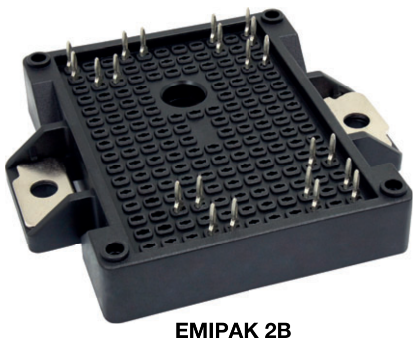
EMIPAK 2B PressFit Power Module 3-Levels Half Bridge Inverter Stage, 75 A



EMIPAK 2B (package example)

PRIMARY CHARACTERISTICS	
Q1 - Q4 IGBT STAGE	
V_{CES}	600 V
$V_{CE(on)}$ typical at I_C = 75 A	1.7 V
I_C at T_C = 89 °C	75 A
Q2 - Q3 IGBT STAGE	
V_{CES}	600 V
$V_{CE(on)}$ typical at I_C = 75 A	1.56 V
I_C at T_C = 122 °C	75 A
Speed	8 kHz to 30 kHz
Package	EMIPAK 2B
Circuit configuration	3-levels half bridge inverter stage

FEATURES

- Trench IGBT technology
- FRED Pt® clamping diodes
- PressFit pins technology
- Exposed Al_2O_3 substrate with low thermal resistance
- Short circuit rated
- Square RBSOA
- Integrated thermistor
- Low internal inductances
- Low switching loss
- PressFit pins locking technology. Patent # US.263.820 B2
- UL approved file E78996
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

DESCRIPTION

VS-ETF075Y60U is an integrated solution for a multi level inverter stage in a single package. The EMIPAK2B package is easy to use thanks to the PressFit pins and the exposed substrate provides improved thermal performance. The optimized layout also helps to minimize stray parameters, allowing for better EMI performance.

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MAX.**	**UNITS**
Operating junction temperature	T_J		175	°C
Storage temperature range	T_{Stg}		-40 to +150	
RMS isolation voltage	V_{ISOL}	T_J = 25 °C, all terminals shorted, f = 50 Hz, t = 1 s	3500	V
Q1 - Q4 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} (1)		200	
Continuous collector current	I_C	T_C = 25 °C	109	A
		T_C = 80 °C	80	
		T_{SINK} = 80 °C	40	
Power dissipation	P_D	T_C = 25 °C	294	W
		T_C = 80 °C	186	
Q2 - Q3 IGBT				
Collector to emitter voltage	V_{CES}		600	V
Gate to emitter voltage	V_{GES}		20	
Pulsed collector current	I_{CM}		250	A
Clamped inductive load current	I_{LM} (1)		250	
Continuous collector current	I_C	T_C = 25 °C	154	A
		T_C = 80 °C	113	
		T_{SINK} = 80 °C	50	
Power dissipation	P_D	T_C = 25 °C	405	W
		T_C = 80 °C	257	

PATENT(S): www.vishay.com/patents
This Vishay product is protected by one or more United States and International patents.

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
D5 - D6 CLAMPING DIODE				
Repetitive peak reverse voltage	V_{RRM}		600	V
Single pulse forward current	I_{FSM}	10 ms sine or 6 ms rectangular pulse, T_J = 25 °C	270	A
Diode continuous forward current	I_F	T_C = 25 °C	78	A
		T_C = 80 °C	55	
		T_{SINK} = 80 °C	28	
Power dissipation	P_D	T_C = 25 °C	174	W
		T_C = 80 °C	110	
D1 - D2 - D3 - D4 AP DIODE				
Single pulse forward current	I_{FSM}	10 ms sine or 6 ms rectangular pulse, T_J = 25 °C	250	A
Diode continuous forward current	I_F	T_C = 25 °C	72	
		T_C = 80 °C	70	
		T_{SINK} = 80 °C	31	
Power dissipation	P_D	T_C = 25 °C	107	W
		T_C = 80 °C	68	

Notes

- Absolute Maximum Ratings indicate sustained limits beyond which damage to the device may occur

(1) V_{CC} = 300 V, V_{GE} = 15 V, L = 500 µH, R_g = 4.7 Ω, T_J = 175 °C

ELECTRICAL SPECIFICATIONS (T_J = 25 °C unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Q1 - Q4 IGBT						
Collector to emitter breakdown voltage	BV_{CES}	V_{GE} = 0 V, I_C = 100 µA	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_C = 60 A	-	1.57	1.8	V
		V_{GE} = 15 V, I_C = 75 A	-	1.7	1.93	
		V_{GE} = 15 V, I_C = 60 A, T_J = 125 °C	-	1.7	-	
		V_{GE} = 15 V, I_C = 75 A, T_J = 125 °C	-	1.86	-	
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 2.1 mA	3.6	5.6	7.1	
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 = 75 A	-	51	-	S
Transfer characteristics	V_{GE}	V_{CE} = 20 V, I_C = 75 A	-	9.6	-	V
Zero gate voltage collector current	I_{CES}	V_{GE} = 0 V, V_{CE} = 600 V	-	0.0002	0.1	mA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C	-	0.01	-	
Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V, V_{CE} = 0 V	-	-	± 200	nA
Q2 - Q3 IGBT						
Collector to emitter breakdown voltage	BV_{CES}	V_{GE} = 0 V, I_C = 500 µA	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_C = 60 A	-	1.45	1.62	V
		V_{GE} = 15 V, I_C = 75 A	-	1.56	1.73	
		V_{GE} = 15 V, I_C = 60 A, T_J = 125 °C	-	1.52	-	
		V_{GE} = 15 V, I_C = 75 A, T_J = 125 °C	-	1.67	-	
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 5.6 mA	3.6	5.3	7.1	
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	V_{CE} = V_{GE}, I_C = 1.4 mA (25 °C to 125 °C)	-	-18	-	mV/°C
Forward transconductance	g_{fe}	V_{CE} = 20 V, I_C = 75 A	-	72	-	S
Transfer characteristics	V_{GE}	V_{CE} = 20 V, I_C = 75 A	-	8.3	-	V
Zero gate voltage collector current	I_{CES}	V_{GE} = 0 V, V_{CE} = 600 V	-	0.0005	0.1	mA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C	-	0.065	-	
Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V, V_{CE} = 0 V	-	-	± 400	nA

ELECTRICAL SPECIFICATIONS (T_J = 25 °C unless otherwise noted)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
D5 - D6 CLAMPING DIODE						
Cathode to anode blocking voltage	V_{BR}	I_R = 100 µA	600	-	-	V
Forward voltage drop	V_{FM}	I_F = 40 A	-	1.83	2.35	V
		I_F = 40 A, T_J = 125 °C	-	1.51	-	V
Reverse leakage current	I_{RM}	V_R = 600 V	-	0.0002	0.1	mA
		V_R = 600 V, T_J = 125 °C	-	0.028	-	mA
D1 - D2 - D3 - D4 AP DIODE						
Forward voltage drop	V_{FM}	I_F = 30 A	-	1.2	1.41	V
		I_F = 30 A, T_J = 125 °C	-	1.06	-	V

SWITCHING CHARACTERISTICS (T_J = 25 °C unless otherwise noted)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Q1 - Q4 IGBT (WITH D5 - D6 CLAMPING DIODE)						
Total gate charge (turn-on)	Q_g	I_C = 75 A V_{CC} = 400 V V_{GE} = 15 V	-	150	-	nC
Gate to emitter charge (turn-on)	Q_{ge}		-	40	-	nC
Gate to collector charge (turn-on)	Q_{gc}		-	60	-	nC
Turn-on switching loss	E_{on}	I_C = 75 A V_{CC} = 300 V V_{GE} = 15 V R_g = 4.7 Ω L = 500 µH (1)	-	0.94	-	mJ
Turn-off switching loss	E_{off}		-	1.1	-	mJ
Total switching loss	E_{tot}		-	2.04	-	mJ
Turn-on delay time	$t_{d(on)}$		-	78	-	ns
Rise time	t_r		-	72	-	ns
Turn-off delay time	$t_{d(off)}$		-	101	-	ns
Fall time	t_f		-	65	-	ns
Turn-on switching loss	E_{on}	I_C = 75 A V_{CC} = 300 V V_{GE} = 15 V R_g = 4.7 Ω L = 500 µH T_J = 125 °C (1)	-	1.13	-	mJ
Turn-off switching loss	E_{off}		-	1.61	-	mJ
Total switching loss	E_{tot}		-	2.74	-	mJ
Turn-on delay time	$t_{d(on)}$		-	78	-	ns
Rise time	t_r		-	72	-	ns
Turn-off delay time	$t_{d(off)}$		-	106	-	ns
Fall time	t_f		-	107	-	ns
Input capacitance	C_{ies}	V_{GE} = 0 V V_{CC} = 30 V f = 1 MHz	-	4440		pF
Output capacitance	C_{oes}		-	245		pF
Reverse transfer capacitance	C_{res}		-	130		pF
Reverse bias safe operating area	RBSOA	T_J = 175 °C, I_C = 200 A, V_{CC} = 300 V, V_P = 600 V, R_g = 4.7 Ω, V_{GE} = 15 V to 0 V		Fullsquare		
Short circuit safe operating area	SCSOA	R_g = 10 Ω, V_{CC} = 400 V, V_P = 600 V V_{GE} = 15 V to 0	-	-	5	µs
Q2 - Q3 IGBT (WITH FREEWHEELING EXTERNAL TO-247 DIODE DISCRETE 30ETH06)						
Total gate charge (turn-on)	Q_g	I_C = 120 A V_{CC} = 400 V V_{GE} = 15 V	-	240	-	nC
Gate to emitter charge (turn-on)	Q_{ge}		-	69	-	nC
Gate to collector charge (turn-on)	Q_{gc}		-	90	-	nC
Turn-on switching loss	E_{on}	I_C = 75 A V_{CC} = 300 V V_{GE} = 15 V R_g = 4.7 Ω L = 500 µH (1)	-	0.85	-	mJ
Turn-off switching loss	E_{off}		-	1.54	-	mJ
Total switching loss	E_{tot}		-	2.39	-	mJ
Turn-on delay time	$t_{d(on)}$		-	111	-	ns
Rise time	t_r		-	81	-	ns
Turn-off delay time	$t_{d(off)}$		-	130	-	ns
Fall time	t_f		-	74	-	ns

SWITCHING CHARACTERISTICS (T_J = 25 °C unless otherwise noted)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Turn-on switching loss	E_{on}	I_C = 75 A V_{CC} = 300 V V_{GE} = 15 V R_g = 4.7 Ω L = 500 μH T_J = 125 °C [1]	-	1.0	-	mJ
Turn-off switching loss	E_{off}		-	1.83	-	
Total switching loss	E_{tot}		-	2.83	-	
Turn-on delay time	$t_{d(on)}$		-	111	-	ns
Rise time	t_r		-	83	-	
Turn-off delay time	$t_{d(off)}$		-	140	-	
Fall time	t_f		-	104	-	
Input capacitance	C_{ies}	V_{GE} = 0 V V_{CC} = 30 V f = 1 MHz	-	7750	-	pF
Output capacitance	C_{oes}		-	550	-	
Reverse transfer capacitance	C_{res}		-	225	-	
Reverse bias safe operating area	RBSOA	T_J = 175 °C, I_C = 250 A, V_{CC} = 300 V, V_P = 600 V, R_g = 4.7 Ω, V_{GE} = 15 V to 0 V		Fullsquare		
Short circuit safe operating area	SCSOA	R_g = 10 Ω, V_{CC} = 400 V, V_P = 600 V V_{GE} = 15 V to 0	-	-	5	μs
D5 - D6 CLAMPING DIODE						
Diode reverse recovery time	t_{rr}	V_R = 200 V I_F = 50 A dI/dt = 500 A/μs	-	59	-	ns
Diode peak reverse current	I_{rr}		-	8.5	-	A
Diode recovery charge	Q_{rr}		-	257	-	nC
Diode reverse recovery time	t_{rr}	V_R = 200 V I_F = 50 A dI/dt = 500 A/μs, T_J = 125 °C	-	110	-	ns
Diode peak reverse current	I_{rr}		-	18.5	-	A
Diode recovery charge	Q_{rr}		-	1020	-	nC
D1 - D2 - D3 - D4 AP DIODE						
Diode reverse recovery time	t_{rr}	V_R = 200 V I_F = 50 A dI/dt = 500 A/μs	-	108	-	ns
Diode peak reverse current	I_{rr}		-	19.5	-	A
Diode recovery charge	Q_{rr}		-	1062	-	nC
Diode reverse recovery time	t_{rr}	V_R = 200 V I_F = 50 A dI/dt = 500 A/μs, T_J = 125 °C	-	174	-	ns
Diode peak reverse current	I_{rr}		-	31	-	A
Diode recovery charge	Q_{rr}		-	2716	-	nC

Note

[1] Energy losses include “tail” and diode reverse recovery

INTERNAL NTC - THERMISTOR SPECIFICATIONS				
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**VALUE**	**UNITS**
Resistance	R25	T_C = 25 °C	5000	Ω
	R100	T_C = 100 °C	493 ± 5 %	
B-value	$B_{25/50}$	$R_2 = R_{25}$ exp. $[B_{25/50}$ (1/T_2 - 1/(298.15 K))]	3375 ± 5 %	K
Maximum operating temperature			220	°C
Dissipation constant			2	mW/°C
Thermal time constant			8	s

THERMAL AND MECHANICAL SPECIFICATIONS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Q1 - Q4 IGBT - junction to case thermal resistance (per switch)	R_{thJC}	-	-	0.51	°C/W
Q2 - Q3 IGBT - junction to case thermal resistance (per switch)		-	-	0.37	
D5 - D6 clamping diode - junction to case thermal resistance (per diode)		-	-	0.86	
D1 - D2 - D3 - D4 AP diode - junction to case thermal resistance (per diode)		-	-	1.4	
Q1 - Q4 IGBT - case to sink thermal resistance (per switch)	R_{thCS} (1)	-	0.84	-	
Q2 - Q3 IGBT - case to sink thermal resistance (per switch)		-	0.8	-	
D5 - D6 clamping diode - case to sink thermal resistance (per diode)		-	1.16	-	
D1 - D2 - D3 - D4 AP diode - case to sink thermal resistance (per diode)		-	1.12	-	
Case to sink thermal resistance per module		-	0.1	-	°C/W
Mounting torque (M4)		2	-	3	Nm
Weight		-	45	-	g

Note

(1) Mounting surface flat, smooth, and greased

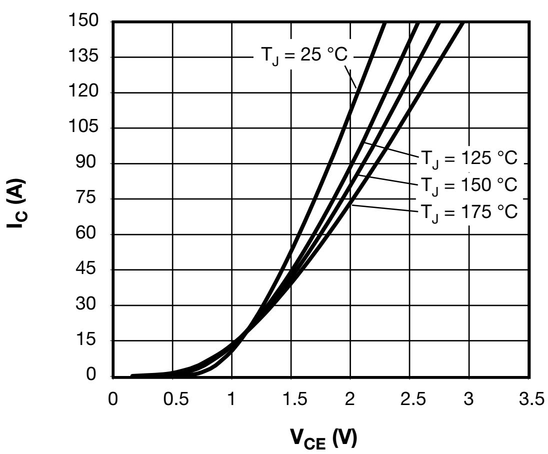


Fig. 1 - Typical Q1 - Q4 Trench IGBT Output Characteristics
V_{GE} = 15 V

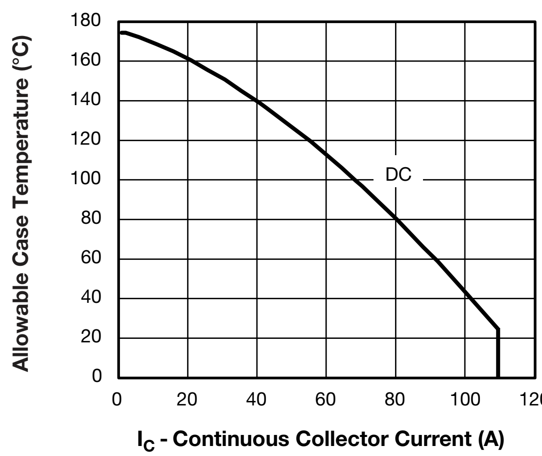


Fig. 3 - Maximum Q1 - Q4 Trench IGBT Continuous Collector Current vs. Case Temperature

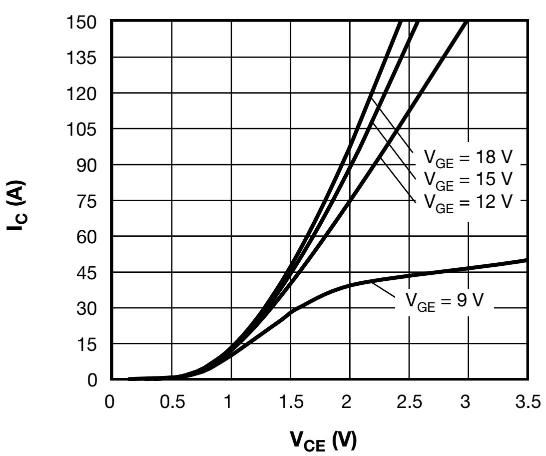


Fig. 2 - Typical Q1 - Q4 Trench IGBT Output Characteristics
T_J = 125 °C

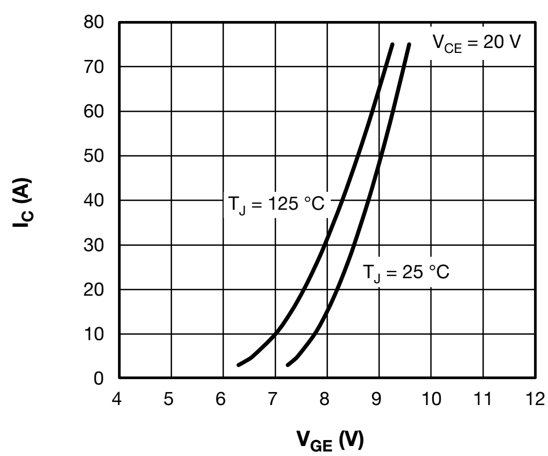


Fig. 4 - Typical Q1 - Q4 Trench IGBT Transfer Characteristics

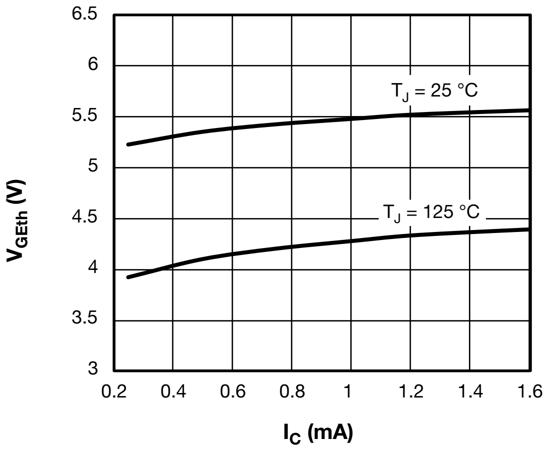


Fig. 5 - Typical Q1 - Q4 Trench IGBT Gate Threshold Voltage

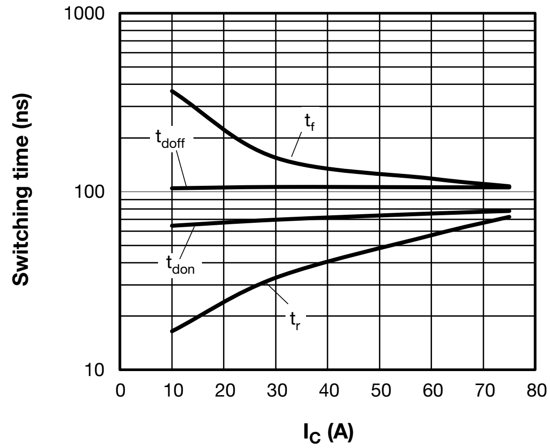


Fig. 8 - Typical Q1 - Q4 Trench IGBT Switching Loss vs. I_C
(with D5 - D6 Clamping Diode)
T_J = 125 °C, V_{CC} = 300 V, R_g = 4.7 Ω, V_{GE} = 15 V, L = 500 μH

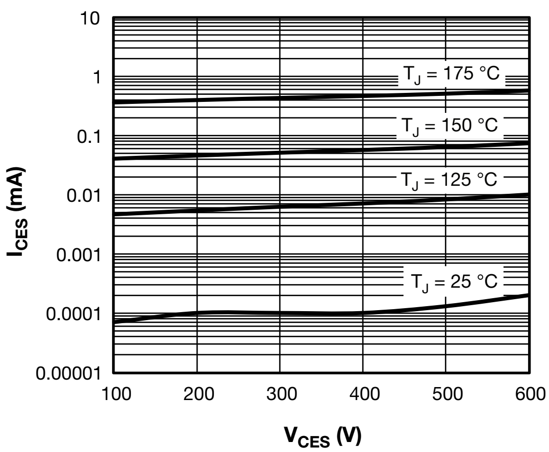


Fig. 6 - Typical Q1 - Q4 Trench IGBT Zero Gate Voltage
Collector Current

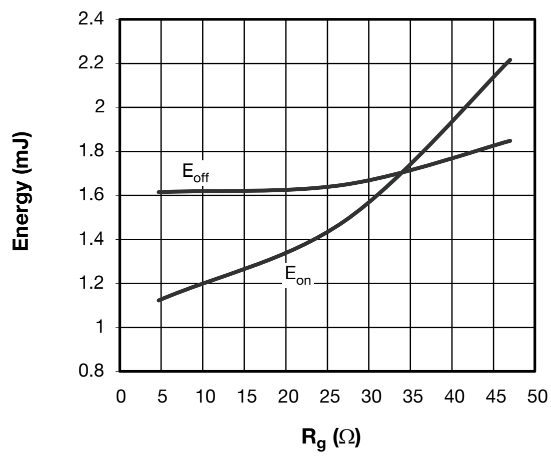


Fig. 9 - Typical Q1 - Q4 Trench IGBT Energy Loss vs. R_g
(with D5 - D6 Clamping Diode)
T_J = 125 °C, V_{CC} = 300 V, I_C = 75 A, V_{GE} = 15 V, L = 500 μH

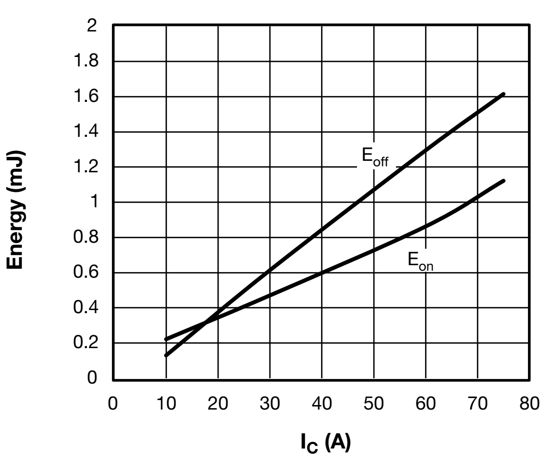


Fig. 7 - Typical Q1 - Q4 Trench IGBT Energy Loss vs. I_C
(with D5 - D6 Clamping Diode)
T_J = 125 °C, V_{CC} = 300 V, R_g = 4.7 Ω, V_{GE} = 15 V, L = 500 μH

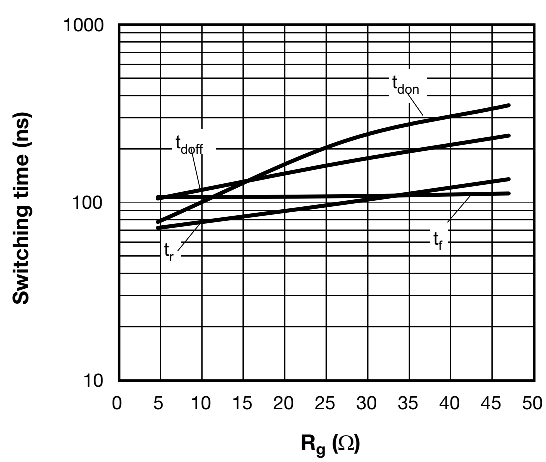


Fig. 10 - Typical Q1 - Q4 Trench IGBT Switching Time vs. R_g
(with D5 - D6 Clamping Diode)
T_J = 125 °C, V_{CC} = 300 V, I_C = 75 A, V_{GE} = 15 V, L = 500 μH

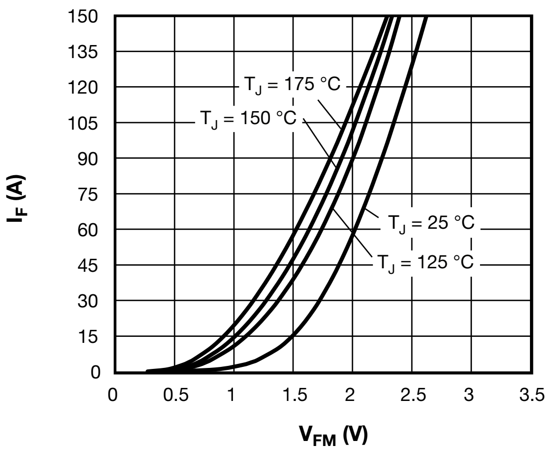


Fig. 11 - Typical D5 - D6 Clamping Diode Forward Characteristics

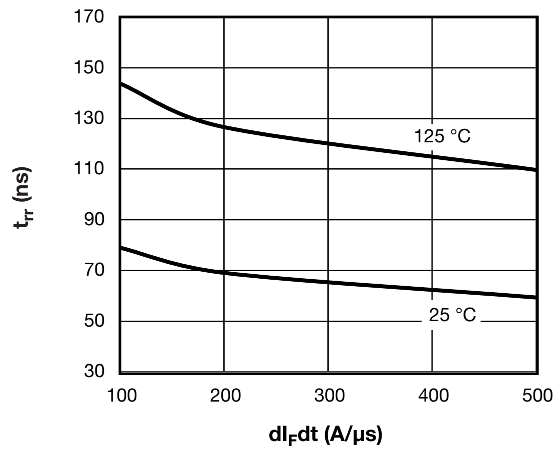


Fig. 14 - Typical D5 - D6 Clamping Diode Reverse Recovery Time vs. dI_F/dt, V_{rr} = 200 V, I_F = 50 A

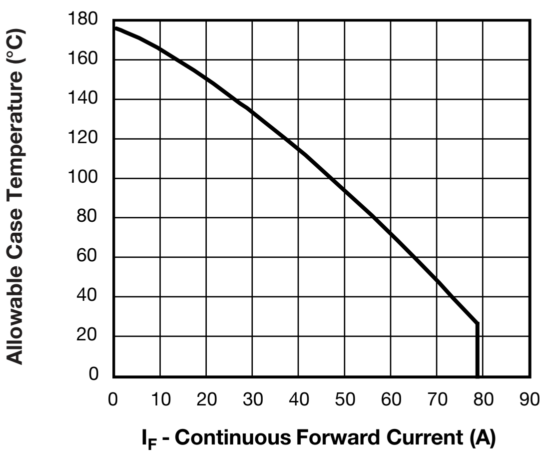


Fig. 12 - Maximum D5 - D6 Clamping Diode Forward Current vs. Case Temperature

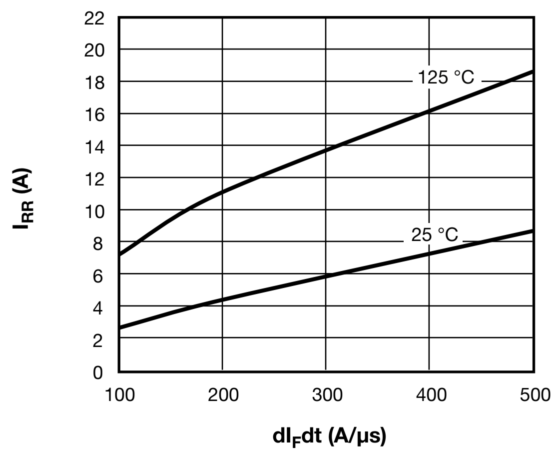


Fig. 15 - Typical D5 - D6 Clamping Diode Reverse Recovery Current vs. dI_F/dt, V_{rr} = 200 V, I_F = 50 A

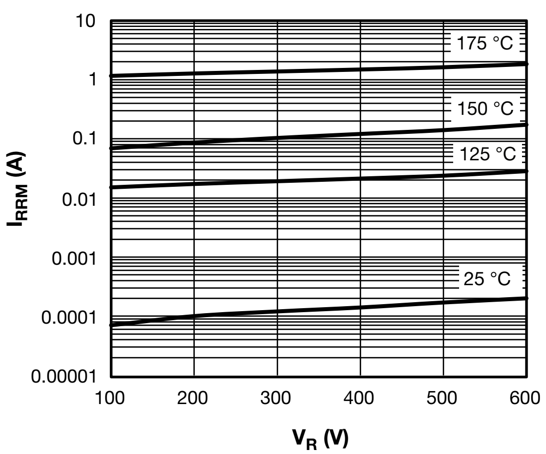


Fig. 13 - Typical D5 - D6 Clamping Diode Reverse Leakage Current

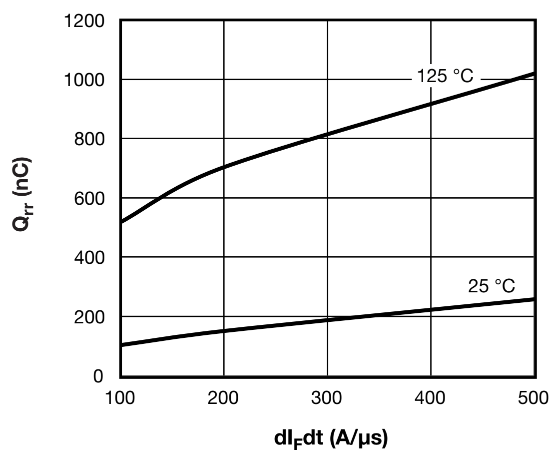


Fig. 16 - Typical D5 - D6 Clamping Diode Reverse Recovery Charge vs. dI_F/dt, V_{rr} = 200 V, I_F = 50 A

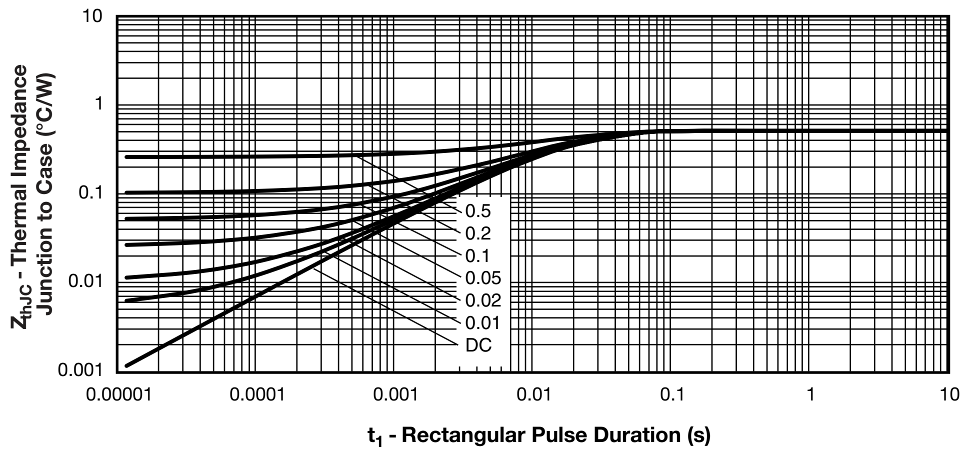


Fig. 17 - Maximum Thermal Impedance Z_{thJC} Characteristics (Q1 - Q4 Trench IGBT)

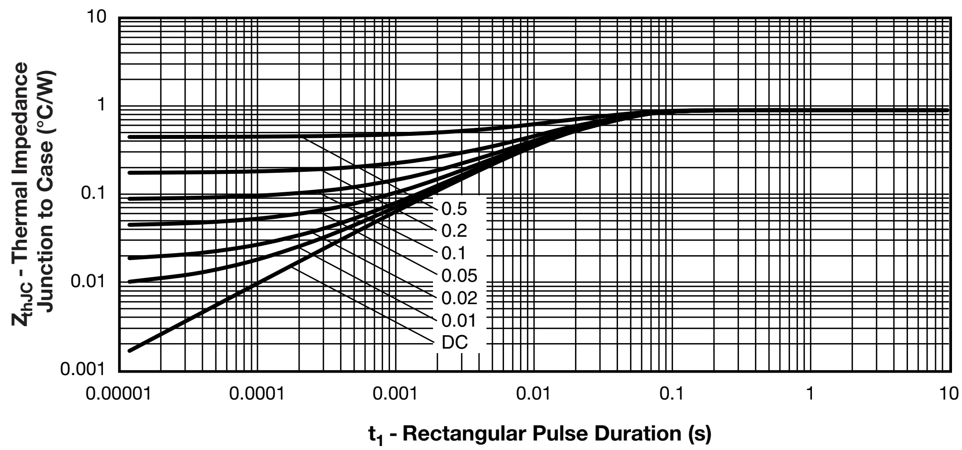


Fig. 18 - Maximum Thermal Impedance Z_{thJC} Characteristics (D5 - D6 Clamping Diode)

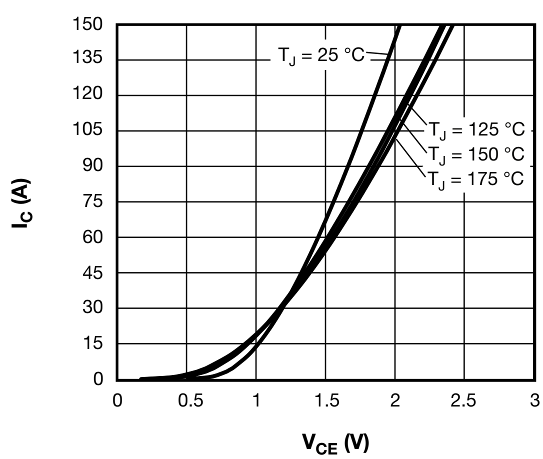


Fig. 19 - Typical Q2 - Q3 Trench IGBT Output Characteristics
V_{GE} = 15 V

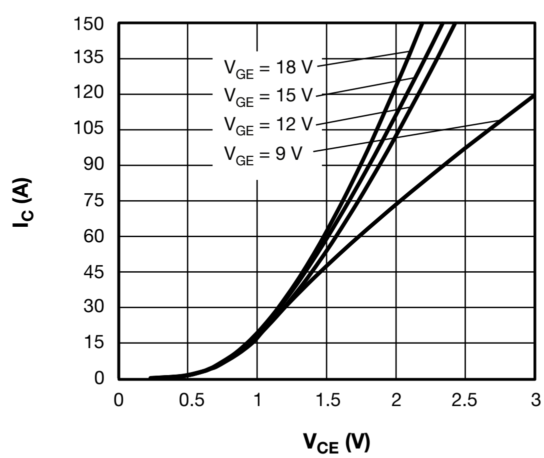


Fig. 20 - Typical Q2 - Q3 Trench IGBT Output Characteristics
T_J = 125 °C

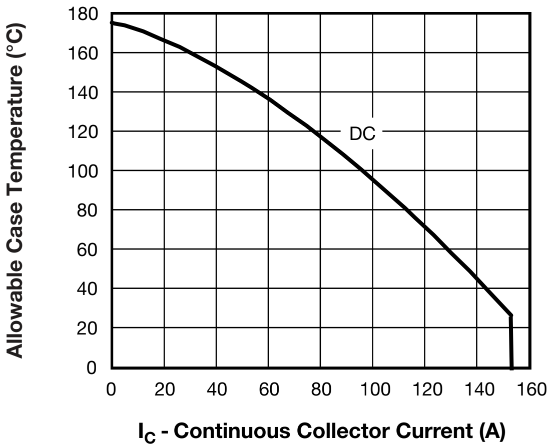


Fig. 21 - Maximum Q2 - Q3 Trench IGBT Continuous Collector Current vs. Case Temperature

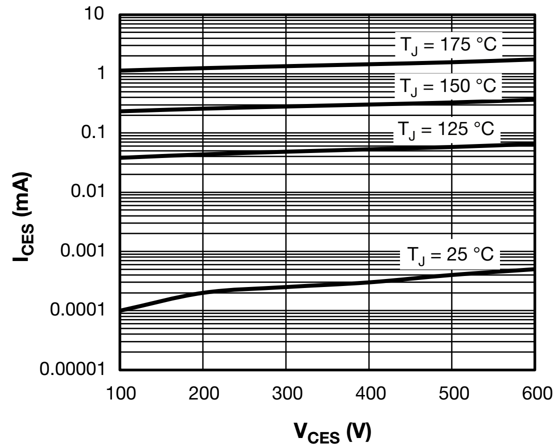


Fig. 24 - Typical Q2 - Q3 Trench IGBT Zero Gate Voltage Collector Current

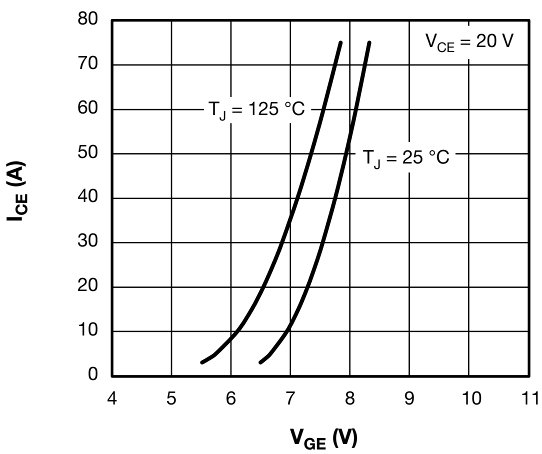


Fig. 22 - Typical Q2 - Q3 Trench IGBT Transfer Characteristics

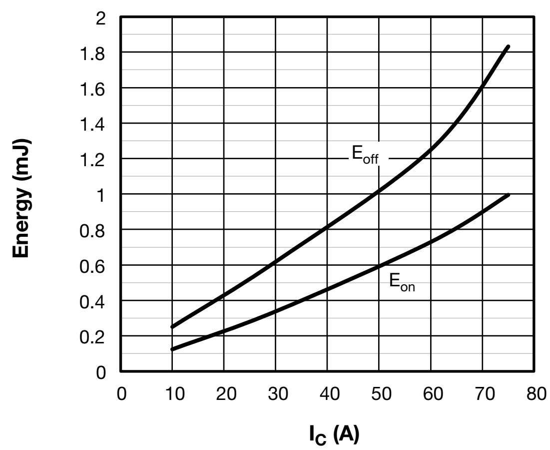


Fig. 25 - Typical Q2 - Q3 Trench IGBT Energy Loss vs. I_C (with Freewheeling External TO-247 Diode Discrete 30ETH06), T_J = 125 °C, V_{CC} = 300 V, R_g = 4.7 Ω, V_{GE} = 15 V, L = 500 μH

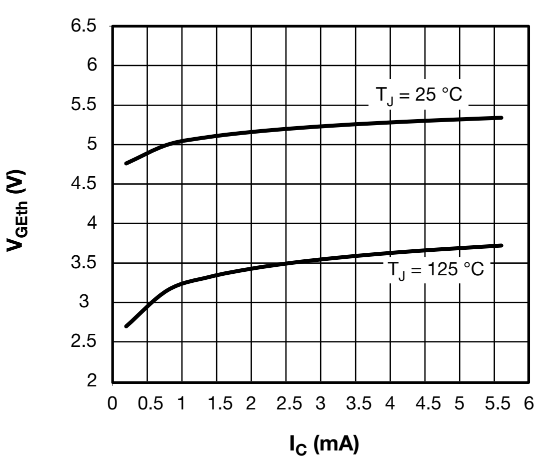


Fig. 23 - Typical Q2 - Q3 Trench IGBT Gate Threshold Voltage

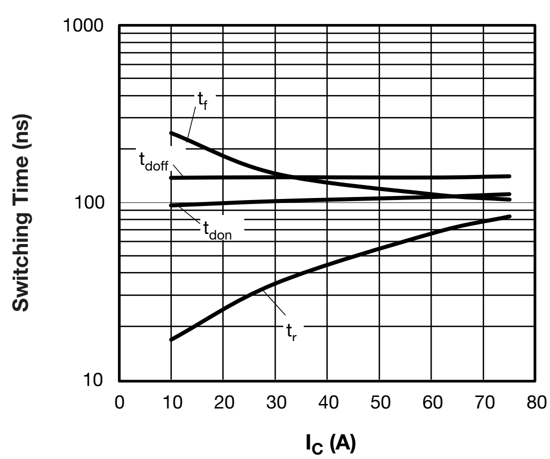


Fig. 26 - Typical Q2 - Q3 Trench IGBT Switching Time vs. I_C (with Freewheeling External TO-247 Diode Discrete 30ETH06), T_J = 125 °C, V_{CC} = 300 V, R_g = 4.7 Ω, V_{GE}= 15 V, L = 500 μH

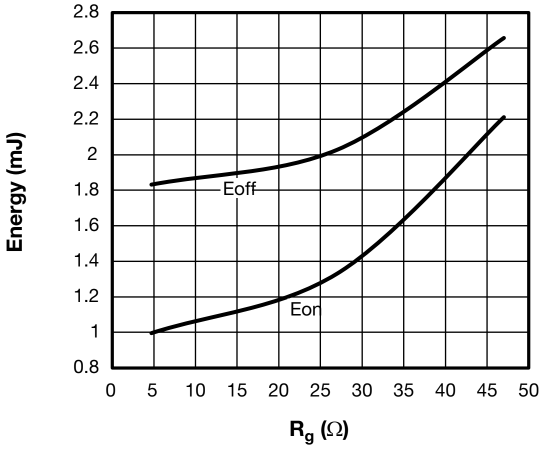


Fig. 27 - Typical Q2 - Q3 Trench IGBT Energy Loss vs. R_g (with Freewheeling External TO-247 Diode Discrete 30ETH06), T_J = 125 °C, V_{CC} = 300 V, I_C = 75 A, V_{GE} = 15 V, L = 500 μH

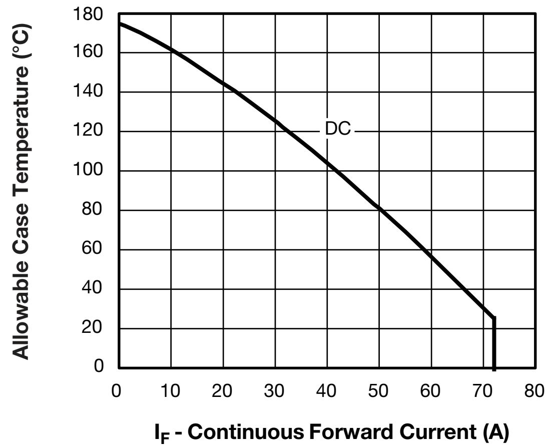


Fig. 30 - Maximum D1 - D2 - D3 - D4 Antiparallel Diode Forward Current vs. Case Temperature

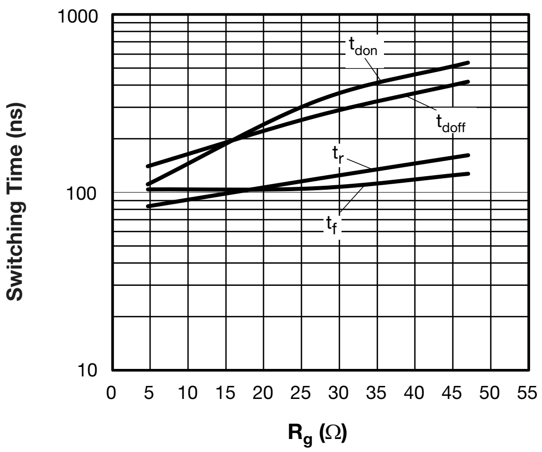


Fig. 28 - Typical Q2 - Q3 Trench IGBT Switching Time vs. R_g (with Freewheeling External TO-247 Diode Discrete 30ETH06), T_J = 125 °C, V_{CC} = 300 V, I_C = 75 A, V_{GE} = 15 V, L = 500 μH

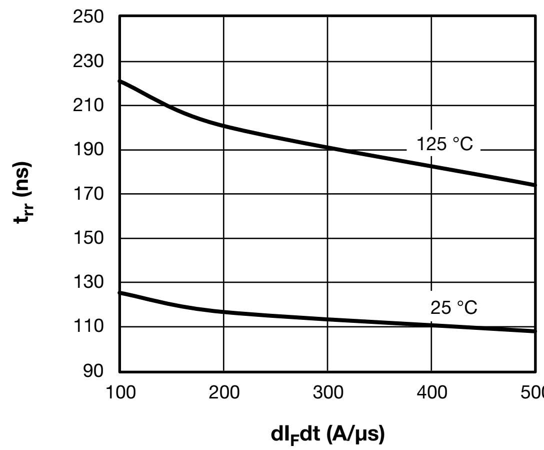


Fig. 31 - Typical D1 - D2 - D3 - D4 Antiparallel Diode Reverse Recovery Time vs. dI_F/dt V_{rr} = 200 V, I_F = 50 A

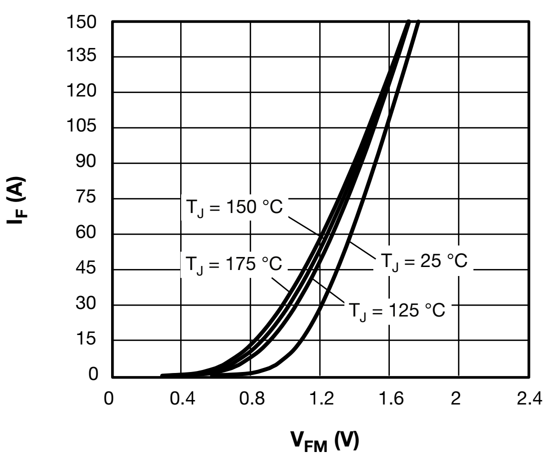


Fig. 29 - Typical D1 - D2 - D3 - D4 Antiparallel Diode Forward Characteristics

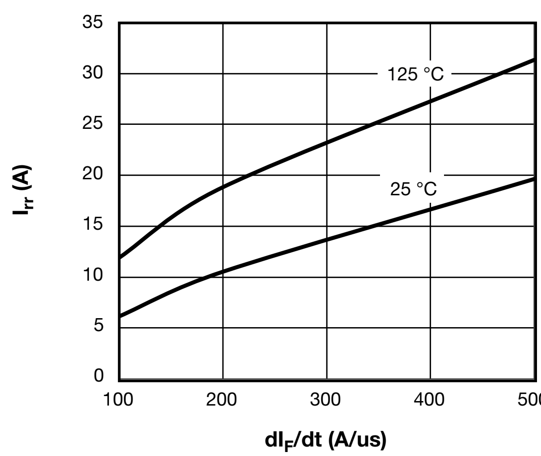


Fig. 32 - Typical D1 - D2 - D3 - D4 Antiparallel Diode Reverse Recovery Current vs. dI_F/dt V_{rr} = 200 V, I_F = 50 A

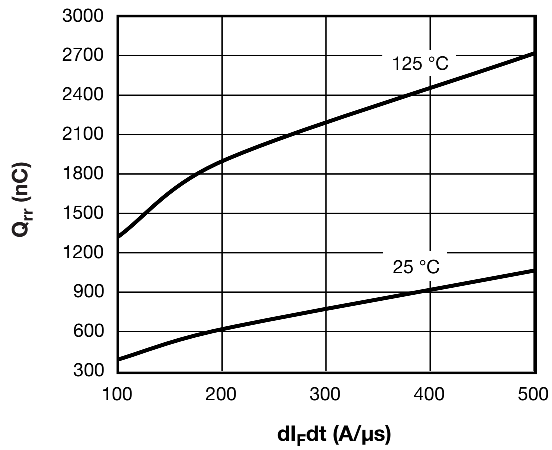


Fig. 33 - Typical D1 - D2 - D3 - D4 Antiparallel Diode
Reverse Recovery Charge vs. dI_F/dt
V_{rr} = 200 V, I_F = 50 A

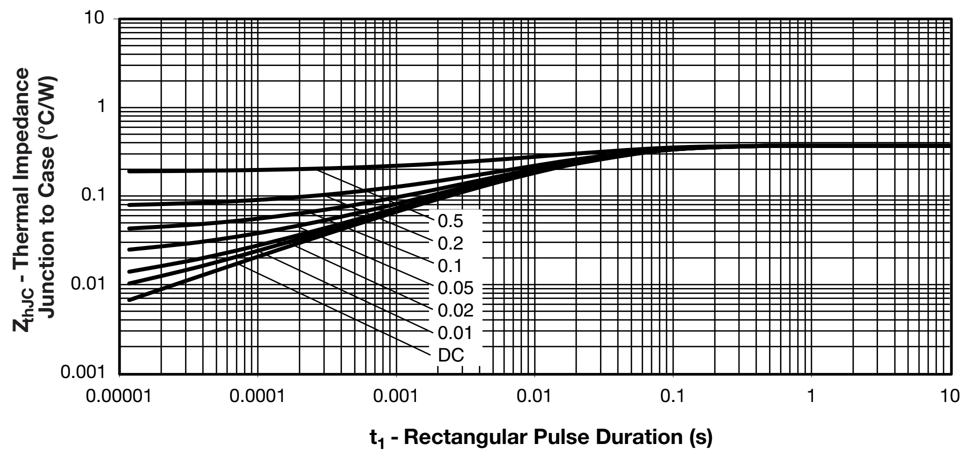


Fig. 34 - Maximum Thermal Impedance Z_{thJC} Characteristics
(Q2 - Q3 Trench IGBT)

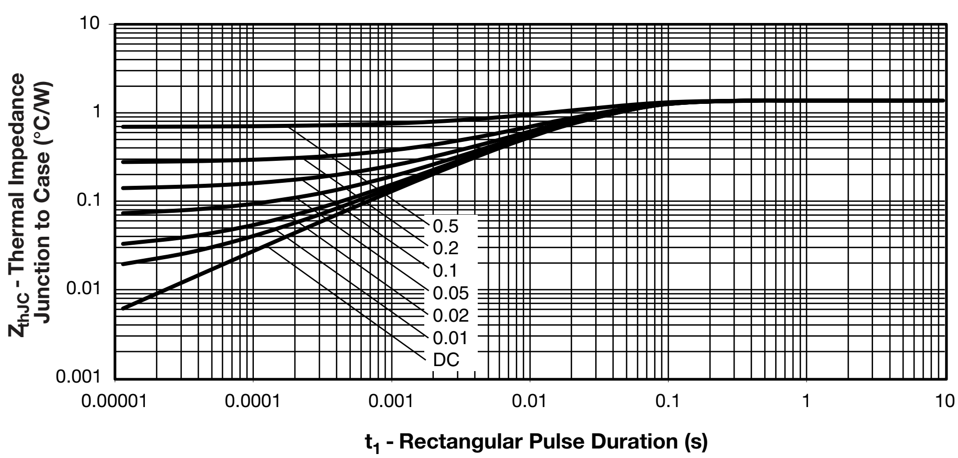


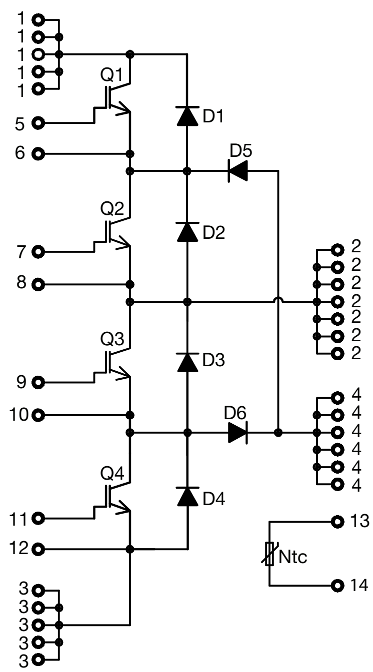
Fig. 35 - Maximum Thermal Impedance Z_{thJC} Characteristics
(D1 - D2 - D3 - D4 Antiparallel Diode)

ORDERING INFORMATION TABLE

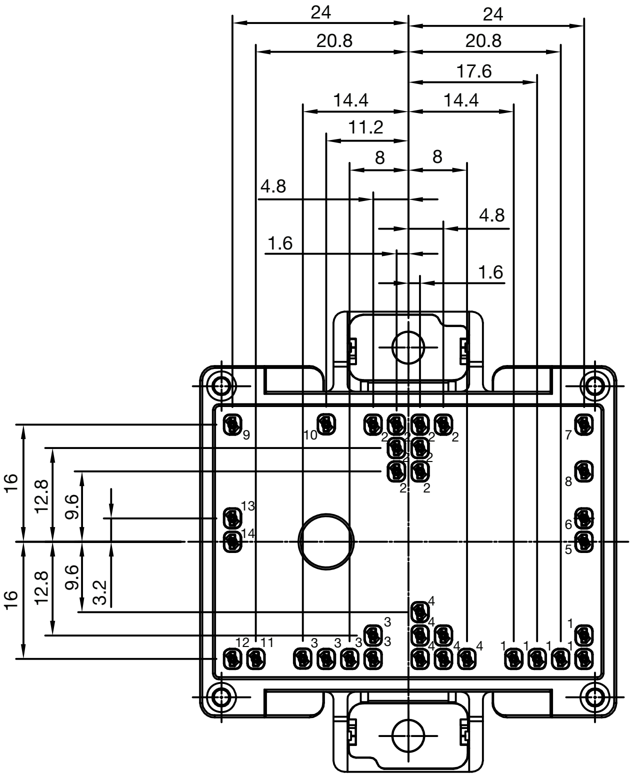
Device code	VS-	ET	F	075	Y	60	U
	1	2	3	4	5	6	7

1 - Vishay Semiconductors product
2 - Package indicator (ET = EMIPAK 2B)
3 - Circuit configuration (F = 3-levels half bridge inverter stage)
4 - Current rating (075 = 75 A)
5 - Switch die technology (Y = trench IGBT)
6 - Voltage rating (60 = 600 V)
7 - Diode die technology (U = ultrafast diode)

CIRCUIT CONFIGURATION



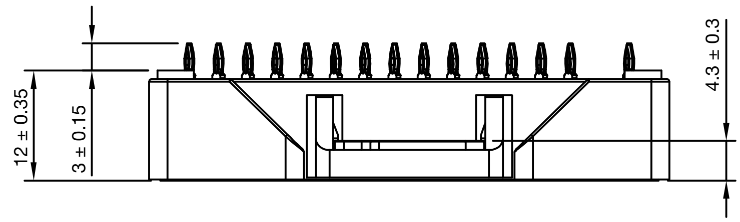
PACKAGE

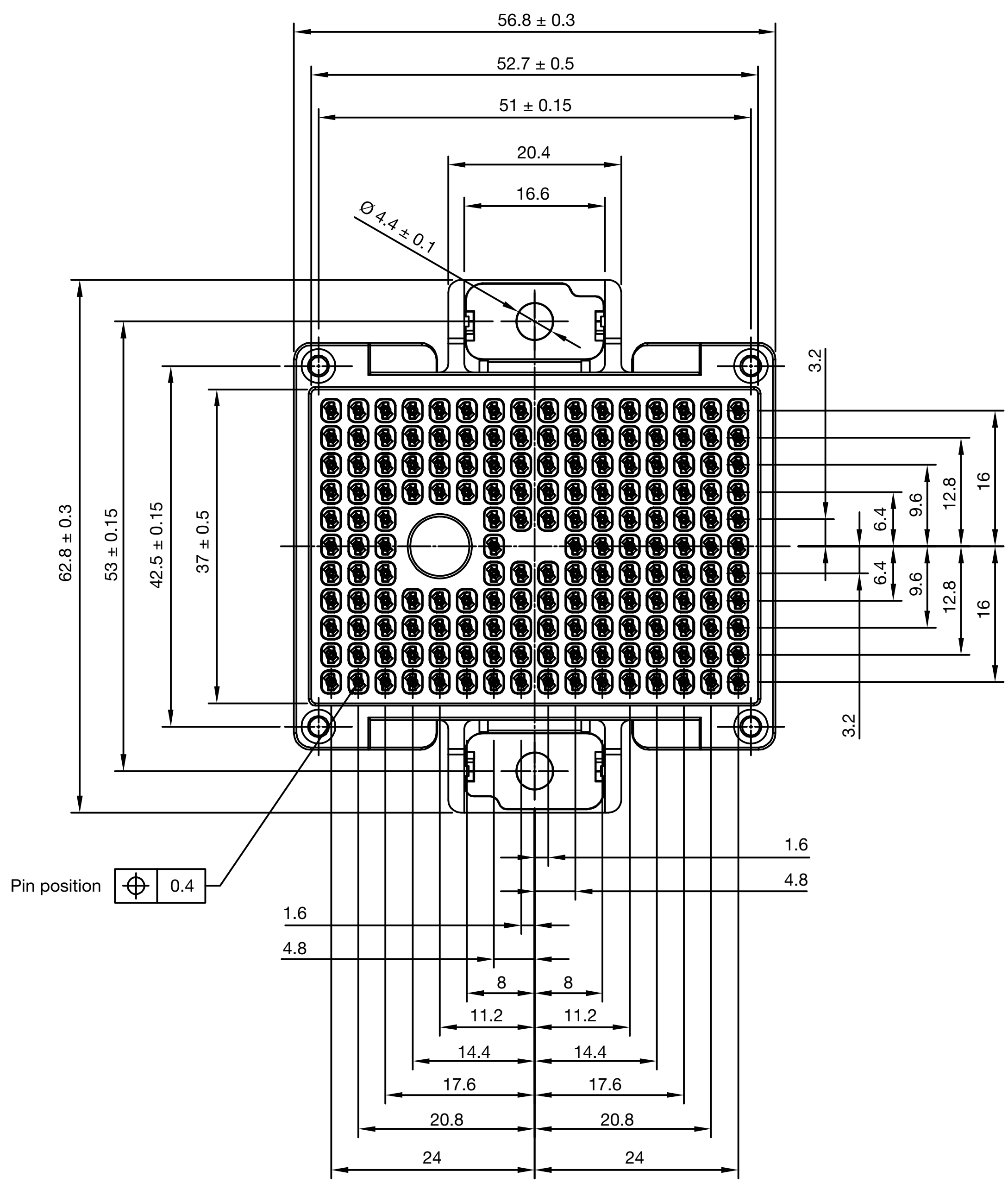


LINKS TO RELATED DOCUMENTS	
Dimensions	www.vishay.com/doc?95559

EMIPAK-2B PressFit

DIMENSIONS in millimeters





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