

### PASSIVATED ASSEMBLED CIRCUIT ELEMENTS

#### Features

- Glass passivated junctions for greater reliability
- Electrically isolated base plate
- Available up to 1200 V<sub>RRM</sub>, V<sub>DRM</sub>
- High dynamic characteristics
- Wide choice of circuit configurations
- Simplified mechanical design and assembly
- UL E78996 approved 

40A

#### Description

The P400 series of Integrated Power Circuits consists of power thyristors and power diodes configured in a single package. With its isolating base plate, mechanical designs are greatly simplified giving advantages of cost reduction and reduced size.

Applications include power supplies, control circuits and battery chargers.

#### Major Ratings and Characteristics

| Parameters       | P400        | Units             |
|------------------|-------------|-------------------|
| $I_D$            | 40          | A                 |
| @ T <sub>C</sub> | 80          | °C                |
| $I_{FSM}$ @ 50Hz | 385         | A                 |
| @ 60Hz           | 400         | A                 |
| $I^2t$ @ 50Hz    | 745         | A <sup>2</sup> s  |
| @ 60Hz           | 680         | A <sup>2</sup> s  |
| $I^2\sqrt{t}$    | 7450        | A <sup>2</sup> √s |
| V <sub>RRM</sub> | 400 to 1200 | V                 |
| V <sub>INS</sub> | 2500        | V                 |
| T <sub>J</sub>   | - 40 to 125 | °C                |

## P400 Series

Bulletin I2776 rev. E 04/99

International  
IOR Rectifier

### ELECTRICAL SPECIFICATIONS

#### Voltage Ratings

| Type number      | $V_{RRM}$ maximum repetitive peak reverse voltage<br>V | $V_{RSM}$ maximum non-repetitive peak reverse voltage<br>V | $V_{DRM}$ maximum repetitive peak off-state voltage<br>V | $I_{RRM}$ max.<br>@ $T_J$ max.<br>mA |
|------------------|--------------------------------------------------------|------------------------------------------------------------|----------------------------------------------------------|--------------------------------------|
| P401, P421, P431 | 400                                                    | 500                                                        | 400                                                      | 10                                   |
| P402, P422, P432 | 600                                                    | 700                                                        | 600                                                      |                                      |
| P403, P423, P433 | 800                                                    | 900                                                        | 800                                                      |                                      |
| P404, P424, P434 | 1000                                                   | 1100                                                       | 1000                                                     |                                      |
| P405, P425, P435 | 1200                                                   | 1300                                                       | 1200                                                     |                                      |

#### On-state Conduction

| Parameter                                                                | P400 | Units                  | Conditions                                                                                                                                                                            |
|--------------------------------------------------------------------------|------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_D$ Maximum DC output current                                          | 40   | A                      | @ $T_C = 80^\circ\text{C}$ , full bridge circuits                                                                                                                                     |
| $I_{TSM}$ Max. peak one-cycle non-repetitive on-state or forward current | 385  | A                      | $t = 10\text{ms}$ No voltage<br>$t = 8.3\text{ms}$ reapplied<br>$t = 10\text{ms}$ 100% $V_{RRM}$<br>$t = 8.3\text{ms}$ reapplied<br>Sinusoidal half wave,<br>Initial $T_J = T_J$ max. |
|                                                                          | 400  |                        |                                                                                                                                                                                       |
|                                                                          | 325  |                        |                                                                                                                                                                                       |
|                                                                          | 340  |                        |                                                                                                                                                                                       |
| $I^2t$ Maximum $I^2t$ for fusing                                         | 745  | $\text{A}^2\text{s}$   | $t = 10\text{ms}$ No voltage<br>$t = 8.3\text{ms}$ reapplied<br>$t = 10\text{ms}$ 100% $V_{RRM}$<br>$t = 8.3\text{ms}$ reapplied<br>Initial $T_J = T_J$ max.                          |
|                                                                          | 680  |                        |                                                                                                                                                                                       |
|                                                                          | 530  |                        |                                                                                                                                                                                       |
|                                                                          | 480  |                        |                                                                                                                                                                                       |
| $I^2/t$ Maximum $I^2/t$ for fusing                                       | 7450 | $\text{A}^2/\text{s}$  | $t = 0.1$ to $10\text{ms}$ , no voltage reapplied<br>$I^2t$ for time $t_x = I^2/t \cdot \sqrt{t_x}$                                                                                   |
| $V_{T(TO)1}$ Low value of threshold voltage                              | 0.83 | V                      | $(16.7\% \times \pi \times I_{T(AV)}) < I < \pi \times I_{T(AV)}$ , $T_J = T_J$ max.                                                                                                  |
| $V_{T(TO)2}$ High value of threshold voltage                             | 1.03 |                        | $(I > \pi \times I_{T(AV)})$ , $T_J = T_J$ max.                                                                                                                                       |
| $r_{t1}$ Low level value of on-state slope resistance                    | 9.61 | $\text{m}\Omega$       | $(16.7\% \times \pi \times I_{T(AV)}) < I < \pi \times I_{T(AV)}$ , $T_J = T_J$ max.                                                                                                  |
| $r_{t2}$ High level value of on-state slope resistance                   | 7.01 |                        | $(I > \pi \times I_{T(AV)})$ , $T_J = T_J$ max.                                                                                                                                       |
| $V_{TM}$ Max. peak on-state or forward voltage drop<br>$V_{FM}$          | 1.4  | V                      | $T_J = 25^\circ\text{C}$ , $I_{TM} = \pi \times I_{T(AV)}$<br>$T_J = 25^\circ\text{C}$ , $I_{TM} = \pi \times I_{F(AV)}$                                                              |
| $di/dt$ Maximum non repetitive rate of rise of turned on current         | 200  | $\text{A}/\mu\text{s}$ | $T_J = 125^\circ\text{C}$ from $0.67 V_{DRM}$<br>$I_{TM} = \pi \times I_{T(AV)}$ , $I_g = 500\text{mA}$ , $t_r < 0.5\mu\text{s}$ , $t_p > 6\mu\text{s}$                               |
| $I_H$ Maximum holding current                                            | 130  | mA                     | $T_J = 25^\circ\text{C}$ anode supply = 6V, resistive load                                                                                                                            |
| $I_L$ Maximum latching current                                           | 250  | mA                     | $T_J = 25^\circ\text{C}$ anode supply = 6V, resistive load                                                                                                                            |

### Blocking

| Parameter                                                                                               | P400 | Units      | Conditions                                                                                 |
|---------------------------------------------------------------------------------------------------------|------|------------|--------------------------------------------------------------------------------------------|
| $dv/dt$ Maximum critical rate of rise of off-state voltage                                              | 200  | V/ $\mu$ s | $T_J = 125^\circ\text{C}$ , exponential to $0.67 V_{\text{DRM}}$ gate open                 |
| $I_{\text{RRM}}$ Max. peak reverse and off-state leakage current at $V_{\text{RRM}}$ , $V_{\text{DRM}}$ | 10   | mA         | $T_J = 125^\circ\text{C}$ , gate open circuit                                              |
| $I_{\text{RRM}}$ Max peak reverse leakage current                                                       | 100  | $\mu$ A    | $T_J = 25^\circ\text{C}$                                                                   |
| $V_{\text{INS}}$ RMS isolation voltage                                                                  | 2500 | V          | 50Hz, circuit to base, all terminal shorted,<br>$T_J = 25^\circ\text{C}$ , $t = 1\text{s}$ |

### Triggering

| Parameter                                                  | P400           | Units | Conditions                                                                                                             |
|------------------------------------------------------------|----------------|-------|------------------------------------------------------------------------------------------------------------------------|
| $P_{\text{GM}}$ Maximum peak gate power                    | 8              | W     |                                                                                                                        |
| $P_{\text{G(AV)}}$ Maximum average gate power              | 2              |       |                                                                                                                        |
| $I_{\text{GM}}$ Maximum peak gate current                  | 2              | A     |                                                                                                                        |
| $-V_{\text{GM}}$ Maximum peak negative gate voltage        | 10             | V     | $T_J = -40^\circ\text{C}$<br>$T_J = 25^\circ\text{C}$<br>$T_J = 125^\circ\text{C}$<br>Anode Supply = 6V resistive load |
| $V_{\text{GT}}$ Maximum gate voltage required to trigger   | 3<br>2<br>1    |       |                                                                                                                        |
| $I_{\text{GD}}$ Maximum gate current required to trigger   | 90<br>60<br>35 |       |                                                                                                                        |
| $V_{\text{GD}}$ Maximum gate voltage that will not trigger | 0.2            | V     | $T_J = 125^\circ\text{C}$ , rated $V_{\text{DRM}}$ applied                                                             |
| $I_{\text{GD}}$ Maximum gate current that will not trigger | 2              | mA    | $T_J = 125^\circ\text{C}$ , rated $V_{\text{DRM}}$ applied                                                             |

### Thermal and Mechanical Specification

| Parameter                                                   | P400       | Units            | Conditions                                                                                                                            |
|-------------------------------------------------------------|------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| $T_J$ Max. operating temperature range                      | -40 to 125 | $^\circ\text{C}$ |                                                                                                                                       |
| $T_{\text{stg}}$ Max. storage temperature range             | -40 to 125 |                  |                                                                                                                                       |
| $R_{\text{thJC}}$ Max. thermal resistance, junction to case | 1.05       | K/W              | DC operation per junction                                                                                                             |
| $R_{\text{thCS}}$ Max. thermal resistance, case to heatsink | 0.10       | K/W              | Mounting surface, smooth and greased                                                                                                  |
| T Mounting torque, base to heatsink                         | 4          | Nm               | A mounting compound is recommended and the torque should be checked after a period of 3 hours to allow for the spread of the compound |
| wt Approximate weight                                       | 58 (2.0)   | g (oz)           |                                                                                                                                       |

## P400 Series

Bulletin I2776 rev. E 04/99

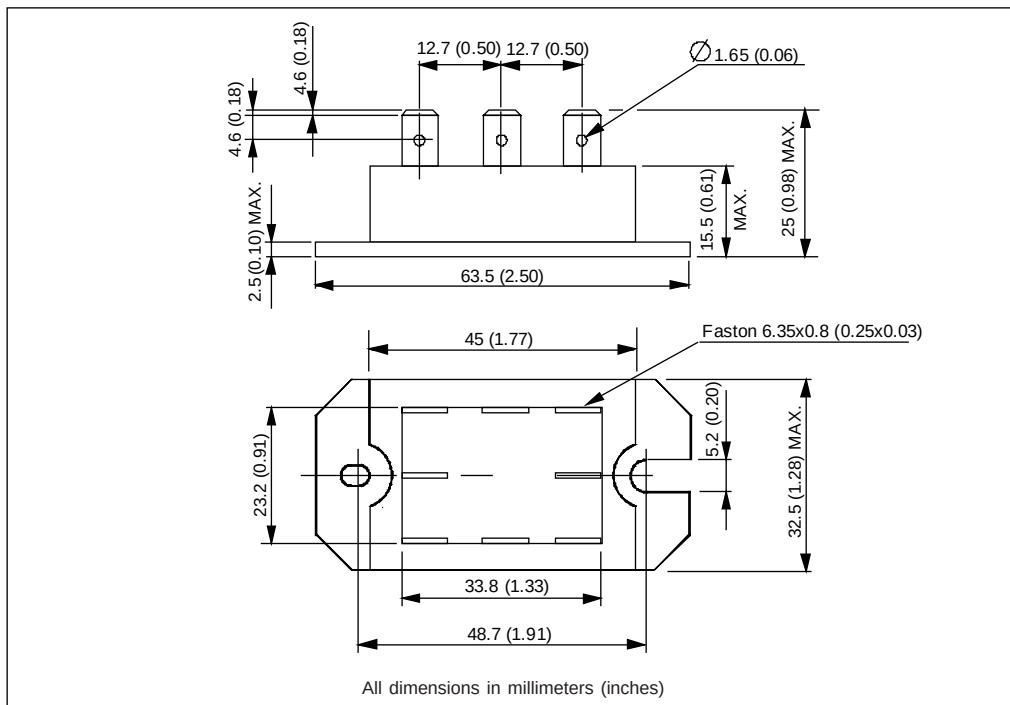
International  
IRF Rectifier

### Circuit Type and Coding \*

|                                                       | Circuit"0" | Circuit"2" | Circuit"3" |
|-------------------------------------------------------|------------|------------|------------|
| Terminal Positions                                    |            |            |            |
| Schematic diagram                                     |            |            |            |
| Basic series                                          | P40.       | P42.       | P43.       |
| With voltage suppression                              | P40.K      | P42.K      | P43.K      |
| With free-wheeling diode                              | P40.W      | -          | -          |
| With both voltage suppression and free-wheeling diode | P40.KW     | -          | -          |

\* To complete code refer to voltage ratings table, i.e.: for 600V P410.W complete code is P402W

### Outline Table



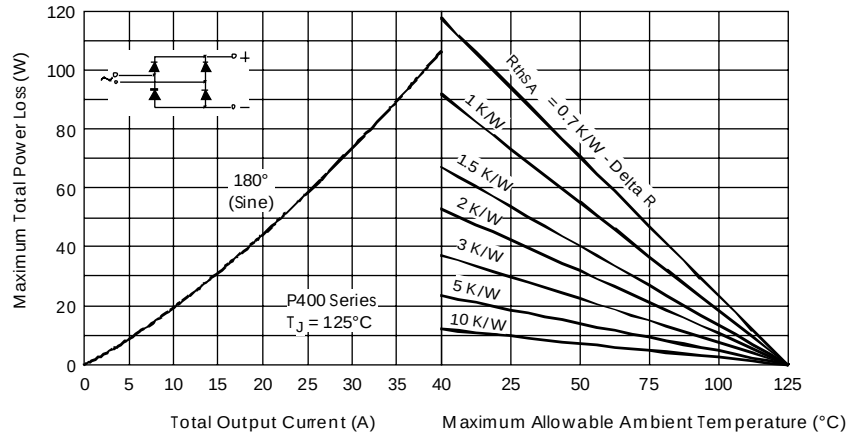


Fig. 1 - Current Ratings Nomogram (1 Module Per Heatsink)

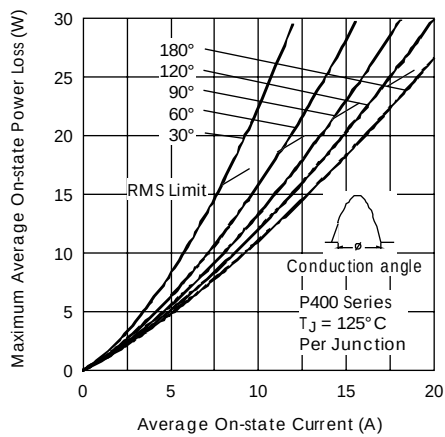


Fig. 2 - On-state Power Loss Characteristics

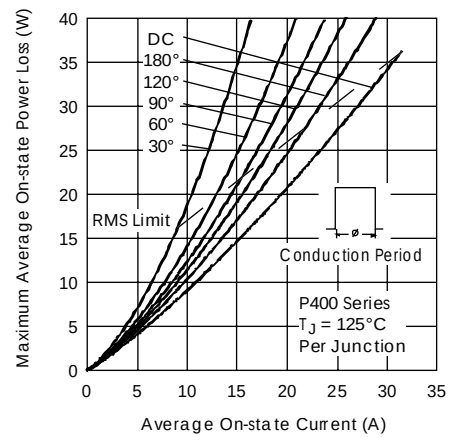


Fig. 3 - On-state Power Loss Characteristics

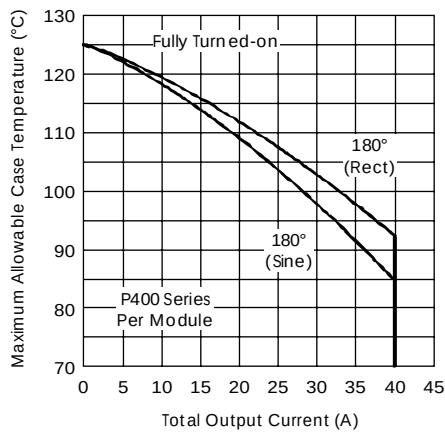


Fig. 4 - Current Ratings Characteristics

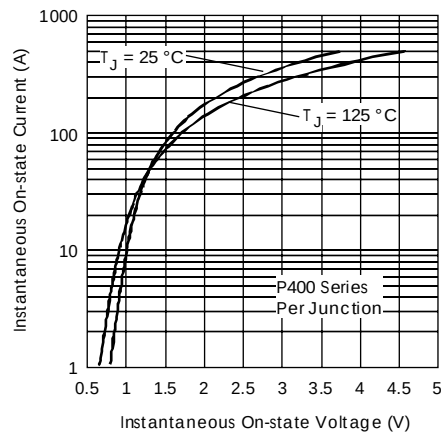


Fig. 5 - On-state Voltage Drop Characteristics

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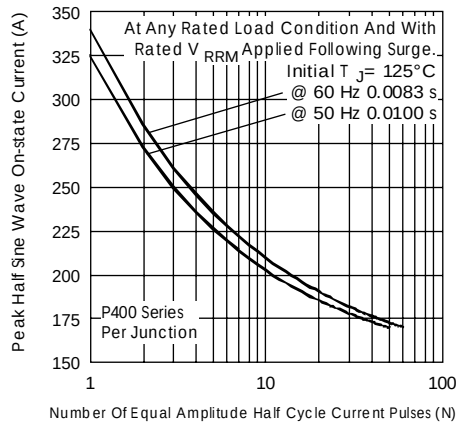


Fig. 6 - Maximum Non-Repetitive Surge Current

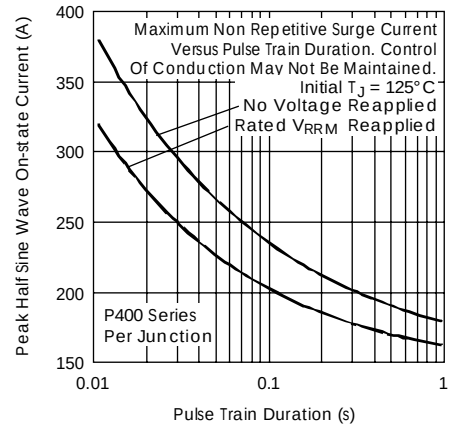


Fig. 7 - Maximum Non-Repetitive Surge Current

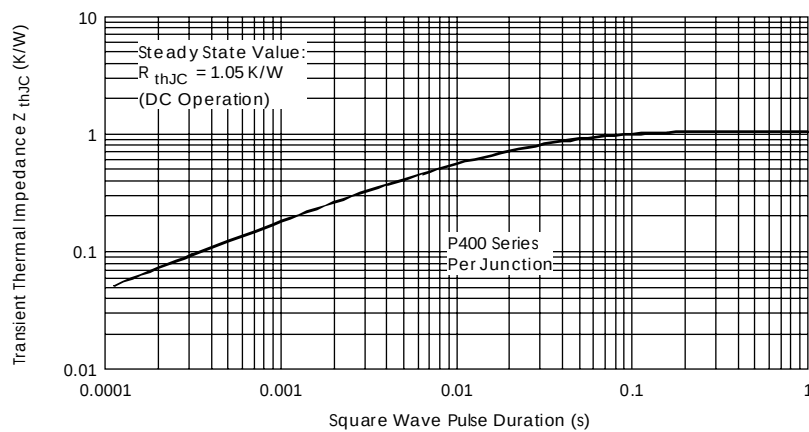


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristics

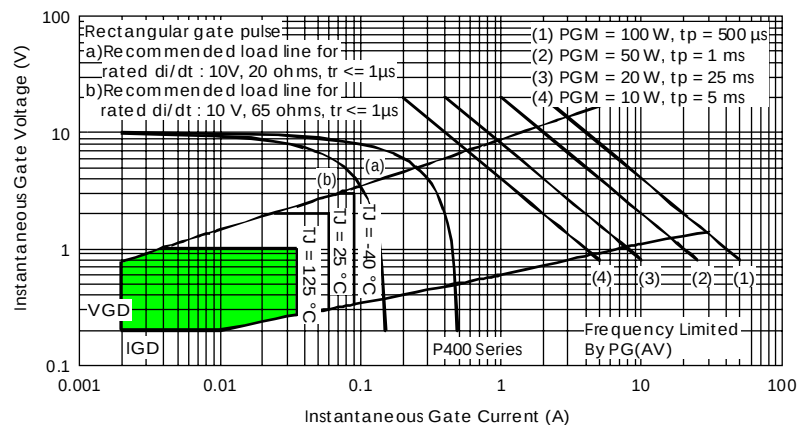


Fig. 9 - Gate Characteristics

