

### Passivated Assembled Circuit Elements, 40 A



PACE-PAK (D-19)

#### FEATURES

- Glass passivated junctions for greater reliability
- Electrically isolated base plate
- Available up to 1200  $V_{RRM}/V_{DRM}$
- High dynamic characteristics
- Wide choice of circuit configurations
- Simplified mechanical design and assembly
- UL E78996 approved
- RoHS compliant



#### 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.

#### PRODUCT SUMMARY

|       |      |
|-------|------|
| $I_D$ | 40 A |
|-------|------|

#### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER     | CHARACTERISTICS | VALUES      | UNITS             |
|---------------|-----------------|-------------|-------------------|
| $I_D$         | 80 °C           | 40          | A                 |
| $I_{FSM}$     | 50 Hz           | 385         | A                 |
|               | 60 Hz           | 400         |                   |
| $I^2t$        | 50 Hz           | 745         | A <sup>2</sup> s  |
|               | 60 Hz           | 680         |                   |
| $I^2\sqrt{t}$ |                 | 7450        | A <sup>2</sup> √s |
| $V_{RRM}$     | Range           | 400 to 1200 | V                 |
| $V_{ISOL}$    |                 | 2500        | V                 |
| $T_J$         |                 | - 40 to 125 | °C                |

#### ELECTRICAL SPECIFICATIONS

##### VOLTAGE RATINGS

| TYPE NUMBER      | $V_{RRM}/V_{DRM}$ , MAXIMUM REPETITIVE PEAK REVERSE AND PEAK OFF-STATE VOLTAGE<br>V | $V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK REVERSE VOLTAGE<br>V | $I_{RRM}$ MAXIMUM AT $T_J$ MAXIMUM<br>mA |
|------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------|------------------------------------------|
| P401, P421, P431 | 400                                                                                 | 500                                                          | 10                                       |
| P402, P422, P432 | 600                                                                                 | 700                                                          |                                          |
| P403, P423, P433 | 800                                                                                 | 900                                                          |                                          |
| P404, P424, P434 | 1000                                                                                | 1100                                                         |                                          |
| P405, P425, P435 | 1200                                                                                | 1300                                                         |                                          |



| ON-STATE CONDUCTION                                                |                          |                                                                                                                                                                      |                            |                                                      |                   |
|--------------------------------------------------------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|------------------------------------------------------|-------------------|
| PARAMETER                                                          | SYMBOL                   | TEST CONDITIONS                                                                                                                                                      |                            | VALUES                                               | UNITS             |
| Maximum DC output current at case temperature                      | $I_D$                    | Full bridge circuits                                                                                                                                                 |                            | 40                                                   | A                 |
|                                                                    |                          |                                                                                                                                                                      |                            | 80                                                   | °C                |
| Maximum peak, one-cycle non-repetitive on-state or forward current | $I_{TSM}$ ,<br>$I_{FSM}$ | t = 10 ms                                                                                                                                                            | No voltage reappplied      | Sinusoidal half wave,<br>initial $T_J = T_J$ maximum | A                 |
|                                                                    |                          | t = 8.3 ms                                                                                                                                                           |                            |                                                      |                   |
|                                                                    |                          | t = 10 ms                                                                                                                                                            | 100 % $V_{RRM}$ reappplied |                                                      |                   |
|                                                                    |                          | t = 8.3 ms                                                                                                                                                           |                            |                                                      |                   |
| Maximum $I^2t$ for fusing                                          | $I^2t$                   | t = 10 ms                                                                                                                                                            | No voltage reappplied      | Sinusoidal half wave,<br>initial $T_J = T_J$ maximum | A <sup>2</sup> s  |
|                                                                    |                          | t = 8.3 ms                                                                                                                                                           |                            |                                                      |                   |
|                                                                    |                          | t = 10 ms                                                                                                                                                            | 100 % $V_{RRM}$ reappplied |                                                      |                   |
|                                                                    |                          | t = 8.3 ms                                                                                                                                                           |                            |                                                      |                   |
| Maximum $I^2\sqrt{t}$ for fusing                                   | $I^2\sqrt{t}$            | t = 0.1 to 10 ms, no voltage reappplied<br>$I^2t$ for time $t_x = I^2\sqrt{t} \cdot \sqrt{t_x}$                                                                      |                            | 7450                                                 | A <sup>2</sup> √s |
| Low level value of threshold voltage                               | $V_{T(TO)1}$             | $(16.7\% \times \pi \times I_{T(AV)}) < I < \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum                                                                              |                            | 0.83                                                 | V                 |
| High level value of threshold voltage                              | $V_{T(TO)2}$             | $I > \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum                                                                                                                     |                            | 1.03                                                 |                   |
| Low level value of on-state slope resistance                       | $r_{\theta 1}$           | $(16.7\% \times \pi \times I_{T(AV)}) < I < \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum                                                                              |                            | 9.61                                                 | mΩ                |
| High level value of on-state slope resistance                      | $r_{\theta 2}$           | $I > \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum                                                                                                                     |                            | 7.01                                                 |                   |
| Maximum on-state voltage drop                                      | $V_{TM}$                 | $I_{TM} = \pi \times I_{T(AV)}$ , $T_J = 25\text{ °C}$                                                                                                               |                            | 1.4                                                  | V                 |
| Maximum forward voltage drop                                       | $V_{FM}$                 | $I_{TM} = \pi \times I_{T(AV)}$ , $T_J = 25\text{ °C}$                                                                                                               |                            | 1.4                                                  | V                 |
| Maximum non-repetitive rate of rise of turned-on current           | dI/dt                    | $T_J = 125\text{ °C}$ from 0.67 $V_{DRM}$<br>$I_{TM} = \pi \times I_{T(AV)}$ , $I_g = 500\text{ mA}$ , $t_r < 0.5\text{ }\mu\text{s}$ , $t_p > 6\text{ }\mu\text{s}$ |                            | 200                                                  | A/μs              |
| Maximum holding current                                            | $I_H$                    | $T_J = 25\text{ °C}$ anode supply = 6 V, resistive load                                                                                                              |                            | 130                                                  | mA                |
| Maximum latching current                                           | $I_L$                    |                                                                                                                                                                      |                            | 250                                                  |                   |

| BLOCKING                                                                    |                          |                                                                                  |  |        |       |
|-----------------------------------------------------------------------------|--------------------------|----------------------------------------------------------------------------------|--|--------|-------|
| PARAMETER                                                                   | SYMBOL                   | TEST CONDITIONS                                                                  |  | VALUES | UNITS |
| Maximum critical rate of rise of off-state voltage                          | dV/dt                    | $T_J = 125\text{ °C}$ , exponential to 0.67 $V_{DRM}$ gate open                  |  | 200    | V/μs  |
| Maximum peak reverse and off-state leakage current at $V_{RRM}$ , $V_{DRM}$ | $I_{RRM}$ ,<br>$I_{DRM}$ | $T_J = 125\text{ °C}$ , gate open circuit                                        |  | 10     | mA    |
| Maximum peak reverse leakage current                                        | $I_{RRM}$                | $T_J = 25\text{ °C}$                                                             |  | 100    | μA    |
| RMS isolation voltage                                                       | $V_{ISOL}$               | 50 Hz, circuit to base, all terminals shorted,<br>$T_J = 25\text{ °C}$ , t = 1 s |  | 2500   | V     |

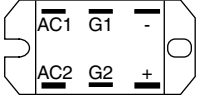
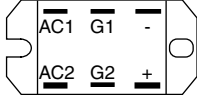
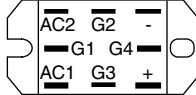
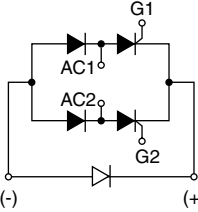
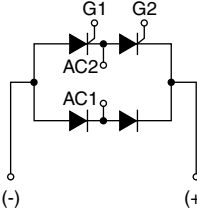
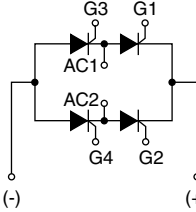


| <b>TRIGGERING</b>                          |             |                                                 |                                      |        |       |
|--------------------------------------------|-------------|-------------------------------------------------|--------------------------------------|--------|-------|
| PARAMETER                                  | SYMBOL      | TEST CONDITIONS                                 |                                      | VALUES | UNITS |
| Maximum peak gate power                    | $P_{GM}$    |                                                 |                                      | 8      | W     |
| Maximum average gate power                 | $P_{G(AV)}$ |                                                 |                                      | 2      |       |
| Maximum peak gate current                  | $I_{GM}$    |                                                 |                                      | 2      | A     |
| Maximum peak negative gate voltage         | $-V_{GM}$   |                                                 |                                      | 10     | V     |
| Maximum gate voltage required to trigger   | $V_{GT}$    | $T_J = -40\text{ °C}$                           | Anode supply =<br>6 V resistive load | 3      | V     |
|                                            |             | $T_J = 25\text{ °C}$                            |                                      | 2      |       |
|                                            |             | $T_J = 125\text{ °C}$                           |                                      | 1      |       |
| Maximum gate current required to trigger   | $I_{GT}$    | $T_J = -40\text{ °C}$                           |                                      | 90     | mA    |
|                                            |             | $T_J = 25\text{ °C}$                            |                                      | 60     |       |
|                                            |             | $T_J = 125\text{ °C}$                           |                                      | 35     |       |
| Maximum gate voltage that will not trigger | $V_{GD}$    | $T_J = 125\text{ °C}$ , rated $V_{DRM}$ applied |                                      | 0.2    | V     |
| Maximum gate current that will not trigger | $I_{GD}$    |                                                 |                                      | 2      | mA    |

| <b>THERMAL AND MECHANICAL SPECIFICATIONS</b>              |                |                                      |  |             |       |
|-----------------------------------------------------------|----------------|--------------------------------------|--|-------------|-------|
| PARAMETER                                                 | SYMBOL         | TEST CONDITIONS                      |  | VALUES      | UNITS |
| Maximum junction operating and storage temperature range  | $T_J, T_{Stg}$ |                                      |  | - 40 to 125 | °C    |
| Maximum thermal resistance, junction to case per junction | $R_{thJC}$     | DC operation                         |  | 1.05        | K/W   |
| Maximum thermal resistance, case to heatsink              | $R_{thCS}$     | Mounting surface, smooth and greased |  | 0.10        |       |
| Mounting torque, base to heatsink <sup>(1)</sup>          |                |                                      |  | 4           | Nm    |
| Approximate weight                                        |                |                                      |  | 58          | g     |
|                                                           |                |                                      |  | 2.0         | oz.   |

**Note**

<sup>(1)</sup> 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

| <b>CIRCUIT TYPE AND CODING (1)</b>                      |                                                                                   |                                                                                    |                                                                                     |
|---------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                                                         | <b>CIRCUIT "0"</b>                                                                | <b>CIRCUIT "2"</b>                                                                 | <b>CIRCUIT "3"</b>                                                                  |
| Terminal positions                                      |  |  |  |
| Schematic diagram                                       |  |  |  |
|                                                         | Single phase<br>hybrid bridge<br>common cathode                                   | Single phase<br>hybrid bridge<br>doubler                                           | Single phase<br>all SCR<br>bridge                                                   |
| Basic series                                            | P40.                                                                              | P42.                                                                               | P43.                                                                                |
| With voltage suppression                                | P40.K                                                                             | P42.K                                                                              | P43.K                                                                               |
| With freewheeling diode                                 | P40.W                                                                             | -                                                                                  | -                                                                                   |
| With both voltage suppression<br>and freewheeling diode | P40.KW                                                                            | -                                                                                  | -                                                                                   |

**Note**

(1) To complete code refer to Voltage Ratings table, i.e.: For 600 V P40.W complete code is P402W

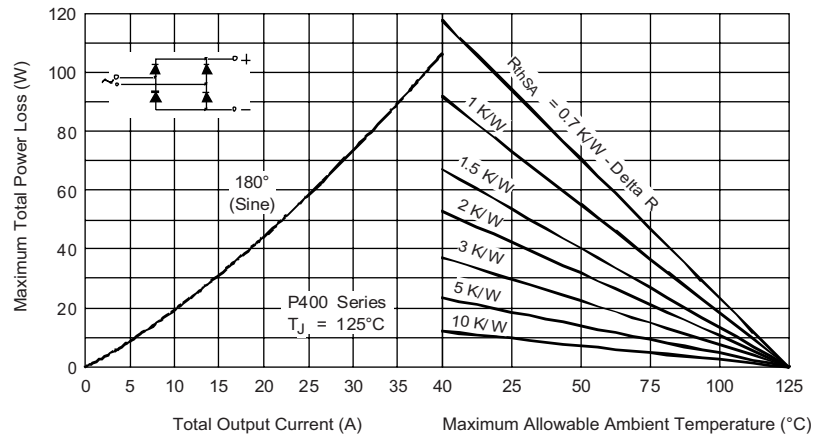


Fig. 1 - Current Ratings Nomogram (1 Module Per Heatsink)

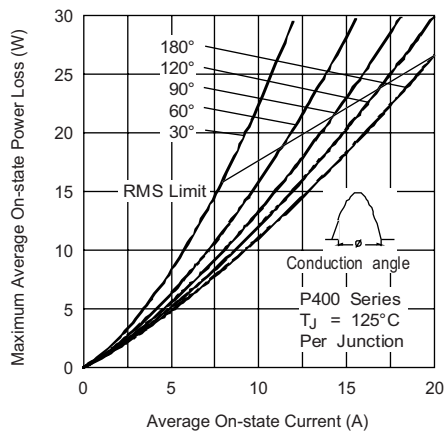


Fig. 2 - On-State Power Loss Characteristics

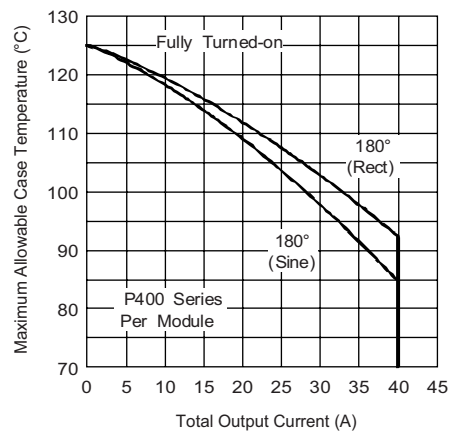


Fig. 4 - Current Ratings Characteristics

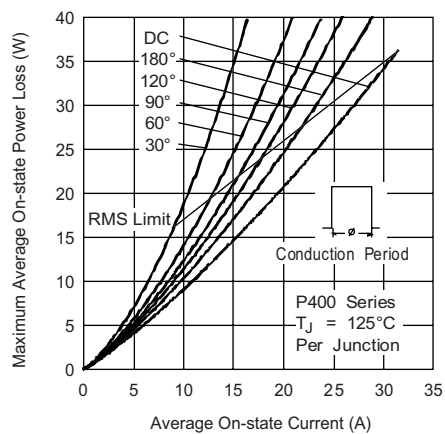


Fig. 3 - On-State Power Loss Characteristics

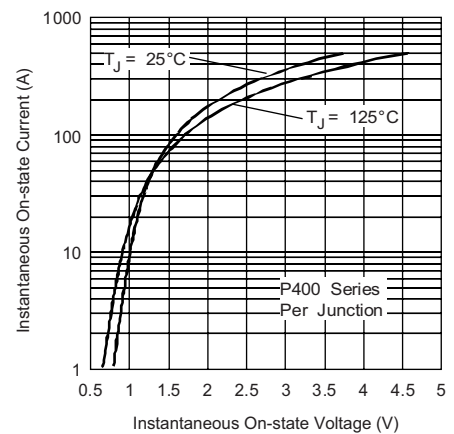


Fig. 5 - On-State Voltage Drop Characteristics

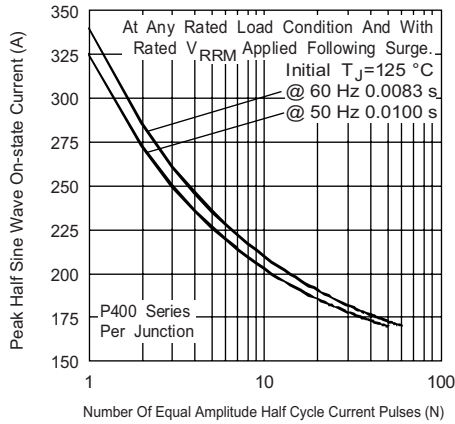


Fig. 6 - Maximum Non-Repetitive Surge Current

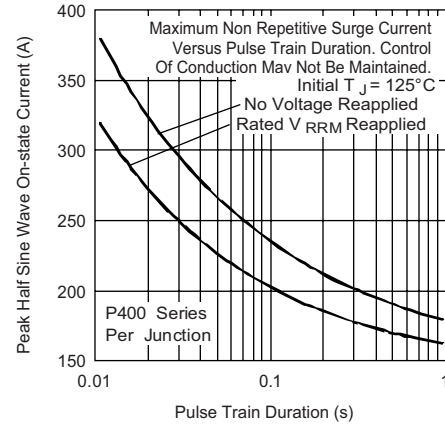


Fig. 7 - Maximum Non-Repetitive Surge Current

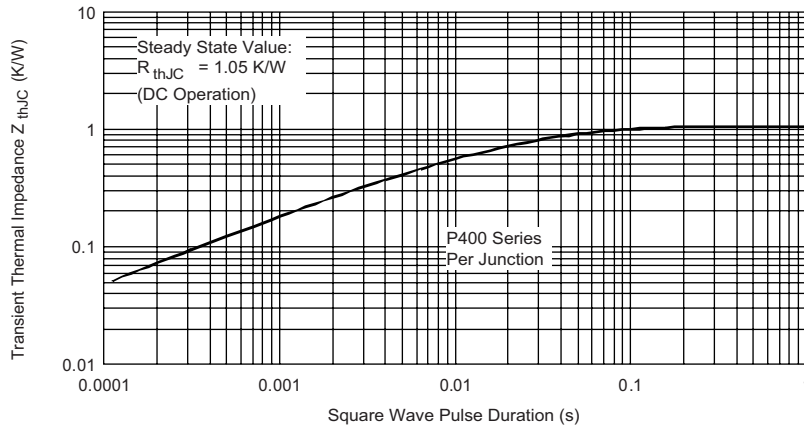


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristics

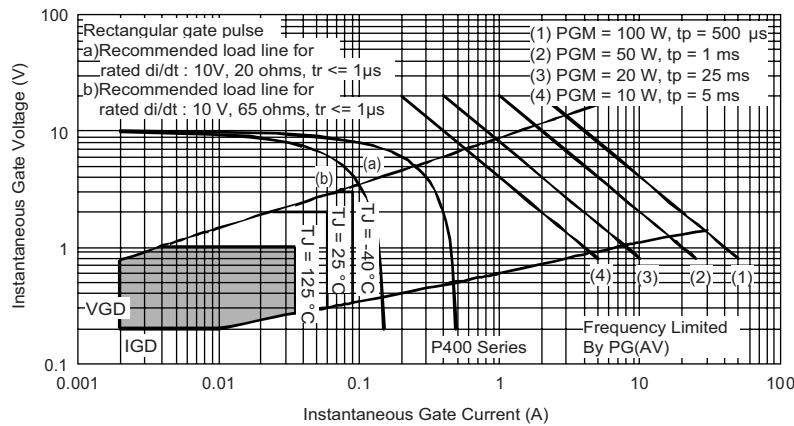


Fig. 9 - Gate Characteristics

### LINKS TO RELATED DOCUMENTS

Dimensions

<http://www.vishay.com/doc?95335>

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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А