

<IGBT Modules>

CM400DY-13T

**HIGH POWER SWITCHING USE
INSULATED TYPE**



dual switch (half-bridge)

Collector current I_C **4 0 0 A**
 Collector-emitter voltage V_{CES} **6 5 0 V**
 Maximum junction temperature T_{vjmax} **1 7 5 °C**

- Flat base type
- Copper base plate (Nickel-plating)
- Tin-plating signal terminals
- RoHS Directive compliant
- UL Recognized under UL1557, File No.E323585

APPLICATION

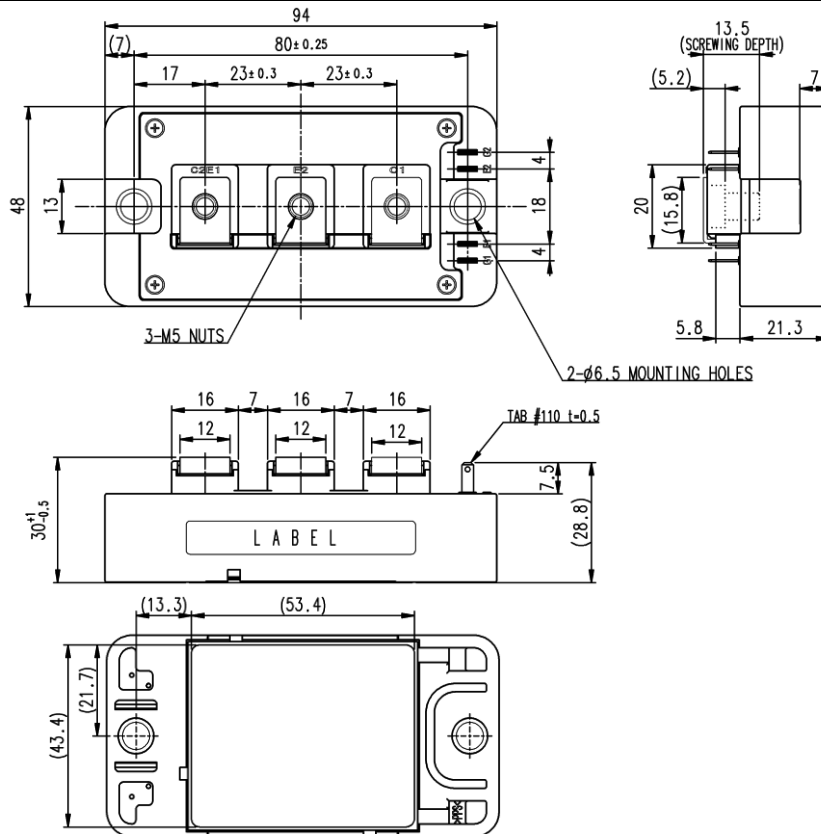
AC Motor Control, Motion/Servo Control, Power supply, etc.

OPTION (Below options are available.)

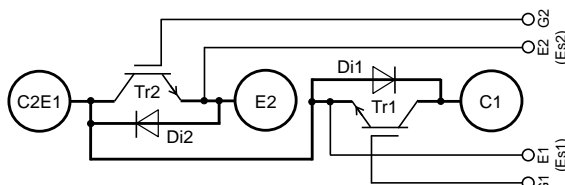
- PC-TIM (Phase Change Thermal Interface Material) pre-apply
- V_{CESat} selection for parallel connection

OUTLINE DRAWING & INTERNAL CONNECTION

Dimension in mm



INTERNAL CONNECTION



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

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HIGH POWER SWITCHING USE
INSULATED TYPEMAXIMUM RATINGS ($T_{vj}=25\text{ }^{\circ}\text{C}$, unless otherwise specified)

Symbol	Item	Conditions	Rating	Unit
V_{CES}	Collector-emitter voltage	G-E short-circuited	650	V
V_{GES}	Gate-emitter voltage	C-E short-circuited	± 20	V
I_C	Collector current	DC, $T_C=125\text{ }^{\circ}\text{C}$ (Note2, 4)	400	A
I_{CRM}		Pulse, Repetitive (Note3)	800	
P_{tot}	Total power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ (Note2, 4)	2830	W
I_E (Note1)	Emitter current	DC (Note2)	400	A
I_{ERM} (Note1)		Pulse, Repetitive (Note3)	800	
V_{isol}	Isolation voltage	Terminals to base plate, RMS, $f=60\text{ Hz}$, AC 1 min	4000	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)

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	$I_C=40\text{ mA}$, $V_{CE}=10\text{ V}$	5.4	6.0	6.6	V	
V_{CEsat} (Terminal)	Collector-emitter saturation voltage	$I_C=400\text{ A}$, $V_{GE}=15\text{ V}$, Refer to the figure of test circuit (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.45	1.75	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	1.55	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	1.60	-	
V_{CEsat} (Chip)		$I_C=400\text{ A}$, $V_{GE}=15\text{ V}$, (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.30	1.55	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	1.35	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	1.35	-	
C_{ies}	Input capacitance	$V_{CE}=10\text{ V}$, G-E short-circuited	-	-	53.5	nF	
C_{oes}	Output capacitance		-	-	2.6		
C_{res}	Reverse transfer capacitance		-	-	1.0		
Q_G	Gate charge	$V_{CC}=300\text{ V}$, $I_C=400\text{ A}$, $V_{GE}=15\text{ V}$	-	1.65	-	μC	
$t_{d(on)}$	Turn-on delay time	$V_{CC}=300\text{ V}$, $I_C=400\text{ A}$, $V_{GE}=\pm 15\text{ V}$, $R_G=1.6\text{ }\Omega$, Inductive load	-	-	400	ns	
t_r	Rise time		-	-	200		
$t_{d(off)}$	Turn-off delay time		-	-	400		
t_f	Fall time		-	-	400		
V_{EC} (Terminal)	Emitter-collector voltage	$I_E=400\text{ A}$, G-E short-circuited, Refer to the figure of test circuit (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	2.10	2.90	V
			$T_{vj}=125\text{ }^{\circ}\text{C}$	-	2.05	-	
			$T_{vj}=150\text{ }^{\circ}\text{C}$	-	2.05	-	
V_{EC} (Chip)		$I_E=400\text{ A}$, G-E short-circuited, (Note5)	$T_{vj}=25\text{ }^{\circ}\text{C}$	-	1.90	2.65	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	$V_{CC}=300\text{ V}$, $I_E=400\text{ A}$, $V_{GE}=\pm 15\text{ V}$,	-	-	200	ns	
Q_{rr} (Note1)	Reverse recovery charge	$R_G=1.6\text{ }\Omega$, Inductive load	-	14	-	μC	
E_{on}	Turn-on switching energy per pulse	$V_{CC}=300\text{ V}$, $I_C=I_E=400\text{ A}$,	-	4.5	-	mJ	
E_{off}	Turn-off switching energy per pulse	$V_{GE}=\pm 15\text{ V}$, $R_G=1.6\text{ }\Omega$, $T_{vj}=150\text{ }^{\circ}\text{C}$,	-	21.6	-		
E_{rr} (Note1)	Reverse recovery energy per pulse	Inductive load	-	9.0	-	mJ	
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, $T_C=25\text{ }^{\circ}\text{C}$ (Note4)	-	0.3	-	$\text{m}\Omega$	
r_g	Internal gate resistance	Per switch	-	1.5	-	Ω	

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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)	-	-	53	K/kW
$R_{th(j-c)D}$		Junction to case, per Inverter FWD (Note4)	-	-	84	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, per 1 module,	Thermal grease applied (Note4, 6)	-	24	K/kW
			PC-TIM applied (Note4, 7)	-	6.3	

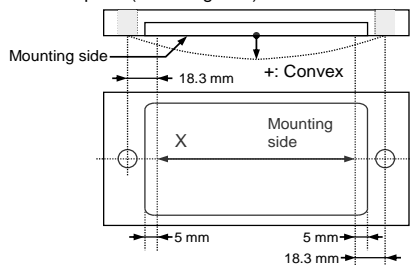
MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
M_t	Mounting torque	Main terminals M 5 screw	2.5	3.0	3.5	N·m
M_s	Mounting torque	Mounting to heat sink M 6 screw	3.5	4.0	4.5	N·m
d_s	Creepage distance	Terminal to terminal	18	-	-	mm
		Terminal to base plate	21.1	-	-	
d_a	Clearance	Terminal to terminal	9.6	-	-	mm
		Terminal to base plate	16.7	-	-	
e_c	Flatness of base plate	On the centerline (Note8)	± 0	-	+200	μm
m	mass	-	-	155	-	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_{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.
- Typical value is measured by using thermally conductive grease of $\lambda=0.9 \text{ W}/(\text{m}\cdot\text{K})/D_{(c-s)}=50 \mu\text{m}$.
- Typical value is measured by using PC-TIM of $\lambda=3.4 \text{ W}/(\text{m}\cdot\text{K})/D_{(c-s)}=50 \mu\text{m}$.
- The base plate (mounting side) flatness measurement points (X) are shown in the following figure.



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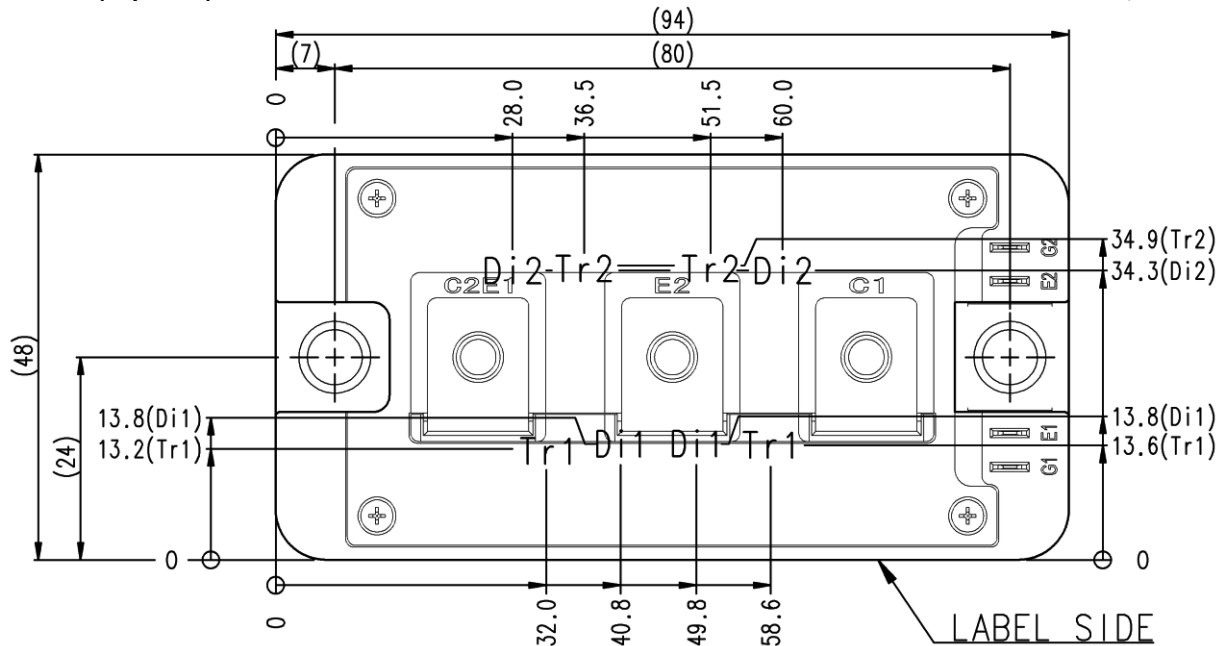
HIGH POWER SWITCHING USE
INSULATED TYPE

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V _{CC}	(DC) Supply voltage	Applied across C1-E2 terminals	-	300	450	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	1.6	-	16	Ω

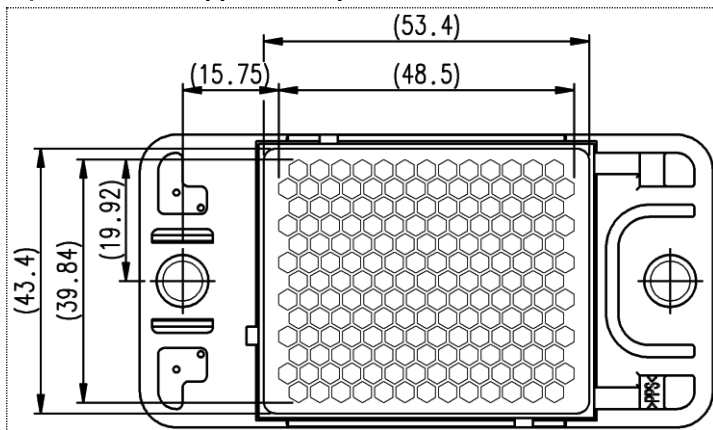
CHIP LOCATION (Top view)

Dimension in mm, tolerance: ±1 mm



Tr1/Tr2: IGBT, Di1/Di2: FWD

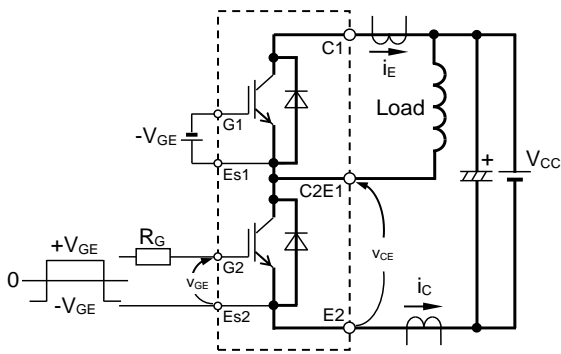
Option: PC-TIM applied baseplate outline



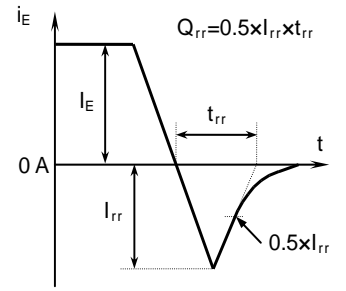
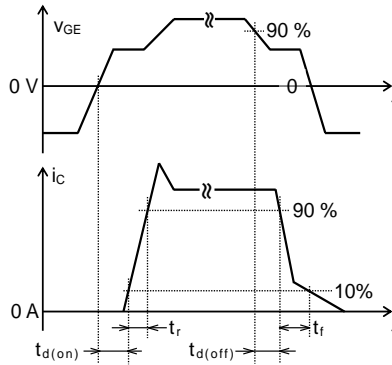
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HIGH POWER SWITCHING USE
INSULATED TYPE

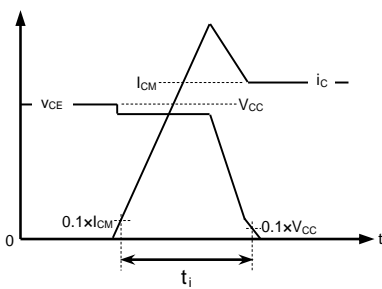
TEST CIRCUIT AND WAVEFORMS



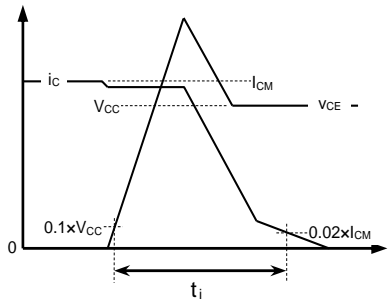
Switching characteristics test circuit and waveforms



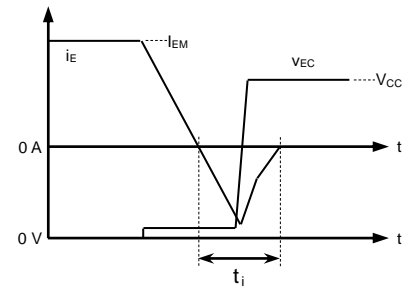
t_{rr} , Q_{rr} characteristics test waveform



IGBT Turn-on switching energy



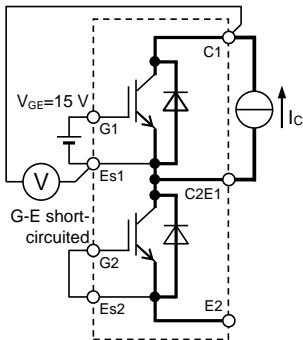
IGBT Turn-off switching energy



FWD Reverse recovery energy

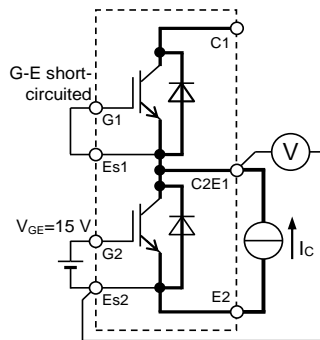
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

TEST CIRCUIT

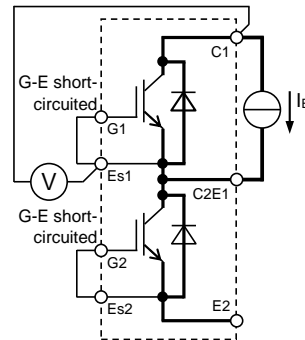


Tr1

V_{CEsat} characteristics test circuit

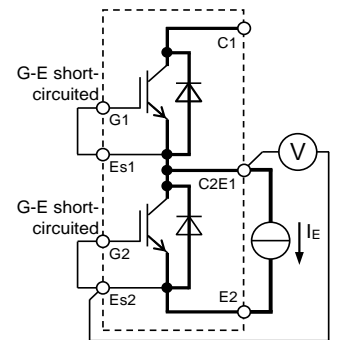


Tr2



Di1

V_{EC} characteristics test circuit



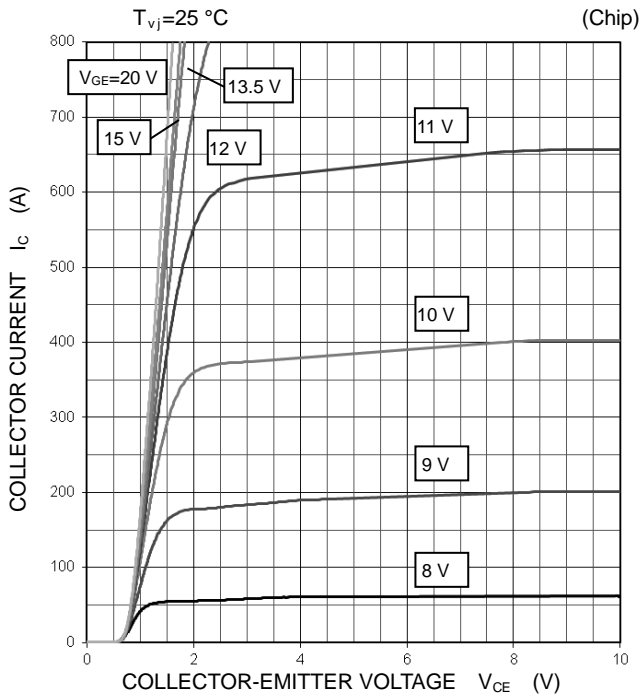
Di2

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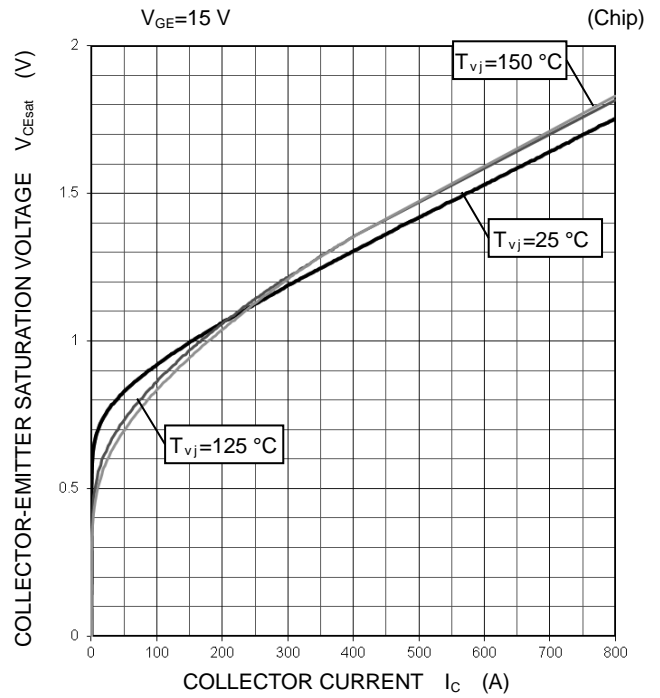
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

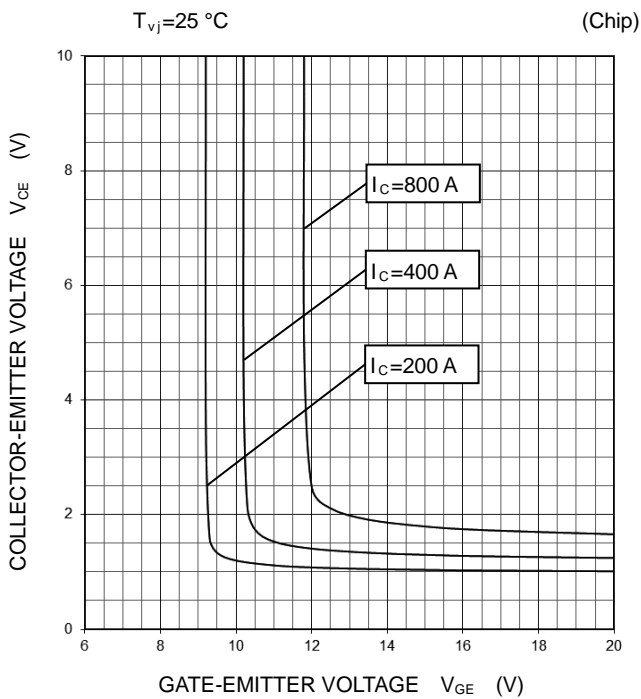
**OUTPUT CHARACTERISTICS
(TYPICAL)**



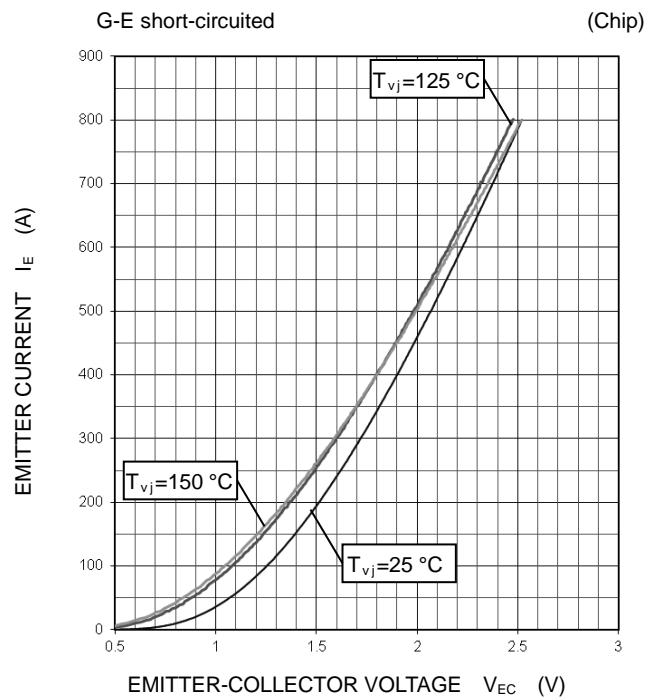
**COLLECTOR-EMITTER SATURATION VOLTAGE
CHARACTERISTICS
(TYPICAL)**



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



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



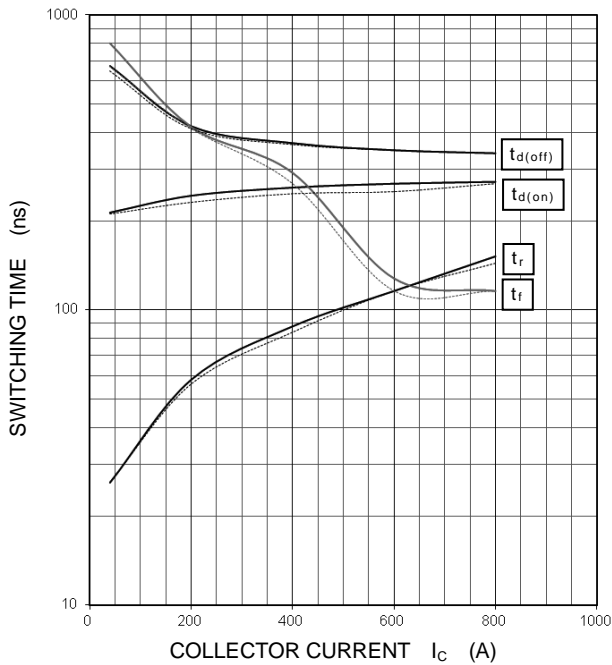
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HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

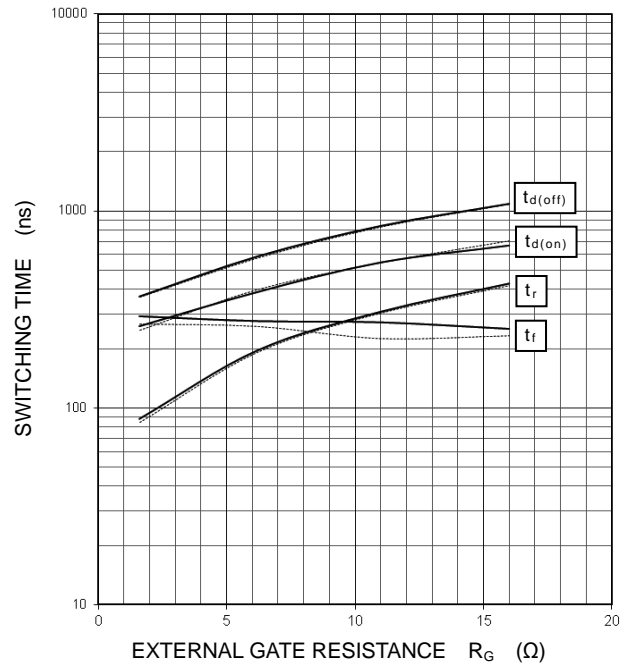
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}=300\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $R_G=1.6\ \Omega$, INDUCTIVE LOAD
 —: $T_{vj}=150\text{ }^\circ\text{C}$, - - - - -: $T_{vj}=125\text{ }^\circ\text{C}$



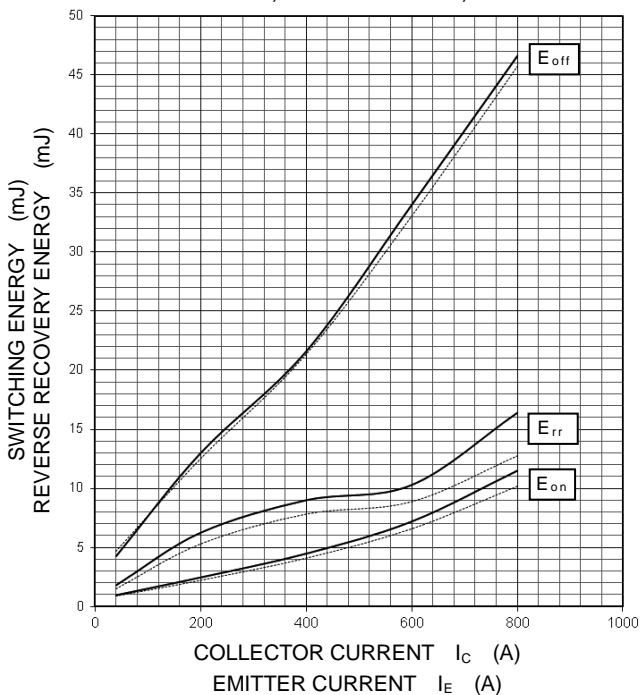
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}=300\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $I_C=400\text{ A}$, INDUCTIVE LOAD
 —: $T_{vj}=150\text{ }^\circ\text{C}$, - - - - -: $T_{vj}=125\text{ }^\circ\text{C}$



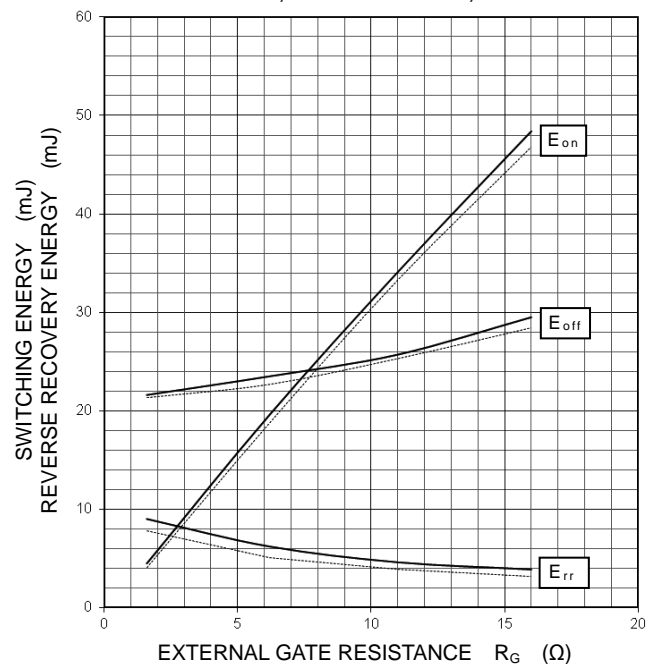
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}=300\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $R_G=1.6\ \Omega$,
INDUCTIVE LOAD, PER PULSE
 —: $T_{vj}=150\text{ }^\circ\text{C}$, - - - - -: $T_{vj}=125\text{ }^\circ\text{C}$



HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

$V_{CC}=300\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $I_C/I_E=400\text{ A}$,
INDUCTIVE LOAD, PER PULSE
 —: $T_{vj}=150\text{ }^\circ\text{C}$, - - - - -: $T_{vj}=125\text{ }^\circ\text{C}$

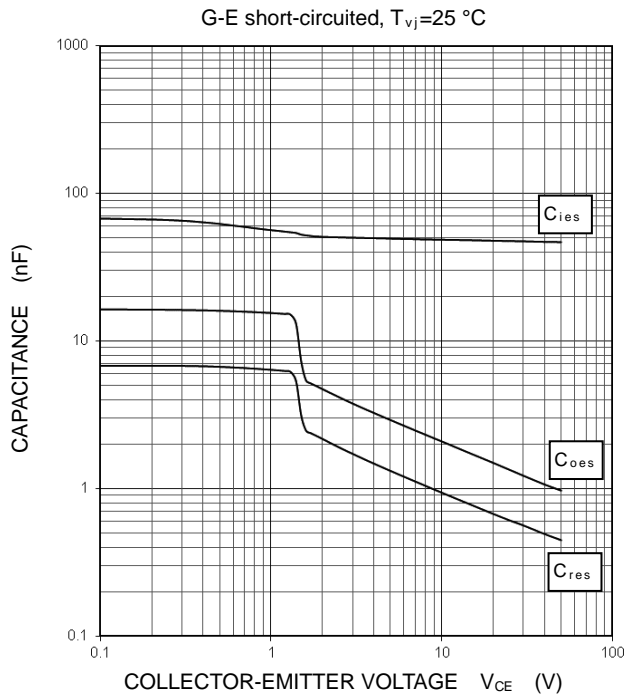


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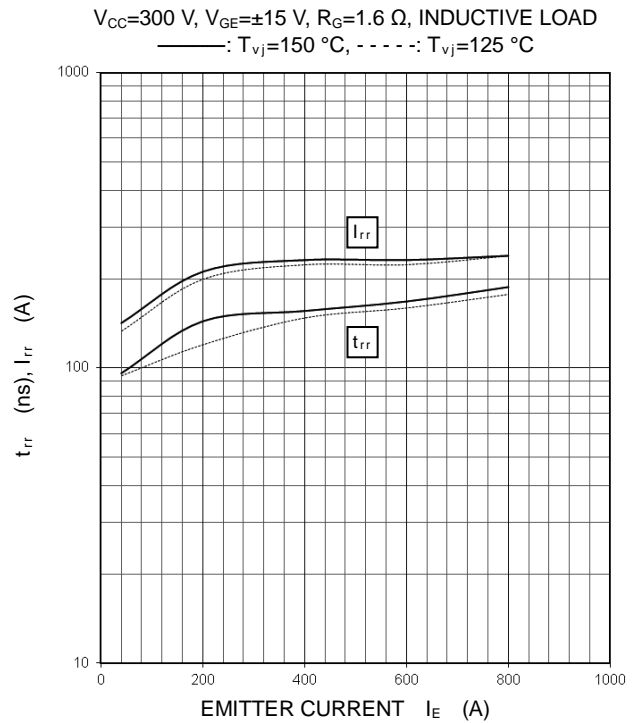
HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

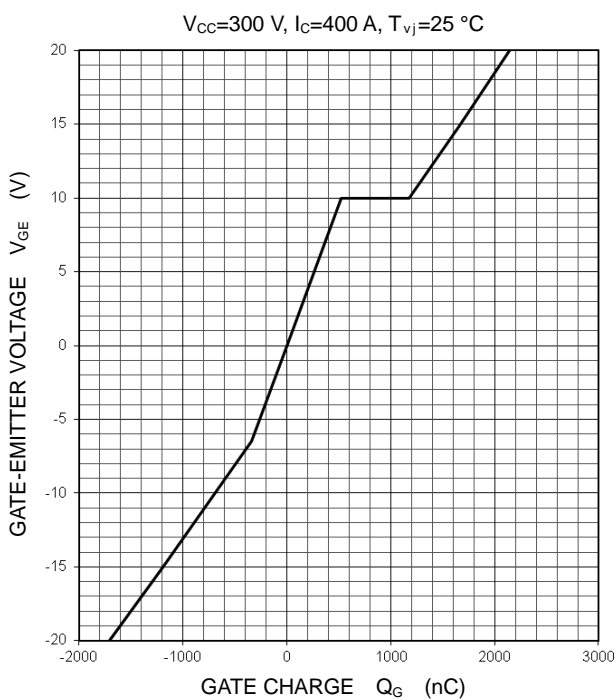
CAPACITANCE CHARACTERISTICS (TYPICAL)



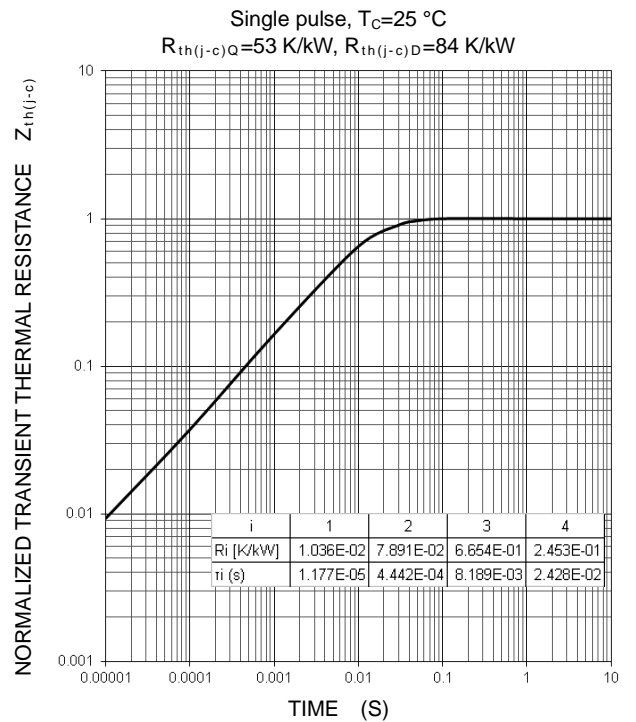
FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



GATE CHARGE CHARACTERISTICS (TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)



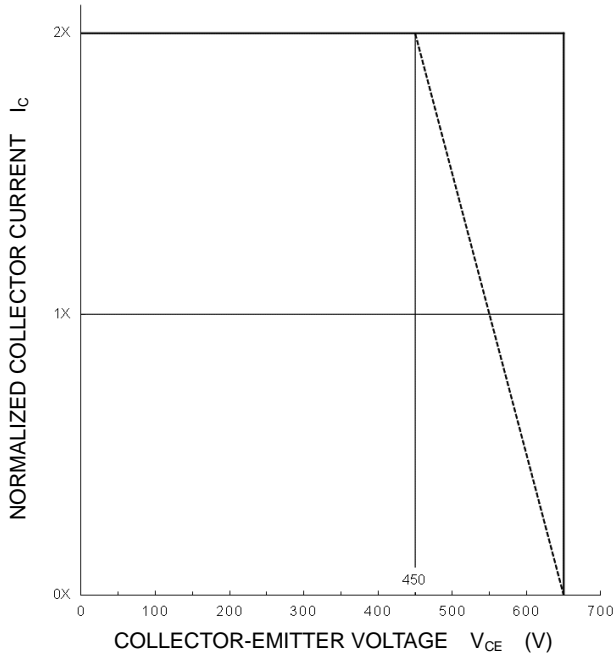
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HIGH POWER SWITCHING USE
INSULATED TYPE

PERFORMANCE CURVES

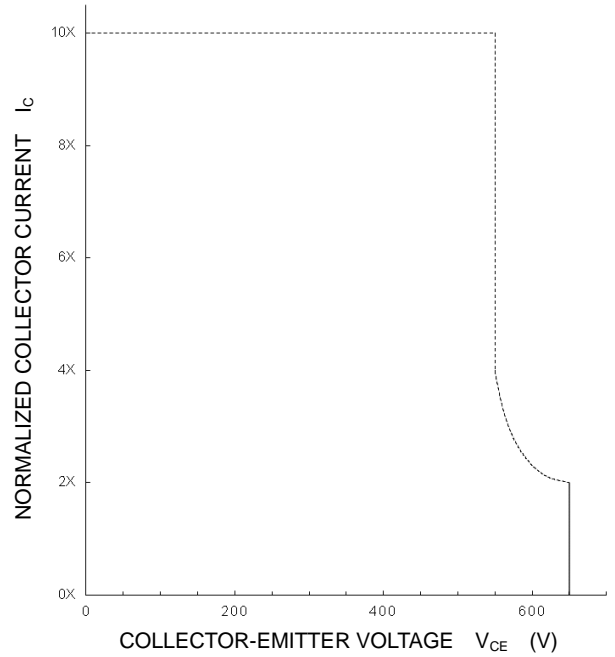
**TURN-OFF SWITCHING SAFE OPERATING AREA
(REVERSE BIAS SAFE OPERATING AREA)
(MAXIMUM)**

$V_{CC} \leq 450 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 1.6 \sim 16 \ \Omega$,
——: $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$ (Normal load operations (Continuous))
- - - - -: $T_{vj} = 175 \text{ }^\circ\text{C}$ (Unusual load operations (Limited period))



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

$V_{CC} \leq 400 \text{ V}$, $V_{GE} = \pm 15 \text{ V}$, $R_G = 1.6 \sim 16 \ \Omega$,
 $T_{vj} = 25 \sim 150 \text{ }^\circ\text{C}$, $t_W \leq 8 \ \mu\text{s}$, Non-Repetitive



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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