

DIAP Trench IGBT Power Module - 1200 V, 300 A Current Fed Inverter Topology


FEATURES

- 1200 V IGBT trench and field stop technology with positive temperature coefficient
- Low switching losses
- Maximum junction temperature 175 °C
- 10 μs short circuit capability
- Low inductance case
- HEXFRED® antiparallel and series diodes with soft reverse recovery
- Isolated copper baseplate using DCB (Direct Copper Bonding) technology
- Speed 4 kHz to 30 kHz
- Direct mounting to heatsink
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

PRIMARY CHARACTERISTICS	
IGBT	
V_{CES}	1200 V
$V_{CE(on)}$ (typical) at 300 A, 25 °C	1.93 V
$I_{D(DC)}$ at $T_C = 80$ °C	300 A
HEXFRED® SERIES DIODE	
V_R	1200 V
V_F (typical) at 300 A, 25 °C	1.99 V
$I_{F(DC)}$ at 80 °C	300 A
IGBT AND HEXFRED® SERIES DIODE	
$V_{CE(on)} + V_F$ typical at 300 A	3.92 V
HEXFRED® ANTIPARALLEL DIODE	
V_F (typical) at 10 A, 25 °C	1.6 V
$I_{F(DC)}$ at 88 °C	40 A
Package	Dual INT-A-PAK

BENEFITS

- Short circuit ruggedness

REMARKS

- Product reliability results valid for $T_J = 150$ °C
- Recommended operation temperature $T_{op} = 150$ °C

ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C unless otherwise noted)				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
IGBT				
Collector to emitter voltage	V_{CES}		1200	V
Collector current	I_C	$T_C = 80$ °C	300	A
		$T_C = 25$ °C	400	
			720	
			700	
Pulsed collector current	I_{CM}		720	
Clamped inductive load current	$I_{LM}^{(1)}$		700	
Gate to emitter voltage	V_{GE}		± 20	V
Maximum power dissipation	P_D	$T_C = 80$ °C	791	W
		$T_C = 25$ °C	1250	
SERIES DIODE				
Cathode to anode breakdown voltage	V_{RRM}		1200	
Continuous forward current	I_F	$T_C = 80$ °C	300	A
		$T_C = 25$ °C	412	
Peak repetitive forward current	I_{FSM}	$T_C = 25$ °C	2200	A
Maximum power dissipation	P_D	$T_C = 80$ °C	593	W
		$T_C = 25$ °C	938	



ABSOLUTE MAXIMUM RATINGS ($T_C = 25\text{ }^\circ\text{C}$ unless otherwise noted)				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
ANTIPARALLEL DIODE				
Continuous forward current	$I_F^{(2)}$	$T_C = 80\text{ }^\circ\text{C}$	42	A
		$T_C = 25\text{ }^\circ\text{C}$	57	
Peak repetitive forward current	I_{FSM}		n/a	A
Maximum power dissipation	P_D	$T_C = 80\text{ }^\circ\text{C}$	106	W
		$T_C = 25\text{ }^\circ\text{C}$	167	
MODULE				
RMS isolation voltage	V_{ISOL}	$f = 50\text{ Hz}$, $t = 1\text{ minute}$	4000	V
Junction temperature range	T_J	-40 °C to +175 °C		°C
Storage temperature range	T_{STG}	-40 °C to +150 °C		

Notes

- Absolute Maximum Ratings indicate sustained limits beyond which damage to the device may occur
- (1) $V_{CC} = 600\text{ V}$, $V_P = 1200\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, $R_g = 4.7\text{ }\Omega$, $T_J = 150\text{ }^\circ\text{C}$
- (2) Maximum RMS current admitted for the terminals 10 A

ELECTRICAL SPECIFICATIONS ($T_C = 25\text{ }^\circ\text{C}$ unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
IGBT						
Collector to emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{ V}$, $I_C = 11.4\text{ mA}$, $T_J = 25\text{ }^\circ\text{C}$	1200	-	-	V
Collector to emitter saturation voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}$, $I_C = 300\text{ A}$, $T_J = 25\text{ }^\circ\text{C}$	-	1.93	-	
		$V_{GE} = 15\text{ V}$, $I_C = 300\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$	-	2.24	-	
		$V_{GE} = 15\text{ V}$, $I_C = 300\text{ A}$, $T_J = 150\text{ }^\circ\text{C}$	-	2.32	-	
Gate to emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, $I_C = 11.4\text{ mA}$, $T_J = 25\text{ }^\circ\text{C}$	-	5.8	-	
Forward transconductance	g_{fe}	$V_{CE} = 20\text{ V}$, $I_C = 300\text{ A}$	-	130	-	S
Transfer characteristics	V_{GE}	$V_{CE} = 20\text{ V}$, $I_C = 300\text{ A}$	-	8.9	-	V
Collector to emitter leakage current	I_{CES}	$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$	-	1.3	-	mA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$	-	0.95	-	
		$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$	-	3.7	-	
Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	250	nA
SERIES DIODE						
Cathode to anode breakdown voltage	V_R	$I_R = 1.0\text{ mA}$, $T_J = 125\text{ }^\circ\text{C}$	1200	-	-	V
Cathode to anode leakage current	I_R	$V_R = 1200\text{ V}$	-	0.05	0.2	mA
		$V_R = 1200\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$	-	3.5	-	
Forward voltage	V_F	$I_F = 300\text{ A}$	-	1.99	-	V
		$I_F = 300\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$	-	2.02	-	
ANTIPARALLEL DIODE						
Forward voltage	V_F	$I_F = 10\text{ A}$	-	1.6	-	V
		$I_F = 10\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$	-	1.4	-	
IGBT AND HEXFRED® SERIES DIODE						
Collector to emitter saturation voltage and Forward voltage	$V_{CE(on)} + V_F$	$I_C = 300\text{ A}$	-	3.92	-	V



SWITCHING CHARACTERISTICS ($T_C = 25\text{ }^\circ\text{C}$ unless otherwise noted)								
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS		
IGBT (with freewheeling diode VS-H3195D12A6B in TO-247 Package)								
Turn-on switching loss	E_{on}	$I_C = 300\text{ A}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $V_{GE} = \pm 15\text{ V}$	-	29.7	-	mJ		
Turn-off switching loss	E_{off}		-	30.3	-			
Total switching loss	E_{tot}		-	60.0	-			
Turn-on delay time	$t_{d(on)}$	$I_C = 300\text{ A}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $V_{GE} = \pm 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$	-	132	-	ns		
Rise time	t_r		-	188	-			
Turn-off delay time	$t_{d(off)}$		-	630	-			
Fall time	t_f		-	84	-			
Turn-on switching loss	E_{on}	$I_C = 300\text{ A}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $V_{GE} = \pm 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$	-	33.2	-	mJ		
Turn-off switching loss	E_{off}		-	37.4	-			
Total switching loss	E_{tot}		-	70.6	-			
Turn-on delay time	$t_{d(on)}$	$I_C = 300\text{ A}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $V_{GE} = \pm 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$	-	147	-	ns		
Rise time	t_r		-	195	-			
Turn-off delay time	$t_{d(off)}$		-	714	-			
Fall time	t_f		-	120	-			
Input capacitance	C_{ies}	$V_{CE} = 25\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 1.0\text{ MHz}$	-	18.7	-	nF		
Reverse transfer capacitance	C_{res}		-	0.7	-			
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}$, $R_g = 4.7\text{ }\Omega$, $V_{GE} = 15\text{ V}$, $I_C = 600\text{ A}$, $V_{CC} = 600\text{ V}$, $V_P = 1200\text{ V}$	Full square					
Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C}$, $V_{GE} = 15\text{ V}$, $V_{CC} = 800\text{ V}$	-	-	10		μs	
SERIES DIODE								
Diode reverse recovery charge	Q_{rr}	$I_F = 50\text{ A}$, $V_R = 400\text{ V}$, $di/dt = -500\text{ A}/\mu\text{s}$	$T_J = 25\text{ }^\circ\text{C}$	-	3.0	-	μC	
Reverse recovery time	t_{rr}		$T_J = 125\text{ }^\circ\text{C}$	-	8.0	-	nS	
			$T_J = 25\text{ }^\circ\text{C}$	-	230	-		
Reverse recovery current	I_{rr}		$T_J = 25\text{ }^\circ\text{C}$	-	26	-	A	
			$T_J = 125\text{ }^\circ\text{C}$	-	43	-		
ANTIPARALLEL DIODE								
Diode reverse recovery charge	Q_{rr}	$I_F = 10\text{ A}$, $V_R = 400\text{ V}$, $di/dt = 500\text{ A}/\mu\text{s}$	$T_J = 25\text{ }^\circ\text{C}$	-	2.1	-	μC	
Reverse recovery time	t_{rr}		$T_J = 125\text{ }^\circ\text{C}$	-	3.4	-	ns	
			$T_J = 25\text{ }^\circ\text{C}$	-	175	-		
			$T_J = 125\text{ }^\circ\text{C}$	-	241	-		

THERMAL AND MECHANICAL SPECIFICATIONS								
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS		
Junction to case per 1/2 module	R_{thJC}		-	-	0.12	K/W		
			IGBT	-	-			0.16
			Series Diode	-	-			0.91
Case to sink	R_{thCS}	Conductive grease applied	-	0.035	-			
Mounting torque		Power terminal screw: M6	2.5 to 5.0			Nm		
		Mounting screw: M6	3.0 to 5.0					
Weight			300				g	

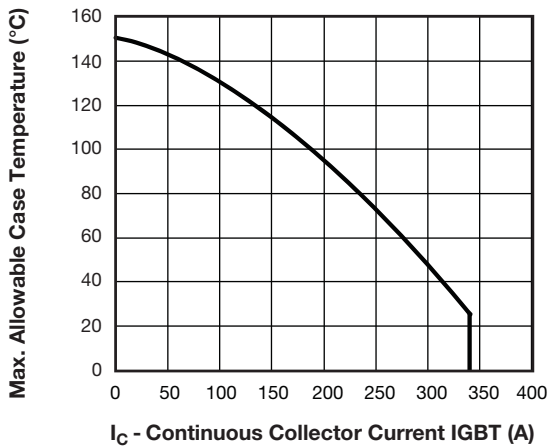


Fig. 1 - Maximum IGBT Continuous Collector Current vs. Case Temperature

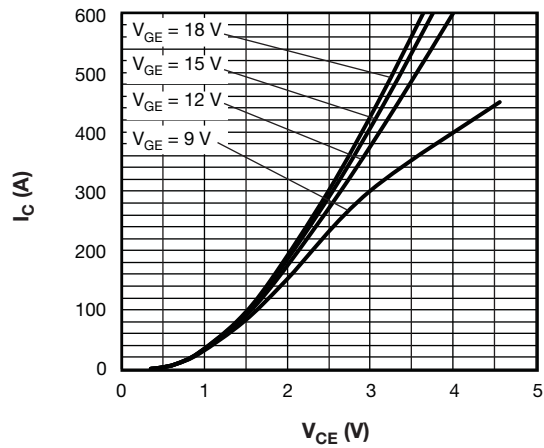


Fig. 4 - Typical IGBT Output Characteristics, $T_J = 150\text{ }^\circ\text{C}$

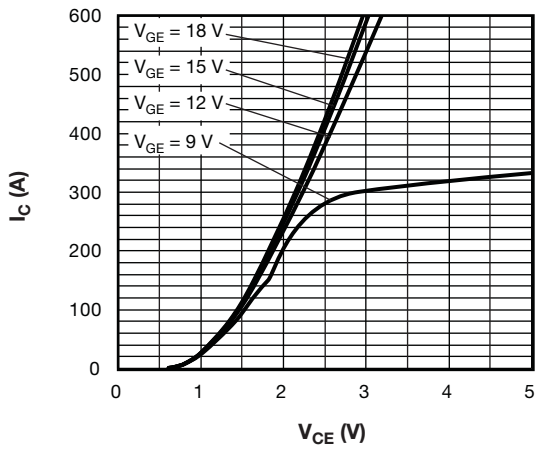


Fig. 2 - Typical IGBT Output Characteristics, $T_J = 25\text{ }^\circ\text{C}$

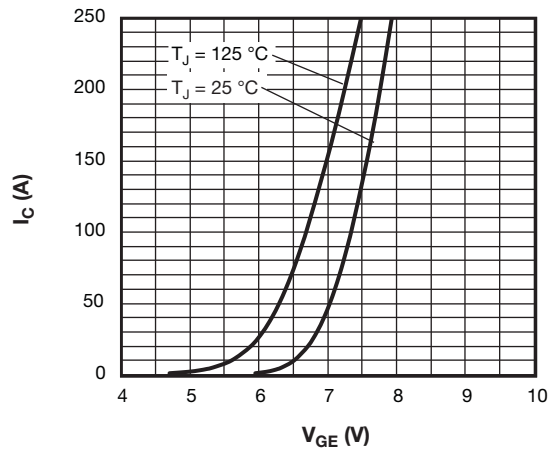


Fig. 5 - Typical IGBT Transfer Characteristics

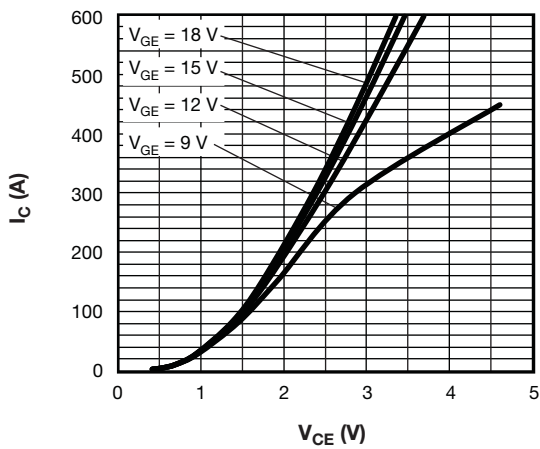


Fig. 3 - Typical IGBT Output Characteristics, $T_J = 125\text{ }^\circ\text{C}$

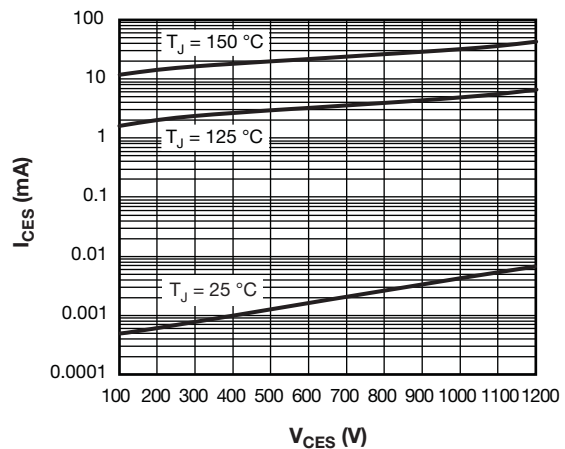


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

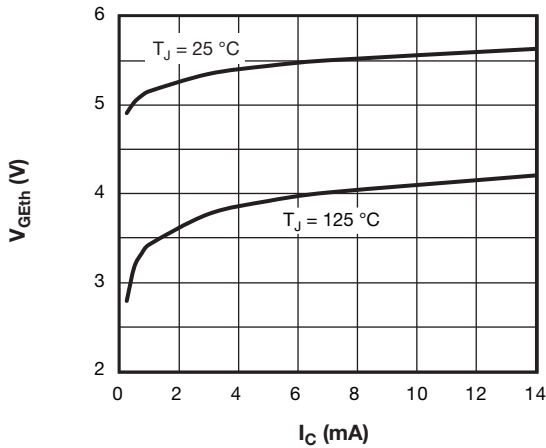


Fig. 7 - Typical IGBT Gate Threshold Voltage

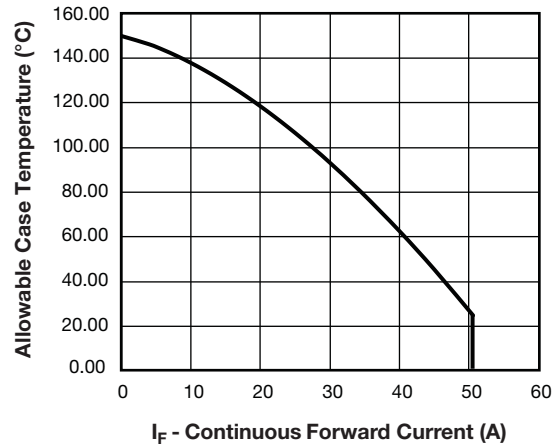


Fig. 10 - Maximum Continuous Forward Current vs. Case Temperature Antiparallel Diode

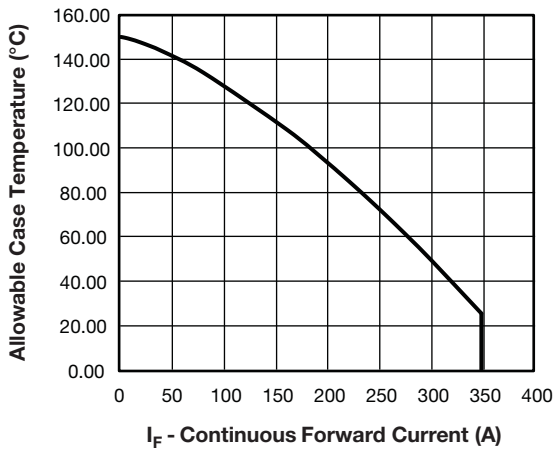


Fig. 8 - Maximum Continuous Forward Current vs. Case Temperature Series Diode

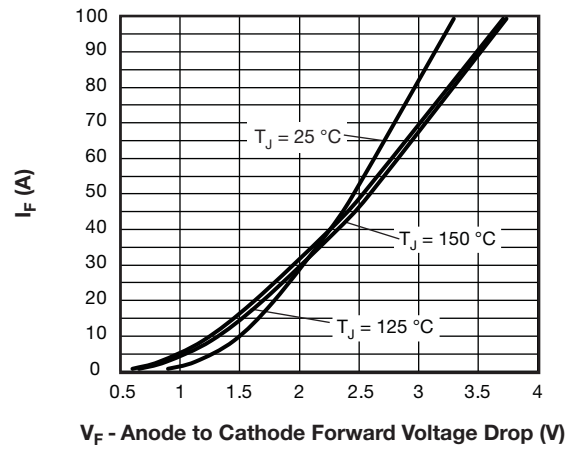


Fig. 11 - Typical Diode Forward Voltage Characteristics of Antiparallel Diode $t_p = 500 \mu s$

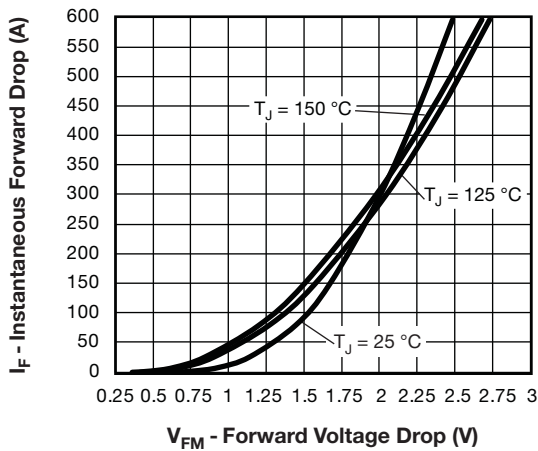


Fig. 9 - Typical Series Diode Forward Voltage

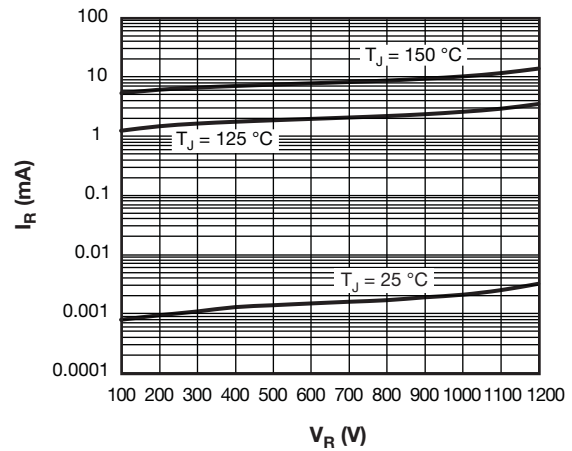


Fig. 12 - Typical Series Diode Leakage Current vs. Reverse Voltage

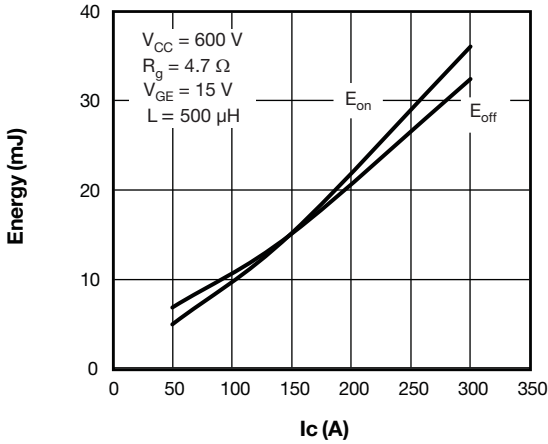


Fig. 13 - Typical IGBT Energy Loss vs. I_c , $T_J = 125$ °C - Freewheeling Diode VS-H3195D12A6B in TO-247 Package

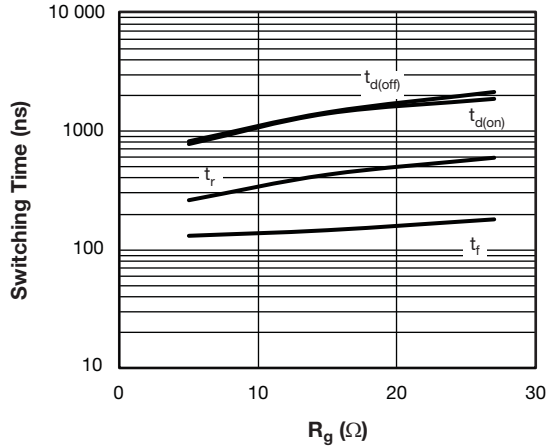


Fig. 16 - Typical IGBT Switching Time vs. R_g , $T_J = 125$ °C, $I_c = 100$ A, $V_{CE} = 360$ V, $V_{GE} = 15$ V, $L = 500$ μ H

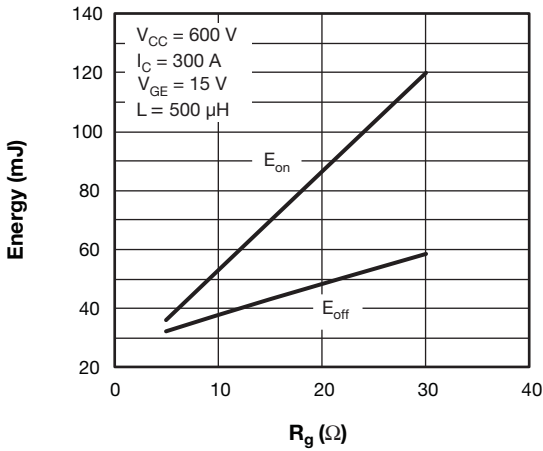


Fig. 14 - Typical IGBT Energy Loss vs. R_g , $T_J = 125$ °C - Freewheeling Diode VS-H3195D12A6B in TO-247 Package

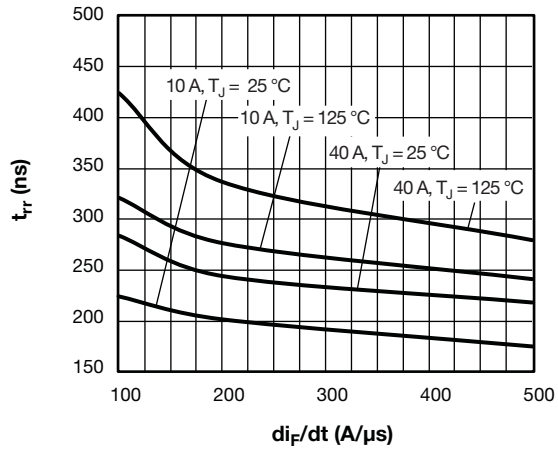


Fig. 17 - Typical t_{rr} Antiparallel Diode vs. di_F/dt , $V_{rr} = 400$ V

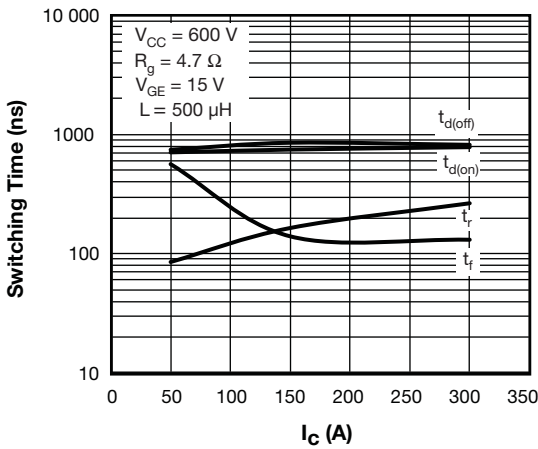


Fig. 15 - Typical IGBT Switching Time vs. I_c , $T_J = 125$ °C - Freewheeling Diode VS-H3195D12A6B in TO-247 Package

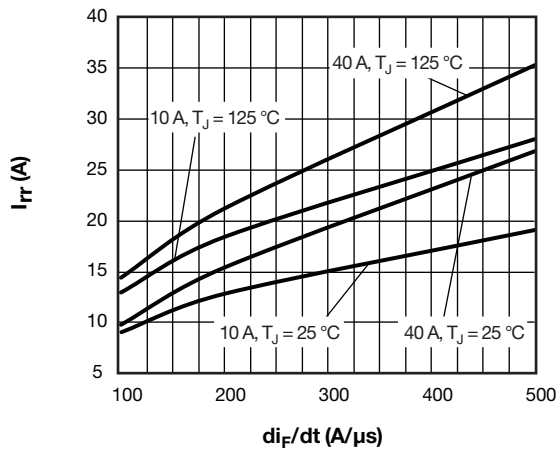


Fig. 18 - Typical I_{rr} Antiparallel Diode vs. di_F/dt , $V_{rr} = 400$ V

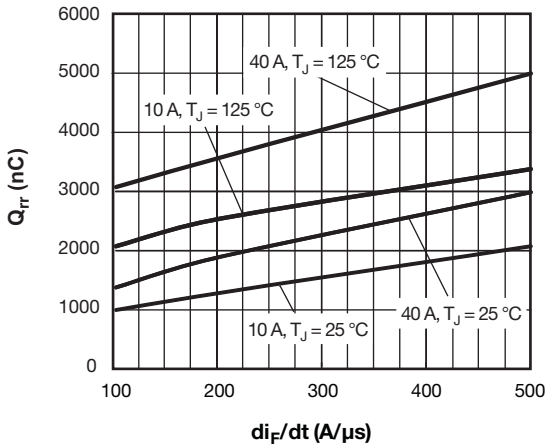


Fig. 19 - Typical Q_{rr} Antiparallel Diode vs. di_F/dt , $V_{rr} = 400$ V

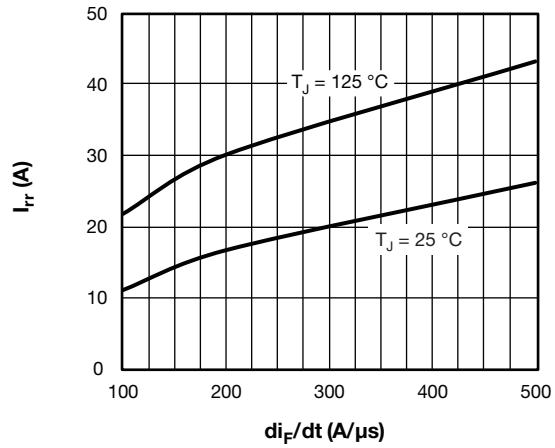


Fig. 21 - Typical I_{rr} Chopper Diode vs. di_F/dt , $V_{rr} = 400$ V, $I_F = 50$ A

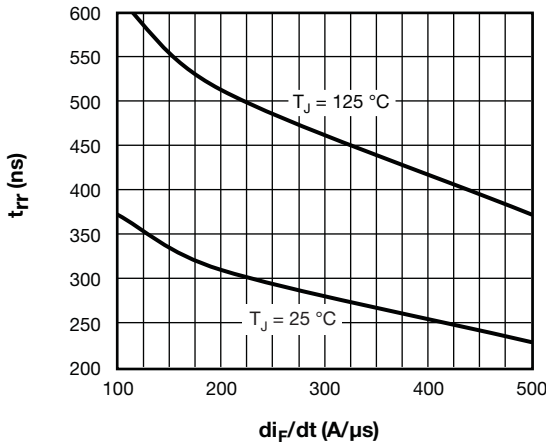


Fig. 20 - Typical t_{rr} Series Diode vs. di_F/dt , $V_{rr} = 400$ V, $I_F = 50$ A

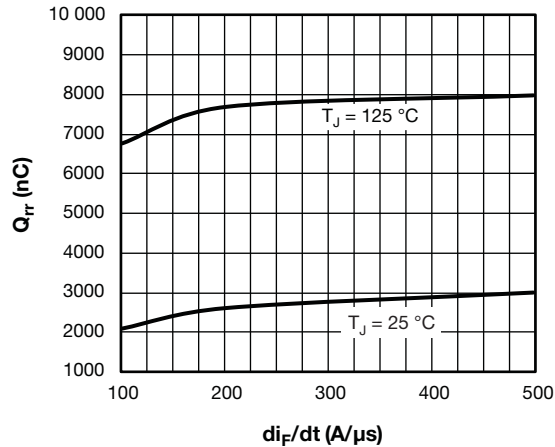


Fig. 22 - Typical Q_{rr} Chopper Diode vs. di_F/dt , $V_{rr} = 400$ V, $I_F = 40$ A

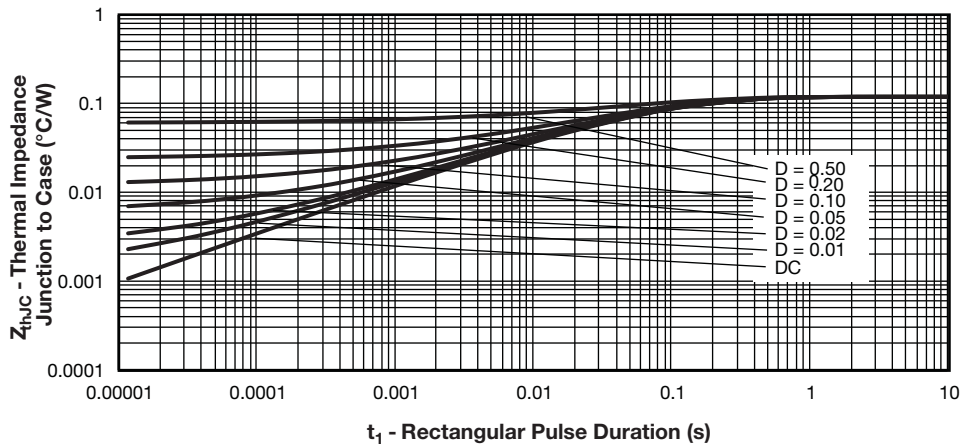


Fig. 23 - Maximum Thermal Impedance Z_{thJC} Characteristics IGBT

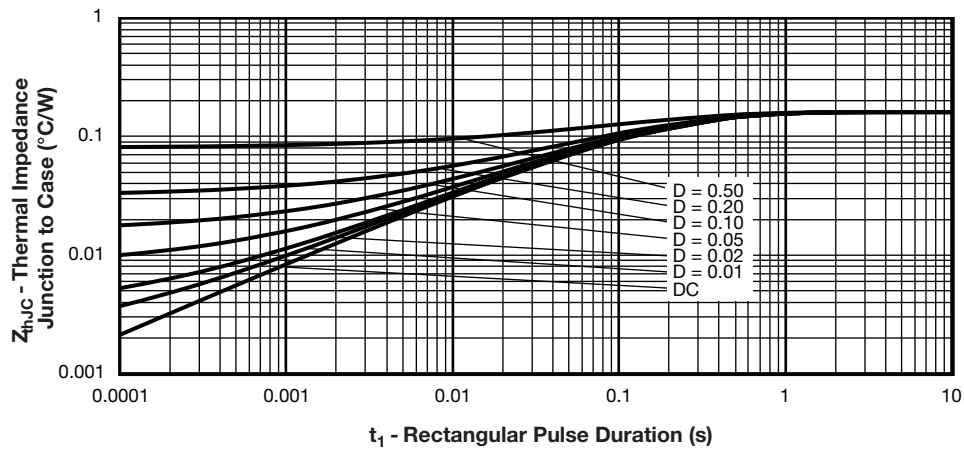


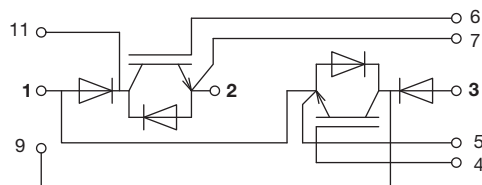
Fig. 24 - Maximum Thermal Impedance Z_{thJC} Characteristics Series Diode

ORDERING INFORMATION TABLE

Device code	VS-	G	T	300	Y	H	120	N
	①	②	③	④	⑤	⑥	⑦	⑧

- 1** - Vishay Semiconductors product
- 2** - Insulated Gate Bipolar Transistor (IGBT)
- 3** - T = trench IGBT technology
- 4** - Current rating (300 = 300 A)
- 5** - Y = current fed inverter
- 6** - Package indicator (dual INT-A-PAK)
- 7** - Voltage rating (120 = 1200 V)
- 8** - N = ultrafast

CIRCUIT CONFIGURATION





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