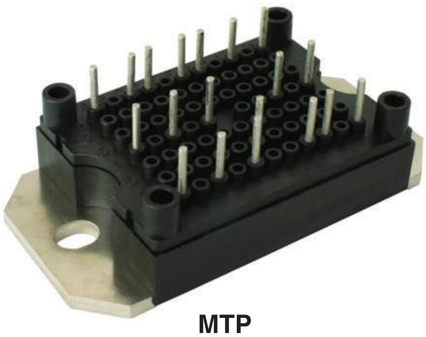
Full Bridge TrenchStop IGBT, MTP Power Modules



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

Pb-free
RoHS
COMPLIANT

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

PRIMARY CHARACTERISTICS	
V_{CES}	600 V
I_C at T_C = 45 °C	50 A
$V_{CE(on)}$ at 50 A	1.81 V
Speed	30 kHz to 100 kHz
Package	MTP
Circuit configuration	Full bridge

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 °C	55	A
		T_C = 80 °C	41	
Pulsed collector current	I_{CM}	V_{GE} = 15 V	115	
Clamped inductive load current	I_{LM}		95	
Diode continuous forward current	I_F	T_C = 25 °C	54	
		T_C = 80 °C	41	
Diode maximum forward current	I_{FM}		250	
Gate to emitter voltage	V_{GE}		± 20	V
RMS isolation voltage	V_{ISOL}	Any terminal to case, t = 1 min	2500	
Maximum power dissipation (only IGBT)	P_D	T_C = 25 °C	144	W
		T_C = 80 °C	91	
Maximum power dissipation (only diode)	P_D	T_C = 25 °C	107	
		T_C = 80 °C	68	

ELECTRICAL SPECIFICATIONS (T_J = 25 °C unless otherwise noted)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Collector to emitter breakdown voltage	$V_{(BR)CES}$	V_{GE} = 0 V, I_C = 0.5 mA	600	-	-	V
Collector to emitter saturation voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_C = 50 A	-	1.81	2.1	$V_{CE(on)}$
		V_{GE} = 15 V, I_C = 50 A, T_J = 125 °C	-	2.1	-	
		V_{GE} = 15 V, I_C = 50 A, T_J = 175 °C	-	2.23	-	
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 0.5 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 mA (25 °C to 125 °C)	-	-9.9	-	mV/°C
Transconductance	g_{fe}	V_{CE} = 20 V, I_C = 50 A	-	37	-	S
Transfer characteristics	V_{GE}	V_{CE} = 20 V, I_C = 50 A	-	6.4	-	V
Zero gate voltage collector current	I_{CES} (1)	V_{GE} = 0 V, V_{CE} = 600 V, T_J = 25 °C	-	0.3	40	µA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C	-	40	-	mA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 175 °C	-	1.2	-	
Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V	-	-	± 200	nA

Note

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

SWITCHING CHARACTERISTICS (T_J = 25 °C unless otherwise specified)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Total gate charge (turn-on)	Q_g	I_C = 50 A V_{CC} = 520 V V_{GE} = 15 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 V, I_C = 50 A, V_{GE} = 15 V, R_g = 4.7 Ω, L = 500 µH, T_J = 25 °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}	V_{CC} = 300 V, I_C = 50 A, V_{GE} = 15 V, R_g = 4.7 Ω, L = 500 µH, T_J = 125 °C	-	0.53	-	
Turn-off switching loss	E_{off}		-	0.31	-	
Total switching loss	E_{tot}		-	0.84	-	
Input capacitance	C_{ies}	V_{CE} = 25 V V_{GE} = 0 V, f = 1 MHz T_J = 25 °C	-	3000	-	pF
Output capacitance	C_{oes}		-	50	-	
Reverse transfer capacitance	C_{res}		-	11	-	
Reverse bias safe operating area	RBSOA	T_J = 175 °C, I_C = 95 A, R_g = 4.7 Ω, V_{GE} = 15 V to 0 V, V_{CC} = 300 V, V_p = 600 V	Fullsquare			

DIODE SPECIFICATIONS (T_J = 25 °C unless otherwise specified)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Diode forward voltage drop	V_{FM}	I_C = 50 A	-	1.66	2.23	V
		I_C = 50 A, T_J = 125 °C	-	1.43	-	
		I_C = 50 A, T_J = 175 °C	-	1.32	-	
Diode reverse recovery time	t_{rr}	V_R = 400 V, I_F = 30 A, dI/dt = 1000 A/µs	-	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 V, I_F = 30 A, dI/dt = 1000 A/µs, T_J= 125 °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	°C
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

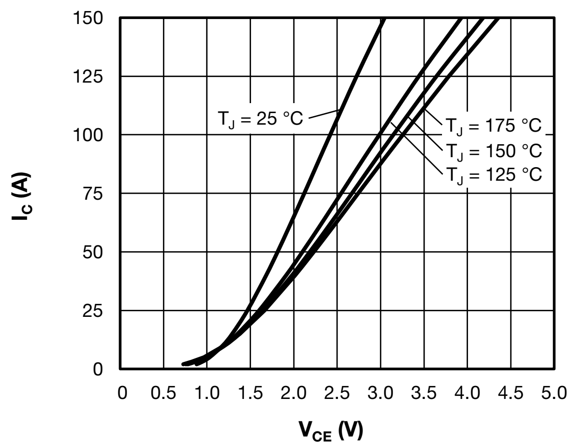


Fig. 1 - Typical Q1 to Q4 IGBT Output Characteristics, V_{GE} = 15 V

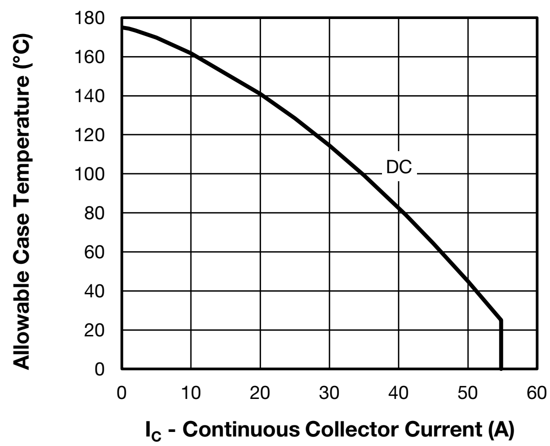


Fig. 3 - Maximum Q1 to Q4 IGBT Continuous Collector Current vs. Case Temperature

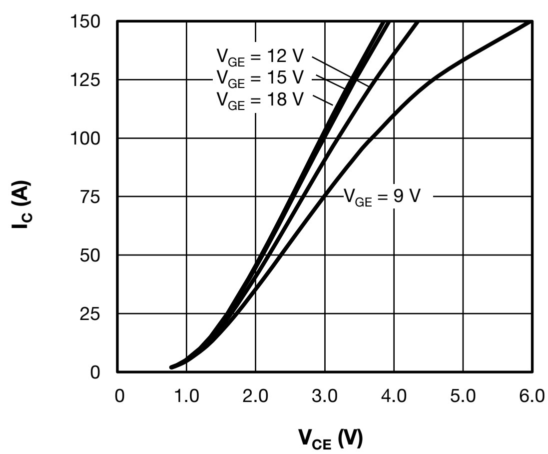


Fig. 2 - Typical Q1 to Q4 IGBT Output Characteristics, T_J = 125 °C

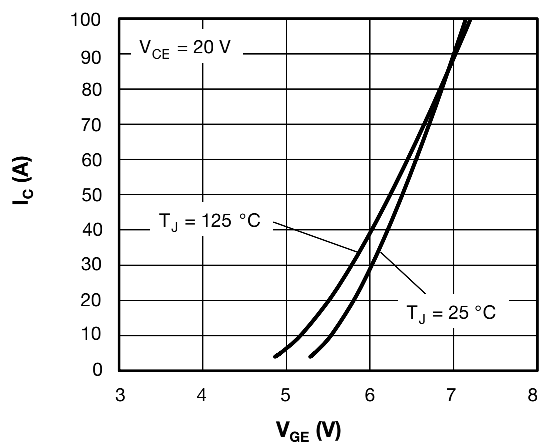


Fig. 4 - Typical Q1 to Q4 IGBT Transfer Characteristics

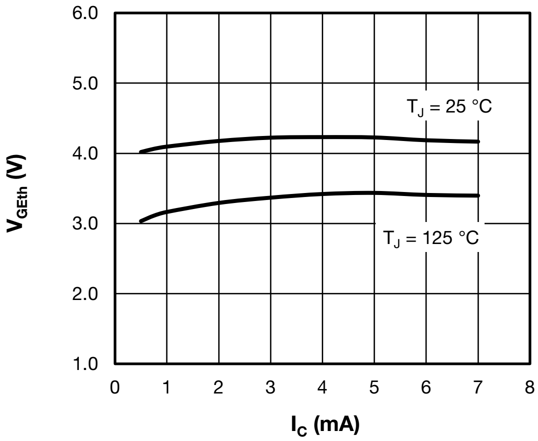


Fig. 5 - Typical Q1 to Q4 IGBT Gate Threshold Voltage

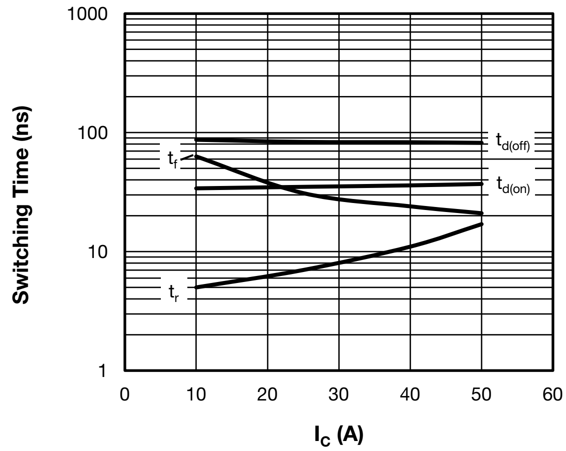


Fig. 8 - Typical Q1 to Q4 IGBT Switching Time vs. I_C (with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 300 V, R_g = 4.7 Ω, V_{GE} = +15 V/-15 V, L = 500 μH

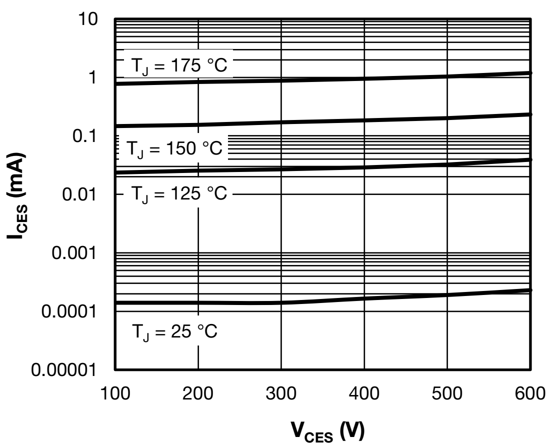


Fig. 6 - Typical Q1 to Q4 IGBT Zero Gate Voltage Collector Current

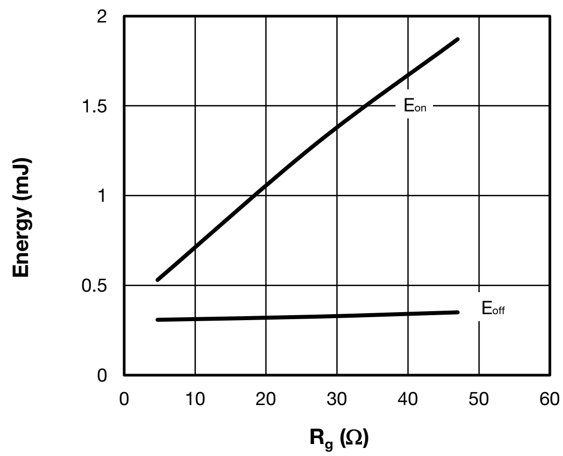


Fig. 9 - Typical Q1 to Q4 IGBT Energy Loss vs. R_g (with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 300 V, I_C = 50 A, V_{GE} = +15 V/-15 V, L = 500 μH

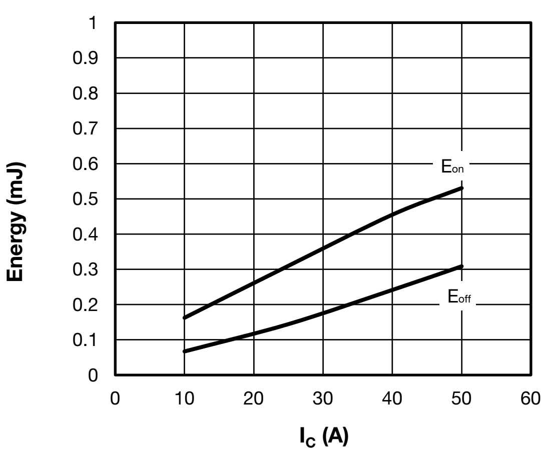


Fig. 7 - Typical Q1 to Q4 IGBT Energy Loss vs. I_C (with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 300 V, R_g = 4.7 Ω, V_{GE} = +15 V/-15 V, L = 500 μH

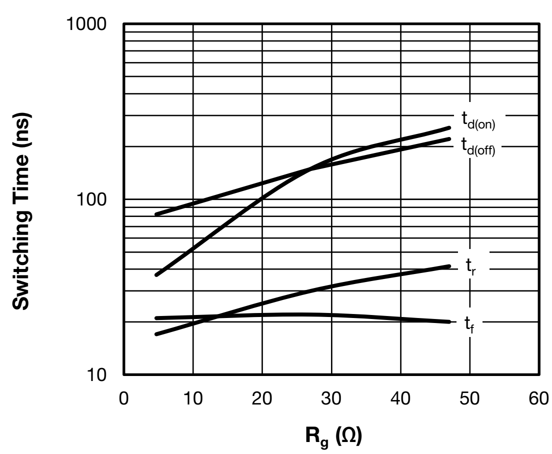


Fig. 10 - Typical Q1 to Q4 IGBT Switching Time vs. R_g (with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 300 V, I_C = 50 A, V_{GE} = +15 V/-15 V, L = 500 μH

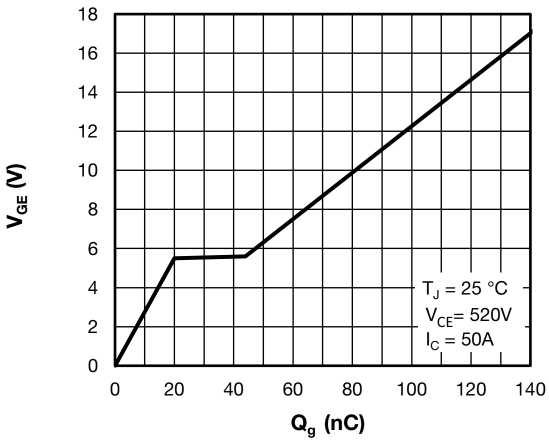


Fig. 11 - Typical Q1 to Q4 IGBT Gate Charge vs. Gate to Emitter Voltage

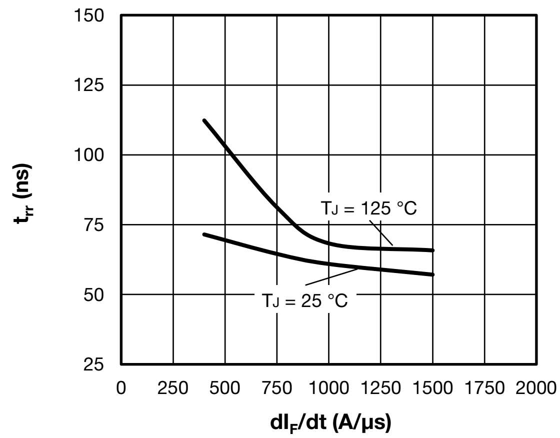


Fig. 14 - Typical D1 to D4 Antiparallel Diode Reverse Recovery Time vs. dI_F/dt
V_{rr} = 400 V, I_F = 30 A

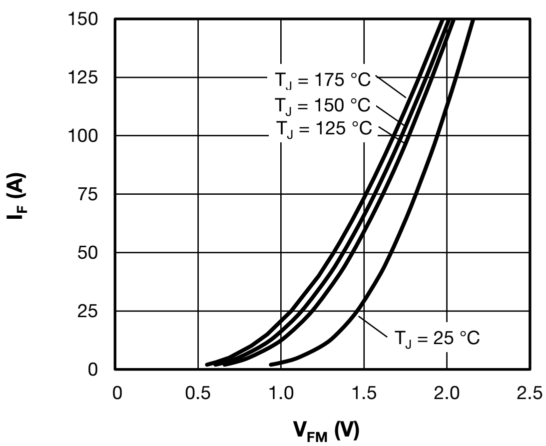


Fig. 12 - Typical D1 to D4 Antiparallel Diode Forward Characteristics

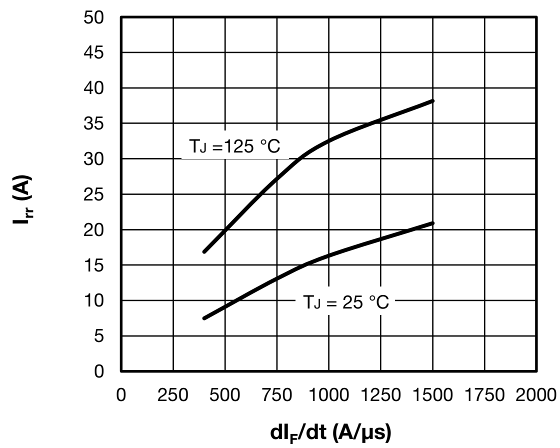


Fig. 15 - Typical D1 to D4 Antiparallel Diode Reverse Recovery Current vs. dI_F/dt
V_{rr} = 400 V, I_F = 30 A

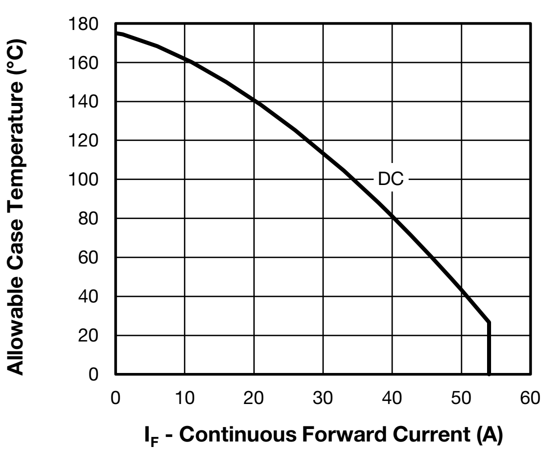


Fig. 13 - Maximum D1 to D4 Antiparallel Diode Continuous Collector Current vs. Case Temperature

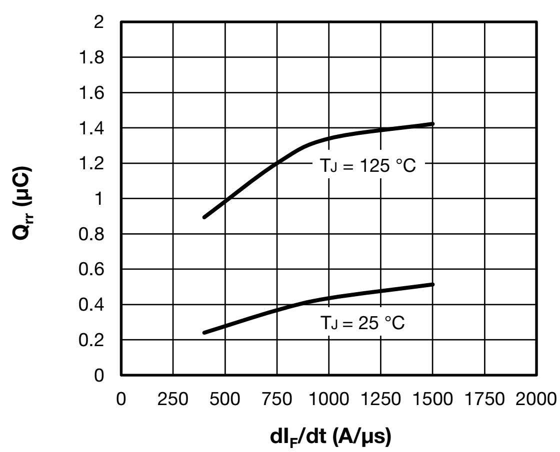


Fig. 16 - Typical D1 to D4 Antiparallel Diode Reverse Recovery Charge vs. dI_F/dt
V_{rr} = 400 V, I_F = 30 A

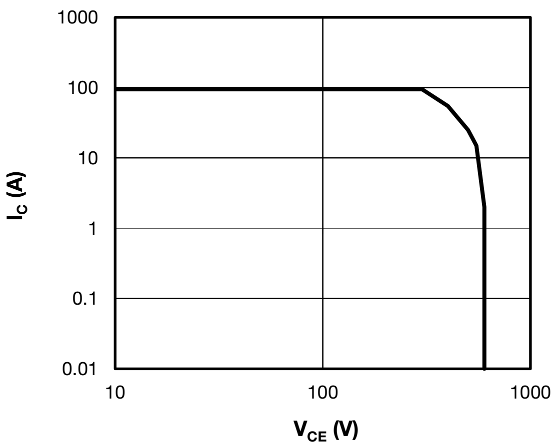


Fig. 17 - Q1 to Q4 IGBT Reverse BIAS SOA
T_J = 175 °C, I_C = 95 A, R_g = 4.7 Ω, V_{GE} = +15 V/0 V, V_{CC} = 300 V,
V_p = 600 V

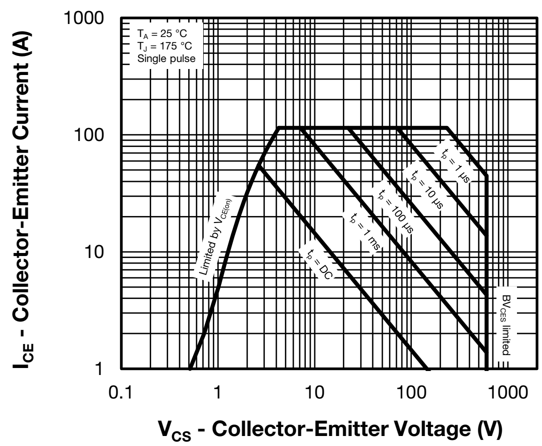


Fig. 18 - Q1 to Q4 IGBT Safe Operating Area

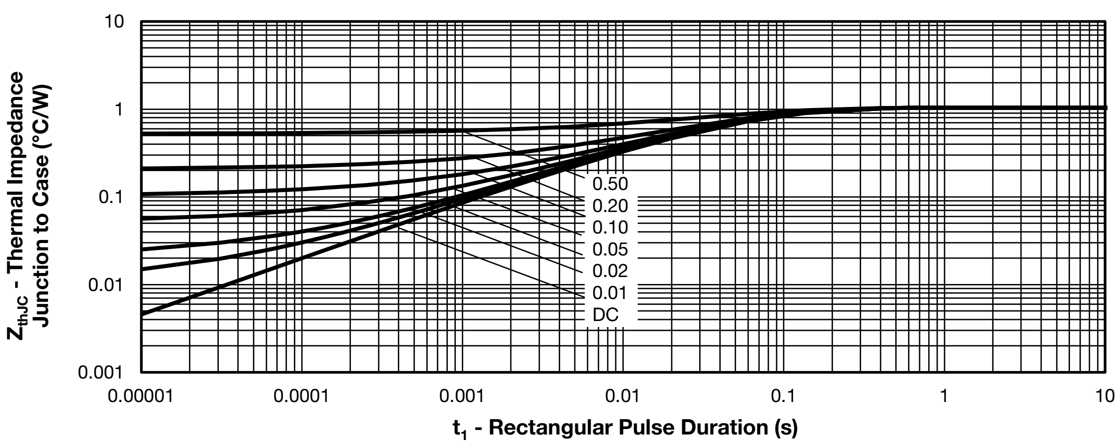


Fig. 19 - Maximum Thermal Impedance Z_{thJC} Characteristics - (Q1 to Q4 PT IGBT)

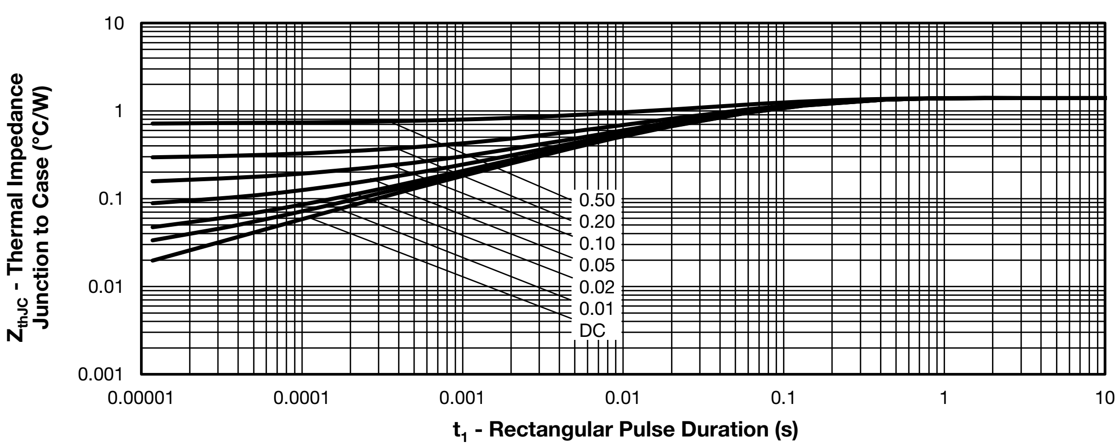


Fig. 20 - Maximum Thermal Impedance Z_{thJC} Characteristics - (D1 to D4 Antiparallel Diode)

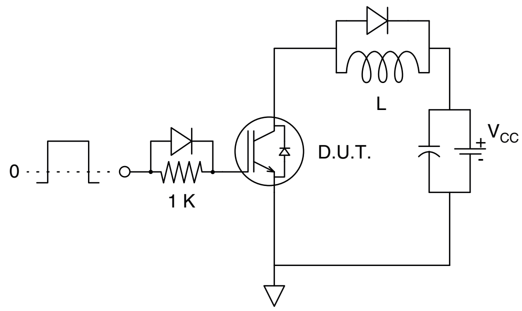


Fig. 21 - Gate Charge Circuit (Turn-Off)

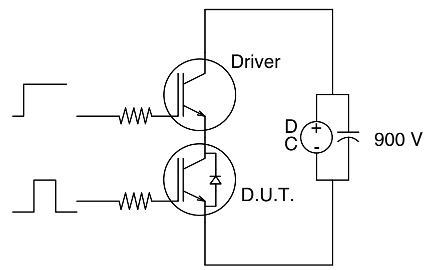


Fig. 23 - S.C. SOA Circuit

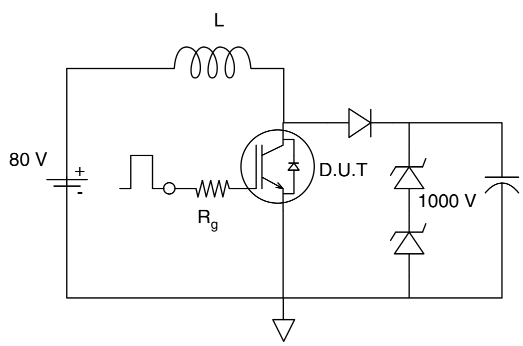


Fig. 22 - RBSOA Circuit

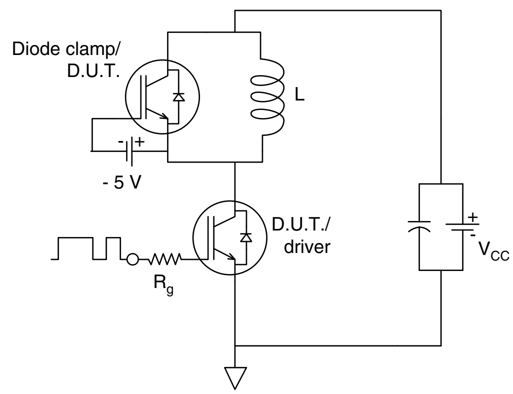
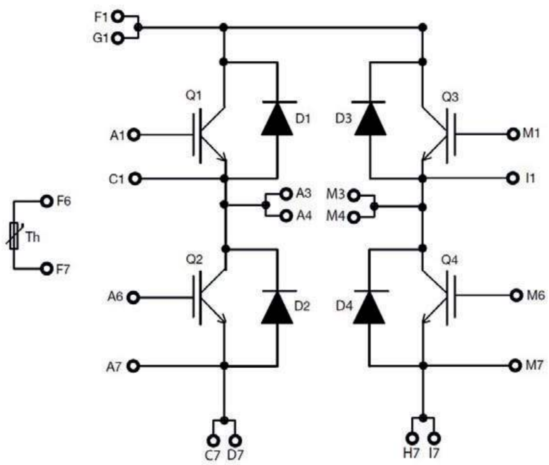


Fig. 24 - Switching Loss Circuit

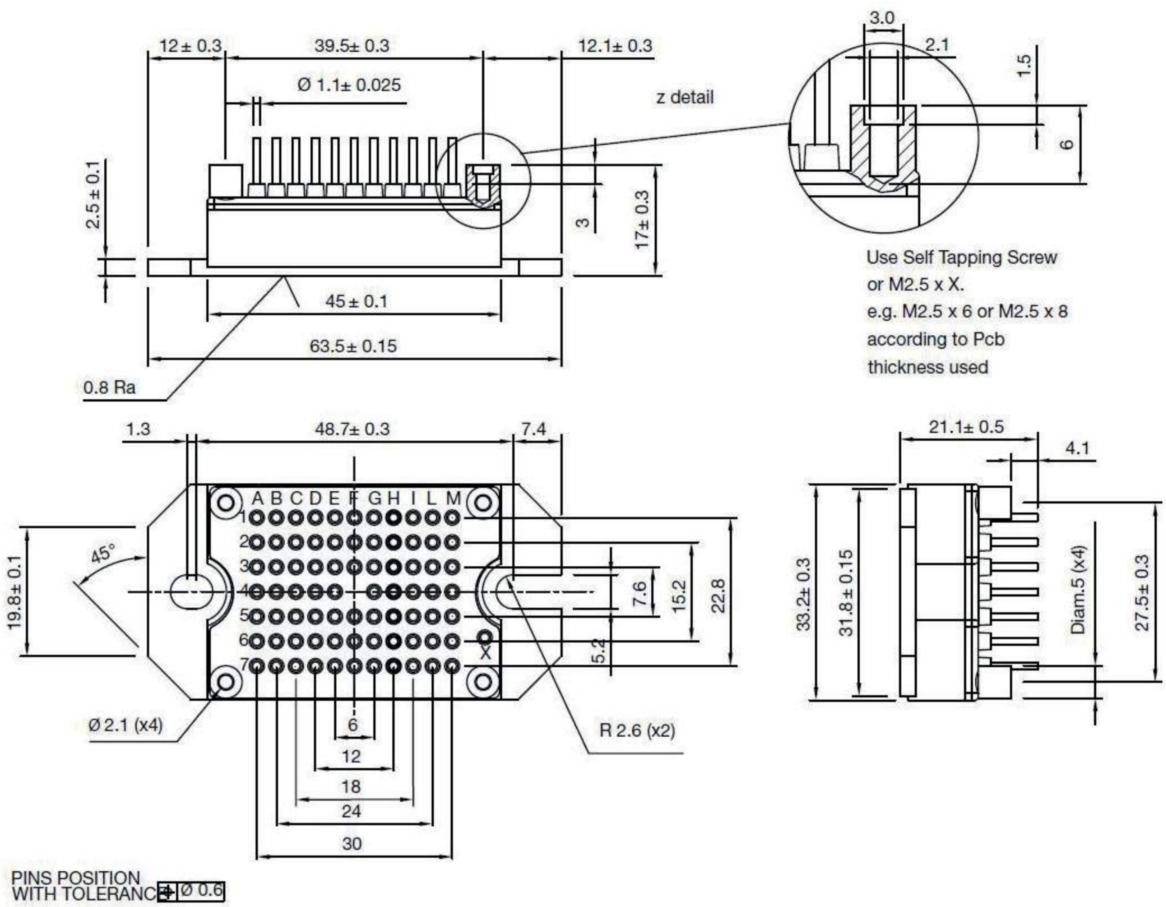
ORDERING INFORMATION TABLE

Device code	VS-	50	MT	060	T	F	T
	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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