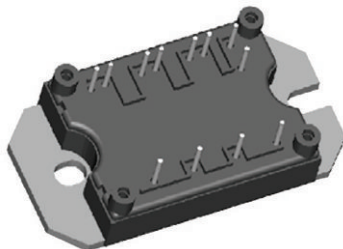





**THE DATASHEET OF
VS-40MT120PHAPBF**



“Half Bridge” MTP Trench IGBT, 75 A


MTP
FEATURES

- Trench gate field stop technology
- Positive $V_{CE(on)}$ temperature coefficient
- 5 μ s short circuit capability
- Square RBSOA
- HEXFRED® antiparallel diodes with ultrasoft reverse recovery and low V_F
- Al_2O_3 DBC
- 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*
Available

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

PRIMARY CHARACTERISTICS

V_{CES}	1200 V
$V_{CE(on)}$ typical at $I_C = 40$ A	2.24 V
I_C at $T_C = 25$ °C	75 A
Speed	8 kHz to 30 kHz
Package	MTP
Circuit configuration	Half bridge

BENEFITS

- Optimized for welding, UPS and SMPS applications
- Rugged with ultrafast performance
- Benchmark efficiency above 20 kHz
- 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	$T_C = 25$ °C	75	A
		$T_C = 102$ °C	40	
Pulsed collector current	I_{CM}	$T_J = 150$ °C, $t_p = 6$ ms, $V_{GE} = 15$ V	150	
Clamped inductive load current	I_{LM}		120	
Diode continuous forward current	I_F	$T_C = 105$ °C	21	
Diode maximum forward current	I_{FM}		160	
Gate to emitter voltage	V_{GE}		± 20	
RMS isolation voltage	V_{ISOL}	Any terminal to case, $t = 1$ min	2500	
Maximum power dissipation (only IGBT)	P_D	$T_C = 25$ °C	305	W
		$T_C = 100$ °C	122	



ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{ V}, I_C = 2\text{ mA}$	1200	-	-	V
Collector to emitter saturation voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$	-	2.24	2.65	V
		$V_{GE} = 15\text{ V}, I_C = 80\text{ A}$	-	2.84	-	
		$V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	2.53	-	
		$V_{GE} = 15\text{ V}, I_C = 80\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	3.44	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 2\text{ mA}$	4.6	5.9	7.6	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 2\text{ mA}$ ($25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$)	-	-13	-	mV/ $^\circ\text{C}$
Transconductance	g_{fe}	$V_{CE} = 50\text{ V}, I_C = 40\text{ A}$	-	29	-	S
Zero gate voltage collector current	I_{CES}	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 25\text{ }^\circ\text{C}$	-	0.6	50	μA
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.31	-	mA
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	1.16	-	mA
Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 250	nA

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	$I_C = 40\text{ A}$ $V_{CC} = 960\text{ V}$ $V_{GE} = 15\text{ V}$	-	158	-	nC
Gate to emitter charge (turn-on)	Q_{ge}		-	17	-	
Gate to collector charge (turn-on)	Q_{gc}		-	85	-	
Turn-on switching loss	E_{on}	$V_{CC} = 600\text{ V}, I_C = 40\text{ A}, V_{GE} = 15\text{ V},$ $R_g = 5\text{ }\Omega, L = 200\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C},$ energy losses include tail and diode reverse recovery	-	0.76	-	mJ
Turn-off switching loss	E_{off}		-	1.14	-	
Total switching loss	E_{tot}		-	1.9	-	
Turn-on switching loss	E_{on}		-	1.02	-	
Turn-off switching loss	E_{off}		-	1.83	-	
Total switching loss	E_{tot}	-	2.85	-		
Input capacitance	C_{ies}	$V_{GE} = 0\text{ V}$ $V_{CC} = 25\text{ V}$ $f = 1.0\text{ MHz}$	-	3200	-	pF
Output capacitance	C_{oes}		-	220	-	
Reverse transfer capacitance	C_{res}		-	80	-	
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 120\text{ A}$ $V_{CC} = 800\text{ V}, V_p = 1200\text{ V}$ $R_g = 10\text{ }\Omega, V_{GE} = +15\text{ V to }0\text{ V}$	Fullsquare			
Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C},$ $V_{CC} = 600\text{ V}, V_p = 1200\text{ V}$ $V_{GE} = +15\text{ V to }0\text{ V}$	5	-	-	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}	$I_C = 40\text{ A}$	-	2.98	3.38	V
		$I_C = 80\text{ A}$	-	3.90	-	
		$I_C = 40\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	3.08	-	
		$I_C = 80\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	4.29	-	
		$I_C = 40\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	3.12	-	
Reverse recovery energy of the diode	E_{rec}	$V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 200\text{ }\mu\text{H}$ $V_{CC} = 600\text{ V}, I_C = 40\text{ A}$ $T_J = 125\text{ }^\circ\text{C}$	-	574	-	μJ
Diode reverse recovery time	t_{rr}		-	120	-	ns
Peak reverse recovery current	I_{rr}		-	43	-	A



THERMAL AND MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range	T_J, T_{Stg}		-40	-	150	°C
Junction to case	IGBT		-	-	0.41	°C/W
	Diode				0.61	
Case to sink per module	R_{thCS}		-	0.06	-	
Clearance (1)		External shortest distance in air between 2 terminals	5.5	-	-	
Creepage (2)		Shortest distance along external surface of the insulating material between 2 terminals	8	-	-	mm
Mounting torque to heatsink		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

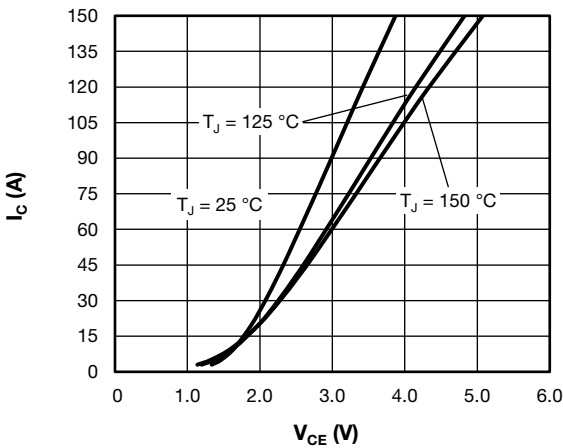


Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE} = 15\text{ V}$

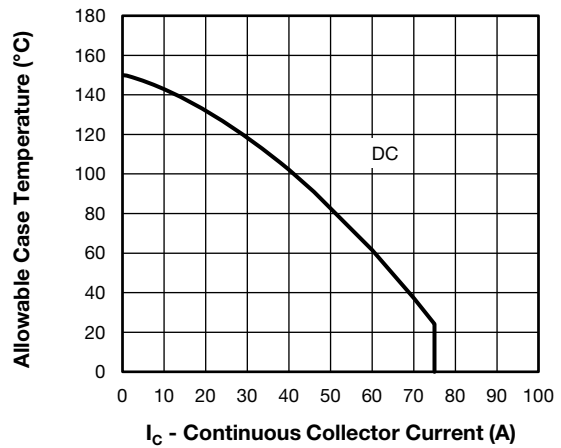


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

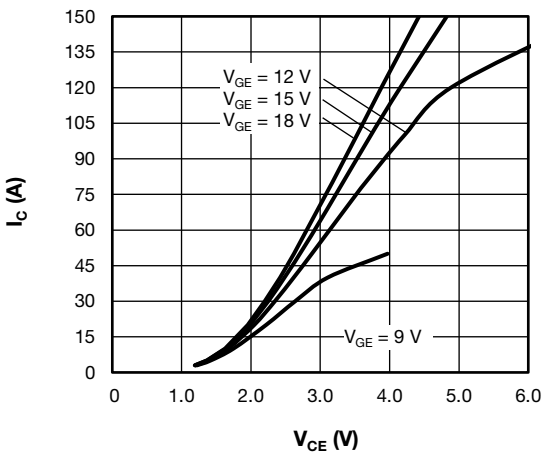


Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J = 125\text{ °C}$

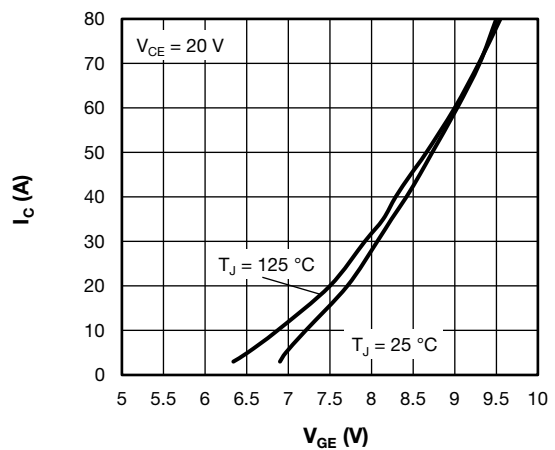


Fig. 4 - Typical Trench IGBT Transfer Characteristics

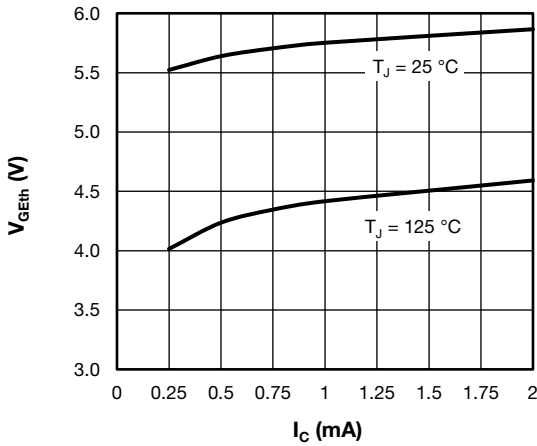


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

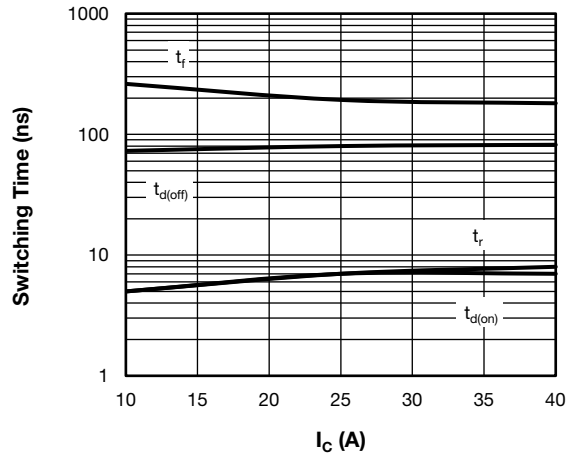


Fig. 8 - Typical Trench IGBT Switching Time vs. I_C (with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{V}/-15\text{V}$, $L = 500\ \mu\text{H}$

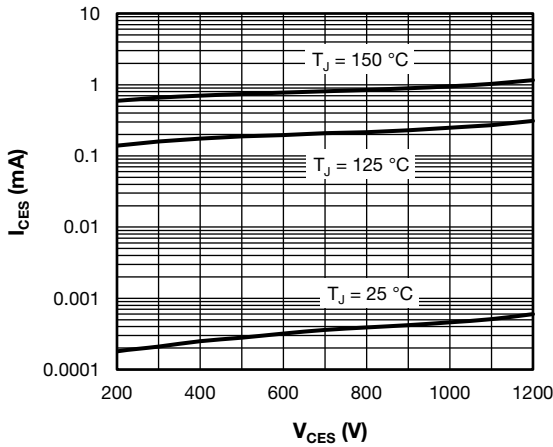


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

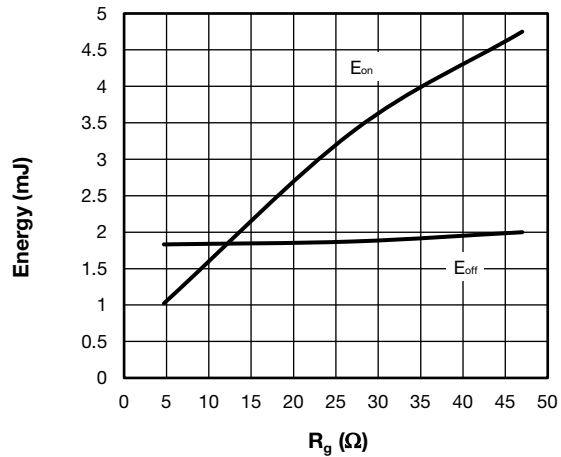


Fig. 9 - Typical Trench IGBT Energy Loss vs. R_g (with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = +15\text{V}/-15\text{V}$, $L = 500\ \mu\text{H}$

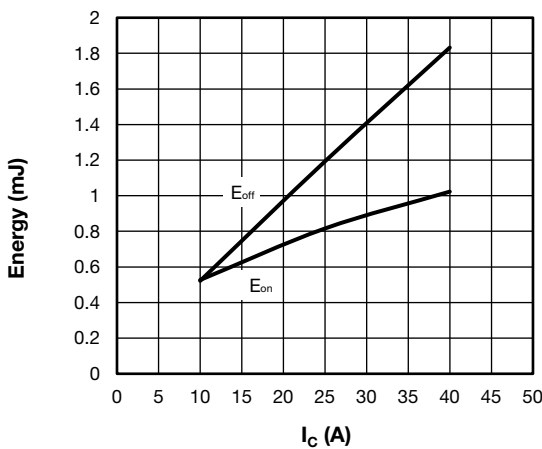


Fig. 7 - Typical Trench IGBT Energy Loss vs. I_C (with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{V}/-15\text{V}$, $L = 500\ \mu\text{H}$

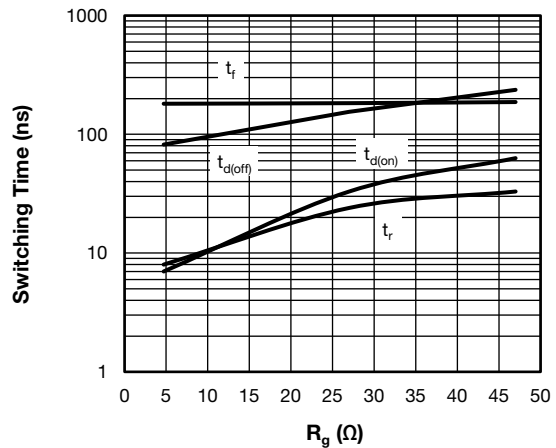


Fig. 10 - Typical Trench IGBT Switching Time vs. R_g (with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = +15\text{V}/-15\text{V}$, $L = 500\ \mu\text{H}$

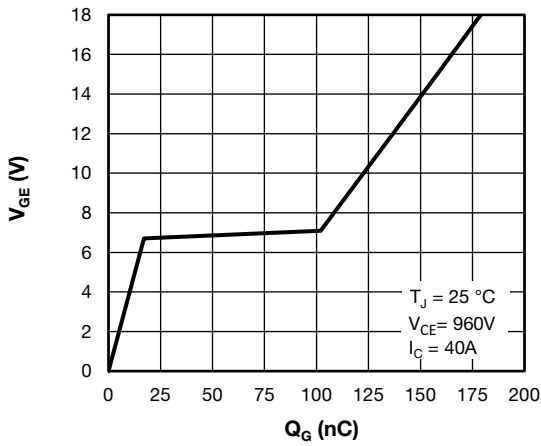


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

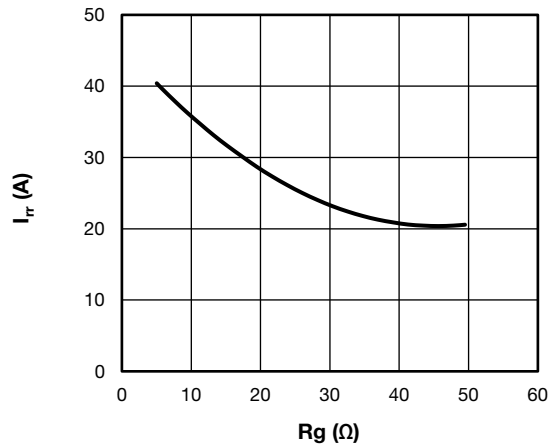


Fig. 14 - Typical Diode I_{rr} vs. R_g
 $T_J = 125\text{ °C}$; $I_F = 40\text{ A}$

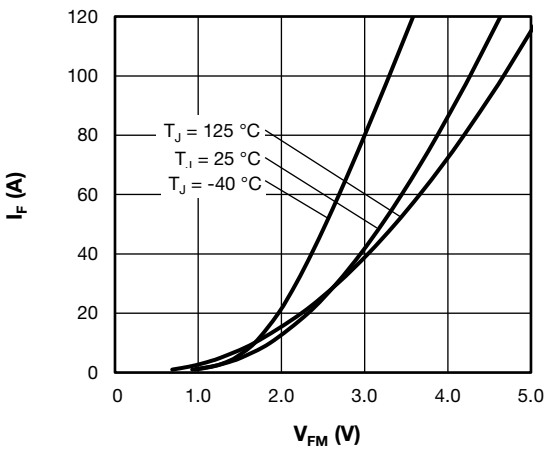


Fig. 12 - Typical Diode Forward Characteristics

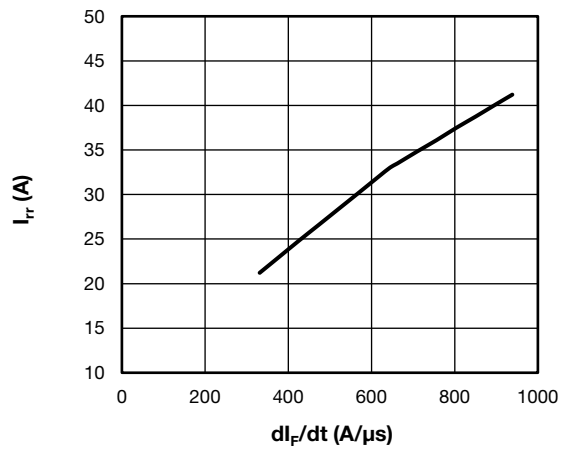


Fig. 15 - Typical Diode I_{rr} vs. di_F/dt
 $V_{CC} = 600\text{ V}$; $V_{GE} = 15\text{ V}$; $I_{CE} = 40\text{ A}$; $T_J = 125\text{ °C}$

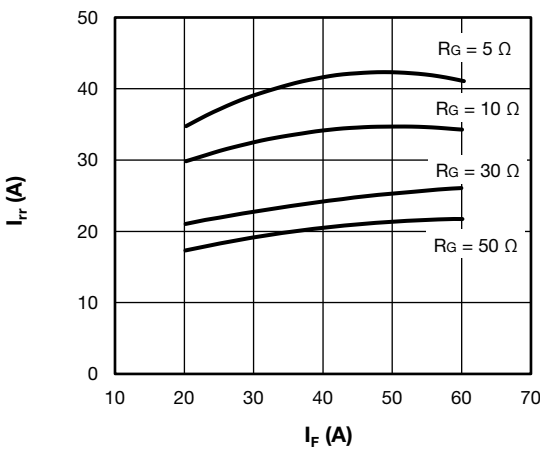


Fig. 13 - Typical Diode I_{rr} vs. I_F ,
 $T_J = 125\text{ °C}$

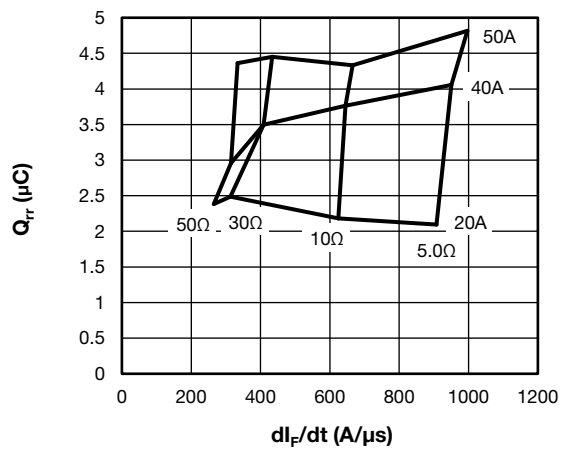


Fig. 16 - Typical Diode Q_{rr} vs. di_F/dt
 $V_{CC} = 600\text{ V}$; $V_{GE} = 15\text{ V}$; $T_J = 125\text{ °C}$

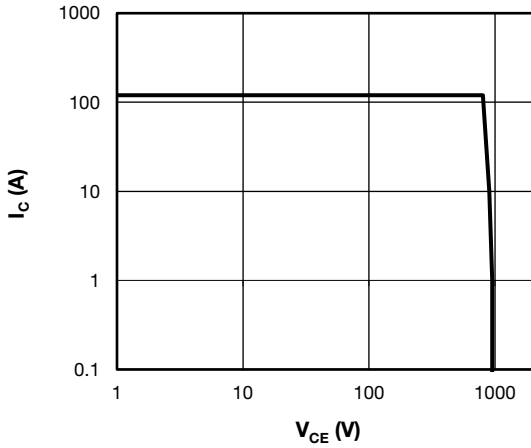


Fig. 17 - Trench IGBT Reverse BIAS SOA
 $T_J = 150\text{ }^\circ\text{C}$, $I_C = 120\text{ A}$, $R_g = 10\ \Omega$, $V_{GE} = +15\text{V} / 0\text{V}$, $V_{CC} = 800\text{ V}$,
 $V_p = 1200\text{ V}$

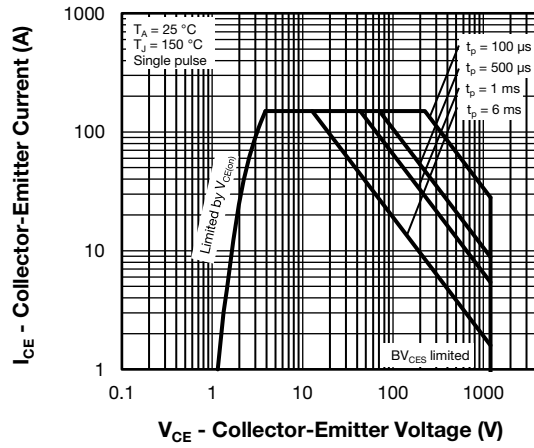


Fig. 18 - Trench IGBT Safe Operating Area

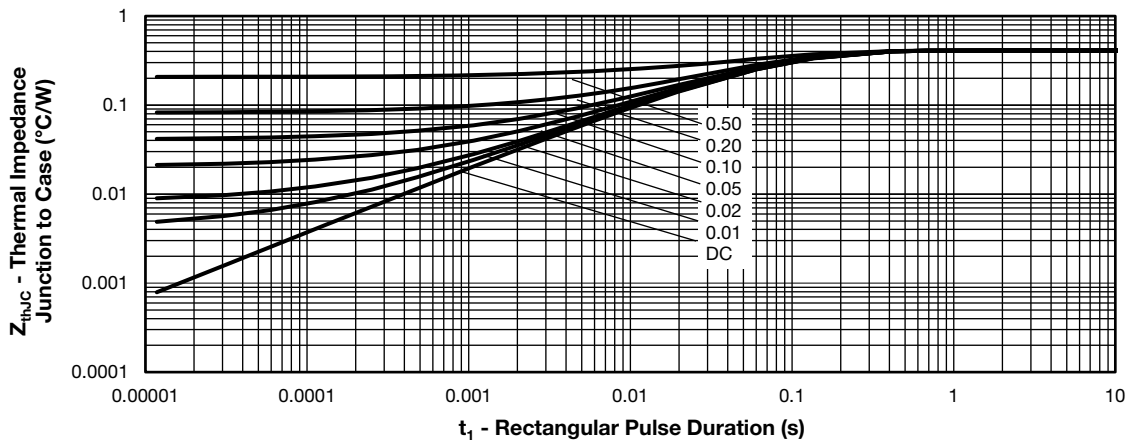


Fig. 19 - Maximum Trench IGBT Thermal Impedance Z_{thJC} Characteristics

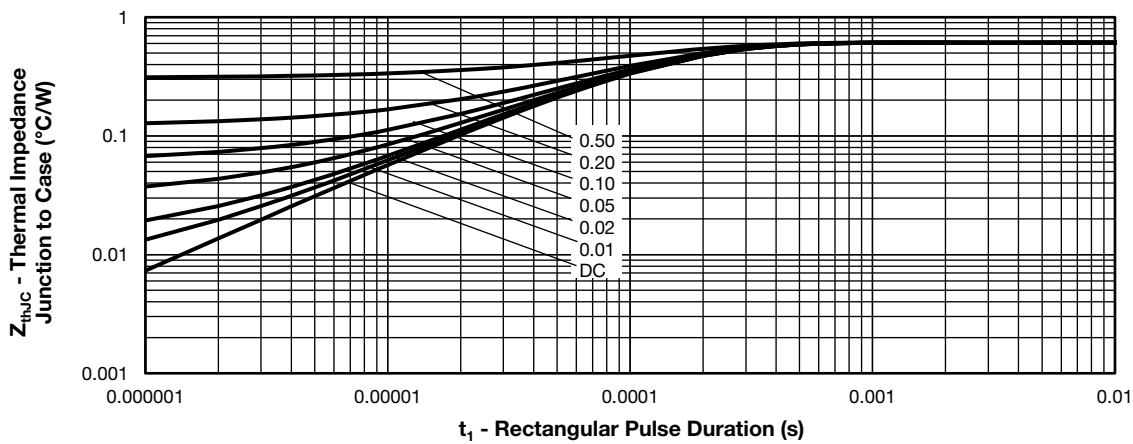


Fig. 20 - Maximum Diode Thermal Impedance Z_{thJC} Characteristics

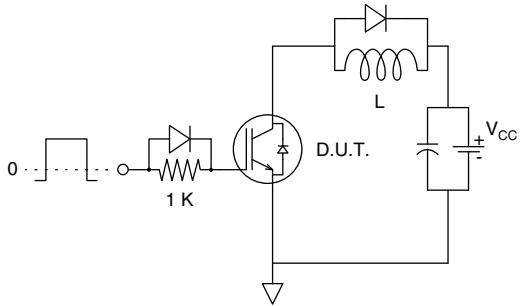


Fig. 21 - Gate Charge Circuit (Turn-Off)

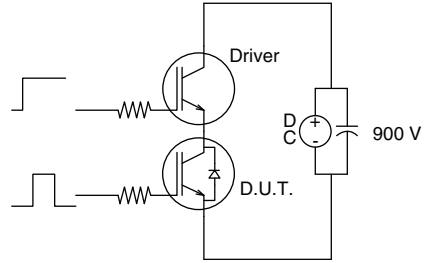


Fig. 23 - S.C. SOA Circuit

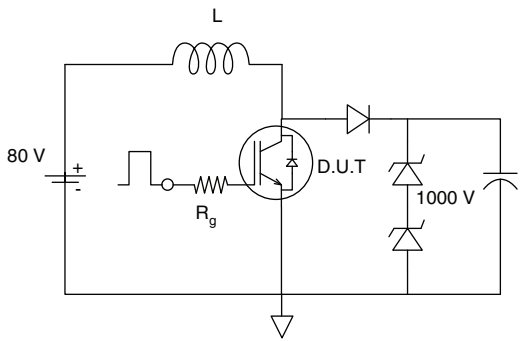


Fig. 22 - RBSOA Circuit

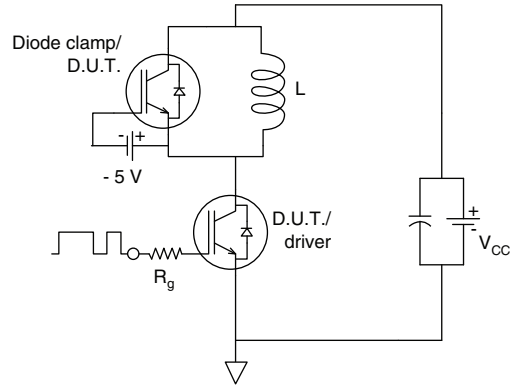


Fig. 24 - Switching Loss Circuit

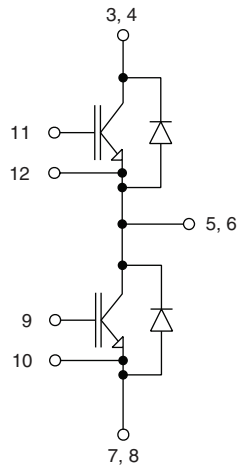
ORDERING INFORMATION TABLE

Device code	VS-	40	MT	120	P	H	A	PbF
	①	②	③	④	⑤	⑥	⑦	⑧

- 1** - Vishay Semiconductors product
- 2** - Current rating (40 = 40 A)
- 3** - Essential part number
- 4** - Voltage code (120 = 1200 V)
- 5** - Speed / type (P = trench IGBT)
- 6** - Circuit configuration (H = half bridge)
- 7** - A = Al₂O₃ DBC substrate
- 8** - PbF = lead (Pb)-free



CIRCUIT CONFIGURATION

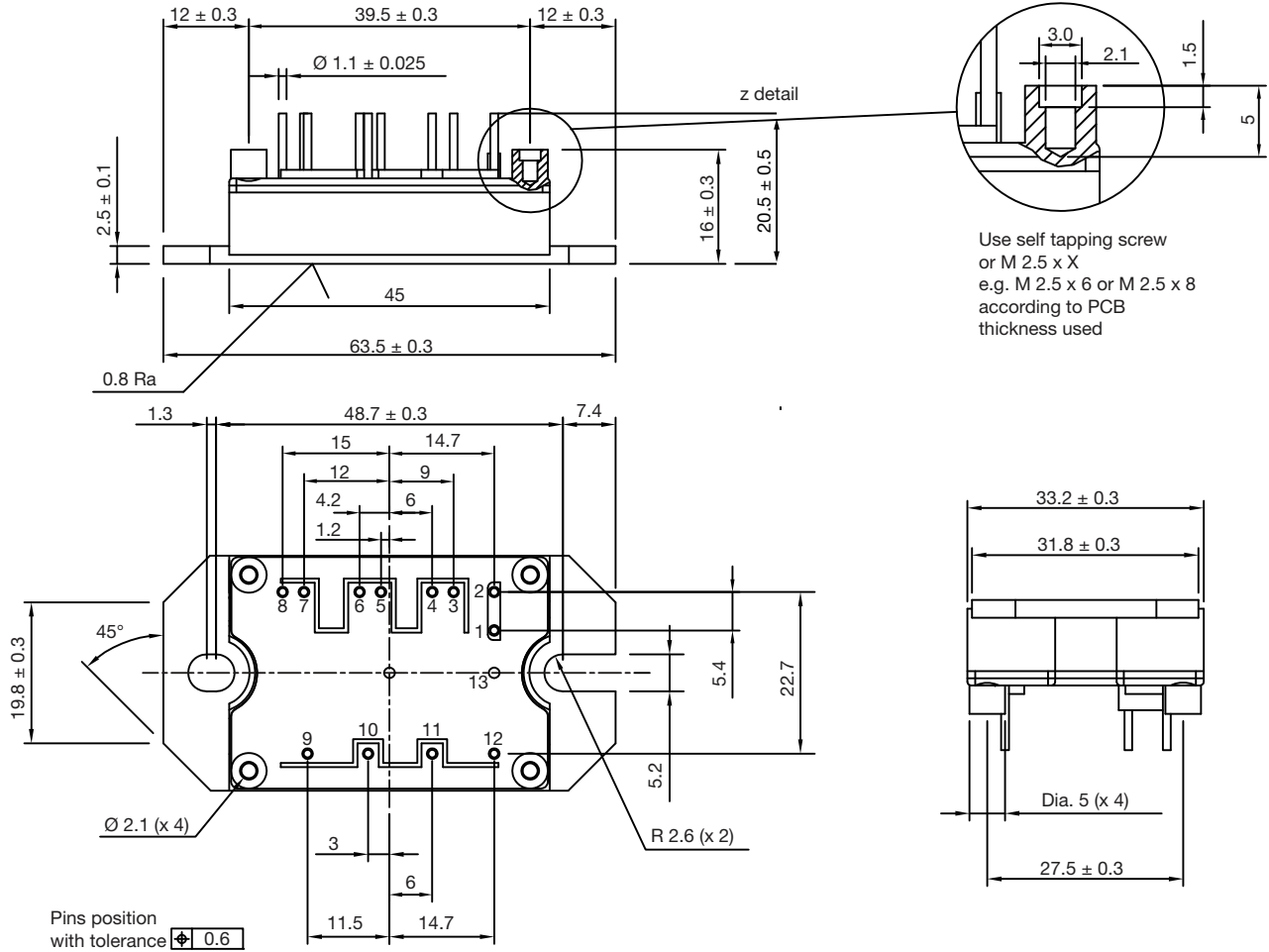


LINKS TO RELATED DOCUMENTS	
Dimensions	www.vishay.com/doc?95175



MTP

DIMENSIONS in millimeters



Use self tapping screw
or M 2.5 x X
e.g. M 2.5 x 6 or M 2.5 x 8
according to PCB
thickness used

Note

- Unused terminals are not assembled in the package



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