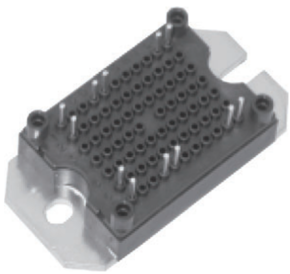
MTP IGBT Power Module Primary Rectifier and PFC



MTP

FEATURES

- Input rectifier bridge
- PFC stage with warp 2 IGBT and FRED Pt® hyperfast diode
- Very low stray inductance design for high speed operation
- Integrated thermistor
- Isolated baseplate
- 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

- Lower conduction losses and switching losses
- Optimized for welding, UPS, and SMPS applications
- PCB solderable terminals
- Direct mounting to heatsink

PRIMARY CHARACTERISTICS	
INPUT BRIDGE DIODE, T_J = 150 °C	
V_{RRM}	1200 V
I_O at 80 °C	48 A
V_{FM} at 25 °C at 20 A	1.05 V
PFC IGBT, T_J = 150 °C	
V_{CES}	600 V
$V_{CE(on)}$ at 25 °C at 40 A	1.93 V
I_C at 80°C	66 A
FRED Pt® PFC DIODE, T_J = 150 °C	
V_R	600 V
$I_{F(DC)}$ at 80 °C	55 A
V_F at 25 °C at 40 A	1.76 V
FRED Pt® AP DIODE, T_J = 150 °C	
V_R	600 V
$I_{F(DC)}$ at 80 °C	13 A
V_F at 25 °C at 4 A	1.1 V
Speed	30 kHz to 150 kHz
Package	MTP
Circuit configuration	Input rectifier bridge

ABSOLUTE MAXIMUM RATINGS

	PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Input Rectifier Bridge	Repetitive peak reverse voltage	V_{RRM}		1200	V
	Maximum average output current T_J = 150 °C maximum	I_O	T_C = 80 °C	48	A
	Surge current (Non-repetitive)	I_{FSM}	Rated V_{RRM} applied	250	
	Maximum I^2t for fusing	I^2t	10 ms, sine pulse	316	A^2s
PFC IGBT	Collector to emitter voltage	V_{CES}	T_J = 25 °C	600	V
	Gate to emitter voltage	V_{GE}	I_{GES} max. ± 250 ns	± 20	
	Maximum continuous collector current at V_{GE} = 15 V, T_J = 150 °C maximum	I_C	T_C = 25 °C	96	A
			T_C = 80 °C	66	
	Pulsed collector current	I_{CM} (1)		250	
	Clamped inductive load current	I_{LM}		250	
	Maximum power dissipation	P_D	T_C = 25 °C	378	W

ABSOLUTE MAXIMUM RATINGS					
	PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
PFC Diode	Repetitive peak reverse voltage	V_{RRM}		600	V
	Maximum continuous forward current T_J = 150 °C maximum	I_F	T_C = 25 °C	82	A
			T_C = 80 °C	55	
	Maximum power dissipation	P_D	T_C = 25 °C	181	W
	Maximum non-repetitive peak current	I_{FSM}	T_C = 25 °C	360	A
AP Diode	Repetitive peak reverse voltage	V_{RRM}		600	V
	Maximum continuous forward current T_J = 150 °C maximum	I_F	T_C = 25 °C	21	A
			T_C = 80 °C	13	
	Maximum power dissipation	P_D	T_C = 25 °C	32	W
	Maximum non-repetitive peak current	I_{FSM}	T_C = 25 °C	60	A
	Maximum operating junction temperature	T_J		150	°C
	Storage temperature range	T_{Stg}		-40 to +150	
	RMS isolation voltage	V_{ISOL}	V_{RMS} t = 1 s, T_J = 25 °C	3500	W

ΔR CONDUCTION PER JUNCTION - SINGLE PHASE BRIDGE DIODE											
DEVICES	SINE HALF WAVE CONDUCTION					RECTANGULAR WAVE CONDUCTION					UNITS
	180°	120°	90°	60°	30°	180°	120°	90°	60°	30°	
70MT060WSP	0.273	0.302	0.322	0.338	0.350	0.236	0.288	0.294	0.287	0.235	°C/W

ELECTRICAL SPECIFICATIONS (T_J = 25 °C unless otherwise noted)							
	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Rectifier Bridge	Blocking voltage	BV_{RRM}	I_R = 250 µA	1200	-	-	V
	Reverse leakage current	I_{RRM}	V_{RRM} = 1200 V	-	-	0.1	mA
			V_{RRM} = 1200 V, T_J = 150 °C	-	-	3.0	
	Forward voltage drop	V_{FM}	I_F = 20 A	-	1.05	1.2	V
			I_F = 20 A, T_J = 150 °C	-	0.94	1.0	
	Forward slope resistance	rt	T_J = 150 °C	-	-	8.7	mΩ
	Conduction threshold voltage	V_T		-	-	0.94	V
PFC IGBT	Collector to emitter breakdown voltage	BV_{CES}	V_{GE} = 0 V, I_C = 0.5 mA	600	-	-	V
	Temperature coefficient of breakdown voltage	$\Delta V_{BR(CES)}/\Delta T_J$	I_C = 0.5 mA (25 °C to 125 °C)	-	0.6	-	V/°C
	Collector to emitter voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_C = 40 A	-	1.93	2.15	V
			V_{GE} = 15 V, I_C = 40 A, T_J = 125 °C	-	2.30	2.55	
	Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 500 µA	2.9	-	5.6	V
	Collector to emitter leakage current	I_{CES}	V_{GE} = 0 V, V_{CE} = 600 V	-	-	0.1	mA
			V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C	-	-	1	
	Gate to emitter leakage	I_{GES}	V_{GE} = ± 20 V	-	-	± 100	nA
PFC Diode	Forward voltage drop	V_{FM}	I_F = 40 A	-	1.76	2.23	V
			I_F = 40 A, T_J = 125 °C	-	1.34	1.62	
	Blocking voltage	BV_{RM}	I_R = 0.5 mA	600	-	-	
	Reverse leakage current	I_{RM}	V_{RRM} = 600 V	-	-	75	µA
			V_{RRM} = 600 V, T_J = 125 °C	-	-	0.5	mA
AP Diode	Forward voltage drop	V_{FM}	I_F = 4 A	-	1.1	1.28	V
			I_F = 4 A, T_J = 125 °C	-	0.95	1.09	

ELECTRICAL SPECIFICATIONS (T_J = 25 °C unless otherwise noted)							
	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
RECOVERY PARAMETER							
PFC Diode	Peak reverse recovery current	I_{rr}	I_F = 40 A dI/dt = 200 A/μs V_R = 200 V	-	4	7	A
	Reverse recovery time	t_{rr}		-	59	79	ns
	Reverse recovery charge	Q_{rr}		-	118	180	nC
	Peak reverse recovery current	I_{rr}	I_F = 40 A, T_J = 125 °C dI/dt = 200 A/μs V_R = 200 V	-	12	17	A
	Reverse recovery time	t_{rr}		-	127	170	ns
	Reverse recovery charge	Q_{rr}		-	733	1200	nC
AP Diode	Peak reverse recovery current	I_{rr}	I_F = 4 A dI/dt = 200 A/μs V_R = 200 V	-	7	10	A
	Reverse recovery time	t_{rr}		-	78	120	ns
	Reverse recovery charge	Q_{rr}		-	290	600	nC

SWITCHING CHARACTERISTICS (T_J = 25 °C unless otherwise noted)							
	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
PFC IGBT	Total gate charge	Q_g	I_C = 50 A V_{CC} = 400 V V_{GE} = 15 V	-	320	-	nC
	Gate to source charge	Q_{gs}		-	42	-	
	Gate to drain (Miller) charge	Q_{gd}		-	110	-	
	Turn-on switching loss	E_{on}	I_C = 70 A, V_{CC} = 360 V, V_{GE} = 15 V R_g = 5 Ω, L = 500 μH, T_J = 25 °C	-	0.13	-	mJ
	Turn-off switching loss	E_{off}		-	0.18	-	
	Total switching loss	E_{tot}		-	0.31	-	
	Turn-on delay time	$t_{d(on)}$		-	193	-	ns
	Rise time	t_r		-	35	-	
	Turn-off delay time	$t_{d(off)}$		-	202	-	
	Fall time	t_f		-	49	-	
	Turn-on switching loss	E_{on}	I_C = 70 A, V_{CC} = 360 V, V_{GE} = 15 V R_g = 5 Ω, L = 500 μH, T_J = 125 °C	-	0.25	-	mJ
	Turn-off switching loss	E_{off}		-	0.32	-	
	Total switching loss	E_{tot}		-	0.57	-	
	Turn-on delay time	$t_{d(on)}$		-	193	-	ns
	Rise time	t_r		-	35	-	
	Turn-off delay time	$t_{d(off)}$		-	208	-	
	Fall time	t_f		-	66	-	
	Input capacitance	C_{ies}	V_{GE} = 0 V V_{CC} = 30 V f = 1 MHz	-	7430	-	pF
	Output capacitance	C_{oes}		-	530	-	
	Reverse transfer capacitance	C_{res}		-	94	-	
	Reverse bias safe operating area	RBSOA	I_C = 250 A, V_{CC} = 400 V, V_P = 600 V, R_g = 22 Ω, V_{GE} = 15 V, L = 500 μH, T_J = 150 °C	Full square			

THERMISTOR ELECTRICAL CHARACTERISTICS (T_J = 25 °C unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Resistance	R	T_J = 25 °C	-	30 000	-	Ω
B value	B	T_J = 25 °C/T_J = 85 °C	-	4000	-	K

Notes

- Repetitive rating; pulsed with limited by maximum junction temperature

THERMAL AND MECHANICAL SPECIFICATIONS						
	SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNITS
Input rectifier bridge	R_{thJC}	Junction to case diode thermal resistance	-	-	0.9	°C/W
PFC IGBT		Junction to case IGBT thermal resistance	-	-	0.33	
PFC diode		Junction to case PFC diode thermal resistance	-	-	0.69	
AP diode		Junction to case AP diode thermal resistance	-	-	3.92	
	R_{thCS}	Case to sink, flat, greased surface per module	-	0.06	-	°C/W
		Mounting torque ± 10 % to heatsink (1)	-	-	4	Nm
		Approximate weight	-	65	-	g

Notes

- 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

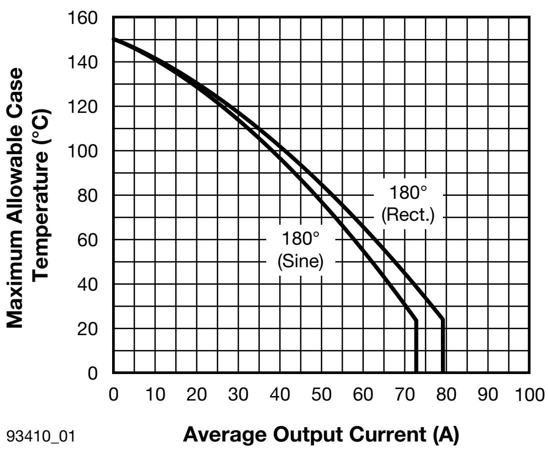


Fig. 1 - Single Phase Input Bridge Output Current Ratings Characteristics

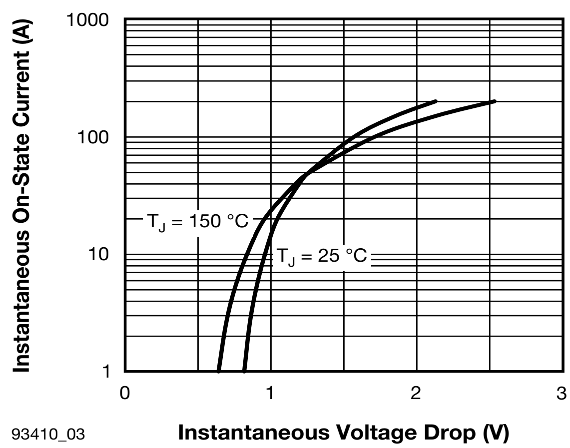


Fig. 3 - Single Phase Input Bridge On-State Voltage Drop Characteristics

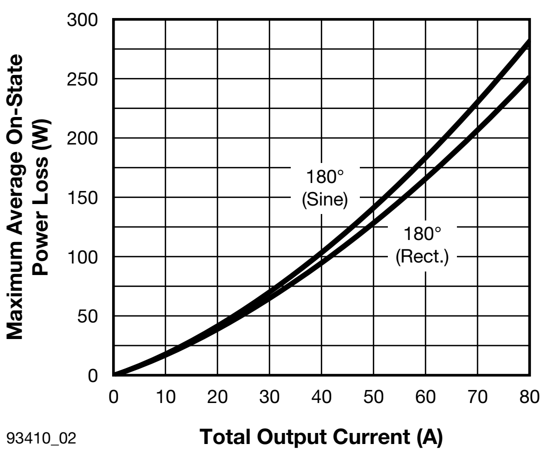


Fig. 2 - Single Phase Bridge On-State Power Loss Characteristics

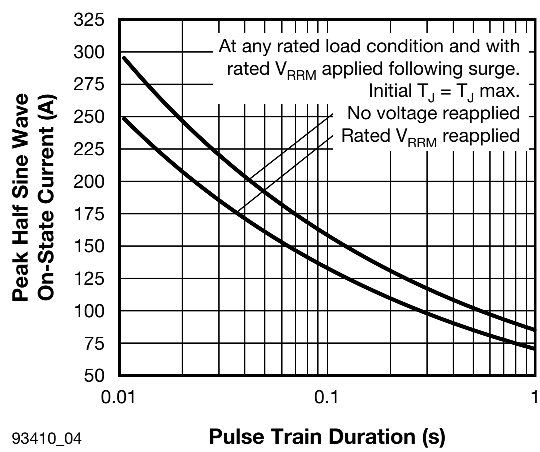


Fig. 4 - Single Phase Input Bridge Maximum Non-Repetitive Surge Current (Per Junction)

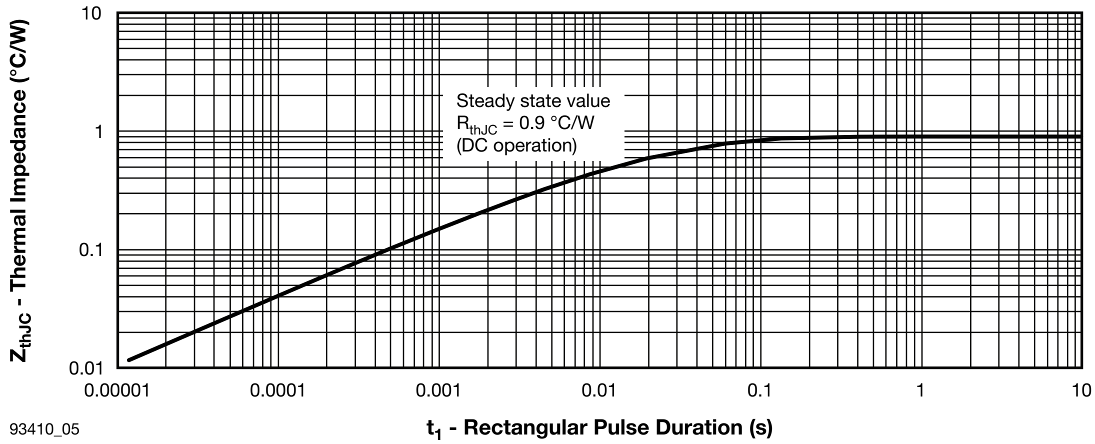


Fig. 5 - Maximum Input Bridge Thermal Impedance Z_{thJC} Characteristics (Per Junction)

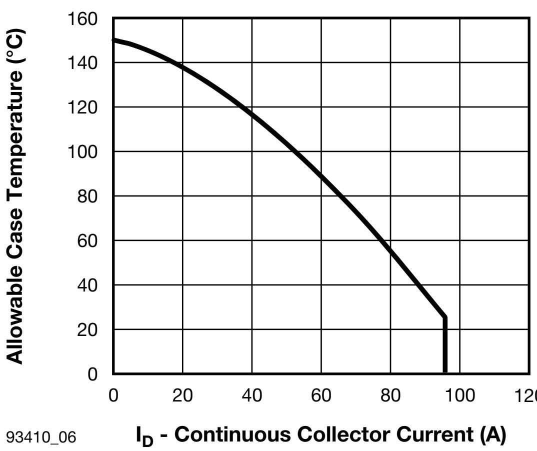


Fig. 6 - Maximum IGBT Continuous Collector Current vs. Case Temperature

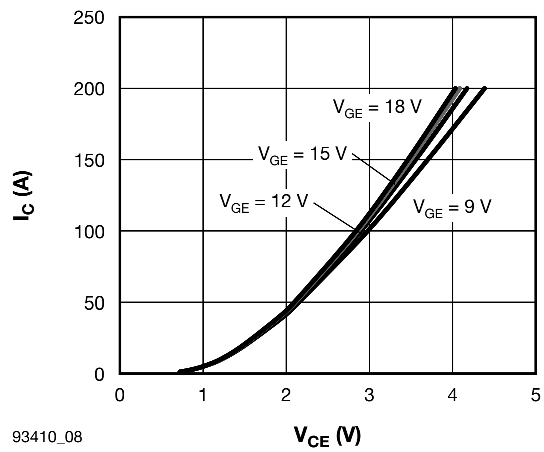


Fig. 8 - Typical IGBT Output Characteristics, T_J = 25 °C

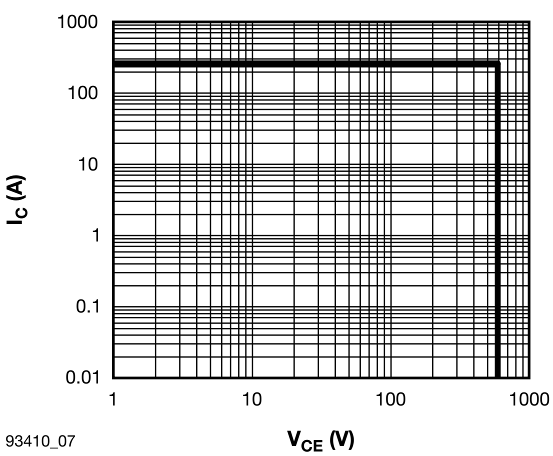


Fig. 7 - IGBT Reverse BIAS SOA T_J = 150 °C, V_{GE} = 15 V

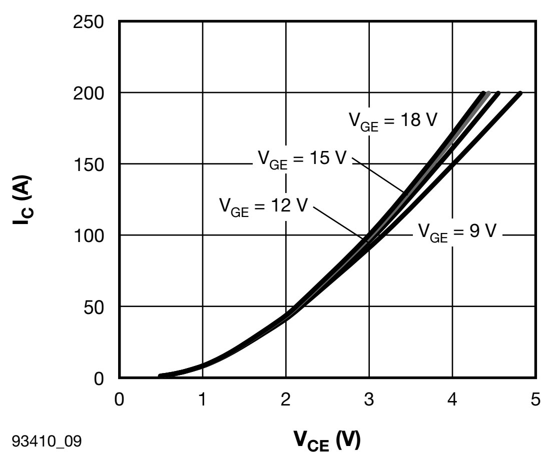


Fig. 9 - Typical IGBT Output Characteristics, T_J = 125 °C

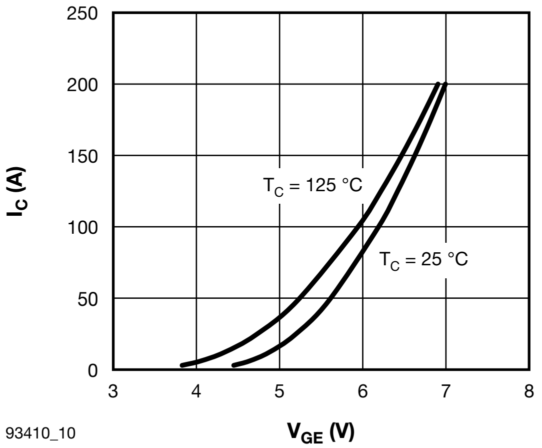


Fig. 10 - Typical IGBT Transfer Characteristics, T_J = 125 °C

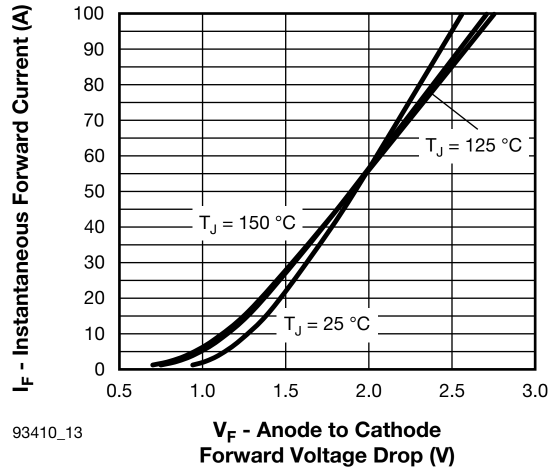


Fig. 13 - Typical Diode Forward Voltage Characteristics of Antiparallel Diode, t_p = 500 µs

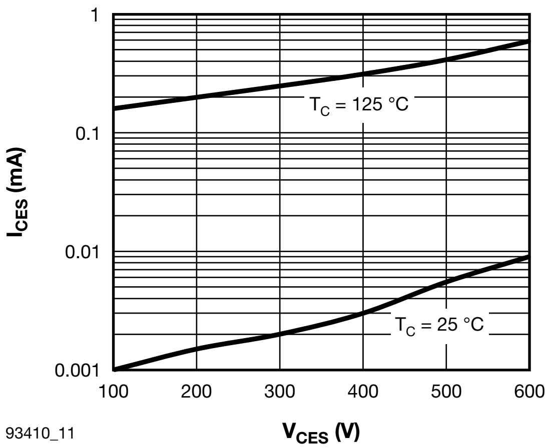


Fig. 11 - Typical IGBT Zero Gate Voltage Collector Current

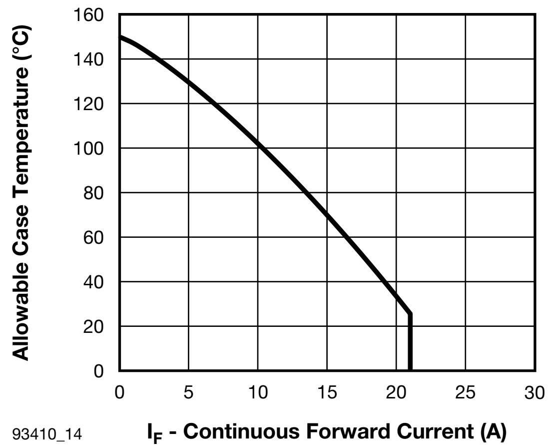


Fig. 14 - Maximum Continuous Forward Current vs. Case Temperature Antiparallel Diode

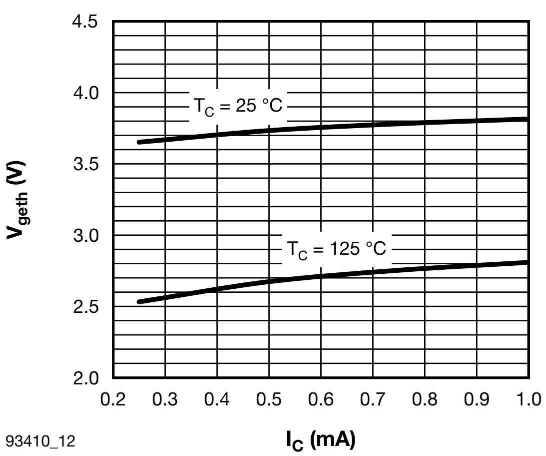


Fig. 12 - Typical IGBT Gate Thresold Voltage

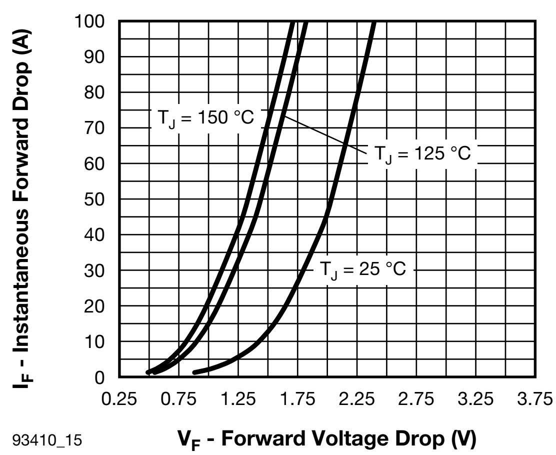


Fig. 15 - Typical PFC Diode Forward Voltage

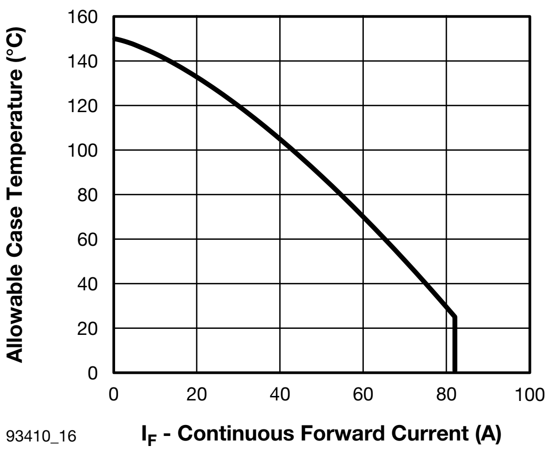


Fig. 16 - Maximum Continuous Forward Current vs. Case Temperature PFC Diode

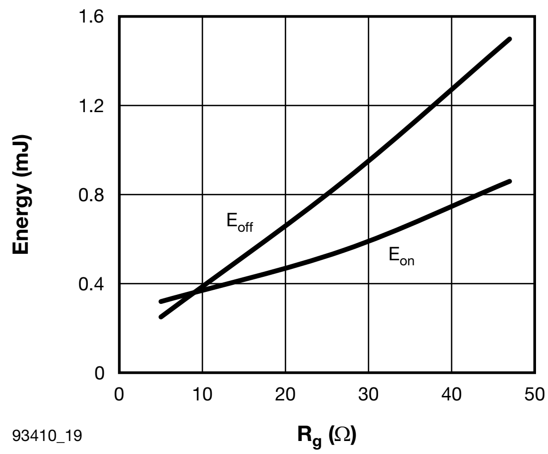


Fig. 19 - Typical IGBT Energy Loss vs. R_g
T_J = 125 °C, I_C = 70 A, V_{CC} = 360 V, V_{GE} = 15 V, L = 500 μH, R_g = 5 Ω

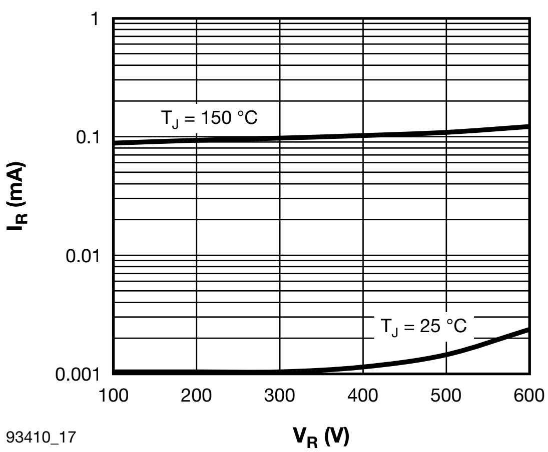


Fig. 17 - Typical FRED Pt® Chopper Diode Reverse Current vs. Reverse Voltage

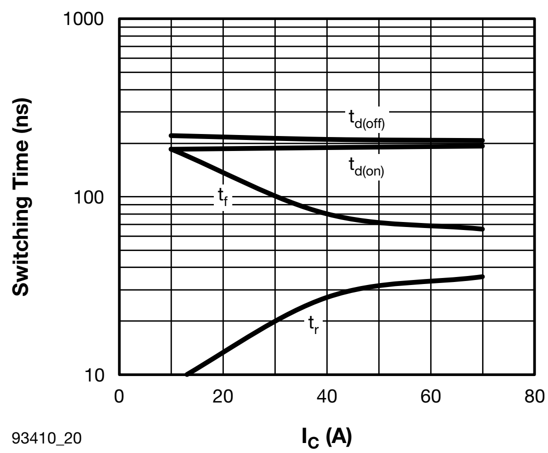


Fig. 20 - Typical IGBT Switching Time vs. I_C
T_J = 125 °C, V_{CC} = 360 V, V_{GE} = 15 V, L = 500 μH, R_g = 5 Ω

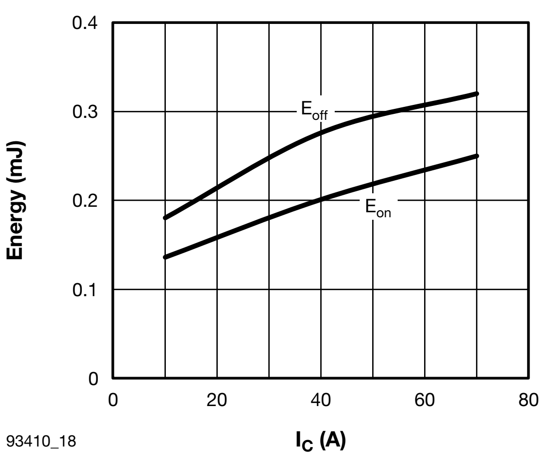


Fig. 18 - Typical IGBT Energy Loss vs. I_C
T_J = 125 °C, V_{CC} = 360 V, V_{GE} = 15 V, L = 500 μH, R_g = 5 Ω

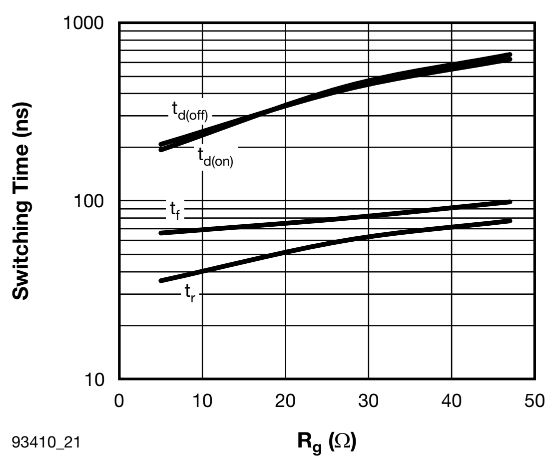


Fig. 21 - Typical IGBT Switching Time vs. R_g
T_J = 125 °C, I_C = 70 A, V_{CE} = 360 V, V_{GE} = 15 V, L = 500 μH

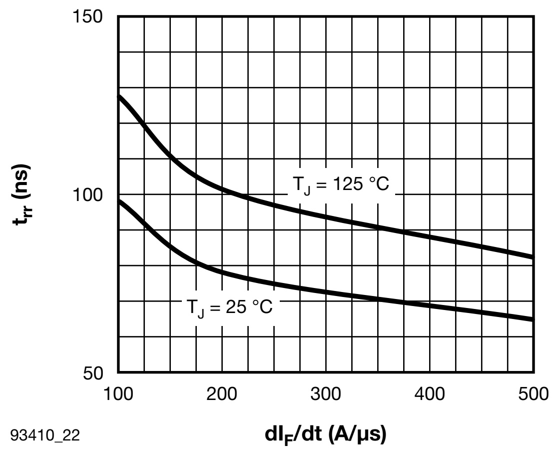


Fig. 22 - Typical t_{rr} Antiparallel Diode vs. dI_F/dt
V_{rr} = 200 V, I_F = 4 A

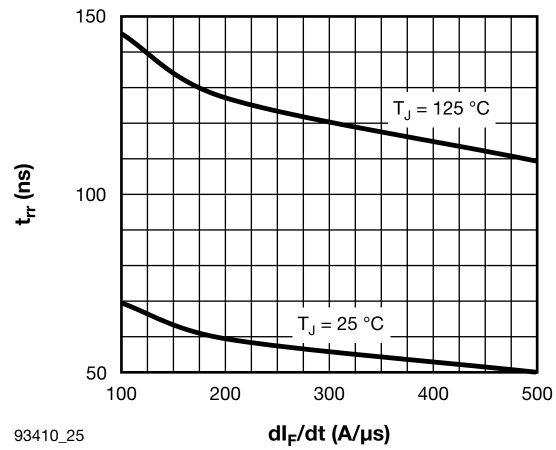


Fig. 25 - Typical t_{rr} Chopper Diode vs. dI_F/dt, V_{rr} = 200 V, I_F = 40 A

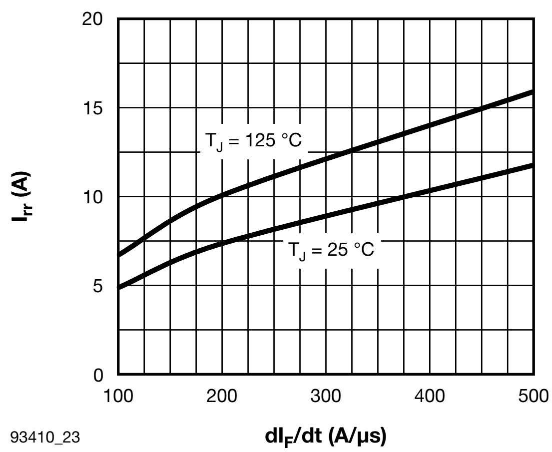


Fig. 23 - Typical I_{rr} Antiparallel Diode vs. dI_F/dt
V_{rr} = 200 V, I_F = 4 A

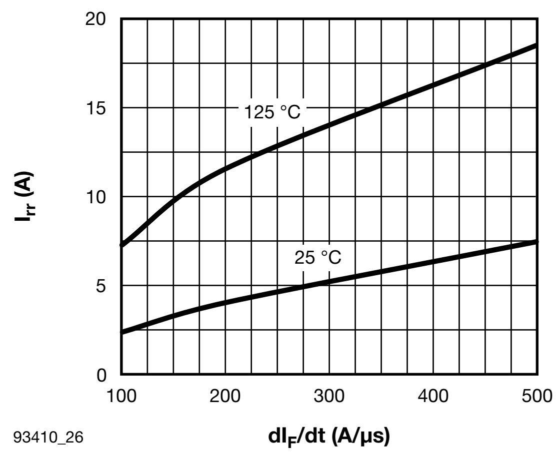


Fig. 26 - Typical I_{rr} Chopper Diode vs. dI_F/dt
V_{rr} = 200 V, I_F = 40 A

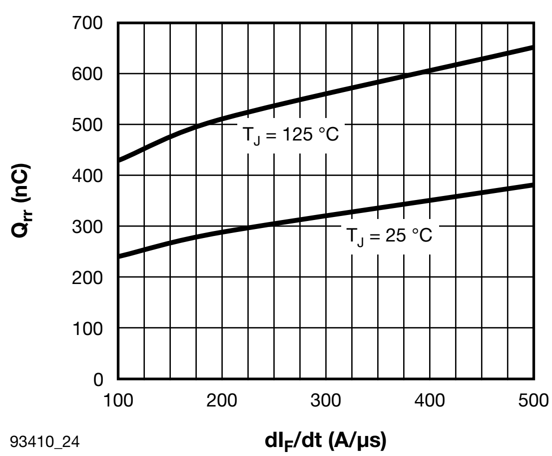


Fig. 24 - Typical Q_{rr} Antiparallel Diode vs. dI_F/dt
V_{rr} = 200 V, I_F = 4 A

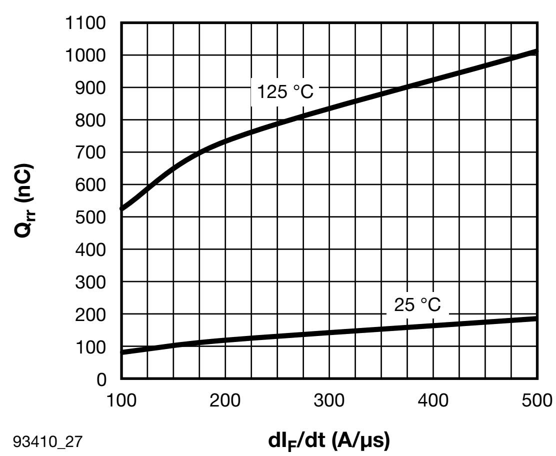


Fig. 27 - Typical Q_{rr} Chopper Diode vs. dI_F/dt, V_{rr} = 200 V, I_F = 40 A

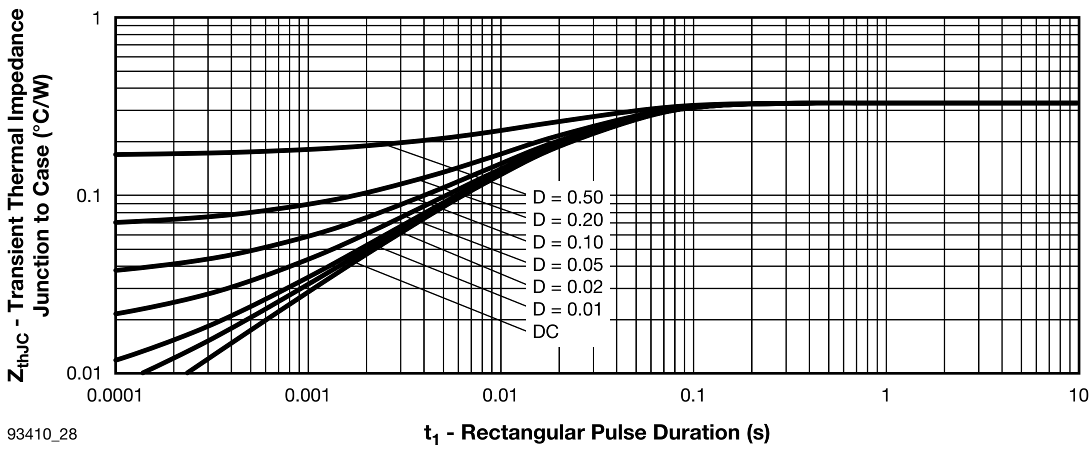


Fig. 28 - Maximum Thermal Impedance Z_{thJC} Characteristics (IGBT)

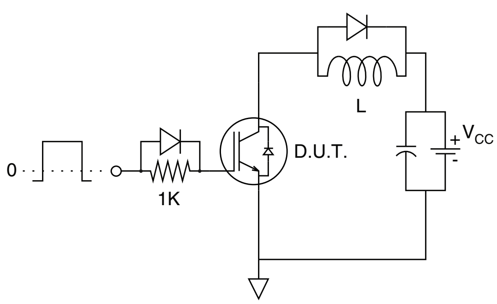


Fig. C.T.1 - Gate Charge Circuit (Turn-Off)

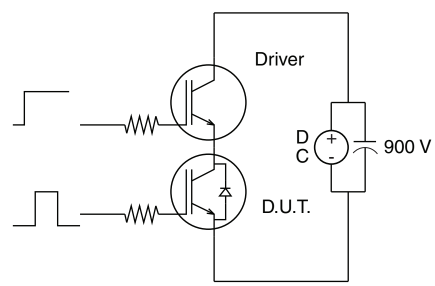


Fig. C.T.3 - S.C. SOA Circuit

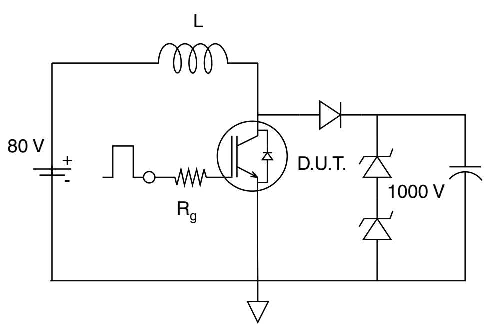


Fig. C.T.2 - RBSOA Circuit

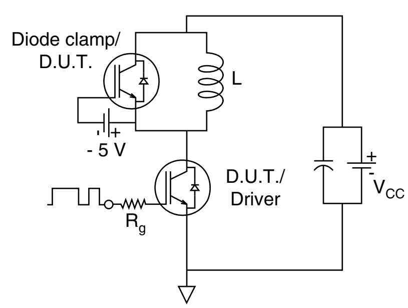


Fig. C.T.4 - Switching Loss Circuit

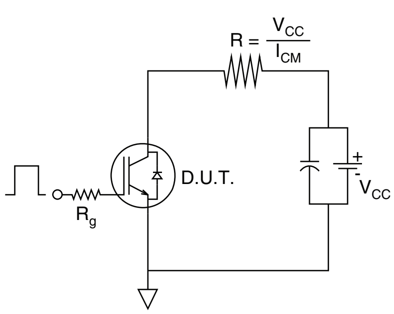
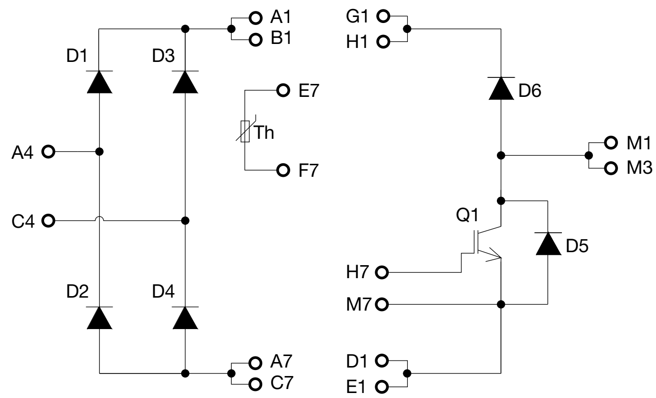


Fig. C.T.5 - Resistive Load Circuit

CIRCUIT CONFIGURATION



ORDERING INFORMATION

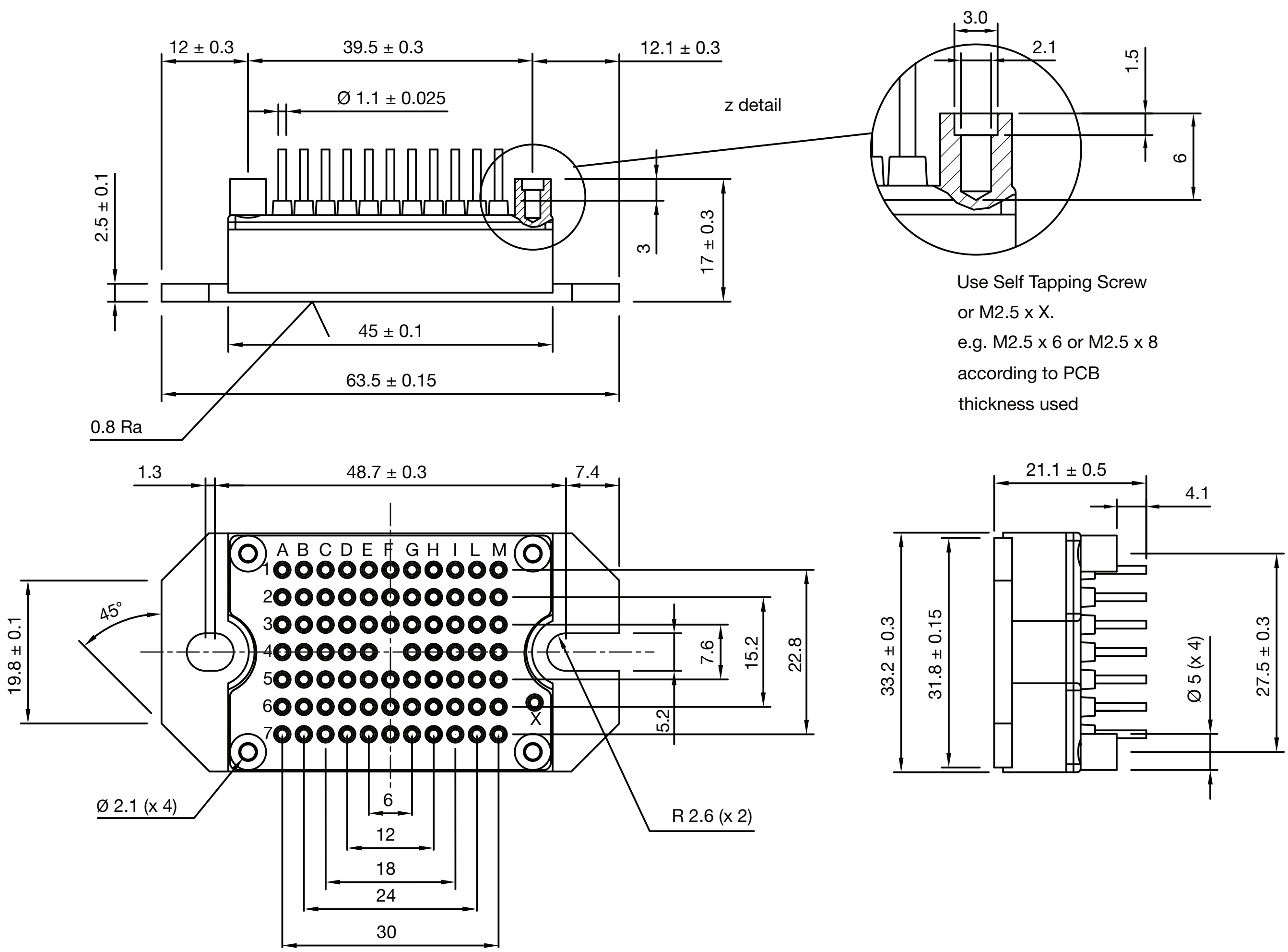
Device code	VS-	70	MT	060	W	SP
	1	2	3	4	5	6

- **1** - Vishay Semiconductors product
- **2** - Current rating (70 = 70 A)
- **3** - Essential part number (MT = MTP package)
- **4** - Voltage code (060 = 600 V)
- **5** - Die IGBT technology (W = warp speed IGBT)
- **6** - Circuit configuration (SP = single phase bridge plus PFC)

LINKS TO RELATED DOCUMENTS	
Dimensions	www.vishay.com/doc?95383

MTP - Full Pin

DIMENSIONS in millimeters



PINS POSITION
WITH TOLERANCE $\boxed{\oplus\ Ø\ 0.6}$

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