

<IGBT Modules>

# CM400C1Y-24S

HIGH POWER SWITCHING USE  
INSULATED TYPE



**dual (AC switch)**

Collector current  $I_C$  ..... **3 5 0 A \***

Collector-emitter voltage  $V_{CES}$  ..... **1 2 0 0 V**

Maximum junction temperature  $T_{jmax}$  ..... **1 7 5 °C**

- Flat base Type
- Copper base plate
- RoHS Directive compliant
- UL Recognized under UL1557, File E323585

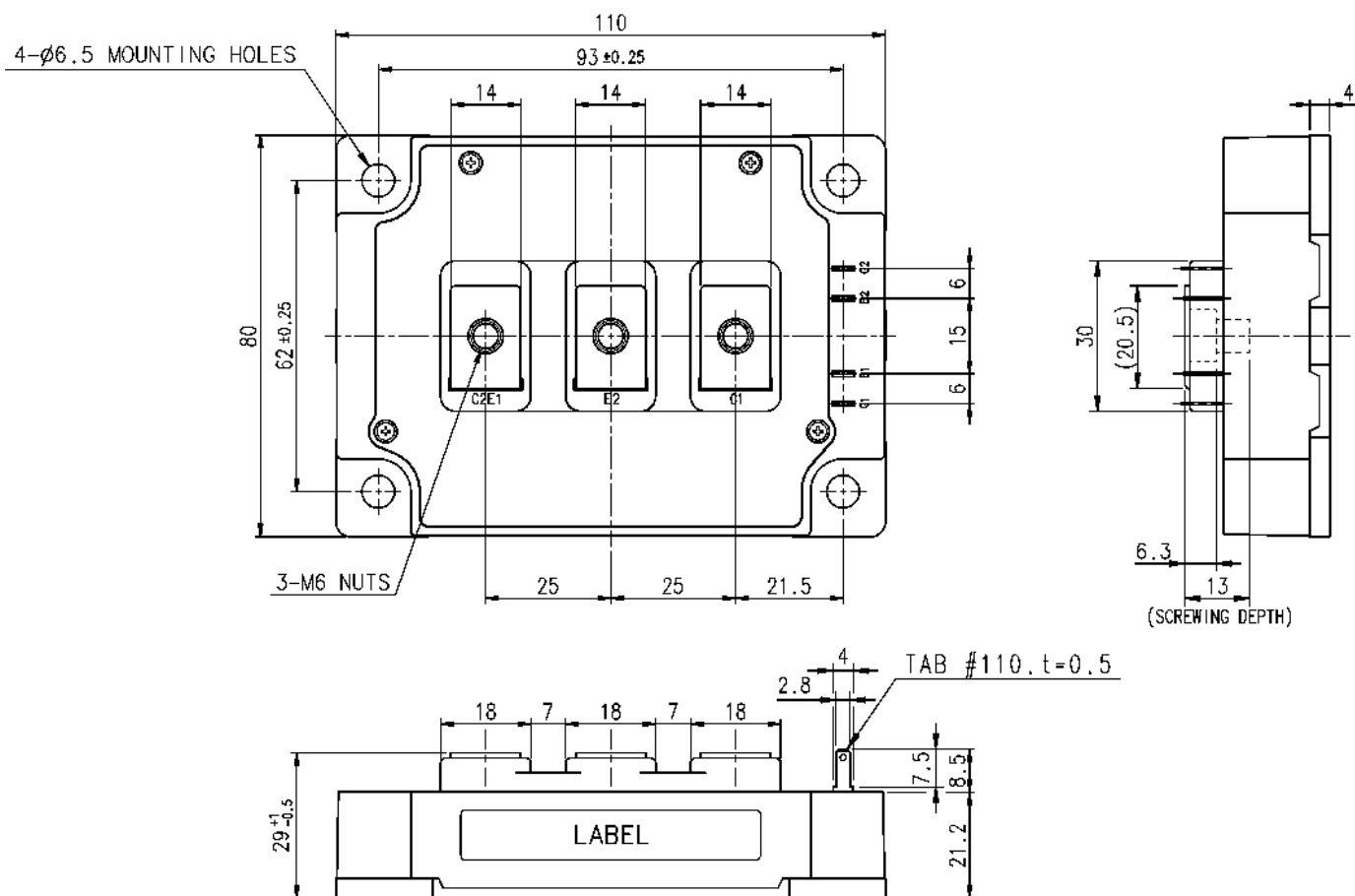
\*. DC current rating is limited by power terminals.

## APPLICATION

AC Power Switch for NPC

## OUTLINE DRAWING & INTERNAL CONNECTION

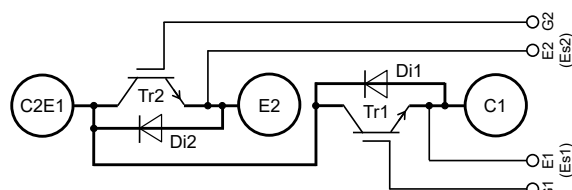
Dimension in mm



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

### INTERNAL CONNECTION



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**MAXIMUM RATINGS** ( $T_J=25\text{ }^{\circ}\text{C}$ , unless otherwise specified)

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, $T_C=124\text{ }^{\circ}\text{C}$ (Note2, 4)	350 *	A
$I_{CRM}$		Pulse, Repetitive (Note3)	800	
$P_{tot}$	Total power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ (Note2, 4)	2670	W
$I_E$ (Note1)	Emitter current	(Note2)	350 *	A
$I_{ERM}$ (Note1)		Pulse, Repetitive (Note3)	800	
$V_{isol}$	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	2500	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)

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> =40 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> =400 A <sup>(Note5)</sup> , V <sub>GE</sub> =15 V, Terminal, Refer to figure of test circuit	T <sub>J</sub> =25 °C	-	1.85	2.30	V
			T <sub>J</sub> =125 °C	-	2.05	-	
			T <sub>J</sub> =150 °C	-	2.10	-	
V <sub>CEsat</sub> (Chip)		I <sub>C</sub> =400 A <sup>(Note5)</sup> , V <sub>GE</sub> =15 V, Chip	T <sub>J</sub> =25 °C	-	1.70	2.15	V
			T <sub>J</sub> =125 °C	-	1.90	-	
			T <sub>J</sub> =150 °C	-	1.95	-	
C <sub>ies</sub>	Input capacitance	V <sub>CE</sub> =10 V, G-E short-circuited		-	-	40	nF
C <sub>oes</sub>	Output capacitance			-	-	8.0	
C <sub>res</sub>	Reverse transfer capacitance			-	-	0.66	
Q <sub>G</sub>	Gate charge	V <sub>CC</sub> =600 V, I <sub>C</sub> =400 A, V <sub>GE</sub> =15 V		-	934	-	nC
t <sub>d(on)</sub>	Turn-on delay time	V <sub>CC</sub> =600 V, I <sub>C</sub> =400 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			-	-	600	
t <sub>f</sub>	Fall time			-	-	300	
V <sub>EC</sub> <sup>(Note.1)</sup> (Terminal)	Emitter-collector voltage	I <sub>E</sub> =400 A <sup>(Note5)</sup> , G-E short-circuited, Terminal, Refer to figure of test circuit	T <sub>J</sub> =25 °C	-	1.85	2.30	V
			T <sub>J</sub> =125 °C	-	1.85	-	
			T <sub>J</sub> =150 °C	-	1.85	-	
V <sub>EC</sub> <sup>(Note.1)</sup> (Chip)		I <sub>E</sub> =400 A <sup>(Note5)</sup> , G-E short-circuited, Chip	T <sub>J</sub> =25 °C	-	1.70	2.15	V
			T <sub>J</sub> =125 °C	-	1.70	-	
			T <sub>J</sub> =150 °C	-	1.70	-	
t <sub>rr</sub> <sup>(Note1)</sup>	Reverse recovery time	V <sub>CC</sub> =600 V, I <sub>E</sub> =400 A, V <sub>GE</sub> =±15 V,		-	-	300	ns
Q <sub>rr</sub> <sup>(Note1)</sup>	Reverse recovery charge	R <sub>G</sub> =0 Ω, Inductive load		-	21.4	-	μC
E <sub>on</sub>	Turn-on switching energy per pulse	V <sub>CC</sub> =600 V, I <sub>C</sub> =I <sub>E</sub> =400 A,		-	39.8	-	mJ
E <sub>off</sub>	Turn-off switching energy per pulse	V <sub>GE</sub> =±15 V, R <sub>G</sub> =0 Ω,		-	44.9	-	
E <sub>rr</sub> <sup>(Note1)</sup>	Reverse recovery energy per pulse	T <sub>J</sub> =150 °C, Inductive load		-	35.2	-	mJ
r <sub>g</sub>	Internal gate resistance	Per switch		-	4.9	-	Ω

## THERMAL RESISTANCE CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance (Note4)	Junction to case, per IGBT	-	-	56	K/kW
$R_{th(j-c)D}$		Junction to case, per DIODE	-	-	95	K/kW
$R_{th(c-s)}$	Contact thermal resistance (Note4)	Case to heat sink, per 1/2 module, Thermal grease applied (Note6)	-	18	-	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 to heat sink M 6 screw	3.5	4.0	4.5	N·m
$m$	Weight	-	-	580	-	g
$e_c$	Flatness of base plate	On the centerline X, Y (Note7)	-100	-	+100	μm

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 (DIODE).

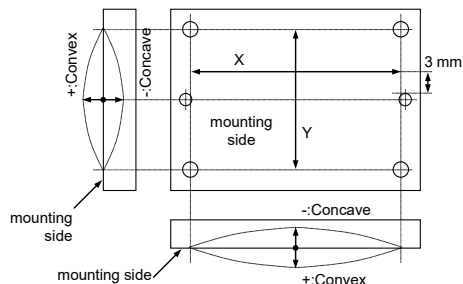
- Junction temperature ( $T_j$ ) should not increase beyond  $T_{jmax}$  rating.
- Pulse width and repetition rate should be such that the device junction temperature ( $T_j$ ) does not exceed  $T_{jmax}$  rating.
- Case temperature ( $T_c$ ) and heat sink temperature ( $T_s$ ) are defined on the each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

The heat sink thermal resistance should measure just under the chips.

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

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

- Base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



\*. DC current rating is limited by power terminals.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$V_{CC}$	(DC) Supply voltage	Applied across C1-E2	-	600	850	V
$V_{GEon}$	Gate (-emitter drive) voltage	Applied across G1-Es1/G2-Es2	13.5	15.0	16.5	V
$R_G$	External gate resistance	Per switch	0	-	10	Ω

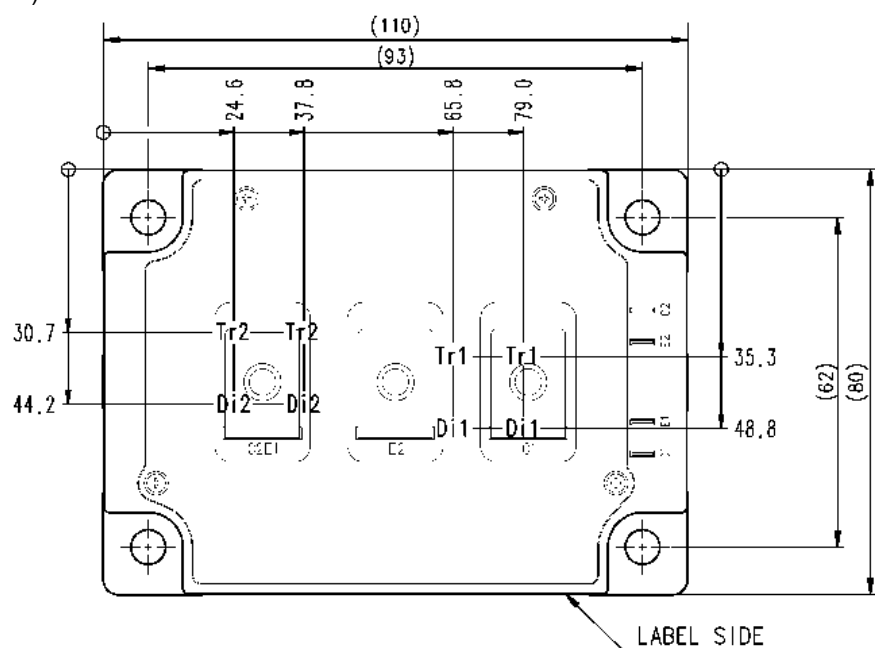
# CM400C1Y-24S

HIGH POWER SWITCHING USE

INSULATED TYPE

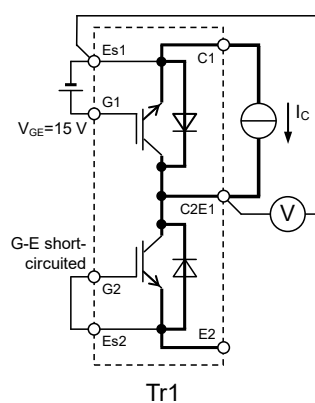
CHIP LOCATION (Top view)

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

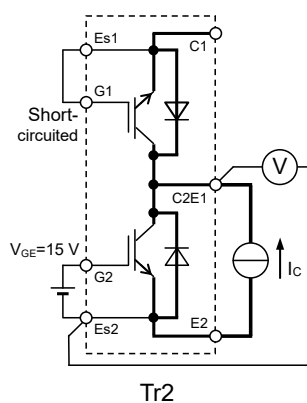


Tr1/Tr2: IGBT, Di1/Di2: DIODE

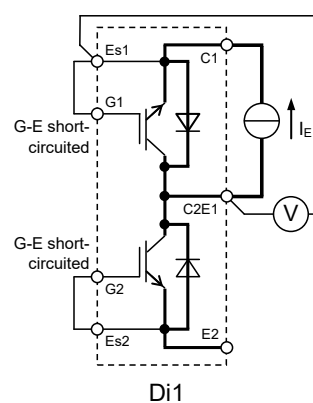
## TEST CIRCUIT



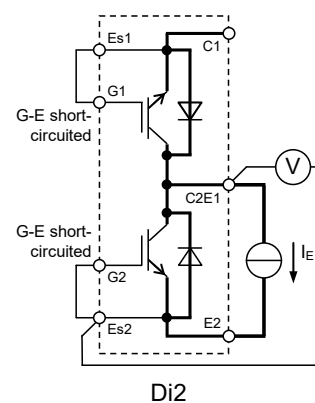
$V_{CEsat}$  test circuit



Tr2



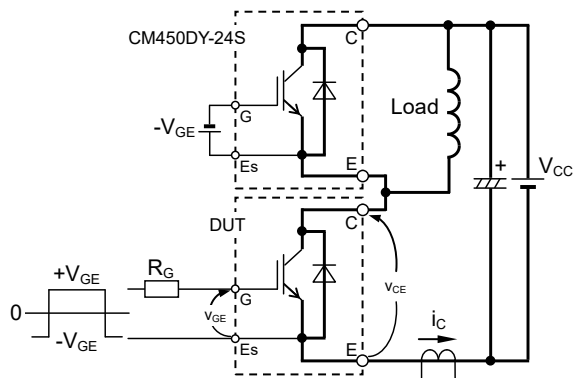
Di1



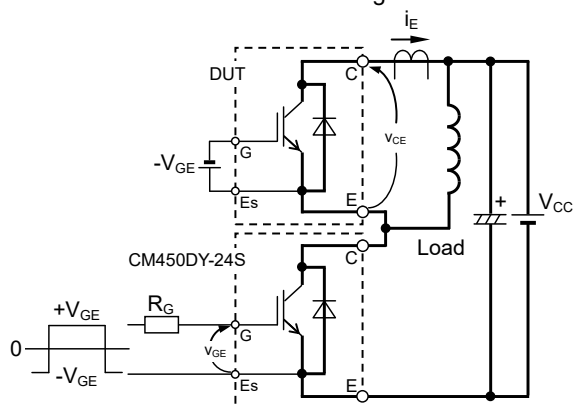
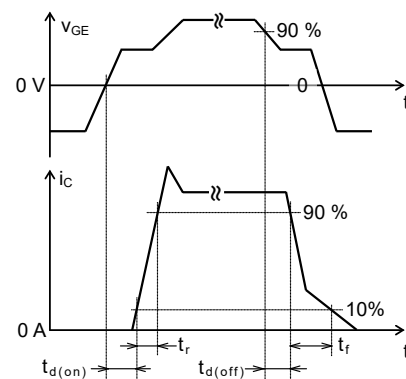
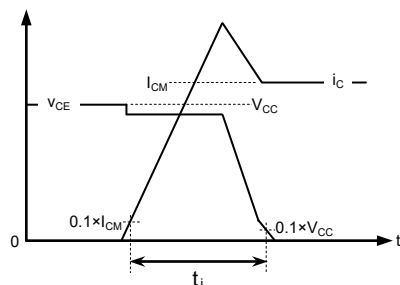
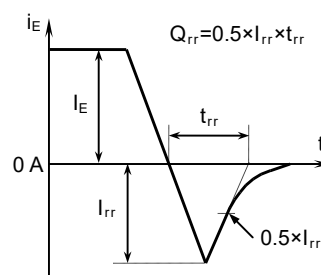
Di2

$V_{EC}$  test circuit

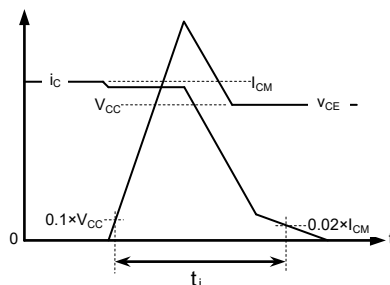
## TEST CIRCUIT AND WAVEFORMS



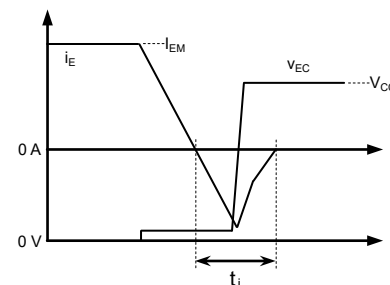
Switching characteristics test circuit and waveform

Reverse recovery characteristics ( $t_{rr}$ ,  $Q_{rr}$ ) test circuit

IGBT Turn-on switching energy



IGBT Turn-off switching energy



DIODE Reverse recovery energy

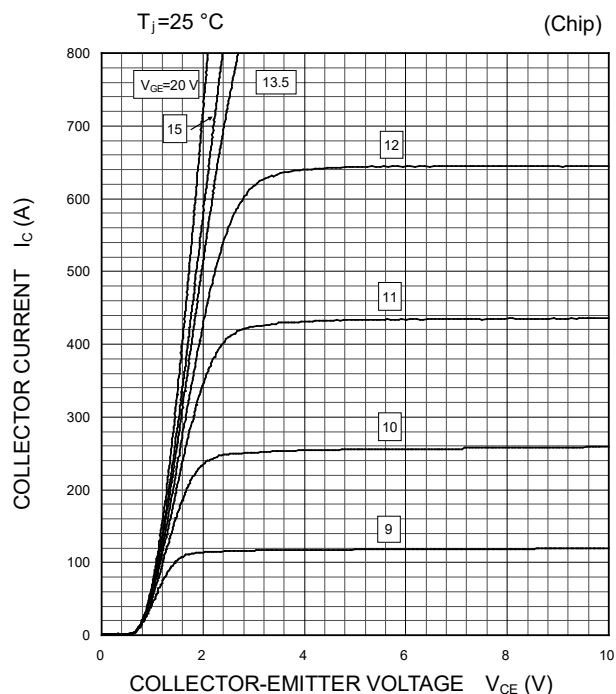
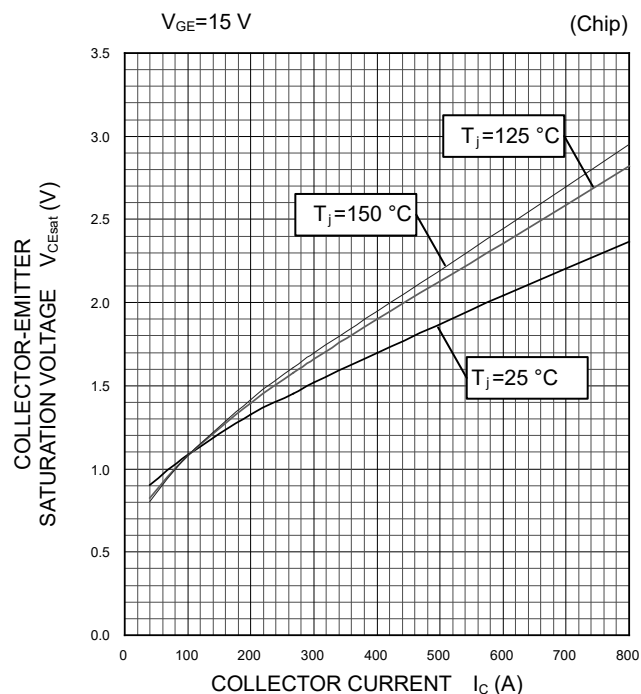
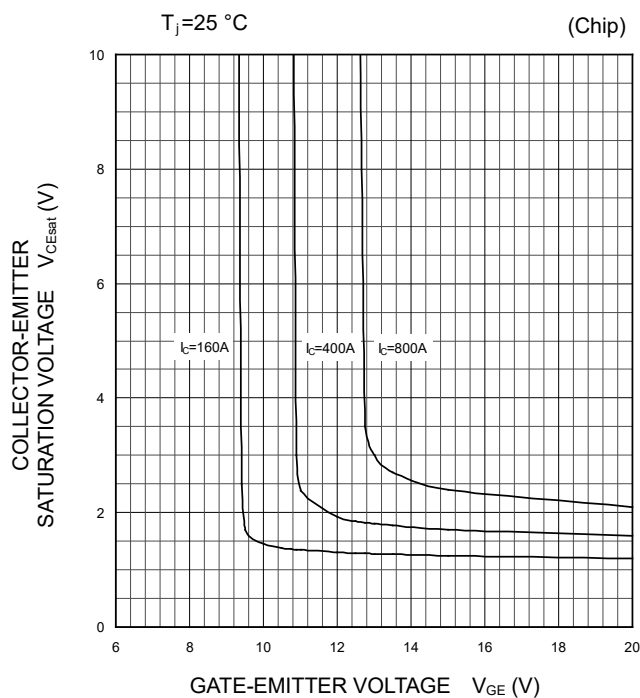
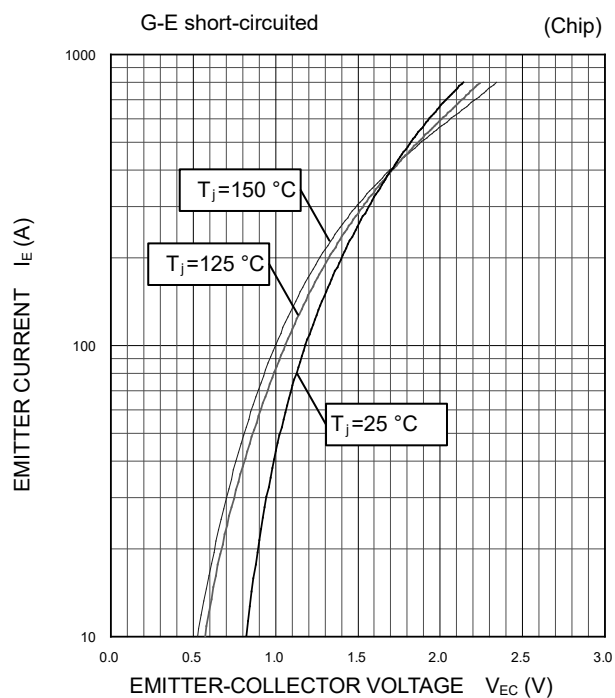
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

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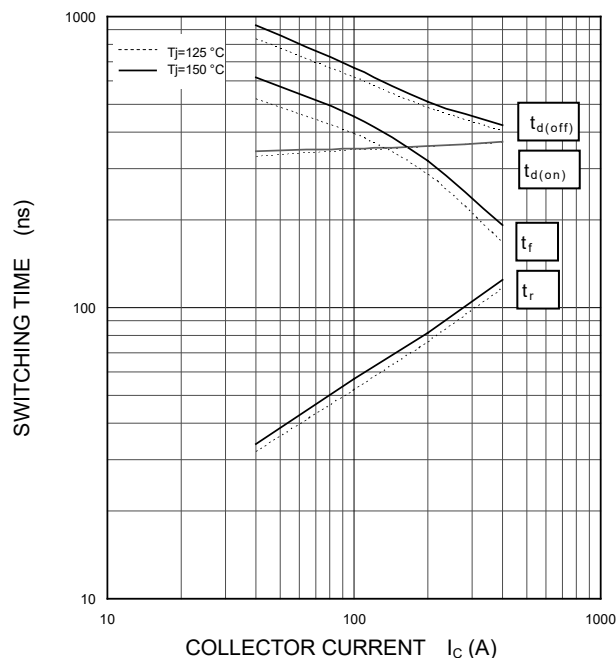
## PERFORMANCE CURVES

OUTPUT CHARACTERISTICS  
(TYPICAL)COLLECTOR-EMITTER SATURATION  
VOLTAGE CHARACTERISTICS  
(TYPICAL)COLLECTOR-EMITTER SATURATION  
VOLTAGE CHARACTERISTICS  
(TYPICAL)FREE WHEELING DIODE  
FORWARD CHARACTERISTICS  
(TYPICAL)

## PERFORMANCE CURVES

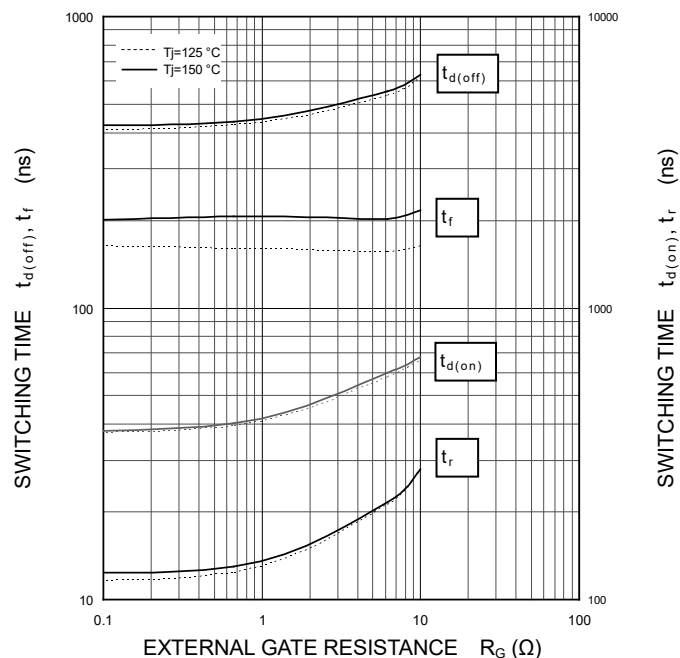
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0\ \Omega$ ,  
INDUCTIVE LOAD



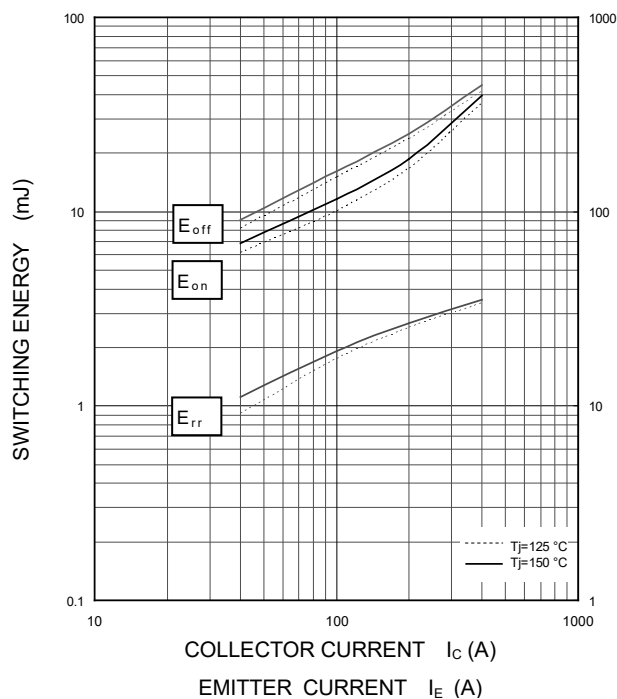
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $I_C=400\text{ A}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  
INDUCTIVE LOAD



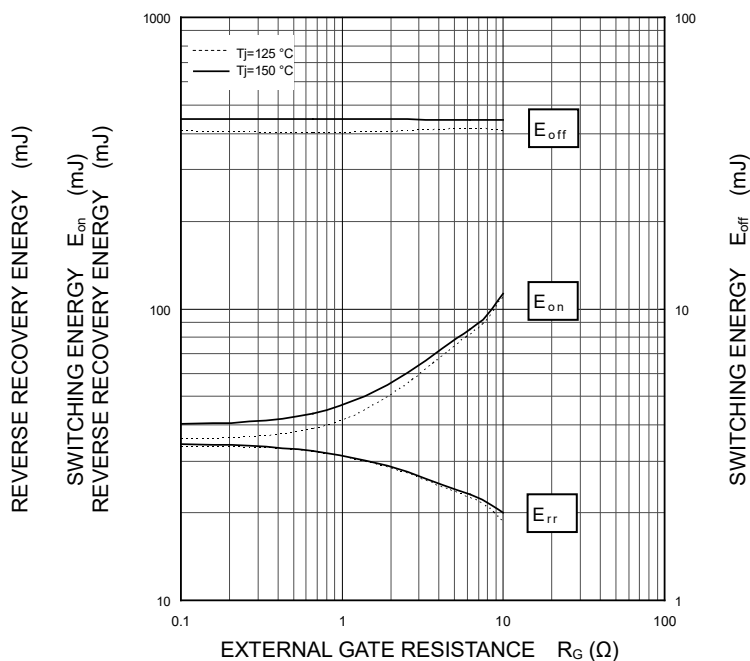
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0\ \Omega$ ,  
INDUCTIVE LOAD, PER PULSE



HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $I_C/I_E=400\text{ A}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  
INDUCTIVE LOAD, PER PULSE

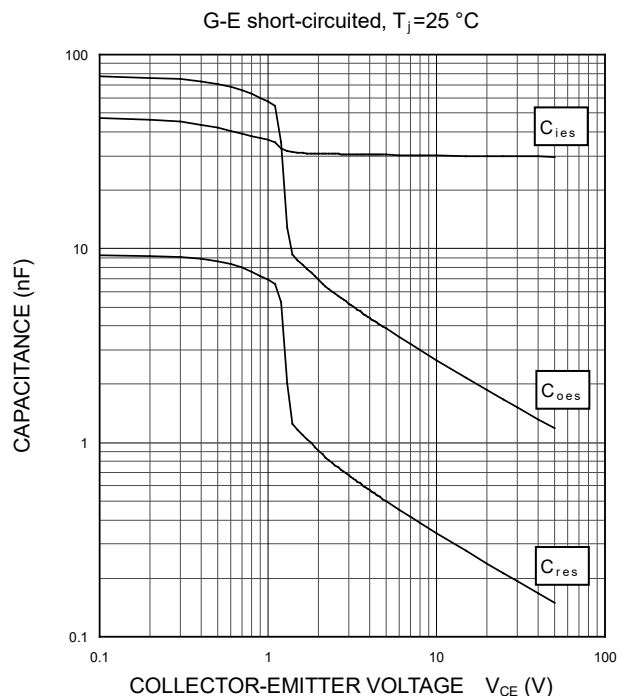
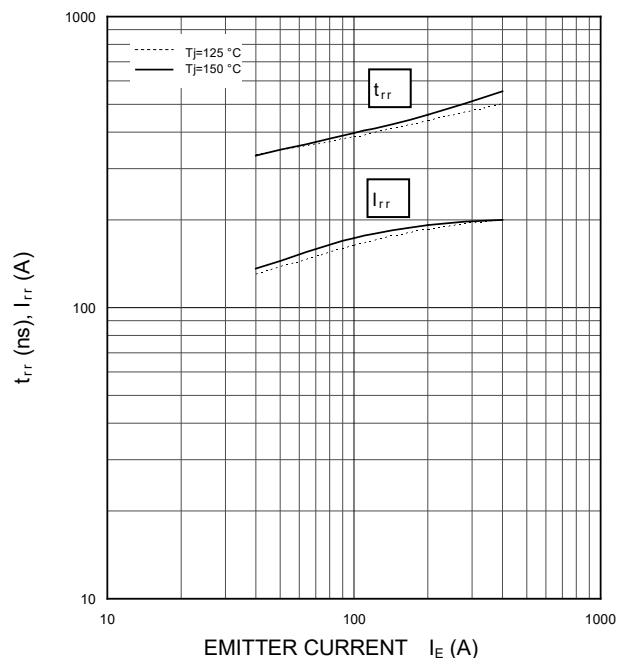
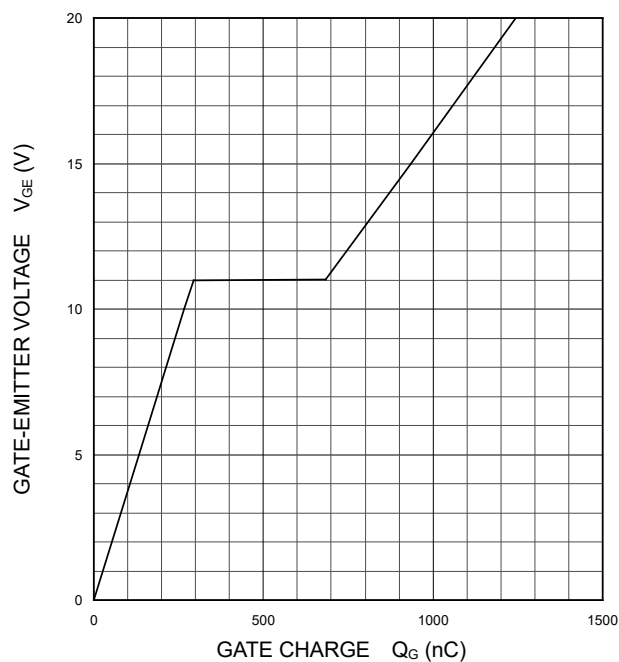
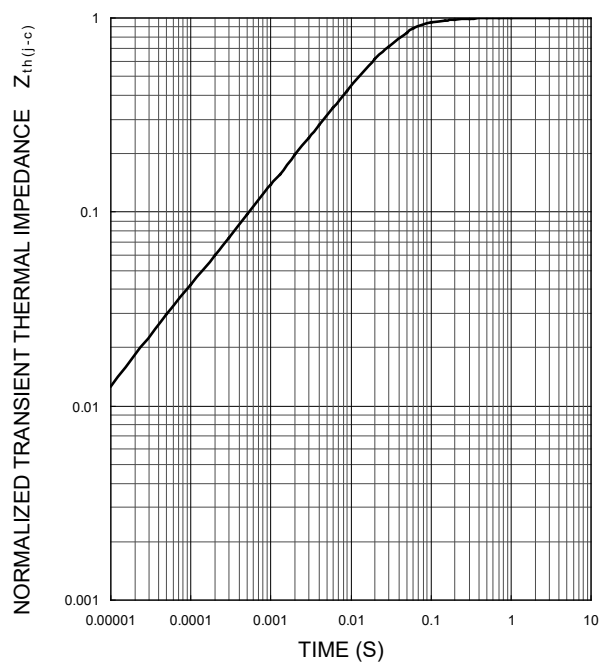


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HIGH POWER SWITCHING USE

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## PERFORMANCE CURVES

CAPACITANCE CHARACTERISTICS  
(TYPICAL)FREE WHEELING DIODE  
REVERSE RECOVERY CHARACTERISTICS  
(TYPICAL) $V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0\text{ }\Omega$ ,  
INDUCTIVE LOADGATE CHARGE CHARACTERISTICS  
(TYPICAL) $V_{CC}=600\text{ V}$ ,  $I_C=400\text{ A}$ ,  $T_J=25\text{ }^{\circ}\text{C}$ TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS  
(MAXIMUM)Single pulse,  $T_C=25\text{ }^{\circ}\text{C}$   
 $R_{th(j-c)Q}=56\text{ K/kW}$ ,  $R_{th(j-c)D}=95\text{ K/kW}$ 



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