


“Full Bridge” IGBT MTP (Ultrafast NPT IGBT), 20 A



MTP

FEATURES

- Ultrafast non punch through (NPT) technology
- Positive $V_{CE(on)}$ temperature coefficient
- 10 μ s short circuit capability
- HEXFRED® antiparallel diodes with ultrasoft reverse recovery
- Low diode V_F
- Square RBSOA
- Al_2O_3 DBC substrate
- Very low stray inductance design for high speed operation
- UL approved file E78996 
- Designed and qualified for industrial level
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

PRIMARY CHARACTERISTICS	
V_{CES}	1200 V
I_C at $T_C = 96^\circ C$	20 A
$V_{CE(on)}$ (typical) at $I_C = 20$ A, $25^\circ C$	3.29 V
Speed	8 kHz to 30 kHz
Package	MTP
Circuit configuration	Full bridge

BENEFITS

- Optimized for welding, UPS and SMPS applications
- Rugged with ultrafast performance
- Outstanding ZVS and hard switching operation
- Low EMI, requires less snubbing
- Excellent current sharing in parallel operation
- Direct mounting to heatsink
- PCB solderable terminals
- Very low junction to case thermal resistance

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter breakdown voltage	V_{CES}		1200	V
Continuous collector current	I_C	$T_C = 96^\circ C$	20	A
Pulsed collector current	I_{CM}		100	
Clamped inductive load current	I_{LM}		100	
Diode maximum forward current	I_{FM}		100	
Gate to emitter voltage	V_{GE}		± 20	
RMS isolation voltage	V_{ISOL}	Any terminal to case, $t = 1$ min	2500	W
Maximum power dissipation (only IGBT)	P_D	$T_C = 25^\circ C$	240	
		$T_C = 100^\circ C$	96	
Operating junction temperature range	T_J		-40 to +150	$^\circ C$



ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{ V}, I_C = 250\text{ }\mu\text{A}$	1200	-	-	V
Temperature coefficient of breakdown voltage	$\Delta V_{(BR)CES}/\Delta T_J$	$V_{GE} = 0\text{ V}, I_C = 3\text{ mA}$ (25 to 125 °C)	-	+1.3	-	V/°C
Collector to emitter saturation voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$	-	3.29	3.59	V
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$	-	4.42	4.66	
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	3.87	4.11	
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	5.32	5.70	
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	3.99	4.27	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	4	-	6	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 3\text{ mA}$ (25 to 125 °C)	-	-14	-	mV/°C
Transconductance	g_{fe}	$V_{CE} = 50\text{ V}, I_C = 20\text{ A}, PW = 80\text{ }\mu\text{s}$	-	17.5	-	S
Zero gate voltage collector current	$I_{CES}^{(1)}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 25\text{ }^\circ\text{C}$	-	-	250	μA
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.7	3.0	mA
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	2.9	9.0	
Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 250	nA

Note

(1) I_{CES} includes also opposite leg overall leakage

SWITCHING CHARACTERISTICS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Total gate charge (turn-on)	Q_g	$I_C = 20\text{ A}$ $V_{CC} = 600\text{ V}$ $V_{GE} = 15\text{ V}$	-	176	264	nC
Gate to emitter charge (turn-on)	Q_{ge}		-	19	30	
Gate to collector charge (turn-on)	Q_{gc}		-	89	134	
Turn-on switching loss	E_{on}	$V_{CC} = 600\text{ V}, I_C = 20\text{ A}, V_{GE} = 15\text{ V},$ $R_g = 5\text{ }\Omega, L = 200\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C},$ energy losses include tail and diode reverse recovery	-	0.513	0.770	mJ
Turn-off switching loss	E_{off}		-	0.402	0.603	
Total switching loss	E_{tot}		-	0.915	1.373	
Turn-on switching loss	E_{on}	$V_{CC} = 600\text{ V}, I_C = 20\text{ A}, V_{GE} = 15\text{ V},$ $R_g = 5\text{ }\Omega, L = 200\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C},$ energy losses include tail and diode reverse recovery	-	0.930	1.395	mJ
Turn-off switching loss	E_{off}		-	0.610	0.915	
Total switching loss	E_{tot}		-	1.540	2.310	
Input capacitance	C_{ies}	$V_{GE} = 0\text{ V}$ $V_{CC} = 30\text{ V}$ $f = 1.0\text{ MHz}$	-	2530	3790	pF
Output capacitance	C_{oes}		-	344	516	
Reverse transfer capacitance	C_{res}		-	78	117	
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 120\text{ A}$ $V_{CC} = 1000\text{ V}, V_p = 1200\text{ V}$ $R_g = 5\text{ }\Omega, V_{GE} = +15\text{ V to }0\text{ V}$	Fullsquare			
Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C}$ $V_{CC} = 900\text{ V}, V_p = 1200\text{ V}$ $R_g = 5\text{ }\Omega, V_{GE} = +15\text{ V to }0\text{ V}$	10	-	-	μs

DIODE SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Diode forward voltage drop	V_{FM}	$I_C = 20\text{ A}$	-	2.48	2.94	V
		$I_C = 40\text{ A}$	-	3.28	3.90	
		$I_C = 20\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.44	2.84	
		$I_C = 40\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	3.45	4.14	
		$I_C = 20\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	2.21	2.93	
Reverse recovery energy of the diode	E_{rec}	$V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 200\text{ }\mu\text{H}$ $V_{CC} = 600\text{ V}, I_C = 20\text{ A}$ $T_J = 125\text{ }^\circ\text{C}$	-	420	630	μJ
Diode reverse recovery time	t_{rr}		-	98	150	ns
Peak reverse recovery current	I_{rr}		-	33	50	A



THERMAL AND MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating junction temperature range	T_J		-40	-	150	$^{\circ}\text{C}$
Storage temperature range	T_{Stg}		-40	-	125	$^{\circ}\text{C}$
Junction to case	IGBT	R_{thJC}	-	0.53	0.64	$^{\circ}\text{C}/\text{W}$
	Diode		-	0.69	0.83	
Case to sink per module	R_{thCS}	Heatsink compound thermal conductivity = 1 W/mK	-	0.06	-	
Clearance		External shortest distance in air between 2 terminals	5.5	-	-	
Creepage		Shortest distance along external surface of the insulating material between 2 terminals	8	-	-	mm
Mounting torque		A mounting compound is recommended and the torque should be checked after 3 hours to allow for the spread of the compound. Lubricated threads.	3 ± 10 %			Nm
Weight			66			g

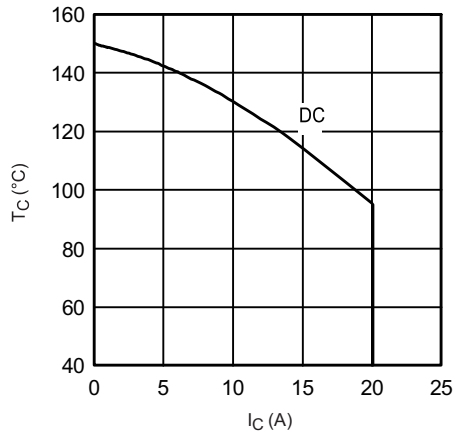


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

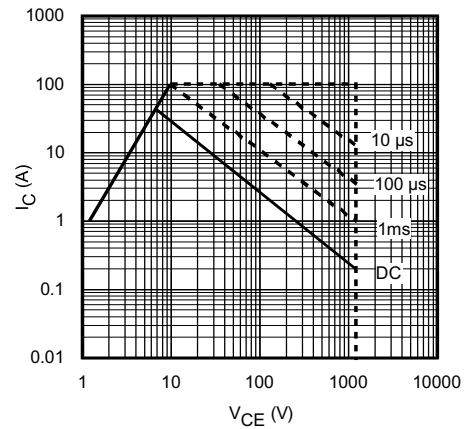


Fig. 3 - Forward SOA
 $T_C = 25^{\circ}\text{C}$; $T_J \leq 150^{\circ}\text{C}$

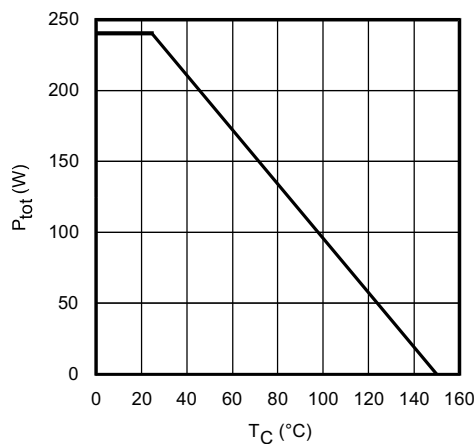


Fig. 2 - Power Dissipation vs. Case Temperature

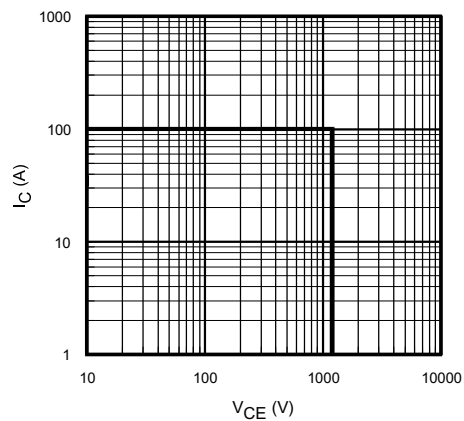


Fig. 4 - Reverse Bias SOA
 $T_J = 150^{\circ}\text{C}$; $V_{GE} = 15\text{V}$

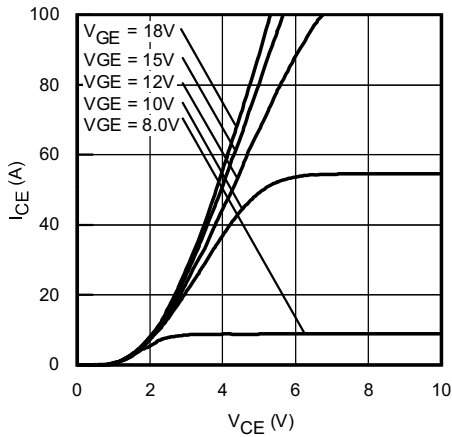


Fig. 5 - Typical IGBT Output Characteristics
 $T_J = -40\text{ }^\circ\text{C}$; $t_p = 80\text{ }\mu\text{s}$

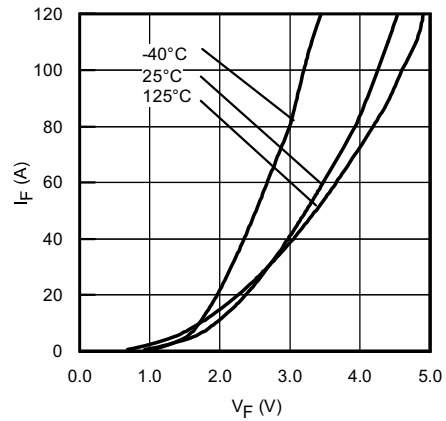


Fig. 8 - Typical Diode Forward Characteristics
 $t_p = 80\text{ }\mu\text{s}$

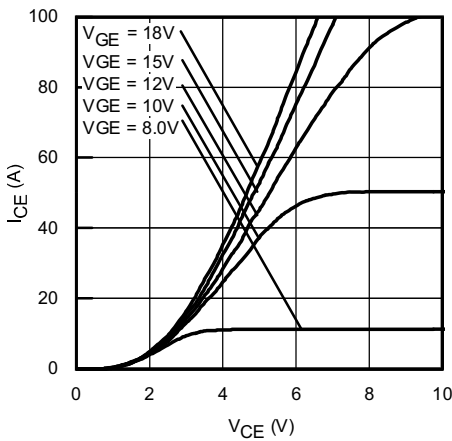


Fig. 6 - Typical IGBT Output Characteristics
 $T_J = 25\text{ }^\circ\text{C}$; $t_p = 80\text{ }\mu\text{s}$

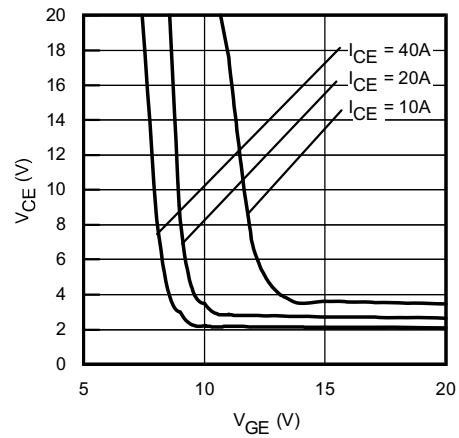


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40\text{ }^\circ\text{C}$

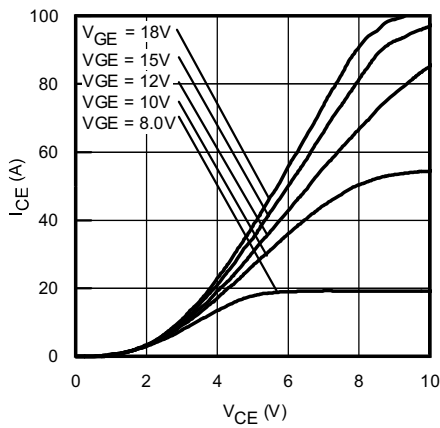


Fig. 7 - Typical IGBT Output Characteristics
 $T_J = 125\text{ }^\circ\text{C}$; $t_p = 80\text{ }\mu\text{s}$

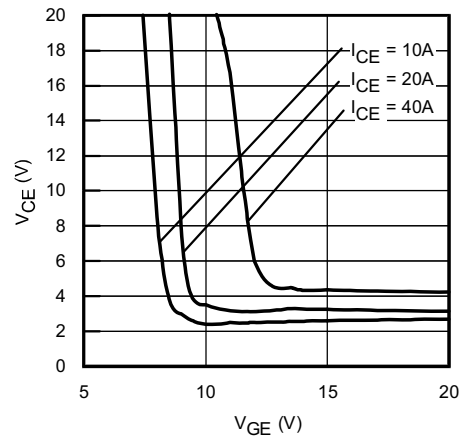


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25\text{ }^\circ\text{C}$

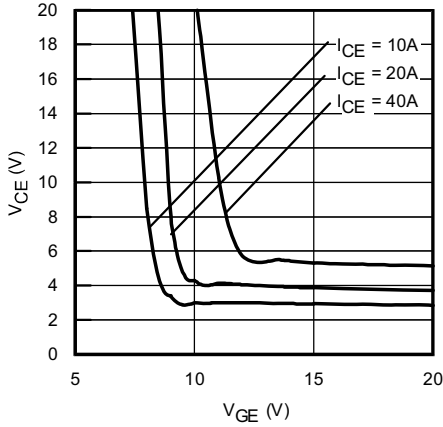


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 125^\circ\text{C}$

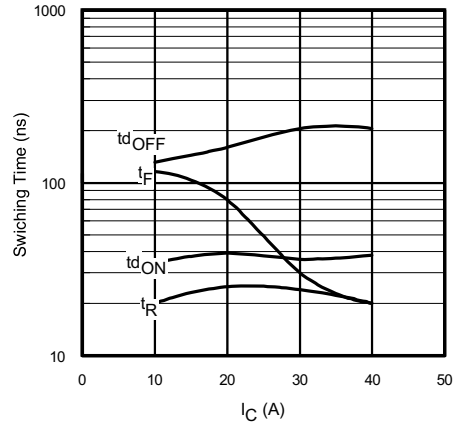


Fig. 14 - Typical Switching Time vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 1.4\text{ mH}$; $V_{CE} = 400\text{ V}$
 $R_g = 100\ \Omega$; $V_{GE} = 15\text{ V}$

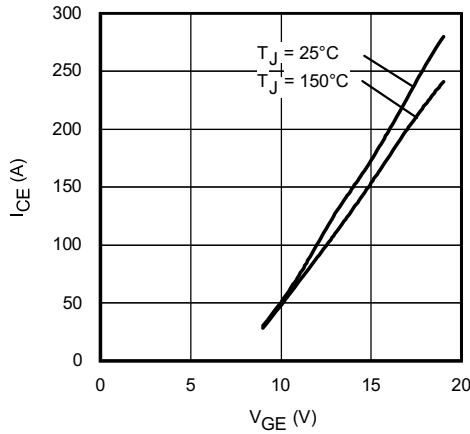


Fig. 12 - Typical Transfer Characteristics
 $V_{CE} = 50\text{ V}$; $t_p = 10\ \mu\text{s}$

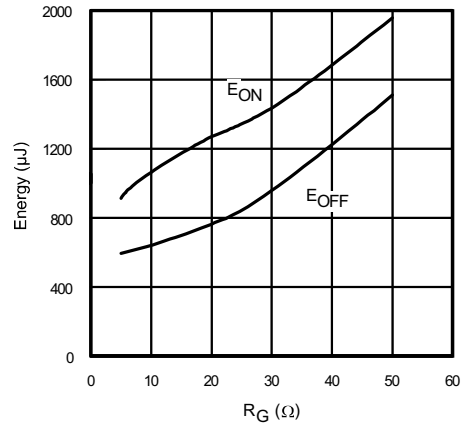


Fig. 15 - Typical Energy Loss vs. R_g
 $T_J = 150^\circ\text{C}$; $L = 1.4\text{ mH}$; $V_{CE} = 400\text{ V}$
 $I_{CE} = 5.0\text{ A}$; $V_{GE} = 15\text{ V}$

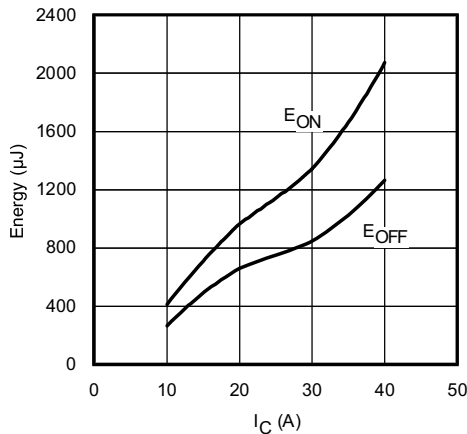


Fig. 13 - Typical Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 1.4\text{ mH}$; $V_{CE} = 400\text{ V}$
 $R_g = 5\ \Omega$; $V_{GE} = 15\text{ V}$

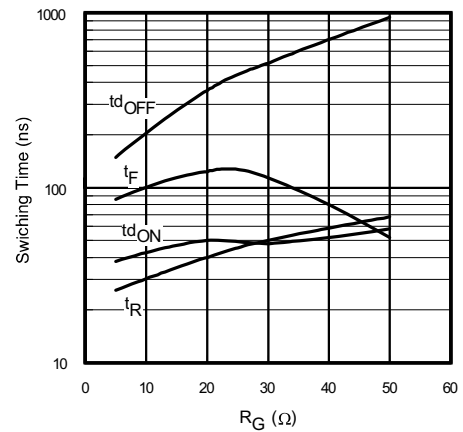


Fig. 16 - Typical Switching Time vs. R_g
 $T_J = 150^\circ\text{C}$; $L = 1.4\text{ mH}$; $V_{CE} = 400\text{ V}$
 $I_{CE} = 5.0\text{ A}$; $V_{GE} = 15\text{ V}$

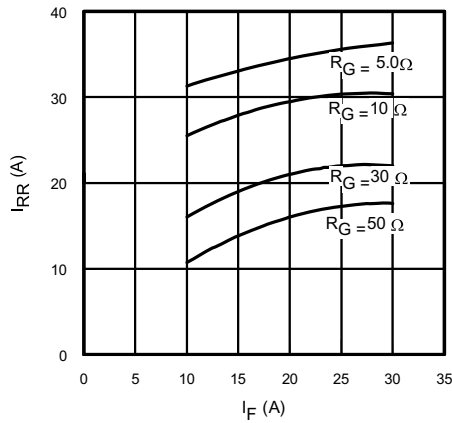


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 150\text{ }^\circ\text{C}$

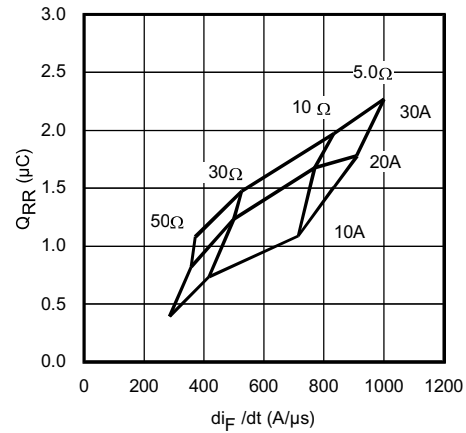


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC} = 400\text{ V}$; $V_{GE} = 15\text{ V}$; $T_J = 150\text{ }^\circ\text{C}$

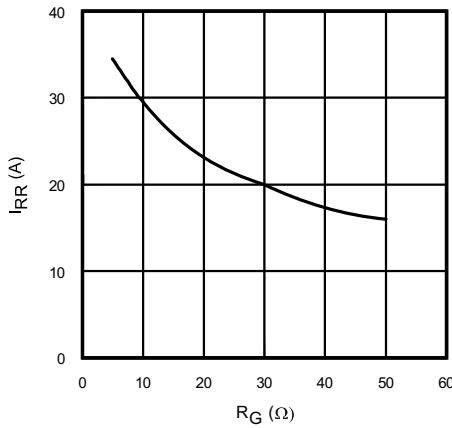


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 150\text{ }^\circ\text{C}$; $I_F = 5.0\text{ A}$

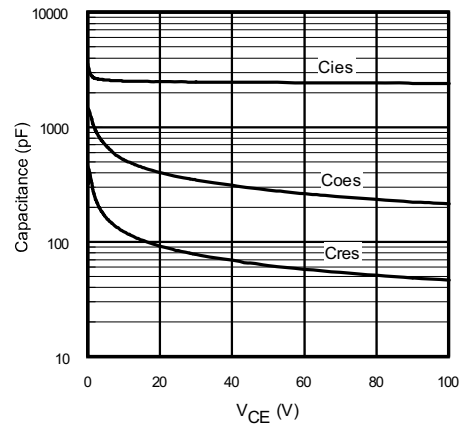


Fig. 21 - Typical Capacitance vs. V_{CE}
 $V_{GE} = 0\text{ V}$; $f = 1\text{ MHz}$

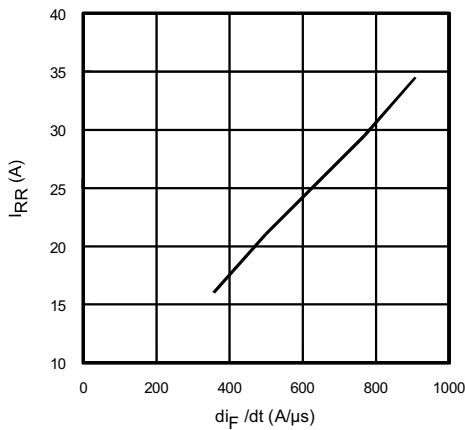


Fig. 19 - Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 400\text{ V}$; $V_{GE} = 15\text{ V}$; $I_{CE} = 5.0\text{ A}$; $T_J = 150\text{ }^\circ\text{C}$

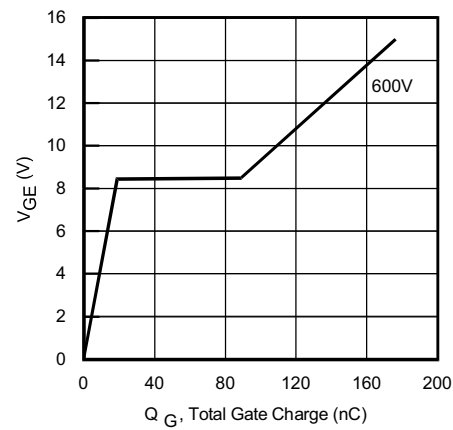


Fig. 22 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 5.0\text{ A}$; $L = 600\text{ }\mu\text{H}$

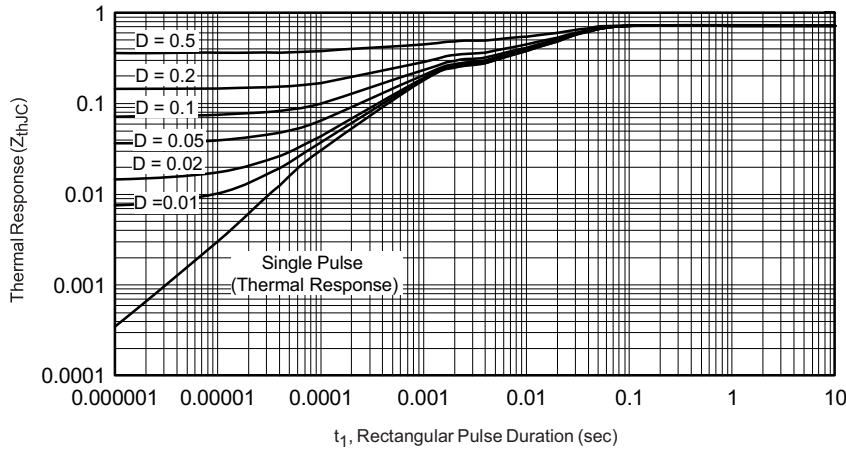


Fig. 23 - Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

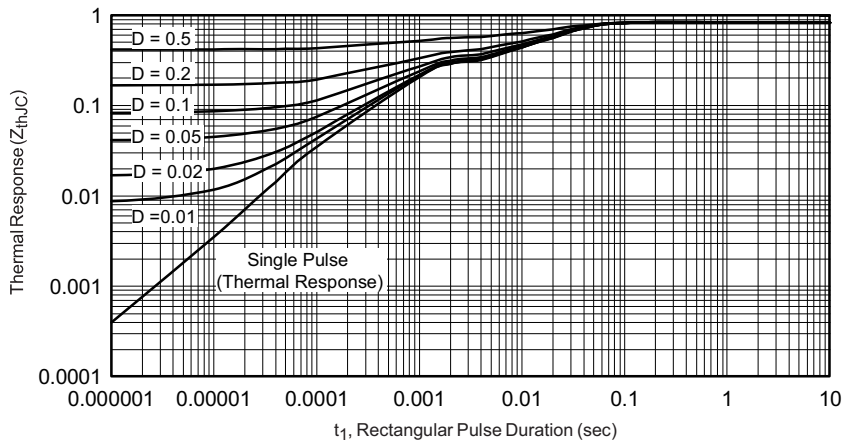


Fig. 24 - Maximum Transient Thermal Impedance, Junction-to-Case (Diode)

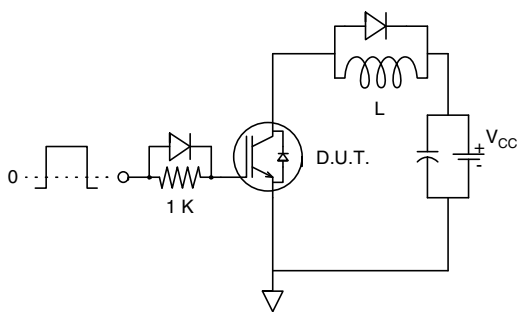


Fig. 25 - Gate Charge Circuit (Turn-Off)

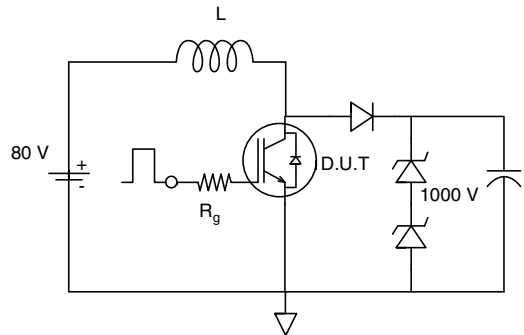


Fig. 26 - RBSOA Circuit

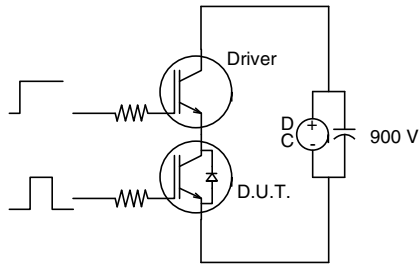


Fig. 27 - S.C. SOA Circuit

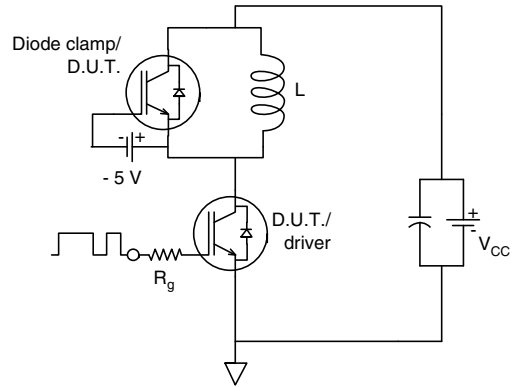


Fig. 28 - Switching Loss Circuit

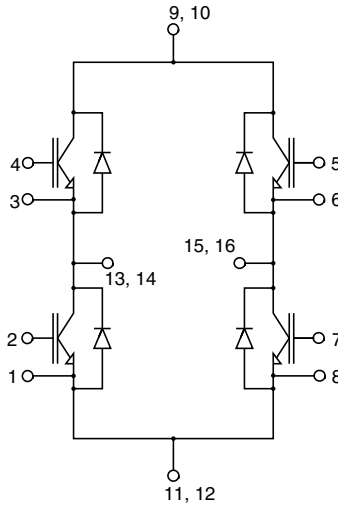


Fig. 29 - Electrical diagram

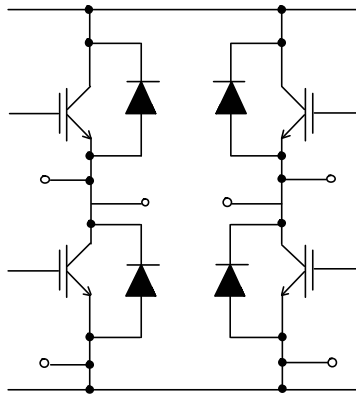
ORDERING INFORMATION TABLE

Device code	VS-	20	MT	120	U	F	A	PbF
	1	2	3	4	5	6	7	8

- 1** - Vishay Semiconductors product
- 2** - Current rating (20 = 20 A)
- 3** - Essential part number
- 4** - Voltage code (120 = 1200 V)
- 5** - Speed / type (U = ultrafast IGBT)
- 6** - Circuit configuration (F = full bridge)
- 7** - A = Al₂O₃ DBC substrate
- 8** - Lead (Pb)-free



CIRCUIT CONFIGURATION



LINKS TO RELATED DOCUMENTS

LINKS TO RELATED DOCUMENTS	
Dimensions	www.vishay.com/doc?95245



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