



# Ruttonsha International Rectifier Ltd.

## SILICON CONTROLLED RECTIFIERS

### High Power Thyristor Hockey Puk Version A-PUK Series 400PA

Types : 400PA 20 to 400PA 160

#### FEATURES

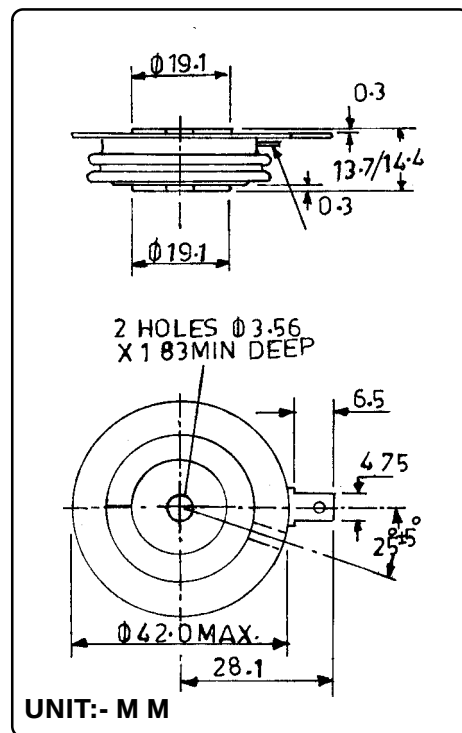
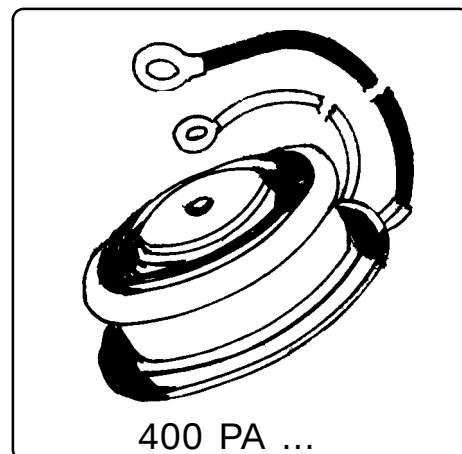
- ❖ Center amplifying gate.
- ❖ International standard case TO-200AB (A-PUK)

#### TYPICAL APPLICATIONS

- ❖ DC motor control (e.g. for machine tools).
- ❖ Controlled rectifiers (e.g. for battery charging, UPS).
- ❖ AC controllers (e.g. for temperature control, lights control).

#### MAJOR RATINGS & CHARACTERISTICS

| Parameters          | 400PA       | Units       |
|---------------------|-------------|-------------|
| $I_{T(AV)}$         | 410         | A           |
| @ $T_{hs}$          | 55          | $^{\circ}C$ |
| $I_{T(RMS)}$        | 780         | A           |
| @ $T_{hs}$          | 25          | $^{\circ}C$ |
| $I_{TSM}$ @ 50 Hz   | 5700        | A           |
| $I^2t$ @ 50 Hz      | 163         | KA $^2$ s   |
| $V_{DRM} / V_{RRM}$ | 200 to 1600 | V           |
| $t_q$ typical       | 100         | $\mu s$     |
| $T_J$               | -40 to 125  | $^{\circ}C$ |



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## 400PA

### ELECTRICAL SPECIFICATION VOLTAGE RATINGS

| Type Number | Voltage Code | $V_{RRM} / V_{DRM}$ , max. repetitive peak and off-state voltage<br>V | $V_{RSM}$ , max. non-repetitive peak voltage<br>V | $I_{DRM} / I_{RRM}$ max.<br>@ 125°C<br>mA |
|-------------|--------------|-----------------------------------------------------------------------|---------------------------------------------------|-------------------------------------------|
| 400PA       | 20           | 200                                                                   | 300                                               | 30                                        |
|             | 40           | 400                                                                   | 500                                               |                                           |
|             | 60           | 600                                                                   | 700                                               |                                           |
|             | 80           | 800                                                                   | 900                                               |                                           |
|             | 100          | 1000                                                                  | 1100                                              |                                           |
|             | 120          | 1200                                                                  | 1300                                              |                                           |
|             | 140          | 1400                                                                  | 1500                                              |                                           |
|             | 160          | 1600                                                                  | 1700                                              |                                           |

### ON-STATE CONDUCTION

|                     | Parameter                                                | 400PA    | Units              | Conditions                                                                                                              |  |  |
|---------------------|----------------------------------------------------------|----------|--------------------|-------------------------------------------------------------------------------------------------------------------------|--|--|
| I <sub>T(AV)</sub>  | Max. average on-state current<br>@ heat sink temperature | 410(165) | A                  | 180° conduction, half sine wave<br>double side (single side) cooled<br>@25°C heat sink temperature (double side cooled) |  |  |
|                     |                                                          | 55(85)   | °C                 |                                                                                                                         |  |  |
| I <sub>T(RMS)</sub> | Max. RMS on-state current                                | 780      | A                  | Sinusodial half wave,<br>Initial T <sub>j</sub> = T <sub>j</sub> max.                                                   |  |  |
| I <sub>TSM</sub>    | Max. peak , one cycle<br>non-repetitive surge current    | 5700     |                    |                                                                                                                         |  |  |
|                     |                                                          | 4800     |                    |                                                                                                                         |  |  |
| I <sup>2</sup> t    | Maximum I <sup>2</sup> t for fusing                      | 163      |                    |                                                                                                                         |  |  |
|                     |                                                          | 115      |                    |                                                                                                                         |  |  |
| I <sup>2</sup> t    | Maximum I <sup>2</sup> t for fusing                      | 1630     | k A <sup>2</sup> s | t = 0.1 to 10ms. No voltage reapplied.                                                                                  |  |  |
| V <sub>T(TO)1</sub> | Low level value of threshold voltage                     | 0.92     | V                  | (16.7% x π x I <sub>F(AV)</sub> < I < π x I <sub>F(AV)</sub> ), T <sub>j</sub> = T <sub>j</sub> max.                    |  |  |
| V <sub>T(TO)2</sub> | High level value of threshold voltage                    | 0.98     |                    | (π x I <sub>F(AV)</sub> < I < 20 x π x I <sub>F(AV)</sub> ), T <sub>j</sub> = T <sub>j</sub> max.                       |  |  |
| r <sub>t1</sub>     | Low level value of on state<br>slope resistance          | 0.88     | mΩ                 | (16.7% x π x I <sub>F(AV)</sub> < I < π x I <sub>F(AV)</sub> ), T <sub>j</sub> = T <sub>j</sub> max.                    |  |  |
| r <sub>t2</sub>     | High level value of on state<br>slope resistance         | 0.81     |                    | (π x I <sub>F(AV)</sub> < I < 20 x π x I <sub>F(AV)</sub> ), T <sub>j</sub> = T <sub>j</sub> max.                       |  |  |
| V <sub>TM</sub>     | Max. on state voltage                                    | 1.69     | V                  | I <sub>pk</sub> = 880A, T <sub>j</sub> = 125°C, t <sub>p</sub> = 10ms sine pulse                                        |  |  |
| I <sub>H</sub>      | Maximum holding current                                  | 300      | mA                 | T <sub>j</sub> = 25°C, anode supply 12V resistive load                                                                  |  |  |
| I <sub>L</sub>      | Latching current                                         | 600      |                    |                                                                                                                         |  |  |

### SWITCHING

|       | Parameter                                                | 400PA | Units | Conditions                                                                                                                        |
|-------|----------------------------------------------------------|-------|-------|-----------------------------------------------------------------------------------------------------------------------------------|
| di/dt | Max. non-repetitive rate of rise<br>of turned-on current | 1000  | A/μs  | Gate drive 20V, 20Ω, $t_r \leq 1 \mu s$<br>$T_J = 125^\circ C$ , anode voltage $\leq 80\% V_{DRM}$                                |
| $t_d$ | Typical delay time                                       | 1.0   | μs    | Gate current 1A, $di_g/dt = 1A/\mu s$<br>$V_d = 0.67\% V_{DRM}$ , $T_J = 25^\circ C$                                              |
| $t_q$ | Typical turn-off time                                    | 100   |       | $I_{TM} = 300A$ , $T_J = 125^\circ C$ , $di/dt = 20A/\mu s$ , $V_R = 50V$<br>$dv/dt = 20V/\mu s$ , Gate 0V 100Ω, $t_p = 500\mu s$ |

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## 400PA

### BLOCKING

|                                      | Parameter                                          | 400PA | Units      | Conditions                                                                    |
|--------------------------------------|----------------------------------------------------|-------|------------|-------------------------------------------------------------------------------|
| dv/dt                                | Maximum critical rate of rise of off-state voltage | 500   | V/ $\mu$ s | $T_J = 125^\circ\text{C}$ , linear to 80% rated $V_{\text{DRM}}$              |
| $I_{\text{RRM}}$<br>$I_{\text{DRM}}$ | Max. peak reverse and off-state leakage current    | 30    | mA         | $T_J = 125^\circ\text{C}$ , rated $V_{\text{DRM}}$ / $V_{\text{RRM}}$ applied |

### TRIGGERING

|                    | Parameter                           | 400PA             |                 | Units | Conditions                                                                                                                                                                                                    |
|--------------------|-------------------------------------|-------------------|-----------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P <sub>GM</sub>    | Maximum peak gate power             | 10.0              |                 | W     | T <sub>J</sub> = 125°C, t <sub>p</sub> ≤ 5ms                                                                                                                                                                  |
| P <sub>G(AV)</sub> | Maximum average gate power          | 2.0               |                 |       | T <sub>J</sub> = 125°C, f= 50Hz, d% = 50                                                                                                                                                                      |
| I <sub>GM</sub>    | Max. peak positive gate current     | 3.0               |                 | A     | T <sub>J</sub> = 125°C, t <sub>p</sub> ≤ 5ms                                                                                                                                                                  |
| +V <sub>GM</sub>   | Max. peak positive gate voltage     | 20                |                 | V     | T <sub>J</sub> = 125°C, t <sub>p</sub> ≤ 5ms                                                                                                                                                                  |
| -V <sub>GM</sub>   | Max. peak negative gate voltage     | 5.0               |                 |       |                                                                                                                                                                                                               |
| I <sub>GT</sub>    | DC gate current required to trigger | TYP.              | MAX.            | mA    | T <sub>J</sub> = -40°C<br>T <sub>J</sub> = 25°C<br>T <sub>J</sub> = 125°C<br><br>Max. required gate trigger/current / voltage are the lowest value which will trigger all units 12V anode-to-cathode applied. |
|                    |                                     | 180<br>90<br>40   | --<br>150<br>-- |       |                                                                                                                                                                                                               |
|                    |                                     |                   |                 |       |                                                                                                                                                                                                               |
| V <sub>GT</sub>    | DC gate voltage required to trigger | 2.9<br>1.8<br>1.2 | --<br>3.0<br>-- | V     | T <sub>J</sub> = -40°C<br>T <sub>J</sub> = 25°C<br>T <sub>J</sub> = 125°C                                                                                                                                     |
|                    |                                     |                   |                 |       |                                                                                                                                                                                                               |
|                    |                                     |                   |                 |       |                                                                                                                                                                                                               |
| I <sub>GD</sub>    | DC gate current not to trigger      | 10                |                 | mA    | T <sub>J</sub> = 125°C<br><br>Max. gate current / voltage not to trigger is the max. value which will not trigger any unit with rated V <sub>DRM</sub> anode-to-cathode applied.                              |
| V <sub>GD</sub>    | DC gate voltage not to trigger      | 0.25              |                 | V     |                                                                                                                                                                                                               |

Max. required gate trigger/current / voltage are the lowest value which will trigger all units 12V anode-to-cathode applied.

Max. gate current / voltage not to trigger is the max. value which will not trigger any unit with rated  $V_{\text{DRM}}$  anode-to-cathode applied.

### THERMAL AND MECHANICAL SPECIFICATION

|                     | Parameter                                      | 400PA              | Units            | Conditions                      |
|---------------------|------------------------------------------------|--------------------|------------------|---------------------------------|
| $T_J$               | Max. operating temperature range               | -40 to 125         | $^\circ\text{C}$ |                                 |
| $T_{\text{stg}}$    | Max. storage temperature range                 | -40 to 150         |                  |                                 |
| $R_{\text{thJ-hs}}$ | Max. thermal resistance, junction to heat sink | 0.17               | K/W              | DC operation single side cooled |
|                     |                                                | 0.08               |                  | DC operation double side cooled |
| F                   | Mounting force, $\pm 10\%$                     | 4900<br>(500)      | N<br>(kg)        |                                 |
| wt                  | Approximate weight                             | 50                 | g                |                                 |
|                     | Case style                                     | To - 200AB (A-PUK) |                  | See outline                     |

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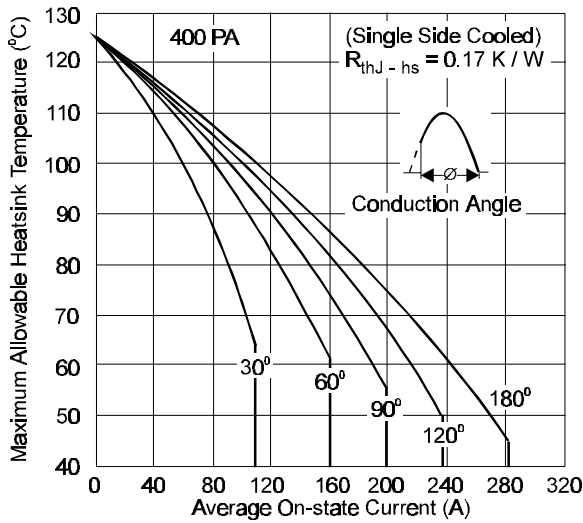


Fig. 1 - Current Ratings Characteristics

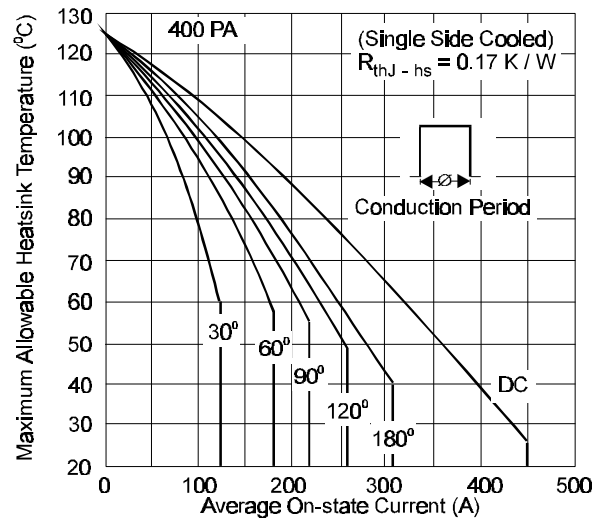


Fig. 2 - Current Ratings Characteristics

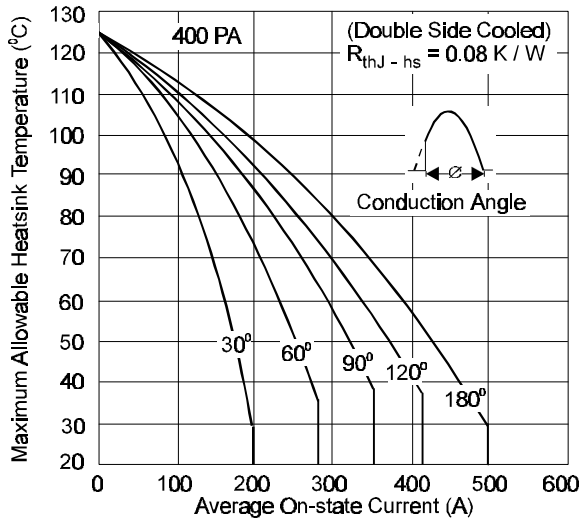


Fig. 3 - Current Ratings Characteristics

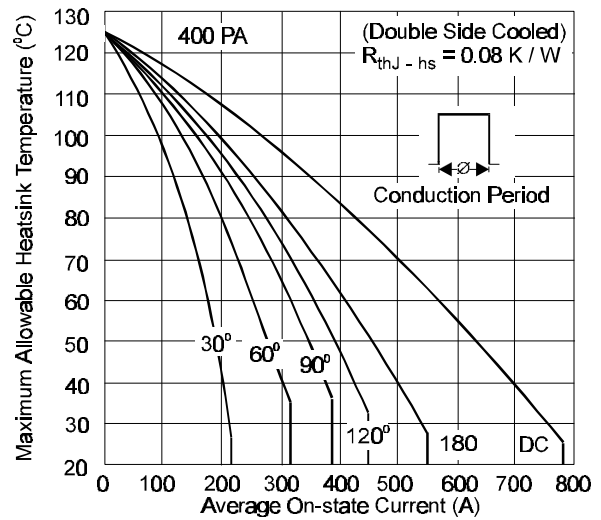


Fig. 4 - Current Ratings Characteristics

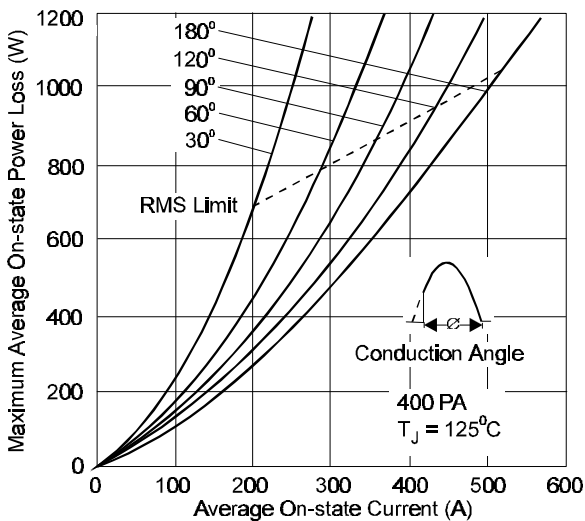


Fig. 5 - On-state Power Loss Characteristics

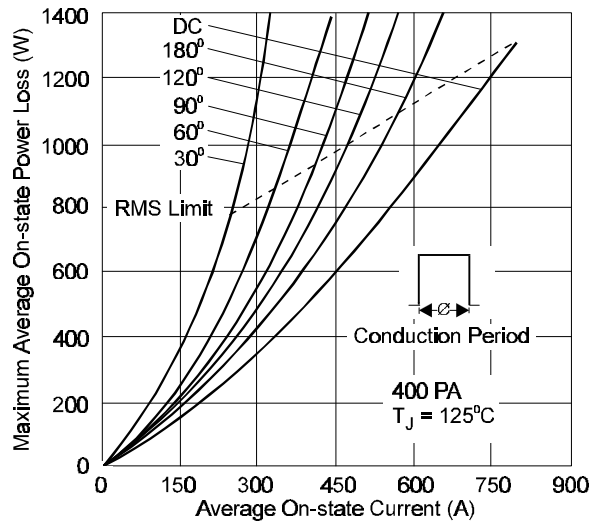


Fig. 6 - On-state Power Loss Characteristics

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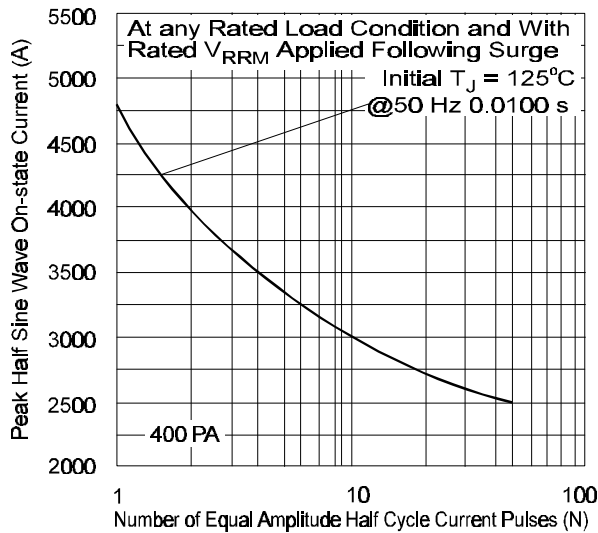


Fig. 7 - Maximum Non-Repetitive Surge Current

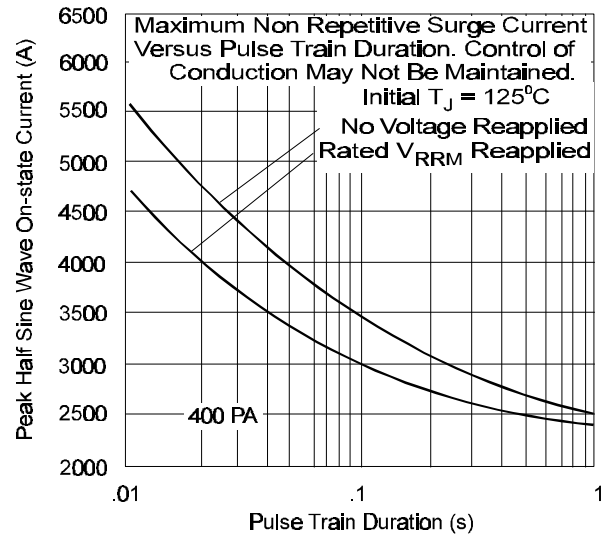


Fig. 8 - Maximum Non-Repetitive Surge Current

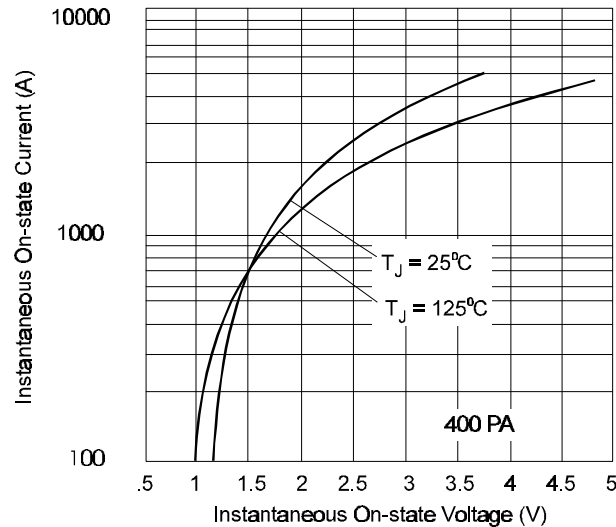


Fig. 9 - On-state Voltage Drop Characteristics

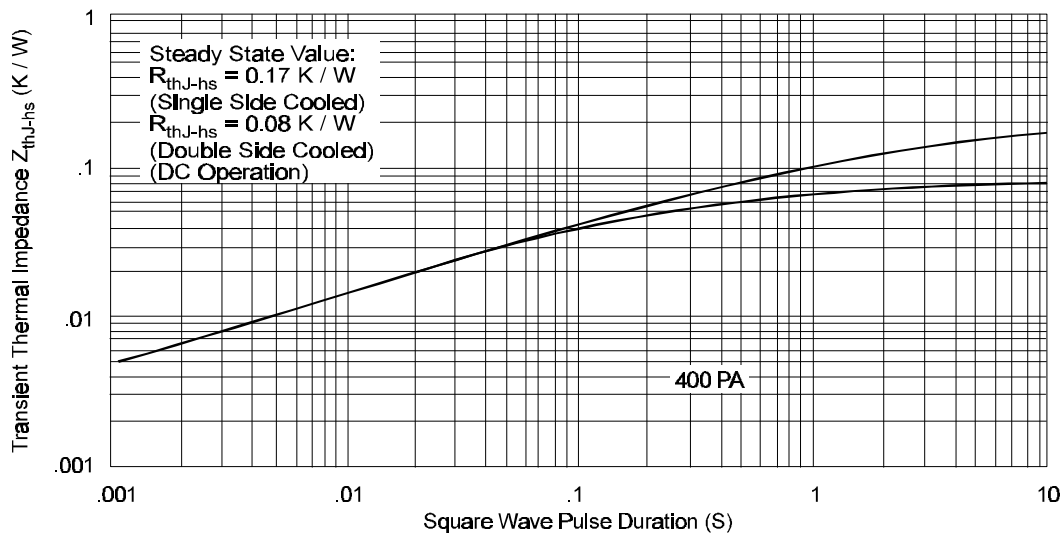


Fig. 10 - Thermal Impedance  $Z_{thJ-hs}$  Characteristics

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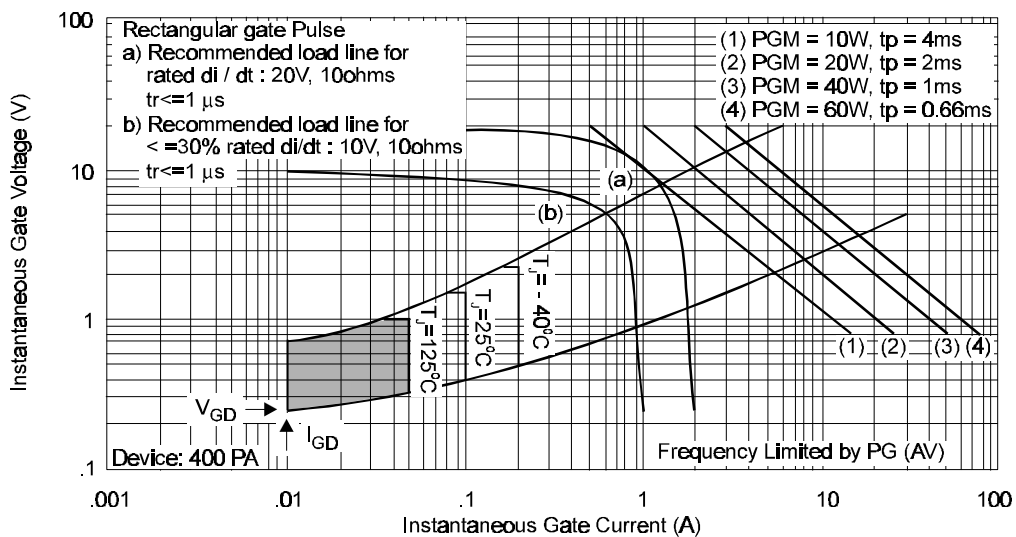


Fig.11 - Gate Characteristics