

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


RoHS
COMPLIANT

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

BENEFITS

- Short circuit ruggedness

REMARKS

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

PRIMARY CHARACTERISTICS	
IGBT	
V_{CES}	1200 V
$V_{CE(on)}$ (typical) at 300 A, 25 °C	1.93 V
$I_{D(DC)}$ at $T_C = 80\text{ °C}$	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

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	
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 °C unless otherwise noted)				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
ANTPARALLEL DIODE				
Continuous forward current	I _F ⁽²⁾	T _C = 80 °C	42	A
		T _C = 25 °C	57	
Peak repetitive forward current	I _{FSM}		n/a	A
Maximum power dissipation	P _D	T _C = 80 °C	106	W
		T _C = 25 °C	167	
MODULE				
RMS isolation voltage	V _{ISOL}	f = 50 Hz, t = 1 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 °C unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
IGBT						
Collector to emitter breakdown voltage	V _{(BR)CES}	V _{GE} = 0 V, I _C = 11.4 mA, T _J = 25 °C	1200	-	-	V
Collector to emitter saturation voltage	V _{CE(on)}	V _{GE} = 15 V, I _C = 300 A, T _J = 25 °C	-	1.93	-	
		V _{GE} = 15 V, I _C = 300 A, T _J = 125 °C	-	2.24	-	
		V _{GE} = 15 V, I _C = 300 A, T _J = 150 °C	-	2.32	-	
Gate to emitter threshold voltage	V _{GE(th)}	V _{CE} = V _{GE} , I _C = 11.4 mA, T _J = 25 °C	-	5.8	-	
Forward transconductance	g _{fe}	V _{CE} = 20 V, I _C = 300 A	-	130	-	S
Transfer characteristics	V _{GE}	V _{CE} = 20 V, I _C = 300 A	-	8.9	-	V
Collector to emitter leakage current	I _{CES}	V _{GE} = 0 V, V _{CE} = 1200 V	-	1.3	-	mA
		V _{GE} = 0 V, V _{CE} = 1200 V, T _J = 125 °C	-	0.95	-	
		V _{GE} = 0 V, V _{CE} = 1200 V, T _J = 150 °C	-	3.7	-	
Gate to emitter leakage current	I _{GES}	V _{GE} = ± 20 V	-	-	250	nA
SERIES DIODE						
Cathode to anode breakdown voltage	V _R	I _R = 1.0 mA, T _J = 125 °C	1200	-	-	V
Cathode to anode leakage current	I _R	V _R = 1200 V	-	0.05	0.2	mA
		V _R = 1200 V, T _J = 125 °C	-	3.5	-	
Forward voltage	V _F	I _F = 300 A	-	1.99	-	V
		I _F = 300 A, T _J = 125 °C	-	2.02	-	
ANTIPARALLEL DIODE						
Forward voltage	V _F	I _F = 10 A	-	1.6	-	V
		I _F = 10 A, T _J = 125 °C	-	1.4	-	
IGBT AND HEXFRED® SERIES DIODE						
Collector to emitter saturation voltage and Forward voltage	V _{CE(on)} + V _F	I _C = 300 A	-	3.92	-	V



SWITCHING CHARACTERISTICS (T _C = 25 °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 A, V _{CC} = 600 V, R _g = 4.7 Ω, L = 500 μH, V _{GE} = ± 15 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)}				-	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 A, V _{CC} = 600 V, R _g = 4.7 Ω, L = 500 μH, V _{GE} = ± 15 V, T _J = 125 °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)}				-	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 V, V _{GE} = 0 V, f = 1.0 MHz		-	18.7	-	nF	
Reverse transfer capacitance	C _{res}			-	0.7	-		
Reverse bias save operating area	RBSOA	T _J = 150 °C, R _g = 4.7 Ω, V _{GE} = 15 V, I _C = 600 A, V _{CC} = 600 V, V _P = 1200 V	Full square					
Short circuit save operating area	SCSOA	T _J = 150 °C, V _{GE} = 15 V, V _{CC} = 800 V	-	-	10	μs		
SERIES DIODE								
Diode reverse recovery charge	Q _{rr}	I _F = 50 A, V _R = 400 V, di/dt = -500 A/μs	T _J = 25 °C	-	3.0	-	μC	
			T _J = 125 °C	-	8.0	-		
Reverse recovery time	t _{rr}		T _J = 25 °C	-	230	-	nS	
			T _J = 125 °C	-	370	-		
Reverse recovery current	I _{rr}		T _J = 25 °C	-	26	-	A	
		T _J = 125 °C	-	43	-			
ANTIPARALLEL DIODE								
Diode reverse recovery charge	Q _{rr}	I _F = 10 A, V _R = 400 V, di/dt = 500 A/μs	T _J = 25 °C	-	2.1	-	μC	
			T _J = 125 °C	-	3.4	-		
Reverse recovery time	t _{rr}		T _J = 25 °C	-	175	-	ns	
			T _J = 125 °C	-	241	-		

THERMAL AND MECHANICAL SPECIFICATIONS							
PARAMETER		SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction to case per ½ module	IGBT	R _{thJC}		-	-	0.12	K/W
	Series Diode			-	-	0.16	
	Antiparallel 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

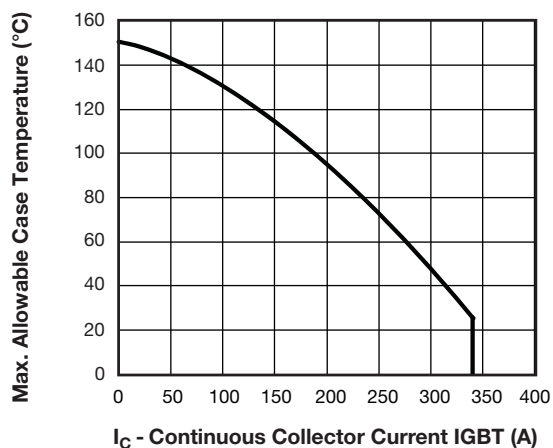


Fig. 1 - Maximum IGBT Continuous Collector Current vs. Case Temperature

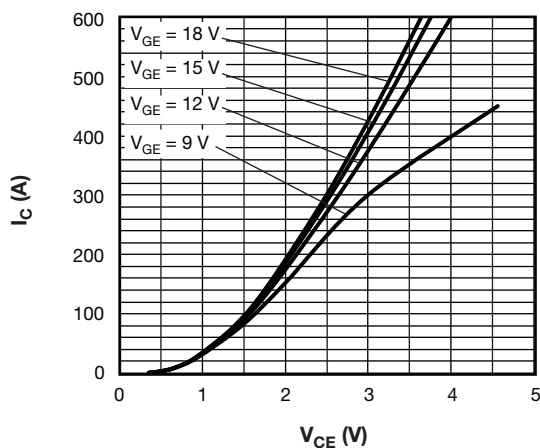


Fig. 4 - Typical IGBT Output Characteristics, $T_J = 150^\circ\text{C}$

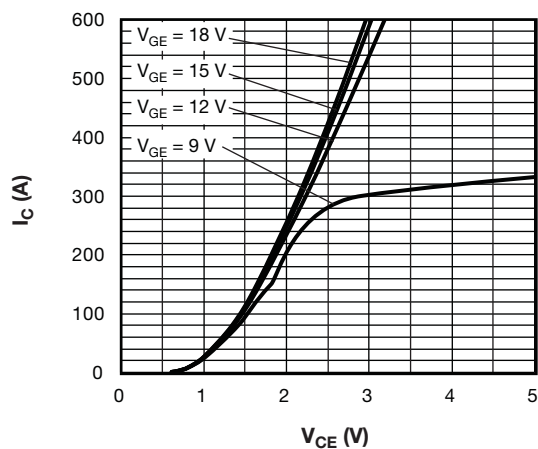


Fig. 2 - Typical IGBT Output Characteristics, $T_J = 25^\circ\text{C}$

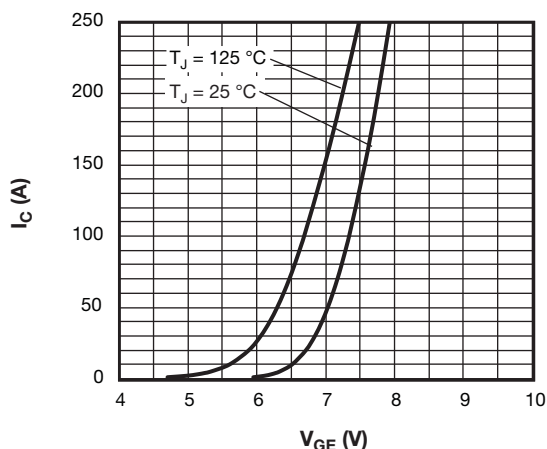


Fig. 5 - Typical IGBT Transfer Characteristics

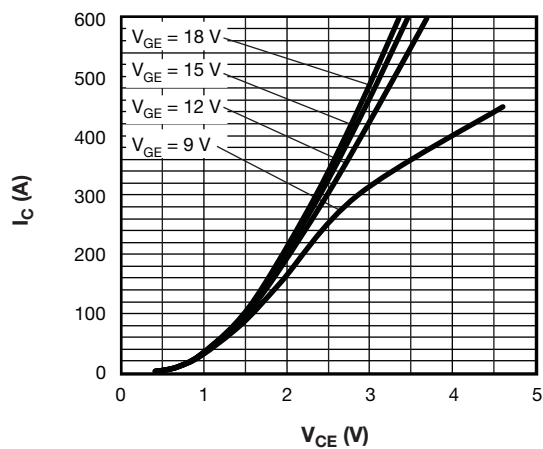


Fig. 3 - Typical IGBT Output Characteristics, $T_J = 125^\circ\text{C}$

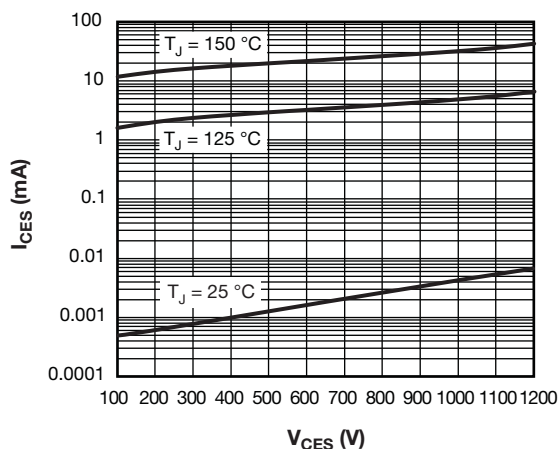


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

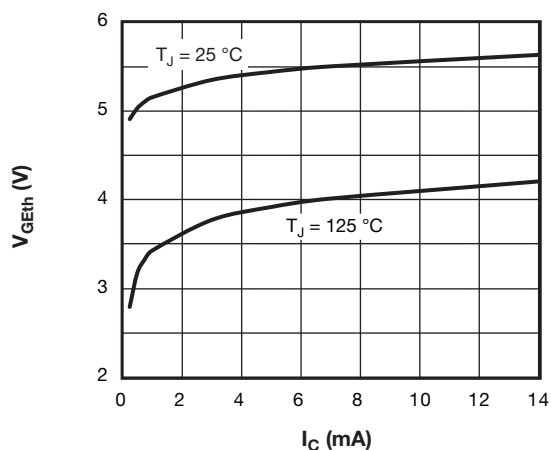


Fig. 7 - Typical IGBT Gate Threshold Voltage

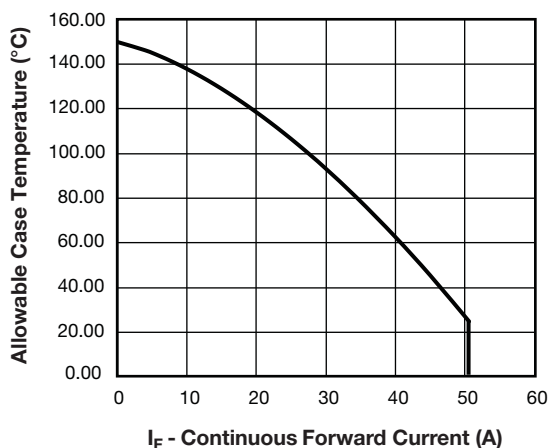


Fig. 10 - Maximum Continuous Forward Current vs. Case Temperature Antiparallel Diode

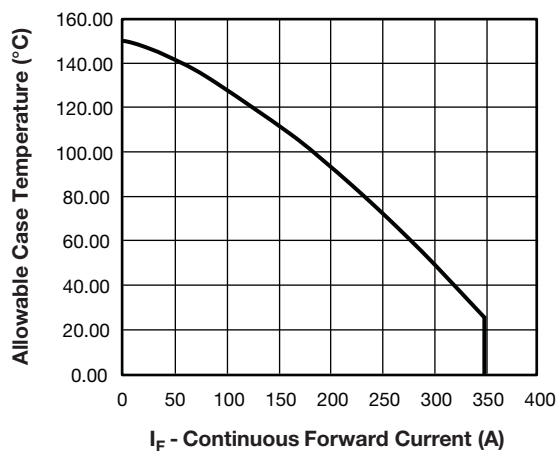


Fig. 8 - Maximum Continuous Forward Current vs. Case Temperature Series Diode

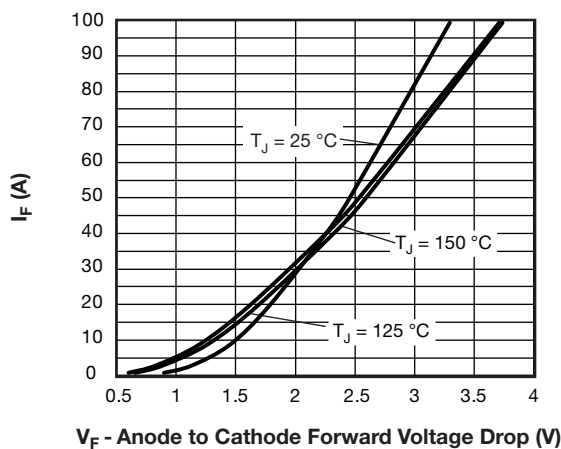
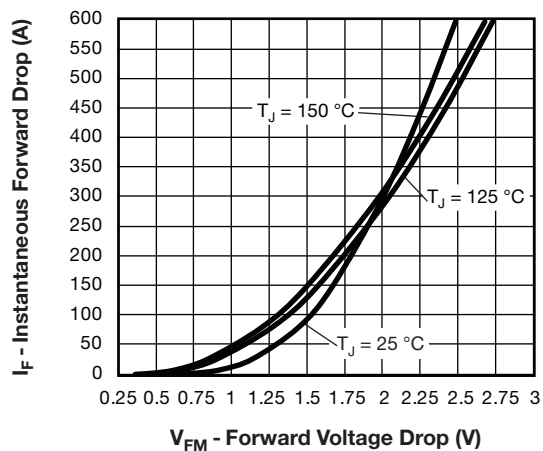

Fig. 11 - Typical Diode Forward Voltage Characteristics of Antiparallel Diode $t_p = 500 \mu s$


Fig. 9 - Typical Series Diode Forward Voltage

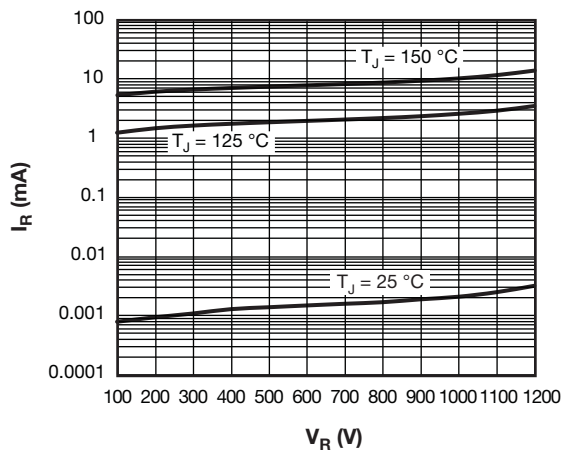


Fig. 12 - Typical Series Diode Leakage Current vs. Reverse Voltage

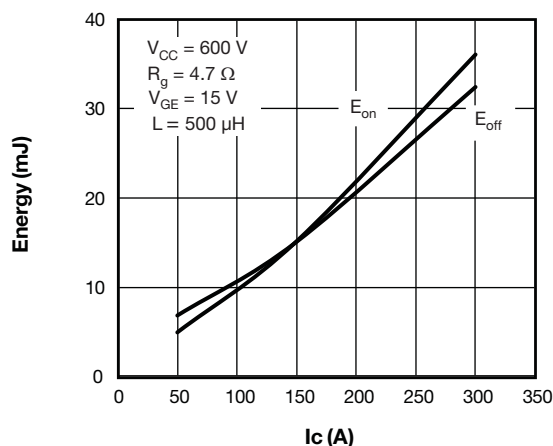


Fig. 13 - Typical IGBT Energy Loss vs. I_C , $T_J = 125$ $^{\circ}$ C - Freewheeling Diode VS-H3195D12A6B in TO-247 Package

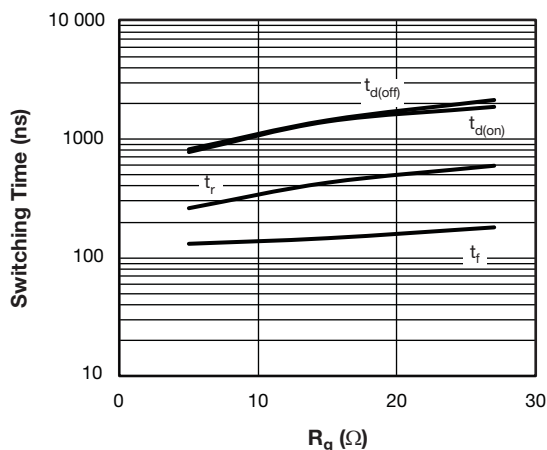


Fig. 16 - Typical IGBT Switching Time vs. R_g , $T_J = 125$ $^{\circ}$ C, $I_C = 100$ A, $V_{CE} = 360$ V, $V_{GE} = 15$ V, $L = 500$ μ H

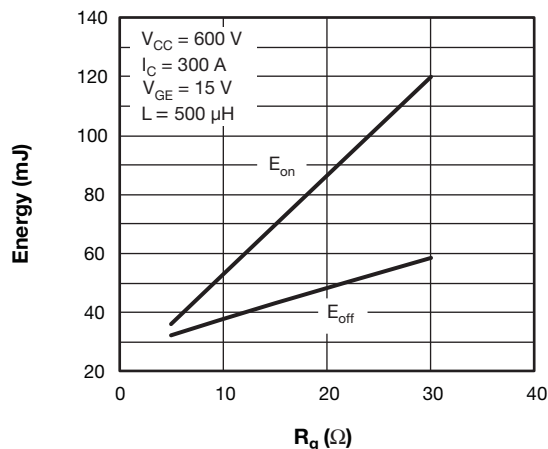


Fig. 14 - Typical IGBT Energy Loss vs. R_g , $T_J = 125$ $^{\circ}$ C - Freewheeling Diode VS-H3195D12A6B in TO-247 Package

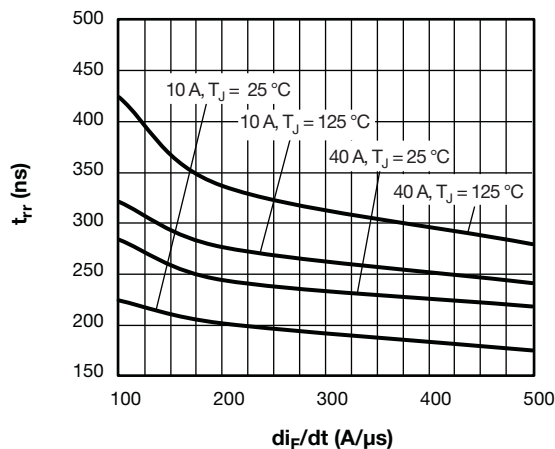


Fig. 17 - Typical t_{rr} Antiparallel Diode vs. di_F/dt , $V_{rr} = 400$ V

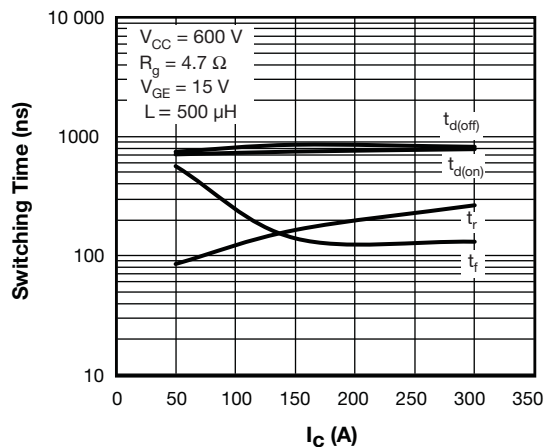


Fig. 15 - Typical IGBT Switching Time vs. I_C , $T_J = 125$ $^{\circ}$ C - Freewheeling Diode VS-H3195D12A6B in TO-247 Package

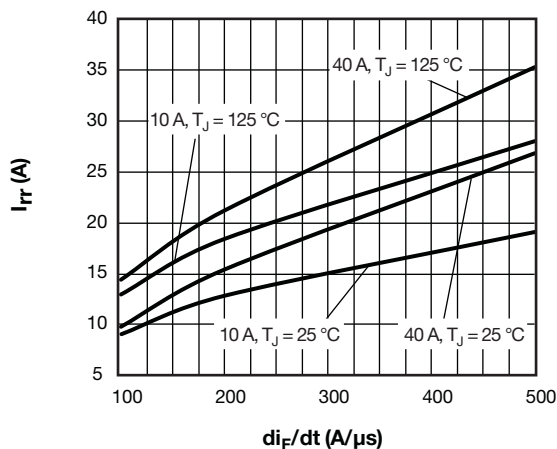
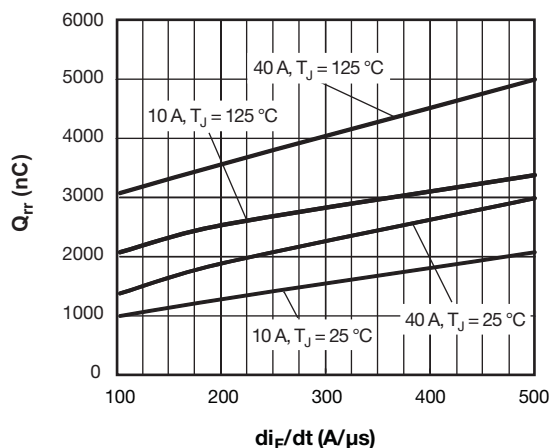
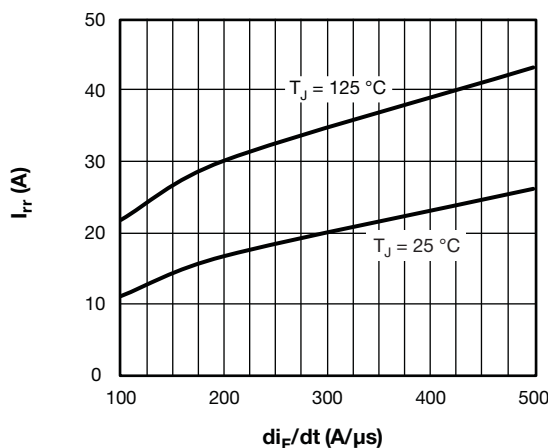
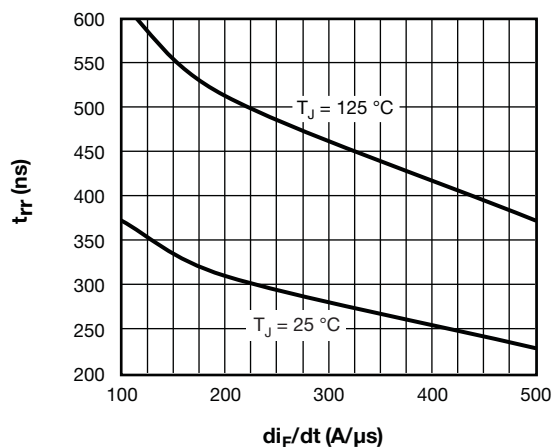
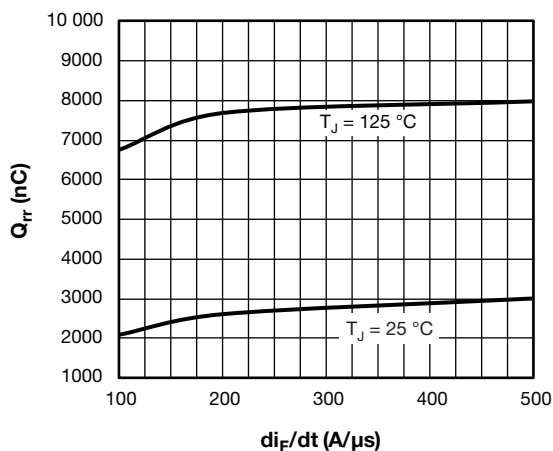
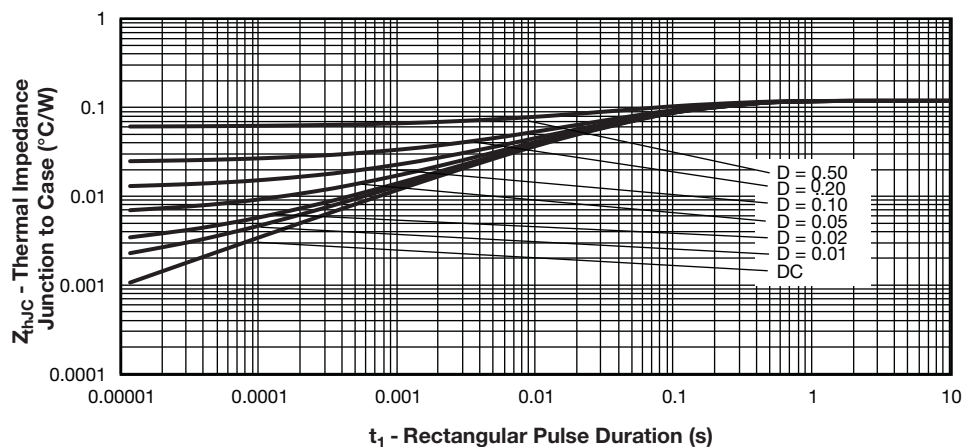


Fig. 18 - Typical I_{rr} Antiparallel Diode vs. di_F/dt , $V_{rr} = 400$ V


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

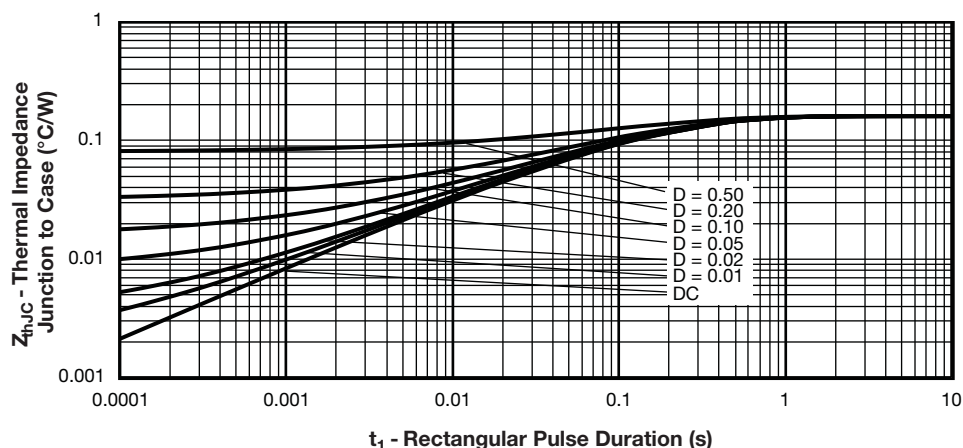
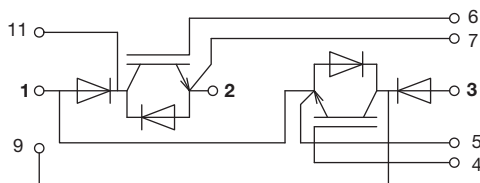


Fig. 24 - Maximum Thermal Impedance Z_{thJC} Characteristics Series Diode

ORDERING INFORMATION TABLE

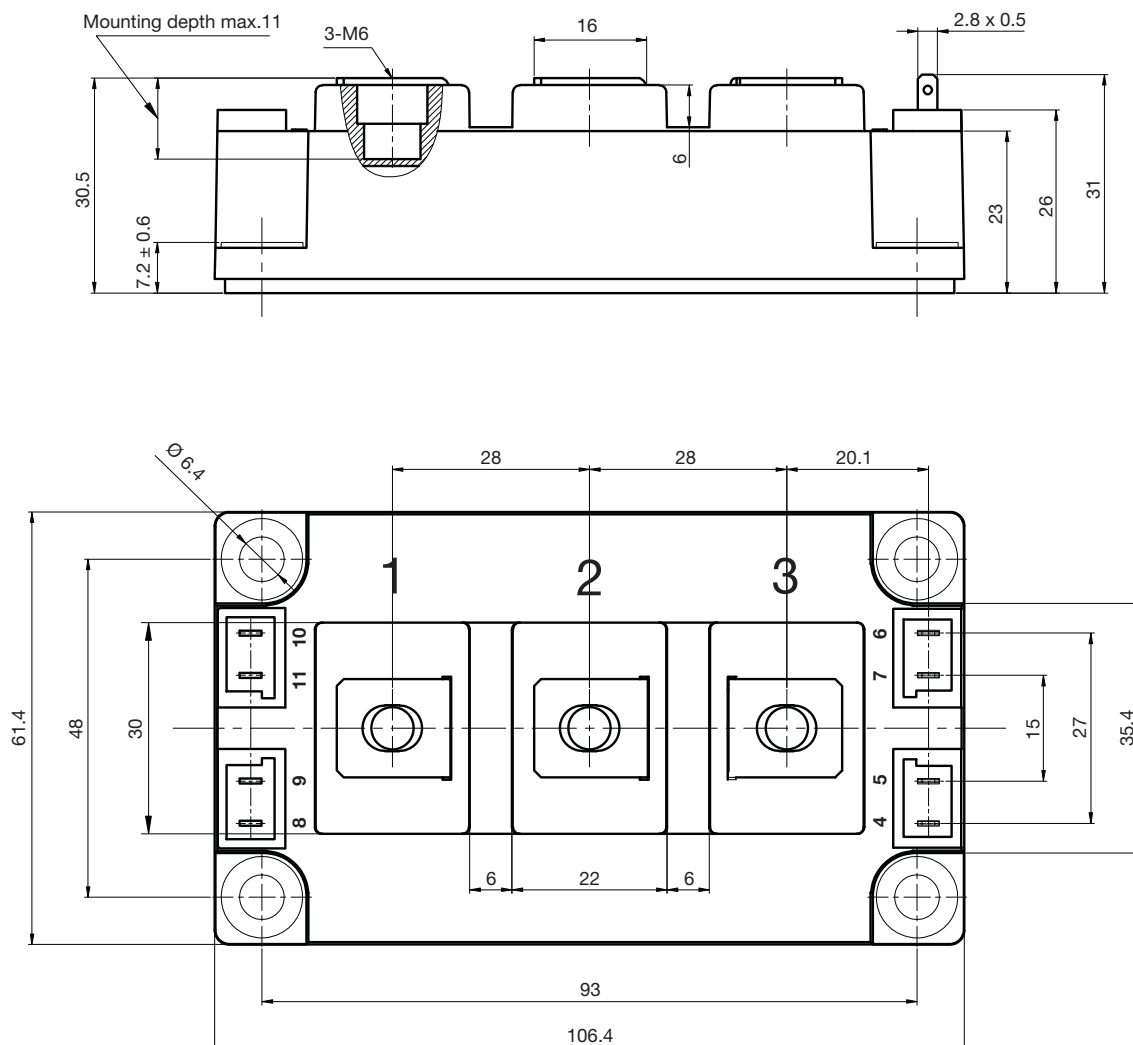
Device code	VS-	G	T	300	Y	H	120	N
	1	2	3	4	5	6	7	8
1	Vishay Semiconductors product							
2	Insulated Gate Bipolar Transistor (IGBT)							
3	T = trench IGBT technology							
4	Current rating (300 = 300 A)							
5	Y = current fed inverter							
6	Package indicator (dual INT-A-PAK)							
7	Voltage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

CIRCUIT CONFIGURATION





DIMENSIONS in millimeters





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