


Possible IGBT Snubber Capacitors



Mitsubishi IGBT Type	RS Part Numbers	Suggested ICEL Snubber	Value Cn	Image (not to scale)	RS Part Numbers
CM450DX-24T#300G	207-4969 207-4967	PMB2123560KSR	0.56uF	 <p>Direct screw mounting onto IGBT modules or busbars. Available for all main manufacturers IGBT packages.</p>	233-2452 (low qty) and 233-2451 (higher qty) https://uk.rs-online.com/web/cp/2332451_2332452/?pst=PMB2123560KSR&sra=p&r=t
		PMB2124100KSR	1.0uF		233-2454 (low qty) and 233-2453 (higher qty) https://uk.rs-online.com/web/cp/2332453_2332454/?pst=PMB2124100KSR&sra=p&r=t
		PMB2124150KSR	1.5uF		233-2456 (low qty) and 233-2455 (higher qty) https://uk.rs-online.com/web/cp/2332455_2332456/?pst=PMB2124150KSR&sra=p&r=t

POLYPROPYLENE FILM CAPACITORS

Features

Polypropylene film capacitors have superior electrical characteristics;
 Low dissipation factor and absorption.
 Very high insulation resistance and high dielectric strength.
 Excellent moisture resistance.
 Good long-term stability and excellent self-healing properties.

Typical Applications

Polypropylene film capacitors are typically used in AC and pulse applications at high frequencies and as DC-Link capacitors.
 They are further used in switched mode power supplies (SMPS), electronic ballasts and snubber applications, in frequency discrimination and filter circuits as well as in energy storage and sample and hold applications.

Suggested types are for Information and guidance only. Clients must select and verify parts for their own operating conditions and applications.



CONTINUE FOR IGBT DATA SHEET



<IGBT Modules>

CM450DX-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

<p>DX</p> 	<p>Collector current I_c 450 A Collector-emitter voltage V_{CES} 1200 V Maximum junction temperature T_{vjmax} 175 °C</p> <ul style="list-style-type: none"> • Flat base type • Copper base plate (Ni-plating) • RoHS Directive compliant • Tin plating pin terminals
<p>DXP</p> 	<p>Collector current I_c 450 A Collector-emitter voltage V_{CES} 1200 V Maximum junction temperature T_{vjmax} 175 °C</p> <ul style="list-style-type: none"> • Flat base type • Copper base plate (Ni-plating) • RoHS Directive compliant • Tin plating pressfit terminals
<p>dual switch (half-bridge)</p> <ul style="list-style-type: none"> • UL Recognized under UL1557, File No. E323585 	

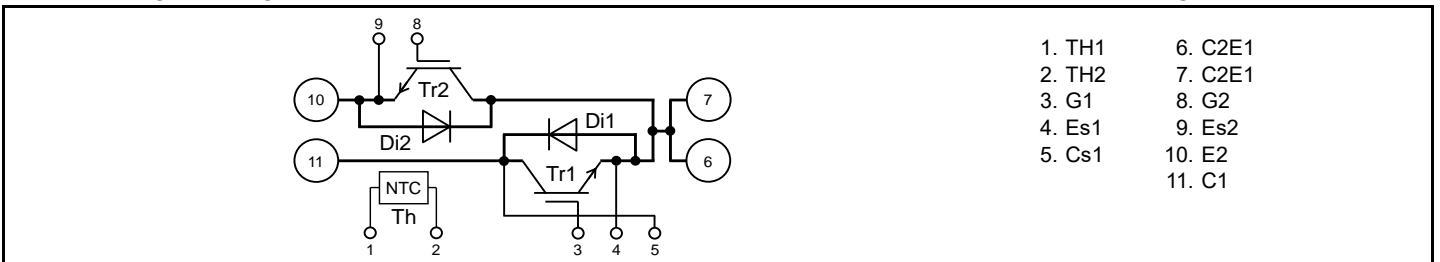
APPLICATION

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

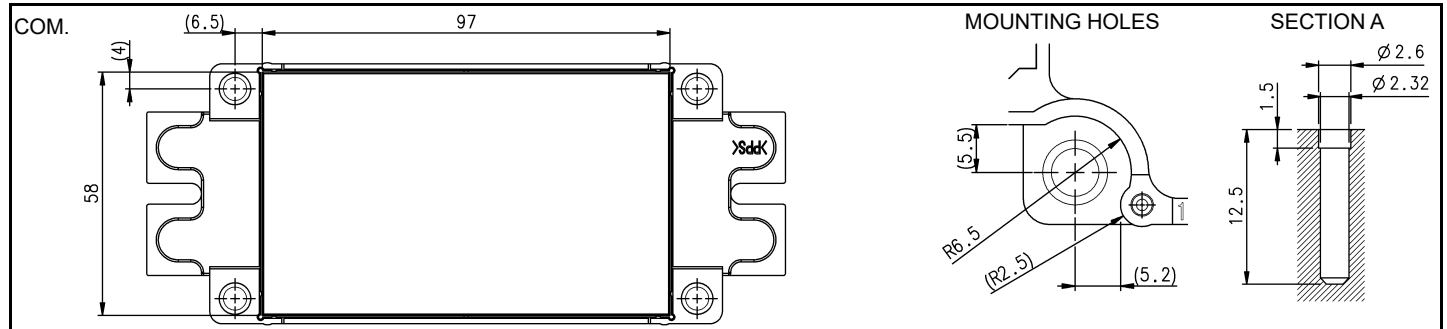
OPTION (Below options are available.)

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

INTERNAL CONNECTION



OUTLINE DRAWING

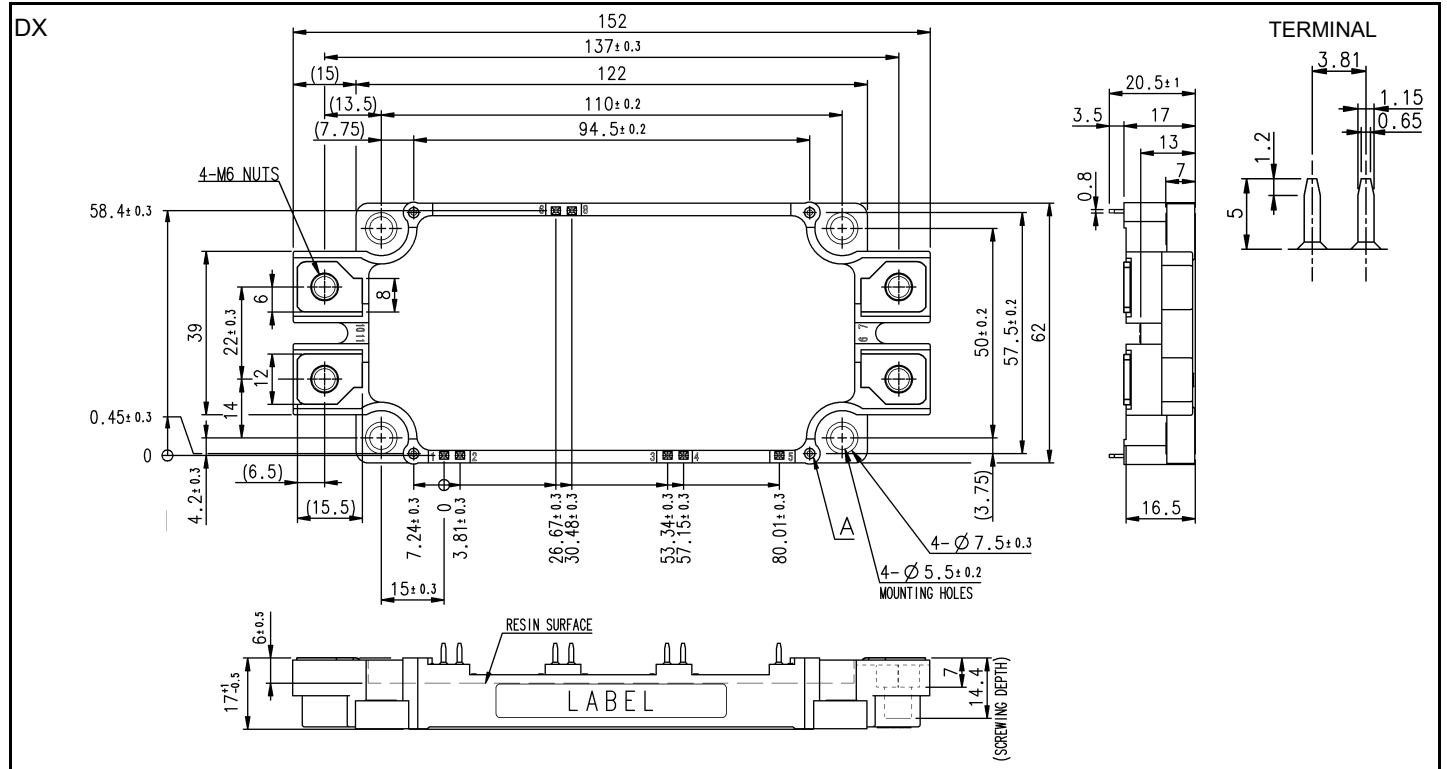


CM450DX-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

OUTLINE DRAWING

Dimension in mm



Tolerance otherwise specified

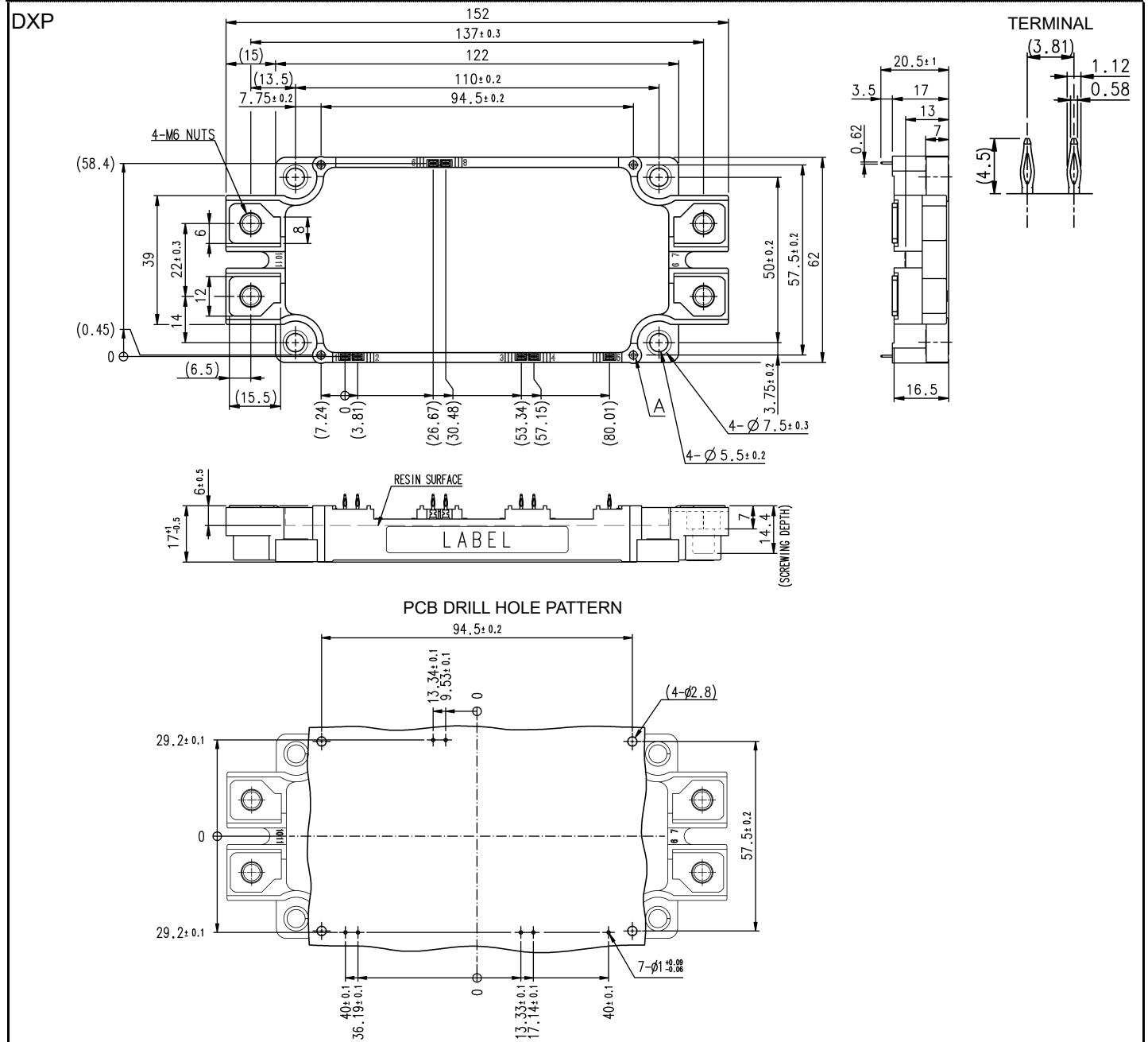
Division of Dimension	Tolerance
0.5 to 3	±0.2
over 3 to 6	±0.3
over 6 to 30	±0.5
over 30 to 120	±0.8
over 120 to 400	±1.2

CM450DX-24T/CM450DXP-24T

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-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

MAXIMUM RATINGS (T_{vj}=25 °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	± 20	V
I _C	Collector current	DC, T _C =118 °C (Note2, 4)	450	A
I _{CRM}		Pulse, Repetitive (Note3)	900	
P _{tot}	Total power dissipation	T _C =25 °C (Note2, 4)	2500	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 Hz, AC 1 min	2500	V
T _{vjmax}	Maximum junction temperature	Instantaneous event (overload) (Note9)	175	°C
T _{Cmax}	Maximum case temperature	(Note4, 9)	125	
T _{vjop}	Operating junction temperature	Continuous operation (under switching) (Note9)	-40 ~ +150	°C
T _{stg}	Storage temperature	-	-40 ~ +125	

ELECTRICAL CHARACTERISTICS (T_{vj}=25 °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	µA	
V _{GE(th)}	Gate-emitter threshold voltage	I _C =45 mA, V _{CE} =10 V	5.4	6.0	6.6	V	
V _{CEsat} (Terminal)	Collector-emitter saturation voltage	I _C =450 A, V _{GE} =15 V, Refer to the figure of test circuit (Note5)	T _{vj} =25 °C	-	1.65	2.05	V
			T _{vj} =125 °C	-	1.85	-	
			T _{vj} =150 °C	-	1.90	-	
V _{CEsat} (Chip)		I _C =450 A, V _{GE} =15 V, (Note5)	T _{vj} =25 °C	-	1.50	1.75	V
			T _{vj} =125 °C	-	1.70	-	
			T _{vj} =150 °C	-	1.75	-	
C _{ies}	Input capacitance	V _{CE} =10 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 V, I _C =450 A, V _{GE} =15 V	-	3.4	-	µC	
t _{d(on)}	Turn-on delay time	V _{CC} =600 V, I _C =450 A, V _{GE} =±15 V, R _G =1.3 Ω, 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 A, G-E short-circuited, Refer to the figure of test circuit (Note5)	T _{vj} =25 °C	-	1.70	2.25	V
			T _{vj} =125 °C	-	1.85	-	
			T _{vj} =150 °C	-	1.90	-	
V _{EC} (Note1) (Chip)		I _E =450 A, G-E short-circuited, (Note5)	T _{vj} =25 °C	-	1.50	1.85	V
			T _{vj} =125 °C	-	1.50	-	
			T _{vj} =150 °C	-	1.50	-	
t _{rr} (Note1)	Reverse recovery time	V _{CC} =600 V, I _E =450 A, V _{GE} =±15 V,	-	-	400	ns	
Q _{rr} (Note1)	Reverse recovery charge	R _G =1.3 Ω, Inductive load	-	35.1	-	µC	
E _{on}	Turn-on switching energy per pulse	V _{CC} =600 V, I _C =I _E =450 A,	-	43.1	-	mJ	
E _{off}	Turn-off switching energy per pulse	V _{GE} =±15 V, R _G =1.3 Ω, T _{vj} =150 °C,	-	45	-		
E _{rr} (Note1)	Reverse recovery energy per pulse	Inductive load	-	32.4	-	mJ	
R _{CC'+EE'}	Internal lead resistance	Main terminals-chip, per switch, T _C =25 °C (Note4)	-	0.75	-	mΩ	
r _g	Internal gate resistance	Per switch	-	0.67	-	Ω	

CM450DX-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

ELECTRICAL CHARACTERISTICS (cont.; T_{vj}=25 °C, unless otherwise specified)

NTC THERMISTOR PART

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R ₂₅	Zero-power resistance	T _C =25 °C (Note4)	4.85	5.00	5.15	kΩ
ΔR/R	Deviation of resistance	R ₁₀₀ =493 Ω, T _C =100 °C (Note4)	-7.3	-	+7.8	%
B _(25/50)	B-constant	Approximate by equation (Note6)	-	3375	-	K
P ₂₅	Power dissipation	T _C =25 °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)	-	-	60	K/kW
R _{th(j-c)D}		Junction to case, per Inverter FWD (Note4)	-	-	87	
R _{th(c-s)}	Contact thermal resistance	Case to heat sink, per 1 module, Thermal grease applied (Note4, 7, 9)	-	11.5	-	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	
d _s	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 _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)	±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 and (EU) 2015/863.

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

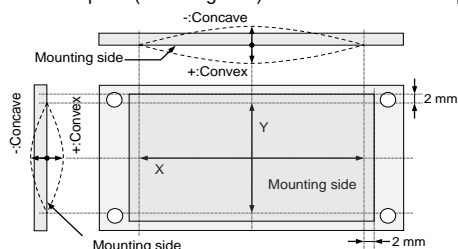
- Junction temperature (T_{vj}) should not increase beyond T_{vjmax} rating.
- Pulse width and repetition rate should be such that the device junction temperature (T_{vj}) dose not exceed T_{vjmax} rating.
- Case temperature (T_C) and heat sink temperature (T_S) are defined on the each surface (mounting 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. Refer to the figure of test circuit.

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

R₂₅: resistance at absolute temperature T₂₅ [K]; T₂₅=25 [°C]+273.15=298.15 [K]

R₅₀: resistance at absolute temperature T₅₀ [K]; T₅₀=50 [°C]+273.15=323.15 [K]

- Reference value. Thermally conductive grease of thermal conductivity λ=0.9 W/(m·K) and thickness D_(c-s)=50 μm.
- The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.



- 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_{vjmax}, T_{vjop}, T_{Cmax}) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

CM450DX-24T/CM450DXP-24T

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 φ2.6×12	0.75 ± 0.075 N·m	

RECOMMENDED OPERATING CONDITIONS

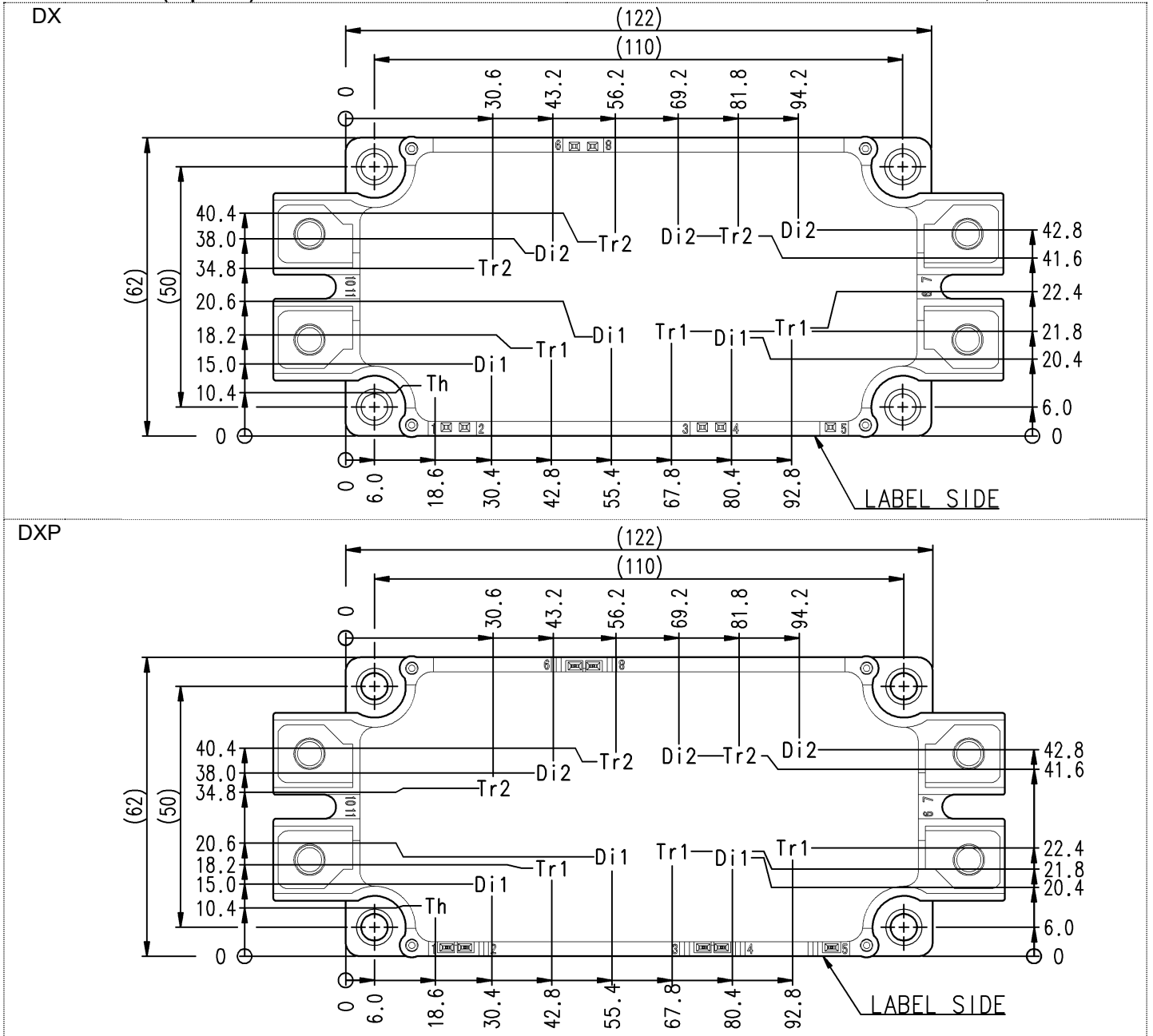
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{CC}	(DC) Supply voltage	Applied across C1-E2 terminals	-	600	850	V
V_{GEon}	Gate (-emitter drive) voltage	Applied across G1-E1s/G2-E2s terminals	13.5	15.0	16.5	V
R_G	External gate resistance	Per switch	1.3	-	10	Ω

CM450DX-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

CHIP LOCATION (Top view)

Dimension in mm, tolerance: ± 1 mm

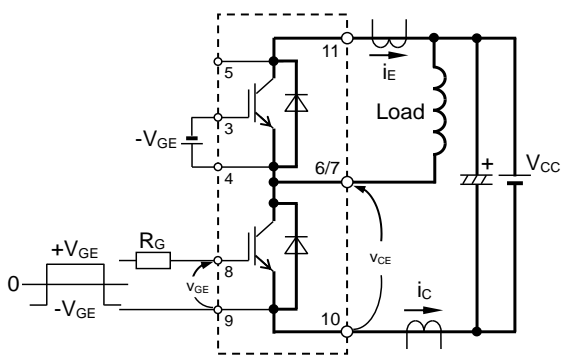


Tr1/Tr2: IGBT, Di1/Di2: FWD, Th: NTC thermistor

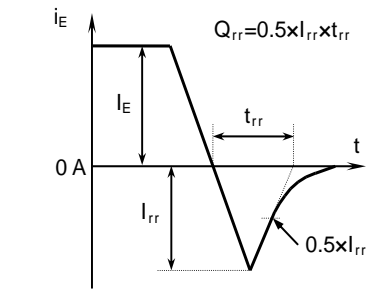
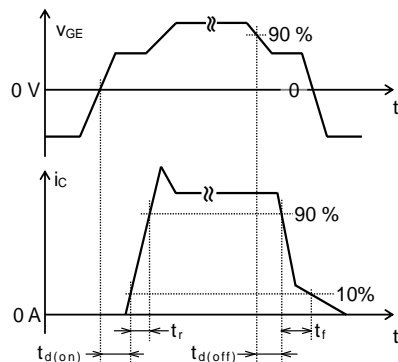
CM450DX-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

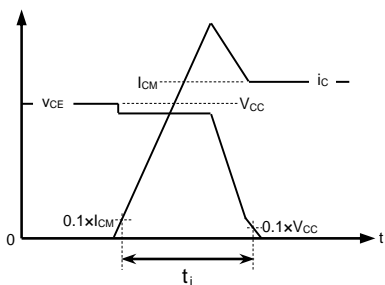
TEST CIRCUIT AND WAVEFORMS



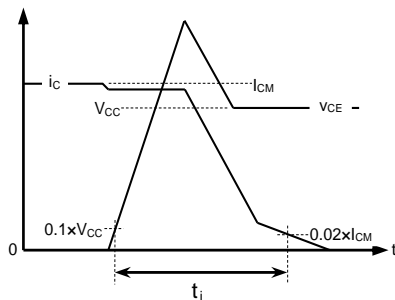
Switching characteristics test circuit and waveforms



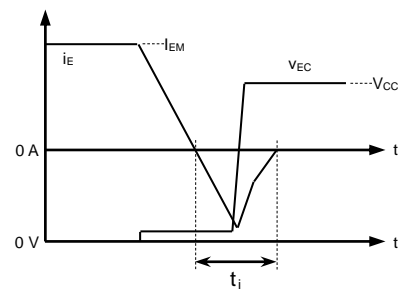
t_{rr} , Q_{rr} characteristics test waveform



IGBT Turn-on switching energy



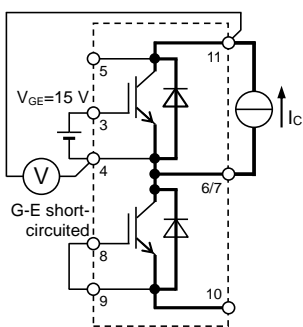
IGBT Turn-off switching energy



FWD Reverse recovery energy

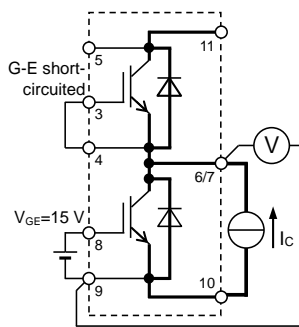
Switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

TEST CIRCUIT

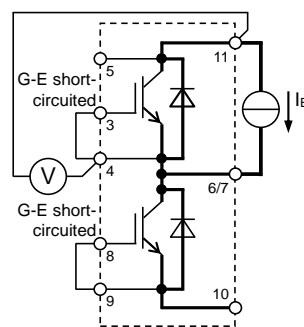


Tr1

V_{CEsat} characteristics test circuit

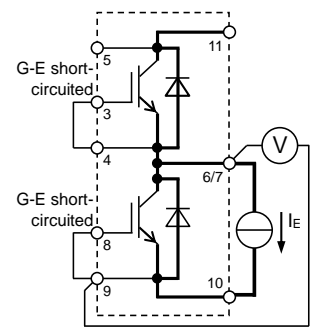


Tr2



Di1

V_{EC} characteristics test circuit



Di2

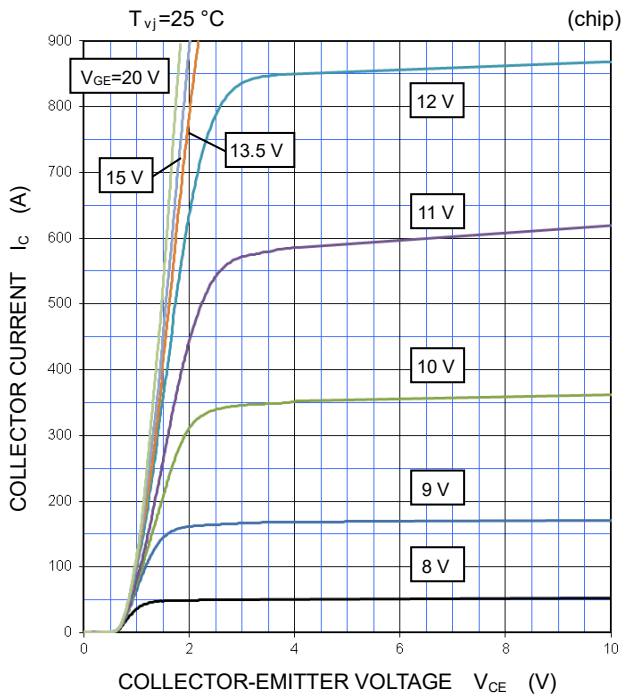
CM450DX-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

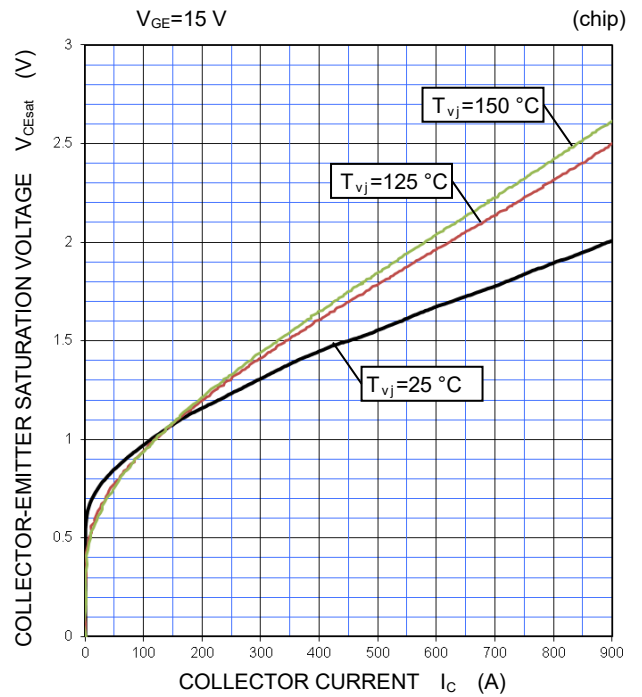
PERFORMANCE CURVES

INVERTER PART

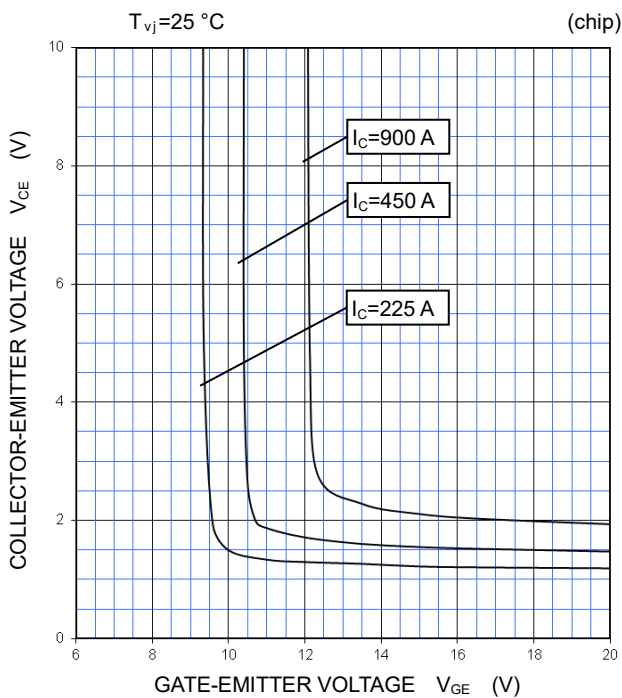
OUTPUT CHARACTERISTICS (TYPICAL)



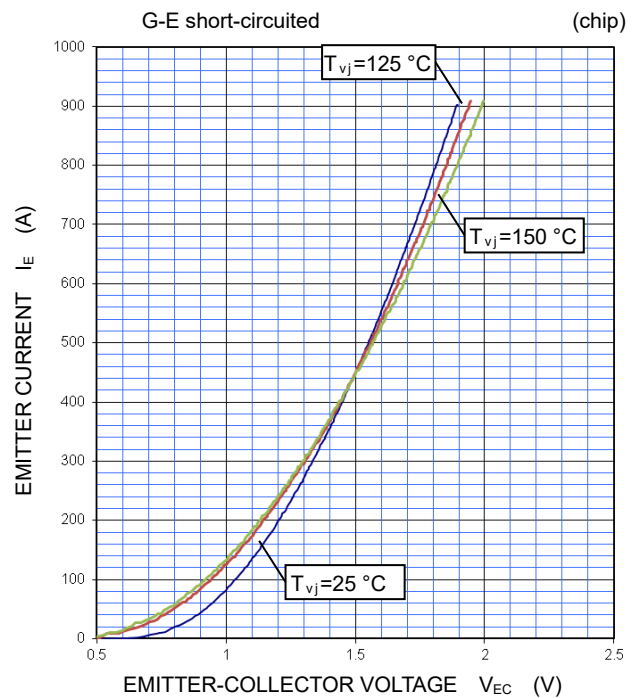
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER VOLTAGE CHARACTERISTICS (TYPICAL)



FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



CM450DX-24T/CM450DXP-24T

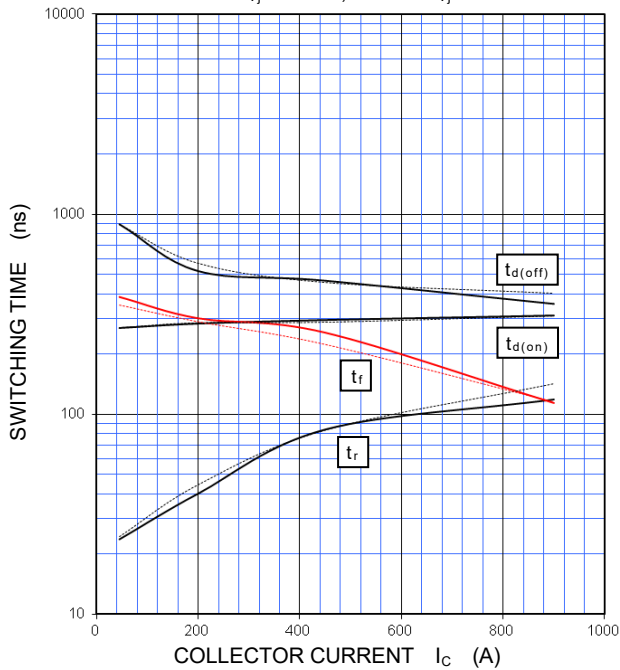
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

INVERTER PART

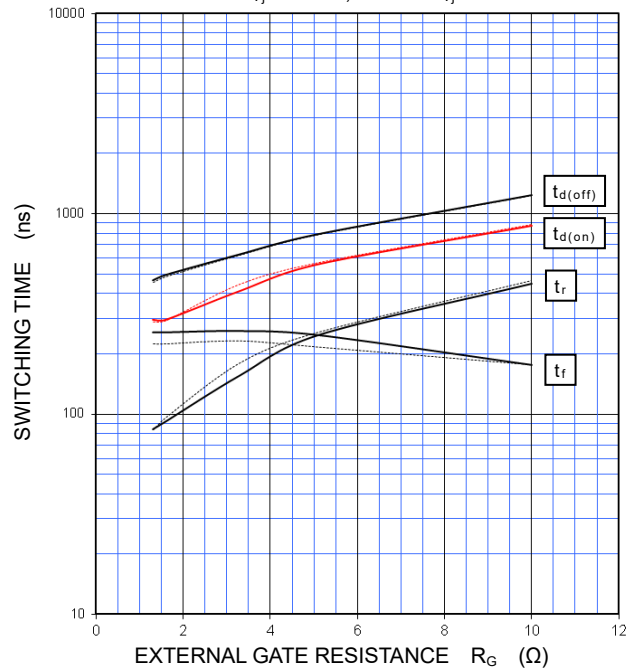
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

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



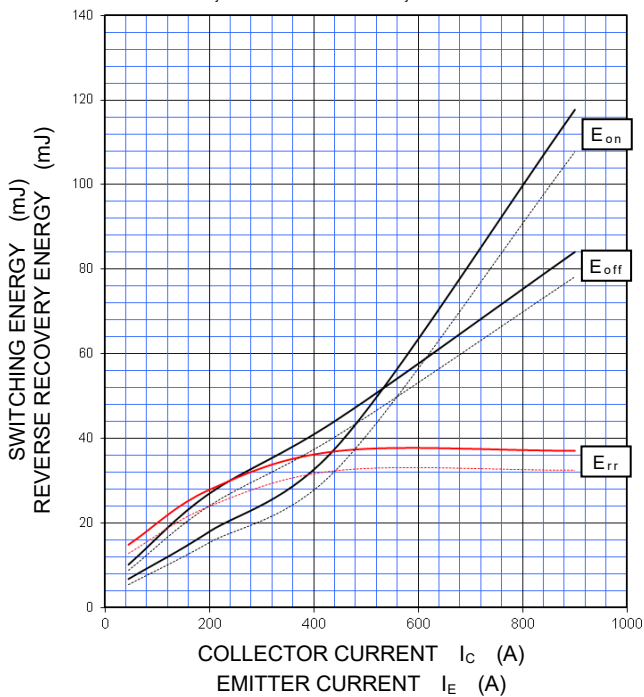
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

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



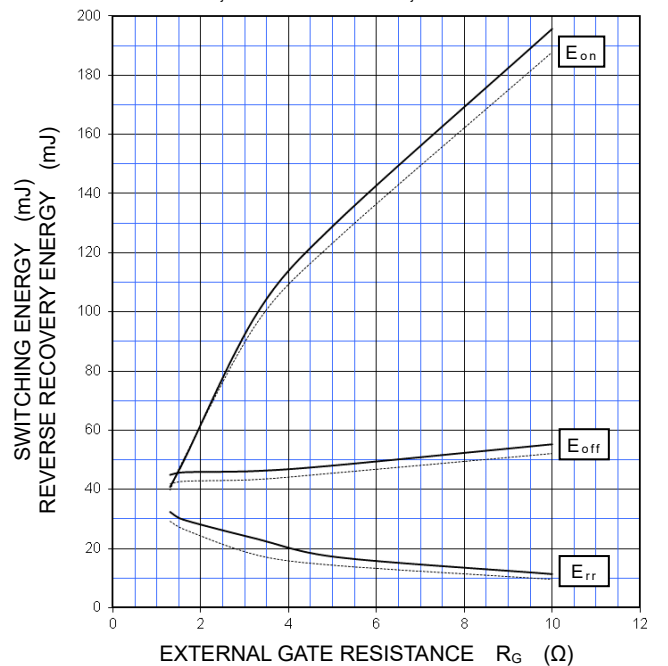
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

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



HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

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



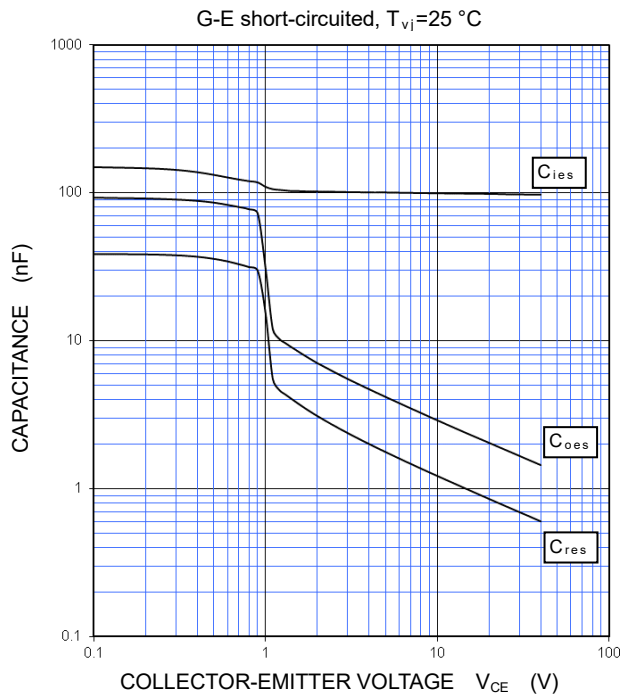
CM450DX-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

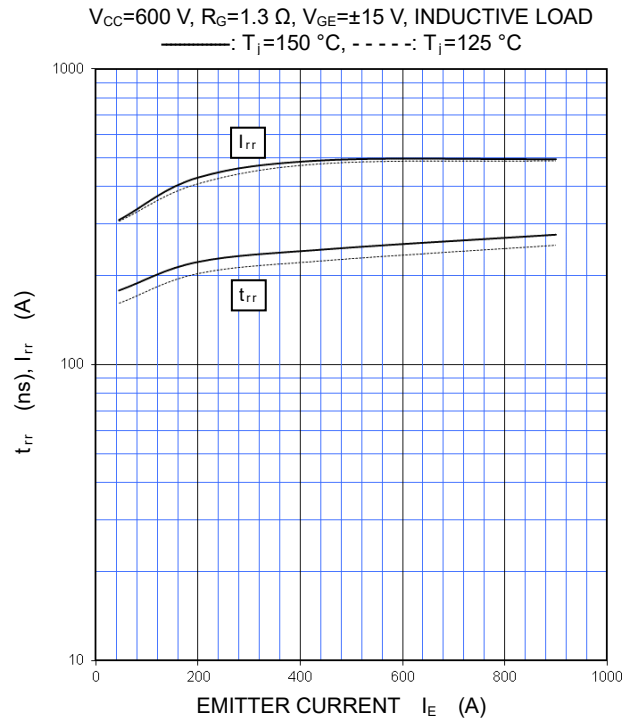
PERFORMANCE CURVES

INVERTER PART

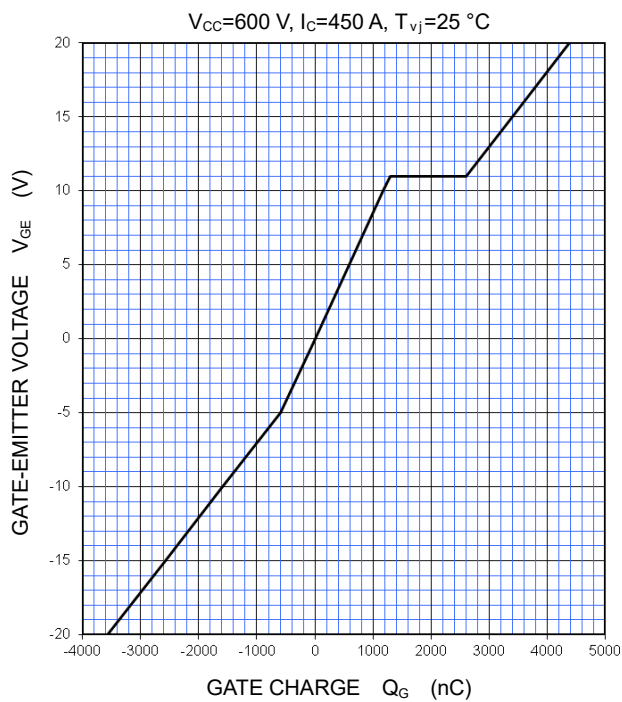
CAPACITANCE CHARACTERISTICS (TYPICAL)



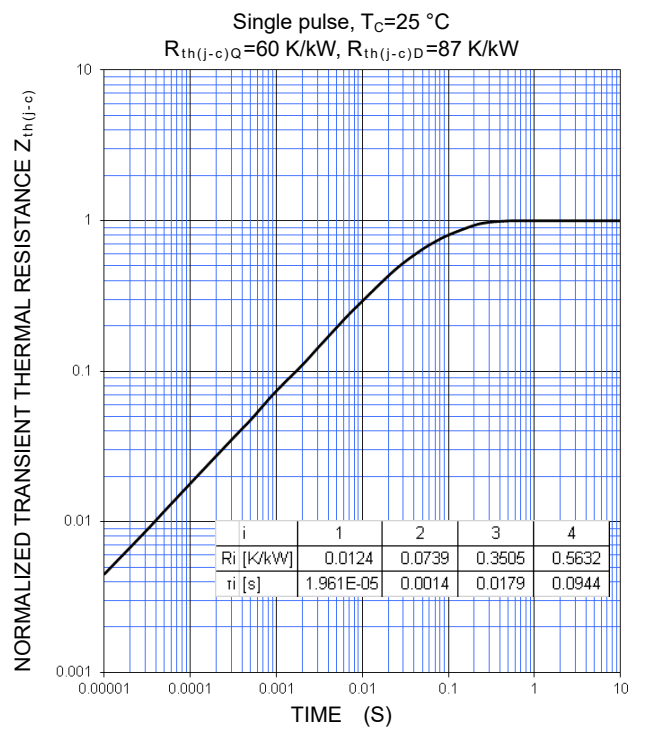
FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



GATE CHARGE CHARACTERISTICS (TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)



CM450DX-24T/CM450DXP-24T

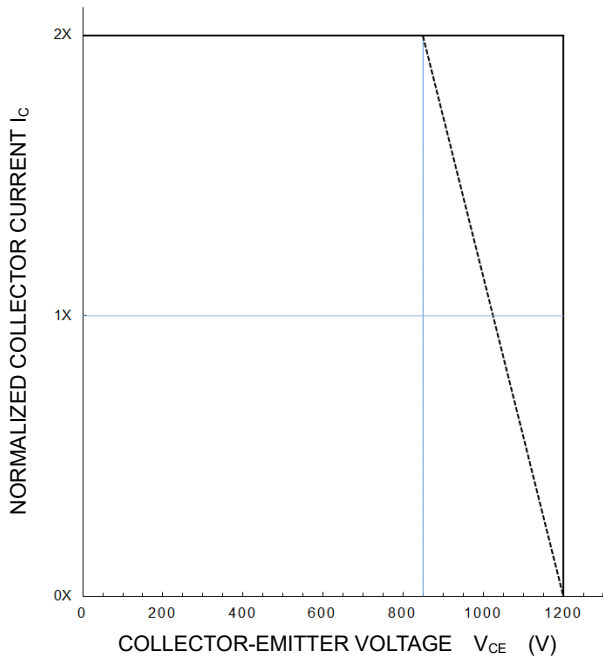
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

INVERTER PART

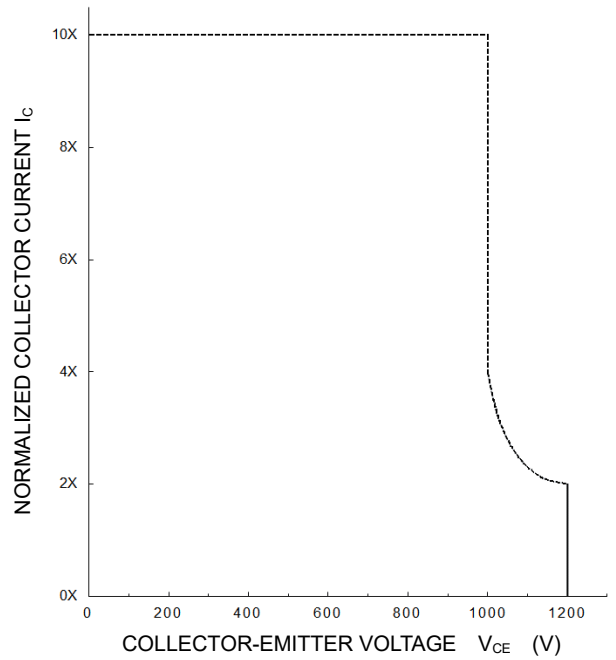
**TURN-OFF SWITCHING SAFE OPERATING AREA
(REVERSE BIAS SAFE OPERATING AREA)
(MAXIMUM)**

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



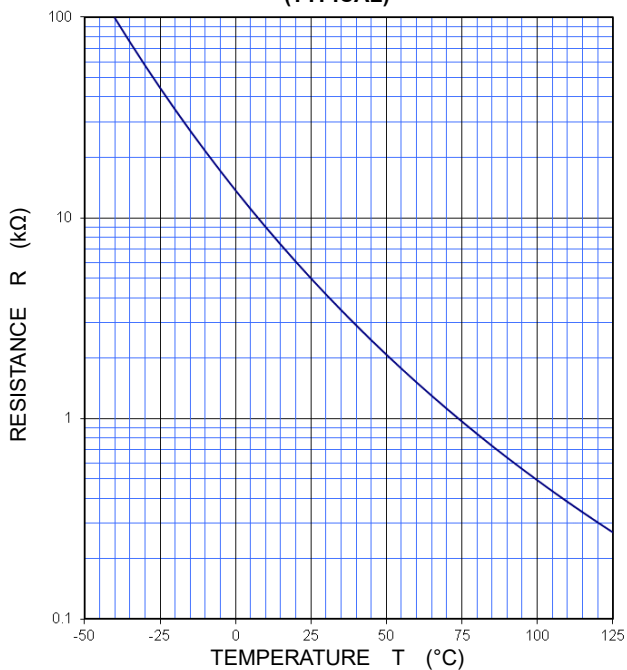
**SHORT-CIRCUIT SAFE OPERATING AREA
(MAXIMUM)**

$V_{CC} \leq 800 \text{ V}$, $R_G = 1.3 \sim 10 \ \Omega$, $V_{GE} = \pm 15 \text{ V}$,
 $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$, $t_W \leq 8 \ \mu\text{s}$, 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-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

Important Notice

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CM450DX-24T/CM450DXP-24T

HIGH POWER SWITCHING USE
INSULATED TYPE

Keep safety first in your circuit designs!

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