

<Hybrid-SiC Modules>

# CMH400DU-24NFH

HIGH POWER SWITCHING USE  
INSULATED TYPE



dual switch (Half-Bridge)

Collector current  $I_C$  ..... 4 0 0 A  
 Collector-emitter voltage  $V_{CES}$  ..... 1 2 0 0 V  
 Maximum junction temperature  $T_{jmax}$  ..... 1 5 0 °C

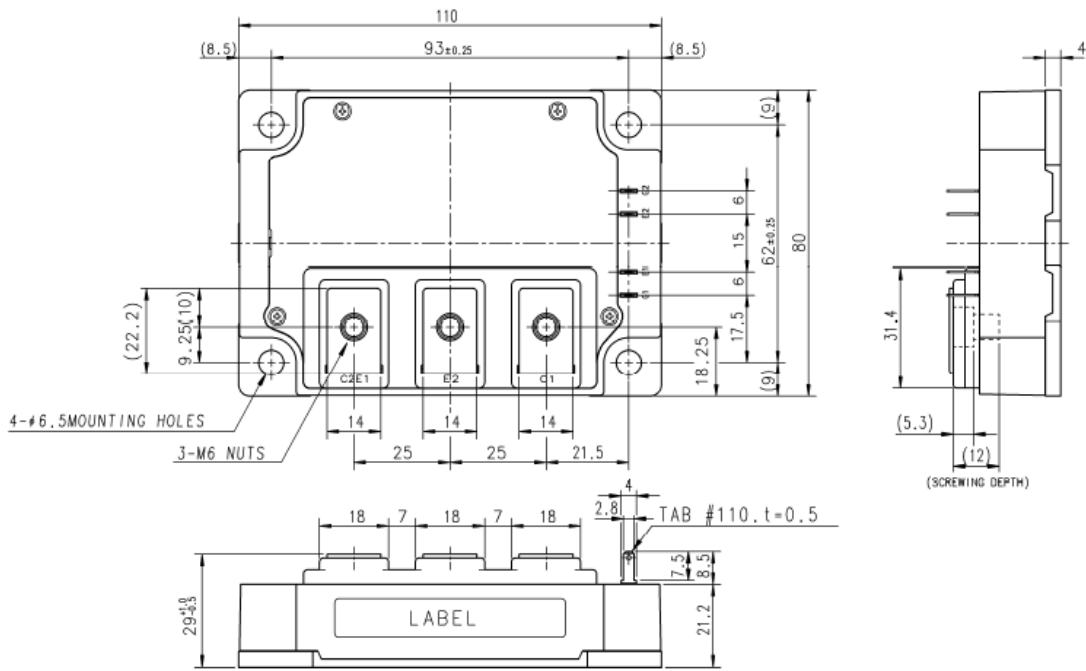
- Silicon IGBT + Silicon Carbide Schottky Barrier Diode
- Flat base Type
- Copper base plate
- RoHS Directive compliant
- Recognized under UL1557, File E323585

**APPLICATION**

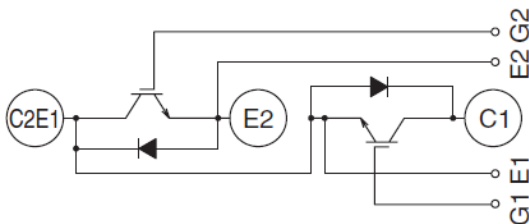
High frequency switching use(30kHz to 60kHz)  
 Gradient magnetic power supply, Induction heating, etc.

**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

## CMH400DU-24NFH

HIGH POWER SWITCHING USE  
INSULATED TYPEMAXIMUM RATINGS ( $T_j=25\text{ }^\circ\text{C}$ , unless otherwise specified, per 1/2 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	$\pm 20$	V
$I_C$	Collector current	DC, $T_C=25\text{ }^\circ\text{C}$ (Note2, 4)	400	A
$I_{CRM}$		Pulse, Repetitive (Note3)	800	
$P_{tot}$	Total power dissipation	$T_C=25\text{ }^\circ\text{C}$ (Note2, 4)	2450	W
$I_E$ (Note1)	Emitter current	DC, $T_C=25\text{ }^\circ\text{C}$ (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	4000	V
$T_j$	Junction temperature	- (Note8)	-40 ~ +150	$^\circ\text{C}$
$T_{stg}$	Storage temperature	-	-40 ~ +125	

ELECTRICAL CHARACTERISTICS ( $T_j=25\text{ }^\circ\text{C}$ , unless otherwise specified, per 1/2 module)

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$I_{CES}$	Collector-emitter cut-off current	$V_{CE}=V_{CES}$ , G-E short-circuited	-	-	21.0	mA
$I_{GES}$	Gate-emitter leakage current	$V_{GE}=V_{GES}$ , C-E short-circuited	-	-	1.4	$\mu\text{A}$
$V_{GE(th)}$	Gate-emitter threshold voltage	$I_C=400\text{ mA}$ , $V_{CE}=10\text{ V}$	4.5	6.0	7.5	V
$V_{CESat}$	Collector-emitter saturation voltage	$I_C=400\text{ A}$ , $V_{GE}=15\text{ V}$ (Note5)	-	5.0	6.5	V
		Refer to the figure of test circuit				
$C_{ies}$	Input capacitance	$V_{CE}=10\text{ V}$ , G-E short-circuited	-	-	63	nF
$C_{oes}$	Output capacitance		-	-	5.3	
$C_{res}$	Reverse transfer capacitance		-	-	1.2	
$Q_G$	Gate charge	$V_{CC}=600\text{ V}$ , $I_C=400\text{ A}$ , $V_{GE}=15\text{ V}$	-	1800	-	nC
$t_{d(on)}$	Turn-on delay time	$V_{CC}=600\text{ V}$ , $I_C=400\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=0.78\text{ }\Omega$ , Inductive load	-	-	300	ns
$t_r$	Rise time		-	-	100	
$t_{d(off)}$	Turn-off delay time		-	-	500	
$t_f$	Fall time		-	-	150	
$V_{EC}$ (Note1)	Emitter-collector voltage	$I_E=400\text{ A}$ , G-E short-circuited (Note5)	-	1.7	2.2	V
		Refer to the figure of test circuit				
$Q_C$ (Note1)	Collector - emitter charge	$V_{CC}=600\text{ V}$ , $I_E=400\text{ A}$ , $V_{GE}=\pm 15\text{ V}$ , $R_G=0.78\text{ }\Omega$ , Inductive load	-	3.3	-	$\mu\text{C}$
$E_{on}$	Turn-on switching energy per pulse	$V_{CC}=600\text{ V}$ , $I_C/I_E=400\text{ A}$ ,	-	6.5	-	mJ
$E_{off}$	Turn-off switching energy per pulse	$V_{GE}=\pm 15\text{ V}$ , $R_G=0.78\text{ }\Omega$ ,	-	16.0	-	
$E_{rec}$ (Note1)	Reverse energy per pulse	$T_j=125\text{ }^\circ\text{C}$ , Inductive load	-	1.3	-	mJ
$r_g$	Internal gate resistance	Per switch	-	0.8	-	$\Omega$

THERMAL RESISTANCE CHARACTERISTICS (per 1/2 module)

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance	Junction to case (Note4)	-	-	0.051	K/W
$R_{th(j-c)D}$		Junction to case (Note4)	-	-	0.123	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, Thermal grease applied (Note4, 6, 8)	-	0.02	-	K/W

Caution; No short-circuit capability is designed.

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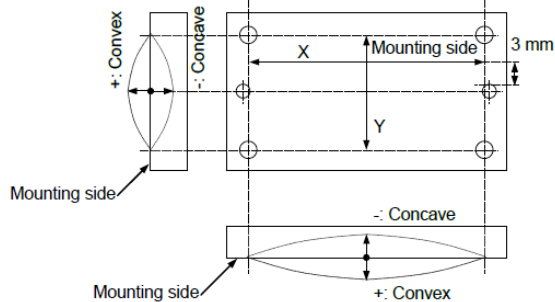
## MECHANICAL CHARACTERISTICS

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 6 screw	3.5	4.0	4.5	N·m
$d_s$	Creepage distance	Terminal to terminal	17.0	-	-	mm
		Terminal to base plate	32.0	-	-	
$d_a$	Clearance	Terminal to terminal	11.0	-	-	mm
		Terminal to base plate	28.1	-	-	
$m$	mass	-	-	580	-	g
$e_c$	Flatness of base plate	On the centerline X (Note7)	-100	-	100	$\mu\text{m}$
		On the centerline Y (Note7)	-100	-	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).

- Junction temperature ( $T_j$ ) should not increase beyond  $T_{jmax}$  rating.
  - Pulse width and repetition rate should be such that the device junction temperature ( $T_j$ ) dose 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.
- Pulse width and repetition rate should be such as to cause negligible temperature rise.
  - Typical value is measured by using thermally conductive grease of  $\lambda=0.9 \text{ W/(m}\cdot\text{K)}$ .
  - The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



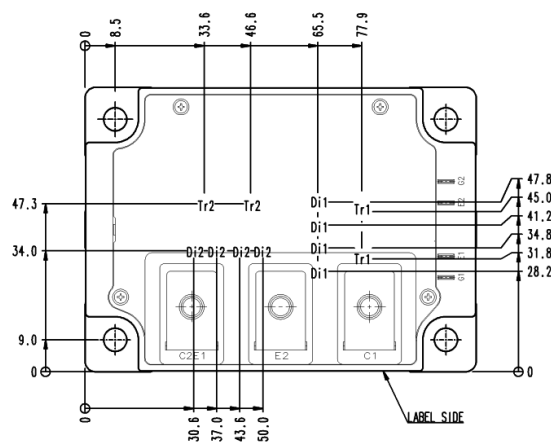
- Long term performance related to thermal conductive material such as thermal grease (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under your specific application conditions. Temperature condition ( $T_j$ ) must be maintained 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	$\Omega$

## CHIP LOCATION (Top view)

Dimension in mm, tolerance:  $\pm 1 \text{ mm}$

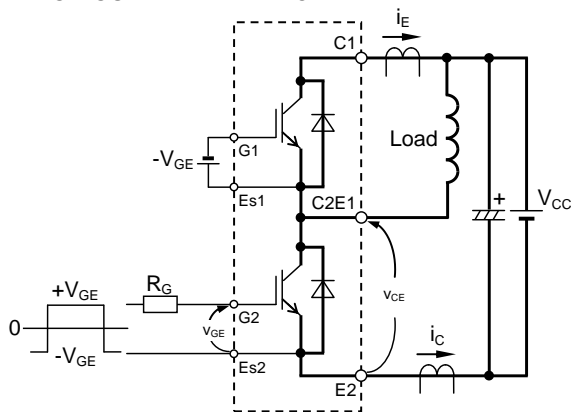


Tr1/Tr2: IGBT, Di1/Di2: DIODE

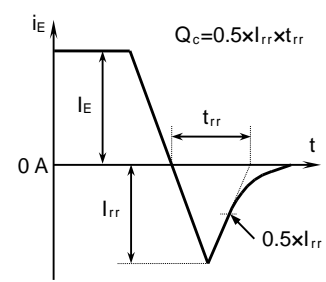
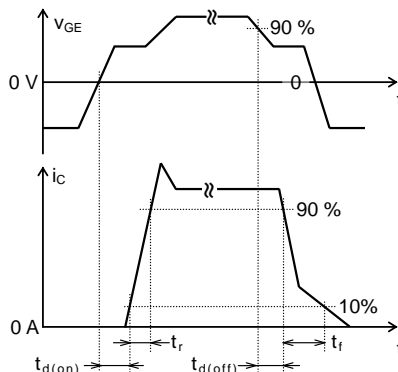
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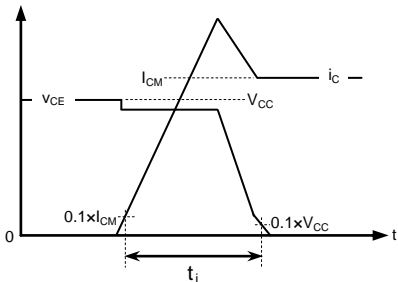
## TEST CIRCUIT AND WAVEFORMS



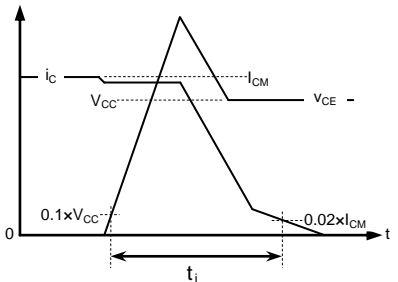
Switching test circuit and waveforms



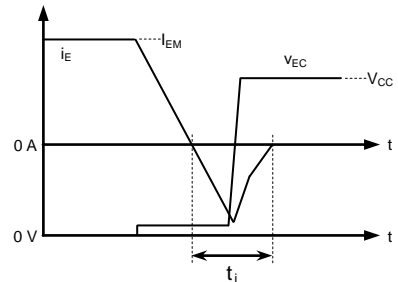
$t_{rr}$ ,  $Q_c$  test waveform



IGBT Turn-on switching energy



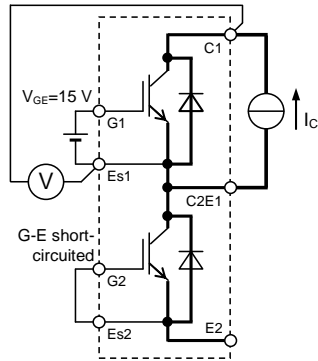
IGBT Turn-off switching energy



DIODE Reverse recovery energy

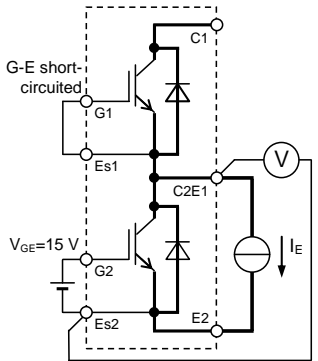
Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

## TEST CIRCUIT

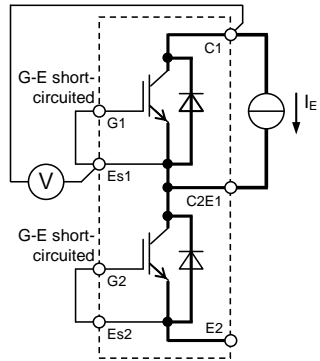


Tr1

$V_{CEsat}$  characteristics test circuit

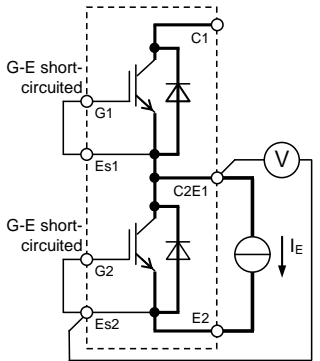


Tr2



Di1

$V_{EC}$  characteristics test circuit



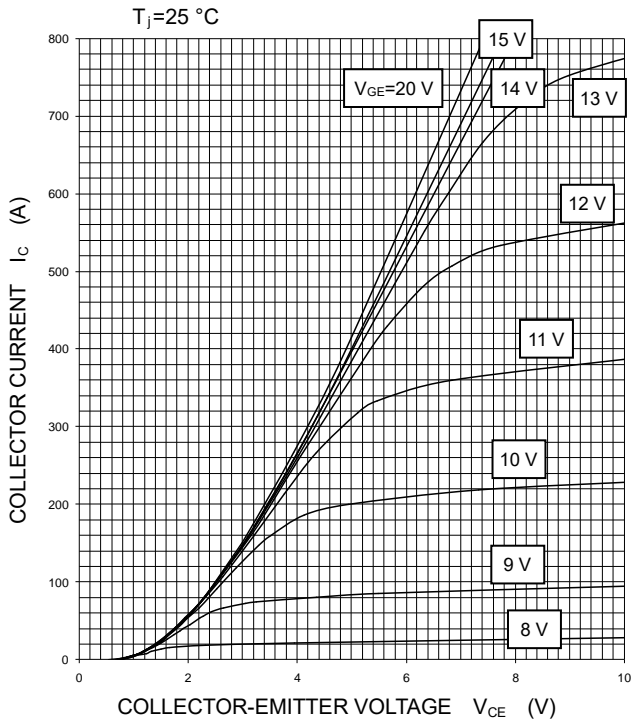
Di2

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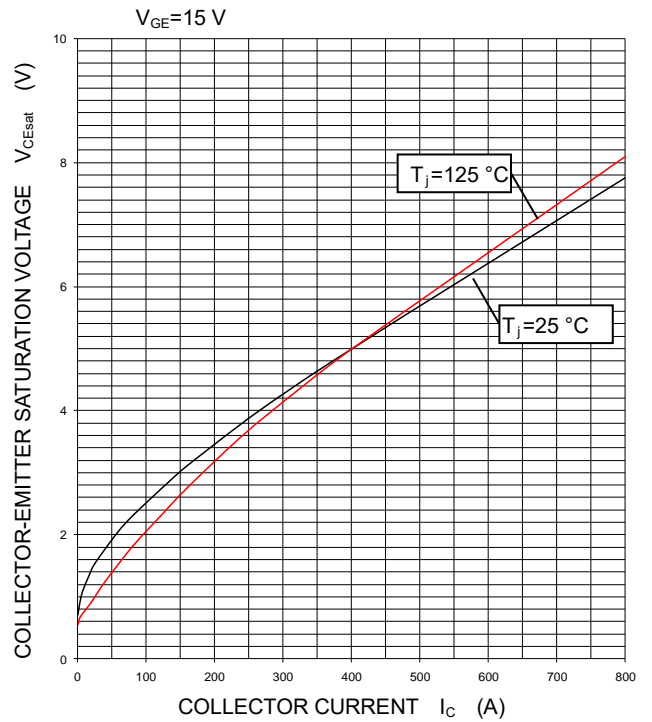
HIGH POWER SWITCHING USE  
INSULATED TYPE

## PERFORMANCE CURVES

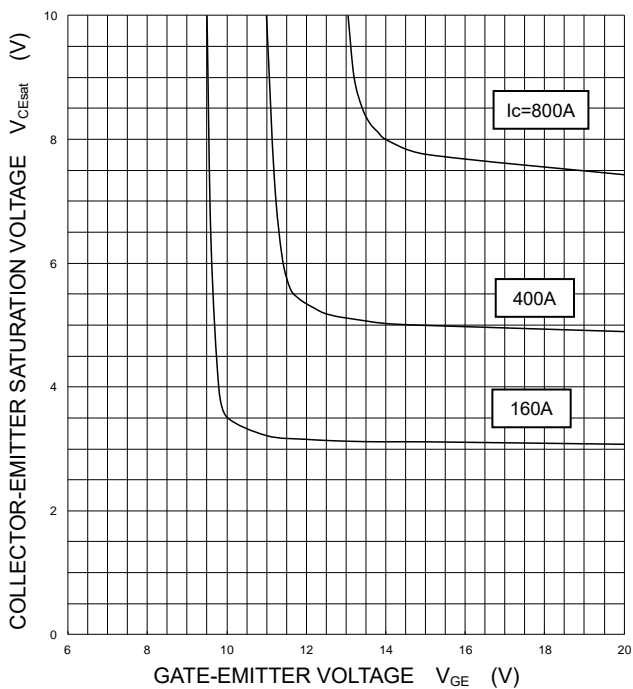
OUTPUT CHARACTERISTICS (TYPICAL)



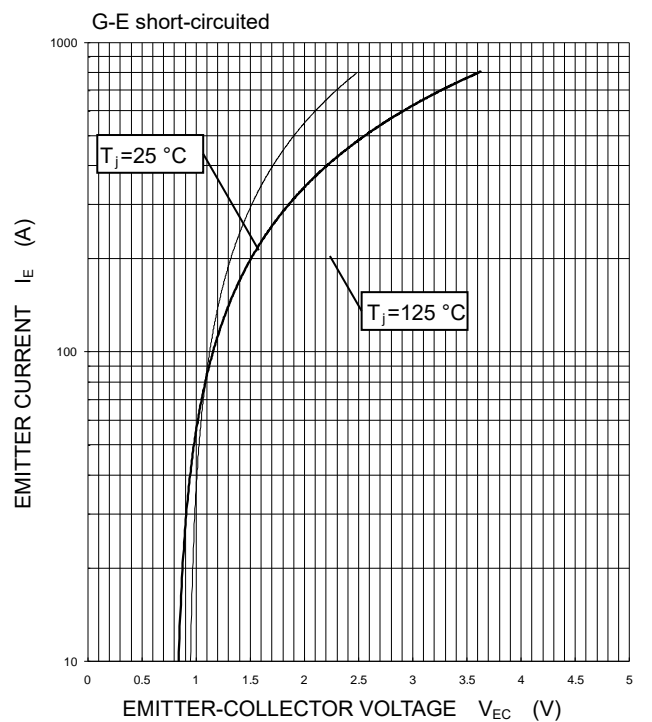
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



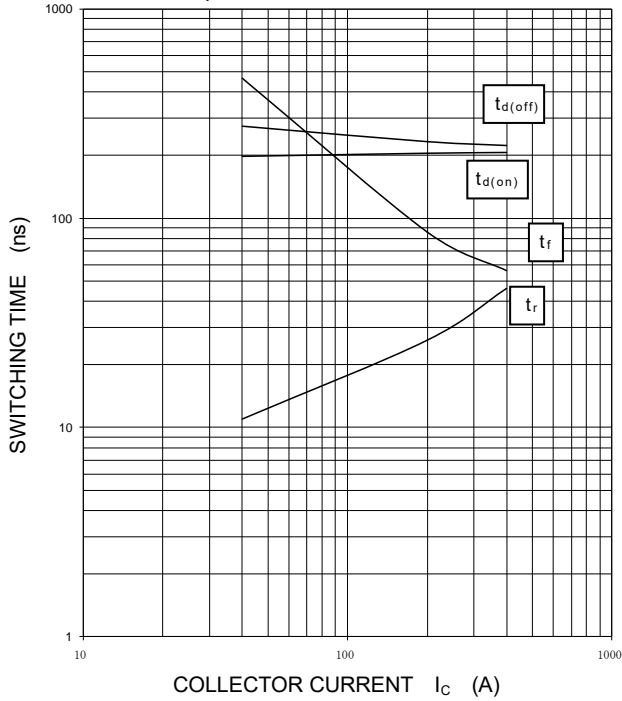
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## PERFORMANCE CURVES

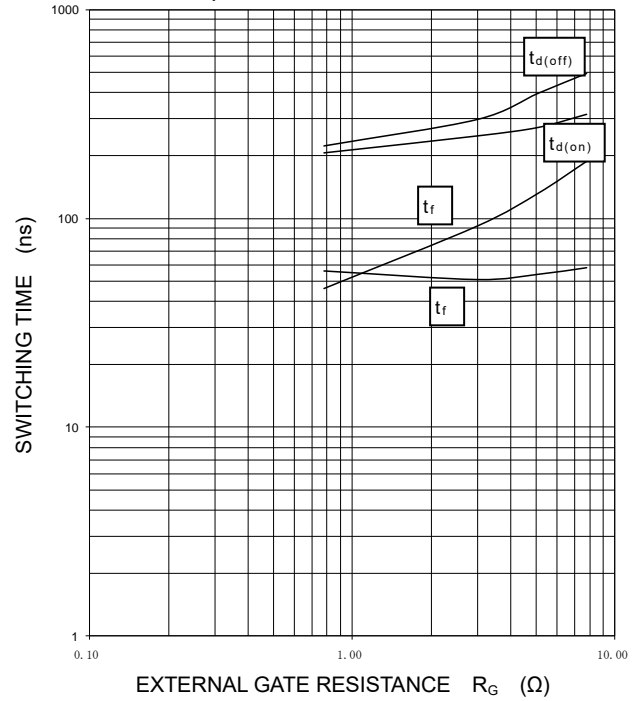
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0.78\ \Omega$ ,  
 $T_j=125\text{ }^\circ\text{C}$ , INDUCTIVE LOAD



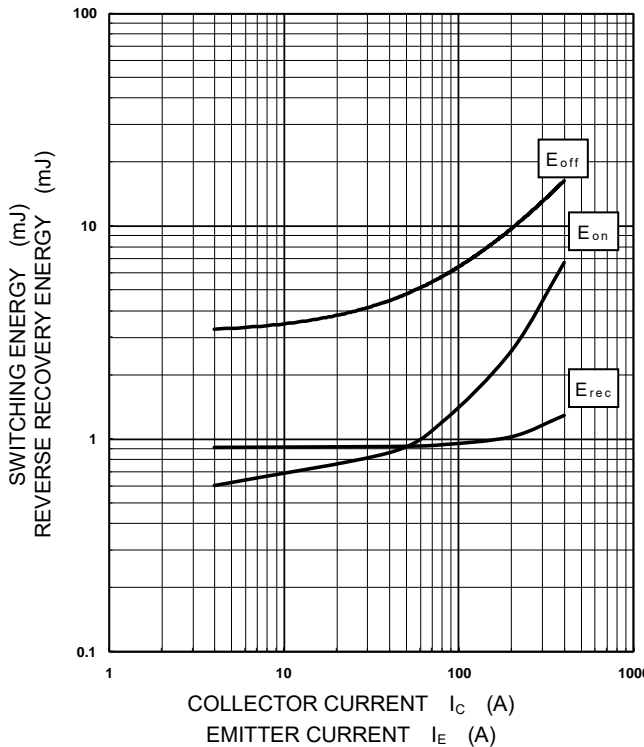
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C=400\text{ A}$ ,  
 $T_j=125\text{ }^\circ\text{C}$ , INDUCTIVE LOAD



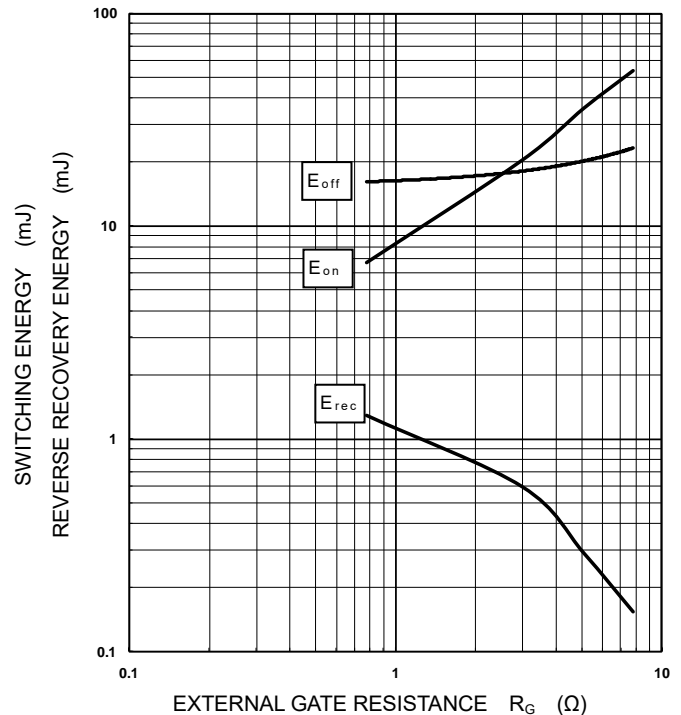
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0.78\ \Omega$ ,  $T_j=125\text{ }^\circ\text{C}$ ,  
INDUCTIVE LOAD, PER PULSE



HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $I_C/I_E=400\text{ A}$ ,  $T_j=125\text{ }^\circ\text{C}$ ,  
INDUCTIVE LOAD, PER PULSE

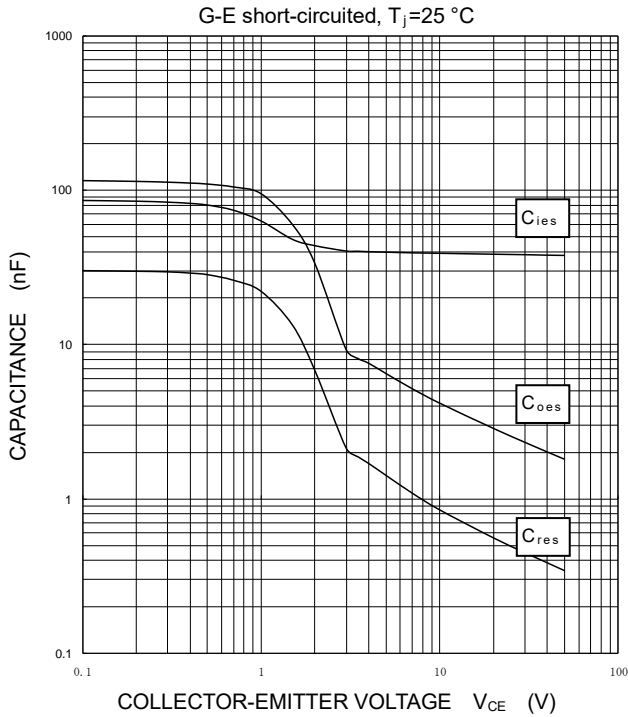


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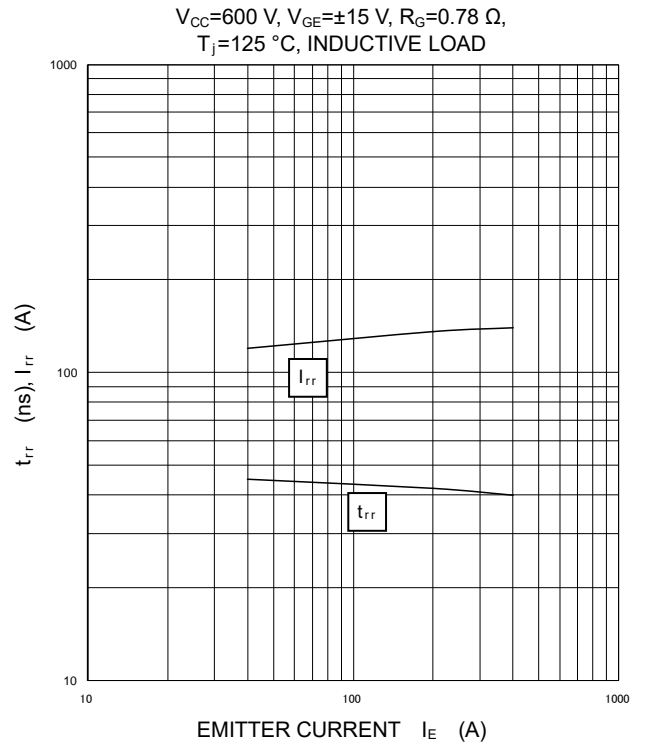
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## PERFORMANCE CURVES

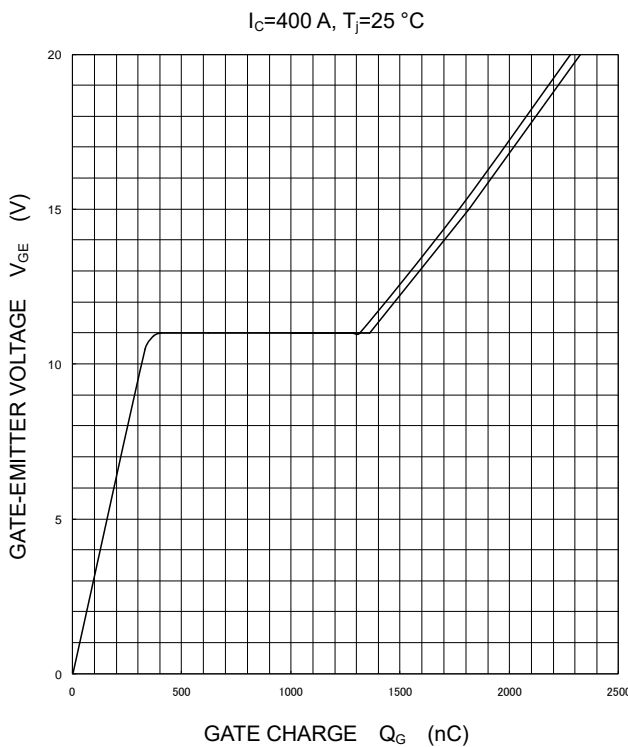
CAPACITANCE CHARACTERISTICS (TYPICAL)



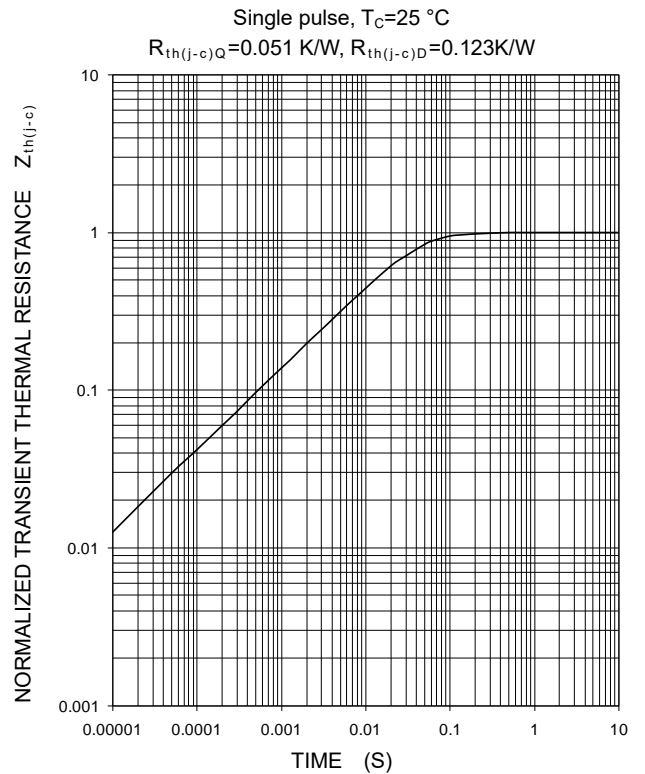
FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



GATE CHARGE CHARACTERISTICS (TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)



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

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