MITSUBISHI ELECTRIC

<IGBT Modules>

CM400DY-40TA

HIGH POWER SWITCHING USE
INSULATED TYPE

Collector Current I_C .... **400** A
Collector-emitter voltage V_{CES} .... **2000** V
Maximum junction temperature T_{vjmax} .... **175** °C

- Dual switch (Half-bridge)
- Flat base type
- Nickel-plating tab terminals
- RoHS Directive compliant
- UL Recognition under 1557, File No.E323585

APPLICATION

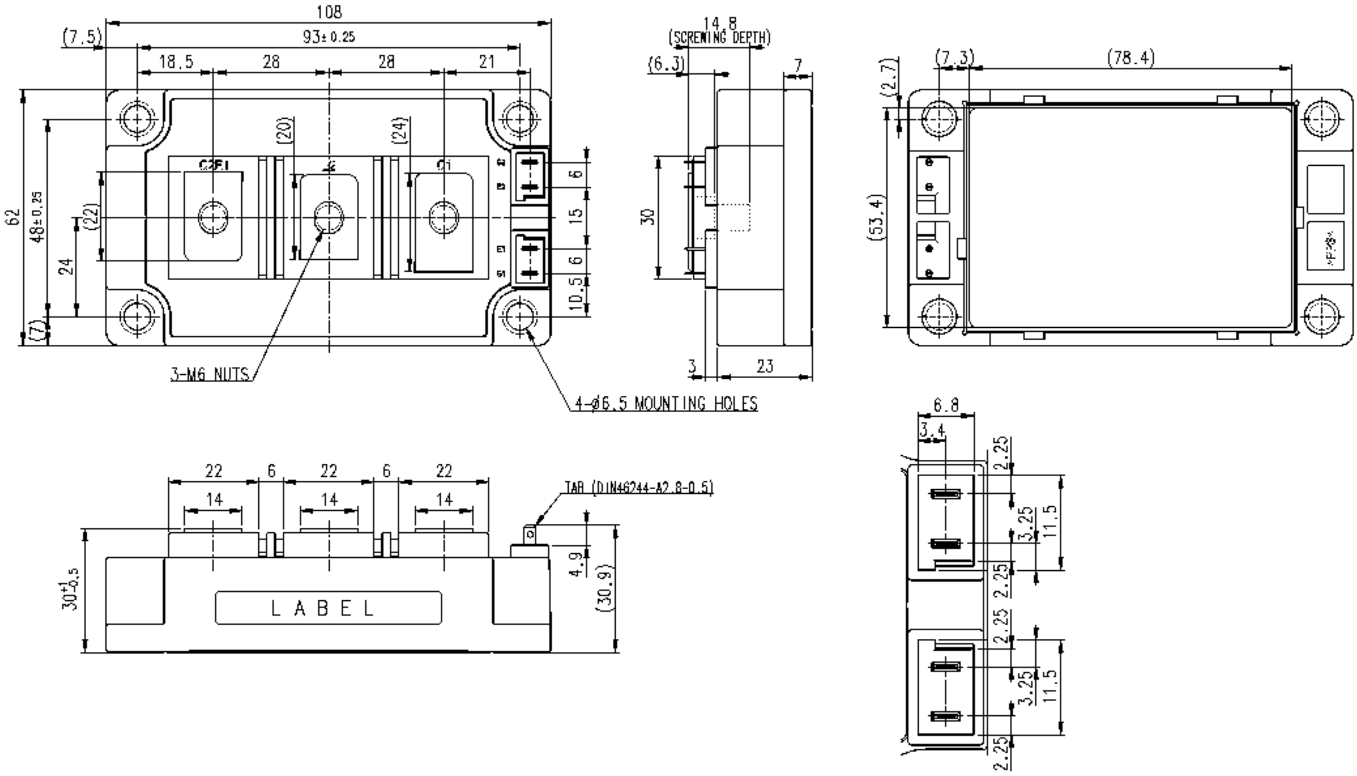
Medium voltage drive, etc.

OPTION

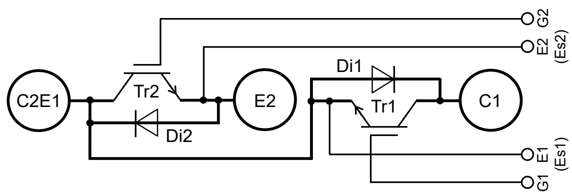
- V_{CEsat} selection for parallel connection
- PC-TIM (Phase Change Thermal Interface Material) pre-apply

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

JIS B 0405 c

MAXIMUM RATINGS (T_{vj}=25 °C, unless otherwise specified)

Symbol	Item	Conditions	Rating	Unit
V_{CES}	Collector-emitter voltage	G-E short-circuited	2000	V
V_{GES}	Gate-emitter voltage	C-E short-circuited	± 20	V
I_C	Collector current	DC, T_C = 139 °C (Note2, 4)	400	A
I_{CRM}		Pulse, Repetitive (Note3)	800	
P_{tot}	Total power dissipation	T_C = 25 °C (Note2, 4)	4285	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 Hz, AC 1 min	4000	V
T_{vjmax}	Maximum junction temperature	Instantaneous event (overload) (Note8)	175	°C
T_{Cmax}	Maximum case temperature	(Note4, 8)	150	
T_{vjop}	Operating junction temperature	Continuous operation (Note8)	-40 ~ +150	°C
T_{stg}	Storage temperature	-	-40 ~ +150	

ELECTRICAL CHARACTERISTICS (T_{vj}=25 °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	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 mA, V_{CE} = 10 V		5.5	6.0	6.6	V
V_{CEsat} (Terminal)	Collector-emitter saturation voltage	I_C = 400 A, V_{GE} = 15 V, Refer to the figure of test circuit (Note5)	T_{vj} = 25 °C	-	1.80	2.15	V
			T_{vj} = 125 °C	-	2.15	-	
			T_{vj} = 150 °C	-	2.20	-	
V_{CEsat} (Chip)		I_C = 400 A, V_{GE} = 15 V, (Note5)	T_{vj} = 25 °C	-	1.75	2.00	V
			T_{vj} = 125 °C	-	2.10	-	
			T_{vj} = 150 °C	-	2.15	-	
C_{ies}	Input capacitance	V_{CE} = 10 V, G-E short-circuited		-	-	110	nF
C_{oes}	Output capacitance			-	-	1.9	
C_{res}	Reverse transfer capacitance			-	-	0.8	
Q_G	Gate charge	V_{CC} = 1300 V, I_C = 400 A, V_{GE} = 15 V		-	3.2	-	μC
$t_{d(on)}$	Turn-on delay time	V_{CC} = 1300 V, I_C = 400 A, V_{GE} = ±15 V, R_G = 0 Ω, Inductive load		-	-	800	ns
t_r	Rise time			-	-	150	
$t_{d(off)}$	Turn-off delay time			-	-	900	
t_f	Fall time			-	-	2300	
V_{EC} (Note1) (Terminal)	Emitter-collector voltage	I_E = 400 A, G-E short-circuited, Refer to the figure of test circuit (Note5)	T_{vj} = 25 °C	-	2.10	3.05	V
			T_{vj} = 125 °C	-	2.40	-	
			T_{vj} = 150 °C	-	2.40	-	
V_{EC} (Note1) (Chip)		I_E = 400 A, G-E short-circuited, (Note5)	T_{vj} = 25 °C	-	2.00	2.75	V
			T_{vj} = 125 °C	-	2.30	-	
			T_{vj} = 150 °C	-	2.30	-	
t_{rr} (Note1)	Reverse recovery time	V_{CC} = 1300 V, I_E = 400 A, V_{GE} = ±15 V, R_G = 0 Ω, Inductive load		-	-	1000	ns
Q_{rr} (Note1)	Reverse recovery charge			-	105	-	μC
E_{on}	Turn-on switching energy per pulse	V_{CC} = 1300 V, I_C = I_E = 400 A, V_{GE} = ±15 V, R_G = 0 Ω, T_{vj} = 150 °C, Inductive load		-	215	-	mJ
E_{off}	Turn-off switching energy per pulse			-	340	-	
E_{rr} (Note1)	Reverse recovery energy per pulse			-	145	-	
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, T_C = 25 °C (Note4)		-	0.30	-	mΩ
r_g	Internal gate resistance	Per switch		-	1.9	-	Ω

THERMAL RESISTANCE CHARACTERISTICS

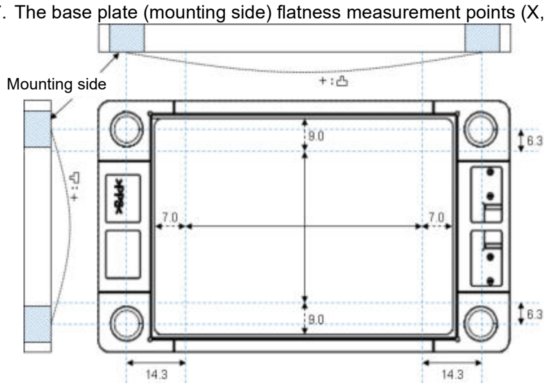
Symbol	Item	Conditions		Limits Min.	Typ.	Max.	Unit
$R_{th(j-c)Q}$	Thermal resistance	Junction to case, per Inverter IGBT (Note4)		-	-	35	K/kW
$R_{th(j-c)D}$		Junction to case, per Inverter FWD (Note4)		-	-	64	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, per 1 module.	Thermal grease applied (Note4, 6, 8)	-	13.3	-	K/kW

MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions		Limits Min.	Typ.	Max.	Unit
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
d_s	Creepage distance	Terminal to terminal		17.3	-	-	mm
		Terminal to base plate		25.3	-	-	
d_a	Clearance	Terminal to terminal		12.6	-	-	mm
		Terminal to base plate		21.8	-	-	
e_c	Flatness of base plate	On the centerline X, Y (Note7)		0	-	+200	μm
m	mass	—		-	260	-	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.

Note 1. Represent ratings and characteristics of the anti-parallel, emitter-collector free-wheeling diode (FWD).
2. Junction temperature (T_{vj}) should not increase beyond T_{vjmax} rating.
3. Pulse width and repetition rate should be such that the device junction temperature (T_{vj}) dose not exceed T_{vjmax} 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. Typical value by using thermally conductive grease of λ=3.0 W/(m·K)/$D_{(C-S)}$=50 μm.
7. The base plate (mounting side) flatness measurement points (X, Y) are shown in the following figure.



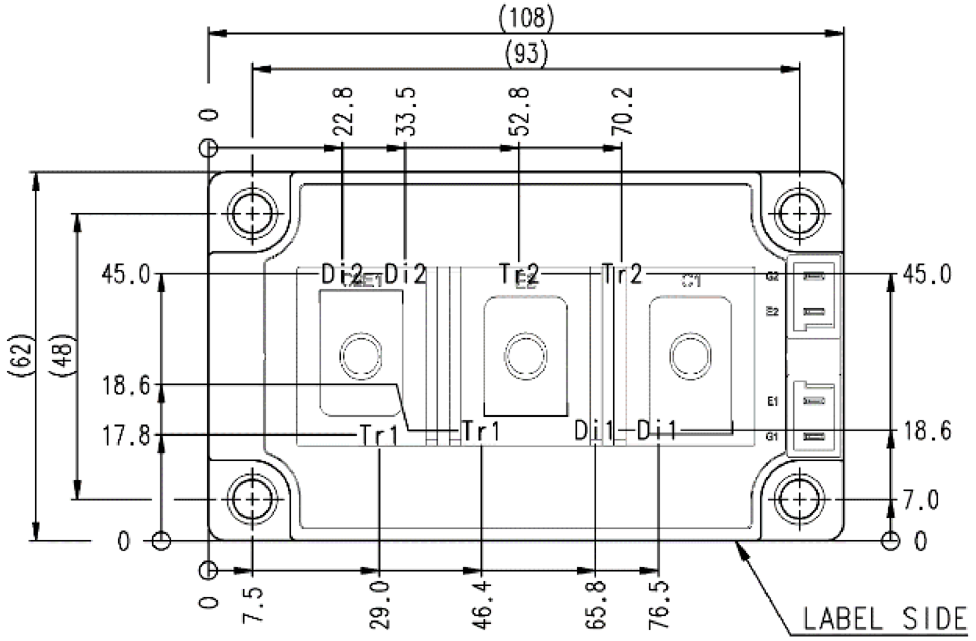
8. Long term performance related to thermal conductive grease (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under user's specific application conditions. Each temperature condition ($T_{vj\,max}$, $T_{vj\,op}$, $T_{C\,max}$)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

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{CC}	(DC) Supply voltage	Applied across C1-E2 terminals	-	1300	1500	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	-	10	Ω

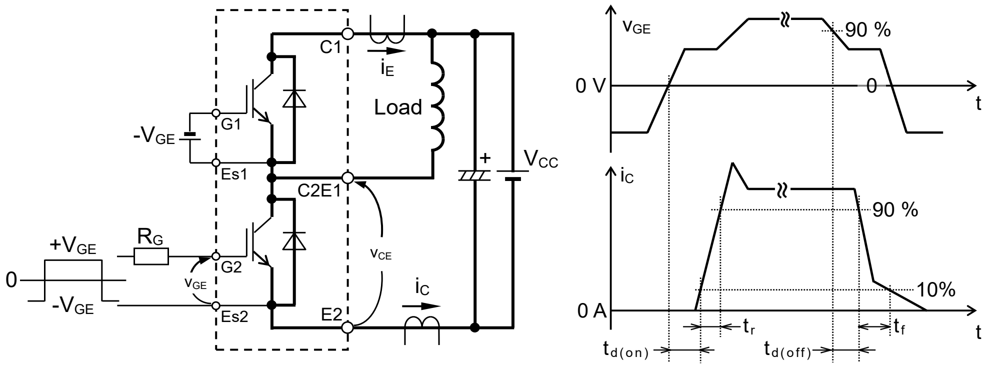
CHIP LOCATION (Top view)

Dimension in mm, tolerance: ±1 mm

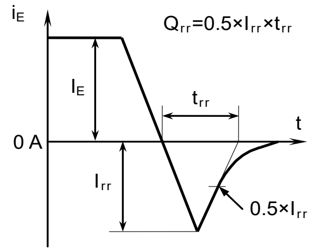


Tr1/Tr2: IGBT, Di1/Di2: FWD

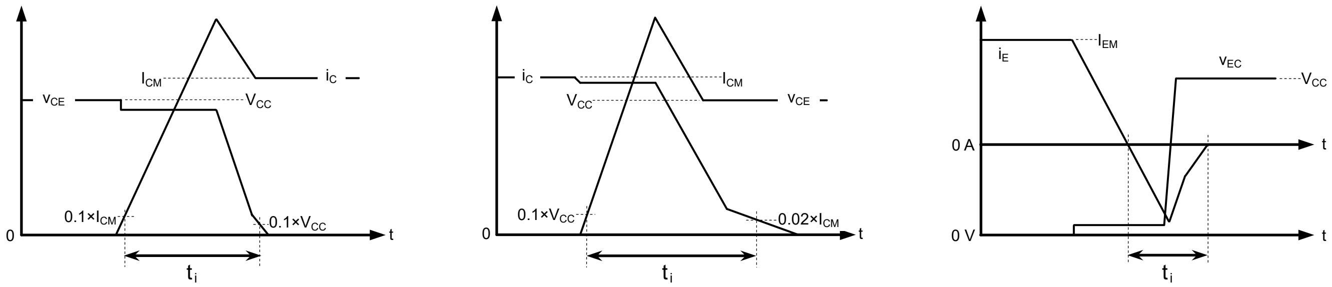
TEST CIRCUIT AND WAVEFORMS



Switching characteristics test circuit and waveforms



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

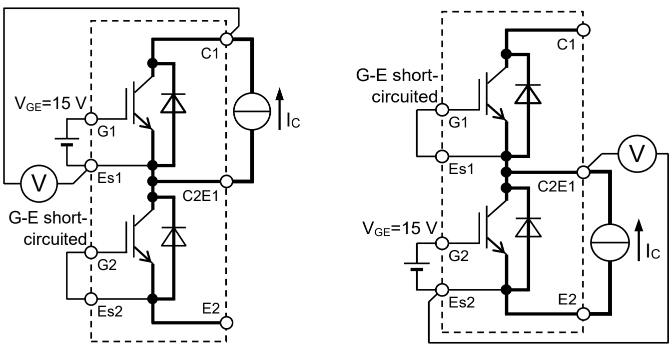


IGBT Turn-on switching energy

IGBT Turn-off switching energy

FWD Reverse recovery energy

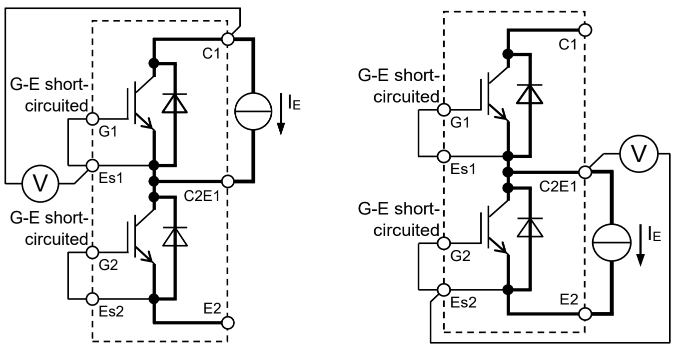
Switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)



Tr1

Tr2

V_{CEsat} characteristics test circuit



Di1

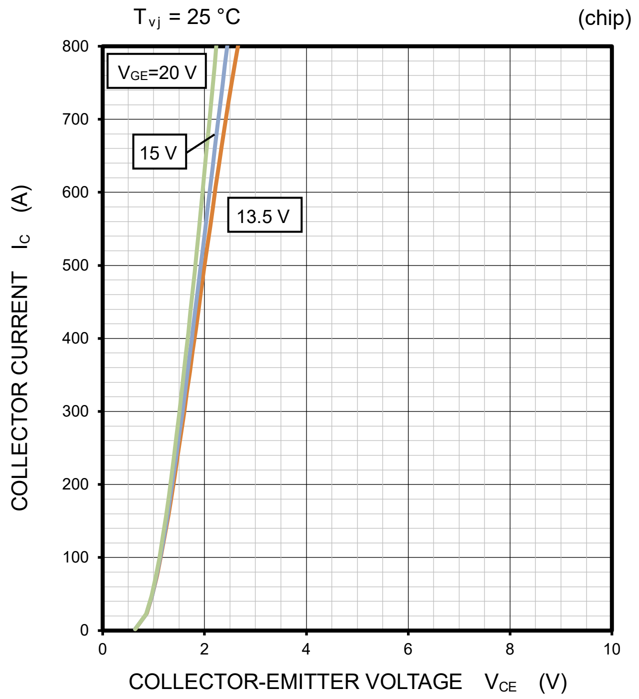
Di2

V_{EC} characteristics test circuit

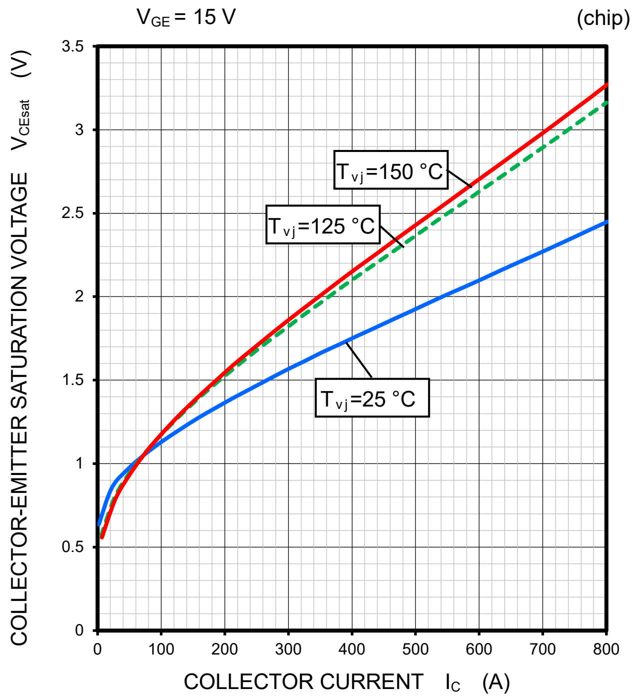
PERFORMANCE CURVES

INVERTER PART

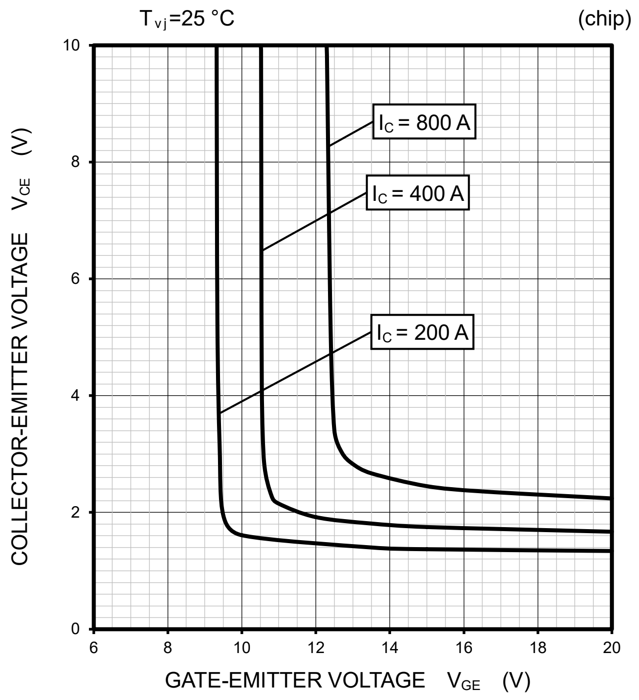
OUTPUT CHARACTERISTICS (TYPICAL)



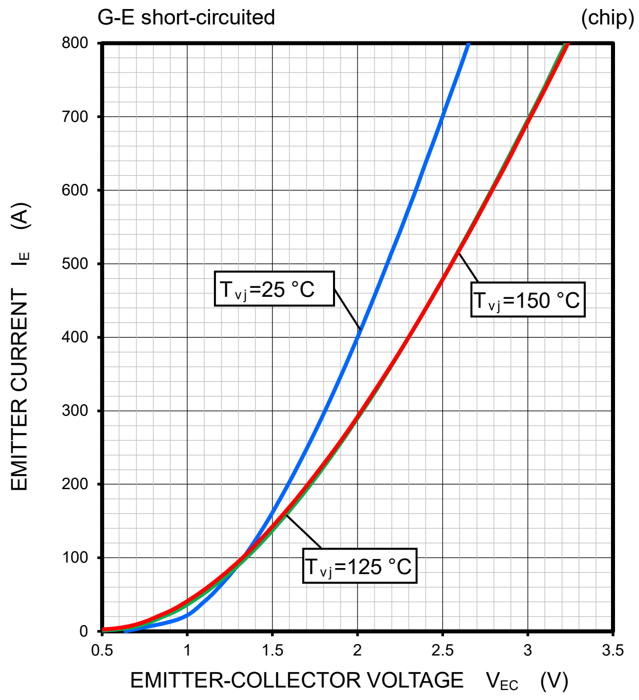
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER VOLTAGE CHARACTERISTICS (TYPICAL)



FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)

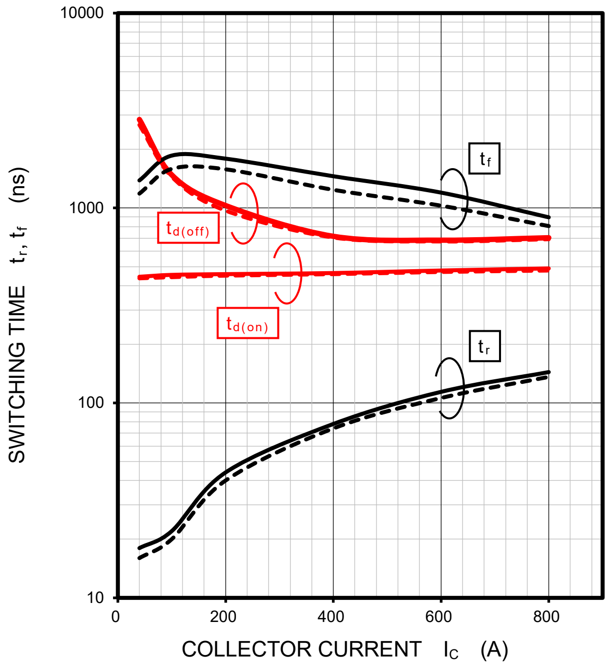


PERFORMANCE CURVES

INVERTER PART (continued)

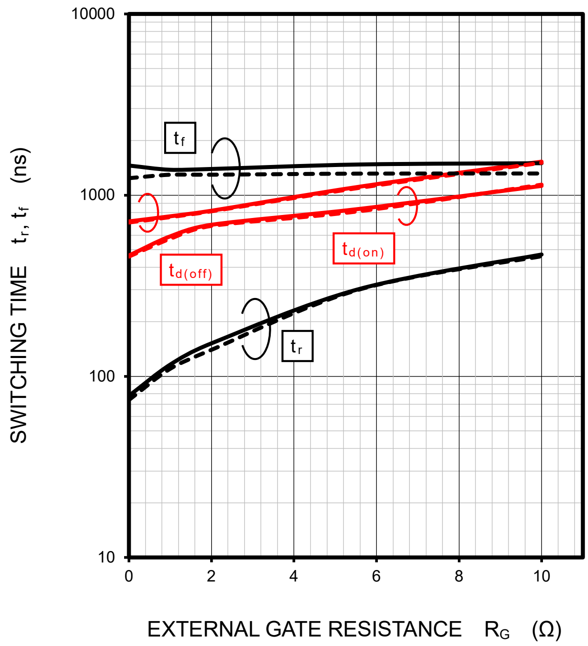
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC} = 1300 V, R_G = 0 Ω, V_{GE} = ±15 V, INDUCTIVE LOAD
———: T_{vj} = 150 °C, - - - - -: T_{vj} = 125 °C



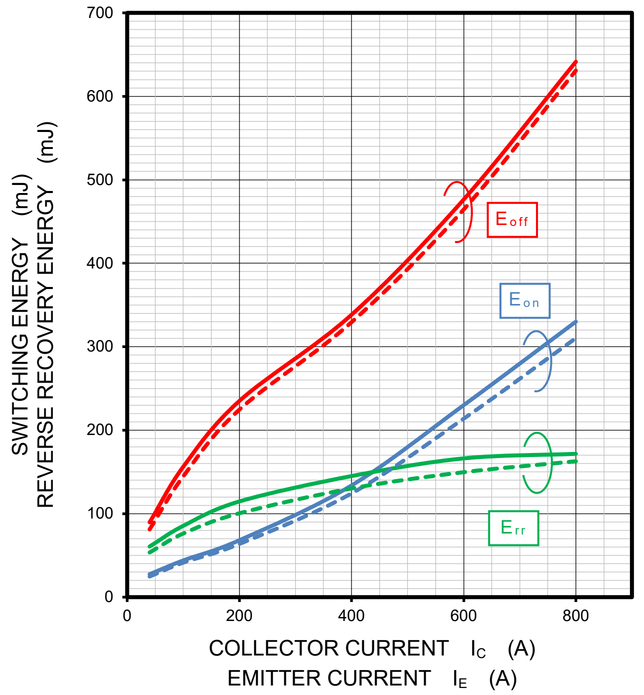
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC} = 1300 V, I_C = 400 A, V_{GE} = ±15 V, INDUCTIVE LOAD
———: T_{vj} = 150 °C, - - - - -: T_{vj} = 125 °C



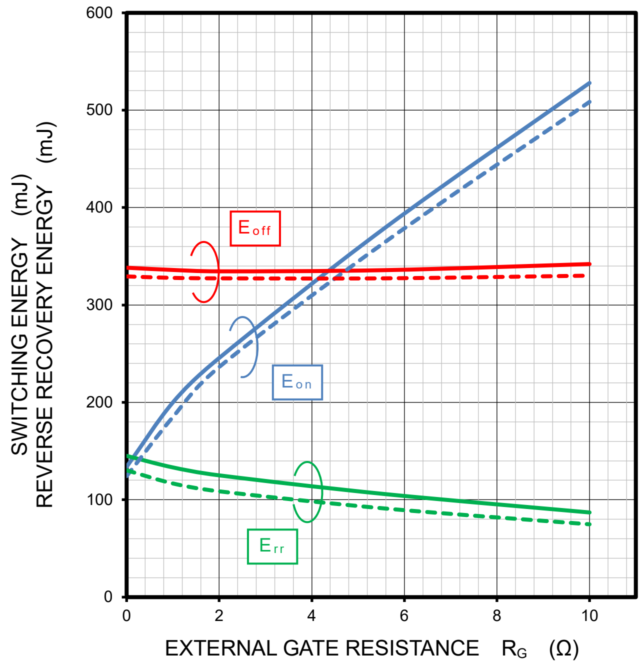
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC} = 1300 V, V_{GE} = ±15 V, R_G = 0 Ω, INDUCTIVE LOAD
———: T_{vj} = 150 °C, - - - - -: T_{vj} = 125 °C, PER PULSE



HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC} = 1300 V, V_{GE} = ±15 V, I_C = 400 A, INDUCTIVE LOAD
———: T_{vj} = 150 °C, - - - - -: T_{vj} = 125 °C, PER PULSE

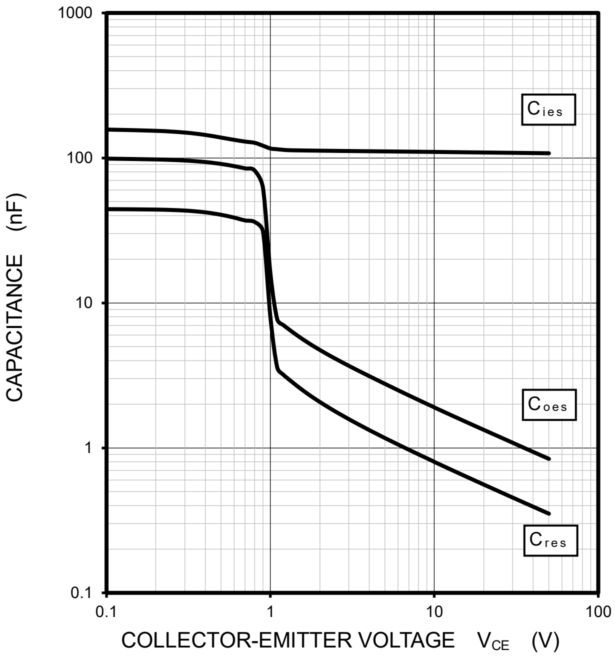


PERFORMANCE CURVES

INVERTER PART (continued)

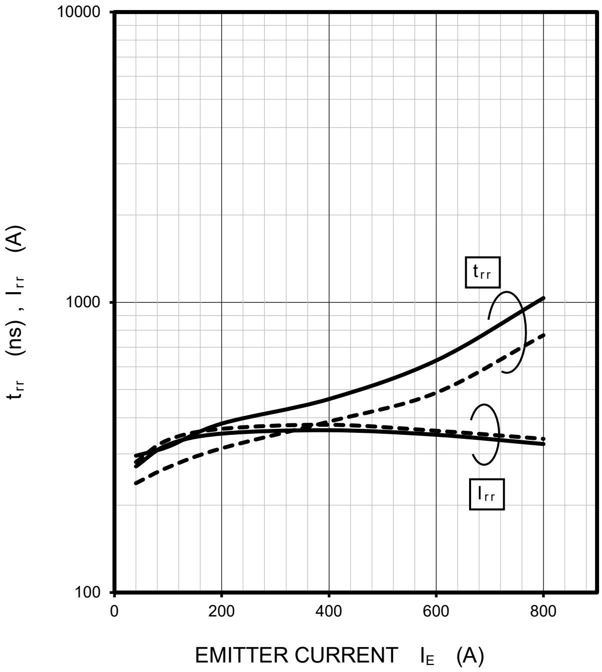
CAPACITANCE CHARACTERISTICS (TYPICAL)

G-E short-circuited, T_{vj} = 25 °C



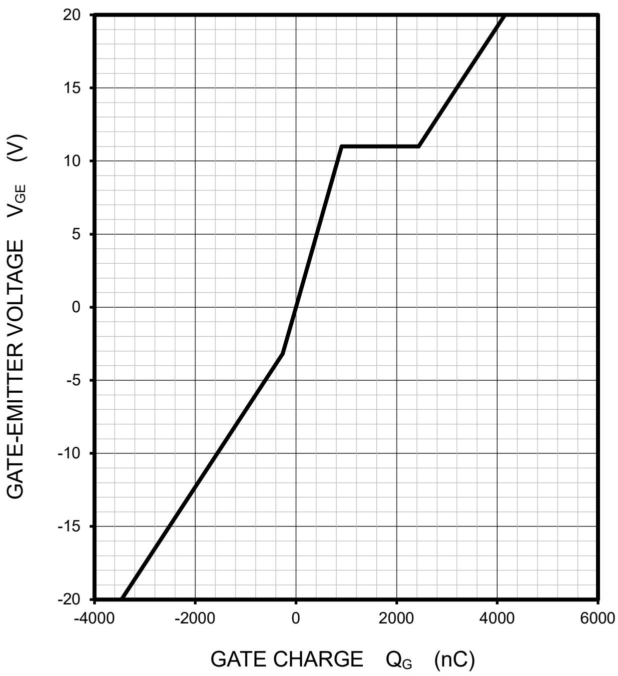
FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

V_{CC} = 1300 V, R_G = 0 Ω, V_{GE} = ±15 V, INDUCTIVE LOAD
———: T_{vj} = 150 °C, - - - - -: T_{vj} = 125 °C



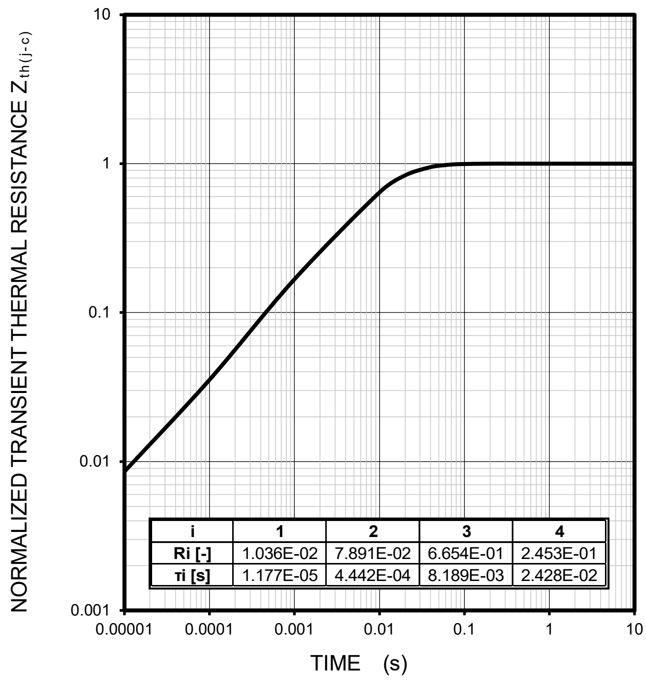
GATE CHARGE CHARACTERISTICS (TYPICAL)

V_{CC} = 1300 V, I_C = 400 A, T_{vj} = 25 °C



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, T_C = 25 °C
$R_{th(j-c)Q}$ = 35 K/kW, $R_{th(j-c)D}$ = 64 K/kW



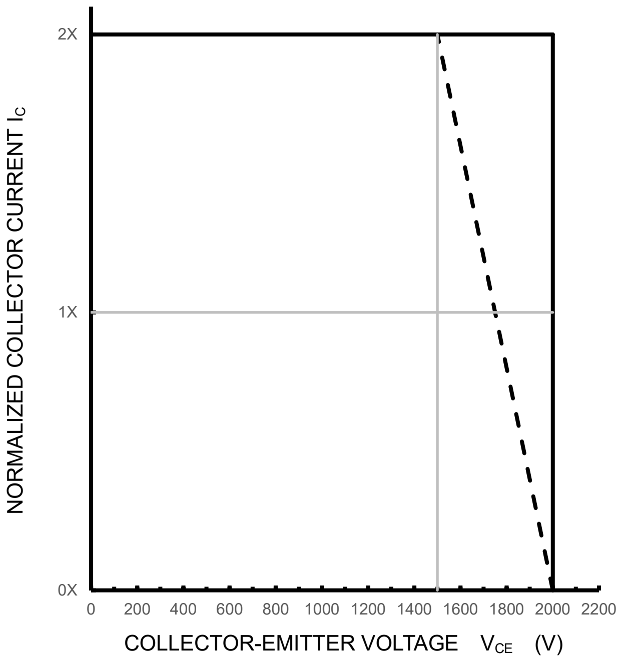
i	1	2	3	4
Ri [-]	1.036E-02	7.891E-02	6.654E-01	2.453E-01
τi [s]	1.177E-05	4.442E-04	8.189E-03	2.428E-02

PERFORMANCE CURVES

INVERTER PART (continued)

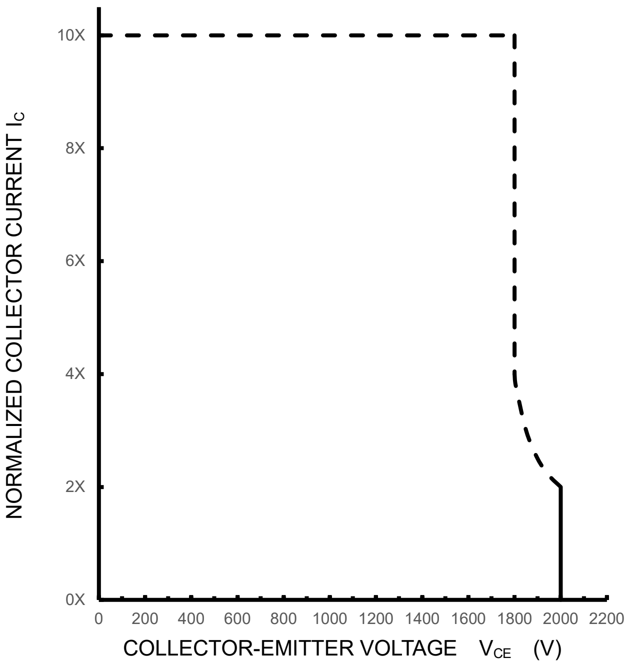
TURN-OFF SWITCHING SAFE OPERATIONG AREA (REVERSE BIAS SAFE OPERATING AREA) (MAXIMUM)

$V_{CC} \leq$ 1500 V, V_{GE} = ±15 V, $R_{G(off)}$ = 0~10 Ω,
———: T_{vj} = 25~150 °C (Normal load operations (Continuous)
- - - - - : T_{vj} = 175 °C (Unusual load operations (Limited period)



SHORT-CIRCUIT SAFE OPERATING AREA (MAXIMUM)

$V_{CC} \leq$ 1500 V, V_{GE} = ±15 V,
T_{vj} = 25~150 °C, $t_W \leq$ 6 μs, Non-Repetitive



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