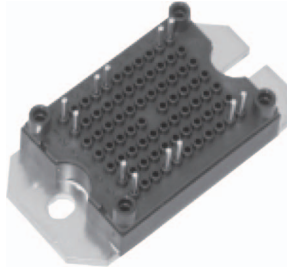


## MTP IGBT Power Module Primary Rectifier and PFC



MTP


**RoHS  
COMPLIANT**

### 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](http://www.vishay.com/doc?99912)

### BENEFITS

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

### PRODUCT SUMMARY

INPUT BRIDGE DIODE, T <sub>J</sub> = 150 °C	
V <sub>RRM</sub>	1200 V
I <sub>O</sub> at 80 °C	48 A
V <sub>FM</sub> at 25 °C at 20 A	1.05 V
PFC IGBT, T <sub>J</sub> = 150 °C	
V <sub>CES</sub>	600 V
V <sub>CE(on)</sub> at 25 °C at 40 A	1.93 V
I <sub>C</sub> at 80 °C	66 A
FRED Pt® PFC DIODE, T <sub>J</sub> = 150 °C	
V <sub>R</sub>	600 V
I <sub>F(DC)</sub> at 80 °C	55 A
V <sub>F</sub> at 25 °C at 40 A	1.76 V
FRED Pt® AP DIODE, T <sub>J</sub> = 150 °C	
V <sub>R</sub>	600 V
I <sub>F(DC)</sub> at 80 °C	13 A
V <sub>F</sub> at 25 °C at 4 A	1.1 V
Speed	30 kHz to 150 kHz
Package	MTP
Circuit	Input rectifier bridge

### ABSOLUTE MAXIMUM RATINGS

	PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Input Rectifier Bridge	Repetitive peak reverse voltage	V <sub>RRM</sub>		1200	V
	Maximum average output current T <sub>J</sub> = 150 °C maximum	I <sub>O</sub>	T <sub>C</sub> = 80 °C	48	A
	Surge current (Non-repetitive)	I <sub>FSM</sub>	Rated V <sub>RRM</sub> applied	250	
	Maximum I <sup>2</sup> t for fusing	I <sup>2</sup> t	10 ms, sine pulse	316	A <sup>2</sup> s
PFC IGBT	Collector to emitter voltage	V <sub>CES</sub>	T <sub>J</sub> = 25 °C	600	V
	Gate to emitter voltage	V <sub>GE</sub>	I <sub>GES</sub> max. ± 250 ns	± 20	
	Maximum continuous collector current at V <sub>GE</sub> = 15 V, T <sub>J</sub> = 150 °C maximum	I <sub>C</sub>	T <sub>C</sub> = 25 °C	96	A
			T <sub>C</sub> = 80 °C	66	
	Pulsed collector current	I <sub>CM</sub> <sup>(1)</sup>		250	
	Clamped inductive load current	I <sub>LM</sub>		250	
Maximum power dissipation	P <sub>D</sub>	T <sub>C</sub> = 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

<b>ΔR CONDUCTION PER JUNCTION - SINGLE PHASE BRIDGE DIODE</b>											
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	$^\circ\text{C}/\text{W}$

<b>ELECTRICAL SPECIFICATIONS (<math>T_J = 25\text{ }^\circ\text{C}</math> unless otherwise noted)</b>							
	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	
Forward slope resistance	$r_t$	$T_J = 150\text{ }^\circ\text{C}$	-	-	8.7	mΩ	
Conduction threshold voltage	$V_T$		-	-	0.94	V	
PFC IGBT	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	$\Delta V_{BR(CES)}/\Delta T_J$	$I_C = 0.5\text{ mA} (25\text{ }^\circ\text{C to } 125\text{ }^\circ\text{C})$	-	0.6	-	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	
	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	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 100$	nA	
PFC Diode	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	
	Blocking voltage	$BV_{RM}$	$I_R = 0.5\text{ mA}$	600	-	-	
	Reverse leakage current	$I_{RM}$	$V_{RRM} = 600\text{ V}$	-	-	75	$\mu\text{A}$
$V_{RRM} = 600\text{ V}, T_J = 125\text{ }^\circ\text{C}$			-	-	0.5	mA	
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	



<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)							
	PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
<b>RECOVERY PARAMETER</b>							
PFC Diode	Peak reverse recovery current	$I_{rr}$	$I_F = 40\text{ A}$ $di/dt = 200\text{ A}/\mu\text{s}$ $V_R = 200\text{ V}$	-	4	7	A
	Reverse recovery time	$t_{rr}$		-	59	79	ns
	Reverse recovery charge	$Q_{rr}$		-	118	180	nC
	Peak reverse recovery current	$I_{rr}$	$I_F = 40\text{ A}, T_J = 125\text{ }^\circ\text{C}$ $di/dt = 200\text{ A}/\mu\text{s}$ $V_R = 200\text{ V}$	-	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	$I_{rr}$	$I_F = 4\text{ A}$ $di/dt = 200\text{ A}/\mu\text{s}$ $V_R = 200\text{ V}$	-	7	10	A
	Reverse recovery time	$t_{rr}$		-	78	120	ns
	Reverse recovery charge	$Q_{rr}$		-	290	600	nC

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

<b>THERMISTOR ELECTRICAL CHARACTERISTICS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Resistance	R	$T_J = 25\text{ }^\circ\text{C}$	-	30 000	-	$\Omega$
B value	B	$T_J = 25\text{ }^\circ\text{C}/T_J = 85\text{ }^\circ\text{C}$	-	4000	-	K

**Notes**

- Repetitive rating; pulsed with limited by maximum junction temperature.

THERMAL AND MECHANICAL SPECIFICATIONS						
	PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Input Rectifier Bridge	Junction to case diode thermal resistance	$R_{thJC}$	-	-	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	
	Case to sink, flat, greased surface per module	$R_{thCS}$	-	0.06	-	°C/W
	Mounting torque $\pm 10\%$ to heatsink <sup>(1)</sup>		-	-	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.

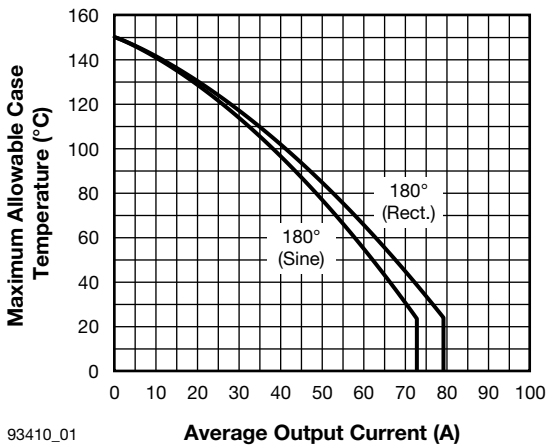


Fig. 1 - Single Phase Input Bridge Output Current Ratings Characteristics

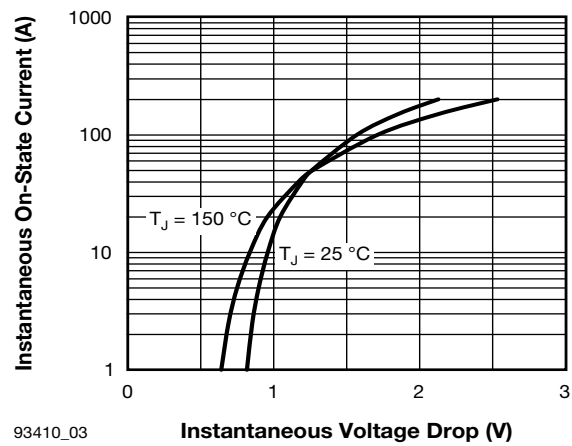


Fig. 3 - Single Phase Input Bridge On-State Voltage Drop Characteristics

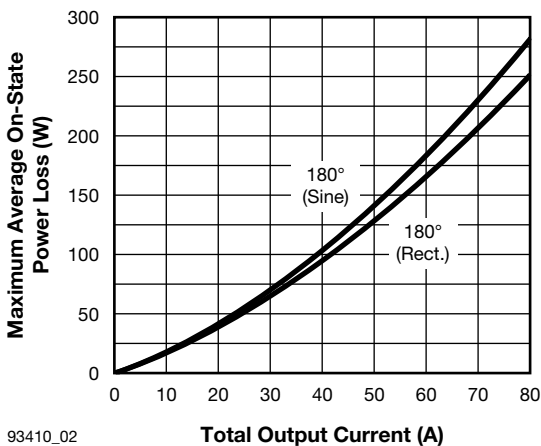


Fig. 2 - Single Phase Bridge On-State Power Loss Characteristics

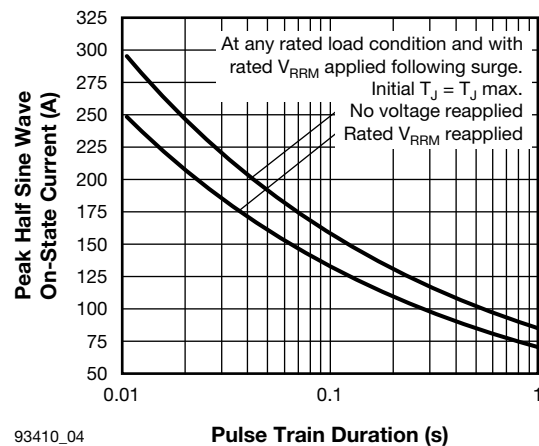


Fig. 4 - Single Phase Input Bridge Maximum Non-Repetitive Surge Current (Per Junction)

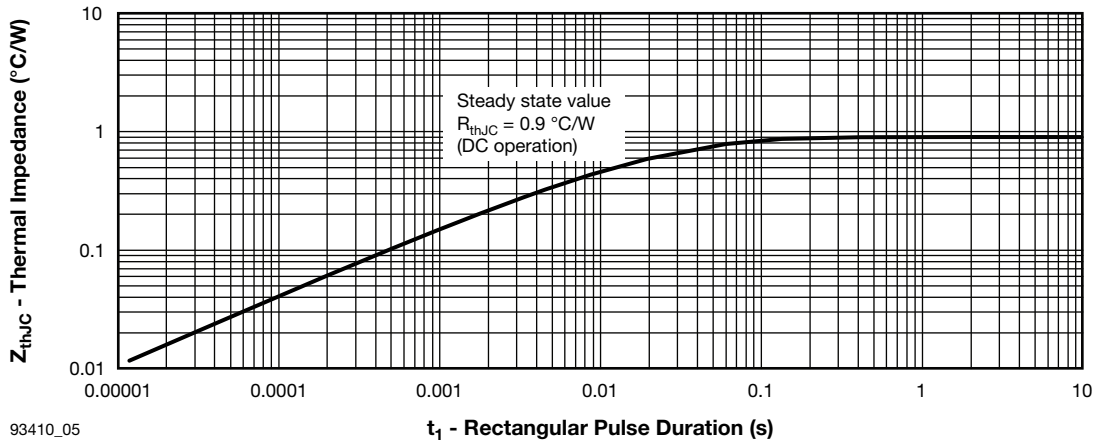
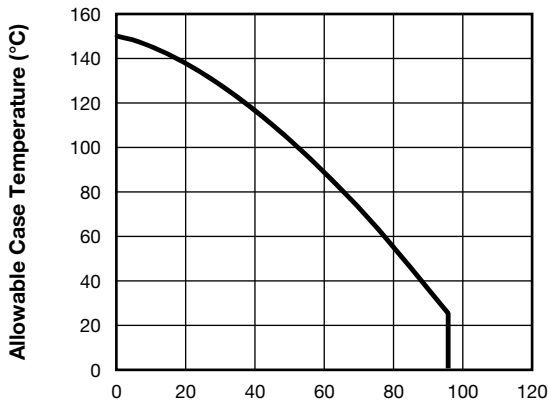
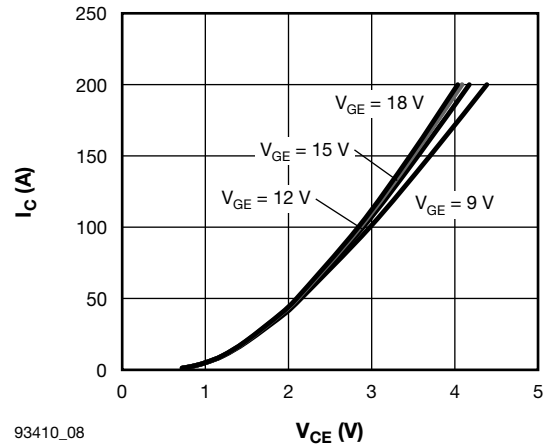


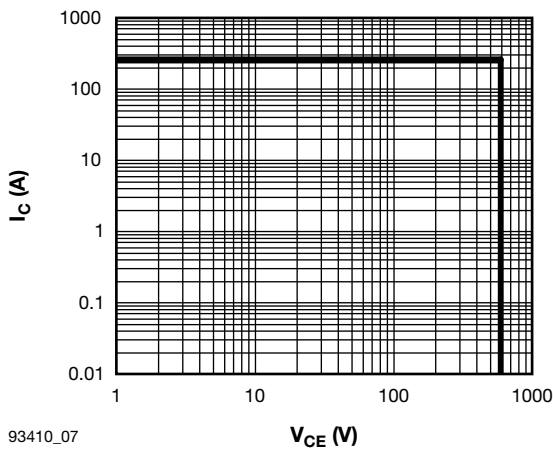
Fig. 5 - Maximum Input Bridge Thermal Impedance  $Z_{thJC}$  Characteristics (Per Junction)



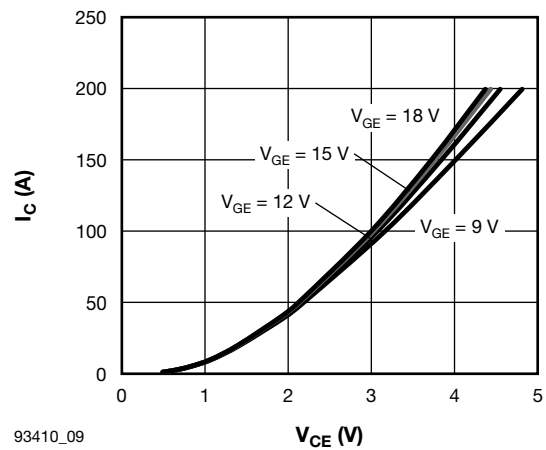
93410\_06  **$I_D$  - Continuous Collector Current (A)**  
Fig. 6 - Maximum IGBT Continuous Collector Current vs. Case Temperature



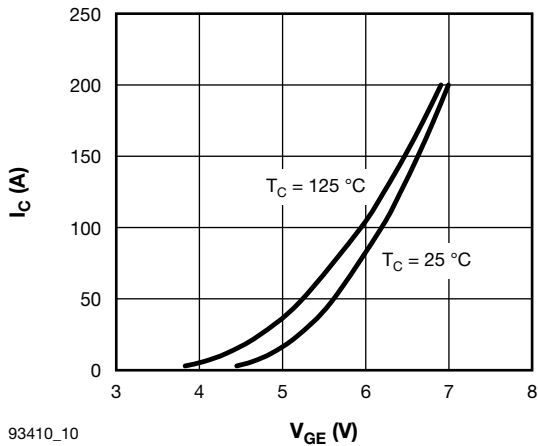
93410\_08  
Fig. 8 - Typical IGBT Output Characteristics,  $T_J = 25 \text{ } ^\circ\text{C}$



93410\_07  
Fig. 7 - IGBT Reverse BIAS SOA  $T_J = 150 \text{ } ^\circ\text{C}$ ,  $V_{GE} = 15 \text{ V}$

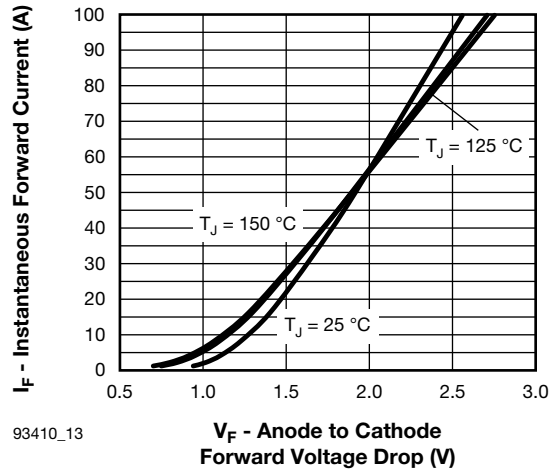


93410\_09  
Fig. 9 - Typical IGBT Output Characteristics,  $T_J = 125 \text{ } ^\circ\text{C}$



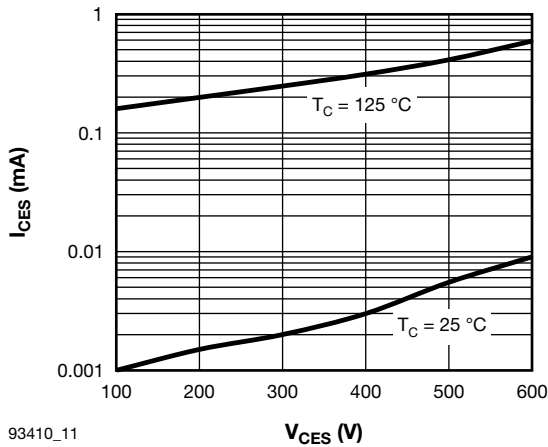
93410\_10

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



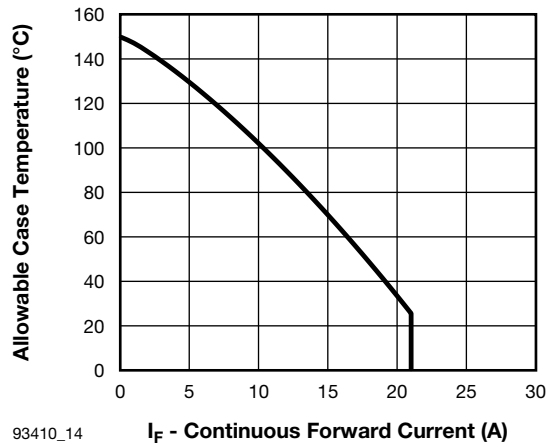
93410\_13

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



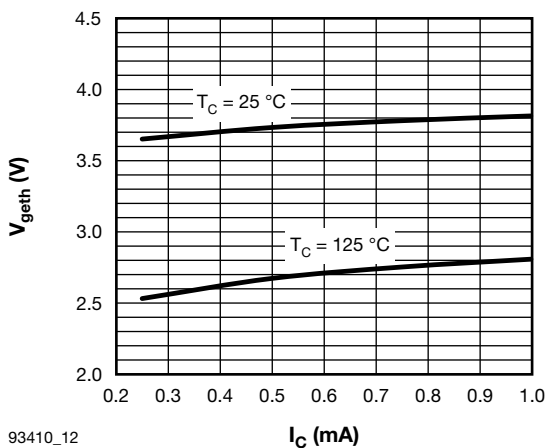
93410\_11

Fig. 11 - Typical IGBT Zero Gate Voltage Collector Current



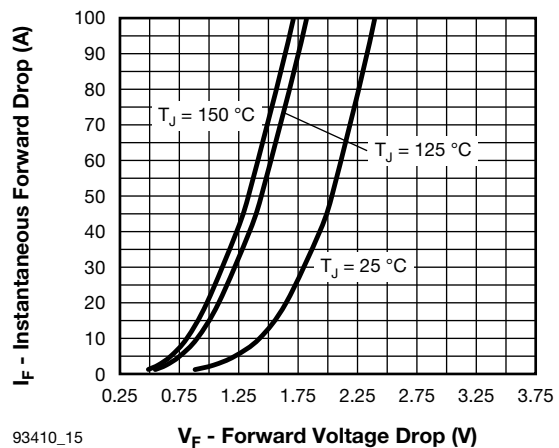
93410\_14

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



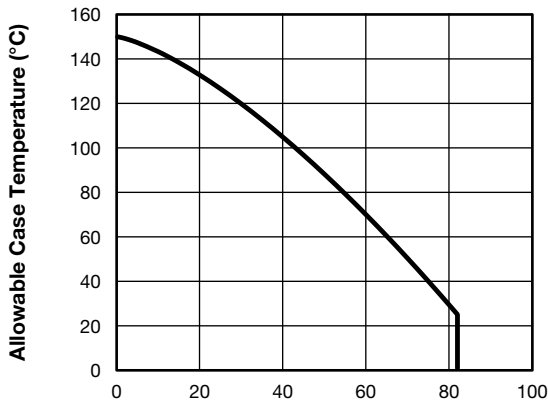
93410\_12

Fig. 12 - Typical IGBT Gate Threshold Voltage

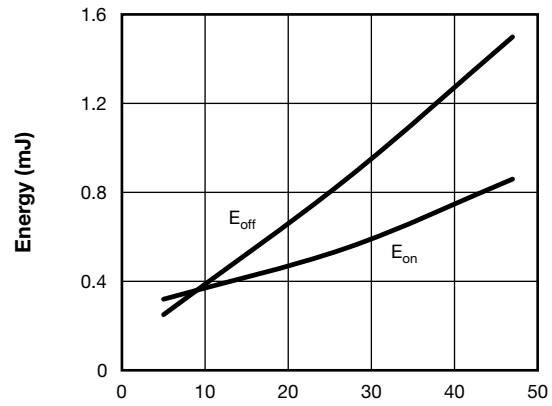


93410\_15

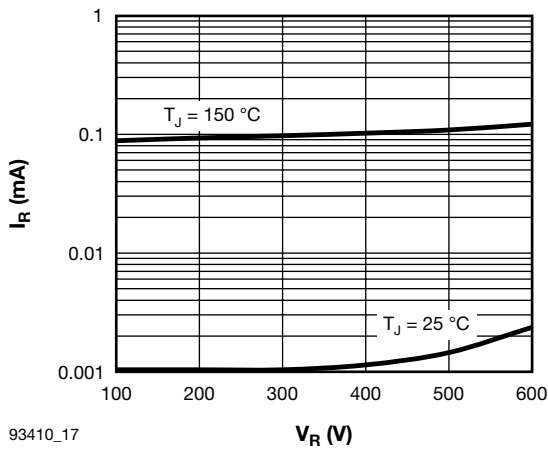
Fig. 15 - Typical PFC Diode Forward Voltage



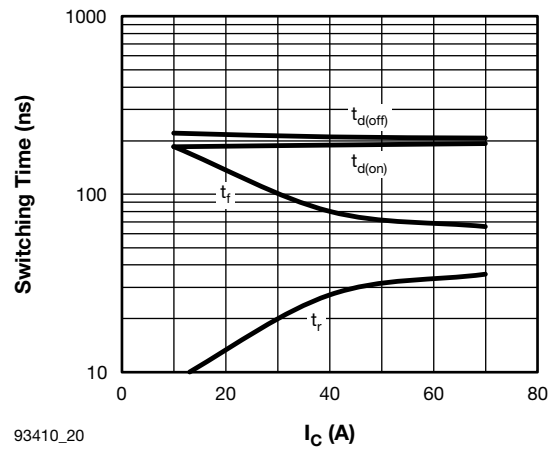
93410\_16 **I<sub>F</sub> - Continuous Forward Current (A)**  
Fig. 16 - Maximum Continuous Forward Current vs. Case Temperature PFC Diode



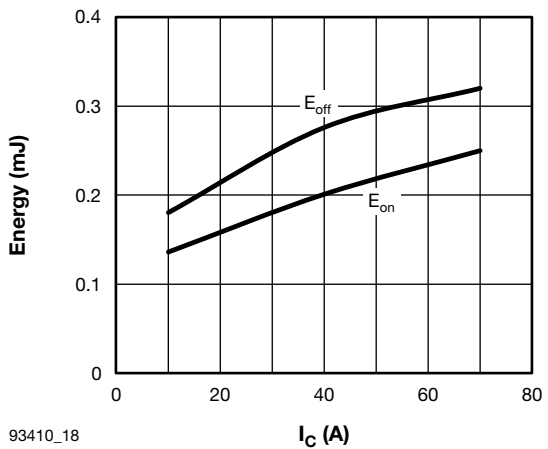
93410\_19 **R<sub>g</sub> (Ω)**  
Fig. 19 - Typical IGBT Energy Loss vs. R<sub>g</sub>  
T<sub>J</sub> = 125 °C, I<sub>C</sub> = 70 A, V<sub>CC</sub> = 360 V, V<sub>GE</sub> = 15 V, L = 500 μH, R<sub>g</sub> = 5 Ω



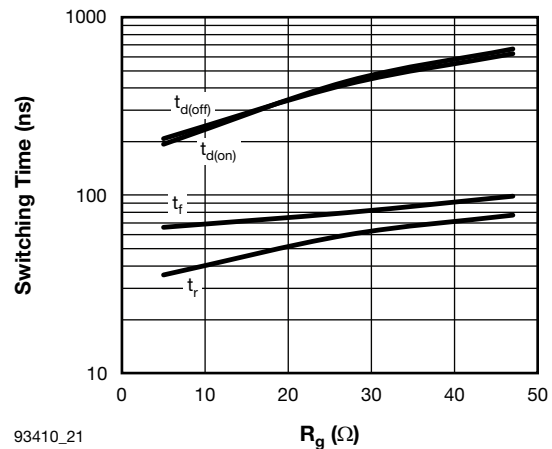
93410\_17 **V<sub>R</sub> (V)**  
Fig. 17 - Typical FRED Pt® Chopper Diode Reverse Current vs. Reverse Voltage



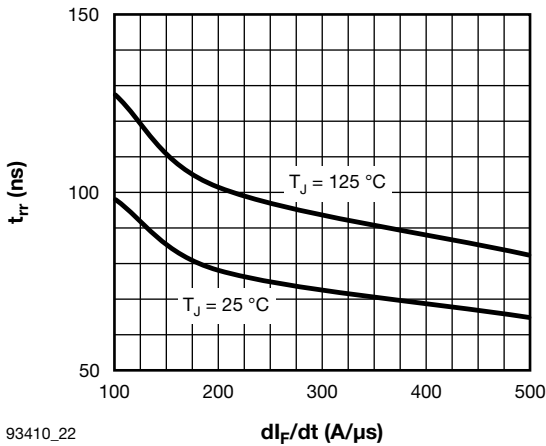
93410\_20 **I<sub>C</sub> (A)**  
Fig. 20 - Typical IGBT Switching Time vs. I<sub>C</sub>  
T<sub>J</sub> = 125 °C, V<sub>CC</sub> = 360 V, V<sub>GE</sub> = 15 V, L = 500 μH, R<sub>g</sub> = 5 Ω



93410\_18 **I<sub>C</sub> (A)**  
Fig. 18 - Typical IGBT Energy Loss vs. I<sub>C</sub>  
T<sub>J</sub> = 125 °C, V<sub>CC</sub> = 360 V, V<sub>GE</sub> = 15 V, L = 500 μH, R<sub>g</sub> = 5 Ω

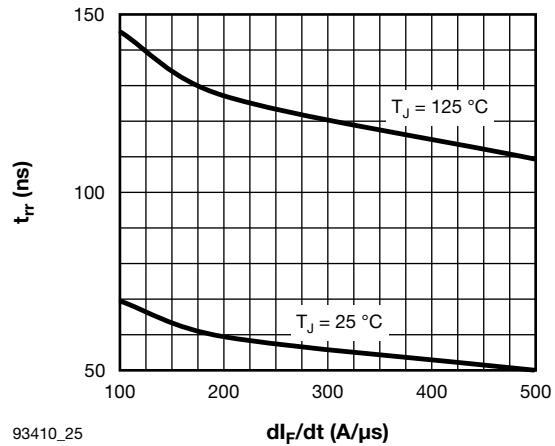


93410\_21 **R<sub>g</sub> (Ω)**  
Fig. 21 - Typical IGBT Switching Time vs. R<sub>g</sub>  
T<sub>J</sub> = 125 °C, I<sub>C</sub> = 70 A, V<sub>CE</sub> = 360 V, V<sub>GE</sub> = 15 V, L = 500 μH



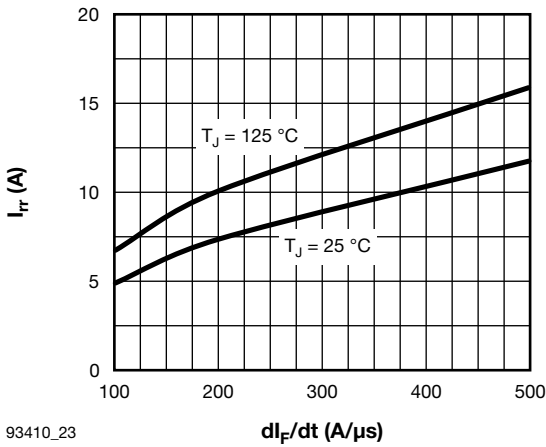
93410\_22

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



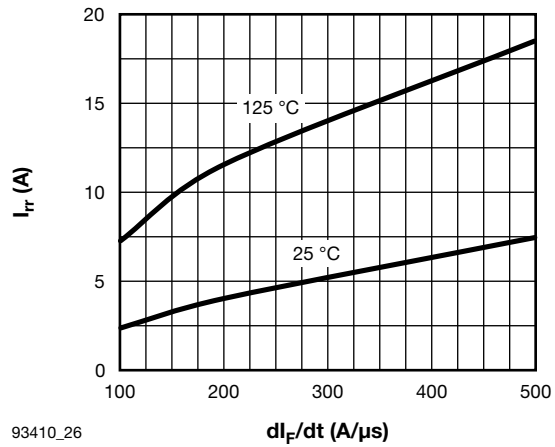
93410\_25

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



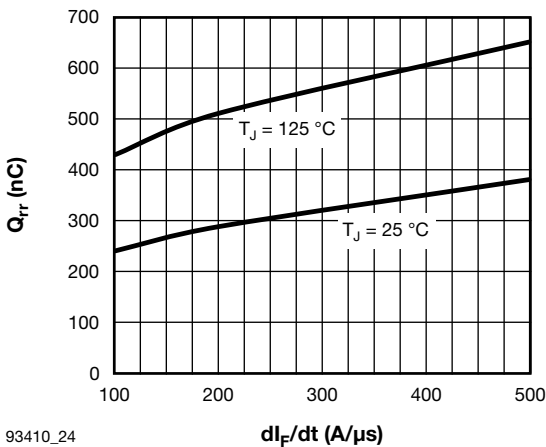
93410\_23

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



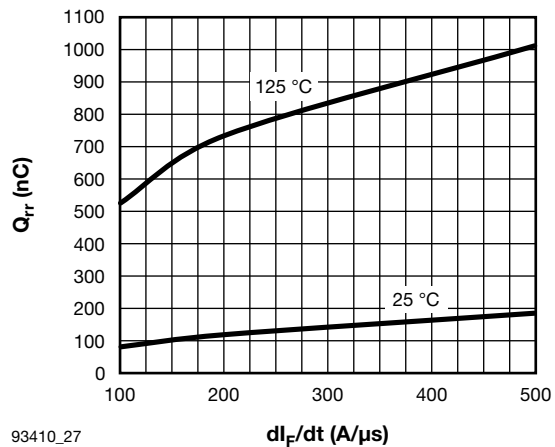
93410\_26

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



93410\_24

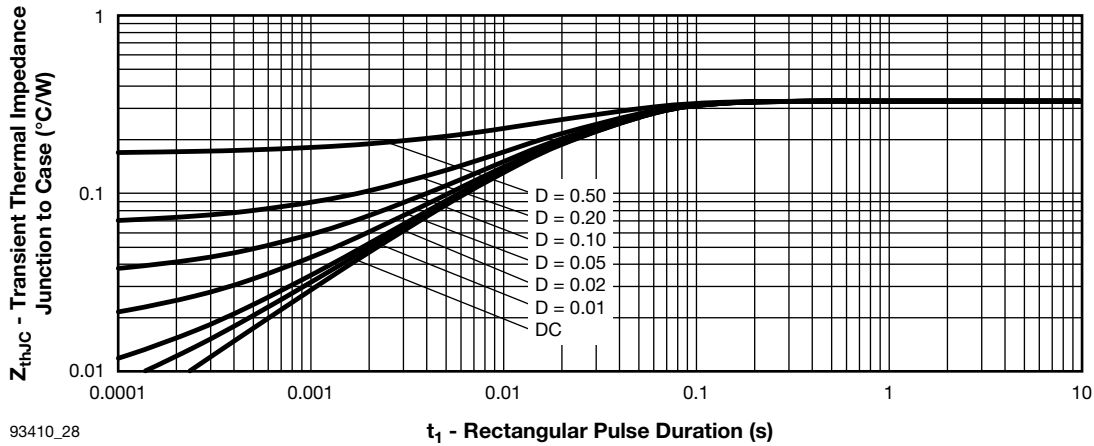
Fig. 24 - Typical  $Q_{rr}$  Antiparallel Diode vs.  $di_F/dt$   
 $V_{rr} = 200$  V,  $I_F = 4$  A



93410\_27

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





93410\_28

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

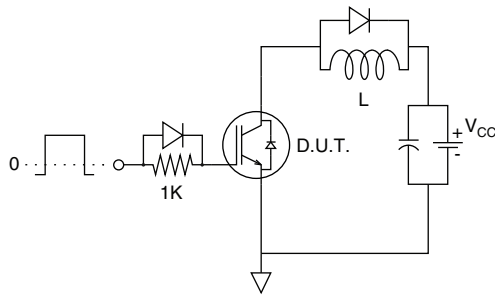


Fig. C.T.1 - Gate Charge Circuit (Turn-Off)

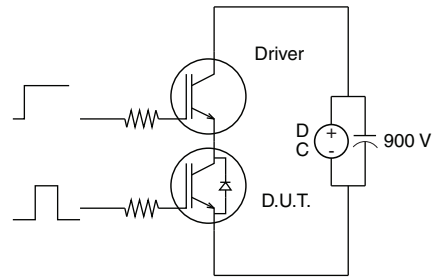


Fig. C.T.3 - S.C. SOA Circuit

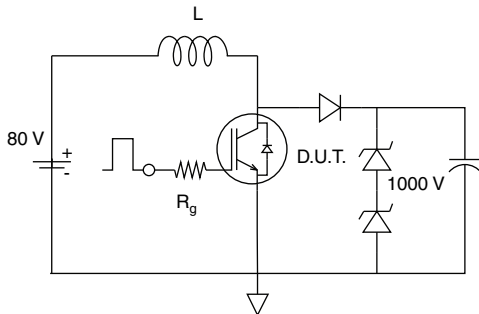


Fig. C.T.2 - RBSOA Circuit

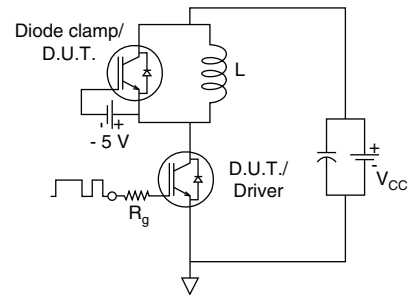


Fig. C.T.4 - Switching Loss Circuit

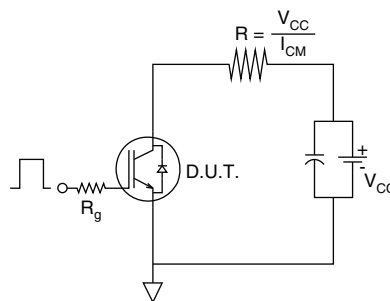
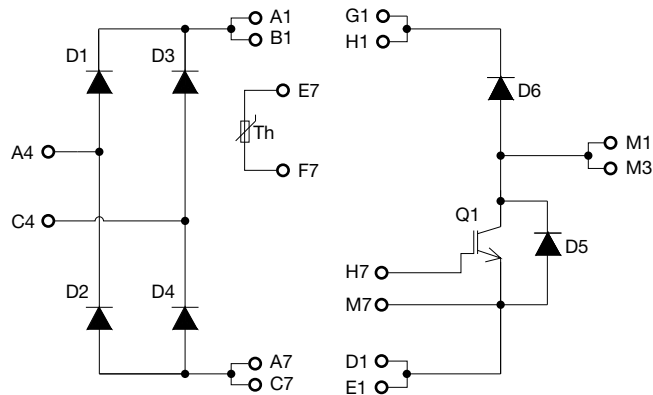


Fig. C.T.5 - Resistive Load Circuit

## CIRCUIT CONFIGURATION



## ORDERING INFORMATION

Device code

<b>VS-</b>	<b>70</b>	<b>MT</b>	<b>060</b>	<b>W</b>	<b>SP</b>
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)

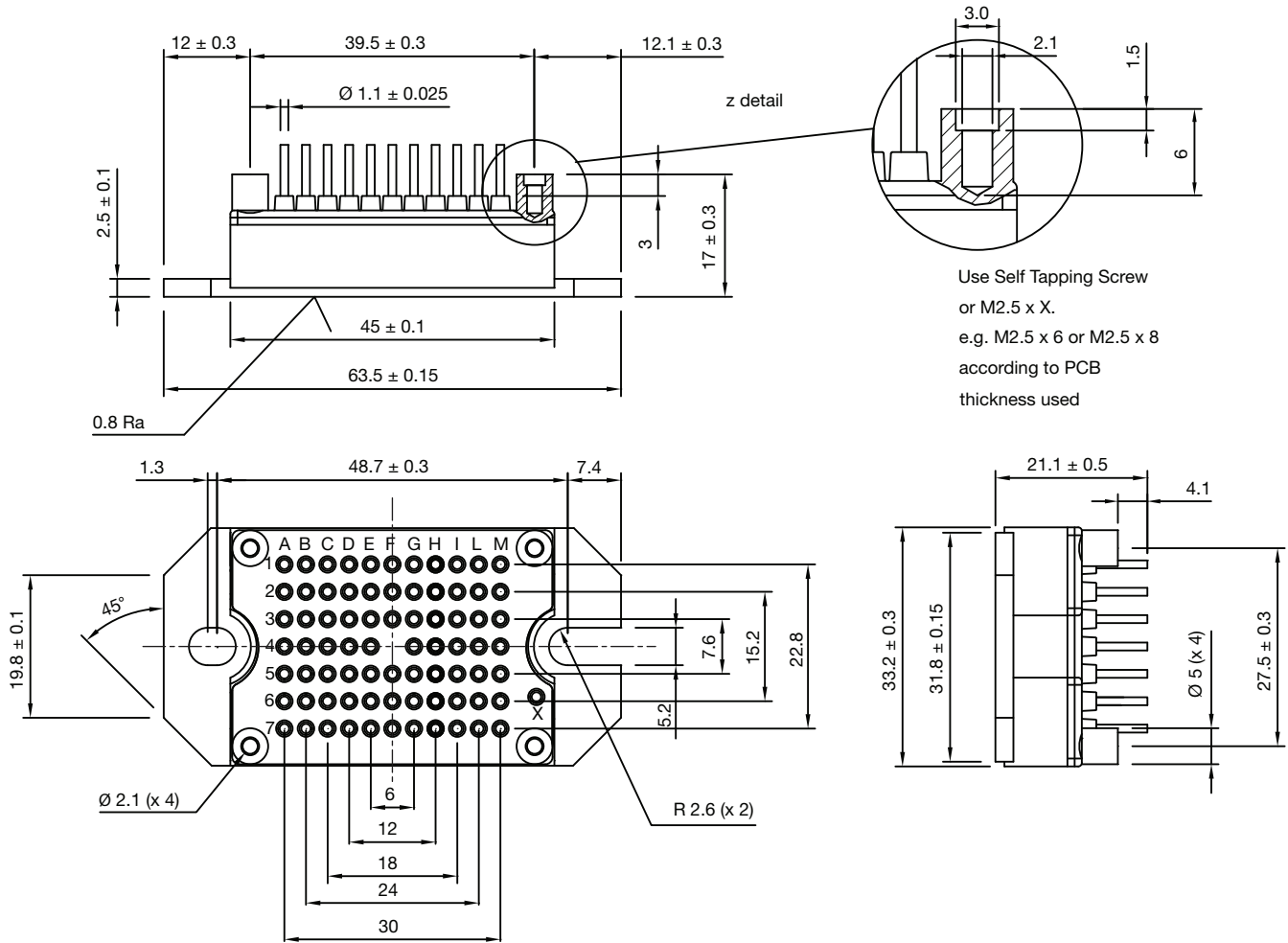
### LINKS TO RELATED DOCUMENTS

Dimensions	<a href="http://www.vishay.com/doc?95383">www.vishay.com/doc?95383</a>
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### MTP - Full Pin

**DIMENSIONS** in millimeters



PINS POSITION  
WITH TOLERANCE  $\varnothing 0.6$



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