

< IGBT MODULES >

# CM1400DUC-24S

HIGH POWER SWITCHING USE  
INSULATED TYPE



Dual switch (Half-Bridge)

Collector current  $I_C$  ..... **1 4 0 0 A**  
 Collector-emitter voltage  $V_{CES}$  ..... **1 2 0 0 V**  
 Maximum junction temperature  $T_{jmax}$  ..... **1 7 5 °C**

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

## APPLICATION

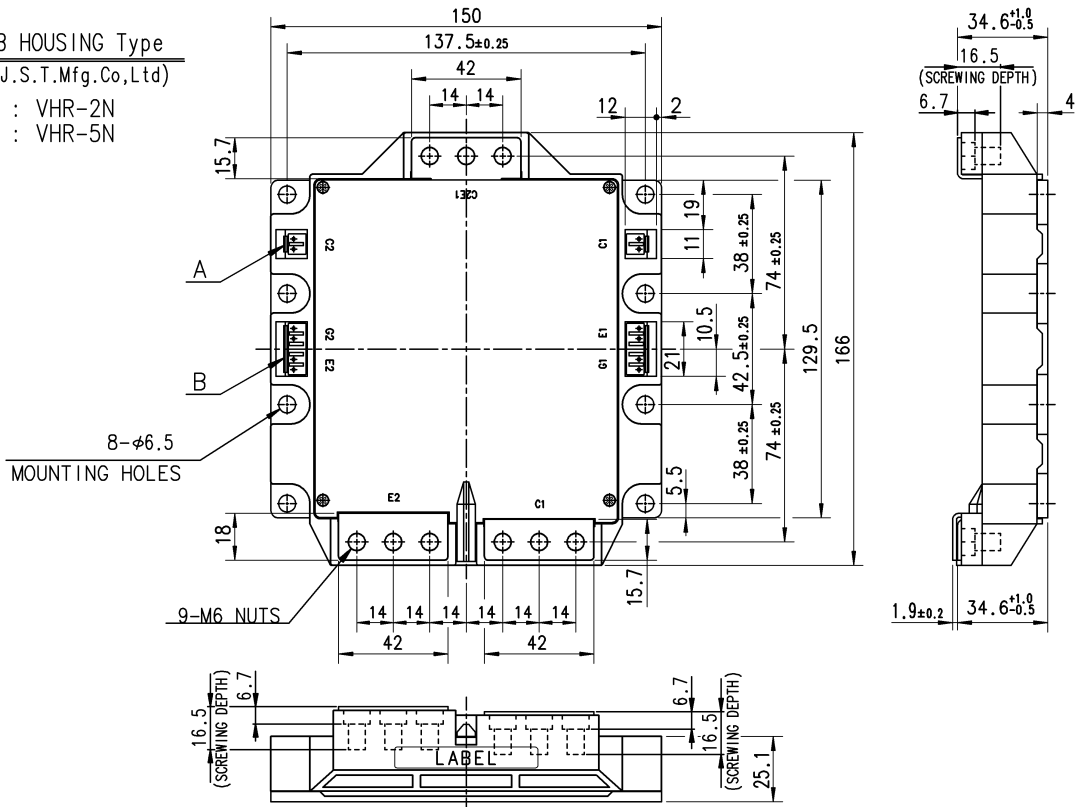
Wind power, Photovoltaic (Solar) power, AC Motor Control, Motion/Servo Control, Power supply, etc.

## OUTLINE DRAWING & INTERNAL CONNECTION

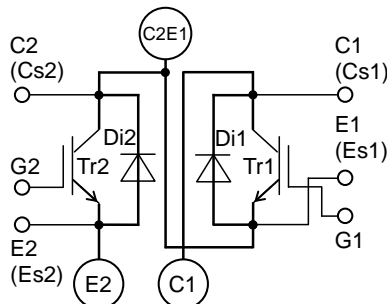
Dimension in mm

A,B HOUSING Type  
(J.S.T.Mfg.Co.,Ltd)

A : VHR-2N  
B : VHR-5N



### 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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MAXIMUM RATINGS (T<sub>j</sub>=25 °C, unless otherwise specified)

Symbol	Item	Conditions	Rating	Unit
V <sub>CES</sub>	Collector-emitter voltage	G-E short-circuited	1200	V
V <sub>GES</sub>	Gate-emitter voltage	C-E short-circuited	± 20	V
I <sub>C</sub>	Collector current	DC, T <sub>C</sub> =124 °C (Note2, 4)	1400	A
I <sub>CRM</sub>		Pulse, Repetitive (Note3)	2800	
P <sub>tot</sub>	Total power dissipation	T <sub>C</sub> =25 °C (Note2, 4)	9375	W
I <sub>E</sub> (Note1)	Emitter current	DC (Note2)	1400	A
I <sub>ERM</sub> (Note1)		Pulse, Repetitive (Note3)	2800	
V <sub>isol</sub>	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	4000	V
T <sub>jmax</sub>	Maximum junction temperature	Instantaneous event (overload)	175	°C
T <sub>Cmax</sub>	Maximum case temperature	(Note4)	125	
T <sub>jop</sub>	Operating junction temperature	Continuous operation (under switching)	-40 ~ +150	°C
T <sub>stg</sub>	Storage temperature	-	-40 ~ +125	

ELECTRICAL CHARACTERISTICS (T<sub>j</sub>=25 °C, unless otherwise specified)

Symbol	Item	Conditions	Limits			Unit	
			Min.	Typ.	Max.		
I <sub>CES</sub>	Collector-emitter cut-off current	V <sub>CE</sub> =V <sub>CES</sub> , G-E short-circuited	-	-	1.0	mA	
I <sub>GES</sub>	Gate-emitter leakage current	V <sub>GE</sub> =V <sub>GES</sub> , C-E short-circuited	-	-	3.0	µA	
V <sub>GE(th)</sub>	Gate-emitter threshold voltage	I <sub>C</sub> =140 mA, V <sub>CE</sub> =10 V	5.4	6.0	6.6	V	
V <sub>CESat</sub>	Collector-emitter saturation voltage	I <sub>C</sub> =1400 A (Note5), V <sub>GE</sub> =15 V, Terminal=chip	T <sub>j</sub> =25 °C	-	1.55	1.90	V
			T <sub>j</sub> =125 °C	-	1.75	-	
			T <sub>j</sub> =150 °C	-	1.80	-	
C <sub>ies</sub>	Input capacitance	V <sub>CE</sub> =10 V, G-E short-circuited	-	-	150	nF	
C <sub>oes</sub>	Output capacitance		-	-	30		
C <sub>res</sub>	Reverse transfer capacitance		-	-	2.5		
Q <sub>G</sub>	Gate charge	V <sub>CC</sub> =600 V, I <sub>C</sub> =1400 A, V <sub>GE</sub> =15 V	-	3500	-	nC	
t <sub>d(on)</sub>	Turn-on delay time	V <sub>CC</sub> =600 V, I <sub>C</sub> =1400 A, V <sub>GE</sub> =±15 V, R <sub>G</sub> =0 Ω, Inductive load	-	-	900	ns	
t <sub>r</sub>	Rise time		-	-	250		
t <sub>d(off)</sub>	Turn-off delay time		-	-	950		
t <sub>f</sub>	Fall time		-	-	350		
V <sub>EC</sub> (Note1)	Emitter-collector voltage	I <sub>E</sub> =1400 A (Note5), G-E short-circuited, Terminal=chip	T <sub>j</sub> =25 °C	-	1.65	2.10	V
			T <sub>j</sub> =125 °C	-	1.65	-	
			T <sub>j</sub> =150 °C	-	1.65	-	
t <sub>rr</sub> (Note1)	Reverse recovery time	V <sub>CC</sub> =600 V, I <sub>E</sub> =1400 A, V <sub>GE</sub> =±15 V,	-	-	450	ns	
Q <sub>rr</sub> (Note1)	Reverse recovery charge	R <sub>G</sub> =0 Ω, Inductive load	-	90	-	µC	
E <sub>on</sub>	Turn-on switching energy per pulse	V <sub>CC</sub> =600 V, I <sub>C</sub> =I <sub>E</sub> =1400 A,	-	82.2	-	mJ	
E <sub>off</sub>	Turn-off switching energy per pulse	V <sub>GE</sub> =±15 V, R <sub>G</sub> =0 Ω, T <sub>j</sub> =150 °C,	-	265	-		
E <sub>rr</sub> (Note1)	Reverse recovery energy per pulse	Inductive load	-	122	-	mJ	
R <sub>CC'+EE'</sub>	Internal lead resistance	Main terminals-chip, per switch, T <sub>C</sub> =25 °C (Note4)	-	0.286	-	mΩ	
r <sub>g</sub>	Internal gate resistance	Per switch	-	1.7	-	Ω	

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**THERMAL RESISTANCE CHARACTERISTICS**

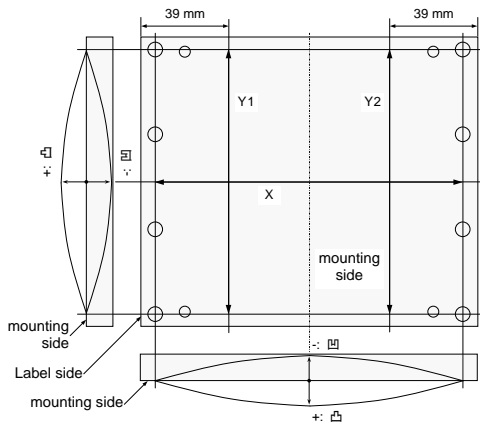
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance	Junction to case, per Inverter IGBT (Note4)	-	-	16	K/kW
$R_{th(j-c)D}$		Junction to case, per Inverter DIODE (Note4)	-	-	26	
$R_{th(c-s)}$	Contact thermal resistance	Case to heat sink, per 1/2 module, Thermal grease applied (Note4, 6)	-	12	-	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 to heat sink M 6 screw	3.5	4.0	4.5	N·m
$d_s$	Creepage distance	Terminal to terminal	24	-	-	mm
		Terminal to base plate	33	-	-	
$d_a$	Clearance	Terminal to terminal	14	-	-	mm
		Terminal to base plate	33	-	-	
$m$	mass	-	-	1450	-	g
$e_c$	Flatness of base plate	On the centerline X, Y1, Y2 (Note7)	-50	-	+100	$\mu$ m

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.  
The heat sink thermal resistance should measure just under the chips.
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 is measured by using thermally conductive grease of  $\lambda=0.9$  W/(m·K).
7. Base plate (mounting side) flatness measurement points (X, Y1 and Y2) are as follows of the following figure.



8. The company name and product names herein are the trademarks and registered trademarks of the respective companies.

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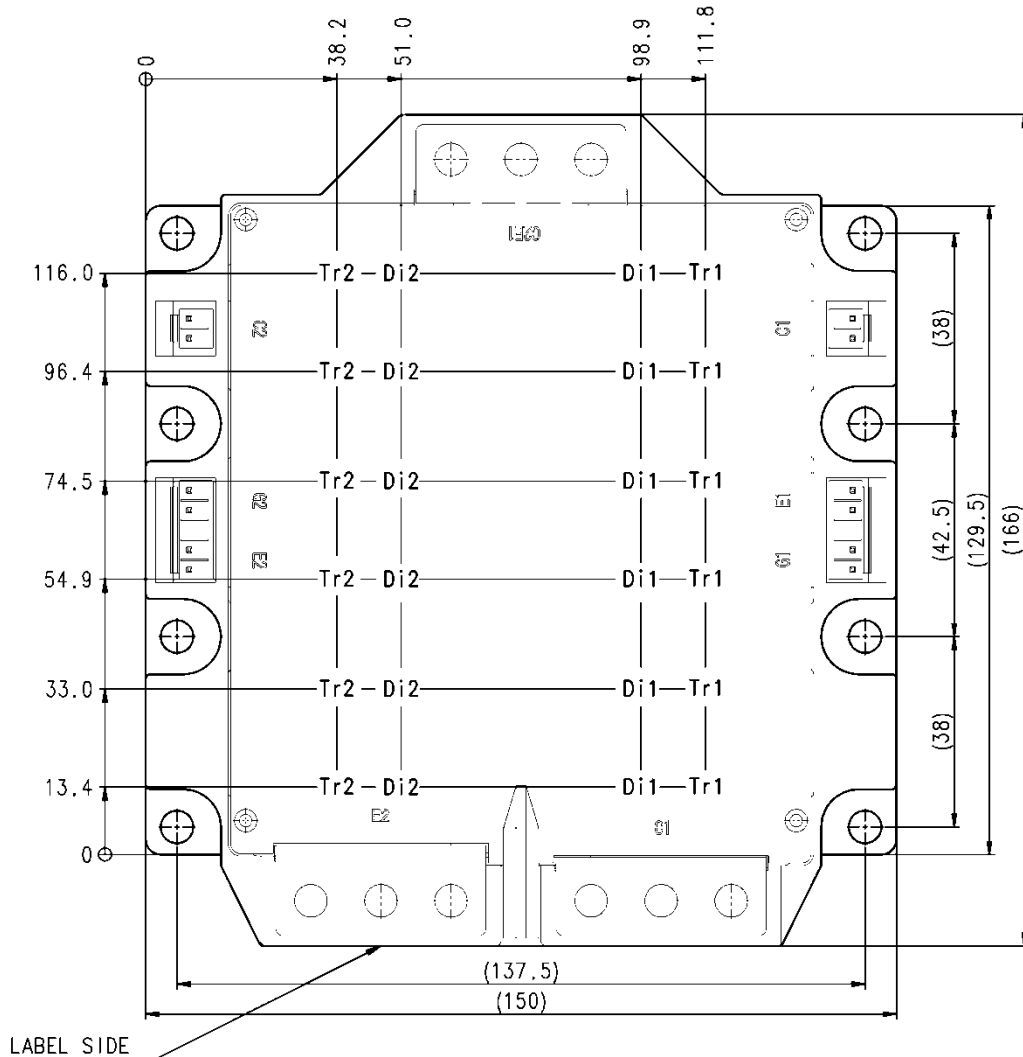
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RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V <sub>CC</sub>	(DC) Supply voltage	Applied across C1-E2 terminals	-	600	850	V
V <sub>GEon</sub>	Gate (-emitter drive) voltage	Applied across G1-Es1/G2-Es2 terminals	13.5	15.0	16.5	V
R <sub>G</sub>	External gate resistance	Per switch	0	-	2.2	Ω

CHIP LOCATION (Top view)

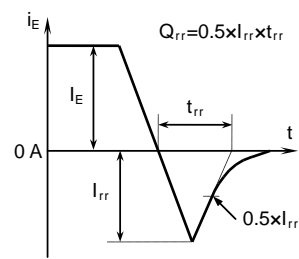
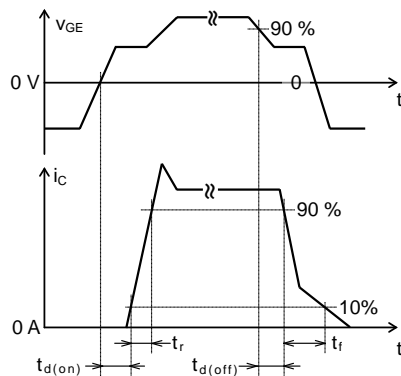
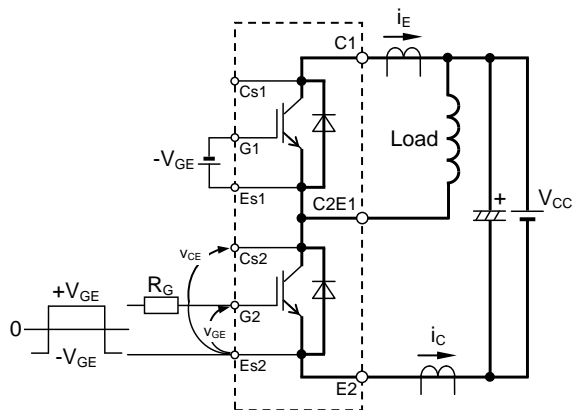
Dimension in mm, tolerance: ±1 mm



Tr1/Tr2: IGBT, Di1/Di2: DIODE

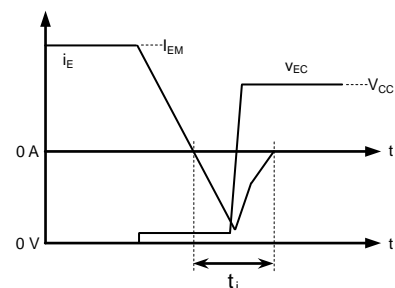
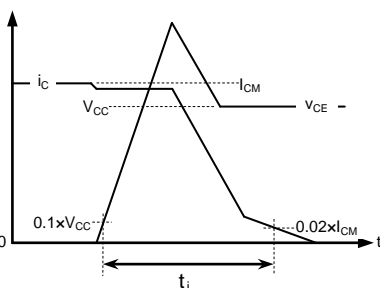
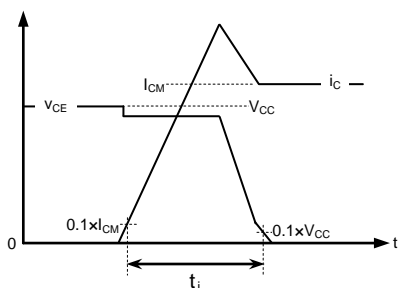
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**TEST CIRCUIT AND WAVEFORMS**



**Switching characteristics test circuit and waveforms**

**$t_{rr}$ ,  $Q_{rr}$  test waveform**



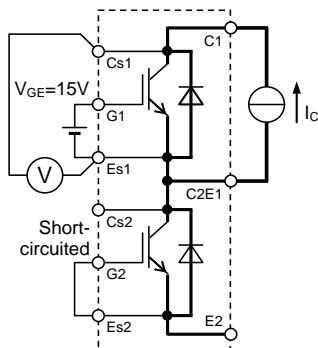
**IGBT Turn-on switching energy**

**IGBT Turn-off switching energy**

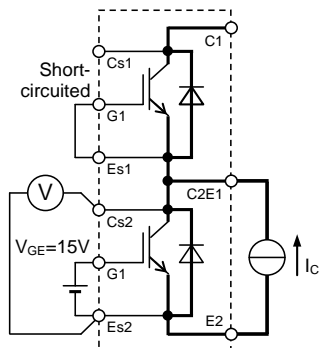
**DIODE Reverse recovery energy**

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

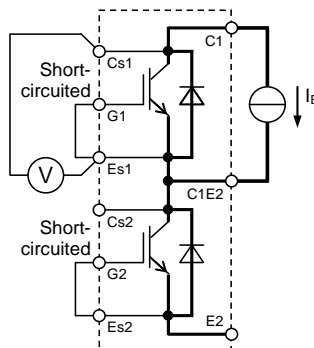
**TEST CIRCUIT**



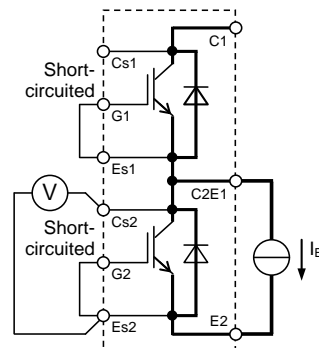
**Tr1  $V_{CEsat}$  test circuit**



**Tr2**



**Di1**

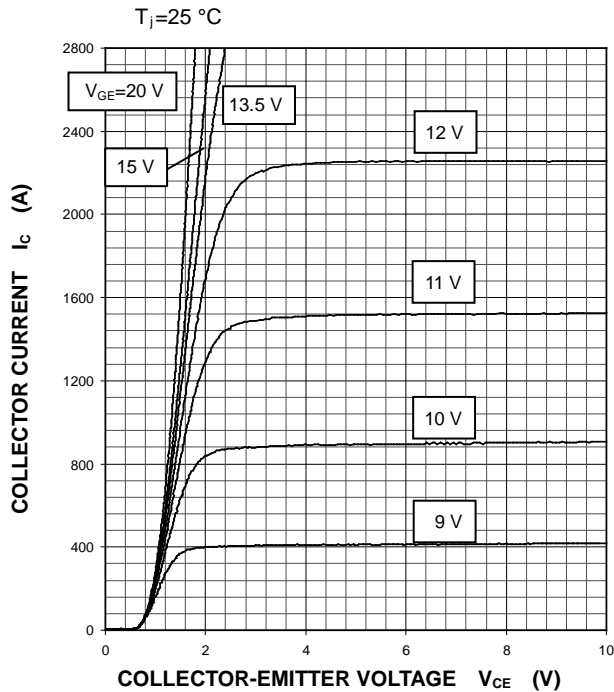


**Di2**

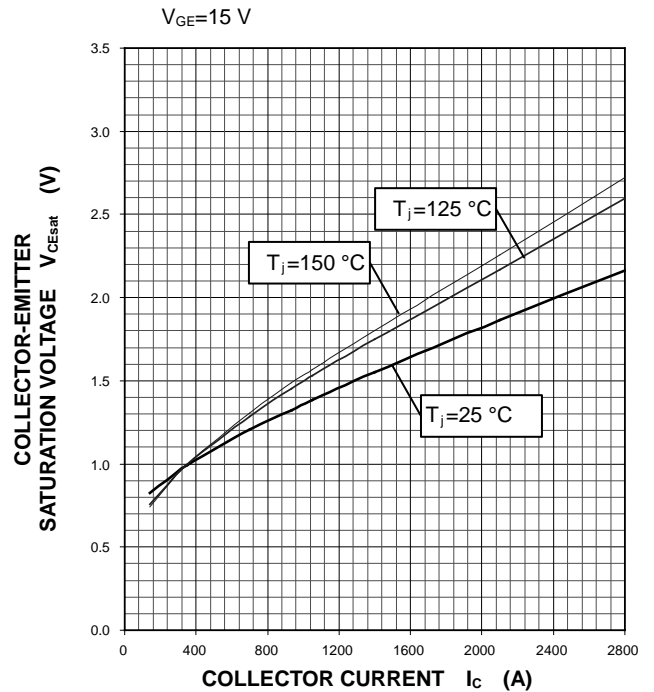
**$V_{EC}$  test circuit**

PERFORMANCE CURVES

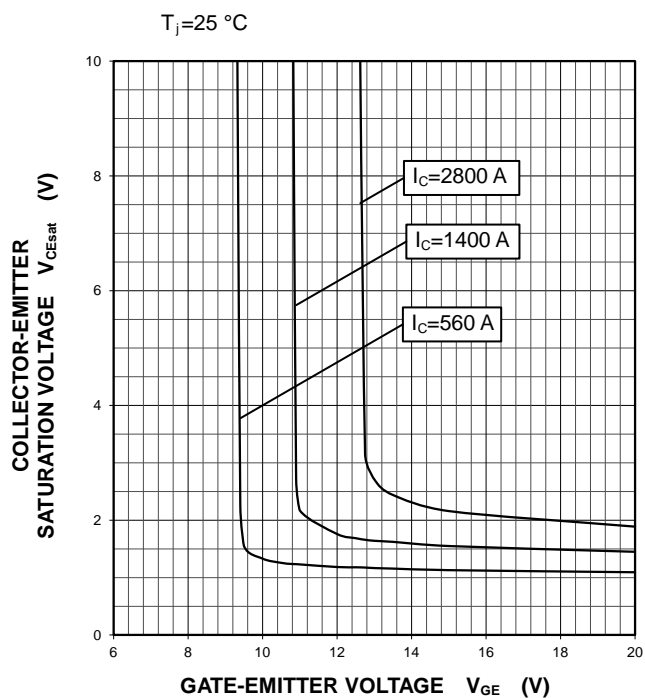
OUTPUT CHARACTERISTICS  
(TYPICAL)



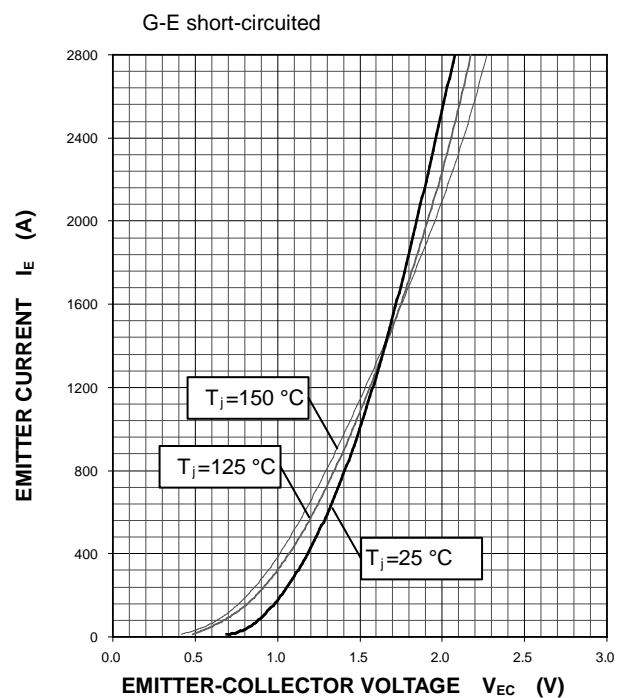
COLLECTOR-EMITTER SATURATION  
VOLTAGE CHARACTERISTICS  
(TYPICAL)



COLLECTOR-EMITTER SATURATION  
VOLTAGE CHARACTERISTICS  
(TYPICAL)



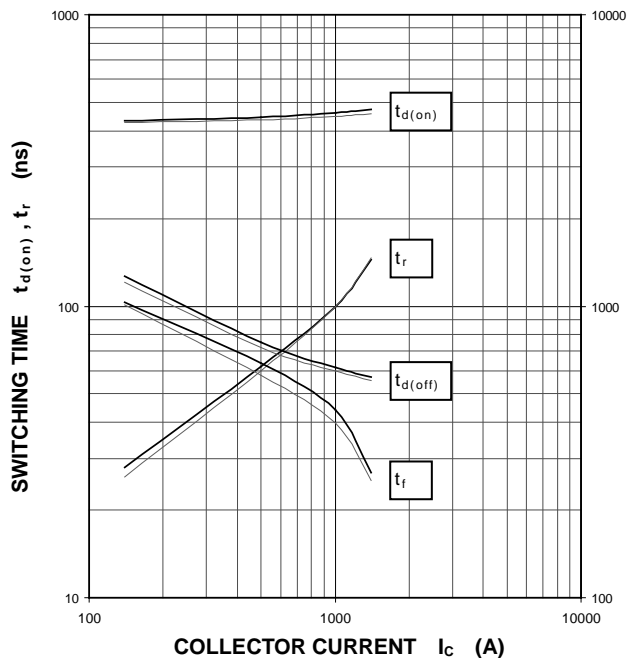
FREE WHEELING DIODE  
FORWARD CHARACTERISTICS  
(TYPICAL)



PERFORMANCE CURVES

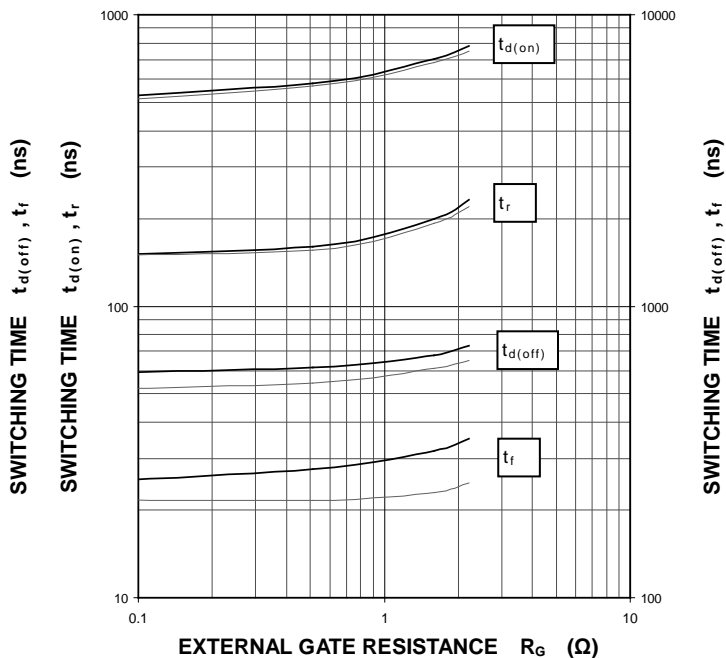
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0\ \Omega$ , INDUCTIVE LOAD  
——:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



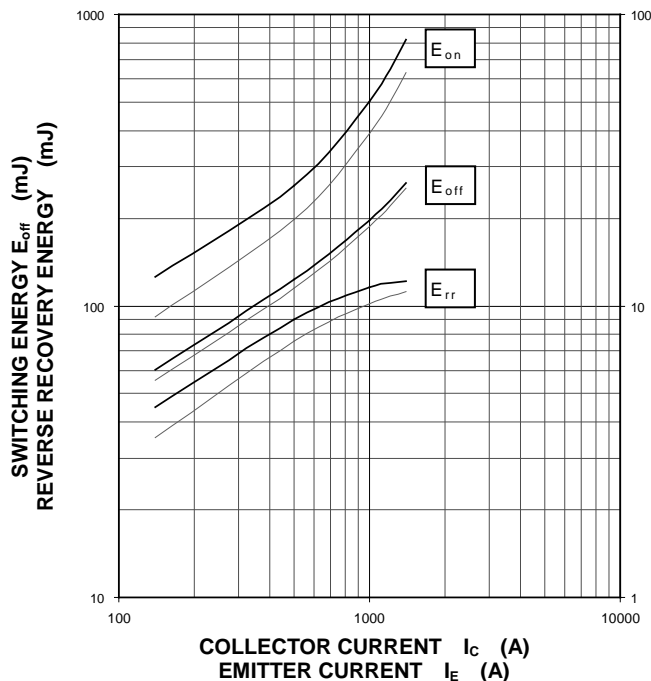
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $I_c=1400\text{ A}$ ,  $V_{GE}=\pm 15\text{ V}$ , INDUCTIVE LOAD  
——:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



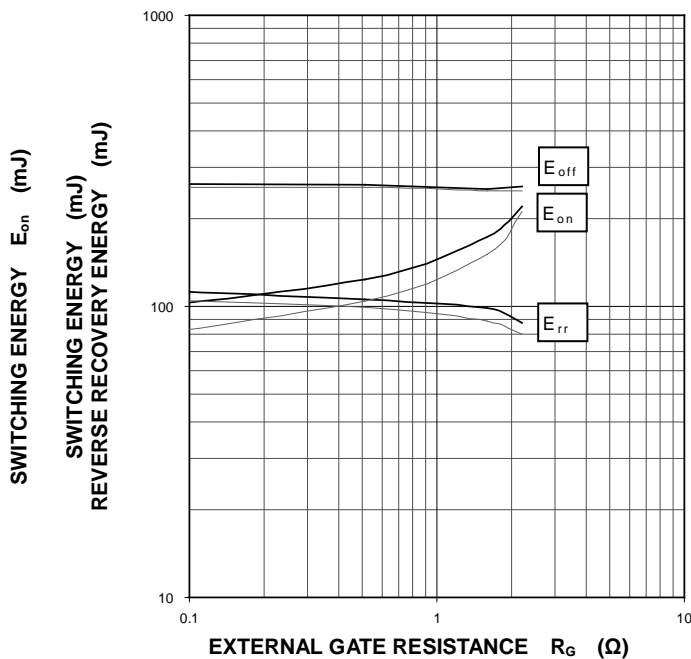
HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0\ \Omega$ ,  
INDUCTIVE LOAD, PER PULSE  
——:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



HALF-BRIDGE  
SWITCHING CHARACTERISTICS  
(TYPICAL)

$V_{CC}=600\text{ V}$ ,  $I_c/I_E=1400\text{ A}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  
INDUCTIVE LOAD, PER PULSE  
——:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$

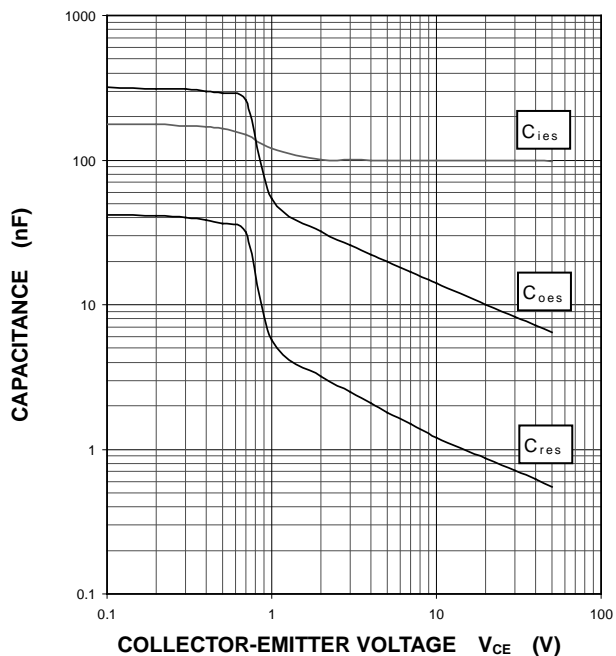


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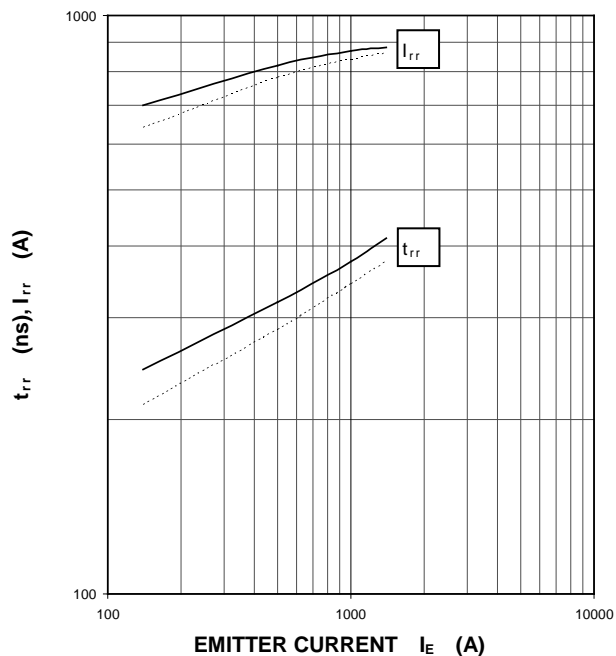
**CAPACITANCE CHARACTERISTICS**  
 (TYPICAL)

G-E short-circuited,  $T_j=25\text{ }^\circ\text{C}$



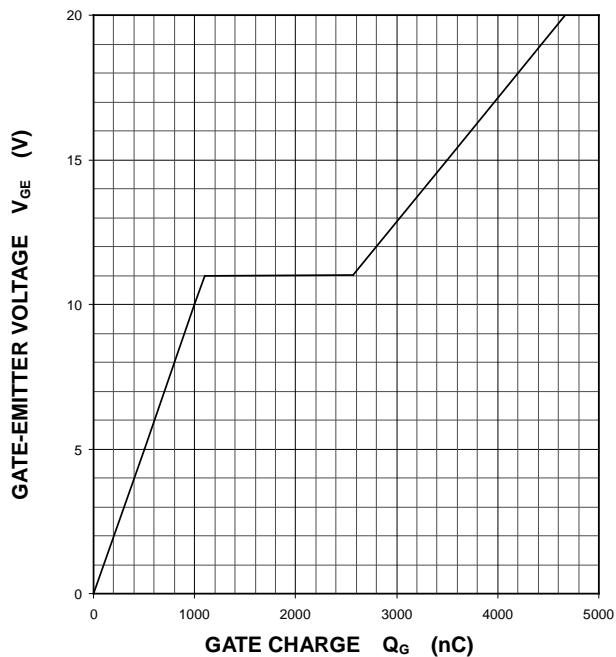
**FREE WHEELING DIODE**  
**REVERSE RECOVERY CHARACTERISTICS**  
 (TYPICAL)

$V_{CC}=600\text{ V}$ ,  $V_{GE}=\pm 15\text{ V}$ ,  $R_G=0\ \Omega$ , INDUCTIVE LOAD  
 —:  $T_j=150\text{ }^\circ\text{C}$ , - - - -:  $T_j=125\text{ }^\circ\text{C}$



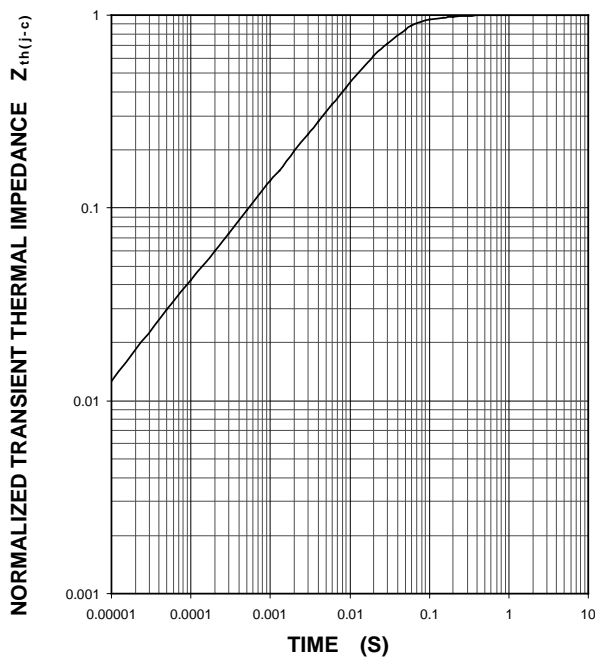
**GATE CHARGE CHARACTERISTICS**  
 (TYPICAL)

$V_{CC}=600\text{ V}$ ,  $I_C=1400\text{ A}$ ,  $T_j=25\text{ }^\circ\text{C}$



**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS**  
 (MAXIMUM)

Single pulse,  $T_C=25\text{ }^\circ\text{C}$   
 $R_{th(j-c)Q}=16\text{ K/kW}$ ,  $R_{th(j-c)D}=26\text{ K/kW}$





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