

## 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 <sub>D</sub>                     | 40          | A                 |
| @ T <sub>C</sub>                   | 85          | °C                |
| I <sub>FSM</sub> @ 50Hz            | 385         | A                 |
| @ 60Hz                             | 400         | A                 |
| I <sup>2</sup> <sub>t</sub> @ 50Hz | 745         | A <sup>2</sup> s  |
| @ 60Hz                             | 680         | A <sup>2</sup> s  |
| I <sup>2</sup> /t                  | 7450        | A <sup>2</sup> /s |
| V <sub>RRM</sub> range             | 400 to 1200 | V                 |
| V <sub>INS</sub>                   | 2500        | V                 |
| T <sub>J</sub>                     | -40 to 125  | °C                |



## 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 |
|------------------------------------------|--------------------------------------------------------|------------------------------------------------------------|----------------------------------------------------------|
| P401, P411, P421, P431, P441, P461, P471 | 400                                                    | 500                                                        | 400                                                      |
| P402, P412, P422, P432, P442, P462, P472 | 600                                                    | 700                                                        | 600                                                      |
| P403, P413, P423, P433, P443, P463, P473 | 800                                                    | 900                                                        | 800                                                      |
| P404, P414, P424, P434, P444, P464, P474 | 1000                                                   | 1100                                                       | 1000                                                     |
| P405, P415, P425, P435, P445, P465, P475 | 1200                                                   | 1300                                                       | 1200                                                     |

## On-state Conduction

| Parameters                 |                                                                   | P400 | Units   | Conditions                                                                                                                       |                |                                                   |
|----------------------------|-------------------------------------------------------------------|------|---------|----------------------------------------------------------------------------------------------------------------------------------|----------------|---------------------------------------------------|
| $I_D$                      | Maximum DC output Current                                         | 40   | A       | @ $T_C = 85^\circ\text{C}$ , full bridge circuits 0,1,2 and 3                                                                    |                |                                                   |
| $I_{T(AV)}$<br>$I_{F(AV)}$ | Maximum average on-state and forward current                      | 20   | A       | 180° sine conduction circuits 6, 7                                                                                               |                |                                                   |
| $I_{RMS}$                  | Maximum RMS current                                               | 44   | A       | 180° sine conduction circuit 4                                                                                                   |                |                                                   |
| $I_{TSM}$<br>$I_{FSM}$     | Maximum peak one-cycle non repetitive on-state or forward current | 385  | A       | 10ms                                                                                                                             | No voltage     | Sinusoidal half Wave<br>Initial $T_J = T_{J,max}$ |
|                            |                                                                   | 400  | A       | 8.3ms                                                                                                                            | reapplied      |                                                   |
|                            |                                                                   | 325  | A       | 10ms                                                                                                                             | 100% $V_{RRM}$ | Sinusoidal half Wave<br>Initial $T_J = T_{J,max}$ |
|                            |                                                                   | 340  | A       | 8.3ms                                                                                                                            | reapplied      |                                                   |
| $i^2t$                     | Maximum $i^2t$ for fusing                                         | 745  | $A^2s$  | 10ms                                                                                                                             | No voltage     | Initial $T_J = T_{J,max}$                         |
|                            |                                                                   | 680  | $A^2s$  | 8.3ms                                                                                                                            | reapplied      |                                                   |
|                            |                                                                   | 530  | $A^2s$  | 10ms                                                                                                                             | 100% voltage   | Initial $T_J = T_{J,max}$                         |
|                            |                                                                   | 480  | $A^2s$  | 8.3ms                                                                                                                            | reapplied      |                                                   |
| $i^2/t$                    | Maximum $i^2/t$ for fusing                                        | 7450 | $A^2/s$ | t=0 to 10ms, no voltage reapplied<br>$i^2t$ for time tx = $i^2/t \cdot \sqrt{tx}$                                                |                |                                                   |
| $V_{T(TO)}$                | Maximum value of threshold voltage                                | 0.85 | V       | $T_J = 125^\circ\text{C}$                                                                                                        |                |                                                   |
| $r_t$                      | Maximum value of on-state or forward slope resistance             | 7.89 | mΩ      | $T_J = 125^\circ\text{C}$ , Av. power = $V_{T(TO)} \cdot I_{T(AV)} + r_t \cdot (I_{T(RSM)})^2$                                   |                |                                                   |
| $V_{TM}$                   | Maximum peak on-state or forward voltage drop                     | 1.35 | V       | $T_J = 25^\circ\text{C}$ $I_{TM} = \pi \times I_{T(AV)}$                                                                         |                |                                                   |
| $V_{FM}$                   |                                                                   | 1.35 | V       | $T_J = 25^\circ\text{C}$ $I_{FM} = \pi \times I_{F(AV)}$                                                                         |                |                                                   |
| $di/dt$                    | Maximum non repetitive rate of rise of turned on current          | 200  | A/μs    | $T_J = 125^\circ\text{C}$ from 0.67 $V_{DRM}$<br>$I_{TM} = \pi \times I_{T(AV)}$ , $I_g = 500\text{mA}$ , tr < 0.5 μs, tp > 6 μs |                |                                                   |
| $I_H$                      | Maximum holding current                                           | 100  | mA      | $T_J = 25^\circ\text{C}$ anode supply=6V, resistive load, gate open                                                              |                |                                                   |
| $I_L$                      | Maximum latching current                                          | 250  | mA      | $T_J = 25^\circ\text{C}$ anode supply=6V, resistive load.                                                                        |                |                                                   |

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Blocking

| Parameters                                                                                              | 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                     |
| $I_{\text{RRM}}$ Maximum 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 terminals shorted<br>$T_J = 25^\circ\text{C}$ , $t = 1 \text{ s}$ |

Triggering

| Parameters                                                 | P400 | Units | Conditions                                               |
|------------------------------------------------------------|------|-------|----------------------------------------------------------|
| $P_{\text{GM}}$ Maximum peak gate power                    | 8.0  | W     |                                                          |
| $P_{\text{G(AV)}}$ Maximum average gate power              | 2.0  | W     |                                                          |
| $I_{\text{GM}}$ Maximum peak gate current                  | 2.0  | A     |                                                          |
| $-V_{\text{GM}}$ Maximum peak negative gate voltage        | 10   | V     |                                                          |
| $V_{\text{GT}}$ Maximum gate voltage required to trigger   | 3.0  | V     | $T_J=-40^\circ\text{C}$                                  |
|                                                            | 2.0  | V     | $T_J = 25^\circ\text{C}$                                 |
|                                                            | 1.0  | V     | $T_J=125^\circ\text{C}$                                  |
| $I_{\text{GT}}$ Maximum gate current required to trigger   | 90   | mA    | $T_J=-40^\circ\text{C}$                                  |
|                                                            | 60   | mA    | $T_J = 25^\circ\text{C}$                                 |
|                                                            | 35   | mA    | $T_J=125^\circ\text{C}$                                  |
| $V_{\text{GD}}$ 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 | 2.0  | mA    | $T_J=125^\circ\text{C}$ , rated $V_{\text{DRM}}$ applied |

Thermal and Mechanical Specifications

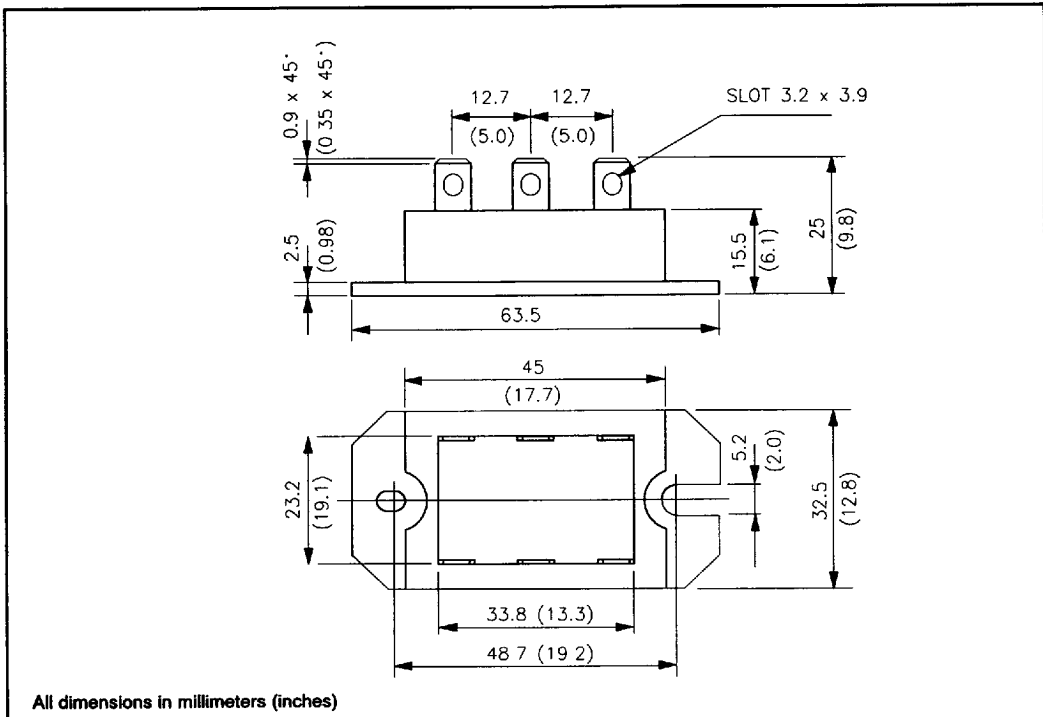
| Parameters                                                     | P400       | Units            | Conditions                                                                                                                             |
|----------------------------------------------------------------|------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| $T_J$ Junction temperature range                               | -40 to 125 | $^\circ\text{C}$ |                                                                                                                                        |
| $T_{\text{stg}}$ Storage temperature range                     | -40 to 150 | $^\circ\text{C}$ |                                                                                                                                        |
| $R_{\text{thJC}}$ Maximum thermal resistance, junction to case | 1.05       | K/W              | DC operation per junction                                                                                                              |
| $R_{\text{thCS}}$ Maximum thermal resistance                   | 0.10       | K/W              | Mounting surface smooth and greased per module 0,1,2,3                                                                                 |
|                                                                | 0.20       | K/W              | Mounting surface smooth and greased per module 4,6,7                                                                                   |
| T Mounting torque, base to heatsink $\pm 10\%$                 | 5          | 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)           |                                                                                                                                        |

## Circuit Type and Coding \*

|                                                              | Circuit*0" | Circuit*1" | Circuit*2" | Circuit*3" | Circuit*4" | Circuit*6" | Circuit*7" |
|--------------------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|
| <b>Terminal Positions</b>                                    |            |            |            |            |            |            |            |
| <b>Schematic diagram</b>                                     |            |            |            |            |            |            |            |
| <b>Basic series</b>                                          | P40.       | P41.       | P42.       | P43.       | P44.       | P46.       | P47.       |
| <b>With voltage suppression</b>                              | P40.K      | P41.K      | P42.K      | P43.K      | P44.K      | -          | -          |
| <b>With free-wheeling diode</b>                              | P40.W      | 41.W       | -          | -          | -          | -          | -          |
| <b>With both voltage suppression and free-wheeling diode</b> | P40.KW     | P41.KW     | -          | -          | -          | -          | -          |

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

## Outline Table



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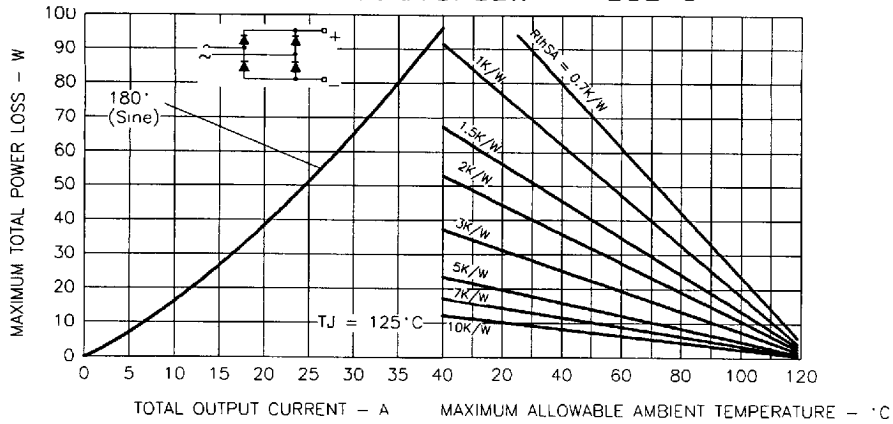


Fig. 1 - Current Rating Nomogram (1 Module Per Heatsink), Circuits '0', '1', '2', '3'

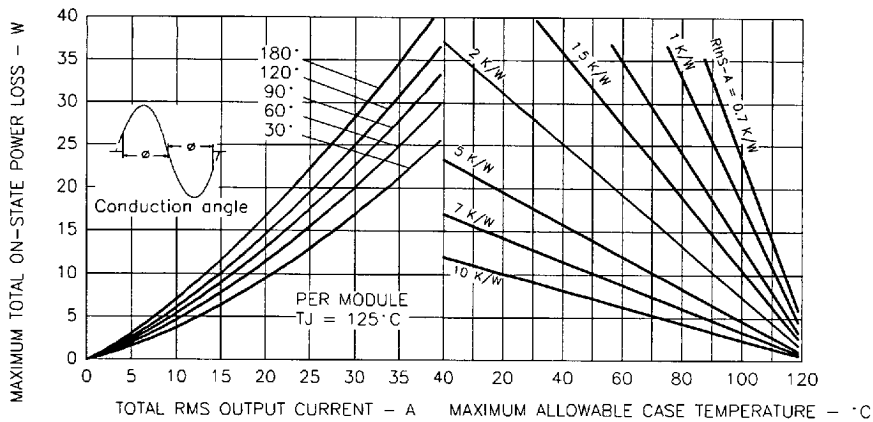


Fig. 2 - Current Rating Nomogram (1 Module Per Heatsink), Circuit '4'

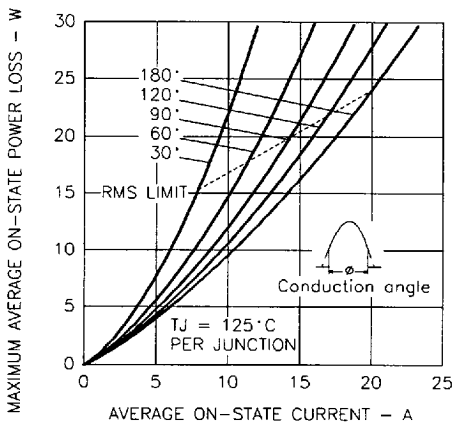


Fig. 3 - On-state Power Loss Characteristics

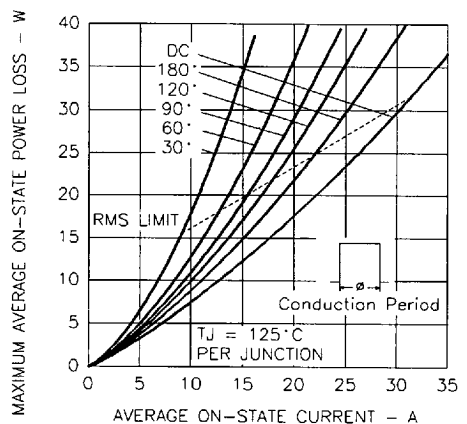


Fig. 4 - On-state Power Loss Characteristics

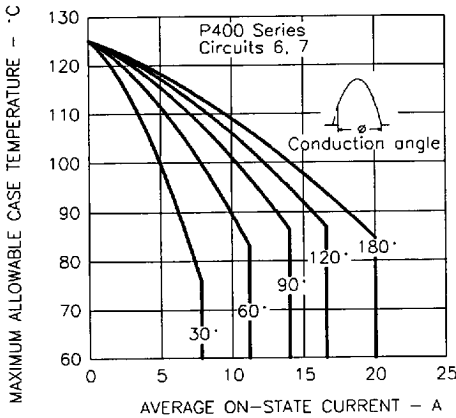


Fig. 5 - Current Ratings Characteristics

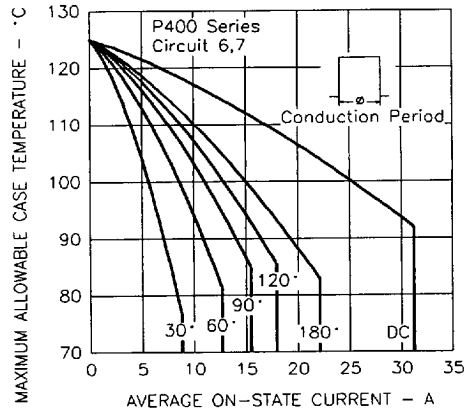


Fig. 6 - Current Ratings Characteristics

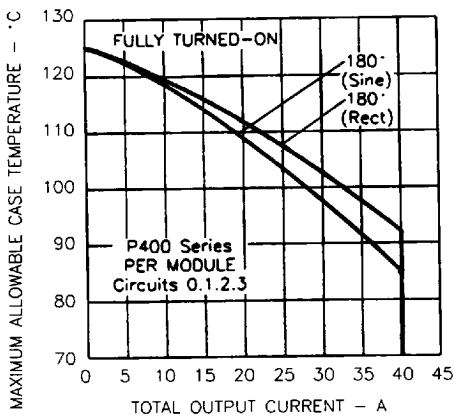


Fig. 7 - Current Ratings Characteristics

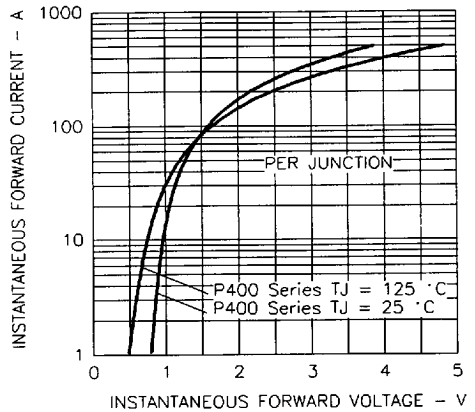


Fig. 8 - On-state Voltage Drop Characteristics

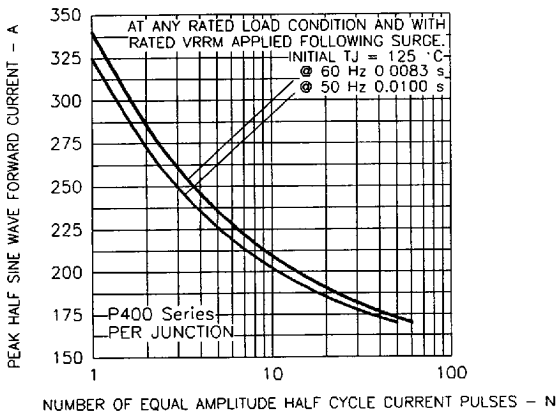


Fig. 9 - Maximum Non-Repetitive Surge Current

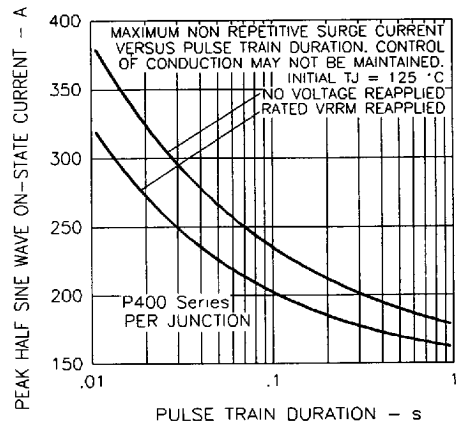


Fig. 10 - Maximum Non-Repetitive Surge Current

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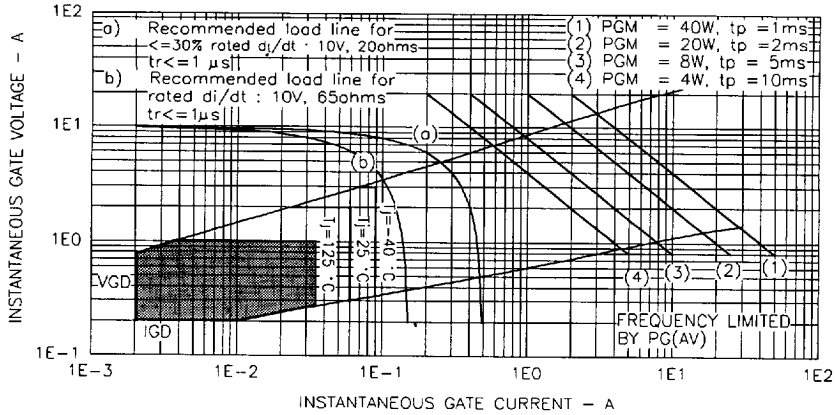


Fig. 11 - Gate Characteristics

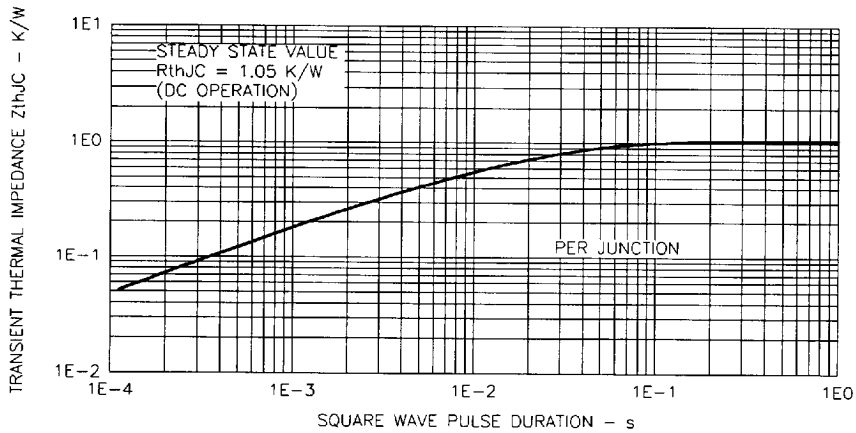


Fig. 12 - Thermal Impedance  $Z_{thJC}$  Characteristics