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MITSUBISHI ELECTRIC

<IGBT Modules>

CM400DX-12A

HIGH POWER SWITCHING USE
INSULATED TYPE

dual switch (Half-Bridge)

Collector current I_C ..... 400 A
Collector-emitter voltage V_{CES} ..... 600 V
Maximum junction temperature T_{jmax} ..... 150 °C

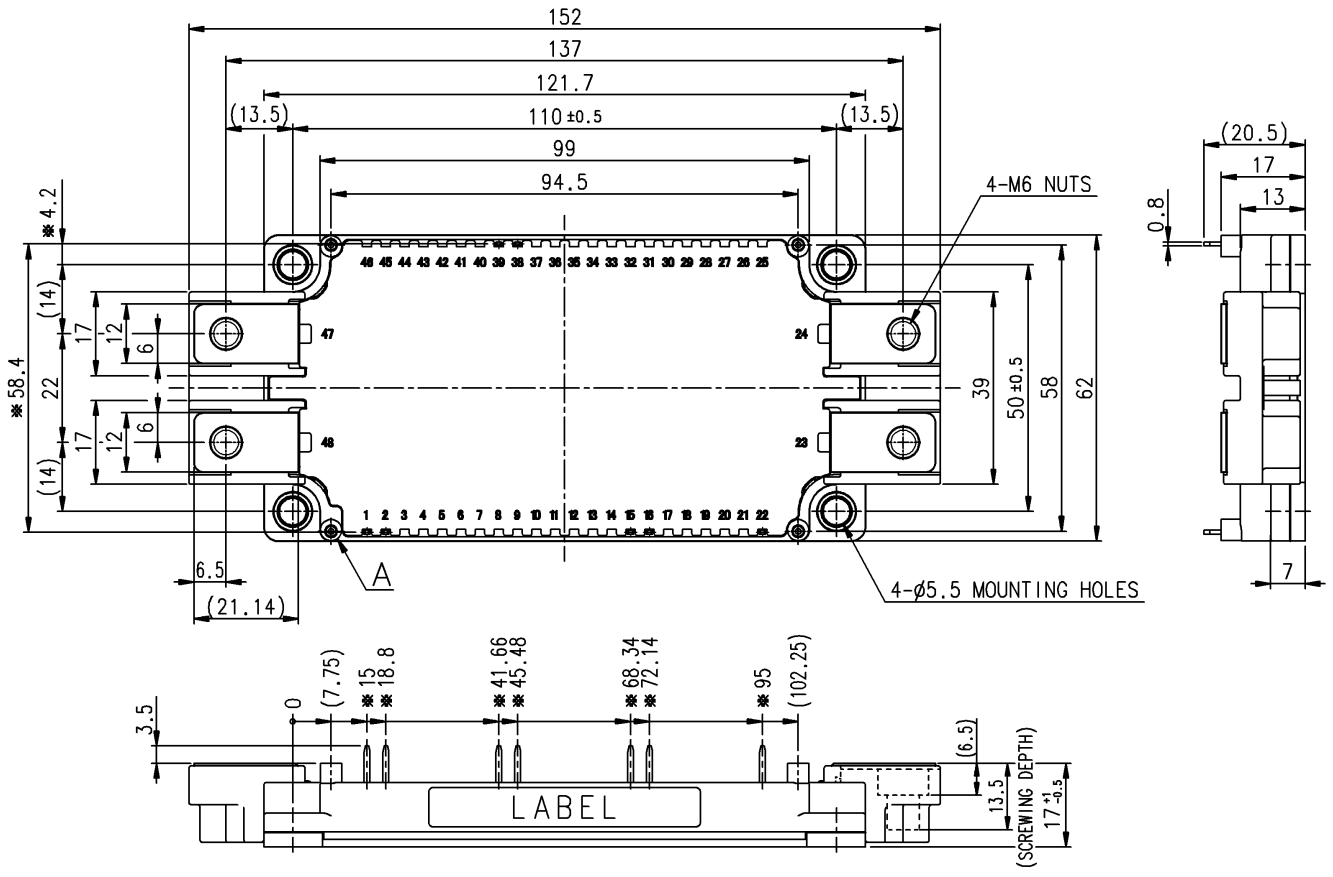
- Flat base Type
- Copper base plate (non-plating)
- RoHS Directive compliant
- Recognized under UL1557, File E323585

APPLICATION

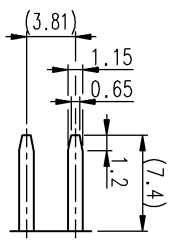
AC Motor Control, Motion/Servo Control, Power supply, etc.

OUTLINE DRAWING & INTERNAL CONNECTION

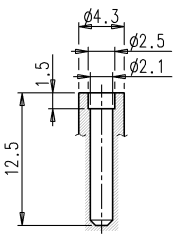
Dimension in mm



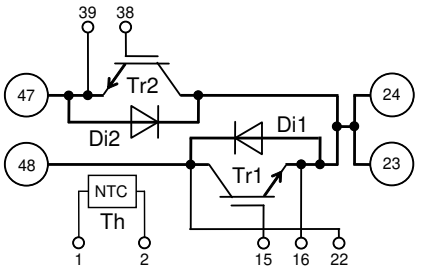
TERMINAL t=0.8



SECTION A



INTERNAL CONNECTION



Terminal code

1	TH1
2	TH2
15	G1
16	Es1
22	Cs1
23	C2E1
24	C2E1
38	G2
39	Es2
47	E2
48	C1

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

※: Dimensions with a Tolerance of ⊕ ø0.5

MAXIMUM RATINGS (T_j=25 °C, unless otherwise specified)

INVERTER PART IGBT/DIODE

Symbol	Item	Conditions	Rating	Unit
V_{CES}	Collector-emitter voltage	G-E short-circuited	600	V
V_{GES}	Gate-emitter voltage	C-E short-circuited	± 20	V
I_C	Collector current	DC, T_C=60 °C (Note2, 4)	400	A
I_{CRM}		Pulse, Repetitive (Note3)	800	
P_{tot}	Total power dissipation	T_C=25 °C (Note2, 4)	1340	W
I_E (Note1)	Emitter current	DC (Note2)	400	A
I_{ERM} (Note1)		Pulse, Repetitive (Note3)	800	

MODULE

Symbol	Item	Conditions	Rating	Unit
V_{isol}	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	2500	V
T_j	Junction temperature	-	-40 ~ +150	°C
T_{stg}	Storage temperature	-	-40 ~ +125	

ELECTRICAL CHARACTERISTICS (T_j=25 °C, unless otherwise specified)

INVERTER PART IGBT/DIODE

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 mA, V_{CE}=10 V		5	6	7	V
V_{CEsat}	Collector-emitter saturation voltage	I_C=400 A, V_{GE}=15 V (Note5)	T_j=25 °C	-	1.7	2.1	V
		Refer to the figure of test circuit	T_j=125 °C	-	1.9	-	
		I_C=400 A, V_{GE}=15 V, chip (Note5)		-	1.6	-	
C_{ies}	Input capacitance	V_{CE}=10 V, G-E short-circuited		-	-	50	nF
C_{oes}	Output capacitance			-	-	5.3	
C_{res}	Reverse transfer capacitance			-	-	1.6	
Q_G	Gate charge	V_{CC}=300 V, I_C=400 A, V_{GE}=15 V		-	1100	-	nC
$t_{d(on)}$	Turn-on delay time	V_{CC}=300 V, I_C=400 A, V_{GE}=±15 V, R_G=3.6 Ω, Inductive load		-	-	200	ns
t_r	Rise time			-	-	200	
$t_{d(off)}$	Turn-off delay time			-	-	400	
t_f	Fall time			-	-	600	
V_{EC} (Note1)	Emitter-collector voltage	I_E=400 A, G-E short-circuited (Note5)	T_j=25 °C	-	2.0	2.8	V
		Refer to the figure of test circuit	T_j=125 °C	-	1.95	-	
		I_E=400 A, G-E short-circuited, chip (Note5)		-	1.9	-	
t_{rr} (Note1)	Reverse recovery time	V_{CC}=300 V, I_E=400 A, V_{GE}=±15 V, R_G=3.6 Ω, Inductive load		-	-	200	ns
Q_{rr} (Note1)	Reverse recovery charge			-	11	-	µC
E_{on}	Turn-on switching energy per pulse	V_{CC}=300 V, I_C=I_E=400 A, V_{GE}=±15 V, R_G=3.6 Ω, T_j=125 °C, Inductive load		-	13.5	-	mJ
E_{off}	Turn-off switching energy per pulse			-	23	-	
E_{rr} (Note1)	Reverse recovery energy per pulse			-	3.8	-	mJ
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, T_C=25 °C (Note4)		-	1.1	-	mΩ
r_g	Internal gate resistance	Per switch, T_C=25 °C (Note4)		-	0	-	Ω

ELECTRICAL CHARACTERISTICS (cont.; T_j=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)	-	-	0.093	K/W
$R_{th(j-c)D}$		Junction to case, per Inverter DIODE (Note4)	-	-	0.16	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, per 1 module, Thermal grease applied (Note4, 7)	-	15	-	K/kW

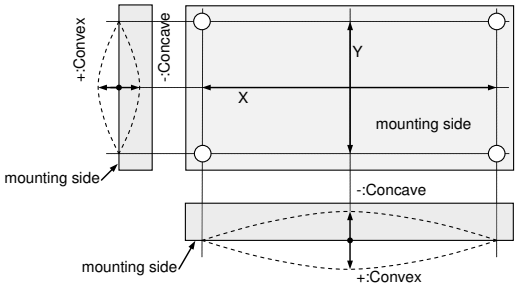
MECHANICAL CHARACTERISTICS

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	Terminal to terminal	11.55	-	-	mm
		Terminal to base plate	12.32	-	-	
d_a	Clearance	Terminal to terminal	10.00	-	-	mm
		Terminal to base plate	10.85	-	-	
m	mass	-	-	330	-	g
e_c	Flatness of base plate	On the centerline X, Y (Note8)	±0	-	+100	μm

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

2. Junction temperature (T_j) should not increase beyond T_{jmax} rating.
3. Pulse width and repetition rate should be such that the device junction temperature (T_j) dose not exceed T_{jmax} 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.
6. $B_{(25/50)} = \ln(\frac{R_{25}}{R_{50}}) / (\frac{1}{T_{25}} - \frac{1}{T_{50}})$,

   R_{25}: resistance at absolute temperature T_{25} [K]; T_{25}=25 [°C]+273.15=298.15 [K]
   R_{50}: resistance at absolute temperature T_{50} [K]; T_{50}=50 [°C]+273.15=323.15 [K]
7. Typical value is measured by using thermally conductive grease of λ=0.9 W/(m·K).
8. The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



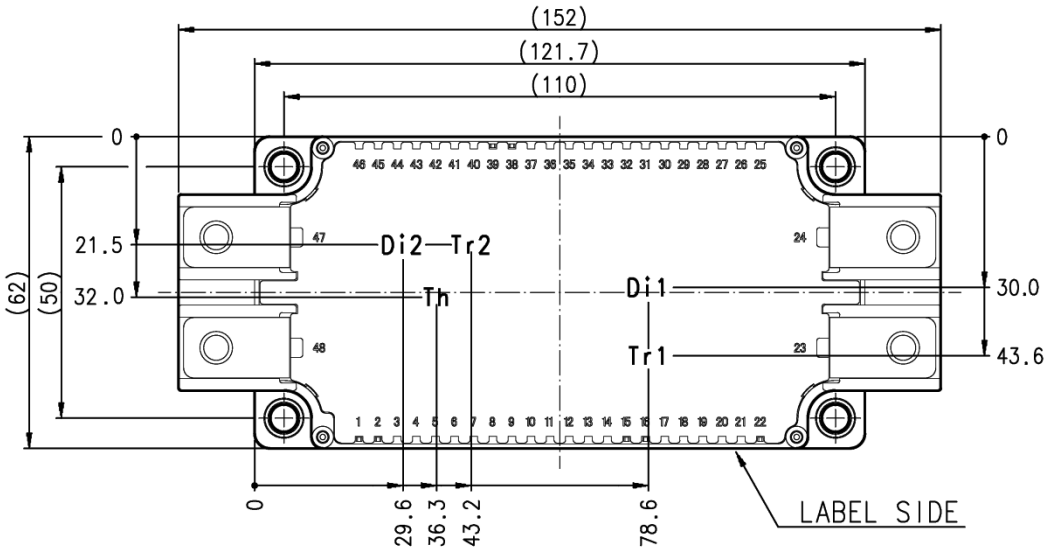
9. Use the following screws when mounting the printed circuit board (PCB) on the standoffs.
   "φ2.3×10 or φ2.3×12, B1 tapping screw"
   The length of the screw depends on the thickness (t1.6~t2.0) of the PCB.

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{CC}	(DC) Supply voltage	Applied across C1-E2 terminals	-	300	400	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

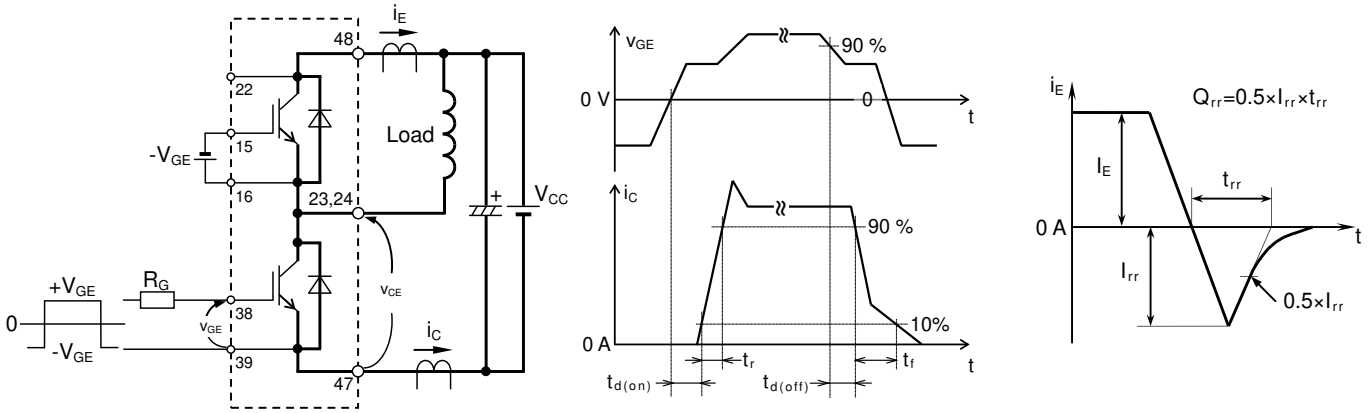
CHIP LOCATION (Top view)

Dimension in mm, tolerance: ±1 mm



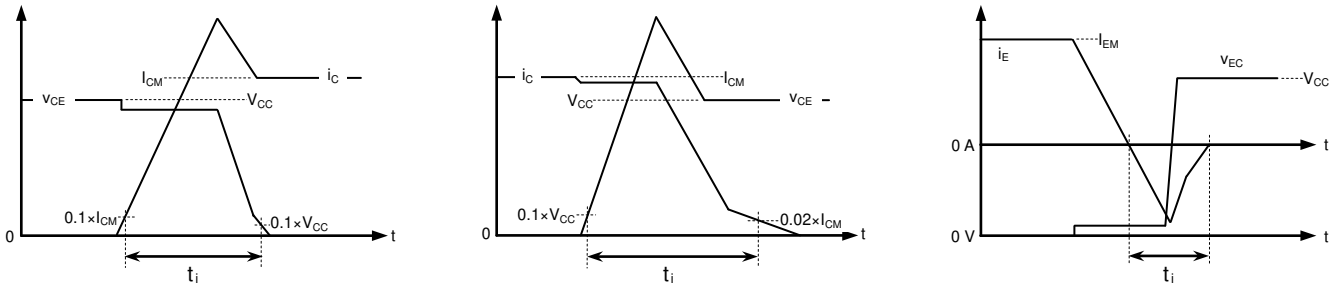
Tr1/Tr2: IGBT, Di1/Di2: DIODE, Th: NTC thermistor

TEST CIRCUIT AND WAVEFORMS



Switching test circuit and waveforms

t_{rr}, Q_{rr} test waveform



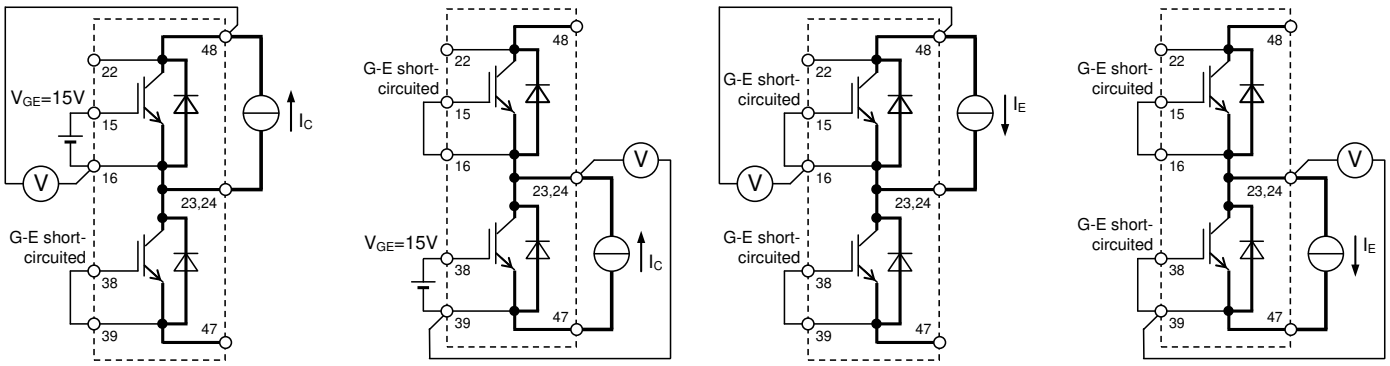
IGBT Turn-on switching energy

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)

TEST CIRCUIT



Tr1

Tr2

Di1

Di2

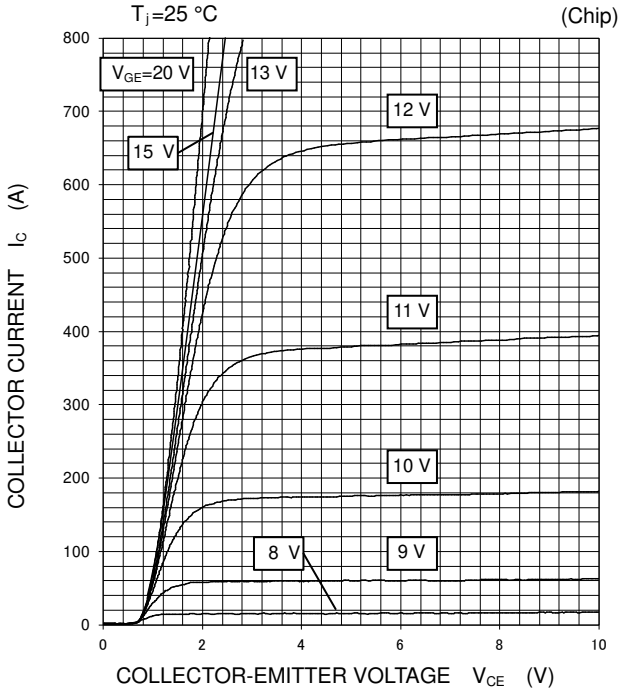
V_{CEsat} characteristics test circuit

V_{EC} characteristics test circuit

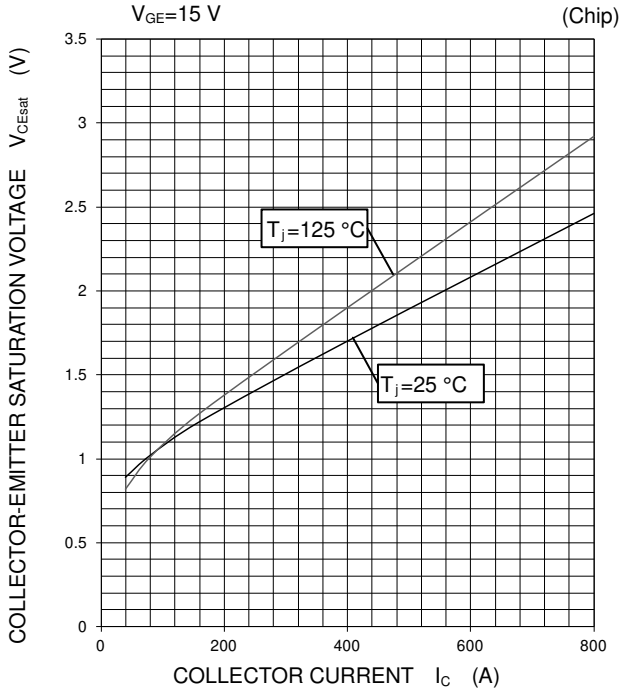
PERFORMANCE CURVES

INVERTER PART

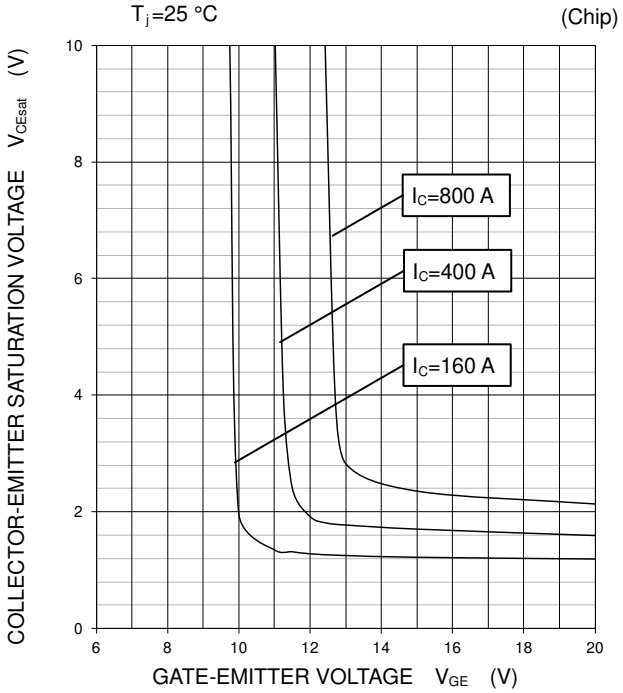
OUTPUT CHARACTERISTICS (TYPICAL)



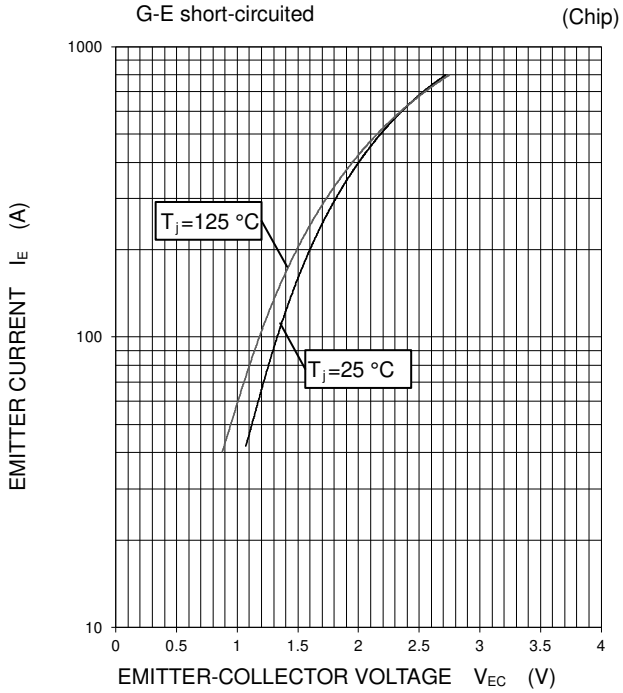
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)

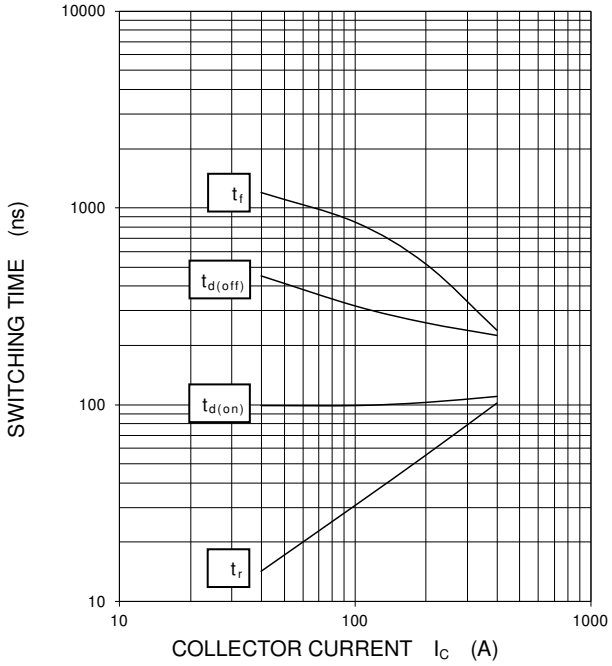


PERFORMANCE CURVES

INVERTER PART

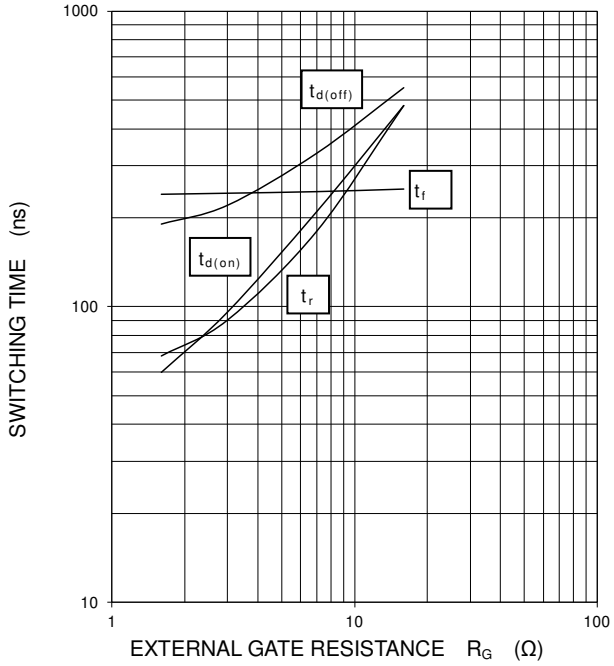
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

V_{CC}=300 V, V_{GE}=±15 V, R_G=3.6 Ω,
T_j=125 °C, INDUCTIVE LOAD



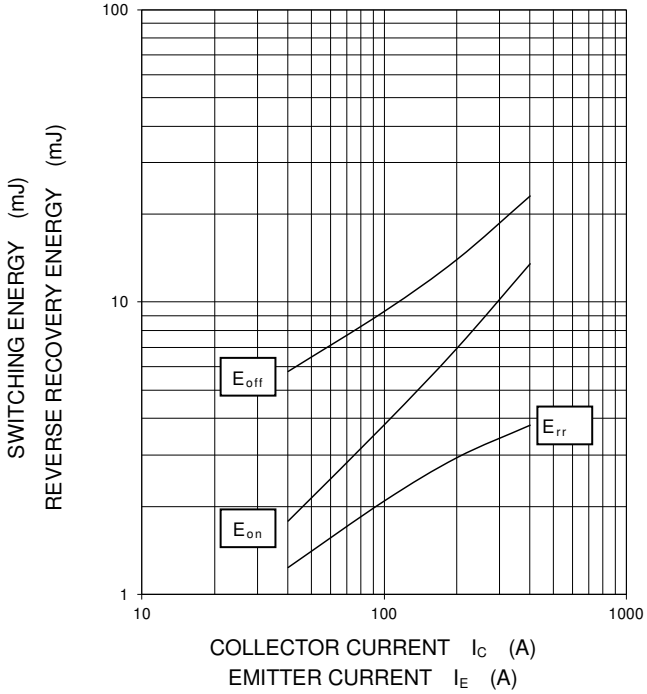
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

V_{CC}=300 V, V_{GE}=±15 V, I_C=400 A,
T_j=125 °C, INDUCTIVE LOAD



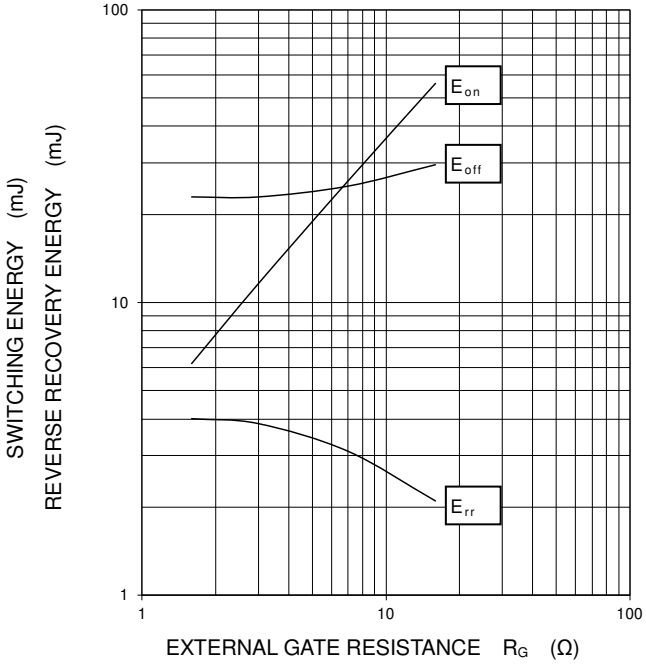
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

V_{CC}=300 V, V_{GE}=±15 V, R_G=3.6 Ω, T_j=125 °C
INDUCTIVE LOAD, PER PULSE



HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

V_{CC}=300 V, V_{GE}=±15 V, I_C/I_E=400 A, T_j=125 °C
INDUCTIVE LOAD, PER PULSE

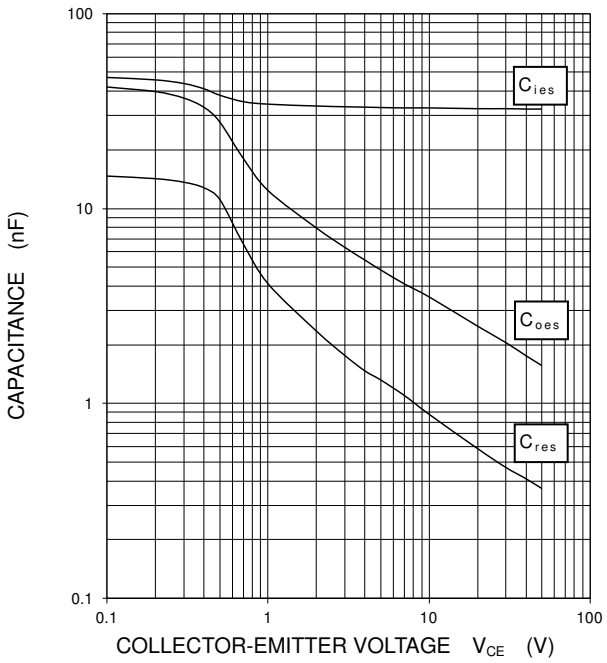


PERFORMANCE CURVES

INVERTER PART

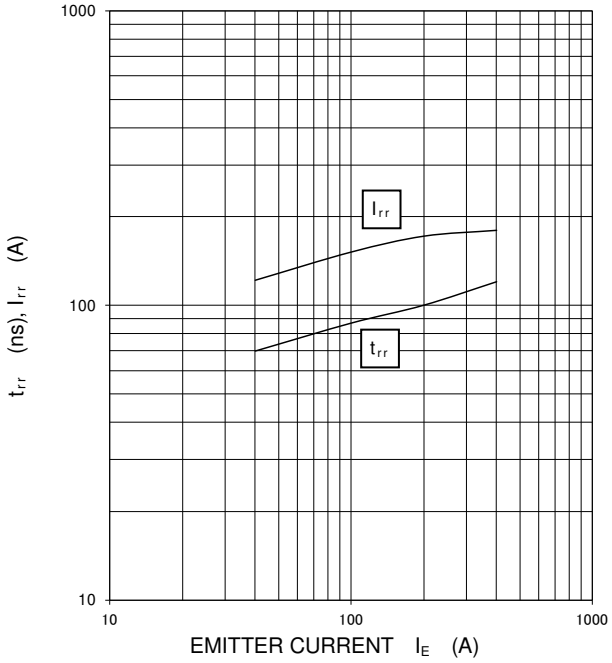
CAPACITANCE
CHARACTERISTICS
(TYPICAL)

G-E short-circuited, T_j=25 °C



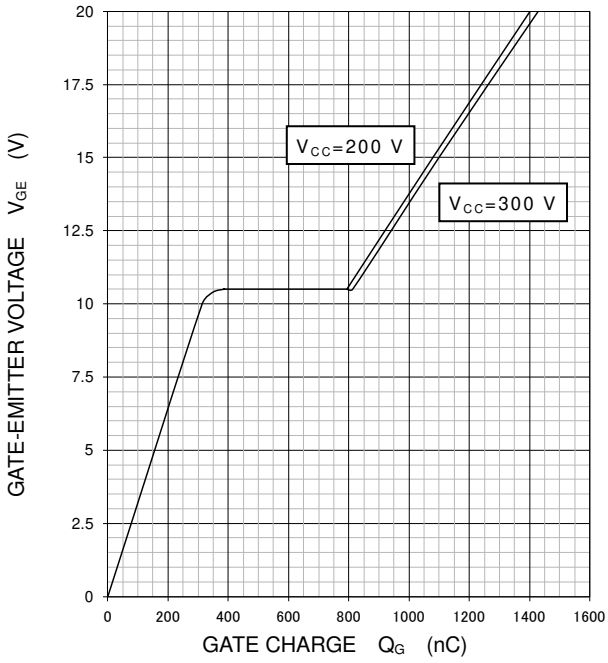
FREE WHEELING DIODE
REVERSE RECOVERY CHARACTERISTICS
(TYPICAL)

V_{CC}=300 V, V_{GE}=±15 V, R_G=3.6 Ω,
T_j=125 °C, INDUCTIVE LOAD



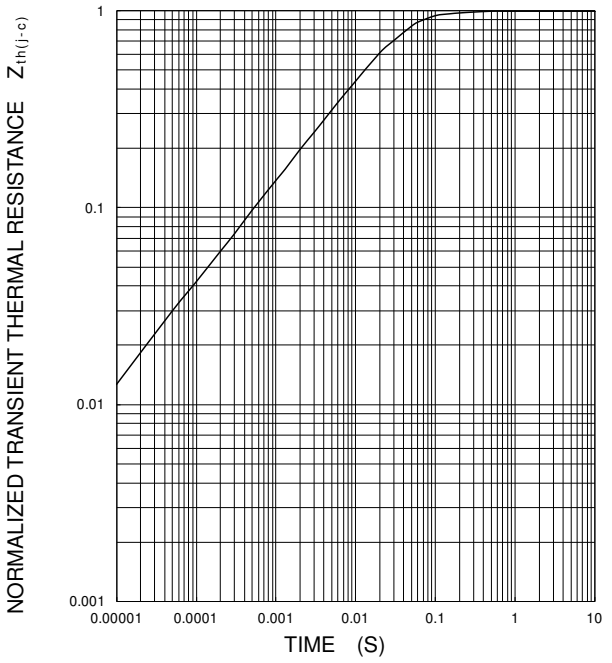
GATE CHARGE
CHARACTERISTICS
(TYPICAL)

I_C=400 A, T_j=25 °C



TRANSIENT THERMAL IMPEDANCE
CHARACTERISTIC S
(MAXIMUM)

Single pulse, T_C=25 °C
$R_{th(j-c)Q}$=0.093 K/W, $R_{th(j-c)D}$=0.16 K/W

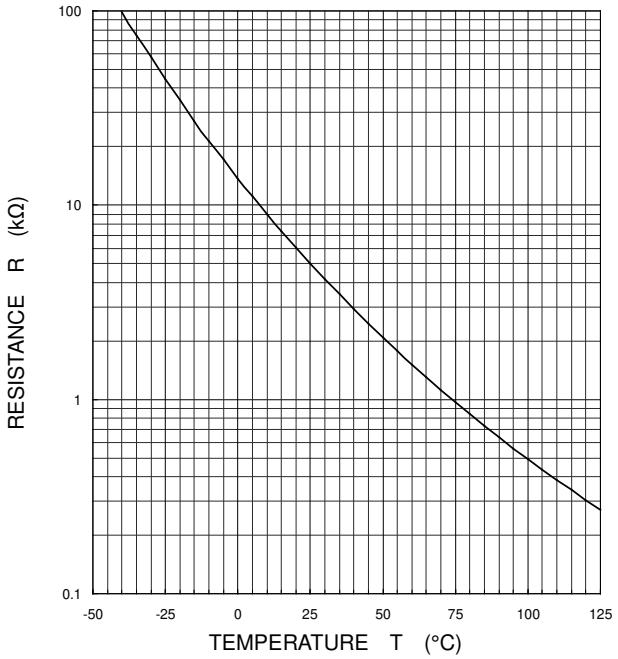


PERFORMANCE CURVES

NTC thermistor part

TEMPERATURE CHARACTERISTICS

(TYPICAL)



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