T/CM450DXP-34T

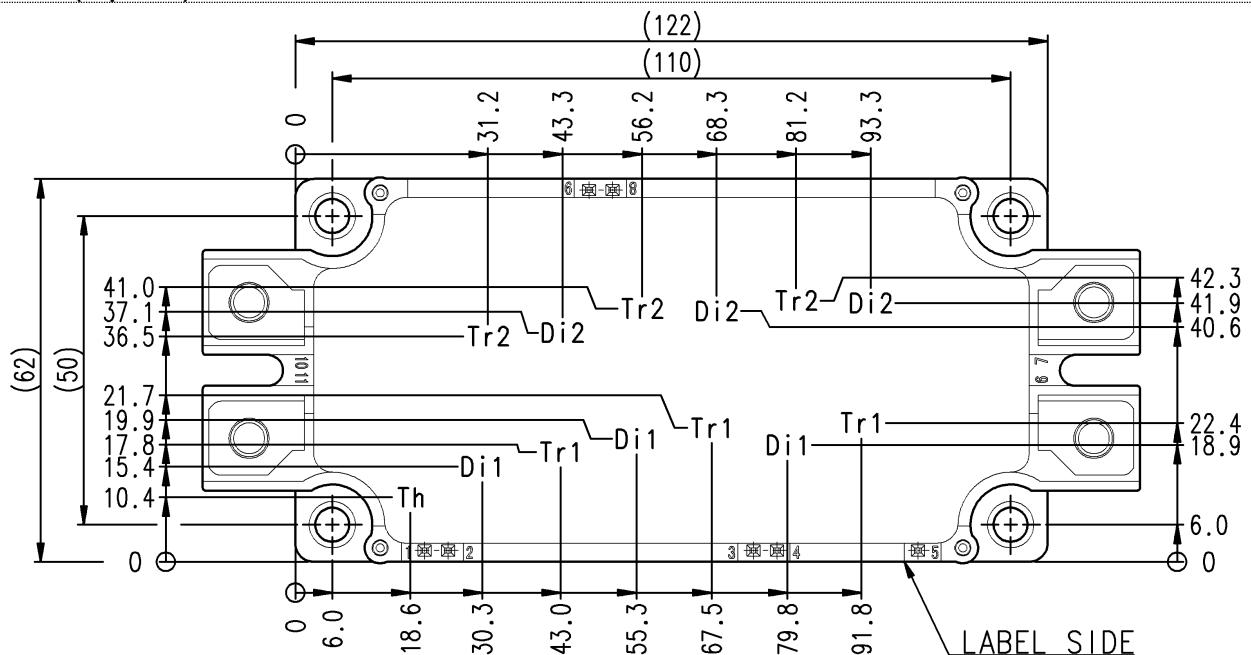
## HIGH POWER SWITCHING USE

## INSULATED TYPE

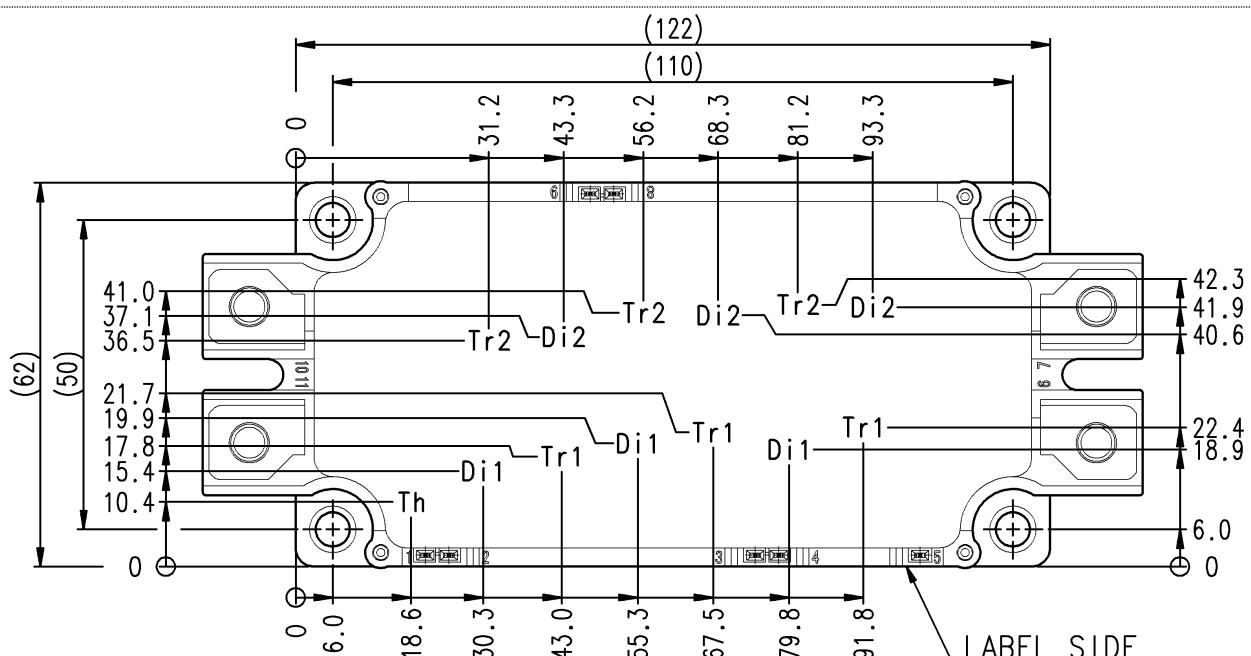
## **CHIP LOCATION (Top view)**

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

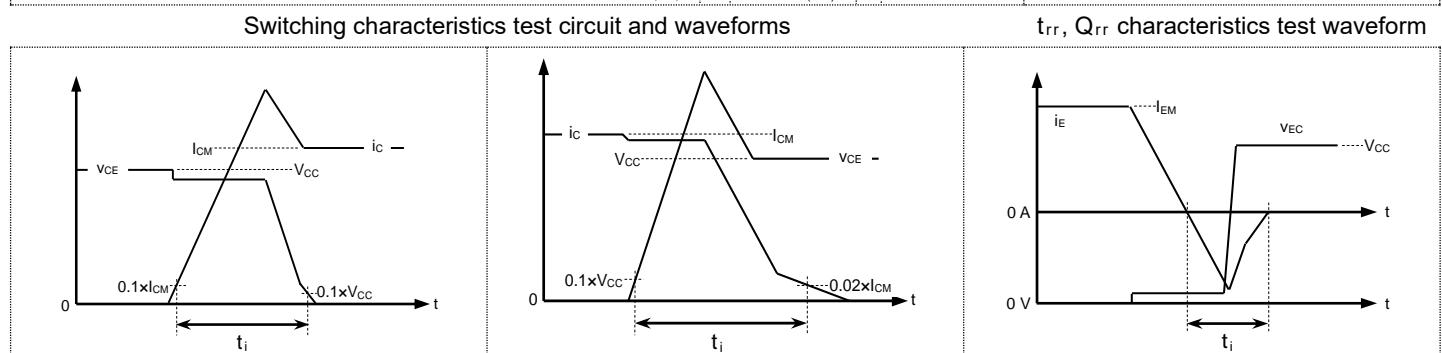
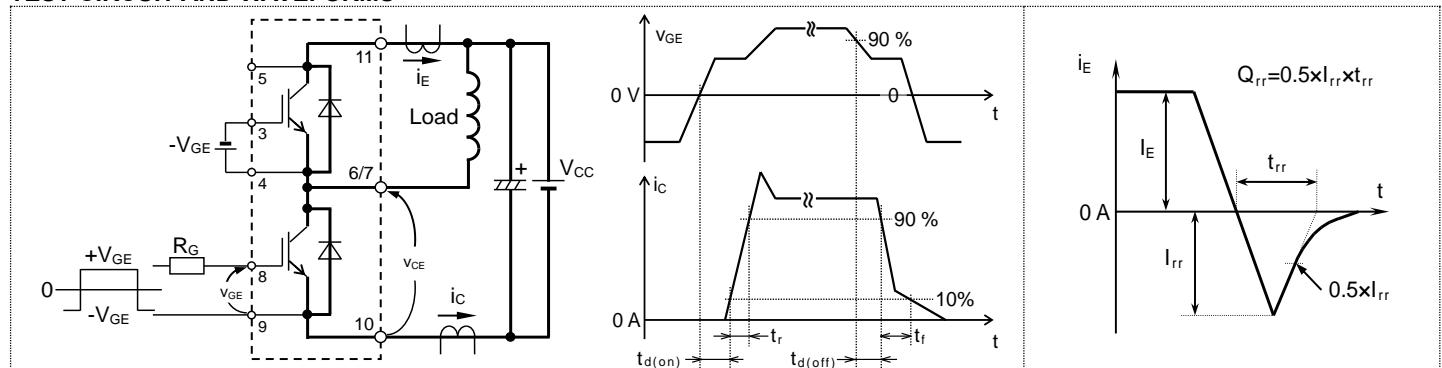
DX



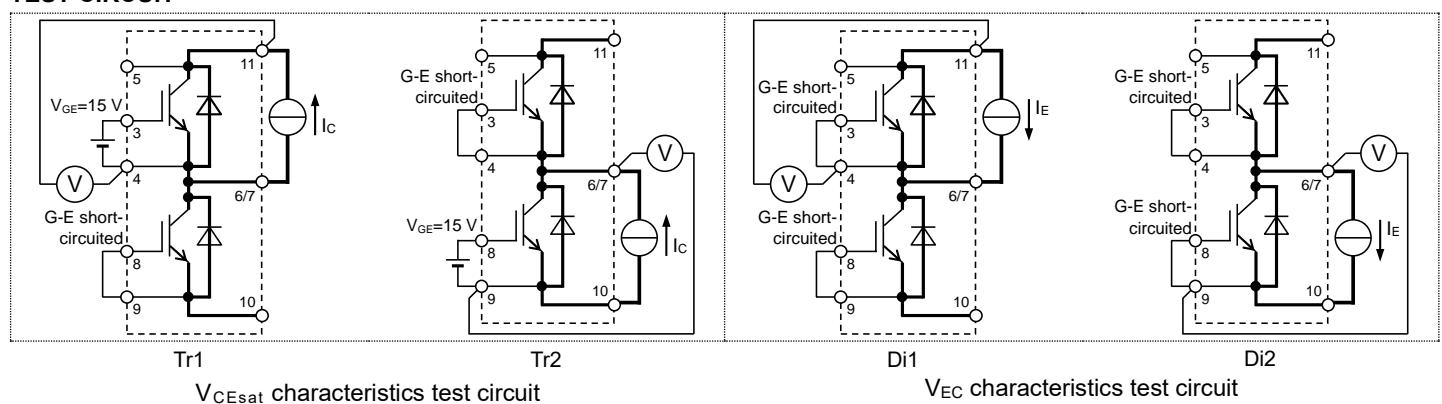
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**DXP**

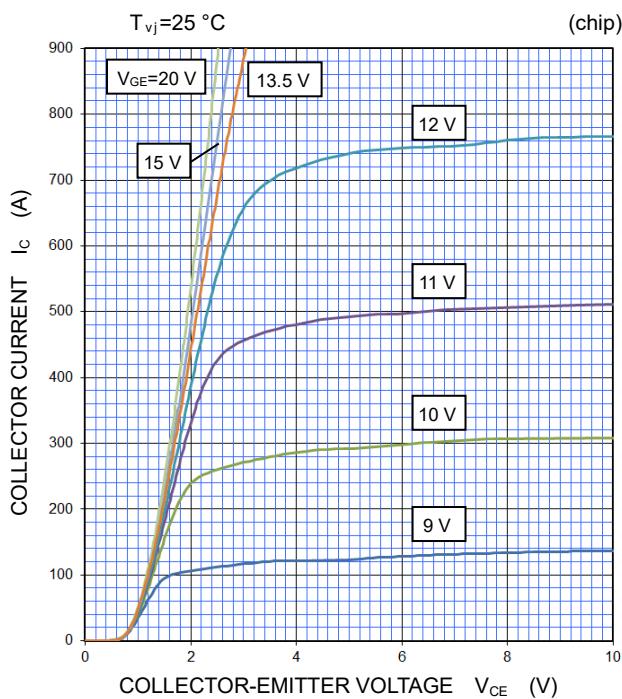
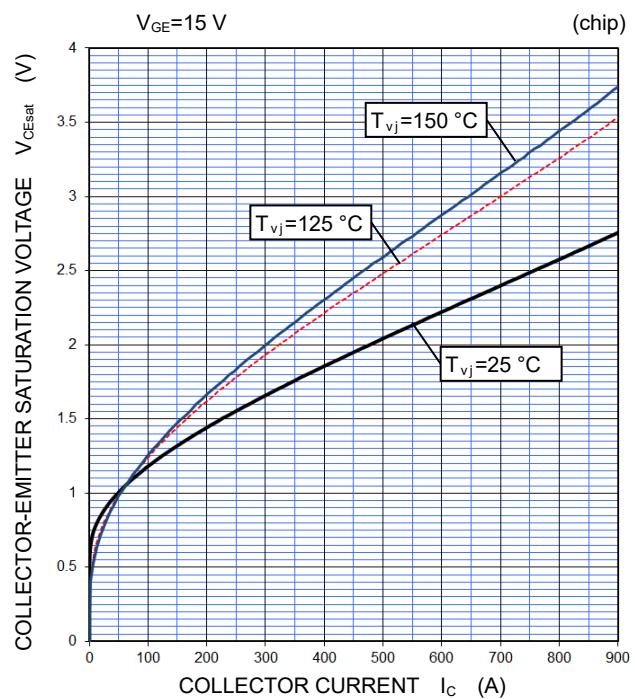
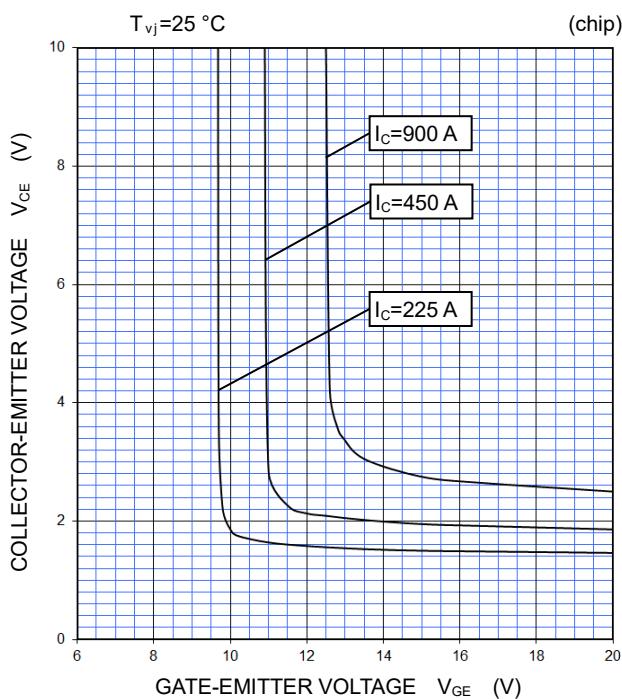
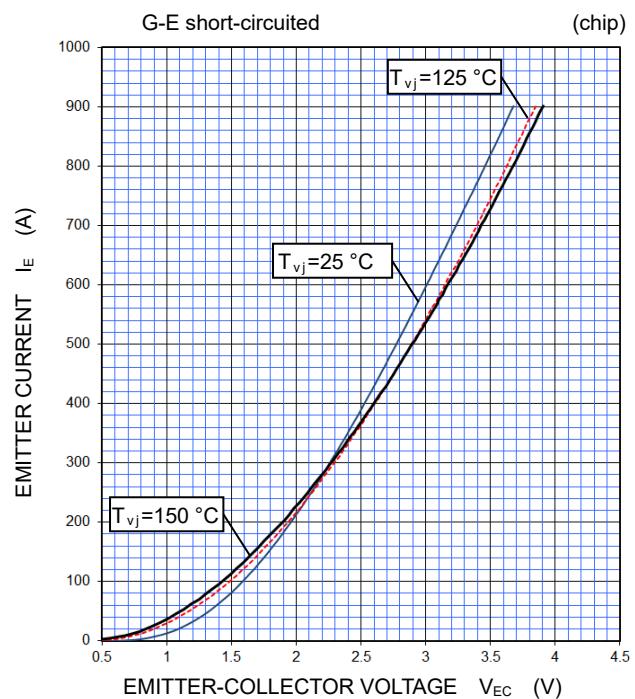


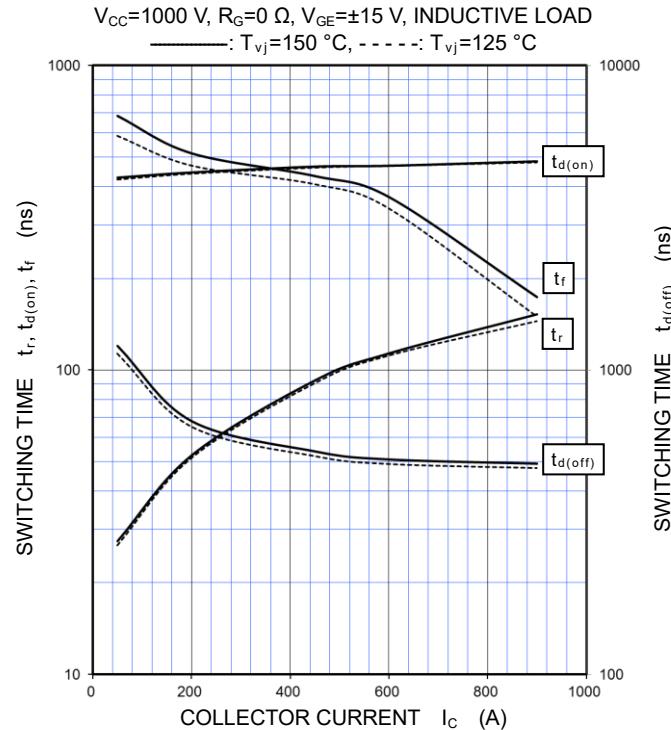
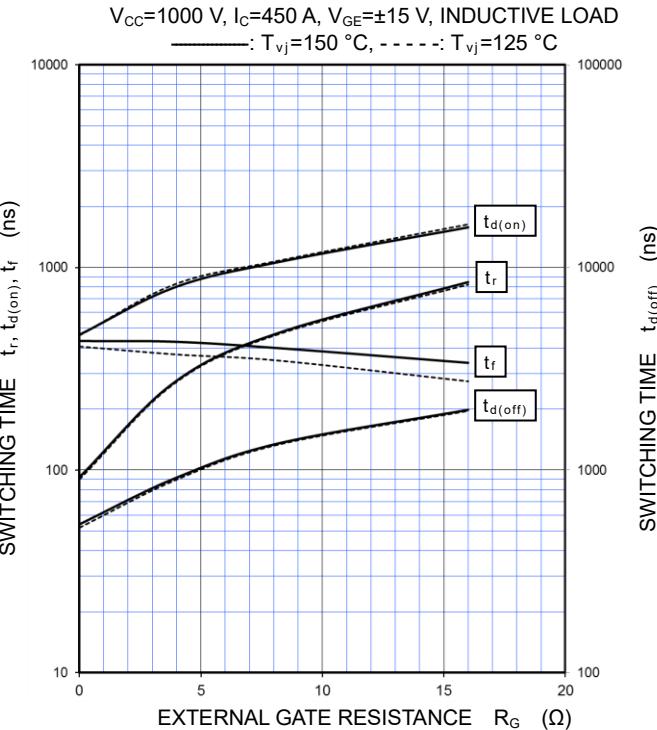
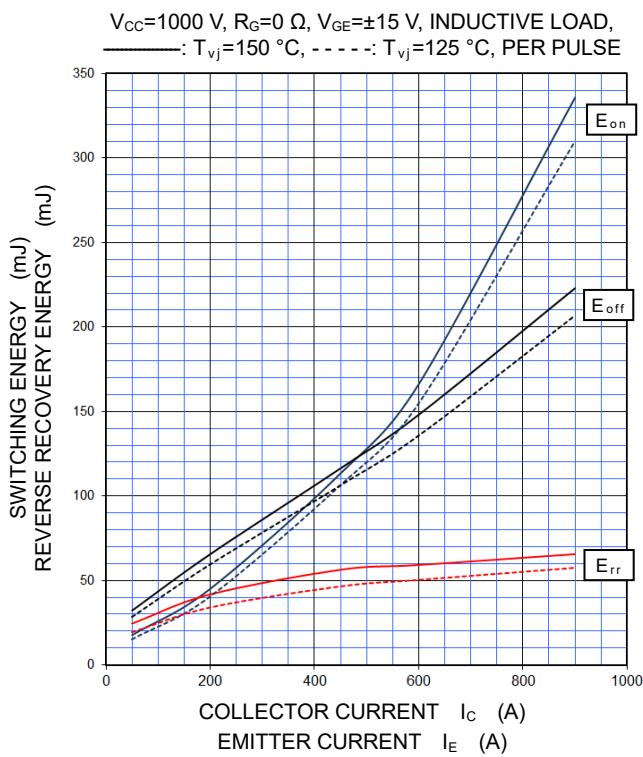
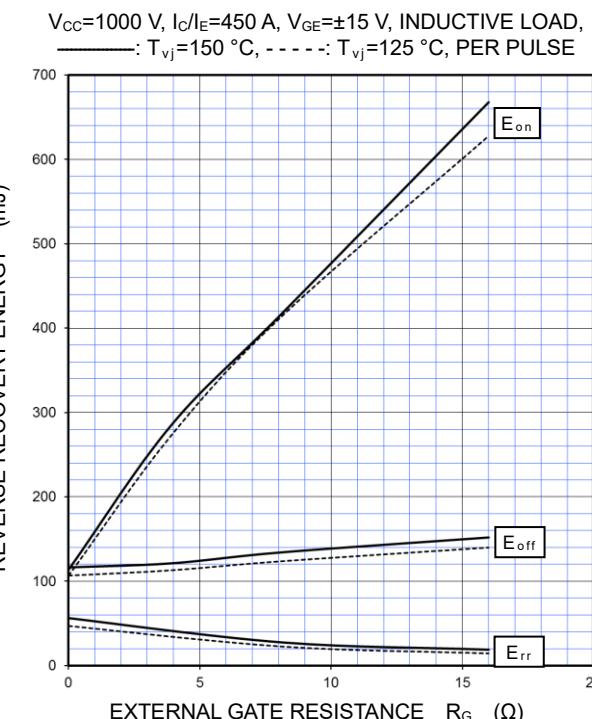
Tr1/Tr2: IGBT, Di1/Di2: FWD, Th: NTC thermistor

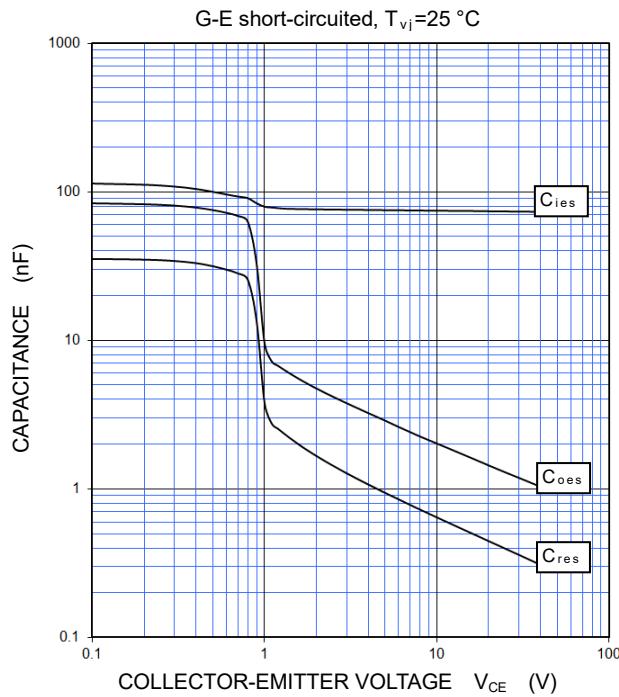
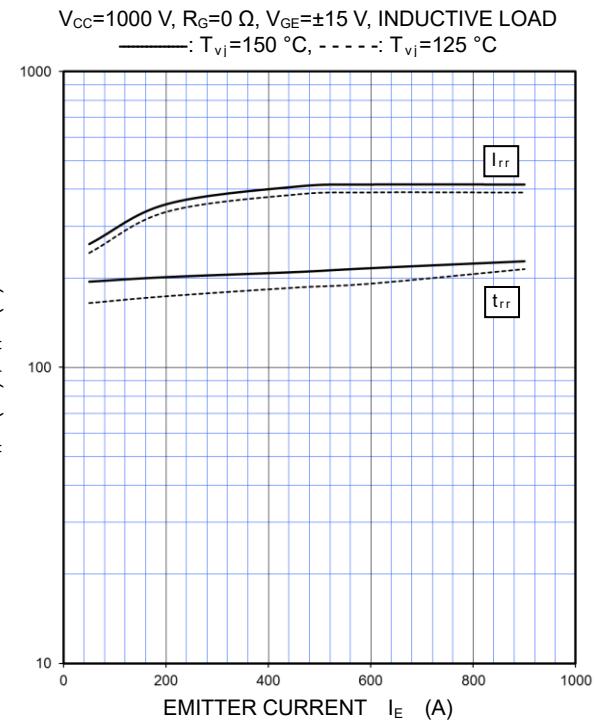
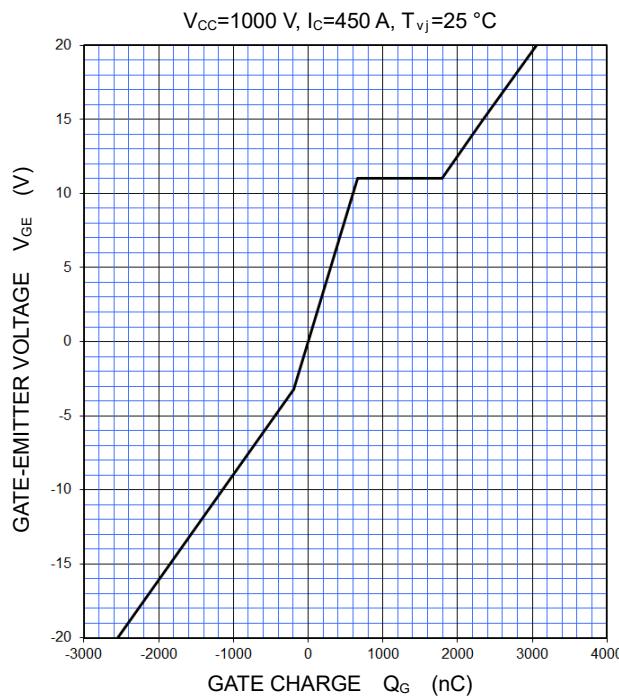
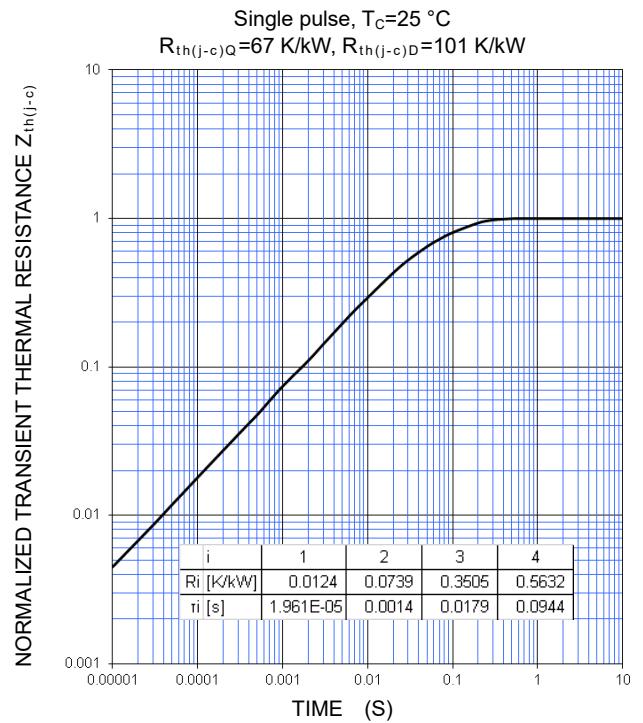
**TEST CIRCUIT AND WAVEFORMS**

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

**TEST CIRCUIT**

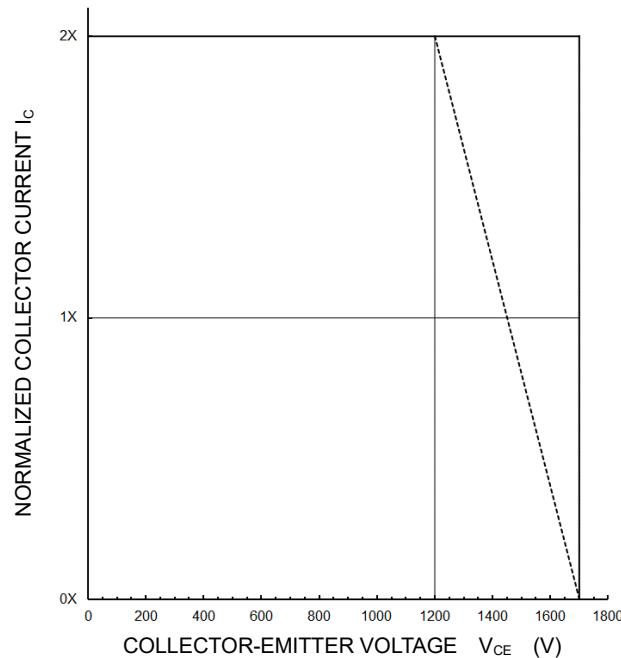
**PERFORMANCE CURVES****INVERTER PART****OUTPUT CHARACTERISTICS  
(TYPICAL)****COLLECTOR-EMITTER SATURATION VOLTAGE  
CHARACTERISTICS  
(TYPICAL)****COLLECTOR-EMITTER VOLTAGE CHARACTERISTICS  
(TYPICAL)****FREE WHEELING DIODE  
FORWARD CHARACTERISTICS  
(TYPICAL)**

**PERFORMANCE CURVES****INVERTER PART****HALF-BRIDGE SWITCHING CHARACTERISTICS  
(TYPICAL)****HALF-BRIDGE SWITCHING CHARACTERISTICS  
(TYPICAL)****HALF-BRIDGE SWITCHING CHARACTERISTICS  
(TYPICAL)****HALF-BRIDGE SWITCHING CHARACTERISTICS  
(TYPICAL)**

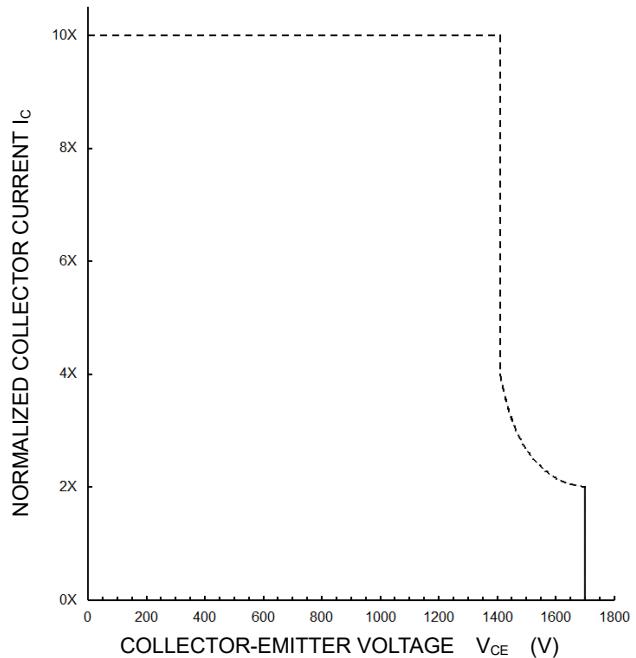
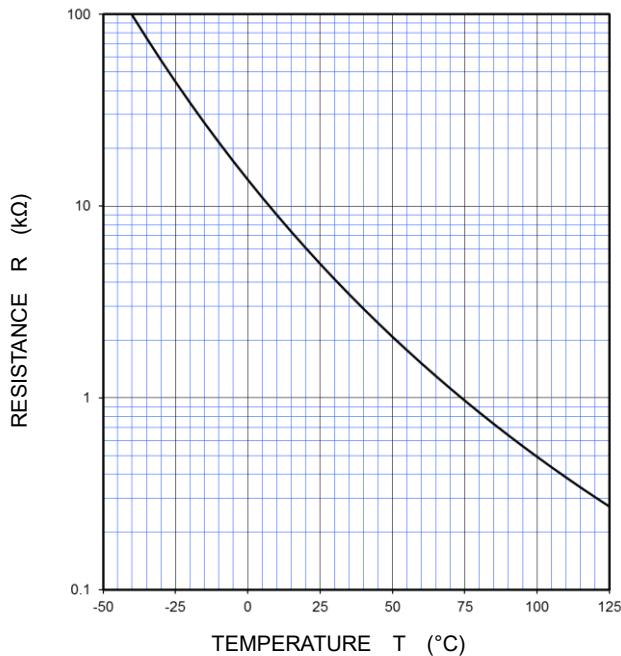
**PERFORMANCE CURVES****INVERTER PART****CAPACITANCE CHARACTERISTICS  
(TYPICAL)****FREE WHEELING DIODE  
REVERSE RECOVERY CHARACTERISTICS  
(TYPICAL)****GATE CHARGE CHARACTERISTICS  
(TYPICAL)****TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS  
(MAXIMUM)**

**PERFORMANCE CURVES****INVERTER PART****TURN-OFF SWITCHING SAFE OPERATION AREA  
(REVERSE BIAS SAFE OPERATING AREA)  
(MAXIMUM)**

$V_{CC} \leq 1200$  V,  $R_G = 0 \sim 16$   $\Omega$ ,  $V_{GE} = \pm 15$  V,  
 —:  $T_{vj} = 25 \sim 150$   $^{\circ}\text{C}$  (Normal load operations (Continuous))  
 - - -:  $T_{vj} = 175$   $^{\circ}\text{C}$  (Unusual load operations (Limited period))

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

$V_{CC} \leq 1200$  V,  $R_G = 0 \sim 16$   $\Omega$ ,  $V_{GE} = \pm 15$  V,  
 $T_{vj} = 25 \sim 150$   $^{\circ}\text{C}$ ,  $t_W \leq 8$   $\mu\text{s}$ , 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.

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