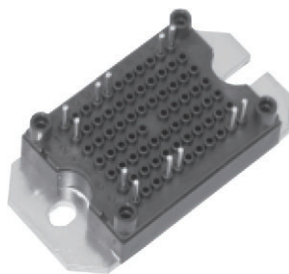


MTP IGBT Power Module Primary Rectifier and PFC



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/doc299912


RoHS
COMPLIANT

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

BENEFITS

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

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 ² t for fusing	I ² t	10 ms, sine pulse	316	A ² s
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 $T_J = 150\text{ }^{\circ}\text{C}$ maximum	I_F	$T_C = 25\text{ }^{\circ}\text{C}$	82	A
			$T_C = 80\text{ }^{\circ}\text{C}$	55	
	Maximum power dissipation	P_D	$T_C = 25\text{ }^{\circ}\text{C}$	181	W
	Maximum non-repetitive peak current	I_{FSM}	$T_C = 25\text{ }^{\circ}\text{C}$	360	A
AP Diode	Repetitive peak reverse voltage	V_{RRM}		600	V
	Maximum continuous forward current $T_J = 150\text{ }^{\circ}\text{C}$ maximum	I_F	$T_C = 25\text{ }^{\circ}\text{C}$	21	A
			$T_C = 80\text{ }^{\circ}\text{C}$	13	
	Maximum power dissipation	P_D	$T_C = 25\text{ }^{\circ}\text{C}$	32	W
	Maximum non-repetitive peak current	I_{FSM}	$T_C = 25\text{ }^{\circ}\text{C}$	60	A
	Maximum operating junction temperature	T_J		150	$^{\circ}\text{C}$
	Storage temperature range	T_{Stg}		-40 to +150	
	RMS isolation voltage	V_{ISOL}	$V_{RMS} t = 1\text{ s}, T_J = 25\text{ }^{\circ}\text{C}$	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	$^{\circ}\text{C}/\text{W}$

ELECTRICAL SPECIFICATIONS ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise noted)

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



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

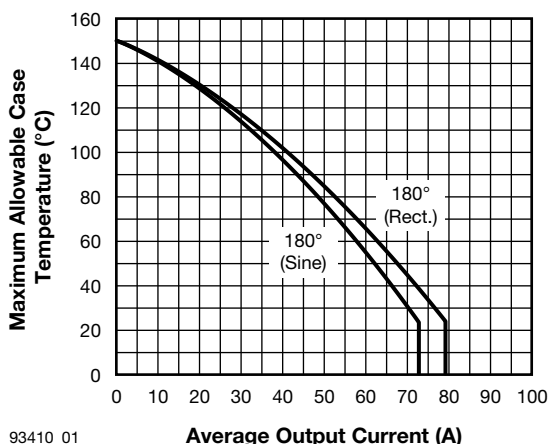


Fig. 1 - Single Phase Input Bridge Output Current Ratings Characteristics

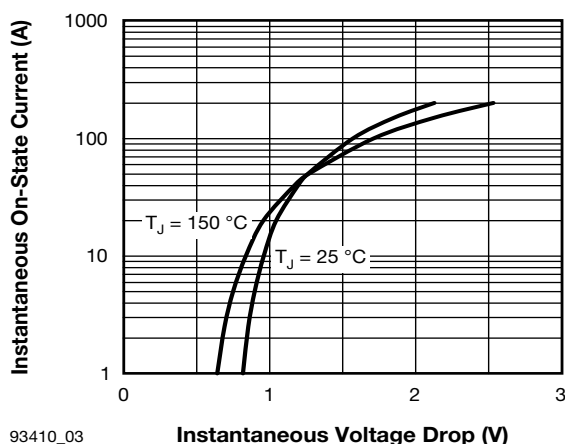


Fig. 3 - Single Phase Input Bridge On-State Voltage Drop Characteristics

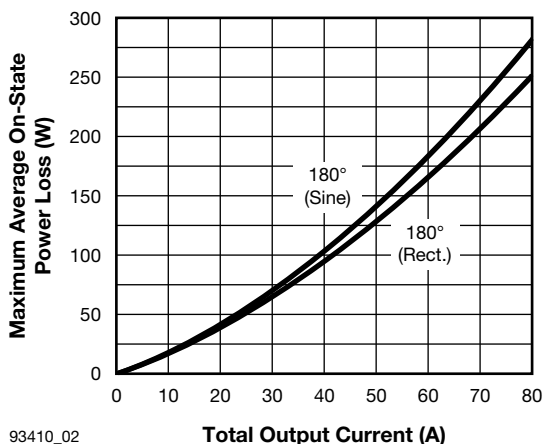


Fig. 2 - Single Phase Bridge On-State Power Loss Characteristics

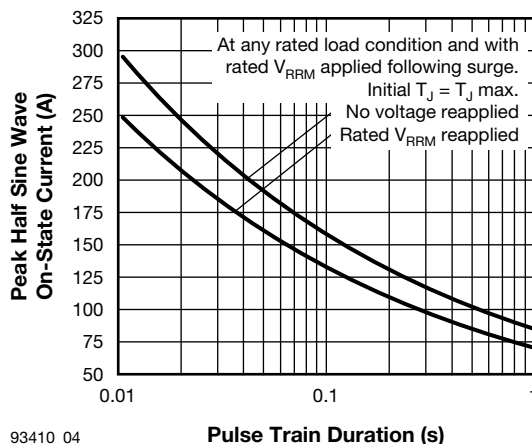


Fig. 4 - Single Phase Input Bridge Maximum Non-Repetitive Surge Current (Per Junction)

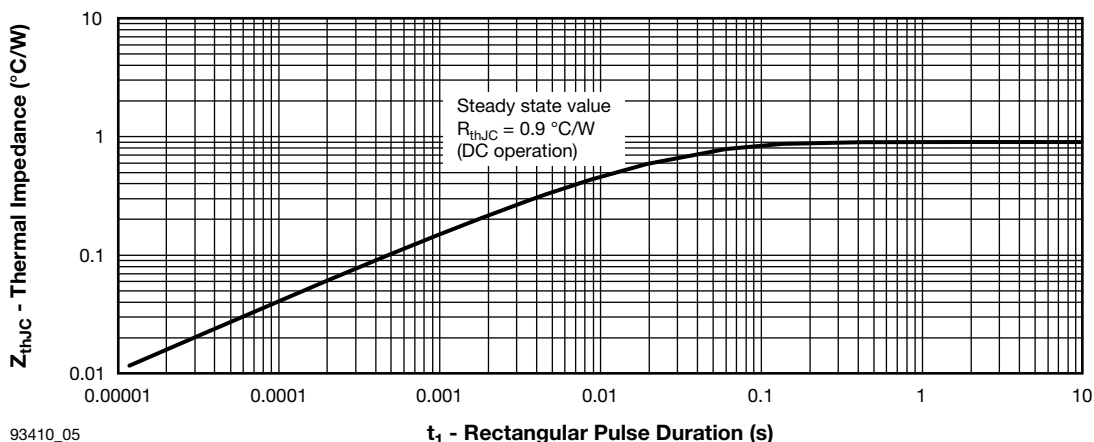


Fig. 5 - Maximum Input Bridge Thermal Impedance Z_{thJC} Characteristics (Per Junction)



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

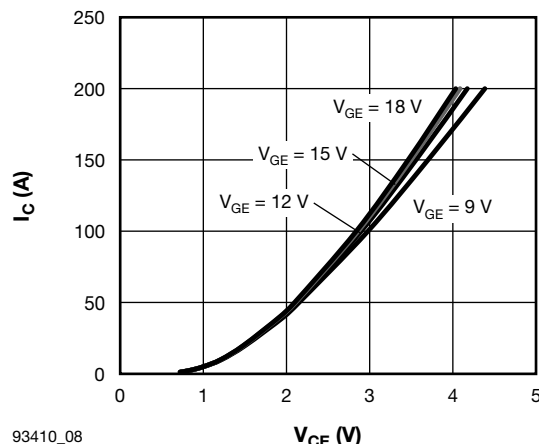


Fig. 8 - Typical IGBT Output Characteristics, $T_J = 25\text{ }^{\circ}\text{C}$

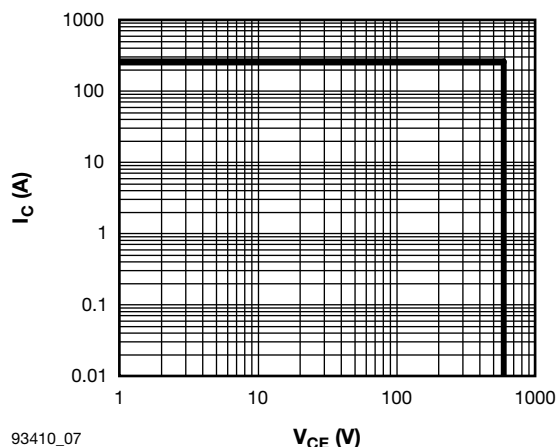


Fig. 7 - IGBT Reverse BIAS SOA $T_J = 150\text{ }^{\circ}\text{C}$, $V_{GE} = 15\text{ V}$

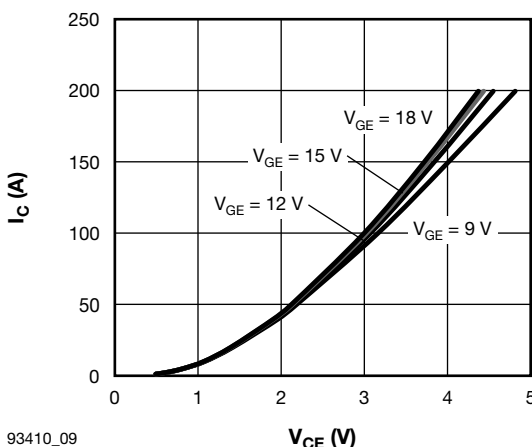
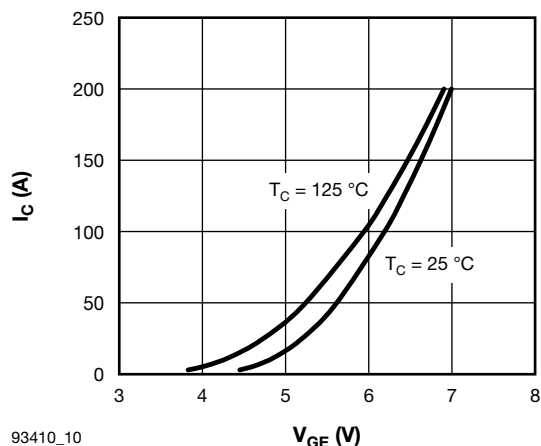
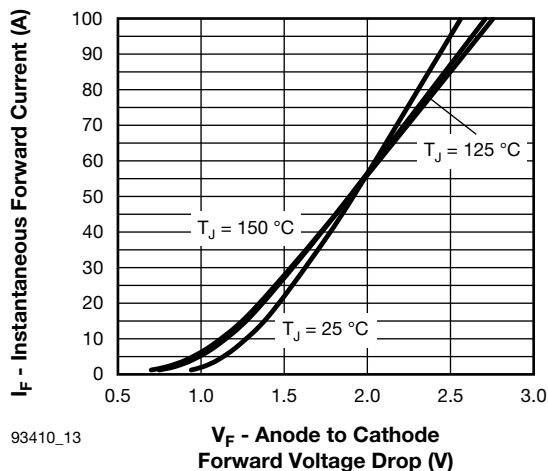


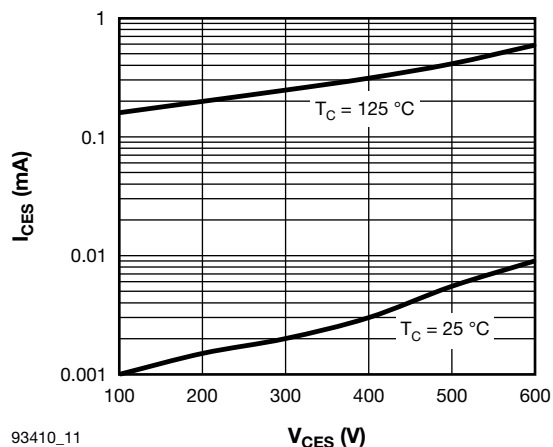
Fig. 9 - Typical IGBT Output Characteristics, $T_J = 125\text{ }^{\circ}\text{C}$



93410_10

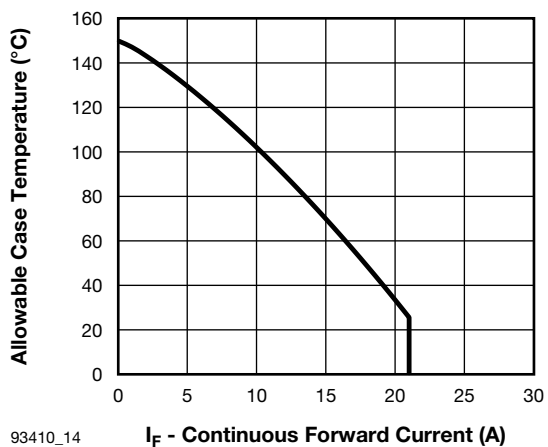
Fig. 10 - Typical IGBT Transfer Characteristics, $T_J = 125\text{ }^{\circ}\text{C}$


93410_13

Fig. 13 - Typical Diode Forward Voltage Characteristics of Antiparallel Diode, $t_p = 500\text{ }\mu\text{s}$


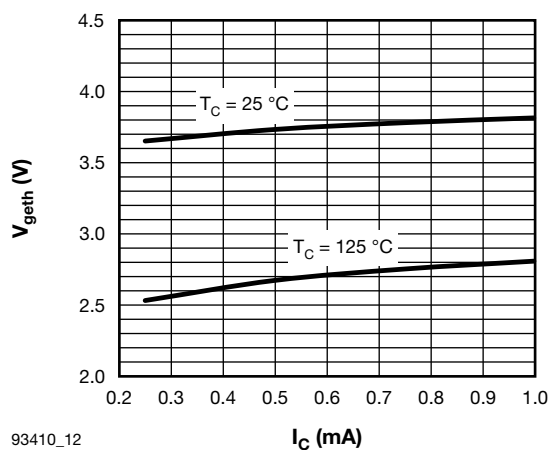
93410_11

Fig. 11 - Typical IGBT Zero Gate Voltage Collector Current



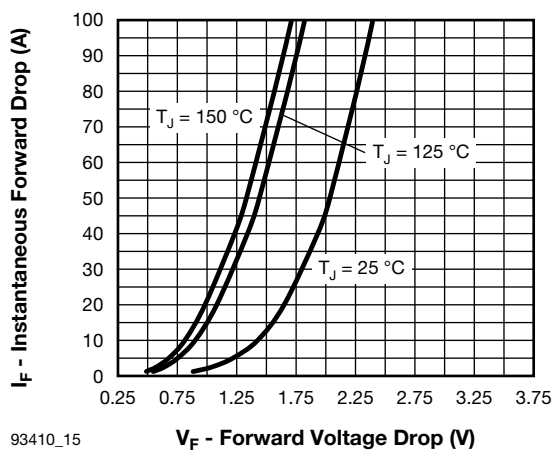
93410_14

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



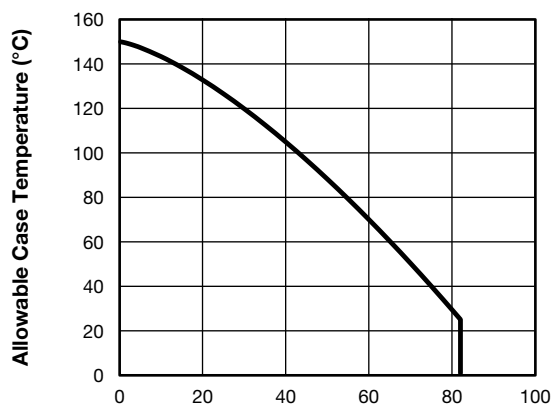
93410_12

Fig. 12 - Typical IGBT Gate Threshold Voltage



93410_15

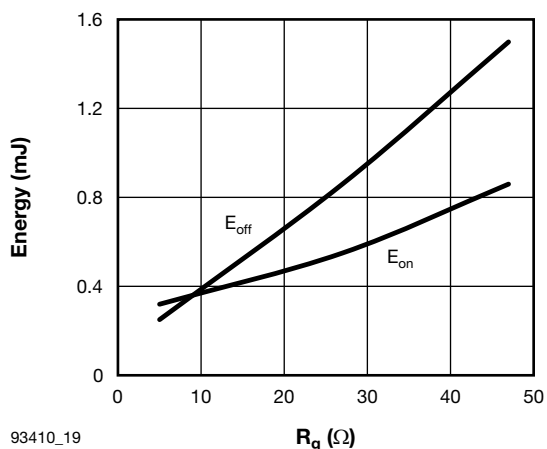
Fig. 15 - Typical PFC Diode Forward Voltage



93410_16

 I_F - Continuous Forward Current (A)

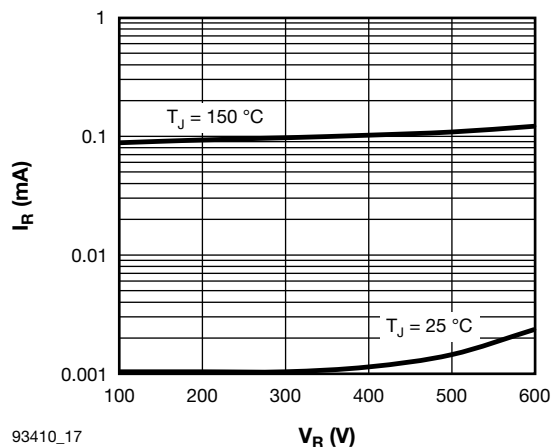
Fig. 16 - Maximum Continuous Forward Current vs. Case Temperature PFC Diode



93410_19

 R_g (Ω)

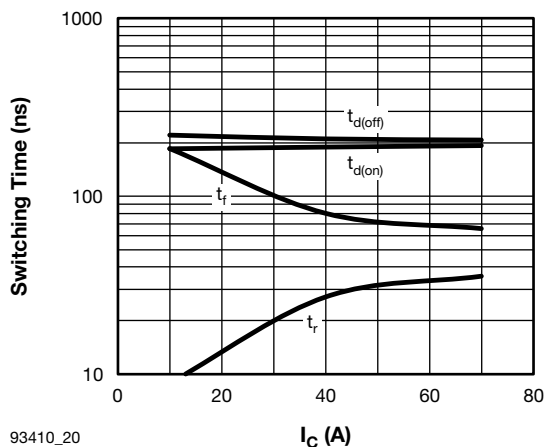
Fig. 19 - Typical IGBT Energy Loss vs. R_g
 $T_J = 125^\circ\text{C}$, $I_C = 70\text{ A}$, $V_{CC} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, $R_g = 5\text{ }\Omega$



93410_17

 V_R (V)

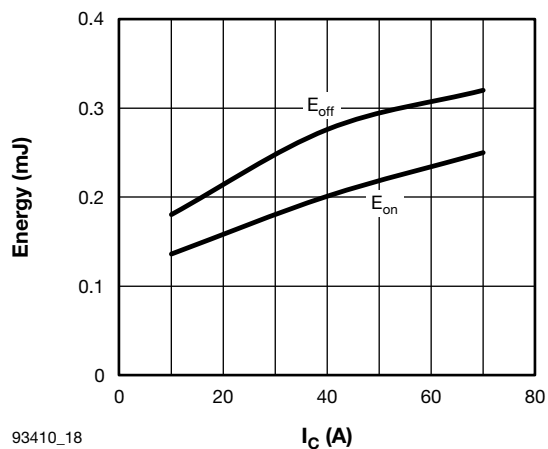
Fig. 17 - Typical FRED Pt® Chopper Diode Reverse Current vs. Reverse Voltage



93410_20

 I_C (A)

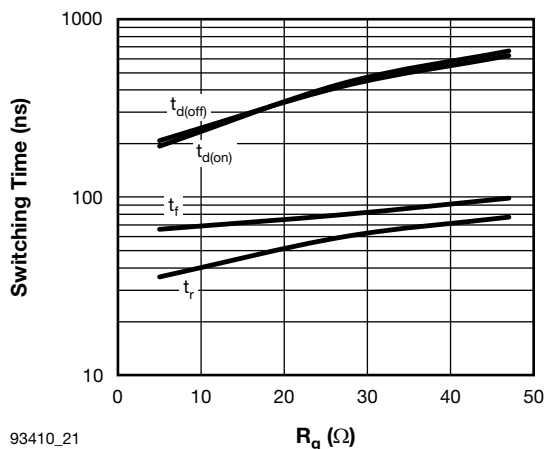
Fig. 20 - Typical IGBT Switching Time vs. I_C
 $T_J = 125^\circ\text{C}$, $V_{CC} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, $R_g = 5\text{ }\Omega$



93410_18

 I_C (A)

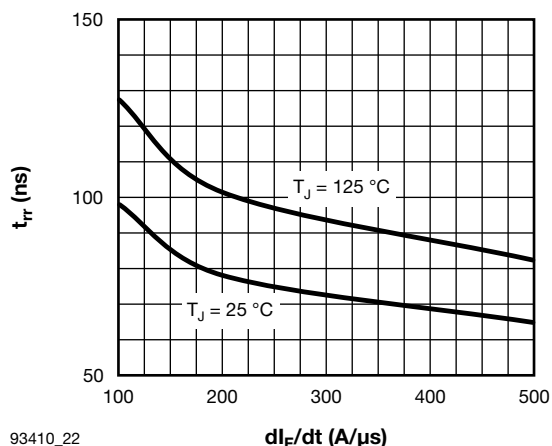
Fig. 18 - Typical IGBT Energy Loss vs. I_C
 $T_J = 125^\circ\text{C}$, $V_{CC} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, $R_g = 5\text{ }\Omega$



93410_21

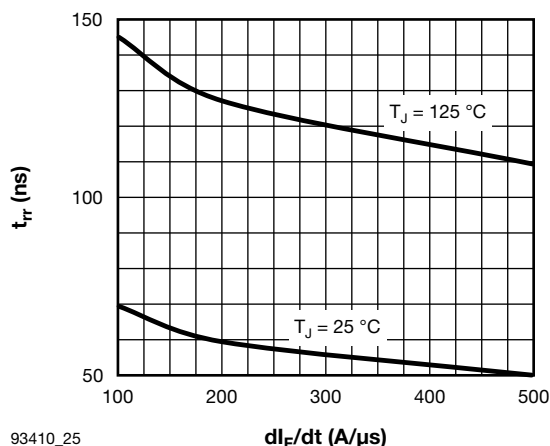
 R_g (Ω)

Fig. 21 - Typical IGBT Switching Time vs. R_g
 $T_J = 125^\circ\text{C}$, $I_C = 70\text{ A}$, $V_{CE} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$



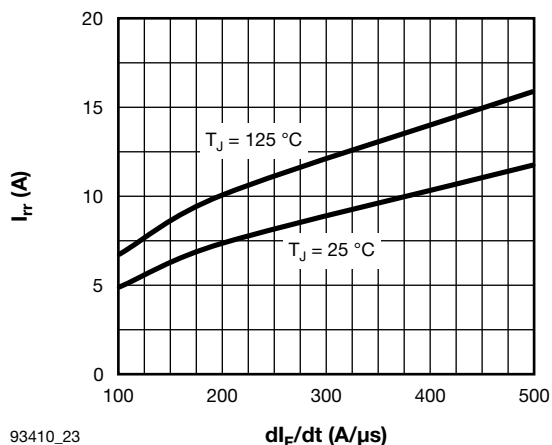
93410_22

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



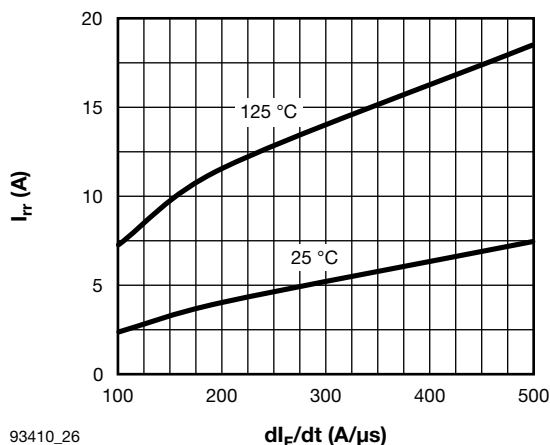
93410_25

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



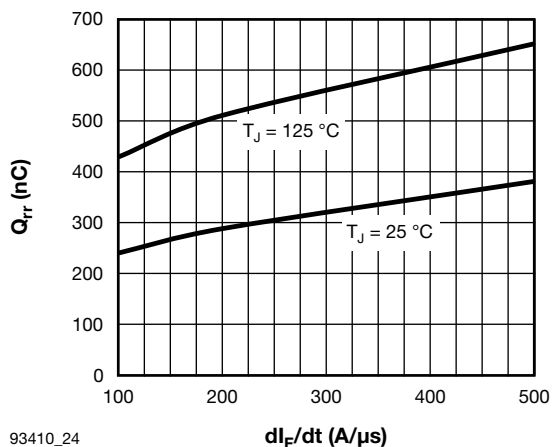
93410_23

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



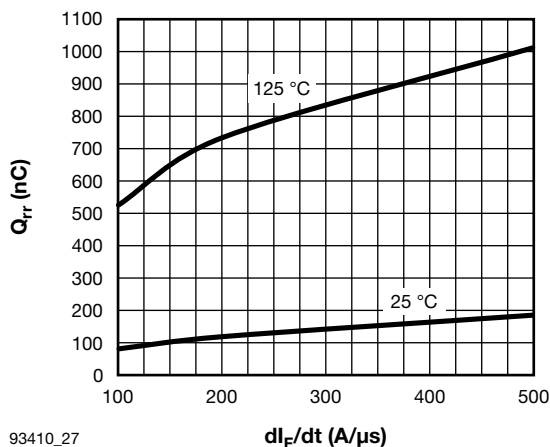
93410_26

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



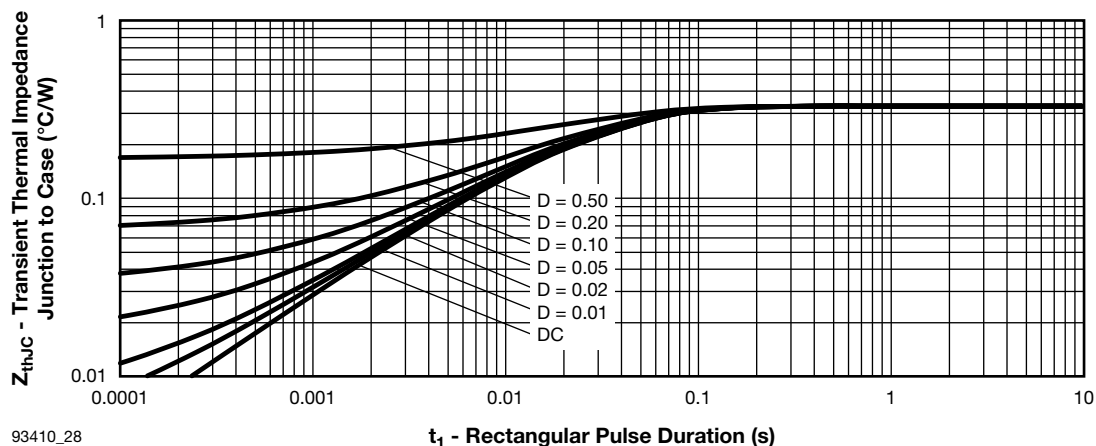
93410_24

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



93410_27

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



93410_28

 t_1 - Rectangular Pulse Duration (s)

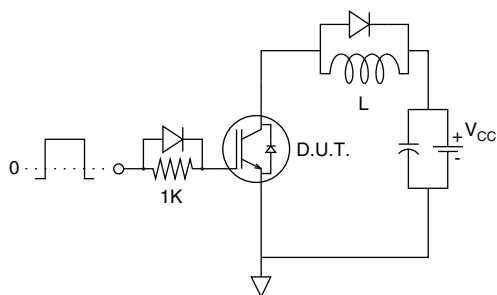
Fig. 28 - Maximum Thermal Impedance Z_{thJC} Characteristics (IGBT)


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

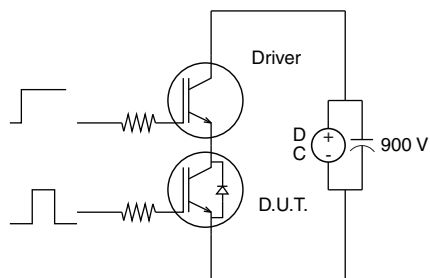


Fig. C.T.3 - S.C. SOA Circuit

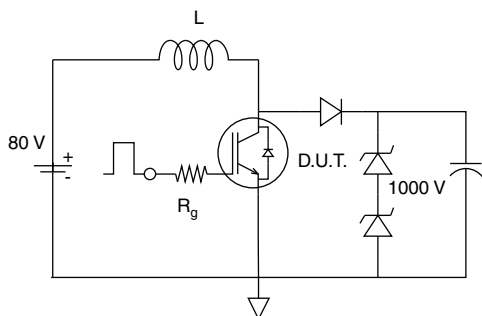


Fig. C.T.2 - RBSOA Circuit

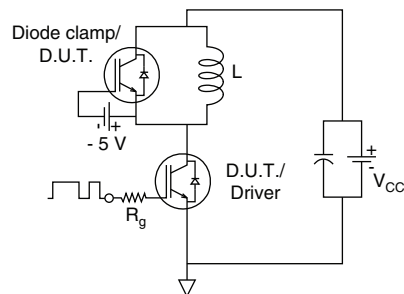


Fig. C.T.4 - Switching Loss Circuit

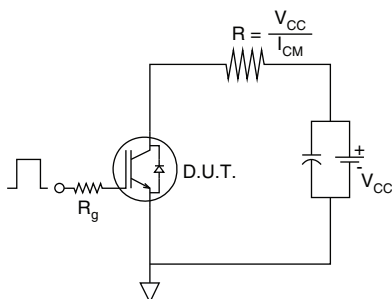
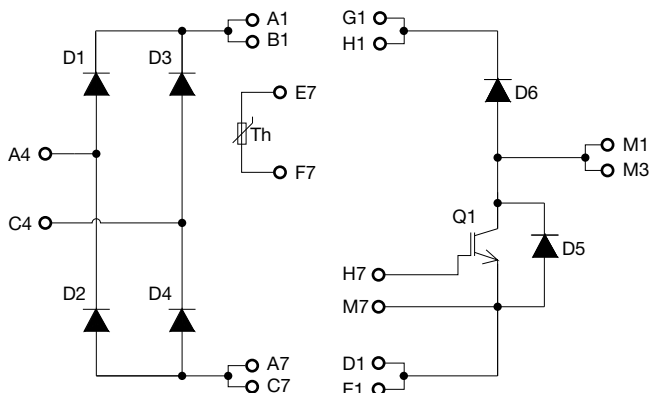


Fig. C.T.5 - Resistive Load Circuit



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

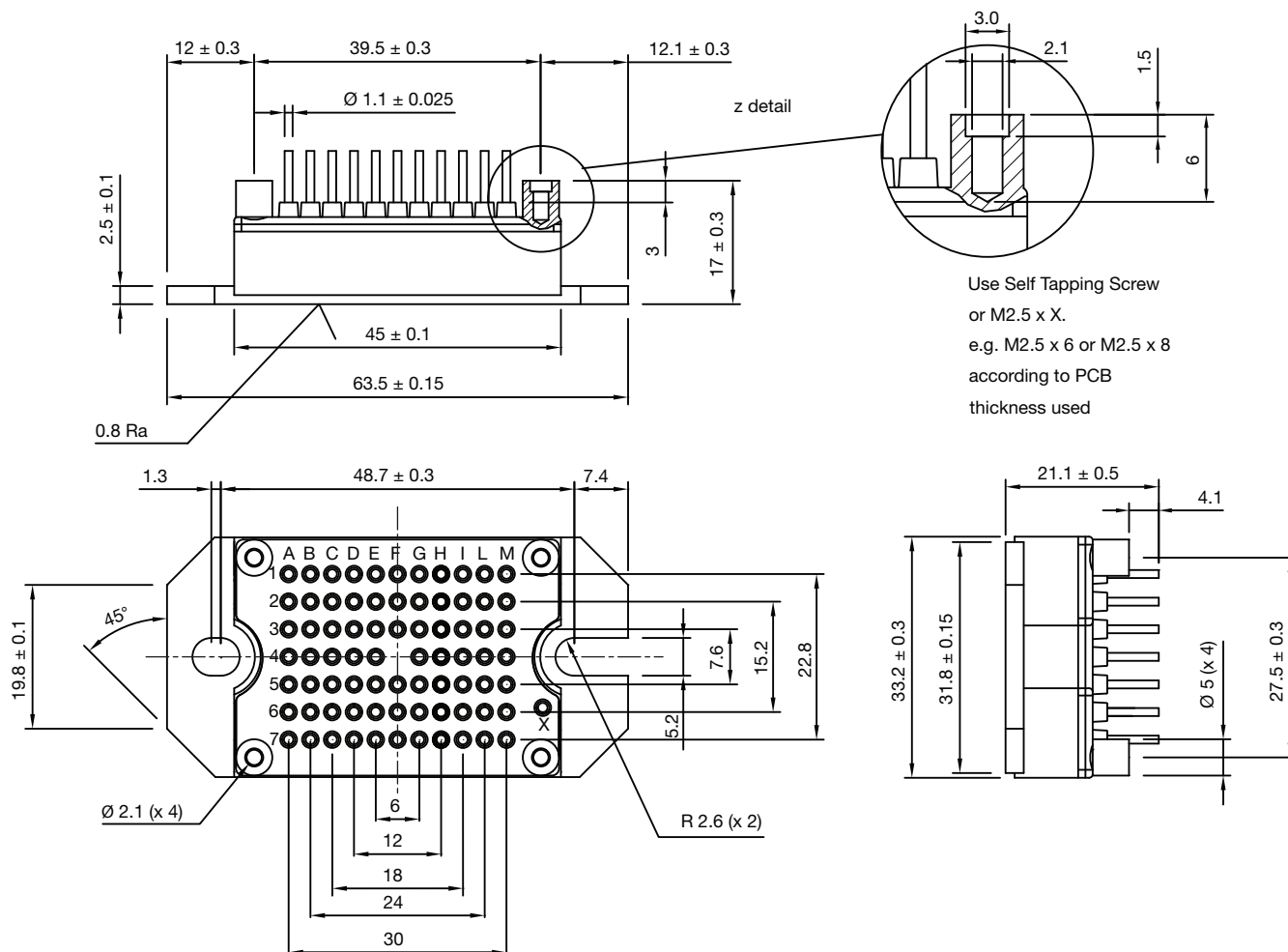
Dimensions

www.vishay.com/doc?95383



MTP - Full Pin

DIMENSIONS in millimeters



Use Self Tapping Screw
or M2.5 x X.
e.g. M2.5 x 6 or M2.5 x 8
according to PCB
thickness used

PINS POSITION
WITH TOLERANCE $\varnothing 0.6$



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