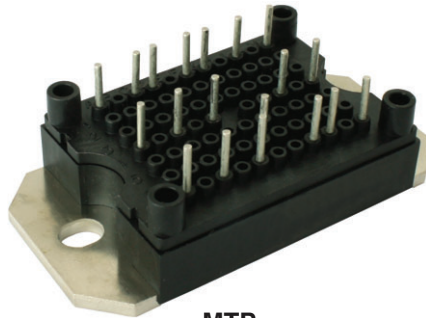


## Full Bridge TrenchStop IGBT, MTP Power Modules



**MTP**  
(Package example)

### FEATURES

- TrenchStop IGBT technology
- Positive  $V_{CE(on)}$  temperature coefficient
- FRED Pt® Gen5 antiparallel diodes with ultrasoft reverse recovery
- Low diode  $V_F$
- Square RBSOA
- 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](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT

PRIMARY CHARACTERISTICS	
$V_{CES}$	600 V
$I_C$ at $T_C = 45\text{ }^\circ\text{C}$	50 A
$V_{CE(on)}$ at 50 A	1.81 V
Speed	30 kHz to 100 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	$V_{CES}$		600	V
Continuous collector current	$I_C$	$T_C = 25\text{ }^\circ\text{C}$	55	A
		$T_C = 80\text{ }^\circ\text{C}$	41	
Pulsed collector current	$I_{CM}$	$V_{GE} = 15\text{ V}$	115	
Clamped inductive load current	$I_{LM}$		95	
Diode continuous forward current	$I_F$	$T_C = 25\text{ }^\circ\text{C}$	54	
		$T_C = 80\text{ }^\circ\text{C}$	41	
Diode maximum forward current	$I_{FM}$		250	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
RMS isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1\text{ min}$	2500	
Maximum power dissipation (only IGBT)	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	144	W
		$T_C = 80\text{ }^\circ\text{C}$	91	
Maximum power dissipation (only diode)	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	107	
		$T_C = 80\text{ }^\circ\text{C}$	68	



<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{ V}, I_C = 0.5\text{ mA}$	600	-	-	V
Collector to emitter saturation voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 50\text{ A}$	-	1.81	2.1	$V_{CE(on)}$
		$V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.1	-	
		$V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 175\text{ }^\circ\text{C}$	-	2.23	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 0.5\text{ mA}$	2.8	4.0	5.3	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 0.5\text{ mA}$ ( $25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ )	-	-9.9	-	mV/ $^\circ\text{C}$
Transconductance	$g_{fe}$	$V_{CE} = 20\text{ V}, I_C = 50\text{ A}$	-	37	-	S
Transfer characteristics	$V_{GE}$	$V_{CE} = 20\text{ V}, I_C = 50\text{ A}$	-	6.4	-	V
Zero gate voltage collector current	$I_{CES}^{(1)}$	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 25\text{ }^\circ\text{C}$	-	0.3	40	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	40	-	mA
		$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 175\text{ }^\circ\text{C}$	-	1.2	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 200$	nA

**Note**

<sup>(1)</sup>  $I_{CES}$  includes also opposite leg overall leakage

<b>SWITCHING CHARACTERISTICS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Total gate charge (turn-on)	$Q_g$	$I_C = 50\text{ A}$ $V_{CC} = 520\text{ V}$ $V_{GE} = 15\text{ V}$	-	123	-	nC
Gate to emitter charge (turn-on)	$Q_{ge}$		-	20	-	
Gate to collector charge (turn-on)	$Q_{gc}$		-	24	-	
Turn-on switching loss	$E_{on}$	$V_{CC} = 300\text{ V}, I_C = 50\text{ A}, V_{GE} = 15\text{ V},$ $R_g = 4.7\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$	-	0.37	-	mJ
Turn-off switching loss	$E_{off}$		-	0.23	-	
Total switching loss	$E_{tot}$		-	0.70	-	
Turn-on switching loss	$E_{on}$		-	0.53	-	
Turn-off switching loss	$E_{off}$		-	0.31	-	
Total switching loss	$E_{tot}$		-	0.84	-	
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{ V}$ $V_{GE} = 0\text{ V}, f = 1\text{ MHz}$ $T_J = 25\text{ }^\circ\text{C}$	-	3000	-	pF
Output capacitance	$C_{oes}$		-	50	-	
Reverse transfer capacitance	$C_{res}$		-	11	-	
Reverse bias safe operating area	RBSOA		$T_J = 175\text{ }^\circ\text{C}, I_C = 95\text{ A}, R_g = 4.7\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 300\text{ V}, V_p = 600\text{ V}$	Fullsquare		

<b>DIODE SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Diode forward voltage drop	$V_{FM}$	$I_C = 50\text{ A}$	-	1.66	2.23	V
		$I_C = 50\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.43	-	
		$I_C = 50\text{ A}, T_J = 175\text{ }^\circ\text{C}$	-	1.32	-	
Diode reverse recovery time	$t_{rr}$	$V_R = 400\text{ V},$ $I_F = 30\text{ A},$ $di/dt = 1000\text{ A}/\mu\text{s}$	-	61	-	ns
Diode peak reverse current	$I_{rr}$		-	16	-	A
Diode recovery charge	$Q_{rr}$		-	400	-	nC
Diode reverse recovery time	$t_{rr}$	$V_R = 400\text{ V},$ $I_F = 30\text{ A},$ $di/dt = 1000\text{ A}/\mu\text{s}, T_J = 125\text{ }^\circ\text{C}$	-	68	-	ns
Diode peak reverse current	$I_{rr}$		-	33	-	A
Diode recovery charge	$Q_{rr}$		-	1300	-	nC

THERMAL AND MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating junction temperature range	$T_J$		-40	-	175	°C
Storage temperature range	$T_{Stg}$		-40	-	150	
Junction to case	IGBT	$R_{thJC}$	-	-	1.04	°C/W
	Diode				1.40	
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	-	-	mm
Creepage		Shortest distance along external surface of the insulating material between 2 terminals	8	-	-	
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

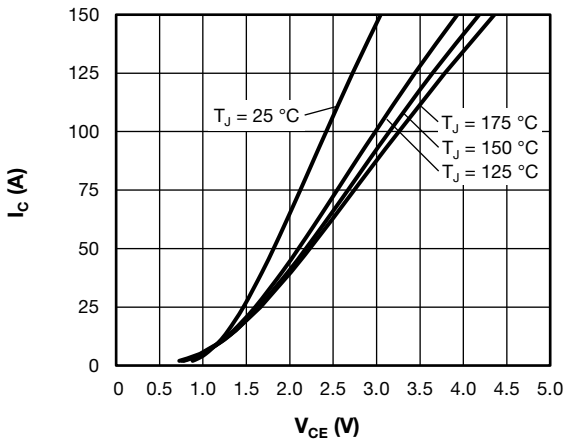


Fig. 1 - Typical Q1 to Q4 IGBT Output Characteristics,  $V_{GE} = 15 V$

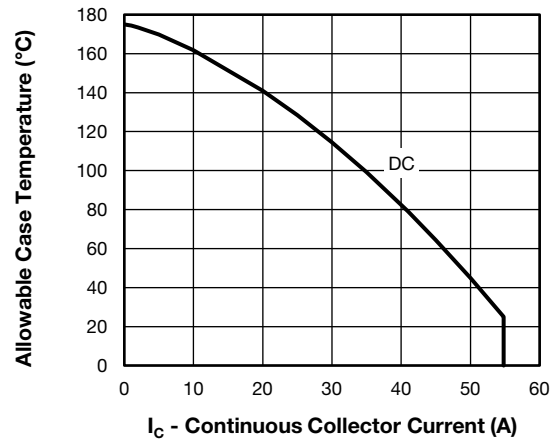


Fig. 3 - Maximum Q1 to Q4 IGBT Continuous Collector Current vs. Case Temperature

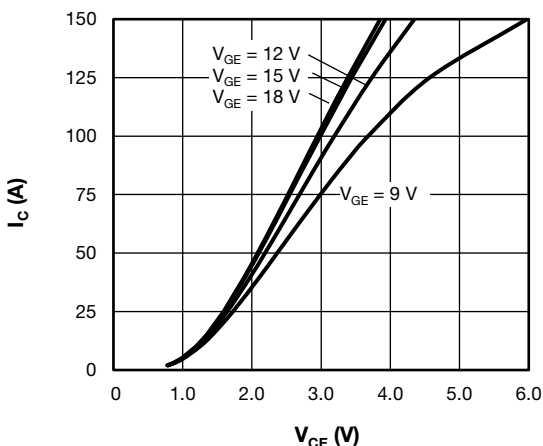


Fig. 2 - Typical Q1 to Q4 IGBT Output Characteristics,  $T_J = 125 °C$

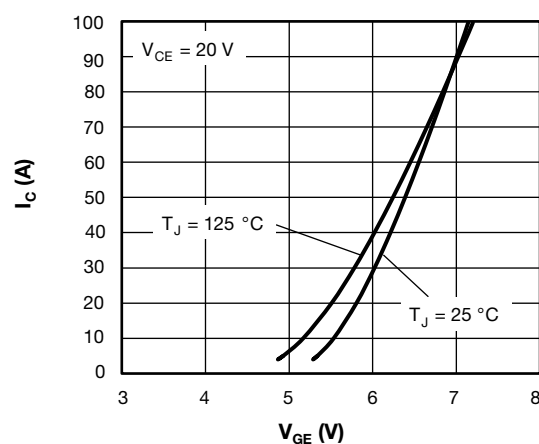


Fig. 4 - Typical Q1 to Q4 IGBT Transfer Characteristics

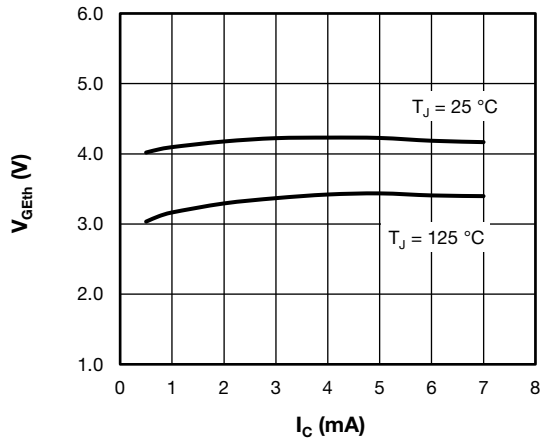


Fig. 5 - Typical Q1 to Q4 IGBT Gate Threshold Voltage

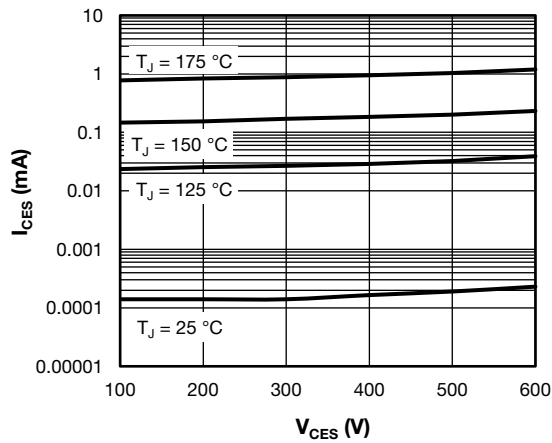


Fig. 6 - Typical Q1 to Q4 IGBT Zero Gate Voltage Collector Current

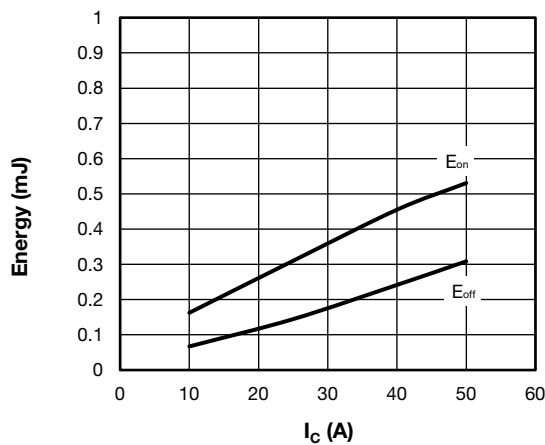


Fig. 7 - Typical Q1 to Q4 IGBT Energy Loss vs.  $I_C$   
(with Antiparallel Diode)

$T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 300\text{ V}$ ,  $R_g = 4.7\text{ }\Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

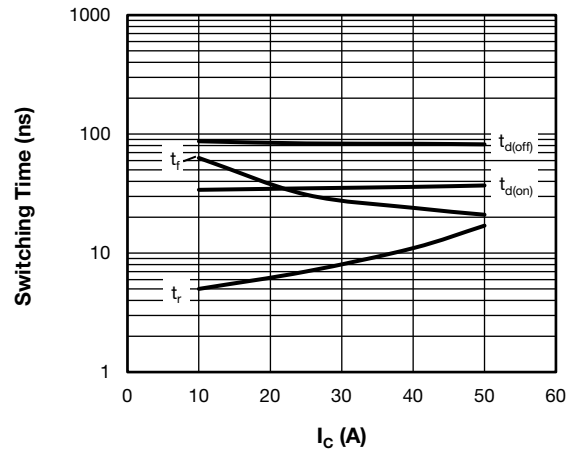


Fig. 8 - Typical Q1 to Q4 IGBT Switching Time vs.  $I_C$   
(with Antiparallel Diode)

$T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 300\text{ V}$ ,  $R_g = 4.7\text{ }\Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

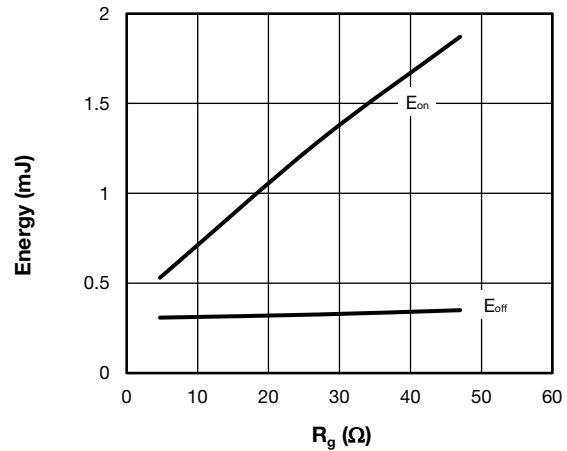


Fig. 9 - Typical Q1 to Q4 IGBT Energy Loss vs.  $R_g$   
(with Antiparallel Diode)

$T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 300\text{ V}$ ,  $I_C = 50\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

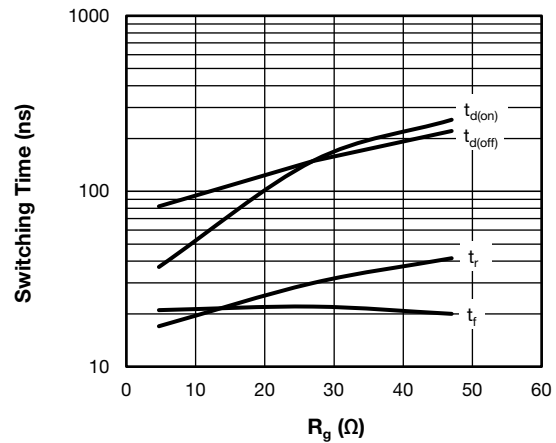


Fig. 10 - Typical Q1 to Q4 IGBT Switching Time vs.  $R_g$   
(with Antiparallel Diode)

$T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 300\text{ V}$ ,  $I_C = 50\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

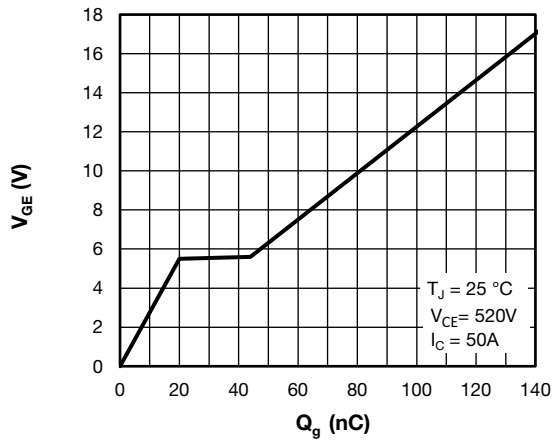


Fig. 11 - Typical Q1 to Q4 IGBT Gate Charge vs. Gate to Emitter Voltage

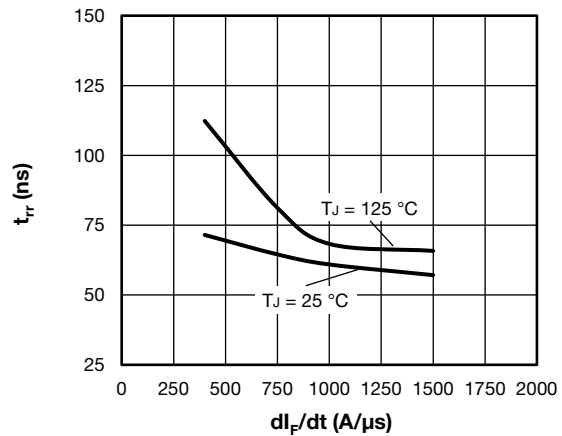


Fig. 14 - Typical D1 to D4 Antiparallel Diode Reverse Recovery Time vs.  $dI_F/dt$   
 $V_{rr} = 400\text{ V}$ ,  $I_F = 30\text{ A}$

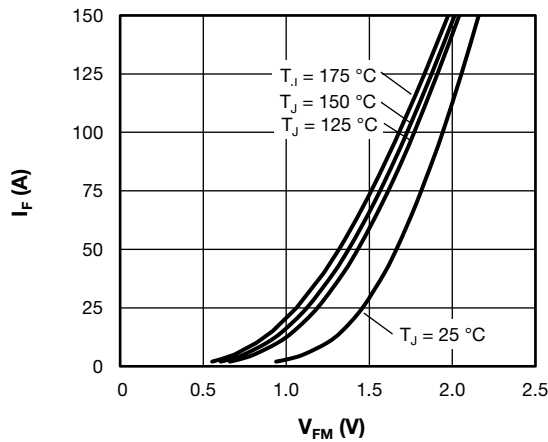


Fig. 12 - Typical D1 to D4 Antiparallel Diode Forward Characteristics

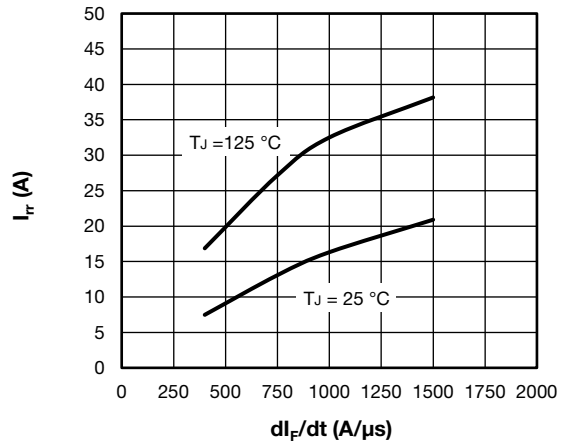


Fig. 15 - Typical D1 to D4 Antiparallel Diode Reverse Recovery Current vs.  $dI_F/dt$   
 $V_{rr} = 400\text{ V}$ ,  $I_F = 30\text{ A}$

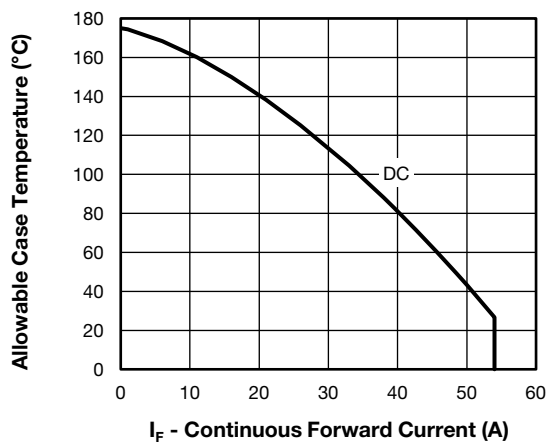


Fig. 13 - Maximum D1 to D4 Antiparallel Diode Continuous Collector Current vs. Case Temperature

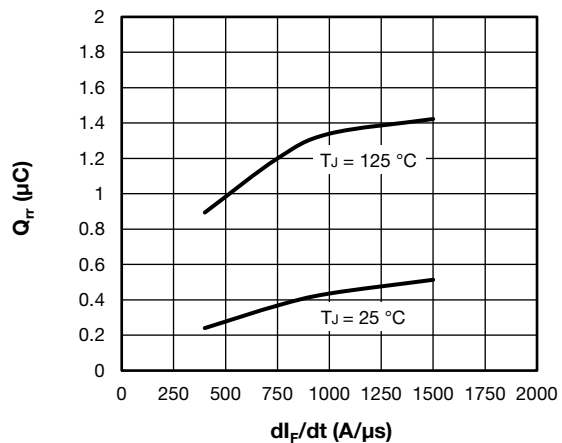


Fig. 16 - Typical D1 to D4 Antiparallel Diode Reverse Recovery Charge vs.  $dI_F/dt$   
 $V_{rr} = 400\text{ V}$ ,  $I_F = 30\text{ A}$

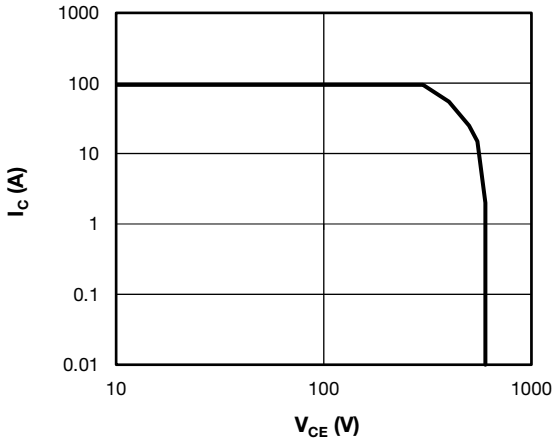


Fig. 17 - Q1 to Q4 IGBT Reverse BIAS SOA  
 $T_J = 175\text{ }^\circ\text{C}$ ,  $I_C = 95\text{ A}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V/0 V}$ ,  $V_{CC} = 300\text{ V}$ ,  
 $V_p = 600\text{ V}$

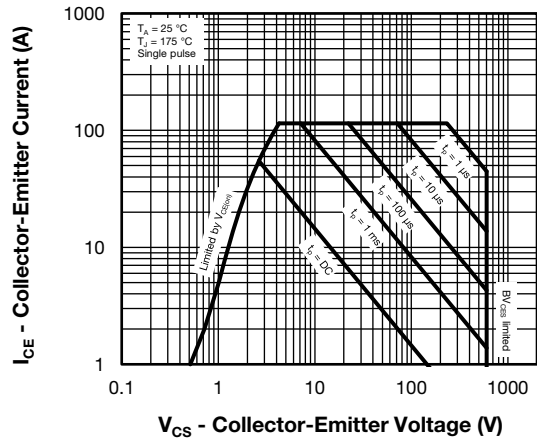


Fig. 18 - Q1 to Q4 IGBT Safe Operating Area

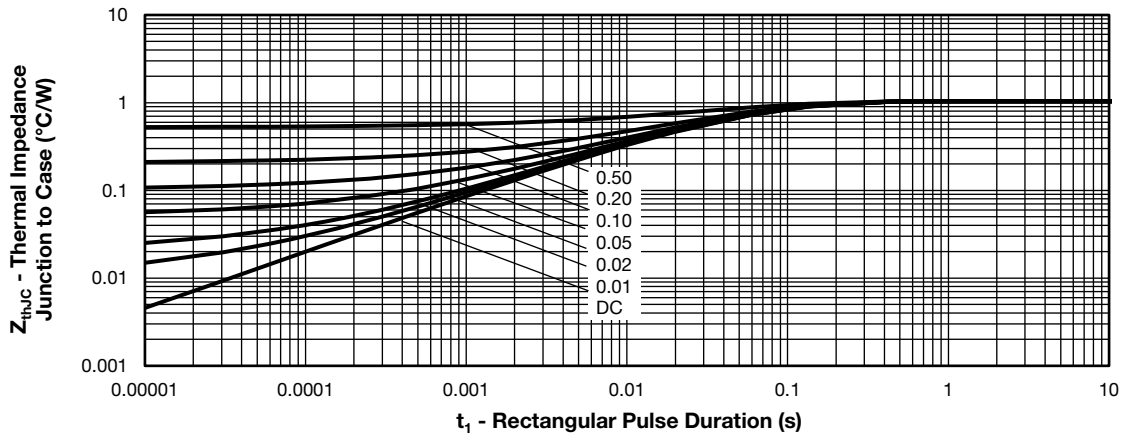


Fig. 19 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics - (Q1 to Q4 PT IGBT)

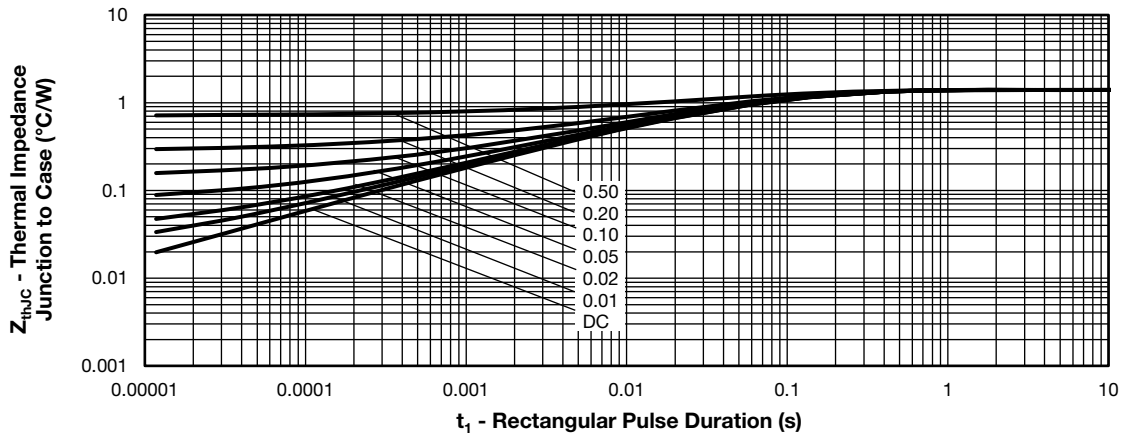


Fig. 20 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics - (D1 to D4 Antiparallel Diode)

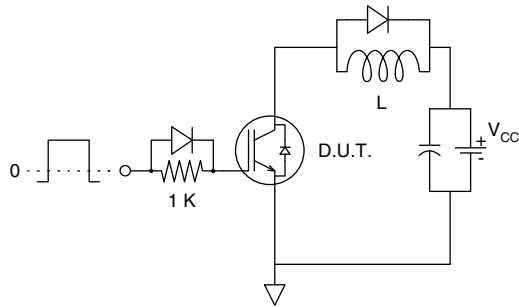


Fig. 21 - Gate Charge Circuit (Turn-Off)

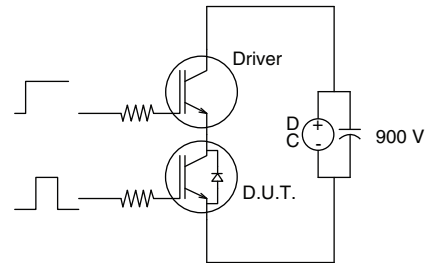


Fig. 23 - S.C. SOA Circuit

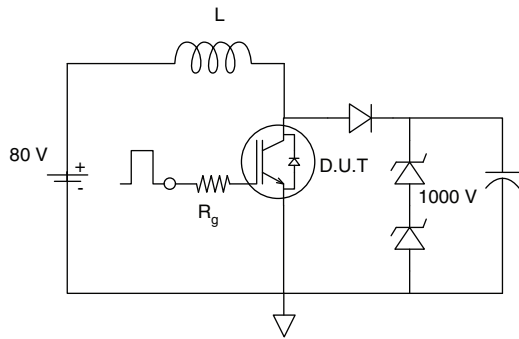


Fig. 22 - RBSOA Circuit

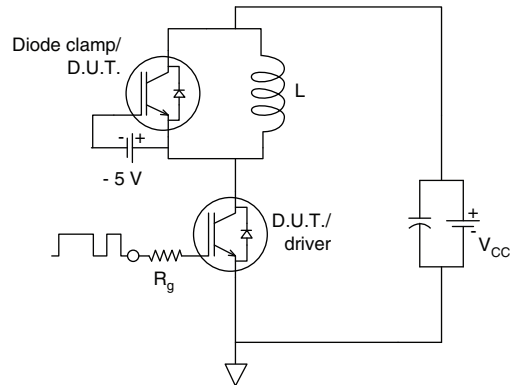


Fig. 24 - Switching Loss Circuit

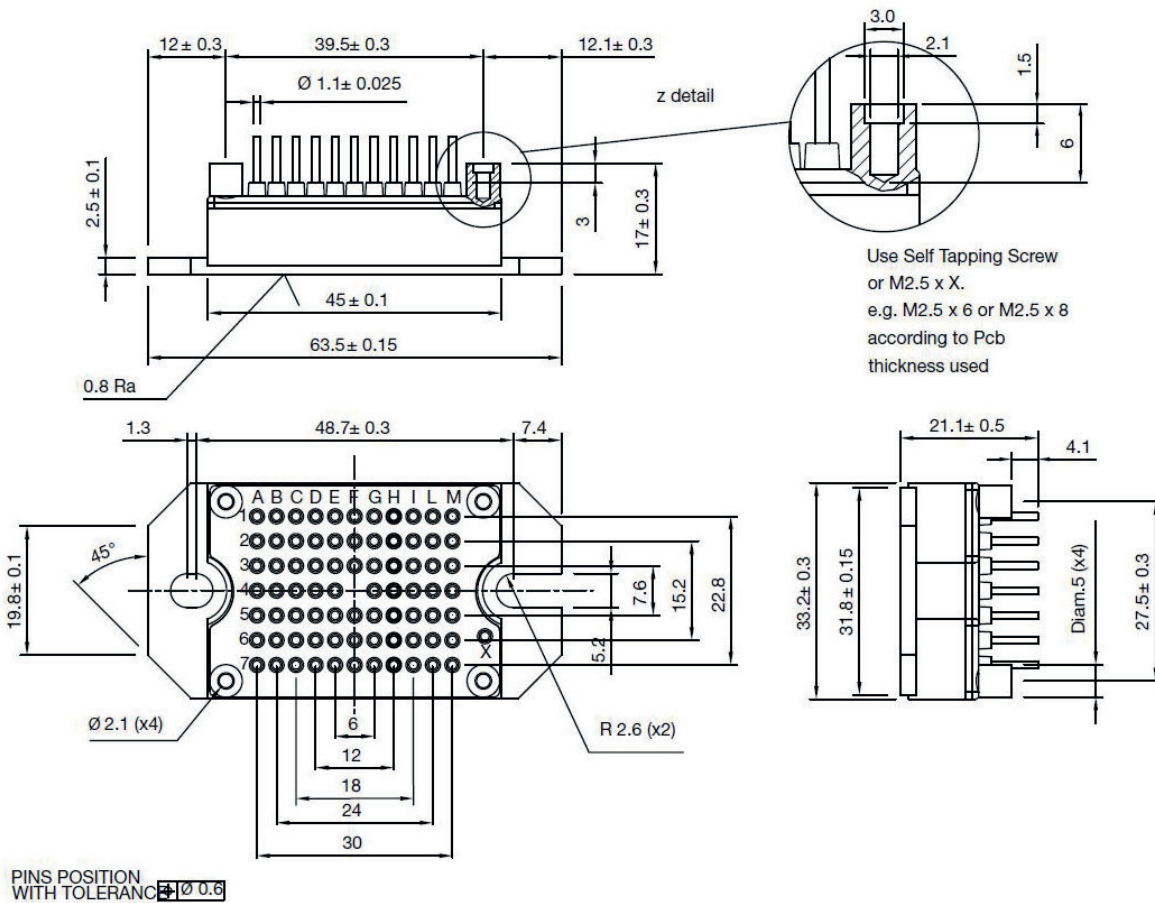
## ORDERING INFORMATION TABLE

Device code	<b>VS-</b>	<b>50</b>	<b>MT</b>	<b>060</b>	<b>T</b>	<b>F</b>	<b>T</b>
	①	②	③	④	⑤	⑥	⑦

- 1** - Vishay Semiconductors product
- 2** - Current rating (50 = 50 A)
- 3** - Essential part number
- 4** - Voltage code (060 = 600 V)
- 5** - Speed / type (T = trench IGBT)
- 6** - Circuit configuration (F = full bridge)
- 7** - T = thermistor

CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Full bridge IGBT	F	

**DIMENSIONS** in millimeters







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