Full Bridge IGBT and MOSFET MTP Power Module

MTP

FEATURES

- Generation 4 warp speed IGBT and power MOSFET technology
- HEXFRED® antiparallel diodes with ultrasoft reverse recovery
- Very low conduction and switching losses
- Operating frequency up to 100 kHz
- 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
- Low EMI, requires less snubbing
- Direct mounting to heatsink
- PCB solderable terminals
- Very low stray inductance design for high speed operation

PRODUCT SUMMARY	
HALF BRIDGE POWER MOSFET	
V_{DSS}	650 V
$R_{DS(on)}$ typical at I_D = 40 A	35 mΩ
I_D at T_C = 80 °C	41 A
HALF BRIDGE WARP IGBT	
V_{CES}	600 V
$V_{CE(on)}$ typical at I_C = 25 A	2.18 V
I_C at T_C = 80 °C	46 A

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS		MAX.	UNITS
Operating junction temperature	T_J			150	°C
Storage temperature range	T_{Stg}			- 40 to 150	
V_{RMS} Insulation voltage	V_{ISOL}	AC 1.2 s		3500	V
Q1, Q2 POWER MOSFET					
Drain to source voltage	V_{DSS}			650	V
Gate to source voltage	V_{GS}			25	
Pulsed drain current	I_{DM} (1)			270	A
Single pulse avalanche energy	E_{AS}	T_C = 25 °C; I_D = I_{AR}, V_{DD} = 50 V		2000	mJ
Avalanche current repetitive	I_{AR}	pulsed width limited by T_J max.		15	A
Peak diode recovery voltage slope	dV/dt (2)			15	V/µs
Continuous drain current	I_D	T_C = 25 °C	V_{GS} = 10 V	52	A
		T_C = 80 °C		41	
Power dissipation	P_D	T_C = 25 °C		284	W
		T_C = 80 °C		159	
Q3, Q4 WARP IGBT					
Collector to emitter voltage	V_{CES}			600	V
Gate to emitter voltage	V_{GES}			20	
Pulsed collector current	I_{CM}			200	A
Clamped inductive load current	I_{LM}			200	
Continuous collector current	I_C	T_C = 25 °C		67	
		T_C = 80 °C		43	
Power dissipation	P_D	T_C = 25 °C		211	W
		T_C = 80 °C		118	

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MAX.**	**UNITS**
D1, D2, AP DIODE OF WARP IGBT				
Repetitive peak reverse voltage	V_{RRM}		600	V
Diode continuous forward current	I_F	T_C = 25 °C	73	A
		T_C = 80 °C	48	
Peak diode forward current	I_{FSM}	T_C = 25 °C	260	
Power dissipation	P_D	T_C = 25 °C	143	W
		T_C = 80 °C	80	
SOURCE DRAIN (MOSFET BODY DIODE)				
Continuous source current	I_S	T_C = 25 °C	52	A
Pulsed source current	I_{SM}	T_C = 25 °C	360	

Notes

(1) Pulse width limited by safe operating area

(2) I_{SD} < 69 A, dI/dt = 400 A/µs, peak V_{SD} < $V_{(BR)DSS}$

ELECTRICAL SPECIFICATIONS (T_J = 25 °C unless otherwise specified)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Q1, Q2 POWER MOSFET						
Drain to source breakdown voltage	$V_{(BR)DSS}$	V_{GS} = 0 V, I_D = 250 µA	650	-	-	V
Static drain to source on resistance	$R_{DS(on)}$	V_{GS} = 10 V, I_D = 50 A	-	35	44	mΩ
		V_{GS} = 10 V, I_D = 50 A, T_J = 150 °C	-	-	104	mΩ
Gate threshold voltage	$V_{GS(th)}$	V_{GE} = V_{GS}, I_D = 0.25 mA	2.8	4	5.4	V
Drain to source leakage current	I_{DSS}	V_{DS} = 650 V, V_{GS} = 0 V	-	-	50	µA
		V_{DS} = 650 V, V_{GS} = 0 V, T_J = 150 °C	-	-	5.0	mA
Gate to source forward leakage	I_{GSS}	V_{GS} = 25 V	-	-	100	nA
Gate to source reverse leakage		V_{GS} = - 25 V	-	-	- 100	
Intrinsic gate resistance	R_g	f = 1 MHz, open drain	-	1.2	-	Ω
Total gate charge	Q_g	I_D = 35 A	-	200	-	nC
Gate to source charge	Q_{gs}	V_{DD} = 520 V	-	60	-	
Gate to drain (Miller) charge	Q_{gd}	V_{GS} = 10 V	-	70	-	
Turn-on delay time	$t_{d(on)}$	V_{DD} = 325 V	-	165	-	ns
Rise time	t_r	L = 500 µH, I_D = 40 A	-	44	-	
Turn-off delay time	$t_{d(off)}$	R_g = 5 Ω, V_{GS} = 10 V, T_J = 125 °C	-	148	-	
Fall time	t_f		-	30	-	
Input capacitance	C_{iss}	V_{GS} = 0 V	-	9800	-	pF
Output capacitance	C_{oss}	V_{DS} = 100 V, f = 1 MHz	-	200	-	
SOURCE DRAIN (MOSFET BODY DIODE)						
Forward voltage	V_{SD}	I_S = 34 A, V_{GS} = 0 V	-	-	1.0	V
Q3, Q4 WARP IGBT						
Collector to emitter breakdown voltage	$V_{(BR)CES}$	V_{GE} = 0 V, I_C = 250 µA	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_D = 25 A	-	2.18	2.83	
		V_{GE} = 15 V, I_C = 25 A T_J = 150 °C	-	1.75	2.34	
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 0.25 mA	2.8	4.9	6.2	V
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	V_{CE} = V_{GE}, I_C = 1 mA (25 °C to 125 °C)	-	- 12	-	mV/°C
Forward transconductance	g_{fe}	V_{CE} = 20 V, I_C = 25 A	-	49	-	S
Zero gate voltage collector current	I_{CES}	V_{GE} = 0 V, V_{CE} = 600 V	-	-	250	µA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C	-	-	5.0	mA
Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V, V_{CE} = 0 V	-	-	± 100	nA
D1, D2, AP DIODE OF WARP IGBT						
Forward voltage drop	V_{FM}	I_F = 25 A	-	1.3	1.41	V
		I_F = 25 A, T_J = 150 °C	-	1.11	1.29	

SWITCHING CHARACTERISTICS (T_J = 25 °C unless otherwise specified)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Q3, Q4 WARP IGBT						
Total gate charge (turn-on)	Q_g	I_C = 25 A V_{CC} = 400 V V_{GE} = 15 V	-	175	-	nC
Gate to emitter charge (turn-on)	Q_{ge}		-	27	-	
Gate to collector charge (turn-on)	Q_{gc}		-	71	-	
Turn-on switching loss	E_{on}	I_C = 25 A V_{CC} = 400 V, V_{GE} = 15 V R_g = 5 Ω , L = 500 µH	-	0.21	-	mJ
Turn-off switching loss	E_{off}		-	0.15	-	
Total switching loss	E_{tot}		-	0.36	-	
Turn-on switching loss	E_{on}	I_C = 25 A V_{CC} = 400 V, V_{GE} = 15 V R_g = 5 Ω , T_J = 125 °C , L = 500 µH	-	0.33	-	mJ
Turn-off switching loss	E_{off}		-	0.36	-	
Total switching loss	E_{tot}		-	0.69	-	
D1, D2, AP DIODE OF WARP IGBT						
Diode reverse recovery time	t_{rr}	V_{RR} = 400 V I_F = 25 A, T_J = 125 °C dI/dt = 200 A/µs	-	118	-	ns
Diode peak reverse current	I_{rr}		-	13.5	-	A
Diode recovery charge	Q_{rr}		-	760	-	nC
SOURCE DRAIN (MOSFET BODY DIODE)						
Diode reverse recovery time	t_{rr}	I_{SD} = 34.5 A V_{DD} = 100 V dI/dt = 100 A/µs	-	563	-	ns
Diode reverse current	I_{rr}		-	35	-	A
Diode recovery charge	Q_{rr}		-	9500	-	nC

THERMISTOR ELECTRICAL CHARACTERISTICS (T_J = 25 °C unless otherwise specified)				
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**TYP.**	**UNITS**
Resistance	R	T_J = 25 °C	5000	Ω
B Value	B	T_J = 125 °C/50 °C	3375	K

MECHANICAL SPECIFICATIONS					
PARAMETER	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Junction to case Q1, Q2 POWER MOSFET thermal resistance (per switch)	R_{thJC}	-	-	0.44	°C/W
Junction to case Q3, Q4 WARP IGBT thermal resistance (per switch)		-	-	0.59	
Junction to case D1, D2, AP diode of WARP IGBT thermal resistance (per diode)		-	-	0.87	
Case to sink, flat, greased surface (per module)	R_{thCS}	-	0.05	-	
Mounting torque ± 10 % to heatsink (1)		-	-	4	Nm
Weight		-	65	-	g

Note

(1) A mounting compound is recommended and the torque should be rechecked after a period of 3 hours to allow for the spread of the compound. Lubricated threads.

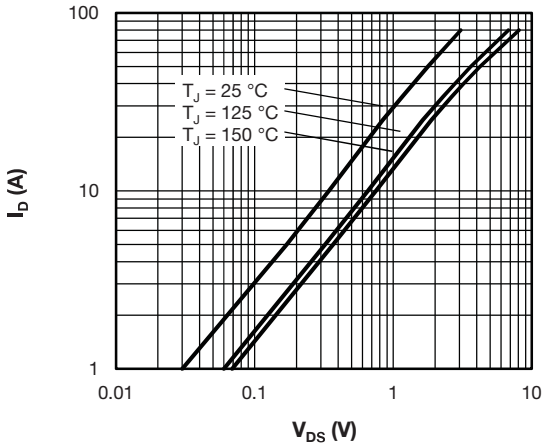


Fig. 1 - Power MOSFET Q1 - Q2 Typical Output Characteristics, V_{GS} = 10 V

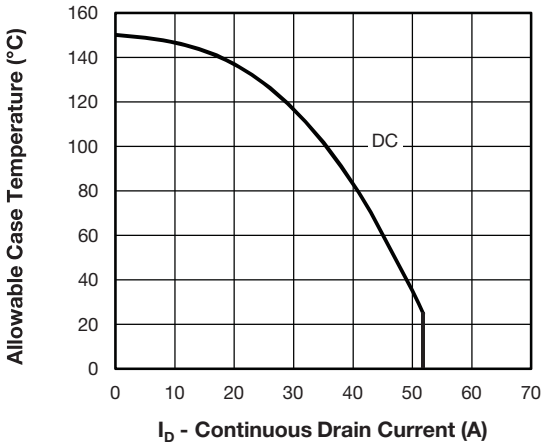


Fig. 4 - Power MOSFET Q1 - Q2 Maximum Continuous Drain Current vs. Case Temperature, V_{GS} = 10 V

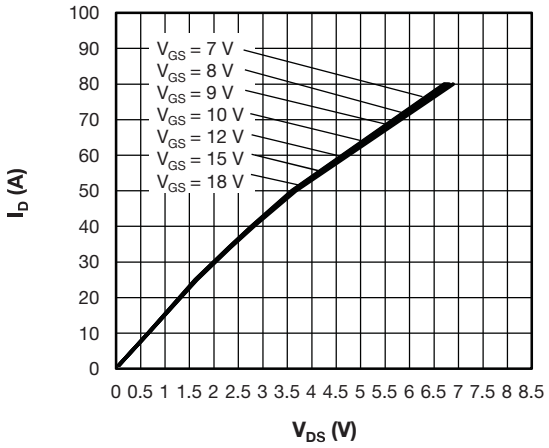


Fig. 2 - Power MOSFET Q1 - Q2 Typical Output Characteristics, T_J = 125 °C

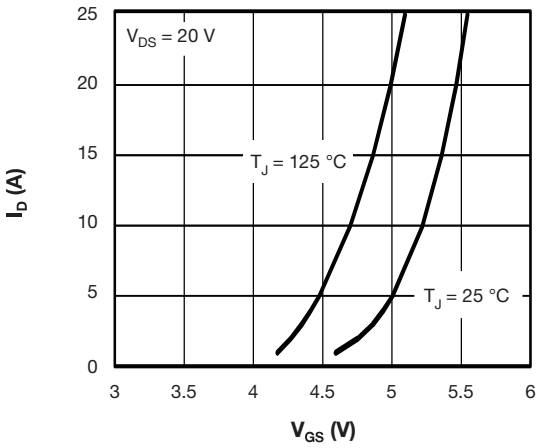


Fig. 5 - Power MOSFET Q1 - Q2 Typical Transfer Characteristics

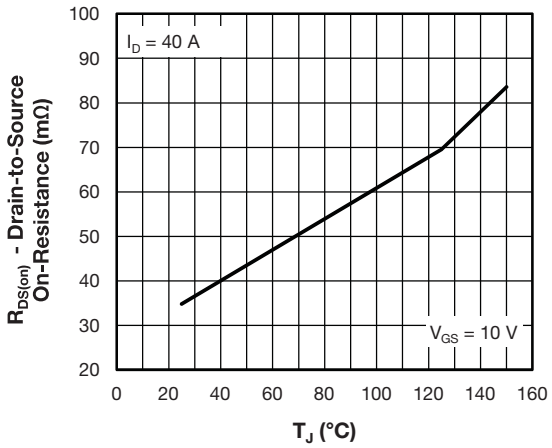


Fig. 3 - Power MOSFET Q1 - Q2 Typical Drain-to-Source On-Resistance vs. Temperature

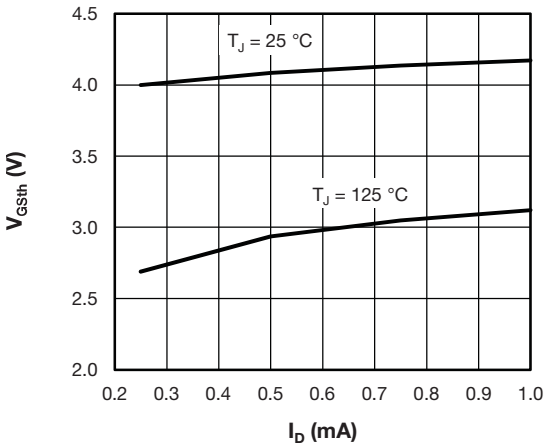


Fig. 6 - Power MOSFET Q1 - Q2 Typical Gate Threshold Voltage

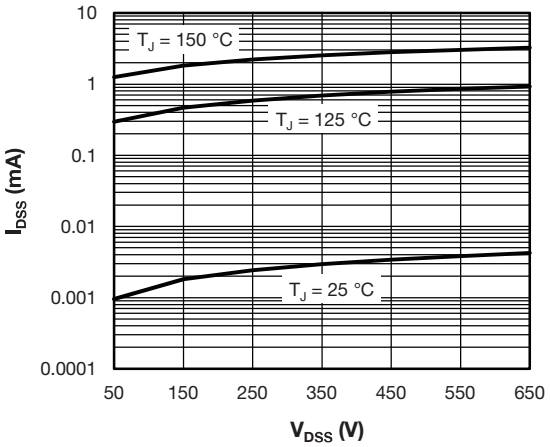


Fig. 7 - Power MOSFET Q1 - Q2 Typical Zero Gate Voltage Drain Current

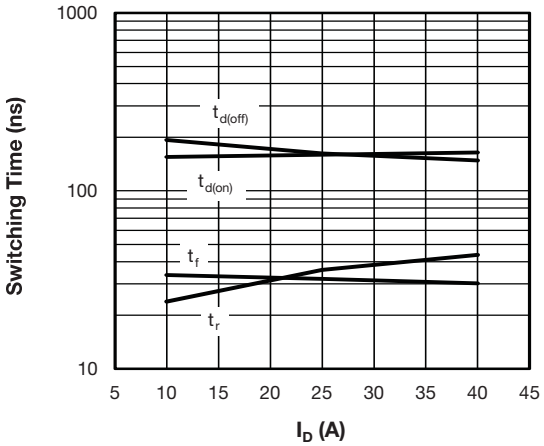


Fig. 9 - Power MOSFET Q1 - Q2 Typical Switching Time vs. I_D (with freewheeling diode 15ETH06),
T_J = 125 °C, V_{DD} = 325 V, R_g = 5 Ω, V_{GS} = 10 V, L = 500 µH

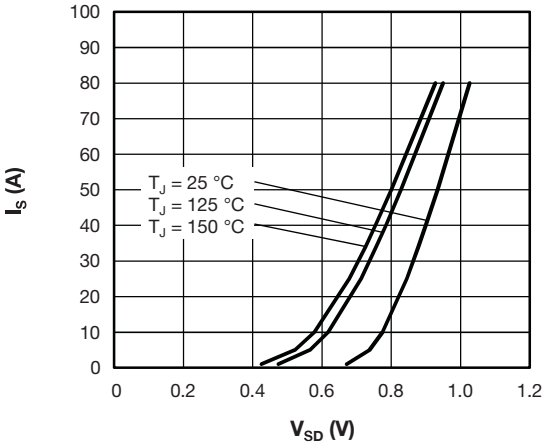


Fig. 8 - Power MOSFET Q1 - Q2 Typical Bodydiode Source-to-Drain Current Characteristics

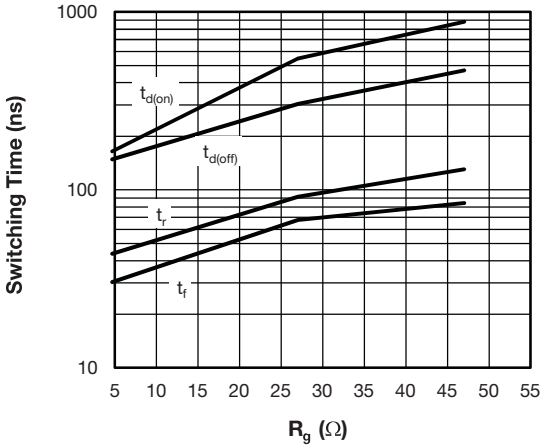


Fig. 10 - Power MOSFET Q1 - Q2 Typical Switching Time vs. R_g (with freewheeling diode 15ETH06),
T_J = 125 °C, V_{DD} = 325 V, I_D = 40 A, V_{GS} = 10 V, L = 500 µH

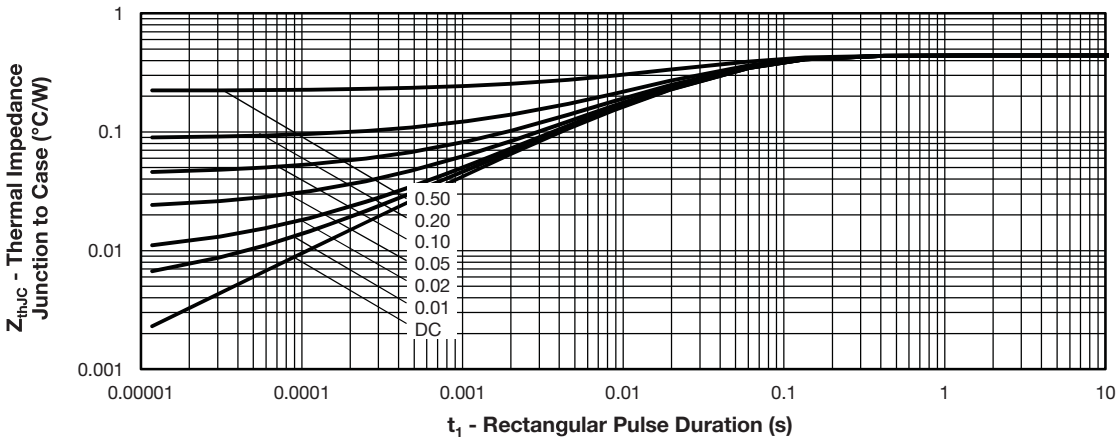


Fig. 11 - Maximum Thermal Impedance Z_{thJC} Characteristics (Q1 - Q2 Power MOSFET)

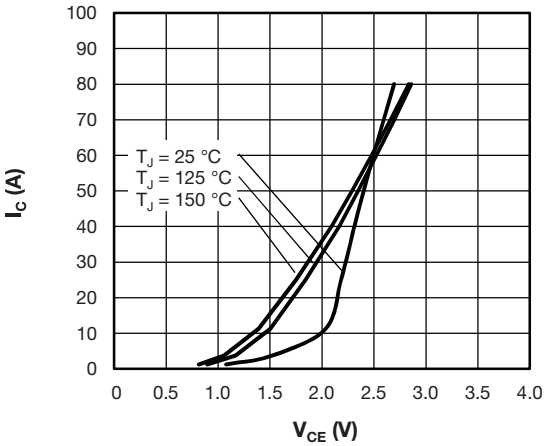


Fig. 12 - Q3 - Q4 IGBT Typical Output Characteristics, V_{GE} = 15 V

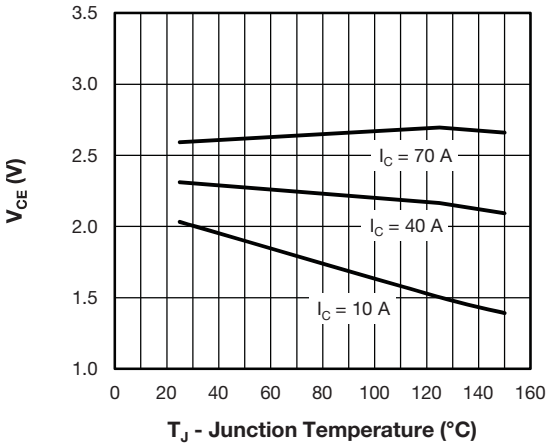


Fig. 15 - Q3 - Q4 IGBT Typical Collector to Emitter Voltage vs. Junction Temperature, V_{GE} = 15 V

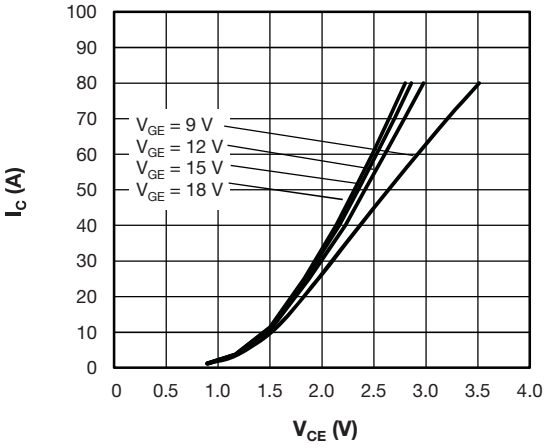


Fig. 13 - Q3 - Q4 IGBT Typical Output Characteristics, T_J = 125 °C

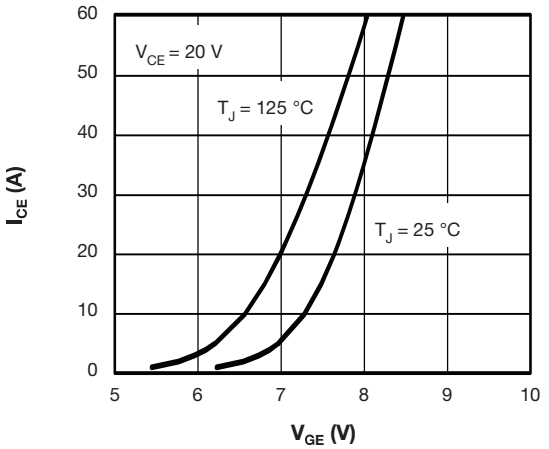


Fig. 16 - Q3 - Q4 IGBT Typical Transfer Characteristics

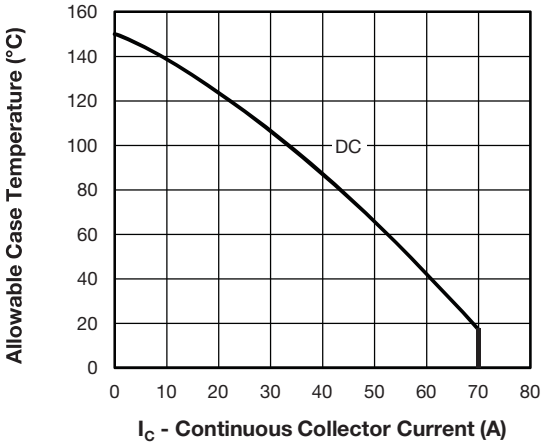


Fig. 14 - Q3 - Q4 IGBT Maximum Continuous Collector Current vs. Case Temperature

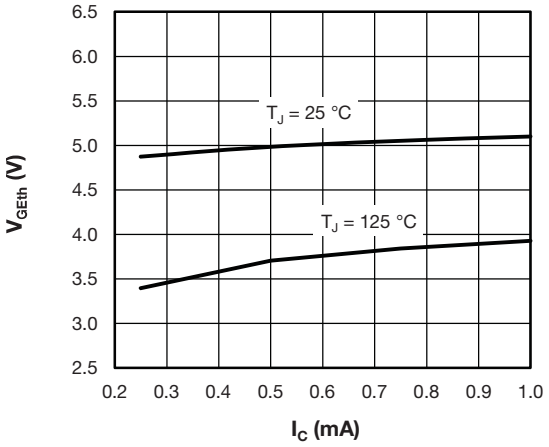


Fig. 17 - Q3 - Q4 IGBT Typical Gate Threshold Voltage

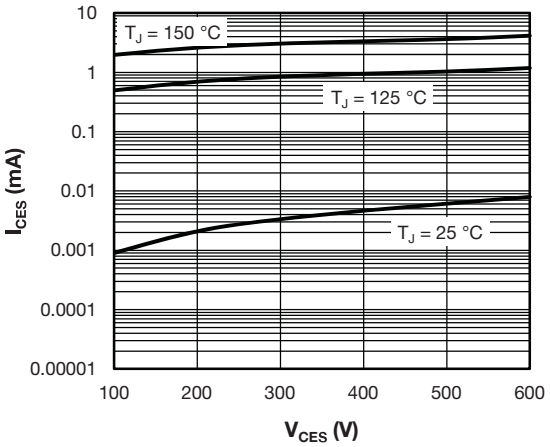


Fig. 18 - Q3 - Q4 IGBT Typical Trench Zero Gate Voltage Collector Current

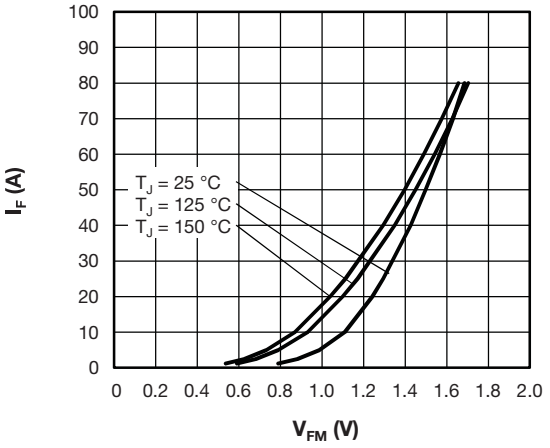


Fig. 19 - D1 - D2 Antiparallel Diode Typical Forward Characteristics

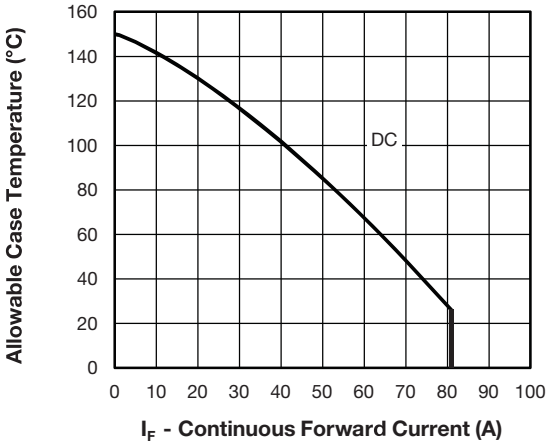


Fig. 20 - D1 - D2 Antiparallel Diode Maximum Forward Current vs. Case Temperature

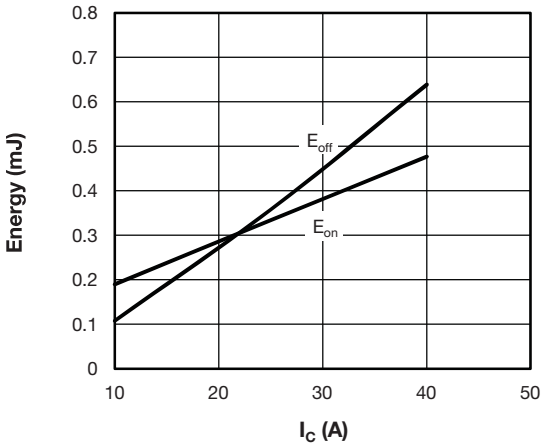


Fig. 21 - Q3 - Q4 IGBT Typical Energy Loss vs. I_C (with freewheeling D1 - D2 antiparallel diode), T_J = 125 °C, V_{CC} = 400 V, R_g = 5 Ω, V_{GE} = 15 V, L = 500 µH

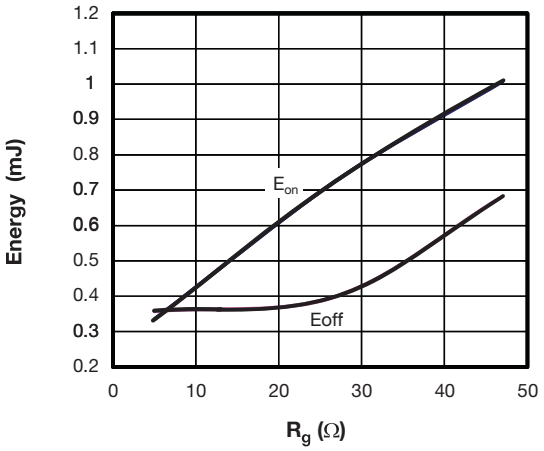


Fig. 22 - Q3 - Q4 IGBT Typical Energy Loss vs. R_g (with freewheeling D1 - D2 antiparallel diode), T_J = 125 °C, V_{CC} = 400 V, V_{GE} = 15 V, L = 500 µH, I_C = 25 A

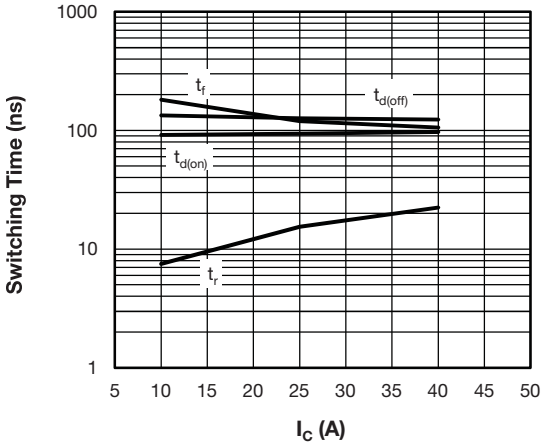


Fig. 23 - Q3 - Q4 IGBT Typical Switching Time vs. I_C (with freewheeling D1 - D2 antiparallel diode), T_J = 125 °C, V_{CC} = 400 V, R_g = 5 Ω, V_{GE} = 15 V, L = 500 µH

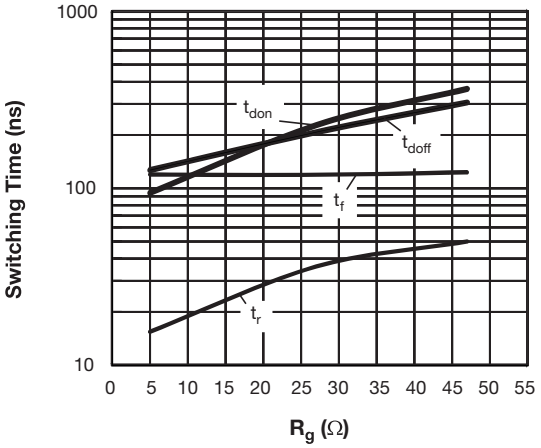


Fig. 24 - Q3 - Q4 IGBT Typical Switching Time vs. R_g (with freewheeling D1 - D2 antiparallel diode), T_J = 125 °C, V_{CC} = 400 V, V_{GE} = 15 V, L = 500 µH, I_C = 25 A

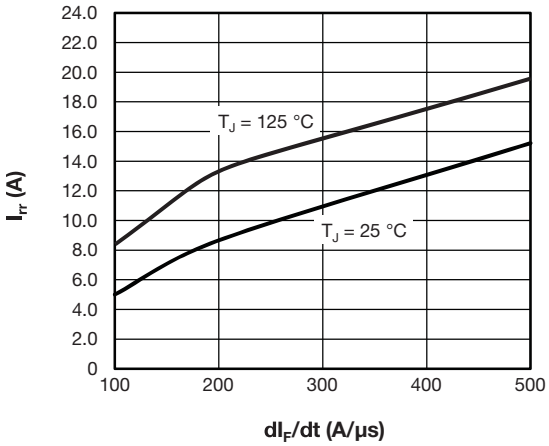


Fig. 26 - D1 - D2 Antiparallel Diode Typical Reverse Recovery Current vs. dI_F/dt, V_{RR} = 400 V, I_F = 25 A

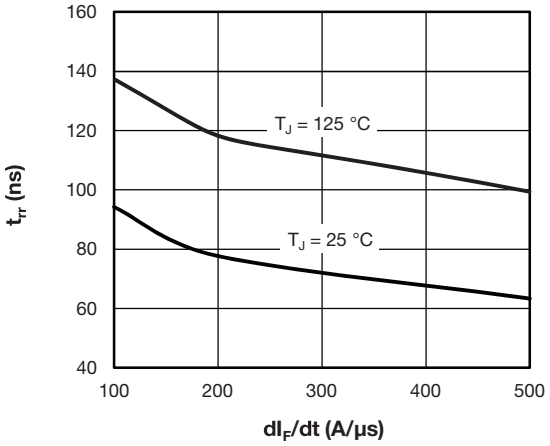


Fig. 25 - D1 - D2 Antiparallel Diode Typical Reverse Recovery Time vs. dI_F/dt, V_{RR} = 400 V, I_F = 25 A

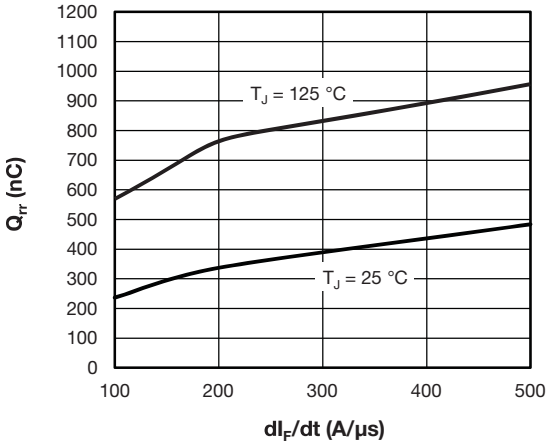


Fig. 27 - D1 - D2 Antiparallel Diode Typical Reverse Recovery Charge vs. dI_F/dt, V_{RR} = 400 V, I_F = 25 A

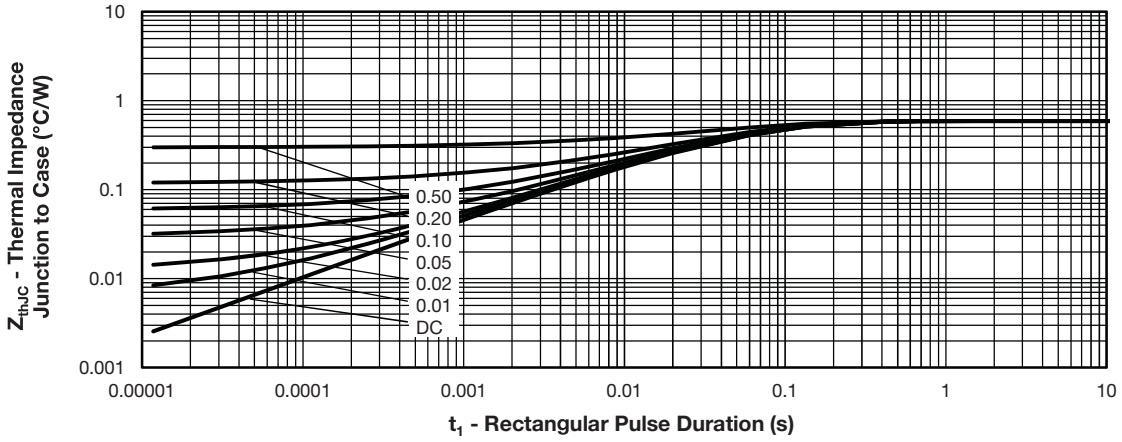


Fig. 28 - Maximum Thermal Impedance Z_{thJC} Characteristics (Q1 - Q2 WARP IGBT)

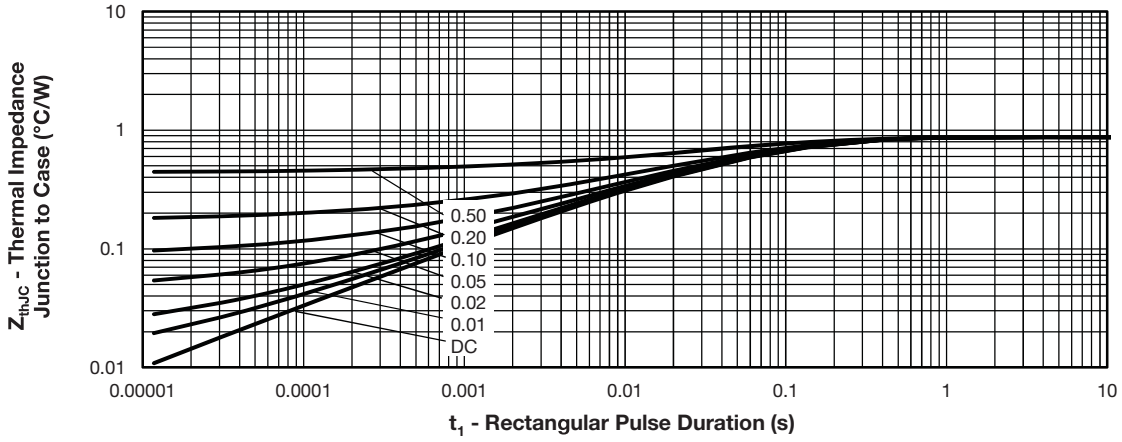


Fig. 29 - Maximum Thermal Impedance Z_{thJC} Characteristics (D1 - D2 Antiparallel Diode)

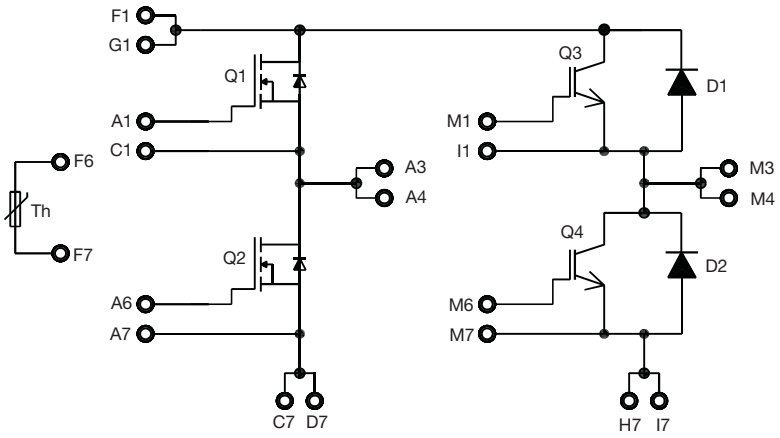
ORDERING INFORMATION TABLE

Device code

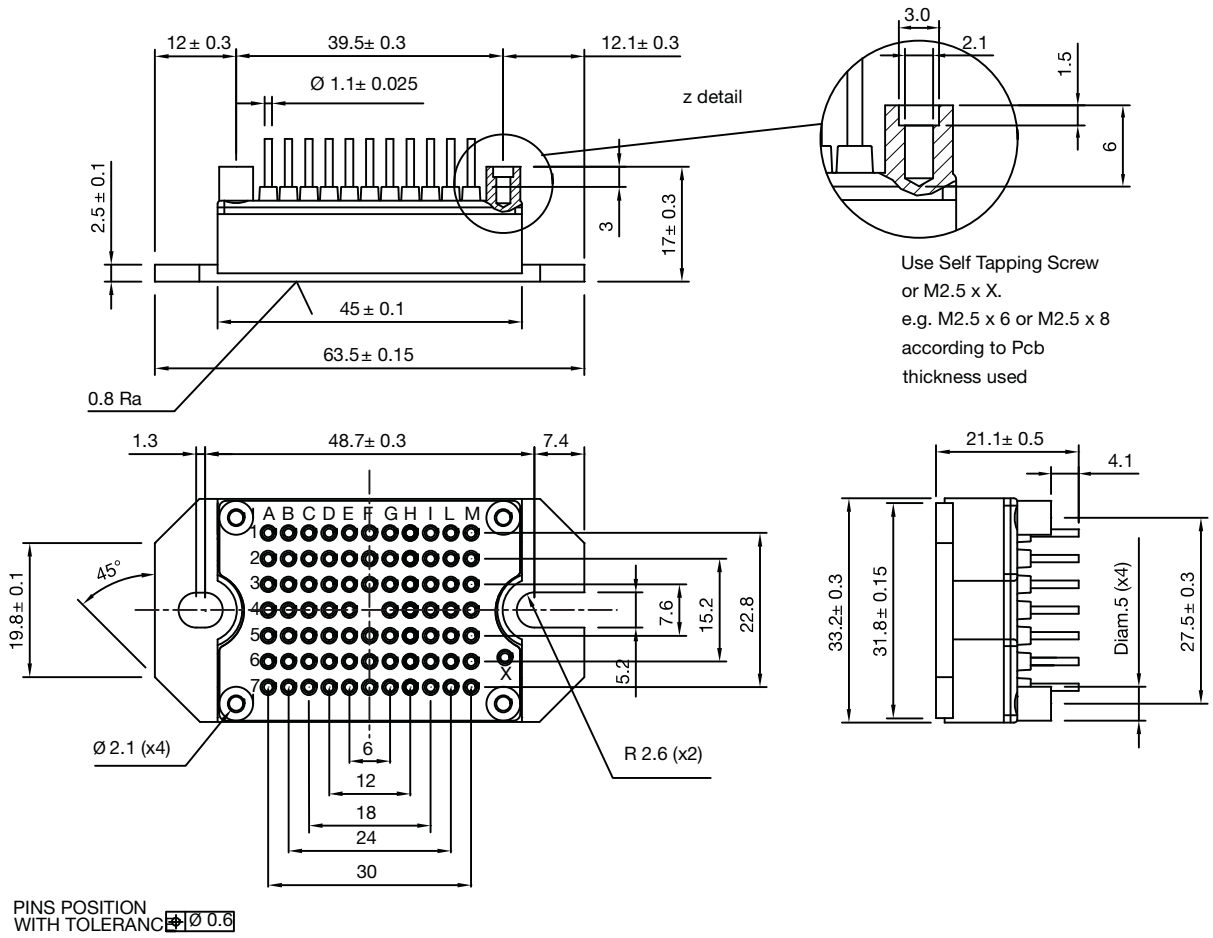
VS-	40	MT	060	W	FH	T
1	2	3	4	5	6	7

1	-	Vishay Semiconductors Product
2	-	Current rating (40 = 40 A)
3	-	MTP package
4	-	Voltage code (060 = 600 V)
5	-	Speed/type (W = Warp IGBT)
6	-	Circuit configuration (FH = Full bridge MOSFET, IGBT)
7	-	Thermistor

CIRCUIT CONFIGURATION

CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Full bridge MOSFET, IGBT	FH	

DIMENSIONS in millimeters



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