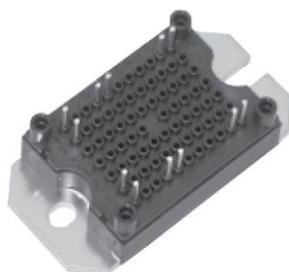


## Primary MTP IGBT Power Module



MTP

### FEATURES

- Buck PFC stage with warp 2 IGBT and FRED Pt<sup>®</sup> hyperfast diode
- Integrated thermistor
- Isolated baseplate
- UL approved file E78996 
- Very low stray inductance design for high speed operation
- 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)


**RoHS**  
COMPLIANT

### BENEFITS

- Lower conduction losses and switching losses
- Higher switching frequency up to 150 kHz
- Optimized for welding, UPS, and SMPS applications
- PCB solderable terminals
- Direct mounting to heatsink

### PRIMARY CHARACTERISTICS

| FRED Pt <sup>®</sup> AP DIODE, T <sub>J</sub> = 150 °C      |                   |
|-------------------------------------------------------------|-------------------|
| V <sub>RRM</sub>                                            | 600 V             |
| I <sub>F(DC)</sub> at 80 °C                                 | 11 A              |
| V <sub>F</sub> at 25 °C at 60 A                             | 2.08 V            |
| IGBT, T <sub>J</sub> = 150 °C                               |                   |
| V <sub>CES</sub>                                            | 600 V             |
| V <sub>CE(on)</sub> at 25 °C at 60 A                        | 1.98 V            |
| I <sub>C</sub> at 80°C                                      | 83 A              |
| FRED Pt <sup>®</sup> CHOPPER DIODE, T <sub>J</sub> = 150 °C |                   |
| V <sub>R</sub>                                              | 600 V             |
| I <sub>F(DC)</sub> at 80 °C                                 | 17 A              |
| V <sub>F</sub> at 25 °C at 60 A                             | 2.06 V            |
| Speed                                                       | 30 kHz to 150 kHz |
| Package                                                     | MTP               |
| Circuit configuration                                       | Dual forward      |

### ABSOLUTE MAXIMUM RATINGS

|                            | PARAMETER                                                                                          | SYMBOL             | TEST CONDITIONS                                  | MAX.        | UNITS |
|----------------------------|----------------------------------------------------------------------------------------------------|--------------------|--------------------------------------------------|-------------|-------|
| FRED Pt antiparallel diode | Repetitive peak reverse voltage                                                                    | V <sub>RRM</sub>   |                                                  | 600         | V     |
|                            | Maximum continuous forward current<br>T <sub>J</sub> = 150 °C maximum                              | I <sub>F(DC)</sub> | T <sub>C</sub> = 25 °C                           | 17          | A     |
|                            |                                                                                                    |                    | T <sub>C</sub> = 80 °C                           | 11          |       |
|                            | Maximum power dissipation                                                                          | P <sub>D</sub>     | T <sub>C</sub> = 25 °C                           | 25          | W     |
| 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        | V     |
|                            | Maximum continuous collector current<br>at V <sub>GE</sub> = 15 V, T <sub>J</sub> = 150 °C maximum | I <sub>C</sub>     | T <sub>C</sub> = 25 °C                           | 121         | A     |
|                            |                                                                                                    |                    | T <sub>C</sub> = 80 °C                           | 83          |       |
|                            | Clamped inductive load current                                                                     | I <sub>LM</sub>    |                                                  | 300         |       |
|                            | Maximum power dissipation                                                                          | P <sub>D</sub>     | T <sub>C</sub> = 25 °C                           | 462         | W     |
| FRED Pt chopper diode      | Repetitive peak reverse voltage                                                                    | V <sub>RRM</sub>   |                                                  | 600         | V     |
|                            | Maximum continuous forward current<br>T <sub>J</sub> = 150 °C maximum                              | I <sub>F</sub>     | T <sub>C</sub> = 25 °C                           | 26          | A     |
|                            |                                                                                                    |                    | T <sub>C</sub> = 80 °C                           | 17          |       |
|                            | Maximum power dissipation                                                                          | P <sub>D</sub>     | T <sub>C</sub> = 25 °C                           | 56          | W     |
|                            | Maximum operating junction temperature                                                             | T <sub>J</sub>     |                                                  | 150         | °C    |
|                            | Storage temperature range                                                                          | T <sub>Stg</sub>   |                                                  | -40 to +150 |       |
|                            | Isolation voltage                                                                                  | V <sub>ISOL</sub>  | V <sub>RMS</sub> t = 1 s, T <sub>J</sub> = 25 °C | 3500        | V     |

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

|                         | PARAMETER                                    | SYMBOL                                 | TEST CONDITIONS                                                                              | MIN. | TYP.  | MAX. | UNITS |
|-------------------------|----------------------------------------------|----------------------------------------|----------------------------------------------------------------------------------------------|------|-------|------|-------|
| AP diode                | Blocking voltage                             | BV <sub>RRM</sub>                      | 0.5 mA                                                                                       | 600  | -     | -    | V     |
|                         | Forward voltage drop                         | V <sub>FM</sub>                        | I <sub>F</sub> = 60 A                                                                        | -    | 2.08  | 2.43 | V     |
|                         |                                              |                                        | I <sub>F</sub> = 60 A, T <sub>J</sub> = 125 °C                                               | -    | 2.05  | 2.3  |       |
| IGBT                    | Collector to emitter breakdown voltage       | BV <sub>CES</sub>                      | V <sub>GE</sub> = 0 V, I <sub>C</sub> = 0.5 mA                                               | 600  | -     | -    | V     |
|                         | Temperature coefficient of breakdown voltage | ΔV <sub>BR(CES)</sub> /ΔT <sub>J</sub> | I <sub>C</sub> = 0.5 mA (25 °C to 125 °C)                                                    | -    | 0.6   | -    | V/°C  |
|                         | Collector to emitter voltage                 | V <sub>CE(on)</sub>                    | V <sub>GE</sub> 15 V, I <sub>C</sub> = 60 A                                                  | -    | 1.93  | 2.29 | V     |
|                         |                                              |                                        | V <sub>GE</sub> = 15 V, I <sub>C</sub> = 60 A, T <sub>J</sub> = 125 °C                       | -    | 2.36  | 2.80 |       |
|                         | Gate threshold voltage                       | V <sub>GE(th)</sub>                    | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 500 μA                                  | 2.9  | -     | 6.0  | V     |
|                         | Collector to emitter leakage current         | I <sub>CES</sub>                       | V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 600 V                                               | -    | -     | 100  | μA    |
|                         |                                              |                                        | V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 600 V, T <sub>J</sub> = 125 °C                      | -    | -     | 2.0  | mA    |
| Gate to emitter leakage | I <sub>GES</sub>                             | V <sub>GE</sub> = ± 20 V               | -                                                                                            | -    | ± 100 | nA   |       |
| FRED Pt chopper diode   | Forward voltage drop                         | V <sub>FM</sub>                        | I <sub>F</sub> = 60 A                                                                        | -    | 2.06  | 2.53 | V     |
|                         |                                              |                                        | I <sub>F</sub> = 60 A, T <sub>J</sub> = 125 °C                                               | -    | 1.83  | 2.26 |       |
|                         | Blocking voltage                             | BV <sub>RM</sub>                       | 0.5 mA                                                                                       | 600  | -     | -    |       |
|                         | Reverse leakage current                      | I <sub>RM</sub>                        | V <sub>RRM</sub> = 600 V                                                                     | -    | -     | 75   | μA    |
|                         |                                              |                                        | V <sub>RRM</sub> = 600 V, T <sub>J</sub> = 125 °C                                            | -    | -     | 0.5  | mA    |
| RECOVERY PARAMETER      |                                              |                                        |                                                                                              |      |       |      |       |
| AP diode                | Peak reverse recovery current                | I <sub>rr</sub>                        | I <sub>F</sub> = 60 A<br>di/dt = 200 A/μs<br>V <sub>R</sub> = 200 V                          | -    | 67    | 11   | A     |
|                         | Reverse recovery time                        | t <sub>rr</sub>                        |                                                                                              | -    | 120   | 160  | ns    |
|                         | Reverse recovery charge                      | Q <sub>rr</sub>                        |                                                                                              | -    | 620   | 850  | nC    |
| FRED Pt chopper diode   | Peak reverse recovery current                | I <sub>rr</sub>                        | I <sub>F</sub> = 60 A<br>di/dt = 200 A/μs<br>V <sub>R</sub> = 200 V                          | -    | 4.5   | 6.0  | A     |
|                         | Reverse recovery time                        | t <sub>rr</sub>                        |                                                                                              | -    | 67    | 85   | ns    |
|                         | Reverse recovery charge                      | Q <sub>rr</sub>                        |                                                                                              | -    | 130   | 250  | nC    |
|                         | Peak reverse recovery current                | I <sub>rr</sub>                        | I <sub>F</sub> = 60 A<br>di/dt = 200 A/μs<br>V <sub>R</sub> = 200 V, T <sub>J</sub> = 125 °C | -    | 9.5   | 12.0 | A     |
|                         | Reverse recovery time                        | t <sub>rr</sub>                        |                                                                                              | -    | 128   | 165  | ns    |
|                         | Reverse recovery charge                      | Q <sub>rr</sub>                        |                                                                                              | -    | 601   | 900  | nC    |

**SWITCHING CHARACTERISTICS** ( $T_J = 25\text{ }^{\circ}\text{C}$  unless otherwise noted)

|          | PARAMETER                     | SYMBOL       | TEST CONDITIONS                                                                                                                                             | MIN. | TYP. | MAX. | UNITS |
|----------|-------------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|-------|
| PFC IGBT | Total gate charge             | $Q_g$        | $I_C = 60\text{ A}$<br>$V_{CC} = 480\text{ V}$<br>$V_{GE} = 15\text{ V}$                                                                                    | -    | 460  | -    | nC    |
|          | Gate to source charge         | $Q_{gs}$     |                                                                                                                                                             | -    | 160  | -    |       |
|          | Gate to drain (Miller) charge | $Q_{gd}$     |                                                                                                                                                             | -    | 70   | -    |       |
|          | Turn-on switching loss        | $E_{on}$     | $I_C = 100\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}$<br>$R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^{\circ}\text{C}$  | -    | 0.2  | -    | mJ    |
|          | Turn-off switching loss       | $E_{off}$    |                                                                                                                                                             | -    | 0.96 | -    |       |
|          | Total switching loss          | $E_{tot}$    |                                                                                                                                                             | -    | 1.16 | -    |       |
|          | Turn-on delay time            | $t_{d(on)}$  |                                                                                                                                                             | -    | 240  | -    | ns    |
|          | Rise time                     | $t_r$        |                                                                                                                                                             | -    | 47   | -    |       |
|          | Turn-off delay time           | $t_{d(off)}$ |                                                                                                                                                             | -    | 240  | -    |       |
|          | Fall time                     | $t_f$        |                                                                                                                                                             | -    | 66   | -    |       |
|          | Turn-on switching loss        | $E_{on}$     | $I_C = 100\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}$<br>$R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^{\circ}\text{C}$ | -    | 0.33 | -    | mJ    |
|          | Turn-off switching loss       | $E_{off}$    |                                                                                                                                                             | -    | 1.45 | -    |       |
|          | Total switching loss          | $E_{tot}$    |                                                                                                                                                             | -    | 1.78 | -    |       |
|          | Turn-on delay time            | $t_{d(on)}$  |                                                                                                                                                             | -    | 246  | -    | ns    |
|          | Rise time                     | $t_r$        |                                                                                                                                                             | -    | 50   | -    |       |
|          | Turn-off delay time           | $t_{d(off)}$ |                                                                                                                                                             | -    | 246  | -    |       |
|          | Fall time                     | $t_f$        |                                                                                                                                                             | -    | 71   | -    |       |
|          | Input capacitance             | $C_{ies}$    | $V_{GE} = 0\text{ V}$<br>$V_{CC} = 30\text{ V}$<br>$f = 1\text{ MHz}$                                                                                       | -    | 9500 | -    | pF    |
|          | Output capacitance            | $C_{oes}$    |                                                                                                                                                             | -    | 780  | -    |       |
|          | Reverse transfer capacitance  | $C_{res}$    |                                                                                                                                                             | -    | 120  | -    |       |

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

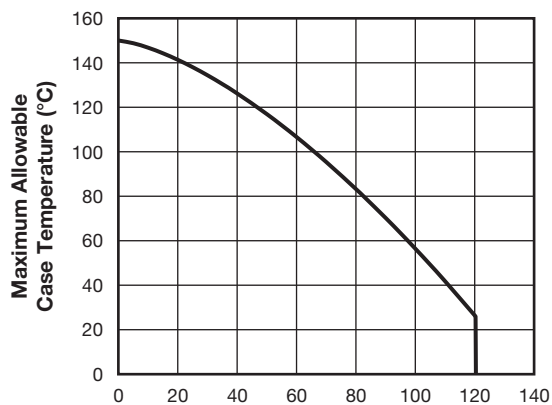
| PARAMETER  | SYMBOL | TEST CONDITIONS                                                     | MIN. | TYP.   | MAX. | UNITS    |
|------------|--------|---------------------------------------------------------------------|------|--------|------|----------|
| Resistance | R      | $T_J = 25\text{ }^{\circ}\text{C}$                                  | -    | 30 000 | -    | $\Omega$ |
| B value    | B      | $T_J = 25\text{ }^{\circ}\text{C}/T_J = 85\text{ }^{\circ}\text{C}$ | -    | 4000   | -    | K        |

**THERMAL AND MECHANICAL SPECIFICATIONS**

|                       | PARAMETER                                             | SYMBOL     | MIN. | TYP. | MAX. | UNITS                       |
|-----------------------|-------------------------------------------------------|------------|------|------|------|-----------------------------|
| AP FRED Pt diode      | Junction to case diode thermal resistance             | $R_{thJC}$ | -    | -    | 4.9  | $^{\circ}\text{C}/\text{W}$ |
| IGBT                  | Junction to case IGBT thermal resistance              |            | -    | -    | 0.27 |                             |
| FRED Pt chopper diode | Junction to case diode thermal resistance             |            | -    | -    | 2.25 |                             |
|                       | Case to sink, flat, greased surface per module        | $R_{thCS}$ | -    | 0.06 | -    | $^{\circ}\text{C}/\text{W}$ |
|                       | Mounting torque $\pm 10\%$ to heatsink <sup>(1)</sup> |            | -    | -    | 4    | Nm                          |
|                       | Approximate weight                                    |            | -    | 65   | -    | g                           |

**Note**

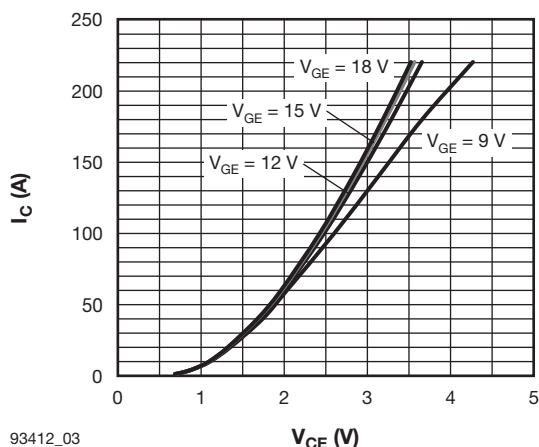
<sup>(1)</sup> A mounting compound is recommended and the torque should be rechecked after a period of 3 hours to allow for the spread of the compound.



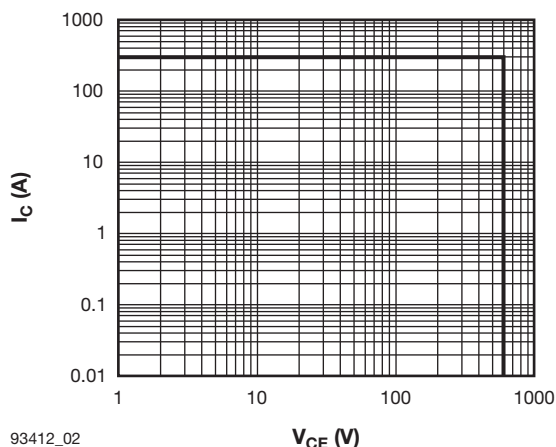
93412\_01

 **$I_C$  - Continuous Collector Current (A)**

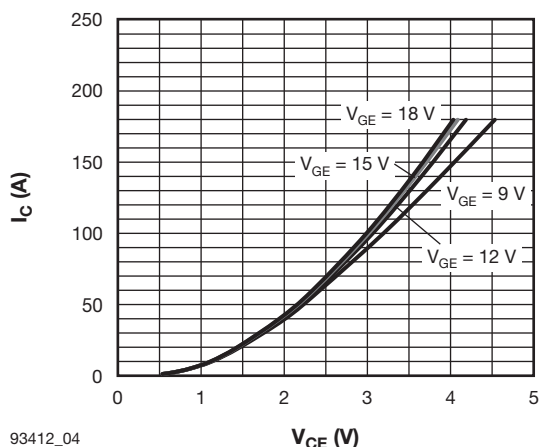
Fig. 1 - Maximum IGBT Continuous Collector Current vs. Case Temperature



93412\_03

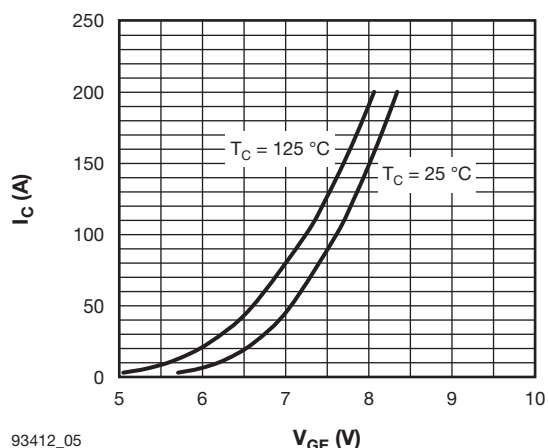
Fig. 3 - Typical IGBT Output Characteristics,  $T_J = 25\text{ }^{\circ}\text{C}$ 

93412\_02

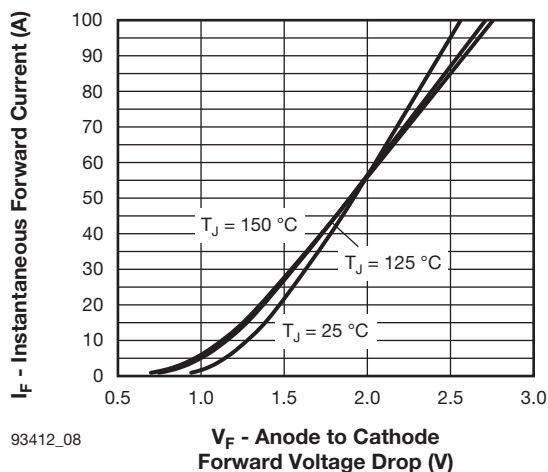
Fig. 2 - IGBT Reverse BIAS SOA  $T_J = 150\text{ }^{\circ}\text{C}$ ,  $V_{GE} = 15\text{ V}$ 

93412\_04

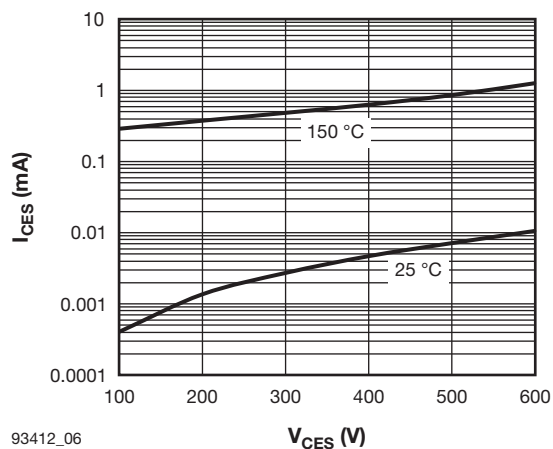
Fig. 4 - Typical IGBT Output Characteristics,  $T_J = 125\text{ }^{\circ}\text{C}$



93412\_05

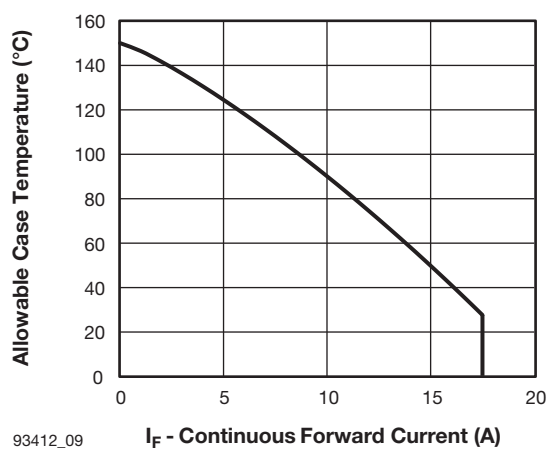
Fig. 5 - Typical IGBT Transfer Characteristics,  $T_J = 125\text{ }^{\circ}\text{C}$ 


93412\_08

Fig. 8 - Typical Diode Forward Voltage Characteristics of Antiparallel Diode,  $t_p = 500\text{ }\mu\text{s}$ 


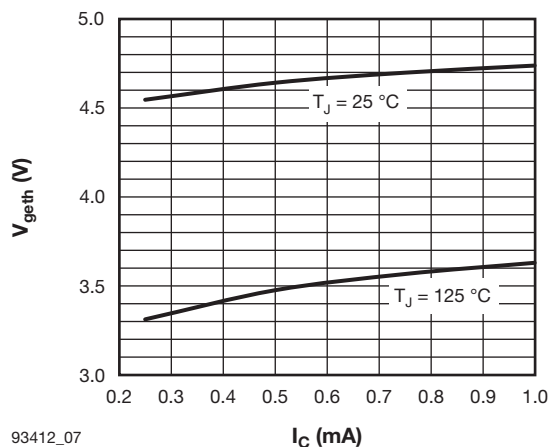
93412\_06

Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current



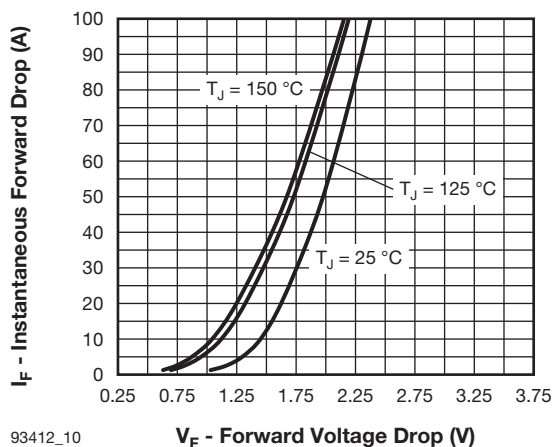
93412\_09

Fig. 9 - Maximum Continuous Forward Current vs. Case Temperature Antiparallel Diode



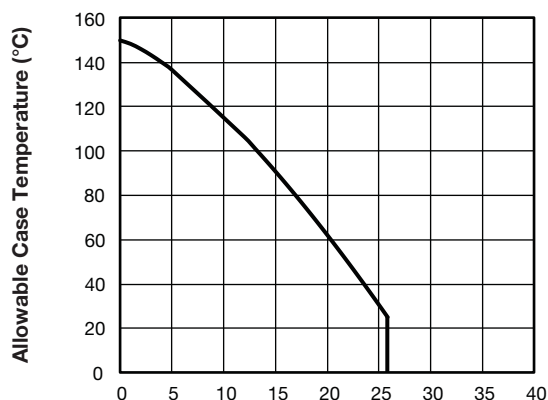
93412\_07

Fig. 7 - Typical IGBT Gate Threshold Voltage



93412\_10

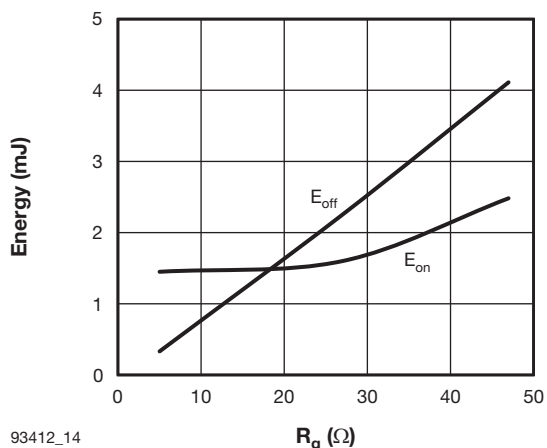
Fig. 10 - Typical PFC Diode Forward Voltage



93412\_11

 **$I_F$  - Continuous Forward Current (A)**

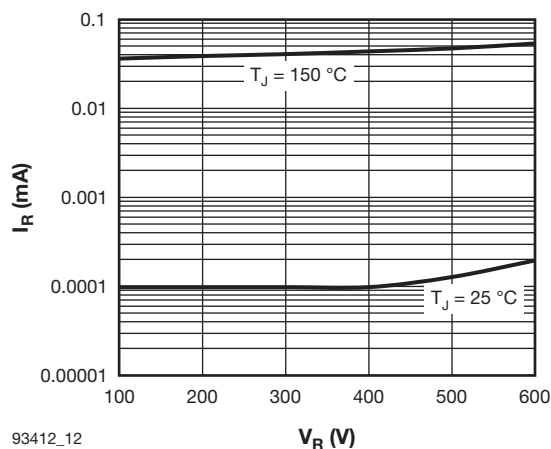
Fig. 11 - Maximum Continuous Forward Current vs. Case Temperature PFC Diode



93412\_14

 **$R_g$  (Ω)**

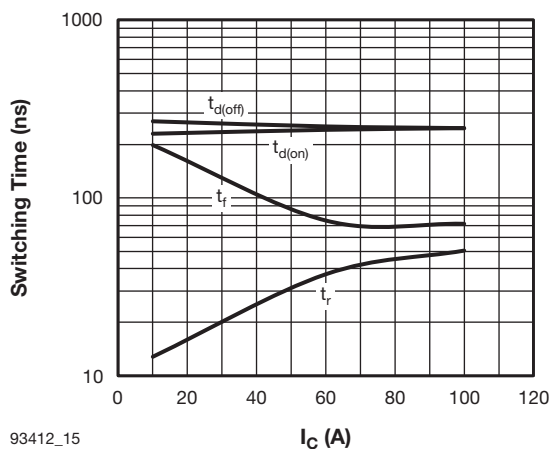
Fig. 14 - Typical IGBT Energy Loss vs.  $R_g$ ,  $T_J = 125^\circ\text{C}$   
 $I_C = 100\text{ A}$ ,  $V_{CC} = 360\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $R_g = 5\text{ }\Omega$



93412\_12

 **$V_R$  (V)**

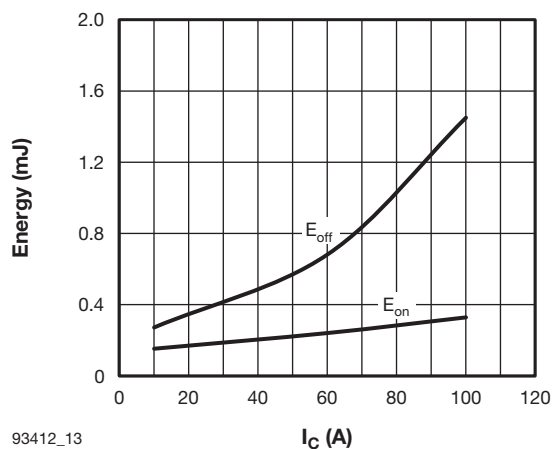
Fig. 12 - Typical FRED Pt Chopper Diode Reverse Current vs. Reverse Voltage



93412\_15

 **$I_C$  (A)**

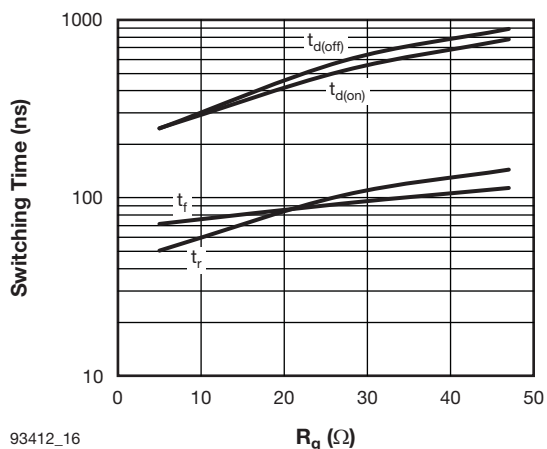
Fig. 15 - Typical IGBT Switching Time vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ,  $V_{DD} = 360\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $R_g = 5\text{ }\Omega$



93412\_13

 **$I_C$  (A)**

Fig. 13 - Typical IGBT Energy Loss vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 360\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $R_g = 5\text{ }\Omega$



93412\_16

 **$R_g$  (Ω)**

Fig. 16 - Typical IGBT Switching Time vs.  $R_g$ ,  $T_J = 125^\circ\text{C}$   
 $I_C = 100\text{ A}$ ,  $V_{CE} = 360\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

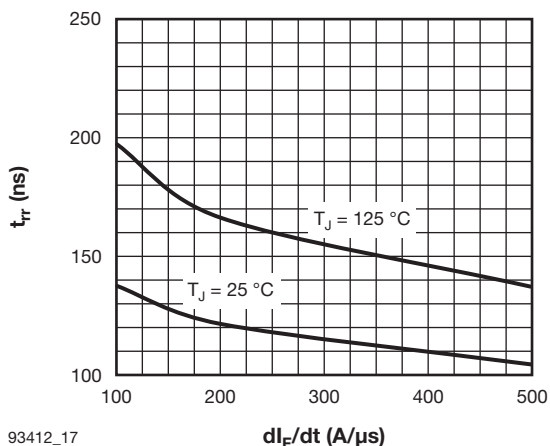


Fig. 17 - Typical  $t_{rr}$  Antiparallel Diode vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 60\text{ A}$

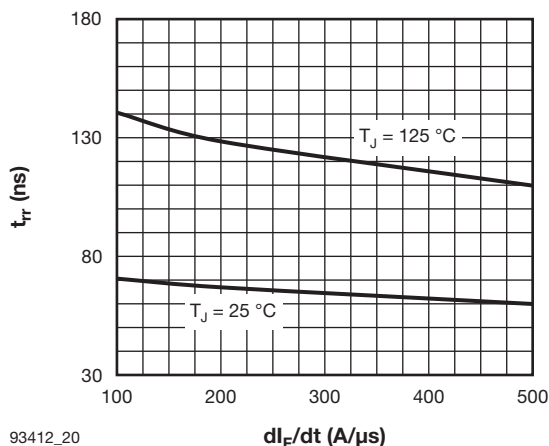


Fig. 20 - Typical  $t_{rr}$  Chopper Diode vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 60\text{ A}$

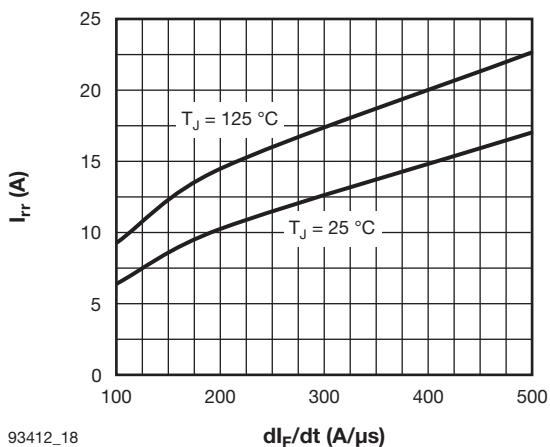


Fig. 18 - Typical  $I_{rr}$  Antiparallel Diode vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 60\text{ A}$

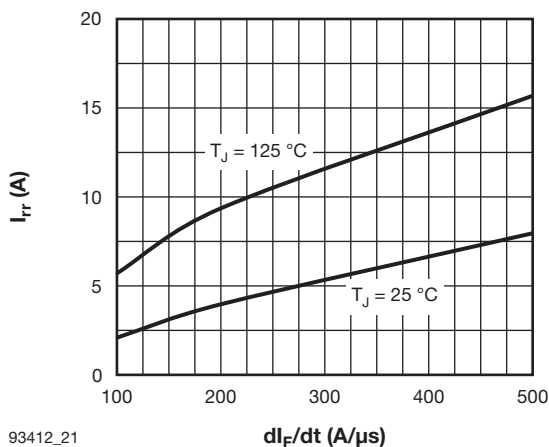


Fig. 21 - Typical  $I_{rr}$  Chopper Diode vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 60\text{ A}$

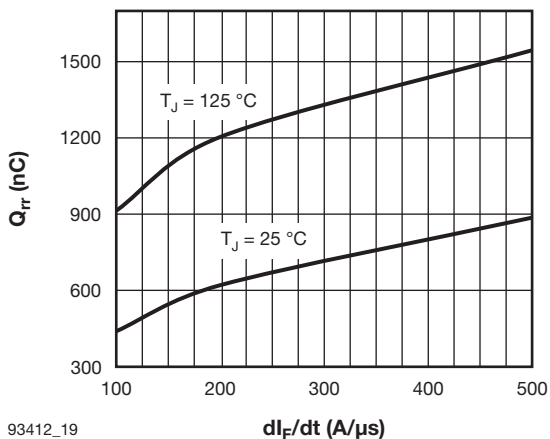


Fig. 19 - Typical  $Q_{rr}$  Antiparallel Diode vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 60\text{ A}$

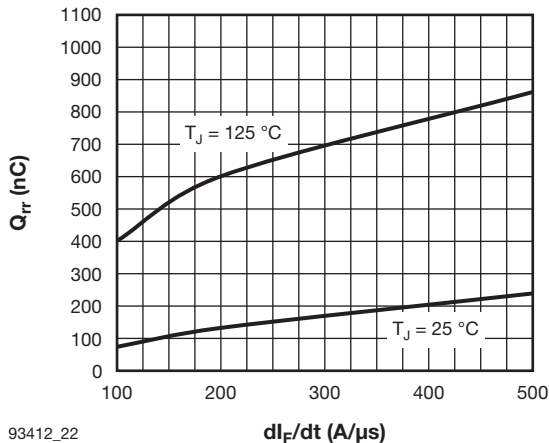


Fig. 22 - Typical  $Q_{rr}$  Chopper Diode vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 40\text{ A}$

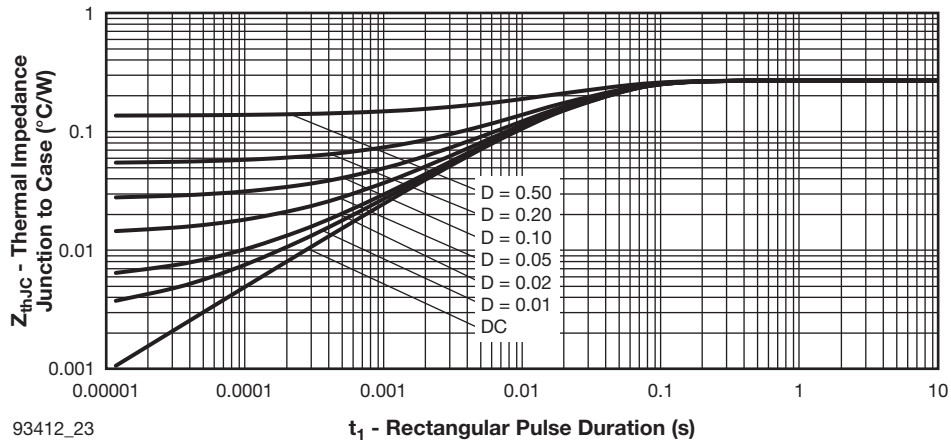


Fig. 23 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (IGBT)

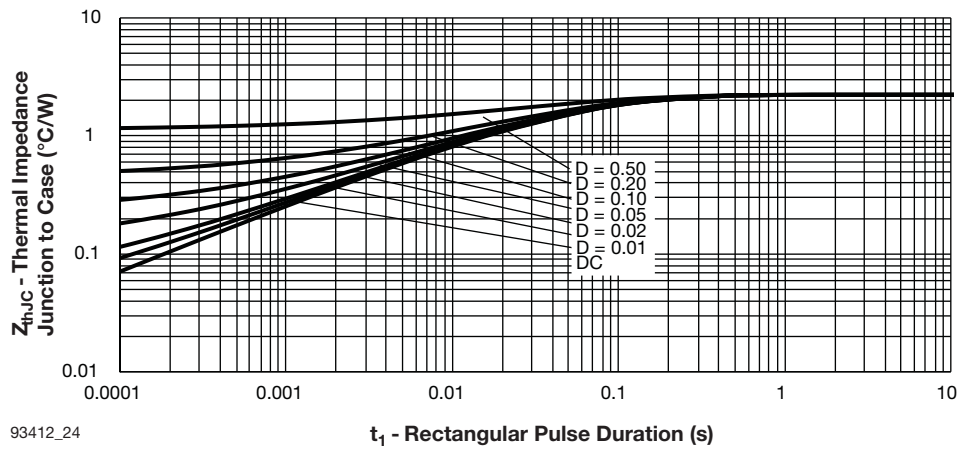


Fig. 24 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (PFC Diode)

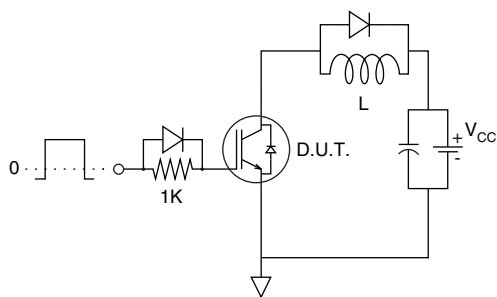


Fig. 25 - Gate Charge Circuit (Turn-Off)

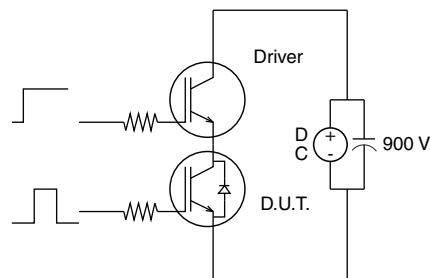


Fig. 27 - S.C. SOA Circuit

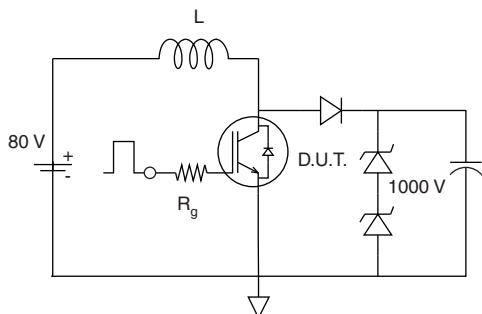


Fig. 26 - RBSOA Circuit

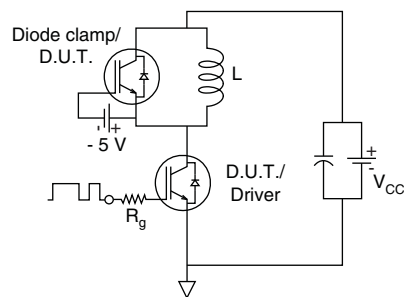


Fig. 28 - Switching Loss Circuit

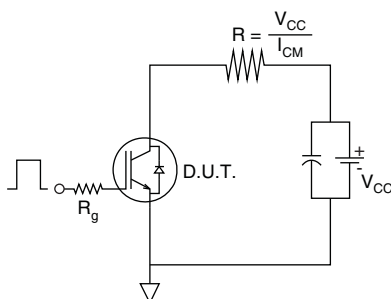
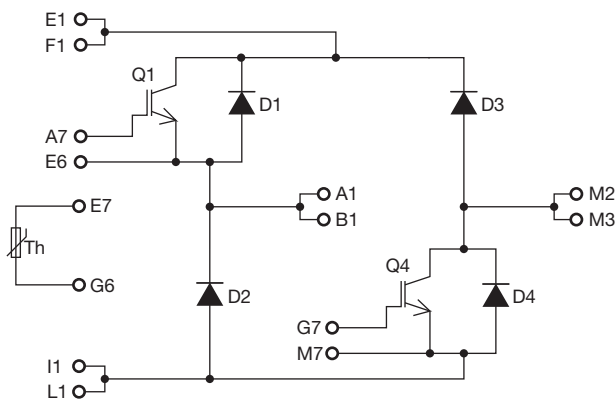


Fig. 29 - Resistive Load Circuit

## CIRCUIT CONFIGURATION







**ORDERING INFORMATION TABLE**

|             |     |     |    |     |   |    |
|-------------|-----|-----|----|-----|---|----|
| Device code | VS- | 100 | MT | 060 | W | DF |
|             | 1   | 2   | 3  | 4   | 5 | 6  |

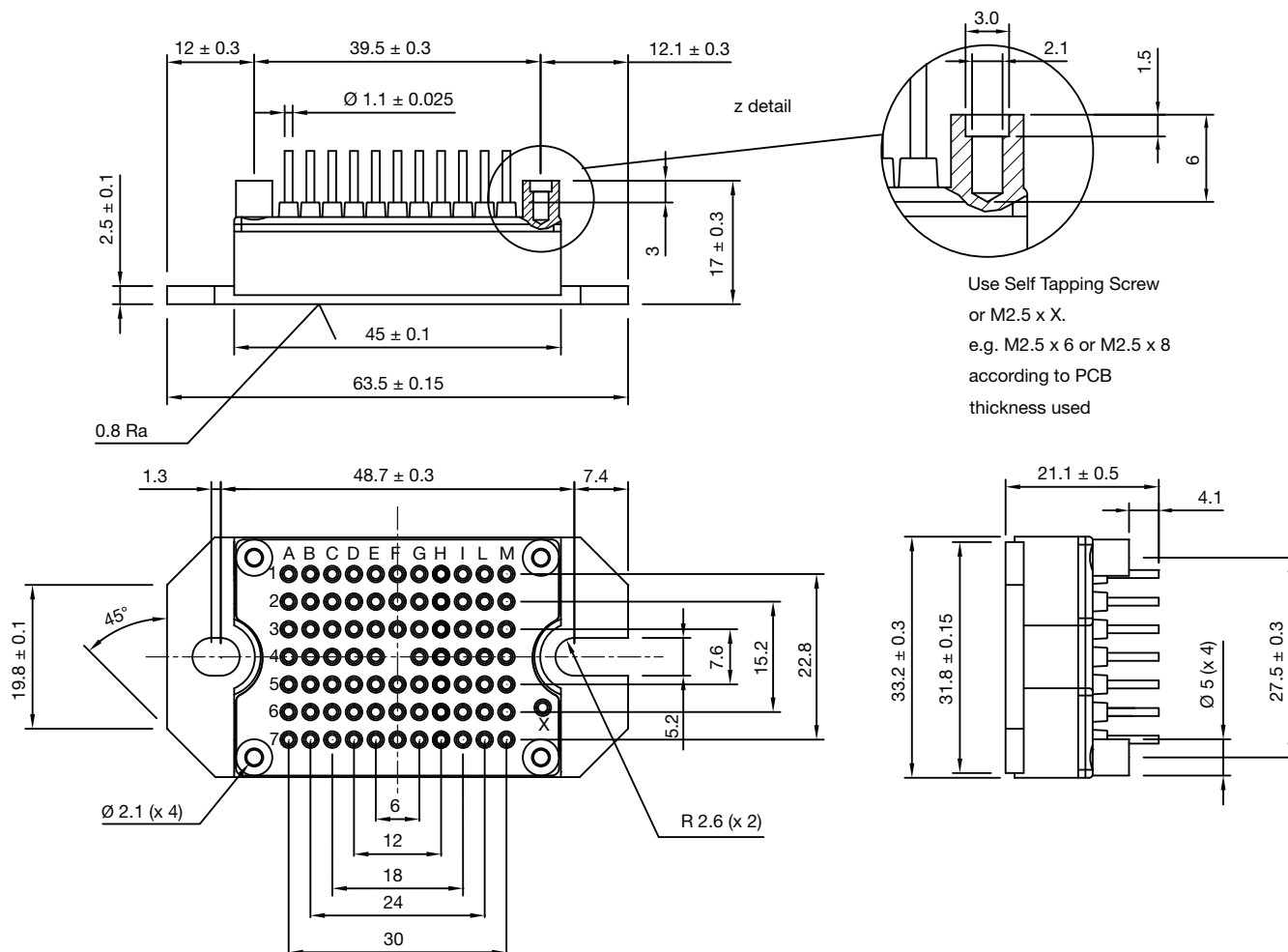
|   |   |                                                           |
|---|---|-----------------------------------------------------------|
| 1 | - | Vishay Semiconductors product                             |
| 2 | - | Current rating (100 = 100 A)                              |
| 3 | - | Essential part number (MT = MTP package)                  |
| 4 | - | Voltage code x 10 = voltage rating (example: 060 = 600 V) |
| 5 | - | Die IGBT technology (W = warp speed IGBT)                 |
| 6 | - | Circuit configuration (DF = dual forward)                 |

| LINKS TO RELATED DOCUMENTS |                                                                        |
|----------------------------|------------------------------------------------------------------------|
| Dimensions                 | <a href="http://www.vishay.com/doc?95383">www.vishay.com/doc?95383</a> |



## 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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