MITSUBISHI ELECTRIC

<Hybrid-SiC Modules>

CMH400HC6-24NFM

HIGH POWER SWITCHING USE
INSULATED TYPE

single switch

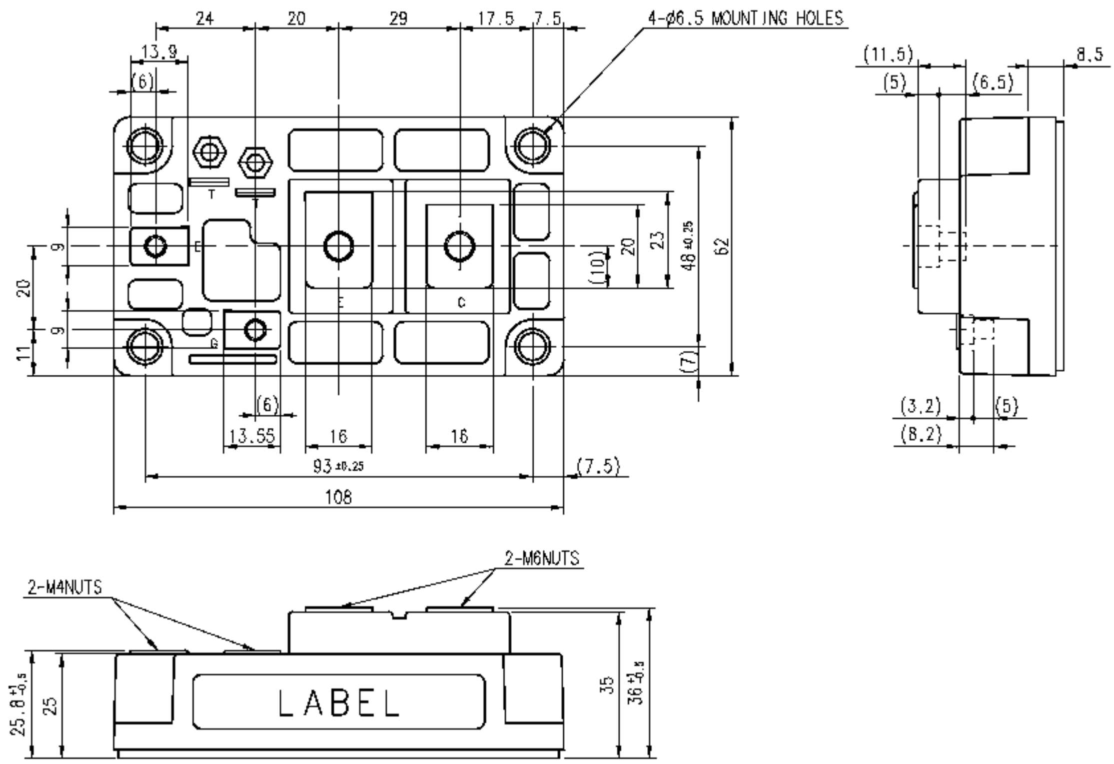
- Collector current I_C .... 400 A
- Collector-emitter voltage V_{CES} .... 1200 V
- Maximum junction temperature T_{jmax} .... 150 °C
- ●Silicon IGBT + Silicon Carbide Schottky Barrier Diode
- ●Flat base Type
- ●Copper base plate
- ●RoHS Directive compliant
- ●Recognized under UL1557, File E323585

APPLICATION

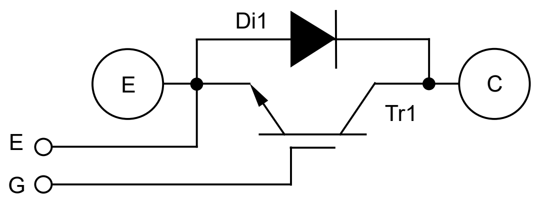
High frequency switching use(30kHz to 60kHz)
Gradient magnetic power supply, Induction heating, etc.

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

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

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=25 °C (Note2, 4)	400	A
I_{CRM}		Pulse, Repetitive (Note3)	800	
P_{tot}	Total power dissipation	T_C=25 °C (Note2, 4)	2715	W
I_E (Note1)	Emitter current	DC, T_C=25 °C (Note2, 4)	400	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_j	Junction temperature	- (Note8)	-40 ~ +150	°C
T_{stg}	Storage temperature	-	-40 ~ +125	

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

Symbol	Item	Conditions		Limits			Unit
				Min.	Typ.	Max.	
I_{CES}	Collector-emitter cut-off current	V_{CE}=V_{CES}, G-E short-circuited		-	-	20.0	mA
I_{GES}	Gate-emitter leakage current	V_{GE}=V_{GES}, C-E short-circuited		-	-	1.4	μA
$V_{GE(th)}$	Gate-emitter threshold voltage	I_C=40 mA, V_{CE}=10 V		4.5	6.0	7.5	V
V_{CEsat}	Collector-emitter saturation voltage	I_C=400 A, V_{GE}=15 V (Note5)	T_j=25 °C	-	3.0	4.5	V
		Refer to the figure of test circuit	T_j=125 °C	-	3.0	-	
C_{ies}	Input capacitance	V_{CE}=10 V, G-E short-circuited		-	-	63	nF
C_{oes}	Output capacitance			-	-	5.3	
C_{res}	Reverse transfer capacitance			-	-	1.2	
Q_G	Gate charge	V_{CC}=600 V, I_C=400 A, V_{GE}=15 V		-	1800	-	nC
$t_{d(on)}$	Turn-on delay time	V_{CC}=600 V, I_C=400 A, V_{GE}=±15 V,		-	-	300	ns
t_r	Rise time			-	-	200	
$t_{d(off)}$	Turn-off delay time	R_G=3.0 Ω, Inductive load		-	-	500	
t_f	Fall time			-	-	200	
V_{EC} (Note1)	Emitter-collector voltage	I_E=400 A, G-E short-circuited (Note5)	T_j=25 °C	-	1.7	2.2	V
		Refer to the figure of test circuit	T_j=125 °C	-	2.1	-	
Q_C (Note1)	Collector - emitter charge	V_{CC}=600 V, I_E=100 A, V_{GE}=±15 V, R_G=3.0 Ω, Inductive load		-	1.5	-	μC
E_{on}	Turn-on switching energy per pulse	V_{CC}=600 V, I_C/I_E=400 A,		-	10.0	-	mJ
E_{off}	Turn-off switching energy per pulse	V_{GE}=±15 V, R_G=3.0 Ω,		-	28.0	-	
E_{rec} (Note1)	Reverse energy per pulse	T_j=125 °C, Inductive load		-	0.7	-	mJ
r_g	Internal gate resistance	Per switch		-	0.75	-	Ω

THERMAL RESISTANCE CHARACTERISTICS (per module)

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance	Junction to case (Note4)	-	-	46	K/kW
$R_{th(j-c)D}$		Junction to case (Note4)	-	-	123	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, Thermal grease applied (Note4, 6, 8)	-	10	-	K/kW

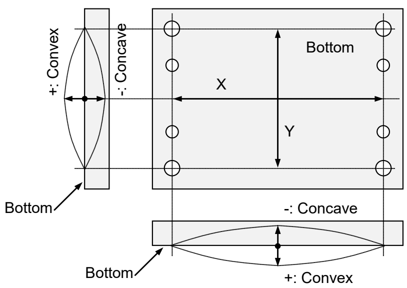
Caution; No short-circuit capability is designed.

MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions		Limits			Unit
				Min.	Typ.	Max.	
M_t	Mounting torque	Main terminals	M 6 screw	1.96	2.45	2.94	N·m
M_t	Mounting torque	G/E auxiliary terminals	M 4 screw	0.98	1.18	1.47	N·m
M_s	Mounting torque	Mounting to heat sink	M 6 screw	1.96	2.45	2.94	N·m
m	mass	-		-	480	-	g
e_c	Flatness of base plate	On the centerline X (Note7)		0	-	100	μm
		On the centerline Y (Note7)		0	-	100	

*: 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 (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. Typical value is measured by using thermally conductive grease of λ=0.9 W/(m·K).
7. The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



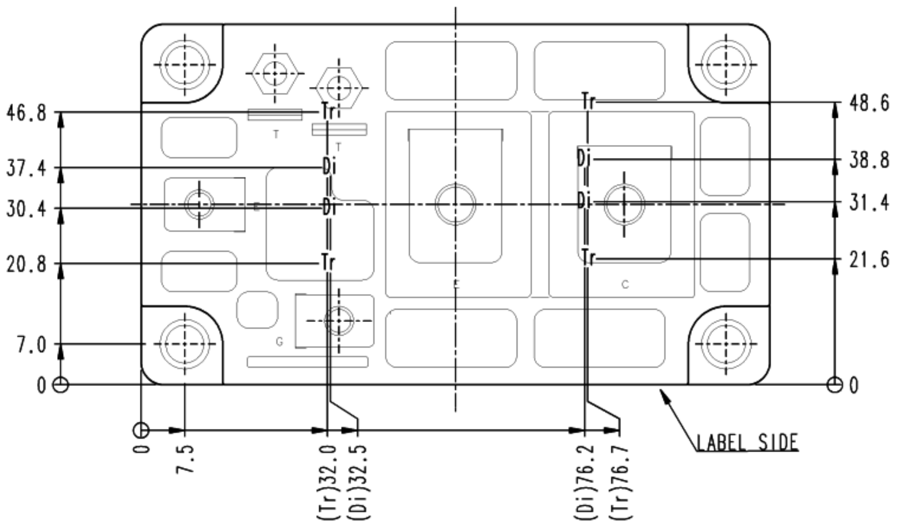
8. Long term performance related to thermal conductive material such as thermal grease (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under your specific application conditions. Temperature condition (Tj) must be maintained 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	-	600	800	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	0.78	-	7.8	Ω

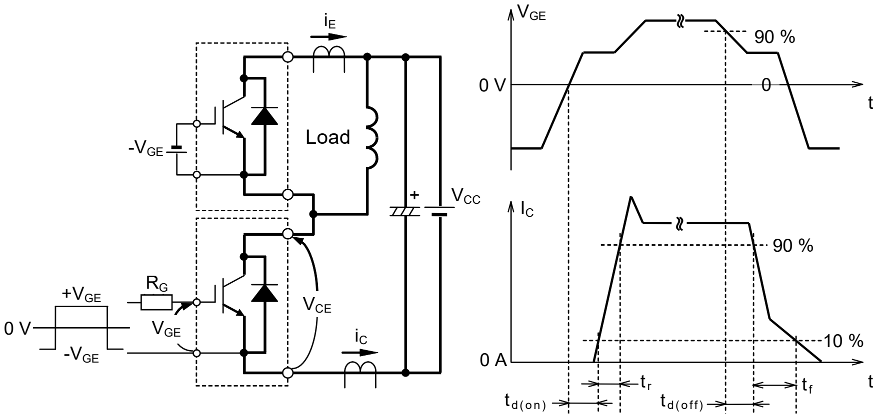
CHIP LOCATION (Top view)

Dimension in mm, tolerance: ±1 mm

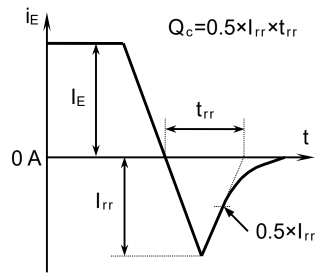


Tr: IGBT, Di: DIODE

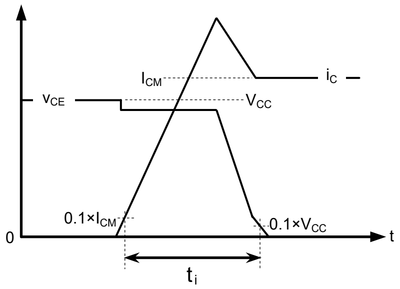
TEST CIRCUIT AND WAVEFORMS



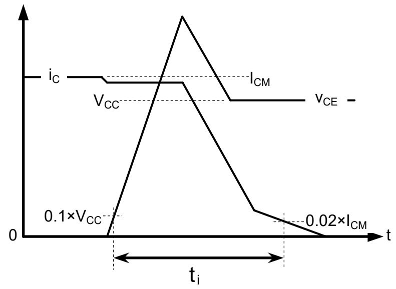
Switching test circuit and waveforms



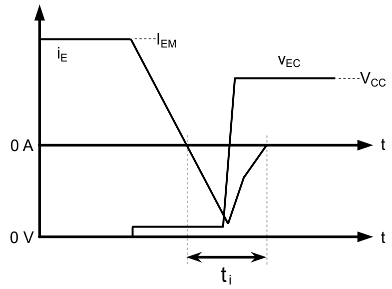
trr, Qc test waveform



IGBT Turn-on switching energy



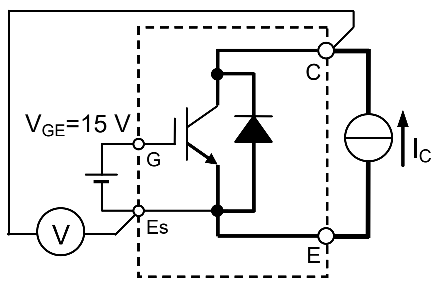
IGBT Turn-off switching energy



DIODE Reverse recovery energy

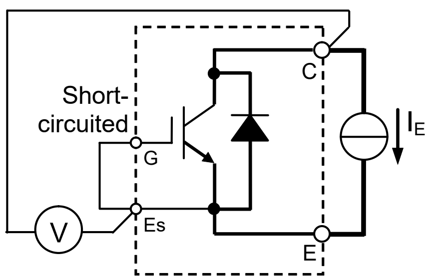
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

TEST CIRCUIT



Tr

V_{CEsat} characteristics test circuit

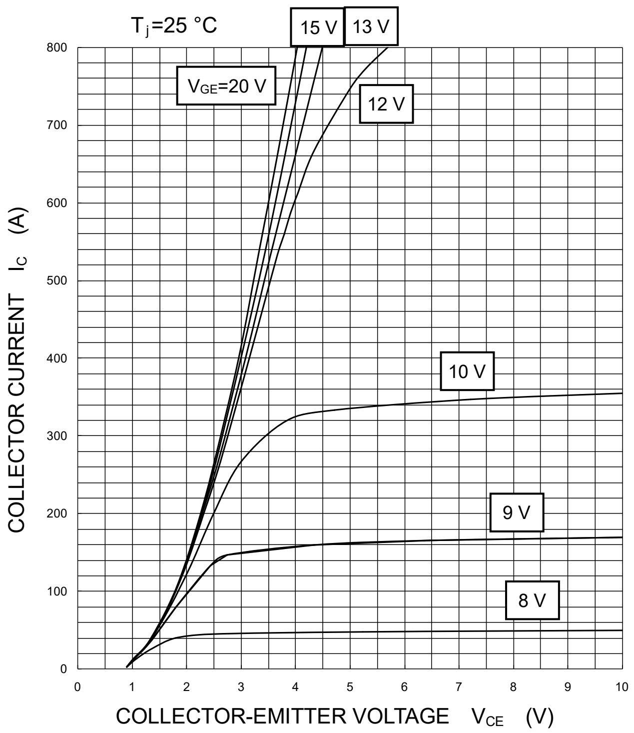


Di

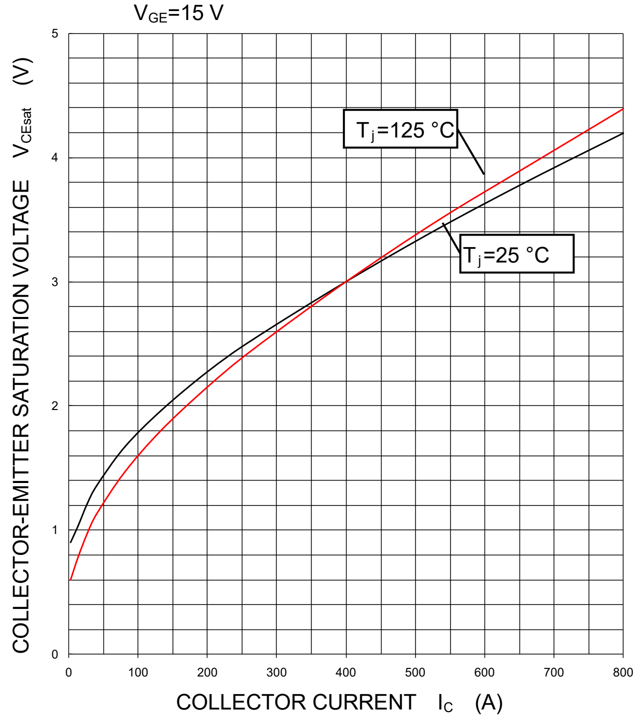
V_{EC} characteristics test circuit

PERFORMANCE CURVES

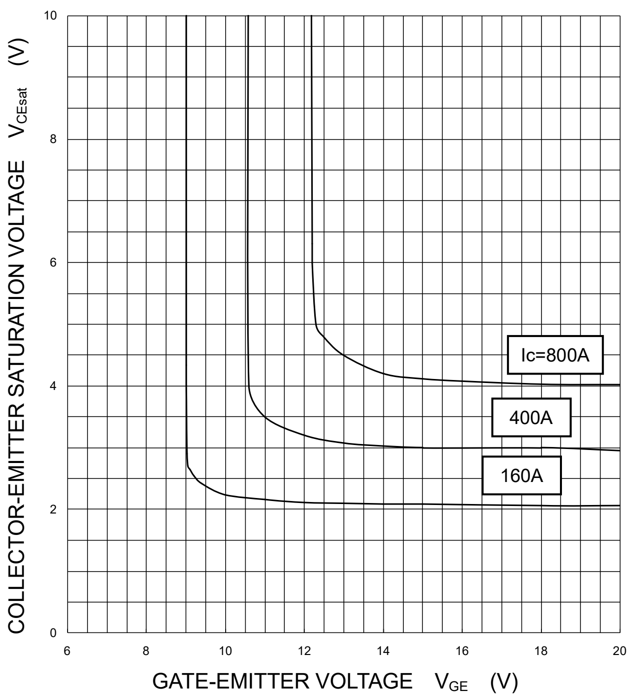
OUTPUT CHARACTERISTICS (TYPICAL)



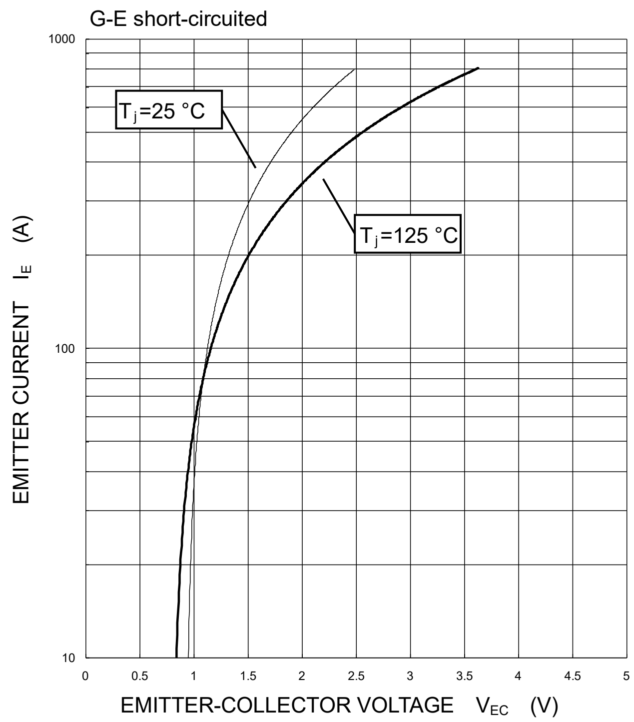
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



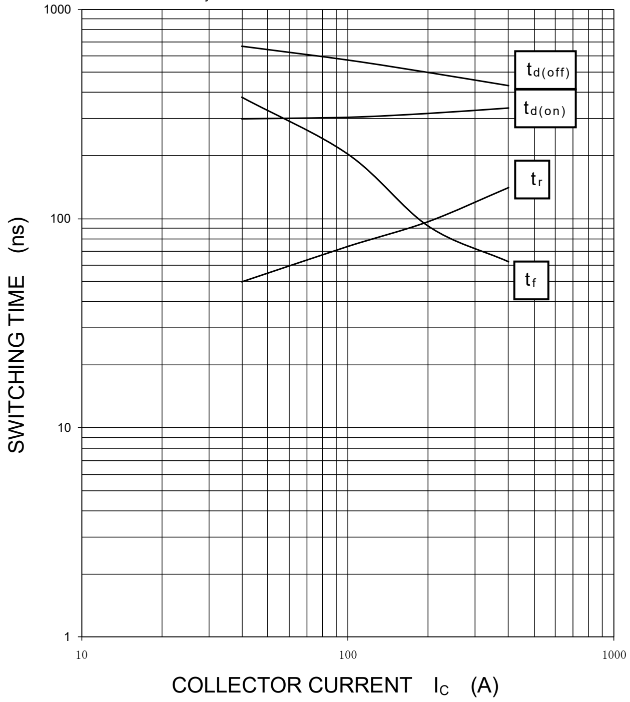
FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



PERFORMANCE CURVES

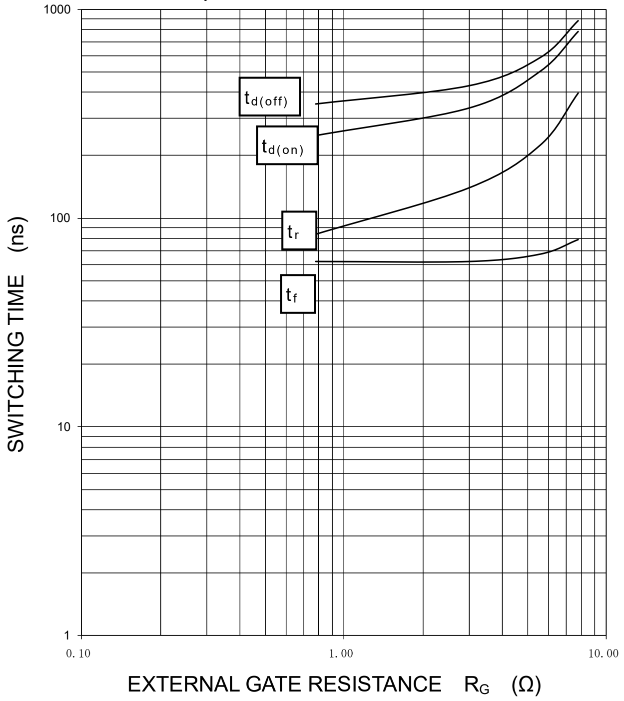
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

V_{CC}=600 V, V_{GE}=±15 V, R_G=3.0 Ω,
T_j=125 °C, INDUCTIVE LOAD



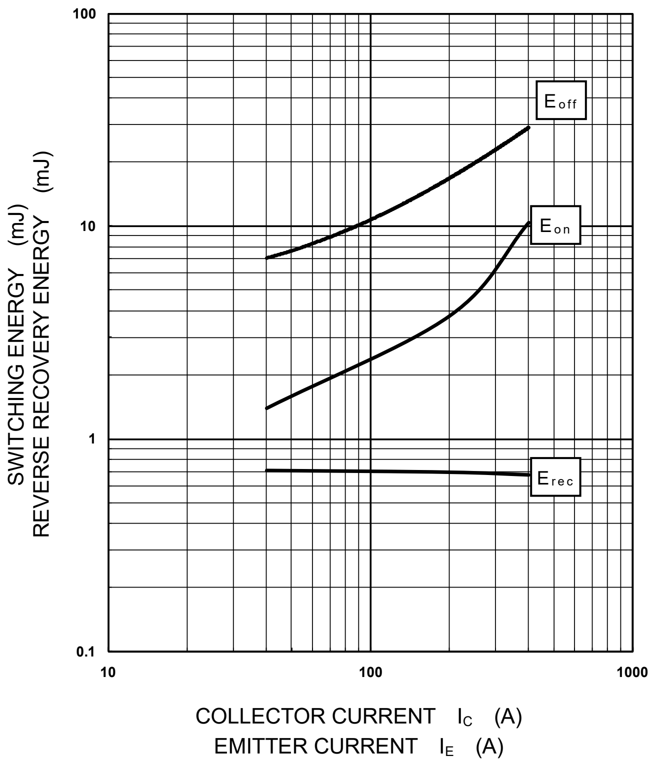
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

V_{CC}=600 V, V_{GE}=±15 V, I_C=400 A,
T_j=125 °C, INDUCTIVE LOAD



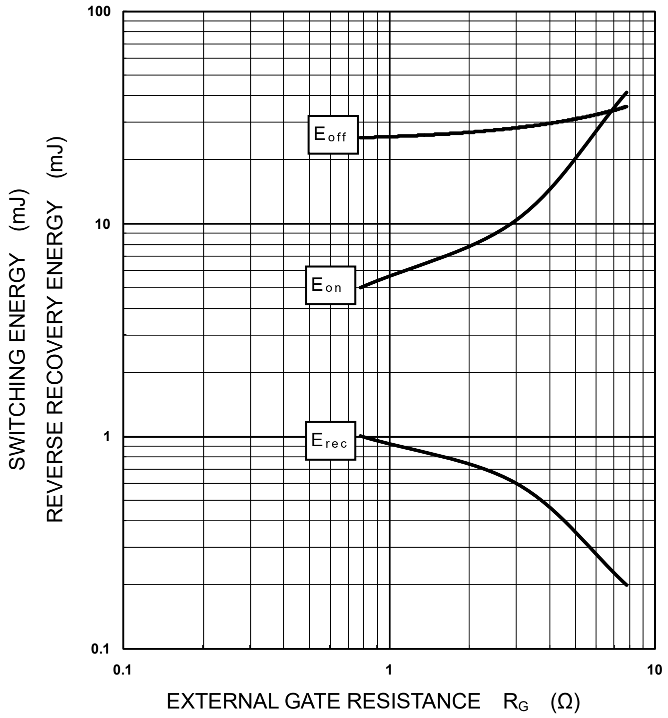
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

V_{CC}=600 V, V_{GE}=±15 V, R_G=3.0 Ω, T_j=125 °C,
INDUCTIVE LOAD, PER PULSE



HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

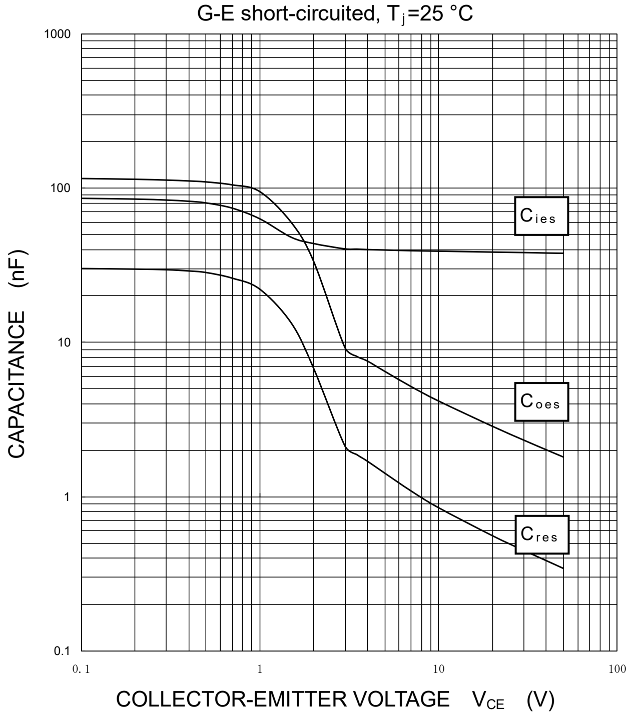
V_{CC}=600 V, V_{GE}=±15 V, I_C/I_E=400 A, T_j=125 °C,
INDUCTIVE LOAD, PER PULSE



PERFORMANCE CURVES

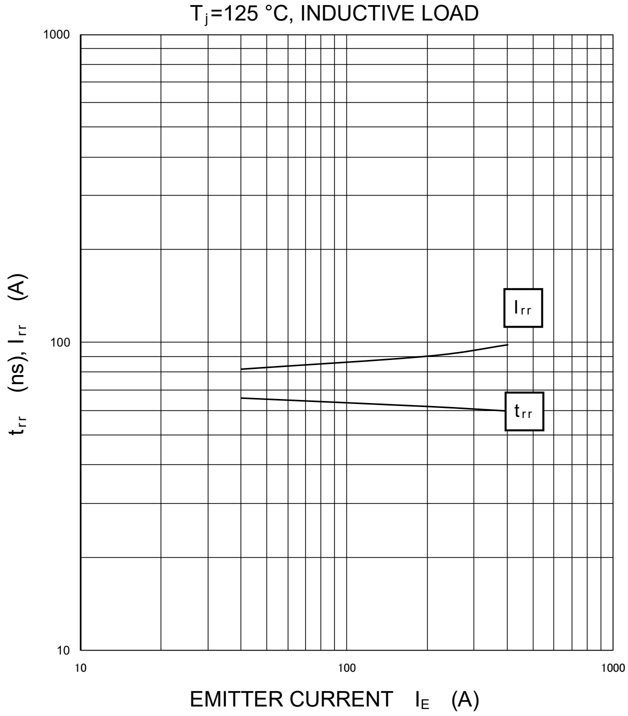
CAPACITANCE CHARACTERISTICS (TYPICAL)

G-E short-circuited, T_j=25 °C



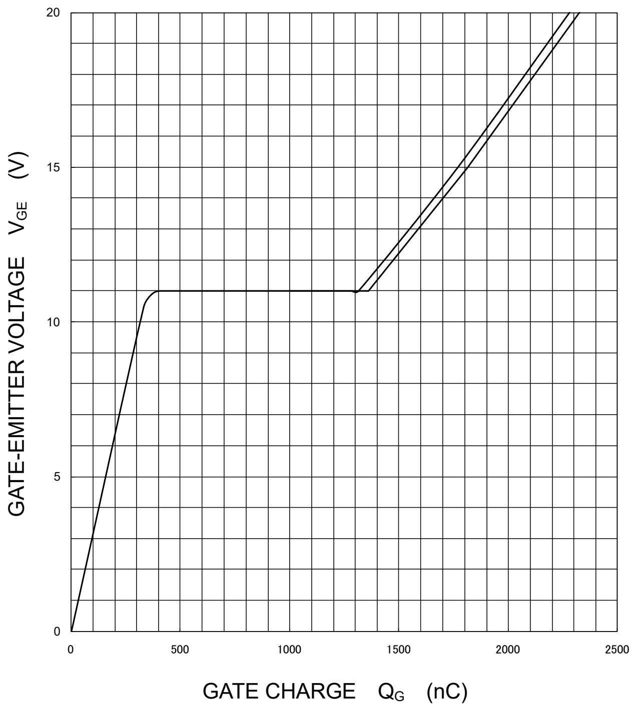
FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

V_{CC}=600 V, V_{GE}=±15 V, R_G=3.0 Ω,
T_j=125 °C, INDUCTIVE LOAD



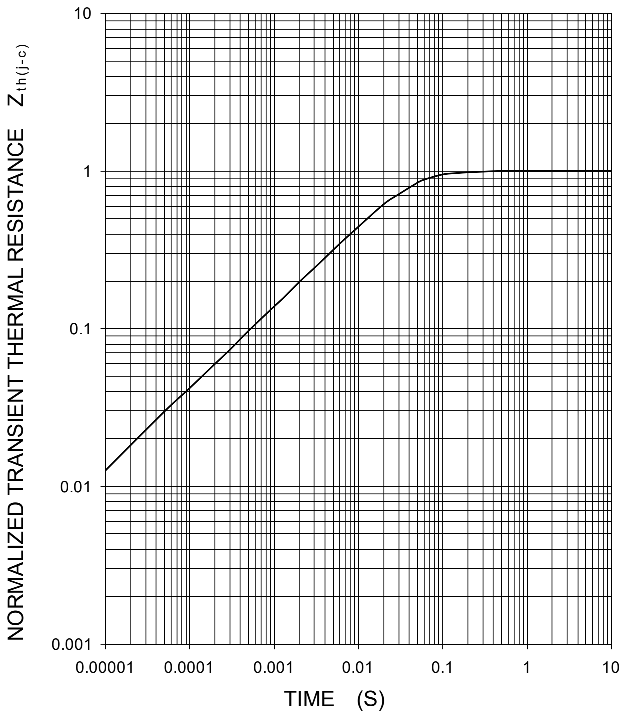
GATE CHARGE CHARACTERISTICS (TYPICAL)

I_C=400 A, T_j=25 °C



TRANSIENT THERMAL IMPEDANCE CHARACTERISTIC S (MAXIMUM)

Single pulse, T_C=25 °C
$R_{th(j-c)Q}$=46 K/kW, $R_{th(j-c)D}$=123 K/kW



Note: The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

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